Recovering climate-related mass transport signals by current and next-generation gravity missions

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Gravity field missions are a unique geodetic measuring system to directly observe mass transport processes in the Earth system. Past and current gravity missions such as CHAMP, GRACE, GOCE and GRACE-Follow On have improved our understanding of large-scale mass changes, such as the global water cycle, melting of continental ice sheets and mountain glaciers, changes in ocean mass that are closely related to the mass-related component of sea level rise, which are subtle indicators of climate change, on global to regional scale. Therefore, mass transport observations are also very valuable for long-term climate applications. Next Generation Gravity Missions (NGGMs) expected to be launched in the midterm future have set high anticipations for an enhanced monitoring of mass transport in the Earth system with significantly improved spatial and temporal resolution and accuracy. This contribution will present results from numerical satellite mission performance simulations designed to evaluate the usefulness of gravity field missions operating over several decades for climate-related applications. The study is based on modelled mass transport time series obtained from future climate projections until the year 2100 following the representative emission pathway RCP8.5. Numerical closed-loop simulations will assess the recoverability of mass variability signals by means of different NGGM concepts, e.g. GRACE-type in-line single-pair missions, Bender double-pair mission being composed of a polar and an inclined satellite pair, or high-precision high-low tracking missions following the MOBILE concept, assuming realistic noise levels for the key payload. In the evaluation and interpretation of the results, special emphasis shall be given to the identification of (natural or anthropogenic) climate change signals in dependence of the length of the measurement time series, and the quantification of robustness of derived trends and systematic changes.