Abstract:

Mantle convection models are powerful tools to improve our understanding of deep earth processes. Over the past two decades they progressed greatly, owing to increasing computational power. The same increase allows geodynamicists to move from a forward to an inverse approach of convection and to explore optimisation problems of mantle flow based on the adjoint method. Though computationally expensive, this novel approach to geodynamic modeling allows us to reconstruct gross earth structure back in time, thus opening entirely new opportunities to test our assumptions on uncertain parameters of dynamic earth models by comparing their time trajectories against a wealth of geologic observations. In this seminar, I briefly review the method including its uniqueness properties, before I introduce a recently published (Colli, Ghelichkhan, Bunge, & Oeser, 2017) global mantle flow retrodiction for a geodynamically plausible, compressible, high resolution Earth model with ~670 million finite elements, going back in time to the Mid Paleogene. Focusing on the African hemisphere, and in particular on Europe and the North Atlantic, I show how the retrodictions produce a spatially and temporally highly variable asthenosphere flow with faster-than-plate velocities, and a history of dynamic topography characterized by local doming events. These results agree with considerations on plate driving forces, and regional scale uplift events reported in the geologic literature. Our results suggest that improved constraints on dynamic topography changes -- provided, for instance, by basin analysis, seismic stratigraphy, landform and fission track studies, or the sedimentation record -- will play a crucial role in our understanding of the recent mantle flow history.

Short Bio: Hans-Peter Bunge

Hans-Peter Bunge is Chair of Geophysics at Munich's Ludwig Maximilians University since 2003. Prior to his Munich appointment he served five years on the Princeton faculty following a European Union postdoctoral year at the Institute de Physique du Globe in Paris. He completed his Berkeley PhD in 1996, the majority of which he spent at the Los Alamos National Laboratory, where his graduate work on global mantle convection models was supported by the Institute of Geophysics and Planetary Physics and the Advanced Computing Laboratory. An elected member of the Academia Europaea, and the Bavarian Academy of Sciences, Bunge served as President of the Geodynamics Division of the European Union of Geosciences from 2007-2009.

Bunge's research interests lie in theoretical and observational geodynamics using high performance computing to tackle problems of Earth dynamics. His work has ranged from modeling mantle and core convection to lithosphere dynamics, and the application of mineral physics to relate seismic information quantitatively to geodynamic models. Recently, he analyzed rapid plate motion variations as a probe into plate boundary forces and paleo mantle flow. Bunge developed fluid dynamics inverse theory based on an adjoint approach as a means to assimilate observations into geodynamic models and to solve the initial condition problem in geodynamics.

Colli, L., Ghelichkhan, S., Bunge, H. P., & Oeser, J. (2017). Retrodictions of Mid Paleogene mantle flow and dynamic topography in the Atlantic region from compressible high resolution adjoint mantle convection models: Sensitivity to deep mantle viscosity and tomographic input model. *Gondwana Research*. http://doi.org/10.1016/j.gr.2017.04.027