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Lateral heterogeneities in the lowermost mantle – To what detail can we resolve them seismically?

S. Hempel (1), T. Nissen-Meyer (2), and C. Thomas (1)

(1) Institute of Geophysics, WWU Münster, Münster, Germany (stefanie.hempel@uni-muenster.de), (2) Institute of Geophysics, ETH Zürich, Zürich, Switzerland

The D" layer in the Earth's lowermost mantle shows lateral variations in elastic properties like density, seismic velocity and anisotropy. In a few areas, one or more reflectors are detected on top and within the D" layer. This D" discontinuity exhibits short- and large-scale topography; the width of the vertical gradient of the elastic properties across the discontinuity varies between a few 10ths and 100 kilometers, and the polarities of the seismic reflectivity show both positive and negative correlation to the core-mantle-boundary reflection. It is difficult to discriminate these complex phenomena in seismological data. To study their effects separately we use an axisymmetric spectral element method to model the 3D seismic wave propagation in Earth models with 2.5D lateral heterogeneities of different length scales, elastic properties, shapes or inclinations. We show that some of these features are resolved by seismology and that others are not. E.g. low inclinations of reflectors result in a travel time perturbation that can be mistaken for varying height of the reflector, whereas very steep topography explains e.g. an unexpectedly low amplitude of the reflection off the core-mantle-boundary (PcP, ScS) and a broad arrival of the reflection off the D" discontinuity (PdP, SdS).