

AATM 551: Fundamentals of Earth's Climate (Class No. 8612, Spring 2024)

Instructor: Aiguo Dai **Room:** ETEC 403
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Lecture times: Tuesdays and Thursdays 3:00–4:20 PM
Lecture location: ETEC 482
Office hours: Tuesday and Wednesday 10–11:00 AM, or by appointment
Credits: 3
Web page: <http://www.atmos.albany.edu/facstaff/adai/ATM551/>
Prerequisite: AATM 504 or permission of the instructor.
Grading scheme: Graded A–E

Description of the course:

This course discusses the key physical processes of Earth's climate, beginning with the seasonal and spatial characteristics of the current climate, and the evolution of Earth's climate on geological time scales. The class then discusses the key physical processes that control Earth's climate, including the global energy balance and transport, the greenhouse effect, the role of water vapor, clouds and aerosols, atmospheric and ocean circulations, air–sea and air–land interactions, and climate feedbacks. Finally, the class discusses the characteristics, formation mechanisms, and climatic impacts of the leading modes of variability, such as ENSO, PDO/IPO, and AMO, and how internal variability may affect our detection of externally-forced climate change. The class ends with an introduction to climate modeling and climate change.

Aims of course:

The goal of this course is to provide students with comprehensive understanding of the physical processes that control Earth's climate and its variations, with a focus on the global-mean climate and the large-scale climate patterns, such as the tropics vs. polar regions and land vs. oceans. This understanding is essential for students who study the climate and climate change, and it will help students better understand issues related to the current global warming and climate change.

Course assessment:

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| 1. Homework assignments | 30% |
| 2. Midterm exam: | 30% |
| 3. Final exam or final term paper: | 30% |
| 4. Attendance and participation in classroom discussions: | 10% |

Basic course outline:

- 1. An overview of Earth's climate (3 lectures)**
 - 1.1 The Earth's climate system: the atmosphere, oceans, land, and cryosphere
 - 1.2 Characteristics of Earth's current climate
 - 1.3 Evolution of Earth's climate over its history
- 2. The Basic controls of Earth's climate (12 lectures)**
 - 2.1 The global energy balance and the greenhouse effect
 - 2.2 Surface energy balance
 - 2.3 The hydrologic cycle and climate
 - 2.4 Atmospheric circulation and climate
 - 2.5 Ocean circulation and climate
 - 2.6 Water vapor, clouds, and aerosols
 - 2.7 Atmospheric convection and tropical climate

- 2.8 Air–sea and land-atmosphere interactions
- 2.9 Sea ice and polar climate
- 2.10 The carbon cycle and climate

3. Climate variability and modes (3 lectures)

- 3.1 Climate internal variability and extremes
- 3.2 El Niño–Southern Oscillation (ENSO) and its impacts
- 3.3 Atlantic and Pacific Multidecadal Variability

4. Climate change and modeling (6 lectures)

- 4.1 Climate forcing and response vs. internal variability
- 4.2 Climate sensitivity
- 4.2 Climate feedbacks
- 4.3 Introduction to climate modeling
- 4.4 Common climate simulations and climate projections
- 4.5 Projected future climate changes and underlying mechanisms

Main Reading Materials:

Neelin, J. D., 2011: *Climate Change and Climate Modeling*. Cambridge Univ. Press, 282pp.

Hartmann, D. L., 2016: *Global Physical Climatology*, Elsevier, Amsterdam, 483pp., 2nd Ed.

Goosse, H., P.Y. Barriat, W. Lefebvre, M.F. Loutre, and V. Zunz, 2012: *Introduction to Climate Dynamics and Climate Modeling*. Online textbook available at <http://www.climate.be/textbook>.

Marshall, J. and R. A. Plumb (2008): *Atmosphere, Ocean, and Climate Dynamics: An Introductory Text*. Elsevier Academic Press, Amsterdam/Boston, 2008, 307pp.

Additional Reading Materials:

Pierrehumbert, R. T., 2010: *Principles of Planetary Climate*. Cambridge University Press, 652pp.

Washington, W.M. and C.L. Parkinson 2005: *An Introduction to Three-Dimensional Climate Modeling*. 2nd edition, University Science Books, Sausalito, CA, 353pp.

Moran, J. M., 2010: *Climate Studies: Introduction to Climate Science*. Amer. Met. Soc., 525pp.

Academic integrity and conduct:

Cheating and plagiarism are unacceptable and will result in a zero for this class and can potentially result in suspension from the University. It is the responsibility of each student to become familiar with the standards of academic integrity. The following university website provides additional information: https://www.albany.edu/graduatebulletin/requirements_degree.htm#standards_integrity.

Religious-based absences:

Absence due to religious observance, New York State Education Law (Section 224-a): Campuses are required to excuse, without penalty, individual students absent because of religious beliefs, and to provide equivalent opportunities for make-up examinations, study, or work requirements missed because of such absences. Faculty should work directly with students to accommodate religious observances. Students should notify the instructor of record in a timely manner.