Locating changes associated to volcanic eruptions at Piton de la Fournaise using ambient seismic noise cross-correlations

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Piton de La Fournaise (PdF) on La Reunion Island, is currently one of the most active volcanoes with two eruptions per year on average. Since the nineties ambient seismic noise is constantly monitored at PdF by a varying number of stations. Brenguier et al. (2008a) have shown that after the reconstruction of the Green's functions from seismic noise cross-correlations between the different stations at PdF, the apparent relative velocity changes can be used as precursors of volcanic eruptions.

In our study, we analyze continuous ambient seismic noise records from the active volcano Piton de la Fournaise on la Reunion Island from June to December 2010. During this time two volcanic eruptions occurred. We calculate the cross-correlation functions between 19 broadband stations. We then study the coda variations of the Green's functions and distinguish two types of measurements associated to two types of changes. On the one hand, we assume that a small local velocity change (weak impedance contrast) will induce a time lapse in the coda waveforms. On the other hand, we assume that a local structural change in the medium (strong impedance contrast) will induce a distortion or decorrelation of the coda waveforms (Larose et al. 2010, Rossetto et al. 2011, Planes 2013). We observe that the temporal variations of both parameters are precursors of volcanic eruptions at Piton de la Fournaise. The strength of the coda variation depends on the position of the station pair relative to the change and the strength of the change itself.

In order to locate these changes in space, we compute sensitivity kernels between the stations using a radiative transfer approach for the intensity propagation. Then we use a linear least-square inversion to locate the changes associated to the eruptions (small velocity changes and structural changes): prior, during and after the eruption.