Geophysical Research Abstracts
Vol. 16, EGU2014-8014, 2014
EGU General Assembly 2014


# Tipping point analysis of seismological data

Valerie N. Livina (1) and Elena Tolkova (2)

(1) National Physical Laboratory, Teddington, UK (valerie.livina@npl.co.uk), (2) NorthWest Research Associates, USA (e.tolkova@gmail.com)

We apply the tipping point toolbox [1-7] to study sensor data of pressure variations and vertical velocity of the sea floor after two seismic events: 21 October 2010, M6.9, D10km (California) and 11 March 2011, M9.0, D30km (Japan). One type of datasets was measured by nano-resolution pressure sensor [8], while the other, for comparison, by a co-located ocean bottom seismometer. Both sensors registered the seismic wave, and we investigated the early warning and detection signals of the wave arrival for possible application with a remote and cabled tsunami warning detector network (NOAA DART system and Japan Trench Tsunami Observation System).

We study the early warning and detection signals of the wave arrival using methodology that combines degenerate fingerprinting and potential analysis techniques for anticipation, detection and forecast of tipping points in a dynamical system. Degenerate fingerprinting indicator is a dynamically derived lag-1 autocorrelation, ACF (or, alternatively, short-range scaling exponent of Detrended Fluctuation Analysis, DFA [1]), which shows short-term memory in a series. When such values rise monotonically, this indicates an upcoming transition or bifurcation in a series and can be used for early warning signals analysis. The potential analysis detects a transition or bifurcation in a series at the time when it happens, which is illustrated in a special contour plot mapping the potential dynamics of the system [2-6]. The methodology has been extensively tested on artificial data and on various geophysical, ecological and industrial sensor datasets [2-5,7], and proved to be applicable to trajectories of dynamical systems of arbitrary origin [9].

In this seismological application, we have obtained early warning signals in the described series using ACF- and DFA-indicators and detected the Rayleigh wave arrival in the potential contour plots. In the case of the event in 2010, the early warning signal starts appearing about 2 min before the first peak of the Rayleigh train is detected by the sensor, whereas in the case of event of 2011, the early warning signal appears closer to the peak arrival, within 1 min. The different strength of early warning signals of the Rayleigh trains may be due to different depths of the events (10 and 30 km), which we plan to test in further analysis.

**References:** [1] Livina and Lenton, GRL 2007; [2] Livina et al, Climate of the Past 2010; [3] Livina et al, Climate Dynamics 2011; [4] Livina et al, Physica A 2012; [5] Livina and Lenton, Cryosphere 2013; [6] Livina et al, Physica A 2013; [7] Livina et al, Journal of Civil Structural Health Monitoring, in press; [8] Tolkova and Schaad, arXiv:1401.0096v1; [9] Vaz Martins et al, PRE 2010.