



Lateral variations of coda wave attenuation in the Alps

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We explore lateral variations of coda wave attenuation in the French Alps and surrounding regions. The area of investigation extends from the Rhine Graben in the north, to the northern Apennine Range in the south, and includes the Eastern and Western Alps. Following the classical work of Aki and Chouet (1975), coda wave attenuation has been characterized by measuring the coda quality factor of short-period S waves (Q_c). We have selected about 2000 weak to moderate earthquakes, with magnitudes ranging from 3 to 5. Waveform data recorded by permanent seismic networks have been collected at the ORFEUS data center through the ArcLink protocol. Q_c has been measured in five frequency bands [1-2], [2-4], [4-8], [8-16], [16-32] Hz, by applying a simple linear regression to the smooth energy envelopes of seismograms in the time domain. Various choices of coda window length (L_w), and coda onset time (t_w , as measured from the origin time) have been tested to ensure that our measurements are free from any systematic effects of lapse-time dependence in the range of epicentral distance considered. The optimal choice, which simultaneously maximizes the geographical coverage and minimizes the measurement biases, is obtained for $L_w=50$ s and $t_w=70$ s, for epicentral distances smaller than 180 km. The map of Q_c is obtained by discretizing the Alpine region into pixels of dimension (20km x 20km). For each source/receiver pair, the estimated value of Q_c is distributed along the direct ray path. An average over all paths that cross an individual pixel is performed to obtain the local value of Q_c . A spatial smoothing over an area covering a square of 9 pixels is subsequently applied. The maps of Q_c display strong lateral variations of attenuation in the Alpine area. At all frequencies, the ratio between the lowest and largest value of Q_c is typically larger than 2. The attenuation pattern is complex but relatively independent of frequency. A notable exception is a low attenuation region located between Torino and Geneva, which is clearly visible in the 1-2 Hz frequency band and disappears at higher frequencies. Some geological formations such as the Upper Rhine Graben and the eastern Alps show up clearly on the maps and systematically exhibit lower attenuation than the Po Valley and the Apennines. The French Alps are characterized by an attenuation gradient increasing from the north-west to the south-east. The typical scale of the spatial variations of the coda quality factor is of the order of 100km, which suggests rapid lateral variation of attenuation properties in the crust.