

## Probability Forecasting: Looking Under the Hood and at the Road Ahead

**Leonard A Smith**

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Probability does not exist. At least no more so than "mass" "spin" or "charm" exist. Yet probability forecasts are common, and there are fine reasons for deprecating point forecasts, as they require an unscientific certainty in exactly what the future holds. What roles do our physical understanding and laws of physics play in the construction of probability forecasts to support of decision making and science-based policy? Will probability forecasting more likely accelerate or retard the advancement of our scientific understanding?

Model-based probability forecasts can vary significantly with alterations in the method of data assimilation, ensemble formation, ensemble interpretation, and forecast evaluation, not to mention questions of model structure, parameter selection and the available forecast-outcome archive. The role of each of these aspects of forecasting, in the context of interpreting the forecast as a real-world probability, is considered and contrasted in the cases of weather forecasting, climate forecasting, and economic forecasting. The notion of what makes a probability forecast "good" will be discussed, including the goals of "sharpness given calibration" and "value".

For a probability forecast to be decision-relevant as such, it must be reasonably interpreted as a basis for rational action through the reflection of the probability of the outcomes forecast. This rather obvious sounding requirement proves to be the source of major discomfort as the distinct roles of uncertainty (imprecision) and error (structural mathematical "misspecification") are clarified. Probabilistic forecasts can be of value to decision makers even when it is irrational to interpret them as probability forecasts. A similar statement, of course, can be said for point forecasts, or for spin. In this context we explore the question: do decision-relevant probability forecasts exist?