GOCE+++

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

Newsletter Issue 1/31.05.2017

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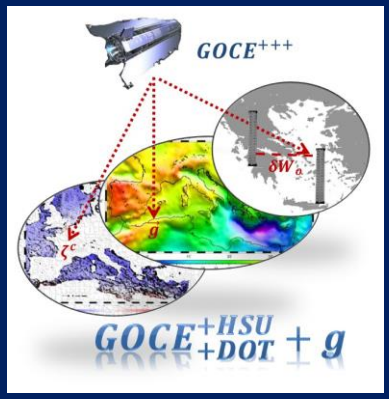
The **GOCE+++**is funded by the European Space Agency (ESA) within its Scientific Experiment Development Program (PRODEX) following a successful application to the General Secretariat for Research & Technology (GSRT) after an invitation to the Greek scientific community. GOCE+++ is a continuation of 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

THE GOCE+++ HEIGHT SYSTEM UNIFICATION OVER MAINLAND GREECE

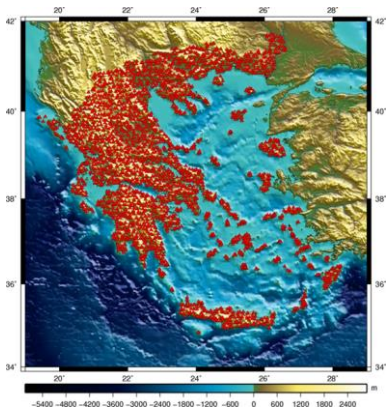


Figure 1: Spatial distribution of the GPS/leveling point values.

The methodology for HSU over mainland Greece and the Greek islands will be based on an estimation of W_o^{LVD}using surface gravity and geoid heights computed from a GGM and GPS/Levelling data. The geopotential number is the potential difference between an equipotential surface (W_i) and a reference equipotential surface (W_o^{LVD}) along a plumb line. The geoid is the traditionally used reference geopotential surface; a local/regional geoid model realizes the origin of a local vertical datum (W_o^{LVD}), while a global geoid model realizes the origin of a global (W_o^{CVD}) conventional vertical datum.

Two different approaches have been tested in order to determine the W_o^{LVD}over mainland Greece. The first one by employing the following equation and the available local data and GOCE-derived GGMs without the use of any weighting scheme.

$$\hat{W}_0^{LVD} = \frac{\sum_{i=1}^{m} W_0^{LVD}}{m} = W_0^{CVD} - \frac{\sum_{i=1}^{m} \Delta C_i^{CVD/LVD}}{m}$$

Table 1: Estimated $\hat{W}_o^{LVD}$ for the Greek mainland from EGM2008 and the GOCE-based models, all evaluated to their maximum d/o of expansion. Unit: [m2/s2].

	$\hat{W}_o^{LVD}$
EGM2008	62636859.9129±0.0317
TIM-R5	62636859.8530±0.1094
TIM-R5 Comb	62636859.9647±0.0314
DIR-R5	62636859.7890±0.1134
DIR-R5 Comb	62636859.9216±0.319
GOCO05s	62636859.7953±0.1168
GOCO05s Comb	62636859.8902±0.0312

In the second one, because in the results a correlation with height was noticed weighted adjustment scheme has been investigated. In each

observation a spectral weight p_i is assigned. Two scenarios are investigated, one with $p_i = {}^{1}/_{H_i}$, where H_i is the orthometric height of each BM and another with $p_i = {}^{1}/_{L_i}$, where L_i is the spherical distance between each BM and the Piraeus TG station, the latter being the origin of the Hellenic LVD. The same adjustment is carried out with the combined estimation of a height dependent parameter λ, which should absorb the height correlations. It should be stressed that the assignment of weights and/or the introduction of the height-dependent parameter λ are ambiguous, since they are based on the assumption that the correlation with height is due to the inherent lower accuracy of spirit leveling when measuring high level differences. The same holds for the weight scheme with $p_i = {}^{1}/_{L_i}$, where it is assumed that since all levelling traverses have started from Piraeus, the largest the distance from the TG the largest the leveling errors should be.

*Table 2: **E**stimated $\widehat{W}_o^{LVD}$ for the Greek mainland from the EGM2008 various weights and a height dependent parameter. Unit: [m2/s2].*

	$\widehat{W}_o^{LVD}$
EGM2008	62636859.9129±0.0317
EGM2008 ($p_i = {}^{1}/_{H_i}$)	62636860.2078±0.0048
EGM2008 ($p_i = {}^{1}/_{L_i}$)	62636859.7933±0.0023
EGM2008 *(λ only)* *λ=-0.000209921 m/s²*	62636860.0200±0.0316
EGM2008 (λ & $p_i = {}^{1}/_{H_i}$) *λ=-0.000621924 m/s²*	62636860.230±0.0048

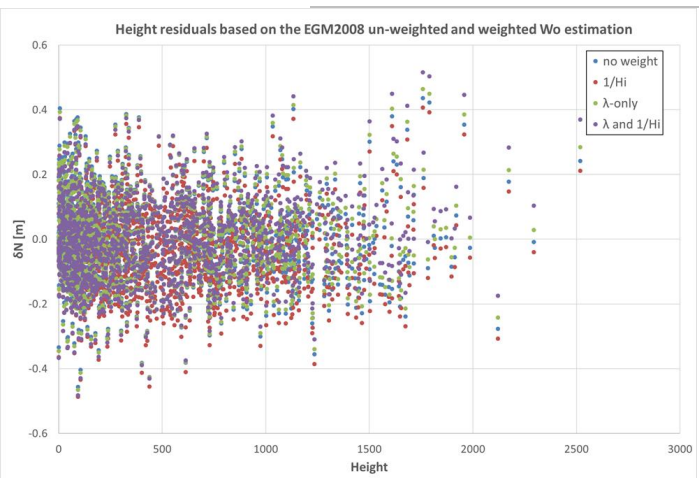


Figure 2: Height residuals from the un-weighted and weighted EGM2008 $\widehat{W}_o^{LVD}$ estimation.

WL-MRA FILTERING IN DOT

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.

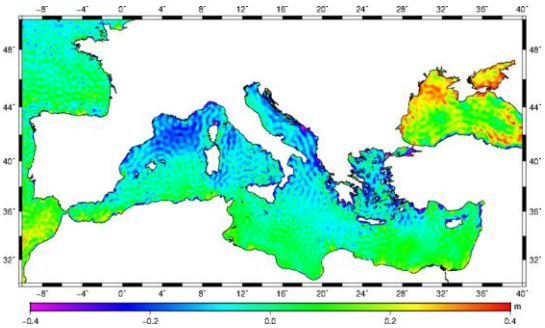


Figure 3: DOT in the Mediterranean for the synthesized field of levels 2 to 12.

By omitting only Level 1 which corresponds to spatial scales between 9 km and 18 km, there is still in GOCE unusable signal, since it contains geoid omission error and noise. When filed of levels 4 to 12 is tested, level 4 corresponds to spatial scales of 72 to 144 which are close to the scales targeted by GOCE missions (larger than 100 km). As a result, we get better results than the previous fields and errors due to the presence of land are smaller.

The last two synthesized fields tested in WL-MRA were created by omitting the first five levels and by omitting the first six levels. So, in these two cases GOCE signal is taken in account after 288 km. As a result, by this choice not only noise but also useful signal of GOCE satellite is lost. This fact is depicted both in Figure 5 and Figure 6 in which DOT is presented and both depict smooth fields.

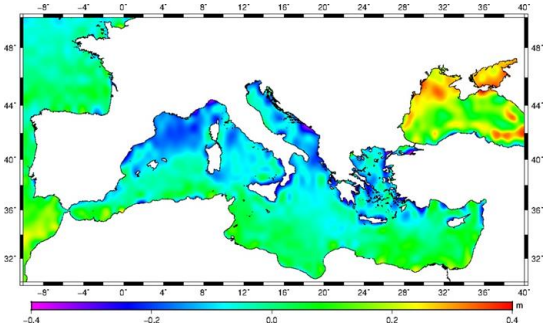


Figure 4 DOT in the Mediterranean for the synthesized field of levels 4 to 12.

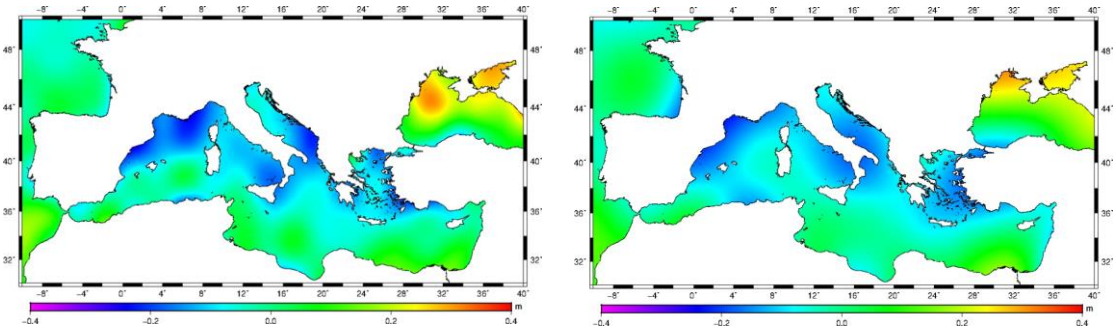


Figure 5: DOT in the Mediterranean for the synthesized field of levels 6 to 12(right) and levels 7 to 12 (left).

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