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Behaviour of mantle transition zone discontinuities beneath the Indian Ocean from PP and SS precursors

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As part of the RHUM-RUM project we investigate the upwelling plume beneath the island La Réunion, located in the Indian Ocean 200 km east of Madagascar. This plume belongs to one of the most active hotspot regions in the world and is still active today. Understanding the depth origin and dimensions of such a plume helps to better understand mantle processes and the heat flux of the Earth. If the plume originates at the core-mantle boundary the Earth is cooled down differently compared with an indirect cooling of plumes originating in the upper mantle. Here we use underside reflections of PP and SS waves off the seismic discontinuities at 410 km and 660 km depth that arrive as precursors to the main phase in order to investigate the topography of these discontinuities that mark the top and bottom of the mantle transition zone. If hotter or colder material intersects the mantle transition zone, the discontinuities at 410 km and 660 km depth are deflected, hence the topography of the mantle transition zone can be an indicator for an upwelling plume. The 410 km discontinuity, which exists due to the phase change of olivine to spinel, should be depressed significantly in the presence of hot upwelling material. Because of the opposite Clapeyron slope of the phase change of spinel to magnesiowuestite and perovskite at 660 km depth, the topography of this discontinuity should be elevated. For this study we analyse over 200 events with $M_w \geq 5.8$ and bounce points distributed over the entire Indian Ocean. Array seismology methods, such as vespagrams and slowness-backazimuth analysis, are used to enhance the signal-to-noise-ratio and detect and identify precursors. Using different source-receiver combinations enables us to get a dense coverage of bounce points of PP and SS waves in the Indian Ocean and especially around La Réunion, also with crossing ray paths. The differential travel times of PP and SS arrivals and their precursors of robust stacks are converted into depth values of the seismic discontinuities. In our data, we can detect clear underside reflections off the 410 km discontinuity and also some off the 660 km discontinuity. The preliminary topography of the two discontinuities indicates a thinned mantle transition zone, which we interpret as a large upwelling beneath La Réunion.