The GEOMED 2 project:
A high resolution geoid of the Mediterranean Sea

The GEOMED 2 research group

The GEOMED 2 partnership

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The GEOMED 2 project (1/2)

- The project aims at estimating the geoid over the area

$$30 < \varphi < 48 \qquad -10 < \lambda < 40$$

with a resolution of 3'×3'

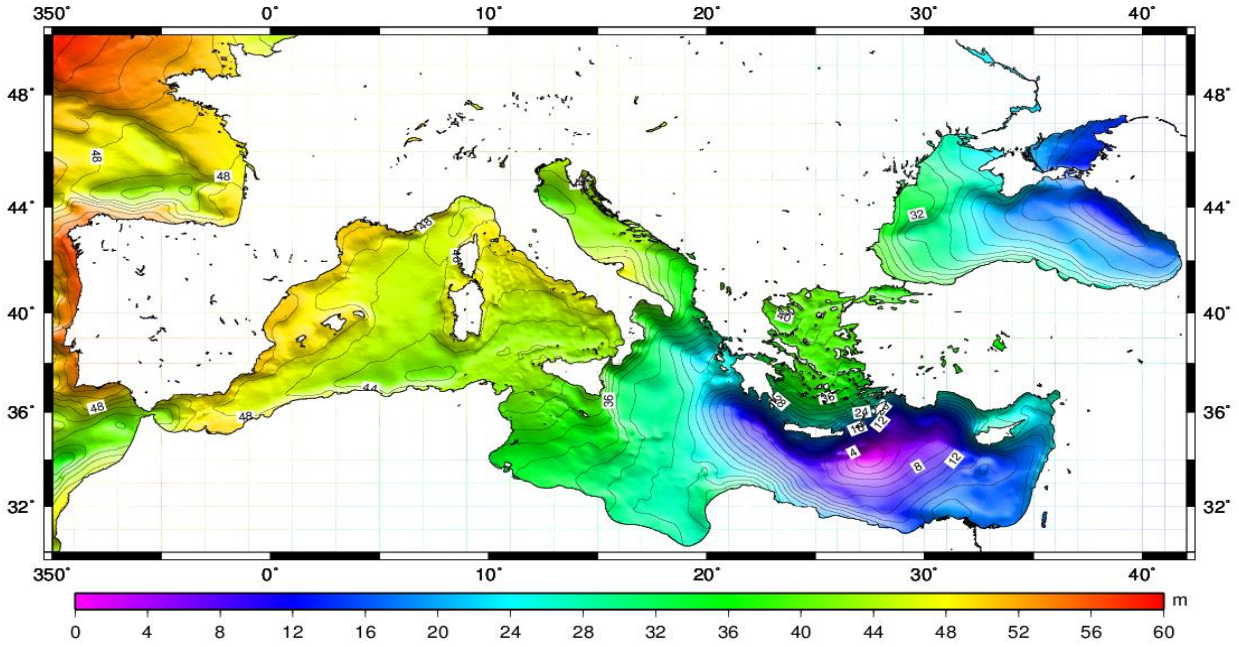
- ***Gravity data only will be used in the computation***

- Methods to be used in the geoid computation:

i) Collocation
ii) Stokes
iii) Stokes-FFT

The GEOMED 2 project (2/2)

- DOT will be then computed by difference with existing MSS altimetry derived estimates (e.g. the DTU2013)



The DTU2013 MSS over the Mediterranean Sea

- The circulation in the Mediterranean Sea will be also estimated

The Adriatic Sea test

- The selected area

$$36 < \varphi < 48 \qquad 10 < \lambda < 21$$

- Gravity data selected with a mean spacing of 2’×2’ from the following databases:

i) BGI
ii) SHOM
iii) Croatia
iv) Greece
v) Italy
vi) EGM2008 (void areas along the Eastern edge)

- Geoid estimate based on the Remove-Restore method

- The DTM/bathymetry model is **SRTM/NOAA** bathymetry at 3”×3” (bathymetry is originally at 1’×1’) in the window

$$35 < \varphi < 49 \qquad 9 < \lambda < 22$$

- The **GGN GOCE-DIR5** to d/o **230** was used for the long wavelength modelling of gravity/geoid

- RTC effect was computed using the ***GRAVSOFT TC*** program (r=80 km from each computation point, data point heights equal to DTM). The reference DTM was estimated by low-pass filtering the detailed DTM (using a 25’ cap)

- Residual gravity values were gridded using the ***GRAVSOFT GEOGRID*** program on a regular 3’×3’ geographical grid in the area

$$36 < \varphi < 48 \qquad 10 < \lambda < 21$$

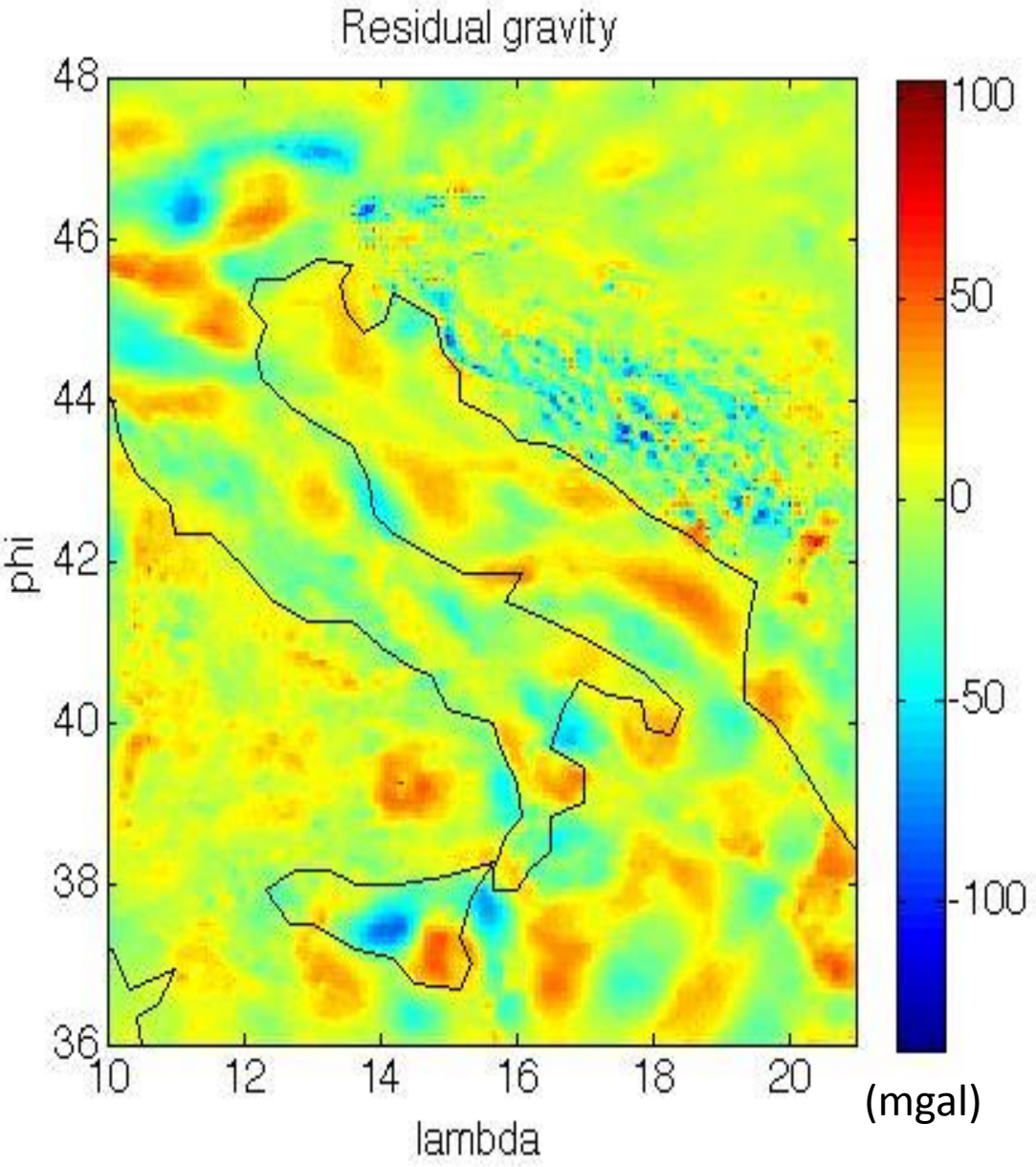
The statistics of the remove step

	Δg_{obs}	$\Delta g_R=\Delta g_{obs}-\Delta g_{MOD}$	$\Delta g_r=\Delta g_{obs}-\Delta g_{MOD}-\Delta g_{RTC}$
n	82657	82657	82657
E(mgal)	11.398	-4.835	-0.853
σ(mgal)	46.676	32.205	20.786
min(mgal)	-184.800	-245.144	-166.528
MAX(mgal)	267.710	216.964	119.615

The statistics of the gridded 3’×3’ residual gravity

	Δg_r(GRID)
n	53261
E(mgal)	-0.304
σ(mgal)	17.799
min(mgal)	-136.760
MAX(mgal)	104.801

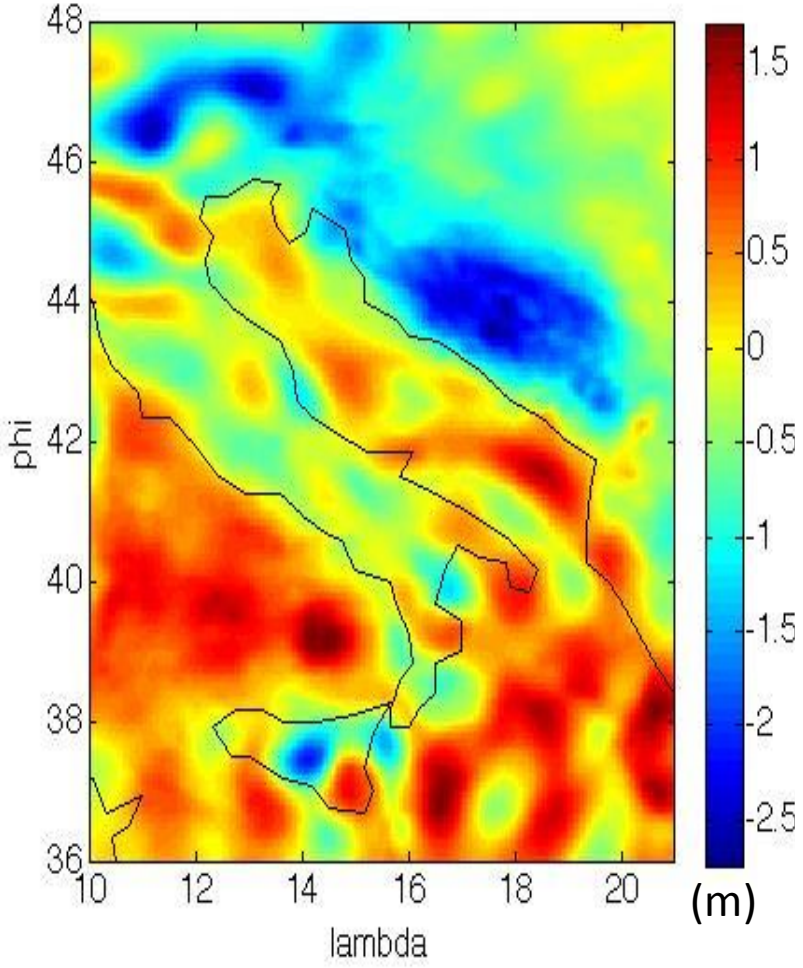
The residual gravity field



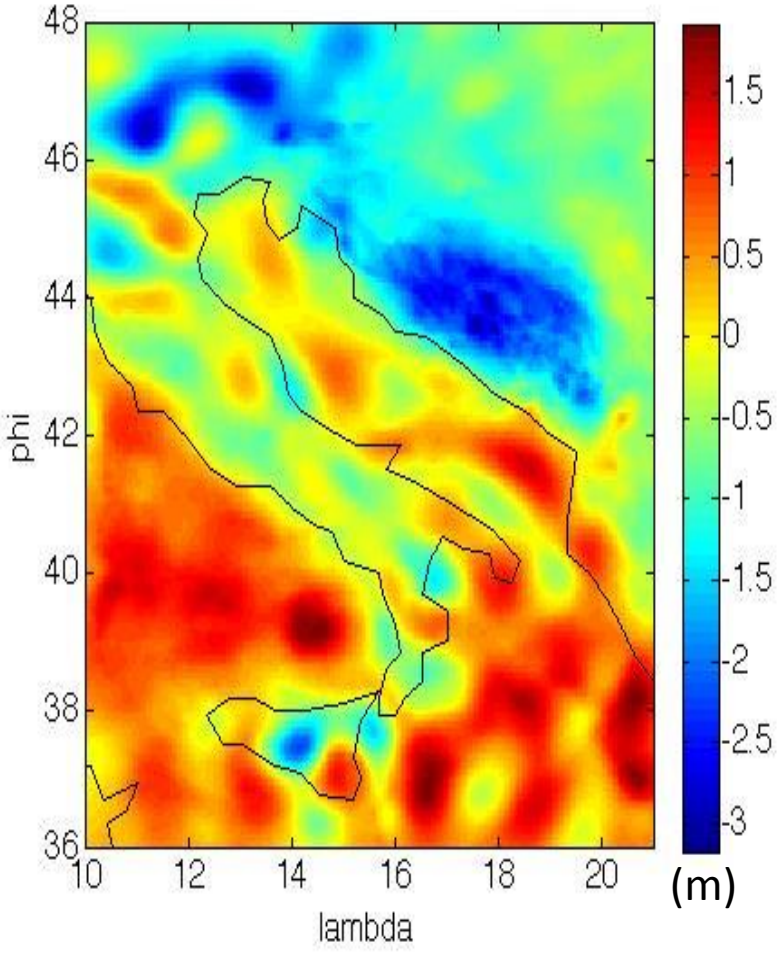
The applied geoid estimation methods

i) FastCollocation (Bottoni and Barzaghi, 1993)
ii) Collocation (Lequentrec-Lalancette et al., 2002)
iii) 1D_FFT (Haagmans et al., 1993)
iv) 2D_FFT (Strang van Hess, 1990)

N_r - FastCollocation



N_r - FFT_1D



The residual geoid statistics

	N_r (FastCol)	N_r (Collocation)	N_r (1D_FFT)	N_r (2D_FFT)
n	53261	53261	53261	53261
E(m)	-0.148	-0.005	-0.200	-0.181
σ(m)	0.801	0.468	0.930	0.924
min(m)	-2.742	-2.267	-3.173	-3.136
MAX(m)	1.720	1.429	1.928	1.971

The statistics of the differences between N_r estimate: 1D_FFT vs FastCollocation

	N_r(1D_FFT)-N_r(FastCollocation)
n	22701
E(m)	-0.061
σ(m)	0.117

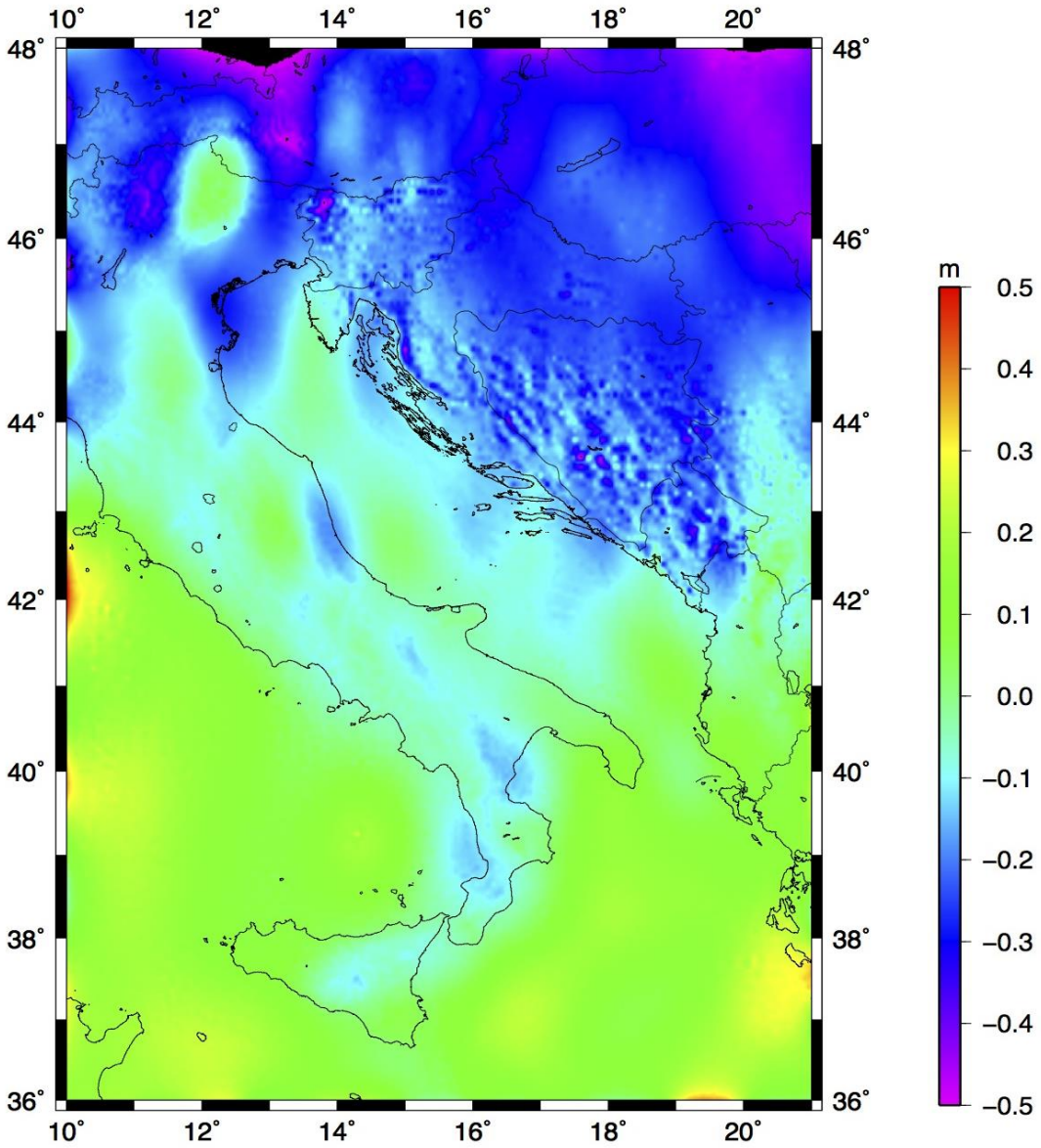
(In the area $38 < \varphi < 46$ $12 < \lambda < 19$)

The statistics of the differences between N_r estimates: 1D_FFT vs 2D_FFT

	N_r(1D_FFT)-N_r(2D_FFT)
n	22701
E(m)	-0.019
σ(m)	0.016

(In the area $38 < \varphi < 46$ $12 < \lambda < 19$)

The differences between N_r estimates: 1D_FFT vs FastCollocation



The statistics of the differences w.r.t. GPS/lev points

$$v = (N_{grav} - N_{GPS/lev}) - \Delta N(\varphi,\lambda) = (N_{grav} - N_{GPS/lev}) - dx\sin\varphi\cos\lambda + dy\sin\varphi\sin\lambda + dz\cos\varphi$$

$$\varphi = 90° - \phi \; ; \quad N_{GPS/lev} = h - H$$

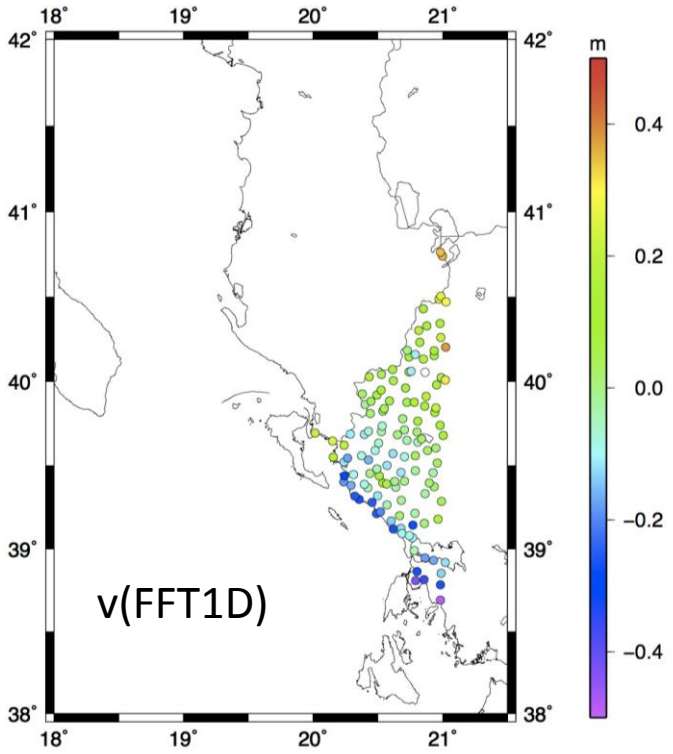
(dx,dy,dz) datum shift translation

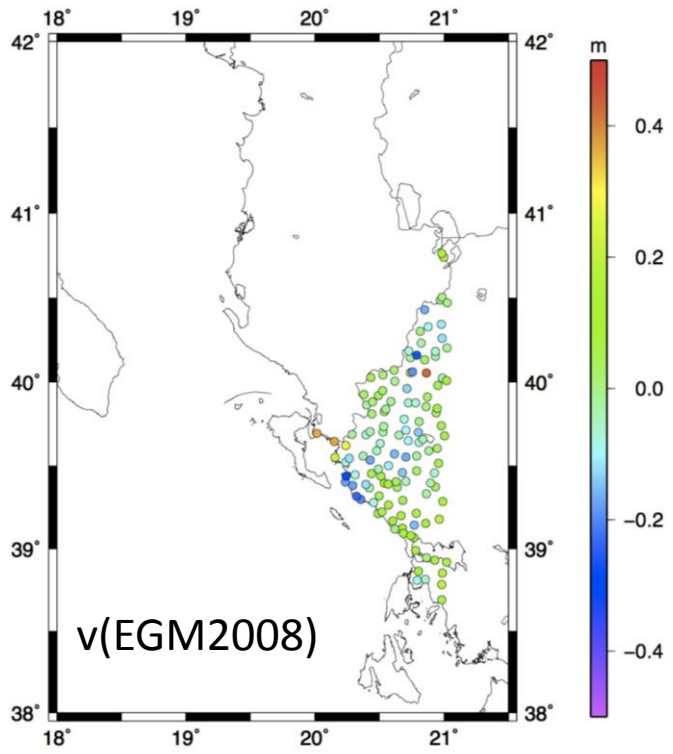
Italy (mainland)

	v(FASTCOL)	v(1DFFT)	v(EGM2008)
n	594	590	595
E(m)	0.000	0.000	0.000
σ(m)	0.095	0.084	0.084
min(m)	-0.243	-0.294	-0.227
MAX(m)	0.260	0.239	0.276

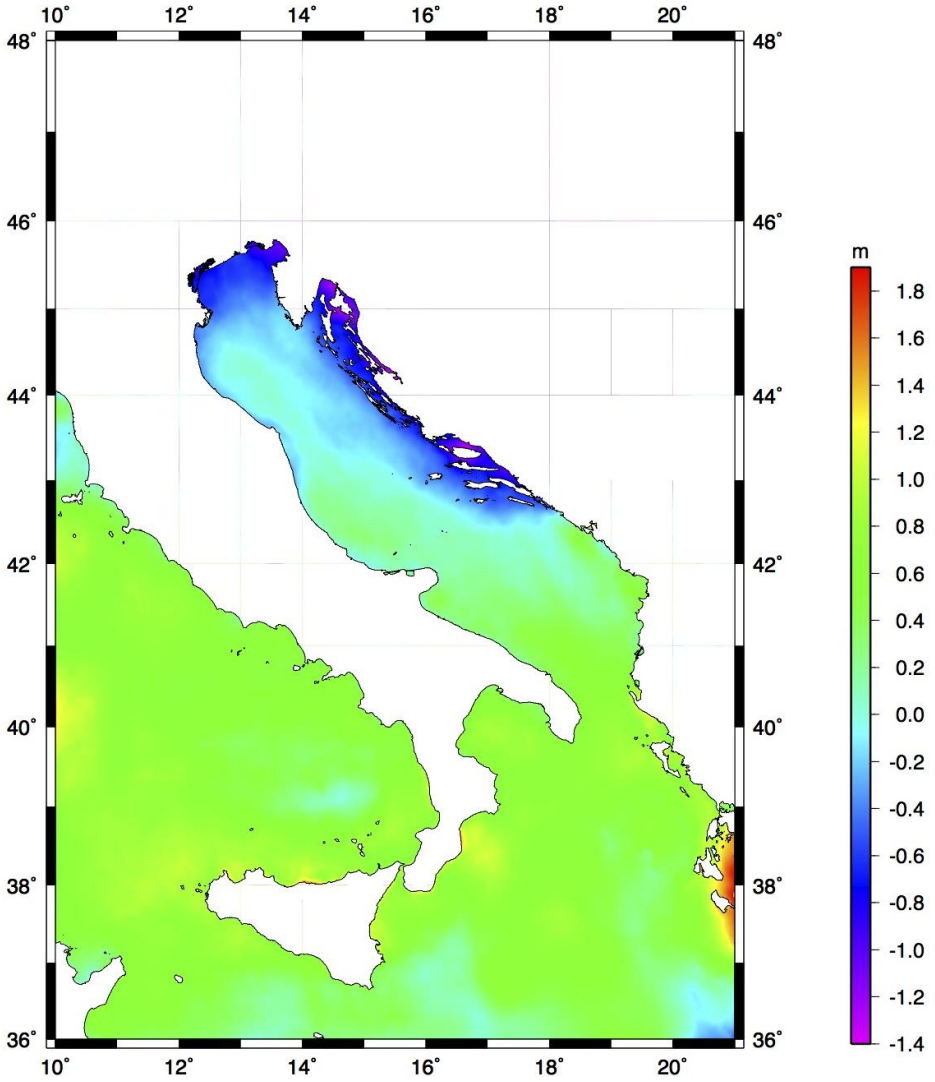
Greece

	v(FASTCOL)	v(1DFFT)	v(EGM2008)
n	126	126	126
E(m)	0.000	0.000	0.000
σ(m)	0.181	0.164	0.118
min(m)	-0.489	-0.485	-0.304
MAX(m)	0.547	0.545	0.434





The DOT in the Adriatic Sea based on the DTU2013 MSS and the 1D_FFT geoid estimate



Comments and conclusions

- The Adriatic Sea Test proved that further checks on the gravity data are needed (consistency among different gravity databases)

- The processing chain seems to be satisfactory but some refinements must be implemented (possibly a denser gravity database should be selected based on a 1'x1' selection grid)

- The GOCE-DIR5 GGM allows an effective data reduction; other solutions will be also tested in the future (e.g. the time-wise and the space-wise solutions)

- Differences in the geoid computation methods are quite large and, to some extent, unexpected (ad hoc analysis will be devised to come to more coherent solutions)