GOCESeaComb

External calibration/validation of ESA's GOCE mission and contribution to DOT and SLA determination through stochastic combination with heterogeneous data

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GOCESeaComb

The **GOCESeaComb** project 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 in response to the 1st PRODEX Programme Call for Greece.

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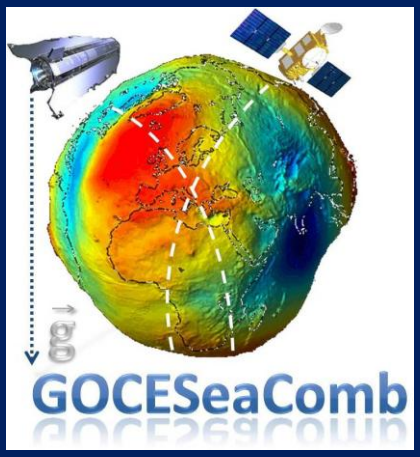
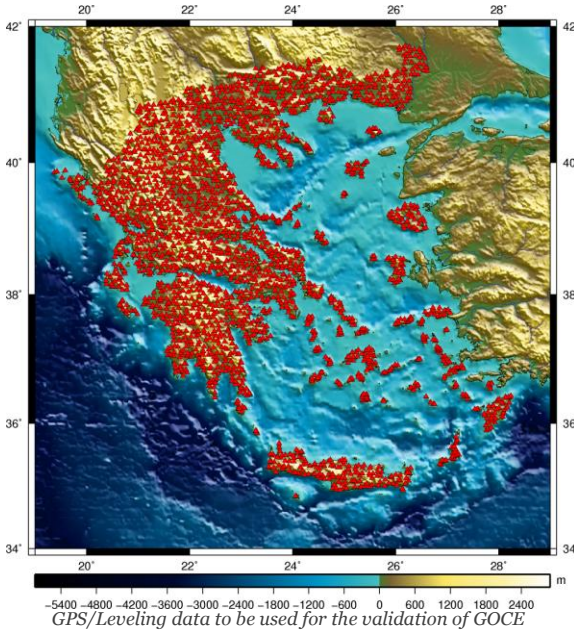
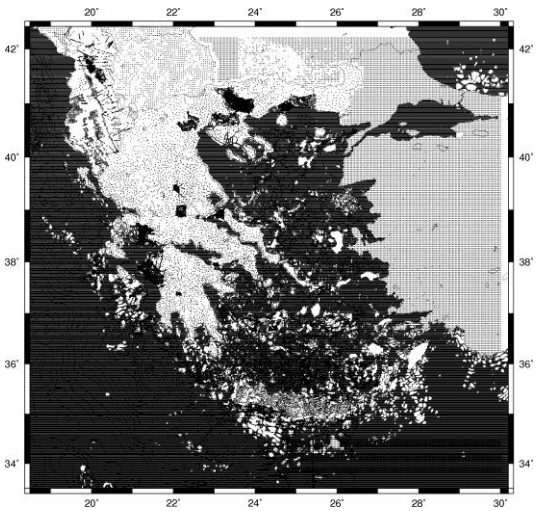


The GOCESeaComb Project Logo

GOCESeaComb methodologies for GOCE validation



GPS/Leveling data to be used for the validation of GOCE observables, geoid models, etc.



Gravity data to be used for the validation of GOCE observables, geoid models, etc.

During the period of this newsletter and since the last newsletter in October 2012, all project activities are going according to schedule. During this two month period, the needed terrestrial and satellite data for the project implementation have been collected and archived to the project server.

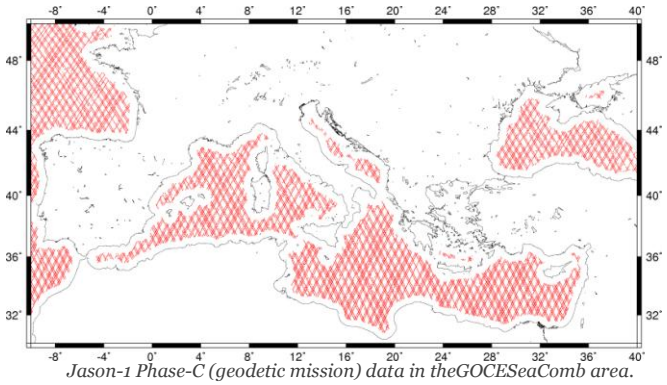
GPS/Leveling BMs

Within this frame, the local data refer to GPS/Leveling observations at collocated BMs. These cover Greece entirely, both the mainland and the islands. The orthometric heights come from the Hellenic Geographic Military Service (both spirit and trigonometric leveling), while the ellipsoidal ones from the Hellenic Positioning System (HEPOS) project. The GPS/Leveling observations have been unified in terms of the tidal model used (all referred to the tide-free system) and the ellipsoid (all referred to GRS80). Moreover, blunder detection and removal has been carried out with a simple 3rms test.

Gravity data

The gravity data consist of ~200k free-air gravity anomalies over land and marine areas unified in terms of the reference ellipsoid, tide system used and gravity reference system. This database refers to irregularly distributed point

gravity data over Greece, with a mean accuracy of 5 mGal generated at an earlier stage by the research team. All data have undergone a blunder detection and removal test with least-squares collocation. For the GOCE GGM validation, geoid estimation, SLA monitoring and DOT determination, and as far as the local gravity data are concerned, a 3 arcsec DTBM (Digital Terrain and Bathymetry Model) has been generated for the area under study to provide the high-frequency content of the gravity field spectrum.



Jason-1 Phase-C (geodetic mission) data in theGOCESeaComb area.

Models	n_{max}	***Data***
EGM2008	2190	S(GRACE), G, A
EIGEN-51C	359	S(GRACE, CHAMP), G, A
EIGEN-6C	1420	S(GOCE, GRACE, LAGEOS), G, A
GOCO01S	224	S(GOCE, GRACE)
GOCO02S	250	S(GOCE, GRACE, CHAMP, SLR)
GOCO03S	250	S(GOCE, GRACE, CHAMP, SLR)
ITG-GRACE2010S	180	S(GRACE)
GIF48A	360	S(GRACE), G, A
DIR_R1	240	S(GOCE + background model EIGEN-51C)
DIR_R2	240	S(GOCE+ background model ITG-GRACE2010S)
DIR_R3	240	S(GOCE, GRACE, LAGEOS)
TIM_R1	224	S(GOCE)
TIM_R2	250	S(GOCE)
TIM_R3	250	S(GOCE)
SPW_R1	210	S(GOCE)
SPW_R2	240	S(GOCE)
DGM-1S	250	S(GRACE, GOCE)

Satellite altimetry data

As far as satellite altimetry data are concerned, the missions of Jason-1, Jason-2, ERS-1, ERS-2 and ENVISAT will be used. All mission data have been collected in the form of SLAs referenced to EGM2008, with unified geophysical and instrumental corrections applied. Especially for Jason-1 the latest Phase C (geodetic mission) SSHs will be incorporated as well for as long as the mission remains operational. For Jason-2, data collection will be a work in progress since the satellite is operational, so that all new cycles will be collected as they become available.

Satellite gravimetry data

As far as satellite gravity are concerned, all the latest GOCE, GOCE/GRACE and combined GGMs have been collected (see insert on the left for a list of the models collected). The GGMs have been unified in terms of the tide system they refer to (the TF system was used), reference ellipsoid (GRS80 used throughout), while the zero-degree harmonic term (N_o) of the GGM contribution has been determined for all models relative to the latest IERS conventions. In all cases, W_o was set to its IAG-nominal value of 62636856.0 m^2/s^2 and a mean Earth radius (R) of 6371008.7714 m was used. Moreover, GOCE gradiometric observations have been collected in the form of Level 2 data (SST_NOM_2), i.e., processed second order derivatives (gravity gradients) of the gravity potential in a local North-East-Up Earth Fixed Reference Frame. GOCE gradiometric observations mentioned earlier are tagged only with their GPS time of acquisition and refer to the GRF. Therefore, a transformation from GRF to IRF and from IRF to EFRF is needed, with all detailed information provided in the SST_PSO_2 product. The GOCE gradiometric observations need to be transformed from the given GRF to IRF, then from IRF to EFRF and finally from EFRF to LNOEF, so that they can be combined with other data (altimetry, local gravity and GPS/Leveling, GGMs, topography/bathymetry, etc.) and be presented in a more meaningful from the GRF earth-based reference system.

GOCESEACOMB METHODOLOGIES FOR GOCE VALIDATION

GOCE data validation will be performed following three main approaches. The first one refers to the evaluation of the GOCE/GRACE based GGMs signal and error in the form of the provided degree and error variances. The second refers to an external evaluation of the GGMs against the local gravity and GPS/Leveling data for various degrees of GGM expansion. The third one will be based on the evaluation of the spectral content of the GOCE/GRACE GGM via a wavelet-based and FFT-based multi-resolution analysis. The validation refers firstly to the external calibration/validation of GOCE data against terrestrial gravity data available by the research team both for continental areas (mainland Greece) and marine regions. As far as GOCE data are concerned, the Level 2 data of the satellite will be used in the form of GOCE-only global geopotential models (GGMs). In a first step, we will use anomaly differences between coefficients from CHAMP-only, GRACE-only and GOCE-only GGMs with the coefficients provided by EGM2008 as reference. The same will be performed for anomaly error degree variances for the same models, so that the corresponding RMS anomaly differences per degree will be computed. The second methodology will be based on the estimation of the anomaly degree variances from the power spectral density (PSD) of the differences between the GGMs from each satellite and EGM08, as well as the

local (terrestrial and marine) gravity data. It should be noted that the contribution of CHAMP, GRACE and GOCE models will be validated for various degrees of expansion, so that an external estimate of the total commission and omission errors can be performed as well. Finally, the idea behind the multi-resolution analysis (MRA) with wavelets is that the two-dimensional wavelet transform can give wavelet coefficients at different spatial scales L_i, while these scales are connected and directly related to the signal frequencies, i.e., harmonic degrees of expansion. Therefore, for each scale of analysis the signal can be analyzed in an approximation and three detail coefficients (horizontal, vertical and diagonal), so that extreme values in the latter coefficients can allow, through the 2D-MRA, to localize the magnitude of the difference, its wavelength and structure.

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