EESC4464: Environmental Data Exploration and Analysis
Spring 2020 Syllabus

Professor: Hilary Palevsky, palevsky@bc.edu, Office: Devlin 321A

Class meetings: 5:30-8:00 pm Wednesdays, Devlin Hall 307

Office hours: Tuesday 1:15-2:30pm, Thursday 11am-12pm, or by appointment

Course description:

Earth and environmental science increasingly depends on scientific programming to explore and analyze large data sets from in situ and autonomous observations, satellite remote sensing, and numerical model output. In this course, students will learn to use MATLAB to visualize earth system data across broad spatial and temporal scales in maps and time-series plots, and apply statistical tools to analyze trends and variability in their datasets. Students will also learn to critically assess datasets and to select and justify appropriate data sources and analytical methods to address scientific questions about earth system processes. Students will practice these skills in a series of data analysis assignments focused on regional and global climate data, and will apply them in a team-based final research project.

Overarching learning goals for the class:

By the end of this class, you will be able to…

- Visualize earth system data across broad spatial and temporal scales in maps and time-series plots using MATLAB
- Apply statistical tools to analyze trends and variability in time-series data and spatial variability in regional and global datasets
- Describe and critically evaluate methods such as observational compilations, remote sensing, and numerical models used to generate global earth science datasets
- Select and justify appropriate data sources and analytical methods to address scientific questions about earth system processes

Transferrable skills:

In this class, you will work on developing your expertise in this broad set of transferrable skills. You each come in with different sets of prior experience with these skills – therefore the class is designed to allow you to build on your existing strengths and to emphasize those skills you are most interested in developing.

1) Programming in a scripting language, including: creating variables, performing calculations, importing and reshaping arrays of data, creating and using functions, and using help documentation and online searches to troubleshoot code
2) Statistical analyses of data, including: calculating the mean, standard deviation, and linear regression, de-trending, removing outlier data points, and error analysis

3) Visualizing data, including: plotting 2-dimensional data (e.g. variable changing over time), using contours and colormaps to visualize 3-dimensional data, creating maps, and optimizing data visualizations for clarity and accessibility
4) Critical consumption of publicly-available data, including: finding data available through public repositories, reading documentation to understand how data were collected and processed, and assessing the suitability of a dataset to address a particular problem/question
5) Reading scientific papers, including approaches for understanding papers with methods, concepts, and/or technical detail that you don't have previous experience with
6) Research using scientific data, including: formulating a question, framing a hypothesis, selecting methods to test your hypothesis, and interpreting results to address your original question
7) Synthesizing and presenting research findings through written papers and oral presentations
8) Collaborating productively with groups, including: dividing roles across team members, managing all team members' expectations, and successfully producing team-created products.

Assignments:

Class preparation assignments

There will be a number of assignments you will complete and submit in preparation for our Wednesday class meetings. Completing these assignments will be critical for your full and effective participation during our class meetings.

Data labs

The first three data analysis projects in this class will be multi-part data "labs" where you will conduct guided analysis of datasets that I have selected for you. This will provide an opportunity for you to develop your skills in programming, data analysis, and data visualization, and apply these to questions about climate science that we will pose and discuss together as a class. You work on these labs in pair-programming teams, but will each submit your own lab write-ups explaining and presenting your analysis.

Programming assessment

There will be a programming assessment roughly one third of the way into the course. The purpose of this assessment is to ensure that you have developed the foundational skills of programming in MATLAB that will support your continued learning and success throughout the rest of the course. This will be a self-scheduled take-home exam (in lieu of a class meeting on February 19). You will have the opportunity to complete revisions to any questions you answer incorrectly on the original assessment, providing a second chance to master any material you had not initially fully understood and to improve your assessment score.

Team research projects

The final portion of the semester will be focused on team research projects addressing earth and environmental science questions of your own choosing, applying data science approaches to analyze existing publicly-available data sets. We will begin these team projects with an opportunity for everyone in the class to pitch ideas for science questions you want to

work on, and personal goals for skills you want to work on in your project. This will be followed by a project "speed dating" session to help you form teams with common interests and complementary skills. The reason for designing these projects to be completed in teams is that it will allow you to practice working in collaborative teams who each bring complementary strengths and skills, as happens in real research, enabling you to together complete a more complex and extensive project than you could complete independently. All team deliverable products will be created collaboratively, and accompanied by a joint statement of contributions/lead roles on each section, as well as an individual reflection from each team member. Team deliverables will include a 1-page project prospectus, an in-class presentation during our final class meeting, and a written report due during exam period.

Setting your own goals (SYOGs) and reflections:

This syllabus identifies a set of learning goals and transferrable skills for you to work on that I have set for the course. But equally important are **your** goals for the course. At the beginning of the semester, you will decide which skills you would like to prioritize working on from the set of Transferrable Skills listed earlier in this document. You may also include your own additional skill goals or other personal objectives for the course. The purpose of this is to help you focus on skills that are of personal interest, and use this focus to decide which roles you want to take on in the team research projects. I will ask you to reflect on your progress towards these personal goals (as well as any changes in your personal goals) throughout the semester in individual reflection assignments you will submit along with each lab and research project deliverable. This will include reflecting on:

1) The transferrable skill goals I set for the course –what skills did you find yourself developing by working on this assignment, what effort did you put towards each of these, and how would you self-assess your achievement on each skill involved in this assignment?
2) Your progress thus far towards your own SYOG goals, including any changes in your personal goals for the class,
3) Your individual experience as a member of your group – what were the strengths and weaknesses of the group as a whole, your own personal strengths and weaknesses as a member of the group, and what lessons do you take away about effective group work from this assignment?
4) Anything else you want to share about your experience with this assignment.

Note: I will never reduce your grade because of honesty in anything you reveal in your reflections that I would otherwise have been unaware of.

Course schedule:

This schedule is a fluid document and may change as the semester progresses. Changes will be announced in class and posted to the course website.

Date	Class plan	Assignments
Jan. 15	Introductions, course overview, & logistics + Data science for the earth sciences + Getting started with GitHub & MATLAB	For class: Install MATLAB & GitHub + complete intro surveys
Jan. 22	Methods of time-series data analysis + Temperature Data Lab, Part 1	For class: Complete MATLAB Onramp tutorial
Jan. 29	Developing and implementing algorithms + Temperature Data Lab, Part 1, continued	For class: Complete SYOG + sign up for SYOG meeting
Feb. 5	Methods & best practices for data visualization + Temperature Data Lab, Part 2	
Feb. 12	Applying earth science theory to data analysis: A case study of ocean CO_2 (Discussion of Takahashi et al., 2002) + Ocean CO_2 Data Lab, Part 1	For class: Read Takahashi et al. 2002, *Deep-Sea Research II* DUE Fri. Feb 14: Temperature Data Lab writeup
Feb. 19	****No class – Ocean Sciences Meeting****	DUE Fri. Feb 21: Self-scheduled programming assessment
Feb. 26	Ocean CO_2 Data Lab, Part 2	
Mar. 4	****No class – Spring break****	
Mar. 11	Accessing and reading in data files + The Blob Data Lab, Part 1	DUE Wed. Mar 11: Ocean CO_2 Data Lab writeup
Mar. 18	Error analysis & Monte Carlo simulations + The Blob Data Lab, Part 2	DUE Fri. Mar. 20: Programming assessment revisions
Mar. 25	Finding publicly-available data sources + Group project pitches & "speed dating"	For class: Submit initial ideas & goals for group project DUE Fri. Mar. 27: The Blob Data Lab writeup
Apr. 1	Guide for earth system data consumers + Work on group projects	
Apr. 8	****No class – Passover/Easter weekend****	DUE Wed. Apr. 8: 1-page group project prospectus + individual reflection on project goals
Apr. 15	Data science Q&A + Work on group projects	
Apr. 22	Data science Q&A + Work on group projects	
Apr. 29	Project presentations	
May 6	DUE: Group writeup of project + individual final reflections	

Assessment:

Grading criteria:

Class preparation assignments – 5%
Data labs – 35%
Programming assessment – 10%
Team research project – 30%
Setting your own goals (SYOG) project – 20%

Guiding principles:

Recognizing that each student enters this class with a different set of prior experiences and strengths in the skills that this class aims to cover, the assessment scheme is designed to allow different paths through the course focusing on individualized choices of skills to emphasize. Students who receive A's in this class will achieve a satisfactory level in all skill areas, but may select different areas of personal interest to focus on in achieving more complete levels of mastery.

Class policies:

Attendance and class participation:

Your attendance and participation in class will be critical to your success in this course. Your presence and active engagement in every class meeting will be especially important in this course because we only meet once per week and because much of our in-class time will be devoted to group activities that will be difficult to make up on your own. Please let me know in advance if you anticipate needing to miss class.

Recognizing that the evening class meeting time overlaps with the time many would regularly eat dinner and being well-nourished is an important prerequisite for your active engagement, you are welcome to bring food to eat during class.

Office hours, email, and Canvas:

I will be available for drop-in meetings during my office hours, and strongly encourage you to take advantage of these opportunities to meet with me individually or in groups to discuss course content, assignments – or anything else you may want to talk about! In addition to my scheduled office hours, you are welcome to make an appointment with me at a mutually convenient time. The best ways to set a meeting are to catch me in class or email me. I will respond to your email as soon as I can, usually within 48 hours and often much sooner, but please do not count on more rapid e-mail turn-around time just before deadlines!

For communication from me, please check our Canvas site and your BC email address regularly, as all official communication for this class will be conducted there.

Accessibility and accommodations:

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. If you are a student with a disability or condition, either long-term or temporary, and need or think you may need disability-related accommodations, I will be glad to work with you to accommodate your needs for this course. If you have a disability and will be requesting accommodations for this course, please register with either Dr. Kathy Duggan (dugganka@bc.edu), Associate Director, Connors

Family Learning Center (learning disabilities or AHD) or Dean Rory Stein, (rory.stein@bc.edu), Assistant Dean for students with disabilities (all other disabilities).

Additional Resources on Campus:

The Connors Family Learning Center (CLFC)
"The mission of the Connors Family Learning Center is to enhance the quality of learning at Boston College. The CFLC offers instructional support for faculty and graduate students, special services to students with learning disabilities, and tutoring and skills workshops to all Boston College students."

Counseling Services
If you are ever struggling emotionally or feeling overwhelmed and would like someone to talk to, University Counseling Services offers free appointments for a number of services. They are located in Gasson Hall 001.

Disability Services Office
"The mission of the Disability Services Office is to assist students with disabilities at Boston College in achieving their educational, career, and personal goals through the full range of institutional and community resources. The office ensures that students with disabilities receive support services and accommodations that permit equal access to all Boston College programs and the opportunity to realize their potential and develop effective self-advocacy skills."

Student Outreach and Support Services
"Many students face challenges as they venture into the rigorous academic environment of Boston College. The Office of Student Outreach and Support Services is committed to helping all students develop into well-rounded and healthy individuals by providing information and resources." This office offers outreach for the LGBTQ+ community on campus, and also to students in crisis.

The Thea Bowman AHANA and Intercultural Center
"The Thea Bowman AHANA and Intercultural Center supports the undergraduate community – with a particular focus on AHANA (people of African, Hispanic, Asian and Native American descent), multicultural, multiracial, and OTE (Options Through Education) students – in navigating college life and fulfilling their potential." Located in Maloney Hall, Suite 455.

Boston College Online Writing Lab (OWL)
"Welcome to the OWL, the online branch of the Connors Family Learning Center's writing tutorial services. Staffed by graduate and undergraduate readers trained at responding to the work of their peers both critically and constructively, the OWL provides free tutoring assistance to the Boston College community. As with in-person tutoring, our mission is to help students improve their writing at the global level, with attention to argument, organization, and effectiveness, rather than extensive grammatical and syntactical revisions."

Save the date: Green Careers Night – *Tuesday March 24, 5:30-7:30pm, Gasson Hall Room 100*
"Connect with alumni and learn about careers in environment, sustainability, and more."
Sponsored by the Career Center and Environmental Studies Program