

Syllabus - ATOC 1060-001, Spring 2021

Our Changing Environment

Primary Course Website: Canvas

Backup Course Website: <http://atoc.colorado.edu/~toohey/ATOC1060-S2021.html>

Synchronous Lectures: Thursdays, 12:45 – 2:00 pm, remote only

Instructor: Prof. Darin Toohey, ATOC (toohey@colorado.edu)

Open House: Tuesday, 12:45 – 2:00 pm

Office Hours: Tuesday, 2:30 – 4:00 pm (individual meetings)

Wednesday, 12:00 – 1:00 pm (individual meetings)

Teaching Assistant: Samuel Mogen, ATOC (Samuel.Mogen@colorado.edu)

Office Hours: Monday: 4:00-5:00pm, Thursday: 2:00-3:00pm

Learning Assistant: Rachel Mooers (Rachel.Mooers@colorado.edu)

Sessions: Monday/Wednesday, 11:20 am – 12:00 pm

Thursday, 9:00 – 9:40 am

Learning Assistant: Joseph Rutten (Joseph.Rutten@colorado.edu)

Sessions: Monday/Wednesday, 1:00 – 1:40 pm

Wednesday, 2:00 – 2:40 pm

Textbook: *The Earth System, 3^{ed}*, Lee R. Kump, James F. Kasting, and Robert G. Crane, Pearson Education, Inc., 2009 (ISBN: 978-0321597793) (pdfs of chapters will be posted on Canvas)

iClicker registration: “Our Changing Environment, Darin Toohey, Spring 2021”

Zoom registration:

<https://cuboulder.zoom.us/meeting/register/tJcrc-ivpJORGtzyacTnyv-lxoiBtlyk4R4F>

Course Description: ATOC 1060 emphasizes the physical, chemical, and biological processes that determine Earth's past, present, and future climate states. Taken as a whole, the behavior of Earth's climate system can be likened to human physiology. Some concepts, like energy balance, are relatively straightforward, whereas others (like feedbacks) are quite complex and often counterintuitive. Because climate is influenced by natural processes (e.g. the sun, clouds, volcanoes, and Earth's orbit) and changes due to humans (e.g., land development, deforestation, greenhouse gas emissions, and air pollution), issues with major socio-economic and ecological implications can be highly political on local, regional, and international levels. These implications, and their political responses, motivate much of the scientific research into Earth's climate, which we will examine in detail throughout this course.

Goals: To develop an appreciation and basic understanding of both natural and anthropogenic roles of the atmosphere, oceans, lithosphere, and biosphere in contributing to the complexity and diversity of the Earth System. To begin to explore the possible solutions to environmental problems and how those solutions are linked to local, regional, and global economic and political issues.

Course Format: *The Earth System* is a highly readable book that comprehensively and accurately deals with the current science of the Earth System. It covers a *great deal of material* in detail that cannot be repeated in entirety during lectures. Students are expected to keep up with material that will be posted on the course website. Most weeks a series of questions on key concepts for that week will be posted on Canvas, and they are to be completed on Canvas by Friday at 8 pm. The Canvas Calendar will provide links to lectures, homework, announcements, etc. Please refer frequently to the calendar before emailing the instructor or the TA.

Assignments and Grading: The primary work in this course will be (1) asynchronous (assigned reading, videos, and pre-taped lectures), which will be accompanied by iClicker questions during synchronous lectures and weekly assessments on Canvas, (2) homework problems, for which assistance will be available from the instructor, TAs, LAs, and (3) exams. Homeworks will emphasize more numerical and mathematical aspects of the material.

There will be four exams worth a total of 55% of the final grade. The lowest grade of the four exams will be dropped. Although each exam will test new material, there will be questions that require proficiency in material from prior exams. *A missed exam for any reason* will result in that exam score being dropped, and the other three each figuring equally in the final total. There will be **NO make-ups** for missed assessments. Quizzes cannot be made up, but at the end of the semester it is likely that one or two will be dropped. The total points for all quizzes will also be scaled to the highest student score (usually at or above 95%). The final grade divisions will be 90% and higher (A-), 80% and higher (B-), 70% and higher (C-), 60% and higher (D-). Grades for individual assignments and tests will *not be curved*.

An additional 10% is available for participation, including for appearing at exam reviews and weekly LA sessions. Complete participation in iClicker questions during synchronous lectures will earn up to one-half of total available participation points (i.e., 5%). *The final course grade will be determined by:*

Exams (Best 3 of 4) = 55%

Homework/Assignments = 20%

Canvas Quizzes = 20%

Participation = 10% (up to 5% for iClicker, remainder for LA sessions and reviews)

Recitation Sections: There are no recitation sections for this 1060 section.

Policies: Students with disabilities or medical conditions should see the instructor as soon as possible to make any special arrangements. Cheating in any form will not be tolerated, and can result in a failing grade in this class. Late assignments will not be accepted, unless by prearrangement. There will be no makeup exams. One missed exam for any excused reason will be permitted.

Expectations (roadmap for success in this class):

Read the book!! It is not practical for me to cover every detail of the phenomena we will study during regular class sessions, and it is virtually impossible for me to know what concepts are difficult for you if you can't tell me where you are stuck in the reading. Even I get stuck on some points.

Come to class!! It is important that you come to lectures regularly. The material presented in class will highlight the important issues, but classes will not simply repeat what is in the book. By discussing the issues both in and out of class with your fellow students, you will gain a much better understanding of the important points and you will develop a greater appreciation for the complexity of the issues and variation in viewpoints. It is our job to keep the material interesting and engaging.

Ask questions and participate!! I like to teach interactively, so I encourage you to ask questions. I don't mind being interrupted (politely) if something I have said is not clear (and especially if I have made a mistake). If you are uncomfortable asking a question in class, please do so afterwards, in recitation, during office hours, or by email, as this will help you to gain more confidence in your understanding of the material. I reward participation, and your opinion will always be respected. But remember that civility and cooperation are essential elements in the classroom. This includes encouraging one another during discussions and working out problems with your classmates, even if your views and opinions conflict.

Schedule of Topics with Associated Reading

S = Synchronous, A = Asynchronous

(Number refers to week, e.g., “S1” means “Synchronous, Week 1”)

(will be updated regularly throughout the semester)

Note – pages listed in red will be confirmed in subsequent drafts of syllabus.

Part I - The Atmosphere, Weather, and Climate

(S1) Thursday, January 14 – Introduction, Syllabus, Format, Grading

- Earth’s Changing Climate - Have we reached the tipping point? (Chapter 1, p 1-19)
- Activity – Temperature trends

(A1) *Quiz 0 - Friday, January 15: The Syllabus (Canvas, due 8 pm)*

(A2) Tuesday, January 19 – Introduction, Natural changes vs. Mankind (Chapter 1)

- Ozone depletion, biodiversity loss, and global warming
- Video – Daisy World
- *Quiz 1 – Wednesday, January 20: Evidence of Global Environmental Change*

(S2) Thursday, January 21 – Earth’s Effective Radiating Temperature (Chapters 2 and 3)

- The Earth System, Feedbacks and Couplings (p 21-26, 32-33)
- Global Energy Balance - Introduction (p 36-37)
- Wein’s Law and the Stephan-Boltzmann Law (p 42-43)
- Earth’s Effective Radiating Temperature and Energy Balance (p 43-44)

(A3) Tuesday, January 26 – Basics of Electromagnetic Radiation (Chapter 3)

- The Electromagnetic Spectrum (p 36-40)
- Temperature, Blackbody Radiation (p 40-42)
- Some helpful videos/Webpages (see Canvas entry for January 26)
- *Quiz 2 – Wednesday, January 27: Energy and Temperature*

(S3) Thursday, January 28 – The Greenhouse Effect, Earth’s Energy Budget (Chapter 3)

- Atmospheric structure, composition, greenhouse gases (p 44-50)
- Clouds, energy balance (p 50-55)
- The atmosphere and energy redistribution (p 57-63)

(A4) Tuesday, February 2 (Chapters 3/4)

- Video - “*Understanding Climate and the Redistribution of Heat, Winds, Water, and Worries*”
- Supplementary: Inverse square law, Water vapor, Saturation, Clouds and feedbacks (p 75-79)
- *Quiz 3 – Wednesday, February 3: Earth’s Energy Balance (p 44-52, 53-54, + video)*

(S4) Thursday, February 4 – Hadley Circulation, Winds, Climate (Chapter 4)

- Earth’s curvature, Differential heating, sea-breeze (p 57-61, 71)
- Hadley circulation, convergence, divergence (p 61-62)
- The Coriolis effect, trade-winds, Earth’s general circulation (p 63-66)
- ***Homework 1 Due – “Earth’s Global Mean Temperature”***

(S5/A5) Tuesday, February 9 – Exam 1 Review

- (S) Geostrophy explained in more detail (p 66-68), Review (Chapters 3 and 4)
- (A) Review videos – Water saturation, clouds and feedbacks, Coriolis and trade winds, Solar flux and surface angle, Earth’s energy diagram

(A) ***Exam 1 – Thursday, February 11, 2021 (available 12:30 pm, due 12:30 pm Friday, Feb 12)***

Part II - The Oceans, Atmosphere-Ocean Coupling, Introduction to Nutrient Cycling

(A6) Tuesday, February 16 –Ocean (Chapter 4 and Chapter 5)

- Seasons (p 68-70) video
- Biomes and climate (video)
- Surface winds and surface ocean currents (p 84-86)
- Ekman Spiral, video

Note = Wednesday, February 17 is a “Wellness Day” – no scheduled class activities – Quiz moved to Wednesday, February 24)

(S6) Thursday, February 18 – Atmosphere/Ocean Coupling (Chapter 5)

- Winds, surface currents, ocean geostrophy, and gyres
- Ekman Spiral (p 86-88)

(A7) Tuesday, February 23 – Salinity, temperature, and ocean water density

- Salinity, density (p 96-101)
- Quiz 4 –Wednesday, February 24 - Seasonality, winds, and ocean currents (note – this was delayed by Wellness Day on February 17)

(S7) Thursday, February 25 – Thermohaline Circulation (Chapter 5)

- Formation of deep water (p 96-106)
- Linking surface and deep water circulations
- **Homework 2 Due – “Climate Variability”**

(A8) Tuesday, March 2 - Atmosphere, Ocean, Cryosphere, and Nutrient Cycling

- “Crude – The Incredible Journey of Oil”
- Response
- Quiz 6 – Wednesday, March 3

(S8) Thursday, March 4

- Climate States, El Nino and La Nina, The Cryosphere (Chapter 5, Chapter 6)
- El Nino/Southern Oscillation (p 89-96)

Exam 2 – Tuesday, March 9, 2021

Part III – Carbon Cycling and The Role of the Biosphere

(A9) Thursday, March 11 - Plate Tectonics, Timescales, and Intro to Nutrient Cycling (Chapter 7)

- Probing Earth’s interior (p 122-130)
- Sea-floor spreading, plate tectonics, and convergent margins (p 130-141)
- The Rock Cycle and introduction to nutrient cycling (p 144-154)
- Quiz 7 – Wednesday, March 10

(A10) Tuesday, March 16 - The Marine Organic Carbon Cycle, Ocean Chemistry (Chapter 8)

- Organic carbon, photosynthesis, respiration, and oxygen (p154-155)
- Producers and consumers, nutrients, and the biological pump (p 157-159)
- Quiz 8 – Wednesday, March 17

(S10) Thursday, March 18 - Inorganic Carbon Cycle, Oceanic Chemistry, Weathering

- Nutrient Limitation, Redfield Ratios (p xxx)
- Inorganic carbon, equilibria, pH, and weathering (p 162-167)
- Long-term storage of carbon (p 159-162)

- **Homework 3 Due – “Reservoirs and Lifetimes”**

(A11) Tuesday, March 23 - Movie

(S11) Thursday, March 25 – Discuss movie (no assignment)

Note: Friday March 26 is schedule “Wellness Day” – no class activities

(A12) Tuesday, March 30 - Life, Ecosystems, Atmospheric Composition (Chapters 9 and 11)

- Weathering and atmospheric CO₂ (p 167-169)
- Life on Earth and Ecosystems, Biodiversity (p 176-188)
- Quiz 9 – Wednesday, March 31

(S12) Thursday, April 1 Atmospheric Oxygen (Chapters 9 and 11)

- Life, methane, nitrogen, oxygen (p 210-216)
- Oxygen and ozone (p 222-223)
- Controls on atmospheric oxygen (p 228-230)
- Homework 4 Due -

Exam 3 - Thursday, April 8, 2021 (Chapters 7,8,9)

Part IV - Climate Change, Past and Future

(A13) Tuesday, April 13 - Past Climates and Life: A Story of Long-Term Stability (Chapters 12 and 15)

- Long-term climate change (p 233-234, 240-243)
- Atmospheric gases and climate (p 248-252)
- Quiz 10, Wednesday April 14

(S13) Thursday, April 15 - Ice ages

- Earth's orbit and the age of glaciations (p 272-281)
- Glacial climate feedbacks and nutrient cycles (p 281-288)

(A14) Tuesday, April 20 - Climate feedbacks

- The Younger Dryas: A cautionary tale of climate states (p 288-293)
- Quiz 11, Wednesday, April 21

(S14) Thursday, April 22

- The Holocene (p 295-301)
- Present day climate variability (p 301-318)

(A15) Tuesday, April 27 - Taking on Climate Change (Chapter 16)

- Global Warming: Effects and consequences (p 321-329)
- Quiz 12 – Wednesday, April 28 – for making up missing quizzes

(S15) Thursday, April 29 – Energy, Climate, and the Human Dimension

- The human dimensions of climate and weather (p 329-338)
- Homework 5 Due – “Carbon Footprint”

FINAL EXAM – TBD as of January 11, 2021

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with

respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

Requirements for COVID-19 (for reference – do not apply to our class)

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

Before returning to campus, all students must complete the [COVID-19 Student Health and Expectations Course](#). Before coming on to campus each day, all students are required to complete a [Daily Health Form](#). In this class, you may be reminded of the responsibility to complete the [Daily Health Form](#) and given time during class to complete it. Instructor will have a handheld remote thermometer for your use.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the [Health Questionnaire and Illness Reporting Form](#) remotely.

In this class, if you are sick **and will not be able to participate in class**, *please contact the instructor as soon as possible* so that work can be rescheduled.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please inform the instructor to make alternative arrangements if there are any scheduling conflicts or if you expect to miss any assignment due to religious practice. See the [campus policy regarding religious observances](#) for full details.