Syllabus

Instructor: Caroline Ummenhofer, Hyodae Seo

Credits: 3

Meeting: Tuesdays and Thursdays, 10:30–12:00 noon; Clark 331 (VC), MIT 54-823

Synopsis: Explore climate variability and change, primarily focusing on the atmosphere and ocean, while gaining hands–on experience applying diagnostic analyses to a wide range of modern observations (instrumental, satellite, reanalysis) and global climate models.

Description: Practical insight into characteristics and mechanisms of climate variability from regional to global scale in the modern world with applications to past and future climates. Major emphasis is placed on the salient features of the mean climate system and their dominant modes of natural variability (e.g., seasonality, El Niño–Southern Oscillation, North Atlantic Oscillation, Indian Ocean Dipole, Madden-Julian Oscillation, Southern Annular Mode, Pacific Decadal Oscillation), as well as observed and projected manifestations of anthropogenic climate change. Timescales covered range from synoptic, sub-seasonal, interannual, to decadal and beyond. Learning is driven by exploration of data and supplemented by lectures, textbook, and published literature. Students gain hands–on experience accessing, analyzing, and visualizing a wide range of gridded data including instrumental, satellite, and reanalysis products, as well as Intergovernmental Panel on Climate Change (IPCC) global climate model simulations.

Philosophy: The perspective and techniques used in diagnosing variability in the modern atmosphere and ocean can be used to make connections across a range of disciplines and time scales. The philosophy of this course can be illustrated with the following example. To learn about the monsoon systems, students will learn about metrics that define for example the strength of subsystems of the Asian monsoon and access appropriate instrumental data sets to explore the mean structure of the monsoon. Other data sets can be employed to characterize how the monsoons change in space and time and what are the consequences for rainfall in various locations. Global climate model output can be accessed to explore how the monsoons might change in response to future anthropogenic forcing compared to its range of natural variability or the extent to which it might have changed in the distant past. Such exercises will complement existing course work that may be based in theory.

Outcome: Students will leave the course equipped with an intuitive knowledge of major modes of climate variability and the tools necessary to apply climate diagnostic analysis to their own research. Students will possess the interdisciplinary edge to critically assess, interpret, and apply the observational and model results underpinning the latest Assessment Reports of the IPCC. Students will have gained hands-on experience in manipulating and visualizing different types of data sets and model output using Matlab, and been exposed to other analysis software (e.g., NCAR Command Language, python).

Target student: The course is aimed at advanced undergraduate science students whose research interests broadly interface with the physical climate system. The focus is hands-on. No prior background in physical oceanography or atmospheric science will be assumed, though a good quantitative background is advantageous. Thus, students from all departments are strongly encouraged to enroll. The course will be highly complementary to a SAW research project by providing the tools and data to apply the knowledge to independently investigate phenomena that are taught theoretically. The course will serve to introduce climate-related topics to advanced undergraduate science students and begin to build their analytical skill set and apply course material directly to a research project.

Prerequisite: Permission of instructor.

Format: Class will meet twice per week, and consist of lectures and tutorials, where active participation in class discussions is encouraged.

Evaluation: Completion of assignments and quality of term project. See grading breakdown.

Grading:

60% Assignments

Assignment #0	10%
Assignment #1	20%
Assignment #3	30%

40% Term project

Assignment #2	10%
Assignment #4	10%
Assignment #5	10%
Presentation	10%

Assignment submission instructions:

All assignments are to be submitted as an email attachment to cummenhofer@whoi.edu.
Assignments need to be received by **6pm ET** on the day indicated.

Required texts:

• Climate Dynamics, Kerry H. Cook, Princeton University Press, 2013, ISBN: 9780691125305.
• Climate Change 2013: The Physical Science Basis (the IPCC Fifth Assessment Report, freely available online): https://www.ipcc.ch/report/ar5/
• Supplemental literature, as provided by the instructor.