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ECHO Project: an integrated series of tools for characterizing seismic sequences evolution

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To discriminate between seismic sequences (a series of small-to-moderate earthquakes that culminate with a mainshock) and swarms (diffuse seismicity w/o mainshock) is one of the most ubiquitous problems in seismology. The typical classification of a seismic sequence in foreshocks, mainshock and aftershock is trivial only in retrospective way, i.e. only after the mainshock has occurred and the rest of the sequence has been completed.

Preliminary attempts to discriminate the difference between swarms or seismic sequence have been recently proposed (De Santis et al., 2010) but deeper studies are compulsory to establish the level of reliability and robustness of the corresponding results in terms of the Chaos theory. We propose to put the seismic sequence as a phenomenon under the same framework provided by the geosystemics (De Santis, 2009, 2014), where the planet Earth and its processes are seen from a holistic point of view, and the New Geophysics (Crampin et al., 2013), where fluid-saturated microcracks in almost all crustal rocks are so closely-spaced they verge on failure and hence are highly-compliant critical systems (Signanini and De Santis, 2012). In this context, nonlinear concepts typical of Chaos and Information theories are fundamental to study and characterize the various features of the series of seismic events, and, eventually, to discriminate between seismic sequences and swarms. The two theories imply the use of non-linear techniques which are innovative in seismology.

In addition, one original nonlinear statistical approach (Manshour et al., 2009, 2010) was tested to check the capability to integrate the results found with the former above techniques. The model applies a complex method, developed for turbulent flows, in order to study the stochastic analysis of seismic vertical velocity waveform. Analysis of the fluctuations of the detrended increments of the series reveals a pronounced transition in their probability density function from Gaussian to non-Gaussian prior to a moderate or large earthquake.

The project ECHO ("Entropy and CHaOs: tools for studying and characterizing seismic sequences evolution"), an INGV-funded project, would aim at applying the above approaches in a more integrated way mainly to establish a suite of effective tools to disclose and characterise the principal features of the series of earthquakes which are of interest. In our view this represents the very first step before to face the more challenging (but longer-term) problem of discriminating between the two kinds of series of seismic events. This poster will describe the activities and relative results in the framework of the project.