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Seismic wave propagation effects in the upper volcanic edifice

Beatriz Martínez Montesinos, Chris Bean, and Ivan Lokmer
University College Dublin, Geophysics, Dublin, Ireland (beatriz.martinez@ucd.ie)

A seismogram contains information about the seismic source and the wave path. Understanding the path effect is important for both source inversions and geophysical imagery. In the case of volcanoes, the correct interpretation of the signals helps us to determine their internal state. For instance, long-period events are commonly associated to magma movements in resonant conduits.
We present an application of the adjoint methodology proposed in Tromp et al. [2004] to study the seismic wave propagation effects in the upper volcanic edifice. We do this by calculating sensitivity kernels, that is, investigating the sensitivity of different parts of a seismogram to different parts of the velocity model. In particular, we examine the influence of near-surface low-velocity volcanic structure to the recorded signals.
We use the SPECFEM 2D software, a two-dimensional elastic wave propagation code based on the spectral-element method, to simulate examples for Mount Etna, Italy.
We calculate synthetic seismograms in 2D heterogeneous models with topography, for the sources with different dominant frequency and locations. Then, we calculate the adjoint wavefield by time-reversing the calculated seismograms and "playing" them back into the medium as simultaneous seismic sources at the original receiver positions. In the last step, by combining the forward and adjoint wavefields, we calculate the traveltime sensitivity kernels of Mount Etna. In order to be able to capture a complex wave travel path, we examine the sensitivity of different parts of a seismic wavefield, that is, different time-window on a seimogram to different parts of the structural models.
Preliminary results show the importance of the velocity structure at the near surface on the recorded traces. This means that we cannot ignore the heterogeneity of the upper volcanic edifice at the time of the interpretation of the recorded signals.