Geophysical Research Abstracts
Vol. 17, EGU2015-15797, 2015
EGU General Assembly 2015

Chimera States in Earthquake Sequencing: Preliminary Results from Global Seismic Records

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Earthquakes are occurrences resulting from significant stress-field alterations among faults. In general, spatio-temporal stress-field fluctuations are complex. They evolve continuously. We propose that they are akin to the dynamics of the collective behaviour of weakly-coupled non-linear "oscillators". Here, an oscillation refers to a fault-system reaching a threshold value for an earthquake occurrence at a given time and then, falling into a quiescence period during which the stress-build-up reoccurs in a prescribed manner. The duration of the quiescence period varies from one fault system to the other, depending on the forces behind it. Since mapping of global stress-field fluctuations in real time at all scales is an impossible task, we consider an earthquake zone as a proxy for a collection of weakly-coupled oscillators the dynamics of which would befit the ubiquitous Kuramoto model. In the present work, we apply the Kuramoto model to understand the non-linear dynamics on a directed graph of a sequence of global earthquakes. For directed graphs with certain properties, the Kuramoto model yields either synchronization or asynchronization. Inclusion of non-local effects evokes the occurrence of chimera states or the co-existence of synchronous and asynchronous behaviour of oscillators. In this presentation, we show how we build the model for directed graphs derived from global seismicity data. Then, we present conditions under which chimera states could occur and subsequently, point out the role of Kuramoto model in understanding the evolution of synchronous and asynchronous regions. We interpret our results with the spectral properties of directed graphs.