Tidal effects on seismic activity and rupture nucleation process

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Recent observation studies have revealed that the occurrence rate of tremors is sensitive to small stress changes such as tides. This might not be surprising in light of the low stress-drop caused by tremors. Interestingly, however, ordinary earthquakes too may be sensitive to weak stress perturbations. Dynamic triggering should be the most prominent illustration of such sensitivity, but the occurrence rate of ordinary earthquakes could also correlate with small stress changes: tides, snowfalls, and rainfalls.

To understand such sensitivities to stress perturbation from a unified point of view, here we analyze the rupture nucleation process on a fault plane subject to weak periodic stress modulation. Assuming the rate- and state-dependent friction law with one state variable, we calculate the seismicity rate as a function of the perturbation (tidal) phase and the threshold amplitude of stress perturbation above which the seismicity correlates with the stress perturbation. The estimated threshold amplitude is comparable to the tidal stress change. Time-to-failure is also estimated, and it is not significantly affected by the stress perturbation. We also discuss the optimum frequency at which the correlation is enhanced.

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