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Hydrologically-induced deformation in Long Valley Caldera and the adjacent Sierra Nevada range

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Long Valley Caldera (LVC, eastern California) and the surrounding region represent a geophysically complex area due to the presence of an active magmatic system and tectonic motion with associated seismicity. Furthermore, being located at the eastern edge of the Sierra Nevada block, this area is also influenced by hydrological forcing associated with the huge amount of precipitation that falls on the Sierra Nevada and its spatiotemporal variability. These superimposed tectonic and non-tectonic processes cause complex deformation including long-term tectonic motion, episodic inflation of the resurgent dome and variable seasonal and multi-year displacements from surface water loading and subsurface discharge/recharge.

Snow accumulation and subsequent runoff play an important role in LVC, as demonstrated by the presence of a diffuse and active hydrothermal system and the occurrence of swarms of shallow earthquakes induced by the spring runoff. Combining displacement data from permanent GPS networks with various hydrological records (spring discharge, lake and groundwater level, rainfall, snow depth), we analyze the non-tectonic deformation affecting the LVC region and the adjacent Sierra Nevada range. We observe a clear vertical deformation pattern whose spatiotemporal variability is likely related to surface loading acting both at the large (regional or continental) and local scales. We highlight anomalous horizontal deformation in the GPS sites on the Sierra Nevada range front, showing its clear correlation with spring discharge. We investigate possible causes of this significant horizontal deformation, including response to snowpack loading and the influence of groundwater recharge.