MTH 463/563   Topics in Applied Mathematics: Mathematics and Climate
Spring 2024

Instructor: Brian Spencer   **Lectures:** Tue/Thu 11:00-12:20
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Course Description: We study important conceptual models of Earth's climate system and the mathematical, statistical and computational techniques for analyzing these models. Topics from climate science include the Earth's energy balance, ocean circulation patterns, atmospheric models, carbon dioxide data and trends, ice caps and glaciation periods. Mathematical, statistical and computational techniques include conservation laws, dynamical systems and bifurcation theory, regression analysis, Fourier transforms, computational solutions of boundary value problems, and statistics of extreme events. About half of the coursework involves computational coding to implement the methods and illustrate theoretical results.

Prerequisites:
- MTH 241, MTH 306 and some experience with computer programming (e.g. MTH 337, CSE 111, CSE 115, etc.).
- It is helpful if students have had some experience with: mathematical models of scientific phenomena (eg science courses or MTH 443/543), basic statistics, and/or introductory partial differential equations.

Relation to Other Core Math Courses: This is a senior-level / beginning graduate-level applied mathematics course typically offered every other year. Many of the mathematical models involve ordinary differential equations with methods of analysis building from background in MTH 306. The course also involves computational methods and programming like MTH 337 and some computational data analysis. The emphasis on computation, as well as applications, model building and mathematical methods makes it a complementary course to MTH 443 and MTH 444. The course also develops some applications of probability that complement the curriculum in MTH 411, and involves some introductory usage of partial differential equations that are developed more thoroughly in MTH 418.

Text: *Mathematics and Climate* by Hans Kaper and Hans Engler (SIAM, 2013).

Coursework: About 1/2 of the topics and assignments will involve some usage of computational software written in matlab. The tentative plan for coursework is graded homework and a final written project.

Matlab: computational software for numerical-based analysis, graphical representation of data, and many homework assignments. I do not expect you to be a proficient coder in matlab. Example codes will be available on UBLearns, I will go through example codes line-by-line in class, and I am available to help debug code.