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Evaluation of PRUDENCE regional climate simulations over Europe using basin-scale combined water-balance data

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Although terrestrial water storage plays an important role in the hydrological cycle, there are insufficient observations of its various components (soil moisture, snow and ice cover, surface and groundwater) to assess the seasonal cycle of terrestrial water storage over continental and sub-continental scales.

Here we use an approach based on the coupling of the terrestrial and atmospheric water balances to diagnose monthly changes in terrestrial water storage in many major river basins of the mid-latitudes. The analysis is based on atmospheric ERA-40 reanalysis data (water vapour flux convergence and changes in atmospheric water content) and conventional river runoff data (routinely measured worldwide). The method has been developed over the Mississippi region (Seneviratne et al., 2004) and then applied to other major mid-latitude river basins to form a diagnostic data set of monthly terrestrial water storage variations (Hirschi et al., 2005). Validation has shown good agreement between diagnosed estimates and observations of terrestrial water storage in Illinois (soil moisture, groundwater, snow) and Asia (soil moisture and snow), both in terms of the mean seasonal cycle and its interannual variations.

The derived data set has illustrated its potential for the analysis and validation of regional climate models in the Rhine basin (van den Hurk et al., 2005). Here, this work is extended to other sub-continental scale river basins in Europe (i.e. Danube, as well as compounds of French and Central European river basins), where the water budget of various regional climate models involved in the EU-project PRUDENCE is evaluated with the derived data set and direct observations of precipitation and runoff. Results demonstrate that there are substantial differences between the models regarding the

different components of the hydrological cycle. In Central Europe, most models overestimate the decrease in terrestrial water storage during summer (the drying of the soil) substantially compared to the diagnostic water-balance estimates. This seems to be associated with too low summer precipitation. In the Danube region, several models underestimate the summer drying, connected with an underestimation in runoff. There are also considerable differences in winter (likely relating to the representation of snow).

References:

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