Geophysical Research Abstracts
Vol. 14, EGU2012-11221, 2012
EGU General Assembly 2012

High resolution RCM simulations for Germany: validation and projected climate changes

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A five-member ensemble of regional climate model (RCM) simulations for Europe is analysed. Two different RCMs, the CLM and WRF, are used to downscale simulations with the ECHAM5 (3 realisations) and CCCma3 general circulation models (GCMs). An approach of double nesting is applied, first to a near 50 km resolution for entire Europe and then to a domain of approximately 7 km covering Germany and its near surroundings for the present (1971-2000) and future (2021-2050) time periods. The ensemble is extended by earlier REMO simulations (ECHAM5, two realisations) at a slightly coarser resolution.

For the control period, simulations are evaluated for mean values and the annual cycles of temperature and precipitation, as well as for the intensity distribution of precipitation for both nests. Comparisons are also made to the performance of the GCMs. Bias from the GCMs are generally carried over to the RCMs, but the RCMs also add their own bias, sometimes cancelling but most often adding to the GCM bias.

The projected climate change signals are evaluated and tested for significance for mean values and the seasonal cycles of temperature and precipitation, as well as for the intensity distribution of precipitation and number of dry days. All GCMs project a significant warming over Europe on seasonal and annual scales and the projected warming of the GCMs is transferred to both nests of the RCMs. For mean annual precipitation the climate change signal varies in the range of -2% to 9% over Germany within the ensemble. For the precipitation intensity distribution a decrease of lower intensities and an increase of moderate and higher intensities is projected by most ensemble members. For the mean values the results indicate that the projected temperature change signal is caused mainly by the GCM and its initial condition, with little impact from the RCM. For precipitation, in addition the RCM impacts the climate change signal significantly.

This ensemble of regional climate simulations provides projected climate change signals in a high spatial resolution, which is required for many climate impact studies, for example for the assessment of changes in flood hazard for small and medium sized river catchments.