Balancing the realities of environmental observations, model uncertainty and model truthfulness

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Abstract: One of the greatest challenges environmental modellers face in this time of climate and ecosystem nonstationarities is how we reconcile limited observations with imperfect models to improve our characterization of physical systems. It is well recognized that observations of physical systems often lack adequate coverage (in time and space) and rarely directly measure the variable we are often most interested in (and certainly not without error). This is compounded by the difficulties in matching observation to models that require a simplified representation of the system processes and often represent measured variables at a different time/space scale.

In light of this, significant effort has been put into the development and refinement of uncertainty frameworks that attempt to probabilistically quantify the relationship between observations and models. However we appear to be at an impasse with how we mathematically describe the complexity of model error. Arguments are made against formal statistical methods for uncertainty analysis that cannot appropriately represent epistemic error, while informal approaches are criticized for their reliance on subjective modeler expertise and their lack of statistical rigor.

For our models to be more truthful we need to identify the patterns in environmental processes that are important to characterize from a systems perspective, and perhaps be less concerned with exactly reproducing time series of observations. This is not a new idea. Several recent studies have demonstrated that by sacrificing/relaxing the desire to produce a perfect fit to observations, by considering novel ways to summarize complex observations, or by incorporating expert knowledge and 'soft' data, we may have models that are more reliable, more 'authentic' (in that they adequately represent environmental physical processes) and better equipped to capture system nonstationarities and extreme conditions. This presentation will aim to discuss how uncommon field observations and expert knowledge can be helpful to improve model trustworthiness and demonstrate how these concepts may be incorporated into uncertainty frameworks.

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