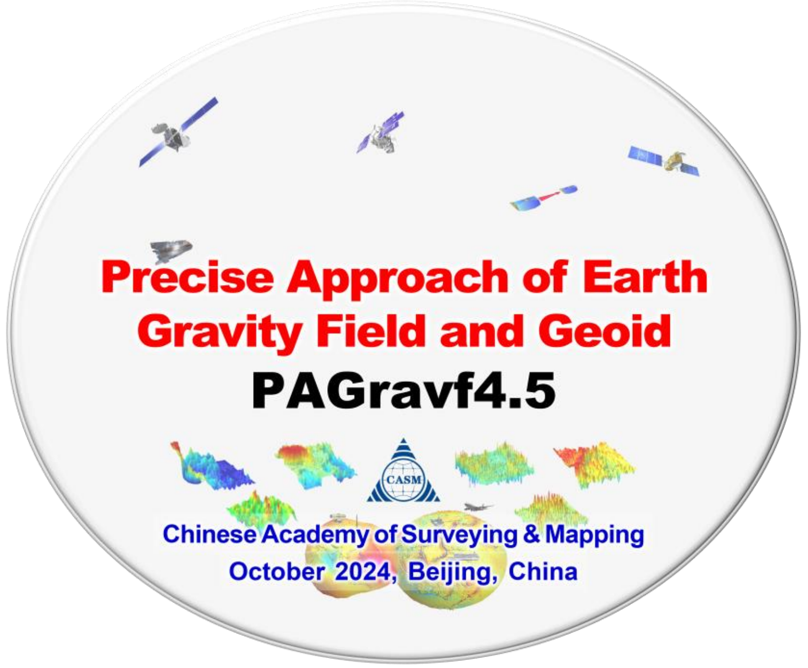
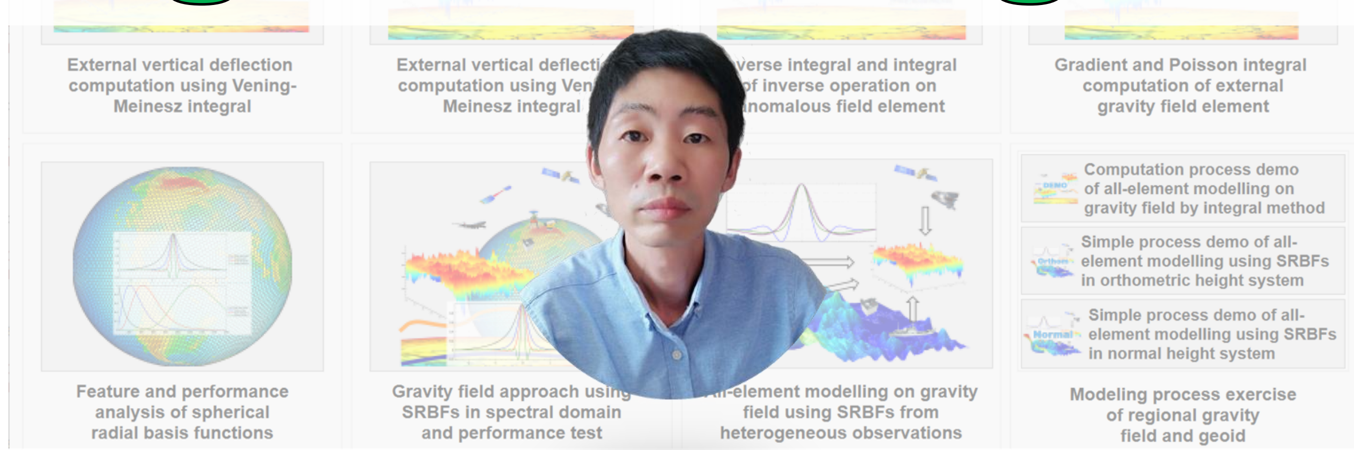
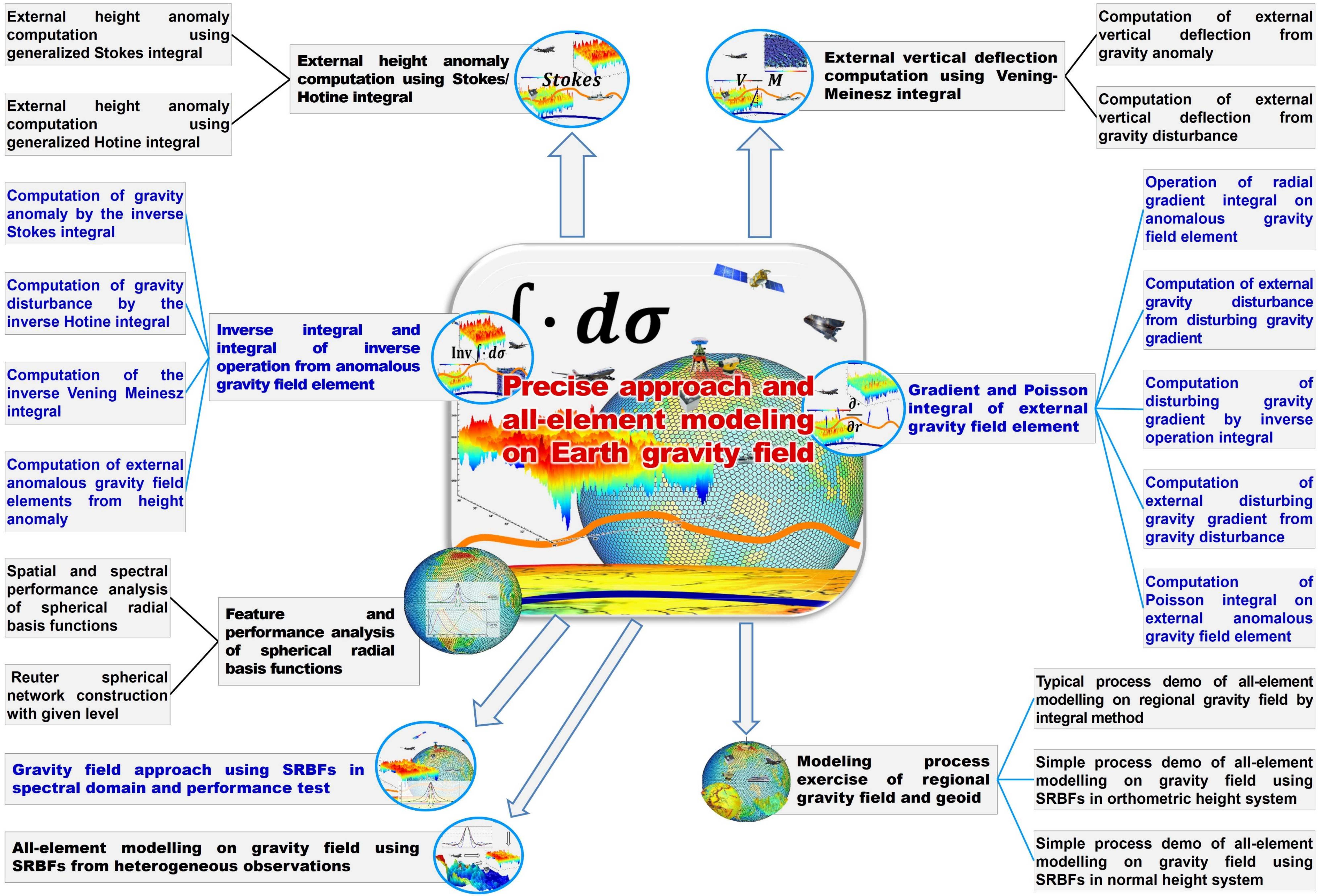
www.zcyphygeodesy.com

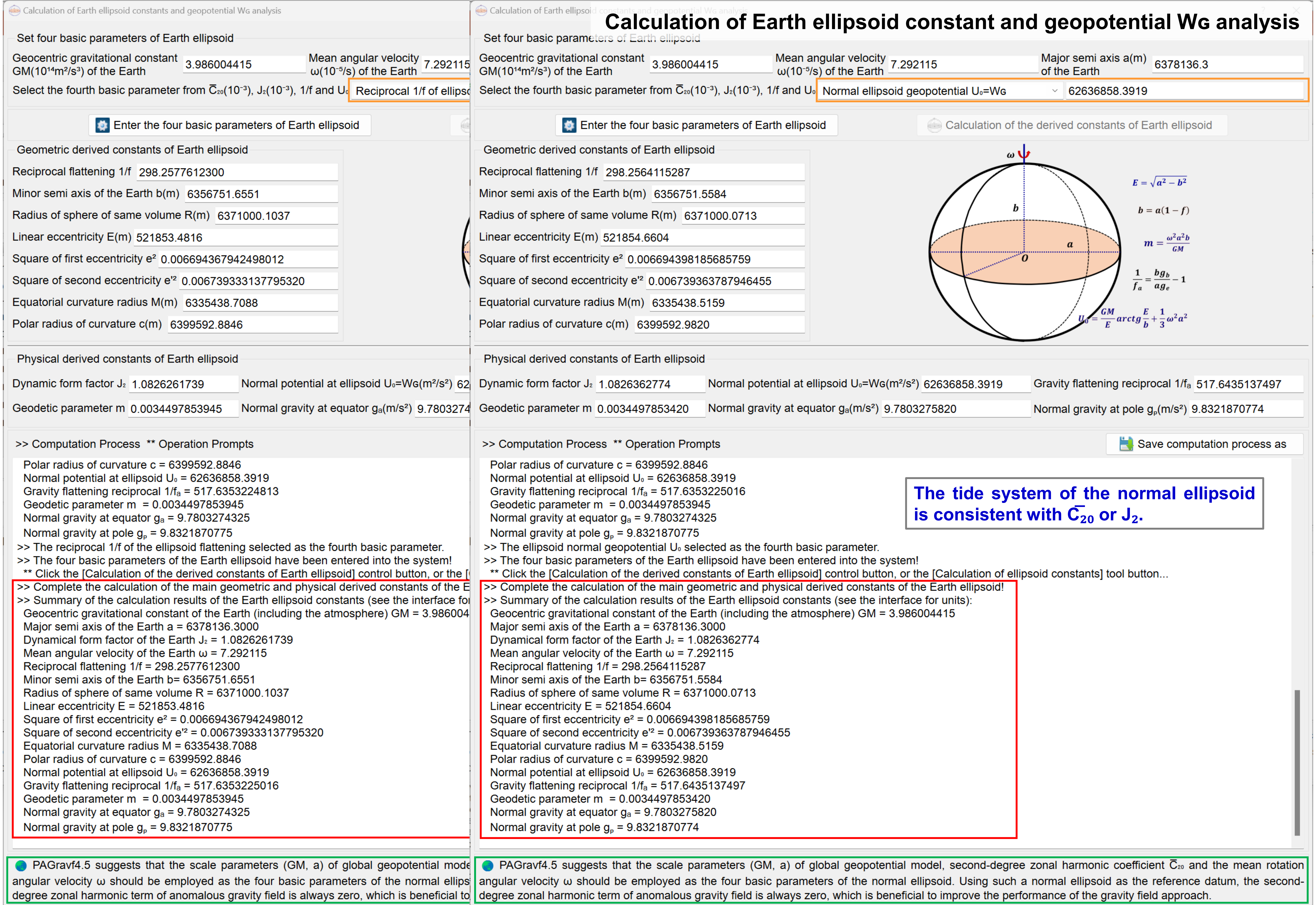


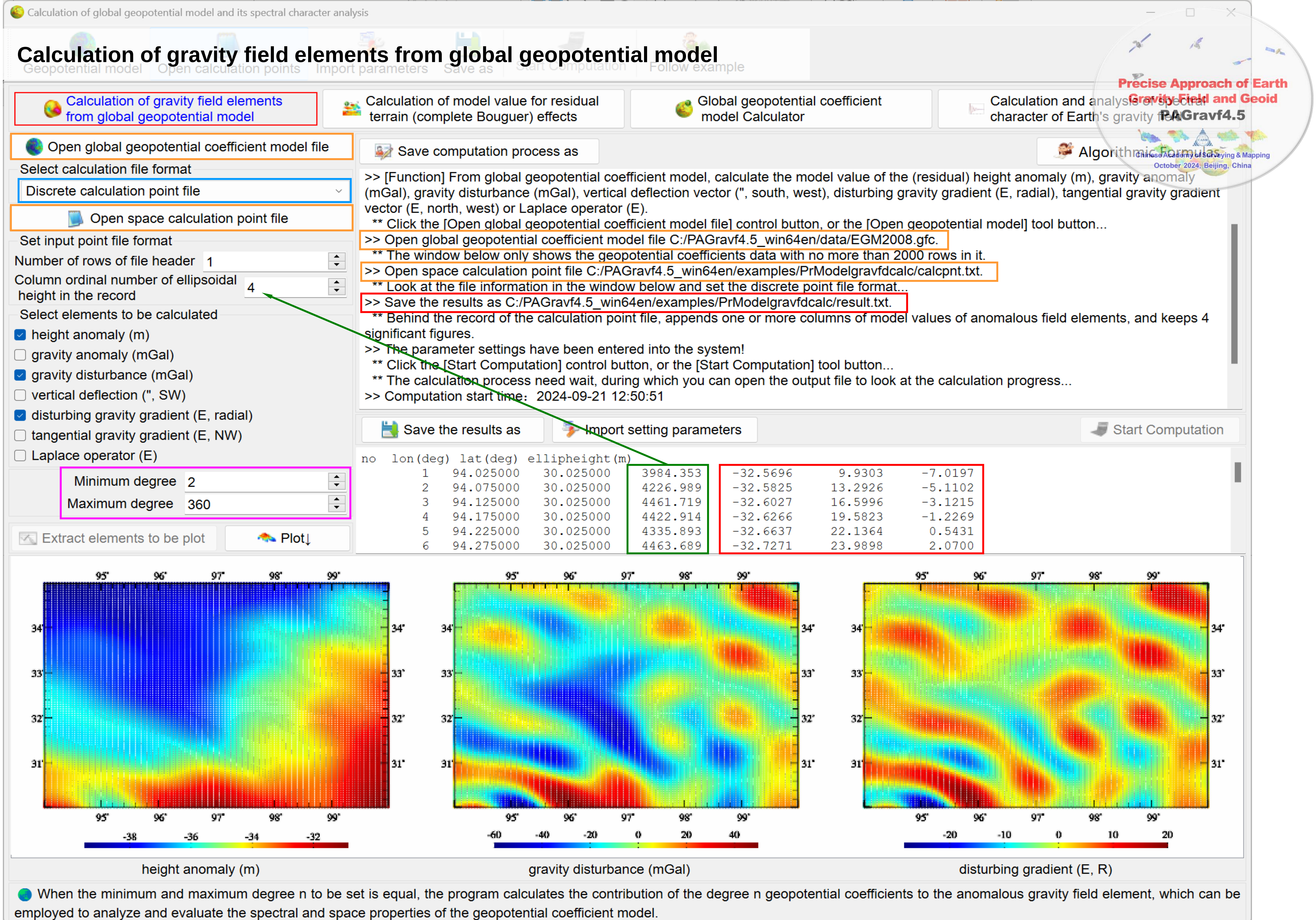
Precise approach and all-element modelling on Earth gravity field

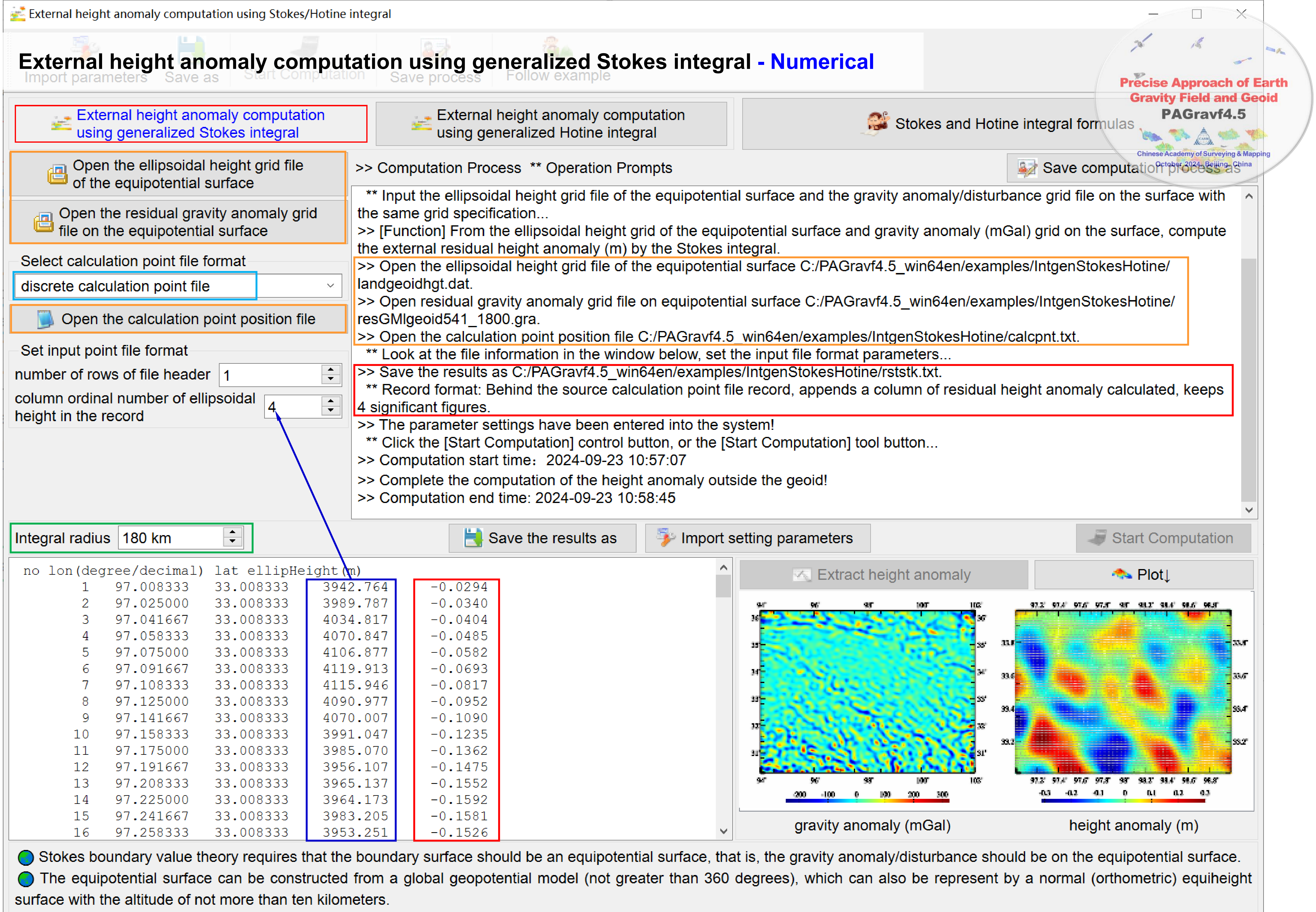


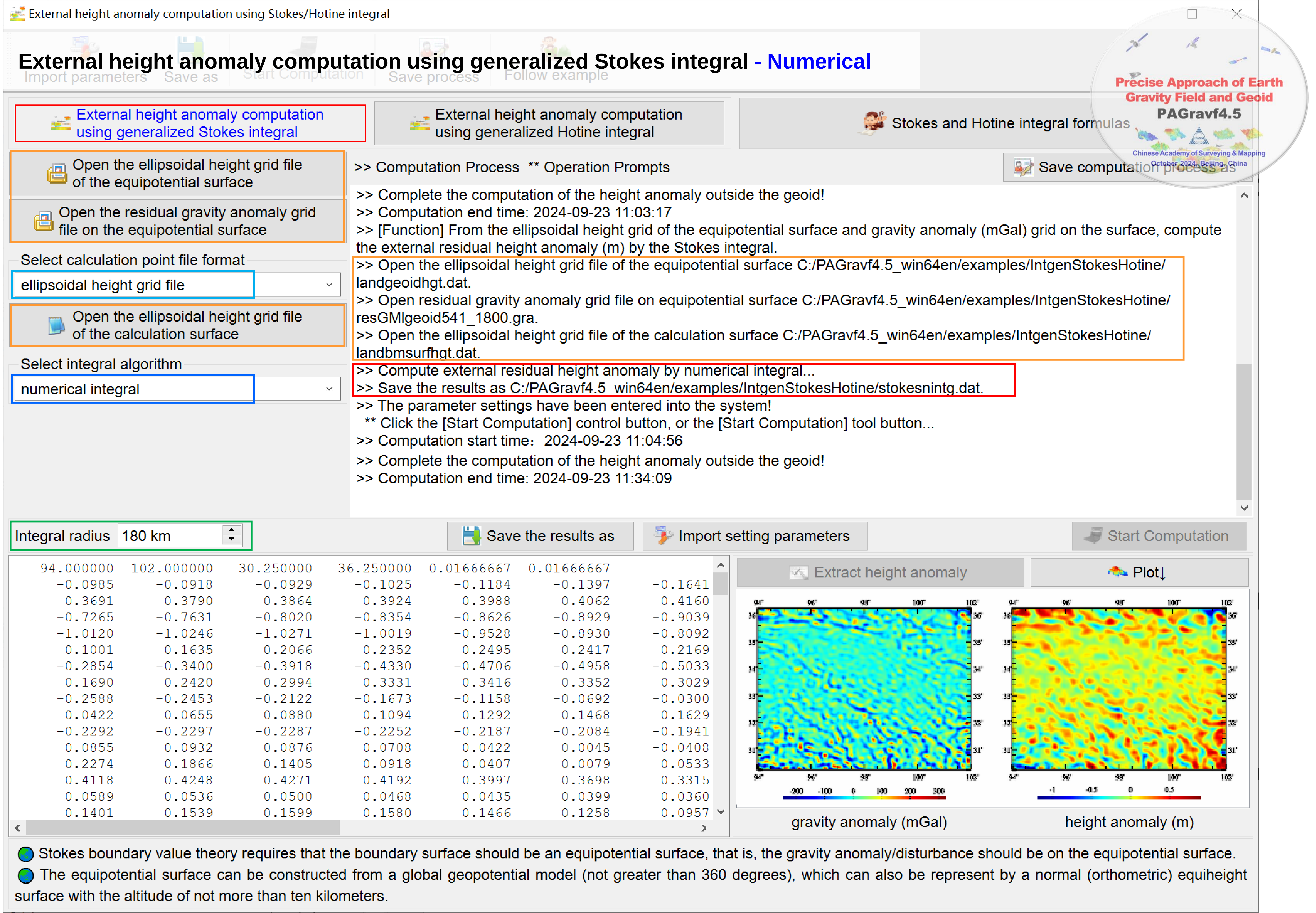
- Cross aliasing of heterogeneous observations in land-sea-space
- Loop closed analytical operations on outer gravity field elements
- All-element modeling on Earth gravity field in whole outer space
- Index measurement of observation errors and computation control

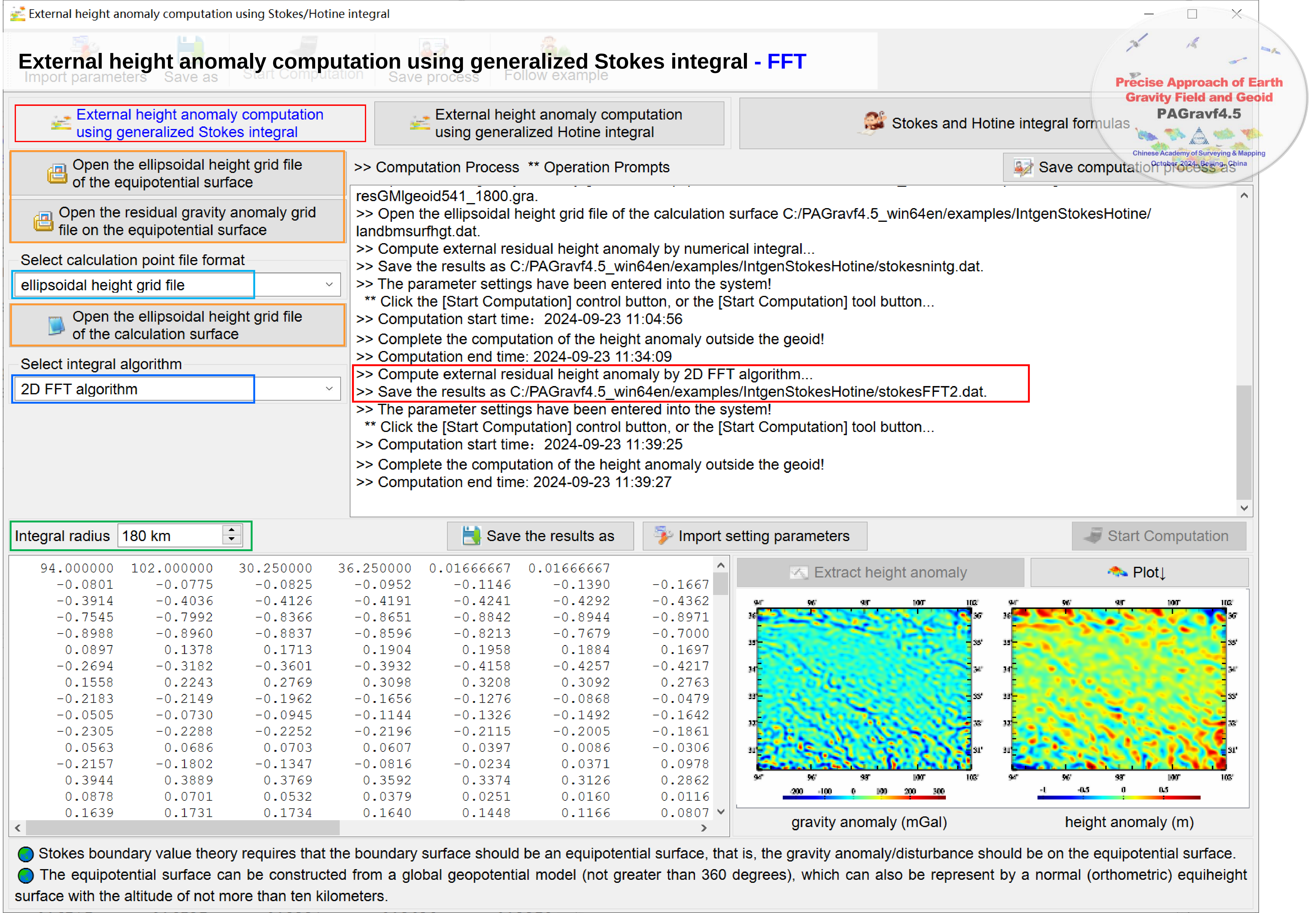

External height anomaly computation using generalized Stokes integral
External height anomaly computation using generalized Hotine integral
External height anomaly computation using Stokes/ Hotine integral
Stokes
V M
External vertical deflection computation using Vening-Meinesz integral
Computation of 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

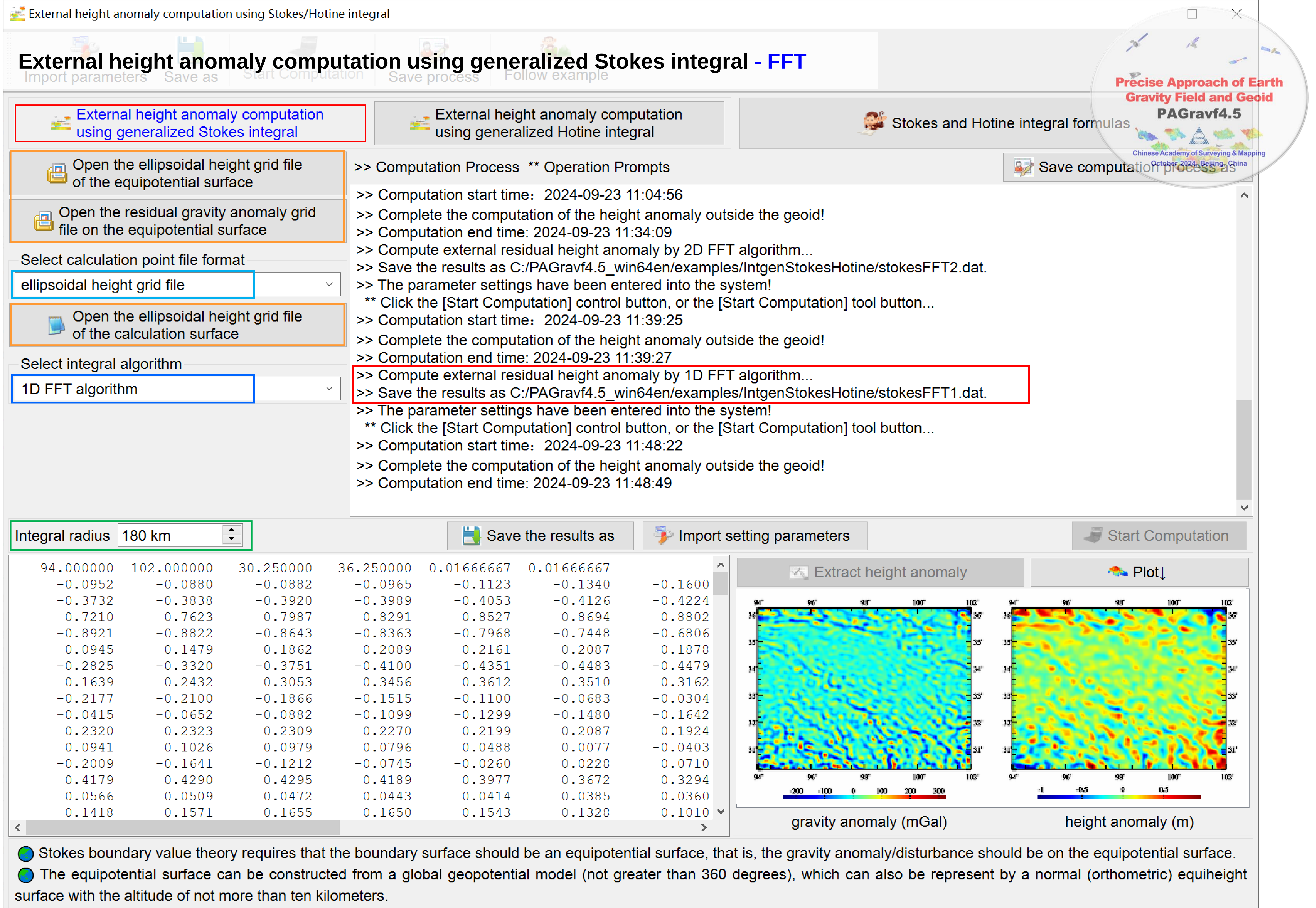

Calculation of Earth ellipsoid constant and geopotential WG analysis
Calculation of Earth ellipsoid constants and geopotential WG analysis
Set four basic parameters of Earth ellipsoid
Geocentric gravitational constant GM(10^14 m²/s³) of the Earth 3.986004415
Mean angular velocity ω(10^-5/s) of the Earth 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
ω b a O
E = √(a² − b²)
b = a(1 − f)
m = ω²a²b / GM
1/fa = bgb / age − 1
U0 = GM/E arctg E/b + 1/3 ω²a²
Physical derived constants of Earth ellipsoid
Dynamic form factor J2 1.0826261739
Normal potential at ellipsoid U0=WG(m²/s²) 62
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.

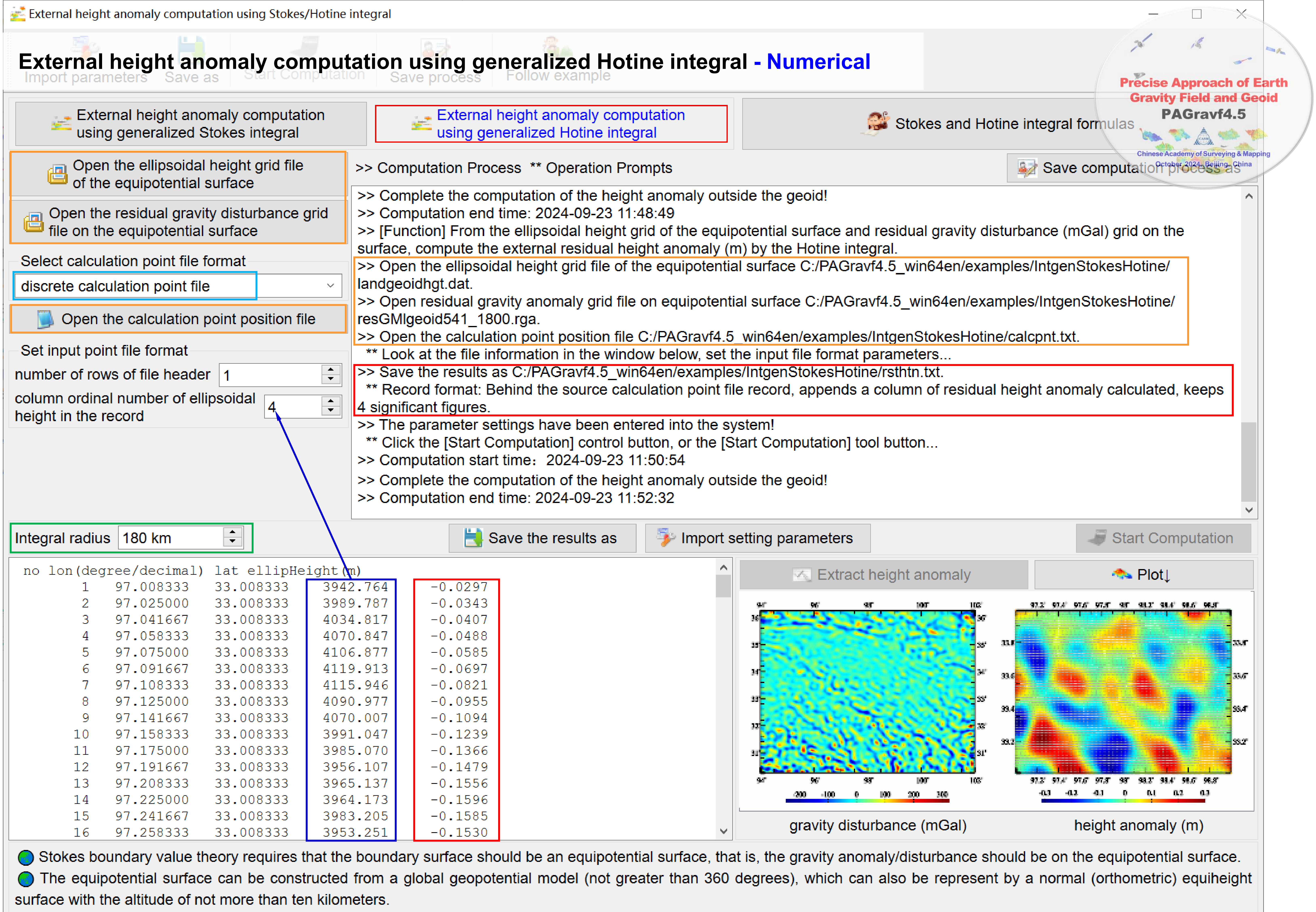

Calculation of global geopotential model and its spectral character analysis
Calculation of gravity field elements from global geopotential model
Geopotential model
Open calculation points
Import parameters
Save as
Start Computation
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
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°
31° 32° 33° 34°
-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.


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.

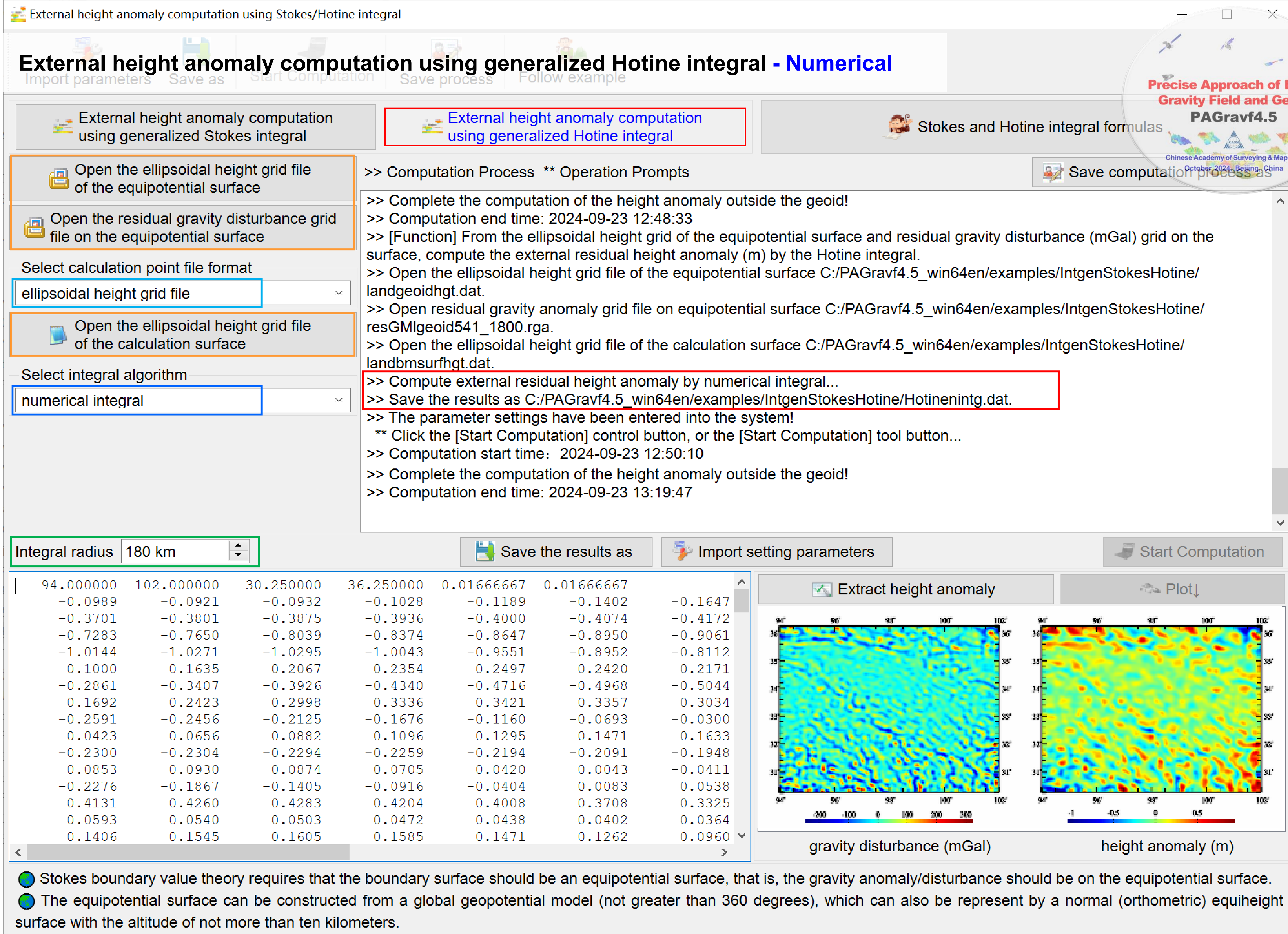

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - Numerical
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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
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.

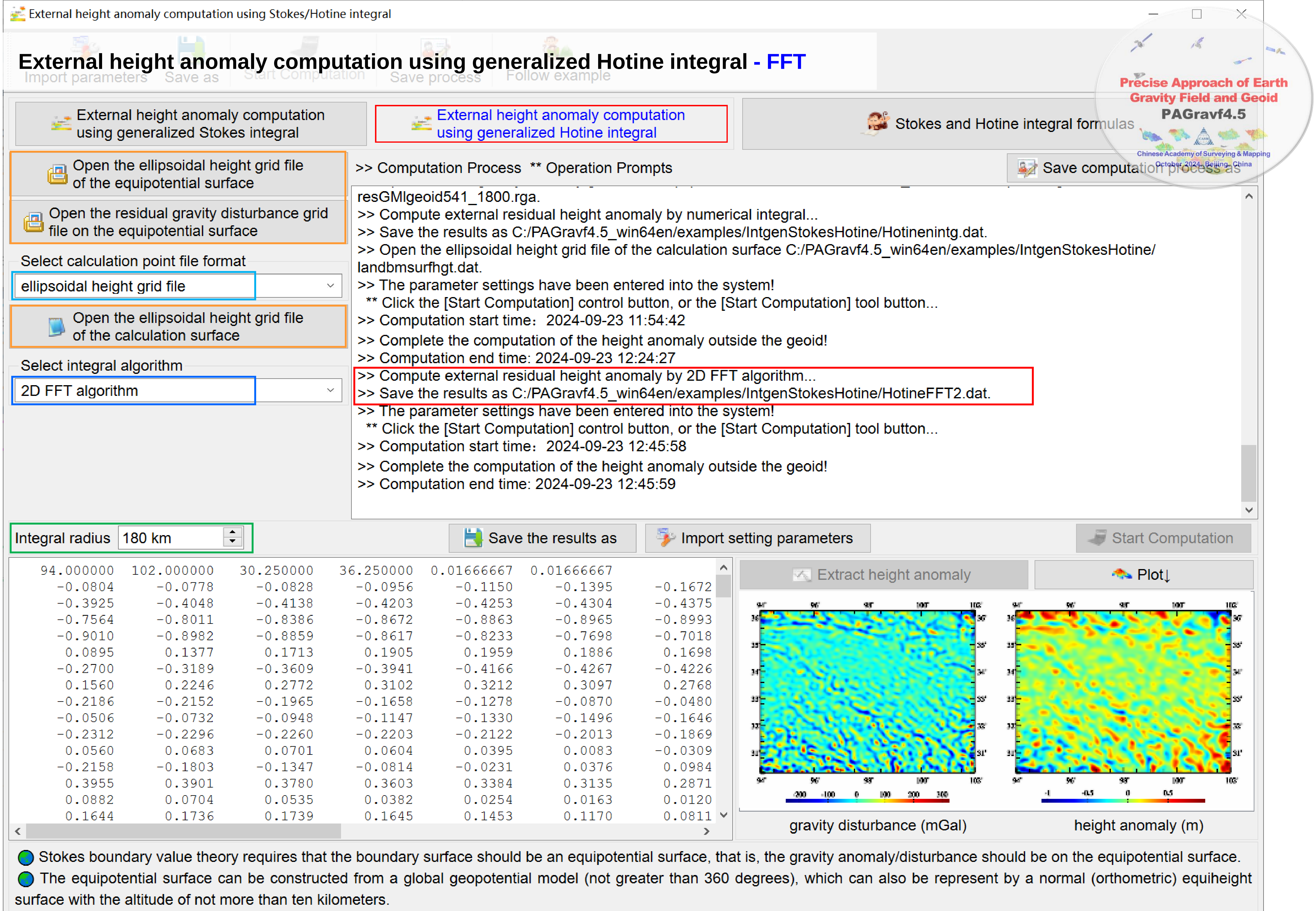

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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
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.

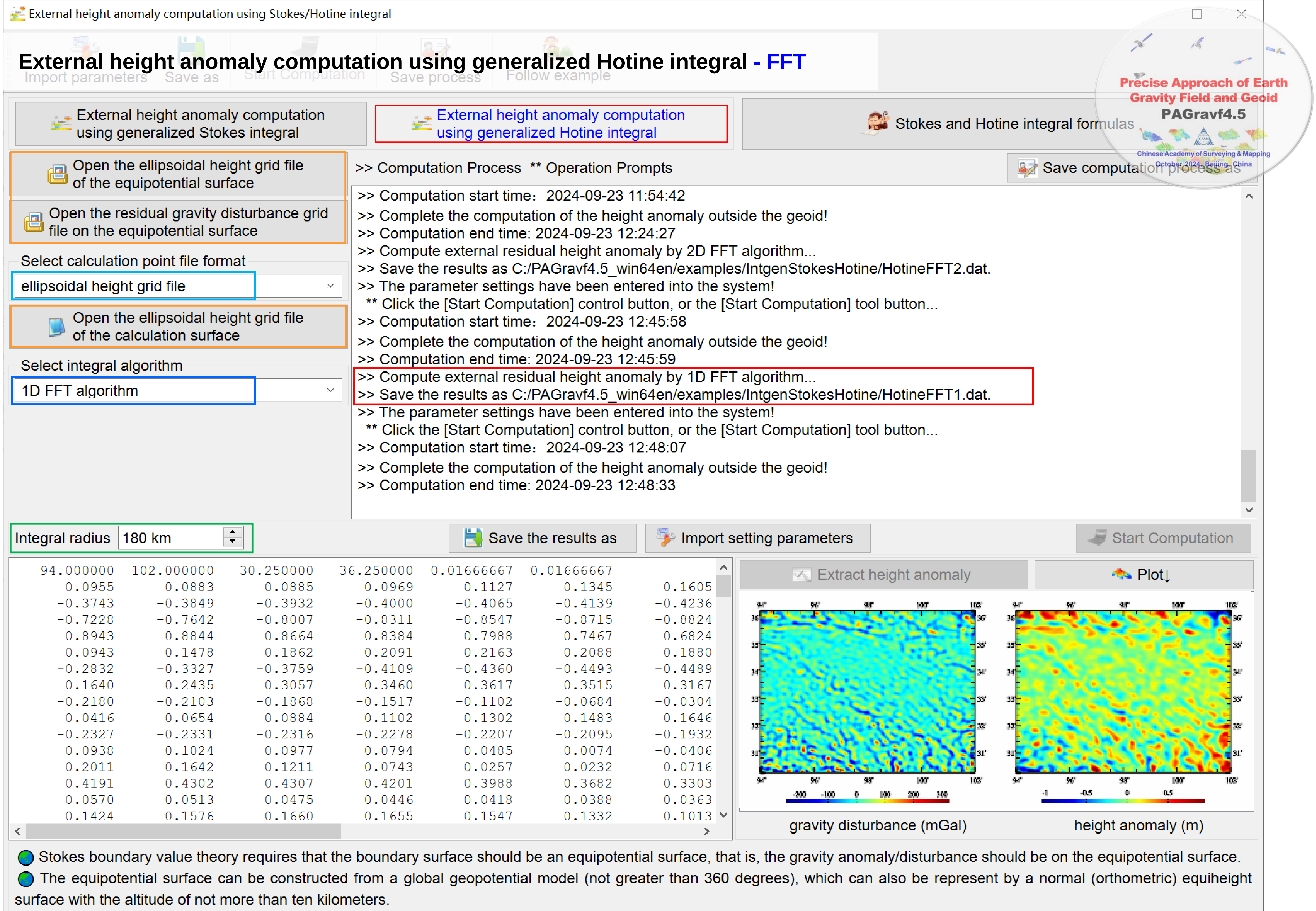

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Stokes integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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.

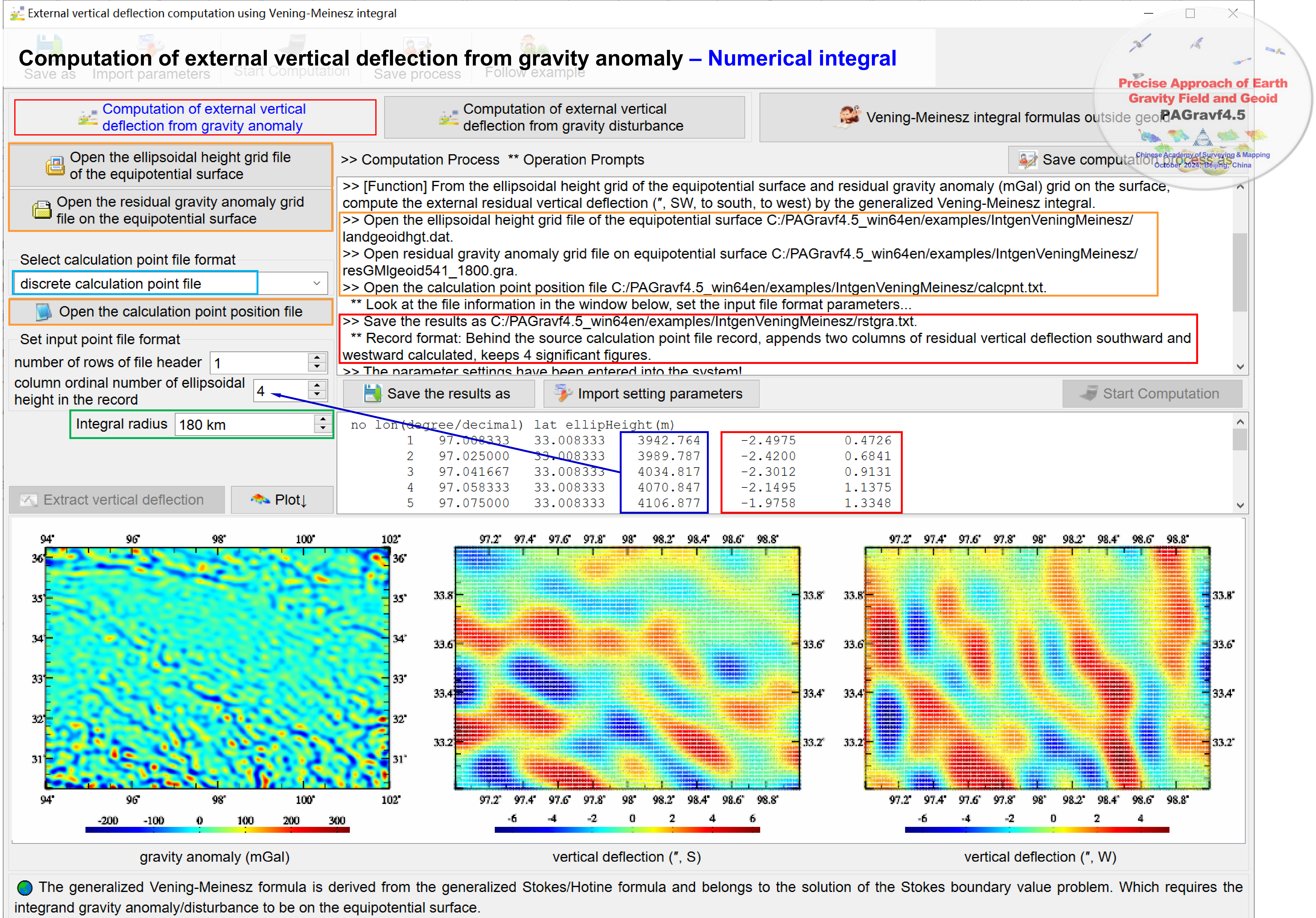


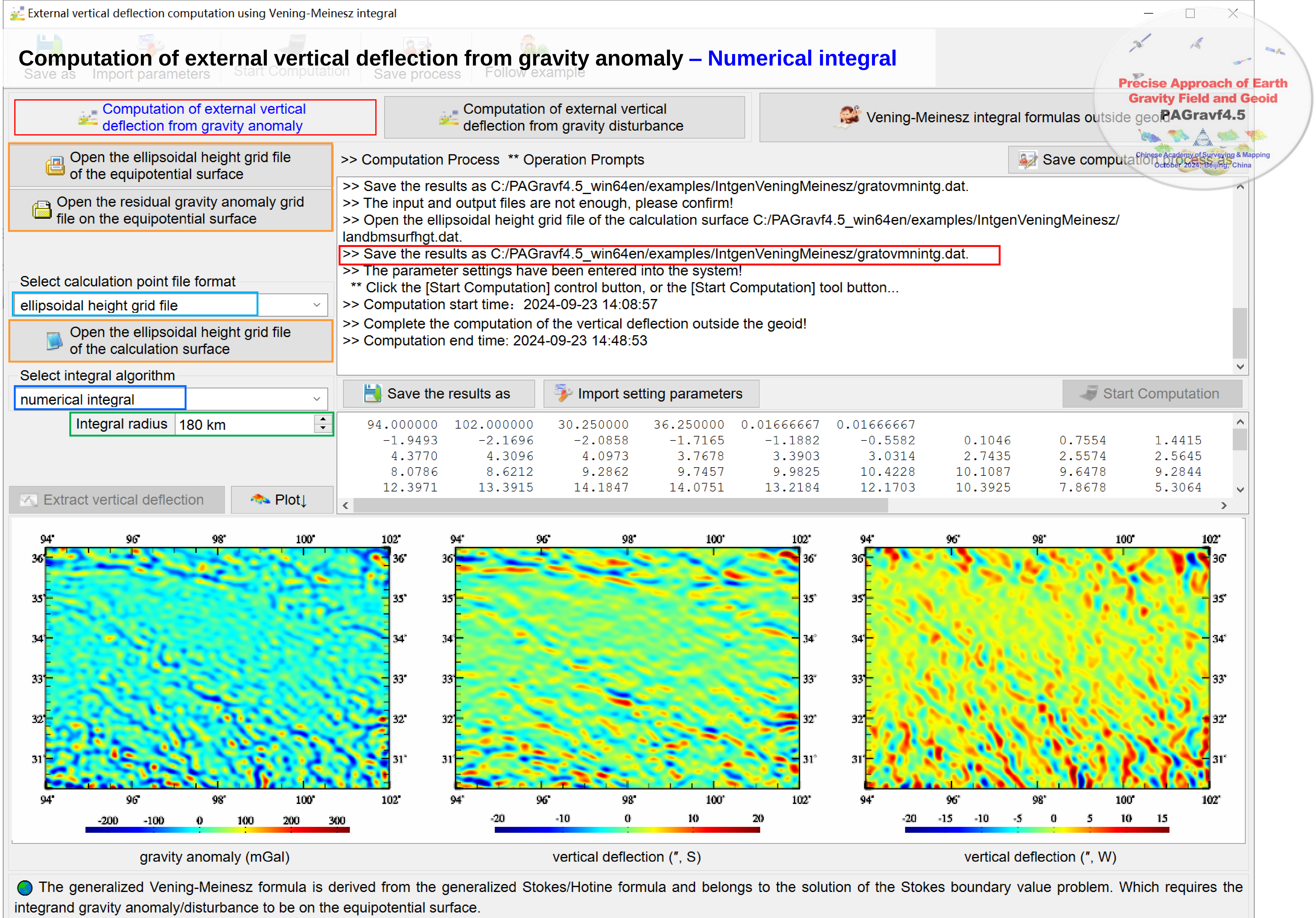
External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - Numerical
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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
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
>> 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
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 -0.0297
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
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.

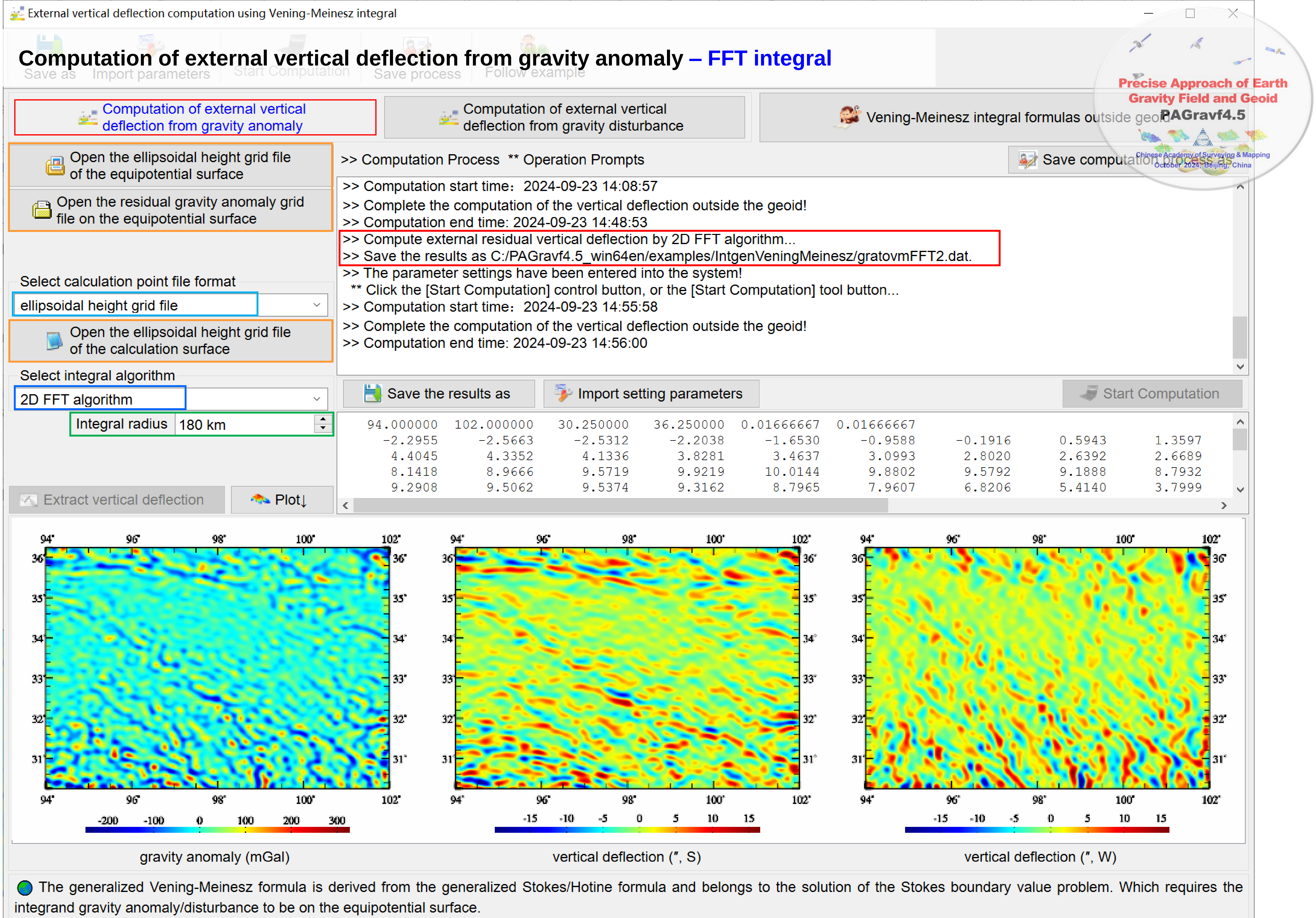

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - Numerical
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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.

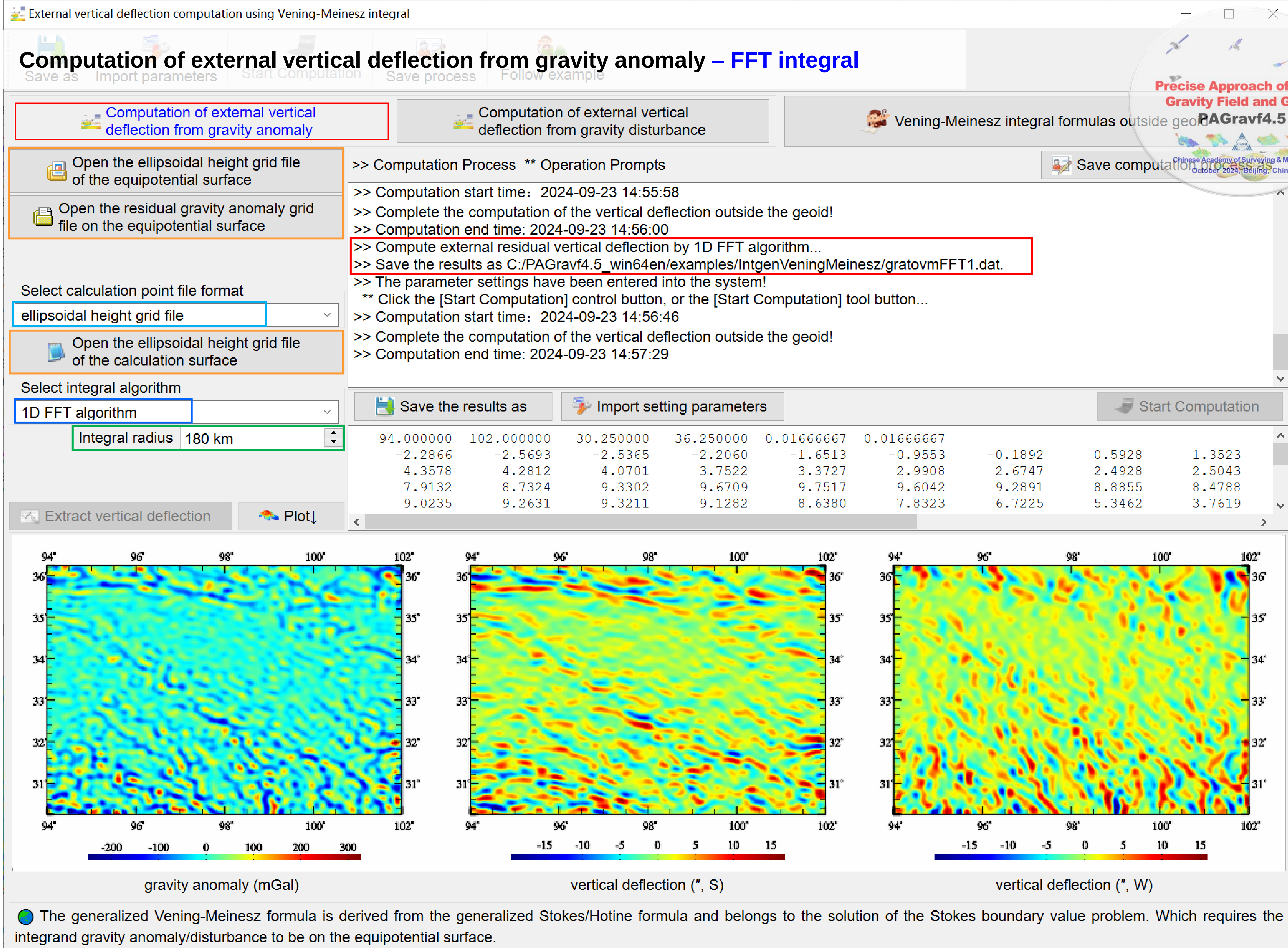

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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.

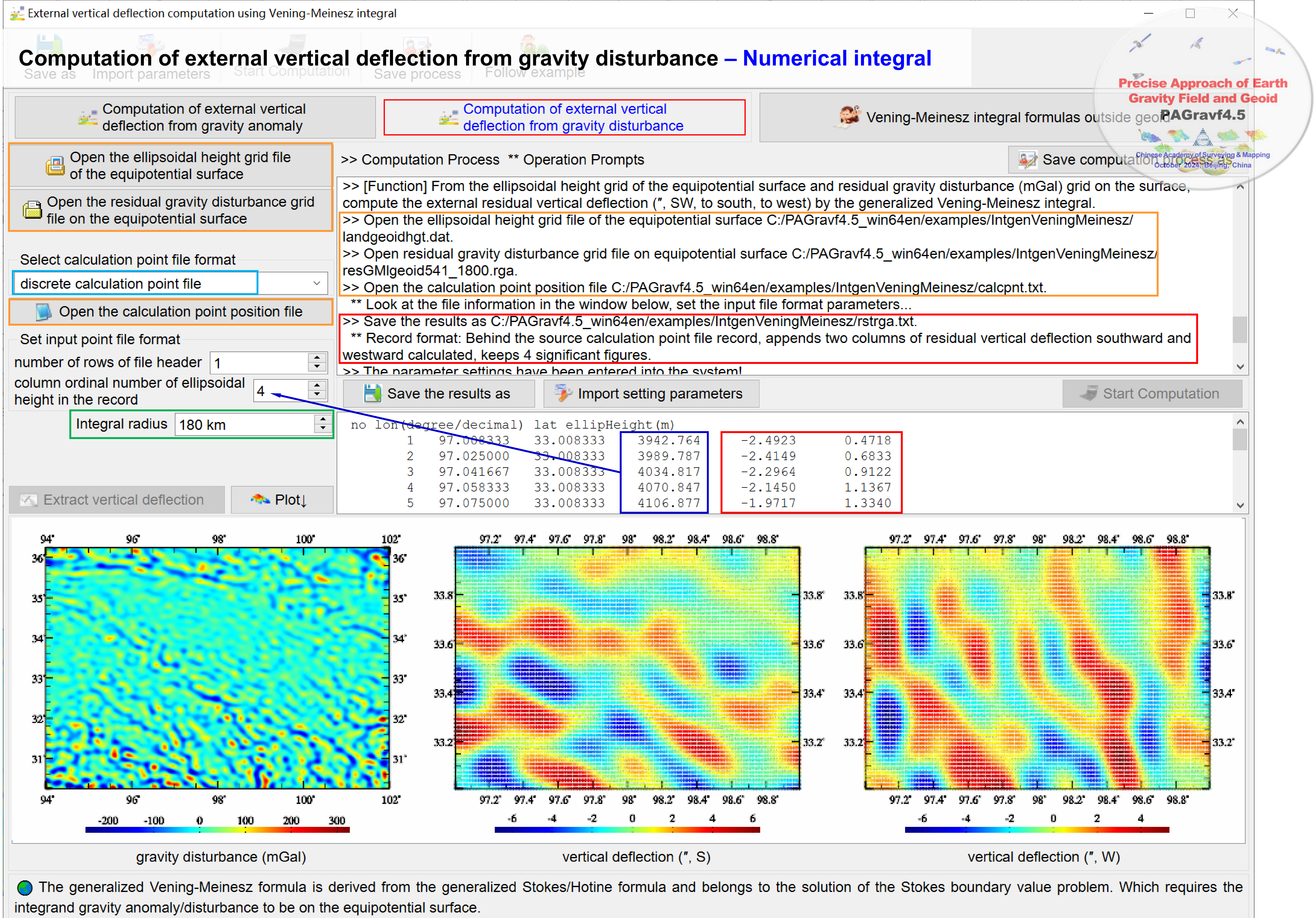

External height anomaly computation using Stokes/Hotine integral
External height anomaly computation using generalized Hotine integral - FFT
Import parameters
Save as
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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.

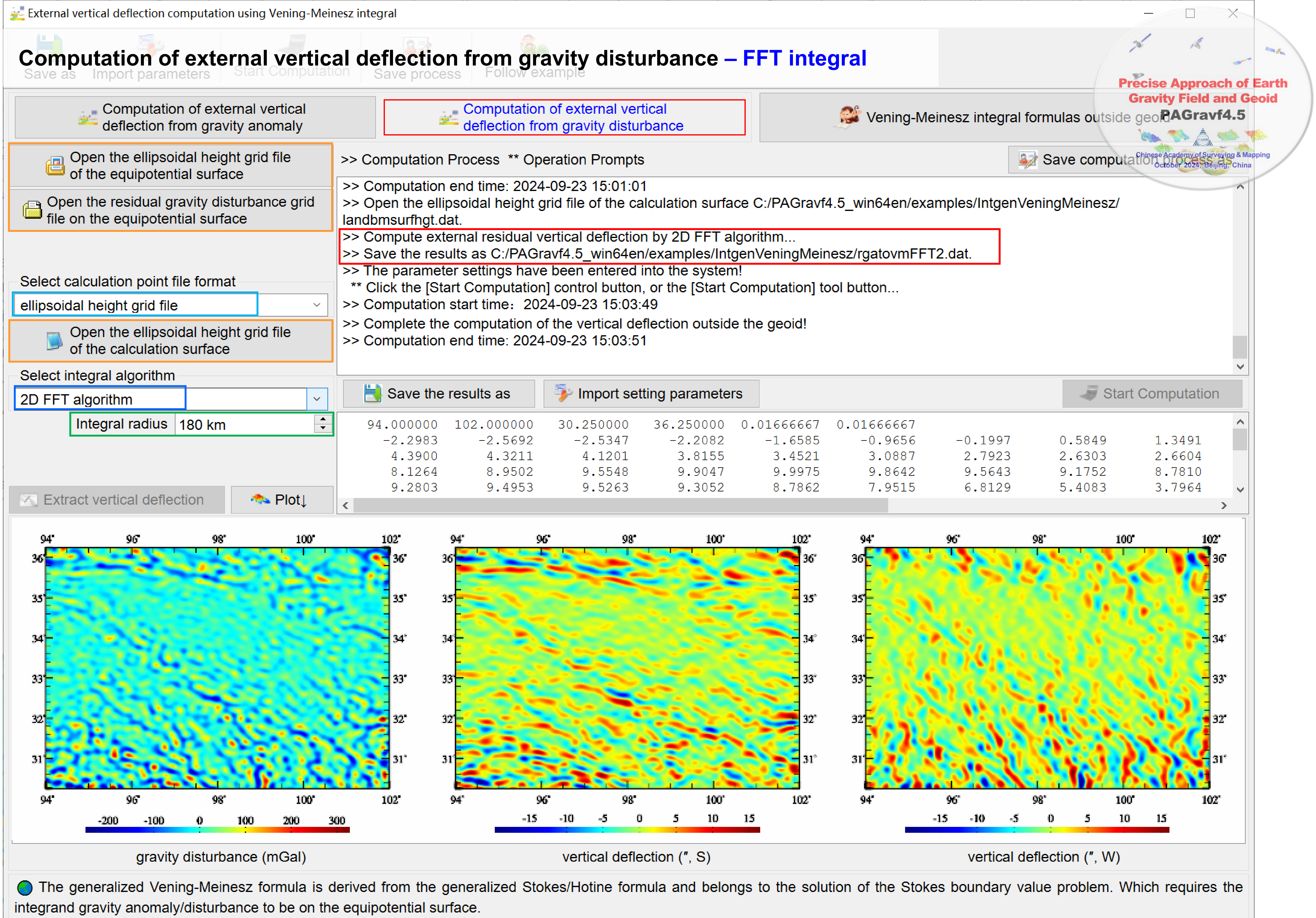

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – Numerical integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy 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
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.

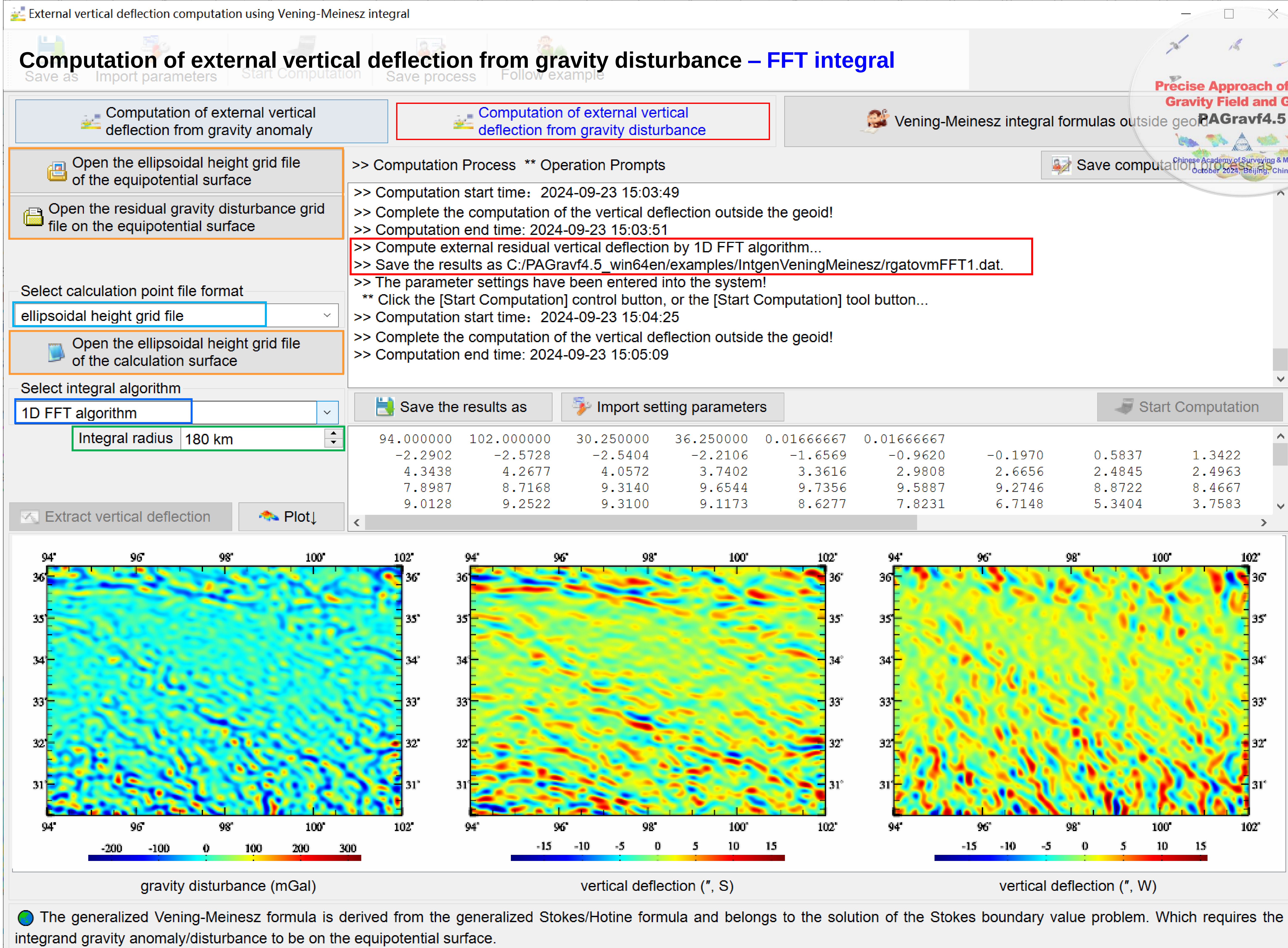

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – Numerical integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy 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.

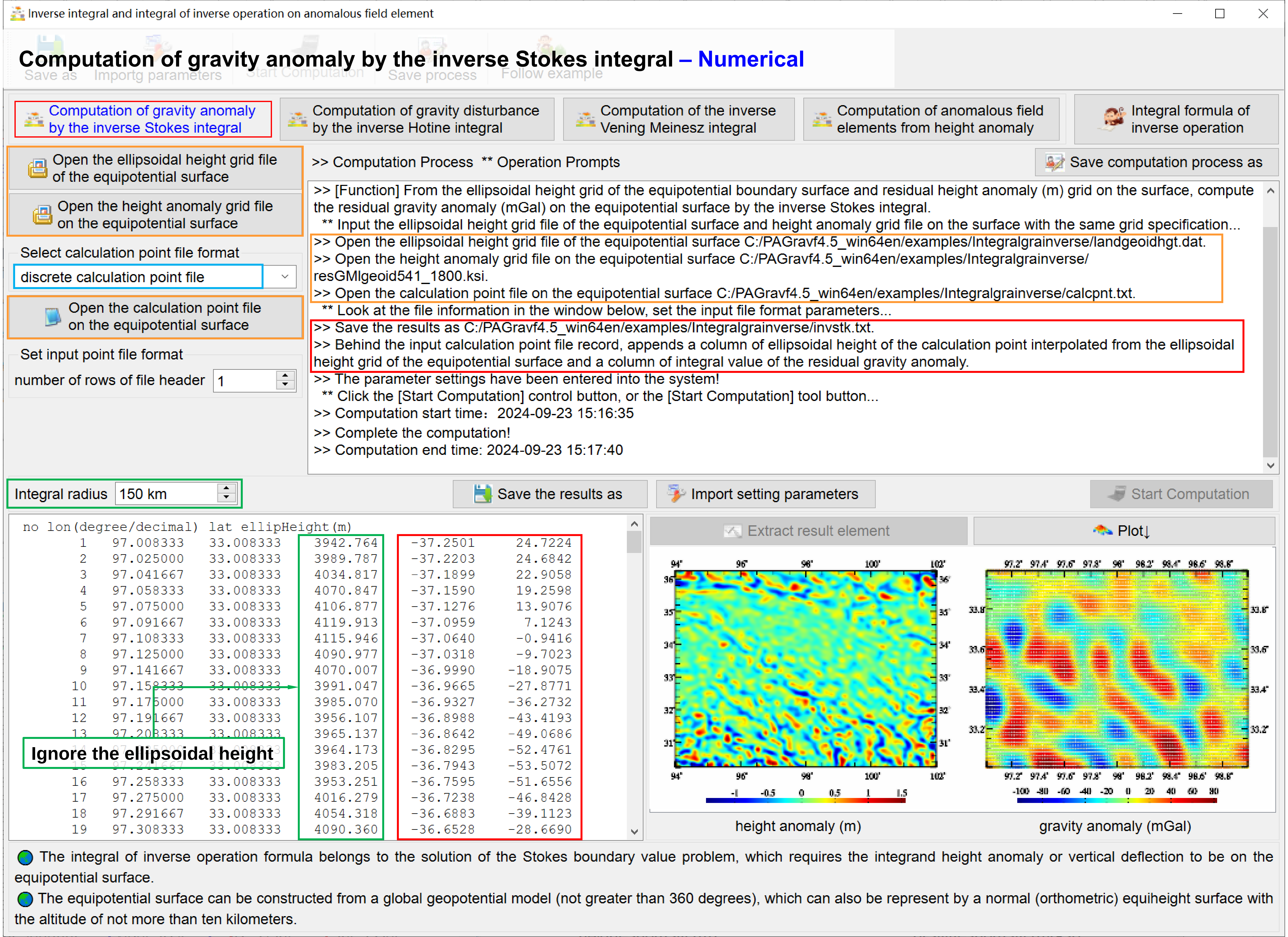

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity anomaly – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of 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°
31° 32° 33° 34° 35° 36°
-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
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
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
94° 96° 98° 100° 102°
31° 32° 33° 34° 35° 36°
-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.

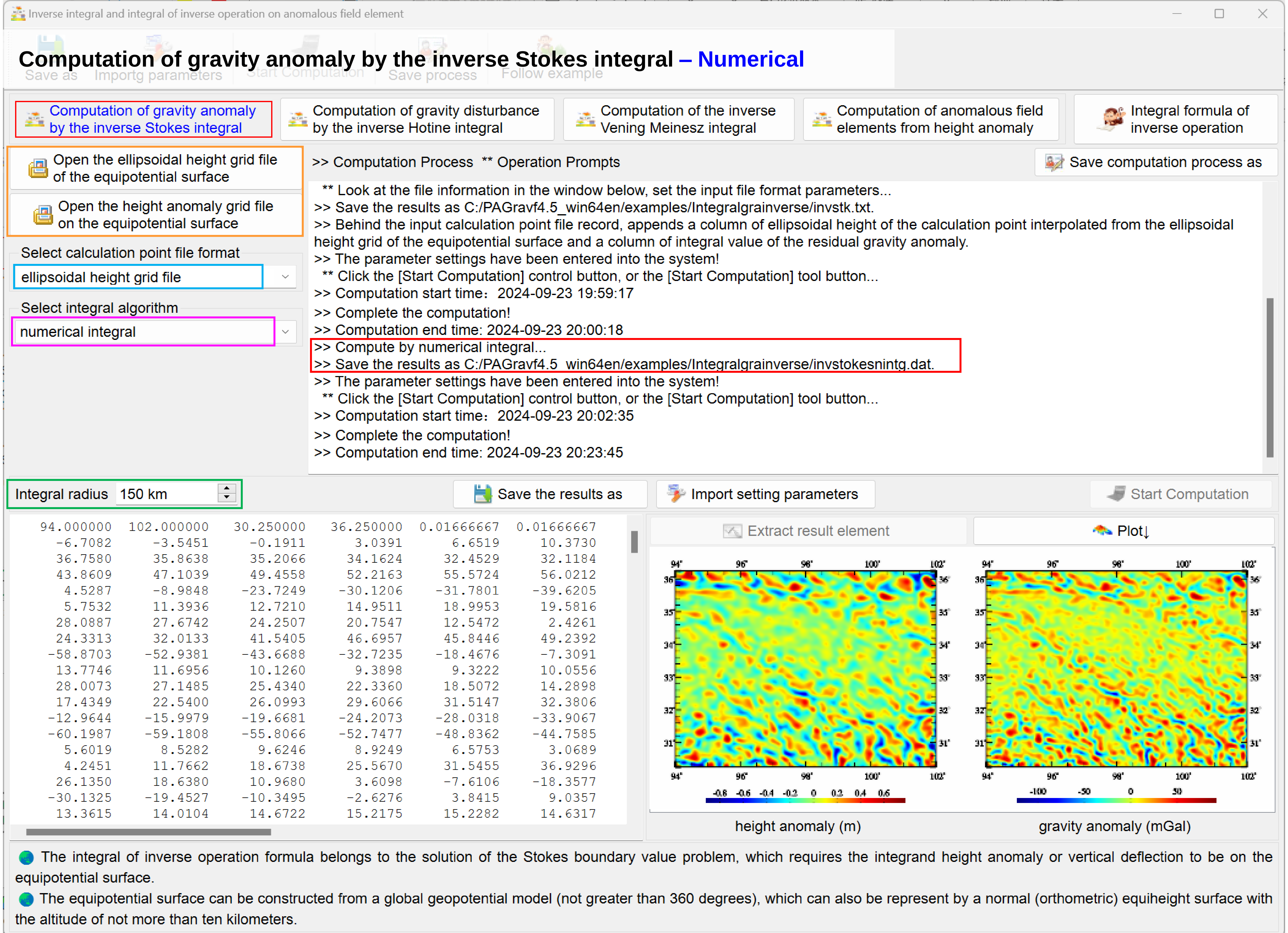

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity disturbance – Numerical integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese 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
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.

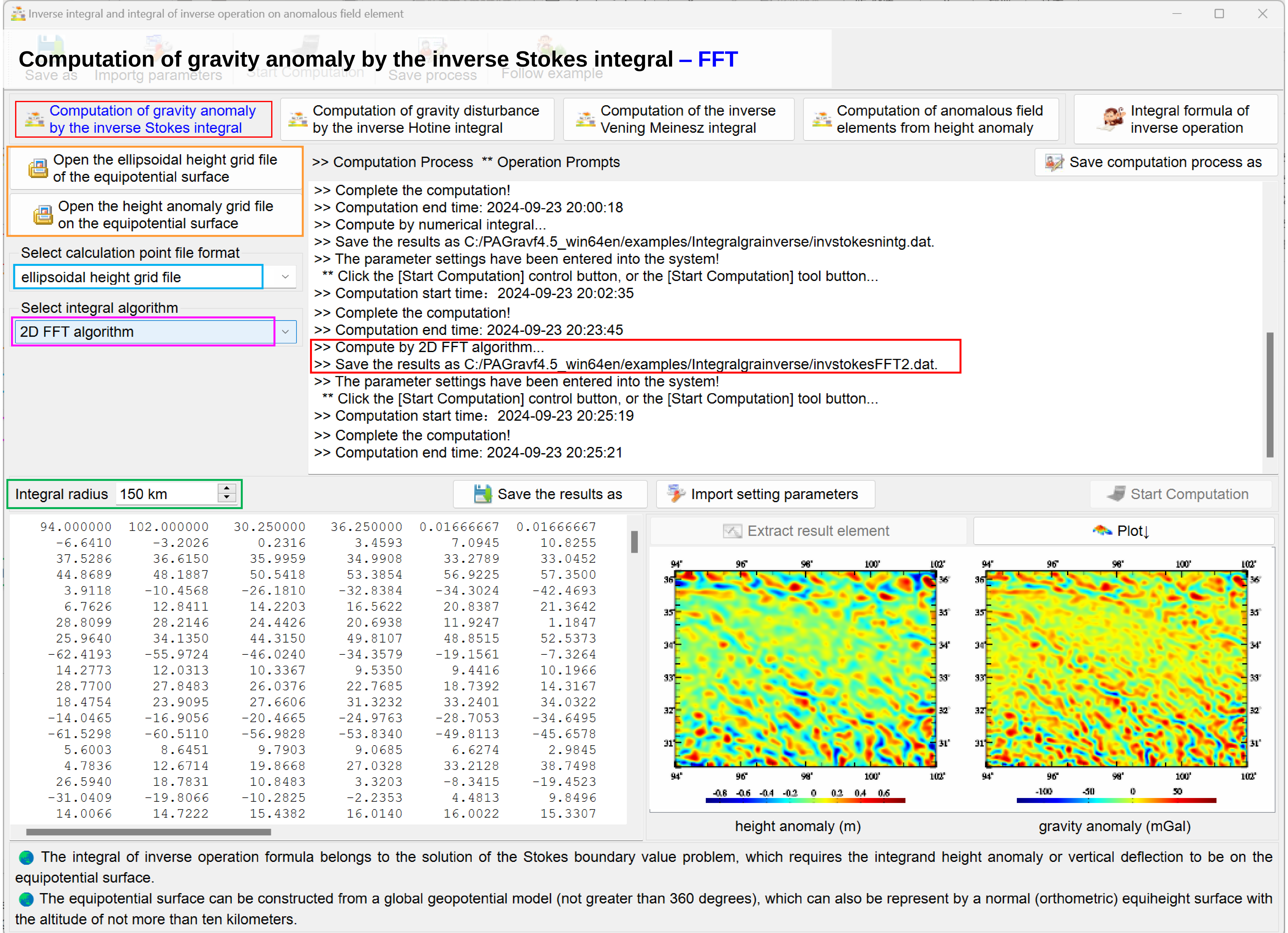

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity disturbance – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Computation of external vertical deflection from gravity anomaly
Computation 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
>> 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↓
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.

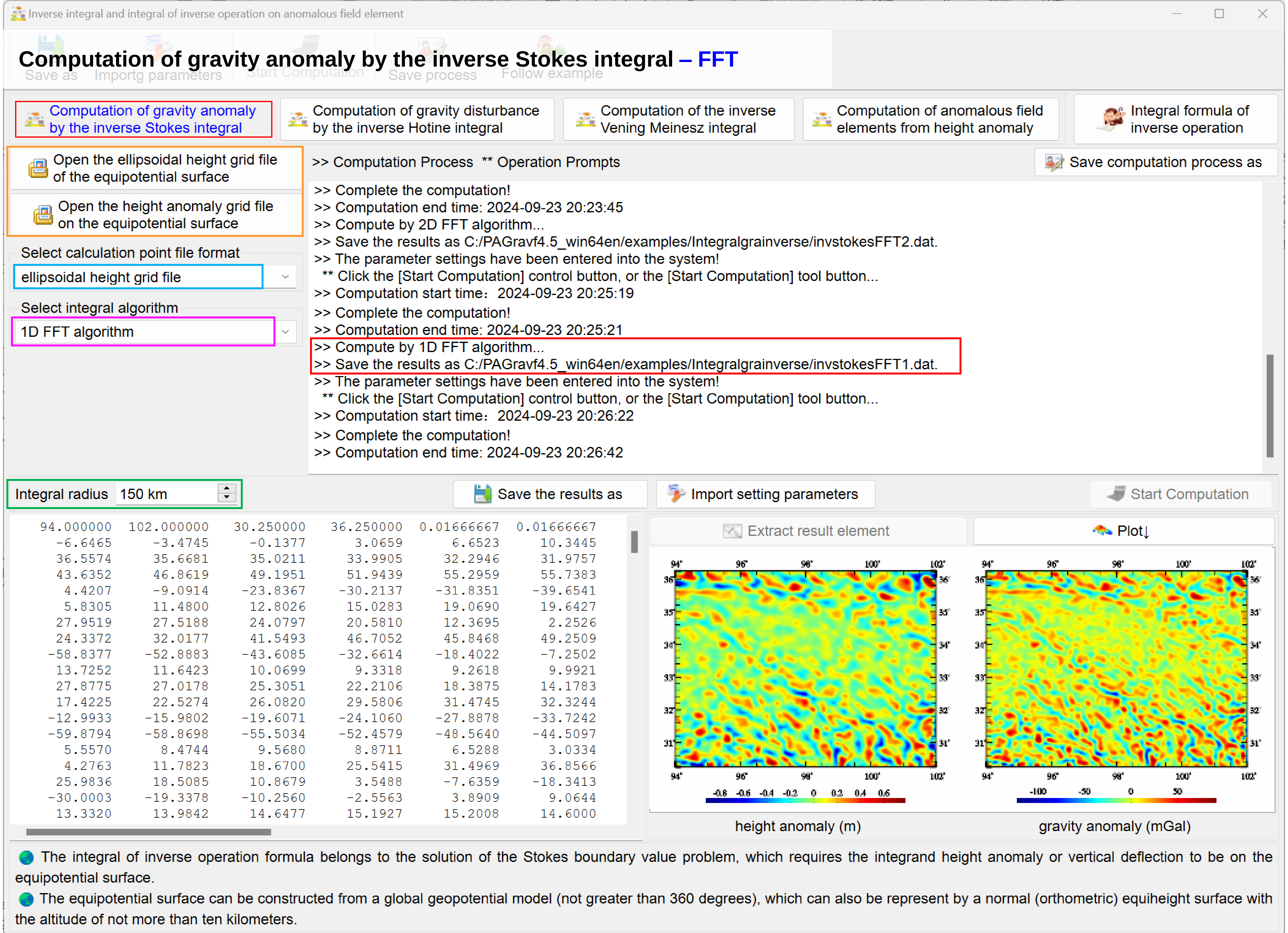

External vertical deflection computation using Vening-Meinesz integral
Computation of external vertical deflection from gravity disturbance – FFT integral
Save as
Import parameters
Start Computation
Save process
Follow example
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy 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
>> 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
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
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
Extract vertical deflection
Plot↓
94° 96° 98° 100° 102°
31° 32° 33° 34° 35° 36°
-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.

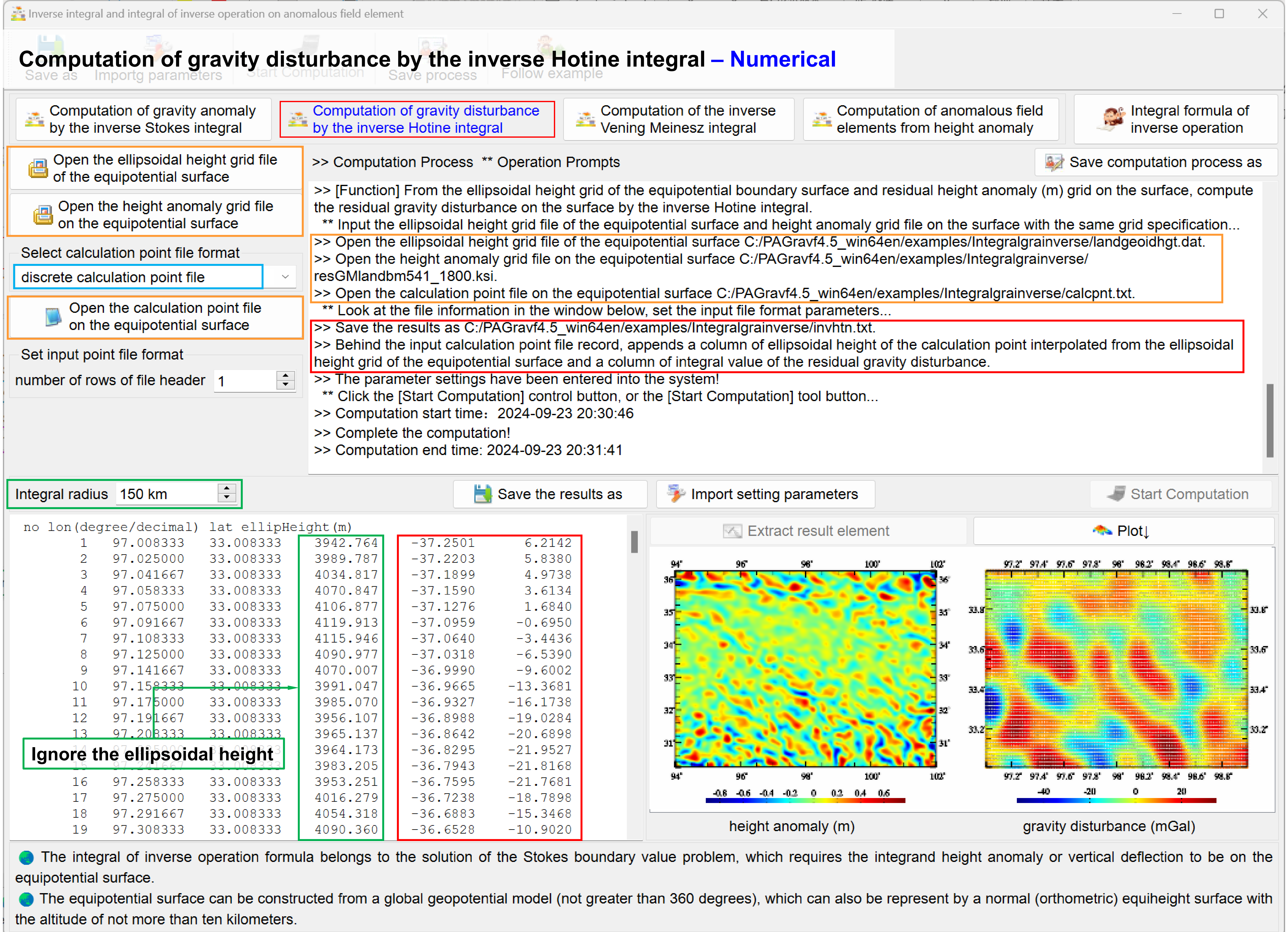


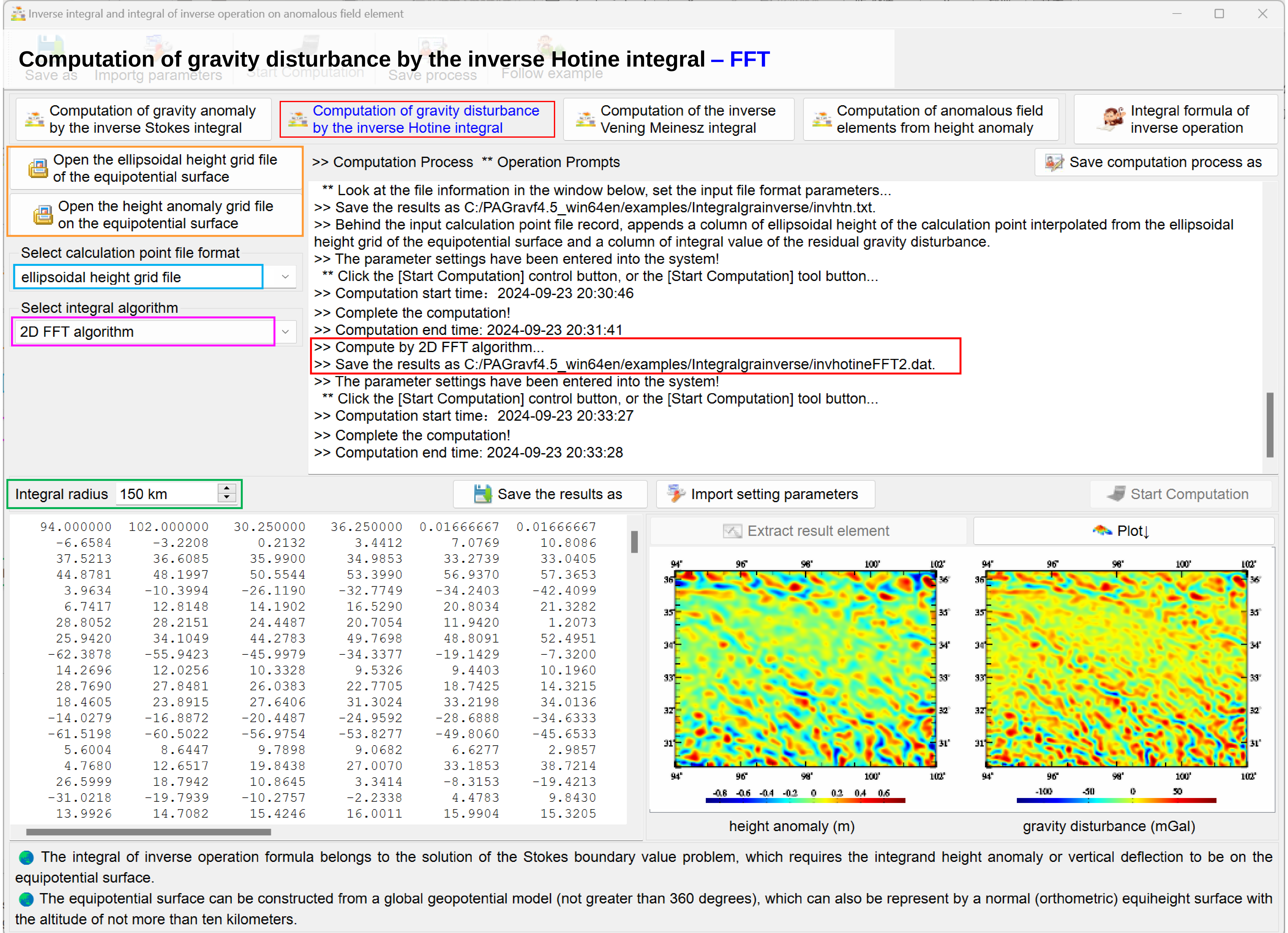
Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of 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
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.

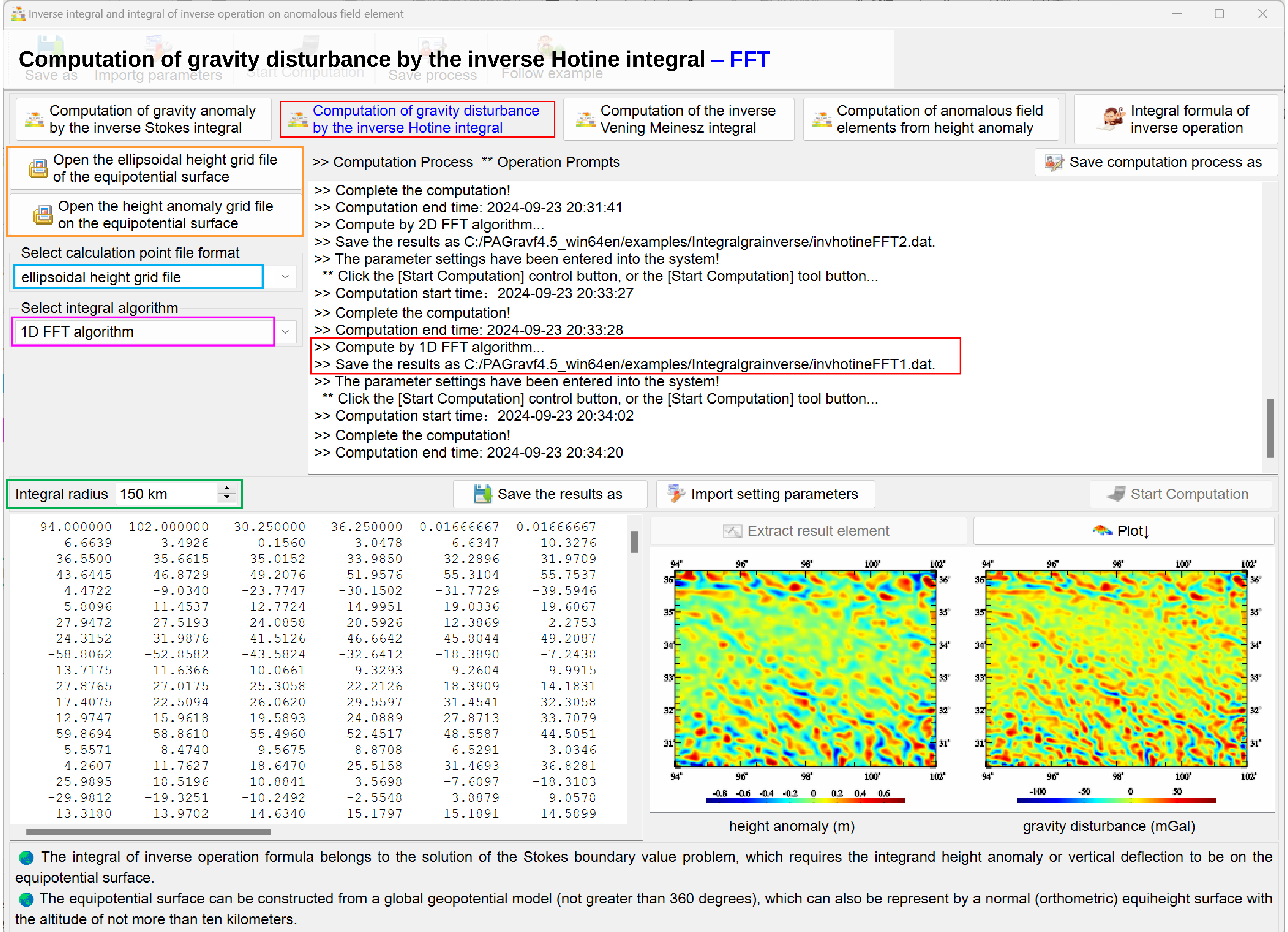

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of 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↓
94° 96° 98° 100° 102°
36° 35° 34° 33° 32° 31°
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6
-100 -50 0 50
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.

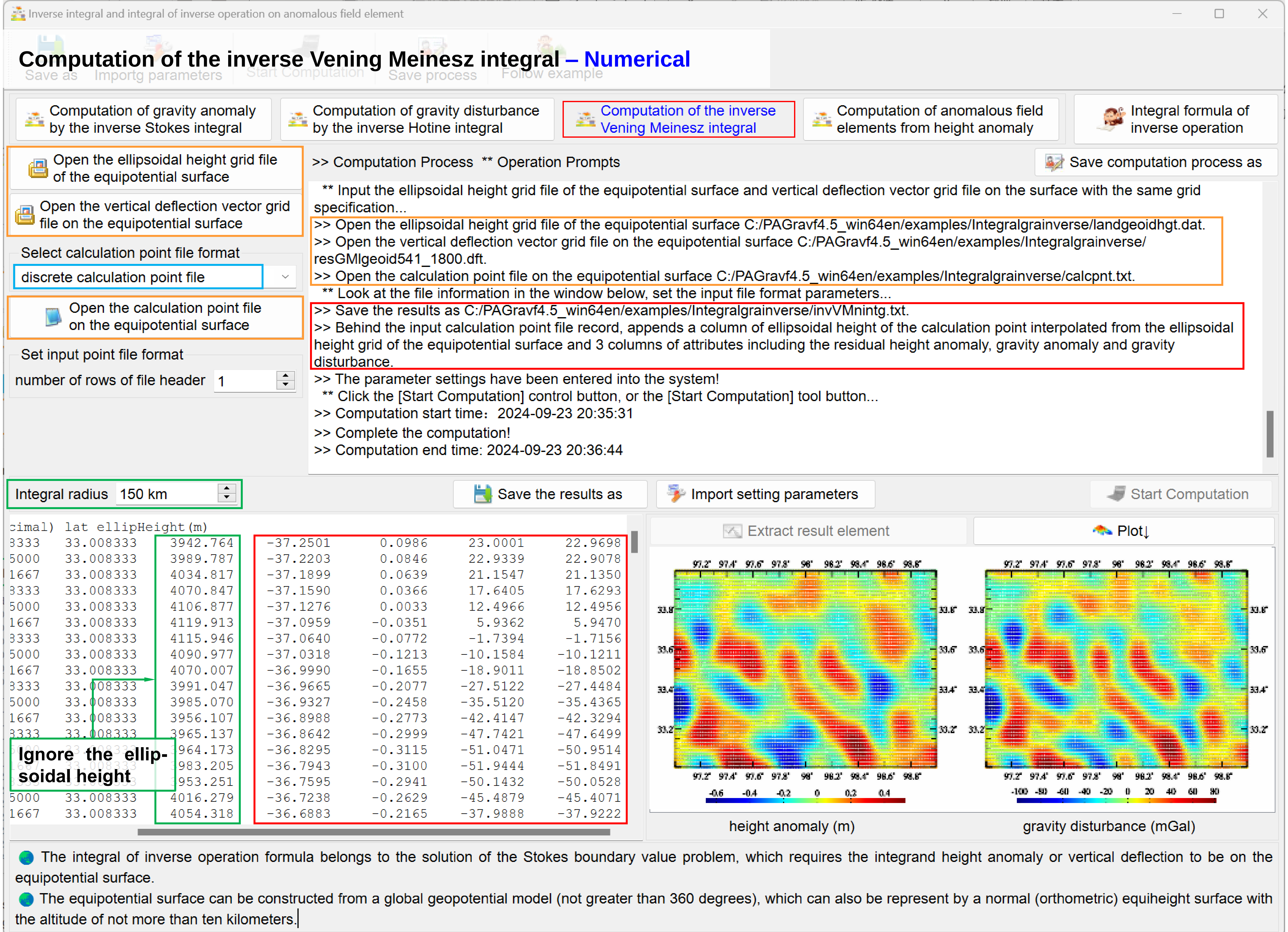

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity anomaly by the inverse Stokes integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity 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.

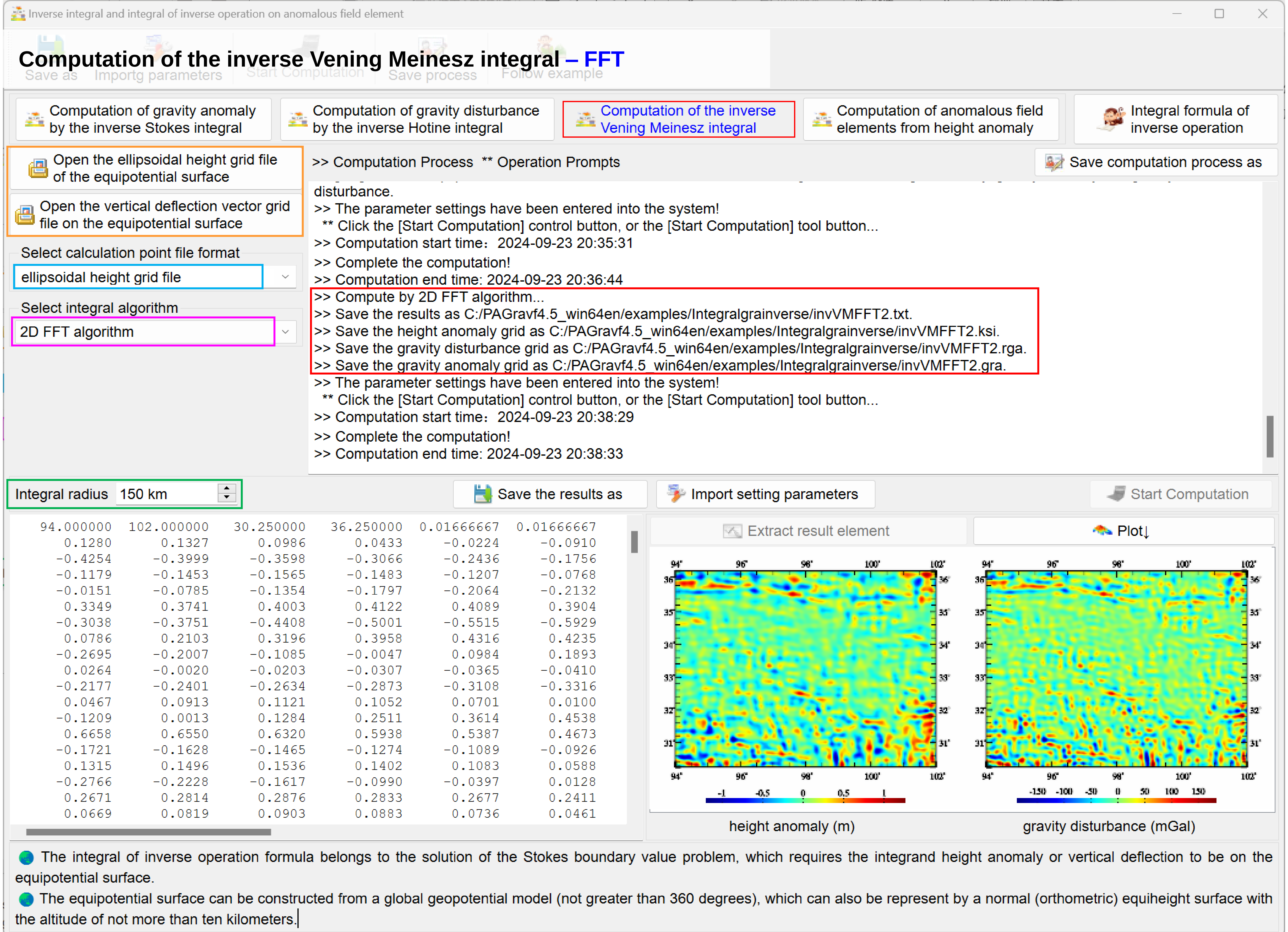

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity disturbance by the inverse Hotine integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation 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 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.

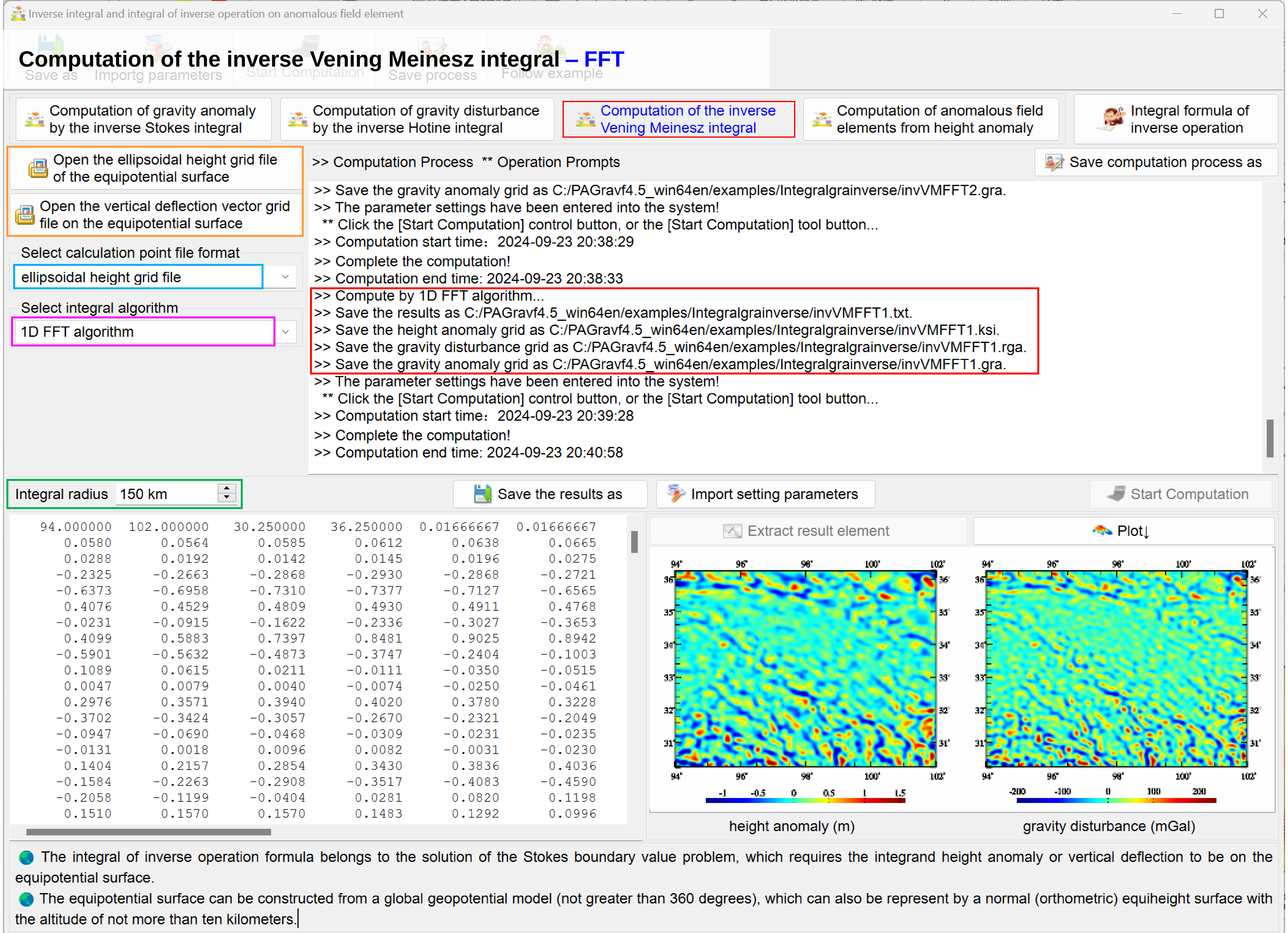

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity disturbance by the inverse Hotine integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity 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
** 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↓
94° 96° 98° 100° 102°
36° 35° 34° 33° 32° 31°
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6
-100 -50 0 50
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.

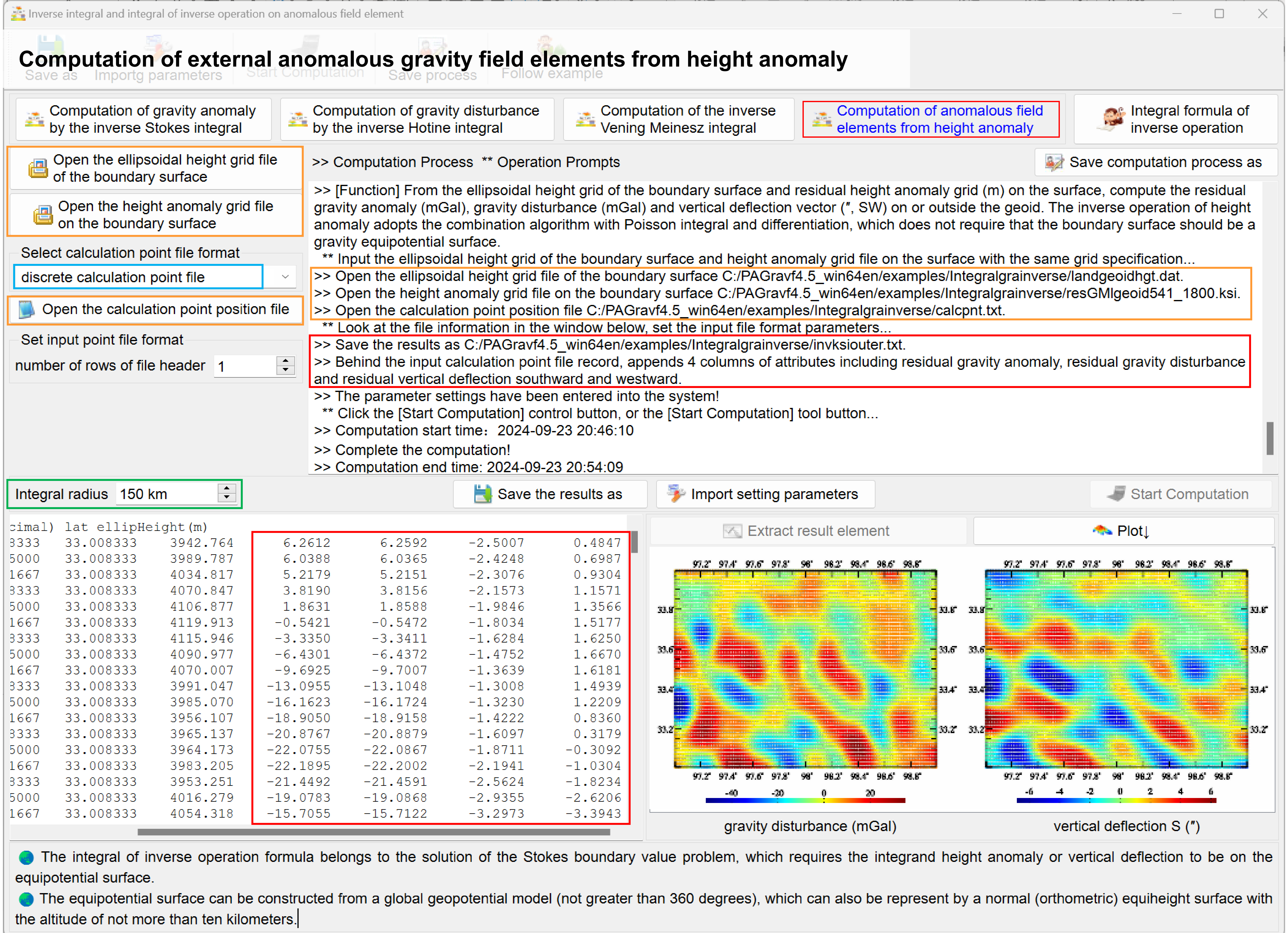

Inverse integral and integral of inverse operation on anomalous field element
Computation of gravity disturbance by the inverse Hotine integral – FFT
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance by the inverse Hotine integral
Computation of the inverse 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.

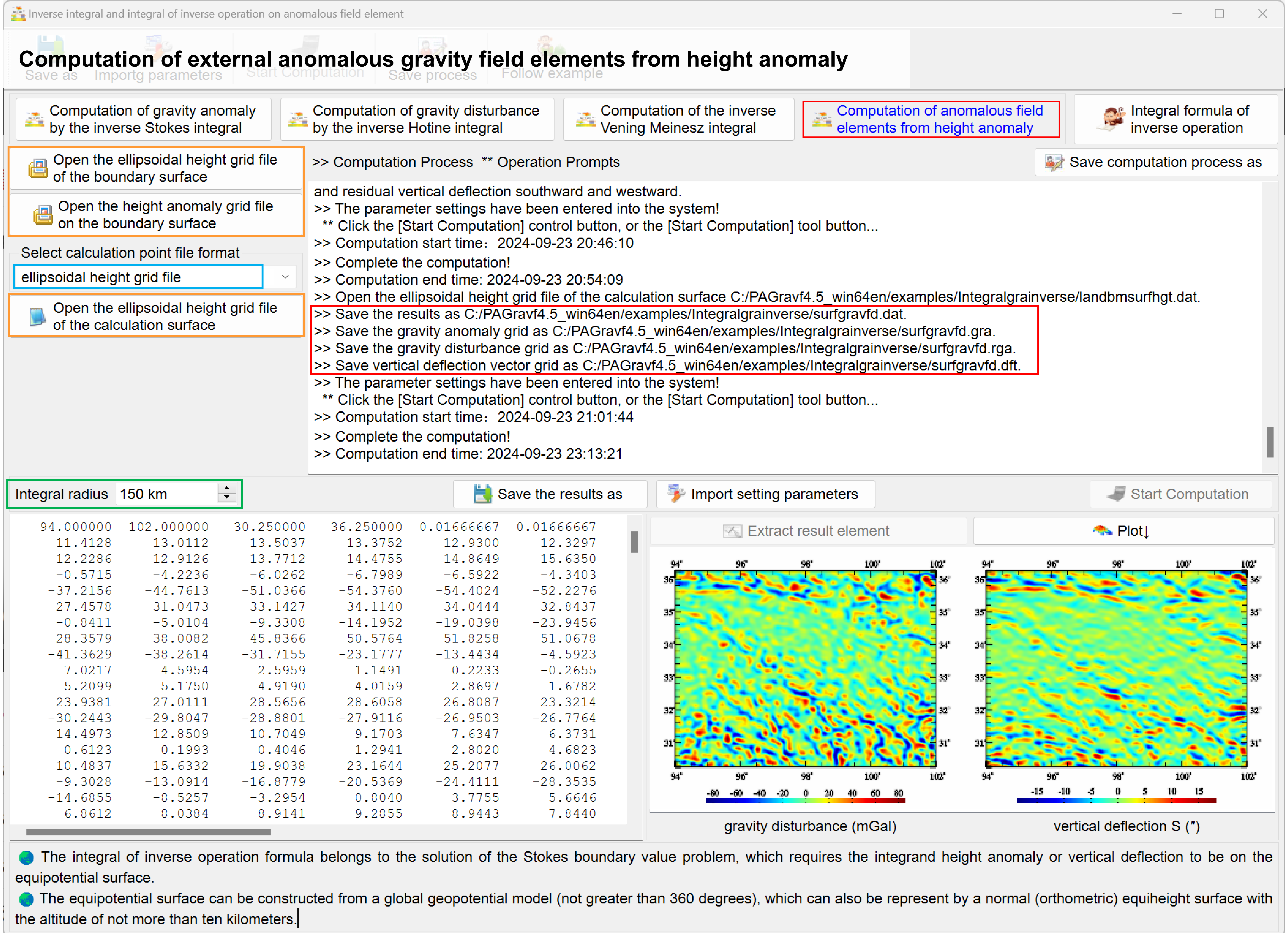

Inverse integral and integral of inverse operation on anomalous field element
Computation of the inverse Vening Meinesz integral – Numerical
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance 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
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
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.

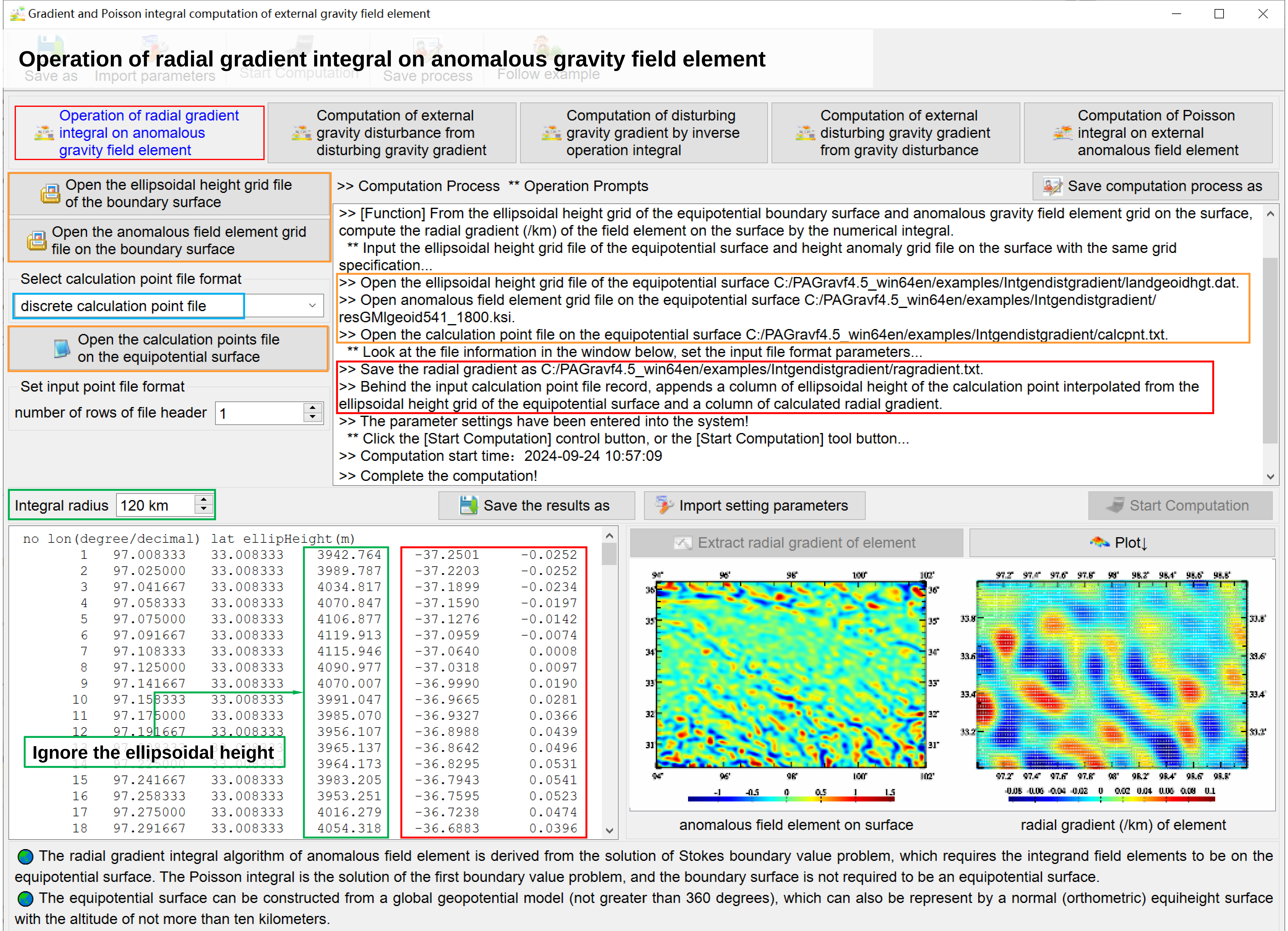
Computation of the inverse Vening Meinesz integral – FFT

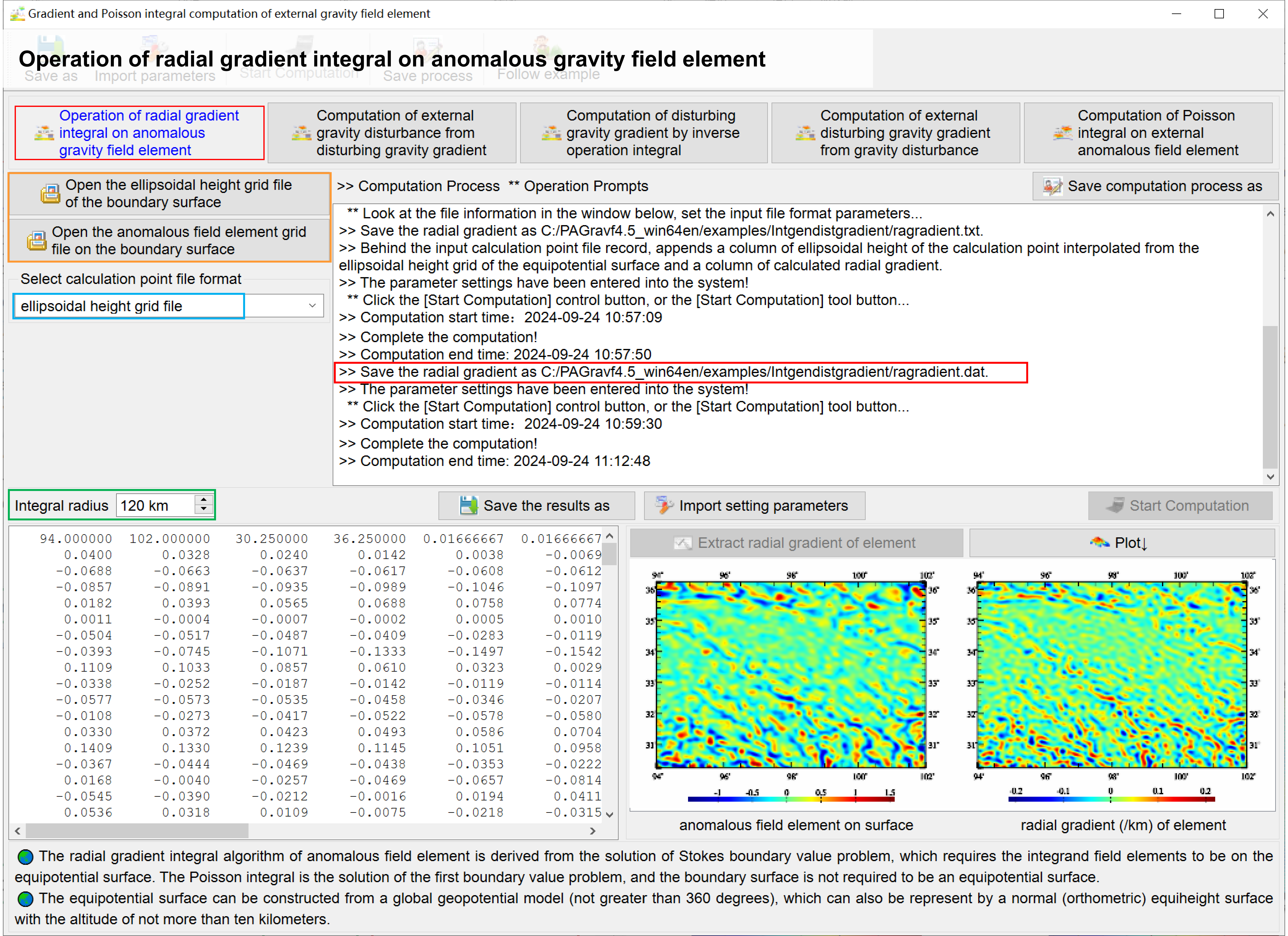


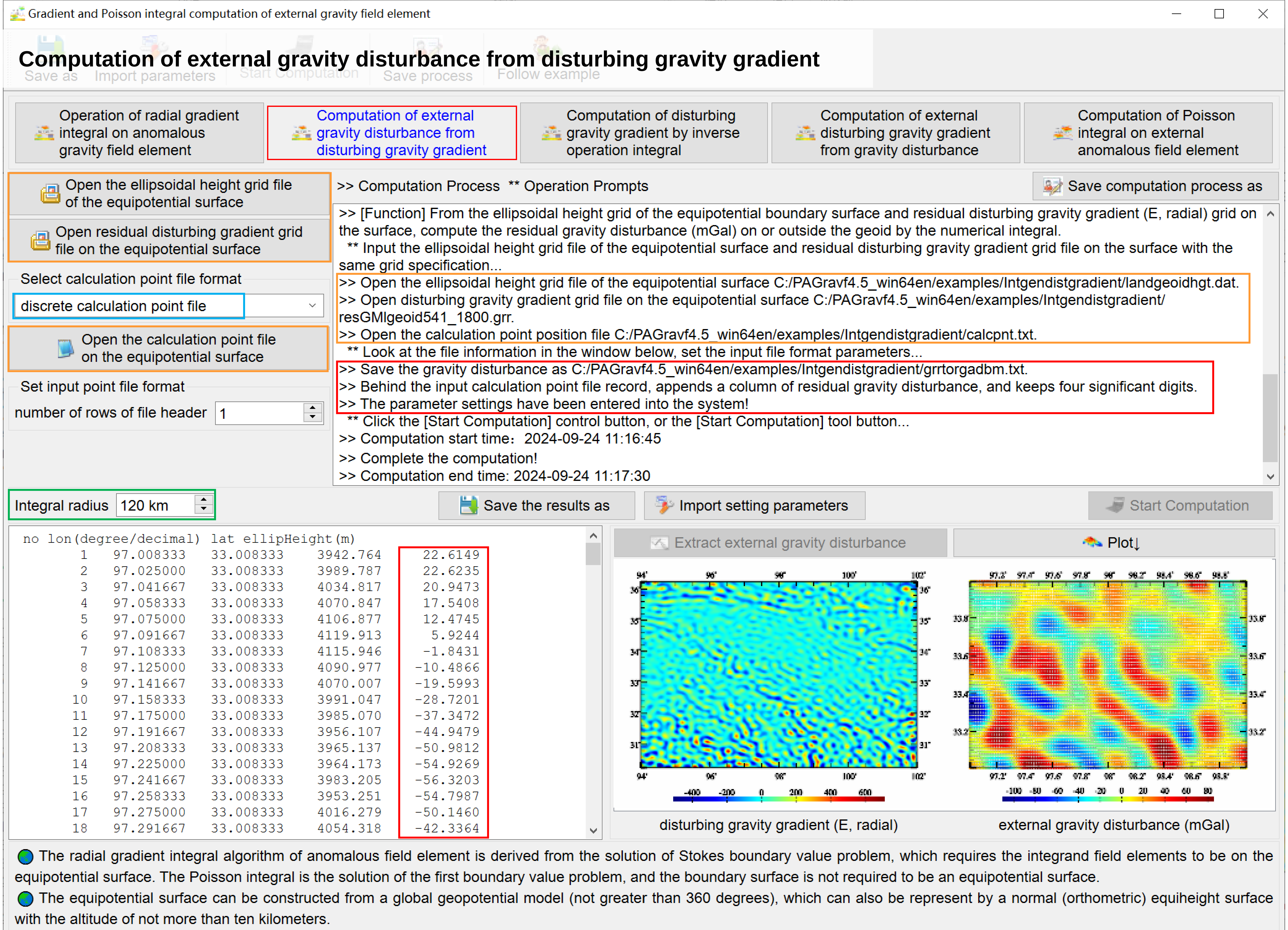

Inverse integral and integral of inverse operation on anomalous field element
Computation of the inverse Vening Meinesz integral – FFT
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation of gravity disturbance 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.

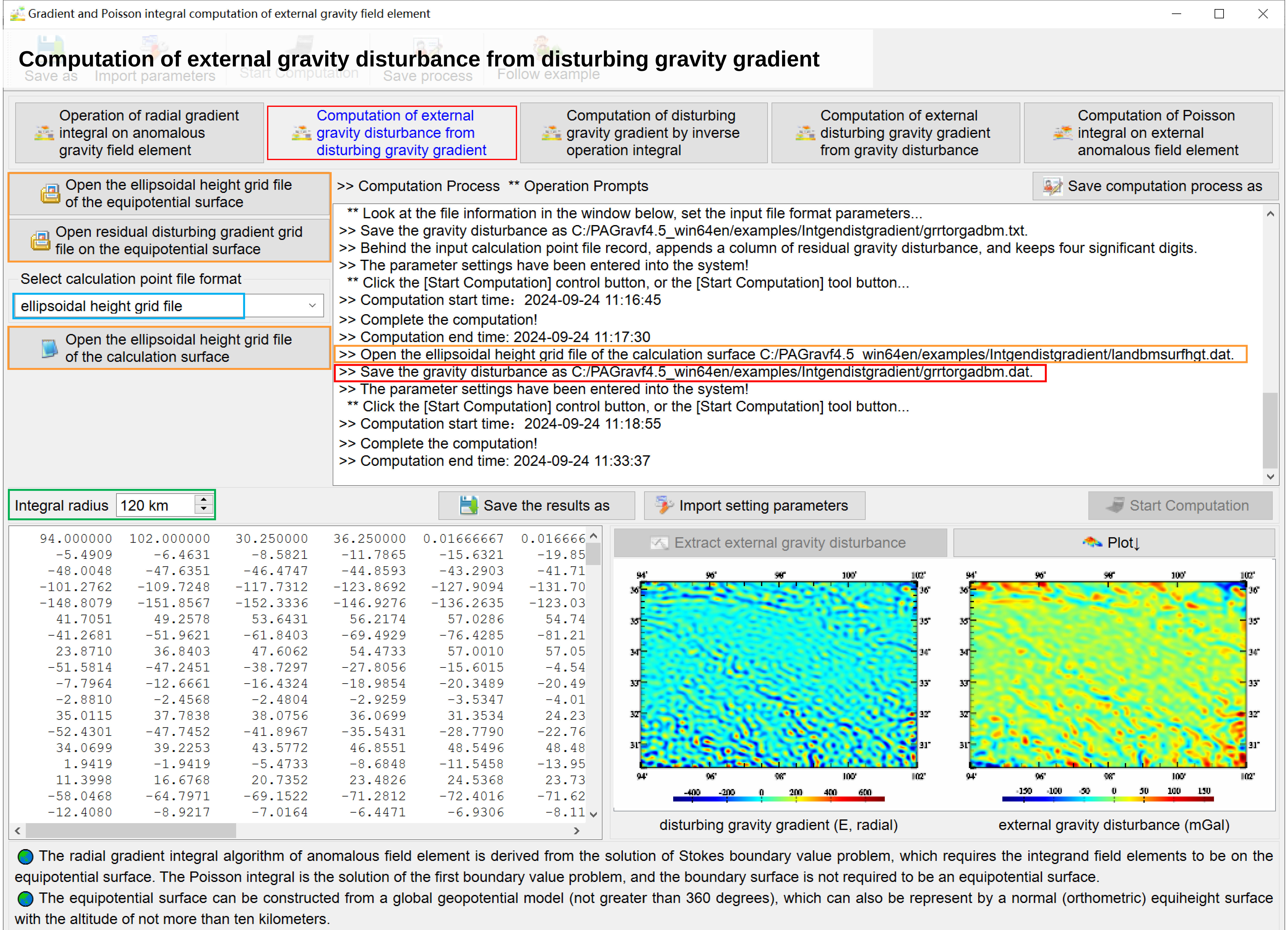

Inverse integral and integral of inverse operation on anomalous field element
Computation of external anomalous gravity field elements from height anomaly
Save as
Importg parameters
Start Computation
Save process
Follow example
Computation of gravity anomaly by the inverse Stokes integral
Computation 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↓
94° 96° 98° 100° 102°
36° 35° 34° 33° 32° 31°
-80 -60 -40 -20 0 20 40 60 80
-15 -10 -5 0 5 10 15
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.

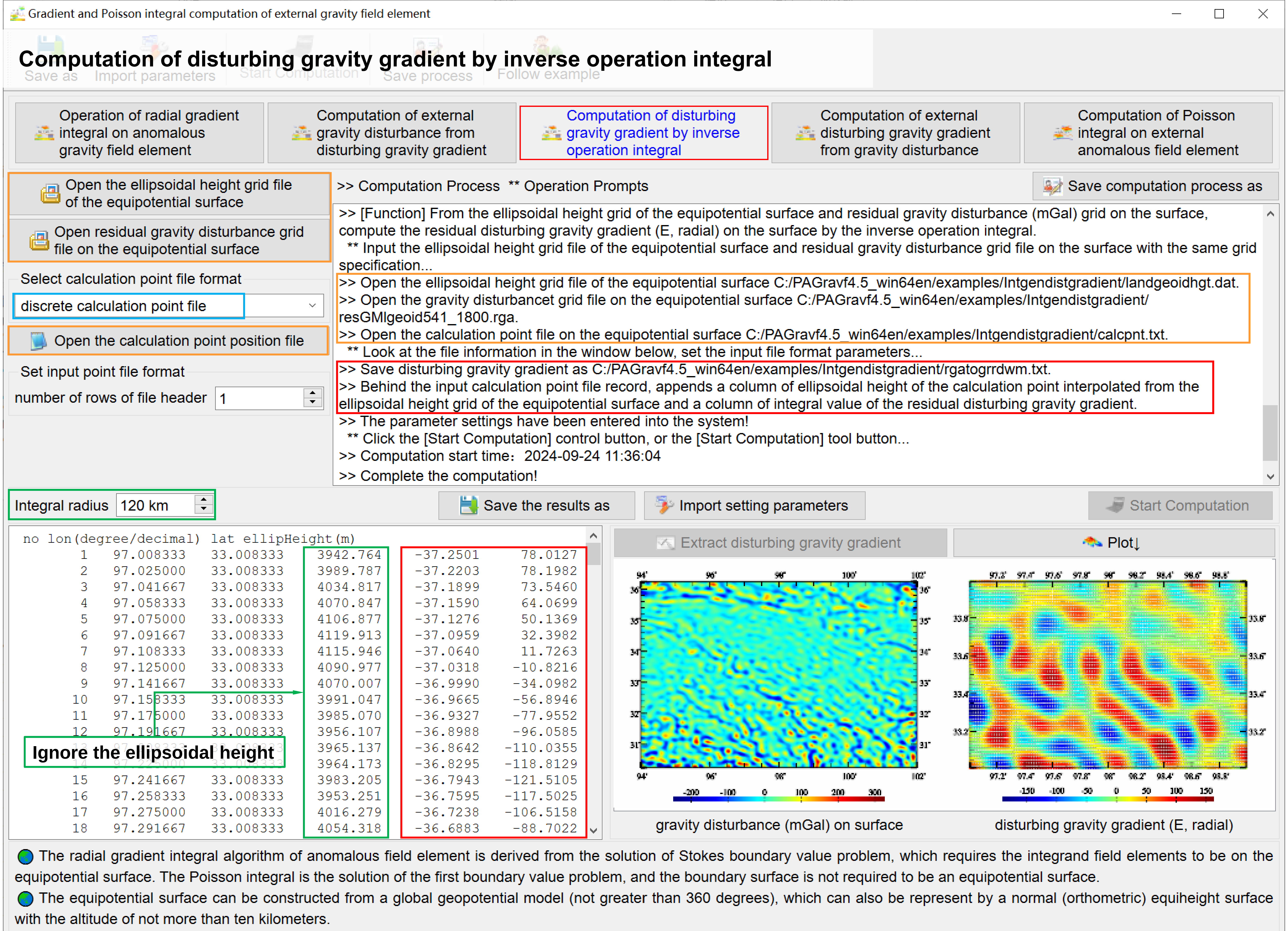

Gradient and Poisson integral computation of external gravity field element
Operation of radial gradient integral on anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

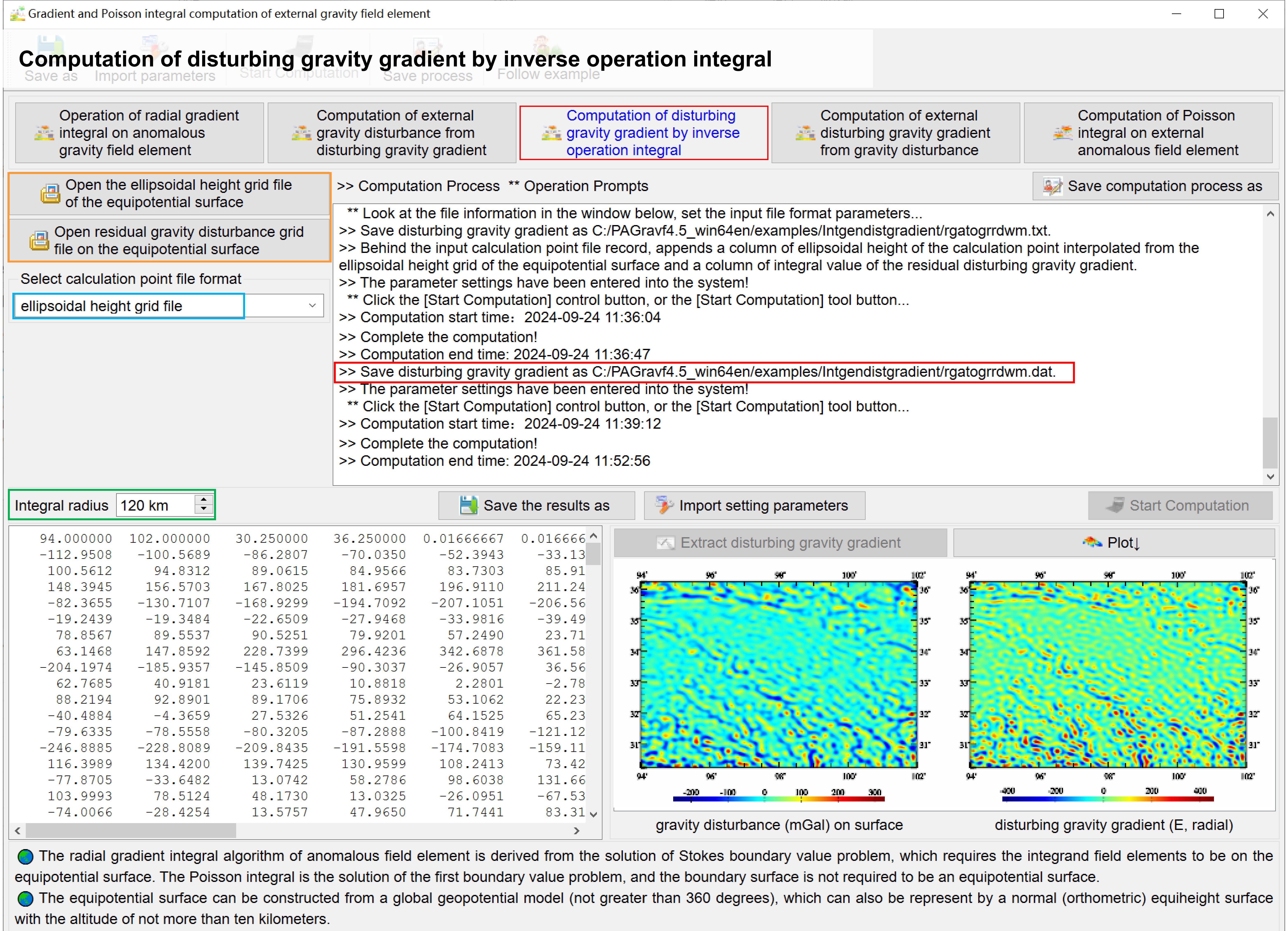

Gradient and Poisson integral computation of external gravity field element
Operation of radial gradient integral on anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

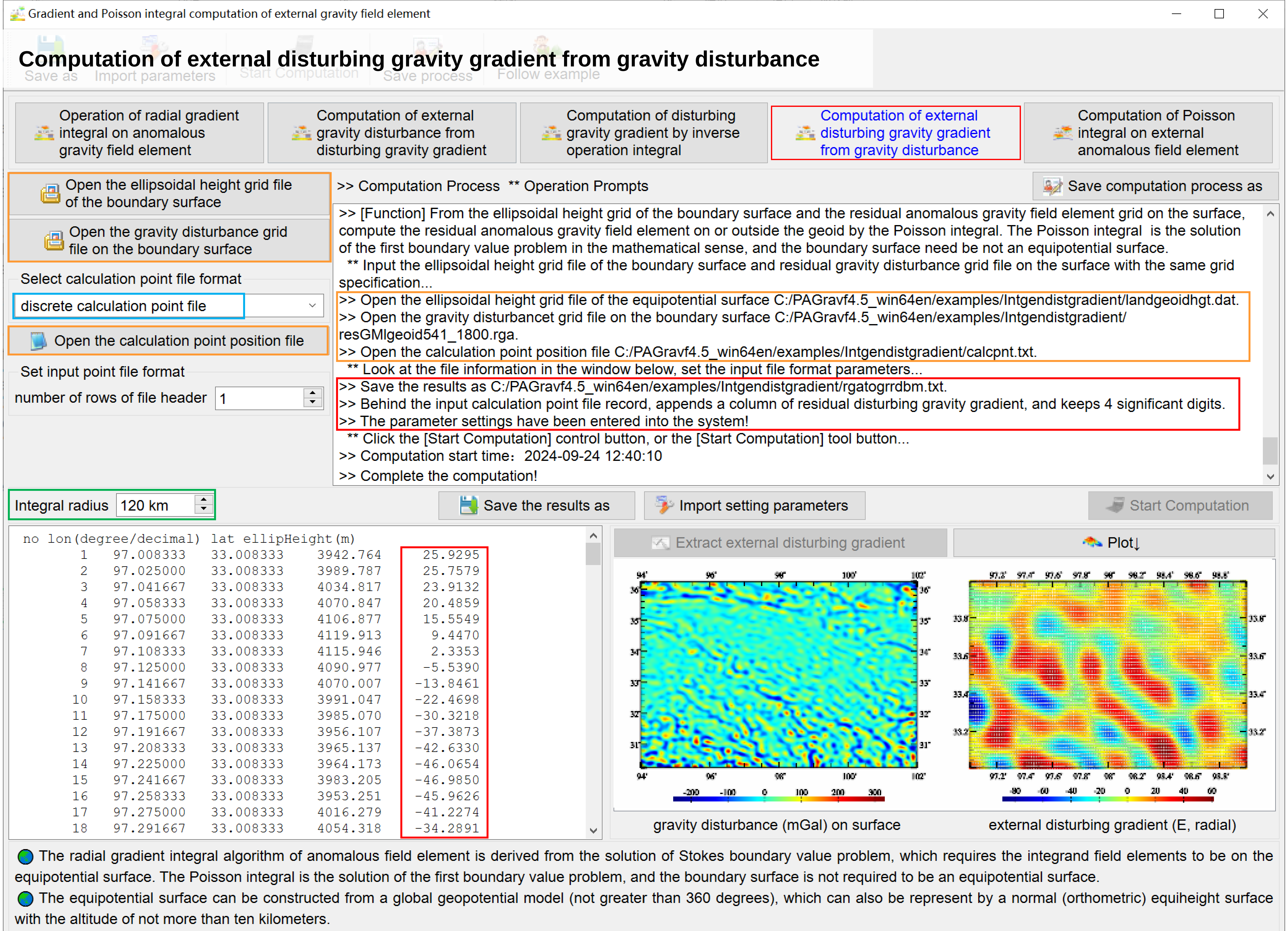

Gradient and Poisson integral computation of external gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

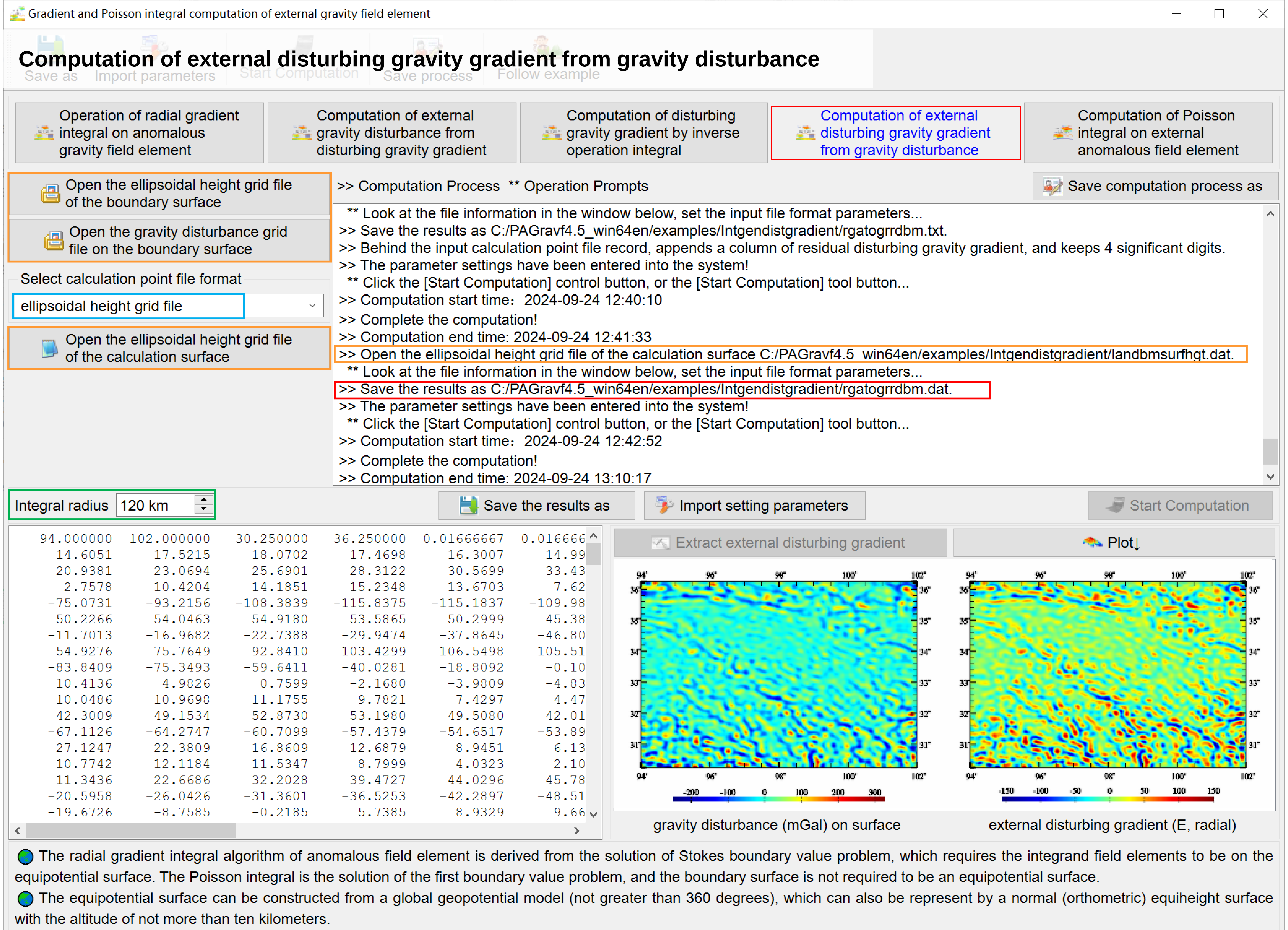


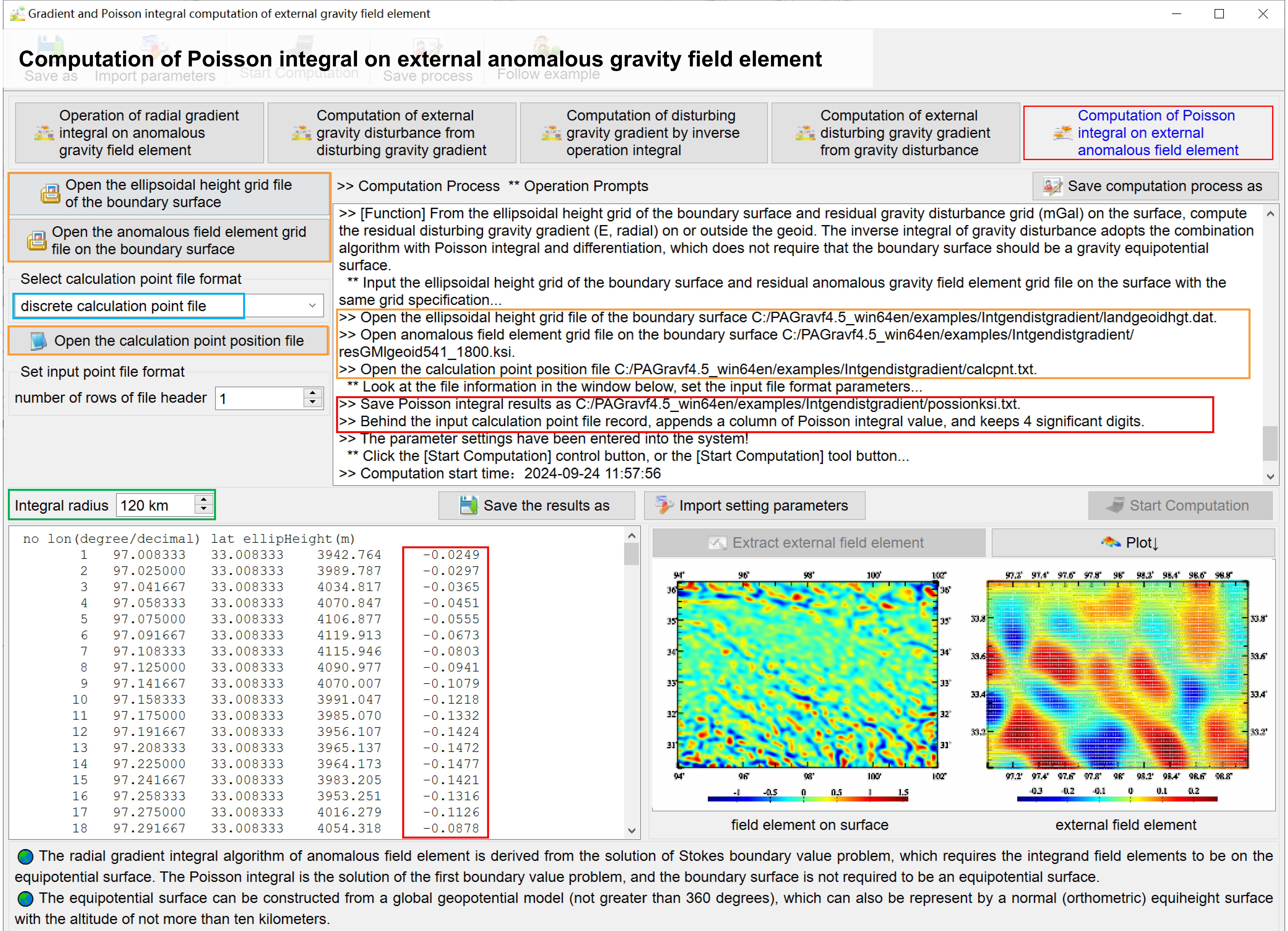
Gradient and Poisson integral computation of external gravity field element
Computation of external gravity disturbance from disturbing gravity gradient
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

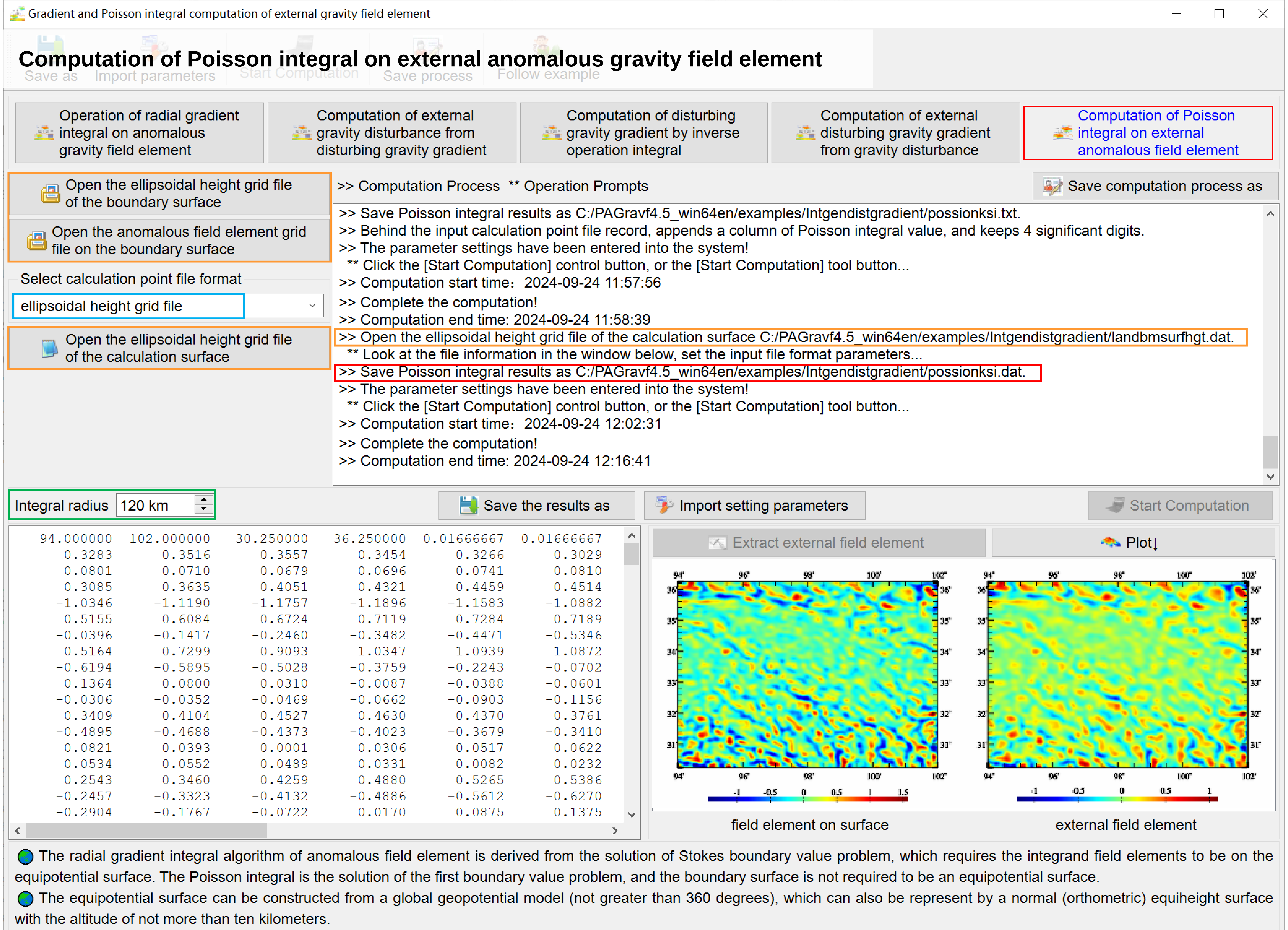

Gradient and Poisson integral computation of external gravity field element
Computation of disturbing gravity gradient by inverse operation integral
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

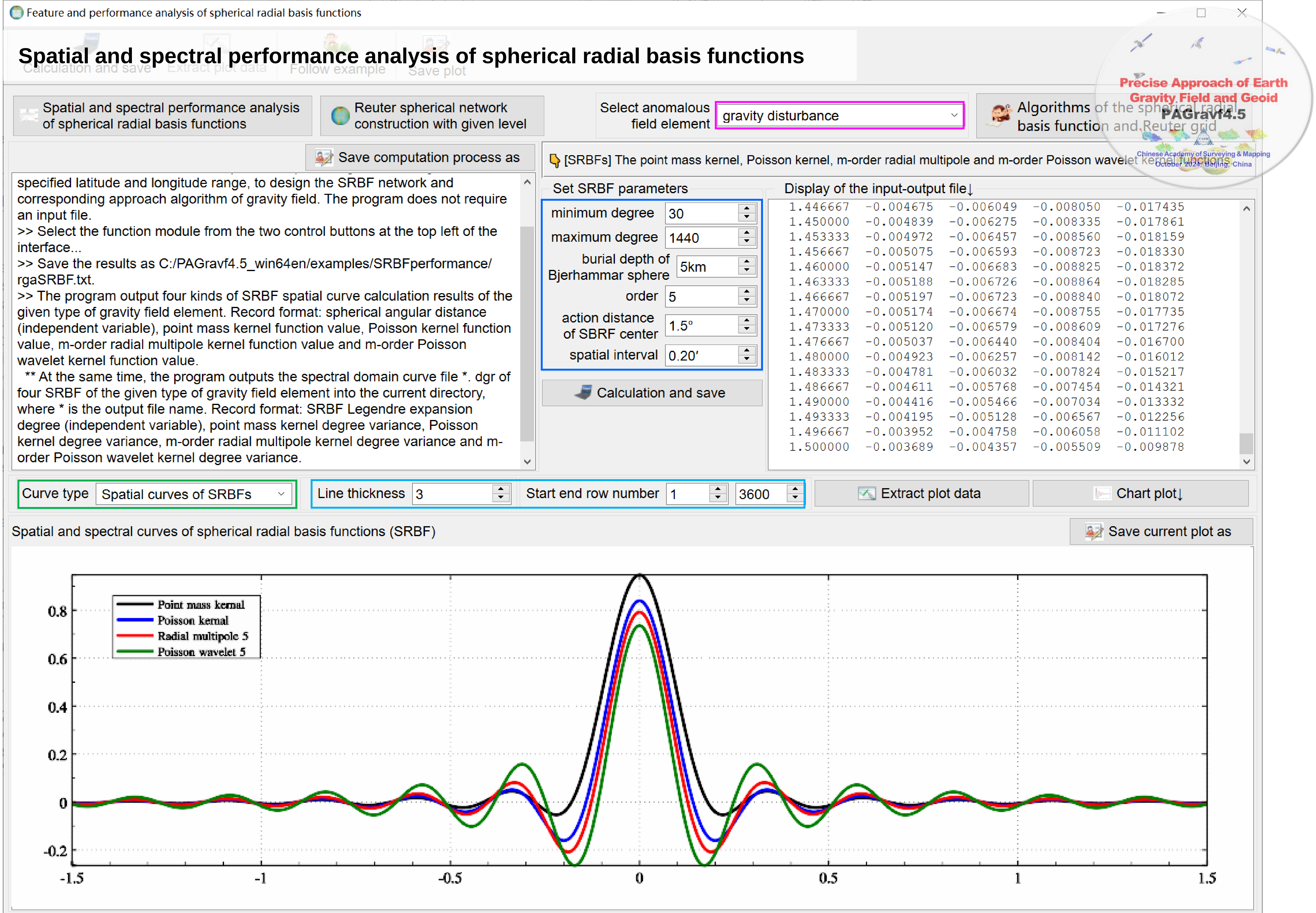

Gradient and Poisson integral computation of external gravity field element
Computation of disturbing gravity gradient by inverse operation integral
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

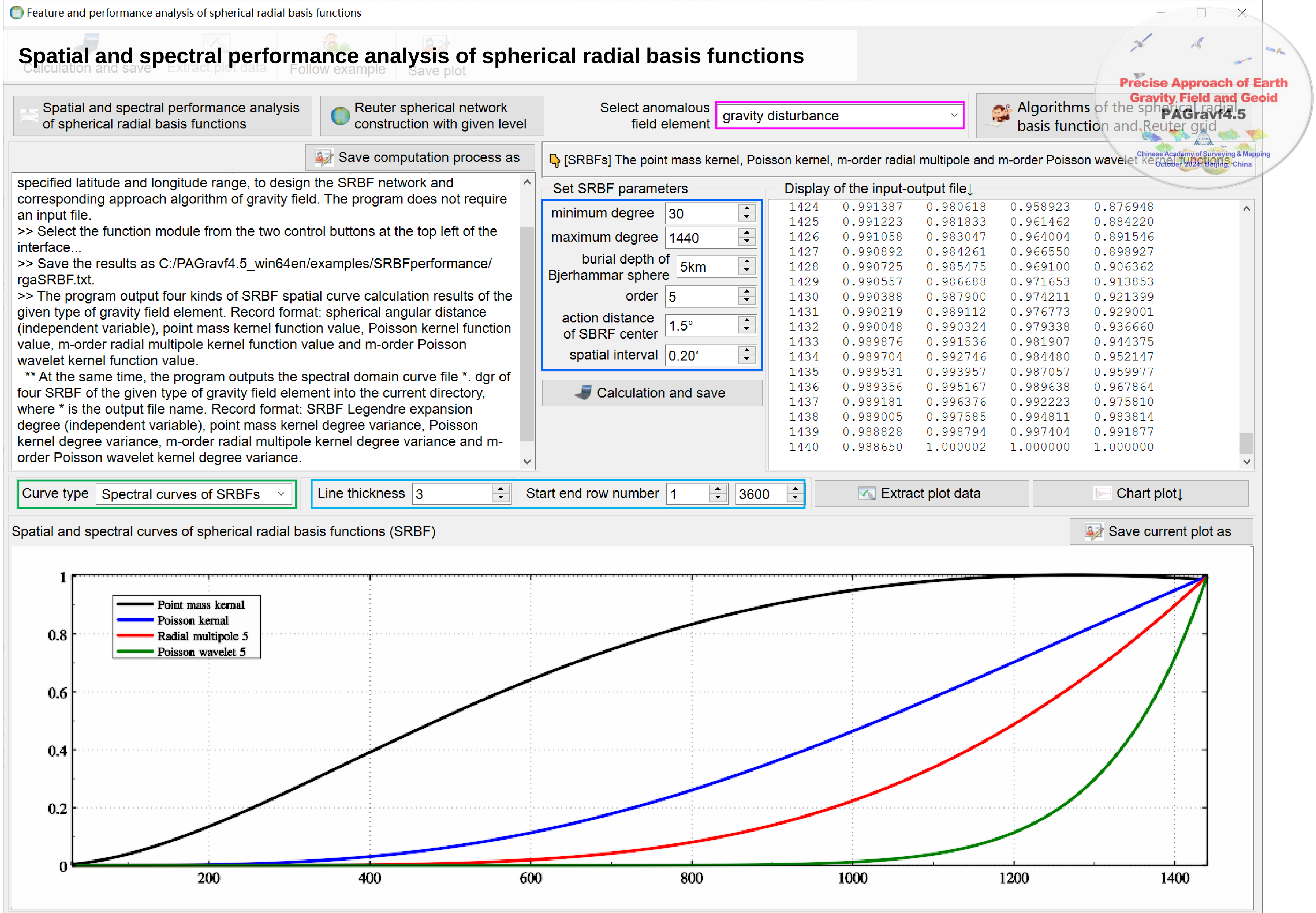

Gradient and Poisson integral computation of external gravity field element
Computation of external disturbing gravity gradient from gravity disturbance
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

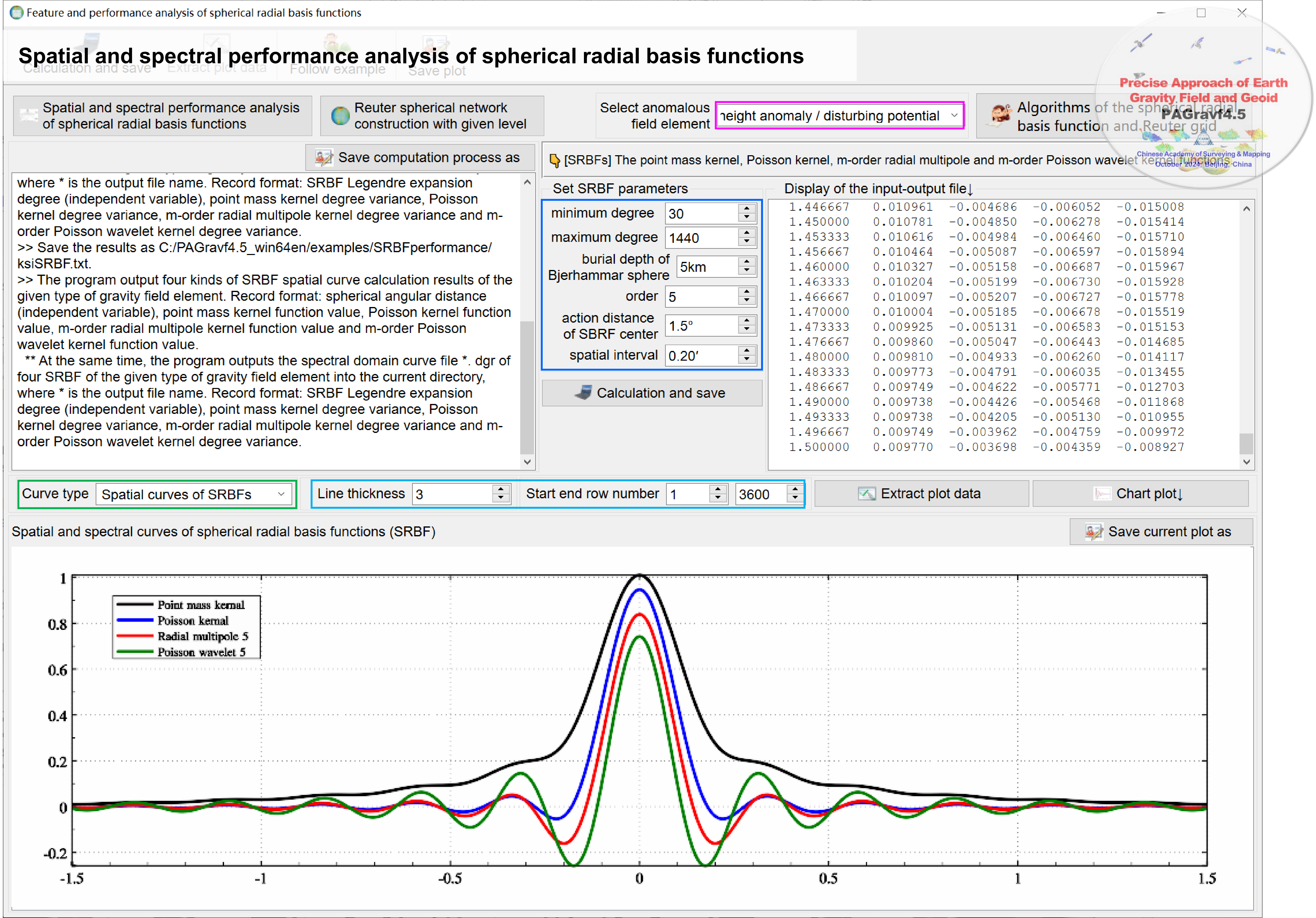

Gradient and Poisson integral computation of external gravity field element
Computation of external disturbing gravity gradient from gravity disturbance
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

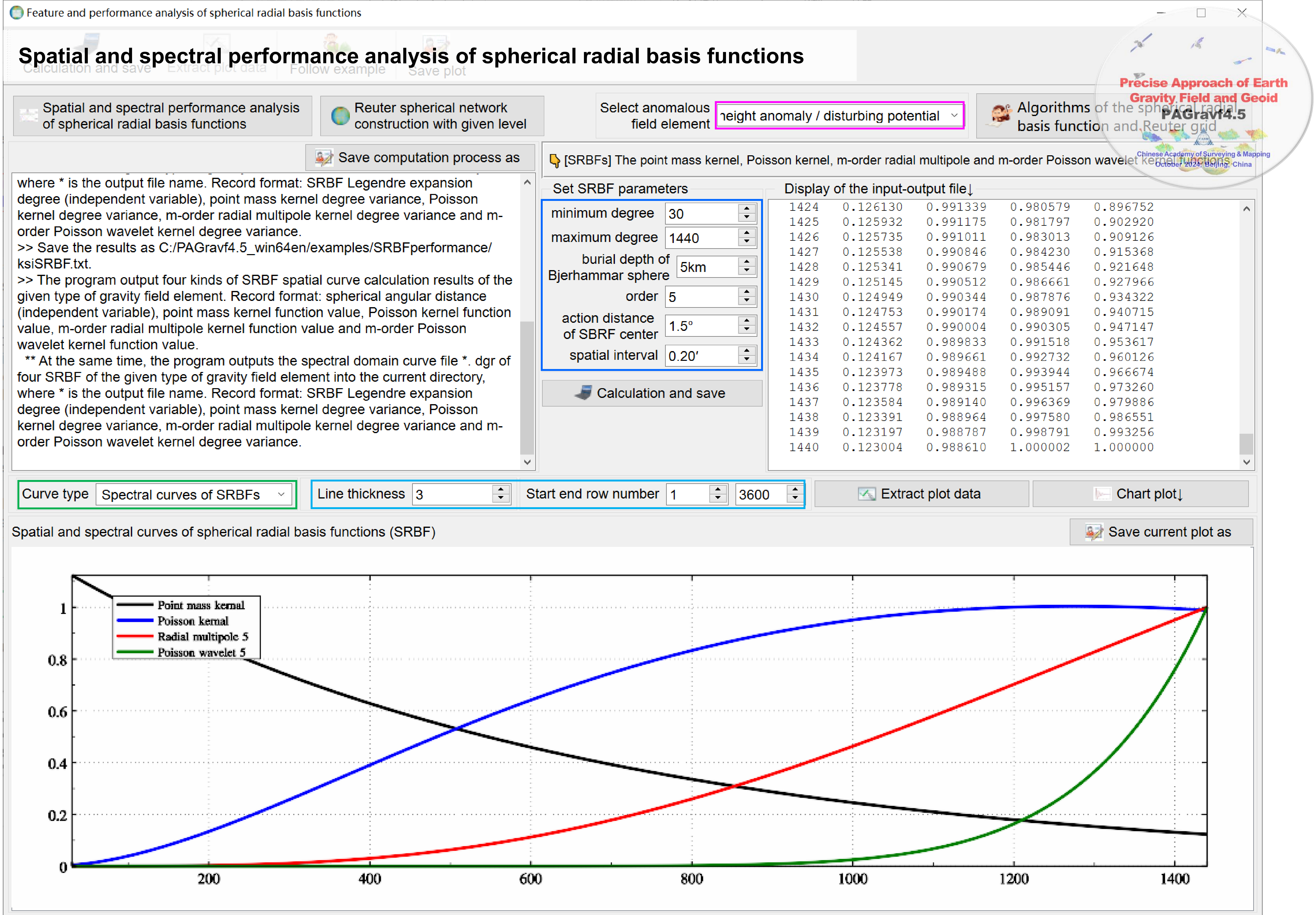

Gradient and Poisson integral computation of external gravity field element
Computation of Poisson integral on external anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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.

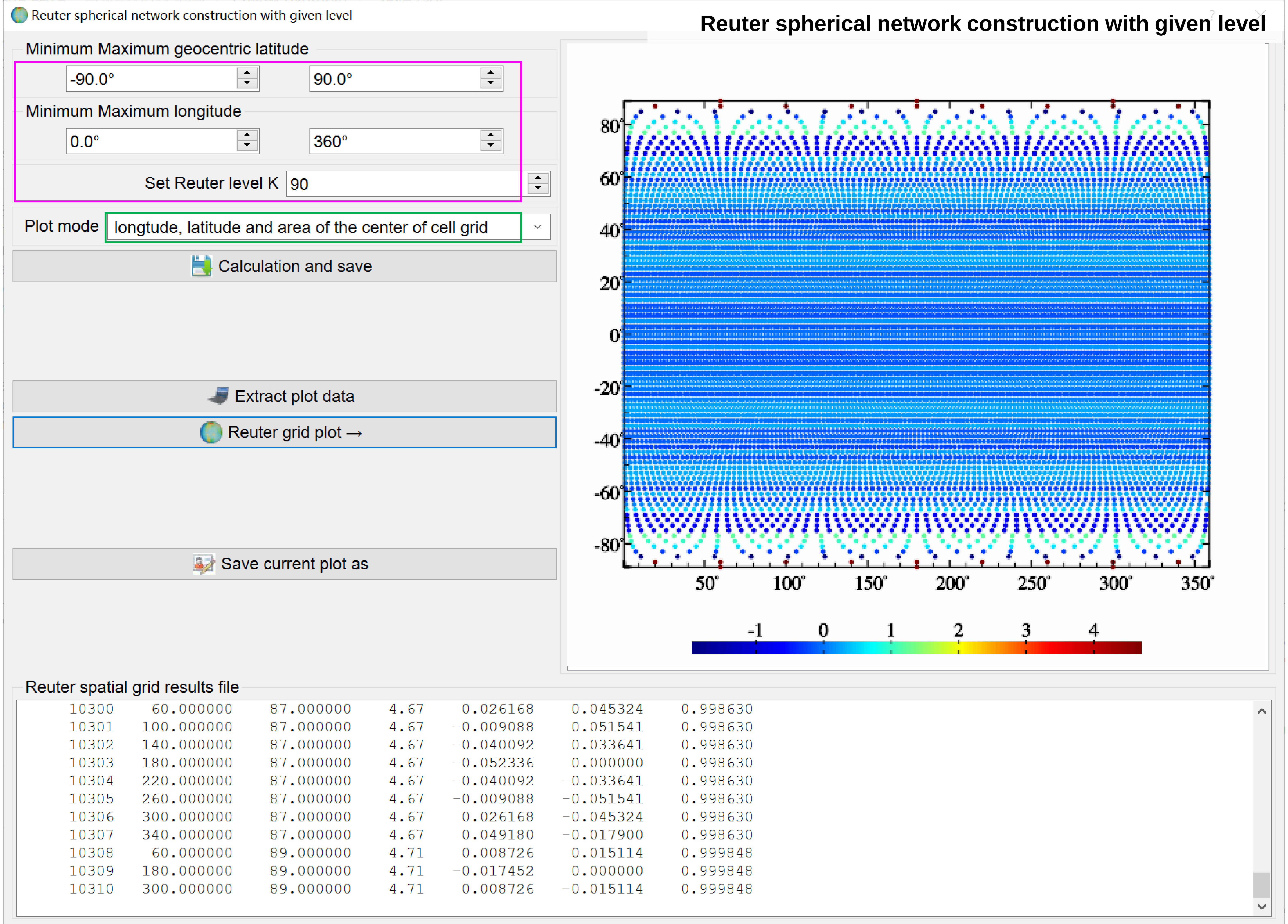

Gradient and Poisson integral computation of external gravity field element
Computation of Poisson integral on external anomalous gravity field element
Save as
Import parameters
Start Computation
Save process
Follow example
Operation of radial gradient integral on anomalous gravity field element
Computation 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 SRBF 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
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 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
0
0.2
0.4
0.6
0.8
1
200
400
600
800
1000
1200
1400

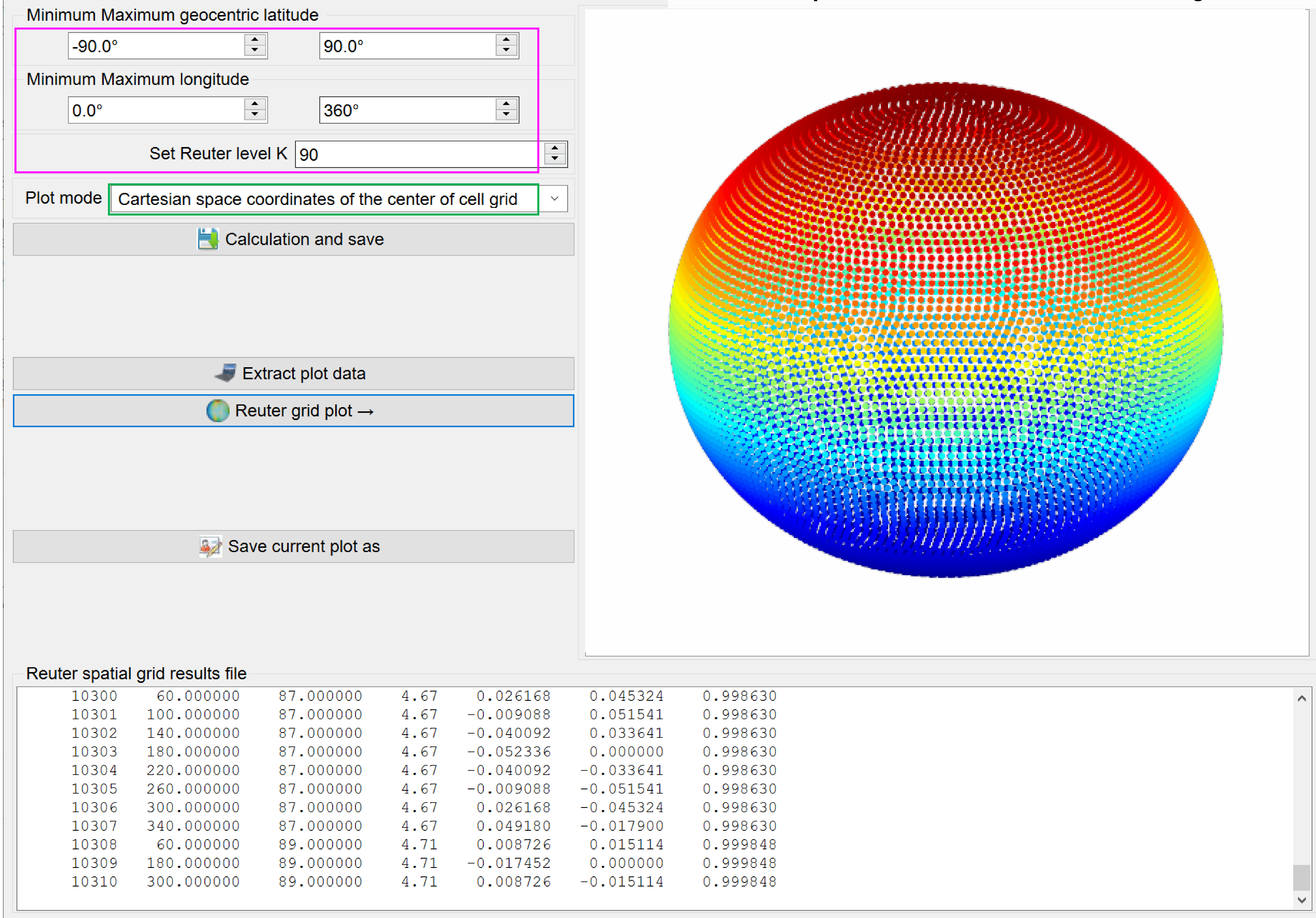

Feature and performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Calculation and save
Extract plot data
Follow example
Save plot
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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
height anomaly / disturbing potential
Algorithms of the spherical radial basis function and Reuter grid
Save computation process as
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.
[SRBFs] The point mass kernel, Poisson kernel, m-order radial multipole and m-order Poisson wavelet kernel functions
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

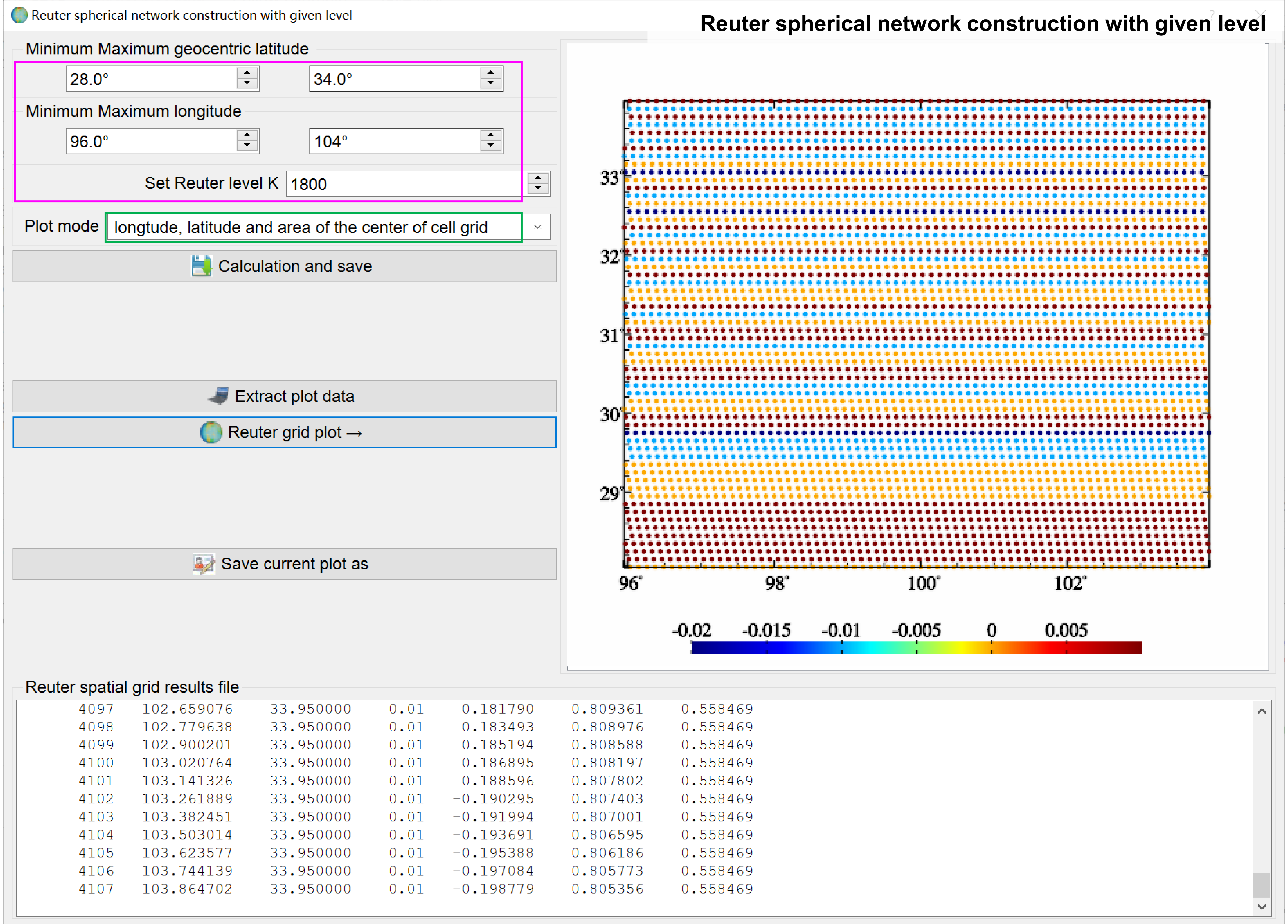

Feature and performance analysis of spherical radial basis functions
Spatial and spectral performance analysis of spherical radial basis functions
Calculation and save
Extract plot data
Follow example
Save plot
Precise Approach of Earth Gravity Field and Geoid
PAGravf4.5
Chinese Academy of Surveying & 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
height anomaly / disturbing potential
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
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

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

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.

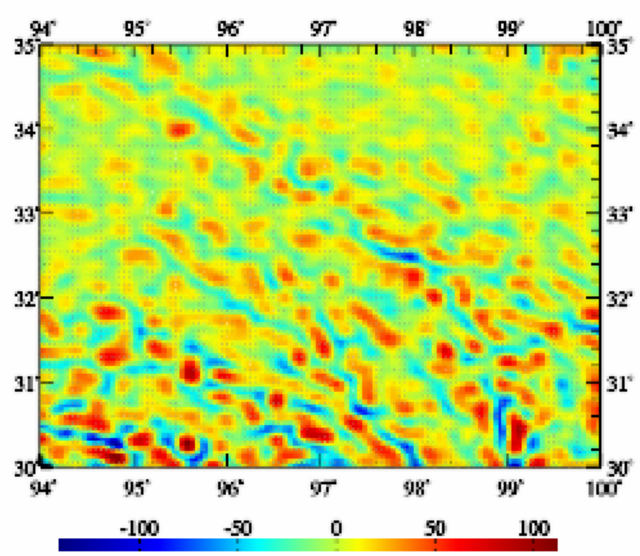
Extract data to be plot | Plot→

SRBF approach algorithms

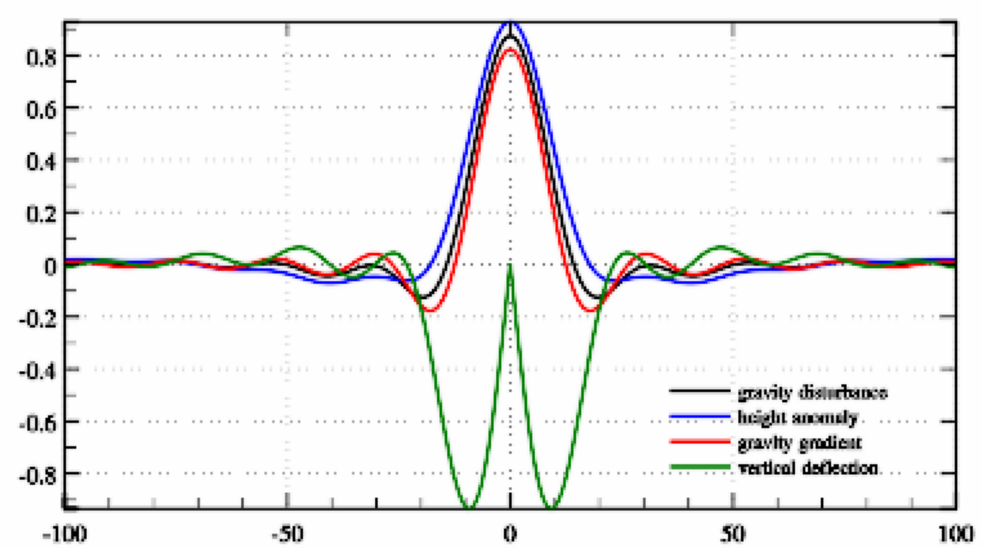
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height,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

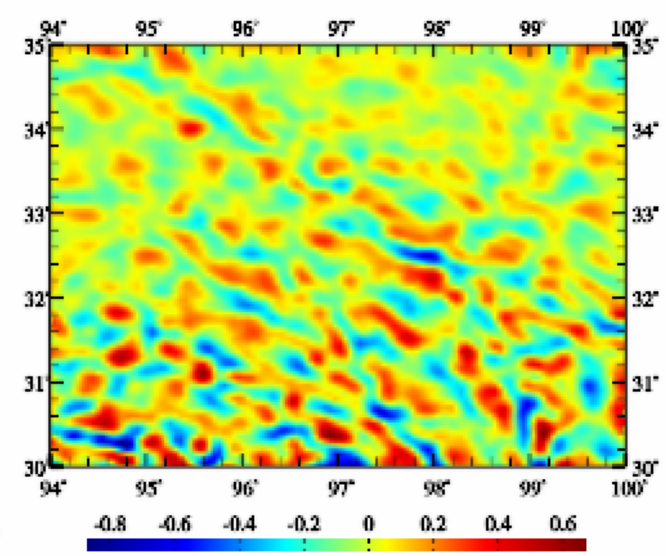
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-0.4934	-0.4466	-0.3004	-0.1309	-0.0358	0.0254	0.0649	0.0679	0.0223	-0.0732
0.1289	0.2125	0.1641	-0.0056	-0.2094	-0.2817	-0.1712	0.0125	0.1665	0.2722
0.0273	-0.2539	-0.4608	-0.4318	-0.2215	0.0453	0.2281	0.2436	0.1685	0.0364
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



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 – once cumulative approach

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

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.

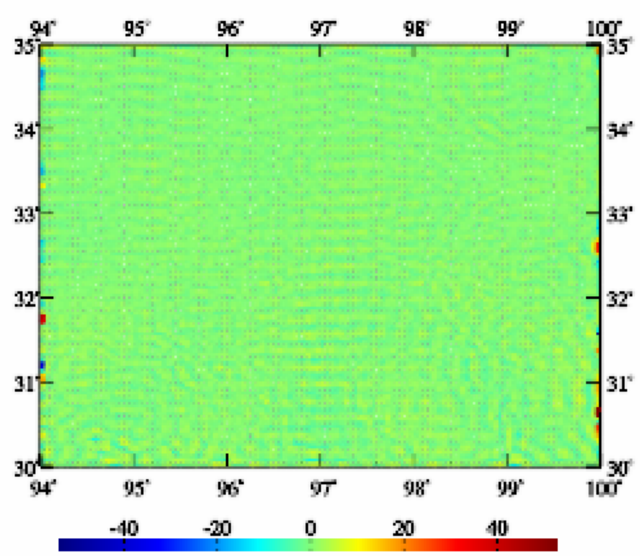
Extract data to be plot | Plot→

SRBF approach algorithms

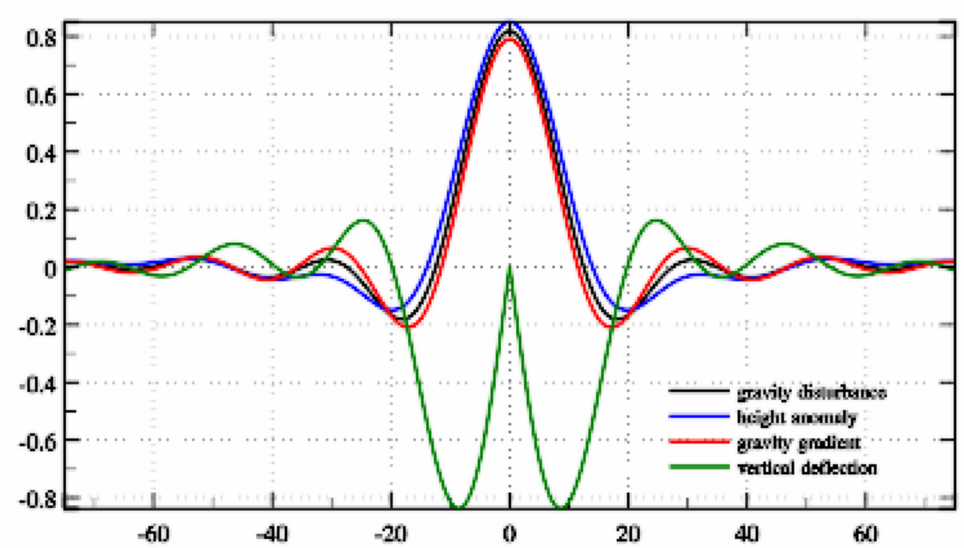
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height,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

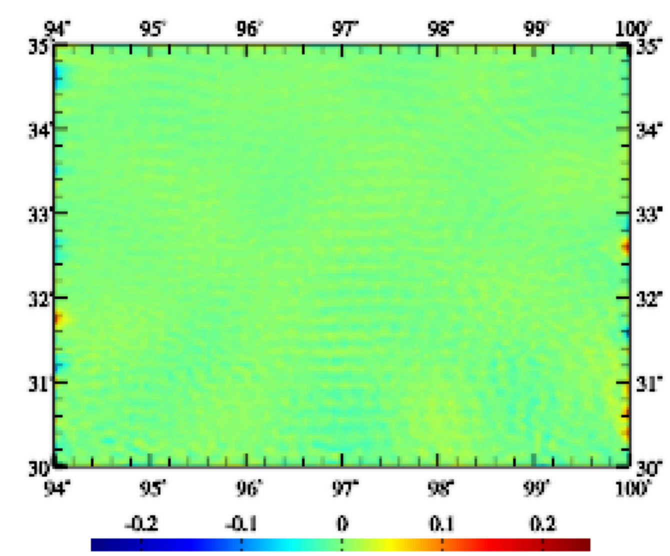
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
0.0062	0.0156	0.0198	0.0140	0.0131	0.0070	0.0129	0.0219	0.0341	0.0222
-0.0377	-0.0595	-0.0418	-0.0222	-0.0199	-0.0378	-0.0153	-0.0140	-0.0054	-0.0043
-0.0170	-0.0175	-0.0034	0.0075	0.0119	0.0092	0.0314	0.0430	0.0474	0.0319
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

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.

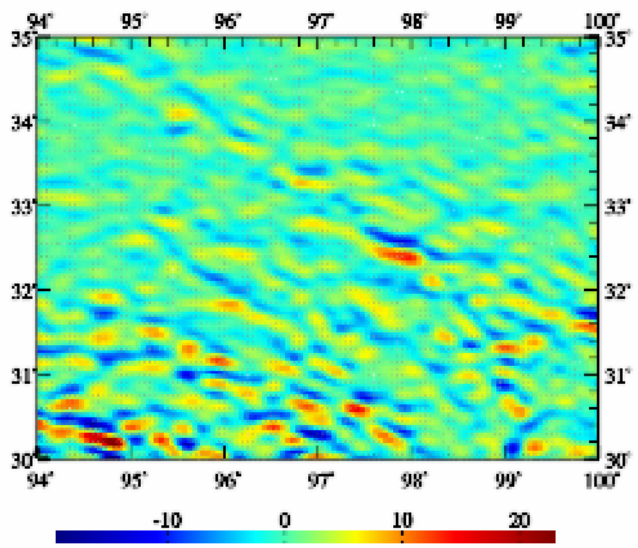
Extract data to be plot | Plot→

SRBF approach algorithms

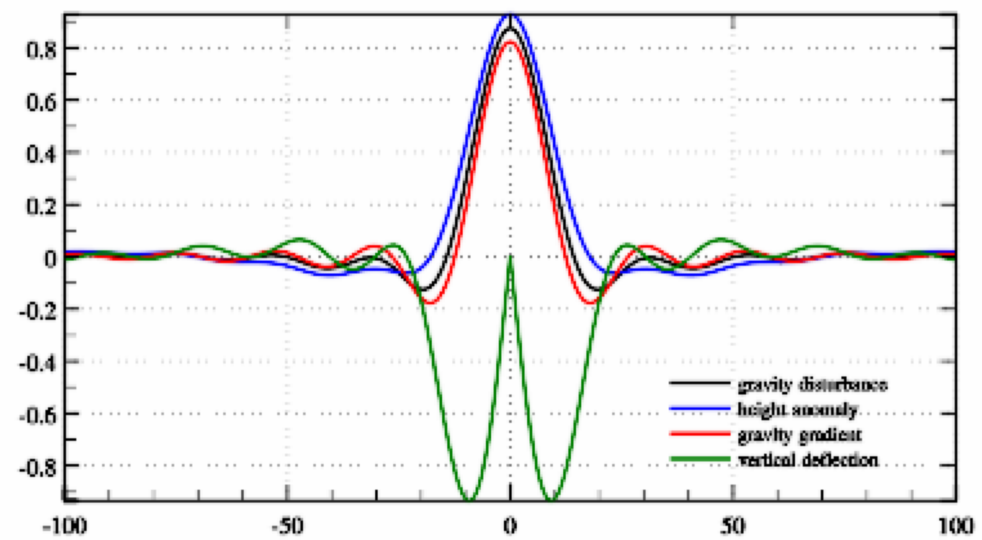
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height,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

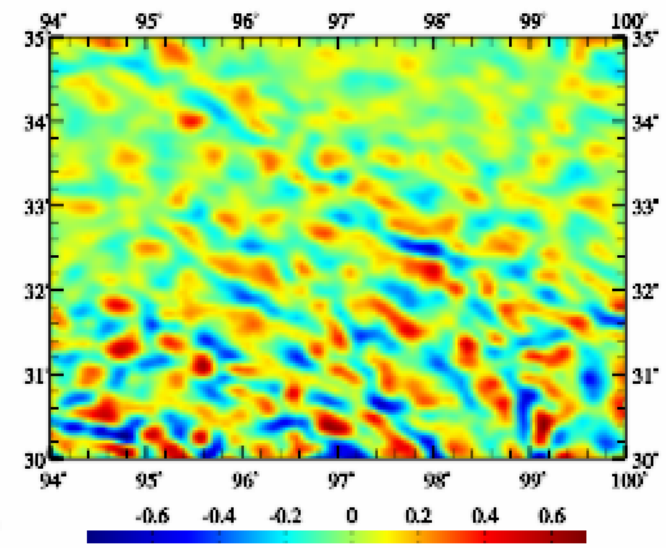
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-0.4808	-0.4329	-0.2845	-0.1120	-0.0144	0.0492	0.0874	0.1029	0.0741	-0.0079
0.1176	0.2158	0.1885	0.0295	-0.1768	-0.2662	-0.1820	-0.0265	0.1247	0.2425
0.0318	-0.2592	-0.4819	-0.4693	-0.2501	0.0327	0.2356	0.2747	0.2107	0.0684
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

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.

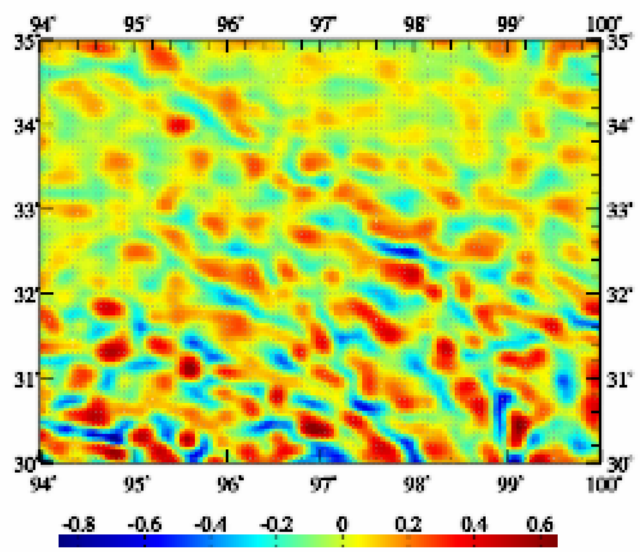
Extract data to be plot | Plot→

SRBF approach algorithms

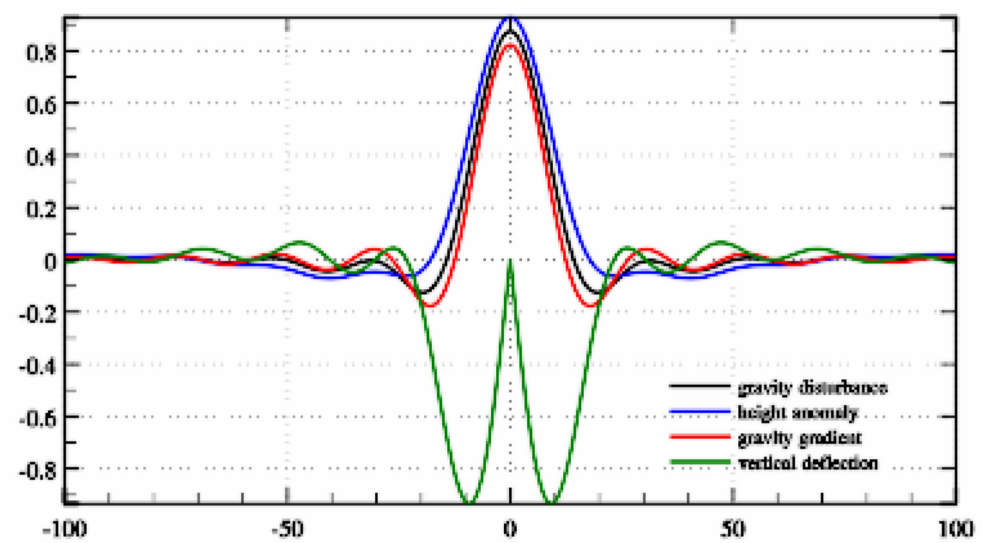
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height,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

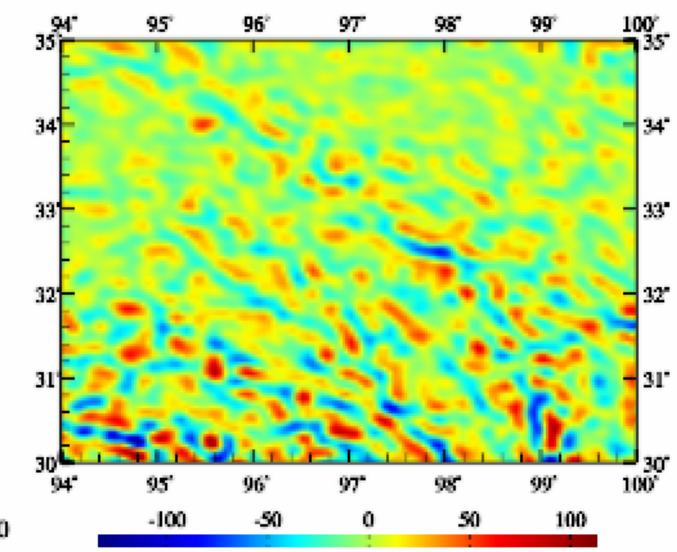
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-65.3591	-58.7649	-35.2841	-10.0337	2.9287	7.2438	10.2652	13.5926	12.0766	-0.3089
6.4548	29.7980	29.7832	2.0592	-35.7794	-53.6309	-39.0541	-13.1329	4.8602	14.6182
6.6296	-41.4182	-73.4118	-66.0062	-26.5807	24.2028	57.9004	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)



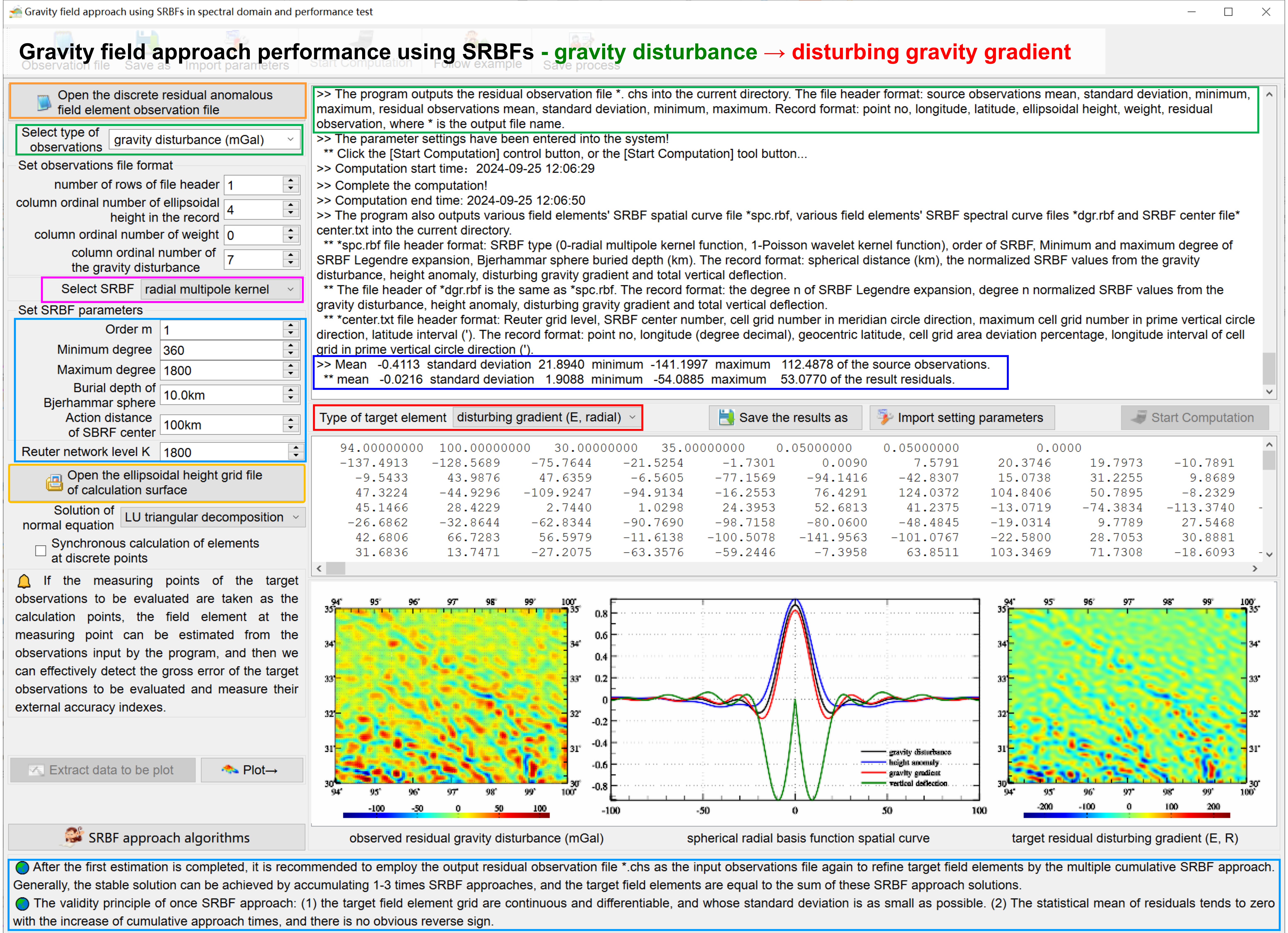
spherical radial basis function spatial curve



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

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: 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.

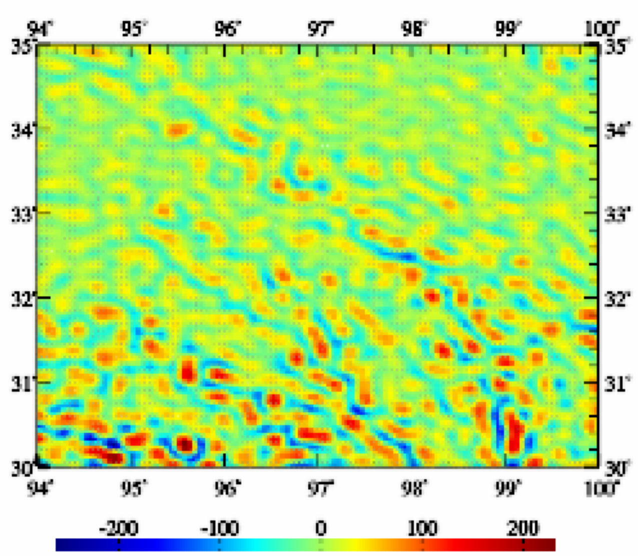
Extract data to be plot | Plot→

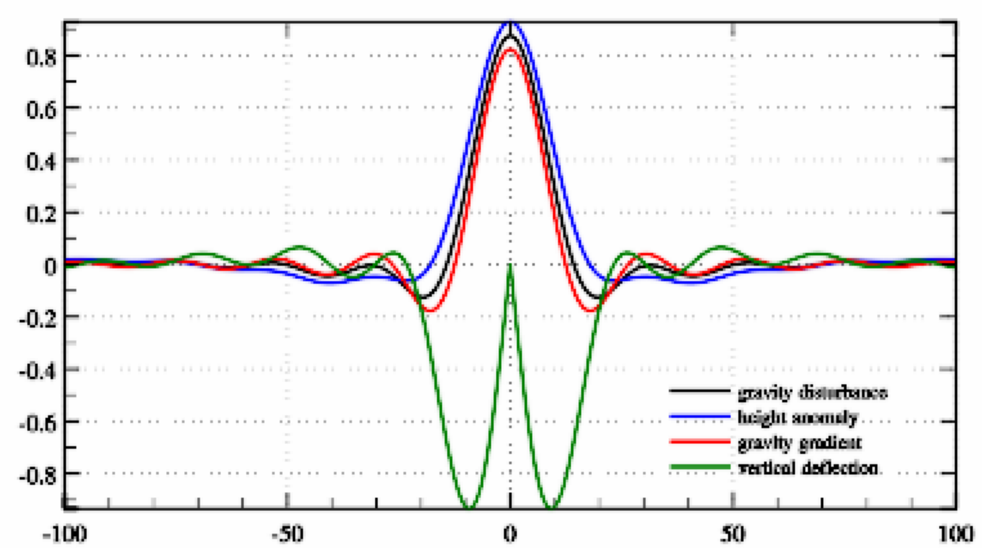
SRBF approach algorithms

>> 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.

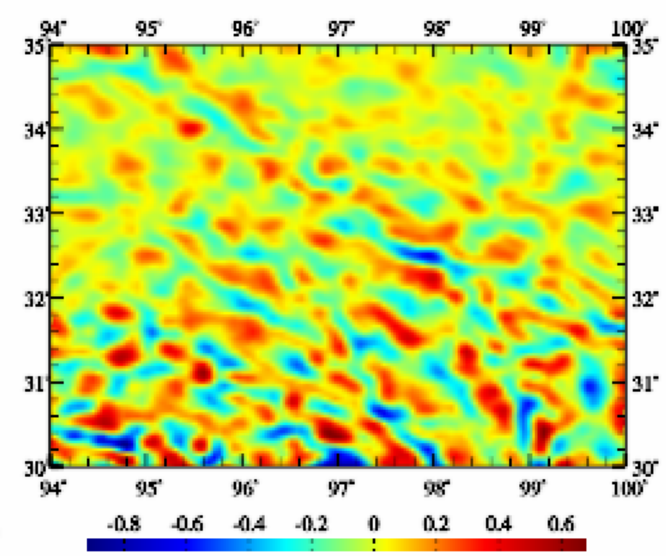
Type of target element: height anomaly (m) | Save the results as | Import setting parameters | Start Computation

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

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

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.

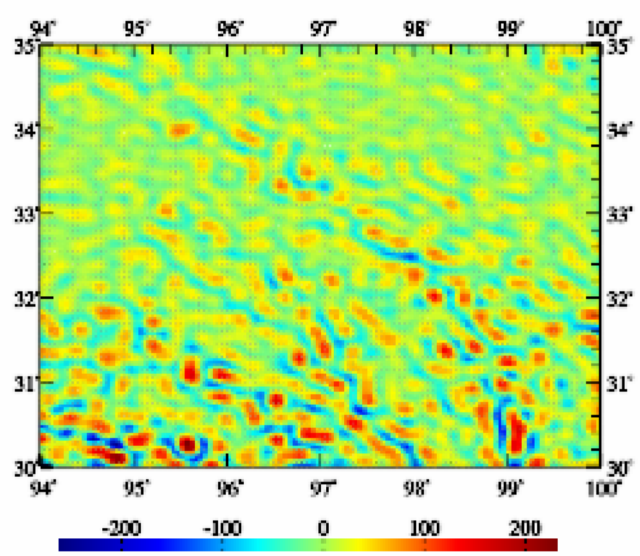
** *center.txt file header format: Reuter grid level, SRBF center number, cell grid number in meridian circle direction, maximum cell grid number in prime vertical circle direction, latitude interval ('). The record format: point no, longitude (degree decimal), geocentric latitude, cell grid area deviation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

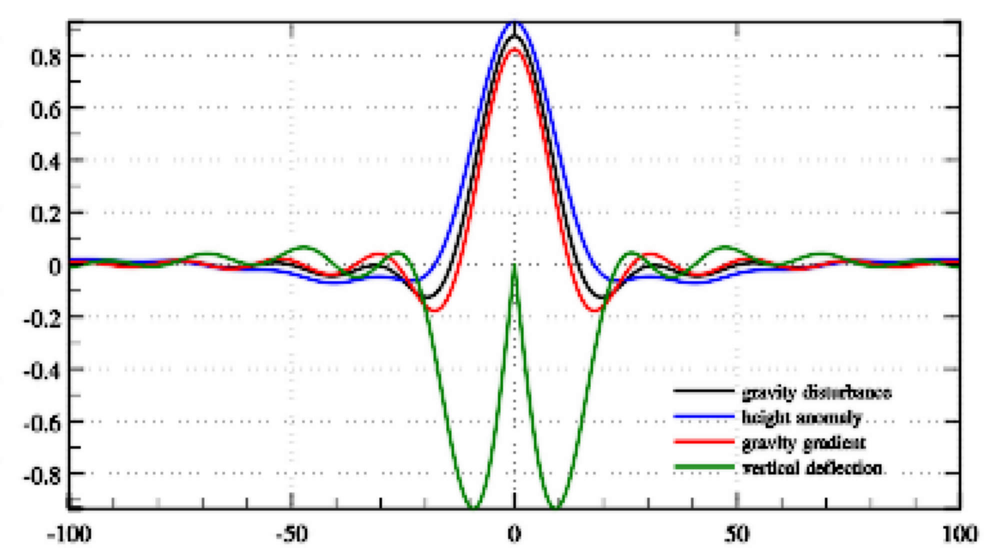
** mean -0.0373 standard deviation 3.7041 minimum -90.4115 maximum 78.2329 of the result residuals.

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

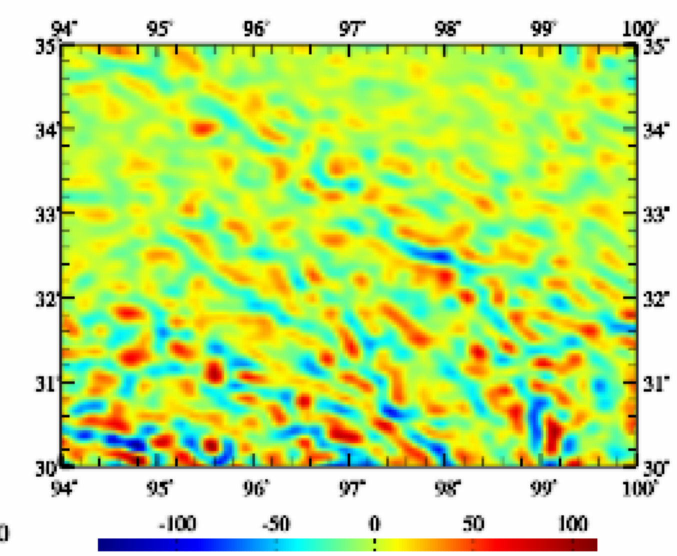
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-86.0957	-82.4429	-54.2835	-22.6428	-7.0178	-1.1718	3.1876	6.8333	2.1125	-15.3716
19.5807	39.6239	29.9655	-4.2432	-41.1459	-48.6841	-22.7812	7.2624	21.6418	19.1479
24.1767	-19.6837	-52.4652	-47.9595	-12.0423	31.0213	53.7371	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.

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 - disturbing gravity gradient → vertical deflection

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

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Chinese Academy of Surveying & Mapping
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.

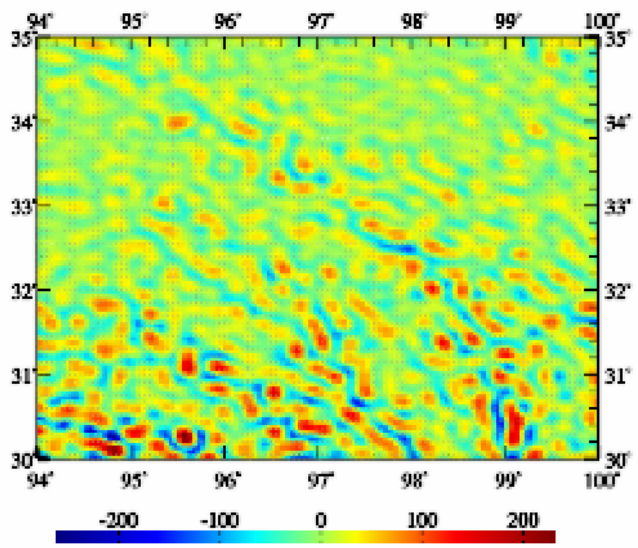
Extract data to be plot   Plot→

SRBF approach algorithms

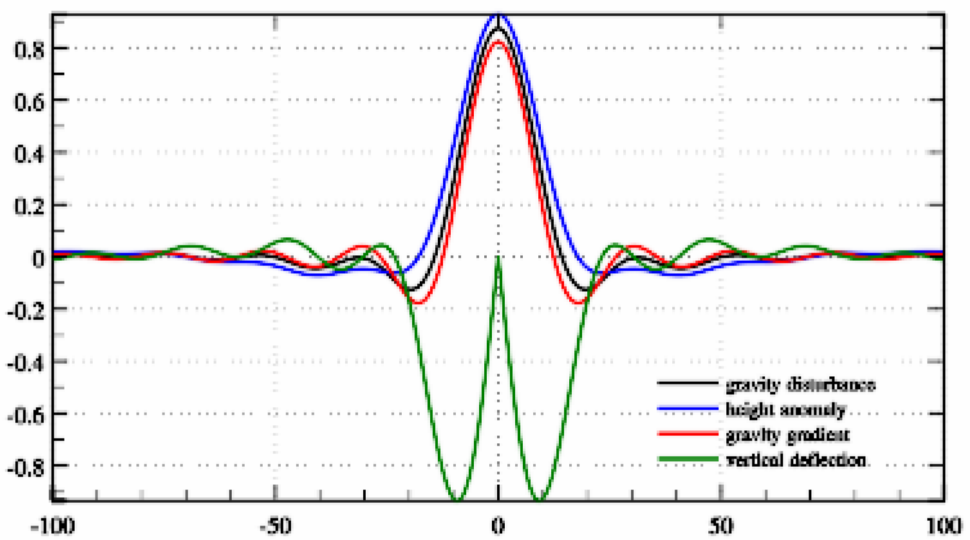
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, 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 12:12:08
>> 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

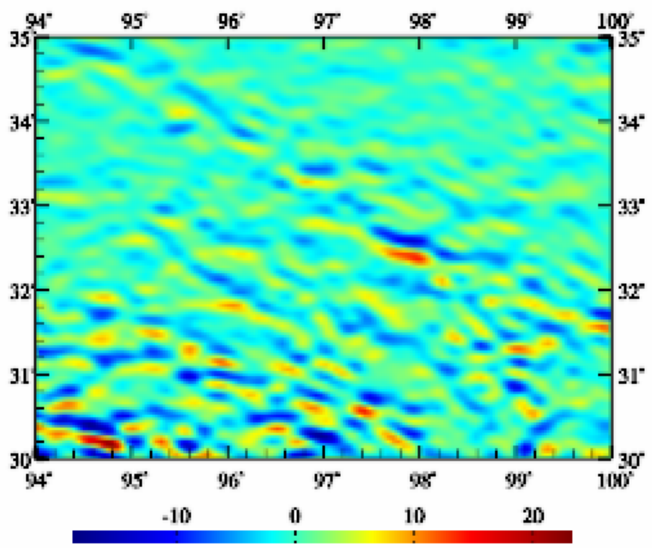
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-4.5854	-5.1192	-5.1277	-4.5604	-3.2649	-1.5760	0.1493	1.5548	2.2531	1.9720
-13.0641	-13.7256	-11.4734	-7.2443	-2.4898	1.0888	2.4705	1.4576	-1.3255	-4.5001
5.4203	6.3758	7.8360	9.0473	9.0195	7.8777	6.5432	5.7170	5.3042	4.4329
-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

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.

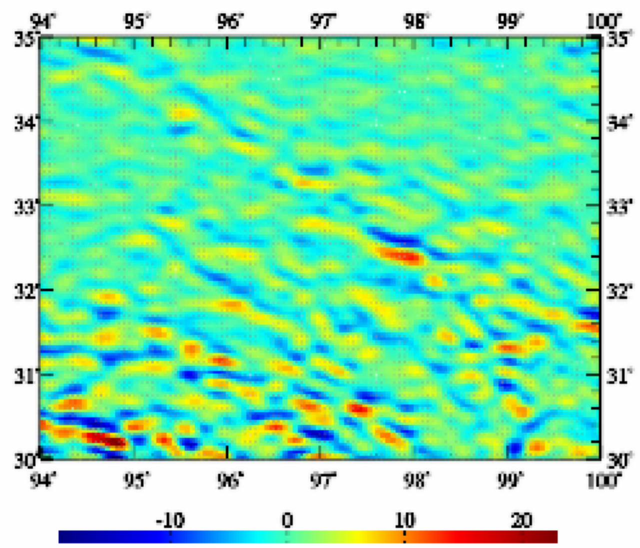
Extract data to be plot | Plot→

SRBF approach algorithms

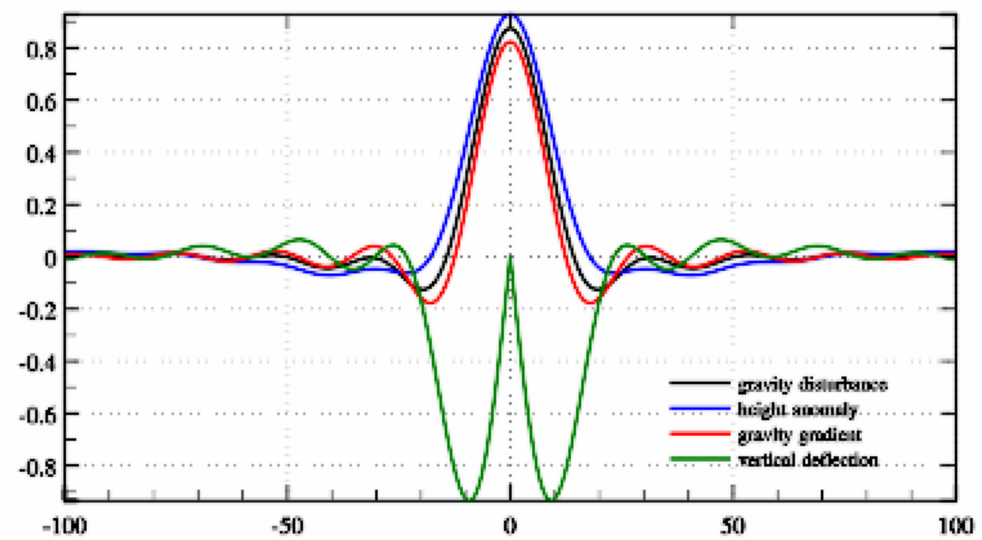
>> The program outputs the residual observation file *. chs into the current directory. The file header format: source observations mean, standard deviation, minimum, maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height,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

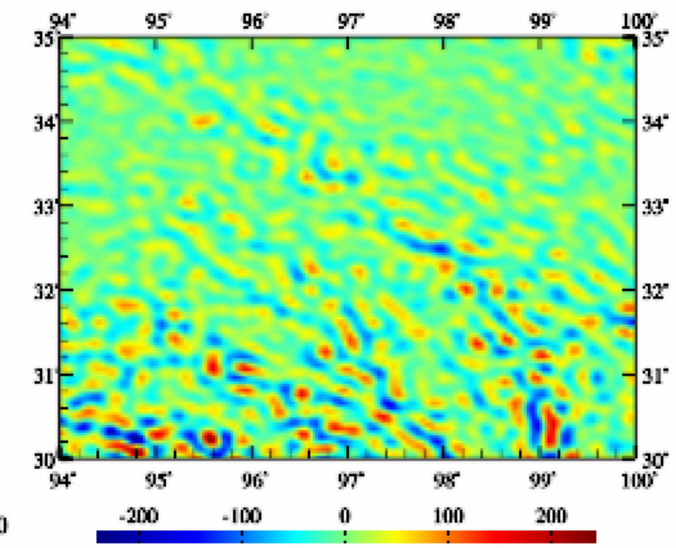
94.00000000	100.00000000	30.00000000	35.00000000	0.05000000	0.05000000	0.0000			
-131.5563	-121.2759	-68.2304	-15.2280	2.8825	4.9227	13.5714	28.3154	28.5758	-1.9308
-20.5629	37.0549	50.9059	4.0181	-65.4929	-87.5943	-45.4304	5.3181	21.8382	5.4180
49.8439	-43.1920	-110.4821	-99.4924	-20.8064	74.7930	127.9823	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



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

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: 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

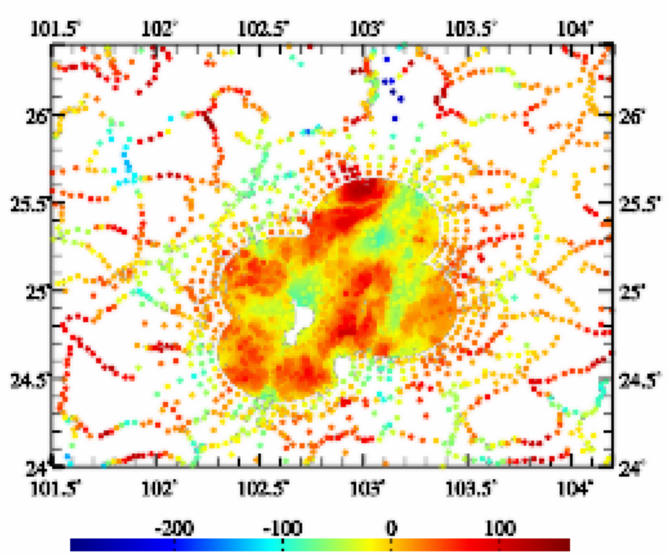
Extract data to be plot | Plot→

SRBF approach algorithms

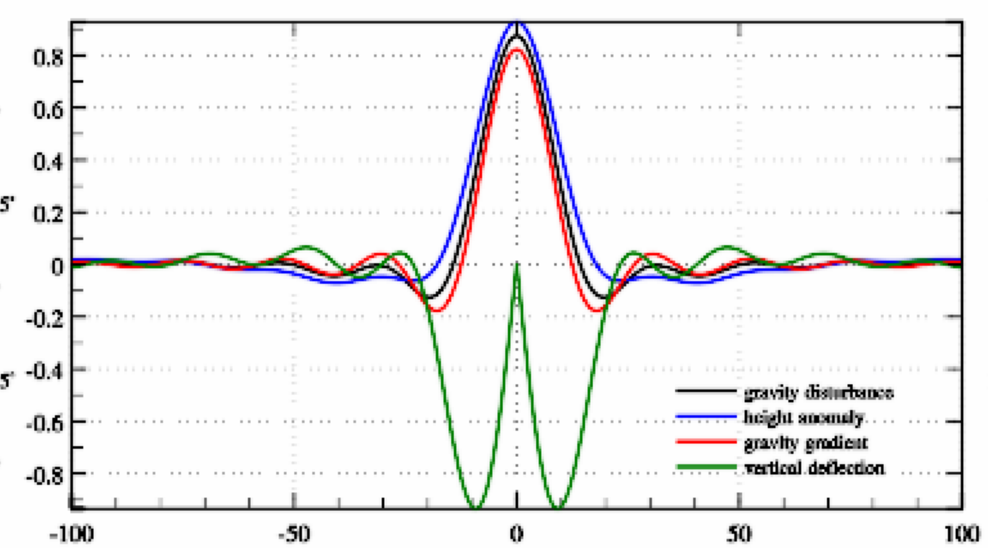
maximum, residual observations mean, standard deviation, minimum, maximum. Record format: point no, longitude, latitude, ellipsoidal height, weight, residual observation, where * is the output file name.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control 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

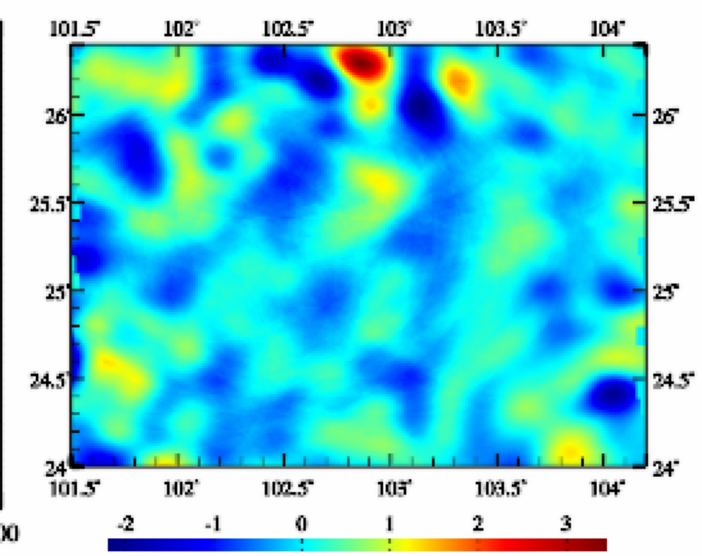
101.500000	104.200000	24.000000	26.400000	8.333333333E-03	8.333333333E-03				
-0.4912	-0.5786	-0.6274	-0.6591	-0.7090	-0.7608	-0.8090	-0.8661	-0.9124	-0.9433
-1.1649	-1.1867	-1.2073	-1.2110	-1.2162	-1.2077	-1.1991	-1.1762	-1.1479	-1.0960
-0.6807	-0.5738	-0.4708	-0.3505	-0.2356	-0.1163	0.0023	0.1311	0.2527	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



observed residual gravity disturbance (mGal)



spherical radial basis function spatial curve

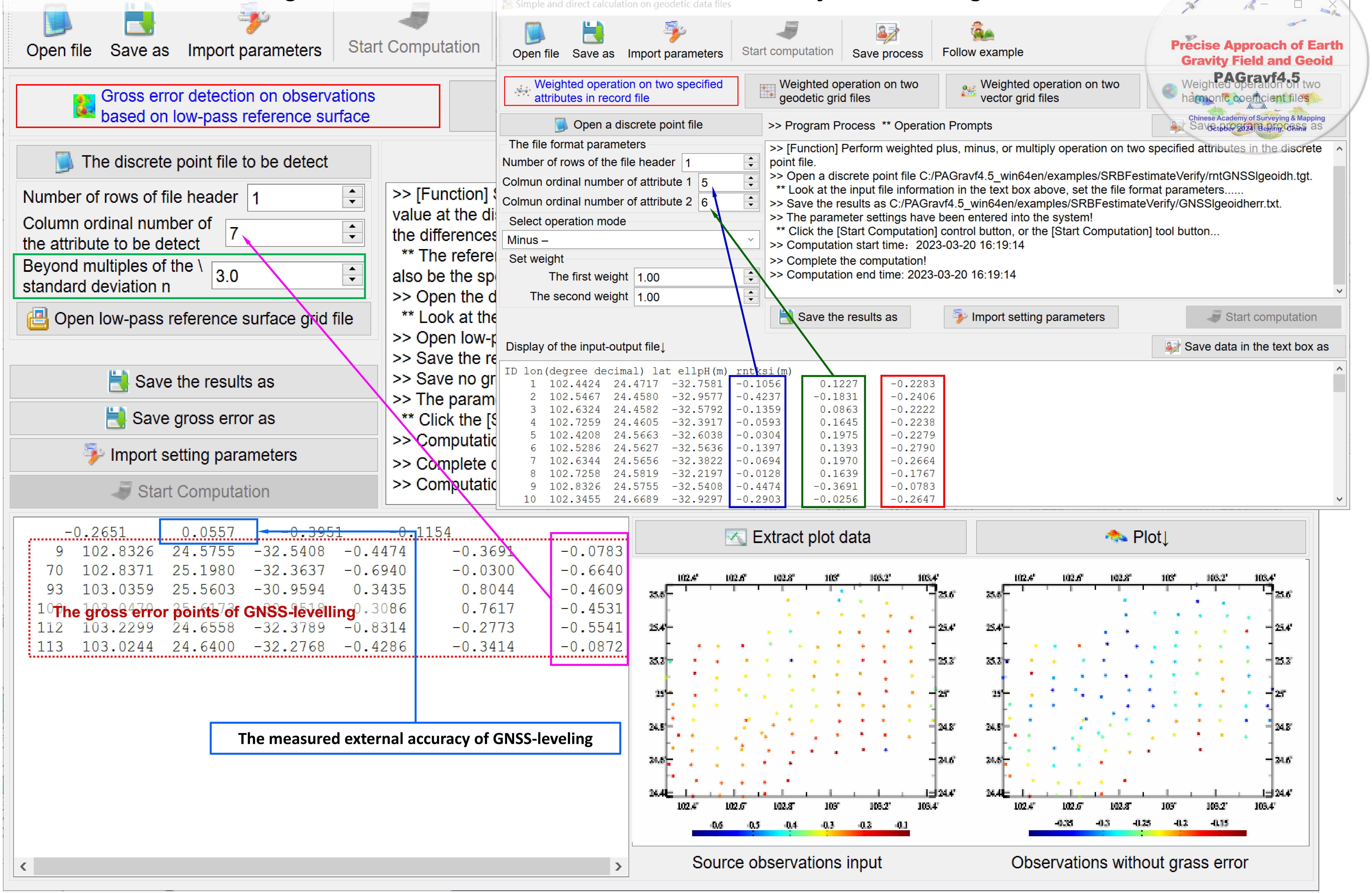


target residual height anomaly (m)

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

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

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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: 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.

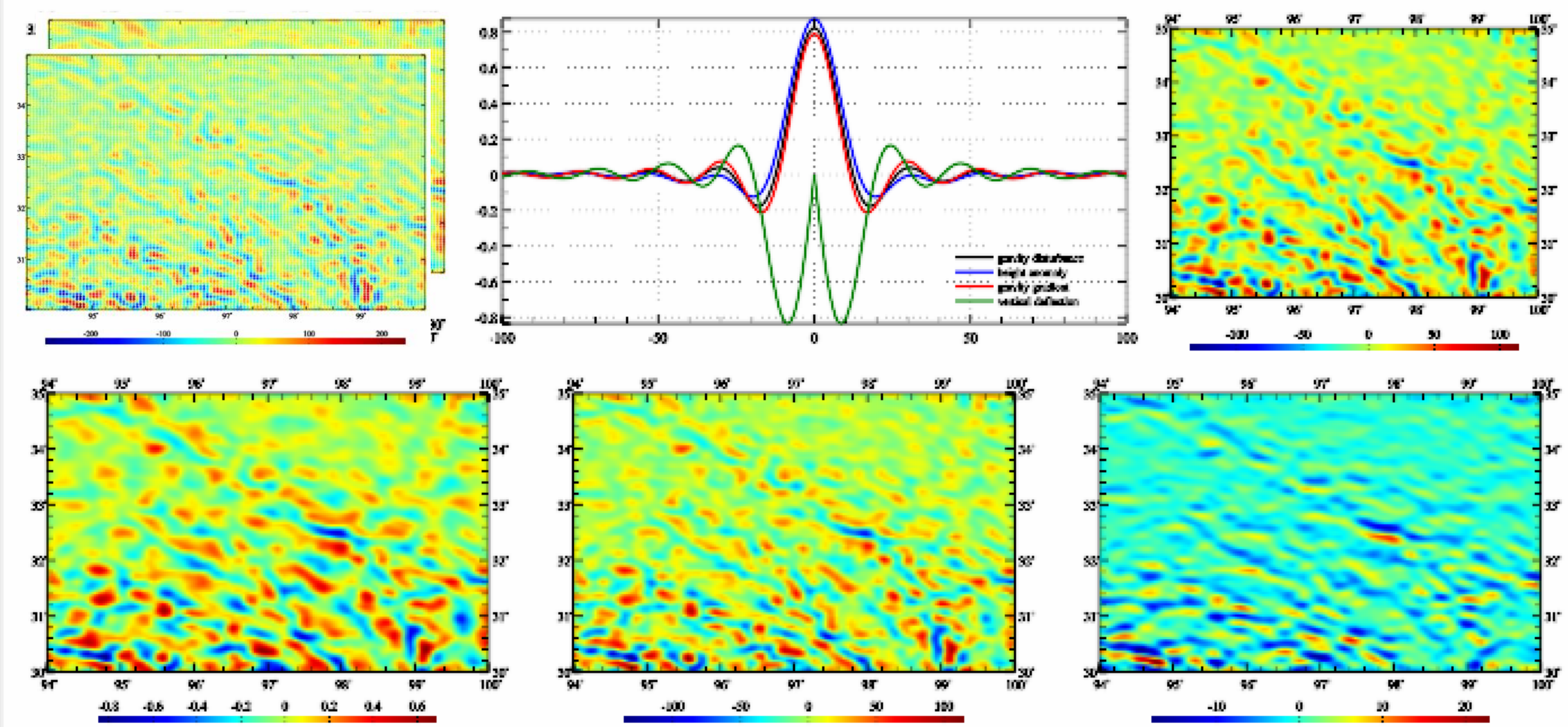
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious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

Extract data to be plot | Plot →

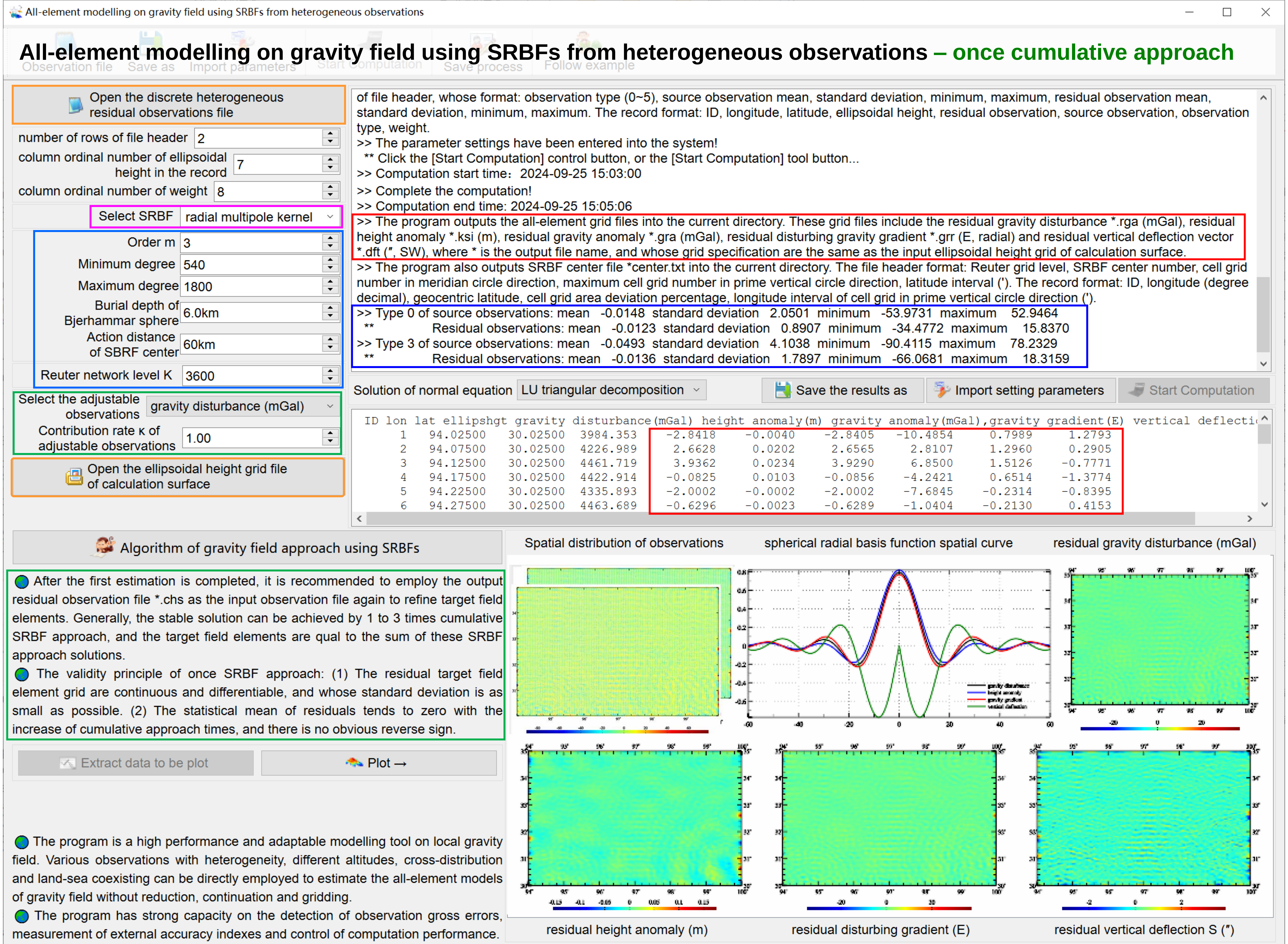
The program is a high performance and adaptable modelling tool on local gravity field. Various observations with heterogeneity, different altitudes, cross-distribution and land-sea coexisting can be directly employed to estimate the all-element models of gravity field without reduction, continuation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

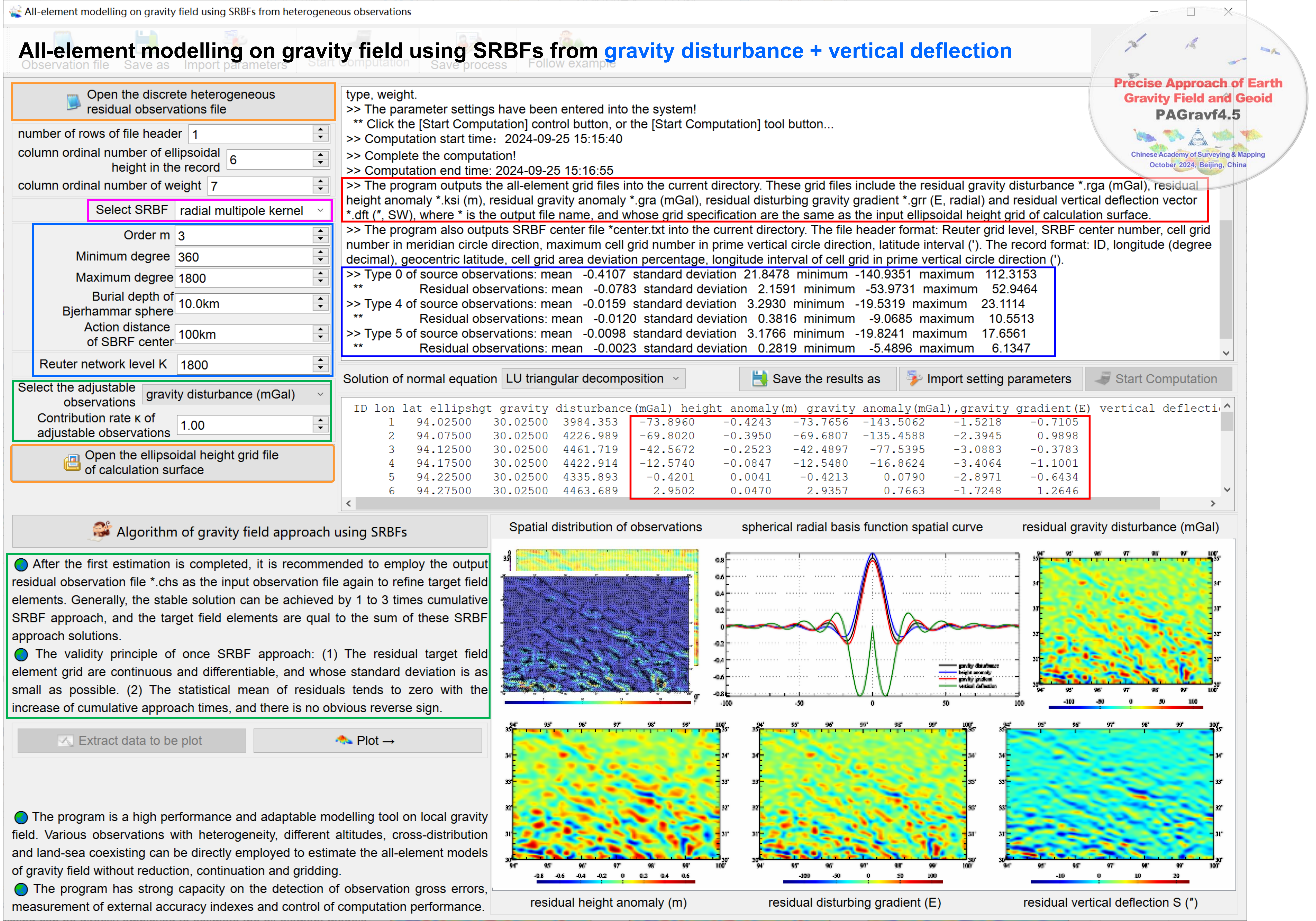
The program has strong capacity on the detection of observation gross errors, measurement of external accuracy indexes and control of computation performance.

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

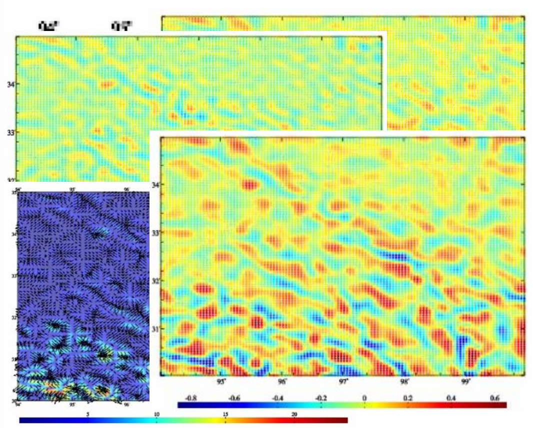
Algorithm of gravity field approach using SRBFs

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.

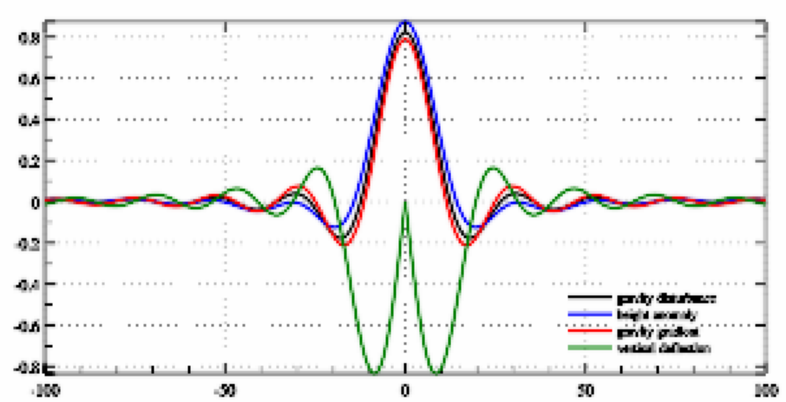
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious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

Extract data to be plot | Plot →

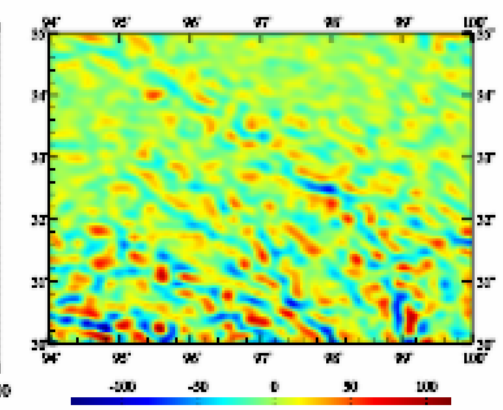
Spatial distribution of observations

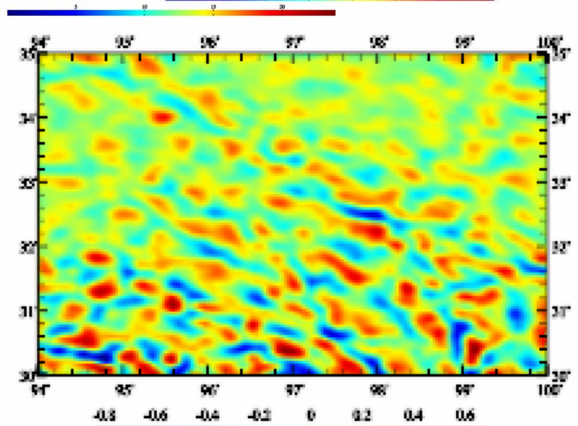


spherical radial basis function spatial curve

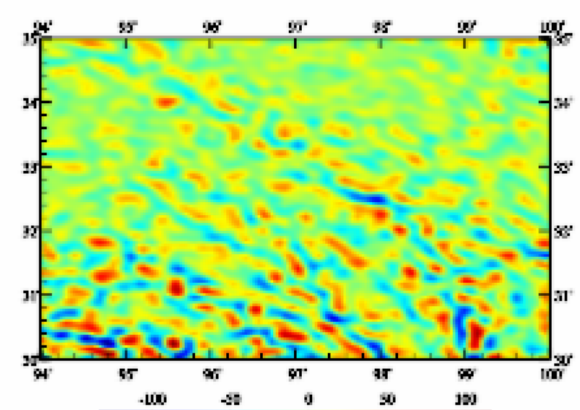


residual gravity disturbance (mGal)

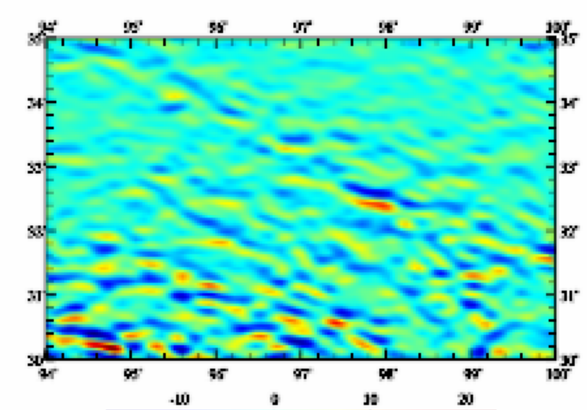




residual height anomaly (m)



residual disturbing gradient (E)



residual vertical deflection S (")

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.

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
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: 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 16:25:00
>> 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

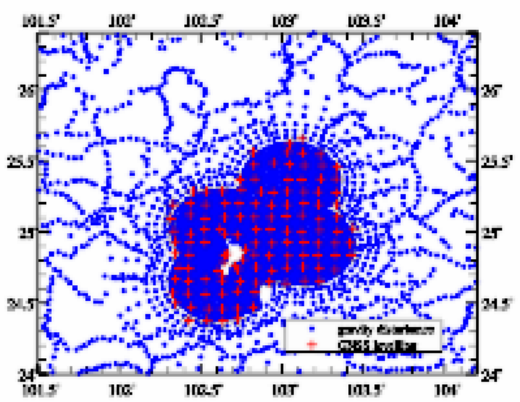
Algorithm of gravity field approach using SRBFs

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.

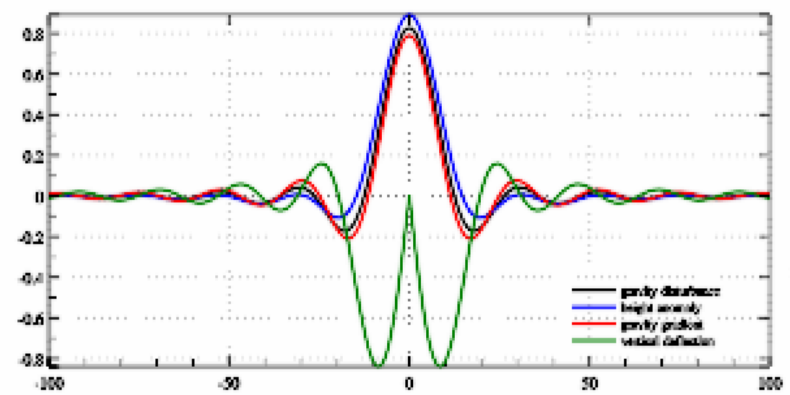
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious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

Extract data to be plot   Plot →

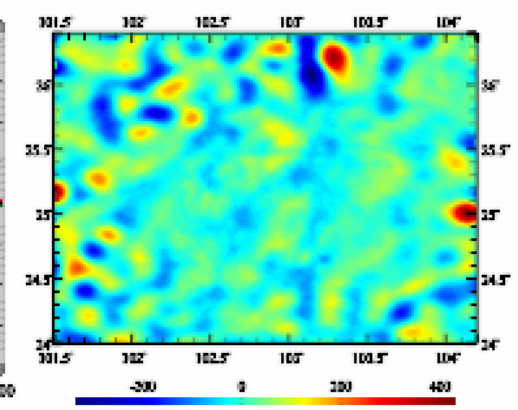
Spatial distribution of observations

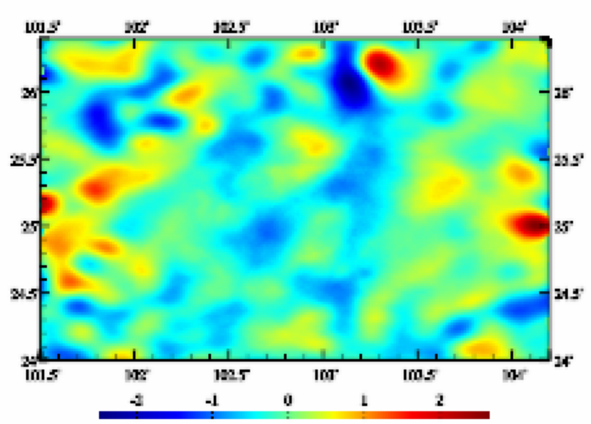


spherical radial basis function spatial curve

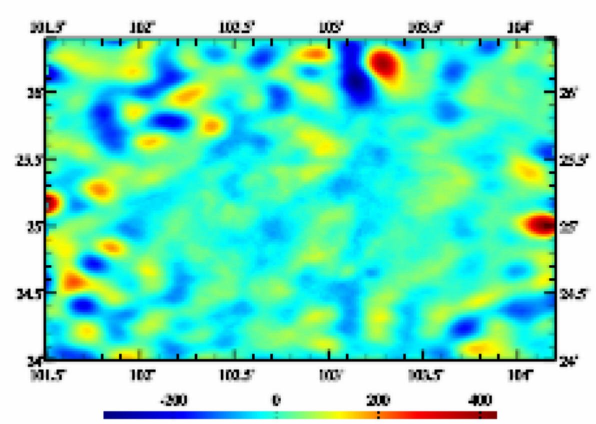


residual gravity disturbance (mGal)

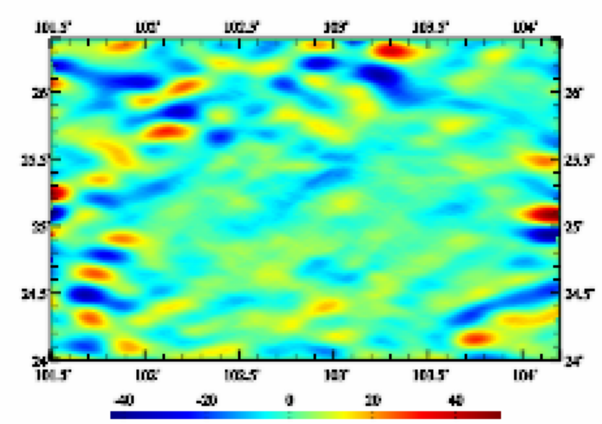




residual height anomaly (m)



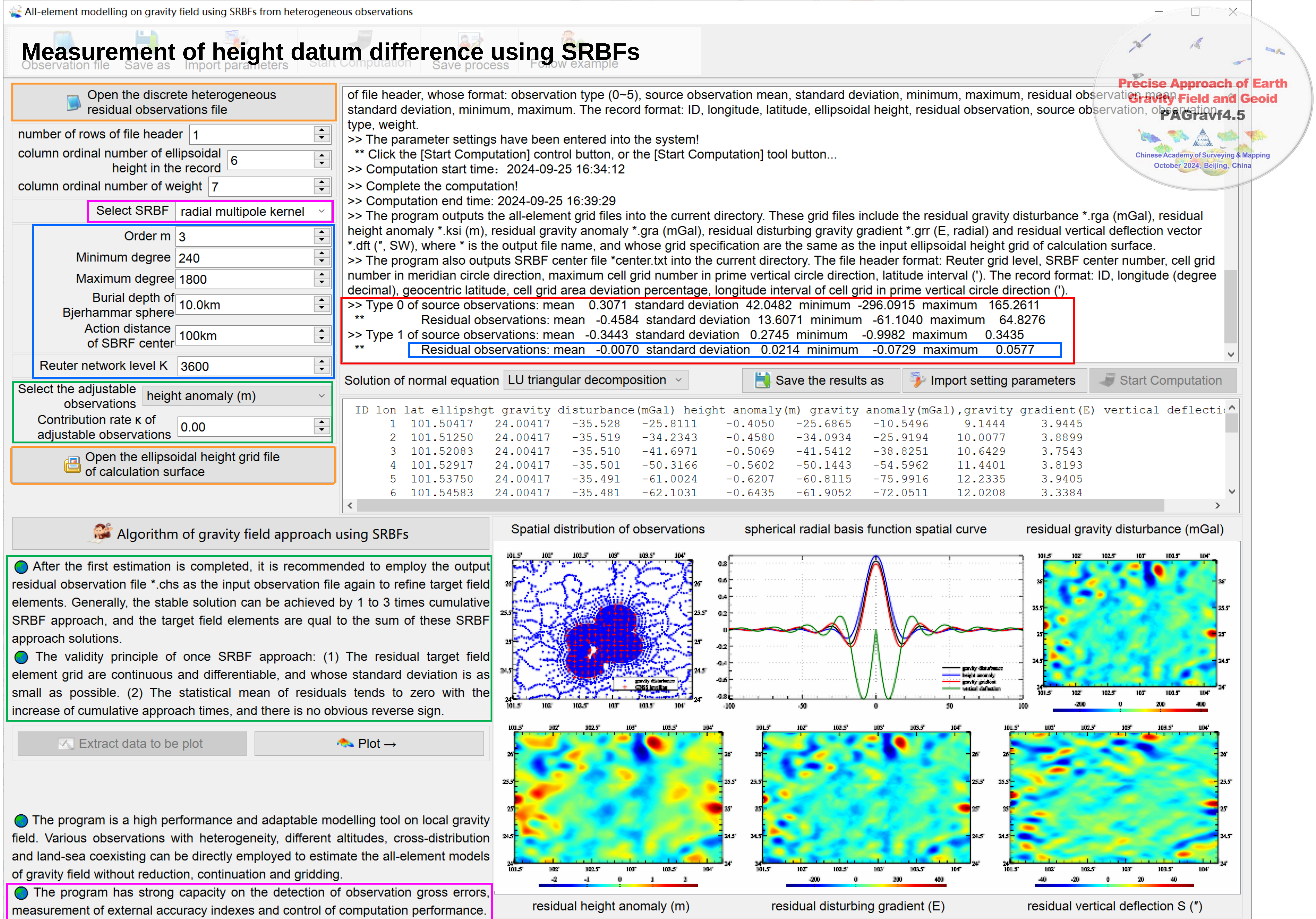
residual disturbing gradient (E)



residual vertical deflection S (″)

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.


All-element modelling on gravity field using SRBFs from heterogeneous observations
Measurement of height datum difference using SRBFs
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 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
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: 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.

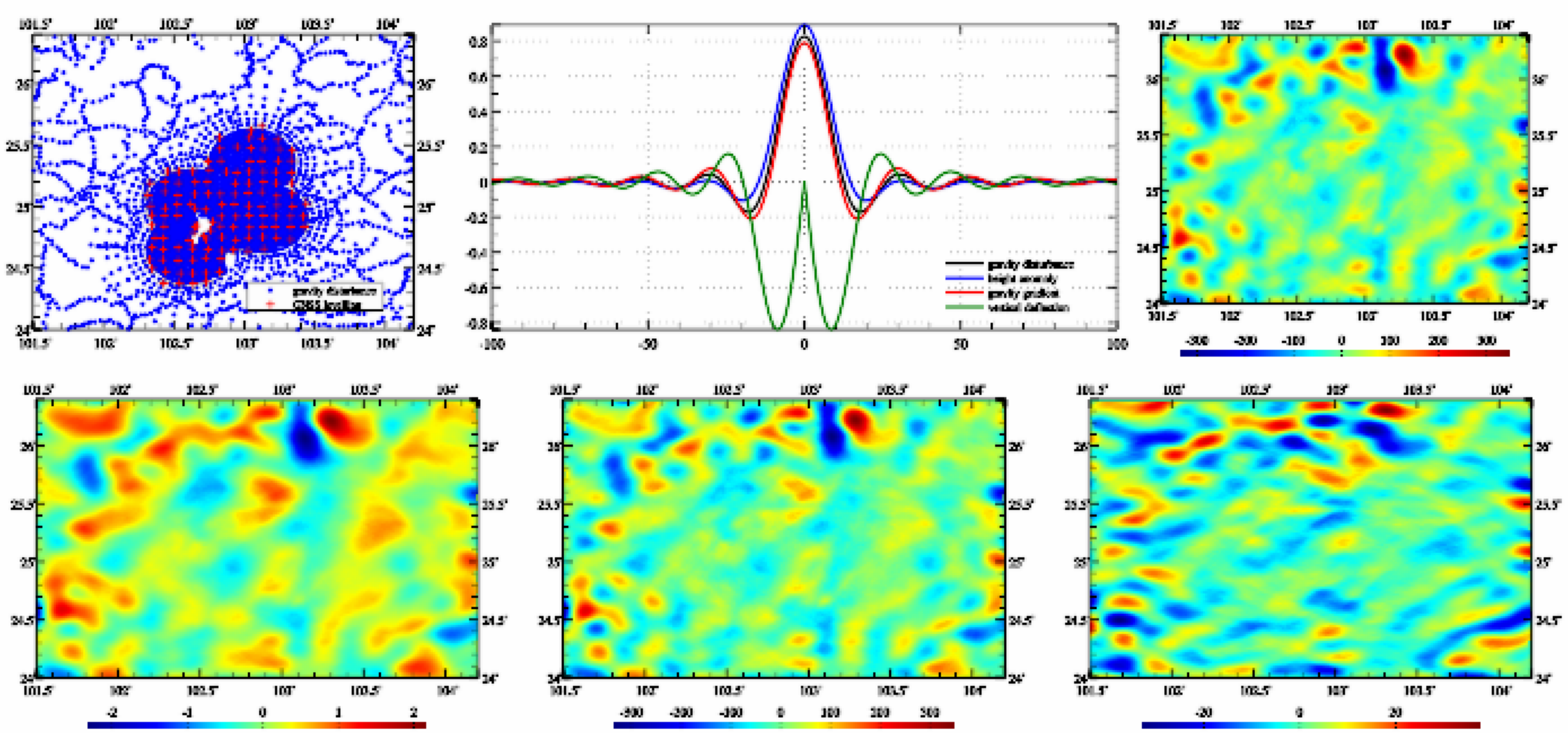
The validity principle of once SRBF approach: (1) The residual target field element grid are continuous and differentiable, and whose standard deviation is as small as possible. (2) The statistical mean of residuals tends to zero with the increase of cumulative approach times, and there is no obvious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

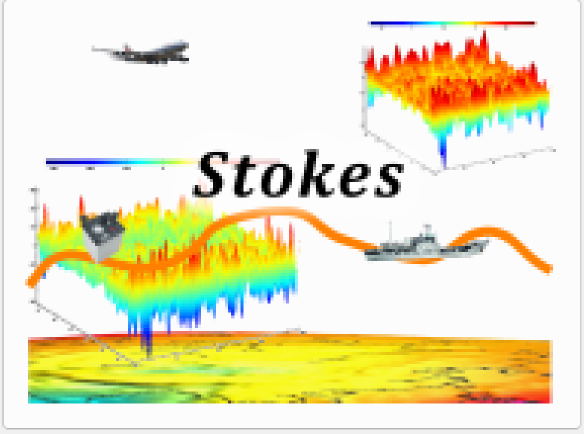
Spatial distribution of observations | spherical radial basis function spatial curve | residual gravity disturbance (mGal)



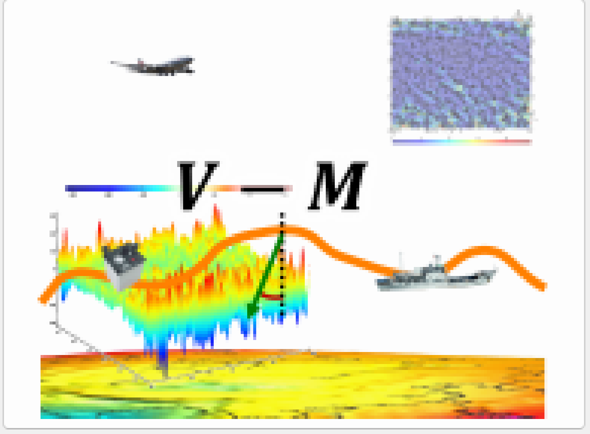
residual height anomaly (m) | residual disturbing gradient (E) | residual vertical deflection S (″)

Precise approach and all-elements modeling of Earth gravity field

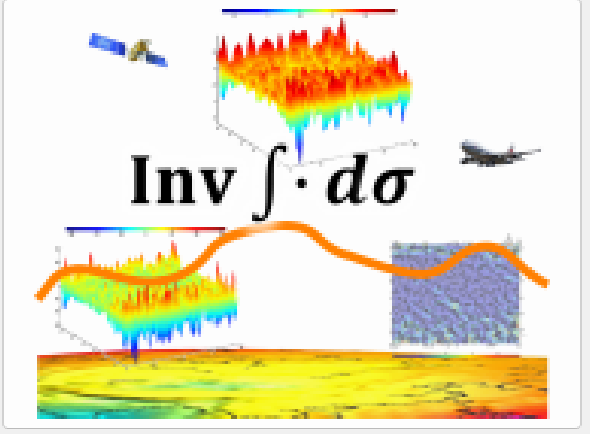
Precise approach and all-element modeling on Earth gravity field



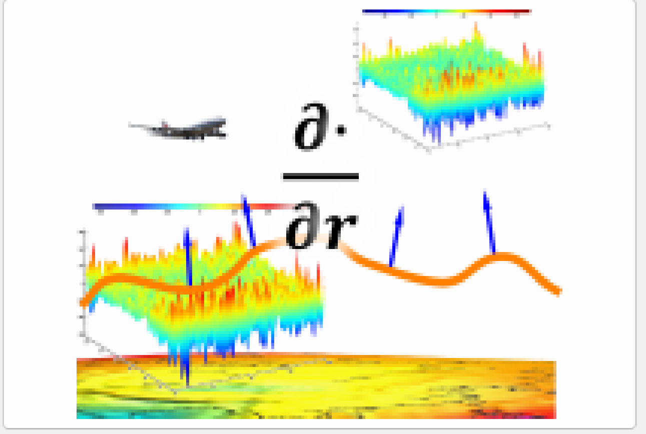
External height anomaly computation using Stokes/Hotine integral



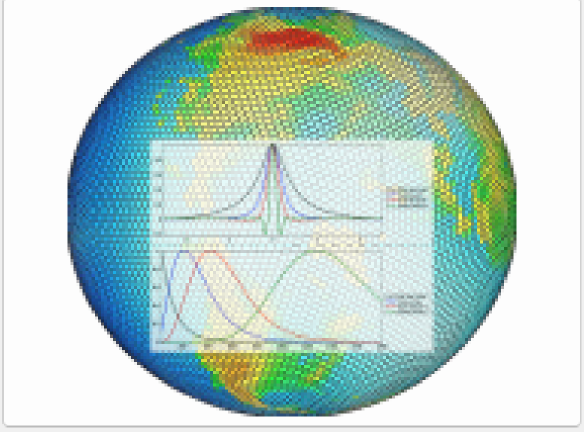
External vertical deflection computation using Vening-Meinesz integral



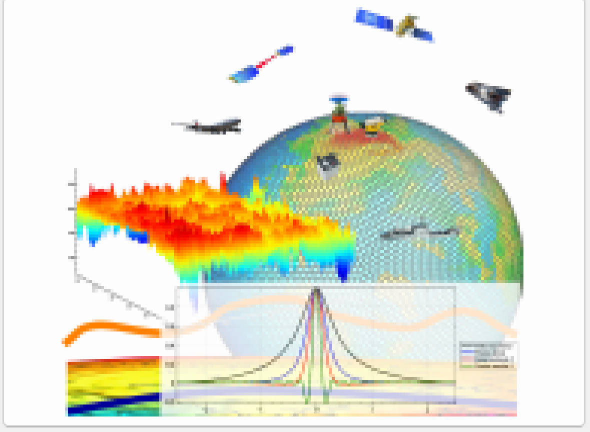
Inverse integral and integral of inverse operation on anomalous field element



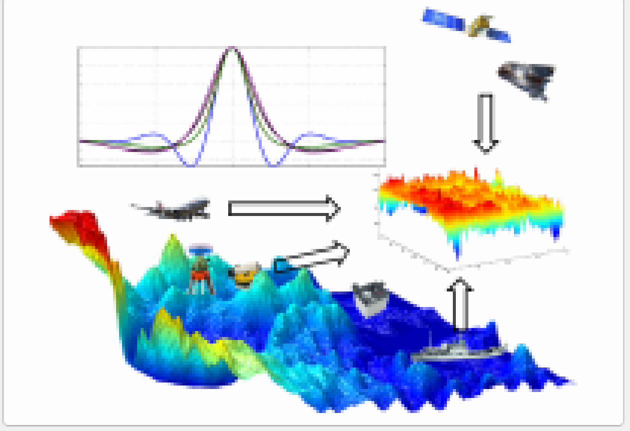
Gradient and Poisson integral computation of external gravity field element



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**
- **All-element modeling on Earth gravity field in whole outer space**
- **Loop closed analytical operations on outer gravity field elements**
- **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.