Gone with the (mantle) wind: Surprising hotspot particle paths in tomography-based mantle convection models

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Decades of studies have characterized the chemical and isotopic variability of the suboceanic mantle, and the distinctive components associated with the mantle plume sources of ocean islands. A major open question is how the surface location of hotspots relates to their deep mantle source, and geochemistry cannot tell us about their actual 4D trajectory from the deep interior to the surface. The ability to map the 4D mantle "wind" with tomography-based global convection models that reconstruct mantle evolution over 10s to 100s of million years (Glišović & Forte 2015, 2016, 2017) provides a unique means for delineating the trajectories of mantle materials from deep interior to the surface. We developed a high-accuracy numerical method for tracing particle paths in the 4D mantle wind predicted by these global convection models, and mapped the connections between a number of global hotspots and their deep sources (see figure below). We find marked differences in the trajectories of Pacific vs Atlantic and Indian hotspots, with large lateral displacements and more rapid ascent rates under the Pacific, versus more vertical and sluggish movements under the Atlantic and Indian oceans.