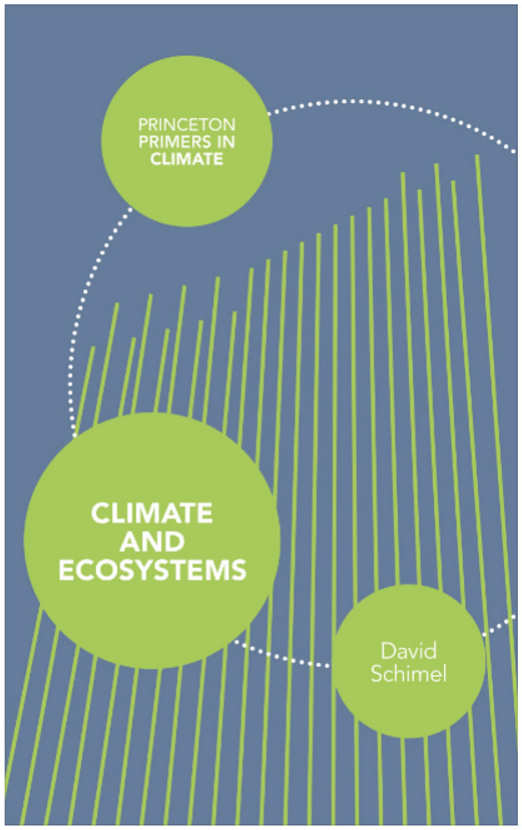
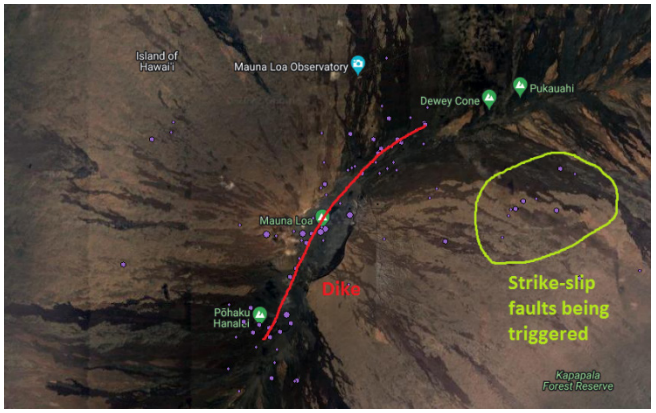
Terrestrial and Marine Ecosystems and Carbon Stock

AOSC 680

Ross Salawitch

Class Web Sites:
http://www2.atmos.umd.edu/~rjs/class/fall2022
https://umd.instructure.com/courses/1327017





https://twitter.com/wattsupbrent/status/1597261904753434625
https://www.volcanocafe.org/trouble-in-paradise-awakening-mauna-loa-2/

Lecture 23: 29 November 2022

Student Projects

- Each student will provide an 18 minute (12 to 15 slide) presentation on a research project, either 2, 6, or 8 December 2022
- Presentations will be in the same order as the discussions of the Princeton Primers in Climate (PPC) readings, to provide some level of proper “spacing”
- Those presenting towards the end of the PPC readings encouraged to get started soon on your research project
- Each student will also submit a 6 to 8 pages single spaced (not including reference list or figures) paper, on the same project**, due at the class meeting that follows the in-class project presentation (or Mon 12 Dec for those presenting on 8 Dec)**
- Project should be ***new work for this class*** but can be related to your dissertation or some other topic in which you’ve had prior interest
- If given a complete draft of your paper at least 7 calendar days prior to due date, I will provide back an edited "mark-up" you can use as input for final submission

AGU Journal Abstract Requirement

Abstract

The abstract (1) states the nature of the investigation and (2) summarizes the important conclusions. The abstract should be suitable for indexing. Your abstract should:

- Be set as a single paragraph.
- Be less than 250 words for all journals except GRL, for which the limit is 150 words.
- Not include table or figure mentions.
- Avoid reference citations unless dependent on or directly related to another paper (e.g., companion, comment, reply, or commentary on another paper(s)). AGU's Style Guide discusses formatting citations in abstracts.
- Define all abbreviations.

New requirement for your Research Paper: you must include an abstract, between 150 and 250 words, that will appear just after the paper title and your name of the first page of the submitted document, that summarizes the content of your paper for an interested, perspective reader.

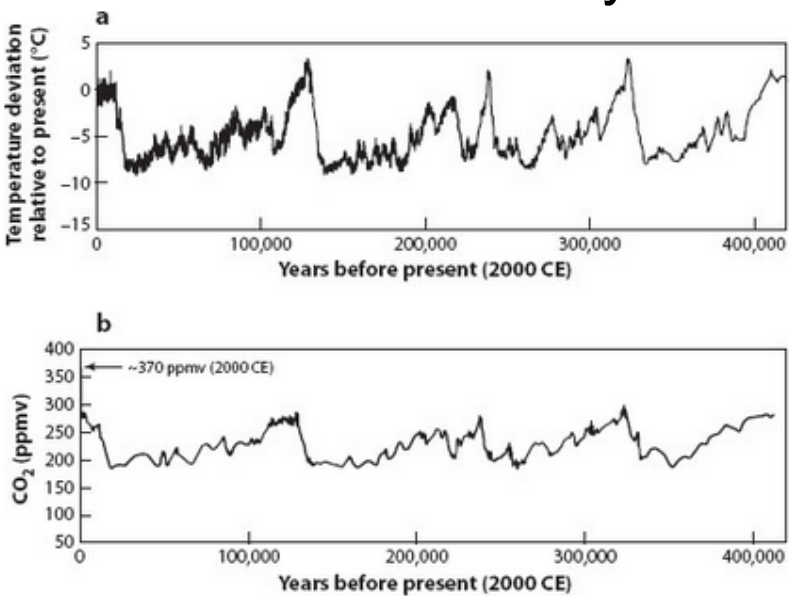
In other words: please express: a) the high level elements of your research paper that you believe a reader will be interested in learning more about, should they decide to read the paper, as well as: b) the high level elements of your paper a reader should "take away", should they not have time to read the rest of the manuscript.

https://www.agu.org/Publish-with-AGU/Publish/Author-Resources/Text-requirements#abstract

Student Project Schedule

11/29	Ecosystems	Chapter 3 from start until page 57 (stop at *Plant Adaptation to Climate*) and Chapter 4 from start to page 121 (stop at *Land Use Change and Deforestation*) *Climate and Ecosystems*	AT 23	**Yixin** Lecture 23			
12/02	Student Presentations, Day 1		No AT	**Jhayron**, **Maddie**	Each Presentation is 18 minutes, with 5 mins for discussion. 2 x 23 = 46 minutes Paper due 11:59 pm on the next class meeting after the discussion.		
12/06	Student Presentations, Day 2		No AT	**Akarsh**, **Shaun**, **Rachel**	Each Presentation is 18 minutes, with 5 mins for discussion. 3 x 23 = 70 minutes Paper due 11:59 pm on the next class meeting after the discussion.		
12/08	Student Presentations, Day 3		No AT	**Alisha**, **Natalia**, **Yixin**	Each Presentation is 18 minutes, with 5 mins for discussion. 3 x 23 = 70 minutes Paper due Dec 11, 11:59 pm		

Climate Sensitivity



Analyzing the glacial–interglacial temperature and carbon cycles, we can estimate the strength of the carbon–climate feedback, which, in fact, corresponds to about an equilibrium 3° global increase in temperature for each doubling of CO_2, which is very much in line with estimates from other calculations.

Figure 11 and text on page 98

https://press.princeton.edu/books/paperback/9780691151960/climate-and-ecosystems

Adopted from Lecture 4, 13 Sept 2022

Scenario #1: Weak **Feedback** found *considering* aerosol radiative forcing in paleo data

Scenario #2: Strong **Feedback** found assuming *no* aerosol radiative forcing in paleo data

	Scenario #1 ΔF (W m $^{-2}$)	Scenario #2 ΔF (W m^{-2})
Doubled CO_2	3.7	3.7
Rise in GMST	1.8	2.8

CO_2 and Temperature

Do changes to temperature cause the changes in the carbon cycle, or vice versa? Very detailed analyses show that temperature changes before CO_2 and the other greenhouse gases affect it. This is just as expected, since the temperature changes are paced by changes to Earth's orbit. CO_2 produces about a third of the temperature change between the glacial and interglacial periods. The carbon cycle *reinforces and amplifies* the glacial–interglacial cycles; in other words, there is a feedback effect.

Schimel, pages 96 to 98 https://press.princeton.edu/books/paperback/9780691151960/climate-and-ecosystems

The precise timing of the rise and fall of temperature and CO_2 during Era 3 of Fig. 1.1 is a source of considerable dispute between the climate "believers" and "deniers". The initial, literal interpretation of the ice core record suggested that changes in temperature proceeded variations in CO_2 by about 800 years (Caillon et al. 2003). If so, the deniers argue, then CO_2 is responding to, rather than driving, global climate change. It is essential to appreciate that: the ice core record of CO_2 is discerned by measuring the composition of bubbles trapped in ice; historic temperature is quantified by measuring isotopic composition of the hydrogen and/or oxygen elements within the ice; and bubbles within the sampled ice cores move with respect to the surrounding ice over geologic time. A recent re-analysis of the timing of variations in temperature and CO_2 of an Antarctic ice core, which considers movement of bubbles with respect to the surrounding ice, reveals synchronous variation within the uncertainty of measurement (Parrenin et al. 2013). This interpretation supports the view that changes in atmospheric CO_2 did indeed drive glacial/interglacial transitions.

, *Paris Climate Agreement: Beacon of Hope* page 5 https://link.springer.com/content/pdf/10.1007/978-3-319-46939-3.pdf

Synchronous Change of Atmospheric CO_2 and Antarctic Temperature During the Last Deglacial Warming

F. Parrenin,[1]* V. Masson-Delmotte,[2] P. Köhler,[3] D. Raynaud,[1] D. Paillard,[2] J. Schwander,[4] C. Barbante,[5,6] A. Landais,[2] A. Wegner,[3]† J. Jouzel[2]

Understanding the role of atmospheric CO_2 during past climate changes requires clear knowledge of how it varies in time relative to temperature. Antarctic ice cores preserve highly resolved records of atmospheric CO_2 and Antarctic temperature for the past 800,000 years. Here we propose a revised relative age scale for the concentration of atmospheric CO_2 and Antarctic temperature for the last deglacial warming, using data from five Antarctic ice cores. We infer the phasing between CO_2 concentration and Antarctic temperature at four times when their trends change abruptly. We find no significant asynchrony between them, indicating that Antarctic temperature did not begin to rise hundreds of years before the concentration of atmospheric CO_2, as has been suggested by earlier studies.

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https://www.science.org/doi/10.1126/science.1226368

Trees and Climate

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June 11, 2019

Trees on the Move

One aspect of tree range shift that is both fascinating and troubling is that tree species in the same forests, even those that are deeply ecologically linked, are responding in different ways to climate change. American beech and hemlock, for example, are iconic species of old-growth forests east of the Mississippi. These trees colonized landscapes left bare 10,000 – 20,000 years ago as the Holocene ice sheets retreated with warming temperatures and have been linked for millennia.

Today, climate change is driving a wedge. Fei's study shows that, over the last three decades in the eastern U.S., hemlock have moved 13 kilometers north while beeches have roved nearly 12 kilometers west.

"It's sort of like an old family being broken apart," Fei said. Changes to tree ranges affect everything in an ecosystem, from the hair-thin strands of fungi that help feed tree roots to top predators.

https://www.americanforests.org/article/trees-on-the-move/
See also https://www.science.org/doi/full/10.1126/sciadv.1603055

The Forest Service Is Experimenting With Relocating Tree Species To Save Them From Climate Change

By Columbia Insight | September 15, 2022

What is assisted migration?

Assisted migration is the idea that because the climate is steadily warming, trees can—and, some argue, should—be moved from where they currently grow to where they are predicted to grow in the future.

This, the idea goes, will introduce trees better adapted to tolerate climate-induced warming and droughts.

While decades of research into assisted migration have provided proof of concept, these past experiments have tended to be small and far more controlled.

Unlike the neat, tightly packed rows of little trees grown in highly controlled conditions, Bower's seedlings are spaced 17 feet part in exactly the sort of chaos foresters face when replanting after a disturbance, such as a harvest or a wildfire. (Bower has another experimental site even further north, in the Okanogan-Wenatchee National Forest where he's planting ponderosa pines in a section of the forest that burned during the 2014 Carlton Complex fire.)

Testing in disorderly real-world conditions is the point.

Bower's experiment is one of the first of many planned in the coming years by the Forest Service to see if the agency can put years of scientific research into assisted migration into operational practice.

https://www.invw.org/2022/09/15/the-forest-service-is-experimenting-with-relocating-tree-species-to-save-them-from-climate-change/

Earth System Science

To understand how the global terrestrial biosphere functions, researchers have to understand atmospheric circulation, marine physics, and biogeochemistry and have hypotheses about the biology derived from the discipline of ecology. This grand unification of the environmental sciences is sometimes termed ***Earth System Science***, so named by Francis Bretherton from the National Center for Atmospheric Research (NCAR) in Boulder, Co. Many problems of ecosystems and climates can be understood only by taking this approach.

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https://link.springer.com/content/pdf/10.1007/978-3-319-46939-3.pdf