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Joint assimilation of SMOS brightness temperature and GRACE terrestrial water storage observations for improved soil moisture estimation

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Observations from recent soil moisture missions (e.g. SMOS) have been used in innovative data assimilation studies to provide global high spatial (i.e. 40 km) and temporal resolution (i.e. 3-days) soil moisture profile estimates from microwave brightness temperature observations. In contrast with microwave-based satellite missions that are only sensitive to near-surface soil moisture (0–5 cm), the Gravity Recovery and Climate Experiment (GRACE) mission provides accurate measurements of the entire vertically integrated terrestrial water storage column but, it is characterized by low spatial (i.e. 150,000 km2) and temporal (i.e. monthly) resolutions. Data assimilation studies have shown that GRACE-TWS primarily affects (in absolute terms) deeper moisture storages (i.e. groundwater). This work hypothesizes that unprecedented soil water profile accuracy can be obtained through the joint assimilation of GRACE terrestrial water storage and SMOS brightness temperature observations. A particular challenge of the joint assimilation is the use of the two different types of measurements that are relevant for hydrologic processes representing different temporal and spatial scales. The performance of the joint assimilation strongly depends on the chosen assimilation methods, measurement and model error spatial structures. The optimization of the assimilation technique constitutes a fundamental step toward a multi-variate multi-resolution integrative assimilation system aiming to improve our understanding of the global terrestrial water cycle.