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Changepoint analysis of Vp/Vs ratio time-series using a trans-dimensional McMC algorithm: an application to the Alto-Tiberina seismic network (Northern Apennines, Italy)

Nicola Piana Agostinetti (1,2,3), Giulio Poggiali (2), Raffaele Di Stefano (3), and Lauro Chiaraluce (3)

(1) Department of Geodynamics and Sedimentology, University of Vienna, Vienna, Austria, (2) Geophysics Section, School of Cosmic Physics, Dublin Institute for Advanced Studies, Dublin, Ireland, (3) Centro Nazionale Terremoti, Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy

Time-series of Vp/Vs ratio have been used to track local changes in elastic properties of the rock volumes associated, e.g., to fluid migration within a fault system. A value of Vp/Vs ratio can be computed from travel-time of P- and S- waves generated from a single local event and it is representative of the value of the Vp/Vs ratio for the rocks traversed by the seismic ray, between the source and the receiver. It is straightforward, during a seismic sequence, to generate time-series of Vp/Vs ratio for colocated events and a single station. Such time-series should be able to "monitor" the variations of elasticity in the rock volume. Due to the expected tiny changes in P- and S-wave velocity, the evaluation of Vp/Vs ratio time-series has been problematic in the past, and subjective choices about, e.g. time-averaging scheme applied or events selection for constructing the time-series, have been proven to strongly affect the outcomes of the analysis.

In this contribution, we present the application of a new methodology for a statistical evaluation of changes in Vp/Vs ratio time-series. The new methodology belongs to the wide class of "changepoint analysis" algorithms and is developed in the framework of Bayesian inference. The posterior probability distribution (PPD) of the changepoint locations is obtained using a trans-dimensional Markov chain Monte Carlo (trans-D McMC) algorithm, where the number (if any) of changepoints is directly dictated by the data themselves. We apply the new algorithm to the seismic catalogue produced by the Alto-Tiberina seismic network (Northern Apennines, Italy). Thanks to the huge amount of seismic data available, we are able locate the occurrence of changepoints in the Vp/Vs ratio time-series. Changepoint time- and space- distributions are compared with the occurrence of Mw2+ seismic events in the area.