

Class Meeting Schedule

LECTURE: 9am-12pm 403 IAB

LAB: 1-3:30pm and 3:30-6pm 403 IAB and 510A IAB

Class & Lab Description

Course Description

This course provides an introductory survey of the Earth's climate system. We will study the salient properties of climate and its characteristic space and time variations. The physical laws governing these variations will be explained to build a rudimentary understanding of the natural phenomena of climate as well as the impact of human industrial and agricultural activities.

Course Outline

The approach of the course follows a general sequence of themes that will: (1) define climate and the difference between climate and weather; (2) explain the source of the Earth's heat energy, how temperature near the surface and aloft are determined, and how the observed seasonal and spatial variations are created; (3) introduce the various motion systems in the atmosphere and ocean and their governing physical laws; and (4) address the contemporary issues of environmental change on different time-scales and of human-induced vs. natural variability.

Daily Activities: Lecture sessions will include discussion and explanation of reading and/or web material, and how to apply critical thinking to planetary environmental questions. The schedule below is a preliminary outline of the semester. Reading assignments are provided and should be completed before the stated lecture date. Additional reading or reference material may be suggested during the course of the lecture. Laboratory sessions will involve both hands-on and minds-on exercises that will require either individual or small group work/reporting.

Session 1: Tuesday, June 3

Lecture 1: Driving Climate - The Sun, Energy and Light: What is climate? Light and energy. What determines the mean temperature of the Earth? Why do we have seasons?

Lecture 2: The Green House Effect and the Radiation Balance of the Earth: What is the greenhouse effect? Energy and atmospheric constituents. What are the spatial patterns of the Earth's radiation balance?

Read: Archer, Ch. 1-4; Kump et al., Ch. 3; Ch 4: pp 68-70.

Lab 1: Introductory material (how to write a lab report); The Earth's Radiation Budget I

Session 2: Tuesday, June 10

Lecture 3: Vertical structure of the Atmosphere, Convection and the Hydrological Cycle:

The relationship between pressure, temperature, and density and how they change with height in the atmosphere; vertical movement of air; moisture in the atmosphere; formation of clouds and rainfall; the hydrological cycle.

Lecture 4: Horizontal Motion of the Atmosphere: Laws of fluid motion on Earth: the Coriolis force; Geostrophic balance; weather: midlatitude and tropical storms.

Read: Archer, Ch. 5 & 6; Kump et al., Ch. 4: pp 57-61 and 70-82.

Lab 2: The Earth's Radiation Budget II

Session 3: Tuesday June 17

Lecture 5: General Circulation of the Atmosphere: Atmospheric heat and moisture transport from the equator to the poles; global and local circulation systems; climate zones as consequence.

Lecture 6: Ocean Circulation - Buoyancy Driven Flow: The ocean basins; vertical structure and spatial variation; temperature and salinity; atmosphere-ocean heat and moisture exchange and the thermohaline circulation.

Read: Kump et al. Ch. 4: pp 58-66 and Ch. 5: pp. 91-100.

Lab 3: Ocean Stratification and the Thermohaline Circulation

Session 4: Tuesday June 24

Lecture 7: Ocean Circulation - Wind Driven Flow and the Impact of the Ocean on Climate: Momentum exchange and wind-driven circulations; ocean upwelling; the Gulf Stream; the ocean and climate; ocean transport, climate zones and the collapse of the thermohaline circulation.

Lecture 8: El Niño - An Atmosphere-Ocean Phenomenon and Other Climate Oscillations: El Niño: tropical variability that affects global climate. Monsoons, the North Atlantic Oscillation, and others. Can climate variability be predicted?

Read: Kump et al. Ch. 5: 83-91 and Ch 15: 308-312.

Lab 4: The Climatic Impacts of El Niño

Mandatory Field trip to Lamont-Doherty Earth Observatory: Monday, June 30th (8 am - 5 pm)

Session 5: Tuesday, July 1

Lecture 9: Climates of the Past, Climate Forcing and Feedbacks: Orbital variations and long-term climate change; ice age cycles; climate of the last millennium

Lecture 10: Polar Climates, Ice and Sea Level Change: Polar ice caps; past sea level changes; contemporary changes in the cryosphere and their implications for the future.

Read: Archer, Ch. 7 & 8: pp 145-149; Kump et al., Ch. 6, 14 and Ch. 15: pp 295-301.

Lab 5: Vostok Ice Core

Session 6: Tuesday, July 8

Lecture 11: Global Warming and the Carbon Cycle: The modern temperature record; carbon sources and reservoirs; short term and long-term carbon fluxes; carbon and the ocean.

Lecture 12: Climate Models and Future Projections: What are climate models and what do they tell us? Projections, impacts and scenarios. Knowns and unknowns.

Read: Archer, Ch. 10-12; Kump et al., Ch. 8, Ch. 15: pp 301-318, and Ch. 16: 321-327.

Lab 6: Climate Change - The Global Temperature Record

Climate Final Examination: Monday, July 14, 9-12PM

Exam will be held in 403 IAB

Textbooks:

"Global Warming: Understanding the Forecast" 2nd Ed. by David Archer, 2012, Blackwell Publishing (203 pp): A survey of the science of anthropogenic climate change and the IPCC forecast. Based on a course taught at the University of Chicago as part of the core science requirements. The book is also accompanied by many online materials that are well done and helpful.

"The Earth System" by Lee R. Kump and James F. Kasting, Robert G. Crane, Prentice Hall, 3rd edition, 2009 (432 p): A basic earth system science book (of which climate is just one part). We use this book in the DEES undergraduate "Climate System" course. It provides a good background on the basics of the Earth system with helpful graphics. The book also provides useful chapter summaries and review questions that you can use to test your understanding of the

course.

Additional texts for this course and for future interest:

1. "Is the Temperature Rising: the uncertain science of global warming" by S. George H. Philander, Princeton University Press, 1998 (262 p): The book explains why the decision on the fate of the Earth climate is so difficult to determine with certainty. It provides rudimentary yet comprehensive explanations of the complexity of the climate system and is appropriate for students from a broad range of disciplines. The explanation is simple and aimed at non-science students. It is illustrated with simple graphics. There are a few short appendices that include some more scientific material and equations. The paperback version is inexpensive and worth having for future reference.
2. "Global warming: the complete briefing" by John Houghton, Cambridge University Press, 4rd edition, 2009 (456 p) is the most updated: A summary of the most recent IPCC (2007) assessment of anthropogenic climate change and the physics behind it. Technical with lots of diagrams but written for a broad audience (does not require math).
3. "Atmospheric science: an introductory survey" by John M. Wallace and Peter V. Hobbs, Elsevier Academic Press, 2nd edition, 2006 (483 p): An advanced undergraduate course in atmospheric science and climate. Some sections require calculus and physics background but the textual and graphical material provides excellent descriptions of phenomena that we discuss in class.
4. "Climate Change: The Science of Global Warming and Our Energy Future" by Edmond Mathez, Columbia University Press, 2009 (344 p): A general summary of the science behind climate change. The book is well illustrated and has extended chapters on paleoclimate, the carbon cycle and future energy assessments. The book is a good general introduction to the issues of climate change, but we will proceed with a more technical discussion of the atmosphere and ocean.

Attendance Policy

Attendance of lectures is strongly encouraged. Complementary material, in addition to required readings, will be presented in lectures and included in examinations/discussions. Discussions will also require in-class participation from all students.

Method of Evaluation

Evaluations:

1. Lab exercises will involve hands-on/minds-on exercises with reports due at the end of each week.
2. The final exam is scheduled at the end of the course and will comprise short answers and

multiple choice questions.

Grades will be based on the following:

70% for Climatology Labs

30% for Climatology Final Exam

Late Policy

Labs are due at midnight on the Friday following each Tuesday laboratory session. Ten percent (10%) of the grade will be deducted per day if the lab reports are submitted past the due date. Materials that are submitted more than one week late will not be accepted.