Harvard Human Evolutionary Biology, Fall 2023
Mondays, 9-11am, MCZ 541
Instructor: Daniel Green
Email: drgreen@fas.harvard.edu
Office Hours: Mondays 11am-noon or by appointment, Peabody 436

Welcome to HEB 1367, African Climate: Earth's history, humanity's future!

Anthropogenic climate change has exacerbated extreme weather, habitat loss, and human health challenges globally. The impacts of climate change are felt disproportionately in Africa, due to its tropical setting, and history of colonialism and development. In this class, weâ€™ll take a long view of climate in Africa, from the origin of the Earth, through the present, and into the future. First, weâ€™ll learn some of the physical principles that govern climate, and trace the broad arc of history of climate and life on the continent. Next, weâ€™ll focus on human history, learning about how climate changes influenced human origins and behavior, up until the present. Lastly, weâ€™ll learn about how climate is projected to change in the coming centuries, and how this will likely impact human health, political fortunes, and conservation.

The class will meet once per week, and will include a lecture, followed by seminar-style discussion. Students will have weekly readings from textbooks and/or scientific journal articles, and be assigned a limited number of problem sets. Students will be expected to give presentations on readings of their choice, and will develop a research project in the second half of the course. Some familiarity with evolutionary biology is advantageous but not required for enrollment.

Grading will be based on bullet points summarizing weekly readings or on related weekly assignments (20 %), participation in discussion (20 %), two student presentations (10 and 15 %), a paper draft (5-8 double-spaced pages, 10 %), and a final paper (10-15 double-spaced pages, 25 %).

Prior to class, unless otherwise noted, please upload or email me bullet points related to the reading. For each reading, write a 1-3 sentence comment or question related to the reading, in bullet point format. Your bullet point need not summarize the text, but ideally should reflect some aspect of the text that you found interesting and would like to discuss. I will not necessarily call on you in class and ask you to describe your comment or question, but I encourage you to speak up in class discussions when the time seems right.

Please note that as an academic, you will follow the Harvard honor code in your work, acknowledging the contributions, work, and publications of others to your scholarship. You may be permitted to use generative AI in some assignments, but must have instructor approval before doing so, and must acknowledge the contributions of AI in completed assignments.

Week 1, September 11: Introduction

This week, we'll introduce ourselves and review the general themes of the class. We'll read several publications prior to class, and discuss them together. Please don't forget to submit bullet points. Our readings are:

1. Wichura *et al.*, (2015) - the discovery of a long lost fossil dramatically alters our understanding of climate change in Africa's past.
2. Alley (2019) - recent research into a monumental climate shift 55 million years ago provides a warning of potential changes to come in Earth's present-day.
3. Thunberg speech - a political statement on our failure to curb global warming to date.
4. Shanguhyia (2023) - a review of how colonialism in Kenya impacted some aspects of the country's land use and ecology.
5. Atwoli *et al.*, (2023) - a comment by African editors in the medical journal the *Lancet* on the urgent need for action on climate change, and its impacts in Africa.

You may find that the most technically complicated reading is the first one. If you find yourself challenged when reading this or other papers, just do your best: we will discuss aspects of the paper including concepts that you found difficult during class discussion.

Next week, we will discuss the mechanisms of past, present, and future climate change. I will post the readings shortly.

Note: if you have not yet read Charles Darwin's *On the Origin of Species*, I recommend that you make an effort to read chapters 1-4 and chapter 14 within the next two weeks. You will not be graded on this

reading, but it will help you with class readings and discussions later this semester. If you have not read these chapters but plan to do so, please email me (drgreen@fas.harvard.edu), and we will find a time to meet and discuss them informally, either in person or over zoom. Later in the course, all students will be assigned chapters 9 & 10. You can access the first edition of Darwin's book here online for free; otherwise I recommend a perfect facsimile of that same edition as it originally appeared, now published by Harvard University Press.

Week 2, September 18: Anthropogenic Climate Change

For this week's class, we'll read three documents that explain certain fundamentals of anthropogenic global warming, and some of the apparent consequences for Earth's ecosystems. We'll return to some of these concepts throughout the semester.

Prior to class, please upload bullet points related to the reading. Our readings are found in the "files" section of the course, in the subfolder for week 2:

1. Archer Chapter 1 - This is from David Archer's book "Global Warming: Understanding the Forecast," which I highly recommend as an introduction to this topic.
2. Ruddiman Chapter 19 - This is from William Ruddiman's book "Earth's Climate Past and Future," and it reviews a variety of natural and human-made mechanisms of climate change on Earth.
3. Garcia *et al.*, (2014) - This paper investigates how climate change impacts ecosystems all over the Earth in different ways. What are some processes that seem unique to Africa? Or to other regions?

I've also included the most recent Intergovernmental Panel on Climate Change (IPCC) policy summary in the readings folder. This isn't required reading, but I recommend investigating it if you have time.

If you have trouble with some of the concepts discussed in these readings, don't worry: we will return to them repeatedly throughout the semester, and you'll have further opportunities to work with me and with students in developing your understanding of these topics.

Week 3, September 25: The Geological Record

This week, we'll learn some of the ways in which information about the history of life and climate on Earth are embedded into the geological record. For readings this week, please read:

1. Chapters 9 & 10 of Darwin's "On the Origin of Species." Recall that in chapters 1-4, Darwin discussed how variation is apportioned among living organisms, and how this variation interacts with the environment to produce evolution by natural selection. Specifically, Darwin had highlighted the difficulty of determining the differences between varying populations and true species. He had explained how populations may be distributed over wide or narrow areas, and how their ranges might be constrained either by natural boundaries or by competition. Lastly, he explained how heritable variation resulted in nonrandom differences in mortality and survivorship, resulting in changes in populations and ultimately species over time. In chapters 9 and 10, Darwin delves further into the spatial and temporal characteristics of evolutionary change, and how these processes can be understood if imperfectly recorded by the geological record.
2. Zachos *et al.*, (2001) - Here, Zachos describes some of the major temporal patterns governing climate over the last 65 million years (the Cenozoic). What are long term trends? Are there cyclical patterns? What about aberrations in ordinary processes?
3. Kappelman *et al.*, (2003) - Kappelman and colleagues attempt to understand the origin of modern African faunal diversity, after the collision of the African and Eurasian plates c. 20-30 million years ago.

Note that in addition to bullet points, you've been given a small group assignment to complete a series of tasks related to the calculation of planetary temperature in Python.

Week 4, October 2: Isotopes, Mesozoic & Cenozoic

This week we'll learn a little more about the Mesozoic of Africa, and about how isotopes inform us about paleoclimates. For readings this week, please read:

1. Griffin *et al.*, (2022) - An effort to test the hypothesis that dinosaur distributions on Earth were

constrained by climate, using some fossils in Zimbabwe. Note that this paper includes a detailed anatomical description of the fossils: this is the standard format that scientists use to report new species, whether living or extinct, all over the world. You can skim this section unless it is of special interest to you, but do at least try to understand how the authors use it to support their claims later in the paper. Further note that this paper also includes supplementary material. You are not required to read this but you may find it helpful at times as a reference.
2. Bowen (2010) - A review of some principles of stable light isotopes, and their utility in understanding climate and ecology. Please note that the paper includes an extended discussion of the mathematics of spatial correlation, and you can skim this section, as it is not useful for the course unless you'll make complex maps for your final project.

October 9: No class on Indigenous People's Day

Week 5, October 16: Carbon Isotopes and the Miocene Transition

For class this week, we'll read about new research into the Cenozoic, and its latter part the Miocene period in Africa. In class, we'll discuss how climatic and environmental processes in Africa interacted with primate evolution, paving the way for our earliest ancestors. Our readings will be:

1. Stromberg and Staver (2022) - Grassy biomes in the past, present and future.
2. Munday *et al.*, (2023) - Deployment of a climate model to test what shapes climate patterns in the East African Rift System.
3. Peppe *et al.,* (2023) - A new paper that shakes the foundation of climatic theories of human origins.

Week 6, October 23: Savannahs and the Hominin Radiation

This week we'll review the classical climatic and ecological theories of human origins, and learn about the dramatic debates that surround them. Our readings are:

1. Cerling *et al.*, (2012) - How do we construct and test a model of woody and savanna biomes associated with human origins using geochemical data?
2. WoldeGabriel *et al.*, (2009) - A paper that partially challenged a dominant environmental theory of human origins.
3. Dominguez-Rodrigo (2014) - A review of the savanna hypothesis and controversies surrounding it.

Week 7, October 30: Fire and Ice

- This week will include student journal club: group presentations on student scientific journal articles of interest.

This week we'll discuss glaciation and fire dynamics in the Pleistocene, with some consideration of how past dynamics can help us anticipate future trends. Our readings are:

1. Archer Chapter 5 - An overview of glacial cycles.
2. Black *et al.*, (2015) - How likely is it that volcanic eruptions caused Neanderthals to go extinct?
3. Karp *et al.*, (2023) - What causes fires to proliferate across Africa (and the world)?

For student journal club, students will sort into groups of three and will choose a paper to present on together on October 30th:

- Each group should prepare a single powerpoint document and email it to me by Sunday, November 29th at 10pm.
- The presentation should be 7-8 minutes long, with time for two minutes of questions from the audience.
- Each of all three students in the group should present at least one slide, or somehow be involved in the presentation.
- The group is not required to choose one of the recommended papers, and can choose a different paper if they like.
- If someone in the group is very, very interested in presenting on a separate paper, please email me.

It's OK if the group ends up presenting on two different papers, but the group should still aim to give a presentation that is cohesive.

Week 8, November 6: Climate and Civilization

- Student rough draft papers or extended outlines are due. These should be 5â€“8 pages, doubled spaced, not including the reference list.
  - Please email me to discuss your proposed paper topic. You do not need to focus on paleoclimate, and can instead choose a topic related to contemporary or future climate change. Health, economics, agriculture, and resilience are examples of broad topics you may explore in your paper. Your paper should relate to Africa and to climate in some way. If you decide that you'd like to change the focus of your final paper after submitting your rough draft, that is OK.
  - One potential structure for your paper is to use a format used in many scientific journals: abstract, introduction, methods, results, discussion and conclusion. You need not adopt this format if you have your own creative ideas about paper structure.
  - For your paper, consider making use of one or multiple figures. This is not a requirement for your rough draft due this week but will be a requirement for your final draft due at the end of the semester. If you are taking or adapting a figure from another publication that you have not made yourself, be sure to credit that publication. Try not to have your figure occupy more than 1/2 of the page. Remember that figures need figure legends.
- Readings for this week are:
  1. Kuper and KrÃ¶pelin, 2006 - Human occupation of the Green Sahara
  2. Willis and Brncic, 2004 - On altered and unaltered forests globally
  3. Oslisly et al., 2013 - Climate and culture in the Congo over 5,000 years.

Week 9, November 13: Colonial History

- This week, we'll have a short lecture reviewing more recent climate history, and then will dive into readings. This week we'll read and discuss:
  1. Pailey, 2013 - A review of Firestone's social and environmental legacy in Liberia. At the end of class, we'll walk down to the Museum of Comparative Zoology's skeletal collections, where we'll see Harvard specimens collected from Firestone plantations in the 1920s.
  2. Lyons and Westoby, 2014 - An exploration of facets of carbon trade and forestry practices in Uganda.
  3. OPTIONAL - Chritz et al., 2016 - Impact of poaching and social unrest on Ugandan fauna, viewed through stable isotope investigations.

Week 10, November 20: Climate Future: Projections and Prospects

- This week will include student journal club: group presentations on student scientific journal articles of interest. Please prepare a 15-minute presentation delivered by your whole group. Make sure everyone in the group has a chance to present at least some part of the presentation. You will be timed, so please practice to be sure you don't go over time. At the end of your presentation, we will have 5 minutes of Q&A.
  - In addition to the paper on which your group is presenting, please also read **one** of the two other papers chosen by the other groups, and write 1-2 bullet points on that paper. You do not need to prepare bullet points for the paper you're presenting:
  - Rogelj et al., 2016
  - Hsiang et al., 2013
  - Myers et al., 2017

Week 11, November 27: Climate Future: Policies

- This week, we'll have two short lectures, and then will discuss these readings:
  1. Armstrong McKay et al., 2022 - A paper on thresholds in Earth's climate.
  2. Chapter 1 from Richard Rhodes' "The Making of the Atomic Bomb."

Week 12, December 4: Student Presentations

- This week will include student lightning talks of their final research projects.
- Final papers will be due December 8.