Weather and Climate Prediction:

An Empirical Technique for Improving Model Forecasts

The chaotic nature of the Earth's atmosphere drives weather forecasts away from reality at an exponential rate, leading to much worse predictions at 3 days than at 3 hours. Even very small errors are magnified drastically over time, which underlines the importance of accurate initial conditions. However, even with perfect estimates of the state of the atmosphere, discrepancies between nature and our models would still produce the runaway effect of chaos. In this talk we discuss a principled approach to the mitigation of those discrepancies. By comparing initial conditions from the past to the forecast errors they generate, the systematic error tendencies of a model can be determined mathematically. Those tendencies can then be counteracted at every forecast step, significantly reducing errors. We first present the results of applying this procedure to a model representing the isolated atmospheric phenomenon of a convection cell. Then, we address the challenges associated with testing the technique on the operational Global Forecast System (GFS) weather model used by the National Weather Service, which has approximately one billion degrees of freedom. If successful, the methodology will be used to improve forecasts of the Earth's climate as well.