Error-Uncertainty Trade-off Judgment for Ensemble Member Selection of Regional Climate Models and Climate Change Impacts Modelling

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Abstract: Climate change and its impacts on the environment have become more than ever a worldwide challenging issue. Hence, decision makers are seeking reliable climate-impact models to take long term appropriate actions against this phenomena. In this study, ten regional climate models (RCMs) obtained from the European Coordinated Downscaling Experiment (EUROCORDEX) platform are evaluated on the Chiese river catchment located in the northeast of Italy. The models’ ensembles are assessed in terms of the uncertainty and error calculated through different statistical and error indices. The uncertainties are investigated in terms of signal (increase, decrease or neutral changes in the variables) and value uncertainties. Together with the spatial analysis of the data over the catchment, the weighted averaged values are used for the models’ evaluations and data projections. Using weighted catchment variables, climate change impacts are assessed on 10 different hydro-climatological variables showing the changes in the temperature, precipitation, rainfall events’ features and the hydrological variables of the Chiese catchment between historical (1991–2000) and future (2071–2080) decades under RCP (Representative Concentration Path for increasing greenhouse gas emissions) scenario 4.5.

The results show that, even though the multi-model ensemble mean (MMEM) could cover the outputs’ uncertainty of the models, it increases the error of the outputs. On the other hand, the RCM with the least error could cause high signal and value uncertainties for the results. Hence, different multi-model subsets of ensembles (MMEM-s) of ten RCMs are obtained through a proposed algorithm for different impact models’ calculation and projection, making tradeoffs between two important shortcomings of model outputs, which are error and uncertainty. The single model (SM) and multi-model (MM) outputs imply that catchment warming is obvious in all cases and, therefore, evapotranspiration will be intensified in the future where there are about 1.28 °C and 6% value uncertainties for monthly temperature increase and the decadal relative balance of evapotranspiration. While rainfall events feature higher intensity and shorter duration
in the SM, there are no significant differences for the mentioned features in the MM, showing high signal uncertainties in this regard. The unchanged catchment rainfall events’ depth can be observed in two SM and MM approaches implying good signal certainty for the depth feature trend; there is still high uncertainty about the depth values. As a result of climate change, the percolation component change is negligible, with low signal and value uncertainties, while decadal evapotranspiration and discharge uncertainties show the same signal and value. While extreme events and their anomalous outcomes direct the uncertainties in rainfall events’ features values towards zero, they remain critical for yearly maximum catchment discharge in 2071–2080 as the highest value uncertainty is observed for this variable.

**Keywords:** climate change; regional climate model; specific region; ensemble evaluation; spatial analysis; impact model; error; uncertainty; hydrological variables