Harnessing high-performance computers and accurate numerical methods to better constrain physical properties of Earth's interior is becoming one of the most important research topics in structural seismology. We use spectral-element and adjoint methods to iteratively improve 3D crustal and upper mantle model of Europe. The spectral-element method, a high-order finite-element method with the advantage of a diagonal mass matrix, is used to accurately calculate three-component synthetic seismograms in a complex 3D Earth model. An adjoint method is used to numerically compute Frechét derivatives of a misfit function based on the interaction between the wavefield for a reference Earth model and a wavefield obtained by using time-reversed differences between data and synthetics at all receivers as simultaneous sources. In combination with gradient-based optimization methods, such as a preconditioned conjugate gradient method, we are able to iteratively improve 3D images of Earth's interior and gradually minimize discrepancies between observed and simulated seismograms. This study involves two stages: in stage one, only phase measurements are used to constrain wavespeed structure of the European crust and upper mantle. Both body and surface waves are employed to simultaneously illuminate deep and shallow structures. Small scale structures are naturally emerged from a smoothed starting model as we iteratively update the model. A new European model, namely EU30, is obtained after 30 preconditioned conjugate gradient iterations. In stage two, both phase and amplitude measurements are used to simultaneously constrain wavespeed and attenuation structure. Exact 20 iterations are applied to construct a new wavespeed and attenuation model of the European crust and mantle, namely EU50. These results enable us to better constrain physical properties of the European upper mantle, such as temperature, partial melting and water content, etc.