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GOCE in ocean modelling - Point mass method applied on GOCE gravity gradients

Herceg, Matija; Knudsen, Per

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GOCE in ocean modelling
- Point mass method applied on GOCE gravity gradients

• **Matija Herceg** and **Per Knudsen**; DTU Space, National Space Institute, Department of Geodesy, Copenhagen, Denmark

Abstract

This presentation is an introduction to my Ph.D project. The main objective of the study is to improve the methodology for combining GOCE gravity field models with satellite altimetry to derive optimal dynamic ocean topography models for oceanography. Here a method for geoid determination using simulated GOCE gradients is presented.

Introduction

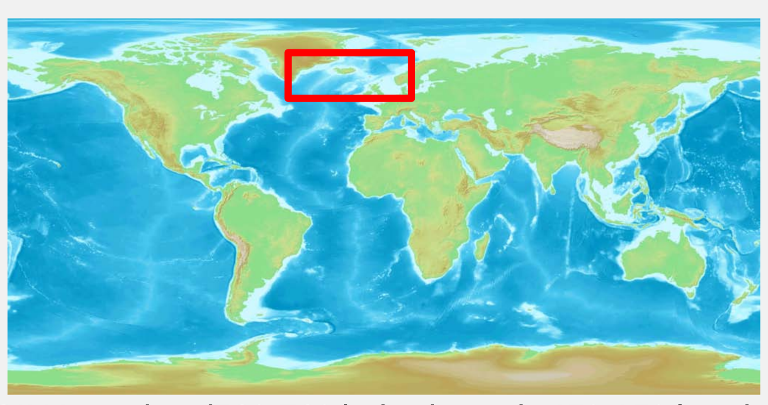
Combining GOCE geoid models with satellite altimetric observations of the sea surface height, might lead to substantialy improvements in the modelling of the ocean transport and circulation.

The primary requirement for oceanographers is to have access to a geoid and its error covariance at the highest spatial resolution and accuracy possible. For that purpose a point mass program is developed for processing GOCE gradients and determination of geoid.

Point mass method

The masses for each point are calculated using the first order derivatives of gravitational potential (from GOCINA gravity anomaly values, EGM96 to degree 200 has been subtracted to obtain residual gravity anomaly values). Then the Earth anomalous gravity field is modelled by the set of base function, each obtained as the anomalous gravity potential from each point masses. From the anomalous gravity field, the geoid is then calculated using Bruns formula. Gradient are then computed using second order derivatives of the gravity potential.

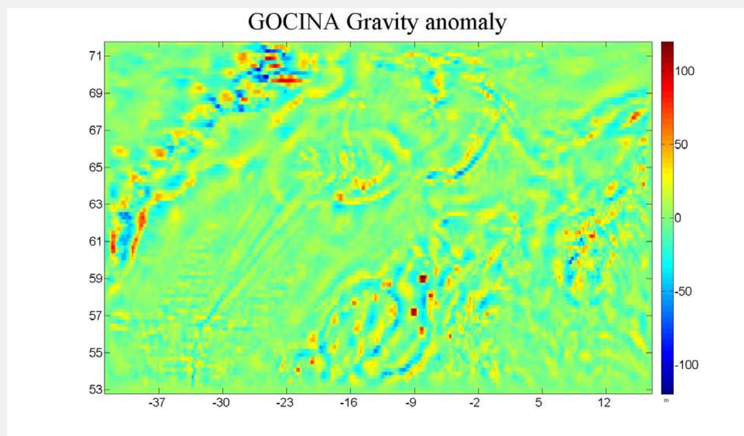
To evaluate the results of the point mass method, the Gravsoft program package is used. Evaluation is carried out in part of the GOCINA region in the North Atlantic.



GOCINA region (53°-72° latitude and -45°-15° longitude)

Furthermore, gradients calculated using GEOFOUR (used as simulated GOCE gradients) are processed in point mass program to obtain geoid. From that, geoid determination using point mass and GOCE gradients is demonstrated.

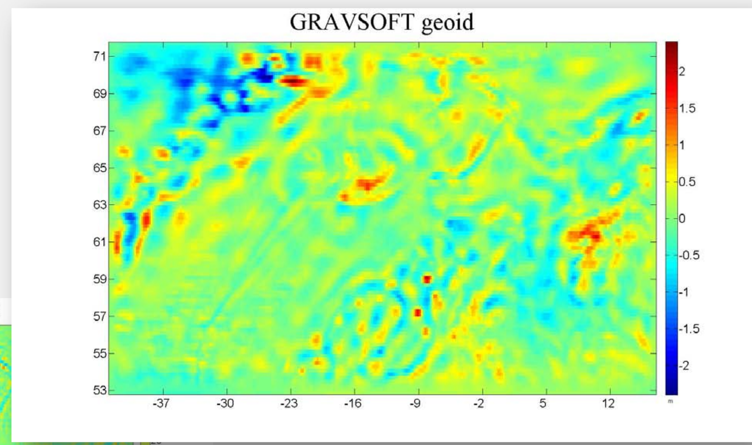
Comparation of point mass method and Gravsoft programms

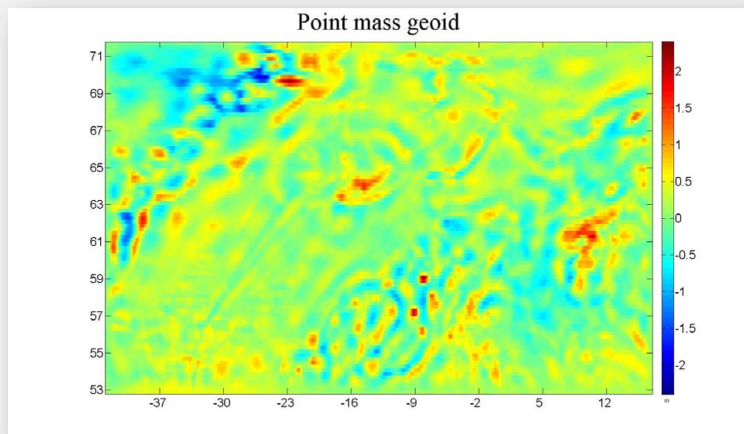


Gravsoft GEOFOUR applied

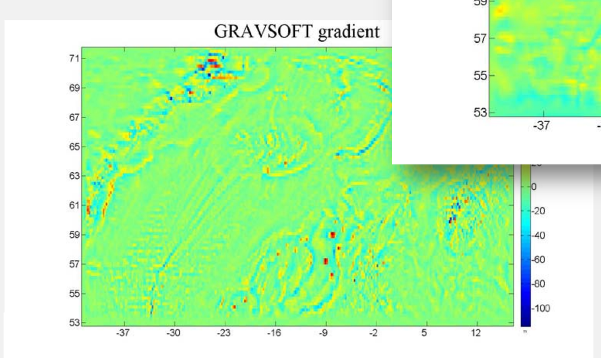
Point mass method applied

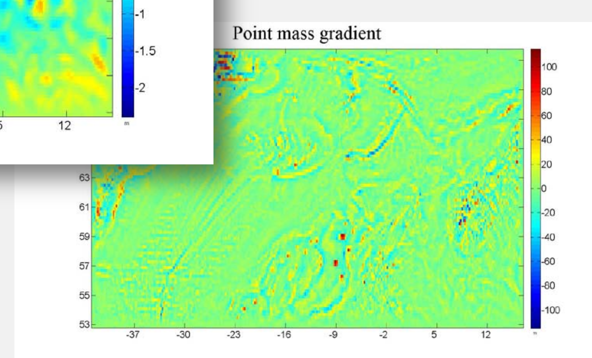
Min	Max	Mean	Stn. Dev.
-2.36m	2.34m	0.00m	0.38



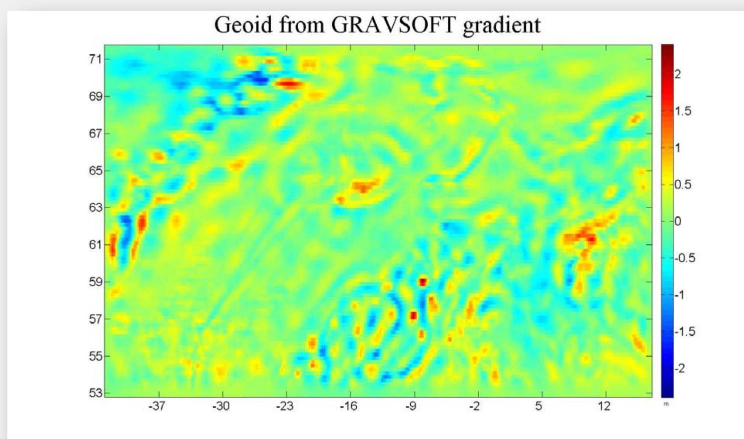


Min	Max	Mean	Stn. Dev.
-1.94m	2.31m	0.09m	0.36





Using Gravsoft gradient and applying point mass method for geoid calculation

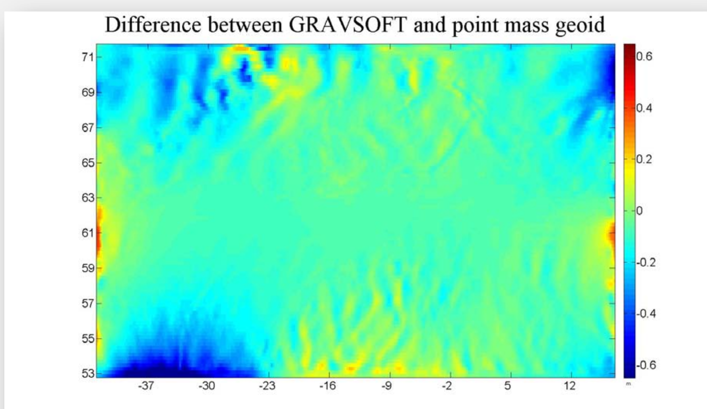


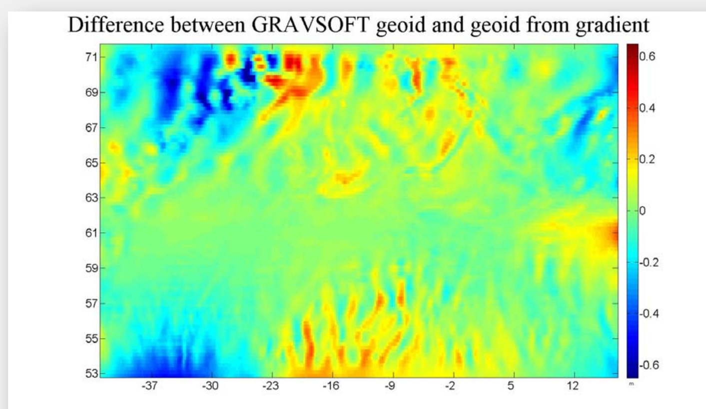
Min	Max	Mean	Stn. Dev.
-1.63m	2.21m	0.01m	0.32

Results

For evaluation of the calculated geoids, Gravsoft GEOFOUR is used as a reference. Calculated geoids are then subtracted from Gravsoft geoid and result can be seen in the following figures.

Min	Max	Mean	Stn. Dev.
-0.82m	0.42m	-0.09m	0.09





Min	Max	Mean	Stn. Dev.
-0.83m	0.54m	-0.01m	0.12

From these figures it is visible that the differences between Point mass method and Gravsoft GEOFOUR are very small – only few centimeters across the grid. The big differences can be seen mostly on the edges; these differences are most likely result of periodicity of the fast FouRier transform used in the GEOFOUR Gravsoft program.

GEOFOUR is program for gravity field modelling using fast Fourier transform. It has many modes, like upward continuation, gravity to geoid and geoid to gravity conversion, solutions for Molodenskys boundary value problems, etc.

Conclusion

Applying the new methods on GOCE results, it is possible to make independent control of already accepted methods of geoid determination. The presented point mass method is suitable for recovering geoid height estimates from GOCE gravity gradient data. The preliminary results show that a substantial part of the gravity field associated with harmonic degrees larger than degree 200 may be recovered using this method. Also, the gravity gradients contain more valuable signal than will be recovered in the planned harmonic expansion to degree 200. New detailed geoid surface will serve as a homogeneous and accurate reference surface for satellite altimetry and in that way it will provide important improvements in the ocean circulation modelling.

References

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Contact: mher@space.dtu.dk