Different geoid computation methods applied on a test dataset: results and considerations

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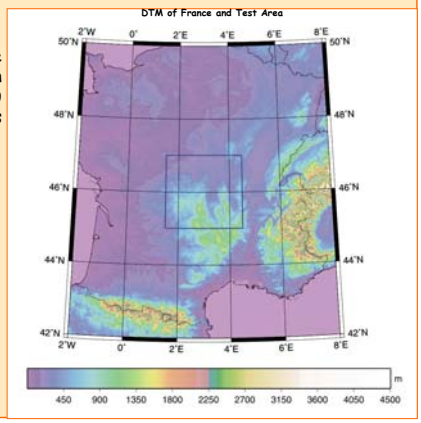
Abstract

Geoid computation is performed nowadays using well known procedures, most of them based on the remove-solve-restore technique. There are different choices that can be considered in the different steps of the computation, towards the integration and prediction methods. With the aim of verifying the equivalence of different techniques used for local geoid and quasigeoid computation in the geodetic community, a systematic comparative test has been performed. The test has been based on a common test field and on common basic guidelines. Different approaches have been considered on the same dataset, with a common basis of fixed general parameters, and leaving each research group free to apply different procedures and methods, for the core estimation step.

This test has been proposed by IGeS (International Geoid Service) and EGGP (European Gravity and Geoid Project), thanks to the data kindly made available by IGN.

Test field

The test field is the Auvergne area, located in the centre of France, and covering a 4° x 6° wide area (see the blue square in the figure). The IGN gravity dataset consists of 244009 values, covering most of the French territory. The employed DTM is based on SRTM, with a 3"x 3" grid spacing, and the global geopotential model taken into account is EIGEN_GL04C up to degree and order 360 (this was the most recent model available at the start up of the project). In the test field, 75 GPS/levelling points are available as control points.



Output requirements

- Height anomalies (quasigeoid, ζ) computed on a 1′ × 1′ grid 44°N < ϕ < 48°N; 0°E < λ < 6°E
- Height anomalies (quasigeoid, ζ) computed on the 75 GPS/levelling control points

Both referred to the GRS80 ellipsoid.

The six solutions

The six participating research groups have performed the computation, using a remove-solve-restore procedure, varying data processing and the core solution. In the following table for each group only the peculiarity of the core computation step ("solve" phase, the residual ζ prediction) is presented.

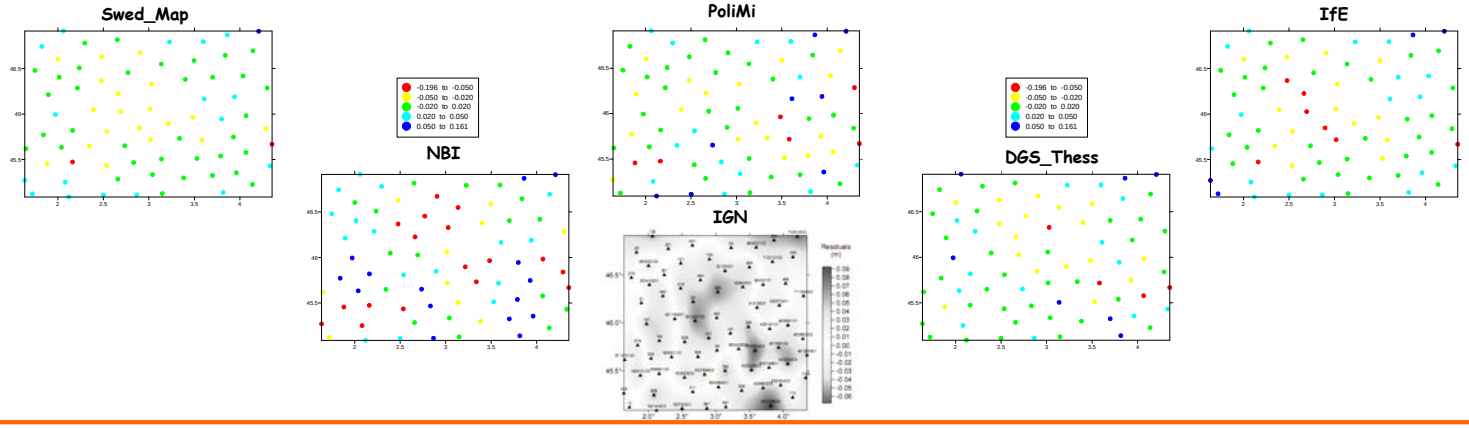
Swedish Mapping, Cadastre and Registry Auth / Zanjan University (**Swed_Map**)	KTH (Sjoberg) method: least squares (stochastic) kernel modification; additive corrections for: topography, downward continuation, the atmosphere and the ellipsoidal shape of the Earth.
Politecnico di Milano (**PoliMi**)	Fast collocation approach.
Institut f.Erdmessung (**IFE**)	Data screening, RTM terrain reductions, spectral combination with 1D FFT.
Niels Bohr Institute (**NBI**)	Least-Squares Collocation as implemented in GEOCOL.
Department of Geodesy and Surveying, Aristotle University of Thessaloniki (**DGS_Thess**)	1D spherical FFT methods.
Laboratoire de Recherche en Géodésie, Institut Géographique National (**IGN**)	Stokes' integration.

Differences between the height anomalies interpolated from the quasigeoids and the 75 GPS/levelling control points

	Swed_Map	PoliMi	IFE	NBI	DGS_Thess	IGN
Number of points	75	75	75	75	75	75
Mean	0.000	0.000	0.000	0.000	0.000	0.000
Standard deviation	0.033	0.037	0.039	0.081	0.038	0.038
Minimum	-0.087	-0.085	-0.081	-0.256	-0.062	-0.108
Maximum	0.090	0.088	0.115	0.198	0.105	0.067
Number of points	75	75	75	75	75	75
Mean	0.000	0.000	0.000	0.000	0.000	0.000
Standard deviation	0.029	0.036	0.035	0.067	0.035	0.037
Minimum	-0.094	-0.100	-0.085	-0.196	-0.066	-0.069
Maximum	0.053	0.078	0.079	0.161	0.092	0.093

After a one parameter transformation

After a three parameters transformation (Heiskanen and Moritz)



Conclusions and Future Perspectives

The results achieved by the different research groups show a reasonable agreement. Differences are only of the second order, thus assessing the substantial equivalence of the different approaches and software. In the frame of a future research it seems interesting to involve other research groups with different methodologies. In a second phase of the project, a comparison among the different used methods will be performed. Also an optimization of different groups' results will be carried out, by testing other data configurations, for instance using other DTMs, or different global models (i.e. EGM08 or EGG2008).

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