Mapping depth variations of the 410 km and 660 km discontinuities across Europe using noise correlations

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The mantle transition zone is delineated by seismic discontinuities at approximately 410-km and 660-km depth. The depth variations of the two seismic discontinuities reflect changes in mineralogy composition, thermal state, and water content, that is key to understand the Earth's dynamics [e.g., for the European region: Wortel & Spakman 2000; Cottaar & Deuss 2016]. Traditional imaging methods based on the analysis of earthquake signals, such as seismic tomography and receiver function analysis, are often limited by earthquake occurrence and uncertainties related to the earthquake source parameters. Recent studies demonstrated the feasibility of recovering body waves from noise correlations, providing new prospects for imaging deep Earth [e.g., Poli et al., 2012; Boué et al.,2013].

In this study, we map the lateral depth variations of the 410-km and 660-km discontinuities using reflected body waves recovered from stacked noise correlations. We take advantage of the large number of available seismic stations in Europe, in particular in the greater Alpine region associated with the AlpArray project. We compute noise correlations of continuous vertical-component recordings from ~2000 broadband stations. The obtained noise correlations are stacked within a spatially moving window to enhance SNR of the reflection phases. The window length is adaptive to the local station density, providing optimal resolution of the resulting topographic maps.

The obtained results provide new constraints on discontinuity geometries in addition to existing results from earthquake tomography and receiver function analysis. This study also sheds light on the data processing and interpretation of noise correlations: i. we examine different strategies for body wave extraction. In particular, we investigate the weighting scheme

for stacking noise correlations over time; ii. we analyze possible spurious arrivals originated from earth resonance and large earthquakes.

References

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