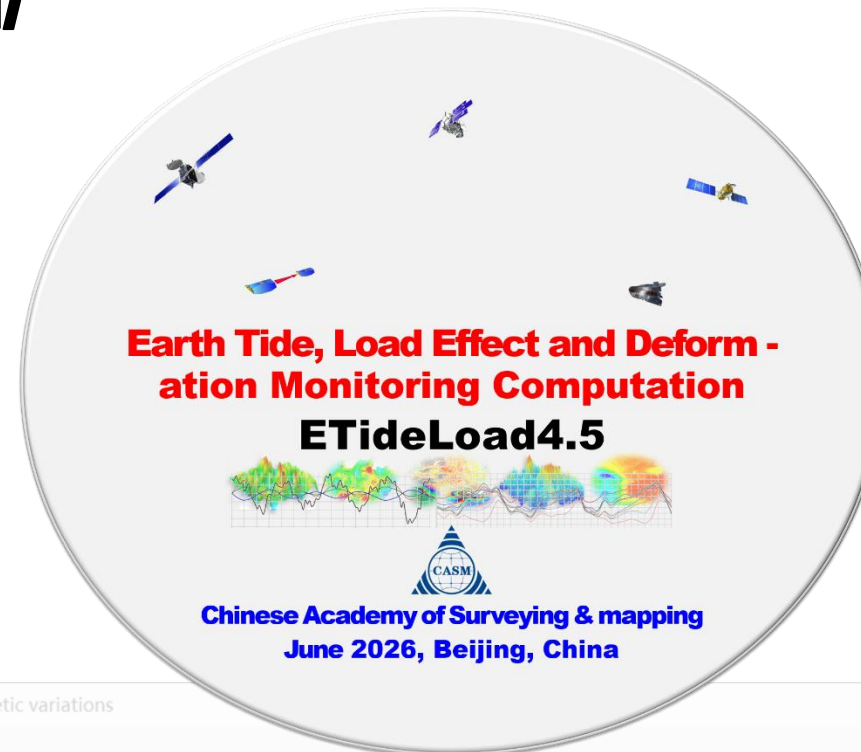
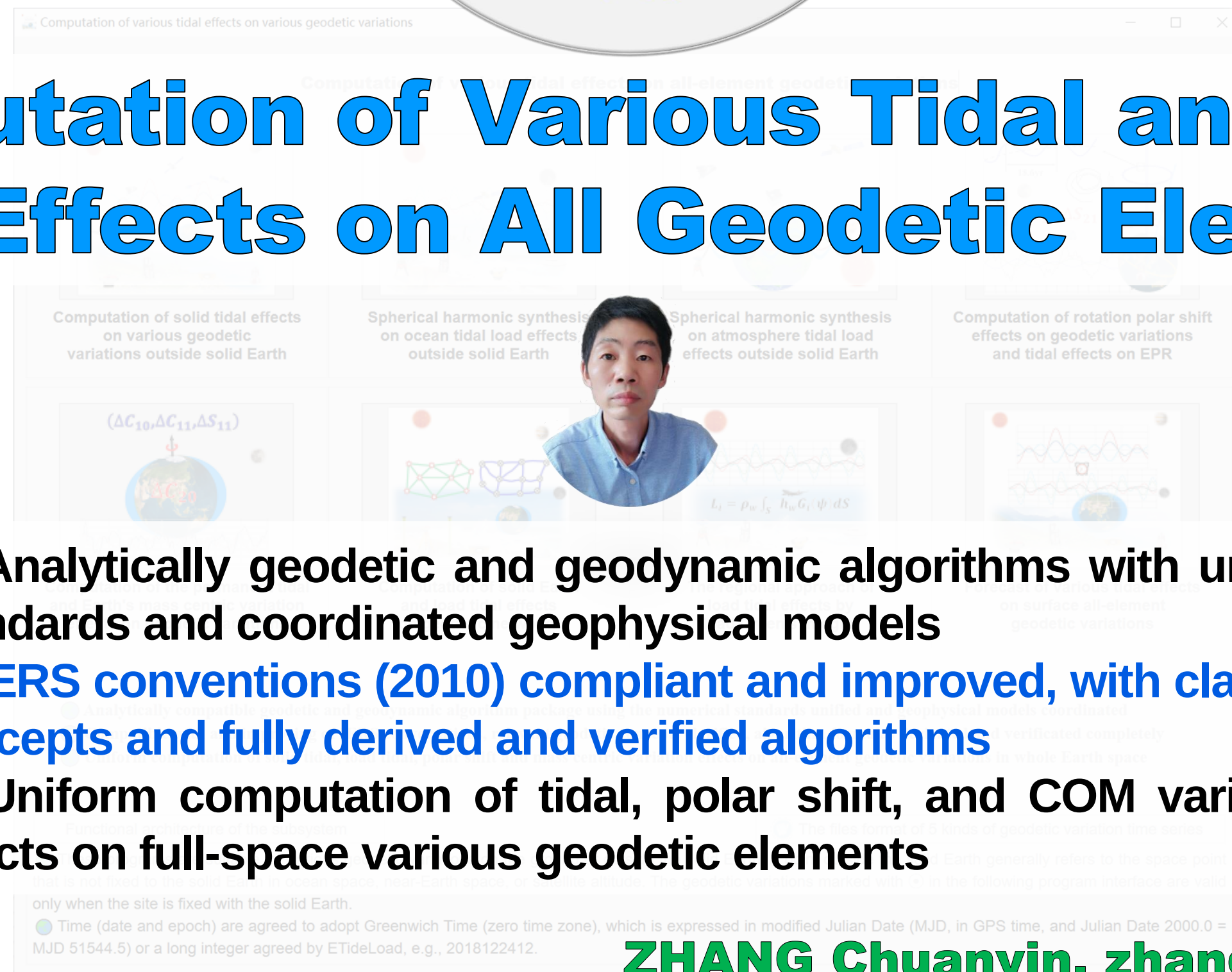




# Computation of Various Tidal and Polar Shift Effects on All Geodetic Elements



- 🌐 Analytically geodetic and geodynamic algorithms with unified standards and coordinated geophysical models
- 🌐 IERS conventions (2010) compliant and improved, with clarified concepts and fully derived and verified algorithms
- 🌐 Uniform computation of tidal, polar shift, and COM variation effects on full-space various geodetic elements

**ZHANG Chuanyin, [zhangchy@casm.ac.cn](mailto:zhangchy@casm.ac.cn)**

Computation of Solid Earth Tidal Effect Time Series at a Ground Point

Computation of Solid Earth Tidal Effects at Batch Points with Given Time

Computation of Solid Earth Tidal Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Solid Tidal Effects on Various Surface Geodetic Elements

Computation of Surface Atmosphere tidal Load Effect Time Series at a Ground Point

Computation of Surface Atmosphere tidal Load Effects at Batch Points with Given Time

Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Computation of Permanent Tide Effects on Various Geodetic Elements

Computation of Earth's COM Variation Effects on Various Geodetic elements

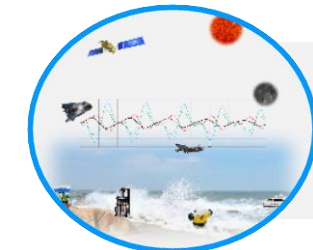
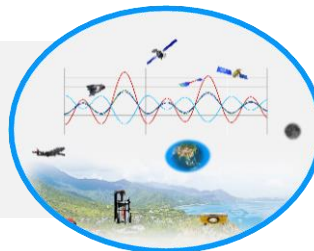
Forecast of Ocean Tidal Load Effects on Earth's Center of Mass

Forecast of Atmosphere Tidal Load Effects on Earth's Center of Mass

Computation of Residual Ocean Tidal Load Effects via Green's Integration

Computation of Residual Atmosphere tidal Load Effects via Green's Integration

Computation of Solid Earth Tidal Effects on Various Geodetic elements External to the Solid Earth



Spherical Harmonic Synthesis of Ocean Tidal Load Effects External to the Solid Earth

Computation of Ocean Tidal Load Effect Time Series at a Ground Point

Computation of Ocean Tidal Load Effects at Batch Points with Given Time

Computation of Ocean Tidal Load Effects for Earth Satellites or External Points

Global Forecast of Ocean Tidal Load Effects on Various Surface Geodetic elements

Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

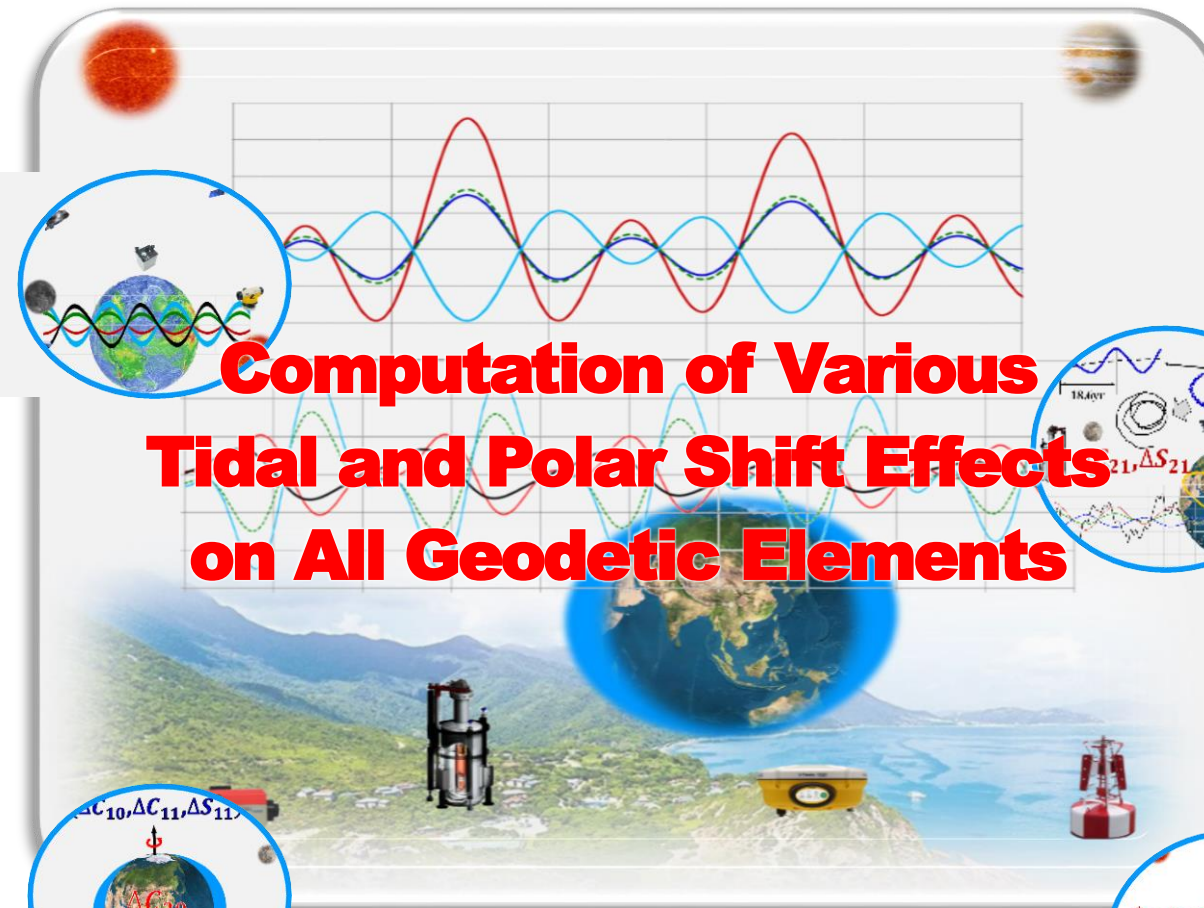
Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites or Points External to the Solid Earth

Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

Forecast of Tide Effect Time Series on Earth Rotation Parameters

Spherical Harmonic Synthesis of Atmosphere tidal Load Effects External to the Solid Earth

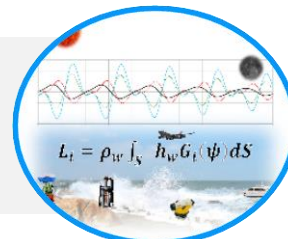


Computation of Earth Rotation Polar Shift Effects on Geodetic Elements and Tidal Effects on EPR

Computation of Permanent Tide and Earth's COM Variation Effects on Geodetic Elements

Computation of Solid Earth Tide and Tidal Load Effects for Geodetic Networks

Regional Approximation of Tidal Load Effects via Load Green's Function Integration



Forecast of Various Tidal Effects on Various Surface Geodetic Elements

Numerical Forecast of Solid Earth Tidal Effects on Various Geodetic Elements

Numerical Forecast of Ocean Tidal Load Effects on Various Geodetic Elements

Numerical Forecast of Surface Atmosphere Tidal Load Effects on Various Geodetic Elements



# Computation of Solid Earth Tidal Effect Time Series at a Ground Point

Open file Save as Import parameters Start computation Save process Follow example

Computation of Solid Earth Tidal Effect Time Series at a Ground Point

Computation of Solid Earth Tidal Effects at Batch Points with Given Time

Computation of Solid Earth Tidal Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Solid Tidal Effects on Various Surface Geodetic Elements

Open the ground variation time series file

Save program process as

Algorithm formulas

Set the file parameters

Column ordinal number of ellipsoidal height in the header 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

>> [Function] Given a ground variation time series file, this module computes the time series of solid Earth tidal effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW: South and West, mas), vertical deflection (SW, mas), Horizontal displacement (EN: East and North, mm), radial displacement (mm), ground normal/orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the ground variation time series file C:/ETideLoad4.5\_win64en/examples/Tideeffectsolidearth/Tmseries.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/Tideeffectsolidearth/tmsqurst.txt.

\*\* Appends the selected tidal effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-06 10:48:20

>> The program also outputs a time series file of the solid Earth tidal effects on the degree-2 geopotential coefficients and figure pole (\*Stdsfpm.txt) into the current directory (\* = input filename).

\*\* • Format: First row is the header. Subsequent rows contain: Epoch time,  $\Delta C_{20}$ ,  $\Delta C_{21}$ ,  $\Delta S_{21}$ ,  $\Delta C_{22}$ ,  $\Delta S_{22}$  ( $\times 10^{-8}$ ),  $\Delta x_{\text{sfp}}$ ,  $\Delta y_{\text{sfp}}$  (in the TRS, unit: m).

>> Complete the computation of solid earth tidal effects!

Save the computed results as

Import setting parameters

Start computation

Display of the input-output file↓

| Forecast     | 121.240000 | 29.428100 | 17.830    | 58456.959028 |          |         |         |       |  |
|--------------|------------|-----------|-----------|--------------|----------|---------|---------|-------|--|
| 201812042301 | 0.000000   | -9.1781   | -156.8405 | -64.8337     | -72.7348 | 6.9147  | -9.0453 | 13.06 |  |
| 201812042316 | 0.010417   | -9.0405   | -126.4444 | -52.4062     | -58.7014 | 7.9809  | -9.4946 | 15.01 |  |
| 201812042331 | 0.020833   | -8.9068   | -94.9272  | -39.5093     | -44.1436 | 9.0491  | -9.7445 | 16.97 |  |
| 201812042346 | 0.031250   | -8.7789   | -62.9361  | -26.4105     | -29.3615 | 10.1045 | -9.7926 | 18.90 |  |
| 201812050001 | 0.041667   | -8.6510   | -31.1000  | -13.7889     | -14.6566 | 11.1322 | -9.6398 | 20.78 |  |
| 201812050016 | 0.052083   | -8.5231   | -0.1200   | -0.6789      | -0.3259  | 12.1177 | -9.2907 | 22.58 |  |
| 201812050031 | 0.062500   | -8.3952   | 29.4430   | 11.4319      | 13.3426  | 13.0468 | -8.7535 | 24.28 |  |
| 201812050046 | 0.072917   | -8.2673   | 56.9866   | 22.7100      | 26.0757  | 13.9061 | -8.0396 | 25.85 |  |
| 201812050101 | 0.083333   | -8.1394   | 81.9584   | 32.9291      | 37.6197  | 14.6833 | -7.1638 | 27.27 |  |
| 201812050116 | 0.093750   | -8.0115   | 103.8654  | 41.8842      | 47.7447  | 15.3671 | -6.1436 | 28.51 |  |
| 201812050131 | 0.104167   | -7.8836   | 122.2731  | 49.3954      | 56.2491  | 15.9477 | -4.9992 | 29.57 |  |
| 201812050146 | 0.114583   | -7.7557   | 136.8147  | 55.3112      | 62.9628  | 16.4168 | -3.7529 | 30.41 |  |
| 201812050201 | 0.125000   | -7.6278   | 147.1977  | 59.5112      | 67.7505  | 16.7675 | -2.4290 | 31.04 |  |

Columns 2 and 3 of the file header are agreed as the longitude and latitude of the ground point

• Tide-Generating Potential (TGP) Model: Lunar: Degrees 2 to 6; Solar: Degrees 2 to 3; and Planetary (others): Degree 2.

• The solid tidal effect on the normal height (amplitude ~300 mm) is out of phase (opposite in sign) with the effect on the ellipsoidal height or geoid (amplitude ~600 mm).

• The east-west component of the effect vector on ground displacement, tilt, or horizontal gradient is generally significantly larger than the north-south component.

• The range (max-min) of solid Earth tidal effects on the figure pole generally exceeds 1 km.



# Computation of Solid Earth Tidal Effects at Batch Points with Given Time

Open file Save as Import parameters Start computation Save process Follow example

- Computation of Solid Earth Tidal Effect Time Series at a Ground Point
- Computation of Solid Earth Tidal Effects at Batch Points with Given Time**
- Computation of Solid Earth Tidal Effects for Earth Satellites or External Points to the Solid Earth
- Global Forecast of Solid Tidal Effects on Various Surface Geodetic Elements

Open the location and time file of the computation points

Set the file parameters

Column ordinal number of ellipsoidal height in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

- Select the type of effects
- ☒ geoid or height anomaly (mm)
  - ☒ ground gravity ( $\mu\text{Gal}$ )
  - ☒ gravity disturbance ( $\mu\text{Gal}$ )
  - ☒ ground tilt (SW, mas)
  - ☒ vertical deflection (SW, mas)
  - ☒ horizontal displacement (EN, mm)
  - ☒ ground radial displacement (mm)
  - ☒ ground normal or orthometric height (mm)
  - ☒ radial gravity gradient ( $10\mu\text{E}$ )
  - ☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

Save program process as

>> Computation end time: 2026-06-06 10:48:21

>> [Function] According to the location and time in the calculation point file, compute the solid Earth tidal effects on the geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, to the south and to the west, mas), vertical deflection (SW, to the south and to the west, mas), horizontal displacement (EN, to the east and to the north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ) or horizontal gravity gradient (NW, to the north and to the west,  $10\mu\text{E}$ ).

>> Open the location and time file of the computation points C:/ETideLoad4.5\_win64en/examples/Tideeffectsolidearth/Postiontm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/Tideeffectsolidearth/Postmrst.txt.

\*\* Appends the selected tidal effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-06 10:50:51

>> Complete the computation of solid earth tidal effects!

>> Computation end time: 2026-06-06 10:50:51

Columns 2 and 3 of the record are agreed as the longitude and latitude of the calculated point

Save the computed results as

Import setting parameters

Start computation

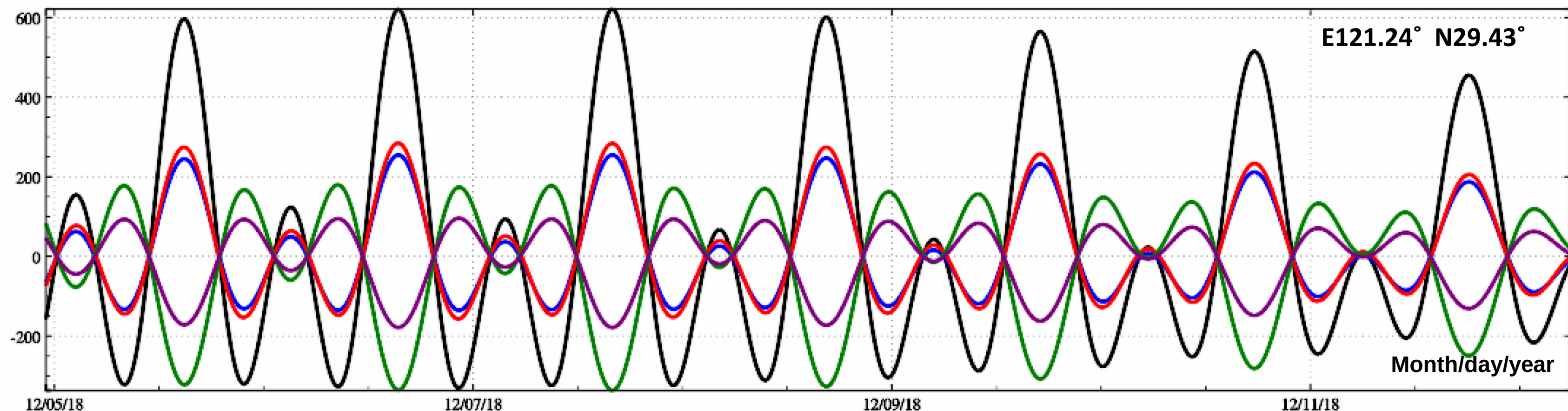
Save data in the text box as

Display of the input-output file↓

|              |            |           |              |           |           |           |         |          |
|--------------|------------|-----------|--------------|-----------|-----------|-----------|---------|----------|
| 101.230000   | 29.910000  | 47.218    | 58484.000000 |           |           |           |         |          |
| 201901010000 | 101.230000 | 29.910000 | 47.218       | 4.5400    | 1.5938    | 1.8815    | 10.3967 | -5.0328  |
| 201901010100 | 101.230000 | 29.910000 | 47.218       | 58.3841   | 23.5680   | 26.8064   | 12.8415 | -2.9395  |
| 201901010200 | 101.230000 | 29.910000 | 47.218       | 77.7136   | 31.2014   | 35.6850   | 14.1545 | 0.3355   |
| 201901010300 | 101.230000 | 29.910000 | 47.218       | 53.3053   | 20.7449   | 24.2861   | 14.0836 | 3.7768   |
| 201901010400 | 101.230000 | 29.910000 | 47.218       | -10.6764  | -5.9421   | -5.3630   | 12.6903 | 6.3132   |
| 201901010500 | 101.230000 | 29.910000 | 47.218       | -97.6404  | -41.8707  | -45.4873  | 10.3233 | 7.1142   |
| 201901010600 | 101.230000 | 29.910000 | 47.218       | -182.8869 | -76.7981  | -84.6356  | 7.5204  | 5.8108   |
| 201901010700 | 101.230000 | 29.910000 | 47.218       | -240.0672 | -99.9398  | -110.7040 | 4.8711  | 2.5864   |
| 201901010800 | 101.230000 | 29.910000 | 47.218       | -248.0760 | -102.7831 | -114.0960 | 2.8762  | -1.8762  |
| 201901010900 | 101.230000 | 29.910000 | 47.218       | -196.6498 | -81.3022  | -90.2338  | 1.8393  | -6.5659  |
| 201901011000 | 101.230000 | 29.910000 | 47.218       | -89.3439  | -37.0804  | -40.8477  | 1.8121  | -10.3839 |
| 201901011100 | 101.230000 | 29.910000 | 47.218       | 56.7775   | 22.8815   | 26.2172   | 2.5980  | -12.3987 |
| 201901011200 | 101.230000 | 29.910000 | 47.218       | 214.6442  | 87.5974   | 98.6094   | 3.8130  | -12.0601 |

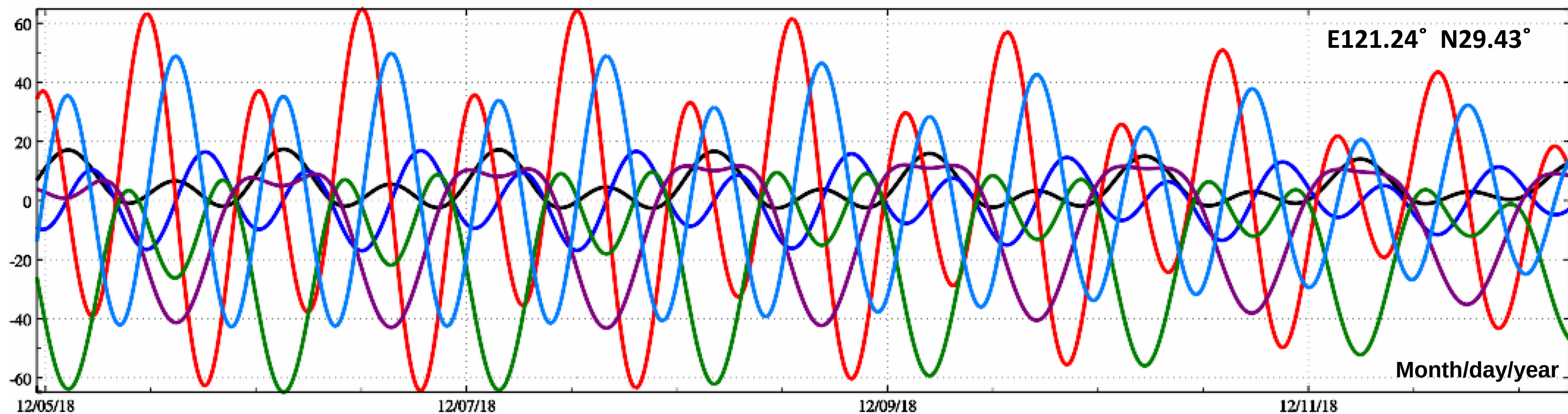
- Tide-Generating Potential (TGP) Model: Lunar: Degrees 2 to 6; Solar: Degrees 2 to 3; and Planetary (others): Degree 2.
- The solid tidal effect on the normal height (amplitude ~300 mm) is out of phase (opposite in sign) with the effect on the ellipsoidal height or geoid (amplitude ~600 mm).
- The east-west component of the effect vector on ground displacement, tilt, or horizontal gradient is generally significantly larger than the north-south component.
- The range (max-min) of solid Earth tidal effects on the figure pole generally exceeds 1 km.





**Solid tidal effects :** geoid or height anomaly (mm) ground gravity ( $\mu\text{Gal}$ ) radial displacement (mm)  
 normal or orthometric height (mm) radial gravity gradient ( $10\mu\text{E}$ )

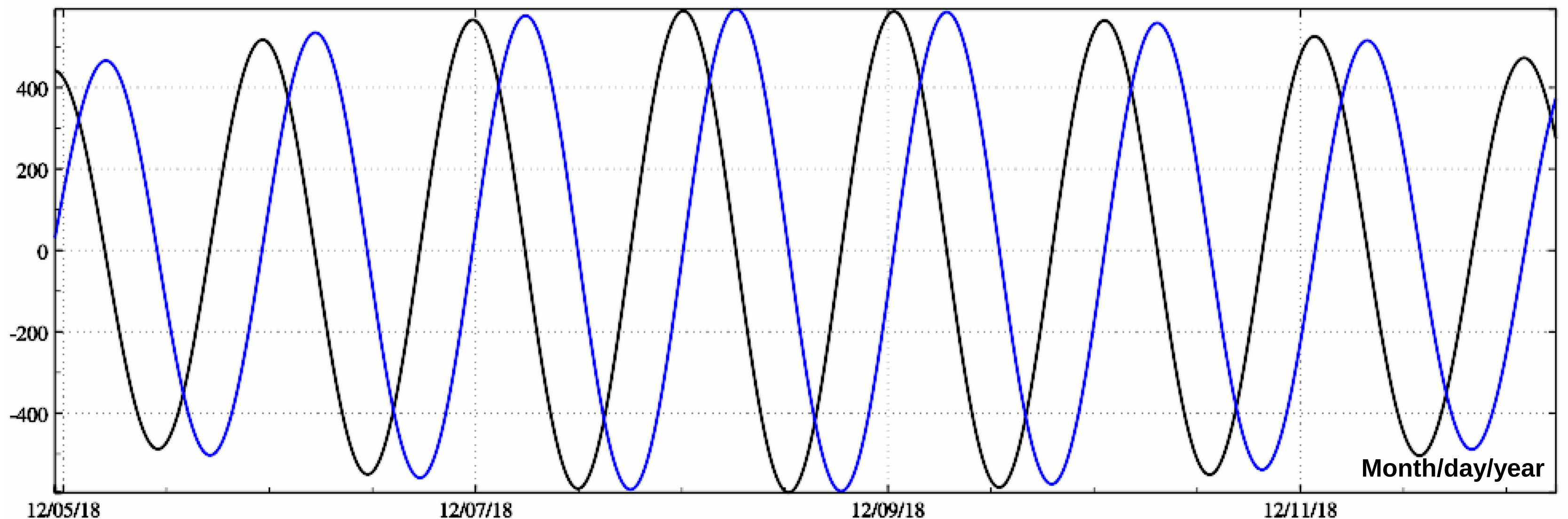
The solid tidal effect on normal height (approximately 300mm) is out of phase with the effect on the ellipsoidal height or geoid (approximately 600mm, namely the sign is opposite).



**Solid tidal effects :** ground tilt (S, mas) tilt (W, mas) horizontal displacement (E, mm) horizontal displacement (N, mm)  
 horizontal gradient (N,  $10\mu\text{E}$ ) horizontal gradient (W,  $10\mu\text{E}$ )



$$\Delta x_{sfp} = -\frac{\sqrt{3}b}{\bar{c}_{20}} \Delta \bar{C}_{21} - \frac{6\bar{S}_{22}b}{(\bar{c}_{20})^2} \Delta \bar{S}_{21}, \quad \Delta y_{sfp} = +\frac{\sqrt{3}b}{\bar{c}_{20}} \Delta \bar{S}_{21} - \frac{6\bar{S}_{22}b}{(\bar{c}_{20})^2} \Delta \bar{C}_{21}$$



Solid Earth tidal effects on the Figure Pole of the Earth:  $\Delta x_{sfp}$ ,  $\Delta y_{sfp}$  (in the ITRS, unit: m)

The range (max-min) of solid Earth tidal effects on the figure pole generally exceeds 1 km.

Solid Earth tide theory is derived from the equilibrium theory of celestial gravitation and centrifugal force; by definition, the tidal force exerted by a celestial body at the Earth's COM is invariably zero. Therefore, geodesy does not specifically investigate the COM variations induced by solid Earth tides.



# Computation of Solid Earth Tidal Effects for Earth Satellites or External Points to the Solid Earth

Computation of Solid Earth Tidal Effect  
Time Series at a Ground Point

Computation of Solid Earth Tidal Effects  
at Batch Points with Given Time

Computation of Solid Earth Tidal Effects for Earth  
Satellites or External Points to the Solid Earth

Global Forecast of Solid Tidal Effects on  
Various Surface Geodetic Elements

Open the location and time file of the external points

Save program process as

Algorithm formulas

Set the file parameters

Column ordinal number of ellipsoidal  
height in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting  
MJD0 in the header 5

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )

☐ gravity vector (XYZ,  $\mu\text{Gal}$ )

☒ gravity vector (ENU,  $\mu\text{Gal}$ )

☐ gravity gradient (XYZ,  $10\mu\text{E}$ )

☒ gravity gradient (ENU,  $10\mu\text{E}$ )

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

>> Computation start time: 2026-06-06 10:50:51

>> Complete the computation of solid earth tidal effects!

>> Computation end time: 2026-06-06 10:50:51

>> [Function] Based on the location and time provided in the external space point file, this module computes the solid Earth tidal effects on Geopotential ( $0.1\text{m}^2/\text{s}^2$ ), Gravity ( $\mu\text{Gal}$ ), or Gravity gradient ( $10\mu\text{E}$ ) at external points to the solid Earth.

>> Open the location and time file of the external space points C:/ETideLoad4.5\_win64en/examples/Tideeffectsoliidearth/outerptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/Tideeffectsoliidearth/outerst.txt.

\*\* Appends the selected tidal effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-06 11:02:16

>> Complete the computation of solid earth tidal effects!

>> Computation end time: 2026-06-06 11:02:16

Columns 2 and 3 of the record  
are agreed as the longitude  
and latitude of the satellite

GRACE satellite altitude

Save the computed results as

Import setting parameters

Start computation

Save data in the text box as

Display of the input-output file↓

|            |        |       |          |              |          |          |          |          |        |  |
|------------|--------|-------|----------|--------------|----------|----------|----------|----------|--------|--|
| NY         | 101.23 | 29.91 | 450000.0 | 58494.000000 |          |          |          |          |        |  |
| 2019010100 | 101.23 | 29.91 | 450000.0 | 0.3604       | -70.1968 | 35.9074  | -1.4347  | -5.6569  | -0.41  |  |
| 2019010101 | 101.23 | 29.91 | 450000.0 | 4.6518       | -86.1581 | 21.8362  | -20.3774 | -12.8867 | 0.02   |  |
| 2019010102 | 101.23 | 29.91 | 450000.0 | 6.1944       | -94.6243 | -0.3418  | -27.1374 | -16.1680 | 0.70   |  |
| 2019010103 | 101.23 | 29.91 | 450000.0 | 4.2516       | -93.8995 | -23.8846 | -18.4910 | -14.5544 | 1.72   |  |
| 2019010104 | 101.23 | 29.91 | 450000.0 | -0.8480      | -84.3469 | -41.5914 | 4.0409   | -8.4398  | 2.98   |  |
| 2019010105 | 101.23 | 29.91 | 450000.0 | -7.7849      | -68.2530 | -47.7595 | 34.5670  | 0.5710   | 4.11   |  |
| 2019010106 | 101.23 | 29.91 | 450000.0 | -14.5906     | -49.2170 | -39.7054 | 64.3857  | 10.1118  | 4.66   |  |
| 2019010107 | 101.23 | 29.91 | 450000.0 | -19.1615     | -31.2465 | -18.4674 | 84.2772  | 17.6806  | 4.14   |  |
| 2019010108 | 101.23 | 29.91 | 450000.0 | -19.8092     | -17.8013 | 11.4510  | 86.9118  | 21.2684  | 2.23   |  |
| 2019010109 | 101.23 | 29.91 | 450000.0 | -15.7095     | -11.0186 | 43.1839  | 68.7753  | 19.8363  | -1.14  |  |
| 2019010110 | 101.23 | 29.91 | 450000.0 | -7.1432      | -11.2874 | 69.1547  | 31.1672  | 13.5472  | -5.77  |  |
| 2019010111 | 101.23 | 29.91 | 450000.0 | 4.5274       | -17.2502 | 82.8776  | -19.9374 | 3.7183   | -11.14 |  |
| 2019010112 | 101.23 | 29.91 | 450000.0 | 17.1380      | -26.2132 | 80.5037  | -75.1125 | -7.4804  | -16.52 |  |

Tide-Generating Potential (TGP) Model: Lunar: Degrees 2 to 6; Solar: Degrees 2 to 3; and Planetary (others): Degree 2.

The solid tidal effect on the normal height (amplitude ~300 mm) is out of phase (opposite in sign) with the effect on the ellipsoidal height or geoid (amplitude ~600 mm).

The east-west component of the effect vector on ground displacement, tilt, or horizontal gradient is generally significantly larger than the north-south component.

The range (max-min) of solid Earth tidal effects on the figure pole generally exceeds 1 km.



# Computation of Solid Earth Tidal Effects for Earth Satellites or External Points to the Solid Earth

Open file Save as Import parameters Start computation Save process Follow example

Computation of Solid Earth Tidal Effect Time Series at a Ground Point

Computation of Solid Earth Tidal Effects at Batch Points with Given Time

Computation of Solid Earth Tidal Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Solid Tidal Effects on Various Surface Geodetic Elements

Open the location and time file of the external points

Save program process as

Algorithm formulas

Set the file parameters

Column ordinal number of ellipsoidal height in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )

☐ gravity vector (XYZ,  $\mu\text{Gal}$ )

☐ gravity vector (ENU,  $\mu\text{Gal}$ )

☐ gravity gradient (XYZ,  $10\mu\text{E}$ )

☒ gravity gradient (ENU,  $10\mu\text{E}$ )

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

>> Computation start time: 2026-06-06 11:02:16

>> Complete the computation of solid earth tidal effects!

>> Computation end time: 2026-06-06 11:02:16

>> [Function] Based on the location and time provided in the external space point file, this module computes the solid Earth tidal effects on Geopotential ( $0.1\text{m}^2/\text{s}^2$ ), Gravity ( $\mu\text{Gal}$ ), or Gravity gradient ( $10\mu\text{E}$ ) at external points to the solid Earth.

>> Open the location and time file of the external space points C:/ETideLoad4.5\_win64en/examples/Tideeffectsoliidearth/satptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/Tideeffectsoliidearth/satprst.txt.

\*\* Appends the selected tidal effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-06 11:03:40

>> Complete the computation of solid earth tidal effects!

>> Computation end time: 2026-06-06 11:03:41

Save the computed results as

Import setting parameters

Start computation

Display of the input-output file↓

| NYB          | 150.24 | 32.42 | 250000.0 | 58119.000000 |          |          |           |
|--------------|--------|-------|----------|--------------|----------|----------|-----------|
| 201901010000 | 150.24 | 32.42 | 250000.0 | 0.2777       | -14.0775 | 4.4894   | -0.4489   |
| 201901010100 | 150.24 | 32.42 | 250000.0 | -5.9123      | -5.5368  | 5.7527   | 16.6033   |
| 201901010200 | 150.24 | 32.42 | 250000.0 | -13.1543     | 5.2957   | 6.5691   | 36.3888   |
| 201901010300 | 150.24 | 32.42 | 250000.0 | -19.3259     | 15.5801  | 6.4614   | 53.0735   |
| 201901010400 | 150.24 | 32.42 | 250000.0 | -22.3930     | 22.6134  | 5.0126   | 61.1675   |
| 201901010500 | 150.24 | 32.42 | 250000.0 | -20.9443     | 24.4922  | 1.9985   | 56.9495   |
| 201901010600 | 150.24 | 32.42 | 250000.0 | -14.5749     | 20.5536  | -2.5187  | 39.4422   |
| 201901010700 | 150.24 | 32.42 | 250000.0 | -4.0300      | 11.5134  | -8.1597  | 10.7348   |
| 201901010800 | 150.24 | 32.42 | 250000.0 | 8.9232       | -0.7050  | -14.2705 | -24.3961  |
| 201901010900 | 150.24 | 32.42 | 250000.0 | 21.8654      | -13.4028 | -20.0322 | -59.4712  |
| 201901011000 | 150.24 | 32.42 | 250000.0 | 32.2542      | -23.7069 | -24.6126 | -87.6891  |
| 201901011100 | 150.24 | 32.42 | 250000.0 | 37.9959      | -29.2208 | -27.3295 | -103.4147 |
| 201901011200 | 150.24 | 32.42 | 250000.0 | 37.9288      | -28.5910 | -27.7875 | -103.4592 |
| 201901011300 | 150.24 | 32.42 | 250000.0 | 32.1058      | -21.8628 | -25.9573 | -87.8569  |

GOCE satellite altitude

Columns 2 and 3 of the record are agreed as the longitude and latitude of the satellite

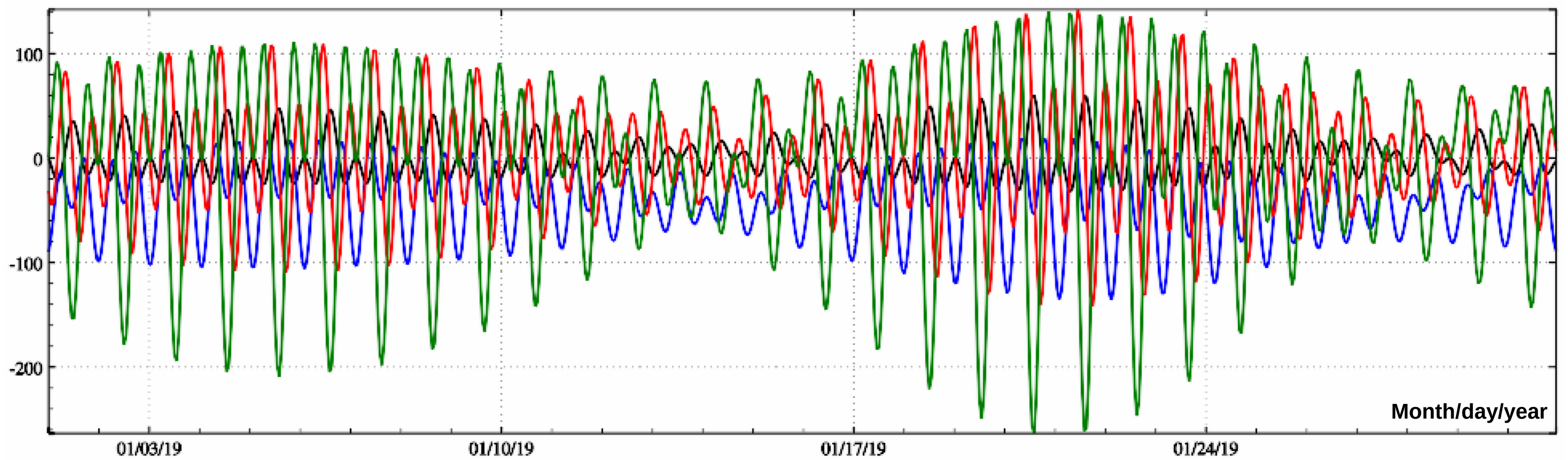
● Tide-Generating Potential (TGP) Model: Lunar: Degrees 2 to 6; Solar: Degrees 2 to 3; and Planetary (others): Degree 2.

● The solid tidal effect on the normal height (amplitude ~300 mm) is out of phase (opposite in sign) with the effect on the ellipsoidal height or geoid (amplitude ~600 mm).

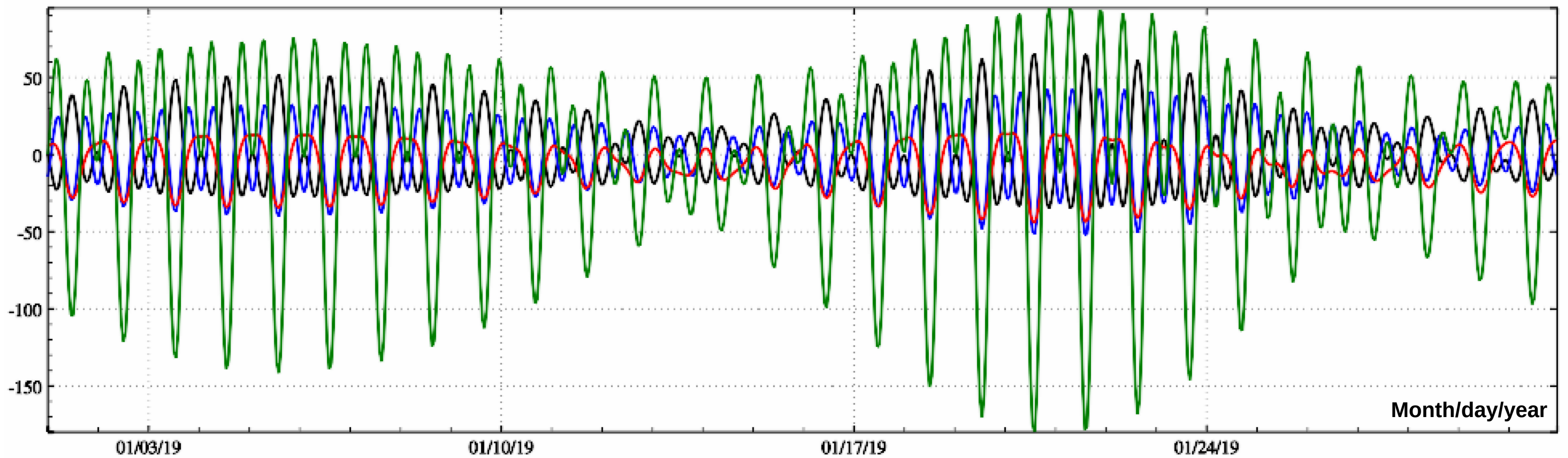
● The east-west component of the effect vector on ground displacement, tilt, or horizontal gradient is generally significantly larger than the north-south component.

● The range (max-min) of solid Earth tidal effects on the figure pole generally exceeds 1 km.





The solid tidal effects at 450km altitude : geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity vector (E, N: along the GRACE orbit/SST-II, U,  $\mu\text{Gal}$ )



The solid tidal effects at 250km altitude : geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity gradient (E, N: along the GOCE orbit, U,  $10\mu\text{E}$ )



## Global Forecast of Solid Tidal Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude

Latitude

Ellipsoidal height

Forecast time series parameters

Start time

End time

Time interval

 Calculate and save as



Tidal effects to be plot

- ☒ geoid or height anomaly (mm)
- ☒ ground gravity ( $\mu\text{Gal}$ )  $\odot$
- ☐ gravity disturbance ( $\mu\text{Gal}$ )
- ☐ ground tilt (SW, mas)  $\odot$
- ☐ vertical deflection (SW, mas)
- ☐ horizontal displacement (EN, mm)  $\odot$
- ☒ ground radial displacement (mm)  $\odot$
- ☒ normal (orthometric) height (mm)  $\odot$
- ☒ radial gravity gradient ( $10\mu\text{E}$ )
- ☐ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

Tidal effect time series on all geodetic elements

|              |          |           |           |           |         |          |
|--------------|----------|-----------|-----------|-----------|---------|----------|
| 201607032040 | 2.861111 | -357.1604 | -147.1050 | -164.6183 | 0.7322  | 1.0685   |
| 201607032050 | 2.868056 | -357.9992 | -147.5027 | -165.0620 | 0.2210  | -0.1083  |
| 2016070321   | 2.875000 | -356.3099 | -146.8649 | -164.3405 | -0.2467 | -1.3169  |
| 201607032110 | 2.881944 | -352.0355 | -145.1672 | -162.4264 | -0.6691 | -2.5490  |
| 201607032120 | 2.888889 | -345.1367 | -142.3926 | -159.3010 | -1.0443 | -3.7961  |
| 201607032130 | 2.895833 | -335.5930 | -138.5315 | -154.9538 | -1.3709 | -5.0493  |
| 201607032140 | 2.902778 | -323.4025 | -133.5821 | -149.3833 | -1.6478 | -6.3000  |
| 201607032150 | 2.909722 | -308.5825 | -127.5506 | -142.5966 | -1.8745 | -7.5390  |
| 2016070322   | 2.916667 | -291.1692 | -120.4506 | -134.6095 | -2.0504 | -8.7574  |
| 201607032210 | 2.923611 | -271.2180 | -112.3039 | -125.4469 | -2.1757 | -9.9465  |
| 201607032220 | 2.930556 | -248.8027 | -103.1400 | -115.1422 | -2.2507 | -11.0973 |
| 201607032230 | 2.937500 | -224.0159 | -92.9958  | -103.7374 | -2.2762 | -12.2013 |
| 201607032240 | 2.944444 | -196.9676 | -81.9159  | -91.2827  | -2.2534 | -13.2502 |
| 201607032250 | 2.951389 | -167.7855 | -69.9518  | -77.8366  | -2.1836 | -14.2360 |
| 2016070323   | 2.958333 | -136.6134 | -57.1621  | -63.4650  | -2.0687 | -15.1510 |
| 201607032310 | 2.965278 | -103.6110 | -43.6116  | -48.2413  | -1.9108 | -15.9881 |
| 201607032320 | 2.972222 | -68.9523  | -29.3717  | -32.2456  | -1.7122 | -16.7405 |
| 201607032330 | 2.979167 | -32.8249  | -14.5190  | -15.5645  | -1.4758 | -17.4021 |
| 201607032340 | 2.986111 | 4.5714    | 0.8646    | 1.7098    | -1.2045 | -17.9673 |
| 201607032350 | 2.993056 | 43.0259   | 16.6924   | 19.4799   | -0.9014 | -18.4311 |
| 2016070400   | 3.000000 | 82.3184   | 32.8740   | 37.6440   | -0.5700 | -18.7895 |

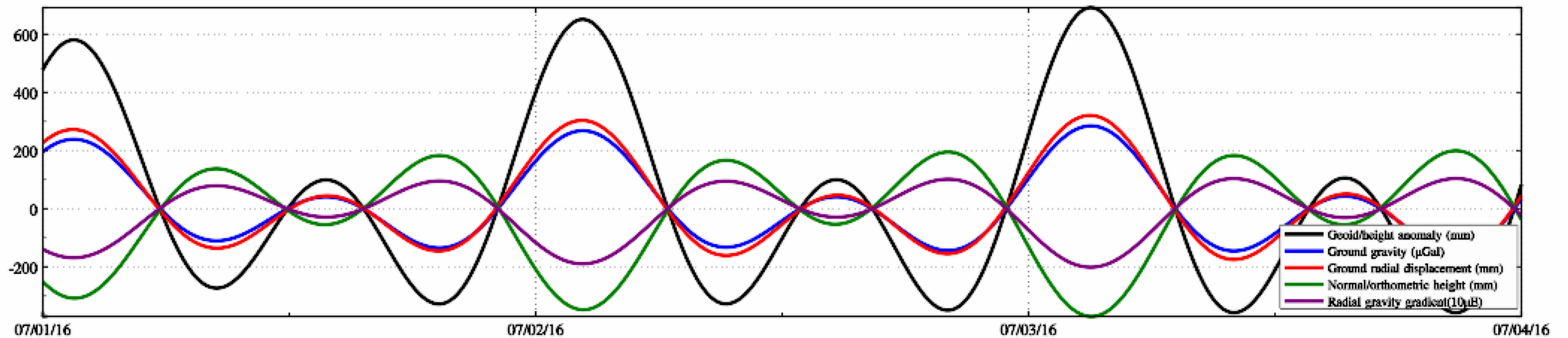
Set line thickness

 Extract time series to be plot

 Plot↓

Tidal effect curve on surface geodetic elements

 Save the current plot as



- Firstly, compute the time series of solid tidal effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various solid tidal effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of effects, and the time-varying characteristics of the tidal effect curves.



## Global Forecast of Solid Tidal Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude 121.240000°

Latitude 29.428100°

Ellipsoidal height 17.830m

Forecast time series parameters

Start time 20160701

End time 20160704

Time interval 10.00 min

Calculate and save as



Tidal effects to be plot

- ☐ geoid or height anomaly (mm)
- ☐ ground gravity ( $\mu\text{Gal}$ )  $\odot$
- ☐ gravity disturbance ( $\mu\text{Gal}$ )
- ☒ ground tilt (SW, mas)  $\odot$
- ☐ vertical deflection (SW, mas)
- ☒ horizontal displacement (EN, mm)  $\odot$
- ☐ ground radial displacement (mm)  $\odot$
- ☐ normal (orthometric) height (mm)  $\odot$
- ☐ radial gravity gradient ( $10\mu\text{E}$ )
- ☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

Tidal effect time series on all geodetic elements

|              |          |           |           |           |         |          |
|--------------|----------|-----------|-----------|-----------|---------|----------|
| 201607032040 | 2.861111 | -357.1604 | -147.1050 | -164.6183 | 0.7322  | 1.0685   |
| 201607032050 | 2.868056 | -357.9992 | -147.5027 | -165.0620 | 0.2210  | -0.1083  |
| 2016070321   | 2.875000 | -356.3099 | -146.8649 | -164.3405 | -0.2467 | -1.3169  |
| 201607032110 | 2.881944 | -352.0355 | -145.1672 | -162.4264 | -0.6691 | -2.5490  |
| 201607032120 | 2.888889 | -345.1367 | -142.3926 | -159.3010 | -1.0443 | -3.7961  |
| 201607032130 | 2.895833 | -335.5930 | -138.5315 | -154.9538 | -1.3709 | -5.0493  |
| 201607032140 | 2.902778 | -323.4025 | -133.5821 | -149.3833 | -1.6478 | -6.3000  |
| 201607032150 | 2.909722 | -308.5825 | -127.5506 | -142.5966 | -1.8745 | -7.5390  |
| 2016070322   | 2.916667 | -291.1692 | -120.4506 | -134.6095 | -2.0504 | -8.7574  |
| 201607032210 | 2.923611 | -271.2180 | -112.3039 | -125.4469 | -2.1757 | -9.9465  |
| 201607032220 | 2.930556 | -248.8027 | -103.1400 | -115.1422 | -2.2507 | -11.0973 |
| 201607032230 | 2.937500 | -224.0159 | -92.9958  | -103.7374 | -2.2762 | -12.2013 |
| 201607032240 | 2.944444 | -196.9676 | -81.9159  | -91.2827  | -2.2534 | -13.2502 |
| 201607032250 | 2.951389 | -167.7855 | -69.9518  | -77.8366  | -2.1836 | -14.2360 |
| 2016070323   | 2.958333 | -136.6134 | -57.1621  | -63.4650  | -2.0687 | -15.1510 |
| 201607032310 | 2.965278 | -103.6110 | -43.6116  | -48.2413  | -1.9108 | -15.9881 |
| 201607032320 | 2.972222 | -68.9523  | -29.3717  | -32.2456  | -1.7122 | -16.7405 |
| 201607032330 | 2.979167 | -32.8249  | -14.5190  | -15.5645  | -1.4758 | -17.4021 |
| 201607032340 | 2.986111 | 4.5714    | 0.8646    | 1.7098    | -1.2045 | -17.9673 |
| 201607032350 | 2.993056 | 43.0259   | 16.6924   | 19.4799   | -0.9014 | -18.4311 |
| 2016070400   | 3.000000 | 82.3184   | 32.8740   | 37.6440   | -0.5700 | -18.7895 |

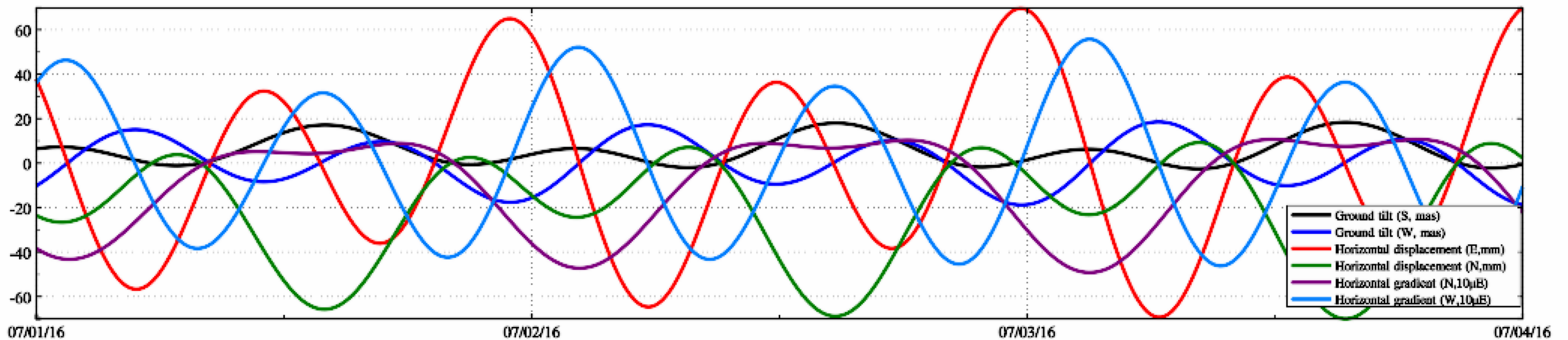
Set line thickness 3

Extract time series to be plot

Plot

Tidal effect curve on surface geodetic elements

Save the current plot as



- Firstly, compute the time series of solid tidal effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various solid tidal effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of effects, and the time-varying characteristics of the tidal effect curves.



# Computation of Ocean Tidal Load Effect Time Series at a Ground Point

Computation of ocean tidal load effect time series at a ground site

Computation of ocean tidal load effects at ground sites with given time

Computation of ocean tidal load effects of Earth satellite or outside solid Earth

Global forecast of ocean tidal load effects on various surface geodetic variations

Open the ground variation time series file

Set the file parameters

Column ordinal number of normal or orthometric height in the header 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

>> Program Process \*\* Operation Prompts

>> Open the ground variations time series file C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/Tmseries.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/Tmsqurst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/Tmsqurst.txt, to look at the computation progress!

>> Computation start time: 2026-06-07 09:24:22

>> The program also outputs a time series file of the ocean tidal load effects on the degree-1 and degree-2 geopotential coefficients (\*Otdcmsiptm.txt) into the current directory (\* = input filename).

\*\* • Format: First row is the header. Subsequent rows contain: Epoch time, 3 columns of  $\Delta C_{10}$ ,  $\Delta C_{11}$ ,  $\Delta S_{11}$  ( $\times 10^{-10}$ ), 5 columns of  $\Delta C_{20}$ ,  $\Delta C_{21}$ ,  $\Delta S_{21}$ ,  $\Delta C_{22}$ ,  $\Delta S_{22}$  ( $\times 10^{-10}$ ), 3 columns effects on the Earth's center of mass (unit: mm), and 2 columns of effects on the figure pole  $\Delta x_{sfp}$ ,  $\Delta y_{sfp}$  (in ITRS, unit: m).

>> Complete the computation of the ocean tidal load effects!

Maximum truncated degree of the coefficient model 120

Save the results as

Columns 2 and 3 of the file header are agreed as the longitude and latitude of the ground point

Display of the input-output file↓

| NYB          | 101      | 230000 | 29.910000 | 47.218  | 58484.000000 |         |         |         |  |  |  |  |  |  |  |  |  |  |  |
|--------------|----------|--------|-----------|---------|--------------|---------|---------|---------|--|--|--|--|--|--|--|--|--|--|--|
| 201901010000 | 0.000000 | 2.764  | 1.7717    | -0.8065 | -0.5333      | -0.3260 | 0.1351  | 0.0020  |  |  |  |  |  |  |  |  |  |  |  |
| 201901010100 | 0.041667 | 2.778  | 1.1277    | -0.3570 | -0.2073      | -0.3976 | 0.0118  | -0.0177 |  |  |  |  |  |  |  |  |  |  |  |
| 201901010200 | 0.083333 | 2.762  | 0.1811    | 0.0404  | -0.0049      | -0.4110 | -0.1253 | -0.0464 |  |  |  |  |  |  |  |  |  |  |  |
| 201901010300 | 0.125000 | 2.724  | -0.8863   | 0.2795  | 0.0081       | -0.2791 | -0.2769 | -0.0589 |  |  |  |  |  |  |  |  |  |  |  |
| 201901010400 | 0.166667 | 2.675  | -1.8226   | 0.4877  | 0.0176       | -0.1319 | -0.4500 | -0.0691 |  |  |  |  |  |  |  |  |  |  |  |
| 201901010500 | 0.208333 | 2.626  | -2.3880   | 0.6370  | 0.0485       | -0.0720 | -0.5929 | -0.0812 |  |  |  |  |  |  |  |  |  |  |  |
| 201901010600 | 0.250000 | 2.582  | -2.4797   | 0.5023  | -0.0996      | 0.0143  | -0.6538 | -0.0618 |  |  |  |  |  |  |  |  |  |  |  |
| 201901010700 | 0.291667 | 2.546  | -2.1169   | 0.1065  | -0.4004      | 0.2000  | -0.6556 | 0.0044  |  |  |  |  |  |  |  |  |  |  |  |
| 201901010800 | 0.333333 | 2.517  | -1.3803   | -0.2650 | -0.5803      | 0.3634  | -0.6313 | 0.0881  |  |  |  |  |  |  |  |  |  |  |  |
| 201901010900 | 0.375000 | 2.489  | -0.4362   | -0.4885 | -0.5524      | 0.4001  | -0.5473 | 0.1586  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011000 | 0.416667 | 2.455  | 0.4859    | -0.6369 | -0.4446      | 0.3657  | -0.3595 | 0.2130  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011100 | 0.458333 | 2.410  | 1.1845    | -0.6862 | -0.2841      | 0.3571  | -0.1032 | 0.2554  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011200 | 0.500000 | 2.354  | 1.5253    | -0.4881 | 0.0397       | 0.3524  | 0.1333  | 0.2678  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011300 | 0.541667 | 2.288  | 1.4545    | -0.0193 | 0.5286       | 0.2566  | 0.3072  | 0.2244  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011400 | 0.583333 | 2.223  | 1.0144    | 0.4953  | 0.9573       | 0.1114  | 0.4397  | 0.1376  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011500 | 0.625000 | 2.169  | 0.3251    | 0.8369  | 1.1313       | 0.0596  | 0.5359  | 0.0451  |  |  |  |  |  |  |  |  |  |  |  |
| 201901011600 | 0.666667 | 2.139  | -0.4155   | 1.0569  | 1.1504       | 0.0658  | 0.5641  | -0.0472 |  |  |  |  |  |  |  |  |  |  |  |
| 201901011700 | 0.708333 | 2.140  | -0.9659   | 1.2274  | 1.1443       | -0.0187 | 0.5323  | -0.1499 |  |  |  |  |  |  |  |  |  |  |  |

Since ocean tidal loads are generally considered to act on the sea surface, the height of the computation point refers to the normal or orthometric height relative to the sea surface (geoid).

The global ocean tidal load spherical harmonic coefficient model (cm) adopts the FES2004 format. Which can be constructed from global tidal height harmonic constant grid models using the function [Spherical Harmonic Analysis on Ocean Tidal Constituent Harmonic Constants].



# Computation of Ocean Tidal Load Effects at Batch Points with Given Time

[Computation of ocean tidal load effect time series at a ground site](#)
[Computation of ocean tidal load effects at ground sites with given time](#)
[Computation of ocean tidal load effects of Earth satellite or outside solid Earth](#)
[Global forecast of ocean tidal load effects on various surface geodetic variations](#)

Open the location and time file of the computation points

Set the file parameters

Column ordinal number of normal or orthometric height in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

>> Program Process \*\* Operation Prompts

>> [Function] According to the location and time specified in the computation point file, this module calculates the ocean tidal load effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the location and time file of the computation points C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/Postiontm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/Postmrst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/Postmrst.txt, to look at the computation progress!

>> Computation start time: 2026-06-07 09:35:15

>> Complete the computation of the ocean tidal load effects!

>> Computation end time: 2026-06-07 09:38:58

Maximum truncated degree of the coefficient model 120

Save the results as

Import setting parameters

Start computation

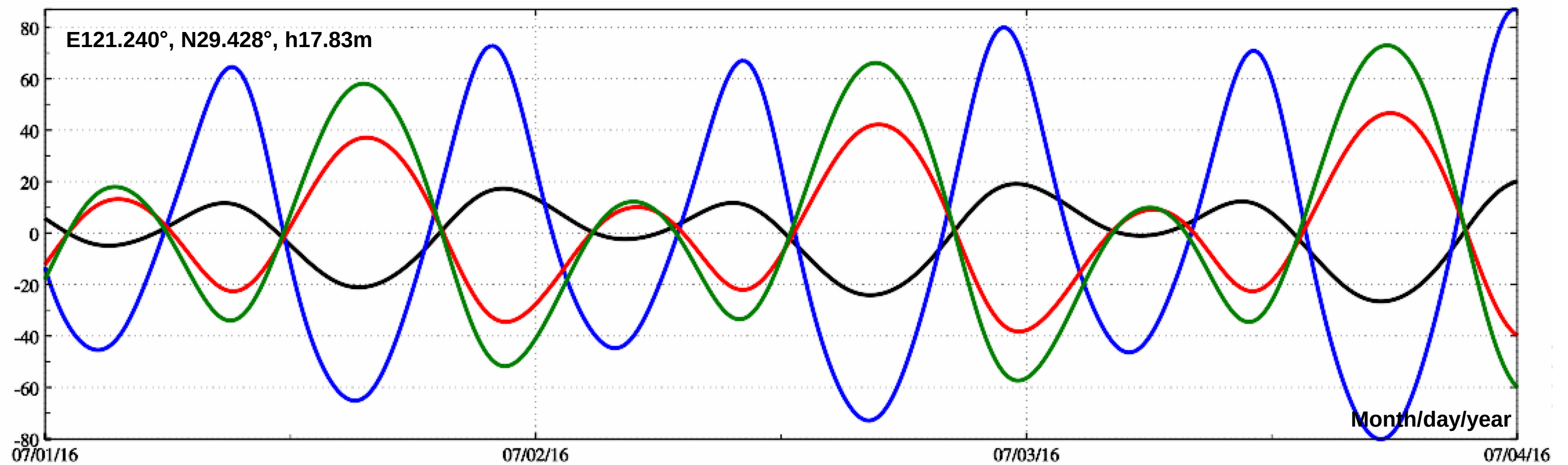
Display of the input-output file↓

| NY         | 151.0901 | 12.5001 | 47.218 | 58484   | 000000  |         |         |         |         |  |
|------------|----------|---------|--------|---------|---------|---------|---------|---------|---------|--|
| 2019010100 | 151.0901 | 12.5001 | 2.52   | 6.8195  | 2.6525  | 3.7841  | 0.0601  | -5.2443 | 0.0716  |  |
| 2019010101 | 151.0901 | 12.5001 | 2.52   | 9.1418  | 3.0137  | 4.4889  | 0.6043  | -4.8543 | 0.3262  |  |
| 2019010102 | 151.0901 | 12.5001 | 2.52   | 10.7919 | 3.3139  | 5.0467  | 1.0761  | -3.2011 | 0.5498  |  |
| 2019010103 | 151.0901 | 12.5001 | 2.52   | 11.3862 | 3.4869  | 5.3330  | 1.3877  | -0.7025 | 0.6975  |  |
| 2019010104 | 151.0901 | 12.5001 | 2.52   | 10.6640 | 3.4233  | 5.1902  | 1.5095  | 2.0883  | 0.7518  |  |
| 2019010105 | 151.0901 | 12.5001 | 2.52   | 8.5686  | 2.9811  | 4.4517  | 1.4505  | 4.5559  | 0.7190  |  |
| 2019010106 | 151.0901 | 12.5001 | 2.52   | 5.3233  | 2.1095  | 3.0875  | 1.2049  | 6.0784  | 0.6034  |  |
| 2019010107 | 151.0901 | 12.5001 | 2.52   | 1.4544  | 0.9701  | 1.3387  | 0.7815  | 6.2269  | 0.4107  |  |
| 2019010108 | 151.0901 | 12.5001 | 2.52   | -2.3524 | -0.1609 | -0.4067 | 0.2781  | 4.9513  | 0.1760  |  |
| 2019010109 | 151.0901 | 12.5001 | 2.52   | -5.5336 | -1.1485 | -1.9271 | -0.1563 | 2.5616  | -0.0412 |  |
| 2019010110 | 151.0901 | 12.5001 | 2.52   | -7.8127 | -2.0656 | -3.2601 | -0.4290 | -0.4074 | -0.1956 |  |
| 2019010111 | 151.0901 | 12.5001 | 2.52   | -9.1073 | -2.9640 | -4.4449 | -0.5308 | -3.3007 | -0.2753 |  |
| 2019010112 | 151.0901 | 12.5001 | 2.52   | -9.4064 | -3.7153 | -5.3348 | -0.4979 | -5.4368 | -0.2915 |  |
| 2019010113 | 151.0901 | 12.5001 | 2.52   | -8.8148 | -4.1478 | -5.7517 | -0.3925 | -6.2859 | -0.2671 |  |
| 2019010114 | 151.0901 | 12.5001 | 2.52   | -7.6135 | -4.2084 | -5.6707 | -0.2978 | -5.6771 | -0.2358 |  |
| 2019010115 | 151.0901 | 12.5001 | 2.52   | -6.1835 | -3.9368 | -5.1832 | -0.2908 | -3.8355 | -0.2340 |  |
| 2019010116 | 151.0901 | 12.5001 | 2.52   | -4.8731 | -3.4076 | -4.4190 | -0.3977 | -1.2256 | -0.2774 |  |
| 2019010117 | 151.0901 | 12.5001 | 2.52   | -3.9036 | -2.7433 | -3.5451 | -0.5872 | 1.5665  | -0.3521 |  |

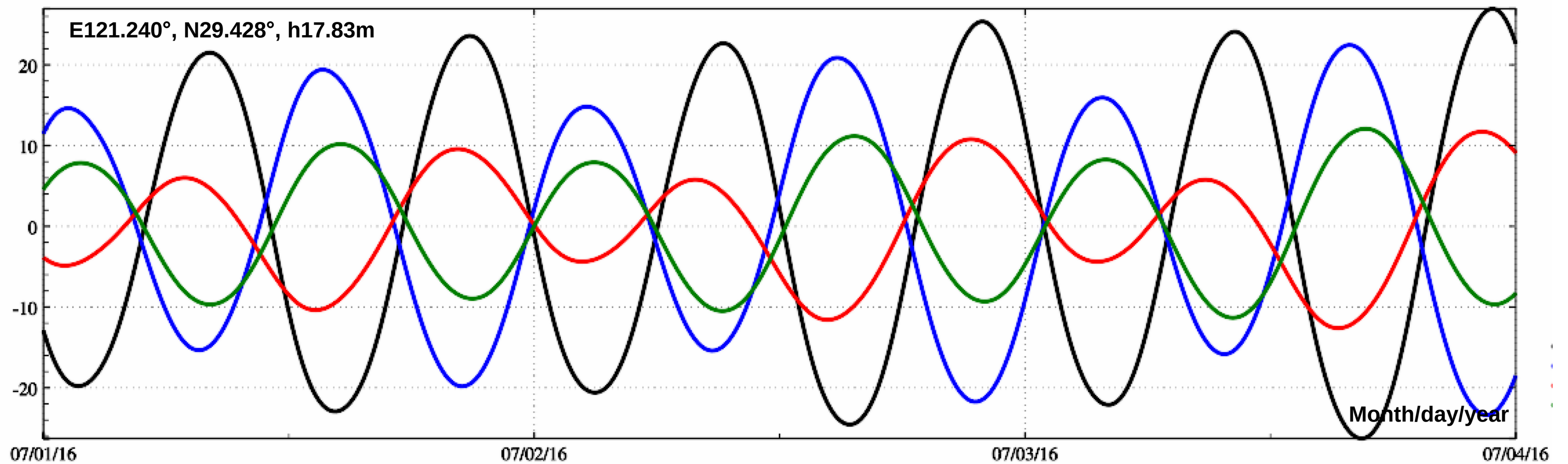
Columns 2 and 3 of the record are agreed as the longitude and latitude of the computation point

- Since ocean tidal loads are generally considered to act on the sea surface, the height of the computation point refers to the normal or orthometric height relative to the sea surface (geoid).
- The global ocean tidal load spherical harmonic coefficient model (cm) adopts the FES2004 format. Which can be constructed from global tidal height harmonic constant grid models using the function [Spherical Harmonic Analysis on Ocean Tidal Constituent Harmonic Constants].



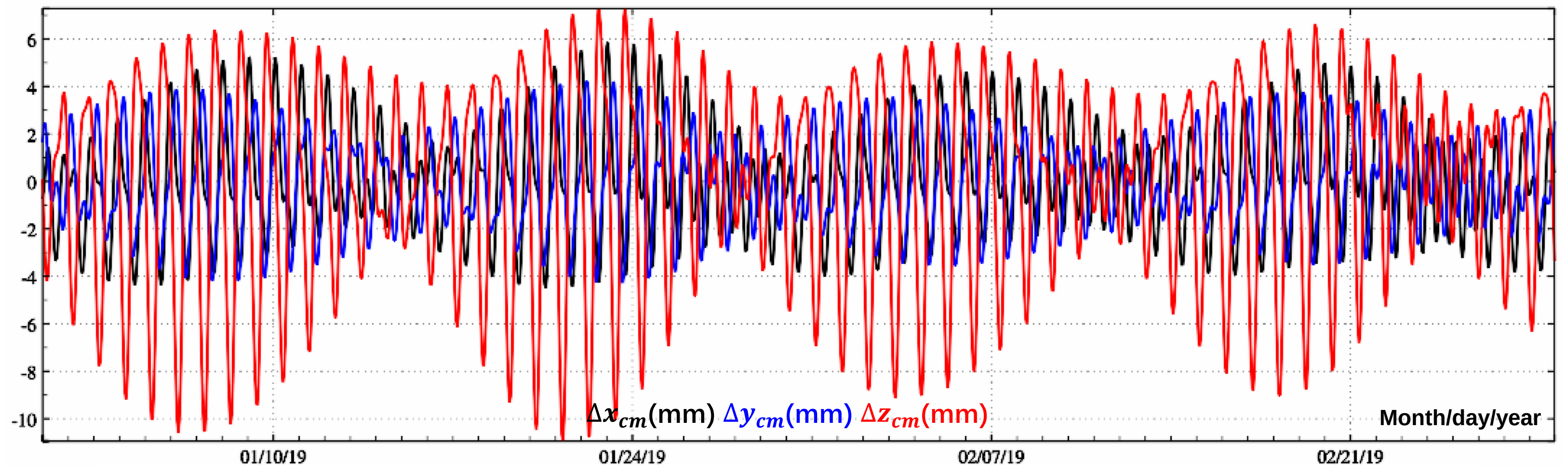


The ocean tidal load effects (360-degree) : height anomaly (mm) ground gravity (μGal) radial displacement (mm) orthometric height (mm)

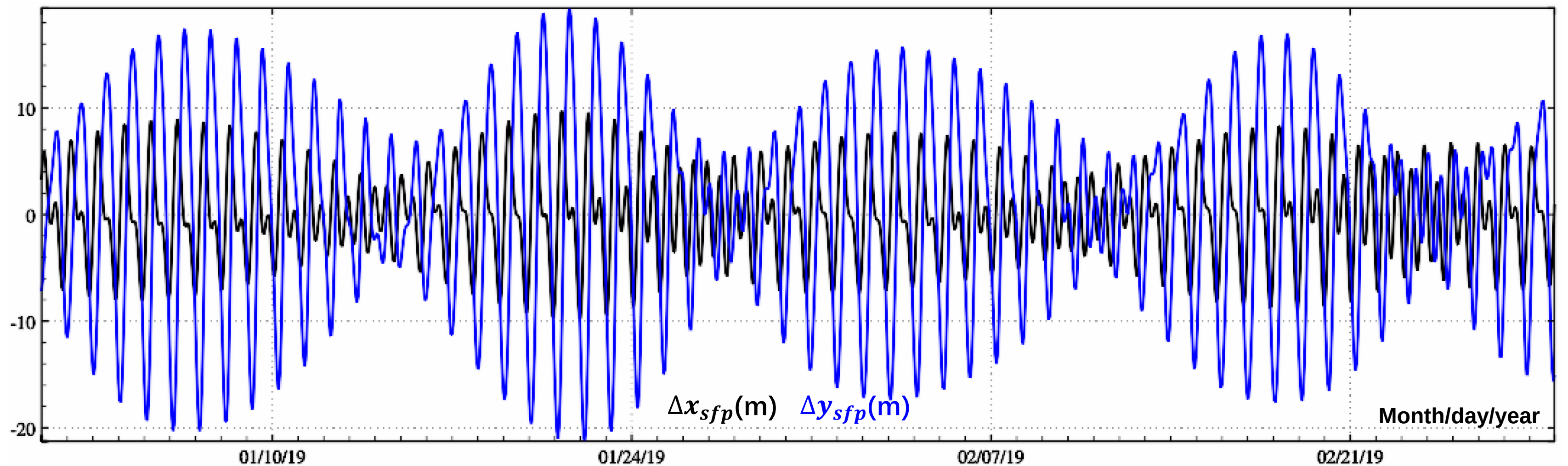


The ocean tidal load effects (360-degree) : ground tilt (S, mas) tilt (W, mas) horizontal displacement (E, mm) horizontal displacement (N, mm)





The ocean tidal load effect time series (mm) on Center of Mass of the Earth



The ocean tidal load effect time series (m) on Earth's figure pole in ITRS



# Computation of Ocean Tidal Load Effects for Earth Satellites or External Points

Computation of ocean tidal load effect time series at a ground site

Computation of ocean tidal load effects at ground sites with given time

Computation of ocean tidal load effects of Earth satellite or outside solid Earth

Global forecast of ocean tidal load effects on various surface geodetic variations

Open the location and time file of the external points

>> Program Process \*\* Operation Prompts

Save program process as

Set the file parameters

Column ordinal number of normal or orthometric height in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )

☐ gravity vector (XYZ,  $\mu\text{Gal}$ )

☒ gravity vector (ENU,  $\mu\text{Gal}$ )

☐ gravity gradient (XYZ,  $10\mu\text{E}$ )

☐ gravity gradient (ENU,  $10\mu\text{E}$ )

>> Complete the computation of the ocean tidal load effects!  
 >> Computation end time: 2026-06-07 09:38:58  
 >> [Function] Based on the location and time provided in the external space point file, this module computes the ocean tidal load effects on the geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity ( $\mu\text{Gal}$ ), or gravity gradient ( $10\mu\text{E}$ ) at points external to the solid Earth.  
 >> Open the location and time file of the external points C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/outerptm.txt.  
 \*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...  
 >> Save the computed results as C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/outerptmrst.txt.  
 \*\* Appends the selected tidal load effect columns to the input record as the output record.  
 >> Setting parameters have been imported into the program!  
 \*\* Click the control button [Start computation], or the tool button [Start computation]...  
 \*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/OTideloadharmsynth/outerptmrst.txt, to look at the computation progress!  
 >> Computation start time: 2026-06-07 10:32:33  
 >> Complete the computation of the ocean tidal load effects!  
 >> Computation end time: 2026-06-07 10:37:52

Maximum truncated degree of the coefficient model 120

Save the results as

Import setting parameters

Start computation

Display of the input-output file

GRACE satellite altitude

Save data in the text box as

| NYB          | 150.24 | 32.42 | 450000.0 | 58119.000000 |         |         |         |         |
|--------------|--------|-------|----------|--------------|---------|---------|---------|---------|
| 201901010000 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.7062  | 1.8994  | 3.6395  | -4.5368 |
| 201901010100 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.7226  | 1.2392  | 2.2724  | -4.9812 |
| 201901010200 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.6455  | 0.1608  | 0.1145  | -4.7514 |
| 201901010300 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.4814  | -1.1760 | -2.3711 | -3.8555 |
| 201901010400 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.2474  | -2.5020 | -4.6259 | -2.3812 |
| 201901010500 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.0279 | -3.5198 | -6.1243 | -0.4961 |
| 201901010600 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.3059 | -4.0274 | -6.5031 | 1.5358  |
| 201901010700 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.5459 | -3.9739 | -5.6522 | 3.3925  |
| 201901010800 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.7143 | -3.4097 | -3.7274 | 4.7711  |
| 201901010900 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.7902 | -2.4276 | -1.1052 | 5.4721  |
| 201901011000 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.7698 | -1.1688 | 1.6849  | 5.4405  |
| 201901011100 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.6668 | 0.1603  | 4.0655  | 4.7565  |
| 201901011200 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.5092 | 1.3309  | 5.5536  | 3.6224  |
| 201901011300 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.3310 | 2.1604  | 5.8885  | 2.3125  |
| 201901011400 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.1594 | 2.5516  | 5.0887  | 1.0591  |
| 201901011500 | 150.24 | 32.42 | 450000.0 | 58119.000000 | -0.0108 | 2.5163  | 3.4329  | -0.0001 |
| 201901011600 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.1052  | 2.1898  | 1.3849  | -0.7773 |
| 201901011700 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.1857  | 1.7899  | -0.5166 | -1.2273 |
| 201901011800 | 150.24 | 32.42 | 450000.0 | 58119.000000 | 0.2399  | 1.5064  | -1.7959 | -1.4002 |

Since ocean tidal loads are generally considered to act on the sea surface, the height of the computation point refers to the normal or orthometric height relative to the sea surface (geoid).

The global ocean tidal load spherical harmonic coefficient model (cm) adopts the FES2004 format. Which can be constructed from global tidal height harmonic constant grid models using the function [Spherical Harmonic Analysis on Ocean Tidal Constituent Harmonic Constants].



# Computation of Ocean Tidal Load Effects for Earth Satellites or External Points

- ☐ Computation of ocean tidal load effect time series at a ground site
 ☐ Computation of ocean tidal load effects at ground sites with given time
 ☒ Computation of ocean tidal load effects of Earth satellite or outside solid Earth
 ☐ Global forecast of ocean tidal load effects on various surface geodetic variations

Open the location and time file of the external points

Set the file parameters

Column ordinal number of normal or orthometric height in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )

☐ gravity vector (XYZ,  $\mu\text{Gal}$ )

☐ gravity vector (ENU,  $\mu\text{Gal}$ )

☐ gravity gradient (XYZ,  $10\mu\text{E}$ )

☒ gravity gradient (ENU,  $10\mu\text{E}$ )

>> Program Process \*\* Operation Prompts

>> Complete the computation of the ocean tidal load effects!

>> Computation end time: 2026-06-07 10:37:52

>> [Function] Based on the location and time provided in the external space point file, this module computes the ocean tidal load effects on the geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity ( $\mu\text{Gal}$ ), or gravity gradient ( $10\mu\text{E}$ ) at points external to the solid Earth.

>> Open the location and time file of the external points C:/ETideLoad4.5\_win64en/examples/OTideloadharmssynth/satptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the computed results as C:/ETideLoad4.5\_win64en/examples/OTideloadharmssynth/satprst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/OTideloadharmssynth/satprst.txt, to look at the computation progress!

>> Computation start time: 2026-06-07 10:39:34

>> Complete the computation of the ocean tidal load effects!

>> Computation end time: 2026-06-07 10:44:58

Maximum truncated degree of the coefficient model 120

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

NYB 150.24 32.42 250000.0 58119.000000

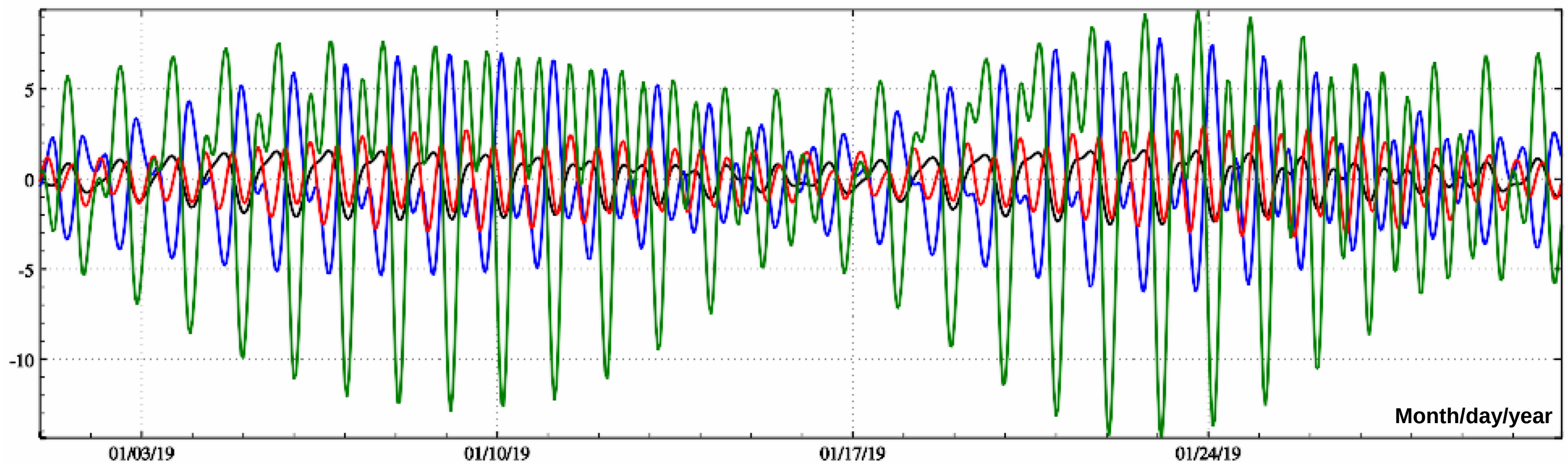
|              |        |       |          |         |         |         |         |
|--------------|--------|-------|----------|---------|---------|---------|---------|
| 201901010000 | 150.24 | 32.42 | 250000.0 | 0.8053  | -3.1881 | -0.5733 | 4.7552  |
| 201901010100 | 150.24 | 32.42 | 250000.0 | 0.8319  | -3.6135 | -0.2601 | 5.4440  |
| 201901010200 | 150.24 | 32.42 | 250000.0 | 0.7499  | -3.4396 | 0.0527  | 5.2184  |
| 201901010300 | 150.24 | 32.42 | 250000.0 | 0.5661  | -2.7244 | 0.3243  | 4.1564  |
| 201901010400 | 150.24 | 32.42 | 250000.0 | 0.2997  | -1.5932 | 0.4757  | 2.3948  |
| 201901010500 | 150.24 | 32.42 | 250000.0 | -0.0173 | -0.1972 | 0.4659  | 0.1546  |
| 201901010600 | 150.24 | 32.42 | 250000.0 | -0.3400 | 1.2391  | 0.3024  | -2.2075 |
| 201901010700 | 150.24 | 32.42 | 250000.0 | -0.6210 | 2.4250  | 0.0029  | -4.2682 |
| 201901010800 | 150.24 | 32.42 | 250000.0 | -0.8196 | 3.1060  | -0.3676 | -5.6278 |
| 201901010900 | 150.24 | 32.42 | 250000.0 | -0.9105 | 3.2028  | -0.6885 | -6.0611 |
| 201901011000 | 150.24 | 32.42 | 250000.0 | -0.8888 | 2.8216  | -0.8345 | -5.5836 |
| 201901011100 | 150.24 | 32.42 | 250000.0 | -0.7700 | 2.1150  | -0.7272 | -4.3450 |
| 201901011200 | 150.24 | 32.42 | 250000.0 | -0.5869 | 1.2442  | -0.3975 | -2.6412 |
| 201901011300 | 150.24 | 32.42 | 250000.0 | -0.3794 | 0.4417  | 0.0376  | -0.9329 |
| 201901011400 | 150.24 | 32.42 | 250000.0 | -0.1803 | -0.0826 | 0.5006  | 0.4233  |
| 201901011500 | 150.24 | 32.42 | 250000.0 | -0.0087 | -0.2765 | 0.9518  | 1.3248  |
| 201901011600 | 150.24 | 32.42 | 250000.0 | 0.1237  | -0.1893 | 1.2933  | 1.7398  |
| 201901011700 | 150.24 | 32.42 | 250000.0 | 0.2132  | 0.1102  | 1.4158  | 1.6557  |
| 201901011800 | 150.24 | 32.42 | 250000.0 | 0.2701  | 0.4983  | 1.2777  | 1.2036  |

GOCE satellite altitude

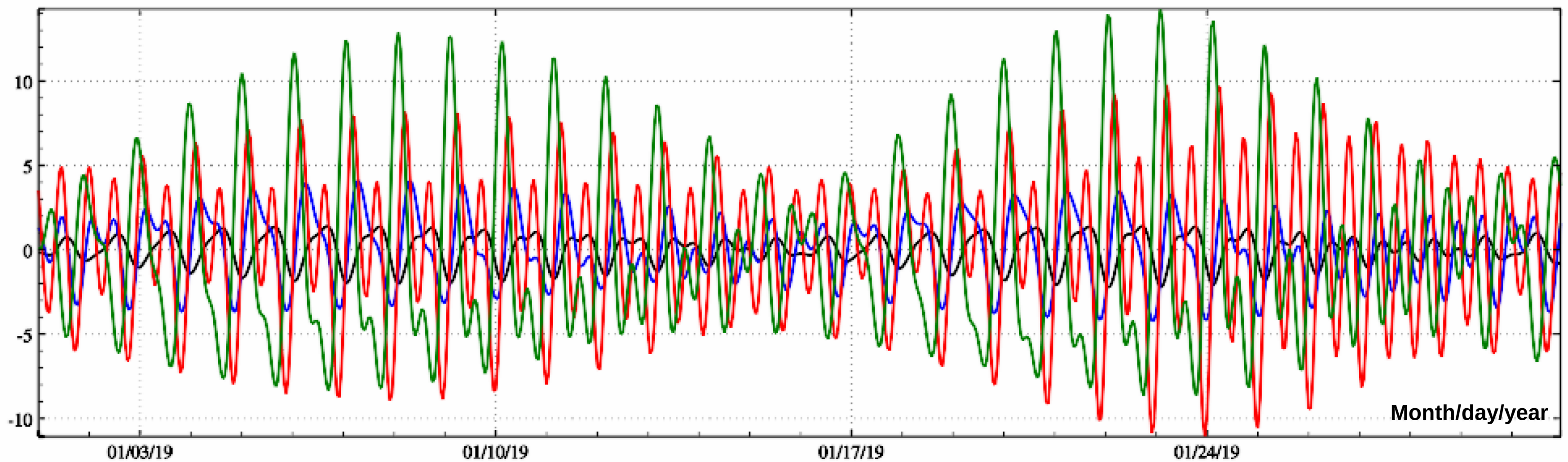
Save data in the text box as

- Since ocean tidal loads are generally considered to act on the sea surface, the height of the computation point refers to the normal or orthometric height relative to the sea surface (geoid).
 The global ocean tidal load spherical harmonic coefficient model (cm) adopts the FES2004 format. Which can be constructed from global tidal height harmonic constant grid models using the function [Spherical Harmonic Analysis on Ocean Tidal Constituent Harmonic Constants].





The ocean tidal load effects at 450km altitude : geopotential (0.1m²/s²), gravity vector (E, N: along the GRACE orbit/SST-II, U,  $\mu$ Gal)



The ocean tidal load effects at 250km altitude : geopotential (0.1m²/s²), gravity gradient (E, N: along the GOCE orbit, U, 10 $\mu$ E)



## Global Forecast of Ocean Tidal Load Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude 121.240000°

Latitude 29.428100°

Normal or orthometric height 17.830m

Forecast time series parameters

Start time 20160701

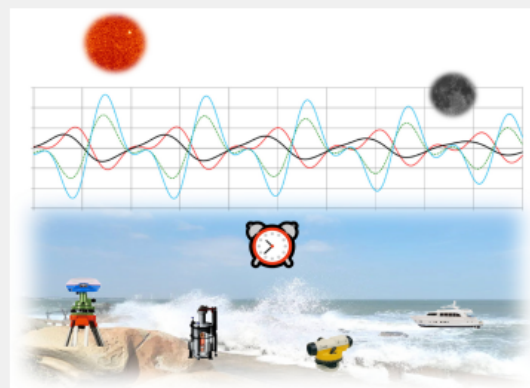
End time 20160704

Time interval 10.00 min

Maximum truncated degree of the coefficients model 360

Calculate and save as

The program needs some time to compute the time series of ocean tidal load effects. Please wait until the button [Extract time series to be plot] becomes available.



Tidal load effects to be plot

- ☒ geoid or height anomaly (mm)
- ☒ ground gravity ( $\mu\text{Gal}$ )
- ☐ gravity disturbance ( $\mu\text{Gal}$ )
- ☐ ground tilt (SW, mas)
- ☐ vertical deflection (SW, mas)
- ☐ horizontal displacement (EN, mm)
- ☒ ground radial displacement (mm)
- ☒ normal (orthometric) height (mm)
- ☐ radial gravity gradient ( $10\mu\text{E}$ )
- ☐ horizontal gravity gradient (NW,  $10\mu\text{E}$ )
- ☒ Sea surface tidal height (cm)

Tidal load effect time series on various geodetic elements

|              |          |         |          |          |          |          |      |
|--------------|----------|---------|----------|----------|----------|----------|------|
| 201607032010 | 2.840278 | -2.9941 | -38.4034 | -40.8687 | -15.6732 | 4.5441   | -3.4 |
| 201607032020 | 2.847222 | -2.4838 | -35.1985 | -37.5062 | -6.3060  | -0.0888  | -0.  |
| 201607032030 | 2.854167 | -1.9043 | -31.7056 | -33.8271 | 3.0449   | -4.6859  | 1.   |
| 201607032040 | 2.861111 | -1.2581 | -27.9283 | -29.8352 | 12.2900  | -9.2199  | 3.   |
| 201607032050 | 2.868056 | -0.5488 | -23.8674 | -25.5323 | 21.3472  | -13.6656 | 6.   |
| 2016070321   | 2.875000 | 0.2195  | -19.5226 | -20.9191 | 30.1430  | -17.9995 | 8.   |
| 201607032110 | 2.881944 | 1.0413  | -14.8934 | -15.9964 | 38.6135  | -22.1993 | 10.  |
| 201607032120 | 2.888889 | 1.9105  | -9.9809  | -10.7670 | 46.7040  | -26.2429 | 12.  |
| 201607032130 | 2.895833 | 2.8195  | -4.7898  | -5.2378  | 54.3698  | -30.1088 | 14.  |
| 201607032140 | 2.902778 | 3.7600  | 0.6696   | 0.5786   | 61.5743  | -33.7746 | 16.  |
| 201607032150 | 2.909722 | 4.7226  | 6.3797   | 6.6616   | 68.2889  | -37.2181 | 17.  |
| 2016070322   | 2.916667 | 5.6968  | 12.3137  | 12.9811  | 74.4909  | -40.4162 | 19.  |
| 201607032210 | 2.923611 | 6.6716  | 18.4342  | 19.4962  | 80.1624  | -43.3460 | 20.  |
| 201607032220 | 2.930556 | 7.6349  | 24.6927  | 26.1542  | 85.2884  | -45.9844 | 22.  |
| 201607032230 | 2.937500 | 8.5742  | 31.0290  | 32.8906  | 89.8553  | -48.3088 | 23.  |
| 201607032240 | 2.944444 | 9.4765  | 37.3719  | 39.6294  | 93.8493  | -50.2976 | 24.  |
| 201607032250 | 2.951389 | 10.3286 | 43.6396  | 46.2840  | 97.2552  | -51.9303 | 24.  |
| 2016070323   | 2.958333 | 11.1175 | 49.7423  | 52.7596  | 100.0555 | -53.1880 | 25.  |
| 201607032310 | 2.965278 | 11.8304 | 55.5835  | 58.9546  | 102.2300 | -54.0538 | 26.  |
| 201607032320 | 2.972222 | 12.4550 | 61.0636  | 64.7643  | 103.7551 | -54.5125 | 26.  |
| 201607032330 | 2.979167 | 12.9800 | 66.0822  | 70.0838  | 104.6045 | -54.5511 | 26.  |
| 201607032340 | 2.986111 | 13.3952 | 70.5422  | 74.8114  | 104.7500 | -54.1588 | 26.  |
| 201607032350 | 2.993056 | 13.6920 | 74.3524  | 78.8520  | 104.1623 | -53.3267 | 26.  |
| 2016070400   | 3.000000 | 13.8632 | 77.4314  | 82.1208  | 102.8130 | -52.0484 | 26.  |

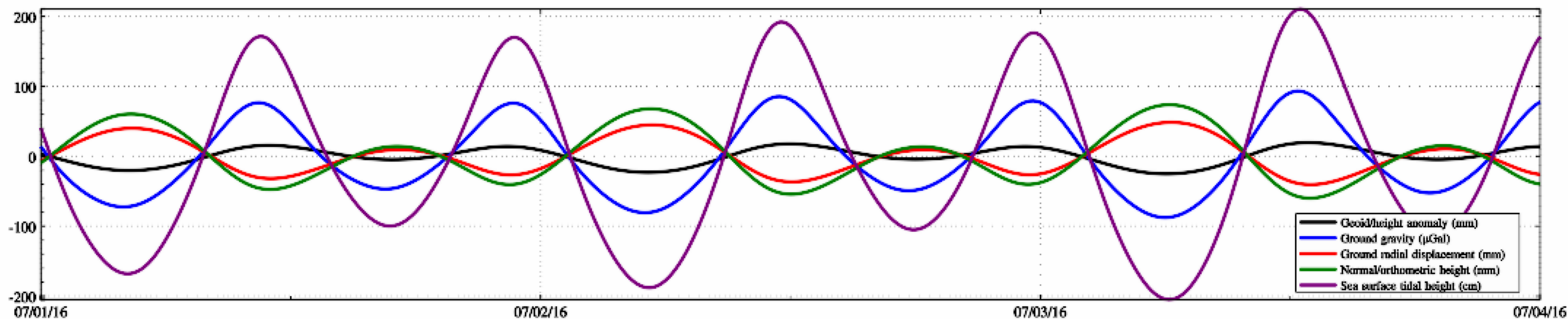
Set line thickness 3

Extract time series to be plot

Plot↓

Tidal load effect curve of surface geodetic elements

Save the current plot as



- Firstly, compute the time series of tidal load effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various tidal load effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of tidal load effects, and the time-varying characteristics of tidal load effect curves.



## Global Forecast of Ocean Tidal Load Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude

Latitude

Normal or orthometric height

Forecast time series parameters

Start time

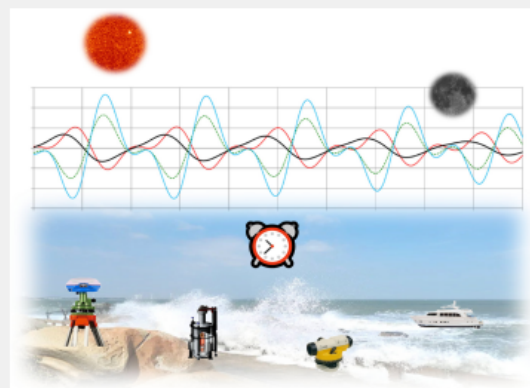
End time

Time interval

Maximum truncated degree of the coefficients model

 Calculate and save as

 The program needs some time to compute the time series of ocean tidal load effects. Please wait until the button [Extract time series to be plot] becomes available.



Tidal load effects to be plot

- ☐ geoid or height anomaly (mm)
- ☐ ground gravity ( $\mu\text{Gal}$ )  $\odot$
- ☐ gravity disturbance ( $\mu\text{Gal}$ )
- ☒ ground tilt (SW, mas)  $\odot$
- ☒ vertical deflection (SW, mas)
- ☒ horizontal displacement (EN, mm)  $\odot$
- ☐ ground radial displacement (mm)  $\odot$
- ☐ normal (orthometric) height (mm)  $\odot$
- ☐ radial gravity gradient ( $10\mu\text{E}$ )
- ☐ horizontal gravity gradient (NW,  $10\mu\text{E}$ )
- ☐ Sea surface tidal height (cm)

Tidal load effect time series on various geodetic elements

|              |          |         |          |          |          |          |      |
|--------------|----------|---------|----------|----------|----------|----------|------|
| 201607032010 | 2.840278 | -2.9941 | -38.4034 | -40.8687 | -15.6732 | 4.5441   | -3.4 |
| 201607032020 | 2.847222 | -2.4838 | -35.1985 | -37.5062 | -6.3060  | -0.0888  | -0.  |
| 201607032030 | 2.854167 | -1.9043 | -31.7056 | -33.8271 | 3.0449   | -4.6859  | 1.   |
| 201607032040 | 2.861111 | -1.2581 | -27.9283 | -29.8352 | 12.2900  | -9.2199  | 3.   |
| 201607032050 | 2.868056 | -0.5488 | -23.8674 | -25.5323 | 21.3472  | -13.6656 | 6.   |
| 2016070321   | 2.875000 | 0.2195  | -19.5226 | -20.9191 | 30.1430  | -17.9995 | 8.   |
| 201607032110 | 2.881944 | 1.0413  | -14.8934 | -15.9964 | 38.6135  | -22.1993 | 10.  |
| 201607032120 | 2.888889 | 1.9105  | -9.9809  | -10.7670 | 46.7040  | -26.2429 | 12.  |
| 201607032130 | 2.895833 | 2.8195  | -4.7898  | -5.2378  | 54.3698  | -30.1088 | 14.  |
| 201607032140 | 2.902778 | 3.7600  | 0.6696   | 0.5786   | 61.5743  | -33.7746 | 16.  |
| 201607032150 | 2.909722 | 4.7226  | 6.3797   | 6.6616   | 68.2889  | -37.2181 | 17.  |
| 2016070322   | 2.916667 | 5.6968  | 12.3137  | 12.9811  | 74.4909  | -40.4162 | 19.  |
| 201607032210 | 2.923611 | 6.6716  | 18.4342  | 19.4962  | 80.1624  | -43.3460 | 20.  |
| 201607032220 | 2.930556 | 7.6349  | 24.6927  | 26.1542  | 85.2884  | -45.9844 | 22.  |
| 201607032230 | 2.937500 | 8.5742  | 31.0290  | 32.8906  | 89.8553  | -48.3088 | 23.  |
| 201607032240 | 2.944444 | 9.4765  | 37.3719  | 39.6294  | 93.8493  | -50.2976 | 24.  |
| 201607032250 | 2.951389 | 10.3286 | 43.6396  | 46.2840  | 97.2552  | -51.9303 | 24.  |
| 2016070323   | 2.958333 | 11.1175 | 49.7423  | 52.7596  | 100.0555 | -53.1880 | 25.  |
| 201607032310 | 2.965278 | 11.8304 | 55.5835  | 58.9546  | 102.2300 | -54.0538 | 26.  |
| 201607032320 | 2.972222 | 12.4550 | 61.0636  | 64.7643  | 103.7551 | -54.5125 | 26.  |
| 201607032330 | 2.979167 | 12.9800 | 66.0822  | 70.0838  | 104.6045 | -54.5511 | 26.  |
| 201607032340 | 2.986111 | 13.3952 | 70.5422  | 74.8114  | 104.7500 | -54.1588 | 26.  |
| 201607032350 | 2.993056 | 13.6920 | 74.3524  | 78.8520  | 104.1623 | -53.3267 | 26.  |
| 2016070400   | 3.000000 | 13.8632 | 77.4314  | 82.1208  | 102.8130 | -52.0484 | 26.  |

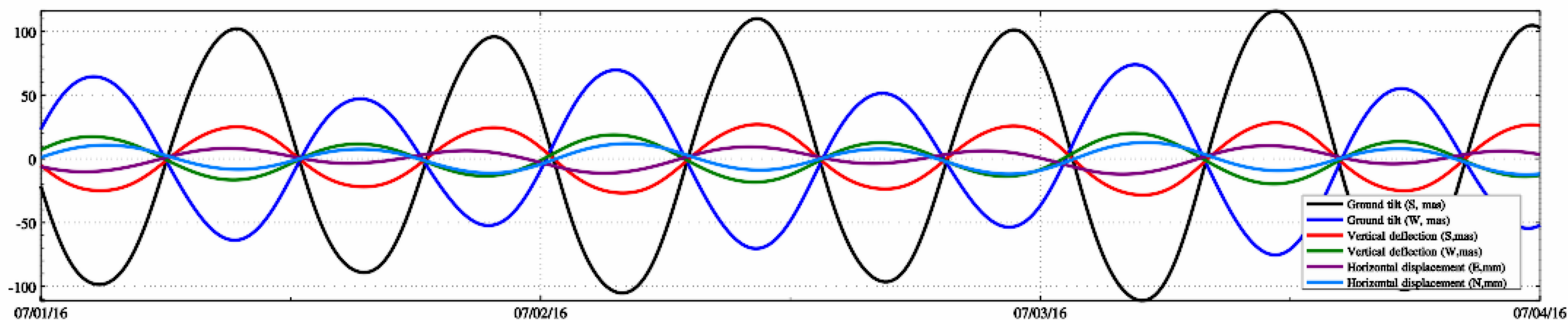
Set line thickness

 Extract time series to be plot

 Plot↓

Tidal load effect curve of surface geodetic elements

 Save the current plot as



- Firstly, compute the time series of tidal load effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various tidal load effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of tidal load effects, and the time-varying characteristics of tidal load effect curves.



## Global Forecast of Ocean Tidal Load Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude 121.240000°

Latitude 29.428100°

Normal or orthometric height 17.830m

Forecast time series parameters

Start time 20160701

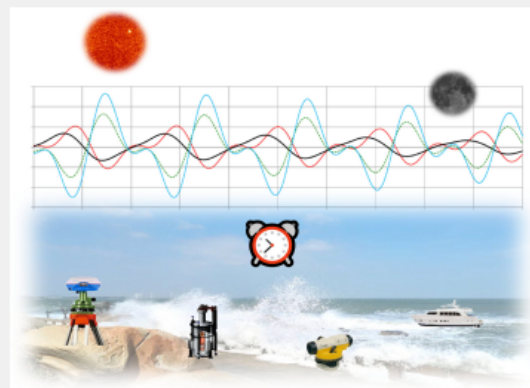
End time 20160704

Time interval 10.00 min

Maximum truncated degree of the coefficients model 360

Calculate and save as

🔔 The program needs some time to compute the time series of ocean tidal load effects. Please wait until the button [Extract time series to be plot] becomes available.



Tidal load effects to be plot

- ☐ geoid or height anomaly (mm)  
☐ ground gravity ( $\mu\text{Gal}$ )  $\odot$   
☐ gravity disturbance ( $\mu\text{Gal}$ )  
☐ ground tilt (SW, mas)  $\odot$   
☐ vertical deflection (SW, mas)  
☐ horizontal displacement (EN, mm)  $\odot$   
☐ ground radial displacement (mm)  $\odot$   
☐ normal (orthometric) height (mm)  $\odot$   
☒ radial gravity gradient ( $10\mu\text{E}$ )  
☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )  
☐ Sea surface tidal height (cm)

Tidal load effect time series on various geodetic elements

|              |          |         |          |          |          |          |      |
|--------------|----------|---------|----------|----------|----------|----------|------|
| 201607032010 | 2.840278 | -2.9941 | -38.4034 | -40.8687 | -15.6732 | 4.5441   | -3.4 |
| 201607032020 | 2.847222 | -2.4838 | -35.1985 | -37.5062 | -6.3060  | -0.0888  | -0.  |
| 201607032030 | 2.854167 | -1.9043 | -31.7056 | -33.8271 | 3.0449   | -4.6859  | 1.   |
| 201607032040 | 2.861111 | -1.2581 | -27.9283 | -29.8352 | 12.2900  | -9.2199  | 3.   |
| 201607032050 | 2.868056 | -0.5488 | -23.8674 | -25.5323 | 21.3472  | -13.6656 | 6.   |
| 2016070321   | 2.875000 | 0.2195  | -19.5226 | -20.9191 | 30.1430  | -17.9995 | 8.   |
| 201607032110 | 2.881944 | 1.0413  | -14.8934 | -15.9964 | 38.6135  | -22.1993 | 10.  |
| 201607032120 | 2.888889 | 1.9105  | -9.9809  | -10.7670 | 46.7040  | -26.2429 | 12.  |
| 201607032130 | 2.895833 | 2.8195  | -4.7898  | -5.2378  | 54.3698  | -30.1088 | 14.  |
| 201607032140 | 2.902778 | 3.7600  | 0.6696   | 0.5786   | 61.5743  | -33.7746 | 16.  |
| 201607032150 | 2.909722 | 4.7226  | 6.3797   | 6.6616   | 68.2889  | -37.2181 | 17.  |
| 2016070322   | 2.916667 | 5.6968  | 12.3137  | 12.9811  | 74.4909  | -40.4162 | 19.  |
| 201607032210 | 2.923611 | 6.6716  | 18.4342  | 19.4962  | 80.1624  | -43.3460 | 20.  |
| 201607032220 | 2.930556 | 7.6349  | 24.6927  | 26.1542  | 85.2884  | -45.9844 | 22.  |
| 201607032230 | 2.937500 | 8.5742  | 31.0290  | 32.8906  | 89.8553  | -48.3088 | 23.  |
| 201607032240 | 2.944444 | 9.4765  | 37.3719  | 39.6294  | 93.8493  | -50.2976 | 24.  |
| 201607032250 | 2.951389 | 10.3286 | 43.6396  | 46.2840  | 97.2552  | -51.9303 | 24.  |
| 2016070323   | 2.958333 | 11.1175 | 49.7423  | 52.7596  | 100.0555 | -53.1880 | 25.  |
| 201607032310 | 2.965278 | 11.8304 | 55.5835  | 58.9546  | 102.2300 | -54.0538 | 26.  |
| 201607032320 | 2.972222 | 12.4772 | 61.1647  | 64.8844  | 103.7800 | -54.5415 | 26.  |
| 201607032330 | 2.979167 | 13.0583 | 66.4980  | 70.5000  | 104.7500 | -54.6588 | 26.  |
| 201607032340 | 2.986111 | 13.5752 | 71.5042  | 74.8114  | 105.1500 | -54.4158 | 26.  |
| 201607032350 | 2.993056 | 14.0286 | 76.1204  | 77.8000  | 105.0000 | -53.8313 | 26.  |
| 2016070400   | 2.999999 | 14.4195 | 80.2844  | 79.4500  | 104.2500 | -52.0484 | 26.  |

The ocean tidal loading effect on gravity gradient can reach more than tens of mE. The high-accuracy and high-resolution ocean tide model should be employed for high precision gravity gradient measurement in coastal areas.

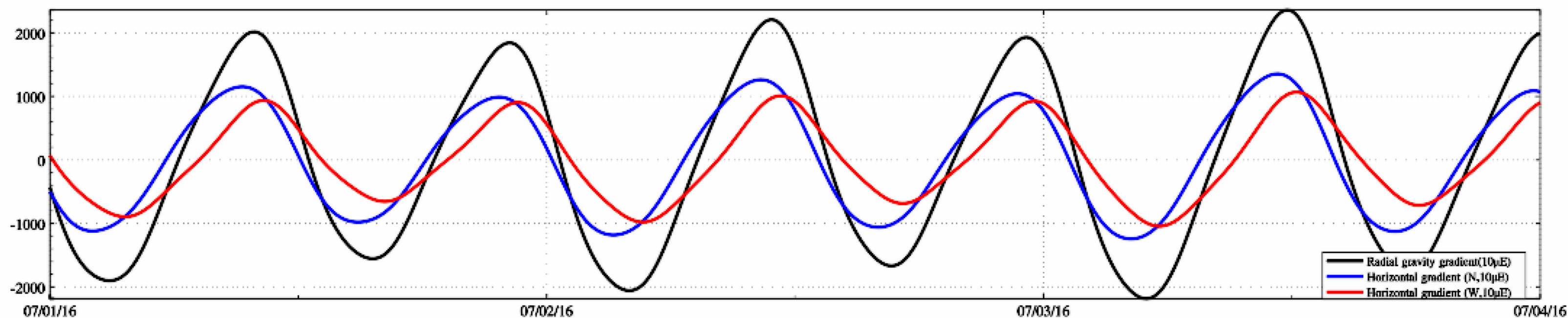
Set line thickness 3

Extract time series to be plot

Plot↓

Tidal load effect curve of surface geodetic elements

Save the current plot as



- Firstly, compute the time series of tidal load effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various tidal load effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of tidal load effects, and the time-varying characteristics of tidal load effect curves.



# Computation of Surface Atmosphere tidal Load Effect Time Series at a Ground Point

Computation of Surface Atmosphere tidal Load Effect Time Series at a Ground Point

Computation of Surface Atmosphere tidal Load Effects at Batch Points with Given Time

Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Open the ground variation time series file

>> Program Process \*\* Operation Prompts

Save program process as

Set the file parameters

Column ordinal number of height relative to the surface in the header 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

>> [Function] Given a ground variation time series file, this module computes the time series of surface atmosphere tidal load effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the ground variation time series file C:/ETideLoad4.5\_win64en/examples/ATideloadharmssynth/Tmseries.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/ATideloadharmssynth/Tmsqurst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/ATideloadharmssynth/Tmsqurst.txt, to look at the computation progress!

>> Computation start time: 2026-06-08 11:45:00

>> The program also outputs a time series file of the atmosphere tidal load effects on the degree-1 and degree-2 geopotential coefficients (\*Otdcmsfptm.txt) into the current directory (\* = input filename).

\*\* • Format: First row is the header. Subsequent rows contain: Epoch time, 3 columns of  $\Delta C_{10}$ ,  $\Delta C_{11}$ ,  $\Delta S_{11}$  ( $\times 10^{-10}$ ), 5 columns of  $\Delta C_{20}$ ,  $\Delta C_{21}$ ,  $\Delta S_{21}$ ,  $\Delta C_{22}$ ,  $\Delta S_{22}$  ( $\times 10^{-10}$ ), 3 columns effects on the Earth's center of mass (unit: mm), and 2 columns of effects on the figure pole  $\Delta x_{\text{sfp}}$ ,  $\Delta y_{\text{sfp}}$  (in ITRS, unit: m).

>> Complete the computation of the atmosphere tidal load effects!

Maximum truncated degree of the coefficient model

120

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

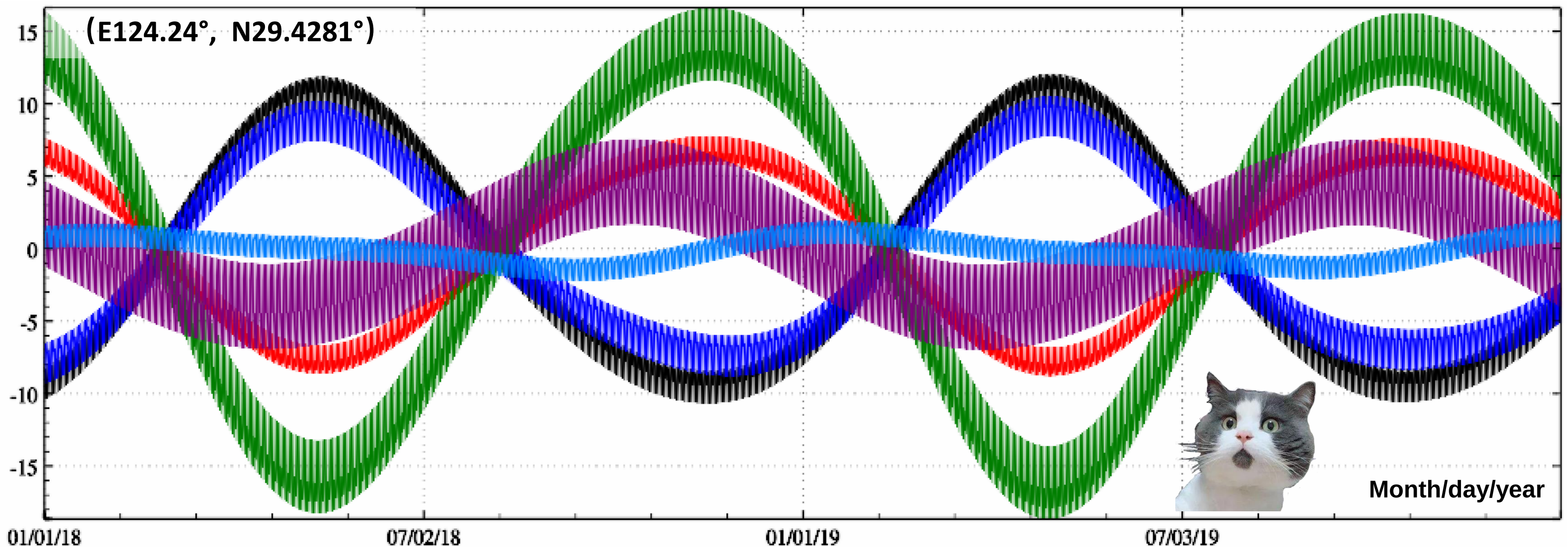
Save data in the text box as

| Forecast   | 121.240000 | 29.428100 | 0.000   | 58119.000000 |        |        |         |        |         |      |  |  |  |  |
|------------|------------|-----------|---------|--------------|--------|--------|---------|--------|---------|------|--|--|--|--|
| 2018010100 | 0.000000   | -8.6691   | -7.9206 | 6.3697       | 4.9036 | 0.8431 | -0.5672 | 0.3648 | -0.2596 | 0.47 |  |  |  |  |
| 2018010103 | 0.125000   | -8.2147   | -7.1096 | 5.8940       | 4.5588 | 0.8537 | -0.2702 | 0.3702 | -0.1412 | 0.32 |  |  |  |  |
| 2018010106 | 0.250000   | -9.1342   | -7.3395 | 6.5245       | 5.1688 | 0.7244 | -0.1673 | 0.3216 | -0.0971 | 0.24 |  |  |  |  |
| 2018010109 | 0.375000   | -9.1453   | -7.1337 | 6.5116       | 5.1977 | 0.6881 | -0.2389 | 0.3091 | -0.1186 | 0.21 |  |  |  |  |
| 2018010112 | 0.500000   | -8.2336   | -6.5034 | 5.7666       | 4.5417 | 0.7813 | -0.2378 | 0.3494 | -0.1009 | 0.13 |  |  |  |  |
| 2018010115 | 0.625000   | -8.6656   | -7.1527 | 6.0979       | 4.7569 | 0.7905 | -0.2430 | 0.3563 | -0.0885 | 0.11 |  |  |  |  |
| 2018010118 | 0.750000   | -10.1846  | -8.8031 | 7.3996       | 5.7968 | 0.6932 | -0.4551 | 0.3159 | -0.1800 | 0.28 |  |  |  |  |
| 2018010121 | 0.875000   | -10.1570  | -9.1459 | 7.5287       | 5.8738 | 0.7033 | -0.6698 | 0.3135 | -0.2871 | 0.48 |  |  |  |  |
| 2018010200 | 1.000000   | -8.5912   | -7.8709 | 6.3132       | 4.8559 | 0.8303 | -0.5563 | 0.3596 | -0.2550 | 0.46 |  |  |  |  |
| 2018010203 | 1.125000   | -8.1364   | -7.0595 | 5.8372       | 4.5108 | 0.8409 | -0.2593 | 0.3649 | -0.1365 | 0.31 |  |  |  |  |
| 2018010206 | 1.250000   | -9.0554   | -7.2889 | 6.4674       | 5.1205 | 0.7116 | -0.1564 | 0.3163 | -0.0925 | 0.23 |  |  |  |  |
| 2018010209 | 1.375000   | -9.0660   | -7.0827 | 6.4542       | 5.1491 | 0.6752 | -0.2280 | 0.3039 | -0.1139 | 0.20 |  |  |  |  |
| 2018010212 | 1.500000   | -8.1539   | -6.4520 | 5.7088       | 4.4930 | 0.7683 | -0.2269 | 0.3441 | -0.0963 | 0.12 |  |  |  |  |
| 2018010215 | 1.625000   | -8.5854   | -7.1009 | 6.0398       | 4.7078 | 0.7775 | -0.2320 | 0.3510 | -0.0839 | 0.10 |  |  |  |  |
| 2018010218 | 1.750000   | -10.1040  | -8.7509 | 7.3411       | 5.7475 | 0.6801 | -0.4441 | 0.3106 | -0.1753 | 0.27 |  |  |  |  |
| 2018010221 | 1.875000   | -10.0760  | -9.0933 | 7.4699       | 5.8243 | 0.6902 | -0.6588 | 0.3082 | -0.2824 | 0.47 |  |  |  |  |
| 2018010300 | 2.000000   | -8.5097   | -7.8178 | 6.2541       | 4.8061 | 0.8172 | -0.5452 | 0.3543 | -0.2503 | 0.46 |  |  |  |  |
| 2018010303 | 2.125000   | -8.0545   | -7.0060 | 5.7778       | 4.4608 | 0.8277 | -0.2482 | 0.3596 | -0.1319 | 0.30 |  |  |  |  |
| 2018010306 | 2.250000   | -8.9731   | -7.2350 | 6.4076       | 5.0702 | 0.6983 | -0.1453 | 0.3109 | -0.0878 | 0.23 |  |  |  |  |

When calculating the indirect effects of surface atmosphere tidal load, the program assumes that atmospheric loads are concentrated on the Earth's land/sea surface. When calculating the direct effects of surface atmosphere tidal load on gravity or gravity gradient, a proportional relationship is assumed between the atmosphere  $P_h$  at height  $h$  and the surface atmosphere  $P_0$ :  $P_h = P_0 (1 - h/44330)^{5225}$ .

The annual periodic amplitude of the surface atmospheric tide is more than 10 times the diurnal periodic amplitude. In land areas, surface atmospheric pressure is high in winter and low in summer, causing the ground to subside in winter and uplift in summer. This results in annual and semi-annual periodic ground vertical deformations, which must be considered in centimeter-level geodesy.

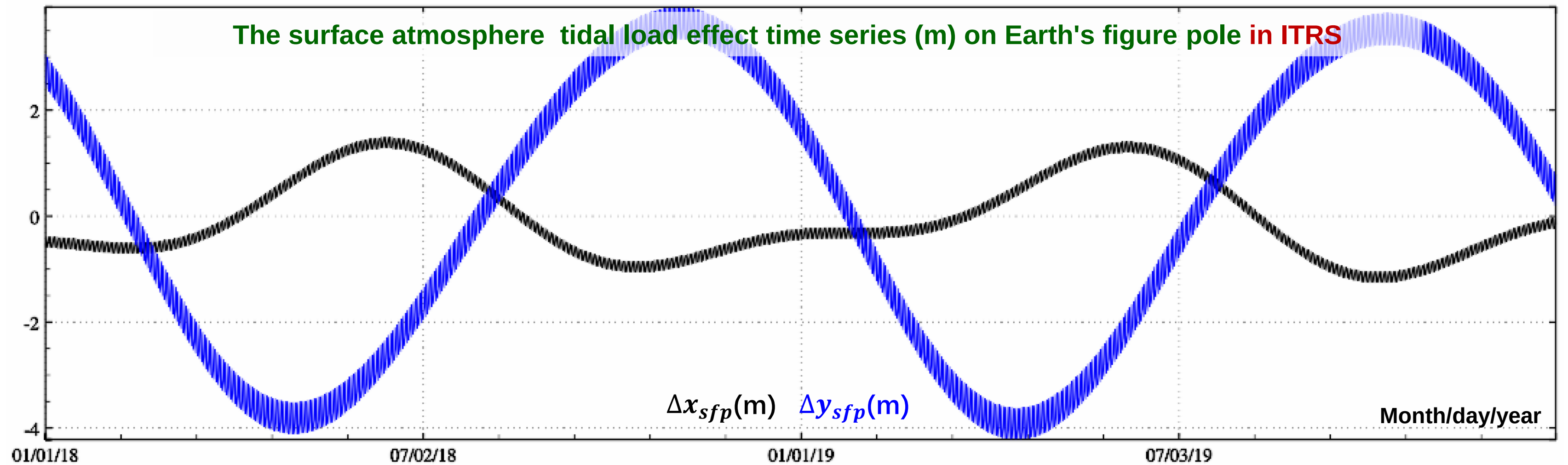
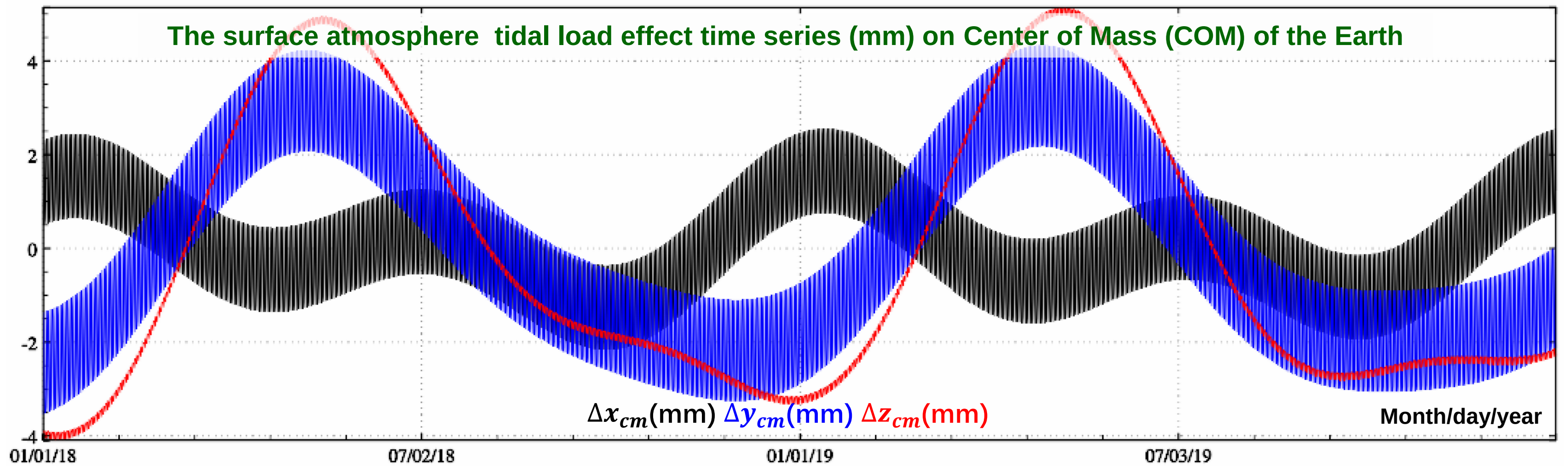




The Surface atmosphere tidal load effects (360-degree) : surface atmosphere(hPa/mbar)  
 height anomaly (mm) ground gravity ( $\mu\text{Gal}$ ) orthometric height (mm) radial gravity gradient  
 ( $10\mu\text{E}$ ) horizontal displacement (N,  $10\mu\text{E}$ )

The annual periodic amplitude of the surface atmospheric tide is more than 10 times the diurnal periodic amplitude. In land areas, surface atmospheric pressure is high in winter and low in summer, causing the ground to subside in winter and uplift in summer. This results in annual and semi-annual periodic ground vertical deformations, which must be considered in centimeter-level geodesy.







# Computation of Surface Atmosphere tidal Load Effects at Batch Points with Given Time

Computation of Surface Atmosphere tidal Load Effect Time Series at a Ground Point

Computation of Surface Atmosphere tidal Load Effects at Batch Points with Given Time

Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Open the location and time file of the computation points

>> Program Process \*\* Operation Prompts

Save program process as

Set the file parameters

Column ordinal number of height relative to the surface in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

3 columns effects on the Earth's center of mass (unit: mm), and 2 columns of effects on the figure pole  $\Delta x_{\text{sfp}}$ ,  $\Delta y_{\text{sfp}}$  (in ITRS, unit: m).

>> Complete the computation of the atmosphere tidal load effects!

>> Computation end time: 2026-06-08 11:47:23

>> [Function] According to the location and time specified in the computation point file, this module calculates the surface atmosphere tidal load effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the location and time file of the computation points C:/ETideLoad4.5\_win64en/examples/ATideloadharmssynth/Postiontm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/ATideloadharmssynth/Postmrst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/ATideloadharmssynth/Postmrst.txt, to look at the computation progress!

>> Computation start time: 2026-06-08 11:52:16

>> Complete the computation of the atmosphere tidal load effects!

>> Computation end time: 2026-06-08 11:52:36

Columns 2 and 3 of the record are agreed as the longitude and latitude of the computation point

Maximum truncated degree of the coefficient model 120

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save data in the text box as

|              |            |           |              |         |         |         |        |         |        |         |
|--------------|------------|-----------|--------------|---------|---------|---------|--------|---------|--------|---------|
| 101.230000   | 29.910000  | 0.0       | 58484.000000 |         |         |         |        |         |        |         |
| 201901010000 | 101.230000 | 29.910000 | 0.0          | -6.1907 | 2.5717  | 1.5546  | 0.3532 | -0.2690 | 0.1689 | -0.0595 |
| 201901010100 | 101.230000 | 29.910000 | 0.0          | -5.4420 | 1.6589  | 0.7758  | 0.3615 | -0.1645 | 0.1737 | -0.0268 |
| 201901010200 | 101.230000 | 29.910000 | 0.0          | -4.7521 | 0.8807  | 0.1210  | 0.3615 | -0.0105 | 0.1772 | 0.0250  |
| 201901010300 | 101.230000 | 29.910000 | 0.0          | -4.2262 | 0.3464  | -0.3177 | 0.3492 | 0.1680  | 0.1768 | 0.0865  |
| 201901010400 | 101.230000 | 29.910000 | 0.0          | -3.9154 | 0.0949  | -0.5095 | 0.3224 | 0.3442  | 0.1704 | 0.1475  |
| 201901010500 | 101.230000 | 29.910000 | 0.0          | -3.8085 | 0.0912  | -0.4870 | 0.2813 | 0.4953  | 0.1574 | 0.1991  |
| 201901010600 | 101.230000 | 29.910000 | 0.0          | -3.8423 | 0.2432  | -0.3317 | 0.2288 | 0.6068  | 0.1388 | 0.2357  |
| 201901010700 | 101.230000 | 29.910000 | 0.0          | -3.9239 | 0.4320  | -0.1474 | 0.1710 | 0.6745  | 0.1170 | 0.2562  |
| 201901010800 | 101.230000 | 29.910000 | 0.0          | -3.9617 | 0.5498  | -0.0279 | 0.1153 | 0.7041  | 0.0959 | 0.2631  |
| 201901010900 | 101.230000 | 29.910000 | 0.0          | -3.8947 | 0.5321  | -0.0287 | 0.0693 | 0.7078  | 0.0792 | 0.2619  |
| 201901011000 | 101.230000 | 29.910000 | 0.0          | -3.7117 | 0.3775  | -0.1510 | 0.0394 | 0.7000  | 0.0702 | 0.2586  |
| 201901011100 | 101.230000 | 29.910000 | 0.0          | -3.4571 | 0.1485  | -0.3407 | 0.0293 | 0.6920  | 0.0707 | 0.2582  |
| 201901011200 | 101.230000 | 29.910000 | 0.0          | -3.2184 | -0.0471 | -0.5050 | 0.0393 | 0.6884  | 0.0804 | 0.2627  |
| 201901011300 | 101.230000 | 29.910000 | 0.0          | -3.1018 | -0.0875 | -0.5396 | 0.0665 | 0.6861  | 0.0974 | 0.2705  |
| 201901011400 | 101.230000 | 29.910000 | 0.0          | -3.2011 | 0.1248  | -0.3610 | 0.1056 | 0.6747  | 0.1184 | 0.2770  |
| 201901011500 | 101.230000 | 29.910000 | 0.0          | -3.5674 | 0.6318  | 0.0660  | 0.1499 | 0.6408  | 0.1395 | 0.2759  |
| 201901011600 | 101.230000 | 29.910000 | 0.0          | -4.1910 | 1.4011  | 0.7134  | 0.1932 | 0.5720  | 0.1570 | 0.2612  |
| 201901011700 | 101.230000 | 29.910000 | 0.0          | -4.9973 | 2.3286  | 1.4913  | 0.2311 | 0.4621  | 0.1688 | 0.2292  |
| 201901011800 | 101.230000 | 29.910000 | 0.0          | -5.8605 | 3.2583  | 2.2667  | 0.2611 | 0.3145  | 0.1742 | 0.1801  |

When calculating the indirect effects of surface atmosphere tidal load, the program assumes that atmospheric loads are concentrated on the Earth's land/sea surface. When calculating the direct effects of surface atmosphere tidal load on gravity or gravity gradient, a proportional relationship is assumed between the atmosphere  $P_h$  at height  $h$  and the surface atmosphere  $P_0$ :  $P_h = P_0 (1 - h/44330)^{5225}$ .

The annual periodic amplitude of the surface atmospheric tide is more than 10 times the diurnal periodic amplitude. In land areas, surface atmospheric pressure is high in winter and low in summer, causing the ground to subside in winter and uplift in summer. This results in annual and semi-annual periodic ground vertical deformations, which must be considered in centimeter-level geodesy.



# Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Computation of Surface Atmosphere tidal Load Effect Time Series at a Ground Point

Computation of Surface Atmosphere tidal Load Effects at Batch Points with Given Time

Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Open the location and time file of the external points

>> Program Process \*\* Operation Prompts

Save program process as

Set the file parameters

Column ordinal number of height relative to the surface in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )

☐ gravity vector (XYZ,  $\mu\text{Gal}$ )

☒ gravity vector (ENU,  $\mu\text{Gal}$ )

☐ gravity gradient (XYZ,  $10\mu\text{E}$ )

☐ gravity gradient (ENU,  $10\mu\text{E}$ )

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/Postmrst.txt, to look at the computation progress!

>> Computation start time: 2026-06-08 11:52:16

>> Complete the computation of the atmosphere tidal load effects!

>> Computation end time: 2026-06-08 11:52:36

>> [Function] Based on the location and time provided in the external space point file, this module computes the surface atmosphere tidal load effects on the geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity ( $\mu\text{Gal}$ ), or gravity gradient ( $10\mu\text{E}$ ) at points external to the solid Earth.

>> Open the location and time file of the external points C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/outerptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/outerprst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/outerprst.txt, to look at the computation progress!

>> Computation start time: 2026-06-08 12:01:52

>> Complete the computation of the atmosphere tidal load effects!

>> Computation end time: 2026-06-08 12:03:37

Maximum truncated degree of the coefficient model

120

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

GRACE satellite altitude

| Forecast   | 121.2400 | 29.4281 | 450000.0 | 58119.00 |         |        |        |
|------------|----------|---------|----------|----------|---------|--------|--------|
| 2018010100 | 121.2400 | 29.4281 | 450000.0 | -0.6276  | -1.1288 | 0.9385 | 2.6999 |
| 2018010104 | 121.2400 | 29.4281 | 450000.0 | -0.5577  | -1.1084 | 0.4650 | 2.5272 |
| 2018010108 | 121.2400 | 29.4281 | 450000.0 | -0.5675  | -0.9437 | 0.5120 | 2.6709 |
| 2018010112 | 121.2400 | 29.4281 | 450000.0 | -0.5035  | -1.1052 | 0.4518 | 2.3798 |
| 2018010116 | 121.2400 | 29.4281 | 450000.0 | -0.6052  | -1.1231 | 0.3106 | 2.6774 |
| 2018010120 | 121.2400 | 29.4281 | 450000.0 | -0.7372  | -0.9749 | 0.8376 | 3.1311 |
| 2018010124 | 121.2400 | 29.4281 | 450000.0 | -0.6238  | -1.1147 | 0.9249 | 2.6797 |
| 2018010204 | 121.2400 | 29.4281 | 450000.0 | -0.5539  | -1.0942 | 0.4514 | 2.5067 |
| 2018010208 | 121.2400 | 29.4281 | 450000.0 | -0.5636  | -0.9294 | 0.4984 | 2.6503 |
| 2018010212 | 121.2400 | 29.4281 | 450000.0 | -0.4996  | -1.0908 | 0.4382 | 2.3591 |
| 2018010216 | 121.2400 | 29.4281 | 450000.0 | -0.6012  | -1.1086 | 0.2970 | 2.6564 |
| 2018010220 | 121.2400 | 29.4281 | 450000.0 | -0.7332  | -0.9604 | 0.8239 | 3.1099 |
| 2018010224 | 121.2400 | 29.4281 | 450000.0 | -0.6198  | -1.1000 | 0.9112 | 2.6583 |
| 2018010304 | 121.2400 | 29.4281 | 450000.0 | -0.5498  | -1.0795 | 0.4376 | 2.4852 |
| 2018010308 | 121.2400 | 29.4281 | 450000.0 | -0.5595  | -0.9146 | 0.4846 | 2.6286 |
| 2018010312 | 121.2400 | 29.4281 | 450000.0 | -0.4954  | -1.0759 | 0.4244 | 2.3372 |
| 2018010316 | 121.2400 | 29.4281 | 450000.0 | -0.5970  | -1.0937 | 0.2832 | 2.6343 |
| 2018010320 | 121.2400 | 29.4281 | 450000.0 | -0.7289  | -0.9453 | 0.8100 | 3.0877 |
| 2018010324 | 121.2400 | 29.4281 | 450000.0 | -0.6154  | -1.0849 | 0.8973 | 2.6359 |
| 2018010404 | 121.2400 | 29.4281 | 450000.0 | -0.5455  | -1.0643 | 0.4237 | 2.4626 |

When calculating the indirect effects of surface atmosphere tidal load, the program assumes that atmospheric loads are concentrated on the Earth's land/sea surface. When calculating the direct effects of surface atmosphere tidal load on gravity or gravity gradient, a proportional relationship is assumed between the atmosphere  $P_h$  at height  $h$  and the surface atmosphere  $P_0$ :  $P_h = P_0 (1 - h/44330)^{5.225}$ .

The annual periodic amplitude of the surface atmospheric tide is more than 10 times the diurnal periodic amplitude. In land areas, surface atmospheric pressure is high in winter and low in summer, causing the ground to subside in winter and uplift in summer. This results in annual and semi-annual periodic ground vertical deformations, which must be considered in centimeter-level geodesy.



# Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Computation of Surface Atmosphere tidal Load Effect Time Series at a Ground Point

Computation of Surface Atmosphere tidal Load Effects at Batch Points with Given Time

Computation of Atmosphere Tidal Load Effects for Earth Satellites or External Points to the Solid Earth

Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Open the location and time file of the external points

>> Program Process \*\* Operation Prompts

Save program process as

Set the file parameters

Column ordinal number of height relative to the surface in the record 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )

☐ gravity vector (XYZ,  $\mu\text{Gal}$ )

☐ gravity vector (ENU,  $\mu\text{Gal}$ )

☐ gravity gradient (XYZ,  $10\mu\text{E}$ )

☒ gravity gradient (ENU,  $10\mu\text{E}$ )

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/outerprst.txt, to look at the computation progress!  
 >> Computation start time: 2026-06-08 12:01:52  
 >> Complete the computation of the atmosphere tidal load effects!  
 >> Computation end time: 2026-06-08 12:03:37  
 >> [Function] Based on the location and time provided in the external space point file, this module computes the surface atmosphere tidal load effects on the geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity ( $\mu\text{Gal}$ ), or gravity gradient ( $10\mu\text{E}$ ) at points external to the solid Earth.  
 >> Open the location and time file of the external points C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/satptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the tidal load effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/satptmrst.txt.

\*\* Appends the selected tidal load effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

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

\*\* The computation process needs to wait... During the computation period, you can open the output file C:/ETideLoad4.5\_win64en/examples/ATideloadharmsynth/satptmrst.txt, to look at the computation progress!

>> Computation start time: 2026-06-08 12:07:32

>> Complete the computation of the atmosphere tidal load effects!

>> Computation end time: 2026-06-08 12:09:17

Maximum truncated degree of the coefficient model 120

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

GOCE satellite altitude

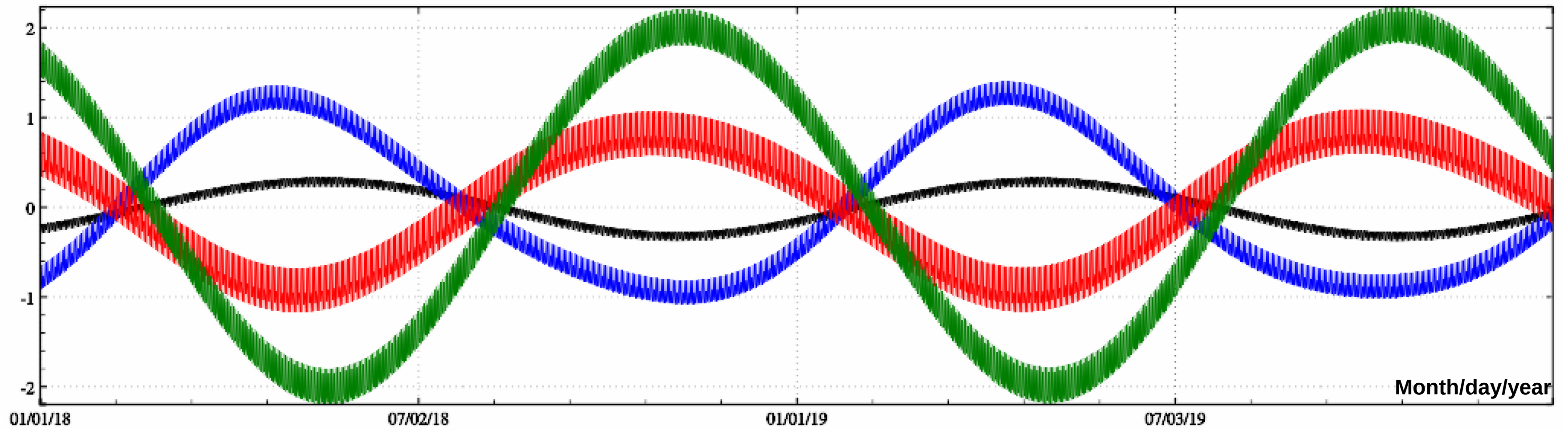
Save data in the text box as

| Forecast   | 121.2400 | 29.4281 | 250000.0 | 58119.00 |        |         |         |
|------------|----------|---------|----------|----------|--------|---------|---------|
| 2018010100 | 121.2400 | 29.4281 | 250000.0 | -0.6861  | 0.8041 | -0.9135 | -2.7813 |
| 2018010104 | 121.2400 | 29.4281 | 250000.0 | -0.6128  | 0.9141 | -0.9044 | -2.8233 |
| 2018010108 | 121.2400 | 29.4281 | 250000.0 | -0.6257  | 1.0474 | -0.8697 | -2.9583 |
| 2018010112 | 121.2400 | 29.4281 | 250000.0 | -0.5555  | 0.9582 | -0.8391 | -2.7579 |
| 2018010116 | 121.2400 | 29.4281 | 250000.0 | -0.6634  | 0.9732 | -0.9110 | -2.9476 |
| 2018010120 | 121.2400 | 29.4281 | 250000.0 | -0.8048  | 0.9478 | -0.9501 | -3.0964 |
| 2018010124 | 121.2400 | 29.4281 | 250000.0 | -0.6819  | 0.7949 | -0.9121 | -2.7619 |
| 2018010204 | 121.2400 | 29.4281 | 250000.0 | -0.6086  | 0.9049 | -0.9029 | -2.8037 |
| 2018010208 | 121.2400 | 29.4281 | 250000.0 | -0.6214  | 1.0381 | -0.8681 | -2.9385 |
| 2018010212 | 121.2400 | 29.4281 | 250000.0 | -0.5511  | 0.9488 | -0.8374 | -2.7379 |
| 2018010216 | 121.2400 | 29.4281 | 250000.0 | -0.6590  | 0.9637 | -0.9093 | -2.9274 |
| 2018010220 | 121.2400 | 29.4281 | 250000.0 | -0.8004  | 0.9383 | -0.9484 | -3.0760 |
| 2018010224 | 121.2400 | 29.4281 | 250000.0 | -0.6774  | 0.7853 | -0.9103 | -2.7414 |
| 2018010304 | 121.2400 | 29.4281 | 250000.0 | -0.6040  | 0.8952 | -0.9010 | -2.7829 |
| 2018010308 | 121.2400 | 29.4281 | 250000.0 | -0.6168  | 1.0284 | -0.8662 | -2.9176 |
| 2018010312 | 121.2400 | 29.4281 | 250000.0 | -0.5465  | 0.9390 | -0.8354 | -2.7167 |
| 2018010316 | 121.2400 | 29.4281 | 250000.0 | -0.6543  | 0.9539 | -0.9073 | -2.9061 |
| 2018010320 | 121.2400 | 29.4281 | 250000.0 | -0.7956  | 0.9284 | -0.9463 | -3.0545 |
| 2018010324 | 121.2400 | 29.4281 | 250000.0 | -0.6726  | 0.7754 | -0.9081 | -2.7196 |
| 2018010404 | 121.2400 | 29.4281 | 250000.0 | -0.5992  | 0.8852 | -0.8988 | -2.7610 |

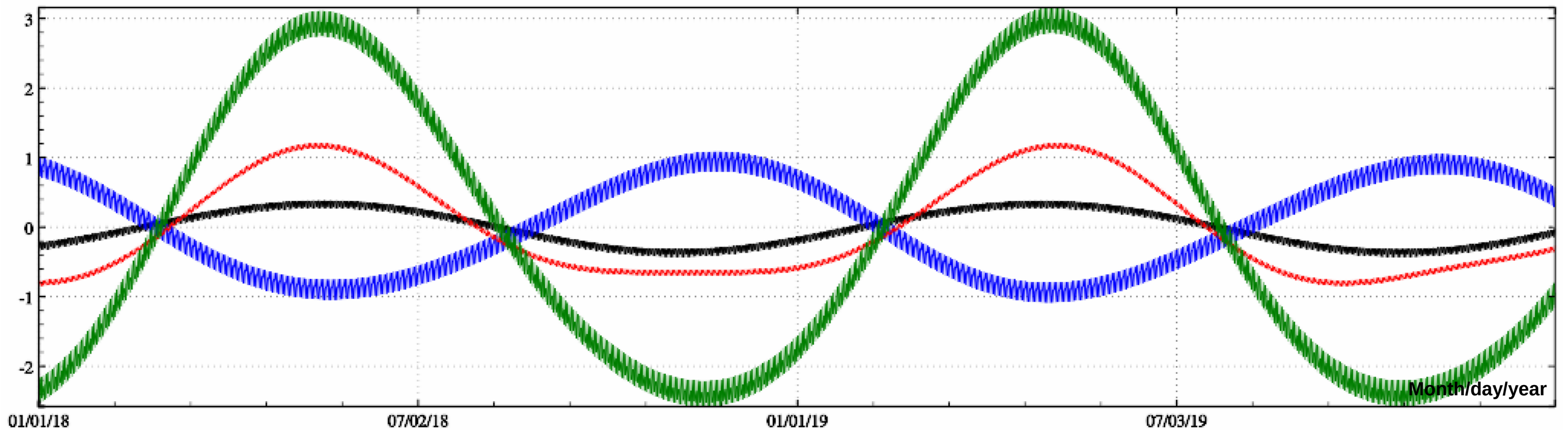
When calculating the indirect effects of surface atmosphere tidal load, the program assumes that atmospheric loads are concentrated on the Earth's land/sea surface. When calculating the direct effects of surface atmosphere tidal load on gravity or gravity gradient, a proportional relationship is assumed between the atmosphere  $P_h$  at height  $h$  and the surface atmosphere  $P_0$ :  $P_h = P_0 (1 - h/44330)^{5.225}$ .

The annual periodic amplitude of the surface atmospheric tide is more than 10 times the diurnal periodic amplitude. In land areas, surface atmospheric pressure is high in winter and low in summer, causing the ground to subside in winter and uplift in summer. This results in annual and semi-annual periodic ground vertical deformations, which must be considered in centimeter-level geodesy.





Surface atmosphere tidal effects at 450km altitude : geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity vector (E, N: along the GRACE orbit/SST-II, U,  $\mu\text{Gal}$ )



Surface atmosphere tidal effects at 250km altitude : geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity gradient (E, N: along the GOCE orbit, U,  $10\mu\text{E}$ )



## Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude 121.240000°  
Latitude 29.428100°

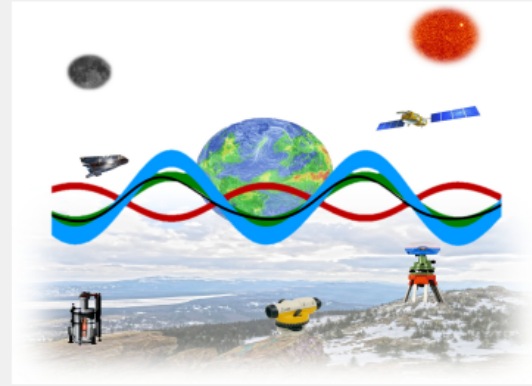
Forecast time series parameters

Start time 20180101  
End time 20200101  
Time interval 240.00 min

Maximum truncated degree of the coefficients model 120

Calculate and save as

⚠ The program needs some time to compute the time series of atmosphere tidal load effects. Please wait until the button [Extract time series to be plot] becomes available.



Tidal effects to be plot

- ☐ geoid or height anomaly (mm)  
☒ ground gravity ( $\mu\text{Gal}$ )  
☐ gravity disturbance ( $\mu\text{Gal}$ )  
☐ ground tilt (SW, mas)  
☐ vertical deflection (SW, mas)  
☐ horizontal displacement (EN, mm)  
☒ ground radial displacement (mm)  
☒ normal (orthometric) height (mm)  
☐ radial gravity gradient ( $10\mu\text{E}$ )  
☐ horizontal gravity gradient (NW,  $10\mu\text{E}$ )  
☒ surface atmosphere (hPa/mbar)

Tidal load effect time series on various geodetic elements

|            |            |         |        |        |        |         |
|------------|------------|---------|--------|--------|--------|---------|
| 2019122804 | 726.166667 | -3.2933 | 2.5342 | 1.9012 | 0.2835 | 0.2501  |
| 2019122808 | 726.333333 | -3.4651 | 3.1292 | 2.4891 | 0.1465 | 0.2405  |
| 2019122812 | 726.500000 | -2.6496 | 2.2293 | 1.7088 | 0.2478 | 0.2169  |
| 2019122816 | 726.666667 | -3.8375 | 2.9789 | 2.2555 | 0.2265 | 0.1643  |
| 2019122820 | 726.833333 | -5.4016 | 4.1488 | 3.1814 | 0.1449 | -0.1691 |
| 2019122824 | 727.000000 | -3.9926 | 2.7539 | 2.0054 | 0.2954 | -0.1006 |
| 2019122904 | 727.166667 | -3.1949 | 2.4334 | 1.8183 | 0.2679 | 0.2627  |
| 2019122908 | 727.333333 | -3.3664 | 3.0282 | 2.4060 | 0.1308 | 0.2531  |
| 2019122912 | 727.500000 | -2.5505 | 2.1281 | 1.6255 | 0.2320 | 0.2296  |
| 2019122916 | 727.666667 | -3.7381 | 2.8774 | 2.1721 | 0.2107 | 0.1769  |
| 2019122920 | 727.833333 | -5.3018 | 4.0471 | 3.0978 | 0.1291 | -0.1565 |
| 2019122924 | 728.000000 | -3.8926 | 2.6520 | 1.9217 | 0.2796 | -0.0880 |
| 2019123004 | 728.166667 | -3.0945 | 2.3312 | 1.7344 | 0.2520 | 0.2753  |
| 2019123008 | 728.333333 | -3.2656 | 2.9258 | 2.3219 | 0.1149 | 0.2657  |
| 2019123012 | 728.500000 | -2.4494 | 2.0255 | 1.5413 | 0.2161 | 0.2421  |
| 2019123016 | 728.666667 | -3.6367 | 2.7746 | 2.0877 | 0.1947 | 0.1895  |
| 2019123020 | 728.833333 | -5.2001 | 3.9440 | 3.0132 | 0.1131 | -0.1440 |
| 2019123024 | 729.000000 | -3.7905 | 2.5487 | 1.8369 | 0.2635 | -0.0755 |
| 2019123104 | 729.166667 | -2.9921 | 2.2277 | 1.6495 | 0.2359 | 0.2878  |
| 2019123108 | 729.333333 | -3.1630 | 2.8221 | 2.2368 | 0.0988 | 0.2782  |
| 2019123112 | 729.500000 | -2.3464 | 1.9215 | 1.4561 | 0.2000 | 0.2546  |
| 2019123116 | 729.666667 | -3.5334 | 2.6704 | 2.0023 | 0.1785 | 0.2020  |
| 2019123120 | 729.833333 | -5.0965 | 3.8396 | 2.9276 | 0.0969 | -0.1315 |
| 2019123124 | 730.000000 | -3.6866 | 2.4441 | 1.7512 | 0.2473 | -0.0630 |

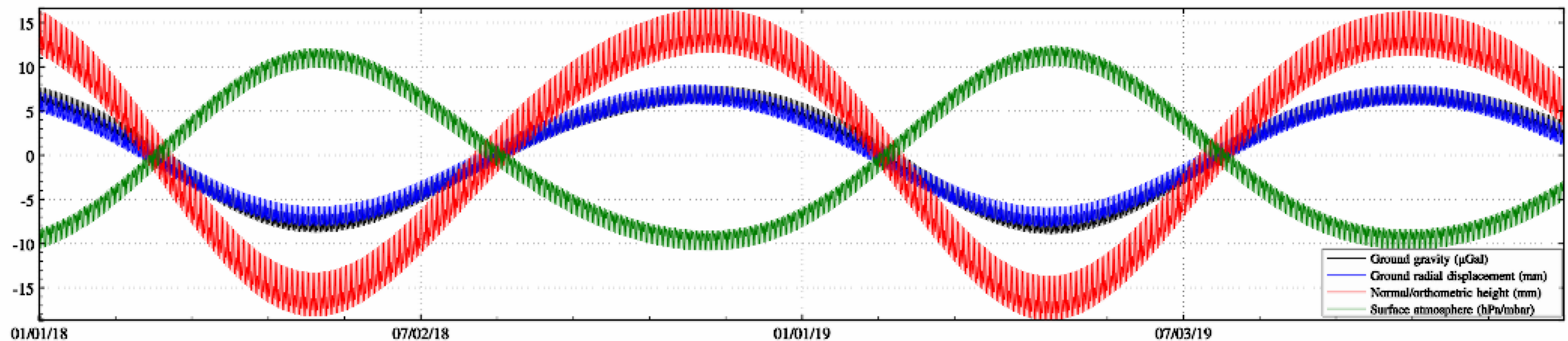
Set line thickness 1

Extract time series to be plot

Plot↓

Tidal load effect curve of surface geodetic elements

Save the current plot as



- Firstly, compute the time series of tidal load effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various tidal load effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of tidal load effects, and the time-varying characteristics of tidal load effect curves.



## Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude 121.240000°  
Latitude 29.428100°

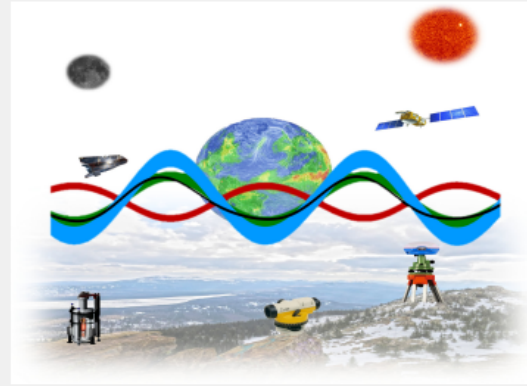
Forecast time series parameters

Start time 20180101  
End time 20200101  
Time interval 240.00 min

Maximum truncated degree  
of the coefficients model 120

Calculate and save as

⚠ The program needs some time to compute the time series of atmosphere tidal load effects. Please wait until the button [Extract time series to be plot] becomes available.



Tidal effects to be plot

- ☐ geoid or height anomaly (mm)  
☐ ground gravity ( $\mu\text{Gal}$ )  
☐ gravity disturbance ( $\mu\text{Gal}$ )  
☒ ground tilt (SW, mas)  
☐ vertical deflection (SW, mas)  
☒ horizontal displacement (EN, mm)  
☐ ground radial displacement (mm)  
☐ normal (orthometric) height (mm)  
☐ radial gravity gradient ( $10\mu\text{E}$ )  
☐ horizontal gravity gradient (NW,  $10\mu\text{E}$ )  
☐ surface atmosphere (hPa/mbar)

Tidal load effect time series on various geodetic elements

|            |            |         |        |        |        |         |
|------------|------------|---------|--------|--------|--------|---------|
| 2019122804 | 726.166667 | -3.2933 | 2.5342 | 1.9012 | 0.2835 | 0.2501  |
| 2019122808 | 726.333333 | -3.4651 | 3.1292 | 2.4891 | 0.1465 | 0.2405  |
| 2019122812 | 726.500000 | -2.6496 | 2.2293 | 1.7088 | 0.2478 | 0.2169  |
| 2019122816 | 726.666667 | -3.8375 | 2.9789 | 2.2555 | 0.2265 | 0.1643  |
| 2019122820 | 726.833333 | -5.4016 | 4.1488 | 3.1814 | 0.1449 | -0.1691 |
| 2019122824 | 727.000000 | -3.9926 | 2.7539 | 2.0054 | 0.2954 | -0.1006 |
| 2019122904 | 727.166667 | -3.1949 | 2.4334 | 1.8183 | 0.2679 | 0.2627  |
| 2019122908 | 727.333333 | -3.3664 | 3.0282 | 2.4060 | 0.1308 | 0.2531  |
| 2019122912 | 727.500000 | -2.5505 | 2.1281 | 1.6255 | 0.2320 | 0.2296  |
| 2019122916 | 727.666667 | -3.7381 | 2.8774 | 2.1721 | 0.2107 | 0.1769  |
| 2019122920 | 727.833333 | -5.3018 | 4.0471 | 3.0978 | 0.1291 | -0.1565 |
| 2019122924 | 728.000000 | -3.8926 | 2.6520 | 1.9217 | 0.2796 | -0.0880 |
| 2019123004 | 728.166667 | -3.0945 | 2.3312 | 1.7344 | 0.2520 | 0.2753  |
| 2019123008 | 728.333333 | -3.2656 | 2.9258 | 2.3219 | 0.1149 | 0.2657  |
| 2019123012 | 728.500000 | -2.4494 | 2.0255 | 1.5413 | 0.2161 | 0.2421  |
| 2019123016 | 728.666667 | -3.6367 | 2.7746 | 2.0877 | 0.1947 | 0.1895  |
| 2019123020 | 728.833333 | -5.2001 | 3.9440 | 3.0132 | 0.1131 | -0.1440 |
| 2019123024 | 729.000000 | -3.7905 | 2.5487 | 1.8369 | 0.2635 | -0.0755 |
| 2019123104 | 729.166667 | -2.9921 | 2.2277 | 1.6495 | 0.2359 | 0.2878  |
| 2019123108 | 729.333333 | -3.1630 | 2.8221 | 2.2368 | 0.0988 | 0.2782  |
| 2019123112 | 729.500000 | -2.3464 | 1.9215 | 1.4561 | 0.2000 | 0.2546  |
| 2019123116 | 729.666667 | -3.5334 | 2.6704 | 2.0023 | 0.1785 | 0.2020  |
| 2019123120 | 729.833333 | -5.0965 | 3.8396 | 2.9276 | 0.0969 | -0.1315 |
| 2019123124 | 730.000000 | -3.6866 | 2.4441 | 1.7512 | 0.2473 | -0.0630 |

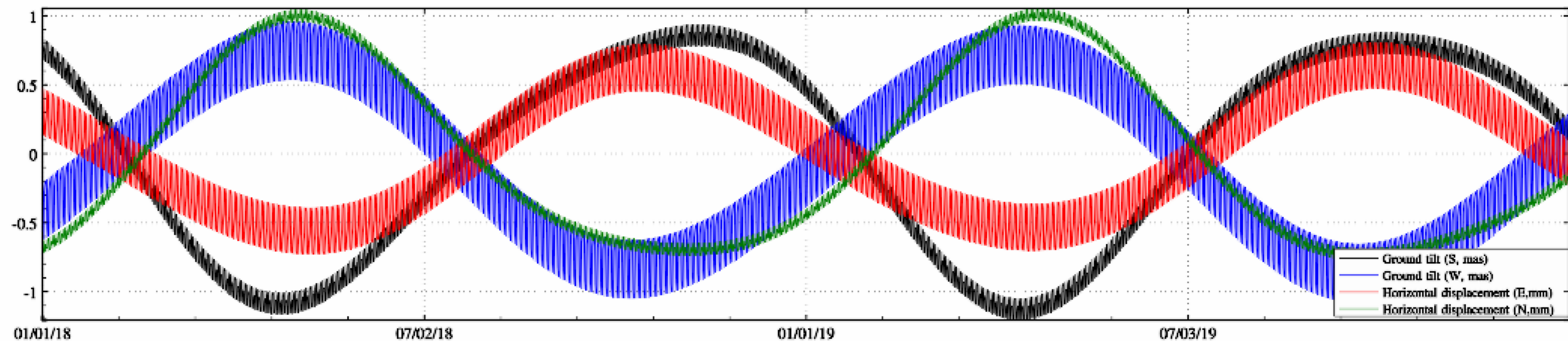
Set line thickness 1

Extract time series to be plot

Plot↓

Tidal load effect curve of surface geodetic elements

Save the current plot as



- Firstly, compute the time series of tidal load effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various tidal load effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of tidal load effects, and the time-varying characteristics of tidal load effect curves.



## Global Forecast of Atmosphere Tidal Load Effects on Various Surface Geodetic Elements

Location of surface point to be forecast

Longitude 121.240000°  
Latitude 29.428100°

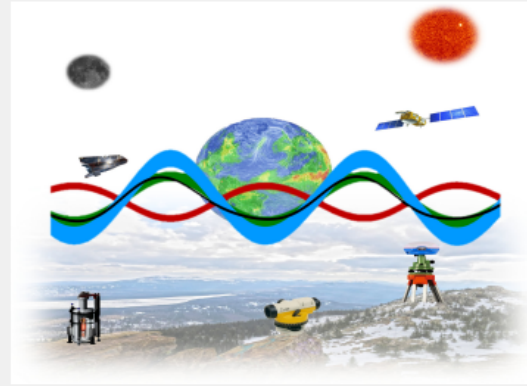
Forecast time series parameters

Start time 20180101  
End time 20200101  
Time interval 240.00 min

Maximum truncated degree of the coefficients model 120

Calculate and save as

⚠ The program needs some time to compute the time series of atmosphere tidal load effects. Please wait until the button [Extract time series to be plot] becomes available.



Tidal effects to be plot

- ☐ geoid or height anomaly (mm)
- ☐ ground gravity ( $\mu\text{Gal}$ )  $\odot$
- ☐ gravity disturbance ( $\mu\text{Gal}$ )
- ☐ ground tilt (SW, mas)  $\odot$
- ☐ vertical deflection (SW, mas)
- ☐ horizontal displacement (EN, mm)  $\odot$
- ☒ ground radial displacement (mm)  $\odot$
- ☐ normal (orthometric) height (mm)  $\odot$
- ☒ radial gravity gradient ( $10\mu\text{E}$ )
- ☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )
- ☐ surface atmosphere (hPa/mbar)

Tidal load effect time series on various geodetic elements

|            |            |         |        |        |        |         |
|------------|------------|---------|--------|--------|--------|---------|
| 2019122804 | 726.166667 | -3.2933 | 2.5342 | 1.9012 | 0.2835 | 0.2501  |
| 2019122808 | 726.333333 | -3.4651 | 3.1292 | 2.4891 | 0.1465 | 0.2405  |
| 2019122812 | 726.500000 | -2.6496 | 2.2293 | 1.7088 | 0.2478 | 0.2169  |
| 2019122816 | 726.666667 | -3.8375 | 2.9789 | 2.2555 | 0.2265 | 0.1643  |
| 2019122820 | 726.833333 | -5.4016 | 4.1488 | 3.1814 | 0.1449 | -0.1691 |
| 2019122824 | 727.000000 | -3.9926 | 2.7539 | 2.0054 | 0.2954 | -0.1006 |
| 2019122904 | 727.166667 | -3.1949 | 2.4334 | 1.8183 | 0.2679 | 0.2627  |
| 2019122908 | 727.333333 | -3.3664 | 3.0282 | 2.4060 | 0.1308 | 0.2531  |
| 2019122912 | 727.500000 | -2.5505 | 2.1281 | 1.6255 | 0.2320 | 0.2296  |
| 2019122916 | 727.666667 | -3.7381 | 2.8774 | 2.1721 | 0.2107 | 0.1769  |
| 2019122920 | 727.833333 | -5.3018 | 4.0471 | 3.0978 | 0.1291 | -0.1565 |
| 2019122924 | 728.000000 | -3.8926 | 2.6520 | 1.9217 | 0.2796 | -0.0880 |
| 2019123004 | 728.166667 | -3.0945 | 2.3312 | 1.7344 | 0.2520 | 0.2753  |
| 2019123008 | 728.333333 | -3.2656 | 2.9258 | 2.3219 | 0.1149 | 0.2657  |
| 2019123012 | 728.500000 | -2.4494 | 2.0255 | 1.5413 | 0.2161 | 0.2421  |
| 2019123016 | 728.666667 | -3.6367 | 2.7746 | 2.0877 | 0.1947 | 0.1895  |
| 2019123020 | 728.833333 | -5.2001 | 3.9440 | 3.0132 | 0.1131 | -0.1440 |
| 2019123024 | 729.000000 | -3.7905 | 2.5487 | 1.8369 | 0.2635 | -0.0755 |
| 2019123104 | 729.166667 | -2.9921 | 2.2277 | 1.6495 | 0.2359 | 0.2878  |
| 2019123108 | 729.333333 | -3.1630 | 2.8221 | 2.2368 | 0.0988 | 0.2782  |
| 2019123112 | 729.500000 | -2.3464 | 1.9215 | 1.4561 | 0.2000 | 0.2546  |
| 2019123116 | 729.666667 | -3.5334 | 2.6704 | 2.0023 | 0.1785 | 0.2020  |
| 2019123120 | 729.833333 | -5.0965 | 3.8396 | 2.9276 | 0.0969 | -0.1315 |
| 2019123124 | 730.000000 | -3.6866 | 2.4441 | 1.7512 | 0.2473 | -0.0630 |

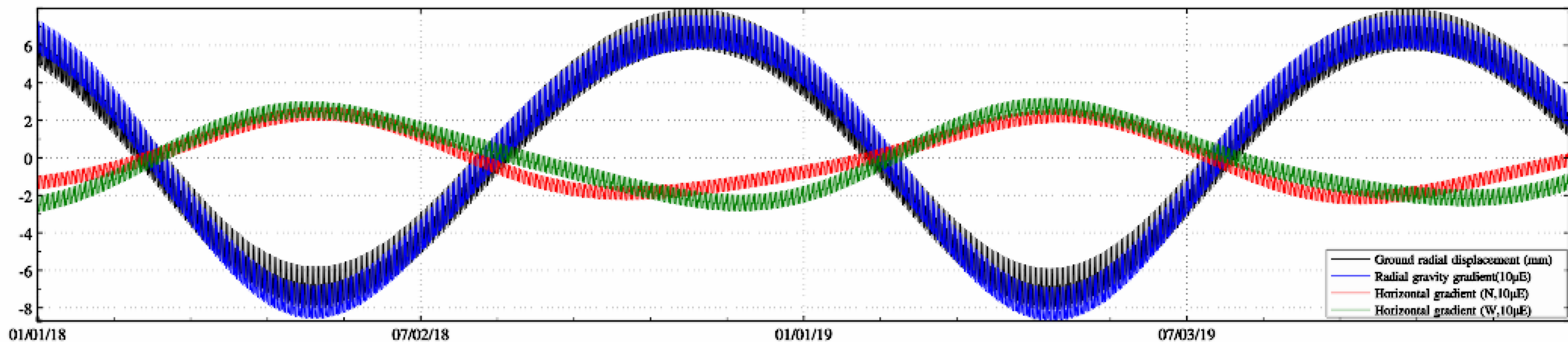
Set line thickness 1

Extract time series to be plot

Plot↓

Tidal load effect curve of surface geodetic elements

Save the current plot as



- Firstly, compute the time series of tidal load effects on all types of geodetic elements, and then select the effects to be plot.
- Look at the amplitude of various tidal load effects, the in-phase or out-of-phase (same or opposite sign) relationship between different types of tidal load effects, and the time-varying characteristics of tidal load effect curves.



# Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

Open the ground variation time series file

Set the file parameters

Column ordinal number of ellipsoidal height in the header 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

Computation of figure polar shift effects from the measured  $\Delta C_{21}$  and  $\Delta S_{21}$

Algorithm formulas

Save program process as

Forecast of Tide Effect Time Series on Earth Rotation Parameters

>> [Purpose] Using the IERS Earth Orientation Parameters (EOP) product file IERSeopc04.dat, this module computes the effects of Earth rotation polar shift and ocean pole tides on various geodetic elements – both terrestrial and those external to the solid Earth. Alternatively, it computes the tidal effects on Earth Rotation Parameters (ERP).

>> Select the computation function from the 6 control buttons on the top of the interface...

>> [Function] Based on a ground variation time series file, this module computes the time series of Earth rotation polar shift or ocean pole tidal effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the ground variation time series file C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscal/Tmseries.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the effect to be computed. After giving the output file name, click the control button [Import setting parameters]....

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscal/Tmsqurst.txt.

\*\* Appends the selected effect columns to the input record as the output record.

>> Setting parameters have been imported into the program!

>> Prepare to compute Earth's rotation polar shift effects ...

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

>> Computation start time: 2026-06-09 10:05:04

>> Complete the computation of Earth's rotation polar shift effects!

>> Computation end time: 2026-06-09 10:05:04

Columns 2 and 3 of the file header are agreed as the longitude and latitude of the ground point

Select the effects to be computed

Rotation polar shift effects

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save data in the text box as

|              |            |           |         |              |        |        |        |         |        |         |
|--------------|------------|-----------|---------|--------------|--------|--------|--------|---------|--------|---------|
| ASB          | 107.230000 | 29.910000 | 72.4    | 56658.000000 |        |        |        |         |        |         |
| 201401010000 | 0.000000   | 6.713     | -2.1021 | -1.1883      | 0.9926 | 0.4196 | 0.4576 | -0.0171 | 0.0908 | -0.0329 |
| 201401011200 | 0.500000   | 6.375     | -2.1060 | -1.1772      | 0.9694 | 0.4102 | 0.4469 | -0.0167 | 0.0908 | -0.0321 |
| 201401020000 | 1.000000   | 6.751     | -2.1099 | -1.1660      | 0.9462 | 0.4007 | 0.4362 | -0.0163 | 0.0908 | -0.0313 |
| 201401021200 | 1.500000   | 6.412     | -2.1188 | -1.1547      | 0.9199 | 0.3899 | 0.4241 | -0.0158 | 0.0910 | -0.0305 |
| 201401030000 | 2.000000   | 6.786     | -2.1277 | -1.1434      | 0.8935 | 0.3792 | 0.4119 | -0.0153 | 0.0912 | -0.0296 |
| 201401031200 | 2.500000   | 6.445     | -2.1378 | -1.1363      | 0.8743 | 0.3714 | 0.4031 | -0.0150 | 0.0915 | -0.0290 |
| 201401040000 | 3.000000   | 6.818     | -2.1480 | -1.1293      | 0.8551 | 0.3636 | 0.3942 | -0.0147 | 0.0918 | -0.0283 |
| 201401041200 | 3.500000   | 6.476     | -2.1553 | -1.1226      | 0.8382 | 0.3567 | 0.3864 | -0.0144 | 0.0920 | -0.0278 |
| 201401050000 | 4.000000   | 6.847     | -2.1626 | -1.1158      | 0.8214 | 0.3499 | 0.3786 | -0.0141 | 0.0922 | -0.0272 |
| 201401051200 | 4.500000   | 6.504     | -2.1712 | -1.1055      | 0.7970 | 0.3400 | 0.3674 | -0.0137 | 0.0924 | -0.0264 |
| 201401060000 | 5.000000   | 6.874     | -2.1799 | -1.0953      | 0.7727 | 0.3300 | 0.3562 | -0.0132 | 0.0926 | -0.0256 |
| 201401061200 | 5.500000   | 6.529     | -2.1932 | -1.0809      | 0.7381 | 0.3160 | 0.3403 | -0.0126 | 0.0929 | -0.0244 |
| 201401070000 | 6.000000   | 6.897     | -2.2065 | -1.0666      | 0.7035 | 0.3019 | 0.3243 | -0.0120 | 0.0932 | -0.0233 |
| 201401071200 | 6.500000   | 6.551     | -2.2200 | -1.0500      | 0.6645 | 0.2860 | 0.3063 | -0.0114 | 0.0935 | -0.0220 |
| 201401080000 | 7.000000   | 6.917     | -2.2336 | -1.0335      | 0.6255 | 0.2701 | 0.2883 | -0.0107 | 0.0938 | -0.0207 |
| 201401081200 | 7.500000   | 6.570     | -2.2405 | -1.0167      | 0.5900 | 0.2556 | 0.2720 | -0.0101 | 0.0939 | -0.0195 |
| 201401090000 | 8.000000   | 6.935     | -2.2474 | -0.9998      | 0.5544 | 0.2411 | 0.2556 | -0.0094 | 0.0939 | -0.0184 |
| 201401091200 | 8.500000   | 6.586     | -2.2532 | -0.9781      | 0.5102 | 0.2230 | 0.2352 | -0.0087 | 0.0939 | -0.0169 |

The Earth's rotation polar shift and figure polar shift are distinct types of geodetic variations. The Earth's figure polar shift represents the normalized angular momentum, which corresponds to the mass load excitation of the Earth's rotation.

The program utilizes the IERS measured or predicted product IERSeopc04.dat (available from the IERS website), which can be updated via the module [System configs for the geophysical models and numerical standards]. The program uses the following Love numbers:  $k_2 = 0.3077 + 0.0036i$ ,  $h_2 = 0.6207$  and  $l_2 = 0.0836$ .



# Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

Open the ground variation time series file

Set the file parameters

Column ordinal number of ellipsoidal height in the header 4

Column ordinal number of time in the record 1

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

Computation of figure polar shift effects from the measured  $\Delta C_{21}$  and  $\Delta S_{21}$

Algorithm formulas

Save program process as

Forecast of Tide Effect Time Series on Earth Rotation Parameters

>> Setting parameters have been imported into the program!  
 >> Prepare to compute Earth's rotation polar shift effects ...  
 \*\* Click the control button [Start computation], or the tool button [Start computation]....  
 >> Computation start time: 2026-06-09 10:05:04  
 >> Complete the computation of Earth's rotation polar shift effects!  
 >> Computation end time: 2026-06-09 10:05:04  
 >> [Function] Based on a ground variation time series file, this module computes the time series of Earth rotation polar shift or ocean pole tidal effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).  
 >> Open the ground variation time series file C:/ETideLoad4.5 win64en/examples/Poleshifteffectscal/Tmseries.txt.  
 \*\* Set the file format parameters according to the text box below, and then select the type of the effect to be computed. After giving the output file name, click the control button [Import setting parameters]...  
 >> Save the results as C:/ETideLoad4.5 win64en/examples/Poleshifteffectscal/Tmsquodrst.txt.  
 \*\* Appends the selected effect columns to the input record as the output record.  
 >> Setting parameters have been imported into the program!  
 >> Prepare to compute ocean pole tidal effects ...  
 \*\* Click the control button [Start computation], or the tool button [Start computation]....  
 >> Computation start time: 2026-06-09 10:05:58  
 >> Complete the computation of ocean pole tidal effects!  
 >> Computation end time: 2026-06-09 10:06:33

Select the effects to be computed

Ocean pole tidal effects

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

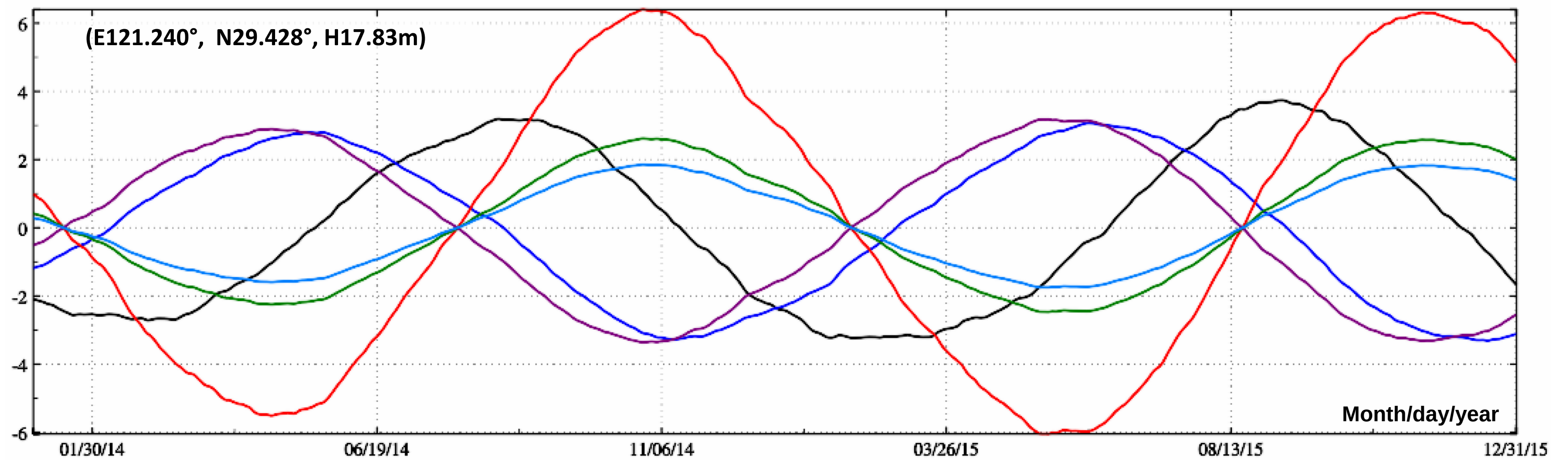
Save data in the text box as

| ASB          | 107.230000 | 29.910000 | 72.4   | 56658.000000 |        |        |        |        |        |         |  |
|--------------|------------|-----------|--------|--------------|--------|--------|--------|--------|--------|---------|--|
| 201401010000 | 0.000000   | 6.713     | 0.0297 | 0.0427       | 0.0535 | 0.0026 | 0.0417 | 0.0004 | 0.0173 | -0.0134 |  |
| 201401011200 | 0.500000   | 6.375     | 0.0295 | 0.0427       | 0.0535 | 0.0026 | 0.0417 | 0.0003 | 0.0173 | -0.0135 |  |
| 201401020000 | 1.000000   | 6.751     | 0.0294 | 0.0428       | 0.0536 | 0.0026 | 0.0418 | 0.0003 | 0.0173 | -0.0135 |  |
| 201401021200 | 1.500000   | 6.412     | 0.0290 | 0.0428       | 0.0536 | 0.0026 | 0.0419 | 0.0003 | 0.0174 | -0.0135 |  |
| 201401030000 | 2.000000   | 6.786     | 0.0287 | 0.0428       | 0.0536 | 0.0026 | 0.0419 | 0.0003 | 0.0174 | -0.0136 |  |
| 201401031200 | 2.500000   | 6.445     | 0.0284 | 0.0429       | 0.0536 | 0.0026 | 0.0420 | 0.0003 | 0.0174 | -0.0136 |  |
| 201401040000 | 3.000000   | 6.818     | 0.0280 | 0.0429       | 0.0536 | 0.0026 | 0.0420 | 0.0003 | 0.0174 | -0.0137 |  |
| 201401041200 | 3.500000   | 6.476     | 0.0277 | 0.0429       | 0.0535 | 0.0026 | 0.0421 | 0.0003 | 0.0174 | -0.0137 |  |
| 201401050000 | 4.000000   | 6.847     | 0.0275 | 0.0429       | 0.0535 | 0.0026 | 0.0421 | 0.0003 | 0.0175 | -0.0138 |  |
| 201401051200 | 4.500000   | 6.504     | 0.0272 | 0.0430       | 0.0535 | 0.0026 | 0.0422 | 0.0003 | 0.0175 | -0.0138 |  |
| 201401060000 | 5.000000   | 6.874     | 0.0269 | 0.0430       | 0.0535 | 0.0026 | 0.0422 | 0.0003 | 0.0175 | -0.0138 |  |
| 201401061200 | 5.500000   | 6.529     | 0.0264 | 0.0430       | 0.0535 | 0.0026 | 0.0423 | 0.0003 | 0.0176 | -0.0139 |  |
| 201401070000 | 6.000000   | 6.897     | 0.0259 | 0.0431       | 0.0535 | 0.0026 | 0.0424 | 0.0003 | 0.0176 | -0.0140 |  |
| 201401071200 | 6.500000   | 6.551     | 0.0254 | 0.0431       | 0.0536 | 0.0026 | 0.0425 | 0.0003 | 0.0176 | -0.0141 |  |
| 201401080000 | 7.000000   | 6.917     | 0.0250 | 0.0432       | 0.0536 | 0.0026 | 0.0426 | 0.0003 | 0.0177 | -0.0141 |  |
| 201401081200 | 7.500000   | 6.570     | 0.0247 | 0.0432       | 0.0536 | 0.0026 | 0.0427 | 0.0003 | 0.0177 | -0.0142 |  |
| 201401090000 | 8.000000   | 6.935     | 0.0244 | 0.0433       | 0.0536 | 0.0026 | 0.0428 | 0.0003 | 0.0178 | -0.0142 |  |
| 201401091200 | 8.500000   | 6.586     | 0.0242 | 0.0434       | 0.0537 | 0.0026 | 0.0429 | 0.0003 | 0.0178 | -0.0143 |  |

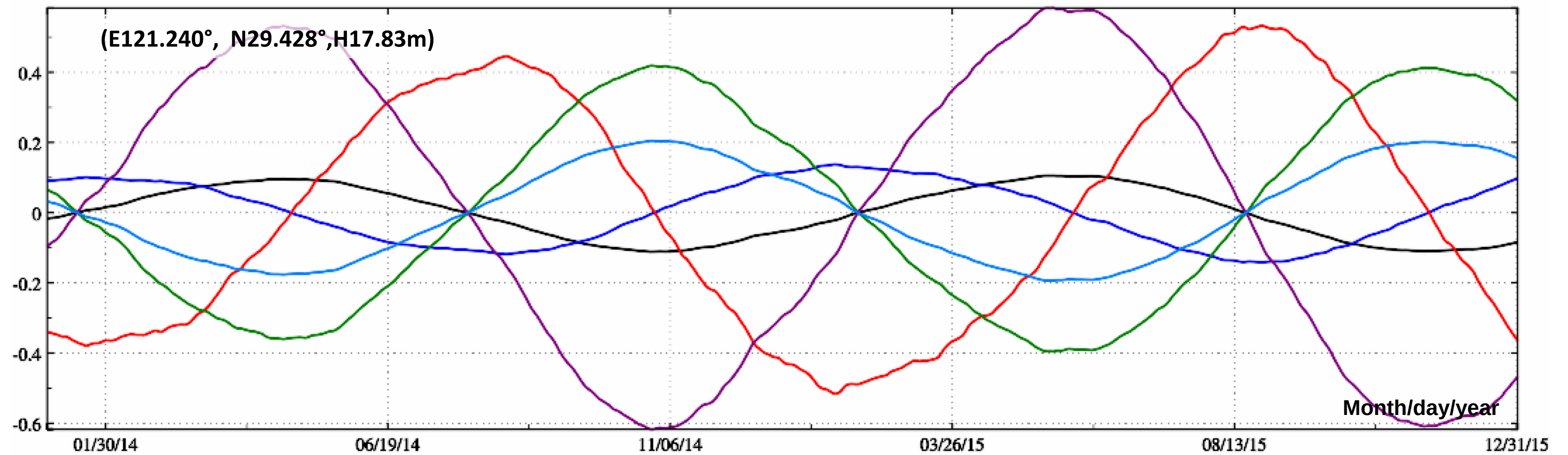
The Earth's rotation polar shift and figure polar shift are distinct types of geodetic variations. The Earth's figure polar shift represents the normalized angular momentum, which corresponds to the mass load excitation of the Earth's rotation.

The program utilizes the IERS measured or predicted product IERSeopc04.dat (available from the IERS website), which can be updated via the module [System configs for the geophysical models and numerical standards]. The program uses the following Love numbers:  $k_2 = 0.3077 + 0.0036i$ ,  $h_2 = 0.6207$  and  $l_2 = 0.0836$ .



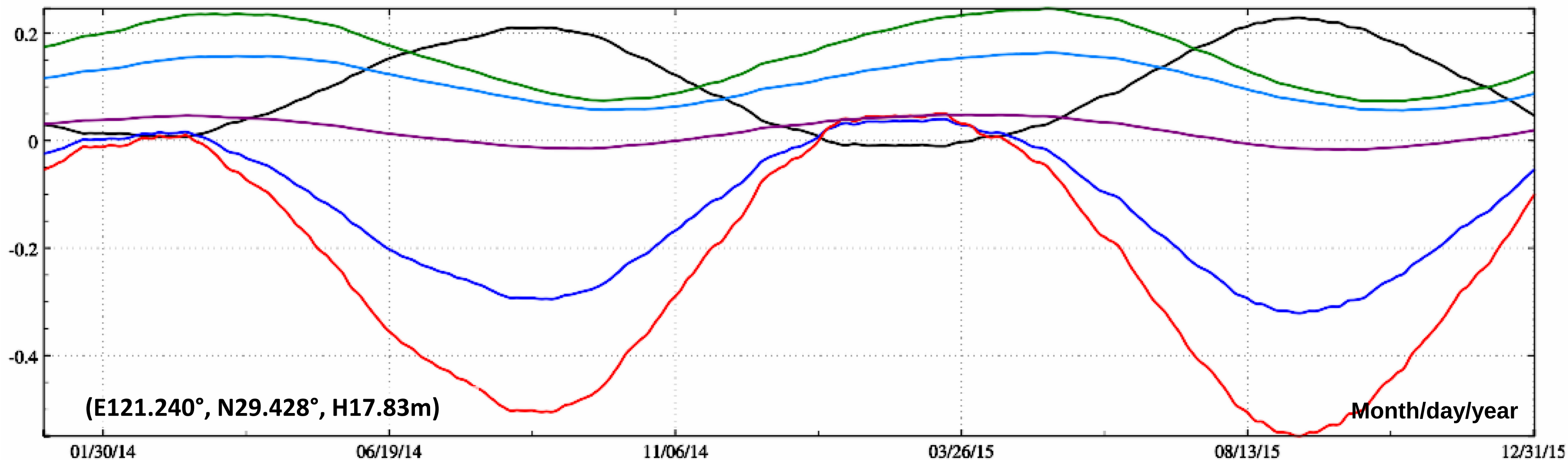


Earth's rotation polar shift ( $\Delta x_p$  m,  $\Delta y_p$  m in ITRS) effects: height anomaly (mm) ground gravity ( $\mu$ Gal)  
orthometric height (mm) radial gravity gradient (10 $\mu$ E)



Earth's rotation polar shift effects: ground tilt (S, W, mas) horizontal displacement (E, N, mm) horizontal gravity gradient (N, W, 10 $\mu$ E)

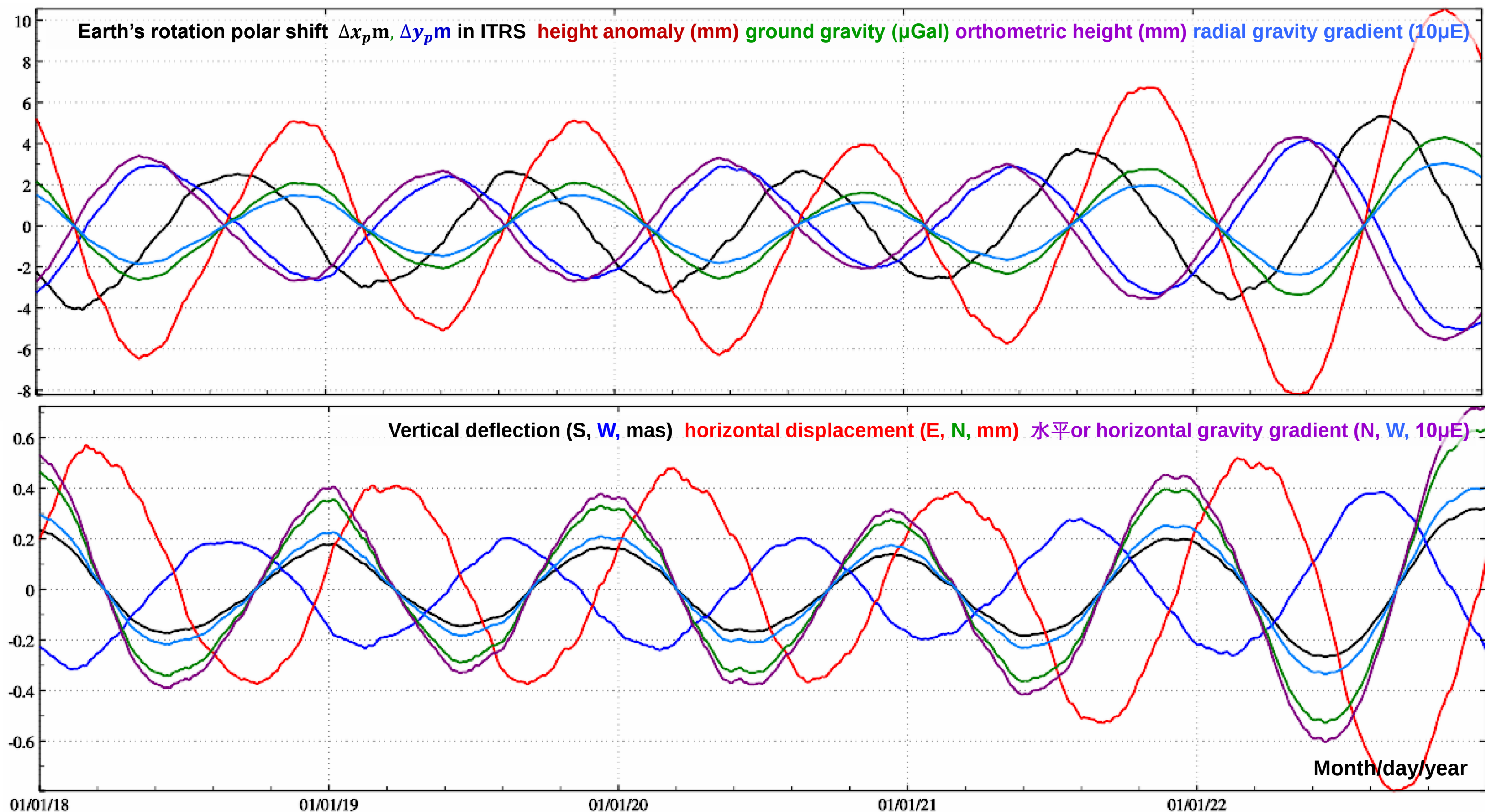




**Ocean pole tidal effects:** height anomaly (mm) ellipsoidal height (mm) orthometric height (mm)  
 radial gravity gradient (10 $\mu$ E)10 $\mu$ E horizontal gravity gradient (N, W, 10 $\mu$ E)

The ocean polar tide effects on various geodetic elements are small, which can be ignored for general geodetic cases.

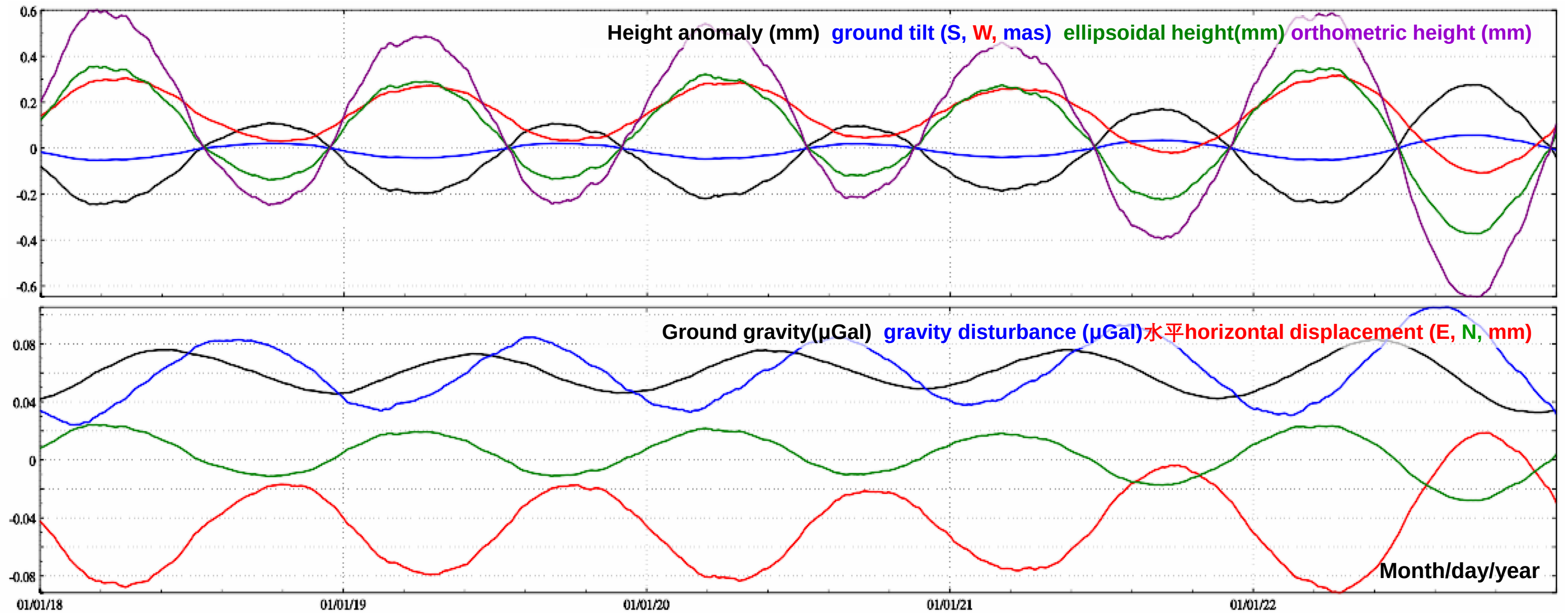




**Earth's rotation polar shift effect time series on various geodetic elements**

Although the Earth's rotation polar shift itself can reach the meter level, the resulting effect on geoid or ground normal height is only in mm level, that on ground gravity is  $\mu$ Gal level, that on radial gravity gradient is  $10\mu$ E level, that on horizontal geodetic elements are small and can be generally ignored.





**Ocean polar tide effect time series on geodetic elements at the point P in the coastal zone area**

The ocean polar tide effects on geodetic elements are small, which can be ignored for general geodetic cases.



# Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

- Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point
- Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time
- Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites
- Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

- Open the location and time file of the computation points
- Computation of figure polar shift effects from the measured  $\Delta C_{21}$  and  $\Delta S_{21}$
- Algorithm formulas
- Save program process as
- Forecast of Tide Effect Time Series on Earth Rotation Parameters

Set the file parameters

Column ordinal number of ellipsoidal height in the record4

Column ordinal number of time in the record1

Column ordinal number of starting MJD0 in the header5

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient ( $10\mu\text{E}$ )

☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

>> Prepare to compute ocean pole tidal effects ...  
\*\* Click the control button [Start computation], or the tool button [Start computation]....  
>> Computation start time: 2026-06-09 10:13:26  
>> Complete the computation of ocean pole tidal effects!  
>> Computation end time: 2026-06-09 10:13:59  
>> [Function] According to the location and time specified in the computation point file, this module calculates the Earth rotation polar shift or ocean pole tidal effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).  
>> Open the location and time file of the computation points C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalc/Postiontm.txt.  
~~\*\* Set the file format parameters according to the text box below, and then select the type of the effect to be computed. After giving the output file name, click the control button [Import setting parameters]...~~  
>> Save the results as C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalc/Postmrst.txt.  
\*\* Appends the selected effect columns to the input record as the output record.  
>> Setting parameters have been imported into the program!  
>> Prepare to compute Earth's rotation polar shift effects ...  
\*\* Click the control button [Start computation], or the tool button [Start computation]....  
>> Computation start time: 2026-06-09 10:15:06  
>> Complete the computation of Earth's rotation polar shift effects!  
>> Computation end time: 2026-06-09 10:15:06

Select the effects to be computedRotaion polar shift effects

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save data in the text box as

|              |            |           |              |          |         |         |        |         |        |         |  |
|--------------|------------|-----------|--------------|----------|---------|---------|--------|---------|--------|---------|--|
| 107.230000   | 29.910000  | 72.4      | 56658.000000 |          |         |         |        |         |        |         |  |
| 201401010000 | 107.230000 | 29.910000 | 72.4         | -17.7068 | -7.2595 | -8.1628 | 0.3078 | -0.1574 | 0.5865 | -0.2979 |  |
| 201401011200 | 107.230000 | 29.910000 | 72.4         | -17.7300 | -7.2690 | -8.1734 | 0.3082 | -0.1574 | 0.5873 | -0.2979 |  |
| 201401020000 | 107.230000 | 29.910000 | 72.4         | -17.7532 | -7.2785 | -8.1841 | 0.3086 | -0.1573 | 0.5880 | -0.2979 |  |
| 201401021200 | 107.230000 | 29.910000 | 72.4         | -17.7795 | -7.2892 | -8.1963 | 0.3090 | -0.1571 | 0.5889 | -0.2975 |  |
| 201401030000 | 107.230000 | 29.910000 | 72.4         | -17.8059 | -7.3000 | -8.2084 | 0.3095 | -0.1570 | 0.5898 | -0.2971 |  |
| 201401031200 | 107.230000 | 29.910000 | 72.4         | -17.8251 | -7.3078 | -8.2173 | 0.3098 | -0.1567 | 0.5904 | -0.2966 |  |
| 201401040000 | 107.230000 | 29.910000 | 72.4         | -17.8443 | -7.3156 | -8.2261 | 0.3102 | -0.1564 | 0.5910 | -0.2960 |  |
| 201401041200 | 107.230000 | 29.910000 | 72.4         | -17.8612 | -7.3224 | -8.2339 | 0.3105 | -0.1562 | 0.5916 | -0.2956 |  |
| 201401050000 | 107.230000 | 29.910000 | 72.4         | -17.8781 | -7.3293 | -8.2417 | 0.3108 | -0.1560 | 0.5922 | -0.2953 |  |
| 201401051200 | 107.230000 | 29.910000 | 72.4         | -17.9024 | -7.3392 | -8.2529 | 0.3112 | -0.1558 | 0.5930 | -0.2949 |  |
| 201401060000 | 107.230000 | 29.910000 | 72.4         | -17.9267 | -7.3491 | -8.2641 | 0.3116 | -0.1556 | 0.5938 | -0.2945 |  |
| 201401061200 | 107.230000 | 29.910000 | 72.4         | -17.9613 | -7.3632 | -8.2801 | 0.3122 | -0.1553 | 0.5949 | -0.2939 |  |
| 201401070000 | 107.230000 | 29.910000 | 72.4         | -17.9959 | -7.3773 | -8.2960 | 0.3128 | -0.1550 | 0.5961 | -0.2933 |  |
| 201401071200 | 107.230000 | 29.910000 | 72.4         | -18.0349 | -7.3932 | -8.3140 | 0.3135 | -0.1547 | 0.5974 | -0.2927 |  |
| 201401080000 | 107.230000 | 29.910000 | 72.4         | -18.0739 | -7.4091 | -8.3320 | 0.3142 | -0.1543 | 0.5986 | -0.2921 |  |
| 201401081200 | 107.230000 | 29.910000 | 72.4         | -18.1095 | -7.4236 | -8.3484 | 0.3148 | -0.1543 | 0.5998 | -0.2920 |  |
| 201401090000 | 107.230000 | 29.910000 | 72.4         | -18.1450 | -7.4381 | -8.3647 | 0.3154 | -0.1542 | 0.6010 | -0.2919 |  |
| 201401091200 | 107.230000 | 29.910000 | 72.4         | -18.1892 | -7.4562 | -8.3851 | 0.3162 | -0.1543 | 0.6025 | -0.2920 |  |

The Earth's rotation polar shift and figure polar shift are distinct types of geodetic variations. The Earth's figure polar shift represents the normalized angular momentum, which corresponds to the mass load excitation of the Earth's rotation.

The program utilizes the IERS measured or predicted product IERSeopc04.dat (available from the IERS website), which can be updated via the module [System configs for the geophysical models and numerical standards].The program uses the following Love numbers:  $k_2 = 0.3077 + 0.0036i$ ,  $h_2 = 0.6207$  and  $l_2 = 0.0836$ .



# Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

Open the location and time file of the external points

Computation of figure polar shift effects from the measured  $\Delta C_{21}$  and  $\Delta S_{21}$

Algorithm formulas

Save program process as

Forecast of Tide Effect Time Series on Earth Rotation Parameters

Set the file parameters

Column ordinal number of ellipsoidal height in the record4

Column ordinal number of time in the record1

Column ordinal number of starting MJD0 in the header5

Select the type of effects

☒geopotential (0.1m<sup>2</sup>/s<sup>2</sup>)

☐gravity vector (XYZ,  $\mu$ Gal)

☒gravity vector (ENU,  $\mu$ Gal)

☐gravity gradient (XYZ, 10 $\mu$ E)

☐gravity gradient (ENU, 10 $\mu$ E)

>> [Purpose] Using the IERS Earth Orientation Parameters (EOP) product file IERSeopc04.dat, this module computes the effects of Earth rotation polar shift and ocean pole tides on various geodetic elements – both terrestrial and those external to the solid Earth. Alternatively, it computes the tidal effects on Earth Rotation Parameters (ERP).

>> Select the computation function from the 6 control buttons on the top of the interface...

>> [Function] According to the location and time in the external space point file, this module computes the Earth rotation polar shift or ocean pole tidal effects on the geopotential (0.1 m<sup>2</sup>/s<sup>2</sup>), gravity ( $\mu$ Gal), or gravity gradient (10 $\mu$ E) external to the solid Earth.

>> Open the location and time file of the external points C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalculouterptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalculoutsatrst.txt.

>> Setting parameters have been imported into the program!

>> Prepare to compute Earth's rotation polar shift effects ...

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

>> Computation start time: 2026-06-09 11:30:09

>> Complete the computation of Earth's rotation polar shift effects!

>> Computation end time: 2026-06-09 11:30:09

Columns 2 and 3 of the record are agreed as the longitude and latitude

GRACE satellite altitude

Select the effects to be computedRotaion polar shift effects

Save the results as

Import setting parameters

Start computation

Save data in the text box as

Display of the input-output file↓

| Forecast   | 121.240000 | 29.428100 | 450000.000 | 58119000000 |         |        |        |
|------------|------------|-----------|------------|-------------|---------|--------|--------|
| 2018010100 | 121.240000 | 29.428100 | 450000.0   | -0.8623     | -1.3486 | 1.4417 | 3.7916 |
| 2018010104 | 121.240000 | 29.428100 | 450000.0   | -0.8637     | -1.3508 | 1.4403 | 3.7978 |
| 2018010108 | 121.240000 | 29.428100 | 450000.0   | -0.8651     | -1.3530 | 1.4389 | 3.8039 |
| 2018010112 | 121.240000 | 29.428100 | 450000.0   | -0.8665     | -1.3552 | 1.4374 | 3.8101 |
| 2018010116 | 121.240000 | 29.428100 | 450000.0   | -0.8680     | -1.3574 | 1.4360 | 3.8163 |
| 2018010120 | 121.240000 | 29.428100 | 450000.0   | -0.8694     | -1.3596 | 1.4346 | 3.8225 |
| 2018010124 | 121.240000 | 29.428100 | 450000.0   | -0.8708     | -1.3617 | 1.4331 | 3.8286 |
| 2018010204 | 121.240000 | 29.428100 | 450000.0   | -0.8721     | -1.3638 | 1.4319 | 3.8345 |
| 2018010208 | 121.240000 | 29.428100 | 450000.0   | -0.8734     | -1.3659 | 1.4307 | 3.8404 |
| 2018010212 | 121.240000 | 29.428100 | 450000.0   | -0.8748     | -1.3680 | 1.4294 | 3.8462 |
| 2018010216 | 121.240000 | 29.428100 | 450000.0   | -0.8761     | -1.3701 | 1.4282 | 3.8521 |
| 2018010220 | 121.240000 | 29.428100 | 450000.0   | -0.8774     | -1.3722 | 1.4269 | 3.8579 |
| 2018010224 | 121.240000 | 29.428100 | 450000.0   | -0.8788     | -1.3743 | 1.4257 | 3.8638 |
| 2018010304 | 121.240000 | 29.428100 | 450000.0   | -0.8799     | -1.3761 | 1.4249 | 3.8690 |
| 2018010308 | 121.240000 | 29.428100 | 450000.0   | -0.8811     | -1.3779 | 1.4241 | 3.8742 |
| 2018010312 | 121.240000 | 29.428100 | 450000.0   | -0.8823     | -1.3798 | 1.4233 | 3.8793 |
| 2018010316 | 121.240000 | 29.428100 | 450000.0   | -0.8835     | -1.3816 | 1.4225 | 3.8845 |
| 2018010320 | 121.240000 | 29.428100 | 450000.0   | -0.8846     | -1.3835 | 1.4217 | 3.8897 |
| 2018010324 | 121.240000 | 29.428100 | 450000.0   | -0.8858     | -1.3853 | 1.4209 | 3.8949 |

The Earth's rotation polar shift and figure polar shift are distinct types of geodetic variations. The Earth's figure polar shift represents the normalized angular momentum, which corresponds to the mass load excitation of the Earth's rotation.

The program utilizes the IERS measured or predicted product IERSeopc04.dat (available from the IERS website), which can be updated via the module [System configs for the geophysical models and numerical standards].The program uses the following Love numbers:  $k_2 = 0.3077 + 0.0036i$ ,  $h_2 = 0.6207$  and  $l_2 = 0.0836$ .



# Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

Open the location and time file of the external points

Computation of figure polar shift effects from the measured  $\Delta C_{21}$  and  $\Delta S_{21}$

Algorithm formulas

Save program process as

Forecast of Tide Effect Time Series on Earth Rotation Parameters

Set the file parameters

Column ordinal number of ellipsoidal height in the record

Column ordinal number of time in the record

Column ordinal number of starting MJD0 in the header

Select the type of effects

☒ geopotential ( $0.1\text{m}^2/\text{s}^2$ )
 ☐ gravity vector (XYZ,  $\mu\text{Gal}$ )
 ☐ gravity vector (ENU,  $\mu\text{Gal}$ )
 ☐ gravity gradient (XYZ,  $10\mu\text{E}$ )
 ☒ gravity gradient (ENU,  $10\mu\text{E}$ )

control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalcul/outsatrst.txt.

>> Setting parameters have been imported into the program!

>> Prepare to compute Earth's rotation polar shift effects ...

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

>> Computation start time: 2026-06-09 11:30:09

>> Complete the computation of Earth's rotation polar shift effects!

>> Computation end time: 2026-06-09 11:30:09

>> [Function] According to the location and time in the external space point file, this module computes the Earth rotation polar shift or ocean pole tidal effects on the geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity ( $\mu\text{Gal}$ ), or gravity gradient ( $10\mu\text{E}$ ) external to the solid Earth.

>> Open the location and time file of the external points C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalcul/satptm.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscalcul/satorbrst.txt.

>> Setting parameters have been imported into the program!

>> Prepare to compute Earth's rotation polar shift effects ...

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

>> Computation start time: 2026-06-09 11:30:55

>> Complete the computation of Earth's rotation polar shift effects!

>> Computation end time: 2026-06-09 11:30:56

Select the effects to be computed Rotaion polar shift effects

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Forecast

121.240000

29.428100

250000.000

58119.000000

2018010100

121.240000

29.428100

250000.0

-0.9427

0.2824

0.8597

-2.5791

2018010104

121.240000

29.428100

250000.0

-0.9443

0.2829

0.8611

-2.5833

2018010108

121.240000

29.428100

250000.0

-0.9458

0.2834

0.8625

-2.5875

2018010112

121.240000

29.428100

250000.0

-0.9474

0.2838

0.8639

-2.5917

2018010116

121.240000

29.428100

250000.0

-0.9489

0.2843

0.8653

-2.5959

2018010120

121.240000

29.428100

250000.0

-0.9504

0.2847

0.8667

-2.6001

2018010124

121.240000

29.428100

250000.0

-0.9520

0.2852

0.8681

-2.6043

2018010204

121.240000

29.428100

250000.0

-0.9534

0.2856

0.8694

-2.6083

2018010208

121.240000

29.428100

250000.0

-0.9549

0.2861

0.8708

-2.6123

2018010212

121.240000

29.428100

250000.0

-0.9563

0.2865

0.8721

-2.6162

2018010216

121.240000

29.428100

250000.0

-0.9578

0.2869

0.8734

-2.6202

2018010220

121.240000

29.428100

250000.0

-0.9592

0.2874

0.8747

-2.6242

2018010224

121.240000

29.428100

250000.0

-0.9607

0.2878

0.8761

-2.6282

2018010304

121.240000

29.428100

250000.0

-0.9620

0.2882

0.8772

-2.6317

2018010308

121.240000

29.428100

250000.0

-0.9633

0.2886

0.8784

-2.6353

2018010312

121.240000

29.428100

250000.0

-0.9646

0.2890

0.8796

-2.6388

2018010316

121.240000

29.428100

250000.0

-0.9659

0.2894

0.8808

-2.6423

2018010320

121.240000

29.428100

250000.0

-0.9671

0.2897

0.8819

-2.6458

2018010324

121.240000

29.428100

250000.0

-0.9684

0.2901

0.8831

-2.6493

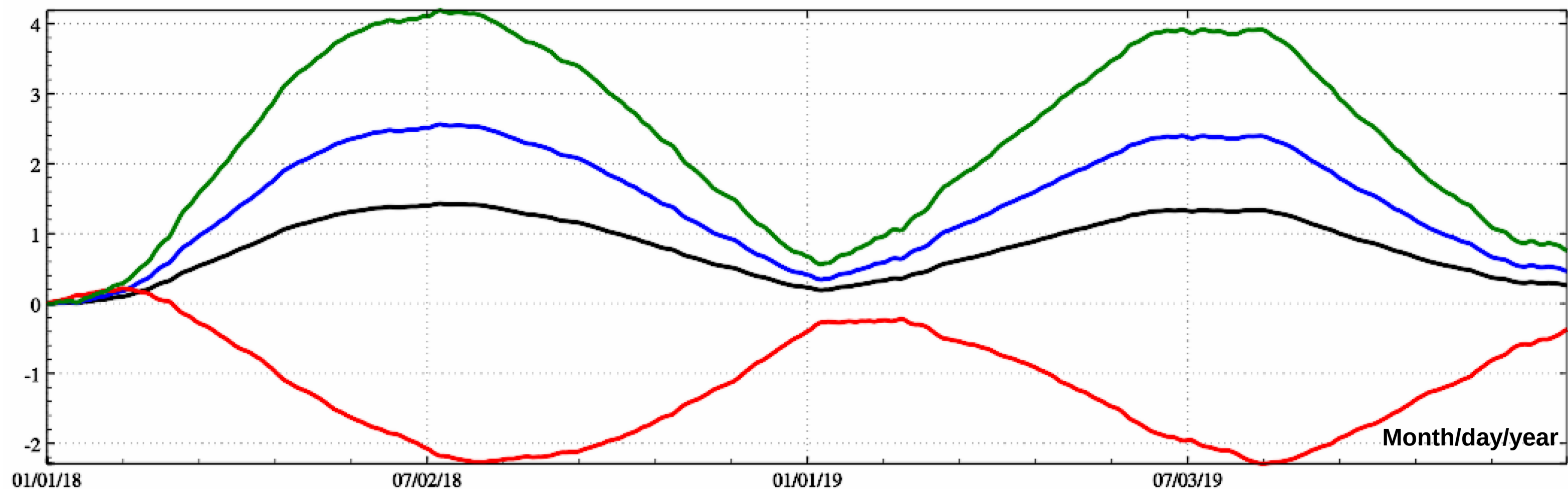
Columns 2 and 3 of the record are agreed as the longitude and latitude

GOCE satellite altitude

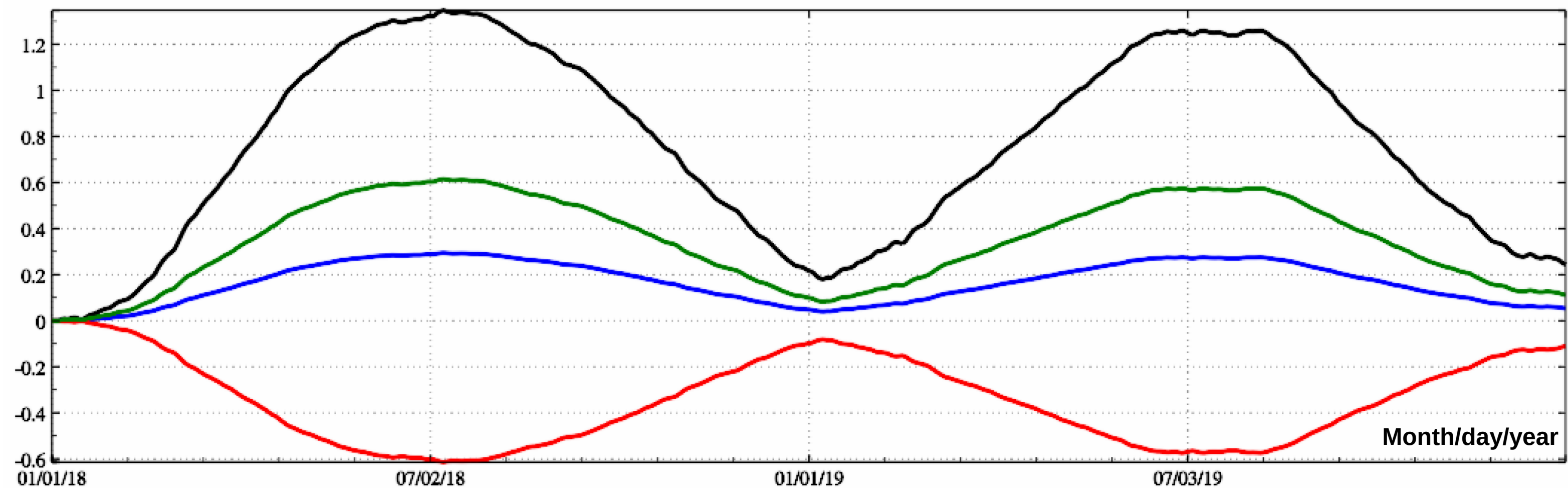
The Earth's rotation polar shift and figure polar shift are distinct types of geodetic variations. The Earth's figure polar shift represents the normalized angular momentum, which corresponds to the mass load excitation of the Earth's rotation.

The program utilizes the IERS measured or predicted product IERSeopc04.dat (available from the IERS website), which can be updated via the module [System configs for the geophysical models and numerical standards].The program uses the following Love numbers:  $k_2 = 0.3077 + 0.0036i$ ,  $h_2 = 0.6207$  and  $l_2 = 0.0836$ .





Earth's rotation polar shift effects at 450km altitude : geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity vector (E, N: along the GRACE orbit/SST-II, U,  $\mu\text{Gal}$ )



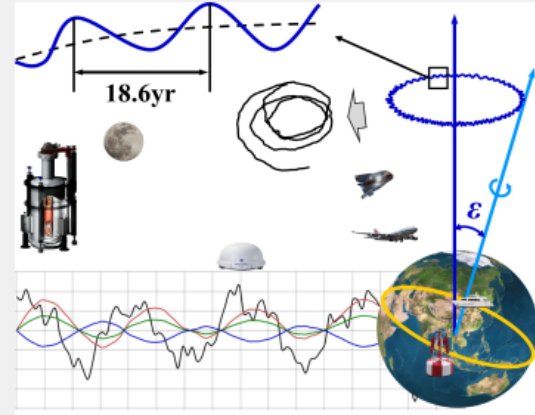
Earth's rotation polar shift effects at 250km altitude : geopotential ( $0.1\text{m}^2/\text{s}^2$ ), gravity gradient (E, N: along the GOCE orbit, U,  $10\mu\text{E}$ )



Location of surface point to be forecast

|                    |         |                                                                                                                                                                        |
|--------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ellipsoidal height | 17.830m | <br> |
|--------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Time interval 240.00 min

 Calculate and save as☐ horizontal gravity gradient (NW, 10 $\mu$ E)

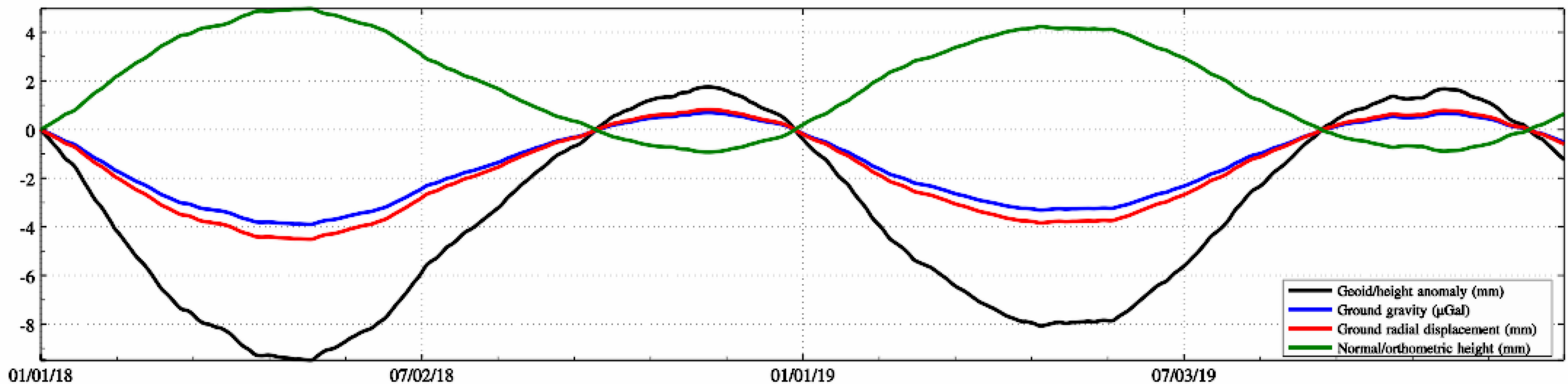
| Forecast   | 121.240000 | 29.428100 | 17.830  | 58119.000000 |        |        |        |
|------------|------------|-----------|---------|--------------|--------|--------|--------|
| 2018010100 | 0.000000   | 0.0000    | 0.0000  | 0.0000       | 0.0000 | 0.0000 | 0.0000 |
| 2018010104 | 0.166667   | -0.0176   | -0.0072 | -0.0081      | 0.0003 | 0.0002 | 0.0000 |
| 2018010108 | 0.333333   | -0.0352   | -0.0143 | -0.0162      | 0.0006 | 0.0004 | 0.0001 |
| 2018010112 | 0.500000   | -0.0528   | -0.0215 | -0.0243      | 0.0010 | 0.0006 | 0.0001 |
| 2018010116 | 0.666667   | -0.0704   | -0.0286 | -0.0324      | 0.0013 | 0.0008 | 0.0002 |
| 2018010120 | 0.833333   | -0.0880   | -0.0358 | -0.0405      | 0.0016 | 0.0010 | 0.0003 |
| 2018010124 | 1.000000   | -0.1055   | -0.0429 | -0.0487      | 0.0019 | 0.0012 | 0.0003 |
| 2018010204 | 1.166667   | -0.1222   | -0.0497 | -0.0564      | 0.0022 | 0.0014 | 0.0004 |
| 2018010208 | 1.333333   | -0.1389   | -0.0565 | -0.0640      | 0.0025 | 0.0016 | 0.0004 |
| 2018010212 | 1.500000   | -0.1556   | -0.0633 | -0.0717      | 0.0028 | 0.0018 | 0.0005 |
| 2018010216 | 1.666667   | -0.1723   | -0.0701 | -0.0794      | 0.0031 | 0.0020 | 0.0006 |
| 2018010220 | 1.833333   | -0.1890   | -0.0769 | -0.0871      | 0.0034 | 0.0021 | 0.0006 |
| 2018010224 | 2.000000   | -0.2057   | -0.0837 | -0.0948      | 0.0037 | 0.0023 | 0.0007 |
| 2018010304 | 2.166667   | -0.2205   | -0.0897 | -0.1016      | 0.0040 | 0.0024 | 0.0007 |
| 2018010308 | 2.333333   | -0.2353   | -0.0957 | -0.1084      | 0.0043 | 0.0026 | 0.0008 |
| 2018010312 | 2.500000   | -0.2500   | -0.1017 | -0.1152      | 0.0045 | 0.0027 | 0.0008 |
| 2018010316 | 2.666667   | -0.2648   | -0.1077 | -0.1220      | 0.0048 | 0.0028 | 0.0009 |
| 2018010320 | 2.833333   | -0.2795   | -0.1138 | -0.1288      | 0.0051 | 0.0029 | 0.0009 |
| 2018010324 | 3.000000   | -0.2943   | -0.1198 | -0.1357      | 0.0054 | 0.0030 | 0.0010 |
| 2018010404 | 3.166667   | -0.3085   | -0.1256 | -0.1422      | 0.0056 | 0.0031 | 0.0010 |
| 2018010408 | 3.333333   | -0.3228   | -0.1315 | -0.1488      | 0.0058 | 0.0032 | 0.0011 |

Set line thickness 3

 Extract time series to be plot

 Plot↓

 Save the current plot as



- Firstly, compute the time series of Earth rotation polar shift effects on various geodetic elements; and Then select the specific effects to be plotted.
- Analyze the amplitude of various rotation polar shift effects, the in-phase or out-of-phase relationships between different types of effects, and the time-varying characteristics of the effect curves.



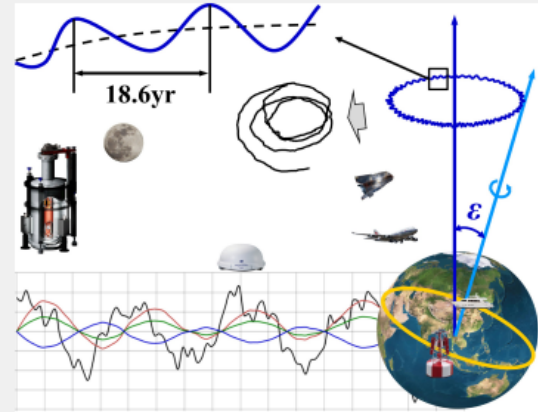




- Location of surface point to be forecast

|                    |             |                                                                                                                                                                        |
|--------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Longitude          | 121.240000° | <br> |
| Latitude           | 29.428100°  | <br> |
| Ellipsoidal height | 17.830m     | <br> |

|               |            |    |
|---------------|------------|----|
| Start time    | 20180101   | ▲▼ |
| End time      | 20200101   | ▲▼ |
| Time interval | 240.00 min | ▲▼ |

 Calculate and save as

- ☐ geoid or height anomaly (mm)
- ☐ ground gravity ( $\mu\text{Gal}$ )  $\odot$
- ☐ gravity disturbance ( $\mu\text{Gal}$ )
- ☐ ground tilt (SW, mas)  $\odot$
- ☐ vertical deflection (SW, mas)
- ☐ horizontal displacement (EN, mm)  $\odot$
- ☐ ground radial displacement (mm)  $\odot$
- ☐ normal (orthometric) height (mm)  $\odot$
- ☒ radial gravity gradient ( $10\mu\text{E}$ )
- ☒ horizontal gravity gradient (NW,  $10\mu\text{E}$ )

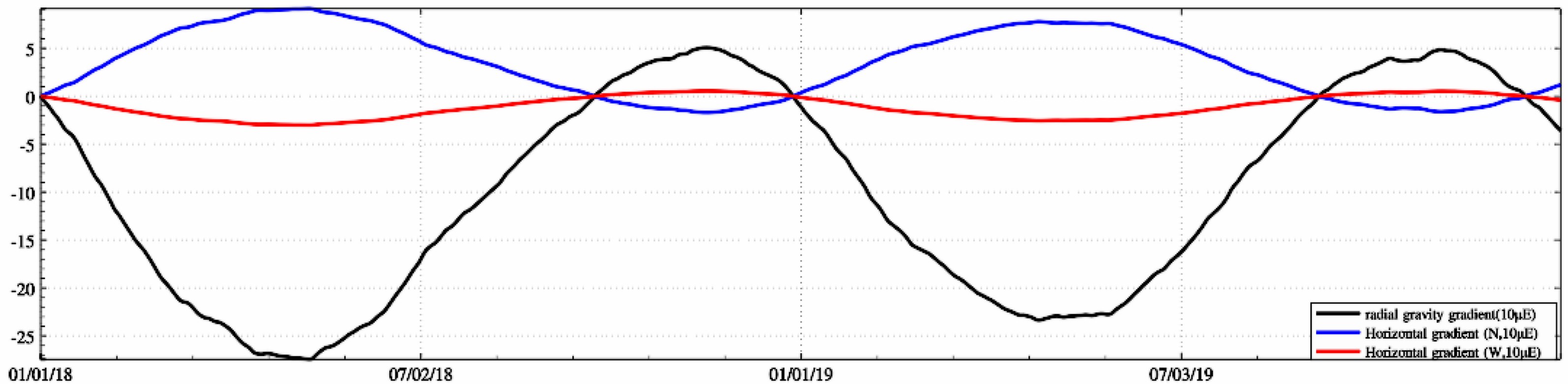
|            |            |           |         |              |        |        |        |
|------------|------------|-----------|---------|--------------|--------|--------|--------|
| Forecast   | 121.240000 | 29.428100 | 17.830  | 58119.000000 |        |        |        |
| 2018010100 | 0.000000   | 0.0000    | 0.0000  | 0.0000       | 0.0000 | 0.0000 | 0.0000 |
| 2018010104 | 0.166667   | -0.0176   | -0.0072 | -0.0081      | 0.0003 | 0.0002 | 0.0000 |
| 2018010108 | 0.333333   | -0.0352   | -0.0143 | -0.0162      | 0.0006 | 0.0004 | 0.0001 |
| 2018010112 | 0.500000   | -0.0528   | -0.0215 | -0.0243      | 0.0010 | 0.0006 | 0.0001 |
| 2018010116 | 0.666667   | -0.0704   | -0.0286 | -0.0324      | 0.0013 | 0.0008 | 0.0002 |
| 2018010120 | 0.833333   | -0.0880   | -0.0358 | -0.0405      | 0.0016 | 0.0010 | 0.0003 |
| 2018010124 | 1.000000   | -0.1055   | -0.0429 | -0.0487      | 0.0019 | 0.0012 | 0.0003 |
| 2018010204 | 1.166667   | -0.1222   | -0.0497 | -0.0564      | 0.0022 | 0.0014 | 0.0004 |
| 2018010208 | 1.333333   | -0.1389   | -0.0565 | -0.0640      | 0.0025 | 0.0016 | 0.0004 |
| 2018010212 | 1.500000   | -0.1556   | -0.0633 | -0.0717      | 0.0028 | 0.0018 | 0.0005 |
| 2018010216 | 1.666667   | -0.1723   | -0.0701 | -0.0794      | 0.0031 | 0.0020 | 0.0006 |
| 2018010220 | 1.833333   | -0.1890   | -0.0769 | -0.0871      | 0.0034 | 0.0021 | 0.0006 |
| 2018010224 | 2.000000   | -0.2057   | -0.0837 | -0.0948      | 0.0037 | 0.0023 | 0.0007 |
| 2018010304 | 2.166667   | -0.2205   | -0.0897 | -0.1016      | 0.0040 | 0.0024 | 0.0007 |
| 2018010308 | 2.333333   | -0.2353   | -0.0957 | -0.1084      | 0.0043 | 0.0026 | 0.0008 |
| 2018010312 | 2.500000   | -0.2500   | -0.1017 | -0.1152      | 0.0045 | 0.0027 | 0.0008 |
| 2018010316 | 2.666667   | -0.2648   | -0.1077 | -0.1220      | 0.0048 | 0.0028 | 0.0009 |
| 2018010320 | 2.833333   | -0.2795   | -0.1138 | -0.1288      | 0.0051 | 0.0029 | 0.0009 |
| 2018010324 | 3.000000   | -0.2943   | -0.1198 | -0.1357      | 0.0054 | 0.0030 | 0.0010 |
| 2018010404 | 3.166667   | -0.3085   | -0.1256 | -0.1422      | 0.0056 | 0.0031 | 0.0010 |
| 2018010408 | 3.333333   | -0.3228   | -0.1315 | -0.1487      | 0.0059 | 0.0032 | 0.0011 |

Set line thickness 3

 Extract time series to be plot

 Plot↓

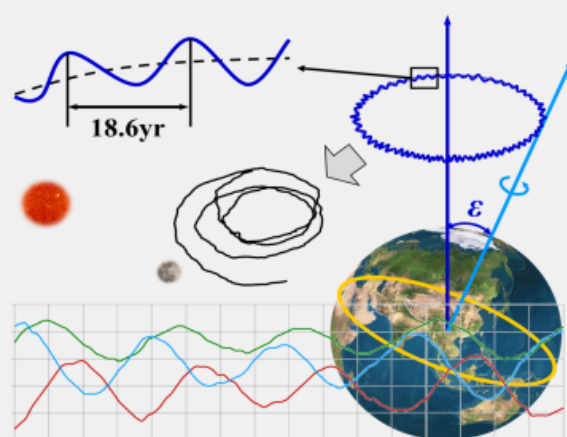
 Save the current plot as



- Firstly, compute the time series of Earth rotation polar shift effects on various geodetic elements; and Then select the specific effects to be plotted.
- Analyze the amplitude of various rotation polar shift effects, the in-phase or out-of-phase relationships between different types of effects, and the time-varying characteristics of the effect curves.



## Forecast of Tide Effect Time Series on Earth Rotation Parameters (EPR)



### Forecast time series parameters

Start time 20180101

End time 20200101

Time interval 240.00 min

select the type of tidal effect Long period tidal effect

Calculate and save as

### The tidal effect time series on EPR

| date       | day | m1 | m2 (uas) | dLOD (us/day) | dUT1 (ms) | dX1 (mas) | dX2 (mas) | dw (e-14rad/s) |         |         |
|------------|-----|----|----------|---------------|-----------|-----------|-----------|----------------|---------|---------|
| 2018010100 |     |    | 0.000000 | 176.3364      | -80.0140  | -16.4154  | -109.4040 | -0.8817        | -0.5187 | 1.3851  |
| 2018010104 |     |    | 0.166667 | 178.0185      | -77.2652  | -28.0124  | -109.4003 | -1.0389        | -0.7073 | 2.3639  |
| 2018010108 |     |    | 0.333333 | 180.1408      | -74.1469  | -37.8732  | -109.3948 | -1.1843        | -0.8874 | 3.1961  |
| 2018010112 |     |    | 0.500000 | 182.6795      | -70.6880  | -45.8797  | -109.3878 | -1.3166        | -1.0572 | 3.8719  |
| 2018010116 |     |    | 0.666667 | 185.6071      | -66.9207  | -51.9376  | -109.3796 | -1.4347        | -1.2152 | 4.3832  |
| 2018010120 |     |    | 0.833333 | 188.8922      | -62.8798  | -55.9783  | -109.3706 | -1.5373        | -1.3598 | 4.7242  |
| 2018010124 |     |    | 1.000000 | 192.5001      | -58.6028  | -57.9595  | -109.3611 | -1.6237        | -1.4898 | 4.8915  |
| 2018010204 |     |    | 1.166667 | 196.3932      | -54.1291  | -57.8657  | -109.3514 | -1.6930        | -1.6038 | 4.8836  |
| 2018010208 |     |    | 1.333333 | 200.5310      | -49.5001  | -55.7085  | -109.3419 | -1.7446        | -1.7007 | 4.7015  |
| 2018010212 |     |    | 1.500000 | 204.8709      | -44.7585  | -51.5258  | -109.3330 | -1.7781        | -1.7798 | 4.3485  |
| 2018010216 |     |    | 1.666667 | 209.3681      | -39.9480  | -45.3814  | -109.3249 | -1.7931        | -1.8402 | 3.8300  |
| 2018010220 |     |    | 1.833333 | 213.9766      | -35.1127  | -37.3636  | -109.3179 | -1.7897        | -1.8813 | 3.1533  |
| 2018010224 |     |    | 2.000000 | 218.6491      | -30.2972  | -27.5838  | -109.3125 | -1.7677        | -1.9027 | 2.3279  |
| 2018010304 |     |    | 2.166667 | 223.3377      | -25.5457  | -16.1743  | -109.3088 | -1.7275        | -1.9043 | 1.3650  |
| 2018010308 |     |    | 2.333333 | 227.9944      | -20.9017  | -3.2863   | -109.3072 | -1.6695        | -1.8860 | 0.2773  |
| 2018010312 |     |    | 2.500000 | 232.5713      | -16.4077  | 10.9126   | -109.3078 | -1.5942        | -1.8479 | -0.9211 |
| 2018010316 |     |    | 2.666667 | 237.0211      | -12.1049  | 26.2411   | -109.3109 | -1.5022        | -1.7903 | -2.2148 |
| 2018010320 |     |    | 2.833333 | 241.2979      | -8.0327   | 42.5072   | -109.3166 | -1.3945        | -1.7137 | -3.5876 |
| 2018010324 |     |    | 3.000000 | 245.3568      | -4.2284   | 59.5107   | -109.3251 | -1.2720        | -1.6188 | -5.0227 |

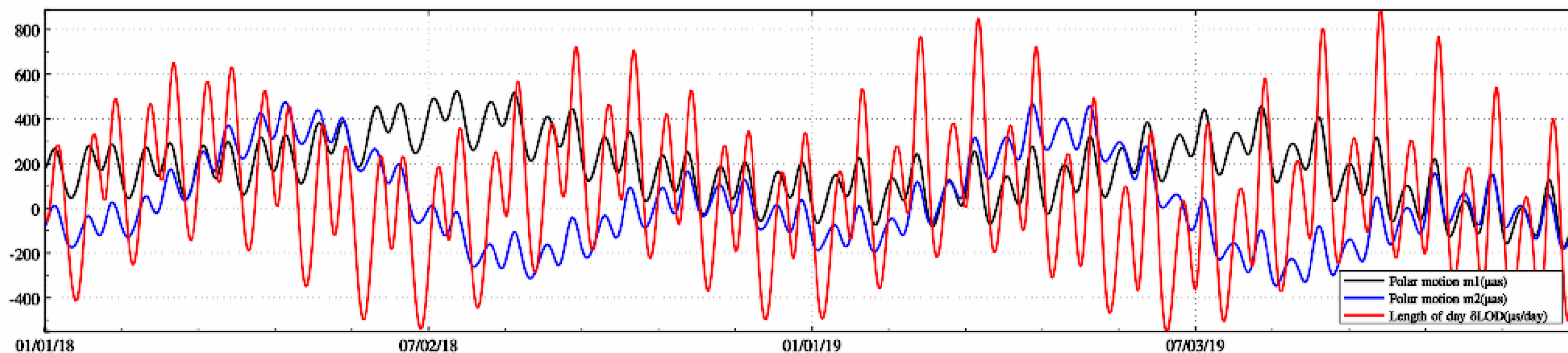
Set line thickness 2

Extract time series to be plot

Plot↓

### The tidal effect time series curves on EPR

Save the current plot as

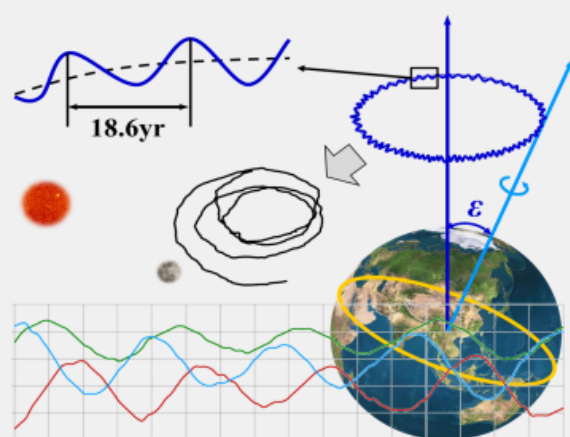


Firstly, set the time series parameters and select the type of tidal effects, then calculate and plot the tidal effect time series on Earth's rotation parameters (EPR).

The calculation function for the zonal tidal effects calls the routine RG\_ZONT2.F, while that for the short period tidal effects calls the routine ORTHO\_EOP.F. The two routines are available from the IERS Conventions (2010) website.



## Forecast of Tide Effect Time Series on Earth Rotation Parameters (EPR)



Forecast time series parameters

Start time 20180301

End time 20180501

Time interval 15.00 min

select the type of tidal effect Short peroid tidal effect

Calculate and save as

The tidal effect time series on EPR

| date         | day | m1       | m2 (uas)  | dLOD (us/day) | dUT1 (us) |
|--------------|-----|----------|-----------|---------------|-----------|
| 2018030100   |     | 0.000000 | -23.1557  | 75.6890       | 204.1958  |
| 201803010015 |     | 0.010417 | -99.7346  | 76.5366       | 190.3564  |
| 201803010030 |     | 0.020833 | -174.2225 | 73.2414       | 172.3248  |
| 201803010045 |     | 0.031250 | -245.5903 | 65.8178       | 150.5021  |
| 2018030101   |     | 0.041667 | -312.8575 | 54.3589       | 125.3551  |
| 201803010115 |     | 0.052083 | -375.1085 | 39.0358       | 97.4075   |
| 201803010130 |     | 0.062500 | -431.5059 | 20.0944       | 67.2315   |
| 201803010145 |     | 0.072917 | -481.3044 | -2.1483       | 35.4381   |
| 2018030102   |     | 0.083333 | -523.8619 | -27.3092      | 2.6667    |
| 201803010215 |     | 0.093750 | -558.6499 | -54.9455      | -30.4258  |
| 201803010230 |     | 0.104167 | -585.2612 | -84.5620      | -63.1759  |
| 201803010245 |     | 0.114583 | -603.4166 | -115.6193     | -94.9249  |
| 2018030103   |     | 0.125000 | -612.9687 | -147.5426     | -125.0301 |
| 201803010315 |     | 0.135417 | -613.9044 | -179.7317     | -152.8755 |
| 201803010330 |     | 0.145833 | -606.3445 | -211.5707     | -177.8827 |
| 201803010345 |     | 0.156250 | -590.5415 | -242.4387     | -199.5204 |
| 2018030104   |     | 0.166667 | -566.8756 | -271.7203     | -217.3138 |
| 201803010415 |     | 0.177083 | -535.8479 | -298.8160     | -230.8529 |
| 201803010430 |     | 0.187500 | -498.0722 | -323.1527     | -239.7994 |

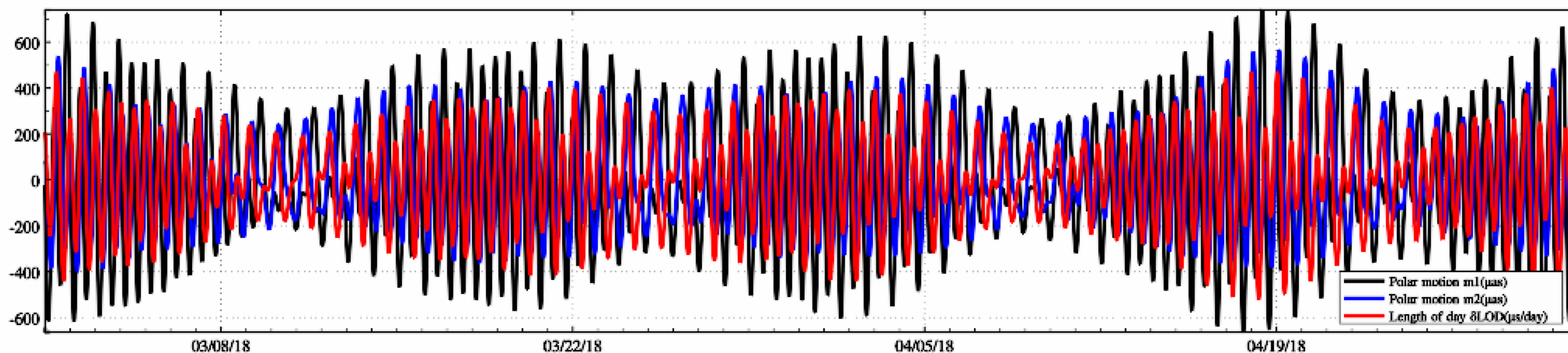
Set line thickness 3

Extract time series to be plot

Plot↓

The tidal effect time series curves on EPR

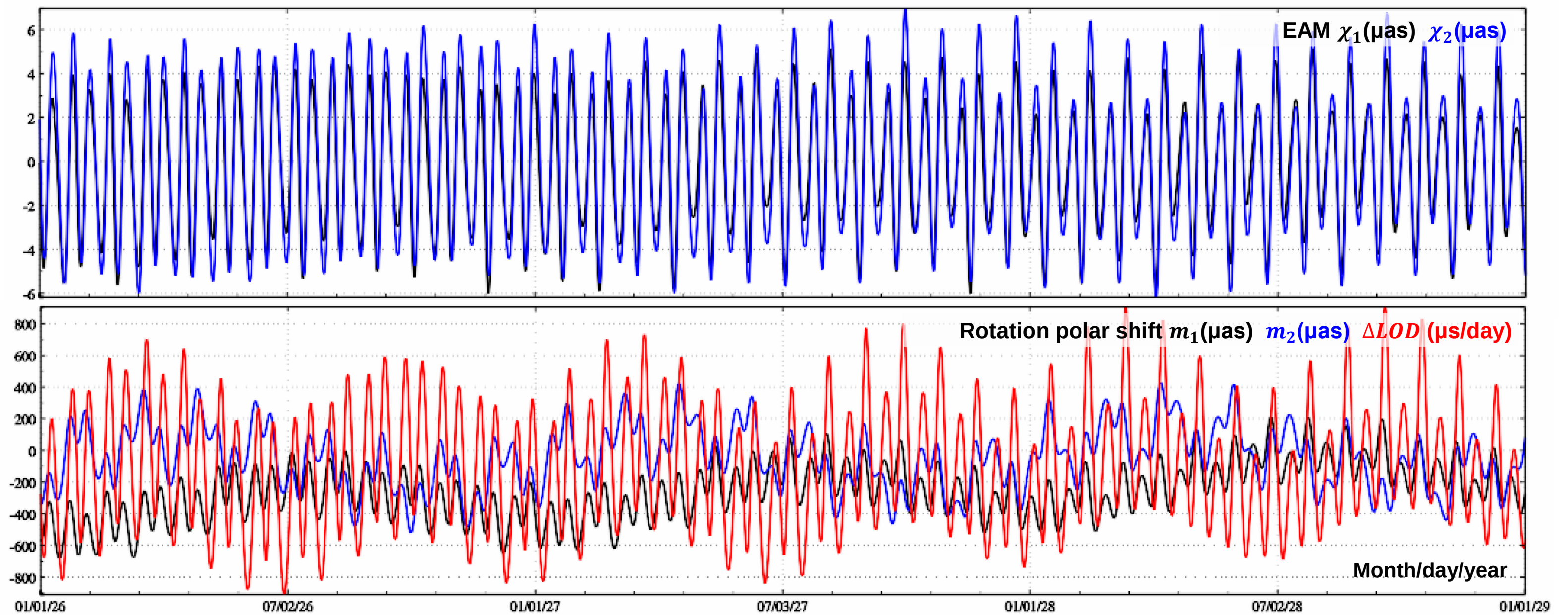
Save the current plot as



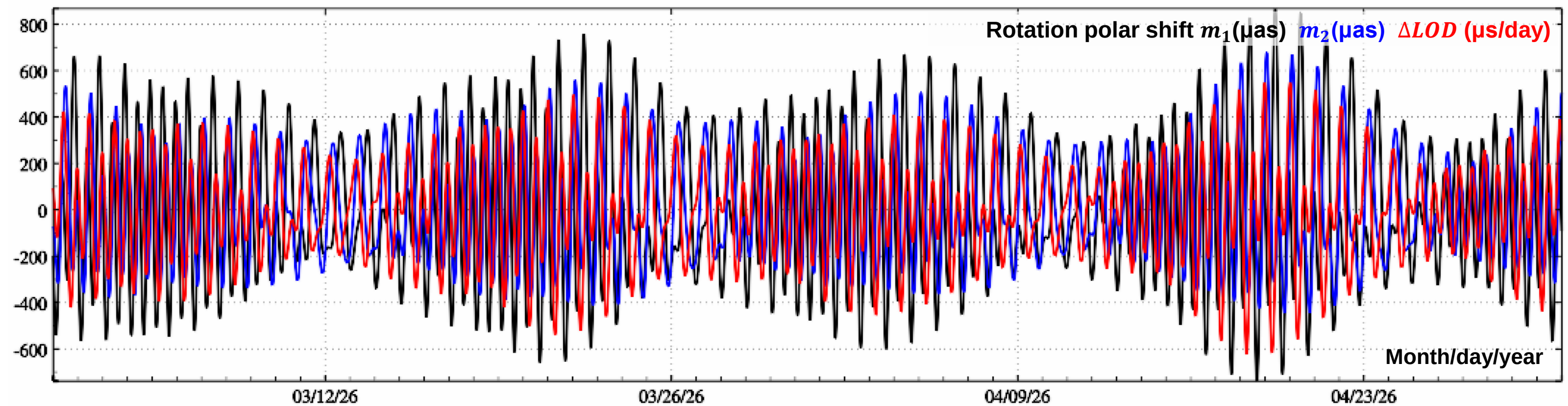
Firstly, set the time series parameters and select the type of tidal effects, then calculate and plot the tidal effect time series on Earth's rotation parameters (EPR).

The calculation function for the zonal tidal effects calls the routine RG\_ZONT2.F, while that for the short period tidal effects calls the routine ORTHO\_EOP.F. The two routines are available from the IERS Conventions (2010) website.





Long-period tidal effect time series for the Earth's rotation motion



The time series of diurnal and semi-diurnal tidal effects on ERP



Open fileSave asImport parametersStart computationSave processFollow example

# Computation of Earth's Figure Polar Shift Effects on Geodetic elements from Measured $\Delta C_{21}$ and $\Delta S_{21}$

Computation of Rotation Polar Shift or Ocean Pole Tidal Effect Time Series at a Ground Point

Computation of Rotation Polar Shift or Ocean Pole Tidal Effects at Batch Points with Given Time

Computation of Rotation Polar Shift or Ocean pole tidal Effects for Satellites

Computation of Rotation Polar Shift Effects on Various Surface Geodetic Elements Anywhere

Open the location and time file of the external points

Computation of figure polar shift effects from the measured  $\Delta C_{21}$  and  $\Delta S_{21}$

Algorithm formulas

Save program process as

Forecast of Tide Effect Time Series on Earth Rotation Parameters

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

>> Computation start time: 2026-06-09 10:20:52

>> Complete the computation of Earth's rotation polar shift effects!

>> Computation end time: 2026-06-09 10:20:53

>> [Function] Input a ground variation time series file and the UT/CSR RL-06 $\Delta C_{21}$  and  $\Delta S_{21}$  monthly time series file C21\_S21\_RL06.txt (located in the directory C:\ETideLoad4.5\_win64en\iers; the program ignores the first 15 rows of the file) to compute the Earth's figure polar shift effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the ground variation time series file C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscal/Tmseries.txt.

\*\* Set the file format parameters according to the text box below, and then select the type of the effect to be computed. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Poleshifteffectscal/fgrpolareffect.txt.

>> Open the UT/CSR RL-06  $\Delta C_{21}$  and  $\Delta S_{21}$  monthly time series file C:/ETideLoad4.5\_win64en/iers/C21\_S21\_RL06.txt.

>> Setting parameters have been imported into the program!

>> Prepare to compute Earth's figure polar shift effects...

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

>> Computation start time: 2026-06-09 10:25:14

>> Complete the computation of Earth's figure polar shift effects!

>> Computation end time: 2026-06-09 10:25:14

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save data in the text box as

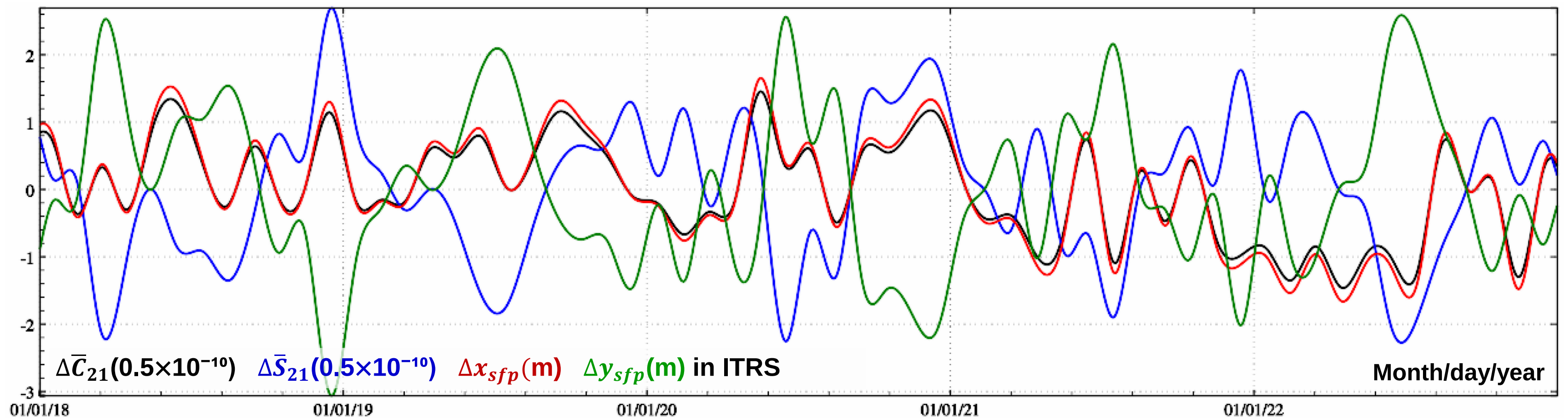
|              |            |       |        |        |        |         |        |        |        |         |  |
|--------------|------------|-------|--------|--------|--------|---------|--------|--------|--------|---------|--|
| ASB          | 107.23     |       |        |        |        |         |        |        |        |         |  |
| 201501161200 | 380.500000 | 6.497 | 0.7126 | 0.4083 | 0.8102 | -0.4642 | 0.1120 | 0.0345 | 0.0515 | -0.0015 |  |
| 201501170000 | 381.000000 | 6.833 | 0.6743 | 0.3920 | 0.7667 | -0.4457 | 0.1118 | 0.0344 | 0.0514 | -0.0014 |  |
| 201501171200 | 381.500000 | 6.454 | 0.6361 | 0.3757 | 0.7233 | -0.4272 | 0.1002 | 0.0308 | 0.0461 | -0.0013 |  |
| 201501180000 | 382.000000 | 6.789 | 0.5979 | 0.3594 | 0.6799 | -0.4087 | 0.0994 | 0.0306 | 0.0457 | -0.0012 |  |
| 201501181200 | 382.500000 | 6.409 | 0.5598 | 0.3432 | 0.6365 | -0.3902 | 0.0884 | 0.0272 | 0.0407 | -0.0011 |  |
| 201501190000 | 383.000000 | 6.742 | 0.5218 | 0.3271 | 0.5933 | -0.3719 | 0.0872 | 0.0268 | 0.0401 | -0.0011 |  |
| 201501191200 | 383.500000 | 6.360 | 0.4840 | 0.3110 | 0.5503 | -0.3536 | 0.0769 | 0.0236 | 0.0354 | -0.0010 |  |
| 201501200000 | 384.000000 | 6.692 | 0.4462 | 0.2950 | 0.5074 | -0.3354 | 0.0751 | 0.0231 | 0.0345 | -0.0010 |  |
| 201501201200 | 384.500000 | 6.309 | 0.4087 | 0.2791 | 0.4647 | -0.3174 | 0.0655 | 0.0201 | 0.0301 | -0.0009 |  |
| 201501210000 | 385.000000 | 6.640 | 0.3714 | 0.2634 | 0.4222 | -0.2995 | 0.0632 | 0.0195 | 0.0291 | -0.0009 |  |
| 201501211200 | 385.500000 | 6.256 | 0.3342 | 0.2478 | 0.3800 | -0.2817 | 0.0544 | 0.0167 | 0.0250 | -0.0008 |  |
| 201501220000 | 386.000000 | 6.585 | 0.2974 | 0.2323 | 0.3381 | -0.2641 | 0.0517 | 0.0159 | 0.0238 | -0.0009 |  |
| 201501221200 | 386.500000 | 6.199 | 0.2608 | 0.2170 | 0.2965 | -0.2468 | 0.0436 | 0.0134 | 0.0200 | -0.0008 |  |
| 201501230000 | 387.000000 | 6.527 | 0.2245 | 0.2019 | 0.2552 | -0.2296 | 0.0405 | 0.0125 | 0.0186 | -0.0009 |  |
| 201501231200 | 387.500000 | 6.140 | 0.1885 | 0.1870 | 0.2143 | -0.2127 | 0.0332 | 0.0102 | 0.0153 | -0.0008 |  |
| 201501240000 | 388.000000 | 6.467 | 0.1529 | 0.1724 | 0.1738 | -0.1960 | 0.0297 | 0.0091 | 0.0137 | -0.0009 |  |
| 201501241200 | 388.500000 | 6.078 | 0.1177 | 0.1579 | 0.1338 | -0.1795 | 0.0231 | 0.0071 | 0.0106 | -0.0008 |  |
| 201501250000 | 389.000000 | 6.404 | 0.0828 | 0.1437 | 0.0942 | -0.1634 | 0.0194 | 0.0060 | 0.0089 | -0.0009 |  |

🌐 The Earth's rotation polar shift and figure polar shift are distinct types of geodetic variations. The Earth's figure polar shift represents the normalized angular momentum, which corresponds to the mass load excitation of the Earth's rotation.

🌐 The program utilizes the IERS measured or predicted product IERSeopc04.dat (available from the IERS website), which can be updated via the module [System configs for the geophysical models and numerical standards].The program uses the following Love numbers:  $k_2 = 0.3077 + 0.0036i$ ,  $h_2 = 0.6207$  and  $l_2 = 0.0836$ .



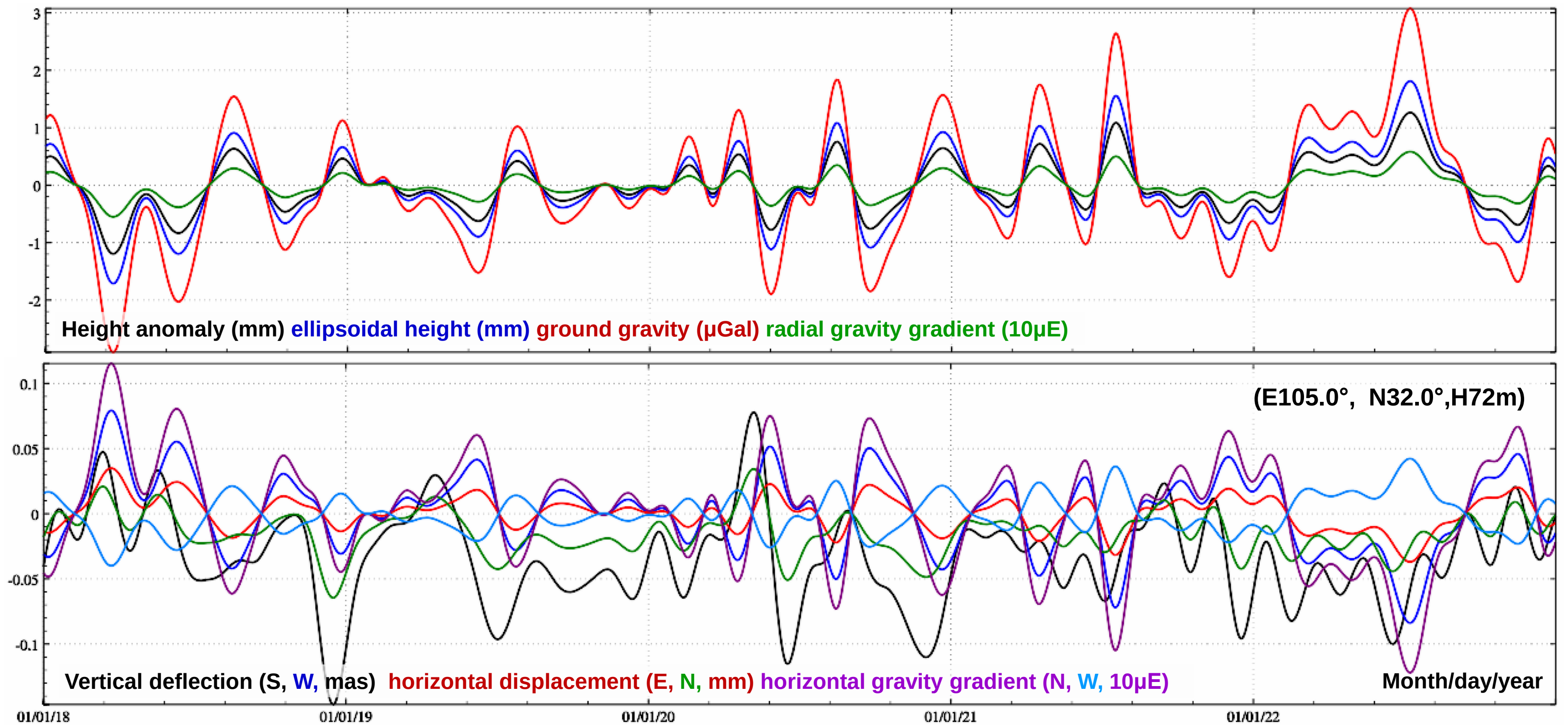
In the Earth-fixed coordinate system with arbitrary positioning and orientation, the mechanical figure polar coordinates of the deforming Earth can be uniquely determined by the degree-2 tesseral harmonic geopotential coefficients ( $\bar{C}_{21}, \bar{S}_{21}$ ). Therefore, the various tidal and non-tidal effects on figure pole can be accurately obtained in geodesy.



**Degree-2 tesseral sector harmonic geopotential coefficient and Earth's figure polar shift time series measured by SLR from UT/CSR**

Although the Earth's figure polar shift itself can reach the meter level, the resulting effect on geoid is not greater than 2mm. The figure polar shift effects on horizontal geodetic elements such as ground horizontal displacement, vertical deviation or horizontal gravity gradient are small and can be generally ignored.





**Earth's figure polar shift effect time series on geodetic elements**

The Earth's rotation polar shift and Earth's figure polar shift respectively represent the kinematic state of the whole Earth system and the characteristics of Earth's mechanical shape changing with time, which are both natural objective behaviors. Both of them will cause various geodetic elements in Earth's space to change with time.



# Computation of Permanent Tide Effects on Various Geodetic Elements

Open file Save as Import parameters Start computation Save process Follow example

Computation of Permanent Tide Effects on Various Geodetic Elements

Computation of Earth's COM Variation Effects on Various Geodetic elements

Forecast of Ocean Tidal Load Effects on Earth's Center of Mass

Forecast of Atmosphere Tidal Load Effects on Earth's Center of Mass

Open the discrete geodetic point record file

Save program process as

Variation of the Earth's Center of Mass and its Load Effects

Set the file parameters

The number of rows of the file header 0

Column ordinal number of ellipsoidal height in the record 4

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ disturbing gravity gradient (radial,  $10\mu\text{E}$ )

☒ horizontal gravity gradient (NE,  $10\mu\text{E}$ )

variations on various geodetic elements.

>> Select the computation function from the 4 control buttons on the top of the interface...

>> [Function] Based on the coordinates provided in the point record file, this module computes the permanent tide effects on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the discrete geodetic point record file C:/ETideLoad4.5 win64en/examples/Permanentdgeocecenter/GNSSIksirent.txt.

\*\* Enter the file format parameters according to the text box below. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5 win64en/examples/Permanentdgeocecenter/permrst.txt.

\*\* Behind the input file record, add several columns of the computed results as the output file record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-10 14:13:00

Columns 2 and 3 of the record are agreed as the longitude and latitude of the computation point.

Type of permanent tidal effects

Total effects

Save the results as

Import setting parameters

Start computation

Display of the input-output file

Save the data in the text box as

|    |            |           |           |         |         |         |         |        |        |
|----|------------|-----------|-----------|---------|---------|---------|---------|--------|--------|
| 2  | 102.546777 | 24.458002 | 1659.0410 | -0.1046 | 63.3095 | 26.1954 | 12.5279 | 4.9793 | 0.0000 |
| 4  | 102.725921 | 24.460578 | 2111.3872 | -0.0612 | 63.2920 | 26.1863 | 12.5236 | 4.9790 | 0.0000 |
| 6  | 102.528697 | 24.562786 | 1936.4260 | -0.0491 | 62.7782 | 25.9745 | 12.4223 | 4.9949 | 0.0000 |
| 9  | 102.832641 | 24.575505 | 1977.4949 | -0.1223 | 62.7136 | 25.9476 | 12.4094 | 4.9968 | 0.0000 |
| 10 | 102.345532 | 24.668953 | 1919.7825 | -0.0782 | 62.2412 | 25.7525 | 12.3161 | 5.0111 | 0.0000 |
| 11 | 102.423972 | 24.652933 | 1959.3369 | -0.0548 | 62.3220 | 25.7857 | 12.3320 | 5.0086 | 0.0000 |
| 13 | 102.631063 | 24.657055 | 1906.3415 | -0.1185 | 62.3016 | 25.7775 | 12.3281 | 5.0093 | 0.0000 |
| 14 | 102.742718 | 24.652871 | 1935.7882 | -0.0767 | 62.3226 | 25.7860 | 12.3322 | 5.0086 | 0.0000 |
| 15 | 102.843573 | 24.642787 | 1880.7707 | -0.1319 | 62.3742 | 25.8076 | 12.3425 | 5.0072 | 0.0000 |
| 16 | 103.137778 | 24.658224 | 1838.4387 | -0.0730 | 62.2964 | 25.7756 | 12.3272 | 5.0096 | 0.0000 |
| 17 | 102.426305 | 24.743284 | 1929.0475 | -0.0771 | 61.8640 | 25.5964 | 12.2415 | 5.0223 | 0.0000 |
| 20 | 102.729945 | 24.734909 | 1856.2213 | -0.1356 | 61.9073 | 25.6146 | 12.2502 | 5.0212 | 0.0000 |
| 21 | 102.840819 | 24.752018 | 2117.8582 | -0.0459 | 61.8178 | 25.5765 | 12.2320 | 5.0233 | 0.0000 |

The permanent tide is a time-invariant potential, corresponding to the zero-frequency term ( $\Delta C_{20}$ ) in long-period solid Earth tides. Its effects on geometric geodetic elements are longitude-independent. The computation employs the following Love numbers:  $k_{20}=0.29525$ ,  $h_{20}=0.6078$ , and  $l_{20}=0.0847$ .

Geodetic measurements can be referenced to different tide systems based on the correction strategy. Mean Tide System: Retains the permanent tide effects; Zero Tide System: Removes the direct loading effects of the permanent tide; and Free Tide System: Removes the sum of direct and indirect (associated) loading effects of the permanent tide.

The variation of the Earth's Center of Mass (COM) is dynamically equivalent to the degree-1 ( $n=1$ ) term of surface load deformation. It induces time-variable changes in both geometric and physical geodetic elements across the Earth's space. It should not be treated merely as a geometric translation (displacement) of the ground point.



# Computation of Earth's COM Variation Effects on Various Geodetic Elements

Open file Save as Import parameters Start computation Save process Follow example

Computation of Permanent Tide Effects on Various Geodetic Elements

Computation of Earth's COM Variation Effects on Various Geodetic elements

Forecast of Ocean Tidal Load Effects on Earth's Center of Mass

Forecast of Atmosphere Tidal Load Effects on Earth's Center of Mass

Open the location and time file of computation points

Save program process as

Variation of the Earth's Center of Mass and its Load Effects

Set the file parameters

Column ordinal number of time in the record 1

Column ordinal number of ellipsoidal height in the record 4

Column ordinal number of starting MJD0 in the header 5

Select the type of effects

- ☒ geoid or height anomaly (mm)
- ☒ ground gravity ( $\mu\text{Gal}$ )
- ☒ gravity disturbance ( $\mu\text{Gal}$ )
- ☒ ground tilt (SW, mas)
- ☒ vertical deflection (SW, mas)
- ☒ horizontal displacement (EN, mm)
- ☒ ground radial displacement (mm)
- ☒ ground normal or orthometric height (mm)
- ☒ disturbing gravity gradient (radial,  $10\mu\text{E}$ )
- ☒ horizontal gravity gradient (NE,  $10\mu\text{E}$ )

>> [Function] Utilizing the COM variation time series derived from Satellite Laser Ranging (SLR) measurements, this module computes the effects of Earth's Center of Mass variations on the following geodetic elements: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient ( $10\mu\text{E}$ ), or horizontal gravity gradient (NW,  $10\mu\text{E}$ ).

>> Open the location and time file of computation points C:/ETideLoad4.5\_win64en/examples/Permanentdgeocecenter/Postiontm.txt.

\*\* Enter the file format parameters according to the text box below. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Permanentdgeocecenter/geocenterst.txt.

\*\* Behind the input file record, add 3 columns of Earth's COM variations interpolated and one or several columns of Earth's mass centric variation effects selected as the output file record..

>> Setting parameters have been imported into the program!

\*\* Click the control button [Start computation], or the tool button [Start computation]

>> Computation start time: 2026-06-10 14:14:37

>> Complete the computation of Earth's COM variation effects!

Columns 2 and 3 of the record are agreed as the longitude and latitude of the computation point

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save the data in the text box as

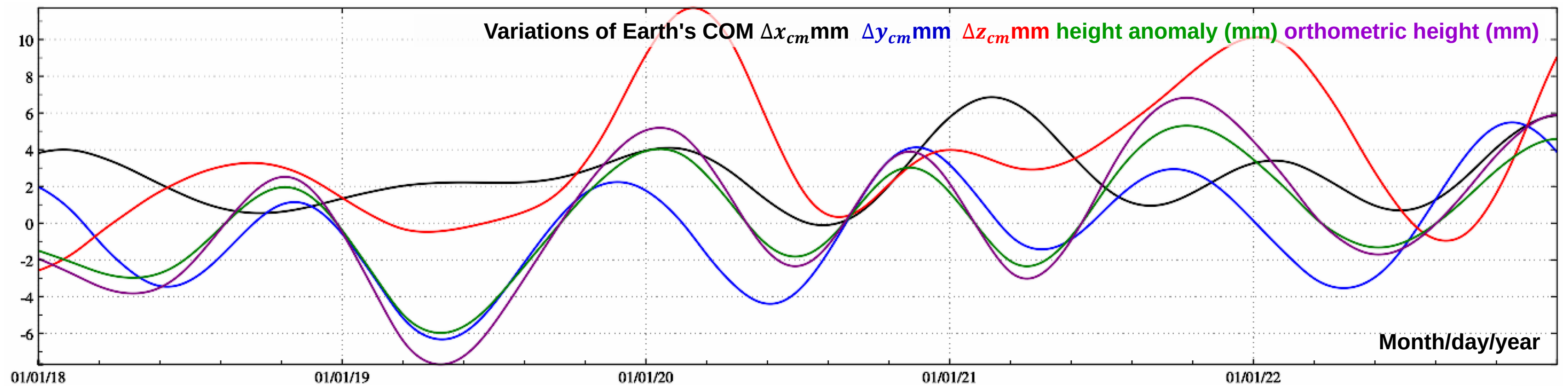
|              |            |           |              |        |         |        |        |        |
|--------------|------------|-----------|--------------|--------|---------|--------|--------|--------|
| 107.230000   | 29.910000  | 72.4      | 56658.000000 |        |         |        |        |        |
| 201401010000 | 107.230000 | 29.910000 | 72.4         | 0.9547 | 0.1535  | 4.5946 | 2.1684 | 0.2837 |
| 201401011200 | 107.230000 | 29.910000 | 72.4         | 0.9543 | 0.1384  | 4.6096 | 2.1634 | 0.2831 |
| 201401020000 | 107.230000 | 29.910000 | 72.4         | 0.9539 | 0.1232  | 4.6244 | 2.1582 | 0.2824 |
| 201401021200 | 107.230000 | 29.910000 | 72.4         | 0.9534 | 0.1080  | 4.6389 | 2.1529 | 0.2817 |
| 201401030000 | 107.230000 | 29.910000 | 72.4         | 0.9528 | 0.0927  | 4.6533 | 2.1475 | 0.2810 |
| 201401031200 | 107.230000 | 29.910000 | 72.4         | 0.9522 | 0.0773  | 4.6675 | 2.1419 | 0.2803 |
| 201401040000 | 107.230000 | 29.910000 | 72.4         | 0.9515 | 0.0618  | 4.6814 | 2.1362 | 0.2795 |
| 201401041200 | 107.230000 | 29.910000 | 72.4         | 0.9507 | 0.0463  | 4.6952 | 2.1303 | 0.2788 |
| 201401050000 | 107.230000 | 29.910000 | 72.4         | 0.9499 | 0.0307  | 4.7088 | 2.1243 | 0.2780 |
| 201401051200 | 107.230000 | 29.910000 | 72.4         | 0.9490 | 0.0151  | 4.7222 | 2.1182 | 0.2772 |
| 201401060000 | 107.230000 | 29.910000 | 72.4         | 0.9480 | -0.0006 | 4.7354 | 2.1120 | 0.2764 |
| 201401061200 | 107.230000 | 29.910000 | 72.4         | 0.9470 | -0.0164 | 4.7484 | 2.1056 | 0.2755 |

The permanent tide is a time-invariant potential, corresponding to the zero-frequency term ( $\Delta C_{20}$ ) in long-period solid Earth tides. Its effects on geometric geodetic elements are longitude-independent. The computation employs the following Love numbers:  $k_{20}=0.29525$ ,  $h_{20}=0.6078$ , and  $l_{20}=0.0847$ .

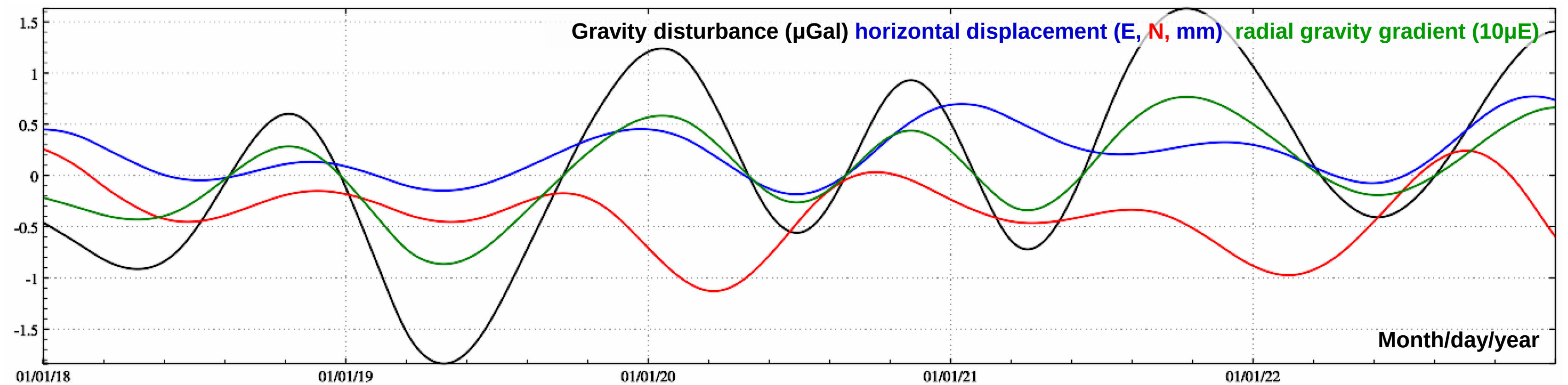
Geodetic measurements can be referenced to different tide systems based on the correction strategy. Mean Tide System: Retains the permanent tide effects; Zero Tide System: Removes the direct loading effects of the permanent tide; and Free Tide System: Removes the sum of direct and indirect (associated) loading effects of the permanent tide.

The variation of the Earth's Center of Mass (COM) is dynamically equivalent to the degree-1 ( $n=1$ ) term of surface load deformation. It induces time-variable changes in both geometric and physical geodetic elements across the Earth's space. It should not be treated merely as a geometric translation (displacement) of the ground point.





**Variations of Earth's COM and their effects on the height anomaly geoid and orthometric height**



**Variation effect time series of Earth's COM on various geodetic variations**

The variation of the Earth's Center of Mass (COM) is dynamically equivalent to the degree-1 ( $n=1$ ) term of surface load deformation. It induces time-variable changes in both geometric and physical geodetic elements across the Earth's space. It should not be treated merely as a geometric translation (displacement) of the ground point.



# Forecast of Ocean Tidal Load Effects on Earth's Center of Mass

Open file Save as Import parameters Start computation Save process Follow example

Computation of Permanent Tide Effects on Various Geodetic Elements

Computation of Earth's COM Variation Effects on Various Geodetic elements

Forecast of Ocean Tidal Load Effects on Earth's Center of Mass

Forecast of Atmosphere Tidal Load Effects on Earth's Center of Mass

Forecast time series parameters

Start time 20160701

End time 20160715

Time interval 60.00 min

Save program process as

Variation of the Earth's Center of Mass and its Load Effects

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

>> Computation start time: 2026-06-10 14:17:04

>> Complete the computation of Earth's COM variation effects!

>> Computation end time: 2026-06-10 14:17:04

>> [Function] Generates a time series forecast of ocean tidal load effects on the Earth's Center of Mass ( $\Delta X_{cm}$ ,  $\Delta Y_{cm}$ ,  $\Delta Z_{cm}$ , unit: mm) based on the degree-1 atmosphere tidal load spherical harmonic coefficient file OtideOne.dat, which can be output by the function [Spherical Harmonic Analysis on Ocean Tidal Constituent Harmonic Constants].

>> Save the results as C:/ETideLoad4.5 win64en/examples/Permanentdgeocecenter/otdgeoctrst.txt.

\*\* The output file record includes the sampling epoch time, 3 columns of the ocean tidal load effects on Earth's COM (Xcm, Ycm, Zcm, in unit mm).

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-10 14:17:30

>> Complete the computation of ocean tidal load effects on Earth's COM!

>> Computation end time: 2026-06-10 14:17:30

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save the data in the text box as

| Otidegeocenter | 0.00     | 0.00    | 0.00    | 57570.000000 |
|----------------|----------|---------|---------|--------------|
| 2016070100     | 0.000000 | 1.8250  | 4.1299  | -1.8888      |
| 2016070101     | 0.041667 | 0.5041  | 4.1937  | -3.5160      |
| 2016070102     | 0.083333 | -0.8168 | 3.6263  | -5.0214      |
| 2016070103     | 0.125000 | -1.9306 | 2.4942  | -6.0838      |
| 2016070104     | 0.166667 | -2.6848 | 0.9966  | -6.4140      |
| 2016070105     | 0.208333 | -3.0220 | -0.5533 | -5.9776      |
| 2016070106     | 0.250000 | -2.9774 | -1.8460 | -4.9099      |
| 2016070107     | 0.291667 | -2.6381 | -2.7016 | -3.3494      |
| 2016070108     | 0.333333 | -2.1152 | -3.0653 | -1.4945      |
| 2016070109     | 0.375000 | -1.5704 | -2.9291 | 0.3139       |
| 2016070110     | 0.416667 | -1.2001 | -2.3514 | 1.7377       |
| 2016070111     | 0.458333 | -1.1110 | -1.5264 | 2.6398       |
| 2016070112     | 0.500000 | -1.2582 | -0.7283 | 3.0545       |

The permanent tide is a time-invariant potential, corresponding to the zero-frequency term ( $\Delta C_{20}$ ) in long-period solid Earth tides. Its effects on geometric geodetic elements are longitude-independent. The computation employs the following Love numbers:  $k_{20}=0.29525$ ,  $h_{20}=0.6078$ , and  $l_{20}=0.0847$ .

Geodetic measurements can be referenced to different tide systems based on the correction strategy. Mean Tide System: Retains the permanent tide effects; Zero Tide System: Removes the direct loading effects of the permanent tide; and Free Tide System: Removes the sum of direct and indirect (associated) loading effects of the permanent tide.

The variation of the Earth's Center of Mass (COM) is dynamically equivalent to the degree-1 ( $n=1$ ) term of surface load deformation. It induces time-variable changes in both geometric and physical geodetic elements across the Earth's space. It should not be treated merely as a geometric translation (displacement) of the ground point.



# Forecast of Atmosphere Tidal Load Effects on Earth's Center of Mass

Open file Save as Import parameters Start computation Save process Follow example

Computation of Permanent Tide Effects on Various Geodetic Elements

Computation of Earth's COM Variation Effects on Various Geodetic elements

Forecast of Ocean Tidal Load Effects on Earth's Center of Mass

Forecast of Atmosphere Tidal Load Effects on Earth's Center of Mass

Forecast time series parameters

Start time 20160701

End time 20160715

Time interval 60.00 min

Save program process as

Variation of the Earth's Center of Mass and its Load Effects

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

>> Computation start time: 2026-06-10 14:17:30

>> Complete the computation of ocean tidal load effects on Earth's COM!

>> Computation end time: 2026-06-10 14:17:30

>> [Function] Generates a time series forecast of atmosphere tidal load effects on the Earth's Center of Mass ( $\Delta X_{cm}$ ,  $\Delta Y_{cm}$ ,  $\Delta Z_{cm}$ , unit: mm) based on the degree-1 atmosphere tidal load spherical harmonic coefficient file AtideOne.dat, which can be output by the function [Spherical Harmonic Analysis on Surface Atmosphere Tidal Harmonic Constants].

>> Save the results as C:/ETideLoad4.5 win64en/examples/Permanentdgeoctrst.txt.

\*\* The output file record includes the sampling epoch time, 3 columns of the atmosphere tidal load effects on Earth's COM (Xcm, Ycm, Zcm, in unit mm).

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-10 14:18:06

>> Complete the computation of atmosphere tidal load effects on Earth's COM!

>> Computation end time: 2026-06-10 14:18:06

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save the data in the text box as

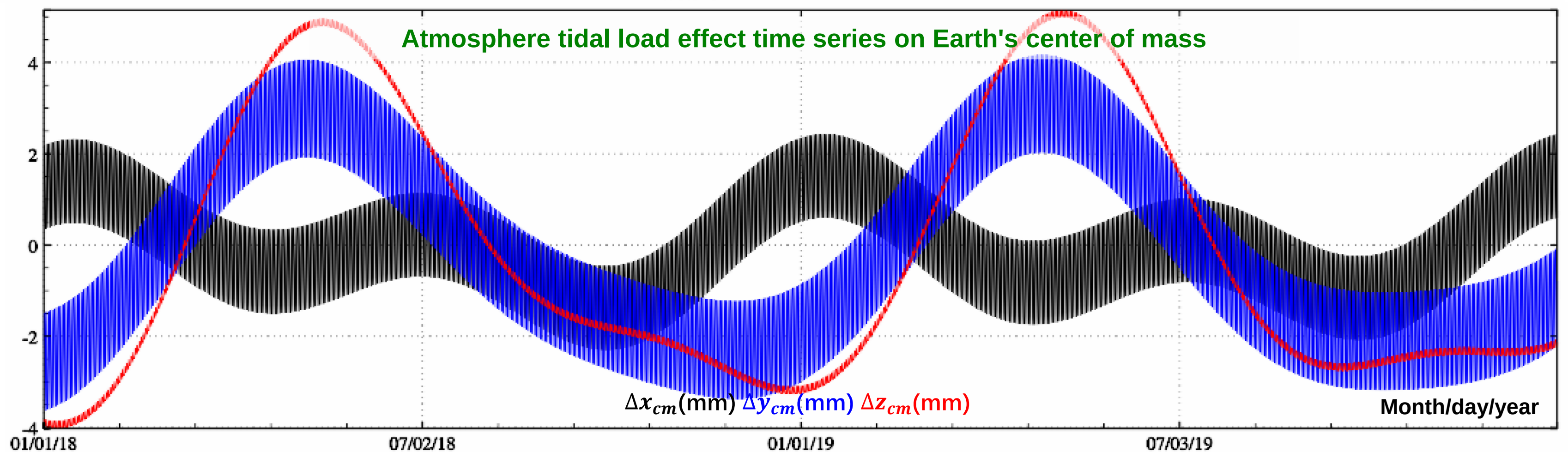
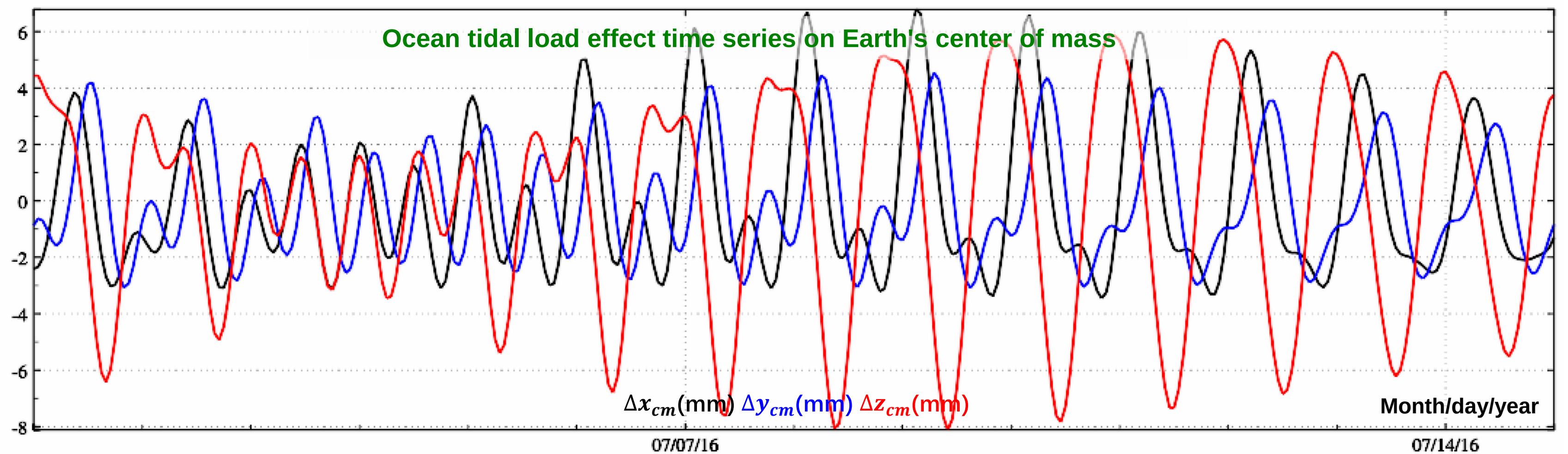
| Atidegeocenter | 0.00     | 0.00    | 0.00   | 57570.000000 |
|----------------|----------|---------|--------|--------------|
| 2016070100     | 0.000000 | 1.5728  | 2.0072 | 3.0910       |
| 2016070101     | 0.041667 | 1.5070  | 1.7158 | 3.0921       |
| 2016070102     | 0.083333 | 1.3772  | 1.4450 | 3.0968       |
| 2016070103     | 0.125000 | 1.1846  | 1.2199 | 3.1016       |
| 2016070104     | 0.166667 | 0.9395  | 1.0633 | 3.1041       |
| 2016070105     | 0.208333 | 0.6616  | 0.9921 | 3.1033       |
| 2016070106     | 0.250000 | 0.3779  | 1.0148 | 3.1005       |
| 2016070107     | 0.291667 | 0.1185  | 1.1292 | 3.0981       |
| 2016070108     | 0.333333 | -0.0884 | 1.3234 | 3.0993       |
| 2016070109     | 0.375000 | -0.2208 | 1.5775 | 3.1070       |
| 2016070110     | 0.416667 | -0.2670 | 1.8664 | 3.1226       |
| 2016070111     | 0.458333 | -0.2270 | 2.1642 | 3.1455       |
| 2016070112     | 0.500000 | -0.1114 | 2.4469 | 3.1729       |

The permanent tide is a time-invariant potential, corresponding to the zero-frequency term ( $\Delta C_{20}$ ) in long-period solid Earth tides. Its effects on geometric geodetic elements are longitude-independent. The computation employs the following Love numbers:  $k_{20}=0.29525$ ,  $h_{20}=0.6078$ , and  $l_{20}=0.0847$ .

Geodetic measurements can be referenced to different tide systems based on the correction strategy. Mean Tide System: Retains the permanent tide effects; Zero Tide System: Removes the direct loading effects of the permanent tide; and Free Tide System: Removes the sum of direct and indirect (associated) loading effects of the permanent tide.

The variation of the Earth's Center of Mass (COM) is dynamically equivalent to the degree-1 ( $n=1$ ) term of surface load deformation. It induces time-variable changes in both geometric and physical geodetic elements across the Earth's space. It should not be treated merely as a geometric translation (displacement) of the ground point.





The Earth's tidal force from the celestial body at the Earth's center of mass is always equal to zero, so geodesy does not specifically study the solid tidal effect on the Earth's center of mass. Ocean tides and surface atmosphere tides lead to the redistribution of surface mass, causing periodic variations of Earth's center of mass.



# Computation of Solid Earth Tidal Effects for Geodetic Networks

Open file Save as Import parameters Start computation Save process Follow example

Computation of Solid Earth Tidal Effects

Computation of Ocean Tidal Load Effects

Computation of Atmosphere Tidal Load Effects

Select the type of control network  
GNSS baseline network

&gt;&gt; Program Process \*\* Operation Prompts

Save program process as

Open Geodetic Network Observation Record File

Set the file parameters

Column ordinal number of starting  
MJD0 in the header

3

Column ordinal number of time  
in the record

10

✗

&gt;&gt; [Function] To compute the effects of Solid Earth Tides, Ocean Tidal Load, and Surface Atmosphere Tidal Load on GNSS baselines or leveling height differences, based on the observation times and locations in the input geodetic network file.

&gt;&gt; Select the type of the control network firstly, and select the computation function from the 3 control buttons on the top of the interface...

&gt;&gt; Compute the solid Earth tidal effects (mm)...

&gt;&gt; Compute the tidal effects on 3-D GNSS baseline vectors...

>> Open Geodetic Network Observation Record File C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/  
GNSSbaseline\_levelingroutine.txt.

\*\* Enter the file format parameters according to the text box below. After giving the output file name, click the control button [Import setting parameters]...

&gt;&gt; Save the results as C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/GNSSbaselsolidtide.txt.

\*\* Behind the input file record, add the tidal effects as the output file record.

&gt;&gt; Setting parameters have been imported into the program!

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

&gt;&gt; Computation start time: 2026-06-10 15:27:50

&gt;&gt; Complete the computation of the tidal effects!

&gt;&gt; Computation end time: 2026-06-10 15:27:51

Display of the input-output file↓

Save the results as

Import setting parameters

Start computation

9 4 57022

|           |            |           |      |            |           |      |          |     |            |        |         |         |         |
|-----------|------------|-----------|------|------------|-----------|------|----------|-----|------------|--------|---------|---------|---------|
| CANN_DONT | 120.424700 | 27.522580 | 21.8 | 121.150270 | 27.834630 | 28.6 | 79493.9  | 1.5 | 2016072412 | 1.2202 | 0.9021  | 0.1274  | -2.7422 |
| CANN_FDIQ | 120.424700 | 27.522580 | 21.8 | 120.207320 | 27.335310 | 32.5 | 29876.4  | 1.5 | 2016072412 | 1.2721 | -0.2673 | -0.0267 | 1.0012  |
| CANN_JHYW | 120.424700 | 27.522580 | 21.8 | 120.078380 | 29.272690 | 32.5 | 196899.1 | 1.5 | 2016072412 | 1.3927 | -0.4186 | -0.2735 | -1.9788 |
| CANN_JINH | 120.424700 | 27.522580 | 21.8 | 119.642580 | 29.217830 | 32.5 | 202930.8 | 1.5 | 2016072412 | 1.6668 | -0.9439 | -0.3836 | -0.5259 |
| CANN_JINX | 120.424700 | 27.522580 | 21.8 | 119.379220 | 29.070950 | 32.5 | 199897.1 | 1.5 | 2016072412 | 1.3931 | -0.0089 | -0.0089 | 0.0074  |
| CANN_JNJZ | 120.424700 | 27.522580 | 21.8 | 119.637540 | 27.976350 | 32.5 | 92473.9  | 1.5 | 2016072412 | 1.2143 | -0.9635 | -0.2428 | 1.6815  |
| CANN_JSAN | 120.424700 | 27.522580 | 21.8 | 118.608560 | 28.727950 | 32.5 | 222881.6 | 2.5 | 2016072512 | 1.2766 | -0.9303 | -1.0175 | 2.8778  |
| CANN_LHAI | 120.424700 | 27.522580 | 21.8 | 121.189470 | 28.905910 | 32.5 | 170695.1 | 2.5 | 2016072512 | 1.3588 | 0.7499  | -0.3840 | -6.9378 |
| CANN_LISH | 120.424700 | 27.522580 | 21.8 | 119.926490 | 28.631360 | 32.5 | 114864.2 | 2.5 | 2016072512 | 1.6040 | -0.1649 | -0.6605 | -1.1000 |
| CANN_LONQ | 120.424700 | 27.522580 | 21.8 | 119.133090 | 28.080720 | 32.5 | 141509.7 | 2.5 | 2016072512 | 1.3241 | -0.7295 | -0.8605 | 2.9925  |
| CANN_LUOY | 120.424700 | 27.522580 | 21.8 | 119.705090 | 27.552460 | 32.5 | 71164.3  | 2.5 | 2016072512 | 1.1005 | -0.4621 | -0.3085 | 2.5352  |
| CANN_PANA | 120.424700 | 27.522580 | 21.8 | 120.436660 | 29.054190 | 32.5 | 169743.8 | 2.5 | 2016072512 | 1.8985 | 0.2692  | -0.2575 | -4.7458 |
| CANN_PCHQ | 120.424700 | 27.522580 | 21.8 | 118.542210 | 27.923210 | 32.5 | 190867.4 | 2.5 | 2016072512 | 1.4645 | -1.1110 | -0.8864 | 5.6815  |
| CANN_PCJM | 120.424700 | 27.522580 | 21.8 | 118.445440 | 28.167970 | 32.5 | 207660.5 | 2.5 | 2016072512 | 1.7441 | -1.1253 | -0.9801 | 5.2647  |
| CANN_QINT | 120.424700 | 27.522580 | 21.8 | 120.289980 | 28.139380 | 32.5 | 69628.7  | 2.5 | 2016072512 | 1.1991 | 0.0136  | -0.1716 | -1.4049 |

Longitude, latitude, and ellipsoidal  
height of Starting-ending stationsThe solid tidal effects on  
GNSS baseline  
displacement  
(ENU, mm)

Tidal effects must be computed at the precise actual observation time. For leveling height differences, the observation duration should not exceed 2 hours to ensure valid computation of semi-diurnal tidal constituents.

Height Definitions: Solid Earth Tide: Use Ellipsoidal Height; Ocean Tidal Load: Use Normal Height or Orthometric Height; and Atmosphere Tidal Load: Use height relative to the surface (typically set to zero in the program).



# Computation of Solid Earth Tidal Effects for Geodetic Ne



## Computation of Atmosphere Tidal Load Effects

 Save program process as



```
>> Computation end time: 2026-06-10 15:29:23
```

 Start computation

|           |            |           |      |            |           |      |          |     |            |        |         |
|-----------|------------|-----------|------|------------|-----------|------|----------|-----|------------|--------|---------|
| CANN_DONT | 120.424700 | 27.522580 | 21.8 | 121.150270 | 27.834630 | 28.6 | 79493.9  | 1.5 | 2016072412 | 1.2202 | 3.2574  |
| CANN_FDIQ | 120.424700 | 27.522580 | 21.8 | 120.207320 | 27.335310 | 32.5 | 29876.4  | 1.5 | 2016072412 | 1.2721 | -1.1628 |
| CANN_JHYW | 120.424700 | 27.522580 | 21.8 | 120.078380 | 29.272690 | 32.5 | 196899.1 | 1.5 | 2016072412 | 1.3927 | 1.8728  |
| CANN_JINH | 120.424700 | 27.522580 | 21.8 | 119.642580 | 29.217830 | 32.5 | 202930.8 | 1.5 | 2016072412 | 1.6668 | 0.1125  |
| CANN_JINX | 120.424700 | 27.522580 | 21.8 | 119.379220 | 29.070950 | 32.5 | 199897.1 | 1.5 | 2016072412 | 1.3931 | -1.1770 |
| CANN_JNJZ | 120.424700 | 27.522580 | 21.8 | 119.637540 | 27.276350 | 32.5 | 92473.9  | 1.5 | 2016072412 | 1.2143 | -2.1936 |
| CANN_JSAN | 120.424700 | 27.522580 | 21.8 | 118.608560 | 28.727950 | 32.5 | 222881.6 | 2.5 | 2016072512 | 1.2766 | -3.8987 |
| CANN_LHAI | 120.424700 | 27.522580 | 21.8 | 119.189170 | 28.655120 | 32.5 | 170695.1 | 2.5 | 2016072512 | 1.3588 | 7.8461  |
| CANN_LISH | 120.424700 | 27.522580 | 21.8 | 119.929490 | 28.461260 | 32.5 | 114864.2 | 2.5 | 2016072512 | 1.6040 | 0.9773  |
| CANN_LONQ | 120.424700 | 27.522580 | 21.8 | 119.133090 | 28.080720 | 32.5 | 141509.7 | 2.5 | 2016072512 | 1.3241 | -3.7956 |
| CANN_LUOY | 120.424700 | 27.522580 | 21.8 | 119.705090 | 27.552460 | 32.5 | 71164.3  | 2.5 | 2016072512 | 1.1005 | -3.0525 |
| CANN_PANA | 120.424700 | 27.522580 | 21.8 | 120.436660 | 29.054190 | 32.5 | 169743.8 | 2.5 | 2016072512 | 1.8985 | 5.1476  |
| CANN_PCHQ | 120.424700 | 27.522580 | 21.8 | 118.542210 | 27.923210 | 32.5 | 190867.4 | 2.5 | 2016072512 | 1.4645 | -6.9589 |
| CANN_PCJM | 120.424700 | 27.522580 | 21.8 | 118.445440 | 28.167970 | 32.5 | 207660.5 | 2.5 | 2016072512 | 1.7441 | -6.5510 |
| CANN_QINT | 120.424700 | 27.522580 | 21.8 | 120.289980 | 28.139380 | 32.5 | 69628.7  | 2.5 | 2016072512 | 1.1991 | 1.4622  |

## The solid tidal effects on height difference of the levelling routine

🌐 Height Definitions: Solid Earth Tide: Use Ellipsoidal Height; Ocean Tidal Load: Use Normal Height or Orthometric Height; and Atmosphere Tidal Load: Use height relative to the surface (typically set to zero in the program).



# Computation of Ocean Tidal Load Effects for Geodetic Networks

Computation of Solid Earth Tidal Effects

Computation of Ocean Tidal Load Effects

Computation of Atmosphere Tidal Load Effects

Select the type of control network

GNSS baseline network

Open Geodetic Network Observation Record File

Set the file parameters

Column ordinal number of starting MJD0 in the header

3

Column ordinal number of time in the record

10

Maximum truncated degree of the coefficients model

120

>> Program Process \*\* Operation Prompts

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

>> Computation start time: 2026-06-10 15:31:37

>> Complete the computation of the tidal effects!

>> Computation end time: 2026-06-10 15:31:37

>> Compute the ocean tidal load effects (mm)....

>> Compute the tidal effects on 3-D GNSS baseline vectors...

>> Open Geodetic Network Observation Record File C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/GNSSbaseline\_levelingroutine.txt.

\*\* Enter the file format parameters according to the text box below. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/GNSSbaselotideload.txt.

\*\* Behind the input file record, add the tidal effects as the output file record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-10 15:32:02

>> Complete the computation of the tidal effects!

>> Computation end time: 2026-06-10 15:33:06

Save program process as

Display of the input-output file↓

Save the results as

Import setting parameters

Start computation

9 4 57022

|           |            |           |      |            |           |      |          |     |            |        |         |         |          |
|-----------|------------|-----------|------|------------|-----------|------|----------|-----|------------|--------|---------|---------|----------|
| CANN_DONT | 120.424700 | 27.522580 | 21.8 | 121.150270 | 27.834630 | 28.6 | 79493.9  | 1.5 | 2016072412 | 1.2202 | 2.9653  | -1.5855 | -5.9971  |
| CANN_FDIQ | 120.424700 | 27.522580 | 21.8 | 120.207320 | 27.335310 | 32.5 | 29876.4  | 1.5 | 2016072412 | 1.2721 | -0.8555 | 0.2769  | 1.8802   |
| CANN_JHYW | 120.424700 | 27.522580 | 21.8 | 120.078380 | 29.272690 | 32.5 | 196899.1 | 1.5 | 2016072412 | 1.3927 | -4.4438 | -0.6162 | -16.3385 |
| CANN_JINH | 120.424700 | 27.522580 | 21.8 | 119.642580 | 29.217830 | 32.5 | 202930.8 | 1.5 | 2016072412 | 1.6668 | -5.4186 | -0.4014 | -21.1547 |
| CANN_JINX | 120.424700 | 27.522580 | 21.8 | 119.379220 | 29.070950 | 32.5 | 199897.1 | 1.5 | 2016072412 | 1.3931 | -5.7411 | 0.2520  | 9150     |
| CANN_JNJZ | 120.424700 | 27.522580 | 21.8 | 119.637540 | 27.976350 | 32.5 | 92473.9  | 1.5 | 2016072412 | 1.2143 | -4.8333 | 1.2520  | 11.1695  |
| CANN_JSAN | 120.424700 | 27.522580 | 21.8 | 118.608560 | 28.727950 | 32.5 | 222881.6 | 2.5 | 2016072512 | 1.2766 | -4.1073 | 0.7879  | -36.4190 |
| CANN_LHAI | 120.424700 | 27.522580 | 21.8 | 121.159470 | 28.905910 | 32.5 | 170695.1 | 2.5 | 2016072512 | 1.3588 | 0       | 0       | 827      |
| CANN_LISH | 120.424700 | 27.522580 | 21.8 | 119.928490 | 28.661570 | 32.5 | 114864.2 | 2.5 | 2016072512 | 1.6040 | -3.5675 | 0.0229  | -16.0621 |
| CANN_LONQ | 120.424700 | 27.522580 | 21.8 | 119.133090 | 28.080720 | 32.5 | 141509.7 | 2.5 | 2016072512 | 1.3241 | -5.2100 | 1.7568  | -23.4411 |
| CANN_LUOY | 120.424700 | 27.522580 | 21.8 | 119.705090 | 27.552460 | 32.5 | 71164.3  | 2.5 | 2016072512 | 1.1005 | -3.7635 | 1.1878  | -7.1760  |
| CANN_PANA | 120.424700 | 27.522580 | 21.8 | 120.436660 | 29.054190 | 32.5 | 169743.8 | 2.5 | 2016072512 | 1.8985 | -2.2732 | 1.8436  | -17.6809 |
| CANN_PCHQ | 120.424700 | 27.522580 | 21.8 | 118.542210 | 27.923210 | 32.5 | 190867.4 | 2.5 | 2016072512 | 1.4645 | -5.1840 | 1.1543  | -30.9806 |
| CANN_PCJM | 120.424700 | 27.522580 | 21.8 | 118.445440 | 28.167970 | 32.5 | 207660.5 | 2.5 | 2016072512 | 1.7441 | -4.6945 | 0.9737  | -34.2959 |
| CANN_QINT | 120.424700 | 27.522580 | 21.8 | 120.289980 | 28.139380 | 32.5 | 69628.7  | 2.5 | 2016072512 | 1.1991 | -1.9022 | 1.5178  | -7.6866  |

Tidal effects must be computed at the precise actual observation time. For leveling height differences, the observation duration should not exceed 2 hours to ensure valid computation of semi-diurnal tidal constituents.

Height Definitions: Solid Earth Tide: Use Ellipsoidal Height; Ocean Tidal Load: Use Normal Height or Orthometric Height; and Atmosphere Tidal Load: Use height relative to the surface (typically set to zero in the program).



# Computation of Ocean Tidal Load Effects for Geodetic N

## Computation of Atmosphere Tidal Load Effects

 Save program process as

Maximum truncated degree of the coefficients model

```
>> Computation end time: 2026-06-10 15:34:56
```



## The ocean tidal load effects on height difference of the levelling routine

 Height Definitions: Solid Earth Tide: Use Ellipsoidal Height; Ocean Tidal Load: Use Normal Height or Orthometric Height; and Atmosphere Tidal Load: Use height relative to the surface (typically set to zero in the program).



# Computation of Atmosphere Tidal Load Effects for Geodetic Networks

Open file Save as Import parameters Start computation Save process Follow example

Computation of Solid Earth Tidal Effects

Computation of Ocean Tidal Load Effects

Computation of Atmosphere Tidal Load Effects

Select the type of control network

GNSS baseline network

Open Geodetic Network Observation Record File

Set the file parameters

Column ordinal number of starting MJD0 in the header

3

Column ordinal number of time in the record

10

Maximum truncated degree of the coefficients model

120

Save program process as

>> Program Process \*\* Operation Prompts

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

>> Computation start time: 2026-06-10 15:33:50

>> Complete the computation of the tidal effects!

>> Computation end time: 2026-06-10 15:34:56

>> Compute the atmosphere tidal load effects (mm)....

>> Compute the tidal effects on 3-D GNSS baseline vectors...

>> Open Geodetic Network Observation Record File C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/GNSSbaseline\_levelingroutine.txt.

\*\* Enter the file format parameters according to the text box below. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/GNSSbaselatideoad.txt.

\*\* Behind the input file record, add the tidal effects as the output file record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-10 15:36:06

>> Complete the computation of the tidal effects!

>> Computation end time: 2026-06-10 15:36:09

Display of the input-output file↓

Save the results as

Import setting parameters

Start computation

9 4 57022

|           |            |           |      |            |           |      |          |     |            |        |         |         |         |
|-----------|------------|-----------|------|------------|-----------|------|----------|-----|------------|--------|---------|---------|---------|
| CANN_DONT | 120.424700 | 27.522580 | 21.8 | 121.150270 | 27.834630 | 28.6 | 79493.9  | 1.5 | 2016072412 | 1.2202 | -0.0310 | -0.0199 | 0.0046  |
| CANN_FDIQ | 120.424700 | 27.522580 | 21.8 | 120.207320 | 27.335310 | 32.5 | 29876.4  | 1.5 | 2016072412 | 1.2721 | 0.0101  | 0.0082  | 0.0158  |
| CANN_JHYW | 120.424700 | 27.522580 | 21.8 | 120.078380 | 29.272690 | 32.5 | 196899.1 | 1.5 | 2016072412 | 1.3927 | -0.0253 | -0.0468 | -0.3490 |
| CANN_JINH | 120.424700 | 27.522580 | 21.8 | 119.642580 | 29.217830 | 32.5 | 202930.8 | 1.5 | 2016072412 | 1.6668 | -0.0092 | -0.0386 | -0.3743 |
| CANN_JINX | 120.424700 | 27.522580 | 21.8 | 119.379220 | 29.070950 | 32.5 | 199897.1 | 1.5 | 2016072412 | 1.3931 | 0.0120  | 0.0009  | 0.1325  |
| CANN_JNJZ | 120.424700 | 27.522580 | 21.8 | 119.637540 | 27.976350 | 32.5 | 92473.9  | 1.5 | 2016072412 | 1.2143 | 0.0251  | -0.0117 | -0.3621 |
| CANN_JSAN | 120.424700 | 27.522580 | 21.8 | 118.608560 | 28.727950 | 32.5 | 222881.6 | 2.5 | 2016072512 | 1.2766 | -0.0044 | -0.0161 | -0.1988 |
| CANN_LHAI | 120.424700 | 27.522580 | 21.8 | 121.169470 | 28.905910 | 32.5 | 170695.1 | 2.5 | 2016072512 | 1.3588 | 0.0209  | 0.0049  | -0.1898 |
| CANN_LISH | 120.424700 | 27.522580 | 21.8 | 119.220490 | 28.661650 | 32.5 | 114864.2 | 2.5 | 2016072512 | 1.6040 | 0.0186  | 0.0104  | -0.0494 |
| CANN_LONQ | 120.424700 | 27.522580 | 21.8 | 119.133090 | 28.080720 | 32.5 | 141509.7 | 2.5 | 2016072512 | 1.3241 | -0.0333 | -0.0434 | -0.2715 |
| CANN_LUOY | 120.424700 | 27.522580 | 21.8 | 119.705090 | 27.552460 | 32.5 | 71164.3  | 2.5 | 2016072512 | 1.1005 | 0.0348  | 0.0161  | -0.2217 |
| CANN_PANA | 120.424700 | 27.522580 | 21.8 | 120.436660 | 29.054190 | 32.5 | 169743.8 | 2.5 | 2016072512 | 1.8985 | 0.0339  | 0.0087  | -0.2787 |
| CANN_PCHQ | 120.424700 | 27.522580 | 21.8 | 118.542210 | 27.923210 | 32.5 | 190867.4 | 2.5 | 2016072512 | 1.4645 | -0.0085 | -0.0131 | -0.1126 |
| CANN_PCJM | 120.424700 | 27.522580 | 21.8 | 118.445440 | 28.167970 | 32.5 | 207660.5 | 2.5 | 2016072512 | 1.7441 |         |         |         |
| CANN_QINT | 120.424700 | 27.522580 | 21.8 | 120.289980 | 28.139380 | 32.5 | 69628.7  | 2.5 | 2016072512 | 1.1991 |         |         |         |

Longitude, latitude, and ellipsoidal height of Starting-ending stations

The atmosphere tidal load effects on GNSS baseline displacement (ENU, mm)

Tidal effects must be computed at the precise actual observation time. For leveling height differences, the observation duration should not exceed 2 hours to ensure valid computation of semi-diurnal tidal constituents.

Height Definitions: Solid Earth Tide: Use Ellipsoidal Height; Ocean Tidal Load: Use Normal Height or Orthometric Height; and Atmosphere Tidal Load: Use height relative to the surface (typically set to zero in the program).



# Computation of Atmosphere Tidal Load Effects for Geodetic Networks

Open file Save as Import parameters Start computation Save process Follow example

Computation of Solid Earth Tidal Effects

Computation of Ocean Tidal Load Effects

Computation of Atmosphere Tidal Load Effects

Select the type of control network  
Levelling control network

Open Geodetic Network Observation Record File

Set the file parameters

Column ordinal number of starting MJD0 in the header 3  
Column ordinal number of time in the record 10

Maximum truncated degree of the coefficients model 120

>> Program Process \*\* Operation Prompts

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

>> Computation start time: 2026-06-10 15:36:06

>> Complete the computation of the tidal effects!

>> Computation end time: 2026-06-10 15:36:09

>> Compute the atmosphere tidal load effects (mm)....

>> Compute the tidal effects on levelling height differences...

>> Open Geodetic Network Observation Record File C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/GNSSbaseline\_levelingroutine.txt.

\*\* Enter the file format parameters according to the text box below. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Controlnetworktidef/levelroutineatideload.txt.

\*\* Behind the input file record, add the tidal effects as the output file record.

>> Setting parameters have been imported into the program!

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

>> Computation start time: 2026-06-10 15:37:02

>> Complete the computation of the tidal effects!

>> Computation end time: 2026-06-10 15:37:05

Display of the input-output file↓

Save the results as

Import setting parameters

Start computation

| Station   | Longitude  | Latitude  | Ellipsoidal Height | Starting MJD | Ending MJD | Time Ordinal | Time     | Atmosphere Tidal Load (mm) | Height Difference (mm)    |
|-----------|------------|-----------|--------------------|--------------|------------|--------------|----------|----------------------------|---------------------------|
| CANN_DONT | 120.424700 | 27.522580 | 21.8               | 121.150270   | 27.834630  | 28.6         | 79493.9  | 1.5                        | 2016072412 1.2202 0.0128  |
| CANN_FDIQ | 120.424700 | 27.522580 | 21.8               | 120.207320   | 27.335310  | 32.5         | 29876.4  | 1.5                        | 2016072412 1.2721 0.0263  |
| CANN_JHYW | 120.424700 | 27.522580 | 21.8               | 120.078380   | 29.272690  | 32.5         | 196899.1 | 1.5                        | 2016072412 1.3927 -0.5863 |
| CANN_JINH | 120.424700 | 27.522580 | 21.8               | 119.642580   | 29.217830  | 32.5         | 202930.8 | 1.5                        | 2016072412 1.6668 -0.6324 |
| CANN_JINX | 120.424700 | 27.522580 | 21.8               | 119.379220   | 29.070950  | 32.5         | 199897.1 | 1.5                        | 2016072412 1.3931 -0.6227 |
| CANN_JNJZ | 120.424700 | 27.522580 | 21.8               | 119.637540   | 27.876350  | 32.5         | 92473.9  | 1.5                        | 2016072412 1.2143 -0.2327 |
| CANN_JSAN | 120.424700 | 27.522580 | 21.8               | 118.608560   | 28.727950  | 32.5         | 222881.6 | 2.5                        | 2016072512 1.2766 -0.6146 |
| CANN_LHAI | 120.424700 | 27.522580 | 21.8               | 119.188170   | 28.655150  | 32.5         | 170695.1 | 2.5                        | 2016072512 1.3588 -0.2838 |
| CANN_LISH | 120.424700 | 27.522580 | 21.8               | 119.929490   | 28.461260  | 32.5         | 114864.2 | 2.5                        | 2016072512 1.6040 -0.3408 |
| CANN_LONQ | 120.424700 | 27.522580 | 21.8               | 119.133090   | 28.080720  | 32.5         | 141509.7 | 2.5                        | 2016072512 1.3241 -0.3294 |
| CANN_LUOY | 120.424700 | 27.522580 | 21.8               | 119.705090   | 27.552460  | 32.5         | 71164.3  | 2.5                        | 2016072512 1.1005 -0.0908 |
| CANN_PANA | 120.424700 | 27.522580 | 21.8               | 120.436660   | 29.054190  | 32.5         | 169743.8 | 2.5                        | 2016072512 1.8985 -0.4549 |
| CANN_PCHQ | 120.424700 | 27.522580 | 21.8               | 118.542210   | 27.923210  | 32.5         | 190867.4 | 2.5                        | 2016072512 1.4645 -0.3771 |
| CANN_PCJM | 120.424700 | 27.522580 | 21.8               | 118.445440   | 28.167970  | 32.5         | 207660.5 | 2.5                        | 2016072512 1.7441 -0.4717 |
| CANN_QINT | 120.424700 | 27.522580 | 21.8               | 120.289980   | 28.139380  | 32.5         | 69628.7  | 2.5                        | 2016072512 1.1991 -0.1938 |

The atmosphere tidal load effects on height difference of the levelling routine

Tidal effects must be computed at the precise actual observation time. For leveling height differences, the observation duration should not exceed 2 hours to ensure valid computation of semi-diurnal tidal constituents.

Height Definitions: Solid Earth Tide: Use Ellipsoidal Height; Ocean Tidal Load: Use Normal Height or Orthometric Height; and Atmosphere Tidal Load: Use height relative to the surface (typically set to zero in the program).



# Computation of Residual Ocean Tidal Load Effects via Green's Integration

Open file Save as Import parameters Start computation Save process Follow example

Open any residual ocean tidal harmonic constant grid file

Computation of Residual Ocean Tidal Load Effects via Green's Integration

Computation of Residual Atmosphere Tidal Load Effects via Green's Integration

Open the location and time file of near-Earth points

>> Program Process \*\* Operation Prompts

Save program process as

Set the format of input file

Column ordinal number of starting MJD0 in the header 5

Column ordinal number of time in the record 1

Column ordinal number of the normal or orthometric height in record 4

Select the type of effects

- ☒ geoid or height anomaly (mm)
- ☒ ground gravity ( $\mu\text{Gal}$ )
- ☒ gravity disturbance ( $\mu\text{Gal}$ )
- ☒ ground tilt (SW, mas)
- ☒ vertical deflection (SW, mas)
- ☒ horizontal displacement (EN, mm)
- ☒ ground radial displacement (mm)
- ☒ ground normal or orthometric height (mm)
- ☒ radial gravity gradient (mE)
- ☒ horizontal gravity gradient (NW, mE)

Green's integral radius 400 km

>> [Purpose] To compute residual ocean or surface atmosphere tidal load effects on ground stations or in near-Earth space using regional residual harmonic constant grids, based on the Load Green's Function Integration method.  
 >> Select the computation function from the two control buttons on the upper right of the interface...  
 >> [Function] Using regional residual ocean tidal harmonic constant grids, this module computes the residual ocean tidal load effects on the following geodetic elements via Load Green's Function integration: Geoid or height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), gravity disturbance ( $\mu\text{Gal}$ ), ground tilt (SW, south and west, mas), vertical deflection (SW, south and west, mas), horizontal displacement (EN, east and north, mm), ground radial displacement (mm), ground normal or orthometric height (mm), radial gravity gradient (mE), or horizontal gravity gradient (NW, mE).

\*\* The valid files of the residual ocean tidal harmonic constants:

C:/ETideLoad4.5\_win64en/residOTide/K1got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/K2got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/M2got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/N2got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/O1got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/P1got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/Q1got4.8\_FES2004.dat  
 C:/ETideLoad4.5\_win64en/residOTide/S2got4.8\_FES2004.dat

8 residual ocean tidal constituent harmonic constants from difference between GOT4.8 and FES2004

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

Save data in the text box as

|            |            |          |           |            |            |        |        |
|------------|------------|----------|-----------|------------|------------|--------|--------|
| 100.000000 | 140.000000 | 0.000000 | 50.000000 | 0.50000000 | 0.50000000 | 165555 |        |
| 0.000      | 0.000      | 0.000    | 0.000     | 0.000      | 0.000      | 0.000  | 14.520 |
| -4.420     | 0.100      | 9.510    | 0.000     | 0.000      | 0.000      | 0.000  | 0.000  |
| 0.000      | 0.000      | 0.000    | 0.000     | 0.000      | -12.330    | -7.470 | -3.630 |
| -6.130     | -6.230     | -6.310   | -5.000    | -4.690     | -3.260     | -2.210 | -1.950 |
| 0.950      | 1.000      | -0.610   | 0.000     | 0.000      | 0.000      | -0.800 | -0.020 |
| -0.220     | -0.410     | -0.490   | 0.000     | 0.000      | 0.000      | 18.180 | 0.000  |
| 0.000      | 0.000      | 0.000    | 0.000     | 0.000      | 0.000      | 0.000  | 0.000  |
| -3.190     | 0.410      | 6.660    | 0.000     | 0.000      | 0.000      | -9.290 | -4.210 |
| 0.000      | 0.000      | 0.000    | 0.000     | 0.000      | 0.000      | -1.050 | -1.130 |
| 0.000      | 0.000      | 0.000    | 0.000     | -3.860     | -2.070     | -1.360 | -0.330 |
| -0.290     | -1.750     | -2.980   | -3.580    | -3.450     | -2.570     |        |        |
| -0.370     | -0.270     | -0.220   | -0.160    | -0.090     |            |        |        |

The seventh attribute of the file header is the Doodson constant

- Residual Harmonic Constants: The difference between the observed harmonic constants and the values synthesized from a global tidal load spherical harmonic coefficient model.
- By applying the Remove-Restore technique, the software refines the computation using Load Green's Function integration. Consequently, the program outputs represent solely the regional residuals of the tidal load effects.



# Computation of Residual Ocean Tidal Load Effects via Green's Integration

Open file Save as Import parameters Start computation Save process Follow example

Open any residual ocean tidal harmonic constant grid file

Computation of Residual Ocean Tidal Load Effects via Green's Integration

Computation of Residual Atmosphere Tidal Load Effects via Green's Integration

Open the location and time file of near-Earth points

>> Program Process \*\* Operation Prompts

Save program process as

Set the format of input file

Column ordinal number of starting MJD0 in the header

5

Column ordinal number of time in the record

1

Column ordinal number of the normal or orthometric height in record

4

Select the type of effects

☒ geoid or height anomaly (mm)

☒ ground gravity ( $\mu\text{Gal}$ )

☒ gravity disturbance ( $\mu\text{Gal}$ )

☒ ground tilt (SW, mas)

☒ vertical deflection (SW, mas)

☒ horizontal displacement (EN, mm)

☒ ground radial displacement (mm)

☒ ground normal or orthometric height (mm)

☒ radial gravity gradient (mE)

☒ horizontal gravity gradient (NW, mE)

Green's integral radius 400 km

C:/ETideLoad4.5\_win64en/residOTide/M2got4.8\_FES2004.dat  
C:/ETideLoad4.5\_win64en/residOTide/N2got4.8\_FES2004.dat  
C:/ETideLoad4.5\_win64en/residOTide/O1got4.8\_FES2004.dat  
C:/ETideLoad4.5\_win64en/residOTide/P1got4.8\_FES2004.dat  
C:/ETideLoad4.5\_win64en/residOTide/Q1got4.8\_FES2004.dat  
C:/ETideLoad4.5\_win64en/residOTide/S2got4.8\_FES2004.dat

8 residual ocean tidal constituent harmonic constants from difference between GOT4.8 and FES2004

>> Open the location and time file of near-Earth points C:/ETideLoad4.5\_win64en/examples/Tdloadgreenintegral/Postiontm.txt.

\*\* Enter the file format parameters according to the text box below, and then enter the Green's integral radius. After giving the output file name, click the control button [Import setting parameters]...

>> Save the results as C:/ETideLoad4.5\_win64en/examples/Tdloadgreenintegral/otdloadchdais.txt.

\*\* Appends the computed residual effect values to the input record.

>> Setting parameters have been imported into the program!

>> Prepare to compute the residual ocean tidal load effects...

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

>> Computation start time: 2026-06-11 08:12:52

>> Complete the Green's Integration for residual ocean tidal load effects!

\*\* There are 8 residual tidal constituent harmonic constants grid models involved in the computation.

>> Computation end time: 2026-06-11 08:12:53

Columns 2 and 3 of the record are agreed as the longitude and latitude

Save the results as

Import setting parameters

Start computation

Display of the input-output file↓

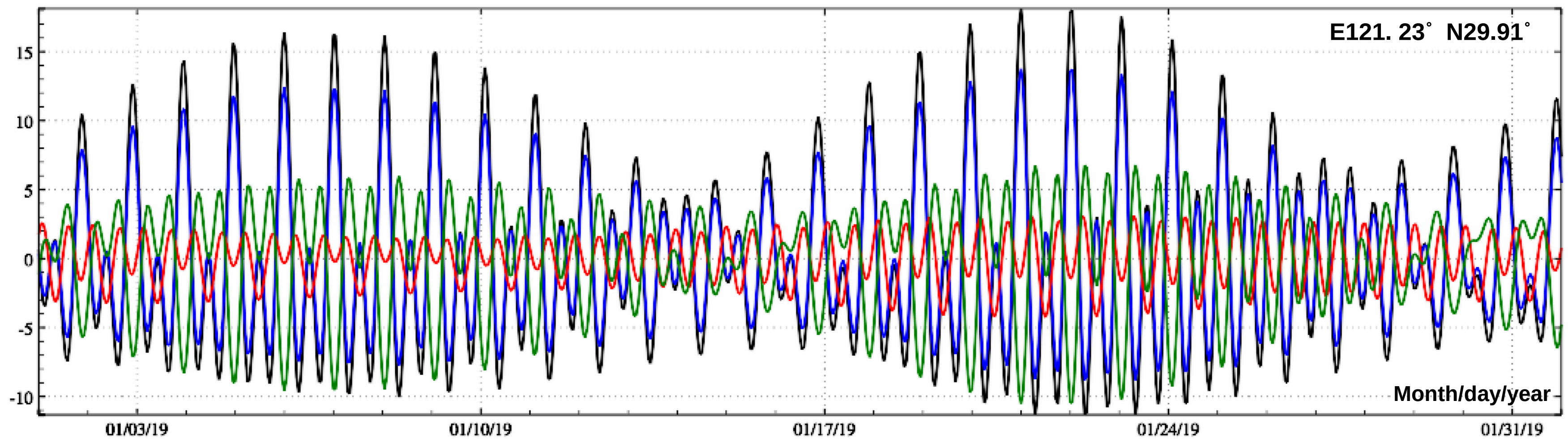
Save data in the text box as

|              | 121.230000 | 29.910000 | 47.218 | 58484.000000 |         |         |         |         |    |
|--------------|------------|-----------|--------|--------------|---------|---------|---------|---------|----|
| 201901010000 | 121.230000 | 29.910000 | 2.218  |              | 1.0864  | 0.8426  | 0.2789  | -0.9590 | 0  |
| 201901010100 | 121.230000 | 29.910000 | 2.218  |              | -1.2644 | -1.0431 | -0.3716 | -1.9073 | -0 |
| 201901010200 | 121.230000 | 29.910000 | 2.218  |              | -3.0046 | -2.4359 | -0.8496 | -2.3699 | -1 |
| 201901010300 | 121.230000 | 29.910000 | 2.218  |              | -3.7807 | -3.0520 | -1.0574 | -2.2214 | -2 |
| 201901010400 | 121.230000 | 29.910000 | 2.218  |              | -3.4908 | -2.8097 | -0.9679 | -1.4900 | -2 |
| 201901010500 | 121.230000 | 29.910000 | 2.218  |              | -2.3067 | -1.8476 | -0.6301 | -0.3505 | -1 |
| 201901010600 | 121.230000 | 29.910000 | 2.218  |              | -0.6276 | -0.4875 | -0.1563 | 0.9193  | -0 |
| 201901010700 | 121.230000 | 29.910000 | 2.218  |              | 1.0228  | 0.8491  | 0.3073  | 2.0076  | 0  |
| 201901010800 | 121.230000 | 29.910000 | 2.218  |              | 2.1328  | 1.7497  | 0.6179  | 2.6458  | 1  |
| 201901010900 | 121.230000 | 29.910000 | 2.218  |              | 2.3361  | 1.9195  | 0.6740  | 2.6751  | 1  |
| 201901011000 | 121.230000 | 29.910000 | 2.218  |              | 1.5110  | 1.2600  | 0.4424  | 2.0860  | 0  |
| 201901011100 | 121.230000 | 29.910000 | 2.218  |              | -0.1807 | -0.0992 | -0.0311 | 1.0200  | -0 |

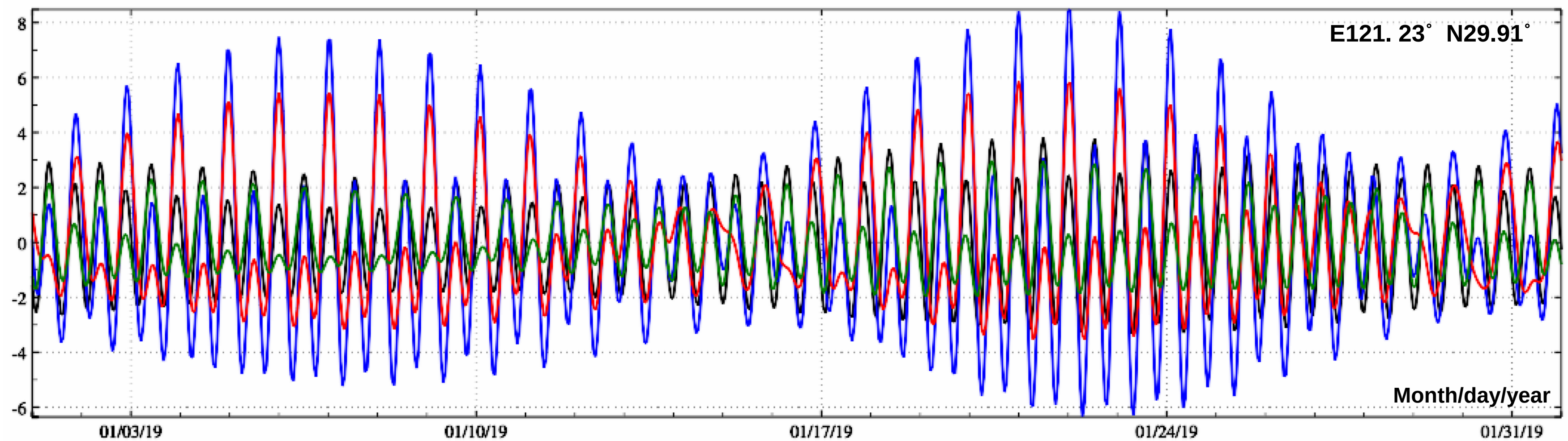
Residual Harmonic Constants: The difference between the observed harmonic constants and the values synthesized from a global tidal load spherical harmonic coefficient model.

By applying the Remove-Restore technique, the software refines the computation using Load Green's Function integration. Consequently, the program outputs represent solely the regional residuals of the tidal load effects.



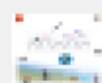


The residual ocean tidal load effects (GOT4.8-FES2004): height anomaly (mm), ground gravity ( $\mu\text{Gal}$ ), radial displacement (mm), orthometric height (mm)

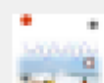


The residual ocean tidal load effects (GOT4.8-FES2004): ground tilt (S, mas), (W, mas), horizontal displacement (E, mm), (N, mm)





Solid Earth tide



Ocean tidal load



Atmosphere tidal load



Import parameters



Forecast



Follow example

## Forecast of Various Tidal Effects on Various Surface Geodetic Elements

**Numerical Forecast of Solid Earth Tidal Effects****Numerical Forecast of Ocean Tidal Load Effects****Numerical Forecast of Surface Atmosphere Tidal Load Effects**

Location of surface point to be forecast

Longitude 121.240000°

Latitude 29.428100°

Height 17.830m



The selection of height type is critical for accurate computation:

- Solid Earth Tide: Utilize the Ellipsoidal Height.
- Ocean Tidal Load: Utilize the Normal Height or Orthometric Height.
- Atmosphere Tidal Load: Utilize the height relative to the local surface (set to zero in the program).

Input the forecast time 201607010930



Import setting parameters



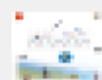
Start to forecast...

Forecast with the given location and time

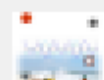
|                                   |          |                                                   |         |                                                   |          |
|-----------------------------------|----------|---------------------------------------------------|---------|---------------------------------------------------|----------|
| geoid or height anomaly (mm)      | -237.159 | ground gravity ( $\mu\text{Gal}$ )                | -95.705 | gravity disturbance ( $\mu\text{Gal}$ )           | -108.813 |
| horizontal displacement (E, mm)   | 20.079   | ground tilt (S, mas)                              | 4.222   | vertical deflection (S, mas)                      | 8.493    |
| horizontal displacement (N, mm)   | -16.345  | ground tilt (W, mas)                              | -5.333  | vertical deflection (W, mas)                      | -10.091  |
| ground radial displacement (mm)   | -119.083 | radial gravity gradient ( $10\mu\text{E}$ )       | 67.971  |                                                   |          |
| normal or orthometric height (mm) | 117.948  | horizontal gravity gradient (N, $10\mu\text{E}$ ) | 4.203   | horizontal gravity gradient (W, $10\mu\text{E}$ ) | -25.594  |

The spherical harmonic coefficient model of the ocean tidal load or surface atmosphere tidal load can be updated via the program [System Configs for Geophysical Models and Numerical Standards].





Solid Earth tide



Ocean tidal load



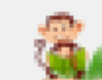
Atmosphere tidal load



Import parameters



Forecast



Follow example

## Forecast of Various Tidal Effects on Various Surface Geodetic Elements



Numerical Forecast of Solid Earth Tidal Effects



Numerical Forecast of Ocean Tidal Load Effects



Numerical Forecast of Surface Atmosphere Tidal Load Effects

Location of surface point to be forecast

Longitude 121.240000°

Latitude 29.428100°

Height 17.830m

Maximum truncated degree of model 360



The selection of height type is critical for accurate computation:

- Solid Earth Tide: Utilize the Ellipsoidal Height.
- Ocean Tidal Load: Utilize the Normal Height or Orthometric Height.
- Atmosphere Tidal Load: Utilize the height relative to the local surface (set to zero in the program).

Sea surface tidal height (cm) -77.433

Input the forecast time 201607010130



Import setting parameters



Start to forecast...

Forecast with the given location and time

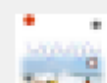
|                                   |         |                                                   |           |                                                   |          |
|-----------------------------------|---------|---------------------------------------------------|-----------|---------------------------------------------------|----------|
| geoid or height anomaly (mm)      | -12.547 | ground gravity ( $\mu\text{Gal}$ )                | -38.621   | gravity disturbance ( $\mu\text{Gal}$ )           | -40.790  |
| horizontal displacement (E, mm)   | -10.338 | ground tilt (S, mas)                              | -83.500   | vertical deflection (S, mas)                      | -20.769  |
| horizontal displacement (N, mm)   | 7.780   | ground tilt (W, mas)                              | 58.130    | vertical deflection (W, mas)                      | 16.004   |
| ground radial displacement (mm)   | 17.526  | radial gravity gradient ( $10\mu\text{E}$ )       | -1622.769 |                                                   |          |
| normal or orthometric height (mm) | 30.073  | horizontal gravity gradient (N, $10\mu\text{E}$ ) | -1084.238 | horizontal gravity gradient (W, $10\mu\text{E}$ ) | -533.235 |

The spherical harmonic coefficient model of the ocean tidal load or surface atmosphere tidal load can be updated via the program [System Configs for Geophysical Models and Numerical Standards].





Solid Earth tide



Ocean tidal load



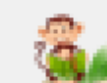
Atmosphere tidal load



Import parameters



Forecast



Follow example

## Forecast of Various Tidal Effects on Various Surface Geodetic Elements



Numerical Forecast of Solid Earth Tidal Effects



Numerical Forecast of Ocean Tidal Load Effects



Numerical Forecast of Surface Atmosphere Tidal Load Effects

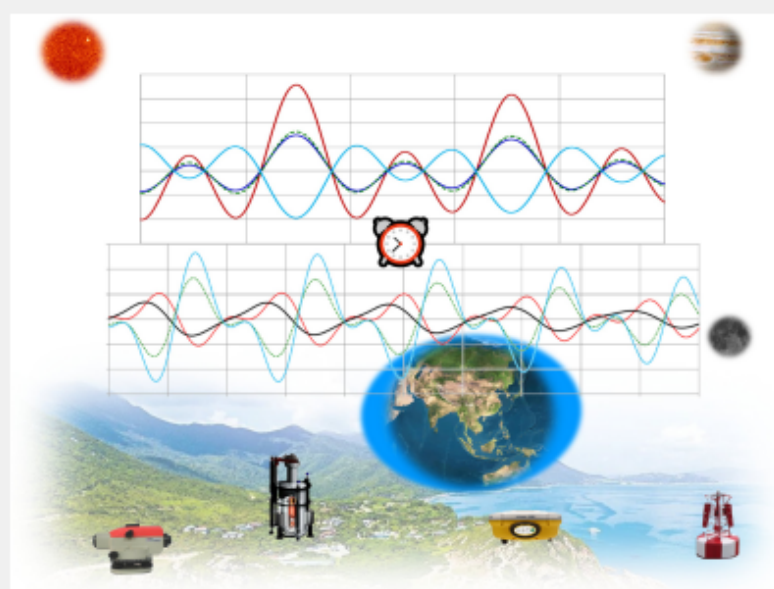
Location of surface point to be forecast

Longitude 121.240000°

Latitude 29.428100°

Height 17.830m

Maximum truncated degree of model 360



The selection of height type is critical for accurate computation:

- Solid Earth Tide: Utilize the Ellipsoidal Height.
- Ocean Tidal Load: Utilize the Normal Height or Orthometric Height.
- Atmosphere Tidal Load: Utilize the height relative to the local surface (set to zero in the program).

Surface atmosphere (hPa/mbar) 10.055

Input the forecast time 201607011105



Import setting parameters



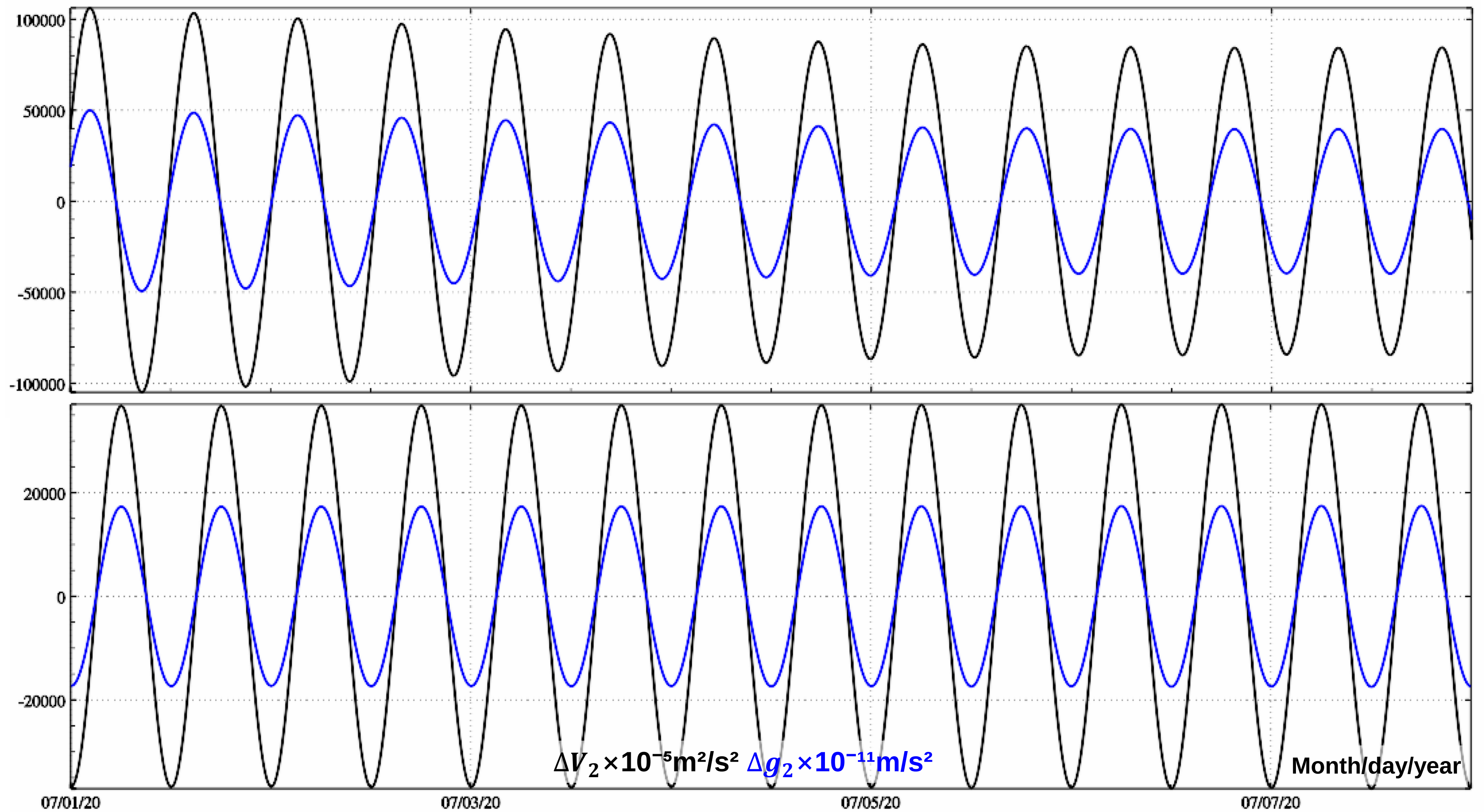
Start to forecast...

Forecast with the given location and time

|                                   |         |                                                   |        |                                                   |        |
|-----------------------------------|---------|---------------------------------------------------|--------|---------------------------------------------------|--------|
| geoid or height anomaly (mm)      | 4.406   | ground gravity ( $\mu\text{Gal}$ )                | -5.437 | gravity disturbance ( $\mu\text{Gal}$ )           | -4.602 |
| horizontal displacement (E, mm)   | -0.434  | ground tilt (S, mas)                              | -0.673 | vertical deflection (S, mas)                      | -0.284 |
| horizontal displacement (N, mm)   | 0.518   | ground tilt (W, mas)                              | 0.665  | vertical deflection (W, mas)                      | 0.268  |
| ground radial displacement (mm)   | -5.949  | radial gravity gradient ( $10\mu\text{E}$ )       | -3.601 |                                                   |        |
| normal or orthometric height (mm) | -10.356 | horizontal gravity gradient (N, $10\mu\text{E}$ ) | 0.655  | horizontal gravity gradient (W, $10\mu\text{E}$ ) | 0.594  |

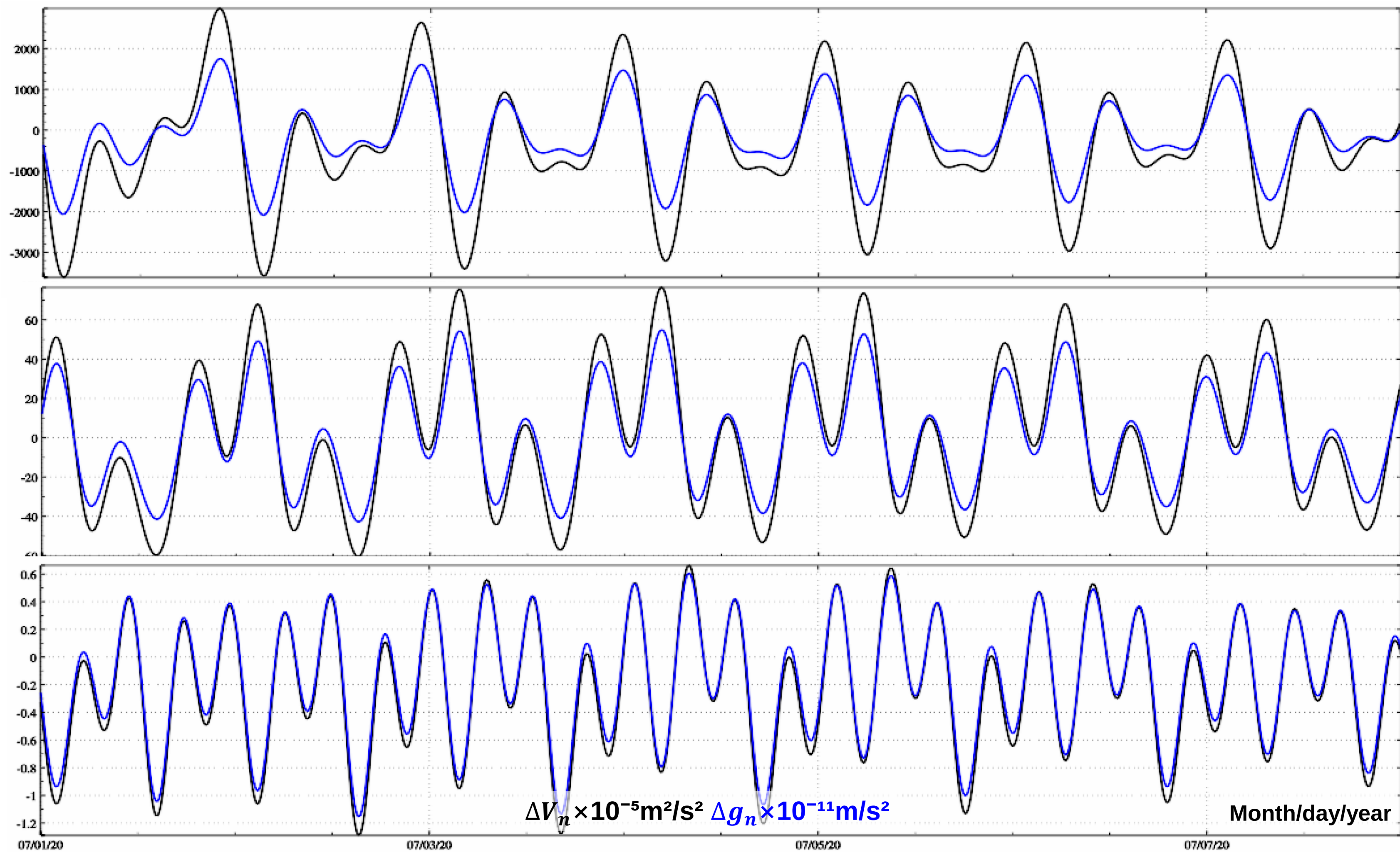
The spherical harmonic coefficient model of the ocean tidal load or surface atmosphere tidal load can be updated via the program [System Configs for Geophysical Models and Numerical Standards].





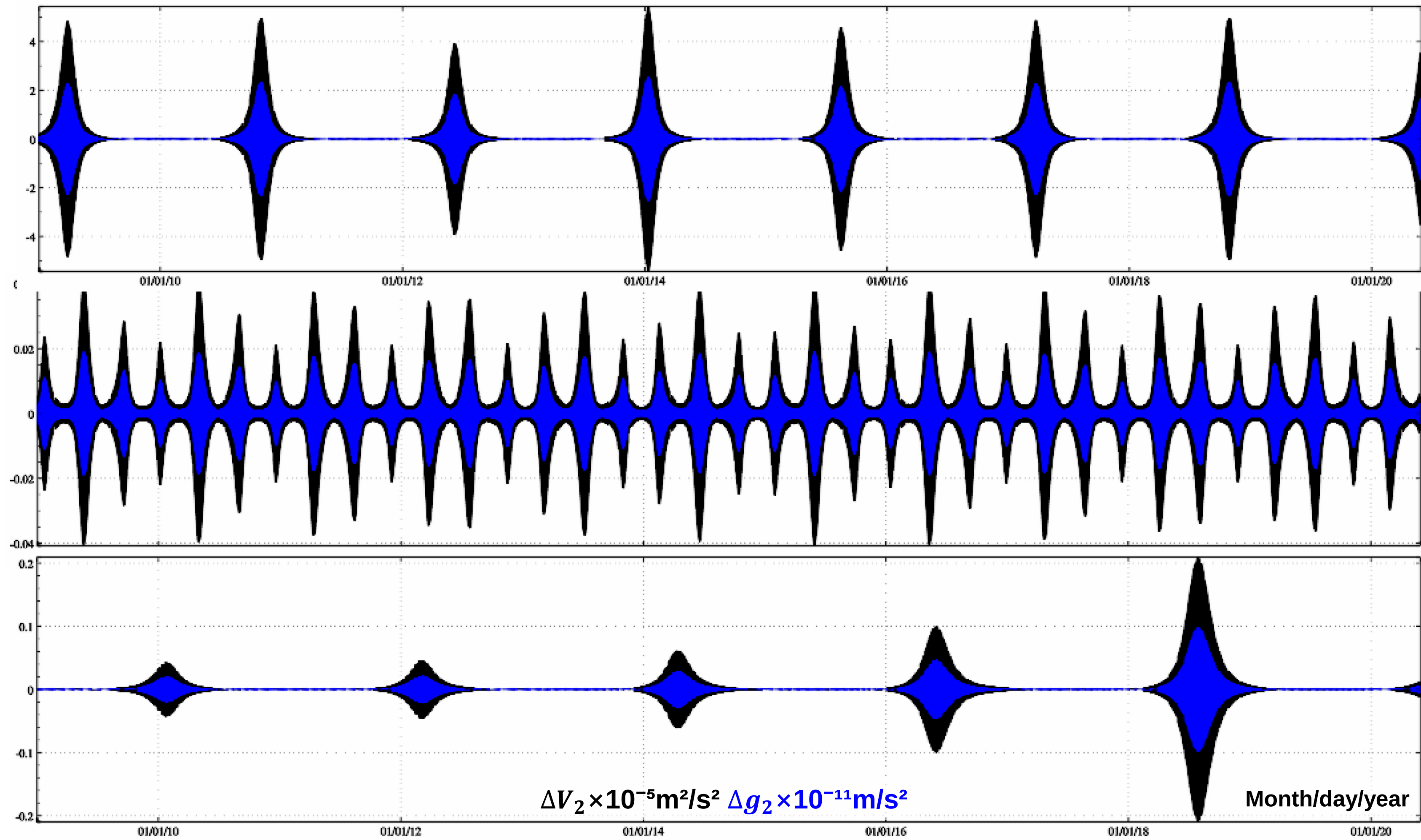
**Degree-2 Earth's tidal potential (force) time series from Moon and Sun (7 days)**





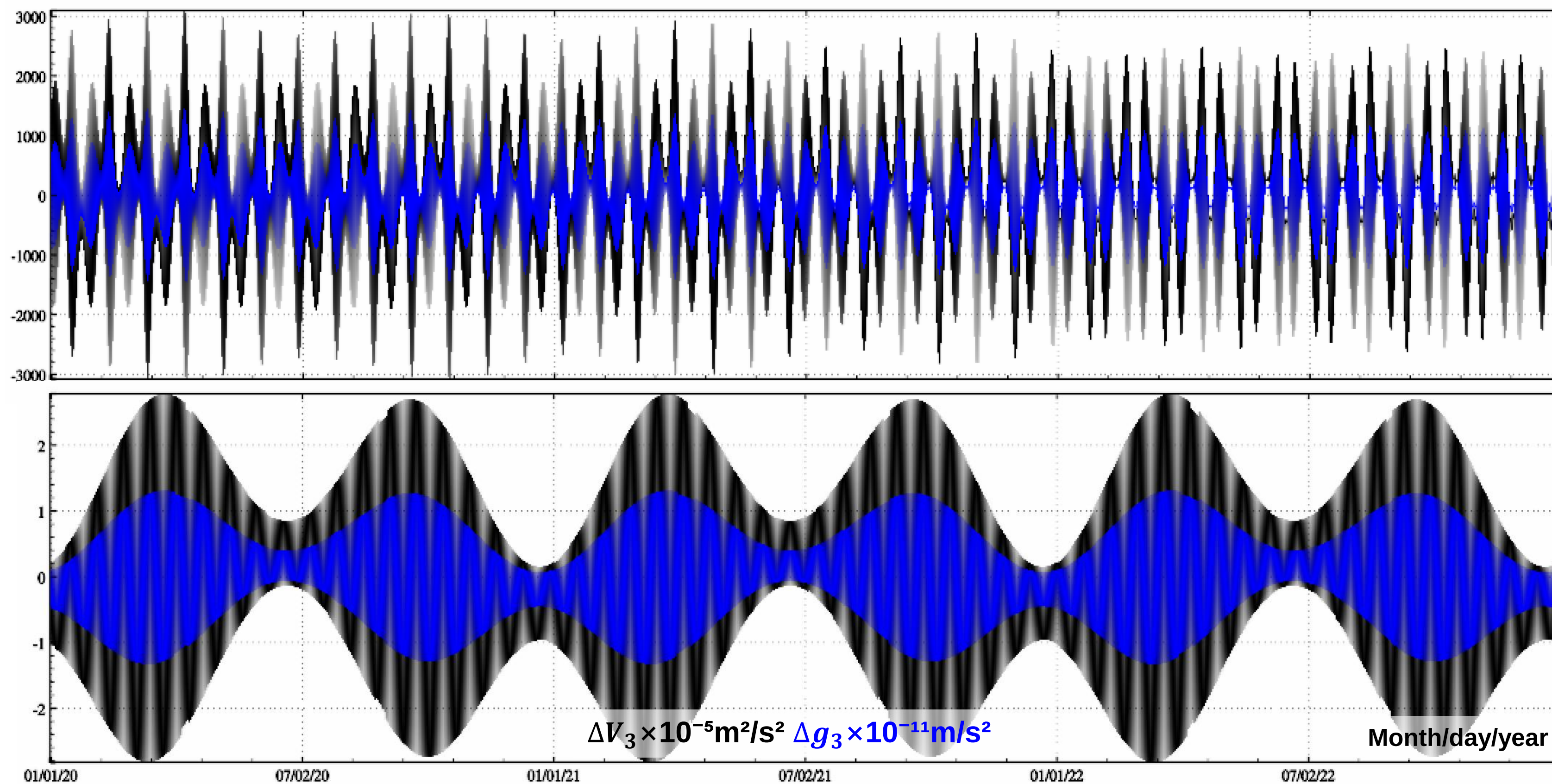
**Degree 3, 4 and 5 Earth's tidal potential (force) time series from Moon (7 days)**





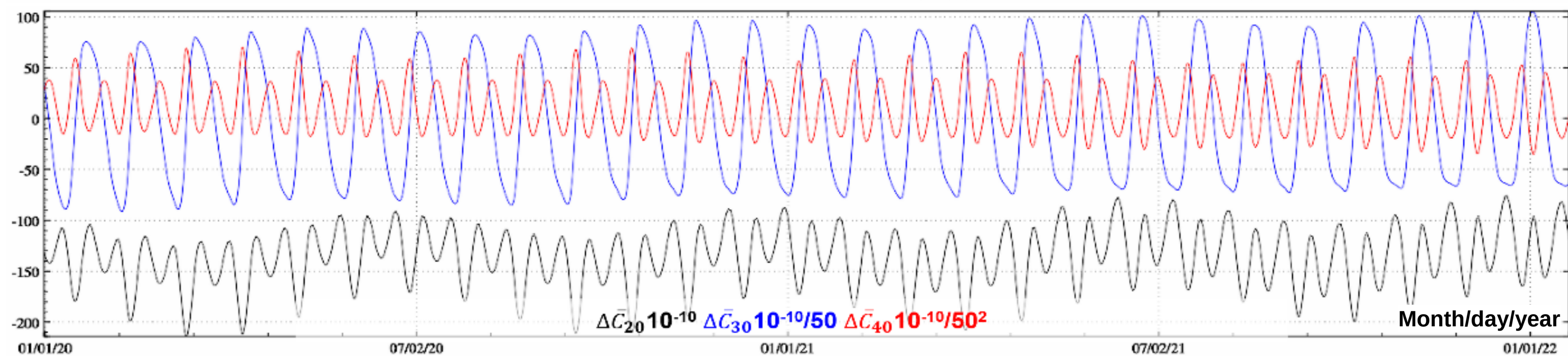
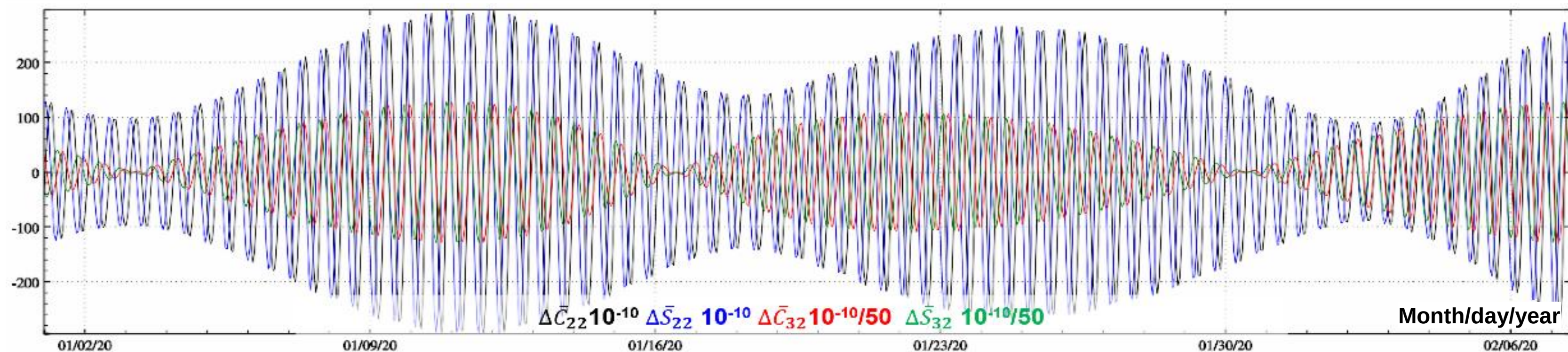
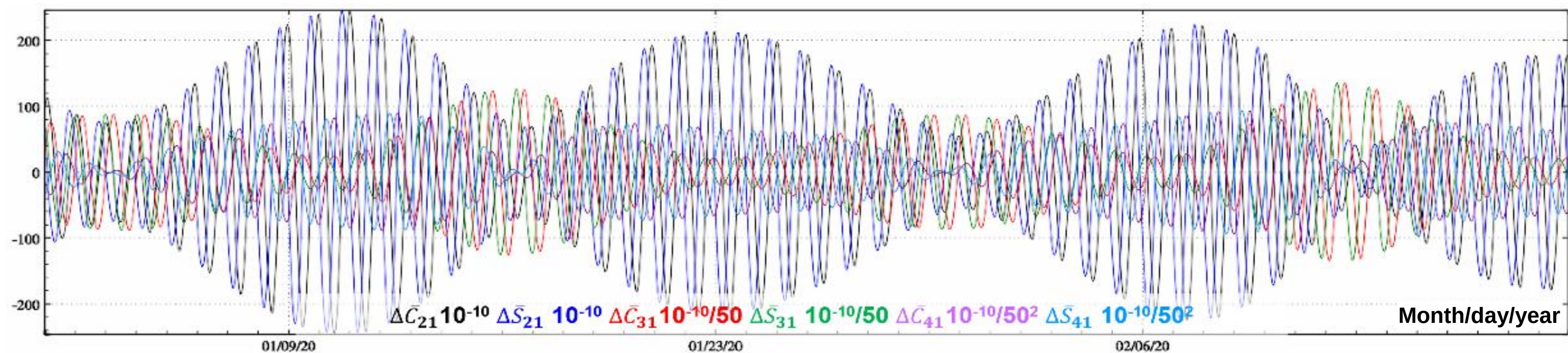
Degree-2 Earth's tidal potential (force) time series from Venus, Jupiter and Mars (12 years)



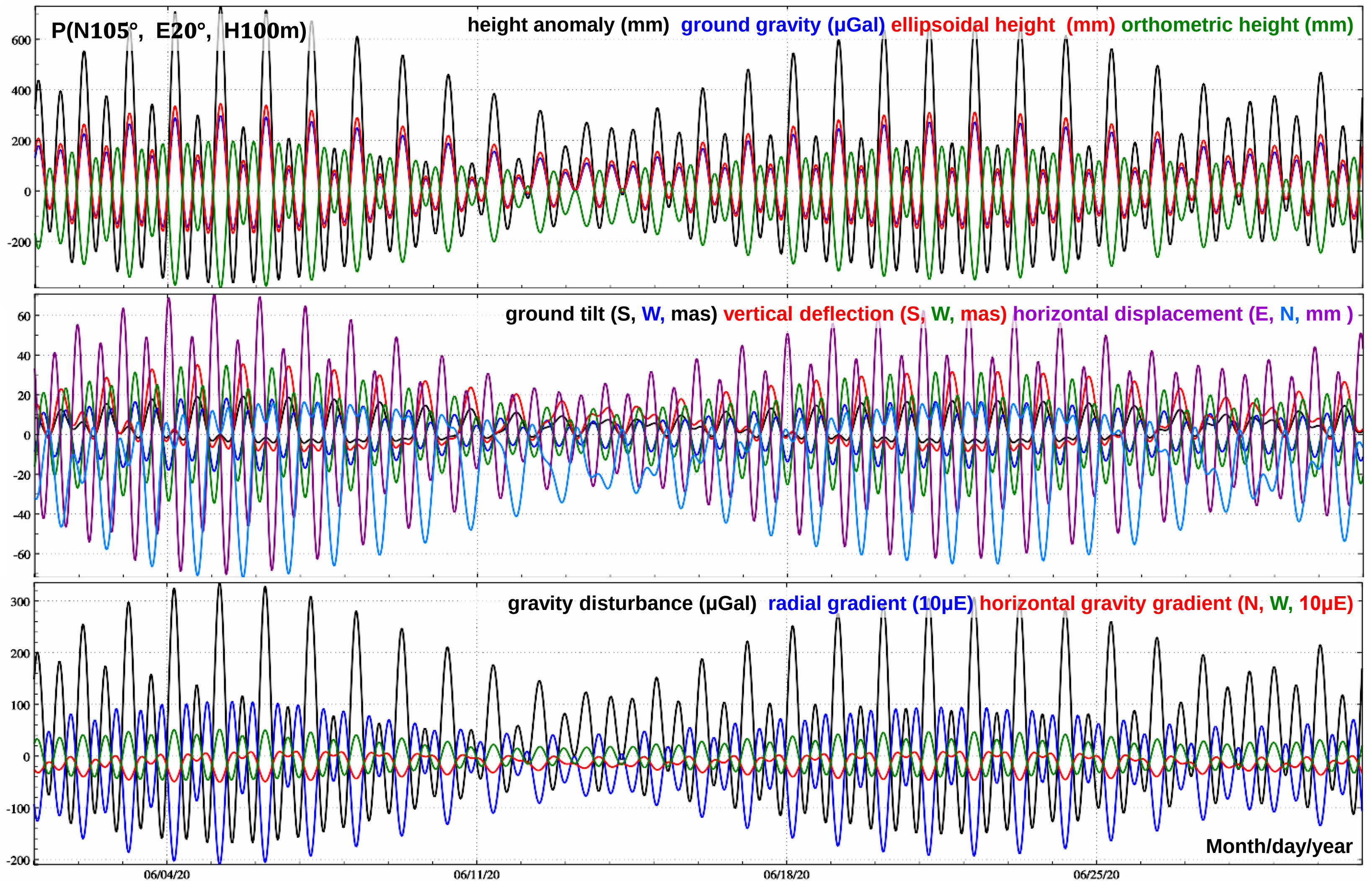


**Degree 3 Earth's tidal potential (force) time series from Moon and Sun (2 years)**



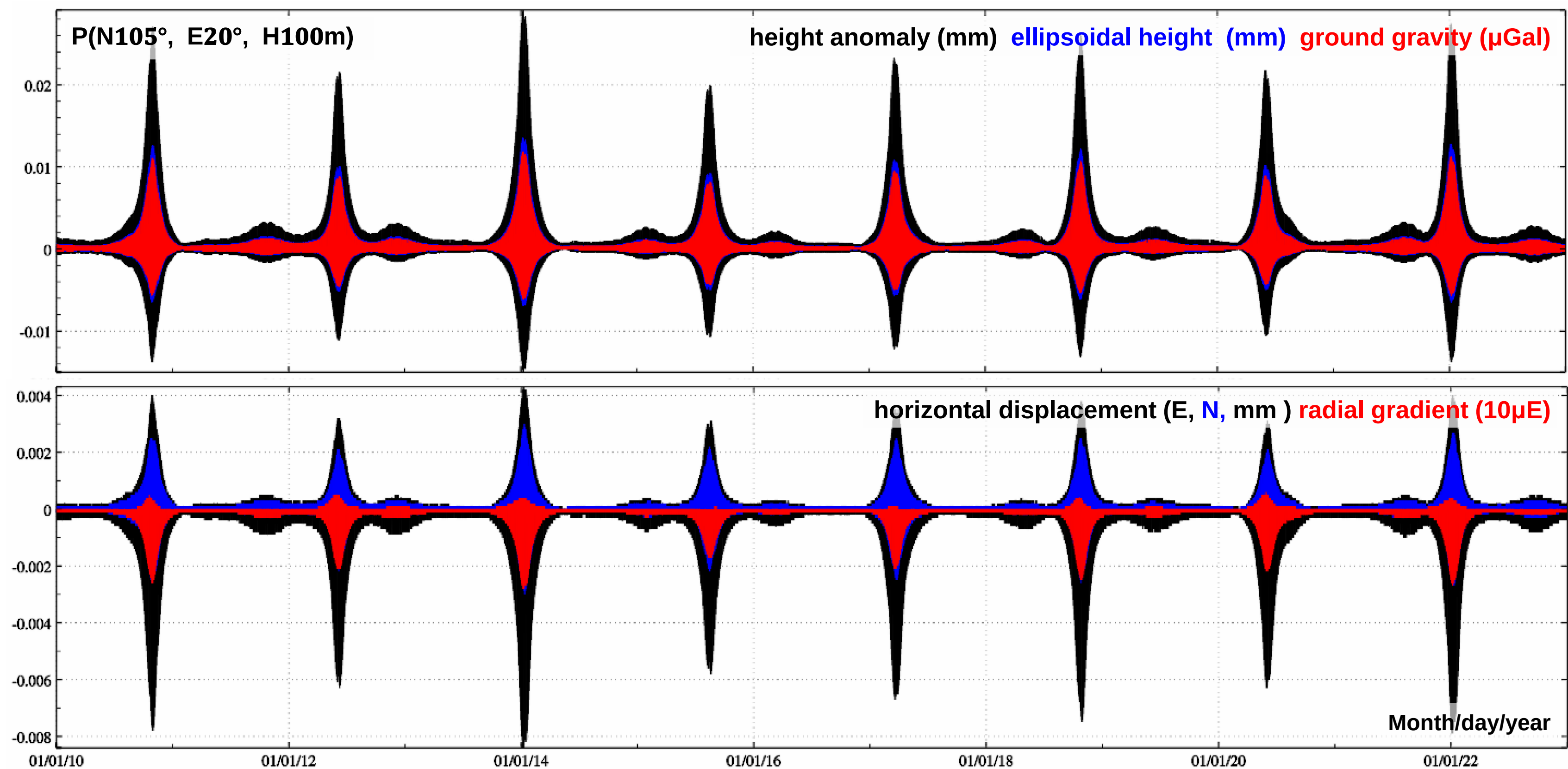






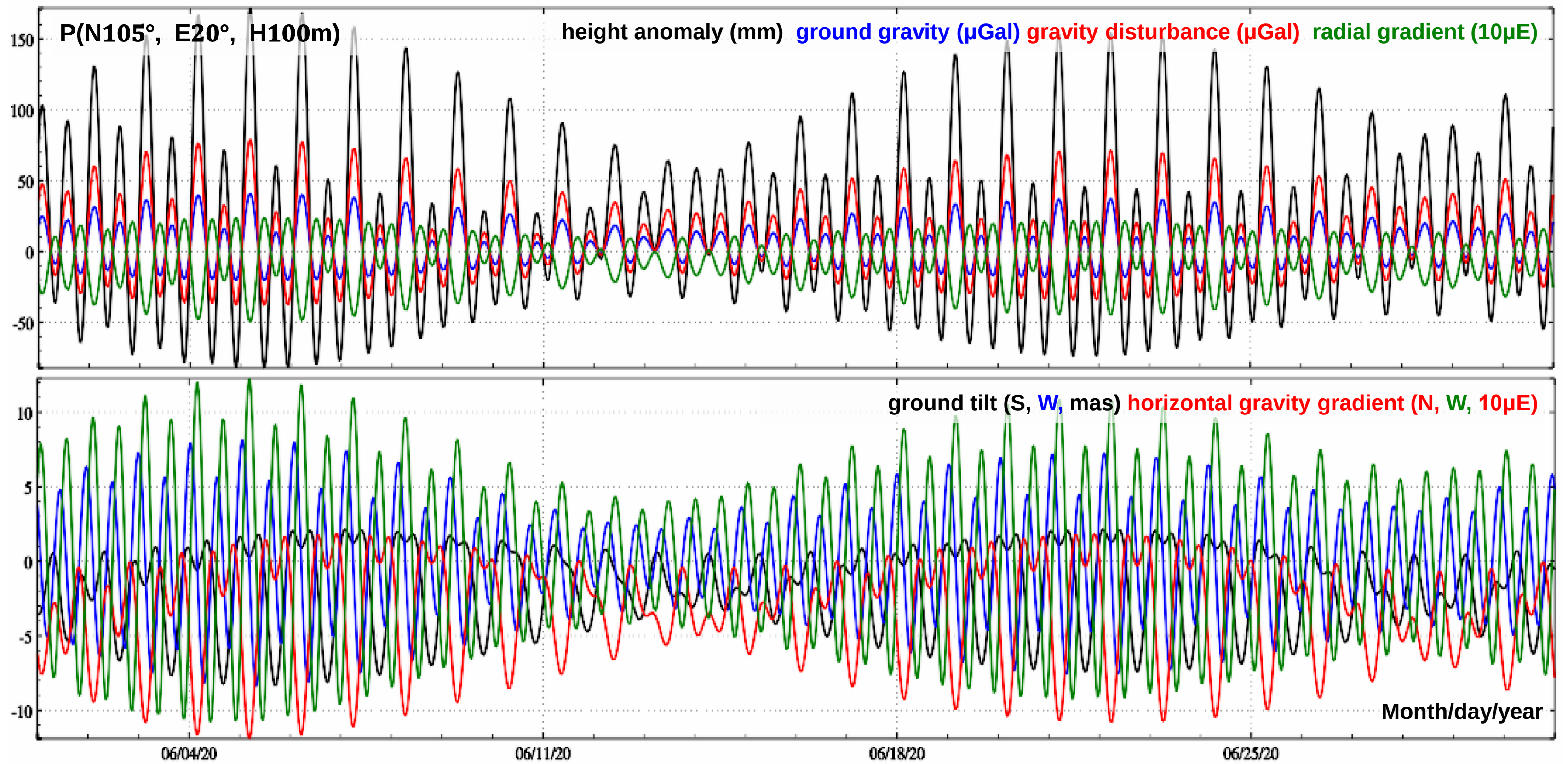
**Solid Earth tidal effect time series on various geodetic elements**





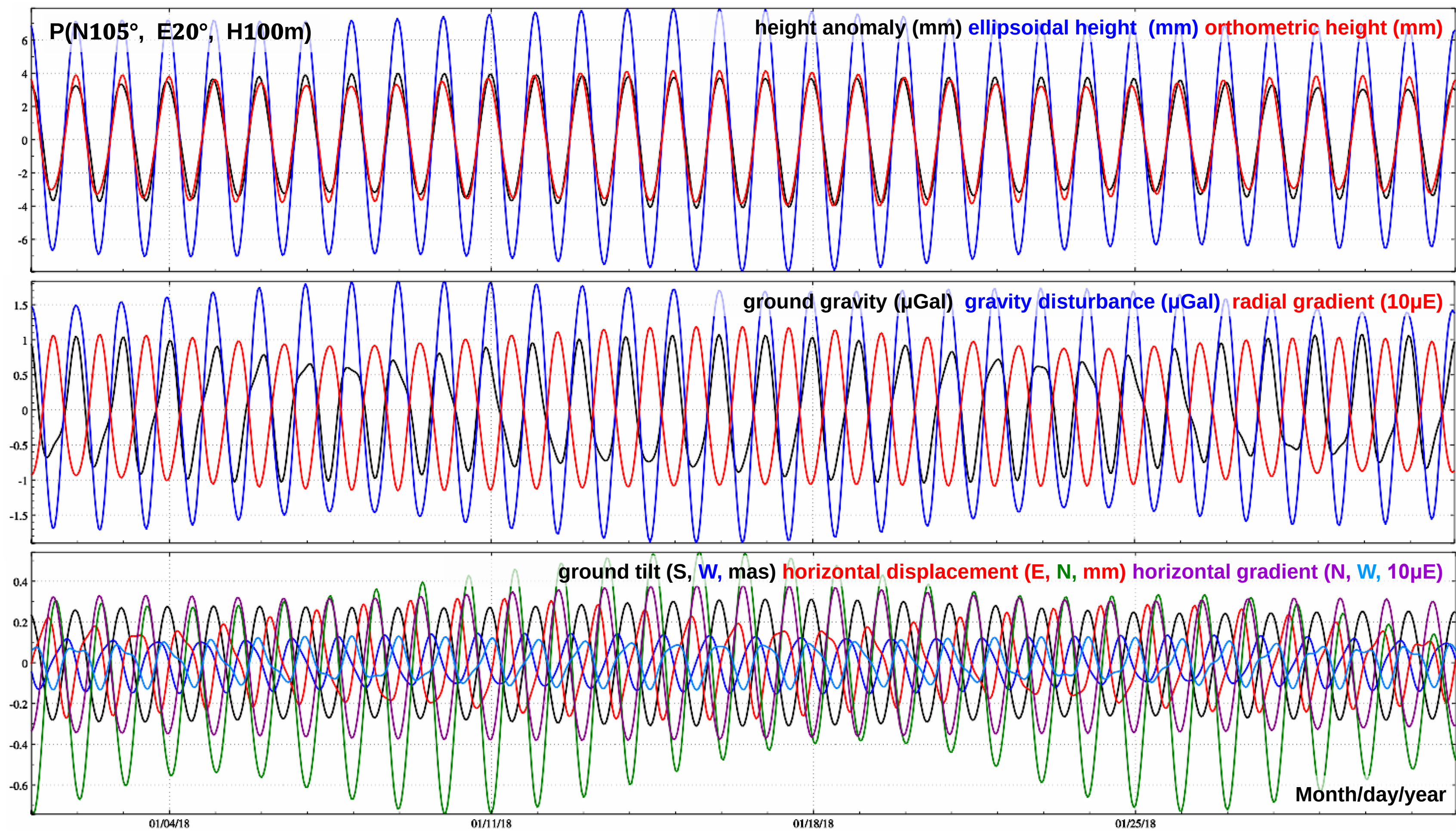
**Solid tidal effect time series from the planets outside Earth**





**The indirect influence time series of tidal potential to geodetic elements**





**Contributions of potential Love number frequency dependent corrections**



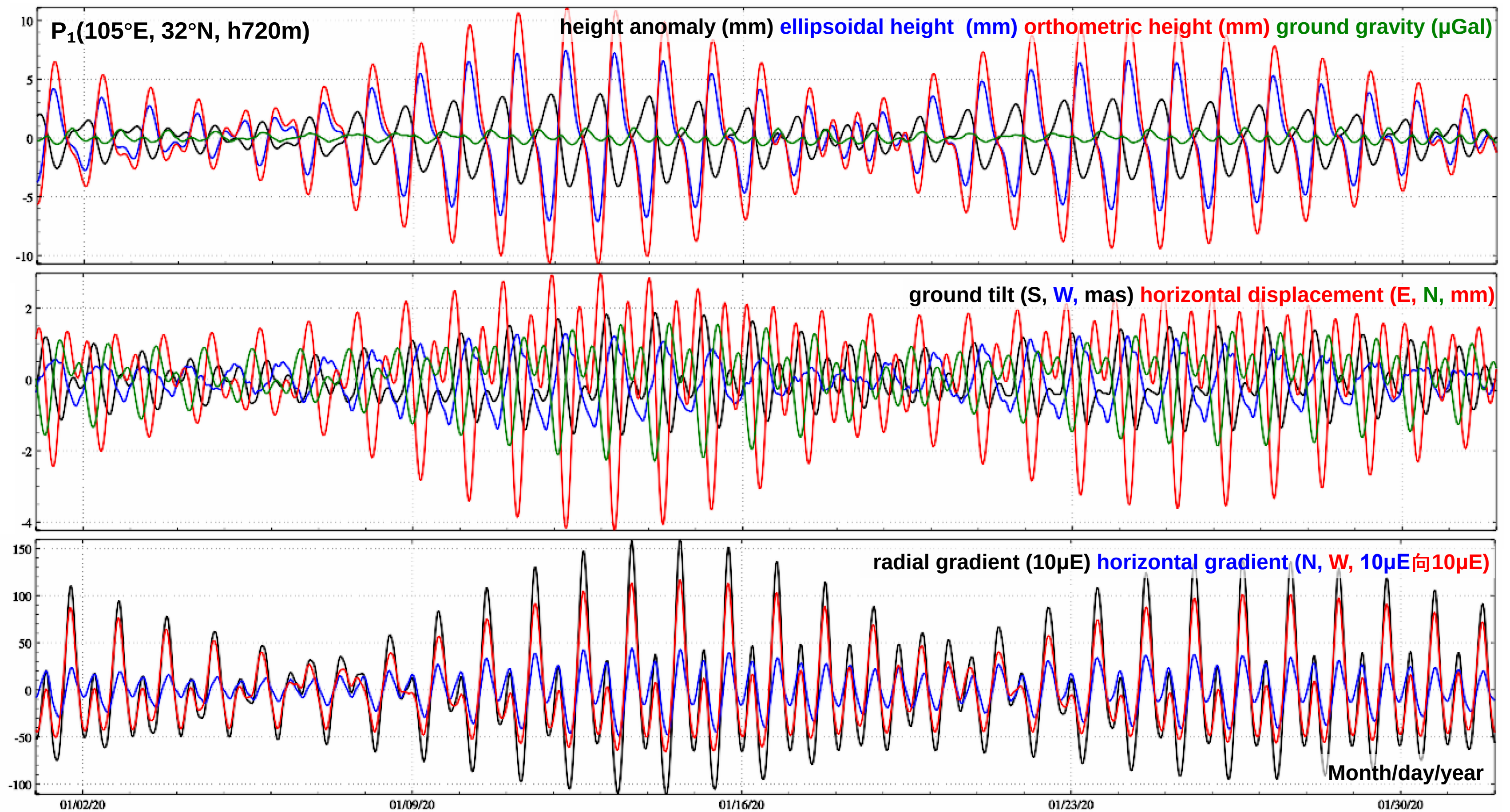
| airptideS1_cs.dat x proS1_.ini x Airtldloads.dat x Otideloadcs.dat x |                                                                                 |   |   |             |             |             |             |          |          |          |          |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------|---|---|-------------|-------------|-------------|-------------|----------|----------|----------|----------|
| 1                                                                    | Ocean tidal height load normalized spherical harmonic coefficient model in cm.  |   |   |             |             |             |             |          |          |          |          |
| 2                                                                    | Created by ETideLoad, ZHANG Chuanyin, Chinese Academy of Surveying and Mapping. |   |   |             |             |             |             |          |          |          |          |
| 3                                                                    | Doodson name                                                                    | n | m | Csin+       | Ccos+       | Csin-       | Ccos-       | C+       | eps+     | C-       | eps-     |
| 4                                                                    | 247.455 2N2                                                                     | 1 | 0 | 0.00458562  | 0.00231038  | 0.00458562  | 0.00231038  | 0.005135 | 63.2596  | 0.005135 | 63.2596  |
| 5                                                                    | 247.455 2N2                                                                     | 1 | 1 | -0.00773380 | 0.00473565  | 0.01063946  | -0.00152991 | 0.009069 | 301.4805 | 0.010749 | 98.1828  |
| 6                                                                    | 247.455 2N2                                                                     | 2 | 0 | 0.01415077  | -0.00470716 | 0.01415077  | -0.00470716 | 0.014913 | 108.3994 | 0.014913 | 108.3994 |
| 7                                                                    | 247.455 2N2                                                                     | 2 | 1 | -0.01749377 | 0.01964053  | -0.02057617 | 0.01244109  | 0.026302 | 318.3086 | 0.024045 | 301.1587 |
| 8                                                                    | 247.455 2N2                                                                     | 2 | 2 | -0.05076973 | 0.15409810  | 0.03408330  | -0.00708020 | 0.162246 | 341.7648 | 0.034811 | 101.7353 |
| 9                                                                    | 247.455 2N2                                                                     | 3 | 0 | -0.00345932 | -0.05402235 | -0.00345932 | -0.05402235 | 0.054133 | 183.6639 | 0.054133 | 183.6639 |
| 10                                                                   | 247.455 2N2                                                                     | 3 | 1 | 0.00459468  | 0.02860553  | 0.08674509  | 0.04125120  | 0.028972 | 9.1250   | 0.096054 | 64.5668  |
| 11                                                                   | 247.455 2N2                                                                     | 3 | 2 | -0.01359111 | -0.04803085 | 0.00043095  | 0.01917460  | 0.049917 | 195.7997 | 0.019179 | 1.2875   |
| 12                                                                   | 247.455 2N2                                                                     | 3 | 3 | 0.11576000  | 0.04745531  | 0.10043379  | -0.03897379 | 0.125109 | 67.7090  | 0.107731 | 111.2090 |
| 13                                                                   | 247.455 2N2                                                                     | 4 | 0 | -0.04607076 | 0.02579335  | -0.04607076 | 0.02579335  | 0.052800 | 299.2429 | 0.052800 | 299.2429 |
| 14                                                                   | 247.455 2N2                                                                     | 4 | 1 | 0.03322584  | 0.01467790  | 0.01394749  | 0.02945707  | 0.036324 | 66.1660  | 0.032592 | 25.3369  |
| 15                                                                   | 247.455 2N2                                                                     | 4 | 2 | 0.06616682  | -0.16308472 | 0.08023800  | 0.03608357  | 0.175996 | 157.9166 | 0.087978 | 65.7862  |
| 16                                                                   | 247.455 2N2                                                                     | 4 | 3 | -0.04323293 | -0.08712246 | -0.08031745 | 0.08908738  | 0.097259 | 206.3921 | 0.119948 | 317.9635 |
| 17                                                                   | 247.455 2N2                                                                     | 4 | 4 | -0.07108370 | 0.11911427  | -0.03283587 | 0.04029420  | 0.138712 | 329.1726 | 0.051979 | 320.8233 |
| 18                                                                   | 247.455 2N2                                                                     | 5 | 0 | 0.00423674  | 0.05025371  | 0.00423674  | 0.05025371  | 0.050432 | 4.8190   | 0.050432 | 4.8190   |

## Ocean tidal load spherical harmonic coefficient model FES2014b720cs.dat

| ECMWF2006.dat x |                                                                                    |   |   |             |             |             |             |          |          |          |          |
|-----------------|------------------------------------------------------------------------------------|---|---|-------------|-------------|-------------|-------------|----------|----------|----------|----------|
| 1               | Atmospheric tide normalized spherical harmonic coefficients model in hPa.          |   |   |             |             |             |             |          |          |          |          |
| 2               | Created by ETideLoad4.0, ZHANG Chuanyin, Chinese academy of surveying and mapping. |   |   |             |             |             |             |          |          |          |          |
| 3               | Doodson name                                                                       | n | m | Csin+       | Ccos+       | Csin-       | Ccos-       | C+       | eps+     | C-       | eps-     |
| 4               | 164.556 S1                                                                         | 1 | 0 | -0.01044031 | 0.00562801  | -0.01044031 | 0.00562801  | 0.011861 | 298.3276 | 0.011861 | 298.3276 |
| 5               | 164.556 S1                                                                         | 1 | 1 | -0.02015273 | -0.30983977 | -0.02700767 | 0.03081953  | 0.310494 | 183.7214 | 0.040979 | 318.7714 |
| 6               | 164.556 S1                                                                         | 2 | 0 | -0.00879779 | 0.02710081  | -0.00879779 | 0.02710081  | 0.028493 | 342.0149 | 0.028493 | 342.0149 |
| 7               | 164.556 S1                                                                         | 2 | 1 | -0.00268684 | -0.06100327 | -0.02133604 | 0.03900132  | 0.061062 | 182.5219 | 0.044456 | 331.3187 |
| 8               | 164.556 S1                                                                         | 2 | 2 | 0.04746907  | -0.07026009 | -0.05105739 | -0.01871012 | 0.084793 | 145.9563 | 0.054378 | 249.8745 |
| 9               | 164.556 S1                                                                         | 3 | 0 | 0.02425656  | 0.01222288  | 0.02425656  | 0.01222288  | 0.027162 | 63.2565  | 0.027162 | 63.2565  |
| 10              | 164.556 S1                                                                         | 3 | 1 | -0.00066157 | 0.08663528  | 0.01518488  | 0.03226590  | 0.086638 | 359.5625 | 0.035660 | 25.2025  |
| 11              | 164.556 S1                                                                         | 3 | 2 | 0.05673625  | -0.01538495 | 0.00624773  | -0.04261815 | 0.058785 | 105.1718 | 0.043074 | 171.6600 |
| 12              | 164.556 S1                                                                         | 3 | 3 | 0.01548229  | 0.03548483  | -0.06617883 | 0.00859431  | 0.038715 | 23.5720  | 0.066735 | 277.3993 |
| 13              | 164.556 S1                                                                         | 4 | 0 | 0.01955708  | -0.01828613 | 0.01955708  | -0.01828613 | 0.026774 | 133.0765 | 0.026774 | 133.0765 |
| 14              | 164.556 S1                                                                         | 4 | 1 | -0.01459852 | 0.00147989  | 0.03554801  | -0.00397062 | 0.014673 | 275.7885 | 0.035769 | 96.3734  |
| 15              | 164.556 S1                                                                         | 4 | 2 | 0.01936298  | 0.02790702  | 0.01483771  | -0.01816466 | 0.033967 | 34.7544  | 0.023454 | 140.7565 |
| 16              | 164.556 S1                                                                         | 4 | 3 | 0.05871492  | 0.05584845  | 0.02091051  | -0.06383148 | 0.081034 | 46.4333  | 0.067169 | 161.8618 |
| 17              | 164.556 S1                                                                         | 4 | 4 | 0.05072226  | -0.00992714 | -0.02941680 | 0.00989714  | 0.051685 | 101.0737 | 0.031037 | 288.5953 |
| 18              | 164.556 S1                                                                         | 5 | 0 | 0.00534727  | -0.01557997 | 0.00534727  | -0.01557997 | 0.016472 | 161.0570 | 0.016472 | 161.0570 |

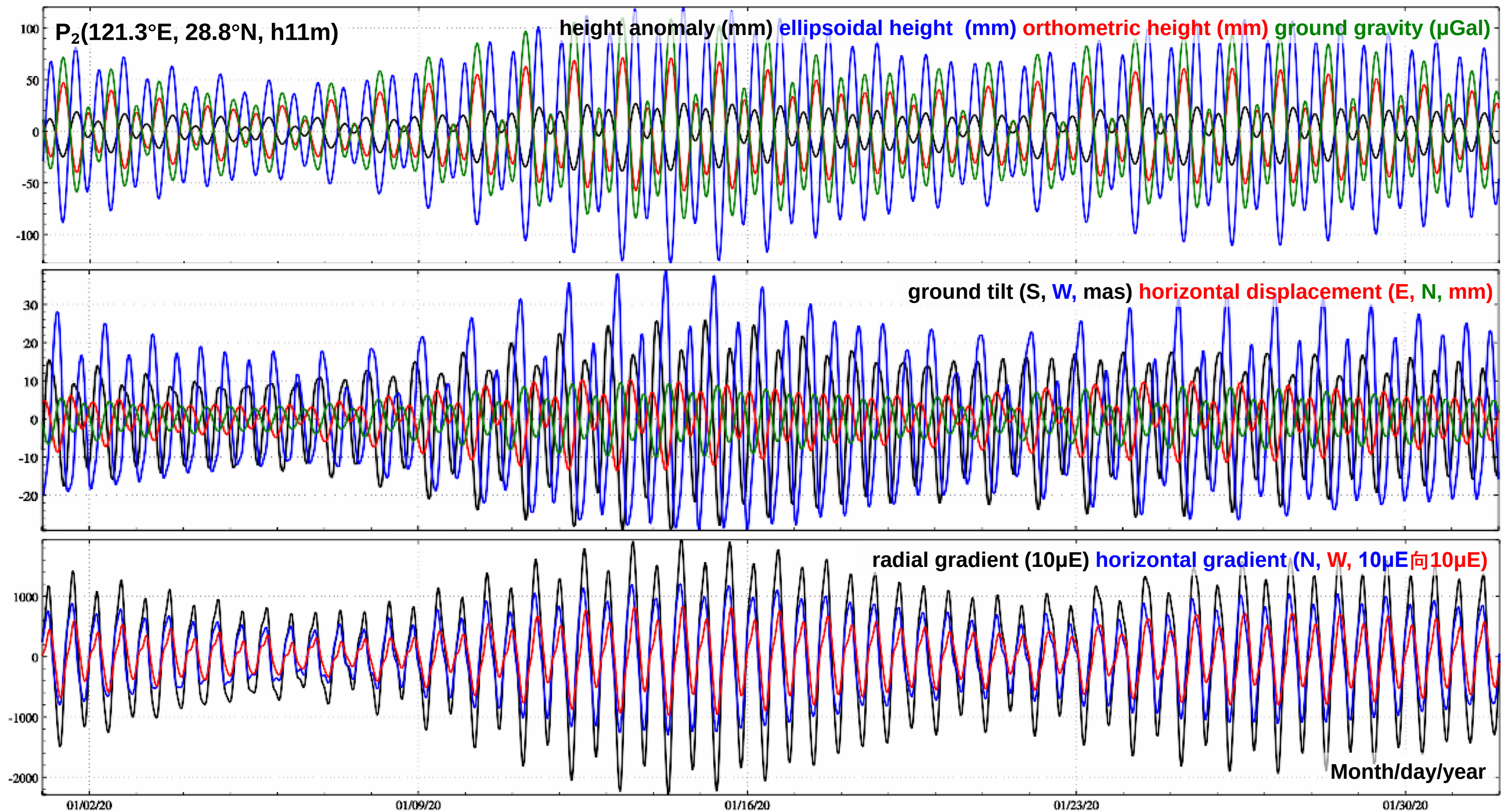
## Atmosphere tidal load spherical harmonic coefficient model ECMF2006cs360.dat





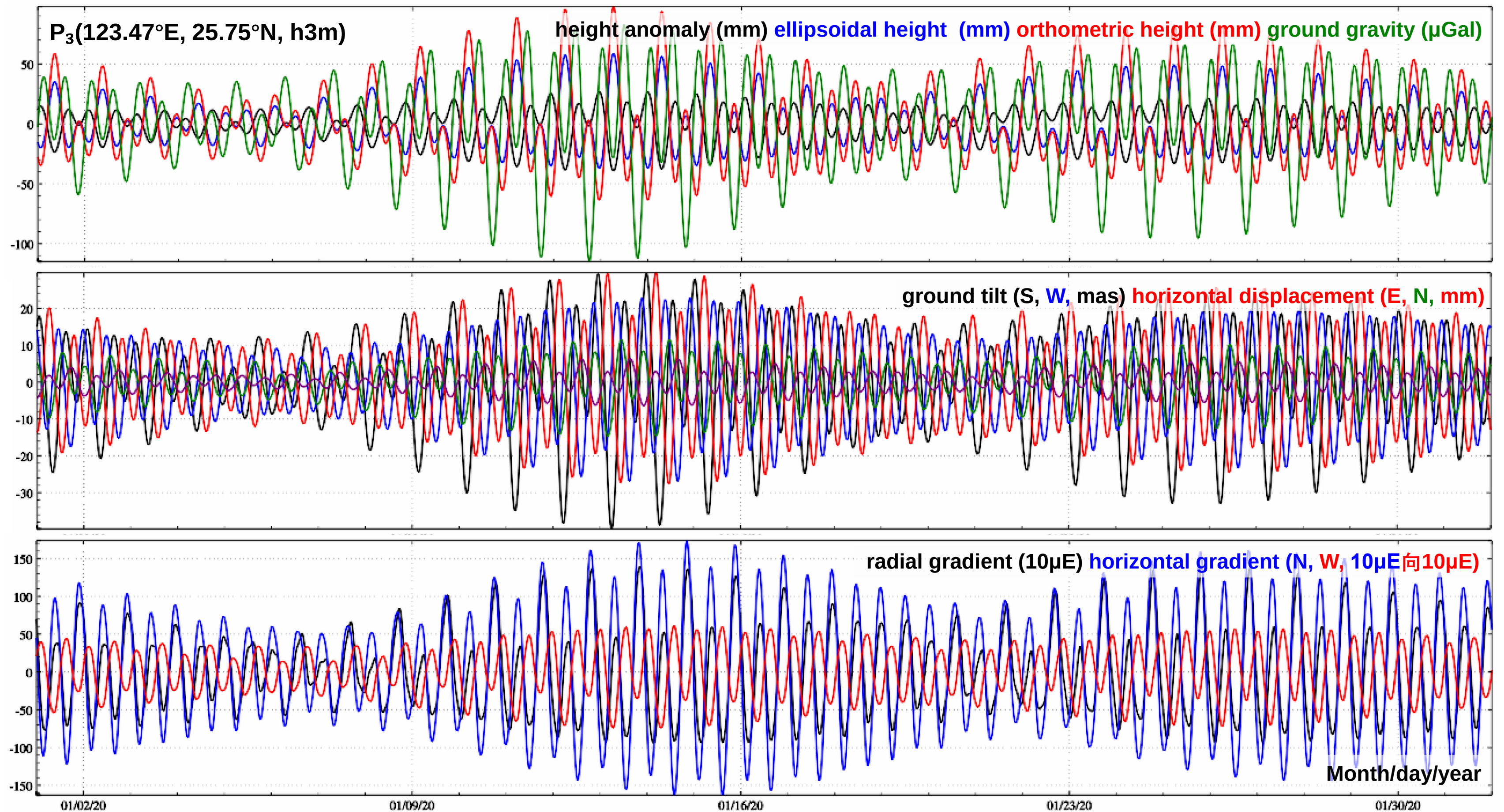
The ocean tidal load effect time series on various geodetic elements at P<sub>1</sub> point in the inland area 400km away from the coastline





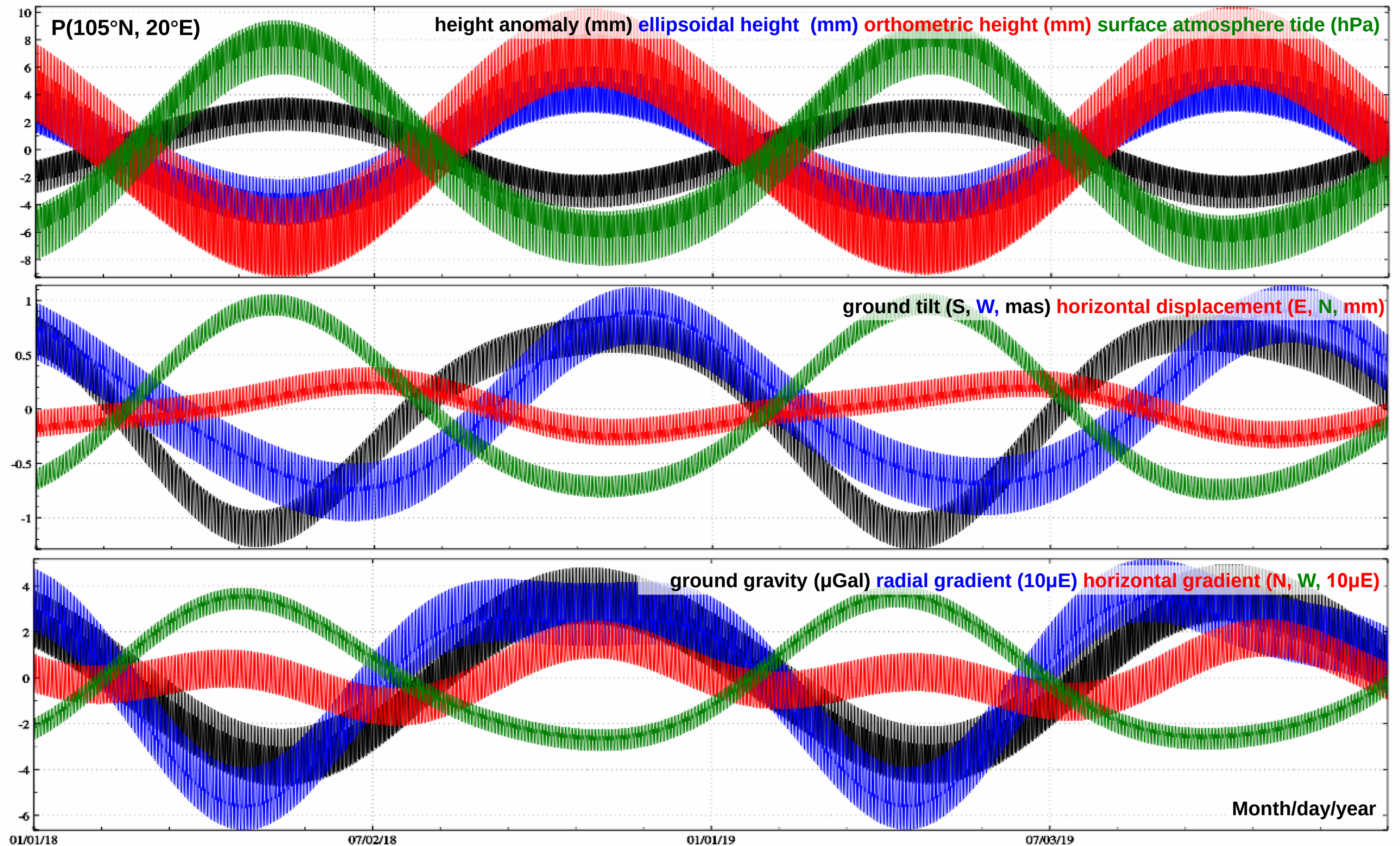
The ocean tidal load effect time series on various geodetic elements at P<sub>2</sub> point on the coastal zone





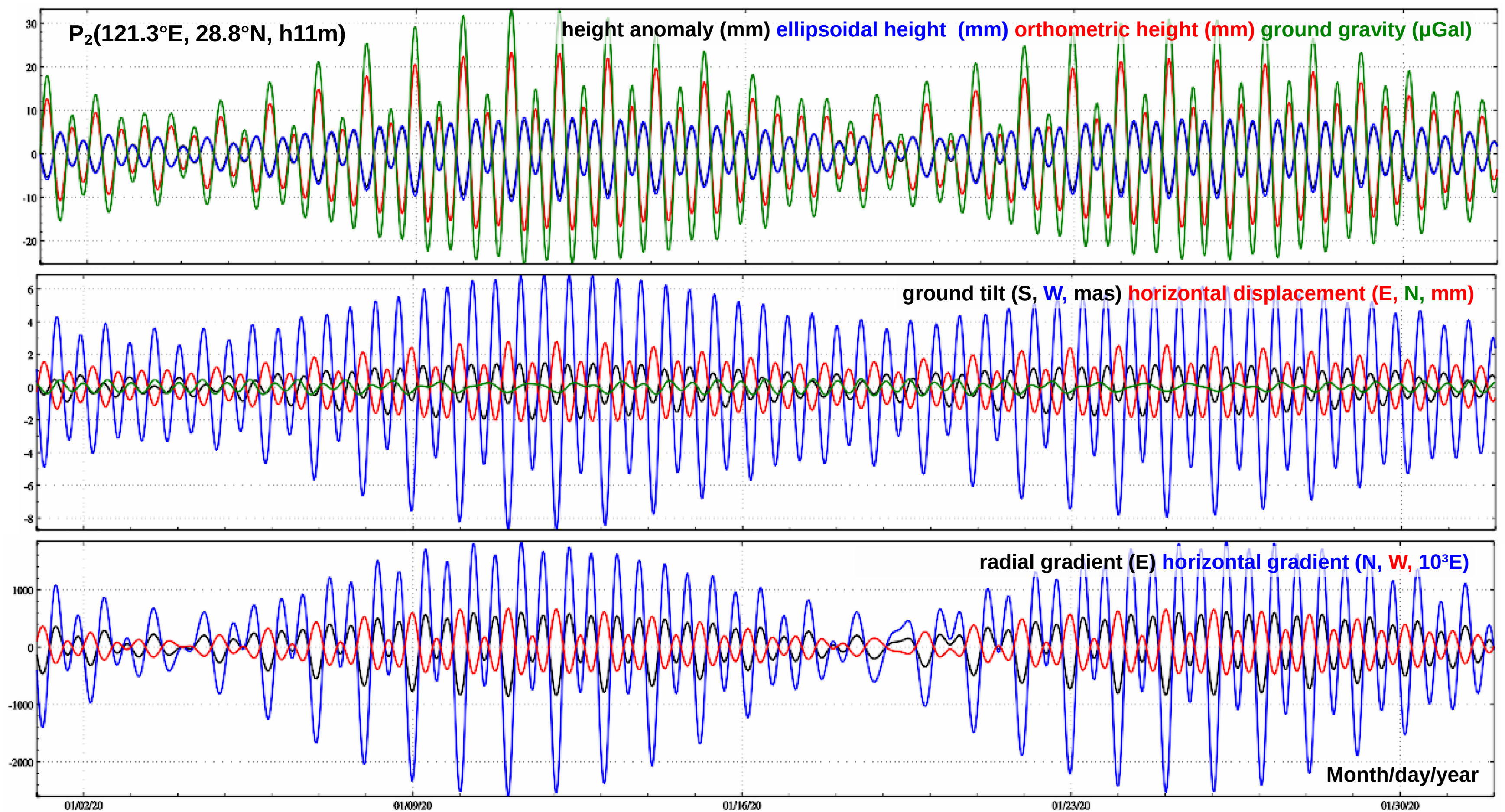
The ocean tidal load effect time series on various geodetic elements at P<sub>3</sub> point on offshore island 200km away from the coastline





The surface atmosphere tidal load effect time series on various geodetic elements

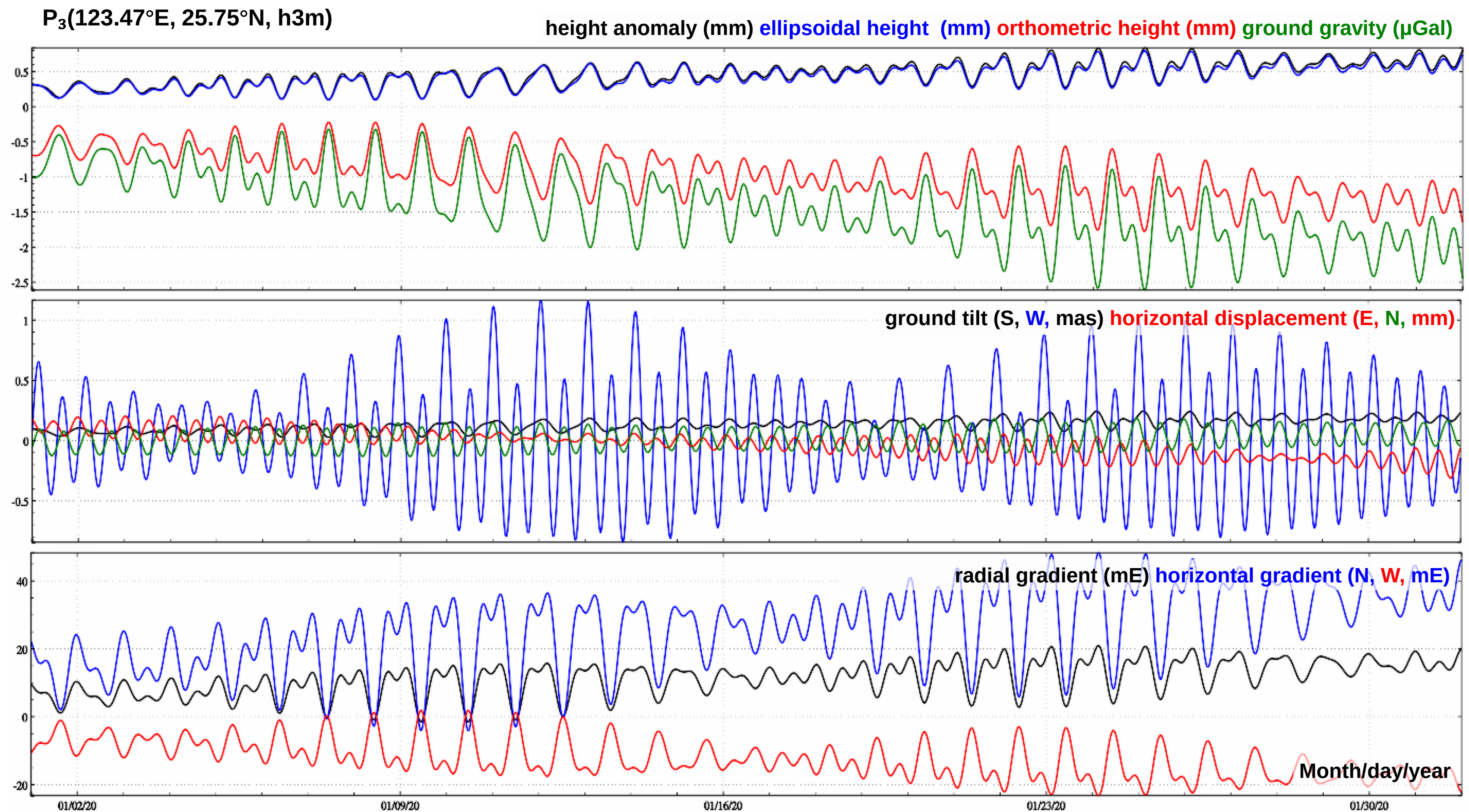




The residual time series of ocean tidal load effects (FES2014b720cs) on various geodetic elements at the P<sub>2</sub> in the coastal zone

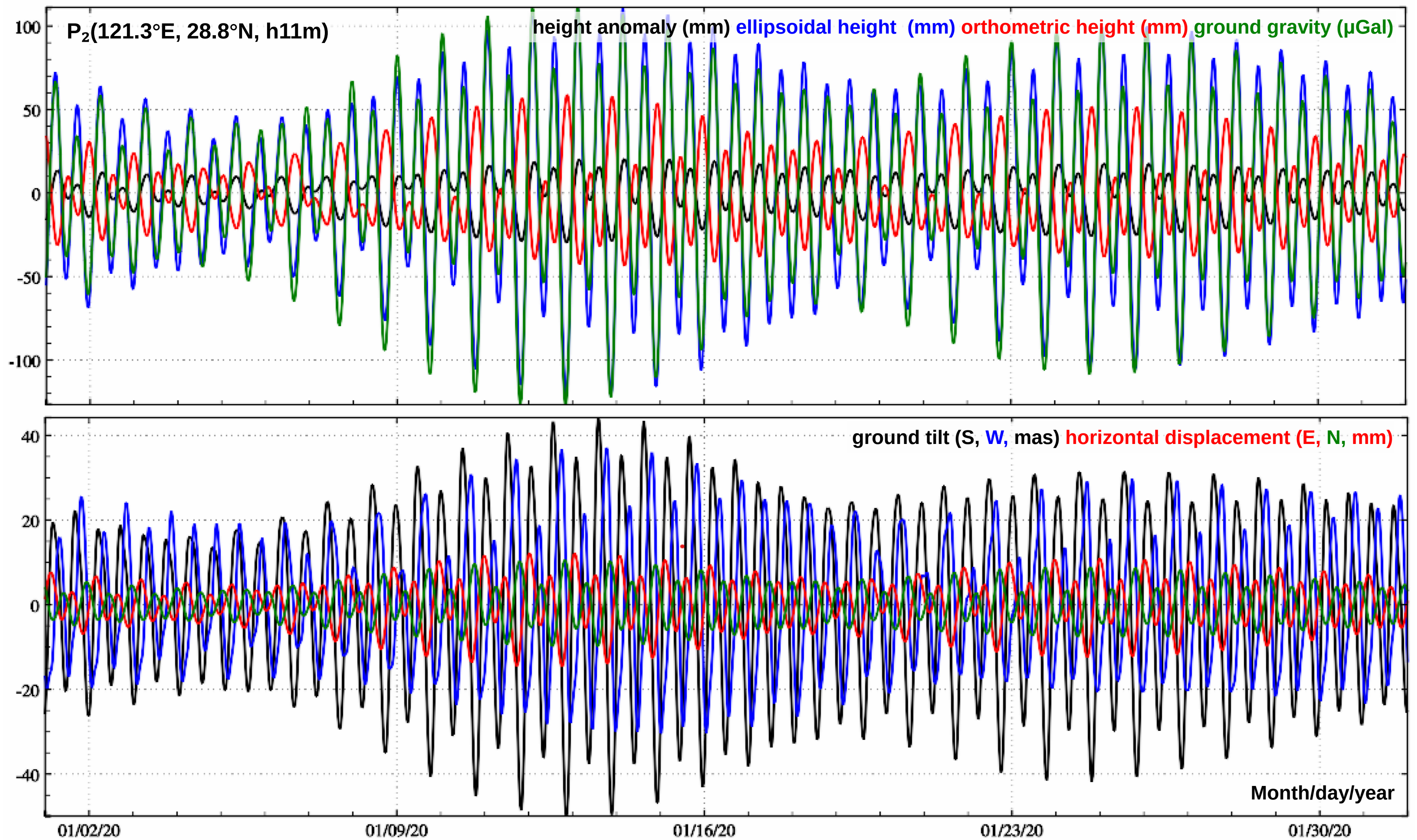
The ocean tidal load effects on gravity gradient are dominant in the ultrashort wave parts, and the high-degree ocean tidal load spherical harmonic coefficient model FES2014b720cs cannot contain these ultrashort wave signals in coastal areas. The calculation results of the residual load effects on gravity gradient are divergent and not available using load Green's function integral.





**The residual time series of ocean tidal load effects (FES2014b720cs) on various geodetic elements at the P<sub>3</sub> on the sea island 200km away from the coastline**





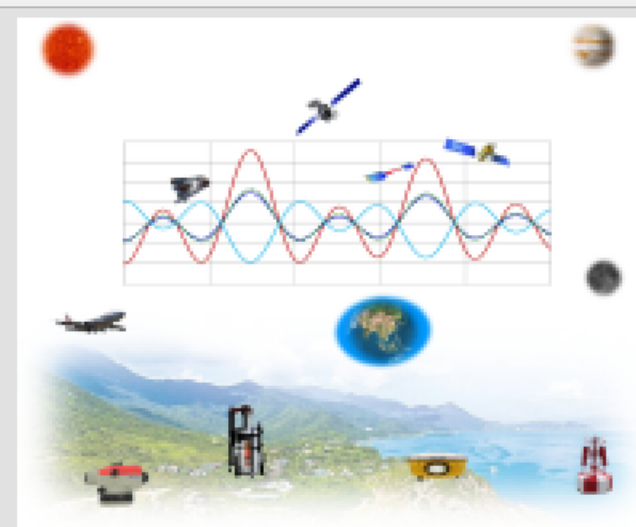
The refine value time series of ocean tidal load effects on various geodetic elements at the P<sub>2</sub> in the coastal zone (FES2014b720cs model + load Green's integral of residual)



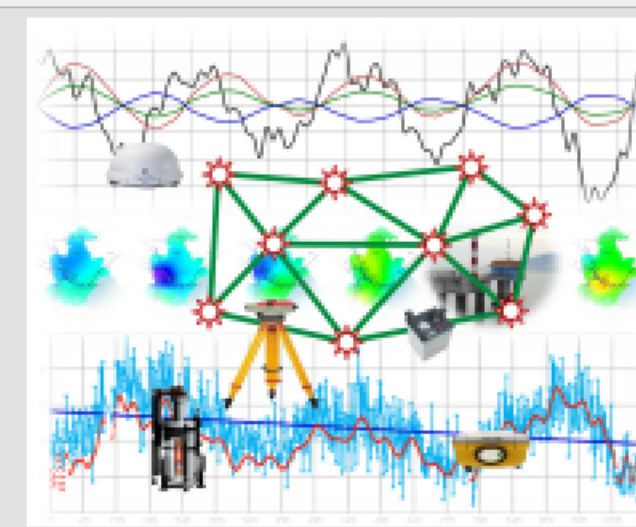


**Summary, parameter settings and visualization for ETideLoad4.5**

- Analytically compatible geodetic and geodynamic algorithm package using the numerical standards unified and geophysical models coordinated
- Compatible with and improving of IERS conversions, relevant geodetic concepts clarified, algorithm formulas derived and verified completely
- Uniform computation of solid tidal, load tidal, polar shift and mass centric variation effects on all-element geodetic variations in whole Earth space
- Analytical computation of surface load effects on all-element geodetic variations and collaborative monitoring of time-varying Earth gravity field
- Geodetic monitoring of the surface hydrological environment and ground stability variations and prediction of their spatio-temporal evolution

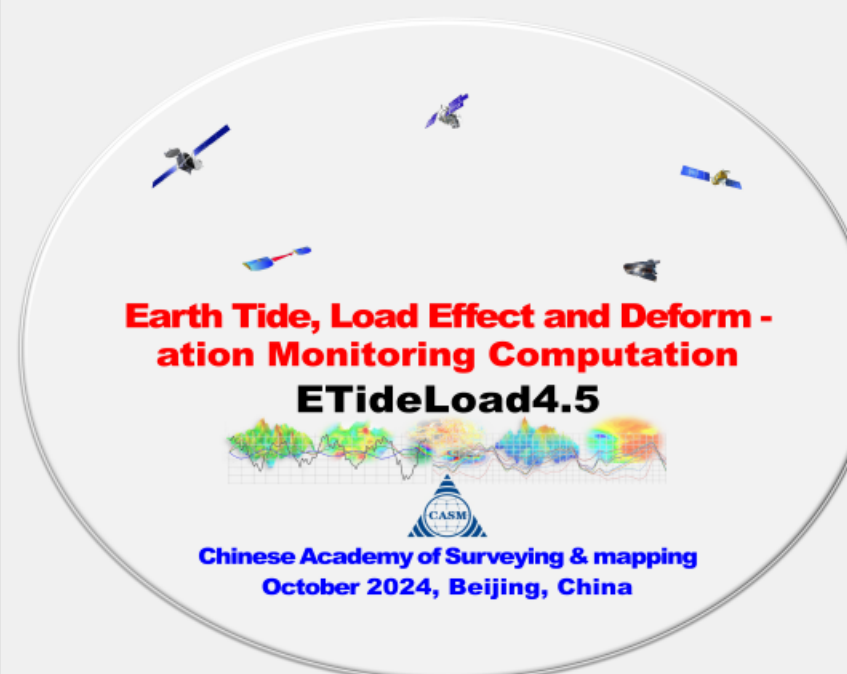


**Computation of various tidal effects on all-element geodetic variations**



**Processing and analysis on non-tidal geodetic variation time series**

[www.zcphygeodesy.com/en/](http://www.zcphygeodesy.com/en/)



**ETideLoad4.5 organization structure**

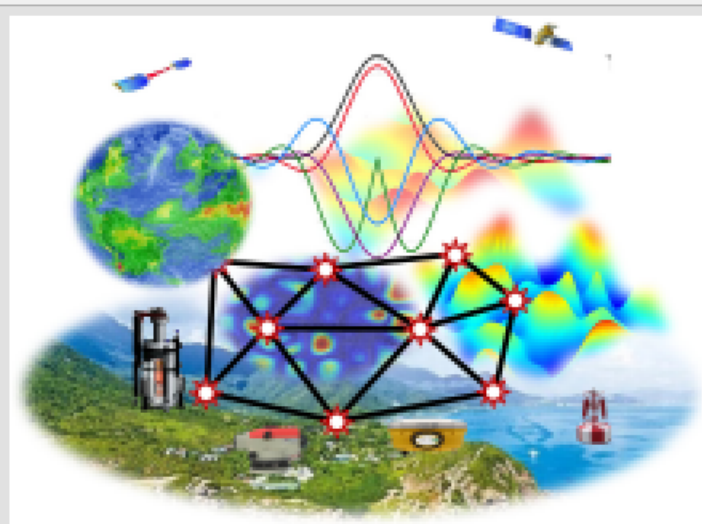
☆ Includes the basic principles, main formulas and important methods of geodesy on the deforming Earth to improve higher education environment.

☆ Can be employed to construct scientifically the technology environment for the deep fusion of multi-source heterogeneous earth data and collaborative monitoring of multiply heterogeneous geodetic system.

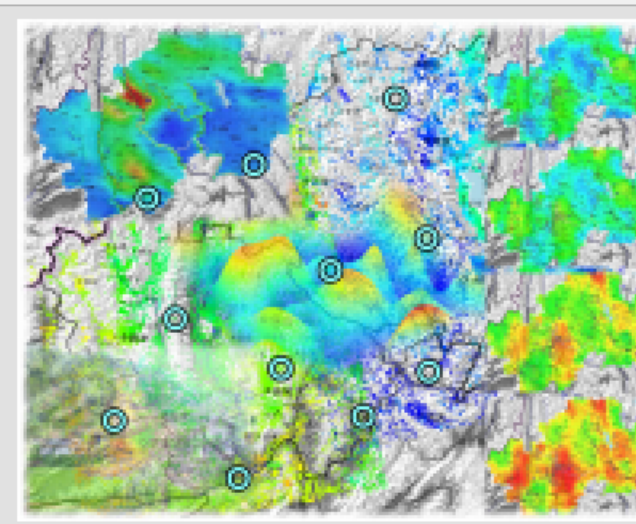
☆ There are the example files saved in the folder C:\ETideLoad4.5\_win64en\examples\ for each Win64 program. It will take about 7 working days to complete all the example exercises. Thereafter, you can use ETideLoad4.5 alone.

● Models and numerical standards

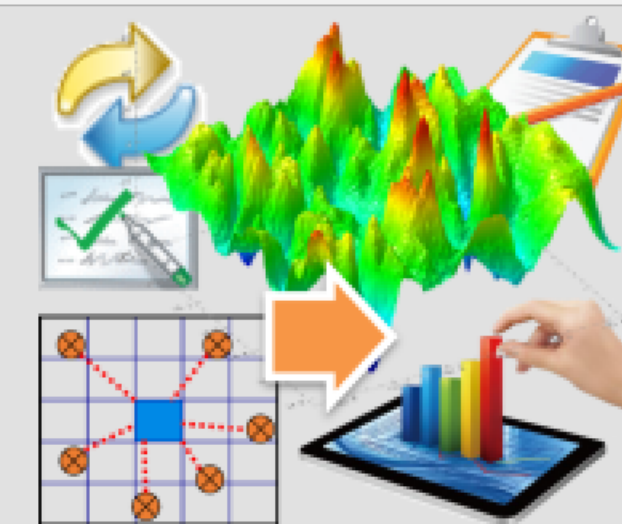
● Geodetic variations in ETideLoad



**Load deformation field approach and monitoring from heterogeneous variations**



**CORS/InSAR collaborative monitoring and ground stability estimation**



**Editing and calculation tools for geodetic data files**