AMERICAN MUSEUM & NATURAL HISTORY

Seminars on Science

Climate Change

Syllabus

Course Title
Climate Change

Course Description
This course explores the science of climate change. Students will learn how the climate system works; what factors cause climate to change across different time scales and how those factors interact; how climate has changed in the past; how scientists use models, observations and theory to make predictions about future climate; and the possible consequences of climate change for our planet. The course explores evidence for changes in ocean temperature, sea level and acidity due to global warming. Students will learn how climate change today is different from past climate cycles and how satellites and other technologies are revealing the global signals of a changing climate. Finally, the course looks at the connection between human activity and the current warming trend and considers some of the potential social, economic and environmental consequences of climate change.

During each week of this six-week course, participants will utilize essays, multimedia, other websites and online discussion forums to explore a facet of climate science. A weekly case study will focus on contemporary research on some aspect of the climate system. These include biologist Gretchen Hofmann, who studies the effect of ocean acidification on sea urchins; geologist Dorte Dahl-Jensen, who analyzes Greenland ice cores to reconstruct climate history; and meteorologist Alan Robock who investigates the effects of volcanic eruptions, nuclear weapons, and other human activity on the climate system.

Objectives

Students will emerge from the course with an understanding of climate change. They will be able to:

1) Demonstrate a solid understanding of the climate system.
2) Evaluate the various factors that shape climate.
3) Describe how past climates contribute to our current understanding of climate change.
4) Explain the consequences, risks, and uncertainties of climate change.

Please refer to the Weekly Schedule below for a detailed outline of the course.

Class Schedule

This is a six-week online graduate course with an additional week to complete final projects. The course is asynchronous and does not meet at specific times. Assignments and discussions change on a weekly basis. Students are expected to complete work within the week it is assigned.

For the current schedule of offerings, please visit **www.amnh.org/learn/calendar.php**.

Instructors

This graduate course is co-taught by an experienced educator and a research scientist.

For current instructor information, please contact seminfo@amnh.org.

Format

1. **Enrollment** is restricted to current or future educators. No prior science background is required.

2. **Weekly activities** involve reading essays, the case study, and textbook assignments. These materials are augmented by data visualizations, interactive simulations, images, videos, and links to material from organizations such as the Goddard Institute for Space Studies and the National Oceanic and Atmospheric Administration.

3. **Online discussions** encourage learners to reflect on course content, support and model the inquiry process, and interact with scientists, seminar instructors, and fellow students.

4. **Final projects** may take one of two forms. Learners can develop of a proposal that explains how they would research a particularly interesting seminar topic, or create an inquiry-based lesson plan that focuses on a key course concept and could be incorporated into their teaching practice.

Course Textbooks

The following textbook is *required*:
Climate Change: The Science of Global Warming and Our Energy Future
by Edmond Mathez
Hardcover: 344 pages
Publisher: Columbia University Press (1st edition, 2009)
ISBN: 0231146426

The following book is *strongly recommended*:
Climate Change: Picturing the Science
by Gavin Schmidt, Joshua Wolfe, and Jeffrey D. Sachs
Hardcover: 320 pages
Publisher: W. W. Norton & Company (1st edition, 2009)
ISBN: 0393331253

Support Services

Technical support is available for technical issues on a 24/7 basis. Please call (877) 740-2213 or email helpdesk@amnh.ecollege.com.

Grading

Assessments are based on a detailed grading rubric developed for this course:

Course Assignments	30%
Course Participation & Communication	40%
Final Project	30%

1. **Course assignments** include reflection questions and written assignments.

2. **Class participation** will be evaluated based on the quality and consistency of contribution to the discussion forum. Grades for participation will be posted two weeks after each question opens.

3. **Final Project:** There are two options for the course project:

   Option I: Teaching Practice
   This is for learners who would like to develop an application that could teach some aspect of the course content to students or other educators. The project may take the form of a classroom unit or a workshop plan (if used for professional development).

   Option II: Research Question
   This is for learners who would like to grapple further with some of the science and skills this course presents. They must develop a research question on some element of the course content.

4. **Policy:** Everything submitted as an assignment, project, or discussion post must be original work. References to resource materials are expected and proper citation is required.

Weekly Overview and Expectations

Week 1: How Does Climate Work?
The course begins with an introduction to the concept of climate as a dynamic Earth system. We will discuss atmospheric and ocean circulation, which determines how heat is transferred across the globe. We then explore the concept of energy balance — how much of the Sun's energy reaches the Earth, is absorbed, and is reflected back into space – and the greenhouse effect. This week's case study is about Curtis Ebbesmeyer, an oceanographer who uses "flotsametrics" and a network of beachcombers worldwide to trace the paths of ocean currents.

Expectations
- Review the course orientation.
- Explore the concept of energy balance and the greenhouse effect.
- Analyze circulation in the atmosphere and ocean.
- Reflect on one scientist's work with ocean circulation.
- Participate in the Icebreaker Discussion.
- Respond to the Discussion Question: Energy Budget

Week 2: What Causes Climate to Change?
Many factors influence climate on various time scales, including plate tectonics, Earth's orbital variations, long-lived greenhouse gases in the atmosphere, variations in solar luminosity, and volcanic eruptions. This week we examine "drivers" of climate change, with an emphasis on those of the twentieth-century. A case study tells the story of Charles Keeling and his pioneering effort to measure the CO_2 content of the atmosphere.

Expectations
- Examine the drivers of climate change.
- Consider drivers affecting climate today.
- Understand the relationship between drivers and forcings.
- Explore early climate science with the Keeling Curve.
- Complete the assignment: Drivers Over Time.
- Engage in the discussion question: The Importance of Drivers

Week 3: How Does the Climate System Respond to Input?
The response of the climate system to changes in radiative forcing will be discussed this week. Also, we review how the carbon cycle works and its fundamental role in the climate system as well as the key role of feedbacks in the climate system. A case study presents Gretchen Hofmann's work on the effects of changing ocean chemistry on ocean life.

Expectations
- Discover the complexity of the climate response to changes in radiative forcing.
- Understand the workings of the carbon cycle and its role in climate change.
- Identify important feedbacks.
- Learn about one scientist's study of ocean acidification and marine calcifiers.
- Participate in the discussion question: Relationships in the Climate System.
- Complete the assignment using a Global Climate Model: Part 1.
- Present preliminary thoughts on the Final Project.

Week 4: How Do We Bring Together Modeling, Theory, and Observation to Understand Cause and Effect?
This week we examine the utility of numerical models in investigating how the climate system works and how it will respond to continued greenhouse gas buildup. We will learn how models are constructed, their inherent reliability, and key factors affecting reliability. Additionally, we will examine how models can help identify the specific forces that caused recent climate change (attribution). A case study describes how meteorologist Alan Robock investigates the effects of volcanic eruptions on the climate system.

Expectations
- Understand the character of climate models and how they are constructed.
- Explore how climate models are used to gain insight into both how the climate system works and what the future may hold.
- Examine how scientists attribute changes in climate to particular forcing factors.
- Consider the importance of both observation and models in understanding the climate system and how they feed off of each other.
- Complete the assignment: Using a Global Climate Model: Part 2.
- Participate in the discussion: Climate Modeling

Week 5: What Can We Learn From the Past?
Variations in past climates are held in ocean and lake sediment cores, ice cores, corals, tree rings, and other geologic records. We will learn how past climate informs us about how the present climate system works, including the sensitivity of climate to changes in radiative balance.

Expectations
- Explain the concept of climate sensitivity.
- Consider the myriad of ways in which past climate informs us about present-day climate change.
- Discover how ice cores are used to decipher past climate.
- Complete the assignment: Using an Empirical Climate Model.
- Respond to the discussion question: The Implications of Understanding.
- Submit an outline for your final project**.**

Week 6: What are the Potential Consequences, Risks, and Uncertainties of Climate Change?
Some of the potential consequences of climate change, such as sea level rise and disruption of the global food supply that could have major negative impacts on humanity are examined this week. We will discuss the uncertainties in how the future may unfold, the important concept of risk as a means of dealing with uncertainty, and the different levels of risk associated with different consequences. This week includes an interview with Dr. James Hansen, Director of the NASA Goddard Institute for Space Studies.

Expectations
- Understand some of the potentially serious consequences of climate change.
- Explore the uncertainties associated with these and other consequences.
- Examine the concept of risk and the interplay of probability and severity of impact in determining risk.
- Consider the work of a climate scientist advocating for action to combat the effects of climate change.
- Participate in the discussion: Are We Ready for the Future?
- Submit your final project.