Towards the next combination mean dynamic topography model DTUUH25MDT

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Abstract.
When deriving the DTUUH22MDT combination model it was found that the differences between the combination model and the geodetic model are within 10 cm. Hence, the effects of integrating the drifter velocities on the MDT are of that order of magnitude. Also, the scales appear to be shorter than a few hundreds of kilometers agreeing well with the resolution of the geodetic model. For comparison the CNES-CLS18 showed larger differences and at longer scales. A recent comparison with the CNES-CLS22 model show the same features as the 18 model. The differences between the DTUUH and the CNES-CLS models may be caused by differences in the choice of reference models, processing of drifter data, methodologies for integrating the data, etc.

To assess the differences between the combination models this presentation focus on clarifying issues with the correction of the buoy data for wind driven flows. Different strategies for deriving empirical correlations are tested and regional averages are compared with velocities derived from the geodetic MDT. Furthermore, experiments of integrating the drifter velocities with the geodetic model are carried out with different weighting schemes to assess how much the combination solution is constrained to the geodetic model and how regional biases in the drifter velocities are affecting the solution.

The Geodetic MDT

Since the previous geodetic model, the DTU22MDT, was derived a newer model for the Mean Sea Surface and has become available. Hence, the following models are used:

- New Mean Sea Surface DTU24MSS, and
- XGM2019e geoid complete to d/o 2160 based on the GOCO06S and terrestrial data including marine gravity anomalies derived from satellite altimetry.

When deriving the new geodetic MDT DTU25MDT the filtering scheme was re-assessed to enhance the western boundary currents. In earlier models the western boundary currents came out too weak due to filtering in combination with missing values on land.

For DTU25MDT an additional step were introduced to recover the finer details of the western boundary currents. Also, the re-gridding of values in the coastal areas were fine tuned.

Developments in the DTU MDT modelling is shown in the table:

	Mean Sea Surface	Geoid
DTU15MDT	DTU15MSS	GOCO05S-EIGEN-6C4 hybrid
DTU16MDT	DTU15MSS	GOCO05C-EIGEN-6C4 hybrid
DTU17MDT	DTU15MSS	OGMOC hybrid
DTU19MDT	DTU18MSS	OGMOC hybrid
DTU22MDT	DTU21MSS	XGM2019e
DTU25MDT	DTU24MSS	XGM2019e

Comparison with drifters:
During the process of optimizing the filtering the derived geostrophic surface currents were compared with drifter velocities.
The drifter velocities had been corrected for Ekman flows empirically and for geostrophic current anomalies obtained from AVISO. Only bins (1/4x1/4 deg) where the mean flow may be computed from at least 20 observations were used. The data set is displayed in Figure 3 below.
The results of the comparison of the models are shown in the table below:

	lat 10-30		lat 30-50	
[cm/s]	u	v	u	v
DTU15MDT	5	5.9	5	4.9
DTU17MDT	4.9	5.5	4.7	4.7
DTU19MDT	4.8	5.5	4.7	4.6
DTU22MDT	4.7	5.3	4.7	4.5
DTU25MDT	4.7	5.1	4.5	4.5

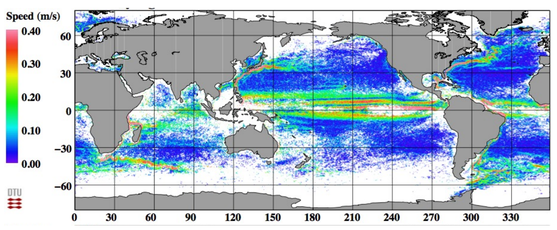

Figure 3. Mean drifter velocities used for the assessment of the geodetic models.

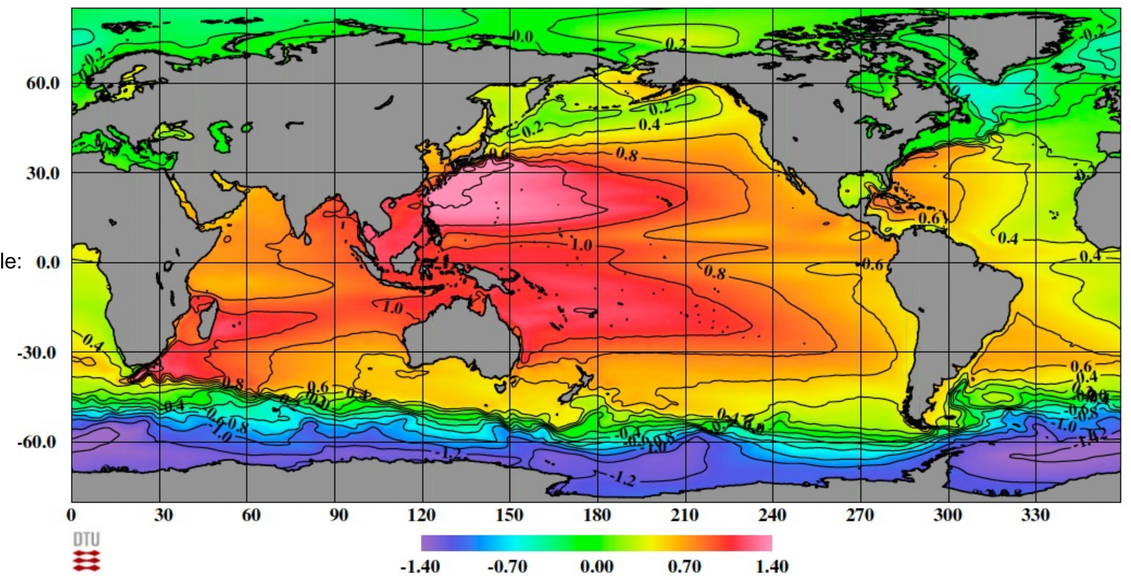

Figure 1. Mean dynamic topography from the geodetic DTU25MDT.

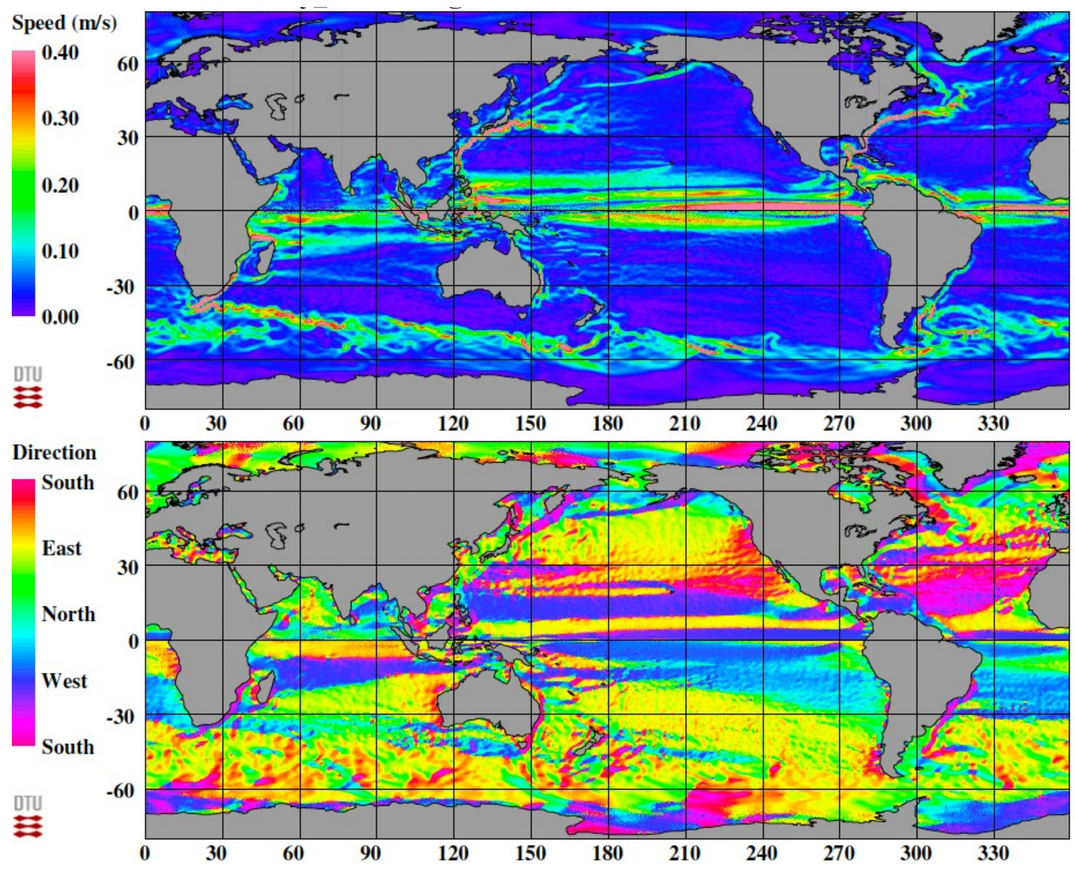

Figure 2. Geostrophic surface current speed and direction associated with the geodetic DTU25MDT model.

The Combination MDT

Since the previous combination model, DTUUH22MDT, the various steps in computations have been revised. That is

- The updating of the geodetic model used as reference model (discussed above),
- The processing of the drifter velocities, mainly the modeling of the wind driven flows,
- The integration.

Correcting for wind driven flows.

Compared to previous analyses, the computation of DTUUH22MDT included, a new model for the wind driven flow, v_w, is used:

$$v_w = a \cdot w + b \cdot \hat{w}$$

Where the factors *a* and *b* are estimated by linear regression in cells of 2 by 5 degree. Subsequently, zonal averages are computed. Also, as previously, the local means in the 2 by 5 degree cells are removed from both drifter velocities and winds.

The results are shown in Fig. 3. For the drogued drifter data sets the *a* factors are symmetric around Equator while the *b* factors change sign according to the changing sign of the perpendicular component. The results obtained using the undrogued data are similar, though the *a* factors have larger values to account for the increased drift. The *b* factors are very similar.

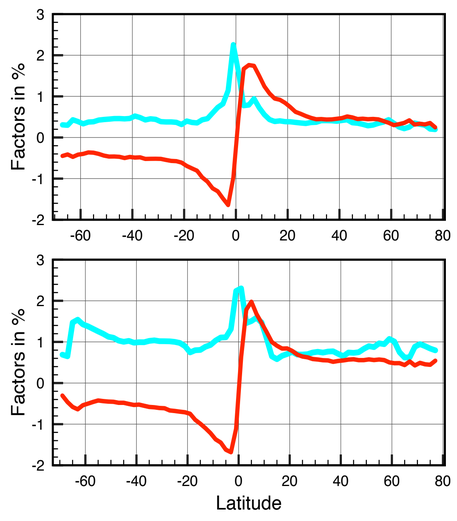

Figure 4. Zonally averaged factors *a* (blue) and *b* (red) for drogued drifters (upper) and for undrogued drifters (lower).

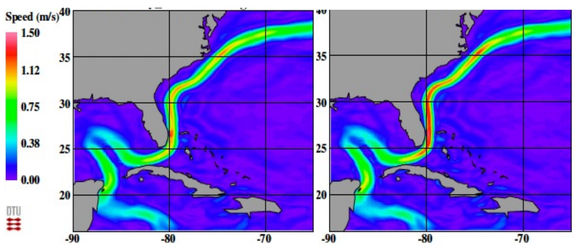

Figure 5. Geostrophic surface current speed associated with the DTUUH22MDT model (left) and the new preliminary combination MDT model (right).

The integration

The combination MDT was derived using a finite difference model into which both the geodetic reference MDT heights and the mean currents may be integrated. To represent covariances and reduce the effects of noise both minimum variance and minimum slope constraints are included. Furthermore, specific constraints at the coastlines was included in the inversion to avoid currents crossing the coastlines.

When deriving the DTUUH22MDT model the weights were determined, so that the effects of noise in the mean drifter velocities were reduced. Hence, the resulting models relatively smooth, perhaps too smooth. For the upcoming DTUUH25MDT model the weights have been adjusted to reveal more details. Many experiments have been carried out. The results are still being assessed. Hence, only a preliminary version of the upcoming DTUUH25MDT model is presented.

For comparison, the geostrophic currents of the DTUUH22MDT model are shown together with the geostrophic currents of the preliminary '25 model in Figure 5.

The geostrophic surface currents associated with the preliminary model for the new combination model DTUUH25MDT are shown in Figure 6.

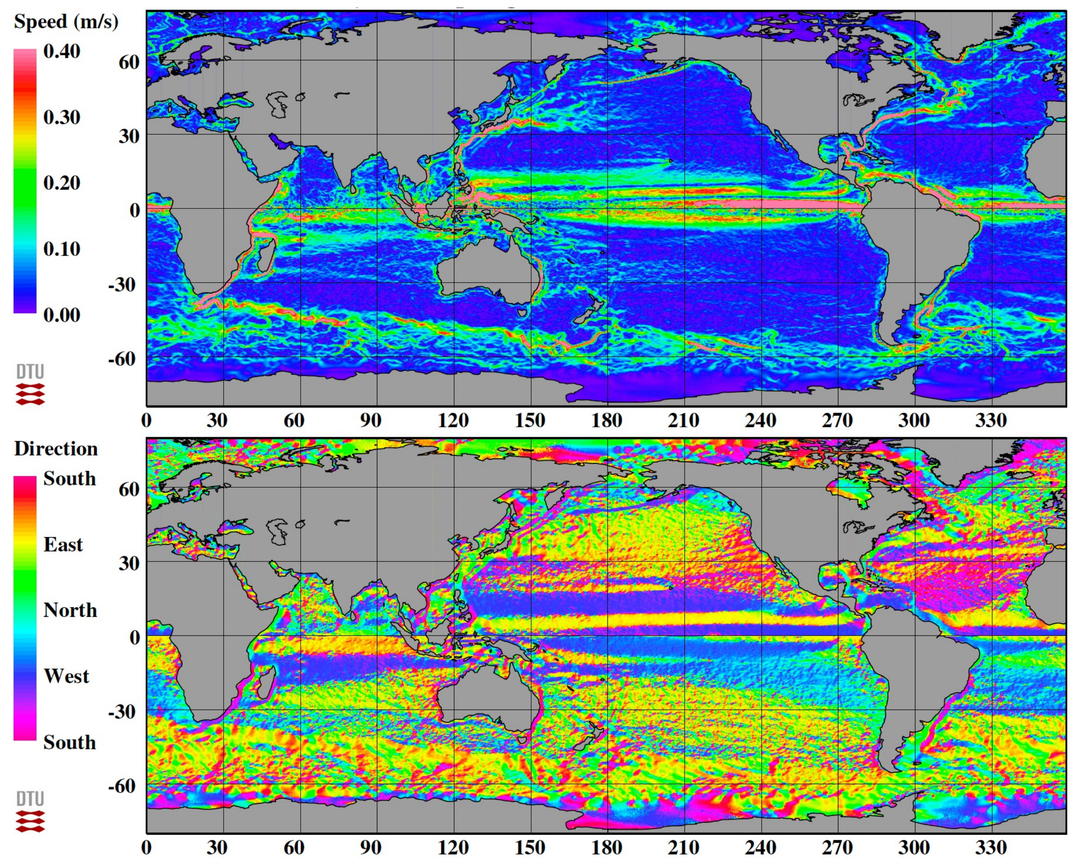

Figure 6. Geostrophic surface current speed and direction associated with the preliminary combination model.

Summary

A two step computation of the MDT is presented:

- An update of the geodetic MDT resulting in the model DTU25MDT and
- An integration of the geodetic MDT with drifter velocities resulting in a premilinary model of the upcoming combination model DTUUH25MDT.

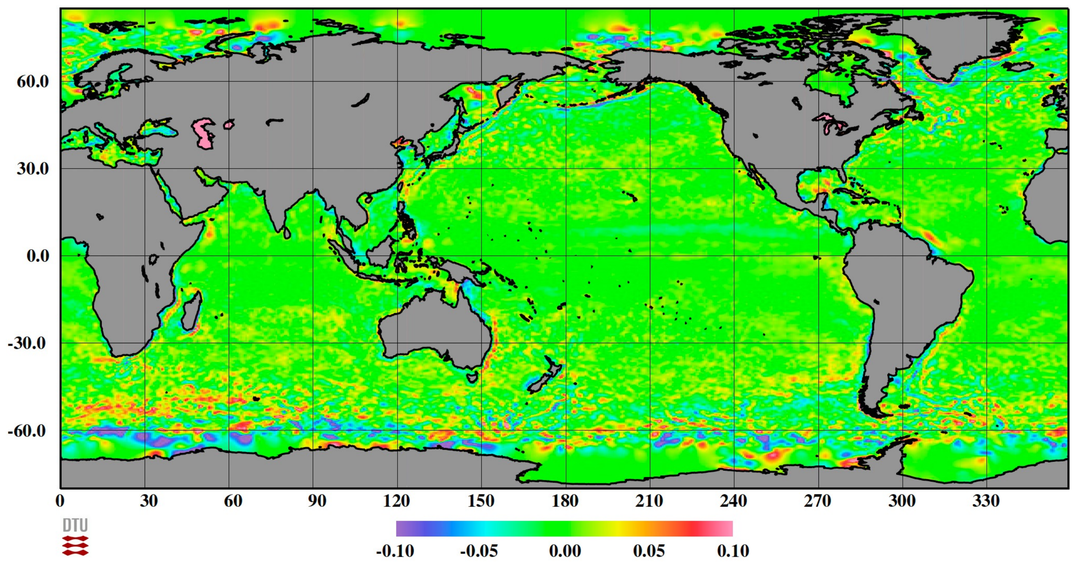

Figure 7. Differences in height [m] between the preliminary combination model and the DTU25MDT geodetic model.

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