Combining Reduced Order Methods with Bayesian inference for the solution of inverse problems with application in Geophysics.

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ABSTRACT

One of the main challenges in modern lithospheric research is the understanding and characterization of the present-day physical state of the thermal and compositional structure of the Earth's lithospheric and sub-lithospheric mantle. In doing so, high resolution inverse problems need to be solved.

One of the most abundant and better constrained data used for the inversion is the Earth's topography. Despite its quality, the topography models included in inversion schemes are usually very simplistic, based on density contrasts and neglecting any dynamic component. The reason for this is simply computational efficiency; 3D dynamic models are just too expensive to be included within the inversion.

In this context we propose the use of a greedy reduced basis strategy within an probabilistic Bayesian inversion scheme (MCMC) that makes feasible accounting for the fully dynamic topography model within the inversion.

We tested the proposed approach in a synthetic experiment aiming to recover the shape of the bottom of a lithospheric plate described by 225 parameters. Our synthetic model is located in Africa, as it is well-agreed within the geophysical community that the dynamic component in the region is not negligible. Our scheme is able to successfully recover the expected shape of the plate while reducing the computational time to less than 1% when compared to a full Finite Element approach.

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