Course Number / Title: ATS 420 / 520 Climate Physics


Term: Winter 2020
Meeting times / locations:
Lecture: Tuesdays and Thursdays NN:00–NN:20 (80 minutes)
Lab: Tuesdays NN:00 - NN:50 (110 minutes)

Instructor(s):
Justin Wettstein, Burt 314
justinw@coas.oregonstate.edu, 541-737-5177
Teaching assistant: to be determined

Office hours: To be determined

Course Credits: 4 credits

Prerequisites:
ATS 420: [MTH 252 (C-) or MTH 252H (C-)] and [PH 202 (C-) or PH 212 (C-)] and ATS 310 (C-) and ATS 310 (C-)

ATS 520: OEAS 530 (C-)


Supplemental textbooks:

Learning Outcomes:

This course is a foundational course in climate science, specifically on the physical processes that control the Earth’s climate system. Upon completion of the course, students will be able to:

1. Develop and analyze the physical constraints that control climate, climate change, and climate variability on Earth in various situations.
2. Calculate various aspects of the climate state or its response to a prescribed forcing.
3. Explain a synthetic perspective on climate dynamics that incorporates the most important thermodynamic, dynamic, radiative, circulation, and other processes relevant for a particular spatial and / or temporal scale.
4. Reconcile lab experiments and demonstrations with lecture content.
5. Analyze and interpret climate observations and output from climate models of varying complexity.
Additional Learning Outcomes: ATS 520

1. Explore and generate higher-order calculus-based approximations to the presented physical relationships, the associated equations and / or their solutions.
2. Explain a particular aspect of atmospheric dynamics in detail via a short in-class lecture focused on a term project or a critical scientific review of relevant journal articles.

Evaluation of Student Performance: The course is graded on a standard A-F scale based on the following percentages:

<table>
<thead>
<tr>
<th>ATS 420</th>
<th>Grade Component</th>
<th>ATS 520</th>
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<tbody>
<tr>
<td>10%</td>
<td>A) Active participation in labs and recitations</td>
<td>5%</td>
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<tr>
<td>40%</td>
<td>B) Approximately weekly homework assignments</td>
<td>35%</td>
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<tr>
<td>20%</td>
<td>C) Midterm exam</td>
<td>20%</td>
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<td></td>
<td>D) Short academic lecture</td>
<td>10%</td>
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<td>30%</td>
<td>E) Final exam</td>
<td>30%</td>
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<td>100%</td>
<td>Total</td>
<td>100%</td>
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Course Topics and Subtopics (tentative schedule):

**Week 1: Introduction and Review**
  - Lecture 1: Introduction to the climate system
  - Lecture 2: Review of foundational thermodynamics and dynamics (ATS 310)

**Week 2: The global energy balance**
  - Lecture 1: Global energy balance of Earth; emission temperature and greenhouse effect
  - Lecture 2: Global and local radiative flux balance; TOA energy balance; poleward energy flux

**Week 3: Atmospheric radiative transfer and climate**
  - Lecture 1: Photons; E-M radiation; Planck’s Law; selective absorption and emission
  - Lecture 2: Radiative transfer across the E-M spectrum; radiative-convective equilibrium; clouds

**Week 4: Energy balance at the surface**
  - Lecture 1: Surface energy budget; radiative heating at the surface; heat capacity
  - Lecture 2: Boundary layer; sensible and latent flux; diurnal, seasonal, and geographic variability

**Week 5: Hydrologic cycle / Ice and climate**
  - Lecture 1: Water budget—general and analytical approaches
  - Lecture 2: Ice—radiative, thermodynamic, and dynamic interactions
Course Topics and Subtopics (tentative schedule, continued):

**Week 6: Atmospheric general circulation and climate**
- Lecture 1: Energy balance and circulation; meridional energy transport; Lorenz energy cycle
- Lecture 2: Angular momentum; meridional momentum transport by mean flow and eddies

**Week 7: Ocean circulation and climate**
- Lecture 1: Relevant properties of seawater; mixed layer; wind-driven circulations
- Lecture 2: Overturning / thermohaline circulation; energy transport in ocean; mechanisms

**Week 8: History and evolution of Earth’s climate**
- Lecture 1: Instrumental records, historical records, paleoclimate records
- Lecture 2: Detection and attribution for past and future climate change; radiative forcing

**Week 9: Climate sensitivity and feedbacks**
- Lecture 1: Feedback processes (radiative, thermodynamic, dynamic) and climate sensitivity
- Lecture 2: Other feedbacks; quantification; equilibrium vs. transient climate sensitivity

**Week 10: Natural and anthropogenic climate change and variability**
- Lecture 1: Natural change and variability (sun, volcanos, aerosols, orbital); variability patterns
- Lecture 2: Anthropogenic climate change

**Lab sessions are required.** The lab session will provide hands-on and computer-based explorations of the theory presented in lectures. Some portions of these sessions will also be used to review assignments and exams as well as set up data and analyses for assignments.

**Statement Regarding Students with Disabilities:** Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval please contact DAS immediately at 541-737-4098 or at http://ds.oregonstate.edu. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

**Statement of Expectations for Student Conduct**

Students are expected to conform to OSU’s guidelines for student conduct by completing the assigned course work as instructed. Homework may be done collaboratively, and students may seek instructor help on the homework assignments, but all answers must be in your own words and based on your own understanding of the material. Exams are intended to measure a student’s individual understanding of the course material.

You are expected to conduct yourself in a professional manner according to your enrollment at this university. Academic dishonesty such as plagiarism and cheating will not be tolerated. Students are expected to be honest and ethical in their academic work. Academic or Scholarly Dishonesty is defined as an act of deception in which a student seeks to claim credit for the work
or effort of another person, or uses unauthorized materials or fabricated information in any academic work or research, either through the student’s own efforts or the efforts of another. According to the Oregon State University’s Student Conduct Code, academic dishonesty includes: 1) cheating, 2) fabrication, 3) assisting, 4) tampering, and 5) plagiarism. Note that plagiarism of one’s own work is possible if the work was performed for some purpose other than this course. Please consult your instructor if you have any questions regarding appropriate student conduct.

It is your responsibility to be familiar with the Student Conduct Code. For more information about academic integrity and the University’s policies and procedures in this area, please refer to this Student Conduct Code. Any violations of the Student Conduct Code will be referred to the Office of Student Conduct and Community Standards for review under the protocol specified in the Student Conduct Code.

Link to comprehensive Code of Student Conduct (including academic dishonesty): http://studentlife.oregonstate.edu/code

**Student Evaluation of Courses:**

The online Student Evaluation of Teaching system opens to students the Monday of dead week and closes the Monday following the end of finals. Students will receive notification, instructions and the link through their ONID. They may also log into the system via Online Services. Course evaluation results are extremely important and used to help improve courses and the learning experience of future students. Responses are anonymous (unless a student chooses to “sign” their comments agreeing to relinquish anonymity) and unavailable to instructors until after grades have been posted. The results of scaled questions and signed comments go to both the instructor and their unit head/supervisor. Anonymous (unsigned) comments go to the instructor only.