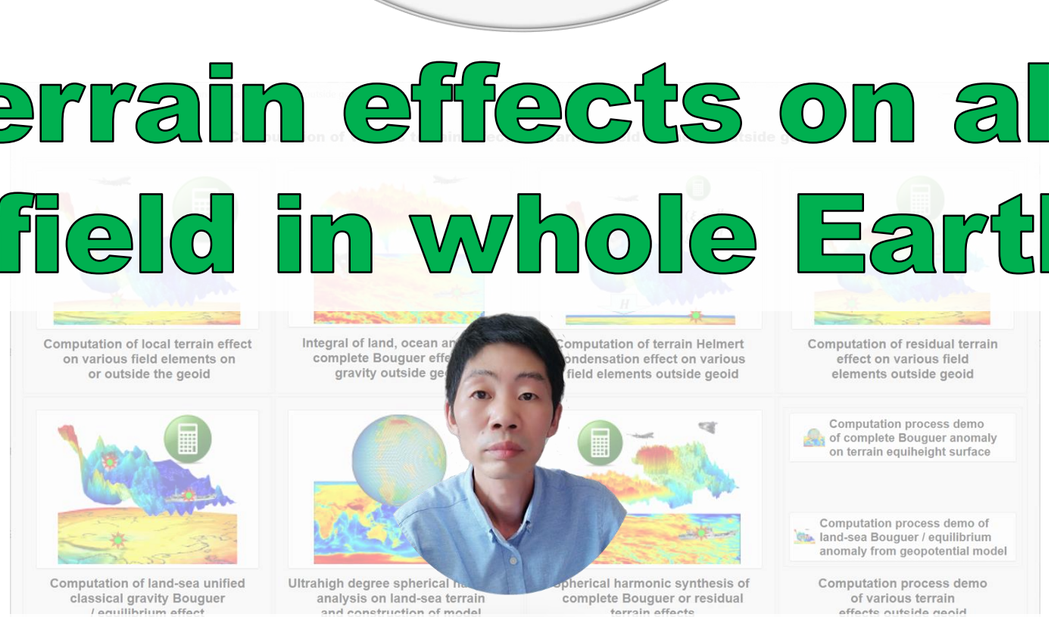
www.zcyphygeodesy.com

Various terrain effects on all-element gravity field in whole Earth space



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

Computation of various terrain effects on various field elements outside geoid

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

- Numerical integral of local terrain effects on various field elements outside geoid
- FFT algorithm of local terrain effects on various gravity field elements outside geoid
- Calculator of local terrain effects on various gravity field elements outside the geoid

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

- Computation of the land-sea unified complete Bouguer effect on gravity outside geoid
- Numerical integral computation of the lake-water complete Bouguer effect on gravity

Computation of residual terrain effect on various field elements outside geoid

- Numerical integral of land-sea residual terrain effects on various gravity field elements
- FFT algorithm of land-sea residual terrain effects on various gravity field elements
- Calculator of land-sea unified residual terrain effect

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

- Numerical integral of terrain Helmert condensation effects on various field elements
- FFT algorithm of terrain Helmert condensation effects on various field elements
- Calculator of terrain Helmert condensation effects on various field elements

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

- Construction of global surface data grid in spherical coordinates
- Ultrahigh degree spherical harmonic analysis of global land-sea terrain model

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

- Integral of land-sea unified classical gravity Bouguer / equilibrium effect
- Calculator of land-sea unified classical gravity Bouguer / equilibrium effect

Computation process demo of various terrain effects outside geoid

- Computation process demo of complete Bouguer anomaly on terrain equiheight surface
- Computation process demo of land-sea Bouguer / equilibrium anomaly from geopotential model

Typical calculation process demo of complete Bouguer effects outside geoid

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

Numerical integral of local terrain effects on various field elements outside geoid

Open DEM Import parameters Save as Start Computation Save process Follow example

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

Numerical integral of local terrain effects on various field elements outside geoid | FFT algorithm of local terrain effects on various field elements outside geoid | Calculator of local terrain effects on various field elements outside geoid | Algorithms of local terrain effect

Open ground digital elevation model file

Open ground ellipsoidal height grid file

Select calculation point file format

discrete calculation point file

Open space calculation point file

Set input point file format

Number of rows of file header 1

Column ordinal number of ellipsoidal height in the record 4

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (")
- [x] disturbing gravity gradient (E, radial)

Extract effects Plot

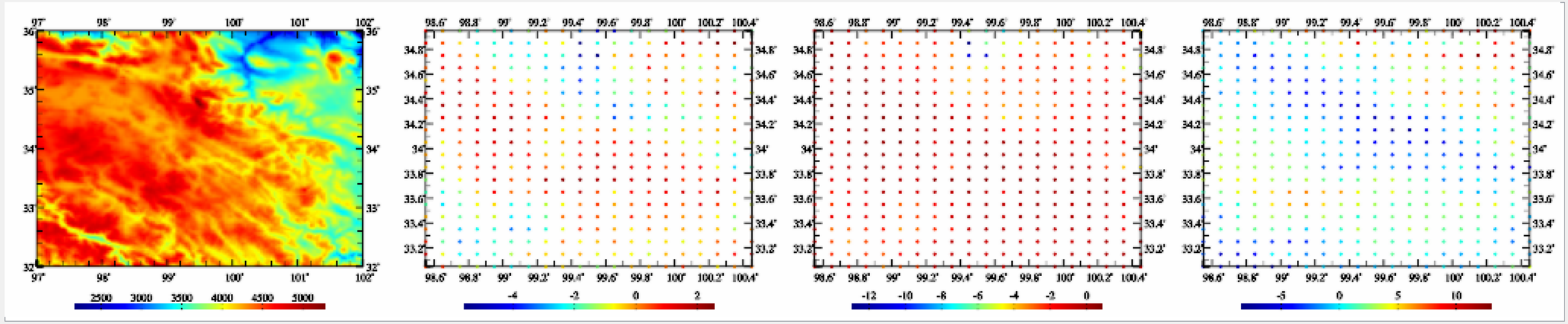
>> Computation Process ** Operation Prompts

Save computation process as

```
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid,
compute the local terrain effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west) or
(disturbing) gravity gradient (E, radial) on or outside the geoid.
  ** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open calculation point position file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfhgt.txt.
  ** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.txt。
  ** Behind the source calculation point file record, appends several columns of local terrain effects on specified types of field elements,
keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button
```

Integral radius 90 km Save the results as Import setting parameters Start Computation

number	long(deg/decimal)	lat	ellipHeight(m)					
1	98.550000	33.050000	4372.431	0.4748	-0.6543	-4.3693	0.2496	1.4964
2	98.650000	33.050000	4372.834	0.6019	-0.3868	-5.4945	-3.2741	0.2816
3	98.750000	33.050000	4530.959	-1.0367	-2.0958	-6.5741	-4.6892	-1.4646
4	98.850000	33.050000	4567.407	-1.0858	-2.0675	-6.9916	-1.1745	22.7751
5	98.950000	33.050000	4646.551	-2.1223	-3.3753	-7.5768	-2.4547	7.9308
6	99.050000	33.050000	4672.380	-2.4157	-2.7630	-4.5712	1.0716	11.8263
7	99.150000	33.050000	4611.765	-2.0435	-2.6243	-0.6258	2.7601	-6.5803



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

- The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
- Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

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

Numerical integral of local terrain effects on various field elements outside geoid

Open DEM Import parameters Save as Start Computation Save process Follow example

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

Numerical integral of local terrain effects on various field elements outside geoid

FFT algorithm of local terrain effects on various field elements outside geoid

Calculator of local terrain effects on various field elements outside geoid

Algorithms of local terrain effect

Open ground digital elevation model file

Open ground ellipsoidal height grid file

Select calculation point file format

ellipsoidal height grid file

Open ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (")
- [x] disturbing gravity gradient (E, radial)

>> Computation Process ** Operation Prompts

Save computation process as

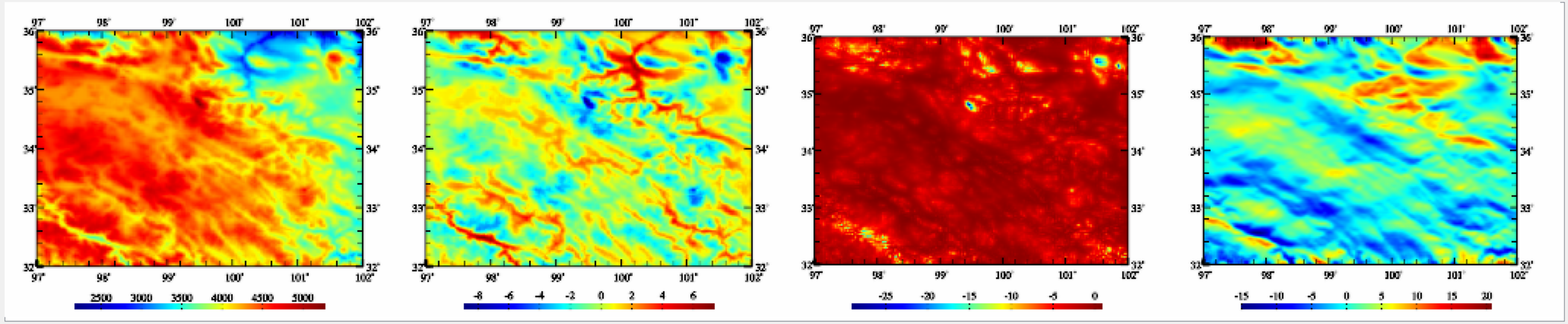
```
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid, compute the local terrain effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west) or (disturbing) gravity gradient (E, radial) on or outside the geoid.
  ** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.dat。
  ** At the same time, the program also outputs the local terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance,*.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the local terrain effect grid files on the specified types of elements.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button
```

Integral radius 90 km

Save the results as Import setting parameters Start Computation

```
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.ksi
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.gra
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.dft
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfnintg.grr
```

Extract effects Plot



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

The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.

Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

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

FFT algorithm of local terrain effects on various gravity field elements outside geoid

Open DEM Import parameters Save as Start Computation Save process Follow example

Numerical integral of local terrain effects on various field elements outside geoid

FFT algorithm of local terrain effects on various field elements outside geoid

Calculator of local terrain effects on various field elements outside geoid

Algorithms of local terrain effect

Open ground digital elevation model file

Open ground ellipsoidal height grid file

Open ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (")
- [x] disturbing gravity gradient (E, radial)

Fast algorithm 2D FFT

>> Computation Process ** Operation Prompts

Save computation process as

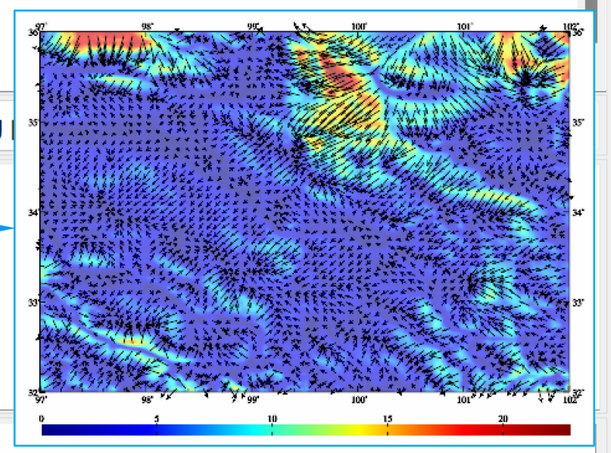
```
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landgeoidhgt.dat.
  ** Look at the file information in the window below, set the input file format parameters...
>> Compute the local terrain effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.txt。
  ** At the same time, the program also outputs the local terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/
disturbance,*.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name
entered from the interface. The program outputs the local terrain effect grid files on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:44:54
```

Integral radius 90 km

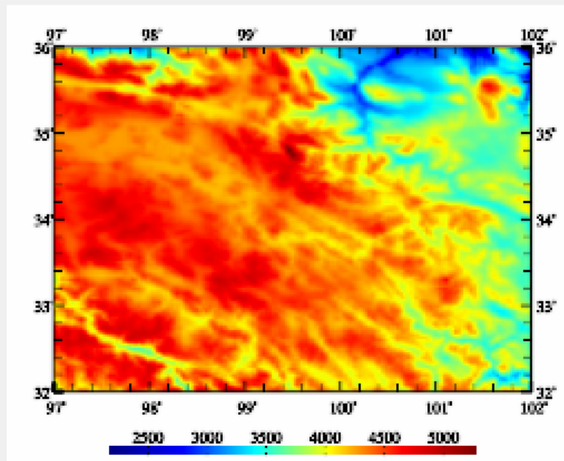
Save the results as

Import setting

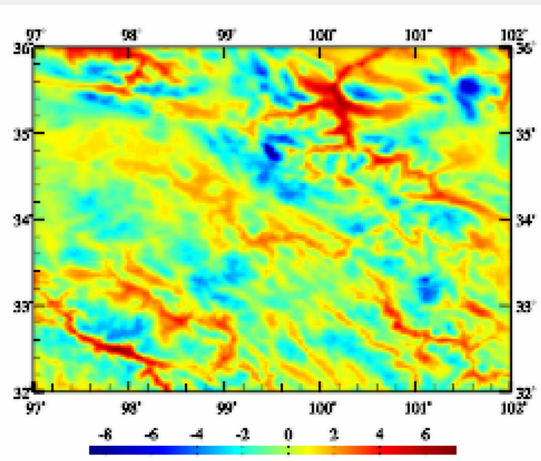
```
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.ksi
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.gra
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.dft
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT2.grr
```



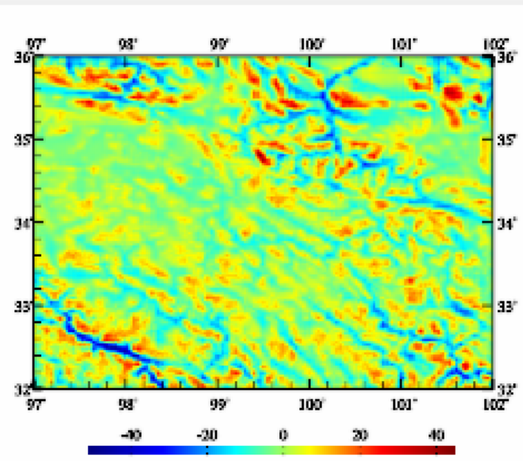
Extract effects Plot



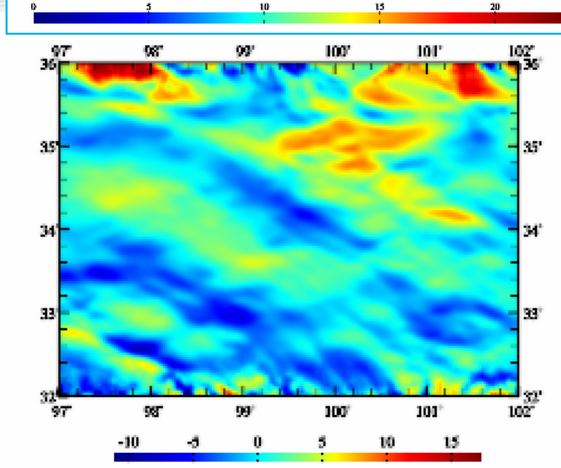
Digital elevation model (m)



height anomaly (m)



gravity (anomaly, mGal)



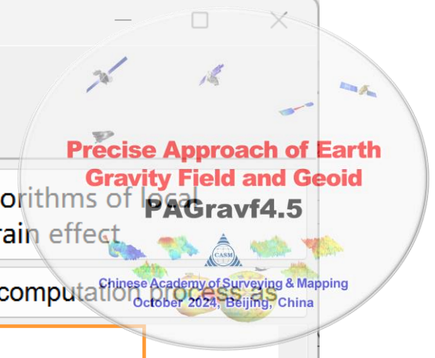
vertical deflection (", S)

- The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
- Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

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

FFT algorithm of local terrain effects on various gravity field elements outside geoid

Open DEM Import parameters Save as Start Computation Save process Follow example



Numerical integral of local terrain effects on various field elements outside geoid

FFT algorithm of local terrain effects on various field elements outside geoid

Calculator of local terrain effects on various field elements outside geoid

Algorithms of local terrain effect

Open ground digital elevation model file

Open ground ellipsoidal height grid file

Open ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [ ] vertical deflection (")
- [x] disturbing gravity gradient (E, radial)

Fast algorithm 1D FFT

>> Computation Process ** Operation Prompts

Save computation process as

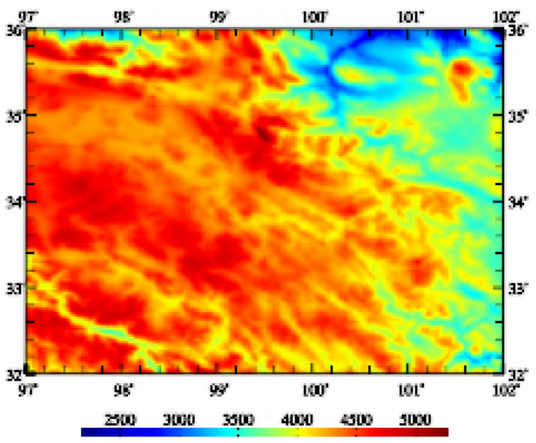
```
>> Open ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landtm1m.dat.
>> Open ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landbmsurfhgt.dat.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/landgeoidhgt.dat.
  ** Look at the file information in the window below, set the input file format parameters...
>> Compute the local terrain effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.txt。
  ** At the same time, the program also outputs the local terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/
disturbance,*.gra), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name
entered from the interface. The program outputs the local terrain effect grid files on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:46:38
```

Integral radius 90 km

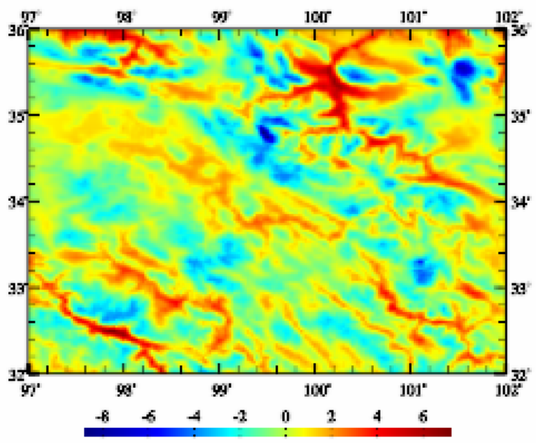
Save the results as Import setting parameters Start Computation

```
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.ksi
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.gra
C:/PAGravf4.5_win64en/examples/TerLocalterraininfl/surfFFT1.grr
```

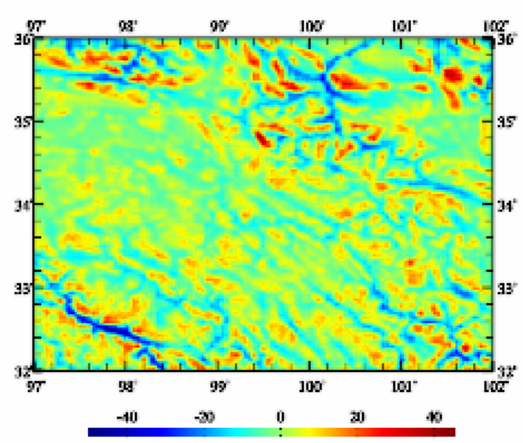
Extract effects Plot



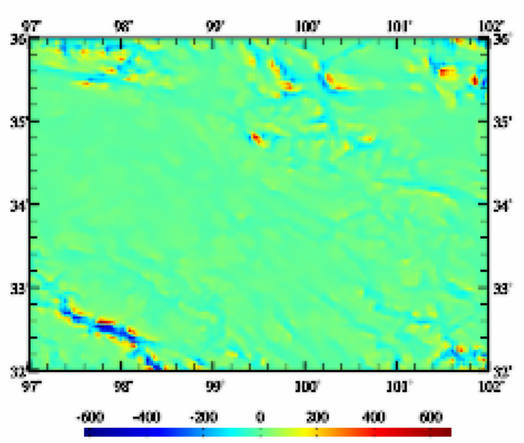
Digital elevation model (m)



height anomaly (m)



gravity (anomaly, mGal)



(disturbing) gradient (E, R)

- The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude.
- Within the integral radius of the grid margin of the ground digital elevation model, there is the integral edge effect. The local terrain effect on gravity is approximately equal to the linear Molodensky I term. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

Calculator of local terrain effects on various gravity field elements outside the geoid

Open ground digital elevation model file

Open ground ellipsoidal height grid file

Input geodetic coordinates of calculation point

longitude 98.240000°

latitude 32.428000°

ellipsoidal height 2017.830m

Integral radius 90 km

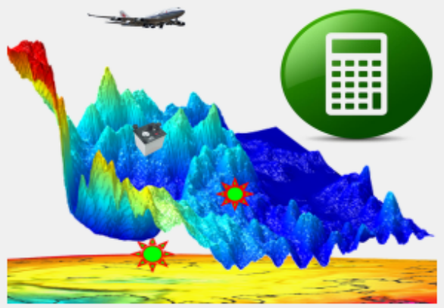
Start calculation

Ground digital elevation model

```
 97.000000  102.000000   32.000000   36.000000  0.01666667  0.01666667
3988.0003   4048.9987   4129.9921   4151.9956   4155.9995   4177.9961   41
4277.9980   4373.9953   4466.9865   4479.9931   4520.9918   4547.9825   44
4242.0005   4229.0008   4211.0001   4165.0054   4150.0047   4157.0059   41
4429.0008   4511.9959   4529.9991   4531.0[illegible]   4539.9993   4531.9988   45
4273.0028   4221.0056   4196.0075               4251.0050   4337.9987   43
4643.9962   4607.0[illegible]   4605.9961           4457.0003   4379.9835   41
4500.0065   4593.9[illegible]                       85.9976   4473.0101   44
4272.0146   4409.0[illegible]                       0046   4729.0038   48
4530.9966   4456.9[illegible]                       42   4071.0117   40
4371.0006   4429.9[illegible]                           4520.9942   44
3868.0107   3964.9992                                   4124.0006   41
4243.0076   4270.0056   43[illegible]                   4347.9933   42
4161.9980   4189.9937   416[illegible]              9926   4040.0077   40
4050.9965   4023.0017   4012.0[illegible]       5   4171.9934   4235.0039   43
4051.0030   4022.0027   3977.0121   4029.9996   4032.9988   3996.0025   39
4299.0025   4415.9991   4516.9921   4514.9967   4458.0037   4431.9971   43
3672.0205   3912.9978   4073.9952   4159.0051   4313.9938   4374.9940   43
4389.9975   4386.9989   4385.9985   4382.9967   4358.9980   4337.9925   42
4185.9964   4135.0004   4099.9998   4073.9998   4073.9986   4110.9920   41
```

Local terrain effect calculation results

height anomaly (m)	-0.1400	gravity (anomaly/disturbance, mGal)	-0.8197
vertical deflection (", S)	-7.0751	vertical deflection (", W)	-0.6231
(disturbing) gradient (E, radial)	17.4820		



- Inputting the ground digital elevation model (standing for terrain relief) and ground geodetic ellipsoidal height grid (standing for the terrain surface location) files with the same grid specifications, the [Start Calculation] button becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the local terrain effects on various field elements at the calculation point can be computed and displayed in time.
- The program allows to replace the ground digital elevation model and the ground ellipsoidal height grid file at any time from the interface, or to change the integral radius, and these user inputs will take effect at once.
- The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

Calculator of local terrain effects on various gravity field elements outside the geoid

Open ground digital elevation model file

Open ground ellipsoidal height grid file

Input geodetic coordinates of calculation point

longitude 100.240000°

latitude 34.428000°

ellipsoidal height 201.830m

Integral radius 90 km

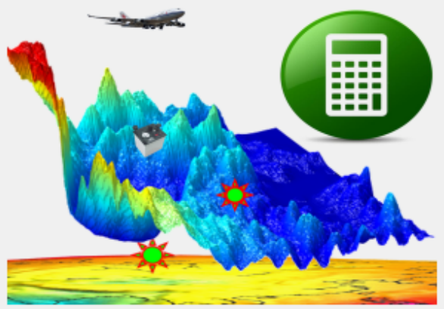
Start calculation

Ground digital elevation model

97.000000	102.000000	32.000000	36.000000	0.01666667	0.01666667	
3988.0003	4048.9987	4129.9921	4151.9956	4155.9995	4177.9961	41
4277.9980	4373.9953	4466.9865	4479.9931	4520.9918	4547.9825	44
4242.0005	4229.0008	4211.0001	4165.0054	4150.0047	4157.0059	41
4429.0008	451[illegible].9959	4529.9991	4531.0014	4539.9993	4531.9988	45
4273.0028	422[illegible].0056	4196.0075	4196.0093	4251.0050	4337.9987	43
4643.9962	460[illegible].0004	4605.9961	458[illegible].9986	4457.0003	4379.9835	41
4500.0065	459[illegible].9997	4650.995[illegible]	46[illegible]89	4585.9976	4473.0101	44
4272.0146	440[illegible].0057	4543[illegible]	45[illegible]1	4647.0046	4729.0038	48
4530.9966	445[illegible]	4[illegible]	[illegible]	4160.0042	4071.0117	40
4371.0006	442[illegible]	[illegible]	[illegible]	4493.9994	4520.9942	44
3868.0107	396[illegible]	[illegible]	[illegible]	[illegible]066.[illegible]037	4124.0006	41
4243.0076	427[illegible]	[illegible]	[illegible]	[illegible]6	4347.9933	42
4161.9980	4189.9[illegible]	[illegible]	[illegible]	[illegible]6	4040.0077	40
4050.9965	4023.001[illegible]	[illegible]	[illegible]	[illegible]934	4235.0039	43
4051.0030	4022.0027	[illegible]	[illegible]	[illegible]9988	3996.0025	39
4299.0025	4415.9991	43[illegible]	[illegible]	4458.0037	4431.9971	43
3672.0205	3912.9978	407[illegible]	4159.0051	4313.9938	4374.9940	43
4389.9975	4386.9989	4385.9[illegible]5	4382.9967	4358.9980	4337.9925	42
4185.9964	4135.0004	4099.9998	4073.9998	4073.9986	4110.9920	41

Local terrain effect calculation results

height anomaly (m)	2.3837	gravity (anomaly/disturbance, mGal)	-12.3434
vertical deflection (", S)	3.5957	vertical deflection (", W)	5.5401
(disturbing) gradient (E, radial)	-23.6988		



- Inputting the ground digital elevation model (standing for terrain relief) and ground geodetic ellipsoidal height grid (standing for the terrain surface location) files with the same grid specifications, the [Start Calculation] button becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the local terrain effects on various field elements at the calculation point can be computed and displayed in time.
- The program allows to replace the ground digital elevation model and the ground ellipsoidal height grid file at any time from the interface, or to change the integral radius, and these user inputs will take effect at once.
- The calculation point may be on the geoid or in near-Earth space, that is, from the geoid to the aviation altitude. There are local terrain effects in the coastal sea area, and that in the deep ocean area are equal to zero.

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

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - Numerical integral

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid

Numerical integral computation of the lake-water complete Bouguer effect on gravity

Formulas of land-sea unified complete Bouguer effect

Open the land-sea terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Select calculation point file format

discrete calculation point file

Open the calculation point location file

Set input point file format

Number of rows of file header 1

Column ordinal number of ellipsoidal height in the record 4

>> Computation Process ** Operation Prompts

Save computation process as

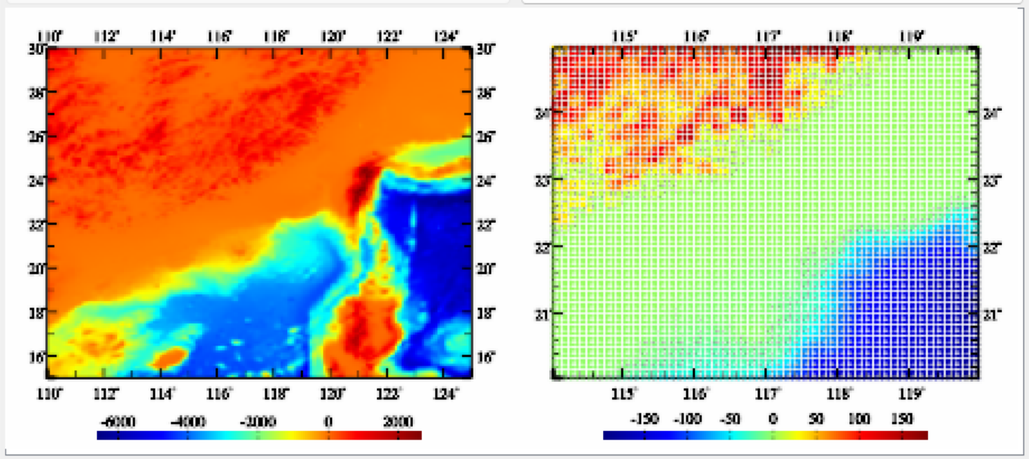
```
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file
of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
  ** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/surfhgt.txt.
  ** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/bgpnt.txt.
>> Behind the source calculation point file record, appends the local terrain effect, spherical Bouguer effect and sea-water complete Bouguer
effect, and keep 4 significant figures.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:06:54
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:07:03
```

Land integral radius 90 km Sea integral radius 300 km

Save the results as | Import setting parameters | Start Computation

lon	lat	hgt				
10849	114.041667	20.041667	2.5061	0.0000	0.0000	-4.9874	-4.987
10850	114.125000	20.041667	2.8389	0.0000	0.0000	-5.7603	-5.760
10851	114.208333	20.041667	3.1673	0.0000	0.0000	-6.1912	-6.191
10852	114.291667	20.041667	3.4899	0.0000	0.0000	-5.7768	-5.776
10853	114.375000	20.041667	3.8056	0.0000	0.0000	-5.3795	-5.379
10854	114.458333	20.041667	4.1136	0.0000	0.0000	-5.3887	-5.388
10855	114.541667	20.041667	4.4137	0.0000	0.0000	-5.7310	-5.731
10856	114.625000	20.041667	4.7058	0.0000	0.0000	-6.4732	-6.473
10857	114.708333	20.041667	4.9907	0.0000	0.0000	-7.4594	-7.459
10858	114.791667	20.041667	5.2696	0.0000	0.0000	-10.2158	-10.215
10859	114.875000	20.041667	5.5440	0.0000	0.0000	-14.0367	-14.036
10860	114.958333	20.041667	5.8158	0.0000	0.0000	-17.8961	-17.896
10861	115.041667	20.041667	6.0875	0.0000	0.0000	-26.1346	-26.134
10862	115.125000	20.041667	6.3615	0.0000	0.0000	-31.5650	-31.565
10863	115.208333	20.041667	6.6404	0.0000	0.0000	-33.8370	-33.837
10864	115.291667	20.041667	6.9265	0.0000	0.0000	-33.5514	-33.551
10865	115.375000	20.041667	7.2221	0.0000	0.0000	-33.4861	-33.486

Extract effects | Plot↓



land-sea terrain model (m) complete Bouguer effects (mGal)

The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.

If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.

The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

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

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - Numerical integral

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid

Numerical integral computation of the lake-water complete Bouguer effect on gravity

Formulas of land-sea unified complete Bouguer effect

Open the land-sea terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Select calculation point file format

ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select integral algorithm

numerical integral

>> Computation Process ** Operation Prompts

Save computation process as

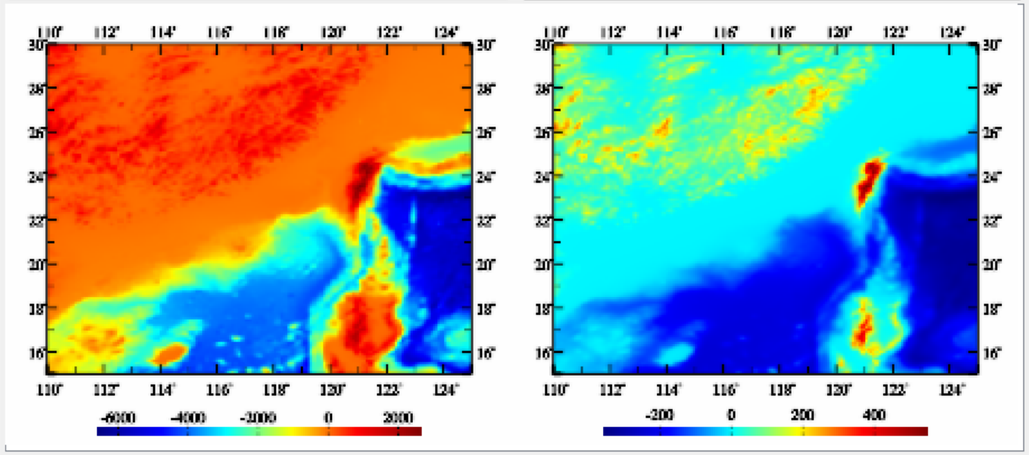
```
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:07:03
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file
of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
  ** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Compute the land-sea unified complete Bouguer effects using numerical integral...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/lndseanintg.dat.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:09:34
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:10:26
```

Land integral radius 90 km | Sea integral radius 300 km

Save the results as | Import setting parameters | Start Computation

110.000000	125.000000	15.000000	30.000000	0.08333333	0.08333333	
-7.8971	-7.8766	-9.1329	-13.9564	-17.1850	-18.6294	-20.8450
-44.6578	-46.2931	-47.8725	-49.2206	-49.7490	-52.1642	-58.2028
-122.3702	-130.1366	-140.1488	-153.4317	-160.9914	-163.4580	-162.3793
-191.4158	-194.5725	-195.9800	-197.2639	-198.6141	-200.3888	-202.6294
-200.4928	-205.5214	-206.6093	-205.9741	-204.5037	-202.9258	-202.5885
-178.2261	-149.0168	-128.2677	-123.2072	-148.5989	-171.0931	-190.9696
-171.9145	-151.3418	-131.5769	-117.4720	-134.9318	-155.1051	-177.0088
-205.7689	-213.4690	-219.2022	-222.2357	-217.2625	-201.2612	-170.7498
-2.2319	37.0377	49.9421	103.4139	109.8637	67.4917	9.9533
107.4283	80.5898	76.5395	-2.8018	-3.8227	-5.0755	-5.0368
-55.8005	-60.4478	-68.3144	-80.9337	-82.7537	-79.9747	-69.3090
-80.1272	-109.2082	-131.7292	-159.3266	-177.3378	-194.1377	-219.8577
-9.7228	-9.3627	-9.8369	-13.9679	-17.8883	-19.5395	-21.4966
-44.6752	-46.2503	-47.7995	-50.0060	-49.1645	-50.0281	-49.0029
-134.8074	-139.8302	-146.6228	-160.3309	-172.5591	-178.2125	-178.0323
-193.4552	-198.5444	-202.4213	-206.8460	-210.7303	-213.6701	-216.0972
-222.1076	-225.8486	-226.2187	-224.2652	-222.6408	-222.4899	-223.7217

Extract effects | Plot↓



land-sea terrain model (m) | complete Bouguer effects (mGal)

The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.

If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.

The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

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

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - FFT integral

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid

Numerical integral computation of the lake-water complete Bouguer effect on gravity

Formulas of land-sea unified complete Bouguer effect

Open the land-sea terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Select calculation point file format

ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select integral algorithm

2D FFT algorithm

>> Computation Process ** Operation Prompts

Save computation process as

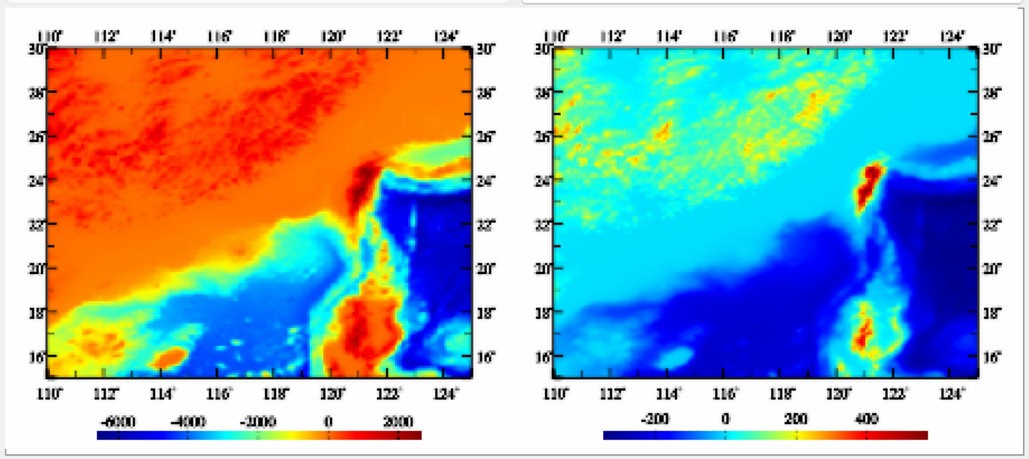
```
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:10:26
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file
of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
  ** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Compute the land-sea unified complete Bouguer effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/lndseaFFT2.dat.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:14:13
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:14:19
```

Land integral radius 90 km Sea integral radius 300 km

Save the results as | Import setting parameters | Start Computation

```
110.000000  125.000000   15.000000   30.000000   0.08333333  0.08333333
    -8.3840     -8.4310     -9.7492    -14.6251    -17.9147    -19.4227    -21.6795
   -46.0804    -47.7576    -49.3916    -50.7882    -51.3851    -53.8891    -59.9925
  -125.7561   -133.7616   -144.0685   -157.5015   -165.2193   -167.7783   -166.8387
  -196.6335   -199.8166   -201.3186   -202.6456   -204.0432   -205.8578   -208.1285
  -206.3994   -211.4598   -212.6164   -212.0782   -210.6699   -209.1409   -208.8170
  -183.9449   -154.6824   -133.6509   -128.7657   -154.2202   -177.0351   -196.9064
  -177.6384   -157.0008   -136.9625   -122.9076   -140.2510   -160.7115   -182.6198
  -211.3937   -218.8423   -224.2816   -227.0769   -221.9265   -205.9211   -175.6084
    -3.9094     36.0852     49.2404    103.5004    110.1038     67.2428     8.8891
   107.7201     80.4641     76.8699     -4.1631     -5.4744     -6.7966    -6.8071
   -58.3003    -63.0309    -71.0464    -83.7201    -85.6414    -82.8324    -72.1778
   -83.4268   -112.8950   -135.9738   -163.8406   -182.2737   -199.3464   -224.3924
   -10.2471     -9.9652    -10.5049    -14.6940    -18.6774    -20.3997    -22.3998
   -46.1861    -47.8194    -49.4312    -51.6749    -50.9006    -51.7915    -50.7816
  -138.4751   -143.8311   -150.9153   -164.7942   -177.1894   -182.9933   -182.9549
  -198.9392   -204.1574   -208.1467   -212.6239   -216.5529   -219.5346   -221.9885
  -228.5733   -232.2644   -232.7040   -230.8908   -229.3755   -229.2764   -230.5019
```

Extract effects | Plot↓



land-sea terrain model (m) complete Bouguer effects (mGal)

The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.

If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.

The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

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

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid - FFT integral

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

Computation of the land-sea unified complete Bouguer effect on gravity outside geoid

Numerical integral computation of the lake-water complete Bouguer effect on gravity

Formulas of land-sea unified complete Bouguer effect

Open the land-sea terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Select calculation point file format

ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select integral algorithm

1D FFT algorithm

>> Computation Process ** Operation Prompts

Save computation process as

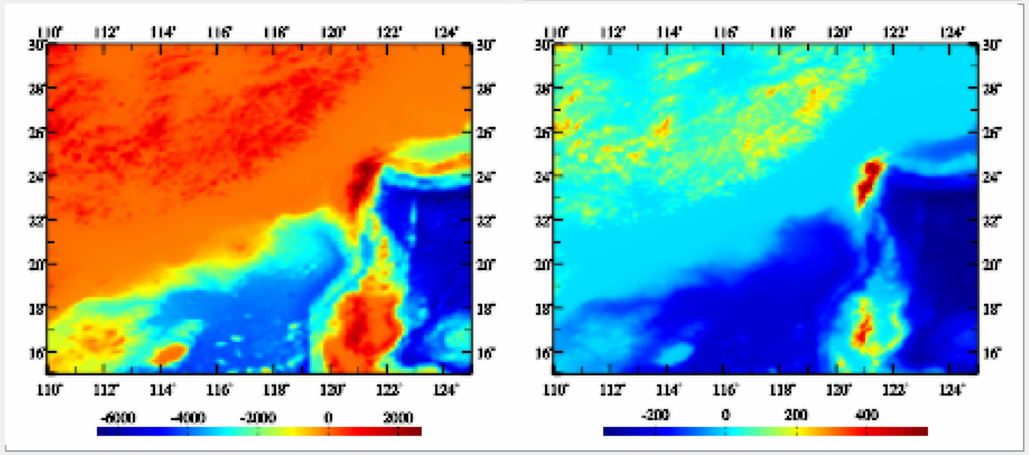
```
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:14:19
>> [Function] Using the rigorous numerical integral method or FFT algorithm, from the land-sea terrain model and ellipsoidal height grid file
of the land-sea surface, compute the land-sea unified complete Bouguer effect on the gravity (mGal) on the geoid or in near-Earth space.
  ** Input the land-sea terrain model and the ellipsoidal height grid files of the land-sea surface with the same grid specifications...
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dtm5m.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/dbmhgt5m.dat.
>> Compute the land-sea unified complete Bouguer effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/lndseaFFT1.dat.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:15:21
>> Complete computation of the land-sea unified complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:15:35
```

Land integral radius 90 km Sea integral radius 300 km

Save the results as | Import setting parameters | Start Computation

110.000000	125.000000	15.000000	30.000000	0.08333333	0.08333333	
-8.2859	-8.2979	-9.5859	-14.4386	-17.6973	-19.1729	-21.4192
-45.5102	-47.1726	-48.7790	-50.1541	-50.7128	-53.1583	-59.2286
-123.6301	-131.4323	-141.4338	-154.6832	-162.1845	-164.6695	-163.6497
-192.5911	-195.6108	-197.0458	-198.3330	-199.6909	-201.4540	-203.7060
-202.1460	-207.0358	-208.1123	-207.5622	-206.1675	-204.6629	-204.3039
-180.3762	-151.5508	-130.9900	-125.9695	-151.2787	-173.5002	-193.1195
-174.2465	-153.8247	-134.2208	-120.1139	-137.5049	-157.4718	-179.0607
-206.9287	-214.2794	-219.6096	-222.4735	-217.4892	-202.0047	-172.0155
-3.4159	36.5032	49.6341	103.8896	110.4780	67.5950	9.2229
108.0989	80.8370	77.2701	-3.7790	-5.1007	-6.4139	-6.4107
-57.4799	-62.1677	-70.0703	-82.7109	-84.5577	-81.8098	-71.1878
-82.0921	-111.1265	-133.5695	-161.0260	-178.8618	-195.2426	-219.8860
-10.1361	-9.8124	-10.3213	-14.4839	-18.4358	-20.1202	-22.1095
-45.5731	-47.1780	-48.7561	-50.9909	-50.1816	-51.0756	-50.0823
-136.0776	-141.1197	-147.9200	-161.5592	-173.7014	-179.3393	-179.1977
-194.5959	-199.6421	-203.4520	-207.8225	-211.6475	-214.5354	-216.9526
-223.4237	-227.0499	-227.4504	-225.6176	-224.1094	-224.0079	-225.2122

Extract effects | Plot↓



land-sea terrain model (m) complete Bouguer effects (mGal)

The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.

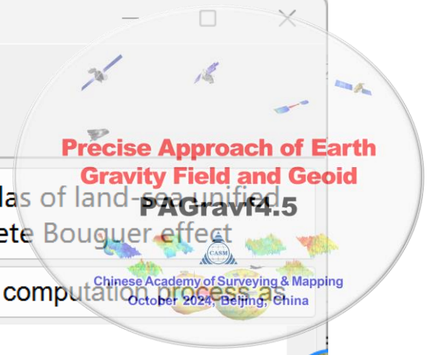
If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.

The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

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

Numerical integral computation of the lake-water complete Bouguer effect on gravity

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example



Computation of the land-sea unified complete Bouguer effect on gravity outside geoid

Numerical integral computation of the lake-water complete Bouguer effect on gravity

Formulas of land-sea unified complete Bouguer effect

Open the lake water-depth grid file

Open the ellipsoidal height grid file of the lake surface

Open the calculation point location file

Set input point file format

Number of rows of file header: 1

Column ordinal number of ellipsoidal height in the record: 4

>> Computation Process ** Operation Prompts

Save computation process as

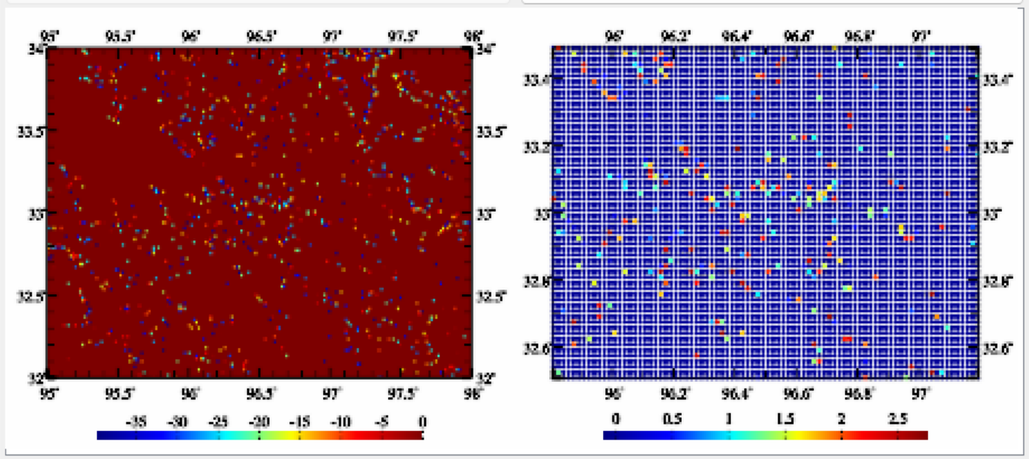
```
>> Computation end time: 2024-09-22 09:15:35
>> [Function] Using the rigorous numerical integral algorith, from the lake water-depth grid (value on land is zero) and ellipsoidal height grid file of the lake surface, compute the lake-water complete Bouguer effect on the gravity (mGal).
>> Open the lake water-depth grid file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/lakedepth.dat.
>> Open the ellipsoidal height grid file of the lake surface C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/lakehgt.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/calcpnt.txt.
  ** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerCompleteBougure/TerLakeseabouginflu/rstlake.txt.
>> Behind the source calculation point file record, appends the lake water complete Bouguer effect, and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 09:17:49
>> Complete computation of the lake-water complete Bouguer effect outside the geoid!
>> Computation end time: 2024-09-22 09:18:08
```

Land integral radius: 90 km

Save the results as | Import setting parameters | Start Computation

Extract effects | Plot↓

no	lon	lat	hgt		
1	95.808333	32.508333	4287.928	0.0074
2	95.825000	32.508333	4393.299	0.0071
3	95.841667	32.508333	4472.533	-0.0030
4	95.858333	32.508333	4455.904	-0.0016
5	95.875000	32.508333	4449.265	-0.0024
6	95.891667	32.508333	4381.011	-0.0010
7	95.908333	32.508333	4330.999	-0.0008
8	95.925000	32.508333	4388.620	-0.0024
9	95.941667	32.508333	4361.609	-0.0021
10	95.958333	32.508333	4261.231	-0.0004
11	95.975000	32.508333	4152.346	0.0012
12	95.991667	32.508333	4138.344	0.0008
13	96.008333	32.508333	4174.044	-0.0005
14	96.025000	32.508333	4193.084	-0.0013
15	96.041667	32.508333	4078.828	-0.0009
16	96.058333	32.508333	3984.327	-0.0007
17	96.075000	32.508333	4052.948	-0.0015
18	96.091667	32.508333	4094.322	-0.0019



lake water-depth grid (m) | complete Bouguer effects (mGal)

The program is suitable for the unified computation of the complete Bouguer effect on gravity, gravity anomaly and gravity disturbance in land, land-sea junction and sea area. The calculation point may be on the geoid or in near-Earth space.

If the ocean water depth in the land-sea terrain model is set to zero, the program automatically computes the land complete Bouguer effect in the near-Earth space. If the terrain height in the land-sea terrain model is set to zero, the program automatically computes the seawater complete Bouguer effect in the near-Earth space.

The complete Bouguer effect here is defined as the variation of Earth gravity field because of the terrain masses above the geoid removed and the seawater density compensated to the terrain density. There is the sea water Bouguer effect in the offshore land area, while there is the local terrain effect in the coastal sea area.

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

Numerical integral of terrain Helmert condensation effects on various field elements

Open DEM Import parameters Save as Start Computation Save process Follow example

Numerical integral of terrain Helmert condensation on various field elements | FFT algorithm of terrain Helmert condensation on various field elements | Calculator of terrain Helmert condensation effects on various field elements | Algorithm formulas

Open the ground digital elevation model file

Open the ground ellipsoidal height grid file

Select calculation point file format

discrete calculation point file

Open the calculation point position file

Set input point file format

Number of rows of file header 1

Column ordinal number of ellipsoidal height in the record 4

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

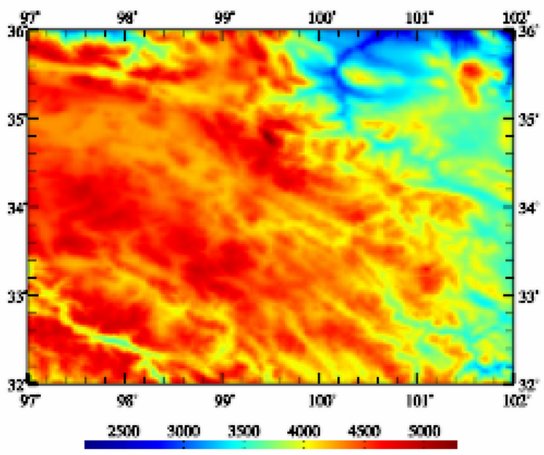
Extract effects Plot↓

>> Computation Process ** Operation Prompts Save computation results

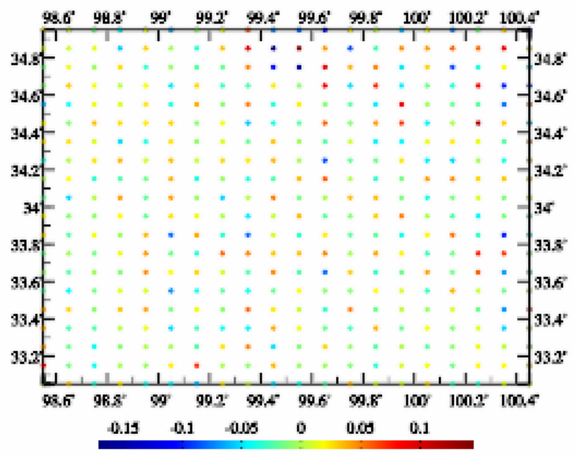
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid, compute the terrain Helmert condensation effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west) or (disturbing) gravity gradient (E, radial) on or outside the geoid.
** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfhgt.txt.
** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/result.txt.
** Record format: Behind the source calculation point file record, appends several columns of the terrain Helmert condensation effects on specified types of field elements, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
** Click the [Start Computation] control button, or the [Start Computation] tool button

Save the results as Import setting parameters Start Computation

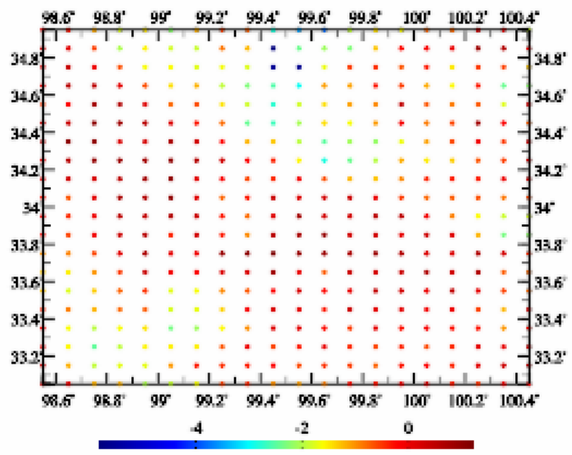
no	lon(deg/decimal)	lat	ellipHeight(m)					
1	98.550000	33.050000	4372.431	0.0056	-0.0969	-8.7481	0.5033	-1.2229
2	98.650000	33.050000	4372.834	0.0347	0.0307	-10.9996	-6.5552	-5.9075
3	98.750000	33.050000	4530.959	-0.0336	-1.1852	-13.1633	-9.3919	5.9238
4	98.850000	33.050000	4567.407	0.0234	-1.1791	-14.0034	-2.3475	-4.6099
5	98.950000	33.050000	4646.551	-0.0401	-2.0462	-15.1799	-4.9229	7.2632
6	99.050000	33.050000	4672.380	-0.0463	-1.9176	-9.1527	2.1447	8.2814
7	99.150000	33.050000	4611.765	-0.0611	-1.6366	-1.2470	5.5278	11.4664
8	99.250000	33.050000	4475.199	0.0232	-0.5479	-1.0704	7.1169	-3.7881



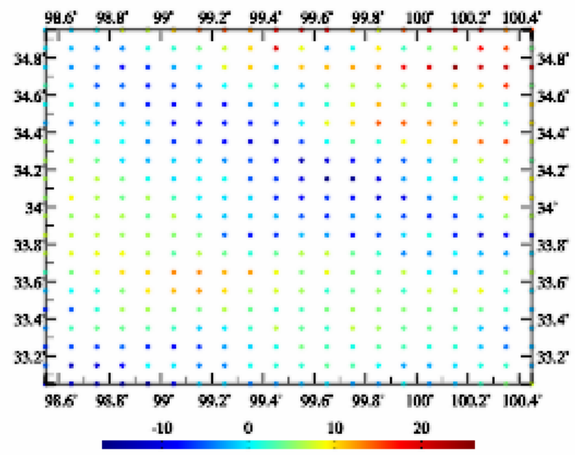
digital elevation model (m)



height anomaly (m)



gravity (anomaly, mGal)



vertical deflection (", S)

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

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

Numerical integral of terrain Helmert condensation effects on various field elements

Open DEM Import parameters Save as Start Computation Save process Follow example

Numerical integral of terrain Helmert condensation on various field elements

FFT algorithm of terrain Helmert condensation on various field elements

Calculator of terrain Helmert condensation effects on various field elements

Algorithm formulas

Open the ground digital elevation model file

Open the ground ellipsoidal height grid file

Select calculation point file format

ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

>> Computation Process ** Operation Prompts

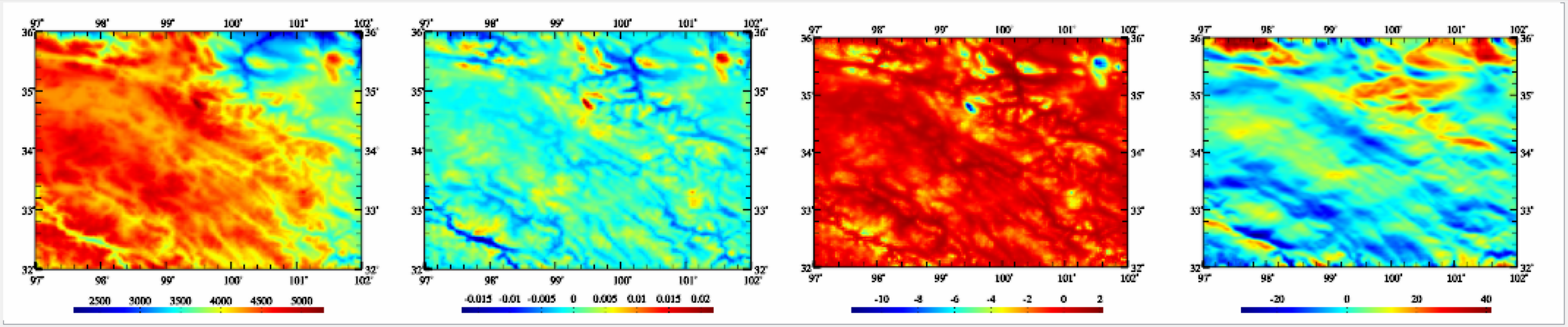
Save computation results

```
>> [Function] Using the rigorous numerical integral algorithm, from the ground digital elevation model and ground ellipsoidal height grid, compute
the terrain Helmert condensation effects on the height anomaly (m), gravity (anomaly/disturbance, mGal), vertical deflection (", to south, to west)
or (disturbing) gravity gradient (E, radial) on or outside the geoid.
  ** Input the ground digital elevation model and ground ellipsoidal height grid file with the same grid specifications...
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/numitng.dat.
  ** At the same time, the program also outputs the terrain Helmert condensation effect  grid files on height anomaly (*.ksi), gravity anomaly (*.gra),
gravity disturbance (*.rga), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name
entered from the interface. The program outputs the terrain Helmert condensation effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button  or the [Start Computation] tool button
```

Save the results as Import setting parameters Start Computation

```
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/numitng.ksi
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/numitng.gra
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/numitng.dft
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/numitng.grr
```

Extract effects Plot↓



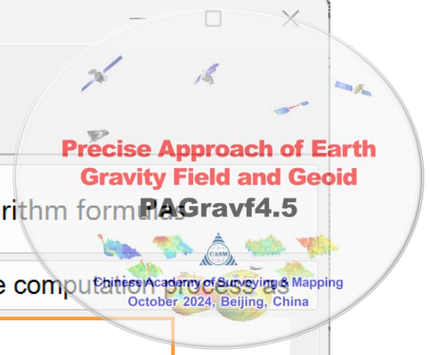
digital elevation model (m) height anomaly (m) gravity (anomaly, mGal) vertical deflection (", S)

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

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

FFT algorithm of terrain Helmert condensation effects on various field elements

Open DEM Import parameters Save as Start Computation Save process Follow example



Numerical integral of terrain Helmert condensation on various field elements

FFT algorithm of terrain Helmert condensation on various field elements

Calculator of terrain Helmert condensation effects on various field elements

Algorithm formulas

Open the ground digital elevation model file

Open the ground ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

>> Computation Process ** Operation Prompts

Save computation results

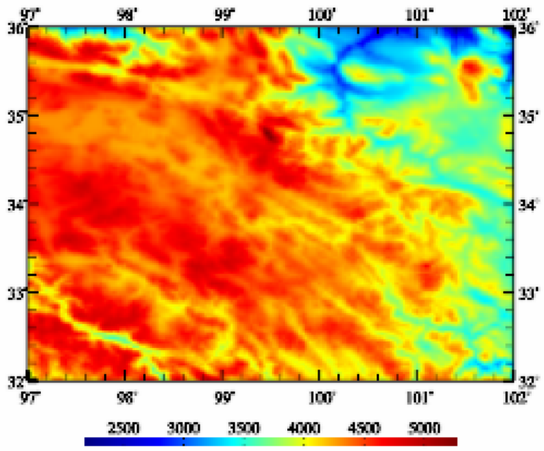
```
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landgeoidhgt.dat.
  ** Look at the file information in the window below, set the input file format parameters...
>> Compute the terrain Helmert condensation effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.txt.
  ** At the same time, the program also outputs the terrain Helmert condensation effect  grid files on height anomaly (*.ksi), gravity anomaly (*.gra), gravity disturbance (*.rga), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name entered from the interface. The program outputs the terrain Helmert condensation effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 11:55:16
>> Complete the computation of terrain Helmert condensation effects!
```

Fast algorithm 2D FFT

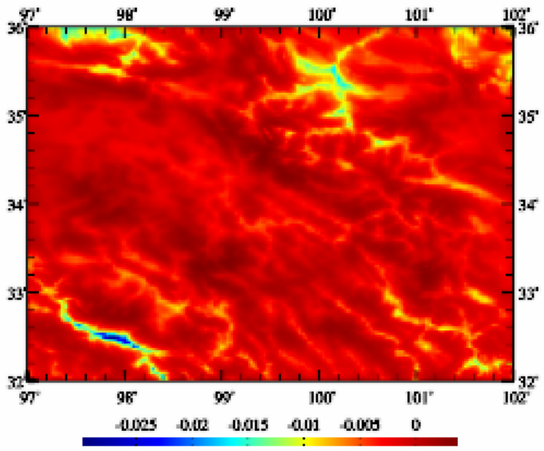
Save the results as Import setting parameters Start Computation

```
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.ksi
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.gra
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.dft
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT2.grr
```

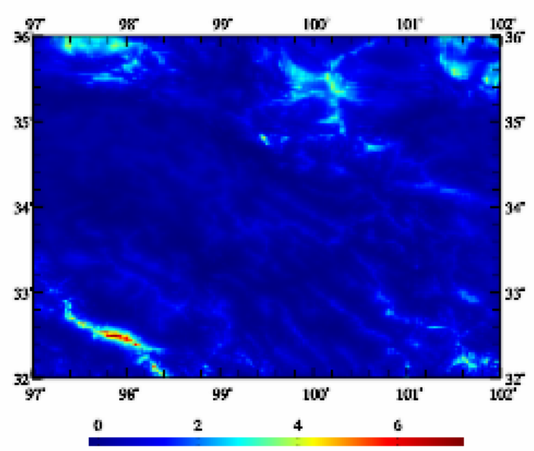
Extract effects Plot↓



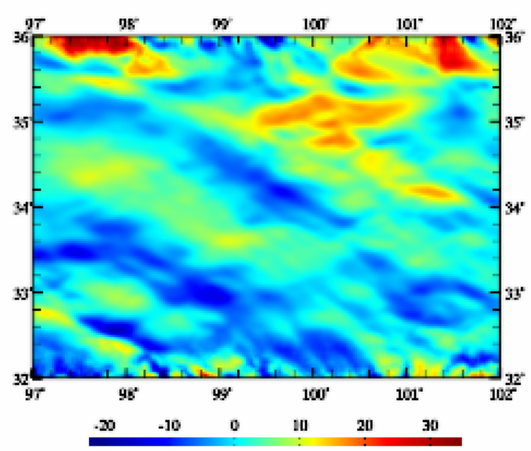
digital elevation model (m)



height anomaly (m)



gravity (anomaly, mGal)



vertical deflection (", S)

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

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

FFT algorithm of terrain Helmert condensation effects on various field elements

Open DEM Import parameters Save as Start Computation Save process Follow example

Numerical integral of terrain Helmert condensation on various field elements

FFT algorithm of terrain Helmert condensation on various field elements

Calculator of terrain Helmert condensation effects on various field elements

Algorithm formulas

Open the ground digital elevation model file

Open the ground ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [ ] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

>> Computation Process ** Operation Prompts

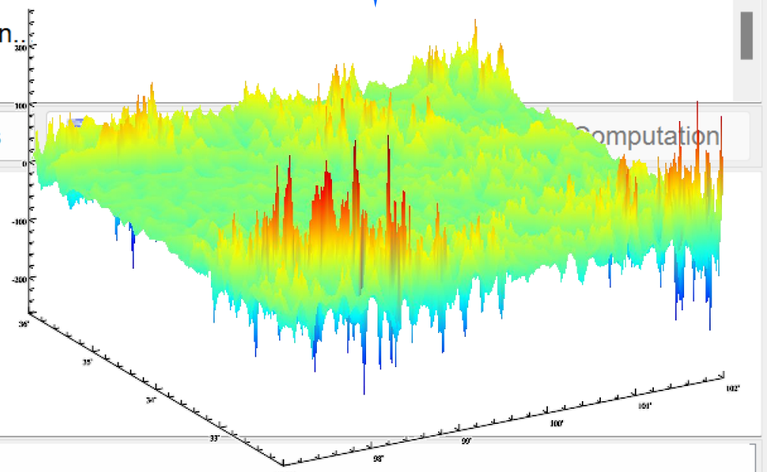
Save computation process as

```
>> Open the ground digital elevation model file C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landtm1m.dat.
>> Open the ground ellipsoidal height grid file  C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/landgeoidhgt.dat.
  ** Look at the file information in the window below, set the input file format parameters...
>> Compute the terrain Helmert condensation effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.txt.
  ** At the same time, the program also outputs the terrain Helmert condensation effect  grid files on height anomaly (*.ksi), gravity anomaly (*.gra),
gravity disturbance (*.rga), vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory. Where * is the output file name
entered from the interface. The program outputs the terrain Helmert condensation effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 11:57:55
>> Complete the computation of terrain Helmert condensation effects!
```

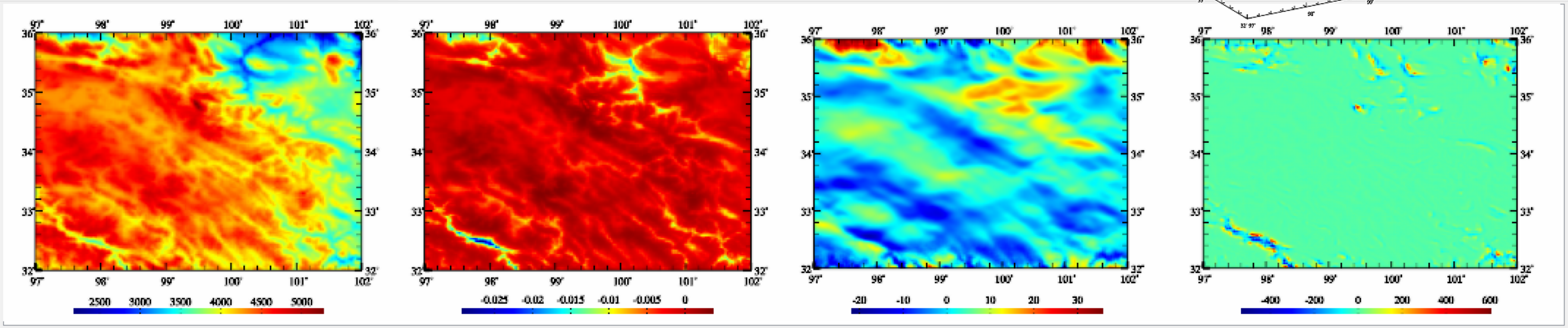
Fast algorithm 1D FFT

Save the results as

```
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.ksi
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.dft
C:/PAGravf4.5_win64en/examples/TerHelmertcondensat/surfFFT1.grr
```



Extract effects Plot↓



digital elevation model (m) | height anomaly (m) | vertical deflection (", S) | disturbing gradient (E, R)

The calculation point may be on the geoid or in near-Earth space.

Compared with local terrain effects, terrain Helmert condensation has more ultrashort wave components. Affected by the continental topography, there is terrain Helmert condensation in the nearshore sea area, and the terrain Helmert condensation in the deep ocean area is equal to zero.

Calculator of terrain Helmert condensation effects on various field elements

Open the ground digital elevation model file

Open the ground ellipsoidal height grid file

Input geodetic coordinates of calculation point

longitude	98.240000°
latitude	32.428000°
ellipsoidal height	2017.830m

Integral radius: 90 km

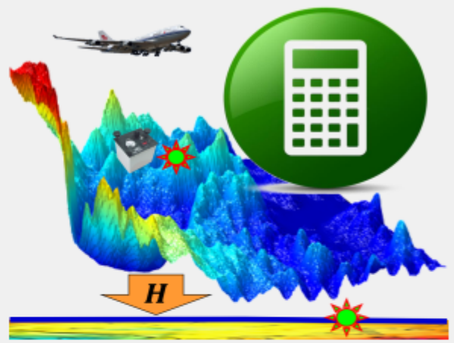
Start calculation

Ground digital elevation model

97.000000	102.000000	32.000000	36.000000	0.01666667	0.01666667
3988.0003	4048.9987	4129.9921	4151.9956	4155.9995	4177.9961
4277.9980	4373.9953	4466.9865	4479.99[illegible]1	4520.9918	4547.9825
4242.0005	4229.0008	4211.0001	4165.0[illegible]4	4150.0047	4157.0059
4429.0008	4511.9959	4529.9[illegible]91	4[illegible]31	4539.9993	4531.9988
4273.0028	4221.0056	419[illegible]	[illegible]	4251.0050	4337.9987
4643.9962	4607.0004	[illegible]	[illegible]	[illegible]57.0003	4379.9835
4500.0065	4593.[illegible]	[illegible]	[illegible]	[illegible].9976	4473.0101
4272.0146	4409.[illegible]	[illegible]	[illegible]	[illegible]0046	4729.0038
4530.9966	4450.99[illegible]	[illegible]	[illegible]	[illegible]	4071.0117
4371.0006	4429.9974	[illegible]	[illegible]	[illegible]	4520.9942
3868.0107	3964.9992	[illegible]	[illegible]	[illegible]	4124.0006
4243.0076	4270.0056	435[illegible]	[illegible]	[illegible]47.9996	4347.9933
4161.9980	4189.993[illegible]	416[illegible]	[illegible]	4143.9926	4040.0077
4050.9965	4023.0017	4012.00[illegible]	[illegible].0105	4171.9934	4235.0039
4051.0030	4022.0027	[illegible]077.012[illegible]	[illegible]02[illegible].9996	4032.[illegible]38	3996.0025
4299.0025	4415.9991	4516.9921	4514.9967	4158.0037	4431.9971
3672.0205	3912.9978	4073.[illegible]952	4159.0051	4313.9938	4374.9940

Terrain Helmert condensation effect calculation results

height anomaly (m)	-0.0207	gravity (anomaly/disturbance, mGal)	-0.6315
vertical deflection (", S)	-14.1486	vertical deflection (", W)	-1.2267
(disturbing) gradient (E, radial)	9.7229		



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

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

Calculator of terrain Helmert condensation effects on various field elements

Open the ground digital elevation model file

Open the ground ellipsoidal height grid file

Input geodetic coordinates of calculation point

longitude 99.640000°

latitude 34.428000°

ellipsoidal height 317.830m

Integral radius 90 km

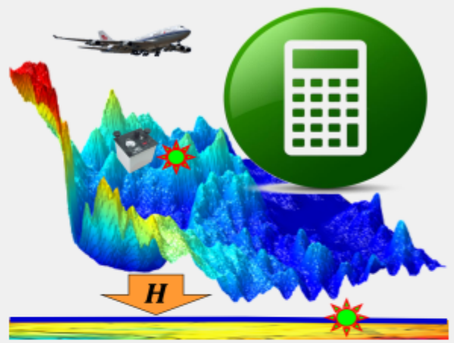
Start calculation

Ground digital elevation model

97.000000	102.000000	32.000000	36.000000	0.01666667	0.01666667
3988.0003	4048.9987	4129.9921	4151.9956	4155.9995	4177.9961
4277.9980	4373.9953	4466.9865	4479.9931	4520.9918	4547.9825
4242.0005	4229.0008	4211.0001	4165.0054	4150.0047	4157.0059
4429.0008	4511.9959	4529.9991	4531.[illegible]	4539.9993	4531.9988
4273.0028	4221.0056	4196.0075	4196.[illegible]	4251.0050	4337.9987
4643.9962	4607.0004	4605.996[illegible]	[illegible]	4457.0003	4379.9835
4500.0065	4593.9[illegible]	4650.9[illegible]	[illegible]	4585.9976	4473.0101
4272.0146	4409.[illegible]	[illegible]	[illegible]	4647.0046	4729.0038
4530.9966	4456[illegible]	[illegible]	[illegible]	.0042	4071.0117
4371.0006	4429[illegible]	[illegible]	[illegible]	[illegible]	4520.9942
3868.0107	3964.[illegible]	[illegible]	[illegible]	[illegible]	4124.0006
4243.0076	4270.00[illegible]	[illegible]	[illegible]	[illegible]	4347.9933
4161.9980	4189.9937	[illegible]	[illegible]	[illegible]	4040.0077
4050.9965	4023.0017	[illegible]	[illegible]	1.9934	4235.0039
4051.0030	4022.0027	3977.[illegible]	[illegible]	4032.9988	3996.0025
4299.0025	4415.9991	4518.[illegible]	4514.9907	4458.0037	4431.9971
3672.0205	3912.9978	4073.9952	4159.0051	4313.9938	4374.9940

Terrain Helmert condensation effect calculation results

height anomaly (m)	0.0015	gravity (anomaly/disturbance, mGal)	-1.5825
vertical deflection (", S)	2.9665	vertical deflection (", W)	7.6491
(disturbing) gradient (E, radial)	1.1203		



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

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

Computation of residual terrain effect on various field elements outside geoid

Numerical integral of land-sea residual terrain effects on various gravity field elements

Open DTM Import parameters Save as Start Computation Save process Follow example

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

Numerical integral of land-sea residual terrain effects on various gravity field elements

FFT algorithm of land-sea residual terrain effects on various gravity field elements

Calculator of land-sea unified residual terrain effect or complete Bouguer effect

Open high-resolution land-sea terrain model file

Open the land-sea low-pass terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Select calculation point file format

discrete calculation point file

Open the calculation point position file

Set input point file format

Number of rows of file header 1

Column ordinal number of ellipsoidal height in the record 4

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

Extract effects Plot↓

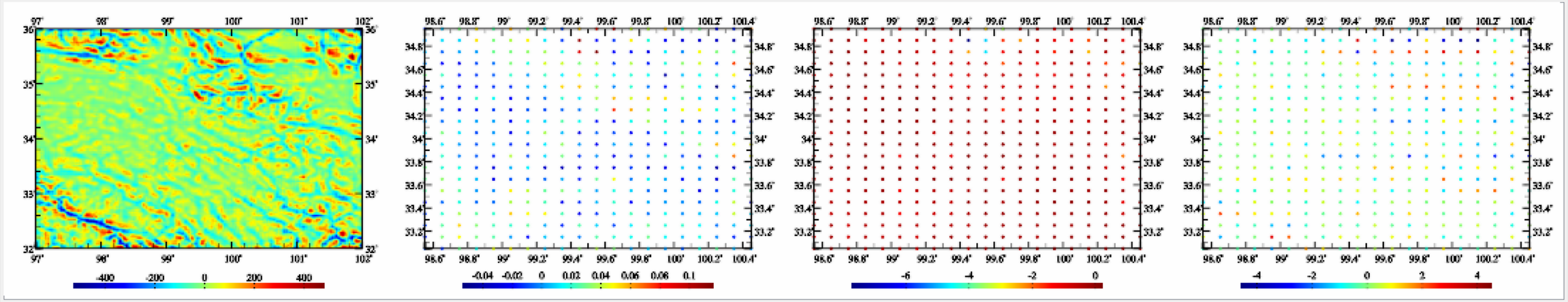
>> Computation Process ** Operation Prompts

Save computation process as

```
residual terrain model (RTM) before integral.
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the calculation point location file C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfhgt.txt.
  ** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/Renterrianeffect/result.txt.
  ** Record format: Behind the source calculation point file record, appends several columns of residual terrain effects on specified types of field elements, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 12:50:02
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 12:50:04
```

Save the results as Import setting parameters Start Computation

number	long(deg/decimal)	lat	ellipHeight(m)					
1	98.550000	33.050000	4372.431	-0.0064	-0.0821	-0.4948	1.6642	9.6285
2	98.650000	33.050000	4372.834	-0.0128	-0.0748	-0.1234	0.1747	53.4893
3	98.750000	33.050000	4530.959	0.0292	-0.3837	-0.3162	-1.3952	-50.7005
4	98.850000	33.050000	4567.407	0.0166	-0.5441	-0.6622	0.5086	66.8856
5	98.950000	33.050000	4646.551	0.0452	-0.7076	-1.6590	-1.6979	-60.9009
6	99.050000	33.050000	4672.380	0.0490	-0.6732	-0.4186	0.3348	-75.5007
7	99.150000	33.050000	4611.765	0.0407	-1.0746	1.6103	0.5141	-111.7206



residual terrain model (m) | height anomaly (m) | gravity (anomaly, mGal) | vertical deflection (", S)

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

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

Computation of residual terrain effect on various field elements outside geoid

Numerical integral of land-sea residual terrain effects on various gravity field elements

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

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

Numerical integral of land-sea residual terrain effects on various gravity field elements

FFT algorithm of land-sea residual terrain effects on various gravity field elements

Calculator of land-sea unified residual terrain effect or complete Bouguer effect

Open high-resolution land-sea terrain model file

Open the land-sea low-pass terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Select calculation point file format

ellipsoidal height grid file

Open the ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

>> Computation Process ** Operation Prompts

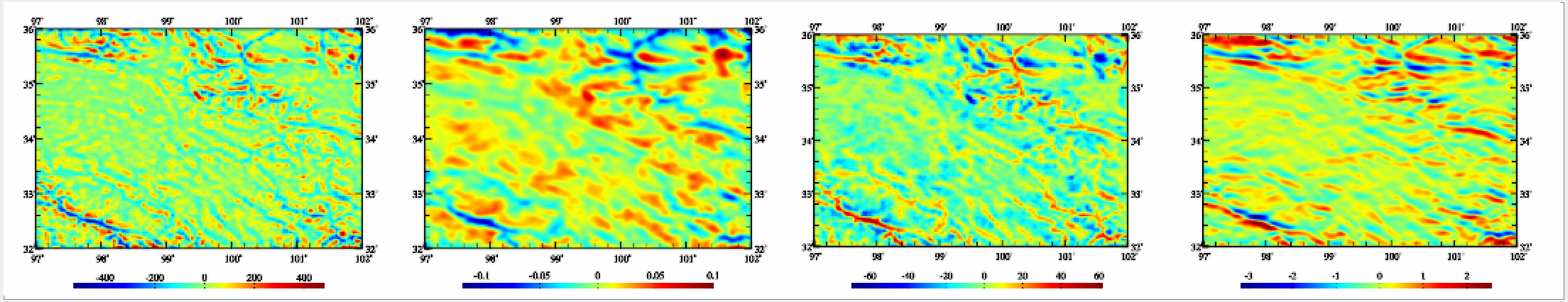
Save computation process as

```
residual terrain model (RTM) before integral.
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landgeoidhgt.dat.
>> Save the results as C:/PAGravf4.5  win64en/examples/Renterrianeffect/numintg.dat.
  ** At the same time, the program also outputs the residual terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra),
vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory, where * is the output file name entered from the interface.
The program outputs residual terrain effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 12:52:09
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 12:58:33
```

Save the results as | Import setting parameters | Start Computation

```
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.ksi
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.gra
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.dft
C:/PAGravf4.5_win64en/examples/Renterrianeffect/numintg.grr
```

Extract effects | Plot↓



residual terrain model (m) | height anomaly (m) | gravity (anomaly, mGal) | vertical deflection (", S)

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

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

Computation of residual terrain effect on various field elements outside geoid

FFT algorithm of land-sea residual terrain effects on various gravity field elements

Numerical integral of land-sea residual terrain effects on various gravity field elements | FFT algorithm of land-sea residual terrain effects on various gravity field elements | Calculator of land-sea unified residual terrain effect or complete Bouguer effect

Open high-resolution land-sea terrain model file

Open the land-sea low-pass terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Open the ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [x] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

>> Computation Process ** Operation Prompts

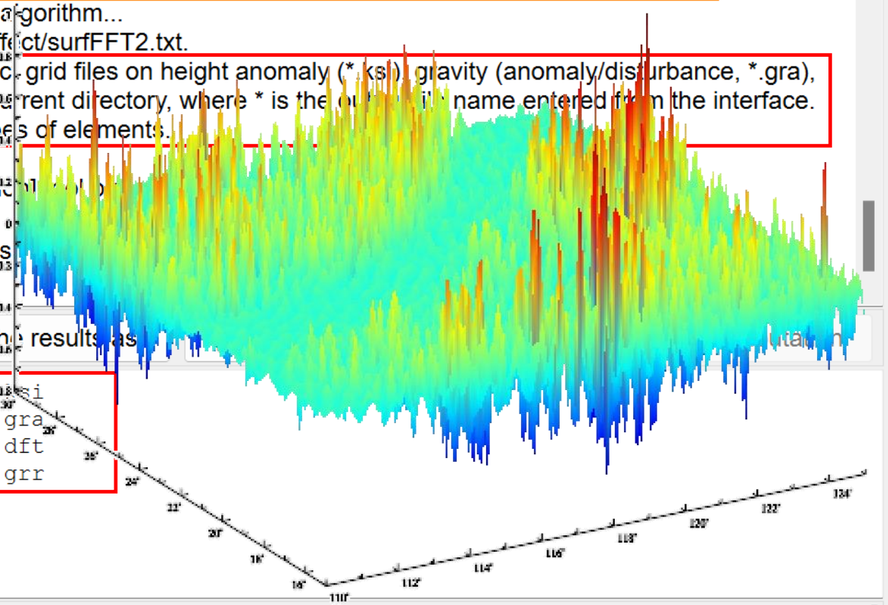
Save computation process as

```
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landgeoidhgt.dat.
>> Compute the land-sea unified residual terrain effects using 2D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT2.txt.
  ** At the same time, the program also outputs the residual terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra),
vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory, where * is the output file name entered from the interface.
The program outputs residual terrain effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] button
>> Computation start time：2024-09-22 13:00:34
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 13:00:37
```

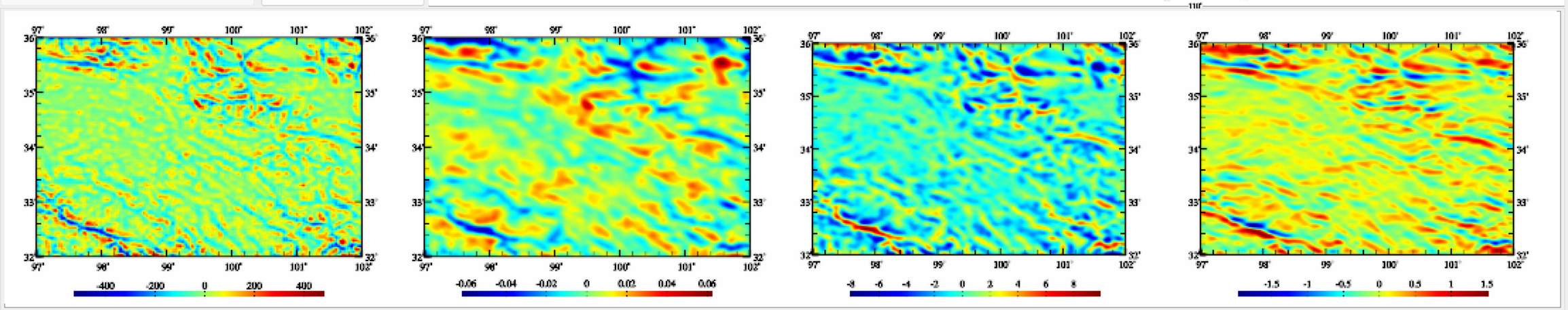
Fast algorithm 2D FFT

Save the results as

```
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT2.ksi
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT2.gra
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT2.dft
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT2.grr
```



Extract effects | Plot↓



residual terrain model (m) | height anomaly (m) | gravity (anomaly, mGal) | vertical deflection (", S)

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

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

Computation of residual terrain effect on various field elements outside geoid

FFT algorithm of land-sea residual terrain effects on various gravity field elements

Numerical integral of land-sea residual terrain effects on various gravity field elements

FFT algorithm of land-sea residual terrain effects on various gravity field elements

Calculator of land-sea unified residual terrain effect or complete Bouguer effect

Open high-resolution land-sea terrain model file

Open the land-sea low-pass terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Open the ellipsoidal height grid file of calculation surface

Select gravity field elements

- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [ ] vertical deflection (", SW)
- [x] disturbing gravity gradient (E, radial)

Integral radius 90 km

>> Computation Process ** Operation Prompts

Save computation process as

```
>> Open the high-resolution land-sea terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1m.dat.
>> Open the land-sea low-pass terrain model file C:/PAGravf4.5_win64en/examples/Renterrianeffect/landtm1mlvb.dat.
>> Open the ellipsoidal height grid file of the land-sea surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landbmsurfhgt.dat.
>> Open the ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Renterrianeffect/landgeoidhgt.dat.
>> Compute the land-sea unified residual terrain effects using 1D FFT algorithm...
>> Save the results as C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.txt.
  ** At the same time, the program also outputs the residual terrain effect grid files on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra),
vertical deflection (*.dft) or (disturbing) gravity gradient (*.grr) into the current directory, where * is the output file name entered from the interface.
The program outputs residual terrain effect grid file on the specified types of elements.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] button
>> Computation start time：2024-09-22 13:02:25
>> Complete the computation of land-sea unified residual terrain effects!
>> Computation end time: 2024-09-22 13:02:51
```

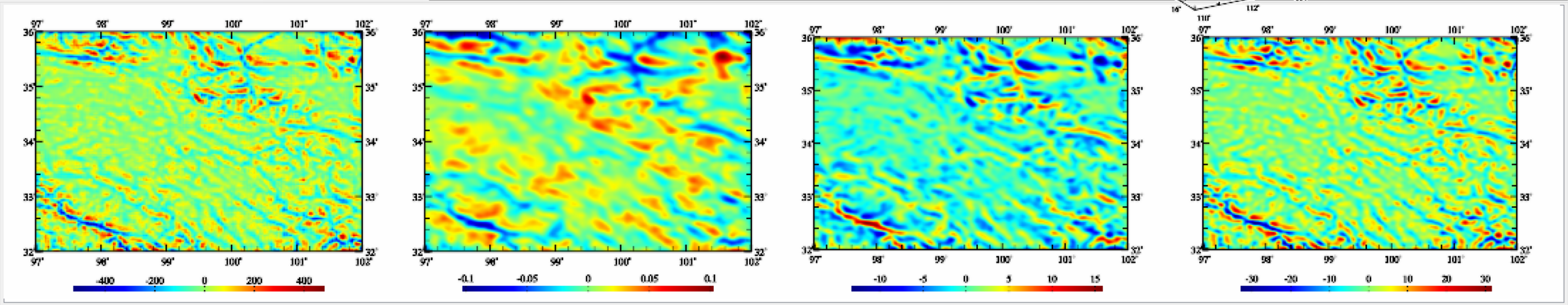
Fast algorithm 1D FFT

Save the results as

```
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.ksi
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.gra
C:/PAGravf4.5_win64en/examples/Renterrianeffect/surfFFT1.grr
```

Extract effects

Plot↓



residual terrain model (m) | height anomaly (m) | gravity (anomaly, mGal) | disturbing gradient (E, R)

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

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

Calculator of land-sea unified residual terrain effect

Calculator of land-sea unified residual terrain effect

Open high-resolution land-sea terrain model file

Open the land-sea low-pass terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Input geodetic coordinates of calculation point

longitude	98.240000°
latitude	32.428000°
ellipsoidal height	2017.830m

Integral radius: 90 km

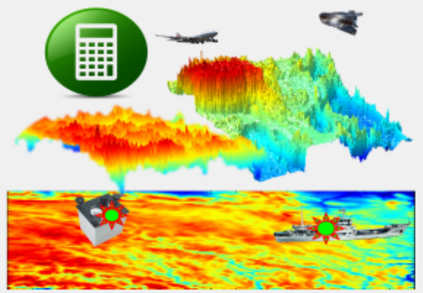
Start calculation

High-resolution land-sea terrain model

97.000000	102.000000	32.000000	36.000000	0.01666667	0.01666667
3988.0003	4048.9987	4129.9921	4151.9956	4155.9995	4177.9961
4277.9980	4373.9953	4466.9865	4479.9931	4520.9918	4547.9825
4242.0005	4229.0008	4211.0001	4165.0054	4150.0047	4157.0059
4429.0008	4511.9959	4529.9991	4531.0014	4539.9993	4531.9988
4273.0028	4221.0056	4196.0075	4196.0093	4251.0050	4337.9987
4643.9962	4607.0004	4605.9961	4587.9886	4457.0003	4379.9835
4500.0065	4593.9997	4650.9959	4632.9989	4585.9976	4473.0101
4272.0146	4409.0057	4543.9	4580.0081	4647.0046	4729.0038
4530.9966	4456.9975	432	160.0042		4071.0117
4371.0006	442		93.9994		4520.9942
3868.0107			0037		4124.0006
4243.0076					4347.9933
4161.9980					4040.0077
4050.9965	402				4235.0039
4051.0030	4022.0127		9988		3996.0025
4299.0025	4415.9991	45	4458.0037		4431.9971
3672.0205	3912.9978	4073.9952	59.003	4313.9938	4374.9940
4389.9975	4385.9989	4385.9985	4382.9967	4358.9980	4337.9925
4185.9964	4135.0004	4099.9998	4073.9998	4073.9966	4110.9920
4310.9929	4297.9951	4309.9918	4309.9894	4250.9985	4242.9906
3884.0033	3950.0001	4024.9995	4176.0000	4119.0000	4160.9984
4240.0001	4300.0001	4352.9995	4350.0033	4355.0002	4373.0002
4236.9985	4228.0000	4229.9976	4212.9986	4207.0000	4262.9950

Residual terrain / complete Bouguer effect calculation results

height anomaly (m)	0.0094	gravity (anomaly/disturbance, mGal)	-7.1398
vertical deflection (", S)	-2.3612	vertical deflection (", W)	-0.9987
(disturbing) gradient (E, radial)	13.2737		



Inputting the high-resolution land-sea terrain model, low-pass land-sea terrain model and ellipsoidal height grid file of the land-sea surface with the same grid specifications, the button [Start Calculation] becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the residual terrain / complete Bouguer effects on various field elements can be computed and displayed in time.

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

Calculator of land-sea unified residual terrain effect

Open high-resolution land-sea terrain model file

Open the land-sea low-pass terrain model file

Open the ellipsoidal height grid file of the land-sea surface

Input geodetic coordinates of calculation point

longitude	100.450000°
latitude	34.428000°
ellipsoidal height	417.830m

Integral radius: 90 km

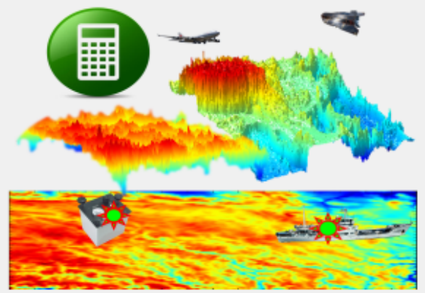
Start calculation

High-resolution land-sea terrain model

97.000000	102.000000	32.000000	36.000000	0.01666667	0.01666667
3988.0003	4048.9987	4129.9921	4151.9956	4155.9995	4177.9961
4277.9980	4373.9953	4466.9865	4479.9931	4520.9918	4547.9825
4242.0005	4229.0008	4211.0001	4165.0054	4150.0047	4157.0059
4429.0008	4511.9959	4529.9991	4531.0014	4539.9993	4531.9988
4273.0028	4221.0056	4196.0075	4196.0093	4251.0050	4337.9987
4643.9962	4607.0004	4605.9961	4587.9886	4457.0003	4379.9835
4500.0065	4593.9997	4650.995	32.9999	4585.9976	4473.0101
4272.0146	4109.0057	43		7.0046	4729.0038
4530.9966	4			.0042	4071.0117
4371.0006	4			994	4520.9942
3868.0107	3				4124.0006
4243.0076	4				4347.9933
4161.9980	4				4040.0077
4050.9965	4			934	4235.0039
4051.0030	4022.0027	3977		4032.9988	3996.0025
4299.0025	4415.9991	4516.9921	4	4458.0037	4431.9971
3672.0205	3912. 978	4073.9952	4159.0051	4313.9938	4374.9940
4389.9975	4386.9989	4385.9985	4382.9967	4358.9980	4337.9925
4185.9964	4135.0004	4099.9998	4073.9998	4075.9986	4110.9920
4310.9929	4297.9951	4309.9918	4309.9884	4250.9985	4242.9906
3884.0033	3950.0001	4024.	4076.0000	4119.0000	4160.9984
4240.0001	4300.0001	4352.9995	4350.0033	4355.0002	4373.0002
4236.9985	4228.0000	4229.9976	4212.9986	4207.0000	4262.9950

Residual terrain / complete Bouguer effect calculation results

height anomaly (m)	0.0206	gravity (anomaly/disturbance, mGal)	-9.2450
vertical deflection (", S)	-0.3546	vertical deflection (", W)	-0.2634
(disturbing) gradient (E, radial)	7.7494		



Inputting the high-resolution land-sea terrain model, low-pass land-sea terrain model and ellipsoidal height grid file of the land-sea surface with the same grid specifications, the button [Start Calculation] becomes available. After that, the geodetic coordinates of the calculation point can be input repeatedly, and the residual terrain / complete Bouguer effects on various field elements can be computed and displayed in time.

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

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

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

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

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

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

Algorithms land-sea unified classic Bouguer and equilibrium effects

Open the land-sea terrain model file

Open the ellipsoidal height grid file of land-sea surface

Select calculation point file format

discrete calculation point file

Open the calculation point location file on land-sea surface

Number of rows of file header 1

Integral radius for local terrain effect 90 km

Integral radius for seawater Bouguer / equilibrium effect 300 km

Equilibrium compensation depth 30 km

Extract effects | Plot↓

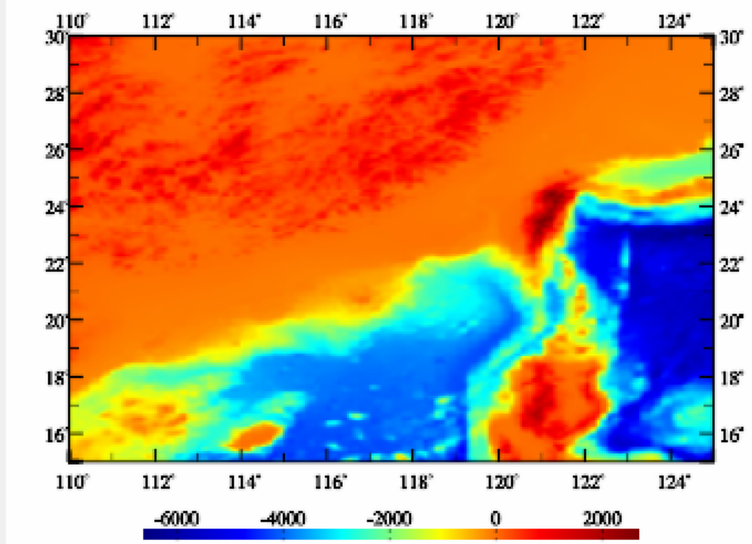
>> Computation Process ** Operation Prompts

Save computation process as

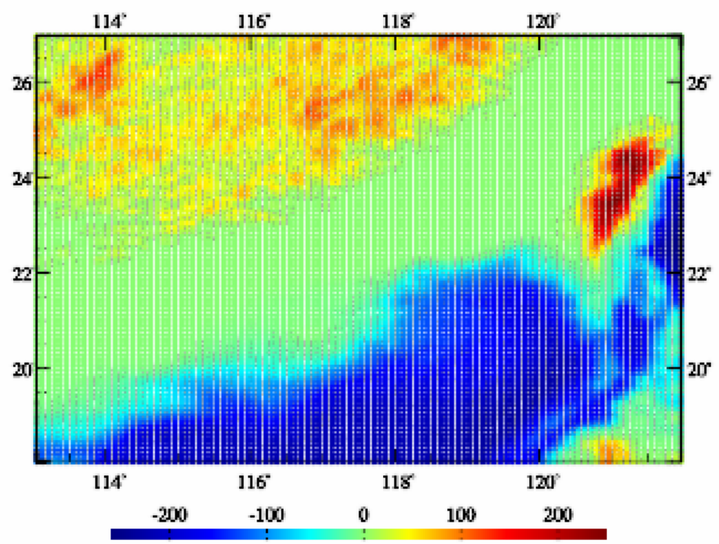
```
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dtm5m.dat.
>> Open the ellipsoidal height grid file of land-sea surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt5m.dat.
>> Open the calculation point location file on land-sea surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt.txt.
  ** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/rstpnt.txt.
  ** Behind the source calculation point file record, appends the terrain height/sea depth, local terrain effect, plane layer effect, seawater Bouguer effect, land equilibrium effect, ocean equilibrium effect, total Bouguer effect and total equilibrium effect, a total of 8 attribute values, keeps 4 significant figures.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 18:31:54
```

Save the results as | Import setting parameters | Start Computation

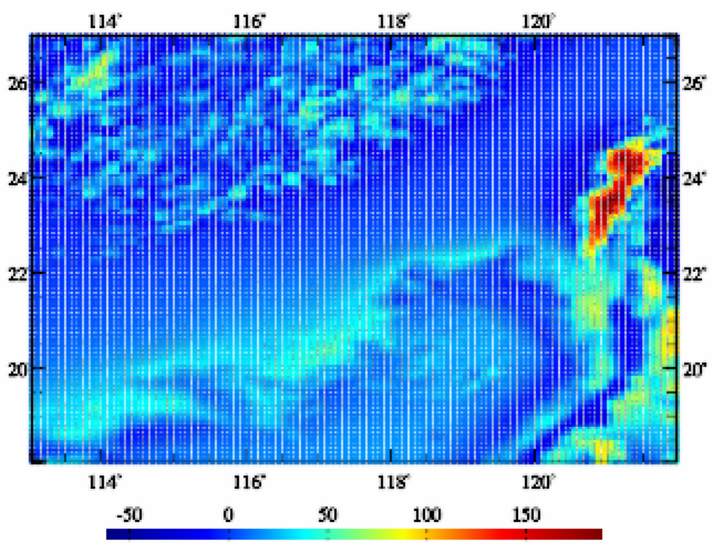
```
terrian, plane layer, sea-water Bouguer, land equilibrium...
18.041667     1.4605    -2191.889     0.0000     0.0000   -109.5704     -0.0009    122.0600   -109.5704     12.4887
18.041667     1.7831    -2072.111     0.0000     0.0000   -103.9803     -0.0003    122.3674   -103.9803     18.3868
18.041667     2.1041    -1926.889     0.0000     0.0000    -97.4649     -0.0000    122.9345    -97.4649     25.4695
18.041667     2.4240    -1638.222     0.0000     0.0000    -89.4900      0.0000    124.4235    -89.4900     34.9336
```



land-sea terrain model (m)



total Bouguer effect (mGal)



total equilibrium effect (mGal)

Classic Bouguer gravity anomaly on geoid = gravity anomaly at the observed point – total Bouguer effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic Bouguer gravity disturbance on geoid = gravity disturbance at the observed point – total Bouguer effect – analytical continuation of gravity disturbance from the observed point to geoid.

Classic equilibrium gravity anomaly on geoid = gravity anomaly at the observed point – total equilibrium effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic equilibrium gravity disturbance on geoid = gravity disturbance at the observed point – total equilibrium effect – analytical continuation of gravity disturbance from the observed point to geoid.

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

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

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

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

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

Algorithms land-sea unified classic Bouguer and equilibrium effects

Open the land-sea terrain model file

Open the ellipsoidal height grid file of land-sea surface

Select calculation point file format

ellipsoidal height grid file

Open the ellipsoidal height grid file on land-sea calculation surface

Integral radius for local terrain effect: 90 km

Integral radius for seawater Bouguer / equilibrium effect: 300 km

Equilibrium compensation depth: 30 km

>> Computation Process ** Operation Prompts

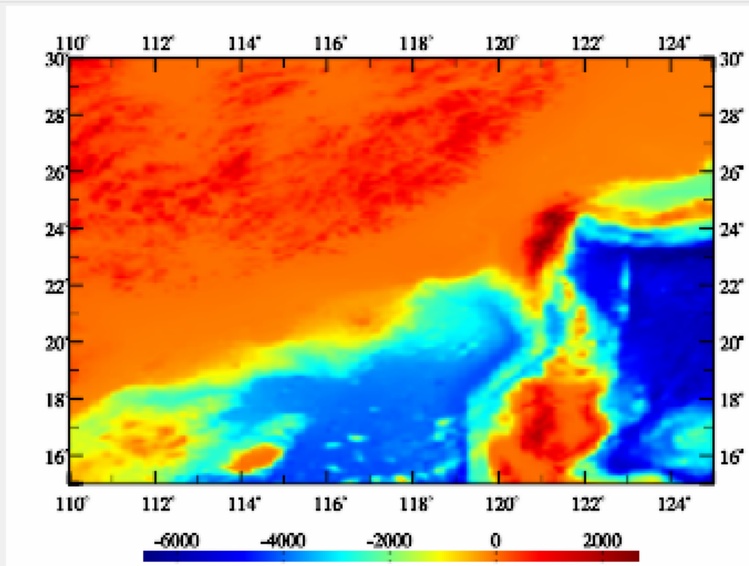
Save computation process as

```
>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dtm5m.dat.
>> Open the ellipsoidal height grid file of land-sea surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt5m.dat.
>> Open the ellipsoidal height grid file on land-sea calculation surface C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/dbmhgt5m.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerSurfacegravinfl/result.txt.
  ** Record format: Point no, longitude, latitude, terrain height/sea depth, local terrain effect, plane layer effect, seawater Bouguer effect, land
equilibrium effect, ocean equilibrium effect, total Bouguer effect and total equilibrium effect.
  ** At the same time, the program also outputs the land-sea total Bouguer effect (*.bgr) and land-sea total equilibrium effect (*.ist) grid files into the
current directory, where * is the output file name entered from the interface.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time: 2024-09-22 18:35:45
```

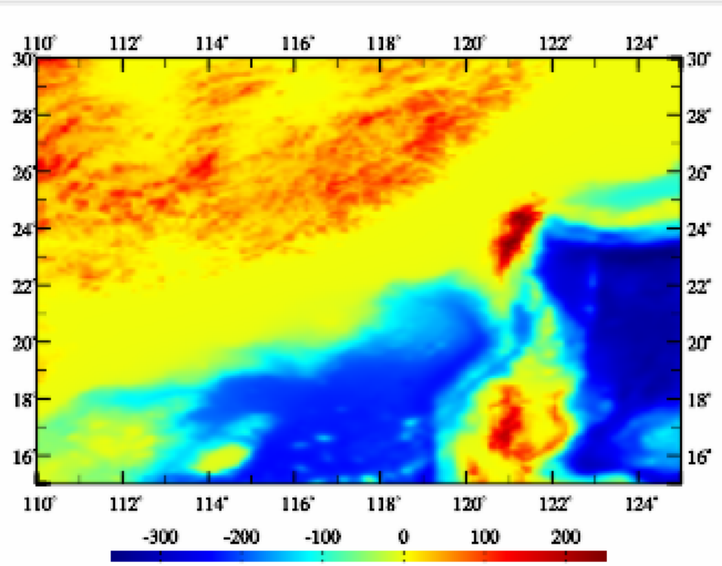
Save the results as | Import setting parameters | Start Computation

no	lon(deg/decimal)	lat	height/depth	local terrian,	plane layer,	sea-water Bouguer effect,	...			
1	110.04167	15.04167	-456.500	0.0000	0.0000	-7.8971	0.0000	12.2480	-7.8971	4
2	110.12500	15.04167	-434.667	0.0000	0.0000	-7.8766	0.0000	14.7200	-7.8766	6
3	110.20833	15.04167	-465.667	0.0000	0.0000	-9.1329	0.0000	17.0115	-9.1329	7
4	110.29167	15.04167	-638.167	0.0000	0.0000	-13.9564	0.0000	19.0292	-13.9564	5

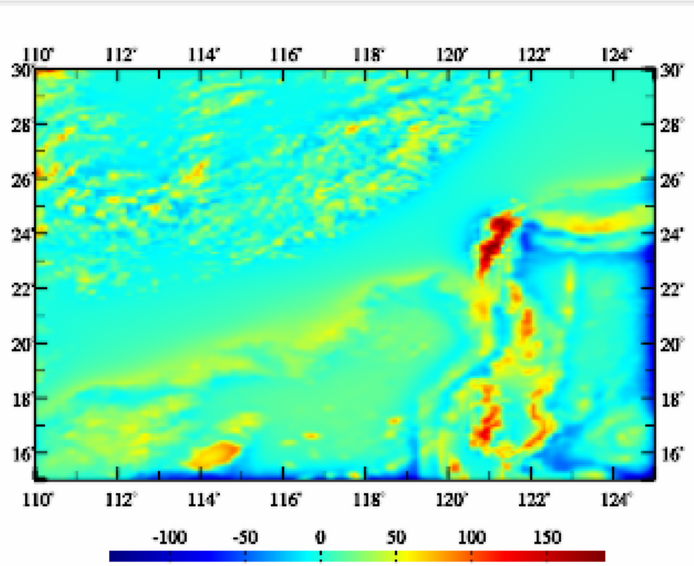
Extract effects | Plot↓



land-sea terrain model (m)



total Bouguer effect (mGal)



total equilibrium effect (mGal)

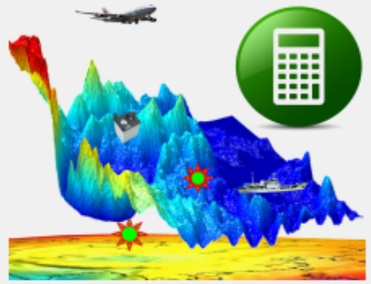
Classic Bouguer gravity anomaly on geoid = gravity anomaly at the observed point – total Bouguer effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic Bouguer gravity disturbance on geoid = gravity disturbance at the observed point – total Bouguer effect – analytical continuation of gravity disturbance from the observed point to geoid.

Classic equilibrium gravity anomaly on geoid = gravity anomaly at the observed point – total equilibrium effect – analytical continuation of gravity anomaly from the observed point to geoid. Classic equilibrium gravity disturbance on geoid = gravity disturbance at the observed point – total equilibrium effect – analytical continuation of gravity disturbance from the observed point to geoid.

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

Open the land-sea terrain model file

Open the ellipsoidal height grid file of land-sea surface



Integral radius for local terrain effect: 90 km

Integral radius for seawater Bouguer /equilibrium effect: 300 km

Equilibrium compensation depth: 30 km

Input geodetic coordinates of calculation pointon land-sea surface

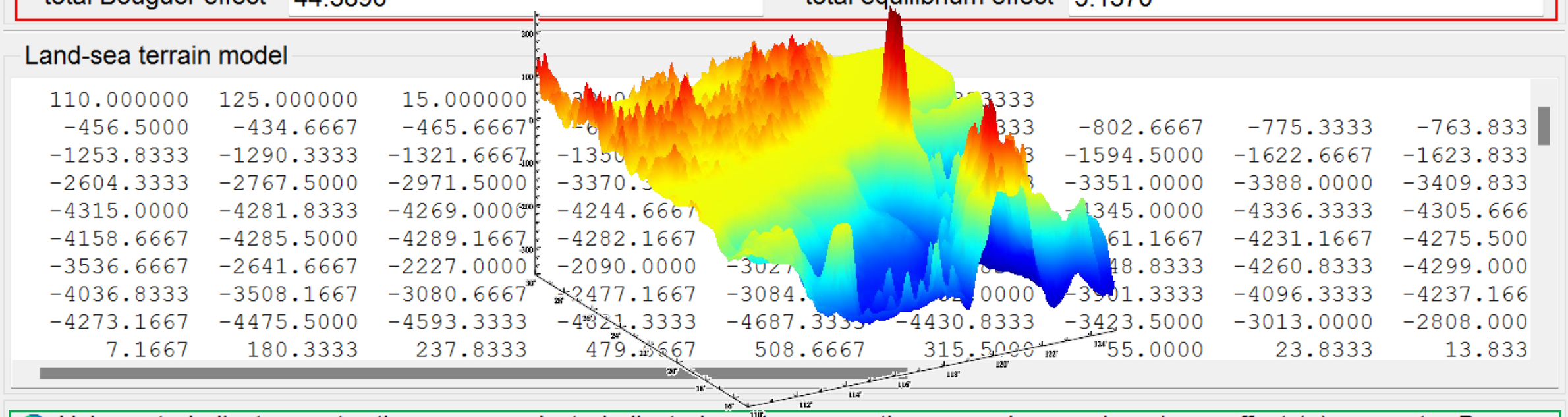
longitude 116.240000° latitude 26.428100°

Start calculation

Terrain effects (mGal) at the calculation pointon

land height/sea depth	400.3811 m	local terrain effect	-0.4405
plane layer effect	44.8300	seawater Bouguer effect	-0.0000
land equilibrium effect	-39.2525	ocean equilibrium effect	0.0000
total Bouguer effect	44.3896	total equilibrium effect	5.1370

Land-sea terrain model



110.000000	125.000000	15.000000						
-456.5000	-434.6667	-465.6667				-802.6667	-775.3333	-763.833
-1253.8333	-1290.3333	-1321.6667				-1594.5000	-1622.6667	-1623.833
-2604.3333	-2767.5000	-2971.5000				-3351.0000	-3388.0000	-3409.833
-4315.0000	-4281.8333	-4269.0000	-4244.6667			-4345.0000	-4336.3333	-4305.666
-4158.6667	-4285.5000	-4289.1667	-4282.1667			-4261.1667	-4231.1667	-4275.500
-3536.6667	-2641.6667	-2227.0000	-2090.0000			-4248.8333	-4260.8333	-4299.000
-4036.8333	-3508.1667	-3080.6667	-2477.1667			-4301.3333	-4096.3333	-4237.166
-4273.1667	-4475.5000	-4593.3333	-4621.3333	-4687.3333	-4430.8333	-3423.5000	-3013.0000	-2808.000
7.1667	180.3333	237.8333	479.1667	508.6667	315.5000	55.0000	23.8333	13.833

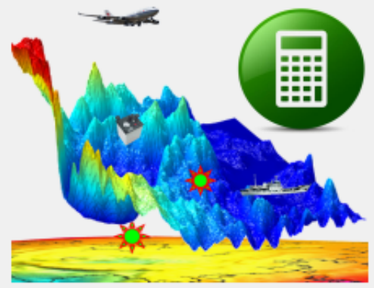
Using + to indicate greater than zero, and - to indicate less than zero, there are always: plane layer effect (+), seawater Bouguer effect (-), land equilibrium effect (-), ocean equilibrium effect (+).

In the coastal sea area, there are local terrain effects and land equilibrium effects. In the offshore land area, there are also seawater Bouguer effects and ocean equilibrium effects.

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

Open the land-sea terrain model file

Open the ellipsoidal height grid file of land-sea surface



Integral radius for local terrain effect: 90 km

Integral radius for seawater Bouguer /equilibrium effect: 300 km

Equilibrium compensation depth: 30 km

Input geodetic coordinates of calculation pointon land-sea surface

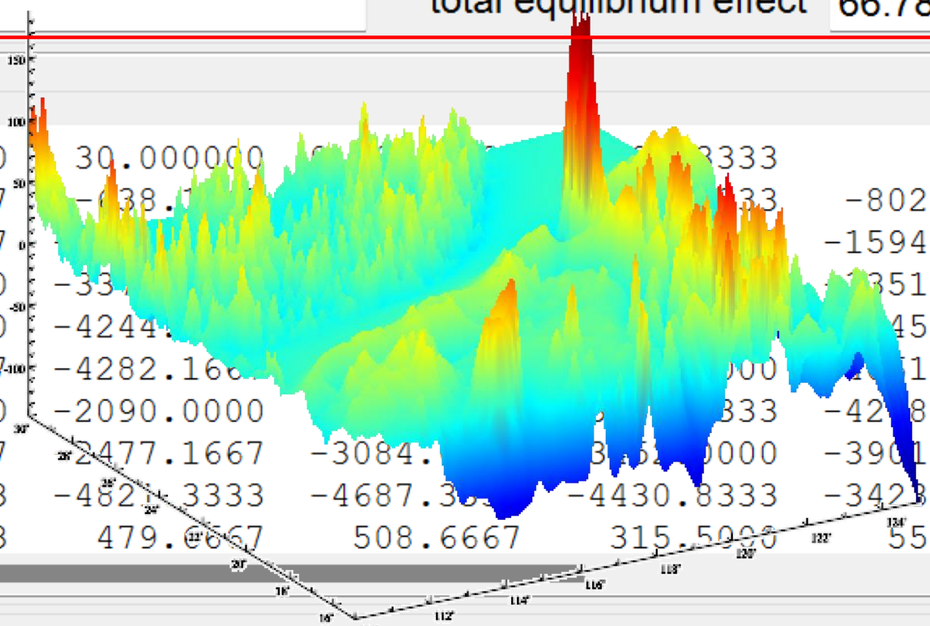
longitude: 121.240000° latitude: 21.428100°

Start calculation

Terrain effects (mGal) at the calculation pointon

land height/sea depth	-2187.1242 m	local terrain effect	0.0017
plane layer effect	0.0000	seawater Bouguer effect	-61.3520
land equilibrium effect	-1.2635	ocean equilibrium effect	129.3990
total Bouguer effect	-61.3503	total equilibrium effect	66.7853

Land-sea terrain model



110.000000	125.000000	15.000000	30.000000					
-456.5000	-434.6667	-465.6667				-802.6667	-775.3333	-763.833
-1253.8333	-1290.3333	-1321.6667				-1594.5000	-1622.6667	-1623.833
-2604.3333	-2767.5000	-2971.5000					-3388.0000	-3409.833
-4315.0000	-4281.8333	-4269.0000					-4336.3333	-4305.666
-4158.6667	-4285.5000	-4289.1667					-4231.1667	-4275.500
-3536.6667	-2641.6667	-2227.0000	-2090.0000				-4260.8333	-4299.000
-4036.8333	-3508.1667	-3080.6667	-2477.1667				-4096.3333	-4237.166
-4273.1667	-4475.5000	-4593.3333					-3013.0000	-2808.000
7.1667	180.3333	237.8333	479.6667	508.6667	315.5000	55.0000	23.8333	13.833

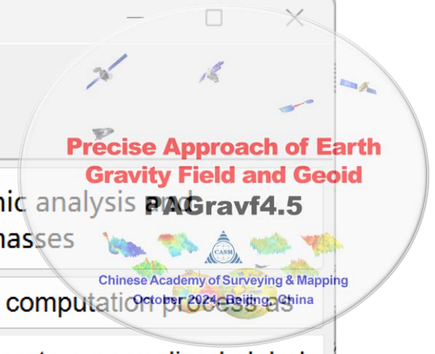
Using + to indicate greater than zero, and - to indicate less than zero, there are always: plane layer effect (+), seawater Bouguer effect (-), land equilibrium effect (-), ocean equilibrium effect (+).

In the coastal sea area, there are local terrain effects and land equilibrium effects. In the offshore land area, there are also seawater Bouguer effects and ocean equilibrium effects.

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

Construction of global surface data grid in spherical coordinates

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



Construction of global surface data grid in spherical coordinates

Ultrahigh degree spherical harmonic analysis of global land-sea terrain model

Algorithm of spherical harmonic analysis and synthesis of land-sea terrain masses

Open global land-sea surface discrete point data file

Set file format

Number of rows of file header: 0

Row ordinal number of target attribute in the record: 4

Target grid resolution: 30.0 '

>> Computation Process ** Operation Prompts

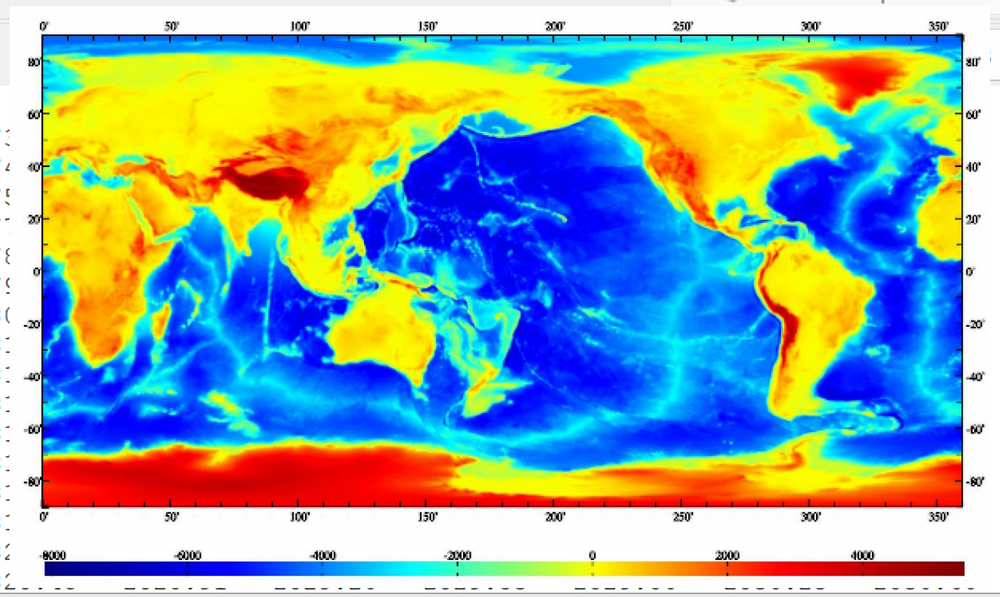
Save computation process as

```
>> [Purpose] Perform spherical harmonic analysis on global land-sea terrain (terrain height/sea depth), and then generate a normalized global
land-sea terrain mass spherical harmonic coefficient model, which can be employed to calculate the land-sea unified complete Bouguer effects
or residual terrain effects on various gravity field elements on the geoid or in whole outer Earth space.
>> Select the function module from the two control buttons at the top left of the interface...
>> [Function] From the global land-sea surface discrete point value data, according to the given grid resolution, construct the spherical
coordinate grid model. When there is no valid discrete point data in the grid element area, the value on the grid element is set to zero.
>> Open global land-sea surface discrete point data file C:/PAGravf4.5_win64en/examples/TerGloharmanalysis/ETOPO30m.txt.
  ** Look at the file information in the window below, set the input file format parameters...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerGloharmanalysis/ETOPO30msph.dat.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
>> Computation start time：2024-09-22 19:26:23
>> Complete the construction of global surface data grid in spherical coordinates!
>> Computation end time: 2024-09-22 19:26:28
```

Save the results as | Import setting parameters | Start Computation

Display of the input-output file↓

```
   0.0 360.0 -90.0  90.0   0.50000000   0.50000000
2734.91   2735.40   2735.93   2736.53   2737.08   2737.61   2738.27   2738.96   273
2743.65   2744.20   2744.92   2745.57   2746.21   2746.86   2747.48   2747.99   274
2753.34   2754.16   2754.80   2755.49   2756.19   2756.79   2757.52   2758.14   275
2764.09   2764.85   2765.68   2766.57   2767.32   2768.02   2768.78   2769.53   277
2776.18   2776.96   2777.86   2778.81   2779.69   2780.46   2781.33   2782.24   278
2789.14   2790.07   2791.04   2791.81   2792.59   2793.41   2794.25   2795.05   279
2801.59   2802.21   2802.88   2803.60   2804.26   2804.90   2805.58   2806.37   280
2811.06   2811.66   2812.18   2812.57   2813.07   2813.50   2813.96   2814.55   281
2817.19   2817.38   2817.57   2817.83   2818.18   2818.39   2818.57   2818.62   281
2819.57   2819.61   2819.63   2819.63   2819.68   2819.74   2819.74   2819.70   281
2819.26   2819.25   2819.13   2819.09   2819.18   2819.03   2819.02   2818.97   281
2818.12   2818.11   2818.07   2818.07   2818.10   2817.92   2817.83   2817.89   281
2817.71   2817.74   2817.67   2817.64   2817.63   2817.64   2817.68   2817.72   281
2818.56   2818.71   2818.88   2819.04   2819.15   2819.25   2819.36   2819.57   281
2821.32   2821.54   2821.86   2822.10   2822.39   2822.63   2822.88   2823.26   282
2825.69   2826.01   2826.32   2826.66   2827.01   2827.35   2827.76   2827.98   282
```



- The degree n of the spherical harmonic coefficients model is equal to the number of grids in the SN direction of the land-sea terrain model. For example, the degree n is equal to 720 with 0.25˚×0.25˚ land-sea terrain model.
- The land terrain areal density, always greater than zero, represents the topographic mass per unit area, which is equal to the product of the terrain height and density.
- The ocean terrain areal density, always less than zero, represents the compensation masses of the sea water per unit area, which is equal to the seafloor depth multiplied by the difference between the seawater density and land terrain density.

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

Ultrahigh degree spherical harmonic analysis of global land-sea terrain model

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

Construction of global surface data grid in spherical coordinates

Ultrahigh degree spherical harmonic analysis of global land-sea terrain model

Open global land-sea terrain model grid in spherical coordinate system

Set iteration termination condition

Residual standard deviation threshold (a) 1.0 ‰

Ttermination condition of residual decrease (b) 1.0 ‰

Simultaneously output terrain geopotential coefficient model

>> Computation Process ** Operation Prompts

```
** 16th iteration. the residual standard deviation = 7.243e+04
** 17th iteration. the residual standard deviation = 7.169e+04
** 18th iteration. the residual standard deviation = 7.103e+04
** 19th iteration. the residual standard deviation = 7.045e+04
** 20th iteration. the residual standard deviation = 6.993e+04
** 21th iteration. the residual standard deviation = 6.947e+04
** standard deviation of global land-sea terrain = 41.76m。
```

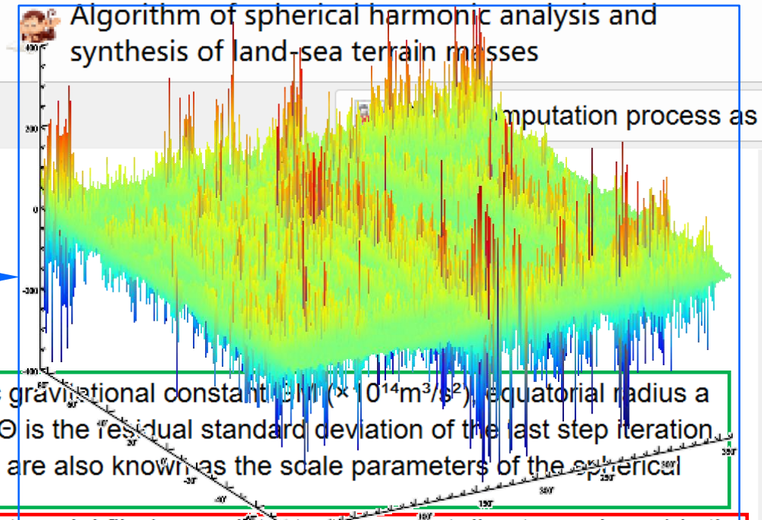
>> The file header of the spherical harmonic coefficient model：the geocentric gravitational constant GM (× $10^{14}m^3/s^2$), equatorial radius a (m) of the Earth，zero-degree term $a\Delta C_{00}$ (kg/m^2), relative error Θ (%), where Θ is the residual standard deviation of the last step iteration as a percentage of the standard deviation of the source grid values, and GM,a are also known as the scale parameters of the spherical harmonic coefficient model.

>> The program also outputs the global land-sea terrain geopotential coefficient model file *geop.dat into the current directory, where * is the file name of the global land-sea terrain mass spherical harmonic coefficient model.

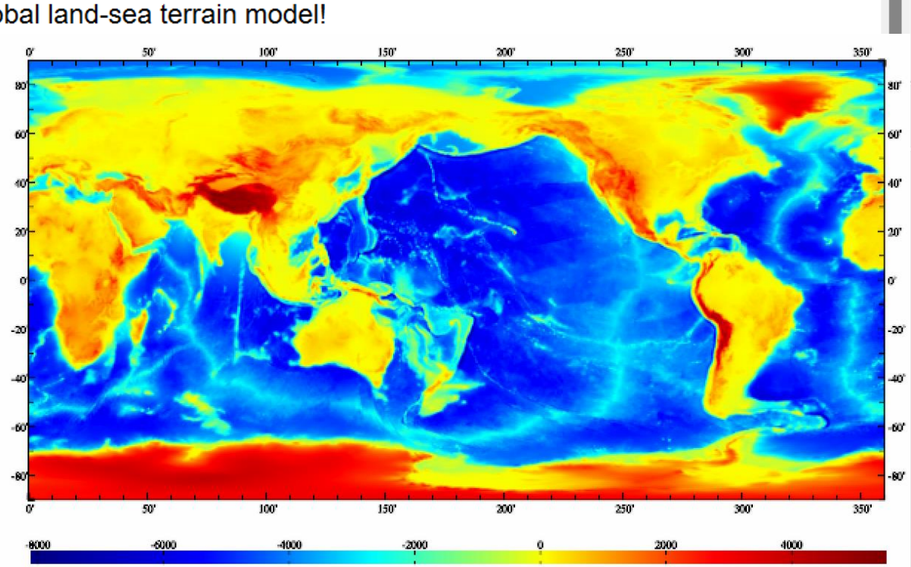
>> Complete the ultrahigh degree spherical harmonic analysis of global land-sea terrain model!

>> Computation end time: 2024-09-22 19:30:22

Algorithm of spherical harmonic analysis and synthesis of land-sea terrain masses



mputation process as



Save the results as | Save residual DTM as | Import setting parameters

Display of the input-output file↓

```
  3.986004415    6378136.30    -3667855.301     2.521
     1      0   1.7136617466283444E-01   0.0000000000000000E+00
     1      1   1.6662830460947373E-01   1.1455495760110544E-01
     2      0   1.6336327492305205E-01   0.0000000000000000E+00
     2      1   8.4790436862281993E-02   9.1248955791892794E-02
     2      2  -1.1820159432578198E-01  -1.6730453760116247E-02
     3      0  -6.4915287439358635E-02   0.0000000000000000E+00
     3      1  -4.4601487637124751E-02   4.0150215900756667E-02
     3      2  -1.3058410613568169E-01   1.2619038828971818E-01
     3      3   3.7363651282940558E-02   1.5252641909794926E-01
     4      0   1.0060940799382276E-01   0.0000000000000000E+00
     4      1  -5.9865766035864118E-02  -8.3251300057076774E-02
     4      2  -1.1442732934894125E-01   1.9235264166930027E-02
     4      3   1.0098478651494894E-01  -4.2950380278059655E-02
     4      4  -1.1646562236291021E-02   1.2919605986189289E-01
     5      0  -1.6569492084399357E-01   0.0000000000000000E+00
     5      1  -7.2051327049100396E-03  -1.9203743552770599E-02
```



```
  0.0 360.0 -90.0  90.0  0.50000000  0.50000000
2734.91  2735.40  2735.93  2736.53  2737.08  2737.61
2743.65  2744.20  2744.92  2745.57  2746.21  2746.86
2753.34  2754.16  2754.80  2755.49  2756.19  2756.79
2764.09  2764.85  2765.68  2766.57  2767.32  2768.02
2776.18  2776.96  2777.86  2778.81  2779.69  2780.46
2789.14  2790.07  2791.04  2791.81  2792.59  2793.41
2801.59  2802.21  2802.88  2803.60  2804.26  2804.90
2811.06  2811.66  2812.18  2812.57  2813.07  2813.50
2817.19  2817.38  2817.57  2817.83  2818.18  2818.39
2819.57  2819.61  2819.63  2819.63  2819.68  2819.74
2819.26  2819.25  2819.13  2819.09  2819.18  2819.03
```

The degree n of the spherical harmonic coefficients model is equal to the number of grids in the SN direction of the 0.25˚×0.25˚ land-sea terrain model.

The land terrain areal density, always greater than zero, represents the topographic mass per unit area, which is equ

The ocean terrain areal density, always less than zero, represents the compensation masses of the sea water per u between the seawater density and land terrain density.

Spherical harmonic synthesis of complete Bouguer or residual terrain effects

Calculation of model value for complete Bouguer or residual terrain effects

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

Calculation of model value for complete Bouguer or residual terrain effects

Calculator of global land-sea terrain effects model

Calculation and analysis of spectral character of global terrain effects model

Open global land-sea terrain mass spherical harmonic coefficient model file

Select calculation file format

Discrete calculation point file

Open space calculation point file

Set input point file format

Number of rows of file header 1

Column ordinal number of ellipsoidal height in the record 4

Select elements to be calculated

- [ ] terrain height/sea depth (m)
- [x] height anomaly (m)
- [x] gravity anomaly/disturbance (mGal)
- [ ] vertical deflection (", SW)
- [x] disturbing gradient (E, radial)
- [ ] tangential gradient (E, NW)
- [ ] disturbing potential/geopotential (m²/s²)

Minimum degree 361

Maximum degree 720

Extract effects | Plot↓

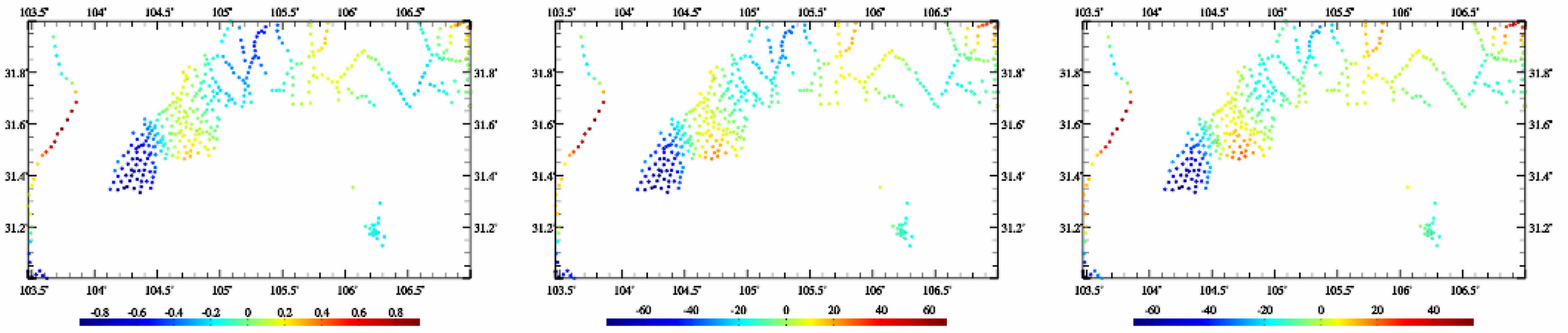
>> Computation Process ** Operation Prompts

Save computation process as

```
>> [Function] From global land-sea terrain mass spherical harmonic coefficient model (kg/m²), calculate the model value of terrain height/sea
depth, as well as the land-sea unified complete Bouguer or residual terrain effects on the height anomaly (m), gravity (anomaly/disturbance,
mGal), vertical deflection vector (", south, west), (disturbing) gravity gradient (E, radial), tangential gravity gradient vector (E, north, west), or
(disturbing) geopotential (m²/s²) on the geoid or in whole outer Earth space.
  ** Click the [Open global land-sea terrain mass spherical harmonic coefficient model file] control button or [Open terrain model] tool button...
>> Open global land-sea terrain mass spherical harmonic coefficient model file C:/PAGravf4.5_win64en/data/ETOPOcs1800.dat.
  ** The window below only shows the spherical harmonic coefficients data with no more than 2000 rows in it.
>> Open space calculation point file C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/calcpnt.txt.
  ** Look at the file information in the window below and set the discrete point file format...
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/rstpnt.txt.
  ** Behind the record of the calculation point file, appends one or more columns of model values of complete Bouguer or residual terrain effects,
and keeps 4 significant figures.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
  ** The calculation process need wait, during which you can open the output file to look at the calculation progress...
>> Computation start time: 2024-09-22 19:42:27
```

Save the results as | Import setting parameters | Start Computation

number	(vulue or str)	long(degree/decimal)	lat(degree/decimal)	ellipHeight(m)		
3248	103.671939	31.938051	2743.9394	-0.0132	-1.0149	0.2600
3249	103.696944	31.864721	2501.2449	-0.1990	-19.0949	-17.2622
3250	103.718330	31.831114	2435.4206	-0.2122	-21.6505	-20.5211
3251	103.735559	31.795280	2366.5700	-0.1467	-17.3694	-17.5808
3252	103.777216	31.776390	2294.0304	-0.0607	-10.6096	-11.9607
3253	103.822773	31.758333	2233.2317	0.0476	-1.3528	-3.7106
3254	103.849717	31.724168	2215.6606	0.2826	18.7685	14.3603



height anomaly (m) | gravity effect (mGal) | disturbing gradient (E, R)

The program is suitable for the unified computation of the complete Bouguer and residual terrain effects on various gravity field elements in land, land-sea junction and sea area. The calculation point may be on the geoid or iin whole outer Earth space.

Spherical harmonic synthesis of complete Bouguer or residual terrain effects

Calculation of model value for complete Bouguer or residual terrain effects

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

Calculation of model value for complete Bouguer or residual terrain effects

Calculator of global land-sea terrain effects model

Calculation and analysis of spectral character of global terrain effects model

Open global land-sea terrain mass spherical harmonic coefficient model file

Select calculation file format

Ellipsoidal height grid file

Open ellipsoidal height grid file of calculation surface

Select elements to be calculated

- [ ] terrain height/sea depth (m)
- [x] height anomaly (m)
- [x] gravity (anomaly/disturbance, mGal)
- [ ] vertical deflection (", SW)
- [x] (disturbing) gradient (E, radial)
- [ ] tangential gradient (E, NW)
- [ ] disturbing potential/geopotential (m²/s²)

Minimum degree 361

Maximum degree 720

Extract effects | Plot↓

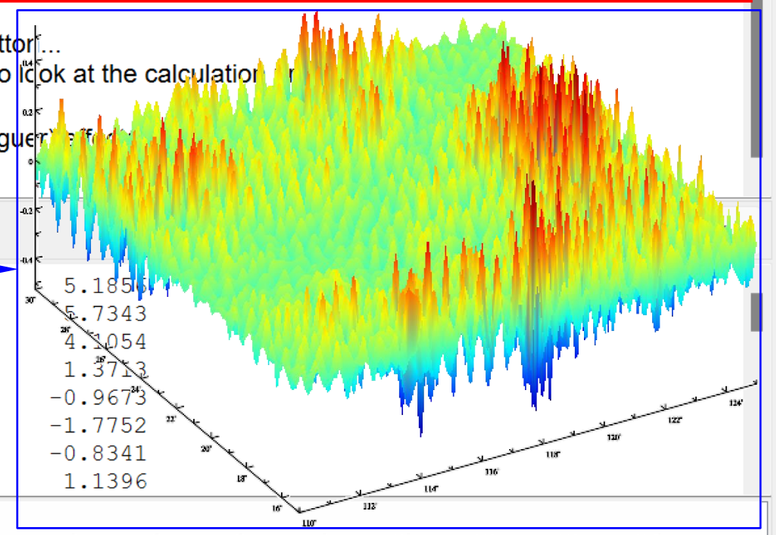
>> Computation Process ** Operation Prompts

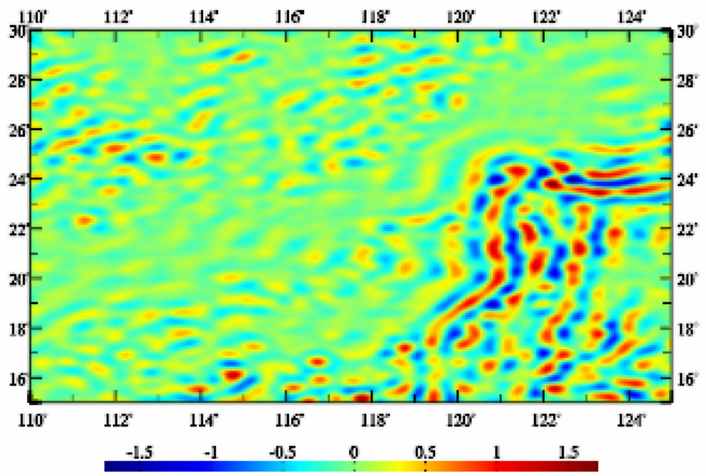
Save computation process as

```
>> Complete the calculation of the model value for residual terrain (complete Bouguer) effects!
>> Computation end time: 2024-09-22 19:57:51
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/dbmhgt5m.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/TerHarmrntinfluence/result.txt.
  ** The record format: point no/name, longitude, latitude, ellipsoidal height, several columns of the model values of complete Bouguer or residual terrain effects.
  ** The program also outputs the model value grid files for the terrain height/sea depth (m), complete Bouguer or residual terrain effects on height anomaly (*.ksi), gravity (anomaly/disturbance, *.gra), vertical deflection vector (*.dft), (disturbing) gravity gradient (*. grr), tangential gravity gradient vector (*.hgd) or (disturbing) geopotential (*.get) into the current directory. Where * is the output file name entered from the interface.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool buttor...
  ** The calculation process need wait, during which you can open the output file to look at the calculation r
>> Computation start time：2024-09-22 19:59:42
>> Complete the calculation of the model value for residual terrain (complete Bouguer...
>> Computation end time: 2024-09-22 20:12:32
```

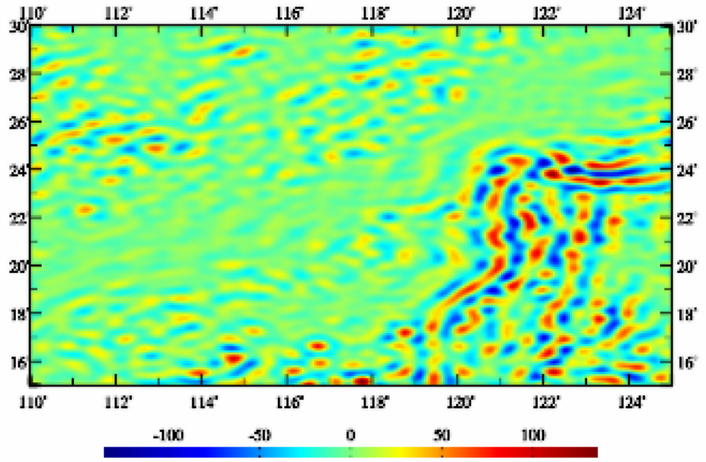
Save the results as | Import setting parameters

1	110.04167	15.04167	-1.947	0.1195	7.4827
2	110.12500	15.04167	-1.724	0.1476	8.8020
3	110.20833	15.04167	-1.484	0.1315	7.1302
4	110.29167	15.04167	-1.222	0.0825	3.5905
5	110.37500	15.04167	-0.937	0.0231	-0.0144
6	110.45833	15.04167	-0.628	-0.0245	-2.1472
7	110.54167	15.04167	-0.295	-0.0484	-2.2535
8	110.62500	15.04167	0.061	-0.0499	-0.8811

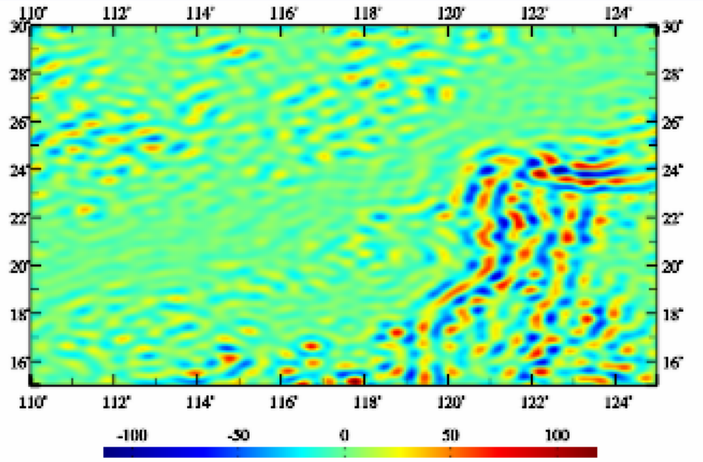




height anomaly (m)



gravity effect (mGal)



disturbing gradient (E, R)

The program is suitable for the unified computation of the complete Bouguer and residual terrain effects on various gravity field elements in land, land-sea junction and sea area. The calculation point may be on the geoid or iin whole outer Earth space.

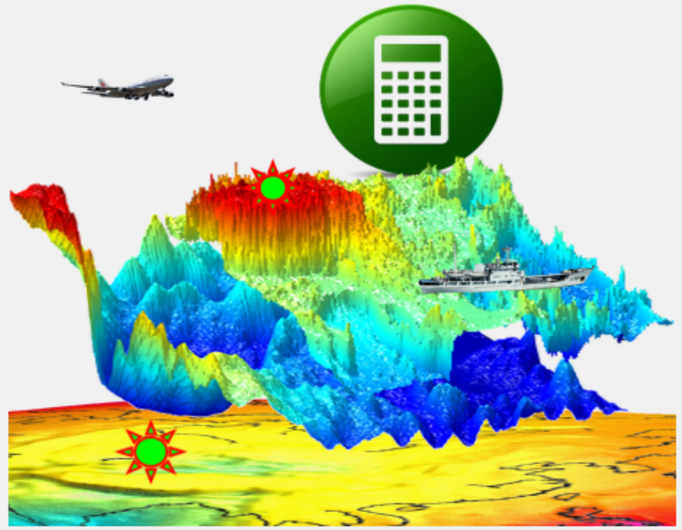
Calculator of global land-sea terrain effects model

Open global land-sea terrain mass spherical harmonic coefficient model file

When opening an ultrahigh degree global land-sea terrain mass spherical harmonic model file, the program need read and initialize, please wait...

Minimum degree 361

Maximum degree 1800



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

Input the geodetic coordinates of calculation point

longitude 121.240000°

latitude 29.428100°

ellipsoidal height 17.830m

Start Calculation

Model values of land-sea unified complete Bouguer or residual terrain effects

terrain height/sea depth (m) 520.04 | gravity (anomaly/disturbance, mGal) 57.9119

height anomaly (m) 0.4661 | vertical deflection (", S) 0.2286 | vertical deflection (", W) 1.3582

(disturbing) gradient (E, radial) 94.2959 | tangential gradient (E, N) -16.2491 | tangential gradient (E, W) -77.8878

(disturbing) geopotential (m²/s²) 4.5643

Global land-sea terrain mass spherical harmonic coefficient model

```
 3.986004415   6378136.30   -3666611.637   1.478
    1     0  1.7073567878991658E-01  0.0000000000000000E+00
    1     1  1.6633036628733813E-01  1.1479210613310797E-01
    2     0  1.6429313329998932E-01  0.0000000000000000E+00
    2     1  8.5035152210278894E-02  9.1333502848550255E-02
    2     2 -1.1793912586067470E-01 -1.7411465069800628E-02
    3     0 -6.5349154204352972E-02  0.0000000000000000E+00
    3     1 -4.4184211923815692E-02  4.0618031845130055E-02
    3     2 -1.3069109856940694E-01  1.2578589265181686E-01
    3     3  3.6582125575328230E-02  1.5294533153047263E-01
    4     0  1.0192376884714217E-01  0.0000000000000000E+00
    4     1 -5.9905008831126150E-02 -8.3292685493168567E-02
    4     2 -1.1471261607043508E-01  1.9460308775542352E-02
```

The relative error Θ (%) of the model

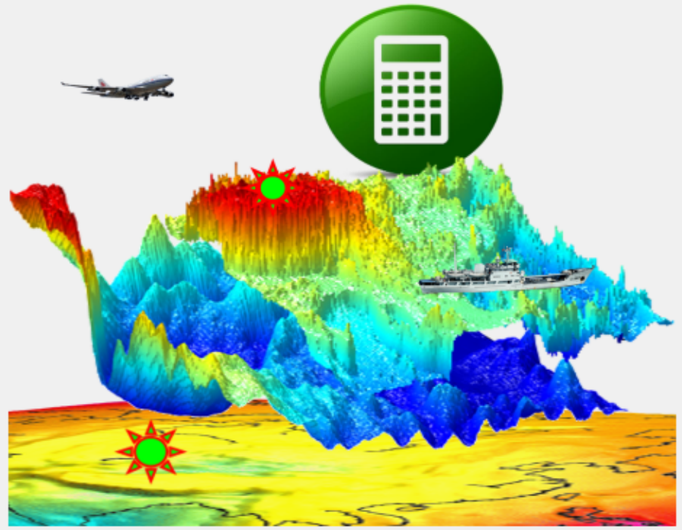
Calculator of global land-sea terrain effects model

Open global land-sea terrain mass spherical harmonic coefficient model file

When opening an ultrahigh degree global land-sea terrain mass spherical harmonic model file, the program need read and initialize, please wait...

Minimum degree 361

Maximum degree 1800



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

Input the geodetic coordinates of calculation point

longitude 132.240000°

latitude 21.428100°

ellipsoidal height 1.830m

Start Calculation

Model values of land-sea unified complete Bouguer or residual terrain effects

terrain height/sea depth (m) -5950.95

gravity (anomaly/disturbance, mGal) -40.4123

height anomaly (m) -0.2083

vertical deflection (", S) -5.2269

vertical deflection (", W) -0.7046

(disturbing) gradient (E, radial) -91.6757

tangential gradient (E, N) 67.2680

tangential gradient (E, W) 24.2020

(disturbing) geopotential (m²/s²) -2.0384

Global land-sea terrain mass spherical harmonic coefficient model

```
 3.986004415   6378136.30   -3666611.637   1.478
    1     0  1.7073567878991658E-01  0.0000000000000000E+00
    1     1  1.6633036628733813E-01  1.1479210613310797E-01
    2     0  1.6429313329998932E-01  0.0000000000000000E+00
    2     1  8.5035152210278894E-02  9.1333502848550255E-02
    2     2 -1.1793912586067470E-01 -1.7411465069800628E-02
    3     0 -6.5349154204352972E-02  0.0000000000000000E+00
    3     1 -4.4184211923815692E-02  4.0618031845130055E-02
    3     2 -1.3069109856940694E-01  1.2578589265181686E-01
    3     3  3.6582125575328230E-02  1.5294533153047263E-01
    4     0  1.0192376884714217E-01  0.0000000000000000E+00
    4     1 -5.9905008831126150E-02 -8.3292685493168567E-02
    4     2 -1.1471261607043508E-01  1.9460308775542352E-02
```

The relative error Θ (%) of the model

Calculation and analysis of spectral character of global terrain effects model

Open global land-sea terrain mass spherical harmonic coefficient model file

Open high-degree geopotential model file

Save the results as

Start Calculation

Display of the input-output file

2	3.125000E-01	6.715451E+00	7.911381E-02
3	8.641975E-02	3.952913E+00	8.823035E-02
4	3.515625E-02	2.312997E+00	2.289217E-02
5	1.760000E-02	1.416801E+00	1.366044E-02
6	1.003086E-02	4.389914E-01	8.191773E-03
7	6.247397E-03	2.654210E-01	5.675256E-03
8	4.150391E-03	9.823847E-02	2.379274E-03
9	2.895900E-03	1.038844E-01	1.819157E-03
10	2.100000E-03	7.850419E-02	1.264171E-03
11	1.570931E-03	3.775911E-02	6.892058E-04
12	1.205633E-03	2.646725E-02	2.284380E-04
13	9.453451E-04	2.874715E-02	5.736342E-04
14	7.548938E-04	2.222554E-02	2.158315E-04
15	6.123457E-04	1.544843E-02	1.950448E-04
16	5.035400E-04	1.479913E-02	1.898962E-04
17	4.190563E-04	1.517999E-02	1.308700E-04
18	3.524615E-04	8.631766E-03	1.393244E-04

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

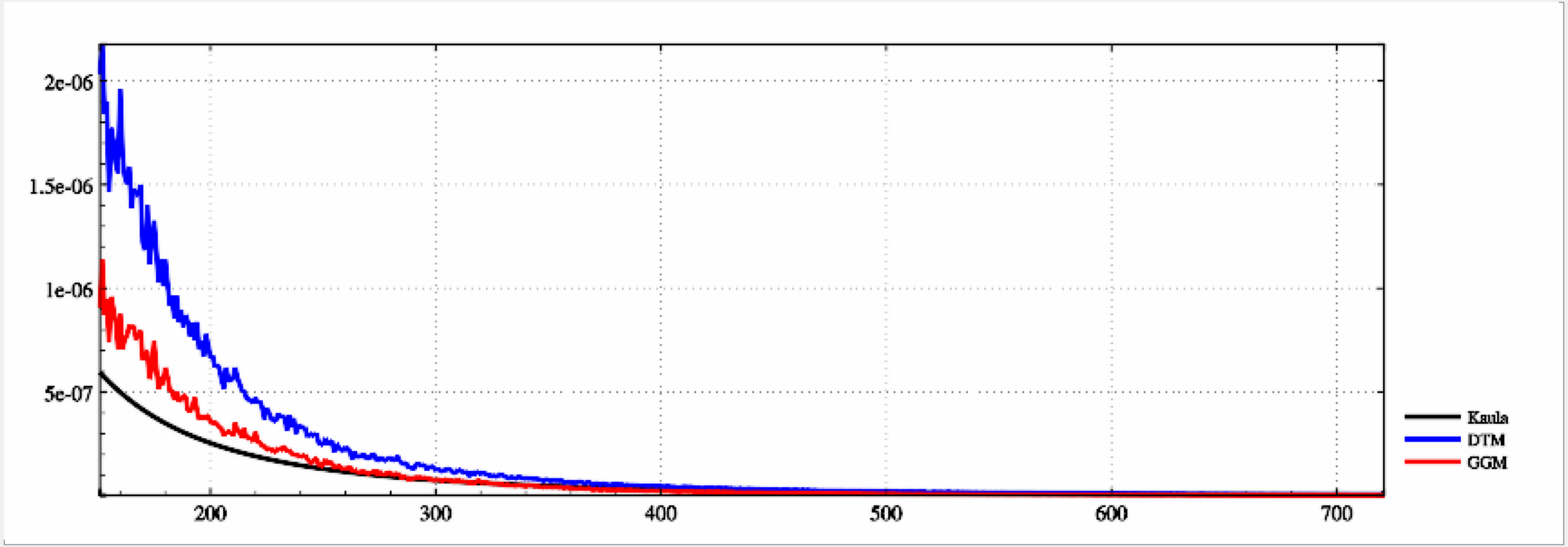
Start end row number 150 720

Line thickness 3

Chart plot↓

Save current plot as

Degree variance curves



Spherical harmonic synthesis of complete Bouguer or residual terrain effects

Calculate the 120″ model complete Bouguer effect grid on the gravity disturbance on the terrain equiheight surface.

Calculation of model value for complete Bouguer or residual terrain effects

Calculator of global land-sea terrain effects model

Calculation and analysis of spectral character of global terrain effects model

Open global land-sea terrain mass spherical harmonic coefficient model file

Select calculation file format

Ellipsoidal height grid file

Open ellipsoidal height grid file of calculation surface

Select elements to be calculated

- [ ] terrain height/sea depth (m)
- [ ] height anomaly (m)
- [x] gravity anomaly/disturbance (mGal)
- [ ] vertical deflection (", SW)
- [ ] disturbing gradient (E, radial)
- [ ] tangential gradient (E, NW)
- [ ] disturbing potential/geopotential (m²/s²)

Minimum degree 2

Maximum degree 900

>> Computation Process ** Operation Prompts

Save computation process as

```
>> [Function] From global land-sea terrain mass spherical harmonic coefficient model (kg/m²), calculate the model value of terrain height/sea depth, as well as
the land-sea unified complete Bouguer or residual terrain effects on the height anomaly (m), gravity anomaly (mGal), gravity disturbance (mGal), vertical
deflection vector (", south, west), disturbing gravity gradient (E, radial), tangential gravity gradient vector (E, north, west), or disturbing geopotential (m²/s²) on
the geoid or in its outer space.
  ** Click the [Open global land-sea terrain mass spherical harmonic coefficient model file] control button, or the [Open terrain model] tool button...
>> Open global land-sea terrain mass spherical harmonic coefficient model file C:/PAGravf4.5_win64en/data/ETOPOcs1800.dat.
  ** The window below only shows the geopotential coefficients data with no more than 2000 rows in it.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Terraininflexercise/TerComplbgprocess/equihgt120s1.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Terraininflexercise/TerComplbgprocess/distgravmdlcmpbg.txt.
  ** The record format: point no/name, longitude, latitude, ellipsoidal height, several columns of the model values of complete Bouguer or residual terrain effects.
  ** The program also outputs the model values grid file for complete Bouguer or residual terrain effects on height anomaly (*.ksi), gravity anomaly (*.gra),
gravity disturbance (*.rga), vertical deflection vector (*.dft), disturbing gravity gradient (*. grr), tangential gravity gradient vector (*.hgd) or disturbing geopotential
(*.get) into the current directory, where * is the output file name entered from the interface.
>> The parameter settings have been entered into the system!
  ** Click the [Start Computation] control button, or the [Start Computation] tool button...
  ** The calculation process need wait, during which you can open the output file to look at the calculation progress.
```

Save the results as

Import setting parameters

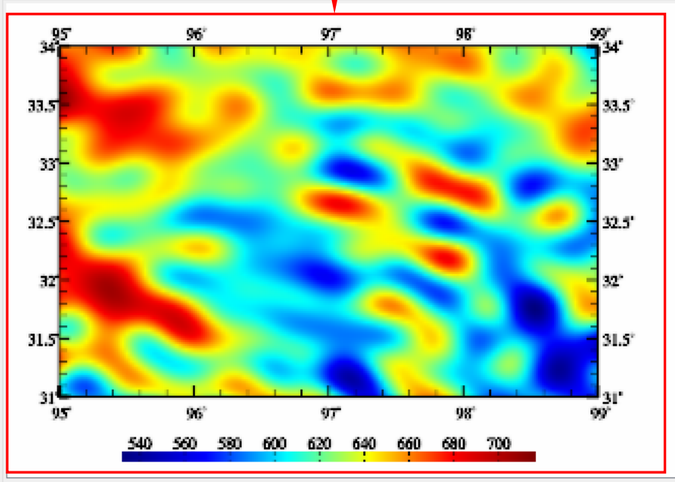
Start Computation

```
   95.000000   99.000000   31.000000   34.000000  0.03333333  0.03333333
   4476.8350   4476.8348   4476.8365   4476.8353   4476.8...
   4476.9302   4476.9403   4476.9518   4476.9660   4476.9...
   4477.1633   4477.1826   4477.2002   4477.2126   4477.2...
   4477.3333   4477.3369   4477.3402   4477.3426   4477.3...
   4477.3162   4477.3113   4477.3065   4477.3017   4477.29
   4477.2949   4477.3014   4477.3107   4477.3215   4477.33
   4477.5921   4477.6261   4477.6627   4477.7016   4477.74
   4478.2944   4478.3510   4478.4090   4478.4673   4478.52
```

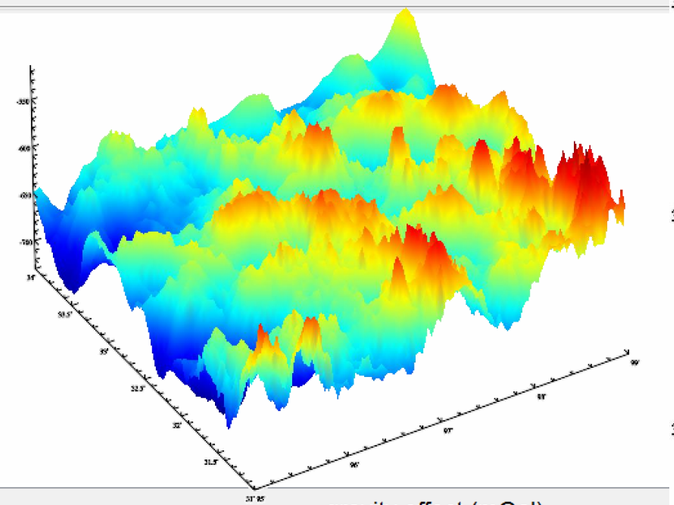
Generate the 120″ complete Bouguer gravity disturbance on the terrain equiheight surface.

Extract effects

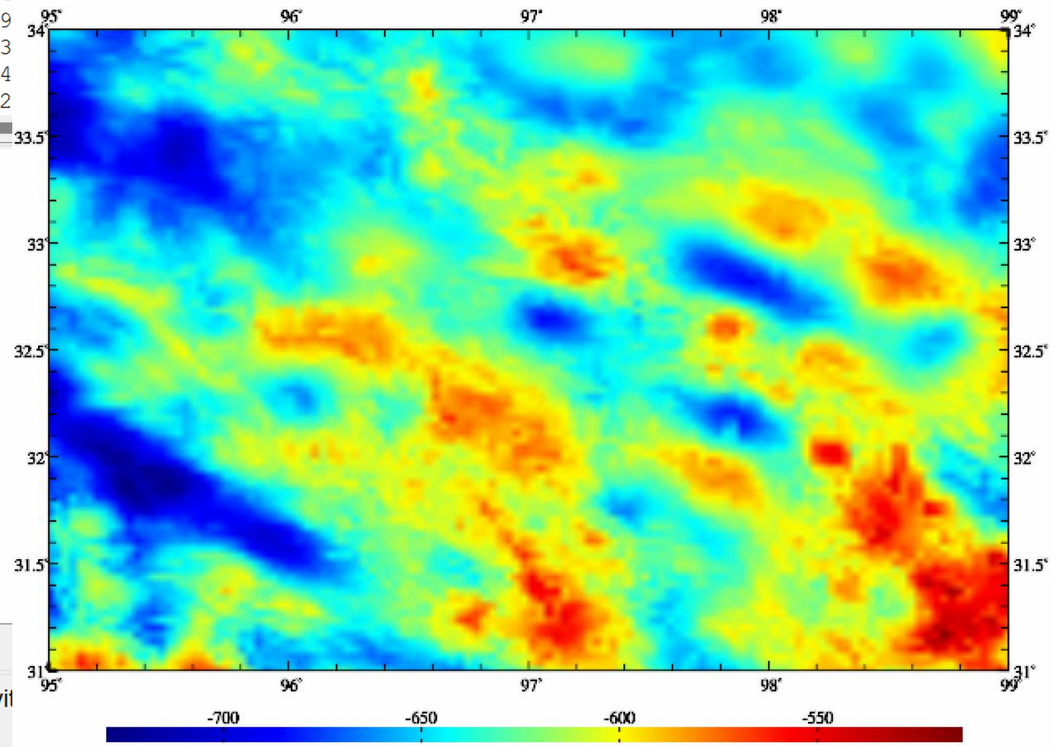
Plot↓



gravity effect (mGal)



gravity effect (mGal)



The program is suitable for the unified computation of the complete Bouguer and residual terrain effects on various gravi
the geoid and its outer Earth space.

Calculation of global geopotential model and its spectral character analysis

Calculate the gravity anomaly and gravity disturbance on geoid from the geopotential coefficient model.

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

Select calculation file format

Ellipsoidal height grid file

Open ellipsoidal height grid file of calculation surface

Select elements to be calculated

- [ ] height anomaly (m)
- [x] gravity anomaly (mGal)
- [x] gravity disturbance (mGal)
- [ ] vertical deflection (", SW)
- [ ] disturbing gravity gradient (E, radial)
- [ ] tangential gravity gradient (E, NW)
- [ ] Laplace operator (E)

Minimum degree 2

Maximum degree 1800

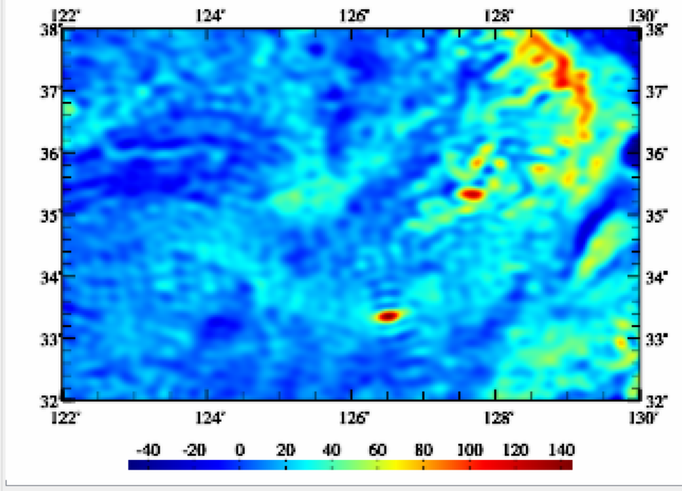
Extract elements to be plot | Plot↓

Save computation process as | Algorithmic Formulas

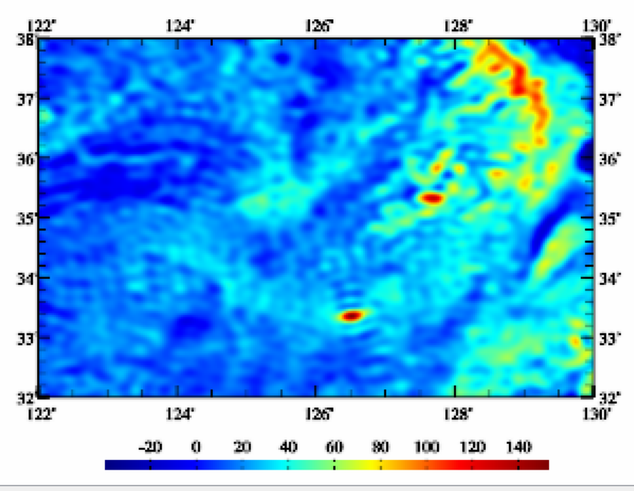
```
>> Open global geopotential coefficient model file C:/PAGravf4.5_win64en/data/EGM2008.gfc.
  ** The window below only shows the geopotential coefficients data with no more than 2000 rows in it.
>> Open ellipsoidal height grid file of calculation surface C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/
GMgeoidh2m_180.ksi.
>> Save the results as C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/EGM2008_2m_1800.txt.
  ** The record format: point no/name, longitude, latitude, ellipsoidal height, several columns of the model values of anomalous field elements.
  ** The program also outputs (residual) height anomaly (*.ksi), gravity anomaly (*.gra), gravity disturbance (*.rga), vertical deflection vector (*.dft),
disturbing gravity gradient (*. grr), tangential gravity gradient vector (*.hgd) or Laplace operator (*.lps) model value grid file into the current
directory. Where * is the output file name entered in the interface, and the program outputs the corresponding (residual) model value grid file
according to the selected gravity field element type.
>> The parameter settings have been entered into the system!
  ** 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：2023-03-19 00:07:22
```

Save the results as | Import setting parameters | Start Computation

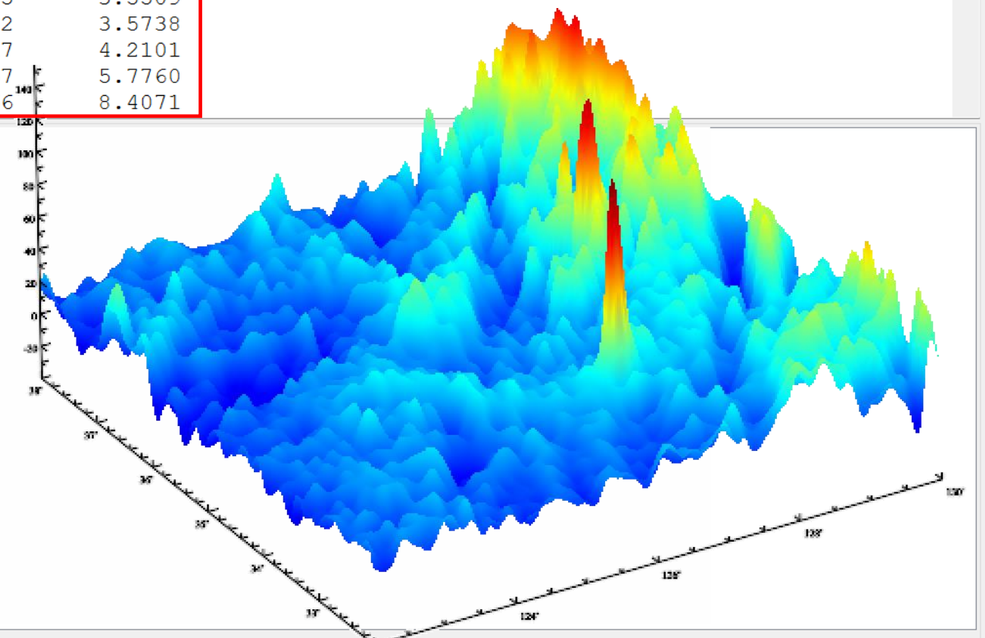
1	122.01667	32.01667	13.031	4.2037	8.2077
2	122.05000	32.01667	13.153	2.6153	6.6517
3	122.08333	32.01667	13.276	1.3041	5.3727
4	122.11667	32.01667	13.399	0.3653	4.4667
5	122.15000	32.01667	13.522	-0.2572	3.8777
6	122.18333	32.01667	13.645	-0.6185	3.5509
7	122.21667	32.01667	13.768	-0.6312	3.5738
8	122.25000	32.01667	13.891	-0.0317	4.2101
9	122.28333	32.01667	14.014	1.4957	5.7760
10	122.31667	32.01667	14.137	4.0866	8.4071



gravity anomaly (mGal)



gravity disturbance (mGal)



vertical deflection (", S

When the minimum and maximum degree n to be set is equal, the program calculates the contribution of the degree n gravity field element to be calculated, which can be employed to analyze and evaluate the spectral and space properties of the geopotential coefficient model.

The 2~1800th model gravity disturbance on geoid

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

Calculate the total Bouguer effects and total equilibrium effects on gravity

Open DTM | Import parameters | Save as | Start Computation | Save process | Follow example

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

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

Algorithms land-sea unified classic Bouguer and equilibrium effects

Open the land-sea terrain model file

Open the ellipsoidal height grid file of land-sea surface

Select calculation points file format

ellipsoidal height grid file

Open the ellipsoidal height grid file on land-sea calculation surface

Integral radius for local terrain effect: 90 km

Integral radius for seawater Bouguer / equilibrium effect: 300 km

Equilibrium compensation depth: 30 km

>> Computation Process ** Operation Prompts

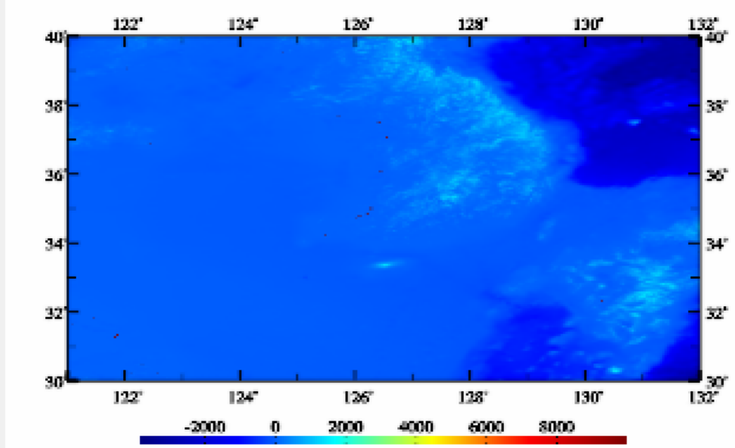
Save computation process as

>> Open the land-sea terrain model file C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/extlandseadtm2m.dat.
>> Open the ellipsoidal height grid file of land-sea surface C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/extlandseahgt2m.dat.
>> Open the ellipsoidal height grid file on land-sea calculation surface C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/extlandseahgt2m.dat.
>> Save the results as C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/BougEquinfl2m.txt0
** Record format: Point no, longitude, latitude, ellipsoidal height, terrain height/sea depth, local terrain effect, plane layer effect, seawater Bouguer effect, land equilibrium effect, ocean equilibrium effect, total Bouguer effect and total equilibrium effect.
** At the same time, the program also outputs the land-sea total Bouguer effect (*.bgr) and land-sea total equilibrium effect (*.ist) grid file into the current directory, where * is the output file name entered from the interface.

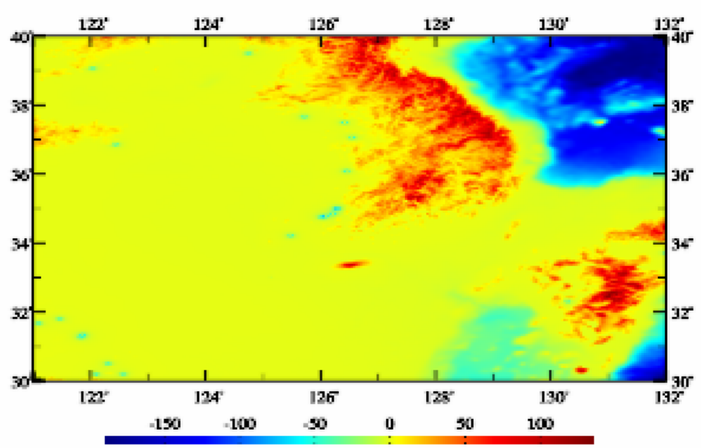
Save the results as | Import setting parameters | Start Computation

no	lon(deg/decimal)	lat	height/depth	local terrian,	plane layer,	sea-water Bouguer effect,	...	
1	121.01667	30.01667	43.360	-0.0930	4.8550	-0.0052	-0.5258	0.0729
2	121.05000	30.01667	20.550	-0.0329	2.3010	-0.0053	-0.5820	0.0774
3	121.08333	30.01667	45.640	-0.1658	5.1102	-0.0056	-0.6299	0.0821
4	121.11667	30.01667	7.880	-0.0164	0.8823	-0.0057	-0.6957	0.0870
5	121.15000	30.01667	6.400	-0.0072	0.7166	-0.0058	-0.7545	0.0922
6	121.18333	30.01667	5.000	-0.0311	0.5598	-0.0060	-0.8137	0.0977

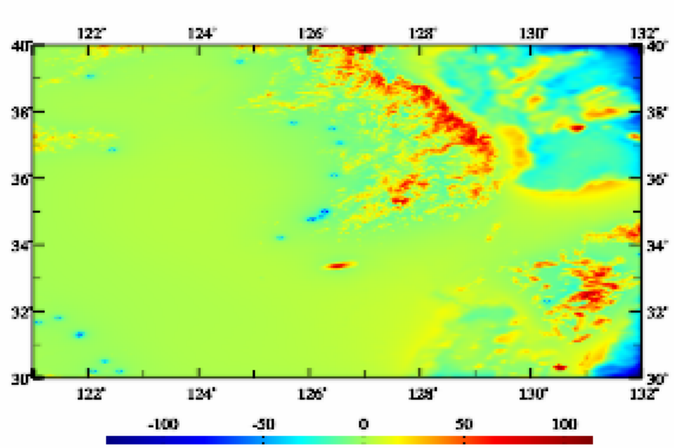
Extract effects | Plot↓



land-sea terrain model (m)



total Bouguer effect (mGal)



total equilibrium effect (mGal)

Classic Bouguer gravity anomaly on geoid = gravity anomaly at the measurement point – total Bouguer effect – analytical continuation of gravity anomaly from the measurement point to the geoid. Classic Bouguer gravity disturbance on geoid = gravity disturbance at the measurement point – total Bouguer effect – analytical continuation of gravity disturbance from the measurement point to the geoid.

Classic equilibrium gravity anomaly on geoid = gravity anomaly at the measurement point – total equilibrium effect – analytical continuation of gravity anomaly from the measurement point to the geoid. Classic equilibrium gravity disturbance on geoid = gravity disturbance at the measurement point – total equilibrium effect – analytical continuation of gravity disturbance from the measurement point to the geoid.

Simple and direct calculation on geodetic data files

Generate the 2′×2′ land-sea unified classical Bouguer / isostatic anomaly grid model.

Weighted operation on two specified attributes in record file | Weighted operation on two geodetic grid files | Weighted operation on two vector grid files | Weighted operation on two harmonic coefficient files

Open geodetic grid file 1

Open geodetic grid file 2

Select operation mode

Plus +

Set weight

The first weight 1.00

The second weight 1.00

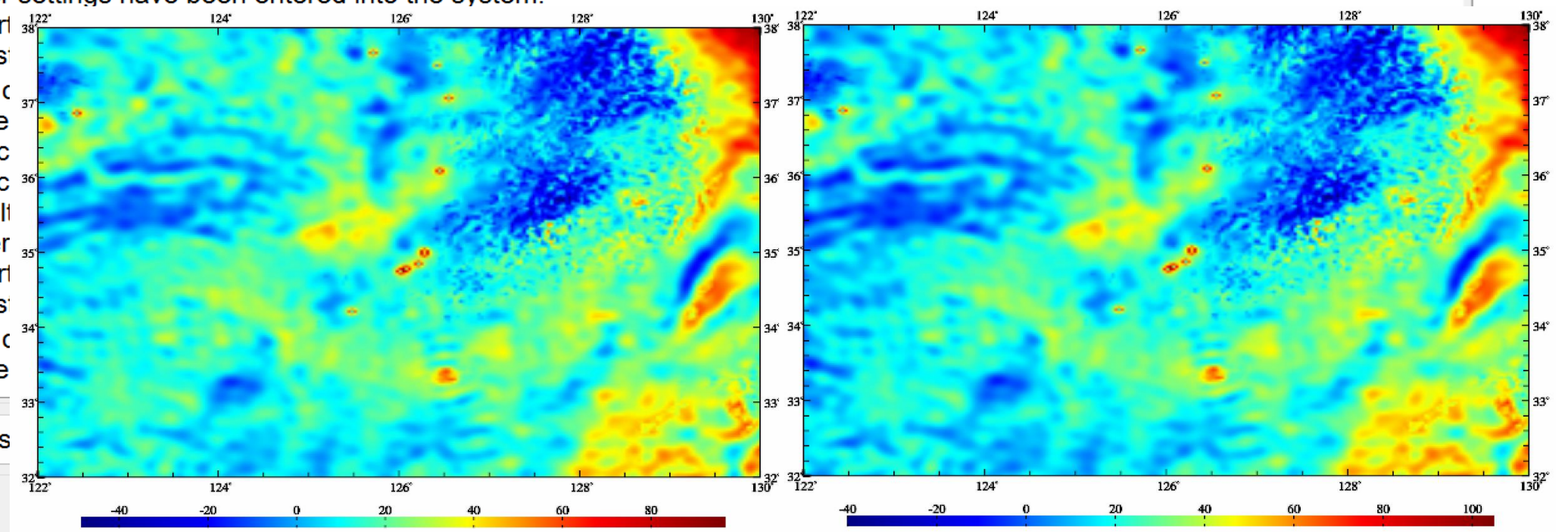
Vector grid operation

>> Program Process ** Operation Prompts

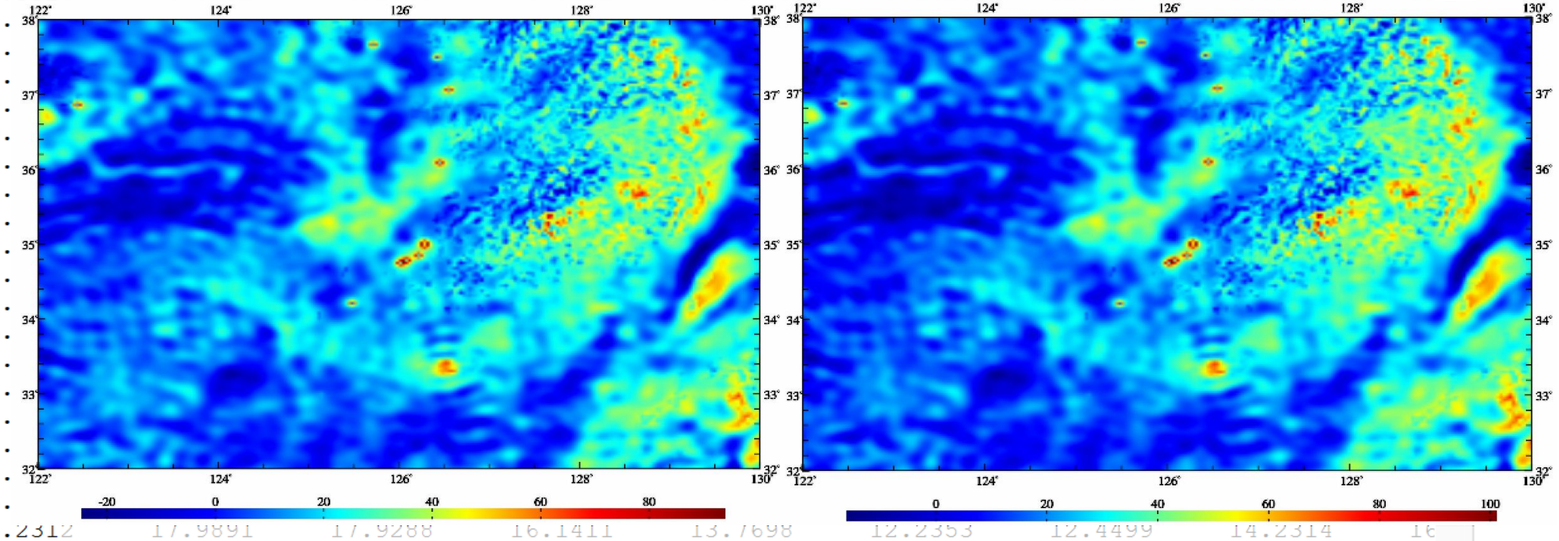
Save program process as

```
>> Select the function module from the four control buttons at the top of the interface...
>> [Function] Perform weighted plus, minus, or multiply operation on grid elements in two (vector) grid files with the same specifications.
>> Open geodetic grid file 1 C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/EGM2008_2m_1800.gra.
>> Open geodetic grid file 2 C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/BougEquinfl2m0.bgr.
>> Save the results as C:/PAGravf4.5_win64en/examples/Terraininflexercise/GMBougEquilibrium/Istbggravanom2m.dat.
>> The parameter settings have been entered into the system!
 ** Click the [Start
>> Computation s
>> Complete the c
>> Computation e
>> Open geodetic
>> Open geodetic
>> Save the result
>> The parameter
 ** Click the [Start
>> Computation s
>> Complete the c
>> Computation e
```

Save the res



The 2′ land-sea unified classical Bouguer gravity anomaly and disturbance



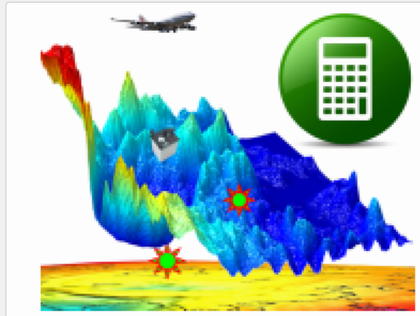
The 2′ land-sea unified classical isostatic gravity anomaly and disturbance

Display of the input-output file↓

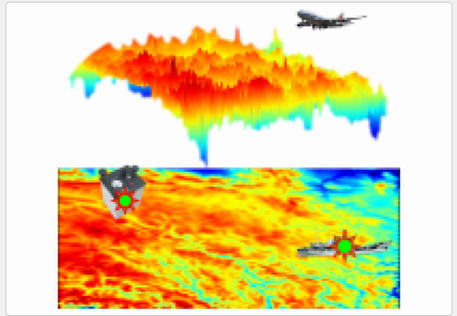
122.000000	130.000000	32.000000	38.000000	0.03333333
8.3775	6.8966	5.6899	4.8540	4.3325
19.2133	17.4019	15.8291	14.7983	14.
24.3218	26.4713	28.0518	28.6086	27.
12.9158	10.3765	10.0539	11.7974	14.
15.3356	13.0657	11.4755	11.0485	11.
22.3411	22.1708	21.4036	20.3436	19.
12.8327	12.3341	11.1957	10.0041	9.
22.0979	22.6739	23.1295	23.1236	22.
23.9972	26.5997	28.6183	30.3440	31.
27.7904	27.6035	26.8185	26.0919	25.
36.7723	32.2543	27.9404	25.2177	24.
23.0243	24.8093	26.4821	28.4630	31.
60.4889	61.1129	60.1925	58.4199	56.
52.1456	47.6924	45.4768	45.1435	45.
9.4949	11.3991	12.7729	13.7259	14.
0.4051	-4.5601	-10.9319	-16.3954	-17.
14.7698	13.3947	11.4517	9.3666	7.
22.1548	20.7063	19.4075	18.5611	18.
22.9153	25.1115	26.7739	27.3524	26.
16.1274	12.9445	12.2021	13.7358	16.2312
16.1741	13.6392	11.3091	9.8888	9.5055

Computation of various terrain effects on various field elements outside geoid

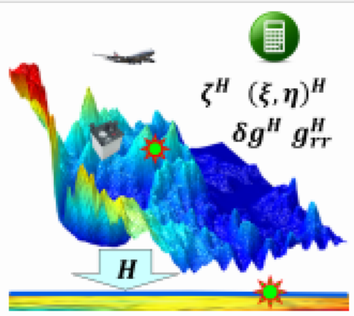
Computation of various terrain effects on various field elements outside geoid



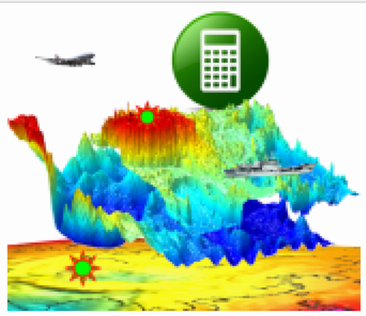
Computation of local terrain effect on various field elements on or outside the geoid



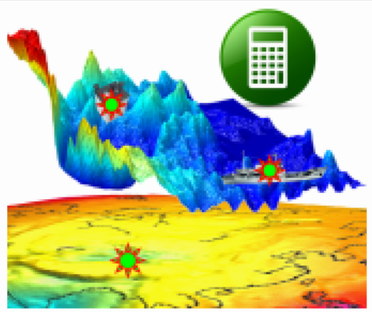
Integral of land, ocean and lake complete Bouguer effect on gravity outside geoid



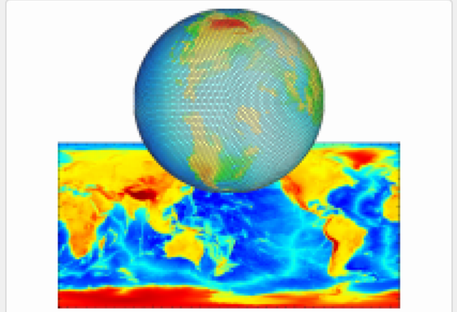
Computation of terrain Helmert condensation effect on various field elements outside geoid



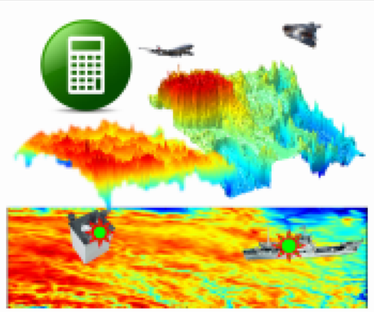
Computation of residual terrain effect on various field elements outside geoid



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



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



Spherical harmonic synthesis of complete Bouguer or residual terrain effects

Computation process demo of complete Bouguer anomaly on terrain equiheight surface

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

Computation process demo of various terrain effects outside geoid

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

Programs and functions structure of the subsystem

Quantitative criterions for terrain effects defined by PAGravf4.5

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

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

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