Distinguishing uncertainty, diversity and insight

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Presented at the NCAR workshop *Uncertainty in Climate Change Research: An Integrated Approach*
August 6-17 2012

The aims, means, and outputs of forecasting for decision support vary with the nature of the system, our level of understanding, and the nature of the decisions being made. Good practice in one case may be disadvantageous (indeed irrational, if not impossible) in another. In many cases one has an insightful prior probability distribution on the likely outcomes (the relevant climatology) and a large archive of forecast/outcome pairs. In these "weather-like" cases the lifetime of a model is very long compared to the decision-relevant lead-time of a forecast. Contrast that with a "climate-like" case in which the forecast/outcome archive is at best small, the lifetime of a model is much less than the lead-time of the forecast, and it is questionable whether past observations provide a relevant prior. While probabilistic weather and climate forecasts will be used for concreteness, the weather-like/climate-like distinction is useful outside of the Earth sciences. Clarifying this distinction sheds some light on the friction commonly observed between advocates of "physical insight" and advocates of "statistical good practice" when forecasting the real world. The roles both of model inadequacy and of uncertainty in observations (and parameters) are shown to differ in the two cases; distinct challenges to the rationality of probability forecasts (used as probabilities in standard decision theory) for decision making are raised in each case, and the possibility of replacing "fair odds" with "sustainable odds" is noted. The diversity of our model simulations provides different information in weather prediction than in climate projection, but in neither case need it quantify the uncertainty in our future. How then are we to judge, constructively criticize, and improve operational forecasting and the models which underpin it?

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