Terrestrial Ecosystems & the Carbon Cycle
GE 456/656 – Fall 2010 Syllabus
Monday, Wednesday, & Friday: 12-1pm CAS 315

Instructor
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Office Hours: Monday 1-3pm

Location: CAS 315

Prerequisites :
GE 100, 101, or 104, college level statistics (CAS MA 113, MA 115, MA 213, or equivalent), and one of the following: BI306, BI443, or GE 530. Or, consent of instructor.

Course description:
Welcome to GE 456/656! This course is directed at graduate students interested global environmental change and undergraduates with a solid science background interested in pursuing an environmental career. In this class we will focus on applying the fundamentals of climate science, ecosystems ecology, and biogeochemistry to explore the past, present, and possible future dynamics of the carbon cycle. In addition, we will discuss global change prediction methods and use different types of datasets to inform our understanding of the carbon cycle. Key topics we will cover will include the physical climate system, variability within natural systems, the carbon cycle and related cycles, ecosystem processes, land use issues, the interactions among climate, ecosystems, and biogeochemistry, and the impact of global change on socially relevant parameters. My approach in this course will be to facilitate your learning through a combination of lecturing, discussion, and quantitative analysis of observational data, manipulative field experiments, and model outputs (we will not be running models, but will examine the outputs). There will be at least one required Saturday field trip (day-long).

Required Text:
The Global Carbon Cycle: Integrating Humans, Climate, and the Natural World. Field, C. and Raupach, M.R. 2004 Island Press, Washington DC, ISBN: 9781559635271, paperback.

Recommended Text:
Biogeochemistry: An Analysis of Global Change. 2nd Edition. W.H. Schlesinger, 1997. Academic Press, New York.

Additional Reading:
Readings from the primary literature, SOCCR, IPCC, and other sources will be posted on blackboard as pdfs.

Due Dates, Make-Ups and Absence
Work must be turned in on time. LATE WORK WILL BE ACCEPTED, BUT THE GRADE FOR THAT ASSIGNMENT WILL BE REDUCED BY 50%. Each student is allowed one unexcused absence after which the participation grade will be reduced by 5% for each additional unexcused absence.

Collaboration

All work prepared for this course must be prepared by you as an individual without collaboration (unless you are explicitly directed otherwise by the teaching staff).

Originality of Work

All work prepared for this course must be written in your own words and prepared specifically for this course. You may not copy phrases, sentences, or paragraphs in written work from ANY source without quotes and specific attribution. This includes web sources. Copying will result in a 0 grade and repeated copying will be considered academic misconduct.

Academic Code

It is your responsibility to know and understand the provisions of the CAS Academic Conduct Code. Copies are available in CAS 105. Suspected cases of academic misconduct will be referred to the Dean's Office. See http://www.bu.edu/cas/students/undergrad-resources/code for conduct information for undergraduates and http://www.bu.edu/cas/students/grad-resources/forms/disciplinefor graduate student conduct requirements.

Assessment:

Undergraduate students are expected to attend all lectures and field trip(s), complete all assigned reading and exams, participate in class discussions, write a 7-8 page term paper (at least 7 references), and deliver a class presentation on their research topic. Graduate students are expected to attend all lectures and field trips, complete all assigned reading and exams, participate in class discussions, write a 10-12 page term paper (at least 10 references), and deliver a class presentation on their research topic. The Graduate student expectation include all those described for undergraduate and their term papers are expected to include a data analysis component based either on data that they have collected for thesis research or publically available datasets. The instructor will be available during office hours to assist with student data analysis.

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

• 10% - 2 Problem sets (5% each)
• 20% - Midterm exam
  - (take-home exam to be distributed October 20 and due October 25 by 12pm)
• 15% - Participation in class and during the paper discussions
• 20% - Final Exam
• 35% - Term paper (25%) & oral presentation (10%)
  - Final term paper due electronically on December 10 by 6pm.

The topic of the term paper can be anything related to the course. Topics should be discussed with one of the instructors.

Examples of paper topics could include (not a comprehensive list):
Recent trends in atmospheric CH_4 concentrations | Methane hydrates and climate change | Effect of climate change on biogenic emissions of CO_2 and/or CH4 | Mitigation solutions for CO_2 or CH4 emissions | Sources of greenhouse gases from biomass burning | Experimental results of the terrestrial CO2 fertilization experiments | Comparing different GCM results for CO2 exchange with the terrestrial biosphere | Decadal-scale changes in atmospheric CO2 buildup | Land strategies for CO_2 sequestration | Changes in terrestrial carbon storage across urban to rural gradients | Remote sensing as a tool to understand terrestrial C stocks &/or CO_2 fluxes

Lecture & Reading Schedule:

Week Beginning:	Topic	Reading
3-Sept	*Friday:* Overview of the Global Carbon Cycle	
6-Sept	*Mon:* No class *Wed:* Overview of the Global Carbon Cycle *Fri:* The Atmosphere	Field & Raupach chapter 2 & Falkowski 2000 (**W**), Schlesinger chapters 3 [highlighted sections for **F**]
13-Sept	*Mon:* Global Climate *Wed:* The Oceans *Fri:* The Lithosphere	Field & Raupach chapter 10; Friedlingstein et al. 2006 (**M**) Field & Raupach chapter, 12 & 13 (**W**) Schlesinger chapters 4 [highlighted sections for **F**]
20-Sept	*Mon:* Atmosphere-Biosphere exchange *Wed:* Atmosphere-Biosphere exchange *Fri:* Net Primary Productivity	IPCC AR4 7.3.3 (pg 526-528) (**M**) Wofsy et al. 1993; Barford et al. 2001 (**W**) Field & Raupach chapters 14 & 15 (**F**)
27-Sept	*Mon:* Photosynthesis *Wed:* Photosynthesis *Fri:* Photosynthesis	Field & Raupach chapters 16 (**M**) Heimann and Reichstein 2008 (**F**)
04-Oct	*Mon:* Autotrophic Respiration *Wed:* Heterotrophic Respiration *Fri:* Measuring/Modeling Respiration	Davidson et al. 2006 Davidson and Janssens 2006
11-Oct*	*Mon:* No class *Tues:* Temperate Ecosystems *Wed:* Tropical Ecosystems *Fri:* Urban Ecosystem	SOCCR chapter 11 (**M**) & Malhi et al. 1999 (**M**) Wright 2005; IPCC AR4 7.3.2.2.4 (**W**) Grimm et al. 2000 (**F**)
18-Oct	*Mon:* boreal ecosystems *Wed:* wetland ecosystems *Fri:* Agricultural & grassland ecosystems	Magnani et al. 2007; Soussana et al. 2004; Paustian et al. 1998, SOCCR chapter 10 & 13
25-Oct	*Mon:* Coupling between cycles (H_2O, N, P, & K) *Wed:* Coupling between cycles (H_2O, N, P, & K) *Fri:* Coupling between cycles (H_2O, N, P, & K)	Schlesinger chapters 6
1-Nov	*Mon:* Paleoclimate *Wed:* Carbon lessons from the past *Fri:* Carbon lessons from the past	Field & Raupach chapter 7 (**M**) IPCC AR4 Ch 6 - exec summary and FAQ 6.2 (**W, F**)
8-Nov	*Mon:* Ecosystem complexity *Wed:* Ecosystem Feedbacks & resilience	Holling 2002 (**M**) Cox et al. 2000 (**W**)

	Fri: Modeling the carbon cycle	Field & Raupach chapter 3 (**F**)
15-Nov	*Mon:* Human modifications: deforestation & fire *Wed:* Food Security *Fri:* Human modifications: urbanization	Foley et al. 2005 (**M**) Battisti and Naylor 2009 (**W**) Field & Raupach chapter 19 (**F**)
22-Nov	*Mon:* Emissions Sources *Wed:* Emissions Sources *Fri:* Emissions Drivers	SOCCR page 57-84 (**M & W**) Field & Raupach chapters 11 (**F**)
22-Nov**	*Mon:* population & consumption drivers *Wed: No Class* *Fri:* No class	Field & Raupach chapters 6 (**M**)
29-Nov	*Mon:* Stabilization *Wed:* Future climate & carbon scenarios Fri: Climate/carbon management	Pacala and Socolow (2004) (**M**) Royal Society (2009)[pp. ix –xii] (**W**) Field & Raupach chapter 4 & 5 (**F**)
6-Dec	*Mon:* Presentations & Discussion *Wed:* Presentations & Discussion *Fri:* Presentations & Discussion	
* No class meeting on Mon, October 11, 2010 – Monday classes meet on Tuesday. ** Fall break, November 24-28, 2010		

Class Reading Reference List:

Barford, C.C., Wofsy, S.C., Goulden, M.L., Munger, J.W., Pyle, E.H., Urbanski, S.P., Hutyra, L., Saleska, S.R., Fitzjarrald, D., Moore, K., Factors controlling long- and short-term sequestration of atmospheric CO_2 in a mid-latitude forest, *Science*, *294*, 1688-1691, 2001.

Batisti, D.S. and R.L. Naylor. 2009. Historical warnings of future food insecurity with unprecedented seasonal heat. Science 323: 240-244.

Cox, P.M., Betts, R.A., Jones, C.D., Spall, S.A., Totterdell, I.J. 2000. Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model. Nature 408: 184-187.

Davidson, E.A., Janssens, I.A., Luo, Y. 2006. On the variability of respiration in terrestrial ecosystems: moving beyond Q10. Global Change Biology 12: 154-164.

Davidson, E.A. and Janssens, I.A. 2006. Temperature sensitity of soil carbon decomposition and feedbacks to climate change. *Nature* 440: 165-173.

Denman, K.L., G. Brasseur, A. Chidthaisong, P. Ciais, P.M. Cox, R.E. Dickinson, D. Hauglustaine, C. Heinze, E. Holland, D. Jacob, U. Lohmann, S Ramachandran, P.L. da Silva Dias, S.C. Wofsy and X. Zhang, 2007: 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* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Falkowski, P., et al. The global carbon cycle: A test of our knowledge of earth as a system. Science 290: 291-296.

Field, C. and M.R. Raupach. 2004. The Global Carbon Cycle: Integrating Humans, Climate, and the Natural World. Island Press, Washington DC, ISBN**:** 9781559635271 [paperback].

Foley, J.A., et al. 2005. Global consequences of land use. Science 309: 570-574.

Grimm, N.B., Grove, J.M., Pickett, S.T.A., Redman, C.L. 2000. Integrated aprroaches to long-term studies of urban ecological systems. *BioScience 50: 571-584.*

Heimann, M. and M. Reichstein. Terrestrial ecosystem carbon dynamics and climate feedbacks. Nature 451: 289-292.

Jansen, E., J. Overpeck, K.R. Briffa, J.-C. Duplessy, F. Joos, V. Masson-Delmotte, D. Olago, B. Otto-Bliesner, W.R. Peltier, S. Rahmstorf, R. Ramesh, D. Raynaud, D. Rind, O. Solomina, R. Villalba and D. Zhang, 2007: Palaeoclimate. 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* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

King, A.W., Dilling, L., Zimmerman, G.P., Fairman, D.M., Houghton, R.A., Marland, G., Rose, A.Z., Wilbanks, T.J., eds. The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and Implications for the Global Carbon Cycle. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC: 29-36, 167-170.

Law, B.E., et al. 2002. Environmental controls over carbon dioxide and water vapor exchange of terrestrial vegetation. *Agricultural and Forest Meteorology* 113: 97-120.

Luysseart, S. et al. 2007. CO2 balance of boreal, temperate, and tropical forests derived for a global database. *Global Change Biology* 13: 2509-2537.

Magnani, F., et al. 2007. The human footprint in the carbon cycle of temperate and boreal forests. Nature 447: 848-850.

Malhi, Y., Baldocchi, D.D., Jarvis, P.G. 1999. The carbon balance of tropical, temperature, and boreal forests. Plant, Cell and Environment 22: 715-740.

Pacala, S. and R. Socolow. 2004. Stabilization wedges: Solving the climate problem for the next 50 years with current technologies. Science 305: 968-972.

Paustian, K., Cole, C.V., Sauerbeck, D., Sampson, N. 1998. CO2 mitigation by agriculture: An overview. Climatic Change 40: 135-162.
The Royal Society. 2009. Geoenegineering the climate: Science, goverance, and uncertainty. The Royal Society, RS1636.
Schlesinger, W.H. 1997. Biogeochemistry: An Analysis of Global Change. 2nd Edition. Academic Press, New York.
Soussana , J.F., Loiseau, P., Vuichard, N., Ceschia, E., Balesdent, J., Chevallier, T., Arrouays, D. 2004. Carbon cycling and sequestration opportunities in temperate grasslands. Soil Use and Management 20: 219-230.
Wofsy, S.C., Goulden, M.L., Munger, J.W., Fan, S.M., Bakwin, P.S., Daube, B.C., Bassow, S.L., Bazzaz, F.A. 1993. Net exchange of CO2 in a mid-latitude forest. *Science* 260: 1314-1317.
Wright, J.S. 2005. Tropical forests in a changing environment. *Trends in Ecology and Evolution* 20: 553-560.