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Constructing optimal ensemble projections for predictive environmental modelling in Northern Eurasia

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Large uncertainties in climate impact modelling are associated with the forcing climate data. This study is targeted at the evaluation of the quality of GCM-based climatic projections in the specific context of predictive environmental modelling in Northern Eurasia. To accomplish this task, we used the output from 36 CMIP5 GCMs from the IPCC AR-5 data base for the control period 1975-2005 and calculated several climatic characteristics and indexes that are most often used in the impact models, i.e. the summer warmth index, duration of the vegetation growth period, precipitation sums, dryness index, thawing degree-day sums, and the annual temperature amplitude. We used data from 744 weather stations in Russia and neighbouring countries to analyze the spatial patterns of modern climatic change and to delineate 17 large regions with coherent temperature changes in the past few decades. GSM results and observational data were averaged over the coherent regions and compared with each other. Ultimately, we evaluated the skills of individual models, ranked them in the context of regional impact modelling and identified top-end GCMs that "better than average" reproduce modern regional changes of the selected meteorological parameters and climatic indexes.

Selected top-end GCMs were used to compose several ensembles, each combining results from the different number of models. Ensembles were ranked using the same algorithm and outliers eliminated. We then used data from top-end ensembles for the 2000-2100 period to construct the climatic projections that are likely to be "better than average" in predicting climatic parameters that govern the state of environment in Northern Eurasia.

The ultimate conclusions of our study are the following.
• High-end GCMs that demonstrate excellent skills in conventional atmospheric model intercomparison experiments are not necessarily the best in replicating climatic characteristics that govern the state of environment in Northern Eurasia, and independent model evaluation on regional level is necessary to identify "better than average" GCMs.
• Each of the ensembles combining results from several "better than average" models replicate selected meteorological parameters and climatic indexes better than any single GCM. The ensemble skills are parameter-specific and depend on models it consists of. The best results are not necessarily those based on the ensemble comprised by all "better than average" models.
• Comprehensive evaluation of climatic scenarios using specific criteria narrows the range of uncertainties in environmental projections.