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Seasonal variations in observed noise amplitudes above 1 Hz in southern California

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Ambient seismic 'noise' signals are ubiquitous small amplitude ground motions recorded continuously, with variable amplitudes at different frequencies and locations, across the entire observed bandwidth. Noise at periods below several tens of seconds is commonly attributed to ocean-seafloor interactions especially near coastal regions. Energies above 1 Hz are usually attributed to cultural noise with strong diurnal component and wind. Here we show that noise amplitudes at frequencies between 2 and 18 Hz exhibit strong seasonal variations in a broad southern California region. The results are based on seismic records at 30 stations between 240-245 deg longitude and 33-35 deg latitude. The data are recorded between 2002 and 2009 continuously by 3 components stations, most of which are in desert (Mojave and Anza) areas, and the strong seasonal changes are found at all examined stations and frequency bands. Focusing on continuous 6-hour nighttime segments, the 20 or 40 Hz sampled data are bandpass-filtered in 9 frequency bands between 2-18 Hz. The data are median-filtered to reduce the influence of earthquake signals, and integrated to yield half-hourly noise energy estimates. The 6-hour minimum energy value is then converted back to ground velocity and used as representative daily noise level amplitude. Notwithstanding various trends, drifts, and some erratic behavior, a common feature of the resulting time series are annual and sub-annual amplitude changes at essentially all frequencies and all stations, in both the horizontal and vertical components. The strength of amplitude variations differs across stations, and variable phase and amplitude differences occur also at individual stations, for different frequencies, at horizontal and/or vertical channels. Significantly, the amplitude variations show no correlation with distance from the coast, and some particularly clear seasonal variations are seen near topographic features. The large area coverage, spatial pattern of observed amplitudes, existence of signals in both horizontal and vertical components, and strong signals in uninhabited arid regions, imply that the signals are unlikely to originate from ocean waves or variations of ground water. The results may reflect ongoing local failures due to thermoelastic strain generated by interaction of atmospheric temperature changes with large-scale variations in topography, lithology and other surface properties.