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Studying temporal velocity changes with ambient seismic noise at Hawaiian volcanoes

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In order to understand the dynamics of volcanoes and to assess the associated hazards, the analysis of ambient seismic noise – a continuous passive source - has been used for both imaging and monitoring temporal changes in seismic velocity. Between pairs of seismic stations, surface wave Green's functions can be retrieved from the background ocean-generated noise being sensitive to the shallow subsurface. Such Green's functions allow the measurement of very small temporal perturbations in seismic velocity with a variety of applications. In particular, velocity decreases prior to some volcanic eruptions have been documented and motivate our present study.

Here we perform ambient seismic noise interferometry to study temporal changes in seismic velocities within the shallow (<5km) subsurface of the Hawaiian volcanoes. Our study is the first to assess the potential for using ambient noise analyses as a tool for Hawaiian volcano monitoring. Five volcanoes comprise the island of Hawaii, of which two are active: Mauna Loa volcano, which last erupted in 1984, and Kilauea volcano, where the Pu'u'O'o-Kupaianaha eruption along the east rift zone has been ongoing since 1983. For our analysis, we use data from the USGS Hawaiian Volcano Observatory (HVO) seismic network from 05/2007 to 12/2009. Our study period includes the Father's Day dike intrusion into Kilauea's east rift zone in mid-June 2007 as well as increased summit activity commencing in late 2007 and leading to several minor explosions in early 2008. These volcanic events are of interest for the study of potential associated seismic velocity changes.

However, we find that volcanic tremor complicates the measurement of velocity changes. Volcanic tremor is continuously present during most of our study period, and contaminates the recovered Green's functions for station pairs across the entire island. Initial results suggest that a careful quality assessment (i.e. visually inspecting the Green's functions and filtering to remove tremor) diminishes the effects of tremor and allows for resolution of relative velocity changes on the order of less than 1%. The observed velocity changes will be compared with known volcanic activity in space and time, and interpreted in view of underlying processes.