Chaos and Weather Forecasting

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Abstract

At first sight, chaos appears to be the perfect excuse for the inaccurate forecaster. Its mathematical credentials make it a much more fashionable scapegoat than either "noise" or "human error." Mathematical chaos, however, has the tools to fight back and clear its name. Early numerical weather prediction provided point forecasts: an estimate of the atmosphere now would go into the model, and one estimate of the future would come out; a single ("point") forecast revealing the future. Or not. Chaos is a property of our mathematical models, not of the world, and chaotic models push us away from making point forecasts, toward making probability forecasts. Since chaos permits accurate probability forecasts the fact that we cannot make them is evidence that "chaos" is not to blame! So what really limits weather forecasting today? Chaos or imperfections in our model? This question is of practical importance, because model inadequacy pushes us away from probability forecasting just as chaos pushed us away from point forecasts. Towards what it is not yet clear; perhaps towards sustainable odds? In any event, accepting that we cannot achieve accountable probabilities also opens the door to many exciting alternative things we might do. Today's models might usefully foresee nasty things lurking in our future, even without a precise probability of their coming to pass. How might this change the way we use weather models in practice?