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Field Significance of Performance Measures in the Context of Regional Climate Model Verification

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The purpose of this study is to rigorously evaluate the skill of dynamically downscaled global climate simulations. We investigate a dynamical downscaling of the ERA-Interim reanalysis using the Weather Research and Forecasting (WRF) model, coupled with the NOAH land surface model within the scope of EURO-CORDEX. WRF has a horizontal resolution of 11° and contains the following physics: the Yonsei university atmospheric boundary layer parameterization, the Morrison two-moment microphysics, the Kain-Fritsch-Eta convection and the Community Atmosphere Model radiation schemes. Daily precipitation is verified over Germany for summer and winter against high-resolution observation data from the German weather service for the first time.

The ability of WRF to reproduce the statistical distribution of daily precipitation is evaluated using metrics based on distribution characteristics. Skill against the large-scale ERA-Interim data gives insight into the potential, additional skill of dynamical downscaling. To quantify it, we transform the absolute performance measures to relative skill measures against ERA-Interim. Their field significance is rigorously estimated and locally significant regions are highlighted.

Statistical distributions are better reproduced in summer than in winter. In both seasons WRF is too dry over mountain tops due to underestimated and too rare high and underestimated and too frequent small precipitations. In winter WRF is too wet at windward sides and land-sea transition regions due to too frequent weak and moderate precipitation events. In summer it is too dry over land-sea transition regions due to underestimated small and too rare moderate precipitations, and too wet in some river valleys due to too frequent high precipitations. Additional skill relative to ERA-Interim is documented for overall measures as well as measures regarding the spread and tails of the statistical distribution, but not regarding mean seasonal precipitation. The added value is spatially more widespread and regards more performance measures in summer, while in winter it is concentrated in mountains. Precipitation intensity is generally improved, deterioration is only documented in summer in land-sea transition regions due to the underestimated small intensities. The frequencies of all precipitation categories are improved in summer. In winter the moderate category shows no skill; significant deterioration is observable due to overprediction of wet-days on windward sides, of small precipitation events in the northern lowlands and of high precipitation events in the North-West coast and the heaths north of the Ore mountains as well as underprediction of high precipitation events in some concave topography forms.

This study demonstrates in a rigorous manner the clear additional value of dynamical downscaling over global climate simulations.