ATMO 620 – Physical Meteorology

Semester: Fall 2025
Class time: TR, 10:30 – 11:45
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When thinking about the journeys that a parcel of air can embark on, it is customary to imagine large atmospheric circulations, strong jets, or powerful updrafts. Yet, like all gases, air parcels don't have to move at all in order to experience change, as a host of physical processes can affect them. This class will be precisely devoted to the study of such processes or, to phrase it more succinctly, to answering the question "In how many ways can a parcel of air change without having to move?".

The class will be divided in three main parts. In the first, students will explore (or revisit) an old branch of Physics, called Thermodynamics. Particular focus will be given to the thermodynamical processes of mixture of gases and to phase transitions, which often occur in the atmosphere. The latter will naturally introduce the second part of the class, which will be dedicated to the study of microphysical processes, such as condensation, cloud drop formation, and rain initiation. The third part of the class will focus on the interaction between the atmosphere and electromagnetic radiation, a topic that sits at the heard of some of the most pressing questions about the future of our planet.

Student Learning Objectives

Upon completion of the course, the student should be able to:

1. Understand the fundamental concepts of Atmospheric Thermodynamics, such as the First and Second Principle of Thermodynamics, and entropy.
2. Understand the microscopical processes that lead to the formation of clouds.
3. Understand and describe the physical processes that lead to the formation of rain.
4. Describe all the ice crystal habits and at what condition each habit forms.
5. Describe electromagnetic radiation.
6. Understand and describe how radiation can interact with the atmosphere.
7. Critically understand the physical principles behind the greenhouse effect.
8. Describe the feedbacks between climate and radiation.

Grading

The final grade will be determined by a combination of weekly assignments, in-class exams, and participation in class:

Weekly Assignments	30%
In-class Exams	60%

Participation in class	10%
	100%

Assignments

Every week, students will be assigned homework that they will have to hand in or email within 3 days. There will be no exceptions. The main objective of the homework will be to help the students better understand the concepts they learnt in class. **Plagiarism of any form will not be tolerated**.

Calendar

08/26	Intro
08/28	Thermo: Ideal gases
09/02	Thermo: Work and heat
09/04	Thermo: First principle of thermodynamics
09/09	Thermo: Entropy
09/11	Thermo: Second principle of thermodynamics
09/16	Thermo: Moist thermodynamics
09/18	Thermo: Moist thermodynamics
09/23	Class canceled
09/25	Class canceled
09/30	Micro: Formation of cloud droplets
10/02	Micro: Droplet growth by condensation
10/07	Micro: Droplet growth by condensation
10/09	Micro: Initiation of rain in warm clouds
10/14	Micro: Initiation of rain in warm clouds
10/16	Micro: Growth of ice crystals
10/21	Micro: Rain and snow
10/23	Micro: Review and practice
10/28	Micro: Water isotopes
10/30	**Mid-term Exam**
11/04	Rad: Planck's function
11/06	Rad: Molecules
11/11	Non-instructional day
11/13	Rad: On spectra
11/18	Rad: Radiative transfer
11/20	Rad: Scattering
11/25	Rad: Transmittance & Heating rates
11/27	Thanksgiving
12/02	Rad: Greenhouse effect
12/04	Rad: Radiative forcing
12/09	Rad: Review and practice
12/11	**Study period**
12/15-19	**Final Exam**

Main reference texts

G. North and T. Erukhimova, *Atmospheric Thermodynamics*, Cambridge University Press
H.R. Pruppacher and J.D. Klett, *Microphysics of Clouds and Precipitation*, Springer
R.R. Rogers and M.K. Yau, *A Short Course in Cloud Physics*, Butterworth-Heinemann
D.G. Andrews, *An Introduction to Atmospheric Physics*, Cambridge University Press
K.N. Liou, *An Introduction to Atmospheric Radiation*, International Geophysics Series

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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.