THE GLOBAL CARBON CYCLE AND GREENHOUSE GASES

The Program on Climate Change, Winter 2009 (ATMS/OCE/ESS 588)

Meeting Time: TTh 12:00-1:20; Meeting Place: OSB 425
Course Web Page: http://courses.washington.edu/pcc588/index.html

Instructors:

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Course Goals and Structure:

The course focuses on factors controlling the global cycle of carbon and the greenhouse gases (CO_2, CH_4, N_2O, O_3 and halocarbons). Goals are to develop an appreciation for:

- The abundance and distribution of carbon and greenhouse gases
- Physical, chemical and biological mechanisms that control ocean-atmosphere and terrestrial-atmosphere exchange of carbon and greenhouse gases.
- The geologic evidence for climate change linked to greenhouse gases
- The fate of anthropogenic greenhouse gases, their impact on climate and strategies for sequestration of anthropogenic gases

These goals will be achieved through lectures and 4 paper discussions.

Assessment:

Grades will be assigned based on the student's performance on the following:

- 30% - 3 Problem sets (10% each)
- 25% - Midterm exam (2/17)
- 15% - Participation in class and during the paper discussions
- 30% - Term paper (due 3/9 @ 9:00 AM) & oral presentation (3/10-12)

The topic of the term paper can be anything related to the course. Examples of such topics are attached. Topics should be discussed with one of the instructors. Papers should be 5-10 pages (1.5 spacing) with greater than 10 references.

Readings:

There is no text for this course. Reading assignments will be put on the web or handed out.

Course Schedule Winter 2009 (check for updates on course web site)			
Date	**Topic**	**Reading***	**Problem**
WEEK 1: Greenhouse Gases and Radiative Forcing			
Tu 01/06 Th 01/08	Introduction / Rad. bal. (LJ) Radiative forcing (LJ)	**IPCC 2007 sum. policymak.** IPCC 2007 tech sum.	 Prob. #1 Out
WEEK 2: Non-CO_2 GHG and aerosols			
Tu 01/13 Th 01/15	*Paper discussion #1* Non-CO_2 GHG #1 (LJ)	 IPCC 2007 Chap 2+7	
WEEK 3: Non-CO_2 GHG and aerosols			
Tu 01/20 Th 01/22	Non-CO_2 GHG #2 (LJ) Aerosols and Climate (LJ)		Prob. #1 Due
WEEK 4: Carbon cycle			
Tu 01/27 Th 01/29	*Paper discussion #2* Carbon Cycle #1 (JS)	 **Broecker (2005) pp. 79-130**	Prob. #2 Out
WEEK 5: Carbon cycle			
Tu 02/03 Th 02/05	Carbon Cycle #2 (JS) Carbon Cycle #3 (JS)	**Emerson & Hedges (2007)** **Chap. 4 & 11**	 Prob. #2 Due
WEEK 6: Carbon cycle			
Tu 02/10 Th 02/12	Carbon Cycle #4 (JS) *Paper discussion #3*		
WEEK 7: Anthropogenic perturbation of Carbon cycle			
Tu 02/17 Th 02/19	*Midterm Exam* Anthropogenic perturbation of C Cycle (JS)	 **Broecker (2005) pp. 130-156**	
WEEK 8: Anthropogenic perturbation of Carbon cycle			
Tu 02/24 Th 02/26	Terrestrial CO_2 uptake (LJ) *Paper discussion #4*		Prob. #3 Out
WEEK 9: Geoengineering			
Tu 03/03 Th 03/05	Geoengineering #1 Geoengineering #2 (+ disc)	**Broecker (2005) pp. 156-164**	Prob. #3 Due
WEEK 10: Student presentations			
Tu 03/10 Th 03/12	Student Presentations Student Presentations		

* Assigned readings are in bold. Other readings are suggested.

Readings (* = assigned)

* Broecker (2005) The Role of the Ocean in Climate Yesterday, Today, and Tomorrow (Eldigio Press, Palisades, NY), pp. 78-164.

Emerson, S. and J. I. Hedges (2007) Carbonate Chemistry, Chapt. 4 In: *Chemical Oceanography and the Carbon Cycle* (Book in press at Cambridge U. Press, the chapter is on the Web site)

Emerson, S. and J. I. Hedges (2007) The Global Carbon Cycle: Atmosphere-Ocean Interactions, Chapt 11 In: (Book in press at Cambridge U. Press, the chapter is on the Web site)

* IPCC (2007), *Summary for Policymakers*, In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (will be available on class web site)

IPCC (2007), *Technical Summary*, In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (will be available on class web site)

IPCC (2007), *Chapter 2 "Changes in Atmospheric Constituents and in Radiative Forcing"*, In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (will be available on class web site)

IPCC (2007), *Chapter 7 "Couplings Between Changes in the Climate System and Biogeochemistry"*, In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (will be available on class web site)

Possible Paper Topics:

Recent trends in atmospheric methane concentrations
Methane hydrates and climate change
Tropospheric ozone: past and future changes
Greenhouse gas emissions by activity sector
Effect of climate change on biogenic emissions of CH_4 and/or N_2O emissions
Mitigation solutions for CH_4 emissions
Sources of greenhouse gases from biomass burning
Stratospheric ozone and global warming
Estimates of aerosol direct and/or indirect radiative effects
Efficacy of climate forcings
The interpretation of atmospheric $\delta^{13}C$-pCO_2 changes in ice cores
Atmospheric O_2/N_2 ratios as tracers of marine and terrestrial CO_2 uptake
Experimental results of the terrestrial CO_2 fertilization effect
Climate change and nitrogen fixation
$CaCO_3$ dissolution response to anthropogenic CO_2
Iron fertilization in the southern ocean during the last glacial age
Potential consequences of continued iron fertilization in iron-limited regions of the ocean
Comparing different GCM results for anthropogenic CO_2 penetration into the ocean
Decadal-scale changes in atmospheric CO_2 buildup
CO_2 sequestration: Land and Ocean strategies
Mechanisms responsible for glacial-age changes in atmospheric CO_2, CH_4 and/or N_2O