Demo Run Description: Least Squares Collocation for Regional Gravimetric Quasigeoid Determination

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`RunDemo.m` is set to use gravity data in an area defined by the coordinates $[141°, 141.5°]$ longitude and $[-32.5°, -32°]$ latitude in *GRID_PARA*, and it creates directories for output files and plots according to *OUTPUT_PARA*. `RunDemo.m` runs according to the following steps:

1 Download input data

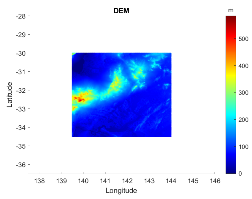
Download two MAT files.`oneTileData141-32.mat` includes the following data:

- `Gravity6D` = [longitude, latitude, orthometric_height, gravity_anomaly, uncertainty (std), flag (1: terrestrial, 2:satellite altimetry, 3: airborne)]
- `DEM3D` = [longitude, latitude, height] of digital elevation model (DEM)
- `LongDEMmatrix` = matrix of longitudes for DEM
- `LatDEMmatrix` = matrix of latitudes for DEM
- `LevellingData3D` = GPS levelling data [longitude, latitude, height]
- `GridRef3D` = [LongDEM(:), LatDEM(:), ZDEM(:)]; these are the x, y, z locations where the quasigeoid model will be computed
- `Coastline` = MATLAB 1×1 structure with fields `lat`, `long`

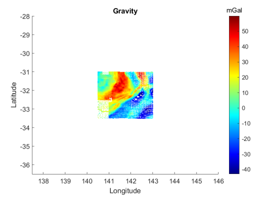
`oneTileGriddedInterpolant141-32.mat` contains MATLAB griddedInterpolant for

- `ZDEM_griddedInterpolant` = DEM elevation gridded interpolant
- `GravityGGM_griddedInterpolant` = GGM gravity gridded interpolant
- `ZetaGGM_griddedInterpolant` = GGM height anomaly gridded interpolant
- `ZetaRef_griddedInterpolant` = reference height anomaly gridded interpolant

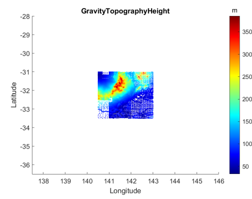
Here we use `GO_CONS_GCF_2_DIR_R6.gfc` from ICGEM for the global gravity model (GGM). These two MAT files are created by running `importAndFormatData.m`. After completing the above steps, you will be able to see three plots: Note that



(a) DEM data



(b) Gravity data



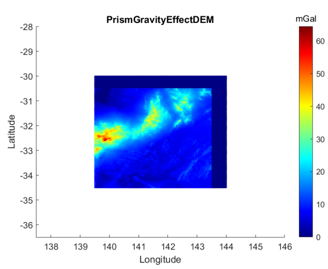
(c) Topographic heights

Figure 1: DEM data, Gravity data and Topographic heights at gravity data points

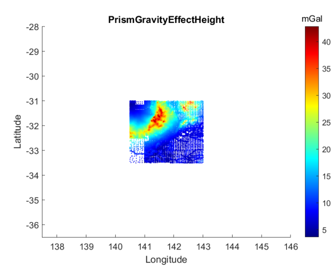
the DEM data are gridded at $1' \times 1'$, while the gravity data are irregular and sparse.

2 Compute terrain tffect

`computeTerrainEffect.m` computes terrain effects at the gravity points and the DEM points, plots them and saves them in a MAT file.



(a) Terrain effect at DEM



(b) Terrain effect at gravity data

Figure 2: Terrain effect at DEM and gravity data points using Prism method

3 Compute LSC

`computeGravimetryLSC` runs the tile-wise LSC. It computes the covariance functions and matrices for each tile. In this area, we have 4 tiles. The following are the areas of each tile along with their empirical covariances and the covariance functions fitted to the empirical values for each tile. As `computeGravimetryLSC` is the most time consuming function, we have timed it using `tic` and `toc`. The elapsed time is 769.52 seconds, which is almost 13 minutes for processing four tiles or blocks. When you run `computeGravimetryLSC`, some computation information will be displayed like the size of the LSC matrix which here for block 1 is 9832×9832. The LSC result for each block will be saved in a '.mat' file in the `OUTPUT_PARA.Tiles_dir_name` folder. After running this function, four mat files will appear in the folder.

4 Mosaic tiles

`mosaicTiles` produces the final geoid model by collating all tiles in the `OUTPUT_PARA.Tiles_dir_name` directory. It adds back the GGM and writes gravity, geoid, and respective error values as TIFF files. Below are the plots generated by running this function.

There are just eight GPS leveling points in this region; the following plots show the LSC gravimetric quasi-geoid at these points and compare them with the geometric geoid at the GPS leveling points.

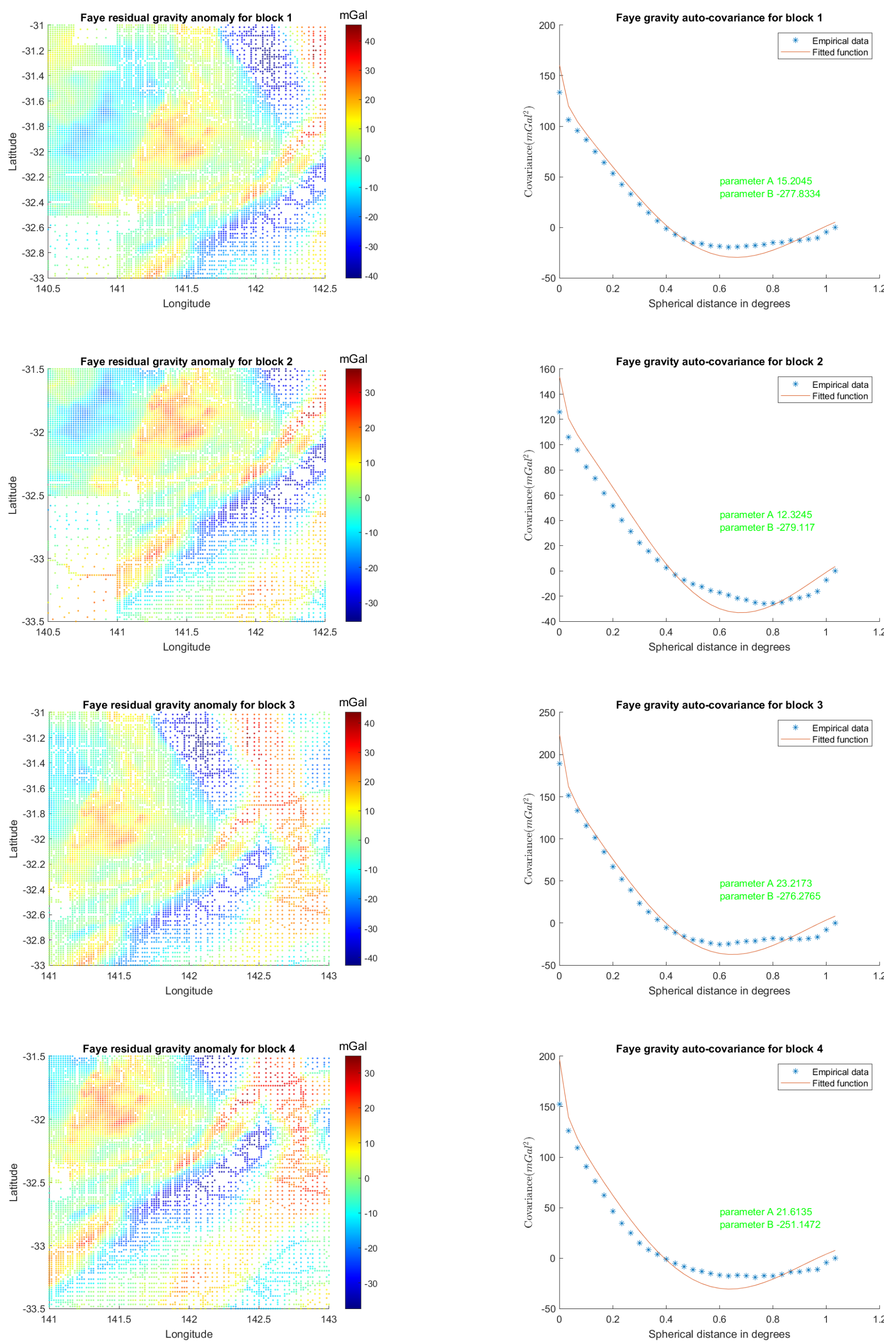
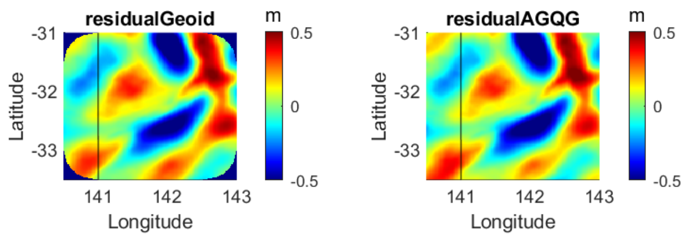
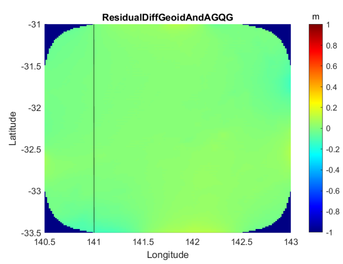


Figure 3: Faye residual gravity anomaly and corresponding empirical and fitted covariances in each block

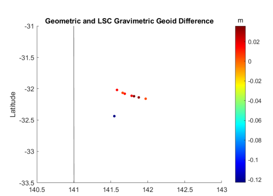


(a) LSC gravimetric residual quasi geoid vs existing AGQG

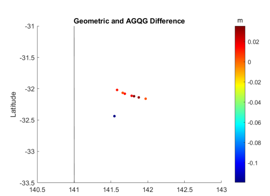


(b) Geoid and AGQG difference

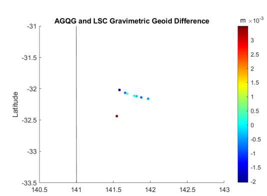
Figure 4: LSC gravimetric residual quasi geoid and existing Australian gravimetric quasi geoid (AGQG) and their difference



(a) GPS levelling and LSC difference

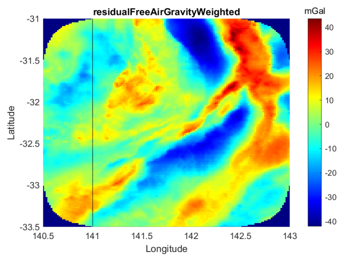


(b) GPS levelling and AGQG difference

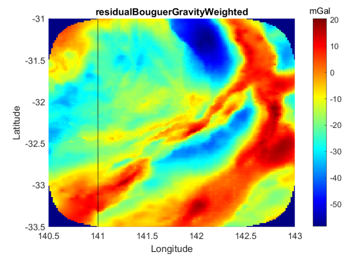


(c) LSC geoid and AGQG difference

Figure 5: LSC gravimetric residual quasi geoid and existing Australian gravimetric quasi geoid (AGQG) and their difference at GPS levelling points

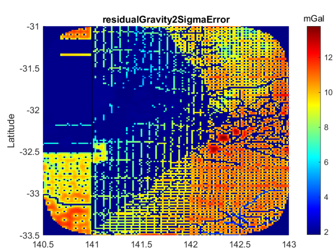


(a) Free air gravity anomalies

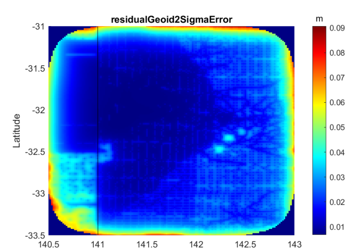


(b) Bouguer gravity anomalies

Figure 6: LSC gridded residual gravity anomalies used for quasi geoid prediction



(a) Gravity error



(b) Geoid error

Figure 7: Gravity 2 sigma error and geoid 2 sigma error