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Global upper mantle heterogeneities observed by AlpArray

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The AlpArray seismic network stretches hundreds of kilometers in width and more than thousand kilometers in length. It is distributed in the greater Alpine region across Europe and it consists of around 250 temporary and around 400 broadband stations with interstation distances around 40 km. The density of the network allows to trace the distortion of group and phase wavefronts (travel time anomalies) of long-period surface waves (30 – 150 s). Examining 30 teleseismic earthquakes from 2016 and 2017 (first two years of the AlpArray project duration) covering the full range of azimuths and adding also other permanent stations from all over the Europe (using around 700 stations altogether), we found arrival directions (predominantly from SSW and NNW) with strikingly pronounced travel time delays across the AlpArray seismic network. Group wavefronts are much more affected than phase wavefronts. Using simple Gaussian beam time-delay modeling of the heterogeneity effects on wavefronts, we are able to estimate the distance of the heterogeneity, its position, lateral size and magnitude of the velocity anomaly, which had caused the observed wavefront distortion. Both phase and group distortions are observed and modeled to increase the reliability of the estimation. The observation serves not only as a detector of upper mantle heterogeneities, but it also allows to determine how phase and group travel time delays and wavefront healing can affect global and regional tomographic studies.