ATMO 606: Cumulus Dynamics

Semester: Spring 2021
Class time: MF, 10:30 – 11:45
Instructor: Prof. Giuseppe Torri
Email: gtorri@hawaii.edu
Phone: (617) 460-1490

Cumulus clouds represent one of the most important components of the Earth's climate. They play an active role in the transport of heat, momentum, chemical species, and also in the radiation budget of the planet. It has been suggested that they hold the key to the long-standing problem of equilibrium climate sensitivity. In Hawaii, cumulus clouds are one of the main protagonists of the hydrological cycle. In spite of their importance, however, there are many aspects associated to these systems that we still do not fully understand.

In ATMO 606, students will immerse themselves in this important subject, and they will learn the main features of the different types of cumulus clouds that are found on Earth. The class will begin with a series of lectures on dry convection, moist thermodynamics, and planetary boundary layer (PBL) growth, which will allow students to build a solid mathematical and conceptual foundation. The focus will then move to cumulus clouds, first analyzing shallow clouds, and discussing their role in the climate of Hawai‘i, and then deeper, cumulonimbus clouds. The class will end with a series of lectures on the interaction between cumulus clouds and large-scale circulations.

Because cumulus clouds are an active subject of research, this class will help students familiarize with the scientific literature on this subject. In order to achieve this, each week will be divided in two parts: in the Monday class, the instructor will deliver a lecture on a given topic, and he will assign a relevant paper taken from recent literature; in the Friday class, the students will engage in a discussion on the paper that was assigned. In order to facilitate the discussion, a questionnaire will be provided with the paper to each student. In addition, by the end of the semester, students will be expected to write a short essay and present it to the class on a topic that they will choose with the help of the instructor.

Student Learning Outcomes

At the end of the class, the student should be able to:

- Understand the main features of cumulus clouds and the processes that control their life cycle.
- Understand the main open problems in the study of cumulus clouds and how they relate to the atmosphere and the climate.
- Read and comprehend recent scientific papers written on various topics within the general framework of cumulus clouds.

- Demonstrate familiarity with the scientific literature on cumulous clouds, or at least some parts of it.

Assignments

Every week, students will be expected to read a paper indicated by the instructor and complete a questionnaire regarding the paper. The template of the questionnaire will be provided to the students at the beginning of the class and will be used for all the papers. In addition, every week students will be expected to participate via Zoom in an oral discussion with the instructor about the paper that has been read. Finally, at the end of the semester, the students will have to submit a final project in writing and present it to the rest of the class in a 15-minute presentation. The project will either be a literature review or a small research project, and the topic will have to be agreed with the instructor at the beginning of the class.

Grading

The final grade will be determined by a weighted average of the grades earned by a student in each of the assignments described above. The weights are as follows:

Weekly Questionnaire	20%
Weekly Discussion	25%
Final Project	40%
In-class Presentation	15%
	100%

The weekly discussions are mandatory, and the questionnaires about each paper will have to be submitted via email before the discussion on the paper. If the questionnaires will be submitted after the deadline, five points will be deducted for each day of delay. **Plagiarism of any form will not be tolerated**.

Calendar

01/11	Introductions, explanation of the class
01/15	Dry convection I
01/18	Martin Luther King Day
01/22	Discussion
01/25	Moist Thermodynamics I
01/29	Discussion
02/01	PBL Dynamics I
02/05	Discussion
02/08	Shallow Cumulus I
02/12	Shallow Cumulus II
02/15	Presidents' Day
02/19	Discussion

02/22	Shallow Cumulus III
02/26	Discussion
03/01	Deep Convection I
03/05	Discussion
03/08	Deep Convection II
03/12	Discussion
03/15	Spring Recess
03/19	Spring Recess
03/22	Deep Convection III
03/26	Kuhio Day
02/29	Discussion
04/02	Good Friday
04/05	Deep Convection IV
04/09	Discussion
04/12	Interaction with large scale I
04/16	Discussion
04/19	Interaction with large scale II
04/23	Discussion
04/26	Interaction with large scale III
04/30	Discussion
05/03	Final review
05/10-14	Final Presentations

Main Reference Texts

K. Emanuel, *Atmospheric Convection*, Oxford University Press
W. Cotton, G. Bryan, S. van den Heever, *Storm and Cloud Dynamics*, Academic Press
P. Siebesma et al., *Clouds and Climate*, Cambridge University Press
R. Houze, *Cloud Dynamics*, Academic Press

Title IX Statement

The University of Hawai‘i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to

make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the **confidential resources available here**: http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact: Dee Uwono Title IX Coordinator (808) 956-2299, t9uhm@hawaii.edu.