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Systematic detection and correction of instrumental time shifts using crosscorrelations of ambient seismic noise

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Timing errors are a notorious problem in seismic data acquisition and processing. We present a technique that allows such time shifts to be detected and corrected in a systematic fashion. The technique relies on virtual-source surface-wave responses retrieved through the crosscorrelation of ambient seismic noise. In particular, it relies on the theoretical time-symmetry of these time-averaged receiver-receiver crosscorrelations. By comparing the arrival time of the surface waves at positive time to the arrival time of the surface waves at negative time for a large a number of receiver-receiver pairs, relative timing errors can be determined in a least-squared sense. The time-symmetry of the receiver-receiver crosscorrelations, however, is contingent on a uniform surface-wave (noise) illumination pattern. In practice, the illumination pattern is often not uniform, leading to errors in the determined relative timing errors. We therefore show that weighting different receiver-receiver pairs differently in the least-squares inversion allows these timing errors to be determined more accurately. The weights are based on the susceptibility of different receiver pairs to illumination-related travel-time errors. The proposed methodology is validated using both synthetic and field data. The field data consists of recordings of ambient seismic noise by an array of stations centered around the tip of the Reykjanes peninsula, southwest Iceland.