Spring 2010

# Climate Modeling (G63.2840)

## Tuesdays 9:30-11:20 in Warren Weaver Hall 517

Amidst the shouting over climate change and what action should be taken about it, this course seeks to focus in on the science of climate prediction. We will work our way through the components of state-of-the-art climate models, endeavoring to understand, or at least appreciate, the science and approximations that lie behind predictions of future climate change. The course will proceed in seminar format. Participants will be expected to read background material on climate models and complete a research oriented project, running and/or analyzing the output from an IPCC class climate model. No experience in climate modeling is required, but a basic knowledge of fluid dynamics and physics will help.

## Instructor

Edwin Gerber
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## Class Expectations and Grades

There will be no quizzes or tests. Students are expected to lectures and read background material. To get the most out of the course, I encourage you to also get your hands wet with climate models from the beginning. Grades will be based on a course project.

## Resources

These textbooks have been put under reserve at the Courant Library. You can also access them in my office.

<u>A Climate Modeling Primer</u> by Kendal McGuffie and Ann Henderson-Sellers.

<u>Fundamentals of Atmospheric Modeling</u> by Mark Z. Jacobson

<u>An Introduction to Three-Dimensional Climate Modeling</u> by Warren M. Washington, Claire L. Parkinson

These "popular science" texts provide the historical context and a broader introduction to the climate change.

<u>An Ocean of Air</u> by Gabrielle Walker

<u>The Discovery of Global Warming</u> by Spencer Weart

Other materials and links will be posted on the course website.

## Course Outline

Our goal is to work through the key components of a climate model. The Earth's climate is determined by interactions between the atmosphere, oceans, cryosphere (ice sheets, glaciers, sea ice) and land surfaces (terrestrial hydrology, biology, etc.). This course will be biased towards the atmospheric component of a climate model, but we will seek to understand how interactions between the atmosphere and the other elements of the climate system are represented in models. Below I've sketched out an ambitious outline for the course.

Part I: Energy Balance Models and the Big Picture

Part II: The General Circulation and Large Scale Dynamics

What are we dealing with: A physical description of the earth's climate

How does it work: The equations of large scale motion

From pencil and paper to Fortran: Numerical Representation

Selecting the right tool: A hierarchy of models, from the barotropic vorticity equation to the dynamical core

Part III: "Climate Physics," or, the interaction and representation of unresolved processes with the large scale equations.

Aerosols

Atmospheric Chemistry

Boundary layer processes

Clouds + Microphysics

Convection

Gravity waves

Radiation

Part IV: Putting it all together. Analyzing and interpreting the output of climate models. Which results can we trust? Which predictions are more tentative?