Geophysical Research Abstracts
Vol. 20, EGU2018-16884-1, 2018
EGU General Assembly 2018

A very high resolution (0.025°) climate projection ensemble for Southern Germany

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Previous studies have indicated heterogeneous climate change signals for areas characterized by complex topography. In order to obtain more reliable and robust projections, an ensemble of regional climate change simulations was used to provide the necessary high spatial resolution on convection permitting scales to cover periods of sufficient length (e.g . 30 years) and which permits the estimation of uncertainty by considering different global forcings. With this aim, a very high resolution ensemble of COSMO-CLM (CCLM) climate simulations was generated. The ensemble used the three global climate models (GCMs) MPI-ESM-LR, EC-EARTH and HadGEM2-ES as forcing, as included in the Coordinated Regional Downscaling Experiment (CORDEX) initiative. One control (1971-2000) and two future periods based on the RCP 8.5 emission scenario are considered, one for the Near Future (NF, 2021-2050) and one for the Distant Future (DF, 2071-2100). The GCM data are dynamically downscaled to the final resolution of 0.025° (about 2.8 km) with a three nest approach. For validation, simulations driven by ERA40 global reanalysis data were regionalized with the same setup. To assess the impact of a different soil-vegetation-atmospheric-transfer (SVAT) model, the CCLM ERA40 driven CCLM simulation was repeated using the SVAT VEG3D instead of the standard SVAT TERRA-ML.

To evaluate the CCLM simulations for the control period, the model results are compared to HYRAS observations provided by the German Weather Service (DWD). An added value of the higher resolution was identified comparing the second nesting step (7 km) to the third (2.8km) for several variables for the ERA40 driven simulation, while it was only noticeable for temperature in the GCM driven simulations. For these, a general cold and wet bias was found, with only small exceptions. The analysis considers not only the mean changes of 2m temperature and precipitation, but also gives an estimate about the changes for different extreme indices/events like heat waves. A general rise of the 2m temperatures of about 0.7°C for the NF (tripling towards 2100) was found, while the increase of the 90th percentile reaches up to 5°C in the DF. The mean precipitation decreases slightly in both future periods, while for extreme precipitation events large spatial variations are identified.