Course Description

This course will provide the student with an understanding of atmospheric structure, composition and processes. Specific concepts include energy content and transfers, water saturation, and climate forcings and feedbacks. The essential questions that will focus, guide, and sustain learning during the course are:

- What does energy content and transfer reveal about the Earth's temperature?
- How does water saturation link clouds, temperature, and stability in the atmosphere?
- How do forcings and feedbacks shape my views of human role in the Earth system?

This course is designed to provide first-year graduate students with climate-rele knowledge of the atmosphere; some students are focused on this area specifically future research and others just want some introductory knowledge. The cours designed to address both of these interests.

Required Materials

The required text is *Thermodynamics of Atmospheres and Oceans*, J. A. Curry & P. J. Webster (1999). It is available for purchase at the Bookstore and is also available as pdf on the course website. Supplementary reading material and handouts (or links to them) are posted on the TritonEd course site.

Course Schedule

SIO 217a		**Atmospheric and Climate Sciences I:**					
2021 Fall		**Atmospheric Thermodynamics**					
Text:		*Thermodynamics of Atmospheres and Oceans, J.A. Curry & P.J. Webster (1999)*					
Date	Dy	**Ch**	**Skip**	**Due**	**Podcast Topics**	**Class Part 1: Presentations**	**Class Part 2: Breakouts**
27-Sep	M	**1**	1.2,8-9		What is thermodynamics?	Course Introduction	H01 Practice
29-Sep	W	**1**		**Q01**	When controls the hydrostatic atmosphere?	Presentation Signups and ARM Data	Temperature-Pressure Profiles
1-Oct	F			**H01**		Office Hours (Online)	
4-Oct	M	**2**		**Q02**	Hurricanes and Energy Cycle Examples.	H01 Solution	H02 Practice
6-Oct	W	**2**	2.11		First and Second Laws of Thermodynamics.	Kevin Sanchez	Temperature-Pressure Changes
8-Oct	F			**H02**		Office Hours (Online)	
11-Oct	M	**3**	3.4-6	**Q03**	Transfer Processes.	H02 Solution	H03 Practice
13-Oct	W	**12.1**			Radiative Balance Model (12.1).	Lysha Matsunobu	Radiative Balances
15-Oct	F			**H03**		Office Hours (Online)	
18-Oct	M	**4**	4.5.3-4.6	**Q04**	Thermodynamics of Water.	H03 Solution	H04 Practice
20-Oct	W					Kristina Pistone	Water Profiles
22-Oct	F			**H04**		Office Hours (Online)	
25-Oct	M	**5**	5.5-7	**Q05**	Nucleation of Cloud Droplets.	H04 Solution	H05 Practice
27-Oct	W					Midterm Review	CCN Time Series
29-Oct	F			**H05**		Office Hours (Online)	
1-Nov	M	**8**		**Q08**	Cloud Characteristics and Processes.	H05 Solution	H08 Practice
3-Nov	W			EXAM		**Midterm Exam (Ch. 1-4, 12).**	
5-Nov	F			**H08**		Office Hours (Online)	
8-Nov	M	**6**		**Q06**	Cloud Formation.	H08 Solution	H06 Practice
10-Nov	W	**6**			Moist Thermodynamic Processes.	Jeramy Dedrick	Dew and Wet Temps
12-Nov	F			**H06**		Office Hours (Online)	
15-Nov	M	**7**		**Q07**	Stability (skim Eqn. 7.4-19; 7.21-22).	H06 Solution	H07 Practice
17-Nov	W	**7**			Stability and Thermodynamic Diagrams.	Tashiana Osborne	CAPE Calculation
19-Nov	F			**H07**		Office Hours (Online)	
22-Nov	M	**12**	12	**Q12**	Global Energy Balances and Circulation.	H07 Solution	H12 Practice
24-Nov	W	**13**	13.6-7		Thermodynamic Feedbacks for Climate.	Yan Feng	Project Feedback
26-Nov	F			**H12**		**Holiday: Thanksgiving.**	
29-Nov	M			**Q13**	Project Feedback.	H12 Solution	Practice Questions
1-Dec	W				Review Ch 1-8, 12, 13	Final Exam Review	Practice Questions

1-Dec	W				Review Ch 1-8, 12, 13.	Final Exam Review	Practice Questions
3-Dec	F			PRpt		Office Hours (Online)	
???				EXAM	**Online and Oral Exams**	**Final Exam (Ch. 1-8, 12, 13, Projects).**	

Course Information

This course is part of an integrated 3-quarter series (SIO 217 a, b, c). The course format is "flipped", meaning that we will incorporate student participation and breakout discussions as integral parts of class time. This form of teaching recognizes that students come to class with prior knowledge on the topics to be studied. Sometimes this knowledge is profound and accurate. Sometimes it isn't. Learning involves first confronting our prior knowledge. This form of teaching also stresses the similarity between the learning experience and the research experience. We learn by actively engaging in formulating questions and discovering the answers to them. This is very different from rote memorization of facts, lecture notes and pages of text.

This class will involve intensive student participation in interactive learning exercises, as well as a term project to be presented in class and in reports. I will use class time for interactive learning exercises that

- reinforce key terms, definitions, and equations or
- explore challenging concepts with additional information and different perspectives.

I will generally not simply repeat the material in the text. Here are my expectations: Participate fully in every class that you can attend. Read the text and watch the pre-recorded podcast before class. Always have the text and your laptop available for class. Take your own notes in addition to the posted slides. Study the assigned material in advance, especially by viewing the podcasts and reading the chapters before class. Be an active participant in class; do not just sit and listen.

There are 10 weeks in the quarter, and we will try to cover 10 chapters of the text, thus about a chapter per week. The ten chapters we will study are 1, 2, 3, 4, 5, 6, 7, 8, 12, and 13. In several chapters, I will specify some of the material to skip. The homework provides practice in key concepts; you are encouraged to get help from me or other students, but the answers you turn in must be in your words with

answers that you can explain and defend. For this reason, an important part of your homework will be presenting your answer.

Expect frequent questions about the readings and in-class assignments that test or document your understanding. I will give guidance in advance on which material is most important. In particular, always know the meaning of every word in the assigned portions of the text because learning the "jargon" of the atmosphere is an important part of this class. Quizzes and the mid-term and final exams will include definitions.

IMPORTANT: In this course, you must not remain silent. You must speak as well as listen. If English is not your first language, make use of this is an essential opportunity to practice your English.

Course Policies

Basis for Final Grade: The goal of the quizzes will be to help the student to learn various nomenclature and background of education. Exams are announced in advance and cannot be rescheduled (except with a letter from a "dean, divinity, doctor, or DoD"). Grading will be as follows:

Assessment	Grade	Learning Purpose
Quizzes (Drop 4 Lowest)	10%	Aid memory, practice terms, and check understanding of lower-level objectives.
Presentations and Leadership	10%	Develop and demonstrate conceptual understanding of higher-level objectives.
Midterm (Timed Online)	10%	Assess mastery of core concepts in first four chapters, including key terms and equations.
Homework	30%	Perform fundamental calculations and provide quantitative applications.
Project (Video and Paper)	20%	Demonstrate application of concepts to a specific data analysis question.
Final (Oral and Timed Online)	20%	Assess mastery of course learning objectives, including term project.

Grading Scale:

- 90 – 100% A
- 80 – 89% B
- 70 – 79% C
- 60 – 69% D
- 0 – 59% F

Grade Dissemination: Graded tests and materials in this course will be returned individually. You can access your scores at any time on TritonEd.

Late Work Policy: There are no make-ups for quizzes or exams. I do not accept late work (except for short delays related to internet access). TritonEd is configured to accept completed assignments up to the due date and time, and then it will not accept submissions. I will share complete information on assignments to allow ample time for completion if you do not procrastinate. Please respect the time of your instructors and your colleagues; plan ahead and submit on time so that we can all progress through this learning experience together.

Grades of "Incomplete": The current university policy concerning incomplete grades will be followed in this course. Incomplete grades are given only in situations where unexpected emergencies prevent a student from completing the course and the remaining work can be completed the next semester. Your instructor is the final authority on whether you qualify for an incomplete. Incomplete work must be finished by the end of the subsequent quarter or the “I” will automatically be recorded as an “F” on your transcript.

Group Work Policy: Everyone must take part in group projects. All members of a group will receive the same score; that is, the project is assessed and everyone receives this score. However, that number is only 90% of your grade for this project. The final 10% is individual, and refers to your teamwork. Once formed, groups cannot be altered or switched, except for reasons of extended illness.

Disability Access: Students requesting accommodations for this course due to a disability must provide a current Authorization for Accommodation (AFA) letter issued by the Office for Students with Disabilities (OSD), which is located in University Center 202 behind Center Hall. Students are required to present their

AFA letters to Faculty (please make arrangements to contact me privately) and to the OSD Liaison in the department in advance so that accommodations may be arranged. Contact the OSD for further information: 858.534.4382 (phone); **osd@ucsd.edu(email (mailto:osd@ucsd.edu(email)**); **http://disabilities.ucsd.edu (http://disabilities.ucsd.edu/)** (website).

Title IX Compliance: The University recognizes the inherent dignity of all individuals and promotes respect for all people. Sexual misconduct, physical and/or psychological abuse will NOT be tolerated. If you have been the victim of sexual misconduct, physical and/or psychological abuse, we encourage you to report this matter promptly. As a faculty member, I am interested in promoting a safe and healthy environment, and should I learn of any sexual misconduct, physical and/or psychological abuse, I must report the matter to the Title IX Coordinator. Should you want to speak to a confidential source you may contact the Counseling Center. The Office for the Prevention of Harassment & Discrimination (OPHD) provides assistance to students, faculty, and staff regarding reports of bias, harassment, and discrimination. OPHD is the UC San Diego Title IX office. Title IX of the Education Amendments of 1972 is the federal law that prohibits sex discrimination in educational institutions that are recipients of federal funds. Students have the right to an educational environment that is free from harassment and discrimination. Students have options for reporting incidents of sexual violence and sexual harassment. Sexual violence includes sexual assault, dating violence, domestic violence, and stalking. Information about reporting options may be obtained at OPHD at (858) 534-8298, ophd@ucsd.edu or**http://ophd.ucsd.edu (http://ophd.ucsd.edu/)** . Students may receive confidential assistance at CARE at the Sexual Assault Resource Center at (858) 534-5793, sarc@ucsd.edu or**http://care.ucsd.edu (http://care.ucsd.edu/)** or Counseling and Psychological Services (CAPS) at (858) 534-3755 or**http://caps.ucsd.edu (http://caps.ucsd.edu/)** . Students may feel more comfortable discussing their particular concern with a trusted employee. This may be a student affairs staff member, a department Chair, a faculty member or other University official. These individuals have an obligation to report incidents of sexual violence and sexual harassment to OPHD. This does not necessarily mean that a formal complaint will be filed. If you find yourself in an uncomfortable situation, ask for help.

Attendance Policy: All students are responsible for all information and updates provided in all scheduled lectures. My expectations for your virtual and mental attendance of class and project times is that you be prepared, engaged, and "present" for all discussions or activities. Illness and unforeseen circumstances may prevent you from attending a few classes during the quarter, and as a matter of courtesy please let instructors know when you will be missing and how you will make up the missed time. Automated podcasts have been scheduled, but they do not always work and do not necessarily include all information given in class (since they do not record what occurs in breakout rooms). Attendance for the problem sessions is optional.

Professionalism Policy: I expect the classroom to be an active, open environment, which encourages diverse thought and comments. Please attend to all university policy and classroom etiquette procedures. Those not heeding the policies will be asked to leave the classroom/lab immediately so as to not disrupt the learning environment. Please arrive on time, be attentive, and respectful for all class meetings. Students who habitually disturb the class by talking, arriving late or other unprofessional behavior may suffer a reduction in their final class grade. Active, positive, engaging, participation in class activities is essential. As pre-professionals or professionals, you should be at the point in your career where you have learned to ask and answer these questions:

1. How do I know when I know something? What is the evidence and how reliable is it?
2. How are things, events, theories, models or people connected? What is the cause and effect?
3. What is new and what is old - have I run across this idea before? When, where, what did it mean to me then, and how I can expand and further connect the concept now?
4. So what? Why does it matter? What does it all mean?

Academic Conduct Policy: The Policy on Integrity of Scholarship aims to encourage and maintain the highest ethical standards in research. The policy reaffirms the University's commitment to integrity: Integrity is essential for an academic community. The University expects that both faculty and students will

honor this principle and in so doing protect the validity of University intellectual work. For students, this means that all academic work will be done by the individual to whom it is assigned, without unauthorized aid of any kind. Instructors, for their part, will exercise care in planning and supervising academic work, so that honest effort will be upheld. It is against policy to submit the same paper for credit in more than one course.

Instructor Goals. At a minimum, I hope to pursue the following goals and solicit your open and timely feedback on how well we are meeting these goals:

- Communicate effectively and frequently;
- Be enthusiastic, active and involved in learning;
- Demonstrate a mastery of the discipline;
- Relate material to current practice and research;
- Clearly explain complex concepts and ideas;
- Provide a framework for lifelong learning;
- Strive to involve participants in class activities;
- Be available to assist participants in or out of class; and
- Have respect and concern for all participants.

Course Learning Objectives

Ch	Students will be able to...
Intro	Identify the content, format, and expectations of the course.
1	Review relationships needed for atmospheric calculations.
1	Explain why thermodynamics is relevant to the atmosphere.
1	Visualize relationships of pressure and temperature in the atmosphere.
1	Visualize course objectives and relationship of processes.
1	Explore the different parts of the course and how the chapters are related.
1	Practice relating pressure and temperature in the atmosphere.
1	Review atmospheric structure and pressure-temperature relationships.
2	Differentiate among isothermal, isobaric, and adiabatic changes.
2	Explore the properties and impacts of hurricanes and their energy.
2	Discuss the Carnot Cycle and the problem statement.
2	Illustrate how heat capacity is different for water and air.
2	Show how to derive equations for adiabatic and isothermal work.
2	Review the definitions and properties of different types of energies.

2	Compare and contrast different types of energies.
2	Practice thermodynamic terms and meanings.
2	Use energy cycles to evaluate effects of warming on hurricanes.
2	Review adiabatic and other processes for fluid changes.
3	Identify and use the equations for radiative calculations.
3	Investigate the properties of direct and diffuse radiation.
12	Evaluate the surface radiation balance from measurements.
3	Identify the fundamental radiation equations.
3	Describe the differences in radiation at different wavelengths.
3	Visualize differences between important terms for radiation.
12	Relate fundamental equations to solve for Tsurf.
12	Describe and diagram the flow of incoming and outgoing radiation.
3	Review radiative transfer equations in radiation model.
4	Visualize the strong dependence of saturation on temperature.
4	Examine current research on role of water for Earth's albedo.
4	Practice calculating water quantities from profile measurements.
4	Evaluate Ch. 4 quantities and calculate relationships.
5	Calculate effect of particle composition on critical supersaturation.

5	Evaluate the role of CCN in the atmosphere.
Rvw	Review key equations for atmospheric energy and water.
5	Identify missing concepts and problems from midterm.
8	Examine the integrated optical extinction for a column of air.
8	Review the contribution of aerosols to light extinction.
6	Examine how a swamp cooler cools a room.
6	Investigate cloud characteristics and their radiative effects.
6	Use wetbulb and equivalent potential temperatures as watermetrics.
6	Review the effect of water on air temperature.
7	Relate convective available potential energy to vertical motion.
7	Describe the effects of precipitation processes.
7	Explore CAPE for different profiles.
7	Review the calculation of CAPE and its effects.
13	Distinguish between forcings and feedbacks for complex examples.
13	Describe how the uncertainties in climate forcings.
Rvw	Review lessons on key thermodynamic concepts for the atmosphere.
13	Review the assumptions and processes in the radiation model.
Rvw	Create questions that review course material and resolve them.
Rvw	Practice answering questions for oral exam.
Rvw	Demonstrate knowledge of key terms and equations.