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Separation of Coincident Multiple Seismic Sources in Volcanoes

A. Moni (1), C. J. Bean (1), I. Lokmer (1), and S. Rickard (2)

(1) School of Geological Sciences, University College Dublin, Dublin, Ireland, (2) Complex and Adaptive Systems Laboratory, University College Dublin, Dublin, Ireland

In an active volcanic setting, there can be multiple sources simultaneously active. For example, there might be a few sources of tremor present at the same time. Source separation has not yet been fully addressed, and would be a important first step to locating simultaneous sources and understanding their source mechanisms.

DUET (Degenerate Unmixing Estimation Technique) is a method developed to separate simultaneous human voices, from recordings from two sensors situated less than half the wavelength of the signal apart. Sources that are non-overlapping in the time-frequency domain are separated based on the time differences of arrival of the signals at the two sensors.

This method is first applied to a synthetic full wavefield data structural model of Mt Etna. In the synthetic tests, seismograms associated with two contemporary explosive sources and two simultaneous oblique tensile cracks are separated successfully from recordings from two seismic stations. Experiments show that DUET is able to separate the original sources from scatterers caused by topography in the model, as these scattering sources arrive with a different time delay.

The technique is also applied to field recordings taken on Mt Etna, during an eruptive period in June 2008. As a test, the method is used to separate Long Period events from tremor, Long Period events from Volcano Tectonic events, from recordings at two seismic stations. Results from these tests lead us to suggest that the technique could be used to classify and denoise LP and VT events. The algorithm is also used to separate multiple sources of tremor from each other.

The separation of N seismic sources leads to N seismograms at a given station, each containing contributions from one source only. Hence, a natural extension to the source separation technique would be to locate the separated sources, for example using existing array location methods. This improved fidelity would allow for more reliable source inversions, especially in the case of seismic tremor.