Simulation of height anomaly precision obtainable from CHAMP−data and from airborne gravity data in Bolivia.

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Using least−squares collocation (LSC, see Moritz, 1980) it is possible to obtain error estimates of the quality of height anomalies (quasi−geoid heights) from various combinations of data and from various types of gravity field variations. It is only necessary to know the position, type and error estimate of the data and its statistical characteristice /covariance function). The FORTRAN programs GEOCOL16, EMPCOV, COVFIT16 and TC from the GRAVSOFT package (Tscherning et al., 1992) have been used to execute the computations described below. Data, job−files and output files are found in http://cct.gfy.ku.dk/bolivia/bolivia.htm .

In this preliminary study we have computed error−estimates for Bolivia, or more precisely for areas bounded by −24 deg. to −9 deg. in latitude and −70 deg. to −55 deg. in longitude, see http://cct.gfy.ku.dk/bolivia/bolivia.pdf. The image shows the topography as obtained from DTM2002, (Saleh and Pavlis, 2002).

CHAMP−data from one year of observations (Howe and Tscherning, 2004) http://cct.gfy.ku.dk/bolivia/bochamp.dat , were used to generate gravity anomalies at an altitude of 300 m above the terrain in order to simulate 32400 airborne gravity data, see http://cct.gfy.ku.dk/bolivia/boliviag.dat . The creation of this data−set was in principle not necessary since the simulations − as mentioned above − may be carried out without using real data. Only positions and error−estimates of the data are needed.

As a reference field EGM96 (Lemoine et al. 1998) to degree 24 was used. The effect of the residual terrain was also subtracted from the CHAMP data, see http://cct.gfy.ku.dk/bolivia/bochamp_tc.dat

These data were used to generate empirical covariance functions in two sub−areas,(−24 deg. − −13 deg. in latitude and −70.0 deg. −63 deg. in longitude) one with high mountains and on in the lowland, (−24 deg. to −13 deg. in latitude and −63 deg. to −55 deg. in longitude), see http://cct.gfy.ku.dk/bolivia/bolivia.htm for input and output−files.

The main result is that a gravity field variance of 413.5 mgal**2 and 1226.6 mgal**2 were found in the low and in the heigh area, respectively, for data from which EGM96 to deg. 24 and residual topographic effects have been subtracted. The value from the high area is probably under−estimated. Real data are necessary in order to obtain a better value.

These values were then used in the computation of simulated error−estimates of height anomalies in two sub−areas within the two areas, bounded by (−24.0 −13.0) in latitude and (−63.0 −55.0) in longitude, and (−24.0 −13.0) in latitude and (−70.0 −63.0) in longitude.
About 3000 CHAMP height anomalies and 2000 gravity anomalies were used in each case.

The subtraction of EGM96 to degree 24 from the data, results in a height anomaly standard deviation of about 3 m. Using the CHAMP data without topography then permits the prediction of height anomalies with overall errors around 1 m. The error will be larger in the high area and lower in the low area.

Using gravity data with a 5’ spacing in the above mentioned sub−areas, the error decreased to between 0.14 m and 0.43 m for the

low area and between 0.18 and 0.56 for the high area, see http://cct.gfy.ku.dk/bolivia/bochampgtclgeoid.pdf and http://cct.gfy.ku.dk/bolivia/bochampgtchgeoid.pdf

Conclusion.

Using CHAMP data combined with airborne gravity data (with 2.0 mgal mean error) spaced 5’ apart it is possible to obtain height anomalies with mean errors of 0.14 m in low areas and 0.18 m in high areas. Improvements may be obtained using a DTM of higher resolution that the one used here and more dense gravity data. The use of a complete higher order reference field like EGM96 to degree 360 is not expected to give much improvement because the regional data used to construct the model is not of high quality.

References:

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