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Repairing signal damage in GRACE due to filtering: A comprehensive data-driven approach

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The monthly GRACE products are contaminated with short wavelength noise. Therefore, filtering is essential for minimizing noise and extracting meaningful signal. However, filtering also affects the signal by introducing leakage that changes its phase and amplitude, which is a source of uncertainty in GRACE products. The approach that is widely applied to minimize this uncertainty is to use model-derived leakage, bias or scale factors to improve GRACE products. This raises a number of concerns, such as which model to use, how the uncertainty in the model affects corrected GRACE. Moreover, GRACE was expected to help us improve models, but we are improving GRACE with the help of models. In a recent contribution, we developed a data-driven method for estimating leakage and correcting GRACE derived time series of total water storage change that is superior to model dependent approaches. The data-driven method demonstrated better performance for a majority of hydrological catchments, but it failed for catchments below the filter resolution, which is a major limitation of the method. In this contribution, we analyse the source for this limitation and tackle it to improve the data-driven method for small catchments also. The performance of the updated data-driven method is not limited by the size of catchment. We validate our findings in two different simulation environments emulating GRACE monthly products. In order to demonstrate that the updated data-driven approach is comprehensive, we compare its performance with the previous data-driven method and three model dependent methods over 32 catchments, covering different scenarios. We find that the updated data-driven method outperforms other methods significantly.