THE GLOBAL CARBON CYCLE AND GREENHOUSE GASES
The Program on Climate Change, Winter 2005 (OCE/ATMS/ESS 588)
Meeting Time: MWF 1:30-2:20; Meeting Place: OTB 205
Course Web Page: http://www.ocean.washington.edu/courses/oc588

Instructors:
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Office hours: To be discussed in class.

Course Goals and Structure:

The goals of the course are to review what is known about the natural global carbon cycle and greenhouse gases and to explore mechanisms controlling the changes caused by anthropogenic forcing.

The course is divided into 5 blocks in which there will normally be four-five lectures, and a paper discussion. In four of the blocks there are problems assigned to be solved using the computer program Matlab. The first block has a lecture on the use of Matlab. Students are asked to prepare a paper and give a 15-minute presentation in the finals week on one of the topics on the attached list or one of their own choosing. Topics should be discussed with one of the instructors. Papers should be 5-10 pages (1.5 spacing) with greater than 10 references.

Assessment:

Grades will be assigned based on the student's performance on the four problems (60%), the quality of the paper and presentation (20%), and participation in the paper discussions (20%).

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Winter 2005, Instructors: Steven Emerson and Lyatt Jaeglé, T.A.: Lia Ossiander

Week	Topic	Reading, Problem
1&2	**INTRODUCTION**	
Jan. 3 M	Radiative Forcing (LJ)	Hand out paper (IPCC, 2001)
Jan. 5 W	Radiative Forcing (LJ)	Hand out Problem #1
Jan. 7 F	Matlab (LO)	
Jan. 10 M	Paper Discussion	
Jan. 12 W	Carbon Fluxes (SE)	
Jan. 14 F	Carbonate Chemistry (SE)	Hand out paper (Toggweiller and Sarmiento, 1985)
3&4	**THE OCEAN BIOLOGICAL PUMP**	
Jan. 17 M	Holiday -- NO CLASS	
Jan. 19 W	Biological Pump (SE)	Problem #1 due + Hand out
Jan. 21 F	Biological Pump (SE)	Problem #2
Jan. 24 M	Paper Discussion	
Jan. 26 W	Biological Pump (SE)	
Jan. 28 F	Biological Pump (SE)	Hand out paper (Quay et al., 1991)
5&6	**NON-CO_2 GREENHOUSE GASES**	
Jan. 31 M	GH Gases (LJ)	Problem #2 due; Hand out Problem #3
Feb. 2 W	GH Gases (LJ)	
Feb. 4 F	GH Gases (LJ)	
Feb. 7 M	Paper Discussion	
Feb. 9 W	GH Gases (LJ)	
Feb. 11 F	GH Gases (LJ)	Hand out Paper (Sabine et al., 2004)
7&8	**FOSSIL FUEL UPTAKE**	
Feb. 14 M	Ocean Uptake – tracers (SE)	Problem #3 due; Hand out Problem #4
Feb. 16 W	Ocean Uptake (SE)	
Feb. 18 F	Paper Discussion	
Feb. 21 M	Holiday -- NO CLASS	
Feb. 23 W	Ocean/Terrestrial Uptake (SE)	
Feb. 25 F	Ocean/Terrestrial Uptake (SE)	
9&10	**TERRESTRIAL CO_2 UPTAKE**	
Feb. 28 M	Guest Lecture (Tom Hinckley)	Problem #4 due; Hand out paper
Mar. 2 W	Historical Trends (SE)	
Mar. 4 F	Paper Discussion	
	MITIGATION	
Mar. 7 M	Sequestration of CO_2 (SE)	
Mar. 9 W	Non-CO_2 Greenhouse Gases (LJ)	
Mar. 11 F	Student Presentations	
Finals wk	**PRESENTATIONS**	
Mar. 14-18	Student Presentations (continued)	

Discussion Papers:

Reading assignments will be put on the class web site and/or handed out.

IPCC (2001) *Climate Change 2001: the scientific basis, Contribution of Working Group I in the Third Assessment Report of the Intergovernmental Panel on Climate Change* (Houghton et al., eds.), Cambridge University Press, Cambridge, U.K. and New York, NY, USA, 881 pp. (We will discuss parts C, D & E of the Technical Summary, p 36-61)

Toggweiller, R. and J. Sarmiento (1985) Glacial to interglacial changes in atmospheric carbon dioxide: The critical role of ocean surface water at high latitudes, in: *The Carbon Cycle and Atmospheric CO2: Natural variations Archean to Present*, (Sundquist, E. and Broecker, W. S., eds) A.G.U. Geophysical Monograph 32, Wash. D. C.

Sabine, C.L., et al., The oceanic sink for anthropogenic CO_2, *Science*, 305, 367-371, 2004.

Takahashi, T., The fate of industrial carbon dioxide, *Science*, 305, 352-353, 2004.

Quay, P., et al., Carbon isotopic composition of atmospheric CH_4: Fossil and biomass burning source strengths, *Global Biogeochemical Cycles*, 5, 25-47, 1991.

Long, S.P., E.A. Ainsworth, A. Rogers, and D.R. Ort, Rising atmospheric carbon dioxide: Plants FACE the Future, *Annu. Rev. Plant Biol.*, 55, 591-628, 2004.

C. Korner, Through enhanced tree dynamics carbon dioxide enrichment may cause tropical forests to lose carbon, *Phil. Trans. R. Soc. Lond. B*, 359, 493-498, 2004.

Possible Paper Topics:

Current trends in atmospheric methane concentration
Methane hydrates and climate change
Stratospheric H_2O: trends and climate effects
Tropospheric ozone: past and future changes
Effect of climate change on CH_4, N_2O emissions
Mitigation solutions for CH_4 emissions
Stratospheric ozone and global warming
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
The feasibility of sequestering anthropogenic CO_2 by pumping it into the ocean
Comparing different GCM results for anthropogenic CO_2 penetration into the ocean