CAS GE 510: Physical Principles of the Environment
Instructor: Nathan Phillips
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Meeting Times: MWF 9:00 - 10:00
Location: GCB 208
Office Hours: MW 10:00-11:00, TH 1:00-2:00

Course description: This course is designed to provide the basic science underlying critical areas of global environmental change, including the greenhouse effect, sea level rise, biogeochemical cycling, and associated impacts on terrestrial and marine ecosystems. These topics will be developed with the perspective of earth as an integrated system having properties including both stability/resilience and the capacity for sudden and non-linear change. The course will be primarily based on recent research findings and syntheses presented by the Intergovernmental Panel on Climate Change, and The Weather Makers, by Tim Flannery. Our coverage of this report will provide students with an understanding of the science behind media headlines and policy development.

Grading:
Individual or group project proposal: 10%
Project status reports: 10%
Individual or group project: 35%
Individual project report: 10%
One in-class midterm exam: 30%
Attendance and participation: 5%

The *individual or group project proposal* should be 10-15 pages, focused generally on a topic or topics covered in the course, and include:

(1) clearly defined project goals, objectives, methodology and product(s)
(2) how the project will benefit both you and your targeted audience
(3) how the project is related to the theme and content of this course
(4) in the case of group projects, how effort will be divided among group members

In order to decide on subject matter for a project, students should preview the entire syllabus and readings during the first week of class. Depending on the subject matter chosen and the order in which class lectures on subjects are presented, students may need to study material in advance of their coverage in lecture.

Your project can be as local/global or general/specific in scope as you wish. Examples of projects could include (but are not limited to):

- a scholarly paper advancing your research interests;
- an energy, carbon and/or greenhouse gas inventory of and mitigation study for Boston University or another facility or community;
- design of a carbon-neutral building, campus, or community;
- a cartoon booklet such as “IPCC for Beginners”;
- a video or photographic documentary or film of a specific environmental issue or event relevant to the course;
- a biodiversity and/or ecosystem services/threat assessment of a local habitat;

- an educational exhibit suitable for museums or science center (for example, see Harvard's "Climate Change: Our Global Experiment" exhibit).

Individuals or groups should consult with me prior to preparing proposals.

In the case of projects that focus on environmental education, an explicit consideration and literature review supporting the pedagogical advance your project will make is required. For example, if an educational poster is a project product, you should include discussion, based on education studies or discussion with education professionals, of what elements and style make for effective educational posters, and how your poster meets these criteria in its unique way.

Project status reports will be due periodically and should include a one-page write-up from each individual (compiled into a single report for group projects) on progress made toward completion of the project.

The *individual or group project* will include the product(s) of the individual or group proposal, and will additionally include an oral presentation of the project at the end of the semester (7-10 minutes per person), and a 10 page *individual project report*, focused on: (a) your unique contribution to the project; (b) how their project illustrates or illuminates subject matter covered in the course; and (c) how your understanding of material in this course has been solidified through completion of this project.

The *midterm exam* will consist of multiple choice, short answer, and short essay questions covering material from the lecture and readings from parts I-III of the course.

Course Policies: The College of Arts and Sciences policies on incomplete grades and academic conduct will be followed. For details refer to the BU undergraduate or graduate bulletins and the CAS Academic Conduct Code. All written work must be your own. **All verbatim or paraphrased text from the literature must be placed within quotation marks with the source citation.**

DATE	TOPIC	READING	ASSIGNMENT
W Sep6	Course Introduction		
	Part I: The Nature of Environmental Stability and Change		
F Sep8	Certainty, uncertainty, and precaution	IPCC WGII 2.6; IPCC WGIII 10.4.2.2; Flannery pp 1-8, Philander pp 1-10	
M Sep11	Properties of Complex Systems: Stability, Instability, Metastability, and Feedback	IPCC WGI 1.1.2, 14.4; Flannery Ch 21	*Project Status Report 1*: Your top two subjects of interest; your interest in individual vs. group projects.
W Sep13	Stability: Gaia and Daisyworld	Flannery, Ch 1, Lovelock	
F Sep15	Instability: Chaos and Climate	IPCC WGI 7.1.3; 14.2.2; Gleick	
M Sep18	Metastability: Thresholds and Surprises	IPCC WGI 7.7; Flannery Ch 5	*Project Status Report 2*: Finalize group or individual participation; sketch out project type
W Sep20	Patchiness vs. smoothness of atmospheric constituents: Mean Residence Time	IPCC WG1 4.1.4	
	Part II: Nuts and Bolts of Climate		
F Sep22	Earth's Energy Balance	IPCC WGI 1.2.	
M Sep25	Radiative Forcing of Climate	IPCC WGI 6 (selections TBA)	*Project Proposal*: first draft due
W Sep27	Greenhouse Gases and Global Warming: History of the idea and observations	IPCC WGI 4.1; Flannery, Ch 2, 4	
F Sep29	Greenhouse Gases and Global Warming: Physics and Chemistry	IPCC WGI 4.2; Flannery, Ch 3	
M Oct2	Aerosols and Global Dimming: properties of Aerosols	IPCC WGI 5.1, 5.2; Flannery Ch 16, pp 158-162	(Receive comments back on first draft)
W Oct4	Aerosols, Clouds and Global Dimming	IPCC WGI 5.3	
F Oct6	Ozone: The Good, Bad and Ugly	IPCC WGI 4.2; Flannery Ch 23	
M Oct9	NO CLASS	None	

Tu Oct10	Subsitute Monday Class – Nov 10?		
W Oct11	*Video: Dimming the Sun (56 min)*	None	
F Oct13	*Video: An Inconvenient Truth (100 min)*	None	
M Oct16	Discussion of Videos	None	*Project Proposal*: Final draft due
	Part III: Global Biogeochemical Cycles		
W Oct18	The Carbon Cycle I: Steady State	IPCC WGI 3.1, 3.2	
F Oct20	The Carbon Cycle II: Global Change	IPCC WGI 3.3-3.5	
M Oct23	The Water Cycle I: Steady State	Schlesinger, Ch.10	*Project Status Report 3*
W Oct25	The Water Cycle II: Global Change	IPCC WGII 4; Flannery Ch 13	
F Oct27	The Nitrogen Cycle: The most under-rated agent of global change	IPCC WGI Ch 3.2.2.5; 4.2.1.2; 4.2.3.3	
M Oct30	**Midterm Exam**	None	*Midterm Exam*
	Part IV: Impacts and Vulnerabilities		
W Nov1	Terrestrial Biodiversity	IPCC WGII 5.2, 5.4, 17.2.5; 19.3.3.2. Flannery, Ch 12, 18	
F Nov3	Aquatic Biodiversity	IPCC WGII 6.3, 6.4; Flannery, Ch 10, 11, 20	
M Nov6	Biodiversity and Ecosystem Function	IPCC WGII 5.4.3.4.3.	*Project Status Report 4*
W Nov8	Wetlands	IPCC WGII 5.8	
F Nov10	NO CLASS – Sub Oct 10? Ice Sheets and Glaciers	IPCC WG1, 11; Flannery Ch 15	
M Nov13	Sea Level Rise	IPCC WG1 11; Flannery Ch 15	
W Nov15	Extreme Weather and El Nino	IPCC WG1 7.6; Flannery Ch 14	
F Nov17	Regional winners and losers	IPCC WGI 10; Flannery Ch 32	
	Part V: Models and Projections		
M Nov20	History and Features of Global Circulation Models	IPCC WGI 1.3.2; Flannery Ch 16	*Project Status Report 5*
W Nov22	NO CLASS		

F Nov24	NO CLASS		
M Nov27	Testing Models by Predicting the Past and Using Models to Predict the Future	IPCC WG1 8, 9 (selections to be announced)	
	Part VI: Mitigation		
W Nov29	Alternative Energy	IPCC WGIII 3.8; Flannery Ch 28, 29, 30, 31, 34	
F Dec1	Biological Carbon Sequestration	IPCC WGIII 4.2; Flannery Ch 27	
M Dec4	Engineering the Globe?	IPCC WGIII 4.7; Flannery Ch 27, 35	
W Dec6	Student Presentations	None	*Project Presentations*
F Dec8	Student Presentations	None	*Project Presentations*
M Dec11	Student Presentations	None	*Project Presentations; Final Project Due*
F Dec15	NO FINAL EXAM		

Required Readings:

The Weather Makers, Tim Flannery, 2005, Atlantic Monthly Press, New York, NY, USA, 357 pp. ISBN-10: 0-87113-935-9

Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.

Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J.J., O. F. Canziani, N. A. Leary, D. J. Dokken, K. S. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1000 pp.

Climate Change 2001: Mitigation. Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, R. Swart and J. Pan (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 700 pp.

All 3 above reports are available at: http://www.grida.no/climate/ipcc_tar/index.htm

Supplemental Readings: The following readings are not required for class, but comprise a set of foundational papers and other highly relevant articles or chapters that relate to the material covered in class.Photocopies of reading materials will be available on reserve (location TBA).

Aldhous P. 2000. Global warming could be bad news for Arctic ozone layer. Nature 404:531.

Arrhenius S. 1896. On the influence of carbonic acid in the air upon the temperature of the ground. Philosophical Magazine 41:237-276.

Crutzen P. J. 1970. TBA

Farman J. C., B. G. Gardiner and J. D. Shanklin. 1985. Large losses of total ozone in Antarctica reveal seasonal ClOX/NoX interaction. Nature 315:207-210.

Federov A. V. and S. G. Philander. 2000. Is El Niño Changing? Science 288:1997-2002.

Gaston K. J. 2000. Global patterns in Biodiversity. Nature 405:220-233.

Graedel T. E. and P. J. Crutzen. 1997. Atmosphere, Climate, and Change. Scientific American Library, Series # 55, W. H. Freeman, New York.

Gregory P. **J. et al.** 1999. Managed Production Systems. Chapter 9 in: The Terrestrial Biosphere and Global Change: implications for natural and managed ecosystems. Eds: Walker B., W. Steffen, J. Canadell, and J. Ingram. IGBP Book Series #4, Cambridge University Press, Cambridge, UK.

Keeling C.D. 1960. The Concentration and Isotopic Abundances of Carbon Dioxide in the Atmosphere. Tellus 12: 200-203

Intergovernmental Panel on Climate Change (IPCC). 2000. Land Use, Land-Use Change, and Forestry: Summary for Policymakers.

Intergovernmental Panel on Climate Change (IPCC). 1998. IPCC workshop on rapid non-linear climate change report.

Lomborg B. The Skeptical Environmentalist. 2001. Cambridge Univ. Press

Lovelock, J. E. 1979. Gaia: A new look at life on earth. Oxford University Press, Oxford.

Michaels P. 2000. The satanic gases. Cato Institute Press, Washington, DC.

Molina M. **J., and F. S. Rowland.** 1974. Stratospheric sink for chloroflouromethanes - chlorine atom catalyzed destruction of ozone. Nature 249:810.

Philander S. **G.** 1998. Is the temperature rising? Princeton University Press, Princeton, New Jersey.

Philander S. **G.** 1990. El Niño, la niña, and the southern oscillation. Academic Press, San Diego.

Postel S. **L., G. C. Daily and P. R. Ehrlich**. 1996. Human appropriation of renewable fresh water. Science 271, 785-788.

Rowland F. **S. and M. J. Molina.** 1975. The ozone question. Science 190:1038.

Schlesinger W. **H.** 1997. Biogeochemistry: An analysis of global change. Academic Press, San Diego.

Shindell D. **T., D. Rind and P. Lonergan.** 1998. Increased polar stratospheric ozone losses and delayed eventual recovery owing to increasing greenhouse-gas concentrations. Nature 392:589-592.

Smil, V. 1999a. Energies: An Illustrated Guide to the Biosphere and Civilization. MIT Press, Cambridge, Massachusetts.

Stoddard J. L. et al. 1999. Regional trends in aquatic recovery from acidification in North America and Europe. Nature 401:575-578.

Vitousek P. and Hooper. 1993. Chapter 1 in: Biodiversity and Ecosystem Function. E.-D. Schulze, H. A. Mooney, Eds. Ecological Studies 99. Springer-Verlag, New York.