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Small-Scale Signal in Mean Dynamic Topographies Applying Combined Geoid Models

Frank Siegismund, **Xanthi Oikonomidou**, and Philipp Zingerle
Institute of Astronomical and Physical Geodesy,Technical University of Munich, Munich, Germany
(frank.siegismund@tum.de)

The Dynamic ocean Topography (DT) describes the deviation of the true ocean surface from a hypothetical equilibrium state ocean at rest forced by gravity alone. With the geostrophic surface currents obtained from its gradients the DT is an essential parameter for describing the ocean dynamics. Observation-based global temporal Mean geodetic DTs (MDTs) are obtained from the difference of altimetric Mean Sea Surface (MSS) and the geoid height, that equipotential surface of gravity closest to the ocean surface.

The geoid is provided either as a satellite-only, or a combined model including in addition gravity anomalies derived from satellite altimetry and ground data. In recent years the focus was on satellite-only models, produced from new space-born observations obtained from the Gravity Recovery and Climate Experiment (GRACE) and Gravity field and Ocean Circulation Explorer (GOCE) satellite missions. Moreover, combined geoid models are only cautiously used for MDT calculation, since it is still in question to what extent the gravity information obtained from altimetry is distorted by the MDT information included therein and how this translates into errors of the MDT.

Here we want to concentrate on MDT models based on recent combined geoid models. An assessment is provided based on comparisons to near-surface drifter data from the Global Drifter Program (GDP). Besides providing a general, global assessment, we focus on signal content on small scales, addressing mainly two questions: 1) Do MDTs obtained from combined geoid models contain signal for scales smaller than resolvable by the
satellite-only models? 2) Is there a maximum resolution beyond which no signal is detectable?

Until recently, these questions couldn't be answered since low resolution MDTs usually contained strong wavy-structured errors and thus needed a strong spatial filtering thereby killing the smallest scales resolved in the MDT. These errors, which worsen with lower resolution, are caused by Gibbs effects provoked by imperfections in bringing the high resolution ocean-only MSS models into spectral consistency with the much lower resolved global geoid model. A new methodology, however, improves the necessary globalization of the MSS. After subtraction of the geoid model, subsequent cutting-off the signal beyond a specific spherical harmonic degree and order (d/o) results in an MDT without any Gibbs effects, also for low resolution models.

To answer the questions posed above applying the new methodology, the scale-dependent signal in MDTs for different geoid models is presented for a list of cut off d/os. To minimize the influence of noise on the results we concentrate on strong signal Western Boundary Currents like the Gulf Stream and the Kuroshio. For the Gulf Stream results of a high resolution hydrodynamic model are available and presented as an independent method to estimate the scale dependent signal.