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

Numerical solution by Finite Volume Method (FVM)

Based on:

$\Delta T(x) = 0$, $x \in \mathbb{R}^3 \cdot \Omega$,

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

$(\nabla T(x), s(x)) = -\delta g(x)$, $x \in \Gamma_L$ (land),

$T(x) = T^{SAT}(x)$, $x \in \Gamma_{SAT}$

$\Rightarrow$ discretization of the computational domain into finite volumes

$\Rightarrow$ local conservation of numerical fluxes
Boundary conditions:

Upper boundary (200 km)

Bottom boundary (ellipsoid)

$T_{SAT}$

$T_{oceans}$

$\delta g_{lands}$
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)

\[21,600 \times 10,800 \times 400 = 93,312,000,000 \text{ unknowns}\]

**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)
Second derivatives on the ellipsoid (1x1 arc min)

\[ T_{XX} \]

\[ T_{YY} \]

\[ T_{ZZ} \]
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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