www.zcyphygeodesy.com

The basic principles, main methods and all the formulas in physical geodesy and Earth gravity field have been realized completely in PAGravf4.5 to popularize higher education.

Program Examples for Precise Approach of Earth Gravity Field and Geoid

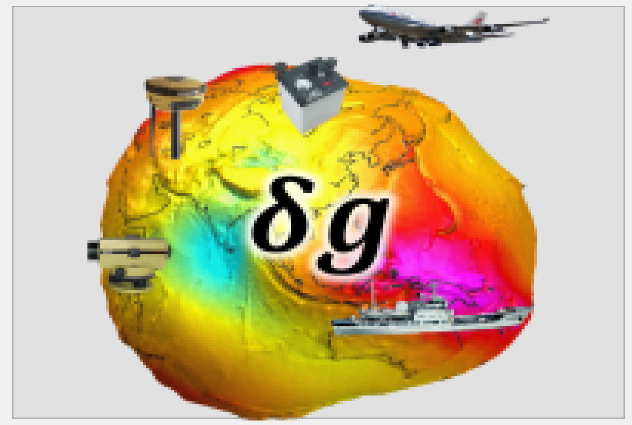
- Cross aliasing of heterogeneous observations in land-sea-space
- Various terrain effects on all-element gravity field in whole space
- Loop closed analytical operations on outer gravity field elements
- All-element modeling on Earth gravity field in whole outer space
- Index measurement of observation errors and computation control
- Gravity prospecting modelling from heterogeneous observations

Classroom Teaching Self-Exercise Science Research Engineer Computing

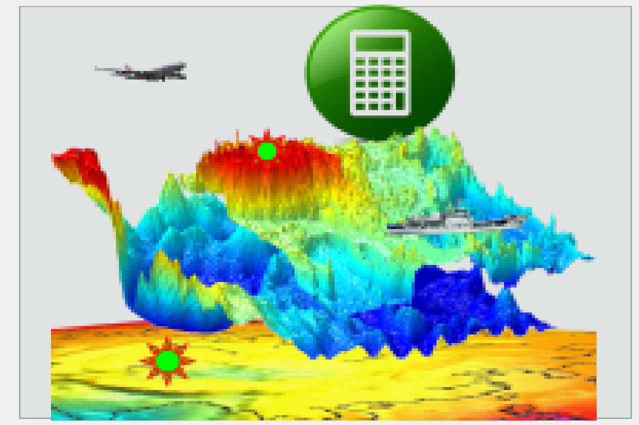
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China

Precise Approach for Earth Gravity field and Geoid PAGravf4.5

Summary, parameter settings and visualization for PAGravf4.5



Data analysis and preprocessing calculation of Earth gravity field



Computation of various terrain effects on various field elements outside geoid

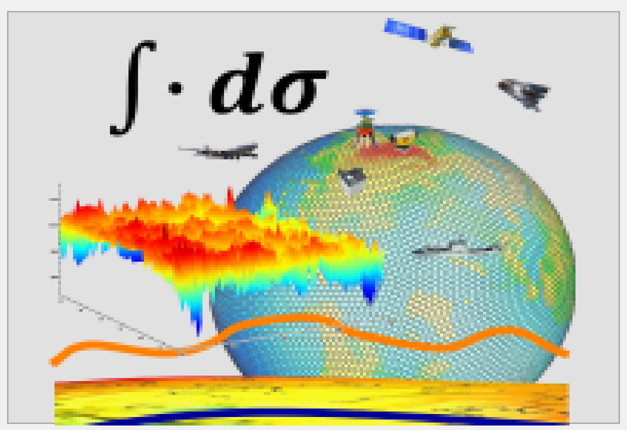
☆ The basic principles, main methods and all the formulas in physical geodesy and Earth gravity field have been realized completely in PAGravf4.5 to imporve high education environment.
☆ Many long-term puzzles such as various terrain effects on various observations, all-element analytical modelling on gravity field, fine gravity prospecting modelling from heterogeneous observations, external accuracy index measurement and computational performance control have been effectively solved to strengthen the application capacity of Earth gravity field.

PAGravf4.5 scientific computation programs organization structure

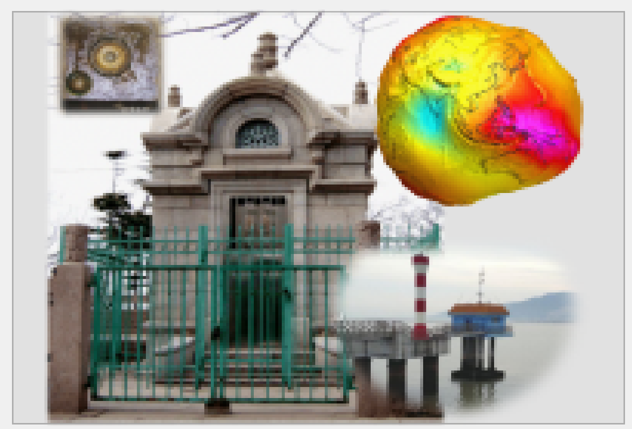
www.zcyphygeodesy.com/en/

☆ PAGravf4.5 is suitable for senior under-graduates, graduate students, scientific researchers, and engineer technicians in geodesy and geophysics, geology and geoscience, geomatics and geographic information, seismic and geodynamics.
☆ There are the example files saved in the folder C:\PAGravf4.5_win64en\examples for each program, which includes the operation process file process.txt, some input-output data files and screenshots. It will take about 5 working days to complete all the example exercises. Thereafter, you can use PAGravf4.5 alone.

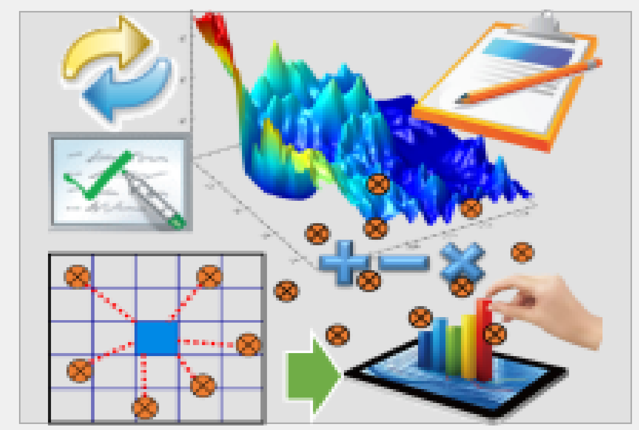
Geodetic data format and geodetic quantity convention in PAGravf4.5



Precise approach and all-element modeling on Earth gravity field



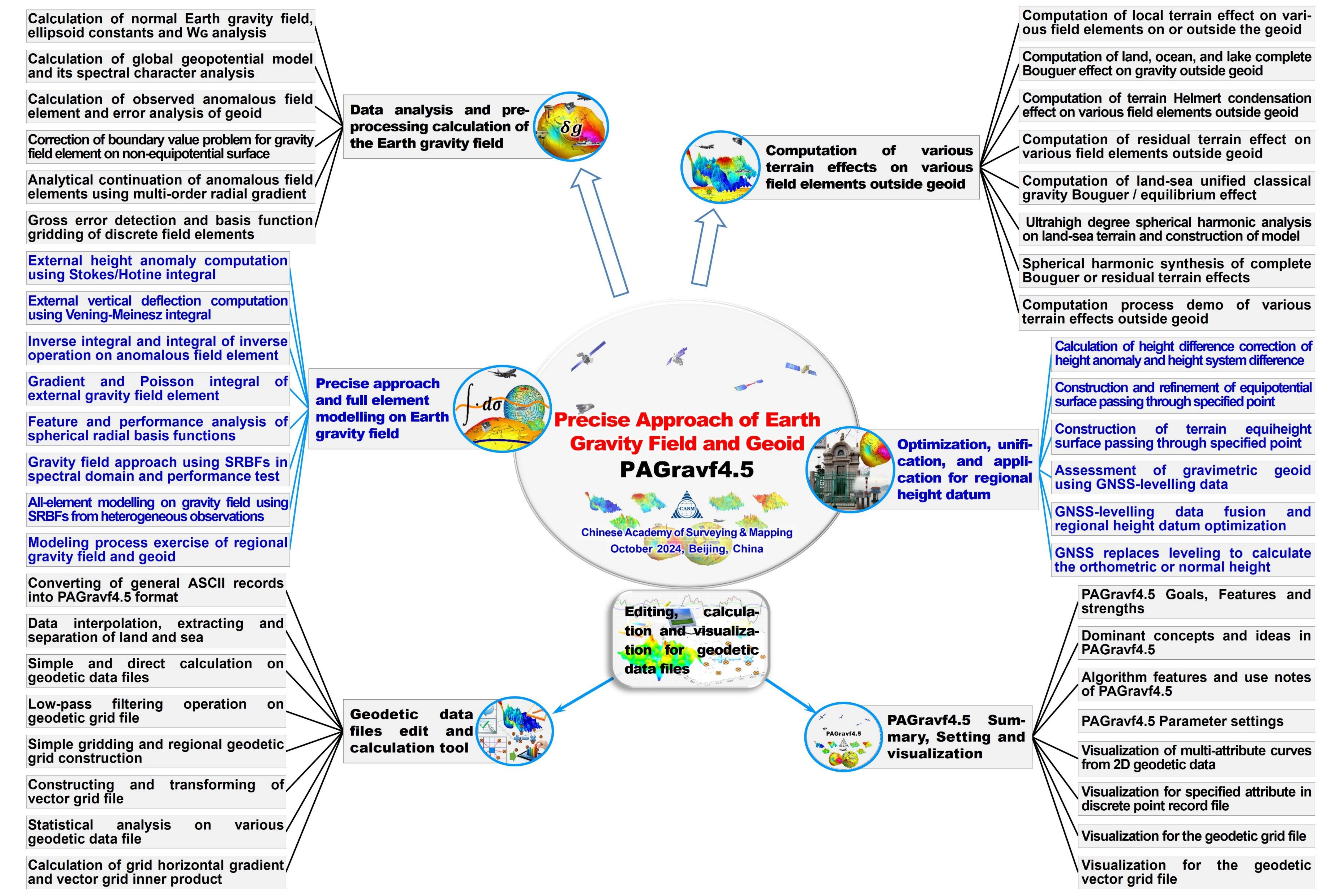
Optimization, unification, and application for regional height datum



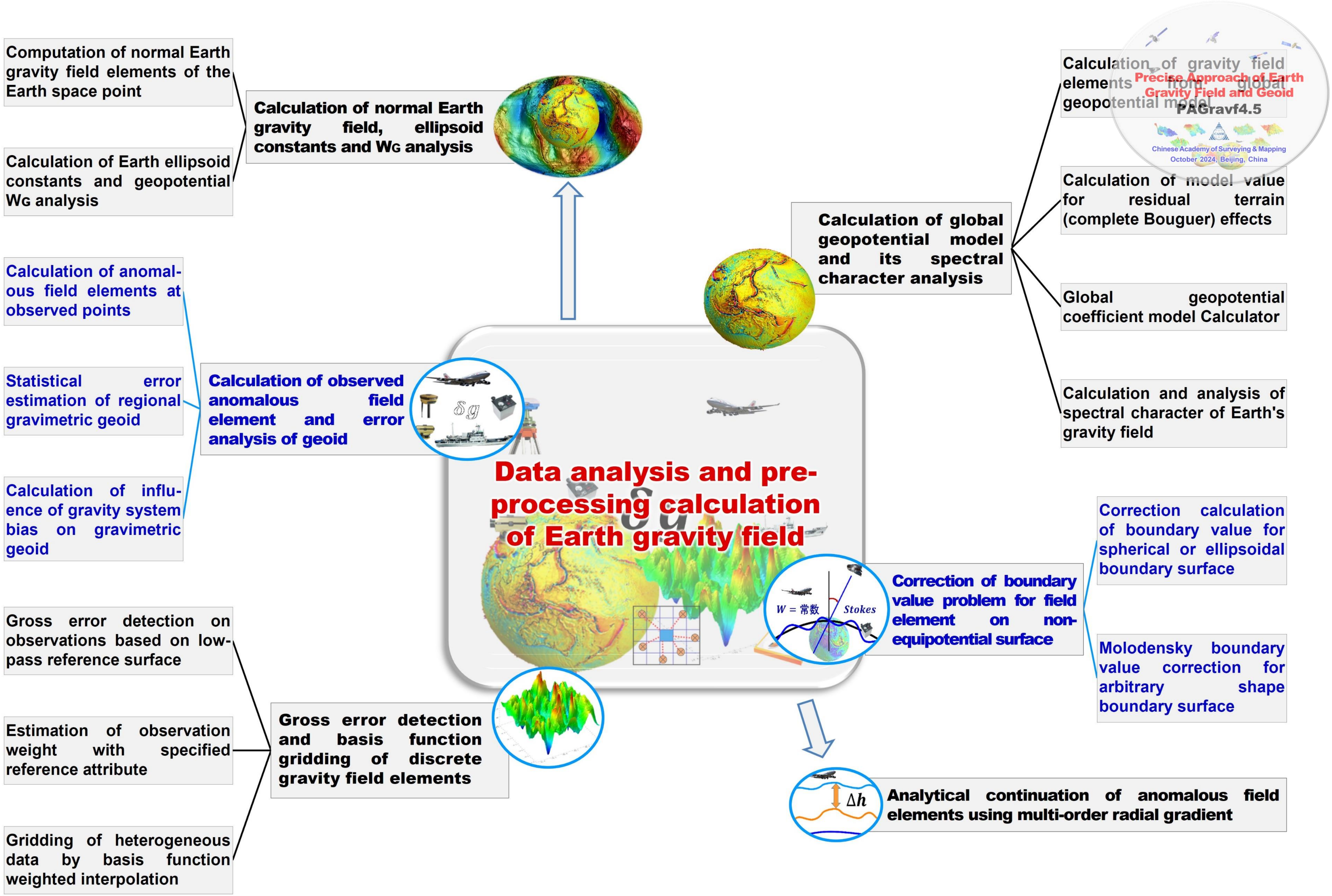
Editing and calculation tools for geodetic data files

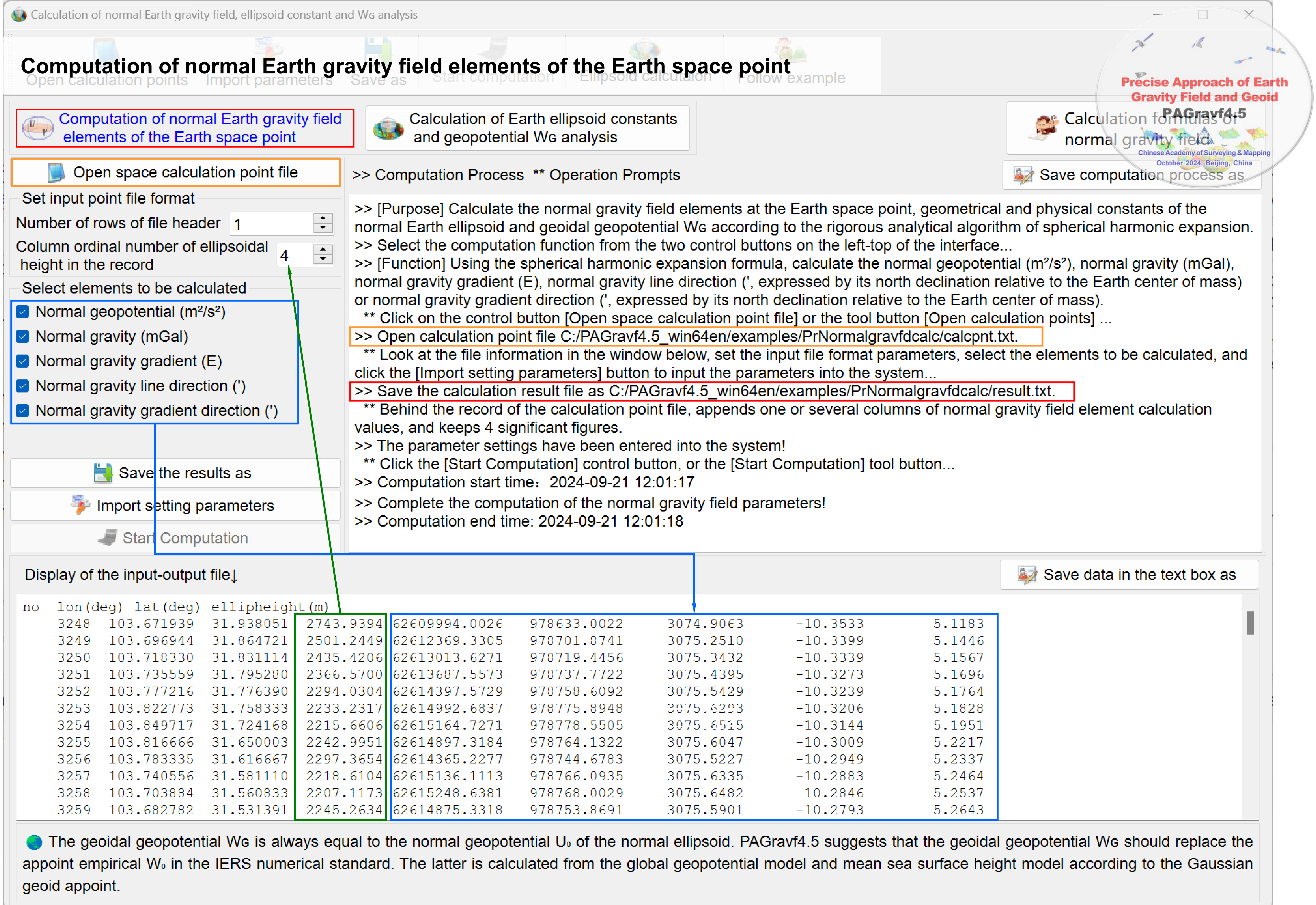
Classroom Teaching, Self-Exercise, Science Research and Engineer Computing

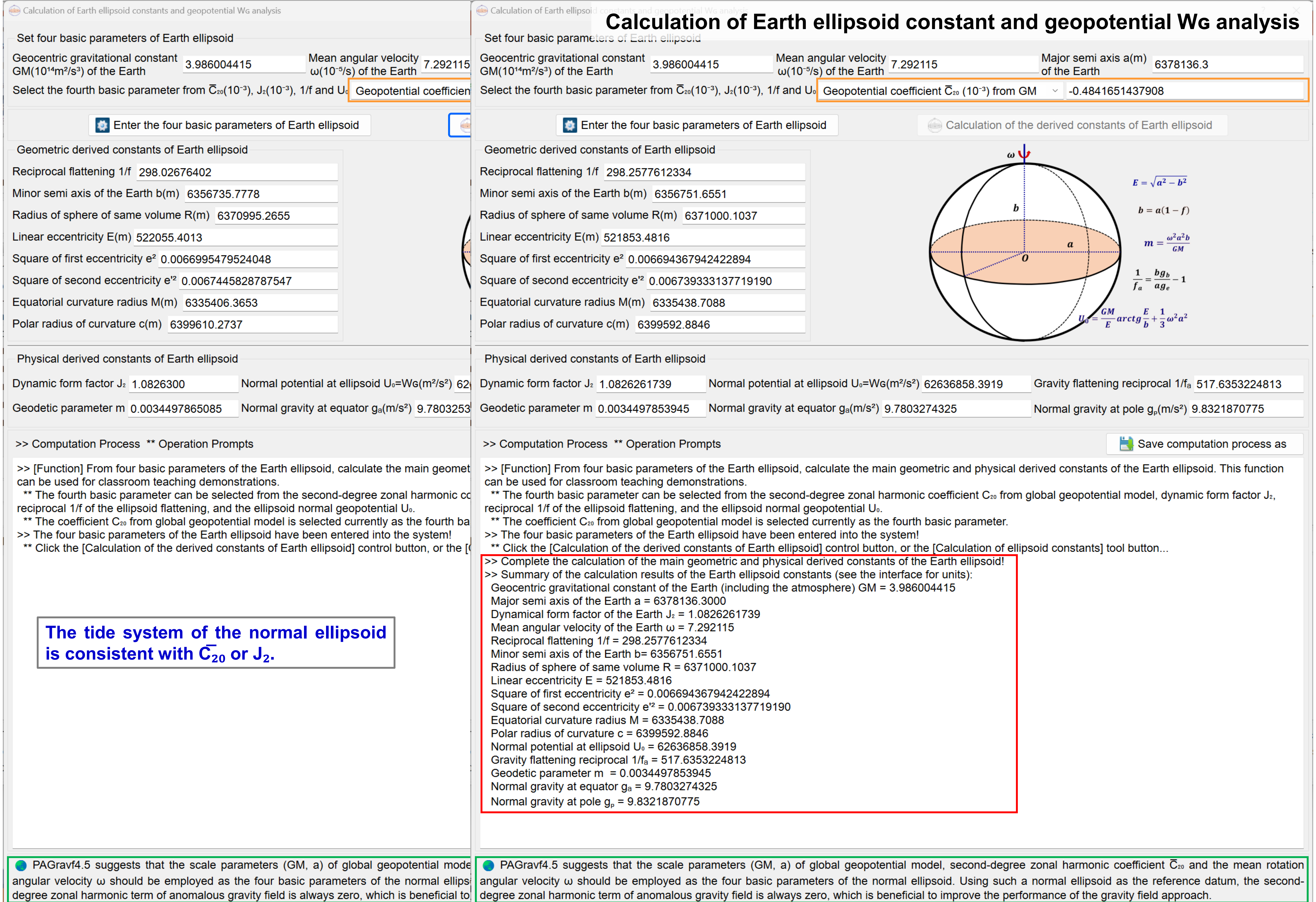
- **Cross aliasing of heterogeneous observations in land-sea-space**
- **Loop closed analytical operations on outer gravity field elements**
- **Index measurement of observation errors and computation control**
- **Various terrain effects on all-element gravity field in whole space**
- **All-element modeling on Earth gravity field in whole outer space**
- **Gravity prospecting modelling from heterogeneous observations**

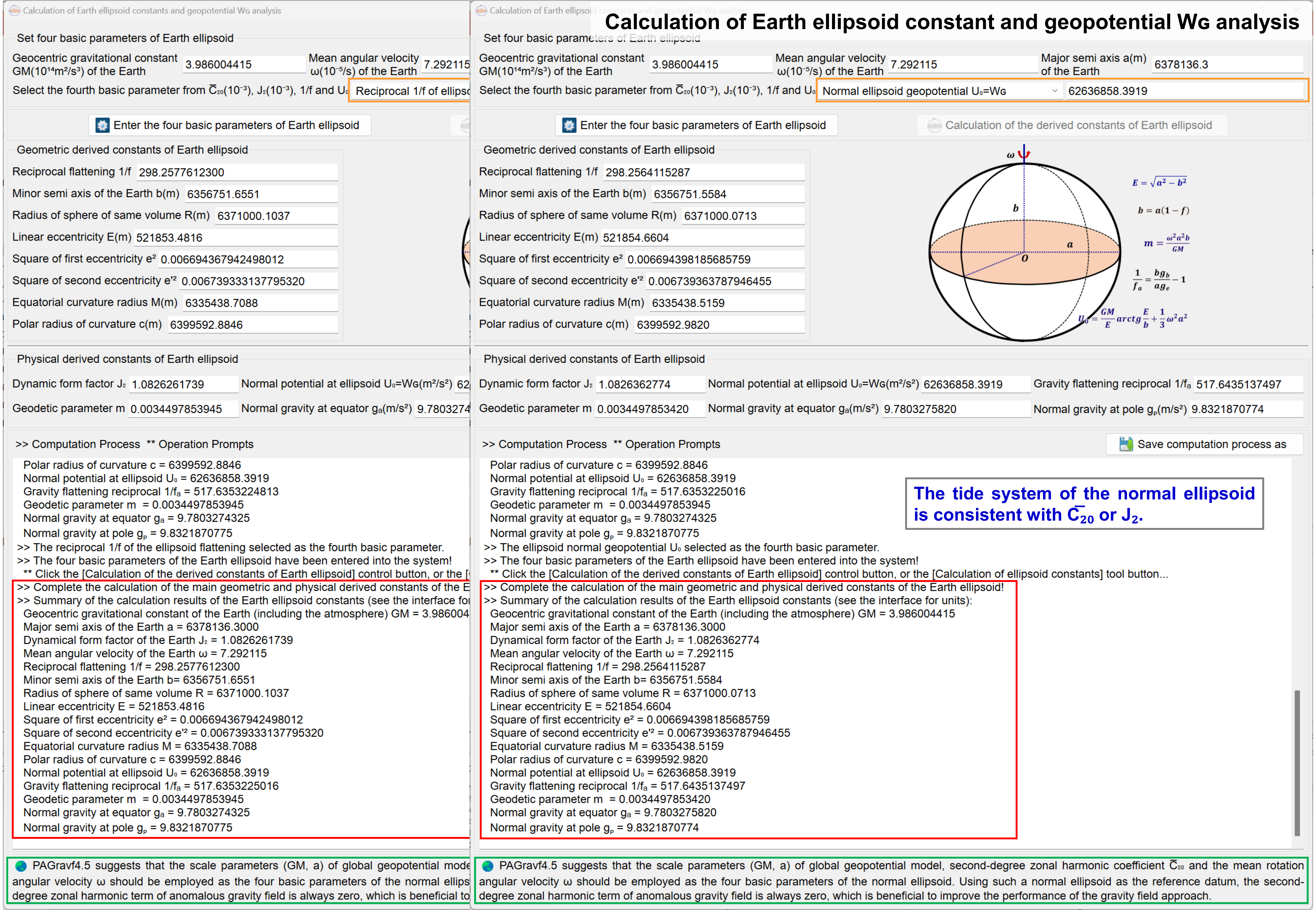


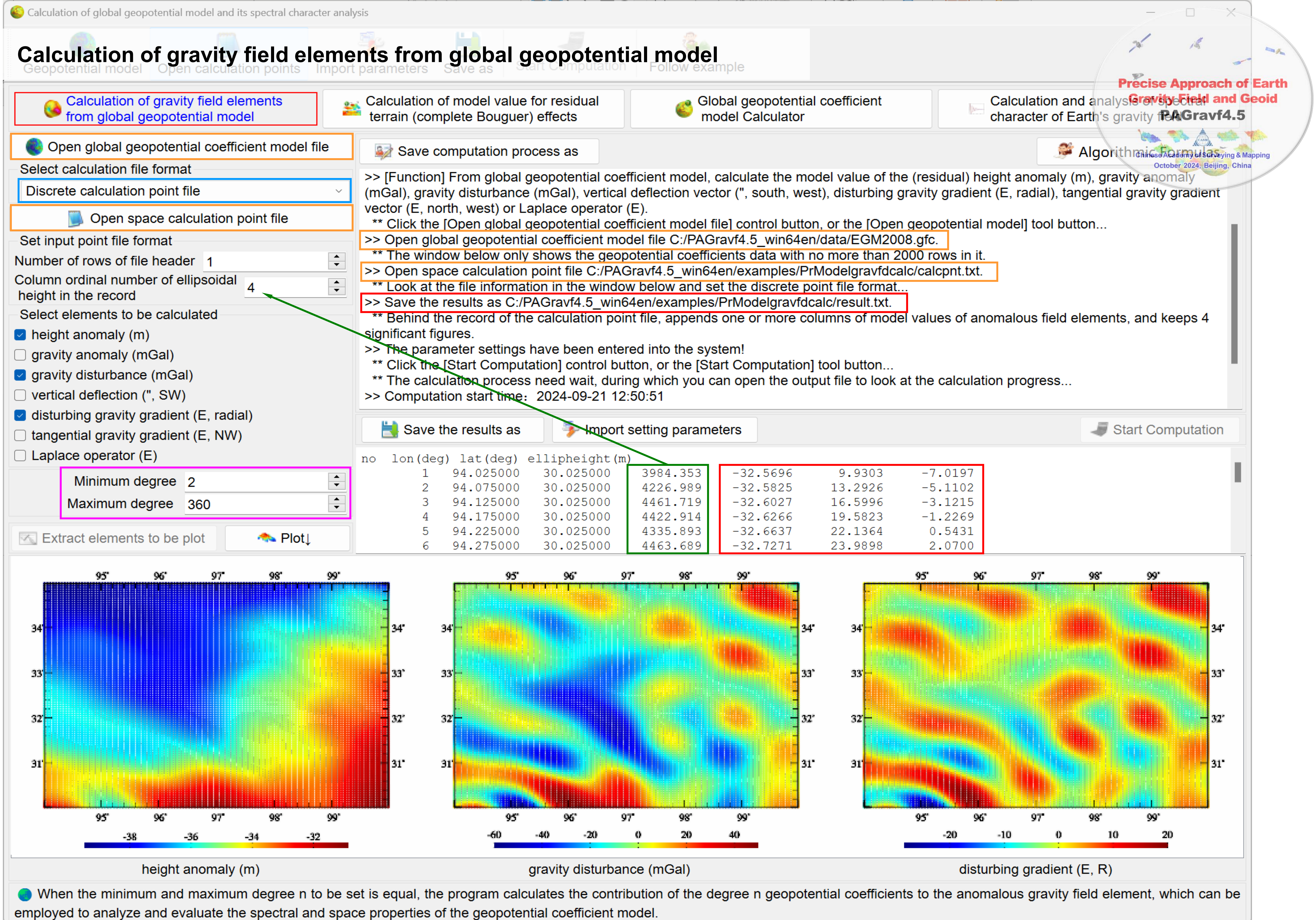
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
CASM
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Data analysis and pre-processing calculation of the Earth gravity field
Calculation of normal Earth gravity field, ellipsoid constants and Wg analysis
Calculation of global geopotential model and its spectral character analysis
Calculation of observed anomalous field element and error analysis of geoid
Correction of boundary value problem for gravity field element on non-equipotential surface
Analytical continuation of anomalous field elements using multi-order radial gradient
Gross error detection and basis function gridding of discrete field elements
Computation of various terrain effects on various field elements outside geoid
Computation of local terrain effect on various field elements on or outside the geoid
Computation of land, ocean, and lake complete Bouguer effect on gravity outside geoid
Computation of terrain Helmert condensation effect on various field elements outside geoid
Computation of residual terrain effect on various field elements outside geoid
Computation of land-sea unified classical gravity Bouguer / equilibrium effect
Ultrahigh degree spherical harmonic analysis on land-sea terrain and construction of model
Spherical harmonic synthesis of complete Bouguer or residual terrain effects
Computation process demo of various terrain effects outside geoid
Precise approach and full element modelling on Earth gravity field
External height anomaly computation using Stokes/Hotine integral
External vertical deflection computation using Vening-Meinesz integral
Inverse integral and integral of inverse operation on anomalous field element
Gradient and Poisson integral of external gravity field element
Feature and performance analysis of spherical radial basis functions
Gravity field approach using SRBFs in spectral domain and performance test
All-element modelling on gravity field using SRBFs from heterogeneous observations
Modeling process exercise of regional gravity field and geoid
Optimization, unification, and application for regional height datum
Calculation of height difference correction of height anomaly and height system difference
Construction and refinement of equipotential surface passing through specified point
Construction of terrain equiheight surface passing through specified point
Assessment of gravimetric geoid using GNSS-levelling data
GNSS-levelling data fusion and regional height datum optimization
GNSS replaces leveling to calculate the orthometric or normal height
Editing, calculation and visualization for geodetic data files
Geodetic data files edit and calculation tool
Converting of general ASCII records into PAGravf4.5 format
Data interpolation, extracting and separation of land and sea
Simple and direct calculation on geodetic data files
Low-pass filtering operation on geodetic grid file
Simple gridding and regional geodetic grid construction
Constructing and transforming of vector grid file
Statistical analysis on various geodetic data file
Calculation of grid horizontal gradient and vector grid inner product
PAGravf4.5 Summary, Setting and visualization
PAGravf4.5 Goals, Features and strengths
Dominant concepts and ideas in PAGravf4.5
Algorithm features and use notes of PAGravf4.5
PAGravf4.5 Parameter settings
Visualization of multi-attribute curves from 2D geodetic data
Visualization for specified attribute in discrete point record file
Visualization for the geodetic grid file
Visualization for the geodetic vector grid file

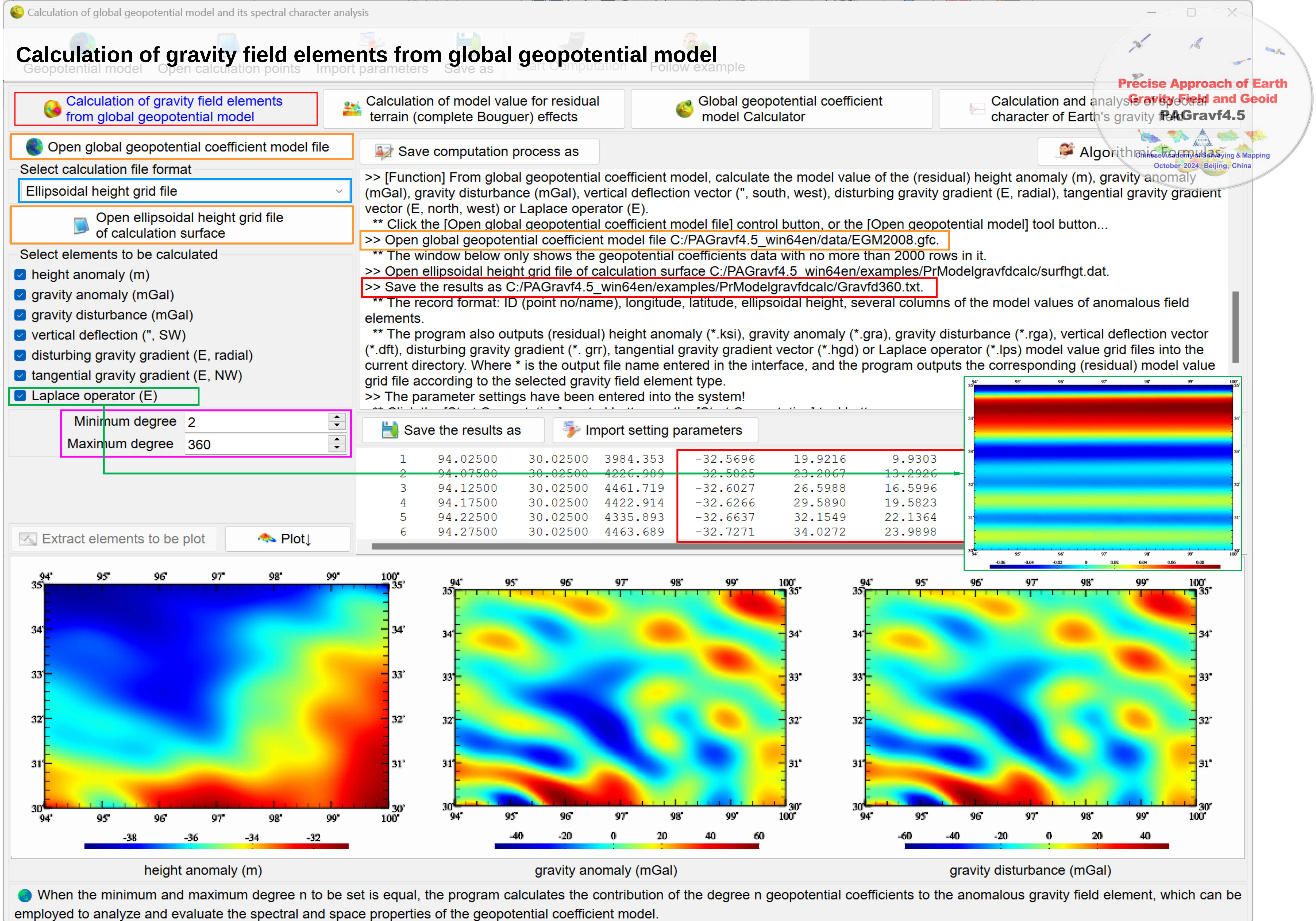

Data analysis and pre-processing calculation of Earth gravity field
Computation of normal Earth gravity field elements of the Earth space point
Calculation of Earth ellipsoid constants and geopotential WG analysis
Calculation of normal Earth gravity field, ellipsoid constants and WG analysis
Calculation of anomalous field elements at observed points
Statistical error estimation of regional gravimetric geoid
Calculation of influence of gravity system bias on gravimetric geoid
Calculation of observed anomalous field element and error analysis of geoid
δg
Gross error detection on observations based on low-pass reference surface
Estimation of observation weight with specified reference attribute
Gridding of heterogeneous data by basis function weighted interpolation
Gross error detection and basis function gridding of discrete gravity field elements
Calculation of global geopotential model and its spectral character analysis
Calculation of gravity field elements from global geopotential model
Calculation of model value for residual terrain (complete Bouguer) effects
Global geopotential coefficient model Calculator
Calculation and analysis of spectral character of Earth's gravity field
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Correction calculation of boundary value for spherical or ellipsoidal boundary surface
Molodensky boundary value correction for arbitrary shape boundary surface
W = 常数
Stokes
Correction of boundary value problem for field element on non-equipotential surface
Δh
Analytical continuation of anomalous field elements using multi-order radial gradient


Calculation of normal Earth gravity field, ellipsoid constant and WG analysis
Computation of normal Earth gravity field elements of the Earth space point
Open calculation points
Import parameters
Save as
Start computation
Ellipsoid calculation
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Computation of normal Earth gravity field elements of the Earth space point
Calculation of Earth ellipsoid constants and geopotential WG analysis
Calculation formulas of normal gravity field
Open space calculation point file
>> Computation Process ** Operation Prompts
Save computation process as
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
Select elements to be calculated
Normal geopotential (m²/s²)
Normal gravity (mGal)
Normal gravity gradient (E)
Normal gravity line direction (')
Normal gravity gradient direction (')
Save the results as
Import setting parameters
Start Computation
>> [Purpose] Calculate the normal gravity field elements at the Earth space point, geometrical and physical constants of the normal Earth ellipsoid and geoidal geopotential WG according to the rigorous analytical algorithm of spherical harmonic expansion.
>> Select the computation function from the two control buttons on the left-top of the interface...
>> [Function] Using the spherical harmonic expansion formula, calculate the normal geopotential (m²/s²), normal gravity (mGal), normal gravity gradient (E), normal gravity line direction (', expressed by its north declination relative to the Earth center of mass) or normal gravity gradient direction (', expressed by its north declination relative to the Earth center of mass).
** Click on the control button [Open space calculation point file] or the tool button [Open calculation points] ...
>> Open calculation point file C:/PAGravf4.5_win64en/examples/PrNormalgravfdcalc/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters, select the elements to be calculated, and click the [Import setting parameters] button to input the parameters into the system...
>> Save the calculation result file as C:/PAGravf4.5_win64en/examples/PrNormalgravfdcalc/result.txt.
** Behind the record of the calculation point file, appends one or several columns of normal gravity field element calculation values, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-21 12:01:17
>> Complete the computation of the normal gravity field parameters!
>> Computation end time: 2024-09-21 12:01:18
Display of the input-output file↓
Save data in the text box as
no lon(deg) lat(deg) ellipheight(m)
3248 103.671939 31.938051 2743.9394 62609994.0026 978633.0022 3074.9063 -10.3533 5.1183
3249 103.696944 31.864721 2501.2449 62612369.3305 978701.8741 3075.2510 -10.3399 5.1446
3250 103.718330 31.831114 2435.4206 62613013.6271 978719.4456 3075.3432 -10.3339 5.1567
3251 103.735559 31.795280 2366.5700 62613687.5573 978737.7722 3075.4395 -10.3273 5.1696
3252 103.777216 31.776390 2294.0304 62614397.5729 978758.6092 3075.5429 -10.3239 5.1764
3253 103.822773 31.758333 2233.2317 62614992.6837 978775.8948 3075.5293 -10.3206 5.1828
3254 103.849717 31.724168 2215.6606 62615164.7271 978778.5505 3075.6515 -10.3144 5.1951
3255 103.816666 31.650003 2242.9951 62614897.3184 978764.1322 3075.6047 -10.3009 5.2217
3256 103.783335 31.616667 2297.3654 62614365.2277 978744.6783 3075.5227 -10.2949 5.2337
3257 103.740556 31.581110 2218.6104 62615136.1113 978766.0935 3075.6335 -10.2883 5.2464
3258 103.703884 31.560833 2207.1173 62615248.6381 978768.0029 3075.6482 -10.2846 5.2537
3259 103.682782 31.531391 2245.2634 62614875.3318 978753.8691 3075.5901 -10.2793 5.2643
The geoidal geopotential WG is always equal to the normal geopotential U₀ of the normal ellipsoid. PAGravf4.5 suggests that the geoidal geopotential WG should replace the appoint empirical W₀ in the IERS numerical standard. The latter is calculated from the global geopotential model and mean sea surface height model according to the Gaussian geoid appoint.

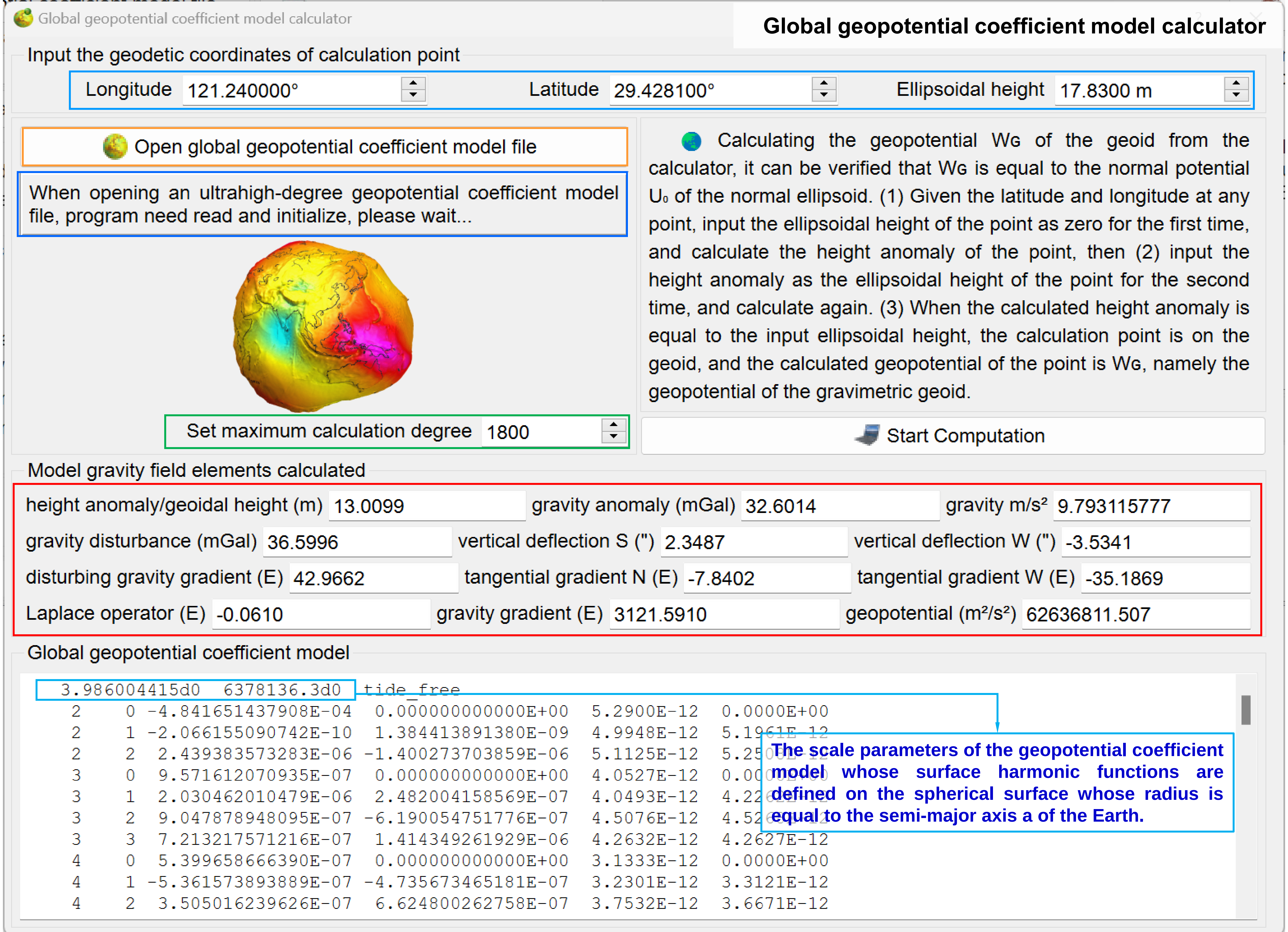

Calculation of Earth ellipsoid constant and geopotential WG analysis
Calculation of Earth ellipsoid constants and geopotential WG analysis
Set four basic parameters of Earth ellipsoid
Geocentric gravitational constant GM($10^{14}m^2/s^2$) of the Earth 3.986004415
Mean angular velocity ω(10^{-5}/s) of the Earth 7.292115
Major semi axis a(m) of the Earth 6378136.3
Select the fourth basic parameter from $\bar{C}_{20}(10^{-3})$, $J_2(10^{-3})$, 1/f and U_0
Geopotential coefficient $\bar{C}_{20}$ (10^{-3}) from GM -0.4841651437908
Enter the four basic parameters of Earth ellipsoid
Calculation of the derived constants of Earth ellipsoid
Geometric derived constants of Earth ellipsoid
Reciprocal flattening 1/f 298.2577612334
Minor semi axis of the Earth b(m) 6356751.6551
Radius of sphere of same volume R(m) 6371000.1037
Linear eccentricity E(m) 521853.4816
Square of first eccentricity e^2 0.006694367942422894
Square of second eccentricity e'^2 0.006739333137719190
Equatorial curvature radius M(m) 6335438.7088
Polar radius of curvature c(m) 6399592.8846
ω
b
a
O
$E=\sqrt{a^2-b^2}$
$b=a(1-f)$
$m=\frac{\omega^2 a^2 b}{GM}$
$\frac{1}{f_a}=\frac{bg_b}{ag_e}-1$
$U_0=\frac{GM}{E}arctg\frac{E}{b}+\frac{1}{3}\omega^2a^2$
Physical derived constants of Earth ellipsoid
Dynamic form factor J_2 1.0826261739
Normal potential at ellipsoid $U_0=W_G(m^2/s^2)$ 62636858.3919
Gravity flattening reciprocal $1/f_a$ 517.6353224813
Geodetic parameter m 0.0034497853945
Normal gravity at equator $g_a(m/s^2)$ 9.7803274325
Normal gravity at pole $g_p(m/s^2)$ 9.8321870775
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From four basic parameters of the Earth ellipsoid, calculate the main geometric and physical derived constants of the Earth ellipsoid. This function can be used for classroom teaching demonstrations.
** The fourth basic parameter can be selected from the second-degree zonal harmonic coefficient C_{20} from global geopotential model, dynamic form factor J_2, reciprocal 1/f of the ellipsoid flattening, and the ellipsoid normal geopotential U_0.
** The coefficient C_{20} from global geopotential model is selected currently as the fourth basic parameter.
>> The four basic parameters of the Earth ellipsoid have been entered into the system!
** Click the [Calculation of the derived constants of Earth ellipsoid] control button, or the [Calculation of ellipsoid constants] tool button...
>> Complete the calculation of the main geometric and physical derived constants of the Earth ellipsoid!
>> Summary of the calculation results of the Earth ellipsoid constants (see the interface for units):
Geocentric gravitational constant of the Earth (including the atmosphere) GM = 3.986004415
Major semi axis of the Earth a = 6378136.3000
Dynamical form factor of the Earth J_2 = 1.0826261739
Mean angular velocity of the Earth ω = 7.292115
Reciprocal flattening 1/f = 298.2577612334
Minor semi axis of the Earth b= 6356751.6551
Radius of sphere of same volume R = 6371000.1037
Linear eccentricity E = 521853.4816
Square of first eccentricity e^2 = 0.006694367942422894
Square of second eccentricity e'^2 = 0.006739333137719190
Equatorial curvature radius M = 6335438.7088
Polar radius of curvature c = 6399592.8846
Normal potential at ellipsoid U_0 = 62636858.3919
Gravity flattening reciprocal $1/f_a$ = 517.6353224813
Geodetic parameter m = 0.0034497853945
Normal gravity at equator g_a = 9.7803274325
Normal gravity at pole g_p = 9.8321870775
PAGravf4.5 suggests that the scale parameters (GM, a) of global geopotential model, second-degree zonal harmonic coefficient $\bar{C}_{20}$ and the mean rotation angular velocity ω should be employed as the four basic parameters of the normal ellipsoid. Using such a normal ellipsoid as the reference datum, the second-degree zonal harmonic term of anomalous gravity field is always zero, which is beneficial to improve the performance of the gravity field approach.
Reciprocal flattening 1/f 298.02676402
Minor semi axis of the Earth b(m) 6356735.7778
Radius of sphere of same volume R(m) 6370995.2655
Linear eccentricity E(m) 522055.4013
Square of first eccentricity e^2 0.0066995479524048
Square of second eccentricity e'^2 0.0067445828787547
Equatorial curvature radius M(m) 6335406.3653
Polar radius of curvature c(m) 6399610.2737
Dynamic form factor J_2 1.0826300
Geodetic parameter m 0.0034497865085
The tide system of the normal ellipsoid is consistent with $\bar{C}_{20}$ or J_2.

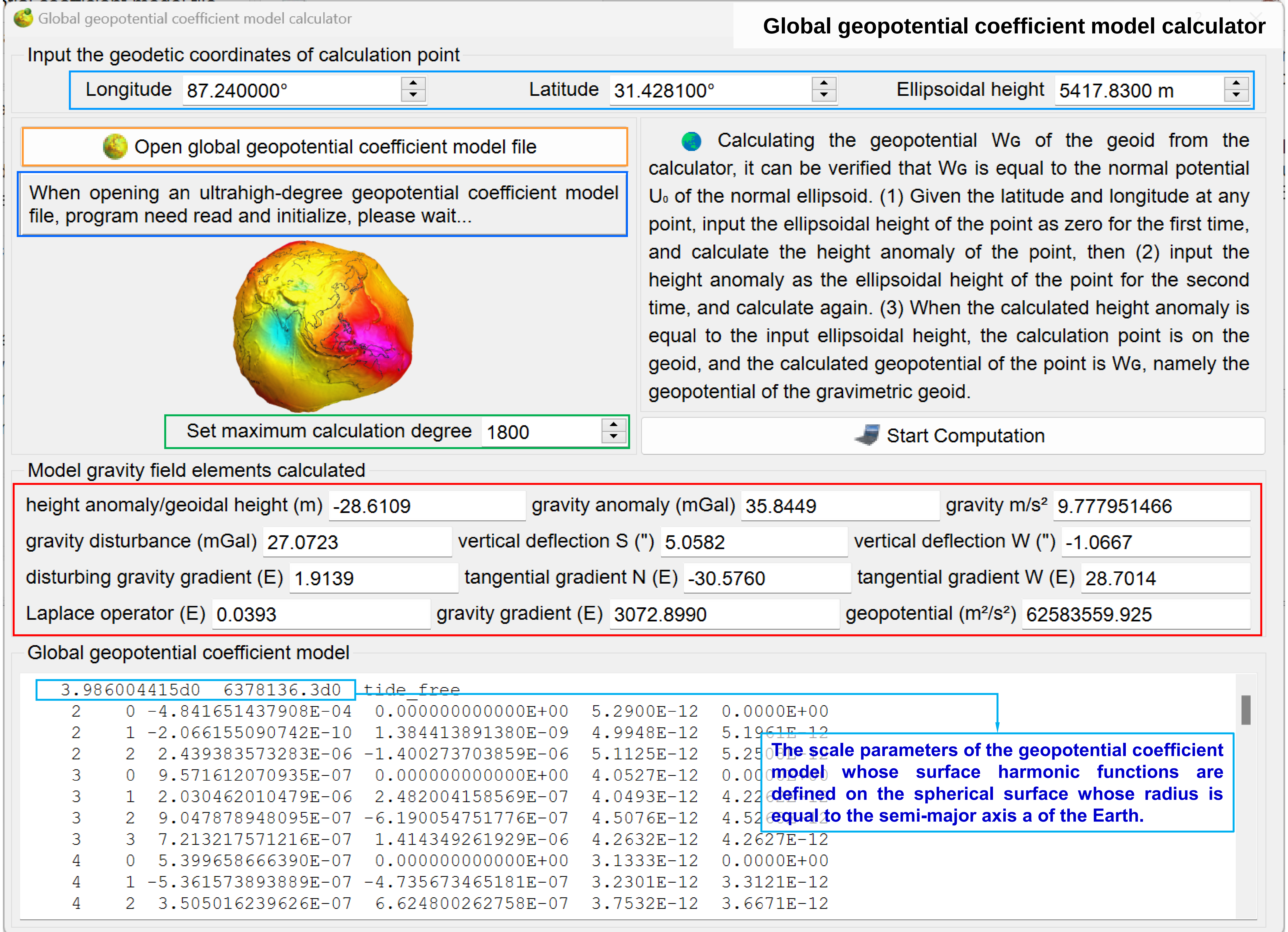

Calculation of Earth ellipsoid constant and geopotential WG analysis
Calculation of Earth ellipsoid constants and geopotential WG analysis
Set four basic parameters of Earth ellipsoid
Geocentric gravitational constant GM(10¹⁴m²/s³) of the Earth
3.986004415
Mean angular velocity ω(10⁻⁵/s) of the Earth
7.292115
Major semi axis a(m) of the Earth
6378136.3
Select the fourth basic parameter from C̄₂₀(10⁻³), J₂(10⁻³), 1/f and U₀
Reciprocal 1/f of ellipsoid
Normal ellipsoid geopotential U₀=WG
62636858.3919
Enter the four basic parameters of Earth ellipsoid
Calculation of the derived constants of Earth ellipsoid
Geometric derived constants of Earth ellipsoid
Reciprocal flattening 1/f 298.2577612300
Minor semi axis of the Earth b(m) 6356751.6551
Radius of sphere of same volume R(m) 6371000.1037
Linear eccentricity E(m) 521853.4816
Square of first eccentricity e² 0.006694367942498012
Square of second eccentricity e'² 0.006739333137795320
Equatorial curvature radius M(m) 6335438.7088
Polar radius of curvature c(m) 6399592.8846
Reciprocal flattening 1/f 298.2564115287
Minor semi axis of the Earth b(m) 6356751.5584
Radius of sphere of same volume R(m) 6371000.0713
Linear eccentricity E(m) 521854.6604
Square of first eccentricity e² 0.006694398185685759
Square of second eccentricity e'² 0.006739363787946455
Equatorial curvature radius M(m) 6335438.5159
Polar radius of curvature c(m) 6399592.9820
$E=\sqrt{a^2-b^2}$
$b=a(1-f)$
$m=\frac{\omega^2a^2b}{GM}$
$\frac{1}{f_a}=\frac{bg_b}{ag_e}-1$
$U_0=\frac{GM}{E}arctg\frac{E}{b}+\frac{1}{3}\omega^2a^2$
Physical derived constants of Earth ellipsoid
Dynamic form factor J₂ 1.0826261739
Normal potential at ellipsoid U₀=WG(m²/s²)
Geodetic parameter m 0.0034497853945
Normal gravity at equator gₐ(m/s²) 9.7803274
Dynamic form factor J₂ 1.0826362774
Normal potential at ellipsoid U₀=WG(m²/s²) 62636858.3919
Gravity flattening reciprocal 1/fₐ 517.6435137497
Geodetic parameter m 0.0034497853420
Normal gravity at equator gₐ(m/s²) 9.7803275820
Normal gravity at pole gₚ(m/s²) 9.8321870774
>> Computation Process ** Operation Prompts
Save computation process as
Polar radius of curvature c = 6399592.8846
Normal potential at ellipsoid U₀ = 62636858.3919
Gravity flattening reciprocal 1/fₐ = 517.6353224813
Geodetic parameter m = 0.0034497853945
Normal gravity at equator gₐ = 9.7803274325
Normal gravity at pole gₚ = 9.8321870775
>> The reciprocal 1/f of the ellipsoid flattening selected as the fourth basic parameter.
>> The four basic parameters of the Earth ellipsoid have been entered into the system!
** Click the [Calculation of the derived constants of Earth ellipsoid] control button, or the [
>> Complete the calculation of the main geometric and physical derived constants of the E
>> Summary of the calculation results of the Earth ellipsoid constants (see the interface fo
Geocentric gravitational constant of the Earth (including the atmosphere) GM = 3.986004
Major semi axis of the Earth a = 6378136.3000
Dynamical form factor of the Earth J₂ = 1.0826261739
Mean angular velocity of the Earth ω = 7.292115
Reciprocal flattening 1/f = 298.2577612300
Minor semi axis of the Earth b= 6356751.6551
Radius of sphere of same volume R = 6371000.1037
Linear eccentricity E = 521853.4816
Square of first eccentricity e² = 0.006694367942498012
Square of second eccentricity e'² = 0.006739333137795320
Equatorial curvature radius M = 6335438.7088
Polar radius of curvature c = 6399592.8846
Normal potential at ellipsoid U₀ = 62636858.3919
Gravity flattening reciprocal 1/fₐ = 517.6353225016
Geodetic parameter m = 0.0034497853945
Normal gravity at equator gₐ = 9.7803274325
Normal gravity at pole gₚ = 9.8321870775
Polar radius of curvature c = 6399592.8846
Normal potential at ellipsoid U₀ = 62636858.3919
Gravity flattening reciprocal 1/fₐ = 517.6353225016
Geodetic parameter m = 0.0034497853945
Normal gravity at equator gₐ = 9.7803274325
Normal gravity at pole gₚ = 9.8321870775
>> The ellipsoid normal geopotential U₀ selected as the fourth basic parameter.
>> The four basic parameters of the Earth ellipsoid have been entered into the system!
** Click the [Calculation of the derived constants of Earth ellipsoid] control button, or the [Calculation of ellipsoid constants] tool button...
>> Complete the calculation of the main geometric and physical derived constants of the Earth ellipsoid!
>> Summary of the calculation results of the Earth ellipsoid constants (see the interface for units):
Geocentric gravitational constant of the Earth (including the atmosphere) GM = 3.986004415
Major semi axis of the Earth a = 6378136.3000
Dynamical form factor of the Earth J₂ = 1.0826362774
Mean angular velocity of the Earth ω = 7.292115
Reciprocal flattening 1/f = 298.2564115287
Minor semi axis of the Earth b= 6356751.5584
Radius of sphere of same volume R = 6371000.0713
Linear eccentricity E = 521854.6604
Square of first eccentricity e² = 0.006694398185685759
Square of second eccentricity e'² = 0.006739363787946455
Equatorial curvature radius M = 6335438.5159
Polar radius of curvature c = 6399592.9820
Normal potential at ellipsoid U₀ = 62636858.3919
Gravity flattening reciprocal 1/fₐ = 517.6435137497
Geodetic parameter m = 0.0034497853420
Normal gravity at equator gₐ = 9.7803275820
Normal gravity at pole gₚ = 9.8321870774
The tide system of the normal ellipsoid is consistent with C̄₂₀ or J₂.
PAGravf4.5 suggests that the scale parameters (GM, a) of global geopotential model, second-degree zonal harmonic coefficient C̄₂₀ and the mean rotation angular velocity ω should be employed as the four basic parameters of the normal ellipsoid. Using such a normal ellipsoid as the reference datum, the second-degree zonal harmonic term of anomalous gravity field is always zero, which is beneficial to improve the performance of the gravity field approach.


Calculation of global geopotential model and its spectral character analysis
Calculation of gravity field elements from global geopotential model
Geopotential model
Open calculation points
Import parameters
Save as
Start Computation
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of gravity field elements from global geopotential model
Calculation of model value for residual terrain (complete Bouguer) effects
Global geopotential coefficient model Calculator
Calculation and analysis of spectral character of Earth's gravity field
Open global geopotential coefficient model file
Save computation process as
Algorithmic Formulas
Select calculation file format
Discrete calculation point file
Open space calculation point file
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
Select elements to be calculated
height anomaly (m)
gravity anomaly (mGal)
gravity disturbance (mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
tangential gravity gradient (E, NW)
Laplace operator (E)
Minimum degree 2
Maximum degree 360
Extract elements to be plot
Plot↓
>> [Function] From global geopotential coefficient model, calculate the model value of the (residual) height anomaly (m), gravity anomaly (mGal), gravity disturbance (mGal), vertical deflection vector (", south, west), disturbing gravity gradient (E, radial), tangential gravity gradient vector (E, north, west) or Laplace operator (E).
** Click the [Open global geopotential coefficient model file] control button, or the [Open geopotential model] tool button...
>> Open global geopotential coefficient model file C:/PAGravf4.5_win64en/data/EGM2008.gfc.
** The window below only shows the geopotential coefficients data with no more than 2000 rows in it.
>> Open space calculation point file C:/PAGravf4.5_win64en/examples/PrModelgravfdcalc/calcpnt.txt.
** Look at the file information in the window below and set the discrete point file format...
>> Save the results as C:/PAGravf4.5_win64en/examples/PrModelgravfdcalc/result.txt.
** Behind the record of the calculation point file, appends one or more columns of model values of anomalous field elements, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The calculation process need wait, during which you can open the output file to look at the calculation progress...
>> Computation start time: 2024-09-21 12:50:51
Save the results as
Import setting parameters
Start Computation
no lon(deg) lat(deg) ellipheight(m)
1 94.025000 30.025000 3984.353 -32.5696 9.9303 -7.0197
2 94.075000 30.025000 4226.989 -32.5825 13.2926 -5.1102
3 94.125000 30.025000 4461.719 -32.6027 16.5996 -3.1215
4 94.175000 30.025000 4422.914 -32.6266 19.5823 -1.2269
5 94.225000 30.025000 4335.893 -32.6637 22.1364 0.5431
6 94.275000 30.025000 4463.689 -32.7271 23.9898 2.0700
95° 96° 97° 98° 99°
34° 33° 32° 31°
-38 -36 -34 -32
-60 -40 -20 0 20 40
-20 -10 0 10 20
height anomaly (m)
gravity disturbance (mGal)
disturbing gradient (E, R)
When the minimum and maximum degree n to be set is equal, the program calculates the contribution of the degree n geopotential coefficients to the anomalous gravity field element, which can be employed to analyze and evaluate the spectral and space properties of the geopotential coefficient model.

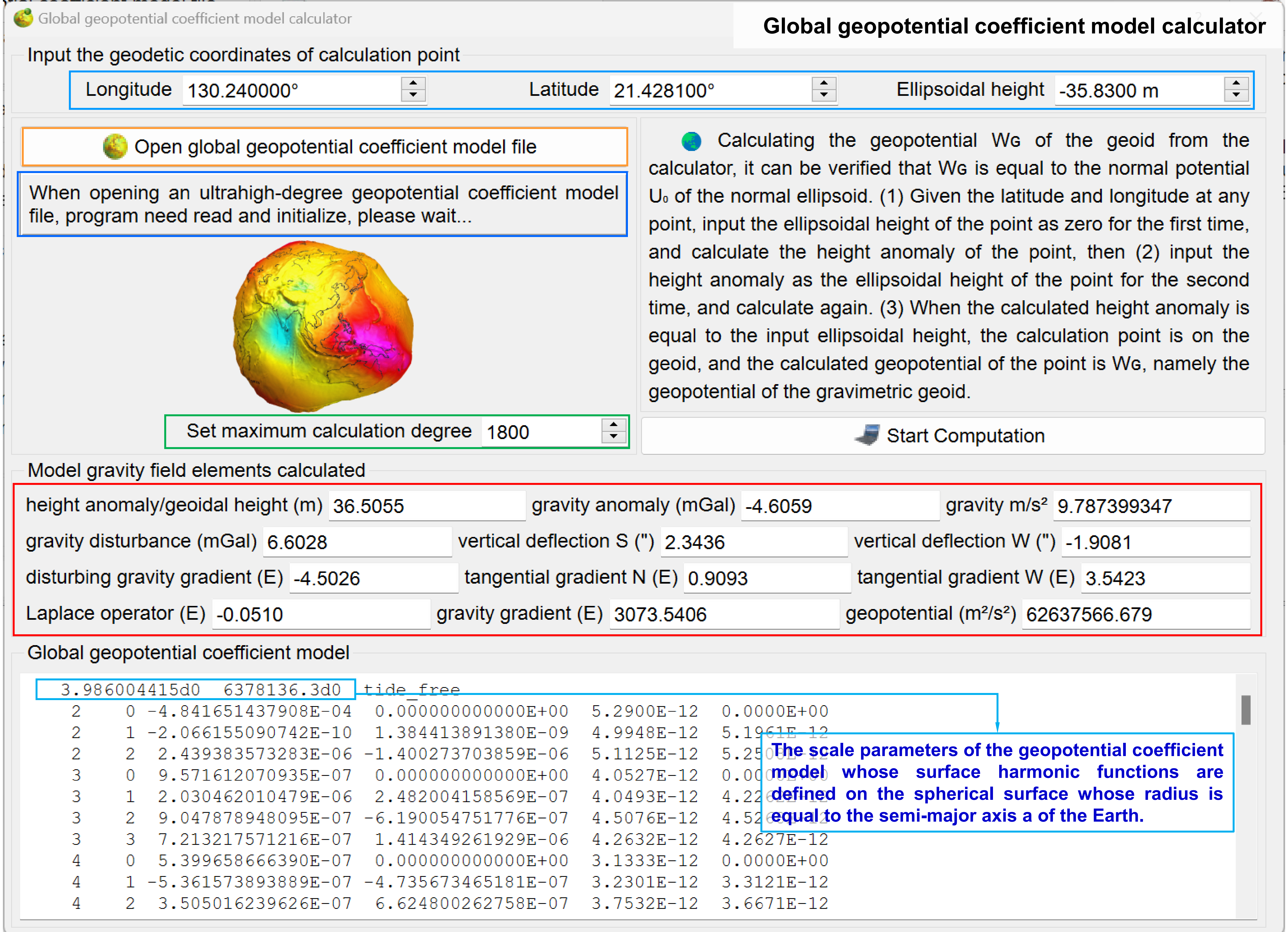


Calculation of global geopotential model and its spectral character analysis
Calculation of gravity field elements from global geopotential model
Geopotential model
Open calculation points
Import parameters
Save as
Start Computation
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of gravity field elements from global geopotential model
Calculation of model value for residual terrain (complete Bouguer) effects
Global geopotential coefficient model Calculator
Calculation and analysis of spectral character of Earth's gravity field
Open global geopotential coefficient model file
Save computation process as
Algorithmic Formulas
Select calculation file format
Ellipsoidal height grid file
Open ellipsoidal height grid file of calculation surface
Select elements to be calculated
height anomaly (m)
gravity anomaly (mGal)
gravity disturbance (mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
tangential gravity gradient (E, NW)
Laplace operator (E)
Minimum degree 2
Maximum degree 360
>> [Function] From global geopotential coefficient model, calculate the model value of the (residual) height anomaly (m), gravity anomaly (mGal), gravity disturbance (mGal), vertical deflection vector (", south, west), disturbing gravity gradient (E, radial), tangential gravity gradient vector (E, north, west) or Laplace operator (E).
** Click the [Open global geopotential coefficient model file] control button, or the [Open geopotential model] tool button...
>> Open global geopotential coefficient model file C:/PAGravf4.5_win64en/data/EGM2008.gfc.
** The window below only shows the geopotential coefficients data with no more than 2000 rows in it.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/PrModelgravfdcalc/surfhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/PrModelgravfdcalc/Gravfd360.txt.
** The record format: ID (point no/name), longitude, latitude, ellipsoidal height, several columns of the model values of anomalous field elements.
** The program also outputs (residual) height anomaly (*.ksi), gravity anomaly (*.gra), gravity disturbance (*.rga), vertical deflection vector (*.dft), disturbing gravity gradient (*. grr), tangential gravity gradient vector (*.hgd) or Laplace operator (*.lps) model value grid files into the current directory. Where * is the output file name entered in the interface, and the program outputs the corresponding (residual) model value grid file according to the selected gravity field element type.
>> The parameter settings have been entered into the system!
Save the results as
Import setting parameters
1 94.02500 30.02500 3984.353 -32.5696 19.9216 9.9303
2 94.07500 30.02500 4226.989 -32.5825 23.2067 13.2926
3 94.12500 30.02500 4461.719 -32.6027 26.5988 16.5996
4 94.17500 30.02500 4422.914 -32.6266 29.5890 19.5823
5 94.22500 30.02500 4335.893 -32.6637 32.1549 22.1364
6 94.27500 30.02500 4463.689 -32.7271 34.0272 23.9898
Extract elements to be plot
Plot↓
height anomaly (m)
gravity anomaly (mGal)
gravity disturbance (mGal)
When the minimum and maximum degree n to be set is equal, the program calculates the contribution of the degree n geopotential coefficients to the anomalous gravity field element, which can be employed to analyze and evaluate the spectral and space properties of the geopotential coefficient model.

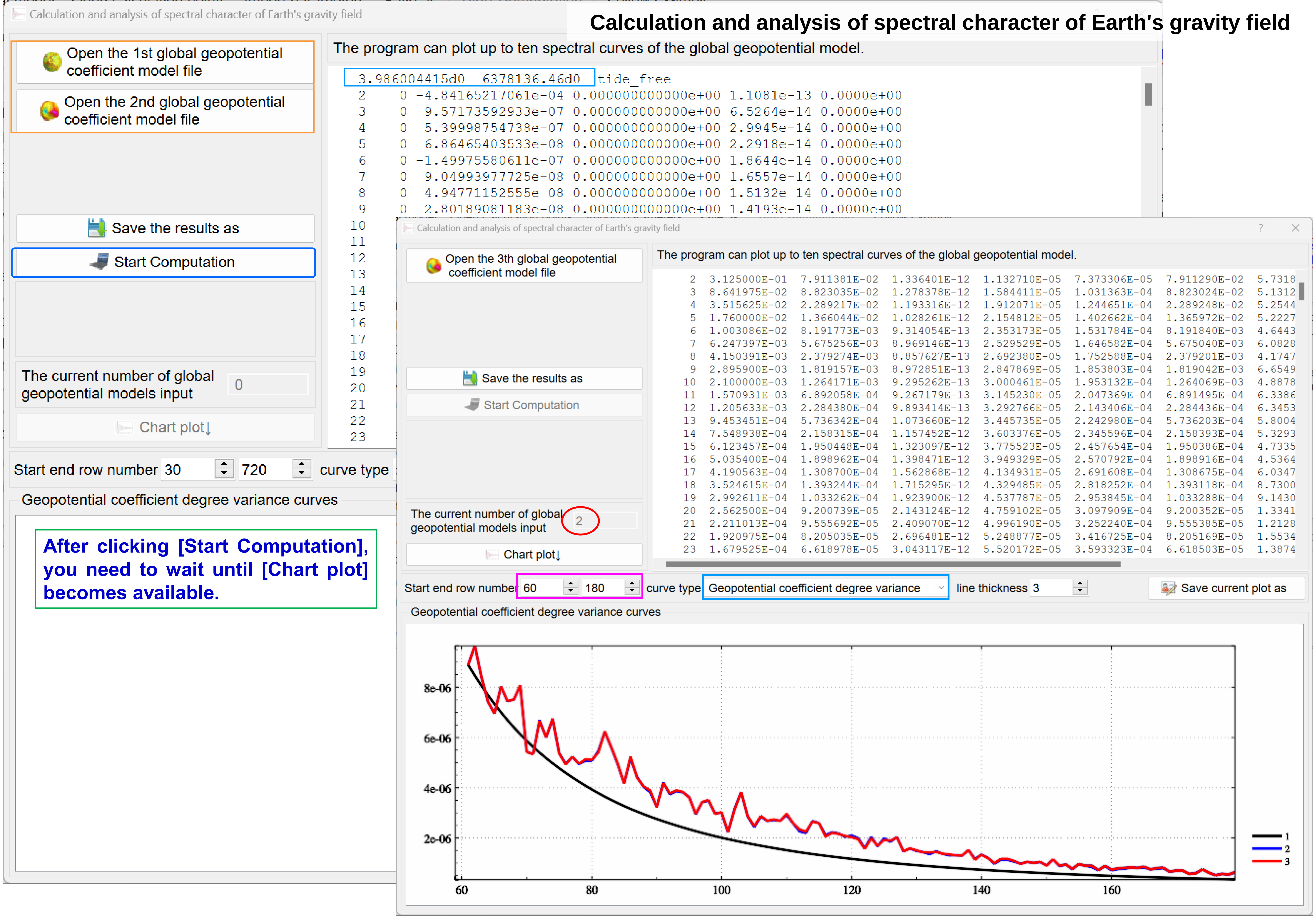

Global geopotential coefficient model calculator
Global geopotential coefficient model calculator
Input the geodetic coordinates of calculation point
Longitude 121.240000°
Latitude 29.428100°
Ellipsoidal height 17.8300 m
Open global geopotential coefficient model file
When opening an ultrahigh-degree geopotential coefficient model file, program need read and initialize, please wait...
Calculating the geopotential WG of the geoid from the calculator, it can be verified that WG is equal to the normal potential U0 of the normal ellipsoid. (1) Given the latitude and longitude at any point, input the ellipsoidal height of the point as zero for the first time, and calculate the height anomaly of the point, then (2) input the height anomaly as the ellipsoidal height of the point for the second time, and calculate again. (3) When the calculated height anomaly is equal to the input ellipsoidal height, the calculation point is on the geoid, and the calculated geopotential of the point is WG, namely the geopotential of the gravimetric geoid.
Set maximum calculation degree 1800
Start Computation
Model gravity field elements calculated
height anomaly/geoidal height (m) 13.0099
gravity anomaly (mGal) 32.6014
gravity m/s² 9.793115777
gravity disturbance (mGal) 36.5996
vertical deflection S (") 2.3487
vertical deflection W (") -3.5341
disturbing gravity gradient (E) 42.9662
tangential gradient N (E) -7.8402
tangential gradient W (E) -35.1869
Laplace operator (E) -0.0610
gravity gradient (E) 3121.5910
geopotential (m²/s²) 62636811.507
Global geopotential coefficient model
3.986004415d0 6378136.3d0 tide_free
2 0 -4.841651437908E-04 0.000000000000E+00 5.2900E-12 0.0000E+00
2 1 -2.066155090742E-10 1.384413891380E-09 4.9948E-12 5.1961E-12
2 2 2.439383573283E-06 -1.400273703859E-06 5.1125E-12
3 0 9.571612070935E-07 0.000000000000E+00 4.0527E-12
3 1 2.030462010479E-06 2.482004158569E-07 4.0493E-12
3 2 9.047878948095E-07 -6.190054751776E-07 4.5076E-12
3 3 7.213217571216E-07 1.414349261929E-06 4.2632E-12 4.2627E-12
4 0 5.399658666390E-07 0.000000000000E+00 3.1333E-12 0.0000E+00
4 1 -5.361573893889E-07 -4.735673465181E-07 3.2301E-12 3.3121E-12
4 2 3.505016239626E-07 6.624800262758E-07 3.7532E-12 3.6671E-12
The scale parameters of the geopotential coefficient model whose surface harmonic functions are defined on the spherical surface whose radius is equal to the semi-major axis a of the Earth.



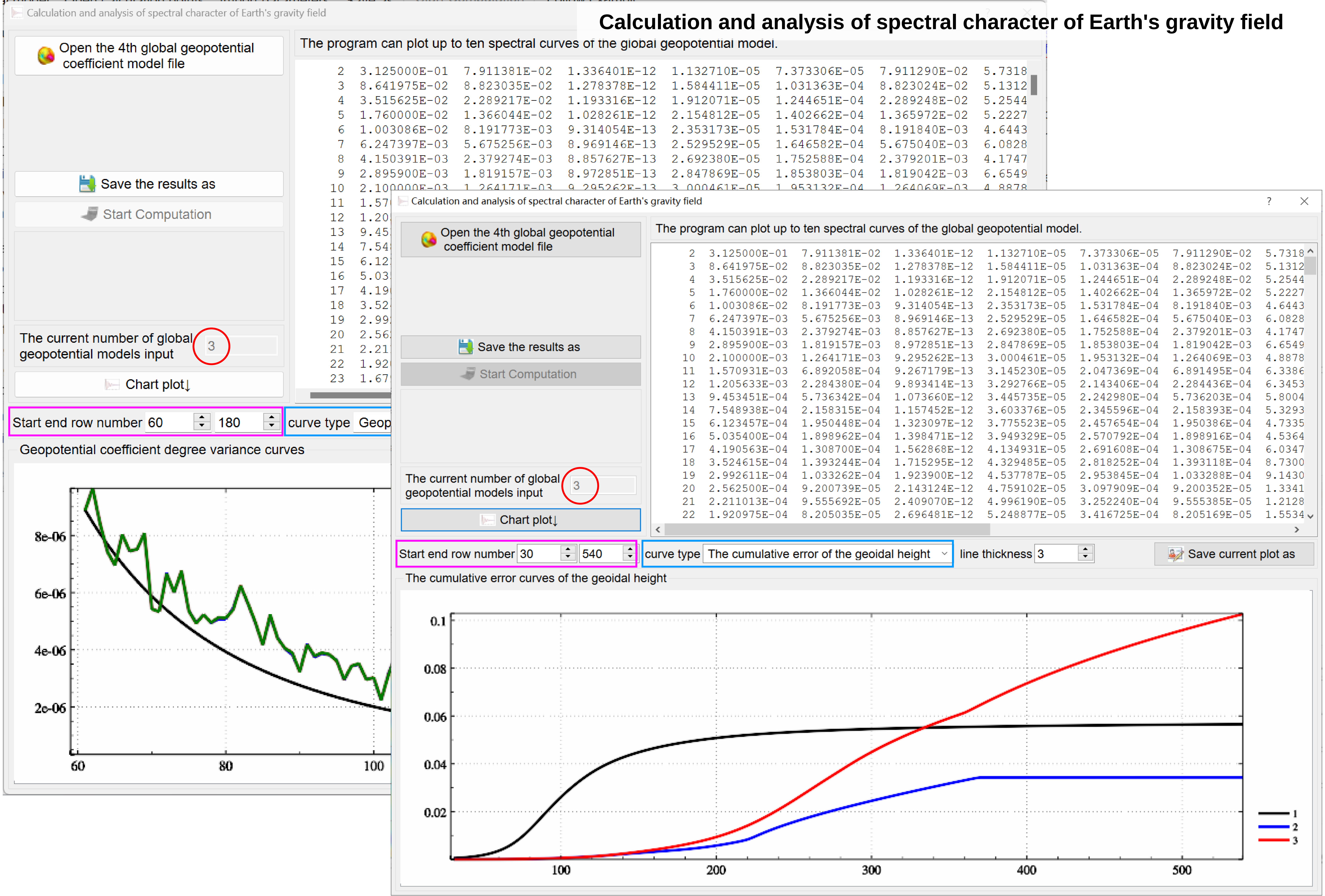
Global geopotential coefficient model calculator
Global geopotential coefficient model calculator
Input the geodetic coordinates of calculation point
Longitude 87.240000°
Latitude 31.428100°
Ellipsoidal height 5417.8300 m
Open global geopotential coefficient model file
When opening an ultrahigh-degree geopotential coefficient model file, program need read and initialize, please wait...
Calculating the geopotential WG of the geoid from the calculator, it can be verified that WG is equal to the normal potential U0 of the normal ellipsoid. (1) Given the latitude and longitude at any point, input the ellipsoidal height of the point as zero for the first time, and calculate the height anomaly of the point, then (2) input the height anomaly as the ellipsoidal height of the point for the second time, and calculate again. (3) When the calculated height anomaly is equal to the input ellipsoidal height, the calculation point is on the geoid, and the calculated geopotential of the point is WG, namely the geopotential of the gravimetric geoid.
Set maximum calculation degree 1800
Start Computation
Model gravity field elements calculated
height anomaly/geoidal height (m) -28.6109
gravity anomaly (mGal) 35.8449
gravity m/s² 9.777951466
gravity disturbance (mGal) 27.0723
vertical deflection S (") 5.0582
vertical deflection W (") -1.0667
disturbing gravity gradient (E) 1.9139
tangential gradient N (E) -30.5760
tangential gradient W (E) 28.7014
Laplace operator (E) 0.0393
gravity gradient (E) 3072.8990
geopotential (m²/s²) 62583559.925
Global geopotential coefficient model
3.986004415d0 6378136.3d0 tide_free
2 0 -4.841651437908E-04 0.000000000000E+00 5.2900E-12 0.0000E+00
2 1 -2.066155090742E-10 1.384413891380E-09 4.9948E-12 5.1961E-12
2 2 2.439383573283E-06 -1.400273703859E-06 5.1125E-12
3 0 9.571612070935E-07 0.000000000000E+00 4.0527E-12
3 1 2.030462010479E-06 2.482004158569E-07 4.0493E-12
3 2 9.047878948095E-07 -6.190054751776E-07 4.5076E-12
3 3 7.213217571216E-07 1.414349261929E-06 4.2632E-12 4.2627E-12
4 0 5.399658666390E-07 0.000000000000E+00 3.1333E-12 0.0000E+00
4 1 -5.361573893889E-07 -4.735673465181E-07 3.2301E-12 3.3121E-12
4 2 3.505016239626E-07 6.624800262758E-07 3.7532E-12 3.6671E-12
The scale parameters of the geopotential coefficient model whose surface harmonic functions are defined on the spherical surface whose radius is equal to the semi-major axis a of the Earth.

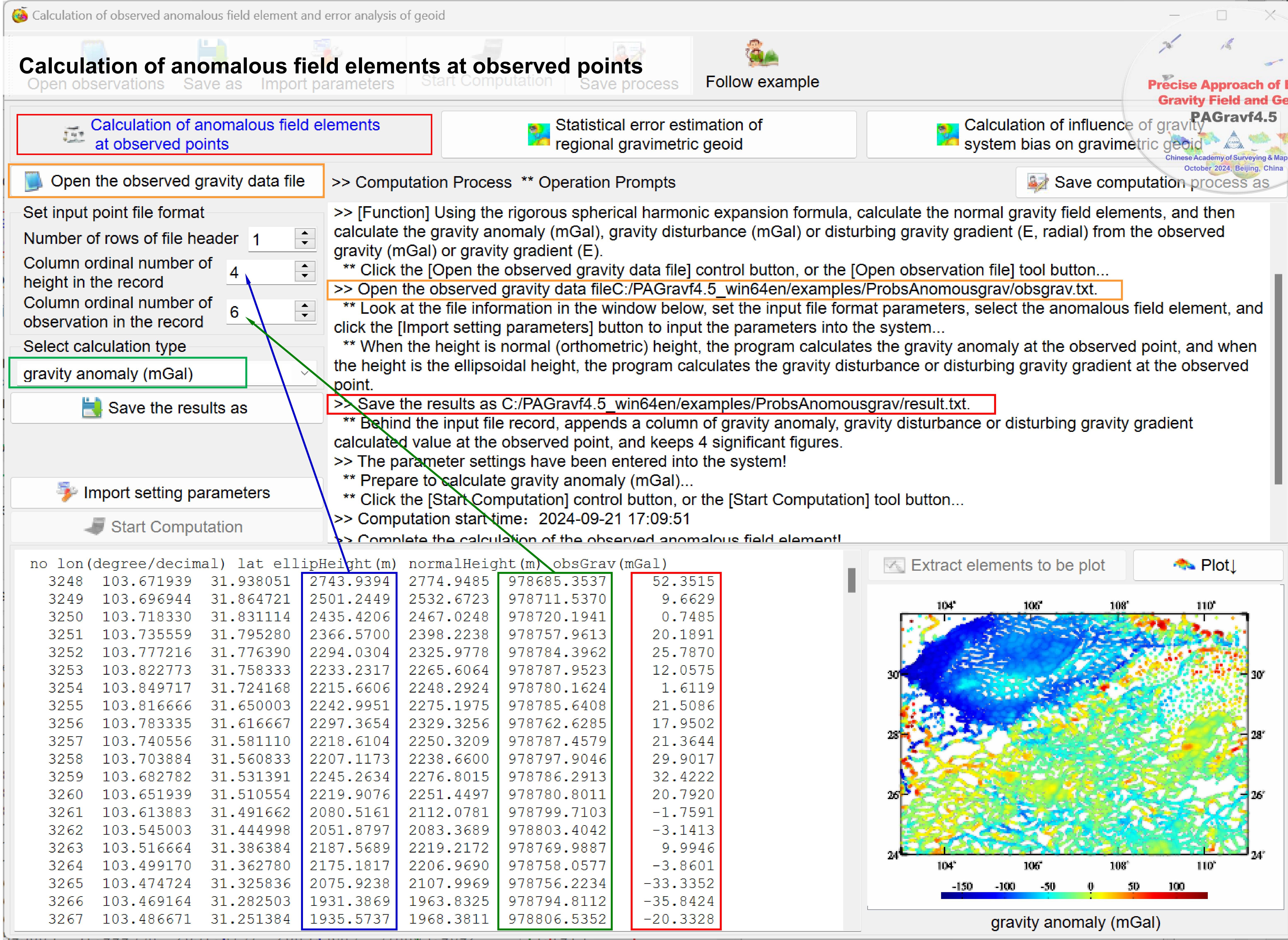

Global geopotential coefficient model calculator
Global geopotential coefficient model calculator
Input the geodetic coordinates of calculation point
Longitude 130.240000°
Latitude 21.428100°
Ellipsoidal height -35.8300 m
Open global geopotential coefficient model file
When opening an ultrahigh-degree geopotential coefficient model file, program need read and initialize, please wait...
Calculating the geopotential WG of the geoid from the calculator, it can be verified that WG is equal to the normal potential U0 of the normal ellipsoid. (1) Given the latitude and longitude at any point, input the ellipsoidal height of the point as zero for the first time, and calculate the height anomaly of the point, then (2) input the height anomaly as the ellipsoidal height of the point for the second time, and calculate again. (3) When the calculated height anomaly is equal to the input ellipsoidal height, the calculation point is on the geoid, and the calculated geopotential of the point is WG, namely the geopotential of the gravimetric geoid.
Set maximum calculation degree 1800
Start Computation
Model gravity field elements calculated
height anomaly/geoidal height (m) 36.5055
gravity anomaly (mGal) -4.6059
gravity m/s² 9.787399347
gravity disturbance (mGal) 6.6028
vertical deflection S (") 2.3436
vertical deflection W (") -1.9081
disturbing gravity gradient (E) -4.5026
tangential gradient N (E) 0.9093
tangential gradient W (E) 3.5423
Laplace operator (E) -0.0510
gravity gradient (E) 3073.5406
geopotential (m²/s²) 62637566.679
Global geopotential coefficient model
3.986004415d0 6378136.3d0 tide_free
2 0 -4.841651437908E-04 0.000000000000E+00 5.2900E-12 0.0000E+00
2 1 -2.066155090742E-10 1.384413891380E-09 4.9948E-12
2 2 2.439383573283E-06 -1.400273703859E-06 5.1125E-12
3 0 9.571612070935E-07 0.000000000000E+00 4.0527E-12
3 1 2.030462010479E-06 2.482004158569E-07 4.0493E-12
3 2 9.047878948095E-07 -6.190054751776E-07 4.5076E-12
3 3 7.213217571216E-07 1.414349261929E-06 4.2632E-12 4.2627E-12
4 0 5.399658666390E-07 0.000000000000E+00 3.1333E-12 0.0000E+00
4 1 -5.361573893889E-07 -4.735673465181E-07 3.2301E-12 3.3121E-12
4 2 3.505016239626E-07 6.624800262758E-07 3.7532E-12 3.6671E-12
The scale parameters of the geopotential coefficient model whose surface harmonic functions are defined on the spherical surface whose radius is equal to the semi-major axis a of the Earth.

Calculation and analysis of spectral character of Earth's gravity field



Calculation and analysis of spectral character of Earth's gravity field




Calculation of observed anomalous field element and error analysis of geoid
Calculation of anomalous field elements at observed points
Open observations
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of anomalous field elements at observed points
Statistical error estimation of regional gravimetric geoid
Calculation of influence of gravity system bias on gravimetric geoid
Open the observed gravity data file
>> Computation Process ** Operation Prompts
Save computation process as
Set input point file format
Number of rows of file header 1
Column ordinal number of height in the record 4
Column ordinal number of observation in the record 6
Select calculation type
gravity anomaly (mGal)
Save the results as
Import setting parameters
Start Computation
>> [Function] Using the rigorous spherical harmonic expansion formula, calculate the normal gravity field elements, and then calculate the gravity anomaly (mGal), gravity disturbance (mGal) or disturbing gravity gradient (E, radial) from the observed gravity (mGal) or gravity gradient (E).
** Click the [Open the observed gravity data file] control button, or the [Open observation file] tool button...
>> Open the observed gravity data fileC:/PAGravf4.5_win64en/examples/ProbsAnomousgrav/obsgrav.txt.
** Look at the file information in the window below, set the input file format parameters, select the anomalous field element, and click the [Import setting parameters] button to input the parameters into the system...
** When the height is normal (orthometric) height, the program calculates the gravity anomaly at the observed point, and when the height is the ellipsoidal height, the program calculates the gravity disturbance or disturbing gravity gradient at the observed point.
>> Save the results as C:/PAGravf4.5_win64en/examples/ProbsAnomousgrav/result.txt.
** Behind the input file record, appends a column of gravity anomaly, gravity disturbance or disturbing gravity gradient calculated value at the observed point, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Prepare to calculate gravity anomaly (mGal)...
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-21 17:09:51
>> Complete the calculation of the observed anomalous field element!
no lon(degree/decimal) lat ellipHeight(m) normalHeight(m) obsGrav(mGal)
3248 103.671939 31.938051 2743.9394 2774.9485 978685.3537 52.3515
3249 103.696944 31.864721 2501.2449 2532.6723 978711.5370 9.6629
3250 103.718330 31.831114 2435.4206 2467.0248 978720.1941 0.7485
3251 103.735559 31.795280 2366.5700 2398.2238 978757.9613 20.1891
3252 103.777216 31.776390 2294.0304 2325.9778 978784.3962 25.7870
3253 103.822773 31.758333 2233.2317 2265.6064 978787.9523 12.0575
3254 103.849717 31.724168 2215.6606 2248.2924 978780.1624 1.6119
3255 103.816666 31.650003 2242.9951 2275.1975 978785.6408 21.5086
3256 103.783335 31.616667 2297.3654 2329.3256 978762.6285 17.9502
3257 103.740556 31.581110 2218.6104 2250.3209 978787.4579 21.3644
3258 103.703884 31.560833 2207.1173 2238.6600 978797.9046 29.9017
3259 103.682782 31.531391 2245.2634 2276.8015 978786.2913 32.4222
3260 103.651939 31.510554 2219.9076 2251.4497 978780.8011 20.7920
3261 103.613883 31.491662 2080.5161 2112.0781 978799.7103 -1.7591
3262 103.545003 31.444998 2051.8797 2083.3689 978803.4042 -3.1413
3263 103.516664 31.386384 2187.5689 2219.2172 978769.9887 9.9946
3264 103.499170 31.362780 2175.1817 2206.9690 978758.0577 -3.8601
3265 103.474724 31.325836 2075.9238 2107.9969 978756.2234 -33.3352
3266 103.469164 31.282503 1931.3869 1963.8325 978794.8112 -35.8424
3267 103.486671 31.251384 1935.5737 1968.3811 978806.5352 -20.3328
Extract elements to be plot
Plot
104° 106° 108° 110°
30° 28° 26° 24°
-150 -100 -50 0 50 100
gravity anomaly (mGal)

Precise Approach of Earth Gravity Field and Geoid
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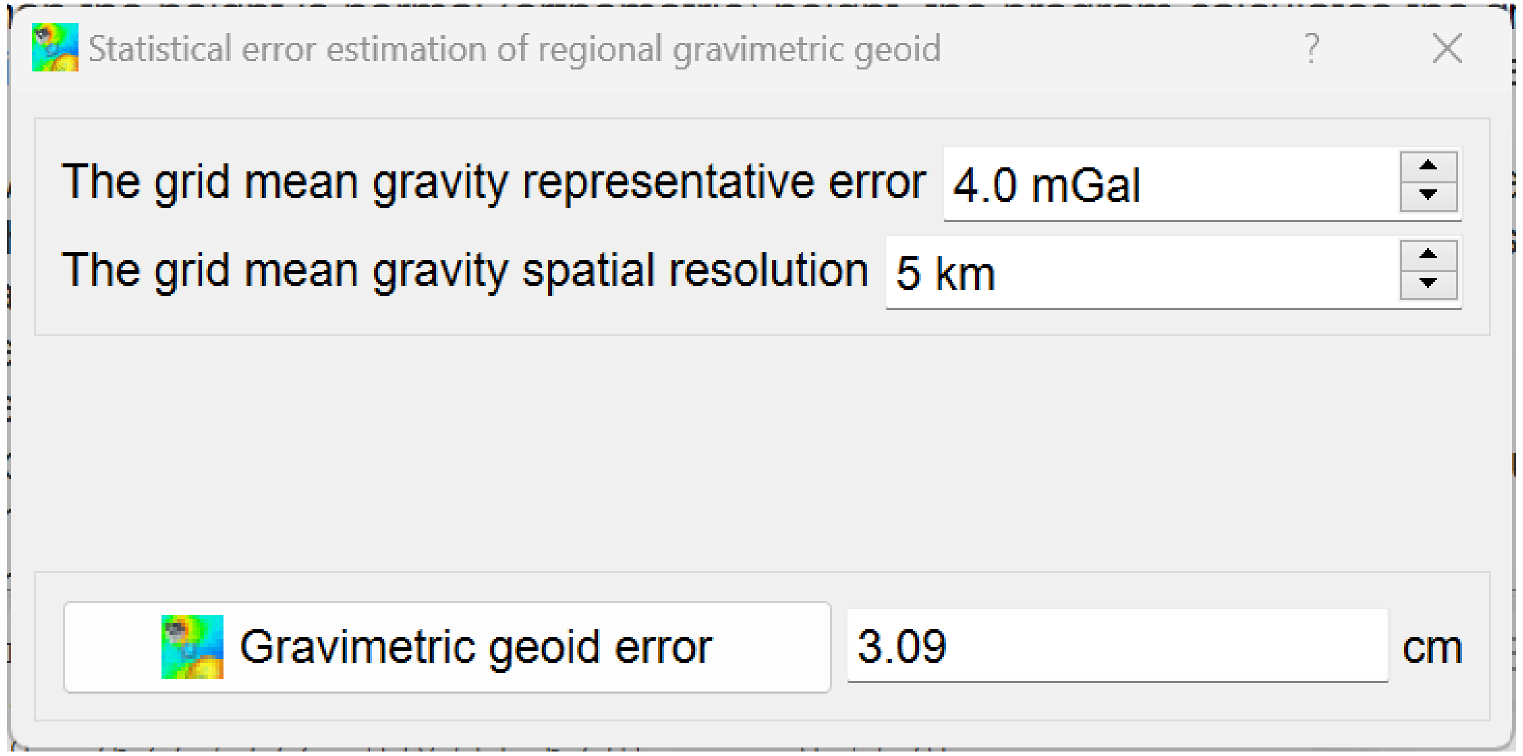
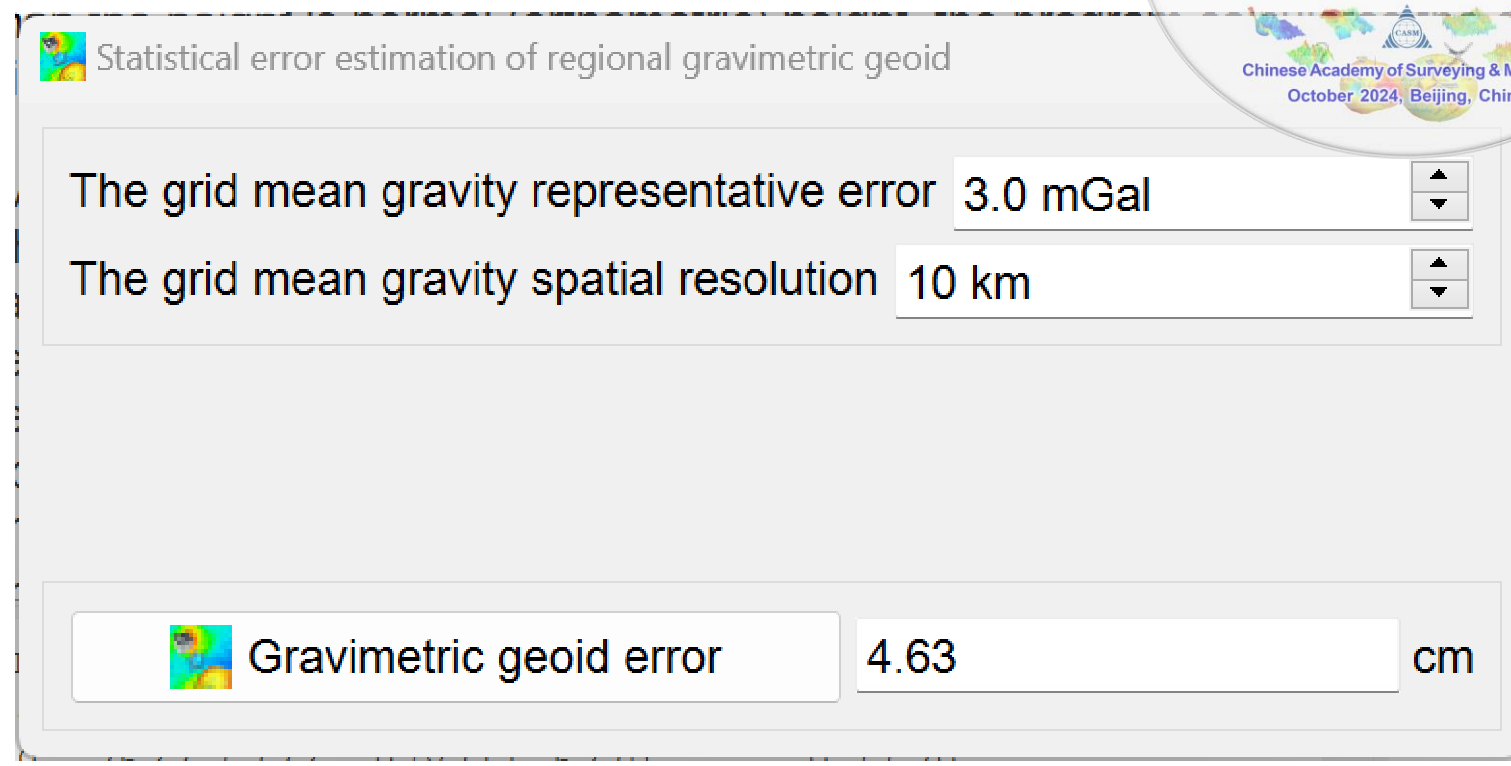
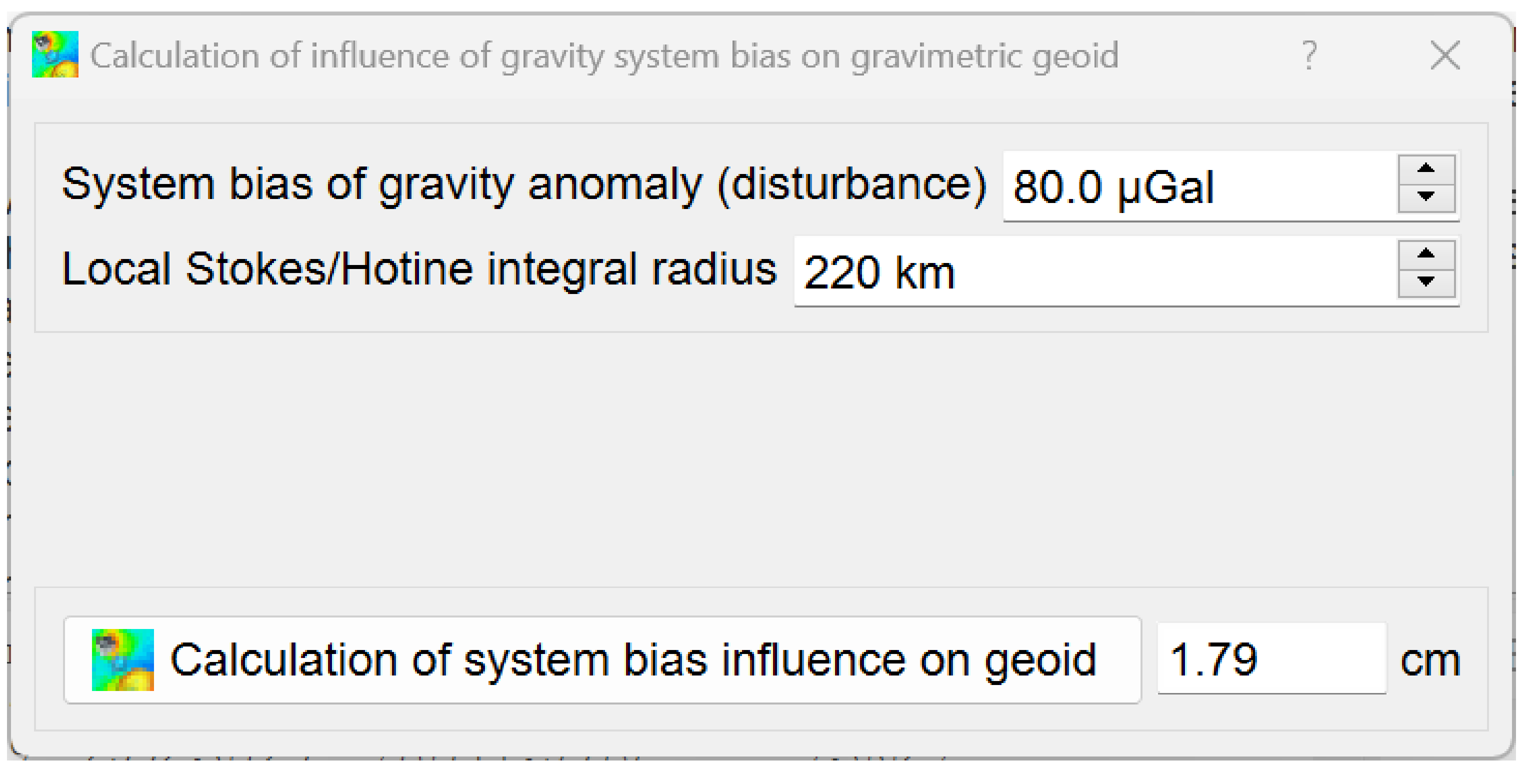
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China

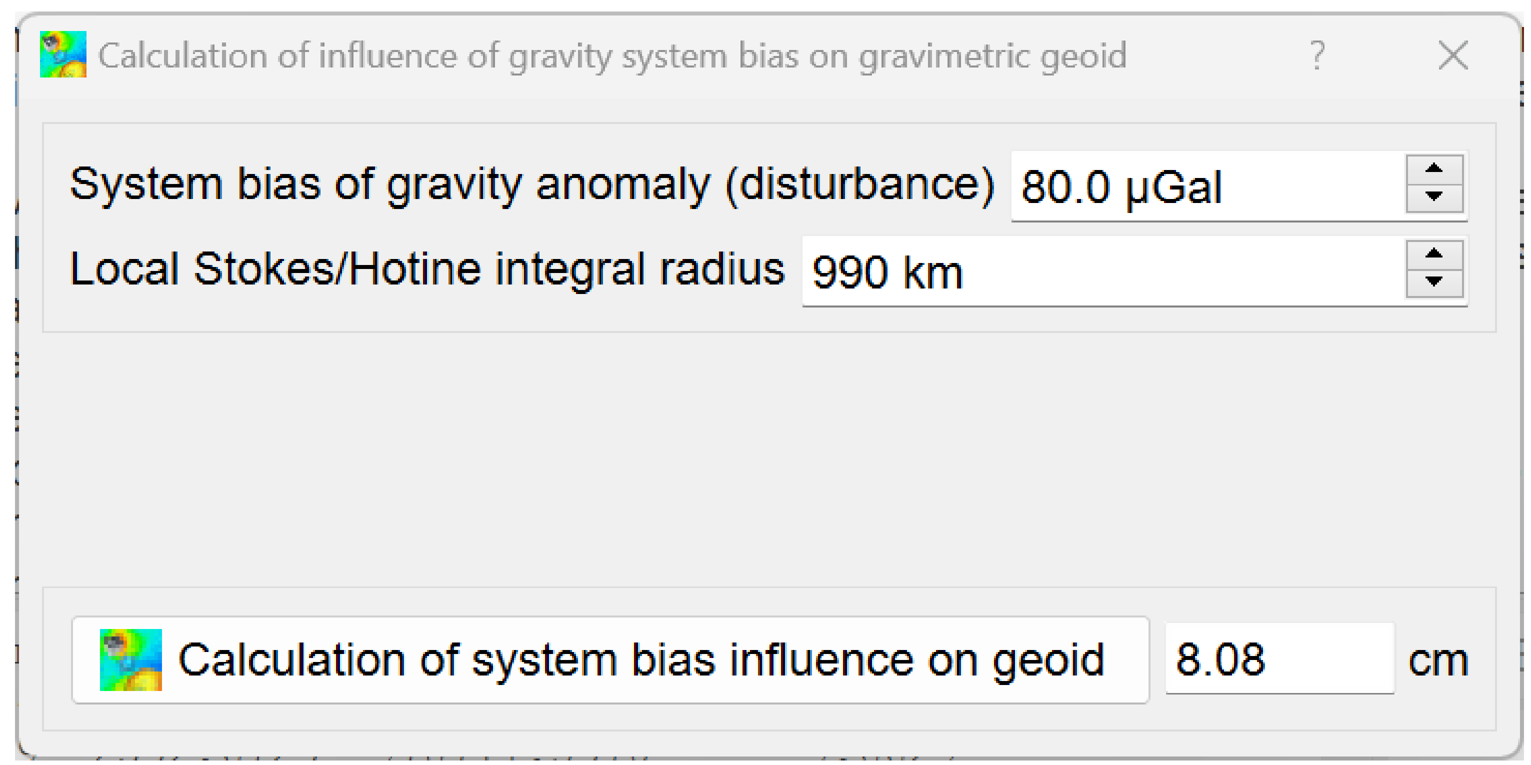
Statistical error estimation of regional gravimetric geoid



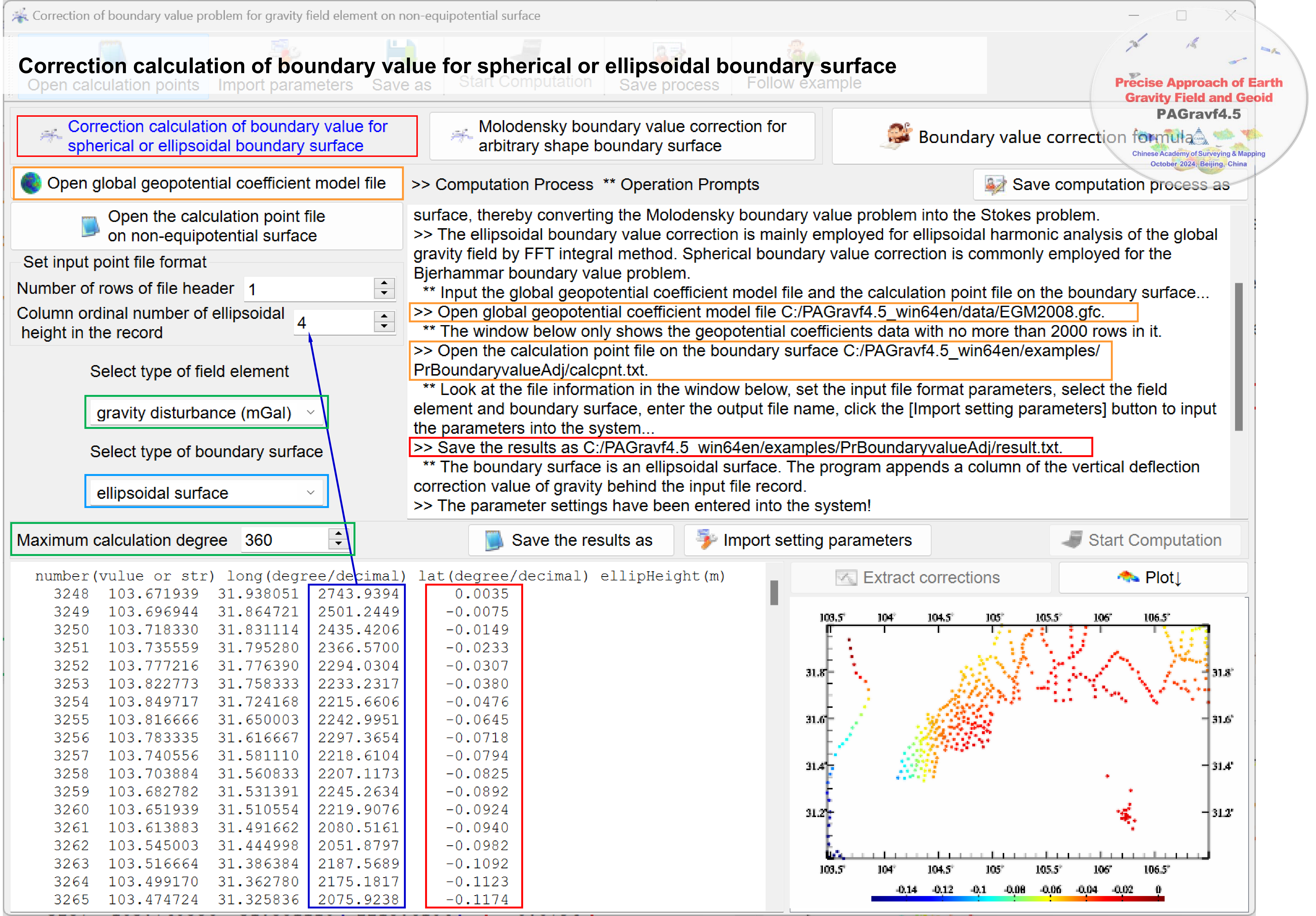


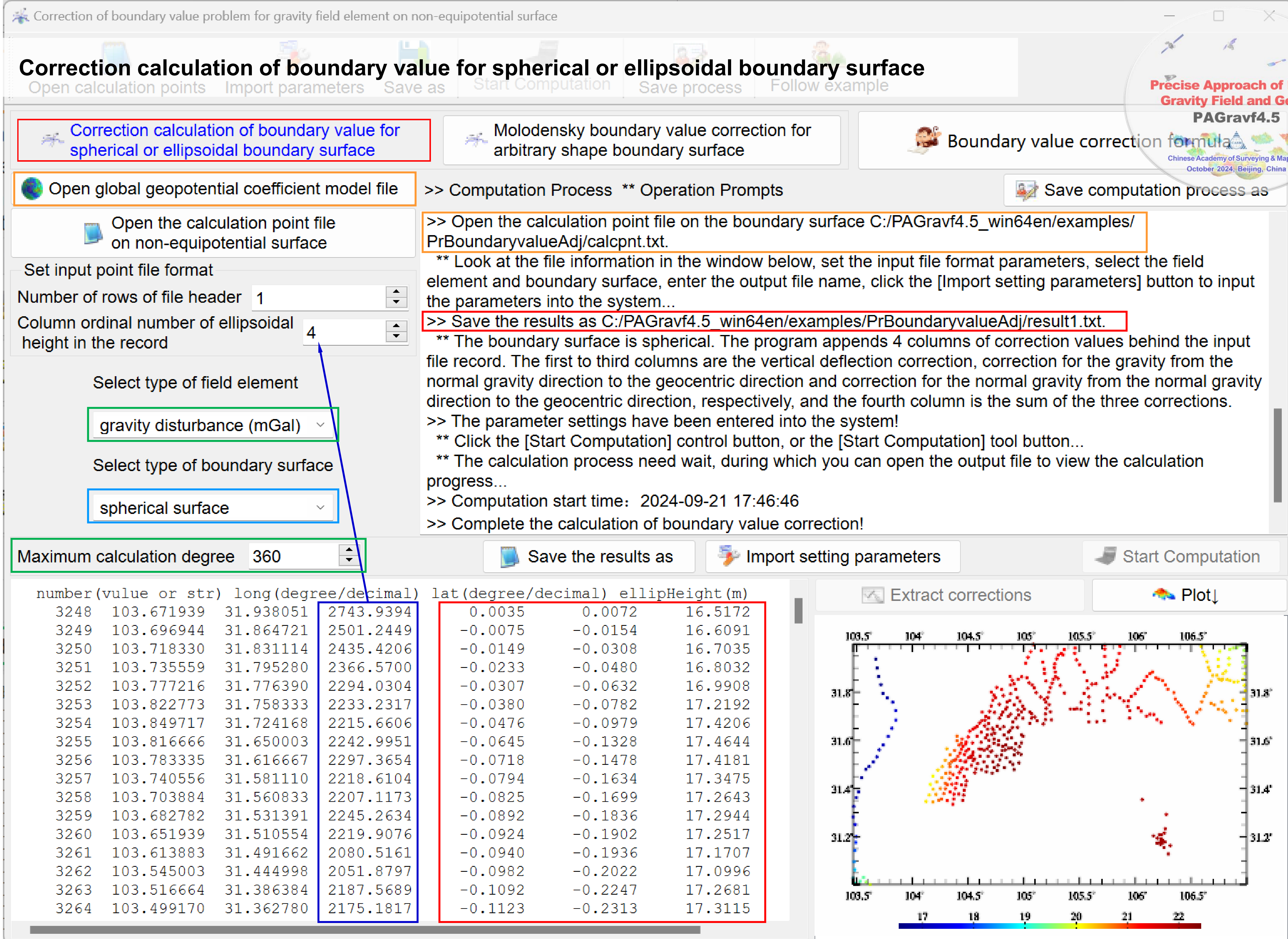
Calculation of influence of gravity system bias on gravimetric geoid



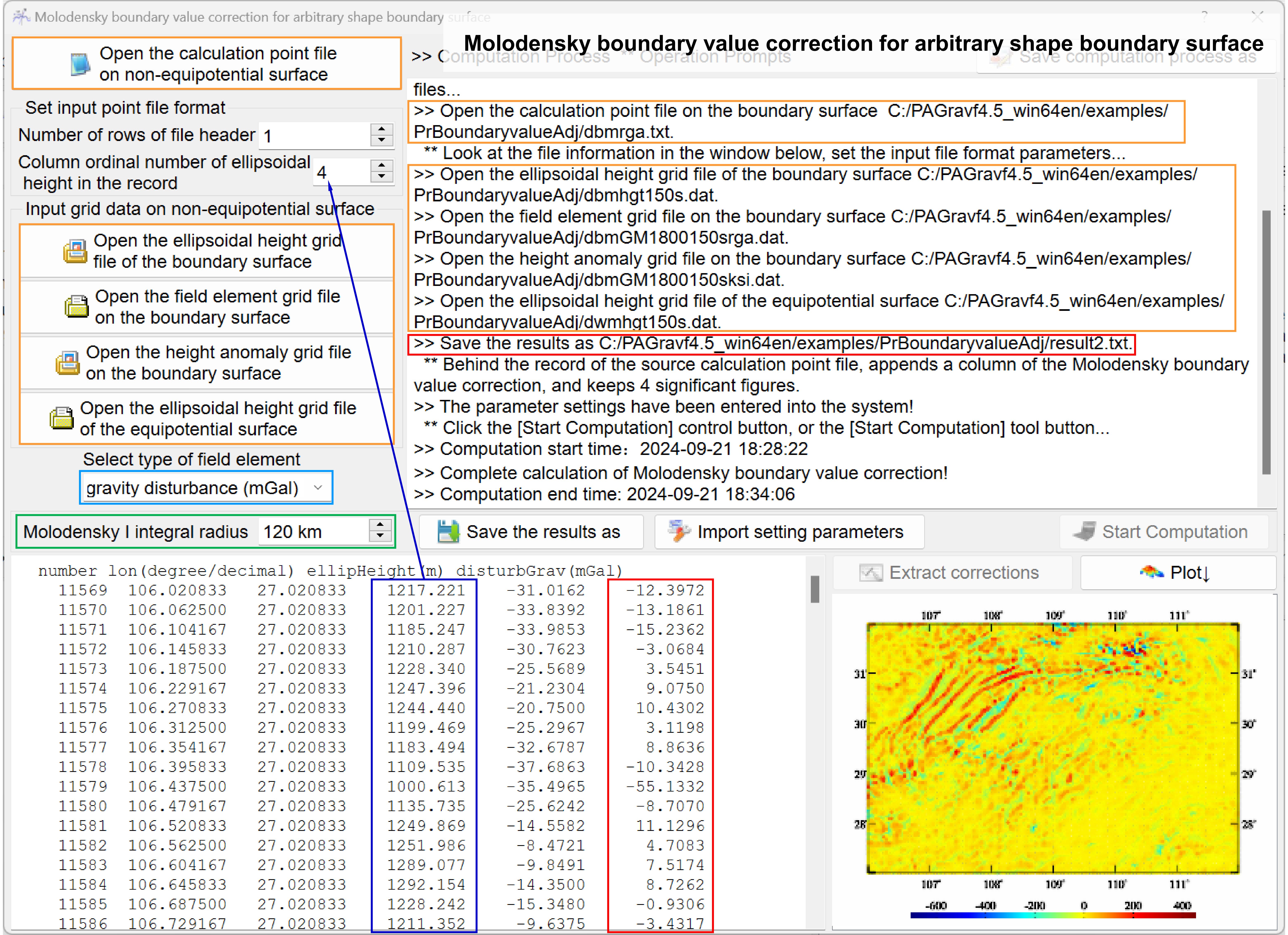


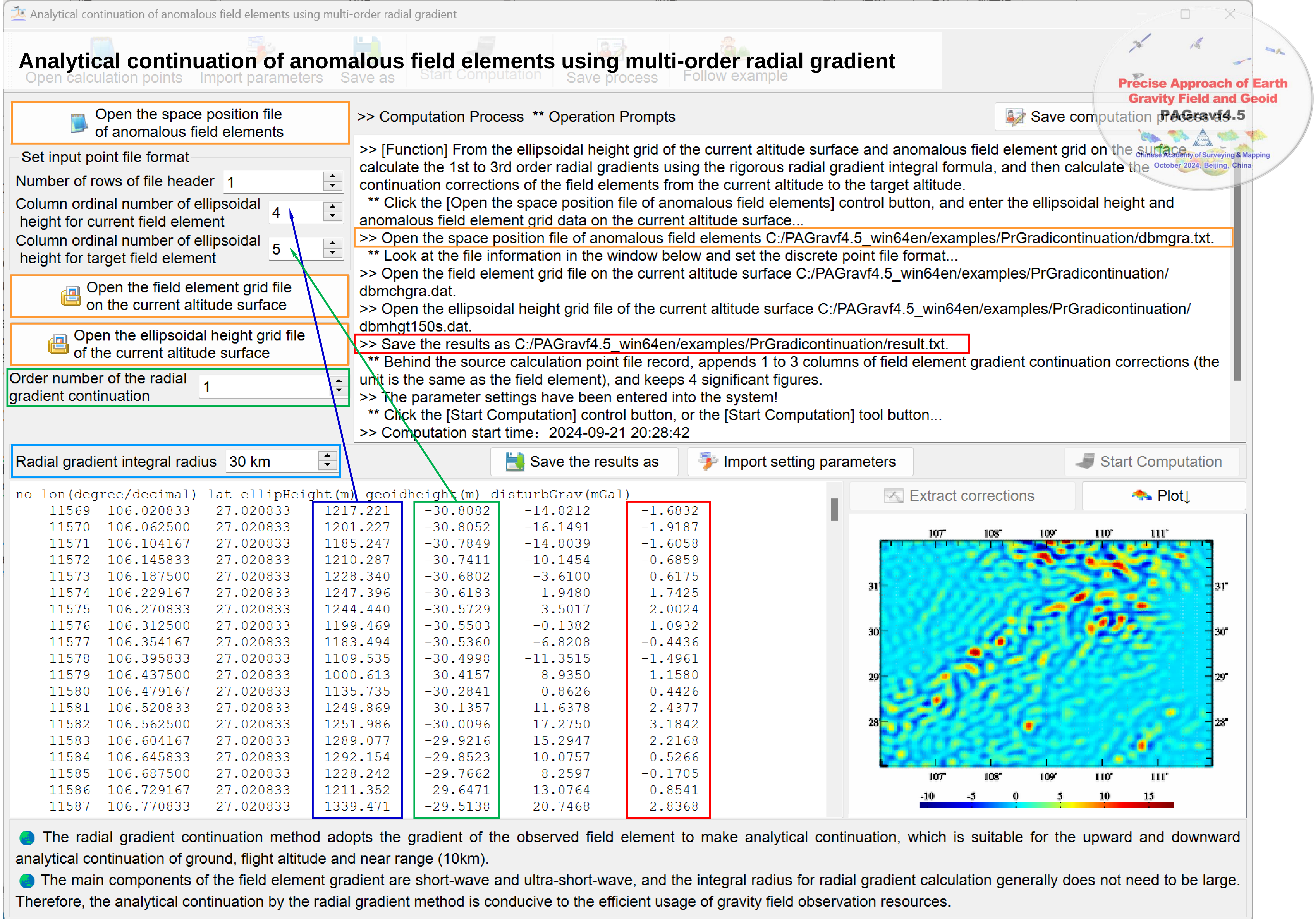
Correction calculation of boundary value for spherical or ellipsoidal boundary surface




Correction of boundary value problem for gravity field element on non-equipotential surface
Correction calculation of boundary value for spherical or ellipsoidal boundary surface
Open calculation points
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Correction calculation of boundary value for spherical or ellipsoidal boundary surface
Molodensky boundary value correction for arbitrary shape boundary surface
Boundary value correction formula
Open global geopotential coefficient model file
>> Computation Process ** Operation Prompts
Save computation process as
Open the calculation point file on non-equipotential surface
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
Select type of field element
gravity disturbance (mGal)
Select type of boundary surface
spherical surface
>> Open the calculation point file on the boundary surface C:/PAGravf4.5_win64en/examples/PrBoundaryvalueAdj/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters, select the field element and boundary surface, enter the output file name, click the [Import setting parameters] button to input the parameters into the system...
>> Save the results as C:/PAGravf4.5_win64en/examples/PrBoundaryvalueAdj/result1.txt.
** The boundary surface is spherical. The program appends 4 columns of correction values behind the input file record. The first to third columns are the vertical deflection correction, correction for the gravity from the normal gravity direction to the geocentric direction and correction for the normal gravity from the normal gravity direction to the geocentric direction, respectively, and the fourth column is the sum of the three corrections.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The calculation process need wait, during which you can open the output file to view the calculation progress...
>> Computation start time: 2024-09-21 17:46:46
>> Complete the calculation of boundary value correction!
Maximum calculation degree 360
Save the results as
Import setting parameters
Start Computation
number(vulue or str) long(degree/decimal) lat(degree/decimal) ellipHeight(m)
3248 103.671939 31.938051 2743.9394 0.0035 0.0072 16.5172
3249 103.696944 31.864721 2501.2449 -0.0075 -0.0154 16.6091
3250 103.718330 31.831114 2435.4206 -0.0149 -0.0308 16.7035
3251 103.735559 31.795280 2366.5700 -0.0233 -0.0480 16.8032
3252 103.777216 31.776390 2294.0304 -0.0307 -0.0632 16.9908
3253 103.822773 31.758333 2233.2317 -0.0380 -0.0782 17.2192
3254 103.849717 31.724168 2215.6606 -0.0476 -0.0979 17.4206
3255 103.816666 31.650003 2242.9951 -0.0645 -0.1328 17.4644
3256 103.783335 31.616667 2297.3654 -0.0718 -0.1478 17.4181
3257 103.740556 31.581110 2218.6104 -0.0794 -0.1634 17.3475
3258 103.703884 31.560833 2207.1173 -0.0825 -0.1699 17.2643
3259 103.682782 31.531391 2245.2634 -0.0892 -0.1836 17.2944
3260 103.651939 31.510554 2219.9076 -0.0924 -0.1902 17.2517
3261 103.613883 31.491662 2080.5161 -0.0940 -0.1936 17.1707
3262 103.545003 31.444998 2051.8797 -0.0982 -0.2022 17.0996
3263 103.516664 31.386384 2187.5689 -0.1092 -0.2247 17.2681
3264 103.499170 31.362780 2175.1817 -0.1123 -0.2313 17.3115
Extract corrections
Plot↓
103.5° 104° 104.5° 105° 105.5° 106° 106.5°
31.8° 31.6° 31.4° 31.2°
17 18 19 20 21 22

Molodensky boundary value correction for arbitrary shape boundary surface




Analytical continuation of anomalous field elements using multi-order radial gradient
Open calculation points
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the space position file of anomalous field elements
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height for current field element 4
Column ordinal number of ellipsoidal height for target field element 5
Open the field element grid file on the current altitude surface
Open the ellipsoidal height grid file of the current altitude surface
Order number of the radial gradient continuation 1
Radial gradient integral radius 30 km
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the current altitude surface and anomalous field element grid on the surface, calculate the 1st to 3rd order radial gradients using the rigorous radial gradient integral formula, and then calculate the continuation corrections of the field elements from the current altitude to the target altitude.
** Click the [Open the space position file of anomalous field elements] control button, and enter the ellipsoidal height and anomalous field element grid data on the current altitude surface...
>> Open the space position file of anomalous field elements C:/PAGravf4.5_win64en/examples/PrGradicontinuation/dbmgra.txt.
** Look at the file information in the window below and set the discrete point file format...
>> Open the field element grid file on the current altitude surface C:/PAGravf4.5_win64en/examples/PrGradicontinuation/dbmchgra.dat.
>> Open the ellipsoidal height grid file of the current altitude surface C:/PAGravf4.5_win64en/examples/PrGradicontinuation/dbmhgt150s.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/PrGradicontinuation/result.txt.
** Behind the source calculation point file record, appends 1 to 3 columns of field element gradient continuation corrections (the unit is the same as the field element), and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-21 20:28:42
Save the results as
Import setting parameters
Start Computation
Extract corrections
Plot↓
no lon(degree/decimal) lat ellipHeight(m) geoidheight(m) disturbGrav(mGal)
11569 106.020833 27.020833 1217.221 -30.8082 -14.8212 -1.6832
11570 106.062500 27.020833 1201.227 -30.8052 -16.1491 -1.9187
11571 106.104167 27.020833 1185.247 -30.7849 -14.8039 -1.6058
11572 106.145833 27.020833 1210.287 -30.7411 -10.1454 -0.6859
11573 106.187500 27.020833 1228.340 -30.6802 -3.6100 0.6175
11574 106.229167 27.020833 1247.396 -30.6183 1.9480 1.7425
11575 106.270833 27.020833 1244.440 -30.5729 3.5017 2.0024
11576 106.312500 27.020833 1199.469 -30.5503 -0.1382 1.0932
11577 106.354167 27.020833 1183.494 -30.5360 -6.8208 -0.4436
11578 106.395833 27.020833 1109.535 -30.4998 -11.3515 -1.4961
11579 106.437500 27.020833 1000.613 -30.4157 -8.9350 -1.1580
11580 106.479167 27.020833 1135.735 -30.2841 0.8626 0.4426
11581 106.520833 27.020833 1249.869 -30.1357 11.6378 2.4377
11582 106.562500 27.020833 1251.986 -30.0096 17.2750 3.1842
11583 106.604167 27.020833 1289.077 -29.9216 15.2947 2.2168
11584 106.645833 27.020833 1292.154 -29.8523 10.0757 0.5266
11585 106.687500 27.020833 1228.242 -29.7662 8.2597 -0.1705
11586 106.729167 27.020833 1211.352 -29.6471 13.0764 0.8541
11587 106.770833 27.020833 1339.471 -29.5138 20.7468 2.8368
107° 108° 109° 110° 111°
31° 30° 29° 28°
-10 -5 0 5 10 15
The radial gradient continuation method adopts the gradient of the observed field element to make analytical continuation, which is suitable for the upward and downward analytical continuation of ground, flight altitude and near range (10km).
The main components of the field element gradient are short-wave and ultra-short-wave, and the integral radius for radial gradient calculation generally does not need to be large. Therefore, the analytical continuation by the radial gradient method is conducive to the efficient usage of gravity field observation resources.

Analytical continuation of anomalous field elements using multi-order radial gradient

Analytical continuation of anomalous field elements using multi-order radial gradient

Open calculation points | Import parameters | Save as | Start Computation | Save process | Follow example

Open the space position file of anomalous field elements

Set input point file format

Number of rows of file header: 1

Column ordinal number of ellipsoidal height for current field element: 4

Column ordinal number of ellipsoidal height for target field element: 5

Open the field element grid file on the current altitude surface

Open the ellipsoidal height grid file of the current altitude surface

Order number of the radial gradient continuation: 2

Radial gradient integral radius: 30 km

>> Computation Process ** Operation Prompts

Save computation process as

>> Save the results as C:/PAGravf4.5_win64en/examples/PrGradicontinuation/result.txt.
** Behind the source calculation point file record, appends 1 to 3 columns of field element gradient continuation corrections (the unit is the same as the field element), and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-21 20:28:42
>> Complete the computation of continuation correction of field elements!
>> Computation end time: 2024-09-21 20:28:44
>> Save the results as C:/PAGravf4.5_win64en/examples/PrGradicontinuation/result1.txt.
** Behind the source calculation point file record, appends 1 to 3 columns of field element gradient continuation corrections (the unit is the same as the field element), and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-21 20:30:40
>> Complete the computation of continuation correction of field elements!
>> Computation end time: 2024-09-21 20:30:46

Precise Approach of Earth Gravity Field and Geoid
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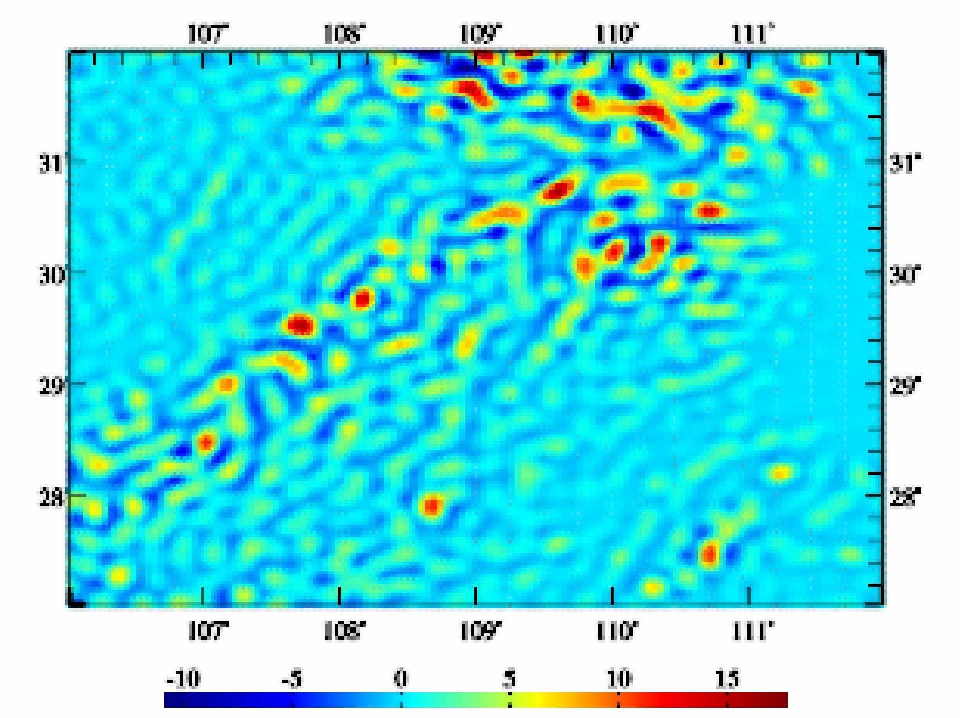
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China

Save the results as | Import setting parameters | Start Computation

Extract corrections | Plot

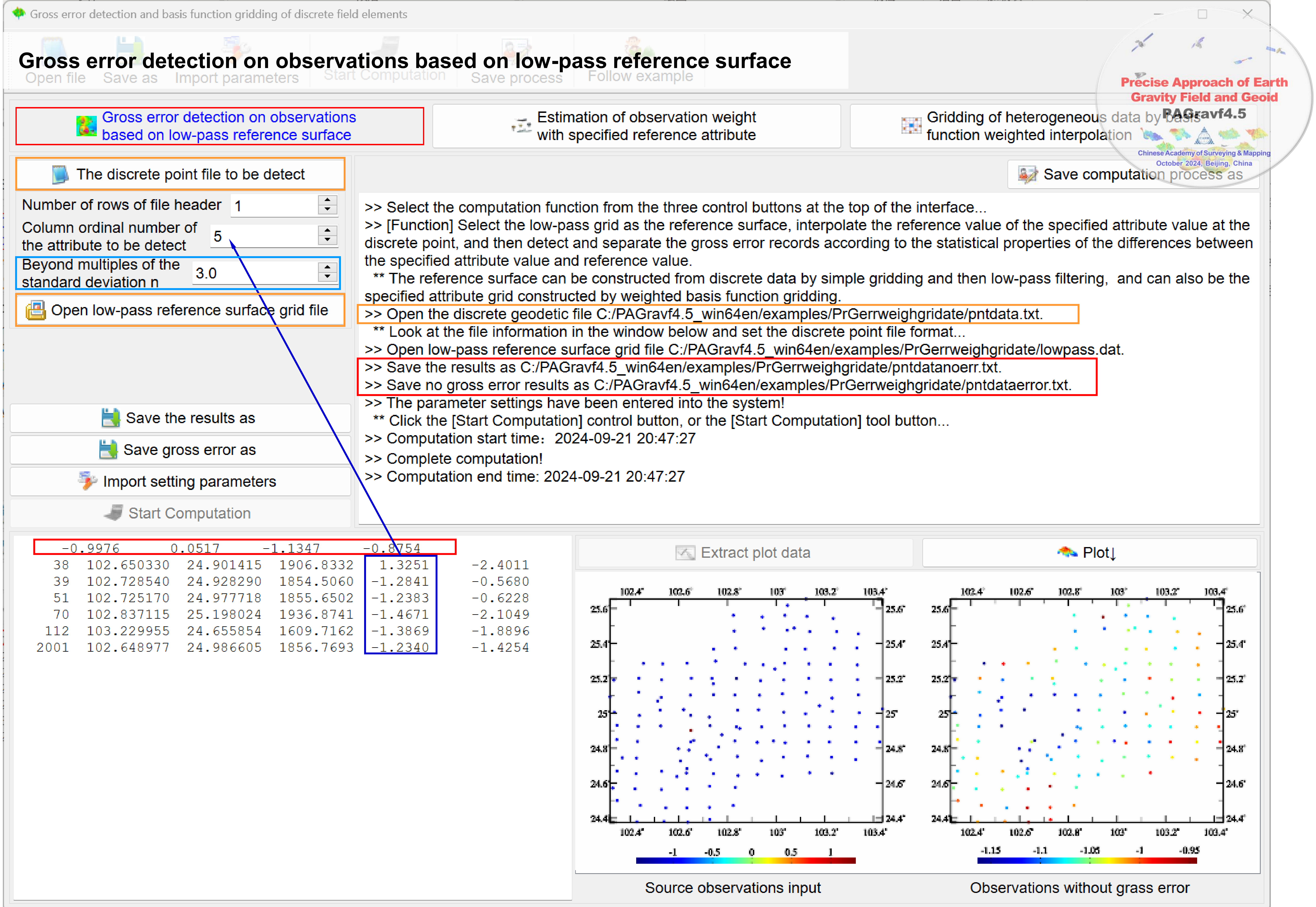
no	lon(degree/decimal)	lat	ellipHeight(m)	geoidheight(m)	disturbGrav(mGal)		
11569	106.020833	27.020833	1217.221	-30.8082	-14.8212	-1.6832	-1.8275
11570	106.062500	27.020833	1201.227	-30.8052	-16.1491	-1.9187	-2.0872
11571	106.104167	27.020833	1185.247	-30.7849	-14.8039	-1.6058	-1.7436
11572	106.145833	27.020833	1210.287	-30.7411	-10.1454	-0.6859	-0.7341
11573	106.187500	27.020833	1228.340	-30.6802	-3.6100	0.6175	0.7001
11574	106.229167	27.020833	1247.396	-30.6183	1.9480	1.7425	1.9451
11575	106.270833	27.020833	1244.440	-30.5729	3.5017	2.0024	2.2364
11576	106.312500	27.020833	1199.469	-30.5503	-0.1382	1.0932	1.2296
11577	106.354167	27.020833	1183.494	-30.5360	-6.8208	-0.4436	-0.4670
11578	106.395833	27.020833	1109.535	-30.4998	-11.3515	-1.4961	-1.6243
11579	106.437500	27.020833	1000.613	-30.4157	-8.9350	-1.1580	-1.2536
11580	106.479167	27.020833	1135.735	-30.2841	0.8626	0.4426	0.5050
11581	106.520833	27.020833	1249.869	-30.1357	11.6378	2.4377	2.7100
11582	106.562500	27.020833	1251.986	-30.0096	17.2750	3.1842	3.5191
11583	106.604167	27.020833	1289.077	-29.9216	15.2947	2.2168	2.4126
11584	106.645833	27.020833	1292.154	-29.8523	10.0757	0.5266	0.5016
11585	106.687500	27.020833	1228.242	-29.7662	8.2597	-0.1705	-0.2775
11586	106.729167	27.020833	1211.352	-29.6471	13.0764	0.8541	0.8714
11587	106.770833	27.020833	1339.471	-29.5138	20.7468	2.8368	3.0884

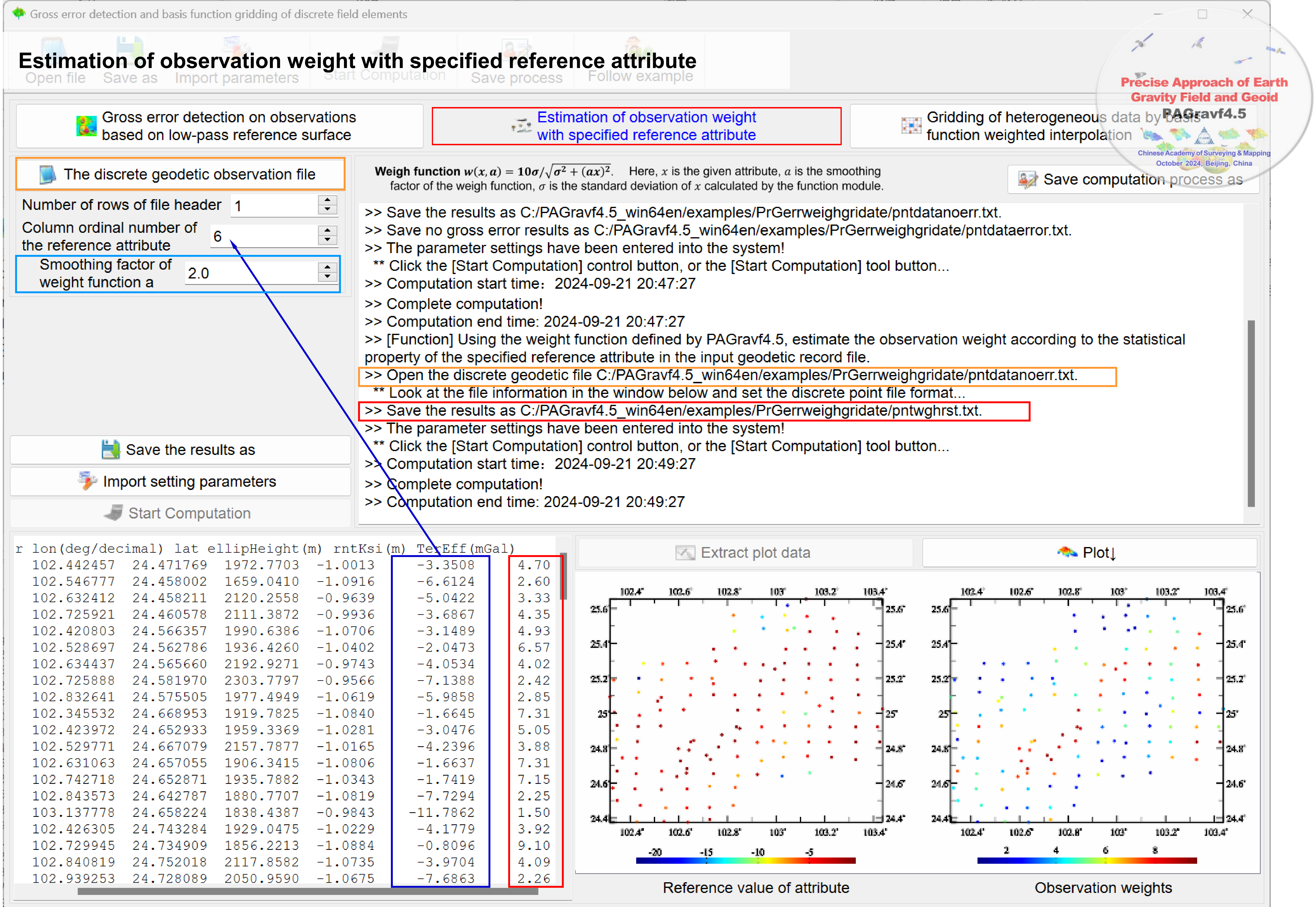


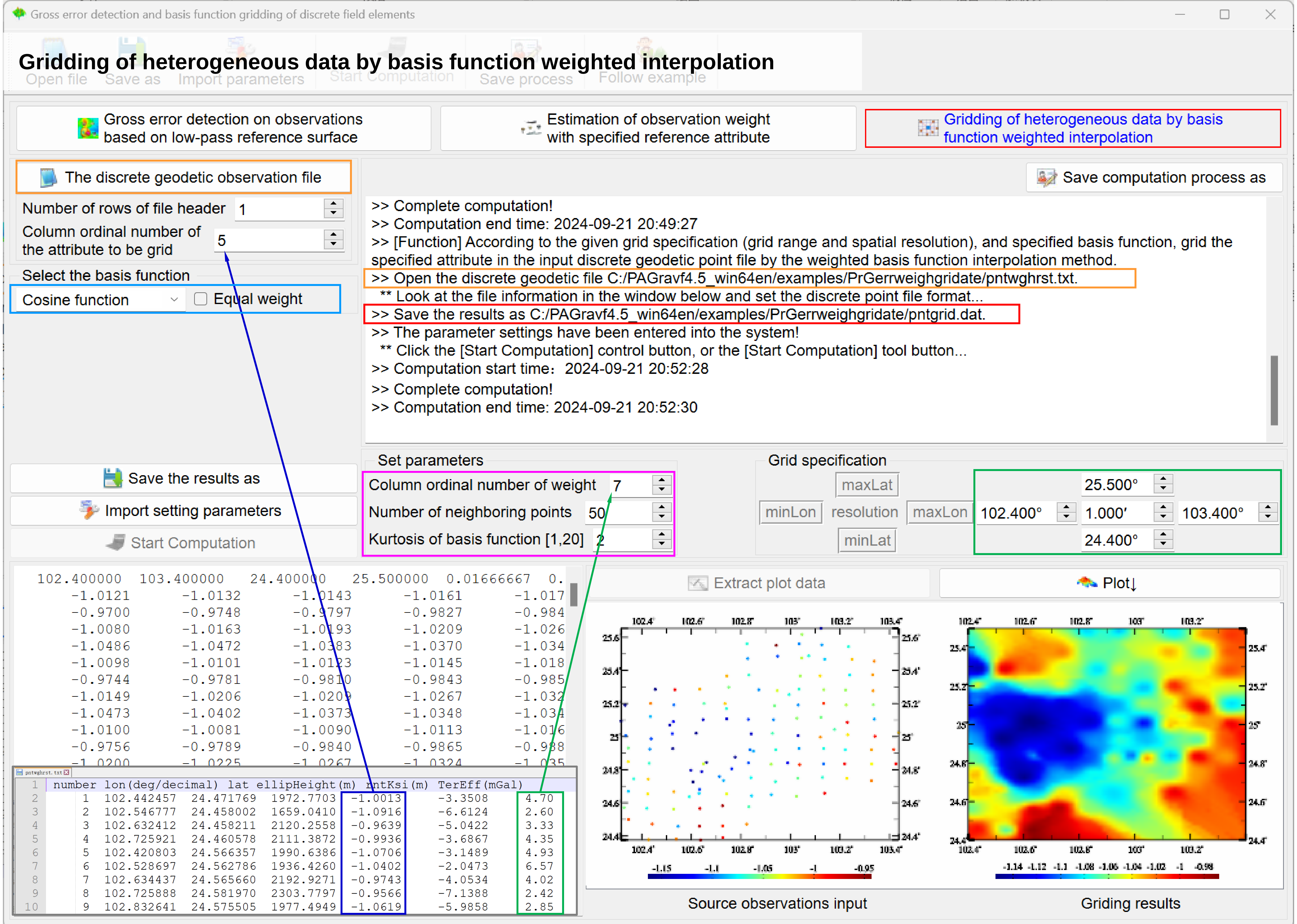
The radial gradient continuation method adopts the gradient of the observed field element to make analytical continuation, which is suitable for the upward and downward analytical continuation of ground, flight altitude and near range (10km).

The main components of the field element gradient are short-wave and ultra-short-wave, and the integral radius for radial gradient calculation generally does not need to be large. Therefore, the analytical continuation by the radial gradient method is conducive to the efficient usage of gravity field observation resources.

Gross error detection on observations based on low-pass reference surface

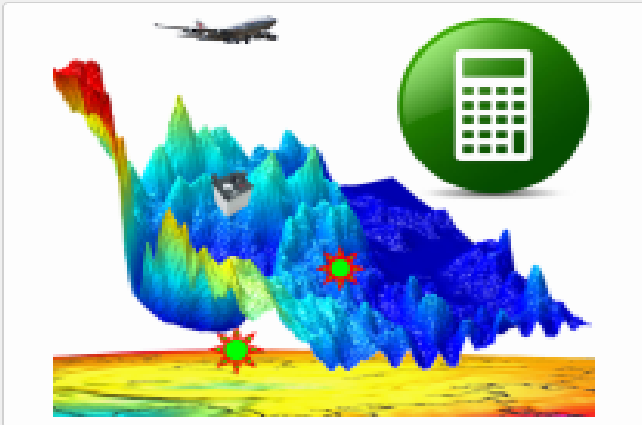



Gross error detection and basis function gridding of discrete field elements
Estimation of observation weight with specified reference attribute
Open file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Gross error detection on observations based on low-pass reference surface
Estimation of observation weight with specified reference attribute
Gridding of heterogeneous data by basis function weighted interpolation
The discrete geodetic observation file
Number of rows of file header 1
Column ordinal number of the reference attribute 6
Smoothing factor of weight function a 2.0
Weigh function $w(x,a) = 10\sigma/\sqrt{\sigma^2 + (ax)^2}$. Here, x is the given attribute, a is the smoothing factor of the weigh function, σ is the standard deviation of x calculated by the function module.
Save computation process as
>> Save the results as C:/PAGravf4.5_win64en/examples/PrGerrweighgridate/pntdatanoerr.txt.
>> Save no gross error results as C:/PAGravf4.5_win64en/examples/PrGerrweighgridate/pntdataerror.txt.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-21 20:47:27
>> Complete computation!
>> Computation end time: 2024-09-21 20:47:27
>> [Function] Using the weight function defined by PAGravf4.5, estimate the observation weight according to the statistical property of the specified reference attribute in the input geodetic record file.
>> Open the discrete geodetic file C:/PAGravf4.5_win64en/examples/PrGerrweighgridate/pntdatanoerr.txt.
** Look at the file information in the window below and set the discrete point file format...
>> Save the results as C:/PAGravf4.5_win64en/examples/PrGerrweighgridate/pntwghrst.txt.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-21 20:49:27
>> Complete computation!
>> Computation end time: 2024-09-21 20:49:27
Save the results as
Import setting parameters
Start Computation
r lon(deg/decimal) lat ellipHeight(m) rntKsi(m) TerEff(mGal)
102.442457 24.471769 1972.7703 -1.0013 -3.3508 4.70
102.546777 24.458002 1659.0410 -1.0916 -6.6124 2.60
102.632412 24.458211 2120.2558 -0.9639 -5.0422 3.33
102.725921 24.460578 2111.3872 -0.9936 -3.6867 4.35
102.420803 24.566357 1990.6386 -1.0706 -3.1489 4.93
102.528697 24.562786 1936.4260 -1.0402 -2.0473 6.57
102.634437 24.565660 2192.9271 -0.9743 -4.0534 4.02
102.725888 24.581970 2303.7797 -0.9566 -7.1388 2.42
102.832641 24.575505 1977.4949 -1.0619 -5.9858 2.85
102.345532 24.668953 1919.7825 -1.0840 -1.6645 7.31
102.423972 24.652933 1959.3369 -1.0281 -3.0476 5.05
102.529771 24.667079 2157.7877 -1.0165 -4.2396 3.88
102.631063 24.657055 1906.3415 -1.0806 -1.6637 7.31
102.742718 24.652871 1935.7882 -1.0343 -1.7419 7.15
102.843573 24.642787 1880.7707 -1.0819 -7.7294 2.25
103.137778 24.658224 1838.4387 -0.9843 -11.7862 1.50
102.426305 24.743284 1929.0475 -1.0229 -4.1779 3.92
102.729945 24.734909 1856.2213 -1.0884 -0.8096 9.10
102.840819 24.752018 2117.8582 -1.0735 -3.9704 4.09
102.939253 24.728089 2050.9590 -1.0675 -7.6863 2.26
Extract plot data
Plot
Reference value of attribute
Observation weights

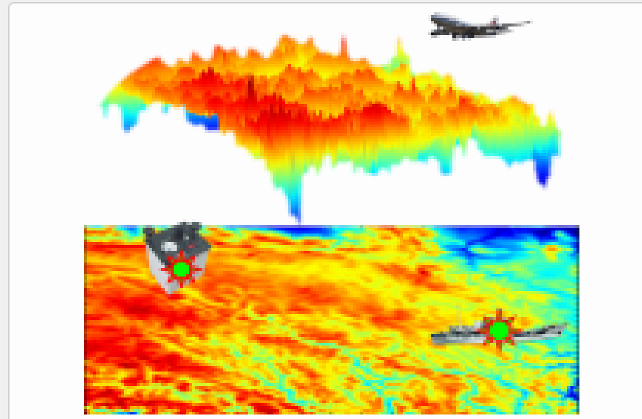

Gross error detection and basis function gridding of discrete field elements
Gridding of heterogeneous data by basis function weighted interpolation
Open file
Save as
Import parameters
Start Computation
Save process
Follow example
Gross error detection on observations based on low-pass reference surface
Estimation of observation weight with specified reference attribute
Gridding of heterogeneous data by basis function weighted interpolation
The discrete geodetic observation file
Number of rows of file header 1
Column ordinal number of the attribute to be grid 5
Select the basis function
Cosine function
Equal weight
Save computation process as
>> Complete computation!
>> Computation end time: 2024-09-21 20:49:27
>> [Function] According to the given grid specification (grid range and spatial resolution), and specified basis function, grid the specified attribute in the input discrete geodetic point file by the weighted basis function interpolation method.
>> Open the discrete geodetic file C:/PAGravf4.5_win64en/examples/PrGerrweighgridate/pntwghrst.txt.
** Look at the file information in the window below and set the discrete point file format...
>> Save the results as C:/PAGravf4.5_win64en/examples/PrGerrweighgridate/pntgrid.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-21 20:52:28
>> Complete computation!
>> Computation end time: 2024-09-21 20:52:30
Save the results as
Import setting parameters
Start Computation
Set parameters
Column ordinal number of weight 7
Number of neighboring points 50
Kurtosis of basis function [1,20] 2
Grid specification
maxLat 25.500°
minLon 102.400°
resolution 1.000′
maxLon 103.400°
minLat 24.400°
Extract plot data
Plot↓
102.400000 103.400000 24.400000 25.500000 0.01666667 0.
-1.0121 -1.0132 -1.0143 -1.0161 -1.017
-0.9700 -0.9748 -0.9797 -0.9827 -0.984
-1.0080 -1.0163 -1.0193 -1.0209 -1.026
-1.0486 -1.0472 -1.0383 -1.0370 -1.034
-1.0098 -1.0101 -1.0123 -1.0145 -1.018
-0.9744 -0.9781 -0.9810 -0.9843 -0.985
-1.0149 -1.0206 -1.0209 -1.0267 -1.032
-1.0473 -1.0402 -1.0373 -1.0348 -1.034
-1.0100 -1.0081 -1.0090 -1.0113 -1.016
-0.9756 -0.9789 -0.9840 -0.9865 -0.988
pntwghrst.txt
number lon(deg/decimal) lat ellipHeight(m) ntKsi(m) TerEff(mGal)
1 102.442457 24.471769 1972.7703 -1.0013 -3.3508 4.70
2 102.546777 24.458002 1659.0410 -1.0916 -6.6124 2.60
3 102.632412 24.458211 2120.2558 -0.9639 -5.0422 3.33
4 102.725921 24.460578 2111.3872 -0.9936 -3.6867 4.35
5 102.420803 24.566357 1990.6386 -1.0706 -3.1489 4.93
6 102.528697 24.562786 1936.4260 -1.0402 -2.0473 6.57
7 102.634437 24.565660 2192.9271 -0.9743 -4.0534 4.02
8 102.725888 24.581970 2303.7797 -0.9566 -7.1388 2.42
9 102.832641 24.575505 1977.4949 -1.0619 -5.9858 2.85
Source observations input
Griding results

Computation of various terrain effects on various field elements outside geoid

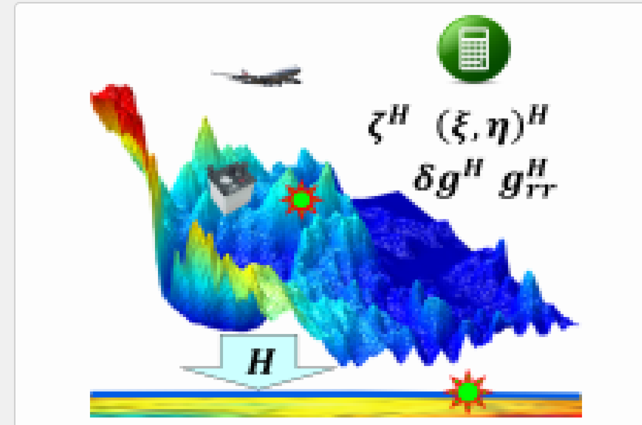
Computation of various terrain effects on various field elements outside geoid



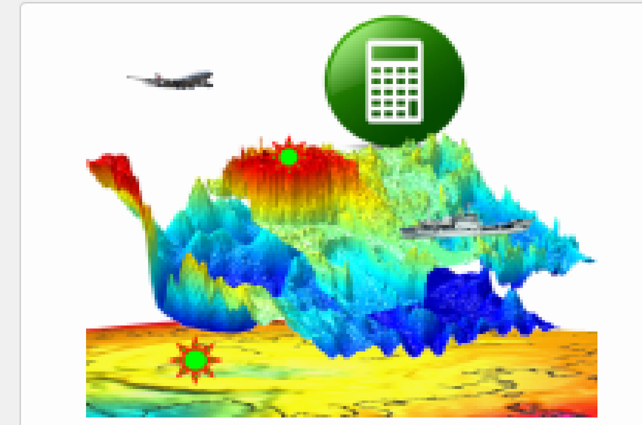
Computation of local terrain effect on various field elements on or outside the geoid



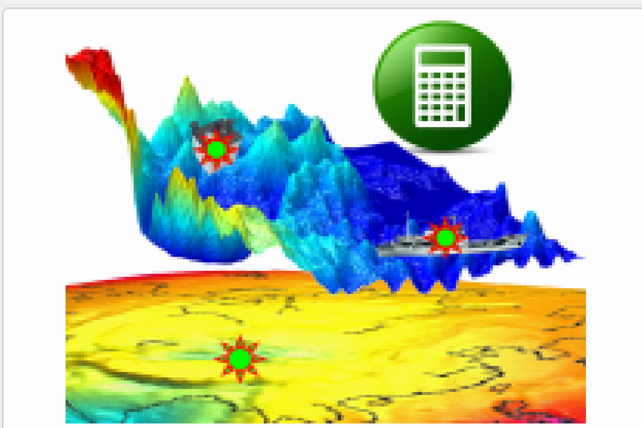
Integral of land, ocean and lake complete Bouguer effect on gravity outside geoid



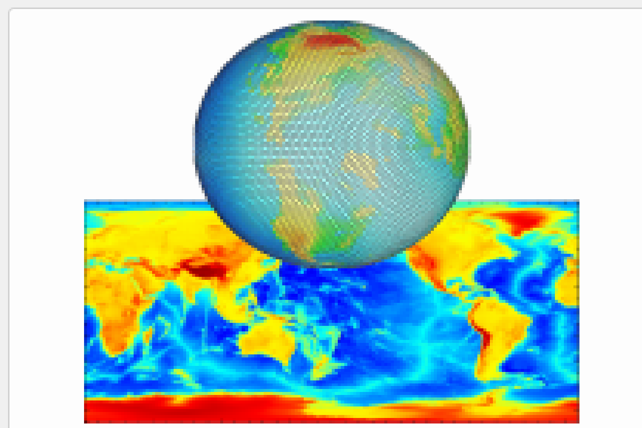
Computation of terrain Helmert condensation effect on various field elements outside geoid



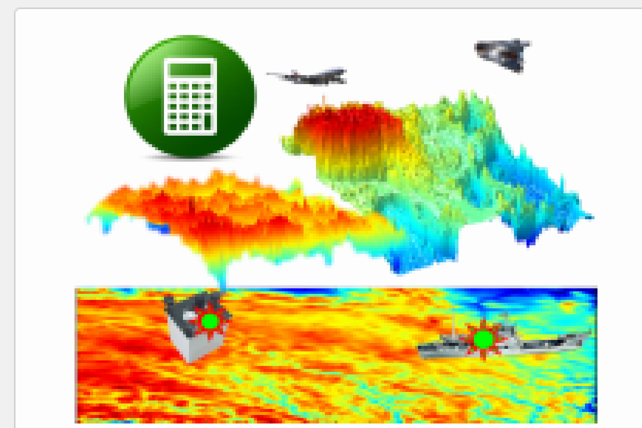
Computation of residual terrain effect on various field elements outside geoid



Computation of land-sea unified classical gravity Bouguer / equilibrium effect



Ultrahigh degree spherical harmonic analysis on land-sea terrain and construction of model



Spherical harmonic synthesis of complete Bouguer or residual terrain effects

Computation process demo of complete Bouguer anomaly on terrain equiheight surface

Computation process demo of land-sea Bouguer / equilibrium anomaly from geopotential model

Computation process demo of various terrain effects outside geoid

- **Cross aliasing of heterogeneous observations in land-sea-space**
- **Full analytical compatibility and algorithm performance control**
- **Various terrain effects on all-element gravity field in whole space**
- **Gravity prospecting modelling from heterogeneous observations**

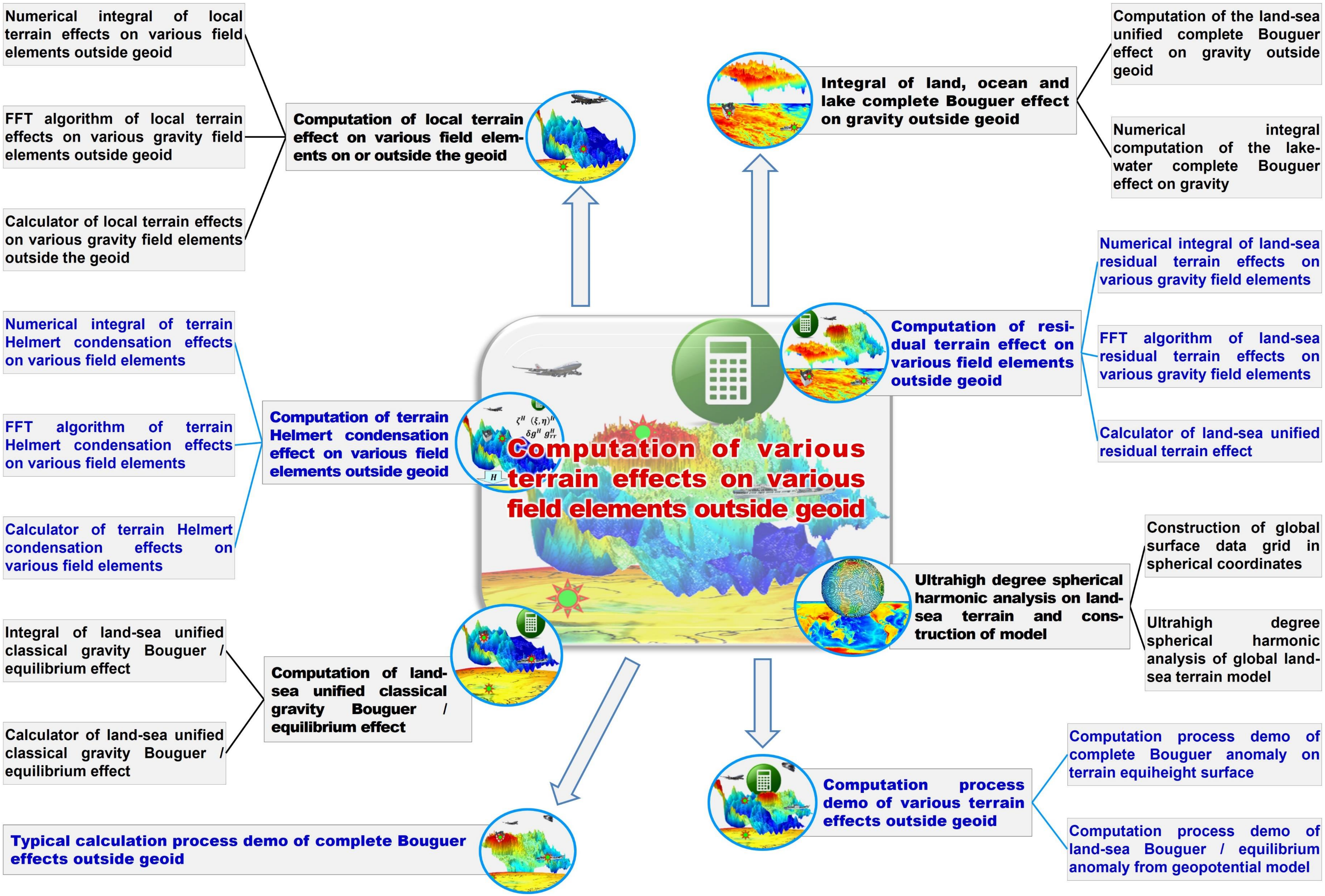
Programs and functions structure of the subsystem

Quantitative criterions for terrain effects defined by PAGravf4.5

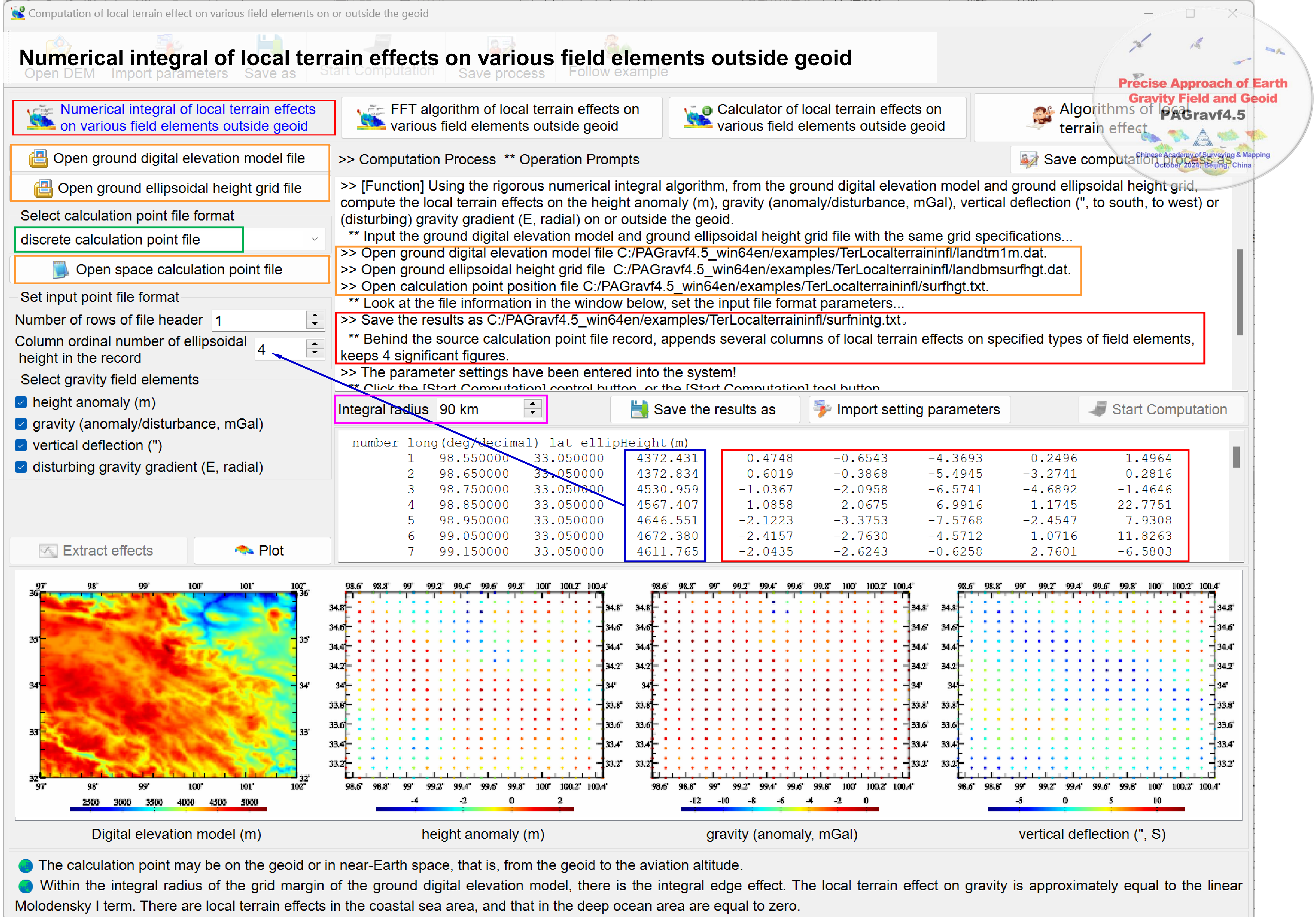
(1) In order to improve the griding performance of discrete field elements, it is expected to improve the smoothness of discrete field elements after the terrain effect removed. In this case, the optimal criterion for terrain effect is that the standard deviation of discrete field elements would decrease after the terrain effect removed. This quantitative criterion is also applicable for gravity prospecting modelling.

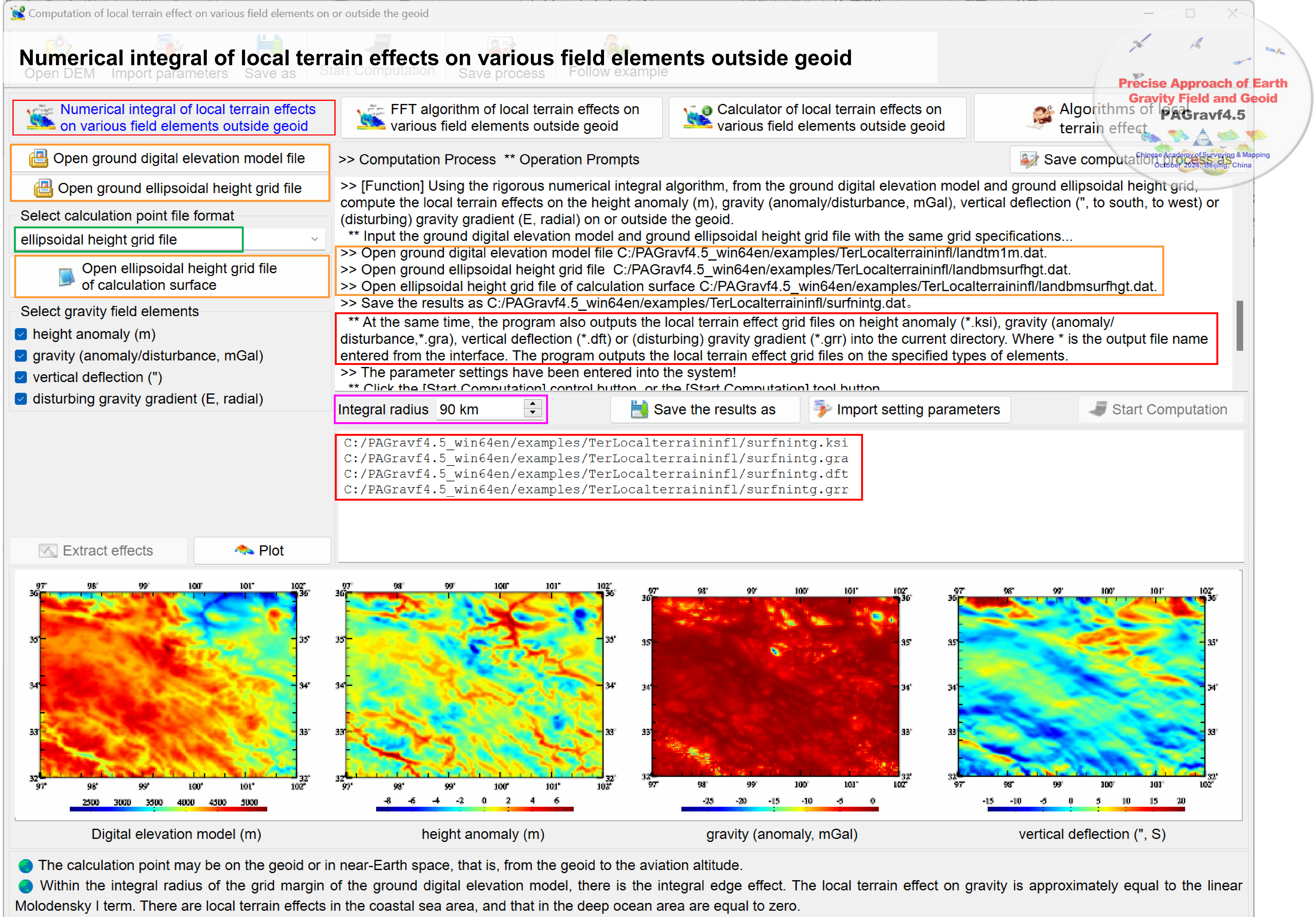
(2) The terrain effect is expected to consist of only ultrashort wave components for gravity field approach purpose, so the optimal criterion should be that the standard deviation of field elements after the terrain effect removed would decrease, and the statistical mean of terrain effects in the range of tens of kilometers is small.

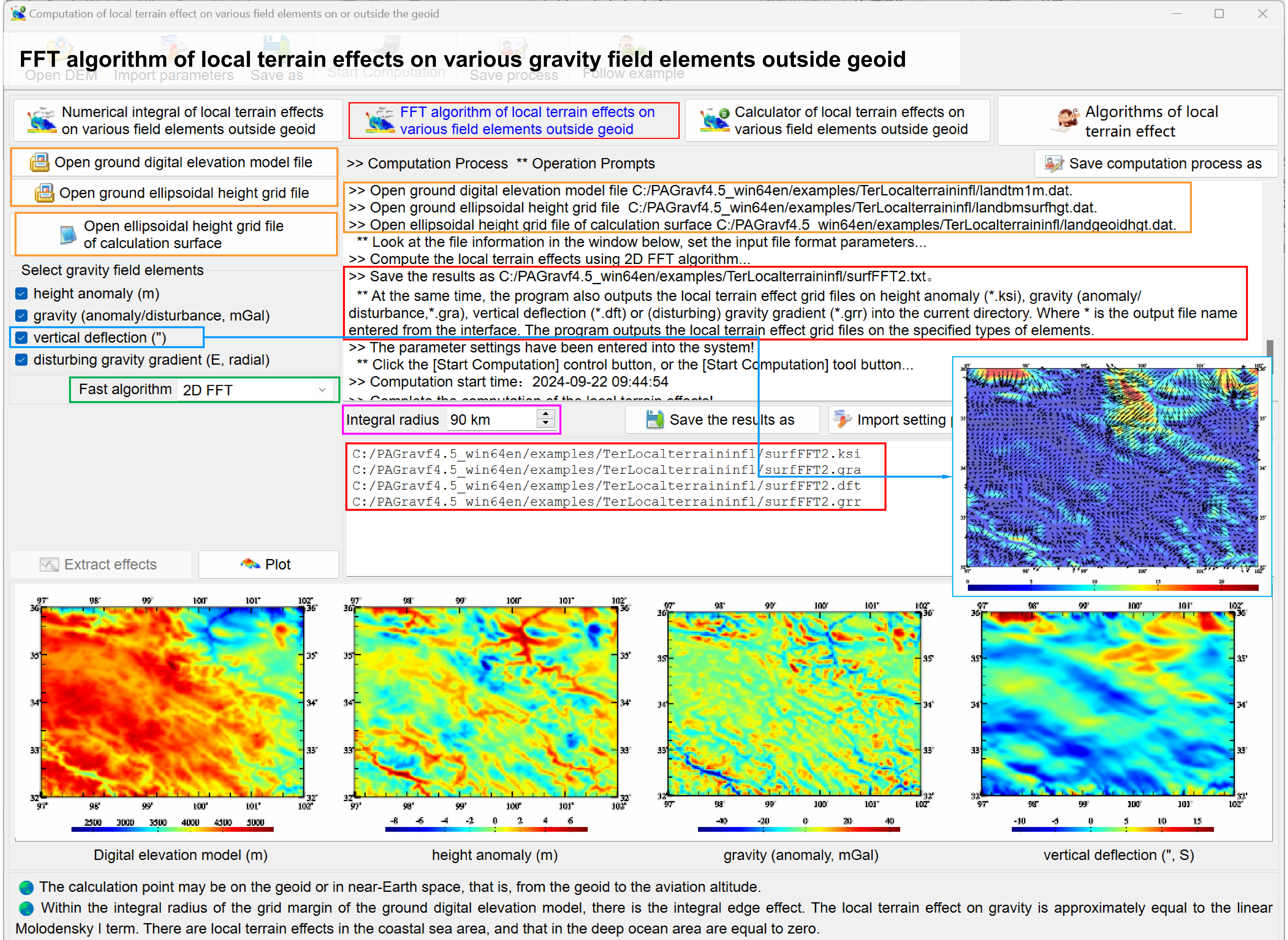
The normal gravity field is the agreed starting datum for the anomalous gravity field, and there is no terrain effect on the normal gravity field. Therefore, the terrain effects on the gravity, gravity disturbance and gravity anomaly anywhere are exact equal, that on the geopotential and disturbing geopotential and that on the gravity gradient and disturbing gravity gradient are also equal, espectively.

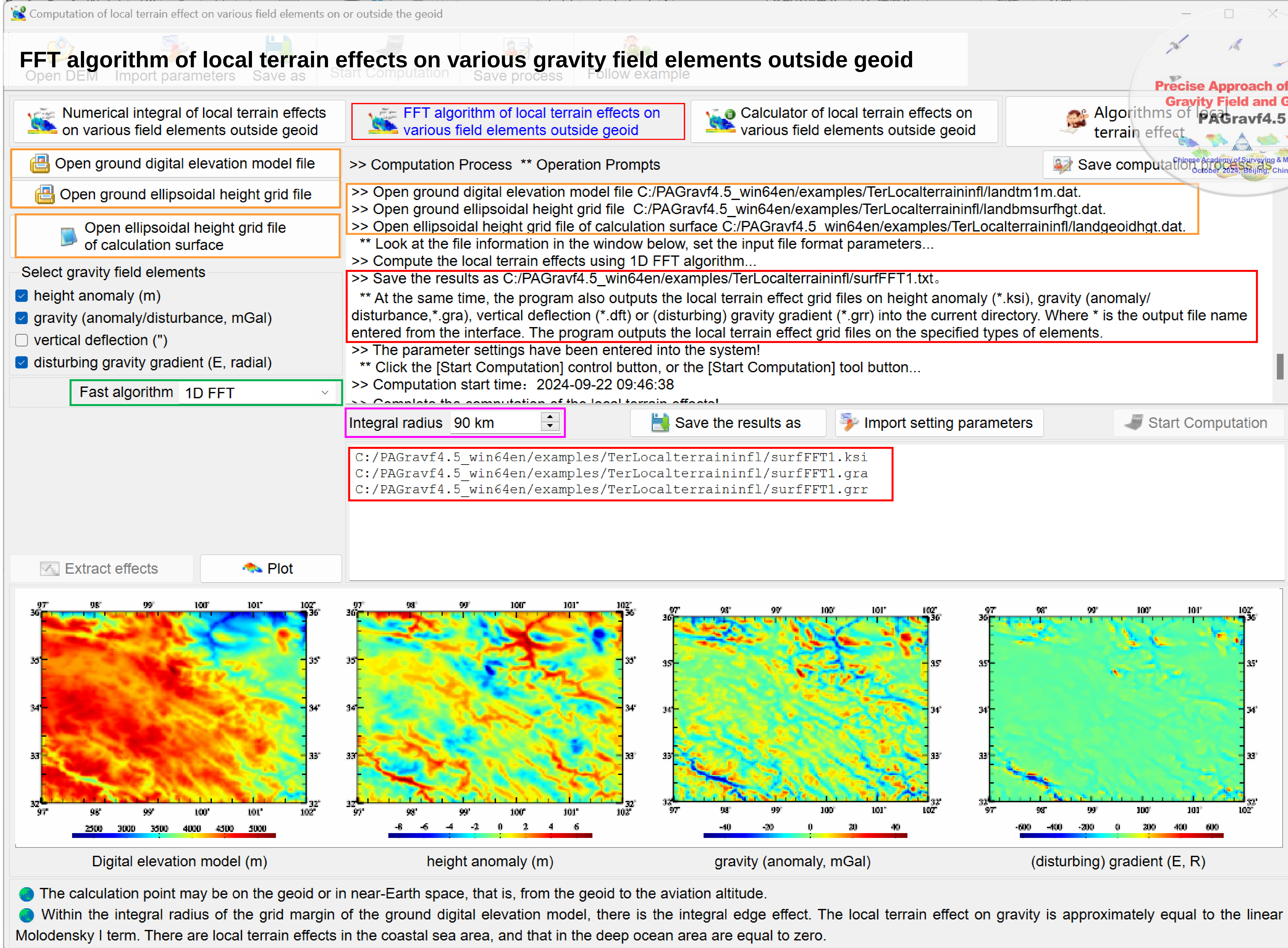


Computation of various terrain effects on various field elements outside geoid
Numerical integral of local terrain effects on various field elements outside geoid
FFT algorithm of local terrain effects on various gravity field elements outside geoid
Calculator of local terrain effects on various gravity field elements outside the geoid
Computation of local terrain effect on various field elements on or outside the geoid
Integral of land, ocean and lake complete Bouguer effect on gravity outside geoid
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Numerical integral of land-sea residual terrain effects on various gravity field elements
FFT algorithm of land-sea residual terrain effects on various gravity field elements
Calculator of land-sea unified residual terrain effect
Computation of residual terrain effect on various field elements outside geoid
Numerical integral of terrain Helmert condensation effects on various field elements
FFT algorithm of terrain Helmert condensation effects on various field elements
Calculator of terrain Helmert condensation effects on various field elements
Computation of terrain Helmert condensation effect on various field elements outside geoid
Construction of global surface data grid in spherical coordinates
Ultrahigh degree spherical harmonic analysis of global land-sea terrain model
Ultrahigh degree spherical harmonic analysis on land-sea terrain and construction of model
Integral of land-sea unified classical gravity Bouguer / equilibrium effect
Calculator of land-sea unified classical gravity Bouguer / equilibrium effect
Computation of land-sea unified classical gravity Bouguer / equilibrium effect
Typical calculation process demo of complete Bouguer effects outside geoid
Computation process demo of various terrain effects outside geoid
Computation process demo of complete Bouguer anomaly on terrain equiheight surface
Computation process demo of land-sea Bouguer / equilibrium anomaly from geopotential model

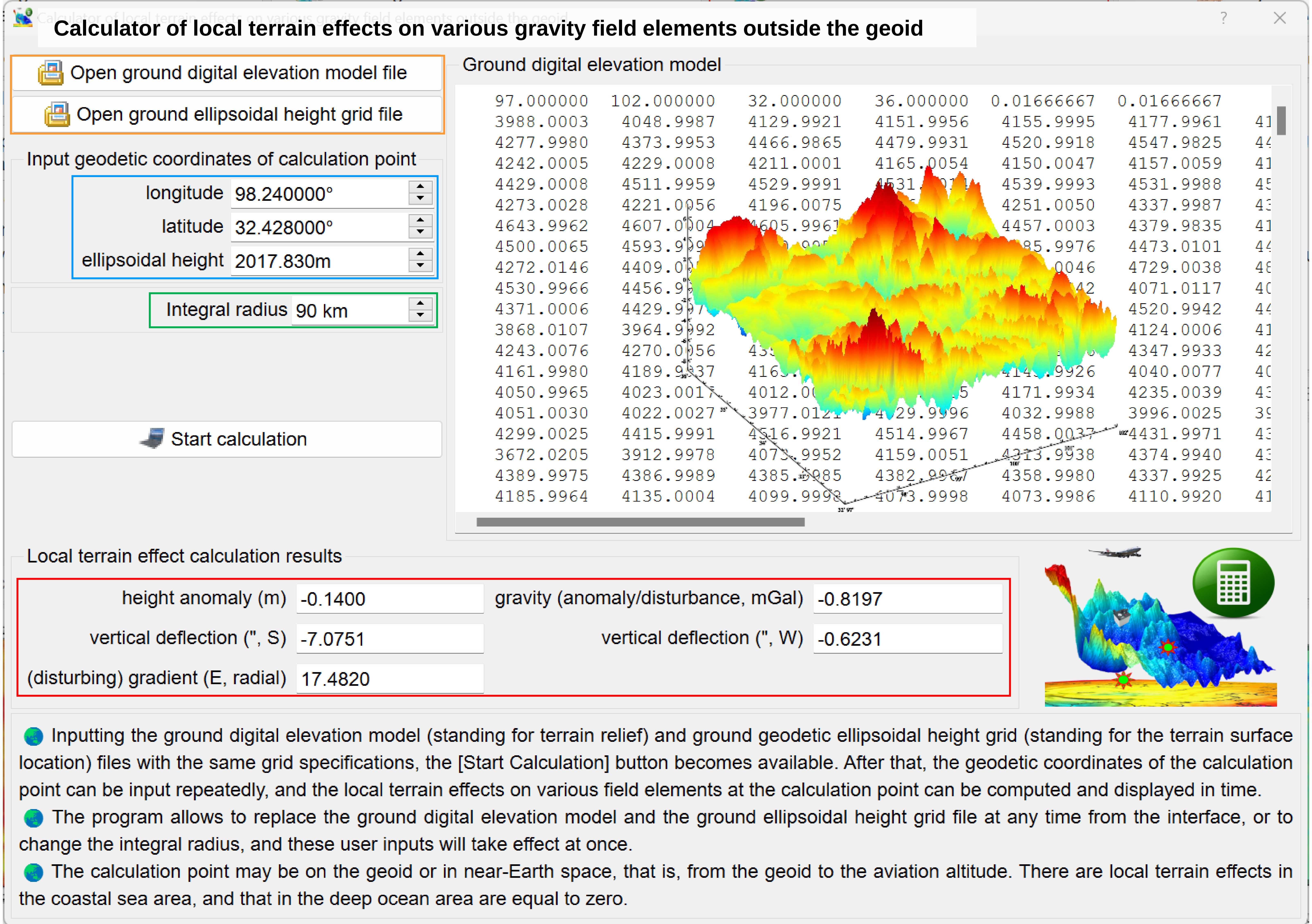

Computation of local terrain effect on various field elements on or outside the geoid
Numerical integral of local terrain effects on various field elements outside geoid
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Numerical integral of local terrain effects on various field elements outside geoid
FFT algorithm of local terrain effects on various field elements outside geoid
Calculator of local terrain effects on various field elements outside geoid
Algorithms of local terrain effect
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open ground digital elevation model file
Open ground ellipsoidal height grid file
Select calculation point file format
discrete calculation point file
Open space calculation point file
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (")
disturbing gravity gradient (E, radial)
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid, compute the local terrain effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west) or (disturbing) gravity gradient (E, radial) on or outside the geoid.
** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open calculation point position file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfhgt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.txt。
** Behind the source calculation point file record, appends several columns of local terrain effects on specified types of field elements, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
Integral radius 90 km
Save the results as
Import setting parameters
Start Computation
number long(deg/decimal) lat ellipHeight(m)
1 98.550000 33.050000 4372.431 0.4748 -0.6543 -4.3693 0.2496 1.4964
2 98.650000 33.050000 4372.834 0.6019 -0.3868 -5.4945 -3.2741 0.2816
3 98.750000 33.050000 4530.959 -1.0367 -2.0958 -6.5741 -4.6892 -1.4646
4 98.850000 33.050000 4567.407 -1.0858 -2.0675 -6.9916 -1.1745 22.7751
5 98.950000 33.050000 4646.551 -2.1223 -3.3753 -7.5768 -2.4547 7.9308
6 99.050000 33.050000 4672.380 -2.4157 -2.7630 -4.5712 1.0716 11.8263
7 99.150000 33.050000 4611.765 -2.0435 -2.6243 -0.6258 2.7601 -6.5803
Extract effects
Plot
Digital elevation model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

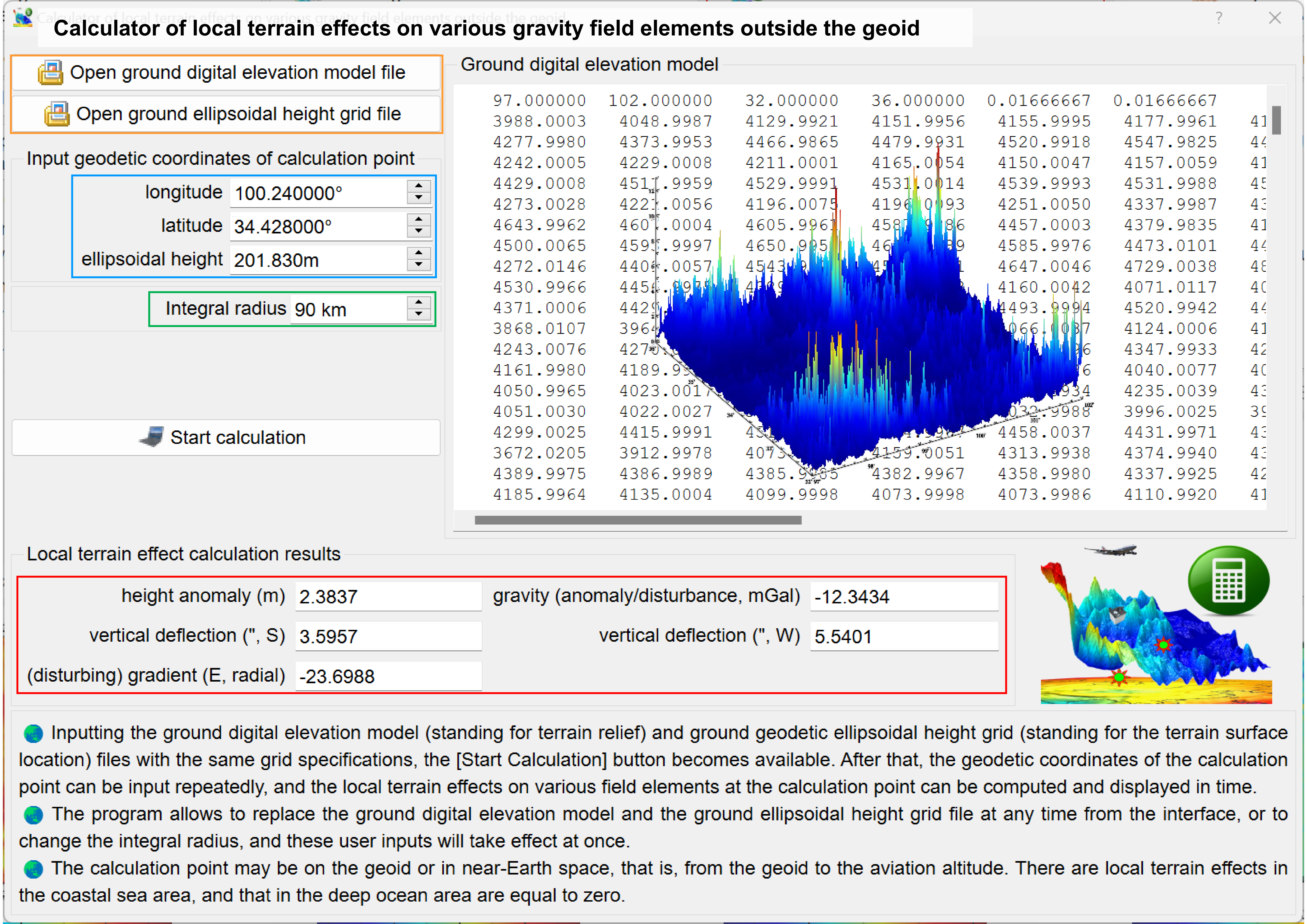

Computation of local terrain effect on various field elements on or outside the geoid
Numerical integral of local terrain effects on various field elements outside geoid
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Numerical integral of local terrain effects on various field elements outside geoid
FFT algorithm of local terrain effects on various field elements outside geoid
Calculator of local terrain effects on various field elements outside geoid
Algorithms of local terrain effect
Open ground digital elevation model file
Open ground ellipsoidal height grid file
Select calculation point file format
ellipsoidal height grid file
Open ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (")
disturbing gravity gradient (E, radial)
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid, compute the local terrain effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west) or (disturbing) gravity gradient (E, radial) on or outside the geoid.
** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.dat。
** At the same time, the program also outputs the local terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance,*.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the local terrain effect grid files on the specified types of elements.
>> The parameter settings have been entered into the system!
Integral radius 90 km
Save the results as
Import setting parameters
Start Computation
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.ksi
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.gra
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.dft
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.grr
Extract effects
Plot
Digital elevation model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.


Computation of local terrain effect on various field elements on or outside the geoid
FFT algorithm of local terrain effects on various gravity field elements outside geoid
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Numerical integral of local terrain effects on various field elements outside geoid
FFT algorithm of local terrain effects on various field elements outside geoid
Calculator of local terrain effects on various field elements outside geoid
Algorithms of local terrain effect
Open ground digital elevation model file
Open ground ellipsoidal height grid file
Open ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (")
disturbing gravity gradient (E, radial)
Fast algorithm
2D FFT
>> Computation Process ** Operation Prompts
Save computation process as
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landgeoidhgt.dat.
** Look at the file information in the window below, set the input file format parameters...
>> Compute the local terrain effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.txt。
** At the same time, the program also outputs the local terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance,*.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the local terrain effect grid files on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:44:54
Integral radius
90 km
Save the results as
Import setting
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.ksi
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.gra
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.dft
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.grr
Extract effects
Plot
Digital elevation model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

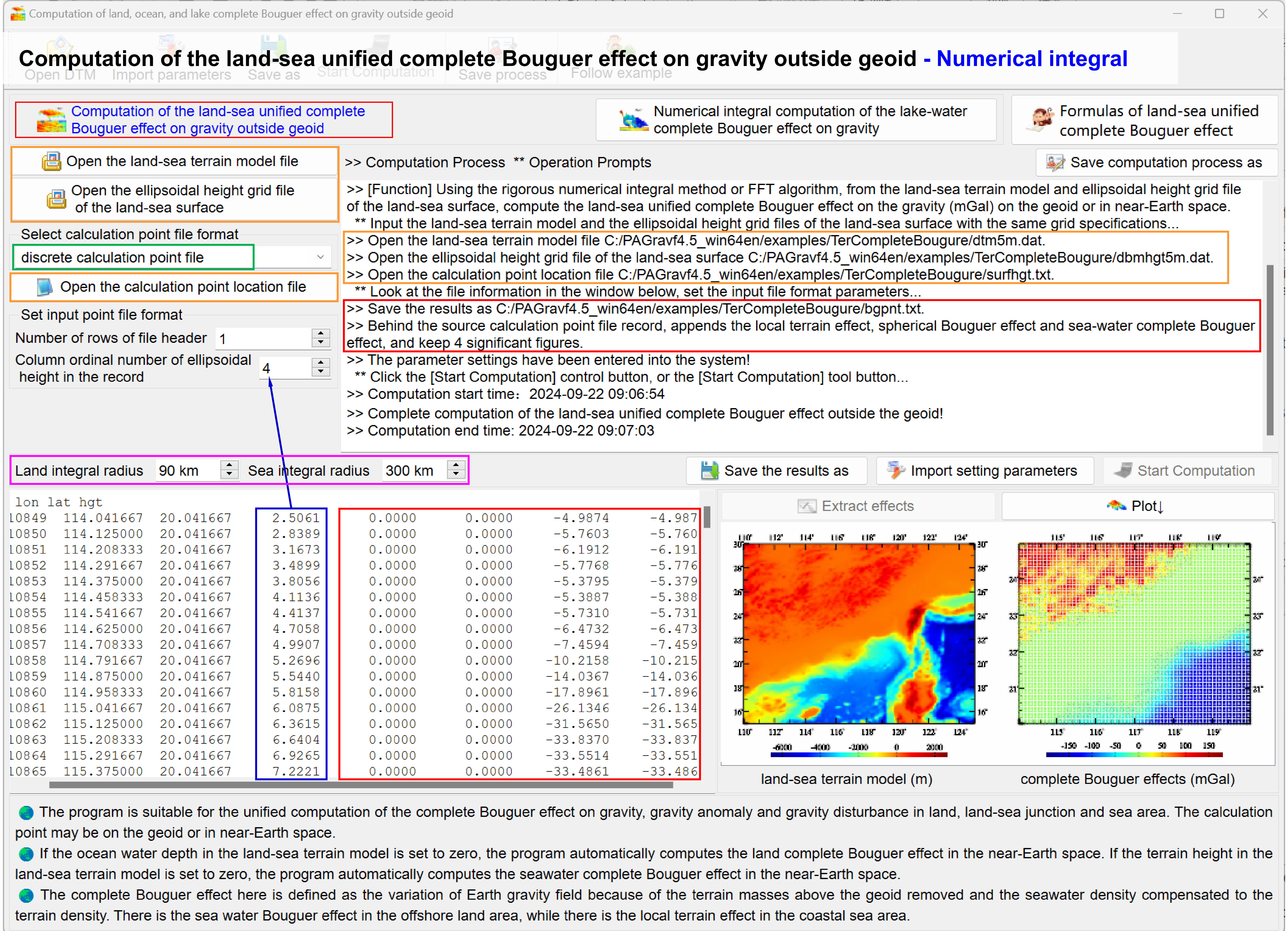


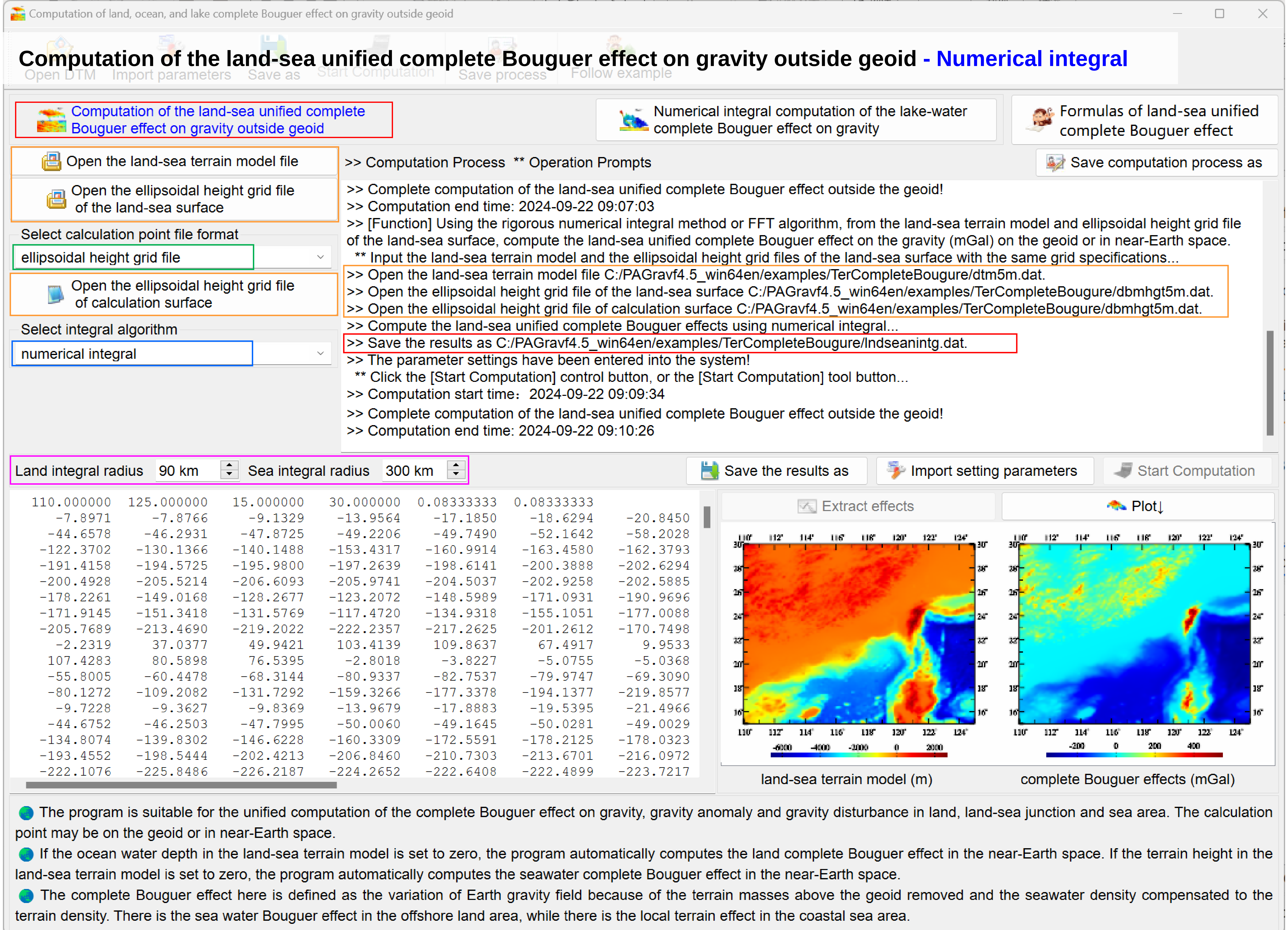
Computation of local terrain effect on various field elements on or outside the geoid
FFT algorithm of local terrain effects on various gravity field elements outside geoid
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Numerical integral of local terrain effects on various field elements outside geoid
FFT algorithm of local terrain effects on various field elements outside geoid
Calculator of local terrain effects on various field elements outside geoid
Algorithms of local terrain effect
Open ground digital elevation model file
Open ground ellipsoidal height grid file
Open ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (")
disturbing gravity gradient (E, radial)
Fast algorithm
1D FFT
>> Computation Process ** Operation Prompts
Save computation process as
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landgeoidhgt.dat.
** Look at the file information in the window below, set the input file format parameters...
>> Compute the local terrain effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.txt。
** At the same time, the program also outputs the local terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance,*.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the local terrain effect grid files on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 09:46:38
Integral radius
90 km
Save the results as
Import setting parameters
Start Computation
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.ksi
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.gra
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.grr
Extract effects
Plot
Digital elevation model (m)
height anomaly (m)
gravity (anomaly, mGal)
(disturbing) gradient (E, R)
The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

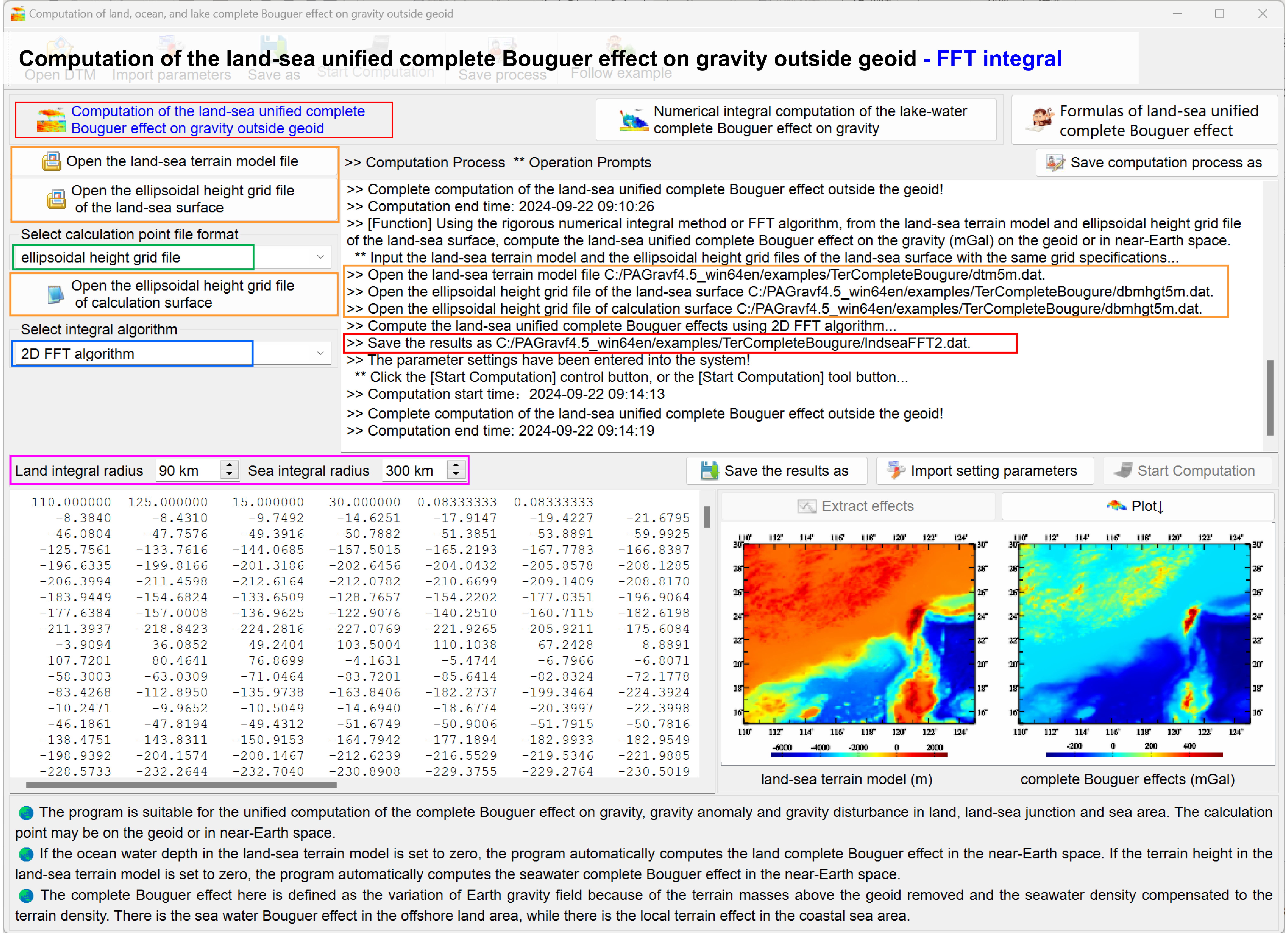

Calculator of local terrain effects on various gravity field elements outside the geoid
Open ground digital elevation model file
Open ground ellipsoidal height grid file
Ground digital elevation model
97.000000 102.000000 32.000000 36.000000 0.01666667 0.01666667
3988.0003 4048.9987 4129.9921 4151.9956 4155.9995 4177.9961
4277.9980 4373.9953 4466.9865 4479.9931 4520.9918 4547.9825
4242.0005 4229.0008 4211.0001 4165.0054 4150.0047 4157.0059
Input geodetic coordinates of calculation point
longitude 98.240000°
latitude 32.428000°
ellipsoidal height 2017.830m
Integral radius 90 km
Start calculation
Local terrain effect calculation results
height anomaly (m) -0.1400
gravity (anomaly/disturbance, mGal) -0.8197
vertical deflection (", S) -7.0751
vertical deflection (", W) -0.6231
(disturbing) gradient (E, radial) 17.4820
Inputting the ground digital elevation model (standing for terrain relief) and ground geodetic ellipsoidal height grid (standing for the terrain surface location) files with the same grid specifications, the [Start Calculation] button becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the local terrain effects on various field elements at the calculation point can be computed and displayed in time.
The program allows to replace the ground digital elevation model and the ground ellipsoidal height grid file at any time from the interface, or to change the integral radius, and these user inputs will take effect at once.
The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.



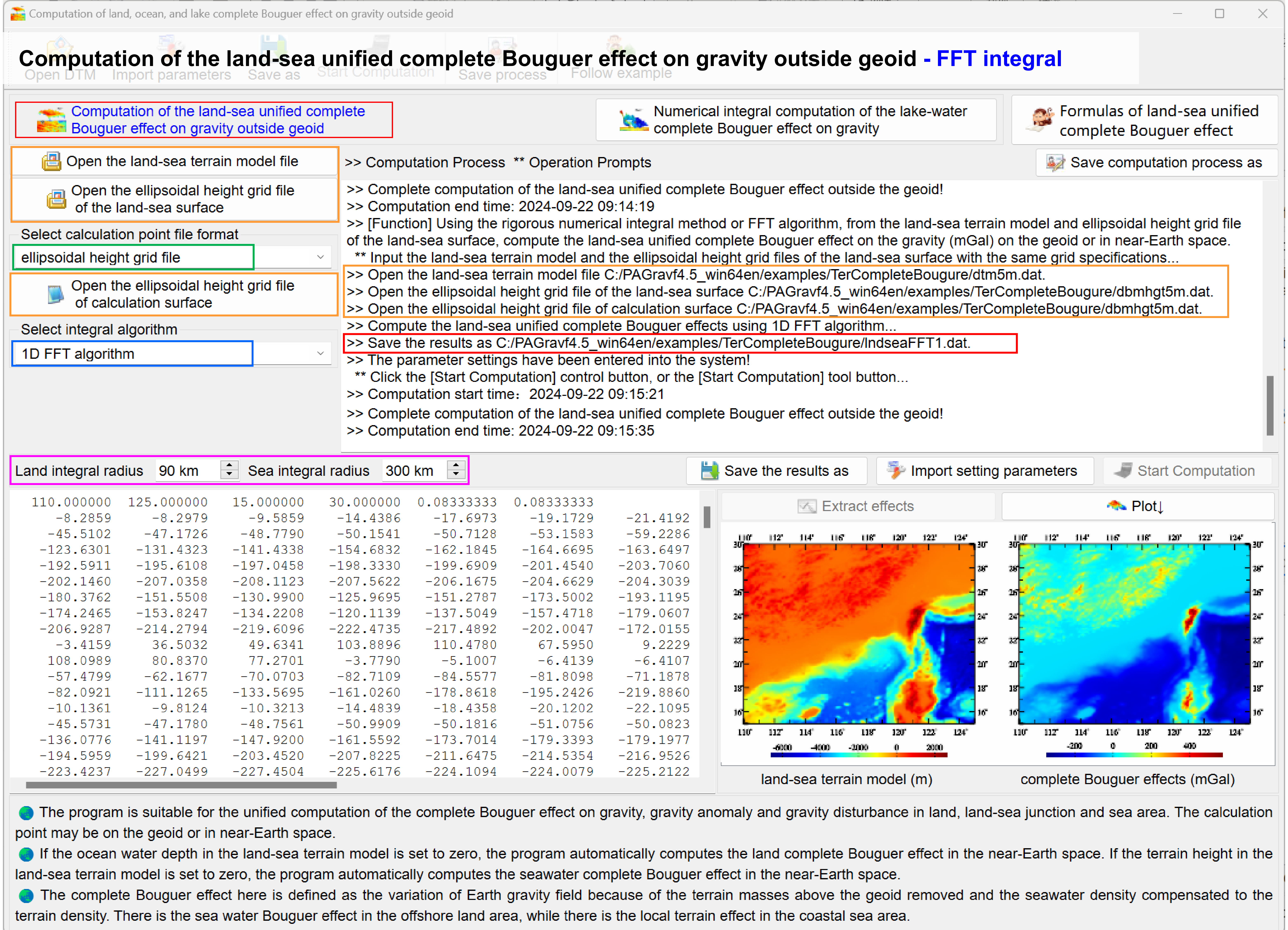
Calculator of local terrain effects on various gravity field elements outside the geoid
Open ground digital elevation model file
Open ground ellipsoidal height grid file
Input geodetic coordinates of calculation point
longitude 100.240000°
latitude 34.428000°
ellipsoidal height 201.830m
Integral radius 90 km
Start calculation
Ground digital elevation model
97.000000 102.000000 32.000000 36.000000 0.01666667 0.01666667
Local terrain effect calculation results
height anomaly (m) 2.3837
gravity (anomaly/disturbance, mGal) -12.3434
vertical deflection (", S) 3.5957
vertical deflection (", W) 5.5401
(disturbing) gradient (E, radial) -23.6988
Inputting the ground digital elevation model (standing for terrain relief) and ground geodetic ellipsoidal height grid (standing for the terrain surface location) files with the same grid specifications, the [Start Calculation] button becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the local terrain effects on various field elements at the calculation point can be computed and displayed in time.
The program allows to replace the ground digital elevation model and the ground ellipsoidal height grid file at any time from the interface, or to change the integral radius, and these user inputs will take effect at once.
The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

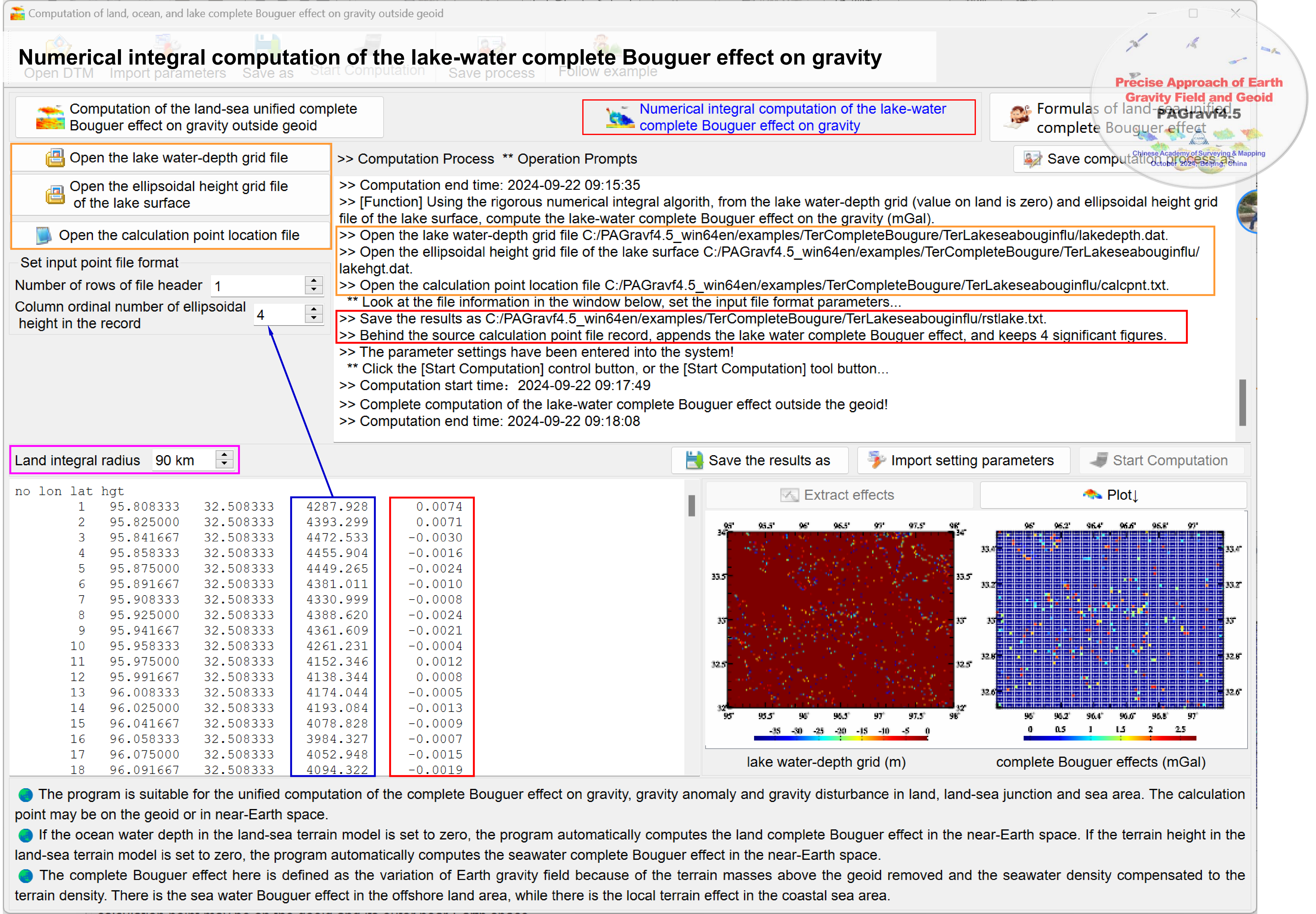

Computation of land, ocean, and lake complete Bouguer effect on gravity outside geoid
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - Numerical integral
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Formulas of land-sea unified complete Bouguer effect
Open the land-sea terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Select calculation point file format
discrete calculation point file
Open the calculation point location file
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/surfhgt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/bgpnt.txt.
>> Behind the source calculation point file record, appends the local terrain effect, spherical Bouguer effect and sea-water complete Bouguer effect, and keep 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:06:54
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:07:03
Land integral radius 90 km
Sea integral radius 300 km
Save the results as
Import setting parameters
Start Computation
Extract effects
Plot↓
lon lat hgt
10849 114.041667 20.041667 2.5061 0.0000 0.0000 -4.9874 -4.987
10850 114.125000 20.041667 2.8389 0.0000 0.0000 -5.7603 -5.760
10851 114.208333 20.041667 3.1673 0.0000 0.0000 -6.1912 -6.191
10852 114.291667 20.041667 3.4899 0.0000 0.0000 -5.7768 -5.776
10853 114.375000 20.041667 3.8056 0.0000 0.0000 -5.3795 -5.379
10854 114.458333 20.041667 4.1136 0.0000 0.0000 -5.3887 -5.388
10855 114.541667 20.041667 4.4137 0.0000 0.0000 -5.7310 -5.731
10856 114.625000 20.041667 4.7058 0.0000 0.0000 -6.4732 -6.473
10857 114.708333 20.041667 4.9907 0.0000 0.0000 -7.4594 -7.459
10858 114.791667 20.041667 5.2696 0.0000 0.0000 -10.2158 -10.215
10859 114.875000 20.041667 5.5440 0.0000 0.0000 -14.0367 -14.036
10860 114.958333 20.041667 5.8158 0.0000 0.0000 -17.8961 -17.896
10861 115.041667 20.041667 6.0875 0.0000 0.0000 -26.1346 -26.134
10862 115.125000 20.041667 6.3615 0.0000 0.0000 -31.5650 -31.565
10863 115.208333 20.041667 6.6404 0.0000 0.0000 -33.8370 -33.837
10864 115.291667 20.041667 6.9265 0.0000 0.0000 -33.5514 -33.551
10865 115.375000 20.041667 7.2221 0.0000 0.0000 -33.4861 -33.486
land-sea terrain model (m)
complete Bouguer effects (mGal)
The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.
If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.
The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

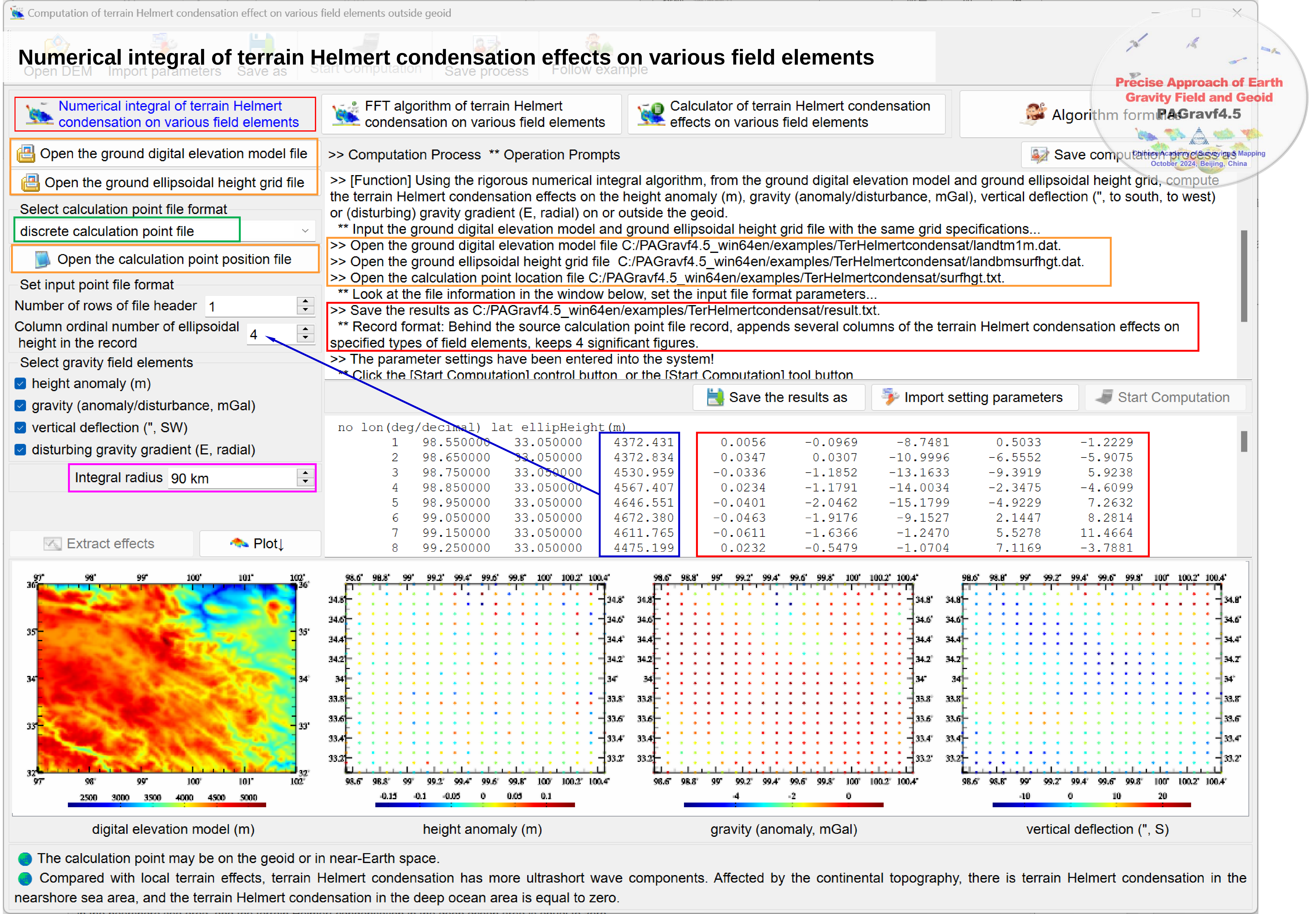

Computation of land, ocean, and lake complete Bouguer effect on gravity outside geoid
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - Numerical integral
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Formulas of land-sea unified complete Bouguer effect
Open the land-sea terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of calculation surface
Select integral algorithm
numerical integral
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:07:03
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Compute the land-sea unified complete Bouguer effects using numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/lndseanintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 09:09:34
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:10:26
Land integral radius 90 km Sea integral radius 300 km
Save the results as
Import setting parameters
Start Computation
110.000000 125.000000 15.000000 30.000000 0.08333333 0.08333333
-7.8971 -7.8766 -9.1329 -13.9564 -17.1850 -18.6294 -20.8450
-44.6578 -46.2931 -47.8725 -49.2206 -49.7490 -52.1642 -58.2028
-122.3702 -130.1366 -140.1488 -153.4317 -160.9914 -163.4580 -162.3793
-191.4158 -194.5725 -195.9800 -197.2639 -198.6141 -200.3888 -202.6294
-200.4928 -205.5214 -206.6093 -205.9741 -204.5037 -202.9258 -202.5885
-178.2261 -149.0168 -128.2677 -123.2072 -148.5989 -171.0931 -190.9696
-171.9145 -151.3418 -131.5769 -117.4720 -134.9318 -155.1051 -177.0088
-205.7689 -213.4690 -219.2022 -222.2357 -217.2625 -201.2612 -170.7498
-2.2319 37.0377 49.9421 103.4139 109.8637 67.4917 9.9533
107.4283 80.5898 76.5395 -2.8018 -3.8227 -5.0755 -5.0368
-55.8005 -60.4478 -68.3144 -80.9337 -82.7537 -79.9747 -69.3090
-80.1272 -109.2082 -131.7292 -159.3266 -177.3378 -194.1377 -219.8577
-9.7228 -9.3627 -9.8369 -13.9679 -17.8883 -19.5395 -21.4966
-44.6752 -46.2503 -47.7995 -50.0060 -49.1645 -50.0281 -49.0029
-134.8074 -139.8302 -146.6228 -160.3309 -172.5591 -178.2125 -178.0323
-193.4552 -198.5444 -202.4213 -206.8460 -210.7303 -213.6701 -216.0972
-222.1076 -225.8486 -226.2187 -224.2652 -222.6408 -222.4899 -223.7217
Extract effects
Plot↓
land-sea terrain model (m)
complete Bouguer effects (mGal)
The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.
If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.
The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

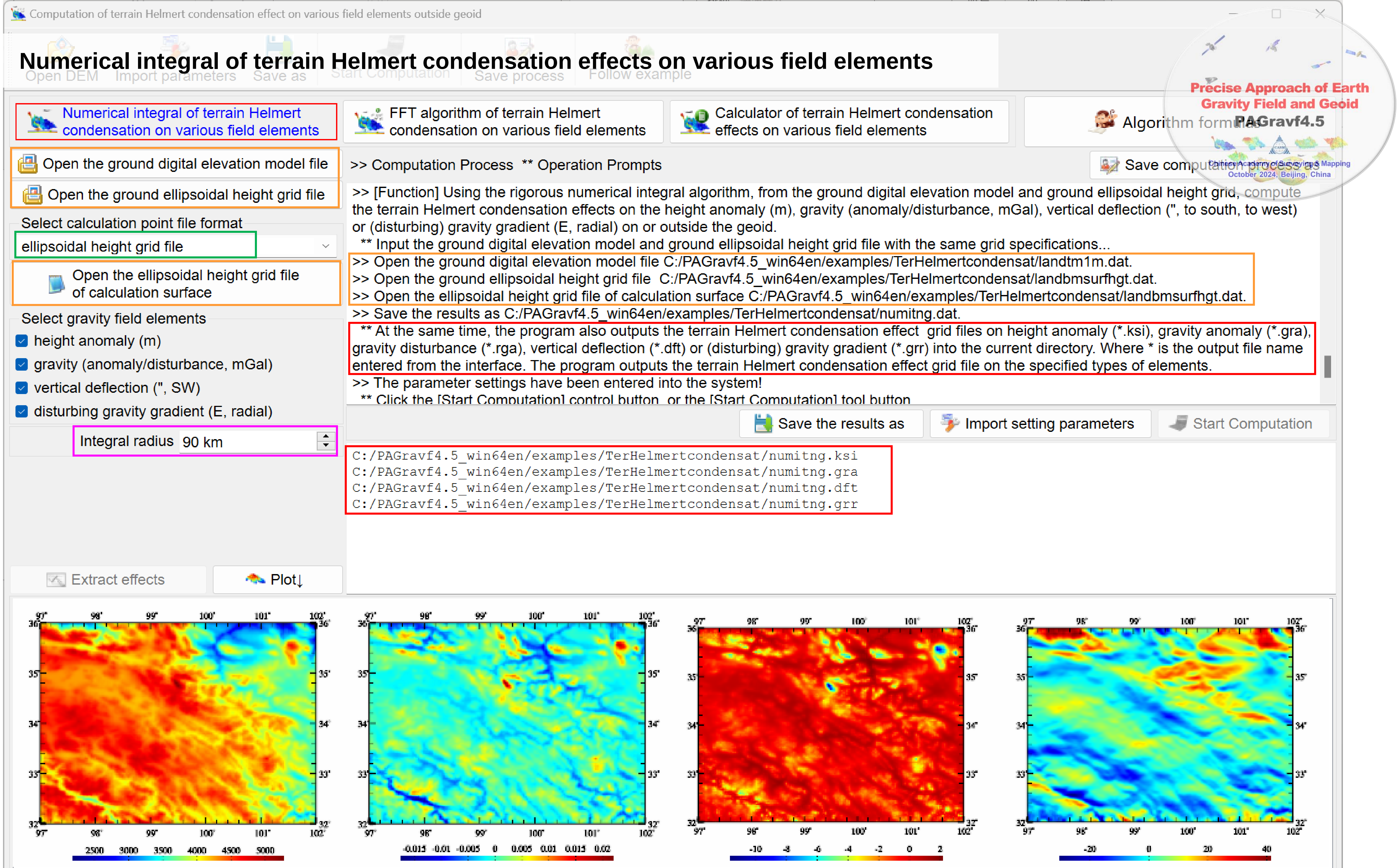


Computation of land, ocean, and lake complete Bouguer effect on gravity outside geoid
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - FFT integral
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Formulas of land-sea unified complete Bouguer effect
Open the land-sea terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of calculation surface
Select integral algorithm
2D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:10:26
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Compute the land-sea unified complete Bouguer effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/lndseaFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 09:14:13
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:14:19
Land integral radius 90 km
Sea integral radius 300 km
Save the results as
Import setting parameters
Start Computation
110.000000 125.000000 15.000000 30.000000 0.08333333 0.08333333
-8.3840 -8.4310 -9.7492 -14.6251 -17.9147 -19.4227 -21.6795
-46.0804 -47.7576 -49.3916 -50.7882 -51.3851 -53.8891 -59.9925
-125.7561 -133.7616 -144.0685 -157.5015 -165.2193 -167.7783 -166.8387
-196.6335 -199.8166 -201.3186 -202.6456 -204.0432 -205.8578 -208.1285
-206.3994 -211.4598 -212.6164 -212.0782 -210.6699 -209.1409 -208.8170
-183.9449 -154.6824 -133.6509 -128.7657 -154.2202 -177.0351 -196.9064
-177.6384 -157.0008 -136.9625 -122.9076 -140.2510 -160.7115 -182.6198
-211.3937 -218.8423 -224.2816 -227.0769 -221.9265 -205.9211 -175.6084
-3.9094 36.0852 49.2404 103.5004 110.1038 67.2428 8.8891
107.7201 80.4641 76.8699 -4.1631 -5.4744 -6.7966 -6.8071
-58.3003 -63.0309 -71.0464 -83.7201 -85.6414 -82.8324 -72.1778
-83.4268 -112.8950 -135.9738 -163.8406 -182.2737 -199.3464 -224.3924
-10.2471 -9.9652 -10.5049 -14.6940 -18.6774 -20.3997 -22.3998
-46.1861 -47.8194 -49.4312 -51.6749 -50.9006 -51.7915 -50.7816
-138.4751 -143.8311 -150.9153 -164.7942 -177.1894 -182.9933 -182.9549
-198.9392 -204.1574 -208.1467 -212.6239 -216.5529 -219.5346 -221.9885
-228.5733 -232.2644 -232.7040 -230.8908 -229.3755 -229.2764 -230.5019
Extract effects
Plot↓
land-sea terrain model (m)
complete Bouguer effects (mGal)
The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.
If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.
The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.


Computation of land, ocean, and lake complete Bouguer effect on gravity outside geoid
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - FFT integral
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Formulas of land-sea unified complete Bouguer effect
Open the land-sea terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of calculation surface
Select integral algorithm
1D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:14:19
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Compute the land-sea unified complete Bouguer effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/lndseaFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 09:15:21
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:15:35
Land integral radius 90 km
Sea integral radius 300 km
Save the results as
Import setting parameters
Start Computation
110.000000 125.000000 15.000000 30.000000 0.08333333 0.08333333
-8.2859 -8.2979 -9.5859 -14.4386 -17.6973 -19.1729 -21.4192
-45.5102 -47.1726 -48.7790 -50.1541 -50.7128 -53.1583 -59.2286
-123.6301 -131.4323 -141.4338 -154.6832 -162.1845 -164.6695 -163.6497
-192.5911 -195.6108 -197.0458 -198.3330 -199.6909 -201.4540 -203.7060
-202.1460 -207.0358 -208.1123 -207.5622 -206.1675 -204.6629 -204.3039
-180.3762 -151.5508 -130.9900 -125.9695 -151.2787 -173.5002 -193.1195
-174.2465 -153.8247 -134.2208 -120.1139 -137.5049 -157.4718 -179.0607
-206.9287 -214.2794 -219.6096 -222.4735 -217.4892 -202.0047 -172.0155
-3.4159 36.5032 49.6341 103.8896 110.4780 67.5950 9.2229
108.0989 80.8370 77.2701 -3.7790 -5.1007 -6.4139 -6.4107
-57.4799 -62.1677 -70.0703 -82.7109 -84.5577 -81.8098 -71.1878
-82.0921 -111.1265 -133.5695 -161.0260 -178.8618 -195.2426 -219.8860
-10.1361 -9.8124 -10.3213 -14.4839 -18.4358 -20.1202 -22.1095
-45.5731 -47.1780 -48.7561 -50.9909 -50.1816 -51.0756 -50.0823
-136.0776 -141.1197 -147.9200 -161.5592 -173.7014 -179.3393 -179.1977
-194.5959 -199.6421 -203.4520 -207.8225 -211.6475 -214.5354 -216.9526
-223.4237 -227.0499 -227.4504 -225.6176 -224.1094 -224.0079 -225.2122
Extract effects
Plot↓
land-sea terrain model (m)
complete Bouguer effects (mGal)
The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.
If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.
The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

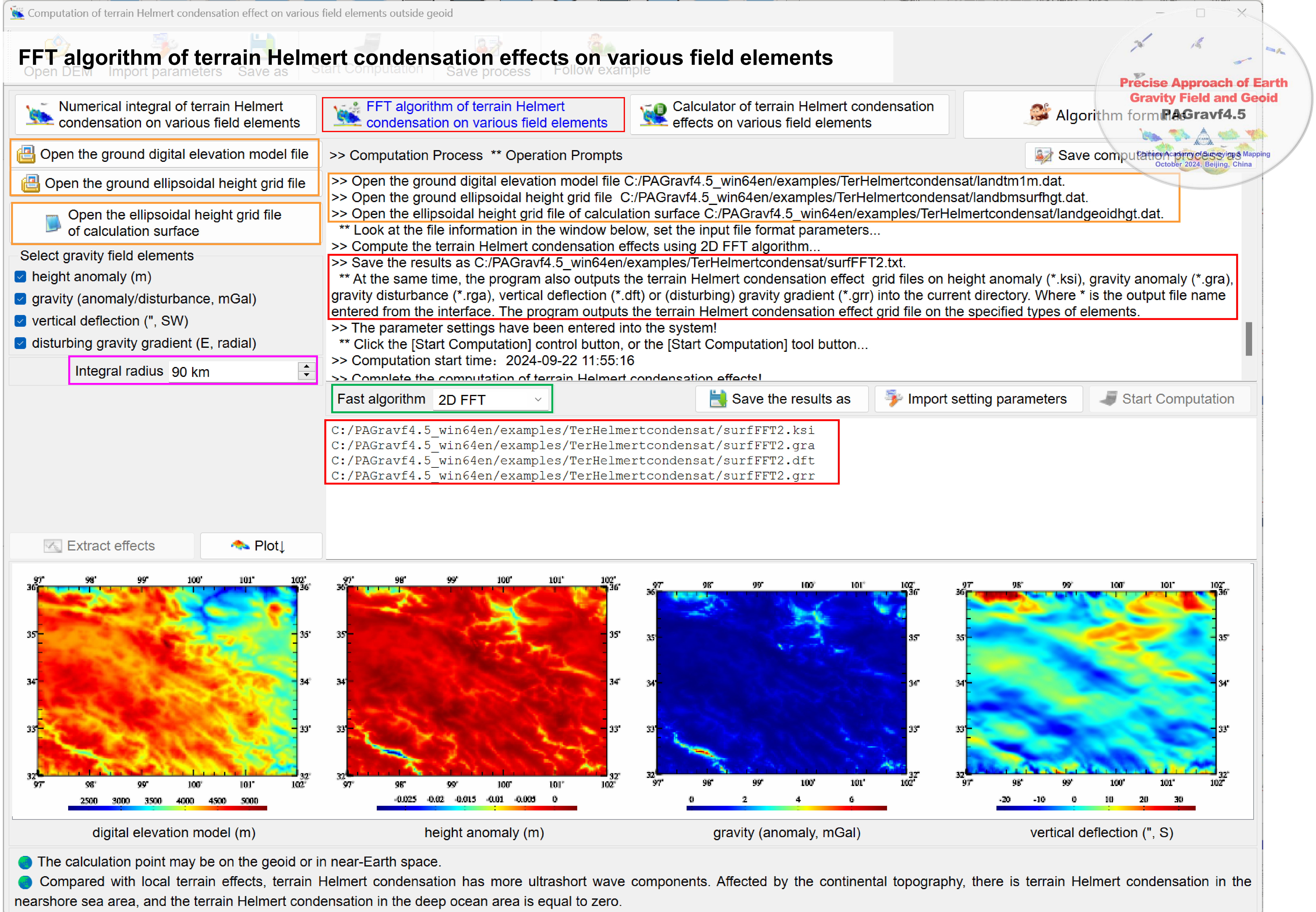

Computation of land, ocean, and lake complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
Numerical integral computation of the lake-water complete Bouguer effect on gravity
Formulas of land-sea unified complete Bouguer effect
Open the lake water-depth grid file
Open the ellipsoidal height grid file of the lake surface
Open the calculation point location file
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation end time: 2024-09-22 09:15:35
>> [Function] Using the rigorous numerical integral algorith, from the lake water-depth grid (value on land is zero) and ellipsoidal height grid file of the lake surface, compute the lake-water complete Bouguer effect on the gravity (mGal).
>> Open the lake water-depth grid file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/lakedepth.dat.
>> Open the ellipsoidal height grid file of the lake surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/lakehgt.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/rstlake.txt.
>> Behind the source calculation point file record, appends the lake water complete Bouguer effect, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:17:49
>> Complete computation of the lake-water complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:18:08
Land integral radius 90 km
Save the results as
Import setting parameters
Start Computation
Extract effects
Plot↓
no lon lat hgt
1 95.808333 32.508333 4287.928 0.0074
2 95.825000 32.508333 4393.299 0.0071
3 95.841667 32.508333 4472.533 -0.0030
4 95.858333 32.508333 4455.904 -0.0016
5 95.875000 32.508333 4449.265 -0.0024
6 95.891667 32.508333 4381.011 -0.0010
7 95.908333 32.508333 4330.999 -0.0008
8 95.925000 32.508333 4388.620 -0.0024
9 95.941667 32.508333 4361.609 -0.0021
10 95.958333 32.508333 4261.231 -0.0004
11 95.975000 32.508333 4152.346 0.0012
12 95.991667 32.508333 4138.344 0.0008
13 96.008333 32.508333 4174.044 -0.0005
14 96.025000 32.508333 4193.084 -0.0013
15 96.041667 32.508333 4078.828 -0.0009
16 96.058333 32.508333 3984.327 -0.0007
17 96.075000 32.508333 4052.948 -0.0015
18 96.091667 32.508333 4094.322 -0.0019
lake water-depth grid (m)
complete Bouguer effects (mGal)
The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.
If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.
The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

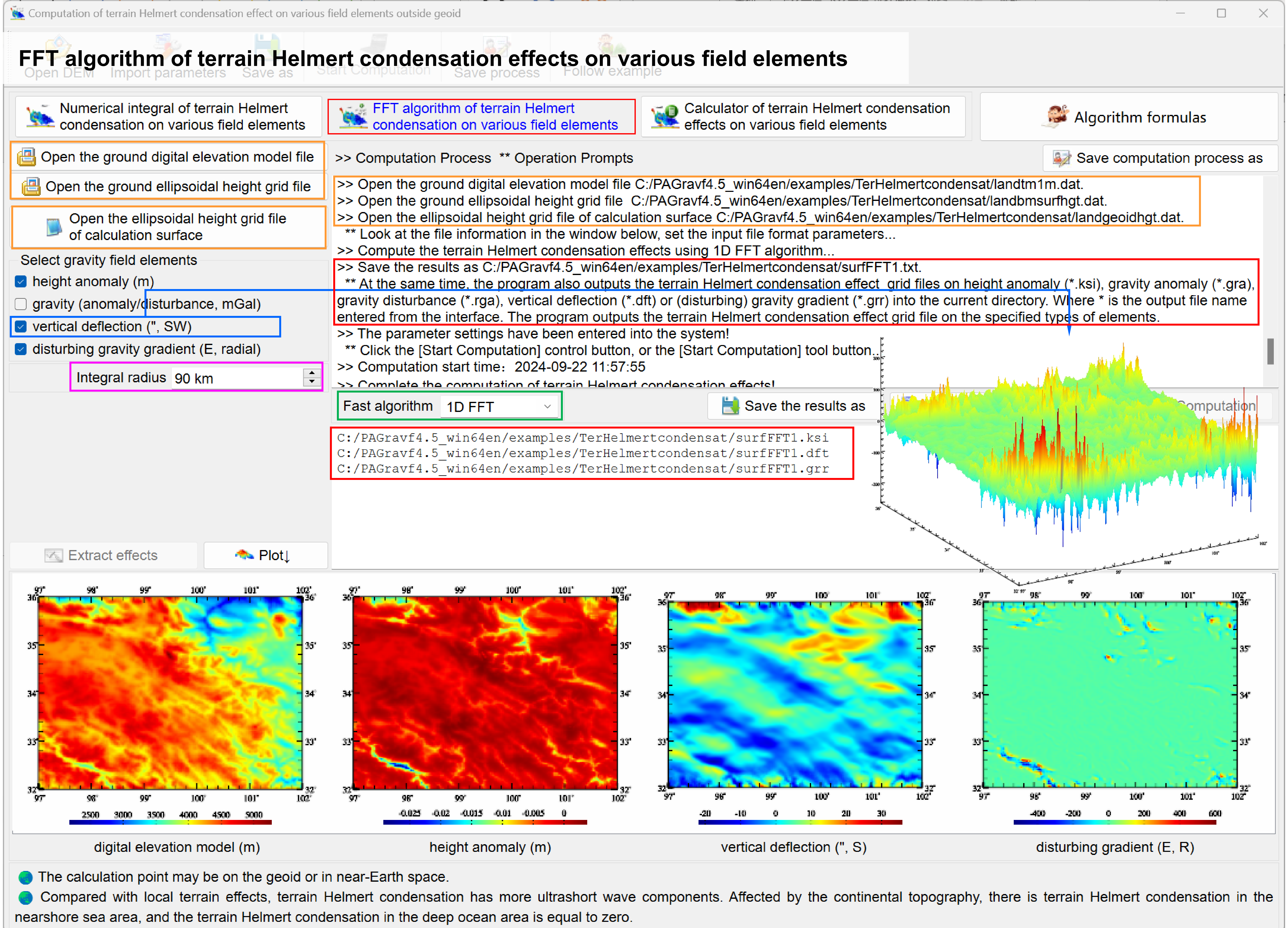

Computation of terrain Helmert condensation effect on various field elements outside geoid
Numerical integral of terrain Helmert condensation effects on various field elements
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Numerical integral of terrain Helmert condensation on various field elements
FFT algorithm of terrain Helmert condensation on various field elements
Calculator of terrain Helmert condensation effects on various field elements
Algorithm formulas
Open the ground digital elevation model file
Open the ground ellipsoidal height grid file
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
Integral radius 90 km
Extract effects
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid, compute the terrain Helmert condensation effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west) or (disturbing) gravity gradient (E, radial) on or outside the geoid.
** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfhgt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/result.txt.
** Record format: Behind the source calculation point file record, appends several columns of the terrain Helmert condensation effects on specified types of field elements, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button
Save the results as
Import setting parameters
Start Computation
no lon(deg/decimal) lat ellipHeight(m)
1 98.550000 33.050000 4372.431 0.0056 -0.0969 -8.7481 0.5033 -1.2229
2 98.650000 33.050000 4372.834 0.0347 0.0307 -10.9996 -6.5552 -5.9075
3 98.750000 33.050000 4530.959 -0.0336 -1.1852 -13.1633 -9.3919 5.9238
4 98.850000 33.050000 4567.407 0.0234 -1.1791 -14.0034 -2.3475 -4.6099
5 98.950000 33.050000 4646.551 -0.0401 -2.0462 -15.1799 -4.9229 7.2632
6 99.050000 33.050000 4672.380 -0.0463 -1.9176 -9.1527 2.1447 8.2814
7 99.150000 33.050000 4611.765 -0.0611 -1.6366 -1.2470 5.5278 11.4664
8 99.250000 33.050000 4475.199 0.0232 -0.5479 -1.0704 7.1169 -3.7881
digital elevation model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The calculation point may be on the geoid or in near-Earth space.
Compared with local terrain effects, terrain Helmert condensation has more ultrashort wave components. Affected by the continental topography, there is terrain Helmert condensation in the nearshore sea area, and the terrain Helmert condensation in the deep ocean area is equal to zero.



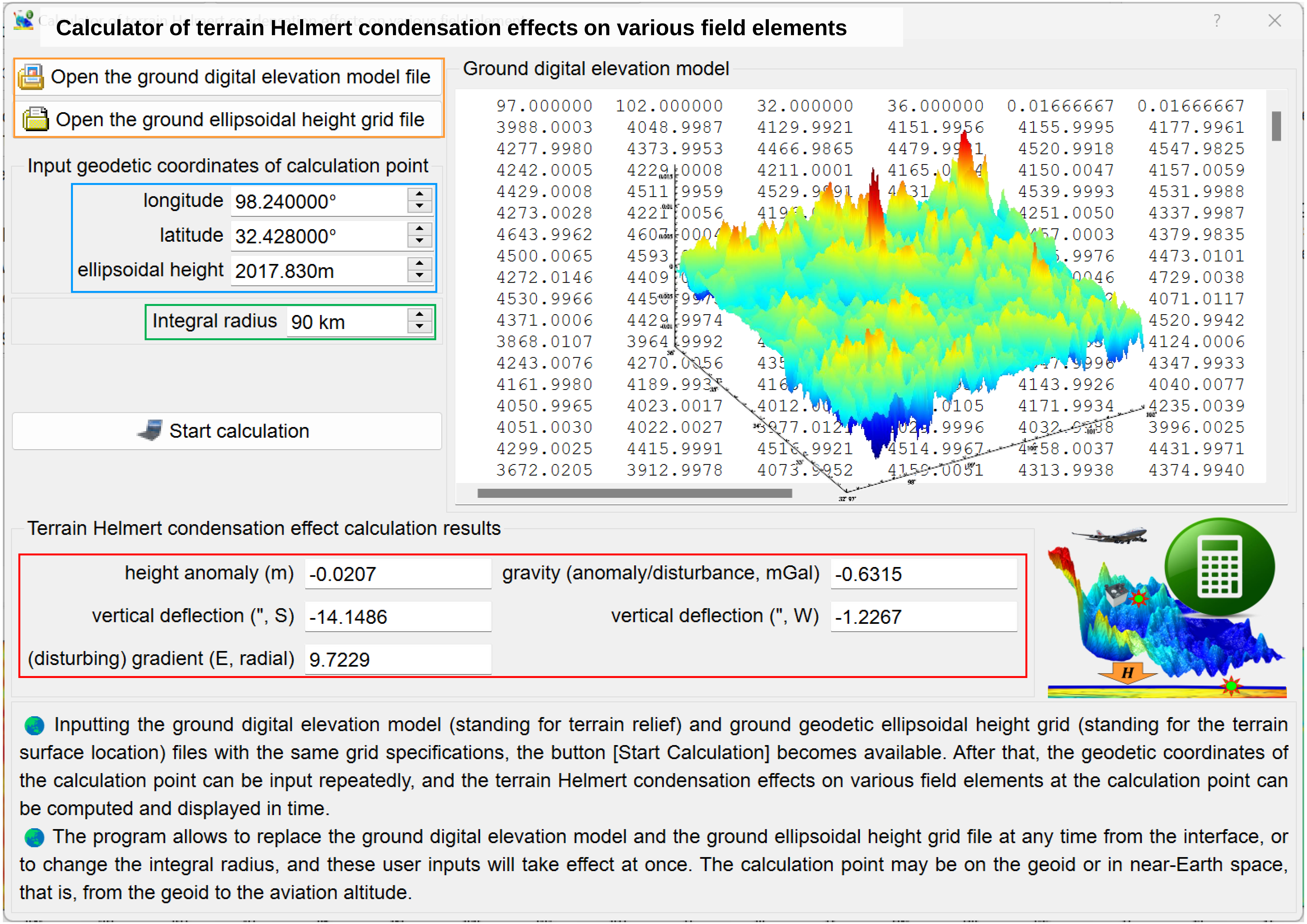
digital elevation model (m) height anomaly (m) gravity (anomaly, mGal) vertical deflection (", S)

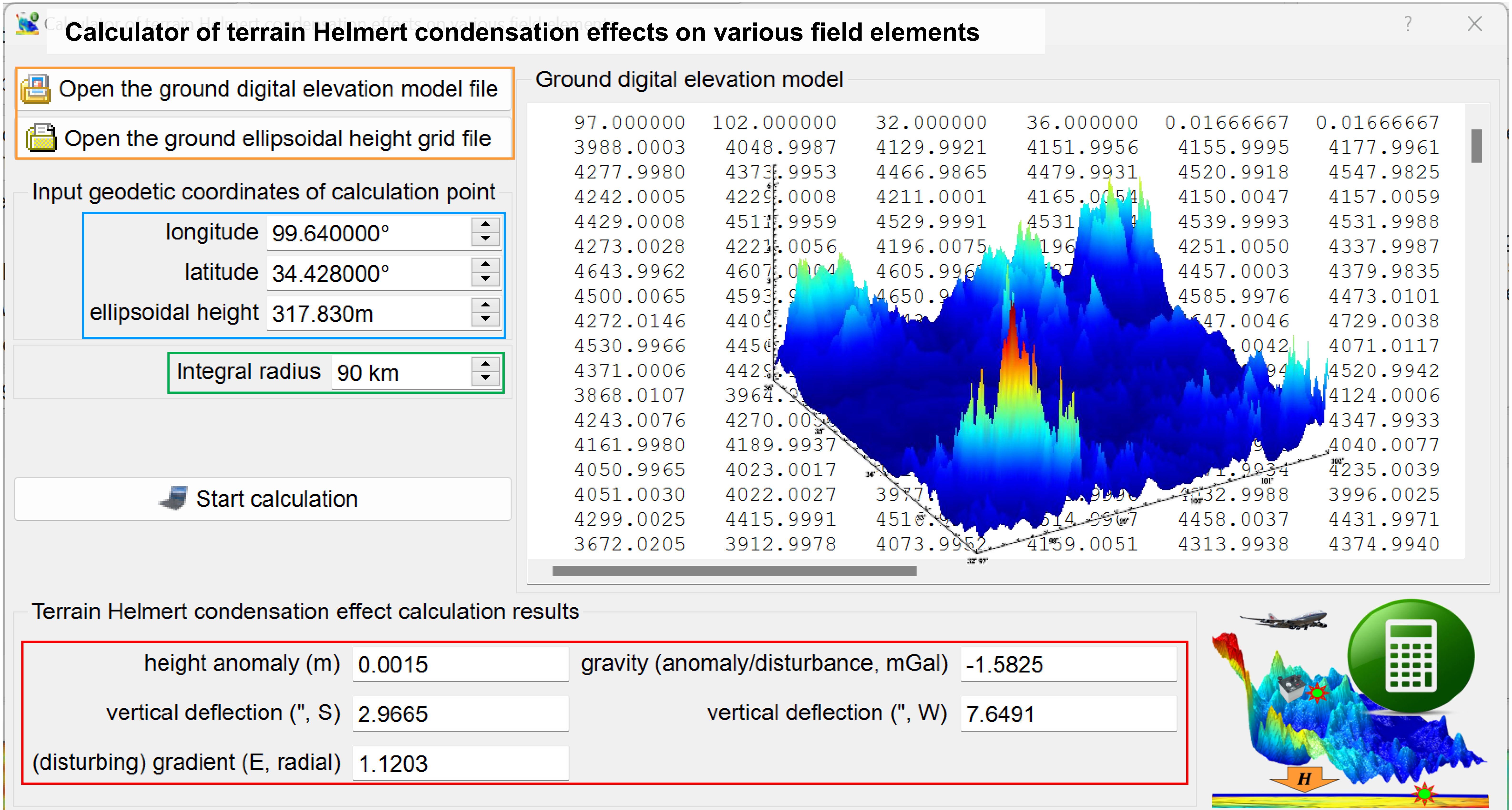
- The calculation point may be on the geoid or in near-Earth space.
- Compared with local terrain effects, terrain Helmert condensation has more ultrashort wave components. Affected by the continental topography, there is terrain Helmert condensation in the nearshore sea area, and the terrain Helmert condensation in the deep ocean area is equal to zero.


Computation of terrain Helmert condensation effect on various field elements outside geoid
FFT algorithm of terrain Helmert condensation effects on various field elements
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Numerical integral of terrain Helmert condensation on various field elements
FFT algorithm of terrain Helmert condensation on various field elements
Calculator of terrain Helmert condensation effects on various field elements
Algorithm formulas
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the ground digital elevation model file
Open the ground ellipsoidal height grid file
Open the ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
Integral radius
90 km
>> Computation Process ** Operation Prompts
Save computation process as
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landgeoidhgt.dat.
** Look at the file information in the window below, set the input file format parameters...
>> Compute the terrain Helmert condensation effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.txt.
** At the same time, the program also outputs the terrain Helmert condensation effect grid files on height anomaly (*.ksi), gravity anomaly (*.gra), gravity disturbance (*.rga), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the terrain Helmert condensation effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 11:55:16
>> Complete the computation of terrain Helmert condensation effects!
Fast algorithm
2D FFT
Save the results as
Import setting parameters
Start Computation
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.ksi
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.gra
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.dft
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.grr
Extract effects
Plot↓
digital elevation model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The calculation point may be on the geoid or in near-Earth space.
Compared with local terrain effects, terrain Helmert condensation has more ultrashort wave components. Affected by the continental topography, there is terrain Helmert condensation in the nearshore sea area, and the terrain Helmert condensation in the deep ocean area is equal to zero.



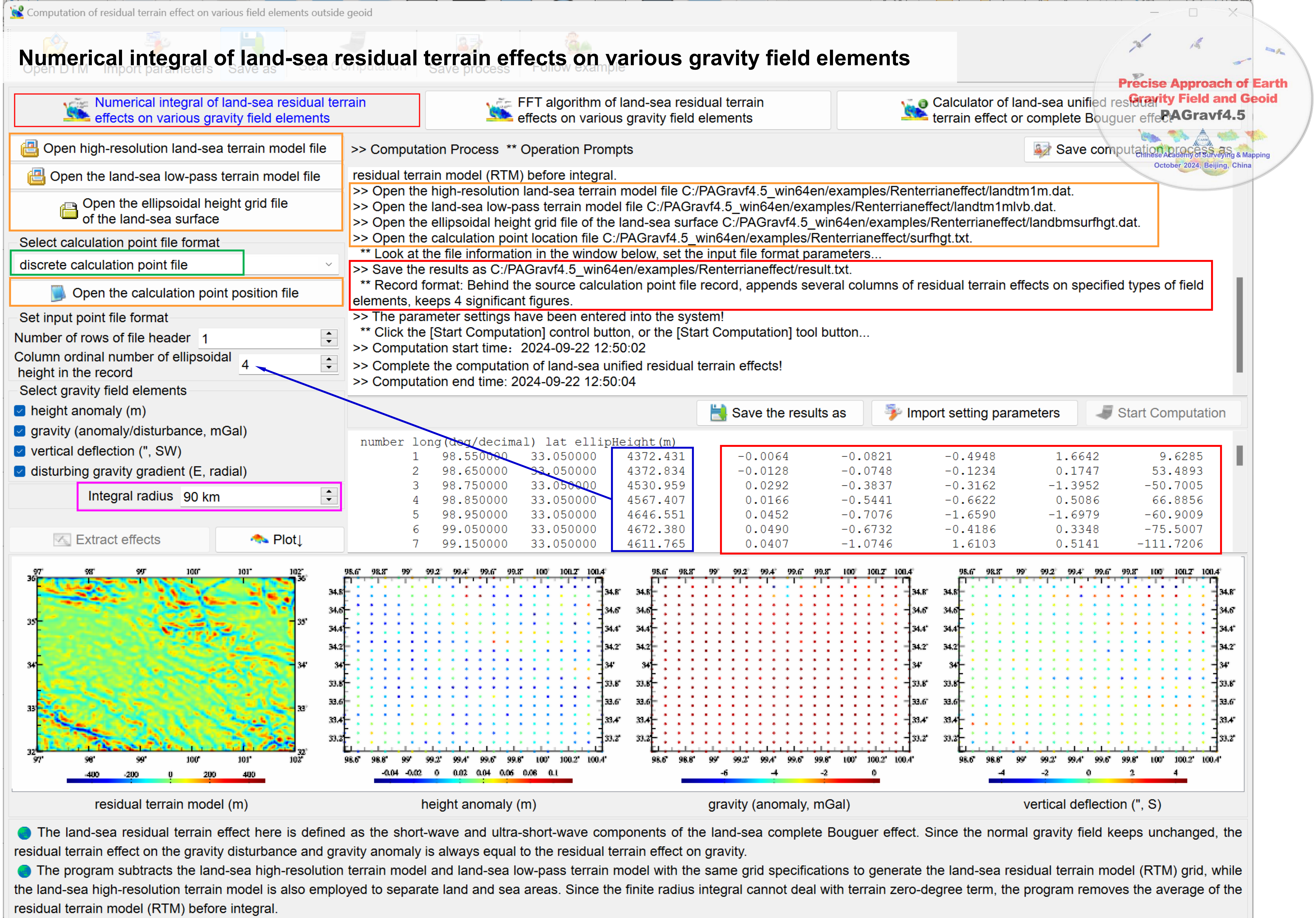
Computation of terrain Helmert condensation effect on various field elements outside geoid
FFT algorithm of terrain Helmert condensation effects on various field elements
Open DEM
Import parameters
Save as
Start Computation
Save process
Follow example
Numerical integral of terrain Helmert condensation on various field elements
FFT algorithm of terrain Helmert condensation on various field elements
Calculator of terrain Helmert condensation effects on various field elements
Algorithm formulas
Open the ground digital elevation model file
Open the ground ellipsoidal height grid file
Open the ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
Integral radius
90 km
>> Computation Process ** Operation Prompts
Save computation process as
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landgeoidhgt.dat.
** Look at the file information in the window below, set the input file format parameters...
>> Compute the terrain Helmert condensation effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.txt.
** At the same time, the program also outputs the terrain Helmert condensation effect grid files on height anomaly (*.ksi), gravity anomaly (*.gra), gravity disturbance (*.rga), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the terrain Helmert condensation effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 11:57:55
>> Complete the computation of terrain Helmert condensation effects!
Fast algorithm
1D FFT
Save the results as
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.ksi
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.dft
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.grr
Extract effects
Plot
digital elevation model (m)
height anomaly (m)
vertical deflection (", S)
disturbing gradient (E, R)
The calculation point may be on the geoid or in near-Earth space.
Compared with local terrain effects, terrain Helmert condensation has more ultrashort wave components. Affected by the continental topography, there is terrain Helmert condensation in the nearshore sea area, and the terrain Helmert condensation in the deep ocean area is equal to zero.

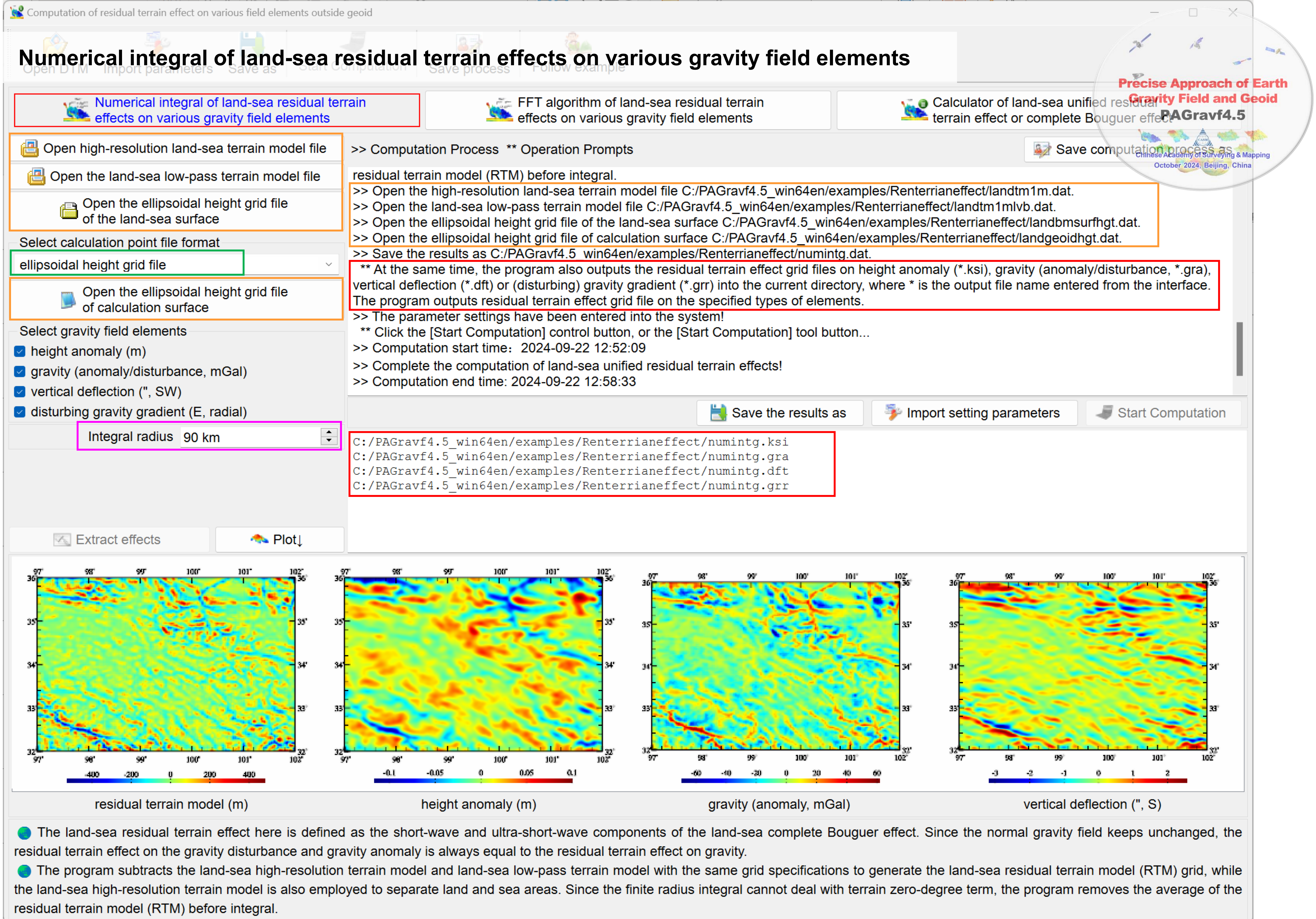

Calculator of terrain Helmert condensation effects on various field elements
Open the ground digital elevation model file
Open the ground ellipsoidal height grid file
Input geodetic coordinates of calculation point
longitude 98.240000°
latitude 32.428000°
ellipsoidal height 2017.830m
Integral radius 90 km
Start calculation
Ground digital elevation model
97.000000 102.000000 32.000000 36.000000 0.01666667 0.01666667
3988.0003 4048.9987 4129.9921 4151.9956 4155.9995 4177.9961
4277.9980 4373.9953 4466.9865 4479.9921 4520.9918 4547.9825
Terrain Helmert condensation effect calculation results
height anomaly (m) -0.0207
gravity (anomaly/disturbance, mGal) -0.6315
vertical deflection (", S) -14.1486
vertical deflection (", W) -1.2267
(disturbing) gradient (E, radial) 9.7229
H
Inputting the ground digital elevation model (standing for terrain relief) and ground geodetic ellipsoidal height grid (standing for the terrain surface location) files with the same grid specifications, the button [Start Calculation] becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the terrain Helmert condensation effects on various field elements at the calculation point can be computed and displayed in time.
The program allows to replace the ground digital elevation model and the ground ellipsoidal height grid file at any time from the interface, or to change the integral radius, and these user inputs will take effect at once. The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.

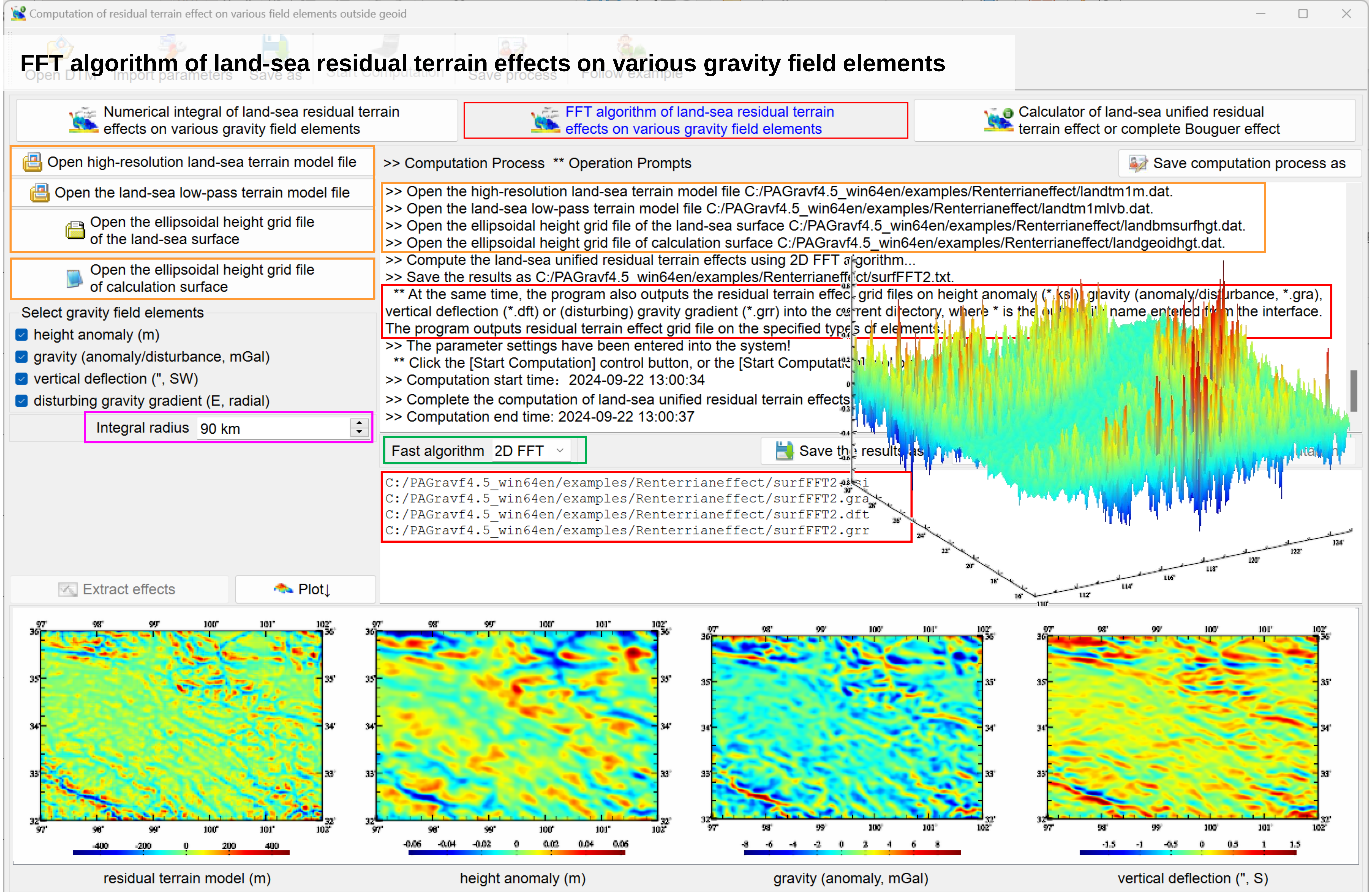


Inputting the ground digital elevation model (standing for terrain relief) and ground geodetic ellipsoidal height grid (standing for the terrain surface location) files with the same grid specifications, the button [Start Calculation] becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the terrain Helmert condensation effects on various field elements at the calculation point can be computed and displayed in time.

The program allows to replace the ground digital elevation model and the ground ellipsoidal height grid file at any time from the interface, or to change the integral radius, and these user inputs will take effect at once. The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.

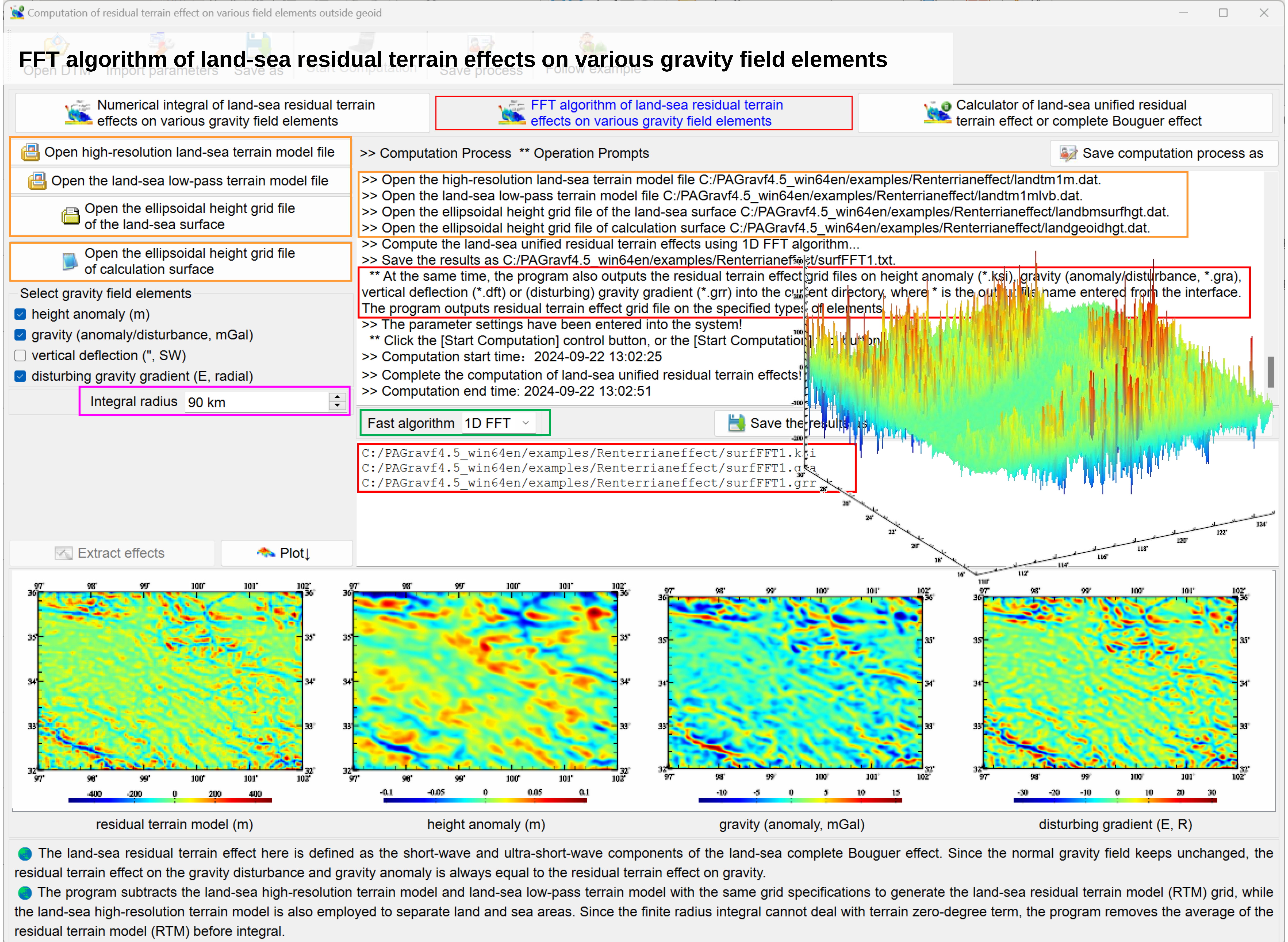

Computation of residual terrain effect on various field elements outside geoid
Numerical integral of land-sea residual terrain effects on various gravity field elements
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Numerical integral of land-sea residual terrain effects on various gravity field elements
FFT algorithm of land-sea residual terrain effects on various gravity field elements
Calculator of land-sea unified residual terrain effect or complete Bouguer effect
Open high-resolution land-sea terrain model file
Open the land-sea low-pass terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
Number of rows of file header 1
Column ordinal number of ellipsoidal height in the record 4
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
Integral radius 90 km
Extract effects
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
residual terrain model (RTM) before integral.
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfhgt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Renterrianeffect/result.txt.
** Record format: Behind the source calculation point file record, appends several columns of residual terrain effects on specified types of field elements, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 12:50:02
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 12:50:04
Save the results as
Import setting parameters
Start Computation
number long(deg/decimal) lat ellipHeight(m)
1 98.550000 33.050000 4372.431 -0.0064 -0.0821 -0.4948 1.6642 9.6285
2 98.650000 33.050000 4372.834 -0.0128 -0.0748 -0.1234 0.1747 53.4893
3 98.750000 33.050000 4530.959 0.0292 -0.3837 -0.3162 -1.3952 -50.7005
4 98.850000 33.050000 4567.407 0.0166 -0.5441 -0.6622 0.5086 66.8856
5 98.950000 33.050000 4646.551 0.0452 -0.7076 -1.6590 -1.6979 -60.9009
6 99.050000 33.050000 4672.380 0.0490 -0.6732 -0.4186 0.3348 -75.5007
7 99.150000 33.050000 4611.765 0.0407 -1.0746 1.6103 0.5141 -111.7206
residual terrain model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The land-sea residual terrain effect here is defined as the short-wave and ultra-short-wave components of the land-sea complete Bouguer effect. Since the normal gravity field keeps unchanged, the residual terrain effect on the gravity disturbance and gravity anomaly is always equal to the residual terrain effect on gravity.
The program subtracts the land-sea high-resolution terrain model and land-sea low-pass terrain model with the same grid specifications to generate the land-sea residual terrain model (RTM) grid, while the land-sea high-resolution terrain model is also employed to separate land and sea areas. Since the finite radius integral cannot deal with terrain zero-degree term, the program removes the average of the residual terrain model (RTM) before integral.

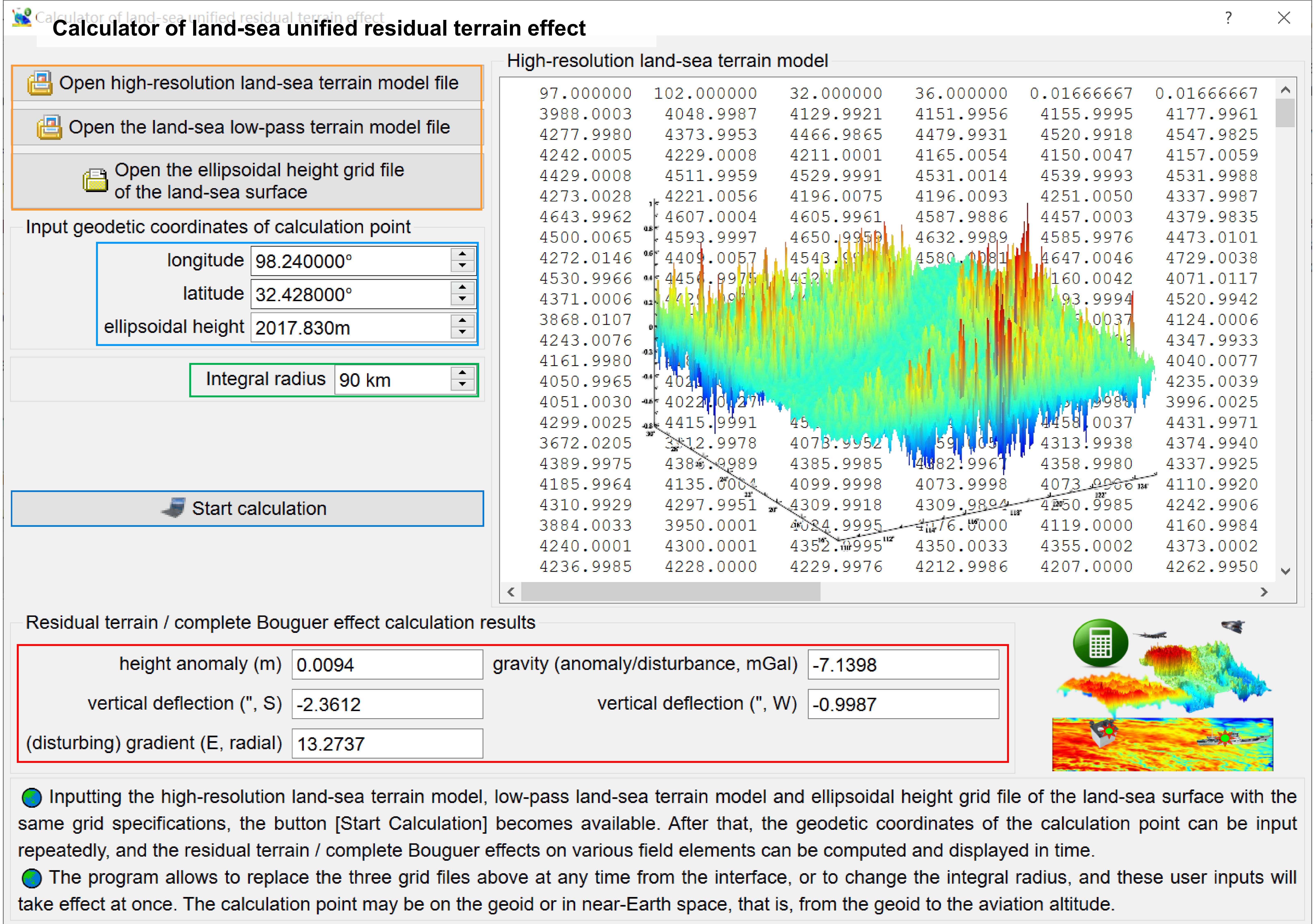

Computation of residual terrain effect on various field elements outside geoid
Numerical integral of land-sea residual terrain effects on various gravity field elements
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Numerical integral of land-sea residual terrain effects on various gravity field elements
FFT algorithm of land-sea residual terrain effects on various gravity field elements
Calculator of land-sea unified residual terrain effect or complete Bouguer effect
Open high-resolution land-sea terrain model file
Open the land-sea low-pass terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
Integral radius
90 km
>> Computation Process ** Operation Prompts
Save computation process as
residual terrain model (RTM) before integral.
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landgeoidhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.dat.
** At the same time, the program also outputs the residual terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory, where * is the output file name entered from the interface. The program outputs residual terrain effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 12:52:09
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 12:58:33
Save the results as
Import setting parameters
Start Computation
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.ksi
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.gra
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.dft
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.grr
Extract effects
Plot↓
residual terrain model (m)
height anomaly (m)
gravity (anomaly, mGal)
vertical deflection (", S)
The land-sea residual terrain effect here is defined as the short-wave and ultra-short-wave components of the land-sea complete Bouguer effect. Since the normal gravity field keeps unchanged, the residual terrain effect on the gravity disturbance and gravity anomaly is always equal to the residual terrain effect on gravity.
The program subtracts the land-sea high-resolution terrain model and land-sea low-pass terrain model with the same grid specifications to generate the land-sea residual terrain model (RTM) grid, while the land-sea high-resolution terrain model is also employed to separate land and sea areas. Since the finite radius integral cannot deal with terrain zero-degree term, the program removes the average of the residual terrain model (RTM) before integral.



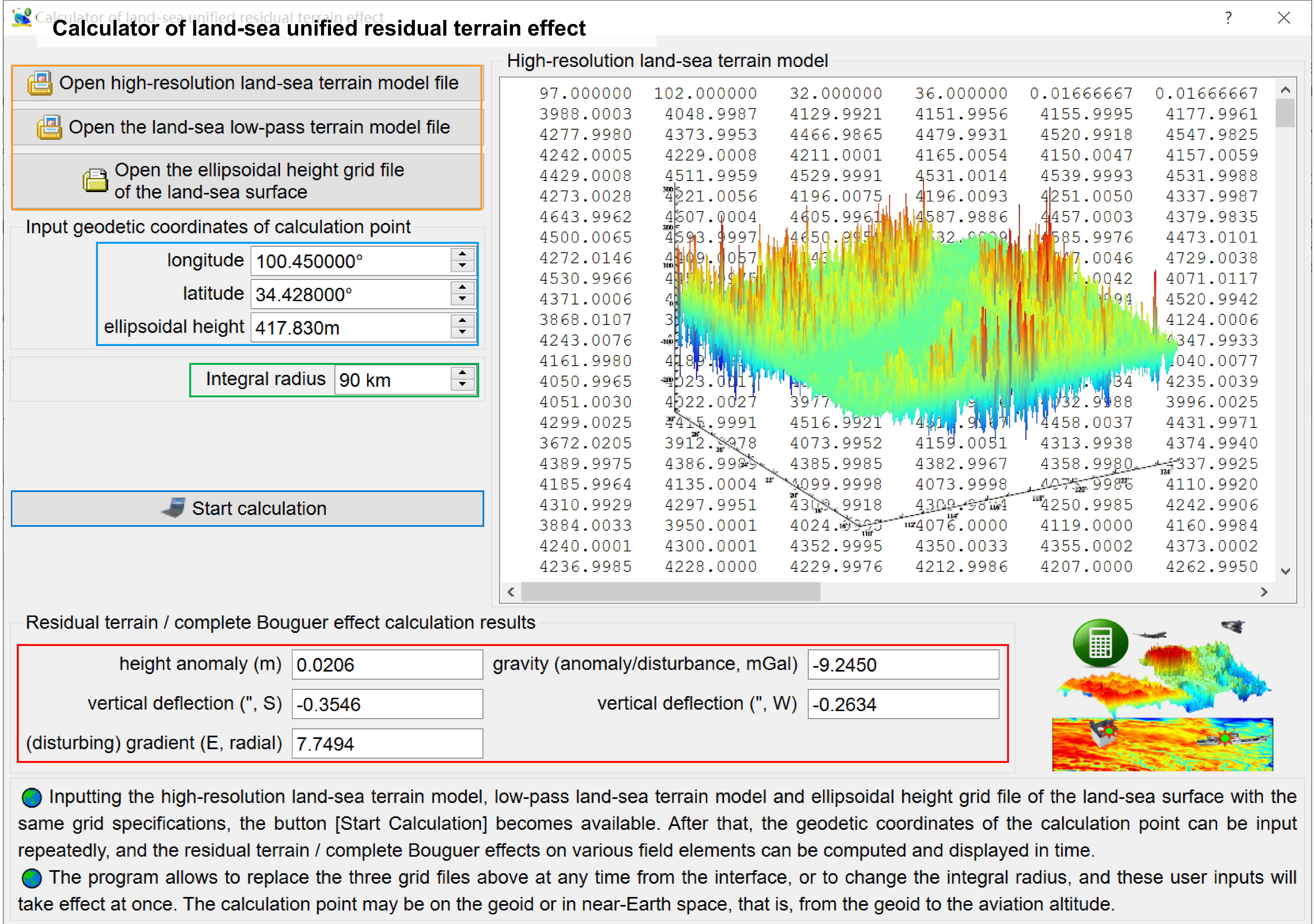
The land-sea residual terrain effect here is defined as the short-wave and ultra-short-wave components of the land-sea complete Bouguer effect. Since the normal gravity field keeps unchanged, the residual terrain effect on the gravity disturbance and gravity anomaly is always equal to the residual terrain effect on gravity.

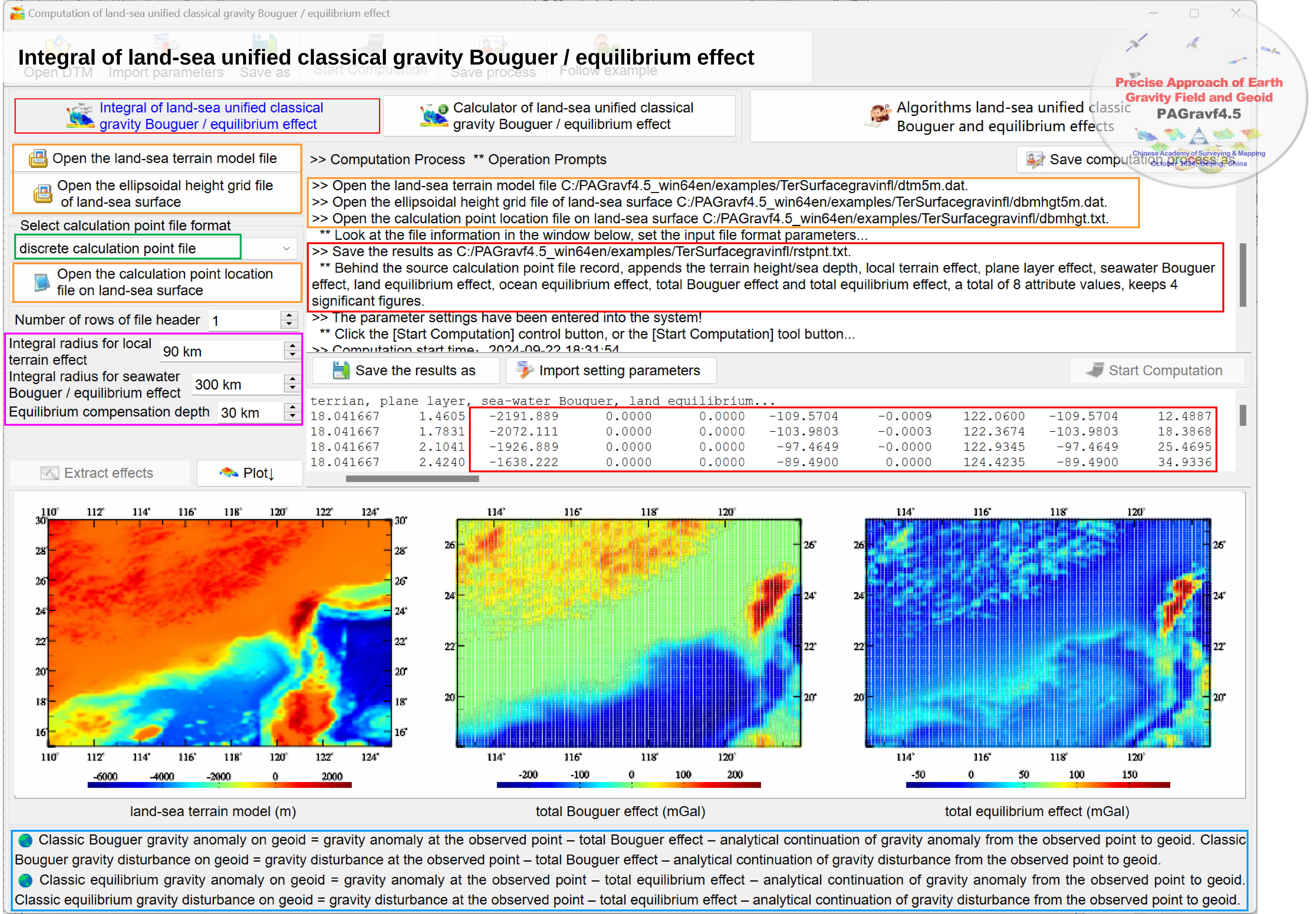
The program subtracts the land-sea high-resolution terrain model and land-sea low-pass terrain model with the same grid specifications to generate the land-sea residual terrain model (RTM) grid, while the land-sea high-resolution terrain model is also employed to separate land and sea areas. Since the finite radius integral cannot deal with terrain zero-degree term, the program removes the average of the residual terrain model (RTM) before integral.

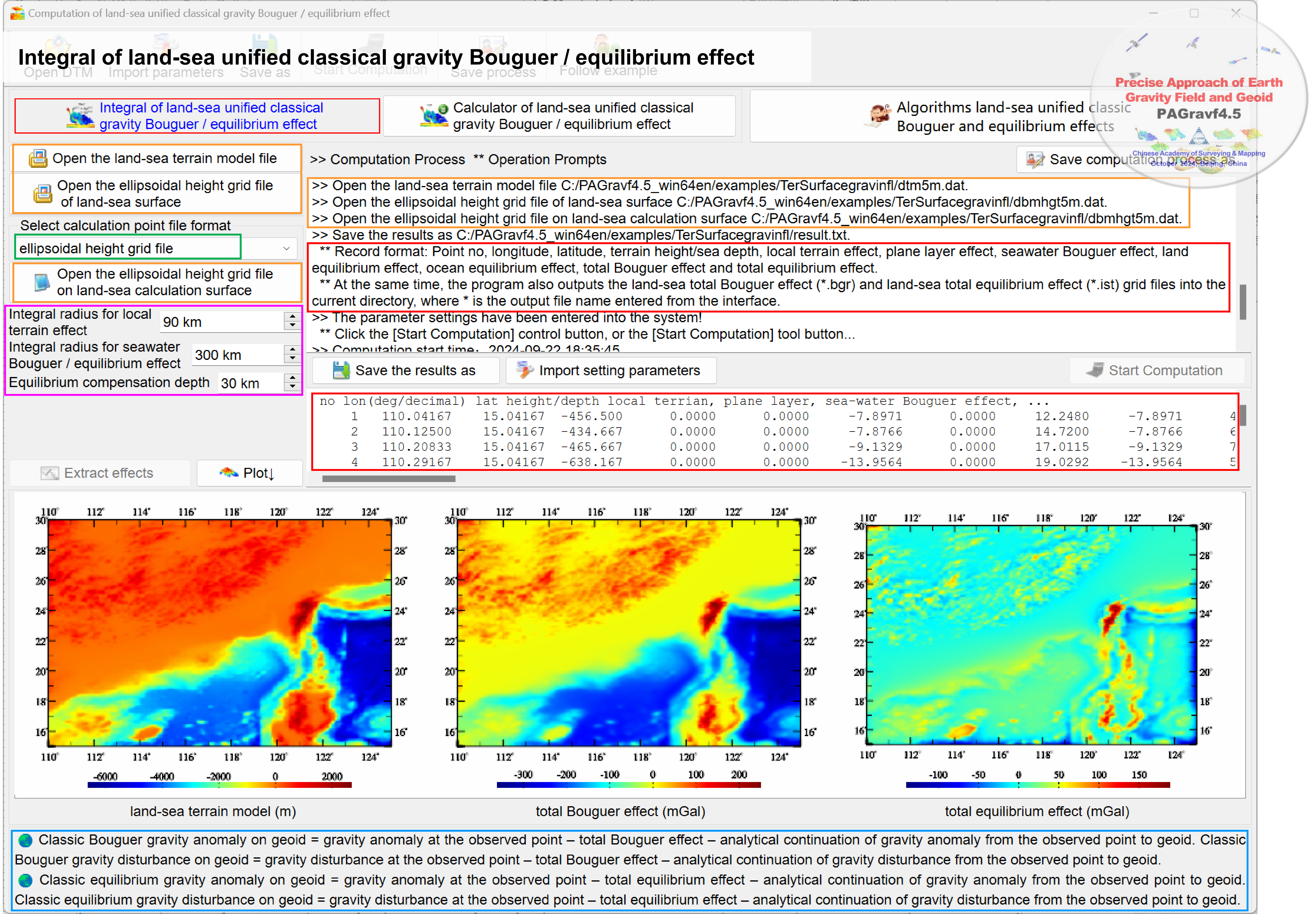

Computation of residual terrain effect on various field elements outside geoid
FFT algorithm of land-sea residual terrain effects on various gravity field elements
Numerical integral of land-sea residual terrain effects on various gravity field elements
FFT algorithm of land-sea residual terrain effects on various gravity field elements
Calculator of land-sea unified residual terrain effect or complete Bouguer effect
Open high-resolution land-sea terrain model file
Open the land-sea low-pass terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Open the ellipsoidal height grid file of calculation surface
Select gravity field elements
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
disturbing gravity gradient (E, radial)
Integral radius 90 km
>> Computation Process ** Operation Prompts
Save computation process as
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landgeoidhgt.dat.
>> Compute the land-sea unified residual terrain effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.txt.
** At the same time, the program also outputs the residual terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory, where * is the output file name entered from the interface.
The program outputs residual terrain effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button.
>> Computation start time: 2024-09-22 13:02:25
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 13:02:51
Fast algorithm 1D FFT
Save the results as
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.ksi
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.gra
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.grr
Extract effects
Plot↓
residual terrain model (m)
height anomaly (m)
gravity (anomaly, mGal)
disturbing gradient (E, R)
The land-sea residual terrain effect here is defined as the short-wave and ultra-short-wave components of the land-sea complete Bouguer effect. Since the normal gravity field keeps unchanged, the residual terrain effect on the gravity disturbance and gravity anomaly is always equal to the residual terrain effect on gravity.
The program subtracts the land-sea high-resolution terrain model and land-sea low-pass terrain model with the same grid specifications to generate the land-sea residual terrain model (RTM) grid, while the land-sea high-resolution terrain model is also employed to separate land and sea areas. Since the finite radius integral cannot deal with terrain zero-degree term, the program removes the average of the residual terrain model (RTM) before integral.

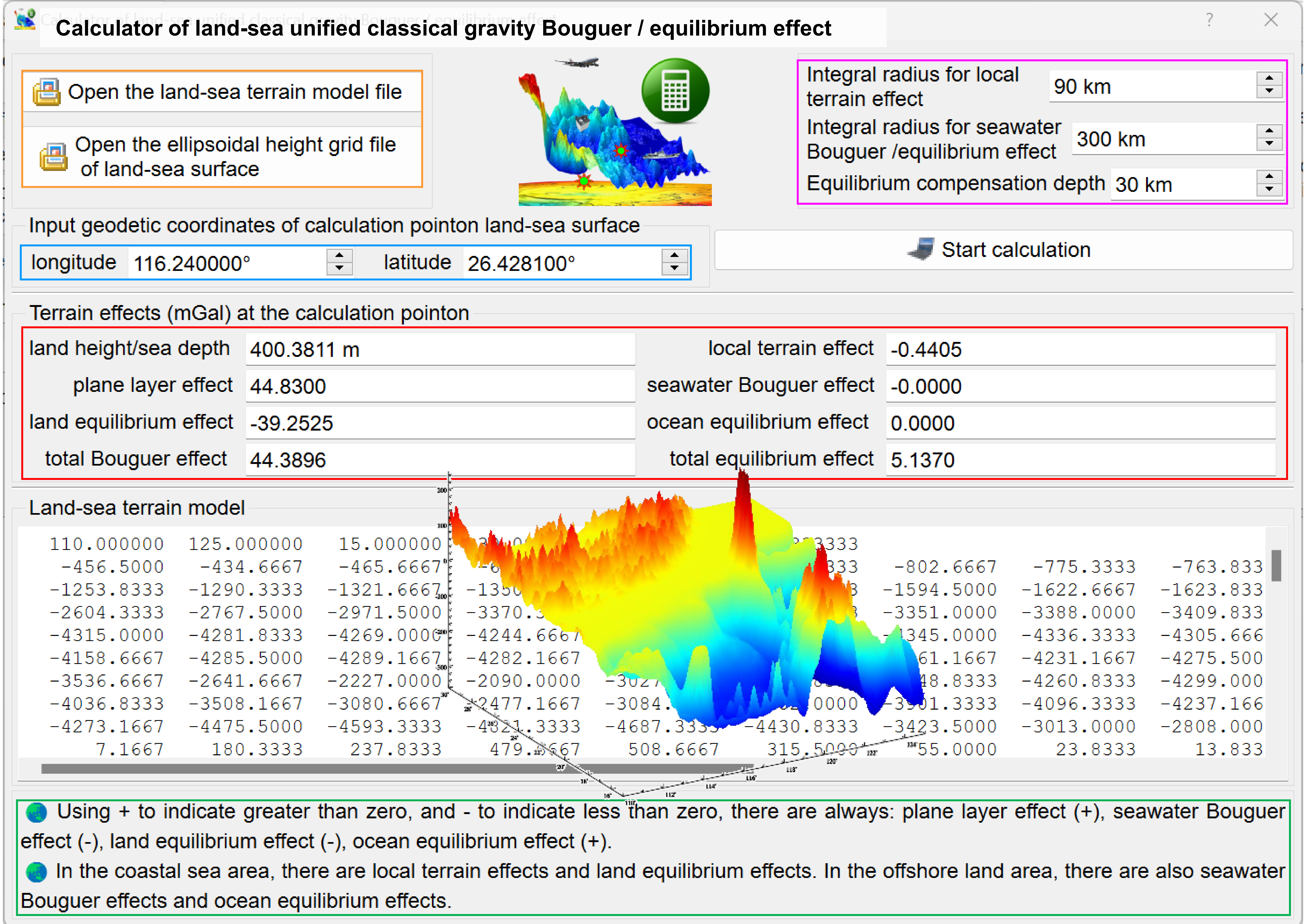


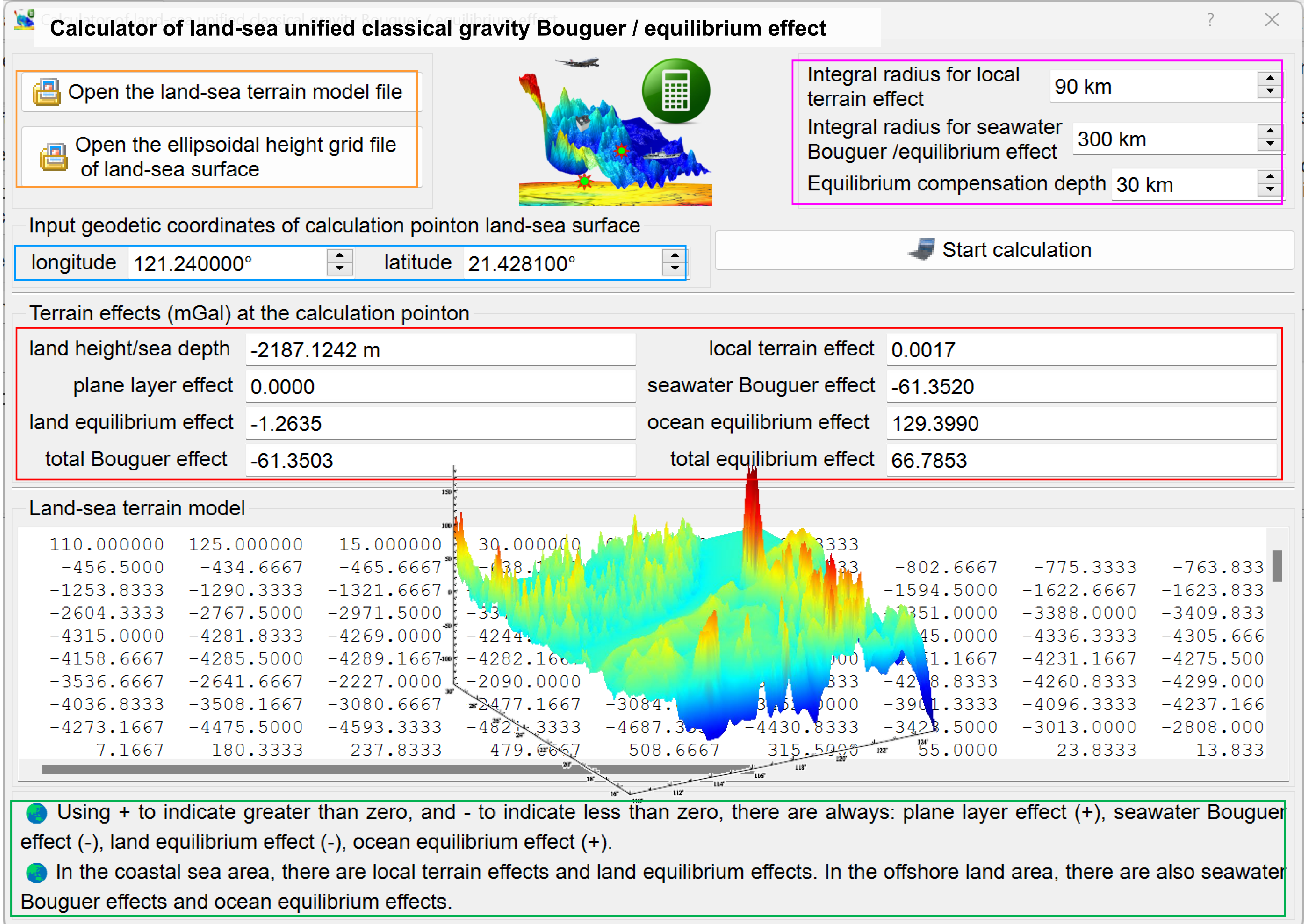
Calculator of land-sea unified residual terrain effect
Open high-resolution land-sea terrain model file
Open the land-sea low-pass terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Input geodetic coordinates of calculation point
longitude 98.240000°
latitude 32.428000°
ellipsoidal height 2017.830m
Integral radius 90 km
Start calculation
High-resolution land-sea terrain model
97.000000 102.000000 32.000000 36.000000 0.01666667 0.01666667
Residual terrain / complete Bouguer effect calculation results
height anomaly (m) 0.0094
gravity (anomaly/disturbance, mGal) -7.1398
vertical deflection (", S) -2.3612
vertical deflection (", W) -0.9987
(disturbing) gradient (E, radial) 13.2737
Inputting the high-resolution land-sea terrain model, low-pass land-sea terrain model and ellipsoidal height grid file of the land-sea surface with the same grid specifications, the button [Start Calculation] becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the residual terrain / complete Bouguer effects on various field elements can be computed and displayed in time.
The program allows to replace the three grid files above at any time from the interface, or to change the integral radius, and these user inputs will take effect at once. The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.

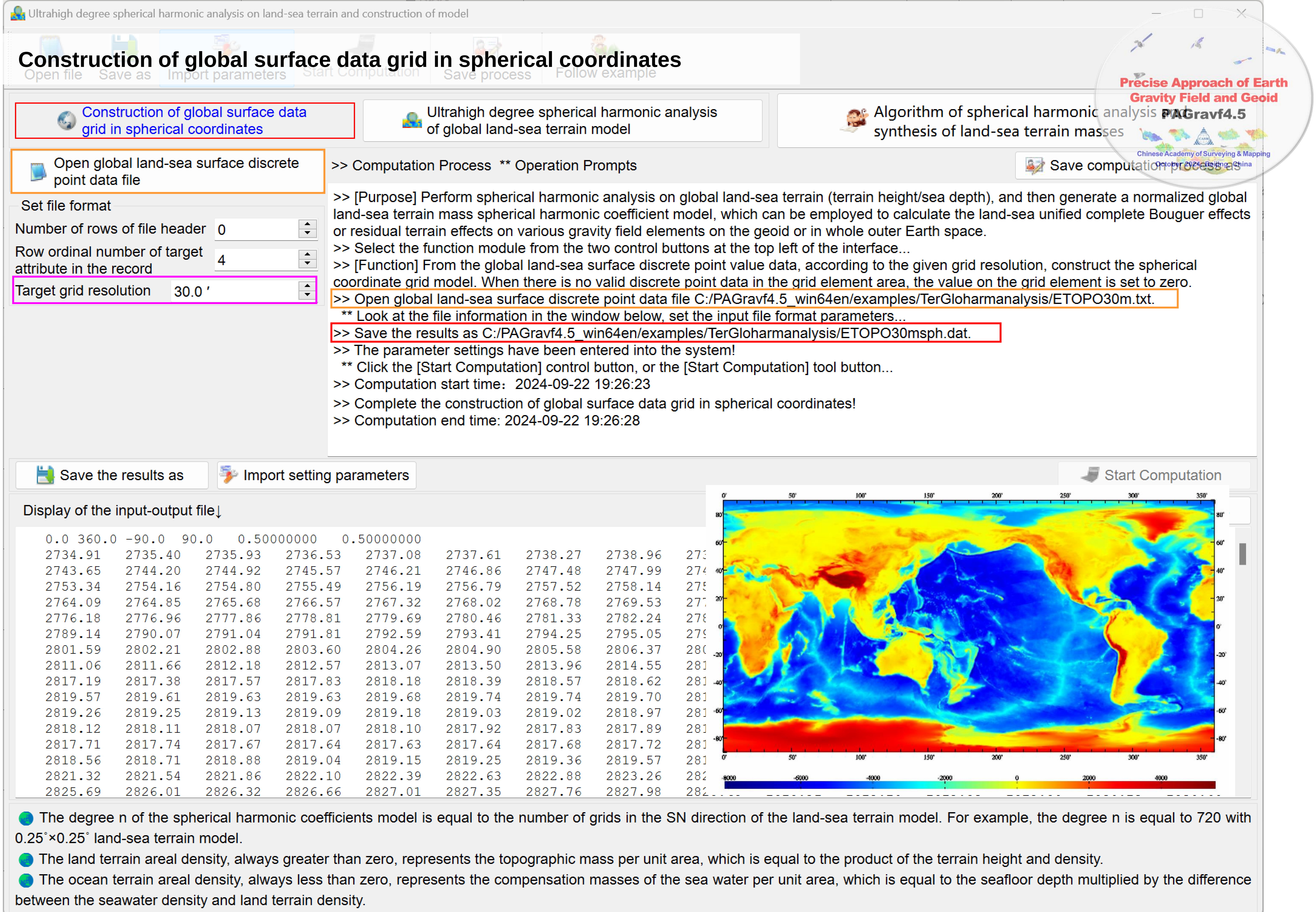

Calculator of land-sea unified residual terrain effect
Open high-resolution land-sea terrain model file
Open the land-sea low-pass terrain model file
Open the ellipsoidal height grid file of the land-sea surface
Input geodetic coordinates of calculation point
longitude 100.450000°
latitude 34.428000°
ellipsoidal height 417.830m
Integral radius 90 km
Start calculation
High-resolution land-sea terrain model
97.000000 102.000000 32.000000 36.000000 0.01666667 0.01666667
Residual terrain / complete Bouguer effect calculation results
height anomaly (m) 0.0206
gravity (anomaly/disturbance, mGal) -9.2450
vertical deflection (", S) -0.3546
vertical deflection (", W) -0.2634
(disturbing) gradient (E, radial) 7.7494
Inputting the high-resolution land-sea terrain model, low-pass land-sea terrain model and ellipsoidal height grid file of the land-sea surface with the same grid specifications, the button [Start Calculation] becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the residual terrain / complete Bouguer effects on various field elements can be computed and displayed in time.
The program allows to replace the three grid files above at any time from the interface, or to change the integral radius, and these user inputs will take effect at once. The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.

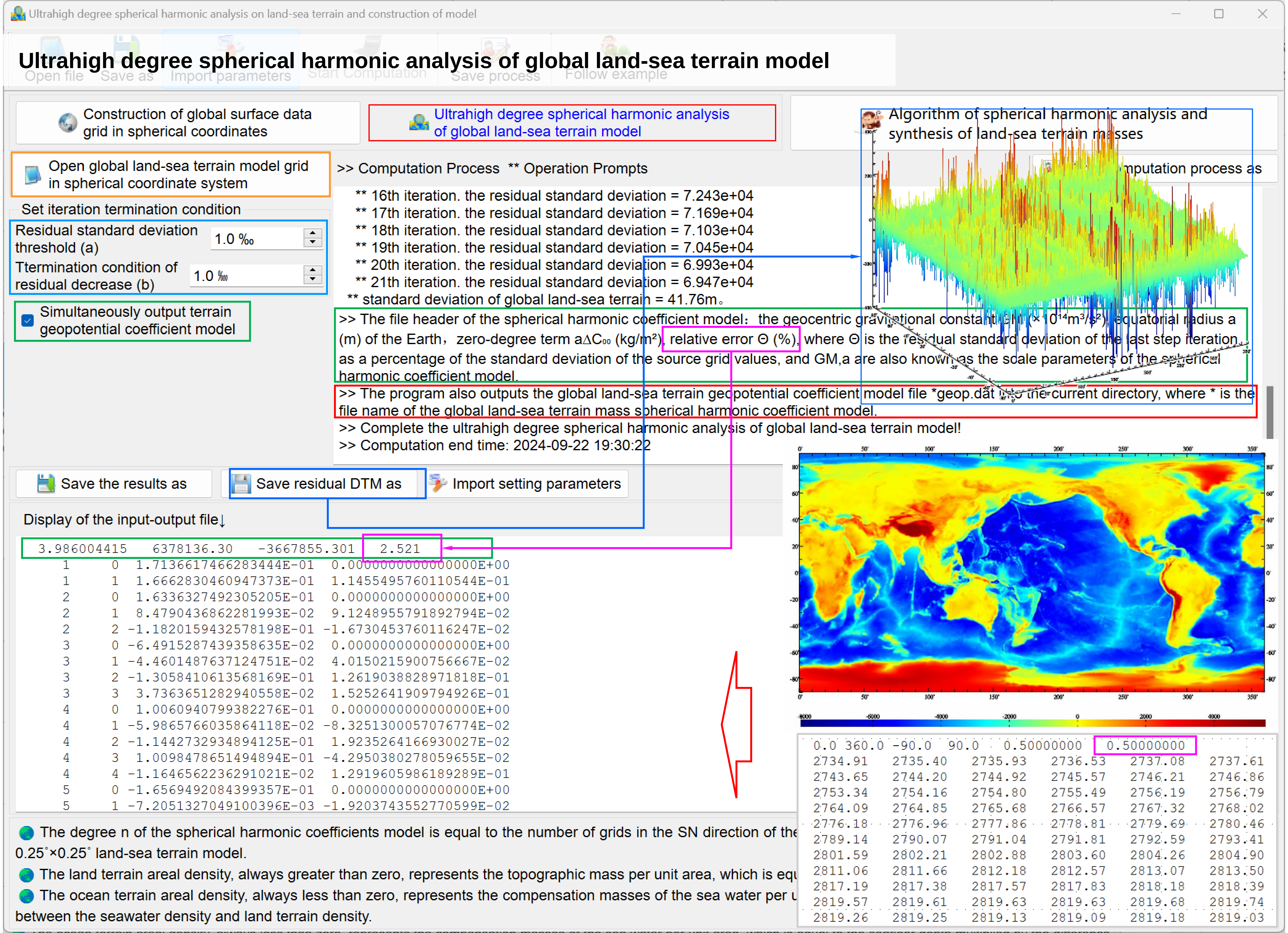

Computation of land-sea unified classical gravity Bouguer / equilibrium effect
Integral of land-sea unified classical gravity Bouguer / equilibrium effect
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Integral of land-sea unified classical gravity Bouguer / equilibrium effect
Calculator of land-sea unified classical gravity Bouguer / equilibrium effect
Algorithms land-sea unified classic Bouguer and equilibrium effects
Open the land-sea terrain model file
Open the ellipsoidal height grid file of land-sea surface
Select calculation point file format
discrete calculation point file
Open the calculation point location file on land-sea surface
Number of rows of file header 1
Integral radius for local terrain effect 90 km
Integral radius for seawater Bouguer / equilibrium effect 300 km
Equilibrium compensation depth 30 km
Extract effects
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dtm5m.dat.
>> Open the ellipsoidal height grid file of land-sea surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt5m.dat.
>> Open the calculation point location file on land-sea surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/rstpnt.txt.
** Behind the source calculation point file record, appends the terrain height/sea depth, local terrain effect, plane layer effect, seawater Bouguer effect, land equilibrium effect, ocean equilibrium effect, total Bouguer effect and total equilibrium effect, a total of 8 attribute values, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 18:31:54
Save the results as
Import setting parameters
Start Computation
terrian, plane layer, sea-water Bouguer, land equilibrium...
18.041667 1.4605 -2191.889 0.0000 0.0000 -109.5704 -0.0009 122.0600 -109.5704 12.4887
18.041667 1.7831 -2072.111 0.0000 0.0000 -103.9803 -0.0003 122.3674 -103.9803 18.3868
18.041667 2.1041 -1926.889 0.0000 0.0000 -97.4649 -0.0000 122.9345 -97.4649 25.4695
18.041667 2.4240 -1638.222 0.0000 0.0000 -89.4900 0.0000 124.4235 -89.4900 34.9336
land-sea terrain model (m)
total Bouguer effect (mGal)
total equilibrium effect (mGal)
Classic Bouguer gravity anomaly on geoid = gravity anomaly at the observed point – total Bouguer effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic Bouguer gravity disturbance on geoid = gravity disturbance at the observed point – total Bouguer effect – analytical continuation of gravity disturbance from the observed point to geoid.
Classic equilibrium gravity anomaly on geoid = gravity anomaly at the observed point – total equilibrium effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic equilibrium gravity disturbance on geoid = gravity disturbance at the observed point – total equilibrium effect – analytical continuation of gravity disturbance from the observed point to geoid.

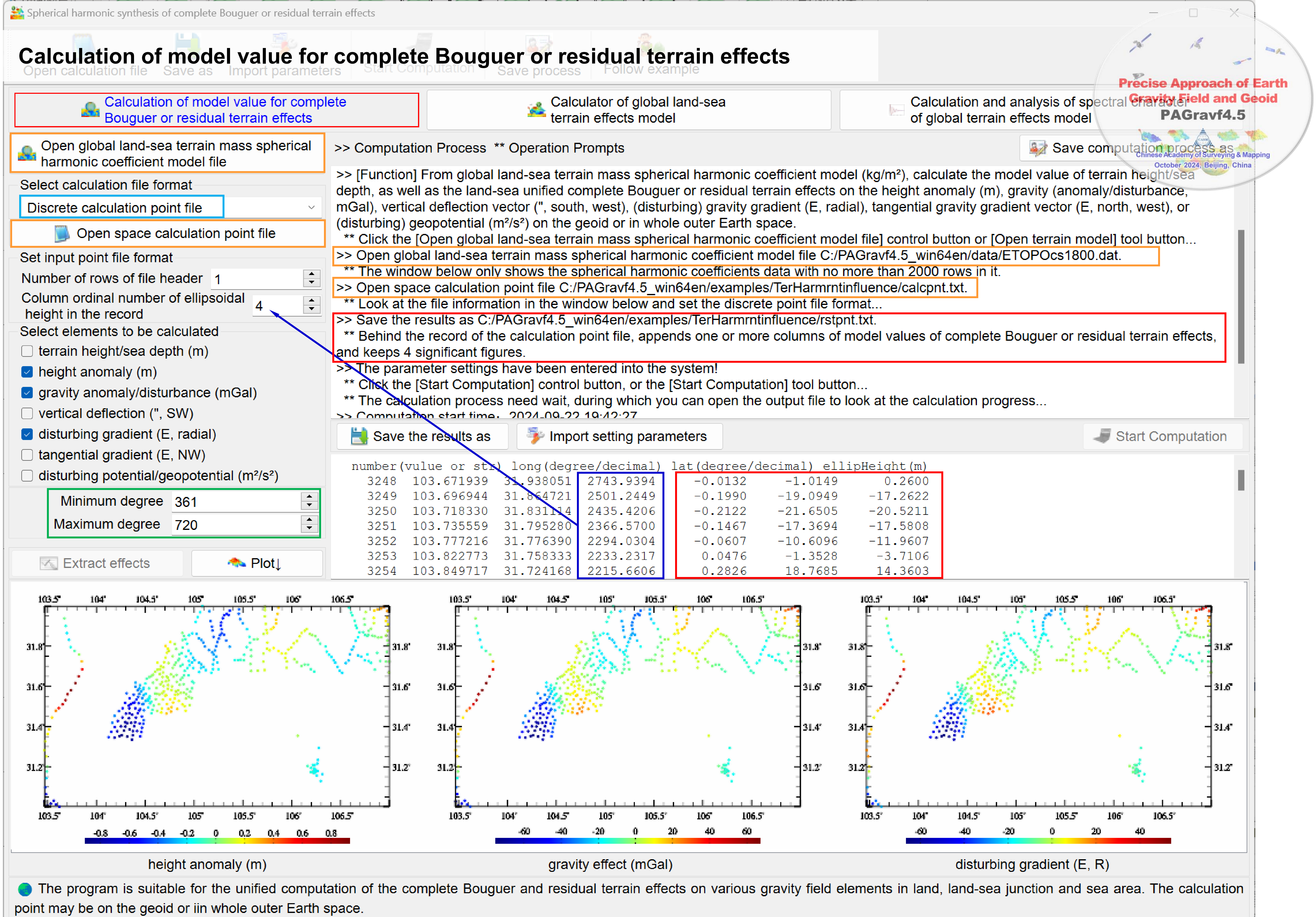

Computation of land-sea unified classical gravity Bouguer / equilibrium effect
Integral of land-sea unified classical gravity Bouguer / equilibrium effect
Open DTM
Import parameters
Save as
Start Computation
Save process
Follow example
Integral of land-sea unified classical gravity Bouguer / equilibrium effect
Calculator of land-sea unified classical gravity Bouguer / equilibrium effect
Algorithms land-sea unified classic Bouguer and equilibrium effects
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Open the land-sea terrain model file
Open the ellipsoidal height grid file of land-sea surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file on land-sea calculation surface
Integral radius for local terrain effect
90 km
Integral radius for seawater Bouguer / equilibrium effect
300 km
Equilibrium compensation depth
30 km
>> Computation Process ** Operation Prompts
Save computation process as
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dtm5m.dat.
>> Open the ellipsoidal height grid file of land-sea surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file on land-sea calculation surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt5m.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/result.txt.
** Record format: Point no, longitude, latitude, terrain height/sea depth, local terrain effect, plane layer effect, seawater Bouguer effect, land equilibrium effect, ocean equilibrium effect, total Bouguer effect and total equilibrium effect.
** At the same time, the program also outputs the land-sea total Bouguer effect (*.bgr) and land-sea total equilibrium effect (*.ist) grid files into the current directory, where * is the output file name entered from the interface.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
Save the results as
Import setting parameters
Start Computation
no lon(deg/decimal) lat height/depth local terrian, plane layer, sea-water Bouguer effect, ...
1 110.04167 15.04167 -456.500 0.0000 0.0000 -7.8971 0.0000 12.2480 -7.8971
2 110.12500 15.04167 -434.667 0.0000 0.0000 -7.8766 0.0000 14.7200 -7.8766
3 110.20833 15.04167 -465.667 0.0000 0.0000 -9.1329 0.0000 17.0115 -9.1329
4 110.29167 15.04167 -638.167 0.0000 0.0000 -13.9564 0.0000 19.0292 -13.9564
Extract effects
Plot
land-sea terrain model (m)
total Bouguer effect (mGal)
total equilibrium effect (mGal)
Classic Bouguer gravity anomaly on geoid = gravity anomaly at the observed point – total Bouguer effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic Bouguer gravity disturbance on geoid = gravity disturbance at the observed point – total Bouguer effect – analytical continuation of gravity disturbance from the observed point to geoid.
Classic equilibrium gravity anomaly on geoid = gravity anomaly at the observed point – total equilibrium effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic equilibrium gravity disturbance on geoid = gravity disturbance at the observed point – total equilibrium effect – analytical continuation of gravity disturbance from the observed point to geoid.

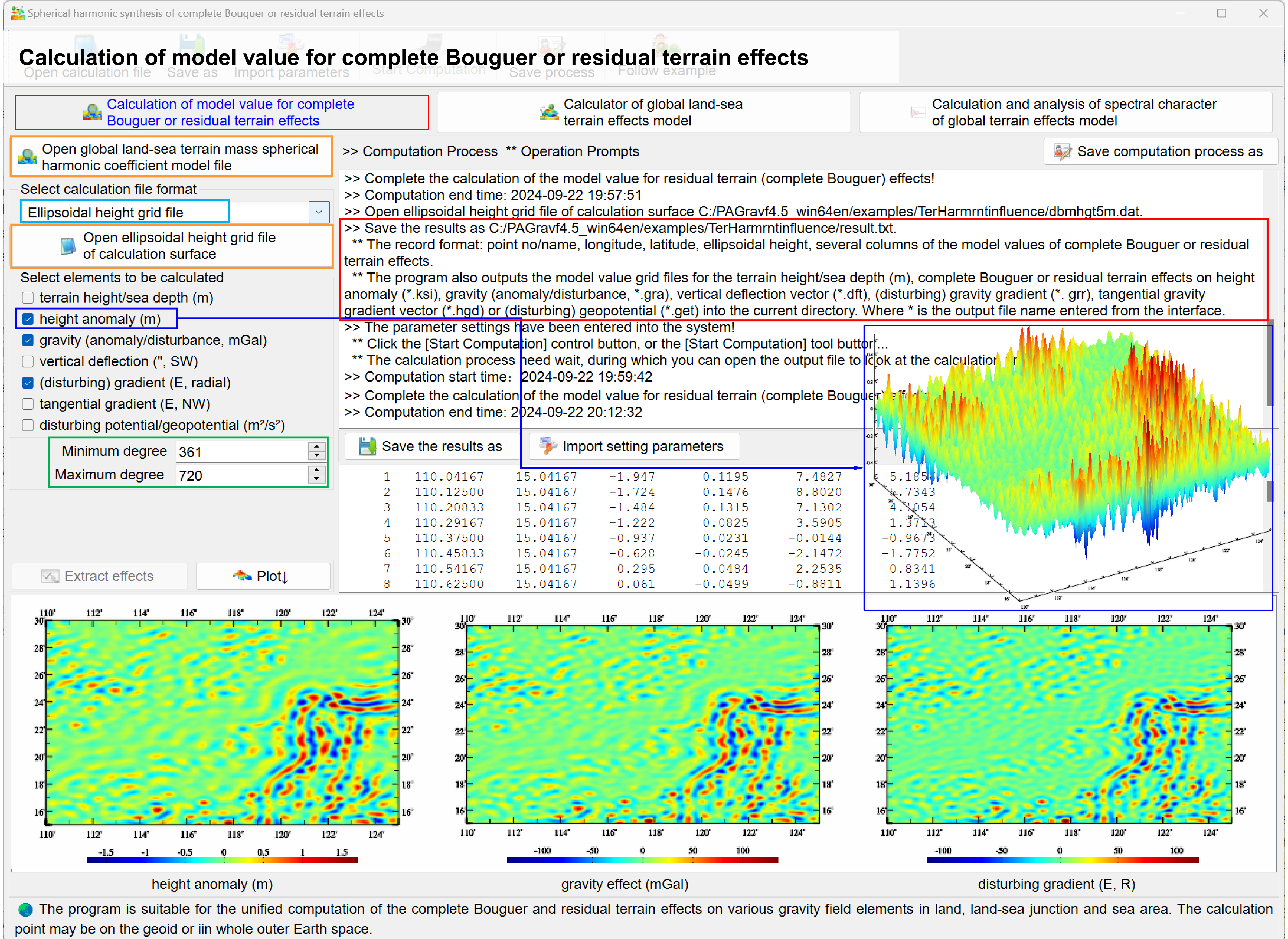

Calculator of land-sea unified classical gravity Bouguer / equilibrium effect
Open the land-sea terrain model file
Open the ellipsoidal height grid file of land-sea surface
Integral radius for local terrain effect
90 km
Integral radius for seawater Bouguer /equilibrium effect
300 km
Equilibrium compensation depth
30 km
Input geodetic coordinates of calculation pointon land-sea surface
longitude
116.240000°
latitude
26.428100°
Start calculation
Terrain effects (mGal) at the calculation pointon
land height/sea depth
400.3811 m
local terrain effect
-0.4405
plane layer effect
44.8300
seawater Bouguer effect
-0.0000
land equilibrium effect
-39.2525
ocean equilibrium effect
0.0000
total Bouguer effect
44.3896
total equilibrium effect
5.1370
Land-sea terrain model
110.000000 125.000000 15.000000
-456.5000 -434.6667 -465.6667 -802.6667 -775.3333 -763.833
-1253.8333 -1290.3333 -1321.6667 -1594.5000 -1622.6667 -1623.833
-2604.3333 -2767.5000 -2971.5000 -3351.0000 -3388.0000 -3409.833
-4315.0000 -4281.8333 -4269.0000 -4336.3333 -4305.666
-4158.6667 -4285.5000 -4289.1667 -4282.1667 -4231.1667 -4275.500
-3536.6667 -2641.6667 -2227.0000 -2090.0000 -4260.8333 -4299.000
-4036.8333 -3508.1667 -3080.6667 -4096.3333 -4237.166
-4273.1667 -4475.5000 -4593.3333 -4430.8333 -3423.5000 -3013.0000 -2808.000
7.1667 180.3333 237.8333 508.6667 23.8333 13.833
Using + to indicate greater than zero, and - to indicate less than zero, there are always: plane layer effect (+), seawater Bouguer effect (-), land equilibrium effect (-), ocean equilibrium effect (+).
In the coastal sea area, there are local terrain effects and land equilibrium effects. In the offshore land area, there are also seawater Bouguer effects and ocean equilibrium effects.


Calculator of land-sea unified classical gravity Bouguer / equilibrium effect
Open the land-sea terrain model file
Open the ellipsoidal height grid file of land-sea surface
Integral radius for local terrain effect
90 km
Integral radius for seawater Bouguer /equilibrium effect
300 km
Equilibrium compensation depth
30 km
Input geodetic coordinates of calculation pointon land-sea surface
longitude
121.240000°
latitude
21.428100°
Start calculation
Terrain effects (mGal) at the calculation pointon
land height/sea depth
-2187.1242 m
local terrain effect
0.0017
plane layer effect
0.0000
seawater Bouguer effect
-61.3520
land equilibrium effect
-1.2635
ocean equilibrium effect
129.3990
total Bouguer effect
-61.3503
total equilibrium effect
66.7853
Land-sea terrain model
110.000000 125.000000 15.000000 30.000000
-456.5000 -434.6667 -465.6667 -802.6667 -775.3333 -763.833
-1253.8333 -1290.3333 -1321.6667 -1594.5000 -1622.6667 -1623.833
-2604.3333 -2767.5000 -2971.5000 -3388.0000 -3409.833
-4315.0000 -4281.8333 -4269.0000 -4336.3333 -4305.666
-4158.6667 -4285.5000 -4289.1667 -4231.1667 -4275.500
-3536.6667 -2641.6667 -2227.0000 -2090.0000 -4260.8333 -4299.000
-4036.8333 -3508.1667 -3080.6667 -4096.3333 -4237.166
-4273.1667 -4475.5000 -4593.3333 -4430.8333 -3013.0000 -2808.000
7.1667 180.3333 237.8333 508.6667 55.0000 23.8333 13.833
Using + to indicate greater than zero, and - to indicate less than zero, there are always: plane layer effect (+), seawater Bouguer effect (-), land equilibrium effect (-), ocean equilibrium effect (+).
In the coastal sea area, there are local terrain effects and land equilibrium effects. In the offshore land area, there are also seawater Bouguer effects and ocean equilibrium effects.

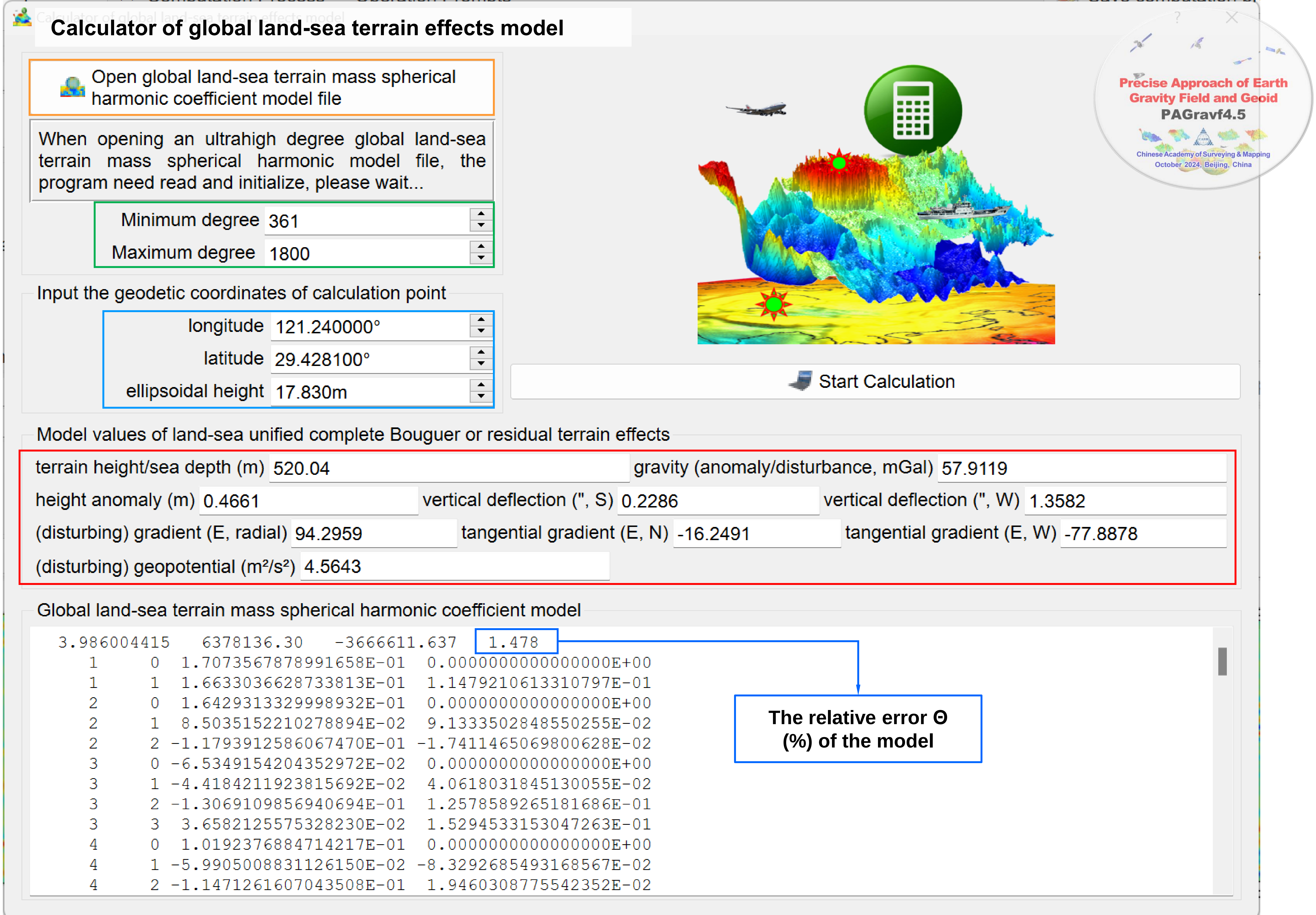

Ultrahigh degree spherical harmonic analysis on land-sea terrain and construction of model
Construction of global surface data grid in spherical coordinates
Open file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
Construction of global surface data grid in spherical coordinates
Ultrahigh degree spherical harmonic analysis of global land-sea terrain model
Algorithm of spherical harmonic analysis and synthesis of land-sea terrain masses
Open global land-sea surface discrete point data file
>> Computation Process ** Operation Prompts
Save computation process as
Set file format
Number of rows of file header 0
Row ordinal number of target attribute in the record 4
Target grid resolution 30.0 ′
>> [Purpose] Perform spherical harmonic analysis on global land-sea terrain (terrain height/sea depth), and then generate a normalized global land-sea terrain mass spherical harmonic coefficient model, which can be employed to calculate the land-sea unified complete Bouguer effects or residual terrain effects on various gravity field elements on the geoid or in whole outer Earth space.
>> Select the function module from the two control buttons at the top left of the interface...
>> [Function] From the global land-sea surface discrete point value data, according to the given grid resolution, construct the spherical coordinate grid model. When there is no valid discrete point data in the grid element area, the value on the grid element is set to zero.
>> Open global land-sea surface discrete point data file C:/PAGravf4.5_win64en/examples/TerGloharmanalysis/ETOPO30m.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerGloharmanalysis/ETOPO30msph.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 19:26:23
>> Complete the construction of global surface data grid in spherical coordinates!
>> Computation end time: 2024-09-22 19:26:28
Save the results as
Import setting parameters
Start Computation
Display of the input-output file↓
0.0 360.0 -90.0 90.0 0.50000000 0.50000000
2734.91 2735.40 2735.93 2736.53 2737.08 2737.61 2738.27 2738.96
2743.65 2744.20 2744.92 2745.57 2746.21 2746.86 2747.48 2747.99
2753.34 2754.16 2754.80 2755.49 2756.19 2756.79 2757.52 2758.14
2764.09 2764.85 2765.68 2766.57 2767.32 2768.02 2768.78 2769.53
2776.18 2776.96 2777.86 2778.81 2779.69 2780.46 2781.33 2782.24
2789.14 2790.07 2791.04 2791.81 2792.59 2793.41 2794.25 2795.05
2801.59 2802.21 2802.88 2803.60 2804.26 2804.90 2805.58 2806.37
2811.06 2811.66 2812.18 2812.57 2813.07 2813.50 2813.96 2814.55
2817.19 2817.38 2817.57 2817.83 2818.18 2818.39 2818.57 2818.62
2819.57 2819.61 2819.63 2819.63 2819.68 2819.74 2819.74 2819.70
2819.26 2819.25 2819.13 2819.09 2819.18 2819.03 2819.02 2818.97
2818.12 2818.11 2818.07 2818.07 2818.10 2817.92 2817.83 2817.89
2817.71 2817.74 2817.67 2817.64 2817.63 2817.64 2817.68 2817.72
2818.56 2818.71 2818.88 2819.04 2819.15 2819.25 2819.36 2819.57
2821.32 2821.54 2821.86 2822.10 2822.39 2822.63 2822.88 2823.26
2825.69 2826.01 2826.32 2826.66 2827.01 2827.35 2827.76 2827.98
-8000 -6000 -4000 -2000 0 2000 4000
The degree n of the spherical harmonic coefficients model is equal to the number of grids in the SN direction of the land-sea terrain model. For example, the degree n is equal to 720 with 0.25˚×0.25˚ land-sea terrain model.
The land terrain areal density, always greater than zero, represents the topographic mass per unit area, which is equal to the product of the terrain height and density.
The ocean terrain areal density, always less than zero, represents the compensation masses of the sea water per unit area, which is equal to the seafloor depth multiplied by the difference between the seawater density and land terrain density.

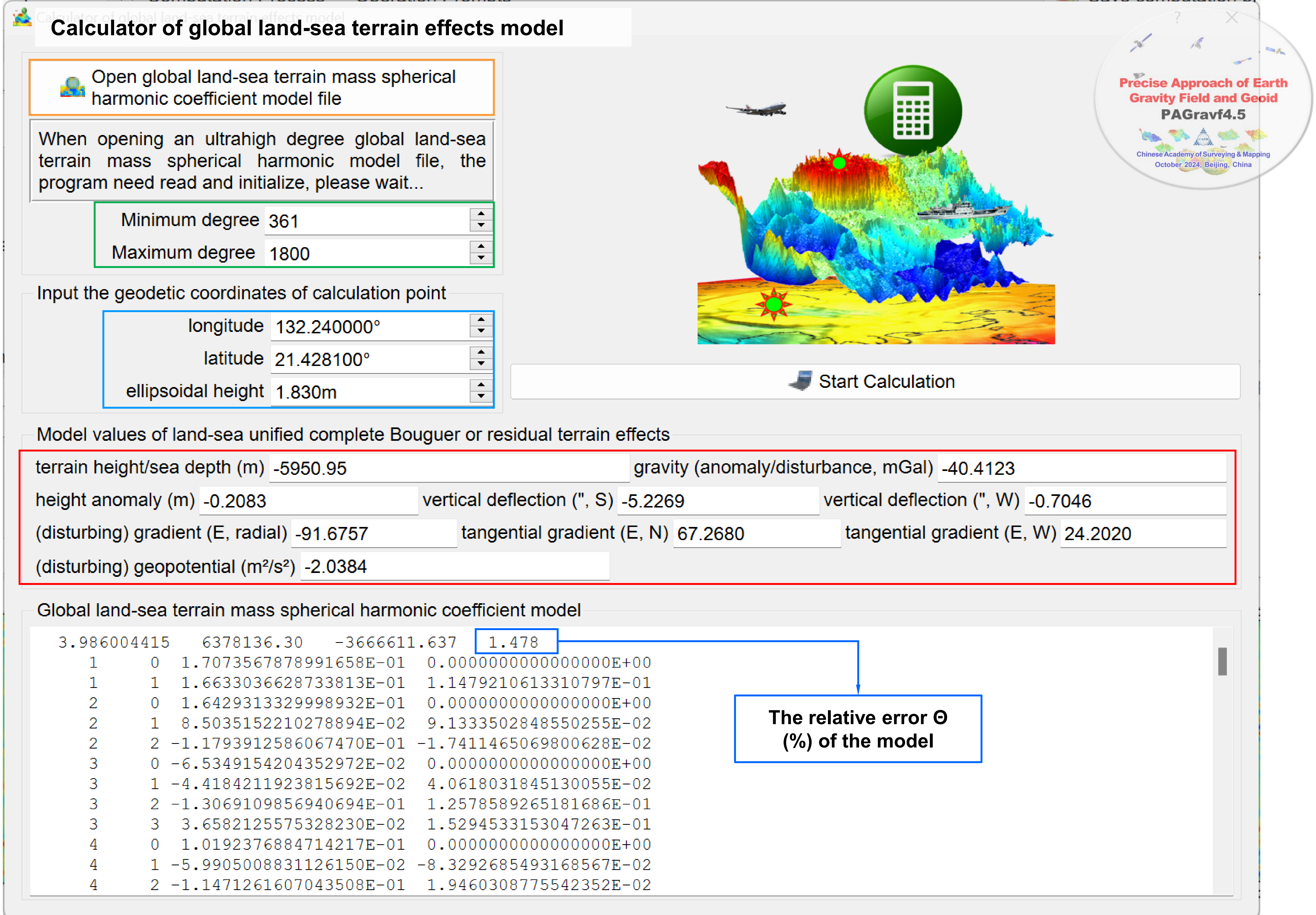

Ultrahigh degree spherical harmonic analysis on land-sea terrain and construction of model
Ultrahigh degree spherical harmonic analysis of global land-sea terrain model
Open file
Save as
Import parameters
Start Computation
Save process
Follow example
Construction of global surface data grid in spherical coordinates
Ultrahigh degree spherical harmonic analysis of global land-sea terrain model
Algorithm of spherical harmonic analysis and synthesis of land-sea terrain masses
Open global land-sea terrain model grid in spherical coordinate system
>> Computation Process ** Operation Prompts
Set iteration termination condition
Residual standard deviation threshold (a)
1.0 ‰
Ttermination condition of residual decrease (b)
1.0 ‰
Simultaneously output terrain geopotential coefficient model
** 16th iteration. the residual standard deviation = 7.243e+04
** 17th iteration. the residual standard deviation = 7.169e+04
** 18th iteration. the residual standard deviation = 7.103e+04
** 19th iteration. the residual standard deviation = 7.045e+04
** 20th iteration. the residual standard deviation = 6.993e+04
** 21th iteration. the residual standard deviation = 6.947e+04
** standard deviation of global land-sea terrain = 41.76m。
>> The file header of the spherical harmonic coefficient model: the geocentric gravitational constant GM (×10¹⁴m³/s²), equatorial radius a (m) of the Earth, zero-degree term aΔC₀₀ (kg/m²), relative error Θ (%), where Θ is the residual standard deviation of the last step iteration as a percentage of the standard deviation of the source grid values, and GM,a are also known as the scale parameters of the spherical harmonic coefficient model.
>> The program also outputs the global land-sea terrain geopotential coefficient model file *geop.dat into the current directory, where * is the file name of the global land-sea terrain mass spherical harmonic coefficient model.
>> Complete the ultrahigh degree spherical harmonic analysis of global land-sea terrain model!
>> Computation end time: 2024-09-22 19:30:22
Save the results as
Save residual DTM as
Import setting parameters
Display of the input-output file↓
3.986004415 6378136.30 -3667855.301 2.521
1 0 1.7136617466283444E-01 0.0000000000000000E+00
1 1 1.6662830460947373E-01 1.1455495760110544E-01
2 0 1.6336327492305205E-01 0.0000000000000000E+00
2 1 8.4790436862281993E-02 9.1248955791892794E-02
2 2 -1.1820159432578198E-01 -1.6730453760116247E-02
3 0 -6.4915287439358635E-02 0.0000000000000000E+00
3 1 -4.4601487637124751E-02 4.0150215900756667E-02
3 2 -1.3058410613568169E-01 1.2619038828971818E-01
3 3 3.7363651282940558E-02 1.5252641909794926E-01
4 0 1.0060940799382276E-01 0.0000000000000000E+00
4 1 -5.9865766035864118E-02 -8.3251300057076774E-02
4 2 -1.1442732934894125E-01 1.9235264166930027E-02
4 3 1.0098478651494894E-01 -4.2950380278059655E-02
4 4 -1.1646562236291021E-02 1.2919605986189289E-01
5 0 -1.6569492084399357E-01 0.0000000000000000E+00
5 1 -7.2051327049100396E-03 -1.9203743552770599E-02
0.0 360.0 -90.0 90.0 0.50000000 0.50000000
2734.91 2735.40 2735.93 2736.53 2737.08 2737.61
2743.65 2744.20 2744.92 2745.57 2746.21 2746.86
2753.34 2754.16 2754.80 2755.49 2756.19 2756.79
2764.09 2764.85 2765.68 2766.57 2767.32 2768.02
2776.18 2776.96 2777.86 2778.81 2779.69 2780.46
2789.14 2790.07 2791.04 2791.81 2792.59 2793.41
2801.59 2802.21 2802.88 2803.60 2804.26 2804.90
2811.06 2811.66 2812.18 2812.57 2813.07 2813.50
2817.19 2817.38 2817.57 2817.83 2818.18 2818.39
2819.57 2819.61 2819.63 2819.63 2819.68 2819.74
2819.26 2819.25 2819.13 2819.09 2819.18 2819.03
The degree n of the spherical harmonic coefficients model is equal to the number of grids in the SN direction of the 0.25˚×0.25˚ land-sea terrain model.
The land terrain areal density, always greater than zero, represents the topographic mass per unit area, which is equ
The ocean terrain areal density, always less than zero, represents the compensation masses of the sea water per u between the seawater density and land terrain density.


Spherical harmonic synthesis of complete Bouguer or residual terrain effects
Calculation of model value for complete Bouguer or residual terrain effects
Open calculation file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of model value for complete Bouguer or residual terrain effects
Calculator of global land-sea terrain effects model
Calculation and analysis of spectral character of global terrain effects model
Open global land-sea terrain mass spherical harmonic coefficient model file
Select calculation file format
Discrete calculation point file
Open space calculation point file
Set input point file format
Number of rows of file header
1
Column ordinal number of ellipsoidal height in the record
4
Select elements to be calculated
terrain height/sea depth (m)
height anomaly (m)
gravity anomaly/disturbance (mGal)
vertical deflection (", SW)
disturbing gradient (E, radial)
tangential gradient (E, NW)
disturbing potential/geopotential (m²/s²)
Minimum degree
361
Maximum degree
720
Extract effects
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From global land-sea terrain mass spherical harmonic coefficient model (kg/m²), calculate the model value of terrain height/sea depth, as well as the land-sea unified complete Bouguer or residual terrain effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection vector (", south, west), (disturbing) gravity gradient (E, radial), tangential gravity gradient vector (E, north, west), or (disturbing) geopotential (m²/s²) on the geoid or in whole outer Earth space.
** Click the [Open global land-sea terrain mass spherical harmonic coefficient model file] control button or [Open terrain model] tool button...
>> Open global land-sea terrain mass spherical harmonic coefficient model file C:/PAGravf4.5_win64en/data/ETOPOcs1800.dat.
** The window below only shows the spherical harmonic coefficients data with no more than 2000 rows in it.
>> Open space calculation point file C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/calcpnt.txt.
** Look at the file information in the window below and set the discrete point file format...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/rstpnt.txt.
** Behind the record of the calculation point file, appends one or more columns of model values of complete Bouguer or residual terrain effects, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The calculation process need wait, during which you can open the output file to look at the calculation progress...
>> Computation start time: 2024-09-22 19:42:27
Save the results as
Import setting parameters
Start Computation
number(vulue or str) long(degree/decimal) lat(degree/decimal) ellipHeight(m)
3248 103.671939 31.938051 2743.9394 -0.0132 -1.0149 0.2600
3249 103.696944 31.864721 2501.2449 -0.1990 -19.0949 -17.2622
3250 103.718330 31.831114 2435.4206 -0.2122 -21.6505 -20.5211
3251 103.735559 31.795280 2366.5700 -0.1467 -17.3694 -17.5808
3252 103.777216 31.776390 2294.0304 -0.0607 -10.6096 -11.9607
3253 103.822773 31.758333 2233.2317 0.0476 -1.3528 -3.7106
3254 103.849717 31.724168 2215.6606 0.2826 18.7685 14.3603
height anomaly (m)
gravity effect (mGal)
disturbing gradient (E, R)
The program is suitable for the unified computation of the complete Bouguer and residual terrain effects on various gravity field elements in land, land-sea junction and sea area. The calculation point may be on the geoid or iin whole outer Earth space.

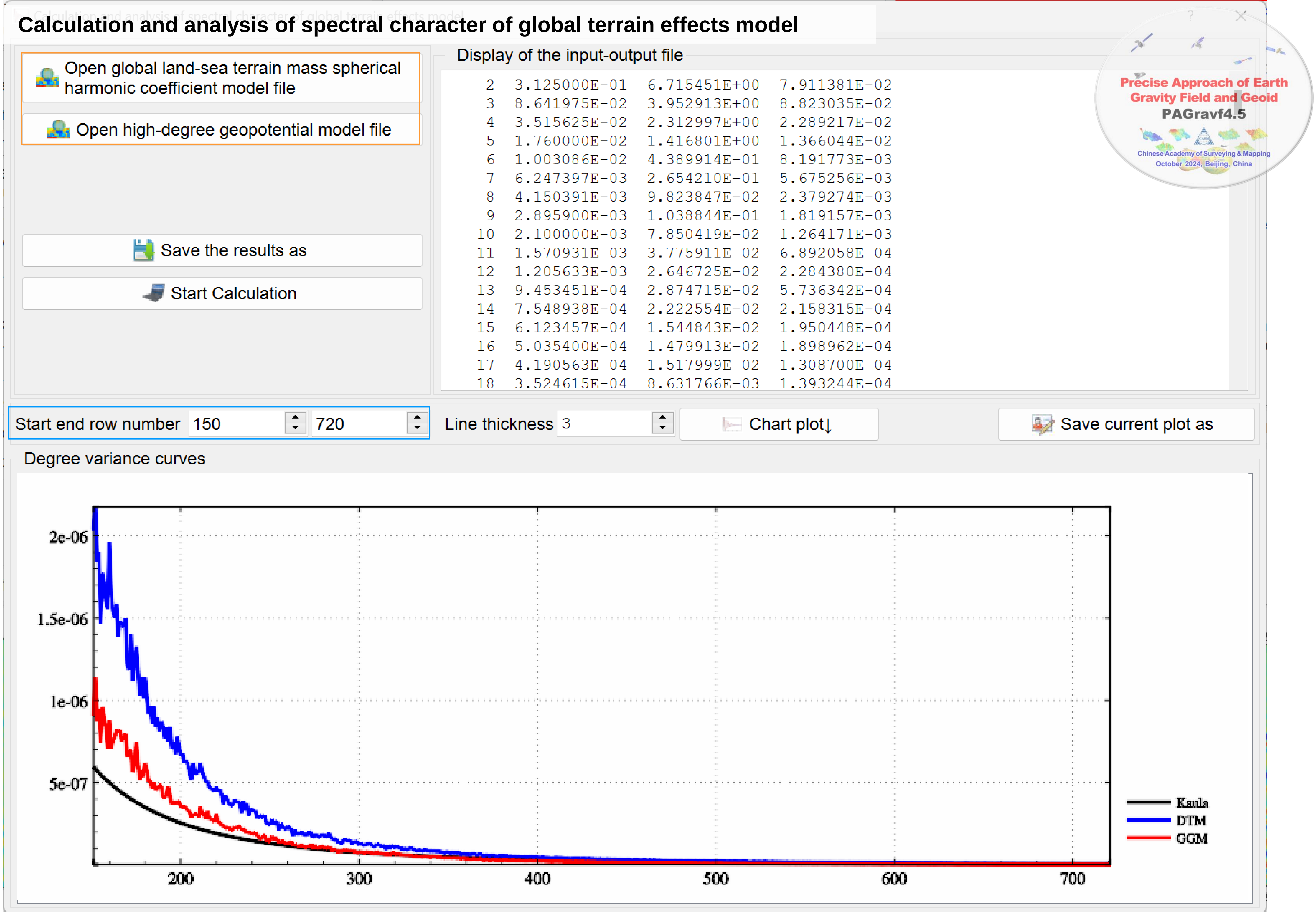


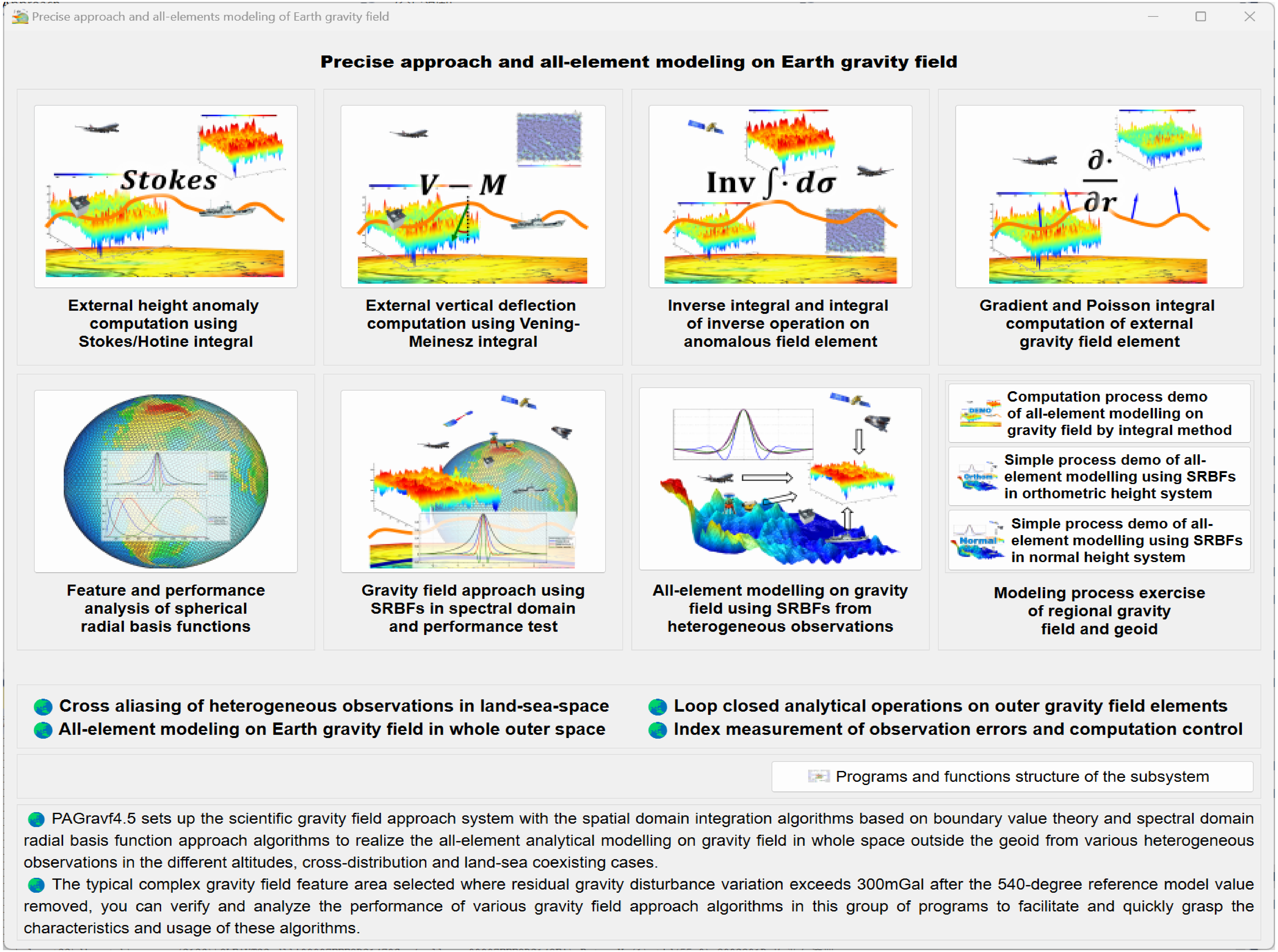
Spherical harmonic synthesis of complete Bouguer or residual terrain effects
Calculation of model value for complete Bouguer or residual terrain effects
Open calculation file
Save as
Import parameters
Start Computation
Save process
Follow example
Calculation of model value for complete Bouguer or residual terrain effects
Calculator of global land-sea terrain effects model
Calculation and analysis of spectral character of global terrain effects model
Open global land-sea terrain mass spherical harmonic coefficient model file
Select calculation file format
Ellipsoidal height grid file
Open ellipsoidal height grid file of calculation surface
Select elements to be calculated
terrain height/sea depth (m)
height anomaly (m)
gravity (anomaly/disturbance, mGal)
vertical deflection (", SW)
(disturbing) gradient (E, radial)
tangential gradient (E, NW)
disturbing potential/geopotential (m²/s²)
Minimum degree 361
Maximum degree 720
Extract effects
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the calculation of the model value for residual terrain (complete Bouguer) effects!
>> Computation end time: 2024-09-22 19:57:51
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/dbmhgt5m.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/result.txt.
** The record format: point no/name, longitude, latitude, ellipsoidal height, several columns of the model values of complete Bouguer or residual terrain effects.
** The program also outputs the model value grid files for the terrain height/sea depth (m), complete Bouguer or residual terrain effects on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra), vertical deflection vector (*.dft), (disturbing) gravity gradient (*. grr), tangential gravity gradient vector (*.hgd) or (disturbing) geopotential (*.get) into the current directory. Where * is the output file name entered from the interface.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The calculation process need wait, during which you can open the output file to look at the calculation
>> Computation start time: 2024-09-22 19:59:42
>> Complete the calculation of the model value for residual terrain (complete Bouguer) effects
>> Computation end time: 2024-09-22 20:12:32
Save the results as
Import setting parameters
1 110.04167 15.04167 -1.947 0.1195 7.4827 5.1856
2 110.12500 15.04167 -1.724 0.1476 8.8020 5.7343
3 110.20833 15.04167 -1.484 0.1315 7.1302 4.1054
4 110.29167 15.04167 -1.222 0.0825 3.5905 1.3713
5 110.37500 15.04167 -0.937 0.0231 -0.0144 -0.9673
6 110.45833 15.04167 -0.628 -0.0245 -2.1472 -1.7752
7 110.54167 15.04167 -0.295 -0.0484 -2.2535 -0.8341
8 110.62500 15.04167 0.061 -0.0499 -0.8811 1.1396
height anomaly (m)
gravity effect (mGal)
disturbing gradient (E, R)
The program is suitable for the unified computation of the complete Bouguer and residual terrain effects on various gravity field elements in land, land-sea junction and sea area. The calculation point may be on the geoid or iin whole outer Earth space.

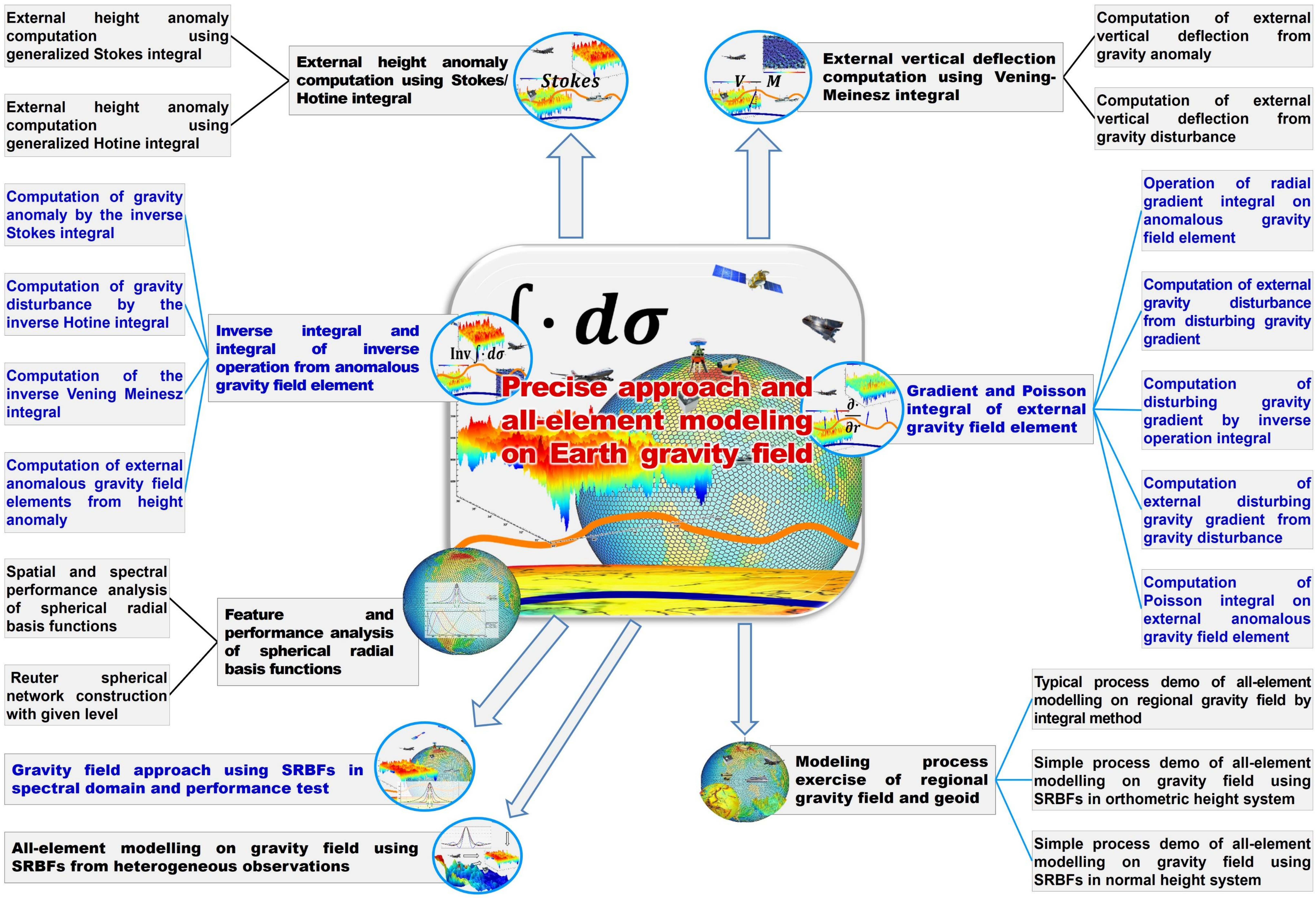

Calculator of global land-sea terrain effects model
Open global land-sea terrain mass spherical harmonic coefficient model file
When opening an ultrahigh degree global land-sea terrain mass spherical harmonic model file, the program need read and initialize, please wait...
Minimum degree 361
Maximum degree 1800
Input the geodetic coordinates of calculation point
longitude 121.240000°
latitude 29.428100°
ellipsoidal height 17.830m
Start Calculation
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Model values of land-sea unified complete Bouguer or residual terrain effects
terrain height/sea depth (m) 520.04
gravity (anomaly/disturbance, mGal) 57.9119
height anomaly (m) 0.4661
vertical deflection (", S) 0.2286
vertical deflection (", W) 1.3582
(disturbing) gradient (E, radial) 94.2959
tangential gradient (E, N) -16.2491
tangential gradient (E, W) -77.8878
(disturbing) geopotential (m²/s²) 4.5643
Global land-sea terrain mass spherical harmonic coefficient model
3.986004415 6378136.30 -3666611.637 1.478
1 0 1.7073567878991658E-01 0.0000000000000000E+00
1 1 1.6633036628733813E-01 1.1479210613310797E-01
2 0 1.6429313329998932E-01 0.0000000000000000E+00
2 1 8.5035152210278894E-02 9.1333502848550255E-02
2 2 -1.1793912586067470E-01 -1.7411465069800628E-02
3 0 -6.5349154204352972E-02 0.0000000000000000E+00
3 1 -4.4184211923815692E-02 4.0618031845130055E-02
3 2 -1.3069109856940694E-01 1.2578589265181686E-01
3 3 3.6582125575328230E-02 1.5294533153047263E-01
4 0 1.0192376884714217E-01 0.0000000000000000E+00
4 1 -5.9905008831126150E-02 -8.3292685493168567E-02
4 2 -1.1471261607043508E-01 1.9460308775542352E-02
The relative error Θ (%) of the model

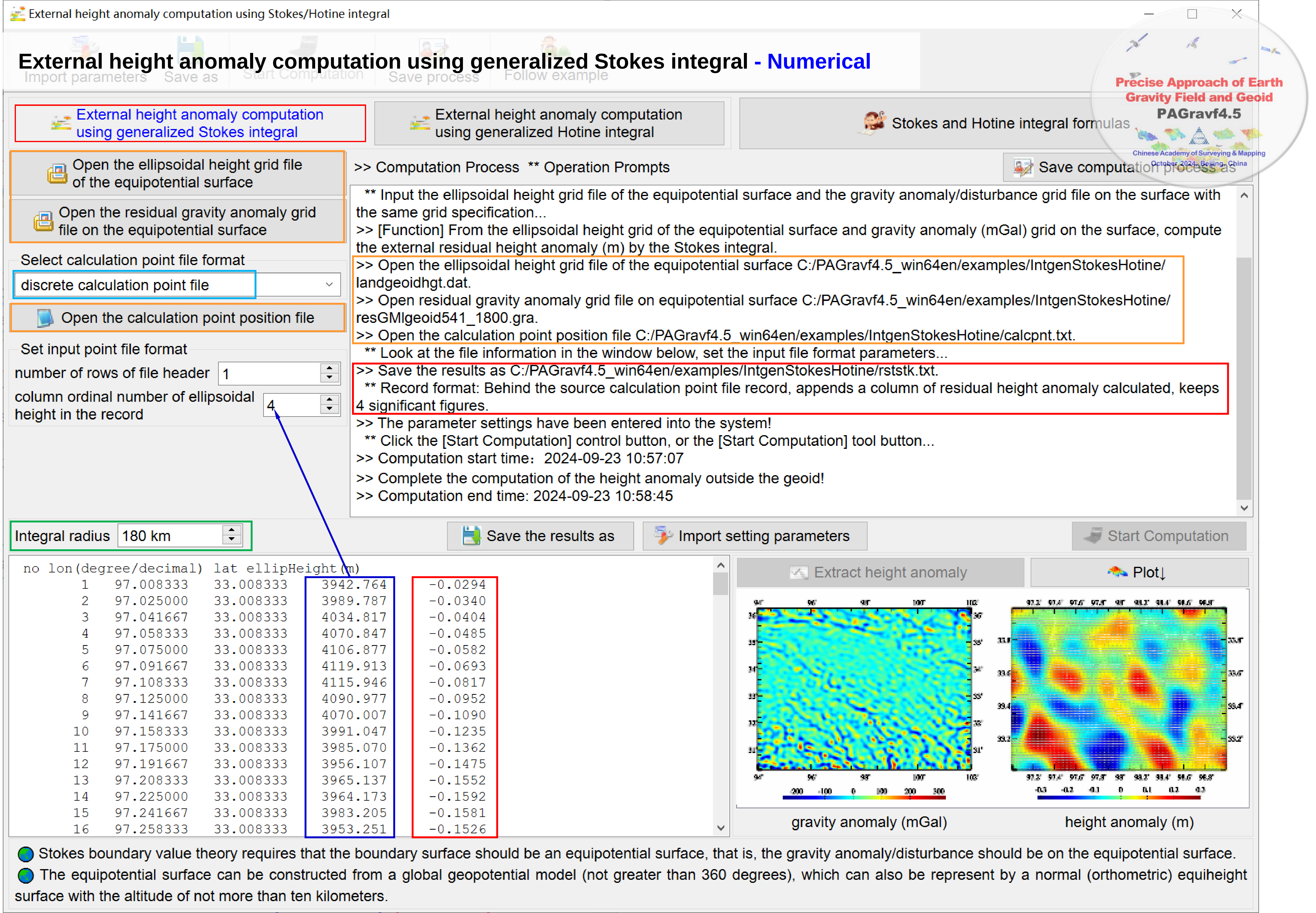


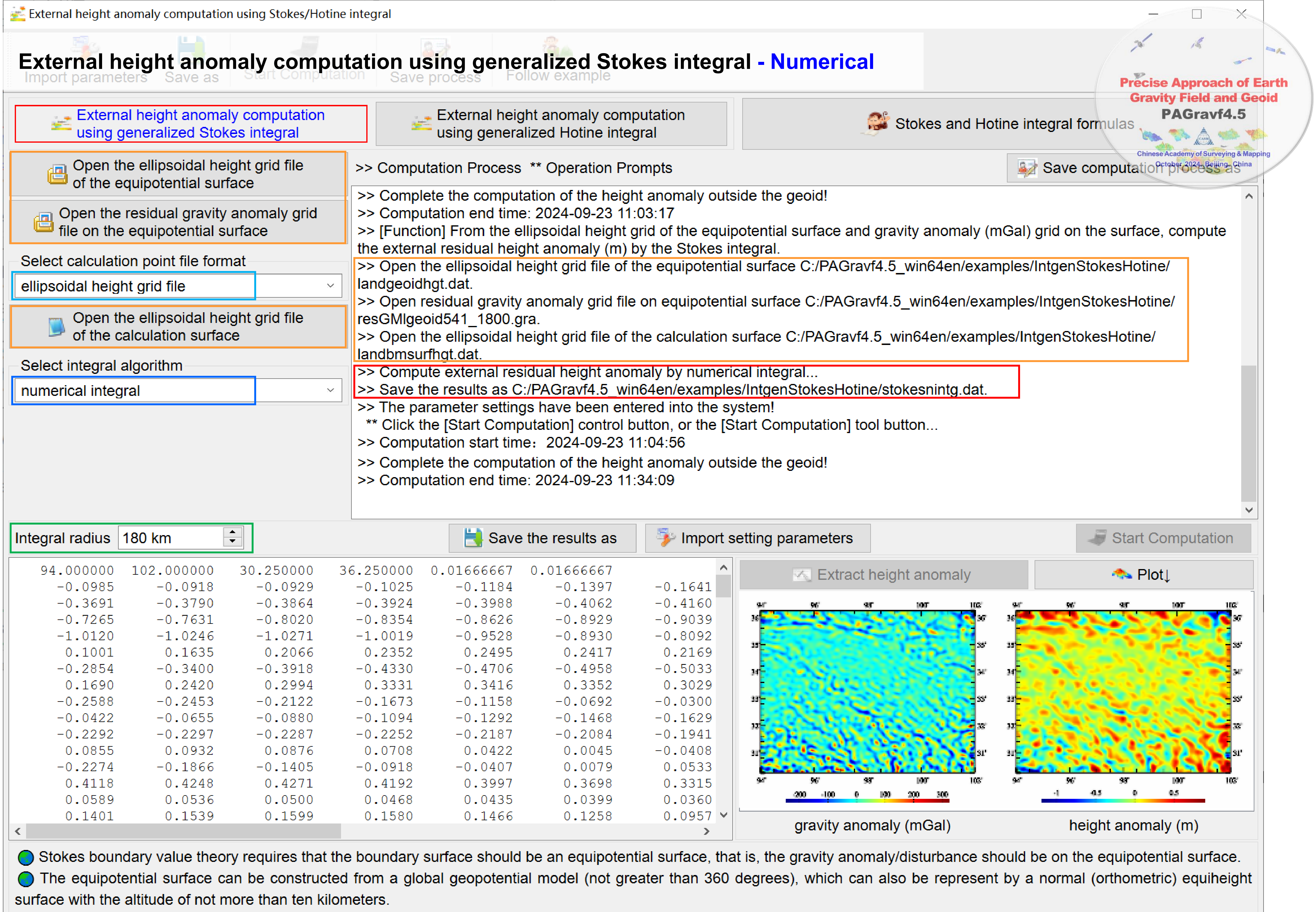
Calculator of global land-sea terrain effects model
Open global land-sea terrain mass spherical harmonic coefficient model file
When opening an ultrahigh degree global land-sea terrain mass spherical harmonic model file, the program need read and initialize, please wait...
Minimum degree 361
Maximum degree 1800
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Input the geodetic coordinates of calculation point
longitude 132.240000°
latitude 21.428100°
ellipsoidal height 1.830m
Start Calculation
Model values of land-sea unified complete Bouguer or residual terrain effects
terrain height/sea depth (m) -5950.95
gravity (anomaly/disturbance, mGal) -40.4123
height anomaly (m) -0.2083
vertical deflection (", S) -5.2269
vertical deflection (", W) -0.7046
(disturbing) gradient (E, radial) -91.6757
tangential gradient (E, N) 67.2680
tangential gradient (E, W) 24.2020
(disturbing) geopotential (m²/s²) -2.0384
Global land-sea terrain mass spherical harmonic coefficient model
3.986004415 6378136.30 -3666611.637 1.478
1 0 1.7073567878991658E-01 0.0000000000000000E+00
1 1 1.6633036628733813E-01 1.1479210613310797E-01
2 0 1.6429313329998932E-01 0.0000000000000000E+00
2 1 8.5035152210278894E-02 9.1333502848550255E-02
2 2 -1.1793912586067470E-01 -1.7411465069800628E-02
3 0 -6.5349154204352972E-02 0.0000000000000000E+00
3 1 -4.4184211923815692E-02 4.0618031845130055E-02
3 2 -1.3069109856940694E-01 1.2578589265181686E-01
3 3 3.6582125575328230E-02 1.5294533153047263E-01
4 0 1.0192376884714217E-01 0.0000000000000000E+00
4 1 -5.9905008831126150E-02 -8.3292685493168567E-02
4 2 -1.1471261607043508E-01 1.9460308775542352E-02
The relative error Θ (%) of the model


Calculation and analysis of spectral character of global terrain effects model
Open global land-sea terrain mass spherical harmonic coefficient model file
Open high-degree geopotential model file
Save the results as
Start Calculation
Display of the input-output file
2 3.125000E-01 6.715451E+00 7.911381E-02
3 8.641975E-02 3.952913E+00 8.823035E-02
4 3.515625E-02 2.312997E+00 2.289217E-02
5 1.760000E-02 1.416801E+00 1.366044E-02
6 1.003086E-02 4.389914E-01 8.191773E-03
7 6.247397E-03 2.654210E-01 5.675256E-03
8 4.150391E-03 9.823847E-02 2.379274E-03
9 2.895900E-03 1.038844E-01 1.819157E-03
10 2.100000E-03 7.850419E-02 1.264171E-03
11 1.570931E-03 3.775911E-02 6.892058E-04
12 1.205633E-03 2.646725E-02 2.284380E-04
13 9.453451E-04 2.874715E-02 5.736342E-04
14 7.548938E-04 2.222554E-02 2.158315E-04
15 6.123457E-04 1.544843E-02 1.950448E-04
16 5.035400E-04 1.479913E-02 1.898962E-04
17 4.190563E-04 1.517999E-02 1.308700E-04
18 3.524615E-04 8.631766E-03 1.393244E-04
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Start end row number 150 720
Line thickness 3
Chart plot↓
Save current plot as
Degree variance curves
2e-06
1.5e-06
1e-06
5e-07
200
300
400
500
600
700
Kaula
DTM
GGM


Precise approach and all-elements modeling of Earth gravity field
Precise approach and all-element modeling on Earth gravity field
Stokes
External height anomaly computation using Stokes/Hotine integral
V − M
External vertical deflection computation using Vening-Meinesz integral
Inv ∫ · dσ
Inverse integral and integral of inverse operation on anomalous field element
∂· / ∂r
Gradient and Poisson integral computation of external gravity field element
Feature and performance analysis of spherical radial basis functions
Gravity field approach using SRBFs in spectral domain and performance test
All-element modelling on gravity field using SRBFs from heterogeneous observations
Computation process demo of all-element modelling on gravity field by integral method
Simple process demo of all-element modelling using SRBFs in orthometric height system
Simple process demo of all-element modelling using SRBFs in normal height system
Modeling process exercise of regional gravity field and geoid
Cross aliasing of heterogeneous observations in land-sea-space
Loop closed analytical operations on outer gravity field elements
All-element modeling on Earth gravity field in whole outer space
Index measurement of observation errors and computation control
Programs and functions structure of the subsystem
PAGravf4.5 sets up the scientific gravity field approach system with the spatial domain integration algorithms based on boundary value theory and spectral domain radial basis function approach algorithms to realize the all-element analytical modelling on gravity field in whole space outside the geoid from various heterogeneous observations in the different altitudes, cross-distribution and land-sea coexisting cases.
The typical complex gravity field feature area selected where residual gravity disturbance variation exceeds 300mGal after the 540-degree reference model value removed, you can verify and analyze the performance of various gravity field approach algorithms in this group of programs to facilitate and quickly grasp the characteristics and usage of these algorithms.


External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
External height anomaly computation using Stokes/ Hotine integral
Stokes
V — M
External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of external anomalous gravity field elements from height anomaly
Inverse integral and integral of inverse operation from anomalous gravity field element
Inv ∫·dσ
∫·dσ
Precise approach and all-element modeling on Earth gravity field
∂·
∂r
Gradient and Poisson integral of external gravity field element
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous gravity field element
Spatial and spectral performance analysis of spherical radial basis functions
Reuter spherical network construction with given level
Feature and performance analysis of spherical radial basis functions
Gravity field approach using SRBFs in spectral domain and performance test
All-element modelling on gravity field using SRBFs from heterogeneous observations
Modeling process exercise of regional gravity field and geoid
Typical process demo of all-element modelling on regional gravity field by integral method
Simple process demo of all-element modelling on gravity field using SRBFs in orthometric height system
Simple process demo of all-element modelling on gravity field using SRBFs in normal height system


External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - Numerical
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
>> Computation Process ** Operation Prompts
Save computation process as
** Input the ellipsoidal height grid file of the equipotential surface and the gravity anomaly/disturbance grid file on the surface with the same grid specification...
>> [Function] From the ellipsoidal height grid of the equipotential surface and gravity anomaly (mGal) grid on the surface, compute the external residual height anomaly (m) by the Stokes integral.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landgeoidhgt.dat.
>> Open residual gravity anomaly grid file on equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/resGMlgeoid541_1800.gra.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/rststk.txt.
** Record format: Behind the source calculation point file record, appends a column of residual height anomaly calculated, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 10:57:07
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 10:58:45
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -0.0294
2 97.025000 33.008333 3989.787 -0.0340
3 97.041667 33.008333 4034.817 -0.0404
4 97.058333 33.008333 4070.847 -0.0485
5 97.075000 33.008333 4106.877 -0.0582
6 97.091667 33.008333 4119.913 -0.0693
7 97.108333 33.008333 4115.946 -0.0817
8 97.125000 33.008333 4090.977 -0.0952
9 97.141667 33.008333 4070.007 -0.1090
10 97.158333 33.008333 3991.047 -0.1235
11 97.175000 33.008333 3985.070 -0.1362
12 97.191667 33.008333 3956.107 -0.1475
13 97.208333 33.008333 3965.137 -0.1552
14 97.225000 33.008333 3964.173 -0.1592
15 97.241667 33.008333 3983.205 -0.1581
16 97.258333 33.008333 3953.251 -0.1526
Extract height anomaly
Plot↓
gravity anomaly (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.


External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - Numerical
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
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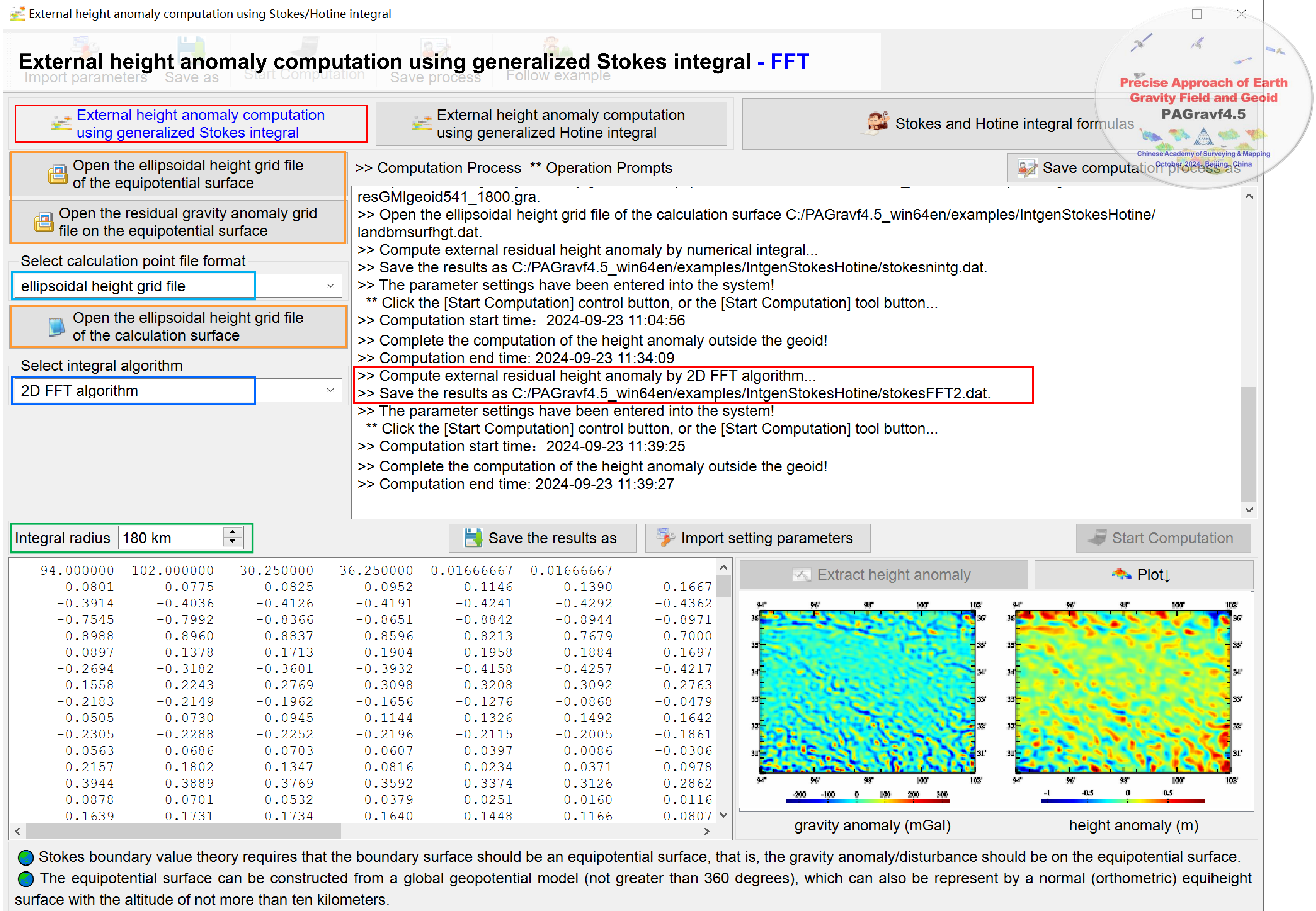
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
numerical integral
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:03:17
>> [Function] From the ellipsoidal height grid of the equipotential surface and gravity anomaly (mGal) grid on the surface, compute the external residual height anomaly (m) by the Stokes integral.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landgeoidhgt.dat.
>> Open residual gravity anomaly grid file on equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/resGMlgeoid541_1800.gra.
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landbmsurfhgt.dat.
>> Compute external residual height anomaly by numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/stokesnintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 11:04:56
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:34:09
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-0.0985 -0.0918 -0.0929 -0.1025 -0.1184 -0.1397 -0.1641
-0.3691 -0.3790 -0.3864 -0.3924 -0.3988 -0.4062 -0.4160
-0.7265 -0.7631 -0.8020 -0.8354 -0.8626 -0.8929 -0.9039
-1.0120 -1.0246 -1.0271 -1.0019 -0.9528 -0.8930 -0.8092
0.1001 0.1635 0.2066 0.2352 0.2495 0.2417 0.2169
-0.2854 -0.3400 -0.3918 -0.4330 -0.4706 -0.4958 -0.5033
0.1690 0.2420 0.2994 0.3331 0.3416 0.3352 0.3029
-0.2588 -0.2453 -0.2122 -0.1673 -0.1158 -0.0692 -0.0300
-0.0422 -0.0655 -0.0880 -0.1094 -0.1292 -0.1468 -0.1629
-0.2292 -0.2297 -0.2287 -0.2252 -0.2187 -0.2084 -0.1941
0.0855 0.0932 0.0876 0.0708 0.0422 0.0045 -0.0408
-0.2274 -0.1866 -0.1405 -0.0918 -0.0407 0.0079 0.0533
0.4118 0.4248 0.4271 0.4192 0.3997 0.3698 0.3315
0.0589 0.0536 0.0500 0.0468 0.0435 0.0399 0.0360
0.1401 0.1539 0.1599 0.1580 0.1466 0.1258 0.0957
Extract height anomaly
Plot↓
gravity anomaly (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.


External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
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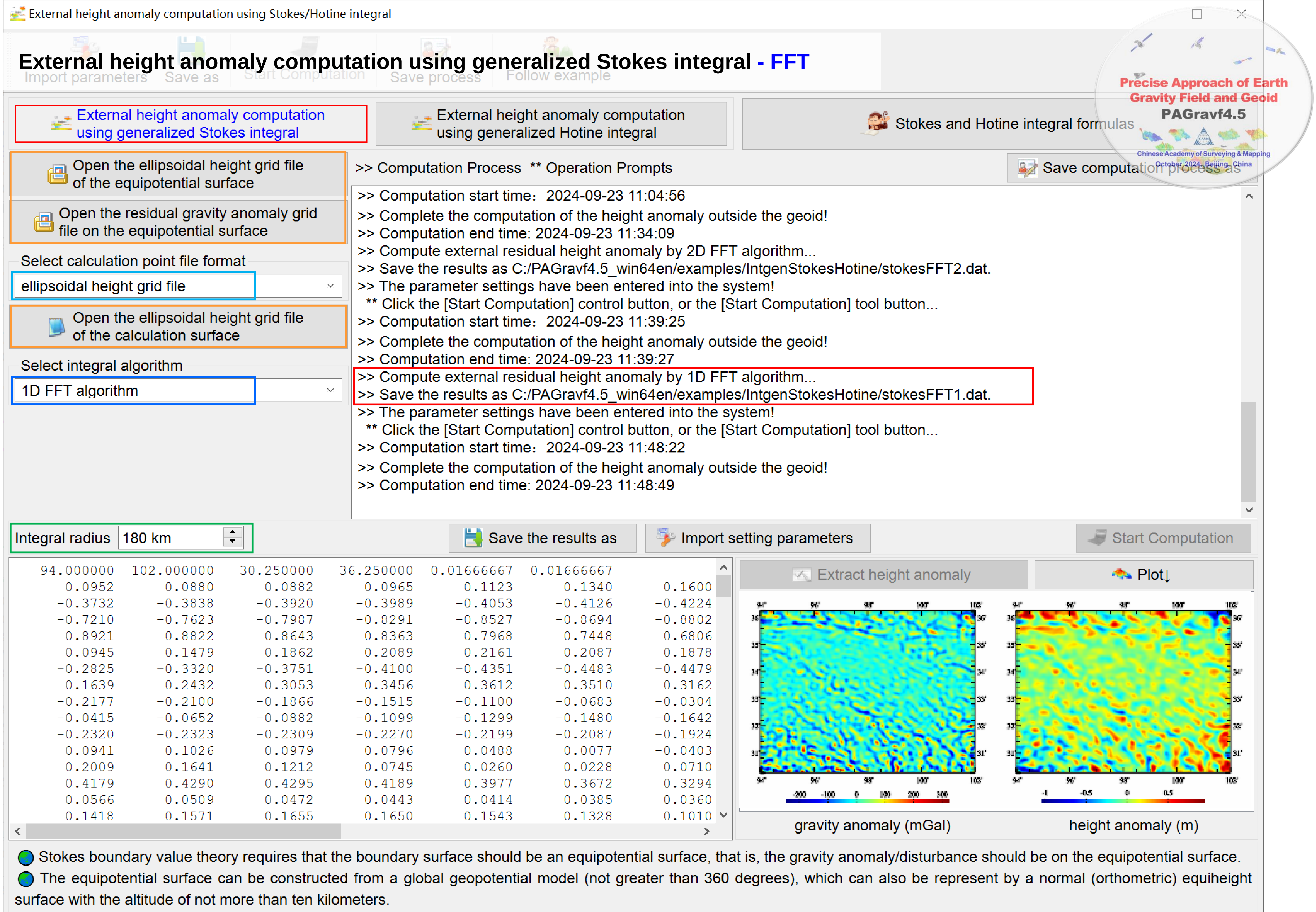
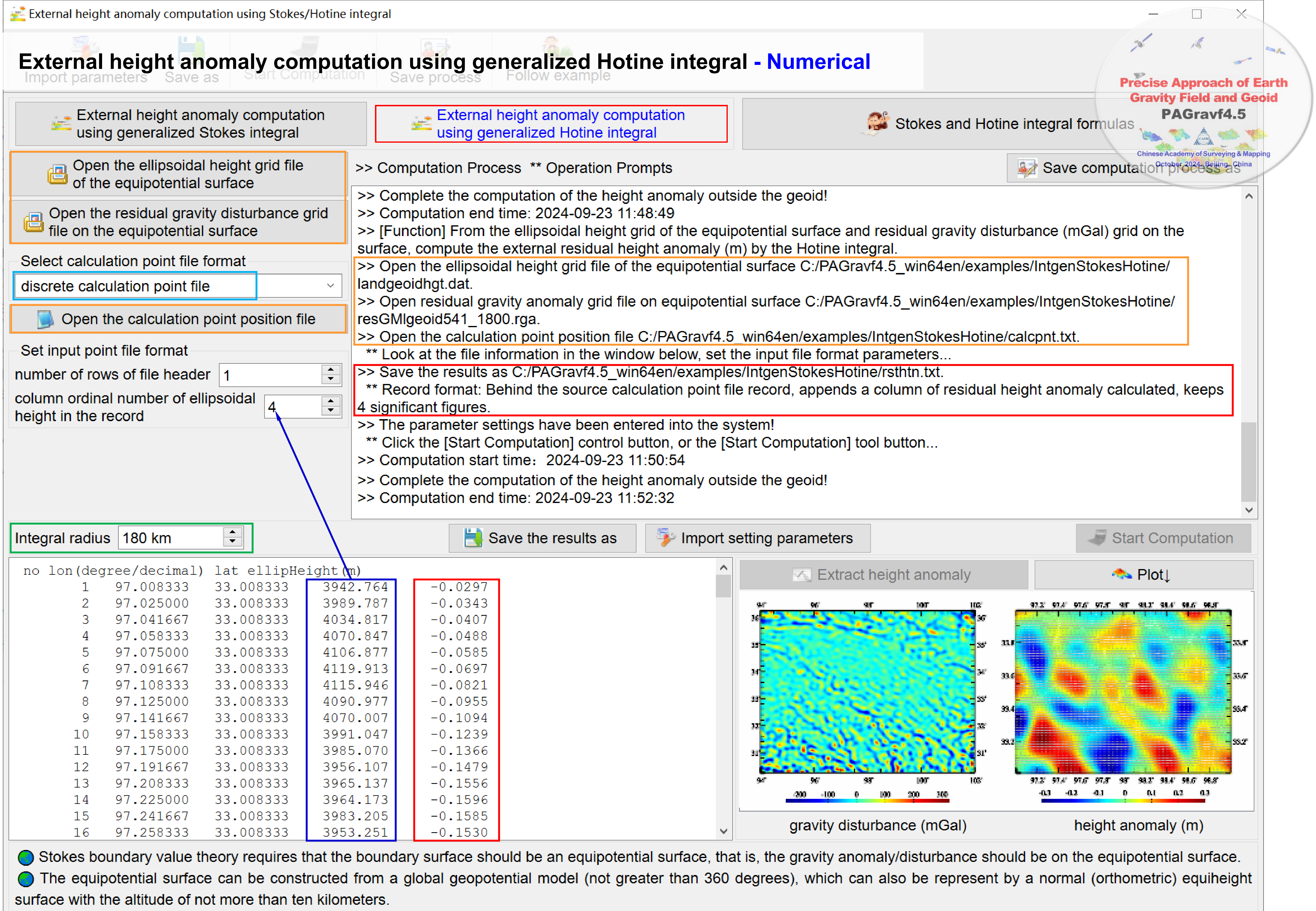
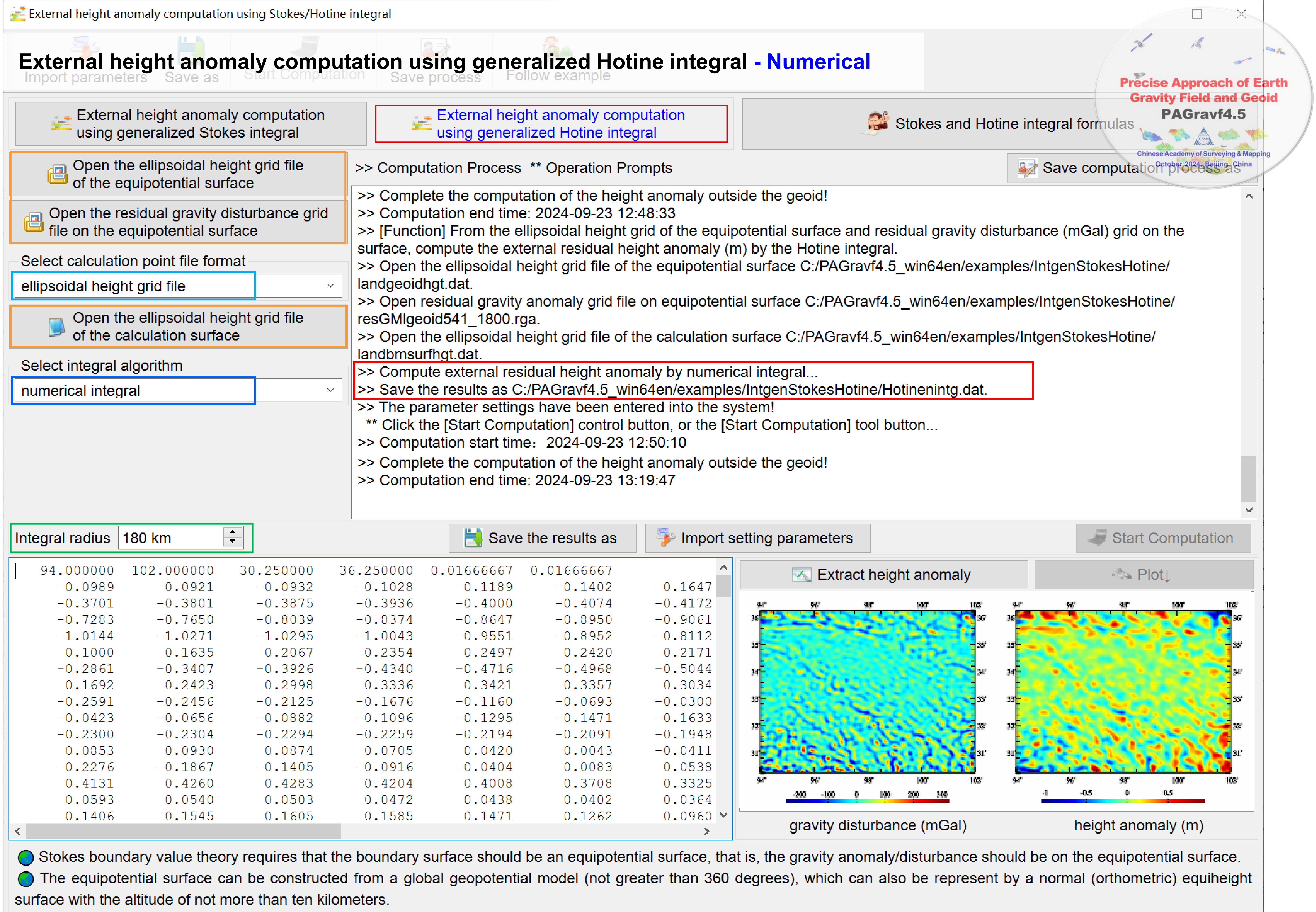
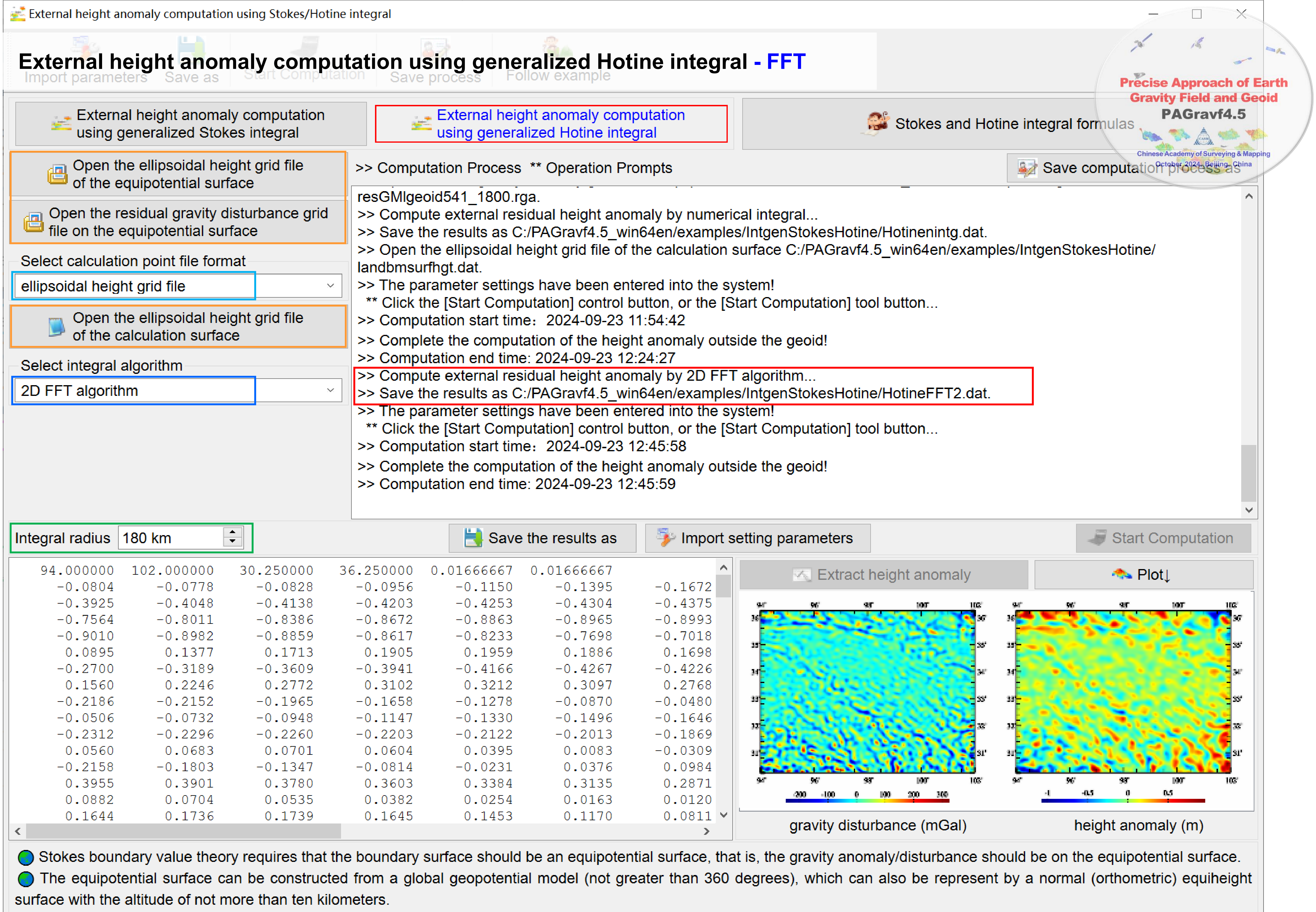
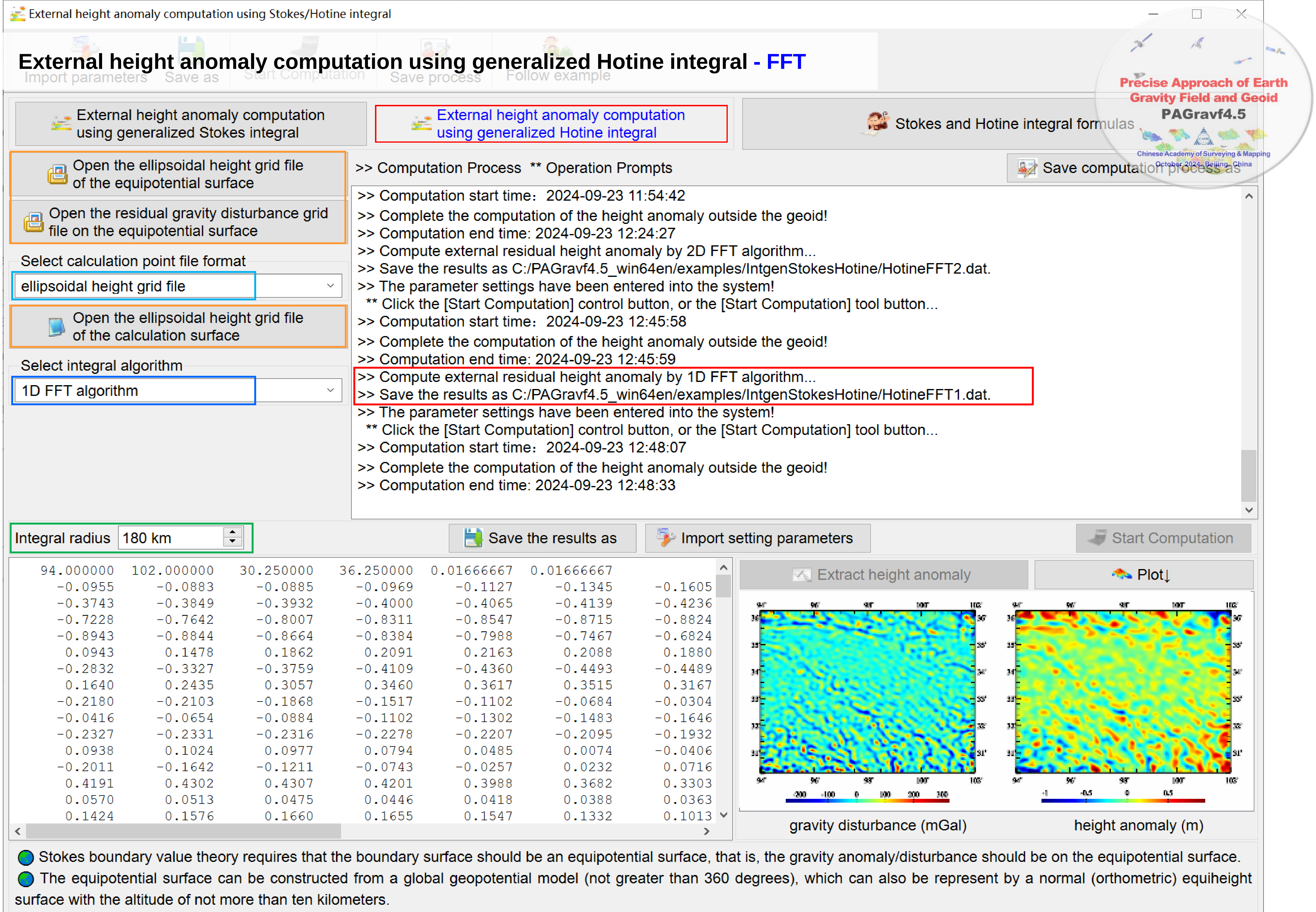
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
2D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
resGMlgeoid541_1800.gra.
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landbmsurfhgt.dat.
>> Compute external residual height anomaly by numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/stokesnintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 11:04:56
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:34:09
>> Compute external residual height anomaly by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/stokesFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 11:39:25
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:39:27
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-0.0801 -0.0775 -0.0825 -0.0952 -0.1146 -0.1390 -0.1667
-0.3914 -0.4036 -0.4126 -0.4191 -0.4241 -0.4292 -0.4362
-0.7545 -0.7992 -0.8366 -0.8651 -0.8842 -0.8944 -0.8971
-0.8988 -0.8960 -0.8837 -0.8596 -0.8213 -0.7679 -0.7000
0.0897 0.1378 0.1713 0.1904 0.1958 0.1884 0.1697
-0.2694 -0.3182 -0.3601 -0.3932 -0.4158 -0.4257 -0.4217
0.1558 0.2243 0.2769 0.3098 0.3208 0.3092 0.2763
-0.2183 -0.2149 -0.1962 -0.1656 -0.1276 -0.0868 -0.0479
-0.0505 -0.0730 -0.0945 -0.1144 -0.1326 -0.1492 -0.1642
-0.2305 -0.2288 -0.2252 -0.2196 -0.2115 -0.2005 -0.1861
0.0563 0.0686 0.0703 0.0607 0.0397 0.0086 -0.0306
-0.2157 -0.1802 -0.1347 -0.0816 -0.0234 0.0371 0.0978
0.3944 0.3889 0.3769 0.3592 0.3374 0.3126 0.2862
0.0878 0.0701 0.0532 0.0379 0.0251 0.0160 0.0116
0.1639 0.1731 0.1734 0.1640 0.1448 0.1166 0.0807
Extract height anomaly
Plot↓
gravity anomaly (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

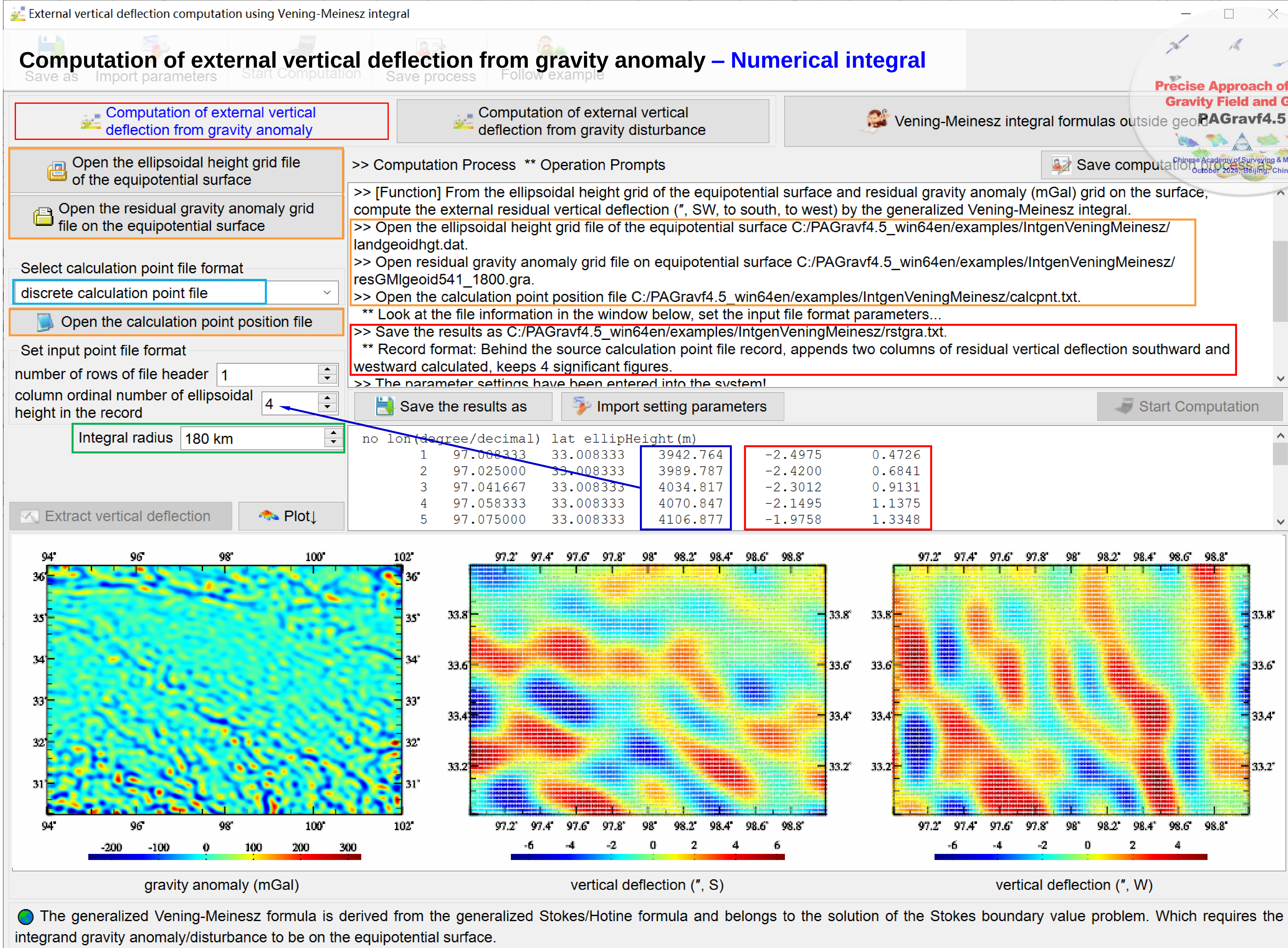

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
1D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation start time: 2024-09-23 11:04:56
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:34:09
>> Compute external residual height anomaly by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/stokesFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 11:39:25
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:39:27
>> Compute external residual height anomaly by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/stokesFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 11:48:22
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:48:49
Integral radius
180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-0.0952 -0.0880 -0.0882 -0.0965 -0.1123 -0.1340 -0.1600
-0.3732 -0.3838 -0.3920 -0.3989 -0.4053 -0.4126 -0.4224
-0.7210 -0.7623 -0.7987 -0.8291 -0.8527 -0.8694 -0.8802
-0.8921 -0.8822 -0.8643 -0.8363 -0.7968 -0.7448 -0.6806
0.0945 0.1479 0.1862 0.2089 0.2161 0.2087 0.1878
-0.2825 -0.3320 -0.3751 -0.4100 -0.4351 -0.4483 -0.4479
0.1639 0.2432 0.3053 0.3456 0.3612 0.3510 0.3162
-0.2177 -0.2100 -0.1866 -0.1515 -0.1100 -0.0683 -0.0304
-0.0415 -0.0652 -0.0882 -0.1099 -0.1299 -0.1480 -0.1642
-0.2320 -0.2323 -0.2309 -0.2270 -0.2199 -0.2087 -0.1924
0.0941 0.1026 0.0979 0.0796 0.0488 0.0077 -0.0403
-0.2009 -0.1641 -0.1212 -0.0745 -0.0260 0.0228 0.0710
0.4179 0.4290 0.4295 0.4189 0.3977 0.3672 0.3294
0.0566 0.0509 0.0472 0.0443 0.0414 0.0385 0.0360
0.1418 0.1571 0.1655 0.1650 0.1543 0.1328 0.1010
Extract height anomaly
Plot↓
gravity anomaly (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

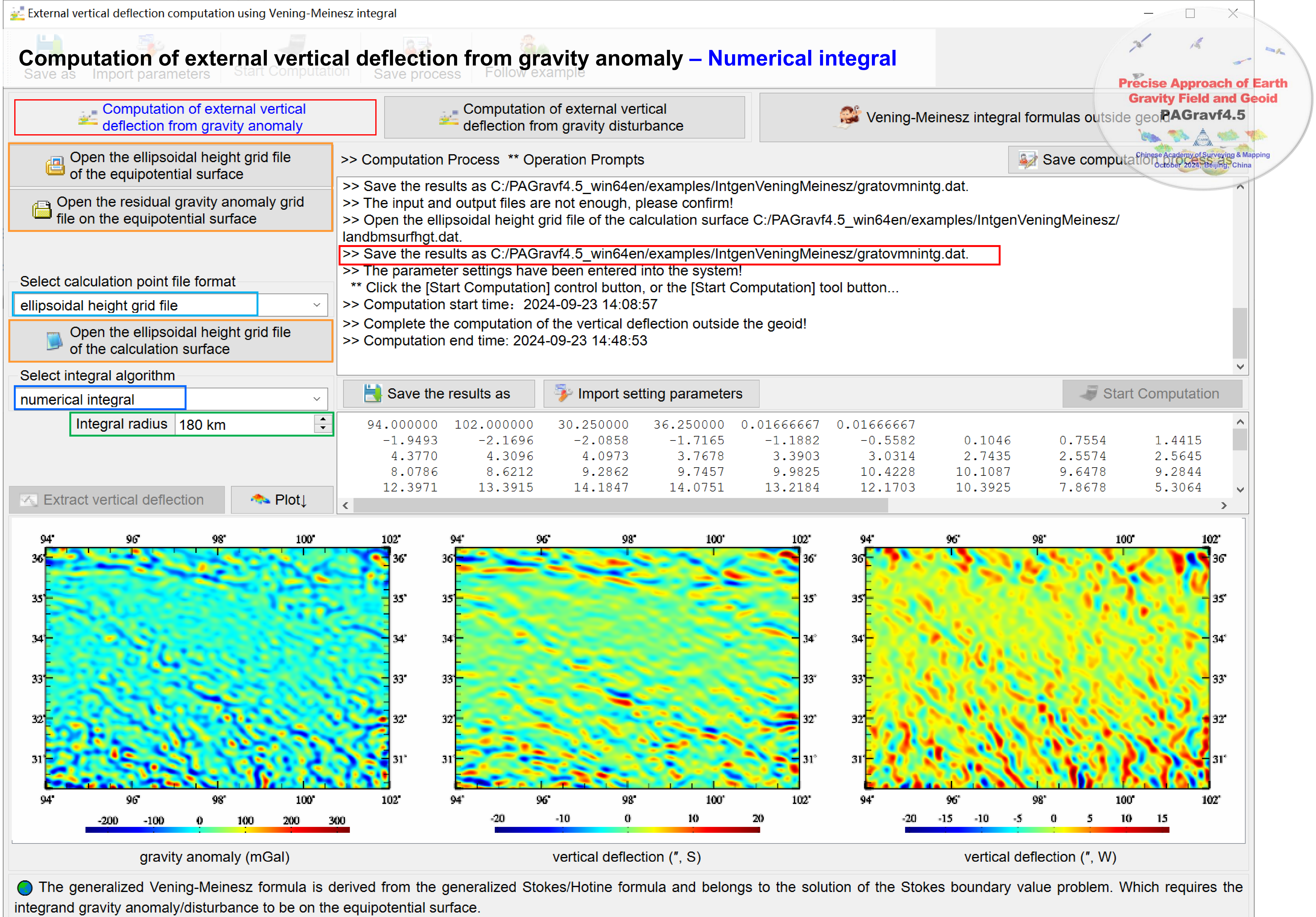

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - Numerical
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
Integral radius 180 km
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:48:49
>> [Function] From the ellipsoidal height grid of the equipotential surface and residual gravity disturbance (mGal) grid on the surface, compute the external residual height anomaly (m) by the Hotine integral.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landgeoidhgt.dat.
>> Open residual gravity anomaly grid file on equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/resGMlgeoid541_1800.rga.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/rsthtn.txt.
** Record format: Behind the source calculation point file record, appends a column of residual height anomaly calculated, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 11:50:54
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 11:52:32
Save the results as
Import setting parameters
Start Computation
Extract height anomaly
Plot↓
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -0.0297
2 97.025000 33.008333 3989.787 -0.0343
3 97.041667 33.008333 4034.817 -0.0407
4 97.058333 33.008333 4070.847 -0.0488
5 97.075000 33.008333 4106.877 -0.0585
6 97.091667 33.008333 4119.913 -0.0697
7 97.108333 33.008333 4115.946 -0.0821
8 97.125000 33.008333 4090.977 -0.0955
9 97.141667 33.008333 4070.007 -0.1094
10 97.158333 33.008333 3991.047 -0.1239
11 97.175000 33.008333 3985.070 -0.1366
12 97.191667 33.008333 3956.107 -0.1479
13 97.208333 33.008333 3965.137 -0.1556
14 97.225000 33.008333 3964.173 -0.1596
15 97.241667 33.008333 3983.205 -0.1585
16 97.258333 33.008333 3953.251 -0.1530
gravity disturbance (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

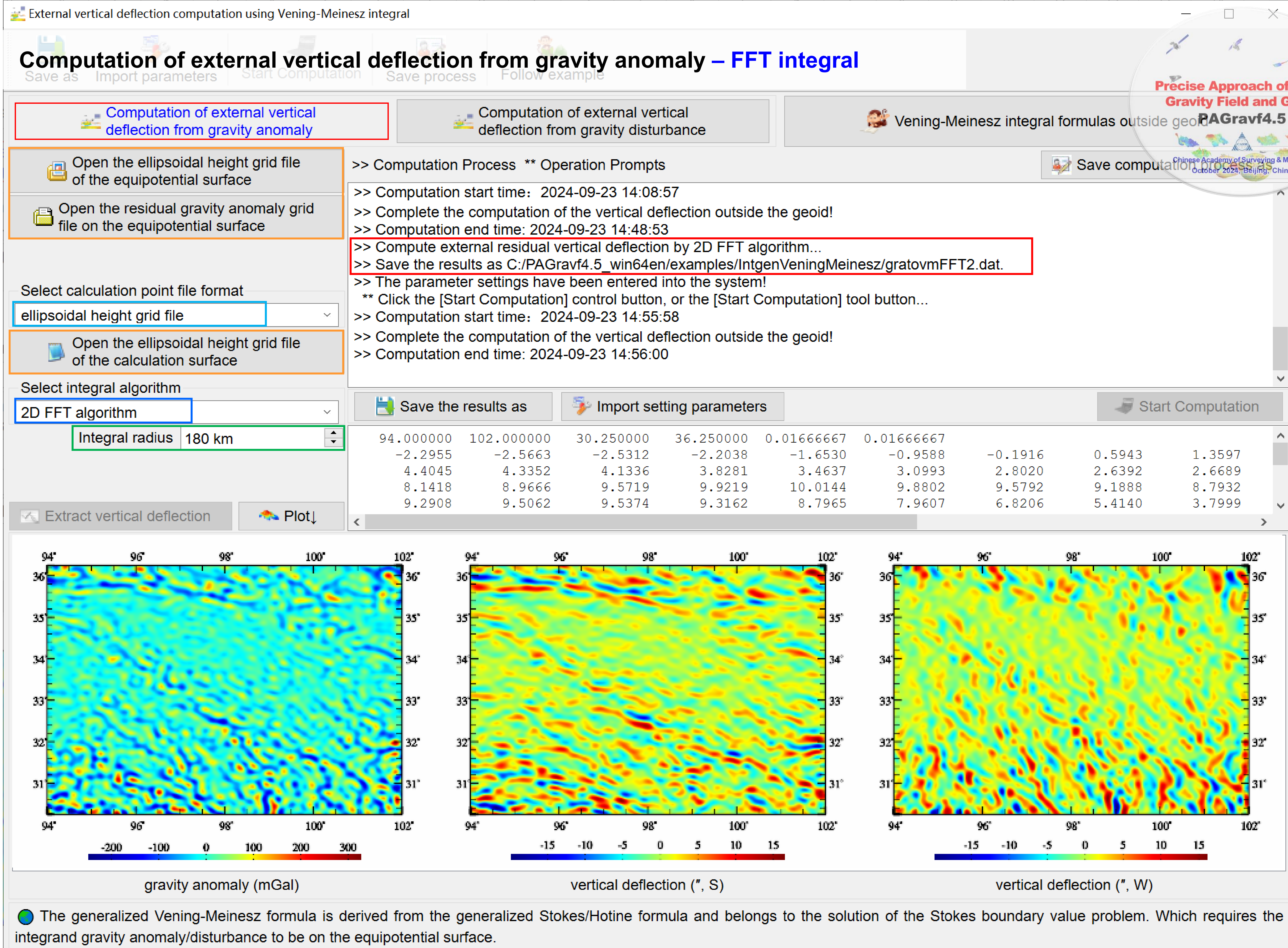

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - Numerical
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
numerical integral
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 12:48:33
>> [Function] From the ellipsoidal height grid of the equipotential surface and residual gravity disturbance (mGal) grid on the surface, compute the external residual height anomaly (m) by the Hotine integral.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landgeoidhgt.dat.
>> Open residual gravity anomaly grid file on equipotential surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/resGMlgeoid541_1800.rga.
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landbmsurfhgt.dat.
>> Compute external residual height anomaly by numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/Hotinenintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 12:50:10
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 13:19:47
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-0.0989 -0.0921 -0.0932 -0.1028 -0.1189 -0.1402 -0.1647
-0.3701 -0.3801 -0.3875 -0.3936 -0.4000 -0.4074 -0.4172
-0.7283 -0.7650 -0.8039 -0.8374 -0.8647 -0.8950 -0.9061
-1.0144 -1.0271 -1.0295 -1.0043 -0.9551 -0.8952 -0.8112
0.1000 0.1635 0.2067 0.2354 0.2497 0.2420 0.2171
-0.2861 -0.3407 -0.3926 -0.4340 -0.4716 -0.4968 -0.5044
0.1692 0.2423 0.2998 0.3336 0.3421 0.3357 0.3034
-0.2591 -0.2456 -0.2125 -0.1676 -0.1160 -0.0693 -0.0300
-0.0423 -0.0656 -0.0882 -0.1096 -0.1295 -0.1471 -0.1633
-0.2300 -0.2304 -0.2294 -0.2259 -0.2194 -0.2091 -0.1948
0.0853 0.0930 0.0874 0.0705 0.0420 0.0043 -0.0411
-0.2276 -0.1867 -0.1405 -0.0916 -0.0404 0.0083 0.0538
0.4131 0.4260 0.4283 0.4204 0.4008 0.3708 0.3325
0.0593 0.0540 0.0503 0.0472 0.0438 0.0402 0.0364
0.1406 0.1545 0.1605 0.1585 0.1471 0.1262 0.0960
Extract height anomaly
Plot
gravity disturbance (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

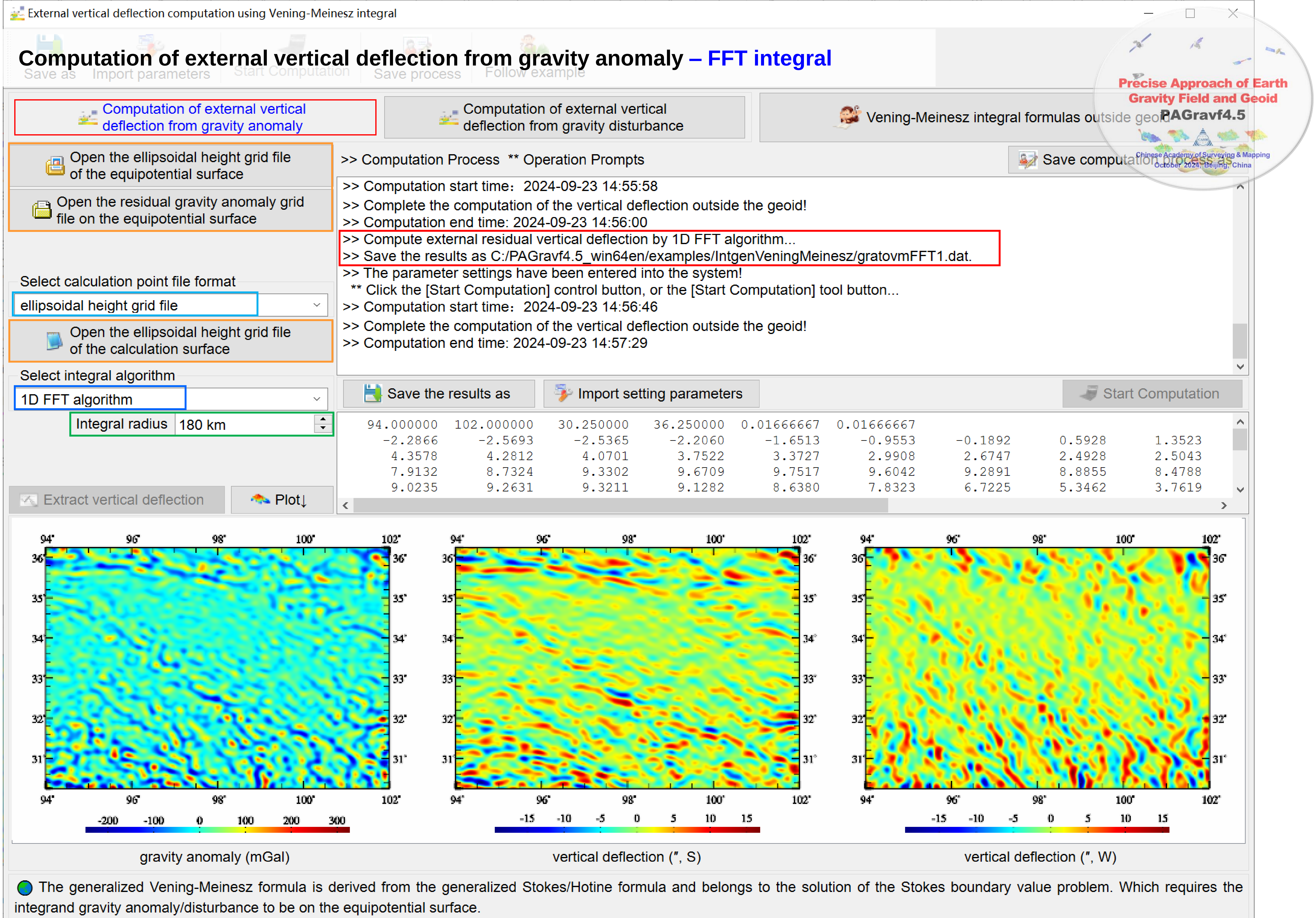

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
2D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
resGMlgeoid541_1800.rga.
>> Compute external residual height anomaly by numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/Hotinenintg.dat.
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/landbmsurfhgt.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 11:54:42
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 12:24:27
>> Compute external residual height anomaly by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/HotineFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 12:45:58
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 12:45:59
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-0.0804 -0.0778 -0.0828 -0.0956 -0.1150 -0.1395 -0.1672
-0.3925 -0.4048 -0.4138 -0.4203 -0.4253 -0.4304 -0.4375
-0.7564 -0.8011 -0.8386 -0.8672 -0.8863 -0.8965 -0.8993
-0.9010 -0.8982 -0.8859 -0.8617 -0.8233 -0.7698 -0.7018
0.0895 0.1377 0.1713 0.1905 0.1959 0.1886 0.1698
-0.2700 -0.3189 -0.3609 -0.3941 -0.4166 -0.4267 -0.4226
0.1560 0.2246 0.2772 0.3102 0.3212 0.3097 0.2768
-0.2186 -0.2152 -0.1965 -0.1658 -0.1278 -0.0870 -0.0480
-0.0506 -0.0732 -0.0948 -0.1147 -0.1330 -0.1496 -0.1646
-0.2312 -0.2296 -0.2260 -0.2203 -0.2122 -0.2013 -0.1869
0.0560 0.0683 0.0701 0.0604 0.0395 0.0083 -0.0309
-0.2158 -0.1803 -0.1347 -0.0814 -0.0231 0.0376 0.0984
0.3955 0.3901 0.3780 0.3603 0.3384 0.3135 0.2871
0.0882 0.0704 0.0535 0.0382 0.0254 0.0163 0.0120
0.1644 0.1736 0.1739 0.1645 0.1453 0.1170 0.0811
Extract height anomaly
Plot↓
gravity disturbance (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

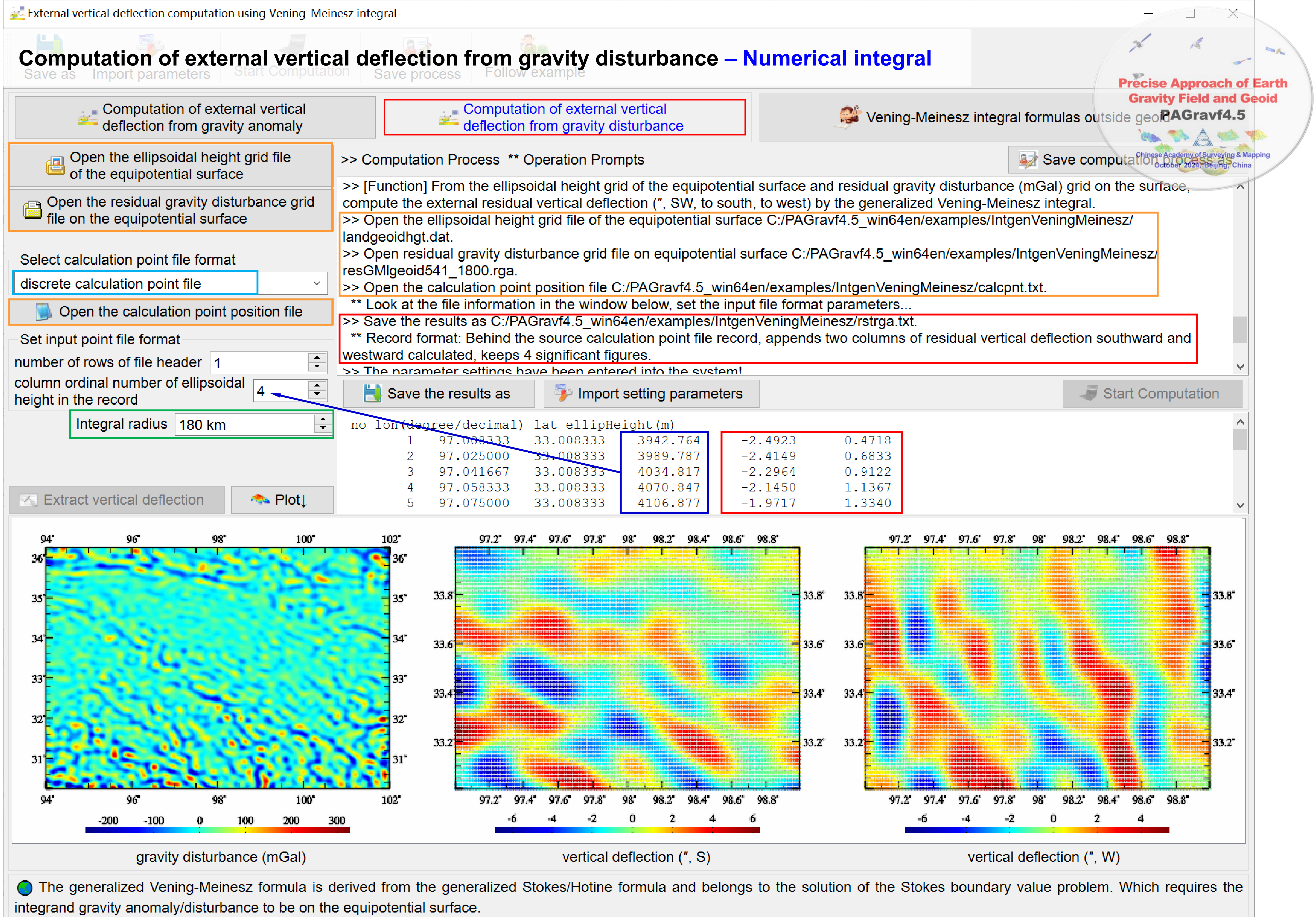

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
Stokes and Hotine integral formulas
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
1D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation start time: 2024-09-23 11:54:42
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 12:24:27
>> Compute external residual height anomaly by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/HotineFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 12:45:58
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 12:45:59
>> Compute external residual height anomaly by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenStokesHotine/HotineFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 12:48:07
>> Complete the computation of the height anomaly outside the geoid!
>> Computation end time: 2024-09-23 12:48:33
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-0.0955 -0.0883 -0.0885 -0.0969 -0.1127 -0.1345 -0.1605
-0.3743 -0.3849 -0.3932 -0.4000 -0.4065 -0.4139 -0.4236
-0.7228 -0.7642 -0.8007 -0.8311 -0.8547 -0.8715 -0.8824
-0.8943 -0.8844 -0.8664 -0.8384 -0.7988 -0.7467 -0.6824
0.0943 0.1478 0.1862 0.2091 0.2163 0.2088 0.1880
-0.2832 -0.3327 -0.3759 -0.4109 -0.4360 -0.4493 -0.4489
0.1640 0.2435 0.3057 0.3460 0.3617 0.3515 0.3167
-0.2180 -0.2103 -0.1868 -0.1517 -0.1102 -0.0684 -0.0304
-0.0416 -0.0654 -0.0884 -0.1102 -0.1302 -0.1483 -0.1646
-0.2327 -0.2331 -0.2316 -0.2278 -0.2207 -0.2095 -0.1932
0.0938 0.1024 0.0977 0.0794 0.0485 0.0074 -0.0406
-0.2011 -0.1642 -0.1211 -0.0743 -0.0257 0.0232 0.0716
0.4191 0.4302 0.4307 0.4201 0.3988 0.3682 0.3303
0.0570 0.0513 0.0475 0.0446 0.0418 0.0388 0.0363
0.1424 0.1576 0.1660 0.1655 0.1547 0.1332 0.1013
Extract height anomaly
Plot↓
gravity disturbance (mGal)
height anomaly (m)
Stokes boundary value theory requires that the boundary surface should be an equipotential surface, that is, the gravity anomaly/disturbance should be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

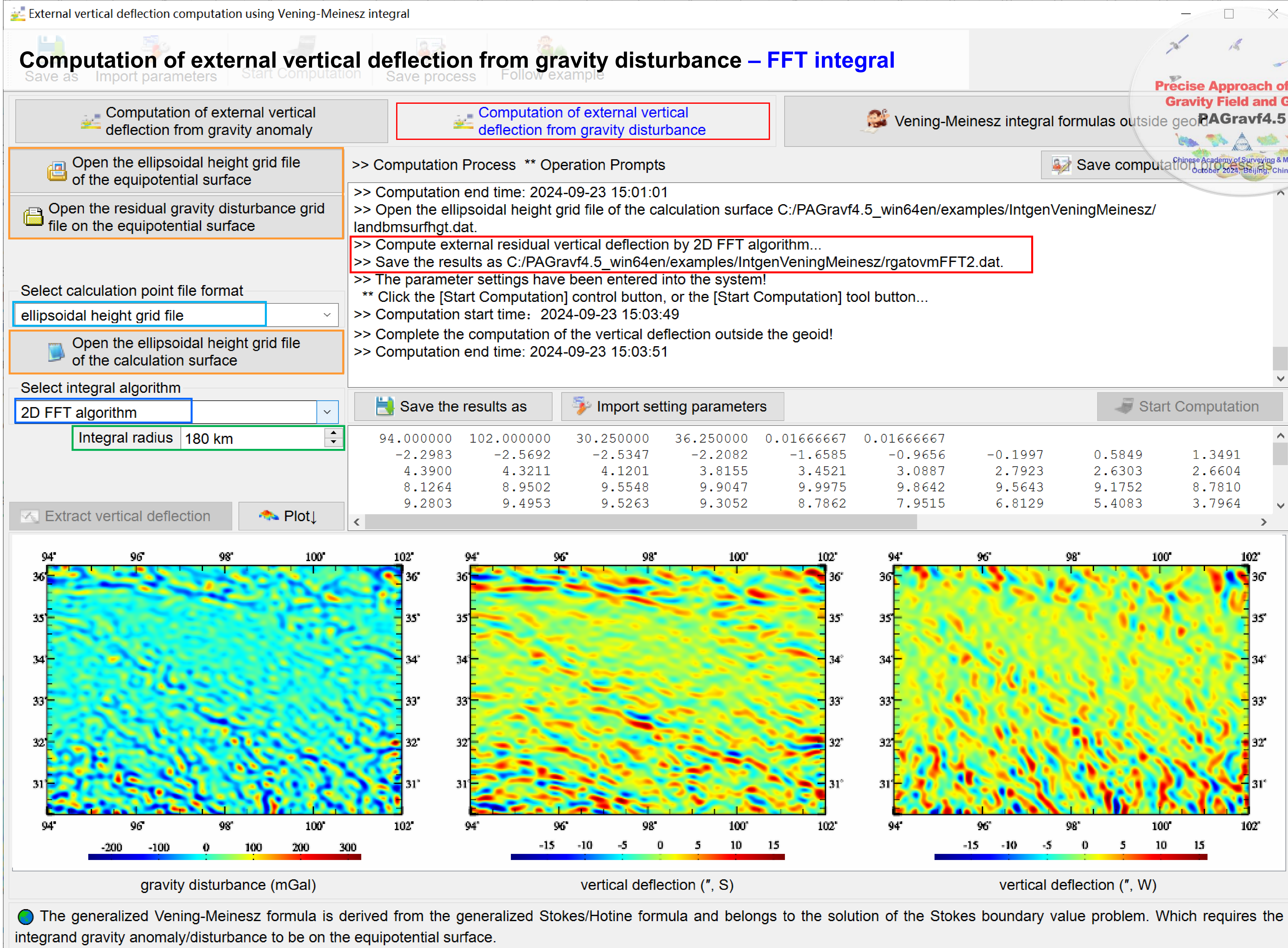

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – Numerical integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
Integral radius 180 km
Extract vertical deflection
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential surface and residual gravity anomaly (mGal) grid on the surface, compute the external residual vertical deflection (″, SW, to south, to west) by the generalized Vening-Meinesz integral.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/landgeoidhgt.dat.
>> Open residual gravity anomaly grid file on equipotential surface C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/resGMlgeoid541_1800.gra.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/rstgra.txt.
** Record format: Behind the source calculation point file record, appends two columns of residual vertical deflection southward and westward calculated, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -2.4975 0.4726
2 97.025000 33.008333 3989.787 -2.4200 0.6841
3 97.041667 33.008333 4034.817 -2.3012 0.9131
4 97.058333 33.008333 4070.847 -2.1495 1.1375
5 97.075000 33.008333 4106.877 -1.9758 1.3348
94° 96° 98° 100° 102°
31° 32° 33° 34° 35° 36°
-200 -100 0 100 200 300
97.2° 97.4° 97.6° 97.8° 98° 98.2° 98.4° 98.6° 98.8°
33.2° 33.4° 33.6° 33.8°
-6 -4 -2 0 2 4 6
-6 -4 -2 0 2 4
gravity anomaly (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.

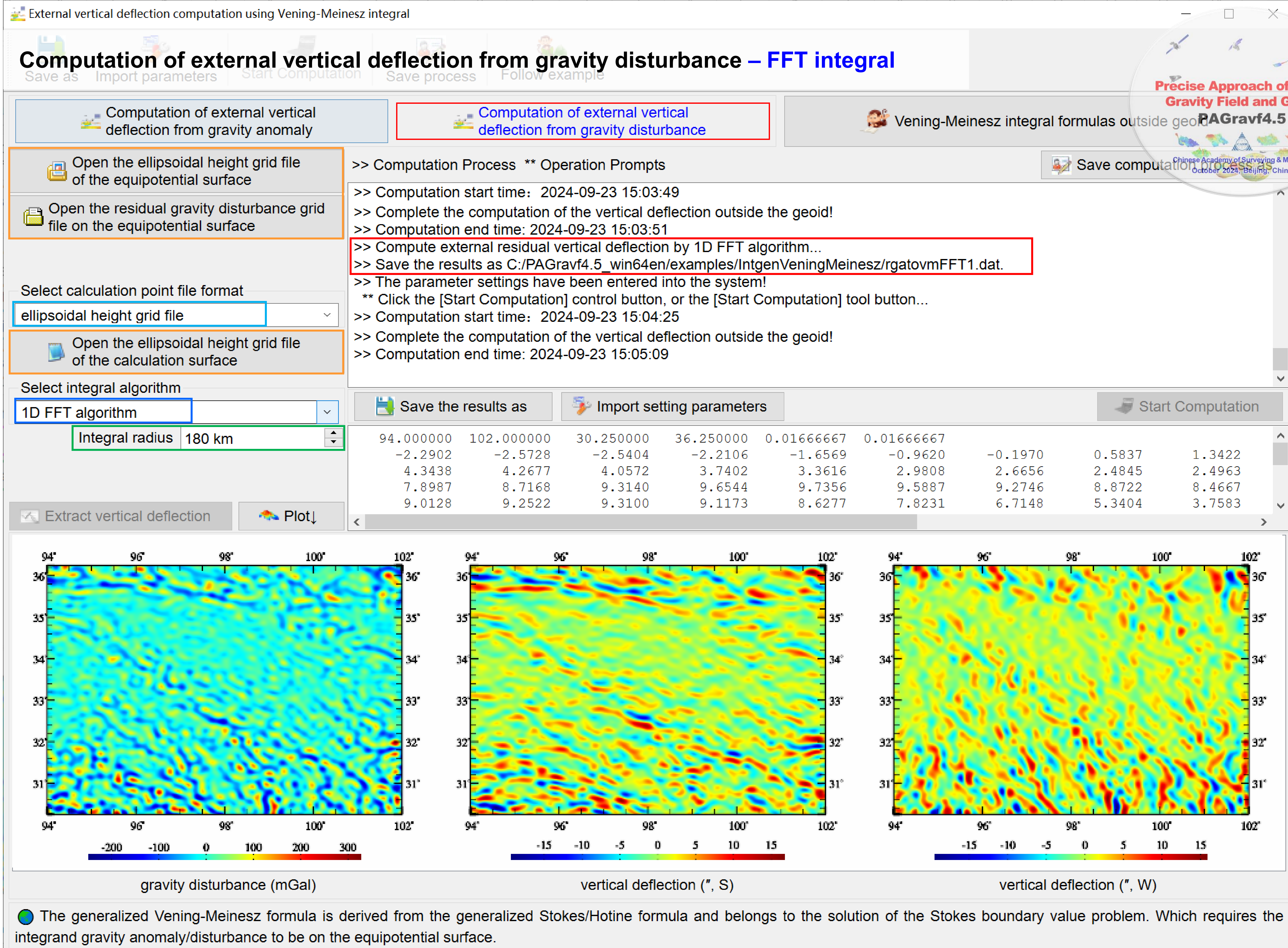

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – Numerical integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
numerical integral
Integral radius
180 km
Extract vertical deflection
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/gratovmnintg.dat.
>> The input and output files are not enough, please confirm!
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/landbmsurfhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/gratovmnintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 14:08:57
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 14:48:53
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-1.9493 -2.1696 -2.0858 -1.7165 -1.1882 -0.5582 0.1046 0.7554 1.4415
4.3770 4.3096 4.0973 3.7678 3.3903 3.0314 2.7435 2.5574 2.5645
8.0786 8.6212 9.2862 9.7457 9.9825 10.4228 10.1087 9.6478 9.2844
12.3971 13.3915 14.1847 14.0751 13.2184 12.1703 10.3925 7.8678 5.3064
gravity anomaly (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.

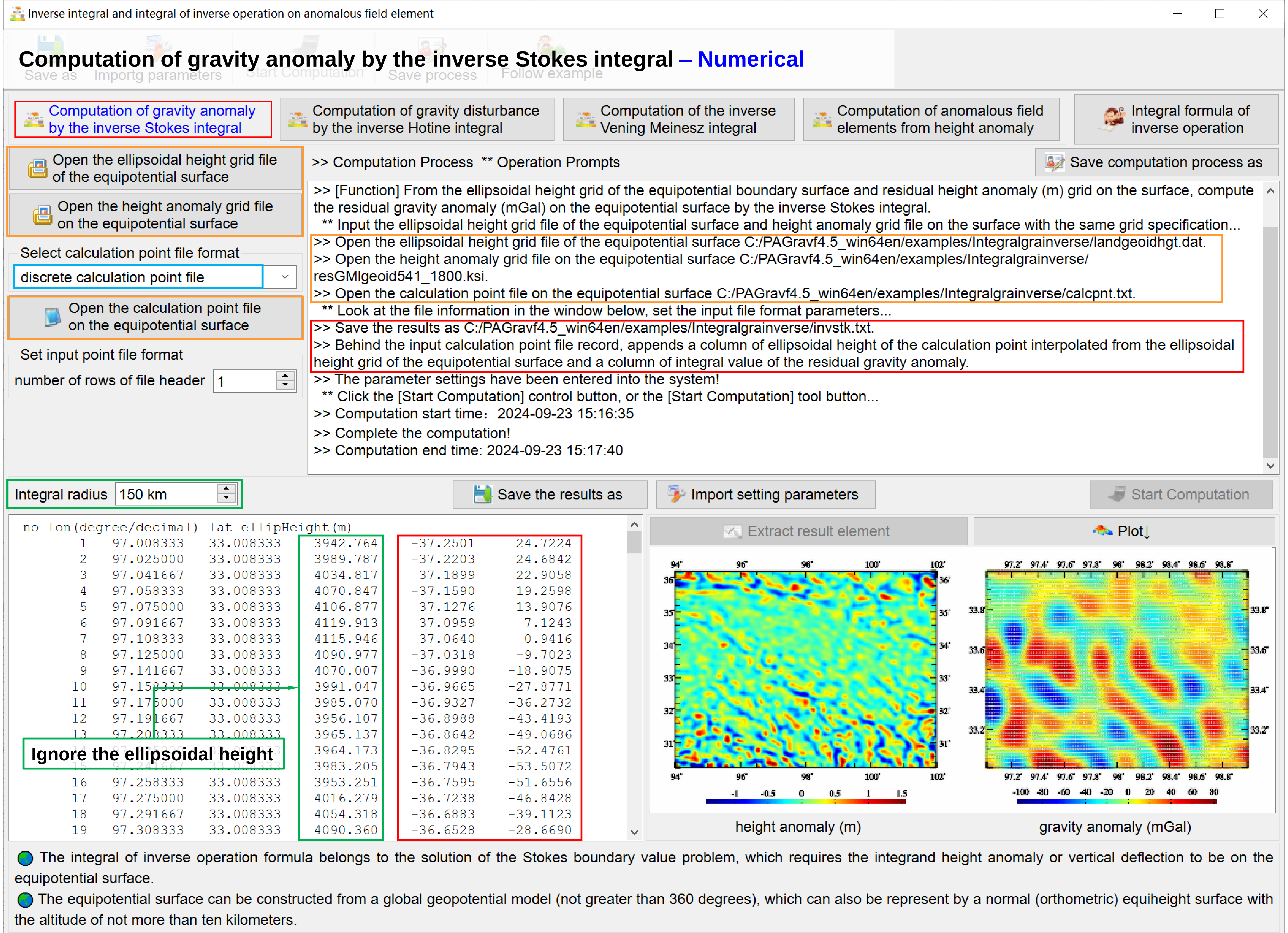

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
2D FFT algorithm
Integral radius
180 km
Extract vertical deflection
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation start time: 2024-09-23 14:08:57
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 14:48:53
>> Compute external residual vertical deflection by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/gratovmFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 14:55:58
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 14:56:00
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-2.2955 -2.5663 -2.5312 -2.2038 -1.6530 -0.9588 -0.1916 0.5943 1.3597
4.4045 4.3352 4.1336 3.8281 3.4637 3.0993 2.8020 2.6392 2.6689
8.1418 8.9666 9.5719 9.9219 10.0144 9.8802 9.5792 9.1888 8.7932
9.2908 9.5062 9.5374 9.3162 8.7965 7.9607 6.8206 5.4140 3.7999
94° 96° 98° 100° 102°
36° 35° 34° 33° 32° 31°
-200 -100 0 100 200 300
-15 -10 -5 0 5 10 15
gravity anomaly (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.

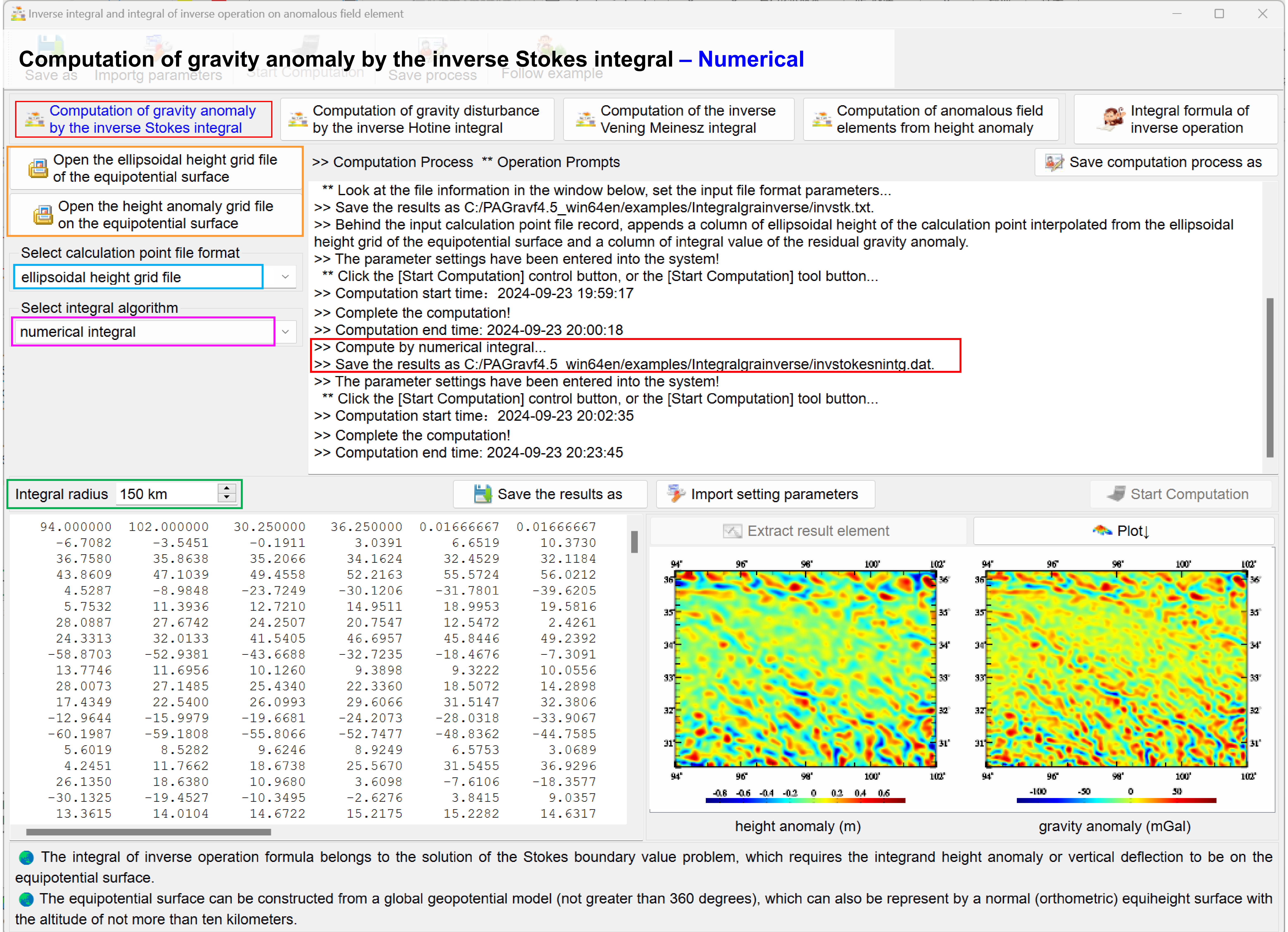

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
1D FFT algorithm
Integral radius
180 km
Extract vertical deflection
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation start time: 2024-09-23 14:55:58
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 14:56:00
>> Compute external residual vertical deflection by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/gratovmFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 14:56:46
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 14:57:29
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-2.2866 -2.5693 -2.5365 -2.2060 -1.6513 -0.9553 -0.1892 0.5928 1.3523
4.3578 4.2812 4.0701 3.7522 3.3727 2.9908 2.6747 2.4928 2.5043
7.9132 8.7324 9.3302 9.6709 9.7517 9.6042 9.2891 8.8855 8.4788
9.0235 9.2631 9.3211 9.1282 8.6380 7.8323 6.7225 5.3462 3.7619
gravity anomaly (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.

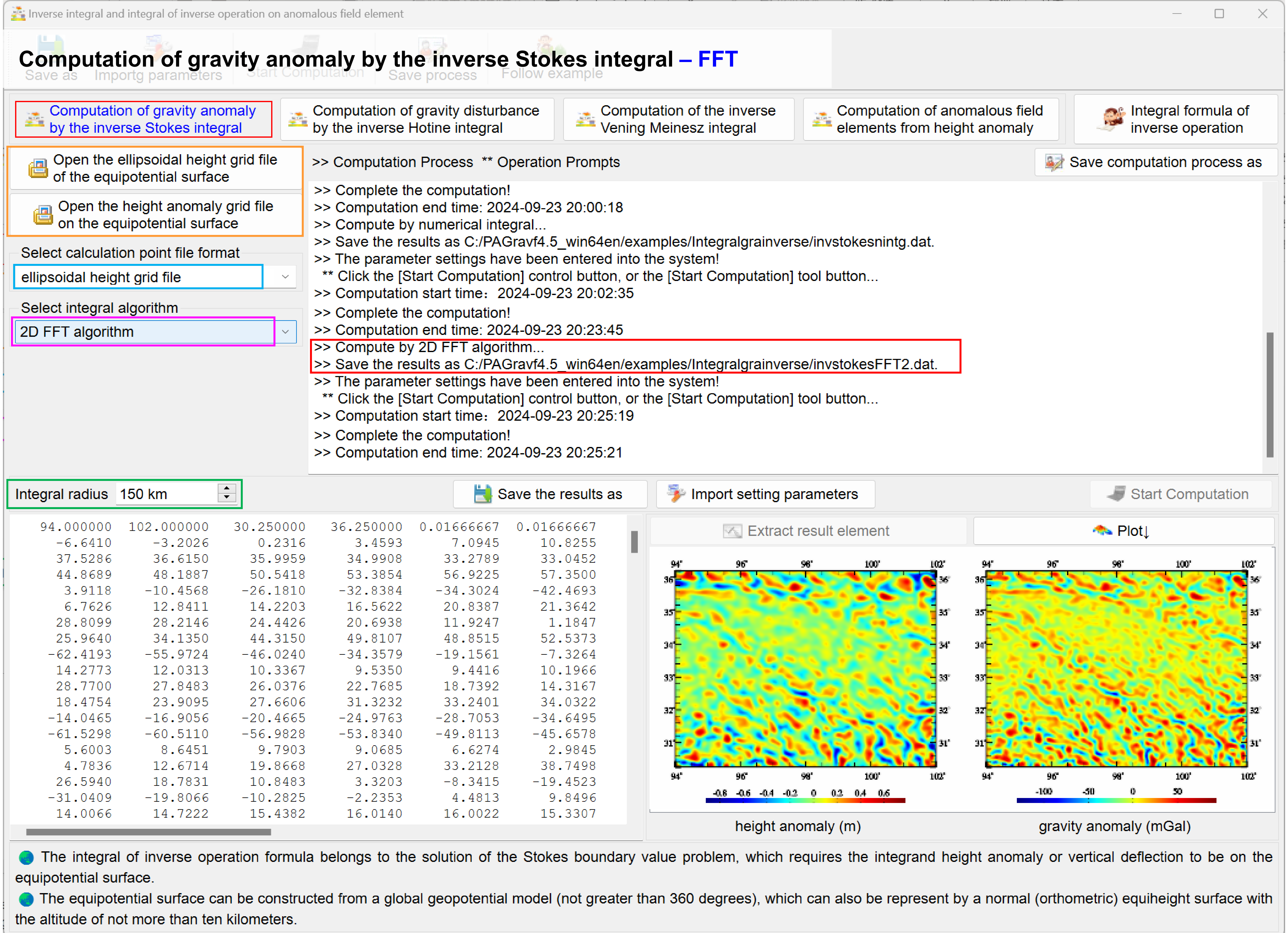

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity disturbance – Numerical integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
Integral radius 180 km
Extract vertical deflection
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential surface and residual gravity disturbance (mGal) grid on the surface, compute the external residual vertical deflection (″, SW, to south, to west) by the generalized Vening-Meinesz integral.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/landgeoidhgt.dat.
>> Open residual gravity disturbance grid file on equipotential surface C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/resGMlgeoid541_1800.rga.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/rstrga.txt.
** Record format: Behind the source calculation point file record, appends two columns of residual vertical deflection southward and westward calculated, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -2.4923 0.4718
2 97.025000 33.008333 3989.787 -2.4149 0.6833
3 97.041667 33.008333 4034.817 -2.2964 0.9122
4 97.058333 33.008333 4070.847 -2.1450 1.1367
5 97.075000 33.008333 4106.877 -1.9717 1.3340
94° 96° 98° 100° 102°
36° 35° 34° 33° 32° 31°
-200 -100 0 100 200 300
97.2° 97.4° 97.6° 97.8° 98° 98.2° 98.4° 98.6° 98.8°
33.2° 33.4° 33.6° 33.8°
-6 -4 -2 0 2 4 6
-6 -4 -2 0 2 4
gravity disturbance (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.

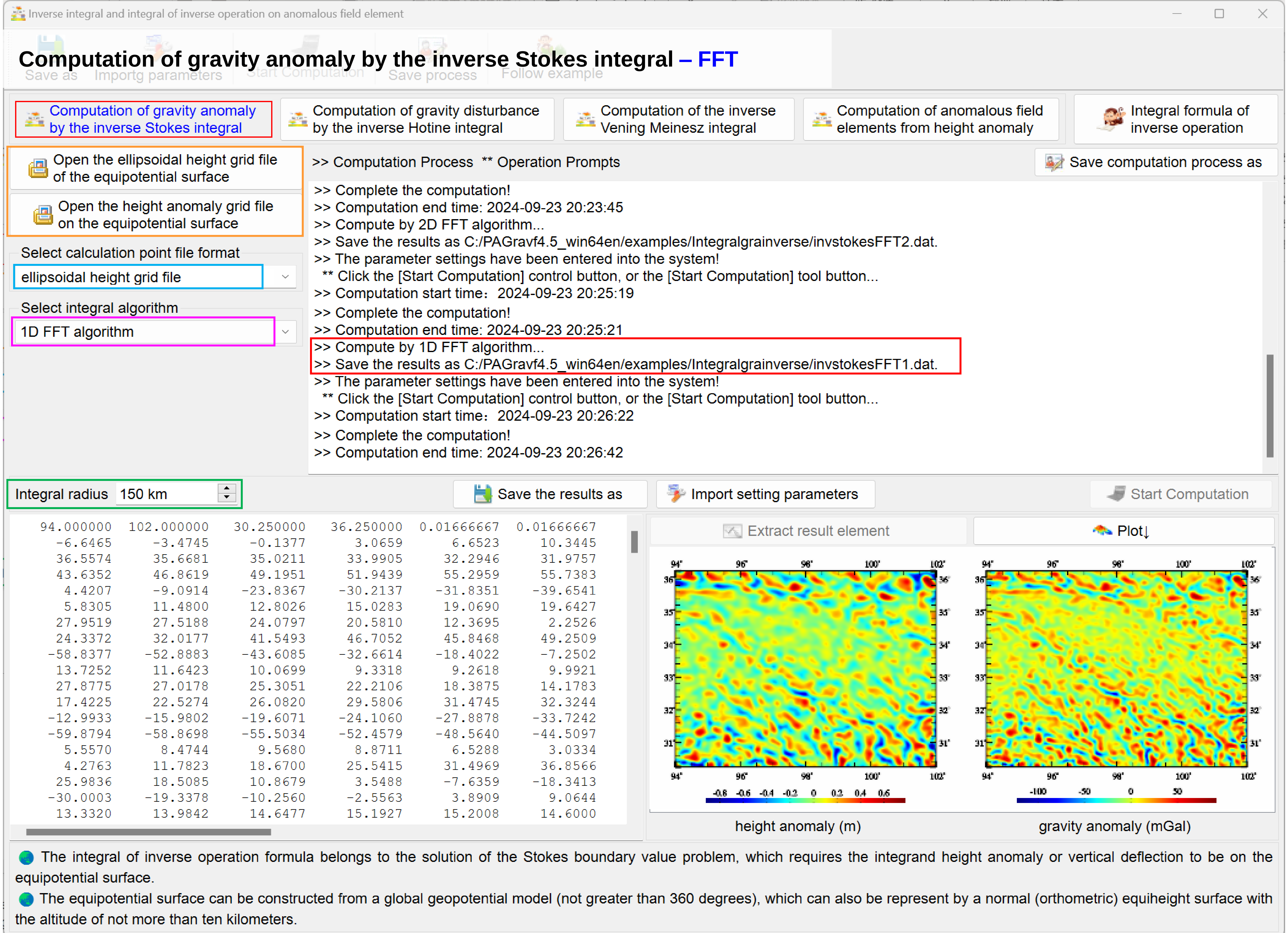

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity disturbance – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation end time: 2024-09-23 15:01:01
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/landbmsurfhgt.dat.
>> Compute external residual vertical deflection by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/rgatovmFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 15:03:49
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 15:03:51
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
2D FFT algorithm
Integral radius 180 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-2.2983 -2.5692 -2.5347 -2.2082 -1.6585 -0.9656 -0.1997 0.5849 1.3491
4.3900 4.3211 4.1201 3.8155 3.4521 3.0887 2.7923 2.6303 2.6604
8.1264 8.9502 9.5548 9.9047 9.9975 9.8642 9.5643 9.1752 8.7810
9.2803 9.4953 9.5263 9.3052 8.7862 7.9515 6.8129 5.4083 3.7964
Extract vertical deflection
Plot↓
gravity disturbance (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.

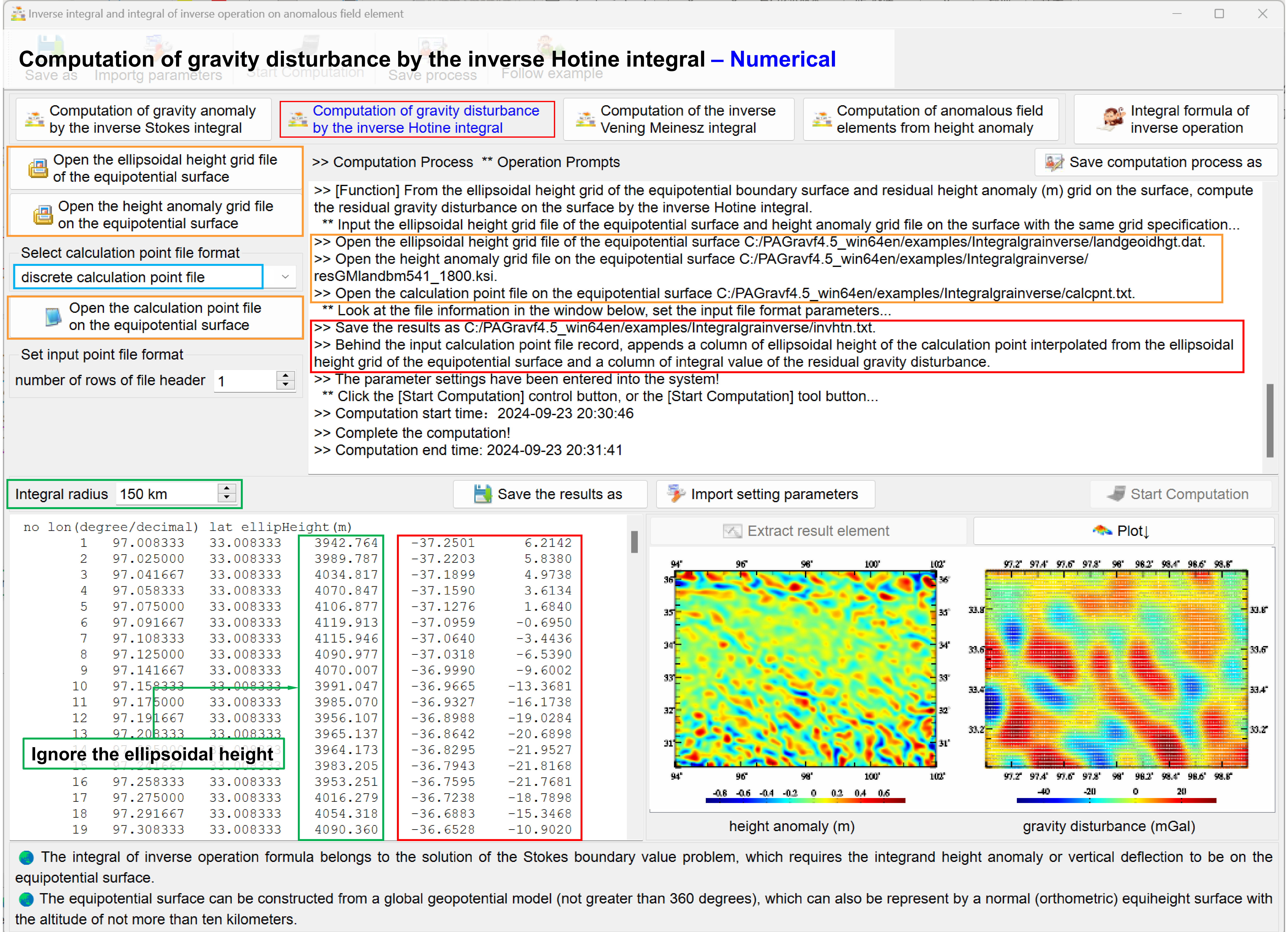

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity disturbance – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Computation of external vertical deflection from gravity anomaly
Computation of external vertical deflection from gravity disturbance
Vening-Meinesz integral formulas outside geoid
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the ellipsoidal height grid file of the equipotential surface
Open the residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
Select integral algorithm
1D FFT algorithm
Integral radius
180 km
Extract vertical deflection
Plot↓
>> Computation Process ** Operation Prompts
Save computation process as
>> Computation start time: 2024-09-23 15:03:49
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 15:03:51
>> Compute external residual vertical deflection by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/IntgenVeningMeinesz/rgatovmFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 15:04:25
>> Complete the computation of the vertical deflection outside the geoid!
>> Computation end time: 2024-09-23 15:05:09
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-2.2902 -2.5728 -2.5404 -2.2106 -1.6569 -0.9620 -0.1970 0.5837 1.3422
4.3438 4.2677 4.0572 3.7402 3.3616 2.9808 2.6656 2.4845 2.4963
7.8987 8.7168 9.3140 9.6544 9.7356 9.5887 9.2746 8.8722 8.4667
9.0128 9.2522 9.3100 9.1173 8.6277 7.8231 6.7148 5.3404 3.7583
94° 96° 98° 100° 102°
36° 35° 34° 33° 32° 31°
-200 -100 0 100 200 300
-15 -10 -5 0 5 10 15
gravity disturbance (mGal)
vertical deflection (″, S)
vertical deflection (″, W)
The generalized Vening-Meinesz formula is derived from the generalized Stokes/Hotine formula and belongs to the solution of the Stokes boundary value problem. Which requires the integrand gravity anomaly/disturbance to be on the equipotential surface.


Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point file on the equipotential surface
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential boundary surface and residual height anomaly (m) grid on the surface, compute the residual gravity anomaly (mGal) on the equipotential surface by the inverse Stokes integral.
** Input the ellipsoidal height grid file of the equipotential surface and height anomaly grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/landgeoidhgt.dat.
>> Open the height anomaly grid file on the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/resGMlgeoid541_1800.ksi.
>> Open the calculation point file on the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstk.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of integral value of the residual gravity anomaly.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 15:16:35
>> Complete the computation!
>> Computation end time: 2024-09-23 15:17:40
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -37.2501 24.7224
2 97.025000 33.008333 3989.787 -37.2203 24.6842
3 97.041667 33.008333 4034.817 -37.1899 22.9058
4 97.058333 33.008333 4070.847 -37.1590 19.2598
5 97.075000 33.008333 4106.877 -37.1276 13.9076
6 97.091667 33.008333 4119.913 -37.0959 7.1243
7 97.108333 33.008333 4115.946 -37.0640 -0.9416
8 97.125000 33.008333 4090.977 -37.0318 -9.7023
9 97.141667 33.008333 4070.007 -36.9990 -18.9075
10 97.158333 33.008333 3991.047 -36.9665 -27.8771
11 97.175000 33.008333 3985.070 -36.9327 -36.2732
12 97.191667 33.008333 3956.107 -36.8988 -43.4193
13 97.208333 33.008333 3965.137 -36.8642 -49.0686
3964.173 -36.8295 -52.4761
3983.205 -36.7943 -53.5072
16 97.258333 33.008333 3953.251 -36.7595 -51.6556
17 97.275000 33.008333 4016.279 -36.7238 -46.8428
18 97.291667 33.008333 4054.318 -36.6883 -39.1123
19 97.308333 33.008333 4090.360 -36.6528 -28.6690
Ignore the ellipsoidal height
Extract result element
Plot↓
height anomaly (m)
gravity anomaly (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

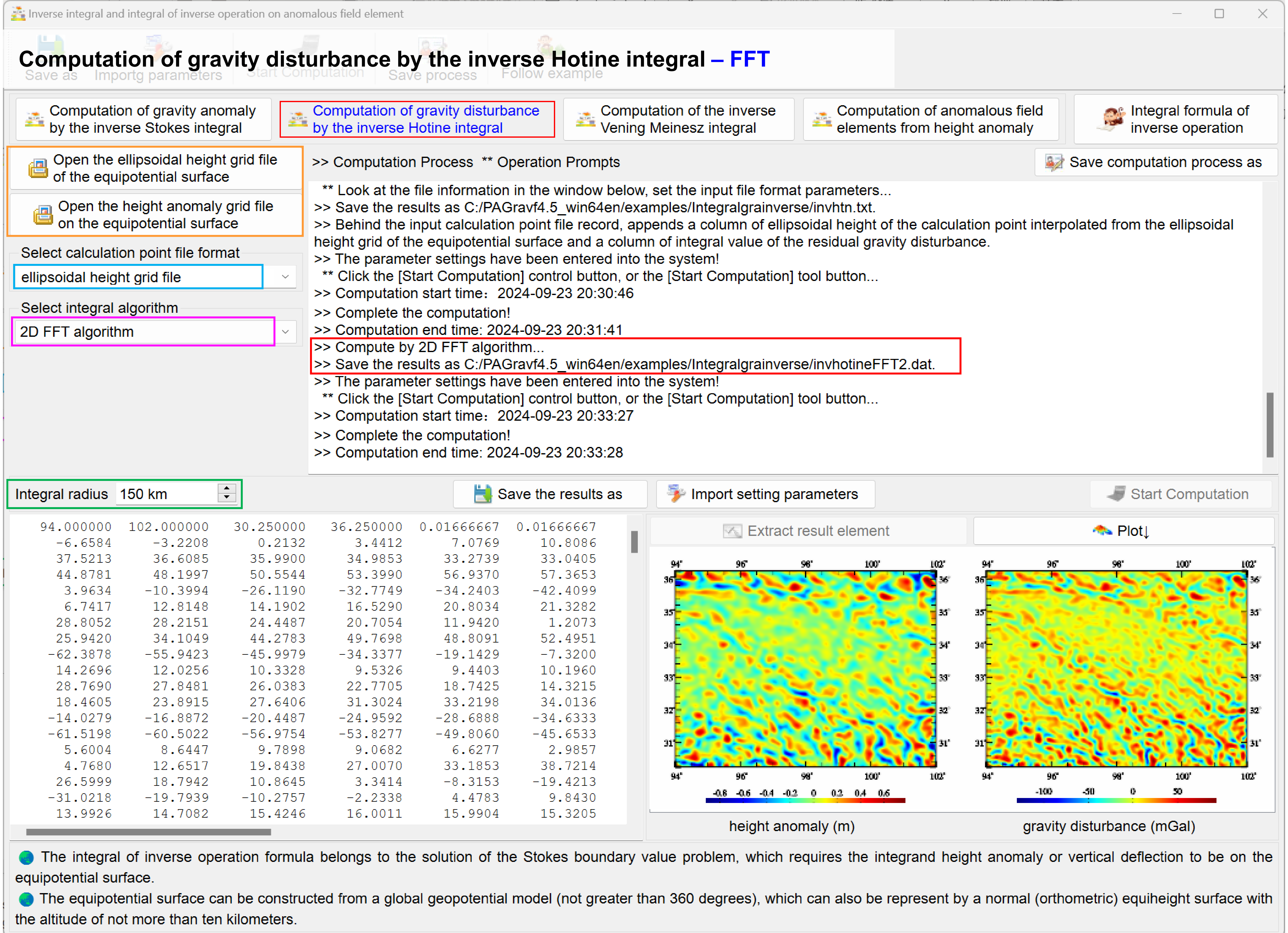

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
numerical integral
>> Computation Process ** Operation Prompts
Save computation process as
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstk.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of integral value of the residual gravity anomaly.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 19:59:17
>> Complete the computation!
>> Computation end time: 2024-09-23 20:00:18
>> Compute by numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstokesnintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:02:35
>> Complete the computation!
>> Computation end time: 2024-09-23 20:23:45
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-6.7082 -3.5451 -0.1911 3.0391 6.6519 10.3730
36.7580 35.8638 35.2066 34.1624 32.4529 32.1184
43.8609 47.1039 49.4558 52.2163 55.5724 56.0212
4.5287 -8.9848 -23.7249 -30.1206 -31.7801 -39.6205
5.7532 11.3936 12.7210 14.9511 18.9953 19.5816
28.0887 27.6742 24.2507 20.7547 12.5472 2.4261
24.3313 32.0133 41.5405 46.6957 45.8446 49.2392
-58.8703 -52.9381 -43.6688 -32.7235 -18.4676 -7.3091
13.7746 11.6956 10.1260 9.3898 9.3222 10.0556
28.0073 27.1485 25.4340 22.3360 18.5072 14.2898
17.4349 22.5400 26.0993 29.6066 31.5147 32.3806
-12.9644 -15.9979 -19.6681 -24.2073 -28.0318 -33.9067
-60.1987 -59.1808 -55.8066 -52.7477 -48.8362 -44.7585
5.6019 8.5282 9.6246 8.9249 6.5753 3.0689
4.2451 11.7662 18.6738 25.5670 31.5455 36.9296
26.1350 18.6380 10.9680 3.6098 -7.6106 -18.3577
-30.1325 -19.4527 -10.3495 -2.6276 3.8415 9.0357
13.3615 14.0104 14.6722 15.2175 15.2282 14.6317
Extract result element
Plot↓
height anomaly (m)
gravity anomaly (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

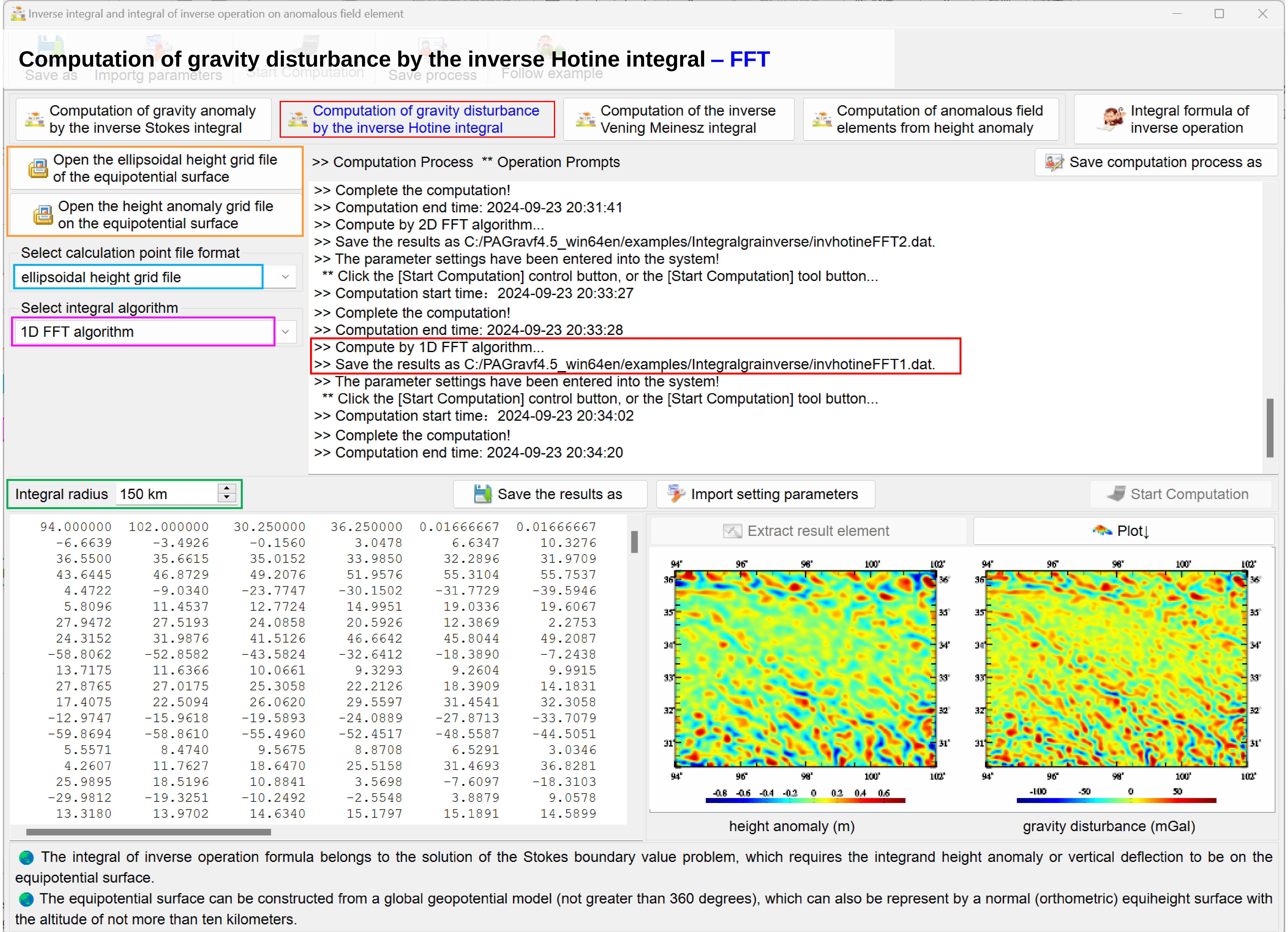

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
2D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the computation!
>> Computation end time: 2024-09-23 20:00:18
>> Compute by numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstokesnintg.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:02:35
>> Complete the computation!
>> Computation end time: 2024-09-23 20:23:45
>> Compute by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstokesFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:25:19
>> Complete the computation!
>> Computation end time: 2024-09-23 20:25:21
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-6.6410 -3.2026 0.2316 3.4593 7.0945 10.8255
37.5286 36.6150 35.9959 34.9908 33.2789 33.0452
44.8689 48.1887 50.5418 53.3854 56.9225 57.3500
3.9118 -10.4568 -26.1810 -32.8384 -34.3024 -42.4693
6.7626 12.8411 14.2203 16.5622 20.8387 21.3642
28.8099 28.2146 24.4426 20.6938 11.9247 1.1847
25.9640 34.1350 44.3150 49.8107 48.8515 52.5373
-62.4193 -55.9724 -46.0240 -34.3579 -19.1561 -7.3264
14.2773 12.0313 10.3367 9.5350 9.4416 10.1966
28.7700 27.8483 26.0376 22.7685 18.7392 14.3167
18.4754 23.9095 27.6606 31.3232 33.2401 34.0322
-14.0465 -16.9056 -20.4665 -24.9763 -28.7053 -34.6495
-61.5298 -60.5110 -56.9828 -53.8340 -49.8113 -45.6578
5.6003 8.6451 9.7903 9.0685 6.6274 2.9845
4.7836 12.6714 19.8668 27.0328 33.2128 38.7498
26.5940 18.7831 10.8483 3.3203 -8.3415 -19.4523
-31.0409 -19.8066 -10.2825 -2.2353 4.4813 9.8496
14.0066 14.7222 15.4382 16.0140 16.0022 15.3307
Extract result element
Plot↓
height anomaly (m)
gravity anomaly (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

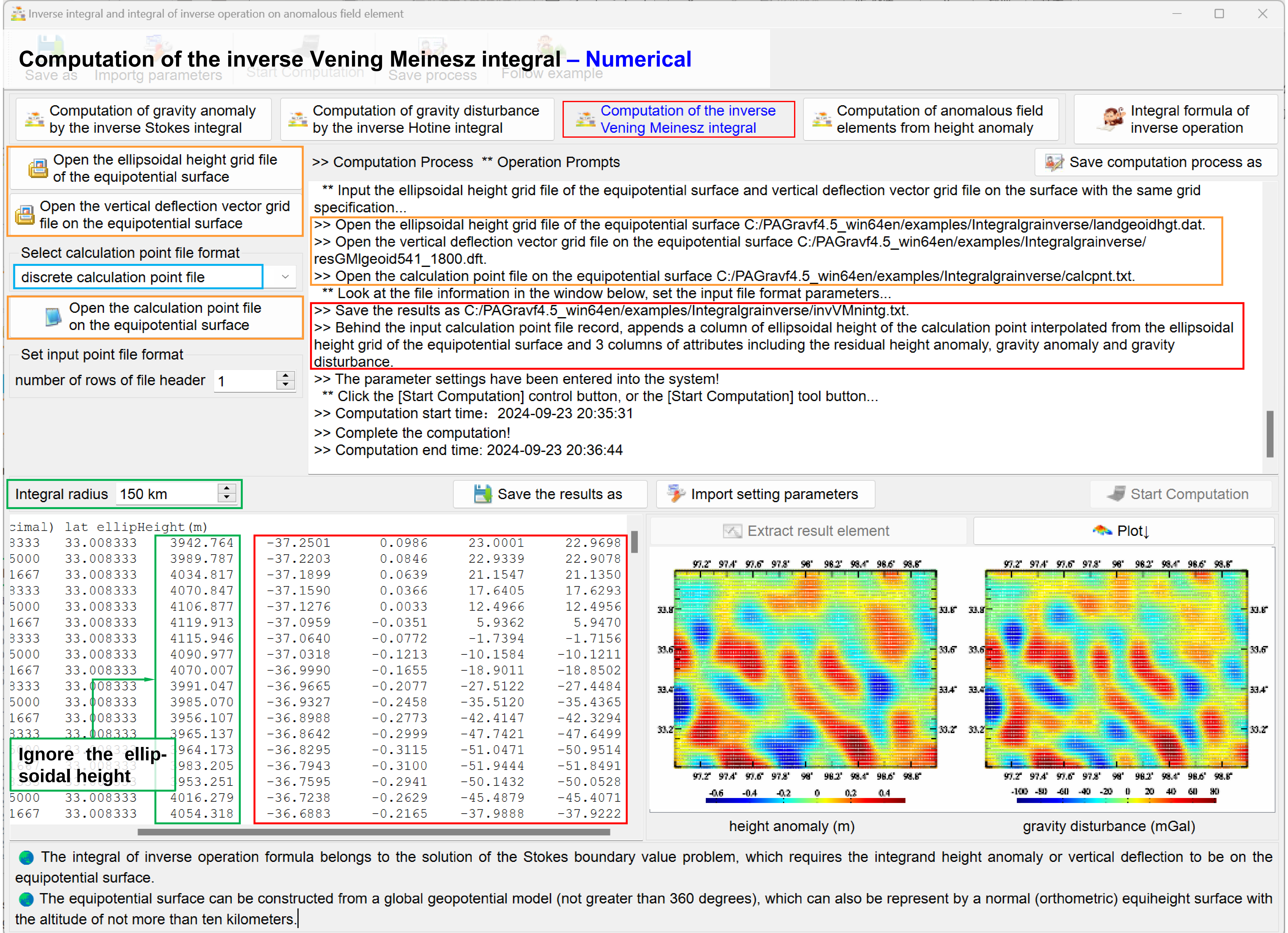

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
1D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the computation!
>> Computation end time: 2024-09-23 20:23:45
>> Compute by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstokesFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:25:19
>> Complete the computation!
>> Computation end time: 2024-09-23 20:25:21
>> Compute by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invstokesFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:26:22
>> Complete the computation!
>> Computation end time: 2024-09-23 20:26:42
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-6.6465 -3.4745 -0.1377 3.0659 6.6523 10.3445
36.5574 35.6681 35.0211 33.9905 32.2946 31.9757
43.6352 46.8619 49.1951 51.9439 55.2959 55.7383
4.4207 -9.0914 -23.8367 -30.2137 -31.8351 -39.6541
5.8305 11.4800 12.8026 15.0283 19.0690 19.6427
27.9519 27.5188 24.0797 20.5810 12.3695 2.2526
24.3372 32.0177 41.5493 46.7052 45.8468 49.2509
-58.8377 -52.8883 -43.6085 -32.6614 -18.4022 -7.2502
13.7252 11.6423 10.0699 9.3318 9.2618 9.9921
27.8775 27.0178 25.3051 22.2106 18.3875 14.1783
17.4225 22.5274 26.0820 29.5806 31.4745 32.3244
-12.9933 -15.9802 -19.6071 -24.1060 -27.8878 -33.7242
-59.8794 -58.8698 -55.5034 -52.4579 -48.5640 -44.5097
5.5570 8.4744 9.5680 8.8711 6.5288 3.0334
4.2763 11.7823 18.6700 25.5415 31.4969 36.8566
25.9836 18.5085 10.8679 3.5488 -7.6359 -18.3413
-30.0003 -19.3378 -10.2560 -2.5563 3.8909 9.0644
13.3320 13.9842 14.6477 15.1927 15.2008 14.6000
Extract result element
Plot↓
height anomaly (m)
gravity anomaly (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

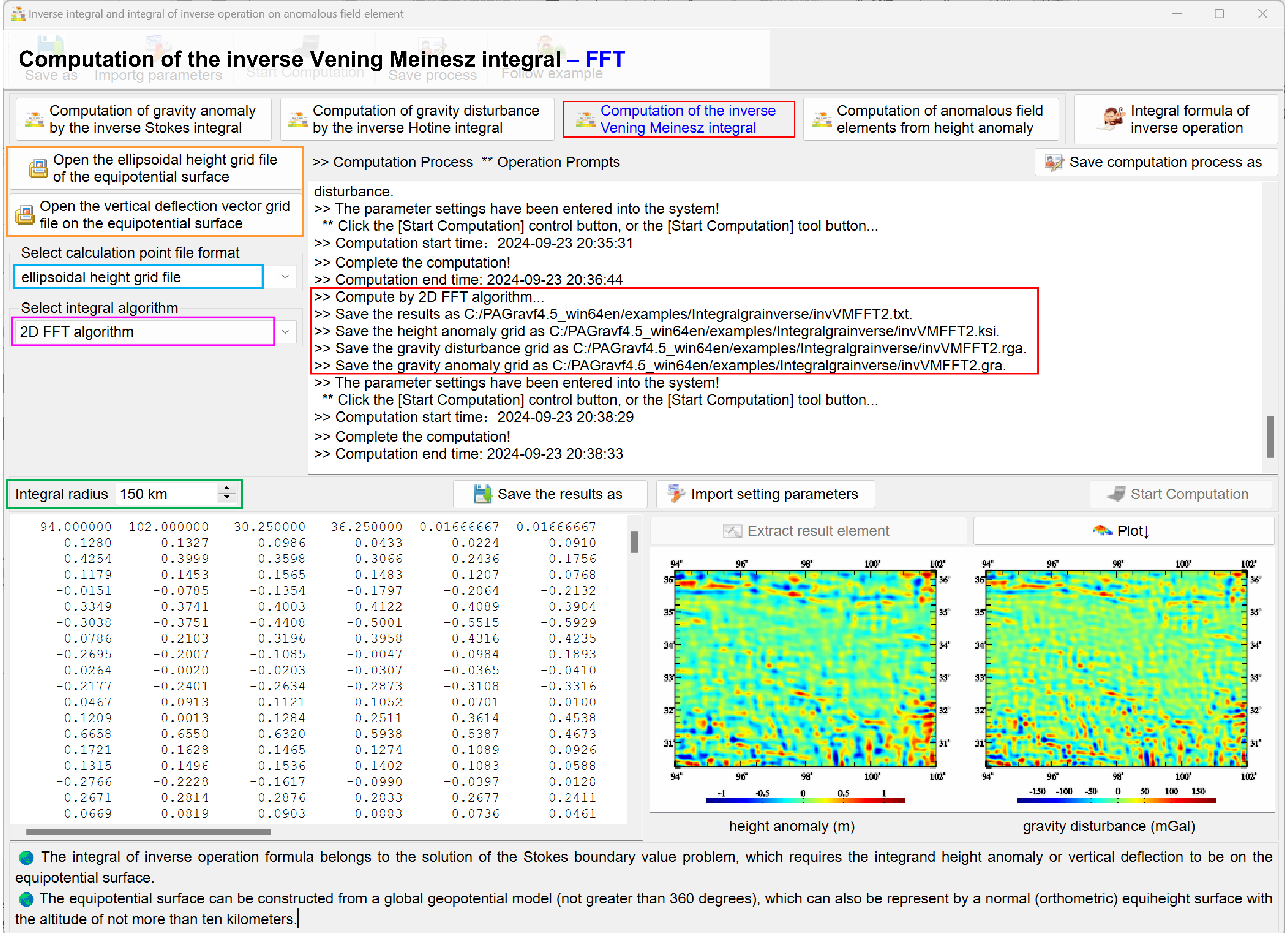


Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity disturbance by the inverse Hotine integral – Numerical
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point file on the equipotential surface
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential boundary surface and residual height anomaly (m) grid on the surface, compute the residual gravity disturbance on the surface by the inverse Hotine integral.
** Input the ellipsoidal height grid file of the equipotential surface and height anomaly grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/landgeoidhgt.dat.
>> Open the height anomaly grid file on the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/resGMlandbm541_1800.ksi.
>> Open the calculation point file on the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invhtn.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of integral value of the residual gravity disturbance.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:30:46
>> Complete the computation!
>> Computation end time: 2024-09-23 20:31:41
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -37.2501 6.2142
2 97.025000 33.008333 3989.787 -37.2203 5.8380
3 97.041667 33.008333 4034.817 -37.1899 4.9738
4 97.058333 33.008333 4070.847 -37.1590 3.6134
5 97.075000 33.008333 4106.877 -37.1276 1.6840
6 97.091667 33.008333 4119.913 -37.0959 -0.6950
7 97.108333 33.008333 4115.946 -37.0640 -3.4436
8 97.125000 33.008333 4090.977 -37.0318 -6.5390
9 97.141667 33.008333 4070.007 -36.9990 -9.6002
10 97.158333 33.008333 3991.047 -36.9665 -13.3681
11 97.175000 33.008333 3985.070 -36.9327 -16.1738
12 97.191667 33.008333 3956.107 -36.8988 -19.0284
13 97.208333 33.008333 3965.137 -36.8642 -20.6898
3964.173 -36.8295 -21.9527
3983.205 -36.7943 -21.8168
16 97.258333 33.008333 3953.251 -36.7595 -21.7681
17 97.275000 33.008333 4016.279 -36.7238 -18.7898
18 97.291667 33.008333 4054.318 -36.6883 -15.3468
19 97.308333 33.008333 4090.360 -36.6528 -10.9020
Ignore the ellipsoidal height
Extract result element
Plot↓
height anomaly (m)
gravity disturbance (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

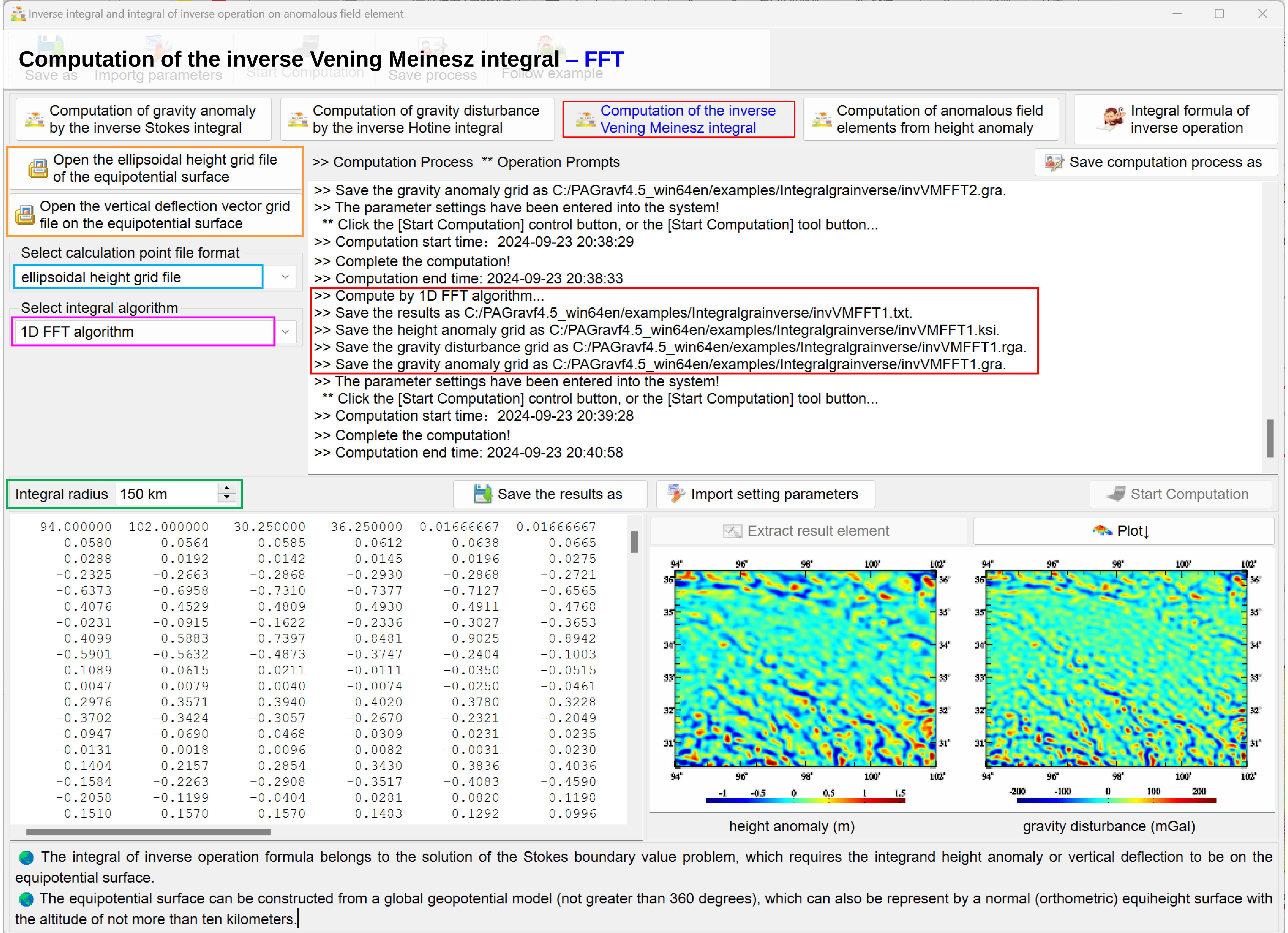

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity disturbance by the inverse Hotine integral – FFT
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
2D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invhtn.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of integral value of the residual gravity disturbance.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:30:46
>> Complete the computation!
>> Computation end time: 2024-09-23 20:31:41
>> Compute by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invhotineFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:33:27
>> Complete the computation!
>> Computation end time: 2024-09-23 20:33:28
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-6.6584 -3.2208 0.2132 3.4412 7.0769 10.8086
37.5213 36.6085 35.9900 34.9853 33.2739 33.0405
44.8781 48.1997 50.5544 53.3990 56.9370 57.3653
3.9634 -10.3994 -26.1190 -32.7749 -34.2403 -42.4099
6.7417 12.8148 14.1902 16.5290 20.8034 21.3282
28.8052 28.2151 24.4487 20.7054 11.9420 1.2073
25.9420 34.1049 44.2783 49.7698 48.8091 52.4951
-62.3878 -55.9423 -45.9979 -34.3377 -19.1429 -7.3200
14.2696 12.0256 10.3328 9.5326 9.4403 10.1960
28.7690 27.8481 26.0383 22.7705 18.7425 14.3215
18.4605 23.8915 27.6406 31.3024 33.2198 34.0136
-14.0279 -16.8872 -20.4487 -24.9592 -28.6888 -34.6333
-61.5198 -60.5022 -56.9754 -53.8277 -49.8060 -45.6533
5.6004 8.6447 9.7898 9.0682 6.6277 2.9857
4.7680 12.6517 19.8438 27.0070 33.1853 38.7214
26.5999 18.7942 10.8645 3.3414 -8.3153 -19.4213
-31.0218 -19.7939 -10.2757 -2.2338 4.4783 9.8430
13.9926 14.7082 15.4246 16.0011 15.9904 15.3205
Extract result element
Plot↓
height anomaly (m)
gravity disturbance (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

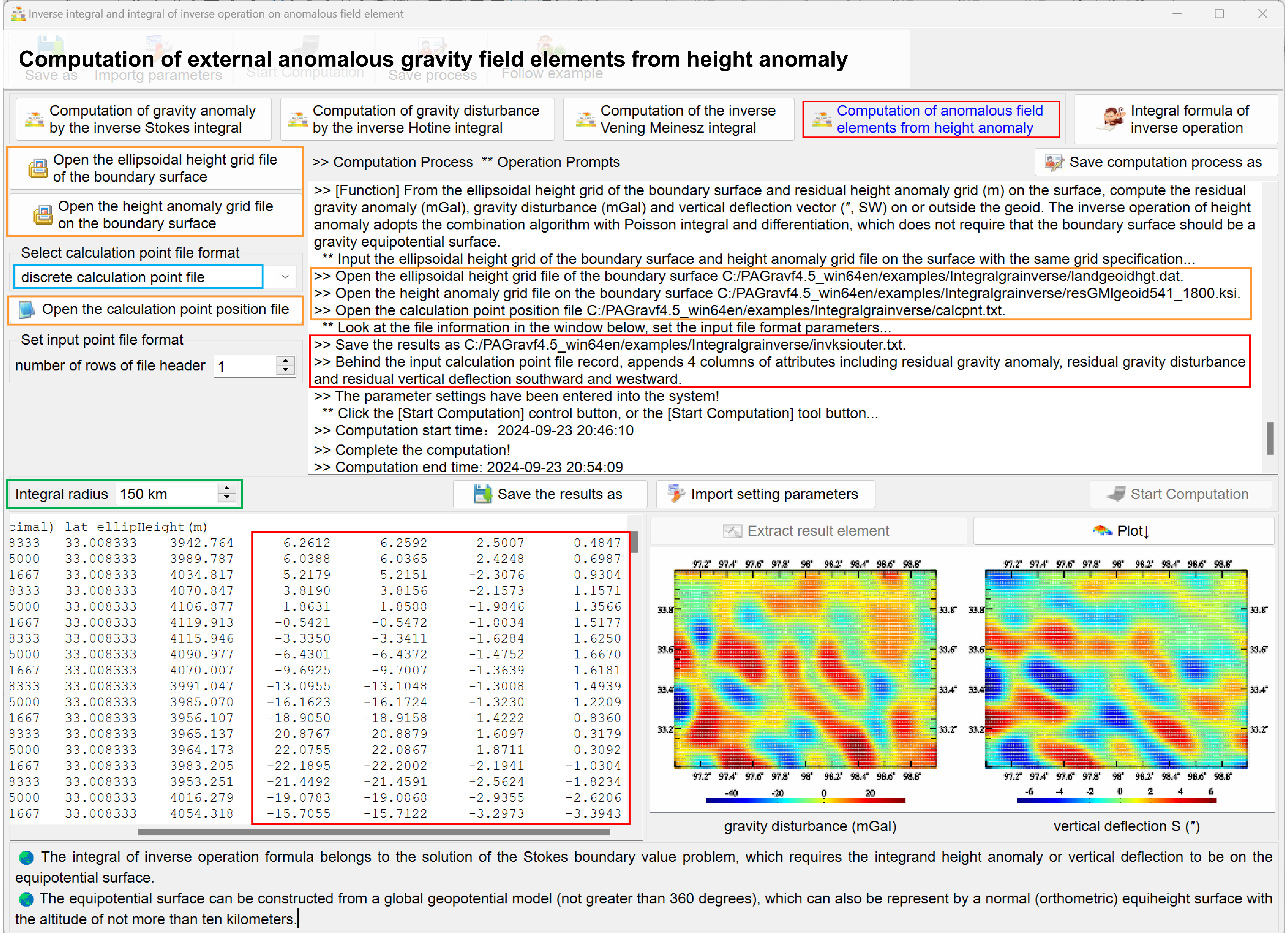

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity disturbance by the inverse Hotine integral – FFT
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the height anomaly grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
1D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Complete the computation!
>> Computation end time: 2024-09-23 20:31:41
>> Compute by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invhotineFFT2.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:33:27
>> Complete the computation!
>> Computation end time: 2024-09-23 20:33:28
>> Compute by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invhotineFFT1.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:34:02
>> Complete the computation!
>> Computation end time: 2024-09-23 20:34:20
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
-6.6639 -3.4926 -0.1560 3.0478 6.6347 10.3276
36.5500 35.6615 35.0152 33.9850 32.2896 31.9709
43.6445 46.8729 49.2076 51.9576 55.3104 55.7537
4.4722 -9.0340 -23.7747 -30.1502 -31.7729 -39.5946
5.8096 11.4537 12.7724 14.9951 19.0336 19.6067
27.9472 27.5193 24.0858 20.5926 12.3869 2.2753
24.3152 31.9876 41.5126 46.6642 45.8044 49.2087
-58.8062 -52.8582 -43.5824 -32.6412 -18.3890 -7.2438
13.7175 11.6366 10.0661 9.3293 9.2604 9.9915
27.8765 27.0175 25.3058 22.2126 18.3909 14.1831
17.4075 22.5094 26.0620 29.5597 31.4541 32.3058
-12.9747 -15.9618 -19.5893 -24.0889 -27.8713 -33.7079
-59.8694 -58.8610 -55.4960 -52.4517 -48.5587 -44.5051
5.5571 8.4740 9.5675 8.8708 6.5291 3.0346
4.2607 11.7627 18.6470 25.5158 31.4693 36.8281
25.9895 18.5196 10.8841 3.5698 -7.6097 -18.3103
-29.9812 -19.3251 -10.2492 -2.5548 3.8879 9.0578
13.3180 13.9702 14.6340 15.1797 15.1891 14.5899
Extract result element
Plot↓
height anomaly (m)
gravity disturbance (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

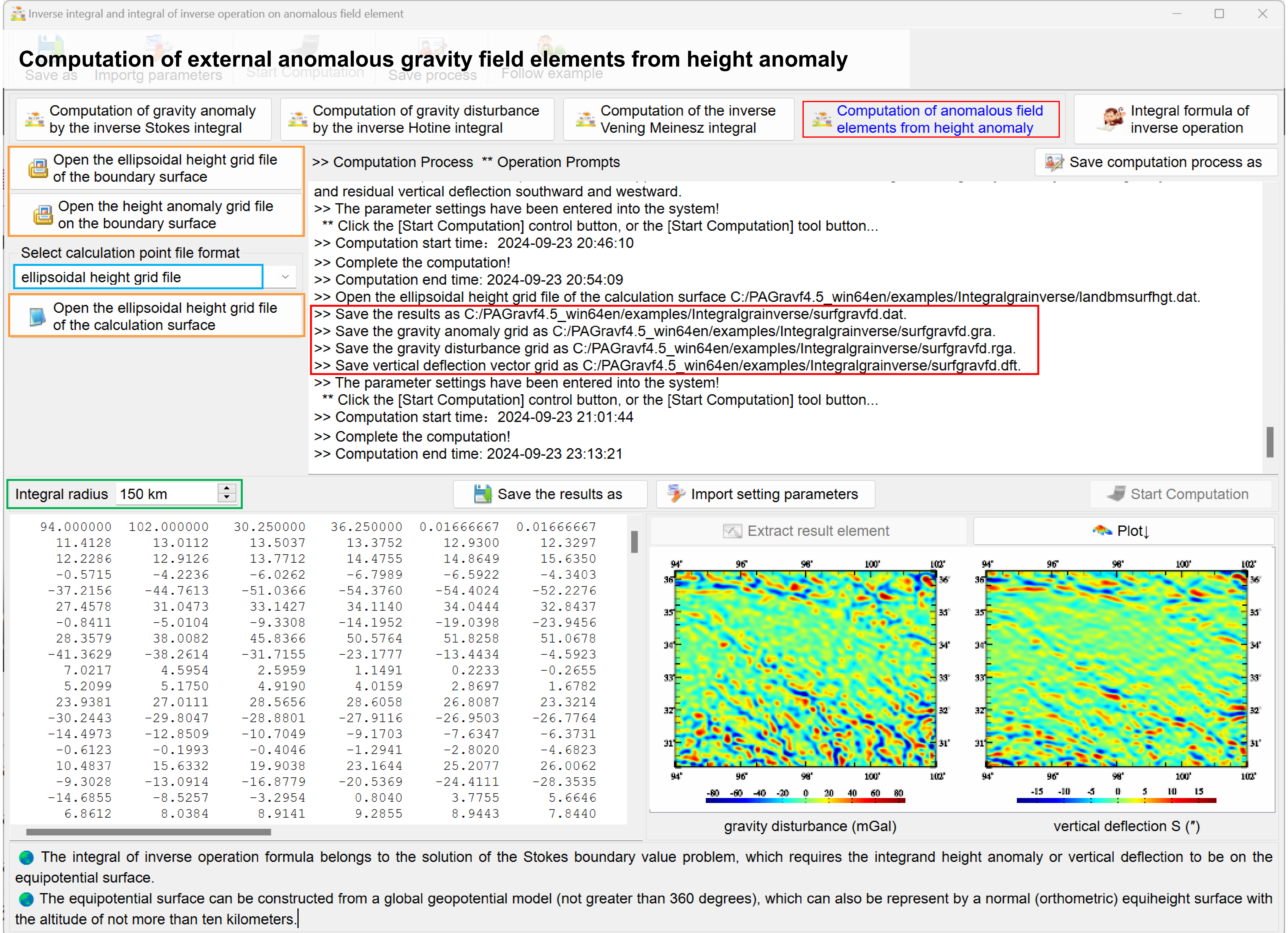

Inverse integral and integral of inverse operation on anomalous field element
Computation of the inverse Vening Meinesz integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the vertical deflection vector grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point file on the equipotential surface
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
** Input the ellipsoidal height grid file of the equipotential surface and vertical deflection vector grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/landgeoidhgt.dat.
>> Open the vertical deflection vector grid file on the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/resGMlgeoid541_1800.dft.
>> Open the calculation point file on the equipotential surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMnintg.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and 3 columns of attributes including the residual height anomaly, gravity anomaly and gravity disturbance.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:35:31
>> Complete the computation!
>> Computation end time: 2024-09-23 20:36:44
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
Extract result element
Plot↓
cimal) lat ellipHeight(m)
3333 33.008333 3942.764 -37.2501 0.0986 23.0001 22.9698
5000 33.008333 3989.787 -37.2203 0.0846 22.9339 22.9078
1667 33.008333 4034.817 -37.1899 0.0639 21.1547 21.1350
3333 33.008333 4070.847 -37.1590 0.0366 17.6405 17.6293
5000 33.008333 4106.877 -37.1276 0.0033 12.4966 12.4956
1667 33.008333 4119.913 -37.0959 -0.0351 5.9362 5.9470
3333 33.008333 4115.946 -37.0640 -0.0772 -1.7394 -1.7156
5000 33.008333 4090.977 -37.0318 -0.1213 -10.1584 -10.1211
1667 33.008333 4070.007 -36.9990 -0.1655 -18.9011 -18.8502
3333 33.008333 3991.047 -36.9665 -0.2077 -27.5122 -27.4484
5000 33.008333 3985.070 -36.9327 -0.2458 -35.5120 -35.4365
1667 33.008333 3956.107 -36.8988 -0.2773 -42.4147 -42.3294
3333 33.008333 3965.137 -36.8642 -0.2999 -47.7421 -47.6499
964.173 -36.8295 -0.3115 -51.0471 -50.9514
983.205 -36.7943 -0.3100 -51.9444 -51.8491
953.251 -36.7595 -0.2941 -50.1432 -50.0528
5000 33.008333 4016.279 -36.7238 -0.2629 -45.4879 -45.4071
1667 33.008333 4054.318 -36.6883 -0.2165 -37.9888 -37.9222
Ignore the ellipsoidal height
height anomaly (m)
gravity disturbance (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

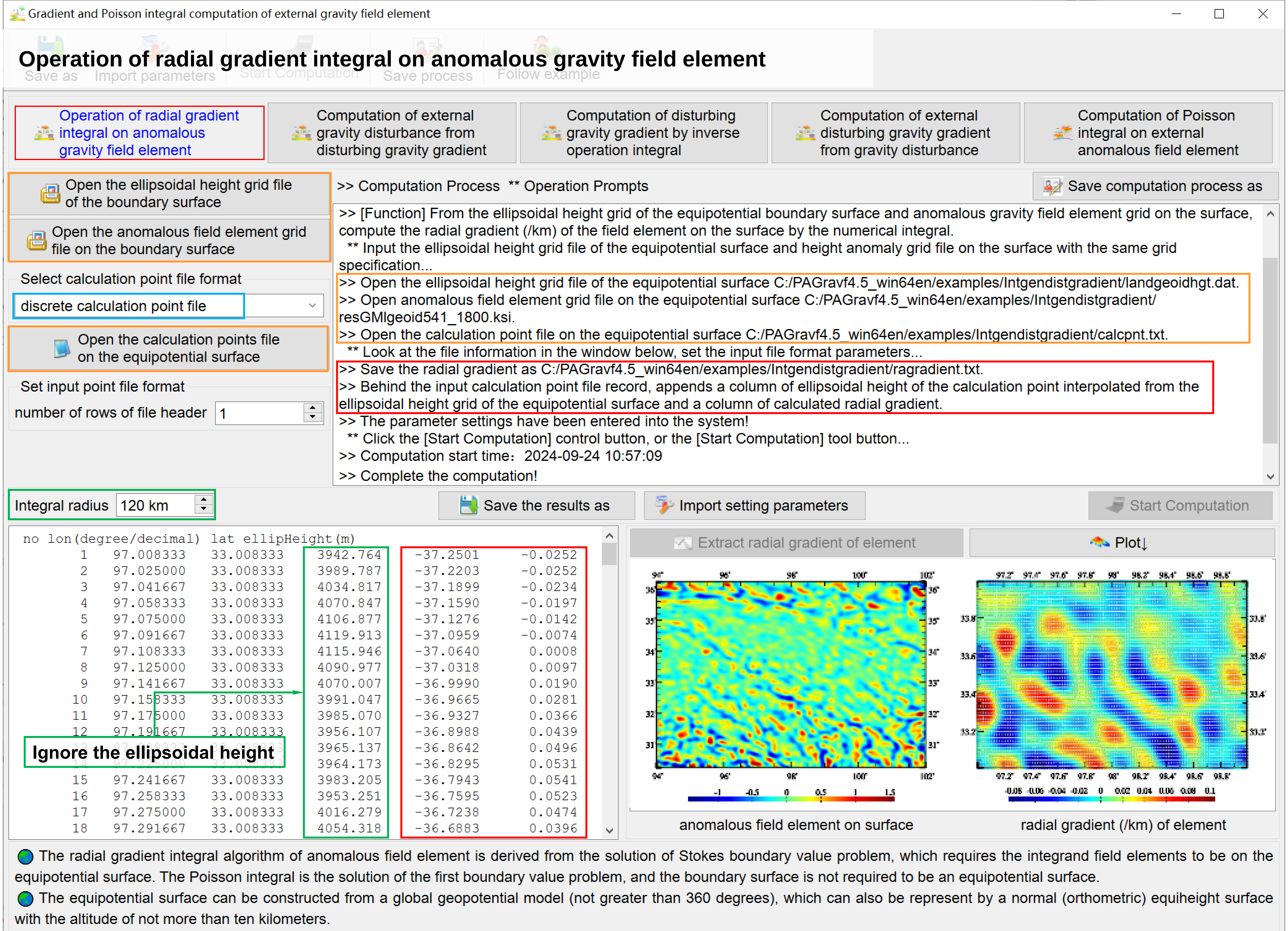


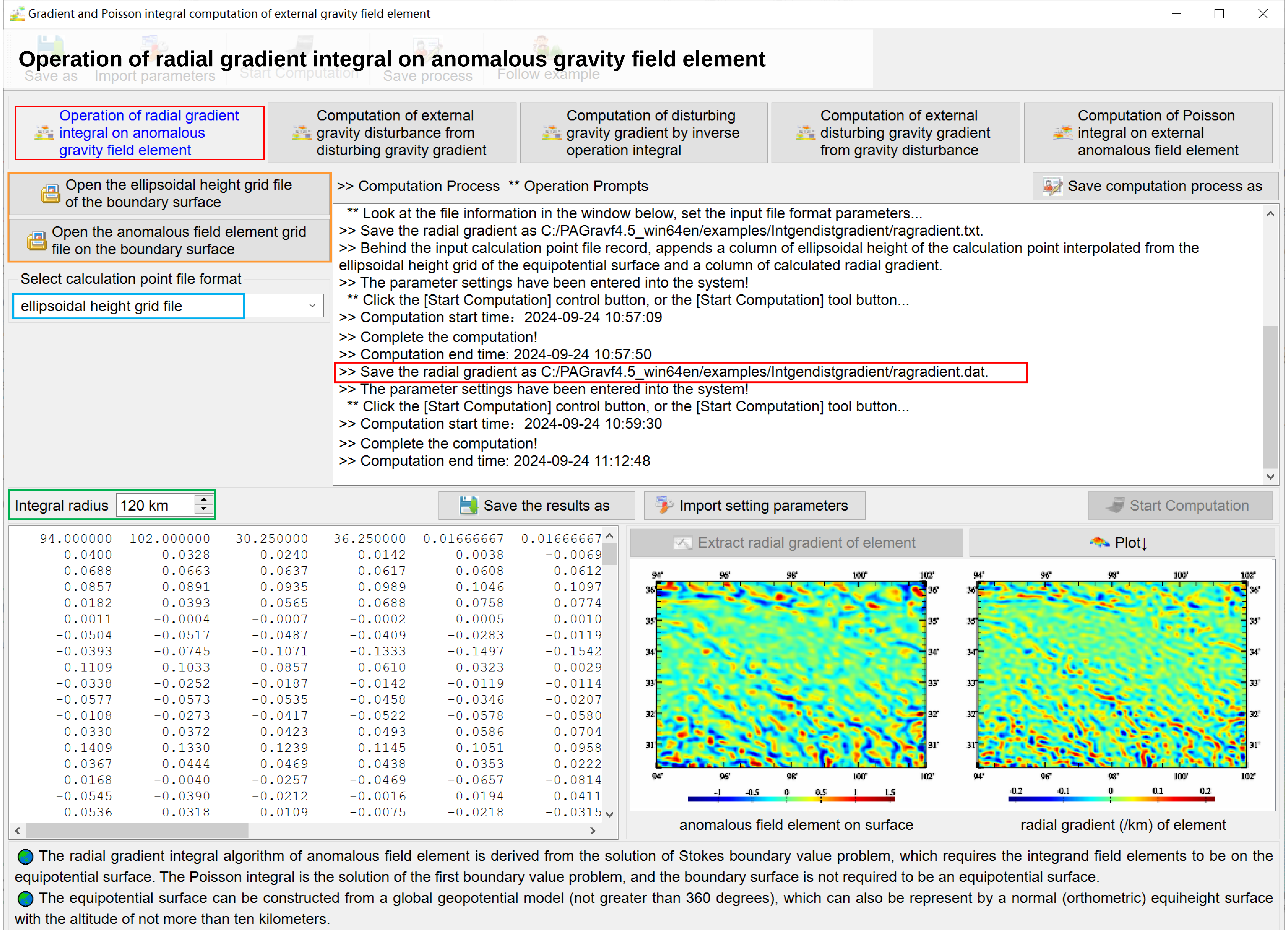
Inverse integral and integral of inverse operation on anomalous field element
Computation of the inverse Vening Meinesz integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the vertical deflection vector grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
2D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
disturbance.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:35:31
>> Complete the computation!
>> Computation end time: 2024-09-23 20:36:44
>> Compute by 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT2.txt.
>> Save the height anomaly grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT2.ksi.
>> Save the gravity disturbance grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT2.rga.
>> Save the gravity anomaly grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT2.gra.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:38:29
>> Complete the computation!
>> Computation end time: 2024-09-23 20:38:33
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
0.1280 0.1327 0.0986 0.0433 -0.0224 -0.0910
-0.4254 -0.3999 -0.3598 -0.3066 -0.2436 -0.1756
-0.1179 -0.1453 -0.1565 -0.1483 -0.1207 -0.0768
-0.0151 -0.0785 -0.1354 -0.1797 -0.2064 -0.2132
0.3349 0.3741 0.4003 0.4122 0.4089 0.3904
-0.3038 -0.3751 -0.4408 -0.5001 -0.5515 -0.5929
0.0786 0.2103 0.3196 0.3958 0.4316 0.4235
-0.2695 -0.2007 -0.1085 -0.0047 0.0984 0.1893
0.0264 -0.0020 -0.0203 -0.0307 -0.0365 -0.0410
-0.2177 -0.2401 -0.2634 -0.2873 -0.3108 -0.3316
0.0467 0.0913 0.1121 0.1052 0.0701 0.0100
-0.1209 0.0013 0.1284 0.2511 0.3614 0.4538
0.6658 0.6550 0.6320 0.5938 0.5387 0.4673
-0.1721 -0.1628 -0.1465 -0.1274 -0.1089 -0.0926
0.1315 0.1496 0.1536 0.1402 0.1083 0.0588
-0.2766 -0.2228 -0.1617 -0.0990 -0.0397 0.0128
0.2671 0.2814 0.2876 0.2833 0.2677 0.2411
0.0669 0.0819 0.0903 0.0883 0.0736 0.0461
Extract result element
Plot↓
height anomaly (m)
gravity disturbance (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

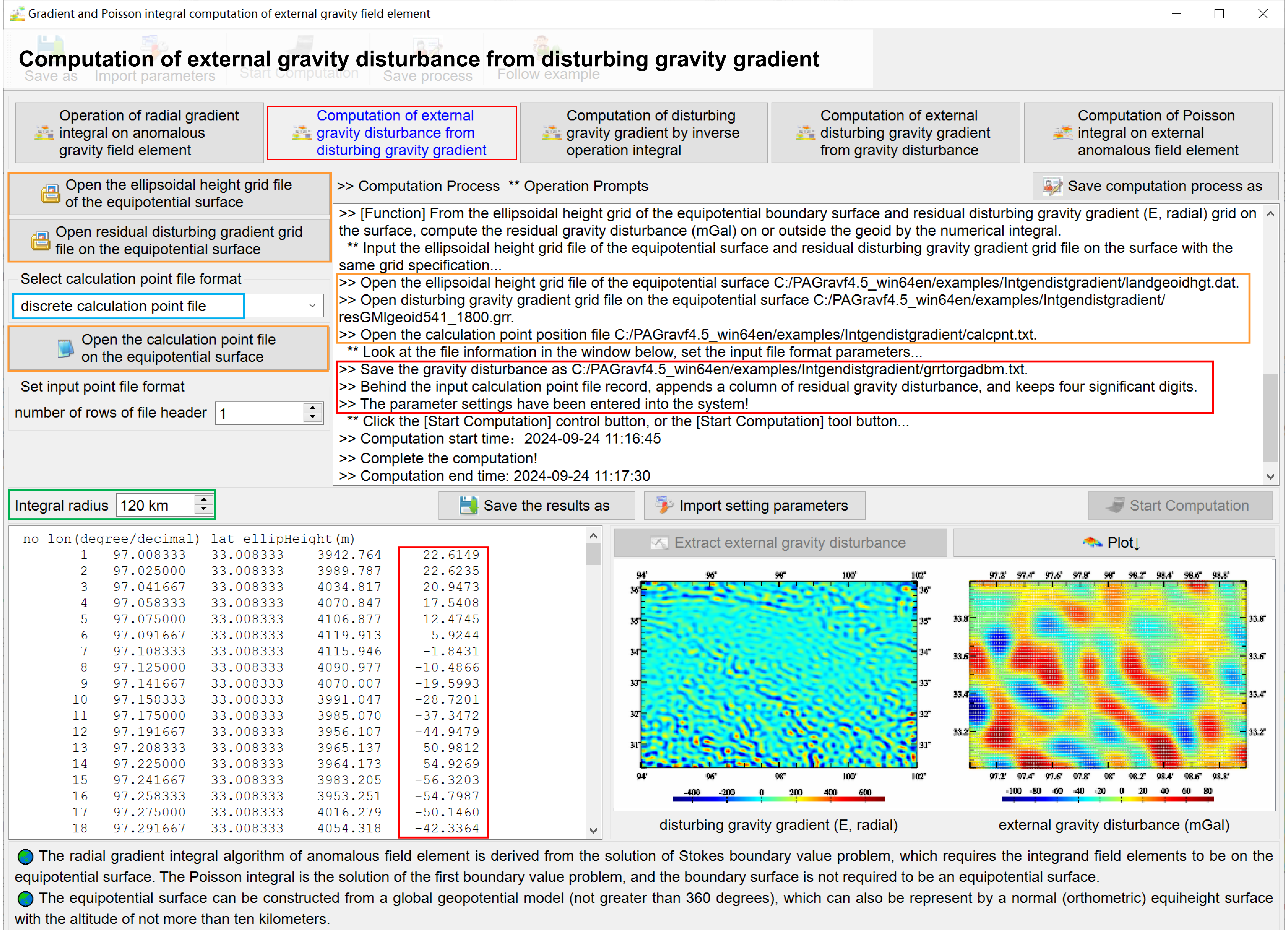

Inverse integral and integral of inverse operation on anomalous field element
Computation of the inverse Vening Meinesz integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the equipotential surface
Open the vertical deflection vector grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Select integral algorithm
1D FFT algorithm
>> Computation Process ** Operation Prompts
Save computation process as
>> Save the gravity anomaly grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT2.gra.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:38:29
>> Complete the computation!
>> Computation end time: 2024-09-23 20:38:33
>> Compute by 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT1.txt.
>> Save the height anomaly grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT1.ksi.
>> Save the gravity disturbance grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT1.rga.
>> Save the gravity anomaly grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invVMFFT1.gra.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:39:28
>> Complete the computation!
>> Computation end time: 2024-09-23 20:40:58
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
0.0580 0.0564 0.0585 0.0612 0.0638 0.0665
0.0288 0.0192 0.0142 0.0145 0.0196 0.0275
-0.2325 -0.2663 -0.2868 -0.2930 -0.2868 -0.2721
-0.6373 -0.6958 -0.7310 -0.7377 -0.7127 -0.6565
0.4076 0.4529 0.4809 0.4930 0.4911 0.4768
-0.0231 -0.0915 -0.1622 -0.2336 -0.3027 -0.3653
0.4099 0.5883 0.7397 0.8481 0.9025 0.8942
-0.5901 -0.5632 -0.4873 -0.3747 -0.2404 -0.1003
0.1089 0.0615 0.0211 -0.0111 -0.0350 -0.0515
0.0047 0.0079 0.0040 -0.0074 -0.0250 -0.0461
0.2976 0.3571 0.3940 0.4020 0.3780 0.3228
-0.3702 -0.3424 -0.3057 -0.2670 -0.2321 -0.2049
-0.0947 -0.0690 -0.0468 -0.0309 -0.0231 -0.0235
-0.0131 0.0018 0.0096 0.0082 -0.0031 -0.0230
0.1404 0.2157 0.2854 0.3430 0.3836 0.4036
-0.1584 -0.2263 -0.2908 -0.3517 -0.4083 -0.4590
-0.2058 -0.1199 -0.0404 0.0281 0.0820 0.1198
0.1510 0.1570 0.1570 0.1483 0.1292 0.0996
Extract result element
Plot↓
height anomaly (m)
gravity disturbance (mGal)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

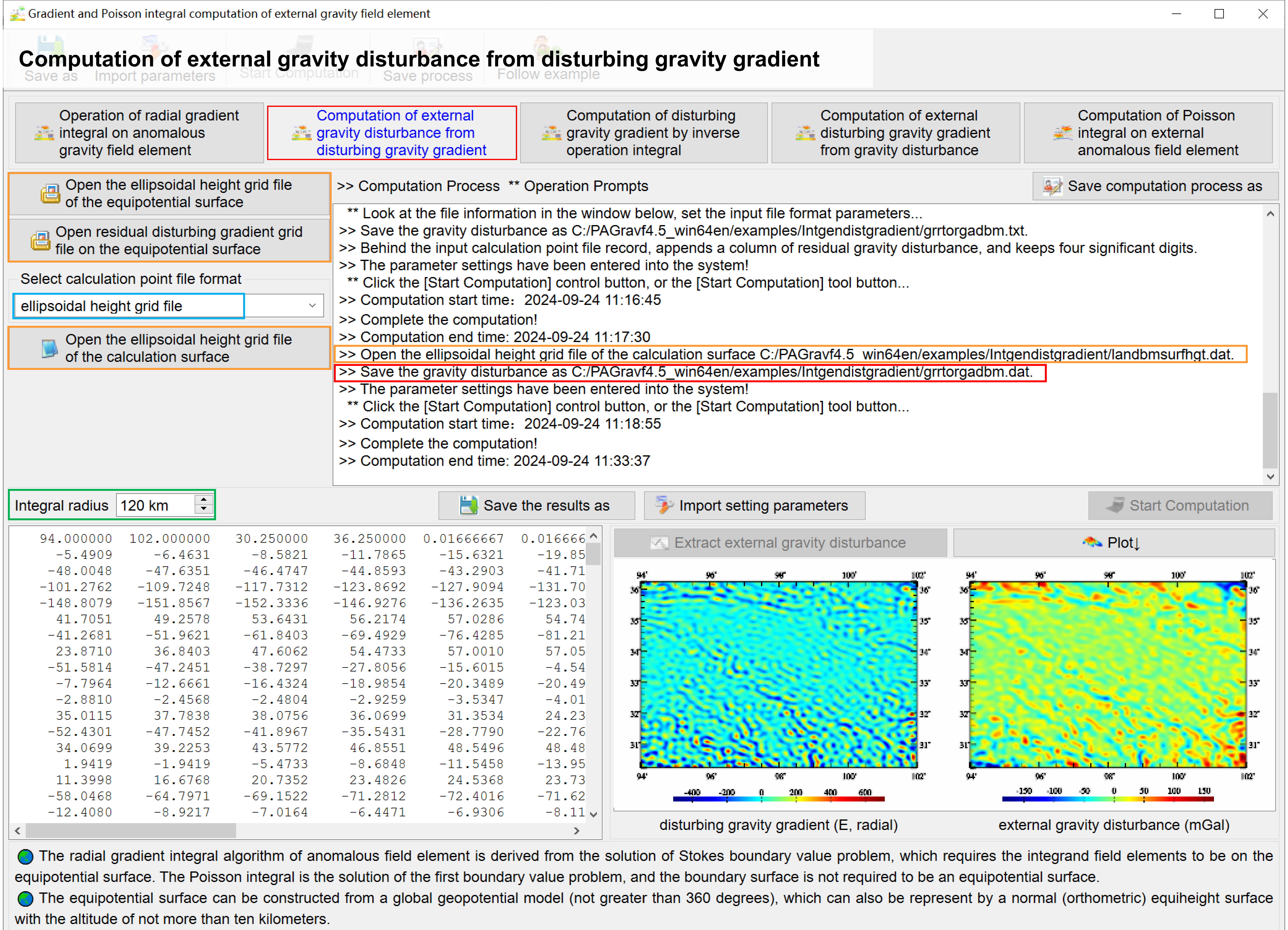

Inverse integral and integral of inverse operation on anomalous field element
Computation of external anomalous gravity field elements from height anomaly
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the boundary surface
Open the height anomaly grid file on the boundary surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the boundary surface and residual height anomaly grid (m) on the surface, compute the residual gravity anomaly (mGal), gravity disturbance (mGal) and vertical deflection vector (″, SW) on or outside the geoid. The inverse operation of height anomaly adopts the combination algorithm with Poisson integral and differentiation, which does not require that the boundary surface should be a gravity equipotential surface.
** Input the ellipsoidal height grid of the boundary surface and height anomaly grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the boundary surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/landgeoidhgt.dat.
>> Open the height anomaly grid file on the boundary surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/resGMlgeoid541_1800.ksi.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/Integralgrainverse/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/invksiouter.txt.
>> Behind the input calculation point file record, appends 4 columns of attributes including residual gravity anomaly, residual gravity disturbance and residual vertical deflection southward and westward.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-23 20:46:10
>> Complete the computation!
>> Computation end time: 2024-09-23 20:54:09
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
cimal) lat ellipHeight (m)
3333 33.008333 3942.764 6.2612 6.2592 -2.5007 0.4847
5000 33.008333 3989.787 6.0388 6.0365 -2.4248 0.6987
1667 33.008333 4034.817 5.2179 5.2151 -2.3076 0.9304
3333 33.008333 4070.847 3.8190 3.8156 -2.1573 1.1571
5000 33.008333 4106.877 1.8631 1.8588 -1.9846 1.3566
1667 33.008333 4119.913 -0.5421 -0.5472 -1.8034 1.5177
3333 33.008333 4115.946 -3.3350 -3.3411 -1.6284 1.6250
5000 33.008333 4090.977 -6.4301 -6.4372 -1.4752 1.6670
1667 33.008333 4070.007 -9.6925 -9.7007 -1.3639 1.6181
3333 33.008333 3991.047 -13.0955 -13.1048 -1.3008 1.4939
5000 33.008333 3985.070 -16.1623 -16.1724 -1.3230 1.2209
1667 33.008333 3956.107 -18.9050 -18.9158 -1.4222 0.8360
3333 33.008333 3965.137 -20.8767 -20.8879 -1.6097 0.3179
5000 33.008333 3964.173 -22.0755 -22.0867 -1.8711 -0.3092
1667 33.008333 3983.205 -22.1895 -22.2002 -2.1941 -1.0304
3333 33.008333 3953.251 -21.4492 -21.4591 -2.5624 -1.8234
5000 33.008333 4016.279 -19.0783 -19.0868 -2.9355 -2.6206
1667 33.008333 4054.318 -15.7055 -15.7122 -3.2973 -3.3943
Extract result element
Plot↓
gravity disturbance (mGal)
vertical deflection S (″)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

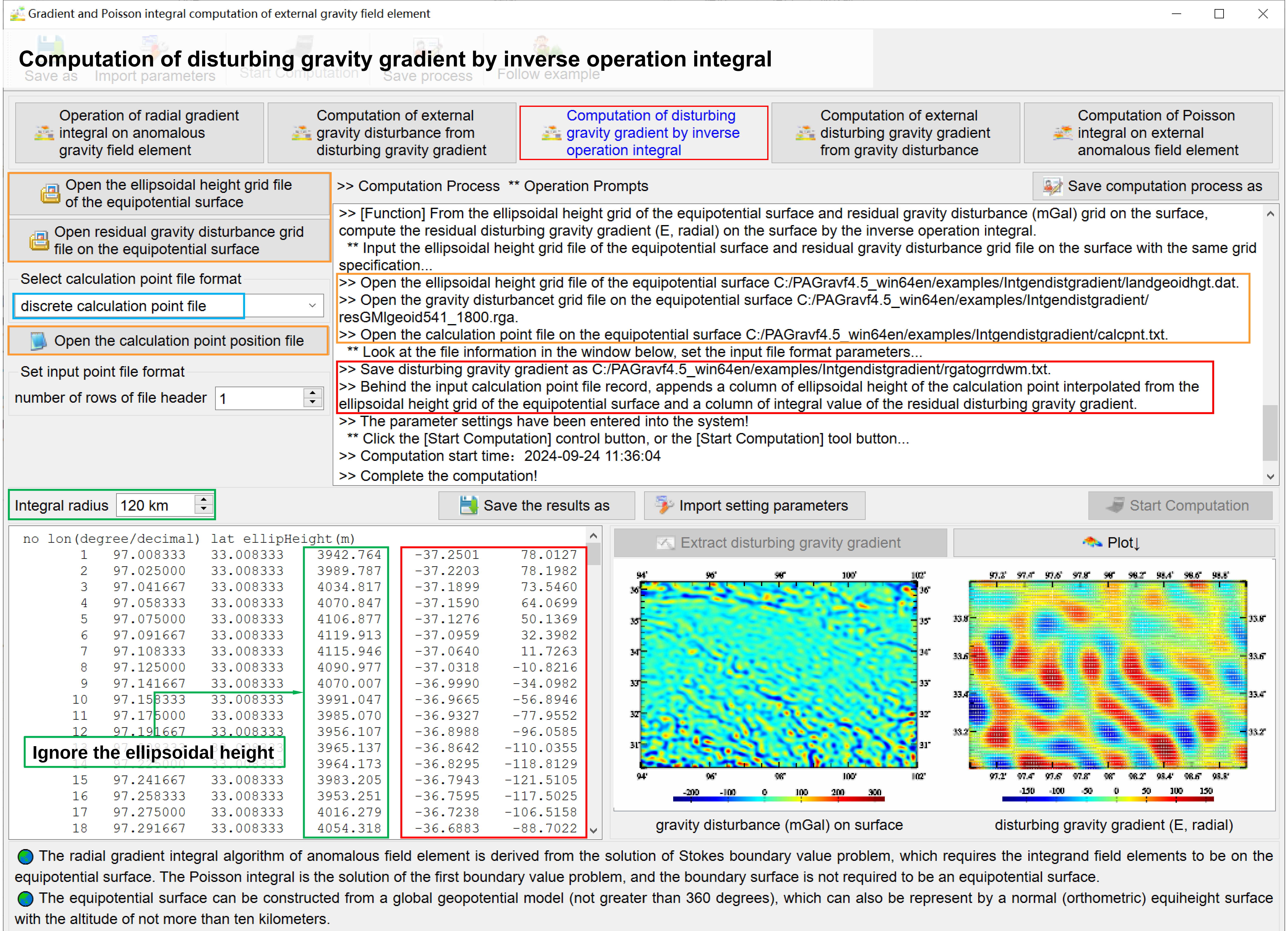

Inverse integral and integral of inverse operation on anomalous field element
Computation of external anomalous gravity field elements from height anomaly
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse Vening Meinesz integral
Computation of anomalous field elements from height anomaly
Integral formula of inverse operation
Open the ellipsoidal height grid file of the boundary surface
Open the height anomaly grid file on the boundary surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
>> Computation Process ** Operation Prompts
Save computation process as
and residual vertical deflection southward and westward.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 20:46:10
>> Complete the computation!
>> Computation end time: 2024-09-23 20:54:09
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/Integralgrainverse/landbmsurfhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Integralgrainverse/surfgravfd.dat.
>> Save the gravity anomaly grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/surfgravfd.gra.
>> Save the gravity disturbance grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/surfgravfd.rga.
>> Save vertical deflection vector grid as C:/PAGravf4.5_win64en/examples/Integralgrainverse/surfgravfd.dft.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-23 21:01:44
>> Complete the computation!
>> Computation end time: 2024-09-23 23:13:21
Integral radius 150 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
11.4128 13.0112 13.5037 13.3752 12.9300 12.3297
12.2286 12.9126 13.7712 14.4755 14.8649 15.6350
-0.5715 -4.2236 -6.0262 -6.7989 -6.5922 -4.3403
-37.2156 -44.7613 -51.0366 -54.3760 -54.4024 -52.2276
27.4578 31.0473 33.1427 34.1140 34.0444 32.8437
-0.8411 -5.0104 -9.3308 -14.1952 -19.0398 -23.9456
28.3579 38.0082 45.8366 50.5764 51.8258 51.0678
-41.3629 -38.2614 -31.7155 -23.1777 -13.4434 -4.5923
7.0217 4.5954 2.5959 1.1491 0.2233 -0.2655
5.2099 5.1750 4.9190 4.0159 2.8697 1.6782
23.9381 27.0111 28.5656 28.6058 26.8087 23.3214
-30.2443 -29.8047 -28.8801 -27.9116 -26.9503 -26.7764
-14.4973 -12.8509 -10.7049 -9.1703 -7.6347 -6.3731
-0.6123 -0.1993 -0.4046 -1.2941 -2.8020 -4.6823
10.4837 15.6332 19.9038 23.1644 25.2077 26.0062
-9.3028 -13.0914 -16.8779 -20.5369 -24.4111 -28.3535
-14.6855 -8.5257 -3.2954 0.8040 3.7755 5.6646
6.8612 8.0384 8.9141 9.2855 8.9443 7.8440
Extract result element
Plot↓
gravity disturbance (mGal)
vertical deflection S (″)
The integral of inverse operation formula belongs to the solution of the Stokes boundary value problem, which requires the integrand height anomaly or vertical deflection to be on the equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

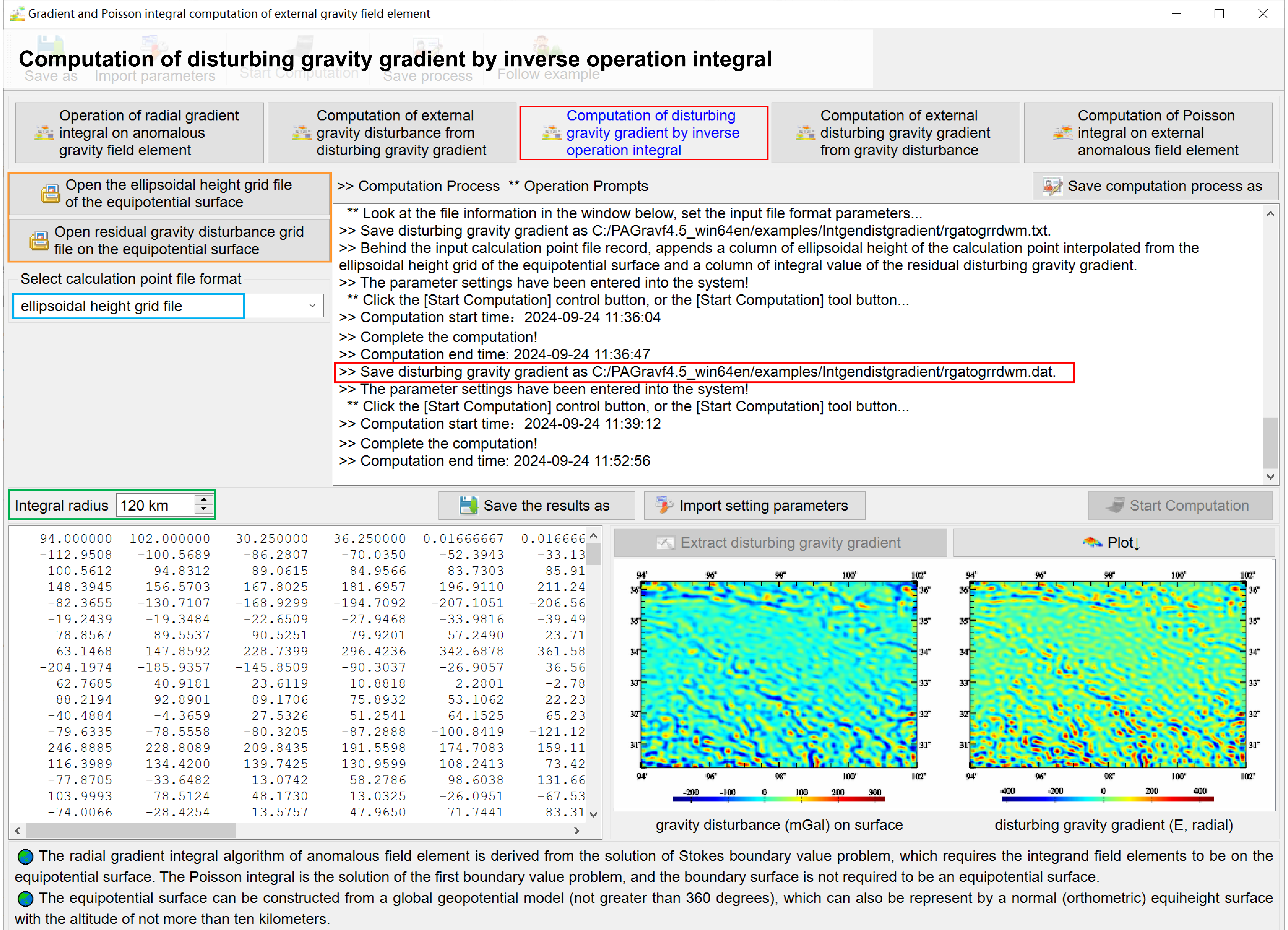

Gradient and Poisson integral computation of external gravity field element
Operation of radial gradient integral on anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the boundary surface
Open the anomalous field element grid file on the boundary surface
Select calculation point file format
discrete calculation point file
Open the calculation points file on the equipotential surface
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential boundary surface and anomalous gravity field element grid on the surface, compute the radial gradient (/km) of the field element on the surface by the numerical integral.
** Input the ellipsoidal height grid file of the equipotential surface and height anomaly grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landgeoidhgt.dat.
>> Open anomalous field element grid file on the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/resGMlgeoid541_1800.ksi.
>> Open the calculation point file on the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the radial gradient as C:/PAGravf4.5_win64en/examples/Intgendistgradient/ragradient.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of calculated radial gradient.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 10:57:09
>> Complete the computation!
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -37.2501 -0.0252
2 97.025000 33.008333 3989.787 -37.2203 -0.0252
3 97.041667 33.008333 4034.817 -37.1899 -0.0234
4 97.058333 33.008333 4070.847 -37.1590 -0.0197
5 97.075000 33.008333 4106.877 -37.1276 -0.0142
6 97.091667 33.008333 4119.913 -37.0959 -0.0074
7 97.108333 33.008333 4115.946 -37.0640 0.0008
8 97.125000 33.008333 4090.977 -37.0318 0.0097
9 97.141667 33.008333 4070.007 -36.9990 0.0190
10 97.158333 33.008333 3991.047 -36.9665 0.0281
11 97.175000 33.008333 3985.070 -36.9327 0.0366
12 97.191667 33.008333 3956.107 -36.8988 0.0439
3965.137 -36.8642 0.0496
3964.173 -36.8295 0.0531
15 97.241667 33.008333 3983.205 -36.7943 0.0541
16 97.258333 33.008333 3953.251 -36.7595 0.0523
17 97.275000 33.008333 4016.279 -36.7238 0.0474
18 97.291667 33.008333 4054.318 -36.6883 0.0396
Ignore the ellipsoidal height
Extract radial gradient of element
Plot↓
anomalous field element on surface
radial gradient (/km) of element
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

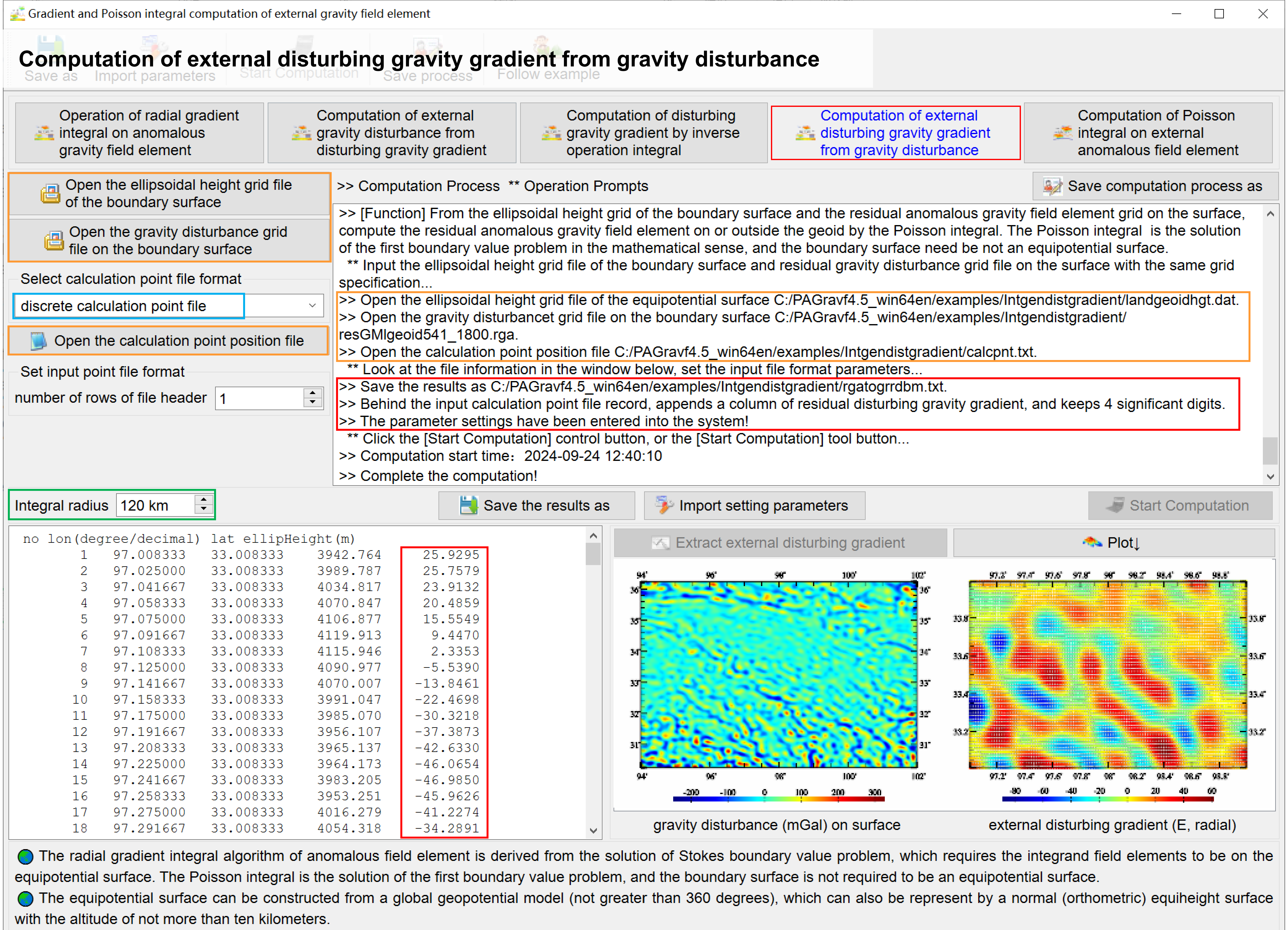

Gradient and Poisson integral computation of external gravity field element
Operation of radial gradient integral on anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the boundary surface
Open the anomalous field element grid file on the boundary surface
Select calculation point file format
ellipsoidal height grid file
>> Computation Process ** Operation Prompts
Save computation process as
** Look at the file information in the window below, set the input file format parameters...
>> Save the radial gradient as C:/PAGravf4.5_win64en/examples/Intgendistgradient/ragradient.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of calculated radial gradient.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 10:57:09
>> Complete the computation!
>> Computation end time: 2024-09-24 10:57:50
>> Save the radial gradient as C:/PAGravf4.5_win64en/examples/Intgendistgradient/ragradient.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 10:59:30
>> Complete the computation!
>> Computation end time: 2024-09-24 11:12:48
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
0.0400 0.0328 0.0240 0.0142 0.0038 -0.0069
-0.0688 -0.0663 -0.0637 -0.0617 -0.0608 -0.0612
-0.0857 -0.0891 -0.0935 -0.0989 -0.1046 -0.1097
0.0182 0.0393 0.0565 0.0688 0.0758 0.0774
0.0011 -0.0004 -0.0007 -0.0002 0.0005 0.0010
-0.0504 -0.0517 -0.0487 -0.0409 -0.0283 -0.0119
-0.0393 -0.0745 -0.1071 -0.1333 -0.1497 -0.1542
0.1109 0.1033 0.0857 0.0610 0.0323 0.0029
-0.0338 -0.0252 -0.0187 -0.0142 -0.0119 -0.0114
-0.0577 -0.0573 -0.0535 -0.0458 -0.0346 -0.0207
-0.0108 -0.0273 -0.0417 -0.0522 -0.0578 -0.0580
0.0330 0.0372 0.0423 0.0493 0.0586 0.0704
0.1409 0.1330 0.1239 0.1145 0.1051 0.0958
-0.0367 -0.0444 -0.0469 -0.0438 -0.0353 -0.0222
0.0168 -0.0040 -0.0257 -0.0469 -0.0657 -0.0814
-0.0545 -0.0390 -0.0212 -0.0016 0.0194 0.0411
0.0536 0.0318 0.0109 -0.0075 -0.0218 -0.0315
Extract radial gradient of element
Plot↓
anomalous field element on surface
radial gradient (/km) of element
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.


Gradient and Poisson integral computation of external gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the equipotential surface
Open residual disturbing gradient grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point file on the equipotential surface
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential boundary surface and residual disturbing gravity gradient (E, radial) grid on the surface, compute the residual gravity disturbance (mGal) on or outside the geoid by the numerical integral.
** Input the ellipsoidal height grid file of the equipotential surface and residual disturbing gravity gradient grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landgeoidhgt.dat.
>> Open disturbing gravity gradient grid file on the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/resGMlgeoid541_1800.grr.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/Intgendistgradient/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the gravity disturbance as C:/PAGravf4.5_win64en/examples/Intgendistgradient/grrtorgadbm.txt.
>> Behind the input calculation point file record, appends a column of residual gravity disturbance, and keeps four significant digits.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:16:45
>> Complete the computation!
>> Computation end time: 2024-09-24 11:17:30
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 22.6149
2 97.025000 33.008333 3989.787 22.6235
3 97.041667 33.008333 4034.817 20.9473
4 97.058333 33.008333 4070.847 17.5408
5 97.075000 33.008333 4106.877 12.4745
6 97.091667 33.008333 4119.913 5.9244
7 97.108333 33.008333 4115.946 -1.8431
8 97.125000 33.008333 4090.977 -10.4866
9 97.141667 33.008333 4070.007 -19.5993
10 97.158333 33.008333 3991.047 -28.7201
11 97.175000 33.008333 3985.070 -37.3472
12 97.191667 33.008333 3956.107 -44.9479
13 97.208333 33.008333 3965.137 -50.9812
14 97.225000 33.008333 3964.173 -54.9269
15 97.241667 33.008333 3983.205 -56.3203
16 97.258333 33.008333 3953.251 -54.7987
17 97.275000 33.008333 4016.279 -50.1460
18 97.291667 33.008333 4054.318 -42.3364
Extract external gravity disturbance
Plot↓
disturbing gravity gradient (E, radial)
external gravity disturbance (mGal)
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

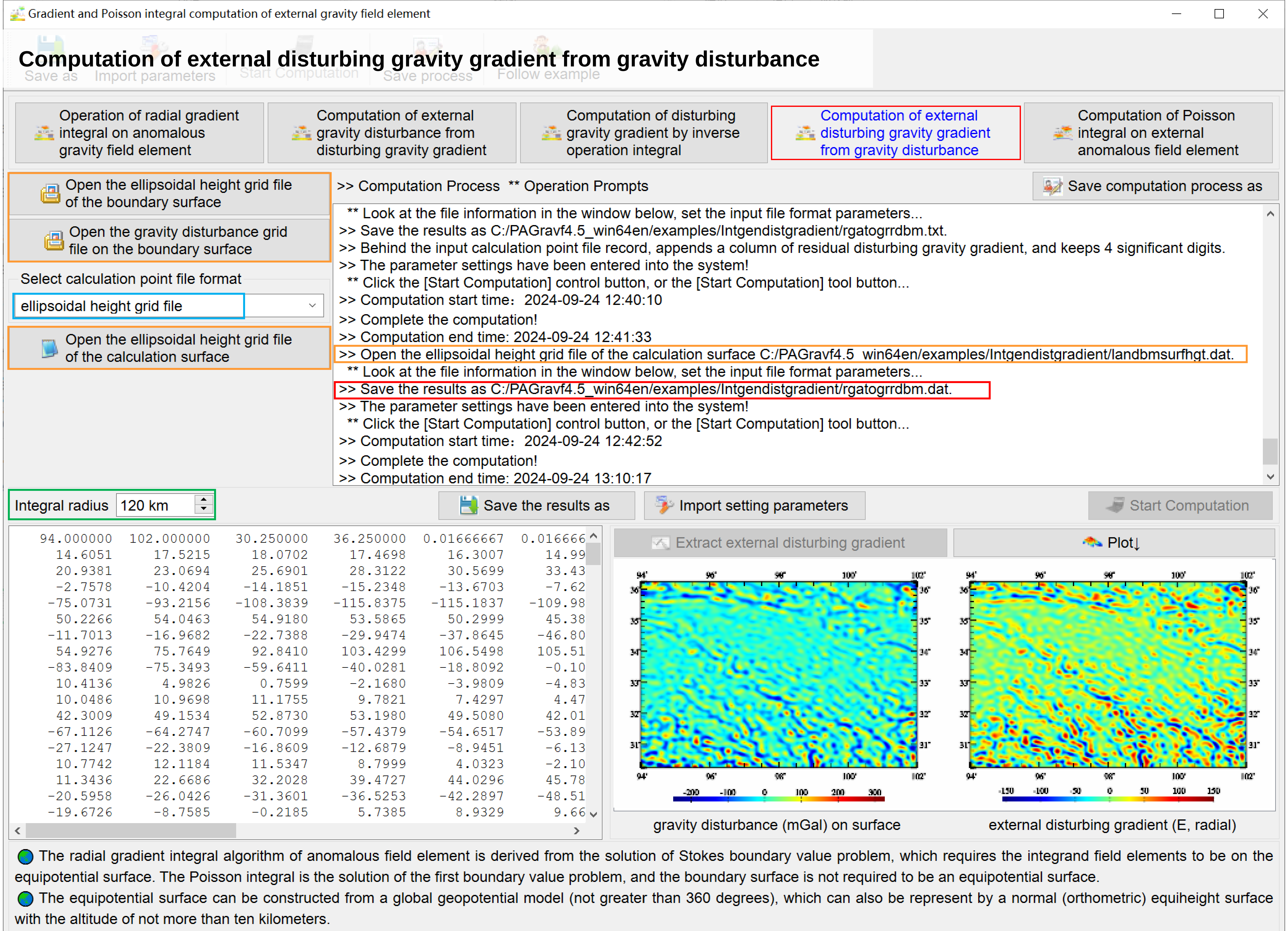

Gradient and Poisson integral computation of external gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the equipotential surface
Open residual disturbing gradient grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
>> Computation Process ** Operation Prompts
Save computation process as
** Look at the file information in the window below, set the input file format parameters...
>> Save the gravity disturbance as C:/PAGravf4.5_win64en/examples/Intgendistgradient/grrtorgadbm.txt.
>> Behind the input calculation point file record, appends a column of residual gravity disturbance, and keeps four significant digits.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:16:45
>> Complete the computation!
>> Computation end time: 2024-09-24 11:17:30
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landbmsurfhgt.dat.
>> Save the gravity disturbance as C:/PAGravf4.5_win64en/examples/Intgendistgradient/grrtorgadbm.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:18:55
>> Complete the computation!
>> Computation end time: 2024-09-24 11:33:37
Integral radius
120 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.016666
-5.4909 -6.4631 -8.5821 -11.7865 -15.6321 -19.85
-48.0048 -47.6351 -46.4747 -44.8593 -43.2903 -41.71
-101.2762 -109.7248 -117.7312 -123.8692 -127.9094 -131.70
-148.8079 -151.8567 -152.3336 -146.9276 -136.2635 -123.03
41.7051 49.2578 53.6431 56.2174 57.0286 54.74
-41.2681 -51.9621 -61.8403 -69.4929 -76.4285 -81.21
23.8710 36.8403 47.6062 54.4733 57.0010 57.05
-51.5814 -47.2451 -38.7297 -27.8056 -15.6015 -4.54
-7.7964 -12.6661 -16.4324 -18.9854 -20.3489 -20.49
-2.8810 -2.4568 -2.4804 -2.9259 -3.5347 -4.01
35.0115 37.7838 38.0756 36.0699 31.3534 24.23
-52.4301 -47.7452 -41.8967 -35.5431 -28.7790 -22.76
34.0699 39.2253 43.5772 46.8551 48.5496 48.48
1.9419 -1.9419 -5.4733 -8.6848 -11.5458 -13.95
11.3998 16.6768 20.7352 23.4826 24.5368 23.73
-58.0468 -64.7971 -69.1522 -71.2812 -72.4016 -71.62
-12.4080 -8.9217 -7.0164 -6.4471 -6.9306 -8.11
Extract external gravity disturbance
Plot↓
disturbing gravity gradient (E, radial)
external gravity disturbance (mGal)
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

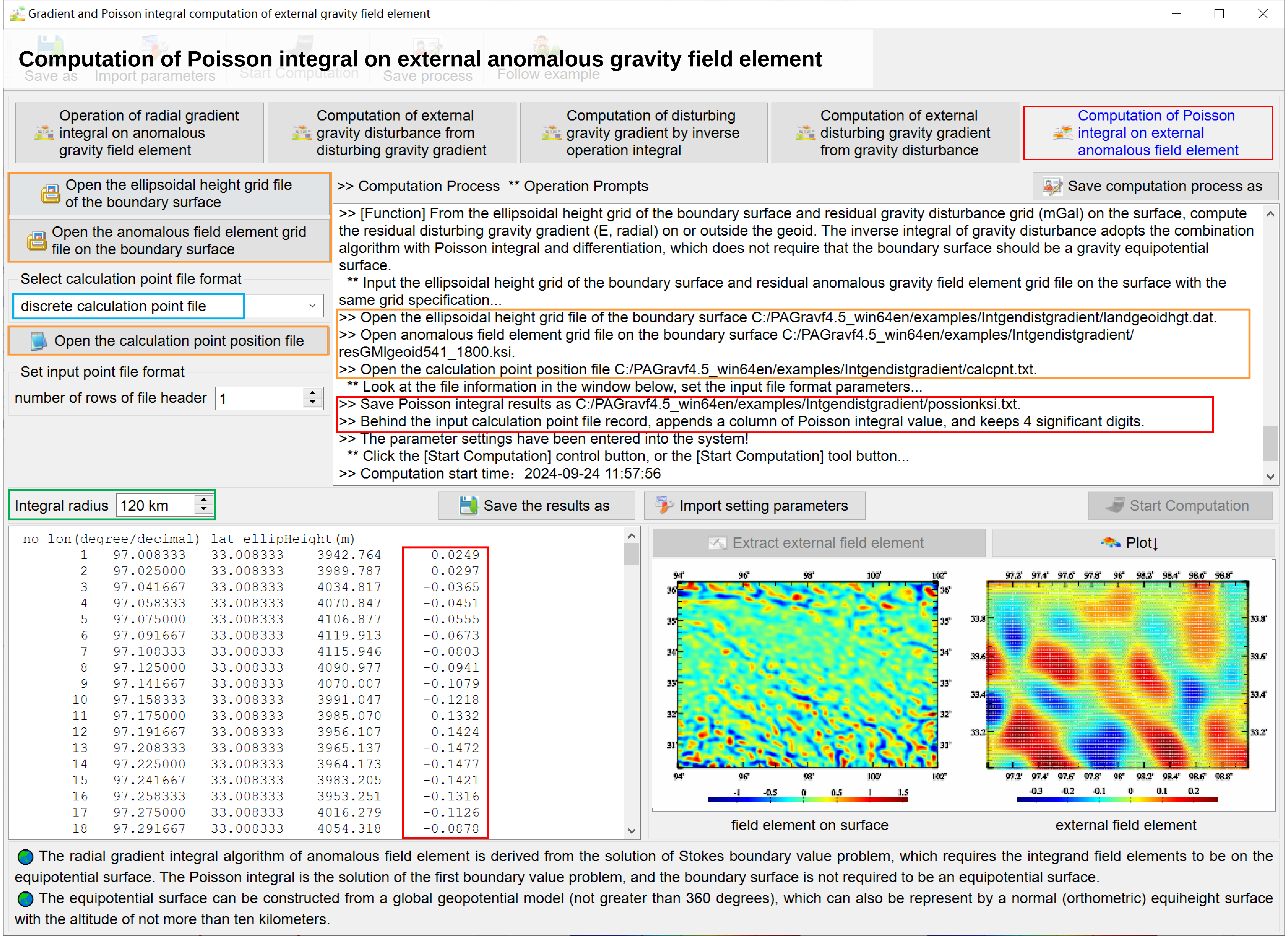

Gradient and Poisson integral computation of external gravity field element
Computation of disturbing gravity gradient by inverse operation integral
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the equipotential surface
Open residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header
1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the equipotential surface and residual gravity disturbance (mGal) grid on the surface, compute the residual disturbing gravity gradient (E, radial) on the surface by the inverse operation integral.
** Input the ellipsoidal height grid file of the equipotential surface and residual gravity disturbance grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landgeoidhgt.dat.
>> Open the gravity disturbancet grid file on the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/resGMlgeoid541_1800.rga.
>> Open the calculation point file on the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save disturbing gravity gradient as C:/PAGravf4.5_win64en/examples/Intgendistgradient/rgatogrrdwm.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of integral value of the residual disturbing gravity gradient.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:36:04
>> Complete the computation!
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -37.2501 78.0127
2 97.025000 33.008333 3989.787 -37.2203 78.1982
3 97.041667 33.008333 4034.817 -37.1899 73.5460
4 97.058333 33.008333 4070.847 -37.1590 64.0699
5 97.075000 33.008333 4106.877 -37.1276 50.1369
6 97.091667 33.008333 4119.913 -37.0959 32.3982
7 97.108333 33.008333 4115.946 -37.0640 11.7263
8 97.125000 33.008333 4090.977 -37.0318 -10.8216
9 97.141667 33.008333 4070.007 -36.9990 -34.0982
10 97.158333 33.008333 3991.047 -36.9665 -56.8946
11 97.175000 33.008333 3985.070 -36.9327 -77.9552
12 97.191667 33.008333 3956.107 -36.8988 -96.0585
3965.137 -36.8642 -110.0355
3964.173 -36.8295 -118.8129
15 97.241667 33.008333 3983.205 -36.7943 -121.5105
16 97.258333 33.008333 3953.251 -36.7595 -117.5025
17 97.275000 33.008333 4016.279 -36.7238 -106.5158
18 97.291667 33.008333 4054.318 -36.6883 -88.7022
Ignore the ellipsoidal height
Extract disturbing gravity gradient
Plot
gravity disturbance (mGal) on surface
disturbing gravity gradient (E, radial)
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

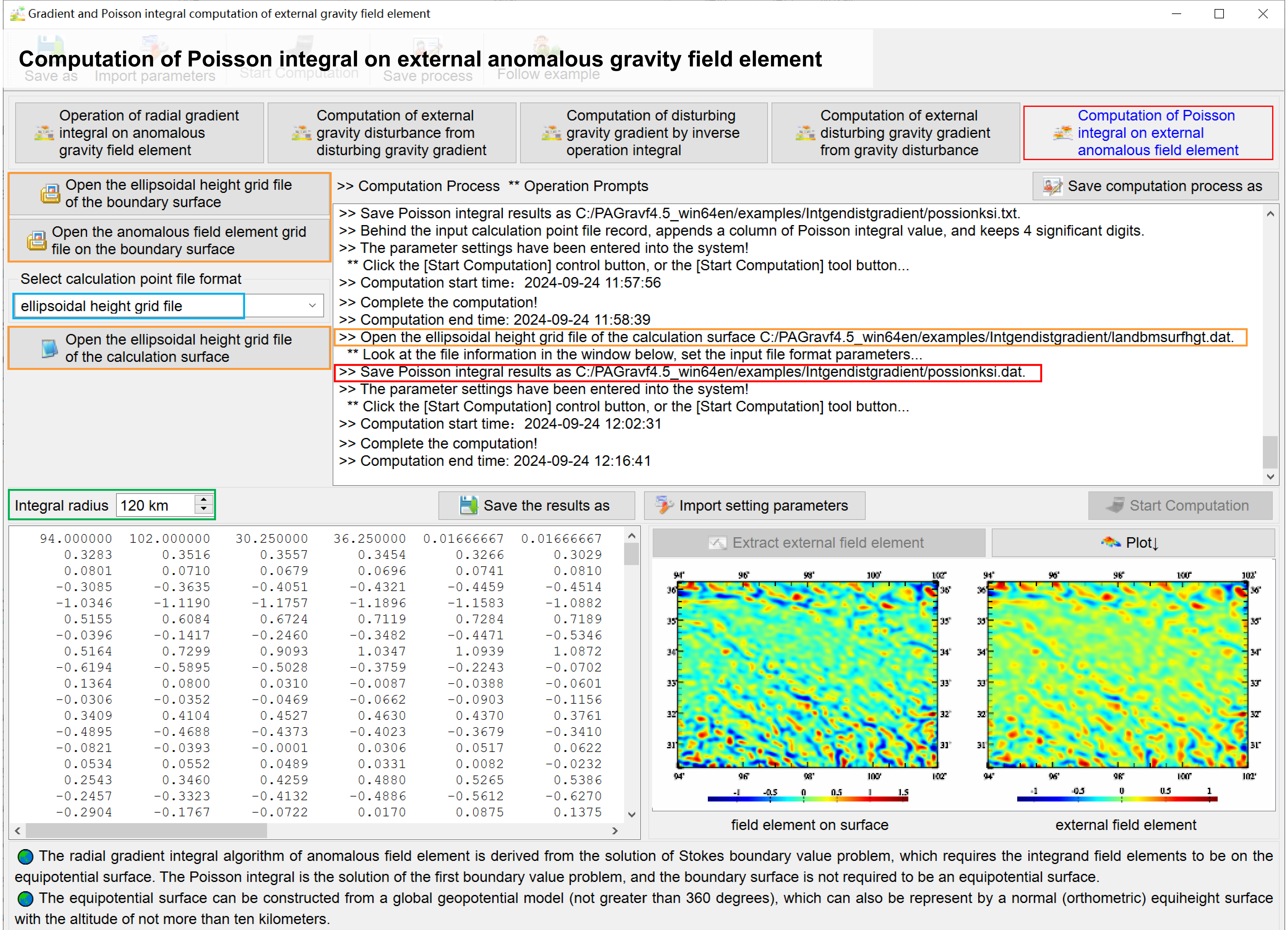

Gradient and Poisson integral computation of external gravity field element
Computation of disturbing gravity gradient by inverse operation integral
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the equipotential surface
Open residual gravity disturbance grid file on the equipotential surface
Select calculation point file format
ellipsoidal height grid file
>> Computation Process ** Operation Prompts
Save computation process as
** Look at the file information in the window below, set the input file format parameters...
>> Save disturbing gravity gradient as C:/PAGravf4.5_win64en/examples/Intgendistgradient/rgatogrrdwm.txt.
>> Behind the input calculation point file record, appends a column of ellipsoidal height of the calculation point interpolated from the ellipsoidal height grid of the equipotential surface and a column of integral value of the residual disturbing gravity gradient.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:36:04
>> Complete the computation!
>> Computation end time: 2024-09-24 11:36:47
>> Save disturbing gravity gradient as C:/PAGravf4.5_win64en/examples/Intgendistgradient/rgatogrrdwm.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:39:12
>> Complete the computation!
>> Computation end time: 2024-09-24 11:52:56
Integral radius
120 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.016666
-112.9508 -100.5689 -86.2807 -70.0350 -52.3943 -33.13
100.5612 94.8312 89.0615 84.9566 83.7303 85.91
148.3945 156.5703 167.8025 181.6957 196.9110 211.24
-82.3655 -130.7107 -168.9299 -194.7092 -207.1051 -206.56
-19.2439 -19.3484 -22.6509 -27.9468 -33.9816 -39.49
78.8567 89.5537 90.5251 79.9201 57.2490 23.71
63.1468 147.8592 228.7399 296.4236 342.6878 361.58
-204.1974 -185.9357 -145.8509 -90.3037 -26.9057 36.56
62.7685 40.9181 23.6119 10.8818 2.2801 -2.78
88.2194 92.8901 89.1706 75.8932 53.1062 22.23
-40.4884 -4.3659 27.5326 51.2541 64.1525 65.23
-79.6335 -78.5558 -80.3205 -87.2888 -100.8419 -121.12
-246.8885 -228.8089 -209.8435 -191.5598 -174.7083 -159.11
116.3989 134.4200 139.7425 130.9599 108.2413 73.42
-77.8705 -33.6482 13.0742 58.2786 98.6038 131.66
103.9993 78.5124 48.1730 13.0325 -26.0951 -67.53
-74.0066 -28.4254 13.5757 47.9650 71.7441 83.31
Extract disturbing gravity gradient
Plot↓
gravity disturbance (mGal) on surface
disturbing gravity gradient (E, radial)
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

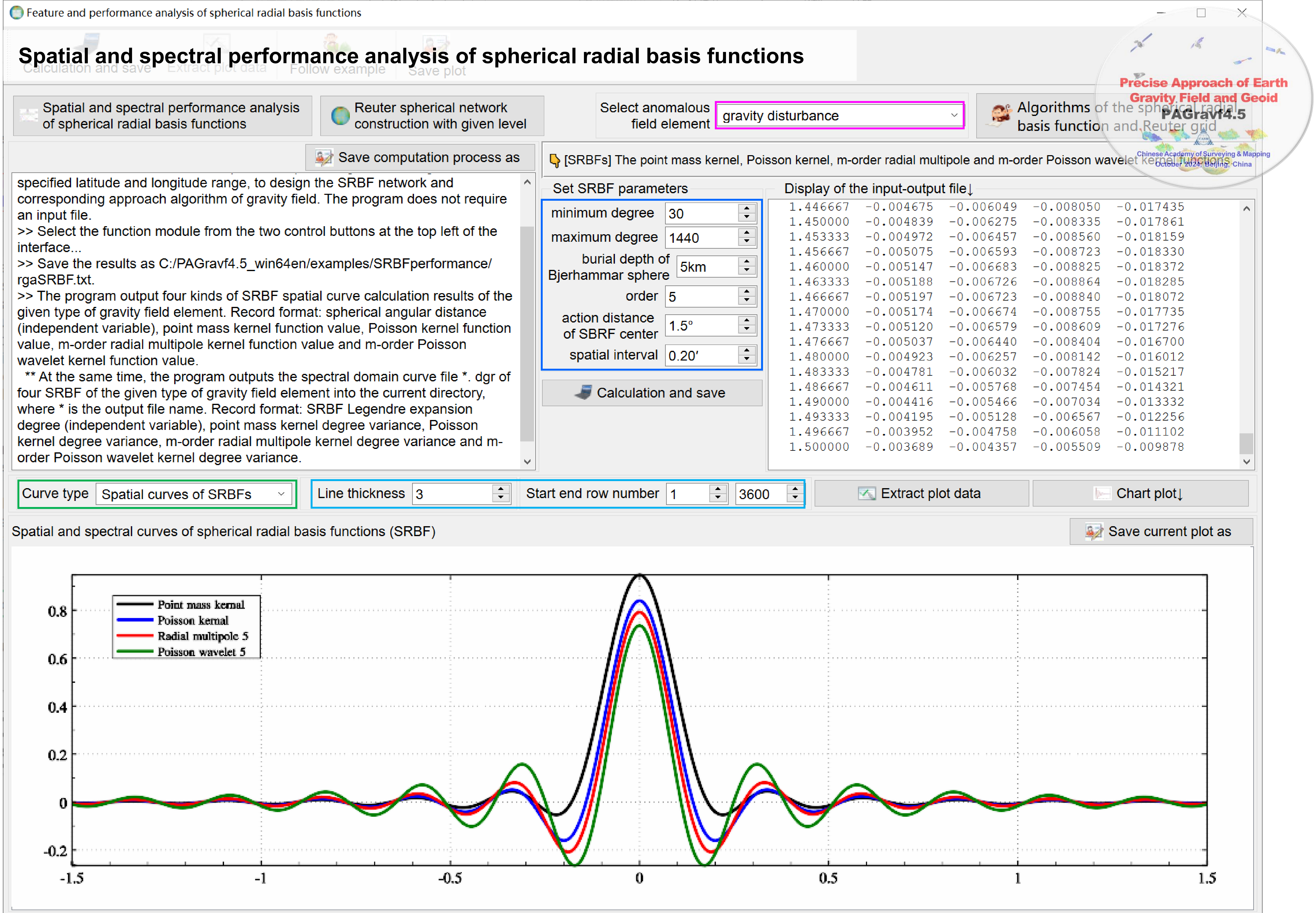


Gradient and Poisson integral computation of external gravity field element
Computation of external disturbing gravity gradient from gravity disturbance
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the boundary surface
Open the gravity disturbance grid file on the boundary surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the boundary surface and the residual anomalous gravity field element grid on the surface, compute the residual anomalous gravity field element on or outside the geoid by the Poisson integral. The Poisson integral is the solution of the first boundary value problem in the mathematical sense, and the boundary surface need be not an equipotential surface.
** Input the ellipsoidal height grid file of the boundary surface and residual gravity disturbance grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landgeoidhgt.dat.
>> Open the gravity disturbancet grid file on the boundary surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/resGMlgeoid541_1800.rga.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/Intgendistgradient/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Intgendistgradient/rgatogrrdbm.txt.
>> Behind the input calculation point file record, appends a column of residual disturbing gravity gradient, and keeps 4 significant digits.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 12:40:10
>> Complete the computation!
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 25.9295
2 97.025000 33.008333 3989.787 25.7579
3 97.041667 33.008333 4034.817 23.9132
4 97.058333 33.008333 4070.847 20.4859
5 97.075000 33.008333 4106.877 15.5549
6 97.091667 33.008333 4119.913 9.4470
7 97.108333 33.008333 4115.946 2.3353
8 97.125000 33.008333 4090.977 -5.5390
9 97.141667 33.008333 4070.007 -13.8461
10 97.158333 33.008333 3991.047 -22.4698
11 97.175000 33.008333 3985.070 -30.3218
12 97.191667 33.008333 3956.107 -37.3873
13 97.208333 33.008333 3965.137 -42.6330
14 97.225000 33.008333 3964.173 -46.0654
15 97.241667 33.008333 3983.205 -46.9850
16 97.258333 33.008333 3953.251 -45.9626
17 97.275000 33.008333 4016.279 -41.2274
18 97.291667 33.008333 4054.318 -34.2891
Extract external disturbing gradient
Plot↓
gravity disturbance (mGal) on surface
external disturbing gradient (E, radial)
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

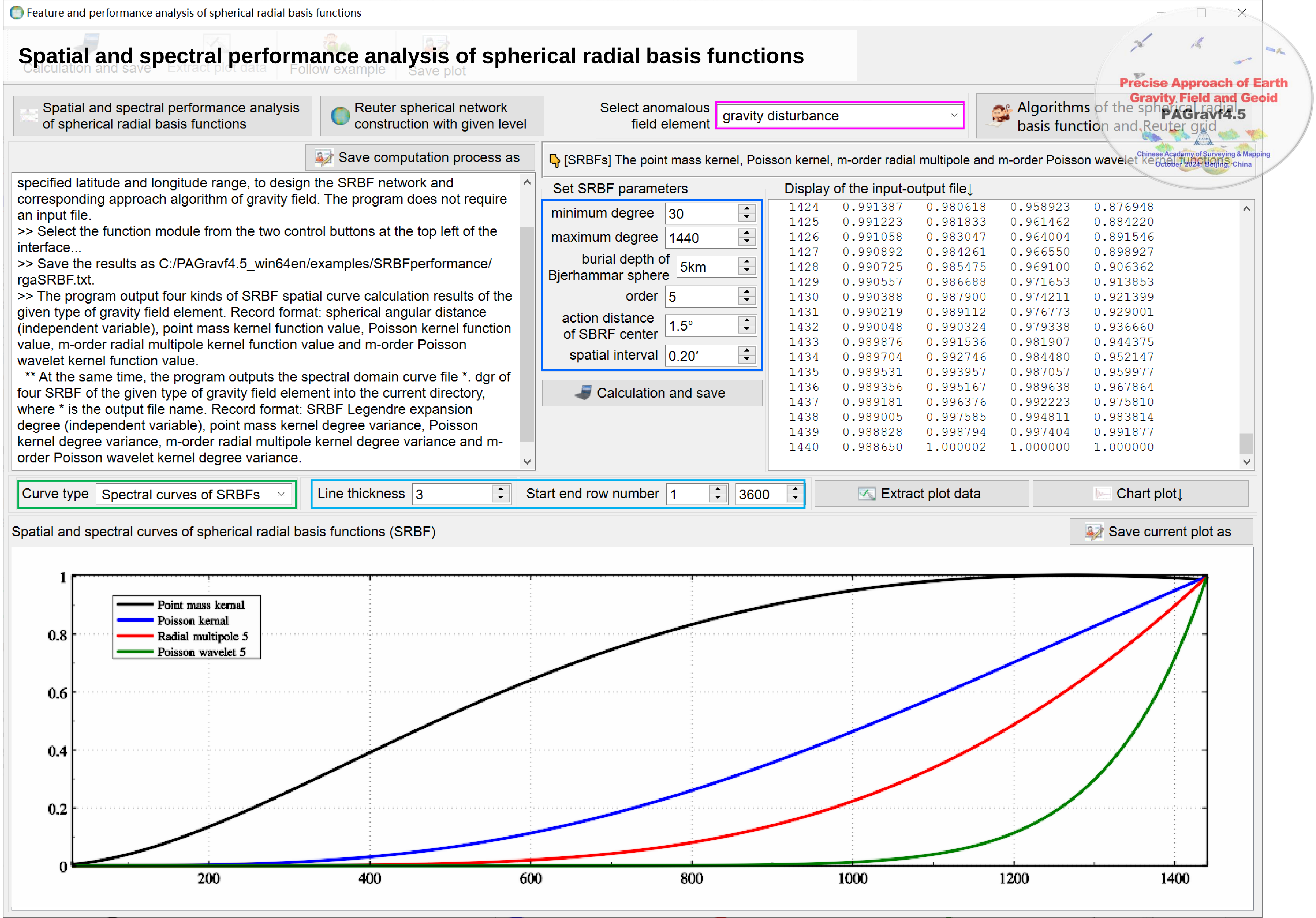

Gradient and Poisson integral computation of external gravity field element
Computation of external disturbing gravity gradient from gravity disturbance
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the boundary surface
Open the gravity disturbance grid file on the boundary surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
>> Computation Process ** Operation Prompts
Save computation process as
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Intgendistgradient/rgatogrrdbm.txt.
>> Behind the input calculation point file record, appends a column of residual disturbing gravity gradient, and keeps 4 significant digits.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 12:40:10
>> Complete the computation!
>> Computation end time: 2024-09-24 12:41:33
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landbmsurfhgt.dat.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Intgendistgradient/rgatogrrdbm.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 12:42:52
>> Complete the computation!
>> Computation end time: 2024-09-24 13:10:17
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.016666
14.6051 17.5215 18.0702 17.4698 16.3007 14.99
20.9381 23.0694 25.6901 28.3122 30.5699 33.43
-2.7578 -10.4204 -14.1851 -15.2348 -13.6703 -7.62
-75.0731 -93.2156 -108.3839 -115.8375 -115.1837 -109.98
50.2266 54.0463 54.9180 53.5865 50.2999 45.38
-11.7013 -16.9682 -22.7388 -29.9474 -37.8645 -46.80
54.9276 75.7649 92.8410 103.4299 106.5498 105.51
-83.8409 -75.3493 -59.6411 -40.0281 -18.8092 -0.10
10.4136 4.9826 0.7599 -2.1680 -3.9809 -4.83
10.0486 10.9698 11.1755 9.7821 7.4297 4.47
42.3009 49.1534 52.8730 53.1980 49.5080 42.01
-67.1126 -64.2747 -60.7099 -57.4379 -54.6517 -53.89
-27.1247 -22.3809 -16.8609 -12.6879 -8.9451 -6.13
10.7742 12.1184 11.5347 8.7999 4.0323 -2.10
11.3436 22.6686 32.2028 39.4727 44.0296 45.78
-20.5958 -26.0426 -31.3601 -36.5253 -42.2897 -48.51
-19.6726 -8.7585 -0.2185 5.7385 8.9329 9.66
Extract external disturbing gradient
Plot↓
gravity disturbance (mGal) on surface
external disturbing gradient (E, radial)
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.


Gradient and Poisson integral computation of external gravity field element
Computation of Poisson integral on external anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the boundary surface
Open the anomalous field element grid file on the boundary surface
Select calculation point file format
discrete calculation point file
Open the calculation point position file
Set input point file format
number of rows of file header 1
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] From the ellipsoidal height grid of the boundary surface and residual gravity disturbance grid (mGal) on the surface, compute the residual disturbing gravity gradient (E, radial) on or outside the geoid. The inverse integral of gravity disturbance adopts the combination algorithm with Poisson integral and differentiation, which does not require that the boundary surface should be a gravity equipotential surface.
** Input the ellipsoidal height grid of the boundary surface and residual anomalous gravity field element grid file on the surface with the same grid specification...
>> Open the ellipsoidal height grid file of the boundary surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landgeoidhgt.dat.
>> Open anomalous field element grid file on the boundary surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/resGMlgeoid541_1800.ksi.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/Intgendistgradient/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save Poisson integral results as C:/PAGravf4.5_win64en/examples/Intgendistgradient/possionksi.txt.
>> Behind the input calculation point file record, appends a column of Poisson integral value, and keeps 4 significant digits.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-24 11:57:56
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
no lon(degree/decimal) lat ellipHeight(m)
1 97.008333 33.008333 3942.764 -0.0249
2 97.025000 33.008333 3989.787 -0.0297
3 97.041667 33.008333 4034.817 -0.0365
4 97.058333 33.008333 4070.847 -0.0451
5 97.075000 33.008333 4106.877 -0.0555
6 97.091667 33.008333 4119.913 -0.0673
7 97.108333 33.008333 4115.946 -0.0803
8 97.125000 33.008333 4090.977 -0.0941
9 97.141667 33.008333 4070.007 -0.1079
10 97.158333 33.008333 3991.047 -0.1218
11 97.175000 33.008333 3985.070 -0.1332
12 97.191667 33.008333 3956.107 -0.1424
13 97.208333 33.008333 3965.137 -0.1472
14 97.225000 33.008333 3964.173 -0.1477
15 97.241667 33.008333 3983.205 -0.1421
16 97.258333 33.008333 3953.251 -0.1316
17 97.275000 33.008333 4016.279 -0.1126
18 97.291667 33.008333 4054.318 -0.0878
Extract external field element
Plot↓
field element on surface
external field element
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

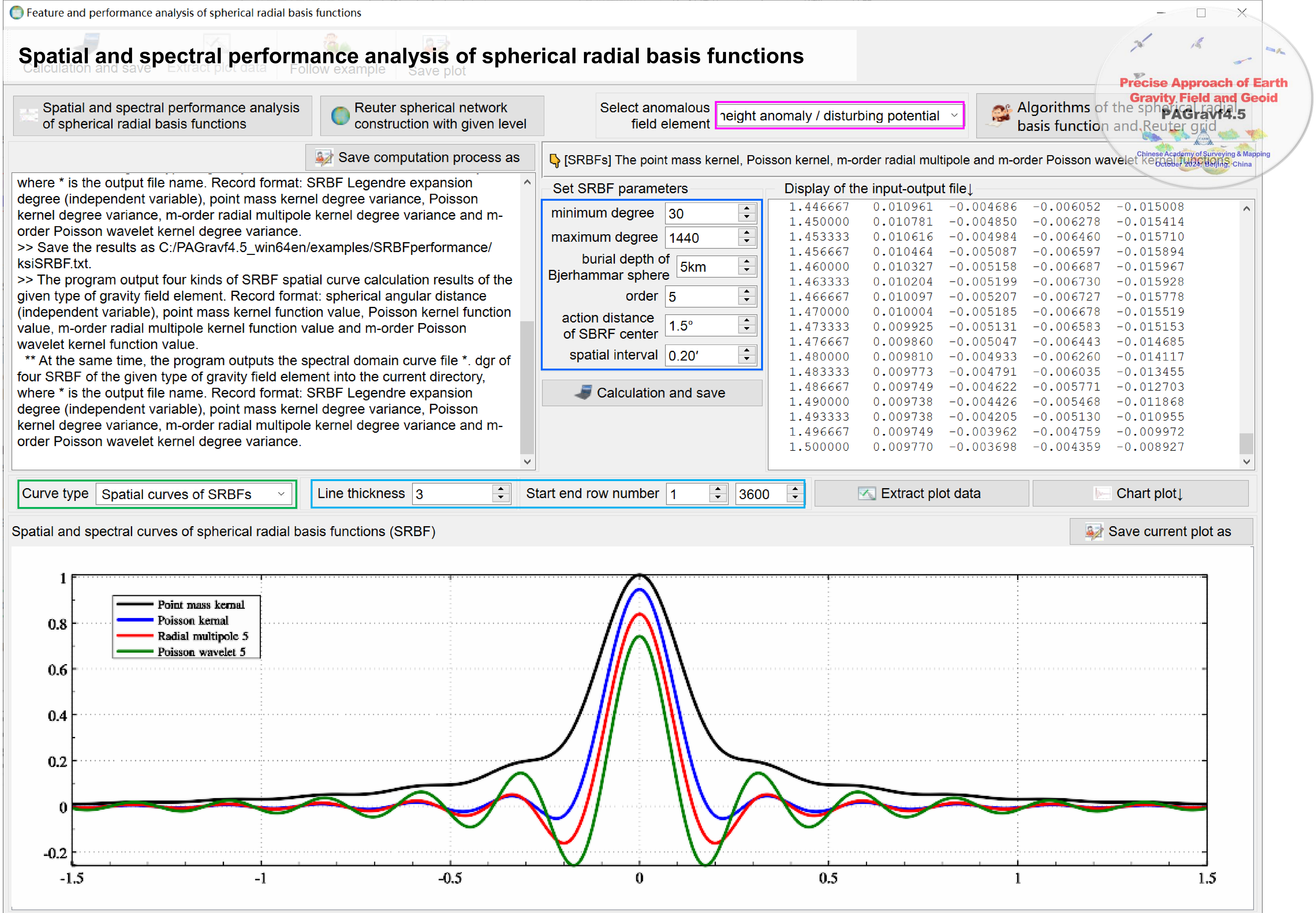

Gradient and Poisson integral computation of external gravity field element
Computation of Poisson integral on external anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Computation of disturbing gravity gradient by inverse operation integral
Computation of external disturbing gravity gradient from gravity disturbance
Computation of Poisson integral on external anomalous field element
Open the ellipsoidal height grid file of the boundary surface
Open the anomalous field element grid file on the boundary surface
Select calculation point file format
ellipsoidal height grid file
Open the ellipsoidal height grid file of the calculation surface
>> Computation Process ** Operation Prompts
Save computation process as
>> Save Poisson integral results as C:/PAGravf4.5_win64en/examples/Intgendistgradient/possionksi.txt.
>> Behind the input calculation point file record, appends a column of Poisson integral value, and keeps 4 significant digits.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-24 11:57:56
>> Complete the computation!
>> Computation end time: 2024-09-24 11:58:39
>> Open the ellipsoidal height grid file of the calculation surface C:/PAGravf4.5_win64en/examples/Intgendistgradient/landbmsurfhgt.dat.
** Look at the file information in the window below, set the input file format parameters...
>> Save Poisson integral results as C:/PAGravf4.5_win64en/examples/Intgendistgradient/possionksi.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-24 12:02:31
>> Complete the computation!
>> Computation end time: 2024-09-24 12:16:41
Integral radius 120 km
Save the results as
Import setting parameters
Start Computation
94.000000 102.000000 30.250000 36.250000 0.01666667 0.01666667
0.3283 0.3516 0.3557 0.3454 0.3266 0.3029
0.0801 0.0710 0.0679 0.0696 0.0741 0.0810
-0.3085 -0.3635 -0.4051 -0.4321 -0.4459 -0.4514
-1.0346 -1.1190 -1.1757 -1.1896 -1.1583 -1.0882
0.5155 0.6084 0.6724 0.7119 0.7284 0.7189
-0.0396 -0.1417 -0.2460 -0.3482 -0.4471 -0.5346
0.5164 0.7299 0.9093 1.0347 1.0939 1.0872
-0.6194 -0.5895 -0.5028 -0.3759 -0.2243 -0.0702
0.1364 0.0800 0.0310 -0.0087 -0.0388 -0.0601
-0.0306 -0.0352 -0.0469 -0.0662 -0.0903 -0.1156
0.3409 0.4104 0.4527 0.4630 0.4370 0.3761
-0.4895 -0.4688 -0.4373 -0.4023 -0.3679 -0.3410
-0.0821 -0.0393 -0.0001 0.0306 0.0517 0.0622
0.0534 0.0552 0.0489 0.0331 0.0082 -0.0232
0.2543 0.3460 0.4259 0.4880 0.5265 0.5386
-0.2457 -0.3323 -0.4132 -0.4886 -0.5612 -0.6270
-0.2904 -0.1767 -0.0722 0.0170 0.0875 0.1375
Extract external field element
Plot↓
field element on surface
external field element
The radial gradient integral algorithm of anomalous field element is derived from the solution of Stokes boundary value problem, which requires the integrand field elements to be on the equipotential surface. The Poisson integral is the solution of the first boundary value problem, and the boundary surface is not required to be an equipotential surface.
The equipotential surface can be constructed from a global geopotential model (not greater than 360 degrees), which can also be represent by a normal (orthometric) equiheight surface with the altitude of not more than ten kilometers.

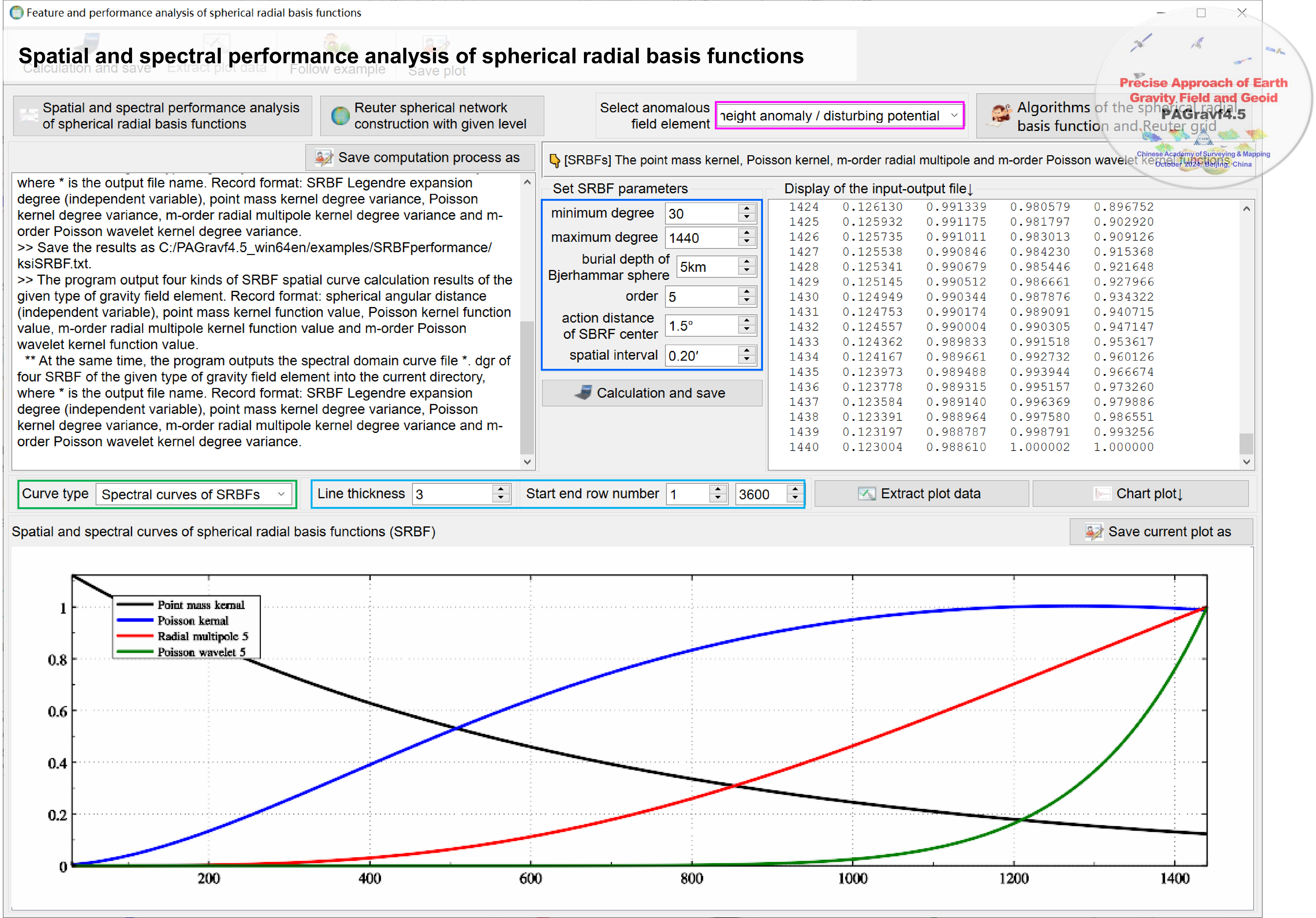


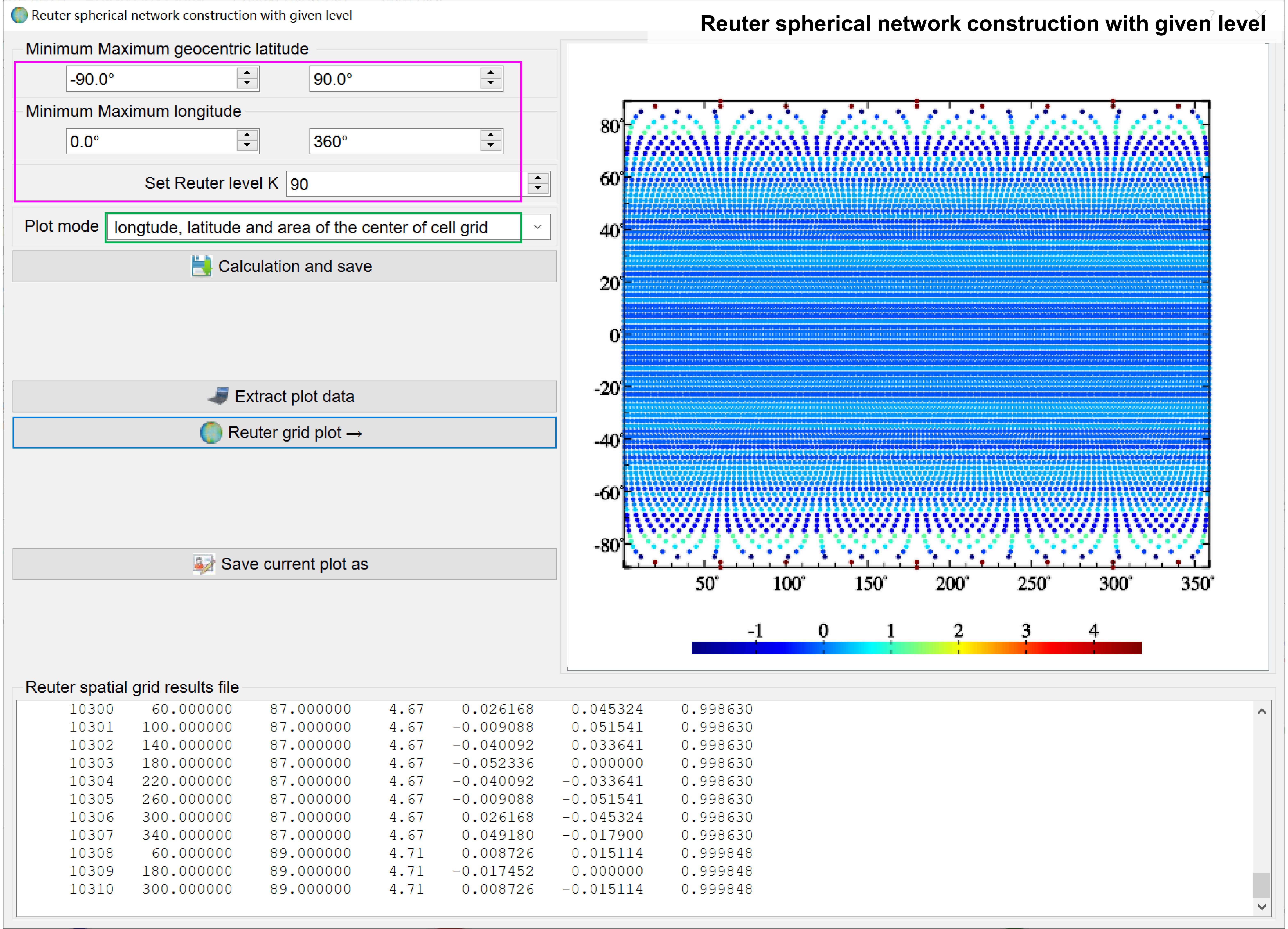
Feature and performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Reuter spherical network construction with given level
Select anomalous field element
gravity disturbance
Algorithms of the spherical radial basis function and Reuter grid
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Save computation process as
[SRBFs] The point mass kernel, Poisson kernel, m-order radial multipole and m-order Poisson wavelet kernel functions
specified latitude and longitude range, to design the SRBF network and corresponding approach algorithm of gravity field. The program does not require an input file.
>> Select the function module from the two control buttons at the top left of the interface...
>> Save the results as C:/PAGravf4.5_win64en/examples/SRBFperformance/rgaSRBF.txt.
>> The program output four kinds of SRBF spatial curve calculation results of the given type of gravity field element. Record format: spherical angular distance (independent variable), point mass kernel function value, Poisson kernel function value, m-order radial multipole kernel function value and m-order Poisson wavelet kernel function value.
** At the same time, the program outputs the spectral domain curve file *. dgr of four SRBF of the given type of gravity field element into the current directory, where * is the output file name. Record format: SRBF Legendre expansion degree (independent variable), point mass kernel degree variance, Poisson kernel degree variance, m-order radial multipole kernel degree variance and m-order Poisson wavelet kernel degree variance.
Set SRBF parameters
minimum degree 30
maximum degree 1440
burial depth of Bjerhammar sphere 5km
order 5
action distance of SBRF center 1.5°
spatial interval 0.20′
Calculation and save
Display of the input-output file↓
1.446667 -0.004675 -0.006049 -0.008050 -0.017435
1.450000 -0.004839 -0.006275 -0.008335 -0.017861
1.453333 -0.004972 -0.006457 -0.008560 -0.018159
1.456667 -0.005075 -0.006593 -0.008723 -0.018330
1.460000 -0.005147 -0.006683 -0.008825 -0.018372
1.463333 -0.005188 -0.006726 -0.008864 -0.018285
1.466667 -0.005197 -0.006723 -0.008840 -0.018072
1.470000 -0.005174 -0.006674 -0.008755 -0.017735
1.473333 -0.005120 -0.006579 -0.008609 -0.017276
1.476667 -0.005037 -0.006440 -0.008404 -0.016700
1.480000 -0.004923 -0.006257 -0.008142 -0.016012
1.483333 -0.004781 -0.006032 -0.007824 -0.015217
1.486667 -0.004611 -0.005768 -0.007454 -0.014321
1.490000 -0.004416 -0.005466 -0.007034 -0.013332
1.493333 -0.004195 -0.005128 -0.006567 -0.012256
1.496667 -0.003952 -0.004758 -0.006058 -0.011102
1.500000 -0.003689 -0.004357 -0.005509 -0.009878
Curve type Spatial curves of SRBFs
Line thickness 3
Start end row number 1 3600
Extract plot data
Chart plot↓
Spatial and spectral curves of spherical radial basis functions (SRBF)
Save current plot as
Point mass kernal
Poisson kernal
Radial multipole 5
Poisson wavelet 5
0.8
0.6
0.4
0.2
0
-0.2
-1.5
-1
-0.5
0
0.5
1
1.5



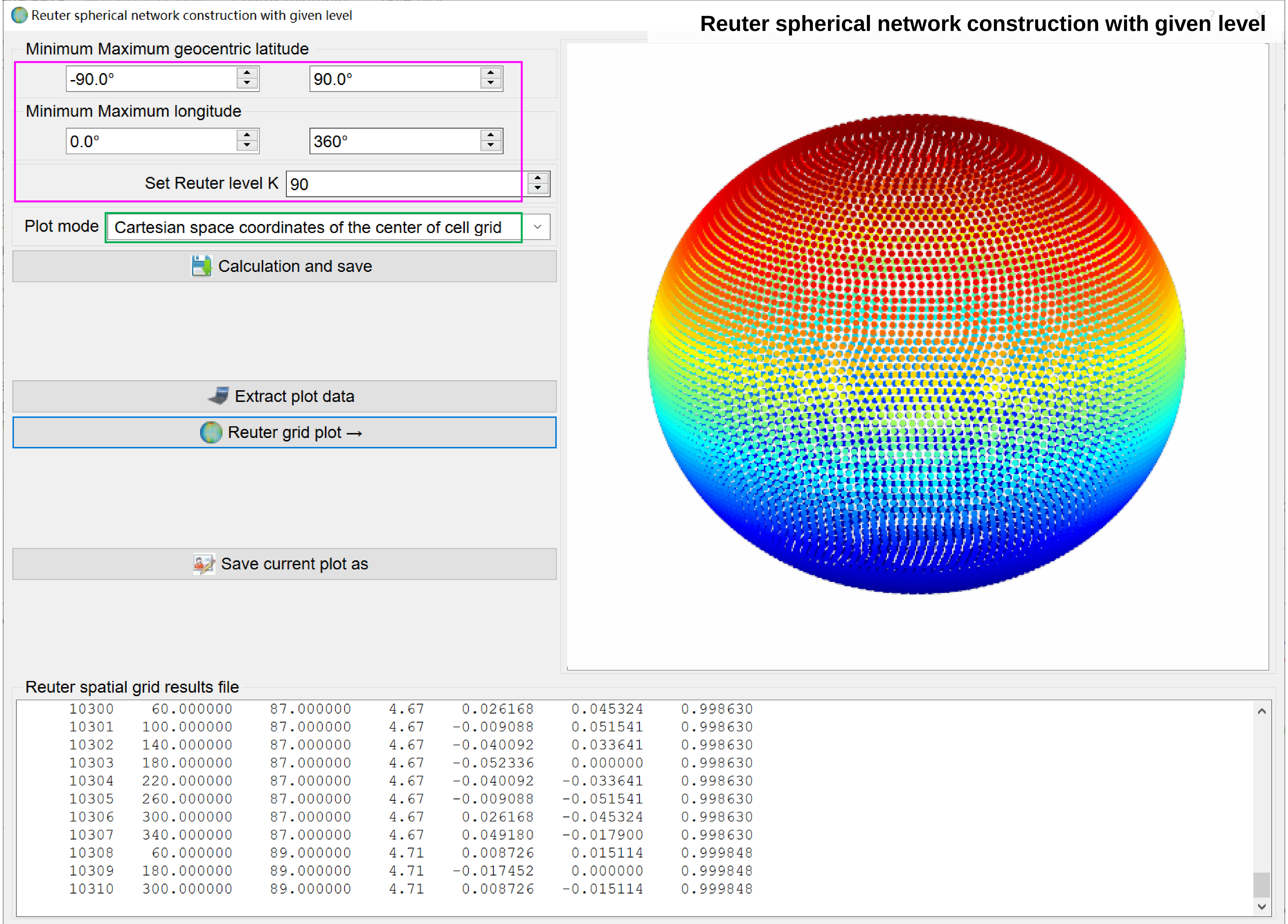
Feature and performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Calculation and save
Extract plot data
Follow example
Save plot
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Spatial and spectral performance analysis of spherical radial basis functions
Reuter spherical network construction with given level
Select anomalous field element
gravity disturbance
Algorithms of the spherical radial basis function and Reuter grid
Save computation process as
[SRBFs] The point mass kernel, Poisson kernel, m-order radial multipole and m-order Poisson wavelet kernel functions
specified latitude and longitude range, to design the SRBF network and corresponding approach algorithm of gravity field. The program does not require an input file.
>> Select the function module from the two control buttons at the top left of the interface...
>> Save the results as C:/PAGravf4.5_win64en/examples/SRBFperformance/rgaSRBF.txt.
>> The program output four kinds of SRBF spatial curve calculation results of the given type of gravity field element. Record format: spherical angular distance (independent variable), point mass kernel function value, Poisson kernel function value, m-order radial multipole kernel function value and m-order Poisson wavelet kernel function value.
** At the same time, the program outputs the spectral domain curve file *. dgr of four SRBF of the given type of gravity field element into the current directory, where * is the output file name. Record format: SRBF Legendre expansion degree (independent variable), point mass kernel degree variance, Poisson kernel degree variance, m-order radial multipole kernel degree variance and m-order Poisson wavelet kernel degree variance.
Set SRBF parameters
minimum degree 30
maximum degree 1440
burial depth of Bjerhammar sphere 5km
order 5
action distance of SRBF center 1.5°
spatial interval 0.20′
Calculation and save
Display of the input-output file↓
1424 0.991387 0.980618 0.958923 0.876948
1425 0.991223 0.981833 0.961462 0.884220
1426 0.991058 0.983047 0.964004 0.891546
1427 0.990892 0.984261 0.966550 0.898927
1428 0.990725 0.985475 0.969100 0.906362
1429 0.990557 0.986688 0.971653 0.913853
1430 0.990388 0.987900 0.974211 0.921399
1431 0.990219 0.989112 0.976773 0.929001
1432 0.990048 0.990324 0.979338 0.936660
1433 0.989876 0.991536 0.981907 0.944375
1434 0.989704 0.992746 0.984480 0.952147
1435 0.989531 0.993957 0.987057 0.959977
1436 0.989356 0.995167 0.989638 0.967864
1437 0.989181 0.996376 0.992223 0.975810
1438 0.989005 0.997585 0.994811 0.983814
1439 0.988828 0.998794 0.997404 0.991877
1440 0.988650 1.000002 1.000000 1.000000
Curve type Spectral curves of SRBFs
Line thickness 3
Start end row number 1 3600
Extract plot data
Chart plot↓
Spatial and spectral curves of spherical radial basis functions (SRBF)
Save current plot as
Point mass kernal
Poisson kernal
Radial multipole 5
Poisson wavelet 5
1
0.8
0.6
0.4
0.2
0
200
400
600
800
1000
1200
1400

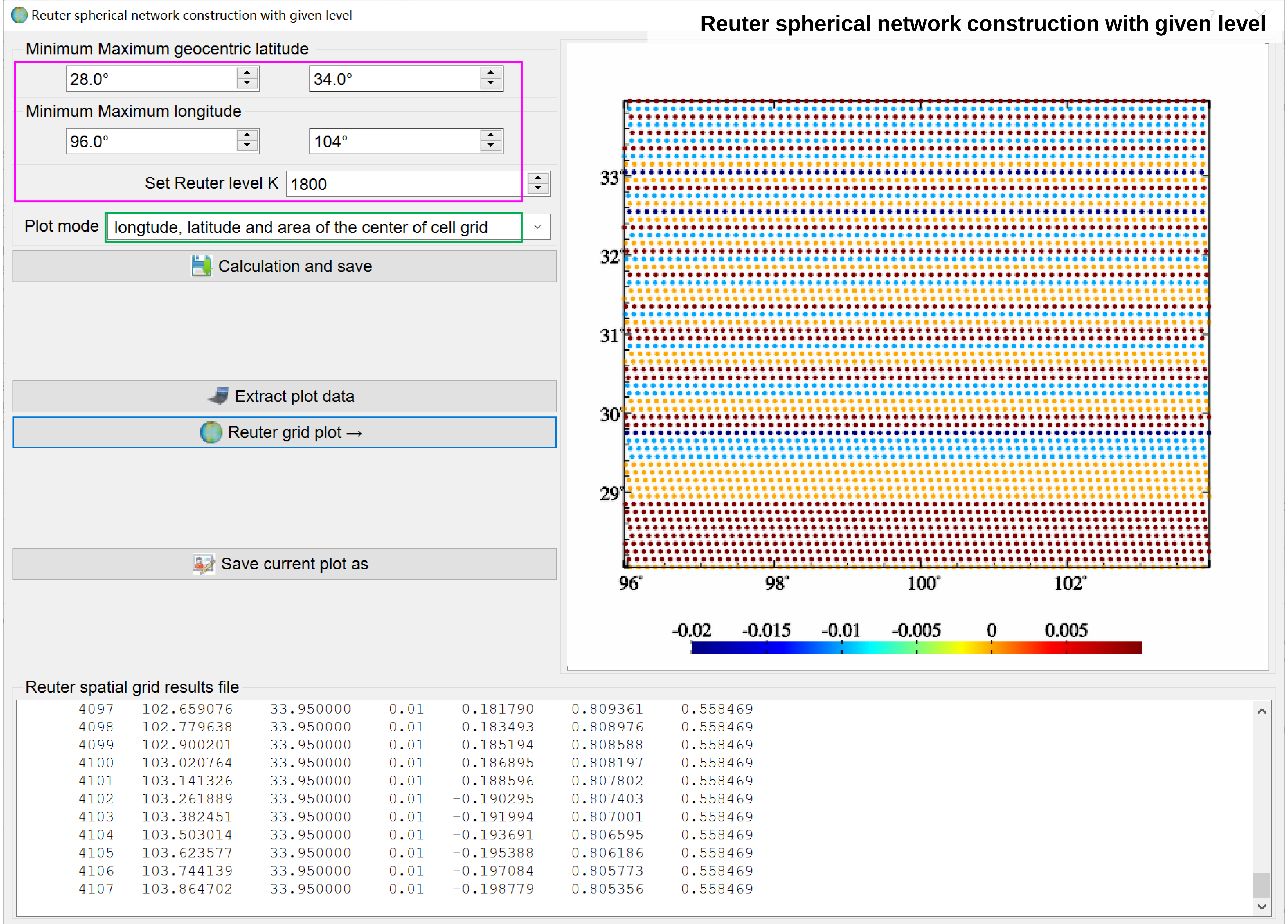

Feature and performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Reuter spherical network construction with given level
Select anomalous field element
height anomaly / disturbing potential
Algorithms of the spherical radial basis function and Reuter grid
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Save computation process as
[SRBFs] The point mass kernel, Poisson kernel, m-order radial multipole and m-order Poisson wavelet kernel functions
where * is the output file name. Record format: SRBF Legendre expansion degree (independent variable), point mass kernel degree variance, Poisson kernel degree variance, m-order radial multipole kernel degree variance and m-order Poisson wavelet kernel degree variance.
>> Save the results as C:/PAGravf4.5_win64en/examples/SRBFperformance/ksiSRBF.txt.
>> The program output four kinds of SRBF spatial curve calculation results of the given type of gravity field element. Record format: spherical angular distance (independent variable), point mass kernel function value, Poisson kernel function value, m-order radial multipole kernel function value and m-order Poisson wavelet kernel function value.
** At the same time, the program outputs the spectral domain curve file *. dgr of four SRBF of the given type of gravity field element into the current directory, where * is the output file name. Record format: SRBF Legendre expansion degree (independent variable), point mass kernel degree variance, Poisson kernel degree variance, m-order radial multipole kernel degree variance and m-order Poisson wavelet kernel degree variance.
Set SRBF parameters
minimum degree 30
maximum degree 1440
burial depth of Bjerhammar sphere 5km
order 5
action distance of SBRF center 1.5°
spatial interval 0.20′
Calculation and save
Display of the input-output file↓
1.446667 0.010961 -0.004686 -0.006052 -0.015008
1.450000 0.010781 -0.004850 -0.006278 -0.015414
1.453333 0.010616 -0.004984 -0.006460 -0.015710
1.456667 0.010464 -0.005087 -0.006597 -0.015894
1.460000 0.010327 -0.005158 -0.006687 -0.015967
1.463333 0.010204 -0.005199 -0.006730 -0.015928
1.466667 0.010097 -0.005207 -0.006727 -0.015778
1.470000 0.010004 -0.005185 -0.006678 -0.015519
1.473333 0.009925 -0.005131 -0.006583 -0.015153
1.476667 0.009860 -0.005047 -0.006443 -0.014685
1.480000 0.009810 -0.004933 -0.006260 -0.014117
1.483333 0.009773 -0.004791 -0.006035 -0.013455
1.486667 0.009749 -0.004622 -0.005771 -0.012703
1.490000 0.009738 -0.004426 -0.005468 -0.011868
1.493333 0.009738 -0.004205 -0.005130 -0.010955
1.496667 0.009749 -0.003962 -0.004759 -0.009972
1.500000 0.009770 -0.003698 -0.004359 -0.008927
Curve type Spatial curves of SRBFs
Line thickness 3
Start end row number 1 3600
Extract plot data
Chart plot↓
Spatial and spectral curves of spherical radial basis functions (SRBF)
Save current plot as
Point mass kernal
Poisson kernal
Radial multipole 5
Poisson wavelet 5
1
0.8
0.6
0.4
0.2
0
-0.2
-1.5
-1
-0.5
0
0.5
1
1.5

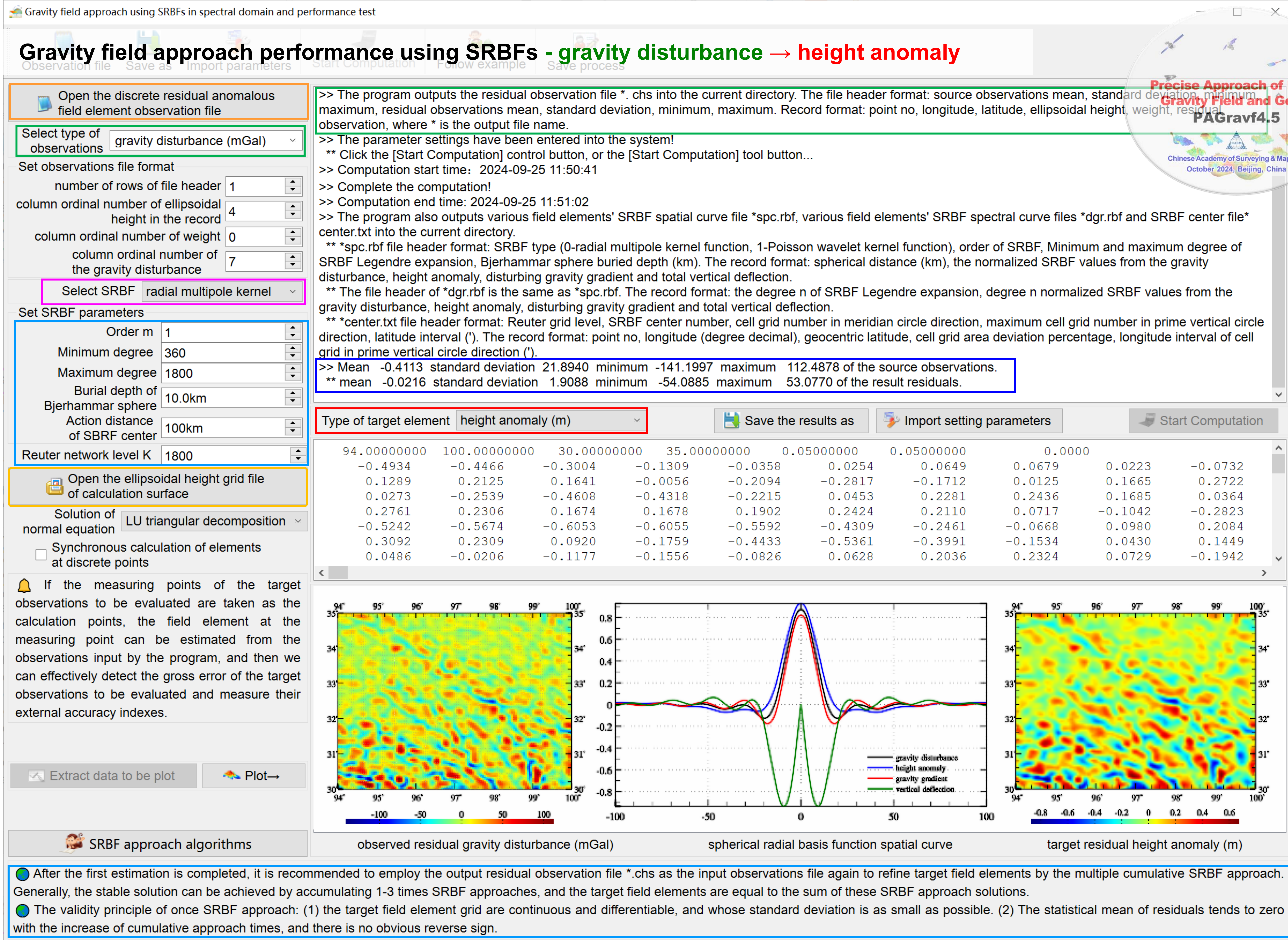

Feature and performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Reuter spherical network construction with given level
Select anomalous field element
height anomaly / disturbing potential
Algorithms of the spherical radial basis function and Reuter grid
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Save computation process as
[SRBFs] The point mass kernel, Poisson kernel, m-order radial multipole and m-order Poisson wavelet kernel functions
where * is the output file name. Record format: SRBF Legendre expansion degree (independent variable), point mass kernel degree variance, Poisson kernel degree variance, m-order radial multipole kernel degree variance and m-order Poisson wavelet kernel degree variance.
>> Save the results as C:/PAGravf4.5_win64en/examples/SRBFperformance/ksiSRBF.txt.
>> The program output four kinds of SRBF spatial curve calculation results of the given type of gravity field element. Record format: spherical angular distance (independent variable), point mass kernel function value, Poisson kernel function value, m-order radial multipole kernel function value and m-order Poisson wavelet kernel function value.
** At the same time, the program outputs the spectral domain curve file *. dgr of four SRBF of the given type of gravity field element into the current directory, where * is the output file name. Record format: SRBF Legendre expansion degree (independent variable), point mass kernel degree variance, Poisson kernel degree variance, m-order radial multipole kernel degree variance and m-order Poisson wavelet kernel degree variance.
Set SRBF parameters
minimum degree 30
maximum degree 1440
burial depth of Bjerhammar sphere 5km
order 5
action distance of SRBF center 1.5°
spatial interval 0.20′
Calculation and save
Display of the input-output file↓
1424 0.126130 0.991339 0.980579 0.896752
1425 0.125932 0.991175 0.981797 0.902920
1426 0.125735 0.991011 0.983013 0.909126
1427 0.125538 0.990846 0.984230 0.915368
1428 0.125341 0.990679 0.985446 0.921648
1429 0.125145 0.990512 0.986661 0.927966
1430 0.124949 0.990344 0.987876 0.934322
1431 0.124753 0.990174 0.989091 0.940715
1432 0.124557 0.990004 0.990305 0.947147
1433 0.124362 0.989833 0.991518 0.953617
1434 0.124167 0.989661 0.992732 0.960126
1435 0.123973 0.989488 0.993944 0.966674
1436 0.123778 0.989315 0.995157 0.973260
1437 0.123584 0.989140 0.996369 0.979886
1438 0.123391 0.988964 0.997580 0.986551
1439 0.123197 0.988787 0.998791 0.993256
1440 0.123004 0.988610 1.000002 1.000000
Curve type Spectral curves of SRBFs
Line thickness 3
Start end row number 1 3600
Extract plot data
Chart plot↓
Spatial and spectral curves of spherical radial basis functions (SRBF)
Save current plot as
Point mass kernal
Poisson kernal
Radial multipole 5
Poisson wavelet 5
1
0.8
0.6
0.4
0.2
0
200
400
600
800
1000
1200
1400


Reuter spherical network construction with given level
Reuter spherical network construction with given level
Minimum Maximum geocentric latitude
-90.0°
90.0°
Minimum Maximum longitude
0.0°
360°
Set Reuter level K
90
Plot mode
longtude, latitude and area of the center of cell grid
Calculation and save
Extract plot data
Reuter grid plot →
Save current plot as
80°
60°
40°
20°
0°
-20°
-40°
-60°
-80°
50°
100°
150°
200°
250°
300°
350°
-1
0
1
2
3
4
Reuter spatial grid results file
10300 60.000000 87.000000 4.67 0.026168 0.045324 0.998630
10301 100.000000 87.000000 4.67 -0.009088 0.051541 0.998630
10302 140.000000 87.000000 4.67 -0.040092 0.033641 0.998630
10303 180.000000 87.000000 4.67 -0.052336 0.000000 0.998630
10304 220.000000 87.000000 4.67 -0.040092 -0.033641 0.998630
10305 260.000000 87.000000 4.67 -0.009088 -0.051541 0.998630
10306 300.000000 87.000000 4.67 0.026168 -0.045324 0.998630
10307 340.000000 87.000000 4.67 0.049180 -0.017900 0.998630
10308 60.000000 89.000000 4.71 0.008726 0.015114 0.999848
10309 180.000000 89.000000 4.71 -0.017452 0.000000 0.999848
10310 300.000000 89.000000 4.71 0.008726 -0.015114 0.999848

Reuter spherical network construction with given level




Reuter spherical network construction with given level
Reuter spherical network construction with given level
Minimum Maximum geocentric latitude
28.0°
34.0°
Minimum Maximum longitude
96.0°
104°
Set Reuter level K
1800
Plot mode
longtude, latitude and area of the center of cell grid
Calculation and save
Extract plot data
Reuter grid plot →
Save current plot as
33°
32°
31°
30°
29°
96°
98°
100°
102°
-0.02
-0.015
-0.01
-0.005
0
0.005
Reuter spatial grid results file
4097 102.659076 33.950000 0.01 -0.181790 0.809361 0.558469
4098 102.779638 33.950000 0.01 -0.183493 0.808976 0.558469
4099 102.900201 33.950000 0.01 -0.185194 0.808588 0.558469
4100 103.020764 33.950000 0.01 -0.186895 0.808197 0.558469
4101 103.141326 33.950000 0.01 -0.188596 0.807802 0.558469
4102 103.261889 33.950000 0.01 -0.190295 0.807403 0.558469
4103 103.382451 33.950000 0.01 -0.191994 0.807001 0.558469
4104 103.503014 33.950000 0.01 -0.193691 0.806595 0.558469
4105 103.623577 33.950000 0.01 -0.195388 0.806186 0.558469
4106 103.744139 33.950000 0.01 -0.197084 0.805773 0.558469
4107 103.864702 33.950000 0.01 -0.198779 0.805356 0.558469


Gravity field approach using SRBFs in spectral domain and performance test
Gravity field approach performance using SRBFs - gravity disturbance → height anomaly
Open the discrete residual anomalous field element observation file
Select type of observations
gravity disturbance (mGal)
Set observations file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
column ordinal number of weight 0
column ordinal number of the gravity disturbance 7
Select SRBF radial multipole kernel
Set SRBF parameters
Order m 1
Minimum degree 360
Maximum degree 1800
Burial depth of Bjerhammar sphere 10.0km
Action distance of SBRF center 100km
Reuter network level K 1800
Open the ellipsoidal height grid file of calculation surface
Solution of normal equation LU triangular decomposition
Synchronous calculation of elements at discrete points
If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.
Extract data to be plot
Plot→
SRBF approach algorithms
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 11:50:41
>> Complete the computation!
>> Computation end time: 2024-09-25 11:51:02
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.4113 standard deviation 21.8940 minimum -141.1997 maximum 112.4878 of the source observations.
** mean -0.0216 standard deviation 1.9088 minimum -54.0885 maximum 53.0770 of the result residuals.
Type of target element height anomaly (m)
Save the results as
Import setting parameters
Start Computation
94.00000000 100.00000000 30.00000000 35.00000000 0.05000000 0.05000000 0.0000
-0.4934 -0.4466 -0.3004 -0.1309 -0.0358 0.0254 0.0649 0.0679 0.0223 -0.0732
0.1289 0.2125 0.1641 -0.0056 -0.2094 -0.2817 -0.1712 0.0125 0.1665 0.2722
0.0273 -0.2539 -0.4608 -0.4318 -0.2215 0.0453 0.2281 0.2436 0.1685 0.0364
0.2761 0.2306 0.1674 0.1678 0.1902 0.2424 0.2110 0.0717 -0.1042 -0.2823
-0.5242 -0.5674 -0.6053 -0.6055 -0.5592 -0.4309 -0.2461 -0.0668 0.0980 0.2084
0.3092 0.2309 0.0920 -0.1759 -0.4433 -0.5361 -0.3991 -0.1534 0.0430 0.1449
0.0486 -0.0206 -0.1177 -0.1556 -0.0826 0.0628 0.2036 0.2324 0.0729 -0.1942
gravity disturbance
height anomaly
gravity gradient
vertical deflection
observed residual gravity disturbance (mGal)
spherical radial basis function spatial curve
target residual height anomaly (m)
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China

Gravity field approach using SRBFs in spectral domain and performance test

Gravity field approach performance using SRBFs – once cumulative approach

Observation file | Save as | Import parameters | Start Computation | Follow example | Save process

Precise Approach of Earth Gravity Field and Geoid
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Open the discrete residual anomalous field element observation file

Select type of observations: gravity disturbance (mGal)

Set observations file format
- number of rows of file header: 1
- column ordinal number of ellipsoidal height in the record: 4
- column ordinal number of weight: 5
- column ordinal number of the gravity disturbance: 7

Select SRBF: radial multipole kernel

Set SRBF parameters
- Order m: 1
- Minimum degree: 540
- Maximum degree: 1800
- Burial depth of Bjerhammar sphere: 6.0km
- Action distance of SBRF center: 75km
- Reuter network level K: 3600

Open the ellipsoidal height grid file of calculation surface

Solution of normal equation: LU triangular decomposition

Synchronous calculation of elements at discrete points

If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.

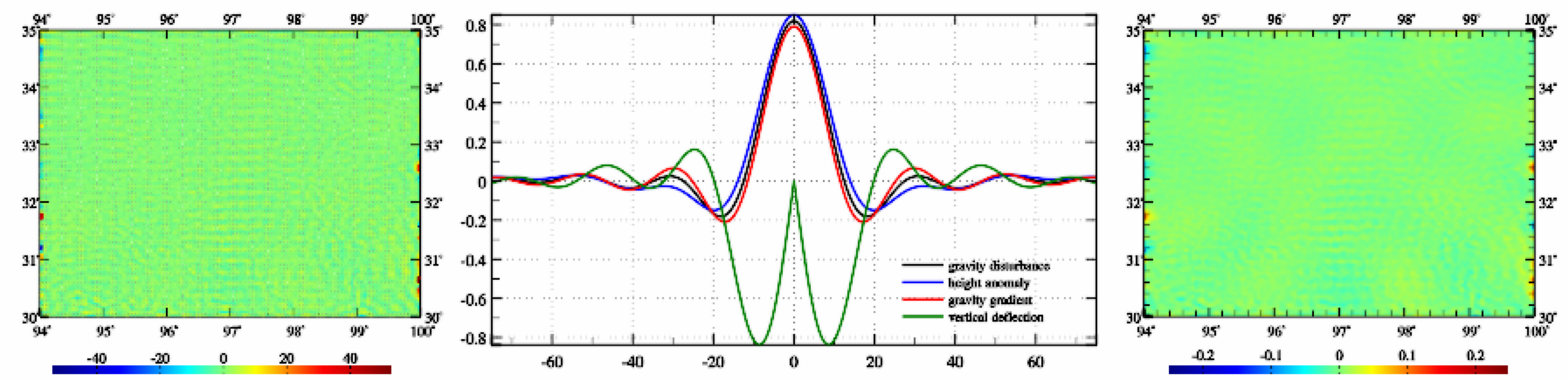
Extract data to be plot | Plot→

SRBF approach algorithms

>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 11:54:21
>> Complete the computation!
>> Computation end time: 2024-09-25 11:55:50
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.0216 standard deviation 1.9088 minimum -54.0885 maximum 53.0770 of the source observations.
** mean -0.0044 standard deviation 0.6536 minimum -28.2780 maximum 11.2439 of the result residuals.

Type of target element: height anomaly (m) | Save the results as | Import setting parameters | Start Computation

94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
0.0062	0.0156	0.0198	0.0140	0.0131	0.0070	0.0129	0.0219	0.0341	0.0222
-0.0377	-0.0595	-0.0418	-0.0222	-0.0199	-0.0378	-0.0153	-0.0140	-0.0054	-0.0043
-0.0170	-0.0175	-0.0034	0.0075	0.0119	0.0092	0.0314	0.0430	0.0474	0.0319
0.0164	0.0141	0.0022	-0.0088	0.0031	0.0067	0.0020	-0.0066	-0.0183	-0.0052
0.0253	0.0220	0.0056	0.0005	0.0232	0.0116	0.0053	-0.0034	-0.0063	0.0051
0.0154	0.0094	-0.0055	-0.0026	0.0034	-0.0012	0.0021	0.0186	0.0390	0.0388
0.0018	0.0060	0.0081	0.0129	0.0031	0.0015	0.0101	0.0183	0.0214	-0.0066



observed residual gravity disturbance (mGal) | spherical radial basis function spatial curve | target residual height anomaly (m)

After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.

The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Gravity field approach using SRBFs in spectral domain and performance test

Gravity field approach performance using SRBFs - vertical deflection → height anomaly

Observation file | Save as | Import parameters | Start Computation | Follow example | Save process

Precise Approach of Earth Gravity Field and Geoid
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October 2024, Beijing, China

Open the discrete residual anomalous field element observation file

Select type of observations: vertical deflection vector (")

Set observations file format

- number of rows of file header: 1
- column ordinal number of ellipsoidal height in the record: 4
- column ordinal number of weight: 0
- column ordinal number of vertical deflection westward: 8
- column ordinal number of vertical deflection southward: 9

Select SRBF: radial multipole kernel

Set SRBF parameters

- Order m: 1
- Minimum degree: 360
- Maximum degree: 1800
- Burial depth of Bjerhammar sphere: 10.0km
- Action distance of SRBF center: 100km
- Reuter network level K: 1800

Open the ellipsoidal height grid file of calculation surface

Solution of normal equation: LU triangular decomposition

☐ Synchronous calculation of elements at discrete points

If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.

Extract data to be plot | Plot→

SRBF approach algorithms

>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.

>> The parameter settings have been entered into the system!

** Click the [Start Computation] control button, or the [Start Computation] tool button...

>> Computation start time：2024-09-25 11:58:13

>> Complete the computation!

>> Computation end time: 2024-09-25 11:58:47

>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.

** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.

** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.

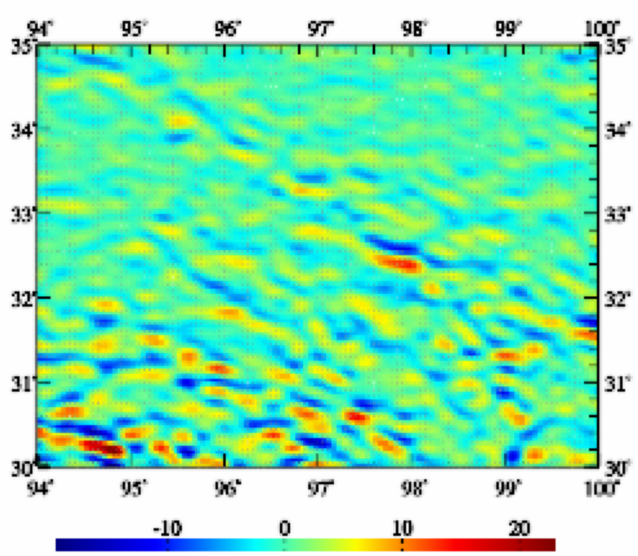
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').

>> Mean -0.0129 standard deviation 3.2354 minimum -19.8241 maximum 23.1114 of the source observations.

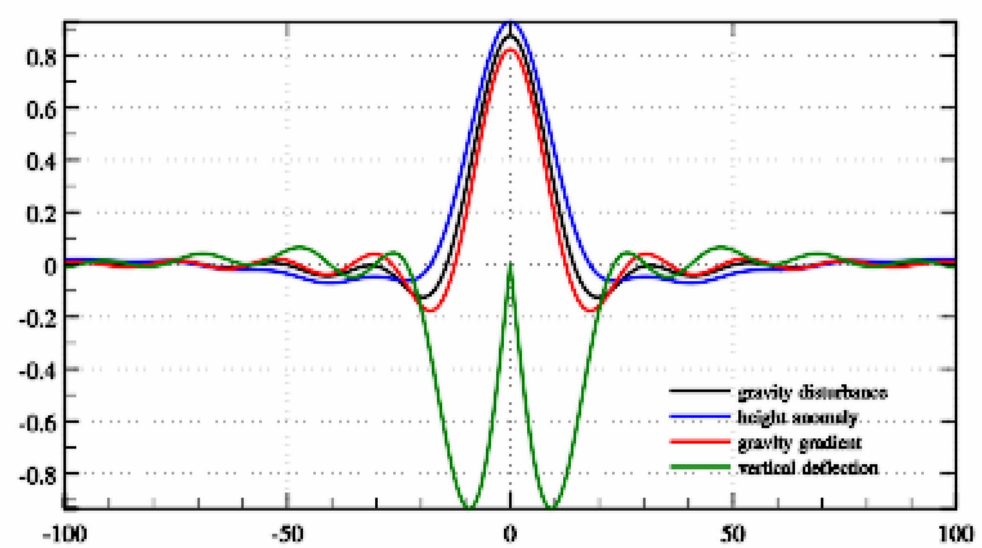
** mean 0.0039 standard deviation 0.3118 minimum -9.2421 maximum 10.5513 of the result residuals.

Type of target element: height anomaly (m) | Save the results as | Import setting parameters | Start Computation

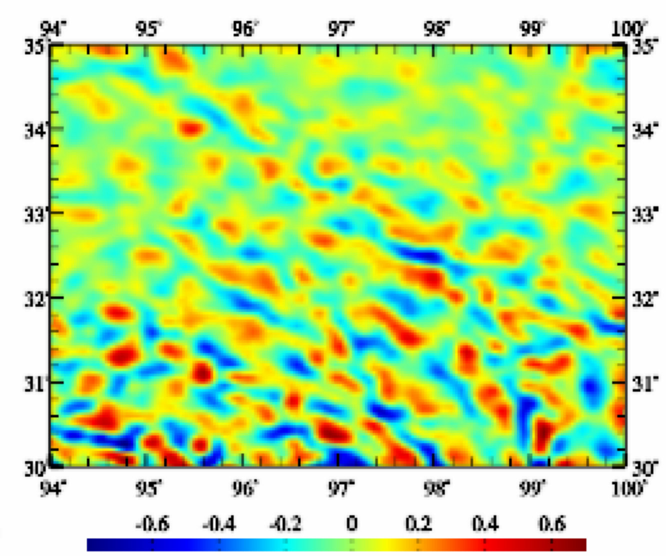
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-0.4808	-0.4329	-0.2845	-0.1120	-0.0144	0.0492	0.0874	0.1029	0.0741	-0.0079
0.1176	0.2158	0.1885	0.0295	-0.1768	-0.2662	-0.1820	-0.0265	0.1247	0.2425
0.0318	-0.2592	-0.4819	-0.4693	-0.2501	0.0327	0.2356	0.2747	0.2107	0.0684
0.2274	0.1964	0.1420	0.1525	0.1764	0.2116	0.1653	0.0179	-0.1573	-0.3123
-0.4060	-0.4720	-0.5360	-0.5683	-0.5500	-0.4631	-0.3231	-0.1673	-0.0224	0.0857
0.3073	0.2396	0.0991	-0.1836	-0.4707	-0.5827	-0.4539	-0.2076	0.0068	0.1091
0.0690	-0.0055	-0.1059	-0.1323	-0.0382	0.1303	0.2883	0.3127	0.1212	-0.1934



observed residual vertical deflection (", S)



spherical radial basis function spatial curve



target residual height anomaly (m)

After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.

The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Gravity field approach using SRBFs in spectral domain and performance test

Gravity field approach performance using SRBFs - height anomaly → gravity disturbance

Observation file | Save as | Import parameters | Start Computation | Follow example | Save process

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Open the discrete residual anomalous field element observation file

Select type of observations: height anomaly (m)

Set observations file format

number of rows of file header: 1

column ordinal number of ellipsoidal height in the record: 4

column ordinal number of weight: 0

column ordinal number of the height anomaly: 5

Select SRBF: radial multipole kernel

Set SRBF parameters

Order m: 1

Minimum degree: 360

Maximum degree: 1800

Burial depth of Bjerhammar sphere: 10.0km

Action distance of SBRF center: 100km

Reuter network level K: 1800

Open the ellipsoidal height grid file of calculation surface

Solution of normal equation: LU triangular decomposition

☐ Synchronous calculation of elements at discrete points

If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.

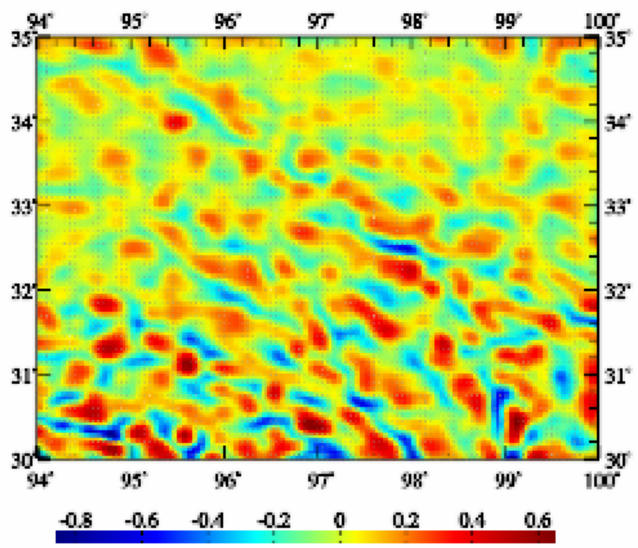
Extract data to be plot | Plot→

SRBF approach algorithms

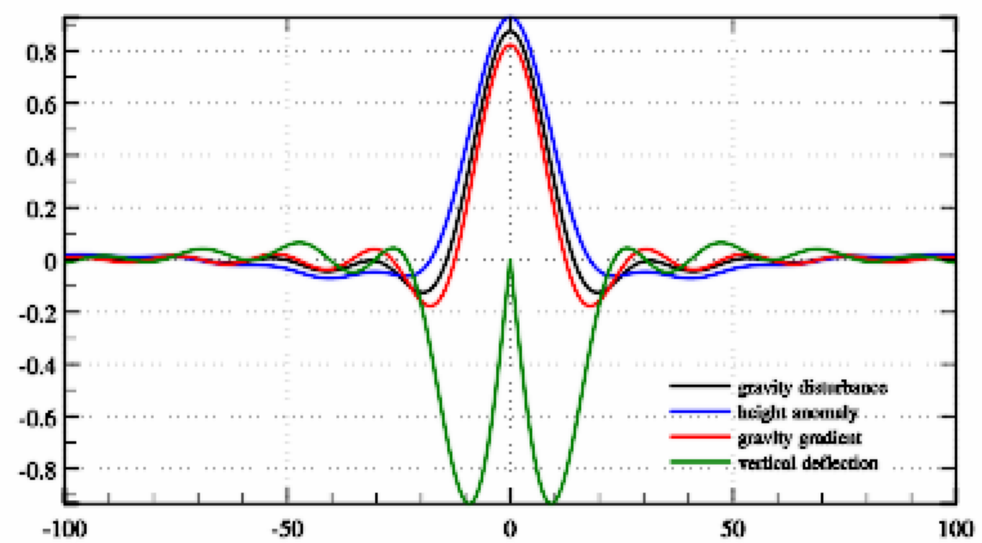
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 12:02:43
>> Complete the computation!
>> Computation end time: 2024-09-25 12:03:01
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.0020 standard deviation 0.1590 minimum -0.8621 maximum 0.6546 of the source observations.
** mean -0.0011 standard deviation 0.0135 minimum -0.3763 maximum 0.4258 of the result residuals.

Type of target element: gravity disturbance (mGal) | Save the results as | Import setting parameters | Start Computation

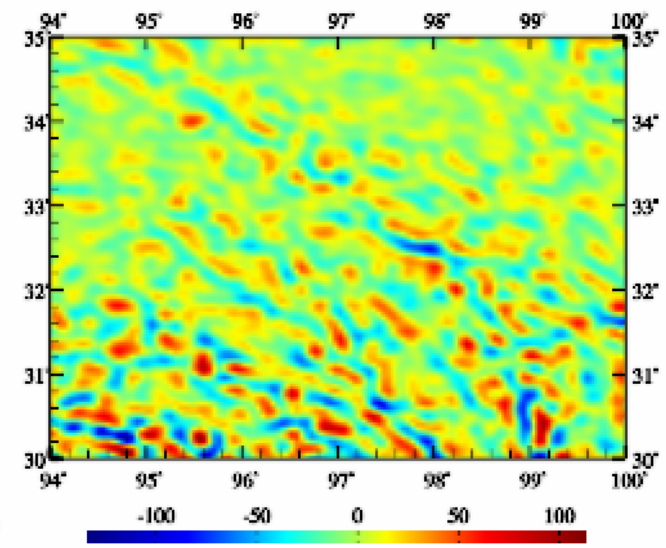
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-65.3591	-58.7649	-35.2841	-10.0337	2.9287	7.2438	10.2652	13.5926	12.0766	-0.3089
6.4548	29.7980	29.7832	2.0592	-35.7794	-53.6309	-39.0541	-13.1329	4.8602	14.6182
6.6296	-41.4182	-73.4118	-66.0062	-26.5807	24.2028	57.9004	58.5887	36.5839	5.0106
29.0963	26.0823	17.9708	17.4266	24.1063	32.7800	24.6379	-1.1940	-30.9331	-51.1497
-15.4188	-22.7403	-39.5771	-54.8616	-60.0889	-51.9314	-35.2718	-19.3994	-3.8652	7.7557
39.4309	43.6354	26.5751	-17.0100	-64.3688	-82.8843	-60.8164	-21.0537	7.6201	16.2492
14.0937	-0.1259	-20.0057	-28.6960	-14.6046	17.8789	51.0941	61.0445	34.1631	-19.7100



observed residual height anomaly (m)



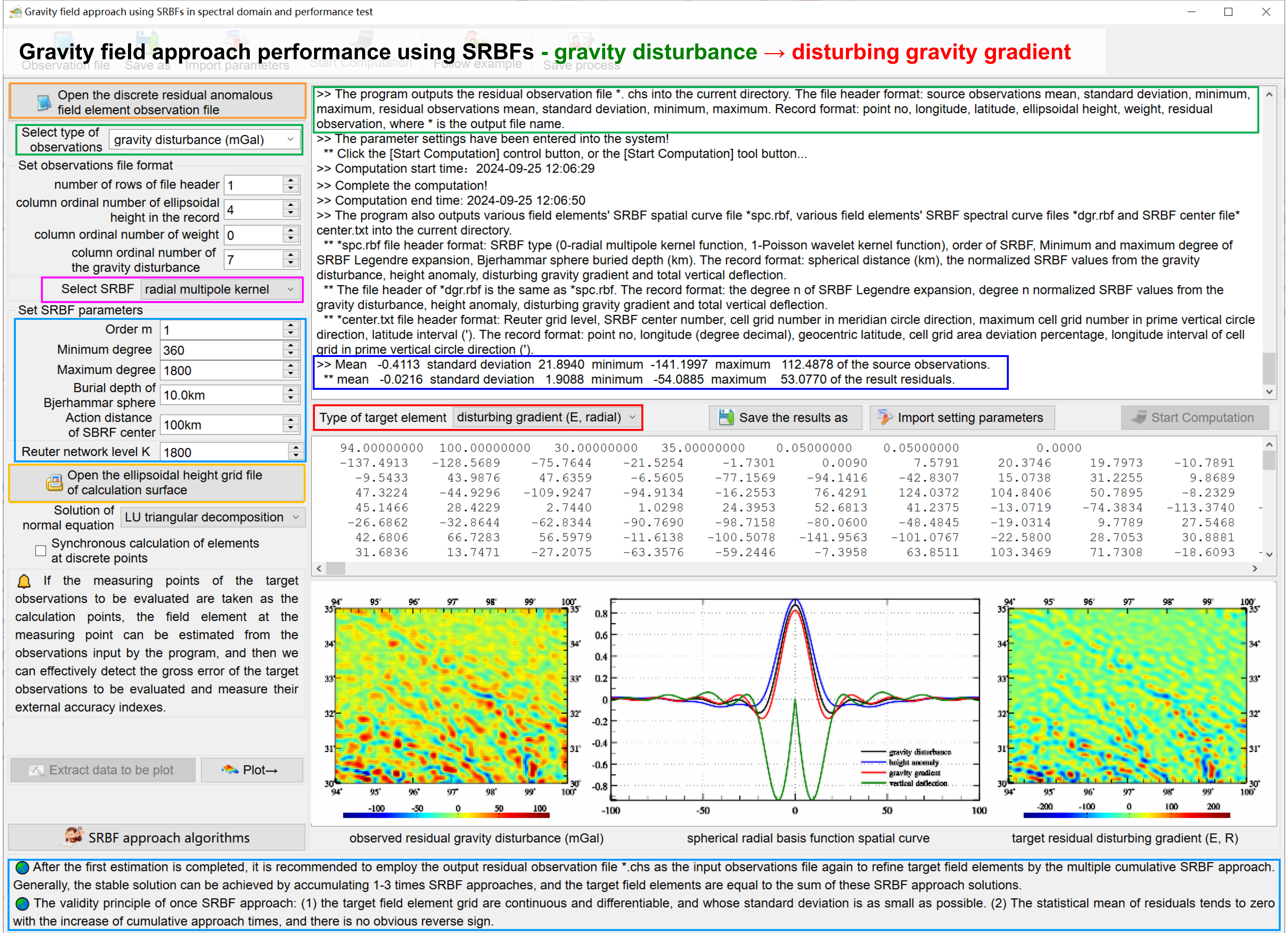
spherical radial basis function spatial curve



target residual gravity disturbance (mGal)

After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.

The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.


Gravity field approach using SRBFs in spectral domain and performance test
Gravity field approach performance using SRBFs - gravity disturbance → disturbing gravity gradient
Open the discrete residual anomalous field element observation file
Select type of observations
gravity disturbance (mGal)
Set observations file format
number of rows of file header
1
column ordinal number of ellipsoidal height in the record
4
column ordinal number of weight
0
column ordinal number of the gravity disturbance
7
Select SRBF
radial multipole kernel
Set SRBF parameters
Order m
1
Minimum degree
360
Maximum degree
1800
Burial depth of Bjerhammar sphere
10.0km
Action distance of SBRF center
100km
Reuter network level K
1800
Open the ellipsoidal height grid file of calculation surface
Solution of normal equation
LU triangular decomposition
Synchronous calculation of elements at discrete points
If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.
Extract data to be plot
Plot→
SRBF approach algorithms
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 12:06:29
>> Complete the computation!
>> Computation end time: 2024-09-25 12:06:50
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.4113 standard deviation 21.8940 minimum -141.1997 maximum 112.4878 of the source observations.
** mean -0.0216 standard deviation 1.9088 minimum -54.0885 maximum 53.0770 of the result residuals.
Type of target element
disturbing gradient (E, radial)
Save the results as
Import setting parameters
Start Computation
94.00000000 100.00000000 30.00000000 35.00000000 0.05000000 0.05000000 0.0000
-137.4913 -128.5689 -75.7644 -21.5254 -1.7301 0.0090 7.5791 20.3746 19.7973 -10.7891
-9.5433 43.9876 47.6359 -6.5605 -77.1569 -94.1416 -42.8307 15.0738 31.2255 9.8689
47.3224 -44.9296 -109.9247 -94.9134 -16.2553 76.4291 124.0372 104.8406 50.7895 -8.2329
45.1466 28.4229 2.7440 1.0298 24.3953 52.6813 41.2375 -13.0719 -74.3834 -113.3740
-26.6862 -32.8644 -62.8344 -90.7690 -98.7158 -80.0600 -48.4845 -19.0314 9.7789 27.5468
42.6806 66.7283 56.5979 -11.6138 -100.5078 -141.9563 -101.0767 -22.5800 28.7053 30.8881
31.6836 13.7471 -27.2075 -63.3576 -59.2446 -7.3958 63.8511 103.3469 71.7308 -18.6093
gravity disturbance
height anomaly
gravity gradient
vertical deflection
observed residual gravity disturbance (mGal)
spherical radial basis function spatial curve
target residual disturbing gradient (E, R)
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Gravity field approach using SRBFs in spectral domain and performance test

Gravity field approach performance using SRBFs - disturbing gravity gradient → height anomaly

Observation file Save as Import parameters Start Computation Follow example Save process

Precise Approach of Earth Gravity Field and Geoid
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October 2024, Beijing, China

Open the discrete residual anomalous field element observation file

Select type of observations: disturbing gradient (E, radial)

Set observations file format

number of rows of file header: 1

column ordinal number of ellipsoidal height in the record: 4

column ordinal number of weight: 0

column ordinal number of disturbing gravity gradient: 10

Select SRBF: radial multipole kernel

Set SRBF parameters

Order m: 1

Minimum degree: 360

Maximum degree: 1800

Burial depth of Bjerhammar sphere: 10.0km

Action distance of SBRF center: 100km

Reuter network level K: 1800

Open the ellipsoidal height grid file of calculation surface

Solution of normal equation: LU triangular decomposition

☐ Synchronous calculation of elements at discrete points

🔔 If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.

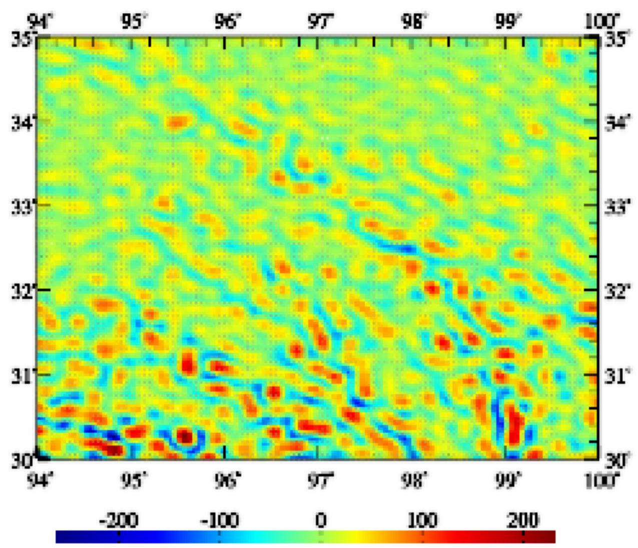
Extract data to be plot Plot→

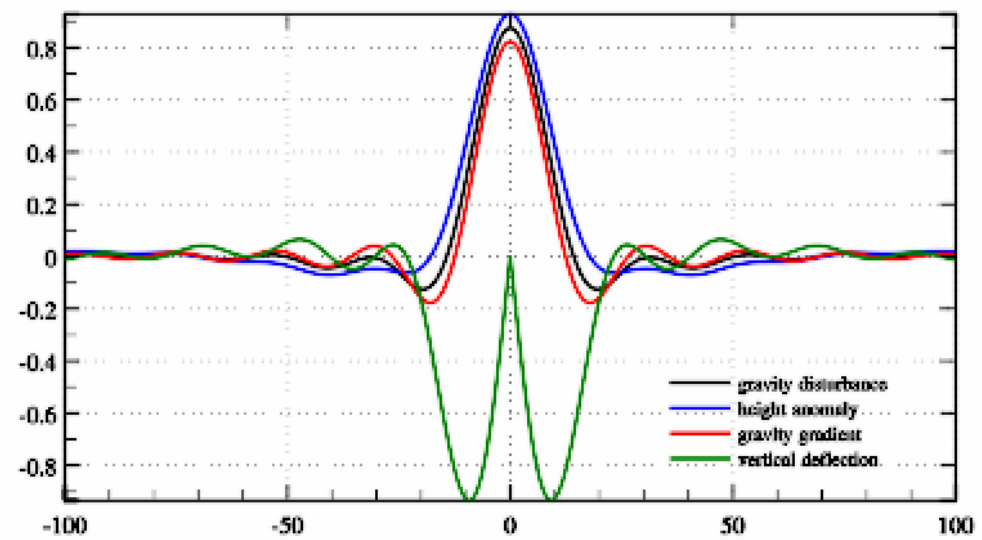
SRBF approach algorithms

>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 12:09:06
>> Complete the computation!
>> Computation end time: 2024-09-25 12:09:25
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.8635 standard deviation 38.2935 minimum -262.7565 maximum 232.6519 of the source observations.
** mean -0.0373 standard deviation 3.7041 minimum -90.4115 maximum 78.2329 of the result residuals.

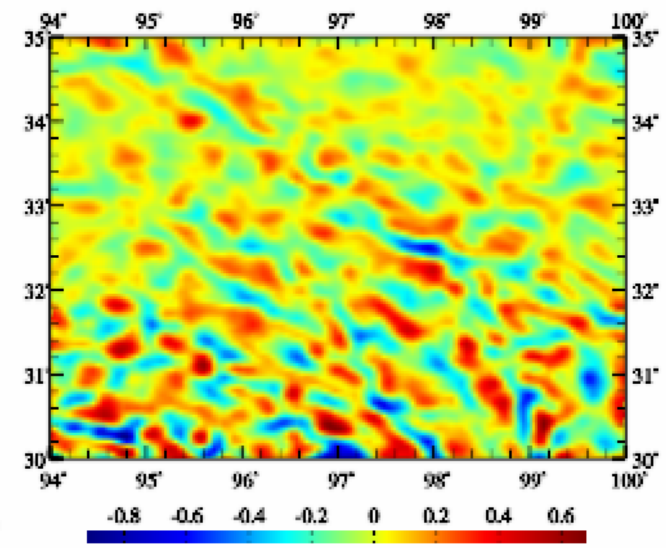
Type of target element: height anomaly (m) Save the results as Import setting parameters Start Computation

94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-0.5445	-0.5102	-0.3560	-0.1739	-0.0708	-0.0012	0.0419	0.0482	-0.0085	-0.1114
0.1839	0.2645	0.1883	0.0030	-0.2013	-0.2539	-0.1254	0.0529	0.1988	0.2703
0.1064	-0.1544	-0.3614	-0.3513	-0.1629	0.0673	0.2065	0.1871	0.0870	-0.0395
0.2908	0.2241	0.1481	0.1425	0.1681	0.2248	0.2043	0.0655	-0.1207	-0.3326
-0.7192	-0.7325	-0.7358	-0.6986	-0.6140	-0.4451	-0.2224	-0.0131	0.1616	0.2708
0.2893	0.2072	0.0790	-0.1720	-0.4170	-0.5050	-0.3697	-0.1306	0.0615	0.1578
0.0520	-0.0110	-0.1084	-0.1595	-0.1227	-0.0041	0.1167	0.1545	0.0335	-0.1824


observed residual disturbing gradient (E, R)



spherical radial basis function spatial curve


target residual height anomaly (m)

After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.

The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Gravity field approach using SRBFs in spectral domain and performance test

Gravity field approach performance using SRBFs - disturbing gravity gradient → gravity disturbance

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Open the discrete residual anomalous field element observation file

Select type of observations: disturbing gradient (E, radial)

Set observations file format

number of rows of file header: 1

column ordinal number of ellipsoidal height in the record: 4

column ordinal number of weight: 0

column ordinal number of disturbing gravity gradient: 10

Select SRBF: radial multipole kernel

Set SRBF parameters

Order m: 1

Minimum degree: 360

Maximum degree: 1800

Burial depth of Bjerhammar sphere: 10.0km

Action distance of SBRF center: 100km

Reuter network level K: 1800

Open the ellipsoidal height grid file of calculation surface

Solution of normal equation: LU triangular decomposition

☐ Synchronous calculation of elements at discrete points

If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.

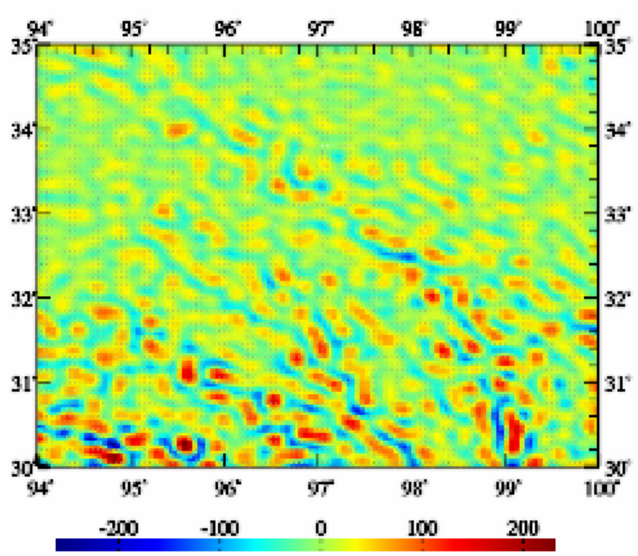
Extract data to be plot | Plot→

SRBF approach algorithms

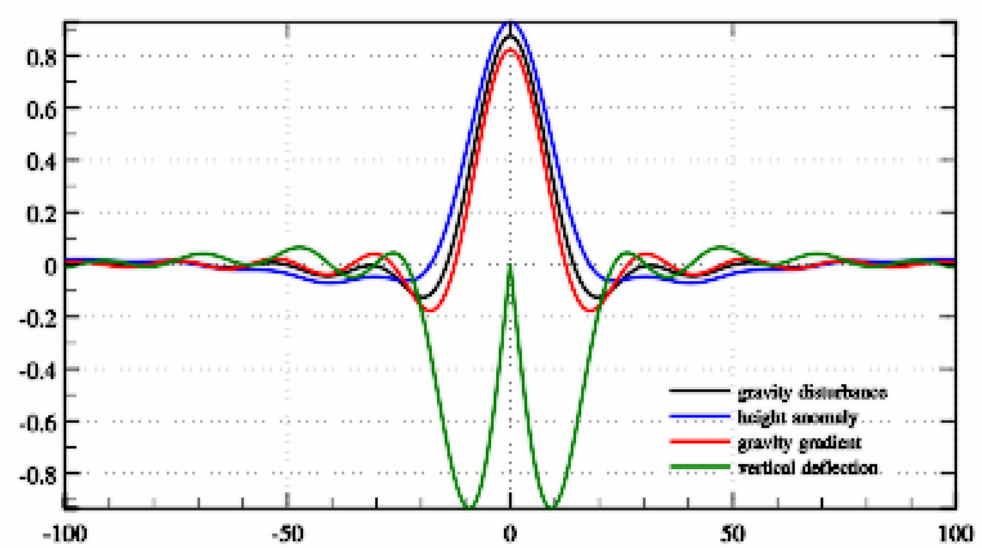
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 12:10:29
>> Complete the computation!
>> Computation end time: 2024-09-25 12:10:48
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.8635 standard deviation 38.2935 minimum -262.7565 maximum 232.6519 of the source observations.
** mean -0.0373 standard deviation 3.7041 minimum -90.4115 maximum 78.2329 of the result residuals.

Type of target element: gravity disturbance (mGal) | Save the results as | Import setting parameters | Start Computation

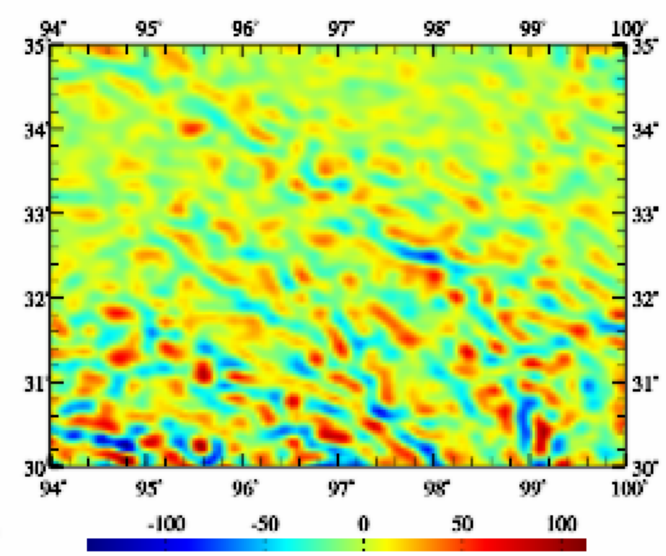
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-86.0957	-82.4429	-54.2835	-22.6428	-7.0178	-1.1718	3.1876	6.8333	2.1125	-15.3716
19.5807	39.6239	29.9655	-4.2432	-41.1459	-48.6841	-22.7812	7.2624	21.6418	19.1479
24.1767	-19.6837	-52.4652	-47.9595	-12.0423	31.0213	53.7371	44.2942	17.0412	-11.6750
32.6849	20.3425	5.5606	3.6310	13.4996	27.5139	25.4570	2.5238	-27.7038	-55.1547
-58.4705	-59.5539	-68.7171	-75.0853	-71.2172	-53.1640	-27.0058	-2.5787	17.3225	28.2437
32.7498	34.0782	21.5186	-14.9527	-56.5772	-75.1354	-54.6346	-15.1664	14.0448	21.2175
11.7707	2.5332	-15.4607	-29.5430	-27.0644	-5.0157	23.2032	37.5784	21.5201	-18.7909



observed residual disturbing gradient (E, R)



spherical radial basis function spatial curve



target residual gravity disturbance (mGal)

After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.

The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Gravity field approach using SRBFs in spectral domain and performance test

Gravity field approach performance using SRBFs - disturbing gravity gradient → vertical deflection

Observation file | Save as | Import parameters | Start Computation | Follow example | Save process

Precise Approach of Earth Gravity Field and Geoid
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Open the discrete residual anomalous field element observation file

Select type of observations: disturbing gradient (E, radial)

Set observations file format

number of rows of file header	1
column ordinal number of ellipsoidal height in the record	4
column ordinal number of weight	0
column ordinal number of disturbing gravity gradient	10

Select SRBF: radial multipole kernel

Set SRBF parameters

Order m	1
Minimum degree	360
Maximum degree	1800
Burial depth of Bjerhammar sphere	10.0km
Action distance of SBRF center	100km
Reuter network level K	1800

Open the ellipsoidal height grid file of calculation surface

Solution of normal equation: LU triangular decomposition

☐ Synchronous calculation of elements at discrete points

If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.

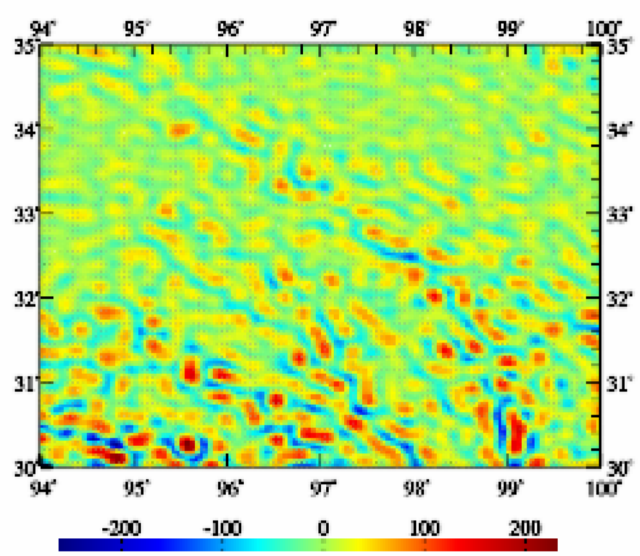
Extract data to be plot | Plot→

SRBF approach algorithms

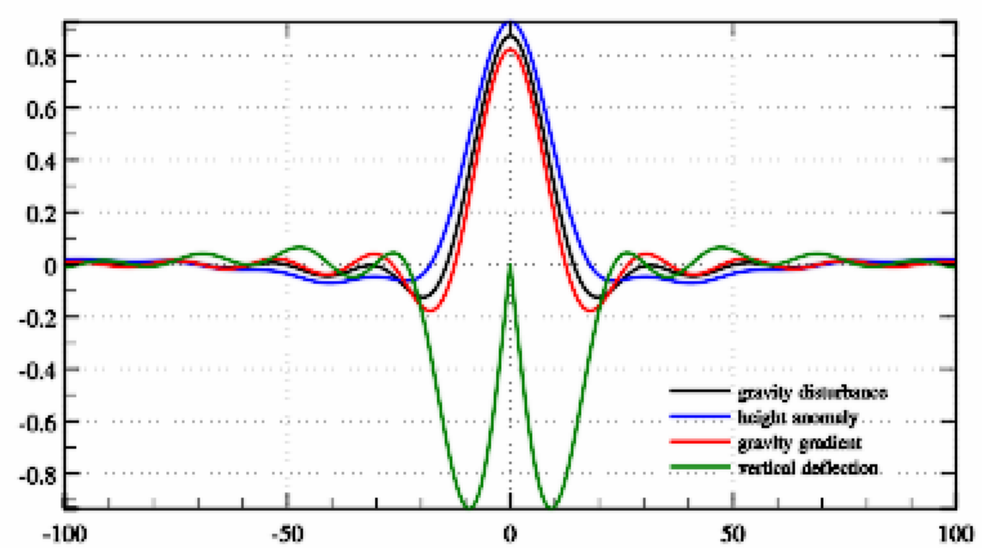
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 12:12:08
>> Complete the computation!
>> Computation end time: 2024-09-25 12:12:26
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.8635 standard deviation 38.2935 minimum -262.7565 maximum 232.6519 of the source observations.
** mean -0.0373 standard deviation 3.7041 minimum -90.4115 maximum 78.2329 of the result residuals.

Type of target element: vertical deflection vector (") | Save the results as | Import setting parameters | Start Computation

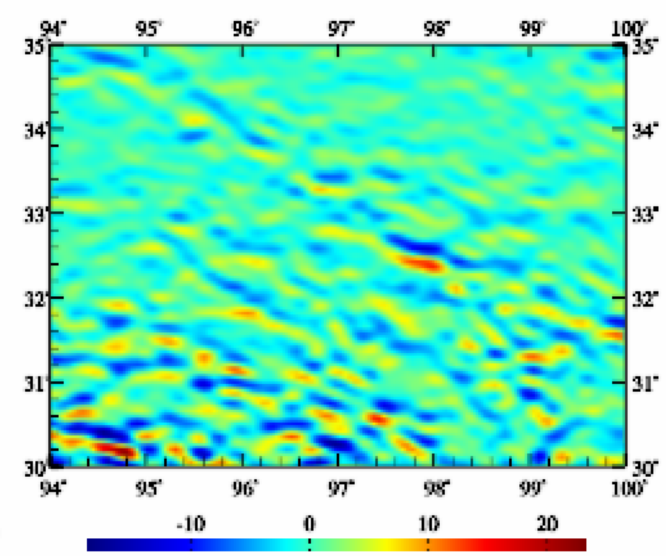
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-4.5854	-5.1192	-5.1277	-4.5604	-3.2649	-1.5760	0.1493	1.5548	2.2531	1.9720
-13.0641	-13.7256	-11.4734	-7.2443	-2.4898	1.0888	2.4705	1.4576	-1.3255	-4.5001
5.4203	6.3758	7.8360	9.0473	9.0195	7.8777	6.5432	5.7170	5.3042	4.4329
-2.7174	-0.9445	0.3396	0.5304	-0.1437	-1.8812	-3.9199	-5.5399	-6.5380	-6.4282
3.4789	3.4859	3.1237	2.8089	2.2345	0.9410	-0.8284	-2.4133	-3.5322	-4.1473
-2.8039	-1.5847	0.1984	2.1158	2.7072	1.2931	-1.1958	-3.1622	-4.1861	-4.7232
0.6454	1.0979	0.3951	-1.5137	-3.4993	-4.2271	-3.1416	-1.1754	0.1605	-0.0969



observed residual disturbing gradient (E, R)



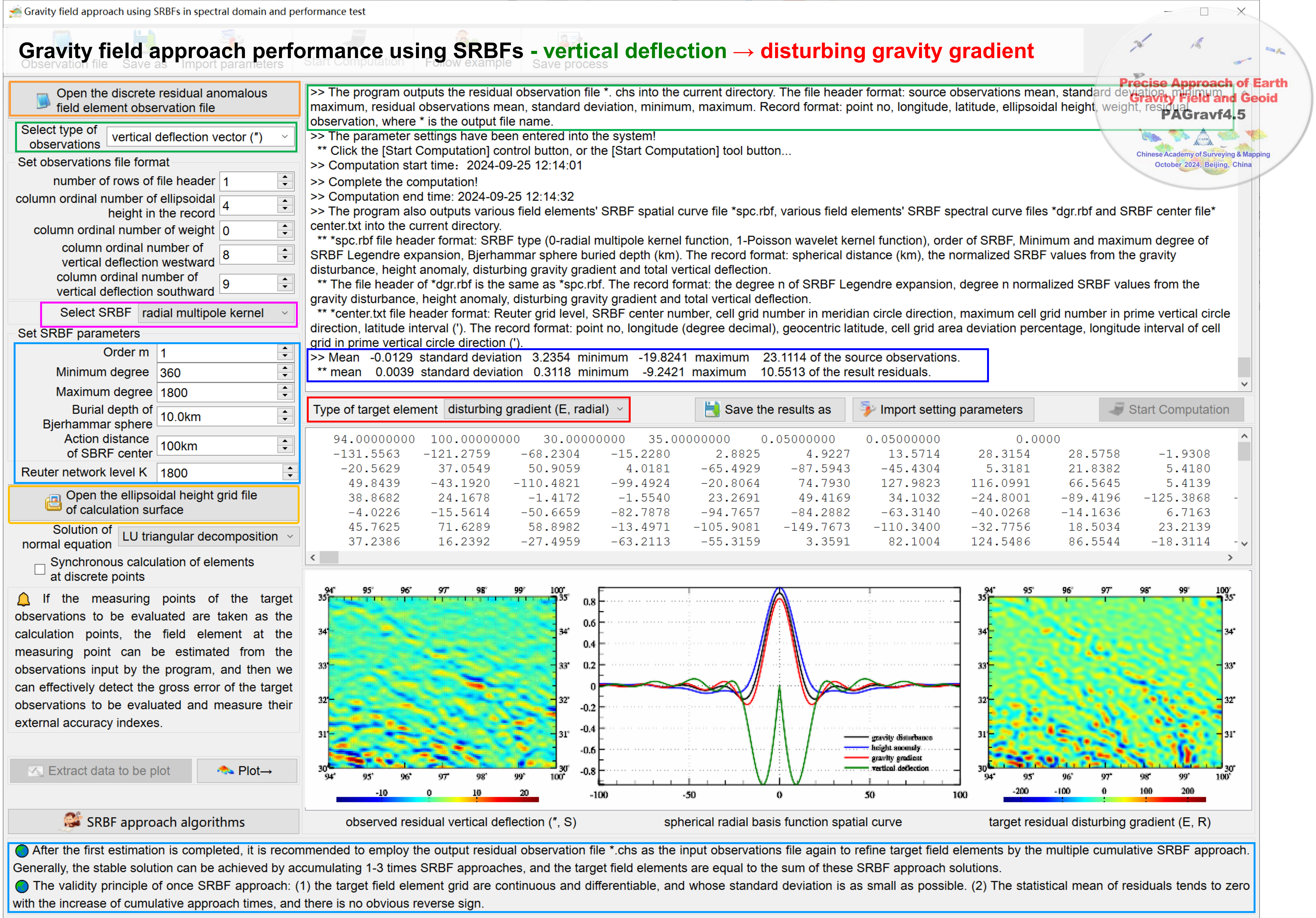
spherical radial basis function spatial curve

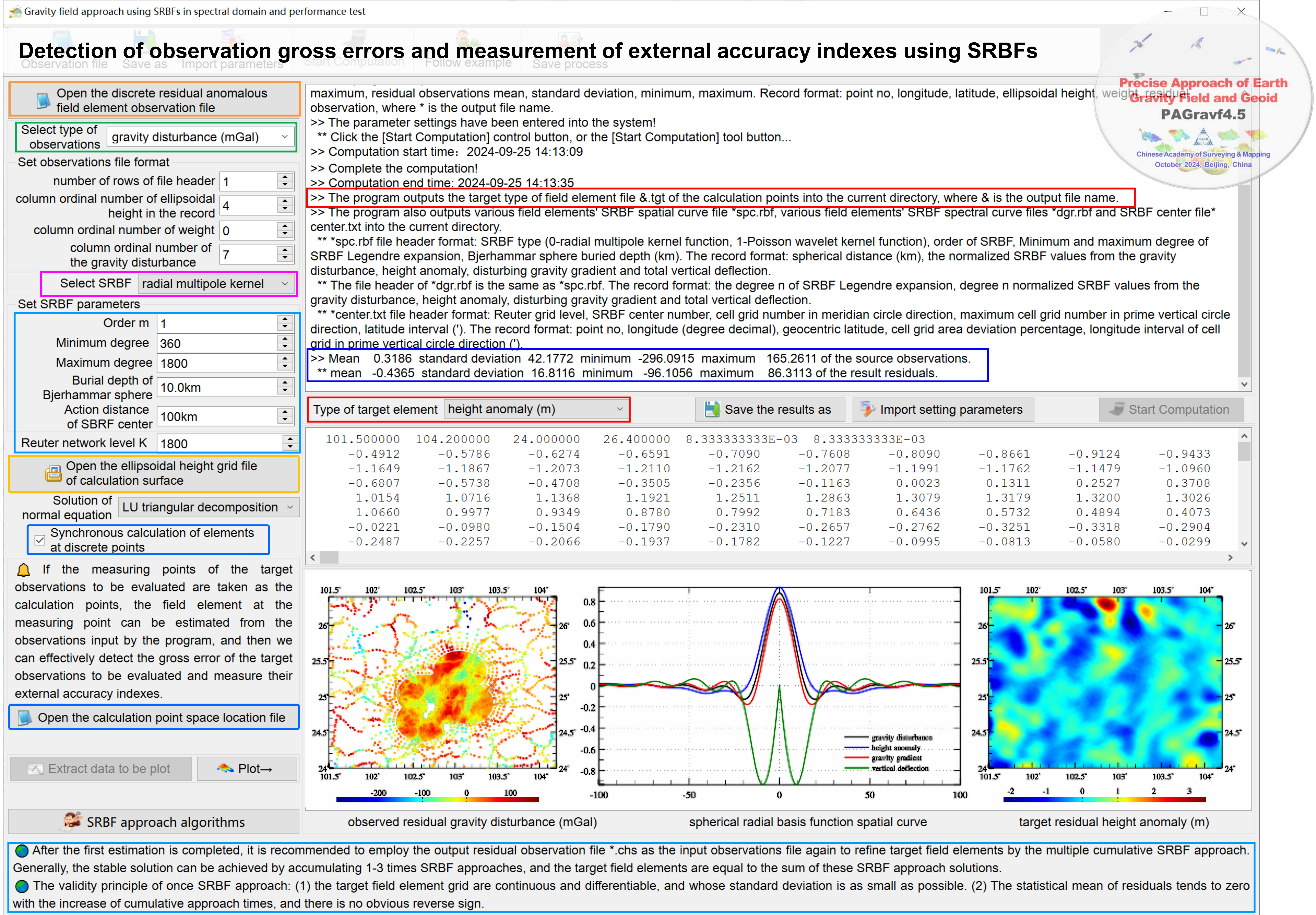


target residual vertical deflection (", S)

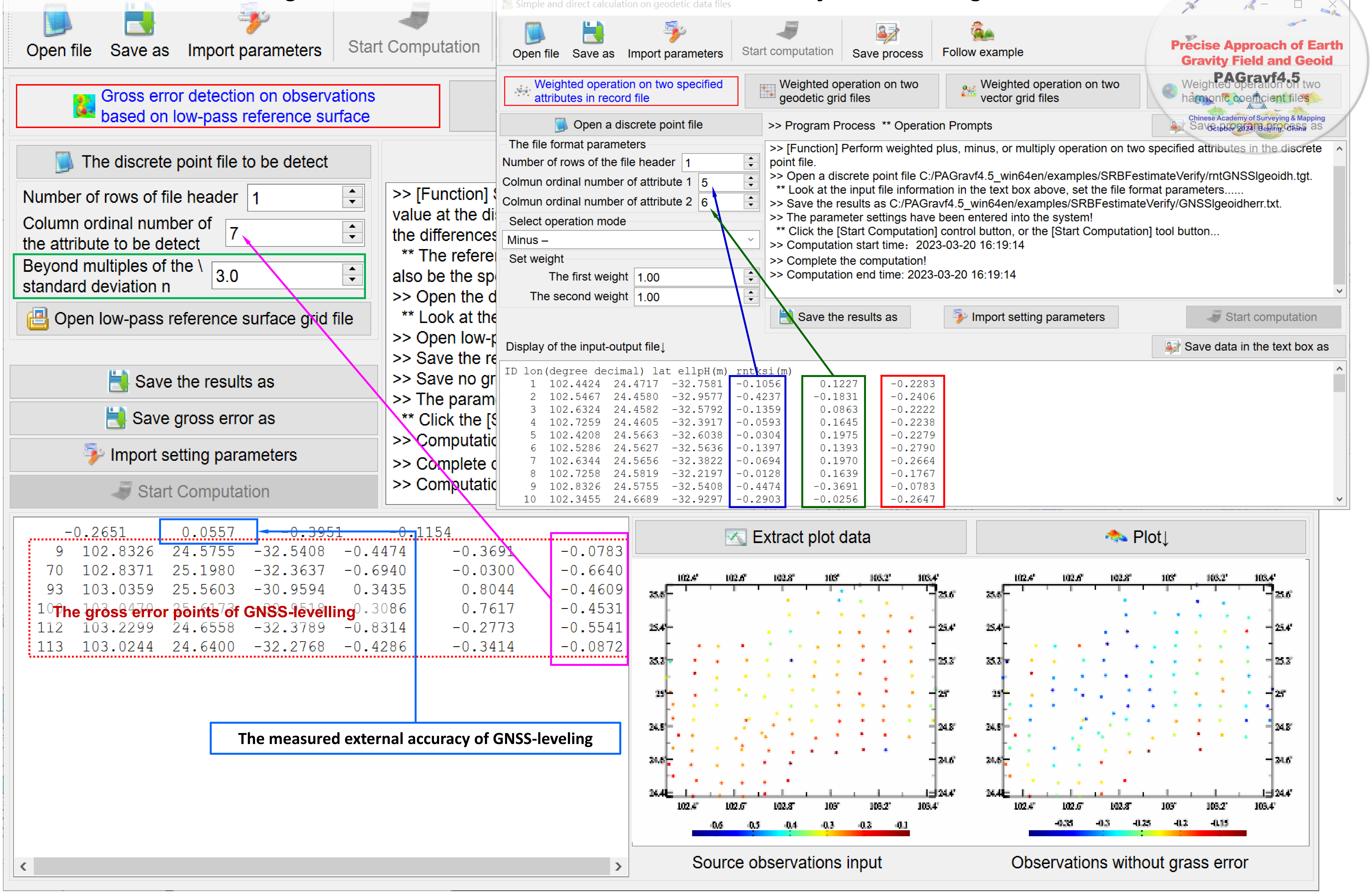
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.

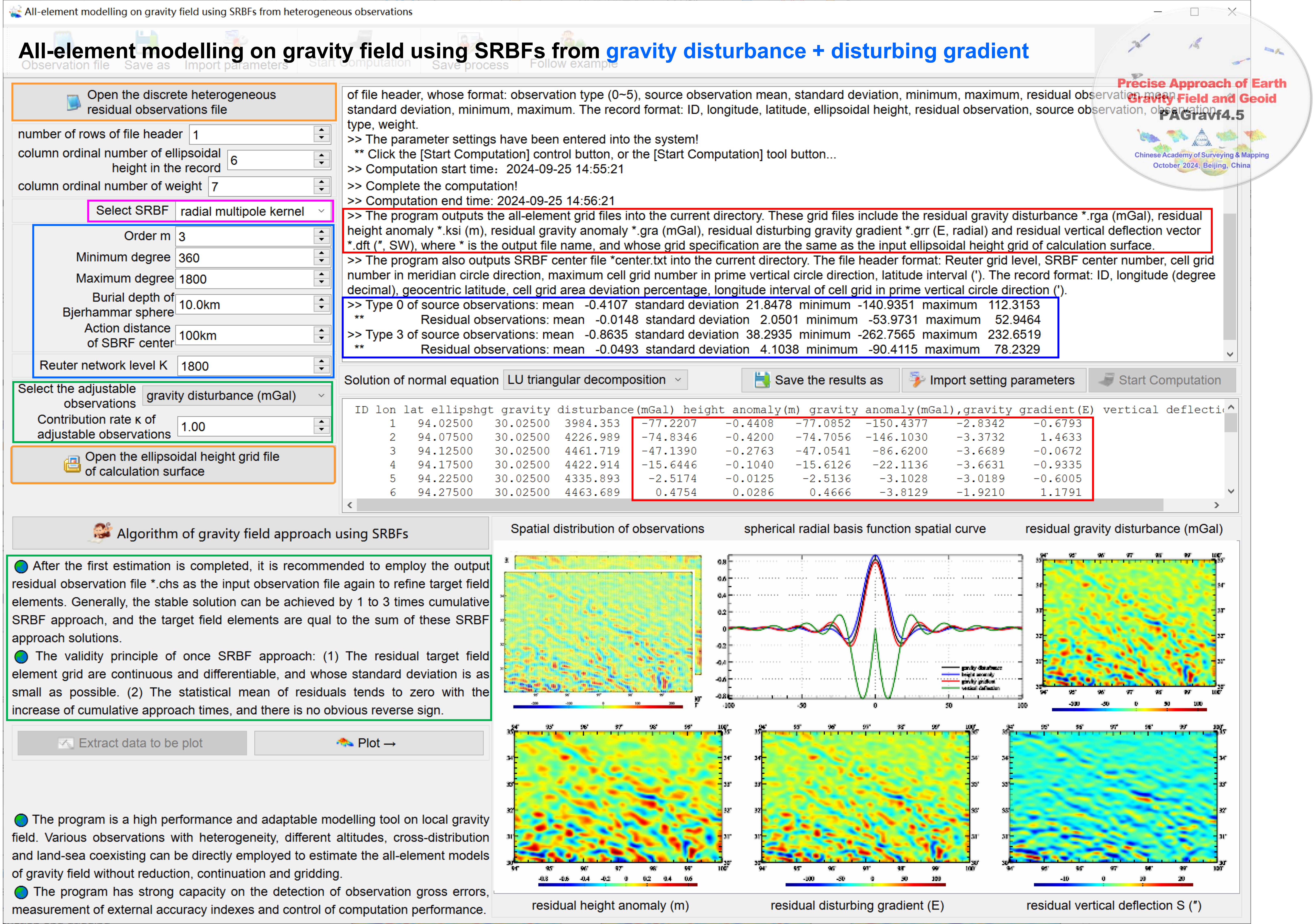
The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

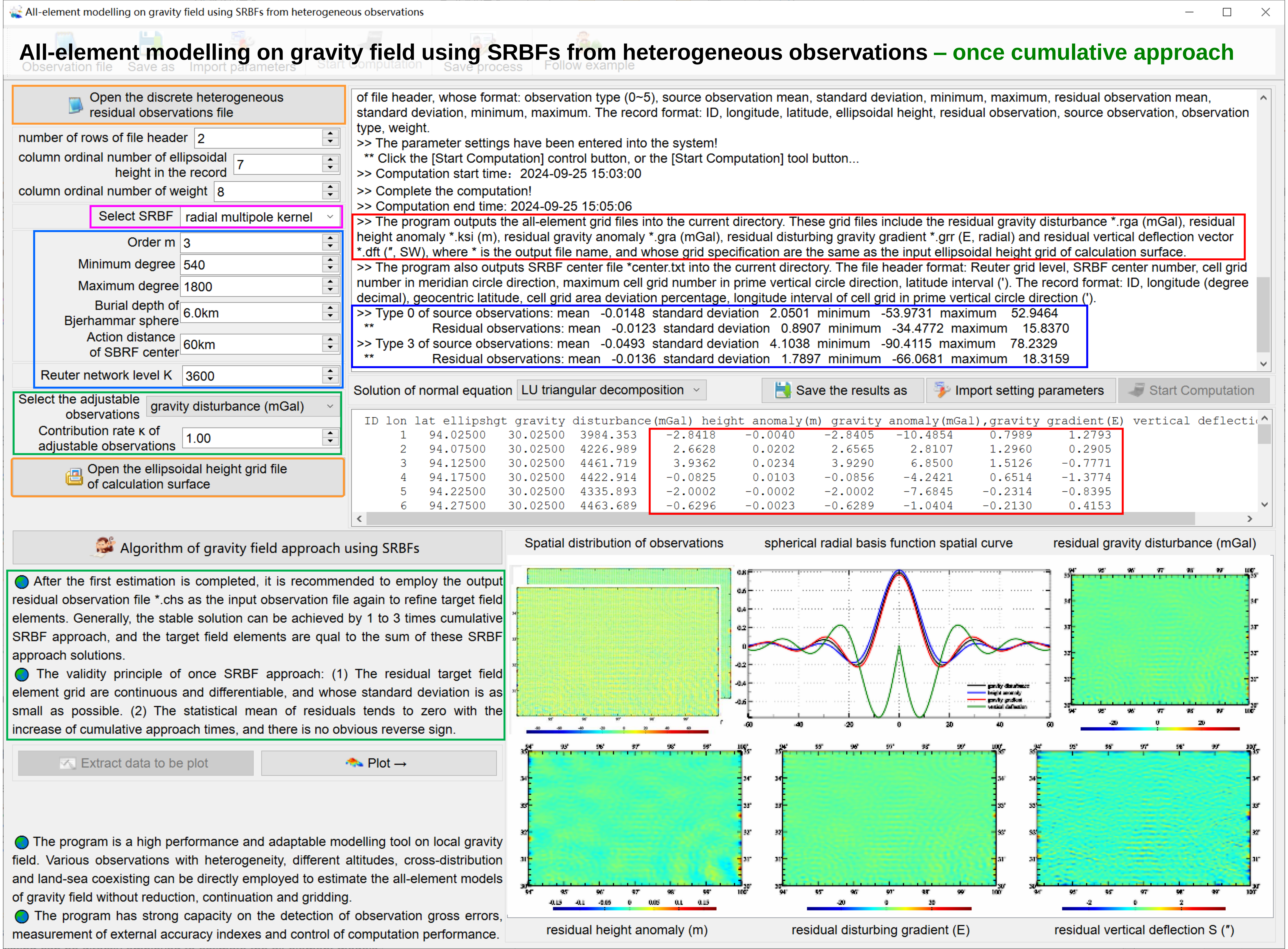

Gravity field approach using SRBFs in spectral domain and performance test
Gravity field approach performance using SRBFs - vertical deflection → disturbing gravity gradient
Observation file
Save as
Import parameters
Start Computation
Follow example
Save process
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the discrete residual anomalous field element observation file
Select type of observations
vertical deflection vector (")
Set observations file format
number of rows of file header
1
column ordinal number of ellipsoidal height in the record
4
column ordinal number of weight
0
column ordinal number of vertical deflection westward
8
column ordinal number of vertical deflection southward
9
Select SRBF
radial multipole kernel
Set SRBF parameters
Order m
1
Minimum degree
360
Maximum degree
1800
Burial depth of Bjerhammar sphere
10.0km
Action distance of SBRF center
100km
Reuter network level K
1800
Open the ellipsoidal height grid file of calculation surface
Solution of normal equation
LU triangular decomposition
Synchronous calculation of elements at discrete points
If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.
Extract data to be plot
Plot→
SRBF approach algorithms
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-25 12:14:01
>> Complete the computation!
>> Computation end time: 2024-09-25 12:14:32
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean -0.0129 standard deviation 3.2354 minimum -19.8241 maximum 23.1114 of the source observations.
** mean 0.0039 standard deviation 0.3118 minimum -9.2421 maximum 10.5513 of the result residuals.
Type of target element
disturbing gradient (E, radial)
Save the results as
Import setting parameters
Start Computation
94.00000000 100.00000000 30.00000000 35.00000000 0.05000000 0.05000000 0.0000
-131.5563 -121.2759 -68.2304 -15.2280 2.8825 4.9227 13.5714 28.3154 28.5758 -1.9308
-20.5629 37.0549 50.9059 4.0181 -65.4929 -87.5943 -45.4304 5.3181 21.8382 5.4180
49.8439 -43.1920 -110.4821 -99.4924 -20.8064 74.7930 127.9823 116.0991 66.5645 5.4139
38.8682 24.1678 -1.4172 -1.5540 23.2691 49.4169 34.1032 -24.8001 -89.4196 -125.3868
-4.0226 -15.5614 -50.6659 -82.7878 -94.7657 -84.2882 -63.3140 -40.0268 -14.1636 6.7163
45.7625 71.6289 58.8982 -13.4971 -105.9081 -149.7673 -110.3400 -32.7756 18.5034 23.2139
37.2386 16.2392 -27.4959 -63.2113 -55.3159 3.3591 82.1004 124.5486 86.5544 -18.3114
gravity disturbance
height anomaly
gravity gradient
vertical deflection
observed residual vertical deflection (", S)
spherical radial basis function spatial curve
target residual disturbing gradient (E, R)
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

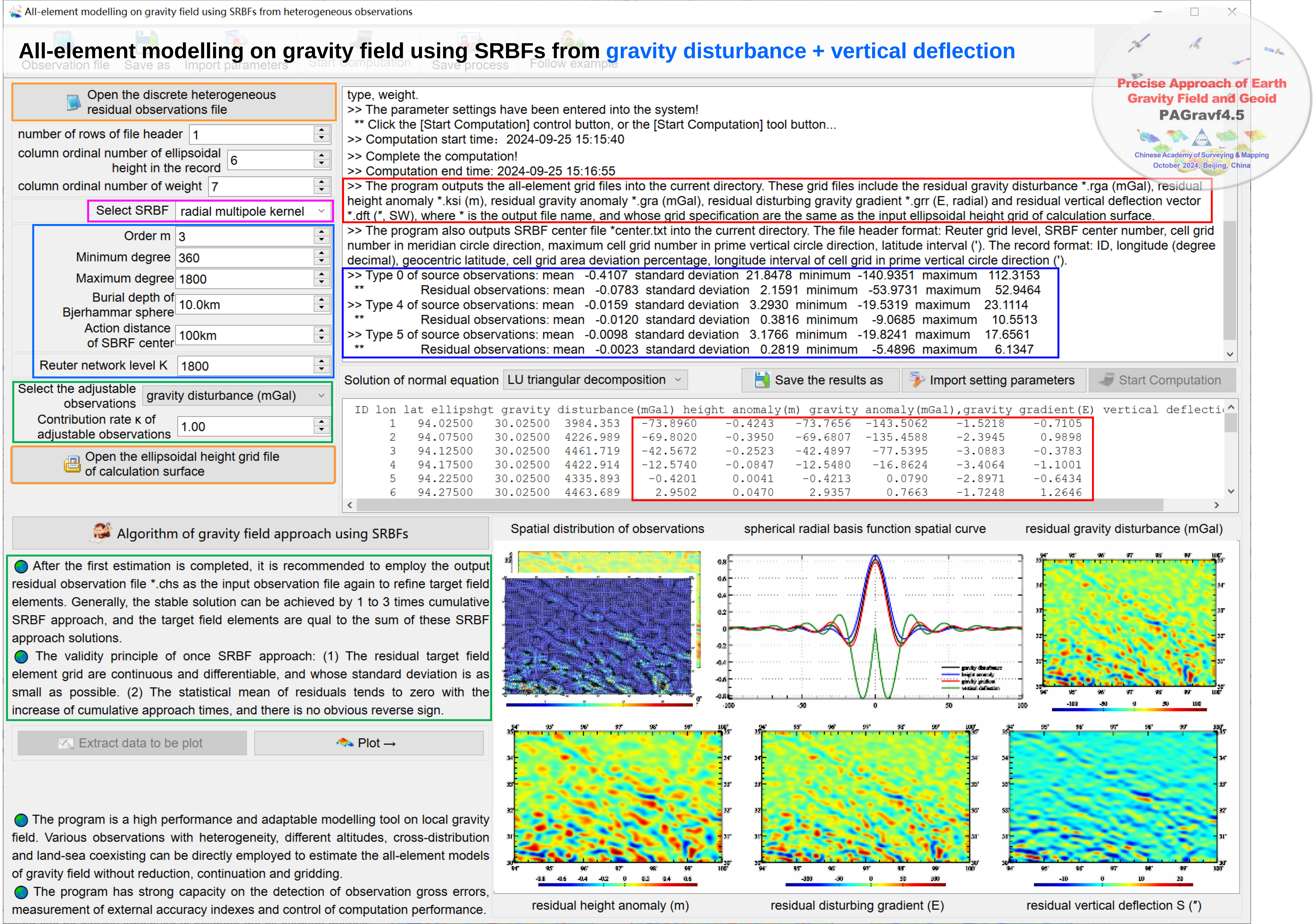

Gravity field approach using SRBFs in spectral domain and performance test
Detection of observation gross errors and measurement of external accuracy indexes using SRBFs
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the discrete residual anomalous field element observation file
Select type of observations
gravity disturbance (mGal)
Set observations file format
number of rows of file header
1
column ordinal number of ellipsoidal height in the record
4
column ordinal number of weight
0
column ordinal number of the gravity disturbance
7
Select SRBF
radial multipole kernel
Set SRBF parameters
Order m
1
Minimum degree
360
Maximum degree
1800
Burial depth of Bjerhammar sphere
10.0km
Action distance of SBRF center
100km
Reuter network level K
1800
Open the ellipsoidal height grid file of calculation surface
Solution of normal equation
LU triangular decomposition
Synchronous calculation of elements at discrete points
If the measuring points of the target observations to be evaluated are taken as the calculation points, the field element at the measuring point can be estimated from the observations input by the program, and then we can effectively detect the gross error of the target observations to be evaluated and measure their external accuracy indexes.
Open the calculation point space location file
Extract data to be plot
Plot→
SRBF approach algorithms
maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-25 14:13:09
>> Complete the computation!
>> Computation end time: 2024-09-25 14:13:35
>> The program outputs the target type of field element file &.tgt of the calculation points into the current directory, where & is the output file name.
>> The program also outputs various field elements' SRBF spatial curve file *spc.rbf, various field elements' SRBF spectral curve files *dgr.rbf and SRBF center file* center.txt into the current directory.
** *spc.rbf file header format: SRBF type (0-radial multipole kernel function, 1-Poisson wavelet kernel function), order of SRBF, Minimum and maximum degree of SRBF Legendre expansion, Bjerhammar sphere buried depth (km). The record format: spherical distance (km), the normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** The file header of *dgr.rbf is the same as *spc.rbf. The record format: the degree n of SRBF Legendre expansion, degree n normalized SRBF values from the gravity disturbance, height anomaly, disturbing gravity gradient and total vertical deflection.
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Mean 0.3186 standard deviation 42.1772 minimum -296.0915 maximum 165.2611 of the source observations.
** mean -0.4365 standard deviation 16.8116 minimum -96.1056 maximum 86.3113 of the result residuals.
Type of target element
height anomaly (m)
Save the results as
Import setting parameters
Start Computation
101.500000 104.200000 24.000000 26.400000 8.333333333E-03 8.333333333E-03
-0.4912 -0.5786 -0.6274 -0.6591 -0.7090 -0.7608 -0.8090 -0.8661 -0.9124 -0.9433
-1.1649 -1.1867 -1.2073 -1.2110 -1.2162 -1.2077 -1.1991 -1.1762 -1.1479 -1.0960
-0.6807 -0.5738 -0.4708 -0.3505 -0.2356 -0.1163 0.0023 0.1311 0.2527 0.3708
1.0154 1.0716 1.1368 1.1921 1.2511 1.2863 1.3079 1.3179 1.3200 1.3026
1.0660 0.9977 0.9349 0.8780 0.7992 0.7183 0.6436 0.5732 0.4894 0.4073
-0.0221 -0.0980 -0.1504 -0.1790 -0.2310 -0.2657 -0.2762 -0.3251 -0.3318 -0.2904
-0.2487 -0.2257 -0.2066 -0.1937 -0.1782 -0.1227 -0.0995 -0.0813 -0.0580 -0.0299
gravity disturbance
height anomaly
gravity gradient
vertical deflection
observed residual gravity disturbance (mGal)
spherical radial basis function spatial curve
target residual height anomaly (m)
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observations file again to refine target field elements by the multiple cumulative SRBF approach. Generally, the stable solution can be achieved by accumulating 1-3 times SRBF approaches, and the target field elements are equal to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) the target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Detection of observation gross errors and measurement of external accuracy indexes using SRBFs




All-element modelling on gravity field using SRBFs from heterogeneous observations
All-element modelling on gravity field using SRBFs from gravity disturbance + disturbing gradient
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the discrete heterogeneous residual observations file
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 6
column ordinal number of weight 7
Select SRBF radial multipole kernel
Order m 3
Minimum degree 360
Maximum degree 1800
Burial depth of Bjerhammar sphere 10.0km
Action distance of SBRF center 100km
Reuter network level K 1800
Select the adjustable observations gravity disturbance (mGal)
Contribution rate κ of adjustable observations 1.00
Open the ellipsoidal height grid file of calculation surface
of file header, whose format: observation type (0~5), source observation mean, standard deviation, minimum, maximum, residual observation mean, standard deviation, minimum, maximum. The record format: ID, longitude, latitude, ellipsoidal height, residual observation, source observation, observation type, weight.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-25 14:55:21
>> Complete the computation!
>> Computation end time: 2024-09-25 14:56:21
>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.
>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Type 0 of source observations: mean -0.4107 standard deviation 21.8478 minimum -140.9351 maximum 112.3153
** Residual observations: mean -0.0148 standard deviation 2.0501 minimum -53.9731 maximum 52.9464
>> Type 3 of source observations: mean -0.8635 standard deviation 38.2935 minimum -262.7565 maximum 232.6519
** Residual observations: mean -0.0493 standard deviation 4.1038 minimum -90.4115 maximum 78.2329
Solution of normal equation LU triangular decomposition
Save the results as
Import setting parameters
Start Computation
ID lon lat ellipshgt gravity disturbance(mGal) height anomaly(m) gravity anomaly(mGal),gravity gradient(E) vertical deflecti
1 94.02500 30.02500 3984.353 -77.2207 -0.4408 -77.0852 -150.4377 -2.8342 -0.6793
2 94.07500 30.02500 4226.989 -74.8346 -0.4200 -74.7056 -146.1030 -3.3732 1.4633
3 94.12500 30.02500 4461.719 -47.1390 -0.2763 -47.0541 -86.6200 -3.6689 -0.0672
4 94.17500 30.02500 4422.914 -15.6446 -0.1040 -15.6126 -22.1136 -3.6631 -0.9335
5 94.22500 30.02500 4335.893 -2.5174 -0.0125 -2.5136 -3.1028 -3.0189 -0.6005
6 94.27500 30.02500 4463.689 0.4754 0.0286 0.4666 -3.8129 -1.9210 1.1791
Algorithm of gravity field approach using SRBFs
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.
Extract data to be plot
Plot →
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.
The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.
Spatial distribution of observations
spherical radial basis function spatial curve
residual gravity disturbance (mGal)
residual height anomaly (m)
residual disturbing gradient (E)
residual vertical deflection S (″)


All-element modelling on gravity field using SRBFs from heterogeneous observations
All-element modelling on gravity field using SRBFs from heterogeneous observations – once cumulative approach
Observation file
Save as
Import parameters
Start Computation
Save process
Follow example
Open the discrete heterogeneous residual observations file
number of rows of file header 2
column ordinal number of ellipsoidal height in the record 7
column ordinal number of weight 8
Select SRBF radial multipole kernel
Order m 3
Minimum degree 540
Maximum degree 1800
Burial depth of Bjerhammar sphere 6.0km
Action distance of SBRF center 60km
Reuter network level K 3600
Select the adjustable observations gravity disturbance (mGal)
Contribution rate κ of adjustable observations 1.00
Open the ellipsoidal height grid file of calculation surface
of file header, whose format: observation type (0~5), source observation mean, standard deviation, minimum, maximum, residual observation mean, standard deviation, minimum, maximum. The record format: ID, longitude, latitude, ellipsoidal height, residual observation, source observation, observation type, weight.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-25 15:03:00
>> Complete the computation!
>> Computation end time: 2024-09-25 15:05:06
>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.
>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Type 0 of source observations: mean -0.0148 standard deviation 2.0501 minimum -53.9731 maximum 52.9464
** Residual observations: mean -0.0123 standard deviation 0.8907 minimum -34.4772 maximum 15.8370
>> Type 3 of source observations: mean -0.0493 standard deviation 4.1038 minimum -90.4115 maximum 78.2329
** Residual observations: mean -0.0136 standard deviation 1.7897 minimum -66.0681 maximum 18.3159
Solution of normal equation LU triangular decomposition
Save the results as
Import setting parameters
Start Computation
ID lon lat ellipshgt gravity disturbance(mGal) height anomaly(m) gravity anomaly(mGal),gravity gradient(E) vertical deflecti
1 94.02500 30.02500 3984.353 -2.8418 -0.0040 -2.8405 -10.4854 0.7989 1.2793
2 94.07500 30.02500 4226.989 2.6628 0.0202 2.6565 2.8107 1.2960 0.2905
3 94.12500 30.02500 4461.719 3.9362 0.0234 3.9290 6.8500 1.5126 -0.7771
4 94.17500 30.02500 4422.914 -0.0825 0.0103 -0.0856 -4.2421 0.6514 -1.3774
5 94.22500 30.02500 4335.893 -2.0002 -0.0002 -2.0002 -7.6845 -0.2314 -0.8395
6 94.27500 30.02500 4463.689 -0.6296 -0.0023 -0.6289 -1.0404 -0.2130 0.4153
Algorithm of gravity field approach using SRBFs
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.
Extract data to be plot
Plot →
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.
The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.
Spatial distribution of observations
spherical radial basis function spatial curve
residual gravity disturbance (mGal)
residual height anomaly (m)
residual disturbing gradient (E)
residual vertical deflection S (″)


All-element modelling on gravity field using SRBFs from heterogeneous observations
All-element modelling on gravity field using SRBFs from gravity disturbance + vertical deflection
Observation file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the discrete heterogeneous residual observations file
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 6
column ordinal number of weight 7
Select SRBF radial multipole kernel
Order m 3
Minimum degree 360
Maximum degree 1800
Burial depth of Bjerhammar sphere 10.0km
Action distance of SBRF center 100km
Reuter network level K 1800
Select the adjustable observations gravity disturbance (mGal)
Contribution rate κ of adjustable observations 1.00
Open the ellipsoidal height grid file of calculation surface
type, weight.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-25 15:15:40
>> Complete the computation!
>> Computation end time: 2024-09-25 15:16:55
>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.
>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Type 0 of source observations: mean -0.4107 standard deviation 21.8478 minimum -140.9351 maximum 112.3153
** Residual observations: mean -0.0783 standard deviation 2.1591 minimum -53.9731 maximum 52.9464
>> Type 4 of source observations: mean -0.0159 standard deviation 3.2930 minimum -19.5319 maximum 23.1114
** Residual observations: mean -0.0120 standard deviation 0.3816 minimum -9.0685 maximum 10.5513
>> Type 5 of source observations: mean -0.0098 standard deviation 3.1766 minimum -19.8241 maximum 17.6561
** Residual observations: mean -0.0023 standard deviation 0.2819 minimum -5.4896 maximum 6.1347
Solution of normal equation LU triangular decomposition
Save the results as
Import setting parameters
Start Computation
ID lon lat ellipshgt gravity disturbance(mGal) height anomaly(m) gravity anomaly(mGal),gravity gradient(E) vertical deflecti
1 94.02500 30.02500 3984.353 -73.8960 -0.4243 -73.7656 -143.5062 -1.5218 -0.7105
2 94.07500 30.02500 4226.989 -69.8020 -0.3950 -69.6807 -135.4588 -2.3945 0.9898
3 94.12500 30.02500 4461.719 -42.5672 -0.2523 -42.4897 -77.5395 -3.0883 -0.3783
4 94.17500 30.02500 4422.914 -12.5740 -0.0847 -12.5480 -16.8624 -3.4064 -1.1001
5 94.22500 30.02500 4335.893 -0.4201 0.0041 -0.4213 0.0790 -2.8971 -0.6434
6 94.27500 30.02500 4463.689 2.9502 0.0470 2.9357 0.7663 -1.7248 1.2646
Algorithm of gravity field approach using SRBFs
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.
Extract data to be plot
Plot →
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.
The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.
Spatial distribution of observations
spherical radial basis function spatial curve
residual gravity disturbance (mGal)
residual height anomaly (m)
residual disturbing gradient (E)
residual vertical deflection S (″)

All-element modelling on gravity field using SRBFs from heterogeneous observations

All-element modelling on gravity field using SRBFs from gravity disturbance + height anomaly + vertical deflection + disturbing gravity gradient

Follow example

Open the discrete heterogeneous residual observations file

number of rows of file header: 1

column ordinal number of ellipsoidal height in the record: 6

column ordinal number of weight: 7

Select SRBF: radial multipole kernel

Order m: 3

Minimum degree: 360

Maximum degree: 1800

Burial depth of Bjerhammar sphere: 10.0km

Action distance of SRBF center: 100km

Reuter network level K: 1800

Select the adjustable observations: height anomaly (m)

Contribution rate κ of adjustable observations: 1.00

Open the ellipsoidal height grid file of calculation surface

>> Complete the computation!
>> Computation end time: 2024-09-25 15:23:44
>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.
>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Type 0 of source observations: mean -0.4107 standard deviation 21.8478 minimum -140.9351 maximum 112.3153
** Residual observations: mean -0.0528 standard deviation 2.0522 minimum -53.9731 maximum 52.9464
>> Type 1 of source observations: mean -0.0020 standard deviation 0.1590 minimum -0.8621 maximum 0.6546
** Residual observations: mean 0.0003 standard deviation 0.0156 minimum -0.3763 maximum 0.4258
>> Type 3 of source observations: mean -0.8635 standard deviation 38.2935 minimum -262.7565 maximum 232.6519
** Residual observations: mean -0.1380 standard deviation 4.7873 minimum -90.4115 maximum 78.2329
>> Type 4 of source observations: mean -0.0159 standard deviation 3.2930 minimum -19.5319 maximum 23.1114
** Residual observations: mean -0.0140 standard deviation 0.4045 minimum -9.0195 maximum 10.5513
>> Type 5 of source observations: mean -0.0098 standard deviation 3.1766 minimum -19.8241 maximum 17.6561
** Residual observations: mean -0.0009 standard deviation 0.3000 minimum -5.4896 maximum 6.1347

Solution of normal equation: LU triangular decomposition | Save the results as | Import setting parameters | Start Computation

ID	lon	lat	ellipshgt	gravity disturbance(mGal)	height anomaly(m)	gravity anomaly(mGal),	gravity gradient(E)	vertical deflecti	
1	94.02500	30.02500	3984.353	-75.3276	-0.4299	-75.1955	-146.9135	-1.9322	-0.6048
2	94.07500	30.02500	4226.989	-71.6500	-0.4020	-71.5266	-139.8571	-2.6832	1.2613
3	94.12500	30.02500	4461.719	-43.8418	-0.2569	-43.7629	-80.4556	-3.2131	-0.2688
4	94.17500	30.02500	4422.914	-12.8478	-0.0850	-12.8217	-17.3550	-3.4320	-1.1824
5	94.22500	30.02500	4335.893	-0.2777	0.0058	-0.2795	0.3683	-2.9123	-0.7375
6	94.27500	30.02500	4463.689	2.7811	0.0482	2.7663	-0.0568	-1.8134	1.2613

Algorithm of gravity field approach using SRBFs

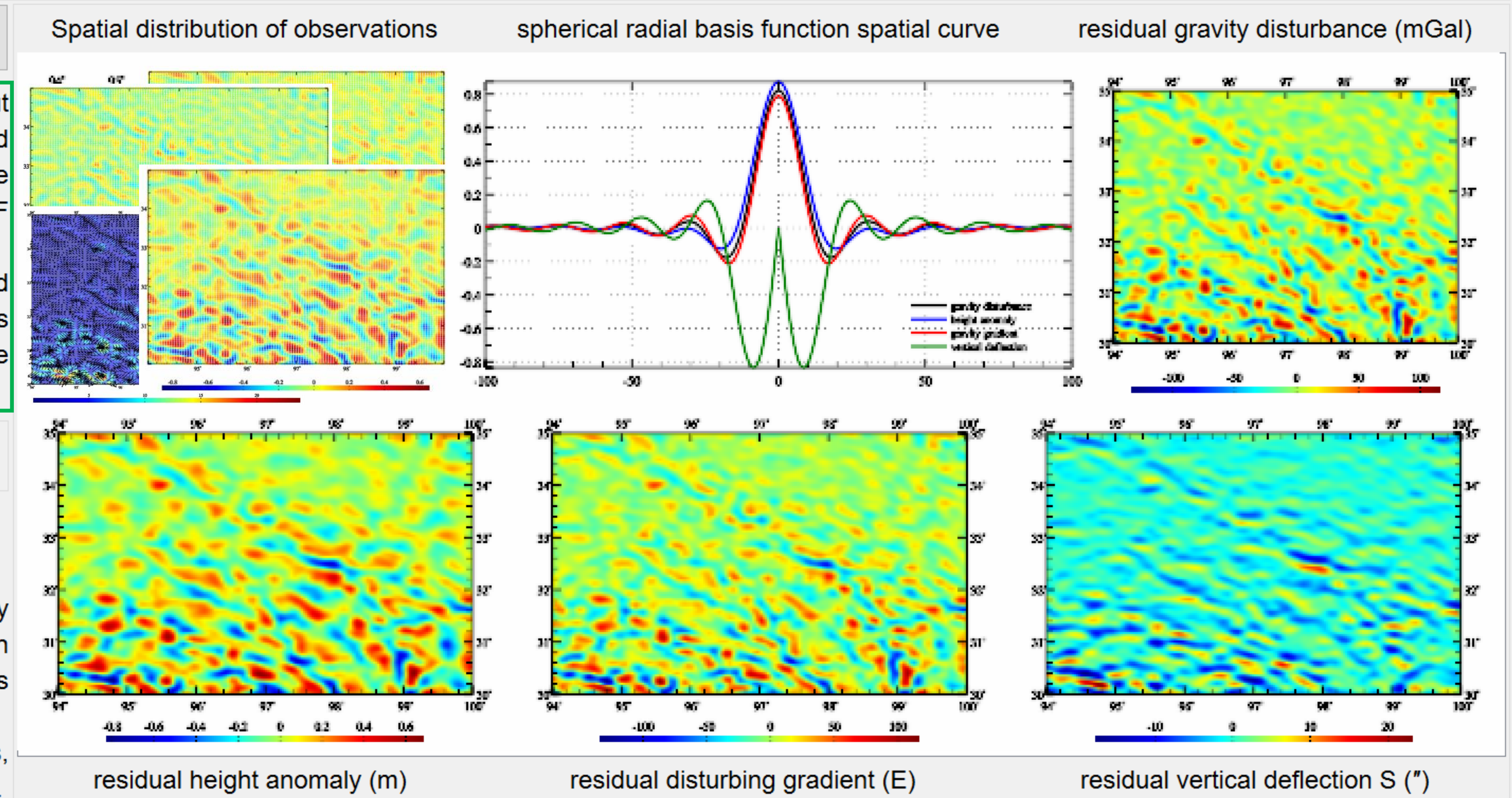
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.

The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Extract data to be plot | Plot →

The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.

The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.



Precise Approach of Earth Gravity Field and Geoid
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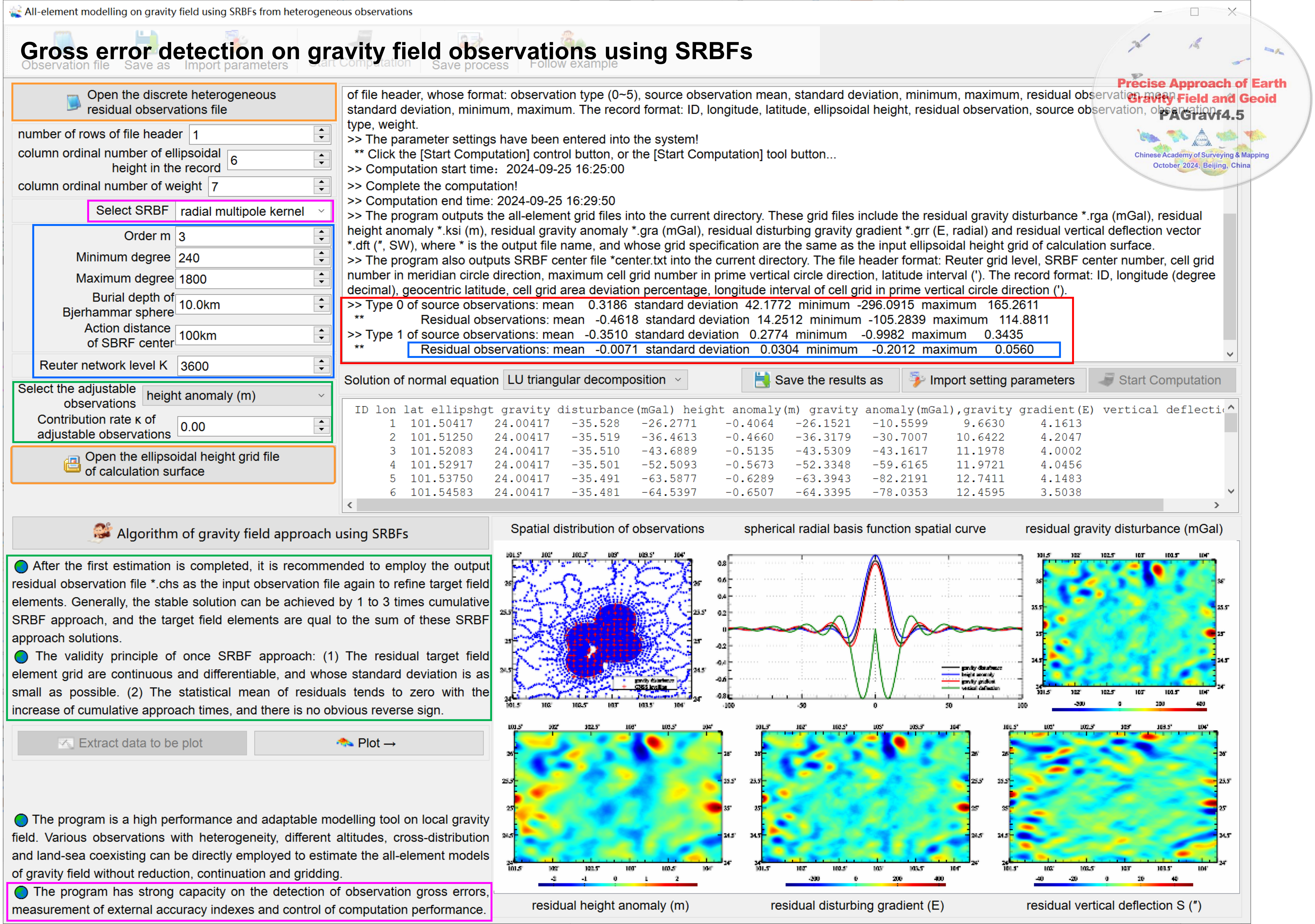
All-element modelling on gravity field using SRBFs from heterogeneous observations
Gross error detection on gravity field observations using SRBFs
Observation file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
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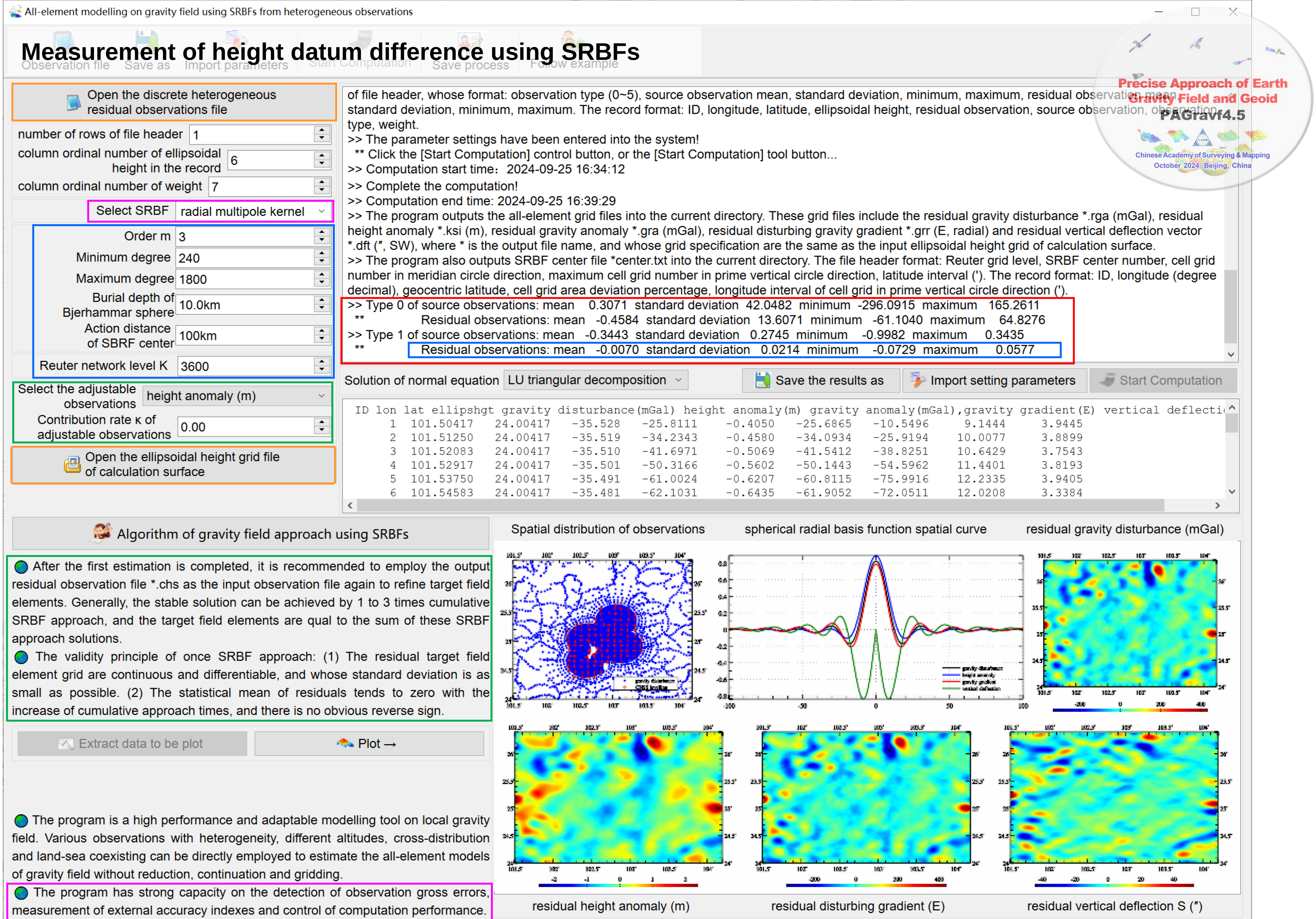
October 2024, Beijing, China
Open the discrete heterogeneous residual observations file
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 6
column ordinal number of weight 7
Select SRBF radial multipole kernel
Order m 3
Minimum degree 240
Maximum degree 1800
Burial depth of Bjerhammar sphere 10.0km
Action distance of SBRF center 100km
Reuter network level K 3600
Select the adjustable observations height anomaly (m)
Contribution rate κ of adjustable observations 0.00
Open the ellipsoidal height grid file of calculation surface
of file header, whose format: observation type (0~5), source observation mean, standard deviation, minimum, maximum, residual observation mean, standard deviation, minimum, maximum. The record format: ID, longitude, latitude, ellipsoidal height, residual observation, source observation, observation type, weight.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-25 16:25:00
>> Complete the computation!
>> Computation end time: 2024-09-25 16:29:50
>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.
>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Type 0 of source observations: mean 0.3186 standard deviation 42.1772 minimum -296.0915 maximum 165.2611
** Residual observations: mean -0.4618 standard deviation 14.2512 minimum -105.2839 maximum 114.8811
>> Type 1 of source observations: mean -0.3510 standard deviation 0.2774 minimum -0.9982 maximum 0.3435
** Residual observations: mean -0.0071 standard deviation 0.0304 minimum -0.2012 maximum 0.0560
Solution of normal equation LU triangular decomposition
Save the results as
Import setting parameters
Start Computation
ID lon lat ellipshgt gravity disturbance(mGal) height anomaly(m) gravity anomaly(mGal),gravity gradient(E) vertical deflecti
1 101.50417 24.00417 -35.528 -26.2771 -0.4064 -26.1521 -10.5599 9.6630 4.1613
2 101.51250 24.00417 -35.519 -36.4613 -0.4660 -36.3179 -30.7007 10.6422 4.2047
3 101.52083 24.00417 -35.510 -43.6889 -0.5135 -43.5309 -43.1617 11.1978 4.0002
4 101.52917 24.00417 -35.501 -52.5093 -0.5673 -52.3348 -59.6165 11.9721 4.0456
5 101.53750 24.00417 -35.491 -63.5877 -0.6289 -63.3943 -82.2191 12.7411 4.1483
6 101.54583 24.00417 -35.481 -64.5397 -0.6507 -64.3395 -78.0353 12.4595 3.5038
Algorithm of gravity field approach using SRBFs
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.
Extract data to be plot
Plot →
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.
The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.
Spatial distribution of observations
spherical radial basis function spatial curve
residual gravity disturbance (mGal)
residual height anomaly (m)
residual disturbing gradient (E)
residual vertical deflection S (″)


All-element modelling on gravity field using SRBFs from heterogeneous observations
Measurement of height datum difference using SRBFs
Observation file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
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Open the discrete heterogeneous residual observations file
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 6
column ordinal number of weight 7
Select SRBF radial multipole kernel
Order m 3
Minimum degree 240
Maximum degree 1800
Burial depth of Bjerhammar sphere 10.0km
Action distance of SRBF center 100km
Reuter network level K 3600
Select the adjustable observations height anomaly (m)
Contribution rate κ of adjustable observations 0.00
Open the ellipsoidal height grid file of calculation surface
of file header, whose format: observation type (0~5), source observation mean, standard deviation, minimum, maximum, residual observation mean, standard deviation, minimum, maximum. The record format: ID, longitude, latitude, ellipsoidal height, residual observation, source observation, observation type, weight.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-25 16:34:12
>> Complete the computation!
>> Computation end time: 2024-09-25 16:39:29
>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.
>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').
>> Type 0 of source observations: mean 0.3071 standard deviation 42.0482 minimum -296.0915 maximum 165.2611
** Residual observations: mean -0.4584 standard deviation 13.6071 minimum -61.1040 maximum 64.8276
>> Type 1 of source observations: mean -0.3443 standard deviation 0.2745 minimum -0.9982 maximum 0.3435
** Residual observations: mean -0.0070 standard deviation 0.0214 minimum -0.0729 maximum 0.0577
Solution of normal equation LU triangular decomposition
Save the results as
Import setting parameters
Start Computation
ID lon lat ellipshgt gravity disturbance(mGal) height anomaly(m) gravity anomaly(mGal),gravity gradient(E) vertical deflecti
1 101.50417 24.00417 -35.528 -25.8111 -0.4050 -25.6865 -10.5496 9.1444 3.9445
2 101.51250 24.00417 -35.519 -34.2343 -0.4580 -34.0934 -25.9194 10.0077 3.8899
3 101.52083 24.00417 -35.510 -41.6971 -0.5069 -41.5412 -38.8251 10.6429 3.7543
4 101.52917 24.00417 -35.501 -50.3166 -0.5602 -50.1443 -54.5962 11.4401 3.8193
5 101.53750 24.00417 -35.491 -61.0024 -0.6207 -60.8115 -75.9916 12.2335 3.9405
6 101.54583 24.00417 -35.481 -62.1031 -0.6435 -61.9052 -72.0511 12.0208 3.3384
Algorithm of gravity field approach using SRBFs
After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.
Extract data to be plot
Plot →
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.
The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.
Spatial distribution of observations
spherical radial basis function spatial curve
residual gravity disturbance (mGal)
residual height anomaly (m)
residual disturbing gradient (E)
residual vertical deflection S (″)

All-element modelling on gravity filed From observed gravity disturbance and GNSS-levelling geoidal height using SRBFs

All-element modelling on gravity field using SRBFs from heterogeneous observations

Observation file | Save as | Import parameters | Start Computation | Save process | Follow example

Precise Approach of Earth Gravity Field and Geoid
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Open the discrete heterogeneous residual observations file

number of rows of file header: 1

column ordinal number of ellipsoidal height in the record: 6

column ordinal number of weight: 7

Select SRBF: radial multipole kernel

Order m: 3

Minimum degree: 240

Maximum degree: 1800

Burial depth of Bjerhammar sphere: 10.0km

Action distance of SRBF center: 100km

Reuter network level K: 3600

Select the adjustable observations: height anomaly (m)

Contribution rate κ of adjustable observations: 1.00

Open the ellipsoidal height grid file of calculation surface

of file header, whose format: observation type (0~5), source observation mean, standard deviation, minimum, maximum, residual observation mean, standard deviation, minimum, maximum. The record format: ID, longitude, latitude, ellipsoidal height, residual observation, source observation, observation type, weight.

>> The parameter settings have been entered into the system!

** Click the [Start Computation] control button, or the [Start Computation] tool button...

>> Computation start time: 2024-09-25 16:42:57

>> Complete the computation!

>> Computation end time: 2024-09-25 16:48:19

>> The program outputs the all-element grid files into the current directory. These grid files include the residual gravity disturbance *.rga (mGal), residual height anomaly *.ksi (m), residual gravity anomaly *.gra (mGal), residual disturbing gravity gradient *.grr (E, radial) and residual vertical deflection vector *.dft (″, SW), where * is the output file name, and whose grid specification are the same as the input ellipsoidal height grid of calculation surface.

>> The program also outputs SRBF center file *center.txt into the current directory. The file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: ID, longitude (degree decimal), geocentric latitude, cell grid area deviation percentage, longitude interval of cell grid in prime vertical circle direction (').

>> Type 0 of source observations: mean 0.3071 standard deviation 42.0482 minimum -296.0915 maximum 165.2611

** Residual observations: mean -0.2139 standard deviation 12.7187 minimum -60.1001 maximum 64.8276

>> Type 1 of source observations: mean -0.0070 standard deviation 0.2745 minimum -0.6609 maximum 0.6808

** Residual observations: mean -0.0003 standard deviation 0.0232 minimum -0.0794 maximum 0.0535

Solution of normal equation: LU triangular decomposition | Save the results as | Import setting parameters | Start Computation

ID	lon	lat	ellipshgt	gravity disturbance(mGal)	height anomaly(m)	gravity anomaly(mGal),	gravity gradient(E)	vertical deflecti
1	101.50417	24.00417	-35.528	-36.3117	-0.3491	-36.2043	-45.0818	7.8888	3.1062
2	101.51250	24.00417	-35.519	-43.6862	-0.3963	-43.5642	-57.7869	8.6648	2.9724
3	101.52083	24.00417	-35.510	-50.4192	-0.4407	-50.2837	-68.8737	9.2166	2.7814
4	101.52917	24.00417	-35.501	-58.7040	-0.4911	-58.5529	-83.8445	9.9607	2.8003
5	101.53750	24.00417	-35.491	-68.0315	-0.5449	-67.8639	-101.6327	10.5899	2.8122
6	101.54583	24.00417	-35.481	-69.9342	-0.5694	-69.7590	-99.7716	10.4463	2.2628

Algorithm of gravity field approach using SRBFs

After the first estimation is completed, it is recommended to employ the output residual observation file *.chs as the input observation file again to refine target field elements. Generally, the stable solution can be achieved by 1 to 3 times cumulative SRBF approach, and the target field elements are qual to the sum of these SRBF approach solutions.

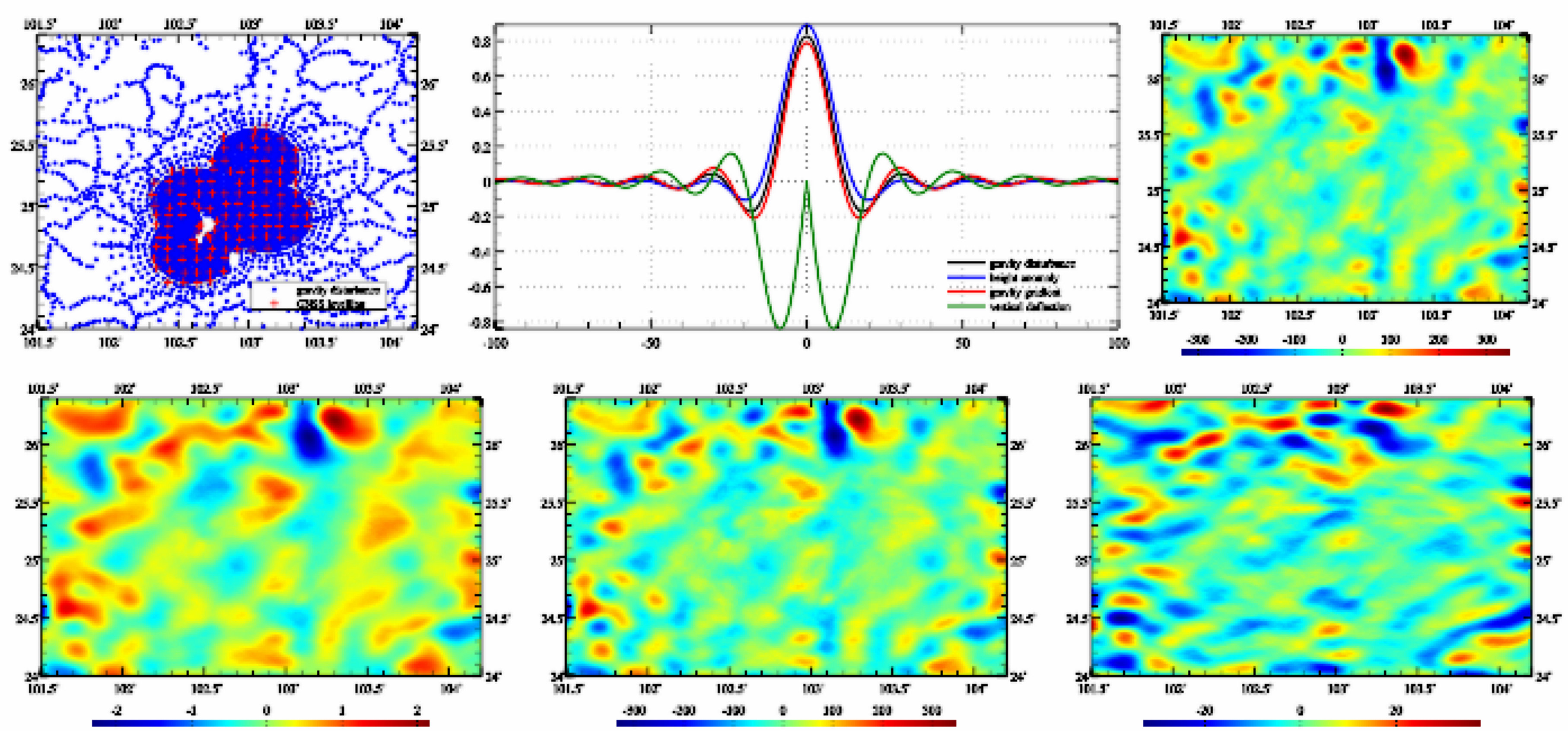
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious reverse sign.

Extract data to be plot | Plot →

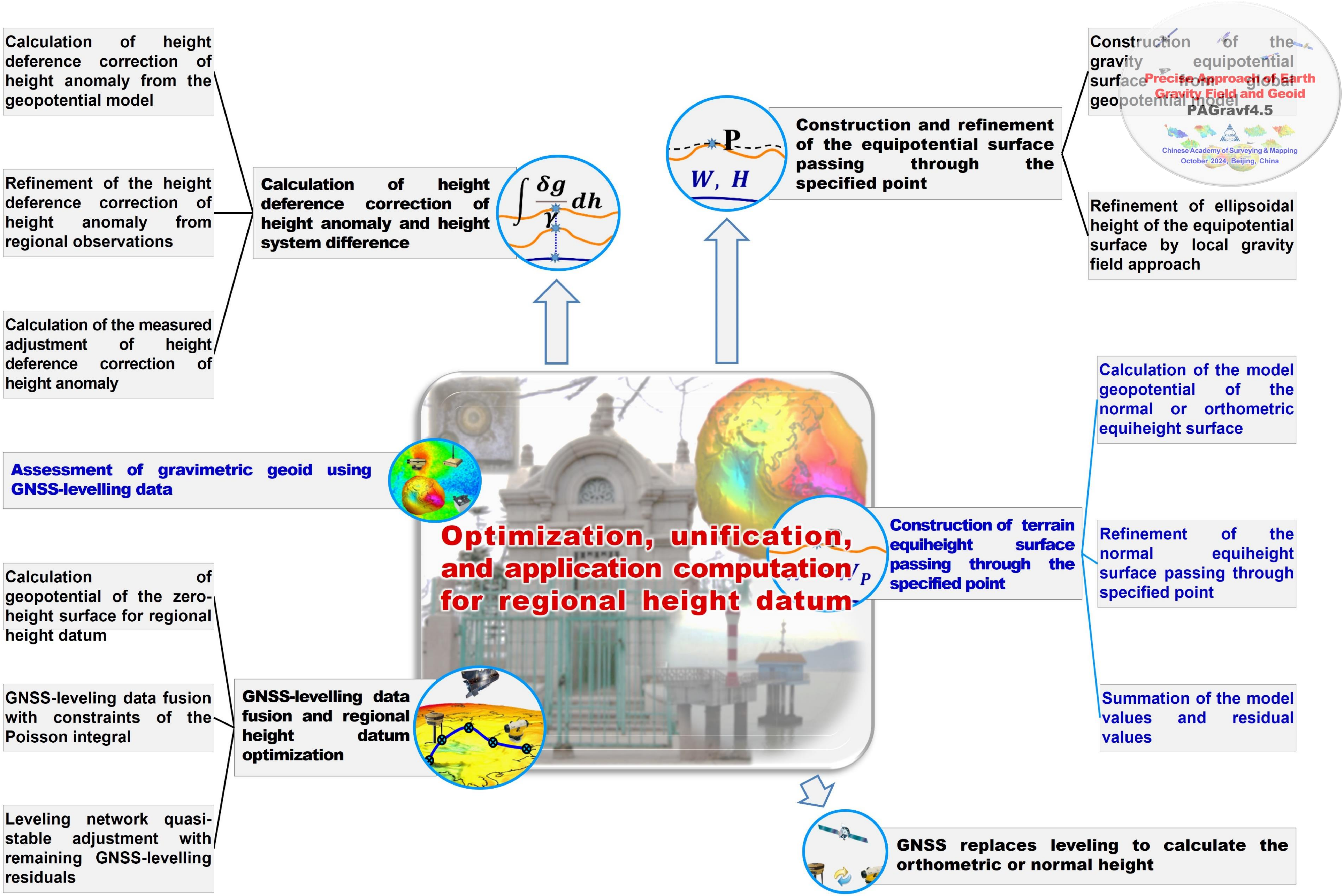
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation and gridding.

The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.

Spatial distribution of observations | spherical radial basis function spatial curve | residual gravity disturbance (mGal)



residual height anomaly (m) | residual disturbing gradient (E) | residual vertical deflection S (″)



Precise Approach of Earth Gravity Field and Geoid
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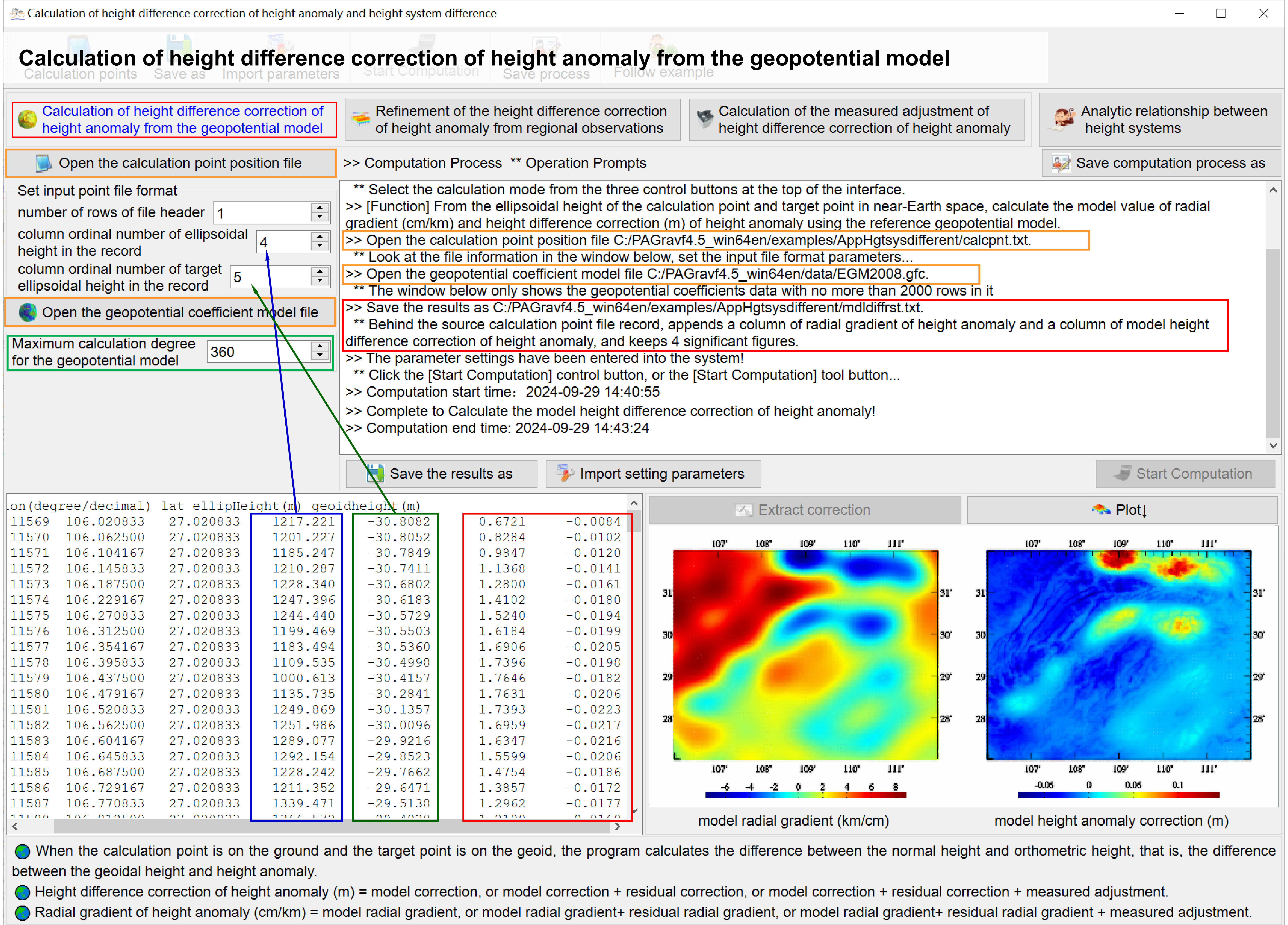
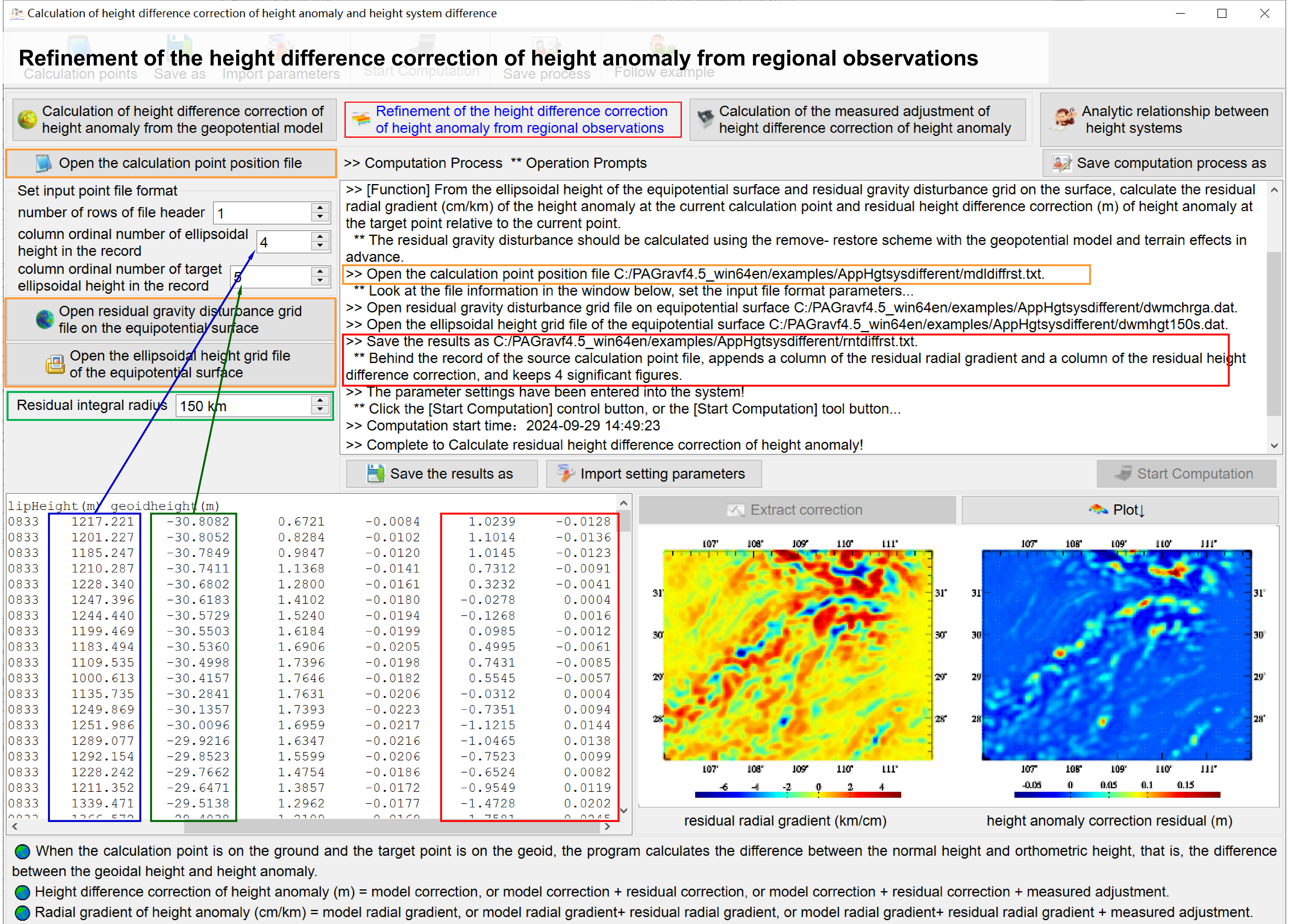
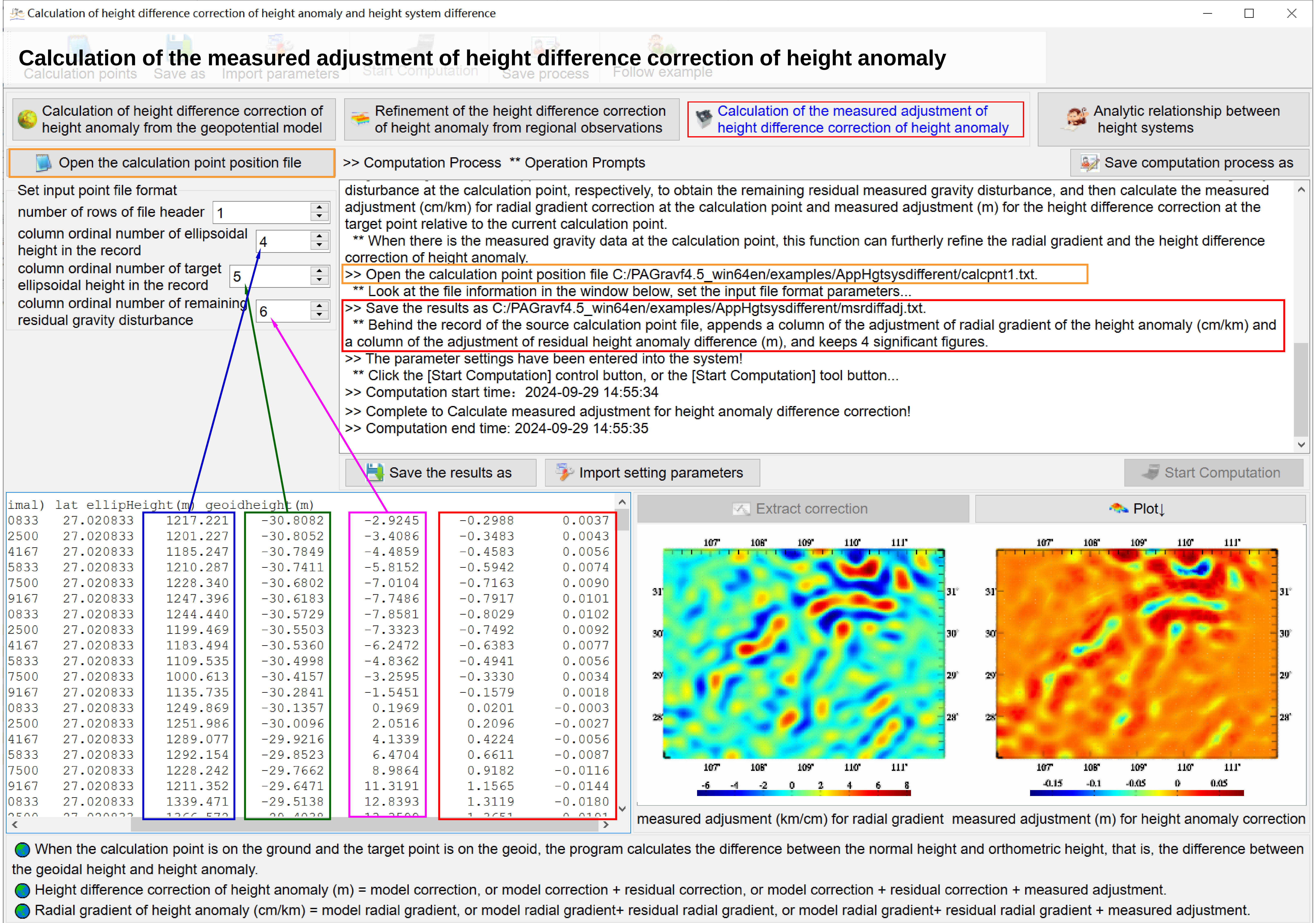

Calculation of height difference correction of height anomaly and height system difference
Calculation of height difference correction of height anomaly from the geopotential model
Calculation points
Save as
Import parameters
Start Computation
Save process
Follow example
Calculation of height difference correction of height anomaly from the geopotential model
Refinement of the height difference correction of height anomaly from regional observations
Calculation of the measured adjustment of height difference correction of height anomaly
Analytic relationship between height systems
Open the calculation point position file
>> Computation Process ** Operation Prompts
Save computation process as
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
column ordinal number of target ellipsoidal height in the record 5
Open the geopotential coefficient model file
Maximum calculation degree for the geopotential model 360
** Select the calculation mode from the three control buttons at the top of the interface.
>> [Function] From the ellipsoidal height of the calculation point and target point in near-Earth space, calculate the model value of radial gradient (cm/km) and height difference correction (m) of height anomaly using the reference geopotential model.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/calcpnt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Open the geopotential coefficient model file C:/PAGravf4.5_win64en/data/EGM2008.gfc.
** The window below only shows the geopotential coefficients data with no more than 2000 rows in it
>> Save the results as C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/mdldiffrst.txt.
** Behind the source calculation point file record, appends a column of radial gradient of height anomaly and a column of model height difference correction of height anomaly, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-29 14:40:55
>> Complete to Calculate the model height difference correction of height anomaly!
>> Computation end time: 2024-09-29 14:43:24
Save the results as
Import setting parameters
Start Computation
on(degree/decimal) lat ellipHeight(m) geoidheight(m)
11569 106.020833 27.020833 1217.221 -30.8082 0.6721 -0.0084
11570 106.062500 27.020833 1201.227 -30.8052 0.8284 -0.0102
11571 106.104167 27.020833 1185.247 -30.7849 0.9847 -0.0120
11572 106.145833 27.020833 1210.287 -30.7411 1.1368 -0.0141
11573 106.187500 27.020833 1228.340 -30.6802 1.2800 -0.0161
11574 106.229167 27.020833 1247.396 -30.6183 1.4102 -0.0180
11575 106.270833 27.020833 1244.440 -30.5729 1.5240 -0.0194
11576 106.312500 27.020833 1199.469 -30.5503 1.6184 -0.0199
11577 106.354167 27.020833 1183.494 -30.5360 1.6906 -0.0205
11578 106.395833 27.020833 1109.535 -30.4998 1.7396 -0.0198
11579 106.437500 27.020833 1000.613 -30.4157 1.7646 -0.0182
11580 106.479167 27.020833 1135.735 -30.2841 1.7631 -0.0206
11581 106.520833 27.020833 1249.869 -30.1357 1.7393 -0.0223
11582 106.562500 27.020833 1251.986 -30.0096 1.6959 -0.0217
11583 106.604167 27.020833 1289.077 -29.9216 1.6347 -0.0216
11584 106.645833 27.020833 1292.154 -29.8523 1.5599 -0.0206
11585 106.687500 27.020833 1228.242 -29.7662 1.4754 -0.0186
11586 106.729167 27.020833 1211.352 -29.6471 1.3857 -0.0172
11587 106.770833 27.020833 1339.471 -29.5138 1.2962 -0.0177
Extract correction
Plot↓
model radial gradient (km/cm)
model height anomaly correction (m)
When the calculation point is on the ground and the target point is on the geoid, the program calculates the difference between the normal height and orthometric height, that is, the difference between the geoidal height and height anomaly.
Height difference correction of height anomaly (m) = model correction, or model correction + residual correction, or model correction + residual correction + measured adjustment.
Radial gradient of height anomaly (cm/km) = model radial gradient, or model radial gradient+ residual radial gradient, or model radial gradient+ residual radial gradient + measured adjustment.



Calculation of height difference correction of height anomaly and height system difference
Refinement of the height difference correction of height anomaly from regional observations
Calculation points
Save as
Import parameters
Start Computation
Save process
Follow example
Calculation of height difference correction of height anomaly from the geopotential model
Refinement of the height difference correction of height anomaly from regional observations
Calculation of the measured adjustment of height difference correction of height anomaly
Analytic relationship between height systems
Open the calculation point position file
>> Computation Process ** Operation Prompts
Save computation process as
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
column ordinal number of target ellipsoidal height in the record 5
Open residual gravity disturbance grid file on the equipotential surface
Open the ellipsoidal height grid file of the equipotential surface
Residual integral radius 150 km
>> [Function] From the ellipsoidal height of the equipotential surface and residual gravity disturbance grid on the surface, calculate the residual radial gradient (cm/km) of the height anomaly at the current calculation point and residual height difference correction (m) of height anomaly at the target point relative to the current point.
** The residual gravity disturbance should be calculated using the remove- restore scheme with the geopotential model and terrain effects in advance.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/mdldiffrst.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Open residual gravity disturbance grid file on equipotential surface C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/dwmchrga.dat.
>> Open the ellipsoidal height grid file of the equipotential surface C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/dwmhgt150s.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/rntdiffrst.txt.
** Behind the record of the source calculation point file, appends a column of the residual radial gradient and a column of the residual height difference correction, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-29 14:49:23
>> Complete to Calculate residual height difference correction of height anomaly!
Save the results as
Import setting parameters
Start Computation
lipHeight(m) geoidheight(m)
0833 1217.221 -30.8082 0.6721 -0.0084 1.0239 -0.0128
0833 1201.227 -30.8052 0.8284 -0.0102 1.1014 -0.0136
0833 1185.247 -30.7849 0.9847 -0.0120 1.0145 -0.0123
0833 1210.287 -30.7411 1.1368 -0.0141 0.7312 -0.0091
0833 1228.340 -30.6802 1.2800 -0.0161 0.3232 -0.0041
0833 1247.396 -30.6183 1.4102 -0.0180 -0.0278 0.0004
0833 1244.440 -30.5729 1.5240 -0.0194 -0.1268 0.0016
0833 1199.469 -30.5503 1.6184 -0.0199 0.0985 -0.0012
0833 1183.494 -30.5360 1.6906 -0.0205 0.4995 -0.0061
0833 1109.535 -30.4998 1.7396 -0.0198 0.7431 -0.0085
0833 1000.613 -30.4157 1.7646 -0.0182 0.5545 -0.0057
0833 1135.735 -30.2841 1.7631 -0.0206 -0.0312 0.0004
0833 1249.869 -30.1357 1.7393 -0.0223 -0.7351 0.0094
0833 1251.986 -30.0096 1.6959 -0.0217 -1.1215 0.0144
0833 1289.077 -29.9216 1.6347 -0.0216 -1.0465 0.0138
0833 1292.154 -29.8523 1.5599 -0.0206 -0.7523 0.0099
0833 1228.242 -29.7662 1.4754 -0.0186 -0.6524 0.0082
0833 1211.352 -29.6471 1.3857 -0.0172 -0.9549 0.0119
0833 1339.471 -29.5138 1.2962 -0.0177 -1.4728 0.0202
Extract correction
Plot↓
residual radial gradient (km/cm)
height anomaly correction residual (m)
When the calculation point is on the ground and the target point is on the geoid, the program calculates the difference between the normal height and orthometric height, that is, the difference between the geoidal height and height anomaly.
Height difference correction of height anomaly (m) = model correction, or model correction + residual correction, or model correction + residual correction + measured adjustment.
Radial gradient of height anomaly (cm/km) = model radial gradient, or model radial gradient+ residual radial gradient, or model radial gradient+ residual radial gradient + measured adjustment.


Calculation of height difference correction of height anomaly and height system difference
Calculation of the measured adjustment of height difference correction of height anomaly
Calculation points Save as Import parameters Start Computation Save process Follow example
Calculation of height difference correction of height anomaly from the geopotential model
Refinement of the height difference correction of height anomaly from regional observations
Calculation of the measured adjustment of height difference correction of height anomaly
Analytic relationship between height systems
Open the calculation point position file
>> Computation Process ** Operation Prompts
Save computation process as
Set input point file format
number of rows of file header 1
column ordinal number of ellipsoidal height in the record 4
column ordinal number of target ellipsoidal height in the record 5
column ordinal number of remaining residual gravity disturbance 6
disturbance at the calculation point, respectively, to obtain the remaining residual measured gravity disturbance, and then calculate the measured adjustment (cm/km) for radial gradient correction at the calculation point and measured adjustment (m) for the height difference correction at the target point relative to the current calculation point.
** When there is the measured gravity data at the calculation point, this function can furtherly refine the radial gradient and the height difference correction of height anomaly.
>> Open the calculation point position file C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/calcpnt1.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/AppHgtsysdifferent/msrdiffadj.txt.
** Behind the record of the source calculation point file, appends a column of the adjustment of radial gradient of the height anomaly (cm/km) and a column of the adjustment of residual height anomaly difference (m), and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-29 14:55:34
>> Complete to Calculate measured adjustment for height anomaly difference correction!
>> Computation end time: 2024-09-29 14:55:35
Save the results as
Import setting parameters
Start Computation
imal) lat ellipHeight(m) geoidheight(m)
0833 27.020833 1217.221 -30.8082 -2.9245 -0.2988 0.0037
2500 27.020833 1201.227 -30.8052 -3.4086 -0.3483 0.0043
4167 27.020833 1185.247 -30.7849 -4.4859 -0.4583 0.0056
5833 27.020833 1210.287 -30.7411 -5.8152 -0.5942 0.0074
7500 27.020833 1228.340 -30.6802 -7.0104 -0.7163 0.0090
9167 27.020833 1247.396 -30.6183 -7.7486 -0.7917 0.0101
0833 27.020833 1244.440 -30.5729 -7.8581 -0.8029 0.0102
2500 27.020833 1199.469 -30.5503 -7.3323 -0.7492 0.0092
4167 27.020833 1183.494 -30.5360 -6.2472 -0.6383 0.0077
5833 27.020833 1109.535 -30.4998 -4.8362 -0.4941 0.0056
7500 27.020833 1000.613 -30.4157 -3.2595 -0.3330 0.0034
9167 27.020833 1135.735 -30.2841 -1.5451 -0.1579 0.0018
0833 27.020833 1249.869 -30.1357 0.1969 0.0201 -0.0003
2500 27.020833 1251.986 -30.0096 2.0516 0.2096 -0.0027
4167 27.020833 1289.077 -29.9216 4.1339 0.4224 -0.0056
5833 27.020833 1292.154 -29.8523 6.4704 0.6611 -0.0087
7500 27.020833 1228.242 -29.7662 8.9864 0.9182 -0.0116
9167 27.020833 1211.352 -29.6471 11.3191 1.1565 -0.0144
0833 27.020833 1339.471 -29.5138 12.8393 1.3119 -0.0180
Extract correction
Plot↓
measured adjusment (km/cm) for radial gradient
measured adjustment (m) for height anomaly correction
When the calculation point is on the ground and the target point is on the geoid, the program calculates the difference between the normal height and orthometric height, that is, the difference between the geoidal height and height anomaly.
Height difference correction of height anomaly (m) = model correction, or model correction + residual correction, or model correction + residual correction + measured adjustment.
Radial gradient of height anomaly (cm/km) = model radial gradient, or model radial gradient+ residual radial gradient, or model radial gradient+ residual radial gradient + measured adjustment.

Construction and refinement of equipotential surface passing through specified point

Construction of the gravity equipotential surface from global geopotential model

Grid range | Save as | Importg parameters | Start Computation | Save process | Follow example

Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China

Construction of the gravity equipotential surface from global geopotential model | Refinement of ellipsoidal height of the equipotential surface by local gravity field approach | Save computation process as

Open the equipotential surface range grid file

Open the geopotential coefficient model file

Input geodetic coordinates of the specified point

longitude 110.24560000°

latitude 27.46720000°

ellipsoidal height 1346.0240 m

Maximum calculation degree for the geopotential model 360

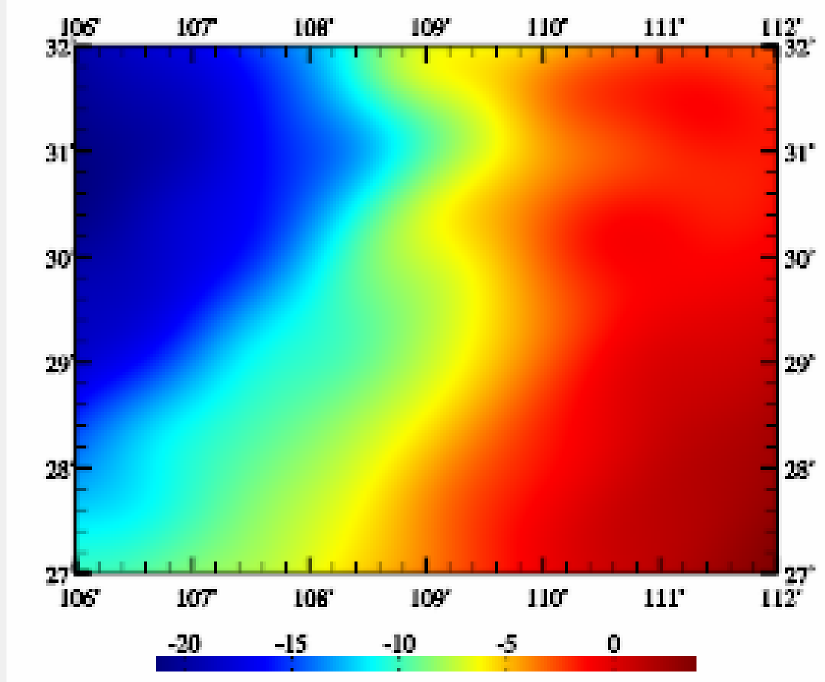
Save the model gravity grid as

Save model ellipsoidal height as

>> [Purpose] Firstly, calculate the model ellipsoidal height value of the gravity equipotential surface from the reference geopotential model, and then furtherly refine the ellipsoidal height grid of the equipotential surface from the anomalous field element grid using the remove-restore scheme.
** Select the function module the two control buttons at the top left of the interface...
>> [Function] From the geopotential coefficient model, calculate the model gravity (mGal) and model ellipsoidal height (m) grid of the gravity equipotential surface passing through the specified points (B, L, H).
>> The equipotential surface range grid file is only employed to give the latitude and longitude range and resolution of the surface grid.
>> Open the equipotential surface range grid file C:/PAGravf4.5_win64en/examples/AppEquipotentialhgt/areagrid.dat.
>> Open the geopotential coefficient model file C:/PAGravf4.5_win64en/data/EGM2008.gfc.
** The window below only shows the geopotential coefficients data with no more than 2000 rows in it
>> Save the model gravity grid as C:/PAGravf4.5_win64en/examples/AppEquipotentialhgt/eqpmdlgrav.dat.
>> Save model ellipsoidal height as C:/PAGravf4.5_win64en/examples/AppEquipotentialhgt/eqpmdlhgt.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The program needs to iteratively calculate the model ellipsoidal height grid of the equipotential surface, please wait...
>> Computation start time: 2024-09-26 10:12:29
>> Complete to calculate the model equipotential surface!
>> Computation end time: 2024-09-26 10:18:35

Import setting parameters | Start Computation | Extract results | Plot↓

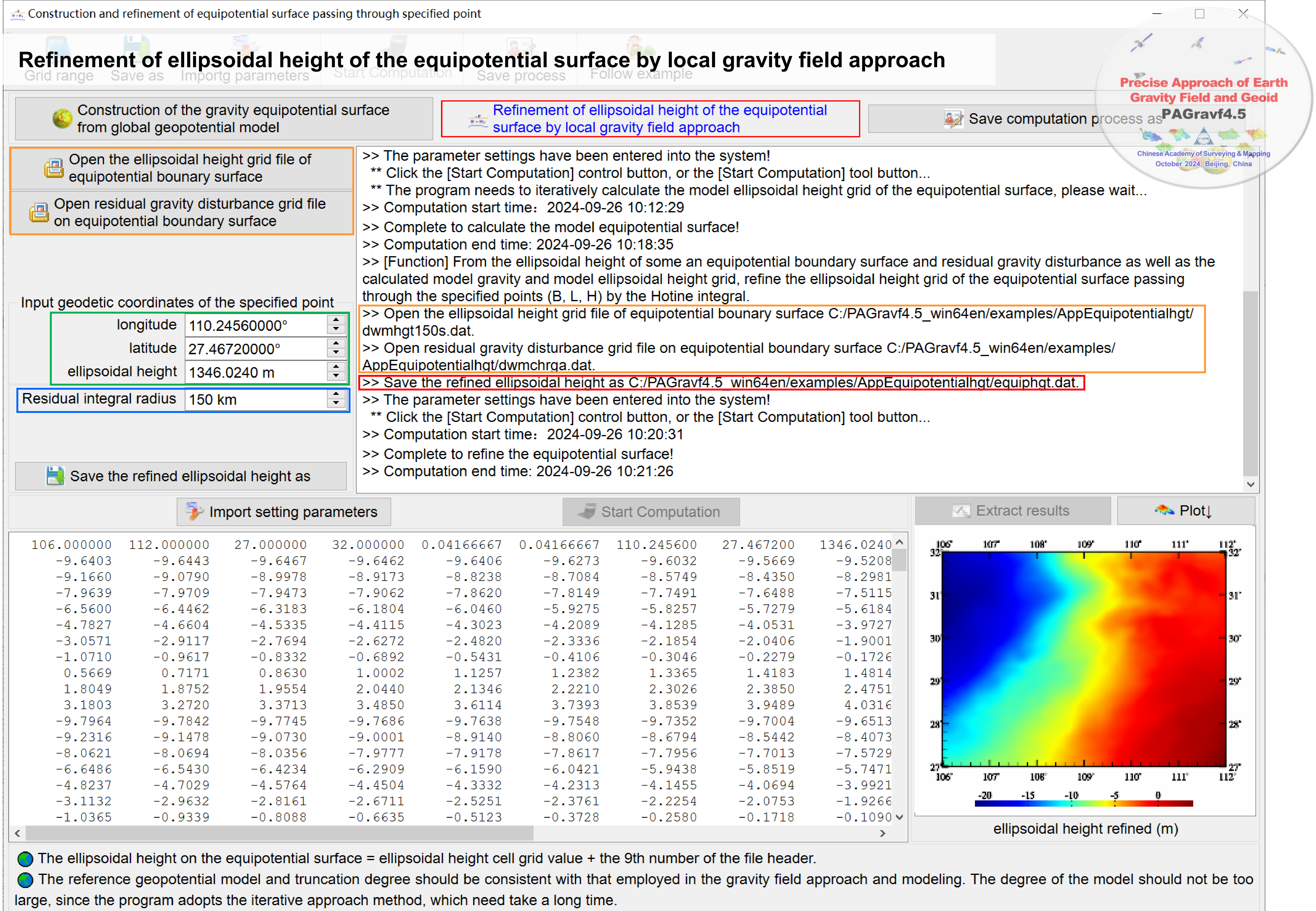
106.000000	112.000000	27.000000	32.000000	0.04166667	0.04166667	110.245600	27.467200	1346.0240
-10.0529	-10.0392	-10.0236	-10.0051	-9.9829	-9.9563	-9.9245	-9.8870	-9.8433
-9.3656	-9.2779	-9.1876	-9.0958	-9.0034	-8.9112	-8.8202	-8.7311	-8.6444
-8.1236	-8.0587	-7.9944	-7.9300	-7.8645	-7.7974	-7.7277	-7.6550	-7.5785
-6.9202	-6.8099	-6.6966	-6.5808	-6.4632	-6.3442	-6.2243	-6.1039	-5.9834
-5.1467	-5.0271	-4.9068	-4.7855	-4.6630	-4.5390	-4.4135	-4.2863	-4.1574
-3.2228	-3.0881	-2.9540	-2.8210	-2.6891	-2.5586	-2.4296	-2.3020	-2.1759
-1.3199	-1.1990	-1.0782	-0.9572	-0.8364	-0.7157	-0.5956	-0.4763	-0.3582
0.3964	0.4892	0.5776	0.6616	0.7415	0.8176	0.8903	0.9602	1.0279
1.5026	1.5788	1.6585	1.7421	1.8295	1.9208	2.0157	2.1139	2.2152
2.9668	3.0750	3.1826	3.2896	3.3960	3.5020	3.6078	3.7138	3.8203
-10.1508	-10.1392	-10.1255	-10.1090	-10.0889	-10.0642	-10.0344	-9.9988	-9.9570
-9.4888	-9.4016	-9.3115	-9.2195	-9.1264	-9.0333	-8.9409	-8.8500	-8.7611
-8.2166	-8.1476	-8.0794	-8.0110	-7.9419	-7.8712	-7.7983	-7.7226	-7.6435
-6.9784	-6.8686	-6.7561	-6.6413	-6.5249	-6.4072	-6.2886	-6.1696	-6.0504
-5.2172	-5.0969	-4.9755	-4.8528	-4.7286	-4.6026	-4.4747	-4.3449	-4.2131
-3.2540	-3.1156	-2.9780	-2.8415	-2.7063	-2.5726	-2.4406	-2.3102	-2.1816
-1.3138	-1.1921	-1.0706	-0.9492	-0.8281	-0.7073	-0.5871	-0.4679	-0.3500



model ellipsoidal height (m)

The ellipsoidal height on the equipotential surface = ellipsoidal height cell grid value + the 9th number of the file header.

The reference geopotential model and truncation degree should be consistent with that employed in the gravity field approach and modeling. The degree of the model should not be too large, since the program adopts the iterative approach method, which need take a long time.


Construction and refinement of equipotential surface passing through specified point
Refinement of ellipsoidal height of the equipotential surface by local gravity field approach
Grid range
Save as
Importg parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
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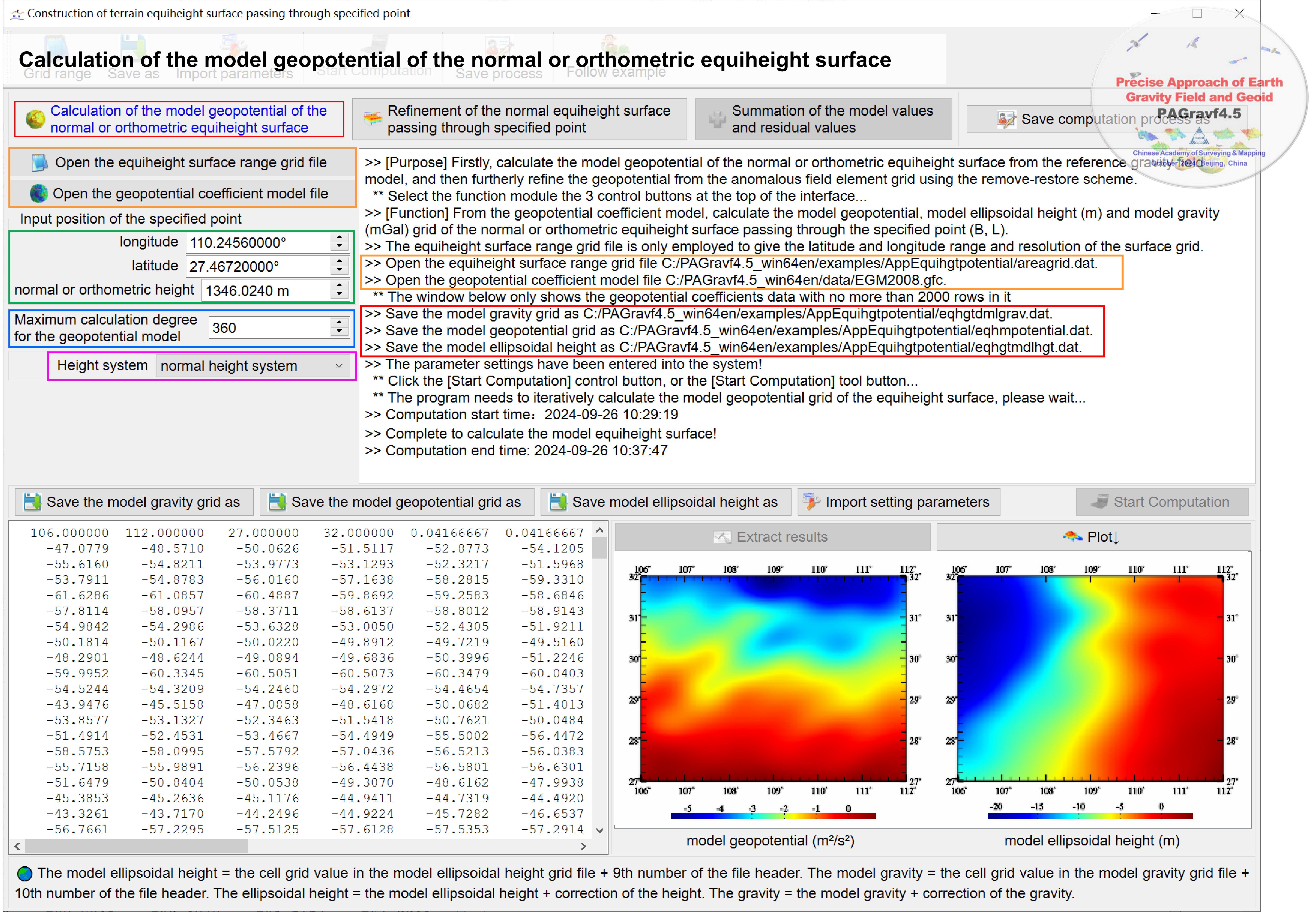
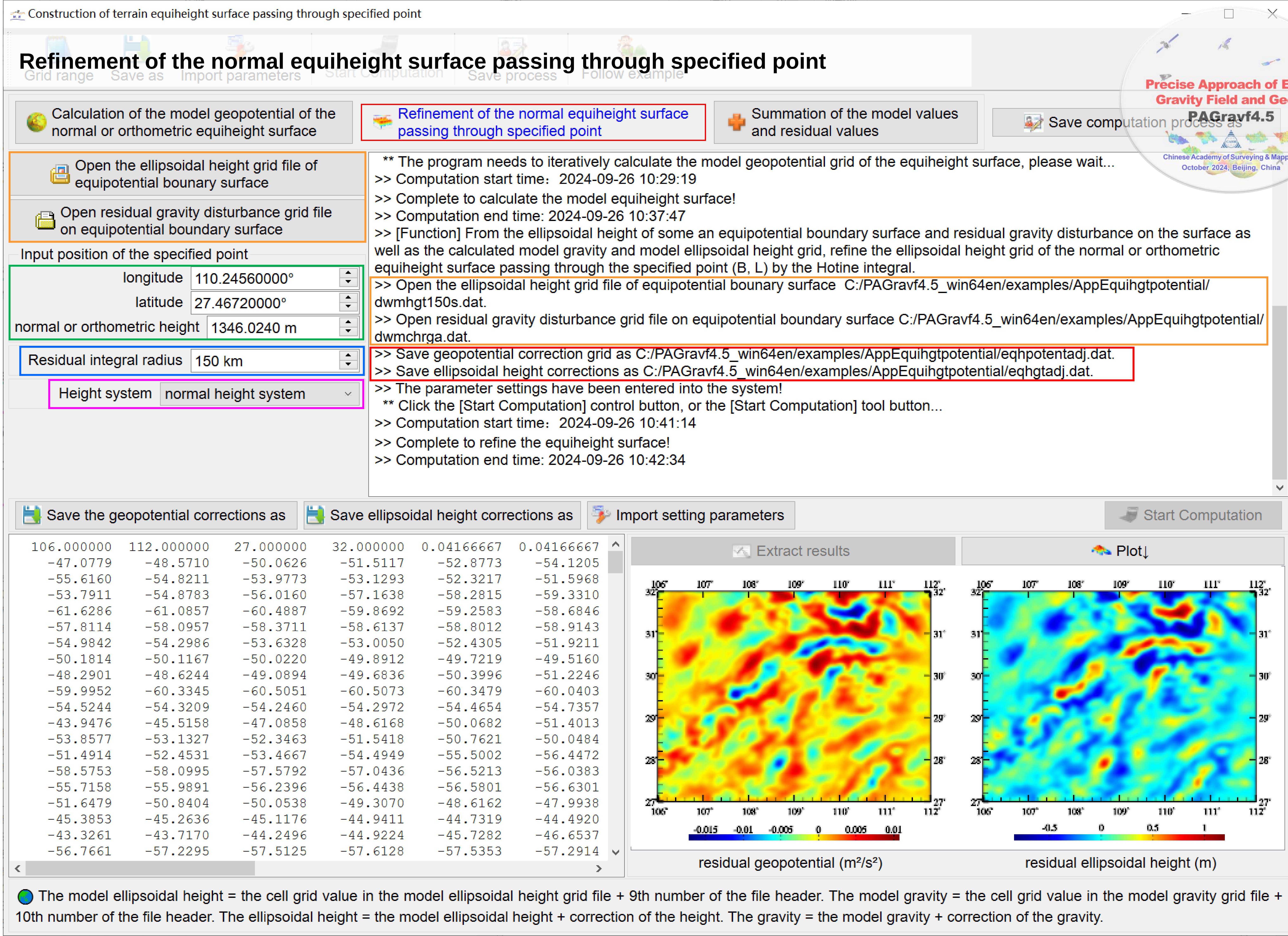
Construction of the gravity equipotential surface from global geopotential model
Refinement of ellipsoidal height of the equipotential surface by local gravity field approach
Save computation process as
Open the ellipsoidal height grid file of equipotential bounary surface
Open residual gravity disturbance grid file on equipotential boundary surface
Input geodetic coordinates of the specified point
longitude 110.24560000°
latitude 27.46720000°
ellipsoidal height 1346.0240 m
Residual integral radius 150 km
Save the refined ellipsoidal height as
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The program needs to iteratively calculate the model ellipsoidal height grid of the equipotential surface, please wait...
>> Computation start time：2024-09-26 10:12:29
>> Complete to calculate the model equipotential surface!
>> Computation end time: 2024-09-26 10:18:35
>> [Function] From the ellipsoidal height of some an equipotential boundary surface and residual gravity disturbance as well as the calculated model gravity and model ellipsoidal height grid, refine the ellipsoidal height grid of the equipotential surface passing through the specified points (B, L, H) by the Hotine integral.
>> Open the ellipsoidal height grid file of equipotential bounary surface C:/PAGravf4.5_win64en/examples/AppEquipotentialhgt/dwmhgt150s.dat.
>> Open residual gravity disturbance grid file on equipotential boundary surface C:/PAGravf4.5_win64en/examples/AppEquipotentialhgt/dwmchrga.dat.
>> Save the refined ellipsoidal height as C:/PAGravf4.5_win64en/examples/AppEquipotentialhgt/equiphgt.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-26 10:20:31
>> Complete to refine the equipotential surface!
>> Computation end time: 2024-09-26 10:21:26
Import setting parameters
Start Computation
Extract results
Plot↓
106.000000 112.000000 27.000000 32.000000 0.04166667 0.04166667 110.245600 27.467200 1346.0240
-9.6403 -9.6443 -9.6467 -9.6462 -9.6406 -9.6273 -9.6032 -9.5669 -9.5208
-9.1660 -9.0790 -8.9978 -8.9173 -8.8238 -8.7084 -8.5749 -8.4350 -8.2981
-7.9639 -7.9709 -7.9473 -7.9062 -7.8620 -7.8149 -7.7491 -7.6488 -7.5115
-6.5600 -6.4462 -6.3183 -6.1804 -6.0460 -5.9275 -5.8257 -5.7279 -5.6184
-4.7827 -4.6604 -4.5335 -4.4115 -4.3023 -4.2089 -4.1285 -4.0531 -3.9727
-3.0571 -2.9117 -2.7694 -2.6272 -2.4820 -2.3336 -2.1854 -2.0406 -1.9001
-1.0710 -0.9617 -0.8332 -0.6892 -0.5431 -0.4106 -0.3046 -0.2279 -0.1726
0.5669 0.7171 0.8630 1.0002 1.1257 1.2382 1.3365 1.4183 1.4814
1.8049 1.8752 1.9554 2.0440 2.1346 2.2210 2.3026 2.3850 2.4751
3.1803 3.2720 3.3713 3.4850 3.6114 3.7393 3.8539 3.9489 4.0316
-9.7964 -9.7842 -9.7745 -9.7686 -9.7638 -9.7548 -9.7352 -9.7004 -9.6513
-9.2316 -9.1478 -9.0730 -9.0001 -8.9140 -8.8060 -8.6794 -8.5442 -8.4073
-8.0621 -8.0694 -8.0356 -7.9777 -7.9178 -7.8617 -7.7956 -7.7013 -7.5729
-6.6486 -6.5430 -6.4234 -6.2909 -6.1590 -6.0421 -5.9438 -5.8519 -5.7471
-4.8237 -4.7029 -4.5764 -4.4504 -4.3332 -4.2313 -4.1455 -4.0694 -3.9921
-3.1132 -2.9632 -2.8161 -2.6711 -2.5251 -2.3761 -2.2254 -2.0753 -1.9266
-1.0365 -0.9339 -0.8088 -0.6635 -0.5123 -0.3728 -0.2580 -0.1718 -0.1090
106° 107° 108° 109° 110° 111° 112°
27° 28° 29° 30° 31° 32°
-20 -15 -10 -5 0
ellipsoidal height refined (m)
The ellipsoidal height on the equipotential surface = ellipsoidal height cell grid value + the 9th number of the file header.
The reference geopotential model and truncation degree should be consistent with that employed in the gravity field approach and modeling. The degree of the model should not be too large, since the program adopts the iterative approach method, which need take a long time.


Construction of terrain equiheight surface passing through specified point
Calculation of the model geopotential of the normal or orthometric equiheight surface
Grid range
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of the model geopotential of the normal or orthometric equiheight surface
Refinement of the normal equiheight surface passing through specified point
Summation of the model values and residual values
Save computation process as
Open the equiheight surface range grid file
Open the geopotential coefficient model file
Input position of the specified point
longitude 110.24560000°
latitude 27.46720000°
normal or orthometric height 1346.0240 m
Maximum calculation degree for the geopotential model 360
Height system normal height system
>> [Purpose] Firstly, calculate the model geopotential of the normal or orthometric equiheight surface from the reference gravity field model, and then furtherly refine the geopotential from the anomalous field element grid using the remove-restore scheme.
** Select the function module the 3 control buttons at the top of the interface...
>> [Function] From the geopotential coefficient model, calculate the model geopotential, model ellipsoidal height (m) and model gravity (mGal) grid of the normal or orthometric equiheight surface passing through the specified point (B, L).
>> The equiheight surface range grid file is only employed to give the latitude and longitude range and resolution of the surface grid.
>> Open the equiheight surface range grid file C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/areagrid.dat.
>> Open the geopotential coefficient model file C:/PAGravf4.5_win64en/data/EGM2008.gfc.
** The window below only shows the geopotential coefficients data with no more than 2000 rows in it
>> Save the model gravity grid as C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/eqhgtdmlgrav.dat.
>> Save the model geopotential grid as C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/eqhmpotential.dat.
>> Save the model ellipsoidal height as C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/eqhgtmdlhgt.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The program needs to iteratively calculate the model geopotential grid of the equiheight surface, please wait...
>> Computation start time：2024-09-26 10:29:19
>> Complete to calculate the model equiheight surface!
>> Computation end time: 2024-09-26 10:37:47
Save the model gravity grid as
Save the model geopotential grid as
Save model ellipsoidal height as
Import setting parameters
Start Computation
106.000000 112.000000 27.000000 32.000000 0.04166667 0.04166667
-47.0779 -48.5710 -50.0626 -51.5117 -52.8773 -54.1205
-55.6160 -54.8211 -53.9773 -53.1293 -52.3217 -51.5968
-53.7911 -54.8783 -56.0160 -57.1638 -58.2815 -59.3310
-61.6286 -61.0857 -60.4887 -59.8692 -59.2583 -58.6846
-57.8114 -58.0957 -58.3711 -58.6137 -58.8012 -58.9143
-54.9842 -54.2986 -53.6328 -53.0050 -52.4305 -51.9211
-50.1814 -50.1167 -50.0220 -49.8912 -49.7219 -49.5160
-48.2901 -48.6244 -49.0894 -49.6836 -50.3996 -51.2246
-59.9952 -60.3345 -60.5051 -60.5073 -60.3479 -60.0403
-54.5244 -54.3209 -54.2460 -54.2972 -54.4654 -54.7357
-43.9476 -45.5158 -47.0858 -48.6168 -50.0682 -51.4013
-53.8577 -53.1327 -52.3463 -51.5418 -50.7621 -50.0484
-51.4914 -52.4531 -53.4667 -54.4949 -55.5002 -56.4472
-58.5753 -58.0995 -57.5792 -57.0436 -56.5213 -56.0383
-55.7158 -55.9891 -56.2396 -56.4438 -56.5801 -56.6301
-51.6479 -50.8404 -50.0538 -49.3070 -48.6162 -47.9938
-45.3853 -45.2636 -45.1176 -44.9411 -44.7319 -44.4920
-43.3261 -43.7170 -44.2496 -44.9224 -45.7282 -46.6537
-56.7661 -57.2295 -57.5125 -57.6128 -57.5353 -57.2914
Extract results
Plot↓
model geopotential (m²/s²)
model ellipsoidal height (m)
The model ellipsoidal height = the cell grid value in the model ellipsoidal height grid file + 9th number of the file header. The model gravity = the cell grid value in the model gravity grid file + 10th number of the file header. The ellipsoidal height = the model ellipsoidal height + correction of the height. The gravity = the model gravity + correction of the gravity.


Construction of terrain equiheight surface passing through specified point
Refinement of the normal equiheight surface passing through specified point
Grid range
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
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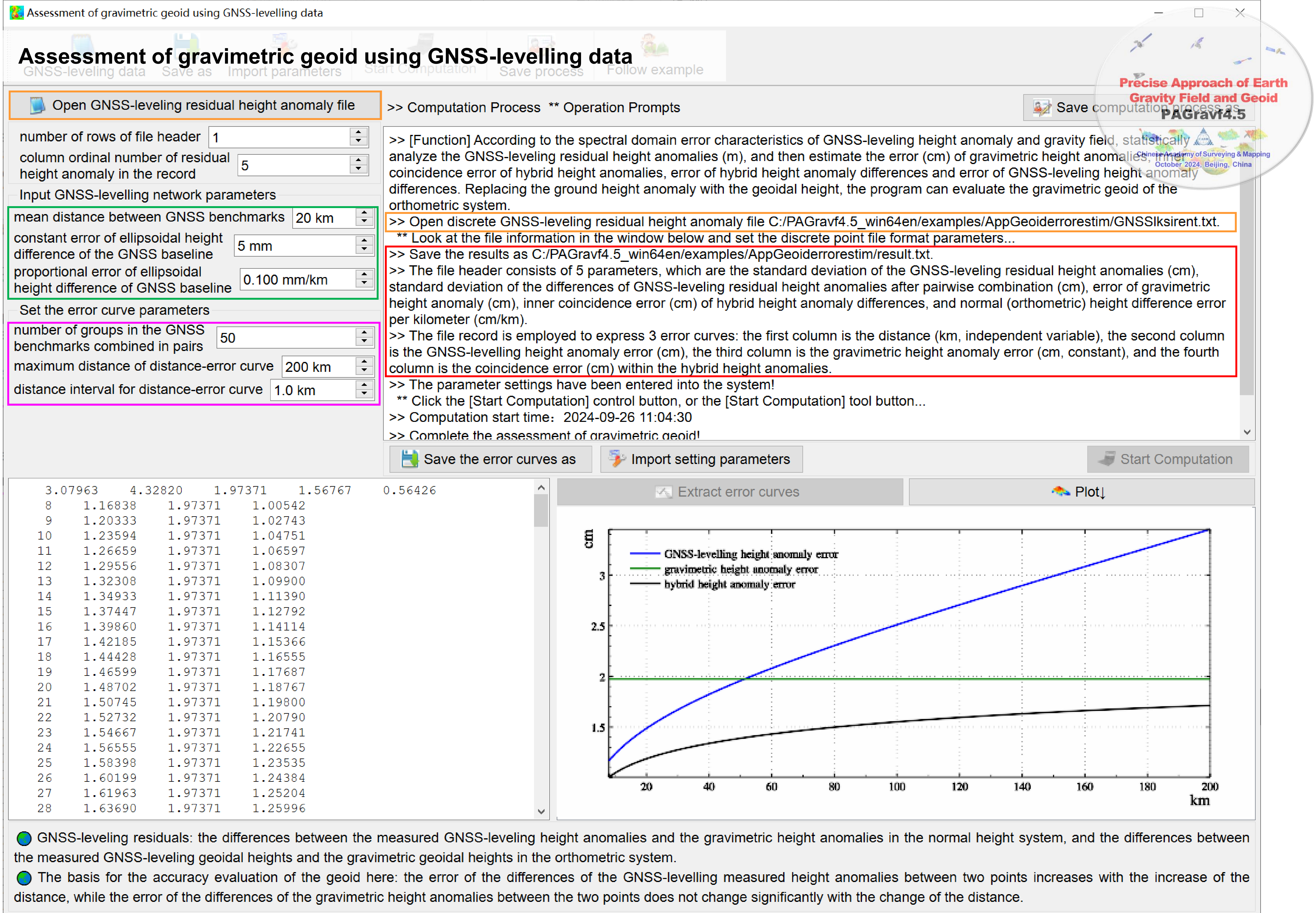
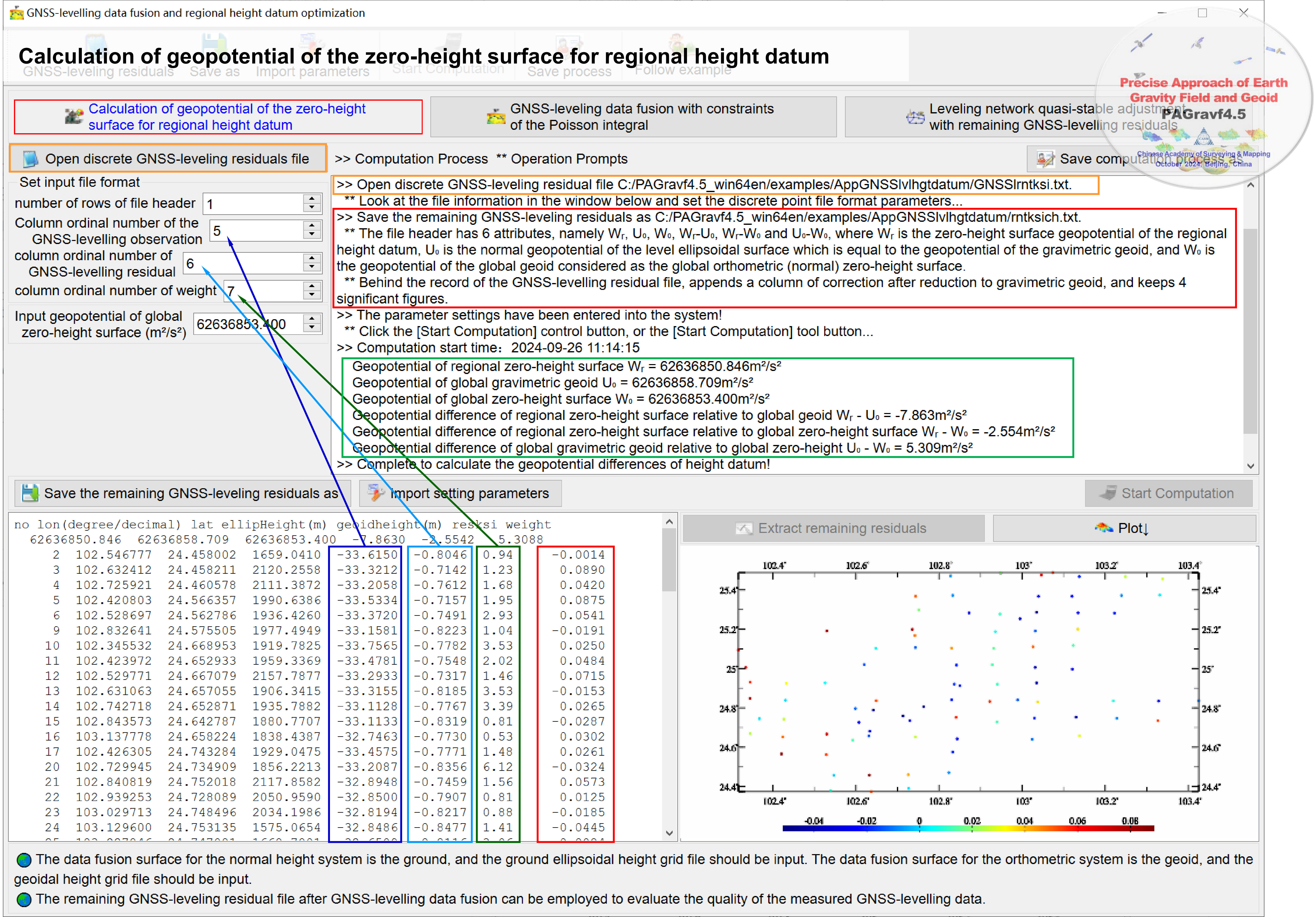
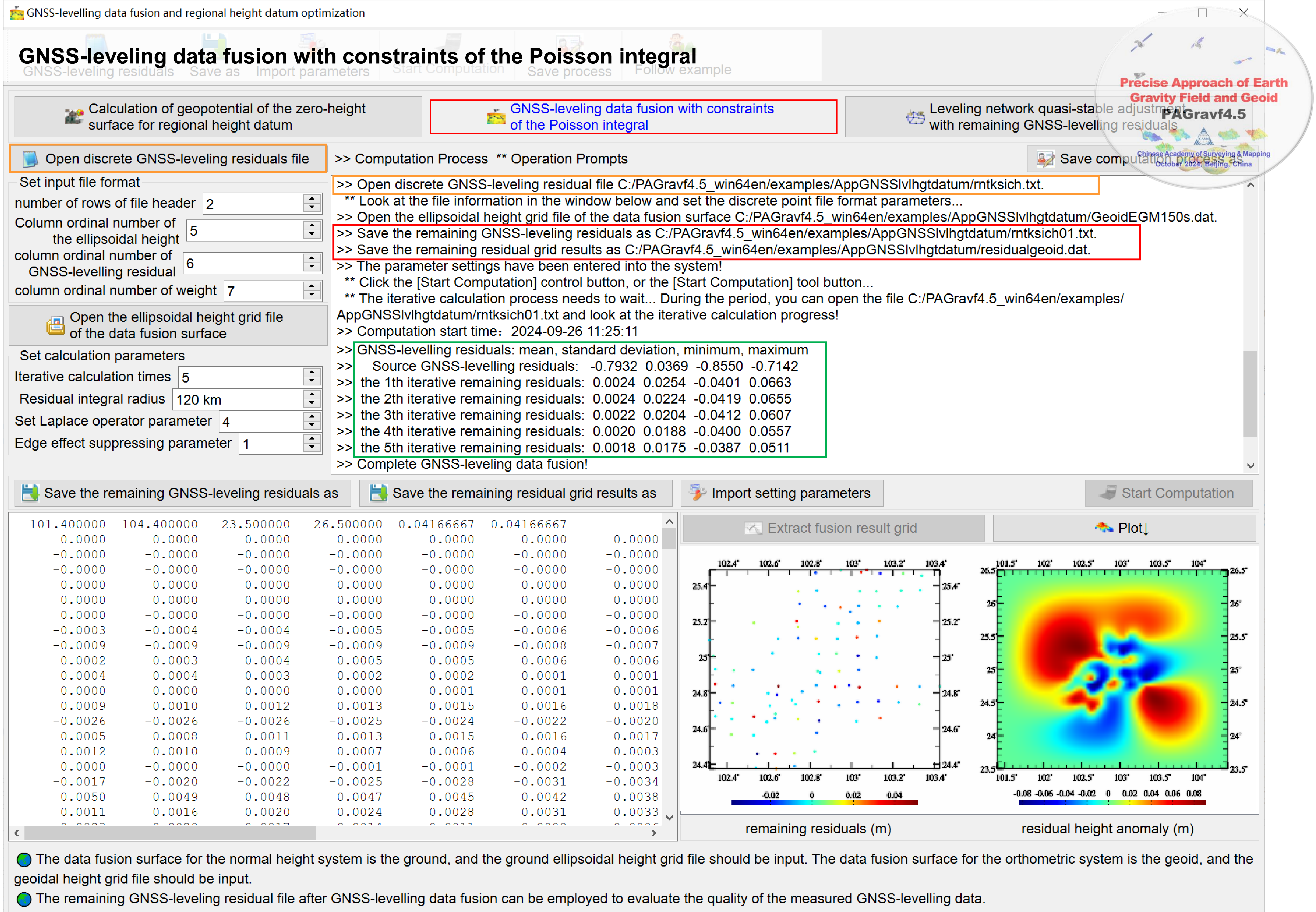
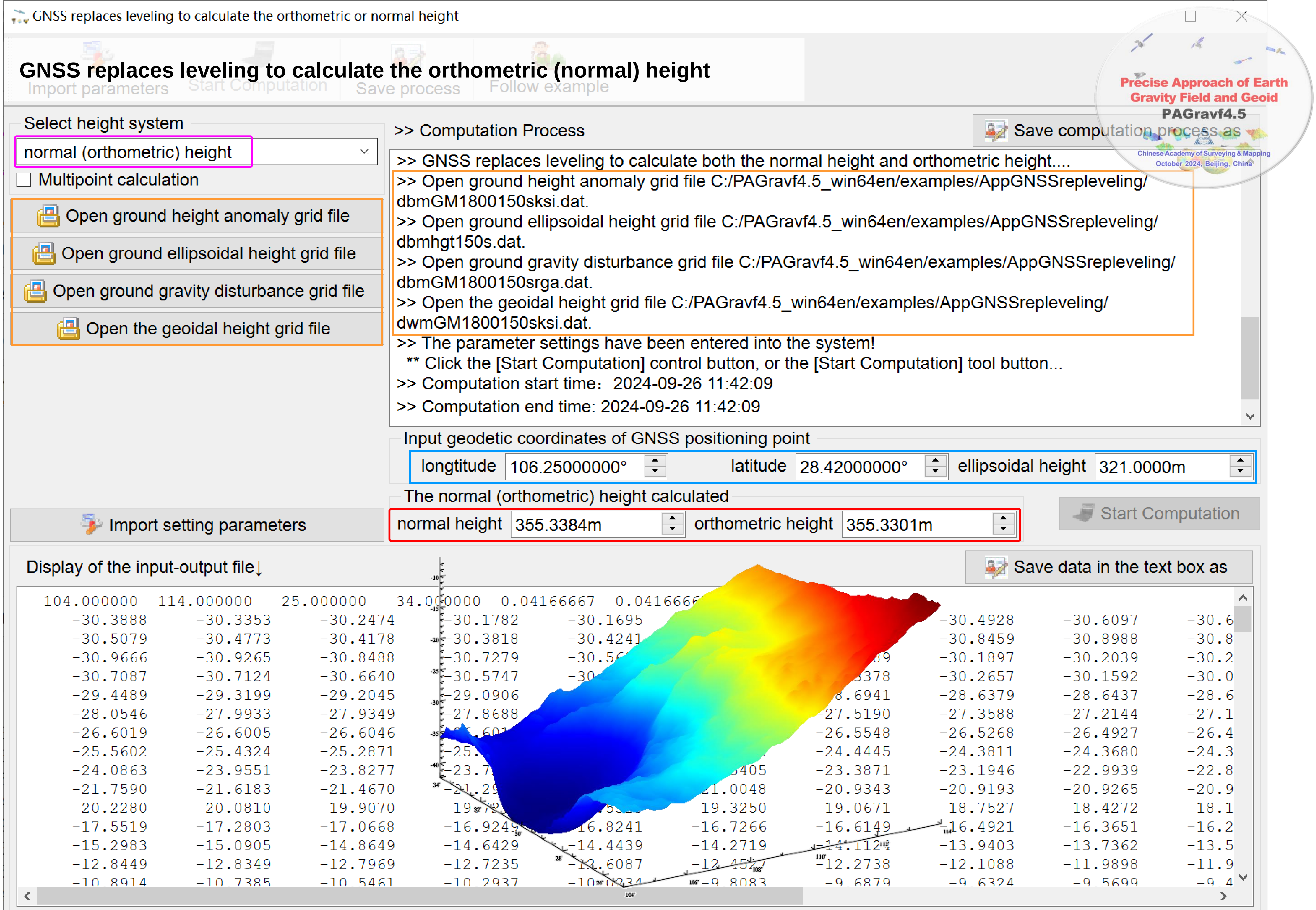
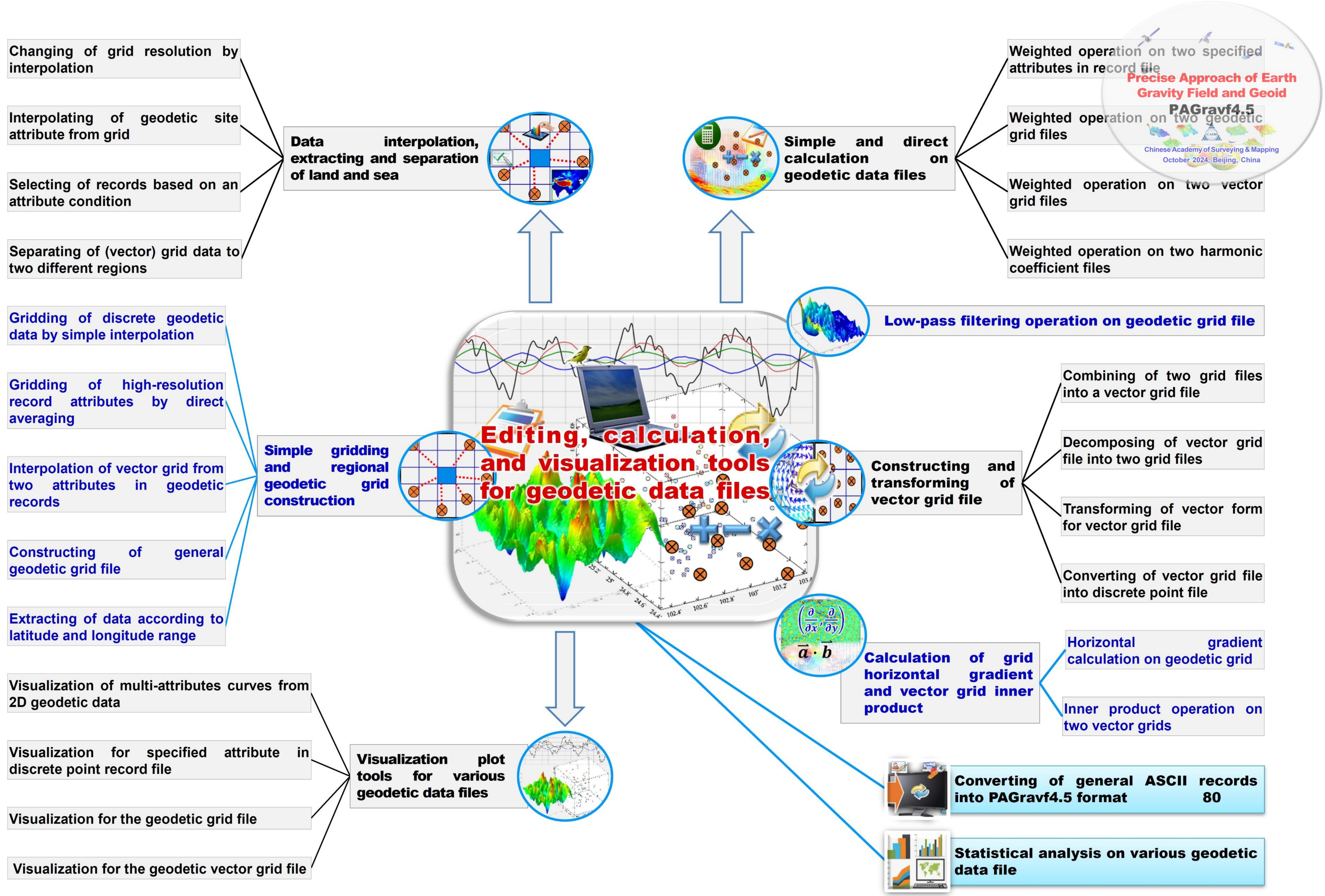
Calculation of the model geopotential of the normal or orthometric equiheight surface
Refinement of the normal equiheight surface passing through specified point
Summation of the model values and residual values
Save computation process as
Open the ellipsoidal height grid file of equipotential bounary surface
Open residual gravity disturbance grid file on equipotential boundary surface
Input position of the specified point
longitude 110.24560000°
latitude 27.46720000°
normal or orthometric height 1346.0240 m
Residual integral radius 150 km
Height system normal height system
** The program needs to iteratively calculate the model geopotential grid of the equiheight surface, please wait...
>> Computation start time: 2024-09-26 10:29:19
>> Complete to calculate the model equiheight surface!
>> Computation end time: 2024-09-26 10:37:47
>> [Function] From the ellipsoidal height of some an equipotential boundary surface and residual gravity disturbance on the surface as well as the calculated model gravity and model ellipsoidal height grid, refine the ellipsoidal height grid of the normal or orthometric equiheight surface passing through the specified point (B, L) by the Hotine integral.
>> Open the ellipsoidal height grid file of equipotential bounary surface C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/dwmhgt150s.dat.
>> Open residual gravity disturbance grid file on equipotential boundary surface C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/dwmchrga.dat.
>> Save geopotential correction grid as C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/eqhpotentadj.dat.
>> Save ellipsoidal height corrections as C:/PAGravf4.5_win64en/examples/AppEquihgtpotential/eqhgtadj.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-26 10:41:14
>> Complete to refine the equiheight surface!
>> Computation end time: 2024-09-26 10:42:34
Save the geopotential corrections as
Save ellipsoidal height corrections as
Import setting parameters
Start Computation
106.000000 112.000000 27.000000 32.000000 0.04166667 0.04166667
-47.0779 -48.5710 -50.0626 -51.5117 -52.8773 -54.1205
-55.6160 -54.8211 -53.9773 -53.1293 -52.3217 -51.5968
-53.7911 -54.8783 -56.0160 -57.1638 -58.2815 -59.3310
-61.6286 -61.0857 -60.4887 -59.8692 -59.2583 -58.6846
-57.8114 -58.0957 -58.3711 -58.6137 -58.8012 -58.9143
-54.9842 -54.2986 -53.6328 -53.0050 -52.4305 -51.9211
-50.1814 -50.1167 -50.0220 -49.8912 -49.7219 -49.5160
-48.2901 -48.6244 -49.0894 -49.6836 -50.3996 -51.2246
-59.9952 -60.3345 -60.5051 -60.5073 -60.3479 -60.0403
-54.5244 -54.3209 -54.2460 -54.2972 -54.4654 -54.7357
-43.9476 -45.5158 -47.0858 -48.6168 -50.0682 -51.4013
-53.8577 -53.1327 -52.3463 -51.5418 -50.7621 -50.0484
-51.4914 -52.4531 -53.4667 -54.4949 -55.5002 -56.4472
-58.5753 -58.0995 -57.5792 -57.0436 -56.5213 -56.0383
-55.7158 -55.9891 -56.2396 -56.4438 -56.5801 -56.6301
-51.6479 -50.8404 -50.0538 -49.3070 -48.6162 -47.9938
-45.3853 -45.2636 -45.1176 -44.9411 -44.7319 -44.4920
-43.3261 -43.7170 -44.2496 -44.9224 -45.7282 -46.6537
-56.7661 -57.2295 -57.5125 -57.6128 -57.5353 -57.2914
Extract results
Plot↓
residual geopotential (m²/s²)
residual ellipsoidal height (m)
The model ellipsoidal height = the cell grid value in the model ellipsoidal height grid file + 9th number of the file header. The model gravity = the cell grid value in the model gravity grid file + 10th number of the file header. The ellipsoidal height = the model ellipsoidal height + correction of the height. The gravity = the model gravity + correction of the gravity.

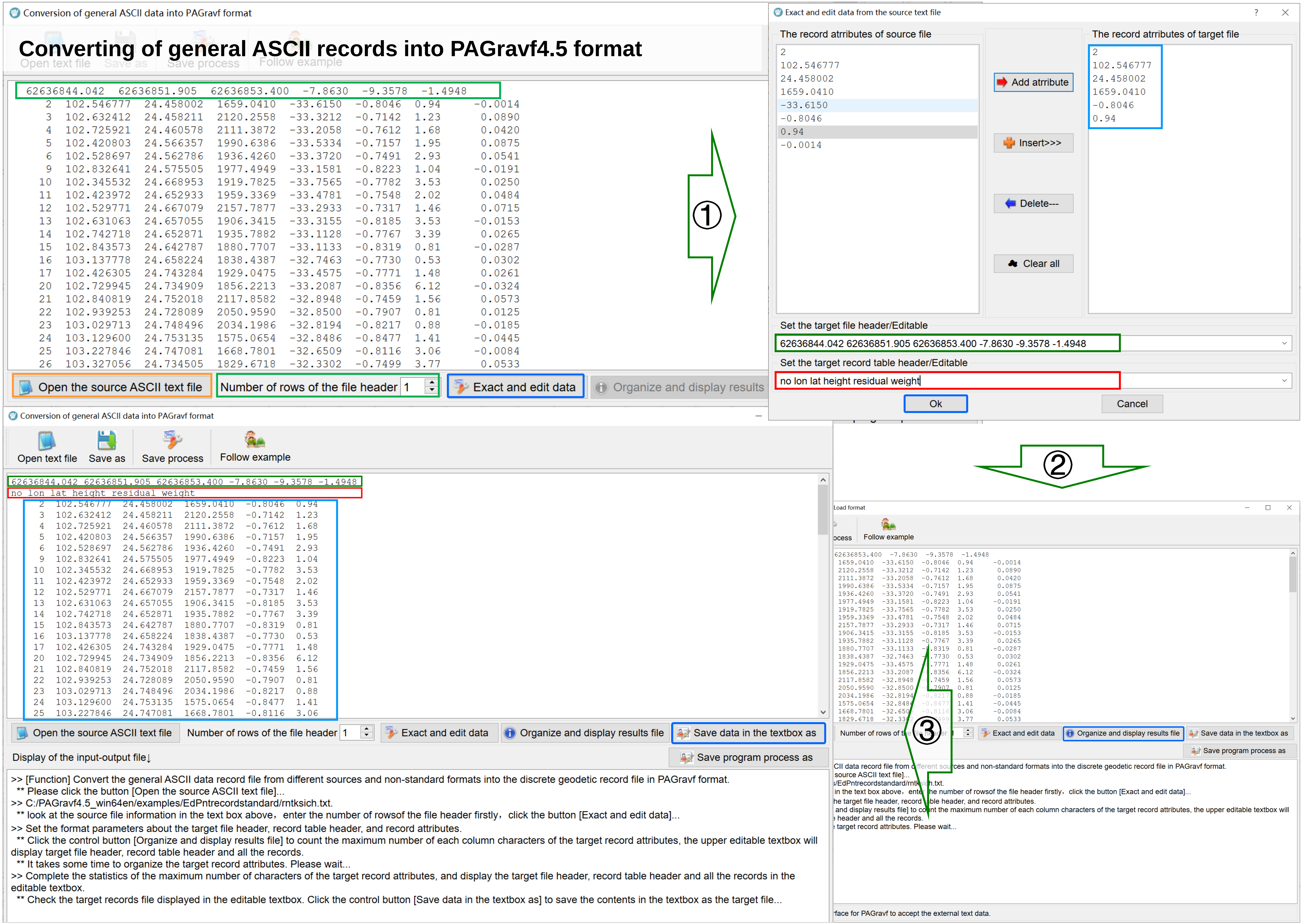

Assessment of gravimetric geoid using GNSS-levelling data
Assessment of gravimetric geoid using GNSS-levelling data
GNSS-leveling data
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open GNSS-leveling residual height anomaly file
number of rows of file header 1
column ordinal number of residual height anomaly in the record 5
Input GNSS-levelling network parameters
mean distance between GNSS benchmarks 20 km
constant error of ellipsoidal height difference of the GNSS baseline 5 mm
proportional error of ellipsoidal height difference of GNSS baseline 0.100 mm/km
Set the error curve parameters
number of groups in the GNSS benchmarks combined in pairs 50
maximum distance of distance-error curve 200 km
distance interval for distance-error curve 1.0 km
>> Computation Process ** Operation Prompts
Save computation process as
>> [Function] According to the spectral domain error characteristics of GNSS-leveling height anomaly and gravity field, statistically analyze the GNSS-leveling residual height anomalies (m), and then estimate the error (cm) of gravimetric height anomalies, inner coincidence error of hybrid height anomalies, error of hybrid height anomaly differences and error of GNSS-leveling height anomaly differences. Replacing the ground height anomaly with the geoidal height, the program can evaluate the gravimetric geoid of the orthometric system.
>> Open discrete GNSS-leveling residual height anomaly file C:/PAGravf4.5_win64en/examples/AppGeoiderrorestim/GNSSlksirent.txt.
** Look at the file information in the window below and set the discrete point file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/AppGeoiderrorestim/result.txt.
>> The file header consists of 5 parameters, which are the standard deviation of the GNSS-leveling residual height anomalies (cm), standard deviation of the differences of GNSS-leveling residual height anomalies after pairwise combination (cm), error of gravimetric height anomaly (cm), inner coincidence error (cm) of hybrid height anomaly differences, and normal (orthometric) height difference error per kilometer (cm/km).
>> The file record is employed to express 3 error curves: the first column is the distance (km, independent variable), the second column is the GNSS-levelling height anomaly error (cm), the third column is the gravimetric height anomaly error (cm, constant), and the fourth column is the coincidence error (cm) within the hybrid height anomalies.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-26 11:04:30
>> Complete the assessment of gravimetric geoid!
Save the error curves as
Import setting parameters
Start Computation
3.07963 4.32820 1.97371 1.56767 0.56426
8 1.16838 1.97371 1.00542
9 1.20333 1.97371 1.02743
10 1.23594 1.97371 1.04751
11 1.26659 1.97371 1.06597
12 1.29556 1.97371 1.08307
13 1.32308 1.97371 1.09900
14 1.34933 1.97371 1.11390
15 1.37447 1.97371 1.12792
16 1.39860 1.97371 1.14114
17 1.42185 1.97371 1.15366
18 1.44428 1.97371 1.16555
19 1.46599 1.97371 1.17687
20 1.48702 1.97371 1.18767
21 1.50745 1.97371 1.19800
22 1.52732 1.97371 1.20790
23 1.54667 1.97371 1.21741
24 1.56555 1.97371 1.22655
25 1.58398 1.97371 1.23535
26 1.60199 1.97371 1.24384
27 1.61963 1.97371 1.25204
28 1.63690 1.97371 1.25996
Extract error curves
Plot↓
cm
GNSS-levelling height anomaly error
gravimetric height anomaly error
hybrid height anomaly error
3
2.5
2
1.5
20 40 60 80 100 120 140 160 180 200
km
GNSS-leveling residuals: the differences between the measured GNSS-leveling height anomalies and the gravimetric height anomalies in the normal height system, and the differences between the measured GNSS-leveling geoidal heights and the gravimetric geoidal heights in the orthometric system.
The basis for the accuracy evaluation of the geoid here: the error of the differences of the GNSS-levelling measured height anomalies between two points increases with the increase of the distance, while the error of the differences of the gravimetric height anomalies between the two points does not change significantly with the change of the distance.

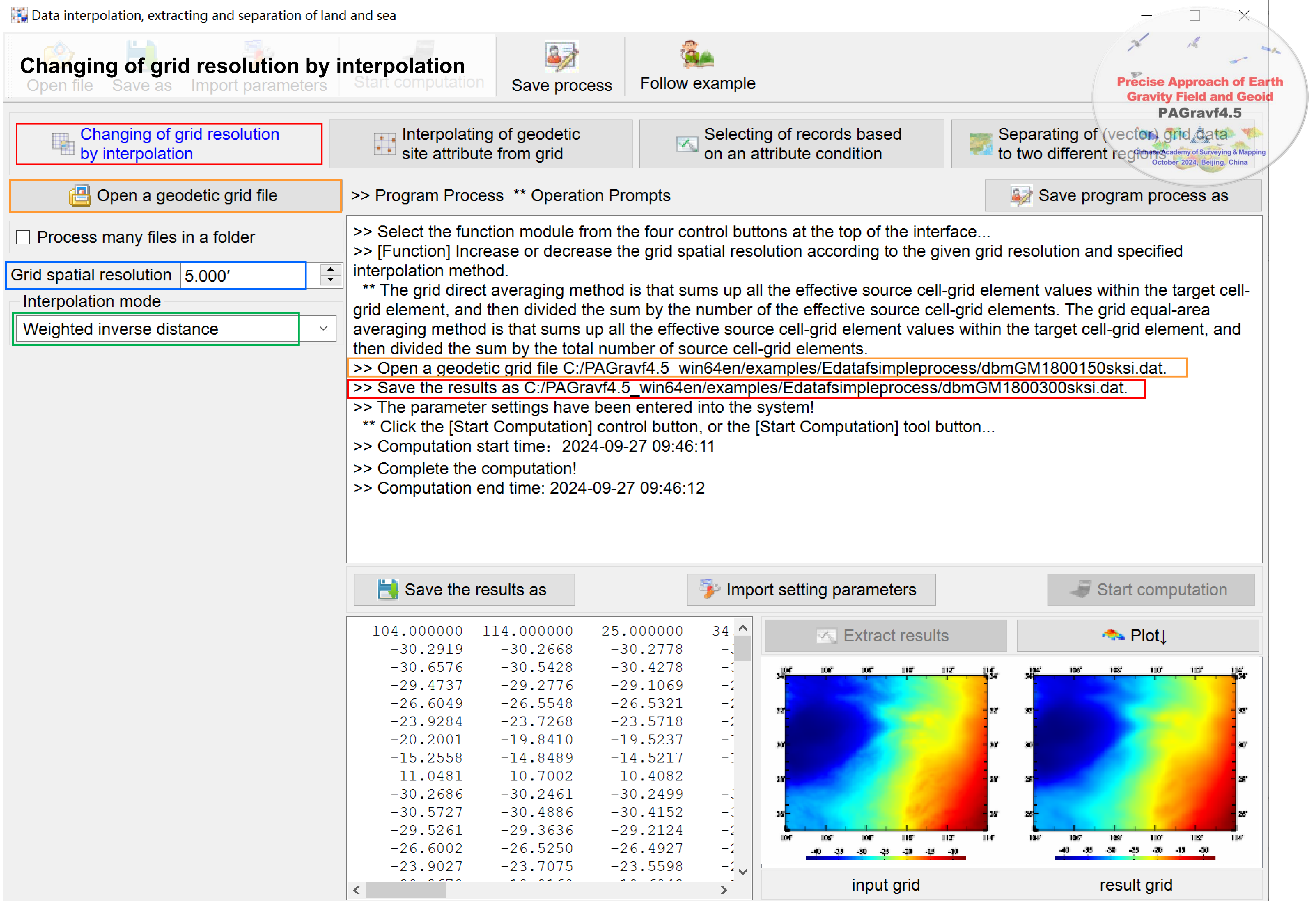

GNSS-levelling data fusion and regional height datum optimization
Calculation of geopotential of the zero-height surface for regional height datum
GNSS-leveling residuals
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of geopotential of the zero-height surface for regional height datum
GNSS-leveling data fusion with constraints of the Poisson integral
Leveling network quasi-stable adjustment with remaining GNSS-levelling residuals
Open discrete GNSS-leveling residuals file
>> Computation Process ** Operation Prompts
Save computation process as
Set input file format
number of rows of file header
1
Column ordinal number of the GNSS-levelling observation
5
column ordinal number of GNSS-levelling residual
6
column ordinal number of weight
7
Input geopotential of global zero-height surface (m²/s²)
62636853.400
>> Open discrete GNSS-leveling residual file C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/GNSSlrntksi.txt.
** Look at the file information in the window below and set the discrete point file format parameters...
>> Save the remaining GNSS-leveling residuals as C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/rntksich.txt.
** The file header has 6 attributes, namely Wᵣ, U₀, W₀, Wᵣ-U₀, Wᵣ-W₀ and U₀-W₀, where Wᵣ is the zero-height surface geopotential of the regional height datum, U₀ is the normal geopotential of the level ellipsoidal surface which is equal to the geopotential of the gravimetric geoid, and W₀ is the geopotential of the global geoid considered as the global orthometric (normal) zero-height surface.
** Behind the record of the GNSS-levelling residual file, appends a column of correction after reduction to gravimetric geoid, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-26 11:14:15
Geopotential of regional zero-height surface Wᵣ = 62636850.846m²/s²
Geopotential of global gravimetric geoid U₀ = 62636858.709m²/s²
Geopotential of global zero-height surface W₀ = 62636853.400m²/s²
Geopotential difference of regional zero-height surface relative to global geoid Wᵣ - U₀ = -7.863m²/s²
Geopotential difference of regional zero-height surface relative to global zero-height surface Wᵣ - W₀ = -2.554m²/s²
Geopotential difference of global gravimetric geoid relative to global zero-height U₀ - W₀ = 5.309m²/s²
>> Complete to calculate the geopotential differences of height datum!
Save the remaining GNSS-leveling residuals as
Import setting parameters
Start Computation
Extract remaining residuals
Plot↓
no lon(degree/decimal) lat ellipHeight(m) geoidheight(m) resksi weight
62636850.846 62636858.709 62636853.400 -7.8630 -2.5542 5.3088
2 102.546777 24.458002 1659.0410 -33.6150 -0.8046 0.94 -0.0014
3 102.632412 24.458211 2120.2558 -33.3212 -0.7142 1.23 0.0890
4 102.725921 24.460578 2111.3872 -33.2058 -0.7612 1.68 0.0420
5 102.420803 24.566357 1990.6386 -33.5334 -0.7157 1.95 0.0875
6 102.528697 24.562786 1936.4260 -33.3720 -0.7491 2.93 0.0541
9 102.832641 24.575505 1977.4949 -33.1581 -0.8223 1.04 -0.0191
10 102.345532 24.668953 1919.7825 -33.7565 -0.7782 3.53 0.0250
11 102.423972 24.652933 1959.3369 -33.4781 -0.7548 2.02 0.0484
12 102.529771 24.667079 2157.7817 -33.2933 -0.7317 1.46 0.0715
13 102.631063 24.657055 1906.3415 -33.3155 -0.8185 3.53 -0.0153
14 102.742718 24.652871 1935.7882 -33.1128 -0.7767 3.39 0.0265
15 102.843573 24.642787 1880.7707 -33.1133 -0.8319 0.81 -0.0287
16 103.137778 24.658224 1838.4387 -32.7463 -0.7730 0.53 0.0302
17 102.426305 24.743284 1929.0475 -33.4575 -0.7771 1.48 0.0261
20 102.729945 24.734909 1856.2213 -33.2087 -0.8356 6.12 -0.0324
21 102.840819 24.752018 2117.8582 -32.8948 -0.7459 1.56 0.0573
22 102.939253 24.728089 2050.9590 -32.8500 -0.7907 0.81 0.0125
23 103.029713 24.748496 2034.1986 -32.8194 -0.8217 0.88 -0.0185
24 103.129600 24.753135 1575.0654 -32.8486 -0.8477 1.41 -0.0445
102.4° 102.6° 102.8° 103° 103.2° 103.4°
25.4° 25.2° 25° 24.8° 24.6° 24.4°
-0.04 -0.02 0 0.02 0.04 0.06 0.08
The data fusion surface for the normal height system is the ground, and the ground ellipsoidal height grid file should be input. The data fusion surface for the orthometric system is the geoid, and the geoidal height grid file should be input.
The remaining GNSS-leveling residual file after GNSS-levelling data fusion can be employed to evaluate the quality of the measured GNSS-levelling data.


GNSS-levelling data fusion and regional height datum optimization
GNSS-leveling data fusion with constraints of the Poisson integral
GNSS-leveling residuals
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Calculation of geopotential of the zero-height surface for regional height datum
GNSS-leveling data fusion with constraints of the Poisson integral
Leveling network quasi-stable adjustment with remaining GNSS-levelling residuals
Open discrete GNSS-leveling residuals file
>> Computation Process ** Operation Prompts
Save computation process as
Set input file format
number of rows of file header 2
Column ordinal number of the ellipsoidal height 5
column ordinal number of GNSS-levelling residual 6
column ordinal number of weight 7
Open the ellipsoidal height grid file of the data fusion surface
Set calculation parameters
Iterative calculation times 5
Residual integral radius 120 km
Set Laplace operator parameter 4
Edge effect suppressing parameter 1
>> Open discrete GNSS-leveling residual file C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/rntksich.txt.
** Look at the file information in the window below and set the discrete point file format parameters...
>> Open the ellipsoidal height grid file of the data fusion surface C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/GeoidEGM150s.dat.
>> Save the remaining GNSS-leveling residuals as C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/rntksich01.txt.
>> Save the remaining residual grid results as C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/residualgeoid.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
** The iterative calculation process needs to wait... During the period, you can open the file C:/PAGravf4.5_win64en/examples/AppGNSSlvlhgtdatum/rntksich01.txt and look at the iterative calculation progress!
>> Computation start time: 2024-09-26 11:25:11
>> GNSS-levelling residuals: mean, standard deviation, minimum, maximum
>> Source GNSS-levelling residuals: -0.7932 0.0369 -0.8550 -0.7142
>> the 1th iterative remaining residuals: 0.0024 0.0254 -0.0401 0.0663
>> the 2th iterative remaining residuals: 0.0024 0.0224 -0.0419 0.0655
>> the 3th iterative remaining residuals: 0.0022 0.0204 -0.0412 0.0607
>> the 4th iterative remaining residuals: 0.0020 0.0188 -0.0400 0.0557
>> the 5th iterative remaining residuals: 0.0018 0.0175 -0.0387 0.0511
>> Complete GNSS-leveling data fusion!
Save the remaining GNSS-leveling residuals as
Save the remaining residual grid results as
Import setting parameters
Start Computation
101.400000 104.400000 23.500000 26.500000 0.04166667 0.04166667
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
-0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000
-0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
0.0000 0.0000 0.0000 0.0000 -0.0000 -0.0000 -0.0000
0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000
-0.0003 -0.0004 -0.0004 -0.0005 -0.0005 -0.0006 -0.0006
-0.0009 -0.0009 -0.0009 -0.0009 -0.0009 -0.0008 -0.0007
0.0002 0.0003 0.0004 0.0005 0.0005 0.0006 0.0006
0.0004 0.0004 0.0003 0.0002 0.0002 0.0001 0.0001
0.0000 -0.0000 -0.0000 -0.0000 -0.0001 -0.0001 -0.0001
-0.0009 -0.0010 -0.0012 -0.0013 -0.0015 -0.0016 -0.0018
-0.0026 -0.0026 -0.0026 -0.0025 -0.0024 -0.0022 -0.0020
0.0005 0.0008 0.0011 0.0013 0.0015 0.0016 0.0017
0.0012 0.0010 0.0009 0.0007 0.0006 0.0004 0.0003
0.0000 -0.0000 -0.0000 -0.0001 -0.0001 -0.0002 -0.0003
-0.0017 -0.0020 -0.0022 -0.0025 -0.0028 -0.0031 -0.0034
-0.0050 -0.0049 -0.0048 -0.0047 -0.0045 -0.0042 -0.0038
0.0011 0.0016 0.0020 0.0024 0.0028 0.0031 0.0033
Extract fusion result grid
Plot↓
remaining residuals (m)
residual height anomaly (m)
The data fusion surface for the normal height system is the ground, and the ground ellipsoidal height grid file should be input. The data fusion surface for the orthometric system is the geoid, and the geoidal height grid file should be input.
The remaining GNSS-leveling residual file after GNSS-levelling data fusion can be employed to evaluate the quality of the measured GNSS-levelling data.

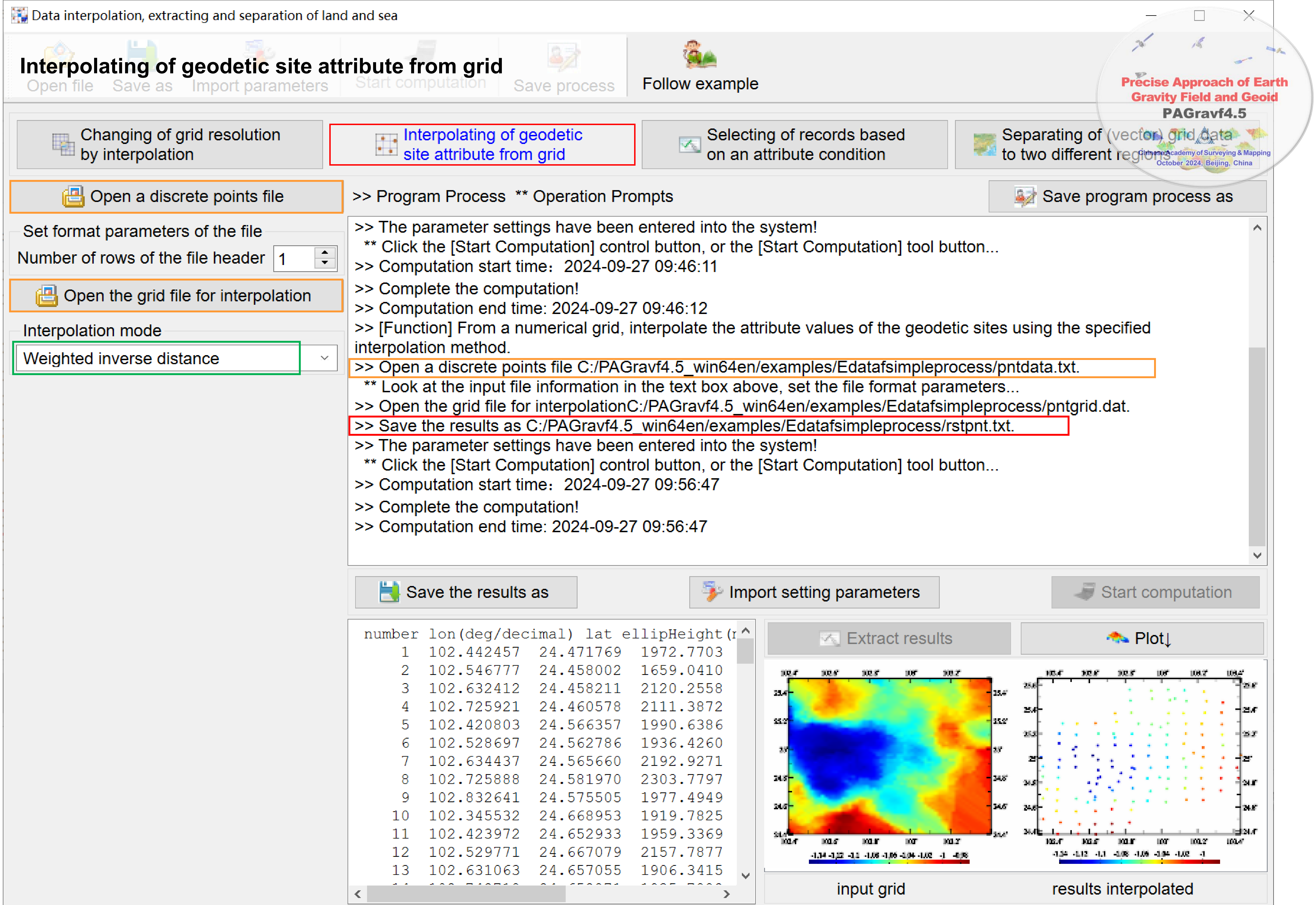

GNSS replaces leveling to calculate the orthometric or normal height
GNSS replaces leveling to calculate the orthometric (normal) height
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Select height system
normal (orthometric) height
Multipoint calculation
Open ground height anomaly grid file
Open ground ellipsoidal height grid file
Open ground gravity disturbance grid file
Open the geoidal height grid file
>> Computation Process
Save computation process as
>> GNSS replaces leveling to calculate both the normal height and orthometric height....
>> Open ground height anomaly grid file C:/PAGravf4.5_win64en/examples/AppGNSSrepleveling/dbmGM1800150sksi.dat.
>> Open ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/AppGNSSrepleveling/dbmhgt150s.dat.
>> Open ground gravity disturbance grid file C:/PAGravf4.5_win64en/examples/AppGNSSrepleveling/dbmGM1800150srga.dat.
>> Open the geoidal height grid file C:/PAGravf4.5_win64en/examples/AppGNSSrepleveling/dwmGM1800150sksi.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-26 11:42:09
>> Computation end time: 2024-09-26 11:42:09
Input geodetic coordinates of GNSS positioning point
longtitude 106.25000000°
latitude 28.42000000°
ellipsoidal height 321.0000m
The normal (orthometric) height calculated
normal height 355.3384m
orthometric height 355.3301m
Import setting parameters
Start Computation
Display of the input-output file↓
Save data in the text box as

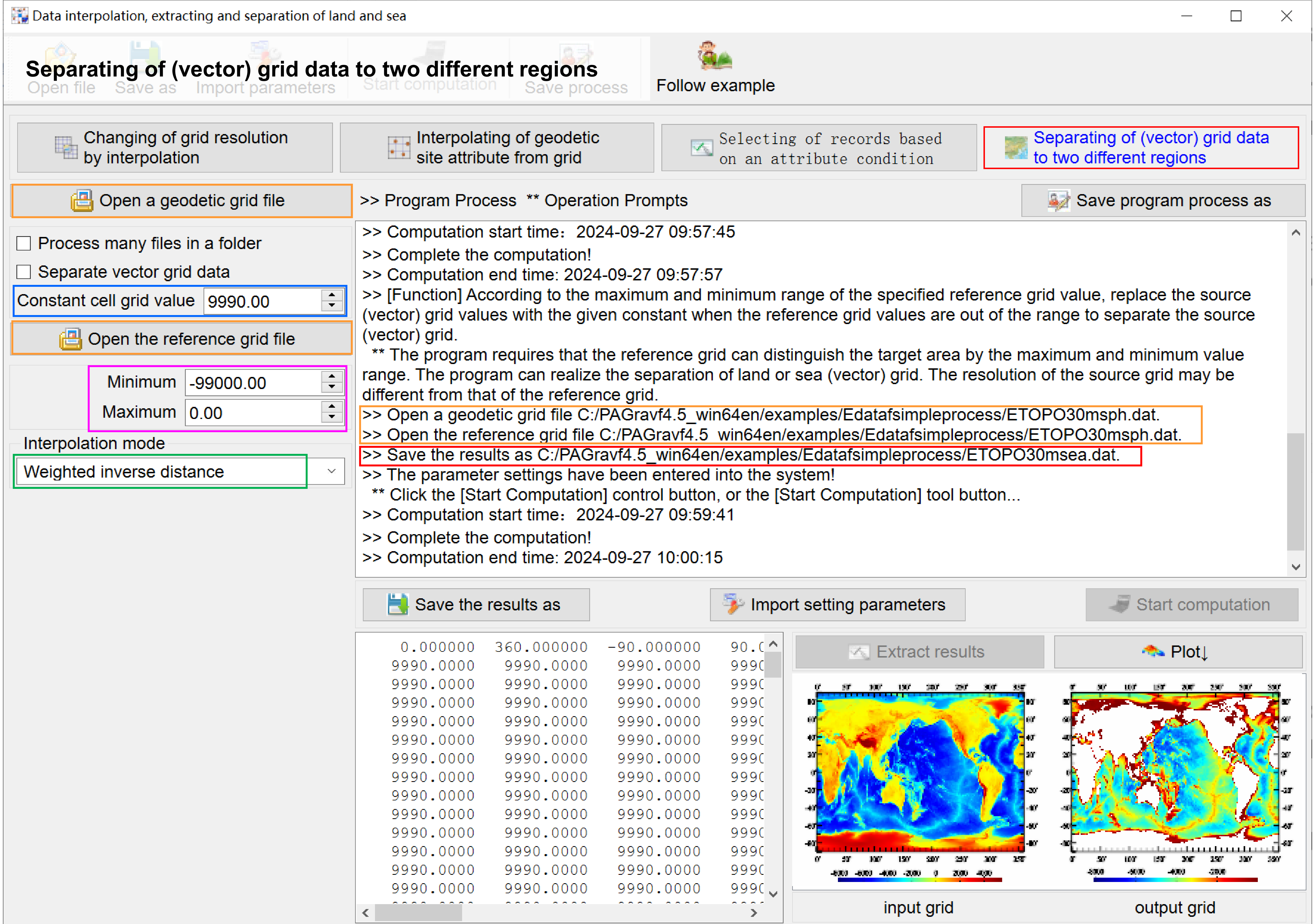

Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Editing, calculation, and visualization tools for geodetic data files
Data interpolation, extracting and separation of land and sea
Changing of grid resolution by interpolation
Interpolating of geodetic site attribute from grid
Selecting of records based on an attribute condition
Separating of (vector) grid data to two different regions
Simple and direct calculation on geodetic data files
Weighted operation on two specified attributes in record file
Weighted operation on two geodetic grid files
Weighted operation on two vector grid files
Weighted operation on two harmonic coefficient files
Low-pass filtering operation on geodetic grid file
Simple gridding and regional geodetic grid construction
Gridding of discrete geodetic data by simple interpolation
Gridding of high-resolution record attributes by direct averaging
Interpolation of vector grid from two attributes in geodetic records
Constructing of general geodetic grid file
Extracting of data according to latitude and longitude range
Constructing and transforming of vector grid file
Combining of two grid files into a vector grid file
Decomposing of vector grid file into two grid files
Transforming of vector form for vector grid file
Converting of vector grid file into discrete point file
Calculation of grid horizontal gradient and vector grid inner product
Horizontal gradient calculation on geodetic grid
Inner product operation on two vector grids
Visualization plot tools for various geodetic data files
Visualization of multi-attributes curves from 2D geodetic data
Visualization for specified attribute in discrete point record file
Visualization for the geodetic grid file
Visualization for the geodetic vector grid file
Converting of general ASCII records into PAGravf4.5 format 80
Statistical analysis on various geodetic data file

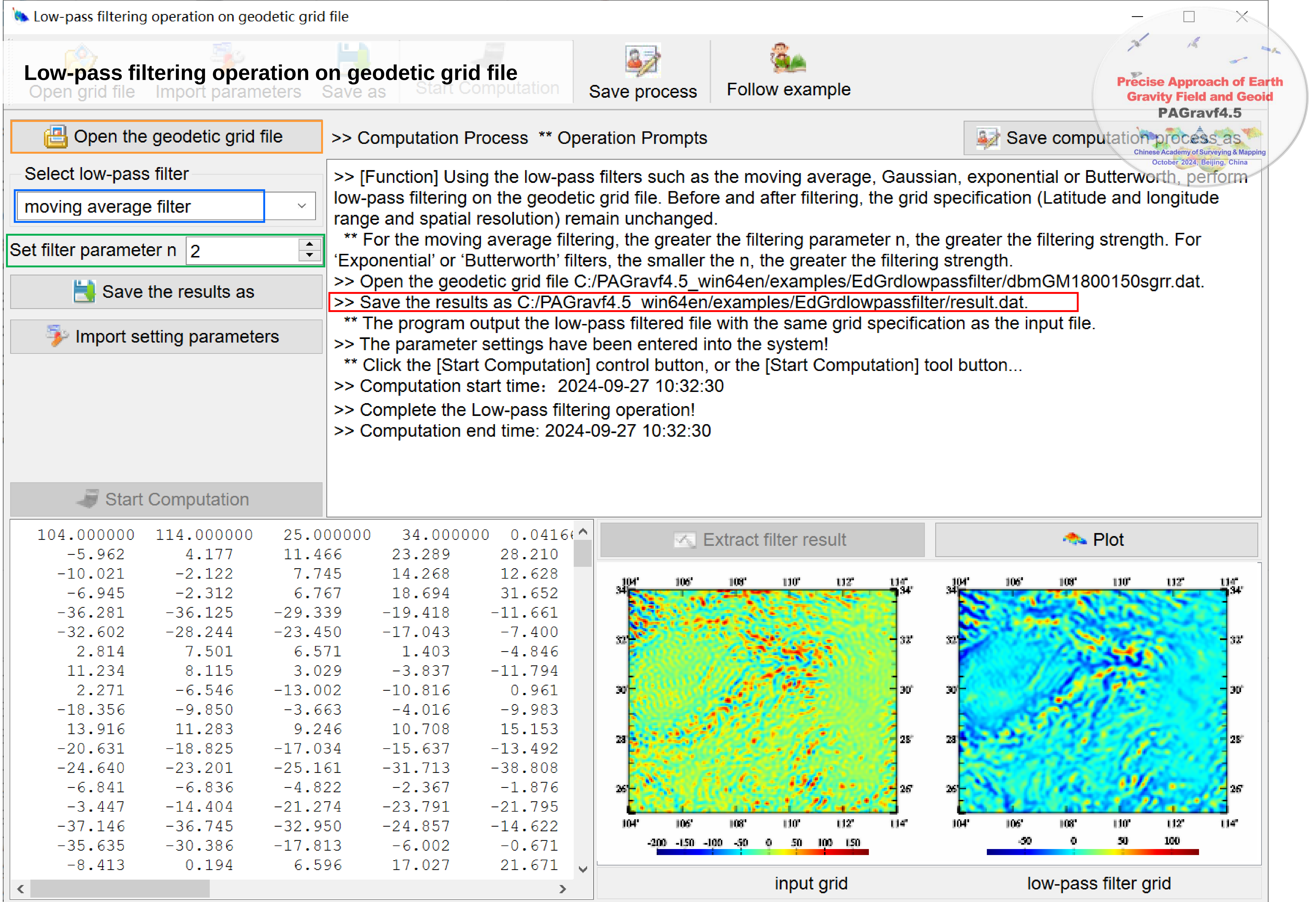

Conversion of general ASCII data into PAGravf format
Converting of general ASCII records into PAGravf4.5 format
62636844.042 62636851.905 62636853.400 -7.8630 -9.3578 -1.4948
Open the source ASCII text file
Number of rows of the file header 1
Exact and edit data
Organize and display results
Exact and edit data from the source text file
The record atrributes of source file
2
102.546777
24.458002
1659.0410
-33.6150
-0.8046
0.94
-0.0014
Add attribute
Insert>>>
Delete---
Clear all
The record atrributes of target file
2
102.546777
24.458002
1659.0410
-0.8046
0.94
Set the target file header/Editable
62636844.042 62636851.905 62636853.400 -7.8630 -9.3578 -1.4948
Set the target record table header/Editable
no lon lat height residual weight
Ok
Cancel
①
②
③
Open text file
Save as
Save process
Follow example
no lon lat height residual weight
Organize and display results file
Save data in the textbox as
Display of the input-output file↓
Save program process as
>> [Function] Convert the general ASCII data record file from different sources and non-standard formats into the discrete geodetic record file in PAGravf format.
** Please click the button [Open the source ASCII text file]...
>> C:/PAGravf4.5_win64en/examples/EdPntrecordstandard/rntksich.txt.
** look at the source file information in the text box above，enter the number of rowsof the file header firstly，click the button [Exact and edit data]...
>> Set the format parameters about the target file header, record table header, and record attributes.
** Click the control button [Organize and display results file] to count the maximum number of each column characters of the target record attributes, the upper editable textbox will display target file header, record table header and all the records.
** It takes some time to organize the target record attributes. Please wait...
>> Complete the statistics of the maximum number of characters of the target record attributes, and display the target file header, record table header and all the records in the editable textbox.
** Check the target records file displayed in the editable textbox. Click the control button [Save data in the textbox as] to save the contents in the textbox as the target file...
Load format
face for PAGravf to accept the external text data.

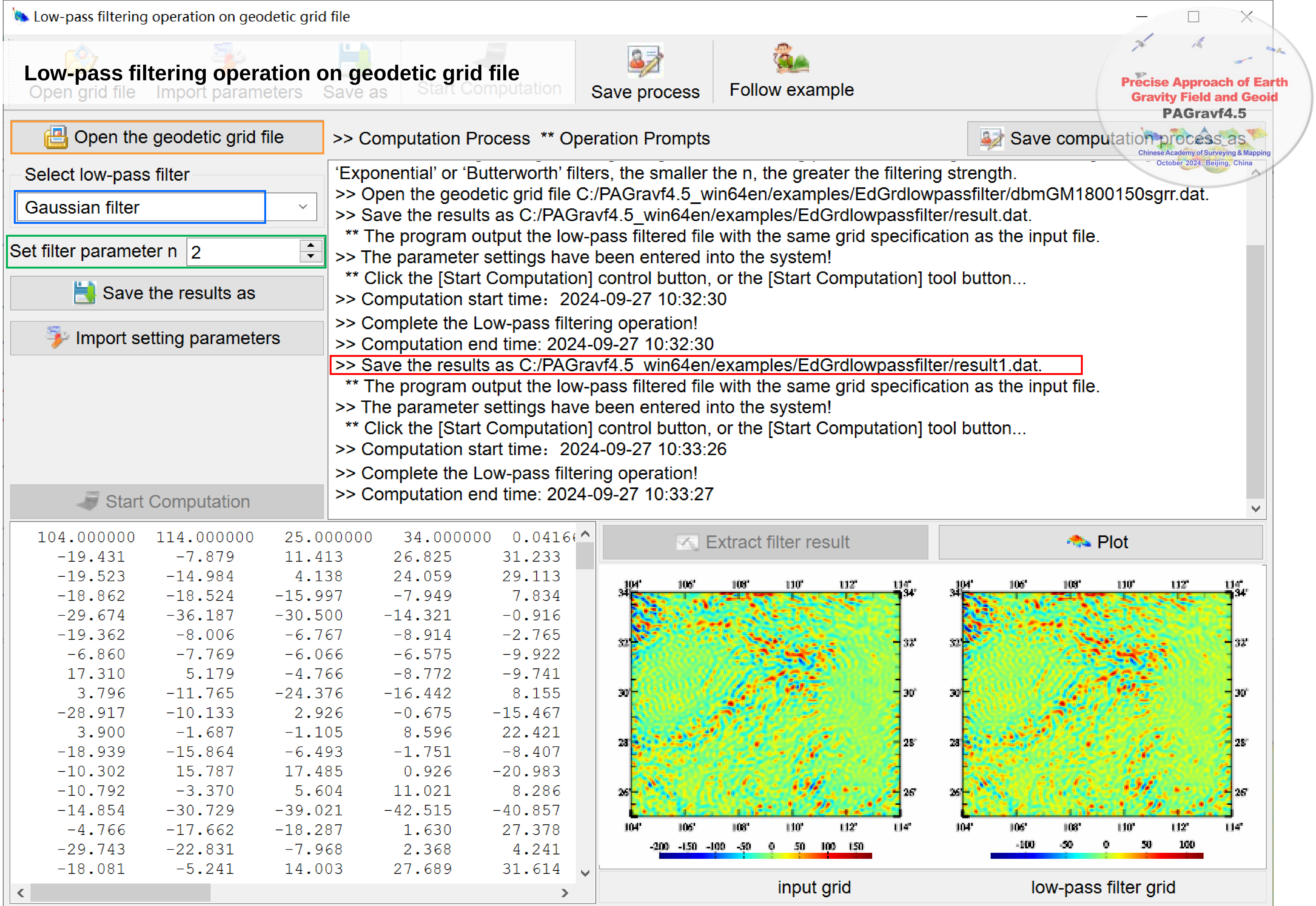


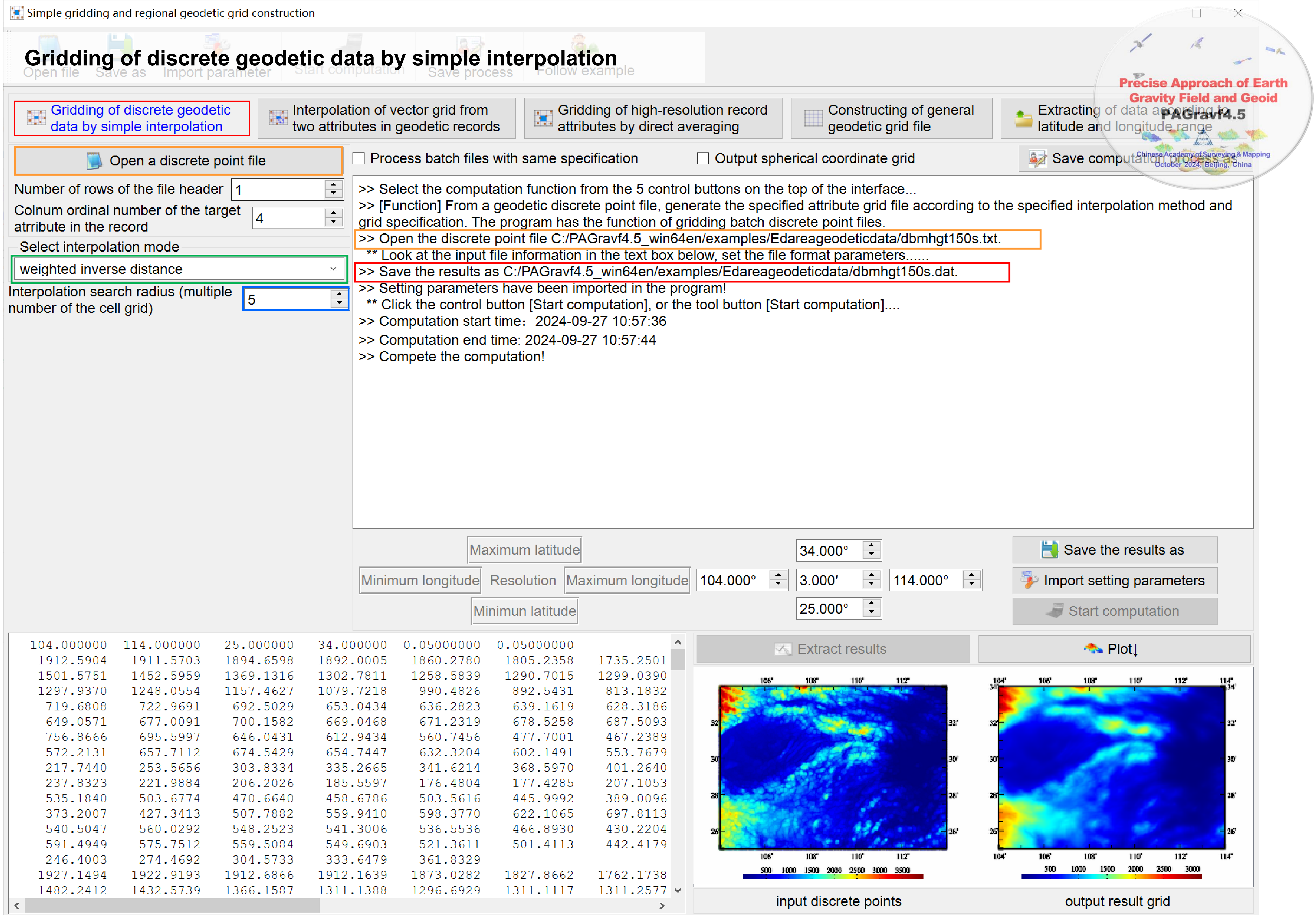
Data interpolation, extracting and separation of land and sea
Changing of grid resolution by interpolation
Open file
Save as
Import parameters
Start computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Changing of grid resolution by interpolation
Interpolating of geodetic site attribute from grid
Selecting of records based on an attribute condition
Separating of (vector) grid data to two different regions
Open a geodetic grid file
>> Program Process ** Operation Prompts
Save program process as
Process many files in a folder
Grid spatial resolution
5.000′
Interpolation mode
Weighted inverse distance
>> Select the function module from the four control buttons at the top of the interface...
>> [Function] Increase or decrease the grid spatial resolution according to the given grid resolution and specified interpolation method.
** The grid direct averaging method is that sums up all the effective source cell-grid element values within the target cell-grid element, and then divided the sum by the number of the effective source cell-grid elements. The grid equal-area averaging method is that sums up all the effective source cell-grid element values within the target cell-grid element, and then divided the sum by the total number of source cell-grid elements.
>> Open a geodetic grid file C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/dbmGM1800150sksi.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/dbmGM1800300sksi.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 09:46:11
>> Complete the computation!
>> Computation end time: 2024-09-27 09:46:12
Save the results as
Import setting parameters
Start computation
104.000000 114.000000 25.000000 34
-30.2919 -30.2668 -30.2778
-30.6576 -30.5428 -30.4278
-29.4737 -29.2776 -29.1069
-26.6049 -26.5548 -26.5321
-23.9284 -23.7268 -23.5718
-20.2001 -19.8410 -19.5237
-15.2558 -14.8489 -14.5217
-11.0481 -10.7002 -10.4082
-30.2686 -30.2461 -30.2499
-30.5727 -30.4886 -30.4152
-29.5261 -29.3636 -29.2124
-26.6002 -26.5250 -26.4927
-23.9027 -23.7075 -23.5598
Extract results
Plot↓
input grid
result grid

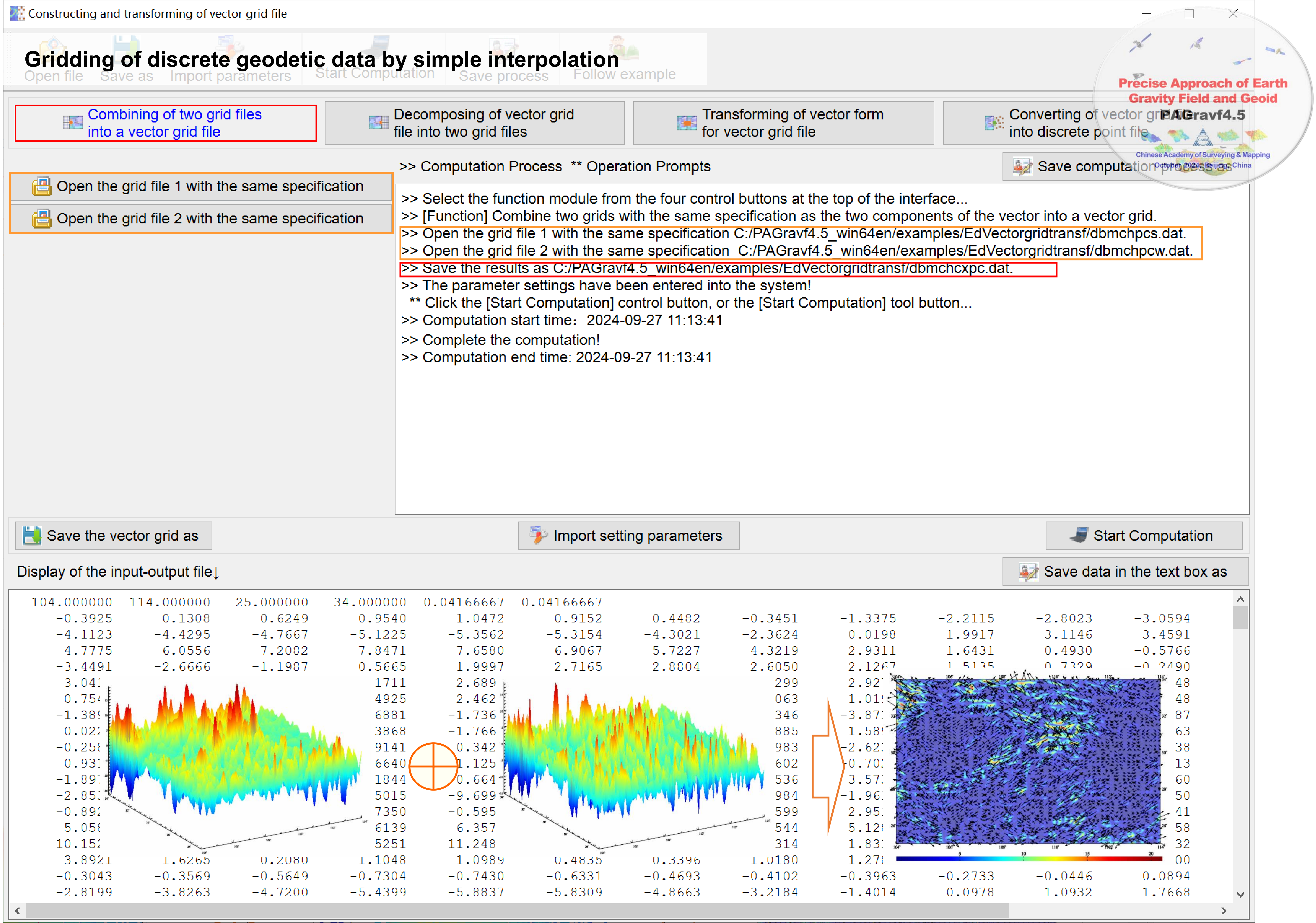

Data interpolation, extracting and separation of land and sea
Interpolating of geodetic site attribute from grid
Open file
Save as
Import parameters
Start computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Changing of grid resolution by interpolation
Interpolating of geodetic site attribute from grid
Selecting of records based on an attribute condition
Separating of (vector) grid data to two different regions
Open a discrete points file
>> Program Process ** Operation Prompts
Save program process as
Set format parameters of the file
Number of rows of the file header
1
Open the grid file for interpolation
Interpolation mode
Weighted inverse distance
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 09:46:11
>> Complete the computation!
>> Computation end time: 2024-09-27 09:46:12
>> [Function] From a numerical grid, interpolate the attribute values of the geodetic sites using the specified interpolation method.
>> Open a discrete points file C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/pntdata.txt.
** Look at the input file information in the text box above, set the file format parameters...
>> Open the grid file for interpolationC:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/pntgrid.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/rstpnt.txt.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 09:56:47
>> Complete the computation!
>> Computation end time: 2024-09-27 09:56:47
Save the results as
Import setting parameters
Start computation
number lon(deg/decimal) lat ellipHeight(r
1 102.442457 24.471769 1972.7703
2 102.546777 24.458002 1659.0410
3 102.632412 24.458211 2120.2558
4 102.725921 24.460578 2111.3872
5 102.420803 24.566357 1990.6386
6 102.528697 24.562786 1936.4260
7 102.634437 24.565660 2192.9271
8 102.725888 24.581970 2303.7797
9 102.832641 24.575505 1977.4949
10 102.345532 24.668953 1919.7825
11 102.423972 24.652933 1959.3369
12 102.529771 24.667079 2157.7877
13 102.631063 24.657055 1906.3415
Extract results
Plot↓
input grid
results interpolated

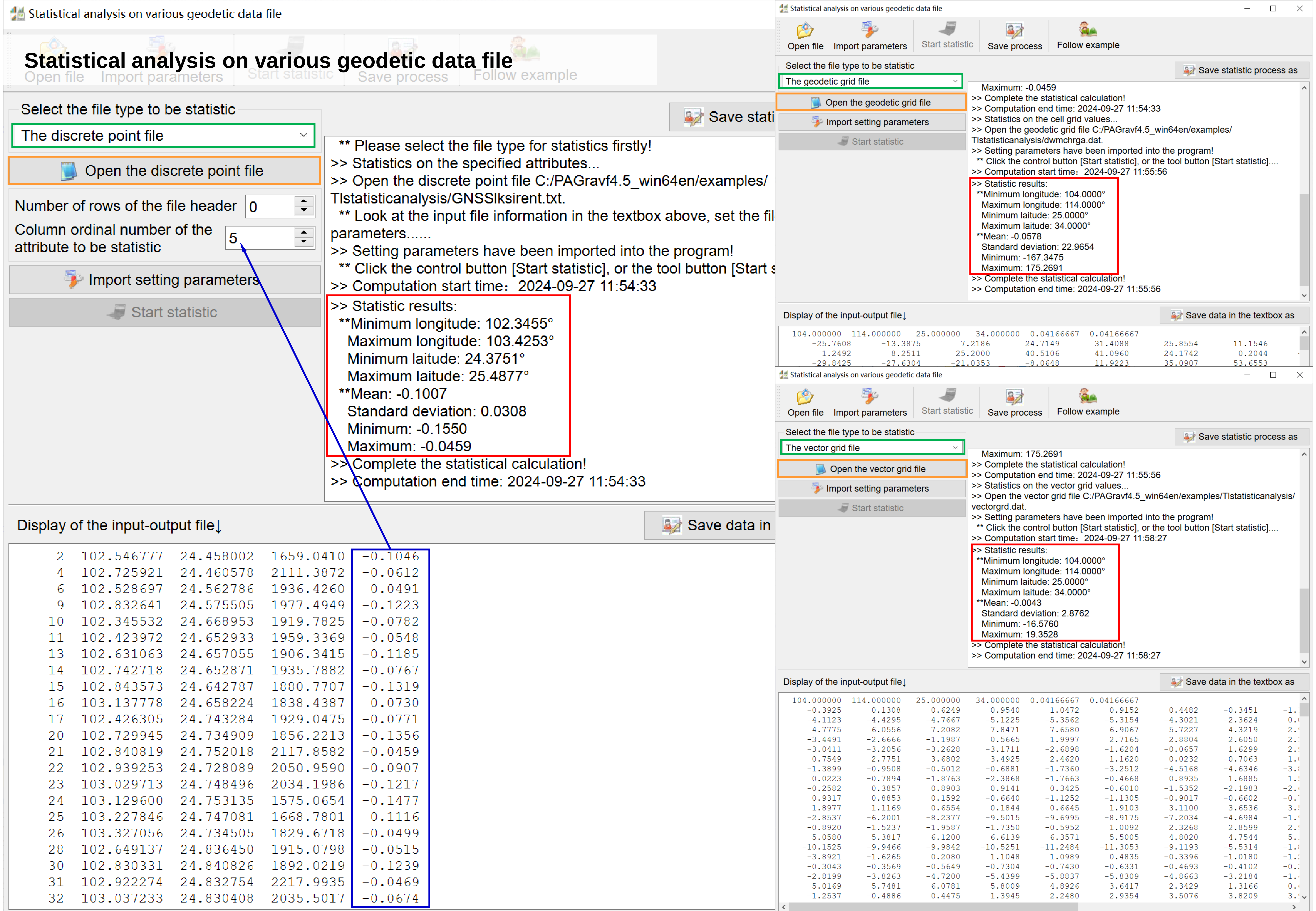

Data interpolation, extracting and separation of land and sea
Separating of (vector) grid data to two different regions
Open file
Save as
Import parameters
Start computation
Save process
Follow example
Changing of grid resolution by interpolation
Interpolating of geodetic site attribute from grid
Selecting of records based on an attribute condition
Separating of (vector) grid data to two different regions
Open a geodetic grid file
>> Program Process ** Operation Prompts
Save program process as
Process many files in a folder
Separate vector grid data
Constant cell grid value 9990.00
Open the reference grid file
Minimum -99000.00
Maximum 0.00
Interpolation mode
Weighted inverse distance
>> Computation start time: 2024-09-27 09:57:45
>> Complete the computation!
>> Computation end time: 2024-09-27 09:57:57
>> [Function] According to the maximum and minimum range of the specified reference grid value, replace the source (vector) grid values with the given constant when the reference grid values are out of the range to separate the source (vector) grid.
** The program requires that the reference grid can distinguish the target area by the maximum and minimum value range. The program can realize the separation of land or sea (vector) grid. The resolution of the source grid may be different from that of the reference grid.
>> Open a geodetic grid file C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/ETOPO30msph.dat.
>> Open the reference grid file C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/ETOPO30msph.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Edatafsimpleprocess/ETOPO30msea.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 09:59:41
>> Complete the computation!
>> Computation end time: 2024-09-27 10:00:15
Save the results as
Import setting parameters
Start computation
0.000000 360.000000 -90.000000 90.0
9990.0000 9990.0000 9990.0000 9990
Extract results
Plot↓
input grid
output grid


Low-pass filtering operation on geodetic grid file
Low-pass filtering operation on geodetic grid file
Open grid file
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the geodetic grid file
>> Computation Process ** Operation Prompts
Save computation process as
Select low-pass filter
moving average filter
Set filter parameter n
2
Save the results as
Import setting parameters
>> [Function] Using the low-pass filters such as the moving average, Gaussian, exponential or Butterworth, perform low-pass filtering on the geodetic grid file. Before and after filtering, the grid specification (Latitude and longitude range and spatial resolution) remain unchanged.
** For the moving average filtering, the greater the filtering parameter n, the greater the filtering strength. For 'Exponential' or 'Butterworth' filters, the smaller the n, the greater the filtering strength.
>> Open the geodetic grid file C:/PAGravf4.5_win64en/examples/EdGrdlowpassfilter/dbmGM1800150sgrr.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/EdGrdlowpassfilter/result.dat.
** The program output the low-pass filtered file with the same grid specification as the input file.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 10:32:30
>> Complete the Low-pass filtering operation!
>> Computation end time: 2024-09-27 10:32:30
Start Computation
104.000000 114.000000 25.000000 34.000000 0.04166
-5.962 4.177 11.466 23.289 28.210
-10.021 -2.122 7.745 14.268 12.628
-6.945 -2.312 6.767 18.694 31.652
-36.281 -36.125 -29.339 -19.418 -11.661
-32.602 -28.244 -23.450 -17.043 -7.400
2.814 7.501 6.571 1.403 -4.846
11.234 8.115 3.029 -3.837 -11.794
2.271 -6.546 -13.002 -10.816 0.961
-18.356 -9.850 -3.663 -4.016 -9.983
13.916 11.283 9.246 10.708 15.153
-20.631 -18.825 -17.034 -15.637 -13.492
-24.640 -23.201 -25.161 -31.713 -38.808
-6.841 -6.836 -4.822 -2.367 -1.876
-3.447 -14.404 -21.274 -23.791 -21.795
-37.146 -36.745 -32.950 -24.857 -14.622
-35.635 -30.386 -17.813 -6.002 -0.671
-8.413 0.194 6.596 17.027 21.671
Extract filter result
Plot
input grid
low-pass filter grid

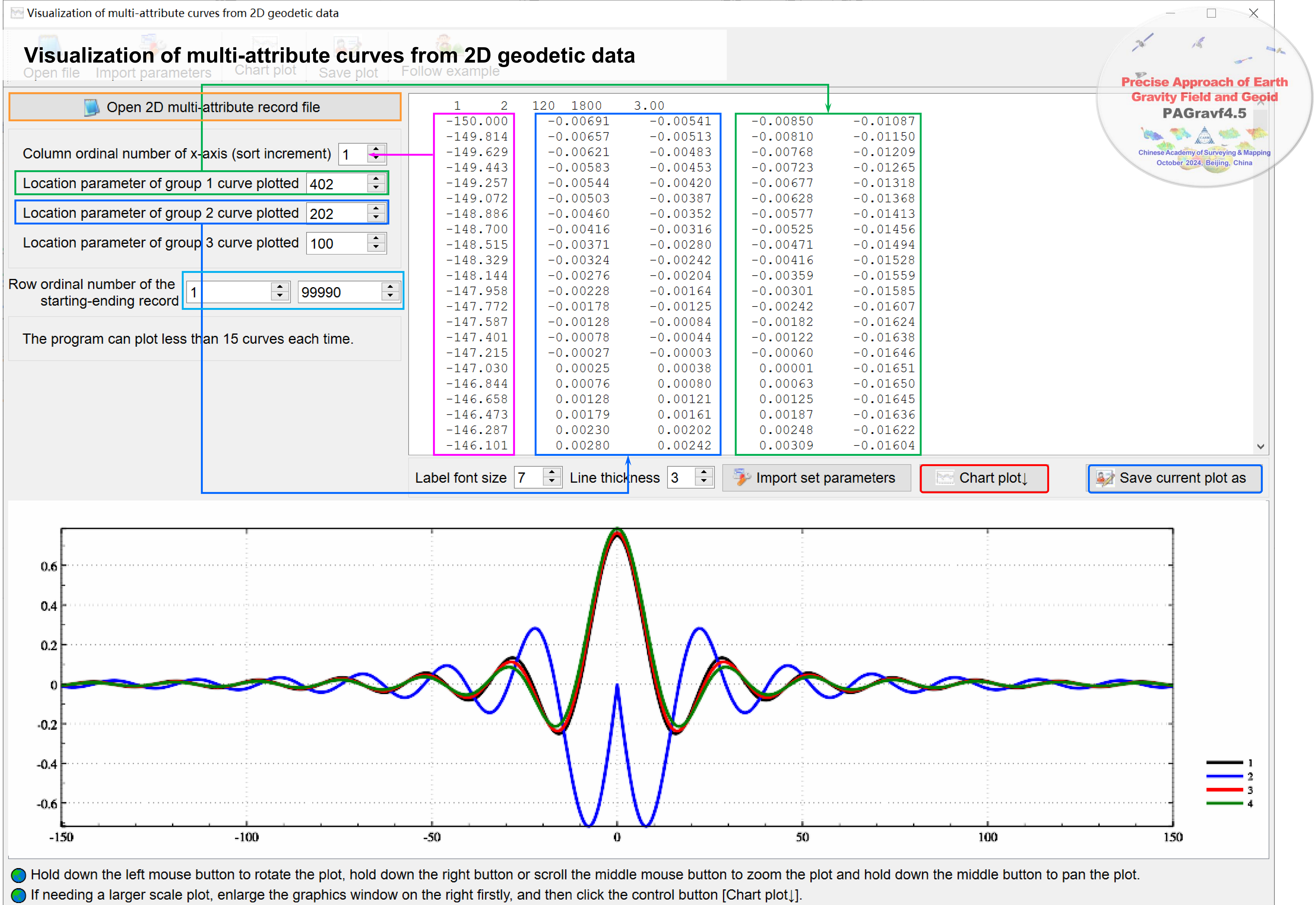

Low-pass filtering operation on geodetic grid file
Low-pass filtering operation on geodetic grid file
Open grid file
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the geodetic grid file
>> Computation Process ** Operation Prompts
Save computation process as
Select low-pass filter
Gaussian filter
Set filter parameter n
2
Save the results as
Import setting parameters
Start Computation
'Exponential' or 'Butterworth' filters, the smaller the n, the greater the filtering strength.
>> Open the geodetic grid file C:/PAGravf4.5_win64en/examples/EdGrdlowpassfilter/dbmGM1800150sgrr.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/EdGrdlowpassfilter/result.dat.
** The program output the low-pass filtered file with the same grid specification as the input file.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 10:32:30
>> Complete the Low-pass filtering operation!
>> Computation end time: 2024-09-27 10:32:30
>> Save the results as C:/PAGravf4.5_win64en/examples/EdGrdlowpassfilter/result1.dat.
** The program output the low-pass filtered file with the same grid specification as the input file.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 10:33:26
>> Complete the Low-pass filtering operation!
>> Computation end time: 2024-09-27 10:33:27
104.000000 114.000000 25.000000 34.000000 0.04166
-19.431 -7.879 11.413 26.825 31.233
-19.523 -14.984 4.138 24.059 29.113
-18.862 -18.524 -15.997 -7.949 7.834
-29.674 -36.187 -30.500 -14.321 -0.916
-19.362 -8.006 -6.767 -8.914 -2.765
-6.860 -7.769 -6.066 -6.575 -9.922
17.310 5.179 -4.766 -8.772 -9.741
3.796 -11.765 -24.376 -16.442 8.155
-28.917 -10.133 2.926 -0.675 -15.467
3.900 -1.687 -1.105 8.596 22.421
-18.939 -15.864 -6.493 -1.751 -8.407
-10.302 15.787 17.485 0.926 -20.983
-10.792 -3.370 5.604 11.021 8.286
-14.854 -30.729 -39.021 -42.515 -40.857
-4.766 -17.662 -18.287 1.630 27.378
-29.743 -22.831 -7.968 2.368 4.241
-18.081 -5.241 14.003 27.689 31.614
Extract filter result
Plot
input grid
low-pass filter grid

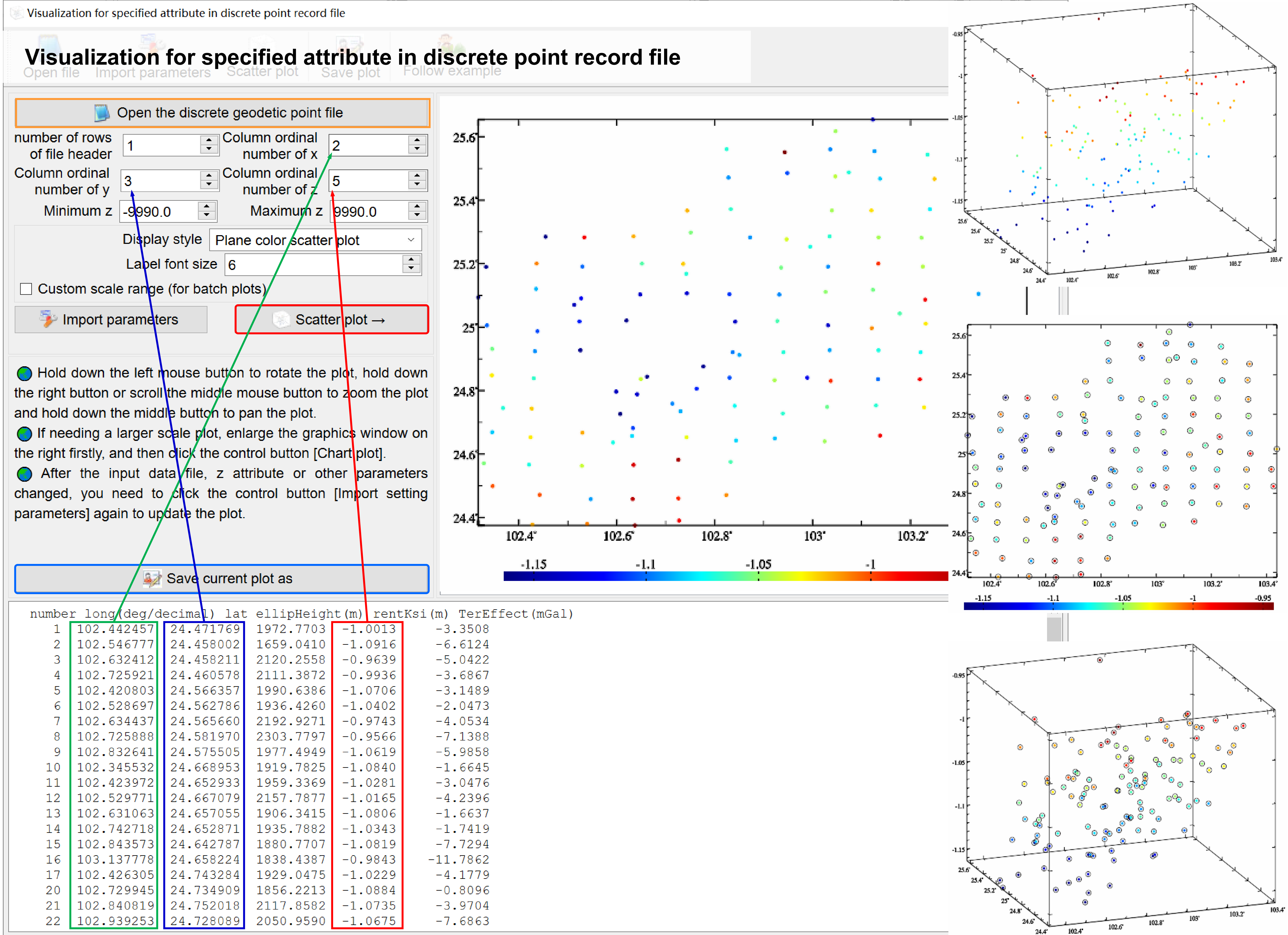

Simple gridding and regional geodetic grid construction
Gridding of discrete geodetic data by simple interpolation
Open file
Save as
Import parameter
Start computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Gridding of discrete geodetic data by simple interpolation
Interpolation of vector grid from two attributes in geodetic records
Gridding of high-resolution record attributes by direct averaging
Constructing of general geodetic grid file
Extracting of data according to latitude and longitude range
Open a discrete point file
Process batch files with same specification
Output spherical coordinate grid
Save computation process as
Number of rows of the file header 1
Colnum ordinal number of the target atrribute in the record 4
Select interpolation mode
weighted inverse distance
Interpolation search radius (multiple number of the cell grid) 5
>> Select the computation function from the 5 control buttons on the top of the interface...
>> [Function] From a geodetic discrete point file, generate the specified attribute grid file according to the specified interpolation method and grid specification. The program has the function of gridding batch discrete point files.
>> Open the discrete point file C:/PAGravf4.5_win64en/examples/Edareageodeticdata/dbmhgt150s.txt.
** Look at the input file information in the text box below, set the file format parameters......
>> Save the results as C:/PAGravf4.5_win64en/examples/Edareageodeticdata/dbmhgt150s.dat.
>> Setting parameters have been imported in the program!
** Click the control button [Start computation], or the tool button [Start computation]....
>> Computation start time：2024-09-27 10:57:36
>> Computation end time: 2024-09-27 10:57:44
>> Compete the computation!
Maximum latitude 34.000°
Minimum longitude 104.000°
Resolution 3.000′
Maximum longitude 114.000°
Minimun latitude 25.000°
Save the results as
Import setting parameters
Start computation
Extract results
Plot↓
104.000000 114.000000 25.000000 34.000000 0.05000000 0.05000000
1912.5904 1911.5703 1894.6598 1892.0005 1860.2780 1805.2358 1735.2501
1501.5751 1452.5959 1369.1316 1302.7811 1258.5839 1290.7015 1299.0390
1297.9370 1248.0554 1157.4627 1079.7218 990.4826 892.5431 813.1832
719.6808 722.9691 692.5029 653.0434 636.2823 639.1619 628.3186
649.0571 677.0091 700.1582 669.0468 671.2319 678.5258 687.5093
756.8666 695.5997 646.0431 612.9434 560.7456 477.7001 467.2389
572.2131 657.7112 674.5429 654.7447 632.3204 602.1491 553.7679
217.7440 253.5656 303.8334 335.2665 341.6214 368.5970 401.2640
237.8323 221.9884 206.2026 185.5597 176.4804 177.4285 207.1053
535.1840 503.6774 470.6640 458.6786 503.5616 445.9992 389.0096
373.2007 427.3413 507.7882 559.9410 598.3770 622.1065 697.8113
540.5047 560.0292 548.2523 541.3006 536.5536 466.8930 430.2204
591.4949 575.7512 559.5084 549.6903 521.3611 501.4113 442.4179
246.4003 274.4692 304.5733 333.6479 361.8329
1927.1494 1922.9193 1912.6866 1912.1639 1873.0282 1827.8662 1762.1738
1482.2412 1432.5739 1366.1587 1311.1388 1296.6929 1311.1117 1311.2577
input discrete points
output result grid


Constructing and transforming of vector grid file
Gridding of discrete geodetic data by simple interpolation
Open file
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
Combining of two grid files into a vector grid file
Decomposing of vector grid file into two grid files
Transforming of vector form for vector grid file
Converting of vector grid into discrete point file
>> Computation Process ** Operation Prompts
Save computation process as
Open the grid file 1 with the same specification
Open the grid file 2 with the same specification
>> Select the function module from the four control buttons at the top of the interface...
>> [Function] Combine two grids with the same specification as the two components of the vector into a vector grid.
>> Open the grid file 1 with the same specification C:/PAGravf4.5_win64en/examples/EdVectorgridtransf/dbmchpcs.dat.
>> Open the grid file 2 with the same specification C:/PAGravf4.5_win64en/examples/EdVectorgridtransf/dbmchpcw.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/EdVectorgridtransf/dbmchcxpc.dat.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-27 11:13:41
>> Complete the computation!
>> Computation end time: 2024-09-27 11:13:41
Save the vector grid as
Import setting parameters
Start Computation
Display of the input-output file↓
Save data in the text box as
104.000000 114.000000 25.000000 34.000000 0.04166667 0.04166667
-0.3925 0.1308 0.6249 0.9540 1.0472 0.9152 0.4482 -0.3451 -1.3375 -2.2115 -2.8023 -3.0594
-4.1123 -4.4295 -4.7667 -5.1225 -5.3562 -5.3154 -4.3021 -2.3624 0.0198 1.9917 3.1146 3.4591
4.7775 6.0556 7.2082 7.8471 7.6580 6.9067 5.7227 4.3219 2.9311 1.6431 0.4930 -0.5766
-3.4491 -2.6666 -1.1987 0.5665 1.9997 2.7165 2.8804 2.6050
-0.3043 -0.3569 -0.5649 -0.7304 -0.7430 -0.6331 -0.4693 -0.4102 -0.3963 -0.2733 -0.0446 0.0894
-2.8199 -3.8263 -4.7200 -5.4399 -5.8837 -5.8309 -4.8663 -3.2184 -1.4014 0.0978 1.0932 1.7668

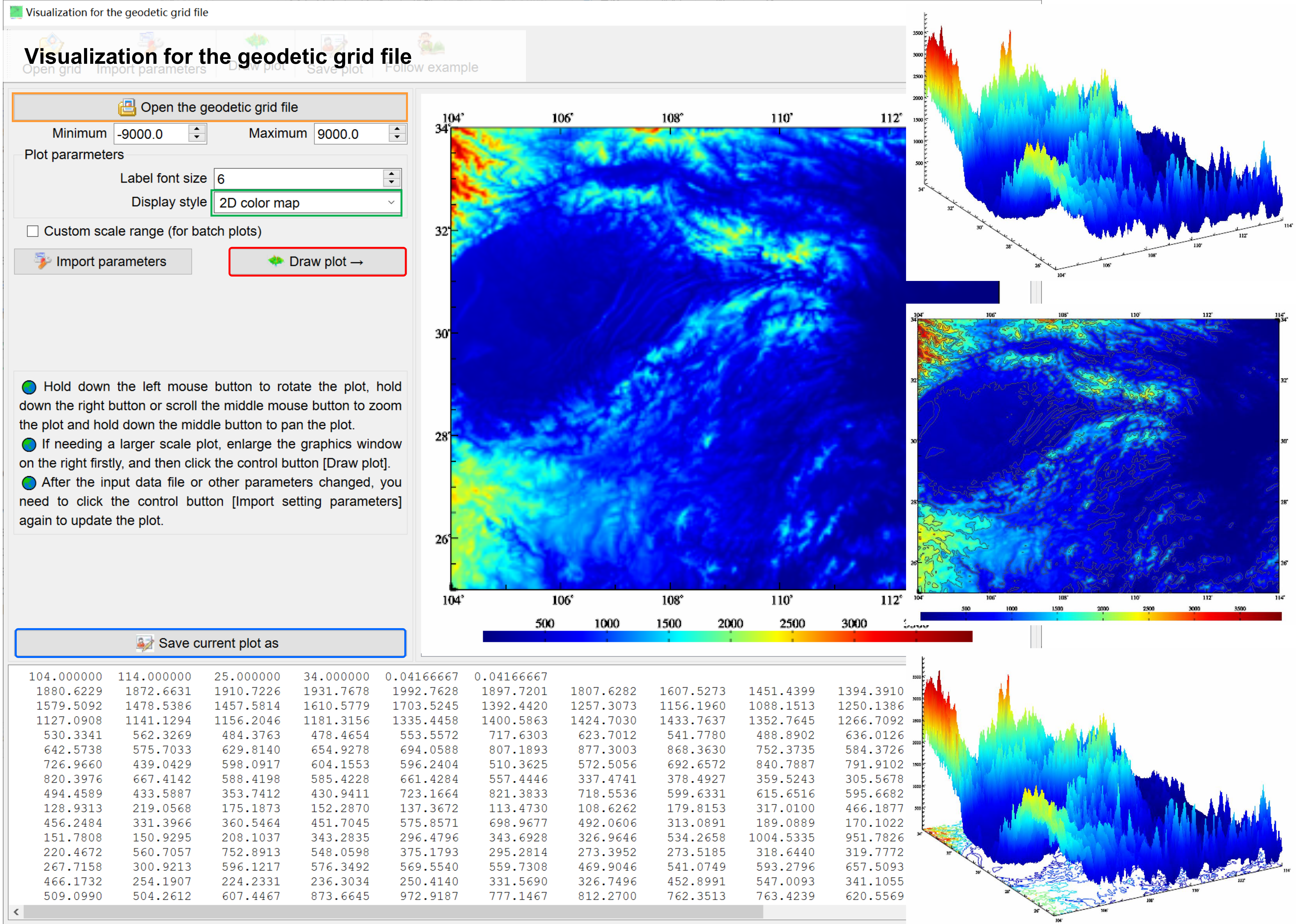


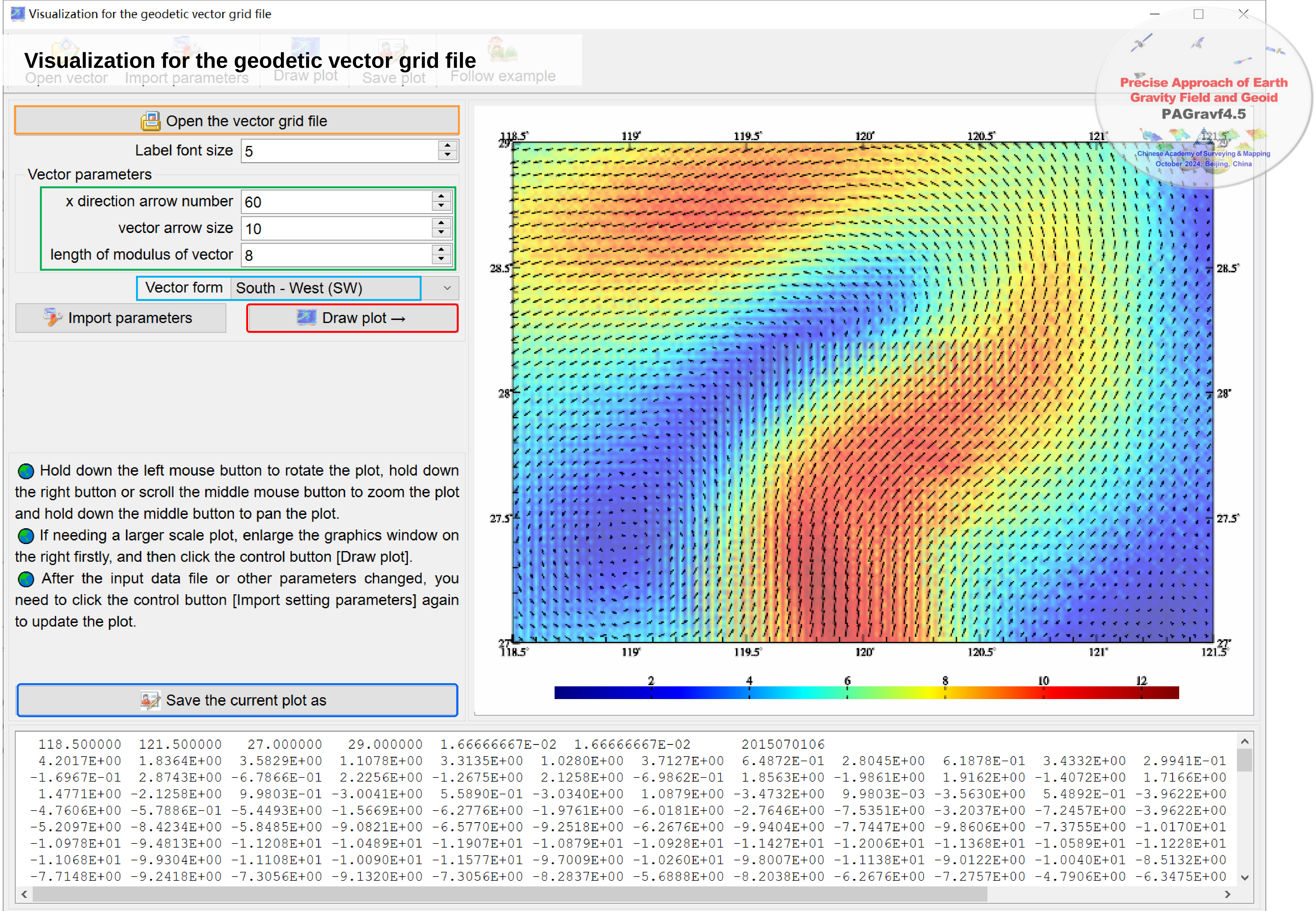
Statistical analysis on various geodetic data file
Open file
Import parameters
Start statistic
Save process
Follow example
Select the file type to be statistic
The discrete point file
Open the discrete point file
Number of rows of the file header 0
Column ordinal number of the attribute to be statistic 5
Import setting parameters
Start statistic
Save stati
** Please select the file type for statistics firstly!
>> Statistics on the specified attributes...
>> Open the discrete point file C:/PAGravf4.5_win64en/examples/TIstatisticanalysis/GNSSlksirent.txt.
** Look at the input file information in the textbox above, set the fil parameters......
>> Setting parameters have been imported into the program!
** Click the control button [Start statistic], or the tool button [Start s
>> Computation start time: 2024-09-27 11:54:33
>> Statistic results:
**Minimum longitude: 102.3455°
Maximum longitude: 103.4253°
Minimum laitude: 24.3751°
Maximum laitude: 25.4877°
**Mean: -0.1007
Standard deviation: 0.0308
Minimum: -0.1550
Maximum: -0.0459
>> Complete the statistical calculation!
>> Computation end time: 2024-09-27 11:54:33
Display of the input-output file↓
Save data in
2 102.546777 24.458002 1659.0410 -0.1046
4 102.725921 24.460578 2111.3872 -0.0612
6 102.528697 24.562786 1936.4260 -0.0491
9 102.832641 24.575505 1977.4949 -0.1223
10 102.345532 24.668953 1919.7825 -0.0782
11 102.423972 24.652933 1959.3369 -0.0548
13 102.631063 24.657055 1906.3415 -0.1185
14 102.742718 24.652871 1935.7882 -0.0767
15 102.843573 24.642787 1880.7707 -0.1319
16 103.137778 24.658224 1838.4387 -0.0730
17 102.426305 24.743284 1929.0475 -0.0771
20 102.729945 24.734909 1856.2213 -0.1356
21 102.840819 24.752018 2117.8582 -0.0459
22 102.939253 24.728089 2050.9590 -0.0907
23 103.029713 24.748496 2034.1986 -0.1217
24 103.129600 24.753135 1575.0654 -0.1477
25 103.227846 24.747081 1668.7801 -0.1116
26 103.327056 24.734505 1829.6718 -0.0499
28 102.649137 24.836450 1915.0798 -0.0515
30 102.830331 24.840826 1892.0219 -0.1239
31 102.922274 24.832754 2217.9935 -0.0469
32 103.037233 24.830408 2035.5017 -0.0674
Statistical analysis on various geodetic data file
Open file
Import parameters
Start statistic
Save process
Follow example
Select the file type to be statistic
The geodetic grid file
Open the geodetic grid file
Import setting parameters
Start statistic
Save statistic process as
Maximum: -0.0459
>> Complete the statistical calculation!
>> Computation end time: 2024-09-27 11:54:33
>> Statistics on the cell grid values...
>> Open the geodetic grid file C:/PAGravf4.5_win64en/examples/TIstatisticanalysis/dwmchrga.dat.
>> Setting parameters have been imported into the program!
** Click the control button [Start statistic], or the tool button [Start statistic]....
>> Computation start time: 2024-09-27 11:55:56
>> Statistic results:
**Minimum longitude: 104.0000°
Maximum longitude: 114.0000°
Minimum laitude: 25.0000°
Maximum laitude: 34.0000°
**Mean: -0.0578
Standard deviation: 22.9654
Minimum: -167.3475
Maximum: 175.2691
>> Complete the statistical calculation!
>> Computation end time: 2024-09-27 11:55:56
Display of the input-output file↓
Save data in the textbox as
Statistical analysis on various geodetic data file
Open file
Import parameters
Start statistic
Save process
Follow example
Select the file type to be statistic
The vector grid file
Open the vector grid file
Import setting parameters
Start statistic
Save statistic process as
Maximum: 175.2691
>> Complete the statistical calculation!
>> Computation end time: 2024-09-27 11:55:56
>> Statistics on the vector grid values...
>> Open the vector grid file C:/PAGravf4.5_win64en/examples/TIstatisticanalysis/vectorgrd.dat.
>> Setting parameters have been imported into the program!
** Click the control button [Start statistic], or the tool button [Start statistic]....
>> Computation start time: 2024-09-27 11:58:27
>> Statistic results:
**Minimum longitude: 104.0000°
Maximum longitude: 114.0000°
Minimum laitude: 25.0000°
Maximum laitude: 34.0000°
**Mean: -0.0043
Standard deviation: 2.8762
Minimum: -16.5760
Maximum: 19.3528
>> Complete the statistical calculation!
>> Computation end time: 2024-09-27 11:58:27
Display of the input-output file↓
Save data in the textbox as


Visualization of multi-attribute curves from 2D geodetic data
Open file
Import parameters
Chart plot
Save plot
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open 2D multi-attribute record file
Column ordinal number of x-axis (sort increment) 1
Location parameter of group 1 curve plotted 402
Location parameter of group 2 curve plotted 202
Location parameter of group 3 curve plotted 100
Row ordinal number of the starting-ending record 1 99990
The program can plot less than 15 curves each time.
1 2 120 1800 3.00
-150.000 -0.00691 -0.00541 -0.00850 -0.01087
-149.814 -0.00657 -0.00513 -0.00810 -0.01150
-149.629 -0.00621 -0.00483 -0.00768 -0.01209
-149.443 -0.00583 -0.00453 -0.00723 -0.01265
-149.257 -0.00544 -0.00420 -0.00677 -0.01318
-149.072 -0.00503 -0.00387 -0.00628 -0.01368
-148.886 -0.00460 -0.00352 -0.00577 -0.01413
-148.700 -0.00416 -0.00316 -0.00525 -0.01456
-148.515 -0.00371 -0.00280 -0.00471 -0.01494
-148.329 -0.00324 -0.00242 -0.00416 -0.01528
-148.144 -0.00276 -0.00204 -0.00359 -0.01559
-147.958 -0.00228 -0.00164 -0.00301 -0.01585
-147.772 -0.00178 -0.00125 -0.00242 -0.01607
-147.587 -0.00128 -0.00084 -0.00182 -0.01624
-147.401 -0.00078 -0.00044 -0.00122 -0.01638
-147.215 -0.00027 -0.00003 -0.00060 -0.01646
-147.030 0.00025 0.00038 0.00001 -0.01651
-146.844 0.00076 0.00080 0.00063 -0.01650
-146.658 0.00128 0.00121 0.00125 -0.01645
-146.473 0.00179 0.00161 0.00187 -0.01636
-146.287 0.00230 0.00202 0.00248 -0.01622
-146.101 0.00280 0.00242 0.00309 -0.01604
Label font size 7
Line thickness 3
Import set parameters
Chart plot↓
Save current plot as
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-150
-100
-50
0
50
100
150
1
2
3
4
Hold down the left mouse button to rotate the plot, hold down the right button or scroll the middle mouse button to zoom the plot and hold down the middle button to pan the plot.
If needing a larger scale plot, enlarge the graphics window on the right firstly, and then click the control button [Chart plot↓].



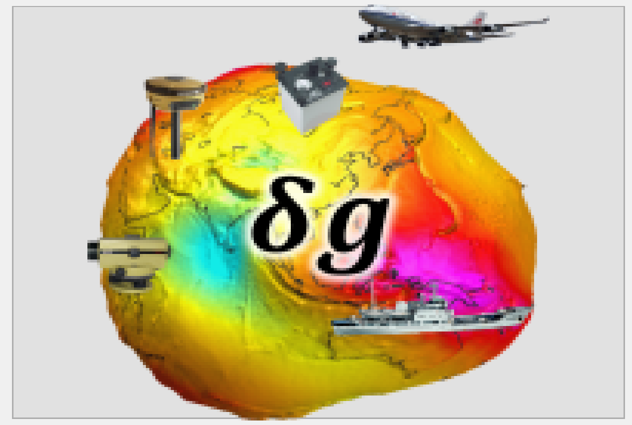
number	long(deg/decimal)	lat	ellipHeight(m)	rentKsi(m)	TerEffect(mGal)
1	102.442457	24.471769	1972.7703	-1.0013	-3.3508
2	102.546777	24.458002	1659.0410	-1.0916	-6.6124
3	102.632412	24.458211	2120.2558	-0.9639	-5.0422
4	102.725921	24.460578	2111.3872	-0.9936	-3.6867
5	102.420803	24.566357	1990.6386	-1.0706	-3.1489
6	102.528697	24.562786	1936.4260	-1.0402	-2.0473
7	102.634437	24.565660	2192.9271	-0.9743	-4.0534
8	102.725888	24.581970	2303.7797	-0.9566	-7.1388
9	102.832641	24.575505	1977.4949	-1.0619	-5.9858
10	102.345532	24.668953	1919.7825	-1.0840	-1.6645
11	102.423972	24.652933	1959.3369	-1.0281	-3.0476
12	102.529771	24.667079	2157.7877	-1.0165	-4.2396
13	102.631063	24.657055	1906.3415	-1.0806	-1.6637
14	102.742718	24.652871	1935.7882	-1.0343	-1.7419
15	102.843573	24.642787	1880.7707	-1.0819	-7.7294
16	103.137778	24.658224	1838.4387	-0.9843	-11.7862
17	102.426305	24.743284	1929.0475	-1.0229	-4.1779
20	102.729945	24.734909	1856.2213	-1.0884	-0.8096
21	102.840819	24.752018	2117.8582	-1.0735	-3.9704
22	102.939253	24.728089	2050.9590	-1.0675	-7.6863


Visualization for the geodetic grid file
Visualization for the geodetic grid file
Open grid
Import parameters
Draw plot
Save plot
Follow example
Open the geodetic grid file
Minimum
-9000.0
Maximum
9000.0
Plot parameters
Label font size
6
Display style
2D color map
Custom scale range (for batch plots)
Import parameters
Draw plot →
Hold down the left mouse button to rotate the plot, hold down the right button or scroll the middle mouse button to zoom the plot and hold down the middle button to pan the plot.
If needing a larger scale plot, enlarge the graphics window on the right firstly, and then click the control button [Draw plot].
After the input data file or other parameters changed, you need to click the control button [Import setting parameters] again to update the plot.
Save current plot as
104° 106° 108° 110° 112°
34° 32° 30° 28° 26°
500 1000 1500 2000 2500 3000
104.000000 114.000000 25.000000 34.000000 0.04166667 0.04166667
1880.6229 1872.6631 1910.7226 1931.7678 1992.7628 1897.7201 1807.6282 1607.5273 1451.4399 1394.3910
1579.5092 1478.5386 1457.5814 1610.5779 1703.5245 1392.4420 1257.3073 1156.1960 1088.1513 1250.1386
1127.0908 1141.1294 1156.2046 1181.3156 1335.4458 1400.5863 1424.7030 1433.7637 1352.7645 1266.7092
530.3341 562.3269 484.3763 478.4654 553.5572 717.6303 623.7012 541.7780 488.8902 636.0126
642.5738 575.7033 629.8140 654.9278 694.0588 807.1893 877.3003 868.3630 752.3735 584.3726
726.9660 439.0429 598.0917 604.1553 596.2404 510.3625 572.5056 692.6572 840.7887 791.9102
820.3976 667.4142 588.4198 585.4228 661.4284 557.4446 337.4741 378.4927 359.5243 305.5678
494.4589 433.5887 353.7412 430.9411 723.1664 821.3833 718.5536 599.6331 615.6516 595.6682
128.9313 219.0568 175.1873 152.2870 137.3672 113.4730 108.6262 179.8153 317.0100 466.1877
456.2484 331.3966 360.5464 451.7045 575.8571 698.9677 492.0606 313.0891 189.0889 170.1022
151.7808 150.9295 208.1037 343.2835 296.4796 343.6928 326.9646 534.2658 1004.5335 951.7826
220.4672 560.7057 752.8913 548.0598 375.1793 295.2814 273.3952 273.5185 318.6440 319.7772
267.7158 300.9213 596.1217 576.3492 569.5540 559.7308 469.9046 541.0749 593.2796 657.5093
466.1732 254.1907 224.2331 236.3034 250.4140 331.5690 326.7496 452.8991 547.0093 341.1055
509.0990 504.2612 607.4467 873.6645 972.9187 777.1467 812.2700 762.3513 763.4239 620.5569

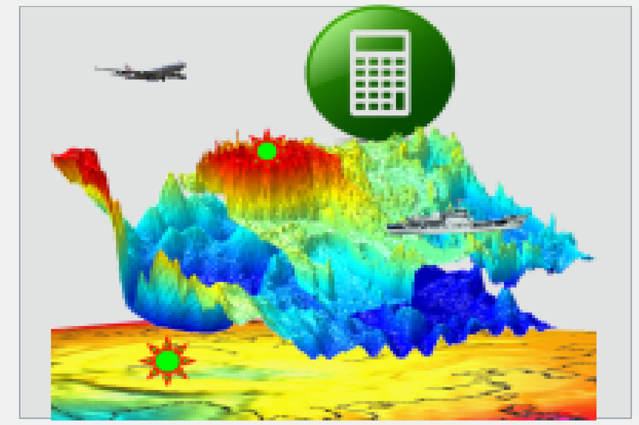

Visualization for the geodetic vector grid file
Visualization for the geodetic vector grid file
Open vector
Import parameters
Draw plot
Save plot
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & Mapping
October 2024, Beijing, China
Open the vector grid file
Label font size 5
Vector parameters
x direction arrow number 60
vector arrow size 10
length of modulus of vector 8
Vector form South - West (SW)
Import parameters
Draw plot →
Hold down the left mouse button to rotate the plot, hold down the right button or scroll the middle mouse button to zoom the plot and hold down the middle button to pan the plot.
If needing a larger scale plot, enlarge the graphics window on the right firstly, and then click the control button [Draw plot].
After the input data file or other parameters changed, you need to click the control button [Import setting parameters] again to update the plot.
Save the current plot as
118.5° 119° 119.5° 120° 120.5° 121° 121.5°
29° 28.5° 28° 27.5° 27°
2 4 6 8 10 12
118.500000 121.500000 27.000000 29.000000 1.66666667E-02 1.66666667E-02 2015070106
4.2017E+00 1.8364E+00 3.5829E+00 1.1078E+00 3.3135E+00 1.0280E+00 3.7127E+00 6.4872E-01 2.8045E+00 6.1878E-01 3.4332E+00 2.9941E-01
-1.6967E-01 2.8743E+00 -6.7866E-01 2.2256E+00 -1.2675E+00 2.1258E+00 -6.9862E-01 1.8563E+00 -1.9861E+00 1.9162E+00 -1.4072E+00 1.7166E+00
1.4771E+00 -2.1258E+00 9.9803E-01 -3.0041E+00 5.5890E-01 -3.0340E+00 1.0879E+00 -3.4732E+00 9.9803E-03 -3.5630E+00 5.4892E-01 -3.9622E+00
-4.7606E+00 -5.7886E-01 -5.4493E+00 -1.5669E+00 -6.2776E+00 -1.9761E+00 -6.0181E+00 -2.7646E+00 -7.5351E+00 -3.2037E+00 -7.2457E+00 -3.9622E+00
-5.2097E+00 -8.4234E+00 -5.8485E+00 -9.0821E+00 -6.5770E+00 -9.2518E+00 -6.2676E+00 -9.9404E+00 -7.7447E+00 -9.8606E+00 -7.3755E+00 -1.0170E+01
-1.0978E+01 -9.4813E+00 -1.1208E+01 -1.0489E+01 -1.1907E+01 -1.0879E+01 -1.0928E+01 -1.1427E+01 -1.2006E+01 -1.1368E+01 -1.0589E+01 -1.1228E+01
-1.1068E+01 -9.9304E+00 -1.1108E+01 -1.0090E+01 -1.1577E+01 -9.7009E+00 -1.0260E+01 -9.8007E+00 -1.1138E+01 -9.0122E+00 -1.0040E+01 -8.5132E+00
-7.7148E+00 -9.2418E+00 -7.3056E+00 -9.1320E+00 -7.3056E+00 -8.2837E+00 -5.6888E+00 -8.2038E+00 -6.2676E+00 -7.2757E+00 -4.7906E+00 -6.3475E+00

Precise Approach for Earth Gravity field and Geoid PAGravf4.5

Summary, parameter settings and visualization for PAGravf4.5



Data analysis and preprocessing calculation of Earth gravity field



Computation of various terrain effects on various field elements outside geoid

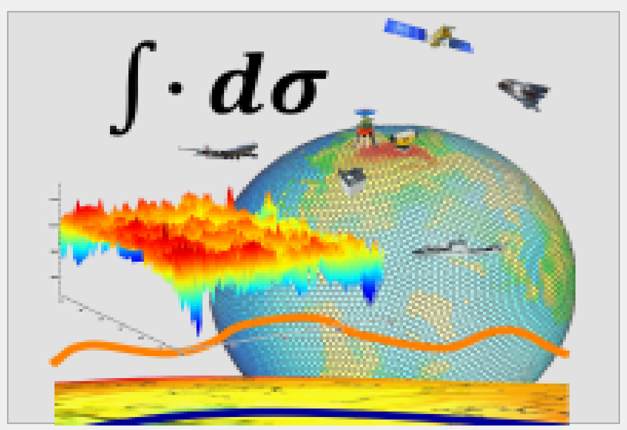
☆ The basic principles, main methods and all the formulas in physical geodesy and Earth gravity field have been realized completely in PAGravf4.5 to imporve high education environment.
☆ Many long-term puzzles such as various terrain effects on various observations, all-element analytical modelling on gravity field, fine gravity prospecting modelling from heterogeneous observations, external accuracy index measurement and computational performance control have been effectively solved to strengthen the application capacity of Earth gravity field.

PAGravf4.5 scientific computation programs organization structure

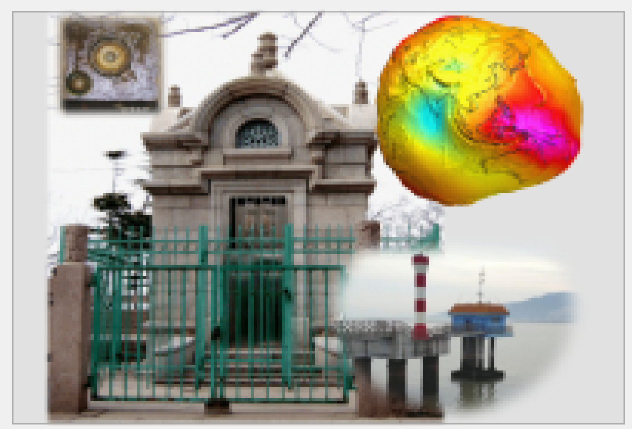
www.zcyphygeodesy.com/en/

☆ PAGravf4.5 is suitable for senior under-graduates, graduate students, scientific researchers, and engineer technicians in geodesy and geophysics, geology and geoscience, geomatics and geographic information, seismic and geodynamics.
☆ There are the example files saved in the folder C:\PAGravf4.5_win64en\examples for each program, which includes the operation process file process.txt, some input-output data files and screenshots. It will take about 5 working days to complete all the example exercises. Thereafter, you can use PAGravf4.5 alone.

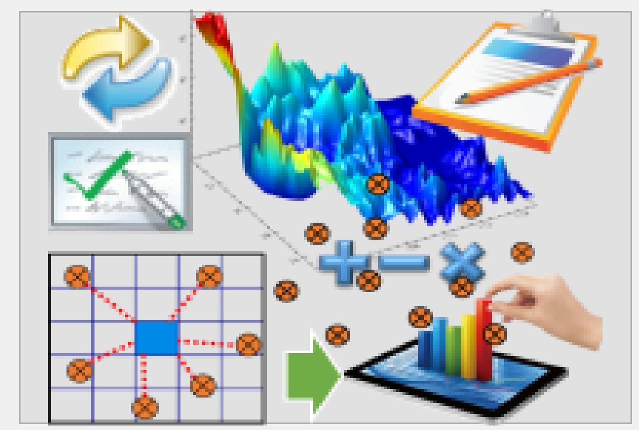
Geodetic data format and geodetic quantity convention in PAGravf4.5



Precise approach and all-element modeling on Earth gravity field



Optimization, unification, and application for regional height datum



Editing and calculation tools for geodetic data files

Classroom Teaching, Self-Exercise, Science Research and Engineer Computing

- **Cross aliasing of heterogeneous observations in land-sea-space**
- **Loop closed analytical operations on outer gravity field elements**
- **Index measurement of observation errors and computation control**
- **Various terrain effects on all-element gravity field in whole space**
- **All-element modeling on Earth gravity field in whole outer space**
- **Gravity prospecting modelling from heterogeneous observations**