The mass transport between the earth's atmosphere, oceans and solid earth is a critical component of global climate change processes and is an important component in the signals associated with global sea level and polar ice mass change, depletion and recharge of continental aquifers, continental soil moisture and change in the deep ocean currents. This mass exchange has a gravitational signal, which can be monitored as an indication of the process. The Gravity Recovery and Climate Experiment (GRACE) is a joint NASA and DLR mission whose purpose is to improve our understanding of the Earth's dynamical system by making pioneering measurements of the gravity signals associated with mass exchange between its components. The primary objectives are to measure: 1) the Earth's time-averaged gravity field over the mission life and 2) the monthly variations in the gravity field at wave lengths between 400 and 4000 km. The accuracy sought in these two quantities is 1000 times better than prior knowledge. The major cause of the time varying mass is water motion and the GRACE mission is providing a continuous, multi-year record characterizing the seasonal cycle of mass transport between the oceans, land and atmosphere; its inter-annual variability; and the secular mass transport. Measurements of continental aquifer mass change, polar ice mass change and ocean bottom currents are examples of new remote sensing capabilities enabled by the GRACE satellite measurements.

The GRACE mission involves two identical satellites in the same orbit plane, orbiting, one behind the other, at an initial altitude of 496 km and an approximate separation distance of 220 km. The orbit plane inclination is 89 deg. The two satellites were launched on March17, 2002 and were designed to operate for a period of five years, but at this time have completed almost eight years in orbit. The primary measurement is provided by the High Accuracy Inter-satellite Ranging System (HAIRS), which measures range change between the two satellites with a precision better than 10 microns. A highly accurate three-axis SuperStar accelerometer, located at the satellite mass center, measures the non-gravitational accelerations with a precision of 10exp-10 g. A satellite GPS receiver positions the satellites over the earth with centimeter level accuracy. With this set of measurements, GRACE provides highly accurate measurements of the global gravity field once every thirty days.

The monthly gravity solutions have been used for groundbreaking measurements in the areas of hydrology, oceanography and cryology, with additional significant results from the areas of geophysics. This presentation will focus on the applications of the monthly gravity model solutions to the areas of hydrology and water resources, with an emphasis on the uses for operational applications.

The results from GRACE are being used to monitor the key reservoirs and the associated fluxes in the global water cycle at spatial resolutions of 300 km, and on seasonal, inter-annual and secular time-scales. The gravity maps from GRACE track the total water storage variability in the major river basins. This signal contains the effects of both surface and subsurface water. The further capability to monitor change in ground water storage has been demonstrated, thereby assisting in water resource planning .

The extended GRACE mission, with its longer data records, provides confidence in the use of the GRACE results. A topic of current interest is centered on the use of the GRACE mass flux measurements as a constraint for climate and weather models. Early experiments with assimilation of the GRACE water storage observations into the GLDAS model combines accurate large-scale data from GRACE with the increased resolution available from the models to generate optimal combinations, which retain the strength of each data type. This is a major step toward possible operational use of GRACE in water resource management and agricultural applications.

Additional results have established that GRACE can monitor ground water storage changes on small river-basin scales. This makes GRACE important not only as an ongoing water resources management tool, but also provides the opportunity to study possible anthropogenic influences on this aspect of global climate. Long-term measurements from GRACE mission continuation increase the confidence in these measurements, and provide an important monitoring function.

Finally, GRACE estimates of terrestrial water storage changes, together with independent precipitation and run-off data, can be used to extract variability of evapo-transpiration across the land–atmosphere boundary. This is a boundary condition for atmospheric circulation models, and is a mechanism for mass and energy exchange between land surface and the atmosphere. The concept has been used to examine evapo-transpiration over 16 major global drainage basins.

This presentation will summarize the progress made in these areas, discuss the prospects of providing a rapid data product that would support agriculture water resource applications and discuss other possible operational applications of the GRACE products.