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Relative phase analysis for volcanic tremor detection and source location

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The analysis of highly coherent seismic signals produced during tremor episodes has been recently gained interest as a mean to study the structure of volcanic systems, and the underlying physical mechanism producing its activity. Volcanic tremor signals usually appear with a non-impulsive gradual onset and can last for long periods of time, ranging from hours to months, during which individual waves cannot be recognized. The lack of identifiable arrivals during tremor episodes and the long duration of the registered signals, renders ineffective classical methods based on the analysis of the travel times, making difficult the location of its sources.

We present observations showing that during tremor episodes, the relative phase of inter-station cross-correlations is approximately constant, which is directly linked to the stability of the source position and mechanism. We propose a new method to identify the relative phase stability (and therefore, wavefield coherence) in recordings obtained from a seismic network, that can also be applied to recordings from a single pair of stations. Then, we use a new approach based on the relative phase measurements to find the position of the source of a tremor episode in 2015 at the Klyuchevskoy Volcanic Group. In general, we show several of the advantages of extracting information from the relative phase as opposed from methods relying on the identification of arrival phases.