Geophysical Research Abstracts
Vol. 12, EGU2010-12490, 2010
EGU General Assembly 2010

Can we expect to predict climate if we cannot shadow weather?

Leonard Smith (1,2)

(1) Centre for the Analysis of Time Series, London School of Economics and Political Science, UK (l.smith@lse.ac.uk), (2) Pembroke College, University of Oxford, UK

What limits our ability to predict (or project) useful statistics of future climate? And how might we quantify those limits? In the early 1960s, Ed Lorenz illustrated one constraint on point forecasts of the weather (chaos) while noting another (model imperfections). In the mid-sixties he went on to discuss climate prediction, noting that chaos, per se, need not limit accurate forecasts of averages and the distributions that define climate. In short, chaos might place draconian limits on what we can say about a particular summer day in 2010 (or 2040), but it need not limit our ability to make accurate and informative statements about the weather over this summer as a whole, or climate distributions of the 2040's. If not chaos, what limits our ability to produce decision relevant probability distribution functions (PDFs)? Is this just a question of technology (raw computer power) and uncertain boundary conditions (emission scenarios)?

Arguably, current model simulations of the Earth's climate are limited by model inadequacy: not that the initial or boundary conditions are unknown but that state-of-the-art models would not yield decision-relevant probability distributions even if they were known. Or to place this statement in an empirically falsifiable format: that in 2100 when the boundary conditions are known and computer power is (hopefully) sufficient to allow exhaustive exploration of today's state-of-the-art models: we will find today's models do not admit a trajectory consistent with our knowledge of the state of the earth in 2009 which would prove of decision support relevance for, say, 25 km, hourly resolution. In short: today's models cannot shadow the weather of this century even after the fact. Restating this conjecture in a more positive frame: a 2100 historian of science will be able to determine the highest space and time scales on which 2009 models could have (i) produced trajectories plausibly consistent with the (by then) observed twenty-first century and (ii) produced probability distributions useful as such for decision support.

As it will be some time until such conjectures can be refuted, how might we best advise decision makers of the detail (specifically, space and time resolution of a quantity of interest as a function of lead-time) that it is rational to interpret model-based PDFs as decision-relevant probability distributions? Given the nonlinearities already incorporated in our models, how far into the future can one expect a simulation to get the temperature "right" given the simulation has precipitation badly "wrong"? When can biases in local temperature which melt model-ice no longer be dismissed, and neglected by presenting model-anomalies? At what lead times will feedbacks due to model inadequacies cause the 2007 model simulations to drift away from what today's basic science (and 2100 computer power) would suggest? How might one justify quantitative claims regarding "extreme events" (or NUMB weather)?

Models are unlikely to forecast things they cannot shadow, or at least track. There is no constraint on rational scientists to take model distributions as their subjective probabilities, unless they believe the model is empirically adequate. How then are we to use today's simulations to inform today's decisions? Two approaches are considered. The first augments the model-based PDF with an explicit subjective-probability of a "Big Surprise". The second is to look not for a PDF but, following Solvency II, consider the risk from any event that cannot be ruled out at, say, the one in 200 level. The fact that neither approach provides the simplicity and apparent confidence of interpreting model-based PDFs as if they were objective probabilities does not contradict the claim that either might lead to better decision-making.