GOCE+++

Height System Unification, Dynamic Ocean Topography and gravity field determination with GOCE

Newsletter Issue 1/31.01.2017

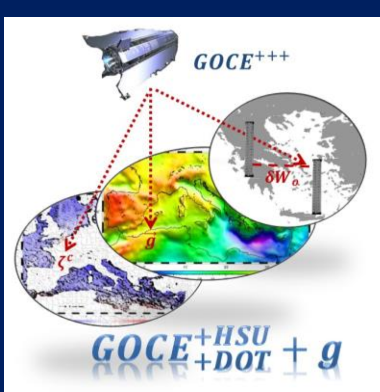
GOCE+++

The **GOCE+++**is funded by the European Space Agency (ESA) within its Scientific Experiment Development Program (PRODEX) following a successful application to the General Secretariat for Research & Technology (GSRT) after an invitation to the Greek scientific community. GOCE+++ is a continuation of the successfully completed GOCESeaComp Project, launched and funcded in response to the 1st PRODEX Programme Call for Greece.

Contract: C400106380 CN3

Duration: February 2016 –

July 2017



The GOCE+++ Project Logo

MEAN DOT DETERMINATION WITH GOCE DATA

With GOCE having completed its mission at the end of October 2013, there still exists a wide range of applications that GOCE-derived products can have a significant contribution to. The abundance of gravity data for the oceans, apart from a high-accuracy static gravity field, can offer unique insights to oceanographic, engineering and geophysical applications. Given the availability of recent GGMs from of GOCE, the latest GGMs from GOCE and GRACE data, GOCO05c will be used to determine mean DOT models for the entire Mediterranean Sea. The raw data used are Sea Level Anomaly (SLA) values from the Cryosat2 satellite for a period of 6 consecutive years 2010-2015 within the entire Mediterranean Basin ($30° \leq \varphi \leq 50°$ and $-10° \leq \lambda \leq 40°$). Cryosat2 data for the period 14/07/2010 (cycle 4) to 07/12/2015 (cycle 73) have been used, resulting in a total number of 795123 point values. The mission of Cryosat2 has a 369-day repeat orbit with a cross-track spacing of 7.5 km at the equator and ~140000 observations per year within the Mediterranean basin. The data have been downloaded from the RADS (RADS 2015) server (DEOS Radar Altimetry Data System) in the form of SLAs relative to EGM2008 (Pavlis et al. 2012), after applying all the necessary geophysical and instrumental corrections. By simply restoring the effect of EGM2008 to the SLAs, sea surface heights (SSHs) from Cryosat2 have been generated for the area under study. The so-derived Cryosat2 data will be used for the along-track DOT determination. Apart from the GOCE GGMs, the estimation will be based on the DTU2015 MSS model, which contains the latest satellite altimetry SSHs from the GEOSAT, ERS1/2, ENVISAT, T/P, Jason1/2 and Cryosat missions and presents a spatial resolution of 1 arcmin (~2 km) (Andersen and Knudsen 2009).

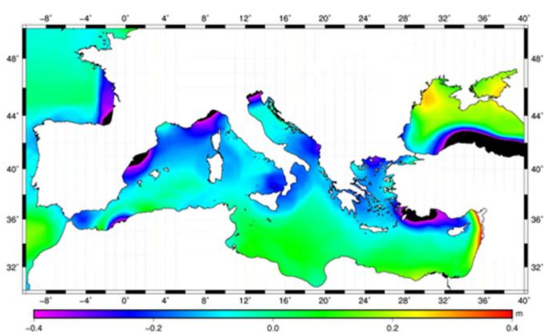


Figure 1: Initial field of DOT in the Mediterranean

MDOT DETERMINATION

The concept of DOT (ζ) estimation, either along-track or in 2D case, is quite simple in its notion and relies on the fact that it can be computed as the difference between the MSS and the geoid, taking into account that both are available for the area under study. Two points that need attention are that both the MSS and geoid fields should refer to the same reference ellipsoid and the same tidal system. Within GOCE+++, and in order to be compatible with the conventions in the satellite altimetry and oceanographic community, the T/P ellipsoid with equatorial radius of 6378.1363 km and a flattening of 1/298.257 (Dumont et al. 2008) and the mean-tide system will be used (Ekman 1989).

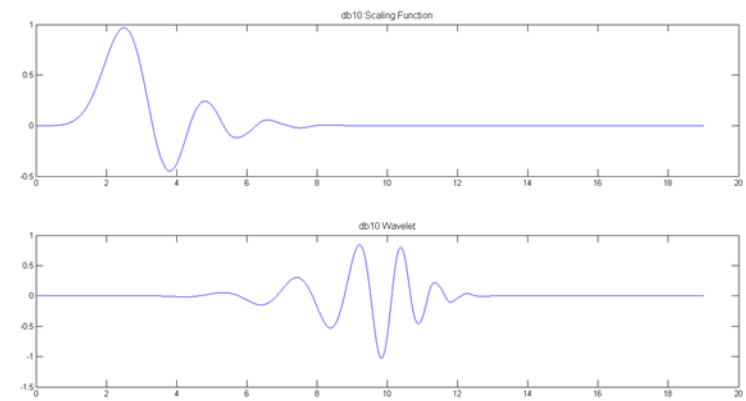


Figure 2: Daubechies 10 (db10) wavelet and its scaling function

After the estimation of the initial DOT, we have to remove or at least reduce, the influence of the δ_{NL} (geoid omission error) and δ_L (geoid commission error). The filtered DOT (ζ) is then estimated by filtering the residuals, or initial For the filtering, GOCE+++ will employ both spatial and spectral filtering. The filter functions tested for the 2D scenario refer to boxcar, Gaussian, cosine-arc and Wiener filters, and for all of them the smoothness of the estimated DOT is related to the filter width chosen (Oppenheim and Schaffer, 2014). Five different widths have been tested corresponding to spatial scales of 50, 100, 200, 400 and 600 km full wavelength.

As far as the spectral filtering is concerned, WL MRA and FIR are examined. The wavelet transform (WT) is based on wavelets ψκχ as basis function in order to represent other functions. The wavelet function ψ carries valuable information about the signal, while the scaling function φ reveals the functional approximation (Mallat 1999). Since wavelets are base functions with localization properties in both space (time) and frequency (scale) domains, there can be a MRA) at various levels of decomposition (Mallat 1989), with each level of decomposition Li corresponding to a different range of spatial resolution. For the WT, an orthogonal wavelet, i.e., Daubechies 10 wavelet (db10) has been selected which is actually a good choice for potential field data since it indicates that p to the 10th moment (derivative) of the field will be zero The third objective of the project is *to determine an improved geoid model for the wider Hellenic territory using GOCE SGG data and local free-air gravity anomalies*. The refinement of the regional geoid for the wider Hellenic region is a key issue, taking into account that the current national geoid dates back to the late ‘80s and is obsolete. Moreover, a combined GOCE-based and local gravity anomaly geoid can serve as the reference surface for engineering applications as well as for environmental monitoring. GOCE SGG data can fill the gap in the existing local gravity databases, especially over mountainous terrain where in-situ observations are scarce or non-existent.

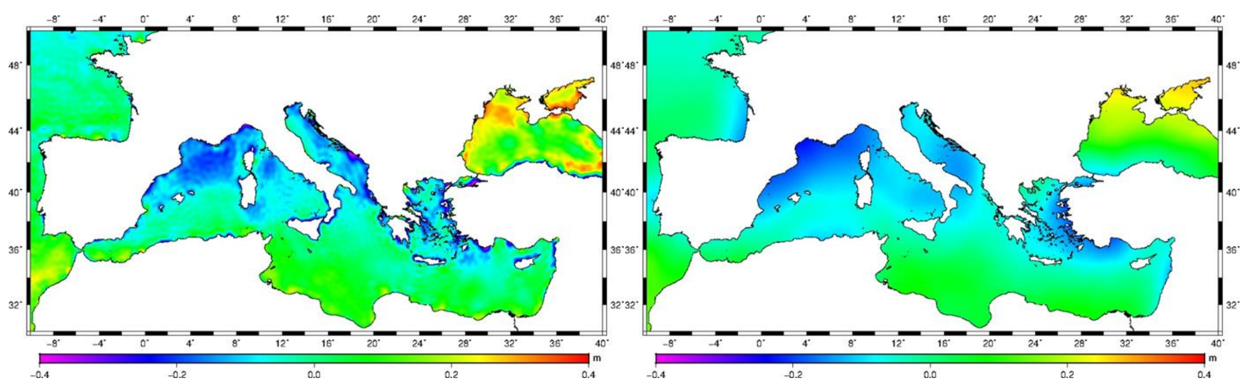


Figure 3: DOT in the Mediterranean after the application of Boxcar 50 km filter(left) and 60 km (right)..

WL MRA allows the decomposition of the signal in distinct levels, each corresponding to a different spectral range. Then, filtering can be performed to each level separately retaining the rest un-altered. Moreover, the signal reconstruction can be achieved during the synthesis process by combining only some levels and omitting the rest. In the present scenario, Level 1 corresponds to spatial scales between 9 km and 18 km, so the band-limited signal offered by GOCE constitutes this level unusable, since it contains only the geoid omission error and noise. As already mentioned, the WL MRA has been carried out based on the db10 wavelet. Through the synthesis process various DOT models can be determined, since each level can be represented by a different model, based on the data performance at each specific level of analysis. Hence, various levels can be combined in the synthesis process in order to provide improved representations of the DOT. This aims at reducing the omission and the commission errors still remaining in the DOT. When GOCE/GRACE GGMs are analysed the gravity signal of the first levels (high-frequencies) is dominated by noise since these spatial scales are not mapped by the GOCE mission. Each level is analysed in an approximation coefficient and three detail coefficient.

Table 1:Statistics of new synthesized fields

MODEL		max	min	mean	rms	std
2_12	DOT (m)	0.42	-0.45	-0.003	0.119	0.119
	vel (m/s)	3.239	0.000	0.328	0.473	0.341
	v (m/s)	2.696	-3.202	-0.001	0.356	0.356
	u (m/s)	2.334	-2.269	0.000	0.311	0.311
3_12	DOT (m)	0.417	-0.423	-0.003	0.114	0.114
	vel (m/s)	3.078	0.000	0.229	0.324	0.229
	v (m/s)	3.071	-2.404	-0.001	0.259	0.259
	u (m/s)	1.618	-1.556	0.001	0.194	0.194
4_12	DOT (m)	0.397	-0.436	-0.005	0.110	0.110
	vel (m/s)	1.054	0.000	0.14	0.185	0.121
	v (m/s)	0.991	-1.053	-0.002	0.147	0.147
	u (m/s)	0.703	-0.601	0.000	0.113	0.113
5_12	DOT (m)	0.358	-0.325	-0.009	0.107	0.107
	vel (m/s)	0.553	0.000	0.097	0.119	0.069
	v (m/s)	0.329	-0.529	-0.004	0.093	0.092
	u (m/s)	0.293	-0.326	0.001	0.075	0.075
6_12	DOT (m)	0.316	-0.251	-0.016	0.105	0.104
	vel (m/s)	0.228	0.000	0.064	0.074	0.038
	v (m/s)	0.222	-0.227	-0.004	0.057	0.057
	u (m/s)	0.141	-0.147	0.000	0.047	0.047
7_12	DOT (m)	0.314	-0.027	-0.025	0.097	0.094
	vel (m/s)	0.116	0.000	0.038	0.043	0.02
	v (m/s)	0.103	-0.061	-0.005	0.026	0.026
	u (m/s)	0.107	-0.054	0.005	0.034	0.034

Contact Us

GeoGrav - AUTh
Department of Geodesy and Surveying, Aristotle University of Thessaloniki
University Campus, University Box 440, GR-54124
Thessaloniki, Greece
T: ++302310996125 | **F**: ++302310995948
tziavos@topo.auth.gr & vergos@topo.auth.gr
http://olimpia.topo.auth.gr/GOCE_HSU_DOT_G/