

Introduction to Atmospheric Science

SYLLABUS

Class time: TR 11:30am to 1pm

Classroom: Murie 230

Instructor: Carmen N. Moelders, aka Nicole Mölders

Email: cmoelders@alaska.edu

Office: Akasofu 309

Hours: Thursday 1-2 pm in Akasofu 319

Course Description: Introduction to Atmospheric Sciences comprises the physical, chemical and dynamical processes of the troposphere. The governing conservation (balance) equations for trace constituents, dry air, water substances, total mass (equation of continuity), energy (1st law of thermodynamics), entropy (2nd law of thermodynamics), and momentum (Newton's 2nd axiom) are presented and explained. This presentation includes basics of cloud physics, and simplifications like the hydrostatic and geostrophic approximations and their application in models. Static and conditional stability criteria are explained too. Phenomena discussed include, for instance, frontal systems, hurricanes, Föhn wind systems (Chinook), monsoon, El Nino Southern Oscillation (ENSO), ice fog. Chemical processes taking place in the atmosphere are analyzed based on kinetic processes, but thermodynamic equilibrium is also discussed. The discussion comprises, among other things, photolytical and gas phase oxidation processes, aqueous chemistry, as well as gas-to-particle conversion. Fundamentals of biogeochemical cycles (e.g., CO₂, H₂O, nitrogen, etc.) and the origin of the ozone layer are covered as well. The chapter on radiation includes solar and terrestrial radiation, major absorbers, radiation balance, radiative equilibrium, radiative-convective

equilibrium, basics of molecular, aerosol, and cloud adsorption and scattering. Satellite imagery, greenhouse gases (e.g., CO₂, H₂O, CH₄, etc.), and optical phenomena like rainbows, halos etc. are included. Interactions of the global energy, water, and trace gas cycles and their influence on general circulation and their role in the climate system are presented. Moreover, fundamentals in numerical modeling of atmospheric and hydro-meteorological processes are provided.

Course objectives and goals: By the end of the semester, all students will

1. Utilize the basic fundamentals such as, the governing conservation (balance) equations for aerosol and trace gas constituents, dry air, water substances, total mass (equation of continuity), energy (1st law of thermodynamics), entropy (2nd law of thermodynamics), and momentum (Newton's 2nd axiom) and their special approximations, in preparation for other ATM classes. This includes
 - Describe a process in terms of equations
 - Analyze and interpret weather maps, diagrams, and satellite images
 - Explain the basics of atmospheric thermodynamics, radiation, circulation, cloud- and precipitation formation, as well as atmospheric chemistry
2. Interpret chemical or other environmental measurements or model results in the framework of the meteorological situation
3. Demonstrate to discuss science in an educated manner
4. Develop skills to read papers critically
5. Apply material learned to new problems
6. Improve the quality of their presentations

Students taking this class at the graduate level will in addition be able to

7. Develop reasonable assumptions based on atmospheric science foundations to problems
8. Evaluate the uncertainty caused by assumption as it is needed in thesis research.

Class delivery: Research showed that teaching someone and active learning else are the best ways to learn (e.g. [here](#)). Therefore, this class is taught in **flipped mode**.

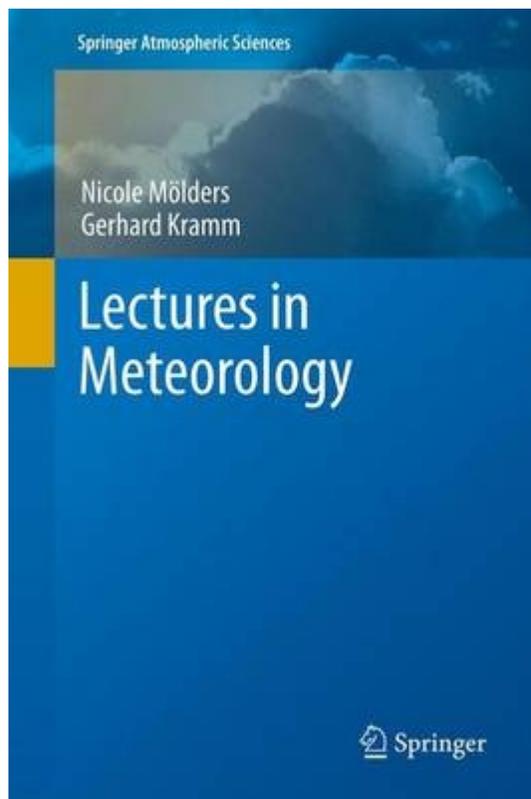
This means you will have to do reading assignments, watch videos, take notes and have to answer the questions given in a unit by 1500 AST the day before class, fill out the equation sheet prior to class, and be prepared to summarize the material learned as your homework. Filling

out the equation sheet, answering the questions and being prepared to summarize the material are part of the grade. I will grade the equation sheets, answers to questions, and the review/summary as homework.

Flipped class also means that the exercises and discussion will be in class. Classes will start with a review by a student on the reading assignment. There will also be a question and answer session where you can seek clarification of the read material. Then an application session follows based on the material covered by the reading assignment. Depending on the type of application this will be either as individual work or in group assignments where I will work with a student or group at a time while the others work on the assignment. The application assignments may be tailored to the three different student groups (ATM401, ATM601, CHEM601). In such cases, when one of the groups has solved their assignment they are to join one of the other groups. In flipped mode, I will collect the application assignments occasionally (i.e. without prior announcement) for grading.

Suggested readings/textbooks: All reading assignments will require using

Mölders, N., Kramm, G. 2014. Lectures in Meteorology, Springer Atmospheric Sciences Series, Heidelberg



Reading the book, watching the video and taking notes are also homework assignment, i.e. inevitable. You will not be able to fill out the equation sheet, answer the questionnaire that helps you to take notes, answer the comprehensive/application questions, and give the review/summary without having done the reading. You also will not be able to seek clarification in the respective box of the questionnaire that asks what you had difficulties understanding and want clarification on. This part of the questionnaire is where you communicate to me, what I should address first thing in class. In other words, here you give me my homework assignment to help you. Without doing the assigned class preparation (watching the videos, reading the assigned sections, filling out the questionnaire), you will not be able to participate efficiently in the in-class application projects. The final examination is open book and only this book will be allowed.

Required technology software: This class has a strong online component. Students need a laptop, PC, Mac or tablet with a browser, a UAF email address to access the questionnaires and quizzes, and access to the internet. On the device software to watch mpi videos has to be installed. I expect that you can handle and work with Adobe reader, google forms, google doc, google sheets, and excel. 😊 You can [download them from the OIT software catalog](#). You can find what [software you can use to open the MP4 videos](#) at the link. You can access

[google here](#). Contact [OIT for support](#) in installing the required software. Students also will need an old-fashioned (offline) calculator for the exam.

Other course resources: Please realize that when students enroll in university-level courses they may need to employ skills that are not directly related to the course content. As a student, you might be required to learn something new to succeed in class even though that skill/material will not specifically be on the final exam. Thus, students should expect to learn [techniques/tools](#) that are needed to fulfill the requirements listed in this course syllabus.

Attendance: You have to attend class regularly and do your reading and video assignments as posted and/or stated in class. Class attendance and participation in the in-class exercises are required and part of your grade. Excused absences are approved in advance or absences due to a documented emergency. Such documentation must be made immediately upon the student's return to class. However, unexcused absences lead to an **F** on popup quizzes that may occur on the day you missed. Please understand that this is a college course – you are expected to be on time for class and have all the required material unpacked.

Homework: There are **two different due dates**.

- Answering and submitting the questionnaires are due **on the day before class at 1500 AST**. I will not accept any late submissions unless approved in writing by me prior to the due date. Submitting the questionnaire **in time** is essential for your grade.
- You will be allowed to revise the submitted version **after class** and resubmit it. The submission of the final version of the questionnaire is due a week after the class. I will grade only **resubmitted versions** or when you did not revise your submission, the first submission. If you fail to submit the first (draft) version of the questionnaire in time (see above), you will get an F even when you submit the final version in time. This policy ensures that students are prepared for class to get the most out of the class.

I expect that each student is able to give a review of the material read and watched in front of the class. The contributions should be thorough and complete, reflecting the thought that you have put into your tasks. You will be picked randomly several times per semester for presenting the homework. You may excuse yourself prior to the start of the class once in a semester for not having your homework. I recommend taking notes while reading the book and/or watching the video.

No late homework can be accepted (except in excused absences to be approved before the event). Late homework has to be submitted in writing and in readable style. “Readable style” means typed, double-spaced, using at least a 12-point font, one-inch margins, and in hard

copy format. It is simply too tricky to edit and make comments in single-spaced type. If you have not met these stipulations, I will return it to you ungraded. Late homework will not be accepted via e-mail or fax unless you make prior arrangements with me.

It is the student's responsibility to prepare homework in time. I strongly suggest that you plan and schedule your work and start working on your homework before it is due. I recommend having backup systems in place so you can have all work completed on schedule. Getting work done on time is a key to early success in your business or scientific career. A major complaint of employers is that faculty do not instill a sense of responsibility in students.

It is part of your homework – even when not said explicitly – to read the assigned parts of the book in addition to watching the videos. This means that at the beginning of the class I will ask questions or ask to summarize the last class. You can offer to answer the questions or do the summary, but I also reserve the right to ask students randomly who do not volunteer. I will grade the review.

Writing etiquette: I expect that you use correct English grammar and spelling in all questionnaire, quizzes, in the final exam, and emails to me. This expectation is to practice being professional in your communication.

Class participation: encompasses to actively contributing to solving in-class application exercises, presenting the material read in form of a review in front of the class, participation in discussions and group-work, summarizing material learned and answering questions. Hint: It is better you ask the class or me a question than I ask you a question that you cannot answer.

In-class exercises: The in-class exercises (applications) may involve group work and are an important learning element to develop your ability to solve scientific questions, to improve your understanding by applying the material you learned in the videos and reading assignments, reviews, and application, and to present complex material. They are also preparation for the exams and your future education at UAF and professional life. Every group member must be able to answer questions.

Teamwork and individual work: I encourage teamwork and will occasionally build teams, because teamwork will be the way to work in future work places. Research also showed that students working together typically become better presenters (a goal of this class) and are more successful in class. If you co-work in groups, everybody of the group must be able to present the work at the board in class. You are expected to present your group's or your in-class application work at the board when you are called to do so. In the presentations of in-class applications, I may randomly ask to switch from one teammate to the other to ensure that nobody takes group work as a free ride.

In-class presentations: You must always be able to present the material that you had to read and watch as a homework assignment in front of the class. This means that you will not be told in advance when you will be the person who gives the review in class. It is the student's responsibility to be aware of and to be prepared for each assigned task when it is due. Give the person who is speaking your undivided attention. It is not only common courtesy, but scanning through pages of notes, whispering or talking can distract, annoy, and even intimidate students around you as well as myself. Essentially, you should treat classmates and me as you would like, and expect, to be treated yourself.

Pop-up quizzes: There may be unannounced popup quizzes. These quizzes cover material of **all** previous classes, results from applications, and reading homework assignments, and sometimes discussion or solving of a problem. Only in case of an emergency, I will allow you to start later on a quiz. Note that some units have a quiz at the end. In this case, it is open book.

Examinations: There will be one major examination. It is the student's responsibility to find out when and where the examination will take place and to be there in time. Only in case of emergency, I will allow you to start later on the exam. There is usually another exam scheduled in this classroom right after your own exam so the room has to be free in time. This means that I cannot give you extra time if you arrive late. The exam is scheduled for finals week. It is open book. Only the *Lectures in Meteorology* are allowed as hard copy. However, if students bring a reasonable scheduling conflict to my attention by the **end of the first week of classes** (e.g., absence for field work, attendance of a conference during finals week) I will work with the student for arrangements. **I will not do the exam prior to AGU as that would take off 14 days of class material.**

Difference between CHEM601 and ATM601: There is no difference between the grading of the completeness, correctness, and understanding of quizzes and the exam. I try to balance the interests of chemistry and atmospheric sciences students and the importance of the material taught for their discipline by assigning applications relevant for their discipline as much as possible. Thus, I will occasionally assign ATM601 and CHEM601 students different kind applications, or parts of exams or quizzes. Students can gain extra credit for also doing the tasks not assigned to them. A difference on an application task could be that ATM601 students have to plot the results of a problem for various quantities, while CHEM601 students have to discuss what the results of the problem mean for the chemical distribution in the atmosphere.

Difference between ATM401 and ATM601: There is a distinct difference in the expectations of the completeness, correctness, and understanding of the homework, quizzes and examinations. I try to balance the interests of undergraduate and graduate students. Therefore, I will assign special tasks for undergraduates that probe the presented material at the undergraduate level. In the case of tasks

that are assigned to all students or the atmospheric sciences students, undergraduate students will get the full credit possible on a task if they reach 80% of the points possible for a graduate student for the same grade, i.e. the grading is shifted towards lower expectations. The same is true for the questions and equation sheets. Moreover, there will be tasks that are ONLY designed for graduate students and these tasks are indicated as such. These tasks require skills that undergraduate students usually do not have yet (e.g., programming) or that are not an expected learning goal for them right now (e.g. making reasonable assumptions, justify assumption). The undergraduate students will be assigned a task at the undergraduate level to work on at that time.

Additional policies:

1. No weapons allowed in class.
2. Due dates are firm, with the exceptions mentioned above as well as documented emergencies.
3. If you have a disability and require any auxiliary aids, services or accommodations under the Americans with Disabilities Act, please contact me after class, see me in the my office, or call me during the first week of the semester to be able to define specific accommodation needs and have enough time for any necessary preparation. Also contact [UAF's disability services](#). If you have any kind of a physical or learning disability you must tell me about it. All disabilities are documented by [UAF's Center for Health & Counseling](#) and instructors receive a formal letter requesting that accommodation are made for any student with disabilities.
4. Any student who is an UAF sponsored athletic or who has other personal or situational difficulty that might affect class performance is invited to contact me in the first week of the semester (or as soon as such matters emerge) so that ways of accommodating the difficulty may be anticipated.
5. If you intend to go to AGU, another scientific conference or on a field trip, you must tell me this in the first week of class. If you find out about mandatory travel later in the semester, you must tell me as soon as you get to know about it. It is your responsibility to make up for the material you missed.
6. Switch your cell phones off and do not text during class.
7. Please do not leave class to go to the restroom and/or fill up your water bottle and/or buy a coffee/snack.
8. I do not answer emails Saturday and Sunday, i.e. I answer within 24 h to emails on Monday to Friday afternoon only. When I am on travel, I do not answer to emails as I cannot guarantee email access.

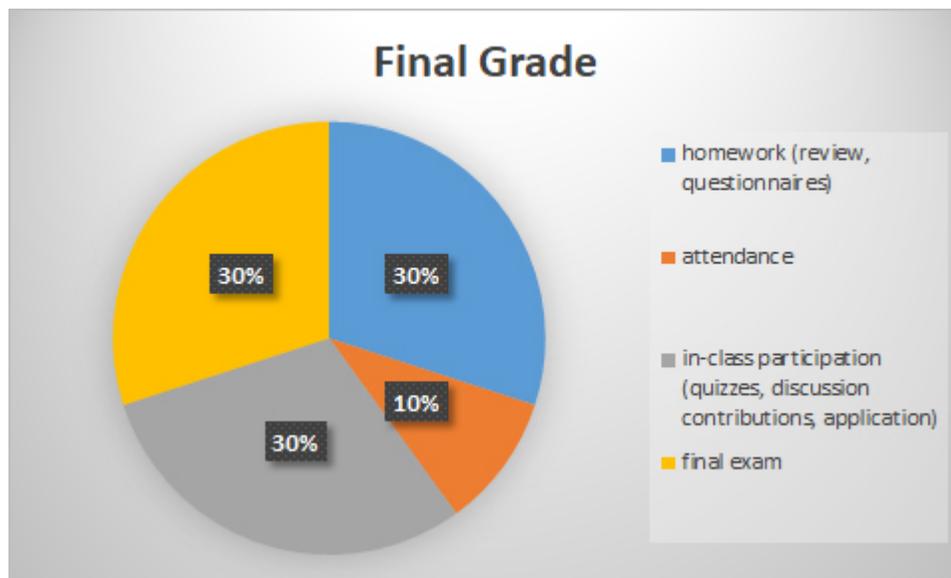
All students in the class were informed about the policies at the beginning of the class and in the syllabus, and it would be unfair to everyone else to give one person an exception.

Other important information: It is essential that you (1) keep up with the reading of the book and video materials, (2) budget your time wisely to complete all of your reading and viewing assignments, and (3) seek clarification on any material, which you do not understand, during office or class hours. Note there is a **Quiz Your Professor** section on the right sidebar of our class page. If I am not covering subjects adequately, or the in-class exercises are confusing or difficult, or if you do not understand the questions in your homework, quiz or examination, please let me know. I want you to understand the material and that you can apply the material to solve problems. Please use the office hours or **one-minute quiz** to seek clarification. One-minute quizzes can be submitted at the end of each class or until 1500 AST on the day before class by slipping it under my office door. The intent of the one-minute quizzes is that you can stay anonymous with your clarification request.

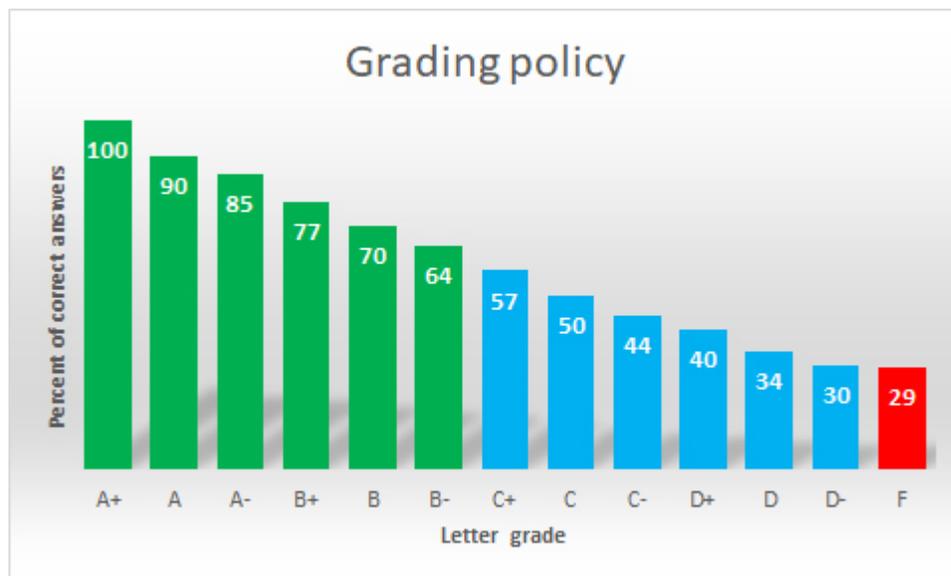
Academic integrity, honor code and plagiarism: I expect students to submit own original work and reference all other work and intellectual ideas with appropriate reference and citation. You are subject to the [Code of Conduct](#).

Grading Policy: This class is a success-oriented course. My aim is for all students to meet their individual learning and grade goals. Of course, this does not mean that you can avoid working hard or work hardly. Instead, it means that (1) all students who do well in the quizzes and examination will be rewarded accordingly and (2) the grade distribution will not be adjusted to make sure it fits a bell-shaped curve. I expect that (1) you aim to give your personal best in the course, and (2) use in-class exercises and questions, homework, quizzes and examination as an opportunity to demonstrate your understanding of the material. To obtain an “A” grade you will need to produce work that far exceeds my normal expectations. My normal expectations are regularly attending the classes, hard work evidence of time spent with the material and an ability to demonstrate understanding of all concepts.

Grading for this class will follow the [UAF guidelines](#). Your grade will be 30% homework (review, questionnaires), 30% in-class participation (quizzes, discussion contributions, application), and 30% final exam, and 10% attendance.



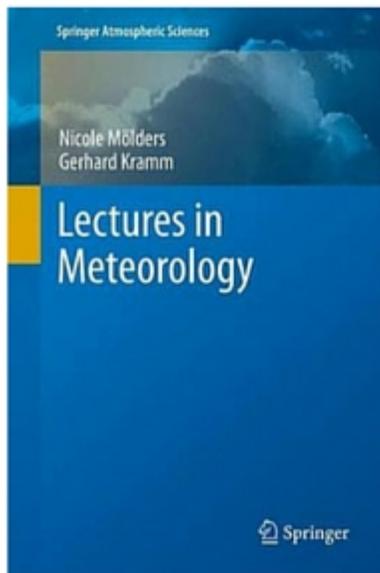
To get a "C" grade, 50% of the points in each category have to be earned. I will give +/- grades with the following UAF rules A 4.0, A- 3.7, B+ 3.3, B 3.0, B- 2.7, C+ 2.3, C 2.0, C- 1.7, D+ 1.3, D 1.0, D- 0.7, and F 0.0, respectively. Thus, 90% and better is an A, 85-89% is A-, 77-84% is B+, 70-76% is B, 64-69% is B-, 57-63% is C+, 50-56% is C, 44-49% is C-, 40-43% is D+, 34-39% is D, 30-33% is D-, less than 30% is F. Grades of "incomplete" will be given only in cases where an extraordinary, exceptional reason, submitted in writing by the student and judged valid by me. See UAF policies for [details](#).



Tentative Schedule: Learning is an interactive process and each class is individual. Although I have put a lot of thought into the sequence of topics, this schedule is tentative by purpose and subject to change as necessary due to availability of support materials, adaptation to specific needs of the class, etc. The **schedule** for this class will remain an on-going construction in light of what is accomplished in each class meeting. Since this course will be attended by undergraduate and graduate students both it will be unavoidable to insert additional subjects or to explain subjects in more detail because of the different levels of the students. Moreover, to get a better understanding for atmospheric sciences it will be required to pick up subjects that are caused by actual weather events. Departures from the schedule, such as additional readings, assignments, deadline changes, and activities, may be announced in class. These changes will take priority over the printed schedule. It is your responsibility to be in class and to keep up-to-date on whatever changes I make, or the class negotiates.



Syllabus Introduction to Atmospheric Sciences



Class time: TR 11:30am to 1pm

Classroom: Murie 230

Instructor: Nicole Mölders

Email: cmoelders@alaska.edu

Office: Aka 309, Tr 1-2 pm



Content

Among others, physical, chemical & dynamical processes of the troposphere; governing conservation equation; irreversible thermodynamics ; basics of cloud physic, gas, photo-, aqueous & aerosol chemistry; atmospheric radiation; optical phenomena; biogeochemical cycles; weather forecast

Objective

Explore physical, chemical and dynamical processes; solve fundamental problems related to atmospheric science; analyze

weather maps or climate diagrams, satellite images



Delivery

Flipped class

<https://intro-atmos-sci.community.uaf.edu>

Difference CHEM601 ATM601

None in grading; discipline specific assignments on occasion

Difference ATM401 ATM601

Lower expectations on completeness, correctness, understanding on homework, quizzes, exam for ATM401





Major Policies

Academic integrity, honor code, no plagiarism;
No weapons: due dates are firm; Americans with Disabilities Act: document at UAF's Center for Health & Counseling in 1st week; sponsored athletic & AGU/conference/field trip: tell me in 1st week; you are responsible to make up for missed classes; Switch cell phones off; no photos; no email answers F after EOB to M

Grading

30% homework (review, questionnaires), 30% in-class participation (quizzes, discussion contributions, application), and 30% final exam, and 10% attendance



Short version of syllabus as infographic

EDIT

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Introduction to Atmospheric Science

SCHEDULE

Our Learning Process for each Unit

Knowledge collection

Student reads the assignments and watches the video

STEP 01

STEP 02

Taking notes

Student fill out the questionaire



This schedule lists what will be covered by the in-class exercises and applications, and which units you have to have done **prior** to the day of class to prepare yourself for the in-class review by students, discussion of the material, and application exercises that will be done during

class time. This means that prior to the day of class you will have to prepare the assigned unit. **Note that it is your responsibility to keep up with the schedule!**

Important information applicable to all units

I will not accept any late submissions unless approved in writing prior to the due date. Submitting the questionnaire **in time** (1500 AST the day before the next class) is essential for your grade. You will be allowed to revise the submitted version **after class** and resubmit it within a week. I will grade only the **resubmitted versions**. If you fail to submit the draft version of the questionnaire in time, you will get an F even when you submit the final version in time.

OIT problems

If you have technical problems or questions that are not related to the material check the [FAQ](#) first. If you have questions on the material, [email](#) your question and **clearly** describe what you did not understand and where you are struggling.

Unit due times

Day of class	Material to be applied during class time	Homework assignment to be prepared for this class time
Week 1, Tuesday, 8-28	Introduction, FAQ, jeopardy of class web page	Make yourself familiar with the class web site and the syllabus
Week 1, Thursday, 8-30	Structure of the atmosphere	unit 1
Week 2, Tuesday, 9-4	Gas laws and their application to meteorology	unit 2
Week 2, Thursday,	Zeroth and first law of thermodynamics:	unit 3

9-6		
Week 3, Tuesday, 9-11	Second law of thermodynamics and its application to meteorology	unit 4
Week 3, Thursday, 9-13	Moist air	unit 5
Week 4, Tuesday, 9-18	Phase Transition processes	unit 6
Week 4, Thursday, 9-20	Stratification and Stability	unit 7
Week 5, Tuesday, 9-25	Air mass modification	unit 8
Week 5, Thursday, 9-27	Cloud microphysical processes	unit 9
Week 6, Tuesday, 10-2	Cloud morphology	unit 10
Week 6, Thursday, 10-4	Atmospheric radiation – nomenclature and basic concepts	unit 11
Week 7, Tuesday, 10-9	Solve these problems that review unit 1 to 8 , as a group prior to class on Thursday 10-11. Submit one solution as a group. When you disagree, please add both solutions and bullet points why you think the respective solution is right. No names please. I want you to exercise working as a diverse team.	Review the material that we covered so far
Week 7,	Shortwave and long-wave radiation, radiation transfer and global energy budget	unit 12

Thursday, 10-11		
Week 8, Tuesday, 10-16	Application of radiation in remote sensing	unit 13
Week 8, Thursday, 10-18	Basic concepts of atmospheric chemistry	unit 14
Week 9, Tuesday, 10-23	Tropospheric and stratospheric gasphase chemistry	unit 15
Week 9, Thursday, 10-25	Aqueous phase chemistry	unit 16
Week 10, Tuesday, 10-30	Aerosols and biogeochemical cycles	unit 17
Week 10, Thursday, 11-1	Vorticity and Navier Stokes equation	unit 18
Week 11, Tuesday, 11-6	Scale analysis and balanced flows	unit 19
Week 11, Thursday, 11-8	Thermal wind, advection, and primitive equations	unit 20
Week 12, Tuesday, 11-13	Waves and Bjerknes polar frontal model	unit21
Week 12, Thursday, 11-14	Conveyor belt model	unit22

Thursday, 11-15		
Week 13, Tuesday, 11-20	Local and regional climate	unit23
Week 13, Thursday, 11-22	Holiday	Happy Thanksgiving
Week 14, Tuesday, 11-27	Climate analysis methods	unit 24
Week 14, Thursday, 11-29	Review for final during class time	Review Part 1
Week 15, Tuesday, 12-4	Review for final during class time	Review Part 2
Week 15, Thursday, 12-6	Review for final during class time	Review on your own terms. The upcoming class time is your last chance for asking for clarification
Week 16, Thursday, 12-13	10:15 am to 12:15 pm	FINALS

Make yourself familiar with the classroom and time scheduled for the examination



EDIT