MPA in Environmental Science and Policy

ENV U6115: Water and Climate Schedule

Summer Semester 2005

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Course Description: A multidisciplinary study of the physical processes on Earth involving on the one hand the climate cycles over long to short-term intervals and on the other hand the global to regional hydrological cycling. A particular emphasis will be placed on the role of humans, in the last centuries, on the perturbation of the natural climate and hydrologic cycles and how these perturbations can be characterized and discerned from natural fluctuations.

The climate system component of the course provides an integrated view of the Earth's energy budget, structure and circulation of the atmosphere and the ocean, interaction between oceans and atmosphere, as well as climate changes over different timescales. This portion of the course will focus on the identification of forcing factors for such changes as well as provide an introduction to uncertainties and predictability in complex systems, such as that of the Earth, that are involved in future predictions (forecast) of change.

The water cycle part of the class is focused on basic physical principles (evaporation, condensation, precipitation, runoff, stream flow, percolation, and groundwater flow), as well as environmentally relevant applications based on case studies. Most specifically, students will be exposed to water quantity and issues from global to regional scales and how human and natural processes affect water availability in surface and groundwater systems. (Note: water quality issues will be mentioned but only briefly since they will be covered more extensively in the following course: ENVP6220 "Environmental Chemistry and Toxicology)

Course Outline: The approach of the course will follow a general sequence of themes that will 1) define the tools and approach of the scientific method 2) introduce the notion of systems, cycles and feedbacks, 3) place the Earth in its spatial and energy context (closed system with respect to matter but open with respect to energy), 4) emphasize the importance of the Sun as the energy source of

Earth, 5) analyze the large and most dynamic physical systems of the Earth namely the Hydrosphere and the Atmosphere integrating their interactions and feedback influences, and finally 6) address the contemporary issues of environmental change on different time-scales (human-induced *vs*. natural).

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 will be provided and should be completed before the stated lecture date. Additional reading or reference material may be suggested during the course of the lecture. ***Discussion sessions*** will involve the critical assessment of either controversial scientific positions related to climate and water issues, or more detailed descriptions of issues viewed in class. These sessions will involve and require small group interactions, reporting, and in some instances the debate of researched materials assigned prior to scheduled meetings. ***Laboratory sessions*** will involve both hands-on and minds-on exercises that will require either individual or small group work/reporting.

Evaluations:

1. Several assignments will be given during the course of the semester. These will consist of take home exercises due at a subsequent lecture meeting.
2. Lab exercises will involve hands-on/minds-on exercises with reports due at a subsequent lab meeting.
3. Final exams for the "Climate" section is scheduled for the end of this section and will be composed of short answers and critical thinking questions.

Grades will be based on the following:

- 40% for Climate Labs
- 40% for Water Labs
- 20% for Climate Exam

Attendance Policy:

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

Policy on Late Submissions:

Ten percent (10%) of the grade will be deducted per day if the lab reports and group papers are submitted past the due date. Materials that are submitted more than one week late will not be accepted.

Course Outline

Climate Section

1) Class 1: June 07, Solar Radiation driving the Earth's climate

Objectives: (Kushnir Lead)

- The Earth radiation balance equation: What determines the planet's mean temperature? Why do we have seasons?

Read:(all readings are from the recommended text book by S.G. Philander) chap. 3

Lab 1: Units, Dimensions & Conversions - The Earth's Radiation Budget I

2) Class 2: June 14, Atmospheric thermal structure, clouds, and rain

Objectives: (Kushnir Lead)

- The laws governing the vertical movement of air. Formation of clouds and generation of rainfall. Air pollution.

Read: Philander, chaps. 4 & 5

Lab 2: The Earth's Radiation Budget II

3) Class 3: June 21, Atmospheric circulation - Climate zones of Earth

Objectives: (Kushnir Lead)

- The atmosphere as a heat engine: distributing warmth and moisture from the tropics to the "high" latitudes. Rainforests, Deserts, and seasonal climates.

Read: Philander, chaps. 6 & 7

Lab 3: Climatological structure of the atmosphere

4) Class 4: June 28, Ocean Circulation and air-sea interaction

Objectives: (Kushnir Lead)

- The ocean heat engine: transport of heat in the oceans

Read: Kump, chap. 8

Lab 4: Ocean Circulation

5) Class 5: July 05, Climate Variability: El Niño and other phenomena

Objectives: (Kushnir Lead)

- How climate changes from year-to-year and decade-to-decade. Can humans influence climate?

Read: Kump, chap. *9 & 12*

Lab 5: El Niño

6) Class 6: July 12, Climate Change - Past and Future

Objectives: (Kushnir Lead)

- How climate changed over very long time scales due to natural causes and what can does this tell us about the future.

Read: Philnader, chaps. 10-11 and13

Lab 6: Photosynthesis, carbon dioxide cycles

Climate Final Examination: July 18 (1-3PM) – Room 413 IAB

Water Section

1) Class 1: July 19, Introduction - Water for the world

Objectives: (Louchouarn Lead)

- Introduction of course: goals and objectives, etc.
- Past, present, and future water needs worldwide. The general issue of (fresh) water as a resource and its link to social and population dynamics.

Read:. Winter et al., III-3 (USGS Primer)

Lab 1: Global and regional water budgets

2) Class 2: July 26, Global water issues - Hydrological cycle

Objectives: (Louchouarn Lead)

- The physical aspects of the hydrological cycle
- Geographic and temporal variability in water availability

Read: Kump et al., 72-77

Lab 2: Hydrological Forecasts and their Communication to Decision-Makers

3) Class 3: August 02, Dams & Reservoirs

Objectives: (Louchouarn Lead)

- Major water works: Their need, the rationale (or lack of) for their existence, their impacts, their future

Read: Gleick, P. 2000. The changing water paradigm: A look at the 20th Century water resources development". Water International, Vol. 25(1). P. 127-138.

Rosenberg, D.M. et al., 1997. Large-scale impacts of hydroelectric development. *Environmental Reviews*, 5: 27-54.

Lab 3: Reservoirs and greenhouse gases

4) Class 4: August 09, Condensation/Precipitation – Streamflow/Floods

Objectives: (Louchouarn Lead)

- The basic dynamics and temporal variability of water in surface continental systems

Read: Hornberger, chap. 5

Lab 4: Precipitation and Flood predictions: A Statistical Analysis

5) Class 5: August 16, Evaporation - Droughts – Land Use Impact on Streamflow

Objectives: (Louchouarn Lead)

- The physical cycling and transfer of water between atmosphere and hydrosphere reservoirs

Read: Hornberger - Chap. 2.

6) Class 6: August 18, Groundwater flow - Groundwater transport

Objectives: (Louchouarn Lead)

- Groundwater systems: the physical background for underground water reservoirs.

Read: Winter et al., 2-78; Hornberger, Chaps. 6-7.

READINGS

Required:

1) "Is the temperature rising" (2001) - by S.G. Philander. Princeton University Press.
2) Several scientific articles will be posted on the course web site during the semester.

Supplementary (these books are suggested to complement class material but are NOT required - Most of these readings are available in Reserve in Lehman Library)**:**

3) "Earth's climate: Past and future" (2001) W.F. Ruddiman.
4) "Global warming: The complete briefing" (1997). J. Houghton. Cambridge University Press.
5) "Elements of Physical Hydrology" (1998). G.M. Hornberger, J.P. Raffensperger, P.L. Wiberg, and K.N. Eshleman. The Johns Hopkins University Press.
6) "Groundwater and surface water - A single resource" (1999). Winter, C.W., Harvey, J.W., Franke, O.L., and Alley, W.M. U.S. Geological Survey Circular 1139. (downloadable from the web at: http://water.usgs.gov/pubs/circ/circ1139/)