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Influence of soil depth on global high-resolution LISFLOOD model experiments

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The global hydrological model LISFLOOD (https://ec-jrc.github.io/lisflood/) is in operational use for, e.g., the Global Flood Awareness System (GloFAS) of the Copernicus Emergency Management Service. Due to its continuous development and open source availability, it is also a valuable tool for other geoscientific applications, like the assessment of terrestrial water storage (TWS) variations that can be also observed with geodetic techniques. Since TWS is understood as the sum of all hydrological storages from the surface to the deepest aquifers, it is sensitive to various aspects of the terrestrial water cycle, including surface water dynamics, soil infiltration, and groundwater flow. The current global configuration of LISFLOOD (GloFAS v4.0) has a spatial resolution of 0.05° (~5km), and utilizes a set of implementation maps that is based on various remote sensing products describing morphological conditions, soil physics, and land use characteristics.

Here we investigate the influence of the soil depth parameterization on the LISFLOOD model results. We perform different model runs (for the time period 2000 – 2022) by exchanging the input soil depth map, and evaluate modeled discharge and TWS on different time scales (long-term trend, interannual and subseasonal signal) against observations. As a reference for TWS we use satellite gravimetry data from the Gravity Recovery and Climate Experiment (GRACE) and its follow-on mission (GRACE-FO), which provides monthly global maps of TWS since 2002. Due to the relatively coarse resolution of the GRACE/-FO observation method, we perform the comparison at basin scale for some of the World’s largest river basins. Discharge is compared with data from gauging stations at the corresponding model grid cells.

Results indicate an overall good match between modelled and satellite based TWS. Furthermore, we demonstrate the significant impact of soil depth on TWS simulations. When running the model with the standard soil map, long-term trends and interannual signals deviate from observations more strongly compared to using an adjusted soil map which is limited by the water table depth. Such findings may be valuable also for the parameterization of other hydrological models.