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Evaluation of precipitation products’characteristics over Germany for hydrologic model forecasts

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Precipitation is central to the Earth’s hydrological cycle. Climate change is expected to increase the frequency and intensity of hydrometeorological extremes, highlighting the demand to improve hydrological forecasting to enable effective water resource management. Accurate precipitation data, as the main input for hydrological modeling, is key to enhance the forecast accuracy. This study evaluates the ECMWF High Resolution (HRES) NWP precipitation data jointly with other precipitation products of various origins (in-situ observations, meteorological radars, satellite observations, reanalyses). This assessment is performed in the context of our daily in-house integrated, high-resolution hydrological forecasts over central Europe, employing ParFlow/CLM driven by HRES. The European Climate Assessment & Dataset (ECA&D) in-situ daily precipitation observations serve as the reference for the 2014 to 2022 time span. The datasets evaluated include the ERA5 and COSMO reanalyses, HYRAS raster data, near real-time RADOLAN and climatological RADKLIM radar data, the OPERA radar composite with its EURADCLIM climatological dataset, and the two integrated multi-satellite products IMERG-Late and IMERG-Final. Results show that both HRES and ERA5 are well suited as atmospheric forcing for the ParFlow/CLM hydrological model runs, but have limitations in accurately simulating extreme events. The HYRAS, RADOLAN, and RADKLIM datasets, however, demonstrate a good performance with respect to extremes. As a consequence, these datasets appear to be beneficial for bias adjustments of HRES, though their application is geographically restricted to Germany. The European near real-time OPERA product often underestimates precipitation, while EURADCLIM improves the spatial representation of precipitation patterns in capturing magnitude and extremes. Both IMERG datasets tend to overestimate precipitation magnitudes and extremes, but are improving the spatial accuracy during summer months. As a next step, we plan to implement a machine learning-based bias adjustment into the quasi-operational hydrological forecasting workflow.

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