Gravity rate of change at convergent margins

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THE NGGM/MAGIC PROJECT

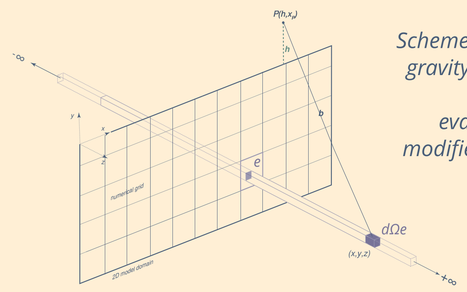
The presented work is part of the ASI founded project **NGGM-MAGIC - a breakthrough in understanding the dynamics of the Earth** [1]. One of the main objectives of the project is to determine the advances that the ESA-planned NGGM/MAGIC mission will allow to achieve in understanding the dynamics of the physical processes that occur in the compartments of the solid and fluid Earth compared to previous missions.

MATHEMATICAL FORMULATION

We performed a set of 2D subduction models using the finite-element algorithm **FALCON** [3], that solves the balance equations combined with a viscoplastic rheology.
The **gravity rate of change** is evaluated as in [3] and [4]:

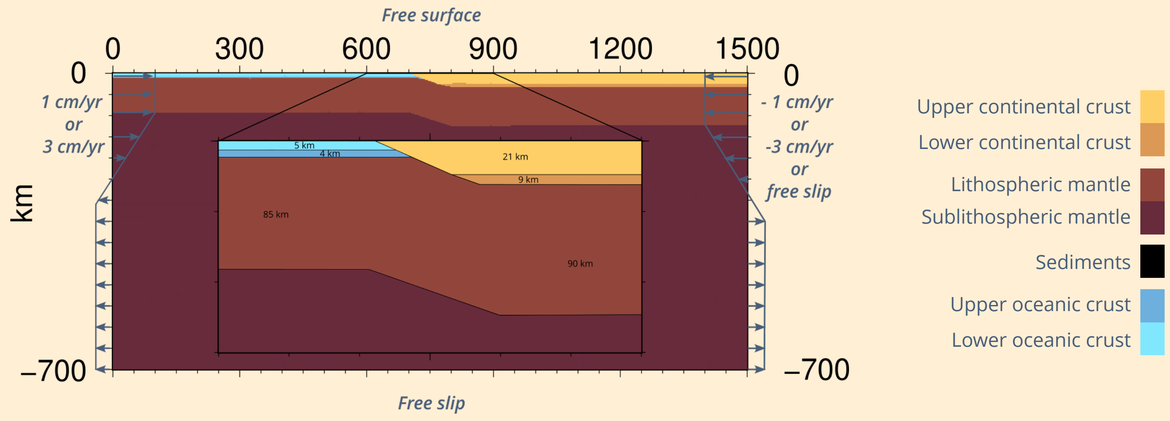
$$\dot{g}(t) = \frac{\partial g(t)}{\partial t} \approx \frac{g(t) - g(t - \delta t)}{\delta t}$$

$$g(t) = \sum_{e=1}^{nelem} g_e(t) = \sum_{e=1}^{nelem} \left\{ G \int_{\Omega_e} \frac{\rho_e}{b^2} d\Omega_e \right\}$$

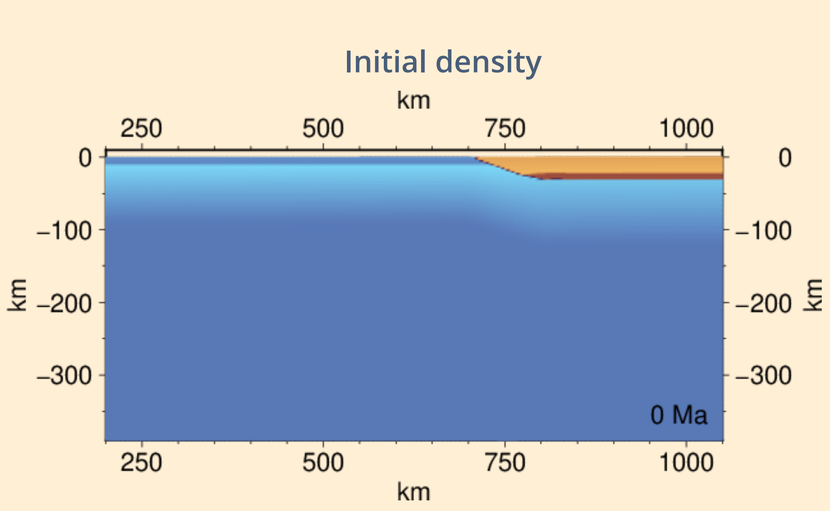


Scheme for the gravity rate of change evaluation modified from [3]

MODEL SETUP

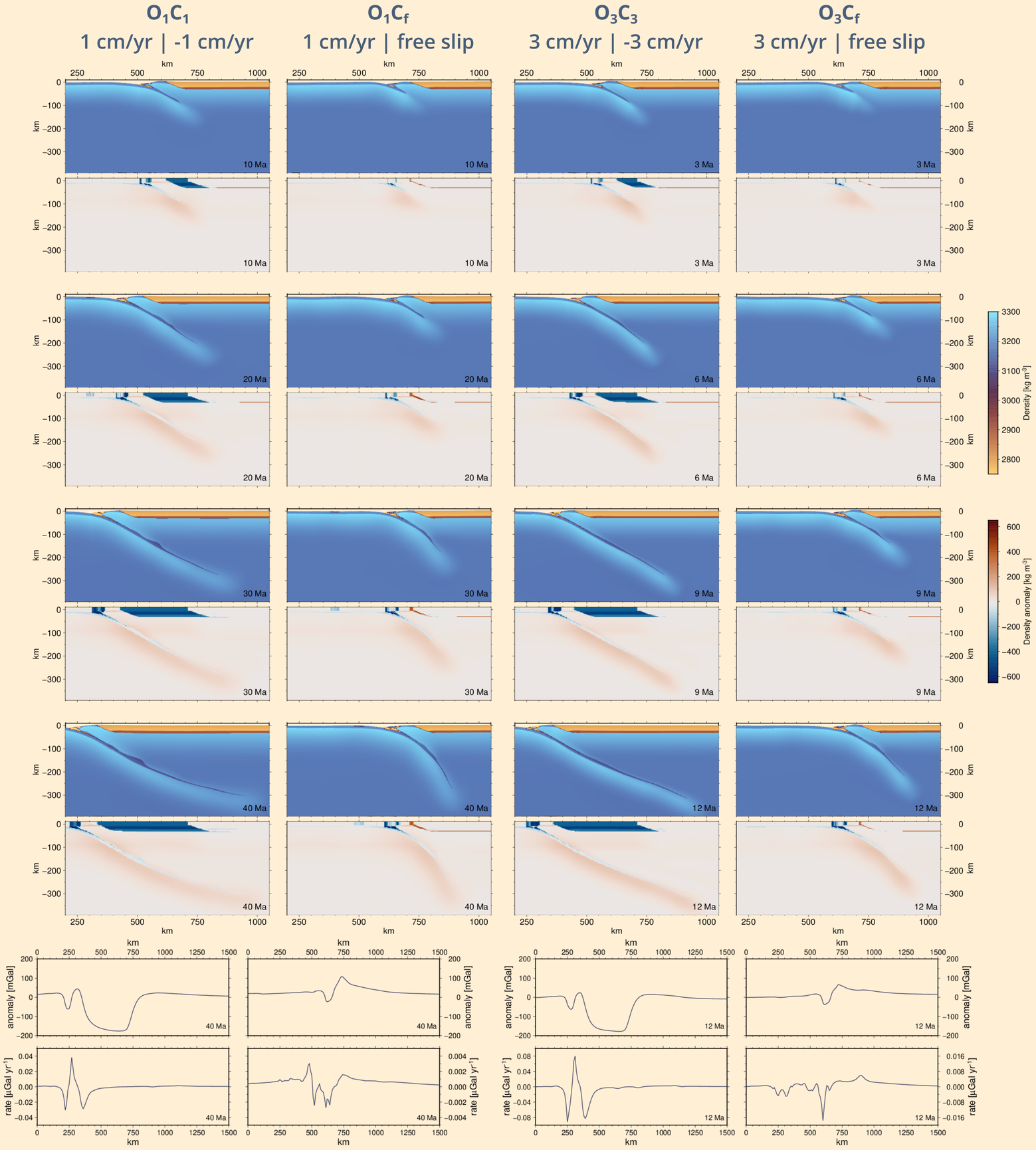


RESULTS



In models with free slip boundary conditions along the upper boundary of the continental plate (models *O1Cf* and *O3Cf*) the trench remains fixed in its initial position and the main contribution to the gravity signature comes from the **positive density anomaly** associated to the **subducting slab**.

When both oceanic and continental plates move (models *O1C1* and *O3C3*), trench retreat occurs as well as **lateral plate movements**. As consequence, strong dynamic **negative density anomalies** are induced at shallow depths, responsible for gravity rate of change that are **1 order of magnitude higher** that those predicted by models *O1Cf* and



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[2] A. Regorda et al. ***Rifting Venus: Insights From Numerical Modeling***. Journal of Geophysical Research: Planets 128 (2023).
[3] A. M. Marotta et al. **The gravitational signature of the dynamics of oceanization in the Gulf of Aden**. Tectonophysics 869, 230110 (2023).
[4] A. M. Marotta et al. **The static and time-dependent signature of ocean–continent and ocean–ocean subduction: the case studies of Sumatra and Mariana complexes**. Geophysical Journal International 221, 788–825 (2020).