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Evaluating dry and wet period changes using an ensemble of GCMs, ENSEMBLES RCMs and additional higher resolved RCMs

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Global and regional climate projections are connected with a multitude of uncertainties. Deriving robust information on future regional climate change, e.g., to develop climate change adaptation measures therefore is highly challenging. Within the German joint research project REGKLAM (development and implementation of a regional climate adaptation program for the model region Dresden) five regional climate models are applied – subsequently called REGKLAM models. They encompass dynamical and statistical downscaling approaches, yet all approaches are based on the same GCM (ECHAM5 / MPI-OM). More GCMs were analysed in comparison to ECHAM5 to put the REGKLAM results in perspective. The ensemble was even broadened by including RCMs from the ENSEMBLES project. A total of 26 models (9 GCMS, 12 ENSEMBLES RCMs and 5 REGKLAM RCMs) are included in the analysis, some of them with several realizations. Analyses focus on the SRES scenario A1B.

The study area – model region of Dresden and surroundings – covers approximately 150 x 150 km. Depending on their spatial resolution, two to 15 GCM grid points were considered in the analysis. 30 grid points were analysed for the ENSEMBLES RCMs, while the REGKLAM RCMs have an even better spatial resolution yielding in a number of 91 to 324 data points. Indicators were calculated separately for each grid point. The resulting change signals were then averaged for the study area.

Daily time series of all models were analysed to explore future changes in dry and wet period duration. A wet/dry period is defined as a period of consecutive days with precipitation of above/less than or equal 1 mm. The whole collective of occurring wet and dry phases – ranging from durations of one day up to several weeks – is analysed applying a threshold exceedance probability analysis, whereby different durations of wet and dry periods were examined as threshold.

The models were validated against observational data for 1961–2000. Those analyses show that most models underestimate the number of dry days and accordingly the duration of dry periods. Model validation furthermore showed that some models had major difficulties in representing the seasonal precipitation cycle of the study area.

Projected changes for the 21st century are analysed for two periods (2021–2050 and 2071–2100) in comparison to the respective reference period 1961–1990. This approach of focusing on the model internal change signals helps dealing with individual model biases. The GCM ECHAM5 results, the basis for regionalisations and the development of adaptation measures within the REGKLAM project, lies in the midrange of all GCMs for wet period results, whereas ECHAM5 shows the strongest drying trends in summer.

Generally the entire ensemble shows trends towards wetter winters and drier summers that match the already observed trends. These are much more pronounced for the late 21st century, whereas the bandwidth for the mid 21st century is very wide. Long lasting dry periods show a strong increase in summer over a wide range of models, while there is a tendency for more wet days and longer wet periods in winter.