

SIO 217C ATMOSPHERIC AND CLIMATE SCIENCES III: CLIMATE AND CLIMATE CHANGE

Spring 2021

Instructor: Nick Lutsko	Time: Tu/Th 4:00pm – 5:30pm
Email: nlutsko@ucsd.edu	Place: (Remote)

Climate science is inextricably linked to the issue of climate change. This class covers some of the key dynamics, thermodynamics and radiation required to understand our changing climate, focused through the lens of three motivating questions:

1. Why does the circulation expand polewards?
2. What is Earth's climate sensitivity?
3. How will precipitation change in the future?

To answer these questions we will cover topics such as jet dynamics, Hadley Cell theory, models of clear-sky radiation, cloud physics and extreme precipitation. We will also discuss some of the latest research on these questions and explore how theory, models and observations can be combined to better constrain these aspects of the climate system's response to CO₂ forcing.

Grading Policy: Group projects (60%), paper discussions (30%), class participation (10%).

Group Projects: Students will work on projects in groups of 2-3. The topics of the projects must be related to topics covered in class. Project titles are due 04/21 and written reports are due 06/07. We will also have group presentations on 06/09.

Paper Discussions: We will discuss papers related to the lectures every 2 weeks. 2-3 students will present papers at each discussion, making sure to leave time for informal discussions. I will provide the list of papers and assign presenters after the first day of class.

Lectures: Because of the remote format, lectures will be a mixture of in-class derivations, discussions and Jupyter notebook presentations. I will provide details about what formats to expect before each lecture.

Attendance Expectations: Students are expected to log in and attend class remotely, or watch Zoom recordings. Please let me know if you are unable to make a class, or have difficulties accessing the recordings.

Office Hours: After class or by appointment.

Background Reading: There is no textbook which covers all of the material in this course. Some papers are linked to in the notes, and I can provide more background reading if necessary.

Course Schedule:

Part 1: Why does the circulation expand polewards?

03/30 — Overview of Earth's circulation/angular momentum fluxes

04/01 — A two-layer model

04/06 — A two-layer model 2

04/08 — Jet shifts

Paper discussion 1: 04/12

04/13 — Hadley Cell dynamics 1 (Momme Hell guest lecture)

04/15 — Hadley Cell dynamics 2

04/20 — Hadley Cell expansion

Project titles due: 04/21

Part 2: What is Earth's climate sensitivity?

04/22 — Earth's insolation

Paper discussion 2: 04/26

04/27 — Energy Balance Models

04/29 — Clear-sky feedbacks 1

05/04 — Clear-sky feedbacks 2

05/06 — Clear-sky feedbacks 3

Paper discussion 3: 05/10

05/11 — Clouds

05/13 — Two-box model, the pattern effect and constraining climate sensitivity

Part 3: How will precipitation change in the future?

05/18 — Why does it rain?

05/20 — Projected changes in the hydrologic cycle

Paper discussion 4: 05/24

05/25 — Radiative considerations

05/27 — Radiative-convective equilibrium

06/01 — Extreme precipitation

06/03 — Monsoons and the ITCZ

Project reports due: 06/07

Group presentations: 06/09