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Waveform Tomography of the North Atlantic Region

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The enormous volumes of newly available, broadband seismic data and the continuing development of waveform tomography techniques present us with an opportunity to resolve the structure of North Atlantic at a new level of detail. Dynamics of the North Atlantic Ridge and the Iceland Hotspot, evolution of the passive margins on both sides of the ocean, and the nature of the upper-mantle flow beneath the region are some of the important fundamental problems that we can make progress on using new, more detailed and accurate models of seismic structure and anisotropy within the lithosphere and underlying mantle. We assemble a very large waveform dataset including all publicly available data in the region, from both permanent and temporary seismic networks and experiments conducted in Northern and Western Europe, Iceland, Canada, USA, Greenland and Russia. The tomographic model is constrained by vertical-component waveform fits, computed using the Automated Multimode Inversion of surface, S and multiple S waves. Each seismogram fit provides a set of linear equations describing 1D average velocity perturbations with respect to a 3D reference velocity model within an approximate sensitivity region between the source and the receiver. The equations are then combined into a large linear system and jointly inverted for a model of shear- and compressional-wave speeds and azimuthal anisotropy within the lithosphere and underlying mantle. The isotropic-average shear speeds reflect the temperature and composition at depth, offering important new information on both regional- and basin-scale lithospheric structure and evolution. Azimuthal anisotropy provides evidence on the past and present deformation in the lithosphere and asthenosphere beneath the region, which can be interpreted together with other evidence from geological and geophysical data and recent plate kinematic models.