Geophysical Research Abstracts
Vol. 18, EGU2016-3410-1, 2016
EGU General Assembly 2016

Polyhedral shape model for terrain correction of gravity and gravity gradient data based on an adaptive mesh

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Since 2007, there are four China Da yang cruises (CDCs), which have been carried out to investigate polymetallic sulfides in the southwest Indian ridge (SWIR) and have acquired both gravity data and bathymetry data on the corresponding survey lines(Tao et al., 2014). Sandwell et al. (2014) published a new global marine gravity model including the free air gravity data and its first order vertical gradient (Vzz). Gravity data and its gradient can be used to extract unknown density structure information(e.g. crust thickness) under surface of the earth, but they contain all the mass effect under the observation point. Therefore, how to get accurate gravity and its gradient effect of the existing density structure (e.g. terrain) has been a key issue. Using the bathymetry data or ETOPO1 (http://www.ngdc.noaa.gov/mgg/global/global.html) model at a full resolution to calculate the terrain effect could spend too much computation time. We expect to develop an effective method that takes less time but can still yield the desired accuracy.

In this study, a constant-density polyhedral model is used to calculate the gravity field and its vertical gradient, which is based on the work of Tsoulis (2012). According to gravity field attenuation with distance and variance of bathymetry, we present an adaptive mesh refinement and coarsening strategies to merge both global topography data and multi-beam bathymetry data. The local coarsening or size of mesh depends on user-defined accuracy and terrain variation (Davis et al., 2011). To depict terrain better, triangular surface element and rectangular surface element are used in fine and coarse mesh respectively. This strategy can also be applied to spherical coordinate in large region and global scale. Finally, we applied this method to calculate Bouguer gravity anomaly (BGA), mantle Bouguer anomaly(MBA) and their vertical gradient in SWIR. Further, we compared the result with previous results in the literature. Both synthetic model tests and field applications indicate that the adaptive terrain correction method can be adopted as a rapid and accurate tool of marine gravity data processing.

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