Tectonic Seasonal Loading Inferred from cGPS Measurements as a Potential Trigger for the 6.0 Magnitude South Napa Earthquake

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Measurements from continuous global positioning system (cGPS) networks continue to unfold details about transient strain signals [*Mavrommatis et al.,* 2014; *Heki,* 2003; *McGuire and Segall,* 2003]. Linking these transient strain signals to seismicity remains elusive, as it requires detailed information about the steady-state tectonic loading sources, faulting geometries, and strain distribution with depth. Here we use cGPS measurements to uncover a regional strain signal peaking just prior to the 6.0 Magnitude August 24, 2014 South Napa earthquake. We observe a pre-seismic strain that appears to have produced a coulomb stress increase, thus favoring slip on the West Napa faulting system. Analysis of cGPS time series between 2006 and 2014 reveals a dilatational strain peak each summer. Stacking these summer dilatational peaks over eight seasons yields an average accumulated strain lobe of $+142 \pm 64 \times 10^{-9}$ in the 100 km^2 Napa Earthquake region. These characteristic dilatational peaks cause a reduced normal stress on right-lateral faults in the region, thereby pushing them closer to failure. We hypothesize that this signal is associated with seasonal hydrologic loading in the Sacramento, San Joaquin, and San Francisco Bay area regions [*Amos et al.,* 2014, *Borsa et al.,* 2014, *Argus et al.,* 2014]. Thermoelastic effects cannot be discounted either [*Prawirodirdjo et al.,* 2006; *Ben Zion and Allam*, 2013]. Our results suggest that densely instrumented geodetic networks are capable of monitoring subtle strain changes within the crust and have the potential to improve region-specific seismicity forecasts.

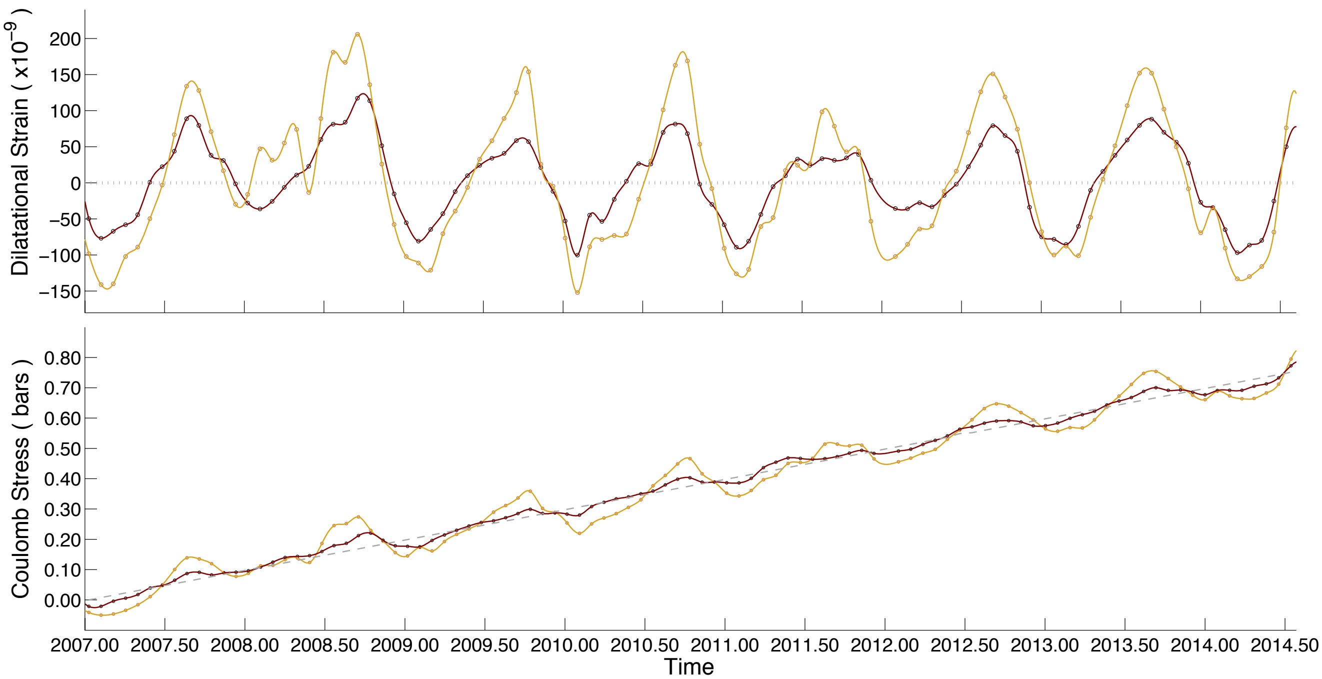

FIGURE- *(Top)* Time evolution of transient dilatational strain (top) for a 10 km x 10 km square region around Napa (brown curve) and a 50 km x 50 km region around and south of South Napa event (black curve). Each point represents the anomalous strain accumulated over the prior 4- month period. Thus each peak in dilatation represents an accumulation between April and August. *(Bottom)* Total stress evolution for the same 100 km^2 (brown) and 500 km^2 region (black) vs. time displaced by a constant tectonic loading stress rate on faults of 0.1 bars/year (dashed line).

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