Characterizing Snow Water Equivalent from Ground-Based Observations of GPS Vertical Displacement and Model-Based Hydrologic Loading Estimates

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ABSTRACT

Winter snowpack is the most variable component of terrestrial water storage (TWS) in the mountainous regions of the Western United States. Snow water equivalent (SWE) is the most important snow characteristic with regards to snow mass and water resource forecasting. The study used ground-based GPS observations of vertical displacement to estimate SWE across snow-dominated regions of the Western United States. The SWE derived from ground-based GPS captured snow mass variations at finer spatial resolutions relative to remote sensing-based SWE retrievals. After accounting for the effects of non-hydrologic loadings on GPS-based vertical displacement, the remaining variations are predominately driven by hydrologic processes, most notably seasonal snow accumulation and ablation.

A "synthetic" experiment was first used to model SWE and soil moisture from the NASA Catchment Land Surface Model in order to evaluate the accuracy of the inversion method as well as to compute the fraction of SWE (normalized by TWS) in the study area. Afterwards, a "real-world" experiment was conducted using ground-based GPS observations from the Plate Boundary Observatory network. The inverted TWS was then compared against TWS retrievals derived from the Gravity Recovery and Climate Experiment (GRACE) mission. Retrieved SWE was validated using SWE observations from the ground- based Snow Telemetry (SNOTEL) network. Preliminary results show that over half of the stations provide a temporal correlation coefficient of $R < -0.7$ between GPS-based vertical displacement and SNOTEL-based SWE, which highlights the dominant effect of snow on the subsequent vertical displacement variation.

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