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Global grids of gravity anomalies and vertical gravity gradients at 10 km altitude from GOCE gradient data and polar gravity

EGU, Wien, April 2013.

PURPOSE

Promote the use of GOCE products by producing (new) grids of gravity anomalies and vertical gravity gradients at 10 km altitude.

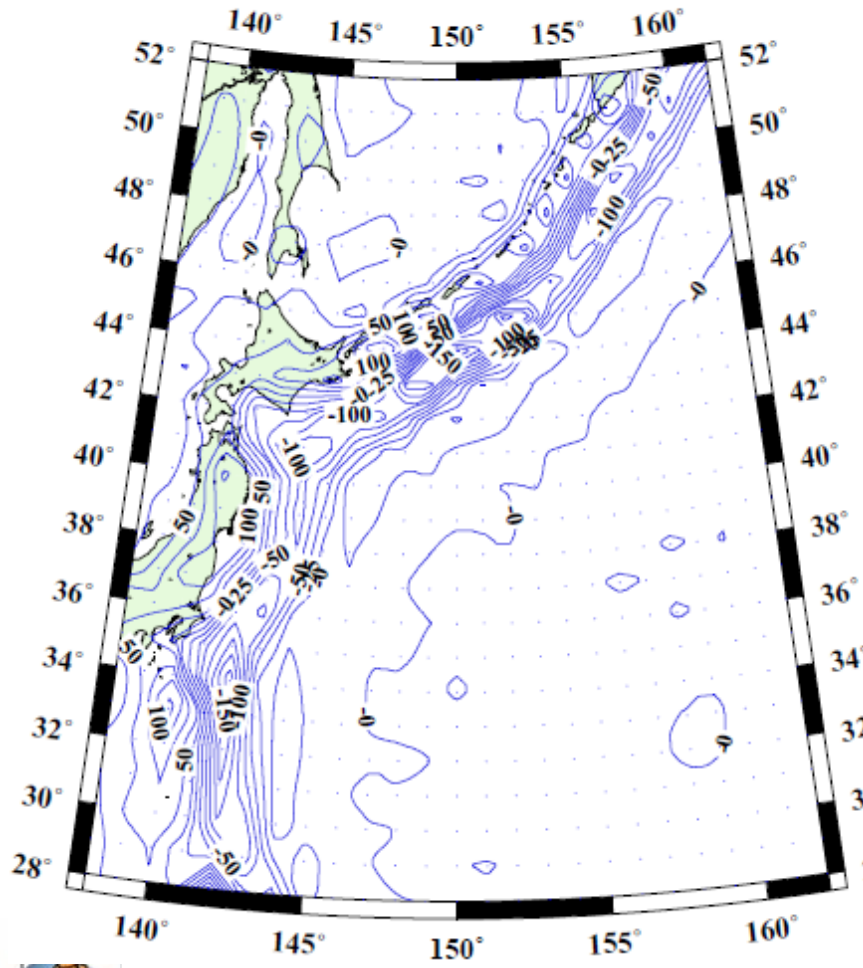
Possible improvement compared to the the HPF product of grids at zero height derived from the EGM's.

Observed gradients may contain more information than expressed through an EGM.

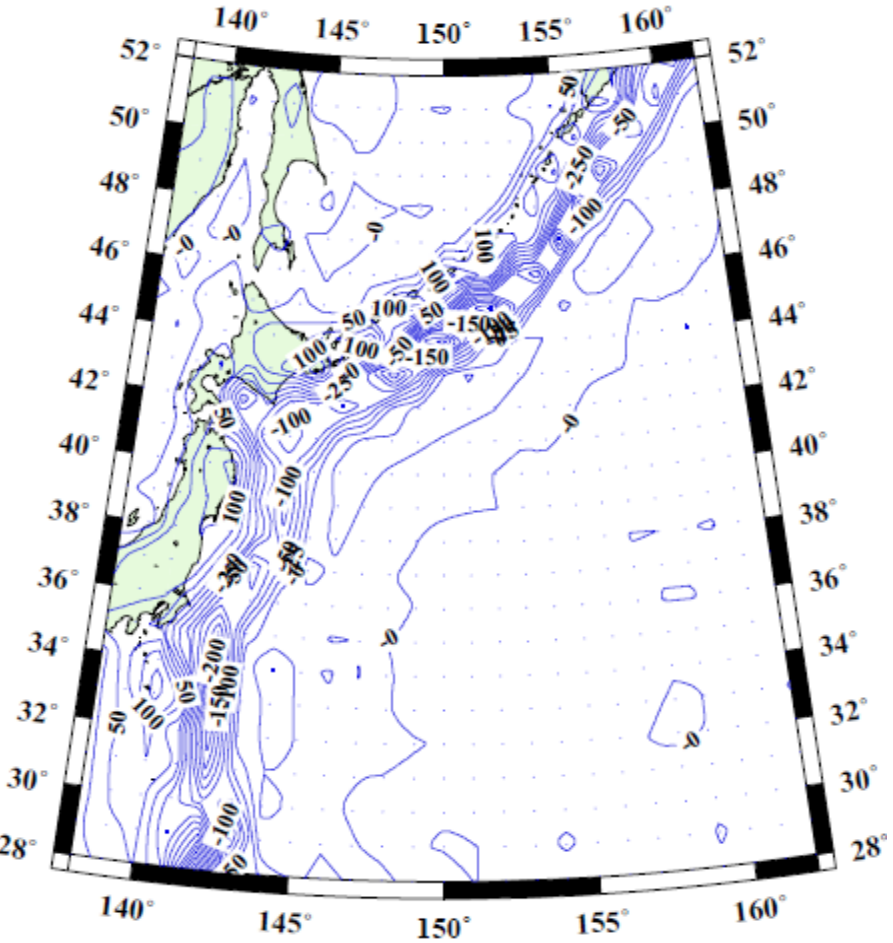
Grid values may be improved using polar gravity.

Example of result from trench area.

dg at 10 km predicted from GOCE Tzz (mgal).



dg at 10 km computed from EGM2008 (to 510) (mgal).



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Data used.

TRF data 2009-12, GRF data 2009-12.

Polar gravity – but not Antarctic gravity.

ITG-GRACE2010s (remove/restore)*

EGM2008, GOCE DIR2 (control data).

Data selected closest to mid-points of 10’ cells and 1/8 deg cells.**

* permits spherical approximation in local areas, help in polar caps.

** nearly all cells filled !

Products: gridded gravity anomalies and vertical gradients, 10 km.

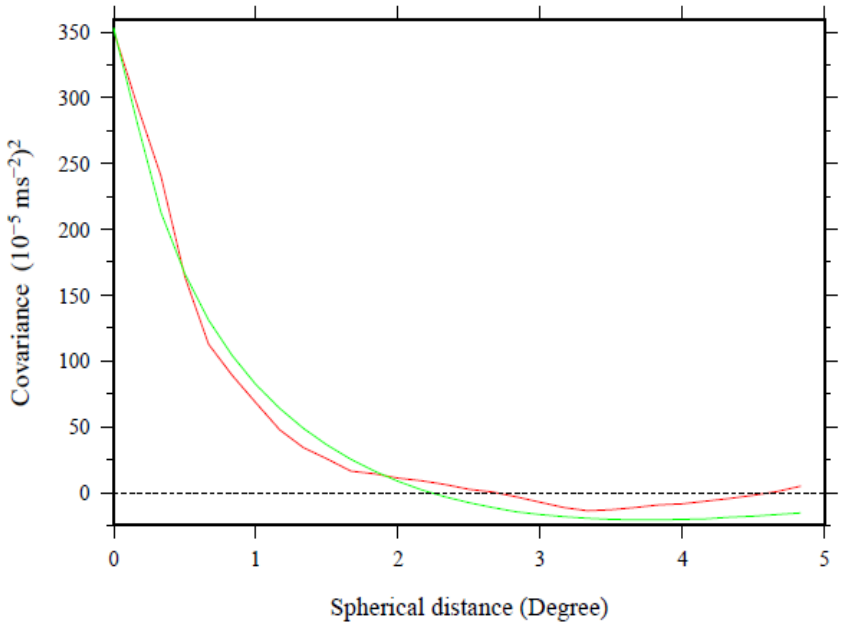
Grids produced in 162 20x20 deg blocks with 10’ spacing.

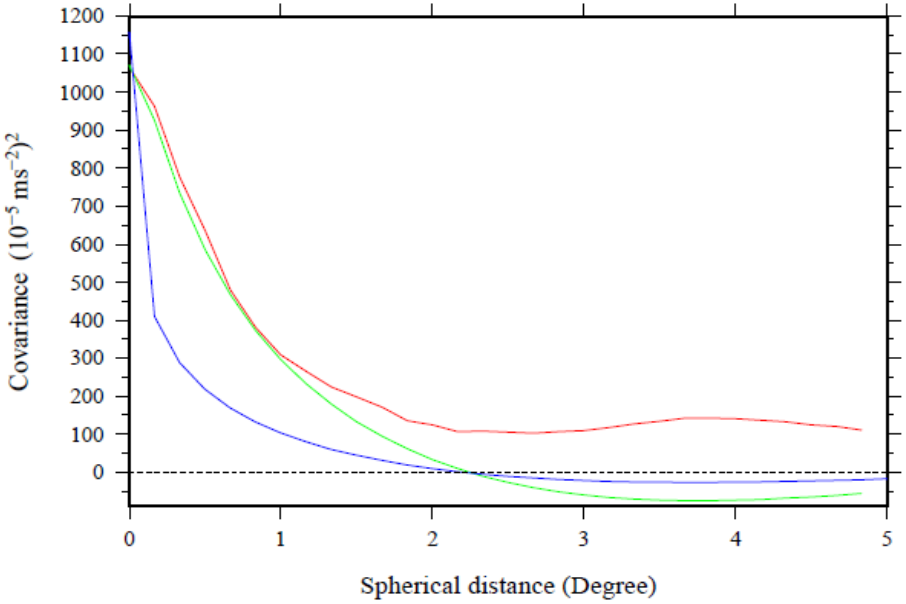
Error-estimates in grids with 1 deg spacing.

Use of Least-Squares Collocation (LSC).

1. Covariance estimation (from reduced data)
2. Selection of analytic representation
3. Selection of data in 25 x 25 deg. block
4. Creation of (upper triangular part of) normal equations
5. Solution of equations (Cholesky)
6. Prediction, comparison with EGM2008 to 512 and error-estimation in 1 deg. Grid.
7. Prediction of 10’ grids.

Covariance estimation (from reduced data),+analytic fitting





Empirical (from EGM08, h=0), analytic,
Analytic from GOCE vertical gradients.

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Best data selection, using TRF data.

Example of Prediction of EGM08 derived gravity anomalies at 10 km, mgal

Number of data	Spacing (degree)	Data type	Mean difference	Standard deviation	Mean error estimate
22464	0.166	T_{zz}	-0.5	9.73	6.92
44929	0.166	$T_{zz}+T_{yy}$	-0.4	9.65	6.85
37971	0.125	T_{zz}	-0.5	9.16	6.79

T_{zz} with 0.125 deg. spacing selected.

Computational considerations with geocol19.

Processor	22	22	4
N	37971	22464	22464
CH	s	s	s
05		10407	41832
10	6764	2709	8381
15	7898	2962	7793
20	6966	2642	7469
25	7221	2836	7748
30	7476	2894	8300

OMP Processing time for 20x20 block, N=number of data,CH=chunk block size. Time depends on rate of disk transfer. (See Kaas et al, 2013, EGU2013).

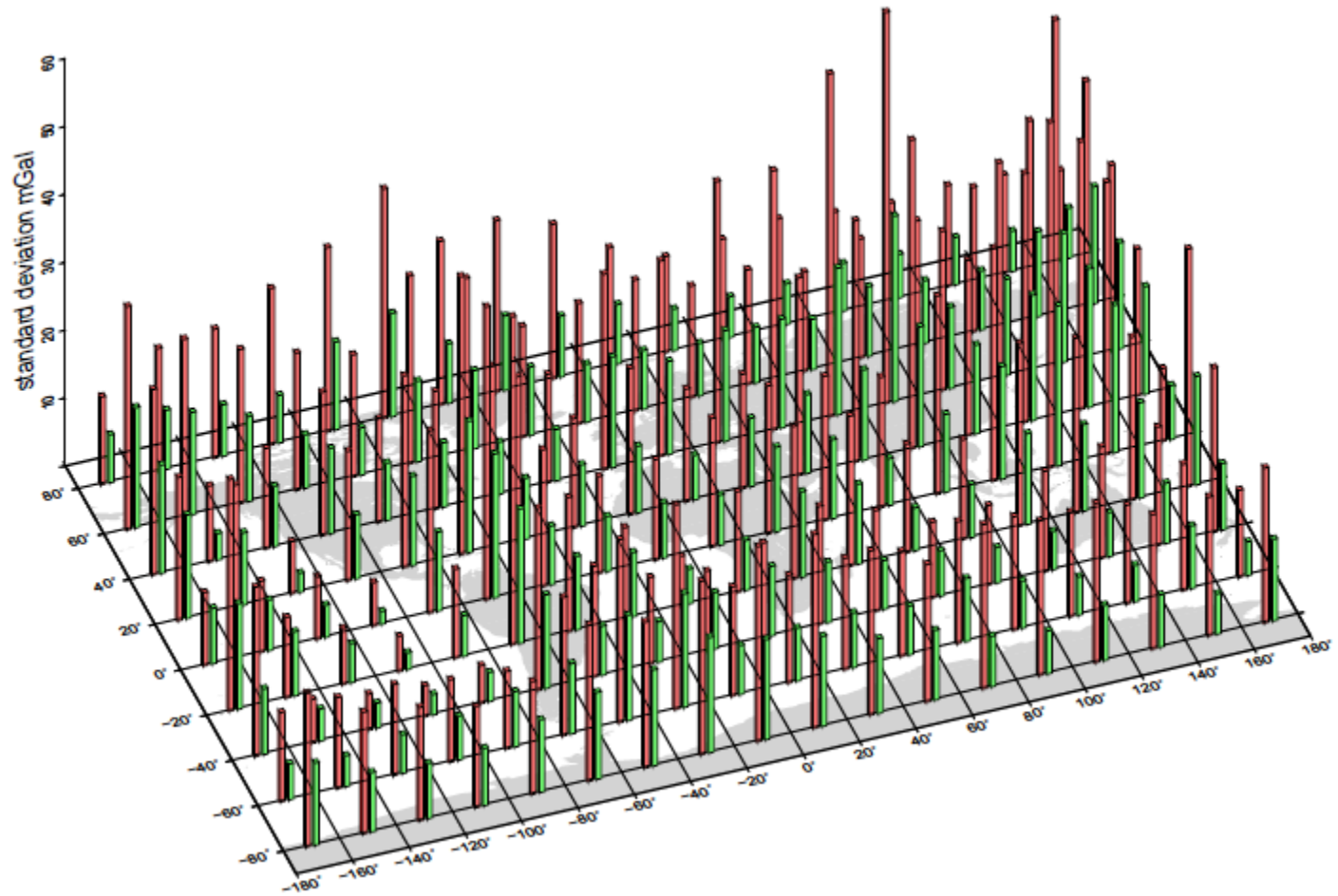
Data noise standard deviation selection

Prediction of EGM08 derived gravity anomalies at 10 km, block 73

Noise (EU)	Dg (mgal)		T_{zz} (EU)	
	Observed-predicted Standard deviation	Error estimates Mean value	Observed-predicted Standard deviation	Error estimates Mean value
0.030	7.41	7.67	3.28	3.06
0.020	7.30	7.22	3.26	2.99
0.010	7.44	6.52	3.29	2.88
0.008	7.62	6.32	3.33	2.84
0.005	8.40	5.75	3.52	2.76
0.003	9.28	5.40	3.77	2.65
EGM08-DIR2	7.58		3.53	

Tzz with 0.02 EU noise st.dev. selected.

Prediction, comparison with EGM08 to 512 st.dev. Δg.



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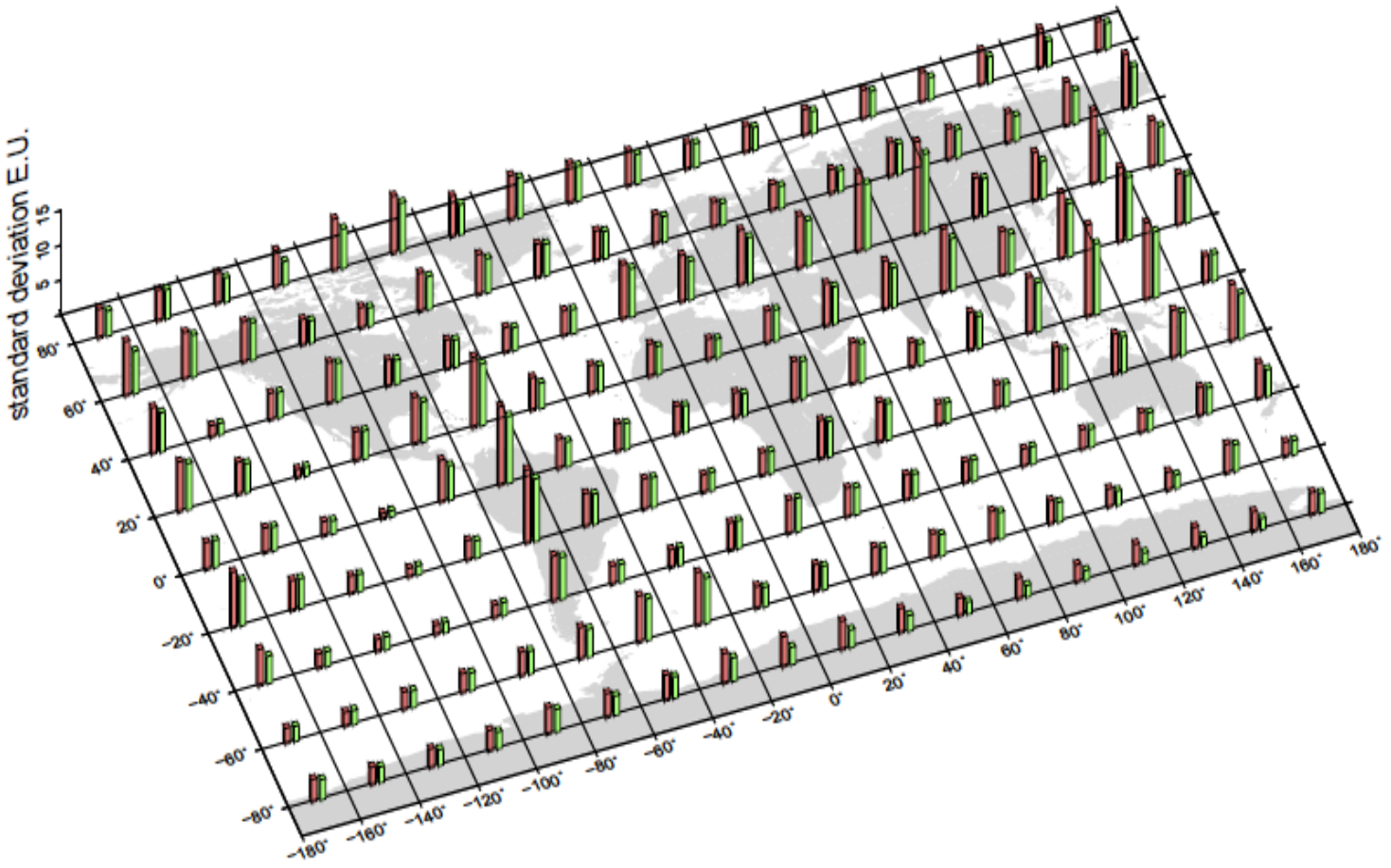
Prediction, comparison with EGM08 to 512 vert. gravity gradients (EU).



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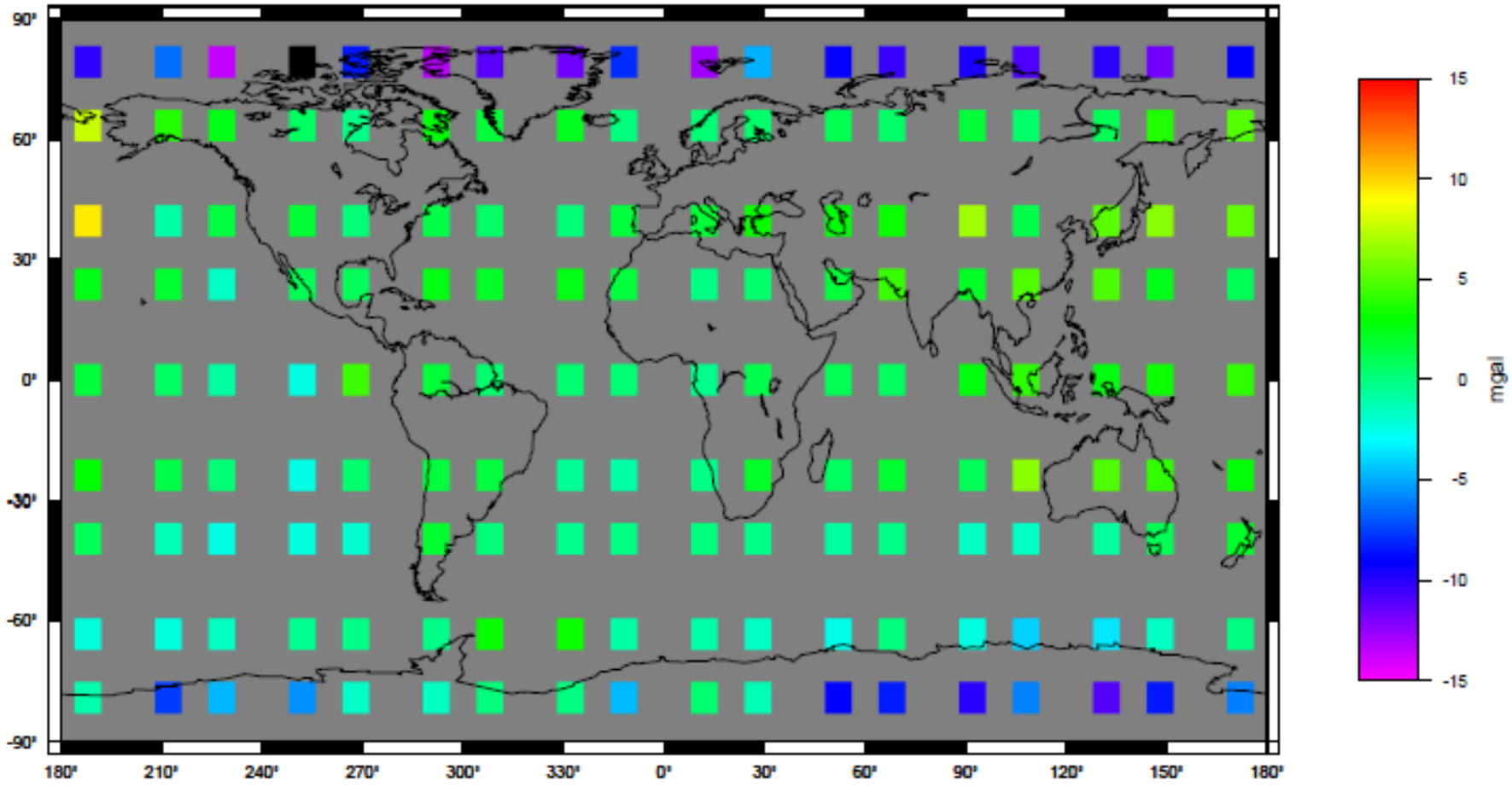
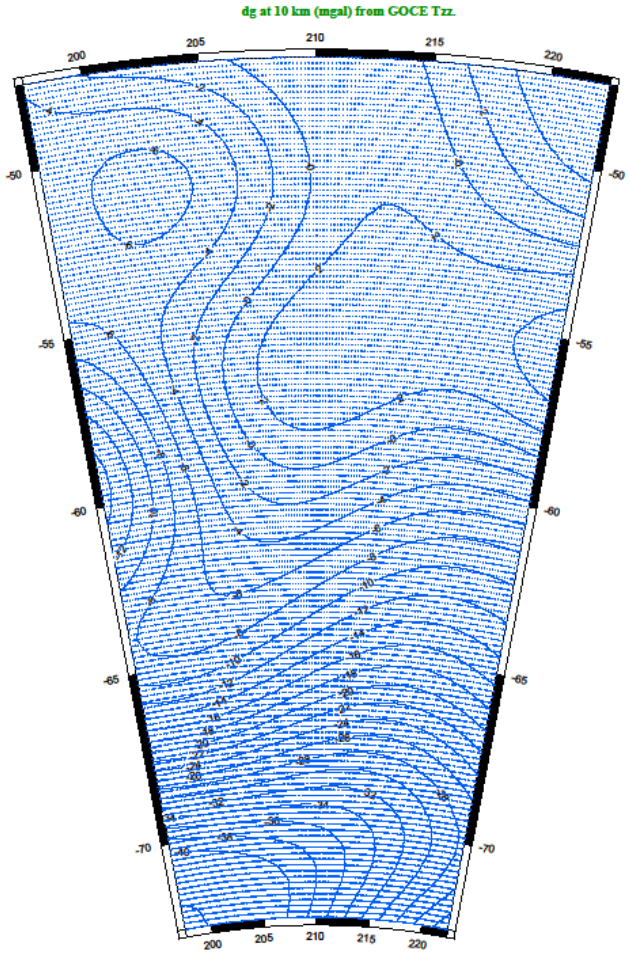
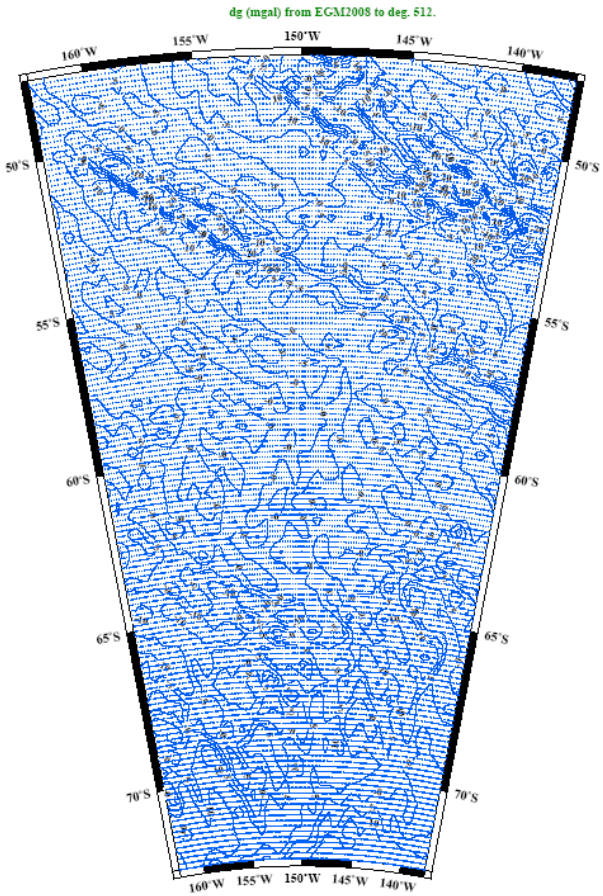
Comparison of Δg st.dev. differences LSC, DIR2 wrt. EGM08. LSC inferior at middle latitudes due to less data used (?).



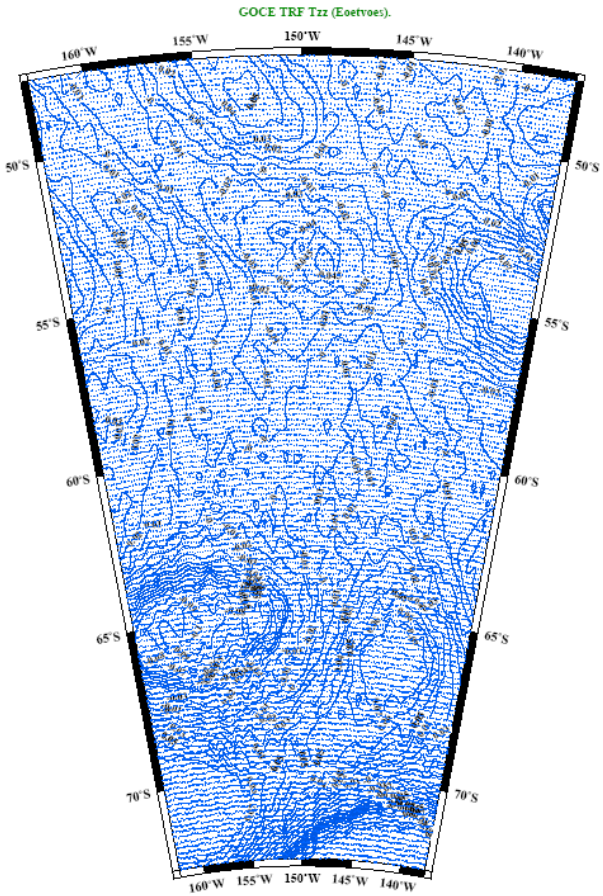
Δg from TRF T_{zz} at 10 km (mgal).



Δg at 10 km from EGM2008 to 512 (mgal).



TRF T_{zz} at satellite height (EU).



Transfer of results and further work.

1. Grids of gravity anomalies and vertical gradients will be made available to the public by ESA.
2. Production to be repeated with POLIMI GRF data and associated error-covariance functions.
3. Using more data at middle latitudes
4. Use of MPI on several servers
5. Will the grid representation be ”better” than an EGM to max. degree 240 ?