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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 and Arctic at a new level of detail. Dynamics of the Mid Ocean Ridge and the Iceland Hotspot, evolution of the passive margins, and the nature of the upper-mantle flow beneath these regions 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 volume between the source and 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. Average S-wave velocity profiles for the oceanic lithosphere as a function of its age show significantly slower lithospheric cooling in the North Atlantic compared to the global trend. This comparison offers an insight into the dynamic effects of the hotspot activity in the North Atlantic region.