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Towards real-time monitoring with a seismic antenna at Merapi volcano

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Seismic antennas are often used on volcanoes to analyse emergent signals as LP events or tremor. In fact, they can be used for any kind of seismicity whether the signal is impulsive or emergent. In this work we are using a seismic antenna as an instrument for monitoring the continuous seismic signal, with the objective of a real-time application.

A seismic antenna composed of 5 broadband stations equipped with Guralp CMG-6TD stations was installed in November 2013 close to the summit of Merapi, on the site called Pasar Bubar. Sensors have a flat response characteristic from 30 s to the Nyquist frequency (50 Hz). This network has an aperture of 280 m. The shortest distance between sensors is 100 m.

In the perspective of a real-time application, the main analysis, which consists of estimating the slowness vector, requires a shorter computation time than the data acquisition time. We thus focused on a signal processing technique based on the calculation of time delays on the vertical component only and in a single frequency band. Given a set of time delays and associated errors calculated between each couple of sensors in the frequency domain, the corresponding slowness vectors can be recovered by inversion. Slowness vectors are estimated for successive time-windows in the frequency band 0.5-3 Hz. Temporal series of back-azimuth and apparent slowness are deduced with respect to time.

The analysis strategy for monitoring is then the following: A weight function expressed as a function of the derivatives of the time delays is calculated for successive moving time-windows. This function was designed in order to identify areas of stability of the back-azimuth values as function of time. A PDF of the back-azimuth and apparent slowness is then estimated for time series of 1 hour. This gives information on the dominant activity by time unit.

We will show the results obtained with the analysis of several months of continuous signal which are including different types of events generated by the on-going eruptive activity of Merapi: 1) volcano-tectonic events, 2) Multi-Phase (MP) events related with magma ascent in the conduit, 3)

low-frequency events, 4) Rock-falls and 5) Pyroclastic density currents.