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Exploration of tidal triggering and models of seismicity

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Tidal forces produce periodic stress variations of the order of ∼103 Pa in the Earth crust. Since this value is much smaller than the average stress drop of earthquakes (∼105-107 Pa), it cannot supply energy liberated in the earthquake. However, it can influence seismicity when applied to the critically stressed fault system. In this project, we assume that a fault that is pre-stressed tectonically to its yield point can be tidally activated only if tidal stresses are oriented to enhance an existing tectonic stress. We look at the Tidal Coulomb Failure Function (TCFF) criterion as a measure of how significant the tidal contribution might be in encouraging slip on the fault.

In order to systematically explore the spatial and temporal distribution of tidally-induced seismicity, we generate synthetic catalogues using real earthquakes' space-time characteristics, so that our work includes the observed complexity in both time and space. We perturb the timing of these events by applying a clock advance/retard function of the Tidal Coulomb Stress Rate (TCSR). This allow the identification of triggering strength threshold below which a given statistic is not able to detect tidal triggering signal even though the effect is in the catalogue. We will describe the statistical techniques developed to quantify the strength of the triggering effect.

This first approach is not based on the physics of the underlying process but rather on a simple time change and we have additionally developed a model based on interacting faults which encapsulated the basic physics of earthquake triggering. We generate a number (> 1000) of fault in the model with a known, random strike and dip, each being driven by the predefined regional stress field (we deliberately include random orientations so that we might observed the selection of orientations for failure). We subject them to constantly increasing, uniformly distributed vector loading until they exhibit the properties of a critical state indicated by power-law scaling of the resulting catalogue. Two parallel models are then run with identical initial conditions. The first is driven purely by the regional stress field and the second with both the regional and tidal stresses. By this method we are able to identify planes optimally oriented for failure by TCFF triggering as well as examine the global properties of the catalogue with respect to local variations in criticality. We also explore the global divergence in the two catalogues and find a long-term sensitivity of macroscopic properties of the catalogues to the small tidal stressing.