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Analysis of inter-variable relations in regional climate model output

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The topic of physical consistency and inter-variable relations of climate model output, in particular when applying statistical downscaling and bias correction to single variables, is widely discussed in the climate impact modelling and climate impact communities. Many climate impact models need multiple climate variables as driving data. Thus, the physical relationships between those variables need to be correct, i. e. as observed in reality, to get physically reasonable impact model output.
In a comparison of correlations gained by raw regional climate model (RCM) output and by observations, considerable differences were found. RCMs are based on physics but use many parameterisations to describe unresolved and complex processes. Those parameterisations—together with model errors, numerics, discretisation, scale discrepancies—not only introduce errors, but also lead to incorrect inter-variable relations.
In this study, the inter-variable relations in RCM output are assessed by comparing joint distributions of pairs of RCM output variables. Therefore conditional densities have been estimated for pairs of variables in an ensemble of RCMs, and compared to the corresponding conditional densities of observed variables. The inter-variable relations of temperature, precipitation, relative humidity, surface air pressure, global radiation, and wind speed were analysed on example regions in Austria using station observation data of the Central Institution for Meteorology and Geodynamics (ZMAG). The RCM data were taken from reanalysis driven RCMs of the ENSEMBLES data-set.
Relating to the need of bias corrected RCM output for the use in impact studies, the effect of bias correcting single RCM output variables on their inter-variable relations is analysed. The bias correction method used here is Quantile Mapping (QM). Our results suggest that there is a mismatch of the conditional densities of RCMs and observations.