Department of Earth System Science

3200 Croul Hall
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http://www.ess.uci.edu/

The Department of Earth System Science focuses on understanding the causes and implications of climate and other environmental change, assessing the impact of these changes on society, and developing the science needed to solve environmental challenges. Earth System Science (ESS) is inherently interdisciplinary in scope, linking oceanography, atmospheric and terrestrial sciences, climatology, hydrology, biology, physics, and chemistry with socioeconomic factors and public policy to understand the environment. ESS faculty includes chemists, biologists, ecologists, physicists, hydrologists, geologists, glaciologists, 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.

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

Faculty

Amir Aghakouchak, Ph.D. University of Stuttgart, *Professor of Civil and Environmental Engineering; Earth System Science* (hydrology, climatology, remote sensing of environment, climate extremes, water-energy nexus, climate change, stochastic modeling, water resources management)

Steven D. Allison, Ph.D. Stanford University, *Professor of Ecology and Evolutionary Biology; Earth System Science*

Jane Baldwin, Ph.D. Princeton University, *Assistant Professor of Earth System Science*

Elizabeth D. Crook, Ph.D. University of California, Santa Cruz, *Associate Professor of Teaching of Earth System Science*

Claudia I. Czimczik, Ph.D. Max Planck Institute, *Professor of Earth System Science*

Kristen A. Davis, Ph.D. Stanford University, *Associate Professor of Civil and Environmental Engineering; Earth System Science* (coastal oceanography, fluid mechanics, turbulent flows)

Steven J. Davis, Ph.D. Stanford University, *Professor of Earth System Science; Civil and Environmental Engineering*

Henri F. Drake, Ph.D. Massachusetts Institute of Technology, *Assistant Professor of Earth System Science*

Ellen R. Druffel, Ph.D. University of California, San Diego, *Fred Kavli Chair in Earth System Science and UCI Distinguished Professor of Earth System Science*

Benis Egoh, Ph.D. Stellenboch University, *Assistant Professor of Earth System Science*

Julie E. Ferguson, Ph.D. Oxford University, *Associate Professor of Teaching of Earth System Science*

Efi Foufoula-Georgiou, Ph.D. University of Florida, *Associate Dean of Research and Innovation for the Samueli School of Engineering and Distinguished Professor of Civil and Environmental Engineering; Earth System Science* (hydrology and geomorphology with emphasis on modeling the interactions between the atmosphere, land, and the terrestrial environment at plot to large-watershed scale)

Michael L. Goulden, Ph.D. Stanford University, *Professor of Earth System Science; Ecology and Evolutionary Biology*

Alex Guenther, Ph.D. Washington State University, *Professor of Earth System Science*

Kathleen Johnson, Ph.D. University of California, Berkeley, *Associate Professor of Earth System Science*

Saewung Kim, Ph.D. Georgia Institute of Technology, *Associate Professor of Earth System Science*

Katherine Mackey, Ph.D. Stanford University, *Associate Professor of Earth System Science; Ecology and Evolutionary Biology*

Gudrun Magnusdottir, Ph.D. Colorado State University, *Professor of Earth System Science*

Adam Martiny, Ph.D. Technical University of Denmark, *Professor of Earth System Science; Ecology and Evolutionary Biology*

Jefferson K. Moore, Ph.D. Oregon State University, *Professor of Earth System Science*

Michael J. Prather, Ph.D. Yale University, *Professor Emeritus of Earth System Science*

Francois W. Primeau, Ph.D. Massachusetts Institute of Technology, *Professor of Earth System Science*

Michael S. Pritchard, Ph.D. University of California, San Diego, *Associate Professor of Earth System Science*

James T. Randerson, Ph.D. Stanford University, *UCI Chancellor's Professor of Earth System Science; Civil and Environmental Engineering; Ecology and Evolutionary Biology*

Angela J. Rigden, Ph.D. Boston University, *Assistant Professor of Earth System Science*

Eric Rignot, Ph.D. University of Southern California, *Donald Bren Professor of Earth System Science; Civil and Environmental Engineering*

Eric S. Saltzman, Ph.D. University of Miami, *UCI Distinguished Professor of Earth System Science; Chemistry*

Soroosh Sorooshian, Ph.D. University of California, Los Angeles, *Director of the Center for Hydrometeorology and Remote Sensing (CHRS) and Distinguished Professor of Civil and Environmental Engineering; Earth System Science* (hydrometeorology, water resources systems engineering, climate studies and application of remote sensing to earth science problems with special focus on the hydrologic cycle and water resources issues of arid and semi-arid zones)

Susan E. Trumbore, Ph.D. Columbia University, *Professor of Earth System Science*

Isabella Velicogna, Ph.D. Università degli Studi di Trieste, *UCI Chancellor's Fellow and Professor of Earth System Science*

Jin Yi Yu, Ph.D. University of Washington, *Professor of Earth System Science*

Charles S. Zender, Ph.D. University of Colorado Boulder, *Professor of Earth System Science; Computer Science*

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.

(II and 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 and 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 and 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. Materials fee.

(II and VA).

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.

Overlaps with PUBHLTH 90.

(II and (VA or VIII)).

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.

(II and Vb).

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.

(II and (VA or VIII)).

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.

(II and (VA or VIII)).

EARTHSS 40A. Earth System Chemistry. 4 Units.
To understand the cycling of matter on Earth, we need to learn about the chemistry of elements and molecules in the environment. Introduces students to the understanding of how chemical principles apply in context to their everyday lives.

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment.

(II and VA).

EARTHSS 40B. Earth System Biology. 4 Units.
Earth System Science is a highly interdisciplinary field that requires knowledge of various components of the Earth as a system, including the biosphere. Students are introduced to several fundamental principles of biology, from the smallest cells to the largest ecosystems.

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment.

(II)

EARTHSS 40C. Earth System Physics. 4 Units.
Covers the fundamental physical forces and laws that affect the Earth system, such as electromagnetic radiation and energy transfer, atmospheric and ocean dynamics. Also covers aspects of physics related to environmental issues, such as electricity generation and transmission.

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment.

(II and VA).

EARTHSS 45. New Student Seminar. 1 Unit.
Weekly meetings led by faculty, current students, and staff, to provide information on the Department of Earth System Science, campus resources, and special programs and opportunities. Designed for students who recently joined the Earth System Science and Environmental Science majors.

Grading Option: Pass/no pass only.

Restriction: Environmental Science Majors have first consideration for enrollment. Earth System Science Majors have first consideration for enrollment. New students only (freshman, transfer, and change of major).

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. Materials fee.

Corequisite: CHEM 1C

Restriction: Environmental Science Majors have first consideration for enrollment. Earth System 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 are also reviewed, with an emphasis on California waters.

Prerequisite: CHEM 1C

Restriction: Earth System Science Majors have first consideration for enrollment. 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: PHYSICS 3B or PHYSICS 7C
Prerequisite: (MATH 2B or MATH 5B) and (PHYSICS 3B or PHYSICS 7C)

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

EARTHSS 70A. Sustainable Energy Systems. 4 Units.
Addresses how modern energy services can be provided sustainably and the challenges and barriers that must be overcome. Major environmental issues are discussed, such as climate change, air pollution, and resource demands.

Prerequisite or corequisite: EARTHSS 40C or PHYSICS 3C or PHYSICS 7E

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

EARTHSS 70B. Sustainable Food and Water Systems. 4 Units.
Explores the biophysical underpinnings of food production, the history of agricultural development, and a range of environmental issues facing agricultural systems, including water management, climate change, and land use.

Corequisite: EARTHSS 40B
Prerequisite: EARTHSS 40B or (BIO SCI 93 and BIO SCI 94)

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

EARTHSS 100. Special Topics in Earth System Science. 1-4 Units.
Devoted to current topics in the field of Earth System Science. Topics addressed vary each quarter.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

Repeatability: May be taken for credit for 12 units as topics vary.

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Earth System 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 70A and EARTHSS 70B)

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

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. Materials fee.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

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

EARTHSS 115. Aquatic Field Methods. 4 Units.
Students design sampling plans, conduct field research techniques, and carry out data analyses that are relevant to aquatic field research. Aquatic field sites covered in the course include marine, estuarine, and fluvial systems. Materials fee.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

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

EARTHSS 116. Introduction to Environmental Data Science. 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.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

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

EARTHSS 118. Analysis, Modeling, and Visualization of Multidimensionnal Environmental Data. 4 Units.
Students learn programming and numerical methods in Python with applications in Earth System Science and ecology. Topics include regression, uncertainty and significance, the development of simple box models, and the visualization of multi-dimensional climate and satellite datasets.

Prerequisite: I&C SCI 31 or EARTHSS 116

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System 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 (PHYSICS 7C or PHYSICS 3B)

Restriction: Environmental Science Majors have first consideration for enrollment. Earth System 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 40C or (PHYSICS 3A and PHYSICS 3B and PHYSICS 3C) or (PHYSICS 7C and PHYSICS 7E)

Restriction: Earth System Science Majors have first consideration for enrollment. 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: (PHYSICS 7C or PHYSICS 3B) and EARTHSS 53

Restriction: Earth System 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 51 and EARTHSS 55) or (EARTHSS 40C and EARTHSS 70B)

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

EARTHSS 133. Soil: It's the Good Dirt. 4 Units.
An introduction to the critical role soils play in sustaining land ecosystems and humans. Covers how soils form and how human actions contribute to the pollution and loss but also the health and productivity of soils.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

Restriction: Environmental Science and Policy Majors only. Environmental Science Majors only. Earth System Science Majors only.

EARTHSS 134. Fundamentals of GIS for Environmental Science. 5 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 51 and EARTHSS 53) or (EARTHSS 70A and EARTHSS 70B)

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Earth System 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 and EARTHSS 53) or (EARTHSS 70A and EARTHSS 70B)

Restriction: Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System 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 include geological time, minerals and the rock cycle, plate tectonics and associated geological hazards, earth resources, and earth surface processes. Materials fee.

Prerequisite: EARTHSS 51 or EARTHSS 70B

Overlaps with EARTHSS 7.

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

EARTHSS 141. Air Quality Management. 4 Units.
Fundamental science and terminology of regional air quality issues and developing and implementing the strategies used to prevent and mitigate air pollution impacts. Topics include setting regional air quality goals, applying measurements and numerical models, cost/benefits analysis, evaluation and enforcement.

Prerequisite: EARTHSS 40A and EARTHSS 40B and EARTHSS 40C

Restriction: Environmental Science and Policy 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 M2C or CHEM H2C or CHEM M3C) and (PHYSICS 3C or PHYSICS 7E) and (MATH 2B or MATH 5B or AP Calculus BC). AP Calculus BC with a minimum score of 4

Restriction: Earth System Science Majors have first consideration for enrollment. 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 CHEM 51C

Restriction: School of Physical Sciences students have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System 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 explores the impacts of air pollution from the beginning of human history to current and emerging issues. Scientific concepts behind air pollution and solutions are discussed.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 40C and EARTHSS 70A)

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

EARTHSS 148. Marine Ecosystems and Global Change. 4 Units.
Presents an overview of marine ecosystem structure, diversity, and processes in the context of global change, including the impacts of climate warming, ocean acidification, marine fisheries, and anthropogenic additions of nutrients and pollutants.

Prerequisite: EARTHSS 53 or (EARTHSS 70A and EARTHSS 70B)

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

Concurrent with EARTHSS 248.

EARTHSS 154. Ecosystem Services. 4 Units.
Covers what ecosystem services are, how to classify them, what the impacts of land degradation are on ecosystem services, how to quantify and value them, and the importance of mainstreaming ecosystem services in decision-making.

Prerequisite: (EARTHSS 70A and EARTHSS 70B) or (EARTHSS 51 and EARTHSS 53 and EARTHSS 55)

EARTHSS 156. The Future of Forests. 4 Units.
Introduces students to the determinants of global forest distribution; ecosystem services associated with forest functioning; threats to forests resulting from climate and land-use change; and, opportunities for conserving natural forests in the near future.

Prerequisite: (EARTHSS 70A and EARTHSS 70B) or (EARTHSS 51 and EARTHSS 53 and EARTHSS 55)

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

EARTHSS 162. The Impact of Climate Change on California's Landscape. 4 Units.
Overview of anticipated impacts of climate change on California's landscape. Includes projections of future climate; anticipated impacts on ecology, hydrology, wildfire, coastal environment, and agriculture; and efforts to reduce greenhouse gas emissions or adapt to climate change through land management.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

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

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: BIO SCI E106 or EARTHSS 51 or EARTHSS 60A or CHEM 51C

Same as BIO SCI E118.

Restriction: Earth System Science Majors have first consideration for enrollment. Ecology and Evolutionary Biol Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment.

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 BIO SCI 94 or (EARTHSS 60A and EARTHSS 60C)

Same as BIO SCI E127.

Restriction: Biological Sciences Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System Science Majors have first consideration for enrollment.

EARTHSS 171. Microbial Biogeochemistry. 4 Units.
Develops an understanding of microorganisms in the context of their environment, environmental impact, and role in the global cycles of C,N,P, etc. Focuses on tools used to evaluate microbial diversity and function, and applications of microbial ecology.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B)

Restriction: Environmental Science and Policy Majors only. Environmental Science Majors only. Earth System Science Majors only.

EARTHSS 176W. Marine Conservation, Policy, and Society. 4 Units.
Conservation of marine ecosystems is important yet challenging due to competing physical, ecological, social, and regulatory issues. Students explore the principles of marine conservation, the scientific basics of marine ecosystems, and political and social processes involved with resource protection.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B). Satisfactory completion of the Lower-Division Writing requirement.

Restriction: Upper-division students only. Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System Science Majors have first consideration for enrollment.

(Ib)

EARTHSS 177W. Documenting and Understanding Earth System Change. 4 Units.
Students select a time series of key environmental interest as the focus for their writing.They become familiar with common writing practices for the Earth Sciences, and exercise their ability to use the scientific method to produce reports.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B). Satisfactory completion of the Lower-Division Writing requirement.

Restriction: Upper-division students only. Environmental Science and Policy Majors only. Environmental Science Majors only. Earth System Science Majors only.

(Ib)

EARTHSS 179. Climate Solutions. 4 Units.
Introduction to climate change science and impacts on the health of people and the planet with a focus on the multi-dimensional aspects of solutions to the climate crisis.

Same as ENGRMAE 119, UPPP 111.

Restriction: Upper-division students only.

EARTHSS 184. Understanding the Carbon Cycle for Climate Change Solutions. 4 Units.
Covers the scientific principles of the carbon cycle and tools for climate change mitigation. Topics include carbon dioxide buildup, its relation to climate change, achieving net-zero emissions, and proposed sequestration technologies. Also explores economic and equity implications.

Prerequisite: (EARTHSS 51 and EARTHSS 53 and EARTHSS 55) or (EARTHSS 70A and EARTHSS 70B) or (CHEM 1C and MATH 2B)

Restriction: Earth System Science Majors have first consideration for enrollment. Environmental Science and Policy 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 is also required. Seminar utilized to analyze forum presentations. Prepare bibliography.

Same as BIO SCI 191A, SOCECOL 186A.

Restriction: Seniors only. Global Sustainability Minors have first consideration for enrollment.

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 is also required. Seminar utilized to analyze forum presentations. Prepare research proposal.

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

Same as BIO SCI 191B, SOCECOL 186B.

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. 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.

(Ib)

EARTHSS 191. Introduction to Research in Earth System Science. 1 Unit.
Weekly presentations by Earth System Science faculty describing ongoing research in their laboratories. Students are introduced to the range of research topics and methods in Earth System Science and to the research opportunities available within the Department.

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

Grading Option: Pass/no pass only.

Restriction: Earth & Atmospheric Sciences Minors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System Science Majors 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: Environmental Science and Policy Majors have first consideration for enrollment. Environmental Science Majors have first consideration for enrollment. Earth System Science Majors have first consideration for enrollment.

EARTHSS 197. Independent Study in Earth System Science. .5-4 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 198W. 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. Satisfactory completion of the Lower-Division Writing requirement.

Overlaps with EARTHSS H198.

(Ib)

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: ESS 199A and ESS 199B

Restriction: Consent of instructor to enroll and Prerequisite required

(Ib)

EARTHSS 199. Undergraduate Research. 1-4 Units.
For undergraduates 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.

Repeatability: May be taken for credit for 12 units.

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 students only. Campuswide Honors Collegium 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 students only. Campuswide Honors Collegium 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 students only. Campuswide Honors Collegium students only.

EARTHSS 200. Global Physical Climatology. 4 Units.
A descriptive overview of Earth's climate system and energy budget. Large-scale circulations, key physical processes, and climate sensitivity of the atmosphere, ocean, land surface, and cryosphere.

Restriction: Graduate students only.

EARTHSS 204. Humans in the Earth System. 4 Units.
Focuses on the human systems of energy and food production which have the greatest effects on the Earth system. Assess the physical mechanisms and feedbacks of human-nature interactions and consider approaches of mitigation, interventions, and adaptation.

Restriction: Graduate students only. Earth System Science Majors only.

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 215. Cryosphere. 4 Units.
A global perspective of the major components of the cryosphere. Includes current extent and trends, mass balance, energetics, and physical processes. Quantitative assessment of current state, in situ and remote observations, and interactions with climate.

Restriction: Graduate students only.

EARTHSS 225. Marine Biogeochemistry. 4 Units.
Overview of ocean biology and biogeochemistry, with a focus on lower trophic levels and the roles of biota in the marine biogeochemical cycles of key elements.

Restriction: Doctor of Philosophy Degree students have first consideration for enrollment. Graduate students only. Earth System Science Majors have first consideration for enrollment.

EARTHSS 226. Land Surface Processes. 4 Units.
A mechanistic perspective of the structure and functioning of terrestrial ecosystems. Includes processes such as nutrient cycling, biogeochemical cycling, mass balance, energetics, terrestrial hydrology, and water cycle.

Restriction: Graduate students only.

EARTHSS 230. 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 7A and PHYSICS 7B and PHYSICS 7E

Restriction: Graduate students only.

EARTHSS 238. 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.

EARTHSS 242. Advanced 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.

Restriction: Graduate students only.

EARTHSS 244. Introduction to Atmospheric Dynamics. 4 Units.
Covers fundamentals of atmospheric dynamics including thermodynamics, quasi-geostrophy, the weak-temperature gradient of the tropics, and the turbulent boundary layer.

Restriction: Graduate students only.

EARTHSS 248. Marine Ecosystems and Global Change. 4 Units.
Presents an overview of marine ecosystem structure, diversity, and processes in the context of global change, including the impacts of climate warming, ocean acidification, marine fisheries, and anthropogenic additions of nutrients and pollutants.

Prerequisite: EARTHSS 224. EARTHSS 224 with a grade of B- or better

Restriction: Graduate students only.

EARTHSS 256. Paleoclimatology and Paleoceanography. 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.

Restriction: Graduate students only.

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

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 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. EARTHSS 280A with a grade of B- or better

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. EARTHSS 280B with a grade of B- or better

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. EARTHSS 286A with a grade of B- or better

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. EARTHSS 286B with a grade of B- or better

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

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. EARTHSS 288B with a grade of B- or better

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 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.