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Ambiant noise tomography of the crustal structure beneath the Pyrenees

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To understand the past and present dynamics of the Pyrenees, it is essential to acquire detailed knowledge of the crustal and upper mantle structure at regional scale.
For this purpose, a dense temporary seismic broadband array of 49 stations was installed in southwestern France and along the Atlantic coast at the end of 2010 in the framework of the PYROPE (PYRenean Observational Portable Experiment) project. We also used records of 70 broadband stations of the third leg of the IberArray project installed in the same time period in northern Spain. The two dense arrays with 60 km average inter-station distance make it possible to obtain high resolution images of the lithosphere beneath the array. To complement the two temporary arrays and avoid smearing effects along their edges, our dataset also includes records of the French and Catalan permanent broadband networks. As a whole, the dataset includes records of 158 broadband stations.
Using one year of data, we computed 12324 two-station correlations of ambient seismic noise records. We then measured group velocity dispersion of the Rayleigh wave fundamental mode in the period range 5 to 30 s. These group velocity curves are subsequently used to obtain 2-D group velocity maps. The final well-resolved zone includes the Pyrenees, the Aquitaine Basin, the Bay of Biscay, and the southern Massif Central in the north, and the Ebro Basin and the Cantabrian range in the south.
At periods in the range 5-15 s, the group velocity maps display low-velocity anomalies in the sedimentary Ebro and Aquitaine basins, while the Pyrenean range is characterized by a narrow high-velocity anomaly. The Bay of Biscay also shows a low-velocity anomaly, stronger than in the basins, suggesting a thicker sedimentary sequence. The Rhone Valley, the Vocontian basin and the Gulf of Lion also display strong low-velocity anomalies. Conversely, the southern Armorican Massif, the Massif Central and the Cantabrian range show high-velocity anomalies. At larger periods in the range 20-30s, the thin crust of the Bay of Biscay appears as a high-velocity anomaly. Similar high-velocity anomalies are observed in the eastern half of Massif Central. In the Western Pyrenees, we obtain a high-velocity anomaly which corresponds to the Labourd-Mauléon positive gravity anomaly.
The last step of our tomography is the inversion of local group velocity dispersion curves for the 3-D Vs structure. The resulting velocity model will, additionally to geodynamic purposes, improve the precision of hypocentral locations in the region.