Use of Coulomb Failure Stresses in Earthquake Rupture Forecasts

Efforts have been initiated to examine the potential of the CFS measures to predict future earthquakes in southern California. Figure x shows *ΔCFS* and peak ΔCFS(*t*) distributions for a M7.8 scenario earthquake on the southern San Andreas fault (ShakeOut-D, Olsen et al., 2009). The failure stresses have been resolved along vertical right-lateral strike-slip faults striking 130° at a depth of 8 km. The *ΔCFS* distribution shows the expected 'sausage' pattern of general stress decrease (blue, up to several MPa's) along the fault, suppressing the chance of another large event on this part of the fault for some time. *ΔCFS* increases in Los Angeles and east San Diego County are generally less than 0.1 MPa. At the ends of the rupturing segment, however, *ΔCFS* increases by several MPa's, a concern for triggering of additional rupture on the San Andreas toward the northwest.

The distribution of peak ΔCFS(*t*) for the M7.8 scenario earthquake (Figure x) shows a somewhat different pattern. The peak ΔCFS(*t*) measure, which by definition cannot be negative, captures the rupture complexity and in particular directivity with values larger than 5MPa toward the northwest. The latter emphasizes the threat of continued rupture of the San Andreas toward the northwest. Most of the greater Los Angeles area experiences peak ΔCFS(*t*) values of less than 0.2 MPa, another result of the southeast-northwest rupture direction. Had the rupture propagated in the opposite direction, Los Angels would have experienced much larger values of peak ΔCFS(*t*). Finally, note how the major strike-slip faults east of San Diego are exposed to values up to 1 MPa. Attention may thus be directed toward the Elsinore and San Jacinto faults, where potential M7+ rupture scenarios could be devastating for Los Angeles.

It is a goal for the CME collaboration to improve earthquake rupture forecasts (erfs) for southern California. We propose to include into the erfs an analysis of dynamic stress changes from large events, thereby introducing a more physics-based foundation for the forecasts. A major shortcoming in any attempt to use CFS measures to predict future earthquakes is the unknown level of stress changes needed for the triggering. While earthquake triggering has been associated with very small stress changes (~0.01MPa, ref), the triggering potential of stress changes on a given fault may depend on many unknown factors. It is the intent of this proposal to map the static and dynamic stresses along faults in southern California due to large ruptures on faults such as the southern San Andreas, San Jacinto and Elsinore faults, and to attempt to further any constraints on the absolute levels of CFS required for triggering of large earthquakes, as attempted by Doser et al., 2009.

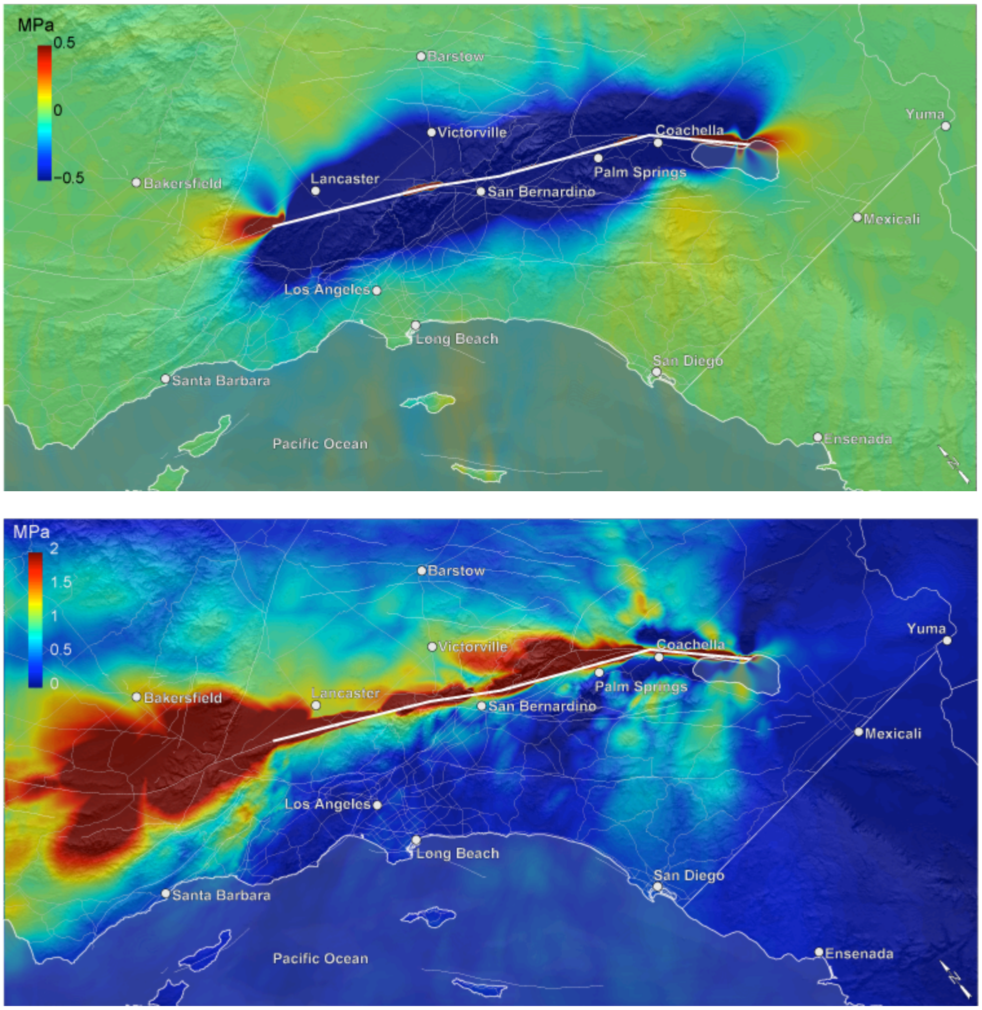

Figure x. (top) Static and (bottom) peak dynamic Coulomb failure stress changes caused by a M7.8 southeast-northwest rupturing earthquake scenario on the southern San Andreas fault (Olsen et al., 2009). The stress changes are resolved on vertical right-lateral strike-slip faults striking 130^{o} at a depth of 8 km using a friction coefficient of 0.4.