Poster #21-19

Title: **Understanding Total Water Storage Anomalies Across the United States with Integrated Hydrologic Modeling and Satellite Estimates.**

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Modeling the global terrestrial water cycle has been referred to as the "grand challenge to hydrology", which would enhance our understanding of scale-dependent relationships between subsurface and surface regimes, between land and atmosphere, and between human influence, including groundwater withdrawals, and future resources. Modern advancements in remote sensing have awarded scientists with the ability to measure mesoscale changes in Earth's terrestrial water storage. The Gravity Recovery and Climate Experiment (GRACE) Program satellite observations measure fluctuations in Earth's gravity attributable to mass flux, or changes in total water storage (TWS). However, GRACE TWS estimates are not without error and are limited in scale; GRACE uncertainty is still a topic of much discussion, and its products range in lateral resolution from 3° to 0.5°. Determining water resource availability for governance at the regional or major aquifer scale either involves downscaling coarse remote observations such as GRACE, or interpolating point observations (wells), both of which introduce uncertainty. Further, while we can infer from GRACE products the change in TWS from a baseline value, we do not know the total mass available, nor can we distinguish between processes driving mass change, such as recharge anomalies, natural variability or anthropogenic abstractions.

Here, I use an integrated hydrologic model, ParFlow, to support and better understand estimates of TWS from GRACE products in the continental United States (CONUS). The CONUS ParFlow configuration extends over a 6.3 million square kilometer area of the continental United States at 1-km lateral resolution. Previously, the CONUS model has been used to analyze continental-scale patterns of water table depth and its mechanistic relationship with topographic indices, recharge and evapotranspiration. This study seeks to use ParFlow to explain sources of groundwater storage loss or gain observed by GRACE remote sensing products. The CONUS model was run for water years 2009 through 2013 and compared to GRACE GFZ, JPL, and CSR gain-corrected time series. We identify regions in which ParFlow CONUS simulated storage change results fall inside GRACE leakage error, and we use ParFlow to explain partitioning of GRACE TWS into changes in snow water equivalent, soil moisture, groundwater, and surface water. ParFlow is also shown to be an effective tool for correcting signal attenuation in GRACE estimates. This study illustrates the benefit of extreme-scale hydrologic modeling, in that it helps bridge existing scale gaps between point observations and remote sensing and inform water resource governance at a range of scales.