MATH 392 Final Project
Seminar in Mathematics and Climate
Spring 2018

The last assignment of the course is to complete a final research project focusing on some particular application related to the course material. Your project will consist of both a typed report (approximately 10 pages) and an in-class presentation (15–20 minutes) during the final week of class. Your report can be written using Maple (which has nice word processing for mathematical symbols), LaTex (if you know it), or a regular word-processing program with a hand-written appendix for mathematical calculations. You are required to work in a small group (2–3 people), although it is expected that each member of the group will contribute equally. Your group does not have to be identical to the one used on the computer projects. The final project is worth 40% of your total course grade.

Timeline and Due Dates:

- March 2, 5:00 pm: Brief description of final project topic due, including at least three references.
- April 12: Brief progress report (1–2 typed pages) due detailing the status of your project, including results and further lines of inquiry. By this date you should have met with me at least once to discuss the content of your project and the plan for your presentation.
- April 26: Detailed outline of your report and presentation due, including title and a list of all group members.
- May 1 and 3: Project Presentations (15–20 minutes; each member must speak for at least 5 minutes).
- May 7, 5:00 pm: Final Report due (typed, double-spaced, double-sided, roughly 10 pages).

Project Details:

The aim of this project is for you to investigate a specific topic involving climate science and apply some of the mathematical techniques we have studied in class. Ideally, you will utilize the mathematics learned in this course, and potentially others, to make an *in-depth* investigation of your topic. You should emphasize depth over breadth when conducting your research.

In addition to gathering information and research related to your topic, you should also strive to accomplish each of the following goals. Depending on your topic you might emphasize one more than the other, but try and include both in your project.

1. **Modeling:** Come up with your own mathematical model, or work with a known model, to study some topic related to climate. Your research could include running different simulations of your model, investigating the equilibrium solutions, conducting a bifurcation analysis (e.g., looking for tipping points), tuning your model, comparing it with known data, performing a model reduction, and/or making model predictions. See the handout from the special class with Dawn DeDeaux for tips regarding model construction.

2. **Data Analysis:** Find and analyze data related to your topic. Do some type of best fit (e.g., regression analysis) to model your data. If relevant, compute the power spectrum of your data set. What conclusions can be drawn from the data? What predictions can be made? How can the data be incorporated into your mathematical model?

   There are many good online sources to obtain data and figures, such as:

   - NOAA Earth System Research Laboratory (`https://www.esrl.noaa.gov/gmd/dv/data/`)
   - National Snow and Ice Data Center (`https://nsidc.org/data`)
   - NASA Goddard Institute for Space Studies (`https://data.giss.nasa.gov/`)
   - NCAR Climate Data Guide (`https://climatedataguide.ucar.edu/`)

Choosing a Topic:

There are many, many different topics involving climate science that you can investigate. The important thing is to chose a topic that you are interested in and then find some readable scientific papers pertaining to that topic. Good articles to use are those that contain data and figures, or involve a mathematical model. I have listed some general topic ideas below. Feel free to investigate something that we have discussed in class or that is presented in the course text by Kaper and Engler.

- Model some specific physical process of the climate system, potentially studying how it contributes to the overall climate (e.g., carbon cycle, Arctic sea ice, ocean circulation, biosphere, permafrost). See Figure 1.1 (on p. 2) of the course text for potential ideas.
- Model the climate of the past (e.g., Neoproterozoic era).
- Model something that has personal meaning to you (e.g., the effect of climate change on the Florida everglades or on coastal wetland loss in Louisiana).
- Study the effects of human activity on the climate (e.g., deforestation, land use, agricultural practices, population growth, globalization)
- Study the effects of climate change on a particular species or plant (e.g., coral reefs, polar bears, New England lobsters)
- Model the climate (e.g., surface temperature) of a planet other than Earth.
- Study a well-known data set (e.g., ice core records) and reproduce known results and/or develop your own hypotheses about the data.

Writing Your Paper:

Your paper should be well written, clear, organized, and in your own words. Scientific results and conclusions you gather from articles should be paraphrased rather than quoted in lengthy passages. You should include a brief abstract at the start of your paper (one paragraph) stating the focus of your paper, your research goals and findings. Be sure to include both an introduction and conclusion to your paper.

All figures should have captions and be appropriately referenced. For example, if you generate a figure, indicate the program used; if the figure comes from a paper or online source, be sure to cite the paper or website in the caption. Pages should be numbered. It is fine to write mathematical equations by hand in the narrative of your paper, or they may be included in an appendix. Take care to proofread your paper and make sure all equations and calculations are included.

References should be informative and in a consistent style. Be careful using material found on the Internet, as some information is inaccurate or out of date. Always try to find an author and date when using anything from the Internet. It is ok to use *Wikipedia* as a source on occasion, but your primary sources should be published (i.e., peer-reviewed) articles from mathematical and scientific journals.

Grade:

Your final project grade will be divided (approximately) into thirds based on the following rubric:

(i) Quality of presentation

(ii) Quality of the mathematics and research conducted

(iii) Quality of the paper (well-written, organized, readable, in your own words, appropriately referenced, followed the above guidelines, etc.)