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Geometrical and gravimetrical observations of the Aral Sea and its tributaries along with hydrological models

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Satellite altimetry is capable of measuring surface water level changes of large water bodies. This is especially interesting for regions where in-situ gauges are sparse or not available. Temporal variations of coastline and horizontal extent of a water body can be derived from optical remote sensing data. A joint analysis of both data types together with a digital elevation model allows for the estimation of water volume changes. Related variations of water mass map into the observations of the satellite gravity field mission GRACE.

In this presentation, we demonstrate the application of heterogeneuous remote sensing methods for studying chages of water volume and mass of the Aral Sea and compare the results with respect to their consistency. Our analysis covers the period 2002-2011. In particular we deal with data from multi-mission radar and laser satellite altimetry that are analyzed in combination with coastlines from Landsat images. The resultant vertical and horizontal variations of the lake surface are geometrically intersected with the bathymetry of the Aral Sea in order to compute volumetric changes. These are transformed into variations of water mass that are subsequently compared with storage changes derived from GRACE satellite gravimetry.

Hence we obtain a comprehensive picture of the hydrological changes in the region. Observations from all datasets correspond quite well with each other with respect to their temporal development. However, geometrically determined volume changes and mass changes observed by GRACE agree less well during years of heavy water inflow in to the Aral Sea from its southern tributary 'Amu Darya' since the GRACE signals are contaminated by the large mass of water stored in the river delta and prearalie region On the other hand, GRACE observations of the river basins of Syr Darya and Amu Dayra correspond very well with hydrological models and mass changes computed from the balance of precipitation, evaporation and runoff determined from the atmospheric-terrestrial water balance.