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GRACE L1b inversion through a self-consistent modified radial basis function approach

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Implementing a regional geopotential representation such as mascons or, more general, RBFs (radial basis functions) has been widely accepted as an efficient and flexible approach to recover the gravity field from GRACE (Gravity Recovery and Climate Experiment), especially at higher latitude region like Greenland. This is since RBFs allow for regionally specific regularizations over areas which have sufficient and dense GRACE observations. Although existing RBF solutions show a better resolution than classical spherical harmonic solutions, the applied regularizations cause spatial leakage which should be carefully dealt with. It has been shown that leakage is a main error source which leads to an evident underestimation of yearly trend of ice-melting over Greenland. Unlike some popular post-processing techniques to mitigate leakage signals, this study, for the first time, attempts to reduce the leakage directly in the GRACE L1b inversion by constructing an innovative modified (MRBF) basis in place of the standard RBFs to retrieve a more realistic temporal gravity signal along the coastline. Our point of departure is that the surface mass loading associated with standard RBF is smooth but disregards physical consistency between continental mass and passive ocean response. In this contribution, based on earlier work by Clarke et al.(2007), a physically self-consistent MRBF representation is constructed from standard RBFs, with the help of the sea level equation: for a given standard RBF basis, the corresponding MRBF basis is first obtained by keeping the surface load over the continent unchanged, but imposing global mass conservation and equilibrium response of the oceans. Then, the updated set of MRBFs as well as standard RBFs are individually employed as the basis function to determine the temporal gravity field from GRACE L1b data. In this way, in the MRBF GRACE solution, the passive (e.g. ice melting and land hydrology response) sea level is automatically separated from ocean dynamic effects, and our hypothesis is that in this way we improve the partitioning of the GRACE signals into land and ocean contributions along the coastline. In particular, we inspect the ice-melting over Greenland from real GRACE data, and we evaluate the ability of the MRBF approach to recover true mass variations along the coastline. Finally, using independent measurements from multiple techniques including GPS vertical motion and altimetry, a validation will be presented to quantify to what extent it is possible to reduce the leakage through the MRBF approach.