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Trans-dimensional Bayesian inversion of multiple dataset for the thermal structure and chemical composition of the crust and upper mantle

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A robust understanding of the Earth's chemical composition and thermal structure is fundamental in order to gather insights on the processes responsible for the planet formation and evolution. Non-linearity and non-uniqueness affecting the relationships between geophysical observables and thermo-chemical structure represents a major issue in probing the Earth's interior. To tackle the problem, we develop an algorithm to perform joint inversion of multiple data-set for the temperature and composition of the crust and upper mantle. The data involved in the inversion are surface waves dispersion curves, receiver functions and surface topography. The algorithm performs the inversion adopting a trans-dimensional hierarchical Bayesian approach. Model parameter space is sampled with a Markov chain Monte Carlo algorithm. A-priori information on chemical composition and thermal state are taken from xenoliths and heat flow measurements, respectively. The forward model consists in computing seismic waves velocity and density first, and then surface waves dispersion curves, receiver functions and isostatic topography. The link between thermo-chemical structure, seismic velocities (Vp and Vs) and density, is established leveraging on mineral physics constraints and a robust thermodynamic framework. Such an approach has never been adopted before in investing the crustal composition. We present results using synthetic data and an application on real data for a permanent station (DSB) of the Irish National Seismic Network.