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Minimizing filter effects in GRACE derived effective angular momentum functions

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Variations of Earth rotation are caused by the redistribution and motion of masses within the Earth system. Since 2002, the satellite mission GRACE observes variations of the Earth's gravity field which are caused by mass displacements. Therefore, time variable gravity field models can be used to determine effective angular momentum functions which describe mass-related excitation mechanisms of Earth rotation. Due to the fact that GRACE time variable gravity field models are contaminated by noise, adequate filter techniques have to be used in order to retrieve meaningful information about mass redistribution within the Earth system. However filtering smooths not only the noise but also the signal. Thus estimations of mass changes in the subsystems of the Earth and as a result GRACE derived effective angular momentum functions suffer from attenuation and leakage.

In this study we show via a closed loop simulation based on the ESA Earth System Model plus realistic noise derived from GRACE filtered and unfiltered gravity field models how effective angular momentum functions of the continental hydrosphere, oceans and cryosphere (especially Antarctica and Greenland) are influenced by the application of a decorrelation filter and how these filter effects can be reduced. We have developed two approaches to minimize the filter effects: (1) on global grid point basis and (2) on the level of effective angular momentum functions. Both methods are independent of geophysical model information. The scaling factors depend only on once and twice filtered GRACE gravity field models. An advantage especially of the effective angular momentum function approach is that it provides significant improvements for all subsystems. Thus in contrast to other filter minimizing methods an equal treatment is possible.