Syllabus

Phys 20054: The Physics of Climate

Spring Semester 2015

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Prerequisites: Math 10360 or 10560

The course is offered by the Physics Department to Science and Engineering Majors and provides an introduction to the physics principles dictating the climate conditions on earth. Topics include climate history and development, solar energy transfer and budget, principles of ocean and atmospheric physics, climate models, and climate change.

Class Content

The discussion about climate and climate change is a topic that increasingly captures the attention of scientists as well as non scientists. The processes leading to the balance in the earth climate system are fundamental physical processes driven by the laws of thermodynamics, convective hydrodynamics, and radiative transfer. The course will focus on the description and analysis of the underlying physical and chemical processes that define the earth climate. The course will present a short overview of the climate history of our planet as indicated by modern techniques of climate recording. Climate depends critically on the overall energy budget, which is balanced by solar energy and the physical and chemical absorption and reflection processes in our oceans and atmosphere. The physics and chemistry of these processes and the impact on climate balance and weather patterns will be discussed. Global climate predictions require extensive mathematic modeling techniques. The underlying principles will be presented. Finally the course will address questions related to observational evidence and possible consequences for natural and anthropogenic climate change. This part will be discussed in student presentations.

Course Outline

1. Solar radiaton and the earth's energy budget
2. Radiative and convective energy transfer
3. Atmosphere and climate
4. Clouds and aerosols
5. Ocean and climate
6. Greenhouse effect
7. Ozone layer
8. History of the earth climate
9. Climate observations
10. Climate models
11. Climate change
12. Consequences of climate change

Class Projects

Anthropogenic Climate Changes

1. The economic consequences and opportunities of climate change
2. Agriculture in Mesopotamia
3. Abandonment of Maya Cities
4. The large Midwest forest clearing
5. Industrial revolution and the impact on global climate
6. Nuclear testing in the 1950-1960ies and the impact on the atmosphere
7. Consequences of tropical deforestation
8. Urban heat islands

Natural Climate Changes

1. Isotope Geology and the mapping of Earth’s climate
2. Chicxulub and the death of dinosaurs
3. Volcano eruptions and the consequences for global temperature
4. Sahara in pre-historic times
5. The role of the Amazon jungle for global climate
6. Noah’s Flood
7. The little ice age and consequences for medieval life
8. The expansion of the Sahel zone

Course Material

The schedule, the lecture notes, and all course material will be posted at the website.

Textbook

F. W. Taylor, *Elementary Climate Physics*, Oxford University Press, 2005,
ISBN 0 19 8567340

Supplementary Reading Material

J. Marshall & R. A. Plumb, *Atmosphere, Ocean, and Climate Dynamics*, Elsevier, 2008,
ISBN-13 978-0-12-558691-7
N. Mason & P. Hughes, *Introduction to Environmental Physics*, Taylor & Francis, 2002, ISBN 0 7484-0765-0
J. P. Peixoto & A.H. Oort, *Physics of Climate*, AIP & Springer Verlag, 1992,
ISBN 0 88318-712-4
K. E. Trenberth, *Climate System Modeling*, Cambridge University Press, reprint 2009,
ISBN 978-0-521-12837-7

Class Grades

Weekly quizzes 10%; Homework 25%; Midterm Exam 20%; Final Exam 20%;
class project 15%; participation 5%

Honor Code

All students should familiarize themselves with the Honor Code on the University's website and observe its provisions in all written and oral work, including oral presentations, quizzes and exams, and drafts and final versions of essays.