Bridging the GRACE/GRACE-FO gap with time-variable gravity from the Swarm satellites using PCA

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As the Gravity Recovery and Climate Experiment (GRACE) mission came to an end in October 2017 after 15 years of measuring the Earth's gravity field, its follow-on mission (GRACE-FO) was launched about six months later, in May 2018. The resulting gap between these two missions, which is expected to have a length of about 14 months, is now a significant issue for scientific research concerning high-resolution time-variable gravity fields.

This study's aim is to assess the feasibility of using data from the Swarm mission to fill this gap, which provides measurements of the Earth's magnetic and gravity fields since December 2013. Monthly and CTAS Swarm data is used, CTAS data consists of a constant and a trend as well as annual and semiannual components. It is combined with patterns from GRACE or the WaterGAP Global Hydrology Model (WGHM). The patterns are obtained from different data decomposition methods, like Principal Component Analysis (PCA) and Independent Component Analysis (ICA). In the entire analysis, all data sets are examined in equivalent water height (EWH) and are developed until degree 12 and 40 through a spherical harmonic synthesis.

The quality of the reconstruction is tested through comparisons to the original GRACE data, both on global and local scales, by computing root mean square differences and basin averages. It can be shown that the reconstruction improves the RMS compared to a RMS between original Swarm and GRACE data. A combination of PCA patterns from GRACE and Swarm CTAS data as observations forms the best reconstruction with a RMS of 2-3cm, which is about one third of the RMS between Swarm and GRACE.