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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. The Automated Multimode Inversion Method (AMI) foots on an inversion technique originally invented by Nolet (1991) which he called partitioned waveform inversion. It performs a fitting of the complete waveform starting from the S-wave onset to the surface wave. Assuming that the location and focal mechanism of a considered earthquake are known, the first basic step is to consider each available seismogram separately and to find the best 1D-model that can explain the seismogram. In a second step, each 1D-model serves as a linear constraint in an inverison for a 3D model. Inversion parameters are variations of shear velocity in the mantle and Moho depth. The theoretical background of AMI is the pure-path approximation which assumes propagation of waves in and around the vertical plane containing source and receiver. AMI extends the partitioned waveform inversion to a completely automated procedure with automated data quality checks and an automated assessment of the quality of fit of the 1D-model to the observed seismogram. In this way, large volumes of data can be efficiently inverted for 3D mantle structure.

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 amd IRIS. In addition, we incorporated data from temporary experiments like SVEKALAPKO, TOR and the Eifel plume project as well as permamnet staions in France. Just recently we were also able to add those data recorded by the EGELADOS network which are already available from the GEOFON data archive. In this way, a huge data set of about 300000 seismograms came about from which about 60000 1D-models could

be constructed. The reduction of usable seismograms is caused by (1) the rigorous automatic quality checks implemented in AMI, (2) the elimination of seismograms for which violations of the pure-path approximations are apparent, e.g. data from stations on nodal planes of the focal mechanism or data containing too high a level of coda. Since AMI expects wave trains of shear and surface waves separated in time, paths shorter than 2000 km are discarded.

The resulting models exhibit an overwhelming 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 Europe 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. Even a high velocity zone beneath the Western alps can be imaged. Low velocity zones are found at depths around 130 km in the Pannonian basin, the back-arc of the Hellenic subduction zone, and the Middle East. A narrow band-like low-velocity anomaly follows the coastline of the Red Sea but shifted about 100 km to the east, opens out in to the Afar triangle and then continues into the East African Rift Zone. The hotspots in North Africa are as clearly imaged as the high-velocity cratonic regions in Africa. At greater depths clear remnants of Tethyan subduction along the Eurasian-African plate boundary are observed.