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 ground 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 (MMXO13) iDOT-profiles for all passes of Topex, Poseidon, Jason1/2, 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:

$$\text{DOT} = h - N \qquad (1)$$

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:

$$\begin{aligned} \text{iDOT} &= 2D[\,h - N\,] = 2D[h] - 2D[N] \\ &= \mathbf{1D}[\boldsymbol{h}] + 2D[h] - \mathbf{1D}[\boldsymbol{h}] - 2D[N] && \text{adding/subtracting } 1D[h] \\ &= 1D[h] - 2D[N] + FC[h] && FC[h] = 2D[h] - 1D[h] \end{aligned}$$

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 $FC[h] \approx FC[N_{EGM}]$ (N_{EGM} high-resolution geoid of EGM2008, Pavlis 2011)

$$\begin{aligned} \text{iDOT} &= 1D[h] - 1D[N_{EGM}] + 2D[N_{EGM}] - 2D[N] \\ &= 1D[h - N_{EGM}] + 2D[N_{EGM} - N] \end{aligned}$$

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).

GOCO03S Filtering

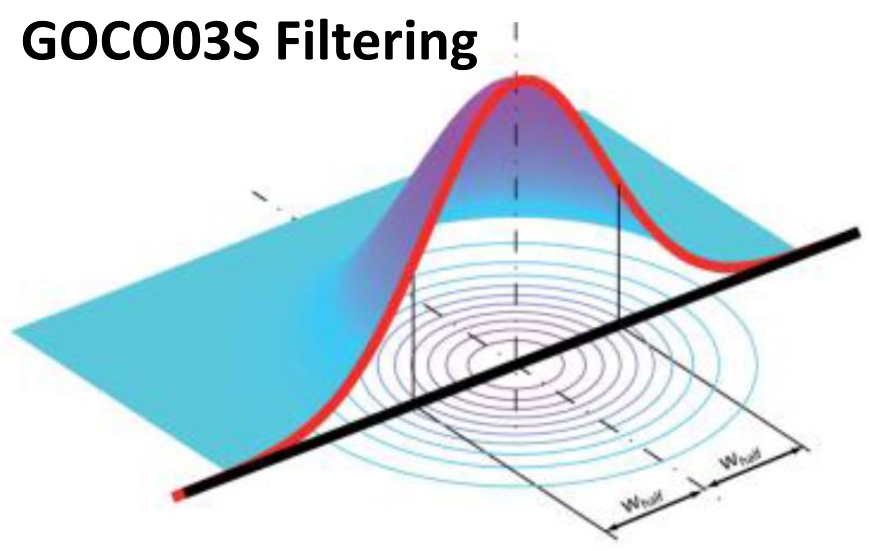


Fig.1: Gauss filter for 2D-filering (blue surface) and 1D-filtering (red line)

GOCO03S (Mayer-Gürr et al., 2012) combines GOCE, GRACE, CHAMP, and SLR data and is given by a spherical harmonic series up to degree 250. We apply an isotropic low-pass Gauss filter (no sidelobes neither in the spatial nor in the spectral domain) with a filter length of only 70 km, corresponding to a spectral degree of N = 210. Thus, we start to resolve meso-scale pattern like Eddies.

Common 10-day iDOT-snapshot of T/P (cyc 380) and Jason-1 (cyc 37)]

Download all iDOT-profiles for
- Topex, Poseidon, , Jason-1/2
- ERS-1, ERS-2, GFO, Envisat
- GFO **here (QR-code):**

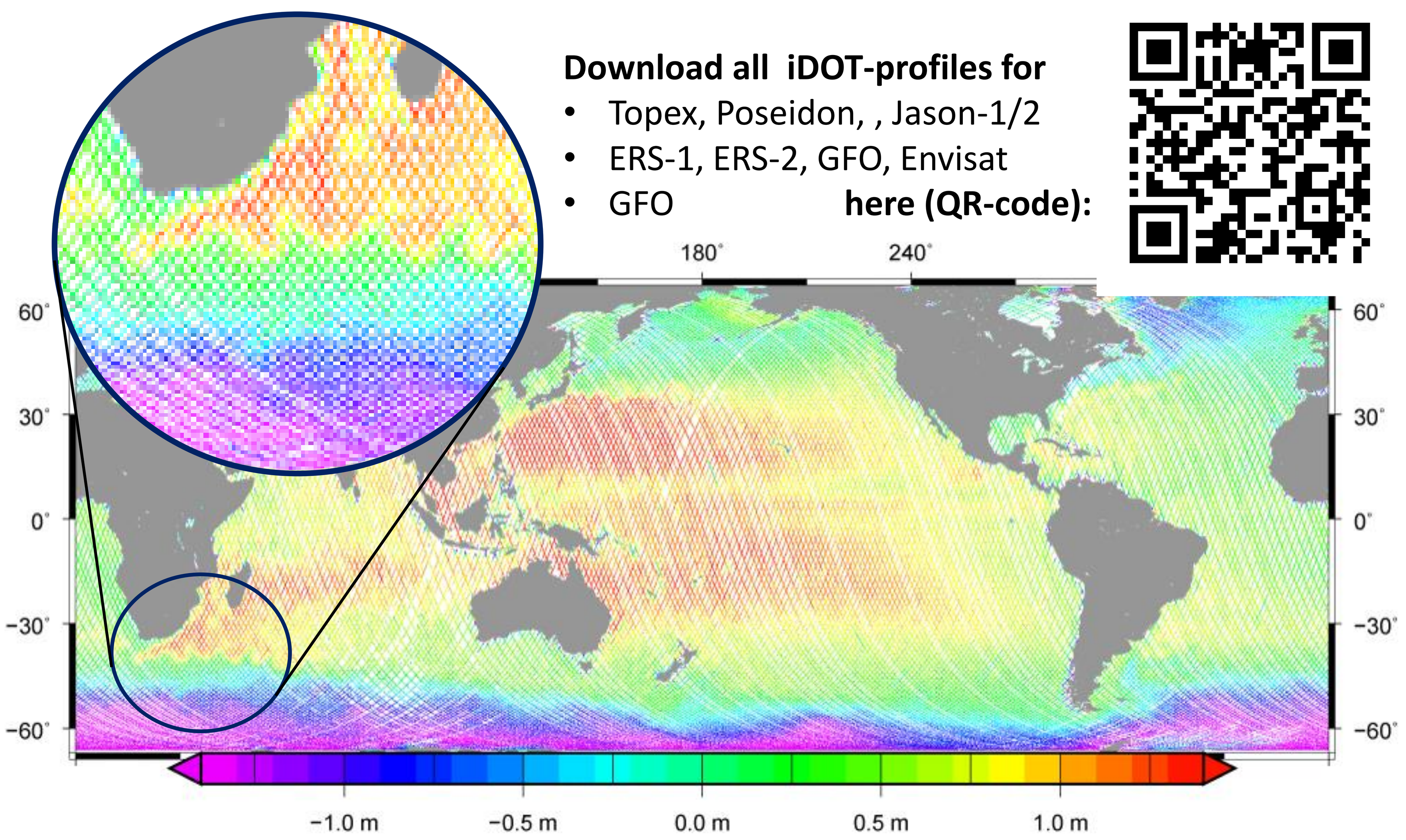
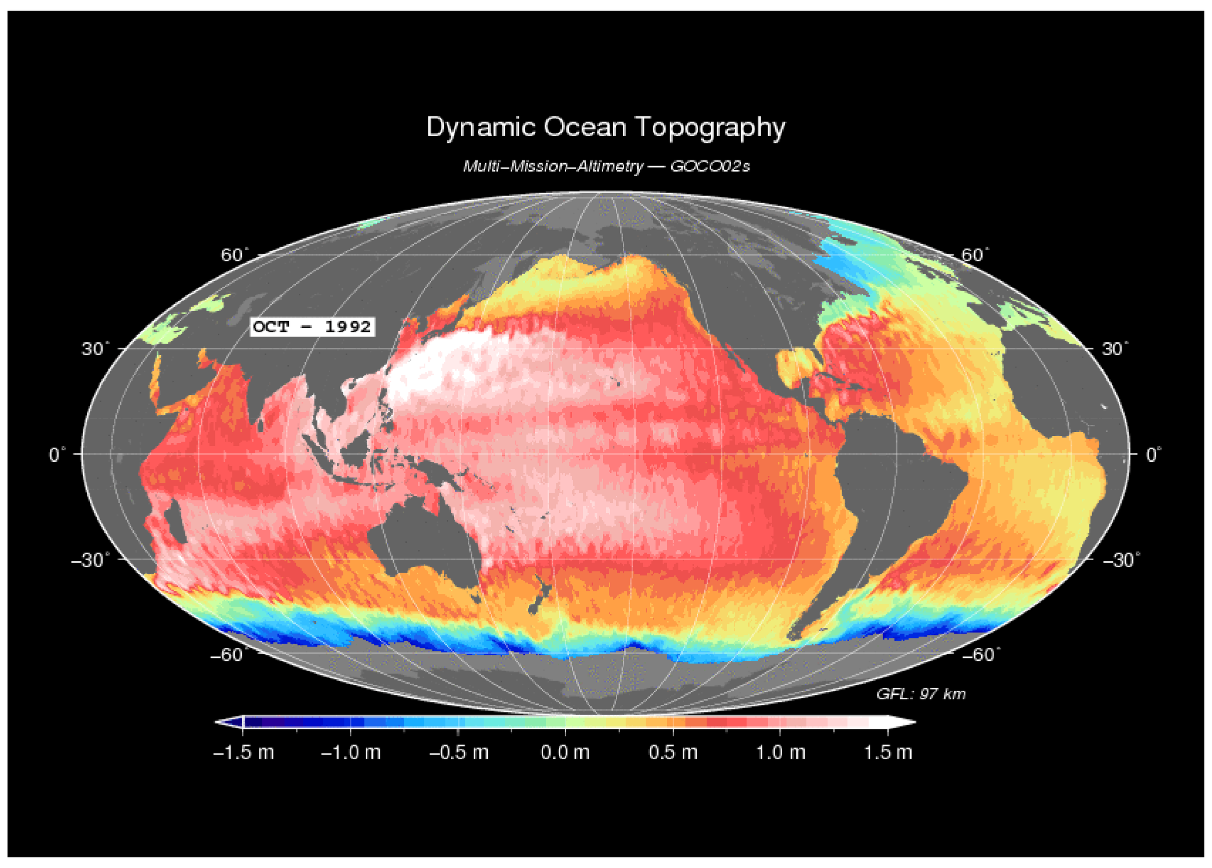


Fig.2: iDOT-profiles of Topex/Poseidon and Jason-1 for a common 10 day period. Even without gridding, the strong Agulhas counter current as well as the front of the Antarctic Circumpolar Current are visible.

iDOT time series (gridded globally)

Time series animation at (QR-code):



Jason-1, pass 50 @ 37°N: Gulf Stream Meandering

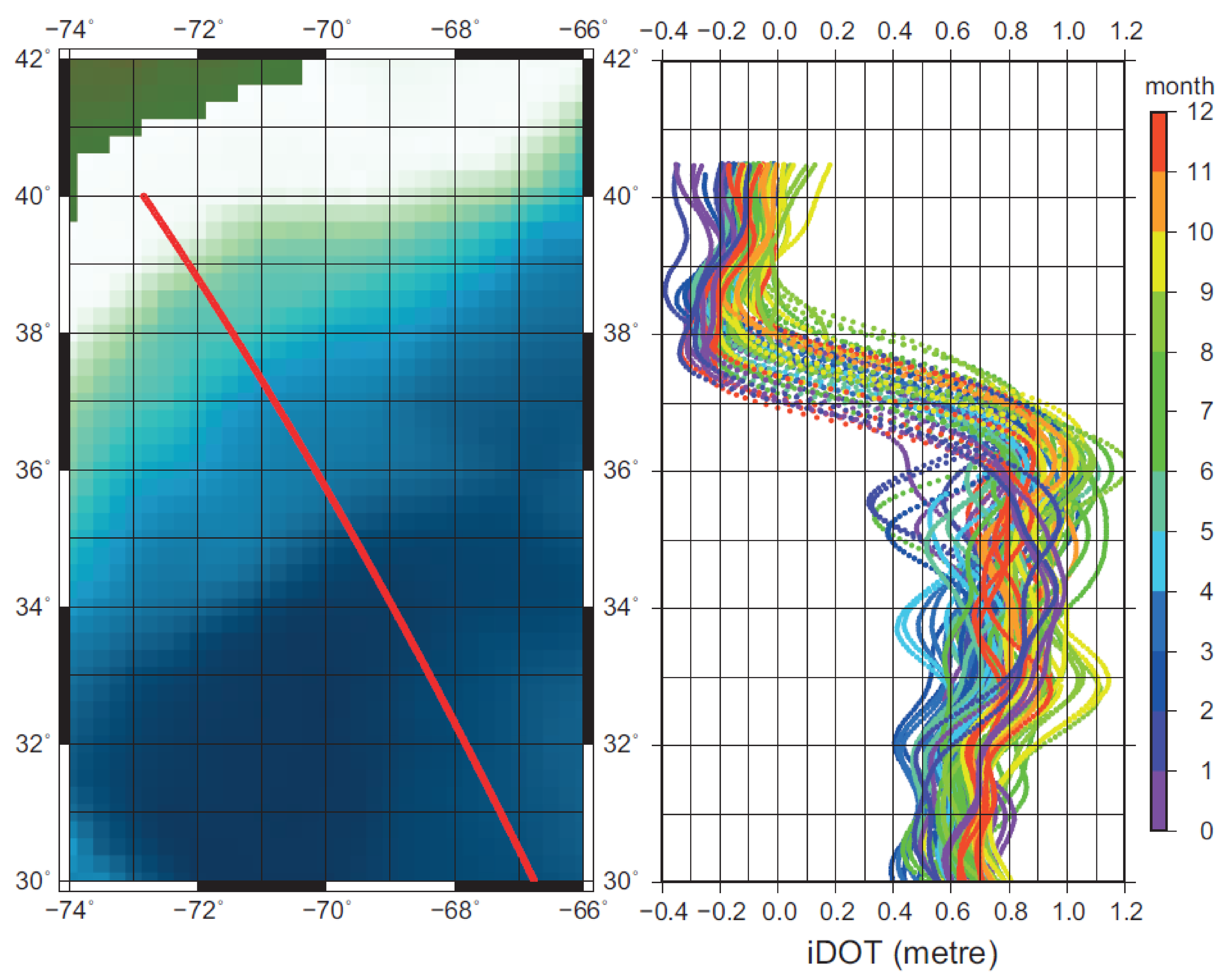
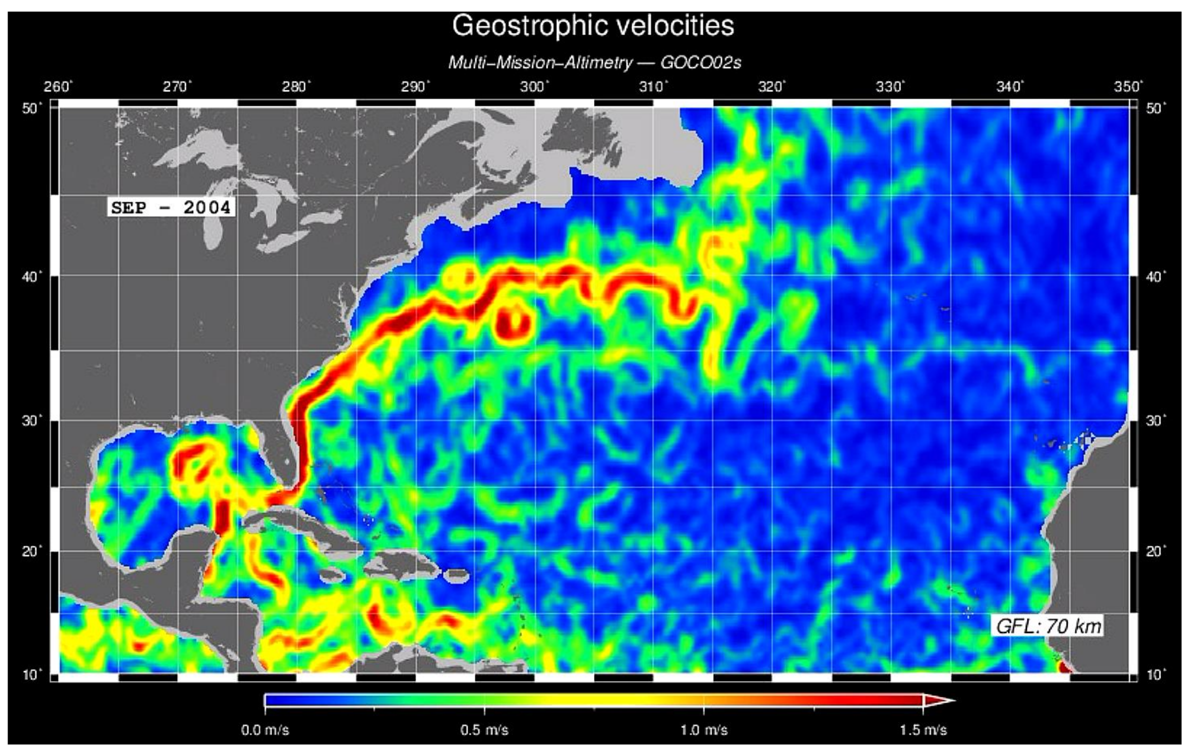


Fig.: Jason-1, pass 50, crossing the Gulf Stream(left); sequence of iDOT-profiles along pass 50 for a time period of about 2 years (right) with the color code indicating the season of the year.

Gulf Stream geostrophic velocities (from iDOT-profiles)

Time series animation at (QR-code):



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

References:

Bosch W., R. Savcenko, D. Dettmering, and C. Schwatke (2012). A two decade time series of Eddy-resolving dynamic ocean topography (iDOT). Proceedings of 20 years of progress on radar altimetry symposium, Venice, Italy, SP-710, ESA/ESTEC
Bosch W., Savcenko R. (2010): On Estimating the Dynamic Ocean Topography. In: Mertikas S.P. (Ed.): Gravity, Geoid and Earth Observation. Springer IAG Symposia, Vol. 135, 263-269.
Mayer-Gürr T., et al. (2012): The new combined satellite only model GOCO03s. Presentation at GGHS 2012, Venice, October 2012
Pavlis N.K., S.A. Holmes, S.C. Kenyon and J.K. Factor, 2011: The development and evaluation of the Erath gravitational model 2008 (EGM2008). J. Geophys.Res., Vol. 117, B04406, doi:10.1029/2011JB008916

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