Science, Simulation and Insight: Developing Confidence when Extrapolating Complicated Complex Systems

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Abstract

Scientific approaches to challenges in climate-like systems differ fundamentally from similar looking challenges in weather-like systems. In weather-like systems one repeatedly attempts to answer the same (or rather similar) questions leading to repeated, truly out-of-sample outcomes; the life-time of a model is long compared to the lead-time of each forecast, allowing a large and growing out-of-sample forecast-outcome archive. In climate-like systems a model's lifetime is a small fraction of the lead-times of most interest, often exceeding the professional lifetime of a researcher. Quantitative out-of-sample forecast-outcomes are very small if not empty. That said broad predictions of unique phenomena and qualitative change may abound, if often without a specific time-line. How is a decision maker, or a scientist, to develop a rational level of confidence in proposed "predictions" in climate-like systems? How might scientists communicate the implications of "as good as it gets" science, while laying bare often severe limitations of today's "best available" simulations? How does one report (?or avoid?) impressive novel mathematical manipulations in model-land that can be expected to tell us nothing about the real world? Can one maintain a focus on communicating scientific outputs which are adequate for purpose without being drawn either into Machiavellian distractions or into the oversell of model-land results for real world application? What challenges do statisticians, applied mathematicians and others face when adapting traditional aids (experimental design, data analysis, interpretation of simulation ...) to climate-like systems? Can multidisciplinary teams effectively evaluate to the relevance of solid "in principle" analysis techniques which can only be applied to today's state-of-the-art models? Approaches to the development and long term maintenance of confidence are discussed, from delivery options and internal terminology, through tests of internal consistency, to confessed deep ignorance and the communication both of confidence and of uncertainty.

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