## Term Information

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|---|---|
| **Effective Term** | Autumn 2024 |

## General Information

| | |
|---|---|
| **Course Bulletin Listing/Subject Area** | Geography |
| **Fiscal Unit/Academic Org** | Geography - D0733 |
| **College/Academic Group** | Arts and Sciences |
| **Level/Career** | Undergraduate |
| **Course Number/Catalog** | 3900.02 |
| **Course Title** | Global Climate Change: Causes & Consequences |
| **Transcript Abbreviation** | Global Climate Chg |
| **Course Description** | An advanced overview of causes and consequences of Earth's changing climate. It engages the fundamentals of climate dynamics and broader political, economic and legal dimensions. Student research investigates the nature and extent of a particular climate change consequence for society and critically evaluates strategies for mitigation and adaptation. |
| **Semester Credit Hours/Units** | Fixed: 4 |

## Offering Information

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|---|---|
| **Length Of Course** | 14 Week, 12 Week |
| **Flexibly Scheduled Course** | Never |
| **Does any section of this course have a distance education component?** | No |
| **Grading Basis** | Letter Grade |
| **Repeatable** | No |
| **Course Components** | Lecture, Recitation |
| **Grade Roster Component** | Lecture |
| **Credit Available by Exam** | No |
| **Admission Condition Course** | No |
| **Off Campus** | Never |
| **Campus of Offering** | Columbus, Lima, Mansfield, Marion, Newark, Wooster |

## Prerequisites and Exclusions

| | |
|---|---|
| **Prerequisites/Corequisites** | |
| **Exclusions** | Not open to students with credit for 3900, 3900.01, 3901H |
| **Electronically Enforced** | No |

## Cross-Listings

**Cross-Listings**

## Subject/CIP Code

| | |
|---|---|
| **Subject/CIP Code** | 40.0401 |
| **Subsidy Level** | Baccalaureate Course |
| **Intended Rank** | Freshman, Sophomore, Junior, Senior |

## Requirement/Elective Designation

Sustainability

The course is an elective (for this or other units) or is a service course for other units

## Course Details

**Course goals or learning objectives/outcomes**

- Articulate the scientific basis for, and consequences of, natural and human-produced climate change.
- Describe how Earth's climate has changed over time, and how scientists have developed this knowledge.
- Demonstrate literacy with concepts of energy and carbon cycling, including dimensional analyses, unit conversion, and usage in real-world case studies.
- Propose compelling strategies to mitigate or adapt to climate change that critically acknowledge implications for different stakeholders and integrate quantitative reasoning.

**Content Topic List**

- Global Warming
- Hydrologic and Carbon Cycles
- Understanding Past Climates
- Orbital Climate Change
- Human History and Climate
- Abrupt Climate Events
- Internal Modes of Climate Variability
- Projected Climate Change

**Sought Concurrence**

No

## Attachments

- 3900.02 Sustainability Proposal.pdf: 3900.02 GE Proposal

  *(GEC Model Curriculum Compliance Stmt. Owner: Godfrey,Ryan B)*
- 3900.02 Research Proposal.pdf: 3900.02 Research Proposal

  *(Other Supporting Documentation. Owner: Godfrey,Ryan B)*
- 3900.02 CCCAP Project & Recitation Description.pdf: 3900.02 Project and Recitation Description

  *(Other Supporting Documentation. Owner: Godfrey,Ryan B)*
- 3900.02 Syllabus.pdf: Syllabus

  *(Syllabus. Owner: Godfrey,Ryan B)*
- Cover letter for GEOG 3900 Submission.pdf: Cover Letter

  *(Cover Letter. Owner: Godfrey,Ryan B)*
- Draft Course Descriptions.pdf: Course Descriptions

  *(Other Supporting Documentation. Owner: Godfrey,Ryan B)*
- 3900.02 Syllabus-rev14Nov23.docx: 3900.02 Syllabus Revision

  *(Syllabus. Owner: Godfrey,Ryan B)*

## Comments

- Based on the subcommittee's revision request, the Department of Geography has made revisions for GEOG 3900.02 on all contingencies and recommendations presented from review. See the uploaded revised syllabus which now includes the correct religious accommodation statement to resolve the contingency required by the subcommittee for approval. See the uploaded revised syllabus now reflecting the 2023-24 updated Student Life-Disability Services and Mental Health statements to incorporate the subcommittee's recommendation. Course Faculty adopted the recommendation to integrate connection to climate change in the first-class session in the revised syllabus. This is now reinforced with introductory readings listed in the first week from the newly released 5th National Climate Assessment Report. *(by Godfrey,Ryan B on 11/15/2023 07:41 PM)*
- Please see Subcommittee feedback email sent 11/03/2023. *(by Hilty,Michael on 11/03/2023 04:32 PM)*

## Workflow Information

| Status | User(s) | Date/Time | Step |
|---|---|---|---|
| Submitted | Godfrey,Ryan B | 09/13/2023 09:28 AM | Submitted for Approval |
| Approved | Coleman,Mathew Charles | 09/13/2023 09:29 AM | Unit Approval |
| Approved | Vankeerbergen,Bernadette Chantal | 10/05/2023 04:11 PM | College Approval |
| Revision Requested | Hilty,Michael | 11/03/2023 04:32 PM | ASCCAO Approval |
| Submitted | Godfrey,Ryan B | 11/15/2023 07:42 PM | Submitted for Approval |
| Approved | Coleman,Mathew Charles | 11/16/2023 09:27 AM | Unit Approval |
| Approved | Vankeerbergen,Bernadette Chantal | 11/16/2023 10:26 AM | College Approval |
| Pending Approval | Jenkins,Mary Ellen Bigler<br>Hanlin,Deborah Kay<br>Hilty,Michael<br>Neff,Jennifer<br>Vankeerbergen,Bernadette Chantal<br>Steele,Rachel Lea | 11/16/2023 10:26 AM | ASCCAO Approval |

# SYLLABUS
# GEOG 3900.02

Global Climate Change: Researching Causes & Consequences
Spring 2024 – Course # XXXXX

## COURSE OVERVIEW

### Course information

- Class lecture periods: Tuesday, Thursday, 9:35 - 10:55 a.m. + weekly 55 minute section
- Credit hours: 4
- Prerequisites: None
- Mode of delivery: In Person

### Instructors

Instructor: 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

Graduate Teaching Assistant: TBD

- Email: TBD.X@buckeyemail.osu.edu
- Office hours: by appointment

### Course description

GEOG 3900.02 is a **research intensive** version of this science class open to all majors that will develop an advanced understanding of how Earth's climate functions and changes over different time scales both naturally and as a result of human activity. The climate system is vitally connected to **sustainability**. Students will critically examine the key evidence of how

climate is changing, gain experience with real climate data, and learn directly from climate researchers how they conduct their science. We will explore the diverse consequences and implications of our presently altered climate and how it will likely continue to change into the future. By the end of this class, students will be able to describe the fundamental processes of Earth's climate and the carbon cycle, be familiar with energy units used in everyday life, appreciate broader economic, policy and legal dimensions of climate change, and have experience identifying creative solutions.

There are ***no prerequisites*** for the class. We will use basic arithmetic and some algebra, but no calculus.

## Goals and Expected Learning Outcomes (ELOs)

This course is part of the **Sustainability theme** in the University's **General Education** (GE) program. In addition, this is a **Research & Creative Inquiry** course, meaning that students can take this course to fulfill the entire Sustainability theme requirement.

This is a sustainability GE course because to understand climate change requires analyzing and explaining how the natural climate system is now fundamentally connected to our social and economic systems. ***Ultimately, human caused climate change amplifies the sustainability challenges our society faces.*** Yet because humans have agency in causing changes, we also have power to enact solutions. Therefore, students will link climate change and society's energy demands, sources and usage. They will research and work collaboratively to generate a scale-specific strategy to address climate change with practical actions or policies.

### Course-based Goals

1. Students can articulate the scientific basis for, and consequences of, natural and human-produced climate change.
2. Students can describe how Earth's climate has changed over time, and how scientists have developed this knowledge.
3. Students can demonstrate literacy with concepts of energy and carbon cycling, including dimensional analyses, unit conversion, and usage in real-world case studies.
4. Students can propose compelling strategies to mitigate or adapt to climate change that critically acknowledge implications for different stakeholders and integrate quantitative reasoning.

### GE Goals & ELOs for all themes:

Goal 1: Successful students will analyze an important topic or idea at a more advanced and in-depth level than the foundations.

ELO 1.1 Engage in critical and logical thinking about the topic or idea of the theme.

ELO 1.2 Engage in advanced, in-depth, scholarly exploration of the topic or idea of the theme.

Goal 2: Successful students will integrate approaches to the theme by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.

ELO 2.1 Identify, describe and synthesize approaches or experiences as they apply to the theme.

ELO 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.

## Sustainability Goals & ELOs:

Goal 3: 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.

ELO 3.1: Describe elements of the fundamental dependence of humans on Earth and environmental systems and on the resilience of these systems.

ELO 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.

ELO 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.

## How does this course address these goals & ELOs?

***GE Goals 1 & 2:*** Climate change implicitly engages students in critical and logical thinking about sustainability because of the coupled ways in which society relies on climate, but also impacts climate. Open to the full diversity of OSU undergraduate students, the class assumes no pre-requisite knowledge, but does encourage self-assessment of developing new understanding.

- Students will critically engage the hypothesis that human activities are altering the balance of radiative energy flows between the sun and Earth by altering the chemistry of the atmosphere, but also reflect on the consequences and implications to future generations (see modules 1, 2).
- Students are challenged to go beyond mere descriptions of the greenhouse effect to derive a model from fundamental laws of radiation physics, and then critically examine observational data showing evidence of diverse effects to test if hypothesized forcings explain the evidence (see modules 3, 4, 5). Students will also access and cite peer-reviewed science literature about paleoclimatology (proxy short paper assignment) and to substantiate their ideas for a final scale-specific solution to human caused climate change (final research project).
- Students engage in a combination of informed peer-group discussions and word problems as exercises on a weekly basis (see weekly modules) that provide opportunities to articulate connections to their broader academic knowledge and life experiences.
- by including an entrance and exit survey to assess knowledge and reflect on level of concern for issues, and compute and reflect on a personal “carbon footprint” calculations. Students engage in a number of interactive exercises culminating in a final project that will allow them to draw upon prior experiences to respond to new challenges.

***Sustainability Goal 3:*** Students will develop an advanced understanding of how social and physical systems are coupled in driving the climate, linking energy to carbon and water cycles. While essential for sustaining life, these are all impacted by human activity, and contribute to drive climate feedbacks.

- 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 through energy conversion (fossil fuel combustion).
- Students will learn how human energy conversion technology has changed over time, resulting in an intensification of carbon dioxide emissions that is on the order of 10x more than natural fluxes (e.g. from volcanoes), causing climate alterations, impacting sustainability now and into the future. Students will study in detail how ideas and technology progressed to solve the problem of ice ages (module 9). Yet human activity also holds potential solutions; students critically evaluate alternative energy technologies, and even geoengineering solutions to cool global warming by radiation modification or carbon dioxide sequestration (modules 14, 15).

- Students will complete a final project involving identifying and formulating a “Scale-specific strategy” to address climate change in a particular context and present a compelling and quantitatively justified case. They will also conduct a formal evaluation of both their own and other group efforts.

## Dimensions of Sustainability

Climate change touches on multiple dimensions of sustainability as defined at OSU: human and natural systems; earth and environmental systems; economy and governance; society and culture; engineering, technology and design; and health and well-being. We will focus primarily on the following four in this course:

- ***Human and natural systems*** are central ideas to the entire course, as we the processes and evidence for how human systems are capable of impacting climate change.
- ***Earth and environmental systems*** are given central focus as students learn fundamentals of how the atmosphere of Earth contains carbon and functions to alter flows of radiation that drives all climate. Properly assessing the causes and consequences of human impacts to climate is premised on understanding how the earth environmental system works.
- ***Economy and governance*** are addressed with guest faculty experts on the economics of climate change and climate change law. Students appreciate that impacts of climate change are not equal, and how more affluent lifestyles cause more warming, while those who suffer most are often the poorest. They will also critically evaluate the costs and benefits of certain strategies to address climate change.
- ***Engineering, technology, and design*** are central to the ways we convert energy to drive economies, and these concepts are likewise important as students critically evaluate all solutions to climate change.

## Research-based objectives and expectations:

1. ***Performance expectations set at appropriately high levels (e.g. students investigate their own questions or develop their own creative projects).***

Students will undertake both a final group “Scale-specific strategy” (S-cubed) project and video presentation requiring them to conceptualize and research a strategy to address climate change, and an individual climate change consequence analysis paper (CCCAP). These projects will require students to identify their own problems and solutions, using critical thinking to frame appropriate and compelling ideas around specific factors related to the particular scale they identify.

2. ***Significant investment of time and effort by students over an extended period of time (e.g., scaffolded scientific or creative processes building across the term, including, e.g., reviewing literature, developing methods, collecting data, interpreting or developing a concept or idea into a full-fledged production or artistic work).***

The course requires an additional 45 hours of research-oriented work from students over the semester. This includes one 55-minute recitation with instructional in-class workshops and two hours per week of out-of-class assignments and activities. This work and additional instructor contact time will provide the scaffolding for the final group research paper. There are multiple scaffolding components that students will engage in to complete the project and acquire the necessary skills to conduct the research and writing.

3. ***Interactions with faculty and peers about substantive matters including regular, meaningful faculty mentoring and peer support.***

Central to the course is working collaboratively to create scale-based solutions to climate change. Working with faculty and peers is a crucial part of understanding the impacts of, and solutions to, climate change. Starting in module 1, the recitation will be established as a forum for students to position themselves as independent learners within a community of creative inquirers.

4. ***Students will get frequent, timely, and constructive feedback on their work, iteratively scaffolding research or creative skills in curriculum to build over time.***

To provide practice with quantitative reasoning, exercises (homework) will expose students to dimensional analysis, energy units/conversion, and actual data on rate usage to scale. These will all get graded and allow students to get feedback. Office hour tutorials are also promoted, additional practice problems and answer keys, and asynchronous videos showing solutions step by step. Similarly, the CCCAP paper drafts and precis also include an annotated bibliography requiring students to not only properly locate peer-reviewed (and other) sources but express how they intend to use the source in their respective research papers. This critical thinking will be important to doing well, and this will permit prof/GTA to give valuable feedback and make corrections.

5. ***Periodic, structured opportunities to reflect and integrate learning in which students interpret findings or reflect on creative work.***

Starting with instruction in module 5, students will engage in reflective integration and review at different stages of their research and writing. They will reflect and respond to feedback with subsequent drafts of papers and the final presentation. In addition, recitations in modules 10 and 12 will focus on communication of research findings to different audiences, and in particular to share with policy makers. This requires meaningful reflection and integrated

syntheses. In modules 13 and 15, students will think about and practice responding to peer-reviewed criticisms about their research, which is an important process of integration and reflection in science. Students will conduct peer-reviews and responses in composing multiple drafts of their final research papers.

6. ***Opportunities to discover relevance of learning through real-world applications (e.g., mechanism for allowing students to see their focused research question or creative project as part of a larger conceptual framework).***

The purpose of the S-cubed and CCCAP projects is for students to research scale specific strategies for addressing/adapting to climate change. Both require students to conceptualize a real-world application or consequence with specific scale and implications. Students are also expected to demonstrate literacy with concepts of energy and carbon cycling, including dimensional analyses. These word problems are real-world applications of climate change as they quantify the problems and necessary solutions. In addition to a dimensional analysis homework assignment that quantifies energy use and production, students are required to include relevant calculations as part of the S-Cubed project. Dimensional analysis is often used to quantify pay back periods for their proposed solutions. Payback periods can be financial, or emissions/energy based allowing students to conceptualize the feasibility of their proposed solution.

7. ***Public Demonstration of competence, such as a significant public communication of research or display of creative work, or a community scholarship celebration***.

As part of the S-Cubed project, students present an ‘elevator pitch’ of their research project, as well as produce a video. The elevator pitches occur during class time and will be open to the public. These pitches are two minutes in length and include a brief overview of the project. Students are encouraged to invite relevant officials to class to see their pitch and initiate conversation regarding implementation of the proposed solution. Likewise, the group project videos will contain detailed information about the proposed solution including background research and quantitative analysis. These videos will be posted publicly online for viewing by anyone who is interested.

8. ***Experiences with diversity wherein students demonstrate intercultural competence and empathy with people and worldview frameworks that may differ from their own.***

Students are assigned to final project groups and are given opportunities to do role-playing exercises to explore the differential impacts of climate change. In the Wedges game, student groups think critically and assign self-rated scores of how their portfolio of policy options to reduce carbon would be perceived by different stakeholders, including members of least

developed countries. In the Climate Simulation game, students enact the differential access of wealth and privilege by positions in the room. In this case, the debriefing is key.

9. ***Explicit and intentional efforts to promote inclusivity and a sense of belonging and safety for students, (e.g. universal design principles, culturally responsible pedagogy).***

The subject matter in this class on climate change exposes students to topics that often can raise personal levels of anxiety, even despair. Frankly, the political contention and dire prognosis of future warming with unjust outcomes can be discomforting. We thus take explicit and intentional efforts to facilitate and equip students to work through and process their emotions while also establishing the classroom to be a safe space to share concerns and engender a welcomed place of belonging regardless of political perspectives. Frequent communication is expected, and we ask students to self-rate and rate each other in terms of their level and nature of interaction with group mates. We also use expert guidance in the form of guided debriefing with professional outreach staff from Byrd Polar.

# HOW THIS COURSE WORKS

**Mode of delivery:** This course will be delivered in-person. Class periods will feature lectures, in-class exercises, discussions, and on-campus tours. Weekly recitation class periods will focus on further developing research related skills and scaffolding activities towards the final research project. Attendance is expected and will contribute to successful completion of the course. All course materials will be accessible from OSU's **Carmen Canvas** interface.

**Weekly activities and materials:** This course is divided into **weekly modules** that are released on Carmen Canvas by the first scheduled class on Tuesday. These will include variable combinations of discussions, exercises, readings, and quizzes covering content from lecture, recitation and assigned readings. Lecture slides will be posted to Carmen as pdfs after lectures. Many weekly assignments are due the following Monday by 11:59 p.m. Other assignments will have longer due dates, like the proxy description, and final project. Students are expected to keep pace with all deadlines and participate in scheduled class activities, arranging their time to complete exercises and readings, and being prepared for in class quizzes. A **weekly class schedule** will be provided outlining content and assignments. The ***schedule is subject to change*** so students should be sure to retain most current version. All scheduling changes will be articulated clearly to class via Carmen Announcements.

**Credit hours and work expectations:** This is a **4-credit-hour course**. According to Ohio State policy, students should expect around 4 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 8 hours of homework (reading, exercises, research 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. In addition to regular exercises, quizzes and exams, the following is a summary of expected participation:

- **Lectures: TWICE PER WEEK.** Lectures will be delivered in person by the Professor as well as occasional guest experts and assistants during scheduled class period in the assigned classroom. These lectures will be held in common with the 3-credit version of the class, and provide regular venue to contact the Professor and GTA.
- **Recitations: ONCE PER WEEK.** Recitations sessions comprise interactive 55-minute in person class periods held in the assigned classroom, and participation is required for this 4-credit version. Activities will focus on building progressive knowledge and practice with research and creative inquiry skills, allowing instructors to provide feedback for scaffolding components of the final project.
- **TopHat: RANDOM DURING LECTURES.** Regular assessment of understanding and participation will be evaluated and recorded via TopHat during lectures. Student participation in these TopHat exercises will be used to assess attendance in class and this, in turn, contributes to the participation category in calculating the final grade. Most value will be participation alone, but a percentage (up to 50%) will be on the correctness.
- **Group activities: PERIODIC.** There will be in-class group activities in addition to the S-cubed group project that will require active participation and a single group grade. Students will be allowed to provide an evaluation of their own and other group member participation effort in the S-cubed project, but active involvement is expected from all students.

# COURSE MATERIALS AND TECHNOLOGIES

## Textbooks

We will use sections from **two primary textbooks** for the class. Required weekly readings will help organize our inquiry into global climate change AND provide good reference to basic principles. Because students can access them in different forms, we do not require purchase; the Dessler (2012, 204) it is listed as recommended with OSU Bookstore.

1. **Dessler, A.** ***Introduction to Modern Climate Change.*** Cambridge University Press. A second edition has only recently been published, so the first edition is also still valid for the class.

First edition (2012): ISBN 978-0-521-17315-5. This has been ordered in previous classes and used copies should be available; it is on AMAZON. But it is also available for limited (2 users at a time) electronic resource through the OSU LIBRARY (accessible when on OSU computers):

https://library.ohio-state.edu/record=b7011024~S7

Second edition (2014): ISBN 978-1-107-48067-4. This newer version has been ordered and should be available at OSU Bookstore. It is also on online sites (e.g. Amazon or B&N for ~$40, or as an eBook on Amazon or Google ~$30).

A second available text is Mathez and Smerdon (2018).

2. **Mathez, E. and J. Smerdon.** ***Climate Change: The Science of Global Warming and our Energy Future.*** Columbia University Press. Full open access version online (pdf chapter downloads): https://doi.org/10.7312/math17282. ISBN 9780231547871 (e-book).

We will also have other assigned readings from additional sources (scientific articles, web pages, book sections). These will be announced in lecture and posted as assignments the modules where we will provide relevant web links or pdfs on Carmen. We will indicate the relevant weekly readings by date.

**All other required articles, book sections, web pages, videos or podcasts are directly embedded in modules on Carmen (see course schedule).**

## Other readings, media:

Occasionally we will also assign readings from additional sources (scientific articles, news, web pages, book sections). When appropriate, we will direct students to important publicly available climate change information like the 5$^{th}$ National Climate Assessment Report (https://nca2023.globalchange.gov/) and materials from the Intergovernmental Panel on Climate Change (https://www.ipcc.ch/). These will be announced in lecture and posted as assignments the modules where we will provide relevant web links or pdfs on Carmen. We will indicate the relevant weekly readings by date.

Other information complementary to the class can be found in mixed media (e.g. videos, podcasts). These will all be provided as pdfs or URL links via Carmen and linked to the weekly modules. One of the valuable resources students will obtain in the class will be a repository of articles, web media, and more that will be archived in Carmen.

Because our class learning goals include becoming familiar with peer-reviewed scientific literature, and critically evaluating material from the internet, we will introduce students to many

sources of information as well as tools to organize, cite and reference them. We will enlist the assistance of a course librarian from the OSU Libraries, Professor Danny Dotson.

## Course technology

For help with your password, university email, Carmen, or any other technology issues, questions, or requests, contact the Ohio State IT Service Desk. Standard support hours are available at ocio.osu.edu/help/hours, and support for urgent issues is available 24/7.

- **Self-Service and Chat support:** ocio.osu.edu/help
- **Phone:** 614-688-4357(HELP)
- **Email:** servicedesk@osu.edu
- **TDD:** 614-688-8743

Basic computer and web-browsing skills are expected, and navigating Carmen is an essential skill for this course. For questions about specific functionality, see the Canvas Student Guide.

### REQUIRED TECHNOLOGY SKILLS SPECIFIC TO THIS COURSE

- CarmenZoom virtrual meetings
- Recording a slide presentation with audio narration
- Recording, editing, and uploading video

### REQUIRED EQUIPMENT

- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed and tested
- Microphone: built-in laptop or tablet mic or external microphone
- Other: a mobile device (smartphone or tablet) or landline to use for BuckeyePass authentication

### REQUIRED SOFTWARE

- Microsoft Office 365: All Ohio State students are now eligible for free Microsoft Office 365 ProPlus through Microsoft's Student Advantage program. Full instructions for downloading and installation can be found at go.osu.edu/office365help.
- Zoom (https://osu.zoom.us/) is the academic audio web conferencing solution for Ohio State, and we will be using it for some guest lectures, possible office hour options, and interactive course elements.
    - Getting started with CarmenZoom

- TopHat: We will use TopHat to deliver quizzes during lecture for synchronous student response.

### 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 |
|---|---|
| Participation | 5 |
| Exercises & Discussions | 10 |
| Paleoclimate proxy short paper | 10 |
| Quizzes | 10 |
| Midterm exam | 10 |
| Group video presentation | 15 |
| Research Recitation/CCCAP | 40 |
| **Total** | **100** |

## Assignment descriptions:

**Participation:** This will be assessed based on student TopHat participation, completion of entrance/exit questionnaires, and attendance taken selectively for in-class activities).

**Exercises & Discussions:** Students will conduct weekly exercises or discussions. Exercises will comprise homework problems or other activities related to material presented in class. Discussions will comprise short answer responses to prompts using Carmen Discussions. Expectations for what comprises full credit will be further articulated for each module. Due dates may extend beyond the end of weekly modules but will be specified in the assignment.

**Paleoclimate proxy short paper:** Students will research and complete a short critical description about a paleoclimate proxy of their choice, demonstrating proper citation of information, including at least two peer-reviewed sources. 3 pages.

**Quizzes:** Quizzes will be given using Carmen quizzes, and will be 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. They are generally released after the Thursday lecture and due the following Monday.

**Exams:** Two exams will be given during the semester based on class content. Guidance will be given beforehand about the format and scope of each exam given.

**Group video presentation**: Groups will be assigned early in the class, and students will be interacting throughout the semester to select a topic and complete a video presentation. Students will also conduct reviews of other group presentations and engage in Q&A with students from other groups.

**Research recitation & CCCAP:** Students will participate in a recitation class each week, developing progressive skills and receiving feedback on scaffolded assignments towards the culminating individual semester final project, the Climate Change Consequences Analysis Paper (CCCAP) (detailed in separate document with grading rubric). The topic will be self-identified, and both accessing and properly citing peer-reviewed literature selected from OSU library databases will be 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.

# COURSE 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.
Lectures 2x/week (160 mins) with third section (55 mins) devoted to recitation/interactive.

| Wk | Module | Lecture/recitation | Date | Due | Assigned | Reading |
|---|---|---|---|---|---|---|
| 1 | Welcome & "Global Warming 101" | 1. Introduction, syllabus, global warming 101 | T 1/09 | | ***Discussion 1: intro self*** | 5th NCA (https://nca2023.globalchange.gov/): Overview (skim); Chp 2 |
| | | 2. What is climate and weather variability? | R 1/11 | | ***Entrance Climate Questionnaire (due 1/18)*** | |
| | | Recitation: Personal geography of climate | F 1/12 | | | Dessler 1 |

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| 2 | Is the climate changing? Critically assessing evidence | 3. Considering the data: is climate changing? | T 1/16 | ***Discussion 1 (due 1/15)*** <br><br> ***Entrance Climate Questionnaire (due 8/29)*** | ***Exercise 1: geography of climate – data & global patterns (due 9/5)*** | Dessler 2, 3 <br><br> 5th NCA (https://nca2023.globalchange.gov/): Chp 3 |
| | | 4. More evidence of current climate change; intro to radiation | R 1/18 | | | |
| | | Recitation: What is Consensus? Understanding the scientific process | F 1/19 | | | |
| 3 | Peer-review & Library Resources; Climate system dynamics | ***Library resources, identifying peer review – librarian Danny Dotson*** | T 1/23 | ***Exercise 1 (due 1/22)*** | ***Discuss 2: weather disasters & climate change*** | Dessler 3, 4 Mathez & Smerdon, 2018 (M&S) Chp 1 (Chp 2 in 2009 edition) |
| | | 5. Sun & Atmosphere Energy Balance | R 1/25 | | | |
| | | Recitation: Activity – Discerning real science in the media | F 1/26 | | | |
| 4 | Earth's planetary energy balance; the greenhouse effect (GHE) | 6. Simple model of GHE from basic radiation laws | T 1/30 | ***Discuss 2 (due 1/29)*** | ***Exercise 2: proxy topic/peer review*** | Dessler 4 Mathez 5 M&S 1-3 |
| | | 7. Simple model of Greenhouse; Real Atmosphere | R 2/01 | | | |
| | | Recitation: Activity – building the atmosphere (measurement, uncertainty, and visualization) | F 2/02 | | | |
| 5 | Flows of Energy: models and reality | 8. Earth's actual climate system; general circulation | T 2/06 | ***Exercise 2 (Due Mon 2/05)*** | ***Exercise 3: climate data 2*** <br><br> ***First Draft Proxy Description*** | Dessler 3, 4 M&S 1, 2, 3, 5 Weart: https://history.aip.org/climate/co2.htm |
| | | 9. Oceans circulation, atmosphere interactions; teleconnections ENSO | R 2/08 | | | |
| | | Recitation: ***RefWorks and Bibliography Building (with annotations) – librarian Danny Dotson*** | F 2/09 | | | |
| 6 | Humans and the | 9. The carbon cycle(s) – slow and | T 2/13 | ***Exercise 3: (due 2/12)*** | | Dessler 5 M&S 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | carbon cycle; predicting future changes | rapid; reservoirs and flows. | | ***First Draft Proxy Description (due Mon, 2/12)*** | Midterm study guide (optional, indep)<br><br>***Discuss 3: popular media***<br><br>***Peer Review of Proxy Description*** | |
| | | 10. Feedbacks, residence time; how carbon influences climate & humans alter the C-cycle | R 2/15 | | | |
| | | Recitation: Proper Peer Revision Techniques | F 2/16 | | | |
| 7 | Scenarios of future & Midterm Exam | 11. Emission scenarios of future climate changes; Impacts of climate change | T 2/20 | ***Discuss 3: popular media (due Mon 2/19)***<br><br>***Peer Review of Proxy Description draft (due Mon, 2/19)*** | ***Final project scaffold (FPS): Pick group by Feb 27 (else assigned)*** | Dessler 6-8 Climate Science Special Report (see Chp 4 on modeling) https://science2017.globalchange.gov/ |
| | | **MIDTERM EXAM** | R 2/22 | | | |
| | | Recitation: Workshop – Peer Feedback on Proxy Description | F 2/23 | | | |
| 8 | Paleoclimatology: Understanding past climates | 12. Paleoclimatology | T 2/27 | ***FPS: Pick group by Feb 27 (else assigned)***<br><br>*Class time for FP groups to meet, share contact info (2/29)* | ***Proxy description paper (final version)*** | M&S 7<br>Dessler 2.2; 7.3<br>Bradley, Paleoclimatology, Chp 1; Cronin 2, Methods |
| | | 13. Natural climate variability and how we've come to understand it | R 2/29 | | | |
| | | Recitation: Discerning real science in the media | F 3/01 | | | |
| 9 | Ice Ages: An historic science discovery of Ice Ages, and modern glaciologist story | 14. Discovery of the pace of ice ages – historical case study of science & worldviews | T 3/05 | ***Proxy description paper (due 3/04)***<br><br>***Discuss: Reflections on historical development of science: Ice Ages (3/05)*** | ***Exercise 4: Carbon footprint (due 3/18)*** | Imbrie & Imbrie, Chp 1-3:<br>*Ice Ages: Solving the Mystery*<br>Supplemental: Hodell (2016), "The smoking gun of the ice ages"<br><br>Shakun, 2015 |
| | | ***GUEST: Dr. Michalea King:*** Big Ice Changes – Ice sheets & sea level | R 3/07 | | | |
| | | Recitation: Activity – Graphing data & decoding ice core data | F 3/08 | | | |
| 10 | **Spring Break** | ***No class*** | T 3/12 | Be safe – get some rest! | | |
| | | ***No class*** | R 3/14 | | | |
| | | ***No recitation*** | F 3/15 | | | |
| 11 | OSU ice core research & practicing | ***Class divided to groups; report to respective location*** | T 3/19 | ***Exercise 4: (due 3/18)*** | ***FPS: group intro video*** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | modeling impacts of societal choices on future climate | ***Class divided to groups; report to respective location*** | R 3/21 | SYNCHRONOUS activities: Tour of BPCRC and EnROADS climate simulation | ***FPS: Final paper précis and biblio*** | |
| | | Recitation: *Discussion – Reflections on EnRoads* | F 3/22 | | | |
| 12 | Psychology, Politics and legal dimensions of climate change | ***GUEST: Prof Matthew Hamilton, SENR:*** From cognition to collective action | T 3/26 | ***FPS: group intro video (due 3/25)*** <br><br> ***FPS: Final paper précis and biblio (due Thurs, 3/28, 11:59 pm)*** | ***FPS: show quantitative reasoning for group strategy*** <br><br> ***FPS: Outlines for Final Paper*** | Dessler 13-14 |
| | | ***GUEST: Prof Carlarne, Law School:*** Legal considerations of climate change | R 3/28 | | | |
| | | Recitation: Activity – Ask an Expert | F 3/29 | | | |
| 13 | A focus on Ohio | ***GUEST: Dr. Mark Shanahan:*** Considering Ohio's energy geography | T 4/02 | ***FPS: show quantitative reasoning for group strategy (due Mon 4/01)*** <br><br> ***FPS: Outlines for Final Paper (due Thurs, 4/04, 11:59 pm)*** | ***FPS: First Draft of Final paper*** | Dessler Chp 8,9 <br> Ohio's energy portfolio: https://www.eia.gov/state/?sid=OH <br><br> ***$S^3$ project: Final video presentations uploaded to discussion forum by 11/28*** |
| | | 20. A view of Ohio's present & future climate from your State Climate Office | R 4/04 | | | |
| | | Recitation: Responding to peer reviews | F 4/05 | | | |
| 14 | How do we deal with (and pay for) the problem? | Wedges Game | T 4/09 | ***FPS: First Draft of Final paper (due Mon, 4/08, 11:59 pm)*** <br><br> ***In-class exercise (4/09)*** | ***Exercise 5: scaling up personal choices*** <br><br> ***Peer Reviews of First Draft*** | Dessler 11, 12 <br> Nordhaus, 2017 |
| | | ***GUEST: Prof. Brent Sohngen:*** Economics of climate change | R 4/11 | | | |
| | | Recitation: Climate Resiliency | F 4/12 | | | |
| 15 | Adaptation, mitigation & geoengineering | ***Group presentations: project pitches*** | 4/16 <br> 4/18 | ***Exercise 5: (due 4/15)*** <br><br> ***Peer Reviews of First Draft (due Thurs, 4/18, 11:59 pm)*** <br><br> ***Discussion: Final project peer-*** | ***Exercise: group project assessment of effort; exit survey*** | ***$S^3$ project: Final video presentations & peer-review*** |
| | | Recitation: Workshop – Peer Feedback for First draft of final paper | 4/19 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | ***reviews and responses to questions from peers*** | | |

Final papers due: Monday, April 29, 11:59 pm.

# OTHER COURSE POLICIES

## Discussion and communication guidelines

The following are my expectations for how we should communicate as a class. Above all, please remember to be respectful and thoughtful.

- **Writing style**: While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. A more conversational tone is fine for non-academic topics.
- **Tone and civility**: Let's maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm doesn't always come across online.
- **Citing your sources**: When we have academic discussions, please cite your sources to back up what you say. For the textbook or other course materials, list at least the title and page numbers. For online sources, include a link.
- **Backing up your work**: Consider composing your academic posts in a word processor, where you can save your work, and then copying into the Carmen discussion.

## Academic integrity policy

- **Quizzes and exams**: You must complete the weekly quizzes and the midterm exam by yourself, without external help or communication from the internet or other people. Accessing personal notes from class material is permitted.
- **Written assignments**: Your written assignments, including discussion posts, 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. ***It will be essential that you use a proper citation style consistently in your proxy description and final paper (further explanation will be provided).*** 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

It is the responsibility of the Committee on Academic Misconduct (COAM) to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

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 COAM.** 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)*

## 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

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@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 or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614--292--5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614--292--5766 and 24 hour emergency help is also available 24/7 **by dialing 988 to reach the Suicide and Crisis Lifeline**.

# 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.

If you are isolating while waiting for a COVID-19 test result, please let me know immediately. Those testing positive for COVID-19 should refer to the Safe and Healthy Buckeyes site for resources. Beyond five days of the required COVID-19 isolation period, I may rely on Student Life Disability Services to establish further reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

## Religious Accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity. (Policy: Religious Holidays, Holy Days and Observances)

## Accessibility of course technology

This course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- CarmenCanvas accessibility
- Streaming audio and video
- CarmenZoom accessibility
- Collaborative course tools

Semester Final Project (GEOG 3900.02)

# Climate Change Consequences Analysis Paper

## Overview

### Evaluating how climate change impacts sustainability requires a critical understanding of the complex interconnections between society and the Earth System at different scales.

- **How are the consequences of climate change attributed to human causes distinct from those caused by natural forcing?**
- **How can geographic research methods elucidate and test the nature and extent of climate change consequences?**
- **How does understanding these complex consequences help inform adaptation?**

Because human activity is now predominating over natural factors in driving up Earth's global temperatures, the myriad consequences of climate change have multiple implications for sustainability. The goal of this research-intensive project is to learn and practice geographic methods by critically examining a particular consequence. Through ***Discussions, Lessons, Activities*** and ***Workshops*** during the **weekly recitation** (see schedule), students survey different methods, refine skills of critical thinking, quantitative reasoning, peer-review, written and oral presentation, and learn to use library database searches and bibliographic software.

Throughout the class, students will interact within groups to complete some assignments and practice peer-review, while also working independently to complete a final **Climate Change Consequences Analysis Paper (CCCAP)**. This CCCAP will focus on a specific consequence (impact) of climate change that the student chooses. The CCCAP is an addition to the group project and video presentation that are also required of students in 3900.01. Moreover, it will comprise a second writing assignment to the individual paleoclimate proxy paper that is also required of students in 3900.01.

To complete the CCCAP, students will need to identify a specific consequence (ex: ghost forests along the US Atlantic Coast) and the changes to the climate system that are causing it (ex: Sea Level Rise). They also must discuss the combined human and natural processes at play that link consequences to causes, scientifically explaining what is happening and why (melting land ice + thermal expansion increases sea levels). After analyzing the consequence, students will provide a critical review of any potential proposed strategy to address the consequence (adaptation techniques). Students will consider if there are any policies/action already taking place elsewhere in the world and evaluate the extent to which they are effective, and for whom.

Students are free to choose their CCCAP topic from the list below or ask the instructors for approval if they have another topic in mind. Students must cite peer-reviewed research (5 articles), support claims with cited evidence, and ultimately use proper in-text citations and a complete bibliography.

## Schedule

| **Recitation Topic**<br>***(Italics = overlap with 3900.01)*** | **In-class activity** | **Assignments**<br>***(SC = Scaffolding Assignments)*** |
|---|---|---|
| 1. Personal geography | ***Discussion:*** Introductions and conversations about where students are from and what their personal geography is. | |
| 2. What is Consensus? Understanding the scientific process | ***Lesson:*** The scientific process and revision process – how it weeds out bad science. | |
| 3. *RefWorks and Bibliography Building (with annotations) – librarian Danny Dotson* | ***Lesson:*** How to build a bibliography in RefWorks or related citation software | *Determine Paleoclimate Proxy topic and identify peer reviewed sources* |
| 4. Building the atmosphere (measurement, uncertainty, and visualization) | ***Activity:*** Students will work in groups to construct the layers of the atmosphere and surface energy budget given different scenarios | Complete first draft of Proxy Description |
| 5. Proper Peer Revision Techniques | ***Lesson:*** Proper strategies for reviewing scientific papers. | Complete 1 peer review of the proxy description using techniques discussed in class |
| 6. Peer Feedback on Proxy Description | ***Workshop:*** Meet with the peer whose paper you reviewed and discuss your recommendations | *Final Draft Proxy Description* |
| 7. Discerning real science in the media | ***Activity:*** students will watch, read, and listen to "scientific" arguments made in the media and will be tasked to determine if the statements are true by researching the sources and motives behind the statement. | **SC: Identify topic for final Paper** |
| 8. Decoding ice cores | ***Activity:*** students will view images of ice cores to deduct historical climate information. | **SC: Identify Peer Review sources for final Paper** |
| 9. Climate Resiliency | ***Discussion:*** students will discuss what climate resiliency means and what they think it looks like. | **SC: Build a bibliography and synopsis of final paper topic** |
| 10. *Reflections on EnRoads* | ***Discussion:*** Students will reflect on the EnRoads activity, discussing how policies have consequences that vary in scale, and how different stakeholder interests inform choices | **SC: Complete a rough draft of the final paper** |

| | | |
|---|---|---|
| 11. Ask an Expert | ***Activity:*** Students will write a brief **email (SC)** asking **an expert** in their paper topic for advice, clarification, and feedback on the topic | **SC: Complete 2 peer reviews of the final paper using techniques discussed in class** |
| 12. Responding to peer reviews | ***Lesson:*** How to develop a formal, typed response to peer reviews to explain why you did or did not accept the suggestions. | **SC: Type a response to peer revisions and complete second draft of final paper** |
| 13. Peer Feedback for First draft of final paper | ***Workshop:*** Meet with the peers who reviewed your papers and discuss the changes you have made to the | Prepare a bulleted list of the main points of your paper and the significance of the topic to share with the class.<br><br>**SC: Make final revisions to the final paper** |
| 14. (If time) Key Findings and topic significance | ***Discussion:*** Divide the class into large groups (8-10) students and allow everyone to briefly discuss the main points of their paper topic and why it is important. | **SC: Make final revisions and submit final paper** |

## Instructions

Writing is a key skill in science since ideas need to be clearly communicated. Your peers will review you.

- Details & format instructions for the paper:
    1. The assignment must be typed in Times New Roman or Calibri at 11- or 12-point font, with 1-inch margins and numbered pages.
    2. 8-10 full pages, double spaced
    3. PROOFREAD everything. Points will be deducted for too many grammatical errors, incorrect spellings and punctuation, and typos.
    4. CITE your sources as you go. Include author (or website title) and year. You may use footnotes or in-text citations (in parentheses). Use the RefWorks cite-as-you-write.
    5. A separate BIBLIOGRAPHY at the end of the essay is required. For web sources, include a full URL so we can see where you got your information. Format with RefWorks.
    6. You must include an Introduction that provides a brief overview of the topic with necessary background information and specific case examples about climate change consequence, and a Conclusion that
    7. Apply and integrate geographic research methods and concepts practiced throughout course assignments and workshops!
    8. You need to submit a rough draft of your paper by the 10$^{th}$ week in order to provide and receive peer review, along with instructor comments. Your final submission must reflect incorporation or at least consideration of peer and instructor feedback.

## Research Questions

You MUST address each of the three questions. We recognize there will be varying degrees of scientific understanding, but the degree to which you are able identify and discuss findings while citing sources of information properly will be reflected in your score (see the rubric, below).

Be creative looking for information! If you do run into barriers while researching these questions, please indicate what information you cannot find. This is not only to illustrate all the research and work you put into the project, but also because these gaps in accessible information are part of the story of the emerging realization of climate change consequences.

1. What is the scientific cause of the problem?
    a. What is happening to cause the problem?
        i. Provide discussion of the key scientific processes involved
    b. How is climate change causing or intensifying the issue?
2. What consequence emerges from the problem?
    a. Who or what is impacted and how?
        i. Include specific examples and numbers
        ii. Define the scale of impact
    b. What are the related implications? Why does it matter, and for whom?
3. What potential or actual proposed adaptation solutions exist?
    a. Are there examples of policy/action taking place? Describe.
    b. What recommendations would you offer?
        i. Support with compelling facts

*For example, an outline of a paper topic:*

*Consequence: Plant species are dying from flooding and increased salinity the US Atlantic Coast*

*Cause: Sea levels are rising, flooding the land with ocean water*

*Scientific processes behind cause: melting glaciers and thermal expansion increase sea levels*

*Then the outline would look as follows:*

1. *Introduction*
2. *Discussing how melting glaciers and thermal expansion increase sea levels.*
    a. *Globally SLR has risen x amount in y years*
3. *Increasing sea levels is resulting in coastal flooding resulting in dying trees*
    a. *Specific species of trees are dying from increased salinity and flooding*
        i. *In Virginia x amount of wetland has become ghost forest since year y*
    b. *US Atlantic Coast*
    c. *Changes to land cover influence biodiversity, farming is impacted by these changes as well*
4. *Levees could be put in place or made taller*

## Possible topics to choose from

**This list of example topics is not exhaustive;** students are free to propose other topics, or variations of these ideas.

- Increased land temperatures and Urban Heat Islands
- Sea Level Rise and Coastal Flooding
- Increased ocean temperatures and Ocean Biology/chemistry
- Health impacts
    - Vector borne disease
    - Heat/cold stress
- Severe storms
- Food security
- Agricultural production
- Wildfires
- Precip extremes – flood and drought
- Human migration
- Geopolitical instability
- Biodiversity
- Economic impacts
- Water resources
- Infrastructure
- Sports/Recreation/tourism

## Rubric and Grading Scale

**Paper Scaffolding and Feedback**

The short essay (*Paleoclimate Proxy Paper*) at the beginning of the semester will introduce concepts of scientific writing and citation of scientific literature, and thus will prepare students for this larger, more comprehensive paper.

Throughout the course of the semester, specific Scaffolding Assignments (SC, as listed in Schedule) will be graded to accumulate to the full value of the final paper. The points are distributed as follows:

1. Select topic (2 pts)
2. Identify peer-reviewed sources (5pts)
3. Build a bibliography and provide a synopsis of the topic (10 pts)
4. Complete a rough draft of the assignment (15 pts)
5. Email an expert to ask questions/gain clarity on the paper topic (10 pts)
6. Peer review two student's rough drafts (10 pts)
7. Formal, typed response to peer reviews (one for all 3 reviews [two peers, 1 instructor]) (8 pts)
8. Complete final draft of paper (25 pts)

Total points: 85

**Assignment Rubric -- Final Draft of paper (25 pts)**

| | 5 pts | 4 pts | 3 pts | 2 pts | 1 pt | 0 pts |
|---|---|---|---|---|---|---|
| Relevant Topic and paper format | | Discusses a clear Cause and Consequence of a relevant climate process in an objective, scientific manner and is properly formatted. | Discusses a clear Cause and Consequence of a relevant climate process, but is not formatted properly | Discusses a clear Cause and Consequence of a relevant climate process in an objective, scientific manner and is properly formatted. | Discusses a clear Cause or Consequence of a relevant climate process in an objective, scientific manner and is properly formatted. | Is not formatted to reflect a scientific paper and does not discuss relevant topics |
| Cause | Identifies the cause of the process and discusses the science behind it using numerical examples. | Identifies the cause of the process and discusses the science behind it but does not use numerical examples. | Identifies the cause of the process and attempts to discuss the science behind it | Identifies the cause of the process but does not discuss the science behind it | Briefly mentions potential causes, but does connect them to the process | Does not identify causes of process |
| Consequence | Identifies a specific impact of the process addressing who/what is impacted and at what scale and why it matters | Identifies a specific impact of the process addressing who/what is impacted and at what scale, but does not discuss why it matters | Identifies a specific impact of the process addressing who/what is impacted and at what scale, but neglects to connect it to the cause and process | Identifies a specific impact of the process addressing who/what is impacted | Identifies who/what is impacted but does not identify a specific impact to focus on | Does not identify a consequence |
| Potential Solution | | | Provides at least one example of a potential scale-specific solution referencing policy/action that has been implemented elsewhere. | Provides at least one example of a potential scale-specific solution but does not reference policy/action that has been implemented elsewhere. | Identifies a solution but it is not appropriate for the scale or does not explain how it can address the problem | Does not provide a scale-specific solution |
| Sources and Citations | Includes at least 5 peer-reviewed sources, contains proper in-text citations and contains | Includes proper in-text citations and contains a complete bibliography, but does not meet the 5 source limit | A proper bibliography is included, but there are errors in the in-text citations | A bibliography is included, but there are errors throughout, but In-text citations remain proper | Includes bibliography but does not include in-text citations | Does not include bibliography |

| | | | | | | |
|---|---|---|---|---|---|---|
| | a complete bibliography. | | | | | |
| Writing | | | Paper is well written with no spelling/grammar errors | One or two spelling/grammar errors | Few spelling/grammar errors throughout | Many spelling or grammar errors make the paper difficult to read |

**Recitation grade**

The Recitation grade will be mostly weighted to the CCCAP Research Paper (85%). However, the in-class activities and discussions will also be graded (15%).

| ASSIGNMENT CATEGORY | POINTS |
|---|---|
| In-Class Activities and Discussions | 15 |
| Final Paper (with scaffolding) | 85 |
| **Total** | **100** |

# GE Theme Course Submission Worksheet

GEOG 3900.02, 4 credits

"Global Climate Change: Researching Causes & Consequences"

Sustainability Theme

**General Expectations of All Themes**

**GOAL 1: Successful students will analyze an important topic or idea at a more advanced and in-depth level than the foundations.**

**Please briefly identify the ways in which this course represents an advanced study of the focal theme.** *In this context, "advanced" refers to courses that are e.g., synthetic, rely on research or cutting-edge findings, or deeply engage with the subject matter, among other possibilities. (50-500 words)*

G3900.02 presents an advanced study thematically tied to sustainability by framing the problem of climate change as one emerging from coupled natural and social systems where humans have agency, so that critically engaged considerations of multiple disciplines is required to address the complex consequences for society. While open to students of all majors, it challenges students to link and synthesize diverse concepts of energy with economic, political and legal considerations. Understanding the causes of global climate change requires knowledge of the biophysical processes within the Earth system – its climate, energy balance, and biogeochemical cycles – and both the natural and human-caused factors that drive climate change. Moreover, students are exposed to concepts of economics, psychology, political science and law as they learn how widespread and complex consequences of climate change challenge society to rethink sustainably development and net-zero energy conversion technology. The course relies on cutting-edge research since changes and their implications are unfolding in real time; students are required to access and cite the scientific peer-reviewed literature, as guided by our class librarian who lectures and provides resources to assist the writing of both the paleoclimate proxy description and final research paper. As a 4-credit research focused class, the final paper will require advanced study and written analysis of a student-selected topic. Finally, students draw on basic algebraic skills to undertake more advanced dimensional analyses to quantify how actions impact energy and carbon emissions.

**ELO 1.1 Engage in critical and logical thinking about the topic or idea of the theme.** *Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)*

To meet the course goal of understanding the fundamentals of Earth's climate and how it changes, students build conceptual understanding starting from fundamental physical principles and then apply logic and scientific reasoning to model the system and test hypotheses. For example, in modules 1 and 2, students gain advanced appreciation of Earth's greenhouse effect by learning the fundamental radiation laws after reviewing wavelengths and conservation of energy. Through lectures and readings, they derive a simple layered model of the Earth's atmosphere. Students then use it to compute surface temperature knowing incoming radiation and relative atmospheric layers. They test scenarios of more greenhouse gases by adding additional layers to the atmosphere and computing resulting increases in temperature without additional incoming solar radiation. They also see how a generalized form of the

model can be tested against neighboring planets to see if it can explain the relative power of greenhouse effects on other planets – and it does. They also synthesize the basic chemistry of photosynthesis and respiration into box models of carbon fluxes between terrestrial, oceanic and atmospheric reservoirs to quantify the nature of human-induced alterations leading to global warming.

To meet the goal of acquiring and intercomparing actual climate data, students have take-home exercises directing them to acquire publicly accessible climate data in various forms. They use online tools to compute and compare trends over time. They also evaluate and intercompare time series of paleoclimate proxy data with measurements to provide quantitative evidence distinguishing human altered climate change from natural. To meet the goal of thoughtfully engaging with current events, students take what they're learning about human impact on climate and reflect critically upon the accuracy of media portrayals of climate change related topics. They come to their own conclusions and express them in succinct passages that they will post to a small group of classmates. They also respond constructively to other commentaries made by their fellow students. This process helps them develop their own conclusions about how climate change is impacting our world and how people are responding.

To meet the goal of appreciating the history of climate change science, students read a section of a popular audience history of solving the Ice Ages and reflect on the historical context and roles of world view in influencing development of ideas. They then reconcile how despite having a short observational record of temperature changes, there is very strong logical basis for the reality of humans causing recent climate change based on a long history of experimentation, and that science progresses by testing and falsifying with evidence.

Students examine human-based approaches to address climate change through energy unit conversions and basic carbon balance calculations. This practice meets the goal of building practical energy literacy and allows students to exercise quantitative tools of logic to critically compare implications of varying strategies to address climate change.

**ELO 1.2 Engage in an advanced, in-depth, scholarly exploration of the topic or idea of the theme.**
*Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)*

Students have multiple opportunities to engage in in-depth scholarly exploration, and two written papers requiring proper citation of scientific literature. To delve deeper into the learning goal of understanding natural climate variability and how science is able to gain insights into past climate, students undertake a guided independent inquiry into paleoclimate proxies. They select a proxy that interests them, then research how it works, and critically describe how it can be used to inform us about past climate and environmental changes. They must explicitly account for the assumptions, strengths, weaknesses and sources of uncertainty in the methodology, and then use library databases to search for case study examples of the proxy being used in research from the scientific peer-reviewed literature, and summarize in writing, properly citing sources. In the group research and video presentation project, students address the goal of critically examining solutions by proposing scale-specific strategies. They must conduct in-depth research on the technology or methods they propose, accounting quantitatively for the impact on carbon emissions. They must substantiate their findings with evidence from published research, and properly cite findings from at least three peer-reviewed research studies. In this 4-credit class, students undertake a semester-long independent scholarly research paper on a topic they identify independently. They further refine research skills by learning to use bibliographic software available

through the OSU libraries (RefWorks) to organize a review of scientific literature and format citations and bibliography.

**GOAL 2: Successful students will integrate approaches to the theme by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.**

**ELO 2.1 Identify, describe, and synthesize approaches or experiences as they apply to the theme.** *Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)*

Students engage in a combination of informed peer-group discussions and word problems as exercises on a weekly basis that provide opportunities to articulate connections to their broader academic knowledge and life experiences. They are assigned randomly to clusters with fellow classmates and are then required to compose thoughtful responses to prompts that ask them to reflect upon either current weather and climate events, or media portrayals of climate change. Once these are submitted, they are allowed to view their peer-responses, and are required to respectfully respond to at least two. This meets the class goal to thoughtfully engage with current events and media presentations related to climate change by connecting to relevant scientific understanding and uncertainty. Also, word problems requiring dimensional analysis of energy and carbon and unit conversion provide students a way to relate their lives beyond class directly to the topic. This meets the ELO's of demonstrating practical energy literacy and critically examining options for solutions. This allows students to apply mathematical reasoning skills (gained outside class, but no calculus required) to the theme of climate change, gaining quantitative connection and critical insight into key aspects of climate change (energy and carbon). Moreover, the examples relate directly to student livelihoods by considering examples relating to how they live and the implications for equivalent carbon emissions resulting from their daily activities. The final project also addresses the learning goal of using fact-based knowledge to assess a scale-specific problem and solution, and the students work as teams, drawing upon their diverse backgrounds and experiences to creatively identify the problem and solution. Students are also able to write their final individual research paper on any theme relating to climate change; many may opt to use this to connect more substantively to their growing expertise or passion based in their major or other academic field of knowledge.

**ELO 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.** Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)

Open to the full diversity of OSU undergraduate students, the class assumes no pre-requisite knowledge, but does encourage self-assessment of developing new understanding by including an entrance and exit survey to assess knowledge. This is based on standards of climate change literacy as developed by the American Association for the Advancement of Science. To meet the twinned goals of critically examining options for human society for mitigating, adapting, and otherwise geoengineering responses to an altered climate, and working with others to use fact-based knowledge to design solutions, students will engage in a number of creative works that will feature opportunities to develop sense of their own learning and build on prior experiences. The class is structured to include three inter-active classroom exercises: in-person experience of climate science in action (research tour of Byrd Polar

and Climate Research Center); creative role-playing where students work in teams to simulate impacts of policy decisions from different economic sectors, checking results with real-time models of future warming based on national determined commitments (Climate Interactive); and team based portfolio construction of "wedges" to reduce emissions across diverse economic sectors, accounting for self-critically scored impressions by different stakeholders (Carbon Wedges). The final project features composing a video presentation, and opportunities to review and evaluate their own and their teammates' participation, as well as conduct peer-review of fellow classmates' projects.

**Specific Expectations of Courses in Sustainability**

**GOAL 3: Students 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.**

**ELO 3.1 Describe elements of the fundamental dependence of humans on Earth and environmental systems and on the resilience of these systems.** Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)

Earth's climate is fundamentally linked to environmental systems involving the recycling of chemical elements (e.g. carbon) throughout the spheres of the Earth System that ultimately have bearing on the levels of greenhouse gases in the atmosphere. Human energy conversion by fossil fuel combustion has facilitated improved well-being and development. But this strongly moderates these biogeochemical processes and thus impacts the climate by altering the radiative properties of the atmosphere. In addressing the learning goal of how the climate system works and how human activity moderates it, students will demonstrate understanding of how the natural climate system operates, including fundamental drivers and feedbacks. This will involve coming to grips with thresholds within these biogeochemical and socio-ecological systems. They will deepen a critical appreciation by examining paleoclimate data documenting these processes throughout Earth's planetary history. They will derive and apply a 1-dimensional model of the natural greenhouse effect, and then alter it by demonstrating the effect of human-induced enhancement. Then, they will be challenged with understanding the myriad ways humans alter these processes, and benefit from them. This requires appreciating how social systems are integrated, and this is accomplished by integrating lectures by guest experts sharing perspective and methods of economics and energy policy. Dr. Shanahan reviews the development of energy in Ohio, revealing many important benefits and ecological impacts of coal, oil and natural gas development, as well as political realities that challenge development of alternative energy. Learning goals reinforce that many options need to be decided through a political system with divergent interests, and students are given opportunities to assess critically both costs and benefit involved in any solution, while being explicit about the political realities of implementation.

**ELO 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.** *Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)*

In distinguishing human induced climate change from natural climate, students will access actual observations of temperature and carbon dioxide levels over time, and critically analyze relative rates of

change over time. In meeting course goals, students will practice a critical reading of time series graphs and be familiar with intercomparing rates of change. Activities will enable students to examine the range of time scales over which natural variations in climate occur in order to understand the role of human activity in the context of past changes in climate. For example, students will plot historical temperature time series data for the month they were born and assess the trend over time. This encourages students to consider the reasoning behind annual variations in temperature and why the historical trend appears as it does. In comparing these trends to trends in fossil fuel emissions, students can draw connections in the relationship between human emissions and temperature trends.

This is further emphasized through discussion of the ice ages. The ice ages occur naturally with a rhythm that is driven ultimately by solar radiation changes but also involves feedbacks with carbon dioxide levels in the ocean-atmosphere system which also occur naturally as a function of changing temperature. Human emissions of carbon dioxide have altered the rhythms of the ice ages, and this has implications for how the impacts of climate change will be felt by different communities including those here in Ohio and the Midwest. Projections of future climate will be critically examined, and students will learn how largest sources of uncertainty relate to human decisions, that are not rational but highly political. A particular emphasis will be placed on the role of world views in influencing scientific theory by using a popular audience text about the discovery of the Ice Ages. Students will critique how human activity and technology are interwoven to allow for discovery and advancement of knowledge.

**ELO 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.** Please link this ELO to the course goals and topics and indicate specific activities/assignments through which it will be met. (50-700 words)

Students will apply the knowledge gained in exercises, discussions, midterm, and readings to both assess a specific problem related to the production of greenhouse gases by human activities and devise an informed and meaningful response. This is the essence of the final group project and video presentation, where students work with others on a team, and not only demonstrate critical thinking but practice compelling communication. This meets multiple learning goals of critical and quantitative thinking around energy and carbon and is tied fundamentally to sustainability. Successful demonstration will require accessing appropriate evidence from the scientific peer-reviewed literature. It will also require students to acknowledge and express values by making their case for action as a “pitch” to a legislative or policy body of their choice. For example, students can frame their problem/solution to be one applying globally, with the policy body as the United Nations, or very local, with the policy body being the Ohio State University Board of Trustees. Fellow students will evaluate their presentation based on how compelling they were with presenting evidence and express their relative preference by allocating imaginary funding amounts. This integration of science and values within a decision-making framework implicitly engages students in a process of informing meaningful responses to problems holistically.

# Research & Creative Inquiry Course Inventory

Pedagogical Practices for Research & Creative Inquiry form

**GEOG 3900.02 Global Climate Change: Causes & Consequences**

***Performance expectations set at appropriately high levels (e.g. students investigate their own questions or develop their own creative projects). Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

G3900.02 aims to be an integrative and high impact course by engaging students in research/creative inquiry practices throughout the class that will provide multiple opportunities for feedback and scaffold towards a culminating final individual research paper and group project video presentation. The class will share two 80-minute lectures per week with the 3-credit class, but then have an exclusive 55-minute recitation class period per week that will comprise lectures, workshop activities, and discussions devoted to the research project. The recitation creates time to develop and practice skills and methods while facilitating engagement with peers and instructors. Recitations will explore different aspects of scientific research, including data collection and contacting experts in related fields.

The final research project will comprise an individual research paper in addition to a final group scale-specific solution ("S-cubed") project and video presentation, common to the other 3-credit class. The group project requires students to work with randomly assigned partners to design a strategy to address a particular challenge they identify that is related to climate change. As a problem-solution framing, this allows students to follow the well-established categories of 'solutions' that have been proposed to climate change: adaptation, mitigation and geo-engineering. However, critical thinking is expected and demonstration of data visualization, quantitative reasoning, accessing and citing peer-review literature will be required.

The research paper will require students to select a specific consequence of climate change and the associated cause. Comprised of a series of scaffolding actives, students will research the scientific processes behind the issue, impacts of the issue itself, and potential adaptation techniques. Scaffolding activities will include utilizing RefWorks to build a bibliography, completing and responding to peer reviews, and contacting an expert who can provide insight on their paper topic. The research paper and scaffolding provide students with experience exploring and compiling information in a scientific manner, exposing them to the rigorous scientific process. In conjunction with the original research, they produce for the S-cubed projects, students will practice producing original research and compiling existing literature.

Additionally, the research paper is designed to allow students to explore a topic that is most interesting to them, encouraging them to think critically about the ways the changing climate system impacts their own values. Individually driven by what interests the student, the paper will encompass the course goals to articulate the science of human climate change, describe changes to Earth's climate over time, and propose mitigation/adaptation strategies.

***Significant investment of time and effort by students over an extended period of time (e.g., scaffolded scientific or creative processes building across the term, including, e.g., reviewing literature,***

***developing methods, collecting data, interpreting or developing a concept or idea into a full-fledged production or artistic work) Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

The course requires an additional 45 hours of research-oriented work from students over the semester. This includes one hour per week of instructional in-class workshops and two hours per week of out-of-class assignments and activities. This work and additional instructor contact time will provide the scaffolding for the final group research paper. There are multiple scaffolding components that students will engage in to complete the project and acquire the necessary skills to conduct the research and writing. For example, students are required to look up, properly distinguish and cite peer-review scientific literature as they write up their research projects. To develop this research skill practically, we have a series of sequential procedures. Students will begin with a lecture by the class librarian, Danny Dotson, who explains thoroughly what peer-review is, how to distinguish if articles have been peer-reviewed, and how to use OSU Library research databases to search for scientific literature. He also provides additional resources for the students and has provided an updated library link on the Carmen/Canvas page for the class with related resources. Subsequently, students are quizzed on recognizing if select articles are peer-reviewed, then they are required to use online databases to conduct searches and access peer-reviewed articles to cite in writing. The expectations build over the extended period of the course, with first having a short paper in module so that students iteratively reinforce their understanding with sustained practice and application.

The last seven weeks of recitation will be devoted to building the final paper where students will be required to select a topic, identify peer-reviewed sources, build a bibliography, complete a rough draft, complete two peer reviews, respond to peer reviews, and complete their final draft. This addresses the course goal to promote in-depth scholarly exploration of a topic while building the students' understanding of the scientific process.

***Interactions with faculty and peers about substantive matters including regular, meaningful faculty mentoring and peer support. Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

Part of this course's description is working collaboratively to create scale-based solutions to climate change. Working with others is a crucial part of understanding the impacts of, and solutions to, climate change and for this reason, peer to peer interactions are prevalent throughout the course. Starting in module 1, the recitation will be established as a forum for students to position themselves as independent learners within a community of creative inquirers. The personal geography of climate allows students to connect fundamental controlling factors of latitude and location to their personal experiences, but also provide personal details for others to learn about and raise any specific concerns with instructors. Group discussions continue in module 3 as students share personal impressions and experiences with severe weather as they evaluate the reality of how an altered climate impacts weather. These concepts are fundamental but are best learned collectively in discussion.

Peer to peer interaction is the nature of the S-Cubed project. Student groups will work together to determine scale-based solutions, discussing what they learned and helping others understand. The S-Cubed project will be evaluated by a group video and the group will be able to assess individual participation. Final project presentation videos are peer-evaluated. And questions are required to be evaluated by all members of the team.

Students will get substantive interactions with instructors by having deadlines for initial drafts of papers. Specific comments from instructors and peer-reviews will be returned to students, even as they learn and practice by reviewing other students. Students will be required to develop a formal response to the peer and instructor reviews explaining why their suggestions were or were not taken. After peer revisions are completed, students will meet with those who reviewed their paper to discuss the recommendations and provide supportive feedback.

***Students will get frequent, timely, and constructive feedback on their work, iteratively scaffolding research or creative skills in curriculum to build over time. Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

To provide practice with quantitative reasoning, exercises (homework) will expose students to dimensional analysis, energy units/conversion, and actual data on rate usage to scale. These will all get graded and then reviewed in class, allowing students to learn from mistakes and get feedback. Office hour tutorials are also promoted, additional practice problems and answer keys, and asynchronous videos showing solutions step by step. Similarly, multiple scaffolded assignments provide opportunities for students to get timely and constructive feedback. We start with a short paper assignment, requiring proper citation of at least two peer-reviewed articles within a 3-page paper about paleoclimate proxies, with an initial draft due weeks before the final draft is due.

Students will learn about and practice peer-review on these initial drafts in week 5. Then, there is a scaffolding moment for the final project, with an intro video describing choice of topic and scale due in module 10. Likewise, the individual research paper topic is identified along an annotated bibliography with at least 3 peer-reviewed articles by module 11. Instructors are able to give feedback and recommendations based on this precis. In addition, a scaffolded exercise requires students to give instructors some examples of quantitative reasoning as they present their solution by module 13. This allows students to apply dimensional analyses skills learned in previous exercises (modules 3, 5, 6) on data they researched to show quantitatively how their strategy is effective, using numbers (i.e., cost-benefits, carbon emissions saved, energy efficiency, etc.).

***Periodic, structured opportunities to reflect and integrate learning in which students interpret findings or reflect on creative work. Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

One of the course goals is for students to articulate the scientific basis for, and consequences of, natural and human-produced climate change. Another goal focuses on proposing a creative strategy to mitigate or adapt to climate change. In combining these goals, the foundation of the course is rooted in students' ability to reflect what they learn from the first half of the semester (understanding the science of climate change) and propose a solution for the S-Cubed project. They will also synthesis their understanding of the causes and consequences of climate change in the research paper

Starting with instruction in module 6, students will engage in peer-review at different stages of their research and writing. They will then reflect and respond to the feedback with subsequent drafts of papers and the final presentation. In addition, recitations in modules 10 and 12 will focus on communication of research findings to different audiences, and in particular to share with policy makers. This requires meaningful reflection and integrated syntheses. In modules 13 and 15, students

will think about and practice responding to peer-reviewed criticisms about their research, which is an important process of integration and reflection in science. In module 11, students will have an on-campus field trip to Byrd Polar and also make use of the EN-ROADS climate simulator with trained facilitators. These will be opportunities to integrate what they've learned in lecture and research of paleoclimate proxies, as well as reflect on how certain policy choices translate into temperature changes by 2100. The facilitators lead a "de-brief" session after the EN-ROADS that is very useful in providing structure to reflect on how their choices impact emissions or not. Many pre-conceived notions get challenged and corrected in this process about relative carbon intensity of different sectors in the energy economy. Using an in-class group game called the "Stability Wedges" in module 14, students think again in structured reflectively about impacts of decisions, but this time work on considering impacts and political perceptions of diverse stakeholders. They compile a portfolio of specific actions to reduce a total of 8 Gt carbon by 2050. This structured opportunity includes justifying selections based on their integration of their knowledge, and then reflecting on how much different stakeholders would like their ideas and providing a numeric score in self-evaluation.

Occasionally, the 55-minute recitation period will be dedicated to reflection and conversation on recent lecture topics. During the 9th week of recitation, reflecting on previous lectures on climate change impacts and solutions, students will discuss climate resiliency. They will contemplate the meaning behind the term and what they think it looks like. In addition to discussions, reflection manifests throughout the course in the projects and in class activities. As part of the research paper, students will be required to contact an expert in the field of their chosen topic. In emailing, calling, or meeting with these professionals, students will need to reflect on what they do and do not understand about the topic. They will need to formulate questions based on what is most relevant to their research topic.

***Opportunities to discover relevance of learning through real-world applications (e.g., mechanism for allowing students to see their focused research question or creative project as part of a larger conceptual framework). Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

The previously mentioned opportunities for students to apply understanding in role-playing exercises (modules 11, 14) facilitate excellent learning by considering that there is no easy solution to the complicated problems of climate change. Role-playing activities, like EN-Roads and the Stability wedges directly simulate the real world. During EN-Roads, students are tasked to represent stake holders around the world and work together to address climate change. They must agree upon actions to take to reduce carbon emissions. Students must research costs and benefits, and reasonably relate how their strategy will be viewed by diverse stakeholders.

**Commented [UC1]:** At some points in the document this is written as EN-ROADS, others like this (EN-Roads); the capitalization should probably be consistent throughout.

In this course, students are expected to demonstrate literacy with concepts of energy and carbon cycling, including dimensional analyses. These word problems are real-world applications of climate change as they quantify the problems and necessary solutions. In addition to a dimensional analysis homework assignment that quantifies energy use and production, students are required to include relevant calculations as part of the S-Cubed project. Dimensional analysis is often used to quantify pay back periods for their proposed solutions. Payback periods can be financial, or emissions/energy based allowing students to conceptualize the feasibility of their proposed solution. The purpose of the S-cubed project is for students to generate a feasible, scale specific solution for climate change, requiring

students to conceptualize a real-world application and envisioning it as just one part of a larger conceptual framework of adaptation, mitigation and geoengineering.

Furthermore, guest lecturers in this course discuss climate change in various real-world contexts. The lecture on the history of Ohio Energy builds describes the political and economic relevance of fossil fuels in Ohio providing context for solution-based thinking and facilitating informed decision-making. Similarly, touring the Byrd Center provides real-world examples of research projects and teams. Lastly, the research paper is designed for students to connect the scientific processes of climate change to tangible, localized impacts. Students will focus on a topic that is interesting to them and explore the large-scale scientific processes behind these issues, tracing the problem through the larger, conceptual framework.

***Public Demonstration of competence, such as a significant public communication of research or display of creative work, or a community scholarship celebration. Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

As part of the S-Cubed project, students present an 'elevator pitch' of their research project, as well as produce a video. The elevator pitches occur during class time and will be open to the public. These pitches are two minutes in length and include a brief overview of the project. Students are encouraged to invite relevant officials to class to see their pitch and initiate conversation regarding implementation of the proposed solution.

Likewise, the group project videos will contain detailed information about the proposed solution including background research and quantitative analysis. These videos will be posted publicly online for viewing by anyone who is interested.

***Experiences with diversity wherein students demonstrate intercultural competence and empathy with people and worldview frameworks that may differ from their own. Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

Students are assigned to final project groups and are given opportunities to do role-playing exercises to explore the differential impacts of climate change. In the Wedges game, student groups think critically and assign self-rated scores of how their portfolio of policy options to reduce carbon would be perceived by different stakeholders, including members of least developed countries. In the Climate Simulation game, students enact the differential access of wealth and privilege by positions in the room. In this case, the debriefing is key.

**Commented [UC2]:** Maybe add something like: ...is key to developing a nuanced understanding of the impacts of individual and regional wealth on sustainable practices.

***Explicit and intentional efforts to promote inclusivity and a sense of belonging and safety for students, (e.g. universal design principles, culturally responsible pedagogy). Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

The subject matter in this class on climate change exposes students to topics that often can raise personal levels of anxiety, even despair. Frankly, the political contention and dire prognosis of future warming with unjust outcomes can be discomforting. We thus take explicit and intentional efforts to facilitate and equip students to work through and process their emotions while also establishing the

classroom to be a safe space to share concerns and engender a welcomed place of belonging regardless of political perspectives. The syllabus makes it explicit that the expectation for all students is to treat others with respect regardless of personal convictions or perspectives. We describe up front and reinforce throughout that group work is expected in the class, and that maintaining respectful decorum and sharing ideas without belittling others is expected. Frequent communication is expected, and we ask students to self-rate and rate each other in terms of their level and nature of interaction with group mates. We also use expert guidance. For example, during module 11, students will engage in role-playing with desktop EN-ROADS simulator. Each student is assigned to be part of a specific stakeholder group with their own interests. Yet the challenge is to try and negotiate with other teams to lower carbon emissions. Afterwards, we hold a group discussion with trained facilitators from the Byrd Polar and Climate Research Center that explicitly asks students to share how they felt throughout. Also, although students are encouraged to communicate together as a group, problems can arise. When they do, clear protocols are established whereby instructors intervene.

***Clear plan to market this course to get a wider enrollment of typically underserved populations. Please link this expectation to the course goals, topics and activities and indicate specific activities/assignments through which it will be met. (50-500 words)***

The Department of Geography is developing a strategy to advertise all its GE courses both together as a group and individually. This will include: flyers sent to all ASC advisors (as in the past) and, now that the GE is unified across the university, to other colleges as well information posted on departmental bulletin boards and our digital screens in Derby and on our departmental website, in-class promotions by instructors of our other GE courses, and promotions on CABS buses. To attract traditionally underrepresented students, we will specifically highlight aspects of the course that might be of interest to these students, including: the multidimensional aspects of inequality in climate change and how climate change impacts are not experienced equally in everyday lives. Another aspect of this course we will advertise that increases inclusion for everyone is no required textbook purchases.