EARTH AND ENVIRONMENTAL SCIENCES

Departmental Offices:
556-7 Schermerhorn Hall Extension | 212-854-4525
106 Geoscience, Lamont-Doherty Earth Observatory | 845-365-8550
http://eesc.columbia.edu

Chair of Department:
Prof. Jerry McManus jmcmanus@ldeo.columbia.edu

Directors of Undergraduate Studies:
Prof. Meredith Nettles and Prof. Kerry Key dees-dus@columbia.edu

Director of Academic Administration and Finance:
Kaleigh Matthews
107 Geoscience, Lamont-Doherty Earth Observatory
845-365-8551 | kaleighm@ldeo.columbia.edu

Undergraduate Program Manager:
Anastasia Yankopoulos, 557 Schermerhorn Hall Extension
212-854-3614 | a.yankopoulos@columbia.edu
(aty2113@columbia.edu)

The undergraduate major in Earth and environmental sciences provides an understanding of the natural functioning of our planet and considers the consequences of human interactions with it. Our program for majors aims to convey an understanding of how the complex Earth system works at a level that encourages students to think creatively about the Earth system processes and how to address multidisciplinary environmental problems. The breadth of material covered provides an excellent background for those planning to enter the professions of law, business, diplomacy, public policy, teaching, journalism, etc. At the same time, the program provides sufficient depth so that our graduates are prepared for graduate school in one of the Earth sciences. The program can be adjusted to accommodate students with particular career goals in mind.

The department's close affiliations with the Lamont-Doherty Earth Observatory, the American Museum of Natural History (AMNH), NASA's Goddard Institute for Space Studies (GISS), the Earth Institute at Columbia (EI), and several departments within the Fu Foundation School of Engineering and Applied Sciences afford opportunities for student participation in a wide variety of current research programs. Summer employment, research, and additional educational opportunities are available at Lamont and GISS. The department encourages majors to become involved in a research project by their junior year.

All majors and concentrators, when planning their programs of study, should regularly consult the directors of undergraduate studies and make themselves aware of the requirements for their particular program.

Programs of Study

Environmental Science Major
The environmental science major curriculum provides an introduction to a variety of fields of study relevant to the environment. Environmental science majors are required to take three semesters of introductory courses and to develop a grounding in basic physics, chemistry, biology, and mathematics. Here, students may select courses depending on their interest. With this introduction to the Earth's environment and equipped with a knowledge of the basic sciences, students are prepared to choose a set of upper-level courses in consultation with an undergraduate adviser. All environmental science majors are required to complete a research project, providing a practical application of mastered course work. This research culminates in a senior thesis. The research and the thesis are usually done at Lamont-Doherty Earth Observatory with guidance from a faculty member or a research scientist. However, other options are also possible.

Environmental science majors have an option to complete the special concentration in environmental biology for environmental science majors.

Earth Science Major
The major in Earth science follows a similar rationale but is designed to allow students to pursue particular fields of the Earth sciences in greater depth. Compared with the environmental science major, one fewer introductory course is required, while one additional advanced course should be part of the plan of study. The Earth science major also offers the possibility of in-depth field experience through a six- to eight-week geology summer field course, arrangements for which are made through another university. The research and senior thesis capstone requirements are the same as for the environmental science major. The geology summer field course may be used as an alternative means of fulfilling the capstone requirement in the Earth science major.

Concentrations
The program for concentrators serves students who want more exposure to Earth and environmental science than is provided by introductory-level courses. The program aims to provide concentrators with experience in data analysis and a thorough introduction to the Earth's systems.

The concentrations in environmental science and in Earth science are designed to give students an understanding of how the Earth works and an introduction to the methods used to investigate Earth processes, including their capabilities and limitations. Concentrators often join the social professions (e.g., business, law, medicine, etc.) and take with them a strong scientific background. They take the same introductory courses as the majors, but fewer basic science and upper-level courses are required.

In addition to the environmental science and Earth science concentrations, the department sponsors a special concentration which must be done in conjunction with the environmental biology major. Students should be aware that they must complete the environmental biology major in order to receive credit for the special concentration. There is also a special concentration in environmental biology for environmental science majors sponsored by the Department of Ecology, Evolution, and Environmental Biology.

Departmental Honors
The Department of Earth and Environmental Science awards departmental honors to the major or majors in Earth science or environmental science judged to have the best overall academic record. The award is accorded to no more than 10% of the graduating class, or one student in the case of a class smaller than 10. A grade point average of at least 3.6 in the major and a senior thesis or equivalent research of high quality are required. Students who wish to be considered should contact the director of undergraduate studies early in their senior year.
Professors
Nicholas Christie-Blick
Joel E. Cohen
Peter B. de Menocal
Hugh Ducklow
Sonya Dyhrman
Peter Eisenberger
Göran Ekström
Arlene M. Fiore
Steven L. Goldstein
Arnold L. Gordon
Kevin L. Griffin
Alex Halliday
Sidney R. Hemming (Chair)
Galen McKinley
Jerry F. McManus (Associate Chair)
William H. Menke
John C. Mutter
Meredith Nettles
Paul E. Olsen
Terry A. Plank
Lorenzo M. Polvani
G. Michael Purdy
Peter Schlosser
Christopher H. Scholz
Adam H. Sobel
Sean C. Solomon
Marc Spiegelman
Martin Stute (Barnard)
Maria Tolstoy
Renata Wentzcovich

Associate Professors
Ryan Abernathey
Kerry Key
Heather Savage

Assistant Professors
Jacqueline Austermann
Roisin Commane
Jonathan Kingslake
Yves Moussallam

Adjunct Professors
Joerg M. Schaefer
Christopher Small
Minfang Ting
Felix Waldhauser
Spahr C. Webb
Gisela Winckler

Adjunct Associate Professors
Alessandra Giannini
Andrew Juhl

Lecturers
Pietro Ceccato
Cornelia Class
Andreas Turnherr
Kevin Uno
Christopher Zappa

Associates
Erin Coughlin
Brian Kahn
Andrew Kruczkiewicz
Catherine Vaughan

Emeritus
Mark Cane
James Hays
Paul Richards
Lynn Sykes
David Walker

Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators

Advising
All majors and concentrators, when planning their programs of study, should regularly consult the directors of undergraduate studies, who can be contacted through the department office on the fifth floor of Schermerhorn. The requirements are different for each major and concentration and must be met in conjunction with the general requirements for the bachelor's degree. Declaration of the major must be approved by the department and filed in the departmental office.

Substitutions and Exceptions
1. Higher-level courses may be used to satisfy supporting mathematics and science requirements for students with Advanced Placement preparation with the permission of the major adviser.
2. In addition to the courses listed for the depth, and breadth and related courses requirements, several graduate-level courses offered in the department as well as several advanced courses offered at Barnard may be substituted with the permission of the major adviser.
3. 1000-level courses in the Earth and Environmental Sciences Department can not be used toward meeting the requirements of any of the majors, concentrations, or special concentrations.
4. The following course is not suitable for undergraduates and can not be used toward meeting any of the requirements for the majors,
concentrations, or special concentrations: EESC GU4930 Earth's Oceans and Atmosphere.

Grading
A grade of C- or better must be obtained for a course to count toward the majors, concentrations, or special concentrations. The grade of P is not acceptable, but a course taken Pass/D/Fail may be counted if and only if the P is uncovered by the Registrar’s deadline.

Major in Earth Science
Please read Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators above.

The major in Earth science requires a minimum of 45.5 points, distributed as follows:

Foundation Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC UN2100</td>
<td>Earth's Environmental Systems: The Climate System</td>
</tr>
<tr>
<td>EESC UN2200</td>
<td>EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH</td>
</tr>
</tbody>
</table>

Students who wish to take both EESC UN2100 Earth's Environmental Systems: The Climate System and EESC UN2300 Earth's Environmental Systems: The Life System can include one of these under breadth and related fields below.

Supporting Mathematics and Science Courses

One semester of Calculus at the level of Calculus I or higher (3 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH UN1101</td>
<td>CALCULUS I</td>
</tr>
</tbody>
</table>

Select one of the following three-course sequences:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM UN1403</td>
<td>GENERAL CHEMISTRY I-LECTURES and GENERAL CHEMISTRY II-LECTURES and General Physics I</td>
</tr>
<tr>
<td>CHEM UN1403</td>
<td>GENERAL CHEMISTRY I-LECTURES and General Physics I and General Physics II</td>
</tr>
</tbody>
</table>

Capstone Experience

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC BC3800</td>
<td>Senior Research Seminar and Environmental Science Senior Seminar</td>
</tr>
<tr>
<td>EESC BC3800</td>
<td>Senior Research Seminar and Environmental Science Senior Seminar</td>
</tr>
</tbody>
</table>

A six to eight week summer geology field course

Breadth and Related Fields Requirement

A minimum of 6 points (two courses) chosen with the major adviser are required.

Breadth and related field courses are science courses relevant for an Earth science major that do not require an Earth science background. Several such courses are offered at the 2000-, 3000- and 4000-level in the department and at Barnard. Examples include:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC UN2100</td>
<td>Earth's Environmental Systems: The Climate System</td>
</tr>
<tr>
<td>EESC UN2300</td>
<td>Earth's Environmental Systems: The Life System</td>
</tr>
</tbody>
</table>

Also included among breadth and related fields courses are science, mathematics, statistics, and engineering courses offered by other departments that count toward fulfilling degree requirements in those departments.

Depth Requirement

A minimum of 12 points (four courses) chosen with the major adviser to provide depth in the field of Earth science.

These courses build on the foundation and supporting courses listed above and provide a coherent focus in some area of Earth science. Students should include at least one of the following in their course of study.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC UN3101</td>
<td>Geochemistry for a Habitable Planet</td>
</tr>
<tr>
<td>EESC UN3201</td>
<td>Solid Earth Dynamics</td>
</tr>
</tbody>
</table>

Areas of focus include one of the courses listed above and three or more additional courses. Students are not required to specialize in a focus area, but examples are given below for those who choose to do so.

Geological Science

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC GU4090</td>
<td>Introduction to Geochronology and Thermochronology</td>
</tr>
<tr>
<td>EESC GU4113</td>
<td>INTRODUCTION TO MINERALOGY I</td>
</tr>
<tr>
<td>EESC GU4223</td>
<td>SEDIMENTARY GEOLOGY</td>
</tr>
<tr>
<td>EESC GU4230</td>
<td>CRUSTAL DEFORMATION</td>
</tr>
<tr>
<td>EESC GU4701</td>
<td>Introduction to Igneous Petrology</td>
</tr>
<tr>
<td>EESC GU4887</td>
<td>ISOTOPE GEOLOGY I</td>
</tr>
<tr>
<td>EESC GU4947</td>
<td>PLATE TECTONICS</td>
</tr>
</tbody>
</table>

It is strongly recommended that students focusing in geological science take the summer geology field course as their capstone experience.

Geochemistry

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC UN3015</td>
<td>The Earth's Carbon Cycle</td>
</tr>
<tr>
<td>EESC BC3016</td>
<td>Environmental Measurements</td>
</tr>
<tr>
<td>EESC BC3200</td>
<td>Ecotoxicology</td>
</tr>
<tr>
<td>EESC GU4090</td>
<td>Introduction to Geochronology and Thermochronology</td>
</tr>
<tr>
<td>EESC GU4113</td>
<td>INTRODUCTION TO MINERALOGY I</td>
</tr>
<tr>
<td>EESC GU4701</td>
<td>Introduction to Igneous Petrology</td>
</tr>
<tr>
<td>EESC GU4885</td>
<td>The Chemistry of Continental Waters</td>
</tr>
<tr>
<td>EESC GU4887</td>
<td>ISOTOPE GEOLOGY I</td>
</tr>
<tr>
<td>EESC GU4926</td>
<td>Principles of Chemical Oceanography</td>
</tr>
</tbody>
</table>

It is recommended that students focusing in geochemistry take CHEM UN1403-CHEM UN1404 General Chemistry I and II, and PHYS UN1201 General Physics I as their supporting science sequence.

Atmosphere and Ocean Science

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC GU4008</td>
<td>Introduction to Atmospheric Science</td>
</tr>
<tr>
<td>EESC GU4920</td>
<td>Paleoclimatology</td>
</tr>
<tr>
<td>EESC GU4924</td>
<td>Introduction to Atmospheric Chemistry</td>
</tr>
<tr>
<td>EESC GU4925</td>
<td>Principles of Physical Oceanography</td>
</tr>
<tr>
<td>EESC GU4926</td>
<td>Principles of Chemical Oceanography</td>
</tr>
</tbody>
</table>
It is recommended that students focusing on atmosphere and ocean science also take a course in fluid dynamics and a course in differential equations.

**Solid Earth Geophysics**

- EESC GU4230 CRUSTAL DEFORMATION
- EESC GU4300 The Earth's Deep Interior
- EESC GU4937 Cenozoic Paleoenography
- EESC GU4947 PLATE TECTONICS
- EESC GU4949 Introduction to Seismology

It is recommended that students focusing in solid Earth geophysics take PHYS UN1201-PHYS UN1202 General Physics I and II, and CHEM UN1403 General Chemistry I as their supporting science sequence and also take MATH UN1201 Calculus II.

**Climate**

- EESC UN3015 The Earth's Carbon Cycle
- EESC BC3025 Hydrology
- EESC GU4008 Introduction to Atmospheric Science
- EESC GU4330 Introduction to Terrestrial Paleoclimate
- EESC GU4835 Wetlands and Climate Change
- EESC GU4920 Paleoenography
- EESC GU4924 Introduction to Atmospheric Chemistry
- EESC GU4925 Principles of Physical Oceanography
- EESC GU4937 Cenozoic Paleoenography

**Paleontology**

- EESC GU4223 SEDIMENTARY GEOLOGY
- EESC GU4550 Plant Ecophysiology
- EESC GU4920 Paleoenography
- EESC GU4924 Introduction to Atmospheric Chemistry
- EESC GU4937 Cenozoic Paleoenography

It is recommended that students focusing in paleontology take EESC UN2300 Earth's Environmental Systems: The Life System, as one of their foundation courses.

**Major in Environmental Science**

Please read Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators above.

The major in environmental science requires a minimum of 47 points, distributed as follows:

**Foundation Courses**

- EESC UN2100 Earth's Environmental Systems: The Climate System
- EESC UN2200 EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
- EESC UN2300 Earth's Environmental Systems: The Life System

**Supporting Mathematics and Science Courses**

One semester of Calculus at the level of Calculus I or higher (3 credits)

- MATH UN1101 CALCULUS I

Select one of the following three-course sequences:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM UN1403</td>
<td>GENERAL CHEMISTRY I-LECTURES and General Physics I</td>
</tr>
<tr>
<td>CHEM UN1404</td>
<td>GENERAL CHEMISTRY II-LECTURES and General Physics I</td>
</tr>
<tr>
<td>PHYS UN1201</td>
<td>Calculus I</td>
</tr>
<tr>
<td>CHEM UN1403</td>
<td>GENERAL CHEMISTRY I-LECTURES and General Physics I</td>
</tr>
<tr>
<td>PHYS UN1201</td>
<td>Calculus I</td>
</tr>
<tr>
<td>PHYS UN1202</td>
<td>Calculus I</td>
</tr>
</tbody>
</table>

**Capstone Experience**

- EESC BC3800 Senior Research Seminar
- EESC BC3801 Senior Research Seminar
- EESC UN3901 Environmental Science Senior Seminar

**Breadth and Related Fields Requirement**

A minimum of 6 points (two courses) chosen with the major adviser are required.

Breadth and related field courses are science courses relevant for an environmental science major that do not require an environmental science background. Several such courses are offered at the 2000-, 3000- and 4000-level in the department and at Barnard. Examples include:

- EESC BC3017 Environmental Data Analysis
- EESC GU4050 Global Assessment and Monitoring Using Remote Sensing
- EESC GU4600 EARTH RESOURCES # SUSTAIN DEV
- EESC GU4917 Earth/Human Interactions
- EESC UN3010 Field Geology

Also included among breadth and related fields courses are science, mathematics, statistics, and engineering courses offered by other departments that count toward fulfilling degree requirements in those departments.

**Depth Requirement**

A minimum of 9 points (three courses) chosen with the major adviser to provide depth in the field of environmental science.

These courses build on the foundation and supporting courses listed above and provide a coherent focus in some area of environmental science. Students should include at least one of the following in their course of study:

- EESC UN3101 Geochemistry for a Habitable Planet
- EESC UN3201 Solid Earth Dynamics

Areas of focus include one of the courses listed above and two or more additional courses. Students are not required to specialize in a focus area, but examples are given below for those who choose to do so.

**Environmental Geochemistry**

- EESC UN3015 The Earth’s Carbon Cycle
- EESC GU4885 The Chemistry of Continental Waters
- EESC GU4887 ISOTOPE GEOLOGY I
- EESC GU4924 Introduction to Atmospheric Chemistry
- EESC GU4926 Principles of Chemical Oceanography
- EESC GU4927 Stable Isotope Geochemistry
- EESC GU4929 Principles of Chemical Oceanography

**Environmental Geology**

- EESC GU4076 Geologic Mapping
- EESC GU4480 Paleobiology and Earth System History
- EAAE E3221

It is recommended that students focusing in environmental geology also take EESC W4050 Remote Sensing.

**Environmental Geochemistry**

- EESC UN3015 The Earth’s Carbon Cycle
- EESC GU4885 The Chemistry of Continental Waters
- EESC GU4887 ISOTOPE GEOLOGY I
- EESC GU4924 Introduction to Atmospheric Chemistry
- EESC GU4926 Principles of Chemical Oceanography
- EESC GU4927 Stable Isotope Geochemistry
- EESC GU4929 Principles of Chemical Oceanography

**Hydrology**

- EESC GU4076 Geologic Mapping
Concentration in Earth Science
Please read Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators above.

The concentration in Earth science requires a minimum of 25 points, distributed as follows:

Foundation Courses
EESC UN2100 Earth's Environmental Systems: The Climate System
or EESC UN2200 Earth's Environmental Systems: The Life System
EESC UN2300 EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH

Supporting Mathematics and Science Courses
Two science or mathematics courses (6-7 points) selected from among those listed for the Earth science major above.

Depth and Breadth and Related Fields Requirements
A minimum of 10 points (typically three courses) is required as follows:
EESC UN3101 Geochemistry for a Habitable Planet
or EESC UN3201 Solid Earth Dynamics
One additional course selected from those listed under either Depth Requirement or Breadth and Related Fields Requirement for the earth science major above.

Concentration in Environmental Science
Please read Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators above.

The concentration in environmental science requires a minimum of 25.5 points, distributed as follows:

Foundation Courses
EESC UN2100 Earth's Environmental Systems: The Climate System

Supporting Mathematics and Science Courses
Two science or mathematics courses (6-7 points) selected from among those listed for the environmental science major above.

Depth and Breadth and Related Fields Requirements
A minimum of 6 points (two courses) is required as follows:
EESC UN3101 Geochemistry for a Habitable Planet
or EESC UN3201 Solid Earth Dynamics
One additional course selected from those listed under either Depth Requirement or Breadth and Related Fields Requirement for the environmental science major above.

Special Concentration in Environmental Science for Majors in Environmental Biology
Please read Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators above.

The Department of Earth and Environmental Sciences sponsors a special concentration which must be done in conjunction with the environmental biology major. Students should be aware that they must complete the environmental biology major in order to receive credit for the special concentration.

The special concentration in environmental science requires a minimum of 31.5 points, distributed as follows:

Introductory Environmental Science (13.5 points)
EESC UN2100 Earth's Environmental Systems: The Climate System
EESC UN2200 EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300 Earth's Environmental Systems: The Life System

Introductory Science (6 points)
Two courses in chemistry, physics, mathematics, or environmental biology from the supporting mathematics and science list for the environmental science major above.

Advanced Environmental Science (12 points)
Four courses at the 3000-level or above chosen from those recommended for the environmental science major above.

Advanced courses used to fulfill requirements in the environmental biology major cannot count toward requirements for the special concentration.
Special Concentration in Environmental Biology for Majors in Environmental Science

Please read Guidelines for all Earth and Environmental Sciences Majors, Concentrators, and Special Concentrators above.

The Department of Ecology, Evolution, and Environmental Biology sponsors a special concentration which must be done in conjunction with the environmental science major. Students should be aware that they must complete the environmental science major in order to receive credit for the special concentration.

The special concentration in environmental biology requires a minimum of 39 points, distributed as follows:

**Introductory Environmental Biology and Environmental Science (17 points)**

- **EEEB UN2001** Environmental Biology I: Elements to Organisms
- **EESC UN2100** Earth's Environmental Systems: The Climate System
- **EESC UN2200** Earth's Environmental Systems: The Solid Earth
- **EEEB UN2002** Environmental Biology II: Organisms to the Biosphere

**Introductory Science (13 points)**

Select one of the following chemistry sequences:

- **CHEM UN1403** - CHEM UN1404 General Chemistry I-Lectures and General Chemistry II-Lectures
- **CHEM UN1604** - CHEM UN2507 2nd Term Gen Chem (Intensive) and Intensive General Chemistry Laboratory

One term of statistics such as the following:

- **STAT UN1101** Introduction to Statistics
- **STAT UN1201** Calculus-Based Introduction to Statistics
- **BIOL BC2286** Statistics and Research Design
- **EEEB UN3005** Introduction to Statistics for Ecology and Evolutionary Biology
- **EEEB UN3087** Conservation Biology

**Advanced Environmental Biology (9 points)**

Three additional advanced EEEB courses (3000-level and above), each chosen from a different curricular area (evolution/genetics, ecology/behavior/conservation, anatomy/physiology/diversity, biology laboratory courses).

Advanced courses used to fulfill requirements in the environmental science major cannot count toward requirements for the special concentration.

**Sustainable Development**

Students interested in sustainable development should refer to the Sustainable Development section in this Bulletin.

---

**Fall 2022**

**EEESC UN1001 DINOSAURS AND HISTORY OF LIFE. 4.00 points.**

CC/GS: Partial Fulfillment of Science Requirement

Given in alternate years.

Prerequisites: Partial Fulfillment of Science Requirement

Prerequisites: Recommended preparation: basic high school science and math.

Prerequisites: Recommended preparation: basic high school science and math. Lab is a hands-on introduction to geochronology, paleontology, and historical geology with field trips. (See W1401 for lectures only.) Dinosaurs: a spectacular example of a common, highly successful form of life, dominant for 135 million years. Where did they come from? Why were they so successful? Why did they die out? ... or did they? A basic introduction to the historical sciences and the interface between geology and biology

**EEESC UN1030 OCEANOGRAPHY. 3.00 points.**

CC/GS: Partial Fulfillment of Science Requirement

Enrollment limited to 160.

Explore the geology of the sea floor, understand what drives ocean currents and how ocean ecosystems operate. Case studies and discussions centered on ocean-related issues facing society

**EEESC UN1401 DINOSAURS & HISTORY OF LIFE-LEC. 3.00 points.**

CC/GS: Partial Fulfillment of Science Requirement

Given in alternate years.

Prerequisites: Recommended preparation: basic high school science and math.

Prerequisites: Recommended preparation: basic high school science and math. Dinosaurs: a spectacular example of a common, highly successful form of life, dominant for 135 million years. Where did they come from? Why were they so successful? Why did they die out? ... or did they? A basic introduction to the historical sciences and the interface between geology and biology

---

**Fall 2022**

**Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment**

**EEESC 1001**

- **001/11574** M W 1:10pm - 2:25pm Room TBA
  - Paul Olsen
  - 4.00
  - 36/40

**EEESC 1001**

- **001/11574** M 4:10pm - 7:00pm 603 Schermerhorn Hall
  - Paul Olsen
  - 4.00
  - 36/40

**EEESC UN1030**

- **001/11575** T Th 10:10am - 11:25am Room TBA
  - Baerbel Hoenisch
  - 3.00
  - 134/160

**EEESC UN1401**

- **001/11576** M W 1:10pm - 2:25pm Room TBA
  - Paul Olsen
  - 3.00
  - 40/100
**EESC UN1600 Earth Resources and Sustainable Development. 3 points.**
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: none; high school chemistry recommended.
Survey of the origin and extent of mineral resources, fossil fuels, and industrial materials, that are non renewable, finite resources, and the environmental consequences of their extraction and use, using the textbook Earth Resources and the Environment, by James Craig, David Vaughan and Brian Skinner. This course will provide an overview, but will include focus on topics of current societal relevance, including estimated reserves and extraction costs for fossil fuels, geological storage of CO2, sources and disposal methods for nuclear energy fuels, sources and future for luxury goods such as gold and diamonds, and special, rare materials used in consumer electronics (e.g., “Coltan”, mostly from Congo) and in newly emerging technologies such as superconducting magnets and rechargeable batteries (e.g., heavy rare earth elements, mostly from China). Guest lectures from economists, commodity traders and resource geologists will provide “real world” input. Discussion Session Required.

---

**EESC UN2100 Earth's Environmental Systems: The Climate System. 4.5 points.**
Priority given to Columbia and Barnard earth science, environmental science, and environmental biology majors should enrollment limits be reinstated.

Prerequisites: high school algebra. Recommended preparation: high school chemistry and physics; and one semester of college science.
Origin and development of the atmosphere and oceans, formation of winds, storms and ocean currents, reasons for changes through geologic time. Recent influence of human activity: the ozone hole, global warming, water pollution. Laboratory exploration of topics through demonstrations, experimentation, computer data analysis, and modeling. Students majoring in Earth and Environmental Sciences should plan to take EESC W2100 before their senior year to avoid conflicts with Senior Seminar.
EESC UN2200 Earth's Environmental Systems: The Solid Earth. 4.50 points.
CC/GS: Partial Fulfillment of Science Requirement
Priority given to Columbia and Barnard earth science, environmental science, and environmental biology majors should enrollment limits be necessary.

Prerequisites: high school algebra and chemistry. Recommended preparation: high school physics.
Recommended preparation: high school chemistry and physics; and one semester of college science. Exploration of how the solid Earth works, today and in the past, focusing on Earth in the Solar system, continents and oceans, the Earth's history, mountain systems on land and sea, minerals and rocks, weathering and erosion, glaciers and ice sheets, the hydrological cycle and rivers, geochronology, plate tectonics, earthquakes, volcanoes, energy resources. Laboratory exploration of topics through examination of rock samples, experimentation, computer data analysis, field exercises, and modeling. Columbia and Barnard majors should plan to take W2200 before their senior year to avoid conflicts with the Senior Seminar.

Spring 2022: EESC UN2200

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2200</td>
<td>001/11918</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Sedelia Rodriguez, William Menke</td>
<td>4.50</td>
<td>46/50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6:03 Schermerhorn Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EESC 2200</td>
<td>001/11918</td>
<td>T 4:10pm - 7:00pm</td>
<td>Sedelia Rodriguez, William Menke</td>
<td>4.50</td>
<td>46/50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6:03 Schermerhorn Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fall 2022: EESC UN2200

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2200</td>
<td>001/11579</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
<td>50/50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6:03 Schermerhorn Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EESC 2200</td>
<td>001/11579</td>
<td>Th 4:10pm - 7:00pm</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
<td>50/50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6:03 Schermerhorn Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EESC UN3101 Geochemistry for a Habitable Planet. 3 points.
Prerequisites: Any 1000-level or 2000-level EESC course; MATH UN1101 Calculus I and CHEM UN1403 General Chemistry I or their equivalents. The origin, evolution, and future of our planet, based on the book How to Build a Habitable Planet by Wallace S. Broecker. This course will focus on the geochemical processes that built Earth from solar material, led to its differentiation into continents and ocean, and have maintained its surface at a comfortable temperature. Students will participate in a hands-on geochemistry project at Lamont-Doherty Earth Observatory.

Spring 2022: EESC UN3101

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 3101</td>
<td>001/11581</td>
<td>T Th 10:10am - 11:25am</td>
<td>Terry Plank</td>
<td>3</td>
<td>24/35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>417 Schermerhorn Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EESC UN3901 Environmental Science Senior Seminar. 3 points.
Prerequisites: EESC BC3800 or EESC BC3801 and a good grounding in basic sciences.
Guided, independent, in-depth research culminating in the senior thesis in the spring. Includes discussion about scientific presentations and posters, data analysis, library research methods and scientific writing. Students review work in progress and share reports through oral presentations. Weekly seminar to review work in progress and share results through oral and written reports.

Spring 2022: EESC UN3901

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 3901</td>
<td>001/11940</td>
<td>Th 4:10pm - 6:00pm</td>
<td>Spahr Webb, Roisin Commane</td>
<td>3</td>
<td>16/40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>536 Altschul Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fall 2022: EESC UN3901

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 3901</td>
<td>001/11582</td>
<td>Th 4:10pm - 6:00pm</td>
<td>Jacqueline Austermann, Sidney Hemming</td>
<td>3</td>
<td>4/50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Room TBA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EESC GU4008 Introduction to Atmospheric Science. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: advanced calculus and general physics, or the instructor's permission.
Basic physical processes controlling atmospheric structure: thermodynamics; radiation physics and radiative transfer; principles of atmospheric dynamics; cloud processes; applications to Earth's atmospheric general circulation, climatic variations, and the atmospheres of the other planets.

Fall 2022: EESC GU4008

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 4008</td>
<td>001/11583</td>
<td>T 4:10pm - 6:40pm</td>
<td>Lorenzo Polvani</td>
<td>3</td>
<td>19/30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>417 Schermerhorn Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**EESC GU4050 Global Assessment and Monitoring Using Remote Sensing. 3 points.**
CC/GS: Partial Fulfillment of Science Requirement
Enrollment limited to 24. Priority given to graduate students in the natural sciences and engineering.

Prerequisites: Course Cap 20 students. Priority given to graduate students in the natural sciences and engineering. Advanced level undergraduates may be admitted with the instructor's permission. Calculus I and Physics I & II are required for undergraduates who wish to take this course.

General introduction to fundamentals of remote sensing; electromagnetic radiation, sensors, interpretation, quantitative image analysis and modeling. Example applications in the Earth and environmental sciences are explored through the analysis of remote sensing imagery in a state-of-the-art visualization laboratory.

**EESC GU4085 GEODYNAMICS. 3.00 points.**
CC/GS: Partial Fulfillment of Science Requirement
Given in alternate years.

Prerequisites: calculus, differential equations, introductory physics. An introduction to how the Earth and planets work. The focus is on physical processes that control plate tectonics and the evolution of planetary interiors and surfaces; analytical descriptions of these processes; weekly physical model demonstrations

**EESC GU4113 INTRODUCTION TO MINERALOGY I. 4.00 points.**
Prerequisites: introductory geology or the equivalent, elementary college physics and chemistry, or the instructor's permission.
Prerequisites: introductory geology or the equivalent, elementary college physics and chemistry, or the instructors permission. Minerals come in dazzling colors, amazing shapes and with interesting optical effects. But mineralogy is also an essential tool for the understanding of Earth processes; weekly physical model demonstrations

**EESC GU4330 Introduction to Terrestrial Paleoclimate. 3 points.**
CC/GS: Partial Fulfillment of Science Requirement
Given in alternate years.

An overview of the archives in which evidence of terrestrial paleoclimate is preserved, the approaches to developing and applying proxies of climate from these archives, approaches for constraining the time represented by the information, and interpretations that have been developed from such archives. Important archives to be included are ice cores, caves, wetlands, lakes, trees, and moraines. The time interval covered will be mostly the last few tens of thousand years, and chronometers based on radiocarbon, U-series and surface exposure dating will be presented. The course will consist of a formal lecture on one day and a recitation on the second day which will emphasize examples and problem solving.

**EESC GU4600 EARTH RESOURCES # SUSTAIN DEV. 3.00 points.**
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: none; high school chemistry recommended. Prerequisites: none; high school chemistry recommended. This course is open to graduate students, and juniors and seniors within DEES, Sus Dev, Engineering, Chemistry, Physics, and APAM - or with the instructors permission. Survey of the origin and extent of mineral resources, fossil fuels, and industrial materials, that are non renewable, finite resources, and the environmental consequences of their extraction and use, using the textbook Earth Resources and the Environment, by James Craig, David Vaughan and Brian Skinner. This course will provide an overview, but will include focus on topics of current societal relevance, including estimated reserves and extraction costs for fossil fuels, geological storage of CO2, sources and disposal methods for nuclear energy fuels, sources and future for luxury goods such as gold and diamonds, and special, rare materials used in consumer electronics (e.g., Coltan; mostly from Congo) and in newly emerging technologies such as superconducting magnets and rechargeable batteries (e.g. heavy rare earth elements, mostly from China). Guest lectures from economists, commodity traders and resource geologists will provide real world; input
EESC GU4887 ISOTOPE GEOLOGY I. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Given in alternate years.

Prerequisites: For undergraduates, basic background in chemistry and physics, plus EESCU2200 (Earth Systems: Solid Earth and EESC UN3101 (Design and Maintenance of a Habitable Planet) or permission from the instructor. For graduate students: basic background in chemistry, physics and earth science.

Prerequisites: For graduate students, basic background in chemistry, physics and earth science. For undergraduates, basic background in chemistry and physics, plus EESC UN2200 Solid Earth and EESC UN3101 Geochemistry for a Habitable Planet, or permission from the instructor. An introduction to the processes that drive the universe, the formation of our solar system, and the history and evolution of our planet. Topics include stellar evolution and nucleosynthesis (origin of the elements), principles of radioactive decay and geochronology, composition of the solar system and the Earth, evolution of the mantle and crust, and using isotopes to trace to geological processes.

### Fall 2022: EESC GU4887

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 4887</td>
<td>001/11589</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Goldstein</td>
<td>3.00</td>
<td>7/25</td>
</tr>
</tbody>
</table>

EESC GU4923 Biological Oceanography. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Given in alternate years. Enrollment limited to 24. Priority given to graduate students and then graduating seniors.

Prerequisites: introductory college-level biology and chemistry.
An overview of the biology and ecology of the oceans with a focus on the interaction between marine organisms and the physics and chemistry of the oceans.

### Fall 2022: EESC GU4923

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 4923</td>
<td>001/11590</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Juhl</td>
<td>3</td>
<td>13/30</td>
</tr>
</tbody>
</table>

EESC GU4925 Principles of Physical Oceanography. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: Recommended preparation: a solid background in mathematics, physics, and chemistry.

Physical properties of seawater, water masses and their distribution, sea-air interaction influence on the ocean structure, basic ocean circulation pattern, relation of diffusion and advection with respect to distribution of ocean properties, ocean tides and waves, turbulence, and introduction to ocean dynamics.

### Fall 2022: EESC GU4925

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 4925</td>
<td>001/11591</td>
<td>T Th 8:40am - 9:55am</td>
<td>Thurnherr</td>
<td>3</td>
<td>4/25</td>
</tr>
</tbody>
</table>

EESC GU4949 Introduction to Seismology. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: advanced calculus and general physics, or the instructor’s permission.
Methods and underpinnings of seismology including seismogram analysis, elastic wave propagation theory, earthquake source characterization, instrumentation, inversion of seismic data to infer Earth structure.

### Fall 2022: EESC GU4949

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 4949</td>
<td>001/11592</td>
<td>T Th 11:40am - 12:55pm</td>
<td>Waldhauser</td>
<td>3</td>
<td>3/40</td>
</tr>
</tbody>
</table>

### Spring 2022

EESC UN1009 GLOBAL WARMING FOR GLOBAL LEADERS. 3.00 points.
Global Warming will dominate civic discourse and inform economic, social, and governmental policies throughout the 21st century, in all walks of life. This course will cover the basics of climate science, anthropogenic global warming, proposed solutions and policy challenges facing society in response to our changing planet. This course will increase your confidence and ability to engage in public discourse on the subject of climate change, climate change solutions, and public policy concerning our collective future.

### Spring 2022: EESC UN1009

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 1009</td>
<td>001/11908</td>
<td>T Th 11:40am - 12:55pm</td>
<td>Hoernisch</td>
<td>3</td>
<td>170/266</td>
</tr>
</tbody>
</table>

EESC UN1010 GEOLO EXCUR TO DEATH VALLEY, CA. 2.00 points.
Enrollment limited to 20.

The trip is restricted to first-years and sophomores from Columbia College/General Studies, Barnard College, and the School of Engineering and Applied Science. Early application is advised, and no later than November 12. A spring-break excursion focused on the geology of Death Valley and adjacent areas of the eastern California desert. Discussion sessions ahead of the trip provide necessary background. Details at: https://eesc.columbia.edu/content/eesc-un1010

### Spring 2022: EESC UN1010

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 1010</td>
<td>001/11911</td>
<td>F 7:30pm - 9:00pm</td>
<td>Blick</td>
<td>2</td>
<td>19/20</td>
</tr>
</tbody>
</table>
EESC UN2100 Earth's Environmental Systems: The Climate System. 4.5 points.
Priority given to Columbia and Barnard earth science, environmental science, and environmental biology majors should enrollment limits be reinstated.

Prerequisites: high school algebra. Recommended preparation: high school chemistry and physics; and one semester of college science. Origin and development of the atmosphere and oceans, formation of winds, storms and ocean currents, reasons for changes through geologic time. Recent influence of human activity: the ozone hole, global warming, water pollution. Laboratory exploration of topics through demonstrations, experimentation, computer data analysis, and modeling. Students majoring in Earth and Environmental Sciences should plan to take EESC W2100 before their senior year to avoid conflicts with Senior Seminar.

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2100</td>
<td>001/11915</td>
<td>T Th 10:10am - 11:25am</td>
<td>Jerry McManus, Michela Biasutti, Robert Pincus</td>
<td>4.5</td>
<td>41/50</td>
</tr>
<tr>
<td>EESC 2100</td>
<td>001/11915</td>
<td>Th 4:10pm - 7:00pm</td>
<td>Jerry McManus, Michela Biasutti, Robert Pincus</td>
<td>4.5</td>
<td>41/50</td>
</tr>
</tbody>
</table>

Fall 2022: EESC UN2100

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2100</td>
<td>001/11578</td>
<td>T Th 11:40am - 12:55pm</td>
<td>Suzana De Camargo, Galen McKinley</td>
<td>4.5</td>
<td>50/50</td>
</tr>
<tr>
<td>EESC 2100</td>
<td>001/11578</td>
<td>T 4:10pm - 7:00pm</td>
<td>Suzana De Camargo, Galen McKinley</td>
<td>4.5</td>
<td>50/50</td>
</tr>
</tbody>
</table>

EESC UN2200 EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH. 4.50 points.
CC/GS: Partial Fulfillment of Science Requirement
Priority given to Columbia and Barnard earth science, environmental science, and environmental biology majors should enrollment limits be necessary.

Prerequisites: high school algebra and chemistry. Recommended preparation: high school physics.
Recommended preparation: high school chemistry and physics; and one semester of college science. Exploration of how the solid Earth works, today and in the past, focusing on Earth in the Solar system, continents and oceans, the Earth's history, mountain systems on land and sea, minerals and rocks, weathering and erosion, glaciers and ice sheets, the hydrological cycle and rivers, geochronology, plate tectonics, earthquakes, volcanoes, energy resources. Laboratory exploration of topics through examination of rock samples, experimentation, computer data analysis, field exercises, and modeling. Columbia and Barnard majors should plan to take W2200 before their senior year to avoid conflicts with the Senior Seminar.

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2200</td>
<td>001/11918</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Sedelia Rodriguez, William Menke</td>
<td>4.50</td>
<td>46/50</td>
</tr>
<tr>
<td>EESC 2200</td>
<td>001/11918</td>
<td>T 4:10pm - 7:00pm</td>
<td>Sedelia Rodriguez, William Menke</td>
<td>4.50</td>
<td>46/50</td>
</tr>
</tbody>
</table>

Fall 2022: EESC UN2200

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2200</td>
<td>001/11579</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
<td>50/50</td>
</tr>
<tr>
<td>EESC 2200</td>
<td>001/11579</td>
<td>T 4:10pm - 7:00pm</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
<td>50/50</td>
</tr>
</tbody>
</table>

EESC UN2300 Earth's Environmental Systems: The Life System. 4.5 points.
CC/GS: Partial Fulfillment of Science Requirement
Priority given to Columbia and Barnard earth science, environmental science, and environmental biology majors should enrollment limits be reinstated.

Prerequisites: high school algebra. Recommended preparation: high school chemistry and physics.
Role of life in biogeochemical cycles, relationship of biodiversity and evolution to the physical Earth, vulnerability of ecosystems to environmental change; causes and effects of extinctions through geologic time (dinosaurs and mammoths) and today. Exploration of topics through laboratories, demonstrations, computer data analysis and modeling. REQUIRED LAB: EESC UN2310. Students should see the Directory of Classes for lab sessions being offered and select one.

Co-meets with EEEB 2002

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2300</td>
<td>001/11920</td>
<td>M W 11:40am - 12:55pm</td>
<td>Paul Olsen, Matthew Palmer, Sonya Dyhrman</td>
<td>4.5</td>
<td>56/65</td>
</tr>
</tbody>
</table>
EESC UN3210 Earth's Environmental Systems: The Life System Required Lab: Sections 001, 002, 003, 004,005. 0 points.
This three hour lab is required of all students who enroll in EESC UN2300. There are currently five lab sections.

### Spring 2022: EESC UN3210

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2310</td>
<td>001/16885</td>
<td>W 4:10pm - 7:00pm 555 Ext Schermerhorn Hall</td>
<td>Paul Olsen, Matthew Palmer, Sonya Dyhrman</td>
<td>0</td>
<td>15/24</td>
</tr>
<tr>
<td>EESC 2310</td>
<td>002/16886</td>
<td>W 4:10pm - 7:00pm 417 Schermerhorn Hall</td>
<td>Paul Olsen, Matthew Palmer, Sonya Dyhrman</td>
<td>0</td>
<td>22/24</td>
</tr>
<tr>
<td>EESC 2310</td>
<td>003/16887</td>
<td>W 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Paul Olsen, Matthew Palmer, Sonya Dyhrman</td>
<td>0</td>
<td>3/24</td>
</tr>
<tr>
<td>EESC 2310</td>
<td>004/16888</td>
<td>Th 4:10pm - 7:00pm 506 Schermerhorn Hall</td>
<td>Paul Olsen, Matthew Palmer, Sonya Dyhrman</td>
<td>0</td>
<td>14/24</td>
</tr>
<tr>
<td>EESC 2310</td>
<td>005/16889</td>
<td>Th 4:10pm - 7:00pm 417 Schermerhorn Hall</td>
<td>Paul Olsen, Matthew Palmer, Sonya Dyhrman</td>
<td>0</td>
<td>4/24</td>
</tr>
</tbody>
</table>

EESC UN3114 CLIMATE IMPACTS ON HUMANS IN NYC. 3.00 points.
How has climate shaped the history and development of NYC? How do climate and climate change affect our lives today? How will climate change affect our lives tomorrow? Variations in climate and weather have been major sources of risk and opportunity for humanity long before the industrial revolution began warming the planet. The growing impacts of climate change on human civilization over recent decades have turned attention from the future of our climate to the present. In this course, we investigate how the climate system intersects and interacts with the complex human system of NYC. The trajectory of this course will be set by the drafting of a final paper which will be done in small pieces throughout the semester. The first few weeks of the course will include lectures, activities, and assignments that will guide the selection of a specific climate impact for NYC and the formation of a research question for your final paper. This initial research question will then guide the majority of your assignments for the rest of the semester. Using this question, the five major sections of a scientific paper to structure the schedule for the remainder of the course: Introduction, Data, Methods, Results, and Conclusions.

### Spring 2022: EESC UN3114

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 3114</td>
<td>001/14402</td>
<td>T Th 2:40pm - 3:55pm 558 Ext Schermerhorn Hall</td>
<td>Nathan Lenssen</td>
<td>3.00</td>
<td>13/15</td>
</tr>
</tbody>
</table>

EESC UN3201 Solid Earth Dynamics. 3 points.
Prerequisites: any 1000-level or 2000-level EESC course; MATH UN1101 Calculus I and PHYS UN1201 General Physics I or their equivalents. Concurrent enrollment in PHYS UN1201 is acceptable with the instructor’s permission.
Properties and processes affecting the evolution and behavior of the solid Earth. This course will focus on the geophysical processes that build mountains and ocean basins, drive plate tectonics, and otherwise lead to a dynamic planet. Topics include heat flow and mantle circulation, earthquakes and seismic waves, gravity, Earth’s magnetic field, and flow of glaciers and ice sheets.

### Spring 2022: EESC UN3201

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 3201</td>
<td>001/11938</td>
<td>M W 10:10am - 11:25am 829 Seeley W. Mudd Building</td>
<td>Meredith Nettles</td>
<td>3</td>
<td>21/40</td>
</tr>
</tbody>
</table>

EESC UN3901 Environmental Science Senior Seminar. 3 points.
Prerequisites: EESC BC3800 or EESC BC3801 and a good grounding in basic sciences.
Guided, independent, in-depth research culminating in the senior thesis in the spring. Includes discussion about scientific presentations and posters, data analysis, library research methods and scientific writing. Students review work in progress and share results through oral reports. Weekly seminar to review work in progress and share results through oral and written reports.

### Spring 2022: EESC UN3901

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 3901</td>
<td>001/11940</td>
<td>Th 4:10pm - 6:00pm 530 Altschul Hall</td>
<td>Spahr Webb, Roisin Commane</td>
<td>3</td>
<td>16/40</td>
</tr>
<tr>
<td>EESC 3901</td>
<td>001/11582</td>
<td>Th 4:10pm - 6:00pm Room TBA</td>
<td>Jacqueline Austermann, Sidney Hemming</td>
<td>3</td>
<td>4/50</td>
</tr>
</tbody>
</table>

EESC GU4009 CHEMICAL GEOLOGY. 3.00 points.
Given in alternate years.

Prerequisites: physical chemistry or the instructor’s permission.
This course will examine geological problems from a standpoint of thermodynamic and kinetic theory. Theoretical thermodynamic concepts will be used to derive the crystallization depth and temperature of metamorphic and magmatic minerals, describe the solubility of volatile species in magmas, predict the composition of volcanic gas mixtures, model the nucleation and growth of crystals and bubbles in a melt and determine the chemical interaction between water and rock at the Earth’s surface. Kinetic treatments on the diffusion of heat and matter through crystals and melts will be used to constrain the timing of geological processes. Recommended preparation: Knowledge of mathematics at the level of partial differential equations; mineralogy (EESC 4113); and petrology (EESC 4701); or permission of the instructor.

### Spring 2022: EESC GU4009

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 4009</td>
<td>001/11945</td>
<td>T Th 2:40pm - 3:55pm 555 Ext Schermerhorn Hall</td>
<td>Yves Moussallam</td>
<td>3.00</td>
<td>11/25</td>
</tr>
</tbody>
</table>
EESC GU4300 The Earth's Deep Interior. 3 points.
Prerequisites: Vector calculus, differential equations, one year of college physics (mechanics, electromagnetism, waves)
An overview of the geophysical study of the Earth, drawing upon geodesy, gravity, seismology, thermal studies, geomagnetism, materials science, and some geochemistry. Covers the principal techniques by which discoveries have been made, and are made, in deep Earth structure. Describes fundamental properties and features of the crust, mantle, and core.

Spring 2022: EESC GU4300
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4300 | 001/11952 | T Th 10:10am - 11:25am | Goran Ekstrom | 3 | 5/30
506 Schermerhorn Hall

EESC GU4885 The Chemistry of Continental Waters. 3 points.
Given in alternate years.

Prerequisites: Recommended preparation: a solid background in basic chemistry.
Introduction to geochemical cycles involving the atmosphere, land, and biosphere; chemistry of precipitation, weathering reactions, rivers, lakes, estuaries, and groundwaters; students are introduced to the use of major and minor ions as tracers of chemical reactions and biological processes that regulate the chemical composition of continental waters.

Spring 2022: EESC GU4885
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4885 | 001/11955 | T Th 11:40am - 12:55pm | Robert Anderson | 3 | 16/40
555 Ext Schermerhorn Hall

EESC GU4920 Paleoclimatology. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Given in alternate years.

Prerequisites: Compliments GU4937 Cenozoic Paleoclimatology, intended as part of a sequence with GU4330 Terrestrial Paleoclimate. For undergrads, UN2100 Earth System: Climate or equivalent, or permission of instructor
The course examines the ocean’s response to external climatic forcing such as solar luminosity and changes in the Earth’s orbit, and to internal influences such as atmospheric composition, using deep-sea sediments, corals, ice cores and other paleoclimatographic archives. A rigorous analysis of the assumptions underlying the use of climate proxies and their interpretations will be presented. Particular emphasis will be placed on amplifiers of climate change during the alternating ice ages and interglacial intervals of the last few million years, such as natural variations in atmospheric “greenhouse gases” and changes in deep water formation rates, as well as mechanisms of rapid climate change during the late Pleistocene. The influence of changes in the Earth’s radiation distribution and boundary conditions on the global ocean circulation, Asian monsoon system and El Nino/Southern Oscillation frequency and intensity, as well as interactions among these systems will be examined using proxy data and models. This course complements W4937 Cenozoic Paleoclimatology and is intended as part of a sequence with W4330 Terrestrial Paleoclimate for students with interests in Paleoclimate.

Spring 2022: EESC GU4920
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4920 | 001/11962 | T Th 10:10am - 11:25am | Jerry McManus | 3 | 19/30
417 Schermerhorn Hall

EESC GU4930 Earth's Oceans and Atmosphere. 3 points.
Prerequisites: Recommended preparation: a good background in the physical sciences.
Physical properties of water and air. Overview of the stratification and circulation of Earth’s ocean and atmosphere and their governing processes; ocean-atmosphere interaction; resultant climate system; natural and anthropogenic forced climate change.

Spring 2022: EESC GU4930
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4930 | 001/11964 | T Th 1:10pm - 2:25pm | Arnold Gordon | 3 | 11/30
417 Schermerhorn Hall

EESC GU4947 PLATE TECTONICS. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Given in alternate years.

Prerequisites: course in solid earth geology or geophysics; solid background in math and physics
Prerequisites: course in solid earth geology or geophysics; one year of general physics Plate tectonics is the foundation of our understanding of all Earth processes including the climate system. This course will focus on four aspects of the development of the plate tectonic theory: the history of science concerning ideas about the evolution of the Earth including accounts of the plate tectonic revolution from the point of view of the people, many at Columbia, who led the way: geophysical methods such as the magnetic, gravity, heat flow and seismic tools and techniques that sparked, and continue to advance, the revolution; unresolved tectonic questions including the generation of mountain belts, the splitting of continents and the formation of large igneous provinces; climatic effects of plate tectonics such as changes in sea level and planetary albedo, the erosion and weathering of mountains, volcanic CO2 release and subduction recycling of carbon

Spring 2022: EESC GU4947
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4947 | 001/16995 | T Th 1:10pm - 2:25pm | W Buck | 3.00 | 7/40
506 Schermerhorn Hall

Of Related Interest
Environmental Science (Barnard)
EESC BC1001 Environmental Science I
EESC BC1011 Environmental Science I Lab
EESC BC3014 Field Methods in Environmental Science
EESC BC3016 Environmental Measurements
EESC BC3017 Environmental Data Analysis
EESC BC3025 Hydrology
EESC BC3033 Waste Management
EESC BC3050 Big Data with Python: Python for Environmental Analysis and Visualisation
EESC BC3200 Ecotaxonomy
EESC BC3300 Workshop in Sustainable Development

Physics
PHYS UN1018 Weapons of Mass Destruction

Generally Alternate Year Courses
EESC UN1001 DINOSAURS AND HISTORY OF LIFE
EESC UN1201 Environmental Risks and Disasters
EESC UN1401 DINOSAUR # HISTORY OF LIFE-LEC
EESC UN3015 Environmental Science I Lab
EESC UN1201 Environmental Risks and Disasters
EESC UN1401 DINOSAUR # HISTORY OF LIFE-LEC
EESC UN3015 The Earth’s Carbon Cycle
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC GU4009</td>
<td>CHEMICAL GEOLOGY</td>
</tr>
<tr>
<td>EESC GU4040</td>
<td>CLIM THERMODYN/ENERGY TRANSFER</td>
</tr>
<tr>
<td>EESC GU4085</td>
<td>GEODYNAMICS</td>
</tr>
<tr>
<td>EESC GU4113</td>
<td>INTRODUCTION TO MINERALOGY I</td>
</tr>
<tr>
<td>EESC GU4330</td>
<td>Introduction to Terrestrial Paleoclimate</td>
</tr>
<tr>
<td>EESC GU4223</td>
<td>SEDIMENTARY GEOLOGY</td>
</tr>
<tr>
<td>EESC GU4300</td>
<td>The Earth’s Deep Interior</td>
</tr>
<tr>
<td>EESC GU4630</td>
<td>Air-sea interaction</td>
</tr>
<tr>
<td>EESC GU4701</td>
<td>Introduction to Igneous Petrology</td>
</tr>
<tr>
<td>EESC GU4835</td>
<td>Wetlands and Climate Change</td>
</tr>
<tr>
<td>EESC GU4885</td>
<td>The Chemistry of Continental Waters</td>
</tr>
<tr>
<td>EESC GU4887</td>
<td>ISOTOPE GEOLOGY I</td>
</tr>
<tr>
<td>EESC GU4888</td>
<td>Stable Isotope Geochemistry</td>
</tr>
<tr>
<td>EESC GU4920</td>
<td>Paleoceanography</td>
</tr>
<tr>
<td>EESC GU4926</td>
<td>Principles of Chemical Oceanography</td>
</tr>
<tr>
<td>EESC GU4937</td>
<td>Cenozoic Paleoceanography</td>
</tr>
<tr>
<td>EESC GU4929</td>
<td>Mixing and Dispersion in the Ocean</td>
</tr>
<tr>
<td>EESC GU4949</td>
<td>Introduction to Seismology</td>
</tr>
<tr>
<td>EESC GR5111</td>
<td>Modern analytical methods in geochemistry</td>
</tr>
<tr>
<td>EESC GR6701</td>
<td>Igneous and metamorphic processes during the creation and evolution of the tectonic plates</td>
</tr>
<tr>
<td>EESC GR6810</td>
<td>The Carbon Cycle</td>
</tr>
<tr>
<td>EESC GR6901</td>
<td>Research Computing for the Earth Sciences</td>
</tr>
<tr>
<td>EESC GR6909</td>
<td>Advanced Time Series Analysis</td>
</tr>
<tr>
<td>EESC GR6920</td>
<td>Dynamics of Climate</td>
</tr>
<tr>
<td>EESC GR6921</td>
<td>Atmospheric Dynamics</td>
</tr>
<tr>
<td>EESC GR6922</td>
<td>Atmospheric Radiation</td>
</tr>
<tr>
<td>EESC GR6928</td>
<td>Tropical Meteorology</td>
</tr>
<tr>
<td>EESC GR6949</td>
<td>ADVANCED SEISMOLOGY I</td>
</tr>
<tr>
<td>EESC GR6930</td>
<td>Ocean Dynamics</td>
</tr>
<tr>
<td>EESC GR9500</td>
<td>SEM-PLANT PHYSIOLOGY &amp; EC</td>
</tr>
</tbody>
</table>