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Sequential estimation of daily surface water mass changes by satellite gravimetry

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We propose an iterative approach to map regional spatio-temporal variations of terrestrial water mass over large continental areas, such as South America and Africa. While classical global Level-2 GRACE solutions are computed as averages over fixed 10-day and monthly time spans, creating important aliasing and smoothing errors, our sequential approach offers the possibility of catching short-term gravity signatures of sudden hydrological events from GRACE satellite data. The 2-by-2 degree water mass solution is constructed at each time step t as the linear combination of the water mass solution at step t-1, the along-track differences of potential derived from Level-1 GRACE KBRR residuals at step t, and a priori error uncertainties and optimal filter coefficients. Different time steps of integration (i.e. 1, 2 and 5 days) are also tested to determine the convergence speed. Recoveries of constant monthly and 10-day water mass maps from noise-free simulated GRACE data show that convergence is relatively fast and yields to exact solutions. In case of inverting real GRACE KBRR data polluted by observational noise, our sequential method of integration provides realistic water mass variation estimates by choosing optimal a priori uncertainty parameters.