



## **Evaluation of the water cycle in regional and global reanalyses using GRACE**

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Atmospheric and terrestrial water budgets are linked by precipitation (P) and evapotranspiration (E) and contribute essential information regarding the interaction of the atmosphere with the land surface. P and E 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 discharge data can be used to assess the realism of atmospheric models.

COSMO-REA6 represents a recent high-resolution (6 km) regional reanalysis for the European CORDEX domain, based on the COSMO numerical weather prediction model developed by Deutscher Wetterdienst (DWD). In this study the realism of atmospheric-terrestrial flux in COSMO-REA6 is validated by closing the terrestrial water budget equation over all major European river basins for the time span 2003 to 2013. The performance of COSMO-REA6 is compared to the performances of global reanalyses (ERA-Interim, MERRA-2) and observation-based data sets (GPPC, GLEAM). Discharge is obtained from the Global Runoff Data Center (GRDC) and insufficiently long time series are extended by applying the monthly Génie Rural rainfall-runoff model (GR2M). A sophisticated error assessment is included.

For most river basins and models the water budget equation can be closed within the error estimate. However, ERA-Interim underestimates P-E over the Iberian Peninsula and MERRA-2 tends to systematically underestimate P-E in summer. While the global models are biased with up to 20 mm/month, COSMO-REA6 performs well with biases mostly between 0 and 10 mm/month which we attribute to the much higher resolution. Variations of de-seasoned and de-trended atmospheric-terrestrial flux are found to agree notably well with flux derived from GRACE and discharge data with correlations of about 0.6 for all models.