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Ambient Seismic Noise Tomography of Southern Norway

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The noise cross-correlation technique is especially useful in regions like southern Norway since local seismicity is rare and teleseismic records are not able to resolve the upper crust. Within the TopoScandiaDeep project, which aims to investigate the relation between surface topography and lithosphere-asthenosphere structure, we process seismic broadband data from the temporary MAGNUS network in Southern Norway. The receivers were recording 20 months of continuous data between September 2006 and June 2008. Additionally, permanent stations of the National Norwegian Seismic Network, NORSAR and GSN stations in the region are used. After usual preprocessing steps (filtering, prewhitening, temporal normalization), we compute 820 cross-correlation functions from 41 receivers for three month time windows. Evaluation of the azimuthal and temporal variation of signal to noise ratios and f-k analysis of NORSAR array data shows that the dominant propagation direction of seismic noise is south-west to north, corresponding well to the Norwegian coast line. During summer months, the signal to noise ratios decrease and the azimuthal distribution becomes smoother. Time-frequency analysis is applied to measure Rayleigh and Love wave group velocity dispersion curves between each station pair for each three-month correlation stack. The mean and variance of all dispersion curves is computed for each path. After rejection of low-quality data using a signal to noise ratio, minimum wavelength and velocity variance criterion, we obtain a large number of reliable velocity estimates (about 600) for periods between 2 and 15 seconds, which we invert for group velocity maps at respective periods. At all inverted periods, we find positive and negative velocity anomalies for Rayleigh and Love waves that correlate very well with local surface geology. While higher velocities (+5%) can be associated with the Caledonian nappes in the central part of southern Norway, the Oslo Graben is reflected by negative velocity anomalies (-5%) relative to the overall average Rayleigh wave group speed of about 3.0 km/s. Furthermore, these observations are consistent with recent results from three active seismic profiles through southern Norway (MAGNUS-REX), reflecting that the investigated frequencies of Rayleigh and Love waves are mostly sensitive to upper crustal structure. The interpretation of the low velocity anomalies in the western part of southern Norway is uncertain. Since the considered surface wave wavelengths are quite short, the effect of large topography contrasts from high mountains to deep fjords might bias the velocities towards lower values in this region.