Estimating Geoid and Sea Surface Topography in the Mediterranean Sea (the GEOMED 2nd project)

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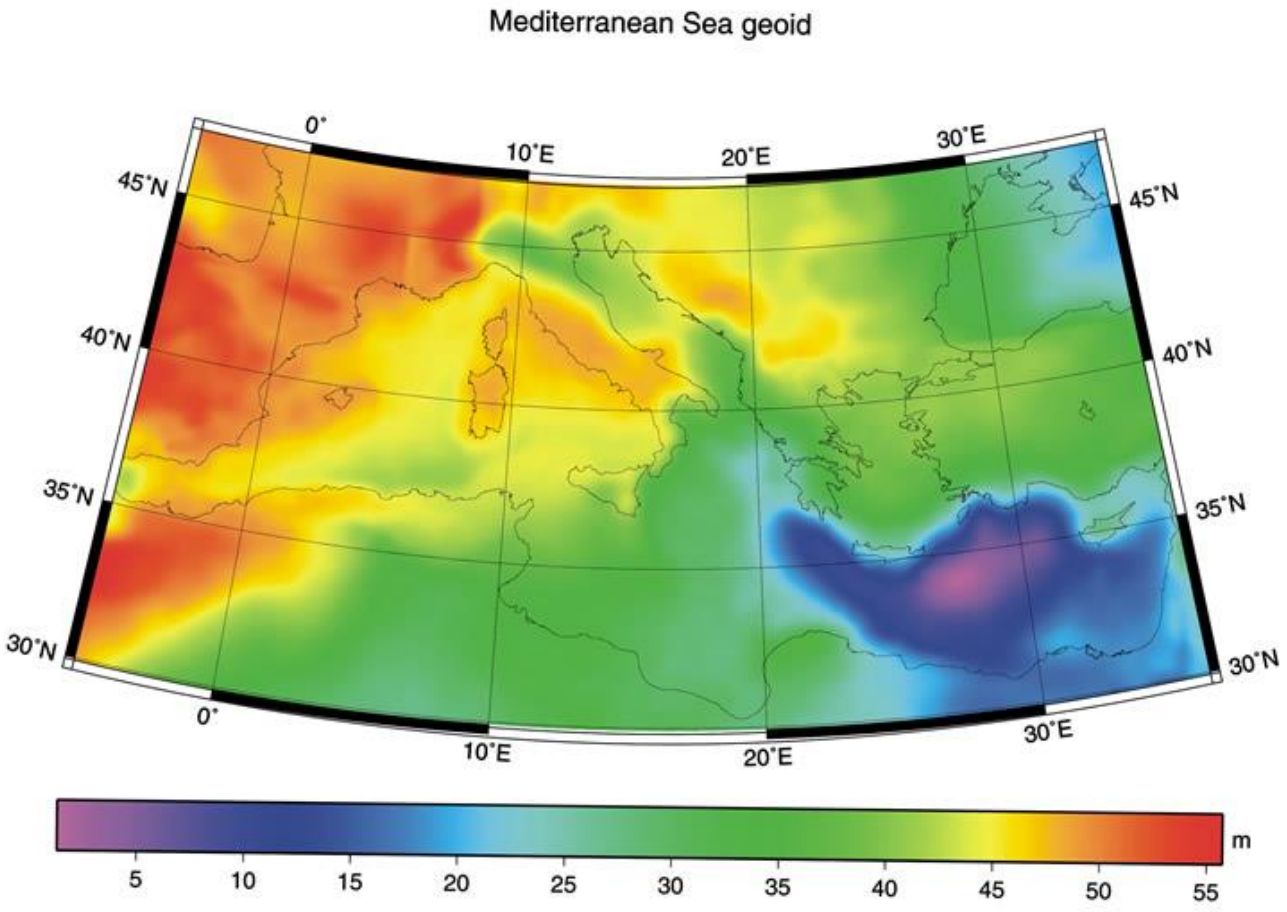
The GEOMED 2nd project (2014-2016)

Estimating the geoid and the SST in the Mediterranean Sea
($31° < \varphi < 47°$ $\quad -9° < \lambda < 39°$)



The GEOMED project geoid (1994)

The project plan (funded by ESA)

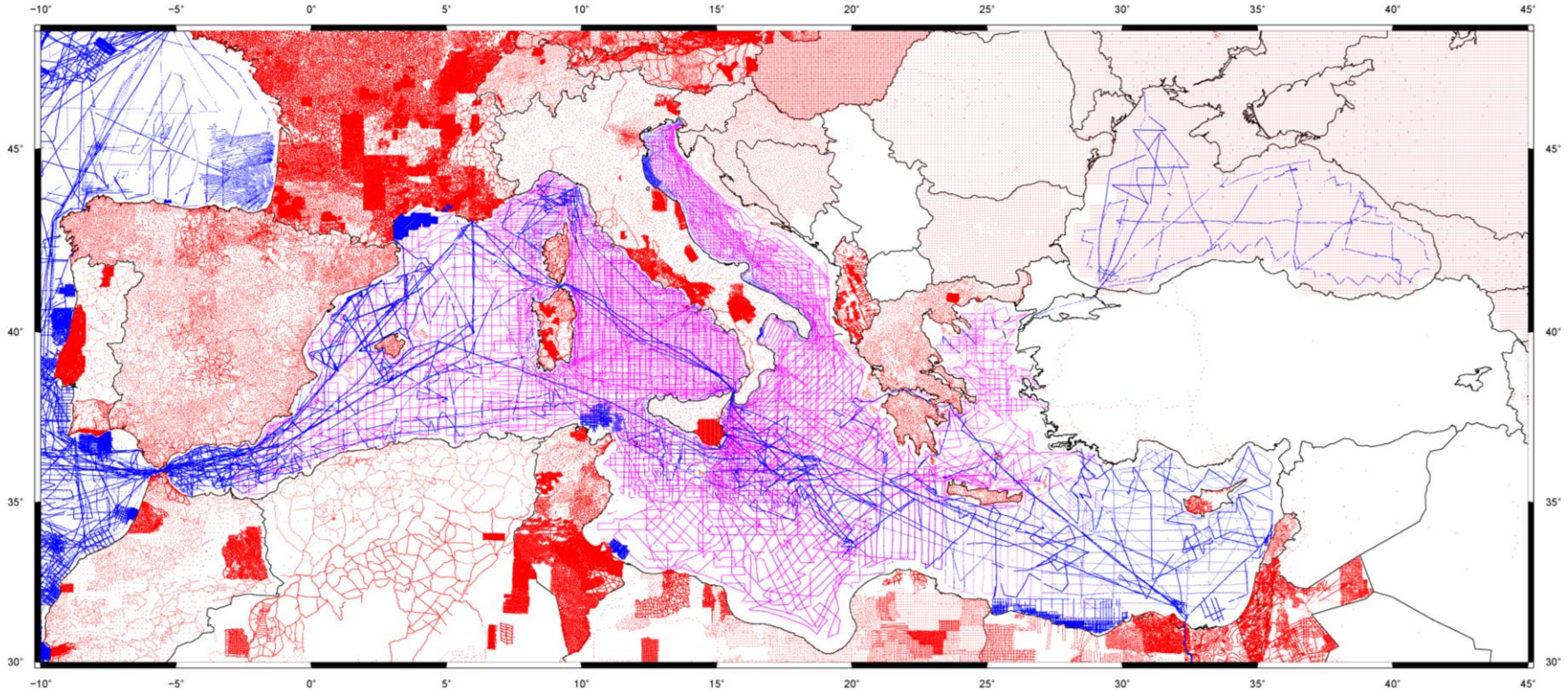
Start date	*End date*	*Task*
07/2014	*09/2014*	*Compilation and evaluation of marine and terrestrial gravity data*
11/2014	*01/2015*	*Preprocessing of marine gravity data*
09/2014	*07/2015*	*Control measurements of terrestrial gravity*
11/2014	*08/2015*	*Preprocessing of terrestrial gravity data*
08/2015	*12/2015*	*Computation of the geoid grids (gravimetric and combined)*
12/2015	*01/2016*	*Computation of the Mean Dynamic Topography (MDT) grids and the currents*
12/2015	*03/2016*	*Evaluation of geoids and MDTs*

The project databases&methods

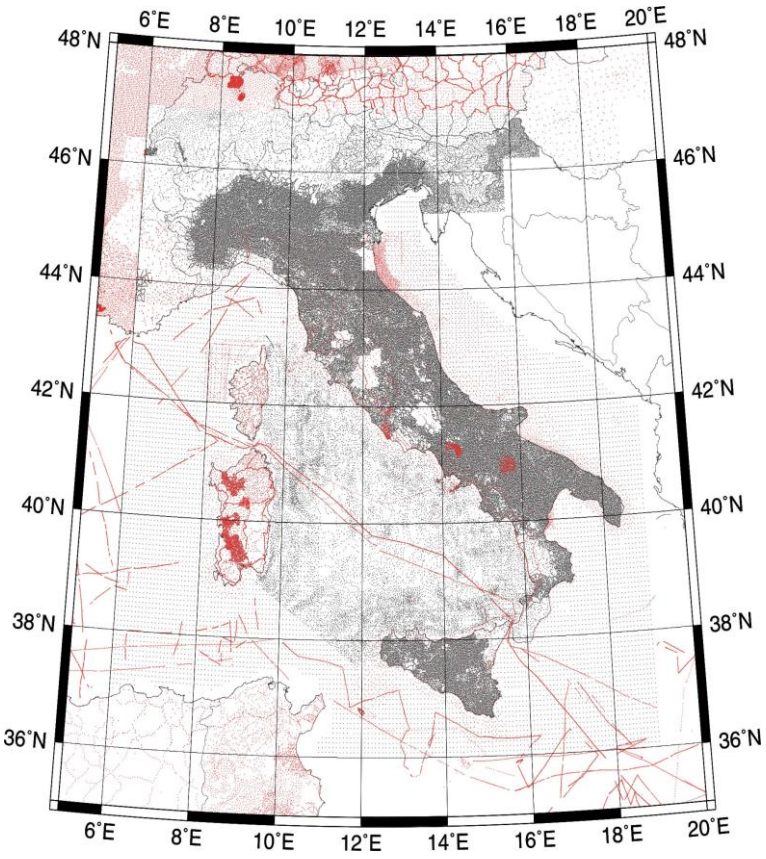
- Gravity data on land and sea (BGI+other national databases)
- Global Geopotential Model from GOCE mission
- Satellite altimetry
- SRTM DTM integrated with bathymetry (e.g. the MISTRAL model)

- Geoid estimation will be carried out using: windowed collocation, fast-collocation, FFT-1D, Stokes integral approach

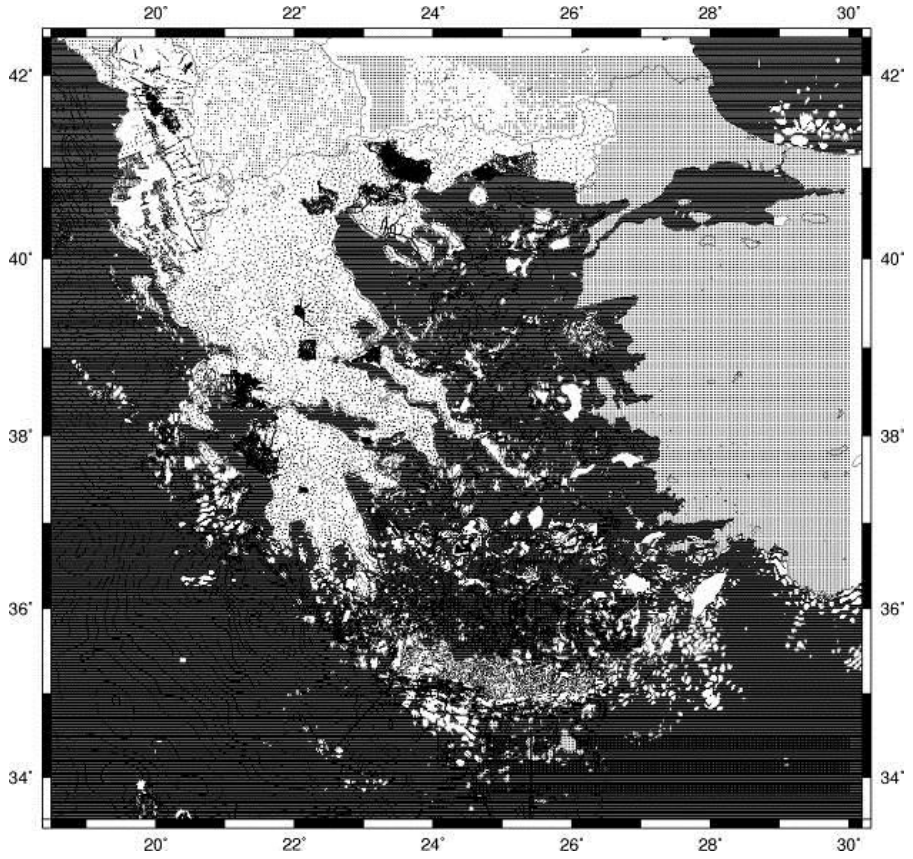
The existing gravity data coverage (source BGI)



The Italian and the Greek gravity databases



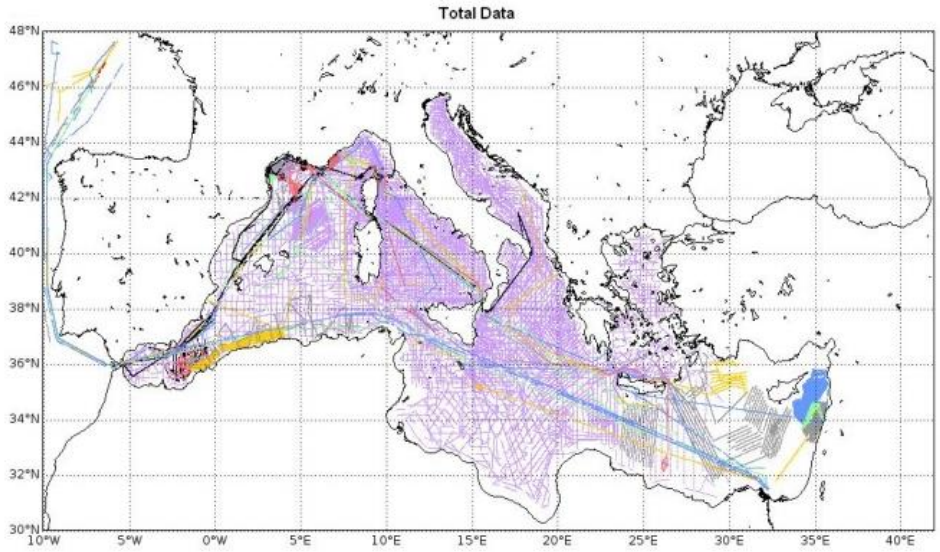
The Italian gravity database



The Greek gravity database

The marine gravity database

A part of marine gravity data have been validated==> ship survey data and Morelli dataset



Total dataset
Number of Crossing points differences = 23038
differences : σ = 3.78 +/- 0.02 mgal

Differences in mgal	EGM08 1834	EIGEN6C2	EIGEN6C3	DTU10	Sandwell 20	GOCE Dir5
Survey data (2 727191 pts)	-1.8 (+/-6.)	-1.66 (+/-5.6)	-1.59(+/-5.7)	-1.81(+/-5.2)	-0.78 (+/-4.)	-8.64(+/-25.8)
Morelli data (100843 pts)	4.31(+/-6.)	4.14(+/-5.8)	4.14 (+/-5.6)	4.25 (+/-5.4)	4.57 (+/-5.1)	0.63 (+/-22.7)

The GOCE model: the DIR5 solution
(available to users at ESA and ICGEM web pages from mid July)

LAGEOS-1/2 SLR data

1985 – 2010 of GRGS release 2 normal equations to degree/order 30

GRACE GPS-SST and K-band range-rate data

Feb 2003 – Dec 2012 of GRGS release 3 normal equations to degree 175

One GRACE/LAGEOS normal equation up to d/o 175, reduced above degree 130 before accumulating with GOCE normal equations

+

GOCE:

SGG data (Txx, Tyy, Tzz, Txz) from 01 November 2009 – 20 October 2013

- *Txx reconstructed for 8/2012, and Tyy reconstructed for 6-7/2013*

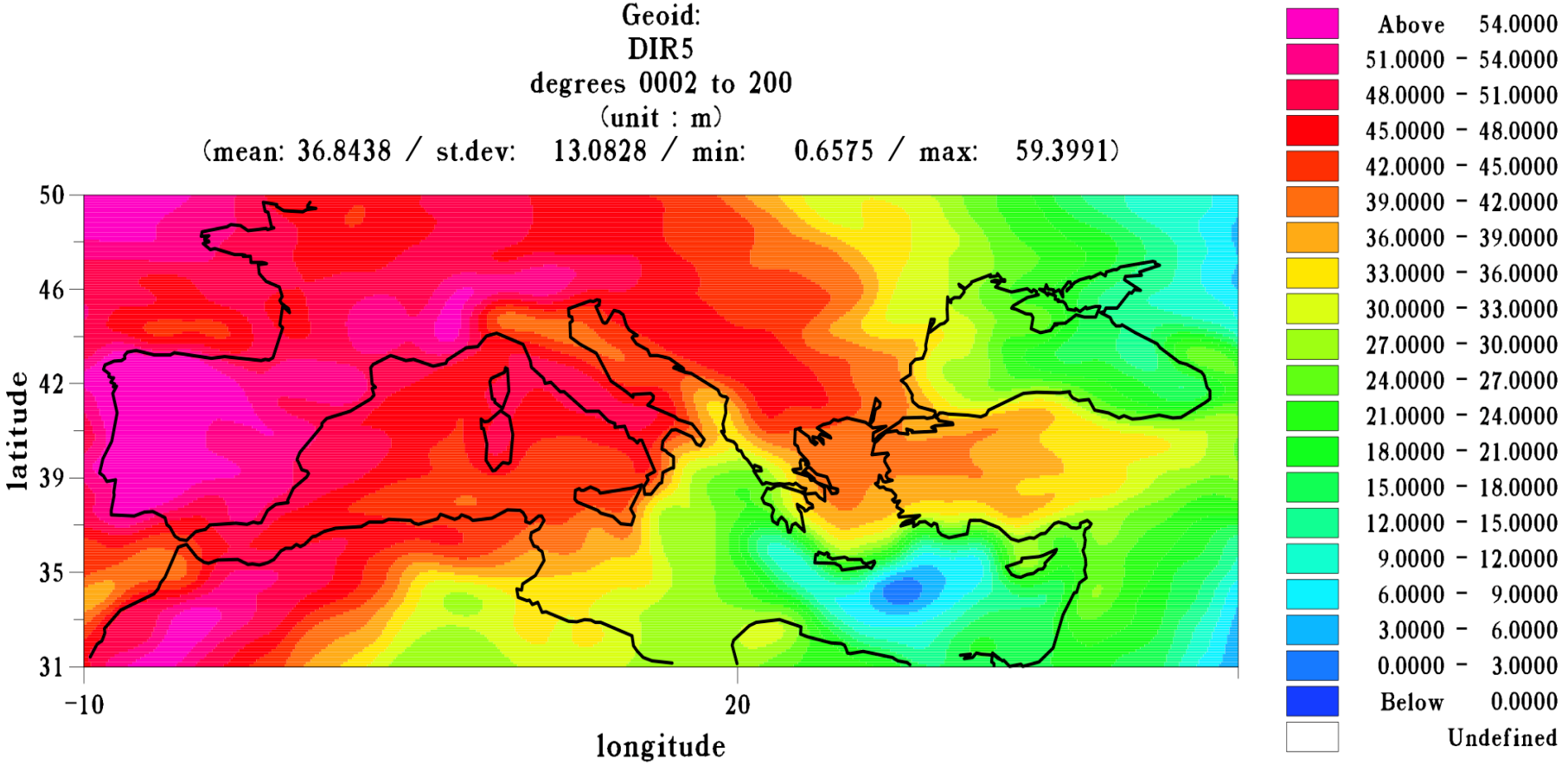
weighting per measurement (based on RMS of residual), cos-latitude weighting

normal equations for each SGG component (4) up to degree/order 300

application of a (120 – 8) s band-pass filter for all four SGG components

The SGG signal is filtered-out below degree ~ 45

The GOCE - DIR5 estimate over the Mediterranean area



REMARK: we plan to use this solution to d/o 200-220

The GOCE - DIR5 estimate VS EGM2008 in the Mediterranean area (spectral comparisons using GPS/lev and gravity)

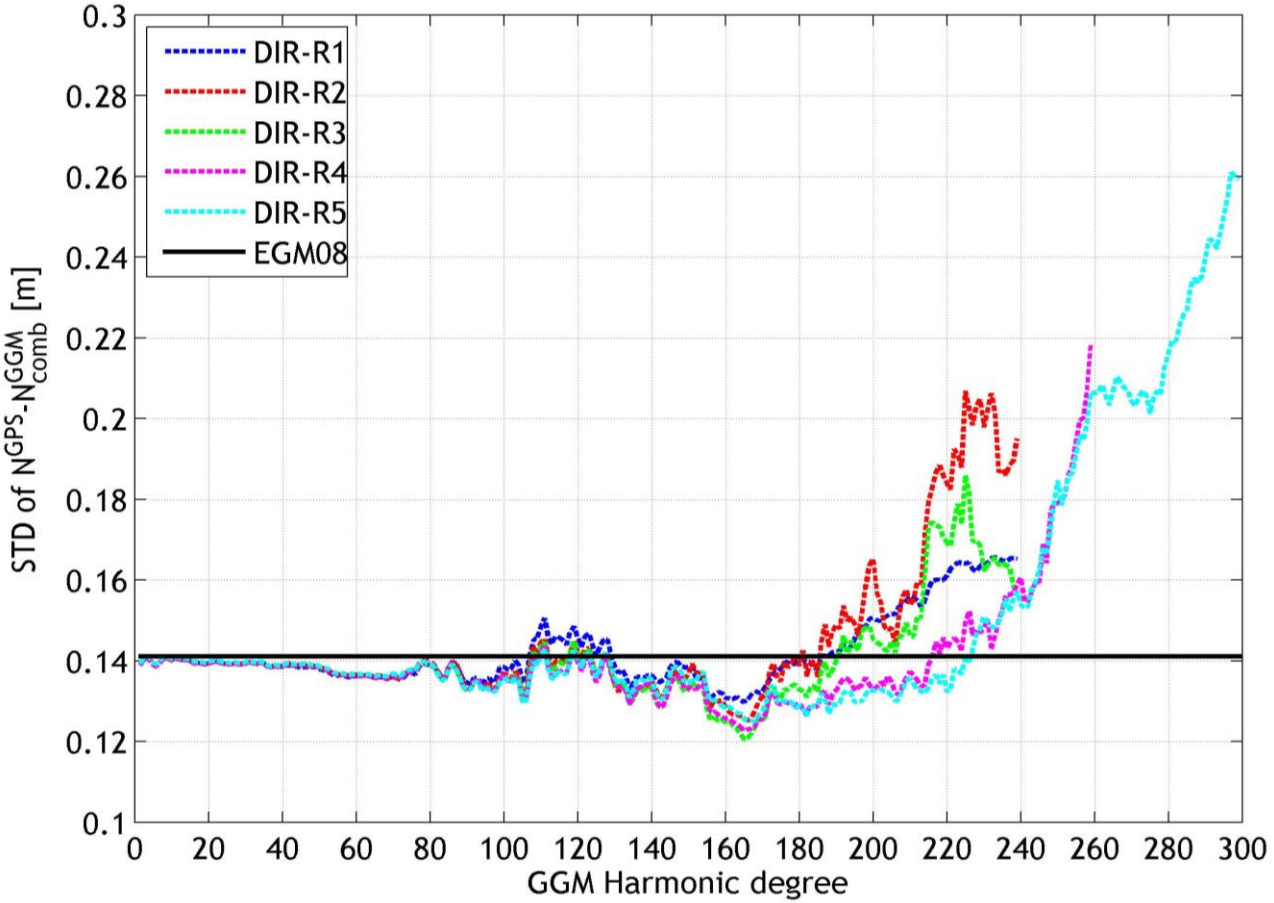
$$\Delta g_{res}^{(a)} = \Delta g_{obs} - \Delta g_{GOCE}\Big|_2^n - \Delta g_{EGM\,2008}\Big|_{n+1}^{2159} - A_{RTC}$$

$$N_{res}^{(a)} = N_{GPS/lev} - N_{GOCE}\Big|_2^n - N_{EGM\,2008}\Big|_{n+1}^{2159} - N_{RTC}$$

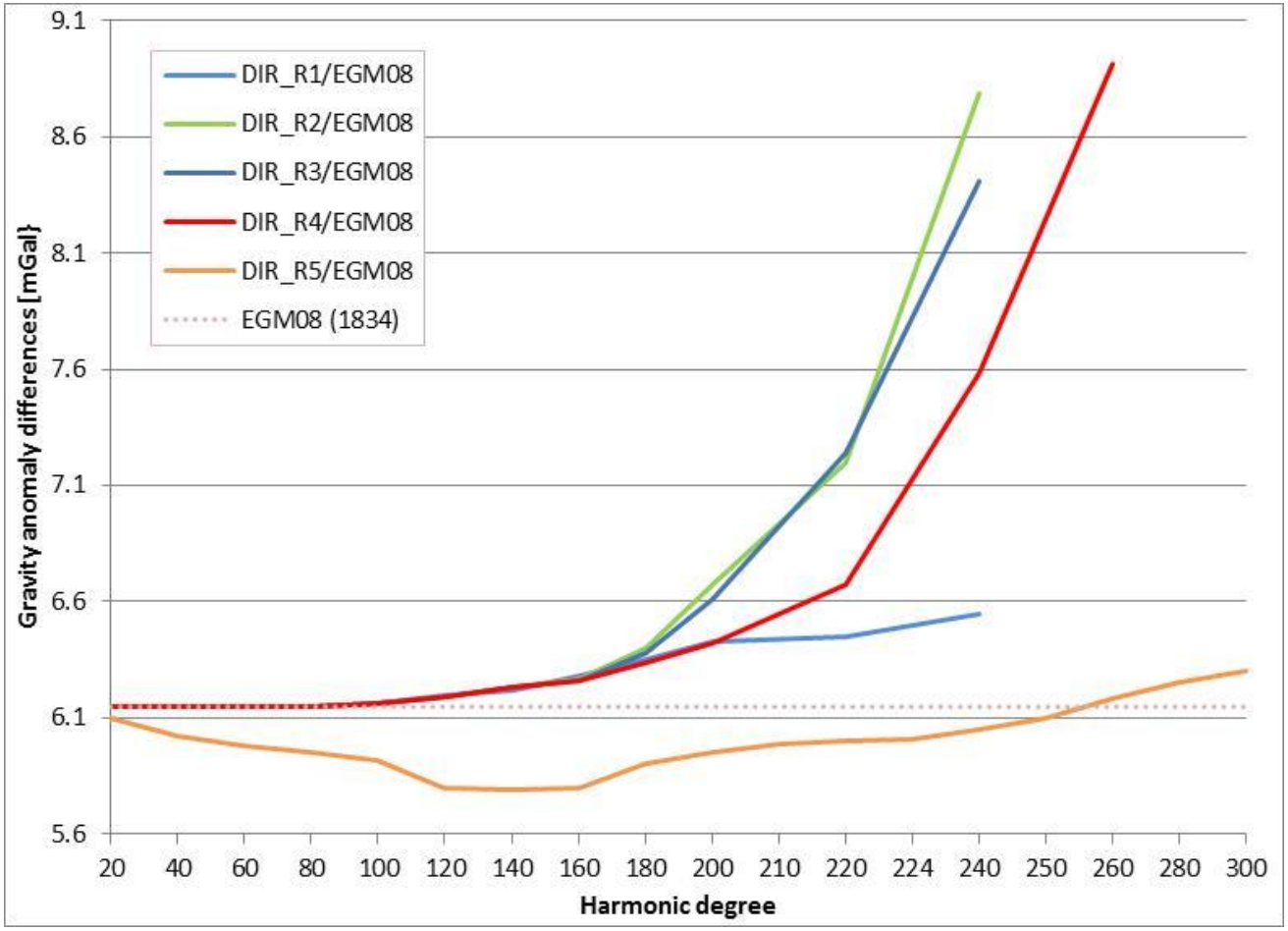
$$\Delta g_{res}^{(b)} = \Delta g_{obs} - \Delta g_{EGM\,2008}\Big|_2^{2159} - A_{RTC}$$

$$N_{res}^{(b)} = N_{GPS/lev} - N_{EGM\,2008}\Big|_2^{2159} - N_{RTC}$$

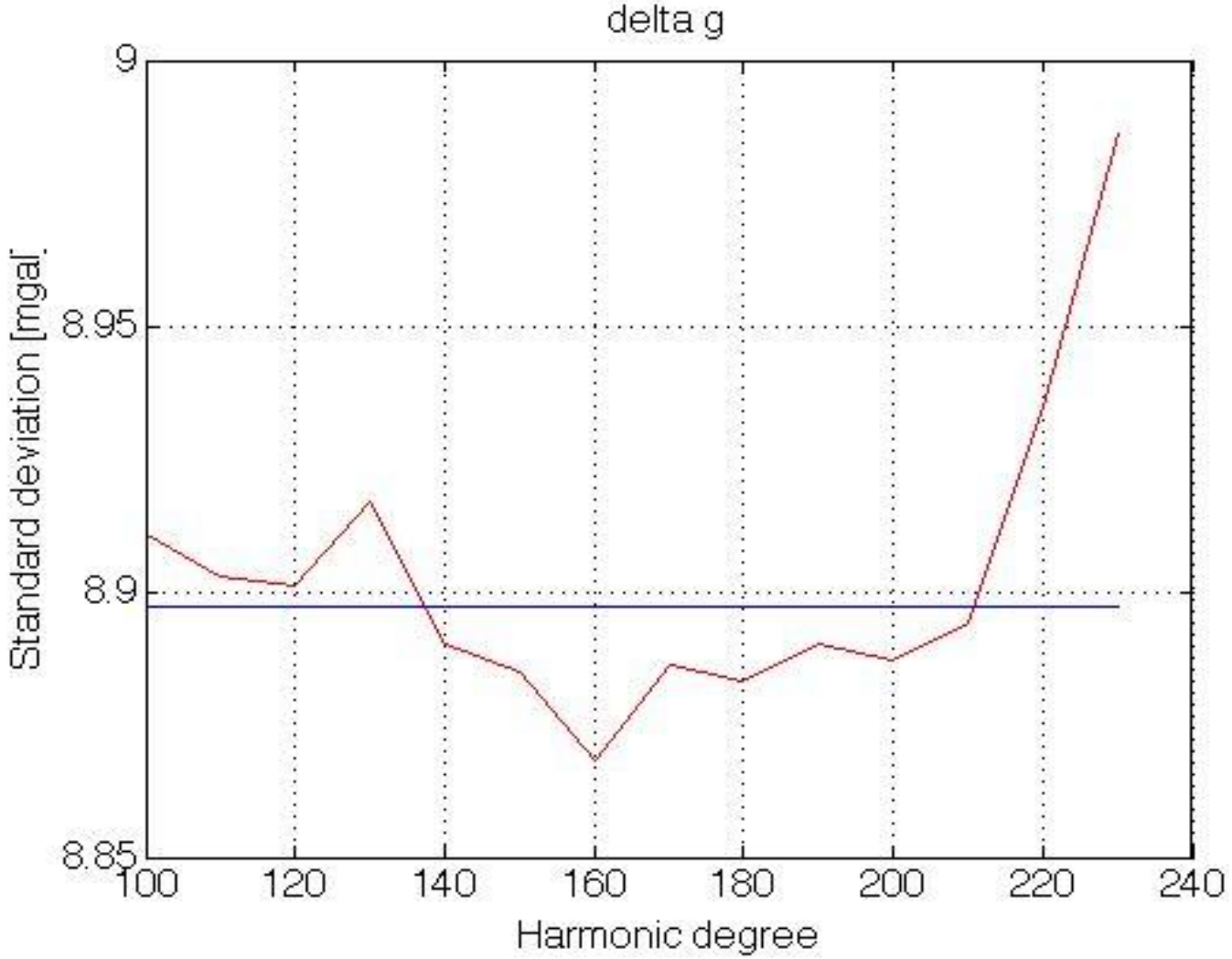
Statistics of Δg_{res} and N_{res} as compared to those of residuals with respect to EGM2008



DIR-R1, R2, R3, R4 and R5 evaluation w.r.t. GPS/Lev BMs over Greece



DIR-R1, R2, R3, R4 and R5 evaluation w.r.t. Gravity data over Greece



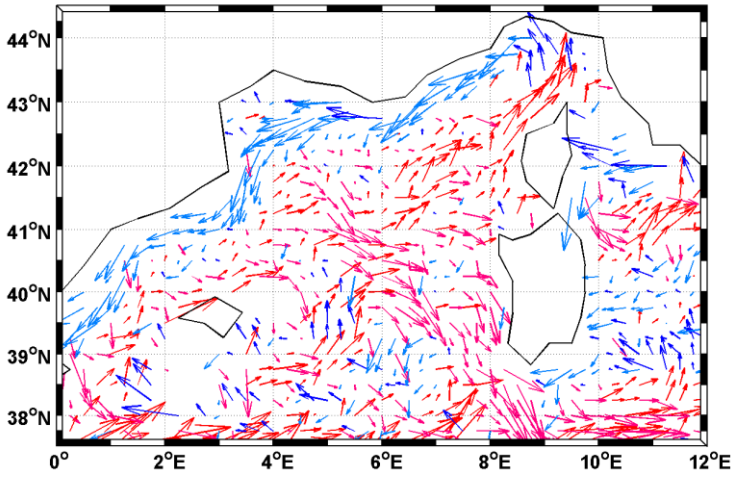
DIR-R5 evaluation w.r.t. Gravity data over Italy

The GOCE - DIR5 estimate VS EGM2008 in the Mediterranean area: some preliminary tests on geostrophic currents estimation

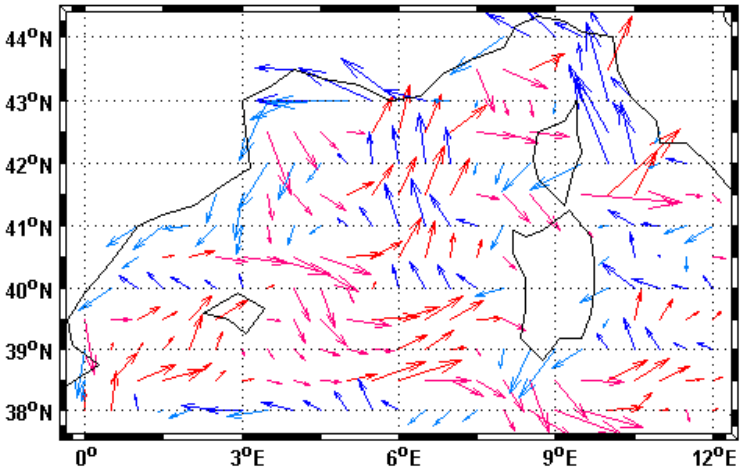
(based on CNES-CLS2011 MSS)

(M. Gilardoni - ESA Sci–Net Workshop 2014, Noordwijk, The Netherlands, May 14°,2014)

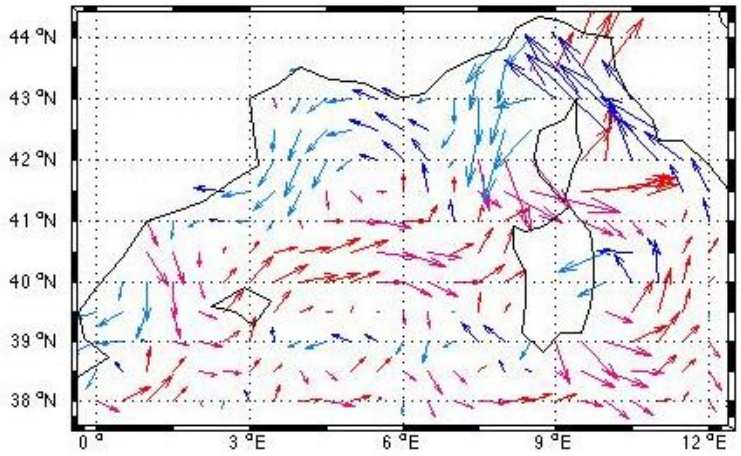
Reference circulation (Poulain et al., 2012)



EGM2008-based currents



GECO-based currents (DIR R5)



Satellite altimetry data

Incorporate all presently available satellite altimetry data for the Mediterranean (both GM and ERM):

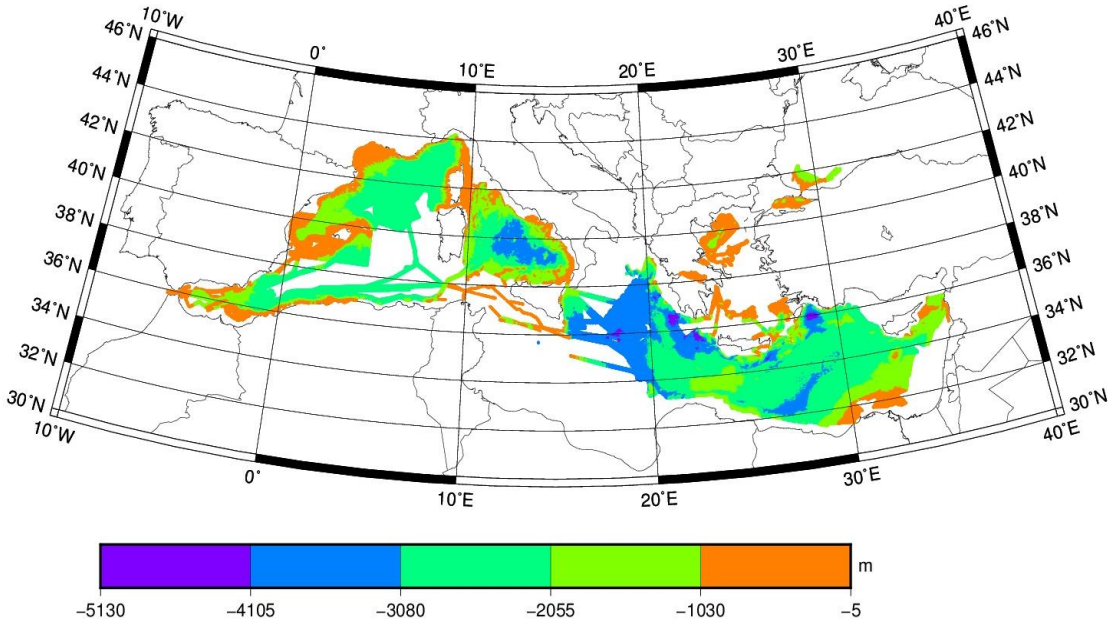
- ERS1/2
- Topex/Poseidon
- Jason 1/2
- ENVISAT
- SARAl/AltiKA
- Cryosat
- Sentinel-3 (when available)

Exploit LRM, SAR and SAR-in data for sea level and DOT determination (standalone and through DTU Mediterranean-based MSS)

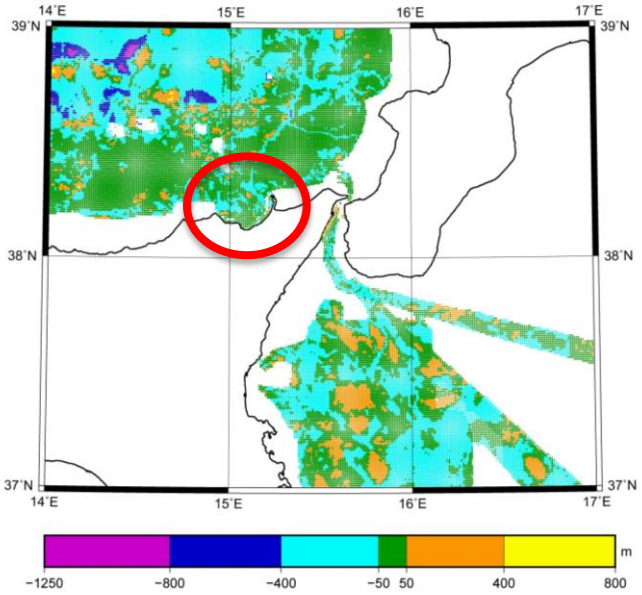
The DOT will be determined either as *DOT=N-MSS* and/or with along-track sea level slopes

Spatial filtering, edge enhancing diffusion, wavelets, etc., will be investigated for the DOT and geostrophic currents determination

The bathymetry models



MediMap Group, Loubrieu B., Mascle J. et al. (2005)
Morpho-bathymetry of the Mediterranean Sea



MediMAp data – Italian DTM/bathymetry
Check for possible discrepancies along the coastlines

Conclusions

- The first checks on the available gravity data set proved that they are consistent and reliable

- Further tests on gravity data will be performed to remove possible outliers

- Large data gaps, as compared to the computation area width, are still present (e.g. Turkey)

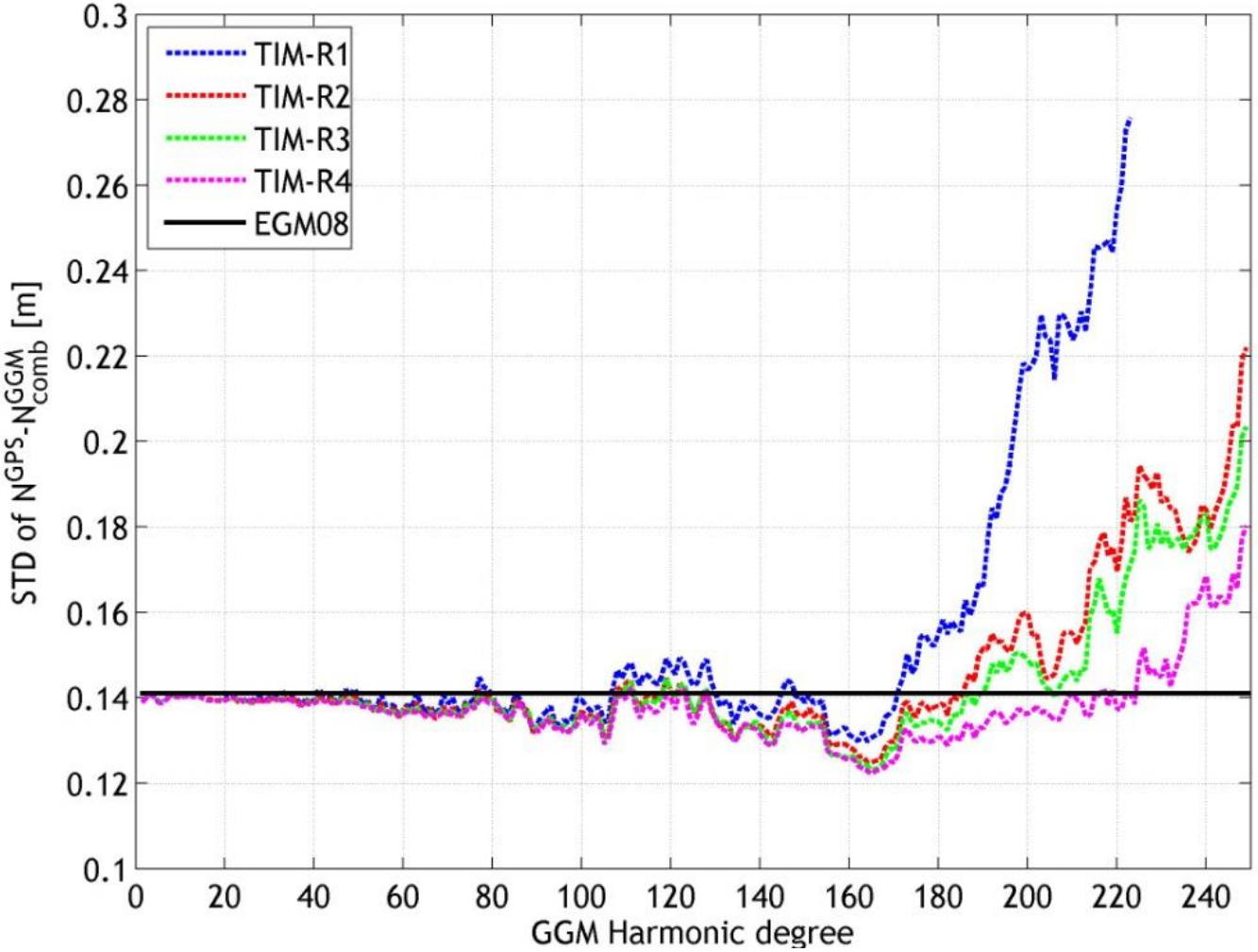
- The GOCE-DIR5 GGM will be assumed for modelling the low-frequency component of the gravity field. This model improved w.r.t the previous models in the bandwidth 140-220 (spherical harmonic expansion). Other GGMs will be tested in the computation procedure.

- The MISTRAL DTM/bathymetry model will be acquired and tested as a reference terrain model for computing the RTC effect over the computation area

- In the context of the “remove-restore” procedure, different methods for geoid estimation will be applied and compared

- Satellite altimeter data over the Mediterranean Sea coming from different satellite missions will be merged and considered as a primary data source for DOT estimation

BACKUP SLIDES



TIM-R1, R2, R3 and R4 evaluation w.r.t. GPS/Lev BMs over Greece

TIM-R1, R2, R3, R4 and R5 evaluation w.r.t. Gravity data over Greece