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Abstract

Amplification of seismic energy in steep topography is widespread and plays an important role affecting the locations of earthquake-induced damage and the distribution of earthquake-triggered landslides. Mountains, and especially the large freestanding massifs of the European Alps, represent extreme topography and may thus exhibit larger topographic amplification than features with less relief. However, suitable broadband seismic data from these locations are rare, in part due to difficult and often dangerous site access. Here we present ambient seismic data collected on two mountains in the Swiss Alps (the Matterhorn and Grosser Mythen), similar in shape but different in scale. At the Matterhorn, comparing data from seismic stations on the summit and ridge to a nearby local reference showed elevated spectral power on the mountain between 0.4 and 1 Hz, and directional site-to-reference spectral amplitude ratios up to 14, which we attribute in part to topographic resonance. We used ambient vibration modal analysis and numerical eigenfrequency modeling to identify the fundamental mode of the Matterhorn at 0.42 Hz, as well as evidence for a second, mutually-perpendicular mode at a similar frequency. Our data further show high modal damping ratios of #20% for these modes, which we ascribe to radiative energy loss. A short campaign measurement at Grosser Mythen, showed similar modal properties with a higher fundamental frequency of 1.8 Hz and peak spectral ratios of 6. At the Matterhorn, we analyzed 13 months of continuous data, showing that spectral peaks are stable over time and that the fundamental frequency of the mountain does not measurably vary. Our results aid estimation of topographic amplification for other mountain features.