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Imaging the crust and the upper mantle using Rayleigh wave ellipticity: Application to Westernmost Iberia

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Illuminating both earthquake sources and Earth structure is particularly challenging in regions with sparse seismic networks and unfavourable geographical settings. This is the case of Portugal, where only a limited number of high quality broadband (BB) seismometers were available up until recently despite its significant seismic activity and associated hazards. Examples of significant past events include the devastating great 1755 Lisbon earthquake (M ∼8.5-8.7), the Setúbal event in 1858 (M ∼7.1), and the 1909 Benavente earthquake (M ∼6.0). In order to better characterize seismicity in the region and earthquake source processes, robust and accurate Earth models are needed. The lack of high quality BB data in the past has hindered quantitative characterization of regional Earth structure in Portugal. Since 2006, however, a large volume of high quality BB data is continuously accumulating due to the significant expansion that Portuguese seismic network has undergone. In the current study, we utilize this newly available dataset to measure Rayleigh wave ellipticity, which will be inverted for the seismic structure of the crust and the upper mantle beneath Westernmost Iberia.

Rayleigh wave ellipticity is commonly defined as the horizontal-to-vertical amplitude ratio (H/V ratio) at a given seismic station, which theoretically depends only on the structure beneath that particular station. We are currently measuring H/V ratios for BB stations in Portugal in the periods ranging from ∼25 s to ∼200 s that will be inverted for velocity profile beneath each station. Also, the use of both narrow bandpass filters and a multitaper method to make H/V ratio measurements is currently being explored. We carry out extensive synthetic tests using theoretical seismograms calculated from normal mode summation in the epicentral distance range [40°, 65°] for the Preliminary Reference Earth Model (PREM), considering the effects of fundamental and higher modes on the H/V ratio estimates. Our initial synthetic tests produce stable H/V ratios with little scatter over all frequencies and distances considered, indicating reliability of our measurement technique. Constraining Earth structure based on the H/V measurements is currently underway.