Seismic structure of the European crust and upper mantle based on adjoint tomography

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We present a new crust and upper mantle model for the European continent and the North Atlantic Ocean, named EU60.It is constructed based on an adjoint-state method and involves 3D variations in elastic wavespeeds, anelastic attenuation, and radial & azimuthal anisotropy. Long-wavelength elastic wavespeed structures agree with previous body- and surface-wave models. Some hitherto unidentified features, such as the Adria microplate, naturally emerge from the smooth starting model. Subducting slabs, slab detachments, ancient suture zones, continental rifts and back-arc basins are well resolved. For anelastic structure, we find an anti-correlation between shear wavespeed and anelastic attenuation at shallow depths. At greater depths, this anti-correlation becomes relatively weak, in agreement with previous attenuation studies at global scales. Consistent with radial anisotropy in 1D reference models, the European continent is dominated by features with a radially anisotropic parameter greater than 1, indicating the presence of horizontal flow within the upper mantle. In addition, subduction zones, such as the Apennines and Hellenic arcs, are characterized by vertical flow at depths greater than 150 km. For azimuthal anisotropy, we find that the direction of the fast anisotropic axis is well correlated with the tectonic evolution in this region, such as extension along the North Atlantic Ridge, trench retreat in the Mediterranean and counter-clockwise rotation of the Anatolian Plate. The "point spread function" is used to assess image quality and to analyze tradeoff between different model parameters.