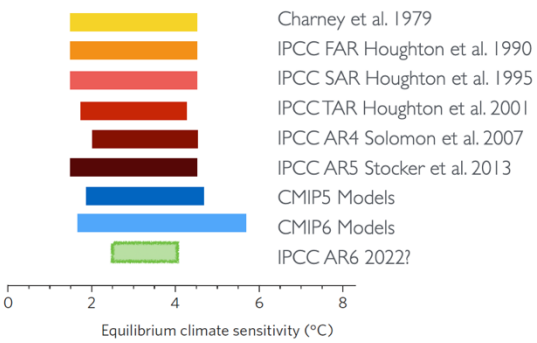
Climate Sensitivity from Charney to AR6

2021FA-ATS-781A4-001



Overview

We will study the processes and methods behind climate sensitivity (forcing, radiative feedbacks, surface temperature evolution) in a historical context. We will discuss the different lines of evidence to infer climate sensitivity (the paleo record, historical observations, general circulation models, and process studies) 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 presentation of climate sensitivity in the forthcoming IPCC AR6 report.

Instructor and office hours

Maria Rugenstein
Office: 407 Atmospheric Science Main (Foothills Campus)
Email: maria.rugensetin@colostate.edu
Office Hours: Tue, noon-2 pm, and by appointment; If I'm not in the office or you prefer to meet onlin, the office hours are virtual: https://zoom.us/j/97437087279
Communication: Preferably through canvas messaging. I might be less responsive on Mondays and Fridays but will aim at answering your emails within two days.

Classroom and class hours

Tuesdays and Thursdays, 9-9:50AM, room 100 ATS

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 and/or analyze CMIP5/6 datasets.
5. Write and judge short research proposals.
6. Follow ongoing scientific discussion on the value of and methods to obtain climate sensitivity.

Assignments

- A1) Attend **CF-MIP meeting**, ask at least two questions and record the answer and your thoughts, submit ½ page pdf to canvas until **Friday 09/17**
- A2) Prepare and conduct a **mock discussion** with fellow students. Topics will be discussed in class and could include "ECS is high versus low", "ECS is useful/too simplistic for science", "ECS is useful/too simplistic for politics", "The constancy of the ECS range is (not) worrisome"; "ECS in models is tuned" …; "The uncertainty in ECS is mostly due to short-wave clouds versus other feedbacks". Resources for the mock discussions are AR6 Chapter 7, Sherwood et al. 2020, and the online ECS symposium talks
  The mock discussions will take place **during class hours on 10/21; 10/28; 11/04**
- A3) Submit a 1page **proposal** for the final project. Follow the (NSF inspired) template on canvas. The page limit is strict, you get a bad grade for a too lengthy or too short proposal (as in real life!). Deadline for proposal submission is **Monday 10/18.** All students will read and comment on each other's proposals. On **Thursday 10/21** we are discussing the proposals in class. If you need inspiration for subjects let me know.
- A4) 3-8 page **report on final project**
  - Linking your own research to climate sensitivity *or*
  - Using energy balance models to predict climate sensitivity *or*
  - ECS in CMIP3/5/6 *or*
  - Deepen arguments on one subject of the class

  If desired, a first (crude or detailed) draft can be handed to me by 11/30 on which I will make suggestions on style and content. This step is purely optional although some might find it of benefit. The final version is due **Friday**

12/17. Please reach out for discussing the final project at any stage. The idea is not to do something as independent as possible but as cool as possible – I would be glad to help making this project *real science*!

Active participation in class discussions is expected.

Auditing students will do A1, A2, and a very short presentation in class. We will discuss these in the first week of class.

Course Outline

date	theme	notes
Tue 8/24 Thur 8/26	intro themes and schedule charney, assignments, student intro	 read Charney 1979
Tue 8/31 Thur 9/2	energy balance models 1 energy balance models 2, form discussion groups	
Tue 9/7 Thur 9/9	emergent constraints 1 & 2 no class	double class 9 - 10:40
Tue 9/14 Thur 9/16	attend CFMIP in class hours or later (online) attend CFMIP in class hours or later (online)	see CFMIP schedule online submit CFMIP questions 09/17
Tue 9/21 Thur 9/23	A1: discussion CFMIP; starting historical historical evidence; satellite, ocean heat uptake obs	
Tue 9/28 Thur 9/30	CMIP5/6 CMIP5/6	guest lecture Margaret Duffy guest lecture Margaret Duffy
Tue 10/5 Thur 10/7	forcings A2: mock discussion 1	
Tue 10/12 Thur 10/14	non-linear terms (online) non-equilibrium (online)	guest lecture Jonah Bloch-Johnson guest lecture Jonah Bloch-Johnson
Tue 10/19 Thur 10/21	non-cloud feedbacks proposal discussion	A3: proposal subm 10/18
Tue 10/26 Thur 10/28	cloud feedbacks A2: mock discussion 2	
Tue 11/2 Thur 11/4	pattern effect A2: mock discussion 3	
Tue 11/9 Thur 11/11	paleo cold paleo warm	
Tue 11/16 Thur 11/18	TCR/scenarios regional climate projections	
	no class, Thanksgiving break no class, Thanksgiving break	
Tue 11/30 Thur 12/2	Earth System Feedbacks (online) Carbon bu1get (online)	A4: final project draft submission guest lecture Scott Denning
Tue 12/7 Thur 12/9	Carbon Budgets and policy (online) wrap up, carbon, or picking up issues	guest lecture Kasia Tokarska
Tue 12/14 Thur 12/16	no class no class	 A4: final project submission 12/15

Assessment Components and Grading

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

- Reading research papers/participating in class discussions: 10%
- Attending the virtual CF-MIP meeting and collecting answers to two questions: 10%
- Preparing and leading a mock discussion: 30%
- Mid-term project proposal: 10%
- Final project: 40%

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 under the specific module. 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.