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The value of total water storage anomalies from GRACE for indicating and observing large-scale flood events

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Time-variable data of the Earth's gravity field provided by the satellite mission GRACE (until 2017) and GRACE-FollowOn (lauch in spring 2018) give information on mass changes on and below the Earth surface, notably water storage changes. With a spatial resolution in the order of 300 km, GRACE provides unique large-scale and integrative observations of variations in total water storage, i.e. the sum of all storage compartments that might be relevant for the generation of flood events (groundwater, soil moisture, snow). Within the EGSIEM project (European Gravity Service for Improved Emergency Management), funded by the Horizon 2020 Framework Program of the European Union, a near real-time gravity field service was set up which delivered daily GRACE data of water storage anomalies with a maximum latency of five days.

In this contribution, we assess the value of the daily GRACE-based water storage anomalies for (1) observing large-scale flood events, and (2) as indicators of above-average wetness conditions in river basins prior to the flood event. The analysis is based on several hundreds of large-scale flood events worldwide, recorded in the Dartmouth Flood Observatory (DFO) within the GRACE operation period. We assess storage anomalies both for the event area as given in DFO, as well as for the entire upstream river basin. For river basins with available river discharge time series, the gravity-based pre-event wetness index is compared to other indices that are frequently used as flood indicators, such as Antecedent Precipitation Index, satellite-based soil moisture indices or baseflow before the event onset. We compare the correlation of these indices to flood characteristics such as peak discharge, flood volume and runoff ratio. Results indicate the early-warning potential of the GRACE-based indices for selected river basins such as the Danube, and in particular for flood events where snow storage and thus snowmelt contribute to flood discharge.