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Regional evapotranspiration and precipitation: Consistency of GRACE with COSMO analysis data

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Atmospheric and terrestrial water budgets are linked by evapotranspiration (E) and precipitation (P). These fields are provided by numerical weather prediction (NWP) models; yet, in particular the quality of E is still not well evaluated. Via the terrestrial water budget equation, water storage derived from products of the Gravity Recovery and Climate Experiment (GRACE) mission, combined with runoff data can be used to assess the realism of atmospheric models.

In this study, we compare terrestrial water storage variations of river basins derived from GRACE products together with discharge data from the Global Runoff Data Center (GRDC) to the flux deficit P-E obtained from the regional NWP models COSMO-DE and COSMO-EU. We focus on European river basins such as Danube, Rhine, Oder, Elbe and combinations of these catchments. The significance of the results is assessed thorough a rigorous error estimation. The applied NWP models include COSMO-DE (formerly known as LMK) and COSMO-EU (formerly known as LME) which are applications of the COSMO model of Deutscher Wetterdienst (DWD) in a specific configuration. Outputs of COSMO-EU have a grid resolution of 0,0625° (7 km) and those of COSMO-DE have 0,025° (2,8 km) resolution. While COSMO-DE only covers areas of Germany, Switzerland and Austria, COSMO-EU extends over the Eastern Atlantic and Europe. For our analysis we use the fields of total precipitation and latent heat flux, which is converted to evapotranspiration, both from operational and reanalysis runs. Results from the regional COSMO models are also compared to global reanalysis as ERA-Interim and MERRA.

We find that the basins of Oder and Elbe are too small to be captured by GRACE. Therefore we combine neighboring catchments. Futhermore, filtering the GRACE data causes an attenuation of the signal and external mass signals leaking into the basin area. We improve our results by considering external mass signals in our calculation e.g., the Black Sea in case of the Danube. Our results show that P-E derived from COSMO-DE and COSMO-EU fit better to GRACE observations compared to P-E from global NWP models such as ERA-Interim and MERRA.