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Data-driven forward modeling using a direct search approach

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The aim of this work is to better understand the rheology and dynamics of the lithosphere by combining geodynamic forward models with inverse modeling techniques.
The inversion of surface gravity data to recover statical density-contrast structures is known for its inherent non-uniqueness. Besides, static gravity based inversion models may lack geodynamical consistency. In our approach, we combine a direct-search inversion technique (Neighborhood algorithm, Sambridge, M., 1999) with geodynamical forward modeling to perform an inversion of gravity and surface velocity signals simultaneously. This is done to derive models that are geodynamically consistent, which has two main benefits: The geodynamical consistency of the forward models helps to curtail ambiguities of the inversion results. Moreover, rheology as well as structural parameters can be constrained concurrently in a least-square sense.

In this work we test the approach with synthetic setups. For the inversion process we use the gravity signal and surface (Stokes) velocities measured on top of the models. We employ a parallel 3D finite difference staggered grid mechanical Stokes code (FDSTAG) as part of the Lithospheric and Mantle Evolution Model (LaMEM by B. Kaus and D. May) to perform the forward models.

References
Sambridge, M. (1999), Geophysical inversion with a neighbourhood algorithm – I. Searching a parameter space, Geophys. J. Int., 138, 479-494.