High-resolution numerical modelling of the altimetry-derived gravity disturbances and disturbing gradients

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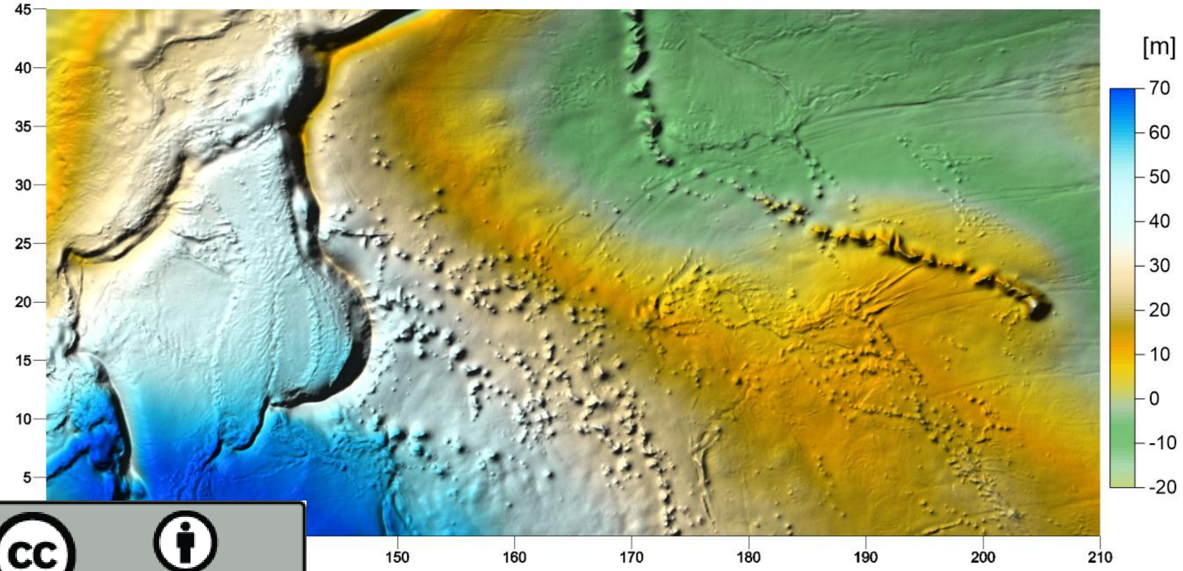
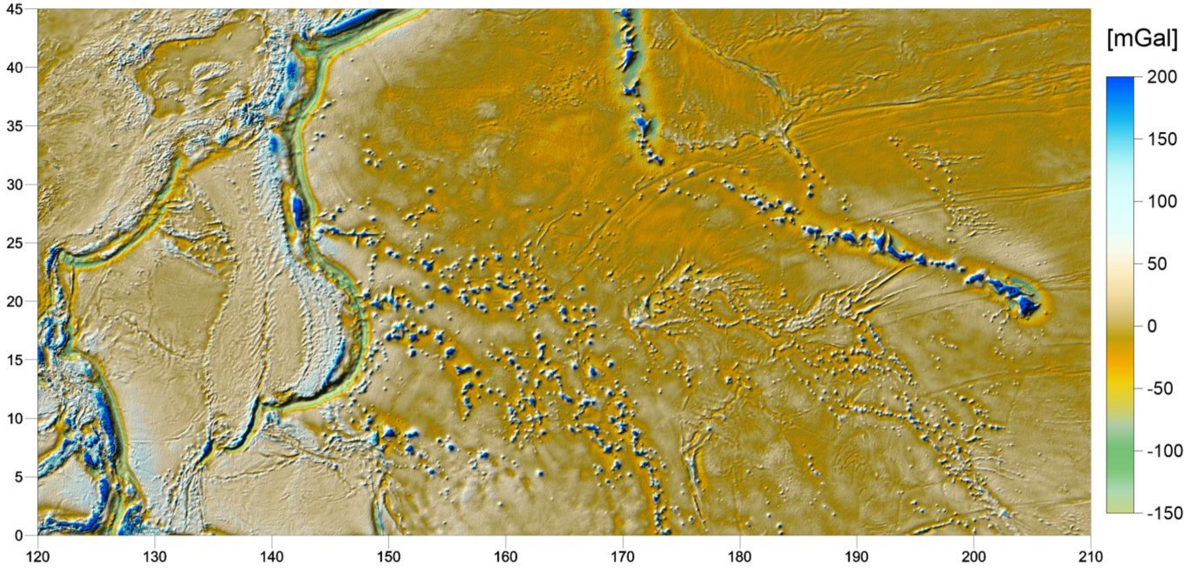
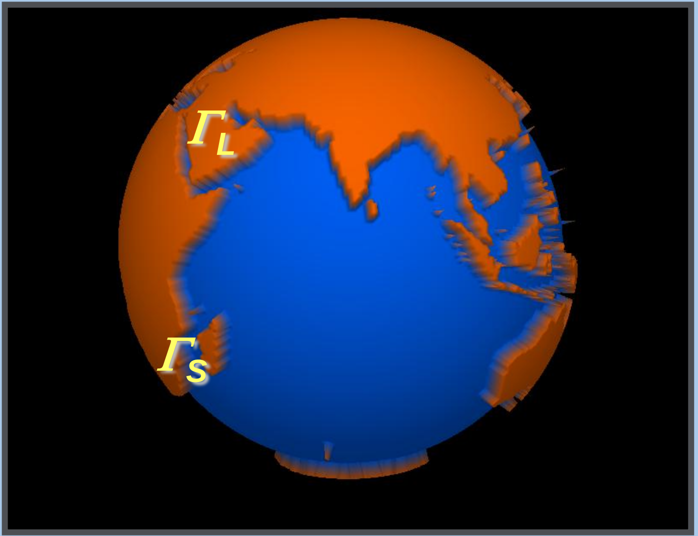
MSS model



altimetry-derived gravity data



Altimetry-gravimetry boundary-value problem

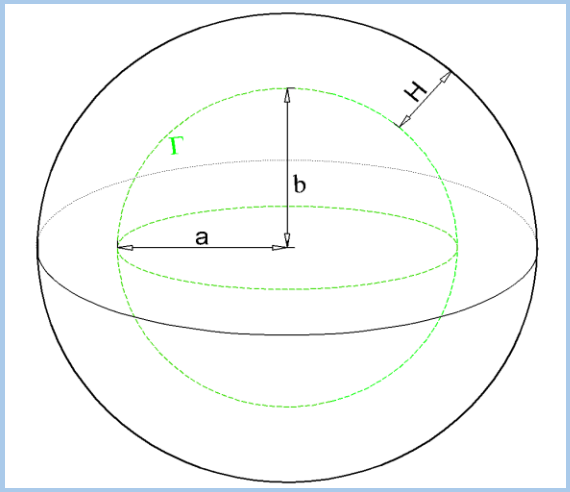


$$\Delta T(\boldsymbol{x}) = 0\,, \qquad \boldsymbol{x} \in R^3 - \Omega\,,$$

$$T(\boldsymbol{x}) = T^{MMS}(\boldsymbol{x}) + \delta W\,, \qquad \boldsymbol{x} \in \Gamma_S \ (sea),$$

$$\langle \nabla T(\boldsymbol{x})\,, s(\boldsymbol{x}) \rangle = -\,\delta g(\boldsymbol{x})\,, \qquad \boldsymbol{x} \in \Gamma_L \,(land),$$

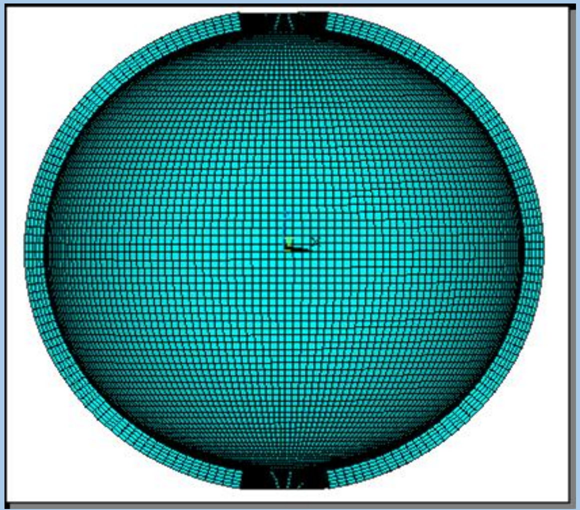
$$\boxed{T(\boldsymbol{x}) = T^{SAT}(\boldsymbol{x}) \qquad \boldsymbol{x} \in \Gamma_{SAT}}$$



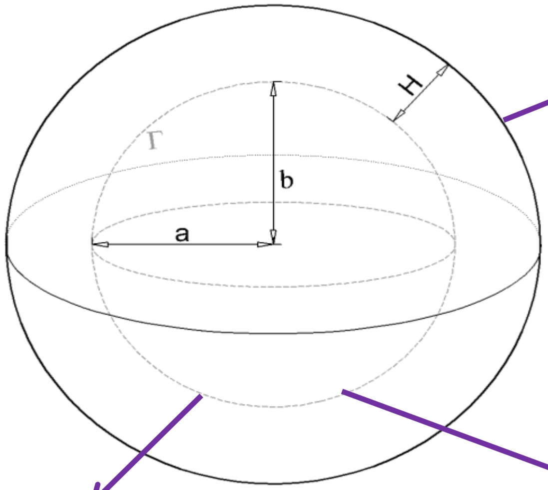
<u>Numerical solution by Finite Volume Method (FVM)</u>

Based on:

⇒ *dicrestization of the computational domain into finite volumes*
⇒ *local conservation of numerical fluxes*

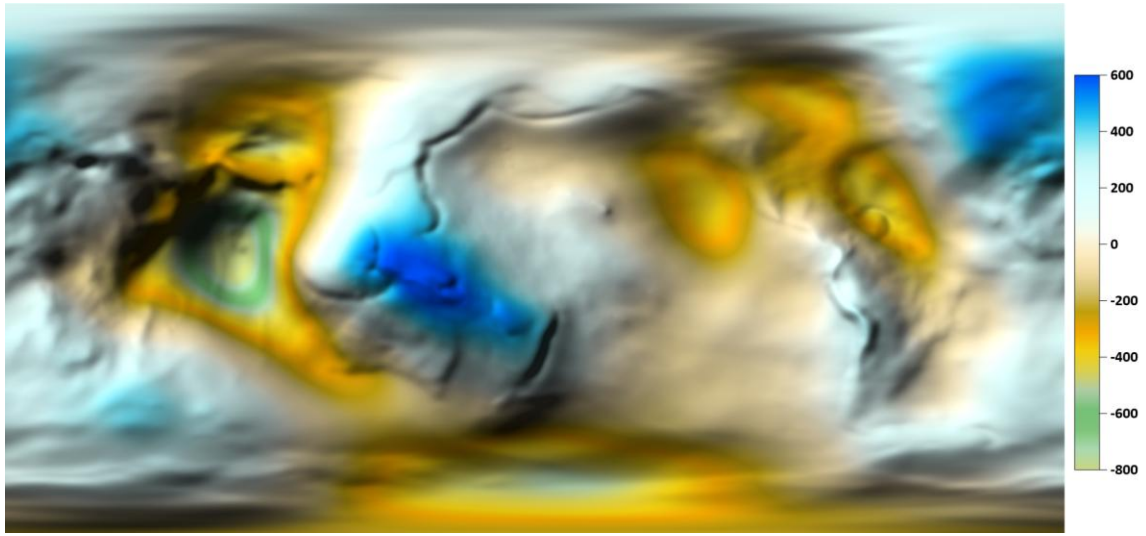


Boundary conditions:



Upper boundary
(200 km)

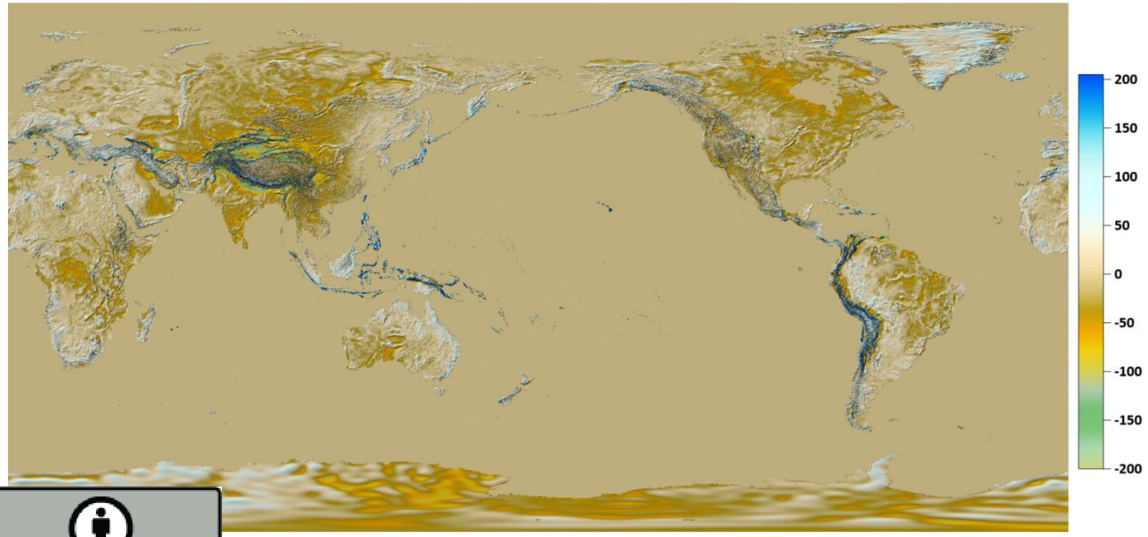
T_{SAT}

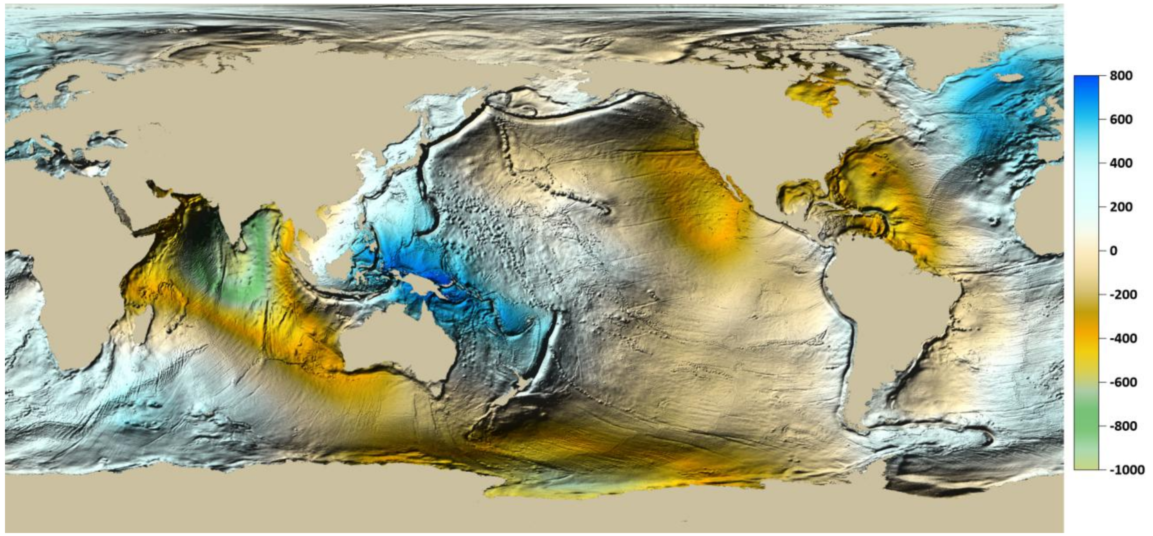


Bottom boundary
(ellipsoid)

δg_{lands}

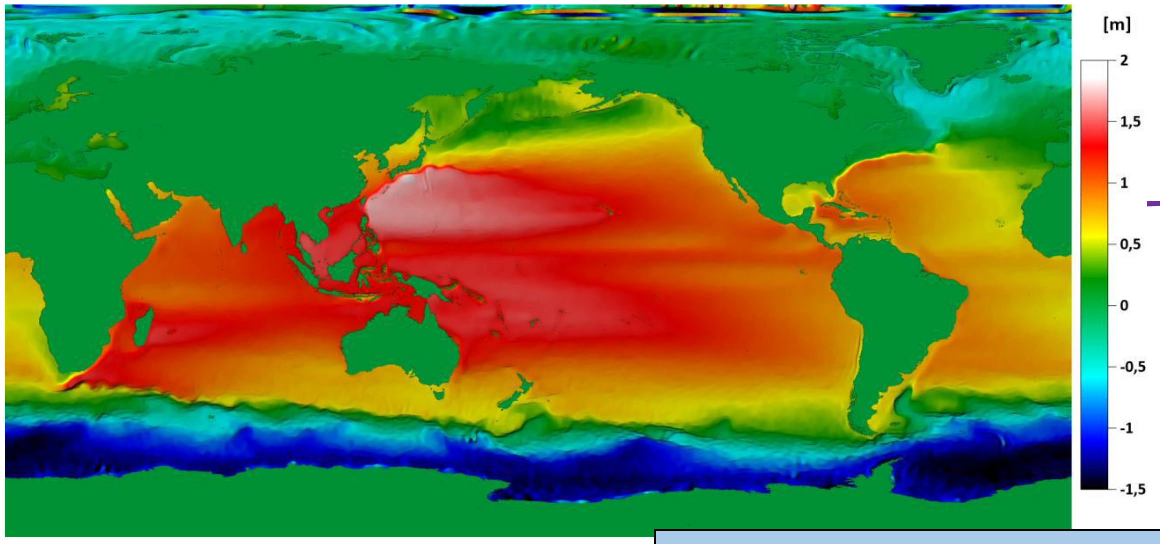
T_{oceans}

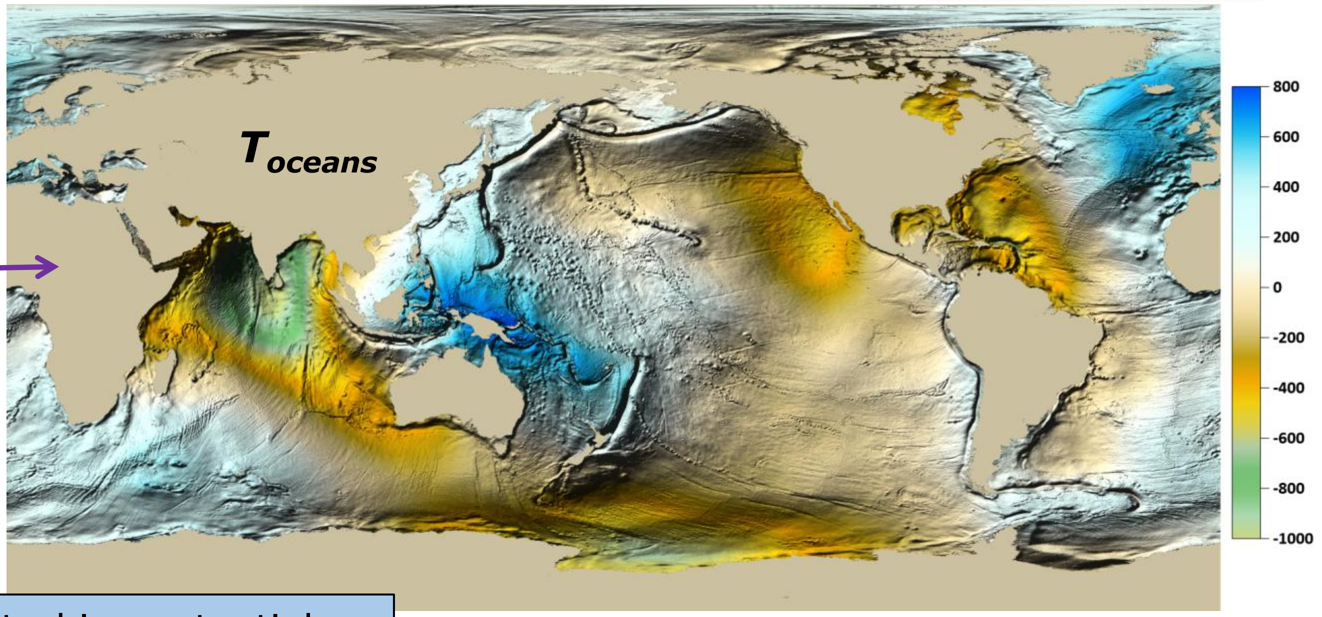




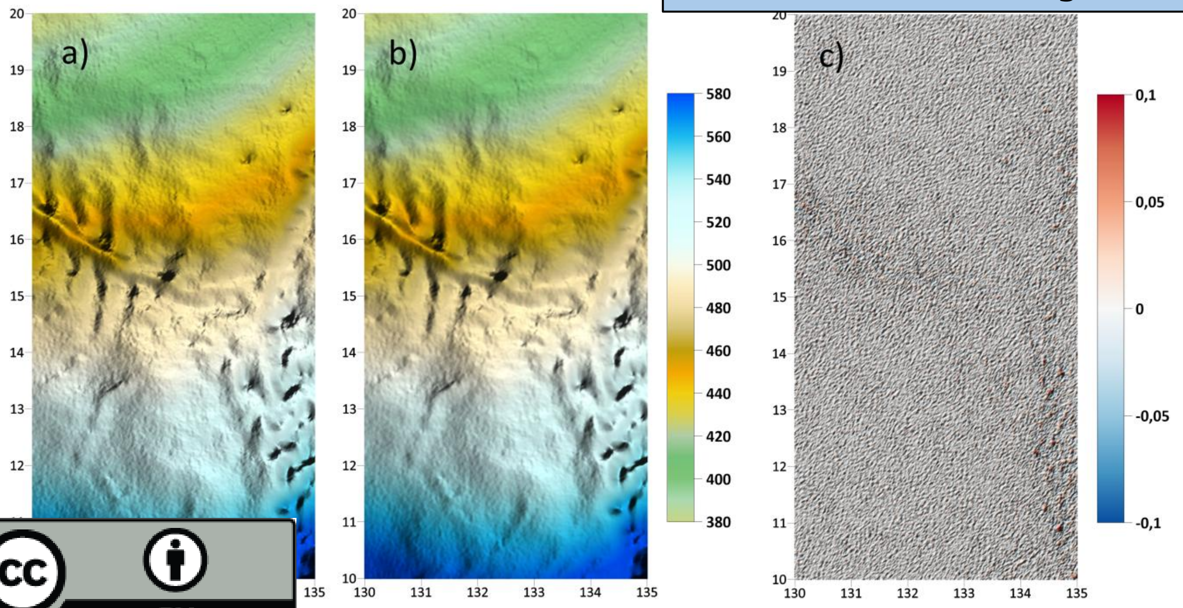
Boundary conditions over oceans/seas:

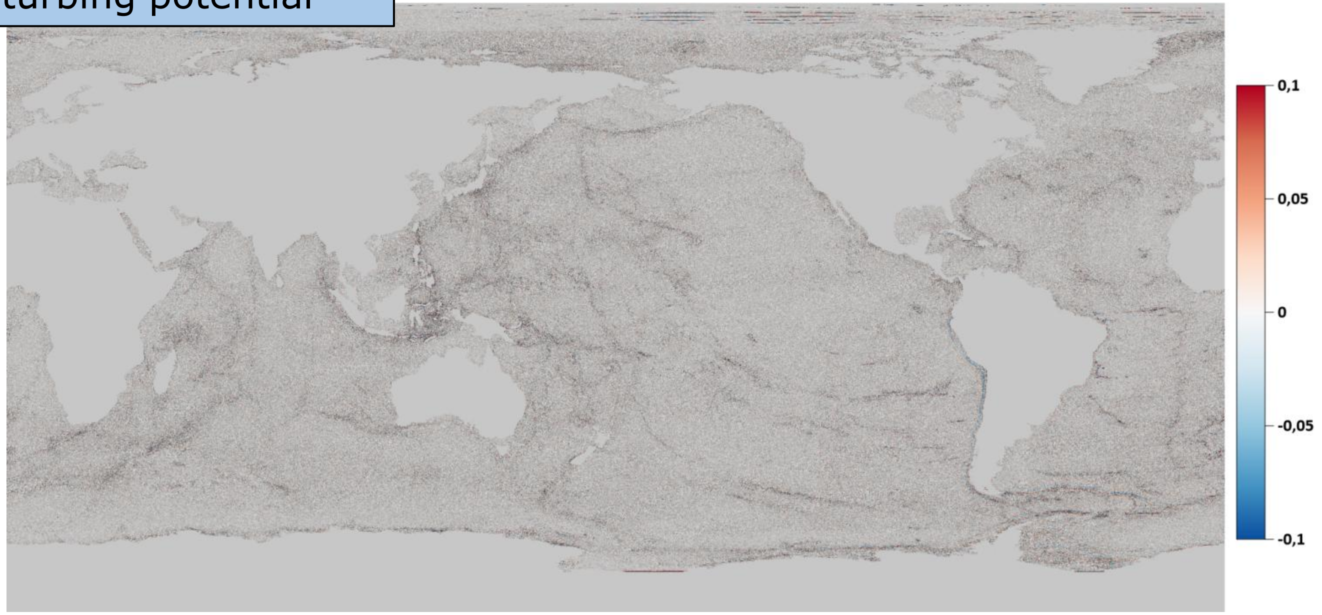
Filtered MDT



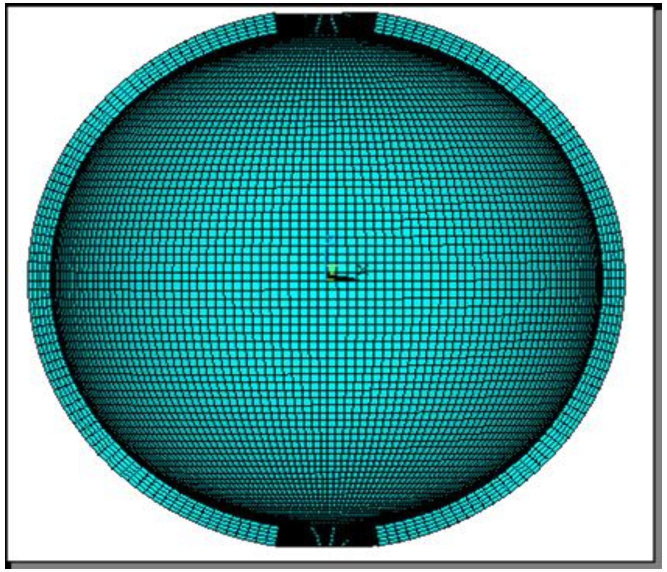


Nonlinear filtering of disturbing potential





Discretization of the computational domain



Resolution: ***1 x 1 arc min (horizontal)***
250 m (radial)

21 600 x 10 800 x 400 = 93 312 000 000 unknowns

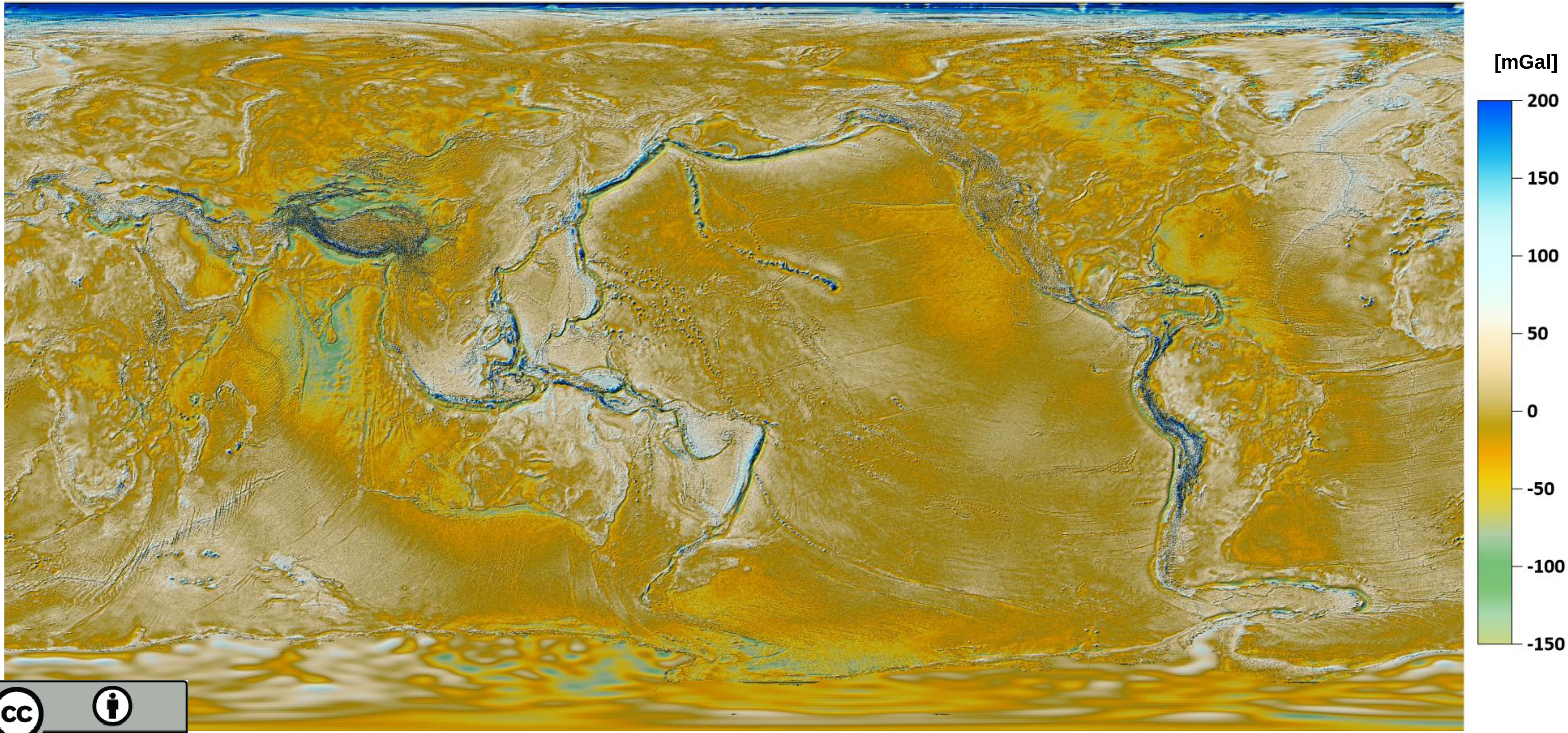
Computational aspects

- large-scale parallel computations:
  - performed on 128 cores (32 MPI processors, each with 4 OpenMP threads)
  - took about 500 h (~ 21 days) of the CPU time

- computational domain divided into 30 subdomains
  (memory reduction by 80%, below 1 TB)

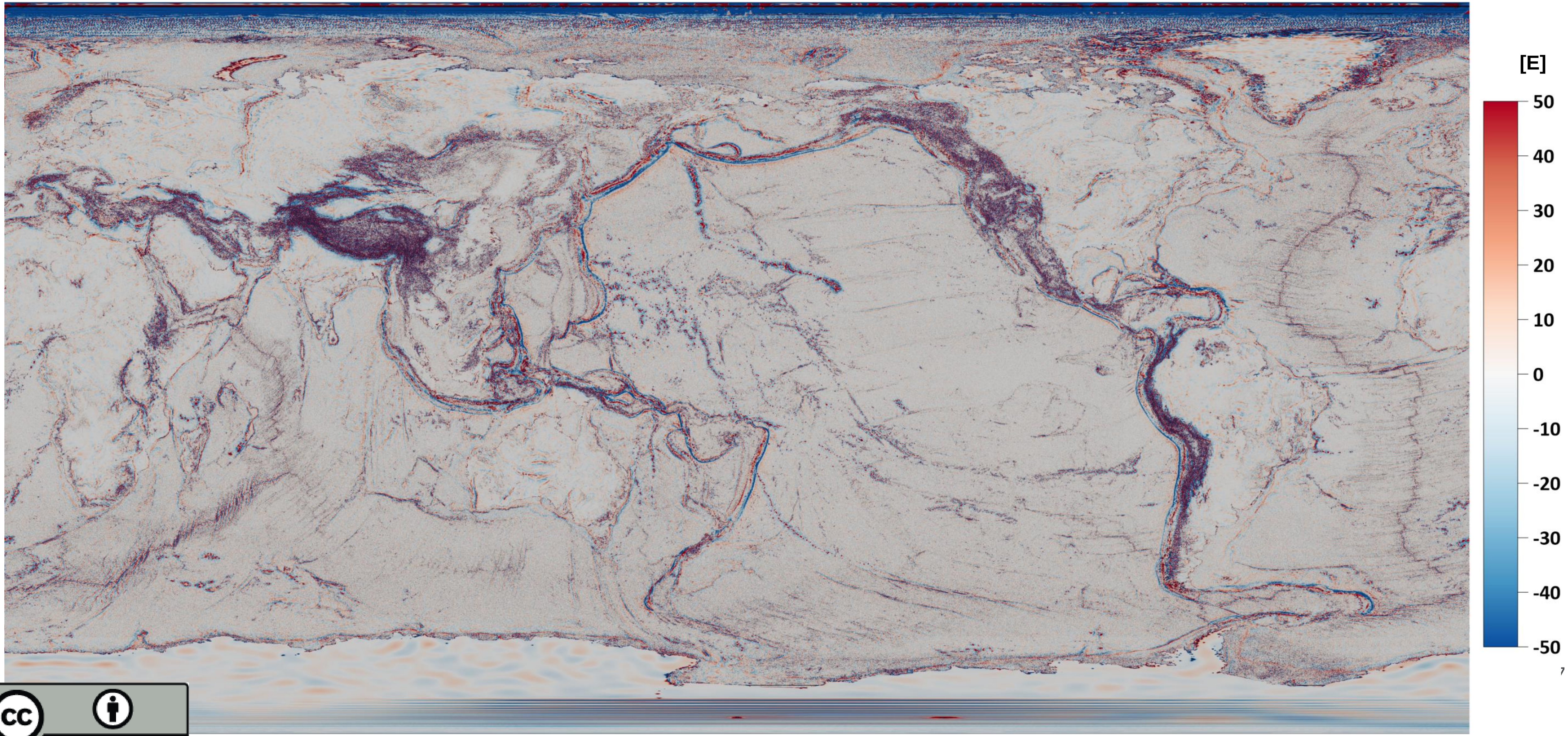
Gravity disturbances on the ellipsoid

(1x1 arc min)



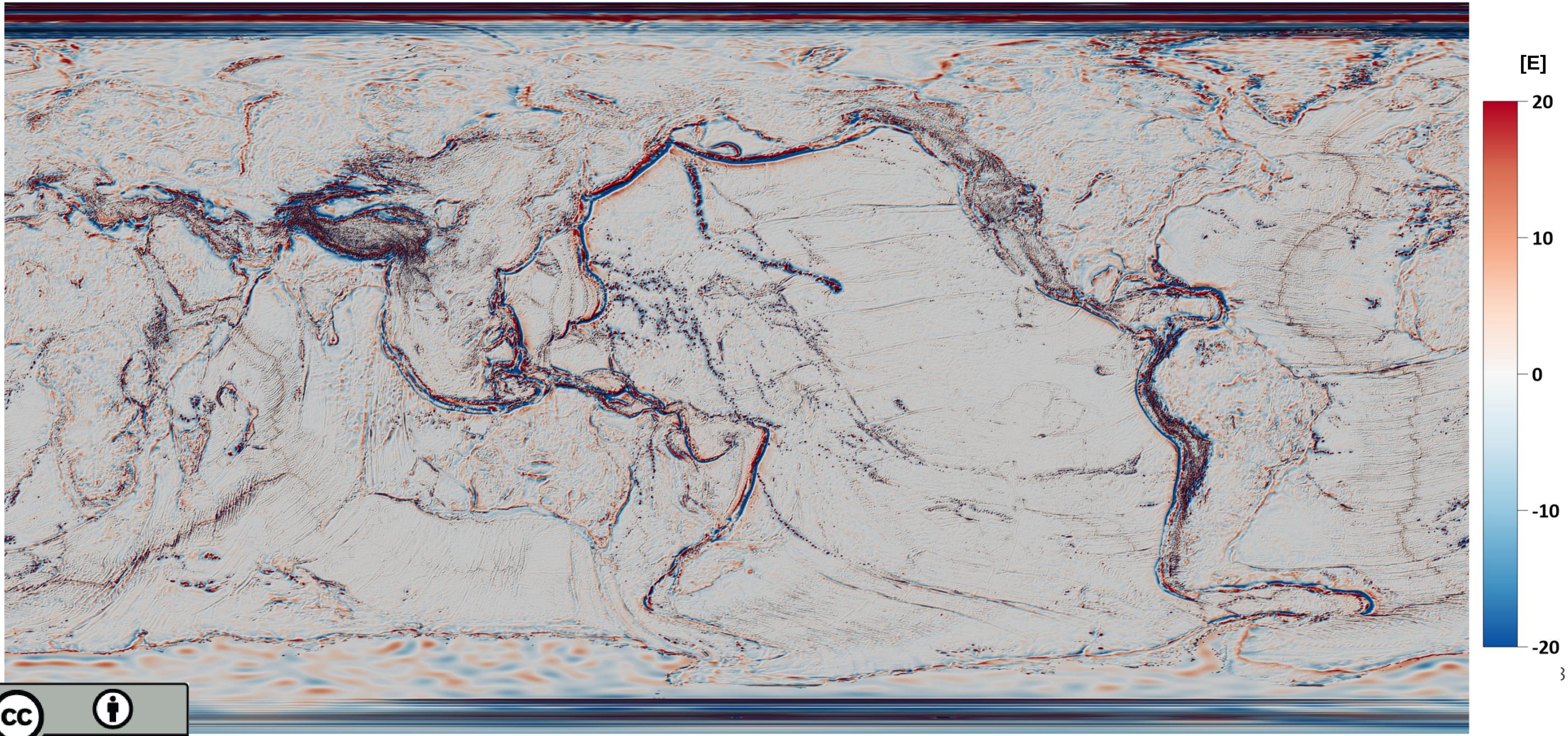
Tzz on the ellipsoid

(1x1 arc min)



Tzz at 10 km

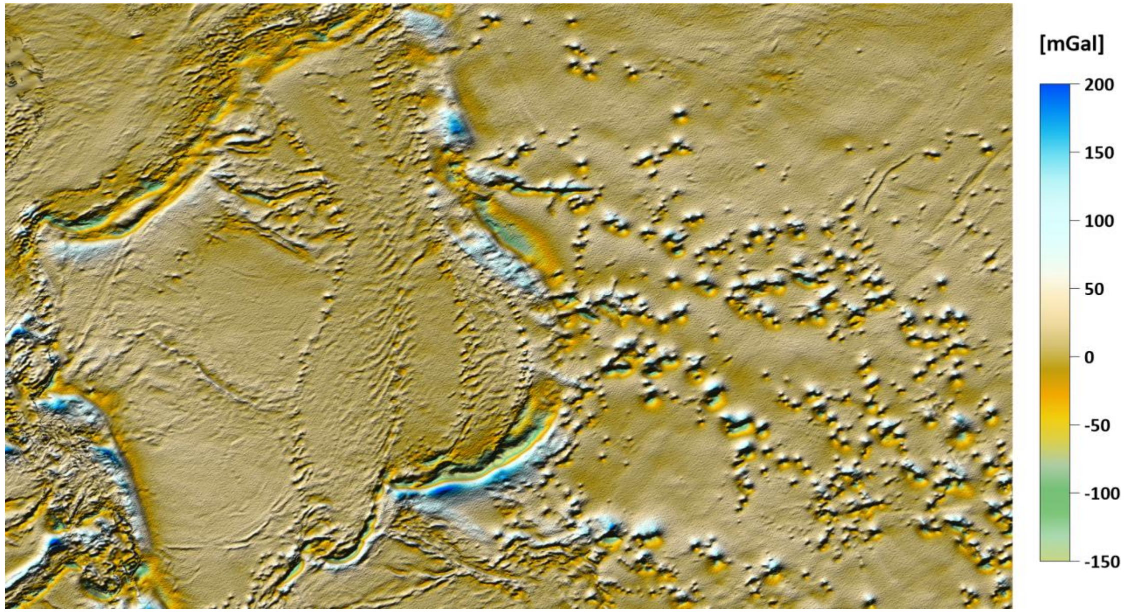
(1x1 arc min)



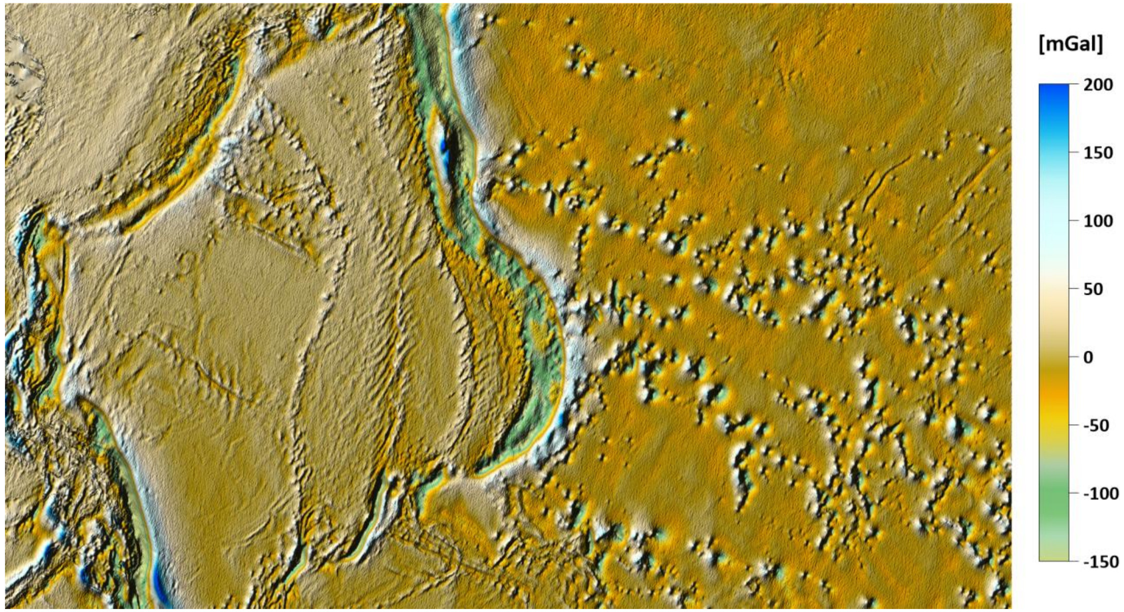
First derivatives on the ellipsoid (1x1 arc min)

STU

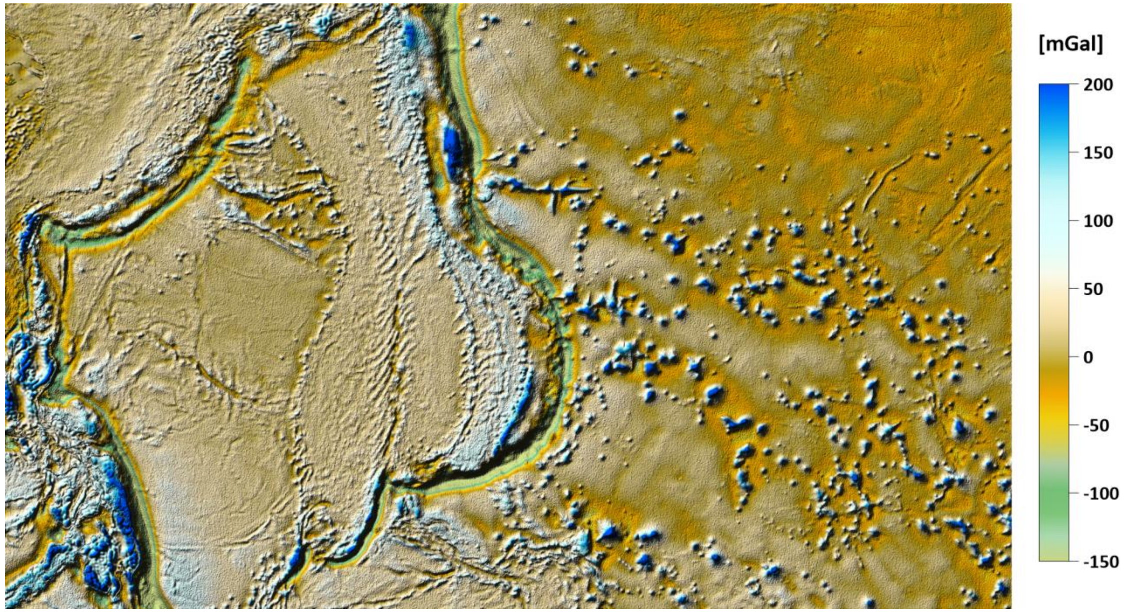
T_X



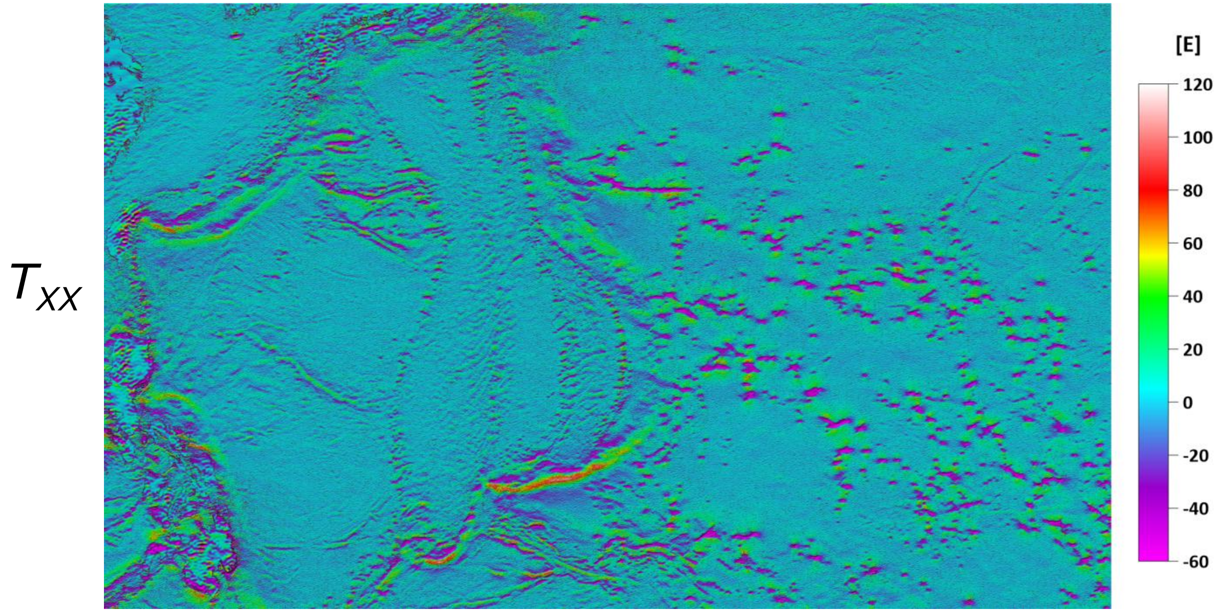
T_Y

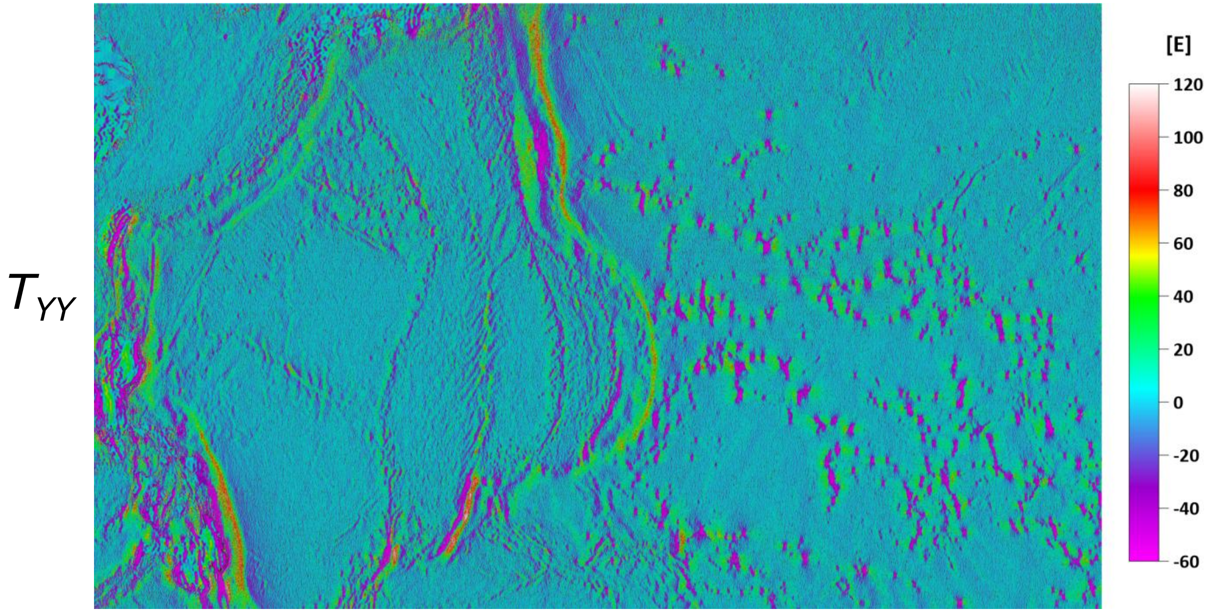


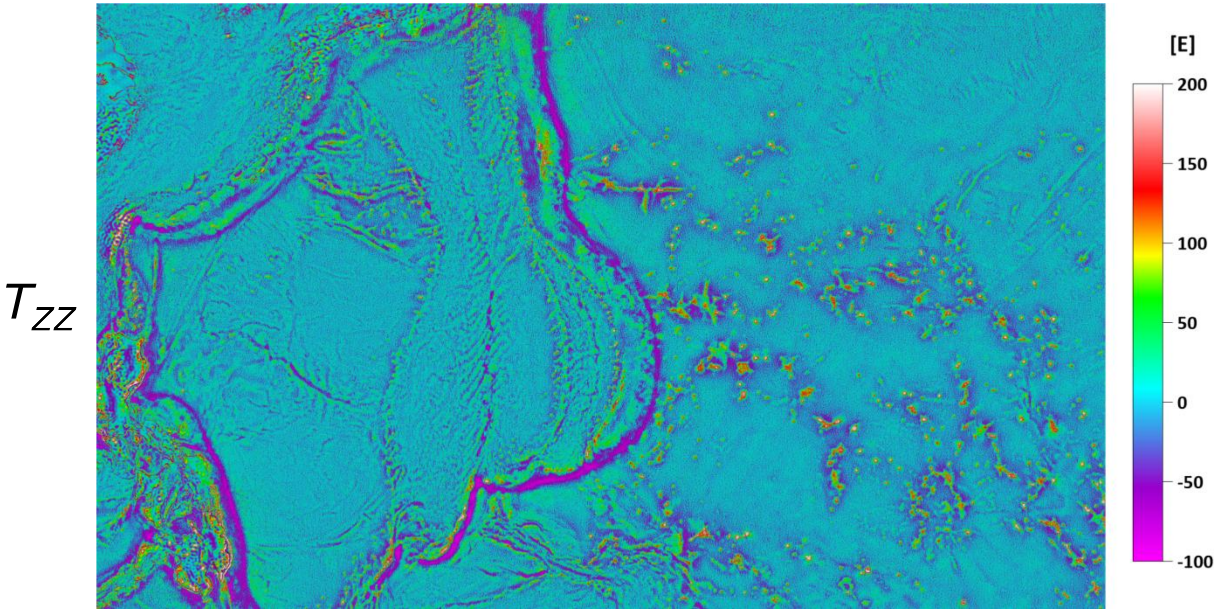
T_Z



Second derivatives on the ellipsoid (1x1 arc min)

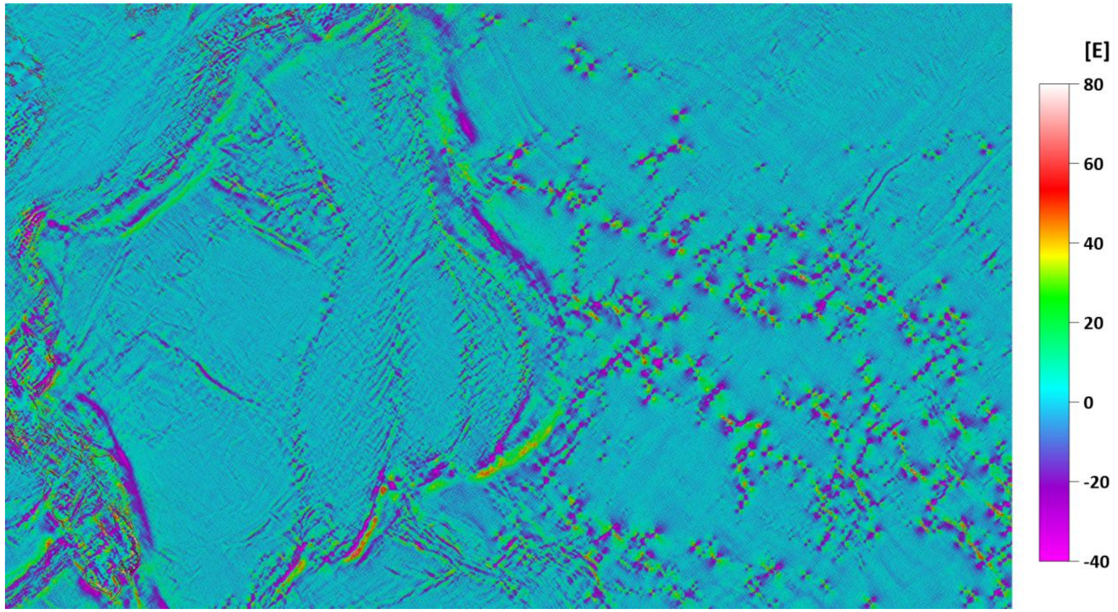




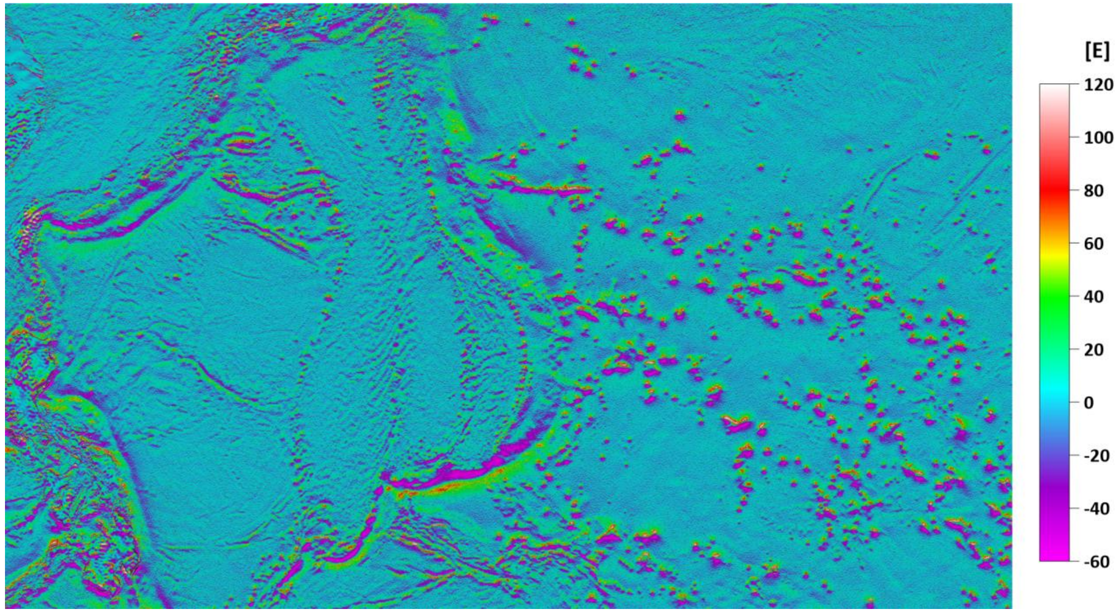


Second derivatives on the ellipsoid (1x1 arc min)

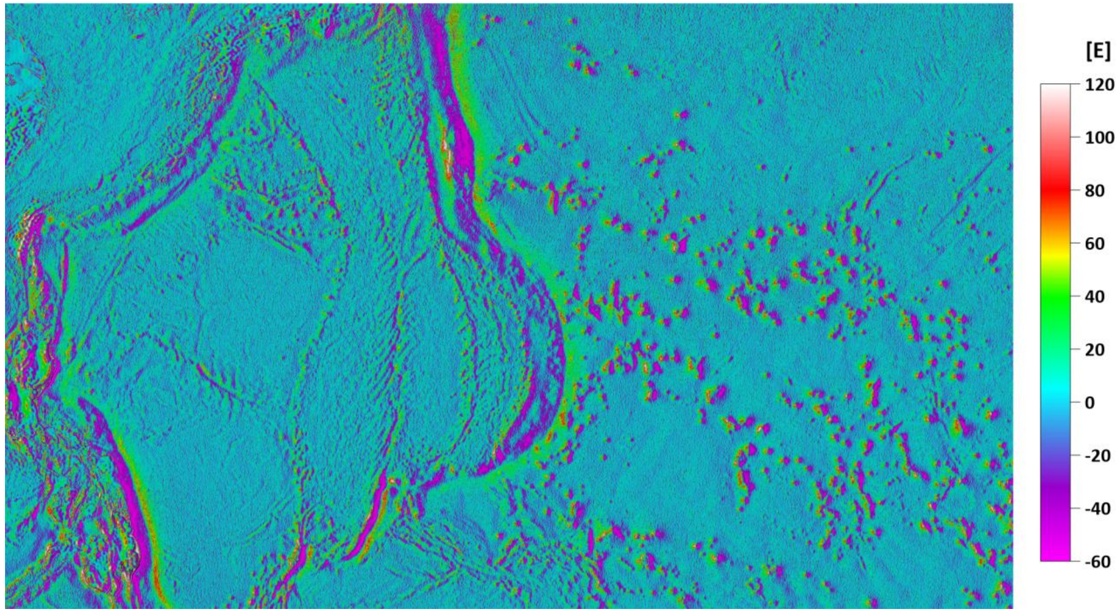
T_{XY}



T_{XZ}

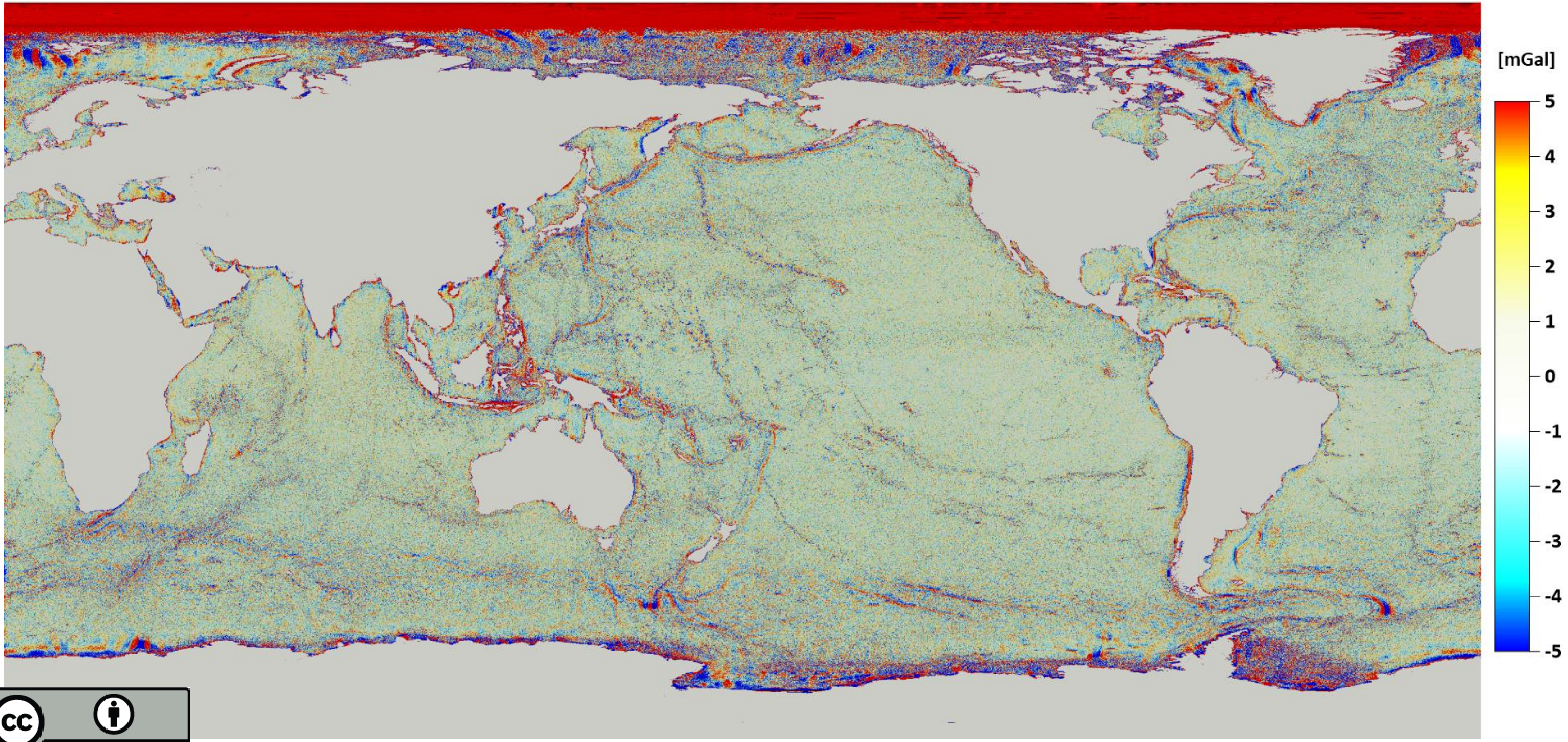


T_{YZ}

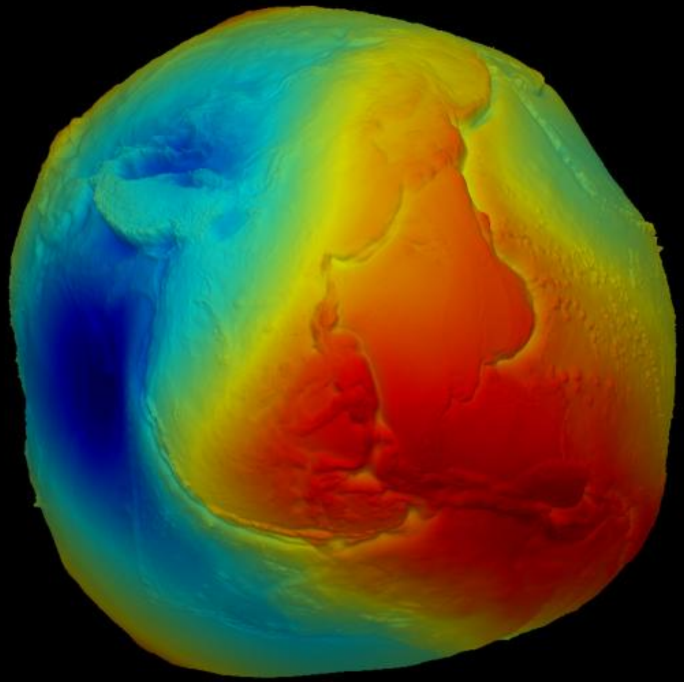


Comparison of gravity disturbances with DTU15_GRAV

(1x1 arc min)



Thank you for your attention!



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