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Land water contribution to sea level change derived from GRACE and Jason-1 data

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As terrestrial hydrological cycle change is one of the least well-known contributors to sea level change, it is important to quantify its influence. We investigate the effect of land water storage changes to global and regional sea level variability on seasonal and long-term time scales. In a joint inversion using GRACE and Jason-1 data we derive mass changes in the 33 world's largest hydrological catchment basins.

Within our inversion method we assume the different contributors to sea level change to exhibit a fixed spatial pattern ('fingerprint') which we pre-compute by considering the effects of self-gravitation, elastic loading and the response of Earth rotation to mass redistribution. By means of a combined inversion of temporal gravity and altimetry data we estimate the time-variable magnitudes for each of about 100 fingerprints, considering ice sheet and glacier melting, thermal expansion, glacial isostatic adjustment (GIA) and hydrological changes.

The global mean sea level trends we obtain from the fingerprint inversion for the different contributors (ice sheets, glaciers, steric changes, hydrological cycle changes, GIA) sum up to 1.56 mm/yr which is about 80% of the 1.94 mm/yr total sea level rise observed for 08/2002 to 07/2009. Particularly, for the 33 catchment basins we estimate a contribution to global mean sea level of -0.20+/-0.04 mm/yr with an annual amplitude of 6.6+/-0.5 mm for this time period. Using only GRACE data in the inversion and comparing to hydrological changes derived from GRACE data directly using a basin averaging method shows a good agreement on a global scale, but considerable differences are found for individual catchment basins (up to 180%). Mapping the hydrological trends to regional sea level reveals the strongest sea level rise along the coastlines of South America and West Africa (max. 0.9 mm/yr and 0.4 mm/yr), whereas around Alaska and Australia we find the hydrological component of sea level falling (min. -2.0 mm/yr and -0.9 mm/yr).