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Methods for separation of geophysical mass variations from monthly GRACE solutions

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The satellite mission GRACE (Gravity Recovery and Climate Experiment) provides global monthly solutions for the Earth's gravity field for the first time. Data of variable gravity solutions are used to infer information about mass transport processes on the earth. Individual processes and amounts of this transports are mostly unknown within unsettled and polar regions, as for Antarctica. This continent owns an important role for the global climatic cycle. Already a small decrease or increase of the Antarctic ice sheet can be important for climate change. Accurate measurements of these transport processes are required.

A challenge for the analysis of monthly GRACE solutions, e. g. from the GFZ (GeoForschungsZentrum Potsdam), is the separation of geophysical mass variations. The GRACE errors increase with spatial resolution of the spherical harmonics. Therefore smoothing is indispensable. It is usually undertaken with standard Gaussian filters. The derivation of mass variations on the Earth's surface can be managed with high accuracies only on large scales by creating spatial averages, e. g. for a defined drainage basin. However, the smoothing of high-frequency signals leads to an incomplete construction of the basin function and therefore to a signal overlay of bordering regions. This leakage error complicates the separation of mass variations of the Antarctic ice sheet from those of the Antarctic Ocean.

Optimised smoothing techniques of *Swenson and Wahr* [2002] and *Swenson, Wahr and Milly* [2003] were used to design filters that depend on features of the GRACE errors and that apply a-priori information about either the basin shape or a stochastic signal model. The techniques were extended for a two spectral dimensions to consider

order-dependency of the GRACE errors and increase the optimisation. The total effect of the GRACE error and the leakage error is then minimised either indirectly through the incomplete basin construction or directly for the stochastic signal model.

The new methods cause a much smaller leakage error than the Gaussian method. Therefore they enable a better separation between signal and noise and between the continental and oceanic signals at the same time. Resulting time series of the continental and oceanic Antarctic signals show clearly less correlations: While Gaussian-filter cause strong positive correlations, the results from the new methods tend to show slight anti-correlations.

Mass variations of Antarctica were derived with an total error of 3.6 mm w.eq. Accuracy analysis were done for formal GRACE-errors, that might be underestimated. However, the best total accuracies arise for the filter that contains information about the basin shape in its design. Compared to the Gaussian smoothing, the accuracy increase is approx. 4 mm w.eq. on scales of 4000 km and approx. 5 mm w.eq. for smaller areas on scales of 500 km.