SUMA K4230 The Earth's Climate System
Instructor: Benjamin Cook

Course Objectives
This course examines the fundamental physical processes that control the primary features and patterns of variability of the Earth's climate system. Specific topics include energy balance and the greenhouse effect, the circulation of the oceans and atmosphere, land surface interactions and feedbacks, the role of the biosphere and cryosphere, paleoclimatology, climate modeling, and global and regional patterns of climate variability and change observed and expected as a consequence of anthropogenic influences.

The goal of the course is to provide students with the opportunity to gain a fundamental understanding of the processes that give rise to observed climate variability at a range of temporal and spatial scales. Students will develop the quantitative skills and knowledge to allow them to independently evaluate scientific claims about the state and behavior of Earth's climate system in the past, present, and future. The course includes case study modules that integrate an understanding of the physical processes and important feedbacks in the context of policy- and management-relevant aspects of current and future climate change.

Required Reading
Kump, Kasting, & Crane, The Earth System (3rd Edition), Prentice Hall

The textbook readings will be supplemented with up-to-the-minute scientific articles when appropriate and available.

Possible Additional Readings
Archer, Global warming: Understanding the Forecast, Blackwell Publishing
Archer & Pierrehumbert , The Warming Papers, Wiley-Blackwell
IPCC, Fourth Assessment Report, http://www.ipcc.ch/
Pierrehumbert, Principles of Planetary Climate, Cambridge University Press
Pielou, The Energy of Nature, University of Chicago Press
Ruddimann, Earth's Climate: Past and Future (2nd Edition), W.H. Freeman

Additional readings from these as well as the peer-reviewed scientific and technical literature will be made available online during the semester

Method of Evaluation

Grading
30% Problem Sets (3 @ 10% each)
35% Final Paper (includes 5% proposal and summary)
35% Final Exam

All problem sets must be turned in at the beginning of the class period in which they are due.

Problem Sets (30% total, 10% for each problem set)
There will be three problem sets based on (1) energy balance, (2) the circulation of the atmosphere and ocean, and (3) A topic to be decided. Students may work in groups, but each student is responsible for their own work and to turn in their own individual assignment.

Final Paper (35% of total grade, including 5% for proposal and precis)
Students will propose and write an analytical paper on a topic of their choice related to the class (approximate length 10 to 15 pages). The paper should incorporate and explore some physical, quantitative aspect of planetary climate systems. Such a paper could therefore take several forms. Students may chose to explore in-depth a controversial or developing area of climate science, synthesizing up-to-date literature and evaluating the relative merits of scientific data, methods, and conclusions. Student may also undertake their own quantitative analysis of some climate or environmental data, describing the data sources, methods, results, and conclusions in the manner of a peer-review manuscript. Finally, students may choose to examine a specific policy or management topic in light of the relevant aspects of the physical climate

system. Such a paper could, for instance, evaluate or develop a policy or management plan reflecting the observed or expected impact on some aspect of the climate system, ecosystem, or human population. There is considerable latitude in developing this paper, so long as the topic and analysis is grounded in a physical understand of the Earth System and goes beyond simply summarizing existing knowledge. The students will first develop a brief (1 or 2 paragraphs) proposal and summary prior to writing the paper itself, in order to allow time for feedback between the instructor and the student on the topic, data, and/or possible approaches.

Final Exam (35% of total grade)
The Final Exam will incorporate materials from the entire course and will ask the students to synthesize concepts within a broad understanding of the climate system and feedbacks and interactions between its components

Academic responsibility and expectations
All students should familiarize themselves with Columbia University's School of Continuing Education Academic Integrity and Community Standards (http://ce.columbia.edu/node/217).

Students are responsible for ensuring their own work and conduct meets the University's Standards.

Course Overview
Week 1: Introduction to the Climate System
Week 2: Global Energy Balance I
Week 3: Global Energy Balance II (**PS#1 assigned)**
Week 4: General Circulation I
Week 5: General Circulation II (**PS#1 due)**
Week 6: General Circulation III (**PS#2 assigned)**
Week 7: Oceans and El Nino

- Spring Break -

Week 8: Carbon Cycle and Cryosphere (**PS#2 due)**
Week 9: Paleoclimate
Week 10: Historical Climate (**PS#3 assigned)**
Week 11: Climate Forcings and Feedbacks
Week 12: Climate Modeling and Attribution (**PS#3 due)**
Week 13: Future Climate
Week 14: Final Class and Review (**Final Paper Due)**