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GRACE-derived groundwater storage estimation: Lake/Reservoir storage controls across Canada

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Abstract:

Accurate estimation of groundwater storage is hindered by the lack of direct observations of groundwater over space and time. Gravity Recovery and Climate Experiment (GRACE) satellite observes total water storage, thus presenting issues in applying water budget approaches to extract GRACE-derived groundwater storage. This is especially true in regions with complicated hydrology, ranging from numerous small lakes/reservoirs, elevation variation, and changes in active layer thickness in regions with frozen ground. While the objective of many GRACE studies is to disaggregate total water storage budget, to separately estimate groundwater storage changes, the influence of reservoir storage change within a basin is generally ignored. Extraction of groundwater time series from GRACE, using hydrologic and land surface model output, fails to capture storage changes caused by changes in lake and reservoir storage. In significant surface water areas, reservoir storage may alter water storage changes by increasing leakage errors, and offsetting seasonal variability, leading to accumulation of errors in groundwater estimates. Here, we conducted data-driven experiments to understand the spatial influence of lake and reservoirs on GRACE-derived groundwater storage estimation, using independent information of recorded lake/reservoir water level. The study included comparisons with in-situ groundwater observations throughout Canada to validate our GRACE-derived groundwater storage signal. Accounting for reservoir storage combined with GRACE, improved our estimate of GRACE-derived groundwater storage changes for most basins. Identifying what factors did or did not influence goodness of fit will be addressed.

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