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Risks of model weighting in multi-model climate projections - lessons learnt from seasonal forecasting

A.P. Weigel (1), R. Knutti (2), M.A. Liniger (1), and C. Appenzeller (1)
(1) Federal Office of Meteorology and Climatology (MeteoSwiss), Climate Services, Zurich, Switzerland (andreas.weigel@meteoswiss.ch), (2) Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland

During the past decade, seasonal forecasting has become a well-established technique, and dynamical seasonal prediction systems are now in operational use at a range of climate prediction centers. In the wake of these developments, an enormous data-base of climate model simulations has been created, which has not only advanced our knowledge about seasonal predictability per se. Given that these data allow for systematic and statistically robust verification, plenty has also been learnt about technical and conceptual issues with relevance to other time-scales, e.g. questions regarding the interpretation and post-processing of ensemble forecasts.

This presentation focuses on the issue of multi-model combination – an issue which is also highly relevant in the context of climate change projections. From the evaluation of seasonal forecasts, it has been demonstrated that multi-models on average outperform any single model strategy. Moreover, seasonal forecasts have helped us to understand the underlying mechanisms and reasons for the success of multi-model combination. In particular, it has been possible to resolve the seeming paradox as to why, and under what conditions, a multi-model can outperform the best participating single model. While the potential benefits of multi-models are now widely accepted on essentially all time-scales, there is so far no consensus on what is the best way to construct a multi-model. The simplest way is to give one vote to each model ("equal weighting"), while more sophisticated approaches suggest to apply model-weights according to some measure of performance ("optimum weighting"). Seasonal forecasts have revealed that model weighting indeed can improve the forecasts, but only if the optimum model weights are accurately known and truly represent the underlying model uncertainties. Otherwise, equal weighting on average yields better results.

These findings have major implications for the context of climate change, where – mainly due to the long time-scales involved - the determination of optimum weights is still an unresolved issue, and the "risk" of inadvertently applying wrong weights is high. In fact, with a conceptual model of climate change we show that more information may actually be lost by wrong weights than could potentially be gained by optimum weights, particularly if internal variability is high. These results do not imply that the derivation of performance-based weights for climate projections is impossible by principle. However, they do imply that a decision to weight climate models should be taken with great care, and that for many applications equal weighting may well be the better and more transparent way to go.

Reference:
Weigel A.P., R. Knutti, M.A. Liniger and C. Appenzeller (2010). Risks of model weighting in multi-model climate projections. J. Clim. in press