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Large-scale shear velocity structure of the upper mantle beneath Europe and surrounding regions

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The automated multimode waveform inversion technique developed by Lebedev et al. (2005) was applied to available data of broadband stations in Europe and surrounding regions.
It performs a fitting of the complete waveform starting from the S-wave onset to the surface wave. Assuming the location and focal mechanism of a considered earthquake as known, the first basic step is to consider each available seismogram separately and to find the velocity perturbations that can explain the filtered seismogram best. In a second step, each velocity perturbations serves as a linear constraint in an inversion for a 3D S-wave velocity model of the upper mantle.

We collected data for the years from 1990 to 2006 from all permanent stations for which data were available via the data centers of ORFEUS, GEOFON and IRIS, and from others that build the Virtual European Seismological Network (VEBSN). In addition, we incorporated data from temporary experiments like SVEKALAPKO, TOR and the Eifel plume project as well as permanent stations in France. Just recently we were also able to add the data recorded by the temporary broadband EGELADOS network in the southern Aegean. In this way, a huge data set of about 500000 seismograms came about from which about 60000 1D-models could be constructed.

The resulting models exhibit an overwhelming structural detail in relation to the size of the region considered in the inversion. They are to our knowledge the most detailed models of shear wave velocity currently available for the European upper mantle and surroundings. Most prominent features are an extremely sharp demarcation of the East European platform from Western Europe. Narrow high velocity regions follow the Hellenic arc and the Ionian trench toward the north. Whereas high velocities are found beneath the western Alps between about 100 km to 200 km depth, the eastern Alps show a low velocity anomaly at these depths. Low velocity zones are found at depths around 150 km in the Pannonian basin, the back-arc of the Hellenic subduction zone, and the Middle East.