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Global surface density of water mass variations by using a two-step inversion by cumulating daily satellite gravity information

Guillaume Ramillien (1), Frédéric Frappart (2), and Lucia Seoane (2)
(1) CNRS, Toulouse, France (guillaume.ramillien@get.obs-mip.fr), (2) Observatoire Midi-Pyrénées, Toulouse, France

We propose a new method to produce time series of global maps of surface mass variations by progressive integration of daily geopotential variations measured by orbiting satellites. In the case of the GRACE mission, these geopotential variations can be determined from very accurate inter-satellite K-Band Range Rate (KBRR) measurements of 5-second daily orbits. In particular, the along-track gravity contribution of hydrological mass changes is extracted by removing de-aliasing models for static field, atmosphere, oceans mass variations (including periodical tides), as well as polar movements. Our determination of surface mass sources is composed of two successive dependent Kalman filter stages. The first one consists of reducing the satellite-based potential anomalies by adjusting the longest spatial wavelengths (i.e. low-degree spherical harmonics lower than 2). In the second stage, the residual potential anomalies from the previous stage are used to recover surface mass density changes - in terms of Equivalent-Water Height (EWH) - over a global network of juxtaposed triangular elements. These surface tiles of $\sim$100,000 km x km (or equivalently 330 km by 330 km) are defined to be of equal areas over the terrestrial sphere. However they can be adapted to the local geometry of the surface mass. Our global approach was tested by inverting geopotential data, and successfully applied to estimate time-varying surface mass densities from real GRACE-based residuals. This strategy of combined Kalman filter-type inversions can also be useful for exploring the possibility of improving time and space resolutions for ocean and land studies that would be hopefully brought by future low altitude geodetic missions.