Tracking Expected Improvements of Decadal Prediction in Climate Services

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ABSTRACT

Physics-based simulation models are ultimately expected to provide the best available (decision-relevant) probabilistic climate predictions, as they can capture the dynamics of the Earth System across a range of situations, situations for which observations for the construction of empirical models are scant if not non-existent. This fact in itself provides neither evidence that predictions from today’s Earth Systems Models will outperform today's empirical models, nor a guide to the space and time scales on which today's model predictions are adequate for a given purpose.

Empirical (data-based) models are employed to make probability forecasts on decadal timescales. The skill of these forecasts is contrasted with that of state-of-the-art climate models, and the challenges faced by each approach are discussed. The focus is on providing decision-relevant probability forecasts for decision support. An empirical model, known as Dynamic Climatology is shown to be competitive with CMIP5 climate models on decadal scale probability forecasts. Contrasting the skill of simulation models not only with each other but also with empirical models can reveal the space and time scales on which a generation of simulation models exploits their physical basis effectively. It can also quantify their ability to add information in the formation of operational forecasts.

Difficulties (i) of information contamination (ii) of the interpretation of probabilistic skill and (iii) of artificial skill complicate each modelling approach, and are discussed. "Physics free" empirical models provide fixed, quantitative benchmarks for the evaluation of ever more complex climate models, that is not available from (inter)comparisons restricted to only complex models. At present, empirical models can also provide a background term for blending in the formation of probability forecasts from ensembles of simulation models. In weather forecasting this role is filled by the climatological distribution, and can significantly enhance the value of longer lead-time weather forecasts to those who use them.

It is suggested that the direct comparison of simulation models with empirical models become a regular component of large model forecast intercomparison and evaluation. This would clarify the extent to which a given generation of state-of-the-art simulation models provide information beyond that available from simpler empirical models. It would also clarify current limitations in using simulation forecasting for decision support. No model-based probability forecast is complete without a quantitative estimate if its own irrelevance; this estimate is likely to increase as a function of lead time.

A lack of decision-relevant quantitative skill would not bring the science-based foundation of anthropogenic warming into doubt. Similar levels of skill with empirical models does suggest a clear quantification of limits, as a function of lead time, for spatial and temporal scales on which decisions based on such model output are expected to prove maladaptive. Failing to clearly state such weaknesses of a given generation of simulation models, while clearly stating their strength and their foundation, risks the credibility of science in support of policy in the long term.

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