In the western US, water resources used for agricultural, domestic, and industrial purposes are largely derived from high-elevation watersheds in the form of annual snowpack and subsequent runoff. As changes in local and global climate contribute to mountain snowpack decline, drought conditions will likely become increasingly severe in the near future, making accurate estimates of terrestrial water storage (TWS) vital for the effective management of freshwater resources. Recent advances in space geodesy, including the Global Navigation Satellite Systems (GNSS), allow for relatively high spatiotemporal estimates of TWS to be made from precise measurements of load-induced crustal deformation associated with changes in surface and subsurface storage. However, the viability of GNSS observations for managing water resources in individual watersheds (e.g., Hydrological Unit Code (HUC)-4 and smaller) and their downstream reaches remains underexplored. In this study, we investigate the spatial resolution limitations of GNSS-derived estimates of TWS as well as the optimal GNSS network configuration for estimating changes in TWS within the Selway-Lochsa watershed in western Montana and eastern Idaho. By inverting displacements produced by a series of synthetic hydrologic loads of varying spatial resolution and distribution, we quantify the maximum spatial resolution of TWS estimates derived from the Selway-Lochsa GNSS Network. Simulation of additional GNSS stations, as well as network rearrangement, yield an improved spatial resolution of TWS estimates. Finally, we explore the impact incorporating a priori hydrologic information on resolution. Placing quantitative limits on model resolution advances understanding of TWS distribution and uncertainties as well as optimal GNSS network design. By improving the ability to accurately estimate TWS in mountain watersheds, we improve the ability to monitor and manage freshwater resources in the context of a changing climate.

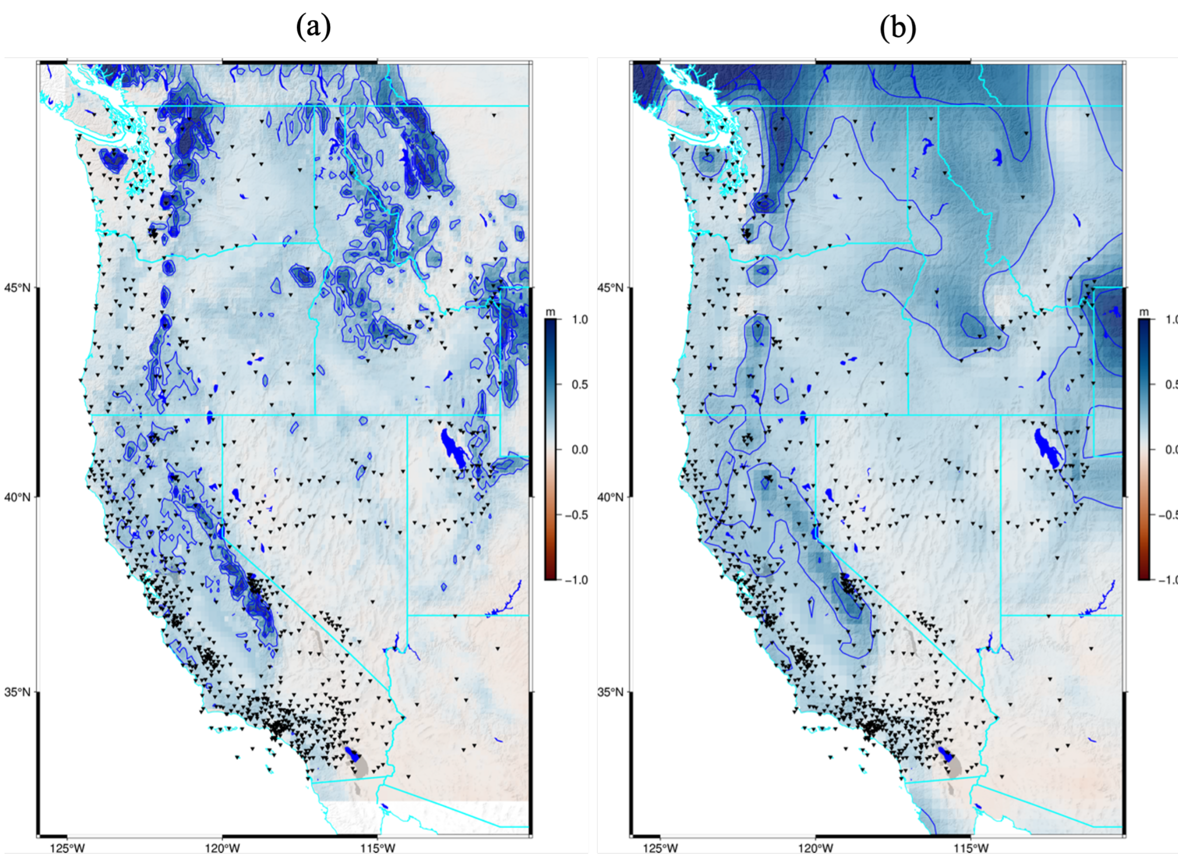

Fig. (a) 1/8° gridded mass load representing the change in NLDAS-2 soil moisture + SNODAS snow water equivalent estimates for the period of October 2010–April 2011 in the western US (b) inverted change in water storage derived from predicted displacements at GNSS stations (black inverted triangles) within the western US. Dark blue lines represent 0.25-meter contour intervals.