

Book

Series
PHY Modeling the Earth
System 1

Spring, 1994

FNR 498G or GEOS 391A

Modeling the Earth System

*A state-of-the-art course in understanding, monitoring
and modeling Global Change
Supported by USRA & NASA's Earth System Science
programs*

James OGG and Rob NEWMAN (Earth & Atmospheric), and Anne SPACIE
(Forestry & Natural Resources)

3 credits; TTh 1:30, Lab sections: T 9:30-11:20 or T 11:30-1:20

An asteroid hitting the Earth results in extinction of half of the animal life; a Volcano exploding in the Philippines contributes to flooding in the Midwest; reduced Sunspot activity on the Sun causes a hundred-year "Little Ice Age" that freezes the Dutch canals; Panama separates the oceans forcing African apes to walk on the ground and think about midterm exams; Refrigeration of food contributes to the destruction of the atmospheric ozone shield; and NASA begins a multi-decade program to monitor the changing Earth.

These are only a few of the case examples of the impacts of Global Change on the interrelated Earth systems to be explored in this course. Each lecture will be an in-depth treatment of the response of the Earth to a different geological, astronomical, biological, atmospheric, oceanographic, or societal impact. We will also examine how to predict and monitor future Global Change. A series of guest lecturers from NASA and other universities will explain the current frontiers and future goals.

The Laboratory portion of the course will be use of various modeling and monitoring computer software (STELLA, SimEarth, Geographical Information Systems, NASA satellite data acquisition and processing, Global Weather simulations, Energy Balance Models, Fisheries management scenarios, etc.).

This course is a combined offering of the departments of Earth & Atmospheric Sciences and Forestry & Natural Resources, but is applicable to all fields of science and technology. Please ask James Ogg, Anne Spacie, Rob Newman, or John Snow for further details.

Spring, 1994

PURDUE UNIVERSITY

Modeling the Earth System

*A state-of-the-art course in understanding, monitoring and modeling Global Change
Supported by NASA's Earth System Science program*

James OGG (Earth & Atmos.) and Anne SPACIE (Forest. Nat. Res.)

Rob NEWMAN (Lab coordinator)

Lecture: TTh 1:30, Lab sections: T 9:30-11:20 or T 11:30-1:20; 3 credits

Tentative Lecture/Lab Schedule

<u>WEEK</u>	<u>TUES</u>	<u>THURS</u>	<u>Lab (Tues)</u>
<u>IMPACTS OF GEOLOGICAL PROCESSES</u>			
Jan. 11,13	Intro/Overview (Mesa Verde)	Gaia	<i>"After the Warming"</i>
Jan. 18,20	<i>Snow-Holiday</i>	Mass extinction (Permian)	<i>SimEarth & Gaia</i>
Jan. 25,27	Super-Greenhouse (Cret.)	Mountains and Man	<i>STELLA tutorial</i>
Feb. 1,3	Volcanic Winter	The 1000-Year Event	<i>Earth Process Models</i>
<u>IMPACTS OF BIOGEOCHEMICAL AND ATMOS-OCEAN PROCESSES</u>			
Feb. 8,10	BioGeoChem/Nutrient Cycles	El Niño	<i>Carbon cycle-1</i>
Feb. 15,17	Ozone	Atmospheric Gases	<i>Carbon cycle-2</i>
Feb. 22,24	Methane ?	Groundwater	<i>Ozone models</i>
Mar. 1,3	Zoogeography	Hurricanes; Coastlines	<i>Fisheries and El Niño</i>
Mar. 7-11	<i>Spring Break</i>	Midterm 3Ms	
Mar. 15,17	Ecosystem dynamics	Ecosystem adaption	<i>Modeling Project</i>
<u>IMPACTS OF HUMANS ON BIOSYSTEMS</u>			
Mar. 22,24	Mediterranean	Introduced Species	<i>GIS Africa</i>
<u>IMPACTS OF ASTRONOMICAL PROCESSES</u>			
Mar. 29,30	Death from the Heavens	Milankovitch Cycles	<i>Presentations of Models</i>
<u>NASA MONITORING OF GLOBAL CHANGE</u>			
Apr. 5,7	Sunspots and Little Ice Age	Monitoring from Space	<i>Energy Balance Model</i>
Apr. 12,14	NASA's EOS	<u>Easter Island</u>	<i>NASA satellite data</i>
<u>LARGE-SCALE IMPACTS OF HUMANS</u>			
Apr. 19,21	Ice Cores; Climate Pulses	Nepal-1	<i>Geoscope (Overview)</i>
Apr. 26,28	Nepal-2	The Big Picture/Review	<i>Geoscope (Brazil)</i>
May 3	--- FINALS --- (Test #3 -- 250 pts -- date = Final's schedule)		

Texts, Supplemental Reading:

Modeling the Earth System (D. Ojima) will be required (given out)

STELLA applications handbook (given out)

BioGeoChemistry -- An Analysis of Global Change (W.H. Schlesinger) -- optional

Patterns of Life (H. Mielke) -- optional

Consider a Spherical Cow -- optional

Atmospheric Change : An Earth System Perspective [T.E. Graedel & Paul J. Crutzen (1993)

Freeman publ., New York; 446 pp., \$42.95] -- optional

The Earth System (R. Crane, J. Kasting et al.; Penn State Univ. course notes) -- optional (may not yet be in print)

Other readings, as appropriate to lectures

Grading:

Total of 1000 pts: 850+ = **A**, 750-850 = **B**, 650-750 = **C**, 550-650 = **D**

Project on an Earth System, with class explanation This will require finding actual numbers, etc.	150
Lab exercises (10 graded labs)	350
Mid-term -- suite of factual and general questions	200
Final -- take-home, two-weeks before end of term; what-if questions	300

Advanced Course

Our advanced course is now formalized as "Geos/Atmos/FNR 420 Global Change Modeling". This course is the first Purdue course to have a triple-listing, which merely reflects the inadequacy of traditional disciplines when approaching the Earth System. This will become a required course by the new School of Science "Environmental Minor" that can be added to all university majors. The pre-requisites are one semester of calculus and of chemistry, and the students have been top quality and extremely enthusiastic. The result of the 1994 offering was 2 students entering this Earth Systems field as their career choice.

The Spring 1995 course had a capped enrollment of 15 (2 full lab sections) due to the number of computer workstations. In the middle of the year, we acquired the new PC version of STELLA, which will allow this course to expand to 30 people in Spring 1996 (or, possibly higher, if we add another laboratory teaching assistant). We will be slightly hindered by the lack of dual Mac/PC versions of some other course software (e.g., Geoscope (PC), Multispec (Mac), and INDISI (PC)), but the STELLA is the heart of the current laboratory portion of the course.

We developed new lab modules:

- Multi-Band Radar Interpretation (MultiSpec; with recent Shuttle data from JPL)
- Long-Term Geological Carbon Cycle (STELLA)
- Integrated Carbon Cycle - Greenhouse - Global Temperature (STELLA)
- Tropospheric Ozone (STELLA)
- Global Change in Africa (INDISI).

In two weeks we plan to have a new GEOSCOPE exercise in downloading and interpreting time-series of satellite data, and an Internet-data acquisition exercise, which will be the final lab in the semester.

We are preparing formal writeups of some of these new labs (especially the Ozone and the combined Radar-Infrared interpretation of vegetation patterns) as stand-alone modules that ESSE can distribute to other schools. The Long-Term Geological Carbon Cycle lab (based on an updated theoretical model by Berner, 1994, in Amer. J. Sci.) was also provided to New York University (Mike Rampino and Tyler Vogt) for use in their course and as a key component of a Master's research project.

The lecture portion of the advanced course had 5 main themes or modules: "Disruptions of the Carbon Cycle" which used a number of geological case examples, "Short-term Excursions of the Atmosphere-Ocean System" which included a brief introduction to chaos of natural systems, "Ecosystem Dynamics and Adaption" which included nitrogen cycles, population models (a future lab module?) and introduced species, "Monitoring of Global Change" which included 3 presentations by Vern Vanderbilt of NASA-Ames and two associated lab exercises, and "Large-Scale Impacts of Humans" which includes case examples of Nepal, Mediterranean and Easter Island collapses of surface processes and ecosystems. This last theme has led to a proposal of an independent course called "Oil", which would involve geology, climate effects, economics and history as a "holistic" approach to the cascading impacts of a resource usage.

Two of the advanced lectures were also given at New York University -- Long-Term Geological Carbon Cycle and the Impact of the Evolution of Land Plants (a fascinating topic in Earth Systems in which land evolution set off a cascade of feedbacks including global cooling and suite of mass extinctions of marine life during the Devonian).

Wadsworth Publishing has invited us (Ogg, Spacie, Chaney) to convert our suite of advanced-course lecture and lab modules into a formal textbook and manual that can be distributed to other universities. However, development of such a textbook would require a significant expenditure of time and effort that is difficult to fit between our current teaching and research commitments. In any case, all of our class-lecture notes and lab-handouts (both in Microsoft WORD) are freely available to anyone interested in such presentations. Perhaps ESSE might consider placing such lecture-lab writeups (perhaps with "gif" conversion of associated graphics) and those of other university programs into a server as part of their ESSE-home page?