

Description of Files Related to Using the EGM2008 Global Gravitational Model to Compute Geoid Undulations with Respect to WGS 84

(1) EGM2008_to2190_TideFree.gz

This file contains the fully-normalized, unit-less, spherical harmonic coefficients of the Earth's gravitational potential $\{\bar{C}_{nm}, \bar{S}_{nm}\}$ and their associated (calibrated) error standard deviations $\{\sigma\bar{C}_{nm}, \sigma\bar{S}_{nm}\}$, as implied by the EGM2008 model. The $\{\bar{C}_{nm}, \bar{S}_{nm}\}$ coefficients are consistent with the expression:

$$V(r, \theta, \lambda) = \frac{GM}{r} \left[1 + \sum_{n=2}^{N_{\max}} \left(\frac{a}{r} \right)^n \sum_{m=0}^n (\bar{C}_{nm} \cos m\lambda + \bar{S}_{nm} \sin m\lambda) \bar{P}_{nm}(\cos \theta) \right] \quad (1)$$

The scaling parameters $\{GM, a\}$ associated with this model have the numerical values:

$$\begin{aligned} GM &= 3986004.415 \times 10^8 \text{ m}^3 \text{ s}^{-2} \\ a &= 6378136.3 \text{ m} \end{aligned} \quad (2)$$

The EGM2008 model is complete to spherical harmonic degree and order 2159, and contains additional coefficients extending to degree 2190 and order 2159. The file contains **2401333** ASCII formatted records, each record containing:

$$\{n, m, \bar{C}_{nm}, \bar{S}_{nm}, \sigma\bar{C}_{nm}, \sigma\bar{S}_{nm}\} \rightarrow \{2i5, 2d25.15, 2d20.10\} \quad (3)$$

Missing and non-existent coefficients (*e.g.*, \bar{S}_{n0}) are written as zeros. The file can also be read with free format. In this file, the second degree zonal harmonic coefficient $\{\bar{C}_{20}\}$ is expressed in the “**Tide Free**” system, as far as the permanent tide is concerned.

(2) Zeta-to-N_to2160_egm2008.gz

This file contains fully-normalized spherical harmonic coefficients of ζ^* -to- N (Height_Anomaly-to-Geoid_Undulation) conversion term $\{\bar{C}\bar{C}_{nm}, \bar{C}\bar{S}_{nm}\}$ in units of **meters**. These ζ^* -to- N conversions are applied to EGM2008 height anomalies computed on the WGS 84 ellipsoid, to yield EGM2008 geoid undulations with respect to WGS 84. The $\{\bar{C}\bar{C}_{nm}, \bar{C}\bar{S}_{nm}\}$ coefficients are consistent with the series:

$$C(\theta, \lambda) = \sum_{n=0}^{N_{\max}} \sum_{m=0}^n (\bar{C}\bar{C}_{nm} \cos m\lambda + \bar{C}\bar{S}_{nm} \sin m\lambda) \cdot \bar{P}_{nm}(\cos \theta) \quad (4)$$

This model is complete to degree and order 2160. The file contains **2336041** ASCII formatted records, each record containing:

$$\{n, m, \bar{C}\bar{C}_{nm}, \bar{C}\bar{S}_{nm}\} \rightarrow \{2i5, 2d25.15\} \quad (5)$$

This file can also be read with free format. For geoid undulation computations, where the full resolution of EGM2008 is sought, we recommend the use of the EGM2008 gravitational model to degree **2190**, with the parallel use of this ζ^* -to- N conversion expansion to degree **2160**.

(3) **Und_min1x1_egm2008_isw=82_WGS84_TideFree.gz**

This file contains POINT values of geoid undulations with respect to WGS 84 in **meters**, on a 1'x1' global grid (equi-angular spacing in terms of WGS 84 geodetic coordinates), computed from **EGM2008** to degree 2190 and using the ζ^* -to- N conversion expansion to degree 2160. The file is global, and contains valid values for ALL 1'x1' cells, regardless whether they are located over land or over ocean. The geoid undulations refer to the “**Tide-Free**” system, as far as the Permanent Tide is concerned.

This file holds the 1'x1' geoid undulations in sequential, unformatted, binary format, with each geoid undulation stored as a single, REAL*4 value. Each record contains all of the geoid undulations for a single parallel band. Each geoid undulation is situated at the **corner** of its respective cell, such that the top-left value in the 1'x1' grid has a longitude of 0° East and a latitude of 90° North. The first record in the file contains the northern-most parallel, and the first value in each record is the western-most value for that parallel. Note that each 1'x1' value situated on the zero meridian appears only once, as the first value in its respective record, at a longitude of 0° East. These values are NOT repeated at the end of their respective records, at longitude of 360° East. As such, this file contains **10801 rows x 21600 columns** of geoid undulations.

This file was created on a SUN computer, which uses a **BIG ENDIAN** internal binary representation.

Global statistics (meters) for this file are:

Number of Values	233301600
Percentage of Area	100.000
Minimum Value	-106.910
Latitude of Minimum	4.683
Longitude of Minimum	78.767
Maximum Value	85.840
Latitude of Maximum	-8.400
Longitude of Maximum	147.367
Arithmetic Mean	-1.317
Area-Weighted Mean	-0.463
Arithmetic RMS	29.274
Area-Weighted RMS	30.596
Arithmetic S.Dev.	29.244
Area-Weighted S.Dev.	30.593

(4) **Und_min2.5x2.5_egm2008_isw=82_WGS84_TideFree.gz**

This file contains POINT values of geoid undulations with respect to WGS 84 in **meters**, on a 2.5'x2.5' global grid (equi-angular spacing in terms of WGS 84 geodetic coordinates), computed from **EGM2008** to degree 2190 and using the ζ^* -to- N conversion expansion to degree 2160. The file is global, and contains valid values for ALL 2.5'x2.5' cells, regardless whether they are located

over land or over ocean. The geoid undulations refer to the “**Tide-Free**” system, as far as the Permanent Tide is concerned.

This file holds the 2.5'x2.5' geoid undulations in sequential, unformatted, binary format, with each geoid undulation stored as a single, REAL*4 value. Each record contains all of the geoid undulations for a single parallel band. Each geoid undulation is situated at the **corner** of its respective cell, such that the top-left value in the 2.5'x2.5' grid has a longitude of 0° East and a latitude of 90° North. The first record in the file contains the northern-most parallel, and the first value in each record is the western-most value for that parallel. Note that each 2.5'x2.5' value situated on the zero meridian appears only once, as the first value in its respective record, at a longitude of 0° East. These values are NOT repeated at the end of their respective records, at longitude of 360° East. As such, this file contains **4321 rows x 8640 columns** of geoid undulations.

This file was created on a SUN computer, which uses a **BIG ENDIAN** internal binary representation.

Global statistics (meters) for this file are:

Number of Values	37333440
Percentage of Area	100.000
Minimum Value	-106.909
Latitude of Minimum	4.667
Longitude of Minimum	78.750
Maximum Value	85.824
Latitude of Maximum	-8.417
Longitude of Maximum	147.375
Arithmetic Mean	-1.318
Area-Weighted Mean	-0.463
Arithmetic RMS	29.273
Area-Weighted RMS	30.596
Arithmetic S.Dev.	29.244
Area-Weighted S.Dev.	30.593

File (1) to (4) above have all been compressed using the Unix “gzip” command.

(5) NPavlis&al_EGU2008.ppt

This file contains the PowerPoint presentation originally describing the development and evaluation of the EGM2008 gravitational model. This presentation was given at the 2008 European Geosciences Union General Assembly, held in Vienna, Austria, April 13-18, 2008.

(6) Citation

Please use the following citation when referencing the EGM2008 model:

Pavlis, N.K., S.A. Holmes, S.C. Kenyon, and J.K. Factor, *An Earth Gravitational Model to Degree 2160: EGM2008*, presented at the 2008 General Assembly of the European Geosciences Union, Vienna, Austria, April 13-18, 2008.