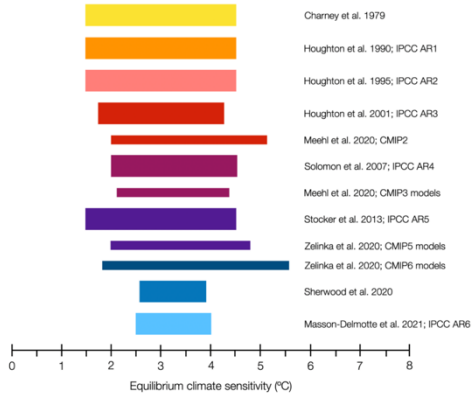
# Forcing, feedbacks, and climate sensitivity

ATS-781A4




## Overview

Climate sensitivity measures the global-mean temperature response to a radiative forcing. We will study the physical processes and methods behind climate sensitivity (forcing, radiative feedbacks, and the spatial surface temperature evolution). We will introduce the different lines of evidence to infer climate sensitivity (historical observations, general circulation models, smaller-scale process models, theory, and the paleo record) and discuss strengths and limits of its applicability in a scientific and political context. Emphasis will be on understanding the ongoing discussion around high climate sensitivity in CMIP6 models and the most recent IPCC report AR6. We will practice writing and judging research proposals, work on a final project including data analysis, and practice sharpening arguments in mock discussions.

## Instructor and office hours

Maria Rugenstein; maria.rugenstein@colostate.edu
Office: 407 Atmospheric Science Main
**Office Hours**: come by my office

## Classroom and class hours

Tuesdays and Thursdays, 11-11:50AM, room 121 ATS West

## Course Learning Objectives

Upon successful completion of this course students will be able to:
1. Explain the energy balance framework assumptions behind climate sensitivity.
2. Compare the uncertainty of different terms in the global energy balance framework.
3. Replicate arguments for high and low climate sensitivity, the need to reduce the overall uncertainty, and the limitations of the energy balance framework.
4. Link own research to climate sensitivity, analyze CMIP5/6 datasets, or construct or apply an energy balance model
5. Write and judge research proposals.

## Course Outline

Week 1 Arrhenius, Charney, IPCC reports
Week 2 Energy balance models
Week 3 Forcing and forcing adjustments
Week 4 Lapse rate, water vapor, and sea ice feedbacks
Week 5 Cloud feedbacks
Week 6 Non-linear terms and pattern effect
Week 7 Coupled model intercomparison and emergent constraints
Week 8 Ocean heat uptake; transient versus equilibrium situations
Week 9 Evidences from historical observations; historical forcings
Week 10 Evidences from satellite observations
Week 11 Earth System Feedbacks
Week 12 Evidences from cold and warm paleo time periods
Week 13 Tipping points
Week 14 Carbon budget
Week 15 Transient climate response to cumulative carbon emissions and climate sensitivity in policy

## Assignments (bold for auditing students)

1) Write a 3-page (NSF-style) research proposal, judge each other's proposals, and refine own
**2) Prepare and deliver a mock panel discussion with fellow students on issues such as "ECS is high versus low", "ECS is useful versus too simplistic for science", "ECS is useful versus too simplistic for politics"**
3) present a paper or present your own research or final project (data analysis)
**4) Final exam: see discussion in first class**

## Assessment Components and Grading

The class gives 2 credits, which will be obtained through:

- Reading research papers/participating in class discussions: 34%
- Preparing and leading a mock discussion: 33%
- Project proposal: 33%
- Final exam: not graded

Grades assigned for the class include: A+ (97-100%), A (93-97%), A- (90-93%), B+ (86-90%), B (83-86%), B- (80-83%), C+ (76-80%), C (70-76%), D (60-70%), F (0-60%). Numerical scores will be curved at the end of the class before grades are assigned.

## Textbook/Reading

There is no textbook for the class. We will read the "Charney report" and I will use parge parts of IPCC AR6 Chapter 7, Chapter 1, and some other chapters. I will also use the recent review paper Sherwood et al. 2020 and other classical papers. All papers will be uploaded to canvas. The IPCC reports can be accessed under: https://www.ipcc.ch/ (Look for Reports and then "Working group 1" – the other working groups are interesting as well but we won't cover them much)

## Statement on Academic Integrity

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog and the Student Conduct Code. At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.