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Applications of EOF filters to GRACE

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The Gravity Recovery and Climate Experiment (GRACE) mission is designed to map the Earth's gravity field at monthly intervals with a spatial resolution of about 250 to 500 km. The solutions provided by the GRACE science team demonstrate that a wide variety of surface mass signals can be observed. For this paper we used the RL04 solution developed by the center of space research at the University of Texas at Austin. We use all available monthly gravity solutions and represent the temporal signal as a surface mass layer under the assumption of an elastic lithosphere.

GRACE gravity fields solutions are affected by noise which we attempt to suppress by means of an Empirical Orthogonal Filtering technique based on Gaussian smoothed surface mass data. We will discuss various implementations of the EOF filtering technique that have enhanced the spatial resolution by which surface mass anomalies can be retrieved from GRACE. Surface mass solutions with EOF algorithm 1 are based upon a singular value decomposition of smoothed surface mass fields. A later version of the EOF method, called algorithm 2, directly operates on the spherical harmonic coefficient sets grouped by spherical harmonic order m.

We obtained surface mass field with EOF algorithm 1 and compared the vertical loading displacements to a set of independent IGS station data acquired within the GRACE observation window. An optimum was found at an EOF compression level of 3 and a smoothing radius of 5 or 6.25 degrees so that the discrepancy between GRACE and GPS vertical loading signals is around 1.9 mm for 59 IGS stations. In this we assume that temporal gravity field changes occur on frequencies shorter than about 3 years because of the way we preprocess the GPS data and GRACE surface mass estimates.

The performance of EOF algorithm 2 was evaluated by means of simulations which demonstrate that it is feasible to obtain a spatial resolution of 250 km. We use this method to estimate small scale surface mass trends for Greenland and found a surface mass trend of 179+/-25 Gton/yr between 2003 and 2008. Between 2003 and 2005 we observed 121+/-27 Gton/yr and between 2006-2008 204+/-25 Gton/yr. This method showed for the first time mass losses above 2000m elevation.