Climate Prediction: Lessons from Simple Non-Linear Systems

Birkeland Workshop

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Abstract

Basic physical understanding is sufficient to justify significant societal efforts to reduce greenhouse gas emissions and mitigate further anthropogenic climate change. Policy makers and society at large often look to climate science to provide guidance on how to respond to the risks posed by climate change. This is usually interpreted as the provision of predictions of future climate since such information is seen as important to motivate greenhouse gas emission reductions (mitigation) and to facilitate preparation for the changes ahead (adaptation). In both cases climate predictions are sought for everything from months to decades to centuries and on spatial scales from global to regional to local. Perhaps one of the biggest challenges facing climate science today is how to provide robust and relevant societal guidance. There may be a number of ways to approach that problem but here I will focus only on the challenges of making climate predictions.

The principal tool for making climate predictions are complex climate models. These have been intensively developed over the last three decades and now include some representation of many aspects of the climate system on grids which are becoming higher and higher resolution such that they can sometimes appear to provide information on the scales relevant to decision making. The critical questions now relate to how to design experiments which explore the different sources of uncertainty – boundary conditions (principally emissions), initial condition uncertainty, model error – and how to interpret the resulting ensembles in terms of the real world.

In this talk I will discuss the various different approaches to exploring uncertainty in climate simulations with complex climate models, utilising results from the climate*prediction*.net experiment. In an attempt to shed light on the design and interpretation of these ensemble experiments I will present some early results of ensemble simulations with very simple non-linear systems including Lorenz '63 and Lorenz '84. Such simple systems have significant value in highlighting potential barriers to climate prediction and suggesting means for ensuring robust uncertainty exploration; at least within a particular model.

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