

Paper Number: 2056

**Data assimilation in global mantle flow models: theory, computation and uncertainties to restore global mantle flow back in time**

Hans-Peter Bunge, Lorenzo Colli, Siavash Ghelichkhan, Jens Oeser, Andre Horbach  
Department of Geosciences, Ludwig-Maximilians University Munich, bunge@lmu.de

---

The ability to extract the motion history of the mantle, which is implied by large-scale seismic structure such as thermal plumes or subducting oceanic slabs, is crucial to constrain key rheologic and buoyancy parameters of the mantle convection system. Here we show, how fluid dynamic inverse theory, based on a variational approach, can be exploited rigorously in a global mantle circulation model to project gross heterogeneity structure back in time. We address questions related to uniqueness, existence and stability of the inverse problem, and derive the inverse equations associated with compressible mantle flow. We present the basic theory of the forward and inverse problem, review observational constraints, provide computational considerations relevant to the global flow problem with 100 million finite elements, and discuss uncertainties. The latter restrict the problem in practice, as our knowledge of deep Earth structure and its interpretation in terms of dynamic flow structures is necessarily limited.

