

Earth System Science, B.S.

<https://www.ess.uci.edu/bachelor-science-earth-system-science> (<https://www.ess.uci.edu/bachelor-science-earth-system-science/>)

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 198W may satisfy Department and UCI upper-division writing requirements.

Students may be admitted to the Earth System Science major upon entering the University as freshmen, via change of major, or 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 the UCI Change of Major Criteria website (<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.

All students must meet the University Requirements (<http://catalogue.uci.edu/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
or EARTHSS 115	Aquatic Field Methods
EARTHSS 116	Introduction to Environmental Data Science
EARTHSS 192	Careers in Earth System Science
MATH 2A- 2B	Single-Variable Calculus I and Single-Variable Calculus II
STATS 7	Basic Statistics
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 I and Basic Physics II and Basic Physics III
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 EARTHSS 114, EARTHSS 115, EARTHSS 116, and EARTHSS H198 (EARTHSS 199 or one quarter of H199A-B-C may count only once toward the elective requirement)	
BIO SCI 93	From DNA to Organisms
BIO SCI 94	From Organisms to Ecosystems
BIO SCI 98	Biochemistry
BIO SCI D105	Cell, Developmental, and Molecular Biology of Plants
BIO SCI E106	Processes in Ecology and Evolution
BIO SCI E120	Marine Biology
BIO SCI E150	Conservation Biology
BIO SCI E179	Limnology and Freshwater Biology
BIO SCI E179L	Field Freshwater Ecology
BIO SCI E189	Environmental Ethics
CHEM 51A	Organic Chemistry
CHEM 51B- 51LB	Organic Chemistry and Organic Chemistry Laboratory
CHEM 51C- 51LC	Organic Chemistry and Organic Chemistry Laboratory
CHEM 141	Environmental Chemistry
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
ENGRMAE 91	Introduction to Thermodynamics
ENGRMAE 130A	Fluid Dynamics I
ENGRMAE 164	Air Pollution and Control
MATH 2D	Multivariable Calculus I
MATH 3A	Introduction to Linear Algebra
MATH 3D	Elementary Differential Equations
MATH 105A	Numerical Analysis I
MATH 112A	Introduction to Partial Differential Equations and Applications I
MATH 115	Mathematical Modeling

PHYSICS 115A	Statistical Physics
UPPP 133	Environmental Law and Policy
UPPP 139	Water Resource Policy
UPPP 145	Environmental Governance
PUBHLTH 161	Environmental Geology
PUBHLTH 163	Introduction to Environmental Health Science
PUBHLTH 167	Air Pollution, Climate, and Health
PUBHLTH 171	Human Exposure to Environmental Contaminants
PUBHLTH 173	Health and Global Environmental Change
Computing Skills (one of the following may be counted toward degree): EECS 10, ENGRMAE 10, I&C SCI 31, 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 four courses from the following lists (three science courses plus one advanced tools course).

Specialization in Atmospheric Science

Requirements	
Three courses selected from the following:	
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 courses selected from the following:	
EARTHSS 118	Analysis, Modeling, and Visualization of Multidimensionnal Environmental Data
EARTHSS 134	Fundamentals of GIS for Environmental Science
EARTHSS 138	Satellite Remote Sensing for Earth System Science
(These courses may overlap in Major Requirements, Section B.)	

Specialization in Hydrology and Terrestrial Ecosystems

Requirements	
Three courses selected from the following:	
EARTHSS 132	Terrestrial Hydrology
EARTHSS 140	Advanced Geology
or EARTHSS 133	Soil: It's the Good Dirt
EARTHSS 156	The Future of Forests
EARTHSS 199	Undergraduate Research (one 4-unit course focused on terrestrial research selected from EARTHSS 199, 198, H198, H199A-H199B-H199C)
One advanced tools course selected from the following:	
EARTHSS 118	Analysis, Modeling, and Visualization of Multidimensionnal Environmental Data
EARTHSS 134	Fundamentals of GIS for Environmental Science
EARTHSS 138	Satellite Remote Sensing for Earth System Science
(These courses may overlap in Major Requirements, Section B.)	

Specialization in Oceanography

Requirements	
Three courses selected from the following:	
EARTHSS 130	Physical Oceanography
EARTHSS 144	Marine Geochemistry and Biogeochemistry
EARTHSS 148	Marine Ecosystems and Global Change

EARTHSS 171	Microbial Biogeochemistry
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	Analysis, Modeling, and Visualization of Multidimensional Environmental Data
EARTHSS 138	Satellite Remote Sensing for Earth System Science
(These courses may overlap in Major Requirements, Section B.)	

Sample Program — Earth System Science

Freshman		
Fall	Winter	Spring
MATH 2A	MATH 2B	STATS 7
CHEM 1A	CHEM 1B	CHEM 1C- 1LC
EARTHSS 1	General Education/Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Sophomore		
Fall	Winter	Spring
EARTHSS 51	EARTHSS 53	EARTHSS 55
PHYSICS 3A	PHYSICS 3B- 3LB	PHYSICS 3C- 3LC
General Education/Elective	General Education/Elective	General Education/Elective
CHEM 1LD	General Education/Elective	General Education/Elective
Junior		
Fall	Winter	Spring
EARTHSS 114	EARTHSS 116	ESS Elective
EARTHSS 192	Approved Elective	ESS Elective
General Education/Elective	General Education/Elective	Elective
Elective	Elective	
Senior		
Fall	Winter	Spring
ESS Elective	ESS Elective	ESS Elective
Approved Elective	Elective	Elective
Elective	Elective	Elective
	Elective	Elective

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 course work 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:

CHEM 193	Research Methods
or PHYSICS 193	Research Methods
EARTHSS 7	Physical Geology ¹
or EARTHSS 140	Advanced Geology
EDUC 55	Knowing and Learning in Mathematics and Science
EDUC 109	Reading and Writing in Mathematics and Science
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)
LPS 60	The Making of Modern Science
PHY SCI 5	California Teach 1: Introduction to Science and Mathematics Teaching
PHY SCI 105	California Teach 2: Middle School Science and Mathematics Teaching

PHYSICS 20A	Introduction to Astronomy
or PHYSICS 20B	Cosmology: Humanity's Place in the Universe

¹ EARTHSS 140 may overlap with the major requirement in section B.

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, visit the Cal Teach website (<http://www.education.uci.edu/calteach/>). 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

Freshman		
Fall	Winter	Spring
MATH 2A	MATH 2B	STATS 7
CHEM 1A	CHEM 1B	CHEM 1C- 1LC
EARTHSS 1	PHYSICS 20A	General Education
Elective	PHY SCI 5	Elective
Sophomore		
Fall	Winter	Spring
EARTHSS 51	EARTHSS 53	EARTHSS 55
PHYSICS 3A	PHYSICS 3B- 3LB	PHYSICS 3C- 3LC
CHEM 1LD	CHEM 193	LPS 60
PHY SCI 105	General Education	EARTHSS 191
Junior		
Fall	Winter	Spring
EARTHSS 114	EARTHSS 116	ESS Elective
EDUC 55	Approved Elective	ESS Elective
General Education	EDUC 143AW	EDUC 148
EARTHSS 192	Elective	
Senior		
Fall	Winter	Spring
EDUC 143BW	EDUC 109	EDUC 158
EARTHSS 140	EDUC 158	ESS Elective
General Education	ESS Elective	Approved Elective

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. Visit the Earth System Science Honors Program website (<https://www.ess.uci.edu/undergrad/ess/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.

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.

- Earth and Atmospheric Sciences, Minor
- Earth System Science, Ph.D.