How ambient is ambient noise?

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Villarrica is an open-vent stratovolcano located in the southern Andes of Chile characterized by strombolian style eruptive activity. Campaigns were conducted from March to October 2010 and February to April 2011 with 8 broadband and 6 short-period stations, respectively. Although these data are dominated by tremor and superposition of closely-spaced events related to bubble-bursting at the surface of the lava lake, the high frequencies should be sufficiently scattered at distances of several km from the summit to be considered ambient noise. We removed the instrument response, normalized with an RMS method, whitened the spectra, and filtered from 1 to 10 Hz where the background noise was high. Hour-long auto- and cross-correlations were computed and the respective functions stacked by day and total time. To track temporal changes we stretched a 24 hour moving window of correlation functions from 90% to 110% of the original and compared them with the total stack. There was an average decrease in relative arrival time from the auto-correlation functions (ACF) during the 2010 array of 0.13%. Cross-correlations from station nearest the summit, to the other stations show comparable decreases. This decrease was interpreted as a velocity increase and attributed to the closing of cracks in the subsurface due either to seasonal snow loading or regional tectonics. In addition to the long-term decrease in relative arrival time across the stations, there are short-term excursions on the same order lasting several days. We compared long-term trends in 1) the time lags between arrivals from discrete seismic and infrasound events (seismic-infrasound lag SIL) and 2) the infrasound tremor frequency with the relative arrival time changes at Villarrica. The relative delay times are correlated with changes in SIL and anti-correlated with the infrasound frequency, which suggests 1) the position of the lava lake changes and 2) the changing source position may explain the short-term variations in relative delays. When evaluating the short-term changes in the ACF interferometrically, we found a better fit using static shifts, than linearly increasing shifts (stretching), supporting the model for variable lava lake levels, rather than short term changes in velocity.