Colorado geoid computation - DTU Space Jan 4, 2019

Method (GRAVSOFT modules in capital letters):

Screen surface data for outliers … about 5 deleted (offsets of ~100 mGal). Correct for height-dependent atmosphere effects.

Remove-restore of XGM2016 to degree 360 by GEOCOL in 0.05 x 0.05° sandwich grid @ 0 and 4 km elevation, full 3D interpolation of XGM2016-effects, both for surface and airborne data (higher orders to be recovered by surface/airborne data)

RTM terrain reduction from DEM with 250 m resolution by prisms (TC) with a mean reference surface of 15' radius filtering, and a simple harmonic correction: $-4\pi G\rho(h-href)$ *for* $h < href$. Geoid restore signal both by prisms (TC), and FFT (TCFOUR), no significant difference found. Note that the terrain effects on airborne data filtered to match roughly the along-track filtering in airborne gravimetry.

Statistics of XGM2016/RTM reductions (mGal):

Unit: mGal	Number of pts	Mean	Std.dev.
Surface gravity data	59303	-10.16	28.57
Δg - XGM2016 to 360	-	-6.73	18.32
Δg - XGM2016 - RTM	-	-3.43	19.72
Airborne data (filtered)	25137	13.81	28.96
Δg - XGM2016 to 360	-	0.00	14.30
Δg - XGM2016 - RTM	-	0.01	11.34

Note: The magnitude of the surface gravity residuals are unusually large (typical statistics should be ~1 and ~10-15 mGal), likely a consequence of very rugged topography, RTM resolution, and possibly harmonic correction issues. There is a systematic bias between the DEM and the height of the gravity points at 5 m with a std.dev. of 25 m, so this can only explain ~1 mGal.

Two geoid versions done:

- Gridding of surface data only (GEOGRID, least_squares collocation) – *geoid1*
- Collocation downward continuation to terrain surface by blocked least-squares collocation (1° x 1° blocks with 0.5° border overlap) and gridding onto 1' x 1' grid – *geoid2.* Surface data averaged to 1'x1' cells and assigned to 1 mGal apriori error, airborne data thinned to 30 sec and assigned 2 mGal error, before the collocation process (GPCOL1).

Spherical FFT with modified Wong-Gore Stokes kernel, 3 bands, transition zone degrees 180-190, 100% zero padding (SPFOUR)

Restore quasigeoid RTM effects at altitude (sandwich grid interpolation) and obtain final quasigeoid ς in a 1´x 1´ grid.

Produce grid *N-ς* by use of 1´x1´ Bouguer anomaly grid (GCOMB) and obtain final geoid heights in GRS80 reference system, and compare to GPS-levelling data in central region (inside 1° border).

Interpolate quasigeoid values at GSVS17 calibration line points, and compute potential values in the 2016 global IHRS vertical datum (ad-hoc W0 program).

Statistics of geoid comparisons (NOAA solution from email Sep 3, 2018)

Unit: m	Number of pts	Mean	Std.dev.
Geoid 1: Older BM GPS-lev data	194	-0.633	0.050
NOAA GSVS17 solution	223	0.206	0.027
Geoid2: Older BM GPS-lev data	194	-0.637	0.052
NOAA GSVS17 solution	223	0.199	0.025

Attached grids are in GRAVSOFT format (rowwise from N to S, cells centered at 1' cells, i.e. grid consists of 301 x 481 points), and are in GRS datum.

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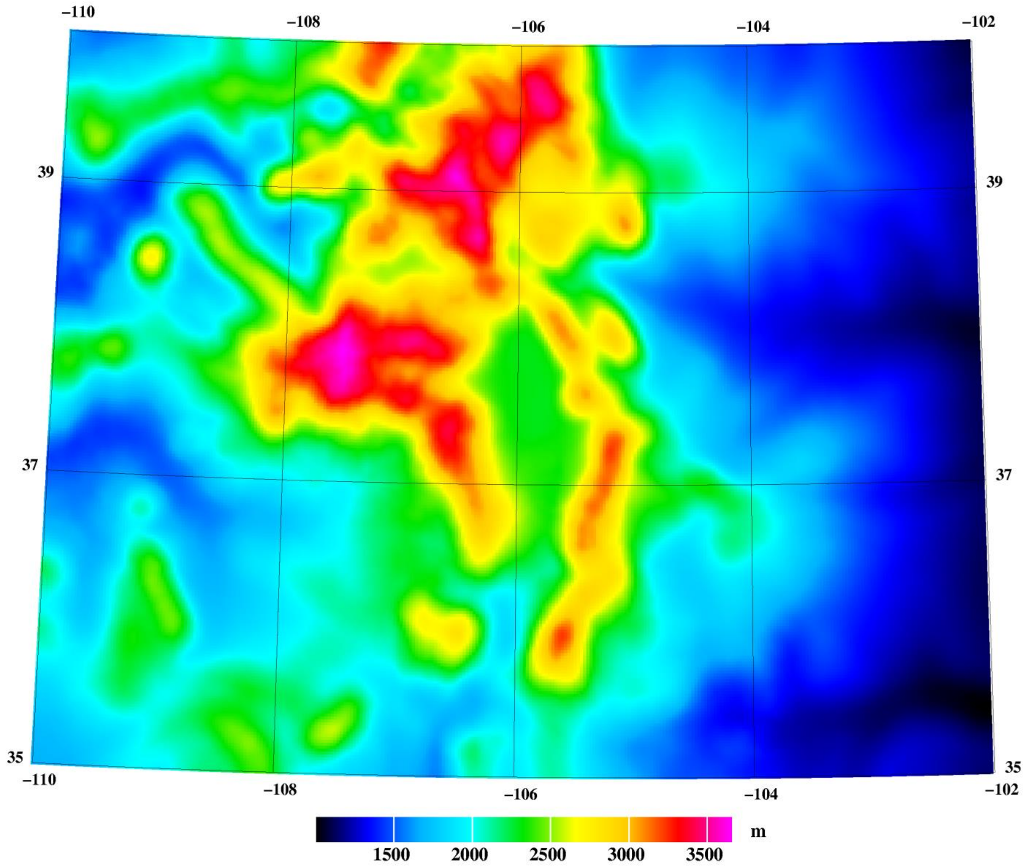
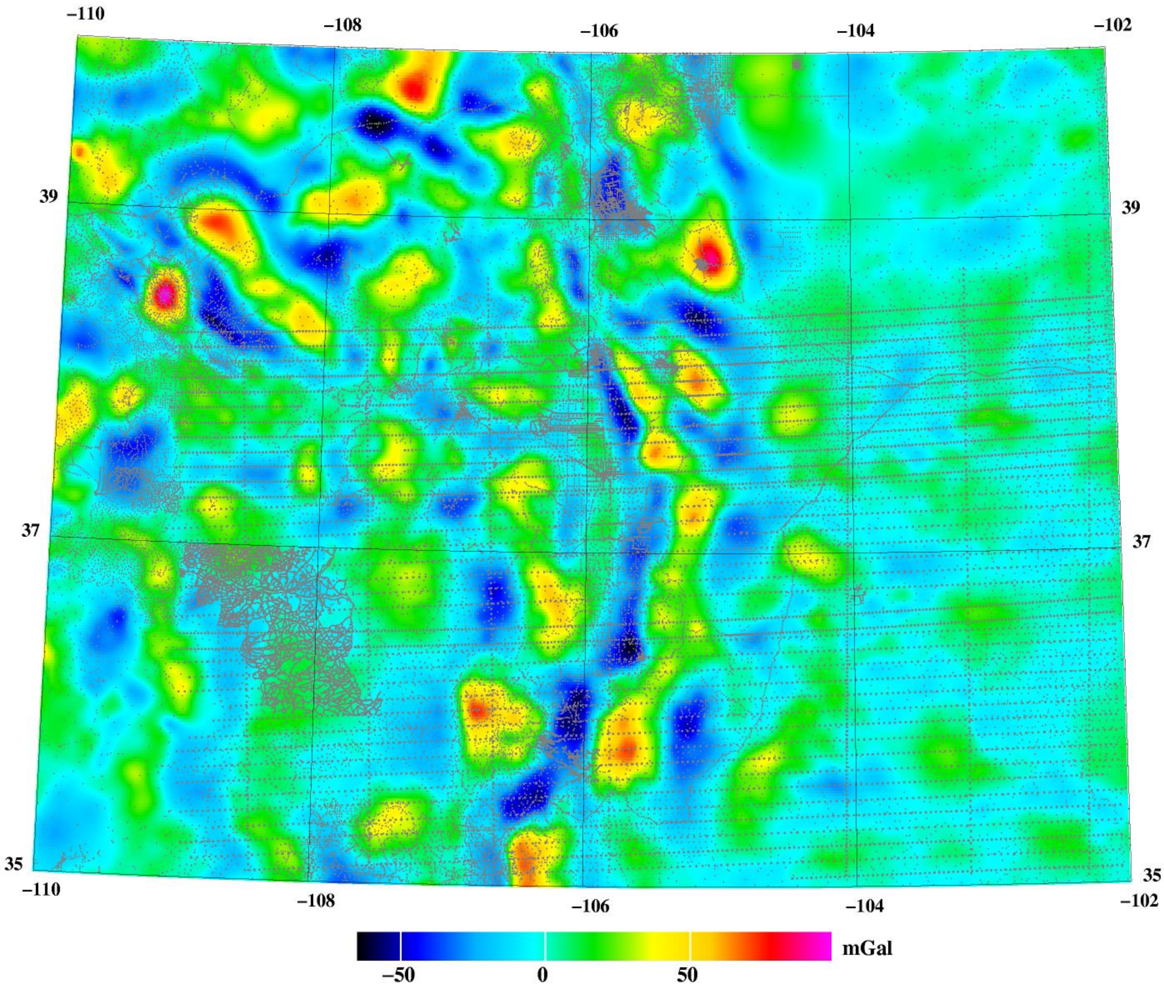


RTM 15' reference topography



Above: Reduced gravity data and underlying gravity data. Below: Geoid-Quasigeoid sepatation.