GEO 2200L | Dynamic Planet Earth Laboratory

Class Number: 12356

Instructor Information

Name: Bewuket Tefera

Course Details

Catalog Description: Laboratory in physical geography. This course affords students the ability to critically examine and evaluate the principles of the scientific method, model construction, and use the scientific method to explain natural experiences and phenomena.
Pre- and Co-Requisites: Prereq or Coreq: GEO 2200 or GEO 2201.
Credit Hours: 1
Course Fees: $0.00

Additional Course Description

Welcome to GEO2200 Lab. This course will provide hands-on experiences and data analysis related to our dynamic planet Earth. This course will be different than a traditional class, as you will be engaging with the materials directly through activities and projects, mostly though this canvas shell. This course is a lab, which means we want you to play with data, experience and engage with real-world systems, and better understand the scientific process of analysis to understand the world around us.

The structure of the labs are such that you must complete all items on the page before the lab will allow you to continue. As such, you can review the lab tabs at the bottom of each lab module for completion. Each lab is composed of many shorter pages to break down the content into steps and not overwhelm you upfront. Content in each lab does build across the module and as your comprehension grows you will be asked to complete more advanced tasks.

In addition, each lab page has different types of questions within it. The main two types are ‘Checking In’ questions, which you should review as you progress

through the lab content. These are quick checks for you to read, answer out loud and then confirm you are correct by revealing the correct answers by clicking on them. These are simple check-ins with yourself to make sure you are following along. The second type of questions are the ‘Stop and Think’ questions, which are the questions you are answering for a grade and must be turned in. Please make sure that you have answered and turned in ALL the Stop and Think Questions at the end of the lab (they are numbered sequentially throughout each lab).

This is a study of some of the basic elements of the physical world in which climates, water, and landforms are examined in terms of their natural occurrences, distribution, and interrelationships. Through practical, hands-on lab activities and data analysis, students will explore these elements to gain a comprehensive understanding of the dynamic nature of Earth. The class meets the General Education requirements of a Physical Science (P) course.

Required Materials

The instructor has stated that there are no items required or recommended for this section.

A Note on Materials

All lecture materials (slides, readings, videos, data and maps) are posted on Canvas. Please check Canvas regularly for updates and weekly modules.

General Education - Physical Sciences

Successful completion of this course fulfills the General Education Physical Sciences requirement.

Natural Science courses must afford students the ability to critically examine and evaluate the principles of the scientific method, model construction, and use the scientific method to explain natural experiences and phenomena. There are two sub-designations under Natural Science at the University of Florida; Biological Sciences (B) and Physical Sciences (P)

Physical Sciences (P)

Physical science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the physical sciences. Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern physical systems. Students will formulate empirically-testable hypotheses derived from the study of physical processes, apply logical reasoning skills through scientific criticism and argument, and apply techniques of discovery and critical thinking to evaluate outcomes of experiments.

Course Goals and Objectives

By the end of this course, you will have developed an understanding in:

1. Climate Dynamics and Natural Phenomena: Comprehending the genesis and distribution patterns of various climatic conditions, hurricanes, coral reefs, hydrology, and drought scenarios, as well as changes in ice mass and sea levels.
2. Environmental Interplay: Gaining insights into how different components of the physical environment are interrelated and how they collectively shape regional geographical patterns.
3. Technological Application in Geography: Applying tools like Google Earth to explore and answer complex geographical questions, bridging the gap between theoretical concepts and practical technological applications.
4. Spatial Intelligence and Representation: Cultivating a robust understanding of spatial concepts using maps and other geographic representations enhances your ability to effectively acquire, process, and communicate spatially relevant information.

Expectations and Student Learning Outcomes

A student who successfully completes this course will be able to:

Content: Students demonstrate competence in the terminology, concepts, theories and methodologies used within the discipline(s).

- Describe the central concepts and theories of physical geography that guide our scientific understanding of our natural world—assessment based on individual assignments, questions, and reports.
- Describe and explain how the Earth's different spheres interact. Assessment: assessment based on individual assignments, questions, and reports.

Critical Thinking: Students carefully and logically analyze information from multiple perspectives and develop reasoned solutions to problems within the discipline(s).

- Identify and analyze differences in hurricanes, ice mass, sea level changes, and corals, and explain their history and formation. Assessment will be based on individual assignments, questions, and reports.
- Analyze and give examples of ice mass and sea level changes that impact natural systems. Assessment: based on individual assignments, questions, and reports.
- Analyze and give examples of how natural systems can impact society in different geographic settings. Assessment: based on individual assignments, questions, and reports.

Communication: Students communicate knowledge, ideas and reasoning clearly and effectively in written and oral forms appropriate to the discipline(s).

- Sketch and describe geographic processes such as global circulation, scales of weather, the hydrological cycle, and hurricanes. Assessment: based on individual assignments, questions, and reports.
- Reason around different ways humans interact with the natural resources and landscape around them and the associated opportunities and threats. Assessment: based on individual assignments, questions, and reports.

Connection: Students connect course content with meaningful critical reflection on their intellectual, personal, and professional development at UF and beyond.

- List some examples of information used by physical geographers and reflect on how these types of information could influence our lives. Assessment: Homework, exercises.

General Education Student Learning Outcomes

• Content: Students Demonstrate Competence In The Terminology, Concepts, Theories And Methodologies Used Within The Discipline(S).
O Describe The Central Concepts And Theories Of Physical Geography Which Guide Our Scientific Understanding Of Our Natural World. Assessment: Exams, Essays.
O Describe And Explain How The Earth’S Different Spheres Interact. Assessment: Exams, Exercises, Homework.
• Critical Thinking: Students Carefully And Logically Analyze Information From Multiple Perspectives And Develop Reasoned Solutions To Problems Within The Discipline(S).
O Identify And Analyze Differences In Physical Landscapes And Explain Their History And Formation. Assessment: Exams, Essays.
O Analyze And Give Examples Of How Humans Can Impact Natural Systems. Assessment: Exams, Homework, Exercises.

O Analyze And Give Examples Of How Natural Systems Can Impact Society In Different Geographic Settings. Assessment: Exams, Homework, Exercises.
• Communication: Students Communicate Knowledge, Ideas And Reasoning Clearly And Effectively In Written And Oral Forms Appropriate To The Discipline(S).
O Sketch And Describe Geographic Processes Such As The Global Circulation, Plate Tectonics, The Hydrological Cycle And The Rock Cycle. Assessment: Exams.
O Reason Around Different Ways Humans Interact With The Natural Resources And Landscape Around Them, And The Associated Opportunities And Threats. Assessment: Exams, Exercises.
• Connection: Students Connect Course Content With Meaningful Critical Reflection On Their Intellectual, Personal, And Professional Development At Uf And Beyond.
O List Some Examples Of Information Used By Physical Geographers And Reflect On How These Types Of Information Could Influence Our Lives. Assessment: Homework, Exercises.

Methods of Evaluation

The course is divided into five modules, each representing a key aspect of geographical science. Students must complete all five modules and all required assignments in order to receive full credit for the course. Modules 1, 2, 3, 4, and 5 are required for Fall 2026. These modules focus on fundamental concepts such as Climatology Basics; Hurricanes; Ice Mass and Sea Level Changes; Corals; Hydrology, and Drought, respectively, This approach allows students to concentrate on mastering essential concepts while completing all required course material during the Fall 2026 semester.

Point allocation for required course modules in Fall 2026.

Assignment	Points
Module 1: Climatology Basics	300
Module 2: Hurricanes: Meteorological Monsters	300
Module 3: Ice Mass and Sea Level Changes	300
Module 4: Corals	300
Module 5: Hydrology, and Drought	300
Total	1500

***Course schedule and points are subject to change**. Students must complete all five modules and all required assignments in order to receive full credit for the course.

Grading Scale

Letter grade and percentage

Letter	Percentage Value
A	93 - 100%
A -	90 - 92.9%
B +	87 - 89.9%
B	83 - 86.9%
B -	80 - 82.9%
C +	77 - 79.9%
C	73 - 76.9%
C -	70 - 72.9%
D +	67 - 69.9%
D	63 - 66.9%
D -	60 - 62.9%
E	< 60%

Minimum Grade Required

A minimum grade of C is required to earn General Education, Quest, and/or Writing Requirement credit. Courses used to satisfy these requirements may not be taken S/U.

Course Schedule

Table 1. Course schedule and assignment deadlines for Fall 2026
Course Schedule — Fall 2026

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Module 1

- Quiz: Course Orientation Quiz — Thursday, August 20, 2026, 11:59 PM
- Module 1, Part 1: Scales of Weather and Climate (Part 1.7) — Friday, August 28, 2026, 11:59 PM
- Module 1, Part 1: Climatology Basics (Part 1.8) — Friday, August 28, 2026, 11:59 PM
- Climate Study (Part 2.11) — Friday, September 4, 2026, 11:59 PM
- Module 1, Part 2: Regional Climate Drivers (Part 2.12) — Friday, September 4, 2026, 11:59 PM
- Module 1, Part 3: Local Weather Stories (Part 3.7) — Friday, September 11, 2026, 11:59 PM

Module 1 note: Required readings, videos, and web resources for this module are listed in the Additional Required Readings and Media List section. Students are expected to complete all assigned Canvas pages, videos, and linked web resources before submitting Module 1 assignments. Optional enrichment resources are identified separately and are not required.

Module 2

- Module 2, Part 1: Hurricanes: Earth’s Meteorological Monsters (P1.5) — Friday, September 18, 2026, 11:59 PM
- Module 2, Part 2: Hurricane Anatomy (P2.6) — Friday, September 25, 2026, 11:59 PM
- Module 2, Part 3: Putting Hurricanes on the Map (P3.5) — Friday, October 2, 2026, 11:59 PM

Module 2 note: Required materials: assigned Canvas pages; SERC EarthLabs hurricane lab pages; NASA videos and visualizations on the 2005 Atlantic hurricane season, Hurricane Katrina, Hurricane Frances, hot towers, and Hurricane Wilma; NOAA/NHC Saffir-Simpson Hurricane Wind Scale; HURDAT2 Atlantic hurricane database; NHC Data Archive; NOAA Historical Hurricane Tracks viewer; and Google Earth storm-track activity.

Table 1. Course schedule and assignment deadlines for Fall 2026
Module 3 • Module 3, Part 1: Rising Concerns Over Rising Sea Levels (P1.4) — Friday, October 16, 2026, 11:59 PM • Module 3, Part 2: Temperature: A Global Trendsetter (P2.7) — Friday, October 23, 2026, 11:59 PM • Module 3, Part 3: Warm with a Chance of Melting (P3.4) — Friday, October 30, 2026, 11:59 PM Module 3 note: Required materials: assigned Canvas pages; GETSI Ice Mass and Sea Level Changes module materials; instructor-provided slides and maps; NASA GISTEMP global temperature anomaly graphs; University of Colorado global mean sea level data; assigned IPCC temperature and sea level projection figures; GRACE/GRACE-FO videos and background resources; University of Maine Climate Reanalyze maps; Greenland temperature and snowmelt activities; and Canvas assignment documents.
Module 4 • Module 4, Part 1: Finding Coral’s Ideal Environment (P1.6) — Monday, November 2, 2026, 11:59 PM • Module 4, Part 2: Factors That Impact Coral Health (P2.10) — Friday, November 6, 2026, 11:59 PM • Module 4, Part 3: Predict Bleaching (P3.6) — Friday, November 13, 2026, 11:59 PM Module 4 note: Required materials: assigned Canvas pages; coral reef and coral bleaching readings; instructor-provided slides and maps; NOAA coral reef and bleaching resources; sea-surface temperature and marine heat-stress resources; and Canvas assignment documents.
Module 5 • Module 5, Part 1: Worldwide Water Distribution (P1.6) — Friday, November 20, 2026, 11:59 PM • Module 5, Part 2: Normal Climate Patterns (P2.6) — Monday, November 30, 2026, 11:59 PM • Module 5, Part 3: Maps That Describe Climate (P3.6) — Wednesday, December 2, 2026, 11:59 PM Module 5 note: Required materials: assigned Canvas pages; instructor-provided slides and maps; global water distribution resources; climate pattern and climate classification resources; map interpretation materials; and Canvas assignment documents. Students should plan ahead because Thanksgiving Break occurs before the final Module 5 deadlines.

Table 1. Course schedule and assignment deadlines for Fall 2026
Extra Credit Extra Credit Assignment: Talking About the Weather (P3.5) — Wednesday, December 2, 2026, 11:59 PM
Course schedule and points are subject to change.

Reading List Note:

All required readings and instructional materials for this course, including Canvas readings, articles, videos, films, podcasts, websites, and other assigned resources, are identified in this syllabus. Module-specific required materials are listed in the "Additional Required Readings List" section, with citation information provided as needed.

Alignment of SLOs

In this physical geography lab, module assignments, lab activities, maps, and written responses help students meet UF Gen Ed SLOs by building knowledge of Earth systems, strengthening data analysis and scientific reasoning, improving written communication, and connecting physical geography to real-world environmental issues.

University Policies and Resources

Information about grading policies, support for students with disabilities, course evaluations, the Honor Code, and other course policies and campus resources can be found on the Syllabus Policies page.

Attendance Policy

Excused and Unexcused Absences

Students may only participate in classes if they are registered officially or approved to audit with evidence of having paid audit fees. The Office of the University Registrar provides official class rolls to instructors.

Students are responsible for satisfying all academic objectives as defined by the instructor. Absences count from the first-class meeting.

Acceptable reasons for absence from or failure to engage in class include illness; Title IX-related situations; serious accidents or emergencies affecting the student,

their roommates, or their family; special curricular requirements (e.g., judging trips, field trips, professional conferences); military obligation; severe weather conditions that prevent class participation; religious holidays; participation in official university activities (e.g., music performances, athletic competition, debate); and court-imposed legal obligations (e.g., jury duty or subpoena). Other reasons (e.g., a job interview or club activity) may be deemed acceptable if approved by the instructor.

For all planned absences, a student in a situation that allows an excused absence from a class, or any required class activity must inform the instructor as early as possible prior to the class. For all unplanned absences because of accidents or emergency situations, students should contact their instructor as soon as conditions permit.

Students shall be permitted a reasonable amount of time to make up the material or activities covered during absence from class or inability to engage in class activities because of the reasons outlined above.

If a student does not participate in at least one of the first two class meetings of a course or laboratory in which they are registered, and they have not contacted the department to indicate their intent, the student can be dropped from the course. Students must not assume that they will be dropped, however. The department will notify students if they have been dropped from a course or laboratory.

The university recognizes the right of the instructor to make attendance mandatory and require documentation for absences (except for religious holidays), missed work, or inability to fully engage in class. After due warning, an instructor can prohibit further attendance and subsequently assign a failing grade for excessive absences.

Religious Holidays Guidelines

At the University of Florida, students and faculty work together to allow students the opportunity to observe the holy days of their faith. A student should inform the faculty member of the religious observances of their faith that will conflict with class attendance, with tests or examinations, or with other class activities prior to the class or occurrence of that test or activity. The faculty member is then obligated to accommodate that particular student's religious observances. Because students represent a myriad of cultures and many faiths, the University of Florida is not able to assure that scheduled academic activities do not conflict

with the holy days of all religious groups. Accordingly, individual students should make their need for an excused absence known in advance of the scheduled activities.

The Florida Board of Education and state law govern university policy regarding observance of religious holidays.

Guidelines

- Students, upon prior notification to their instructors, shall be excused from class or other scheduled academic activity to observe a religious holy day of their faith.
- Students shall be permitted a reasonable amount of time to make up the material or activities covered in their absence.
- Students shall not be penalized due to absence from class or other scheduled academic activity because of religious observances.

If a faculty member is informed of or is aware that a significant number of students are likely to be absent from class because of a religious observance, the faculty member should not schedule a major exam or other academic event at that time.

A student who is to be excused from class for a religious observance is not required to provide a second party certification of the reason for the absence. Furthermore, a student who believes that they have been unreasonably denied an education benefit due to religious beliefs or practices may seek redress through the student grievance procedure.

Absence due to Illness

A student who is absent from class or any required class-related activity because of illness should contact their instructor, if feasible, as early as possible prior to the missed class or activity.

Students shall be permitted a reasonable amount of time to make up the material or activities covered during an excused absence.

Students should contact their college by the deadline to drop a course for medical reasons. Students can petition the Dean of Students Office to drop a course for medical reasons. The university’s policy regarding medical excuse from classes is maintained by the Student Health Care Center.

Twelve-Day Rule

Students who participate in university-sponsored athletic or scholarly activities are permitted to be absent 12 scholastic days per semester without penalty. A scholastic day is any day on which regular class work is scheduled as defined in the approved university calendar. More Info

The student or student's advisor must notify the instructor as early as possible prior to the anticipated absence to allow ample time for accommodations. Instructors must be flexible and not penalize students when re-scheduling during-term and final exams, class assignments, and other required activities and must follow the UF Attendance Policy herein and UF Examination Policies. As noted in the UF Examination Policies, during-term exams should be re-scheduled no later than before the end of the semester, while final exams no later than 90 days after the originally scheduled exam time. However, instructors are encouraged to re-schedule final and during-term exams, assignments, and other activities as soon as possible after the last day of the absence and must not penalize the student in any way. More Info

A group's schedule that requires absence of more than 12 scholastic days should be adjusted so that no student is absent from campus more than 12 scholastic days. Students who previously have been warned in writing by their instructor about the impact of absences on their individual class performance should not incur additional absences, even if they have not been absent 12 scholastic days. The student is responsible to maintain satisfactory academic performance and attendance.

Course Policies and Resources

Meeting Policy

If you need help with any aspect of the course, you are encouraged to come to office hours (see the details on Page 1 of this syllabus). Alternatively, you can schedule a 1-on-1 meeting with the instructor. Please email Bewuket Tefera to arrange a meeting time. Outside of office hours, email is the preferred method of contact. I will do my best to respond to messages within 72 hours (not including weekends or holidays). As a courtesy, please check the syllabus and Canvas before reaching out; answers to many of your questions can be found there.

Canvas

Important announcements and updates will be regularly posted to the course Canvas website, so be sure to check Canvas frequently. To ensure that you do not miss anything, please make sure that your Canvas profile is set to receive notifications.

Email Accounts

It is UF policy that you use your GatorLink account or Canvas when emailing your instructors; we will not answer emails sent from other accounts (e.g., personal Gmail, etc.).

Professional Conduct

All members of the class are expected to conduct themselves in a professional and respectful manner at all times. Please use appropriate etiquette when interacting with your peers and instructors, including on Canvas and via email. Students who behave disrespectfully or disruptively will be reported to the Dean of Students Office.

Extra Credit

Extra credit assignments may be posted at the instructors' discretion only. Any other extra work submitted in order to raise a grade will not be accepted and requests for additional extra credit will not be considered.

Submitting Assignments

All assignments must be submitted electronically via Canvas unless otherwise noted. Emailed or paper submissions for Canvas assignments will not be accepted. You are responsible for ensuring that all your work is uploaded correctly and completely by the deadline. Corrupted files will be treated as missing work (= 0 grade) until they are re-uploaded correctly and late penalties will apply if your resubmission is past the deadline. So, please always double-check your files right after you upload them. If you experience technical problems when submitting your work in Canvas, contact the UF Computing Help Desk for assistance: https://helpdesk.ufl.edu .

Disputing a Grade

If you wish to dispute a grade for any assignment, you must contact the instructor in writing within two business days (48 hours) after the assignment has been returned. In your message, you must include a specific explanation for why you

think the grade is incorrect and how you think it should be changed. An instructor will then arrange a meeting with you to discuss the issue and determine whether or not to the grade should be changed. The grade assigned following this meeting will be final.

Accommodations

Instructors' note: We want you to succeed in this course! To ensure your accommodations are in place when you need them, please be sure to have your DRC accommodation letter sent to us as early as possible– ideally at the beginning of the semester.

Artificial Intelligence & Large Language Model (LLM) use policy

In this course, the use of generative AI tools (such as ChatGPT or Adobe Firefly) is not permitted during the completion of any assigned work. Use of a generative AI tool to complete assigned work in whole or in part may be referred under the Code of Student Conduct academic dishonesty provisions for further action by the Dean of Students Office. Students may use generative AI tools to support their independent study of course topics, but should do so with the understanding that generative AI tools may not be trustworthy.

Understanding This Syllabus

It is your responsibility to ensure that you fully understand the policies outlined in this syllabus as well as the policies of the university as they relate to this course. By remaining enrolled in this course, you agree that you have read and understood all of these policies and that you will be held accountable to them.

At their discretion, the instructor may change aspects of the course during the semester to accommodate new opportunities, unforeseen disruptions, or other circumstances. These changes will be communicated clearly in class and through Canvas. The current version of the syllabus will always be available on our course's Canvas website. It is your responsibility to ensure that you are following the most recent version of the syllabus.

If you have any questions, please contact the instructors as soon as possible (preferably at the beginning of the course)!

Late and Make Up Work Policy

All assignments must be submitted by the due date and time indicated on Canvas. If an assignment is submitted late, 10% of its total point value will be deducted for every day that it is late. Credit cannot be earned for assignments that are turned in 10+ days past the due date. Late work will not be accepted after the deadline for the final assignment in the course.

Extensions will be considered on a case-by-case basis (at the instructor's discretion) only in the event of unforeseen emergencies. In such a case, you must contact the instructor as soon as possible to discuss the situation; note that the instructor may request documentation. No extensions will be granted for students who miss the due date for any other reason.

A note about deadlines: Remember, the due date does not have to be the "do" date. In other words, it is highly encouraged to work on your assignments in advance– do not wait until right before the deadline to submit your work. Last-minute computer problems or other non-emergency situations that arise right before the deadline are not valid reasons for requesting an extension; such requests will not be considered and late penalties will be applied to your work if it is not submitted before the deadline.

Classroom Behavior

Instructors' note: Any action that subverts the learning goals of the course (or a particular course activity) will be treated as academic misconduct and reported to the Dean of Students Office. This includes– but is not limited to– cheating or assisting others in cheating, plagiarism (i.e., misrepresenting someone else's work as your own, whether it is copied directly or paraphrased), self-plagiarism (i.e., copying/reusing work that you have submitted previously), collaborating with others when it is not permitted, fabricating data, lying to an instructor, and bad faith attempts to undermine the intent of an learning activity. If found responsible by the Dean of Students Office, a grade adjustment will be applied, typically resulting in a score of zero on the assignment.

Technology in the Classroom

Minimum Technology Requirements

The University of Florida expects students entering an online program to acquire computer hardware and software appropriate to their degree program. Most computers are capable of meeting the following general requirements. A student's computer configuration should include:

- Webcam
- Microphone
- Broadband connection to the internet and related equipment (cable/DSL modem)
- Microsoft Office Suite installed (provided by the university)

Individual colleges may have additional requirements or recommendations, which students should review before starting their program.

Minimum Technical Skills

To complete your tasks in this course, you will need a basic understanding of operating a computer and using word processing software.

Materials/Supply Fees

There is no supply fee for this course.

Zoom

Zoom is an easy-to-use video conferencing service available to all UF students, faculty, and staff that allows for meetings of up to 100 participants.

You can find resources and help using Zoom at the University of Florida's ZoomLinks to an external site. website.

Additional Required Readings List

Module 1. Climatology Basics: Global, Regional, and Local Weather Drivers

Overview

- Science Education Resource Center (SERC) at Carleton College. (2011). Lab 3: Climatology Basics What Factors Affect Climate? EarthLabs. Available in Canvas and adapted from EarthLabs materials. https://serc.carleton.edu/earthlabs/weather_climate/lab_3.html
- Science Education Resource Center (SERC) at Carleton College. (2011). EarthLabs Weather and Climate Lab Overviews. Available in Canvas. This overview explains that students use graphics, videos, and maps to study the physical factors influencing climate and the drivers operating at global, regional, and local scales. https://serc.carleton.edu/earthlabs/weather_climate/overview.html

Part 1. Planetary Circulation Patterns

- Science Education Resource Center (SERC) at Carleton College. (2011). Climatology Basics, Part 1 / 3A: Planetary Circulation Patterns. EarthLabs. Available in Canvas. https://serc.carleton.edu/earthlabs/weather_climate/lab_3.html
- EarthLabs. (2008). Simplified global climate patterns. Figure used in module materials. Listed in the module content you shared.
- NASA Scientific Visualization Studio. (2009). GEOS-5 Modeled Clouds at 3.5-km Global Resolution. Video/visualization showing clouds from the Goddard Earth Observing System Model, Version 5 (GEOS-5). https://svs.gsfc.nasa.gov/3659
- TERC & Informmotion. (2022). Moving Heat. Video adaptation of the EarthLabs interactive application used to examine how the ocean and atmosphere move heat and moisture around the globe. This resource is named in module text.
- Science Education Resource Center (SERC) at Carleton College. (2011). Climatology Basics. EarthLabs introduction to global circulation, climate drivers, and weather–climate timescales. https://serc.carleton.edu/earthlabs/weather_climate/lab_3.html

Part 2. Regional Climate Drivers

- Science Education Resource Center (SERC) at Carleton College. (2011). Climatology Basics, Part 2 / 3B: Regional Climate Drivers. EarthLabs. https://prism.oregonstate.edu/normals/ . Regional drivers listed include air masses, fronts, pressure systems, wind patterns, ocean surface currents, and mountain ranges/topography. https://serc.carleton.edu/eslabs/weather/3b.html
- UCAR Center for Science Education. (2026.). Air Masses. Educational resource explaining air-mass naming and classification by humidity and source-region temperature. https://scied.ucar.edu/learning-zone/how-weather-works/air-masses
- National Weather Service. (2022). Air circulation patterns around high and low pressure centers. Figure/resource referenced in module materials.
- UCAR Center for Science Education. (2026). The Highs and Lows of Air Pressure. Background resource on pressure, density, and high/low pressure systems. https://scied.ucar.edu/learning-zone/how-weather-works/highs-and-lows-air-pressure
- ArcGIS / Esri. (2018). What Causes Ocean Currents? StoryMap. Used in the module to examine current motion, Coriolis effects, and geographic patterns of ocean circulation. https://www.arcgis.com/home/item.html?id=d629dd5cc3fe48ea9fc744dada861da0
- NOAA National Centers for Environmental Information (NCEI). (2026). Climate at a Glance: Statewide Time Series and related state climate resources. Used in the module for state climate summaries and regional climate context. https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide/time-series

Part 3. Local Weather Stories

- Science Education Resource Center (SERC) at Carleton College. (2011). Climatology Basics, Part 3 / 3C: Local Weather Stories. EarthLabs. Available in Canvas. https://serc.carleton.edu/eslabs/weather/3c.html
- National Weather Service. (2022). Weather map for October 25, 2022. Figure/resource referenced in module materials.
- Science Education Resource Center (SERC) at Carleton College. (2022). Track a Storm System slideshow/activity.
- Community Collaborative Rain, Hail and Snow Network (CoCoRaHS). (2026.). CoCoRaHS. Volunteer weather-observation network referenced in the module for

local weather observation. CoCoRaHS describes itself as a grassroots volunteer network measuring and mapping precipitation. https://www.cocorahs.org/

Optional Readings and Media

- UCAR Center for Science Education. (2026). How Weather Works. Optional background on atmospheric circulation, fronts, and weather maps. https://scied.ucar.edu/learning-zone/how-weather-works
- UCAR Center for Science Education. (2026). Image Gallery including air masses, global atmospheric circulation, and high/low pressure systems. Optional extension resource. https://scied.ucar.edu/image?field_learning_zone_category_target_id=31
- ArcGIS / Esri. (2026). How Do Ocean Currents Impact the World? Optional story map extension referenced in the module materials. The module text also includes the companion current-circulation story map. https://community.esri.com/t5/ocean-science-blog/new-ocean-currents-story-map/ba-p/903025
- Additional optional demonstrations and extensions listed in the module materials, including air masses and fronts, air pressure and soda cans, surface currents and coastal temperatures, clouds and air pressure, and weather-related case examples.

Module 2. Hurricanes: Earth's Meteorological Monsters

Overview

- Science Education Resource Center (SERC) at Carleton College. (2026) https://serc.carleton.edu/index.html . Hurricanes Unit Overview. EarthLabs (https://serc.carleton.edu/earthlabs/index.html . Available in Canvas and adapted from EarthLabs materials. https://serc.carleton.edu/earthlabs/hurricanes/index.html

- Science Education Resource Center (SERC) at Carleton College. (2026). Module 2 Overview: Hurricanes. Course page available in Canvas. Module 2 is organized into Part 1, Part 2, and Part 3, with required Canvas pages and assignment submissions.

Part 1. Hurricanes: Earth's Meteorological Monsters

- Science Education Resource Center (SERC) at Carleton College. (2026). Lab 1: Meteorological Monsters. EarthLabs. Available in Canvas. This lab centers on interpretation of a NASA visualization of the 2005 Atlantic hurricane season. (SERC)
- NASA Scientific Visualization Studio. (2006). 27 Storms: Arlene to Zeta. Greenbelt, MD: National Aeronautics and Space Administration. Video/visualization of the 2005 Atlantic hurricane season. (https://svs.gsfc.nasa.gov/3354)
- NASA Scientific Visualization Studio. (2005/2010). Named Storms from the 2005 Atlantic Hurricane Season or 2005 Hurricane Season. Greenbelt, MD: National Aeronautics and Space Administration. Visualization showing sea-surface temperatures, infrared cloud data, storm tracks, and storm names. (https://svs.gsfc.nasa.gov/3279)
- NASA Earth Observatory. (2005, December 17). 2005 Atlantic Hurricane Season. National Aeronautics and Space Administration. (https://science.nasa.gov/earth/earth-observatory/2005-atlantic-hurricane-season-6116/)
- National Aeronautics and Space Administration (NASA). (2007). Global wind circulation patterns / educational figure used in module materials. Available

through NASA educational resources and Canvas-linked course materials. (https://serc.carleton.edu/earthlabs/hurricanes/2.html)

Part 2. Hurricane Anatomy

- Science Education Resource Center (SERC) at Carleton College. (n.d.). Lab 2: Hurricane Anatomy. EarthLabs. (https://serc.carleton.edu/earthlabs/hurricanes/2.html)
- National Hurricane Center. (n.d.). Saffir-Simpson Hurricane Wind Scale. National Oceanic and Atmospheric Administration. (National Hurricane Center https://www.nhc.noaa.gov/aboutsshws.php)
- NASA Scientific Visualization Studio. (2010, August 24). Katrina Retrospective: 5 Years After the Storm. National Aeronautics and Space Administration. (https://svs.gsfc.nasa.gov/10633)
- NASA Earth Observatory. (2004, September 7). Hurricane Frances. National Aeronautics and Space Administration. This resource documents sea-surface temperature observations from the AMSR-E instrument aboard Aqua. (https://science.nasa.gov/earth/earth-observatory/hurricane-frances-13805/)
- NASA Global Precipitation Measurement / Precipitation Education. (n.d.). Towers in the Tempest. National Aeronautics and Space Administration. Educational video on “hot towers” and hurricane intensification. (NASA GPM Mission https://gpm.nasa.gov/education/videos/towers-tempest)
- NASA Scientific Visualization Studio. (2007, May 10). Towers in the Tempest. National Aeronautics and Space Administration. (NASA Scientific Visualization Studio https://svs.gsfc.nasa.gov/3413)
- NASA Scientific Visualization Studio. (2005, September 27). Hurricane Wilma Rain Accumulation. National Aeronautics and Space Administration. Visualization based on TRMM precipitation data. (NASA Scientific Visualization Studio https://svs.gsfc.nasa.gov/3290)
- NASA Earth Observatory. (2005, October 26). Hurricane Wilma. National Aeronautics and Space Administration. (NASA Science https://science.nasa.gov/earth/earth-observatory/hurricane-wilma-15719)

Part 3. Putting Hurricanes on the Map

- National Hurricane Center. (2025). HURDAT2 Atlantic Hurricane Database (https://www.nhc.noaa.gov/data/hurdat/hurdat2-1851-2021-100522.txt) . National Oceanic and Atmospheric Administration. Used for storm selection and storm-track data. (AOML) https://www.nhc.noaa.gov/data/hurdat/hurdat2-format-atlantic.pdf
- National Hurricane Center. (2026. NHC Data Archive. National Oceanic and Atmospheric Administration. Used for Tropical Cyclone Reports and storm summary reports. (National Hurricane Center https://www.nhc.noaa.gov/data)
- NOAA Office for Coastal Management. 2026). Historical Hurricane Tracks. National Oceanic and Atmospheric Administration. Interactive mapping tool for searching and visualizing hurricane tracks by storm, location, and year. (NOAA Coast) https://coast.noaa.gov/hurricanes/#map=4/32/-80, https://oceanservice.noaa.gov/news/historical-hurricanes/
- Google. (2026.). Google Earth. Used in the module to create storm-track visualizations from HURDAT2 data. https://earth.google.com/web, https://www.google.com/earth/about/versions/
- National Hurricane Center. (2014). The Revised Atlantic Hurricane Database (HURDAT2). Documentation PDF for reading storm titles and best-track entries. (National Hurricane Center) https://www.nhc.noaa.gov/data/hurdat/hurdat2-format-atlantic.pdf

Optional Readings and Media

- NASA NESDIS / NOAA. (2026). Live Hurricane Tracker. Optional real-time hurricane monitoring resource. (NOAA Satellite and Information Service) https://www.nesdis.noaa.gov/imagery/hurricanes/live-hurricane-tracker
- NOAA Office for Coastal Management. (2026). Historical Hurricane Tracks Data Download / Digital Coast Data Page. Optional extension for GIS-based exploration of hurricane tracks. (NOAA Coast) https://coast.noaa.gov/digitalcoast/data/hurricanes.html, https://www.nhc.noaa.gov/gis
- NASA Scientific Visualization Studio. (n.d.). Hurricane Resources. Optional gallery of hurricane-related visualizations. (https://svs.gsfc.nasa.gov/gallery/hurricane-resources)

Module 3. Ice Mass and Sea Level Changes

Overview

- Science Education Resource Center (SERC) at Carleton College. (2015). Ice Mass and Sea Level Changes. GEodesy Tools for Societal Issues (GETSI). Available in Canvas and adapted from GETSI materials. (SERC https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/index.html) https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/student_materials/index.html
- Science Education Resource Center (SERC) at Carleton College. (2015). Overview of the Ice Mass and Sea Level Changes Module. Course content focused on Greenland ice mass change, sea level, and Earth-system interactions. (SERC) https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/student_materials/index.html

Part 1. Rising Concerns Over Rising Sea Levels

- Science Education Resource Center (SERC) at Carleton College. (2015). Ice Mass and Sea Level Changes module materials, Part 1: sea level rise impacts and societal implications. (SERC) https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/student_materials/index.html , https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/index.html
- World Bank. (2010). Map of poverty in Bangladesh. Resource referenced in module materials for examining vulnerability to sea level rise in Bangladesh. https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/unit1.html
- Instructor-provided PowerPoint slides on sea level rise and contributing environmental factors. Available in Canvas.
- Assigned article: Rising Concerns Over Rising Sea Levels in Bangladesh. Available in Canvas or linked course materials.

Part 2. Temperature: A Global Trendsetter

- Science Education Resource Center (SERC) at Carleton College. (2015). Module lesson materials for sea level trends, projections, and climate data interpretation. (SERC)
- National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA GISS). (n.d.). GISS Surface Temperature Analysis (GISTEMP v4). Global temperature anomaly graphs and data. (GISS Data) https://data.giss.nasa.gov/gistemp/graphs_v4/

- National Aeronautics and Space Administration. (2026). Global Temperature. Earth Indicators. Explains the anomaly baseline and current global temperature context. (https://science.nasa.gov/earth/explore/earth-indicators/global-temperature)
- National Aeronautics and Space Administration. (2026). World of Change: Global Temperatures. Background on temperature anomalies and long-term warming patterns. (https://science.nasa.gov/earth/earth-observatory/world-of-change/global-temperatures)
- Sea Level Research Group, University of Colorado Boulder. (2026). Global Mean Sea Level. Global sea level data and related background information. (https://sealevel.colorado.edu/)
- Science Education Resource Center (SERC) at Carleton College. (2026). The Math You Need, When You Need It. Rate-of-change and trend-line tutorials used in the Helpful Math lesson. These materials are hosted by SERC and include graphing and rates tutorials. (https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/index.html)
- Metric Conversions. 2026). Celsius to Fahrenheit Converter. Optional support tool referenced in the module for interpreting temperature units. metric-conversions.org/temperature/celsius-to-fahrenheit.htm

Part 3. Warm With a Chance of Melting

- Science Education Resource Center (SERC) at Carleton College. (2015). Unit 3: Warm with a Chance of Melting. Greenland temperature, snowmelt, ice elevation, ice velocity, and GRACE-based ice mass change activities. (https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/unit3.html https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/overview.html)
- NASA Jet Propulsion Laboratory. (2026). Gravity 101. GRACE mission overview explaining how changes in Earth's gravity field are measured. (GRACE Tellus https://grace.jpl.nasa.gov/mission/gravity-101)
- NASA Jet Propulsion Laboratory. (2019). NASA's GRACE: What We've Learned from Water in Motion. Background on GRACE observations of Greenland and global water mass change. (https://www.jpl.nasa.gov/news/nasas-grace-what-weve-learned-from-water-in-motion)
- NASA Jet Propulsion Laboratory / NASA. (2020). GRACE, GRACE-FO Satellite Data Track Ice Loss at the Poles. Background on Greenland and Antarctic ice loss observed by GRACE missions. (https://www.nasa.gov/centers-and-facilities/jpl/grace-grace-fo-satellite-data-track-ice-loss-at-the-poles)
- University of Maine Climate Reanalyze. (2026). Climate Reanalyze. Greenland air temperature maps used in the air-temperature preparation activity.
- NASA. (2026). Freshwater storage in the United States, as measured by GRACE. Resource referenced in the GRACE USA map activity.
- Instructor-provided Greenland air temperature, snowmelt, and prediction/evidence maps. Available in Canvas.
- https://d32ogoqmya1dw8.cloudfront.net/files/getsi/teaching_materials/ice_sealevel/student_materials/group_air_temperature_snow.v3.pdf
- GEodesy Tools for Societal Issues (GETSI). (2026). Greenland air temperature, snowmelt, and study-site maps used for prediction and evidence exercises. (https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/overview.html , https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/unit3.html) https://d32ogoqmya1dw8.cloudfront.net/files/getsi/teaching_materials/ice_sealevel/student_materials/air_temperature_preparation_ex.pdf

Optional Readings and Media

- Science Education Resource Center (SERC) at Carleton College. (2026.). The Math You Need, When You Need It. Additional optional math help for graphing,

best-fit lines, and rates of change. (https://serc.carleton.edu/getsi/teaching_materials/ice_sealevel/index.html)
- NASA Jet Propulsion Laboratory Education. (2025). Tracking Water Using NASA Satellite Data. Optional extension activity related to GRACE and water storage. (https://www.jpl.nasa.gov/edu/resources/lesson-plan/tracking-water-using-nasa-satellite-data)
- NASA Jet Propulsion Laboratory Education. (2024). NASA Mission Gets the View on Earth's Water Resources From Space. Optional teaching resource on GRACE-FO and water-cycle monitoring. (https://www.jpl.nasa.gov/edu/resources/teachable-moment/nasa-mission-gets-the-view-on-earths-water-resources-from-space)
- NASA Sea Level Change Team. (2020). Study: 2019 Sees Record Loss of Greenland Ice. Optional reading on recent Greenland ice-loss context. (https://sealevel.nasa.gov/news/190/study-2019-sees-record-loss-of-greenland-ice)

Modules 4 Corals

Overview

- Science Education Resource Center (SERC) at Carleton College. (2008). Corals Unit Overview. EarthLabs. Available in Canvas and adapted from EarthLabs materials. https://serc.carleton.edu/earthlabs/corals/index.html
- Science Education Resource Center (SERC) at Carleton College. (2008). Corals Lab Overviews. EarthLabs. Available in Canvas. This overview lists the coral module labs, including Finding Coral's Ideal Environment, Trouble in Paradise: Factors that Impact Coral Health, and Using Data to Identify Hot Spots and Predict Bleaching Events. https://serc.carleton.edu/earthlabs/corals/activities.html
- National Oceanic and Atmospheric Administration (NOAA). (2026). Coral reef ecosystems. NOAA Education Resource Collection. Background resource on coral reefs, zooxanthellae, reef-building corals, and coral reef ecosystem importance. https://www.noaa.gov/education/resource-collections/marine-life/coral-reef-ecosystems

Part 1. Finding Coral's Ideal Environment

- Science Education Resource Center (SERC) at Carleton College. (2008). Lab 4: Finding Coral's Ideal Environment. EarthLabs. Available in Canvas. This lab examines sea surface temperature, depth, salinity, and aragonite saturation to identify the environmental conditions in which coral reefs thrive. https://serc.carleton.edu/earthlabs/corals/4.html
- National Oceanic and Atmospheric Administration (NOAA). (2021). Coral reef locations around the world. Map/resource referenced in module materials.
- National Oceanic and Atmospheric Administration (NOAA). (2007). Monthly Mean Global Sea Surface Temperature (SST): February Climatology, 1982–1995. Figure/resource referenced in module materials.
- National Aeronautics and Space Administration (NASA). (n.d.). Average global ocean salinity using the Practical Salinity Scale (PSS). Figure/resource referenced in module materials.
- Hoegh-Guldberg, O., Mumby, P. J., Hooten, A. J., Steneck, R. S., Greenfield, P., Gomez, E., Harvell, C. D., Sale, P. F., Edwards, A. J., Caldeira, K., Knowlton, N., Eakin, C. M., Iglesias-Prieto, R., Muthiga, N., Bradbury, R. H., Dubi, A., & Hatziolos, M. E. (2007). Coral reefs under rapid climate change and ocean acidification. Science, 318(5857), 1737–1742. https://doi.org/10.1126/science.1152509

- NOAA National Ocean Service. (2024). In what types of water do corals live? Background resource on coral temperature, salinity, clear water, sunlight, and zooxanthellae requirements. https://oceanservice.noaa.gov/facts/coralwaters.html

Part 2. Trouble in Paradise: Factors That Impact Coral Health

- Science Education Resource Center (SERC) at Carleton College. (2008). Lab 5: Trouble in Paradise: Factors that Impact Coral Health. EarthLabs. Available in Canvas. This lab uses Google Earth and reef-threat data to examine local and global factors that disrupt coral reef ecosystems. https://serc.carleton.edu/earthlabs/corals/5.html
- World Resources Institute. (2011). Reefs at Risk Revisited. Report and data resources used to evaluate coral reef threats from human activities, including watershed pollution, coastal development, exploitive fishing, physical damage, warming, and ocean acidification. https://www.wri.org/research/reefs-risk-revisited
- World Resources Institute. (2011). Reefs at Risk Revisited Data Sets. Data resources used in the module's Google Earth reef-risk activities. https://www.wri.org/data/reefs-risk-revisited
- World Resources Institute. (2011). Reefs at Risk Projections: Present, 2030, and 2050. Data resource used to compare present and projected future reef-threat levels. https://www.wri.org/data/reefs-risk-projections-present-2030-and-2050
- National Oceanic and Atmospheric Administration (NOAA). (2007). Blast fishing and coral reef damage. Image/resource referenced in module materials.
- NOAA National Ocean Service. (2024). What is coral bleaching? Background resource explaining bleaching, zooxanthellae loss, thermal stress, and coral mortality risk. https://oceanservice.noaa.gov/facts/coral_bleach.html

Part 3. Using Data to Identify Hot Spots and Predict Bleaching Events

- Science Education Resource Center (SERC) at Carleton College. (2008). Lab 6: Using Data to Identify Hot Spots and Predict Bleaching Events. EarthLabs. Available in Canvas. This lab uses NOAA Coral Reef Watch data products to identify bleaching hot spots, degree heating weeks, and reef areas at risk for bleaching. https://serc.carleton.edu/earthlabs/corals/6.html
- NOAA Coral Reef Watch. (2026). NOAA Coral Reef Watch homepage and near real-time satellite coral bleaching monitoring. Used in the module to access HotSpot, Degree Heating Week, Bleaching Alert Area, and Virtual Station products. https://coralreefwatch.noaa.gov/
- NOAA Coral Reef Watch. (2026). Daily Global 5 km Satellite Coral Bleaching Heat Stress Monitoring. Used in the module for current SST, SST anomaly, Coral Bleaching HotSpot, Degree Heating Week, Bleaching Alert Area, and 90-day animations. https://coralreefwatch.noaa.gov/product/5km/
- NOAA Coral Reef Watch. (2026). NOAA Coral Reef Watch 5 km Methodology. Background resource explaining Coral Bleaching HotSpot and heat-stress monitoring products. https://coralreefwatch.noaa.gov/product/5km/methodology.php
- NOAA Coral Reef Watch. (2026). 5 km Degree Heating Week Product. Background resource explaining how accumulated heat stress is measured over the previous 12 weeks. https://coralreefwatch.noaa.gov/product/5km/tutorial/crw10a_dhw_product.php
- NOAA Coral Reef Watch. (2026). Daily 5 km Regional Virtual Stations. Used in the module to examine bleaching heat-stress data for reef locations such as the Florida Keys, Belize, Guam, Bali/East Java, and the Great Barrier Reef. https://coralreefwatch.noaa.gov/product/vs/map.php
- NOAA Coral Reef Watch. (2026). Recommendations for citing Coral Reef Watch data and products. Citation guidance for NOAA Coral Reef Watch satellite

products, Virtual Stations, HotSpot, Degree Heating Week, and Bleaching Alert data. https://coralreefwatch.noaa.gov/satellite/docs/recommendations_crw_citation.php
- National Oceanic and Atmospheric Administration (NOAA). (2016). Bleaching hot spot map for the Eastern Pacific and Atlantic Oceans, April 14, 2016. Figure/resource referenced in module materials.
- National Oceanic and Atmospheric Administration (NOAA). (2016). Degree Heating Week map for North America, April 14, 2016. Figure/resource referenced in module materials.
- National Oceanic and Atmospheric Administration (NOAA). (2016). Satellite image showing the location of Sombrero Reef and the Florida Keys Reef Tract. Figure/resource referenced in module materials.
- BBC. (2022). Bleached coral image. Image/resource referenced in module materials.
- Hughes, T. P., Anderson, K. D., Connolly, S. R., Heron, S. F., Kerry, J. T., Lough, J. M., Baird, A. H., Baum, J. K., Berumen, M. L., Bridge, T. C., Claar, D. C., Eakin, C. M., Gilmour, J. P., Graham, N. A. J., Harrison, H., Hobbs, J. P. A., Hoey, A. S., Hoogenboom, M., Lowe, R. J., McCulloch, M. T., Pandolfi, J. M., Pratchett, M., Schoepf, V., Torda, G., & Wilson, S. K. (2018). Spatial and temporal patterns of mass bleaching of corals in the Anthropocene. Science, 359(6371), 80–83. https://doi.org/10.1126/science.aan8048
- Carbon Brief. (2018). Severe coral reef bleaching now “five times more frequent” than 40 years ago. Article referenced in the module to summarize research on increasing coral bleaching frequency. https://www.carbonbrief.org/severe-coral-reef-bleaching-now-five-times-more-frequent-than-40-years-ago/

Optional Readings and Media

- NOAA Coral Reef Watch. (2026). Four-Month Coral Bleaching Outlook. Optional extension resource for examining predicted coral bleaching heat stress up to four months into the future. https://coralreefwatch.noaa.gov/satellite/bleachingoutlook_cfs/outlook_cfs.php
- NOAA Ocean Acidification Program. (2026). Corals. Optional background resource on shallow-water coral reefs, calcium carbonate skeletons, aragonite, and ocean acidification impacts. https://oceanacidification.noaa.gov/ocean-acidification-research/ocean-acidification-biological-response/corals-2/
- NOAA Fisheries. (2026). Shallow Coral Reef Habitat. Optional background resource on zooxanthellae, sunlight, shallow reef habitat, and coral reef conservation. https://www.fisheries.noaa.gov/national/habitat-conservation/shallow-coral-reef-habitat
- Reef Resilience Network. (n.d.). Coral reef stressors and resilience resources. Optional extension resource on local threats, climate change, bleaching, and reef management. https://reefresilience.org/
- Additional optional demonstrations and extensions listed in the module materials include deep-sea coral resources, NOAA story maps about deep-sea corals, cold-water coral videos, mesophotic coral resources, Google Earth tutorials, reef-threat KML/KMZ activities, Coral Reef Watch animations, and Virtual Station data exploration.

Module 5. Hydrology and Drought:

Overview

- Science Education Resource Center (SERC) at Carleton College. (2008). Drought Unit Overview. EarthLabs. Available in Canvas and adapted from EarthLabs materials. https://serc.carleton.edu/earthlabs/drought/index.html

- Science Education Resource Center (SERC) at Carleton College. (2015). Drought Lab Overviews. EarthLabs. Available in Canvas. This overview lists the drought module labs, including Where's the Water?, Normal Climate Patterns, and When Precipitation Patterns Change. https://serc.carleton.edu/eslabs/drought/lab_overviews.html
- Science Education Resource Center (SERC) at Carleton College. (2008). EarthLabs Drought module. Available in Canvas. This module introduces drought as a slow-onset hazard and examines water distribution, climate patterns, precipitation departures, streamflow, and drought monitoring tools. https://serc.carleton.edu/earthlabs/drought/index.html

Part 1. Where's the Water? / Worldwide Water Distribution

- Science Education Resource Center (SERC) at Carleton College. (2008). Lab 1: Where's the Water? EarthLabs. Available in Canvas. This lab introduces global water distribution, the water cycle, residence time, freshwater availability, population pressure, and water scarcity. https://serc.carleton.edu/earthlabs/drought/1.html
- World Water Council. (n.d.). Water and life. Background resource referenced in the module to introduce the importance of water for living organisms, food production, and ecosystems. https://www.worldwatercouncil.org/
- Worldmapper. (2018). Water use / annual water consumption cartogram. Data visualization referenced in the module for comparing global water use among countries. https://worldmapper.org/maps/
- Worldmapper. (2018). Total access to water / water-related worldmapper resource. Figure/resource referenced in module materials. https://worldmapper.org/wp-content/uploads/2018/04/Housing_TotalAccessWater_2015.png
- Worldmapper. (2018). Total population cartogram. Figure/resource used for comparison with the global water-use map. https://worldmapper.org/wp-content/uploads/2018/03/People_TotalPopulation_2018.png
- United Nations Environment Programme (UNEP). (2000). Vital Water Graphics: A World of Salt. Background graphic/resource referenced in the module for global water distribution and freshwater availability. https://www.unep.org/resources/report/vital-water-graphics
- Shiklomanov, I. A. (1999). World water resources and their use. State Hydrological Institute, St. Petersburg, and United Nations Educational, Scientific and Cultural Organization, Paris. Data source listed in the module materials for global water volume and residence-time estimates.
- Max Planck Institute for Meteorology. (1994). Hydrologic-cycle and water-residence-time data. Hamburg, Germany. Data source listed in the module materials.
- Freeze, R. A., & Cherry, J. A. (1979). Groundwater. Prentice-Hall. Data source listed in the module materials for groundwater and hydrologic-cycle information.
- United Nations Environment Programme (UNEP). (2000). The world's freshwater supplies: Annual renewable supplies per capita per river basin, projections for 2025. Figure/resource referenced in the module materials.

Part 2. Normal Climate Patterns

- Science Education Resource Center (SERC) at Carleton College. (2008). Lab 3: Normal Climate Patterns. EarthLabs. Available in Canvas. This lab guides students through graphs, charts, and maps used to describe normal climate conditions. https://serc.carleton.edu/earthlabs/drought/3.html
- Science Education Resource Center (SERC) at Carleton College. (2008). Normal Climate Patterns. EarthLabs student lab. Available in Canvas. Includes Planning

for a Visitor, Graphs that Describe Climate, and Maps that Describe Climate. https://serc.carleton.edu/eslabs/drought/3.html
- Science Education Resource Center (SERC) at Carleton College. (2008). Normal Climate Patterns, Part C: Maps that Describe Climate. EarthLabs. Available in Canvas. This lesson uses maps to examine spatial patterns of temperature and precipitation. https://serc.carleton.edu/eslabs/drought/3c.html
- NOAA National Centers for Environmental Information (NCEI). (2026). Climate at a Glance: Divisional Time Series. Used in the module to generate temperature and precipitation graphs by climate division. https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/divisional/time-series/
- NOAA National Centers for Environmental Information (NCEI). (2026). Climate at a Glance. Tool for historical and spatial comparisons of temperature, precipitation, and drought variables. https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/
- NOAA National Centers for Environmental Information (NCEI). (2026). U.S. Climate Atlas. Used in the module to generate and interpret maps of mean temperature and precipitation patterns. https://www.ncei.noaa.gov/access/climateatlas/
- NOAA Climate.gov. (2026). Maps and Data. Background resource for climate maps, monthly climate conditions, and Climate at a Glance mapping tools. https://www.climate.gov/maps-data
- National Weather Service. (2026). Weather.gov. Used in the module for locating local forecast offices, climate records, past weather, and local climate graphs. https://www.weather.gov/

Part 3. When Precipitation Patterns Change / Drought Indicators

- Science Education Resource Center (SERC) at Carleton College. (2008). Lab 4: When Precipitation Patterns Change. EarthLabs. Available in Canvas. This lab introduces drought definitions, precipitation departures, streamflow indicators, drought-monitor maps, and drought index interpretation. https://serc.carleton.edu/earthlabs/drought/4.html
- Science Education Resource Center (SERC) at Carleton College. (2008). When Precipitation Patterns Change. EarthLabs student lab. Available in Canvas. This lesson supports interpretation of climographs, precipitation data, streamflow data, drought maps, and Palmer Drought Severity Index maps. https://serc.carleton.edu/eslabs/drought/4.html
- NOAA National Water Prediction Service. (2026). Quantitative Precipitation Estimates. Used in the module to examine observed precipitation, normal precipitation, and precipitation departures across the United States. https://water.noaa.gov/
- NOAA National Water Prediction Service. (2026). National Water Prediction Service Quantitative Precipitation Estimates. Background resource on observed precipitation, normal precipitation, and derived precipitation products. https://www.drought.gov/data-maps-tools/national-water-prediction-service-nwps-quantitative-precipitation-estimates
- National Weather Service. (n.d.). Advanced Hydrologic Prediction Service / precipitation resources. Resource referenced in the module for precipitation maps and drought-indicator exploration. https://www.weather.gov/serfc/ahps
- U.S. Geological Survey (USGS). (2026). WaterWatch Streamflow Data. Used in the module to examine streamflow conditions and identify below-normal flows or hydrologic drought. https://www.drought.gov/data-maps-tools/usgs-waterwatch
- U.S. Geological Survey (USGS). (2026). WaterWatch surface water. Resource providing maps, graphs, and tables of real-time, recent, and past streamflow conditions, including flood and drought conditions. https://www.usgs.gov/data/waterwatch-surface-water

- U.S. Geological Survey (USGS). (n.d.). Google Earth Streamflow KML Files. Resource referenced in the module for displaying USGS WaterWatch streamflow data in Google Earth. https://serc.carleton.edu/resources/34486.html
- U.S. Geological Survey (USGS). (2026). Water Services Web. Resource for current streamflow, gage height, and water-data access. https://waterservices.usgs.gov/
- U.S. Drought Monitor. (2026). Current Map. Used in the module to compare student drought predictions with current drought severity categories. https://droughtmonitor.unl.edu/
- U.S. Drought Monitor. (2026). Data Download. Used in the module to access drought-monitor GIS data, including KMZ files for Google Earth. https://droughtmonitor.unl.edu/DmData/DataDownload.aspx
- U.S. Drought Monitor. (2026). About the Data. Background resource explaining drought classification, drought indicators, and U.S. Drought Monitor methodology. https://droughtmonitor.unl.edu/About/AbouttheData.aspx
- U.S. Drought Monitor. (2026). Current Conditions. Resource referenced in the module for weekly drought summaries, drought maps, and drought-status interpretation. https://droughtmonitor.unl.edu/ConditionsOutlooks/CurrentConditions.aspx
- NOAA National Centers for Environmental Information (NCEI). (2026). Historical Palmer Drought Indices. Used in the module for interpreting Palmer Drought Severity Index and related drought-condition maps. https://www.ncei.noaa.gov/access/monitoring/historical-palmers/
- NOAA National Centers for Environmental Information (NCEI). (2026). Weekly Palmer Drought Indices. Resource for weekly Palmer Drought Severity Index and Palmer Hydrological Drought Index maps and data. https://www.ncei.noaa.gov/access/monitoring/weekly-palmers/
- National Integrated Drought Information System. (2026). U.S. Gridded Palmer Drought Severity Index from gridMET. Background resource explaining PDSI as a standardized index based on a simplified soil-water balance and relative soil-moisture conditions. https://www.drought.gov/data-maps-tools/us-gridded-palmer-drought-severity-index-pdsi-gridmet
- National Integrated Drought Information System. (2026). North American Drought Monitor Indices and Data. Background resource on drought indicators including Standardized Precipitation Index, percent of average precipitation, and Palmer Drought Severity Index. https://www.drought.gov/data-maps-tools/north-american-drought-monitor-nadm-indices-and-data
- https://drought.unl.edu/Education/DroughtforKids.aspx
- https://earthobservatory.nasa.gov/

Optional Readings and Media

- NOAA Climate.gov. (2026). Climate Data and Maps. Optional resource for exploring temperature, precipitation, climate summaries, and U.S. climate mapping tools. https://www.climate.gov/maps-data
- National Integrated Drought Information System. (2026). Drought.gov. Optional resource for drought monitoring, drought indicators, drought outlooks, and drought impacts across the United States. https://www.drought.gov/
- U.S. Geological Survey (USGS). (2026). Water Data for the Nation. Optional resource for streamflow, groundwater, water-quality, and hydrologic monitoring data. https://waterdata.usgs.gov/
- Google Earth. (2026). Google Earth Pro on Desktop. Optional tool used for map-based activities and KMZ/KML data exploration. https://www.google.com/earth/versions/

Additional optional demonstrations and extensions listed in the module materials include water-cycle diagrams, residence-time tables, global freshwater graphics, population and water-use cartograms, climate graphs, precipitation-departure maps, streamflow maps, drought-monitor KMZ layers, drought-index maps, and local climate records.