Department of Earth System Science

3200 Croul Hall; (949) 824-8794
http://www.ess.uci.edu/
Michael L. Goulden, Chair

Understanding global environmental issues such as global warming, stratospheric ozone depletion, and worldwide air pollution requires the cooperation of scientists across many fields. Global change is projected to accelerate through the twenty-first century and will impact the ecosystems that preserve the habitability of the planet. The Department of Earth System Science focuses on the atmosphere, land, and oceans, how these interact as a system, and how the Earth will change over a human lifetime. Earth System Science (ESS) is inherently interdisciplinary in scope, linking oceanography, atmospheric and terrestrial sciences, climatology, hydrology, biology, physics, and chemistry to understand the environment. ESS faculty includes chemists, biologists, ecologists, physicists, hydrologists, geologists, meteorologists, engineers, applied mathematicians, and oceanographers. The wide-ranging expertise of ESS faculty and teaching assistants allows students to learn valuable scientific skills in the classroom, laboratory, and field experiences.

Degrees. The Department offers the B.S., M.S.*, and Ph.D. degrees in Earth System Science, and the B.A. degree in Environmental Science. (*The M.S. is awarded only to students admitted to the Ph.D. program.)

Undergraduate Programs

Bachelor of Science Major in Earth System Science

http://ess.uci.edu/undergrad/bs

Earth System Science is an interdisciplinary field of study that combines oceanography, atmospheric science, meteorology, geography, geology, hydrology, and environmental science. ESS students gain an understanding of how individual aspects of the environment interact, including the influence of humans on this complex system.

Examples of important questions in Earth System Science include, but are not limited to, the influence of atmospheric chemistry on climate and air quality, biological controls on the chemistry of the oceans, and physical controls on atmosphere and ocean circulation.

The Earth System Science (B.S.) program provides students with a fundamental understanding of the oceanographic, atmospheric, and terrestrial sciences. This program of study prepares students for careers in science, research, or technical fields. Students learn to apply basic sciences (physics, chemistry, mathematics, and biology) to understand the major processes and systems governing the Earth’s climate, biogeochemical cycles, and global change. Central to the B.S. program is an understanding of relevant scientific literature, methods to collect/analyze data, and interpret results in the context of scientific theory. Students will learn to work collaboratively to understand and address complex problems and communicate scientific knowledge.

Through the core course work, students will learn to explain the current and projected future state of the Earth system in the context of past climate change and current human activities. Once the core course work is complete, students are encouraged to focus on a particular area within Earth System Science and to choose electives that build a coherent core of knowledge. Focus areas include but are not limited to climatology, biogeochemical cycles, oceanography, hydrology, terrestrial sciences, and atmospheric sciences. Optional specializations are available in Atmospheric Science, Hydrology and Terrestrial Ecosystems, and Oceanography.

Earth System Science students are encouraged to become directly involved in research. The Department provides excellent opportunities to learn from and work with recognized experts in the field, while fulfilling degree requirements. EARTHSS 198 may satisfy Department and UCI upper-division writing requirements.

Careers for the Earth System Science Major

Some students go on to graduate school in physical sciences, engineering, or related areas. Others begin careers as research scientists in academic, public, or private institutions (may require a graduate-level degree). Options that may be available are scientist positions in the following roles: environmental policy and planning, environmental consulting, air quality monitoring and assessment, laboratory analysis, scientific research, science education, natural resource management, wildlife management, conservation and environmental protection, and water resource management.

Special Programs

Earth System Science Honors Program. In the year-long honors course sequence, students admitted into the ESS Honors Program pursue research with faculty in the Department, and prepare a written thesis of their work. See http://ess.uci.edu/undergrad/honors for more information.

Teaching Certification. Earth System Science students interested in teaching careers can earn a bachelor’s degree concurrently with a California Preliminary Single Subject Teaching Credential. See the Concentration in Geosciences Education with Secondary Teaching Certification section below for more information.

Admission to the Earth System Science Major

Students may be admitted to the Earth System Science major upon entering the University as freshmen, via change of major, and as transfer students from other colleges and universities. Information about change of major policies is available in the Physical Sciences Student Affairs Office and at http://www.changeofmajor.uci.edu. For transfer student admission, preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed the following required courses: one year of approved calculus and one year of either general chemistry with laboratory (preferred) or one-year of calculus-based physics with laboratory.

NOTE: The major is open to all students except Environmental Science majors and Earth and Atmospheric Sciences minors.
Requirements for the B.S. Degree in Earth System Science

All students must meet the University Requirements (catalogue.uci.edu/previouseditions/2013-14/informationforadmittedstudents/requirementsforabachelorsdegree).

School Requirements: None.

Major Requirements

A. Complete:
EARTHSS 1 Introduction to Earth System Science
or EARTHSS 3 Oceanography
or EARTHSS 5 The Atmosphere
EARTHSS 51 Land Interactions
EARTHSS 53 Ocean Biogeochemistry
EARTHSS 55 Earth’s Atmosphere
EARTHSS 114 Earth System Science Laboratory and Field Methods
EARTHSS 116 Data Analysis for Earth Sciences
EARTHSS 191 Title Introduction to Research in Earth System Science
EARTHSS 192 Careers in Earth System Science
MATH 2A- 2B Single-Variable Calculus and Single-Variable Calculus
or MATH 3A Introduction to Linear Algebra

Select one of the following sequences and accompanying labs:
CHEM 1A- 1B- 1C General Chemistry and General Chemistry and General Chemistry
CHEM 1LC- 1LD General Chemistry Laboratory and General Chemistry Laboratory

or
CHEM H2A- H2B- H2C Honors General Chemistry and Honors General Chemistry and Honors General Chemistry
CHEM H2LA- H2LB- H2LC Honors General Chemistry Laboratory and Honors General Chemistry Laboratory and Honors General Chemistry Laboratory

Select one of the following sequences and accompanying labs:
PHYSICS 3A- 3B- 3C Basic Physics and Basic Physics and Basic Physics
PHYSICS 3LB- 3LC Basic Physics Laboratory and Basic Physics Laboratory

or
PHYSICS 7C- 7E Classical Physics and Classical Physics
PHYSICS 7LC Classical Physics Laboratory

B. Select seven electives from the following (at least four must be Earth System Science courses):

All 4-unit upper-division EARTHSS courses except 114, 116, 190C, and 198 or H198 (199 or one quarter of H199A-B-C may count only once toward the elective requirement)
CHEM 51A Organic Chemistry
CHEM 51B- 51LB Organic Chemistry and Organic Chemistry Laboratory
CHEM 51C- 51LC Organic Chemistry and Organic Chemistry Laboratory
CHEM H52A- H52LA Honors Organic Chemistry and Honors Organic Chemistry Laboratory
CHEM H52B- H52LB Honors Organic Chemistry and Honors Organic Chemistry Laboratory
CHEM 130A Chemical Thermodynamics
CHEM 130B Quantum Chemistry, Spectroscopy and Bonding
CHEM 130C Structure, Statistical Mechanics, and Chemical Dynamics
CHEM 131A Quantum Principles
CHEM 131B Molecular Structure and Elementary Statistical Mechanics
CHEM 131C Thermodynamics and Chemical Dynamics
PHYSICS 51A Modern Physics
PHYSICS 51B Modern Physics
PHYSICS 115A Statistical Physics
PHYSICS 120 Electronics for Scientists
PHYSICS 134A Physical and Geometrical Optics
PHYSICS 137 Introduction to Cosmology
PHYSICS 144 Stellar Astrophysics
PHYSICS 145 High-Energy Astrophysics
MATH 2D Multivariable Calculus (may be counted only once; or MATH 3A, may be counted only once)
MATH 3D Elementary Differential Equations
MATH 105A Numerical Analysis
MATH 112A Introduction to Partial Differential Equations and Applications
MATH 115 Mathematical Modeling
MATH 131A Introduction to Probability and Statistics
MATH 131B Introduction to Probability and Statistics
MATH 131C Introduction to Probability and Statistics
ENGRMAE 60 Electric Circuits
ENGRMAE 91 Introduction to Thermodynamics
ENGRMAE 130A Introduction to Fluid Mechanics
ENGRMAE 164 Air Pollution and Control
ENGRMAE 185 Numerical Analysis in Mechanical Engineering
ENGRCEE 156 Foundation Design
ENGRCEE 162  Introduction to Environmental Chemistry
ENGRCEE 171  Water Resources Engineering
ENGRCEE 172  Groundwater Hydrology
ENGRCEE 176  Hydrology
ENGRCEE 178  Fluid Mechanics of Open Channels
BIO SCI 93  From DNA to Organisms
BIO SCI 94  From Organisms to Ecosystems
BIO SCI 96  Biochemistry
BIO SCI D105  Cell, Developmental, and Molecular Biology of Plants
BIO SCI E106  Processes in Ecology and Evolution
BIO SCI E178  Ocean Ecology
BIO SCI E179  Limnology and Freshwater Biology
BIO SCI E179L  Field Freshwater Ecology
BIO SCI E186  Population and Community Ecology
BIO SCI E189  Environmental Ethics
BIO SCI M133  High-Resolution Structures: NMR and X-ray
CRM/LAW C148  Geographic Information Systems
PP&D 136  Global Environmental Issues
PP&D 139  Water Resource Policy
PUBLTH 161  Environmental Geology

Computing Skills (one of the following may be counted toward degree):
I&C SCI 31, EECS 10, ENGRMAE 10, PHYSICS 53, or an approved programming course.

Optional Specializations

Three optional specializations are available: Atmospheric Science, Hydrology and Terrestrial Ecosystems, and Oceanography. The specializations require the completion of at least five courses from the following lists (four science courses plus one advanced tools course).

Specialization in Atmospheric Science

Requirements

Four courses selected from the following:
EARTHSS 101  Paleoclimatology
EARTHSS 112  Global Climate Change and Impacts
EARTHSS 122  Atmospheric Dynamics
EARTHSS 124  Weather Analysis
EARTHSS 142  Atmospheric Chemistry
EARTHSS 199  Undergraduate Research (one 4-unit course focused on atmospheric research selected from EARTHSS 199, 198, H198, H199A-H199B-H199C)

One advanced tools course selected from the following:
EARTHSS 118  Advanced Data Analysis and Modeling
EARTHSS 134  Fundamentals of GIS for Environmental Sciences
EARTHSS 138  Satellite Remote Sensing for Earth System Science
EARTHSS 150  Laboratory Methods in Earth Systems Science
(These courses may overlap in Major Requirements, Section B.)

Specialization in Oceanography

Requirements

Four courses selected from the following:
EARTHSS 101  Paleoclimatology
EARTHSS 112  Global Climate Change and Impacts
EARTHSS 130  Physical Oceanography
EARTHSS 144  Marine Geochemistry and Biogeochemistry
EARTHSS 170  Environmental Microbiology
EARTHSS 199  Undergraduate Research (one 4-unit course focused on oceanographic research selected from EARTHSS 199, 198, H198, H199A-H199B-H199C)

One advanced tools course selected from the following:
EARTHSS 118  Advanced Data Analysis and Modeling
EARTHSS 138  Satellite Remote Sensing for Earth System Science
EARTHSS 150  Laboratory Methods in Earth Systems Science
(These courses may overlap in Major Requirements, Section B.)

Sample Program — Earth System Science

Freshman

Fall
MATH 2A
CHEM 1A
EARTHSS 1
Gen. Ed./Elective

Winter
MATH 2B
CHEM 1B
Gen. Ed./Elective
Gen. Ed./Elective

Spring
MATH 2D or 3A
CHEM 1C-1LC
Gen. Ed./Elective
Gen. Ed./Elective

Sophomore

Fall
EARTHSS 51
PHYSICS 3A

Winter
EARTHSS 53
PHYSICS 3B-3LB

Spring
EARTHSS 55
PHYSICS 3C-3LC
Some students (particularly transfer students) take EARTHSS 51, EARTHSS 53, and EARTHSS 55 in the junior year.

### Concentration in Geosciences Education with Secondary Teaching Certification

This concentration allows students pursuing the B.S. in Earth System Science to earn a bachelor's degree and complete the required coursework and field experience for a California Preliminary Single Subject Teaching Credential at the same time. In addition to the requirements listed above, students must complete the following courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY SCI 5</td>
<td>California Teach 1: Introduction to Science and Mathematics Teaching</td>
</tr>
<tr>
<td>PHY SCI 105</td>
<td>California Teach 2: Middle School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>CHEM 193</td>
<td>Research Methods</td>
</tr>
<tr>
<td>or PHYSICS 193</td>
<td>Research Methods</td>
</tr>
<tr>
<td>LPS 60</td>
<td>The Making of Modern Science</td>
</tr>
<tr>
<td>EDUC 55</td>
<td>Knowing and Learning in Mathematics and Science</td>
</tr>
<tr>
<td>EDUC 109</td>
<td>Reading and Writing in Secondary Mathematics and Science Classrooms</td>
</tr>
<tr>
<td>EDUC 143AW</td>
<td>Classroom Interactions I</td>
</tr>
<tr>
<td>EDUC 143BW</td>
<td>Classroom Interactions II</td>
</tr>
<tr>
<td>EDUC 148</td>
<td>Complex Pedagogical Design</td>
</tr>
<tr>
<td>EDUC 158</td>
<td>Student Teaching Mathematics and Science in Middle/High School (two quarters)</td>
</tr>
</tbody>
</table>

With careful, early planning, it is possible for students to complete the bachelor’s degree and the secondary teaching certification in four years.

For additional information about teacher certification requirements and enrollment procedures, see http://gse.uc.edu/calteacher. Interested students are strongly encouraged to contact the Cal Teach Resource and Advising Center or the Physical Sciences Student Affairs Office.

### Sample Program – Concentration in Geosciences Education with Secondary Teaching Certification

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 2A</td>
<td>MATH 2B</td>
<td>MATH 2D or 3A</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C-1LC</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Sophomore</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>EARTHSS 51</td>
<td>EARTHSS 53</td>
<td>EARTHSS 55</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 3A</td>
<td>PHYSICS 3B-3LB</td>
<td>PHYSICS 3C-3LC</td>
<td></td>
</tr>
<tr>
<td>CHEM 1LD</td>
<td>CHEM 193</td>
<td>LPS 60</td>
<td></td>
</tr>
<tr>
<td>PHY SCI 105</td>
<td></td>
<td>Gen. Ed.</td>
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</table>

<table>
<thead>
<tr>
<th>Senior</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHSS 116</td>
<td>EARTHSS 114</td>
<td>EARTHSS 114</td>
<td></td>
</tr>
<tr>
<td>EARTHSS 191</td>
<td>Approved Elective</td>
<td>ESS Elective</td>
<td></td>
</tr>
<tr>
<td>EDUC 55</td>
<td>EDUC 143AW</td>
<td>EDUC 148</td>
<td></td>
</tr>
<tr>
<td>Gen. Ed.</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| EARTHSS 192 | Approved Elective |

### Bachelor of Arts Major in Environmental Science

http://ess.uci.edu/undergrad/ba

The Gulf Oil Spill. Global Climate Change. Drought and Water Supply. Each of these topics illustrates the continuing need for environmental professionals with training in the natural sciences, social sciences, economics, and public policy. The Environmental Science B.A. degree program prepares students interested in environmental problem solving by linking an understanding of natural science with socioeconomic factors and public policy. The curriculum combines a quantitative understanding of environmental science, chemistry, and biology with studies of social science, policy, and micro- and macroeconomics to provide a foundation for careers in environmental policy, resource management, education, environmental law, and related fields.

The Environmental Science program provides students with a solid foundation to recognize the impacts of human activities on the environment, and in turn the impacts of environmental change on society. Students will understand the mechanisms by which key institutions, policies, and regulations impact ecosystems and the physical environment. Once the core course work is complete, students are encouraged to focus on a particular area within Environmental Science and to choose electives that build a coherent core of knowledge. Focus areas include, but are not limited to planning, policy and design, sociology, economics, climatology, water resources, water quality, air pollution, resource management, and atmospheric sciences.

### Careers for the Environmental Science Major

Some students may find career opportunities in roles such as policy advisor, data analyst (may require a graduate-level degree), scientific journalist, or technical writer. Other options that may be available are scientist positions in the following roles: environmental policy and planning, environmental consulting, air quality monitoring and assessment, natural resource management, wildlife management, conservation and environmental protection.

### Special Programs

**Environmental Science Honors Program.** In the year-long honors course sequence, Environmental Science students admitted into the ESS Honors Program pursue research with faculty in the Department, and
prepare a written thesis of their work. See http://ess.uci.edu/undergrad/ honors for more information.

**Teaching Certification.** Environmental Science students interested in teaching careers can earn a bachelor’s degree concurrently with a California Preliminary Single Subject Teaching Credential. See the Concentration in Geosciences Education with Secondary Teaching Certification section below for more information.

**Admission to the Environmental Science Major**

Students may be admitted to the Environmental Science major upon entering the University as freshmen, via change of major, and as transfer students from other colleges and universities. Information about change of major policies is available in the Physical Sciences Student Affairs Office and at http://www.changeofmajor.uci.edu. For transfer student admission, preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed one year of either general chemistry with laboratory (preferred) or one year of biology with laboratory. One year of economics or sociology is recommended.

**NOTE:** The major is open to all students except Earth System Science B.S. majors and Earth and Atmospheric Sciences minors.

**Requirements for the B.A. Degree in Environmental Science**

All students must meet the University Requirements (catalogue.uci.edu/previouseditions/2013-14/informationforadmittedstudents/requirementsforabachelorsdegree).

School Requirements: None.

**Major Requirements**

**A. Select one of the following:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHSS 1</td>
<td>Introduction to Earth System Science</td>
</tr>
<tr>
<td>EARTHSS 3</td>
<td>Oceanography</td>
</tr>
<tr>
<td>EARTHSS 5</td>
<td>The Atmosphere</td>
</tr>
<tr>
<td>EARTHSS 7</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>EARTHSS 11</td>
<td>Climate Change and Policy</td>
</tr>
<tr>
<td>EARTHSS 13</td>
<td>Global-Change Biology</td>
</tr>
<tr>
<td>EARTHSS 15</td>
<td>Introduction to Global Climate Change</td>
</tr>
<tr>
<td>EARTHSS 17</td>
<td>Hurricanes, Tsunamis, and other Catastrophes</td>
</tr>
<tr>
<td>EARTHSS 21</td>
<td>On Thin Ice: Climate Change and the Cryosphere</td>
</tr>
<tr>
<td>EARTHSS 23</td>
<td>Air Pollution: From Urban Smog to Global Change</td>
</tr>
</tbody>
</table>

**Complete:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHSS 60A- 60B- 60C</td>
<td>Fundamental Processes in Earth and Environmental Studies and Local and Regional Environmental Issues and Global Environmental Issues</td>
</tr>
<tr>
<td>EARTHSS 114</td>
<td>Earth System Science Laboratory and Field Methods</td>
</tr>
<tr>
<td>EARTHSS 180</td>
<td>Environmental Sustainability I</td>
</tr>
<tr>
<td>EARTHSS 182</td>
<td>Environmental Sustainability II</td>
</tr>
<tr>
<td>EARTHSS 192</td>
<td>Careers in Earth System Science</td>
</tr>
</tbody>
</table>

**B. Select one of the following sequences and accompanying labs:**

- **CHEM 1A- 1B- 1C** General Chemistry and General Chemistry
- **CHEM 1LC- 1LD** General Chemistry Laboratory and General Chemistry Laboratory
- **CHEM H2A- H2B- H2C** Honors General Chemistry and Honors General Chemistry
- **CHEM H2LA- H2LB- H2LC** Honors General Chemistry Laboratory and Honors General Chemistry Laboratory

**Complete:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIO SCI 93</td>
<td>From DNA to Organisms</td>
</tr>
<tr>
<td>BIO SCI 94</td>
<td>From Organisms to Ecosystems</td>
</tr>
</tbody>
</table>

**C. Select three courses from the following:**

- **MATH 2A- 2B** Single-Variable Calculus and Single-Variable Calculus
- **MATH 4** Mathematics for Economists
- **STATS 7** Basic Statistics
- **SOC SCI 10A- 10B- 10C** Probability and Statistics in Social Sciences I and Probability & Statistics in Social Sciences II and Probability & Statistics in Social Sciences III
- **ECON 15A- 15B** Probability and Statistics in Economics I and Probability and Statistics in Economics II
- **EARTHSS 19** Introduction to Modeling the Earth System
- **EARTHSS 116** Data Analysis for Earth Sciences
- **EARTHSS 134** Fundamentals of GIS for Environmental Sciences

**D. Select four courses from the following:**

- **SOCIOL 1** Introduction to Sociology
- **SOCIOL 2** Global and International Sociology
- **SOCIOL 3** Introduction to Social Problems
- **ECON 13** Global Economy
- **ECON 20A- 20B** Basic Economics I and Basic Economics II
- **PP&D 4** Introduction to Urban Studies
- **PP&D 134** Human Ecology
- **PP&D 139** Water Resource Policy
- **PP&D 140** Ethics and International Relations
- **PP&D 151** Environmental Psychology
E. Select two electives each from the following three categories:
1. Select any upper-division, 4-unit course in EARTHSS (199/H199 may count only once; the combination of 190A and 190B may be used as one elective requirement); courses may not be used as electives if counted toward degree requirements.

2. CHEM 51A Organic Chemistry
   CHEM 51B- 51LB Organic Chemistry and Organic Chemistry Laboratory
   CHEM 51C- 51LC Organic Chemistry and Organic Chemistry Laboratory
   CHEM H52A- H52LA Honors Organic Chemistry and Honors Organic Chemistry Laboratory
   CHEM H52B- H52LB Honors Organic Chemistry and Honors Organic Chemistry Laboratory
   CHEM H52C Honors Organic Chemistry
   BIO SCI 20 California Natural History
   BIO SCI 55 Introduction to Ecology
   BIO SCI 65 Biodiversity & Conservation
   BIO SCI 97 Genetics
   BIO SCI 98 Biochemistry
   BIO SCI 99 Molecular Biology
   BIO SCI E106 Processes in Ecology and Evolution
   BIO SCI E138 Comparative Animal Physiology
   BIO SCI E140 Evolution and the Environment
   BIO SCI E150 Conservation Biology
   BIO SCI E151 Population Dynamics in Ecology, Epidemiology, and Medicine
   BIO SCI E160 Biology of Birds
   BIO SCI E161L Biology of Birds Lab
   BIO SCI E166W Field Methods in Ecology
   BIO SCI E172 Plant Diversity in a Changing World
   BIO SCI E174 Behavioral Ecology
   BIO SCI E175 Restoration Ecology
   BIO SCI E176 Evolution of Infectious Disease
   BIO SCI E178 Ocean Ecology
   BIO SCI E179 Limnology and Freshwater Biology
   BIO SCI E179L Field Freshwater Ecology
   BIO SCI E181 Conservation in the American West
   BIO SCI E182 Mediterranean Ecosystems: Biodiversity and Conservation
   BIO SCI E184 Ecology and Diversity of Insects
   BIO SCI E186 Population and Community Ecology
   BIO SCI E189 Environmental Ethics
   PHYSICS 3A Basic Physics
   PHYSICS 3B Basic Physics
   PHYSICS 3C Basic Physics

PHYSICS 7C Classical Physics
PHYSICS 14 Physics of Energy and the Environment
PHYSICS 20A Introduction to Astronomy
PHYSICS 20B Cosmology: Man's Place in the Universe
PHYSICS 20C Observational Astronomy
PHYSICS 20D Space Science

3. ECON 100A- 100B- 100C Intermediate Economics I and Intermediate Economic II and Intermediate Economic III
   ECON 142A- 142B- 142CW Industrial Organization I and Industrial Organization II and Industrial Organization III
   ECON 144A- 144B- 144CW Urban Economics I and Urban Economics II and Urban Economics III
   ECON 145E Economics of the Environment
   ECON 145L Economics of Law
   SOCIOL 31 Introduction to Social Psychology
   SOCIOL 43 Urban Sociology
   SOCIOL 44 Populations
   SOCIOL 110 Research Methods
   SOCIOL 141 Organizations
   SOCIOL 147A Cities and Social Change
   SOCIOL 171 Environmental Sociology

Other courses may be substituted for approved electives by petition.

Sample Program – Environmental Science

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>EARTHSS 1</td>
<td>MATH 2A</td>
<td>STATS 7</td>
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<td></td>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C- 1LC</td>
</tr>
<tr>
<td>Sophomore</td>
<td>EARTHSS 60A</td>
<td>EARTHSS 60B</td>
<td>EARTHSS 60C</td>
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<td></td>
<td>CHEM 1LD</td>
<td>Gen. Ed./Elective</td>
<td>Gen. Ed./Elective</td>
</tr>
<tr>
<td>Junior</td>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>EARTHSS 114</td>
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<td></td>
<td>Approved Elective</td>
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<td>EARTHSS 182</td>
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<tr>
<td>Senior</td>
<td>ESS Elective</td>
<td>ESS Elective</td>
<td>Approved Elective</td>
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<tr>
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<td>EARTHSS 192</td>
<td>Approved Elective</td>
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Concentration in Geosciences Education with Secondary Teaching Certification

This concentration allows students pursuing the B.A. in Environmental Science to earn a bachelor's degree and complete the required course
work and field experience for a California Preliminary Single Subject Teaching Credential at the same time. With careful, early planning, it is possible for students to complete the bachelor’s degree and the secondary teaching certification in four years.

For additional information about teacher certification requirements and enrollment procedures, see http://gse.uci.edu/calteach. Interested students are strongly encouraged to contact the Cal Teach Resource and Advising Center or the Physical Sciences Student Affairs Office.

Departmental Requirements

A. Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHSS 1</td>
<td>Introduction to Earth System Science</td>
</tr>
<tr>
<td>EARTHSS 3</td>
<td>Oceanography</td>
</tr>
<tr>
<td>EARTHSS 5</td>
<td>The Atmosphere</td>
</tr>
<tr>
<td>EARTHSS 7</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>EARTHSS 11</td>
<td>Climate Change and Policy</td>
</tr>
<tr>
<td>EARTHSS 13</td>
<td>Global-Change Biology</td>
</tr>
<tr>
<td>EARTHSS 15</td>
<td>Introduction to Global Climate Change</td>
</tr>
<tr>
<td>EARTHSS 17</td>
<td>Hurricanes, Tsunamis, and other Catastrophes</td>
</tr>
<tr>
<td>EARTHSS 21</td>
<td>On Thin Ice: Climate Change and the Cryosphere</td>
</tr>
<tr>
<td>EARTHSS 23</td>
<td>Air Pollution: From Urban Smog to Global Change</td>
</tr>
</tbody>
</table>

Complete:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHSS 60A- 60B- 60C</td>
<td>Fundamental Processes in Earth and Environmental Studies and Local and Regional Environmental Issues and Global Environmental Issues</td>
</tr>
<tr>
<td>EARTHSS 114</td>
<td>Earth System Science Laboratory and Field Methods</td>
</tr>
<tr>
<td>EARTHSS 180</td>
<td>Environmental Sustainability I</td>
</tr>
<tr>
<td>EARTHSS 182</td>
<td>Environmental Sustainability II</td>
</tr>
<tr>
<td>EARTHSS 192</td>
<td>Careers in Earth System Science</td>
</tr>
</tbody>
</table>

B. Select one of the following sequences and accompanying labs:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A- 1B- 1C</td>
<td>General Chemistry and General Chemistry</td>
</tr>
<tr>
<td>CHEM 1LC- 1LD</td>
<td>General Chemistry Laboratory and General Chemistry Laboratory</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM H2A- H2B- H2C</td>
<td>Honors General Chemistry and Honors General Chemistry</td>
</tr>
<tr>
<td>CHEM H2LA- H2LB- H2LC</td>
<td>Honors General Chemistry Laboratory and Honors General Chemistry Laboratory</td>
</tr>
</tbody>
</table>

Complete:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 93</td>
<td>From DNA to Organisms</td>
</tr>
<tr>
<td>BIO SCI 94</td>
<td>From Organisms to Ecosystems</td>
</tr>
</tbody>
</table>

C. Select three courses from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 2A- 2B</td>
<td>Single-Variable Calculus and Single-Variable Calculus</td>
</tr>
<tr>
<td>MATH 4</td>
<td>Mathematics for Economists</td>
</tr>
<tr>
<td>STATS 7</td>
<td>Basic Statistics</td>
</tr>
<tr>
<td>EARTHSS 19</td>
<td>Introduction to Modeling the Earth System</td>
</tr>
<tr>
<td>EARTHSS 116</td>
<td>Data Analysis for Earth Sciences</td>
</tr>
<tr>
<td>EARTHSS 134</td>
<td>Fundamentals of GIS for Environmental Sciences</td>
</tr>
</tbody>
</table>

D. Select two courses from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOCIOL 1</td>
<td>Introduction to Sociology</td>
</tr>
<tr>
<td>SOCIOL 2</td>
<td>Global and International Sociology</td>
</tr>
<tr>
<td>SOCIOL 3</td>
<td>Introduction to Social Problems</td>
</tr>
<tr>
<td>ECON 13</td>
<td>Global Economy</td>
</tr>
<tr>
<td>ECON 20A- 20B</td>
<td>Basic Economics I and Basic Economics II</td>
</tr>
<tr>
<td>PP&amp;D 4</td>
<td>Introduction to Urban Studies</td>
</tr>
<tr>
<td>PP&amp;D 134</td>
<td>Human Ecology</td>
</tr>
<tr>
<td>PP&amp;D 139</td>
<td>Water Resource Policy</td>
</tr>
<tr>
<td>PP&amp;D 140</td>
<td>Ethics and International Relations</td>
</tr>
<tr>
<td>PP&amp;D 151</td>
<td>Environmental Psychology</td>
</tr>
<tr>
<td>BIO SCI E189</td>
<td>Environmental Ethics</td>
</tr>
<tr>
<td>EARTHSS 110</td>
<td>Environmental Controversies</td>
</tr>
<tr>
<td>EARTHSS 178</td>
<td>Solving the Energy-Carbon-Climate Problem</td>
</tr>
<tr>
<td>LPS 60</td>
<td>The Making of Modern Science</td>
</tr>
</tbody>
</table>

E. Select two electives each from the following three categories:

1. Any upper-division, 4-unit course in EARTHSS or 190A-B (199/H199 may count only once; the combination of 190A and 190B may be used as one elective requirement); courses may not be used as electives if counted toward degree requirements.

2.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 51A</td>
<td>Organic Chemistry</td>
</tr>
<tr>
<td>CHEM 51B- 51LB</td>
<td>Organic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 51C- 51LC</td>
<td>Organic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM H52A- H52LA</td>
<td>Honors Organic Chemistry Laboratory</td>
</tr>
</tbody>
</table>
3. ECON 100A- 100B- 100C Intermediate Economics I and Intermediate Economic II and Intermediate Economic III

ECON 142A- 142B- 142CW Industrial Organization I and Industrial Organization II and Industrial Organization III

ECON 144A- 144B- 144CW Urban Economics I and Urban Economics II and Urban Economics III

ECON 145E Economics of the Environment

ECON 145L Economics of Law

SOCIOL 31 Introduction to Social Psychology
SOCIOL 43 Urban Sociology
SOCIOL 44 Populations
SOCIOL 110 Research Methods
SOCIOL 141 Organizations
SOCIOL 147A Cities and Social Change
SOCIOL 171 Environmental Sociology

F. Complete:

PHY SCI 5- 105 California Teach 1: Introduction to Science and Mathematics Teaching and California Teach 2: Middle School Science and Mathematics Teaching
CHEM/PHYSICS 193 Research Methods
LPS 60 The Making of Modern Science
EDUC 55 Knowing and Learning in Mathematics and Science
EDUC 109 Reading and Writing in Secondary Mathematics and Science Classrooms
EDUC 143AW Classroom Interactions I
EDUC 143BW Classroom Interactions II
EDUC 148 Complex Pedagogical Design
EDUC 158 Student Teaching Mathematics and Science in Middle/High School (two quarters)

Sample Program — Concentration in Geosciences Education with Secondary Teaching Certification

Freshman
Fall
EARTHSS 1 MATH 2A
CHEM 1A CHEM 1B
PHY SCI 5 Gen. Ed.
Gen. Ed.
Winter
EARTHSS 114
EDUC 55
EDUC 143AW
EDUC 148
Spring
EARTHSS 116
EARTHSS 180
EARTHSS 182
Approved Elective
Approved Elective
Approved Elective

Sophomore
Fall
EARTHSS 60A EARTHSS 60B
PHY SCI 105 CHEM 193 or PHYSICS 193
SOCIOIL 1 LPS 60
Gen. Ed.
Gen. Ed.
Approved Elective
Winter
EARTHSS 116
EARTHSS 180
EARTHSS 182
Approved Elective
Approved Elective
Approved Elective
Spring
EARTHSS 192
Approved Elective
Approved Elective
Approved Elective

Junior
Fall
BIO SCI 93 BIO SCI 94
EDUC 55 EDUC 143AW
EARTHSS 116 EARTHSS 180
Approved Elective approved Elective
Approved Elective
Winter
Approved Elective
Approved Elective
Approved Elective
Spring
Approved Elective
Approved Elective
Approved Elective

Senior
Fall
Approved Elective
Approved Elective
Approved Elective
EDUC 109
EDUC 158
EDUC 158
Approved Elective
Approved Elective
Approved Elective
Winter
Gen. Ed.
Gen. Ed.
Gen. Ed.

Honors Program in Earth System Science

The Department of Earth System Science awards honors to students who have completed a customized year-long research program in
their senior year. ESS honors students engage in advanced research, alongside faculty, research staff, and graduate students within well-equipped laboratories in Earth System Science. The program involves both conducting original research and communicating scientific findings.

The Honors Program in Earth System Science provides an opportunity for selected students majoring in Earth System Science or Environmental Sciences to pursue research with faculty in the Department during their senior year. Admission to the program is based on an application normally submitted by the sixth week of the spring quarter during the junior year.

To be considered for Departmental Honors, a student must have satisfied the following requirements:

1. Completion of all mathematics, chemistry, and physics requirements for the major;
2. Completion of EARTHSS 51- EARTHSS 53- EARTHSS 55 or EARTHSS 60A- EARTHSS 60B- EARTHSS 60C.
3. Achievement of an overall GPA at UCI of at least 3.3; and

Students must also demonstrate potential for carrying out research of honors quality, as judged by the Earth System Science faculty member who will supervise their research. Application materials are available at http://ess.uci.edu/undergrad/honors.

Once admitted to the program, students will enroll in:

- EARTHSS H199A- H199B- H199C Honors Research in Earth System Science
- EARTHSS H199A- H199B- H199C Honors Research in Earth System Science
- EARTHSS H198 Honors Thesis in Earth System Science

In the Honors Research series, students will commit 10–15 hours a week to conduct research with an ESS faculty. At the end of each quarter, a written report is required.

In the Honors Thesis course, students will prepare and submit a seminar, poster, and written thesis describing their research. The thesis will be written in the style of a scientific manuscript, with separate abstract, introduction, methods, results and discussion sections. If the thesis is deemed honors quality by the ESS faculty and the student’s final accumulative GPA is above 3.3, the student will graduate with Departmental Honors.

**Minor in Earth and Atmospheric Sciences**

The science of the Earth as a system has implications for many fields of study. Students interested in understanding how the Earth's systems work can complete the requirements for a minor in Earth and Atmospheric Sciences. The program is primarily designed for students in the natural sciences and engineering who wish to explore interdisciplinary problems and broaden their studies to include the application of their fields to understanding the Earth system.

**Requirements for the Minor**

Select one of the following series:

- **EARTHSS 51- 53- 55** Land Interactions and Ocean Biogeochemistry and Earth’s Atmosphere

  or

- **EARTHSS 60A- 60B- 60C** Fundamental Processes in Earth and Environmental Studies and Local and Regional Environmental Issues and Global Environmental Issues

and select four electives from the approved elective list for the B.S. in Earth System Science major, at least two of which must be Earth System Science courses.

**Graduate Program**

The Earth, as a coupled system of atmosphere, ocean, land, and cryosphere, has changed in our lifetime. The observed depletion of stratospheric ozone at high latitudes has been attributed directly to industrial use of halocarbons. Global warming is likely to result from increases in the atmospheric concentrations of greenhouse gases, such as carbon dioxide and methane, which are released by the use of fossil fuel and agricultural practices. These examples illustrate the ability of humans to alter the global environment on the time-scale of decades. Understanding the sensitivity of the Earth’s climate system requires a broad base of scientific knowledge, which includes detection, quantification, and prediction of the rates of change of chemical, physical, and biological variables.

The Department’s doctoral program is aimed at training new research scientists in the field of Earth System Science. The graduate education provides a comprehensive curriculum, along with opportunities to conduct groundbreaking research. The Department’s doctoral-level students are expected to become researchers with a global perspective and broad research skills as well as a high level of expertise in specific areas. Active programs of research are underway in atmospheric chemistry, biogeochemical cycles, and physical climate.

**Course Requirements.** Students must complete a minimum of 10 approved graduate-level courses, including the core curriculum, with an average grade of B or better. All courses must be approved by the student’s advisor.

**Core Curriculum**

- EARTHSS 202 Climate Change
- EARTHSS 212 Geoscience Modeling and Data Analysis
- EARTHSS 224 Ocean Processes
- EARTHSS 226 Land Surface Processes
- EARTHSS 228 Geophysical Fluid Dynamics
- EARTHSS 240 Atmospheric Chemistry and Physics
- EARTHSS 266 Global Biogeochemical Cycles
- EARTHSS 298 Practicum in Earth System Science
Residency. Academic Senate regulations specify a minimum period of residence of six quarters for Ph.D. candidates. Enrollment in a minimum of 12 units of graduate/upper-division course work per quarter is required. Registration in every regular academic session is necessary until all requirements for the degree have been completed, unless a formal Leave of Absence is granted by the Graduate Division. All Ph.D. requirements must be completed within 15 quarters in residence (five years), excluding summer quarters. Exceptions must be put to a vote of the Earth System Science faculty. The maximum time permitted is seven years.

Comprehensive Examination. Progress toward the degree and readiness to begin research is assessed by a comprehensive examination covering breadth, general knowledge, and the ability to integrate and use information covered in the core curriculum and other course work. At the end of the spring quarter, the ESS Comprehensive Examination Committee administers the written and oral examinations. The oral comprehensive examination is offered after the written examination and provides an opportunity to clarify questions that arise from the student’s performance on the written examination.

Teaching and Seminar. Students are required to complete a teaching assistant training program and to have a minimum of two quarters of experience as a teaching assistant, provided opportunities are available. Students can enroll in EARTHSS 399 while serving as a teaching assistant. Students are also expected to participate in the Earth System Science seminar.

Advance to Ph.D. Candidacy. Following completion of the Comprehensive Examination, those students who receive a recommendation to continue Ph.D. work will pursue research on a potential dissertation topic and then take the Advancement to Candidacy Examination. This oral examination is given by a faculty committee, including extra-departmental faculty. The normative time for advancement for candidacy is two years.

Dissertation. After advancing to candidacy, students are expected to be fully involved in research toward writing their Ph.D. dissertation. Students should keep in steady contact/interaction with their Doctoral Committee. A dissertation based on original research and demonstrating critical judgment, intellectual synthesis, creativity, and clarity in written communication is required for the Ph.D. degree. The dissertation must summarize the results of original research performed by the student under the supervision of a faculty member of the Department. The dissertation will be evaluated by the Dissertation Committee, based on suitability for publication in a peer-reviewed journal of high editorial standards. The dissertation may be a compilation of published papers or manuscripts accepted for publication, so long as the candidate has produced a major proportion of the material independently. The Dissertation Committee approves the format and content, which must meet University requirements for style, format, and appearance.

Doctor of Philosophy in Earth System Science

1. Completion of course work (10 courses, including core courses)
2. Six quarters in residence at UCI
3. Completion of the Comprehensive Examination, with recommendation to continue for the Ph.D.
4. Completion of the teaching and seminar requirements
5. Pass the Advancement to Candidacy Examination

Master of Science in Earth System Science

1. Completion of course work (8 courses, including core courses)
2. Three quarters in residence at UCI
3. Completion of the Comprehensive Examination.

Faculty

Ralph J. Cicerone, Ph.D. University of Illinois, Chancellor Emeritus and Professor Emeritus of Earth System Science (atmospheric and analytical chemistry)

Claudia Czimczik, Ph.D. Max-Planck Institute for Biogeochemistry and Friedrich Schiller University Jena, Assistant Professor of Earth System Science (terrestrial biogeochemistry)

Steven J. Davis, J.D. University of Virginia; Ph.D. Stanford University, Assistant Professor of Earth System Science (human dimensions of climate change)

Ellen R. M. Druffel, Ph.D. University of California, San Diego, Professor of Earth System Science (chemical oceanography and biogeochemistry)

Todd K. Dupont, Ph.D. Pennsylvania State University, Assistant Professor of Earth System Science (cryospheric change, glaciology, ice sheet dynamics)

James S. Famiglietti, Ph.D. Princeton University, Director of the UC Center for Hydrologic Modeling and Professor of Earth System Science and of Civil and Environmental Engineering (hydrology and climate)


Michael L. Goulden, Ph.D. Stanford University, Department Chair and Professor of Earth System Science, and Professor of Ecology and Evolutionary Biology (terrestrial ecology)

Kathleen R. Johnson, Ph.D. University of California, Berkeley, Assistant Professor of Earth System Science (paleoclimatology)

Saewung Kim, Ph.D. Georgia Institute of Technology, Assistant Professor of Earth System Science (atmospheric chemistry)

Gudrun Magnusdottir, Ph.D. Colorado State University, Professor of Earth System Science (atmospheric dynamics)

Adam C. Martiny, Ph.D. Technical University of Denmark, Associate Professor of Earth System Science and of Ecology and Evolutionary Biology (microbial oceanography)

J. Keith Moore, Ph.D. Oregon State University, Associate Professor of Earth System Science (biogeochemistry)

Michael Prather, Ph.D. Yale University, Director of the UCI Environment Institute, Professor of Earth System Science, and Fred Kavli Chair in Earth System Science (atmospheric chemistry)

Francois W. Primeau, Ph.D. Massachusetts Institute of Technology/Woods Hole Oceanographic Institution, Associate Professor of Earth System Science (physical oceanography)

Michael S. Pritchard, Ph.D. University of California, San Diego, Scripps Institution of Oceanography, Assistant Professor of Earth System Science (atmospheric sciences)
Courses

EARTHSS 1. Introduction to Earth System Science. 4 Units.
Covers the origin and evolution of the Earth, its atmosphere, and oceans, from the perspective of biogeochemical cycles, energy use, and human impacts on the Earth system.

Overlaps with EARTHSS 25.

(II, Va)

EARTHSS 3. Oceanography. 4 Units.
Examines circulation of the world oceans and ocean chemistry as it relates to river, hydrothermal vent, and atmospheric inputs. Geological features, the wide variety of biological organisms, and global climate changes, such as greenhouse warming, are also studied.

(II, Va)

EARTHSS 5. The Atmosphere. 4 Units.
The composition and circulation of the atmosphere with a focus on explaining the fundamentals of weather and climate. Topics include solar and terrestrial radiation, clouds, and weather patterns.

(II, Va)

EARTHSS 7. Physical Geology. 4 Units.
Introduction to Earth materials and processes. Topics include rocks and minerals, plate tectonics, volcanoes, earthquakes, Earth surface processes, Earth resources, geologic time, and Earth history. Laboratory work involves hands-on study of geologic materials, maps, and exercises pertaining to geologic processes.

(II, Va)

EARTHSS 11. Climate Change and Policy. 4 Units.
Develops an understanding of the physical basis behind global climate change; examines how human activities cause it, looks to future rates and impacts of global warming, and reviews the international conventions, protocols, and scientific assessments of climate change.

(II)

EARTHSS 13. Global-Change Biology. 4 Units.
Addresses ways in which humans are altering the global environment, with consequences for the ecology of animals, plants, and microbes. Discussion on how these biologically oriented questions relate to human society, politics, and the economy.

Same as BIO SCI 9K.

(II)

EARTHSS 15. Introduction to Global Climate Change. 4 Units.
Introduction of scientific, technological, environmental, economic, and social aspects underlying the threat and understanding of global climate change. Human and natural drivers of climate. Impacts of climate on natural, managed, and human systems, including their vulnerability and ability to adapt.

(II and (VA or VIII)).
EARTHSS 17. Hurricanes, Tsunamis, and other Catastrophes. 4 Units.
Introduction to the basic science and state of predictability of various natural catastrophic events including earthquakes, volcanic eruptions, tsunamis, landslides, floods, hurricanes, fires, and asteroid impacts and their interactions and implications with human society in the U.S. and globally.

EARTHSS 19. Introduction to Modeling the Earth System. 4 Units.
Simulate the Earth's system using computer models. Covers the interaction of the air, land, and ocean, and explores how changes to one part of the environment affect the complete Earth system. Utilizes technological tools to understand scientific principles.

EARTHSS 21. On Thin Ice: Climate Change and the Cryosphere. 4 Units.
Introduction of the basic science that governs the cryosphere and its interaction with the climate system. Covers some of the significant economic, sociological, and political consequences of the recent melting of the cryosphere driven by anthropogenic climate change.

EARTHSS 23. Air Pollution: From Urban Smog to Global Change. 4 Units.
Air pollution occurs on regional to global scales. A wide range of air pollution sources and physical, chemical, and meteorological sciences behind air pollution are introduced. The consequences of air pollution to our society are also discussed.

EARTHSS 51. Land Interactions. 4 Units.
The role of terrestrial processes in the Earth system. Provides an introduction to ecosystem processes that regulate the cycling of energy, water, carbon, and nutrients. Analysis of the impact of human activities.

Prerequisite: CHEM 1C.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 53. Ocean Biogeochemistry. 4 Units.
Overview of oceanography for those interested in earth system science. Focus is on physical, chemical, and biological processes that drive biogeochemical cycling in the oceans. Coastal systems also reviewed, with emphasis on California waters.

Prerequisite: CHEM 1C. Prerequisite or corequisite: MATH 2B or AP Calculus BC exam with a minimum score of 4.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 55. Earth’s Atmosphere. 4 Units.
Composition, physics, and circulation of Earth’s atmosphere with an emphasis on explaining the role of atmospheric processes in shaping the climate system. Topics include: atmospheric composition, the global energy balance, radiative transfer and climate, atmospheric circulation and climate sensitivity.

Corequisite: MATH 2B or PHYSICS 3B or PHYSICS 7B.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 60A. Fundamental Processes in Earth and Environmental Studies. 4 Units.
An introduction to the physical environment, biological systems, and human-environment interactions. Explores physical principles such as fluid transport and reaction rates using environmental examples as well as principles of populations, ecosystems, carrying capacity, and sustainable use of resources.

Corequisite: EARTHSS 1 or EARTHSS 25 or UNI STU 13A.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 60B. Local and Regional Environmental Issues. 4 Units.
An introduction to common environmental issues using case studies from Orange County and California. Studies natural hazards as well as human-caused problems with air quality, water quality, coastal pollution, ecosystem degradation, and urban climate.

Prerequisite: (EARTHSS 60A or EARTHSS 25) and (CHEM 1B or CHEM H2B).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 60C. Global Environmental Issues. 4 Units.
An overview of global environmental changes including climate change, sea level rise, biodiversity loss, land and ocean degradation, and resource depletion. Discusses scientific, cultural, historical, and policy dimensions of these issues as well as possible solutions.

Prerequisite: (EARTHSS 60A or EARTHSS 25) and (CHEM 1B or CHEM H2B).

EARTHSS H90. The Idiom and Practice of Science. 4 Units.
A series of fundamental and applied scientific problems are addressed, illustrating the pervasive role of mathematical analysis. Topics may include energy utilization, the climate system, the “greenhouse effect,” zone depletion and air pollution, ecological consequences of water pollution, nutrient cycles.

Restriction: Campuswide Honors Program students only.

(II, Va)
EARTHSS 101. Paleoclimatology. 4 Units.
Explores past changes in Earth's climate. Topics include tools and techniques used to reconstruct past climate from natural archives; records and mechanisms of past climate changes throughout Earth history; and lessons learned from the paleo-record for prediction of future climate.
Prerequisite: (EARTHSS 60A and EARTHSS 60B and EARTHSS 60C) or (EARTHSS 51 and EARTHSS 53 and EARTHSS 55).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 110. Environmental Controversies. 4 Units.
Examines the roles and strategies of advocacy groups, scientists, lobbyists, celebrities, pundits, politicians, and other opinion-makers in creating and shaping public opinion on controversial environmental issues. Use and misuse of science to influence public opinion is elicited.
Prerequisite: (EARTHSS 60A and EARTHSS 60B and EARTHSS 60C) or (EARTHSS 51 or EARTHSS 53 or EARTHSS 55).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 112. Global Climate Change and Impacts. 4 Units.
Observations over the 20th century show extensive changes in atmospheric composition, climate and weather, and biological systems that have paralleled industrial growth. Evidence of globally driven changes in these biogeochemical systems is studied, including projected impacts over the 21st century.
Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 60A and EARTHSS 60B and EARTHSS 60C).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

Concurrent with EARTHSS 222.

EARTHSS 114. Earth System Science Laboratory and Field Methods. 4 Units.
Introduction to methods used to measure exchange of gases and energy between the atmosphere and terrestrial ecosystems. Laboratories include data acquisition and isotopic and chromatographic analysis. Field measurements at UCI's Marsh Reserve include microclimate, hydrology, trace-gas exchange, and plant growth.
Prerequisite: EARTHSS 51 or EARTHSS 60A.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 116. Data Analysis for Earth Sciences. 4 Units.
Analysis and interpretation of geophysical data, including functional fitting, probability density functions, and multidimensional time-series methods, with applications in atmospheric, oceanic, and biogeochemical sciences.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

Concurrent with EARTHSS 232.

EARTHSS 118. Advanced Data Analysis and Modeling. 4 Units.
Covers advanced data analysis and modeling techniques for applications within Earth system science. These applications will come from variety of Earth science (wrt large) problems. Students will gain programming proficiency by implementing computational methods in MATLAB.
Prerequisite: EARTHSS 116 and (MATH 2B or AP Calculus BC exam with a minimum score of 4).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 122. Atmospheric Dynamics. 4 Units.
Fluid dynamical processes that determine the large-scale flow of the atmosphere and ocean. Most important are interactions between the density stratification and the Coriolis force associated with Earth’s rotation. Topics include circulation, vorticity, planetary waves and their role in climate.
Prerequisite: EARTHSS 55 and MATH 2D and (PHYSICS 7B or PHYSICS 7C).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 124. Weather Analysis. 4 Units.
Provides an overview of weather systems in midlatitudes and tropics. The fundamental dynamics possible for these weather systems are described. Elementary weather analysis and forecasting techniques are introduced.
Prerequisite: EARTHSS 55 or EARTHSS 60A.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 130. Physical Oceanography. 4 Units.
Physical processes that determine the distribution of water properties such as salt and temperature. Fluid-dynamical underpinnings of physical oceanography. Wave motions. The wind-driven and thermohaline circulation. Similarities and differences between ocean and atmosphere dynamics.
Prerequisite: MATH 2D and (PHYSICS 7B or PHYSICS 7C).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 132. Terrestrial Hydrology. 4 Units.
Comprehensive treatment of modern conceptual and methodological approaches to hydrological science. Combines qualitative understanding of hydrological processes with quantitative representation, approaches to measurement, and treatment of uncertainty. Components of the hydrological cycle and their linkages within the coupled Earth system.
Prerequisite: EARTHSS 60A or EARTHSS 51.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

Concurrent with EARTHSS 232.
EARTHSS 134. Fundamentals of GIS for Environmental Sciences. 4 Units.
Introduction to Geographic Information Systems (GIS). Topics include fundamentals of cartography, creating/editing GIS data, linking spatial and tabular data, georeferencing, map projections, geospatial analysis, spatial statistics and the development of GIS models. Examples from hydrology, ecology, and geology.
Prerequisite: EARTHSS 60A or EARTHSS 60C or EARTHSS 51 or EARTHSS 53.
Overlaps with CRM/LAW C148.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 138. Satellite Remote Sensing for Earth System Science. 4 Units.
Satellite remote sensing data are increasingly used to study the Earth system. Provides an overview of the principles behind remote sensing, and the types of satellite data available for study of the oceans, land, and atmosphere.
Prerequisite: EARTHSS 51 or EARTHSS 53 or EARTHSS 60A or EARTHSS 60C.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 140. Advanced Geology. 4 Units.
Introduces students to the geological processes which have formed and continue to shape the Earth. Topics will include geological time, minerals and the rock cycle, plate tectonics and associated geological hazards, earth resources, and earth surface processes.
Prerequisite: EARTHSS 51 or EARTHSS 60A.
Overlaps with EARTHSS 7.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 142. Atmospheric Chemistry. 4 Units.
Chemistry of the troposphere and stratosphere. Topics include: processes controlling the lifetime and reaction pathways of chemicals in the atmosphere, the role of the atmosphere in biogeochemical cycles, and interactions between atmospheric chemistry and the physical climate system.
Prerequisite: (CHEM 1C or CHEM H2C) and (MATH 2B or AP Calculus BC exam with a minimum score of 4).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 144. Marine Geochemistry and Biogeochemistry. 4 Units.
Processes controlling the major and minor element composition of seawater and element distributions in the ocean. Gas exchange, carbon dioxide system, stable isotopes, radionuclides as tracers and chronometers, particle fluxes, organic geochemistry, sediment geochemistry, global cycles of biogeochemically important elements.
Prerequisite: (EARTHSS 53 or EARTHSS 60A) and EARTHSS 60C.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 146. Consequences of Air Pollution. 4 Units.
From public health to the global climate system this course will explore the impacts of air pollution from the beginning of human history to current and emerging issues. Scientific concepts behind air pollution and solutions will be discussed.
Prerequisite: (EARTHSS 60A and EARTHSS 60B and EARTHSS 60C) or (EARTHSS 51 and EARTHSS 53 and EARTHSS 55).
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 150. Laboratory Methods in Earth Systems Science. 4 Units.
Introduction to analytical methods used in Earth science research. Lectures cover theory and applications of each method. Laboratories cover sample preparation, experimental design, standardization and calibration, operation of analytical instruments (mass spectrometers, gas chromatographs, and spectrophotometers), and analysis of data.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.
Concurrent with EARTHSS 250.

EARTHSS 164. Ecosystem Ecology. 4 Units.
A mechanistic perspective on ecosystem processes. Covers ecosystem development, element cycling, and interactions with plants and microbes. The role of ecosystems in environmental change is also addressed.
Prerequisite: CHEM 51C.
Same as BIO SCI E118.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.
Concurrent with EARTHSS 264.

EARTHSS 168. Physiological Plant Ecology. 4 Units.
An examination of the interactions between plants and their environment. Emphasis on the underlying physiological mechanisms of plant function, adaptations and responses to stress, and the basis of the distribution of plants and plant assemblages across the landscape.
Prerequisite: (EARTHSS 51 or EARTHSS 60A) and (EARTHSS 60C or BIO SCI E106).
Same as BIO SCI E127.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.
Concurrent with EARTHSS 268.
**EARTHSS 170. Environmental Microbiology. 4 Units.**
Establishes a fundamental understanding of microbes living in the environment, including their distribution, diversity, and biochemistry, and discusses how they attribute to global biogeochemical cycles.

Prerequisite: (EARTHSS 53 or EARTHSS 60A) and (EARTHSS 60C or BIO SCI E106).

Same as BIO SCI E163.

Concurrent with EARTHSS 270.

**EARTHSS 172. Science Communication and Outreach. 2 Units.**
Students learn and practice effective science communication skills useful in public and educational outreach. Topics include research explication, language scaffolding, educational psychology, oral presentation techniques, K-12 science standards, and effective writing styles for op-eds, blogs, and Web sites.

Prerequisite: EARTHSS 51 or EARTHSS 60A.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit 3 times.

Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

Concurrent with EARTHSS 272.

**EARTHSS 174. Ice in the Climate System. 4 Units.**
Examines the major components of the Earth’s cryosphere. Characteristics, volume, extent, remote sensing observations, long-term trends, mass balance, key physical processes, relevance and importance to the climate system, responses and feedbacks, future evolution, and key uncertainties will be discussed.

Prerequisite: (EARTHSS 60A and EARTHSS 60B and EARTHSS 60C) or (EARTHSS 51 and EARTHSS 53 and EARTHSS 55).

Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

Concurrent with EARTHSS 274.

**EARTHSS 178. Solving the Energy-Carbon-Climate Problem. 4 Units.**
Why is climate change such a difficult problem? What can we do about it? The course will introduce the global politics of energy and climate, assess options for decreasing energy demand, generating low-carbon energy, sequestering carbon, geoengineering, and adaptation.

Prerequisite: (EARTHSS 60A and EARTHSS 60B and EARTHSS 60C) or (EARTHSS 51 and EARTHSS 53 and EARTHSS 55).

Restriction: Earth System Science majors and Environmental Science majors have first consideration for enrollment.

**EARTHSS 180. Environmental Sustainability I. 4 Units.**
Provides an introduction to sustainability from different points of view; historical, scientific, political, ethical, and economic.

Same as PP&D 131.

Restriction: Urban Studies and Social Ecology majors have first consideration for enrollment.

**EARTHSS 182. Environmental Sustainability II. 4 Units.**
Investigates how sustainability can be implemented in a variety of contexts including water, energy, non-renewable resources, biodiversity, and urban policy, and also how it could be measured.

Same as PP&D 132.

Restriction: Urban Studies, Social Ecology, Earth System Science, and Environmental Science majors have first consideration for enrollment.

**EARTHSS 190A. Senior Seminar on Global Sustainability I. 2 Units.**
Students attend weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze forum presentations. Prepare bibliography.

Prerequisite: BIO SCI 65 and ENVIRON E20 and EARTHSS 10.

Grading Option: In progress only.

Same as BIO SCI 191A, SOCECOL 186A.

Restriction: Seniors only.

**EARTHSS 190B. Senior Seminar on Global Sustainability II. 2 Units.**
Students attend weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze forum presentations. Prepare research proposal.

Prerequisite: BIO SCI 191A or SOCECOL 186A or EARTHSS 190A.

Grading Option: In progress only.

Same as BIO SCI 191B, SOCECOL 186B.

Restriction: Seniors only.

**EARTHSS 190C. Senior Seminar on Global Sustainability III. 4 Units.**
Weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze forum presentations and to prepare senior research paper. Prepare/write research paper under the direction of a faculty member.

Prerequisite: BIO SCI 191B or EARTHSS 190B or SOCECOL 186B.

Same as BIO SCI 191C, SOCECOL 186C.

Restriction: Seniors only.

**EARTHSS 190CW. Writing/Senior Seminar on Global Sustainability III. 4 Units.**
Students attend weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze Forum presentations and to prepare senior research paper. Prepare/write research paper under direction of faculty member.

Prerequisite: BIO SCI 191B or EARTHSS 190B or SOCECOL 186B.

Satisfactory completion of the Lower-Division Writing requirement.

Same as BIO SCI 191CW, SOCECOL 186CW.

Restriction: Seniors only.
EARTHSS 191. Title Introduction to Research in Earth System Science. 1 Unit.
Weekly presentations by Earth System Science faculty describing ongoing research in their laboratories. The goals are to introduce students to the range of research topics and methods in Earth System Science and to the research opportunities available within the Department.

Grading Option: Pass/no pass only.

Restriction: Upper-division students only. Earth System Science and Environmental Science majors have first consideration for enrollment. Earth and Atmospheric Sciences minors have first consideration for enrollment.

EARTHSS 192. Careers in Earth System Science. 1 Unit.
A weekly seminar course designed to help students transition to post-graduation career paths. Topics include designing effective resumes, applying to graduate school, and seeking employment. Also includes presentations by faculty, business, and government leaders describing potential environmental science career trajectories.

Grading Option: Pass/no pass only.

Restriction: Seniors only. Earth System Science and Environmental Science majors have first consideration for enrollment.

EARTHSS 197. Independent Study in Earth System Science. 1-4 Units.
Field study, educational outreach, or other independent projects under faculty direction. Interested students should arrange with an ESS faculty member to supervise and support an independent study project. A written summary is required at the end of each quarter.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit for 12 units.

EARTHSS 198. Senior Thesis in Earth System Science. 4 Units.
Students receive guidance on the effective oral and written communication of research results. Students prepare and present a seminar, a poster, and a written thesis describing their research in Earth System Science.

Prerequisite: Two quarters of EARTHSS 199.

Overlaps with EARTHSS H198.

EARTHSS H198. Honors Thesis in Earth System Science. 4 Units.
Students receive guidance on effective written and oral communication of research results. Students prepare and present a seminar, poster, and written thesis describing their honors research in Earth System Science. Submission of the thesis and successful completion of this course will also satisfy the UCI upper-division writing requirement.

Prerequisite: EARTHSS 199A and EARTHSS 199B

Restriction: Consent of instructor to enroll and Prerequisite required

EARTHSS 199. Undergraduate Research. 1-4 Units.
For junior and senior undergraduates, preferably with majors in science or engineering. Interested students should arrange with an ESS faculty member to supervise and support a research project. A written summary is required at the end of each quarter.

Restriction: Juniors and Seniors only.

EARTHSS H199A. Honors Research in Earth System Science. 4 Units.
Undergraduate honors research in Earth System Science. A student commitment of 10-15 hours a week is expected, and a written report is required at the end of the quarter.

Restriction: Earth System Science Honors Program students only. Earth System Science majors only. Campuswide Honors Program students only.

EARTHSS H199B. Honors Research in Earth System Science. 4 Units.
Undergraduate honors research in Earth System Science. A student commitment of 10-15 hours a week is expected, and a written report is required at the end of the quarter.

Restriction: Earth System Science Honors Program students only. Earth System Science majors only. Campuswide Honors Program students only.

EARTHSS H199C. Honors Research in Earth System Science. 4 Units.
Undergraduate honors research in Earth System Science. A student commitment of 10-15 hours a week is expected, and a written report is required at the end of the quarter.

Restriction: Earth System Science Honors Program students only. Earth System Science majors only. Campuswide Honors Program students only.

EARTHSS 202. Climate Change. 4 Units.
Explores past, present, and projected changes in Earth’s climate. Topics include paleoclimate records and mechanisms of natural climate variability at a range of timescales (orbital to seasonal); General Circulation Models; and IPCC observations and projections of future climate change.

Restriction: Graduate students only.

EARTHSS 208B. Global Biogeochemical Cycles. 2 Units.
Global biogeochemical cycling of the elements. Topics include: global cycling of carbon, nitrogen, oxygen, and sulfur; impact of human activities on biogeochemical processes.
EARTHSS 212. Geoscience Modeling and Data Analysis. 4 Units.
Computer-based course. Fundamental statistical techniques needed to
analyze Earth system data and models. Basic numerical techniques to
solve Earth system models. Focuses on linear and non-linear ordinary
differential equations, as well as simple partial differential equations.

Restriction: Graduate students only.

EARTHSS 222. Global Climate Change and Impacts. 4 Units.
Observations over the 20th century show extensive changes in
atmospheric composition, climate and weather, and biological systems
that have paralleled industrial growth. Evidence of globally driven changes
in these biogeochemical systems is studied, including projected impacts
over the 21st century.

Concurrent with EARTHSS 112.

EARTHSS 224. Ocean Processes. 4 Units.
Introduction to the physics, chemistry, and biology of the oceans. Offers
a mechanistic perspective of the structure and functioning of marine
ecosystems, nutrient cycles, and role of ecosystem dynamics in local and
global biogeochemistry.

Restriction: Graduate students only.

EARTHSS 226. Land Surface Processes. 4 Units.
Introduction to the physics, chemistry, and biology of the oceans. Offers
a mechanistic perspective of the structure and functioning of marine
ecosystems, nutrient cycles, and role of ecosystem dynamics in local and
global biogeochemistry.

Restriction: Graduate students only.

EARTHSS 228. Geophysical Fluid Dynamics. 4 Units.
Introduces fluid dynamical processes that determine the large-scale flow
of the atmosphere and ocean, with particular emphasis on the interactions
between the stable density stratification and the Coriolis force associated
with Earth’s rotation.

Restriction: Graduate students only.

EARTHSS 232. Terrestrial Hydrology. 4 Units.
Comprehensive treatment of modern conceptual and methodological
approaches to hydrological science. Combines qualitative understanding
of hydrological processes with quantitative representation, approaches
to measurement, and treatment of uncertainty. Components of the
hydrological cycle and their linkages within the coupled Earth system.

Prerequisite: EARTHSS 60A or EARTHSS 51.

Concurrent with EARTHSS 132

EARTHSS 236. Radiative Processes and Remote Sensing. 4 Units.
Solar and terrestrial radiation and Earth system interaction. Radiative
transfer theory. Principles, applications of remote sensing of environment.
Planck’s law, radiative transfer equation, radiative properties of trace
gasses and aerosols, remote sensing techniques, global trends in radiative
forcing.

Prerequisite: MATH 2D and PHYSICS 7A and PHYSICS 7B and
PHYSICS 7D.

EARTHSS 240. Atmospheric Chemistry and Physics. 4 Units.
Examines the physical/chemical processes which determine the structure
and composition of Earth’s atmosphere and its role in the climate system.

Restriction: Graduate students only.

EARTHSS 250. Laboratory Methods in Earth System Science. 4 Units.
Introduction to analytical methods used in Earth science research.
Lectures cover theory and applications of each method. Laboratories
cover sample preparation, experimental design, standardization and
calibration, operation of analytical instruments (mass spectrometers, gas
chromatographs, and spectrophotometers), and analysis of data.

Concurrent with EARTHSS 150.

EARTHSS 264. Ecosystem Ecology . 4 Units.
A mechanistic perspective on ecosystem processes. Covers ecosystem
development, element cycling, and interactions with plants and microbes.
The role of ecosystems in environmental change is also addressed.

Prerequisite: CHEM 51C.

Concurrent with EARTHSS 164 and BIO SCI E118.

EARTHSS 266. Global Biogeochemical Cycles. 4 Units.
Global biogeochemical cycling of the elements. Topics include global
cycling of carbon, nitrogen, oxygen, and sulfur; impact of human activities
on biogeochemical processes.

Restriction: Graduate students only.

EARTHSS 268. Physiological Plant Ecology. 4 Units.
An examination of the interactions between plants and their environment.
Emphasis on the underlying physiological mechanisms of plant function,
adaptations and responses to stress, and the basis of the distribution of
plants and plant assemblages across the landscape.

Prerequisite: (EARTHSS 51 or EARTHSS 60A) and (EARTHSS 60C or
BIO SCI E106).

Concurrent with EARTHSS 168 AND BIO SCI E127.

EARTHSS 270. Environmental Microbiology. 4 Units.
Establishes a fundamental understanding of microbes living in the
environment, including their distribution, diversity, and biochemistry, and
discusses how they attribute to global biogeochemical cycles.

Prerequisite: (EARTHSS 53 or EARTHSS 60A) and (EARTHSS 60C or
BIO SCI E106).

Concurrent with EARTHSS 170 and BIO SCI E163.

EARTHSS 272. Science Communication and Outreach. 2 Units.
Students learn and practice effective science communication skills useful
in public and educational outreach. Topics include research explication,
language scaffolding, educational psychology, oral presentation
techniques, K-12 science standards, and effective writing styles for op-
eds, blogs, and Web sites.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be taken for credit 3 times.

Concurrent with EARTHSS 172.
EARTHSS 274. Ice in the Climate System. 4 Units.
Examines the major components of the Earth’s cryosphere. Characteristics, volume, extent, remote sensing observations, long-term trends, mass balance, key physical processes, relevance and importance to the climate system, responses and feedbacks, future evolution, and key uncertainties will be discussed.

Concurrent with EARTHSS 174.

EARTHSS 280A. Special Topics in Earth System Science. 1-4 Units.
Each quarter is devoted to current topics in the field of Earth System Science. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

EARTHSS 280B. Special Topics in Earth System Science. 1-4 Units.
Each quarter is devoted to current topics in the field of Earth System Science. Topics addressed vary each quarter.

Prerequisite: EARTHSS 280A.

Repeatability: Unlimited as topics vary.

EARTHSS 280C. Special Topics in Earth System Science. 1-4 Units.
Each quarter is devoted to current topics in the field of Earth System Science. Topics addressed vary each quarter.

Prerequisite: EARTHSS 280B.

Repeatability: Unlimited as topics vary.

EARTHSS 282A. Special Topics in Climate. 1-4 Units.
Each quarter is devoted to in-depth analysis of an important and rapidly developing area in the field of climate dynamics. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 282B. Special Topics in Climate. 1-4 Units.
Each quarter is devoted to in-depth analysis of an important and rapidly developing area in the field of climate dynamics. Topics addressed vary each quarter.

Prerequisite: EARTHSS 282A.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 282C. Special Topics in Climate. 1-4 Units.
Each quarter is devoted to in-depth analysis of an important and rapidly developing area in the field of climate dynamics. Topics addressed vary each quarter.

Prerequisite: EARTHSS 282B.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 284A. Special Topics in Atmospheric Chemistry. 1-4 Units.
Each quarter is devoted to current topics in the field of Atmospheric Chemistry. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

EARTHSS 284B. Special Topics in Atmospheric Chemistry. 1-4 Units.
Each quarter is devoted to current topics in the field of Atmospheric Chemistry. Topics addressed vary each quarter.

Prerequisite: EARTHSS 284A.

Repeatability: Unlimited as topics vary.

EARTHSS 284C. Special Topics in Atmospheric Chemistry. 1-4 Units.
Each quarter is devoted to current topics in the field of Atmospheric Chemistry. Topics addressed vary each quarter.

Prerequisite: EARTHSS 284B.

Repeatability: Unlimited as topics vary.

EARTHSS 286A. Special Topics in Biogeochemistry. 1-4 Units.
Each quarter is devoted to in-depth analysis of a subarea in biogeochemistry which is undergoing rapid development. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 286B. Special Topics in Biogeochemistry. 1-4 Units.
Each quarter is devoted to in-depth analysis of a subarea in biogeochemistry which is undergoing rapid development. Topics addressed vary each quarter.

Prerequisite: EARTHSS 286A.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 286C. Special Topics in Biogeochemistry. 1-4 Units.
Each quarter is devoted to in-depth analysis of a subarea in biogeochemistry which is undergoing rapid development. Topics addressed vary each quarter.

Prerequisite: EARTHSS 286B.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 288A. Special Topics in Ecosystems. 1-4 Units.
Each quarter is devoted to current topics relating to Ecosystems. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

EARTHSS 288B. Special Topics in Ecosystems. 1-4 Units.
Each quarter is devoted to current topics relating to Ecosystems. Topics addressed vary each quarter.

Prerequisite: EARTHSS 288A.

Repeatability: Unlimited as topics vary.

EARTHSS 288C. Special Topics in Ecosystems. 1-4 Units.
Each quarter is devoted to current topics relating to Ecosystems. Topics addressed vary each quarter.

Prerequisite: EARTHSS 288B.

Repeatability: Unlimited as topics vary.
EARTHSS 290. Seminar. 1 Unit.
Weekly seminars and discussions on topics of general and current interest in Earth System Science. Topics addressed vary each quarter.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EARTHSS 291. Research Seminar. 1-4 Units.
Detailed discussions of ongoing research in earth system science. Format, content, and frequency of the course are variable.

Repeatability: May be repeated for credit unlimited times.

EARTHSS 298. Practicum in Earth System Science. 4 Units.
Designed to introduce first-year graduate students to research. Students explore research opportunities and develop a proposal for a summer research project under the direction of a faculty mentor.

Restriction: Graduate students only.

EARTHSS 299. Research. 2-12 Units.
Supervised original research in areas of Earth System Science.

Repeatability: May be repeated for credit unlimited times.

EARTHSS 399. University Teaching. 1-4 Units.
Limited to Teaching Assistants.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.