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G3P: A global data set of groundwater storage variations based on satellite gravimetry

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The Global Gravity-based Groundwater Product (G3P) developed a satellite-based groundwater storage anomaly (GWSA) data set as a prototype for a future product within the EU Copernicus Climate Change Service. As the world's largest distributed freshwater storage, GW is a key resource for mankind, industrial, and agricultural demands. In Copernicus, there is no service available yet to deliver data on this fundamental resource, nor is there any other data source worldwide that operationally provides information on changing groundwater resources in a consistent way, observation-based, and with global coverage. Therefore, G3P developed the global data set of groundwater storage variations as a cross-cutting extension of the existing Copernicus portfolio. G3P capitalizes from the unique capability of GRACE and GRACE-FO satellite gravimetry as the only remote sensing technology to monitor subsurface mass variations, and from other satellite-based water storage products to provide a data set of groundwater storage change for large areas with global coverage. G3P is obtained by using a mass balance approach, i.e., by subtracting satellite-based water storage compartments (WSCs) such as snow water equivalent, root-zone soil moisture, glacier mass, and surface water storage from GRACE/GRACE-FO monthly terrestrial water storage anomalies (TWSA). For a consistent subtraction of all individual WSCs from GRACE-TWSA, the individual WSCs are filtered in a similar way as GRACE-TWSA, where optimal filter types were derived by analyses of spatial correlation patterns. G3P groundwater variations are provided for almost two decades (from 2002 to 2020), with a monthly resolution, and at a 0.5-degree spatial resolution globally.

In this contribution, we also illustrate selected results of the G3P-based GWSA data set, including the global trends of groundwater storage and the uncertainties of the GWSA data as well as of the contributing storage compartments. The GWSA is also evaluated against in-situ groundwater observations, using 13 large aquifers worldwide with available in-situ groundwater observations. Results show a high correlation between the variations of in-situ groundwater data and G3P-based

GWSA for most of the aquifers, such as the Ogallala aquifer, Floridan aquifer, Paris Basin, South of Outer Himalayas aquifer.

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