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Evaluation of CMIP5 models in the Context of Dynamical Downscaling over Europe

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The quality of a regional climate model (RCM) simulation is strongly dependent on the quality of the data which is provided at its lateral boundary conditions (LBC). This data typically comes from general circulation models (GCMs) like those from the Coupled Model Intercomparison Project 5 (CMIP5). Commonly the quality of near surface parameters (e.g., temperature or precipitation) of GCM simulations in the region of interest is analyzed to avoid downscaling GCMs with large biases or un-physical behavior. However, this does not necessarily mean that the LBC for the RCM have also a high quality.

The test-suit for this study is the European domain of the Coordinated Regional Climate Downscaling Experiment (EURO-CORDEX). A squared error model performance index (MPI) is used to evaluate the skill of the CMIP5 GCMs to reproduce near surface conditions within the domain and free atmosphere parameters along the EURO-CORDEX lateral boundary. As reference for the near surface parameters serves the European high-resolution observational gridded data set (E-OBS) and for upper air parameters the European Centre for Medium-Range Weather Forecasts 40 year reanalysis (ERA-40). To show any kind of connectedness between the MPIs of the different parameters investigated Spearman rank correlations coefficients have been calculated.

Results suggest that a GCMs' ability to correctly reproduce parameters near the surface, does not implicate that the model provides correct data necessary for driving a RCM. Sometimes even the opposite is the case. Revealingly, the model that performs best near the surface performs worst over the upper air parameters over the lateral boundary zone. Also the upper air parameters over the lateral boundary show only a weak inter-variable consistency being strongest for the same parameters on adjacent pressure levels. However, the major implications for model evaluations in the context of Regional Climate Modeling is that an analysis solely based on near surface parameters does not cover the quality of the driving data. A multi-variable analysis is necessary which has to cover the parameters that are used as LBC for RCMs at different pressure levels.