Professor Leonard Smith: Abstract
Venue: 20 years of Nonlinear Dynamics in Geosciences; Rhodes, June 2006

Insights from a Century of Forecast Errors:
The Evolving Role of Nonlinearity in Operational Forecast Systems

The implications of using nonlinear models in forecasting physical systems are explored, using numerical weather prediction methods as a prime real-time real-world example. There has been a great increase in the value of weather forecasts since Fitzroy's early attempts to propagate information Eastward faster than the winds carried it. An informed allocation of resources is required if we are to increase the value of the more complex simulation models developed in the last century; this has been clear since Thompson's 1957 paper on the importance of uncertainty in the initial condition on forecast accuracy.

And the impacts of nonlinearity are shown to change the ground rules: what exactly quantifies accuracy in a 10^7 dimensional, imperfect model? How are we to use the experience of our archive of past forecasts to decide between increasing the size of an ensemble forecast and increasing the complexity of the model on which it is based? Or should those computational resources be diverted into getting a better initial ensemble, and if so is that best accomplished by investing in more relevant observations or in more computationally intensive data assimilation? Our linear intuitions here are misleading at best.

We have no definitive answers to these questions today, nor can we clearly quantify the socio-economic benefit to more clearly justify the rational level of investment of recourses. What we can see is that improving weather forecasting will become more and more important as the climate changes, and better forecasts can provide direct feedbacks with climate impacts. The need to better understand nonlinear dynamics becomes more and more clear as time passes.