

2023 Winter Rain and Snow
 Replenishes Subsurface Water in California,
 Beginning to Break
 the Prior Three Years of Drought

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Heavy precipitation in the 20 days from Dec 27, 2022 to Jan 15, 2023 dumped a huge 92 cubic kilometers (0.6 meter) of water into California's primary river basin, about equal to the median total yearly precipitation in the past seventeen years. In this study, we (a) integrate GPS elastic displacements and GRACE gravity to extend the series of total water in Argus et al. [GRL 2022] as a function of location and time to the present; (b) infer change in subsurface water using models of snow water equivalent, and (c) attempt to track the dumping and dissipation of atmospheric river water each day. Contrary to land surface hydrology models, a significant fraction of rain and snow does not run off; we are inferring from GPS that 30 per cent of rain and melting snow is each year stored as subsurface water. In the Los Angeles Times news article "Anger flares as California stormwater washes out to sea", January 20, 2023, Hayley Smith correctly communicates that 95% of water reaching California's Sacramento-San Joaquin-Tulare River Delta enters the ocean. However, by weighing water mass at Earth's surface using GPS elastic displacements, we are finding that 45% of precipitation is each year stored as snow, as surface water in artificial reservoir, as soil moisture, or as groundwater. Drought is standardly assessed in terms of mountain snowpack, soil moisture, artificial reservoir water, and water available to farmers to irrigate crops. We advocate that subsurface water as estimated by GPS and snow models be an additional metric for evaluating drought.

Sacramento-San Joaquin-Tulare River basin

