Drought-related tree mortality at a low elevation forest in Sequoia National Park; October 2015. (photo: Nate Stephenson)

OEB 120: Plants and Climate

Monday 3-5:30 pm

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Course Overview

If you were dropped anywhere on the land surface of the planet, one look at the vegetation would tell you a lot about the climate. Similarly, given a description of the climate (temperature, precipitation, humidity) of a particular point, you could make a good guess at what the vegetation would look like. Plants and climate are closely linked and not only does the climate affect plants, but plants also affect climate.

Plant/climate interactions are key to understanding why the structure and productivity of terrestrial ecosystems changes as we move across the globe, including up in elevation. Thus, this course will give you the tools to understand plant form and function in relation to the environment (a sub-discipline sometimes referred to as "eco-physiology"). And because the climate has changed over the 465 million years of plant evolution on land, plant/climate interactions provides context for understanding the evolution of key innovations such as C4 photosynthesis and the rise of angiosperms. However, a major reason to understand plants and climate is the fact that our climate is changing dramatically as a result of human activities. Thus an important goal of the course will be to understand how changes in our climate are likely to impact both agricultural and natural ecosystems.

We will use photosynthesis as a lens to understand plant/climate interactions. A focus on photosynthesis

makes sense because photosynthesis is how plants obtain the resources needed to grow, reproduce, and defend against attacks by pathogens and predators. It is also the major way that plants affect both the global carbon cycle and terrestrial energy balance. Here we will take a broad view of photosynthesis and include in our study the supply of water and nutrients needed to maintain open stomata and to build the biochemistry needed for synthesizing carbohydrates from CO_2.

Course Organization

The class meets 1x per week for 2.5 hours. The first half of the class meeting will have a more traditional lecture format, while the second half will be a discussion that draws on the primary literature and uses concepts from the lectures in participatory exercises focusing on plants and climate and climate change. Occasionally throughout the semester specific plant biology research tools will be brought in to exhibit how different processes are measured. We will also use the spectacular diversity of plants to illustrate how specific types of plants such as tropical alpine giant rosette plants, mangroves, baobab trees, and closer to home trees of Harvard Forest, as examples of plant/climate interactions.

There are no prerequisites for the class other than an interest in how plants work. LS1A, OEB 10, and OEB 52 provide useful background and context, but are not necessary to do well in the class.

Readings

The class will draw on chapters from a number of textbooks, in addition to the primary literature. All readings will be available through the course website (see Pages tab on Canvas site). Each week students will be asked to submit two discussion questions based on the reading for that week.

Grading

Class participation (10%): Graded based on engagement in discussion sections and in-class activities, as well as discussion questions submitted in advance of class meetings.

Problem sets (60%; 5 @ 12 pts each): Problem sets will be a combination of short-answer questions designed to test conceptual understanding and quantitative problems. We will work sample problems in class and there will always be time to discuss topics that seem unclear or require additional background. Problem sets will be handed out on 9/25, 10/9, 10/30, 11/13 and 11/27 and due two weeks later. Students will be allowed to re-submit answers for additional (partial) credit, however - these re-submissions will be oral and not written.

Final exam (30%): Each student will take a 30 minutes oral exam, scheduled during reading period. Questions/topic areas will be provided in advance and students will be encouraged to use the white board to support their answers. We will provide ample opportunities during the semester to practice answering questions at the board.

Class Honor Code and Code of Conduct:

The teaching staff is committed to treating each student with respect and fostering a classroom environment that supports each student's ability to learn and contribute. In return, we ask that you treat your fellow students with respect and recognize that we all come to this topic with different backgrounds, interests, and experience. This topic, "plants and climate," has real world importance and we will all learn from each other. We ask that you acknowledge and credit all of your sources, whether they be a published paper, wikipedia, your roommate, or chatGPT. We value teamwork and there will be opportunities within the class to work together. We also hope that, when asked, you will be willing to challenge yourself and present work that you have done on your own. Our goal is to help you learn about plants and climate and we look forward to this journey together.

Syllabus

Week	**Lecture topic**	Activity/Discussion
1 - September 11	Introduction to plants and climate: temperature and precipitation basics	Biomes, plant/climate adaptations

2 - September 18	Past and future plants and climate	Tree rings
3 - September 25	Photosynthesis - overview and light utilization	
4 - October 2	Photosynthesis - Calvin cycle, Rubisco kinetics and photorespiration	Discussion of paper about the role of plants in relation to global atmospheric C cycle: Field et al 1992 and Keenan et al 2016
No Class (Oct 9) PS1 due	**In lieu of class on October 9, students should attend Prof. Chris Field's Bullard Lecture on Thursday October 19 at 5 pm.**	
5 - October 16	Photosynthesis - C4 and CAM pathways	
6 - October 23	Ecophysiology of photosynthesis: N deposition and elevated CO2	
7 - October 30 PS2 due	What controls leaf temperature? - leaf energy balance and stomatal regulation	CO2 enrichment experiments: lessons learned
8 - November 6	Water balance and water stress	Agriculture-climate interactions
9 - November 13 PS3 due	Xylem transport and cavitation	Megadroughts and tree mortality
10 - November 20	Mitochondrial respiration and carbohydrate transport	Elevational gradients
11 - November 27	Carbohydrate storage, allocation and growth dynamics	Arctic climate-shrub interactions (for readings look at pages tab, and specifically "discussion readings" link in that tab.)
12 - December 4 PS4 due	Future projections: Amazon climate interactions, agriculture, arctic, and beyond	
Reading period PS5 due Dec 11		