Instantaneous Profiles of Dynamic Ocean Topography (iDOT-profiles) – updated with GOCO03S
A vote against a long-term Mean Dynamic Topography (MDT)

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Keynote:
Usually ‘geodetic’ estimates of the Dynamic Ocean Topography (DOT) are performed w.r.t. a long-term Mean Sea Surface (MSS), already implying a significant temporal smoothing. The profile approach developed at DGFI (Bosch & Savcenko 2010) provides estimates of the instantaneous dynamic ocean topography (iDOT) along individual grid tracks of any altimeter mission. Thereby iDOT-profiles allow studying the variability of the dynamic ocean topography and are well suited for assimilation into oceanographic models.

After a new multi-mission cross-calibration (MMX013) iDOT-profiles for all passes of Topex, Poseidon, Jason-1/2, ERS1/2, Envisat, and GFO were recomputed with GOCO03S (Mayer-Gürr et al. 2013), one of the latest combined GRACE/GOCE gravity models. All together the total set of iDOT-profiles realize a multi-mission sampling of the DOT with dense spatial and temporal resolution. The geostrophic velocity field of gridded iDOT profiles show much more details and significant stronger velocities than an MSS-based DOT. The iDOT-profiles realize (smoothed) snapshots of the DOT and allow to construct (for the period up to 1993) DOT time series and the associated geostrophic velocity field, illustrating in particular the Eddy formation in the strong western boundary currents.

The Profile Approach
The geodetic ocean dynamic topography (DOT) is derived by subtracting geoid heights N of a satellite-only gravity fields (like GOCO03S) from altimetric sea surface heights h:

\[ \text{DOT} = h - N \]  

While N is rather smooth and can be computed everywhere, h has high frequencies and is available only along altimeter tracks. The rationale for the profile approach is (i) to avoid any initial gridding or global extension of h and (ii) to perform the difference (1) directly on the altimeter profiles.

As h and N are spectrally different, both have to be consistently filtered. With the (linear) 2-dimensional filter operator 2D() we have:

\[ \text{iDOT} = 2D(h - N) = 2D(h) - 2D(N) = 10(N) + 2D(h) - 10(h) = 1D(h) + 2D(N) + FC(h) = FC(h) + 2D(h) - 1D(h) \]

The first two terms can be easily computed. The remaining term FC(h), called filter correction accounts for systematic differences between 1D() and 2D() operators. Approximating FC(h) ≈ FC(NGEO, high-resolution geoid of EGM2008, Pavlis 2011)

\[ \text{iDOT} = 1D(h) - 1NCGEO + 2D(NCGEO) - 2D(N) \]

Here, the 1D-operator gives an approximate DOT-profile, to be corrected by the 2D-term, called pre-geoid correction (can be computed once in advance).

iDOT time series (gridded globally)

Time series animation at (QR-code):

Gulf Stream geostrophic velocities (from iDOT-profiles)

Time series animation at (QR-code):

Further animation (Agulhas Counter Current at (QR-code):

References:

Ocean Surface Topography Science Team (OSTST) Meeting, 07-11 October 2013, Boulder, Colorado, USA