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Surface and deep deformation of the great Alpine region from GNSS and seismic anisotropy measurements

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The comparison of crustal and mantle shear directions can provide insights into the extent of crustal-mantle coupling and the dynamics guiding surface movements and active tectonics in continental deformation zones. Here we present a first attempt of comparing surface deformation from GNSS and deep deformation from seismic anisotropy observations for the Great Alpine Area, mainly through France, Switzerland, Italy, Germany and Slovenia. The developments of the European GNSS infrastructure, integrating public and private GNSS networks, allow now to precisely determining crustal deformation over the Alps. We present a new 3D surface velocity field obtained from a recent re-analysis of 22 years of GPS data obtained from >800 continuous GNSS stations operating across the Alps and its surroundings. Unlike the crust, the orientation of the strain field within the mantle cannot be directly measured and must be inferred from either mantle earthquakes or seismic observations, such as seismic anisotropy observations. We compiled a new map of SKS directions merging data collected during several experiments and available from different databases, deriving a new continuous mantle deformation pattern over the Great Alpine Region. Geodetically determined displacements of the Earth's surface reflect the response to different processes acting at different spatial scales. In the comparison between crustal and mantle deformation we accounted for the intrinsic multi-scale characteristics of geodetic deformation measurements, estimating the geodetic strain-rate field using a multi-scale spherical wavelet-based method, where the velocity value at a given point of the Earth's surface is obtained as a superposition of values obtained at different spatial scales. From the geodetic strain-rate tensors we computed the two planes of shear (or no-length-changes) directions, which are compared with the directions of SKS splitting over the study region.