

**Instructor**

Prof. Edwin Gerber

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Office Hours: Tuesday 2-3pm, Wednesday 11 am-12 noon

Teaching Assistant

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Office Hour: Thursday 2-3 pm

Course Meeting Times and Locations

Lectures: Monday and Wednesday, 2:00-3:15 pm, Bobst LL150

Recitation: Friday, 2-3:15 pm, 12 Waverly Place L113

Course Description

Our goal is to understand the processes that govern the Earth's climate, with particular focus on the mean state and variability of the atmosphere. Topics will include the global energy balance, atmospheric convection and radiation, the "greenhouse effect," the impact of planetary rotation, the structure of the atmospheric and oceanic circulations, and how these elements combine to produce our climate. Along the way we'll come understand exactly what we mean by "climate" (and how this both differs and depends on "weather"), why Earth is a habitable planet, and how our dependence on fossil fuels could change that in the future.

Course Expectations

Throughout the course I will try to strike a balance between a qualitative, physics focussed perspective on climate processes, vs. a more quantitative, mathematical description of the atmosphere. By qualitative, I mean an intuitive understanding of the underlying physical processes and how they interact together. For this reason, it is strongly encouraged that students have some background in physics before taking this course. By quantitative, I mean the ability to abstract and express these physical laws as mathematical relationships (also known as equations!).

This said, I'm not expecting you to be a card carrying physical scientist or mathematician. We will (quite literally) start from the ground up in building our physical and mathematical understanding of Earth's atmosphere. Hence, the most important requisite for this course is a genuine interest in learning more about our climate!

I expect you to be intellectually curious, and to go behind the textbook readings and lectures. The final project of the course will require you to analyze a scientific paper or conduct some research of your own, and present it to the class.

Grades

Class and recitation participation: 20% I expect you to attend lecture and recitation unless you have a very good reason to miss it (e.g., religious observance, illness). In these cases, please write me to note the absences, preferably in advance if possible. Lectures and recitation will include in-class exercises, data analysis, computer labs, and experiments. If you miss anything, you will be expected to make it up. You must also attend and report back (1 page summary) on two scientific talks throughout the semester. More details will be provided in class.

Homework: 20% I will assign bi-weekly assignments, on which you may collaborate with other students, provided you all note each others' names.

Class Project: 20% This project will take you outside of the material discussed in lectures and labs. You'll put together a report (c. 4-6 pages) based on your reading of a scientific paper and/or your own research on the topic. The grade will also be based on an oral presentation of your report to the class at the end of the semester. You should discuss the topic with me by the end of March. **Complete drafts of the your report are due Nov. 24** (this allows me time to give you feedback on your draft), and the final, graded report on the last day of class, **Wed. December 10**.

Midterm and Final Exam: 20% each. There will be two exams, the first on **Wednesday October 15th** and the second during the exam period, as scheduled by the registrar.

Textbook

Marshall, J and Plumb, R. A., 2008: *Atmosphere, Ocean, and Climate Dynamics*, Academic Press, 319 pp.

Disability Disclosure Statement

Academic accommodations are available for students with disabilities. The Moses Center website is <https://www.nyu.edu/life/community-flourishing/centers-and-communities/accessibility.html>. Please contact the Moses Center (via their online portal or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center as early as possible in the semester for assistance.

On respect and inclusion

As an instructor, I will strive to create a safe, respectful, and inclusive environment for all students regardless of their identity. I recognize and value diversity inside and outside of the classroom, and recognize that each student has a unique contribution to make and brings with them different strengths and weaknesses. I welcome your ideas for how to promote a better understanding and deeper learning in this class as a community. Please feel free to ask questions, to participate in discussions, and to suggest new approaches to the class content. Please also feel welcome to raise any issue you may have in class or outside of class, including reporting incidents of bias or discrimination, whether intentional or unintentional, either to me, to your advisor(s)/mentor(s), or by using the NYU Bias Response Line.

Course Plan

The following schedule is a rough draft, and may change depending on the rate at which we can progress. Key topics are noted in bold and sections from the textbook, denoted by (§xx), should be read *before* class that week.

9/3: **Intro to atmosphere and ocean sciences, fluid dynamics and climate** (§0), and perhaps a bit on atmospheric composition (§1).

9/8,10: **Atmospheric composition and Black Body radiation.** Atmospheric composition and ideal gas law (§1). Black body radiation, planetary albedo, emission temperature, absorption of radiation (§2.1-2).

9/15,17: **Greenhouse effect, Vertical structure of the atmosphere** The greenhouse effect (§2.3); Climate change and climate sensitivity (§2.4); Vertical distribution of temperature and gases (§3.1)

9/22,24: **Vertical structure of the atmosphere and hydrostatic Balance** Hydrostatic balance, vertical structure of pressure and density (§3.2-3);

9/29,10/1 **Convection; potential temperature** Buoyancy and convection (§4.1-2), Stable atmospheres; dry convection; potential temperature (§4.3-4.4)

10/6,8: **Potential Temperature and Moist Convection** Saturation and relative humidity; moist adiabatic; cloud types; radiative forcing of the atmosphere (§4.4,4.5)

10/14,15: **Review and midterm exam** (§1-4)

10/20,22: **Meridional structure of the atmosphere** Zonal wind and temperature; humidity; global circulation (§5.1-2)

10/27,29: **Newtonian mechanics** Conservation of momentum, mass and heat in a fluid; Force balance; Rotating frame of reference, Coriolis acceleration (§6 and instructors notes - we will cover this chapter very lightly)

11/3,5: **Geostrophic Balance** Relationship between pressure, wind and temperature on a rotating planet (geostrophic and thermal wind balance) - weather patterns (§7)

11/10,12: **General circulation of atmosphere** Thermal wind, angular Momentum; Tropical Hadley circulation; (§8.1-2)

11/17,19: **General circulation of atmosphere:** Potential energy and baroclinic instability; Storms and storm tracks (§8.3) Energy and momentum transport in the atmosphere; the Jet stream; Climate variations with latitude. (§8.3-6).

11/24: **Climate Variability** El Nino; Paleoclimate; the Ice Ages; anthropogenic climate change. (§12.1-2) **Rough draft of papers due!*

12/1,3: **Student Presentations**

12/8,10: **Presentations, cont. and review for Final Exam**

Final Exam: t.b.d.