THE OHIO STATE UNIVERSITY

College of Arts and Sciences
Department of Geography and School of Earth Sciences

SYLLABUS
GEOG/EARTHSC 4911

Earth's climate: Past and Future
Spring 2023 –Course # 4911

COURSE OVERVIEW

Course information

- Class lecture periods: Tuesdays and Thursdays 12:45-2:05pm.
- Credit hours: 3
- Prerequisites: either EARTHSC/HIST/EEOB 1911 or GEOG 3900/3901H
- Mode of delivery: in person

Instructors

Instructors:

Dr. Bryan G. Mark (address as Professor Mark)

- Email address: mark.9@osu.edu
- Phone number: 614-247-6180
- Office hours: T/R 11 a.m. -12 p.m. on zoom or by appointment

Dr. Matthew R. Saltzman

- Email address: saltzman.11@osu.edu
- Phone number: 614-292-0481
- Office hours: T/R 10 a.m. -11 a.m. on zoom or by appointment

GE Category Description & Goals

This class will examine Earth's climate and its natural development as understood from the geologic record spanning the full history of the planet, as well as how the future climate is likely to evolve under ongoing human modifications.

New **GE Theme Goals & ELOs**

This course may fulfill the following GE Theme:

Sustainability: GE Goal and Expected Learning Outcomes for Sustainability Theme courses:

GOALS: Successful Students will (1) analyze sustainability at a more advanced and in-depth level than in the foundations; (2) integrate approaches to sustainability by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or work they have done in previous classes and that they anticipate doing in the future; and (3) (specific to *Sustainability Theme*) analyze and explain how social and natural systems function, interact, and evolve over time; how human wellbeing depends on these interactions; how actions have impacts on subsequent generations and societies globally; and how human values, behaviors, and institutions impact multi-faceted, potential solutions across time.

EXPECTED LEARNING OUTCOMES: Successful students are able to: (1.1) engage in critical and logical thinking about sustainability; (1.2) engage in advanced, in-depth, scholarly exploration of sustainability; (2.1) Identify, describe and synthesize approaches or experiences as they apply to sustainability; (2.2) Demonstrate a developing sense of self as a learner through reflection, self-assessment and creative work, building on prior experiences to respond to new and challenging contexts; (3.1) (specific to *Sustainability Theme*) describe elements of the fundamental dependence of humans on Earth and environmental systems and on the resilience of these systems; (3.2) describe, analyze and critique the roles and impacts of human activity and technology on both human society and the natural world, in the past, currently, and in the future, and (3.3) devise informed and meaningful responses to problems and arguments in the area of sustainability based on the interpretation of appropriate evidence and an explicit statement of values.

This course fulfills the learning outcomes for the Sustainability Theme by:

Providing a context to distinguish the natural Earth climate system as an integrated system of energy and biogeochemistry that humans can and do alter on different scales. At the end of this course, students should successfully be able to:

- Draw upon fundamental Earth system science concepts to describe how the evolution of earth's climate system relates to the evolution of planet/solar system. *To address ELO 3.1 students will develop an advanced understanding of how chemical elements*

like carbon originate and are distributed throughout our planetary system, giving perspective on how they are essential for sustaining life, and are impacted by human activity.

- Apply the scientific method to evaluate how plate tectonics influences the long-term carbon cycle. *To address ELO 3.2 students will learn that volcanic activity emits carbon dioxide at a rate that is more than a factor of 10 less than humans, and therefore only human activity can explain the growth of carbon dioxide in Earth's atmosphere in the past century.*
- Recall the fundamental radiation laws and apply them to the history of Earth's atmosphere to explain relative intensity of the greenhouse effect. *By connecting the composition of Earth's atmosphere to radiative balance, students will conceptually link fundamental physics to the resilience of the Earth system, as moderated by humans. Emissions of greenhouse gases generated through human activity cause more energy to be retained, impacting sustainability now and into the future; technology could be applied to cool by radiation modification or carbon dioxide sequestration (ELOs 3.1, 3.2)*.
- Quantitatively describe the interactions of the short-term carbon cycle and anthropogenic sources of greenhouse gases.
- Critically evaluate the methods and limitations of using proxies to understand past climates over different spans of time.
- Students will be able to recognize spatial and temporal variations in climate patterns
- Students will develop practical experience analyzing paleoclimate data time series. *To address ELO 3.3 students will devise informed and meaningful responses to problems and arguments in the area of sustainability by visually examining the carbon dioxide levels on Earth that occurred naturally in the past 800,000 years, which clearly delineates a period of perturbed and unabated increase in CO2 that can be contrasted with the natural variability which was far less than current levels.*

HOW THIS COURSE WORKS

Class Format: This course will be delivered ***in-person***, with all course materials accessible from OSU's **Carmen Canvas** interface.

Credit hours and work expectations: This is a **3-credit-hour course**. According to Ohio State policy, students should expect around 3 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 6 hours of homework (reading and assignment preparation, for example) to receive a passing grade.

Attendance and participation requirements: Student attendance and participation will be tracked by use of TopHat, as well as completion of feedback and entrance/exit surveys. Students are expected therefore to be attentive regularly to the class Carmen page.

- **TopHat: RANDOM DURING LECTURES.** Regular assessment of understanding and participation will be evaluated and recorded via TopHat during lectures. We will count full credit for participating, but award additional extra credit for correct responses.
- **Group activities: PERIODIC.** There will be in-class activities that will require active participation and a single group grade. The final project grade will be modified to reflect individual participation effort, but active involvement is expected from all students.

COURSE MATERIALS

Textbook

We will use a **primary textbook** for the class. Required weekly readings will help organize our inquiry into global climate change AND provide good reference to basic principles. Any edition is sufficient. It can be purchased through the OSU Bookstore.

1. **Ruddiman, W.F., *Earth's Climate: Past and Future.*** There are 3 versions of the book, and any version can be used. The latest version will be available at the OSU Book Store, with ISBN: 9781429255257

Other readings, media:

As relevant, we may introduce other readings from news and scientific journals, as well as mixed media (video, podcasts). These will all be provided as pdfs or URL links via Assignments in Carmen and linked to the weekly modules. As this is a rapidly developing field, these readings may change from semester to semester.

1. Intergovernmental Panel on Climate Change, Assessment Report #6, Ch 2 Changing State of Climate System, Gulev, S.K., P.W. Thorne, J. Ahn, et al., 2021: Changing State of the Climate System. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 287–422, doi:10.1017/9781009157896.004.
https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

CARMEN ACCESS

You will need to use BuckeyePass multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you take the following steps:

- Register multiple devices in case something happens to your primary device. Visit the BuckeyePass - Adding a Device help article for step-by-step instructions.

- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.
- Download the Duo Mobile application to all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357 (HELP) and IT support staff will work out a solution with you.

GRADING AND FACULTY RESPONSE

How your grade is calculated (% breakdown)

ASSIGNMENT CATEGORY	% POINTS
TopHat (quizzes)	15
Climate connections (2 during semester)	10
Team Projects (abstract and presentation)	25
Midterm exam	25
Final exam	25
Total	**100**

Assignment descriptions:

Top Hat and Quizzes: At least one quiz will be given per lecture, based on material presented in lectures, readings, videos and other online material from the respective module. Note that some material from previous modules may also be on quizzes. Students will receive points for both participation (0.5 points/question) and correct answers (0.5 points/question) for a total possible of 1 point per question.

Climate connections (2): Students will be required to find relevant articles published in main-stream news media and write a 1-page synthesis describing how the story relates to any topic discussed in class, and how paleoclimate approaches, data and/or methods are used. These

short essays will include properly cited references to scholarly literature. For example, daily news articles are readily accessible through the New York Times climate portal and serves as a reputable source of news and information https://www.nytimes.com/section/climate. Two submissions are required and can be submitted any time before the last week of lectures. Submission is electronic and uploaded via Carmen.

Team project: The final project will include a group presentation. The groups will be assigned early in the class, and students will be interacting throughout the semester to select a topic and complete a multi-media presentation.

Description of Team Project Assignment

During 4th week, we will split up into groups of 3-4 students. Each group will need to decide on a class-related topic that interests them, on which they will give a 20 minute presentation during the last 2 classes of the semester. Once you decide on something (I would recommend choosing about ½ way through the semester), let us know what it is. The assignment will be to follow the development of thinking on the topic through the literature, describing the evolution of the idea. This will involve making liberal use of ISI or GEOREF searches: each pointade in the presentation needs to be backed up by a peer-reviewed citation. The project includes the following deliverables:

• Topic and science question: 8th week. Science questions need to address a single, specific question related to the course material. Calculations are not required, but literature must be consulted in formulating the question.

• Abstract: 11th week. A paragraph elaborating the science question, and describing the main conclusions needs to be emailed to both instructors. Thus, the conclusions of the project should be mostly finalized by this time.

• Presentations: last week. The science question, analysis of the literature, and conclusions should be clearly presented. Examples related to the question and your answers need to be presented. For the presentation, Powerpoints are encouraged, but only to show figures – no written words are allowed on slides (besides references or figure labels). This helps you learn what you are talking about; otherwise, it's easy to just recite words pulled from a paper. Each group member will need to contribute to equally to the presentation.

Exams: There will be a midterm and a final consisting of multiple choice and short answer essay questions. Some quantitative questions will require algebra and students will be able to show their work on these calculations. No calculus is required.

Late assignments

Please refer to Carmen for due dates. Generally, modules will be completed by midnight on Monday night before new modules begin on Tuesdays (first class session of each week). Late assignments will be penalized by 10% per day late, and only accepted up to a maximum of 4 days late. If students anticipate having conflicts they are expected to discuss with instructors ahead of time.

Grading scale

93–100: A
90–92.9: A-
87–89.9: B+
83–86.9: B
80–82.9: B-
77–79.9: C+
73–76.9: C
70 –72.9: C-
67 –69.9: D+
60 –66.9: D
Below 60: E

Instructor feedback and response time

We provide the following list to give you an idea of our intended availability throughout the course. (Remember that you can call **614-688-HELP** at any time if you have a technical problem.)

- **Grading and feedback:** For regular assignments, you can generally expect feedback within 10 days. Some exercises and papers will take longer to grade.
- **Email:** We will generally reply to emails and Carmen messages within **24 hours on days when class is in session at the university**. Please add "G3900" to the subject in your email to identify yourself; we teach multiple classes.
- **Discussion board:** We will check and reply to messages in the Carmen discussion boards regularly.

OTHER COURSE POLICIES

Academic integrity policy

POLICIES FOR THIS COURSE

- **Quizzes and exams**: You must complete the TopHat quizzes and the exams by yourself, without external help or communication from the internet or other people.
- **Written assignments**: Your written assignments should be your own original work. In formal assignments, you should follow a consistent citation style (e.g. MLA, APA, or

AGU) to cite the ideas and words of your research sources. You are encouraged to ask a trusted person to proofread your assignments before you turn them in—but no one else should revise or rewrite your work.

- **Reusing past work**: In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the situation with us.
- **Falsifying research or results**: All research you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.
- **Collaboration and informal peer-review**: The course includes opportunities for formal collaboration with your classmates. While study groups and peer-review of major written projects is encouraged, remember that comparing answers on a quiz or assignment is not permitted. If you're unsure about a particular situation, please feel free just to ask ahead of time.
- **Group projects**: This course includes group projects, which can be stressful for students when it comes to dividing work, taking credit, and receiving grades and feedback. We have attempted to make the guidelines for group work as clear as possible for each activity and assignment, but please let us know if you have any questions.

OHIO STATE'S ACADEMIC INTEGRITY POLICY

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's *Code of Student Conduct*, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If we suspect that a student has committed academic misconduct in this course, we are obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's *Code of Student*

Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact us.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- The Committee on Academic Misconduct web pages (COAM Home)
- *Ten Suggestions for Preserving Academic Integrity (Ten Suggestions)*
- *Eight Cardinal Rules of Academic Integrity* (www.northwestern.edu/uacc/8cards.htm)

Copyright disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on Title IX

All students and employees at Ohio State have the right to work and learn in an environment free from harassment and discrimination based on sex or gender, and the university can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.

If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin and disability. For more information on OIE, visit equity.osu.edu or email equity@osu.edu.

Your mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily

activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you find yourself feeling isolated, anxious or overwhelmed, please know that there are resources to help: ccs.osu.edu. You can reach an on-call counselor when CCS is closed at (614) 292-5766 and 24 hour emergency help is also available through the 24/7 National Prevention Hotline at 1-(800)-273-TALK or at suicidepreventionlifeline.org. The Ohio State Wellness app is also a great resource available at go.osu.edu/wellnessapp.

COURSE SCHEDULE

See separate document that will be updated regularly on Carmen and labeled with current version date. Class content is subject to change, so students should download most current version. Changes will also be communicated using Announcements on Carmen.

ACCESSIBILITY ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Requesting accommodations

The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let us know immediately so that we can privately discuss options. To establish reasonable accommodations, we may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. **SLDS contact information:** slds@osu.edu; 614-292-3307; 098 Baker Hall, 113 W. 12th Avenue.

WEEKLY SCHEDULE

Class Topics, Required Readings, and Exercises

*Note: These topics and readings are *subject to change*! Students will be advised of updates to the schedule on Carmen, and should follow the version with most current date. R = Ruddiman; IPCC = IPCC Changing State of Climate System (Ch2)

Wk	Module-Part	Lecture topic	Date	Final project	Instructor	Text chapter
1	**Part I** Framework of Climate Science	1. Overview of climate science	T 1/12		Both	R1 (3-18)
		2. Earth's Climate System Today	R 1/14		Bryan	R2 (19-54); IPCC (287-295)
2		3. Climate Archives, Data, and Models (1)	T 1/19		Bryan	R3 (55-68); IPCC (296-317)
		4. Climate Archives, Data, and Models (2)	R 1/21		Matt	R3 (68-80)
3	**Part II** Tectonic-Scale Climate Change	5. CO2 and Long-Term Climate	T 1/26		Matt	R4 (81-96)
		6. Plate Tectonics and Long-Term Climate (1)	R 1/28		Matt	R5 (97-107)
4		7. Plate Tectonics and Long-Term Climate	T 2/02		Matt	R5 (108-120)
		8. Greenhouse climate	R 2/04	Groups assigned	Matt	R6 (121-136)
5		9. From Greenhouse to Icehouse: The Last 50 Million Years (1)	T 2/09		Matt	R7 (137-142); IPCC (318-369)
		10. From Greenhouse to Icehouse: The Last 50 Million Years (2)	R 2/11		Matt	R7 (143-155); IPCC (370-376)
6	**Part III** Orbital-Scale Climate Change	11. Astronomical Control of Solar Radiation (1)	T 2/16		Matt	R8 (156-164)
		12. Astronomical Control of Solar Radiation (2)	R 2/18		Matt	R8 (165-176)
7		13. Insolation Control of Monsoons	T 2/23		Bryan	R9 (177-194)
		14. Insolation Control of Ice Sheets	R 2/25		Bryan	R10 (195-214)
8		15. Orbital-Scale Changes in Carbon Dioxide and Methane (1)	T 3/02		Matt	R11 (215-220)
		16. Orbital-Scale Changes in Carbon Dioxide and Methane (2)	R 3/04	Topic and Science questions due	Matt	R11 (221-232)

9		17. Orbital-Scale Interactions, Feedbacks, and Unsolved Mysteries	T 3/09		Bryan	R12 (233-250)
		MIDTERM EXAM	R 3/11			
10	**SPRING BREAK**		T 3/16			
			R 3/18			
11	**Part IV** Glacial/Deglacial Climate Change	19. The Last Glacial Maximum	T 3/23		Bryan	R13 (251-272)
		20. Climate During and Since the Last Deglaciation	R 3/25	Abstract due	Bryan	R14 (273-294)
12		21. Millennial Oscillations of Climate	T 3/30		Bryan	R15 (295-314)
	Part V Historical and Future Climate Change	22. Humans and Preindustrial Climate	R 4/01		Bryan	R16 (315-334)
13		23. Climate Changes During the Last 1,000 Years	T 4/06		Bryan	R17 (335-356)
		24. Climatic Changes Since 1850	R 4/08		Matt	R18 (357-374)
14		25. Causes of Warming over the Last 125 Years	T 4/13		Matt	R19 (375-392)
		26. Future Climatic Change	R 4/15		Bryan	R20 (393-409)
15		Group presentations	T 4/20	Final project due		
			R 4/22			
Final Exam			R 4/29			

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