Geophysical Research Abstracts
Vol. 16, EGU2014-15334, 2014
EGU General Assembly 2014

Integrated approach to estimate the ocean's time variable dynamic topography including its covariance matrix

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The ocean's mean dynamic topography as the difference between the sea surface and the geoid reflects many characteristics of the general ocean circulation. Consequently, it provides valuable information for evaluating or tuning ocean circulation models. However, the determination of the mean dynamic topography from satellite based gravity field and altimetric observations is not straightforward. For the integration of the dynamic topography into ocean circulation models not only the dynamic topography itself but also its inverse covariance matrix on the ocean model grid is required. We developed a rigorous combination method where both instrumental errors and omission errors are accounted for, including the determination of optimal relative weights between the observation groups. The altimetric mean sea surface is expressed as a sum of geoid heights represented in terms of spherical harmonics and the mean dynamic topography parameterized by a finite element method which can be directly related to the particular ocean model grid. The different observation groups are combined in terms of normal equations. This allows the direct determination of the normal equations of the mean dynamic topography which contain the appropriate weights for
model-data misfits in least-squares ocean model inversions. The developed integrated approach can be extended by modeling the time variable component of the dynamic topography to provide estimates not only at a mean state but also at arbitrary points in time including a rigorously computed covariance matrix.

The focus of this study is on the North Atlantic Ocean. We will present the conceptual design and dynamic topography estimates based on time variable data from several satellite altimeter missions in combination with GOCE and GRACE
gravity field models.