CATS CENTRE FOR THE ANALYSIS OF TIME SERIES

Contrasting Weather Prediction, Climate Projection and Scientific Insight:
Can technical aspects of Data Assimilation tell us about the Decision Relevance of Models?

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Ideally, scientific simulation models make contact with reality at least twice: once when we start them off (via data assimilation) and again when we relate model output to real world expectations (forecast formation). These two points of contact are well defined but often rather technical mathematically; one hopes our models also provide insight and understanding of the system of interest, even if how this happens is unclear. I will investigate when such insight may prove the most valuable product of simulation both scientifically and in terms of decision support.

A new approach to data assimilation called ISIS is shown to outperform two more common approaches, namely 4D Variational Assimilation (4DVAR+SVD) and the ensemble Kalman filter (ENKF). This is illustrated in several examples where the nonlinearities of the system are relevant. Insights from dynamical systems theory suggest this is arguably a general result - As long as the model is a mathematically perfect representation of the physical system.

Outside this perfect model scenario, the very aim of data assimilation is less clear. Viewing model dynamics geometrically clarifies the challenge here, a challenge that reappears when considering the relevance of simulation models in decision support both on weather and on climate timescales. In spite of their imperfections, weather models provide valuable, decision-support relevant, quantitative forecasts; not quite probabilities one can bet with, but predictive distributions one can take informed action under. I will argue that this is, in large part, due to the ability to weather models to (almost) shadow the weather and secondly because we are largely betting against each other - so the value of marginal information (in bits) is high. Even with weather, the distinction between skill (of the forecast relative to climatology) and value (to a decision maker) needs to be kept clear, especially by those selling forecasts to decision makers.

Simulating farther into the future, shifting from weather to climate, the system modelled becomes more complex while the model must become more simple (to run faster on similar hardware). Are there any lead-times at which complex (GCM) models can make a claim to the kind of quantitative value-added over statistical models that is well documented for weather models? Examining climate simulation in the context of dynamical systems theory suggests the decision-relevant output is qualitative insight, not numbers. The same factors that obscure the goals of data assimilation, cast significant doubt the relevance of climate projections (even if future emissions path were known). More specifically: given the large systematic errors in today's climate models and the fact that known feedbacks in the system are imperfectly modelled (or absent), there is no a priori justification for the claim that today's best available model is fit for quantitative decision support. Might we find empirical justification?

A framework for quantifying how the relevance of current simulations decreases with lead-time is sketched, and a shift towards extracting merely insights is suggested. Several "Myths of Climate Modelling" are discussed; the odd fact that belief in these widely held misconceptions are in fact rare within climate science itself is noted. Suggestions for advancing the understanding of climate science and the healthy elimination of these myths in the face of anti-science political activism are requested!

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