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The Influence of Volcanic Processes on the Distribution of Seismic Velocity Changes at Piton de la Fournaise Volcano (La Reunion)

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The velocity of seismic waves propagating in the edifice of Piton de la Fournaise volcano (La Reunion) is known to change in response to volcanic eruptions. Here we present a detailed investigation of a the period from end of 2009 until end of 2011 that contains eruptions, non-eruptive intrusions and periods of relaxation and perform a detailed comparison of the associated velocity signals.
We use data from by 21 seismograph stations of the IPGP/OVPF seismic network installed on Piton de la Fournaise volcano within the UnderVolc project. Seismic noise of vertical and horizontal components of all possible station pairs is cross-correlated in chunks of 24 hours to obtain daily approximations of Green's functions in order to monitor tiny changes in therein that are related to changes of the elastic properties in the volcano.
Velocity changes are measured as apparent stretching of the coda. For some station pairs the apparent velocity changes exceed 1% and a decorrelation of waveforms is observed at the time of volcanic activity. This distorts monitoring results if changes are measured with respect to a global reference. To overcome this we present a method to estimate changes using multiple references that stabilizes the quality of estimated velocity changes.
We observe abrupt changes that occur coincident with volcanic events as well as long term transient signals. Using a simple assumption about the spatial sensitivity of our measurements we can map the spatial distribution of velocity changes for selected periods. Comparing these signals with volcanic activity and GPS derived surface displacement we can identify patterns of the velocity changes that appear characteristic for the different types of volcanic activity. We can differentiate intrusive processes associated with inflation and increased seismic activity, periods of relaxation without seismicity and eruptions solely based on the velocity signal.
This information can help to assess the processes acting in the volcano by offering an alternative observable to GPS, seismicity and tilt.