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Evaluation of a regional model climatology in Europe using dynamical downscaling from a seamless Earth prediction approach (EC-Earth)

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Climate and weather forecasting applications share a common ancestry and build on the same physical principles. Nevertheless, climate research and numerical weather prediction are commonly seen as different disciplines. The emerging concept of "seamless prediction" forges weather forecasting and climate change studies into a single framework (Palmer et al., 2008). In principle, as models develop towards higher resolution and more feedbacks are included, some aspects of model uncertainty should reduce. However, global models can only resolve processes down to 50-100 km at present. Moreover, users of climate information often require much higher detail and downscaling methods are needed to provide regional climate information consistent with global climate trajectories.

Therefore, this work presents an evaluation of the ability of a regional climate model (RCM) to reproduce the present climatology over Europe using a high resolution (25 km). The RCM used in this study is a climate version of the MM5 model (Fernández et al., 2007). The analysis here focuses on the annual and seasonal biases and variability for temperature (mean, maximum and minimum) and precipitation. The statistical parameters are obtained by interpolating the simulated values on the E-OBS gridded dataset from the European Climate Assessment & Dataset (ECA&D) at a resolution of 0.5° for the period 1990-2000.

The novel approach of this contribution is that the driving model is EC-Earth version 2 (Hazeleger et al., 2010), which follows the seamless prediction approach to provide climate forcings to the regional model. The atmospheric model of EC-Earth is based on ECMWF's Integrated Forecast System, cycle 31r1, corresponding to the current seasonal forecast system of ECMWF. The standard configuration runs at T159 horizontal spectral resolution with 62 vertical levels. The ocean component is based on version 2 of the NEMO model with a horizontal resolution of nominally 1 degree and 42 vertical levels. The sea ice model is the LIM2 model. The ocean/ice model is coupled to the atmosphere/land model through the OASIS 3 coupler. The fully coupled model has run for 10 years, starting from 1990 after a spin-up of 250 years, with 20th century boundary conditions (greenhouse gases, aerosols, land use and solar activity). Furthermore, simulations for the same period have been carried out driven by ERA-Interim (EI) reanalysis to provide a framework of reference for the same period.

The results indicate a similar distribution of the biases for MM5-EC-Earth and MM5-EI. For temperature, both models show a systematic cold bias for maximum temperature; however, a warm bias is depicted for the minimum temperature in more northern Europe, showing a strong latitudinal gradient. The temperature biases are larger in EC-Earth driven simulations compared to EI, with a 5 K cold bias in the summer season. Moving to precipitation, the models tend to underestimate precipitation over the main mountain chains (e.g. Alps), likely as a result of the smooth model topography associated with this chains. The precipitation biases show more varied patterns than temperature and a predominant tendency to underestimate precipitation over Europe. It should be highlighted that the biases for RCM simulations driven both by EI and EC-Earth are somewhat constant both spatially and also seasonally. Also, the variability is estimated for the different variables by the standard deviation of the seasonal values. The results show a good performance in reproducing the observed temperature variability, with errors being lower than 20%. For precipitation, the errors are larger, since the MM5-RCM simulations introduce a general overprediction of the variability, which may be related to the lack of measurements in the

database used. However, Giorgi (2002) found that the variability increases as the spatial scale becomes smaller, especially for precipitation. This result is consistent with the analysis performed here.

References:

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