

Dynamic Probabilities, Mature Probabilities, and the Links Between Data Assimilation and Ensemble Forecasting in Actual Decision Support

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Given a perfect model, the aim of data assimilation is well-defined and generally widely-agreed. While finite computational resources will preclude a perfect probability forecast, an accountable forecast can be achieved. An accountable forecast suffers only from the sampling uncertainties unavoidable in any finite ensemble, and converges toward a perfect probability forecast as the ensemble size increases to infinity, yielding what I.J. Good termed "dynamic probability". In this case, the aims of data assimilation can be cast in a fully Bayesian framework, while means of achieving useful probabilistic forecasts may follow a different path and deliver something less than a full probability distribution for the forecast target. These insights from the Bayesian Way can be extended to the case of uncertain parameter values, but not to the case of structural model error: error in the mathematical form of the model equations such that the model class in-hand does not admit a model consistent with the mechanism generating the observations. In this case, the aim of data assimilation will vary with the forecast target and lead-time; nevertheless there are more effective and less effective approaches to ensemble formation and forecasting, and the two become perhaps more deeply intertwined. While the Bayesian Way may still guide our thinking, the relevance of the probability calculus (and thus of Bayes' Theorem) is no longer assured. Indeed the very notion of "the distribution of truth" can prove worse than a distraction.

Ensemble climate forecasts require consideration of "mature probabilities" and while an estimate of the inherent forecast uncertainty of future states of the atmosphere remains the aim, it is no longer at all clear that this inherent uncertainty is best communicated or explored when cast as a probability. Both robust conclusions and more speculative suggestions for decision support outside the perfect model scenario will be presented.