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Surface water storage variations in Anatolia and Surrounding Territories observed by GRACE

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NASA/GFZ's joint satellite-to-satellite tracking mission GRACE has the primary science objective of measuring climate-sensitive signals generated by mass redistributions on Earth including the oceans and land at spatial scales greater than several hundred km and temporal scales longer than 30 days. Its main science data include the monthly time series of global geopotential models in terms of spherical harmonic coefficients (SHC) which is one of the so-called L2 data products. As the well-known effects on the orbital perturbations such as the planetary bodies, ocean tides, solid Earth tides and other high-frequency variations in ocean and atmosphere are forward modeled prior to the estimation of monthly SHC, the difference between the SHC mainly represents the changes of climate sensitive signals such as hydrology, ice sheet mass balance and ocean mass change. Although the SHC still include the residual effects of tides and atmosphere due to imperfect models and temporal aliasing, recent studies have shown that the hydrology signal can be estimated with an accuracy of several cm in equivalent water tickness and a resolution of several hundred km.

One other way to estimate the hydrology signal is the regional inversion method where we use the in situ intersatellite potential difference observations computed based on the energy conservation principle (Jekeli, 1999). To this end, we use the GRACE L1B data products such as range rate, accelerometer and star camera data for the energy integral of the satellites. The well known effects, N-body tides, ocean and solid Earth tides, the high frequency atmospheric mass variations and barotropic ocean response due to atmospheric forcing are forward modeled based on best current models and ancillary data and removed from the in-situ potential differences. The remaining in-situ potential differences are then used as observations based on Newton's law of gravitation to estimate the surface water mass changes with respect to a reference geopotential field, e.g., GGM01C.

In this study, the surface water mass changes over Anatolia and the surrounding region located between 20-47 degree East longitudes and 30-48 degree North latitudes are computed based on the monthly SHC model and the regional inversion of the in situ potential difference observations. Two distinct solutions have different temporal and spatial resolutions even though the estimated accuracies are similar. The former is computed with a temporal resolution of one month and a spatial resolution of 300 km. The regional solution has computed with monthly and sub-monthly intervals with a spatial resolution as fine as 165 km. Both solutions have accuracies of 2-3 cm in terms of water column height. In addition, the results have been compared with the water level heights observed by Envisat tracks at the Ataturk dam reservoir between the years 2003-2009. Even though the GRACE monthly water storage estimates and the observed water level heights have different amplitudes, both follow a similar seasonal pattern.