EAPS 53600 Introduction to General Circulation of the Atmosphere
Spring 2020

Purdue honor pledge: As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue. (https://www.purdue.edu/provost/teachinglearning/honor-pledge.html)

Basics
Time: 9:00a-10:15a TR
Location: HAMP 3214

Instructor: Professor Dan Chavas
Office: HAMP 3221
Telephone: 765-496-6661
Email: dchavas@purdue.edu
Office Hour: by appointment

Course Description
Why does our atmosphere move, and how? This course focuses on understanding large-scale circulations in the Earth's atmosphere, in both the tropics and extratropics, and their role within the climate system. This includes: gravity waves, Rossby waves, equatorial waves, barotropic and baroclinic instability; the jet stream, the Hadley cell, the monsoon, and extratropical and tropical cyclones. We will use theory, idealized computer models, rotating tank experiments, and reanalysis data to understand what gives rise to these motions and how they fit into the broader context of the Earth's planetary climate. This course is designed to be hypothesis-driven wherever possible.

Course open to graduate students and motivated senior undergraduates.

Required Texts:
Global Physical Climatology by Dennis Hartmann
https://www.amazon.com/Global-Physical-Climatology-Dennis-Hartmann/dp/0123285313
Hardcover: 498 pages
Publisher: Elsevier Science; 2 edition (January 2, 2016)
Language: English
ISBN-10: 0123285313
ISBN-13: 978-0123285317

Essentials of Atmospheric and Oceanic Dynamics by Geoff Vallis **(NOTE: this is the abridged version of the full Vallis (2017) AOFD "big book" – the "Essentials" version used here is much more accessible!)**

https://www.amazon.com/Essentials-Atmospheric-Oceanic-Dynamics-Geoffrey/dp/1107692792
Paperback: 366 pages
Publisher: Cambridge University Press; 1 edition (March 7, 2019)
Language: English
ISBN-10: 1107692792
ISBN-13: 978-1107692794

Prerequisites
Atmospheric dynamics and thermodynamics, differential equations.

Grading
Homework/Labs: 30%
Midterm: 20%
Final course project: 30%
Class participation: 20%

The grading scale is as follows:
A> 90%
80% < B < 90%
70% < C < 80%
60% < D < 70%
F < 60%

Attendance
In the event of an absence known in advance, it is your responsibility to inform the instructor in a timely fashion, when possible.

Given that this class is heavily student-led, attendance is crucial for everyone's mutual benefit. If you choose not to attend class, you should not expect the instructor to provide personal lectures for you during office hours.

Course structure
This course will be strongly student-driven and will be a mix of lectures and student-led discussions, labs, and a semester project.

The activities in this course are designed to be **hypothesis-driven** as much as possible. Testing a hypothesis is integral to the scientific method. Learning how to define a clear, testable hypothesis and how to test that hypothesis is a difficult but critical skill for your career.

Homework/Labs
Homework will be at regular intervals (every ~2 weeks) throughout the semester. Homework may include analytical problem solving, coding, laboratory work, or scientific writing related to journal paper discussions.

Students will perform laboratory experiments in groups using the Geophysical Fluid Dynamic rotating tank. Following the experiment, each student will type a formal, professional-quality lab report answering pertinent questions.

Homework/labs are due at the beginning of class on the due date. Late submission can be accepted one day after it is due with an automatic 25% penalty. Working together with classmates on homework assignments is strongly encouraged, though students must turn in their own work and demonstrate independent thinking.

Semester project

Each student will lead their own independent semester project on a topic of their choosing. Undergraduate students may work in pairs if desired. For the project the student will define a clear testable hypothesis, test that hypothesis using a model and/or data, and present their findings in a final written paper (25% of final course grade) and oral presentation (5% of final course grade). A schedule of project milestones during the course of the semester is included in the course schedule to obtain regular feedback from peers and assist with project progression.

Academic Integrity

As a student in this class, you are expected to uphold the Purdue honor pledge stated at the top of this document. Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breeches of this value by either emailingintegrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

Plagiarism and other academic misconduct will be handled as outlined in the *University Regulations:* https://www.purdue.edu/odos/academic-integrity/

Additional Information

Campus emergency: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Please contact the instructor by e-mail or read the course announcement on Blackboard to get information about changes in this course.

CAPS Information: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765)494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

Course Objectives

This course develops understanding of the essential underlying physics that govern the range of large-scale atmospheric circulations found on Earth, with an explicit effort to teach the fluid dynamics of the tropics and the extratropics together in a holistic course. Students will learn via hypothesis-driven inquiry using labs, models, and data.

Learning goals for this course:

Skills:

- Interpret and critically evaluate physical/conceptual explanations
- Define scientific theories and questions as testable hypotheses
- Design experiments/analyses using idealized models/data to test hypotheses
- Synthesize physical and conceptual understanding professionally and scientifically in concise, logical written and engaging oral presentation

Science:

- Explain what the Earth's atmosphere would look like if it didn't move
- Describe the basic characteristics of a range of fundamental large-scale circulations found in the Earth's atmosphere in both the tropics and extratropics
- Define the essential ingredients required for the generation of these circulations and the key differences between tropical and extratropical phenomena
- Explain how circulations fit into the broader context of the Earth's planetary climate system
- Apply physical understanding to hypothesize how these circulations may be modified by variations in the Earth and its climate system

Additional References

Emanuel, K.A., 1994. *Atmospheric convection*. Oxford University Press on Demand.
Archer, D., 2012. *Global warming: understanding the forecast*. John Wiley & Sons.