Colorado Detailed Geoid COLgeo2019

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Reduce

In the framework of the window remove-restore technique (Abd-Elmotaal and Kühtreiber, 1999, 2003), the reduced gravity anomalies Δg_{red} for the point data on land ($35^\circ \le \phi \le 40^\circ; -110^\circ \le \lambda \le -102^\circ$) can be computed by

$$\Delta g_{red} = \Delta g_F - \Delta g_{Tlwin} - \Delta g_{EIGEN-6C4}\Big|_{n=2}^{2190} + \Delta g_{wincoff}\Big|_{n=2}^{2190} \ . \qquad (1)$$

where Δg_{Tlwin} is the contribution of the topographic-isostatic masses within the fixed data window ($33^\circ \le \phi \le 42^\circ; -112^\circ \le \lambda \le -100^\circ$), $\Delta g_{EIGEN-6C4}$ is the contribution of the global reference model and $\Delta g_{wincoff}$ is the contribution of the dimensionless harmonic coefficients of the topographic-isostatic masses for the same fixed data window. The dimensionless harmonic coefficients of the topographic-isostatic masses for the same fixed data window for the ultra high degree ($N_{\max} = 2190$) have been computed using the rigorous expressions given first by Abd-Elmotaal and Kühtreiber (2015) and improved numerically by Abd-Elmotaal and Kühtreiber (2019).

Interpolate

The Kriging interpolation technique with zero Nugget effect takes place for the data window ($35^\circ \le \phi \le 40^\circ; -110^\circ \le \lambda \le -102^\circ$) on a 1' × 1' grid yielding the interpolated gridded reduced anomalies Δg_{red}^G.

Compute

The contribution of the reduced anomalies Δg_{red}^G to the geoid $N_{\Delta g}$ is determined using Stokes integral employing Meissl (1971) modified kernel, i.e.,

$$N_{\Delta g} = \frac{R}{4\pi\gamma}\iint_\sigma \Delta g_{red}^G S^{ME}(\psi)\, d\sigma \ , \qquad (4)$$

where

$$S^{ME}(\psi) = \begin{cases} S(\psi) - S(\psi_o) & \text{for} \quad 0 < \psi \le \psi_o \\ 0 & \text{for} \quad \psi > \psi_o \end{cases} \ , \qquad (5)$$

where ψ_o is the cap size. A value of ψ_o between 0.3º to 4º have been tested to choose the best cap size ψ_o that gives the best fitting to the GPS/leveling geoid. This test reveals that $\psi_o = 0.5^o$ is the best cap size value for Colorado geoid determination.

Restore

The full geoid restore expression for the window remove-restore technique reads

$$N = N_{\Delta g} + N_{Tlwin} + \zeta_{EIGEN-6C4}\Big|_{n=2}^{2190} - \zeta_{wincoff}\Big|_{n=2}^{2190} + (N-\zeta)\ , \qquad (6)$$

where N_{Tlwin} is the contribution of the topographic-isostatic masses for the data window and both $\zeta_{EIGEN-6C4}$ and $\zeta_{wincoff}$ gives the contribution of the used global reference field and the dimensionless harmonic coefficients of the topographic-isostatic masses for the fixed data window, respectively.

The term $(N-\zeta)$ is computed using the following expression

$$(N-\zeta) = \frac{H}{\bar{\gamma}}\left(\Delta g_{EIGEN-6C4}\Big|_{n=2}^{2190} - \Delta g_{wincoff}\Big|_{n=2}^{2190}\right), \qquad (7)$$

where the height *H* is given by the COLH19M05 (5′×5′) DTM.

Results and Deliverables

The geoid of Colorado COLgeo2019 is illustrated in Fig. 1. The values of the geoid range between -27.31 m and -13.12 m with an average of -19.99 m. The geoid solution is delivered on a 1' × 1' grid covering the full window ($35^\circ \le \phi \le 40^\circ; -110^\circ \le \lambda \le -102^\circ$). The geoid file name is COLgeo2019.dat. A high-resolution geoid image is provided in file COLgeo2019.emf.

The geoid values are computed at 223 stations for the purpose of geopotential computation. These values are provided in the file: gsvs17_IGS08_2017p4_geo_pot.xls.

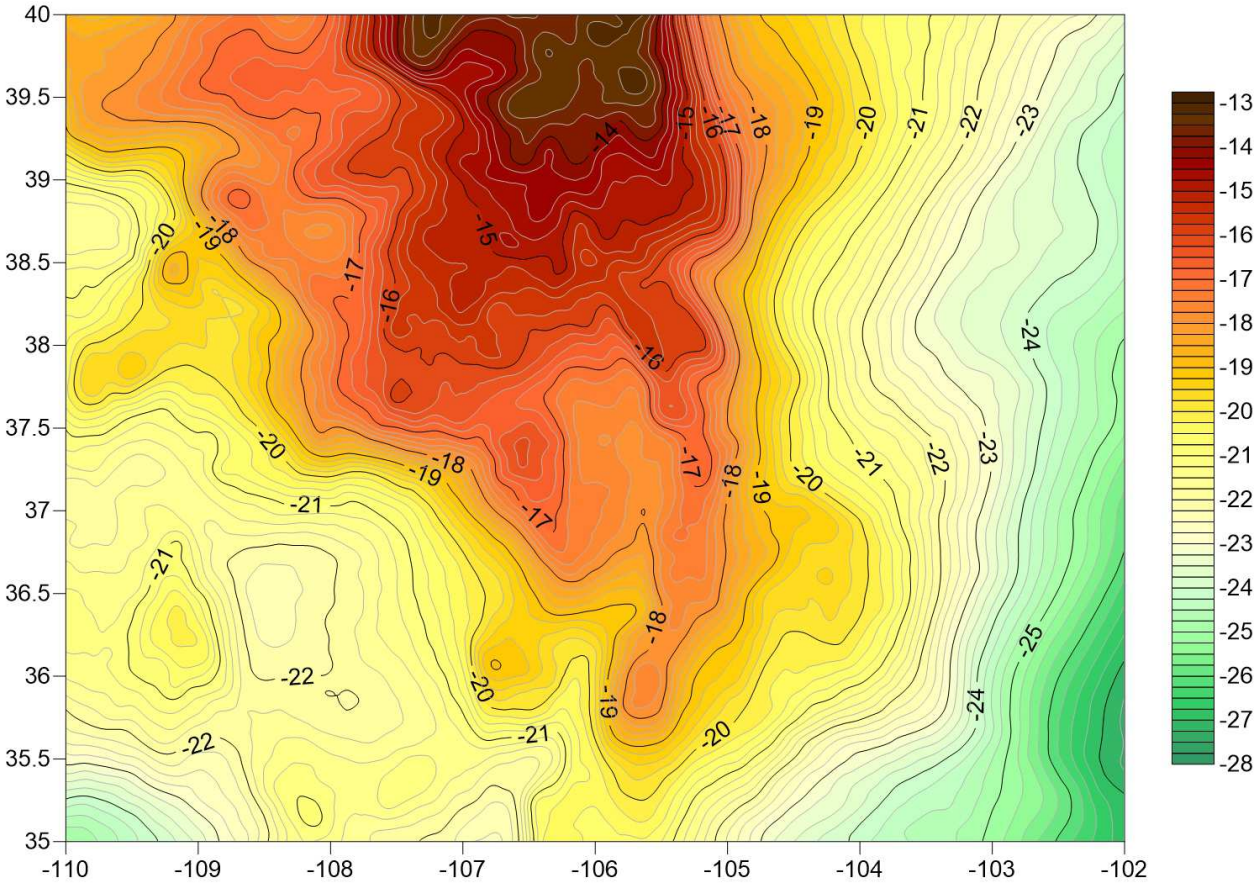

Fig. 1: The COLgeo2019 Colorado geoid model. Units in [m].

Comparison versus GPS/levelling geoid

The computed geoid COLgeo2019 has been compared versus 509 GPS stations with known orthometric height. The results are given in file: N_COLgeo2019-N_GPS.xls. The statistics of the differences between the COLgeo2019 geoid model and the GPS/levelling geoid are illustrated in Table 1.

Table 1: Statistics of the difference between COLgeo2019 model and the GPS/levelling geoid

	N-N_{GPS} [cm]
Number of values	509
Minimum	-17.4
Maximum	15.2
Range	32.6
Mean	0.00
Standard deviation	5.2

References

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