Absolute dynamic topography

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The third and latest release of time-wise (TIM_R3) GOCE gravity model is used for the computation of geoid. TIM_R3 model is a GOCE-only model (12 months of GOCE data in the time interval 1 November 2009 to 14 April 2011), i.e., no external gravity field information has been used, neither as reference model, nor for constraining the solution [for more details, see *Bruinsma et al.* (2010) and *Pail et al.* (2011)]. TIM_R3 geoid is determined from TIM_R3 gravity models in the mean-tide system and relative to Topex-ellipsoid, in order to be consistent with the CNES_CLS10 Mean sea surface (MSS) data.

The computation of time-invariant Mean Dynamic Topography (MDT) from mean sea surface and geoid (G) is conceptually very simple as expressed by equation MDT = MSS – G. However as indicated by *Benveniste et al.* (2007) there are several issues that must be considered in order to obtain a good MDT product. All these issues are considered here by following the recommendations of GUT user tool box. A Gaussian filter of 140 km is applied to the CNES_CLS10 MSS data (integrated over the period 1993-2009) and the TIM_R3 geoid prior to the calculation of MDT in order to remove geoid commission error and the omission error according to *Knudsen et al.* (2011).

Absolute Dynamic Topography (ADT) from GOCE only MDT is determined as the sum of MDT and weekly sea level anomalies (SLA) from 1992-2012 at a spatial resolution of 0.25º obtained from Aviso produced by Ssalto/Duacs (http://www.aviso.oceanobs.com/duacs/) which are based on merged TOPEX/POSEIDON (T/P) and ERS-I and II. The weekly SLA is corrected for the inverted barometer effect, tides, and tropospheric effects. Weekly absolute velocities are obtained from ADT using standard geostrophic relation.

The current state of the art MDT, CNES_CLS09 MDT [*Rio et al.,* 2011] uses 4.5 year GRACE geoid. Recent studies show significant improvements of GOCE derived geoid and MDT over the GRACE satellite data at higher spatial resolution of around 100-200 km (*Bingham et al.,* 2011; *Knudsen et al.,* 2011). Hence a combined MDT (*Raj et al.,* 2012, in prep) which is a combination of coarser spatial scales (< 140 km) of CNES_CLS09 MDT and higher spatial scales (> 140 km) of GOCE MDT is determined. For this purpose, TIM_R3 MDT is added to coarser spatial scales (< 140 km) of CNES-CLS09 MDT to estimate the combined-MDT. The coarser spatial scales of CNES-CLS09 MDT is obtained by first applying a 140 km Gaussian filter to the original CNES-CLS09 MDT, and then subtracting the filtered MDT from the unfiltered one. This combined MDT is further added to SLA at a spatial resolution of 0.25º to determine ADT and absolute geostrophic velocities.

Dataset provided:

1. GOCE only
    a. TIM-R3 ADT

b. TIM_R3 absolute u and v velocities

2. Combined CNES-CLS09 and GOCE

   a. Combined ADT

   b. Combined absolute u and v velocities.

Data coverage: 40ºN to 90ºN and 180ºW to 180ºE

Note that due to the absence of SLA data beyond 81ºN, there is no valid ADT and velocity data above this point.

Grid: ~0.25º latitude and ~0.25º longitude

Time period: 14-OCT-1992 to 08-FEB-2012

These data are provided by Nansen Environmental and Remote Sensing Center.

Benveniste. J, Knudsen P, and the GUTS Team (2007) The GOCE user toolbox. In: Fletcher. K (ed) Proceedings of the 3rd international GOCE user workshop, 6–8 November 2006, Frascati, Italy. European Space Agency, Noordwijk.

Bingham RJ, Knudsen P, Andersen O, Pail R (2011) An initial estimate of the North Atlantic steady-state geostrophic circulation from GOCE. Geophys Res Lett 38:L01606. doi:10.1029/2010GL045633.

Bruinsma S.L., J. C. Marty, G. Balmino, R. Biancale, C. Foerste, O. Abrikosov and H. Neumayer (2010), GOCE Gravity Field Recovery by Means of the Direct Numerical Method, presented at the ESA Living Planet Symposium, 27th June - 2nd July 2010,Bergen, Norway; See also: earth.esa.int/GOCE.

Knudsen, P., R. Bingham, O. Andersen, M-H.Rio (2011), A global mean dynamic topography and ocean circulation estimation using a preliminary GOCE gravity field. Journal of Geodesy 2011, 85(11), 861-879. DOI 10.1007/s00190-011-0485-8.

Pail R., S. Bruinsma, F. Migliaccio, C. Foerste, H. Goiginger, W.-D. Schuh, E. Hoeck, M. Reguzzoni, J. M. Brockmann, O. Abrikosov, M. Veicherts, T. Fecher, R. Mayrhofer, I. Krasbutter, F. Sanso, and C. C. Tscherning (2011), First GOCE gravity field models derived by three different approaches, Journal of Geodesy., 85, 11, 819-843.

Raj. P. R., J. A. Johannessen, and J. E. Ø. Nilsen (2012), The GOCE geoid and the surface circulation of the northern Nordic Seas. *In prep.*

Rio, M. H., S. Guinehut, and G. Larnicol (2011), New CNES-CLS09 global mean dynamic topography computed from the combination of GRACE data, altimetry, and in situ measurements, J. Geophys. Res.,116, C07018, doi: 10.1029/2010JC006505.