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# AlpRA25: a new radial anisotropy model of the Alps from ambient noise and earthquake surface waves

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The Alps, together with the Northern Apennines and the Northern Dinarides, represent one of the most complex and best-studied examples of continental collision in the world. Over the years, several active and passive seismic experiments have been deployed in the Alpine region. More recently, the installation of large and dense seismic arrays, such as AlpArray and AdriaArray, has provided unprecedented spatial coverage, enabling the development of increasingly detailed seismic velocity models. However, most existing regional models of the Alps primarily rely on isotropic seismic velocities. Radially anisotropic models, which map the parameter $\xi = Vsh^2/Vsv^2$, provide complementary information by revealing the preferential orientation of anisotropic minerals and structural fabrics produced by past and ongoing tectonic processes.

In this study, we combine ambient noise and earthquake surface-wave data from more than 3,300 permanent and temporary broadband seismic stations to construct a high-resolution Alpine Radial Anisotropy model (AlpRA25) of the crust and upper mantle. Ambient noise data collected between 2017 and 2019 from approximately 700 seismic stations were used to calculate ~46,000 Rayleigh- and ~40,000 Love-wave dispersion curves. These were merged with ~295,000 Rayleigh- and ~200,000 Love-wave dispersion curves obtained from about 6,000 earthquakes recorded at approximately 3,300 broadband seismic stations between 1990 and 2022, resulting in a total of ~295,000 Rayleigh and ~240,000 Love dispersion curves spanning periods from 3 to 250 s.

These data were inverted for phase-velocity maps using a least-squares algorithm with an average knot spacing of 30 km. An *a posteriori* outlier analysis discarded 15% of the interstation measurements with the highest residuals, after which the model was recomputed. Local dispersion curves were then extracted at each grid node and evaluated for their frequency-dependent roughness. The Rayleigh and Love local dispersion curves were jointly inverted for 1-D shear-wave velocity structure using a particle swarm optimization algorithm, yielding vertical and horizontal shear-wave velocities (Vsv and Vsh, respectively). The final AlpRA25 model is a high-resolution 3-D model of Vsv, Vsh, and $\xi$ from 5 to 250 km depth, covering the Alps, the Northern

Apennines, the Northern Dinarides, and the adjacent foreland and back-arc basins. AlpRA25 provides new constraints on the lithospheric architecture and deformation of the Alpine region, highlighting the role of radial anisotropy in imaging tectonic processes from the crust to the upper mantle.