Assimilating GRACE Terrestrial Water Storage for Improving Land Surface Processes and Drought Monitoring

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Gravity Recovery and Climate Experiment (GRACE) twin satellites, launched in 2002, were designed to map the earth's gravity field and its temporal variations. Over the land, temporal changes in the gravity field is usually associated with changes in the atmosphere and terrestrial water storage (TWS) which includes snow, soil moisture, groundwater and surface water. By removing the temporal mean of the GRACE observed gravity field and atmospheric influences, anomalies of TWS, in equivalent water heights (cm), can be obtained. One major advantage of GRACE is its ability to detect water storage changes in the deeper subsurface including groundwater which cannot be sensed by other earth-orbiting satellites. Studies have linked long-term decreasing trends observed by GRACE to depletion of groundwater in several regions where groundwater withdrawal exceeded its natural replenishing rate.

Due to the smoothing techniques used in retrieving TWS, GRACE derived TWS is provided at about 150,000 km^2 spatial resolution and monthly temporal resolution, which often do not provide enough details for hydrological applications. In addition, since GRACE TWS values represent integrated changes in snow, soil moisture and groundwater (surface water is often negligible due to their small areal coverage), skillful disaggregation into individual states which are more relevant to hydrological purposes is needed. Data assimilation techniques in conjunction with a high resolution land surface model can be used to dynamically downscale (in space and time) and disaggregate GRACE TWS along the profile of the land surface. In this presentation we will present GRACE data assimilation results using an ensemble Kalman smoother (EnKS) and the NASA Catchment model in Western and Central Europe. Although significant improvements were obtained in runoff estimates through GRACE data assimilation, issues such as mass imbalances were also discovered. GRACE assimilated soil moisture and groundwater fields have also been applied for drought monitoring in the US and some of those results will be presented as well.