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Future satellite missions for time-variable geopotential recovery – results from the ESA Mass Transport Project

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With the successful GRACE mission (data collection since Spring 2002), global time-variable gravity fields can be recovered beyond the lower degrees for the first time. Although GRACE is able to detect significant features of the time-variable geopotential, e.g. the continental hydrological cycle, trends in ice-mass change in Antarctica or Greenland or sea level rise, its mission concept suffers from inherent deficiencies. The main limitations of GRACE are (i) the range-rate measurements (insufficient accuracy, anisotropy of the leader-follower-formation), (ii) aliasing due to spatial and temporal undersampling and (iii) inaccurate de-aliasing products. This leads to an erroneous North-South striping pattern and a limited accuracy and resolution for many scientific studies. Within the ESA project „Monitoring and Modeling Individual Sources of Mass Distribution and Transport in the Earth System by Means of Satellites“ potential future satellite mission concepts, which could improve time-variable geopotential-recovery, have been studied. An improved accuracy of a future laser instrument as well as an enhanced temporal sampling have been regarded in the simulations, which were based on repeat orbits. An enhanced sampling can be achieved by means of multi-satellite-missions, where the spatial and/or temporal resolutions are improved by: 1) additional satellites on interleaved groundtracks and/or 2) time shifted satellites on the same groundtrack. Another possibility is the so-called Pete-Bender-design, where the satellites fly on different repeat-orbits with different inclinations, which also allows for more homogeneous groundtrack coverage. Sophisticated satellite-formations such as cartwheels or gravity wheels have not been regarded so far due to the unsolved technical problems (e.g. control of the laser instrument) related to these designs. The primary objective of the simulation studies was the precise recovery of the input hydrological signal and the trends of the ice-melting in Antarctica and Greenland. Furthermore, the detection of the Sumatra Earthquake and the separability of hydrology, the ocean signal and ocean tides have been investigated. The simulations and results as well as open questions and issues will be presented.