

Using environmental variables to spatially downscale GRACE observed changes in terrestrial water storage anomalies

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Abstract. Gravity Recovery and Climate Experiment satellites (GRACE) observe terrestrial gravitational anomalies, which can be used to estimate terrestrial water storage anomalies (TWSA) at a coarse spatial resolution ($\sim 160,000 \text{ km}^2$). Such information is valuable in regional modeling and management studies. However, hydrological processes and their interactions with climate system occur at much smaller spatial scales than the resolution of GRACE. Therefore, it is necessary to disaggregate regional information into smaller components to benefit local water management. In this study, we present a method to spatially downscale GRACE-observed changes in terrestrial water storage anomalies ($dTWSA/dt$) using observed precipitation (P) and leaf area index (LAI). Using observed precipitation (P), evapotranspiration (ET) and runoff (Q), series of GRACE observed $dTWSA/dt$ of the Sacramento and San Joaquin river basins were optimally scaled to accurately capture peaks in $P-ET-Q$ anomalies. Using Singular Spectrum Analysis (SSA), noise and random errors in region-averaged $dTWSA/dt$, P and LAI time series were reduced. Noise filtered $dTWSA/dt$, P and LAI series were then used to develop a multivariate linear regression model to estimate $dTWSA/dt$. To estimate $dTWSA/dt$ at small spatial scale, we propose to use a multivariate linear model along with fine scale P and LAI . Validation of the downscaling method will be performed by comparing estimated $dTWSA/dt$ and $P-ET-Q$ anomalies for small sub-basins located within the study region. This paper presents the optimal methodology to downscale GRACE $dTWSA/dt$ and its validation procedure along with their statistical analysis.