

Demonstration of Land-Sea Bouguer and Isostatic Anomalies- Disturbances Derived from a Geopotential Model

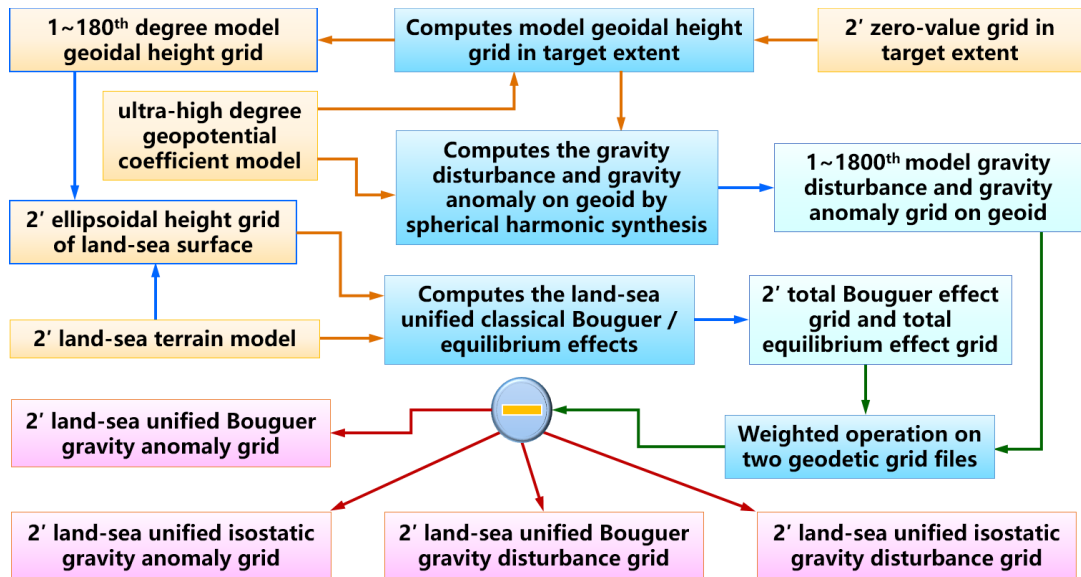
PAGravf4.5; <https://www.zcyphygeodesy.com/en/>

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March 2026, Beijing, 100830, China

This module demonstrates a rapid workflow for computing classical Bouguer gravity anomalies (or disturbances) and isostatic gravity anomalies (or disturbances) for any global region. Utilizing an Earth geopotential coefficient model and a land-sea terrain mass spherical harmonic coefficient model, the process executes four key steps to synchronously generate unified land-sea anomaly models.



**Computation Process of Land-Sea Bouguer and Isostatic Gravity Anomalies/Disturbances
Derived from a Geopotential Model**

(1) Construction of the Model Geoidal Height Grid (Degrees 1 – 180) as the Reduction Surface

Function Call: [Computation of Gravity Field Elements from a Global Geopotential Model].

Parameters:

- Degree Range: Min = 1, Max = 180.
- Output Type: Height Anomaly (approximating geoidal height in this context).

Inputs:

- Geopotential Model: EGM2008.gfc.
- Target Latitude and Longitude Extent Definition: Zero-value grid file zero2m.dat.

Output File: 2'x2' Model Geoidal Height Grid: GMgeoidh2m_180.ksi.

Physical Role: This grid serves as the gravity reduction surface and the reference surface for subsequent classical Bouguer and isostatic anomaly computations.

(2) Computation of Gravity Anomaly and Disturbance on the Geoid from a a Global Geopotential Model

Function Call: [Computation of Gravity Field Elements from a Global Geopotential Model].

Parameter Settings:

- Degree Range: Min = 1, Max = 1800.
- Output Elements: Select both Gravity Anomaly and Gravity Disturbance.

Input Files:

- Geopotential Model: EGM2008.gfc.
- Computation Surface: The model geoidal height grid GMgeoidh2m_180.ksi generated in Step (1).

Output Files:

- 2'x2' Gravity Anomaly Grid: EGM2008_2m_1800.gra.
- 2'x2' Gravity Disturbance Grid: EGM2008_2m_1800.rga.

The screenshot shows the software interface for computing gravity anomalies and disturbances. The main window title is "(1) Construction of the Model Geoidal Height Grid (Degrees 1 - 180) as the Reduction Surface". The interface includes a menu bar, a toolbar, and several panels. The "Select elements to be computed" panel has "height anomaly (m)" selected. The "Minimum degree" is set to 1 and "Maximum degree" is set to 180. A table shows 7 rows of data with columns for ID, longitude, latitude, ellipsoidal height, and several other values. Below the table are two plots: "height anomaly (m)" and "gravity disturbance (mGal)". A text box points to the first plot with the text: "The 1~180th degree model geoidal height grid as the gravity reduction surface grid".

1	122.01667	32.01667	0.000	13.0311
2	122.05000	32.01667	0.000	13.1534
3	122.08333	32.01667	0.000	13.2
4	122.11667	32.01667	0.000	13.3
5	122.15000	32.01667	0.000	13.5
6	122.18333	32.01667	0.000	13.6
7	122.21667	32.01667	0.000	13.7

(3) Computation of Total Bouguer and Total Isostatic Effects on Gravity

Function Call: [Integration of Land-Sea Unified Classical Gravity Bouguer / Equilibrium Effect].

Input Files:

- Land-Sea Terrain Model: extlandseadm2m.dat.
- Land-Sea Surface Ellipsoidal Height Grid: extlandseahgt2m.dat.

(2) Computation of Gravity Anomaly and Disturbance on the Geoid from a Global Geopotential Model

Start Computation Follow example

Computation of Gravity Field Elements from a Global Geopotential Model

Computation of Model Values for Residual Terrain (Complete Bouguer) Effects

Global Geopotential Coefficient Model Calculator

Calculation and Analysis of Spectral Characteristics of the Earth's Gravity Field

Open Global Geopotential Coefficient Model File

Select computation file format

Surface Ellipsoidal height grid file

Open Computation Surface Ellipsoidal Height Grid File

Select elements to be computed

height anomaly (m)

gravity anomaly (mGal)

gravity disturbance (mGal)

vertical deflection (" SW)

disturbing gravity gradient (E, radial)

tangential gravity gradient (E, NW)

Laplace operator (E)

Minimum degree 1

Maximum degree 1800

Save computation process as

Algorithmic Formulas

>> [Function] Utilizing a global geopotential coefficient model, this module computes model values for (residual) height anomaly (m), gravity anomaly (mGal), gravity disturbance (mGal), vertical deflection vector (" south, west components), disturbing gravity gradient(E, radial component), tangential gravity gradient vector(E, north, west components), or Laplace operator (E) component).

>> Click the [Open Global Geopotential Coefficient Model File] control button, or the [Open Geopotential Model] tool button...

>> Open Global Geopotential Coefficient Model File C:/PAGrav4_5_win64en/data/EGM2008.gfc

** The window below only shows the geopotential coefficients data with no more than 2000 rows in it.

>> Open Computation Surface Ellipsoidal Height Grid File C:/PAGrav4_5_win64en/examples/TerrainInflexercise/GMBougeEquilibrium/GMGeoidh2m 180.ksl

>> Save the results as C:/PAGrav4_5_win64en/examples/TerrainInflexercise/GMBougeEquilibrium/EGM2008_2m_1800.txt

** The record format: ID (point no/name), longitude, latitude, ellipsoidal height, several columns of the modal values of anomalous field elements.

** The program automatically generates corresponding (residual) model value grid files in the current directory with the following extensions based on the selected element: height anomaly (" ksl), gravity anomaly (" rga), gravity disturbance (" rga), vertical deflection vector (" dft), disturbing gravity gradient (" mgr), tangential gravity gradient vector (" hgd), or Laplace operator (" lps) into the current directory. Where " is the user-defined output filename prefix.

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

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

Extract elements to be plot Plot

gravity anomaly (mGal)

gravity disturbance (mGal)

The 1-1800th degree model gravity disturbance on geoid

(3) Computation of Total Bouguer and Total Isostatic Effects on Gravity

Open DTM Import parameters Save as Save process Follow example

Integration of Unified Land-Sea Classical Gravity Bouguer and Isostatic Effects

Interactive Calculator for Unified Land-Sea Classical Gravity Bouguer and Isostatic Effects

Algorithms land-sea unified classic Bouguer and equilibrium effects

Open Land-Sea Terrain Model File

Open Land-Sea Surface Ellipsoidal Height Grid File

Select computation point file format

Open Land-sea Computation Surface Ellipsoidal Height Grid File

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

>> [Function] Computes the unified land-sea classical Bouguer and isostatic effects on surface gravity (mGal) based on the input land-sea terrain model and land-sea surface ellipsoidal height grid files.

>> Open Land-Sea Terrain Model File C:/PAGrav4_5_win64en/examples/TerrainInflexercise/GMBougeEquilibrium/extlandseadm2m.dat

>> Open Land-Sea Surface Ellipsoidal Height Grid File C:/PAGrav4_5_win64en/examples/TerrainInflexercise/GMBougeEquilibrium/extlandseahg2m.dat

>> Open Land-sea Computation Surface Ellipsoidal Height Grid File C:/PAGrav4_5_win64en/examples/TerrainInflexercise/GMBougeEquilibrium/extlandseahg2m.dat

>> Save the results as C:/PAGrav4_5_win64en/examples/TerrainInflexercise/GMBougeEquilibrium/BougeEquinft2m0.txt

** Outputs formatted records: ID, Lon, Lat, h, [Seven Effect Values...]

** Automatically generates: Unified Land-Sea Total Bouguer Effect: .bgr, and Unified Land-Sea Total Isostatic Effect: .ist.

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

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

>> Computation start time: 2026-04-11 12:15:15

>> Complete the computation of land-sea unified classical Bouguer / equilibrium effects!

Save the results as Import setting parameters

Start Computation

no	lon (deg/decimal)	lat	height/depth local	terrain, plane layer, sea-water Bouguer effect, ...						
1	121.01667	30.01667	43.360	-0.0930	4.8550	-0.0052	-0.5258	0.0729	4.7567	4.3039
2	121.05000	30.01667	20.550	-0.0329	2.3010	-0.0053	-0.5820	0.0774	2.2627	1.7551
3	121.08333	30.01667	45.640	-0.1658	5.1102	-0.0056	-0.6299	0.0821	4.5389	4.3910
4	121.11667	30.01667	7.880	-0.0164	0.8823	-0.0057	-0.6957	0.0870	0.8602	0.2515
5	121.15000	30.01667	6.400	-0.0072	0.7166	-0.0058	-0.7545	0.0922	0.7036	0.0413

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.

Parameter Settings:

- Land Integration Radius: 90 km.

- Sea Integration Radius: 200 km.
- Isostatic Compensation Depth: 30 km.

Output Files:

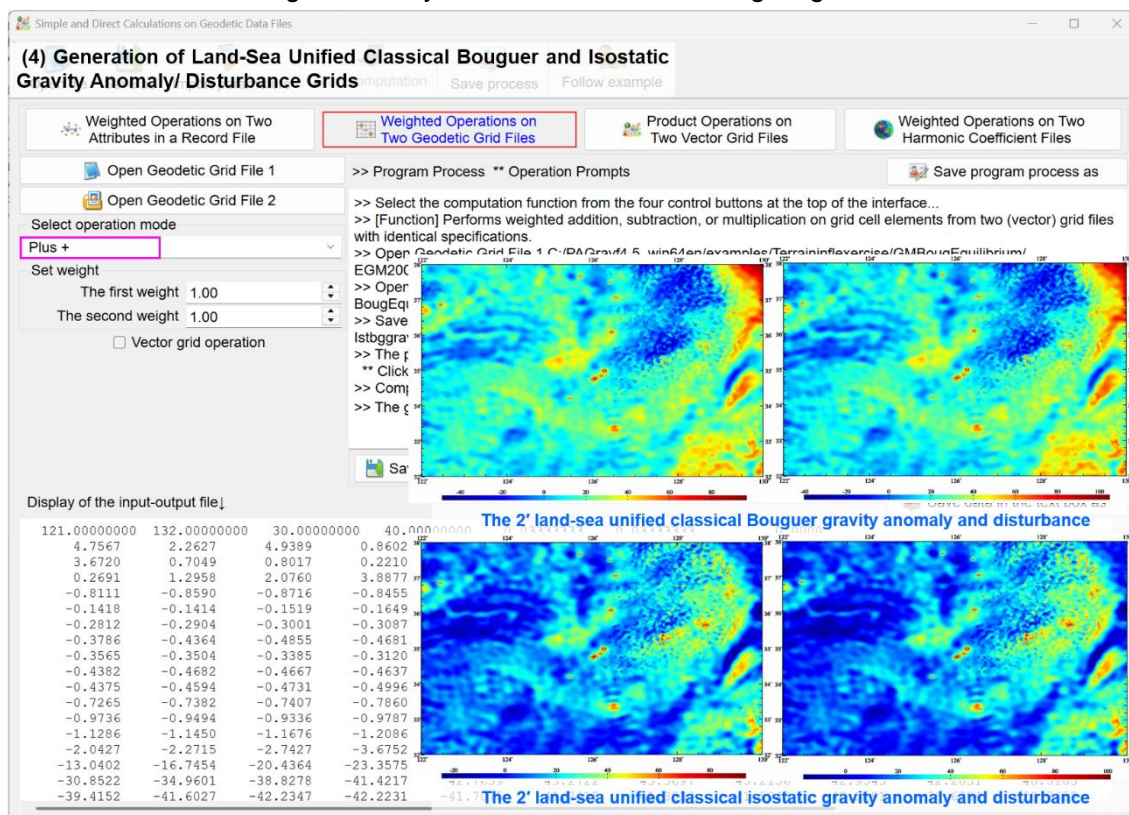
- 2'x2' Total Bouguer Effect Grid: BougEquinfl2m.bgr.
- 2'x2' Total Isostatic Effect Grid: BougEquinfl2m.ist.

Theoretical Note: Given the invariance of the normal gravity field with respect to the chosen reference surface, the computed Bouguer/Isostatic effects are numerically identical for both gravity anomalies and gravity disturbances. Consequently, there is no need to distinguish between these two quantities in the reduction process.

(4) Generation of Land-Sea Unified Classical Bouguer and Isostatic Gravity Anomaly/ Disturbance Grids

Classical Bouguer Anomalies:

- Operation: Subtract the edge-truncated total Bouguer effect grid (BougEquinfl2m0.bgr) from the geoid-based gravity anomaly (EGM2008_2m_1800.gra) and gravity disturbance (EGM2008_2m_1800.rga) grids, respectively.
- Output Models:
 - Classical Bouguer Gravity Anomaly Model: Clsbggravanom2m.dat.
 - Classical Bouguer Gravity Disturbance Model: Clsbgdistgrav2m.dat.



Classical Isostatic Anomalies:

- Operation: Subtract the edge-truncated total isostatic effect grid (BougEquinfl2m0.ist) from the geoid-based gravity anomaly (EGM2008_2m_1800.gra) and gravity disturbance

(EGM2008_2m_1800.rga) grids, respectively.

- Output Models:
 - Classical Isostatic Gravity Anomaly Model: Istbggravanom2m.dat.
 - Classical Isostatic Gravity Disturbance Model: Istbgdistgrav2m.dat.