

Extrapolation as a potential cause for inconsistencies in future climate projections with empirical downscaling

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Several steps have to be undertaken in the procedure of development and application of empirical models (EMs) for projections of general circulation model (GCM) results to a regional or a local scale. The basis of development plausible EMs is to select appropriate large-scale predictors and their regions with impact on local predictand variability, to select appropriate mathematical method that describe well the predictors-to-predictand relationship, and to define appropriate seasons with different synoptic large-scale forcings on regional or local climate variability. Incorrect or incomplete performance of one of these steps can lead to EMs whose results can introduce inconsistencies in future climate change projections. This is especially the case, when the EMs are used in extrapolation mode - applied on predictors' data outside the range used for EM development. Such a case is air temperature, which is expected to increase much above the present values until the end of the century. Future projections with biased EMs can lead for example an unrealistic description of air-temperature annual cycle with warmer winter than spring or autumn months.

The problem of using EMs in extrapolation mode is illustrated on the example of future air temperature (T2m) and precipitation (PRC) projections for several locations in Slovenia. Monthly averages of observed T2m and PRC values are used together with NCEP/NCAR reanalysis for sea level pressure (SLP), T2m, and PRC to construct the EMs either separately for single months, single seasons, or without separation of a year to sub-periods. Different combinations of large-scale predictors and predictor regions are also used to illustrate their impact on the quality of EMs and their results if used in extrapolation mode. Multiple regression on principal components was used to related predictors' to predictand's variability.

The goal of our study is to illustrate the importance of accurate performance of empirical downscaling to avoid introducing additional uncertainty in climate change projections and to add plausible regional information to low-resolution GCM results. Only plausible projections can be used for the development of regional or local climate change scenarios and for evaluation of climate change impacts in future.