GEOL 202 - Climate Dynamics

Instructor: Dr Lizz Ultee (eultee@middlebury.edu, BiHall 415)
Office Hours: 1:30-2:30 Tu, 4:15-5:15 Th, or by appointment.
Teaching assistant: Sophie Johnson
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TA hours: 6:30-8:00pm Th, or by email

Atmospheric circulation cells (AGU Eos)

Course description:
In this course we will explore the interconnected components of Earth's climate system, the laws governing their dynamics, and their changes over time. We will describe how we gather information about Earth's climate and how we know it is changing. In a weekly laboratory, we will analyse real data and apply simple numerical models to draw conclusions about phenomena in the atmosphere, ocean, ice sheets, and more. A major goal of this course is for students to gain confidence in quantitative methods for studying the Earth system.
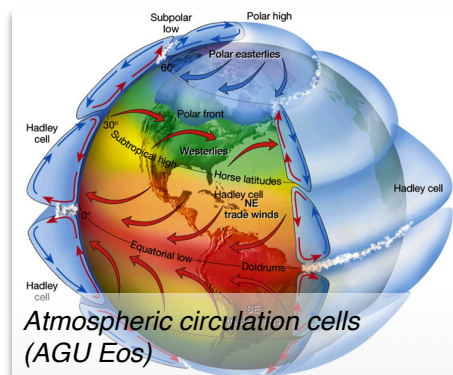
Objectives:
At the conclusion of this course, you will be able to
  • Describe the components of Earth's climate system;
  • Explain simple differential equations of the climate system and translate them into Python code;
  • Reason about the effects of a particular change in the climate system; and
  • Identify reputable sources of information about modern climate change.
Our work together will help you develop skills including
  • Quantitative reasoning,
  • Interpreting and reproducing Python code, and
  • Self-directed learning.

Resources:
We will draw on two textbooks:
  • Andrew Dessler, *Introduction to Modern Climate Change*
  • Kump, Kasting & Crane ("KKC"), *The Earth System*
The Dessler textbook is more intuitive and focuses on modern climate change. The KKC textbook is broader and includes more equations and plots. Each week will have a required reading from one or the other, not both. I may indicate an additional recommended reading where applicable.

Collaborative annotation:
I have posted each assigned course reading on Canvas. Before each class session, I will ask you to use the Hypothesis tool to post comments and/or questions on the assigned reading. This collaborative annotation will help me see common themes in your thinking, and ideally help you all learn from each other's perspectives. We can practice accessing Hypothesis during the first class session.

Assessment and grading:
We will use frequent check-ins, not all of which will be graded, to gauge progress and evolving needs. Example assessments could include
  • Short in-class writing assignments ("minute papers"),
  • Surveys,
  • Group exercises and brief presentations,
  • Online annotation of readings,
  • Lab sheets,
  • Problem sets, and
  • Reflective writing

Your course mark will be assigned according to the suggested weighting and ranges listed below. **You will set and self-assess goals for your participation in learning within this class.**

60%	Assignments (6)
20%	Participatory learning
15%	Class preparation (inc. annotation)
5%	Lab participation

Course mark	Numerical range
A	93-100
A-	90-92
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	68-72
D	55-67
F	<50

Course schedule:

Below is a course schedule, subject to adjustments according to our class needs and wants. Required course readings have an annotation assignment on Canvas, due *before* we discuss the topic in class. It is essential to do the assigned preparation, as we will spend class time building on these resources.

Week	Topic	Reading	Lab	Due
2/14-2/18	Course intro + computational basics	Dessler Ch 1	Python, Jupyter, Climlab installation	Participatory learning plan
2/21-2/25	What is the climate system	Dessler Ch 2	Visualizing global data	Assignment 1 (Friday 25th)
2/28-3/4	Earth's energy budget 1: blackbody	Dessler Ch 3	Modelling the global energy budget	
3/7-3/11	Energy budget 2: an absorbing atmosphere	Dessler Ch 4	Elementary greenhouse models	Assignment 2 (Tuesday 8th)
3/14-3/18	Greenhouse effect + carbon cycle	Dessler Ch 5	Climate sensitivity and feedback	Assignment 3 (Friday 18th)
3/21-3/25	**SPRING BREAK**			
3/28-4/1	Radiative forcing + feedbacks	Dessler Ch 6	Exploring global temperature & precipitation data	Participatory learning check-in (Friday 1st)
4/4-4/8	Structure & circulation of the atmosphere	KKC Ch 4	Density stratification and mixing	Assignment 4 (Tuesday 5th)
4/11-4/15	Structure & circulation of the ocean	KKC Ch 5	El Niño - Southern Oscillation data	Assignment 5 (Friday 15th)
4/18-4/22	Long-term climate regulation	KKC Ch 12	Insolation and orbital parameters	
4/25-4/29	Modern climate change observations	Dessler Ch 7	Transient warming after doubling CO2	Assignment 6 (Tuesday 26th)
5/2-5/6	Future climate change	Dessler Ch 8	Negotiating our global climate future	WCS prep sheet (Thursday 5th)
5/9-5/13	Climate change impacts & action	Dessler Ch 9	Course response forms	Participatory learning memo (Wednesday 10th)

Policies & resources

What to bring to class
A notebook, pen, and laptop (for lab). In-class activities will often ask you to write things down. Numerical modelling and data exploration labs will be on the computer, and it is probably easiest for you to use your own laptop. Sometimes we will do numerical modeling and data exploration in class as well.

How to participate in class
There are lots of ways to be an active participant in class. Here are some options for how you can participate, according to what best suits your style:
- Sharing your ideas and questions with the class
- Making space for others to contribute to class discussions
- Posting thoughtful questions and comments in our online spaces (Canvas, Hypothesis, etc.)
- Working together with classmates on graded assignments
- Attending office hours
- Discussing class material with friends and family outside of class

You will be responsible for setting and assessing your own goals for class participation. Keep track of these goals; you will report them to me in the last week of class.

Honor Code
I am required to remind you that this course is subject to the Undergraduate Honor System (go.middlebury.edu/honorcode). Plagiarism, cheating, duplication of work, and falsifying data are all prohibited under the Code. I do encourage you to work together on assignments and labs; simply ensure that you each write up your own version of anything you hand in unless otherwise specified, and make note of anyone you worked with. I also encourage you to consult the course materials and the scientific literature to inform your work; simply ensure you cite as required by the Code. I tend to use APA style citation, but I'm not too picky. If you are confused about a point relating to the Honor Code, including any troubles with attribution, please come and talk to me.

Late work
Some assignments, such as annotating readings in Hypothesis or completing an in-class writing exercise, are very specific to what we're doing in class on a given day, so it doesn't really make sense to turn them in late. Those cannot be turned in late, but we will drop your lowest score for annotation assignments.
For bigger assignments, I would like to have everyone's work as close to the deadline as possible so that I can return it to you with feedback as fast as possible. Plus, when you hand things in on time, you can move on to handling other important things in your life.
To balance flexibility and structure, I will offer a budget of 5 free late days for everyone, to be used across the semester, on larger assignments. I will have Canvas track late days automatically. After all late days are used up, further late submissions will incur a penalty of 10% per day. If you know you need to use up lots of late days, get in touch and we can discuss a plan.

Extra credit
In the interest of an equitable grading approach for everyone in class, I don't give individual opportunities for extra credit. Sometimes, really cool and unexpected events that relate directly to our course will come up in the middle of the semester. In that case, I might entice you to participate in those events by announcing an extra credit opportunity to the whole class. In general, if you are worried about your course mark, please get in touch with me to make a plan.

Attendance
It is my goal to provide you with an excellent learning environment in class. I hope you will attend every class in order to benefit from that environment. Please contact me if you know you will be missing more than two regular class sessions or one lab session. If you miss several sessions and I don't hear from you, I will contact you so we can make a plan together.
        Although I am anticipating some disruption to our class due to COVID, please note that in general I will not be able to offer a synchronous Zoom option on days when class is held in person. Please plan to be in touch with your classmates and the TA to catch up on anything you miss during class periods when you can't attend due to COVID.

Communication expectations
Cultivating a healthy work-life balance helps me keep doing work I love for the long term. I encourage you to consciously create your best schedule as well. Part of that, for me, means not checking email outside of College business hours. That means that it might take up to 36 hours (or more on the weekend) to get a response to an email you send me. If you really need a faster response, the best thing to do is to stop by my office (MBH 415). You can also try sending an email with [URGENT] in the subject line. The best time to discuss course questions is during office hours or a scheduled appointment.

Extenuating circumstances
Life happens. There are lots of circumstances that can make it hard to learn: food insecurity, health concerns, and family crises, to name just a few. If you are struggling, please do reach out to me, your student life Dean, or to another trusted advisor on campus so that we can connect you with resources to support you. I will do what I can to ensure you have what you need and can focus on learning.

Mental health services
I encourage you to seek help anytime you need it. The office of Health and Wellness can provide free and confidential mental health evaluations, urgent care, group therapy, medication management, and referrals to off-campus providers. This year, Middlebury Counseling is prioritizing as-needed services, in many cases offering appointments on the same day they're requested. I am not a qualified mental health provider, but I can direct you to additional resources on campus as needed.

Accommodations and adjustments

I am committed to fostering an inclusive and encouraging classroom environment. Please come to me any time to discuss things I could start, stop, or continue doing to promote inclusion. In addition, if you have a Letter of Accommodation, please contact me as early in the semester as possible to ensure that we can implement the necessary accommodations in a timely fashion. For eligible students without current Letters of Accommodation, assistance is available through the Disability Resource Center (DRC).   Please contact ADA Coordinators Jodi Litchfield and Peter Ploegman of the DRC at ada@middlebury.edu for more information. All discussions will remain confidential.

IT services and open software

Wherever possible, I will point you to open software alternatives to paid software. I view this as a support for your career: it ensures that you can continue working with familiar software no matter where you go after graduation. This said, the College does have a site license for several paid software packages you might like to use for this course or others: for example, MATLAB and the Adobe Creative Cloud. Definitely check in with ITS (go.middlebury.edu/software) or visit a campus computer lab before you consider buying software yourself.

Library helpdesk

Libraries are amazing. Librarians are information wizards. Did you know that every department at the College has a specialist librarian to help researchers find information they need? The College libraries have a number of tools you may like to explore, but for general inquiries, you can navigate to the library homepage (go.middlebury.edu/library) and click "Chat with a Librarian". During business hours, someone will respond to you via text chat; outside business hours, your message will be sent to an inbox and handled when the librarians return. No need to even leave the house!