

GA Tech

Survey  
GAT Habitable Planet

### Habitable Planet

EAS 1804

Spring Term, 1999

209 EAS (OCE)

**INSTRUCTOR:** Flip Froelich, School of Earth & Atmospheric Sciences, Hinman 213  
Office Telephone: 404-894-3944; Office Hours (in classroom) Tues-Thurs 5:00-  
email: philip.froelich@eas.gatech.edu

**TEXT:** *How to Build a Habitable Planet* (W. S. Broecker).

Purchase from Susan Ryan in EAS-205A, \$20. Additional reading materials will be assigned and handed out in class or placed on the web reserve. Class notes will be put on reserve, web and hard copy.

**TIME and PLACE:** Lectures (Froelich): Tuesdays and Thursdays, 3:00-4:30 pm.  
Labs and Recitations: Mondays, 3:00 - 6:00 pm.  
Room 209 in EAS (OCE). Attendance at lectures is required. Reading assignments must be completed prior to lectures on each subject.  
Unannounced "pop" quizzes will occur randomly.

**FIELD TRIPS:** There will be at least two field trips. One will be an evening sky and telescope foray to view the Moon, Venus, Mars, maybe Saturn, and selected star clusters, the Andromeda Galaxy, a nebulae, and if we're lucky, a meteor shower (to be announced in class - because of weather - one day warning !). The second field trip is on your own time - to visit Fernbank.

**PROBLEM SETS:** Handed out every few weeks, each will be due about two weeks later. Each will be based on lectures and readings. You are expected to work independently on each problem set.

**EXAMS:** Mid-Term Exam: Monday April 26, 3:00 - 5:00 pm (in class).  
Final Exam, as scheduled: Monday June 7, 2:50 - 5:40 pm (in class).  
The mid-term exam will cover the first half of the course. The final exam will cover the last half of the course.

**GRADES:** 25% Problem Sets, Pop Quizzes and Chapter Summaries; 25% Mid-Term Exam; 25% Final Exam; 25% Lab Reports and Special Topics

**Habitable Planet (EAS 1804)**  
**Spring Term 1999**  
**Philip N. Froelich**

<u>Date</u>	<u>Reading Assignment (Text)</u>	<u>Lecture/Lab Topics</u>
March 30	Chap. 1	Cosmogogenesis - the Big Bang
April 1		The Creation of Everything
5 (Monday)		<i>Lab Intro/Lecture/Math Reality</i>
6	Chap. 2	Nucleosynthesis in Stars
8		Creation of the Elements
12 (Monday)		<i>Nucleonics Lab - Recitation</i>
13	Chap. 3	Origin of Solar System
15		Meteorite Clues
19 (Monday)		<i>Star &amp; Telescope Lab - Field</i>
20	Chap. 4	Radioisotope Clocks - Ages of
22		Events and our Galaxy
26 (Monday)		<b>MID-TERM EXAM (3 - 5 pm)</b>
27		The Supernova Hypothesis
29	Chap. 5 (Part I)	Construction of Planet Earth
May 3 (Monday)		<i>Radiodecay-Ingrowth Lab (I)</i>
4	Chap. 5 (Part II)	Sea-Floor Spreading, Isotasy
6	Chap. 6	Moons, Asteroids & Craters
10 (Monday)		<i>Radiodecay-Ingrowth Lab (II)</i>
11		Moon's Origin, Impacts
13	Chap. 7	Terraforming Planet Earth
17 (Monday)		<i>Rocks and Minerals Lab</i>
18*		NO CLASS*
20		Oceans & Atmospheres
24 (Monday)		<i>Isotasy Lab</i>
25		Natural Climate Change
27		Geological Treasure Troves
31 (Monday Memorial Day)*		<b>HOLIDAY - NO CLASS*</b>
June 1	Chaps. 8 & 9	Origin & Evolution of Life
3		Future of Planet Earth
7 (Monday)		<b>FINAL EXAM (3 - 5 pm)</b>
	* Fernbank Assignment *	

# NEW COURSE PROPOSAL

## NEW COURSE PROPOSAL

Graduate: Level 1 \_\_\_\_\_ Level II \_\_\_\_\_ Undergraduate: Lower Division

SCHOOL, DEPARTMENT, COLLEGE  
EAS/COS

DATE \_\_\_\_\_

1. Course Number EAS 2601 Program Number	2. Hours: Lecture 3 Lab 3 Credit 4	3. Implementation Date Fall 1999 (Semester conversion)																				
4. Descriptive Title: How to Build and Maintain a Habitable Planet																						
5. Recommended Abbreviation for Transcript (24 characters including spaces):  H A B I T A B L E _ _ P L A N E T																						
6. Catalog Description (25 words or less): Introduction to the origin and evolution of Planet Earth, creation of the universe and the elements, early history of Earth, radioisotope geochemistry and the timing of events in the universe, the galaxy, and on Earth. Formation of the atmosphere and oceans. Climate.																						
7. Basis: L/G <input checked="" type="checkbox"/> P/F _____ Audit _____																						
8. Prerequisites: None  Corequisites: None																						
9. Has the course been taught as a special topic? Yes If YES, When? Spring '94, '95, '96 Enrollment: 12-24																						
10. Expected Mode of Presentation:	<table border="1"> <thead> <tr> <th>MODE</th> <th>% OF COURSE</th> </tr> </thead> <tbody> <tr> <td>Lecture</td> <td>75</td> </tr> <tr> <td>Laboratory - Supervised</td> <td>25</td> </tr> <tr> <td>Unsupervised</td> <td>_____</td> </tr> <tr> <td>Discussion</td> <td>_____</td> </tr> <tr> <td>Seminar</td> <td>_____</td> </tr> <tr> <td>Independent Study</td> <td>_____</td> </tr> <tr> <td>Library Work</td> <td>_____</td> </tr> <tr> <td>Demonstration</td> <td>_____</td> </tr> <tr> <td>Other (Specify)</td> <td>_____</td> </tr> </tbody> </table>	MODE	% OF COURSE	Lecture	75	Laboratory - Supervised	25	Unsupervised	_____	Discussion	_____	Seminar	_____	Independent Study	_____	Library Work	_____	Demonstration	_____	Other (Specify)	_____	
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Library Work	_____																					
Demonstration	_____																					
Other (Specify)	_____																					

	<u>Term to be Offered</u>	<u>Expected Enrollment</u>
11. Planned Frequency of Offering: Annual, perhaps twice per year depending on demand	Fall <u>X</u> Spring _____ Summer _____	<u>30-150</u> _____ _____
12. Are you requesting that this course satisfy: Humanities _____ Social Science _____  Will satisfy Tech's semester lab-based core curriculum requirement		
13. Probable instructor(s) (Please mark with an asterisk any non-tenure track individuals): P. N. Froelich		
14. Purpose of the course (Relation to Other Courses, Programs, and Curricula): Introduction to Earth System Science and Environmental Sciences; Required entry-level Core Course in EAS;		
15. Required <u>X</u> Elective <u>X</u>		
16. Full Justification of Requests (Please use additional sheet if necessary): This will provide the entry-level core course for EAS' new semester-based curriculum and will thus be required of all freshmen in the program. It will also satisfy the Tech core requirement for lab-based science core curriculum		
17. Please attach a topical outline of the course. Attached		

Registrar 1997

### How to Build and Maintain a Habitable Planet

#### Semester Conversion

**INSTRUCTOR:** Professor Philip Froelich, School of Earth & Atmospheric Sciences,  
Earth & Atmospheric Sciences Building (OCE - 221 Bobby Dodd Way)

**TEXT:** *How to Build a Habitable Planet* (W. S. Broecker).

**TIME and PLACE:** Lectures (Froelich)-----

Labs -----

**FIELD TRIP:** Stars and Telescopes: An optional outing to a dark hilltop on some clear night to view Mars, Saturn's rings, Jupiter's moons, our Moon's craters, the Andromeda Galaxy, a comet, and if we're lucky, a meteor shower. Date and time to be announced in class (1 day warning!).

**PROBLEM SETS:** Handed out every few weeks, each will be due about two weeks later. Each will be based on lectures and readings. You are expected to work

independently on each problem set.

EXAMS: Mid-Term Exam: -----

Final Exam: as scheduled:

The mid-term exam will cover the first half of the course. The final exam will cover the last half of the course.

TERM PAPERS: None

GRADES: 15% Problem Sets and Pop Quizzes; 25% Mid-Term Exam; 25% Final Exam; 10% Class Participation and Chapter Summaries; 25% Laboratory

### **How to Build and Maintain a Habitable Planet (EAS 2601)**

#### **(Semester Conversion)**

Introduction to the origin and evolution of our planet, creation of the universe and the elements and history of Earth. Radioisotope geochemistry and the timing of events in the universe, in our galaxy, and on Earth. Formation of the Earth's atmosphere and oceans. Climate. Evolution of Life

#### Week Lectures

Week 1 Cosmogenesis - the Big Bang, Creation of the Universe

Week 2 Nucleosynthesis in Stars, Creation of the Elements

Week 3 Condensation - Creation of Solar System - Meteorite Clues

Week 4 Radioisotope Clocks - Ages of Events in our Galaxy

Week 5 Radioisotope Clocks - Ages of Events on Earth

Week 6 Planetary Systems (Other Solar Systems)

Week 7 Segregation of Earth's Shells, Tectonics

Week 8 Satellite, Moons, Asteroids, Comets, Impact Craters & Rings

Week 9 Origin of Atmospheric Gases and Oceanic Water

Week 10 Ocean and Atmosphere Maintenance

Week 11 Geological Treasure Troves, Storing up Fossil Fuels & Fertilizers,

Week 12 Evolution of Life

Week 13 Evolution of Climate

Week 14 Maintenance of Life on Planet Earth

Week 15 Man's Impact

Week 16 Review & Final Exam

#### Week Laboratories

Week 1 Organization

Week 2 Math Reality Lab (review of algebra, trig., pre-calculus: the basic forms and usage of equations in the environmental sciences)

Week 3 Laws of Electromagnetic Radiation (emission and absorption; spectra; measure velocity and distance by triangulation and by red shift w/ sound)

Week 4 Laws of Nuclear Physics (stability) - demonstration lab - produces general shape of the valley of nuclear stability from first principles of nuclide packing fractions.

Week 5 Laws of Planetary Motion (Newtonian) - mass, density, velocity, spin, gravity, and angular momentum (derives the basic gravity and orbital equations from simple physics measurements in lab)

Week 5 Laws of Planetary Geochemistry (rocks & minerals, melts, crystals,

coordination chemistry; partial melting & fractional crystallization. Lab will produce and cool melts of known chemistry to produce rocks composed of unknown minerals that must be identified)

Week 6 Radiodecay Laws (detectors and decay rates, atom populations. Lab will measure decay rates of naturally-occurring radionuclides)

Week 7 Isotasy - Archimedes principle applied to crustal materials. Lab will produce data from which the isostatic equation must be derived.

Week 8 Laws of Energy Transfer I - Radiometer measurements of black bodies, incoming sunlight, outgoing infrared, clouds, etc. Measurements will provide framework to construct a conceptual thermal balance model for Earth.

Week 9 Laws of Energy Transfer II - Constructing a simple functional radiative balance computer model for Earth with a simple atmosphere (Stella). 2 X CO<sub>2</sub> climate simulation.

Week 10 Laws of Mass Transfer - Constructing a simple functional chemical mass balance computer model of continental weathering and mountain building with ocean-atmosphere-crust CO<sub>2</sub> and H<sub>2</sub>O feedbacks (Stella).

Week 11 Global Sustainability I - the environmental science of power generation - Demo lab in which the global environmental impacts of fossil fuel, fission, fusion and hydro/solar/wind/ocean thermal power generation are contrasted. Lab will utilize input data to simulate global effects from previous Stella models.

Week 12 Global Sustainability II - the environmental science of the global water balance. Lab will utilize input data to simulate global effects

of man's alteration of the global water balance.

Week 13 Laws of Evolution and Probability - mathematics of population homeostatis, exponential growth, resource limitation, natural vs. random selection, punctuated evolution, lineage trees. Computer lab will produce "data" to test the theory of evolution.

Week 14 Laboratory Final Exam

**b) Senior Level Course**

Dates Taught: Spring 1998

1) Title of course taught: (EAS 4411 and 8113): "Earth System Modeling"

2) Is this a new course or a modification of an existing course?

It is a complete revamping of the previous course taught by Dr. Hartley. Dr. Carolyn Ruppel has taken over this course after Dr. Dana Hartley's resignation and added modules with geophysical, geochemical, and atmospheric modeling components.

3) How has ESSE directly or indirectly impacted the timely offering and content of the course?

Being part of the program has given us the provisions for a TA, capability to purchase interactive media and modeling software, all of which greatly aided in the computer lab component of this course. Furthermore, we take advantage of formal seminar series in the department to invite interactions with students in the class. The students really got motivated hearing about the actual research in Earth System Modeling from the various guest lecturers. This course will become a semester long core course in the upcoming semester conversion (Fall 1999) and become the capstone (required senior-level class) course of our new earth system science curriculum.

4) Principal faculty involved in teaching the course.

Dr. Carolyn Ruppel

5) Name and major of TA.

Ryan Gesser, graduate student in Atmospheric Sciences  
Danielle Haas-Laursen, graduate student in Atmospheric Sciences

6) Enrollment Profile:

Spring 1998

Enrollment:	<u>11</u>
Class Year of Students:	
No. Freshmen:	<u>0</u>
No. Sophomores:	<u>0</u>
No. Juniors:	<u>2</u>
No. Seniors:	<u>8</u>
No. Graduate Students	<u>1</u>
Student Majors:	
No. Science Majors:	<u>11</u>
No. Non-Science Majors:	<u>0</u>
Most common majors:	<u>Earth &amp; Atmospheric Sciences</u> <u>1 in Physics</u>

II. Visitors Invited/Funded Under the ESSE Program

None this past year

III. Describe any interactions with NASA Affiliate:

Since Dr. Hartley's resignation, we have dropped the ball in involving ourselves. Our goal is to involve our affiliate with the Earth System Modeling course in the next year.

IV. What has been your principal role as PI of this project?

My (Froelich's) role has been limited to reconstructing the Habitable Planet course and planning and deploying these labs for the semester conversion. Hartley had served as the main interface with the ESSE group, a responsibility either I or Carolyn Ruppel will pick up if the project continues.

V. List course resource materials that you have developed for curricula in Earth System Science or that exist at your university that could be made available to the university community.

A text is in preparation for Habitable Planet, with a teaching and lab guide. The course material is currently formatted and displayed on the Tech web site, but will not be available off campus until next year. The earth system modeling course has produced computer modules that have the most potential to reach a larger community. We hope to acquire additional funding to complete that project. In addition, we are realizing that investments in computers and workstations for undergraduate education programs that are interactive and hands-on requires significant funds.

VI. Comments:

Due to Dr. Hartley's untimely resignation last year (for health reasons), many of the ESSE outreach activities that she orchestrated have not been continued. In addition, there is approximately \$16,780 in unexpended funds remains that we could dearly use to purchase new student computers and hire teaching and lab assistants. A no-cost extension is thus requested.

Syllabi attached

ESSE Course Descriptions

270.116 Environmental Earth Systems

An introduction to the processes which control Earth's global environment; reviews environmental change in geologic history, studies processes controlling change, and explores human influence on the global environment

270.310 Modeling Earth Systems

Development and analysis of mathematical models of Earth system processes, using simulation software and remote sensing data.

For junior and senior science and engineering majors; must be taken concurrently with 270.116.

270.116 Environmental Earth Systems

Spring Semester, 1994

George W. Fisher  
Earth and Planetary Sciences  
327 Olin Hall  
516-7237

<u>Date</u>	<u>Topic</u>
Jan 27, 28	Introduction, outline of earth systems
Feb 3, 4	History of Earth, plate tectonics
Feb 10, 11	Plate tectonics, geochemical cycle
Feb 17, 18	Atmospheric dynamics
Feb 24, 25	Weathering, soils
Mar 3, 4	Water chemistry (EXAM)
Mar 10, 11	Terrestrial biosphere
Mar 17, 18	Rivers and wetlands
Mar 24, 25	Spring Break
Mar 31, Apr 1	Estuaries and oceans
Apr 7, 8	El Nino (EXAM)
Apr 14, 15	Carbon cycle
Apr 21, 22	Nitrogen cycle
Apr 28, 29	Managing Earth
May 6, 2 PM	(FINAL EXAM)

There is no book for this course; periodic readings from the literature will be assigned.

Grades are based on two in-class exams (each 30% of the grade), and the final (40% of the grade).