Scientific Support for Climate Policy: Is a VVUQ analysis of today's models helpful? And where not: what then?

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Climate policy aims to manipulate the causal chain that starts with actions by people and ends with impacts on people. Science in support of policy provides information on the impacts of interest as a function of the levers of change available. A critical element in the provision of any simulation results from today's models is a detailed discussion of where those models are likely to fail to provide robust, decision-relevant information; transparency about the predictive capabilities of such modeling is critical here.

One approach to communicating this information is to provide the probability that the model-structure is misinformative (as a function of lead time and spacial scale) for the environmental drivers of each impact of interest. Quantifying the "uncertainty" within this model structure for lead times where this probability is large merely reflects model diversity, not predictive uncertainty, and may lead to maladaptive policies. Climate-like problems require simulation models to extrapolate, and thus are never "data rich" VVUQ given nonlinear models in such cases is challenging.

Current technology and scientific understanding each limits simulations to sampling a restricted set of model structures (hereafter: the model class). Knowing one has implemented the maths and the physics correctly in the simulation model is of deep value. While one can never validate the output of a simulation in climate-like problems, one can assign subjective probabilities on today's model-class providing adequate simulations of the future. Communicating this information to decision makers is crucial. So is its role in experimental design: in the distribution of resources between, for example, sampling initial conditions, sampling parameters, maximum lead time, model resolution, and variants of model structure among other things.

If none of the available models is empirically adequate, both the experimental design and the effectiveness of simulations will depend on the purpose of interest: the "best available" model is irrelevant if it is not adequate-for-purpose. While one cannot evaluate models on their intended targets (the future is unknown), one can evaluate the adequacy of models in the past. Some tests of internal consistency (merely necessary conditions for dynamical simulations, not sufficient conditions for reliable extrapolation) are discussed. Evidence suggests that for many questions of interest, today's climate models fail these necessary conditions. In that case, UQ tells us about the diversity of our models, not the uncertainty in our future. By engaging in discussions with policy makers, climate science can still inform policy making (Smith and Stern, 2011). This suggests a different approach to deploying and developing simulation models to the one