Weighing TUZO and JASON individually

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Abstract

There exist two large (~1000 km) dome-like structures rising from the base of the mantle in global tomographic models that exhibit low seismic wave-speeds, known as “Large Low Velocity Provinces” (LLVPs). The LLVP beneath Africa is also known as Tuzo, while the LLVP beneath the Pacific Ocean is known as Jason – two early pioneers of plate tectonics and plume theory (Wilson and Morgan, respectively). The source of these anomalously low wave-speeds is debated as both thermal and chemical heterogeneities can lower wave-speeds. These heterogeneities, however, lead to dynamically different modes of convection, where the former results in buoyant LLVPs and the latter relatively dense LLVPs. Recent studies that include dynamical modeling, Stoneley modes, and body tide constraints, are beginning to converge towards a picture where dense, chemical heterogeneities may be stored in the deepest part of the LLVPs. Many of these analyses, however, have not treated each LLVP distinctly. Considering the interdisciplinary focus of this session, we combine the unique geodetic observation of Earth’s solid body tide with methods that combine Backus-Gilbert estimation with theoretical advances in adjoint methodology, to constrain the density of each LLVP separately. This process results in the enhancement of the combined data sensitivity to a chosen region (e.g., one LLVP) while diminishing the combined data sensitivity elsewhere. We discuss the results in the context of geochemical observations unique to Tuzo and Jason and implications for the dynamics of mantle evolution.

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