1 Introduction

Recently, there has been much attention focused on understanding the role of our changing weather and climate to its effects on the earth on both a local as well as global scale. Currently, there are a number of mathematical as well as phenomenological models that connect climate changes to impacts on our planet. Since none of the models can take into account all of the effects on weather and climate, there is an inherent uncertainty in what the (mathematical) models can predict. In this year’s Junior Faculty Forum at the National Center for Atmospheric Research (NCAR), we propose to establish a collaboration between climatologists and mathematicians concerning how certain mathematical models for weather and climate studies are affected by random parameters in said models, and how statistical methods can be used to quantify the uncertainty and constrain it with the use of observations.

In particular, the topic of interest here is entitled “Regional and Climate Models: A study of parameter sensitivities in various models”. In this workshop, we will examine two subtopics. These subtopics are entitled “Parameterizations and parameter sensitivities in climate models” and “Random Parameters in Differential Equations”.
2 Outline of topics for forum discussion

Below, we give an outline of the topics which will be the focus of this Junior Faculty Forum entitled: “Regional and Global Models: A study in model sensitivities to various parameters”.

- Parameterizations and parameter sensitivities in global models: limitations and implications for predictability and uncertainty

_Understanding the limitations of sub grid scale parameterizations and their effects on uncertainty in future climate projections. The use of Monte Carlo methods and observations to constrain model parameters and reduce uncertainty in climate models_

- Random Parameters in Differential Equations

_Understanding how deterministic differential equations arising in climate models are influenced by random parameters (given some distribution of the parameter of interest) and how this could be applied to global models in the future_

The motivation for the first topic is that most climate models cannot currently resolve many of the crucial processes due to computational constraints, for example cloud condensation, local processes related to steep topography, or ocean eddies. Therefore the effect of those processes on the climate mean state and variability must be parameterized in some way. Those parameterizations are often evaluated separately against observations, and the sensitivity of the model against parameter settings is studied. Recently large efforts were made to run very large ensembles of models and to constrain some of the parameters used in those parameterizations by evaluating the complete model output against observations. While this is computationally expensive, it is feasible to some degree. However, it only aims at finding a distribution of a particular parameter, without changing the parameterization itself. These so-called structural uncertainties are very hard to quantify. Also, the parameterizations used are deterministic in most cases, i.e. do not include random components. This motivates the second topic. The goals here are that we wish to connect the mathematics to climate models of practical interests to climatologists. In this collaboration, the idea is to have climatologists discuss certain mathematical models of interest in their work. Once the mathematical models are established, the mathematicians (as well as others) will see how these models are affected by random inputs into certain parameters within the models and/or the initial data (The randomness of interest here may be additive or multiplicative as well as having spatial and/or time extent) and once a problem (or several problems) are discussed, it is the goal of this forum to begin the establishment of a collaboration between said climatologists and mathematicians. Also, statistical methods need to be developed to efficiently evaluate the climatic effect of those new parameterizations, and the interactions between several such random parameterizations, against observations and how to constrain the random components introduced.

3 Forum Program

Dates for the JFF on Future Scientific Directions:
• Tuesday, August 1, 2006

• Wednesday, August 2, 2006

• Thursday, August 3, 2006
References


