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Off-great-circle propagation of teleseismic surface waves across AlpArray

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Distributed across the greater Alpine region in Europe, the AlpArray seismic network stretches hundreds of kilometers in width and more than thousand kilometers in length, with interstation distances around 40 km. AlpArray can thus be used to study heterogeneities in crust and mantle by their influence on long-period surface waves propagating from distant earthquakes to the array. The heterogeneous structure of the orogenic belt may produce characteristic effects on the propagation pattern of surface waves as they pass through the region. We present a mapping of true propagation paths of 20 – 150 s surface waves that deviate from the great-circles as they propagate from the source to the receiver.
We utilize array beamforming techniques to investigate (deterministic) surface waves from regional and teleseismic earthquakes. The signal is well-recognized and the fundamental mode for both Love and Rayleigh waves is separated before the beamforming. Instead of searching for energy of all possible signals as used in traditional beamforming, we identify the frequency-dependence of surface wave phase velocity and the true backazimuths of propagation. We consider each AlpArray station as a centre of a subarray of neighboring (6 – 15) stations. This allows us to calculate the local phase velocity dispersion curves for individual subarrays with a diameter of approximately 80 – 100 km. We repeat the procedure for more than 450 stations included in the AlpArray project. By the beamforming, phase velocities are corrected for the true propagation backazimuth, which is slightly frequency-dependent for each event. The local phase velocity dispersion curves for each subarray are inverted for the local 1D velocity model. In addition, the true backazimuths determined for each subarray and plotted for all the subarrays together show the frequency-dependent propagation paths through the whole Alpine region.
To benchmark the backazimuths from the array measurement of phase velocities, we also determine the teleseismic surface wavefronts by measuring the group velocities at each station separately. We also use polarization analysis of the horizontal particle motion at each station as yet another method of determining the true propagation backazimuths.