AGU FALL MEETING
San Francisco | 14 – 18 December 2015

DI23A-03: Pattern recognition constrains mantle properties, past and present

ABSTRACT

Tuesday, 15 December 2015
14:10 - 14:25
Moscone South - 303

Understanding and modelling mantle convection requires knowledge of many mantle properties, such as viscosity, chemical structure and thermal proerties such as radiogenic heating rate. However, many of these parameters are only poorly constrained.

We demonstrate a new method for inverting present day Earth observations for mantle properties. We use neural networks to represent the posterior probability density functions of many different mantle properties given the present structure of the mantle. We construct these probability density functions by sampling a wide range of possible mantle properties and running forward simulations, using the convection code StagYY. Our approach is particularly powerful because of its flexibility. Our samples are selected in the prior space, rather than being targeted towards a particular observation, as would normally be the case for probabilistic inversion. This means that the same suite of simulations can be used for inversions using a wide range of geophysical observations without the need to resample. Our method is probabilistic and non-linear and is therefore compatible with non-linear convection, avoiding some of the limitations associated with other methods for inverting mantle flow. This allows us to consider the entire history of the mantle. We also need relatively few samples for our inversion, making our approach computationally tractable when considering long periods of mantle history.

Using the present thermal and density structure of the mantle, we can constrain rheological and compositional parameters such as viscosity and yield stress. We can also use the present day mantle structure to make inferences about the initial conditions for convection 4.5 Gyr ago. We can constrain initial mantle conditions including the initial concentration of heat producing elements in the mantle and the initial thickness of primordial material at the CMB. Currently we use density and temperature structure for our inversions, but we can extend this method to many other geophysical observables, such as inferred viscosity structure, continent distribution and surface heat flux.

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Session: Across the Scales: Earth's Mantle Dynamics through Space and Time II

Section/Focus Group: Study of Earth's Deep Interior

Day: Tuesday, 15 December 2015