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The global land water storage data set GLWS 2.0: assimilating GRACE and GRACE-FO into a global hydrological model

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The satellite mission Gravity Recovery And Climate Experiment (GRACE) provided and its successor GRACE-FollowOn (GRACE-FO) provides a great opportunity to derive observations of the global water cycle from space. The missions have contributed and largely increased our knowledge about various hydrological processes on Earth, for example the melting of glaciers in Greenland or groundwater depletion in India. Nonetheless, the spatial resolution of about 300 km, missing months in the time series and the multi-month gap between GRACE and GRACE-FO complicate or even impede the usage in some applications. Further, separating single storage information, e.g. groundwater, from the GRACE/-FO derived total water storage anomalies (TWSA) is still difficult.

In recent decades, data assimilation techniques were used to downscale and disaggregate the GRACE/-FO TWSA, however, to our knowledge they focus on hydrological instead of geodetic applications, only a few assimilate GRACE/-FO TWSA on a global scale and open access is rare. Therefore, we provide the new Global Land Water Storage (GLWS2.0) data set that offers total water storage anomalies on a 0.5° monthly grid covering the global land except Greenland and Antarctica for the time period 2003 to 2019 without missing months and the GRACE/GRACE-FO gap and will soon be publicly available. GLWS2.0 is derived by assimilating GRACE and GRACE-FO TWSA into the WaterGAP model using the Ensemble Kalman Filter considering uncertainties.

We contrast the GLWS2.0 data with the GRACE/-FO observations and the model simulations in the spatial domain via linear trends, annual amplitudes and non-seasonal TWSA and in the spectral domain via degree variances, c20 coefficients and other representation of spherical harmonics. Worldwide, 1030 GNSS stations are used to validate GLWS2.0 by analyzing the vertical loading at short-term, seasonal and long-term temporal bands and we find that GLWS2.0 agrees better with GNSS than GRACE/-FO. In addition, a good agreement to another global data assimilation product is found, which assimilates GRACE/-FO TWSA into the Catchment Land Surface Model by NASA's Goddard Space Flight Center.