

CLIMATE/SPACE/EARTH 380 F19

1:30-3:00 MF 2424 SRB

Lecturer: Xianglei Huang (1533 SRB) Tel: 936-0491 Email: xianglei@umich.edu

Office hour: TBD

Mid-term: 1.5-hr exam, in-class, October 25, Friday

Final: As decided by the Office of Registrar, Tuesday December 17, 1:30-3:00pm

Course description

This course teaches the fundamentals about radiative transfer, with an emphasis on its application in climate and space sciences and engineering. The emphasis will be on the concepts and physical laws in the radiative transfer, and how to use such knowledge to explain phenomena in real world. The key skillsets to acquire, in addition to the understanding of the physics of radiative transfer, are (1) order-of-magnitude estimation, (2) dimensional analysis, (3) relating mathematical equations with physical interpretations.

Reference Textbooks

1. A first course in atmospheric radiation / Grant W. Petty. (order it from <http://www.sundogpublishing.com/orderform.php>)
2. An introduction to atmospheric radiation / K.N. Liou. 2nd Ed. (UM electronic access to full book <http://app.knovel.com/web/toc.v/cid:kplARE0015/>)

I will provide copies of relevant chapters in Petty's book.

Required Reading materials (Reserved at AAEL and available on CANVAS)

3. Chapter 3 in *An Introduction to Atmospheric Physics* / David G. Andrews (on CANVAS/Files/Required Reading Materials)
4. Chapter 4 in *Atmospheric Science: An Introductory Survey* / Michael Wallace and Peter Hobbs (on CANVAS/Files/Required Reading Materials)

These two Chapters serve as a good introductory text to concisely illustrate concepts and basic laws pertinent to atmospheric radiation.

Optional Reading materials (Reserved at AAEL)

5. Radiation and cloud processes in the atmosphere: theory, observation and modeling / K.N. Liou.
6. Remote sensing of the lower atmosphere: an introduction / Graeme L. Stephens.

Learning Objectives

From minimum to maximum, the goals are:

1. **Know the jargons, Perform educated guess:** understand basic concepts, fundamental physical laws, perform orders of magnitude estimates

2a. **Know the procedures:** Conceptual flow charts of how to conduct radiative transfer calculation

2b. **Know the big pictures:** The role played by radiative transfer in the climate system and space science, and its interaction with other components; the role of radiative transfer in the remote sensing (know the big pictures)

3. **Know the frontiers:** understand contemporary issues and challenges in 2a & 2b

Skill Development Objectives

1. Apply the knowledge to qualitatively interpret relevant phenomena
2. Develop “physical intuition”: Scaling analysis, order-of-magnitude estimate
Dimensional analysis
3. Cultivate ability of quick learning (from “blocks” to “big pictures”)
4. “Math in the physics”: First physics, then express it in math

Lecturing Schedule

I: [3 lectures] Sep 6-13

Logistics and course policy. Review of relevant basic concepts/physical laws: Harmonic wave, interaction of waves, electromagnetic wave, photon and the wave-particle duality, electromagnetic spectrum. The first law of thermodynamics, ideal gas law. Background knowledge of atmosphere: structure and composition of upper and lower atmospheres.

II: [4-6 lectures] Sep 16 - Oct 04

Basic radiometric quantities; terminology and unit. Basic physical processes of radiative transfer and relevant physical laws. The concept of thermal dynamical equilibrium. The equation of radiative transfer.

III: [2 lectures] Oct 07-11

Facts about the gas molecular spectroscopy. Major absorption features of atmospheric gases.

IV: [3-4 lectures] Oct 18 - Nov 01

The essence of longwave radiative transfer. Solution for the 1-layer atmosphere longwave radiative transfer. The concept of weighting function. The fact about longwave flux and heating rate for clear-sky atmosphere.

V: [3-4 lectures] Nov 04 - Nov 15

Interference and diffraction of waves. Basic concepts about electromagnetic scattering. Light scattering by molecules and particles. Rayleigh scattering. Mie scattering.

Geometric optics. Scattering limits.

VI: [3-4 lectures] Nov18 - Dec 02

Single scattering approximation. Qualitative depiction of multiple scattering. Two-stream treatment of multiple scattering.

VII: [1-2 lectures] Dec 06-09

Application of atmospheric radiation: remote sensing and numerical modeling.

Note: 1-2 lectures might be used to review problem sets and relevant concepts/skills

Course Policy and Information

a) Grading: 45% problem sets; 20% mid-term; 20% final; 7% short essay; 8% class performance.

Numeric-to-Letter Grade Conversion available on Canvas and copied below.

>92	A+
85-92	A
77-85	A-
70-77	B+
65-70	B
60-65	B-
55-60	C+
50-55	C
45-50	C-
40-45	D
35-40	E
<35	F

Grading Standard:

Above conversion table is based on previous 380 classes that I have taught in last 10 years. In this context,

- "B" designates expected "average" work
- "A-" designates expected "good" work
- "A+" designates truly "excellent" work

b) Exams: both closed book exams. I will provide **samples of exams** before each actual exam.

c) Short Essay: write a short essay to explain either a phenomenon or a term/jargon used in your field **with relevance to radiative transfer learned in the class**. Requirements:

(1). No more than two paragraphs (references excluded). **In total everything must fit into one letter-size page with a font size no less than 11.**

(2). Clearly yet succinctly describe the phenomenon or term. You can treat it as if you were asked to write an extended item for a glossary (e.g. http://glossary.ametsoc.org/wiki/Main_Page)

(3). Your explanation of the phenomenon or term **must have** relevance to radiative transfer knowledge discussed in the class.

(4). It is not encourage choosing a term that has been fully explained in the class.

Timeline: (1) By November 1st, please email me which term/phenomenon you are to write about. I will compile a list and, if necessary, coordinate with you to avoid duplicated topics.

(2) The short essay will be due on December 11, Wednesday with electronic submission to me.

(3) If you want feedback from me for your draft of essay, please email me no later than November 27 (the day before Thanksgiving break).

Grading standards: Relevance to the class (20%); clarity of the writing (40%); technical correctness (40%).

I will provide more detailed rubrics for this grading as it is close to the end of semester. In my view, it is crucial for you to learn to communicate your ideas effectively, correctly, and clearly in writing. Most people find writing much more difficult than talking. Although I may know what you're trying to express because I have heard you discuss your ideas during class or in office hours, **I will evaluate your written work on the basis of how well and how correctly the words on the page communicate your ideas**. Developing such writing skill will help you to succeed in your remaining classes, in graduate or professional school, and in the workplace.

d) Homework

Weekly (occasionally bi-weekly) homework, normally due on Friday. 6-8 problem sets in total. No homework due in the exam weeks.

Late homework policy: **For the fairness of all students**, generally no grade for late homework as time management is also a key skill to acquire in the college. Under exceptional and justifiable circumstances, an extension can be granted. **Request with enough justification for such extension must be sent to the lecturer at least 24 hours before the due time, and it is up to lecturer to**

approve it or not. I will respond as soon as I can for such request. Once approved, the extension is usually no more than one week.

Homework is always due at the beginning of each lecture. A student should turn in homework right after entering the classroom. Homework turned in 5 minutes after the entrance to the classroom is deemed as late homework and will not be accepted.

e) Collaboration policy:

1) You can discuss and collaborate with classmates or whomever you want. **However, for every word/derivation/calculation, every line of code, and every plot in the homework that you turn in, they MUST be from your own.**

2) **Borrowing problem solutions or graded homework from students attending the previous CLIMATE380 is a direct violation of the Honor Code.** An honor code pledge has to be signed and attached with each homework submission.

3) Directly “Copy & Paste” sentences from websites (e.g., google, yahoo, wiki) or other sources is **NOT** tolerated and **IS** a violation of the Honor Code.

4) If any of the above is violated, according to the Honor Code, it directly goes to the Honor Code committee and will be up to their decision.

f) Attendance policy

It is expected that students attend all lectures. If you are to miss lectures for legitimate reasons, please try your best to notify me in advance.

- 1) Close engagement with the reading assignments, lectures and in-class discussion and exercise are all crucial parts of learning. Therefore, attending class is critical for your own success and for the success of the course.
- 2) I will excuse your absence if you bring me a note from a doctor or health professional, a signed letter from a University team or program, or documentation of a family emergency.
- 3) You may miss **two** class sessions without penalty.
- 4) Once you have reached your limit of two unexcused absences, I will lower your class performance by 10% for each additional absence.
- 5) If you miss a class, please ask another student to share his/her notes and tell you about what you. I can also be of help during office hour for such make-up.

g) Office hour

The time for office hour will be decided at the first class. The goal is to find a 1-2 hour slot that everyone is available, at least for part of it. I understand your daily

schedule might change during the semester. If your schedule does have a conflict with the office hour, please email me so we can arrange another time to meet and discuss course-related questions that you have.

h) Religious Observances

If a class session or due date conflicts with your religious holidays, please notify me so that we can make alternative arrangements. In accordance with UM policy on religious/academic conflicts, your absence will not affect your grade in the course.

i) Participation

- 1) The success of our course depends on each of you being prepared to participate.
- 2) I will post lecture slides and reading assignments ahead of the lecture time. Reading assignments are usually listed at the end of each PowerPoint file.
- 3) Given the nature of radiative transfer, I especially encourage participation regarding the clarification of concepts and physical laws (the “muddy” points). Besides asking questions, you can also offer your comments and reflections, and share your own observations and insights!
- 4) Code of participation: A positive learning environment relies upon creating an atmosphere where diverse perspectives can be expressed.
 - Respect others' rights to hold opinions and beliefs that differ from your own. Challenge or criticize the idea, not the person.
 - Listen carefully to what others are saying even when you disagree with what is being said. Comments that you make (asking for clarification, sharing critiques, expanding on a point, etc.) should reflect that you have paid attention to the speaker's comments.
 - Be courteous. Don't interrupt or engage in private conversations while others are speaking.
 - Support your statements. Use evidence and provide a rationale for your points.
 - Allow everyone the chance to speak. If you have much to say, try to hold back a bit; if you are hesitant to speak, look for opportunities to contribute to the discussion.
 - If you are offended by something or think someone else might be, speak up and don't leave it for someone else to have to respond to.

j) Cell Phones, Electronic Devices, and Laptops

- Please be sure to put your cell phones away before class begins, unless you expect a call during class (e.g. family emergency). It will be distracting for all of us if you text or use an electronic device during class.
- If you are used to take note on your ipad/laptops in the course of lecturing, you are welcome to use them. Otherwise, I will ask that you refrain from

using your laptop or ipad for other purposes in class.

Other Information

a) Accommodations for Special Needs

The University of Michigan is committed to ensuring the full participation of all students, and I am committed to making learning as accessible as possible for all students. If you have a disability and need an accommodation to participate in this class or to complete course requirements, please ask Services for Students with Disabilities (SSD) to provide documentation of the accommodations that you need. Then, please share this documentation with me as soon as possible, **preferably within the first few weeks of class**. I will treat as private and confidential any information that you share.

If you suspect that you may have a disability and would like to be tested, Services for Students with Disabilities can provide free screenings and referrals to low-cost diagnostic services.

Here is the contact information for Services for Students with Disabilities:

- Location: G-664 Haven Hall
- Phone: 734-763-3000
- Website: <http://ssp.umich.edu/>

b) Mental Health Resources

1) As a student, you may experience challenges that negatively affect your learning, such as anxiety, depression, interpersonal or sexual violence, difficulty with eating or sleeping, grief/loss, and alcohol or drug problems. The University of Michigan offers several confidential services that you might find helpful for addressing such challenges, including

- Counseling and Psychological Services (CAPS): 734-764-8312
- Sexual Assault Prevention and Awareness Center (SAPAC) 24-Hour Crisis Line: 734-936-3333
- Psychiatric Emergency Services: 734-996-4747.

2) If you have a diagnosed mental health condition, you may also be able to register with Services for Students with Disabilities: see

<http://ssd.umich.edu/mental-health-conditions>.

c) Sweetland Center for Writing

1) The Sweetland Center for Writing-located at 1310 North Quad-is a wonderful and free resource! If you would like additional feedback or assistance as you're planning, drafting, or revising your writing assignments, you can schedule an individual appointment with a Sweetland faculty member, drop in for a peer-tutoring session, correspond online with a peer tutor, or submit your work online to receive feedback within 72 hours.

2) Sweetland faculty members and peer tutors will not edit or but they can assist you with understanding assignments, generating ideas, developing and organizing arguments, using evidence and sources, and clarifying your writing.

3) For more information, please visit:

<http://www.lsa.umich.edu/sweetland/undergraduate>

d) Plagiarism

- 1) Building on others' words and ideas is an essential element of effective scholarship. However, **we must give credit to those whose words and ideas we incorporate into our writing**. Using someone else's words, ideas, or work without proper attribution is plagiarism, and such an act is considered a serious ethical violation within the university community.
- 2) If you complete an assignment for one course and then submit that same assignment as original work for a different course, you are also committing plagiarism.
- 3) Direct copy and paste from website is also a plagiarism.
- 4) If you have additional questions about how to reference material that you find in books or online, please let me know.
- 5) If you commit an act of academic dishonesty in this course either by plagiarizing someone's work or by allowing your own work to be misused by another person, you will face the following consequences:
 - I will forward your case, with an explanatory letter and all pertinent materials, to the CoE honor code committee.
 - Once the case is forwarded, the committee will be responsible for hearing and determine an appropriate penalty. You may fail the assignment and the course.

* Some texts are based on a syllabus developed by Mr. Paul Barron, Director of Learning, Data, and Assessment, LSA Opportunity Hub.