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Quantifying fundamental mode Rayleigh waves great-circle deviations by broadband array analysis

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The deviation of propagating surface waves from the great-circle path between seismic source and receiver is indicative of complex propagation effects, and may bias the results of some surface wave tomography techniques. We quantify these effects based on the analysis of almost 300 seismic events recorded by the temporary broadband network LAPNET, located in northern Finland. The deviations of fundamental mode Rayleigh waves, as indicated by the difference of observed back azimuths with the great-circle, have systematic variations with source location. These frequency dependent variations are spatially coherent on length scales that are wavelength dependent. Deviations at short period (10-50s) peak to more than 20 degrees at 10-30s period, but are also significant at long periods (>50s). The average absolute deviation at 50s period and above is approximately constant at a level of 3-4 degrees, possibly part of this value being due to random errors. The comparison with deviations observed on seismic records created by noise correlations shows that the amplitudes of the deviations and their frequency dependence is well reproduced. The two types of observations are remarkably similar in the cases where earthquakes are located close to seismic stations. This agreement confirms that the noise correlations do indeed capture the diffraction phenomena associated with surface wave propagation. It also indicates that at least in the cases for which we have data, the earthquake depth, mechanism and slip history have only limited impact on the deviations.