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Using Cross-Correlation to Detect Upper Mantle Phases beneath Spain and Morocco

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A novel technique is implemented to search for weak amplitude upper mantle phases that arrive in the P-wave coda. Cross-correlation and stacking techniques are applied in order to detect waveform similarity and eliminate the source influence from the vertical and radial component of records from single stations. A pilot wave is selected from the vertical component, this wavelet contains the P-wave and part of its coda. Phase cross-correlation (PCC) and geometrically normalized cross-correlation (CCGN) are performed between this pilot and the vertical, and the radial component of each event. It is expected that this procedure detects P to s conversions, and reflections at different mantle discontinuities (such as 410-km and 660-km depth discontinuities). Stacking is used to enhance signals which arrive consistently (near receiver conversions and reflections) and attenuate isolated depth phases and also spurious arrivals. Besides the source equalization, PCC and CCGN provide relative travel times with respect to the P phase through their correlation maxima. The data set used in the real data example is obtained from more than 40 stations selected from the first phase of the IberArray seismic network deployment (TopoIberia project) in south Spain and north Morocco. P-wave reflections and P to s conversions at 410-km and 660-km upper mantle discontinuities were detected beneath the studied region. Both discontinuities are on average within the expected depth range from global studies.