ATS 743 Interactions of the Ocean and Atmosphere – Fall 2025

Instructors
Maria Rugenstein, 314 ATS Main, I prefer personal contact or slack over email.
Office Hours: Preferably right after class on Monday and Wednesday, Monday mornings, or any other time come by my office.
Reach out to TA Ben Johnson for assigning papers, submitting questions on weekly paper on Mondays, and testing your chalk talk figure.

Class Schedule
Class meets in 212B ACRC from 3-4:15p.m. Monday and Wednesday.

Student Learning Goals and Objectives
The successful student will be able to

- demonstrate a graduate level process-oriented understanding of the coupled ocean-atmosphere physical climate system, including the mean state of the coupled circulation, interannual and decadal variability, and climate change in the Tropics, extra tropics, and high latitudes
- identify the most pressing open questions in the area of large-scale ocean-atmosphere interaction, and relate them to the classical works over the last decades
- present a research paper in a chalk talk and lead and participate in paper discussions
- relate current topics in ocean-atmosphere interaction to their PhD research subject

Format and grading
The format of the class will be around 1/3 lectures, 1/3 paper discussions of classical and recent papers, and 1/3 work on the assignment, which we will develop together. The final grade will be 1/3 paper presentation (based on a rubric), 1/3 the paper discussions (submitting questions and participating in the discussions), and 1/3 on the final project.

Textbooks
We will be loosely following the book "Coupled Atmosphere-Ocean Dynamics. From El-Nino to Climate Change" by Shang-Ping Xie.

Web
Class notes, discussion papers, and assignments will be posted on Canvas.

Paper discussions
Each student will lead one discussion of a journal article. Papers will be assigned during the first week of class (see list below). All other students are required to read the paper in depth, submit questions on Monday 6pm to Ben, and participate fully in the discussion. The student presenting will develop and deliver a chalk talk: They will present the idea of a concept or issue, draw out and explain key figures of the paper, and develop what future research questions could be talked around that concept or issue. This will happen either on a white board or drawing on an ipad which is projected. After drawing our the core concept, you can also use traditional slides to make other points and deepen the discussion.

Assignments
We will decide together how the learning will be assessed (see email with details).

Course Outline:

Date	W	Monday	Wednesday *(paper discussion)*
08/25-08/27	1	Intro, student presentations	*Battisti et al. 2019*
09/01-09/03	2	Labor Day, no class	Climatology ocean: upwelling, response to wind stress forcing
09/08-09/10	3	Climatology atmosphere: Hadley, Walker, Convection, ITCZ	*Bjerknes 1966, 1969* *Bao et al. 2022*
09/15-09/17	4	Coupled feedbacks: WES, cold tongue	*Heede and Federov 2020*
09/22-09/24	5	ENSO and Bjerkness feedback	*Meinen and McPhaden 2000*
09/29-10/01	6	More on ENSO or guest lecture paleo ENSO	*Pontes et al. 2022*
10/06-10/08	7	Teleconnections from the tropics to the extra-tropics	*Alexander et al. 2002*
10/13-10/15	8	Subtropical climates: trade winds, low clouds, and ocean heat uptake	*Zuidema et al. 2017*
10/20-10/22	9	Teleconnections of the extra-tropics into the Tropics	*Kang et al. 2023*
10/27-10/29	10	Mid-latitude ocean-atmosphere interaction	*Wills et al. 2019*
11/03-11/05	11	Pacific forced response	*Watanabe et al. 2024*
11/10-11/12	12	Ocean heat uptake in a forced climate	*Armour et al. 2016*
11/17-11/19	13	Interhemispheric energy transport	*Donohoe et al. 2024*
11/24-11/26	14	Fall break, no class	Fall break, no class
12/01-12/03	15	Buffer	Buffer
12/08-12/10	16	Internal Variability of ocean heat uptake/hiatus	*Hedemann et al. 2017*
12/11-12/17	17	Finals/AGU	Finals/AGU

Paper discussions

Bjerknes, J., 1966: A possible response of the atmospheric Hadley circulation to equatorial anomalies of ocean temperature. *Tellus,* **18**, 820–829.
Bjerknes, J., 1969: Atmospheric teleconnections from the equatorial Pacific. *Monthly Weather Review*, **97**, 163–172.

Armour et al. 2016: Southern Ocean warming delayed by circumpolar upwelling and equatorward transport. Nature Geoscience, https://www.nature.com/articles/ngeo2731

Bao et al. 2022: Zonal temperature gradients in the Tropical Free Troposphere
https://journals.ametsoc.org/view/journals/clim/35/24/JCLI-D-22-0145.1.xml

Battisti et al. 2019, 100 Years of Progress in Understanding the Dynamics of Coupled Atmosphere-Ocean Variability;
https://journals.ametsoc.org/view/journals/amsm/59/1/amsmonographs-d-18-0025.1.xml

Dong et al. 2019: Attributing Historical and Future Evolution of Radiative Feedbacks to Regional Warming Patterns using a Green's Function Approach: The Preeminence of the Western Pacific. Journal of Climate, https://journals.ametsoc.org/view/journals/clim/32/17/jcli-d-18-0843.1.xml.

Donohoe et al. 2024: Model biases in the atmosphere-ocean partitioning of poleward heat transport are persistent across three cmip generations; https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023GL106639

Meinen and McPhaden, 2000: Observations of warm water volume changes in the equatorial Pacific and their relationship to El Niño and La Niña. *J. Climate*, **13**, 3551–3559.

Heede and Fedorov, 2020: Time Scales and Mechanisms for the Tropical Pacific Response to Global Warming: A Tug of War between the Ocean Thermostat and Weaker Walker, https://journals.ametsoc.org/view/journals/clim/33/14/JCLI-D-19-0690.1.xml

Watanabe et al. 2024: Possible shift in controls of the tropical Pacific surface warming pattern, https://www.nature.com/articles/s41586-024-07452-7

Alexander et al., 2002: The atmospheric bridge: The influence ENSO teleconnections on air-sea interaction over the global oceans. J. Climate, 15, 2205-2231. https://journals.ametsoc.org/view/journals/clim/15/16/1520-0442_2002_015_2205_tabtio_2.0.co_2.xml

Kang et al. 2023: Global impact of recent Southern Ocean cooling. PNAS, https://www.pnas.org/doi/10.1073/pnas.2300881120

Hedemann et al. 2017: On the subtle origins of surface-warming hiatuses. Nature Climate Change, https://www.nature.com/articles/nclimate3274

Pontes et al. 2022: Mid-Pliocene Al Nino/Southern Oscillation suppressed by Pacific intertropical convergence zone shift, Nature Geoscience, https://www.nature.com/articles/s41561-022-00999-y

Wills et al, 2019: Ocean Circulation Signatures of North Pacific Decadal Variability. GRL, https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2018GL080716

Zuidema et al. 2017: Challenges and prospects for reducing coupled climate model SST biases in the eastern tropical Atlantic and Pacific oceans, BAMS, https://journals.ametsoc.org/view/journals/bams/97/12/bams-d-15-00274.1.xml

Further Background Reading

Texts:

Gill, A. E., 1982: *Atmosphere-Ocean Dynamics*, Academic Press, 662pp.
Vallis, G. K., 2006. *Atmospheric and Oceanic Fluid Dynamics*. Cambridge University Press, 745 pp.

CSU Atmospheric Science promotes inclusive community:

CSU Atmospheric Science is a leading global institution, and as such, all members of our community regardless of race, ethnicity, culture, religion, sexual orientation, gender identity and expression, physical ability, age, socioeconomic status or nationality are welcome as equal contributors. We value and appreciate diversity, and we believe that diversity on our campus strengthens our entire scientific community.

I would like this class to be highly interactive and serve your own research. The goal is that you take away relevant information and ideally even new research directions from it, not that you sit through my lectures. To do so, we rely on everyone's opinions and willingness to share and engage.