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One-way coupled model chain for seasonal predictions of hydrometerological extreme events: concept and focus on meteorological regionalization

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It is expected that global climate change will increase the probability of extreme hydrometeorological events like droughts and floods. In order to adapt to this changing climate and to maintain basic water-, power-, and food supply, especially water-scarse regions require reliable knowledge about the available freshwater resources and potential extreme events during the next season. However, the headwaters of semi-arid catchments are often characterized by complex terrain and strong topographic gradients. To predict seasonal extreme events in such regions, hydrological models require high-resolution forecasts of precipitation and temperature. A 35 km horizontal resolution of the latest global seasonal forecast products is not suited for regional hydrological applications in such catchments. Therefore, it is mandatory to improve the spatial resolution of the hydrometeorological information to better represent the regional conditions in river basins with complex terrain. In particular, if such information is used as driving data in a one-way coupled model chain with subsequent hydrological models, a high-resolution and high-quality meteorological input is a key factor.

In this study, we demonstrate the concept of achieving this improved and regionalized meteorological input. For eight river basins in semi-arid regions like Iran, Brazil, Sudan, and West-Africa, we perform a dynamical downscaling of the global atmospheric fields with the use of the Weather Research and Forecasting (WRF) model. The best possible regionalization of the global fields is identified by testing up to 32 parameterization combinations of the WRF model for different representations of subgrid-scale convection, cloud microphysics, radiation physics and boundary layer physics for each individual region. For these configuration runs we use ERA-Interim re-analyses which also serve as the initialization for the latest seasonal predictions of the European Centre for Medium-Range Weather Forecasts (ECMWF SEAS5) re-forecasts. Five consecutive years for each of the 32 parameterization combinations are simulated and their performance is analyzed with the use of local station data for identifying an optimized model setup for each region. Preliminary results already indicate that this identified configuration does not only depend on the performance of the modeled meteorological information, but also on the required computation time that strongly differs between the individual configurations. With this optimized WRF setup for each region, we finally downscale the global SEAS5 forecasts and thereby provide the regionalized input for the subsequent hydrological model systems.

Our study is the first step towards an one-way coupled model chain that finally allows to provide high-resolution hydrometeorological and hydrological forecasts for the next season. In the end, this derived information has the potential to significantly improve the regional water management, especially in semi-arid regions and in the context of extreme events like e.g. droughts.