Estimating Snow Water Equivalent from a Combination of GPS and GRACE Observations over the Western United States

GAOHONG YIN\textsuperscript{1}, BARTON A. FORMAN\textsuperscript{1}, BRYANT D. LOOMIS\textsuperscript{2}, AND SCOTT B. LUTHCKE\textsuperscript{2}

ABSTRACT

Snow plays a critical role in Western United States water supply – snow water equivalent (SWE) is one of the most important metrics in water resource forecasting. This study proposes the use of a combination of vertical displacement observations derived from a Global Positioning System (GPS) along with terrestrial water storage (TWS) retrievals derived from the Gravity Recovery and Climate Experiment (GRACE) mission in order to improve SWE estimates. After accounting for the effects of atmospheric loading, non-tidal ocean loading, and glacier isostatic adjustment (GIA) in the GPS observations, the remaining vertical displacement changes are driven predominately by terrestrial hydrologic processes, and thus, can be used to reflect the movement and redistribution of TWS and SWE.

For each GPS station, GRACE-based vertical displacement is acquired through the link between hydrological loadings and crustal deformation. A comparison of vertical displacement derived from GPS (after removing non-hydrological related loadings) with vertical displacement derived from GRACE in conjunction with SWE measurements from SNOW Telemetry (SNOTEL) is conducted for each GPS station in the study area. Correlation coefficients (R) between co-located GPS and SNOTEL, co-located GRACE and SNOTEL measurements, and co-located GPS and GRACE are provided. Over 75% stations provide a $R > 0.7$ between GPS-based and GRACE-based vertical displacement whereas a strong negative relationship can be detected between SWE and vertical displacement. The larger magnitude of variation in SWE corresponds to more variability in vertical displacement changes, which suggests potential for applying a combination of observations from both GPS and GRACE to better estimate regional SWE.

\textsuperscript{1} University of Maryland, College Park, MD, USA
\textsuperscript{2} NASA Goddard Space Flight Center, Greenbelt, MD, USA