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Initial results of fully coupled water cycle EURO-CORDEX evaluation simulations with TerrSysMP from 1989-2008

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Interactions and feedbacks between the sub-surface including groundwater, the land surface and the atmosphere are highly relevant for weather and the climate system. However, many state of the art global and regional earth system models do not consider the impacts of groundwater dynamics, which are critical for the closure of the hydrological cycle on different spatial and temporal scales. In this study we implement the coupled Terrestrial Systems Modelling Platform over the EURO-CORDEX domain for evaluation experiments in line with the CORDEX experiment design in order to study how the explicit treatment of groundwater affects states and fluxes of the terrestrial water and energy cycle over a continental domain on longer simulation time spans and in relation to existing uncoupled EURO-CORDEX RCM simulations. The Terrestrial Systems Modelling Platform (TerrSysMP) is a fully coupled scale-consistent numerical modelling system, currently consisting of the COSMO NWP model, the Community Land Model (CLM) and the ParFlow variably saturated surface and subsurface hydrological model, coupled with the external coupler OASIS3(-MCT). TerrSysMP allows for a physically-based representation of transport processes across scales down to sub-km resolution with explicit feedbacks between the individual compartments, including 3D groundwater dynamics and a full representation of the terrestrial hydrological cycle. The land surface-groundwater subsystem is spun up with a 1979-1989 cyclic climatological forcing derived from ERA-Interim reanalysis until an equilibrated groundwater state is achieved. Using this as the initial conditions, the fully coupled simulation for the period from 1989 to 2008 are carried out over the EURO-CORDEX domain at 12 km resolution using ERA-Interim as lateral boundary forcing. COSMO physics settings are in line with the CCLM consortium runs done for EURO-CORDEX to allow for a better comparison. The JUBE2 (Juelich Benchmarking Environment) workflow engine is used to manage the complex operation of the simulations. In the analysis, we discuss the impact of groundwater on land atmosphere feedbacks and atmospheric boundary layer properties to demonstrate the added value of the coupled simulations. Several climate indices and performance metrics are used over PRUDENCE analysis regions in a comparison with observational data.