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.

**Climate System Science Major**

The climate system science major is designed for students who are interested in how the past, present, and future climate system works and in solution strategies for the rapidly accelerating climate crisis. The overall goal is to establish the fundamental sciences at the core of the climate system, and to inspire solution-oriented analytical thinking and expertise. The flexible course structure combines geology, physics, biology, chemistry, and math with a core in climate system science and climate solution, justice, policy and communication courses. Sample tracks through the major in sea level change, decarbonization and modern climate link to the mission and applied centers of Columbia’s Climate School. We believe that any admitted student has the potential to succeed in climate science.

Climate System Science majors begin with foundational courses in the climate system and introductory courses in global warming, oceanography or other relevant topics. Supporting courses include a grounding in calculus and natural sciences. Five climate core courses include both paleoclimate and modern climate requirements, as well as three other electives. Students pursue topics in climate solutions, policy, justice and communication in courses outside the sciences, in architecture, economics, political science or engineering. All climate system science majors are required to complete a capstone experience, which can include a field course or independent research project, typically at Lamont-Doherty Earth Observatory with guidance from a leading climate scientist.

**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  
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)  
Bärbel Hönisch  
Peter B. Kelemen  
Folarin Kolawole  
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 Wentzovich  

**Associate Professors**

Ryan Abernathey  
Kerry Key  
Heather Savage  

**Assistant Professors**

Jacqueline Austermann  
Roisin Commane  
Jonathan Kingslake  
Yves Moussallam  

**Adjunct Professors**

Robert F. Anderson  
W. Roger Buck IV  
Denton Ebel  
John J. Flynn  
James Gaherty  
Lisa M. Goddard  
Arthur Lerner-Lam  
Alberto Malinverno  
Douglas G. Martinson  
Ronald L. Miller  
Mark A. Norell  
Dorothy M. Petee  
Maureen Raymo  
Andrew Robertson  
Joerg M. Schaefer  
Christopher Small  
Minfang Ting  
Felix Waldauser  
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
Guidelines for all Earth Science, Environmental Science, and Climate System Science 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, 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 cannot 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 cannot be used toward meeting any of the requirements for the majors, concentrations, or special concentrations: EESC GU4930 EARTH’S OCEANS & 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 Science, Environmental Science, & Climate System Science Majors, Concentrators, and Special Concentrators above.

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

Foundation Courses
EESC UN2100 EARTH’S ENVIRO SYST: CLIM SYST
EESC UN2200 EARTH’S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH

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:
CHEM UN1403 GENERAL CHEMISTRY I-LECTURES
- CHEM UN1404 and GENERAL CHEMISTRY II-LECTURES
- PHYS UN1201 and GENERAL PHYSICS I
CHEM UN1403 GENERAL CHEMISTRY I-LECTURES
- PHYS UN1201 and GENERAL PHYSICS I
- PHYS UN1202 and GENERAL PHYSICS II

Capstone Experience
Select one of the following:
EESC BC3800 ENVIR SCIENCE SENIOR SEMINAR
- EESC UN3901 SENIOR SEMINAR
EESC BC3801 ENVIR SCIENCE SENIOR SEM II
- EESC UN3901 SENIOR SEMINAR
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:
EESC UN2100 EARTH’S ENVIRO SYST: CLIM SYST
EESC UN2300 EARTH’S ENVIRO SYST: LIFE SYST
EESC UN3010 FIELD GEOLOGY
EESC BC3017 ENVIRONMENTAL DATA ANALYSIS
EESC GU4050 GLOBAL ASSMT-REMOTE SENSING
EESC GU4600 EARTH RESOURCES & SUSTAIN DEV
EESC GU4917 THE EARTH/HUMAN INTERACTIONS
EAEE E2002 ALTERNATIVE ENERGY RESOURCES

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:
EESC UN3101 Geochemistry for a Habitable Planet
or EESC UN3201 SOLID EARTH DYNAMICS

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
EESC GU4090 INTRO TO GEOCHRONOLGY
EESC GU4113 INTRODUCTION TO MINERALOGY I
The major in environmental science requires a minimum of 47 points, distributed as follows:

**Foundation Courses**
- EESC UN2100 Earth’s Environment Systems: Clim Sys
- EESC UN2200 Earth’s Environmental Systems: The Solid Earth

**Supporting Mathematics and Science Courses**
One semester of Calculus at the level of Calculus I or higher (3 credits)

**Capstone Experience**
- EESC BC3800 Envr Science Senior Seminar
- EESC UN3901 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 Assmt-Remote Sensing
- EESC GU4600 Earth Resources # Sustain Dev
- EESC GU4917 The 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.
science. Students should include at least one of the following in their course of study:

EESC UN3101  Geochemistry for a Habitable Planet
or 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 Geology**
EESC GU4076  Geologic Mapping
EESC GU4480  Paleobiology and Earth System History
EAEE 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  CHEMISTRY OF CONTINENTL WATERS
EESC GU4887  ISOTOPE GEOLOGY I
EESC GU4924  INTRO TO ATMOSPHERIC CHEMISTRY
EESC GU4888  Stable Isotope Geochemistry
EESC GU4926  INTRO TO CHEMICAL OCEANOGRAPHY

**Hydrology**
EESC GU4076  Geologic Mapping
EESC GU4835  Wetlands and Climate Change
EESC GU4885  CHEMISTRY OF CONTINENTL WATERS
EESC BC3025  HYDROLOGY
EAEE E3221

**Climate Change**
EESC UN3015  The Earth's Carbon Cycle
EESC GU4008  Introduction to Atmospheric Science
EESC GU4330  Introduction to Terrestrial Paleoclimate
EESC GU4480  Paleobiology and Earth System History
EESC GU4835  Wetlands and Climate Change
EESC GU4920  PALEOCEANOGRAPHY

It is recommended that students focusing in environmental geology also take EESC GU4050 Remote Sensing.

**Energy and Resources**
EESC GU4076  Geologic Mapping
EESC GU4701  Introduction to Igneous Petrology
EAEE E2002  ALTERNATIVE ENERGY RESOURCES

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**Major in Climate System Science**
Please read Guidelines for all Earth Science, Environmental Science, & Climate System Science Majors, Concentrators, and Special Concentrators above.

The major in climate system science requires a minimum of 43.5 points, distributed as follows:

**Foundational Courses**
7.5 points minimum (2 courses):

Required:
EESC UN2100  EARTH'S ENVIRO SYST: CLIM SYST
And any one of:

EESC UN1009  GLOBAL WARMING FOR GLOBAL LEADERS
EESC UN1030  OCEANOGRAPHY
EESC UN1201  Environmental Risks and Disasters
EESC UN1600  EARTH RESOURCES # SUSTAIN DEV
or EESC GU4600  EARTH RESOURCES # SUSTAIN DEV
EESC UN2200  EARTH'S ENVIRO SYST LIFE SYST
EESC UN2300  SCIENCE FOR SUSTAINABLE DEVPT
EESC UN2330  COMPC FOR SUSTDEV
EESC UN3015  The Earth's Carbon Cycle
EESC UN1009  GLOBAL WARMING FOR GLOBAL LEADERS
EESC UN1030  OCEANOGRAPHY
EESC UN1201  Environmental Risks and Disasters
EESC UN1600  EARTH RESOURCES # SUSTAIN DEV
or EESC GU4600  EARTH RESOURCES # SUSTAIN DEV
EESC UN2200  EARTH'S ENVIRO SYST LIFE SYST
EESC UN2300  SCIENCE FOR SUSTAINABLE DEVPT
EESC UN2330  COMPC FOR SUSTDEV

**Supporting Courses**
12 points minimum (4 courses):

One semester of Calculus at the level of Calculus I or higher:
MATH UN1101  CALCULUS I
And any three courses:
PHYS UN1201  GENERAL PHYSICS I
PHYS UN1202  GENERAL PHYSICS II
CHEM UN1403  GENERAL CHEMISTRY I-LECTURES
CHEM UN1404  GENERAL CHEMISTRY II-LECTURES
ECEE UN2001  ENVIRONMENTAL BIOLOGY I
EESC UN2300  EARTH'S ENVIRO SYST LIFE SYST

**Climate System Core**
15 points minimum (five courses):

Required: at least one Paleoclimate Course
EESC GU4235  SEA LEVEL CHANGE
EESC GU4330  Introduction to Terrestrial Paleoclimate
EESC GU4480  Paleobiology and Earth System History
EESC GU4920  PALEOCEANOGRAPHY
EESC GU4937  CENOZOIC PALEOCEANOGRAPHY

Required: at least one Modern Climate Course
EESC UN3109  CLIMATE PHYSICS
EESC GU4008  Introduction to Atmospheric Science
EESC GU4020  HUMANS # THE CARBON CYCLE
EESC GU4040  CLIM THERMODYN/ENERGY TRANSFER
EESC GU4925  INTRO TO ATMOSPHERIC CHEMISTRY
EESC GU4930  EARTH'S OCEANS # ATMOSPHERE

Could include: Other Climate System Course
EESC BC3109 Hydrology
EESC UN3101  Geochemistry for a Habitable Planet
EESC UN3201  SOLID EARTH DYNAMICS
EESC GU4220  GLACIOLOGY
EESC GU4835  Wetlands and Climate Change
EESC GU4885  CHEMISTRY OF CONTINENTL WATERS
EESC GU4923  Biological Oceanography
EESC GU4924  INTRO TO ATMOSPHERIC CHEMISTRY
EESC GU4926  INTRO TO CHEMICAL OCEANOGRAPHY

Could include one: Supporting EESC Course
EESC UN3400  COMPUTATIONAL EARTH SCIENCE
EESC GU4210  GEOPHYSICAL FLUID DYNAMICS
EESC GU4223  SEDIMENTARY GEOLOGY
EESC GU4230  CRUSTAL DEFORMATION
EESC GU4887  ISOTOPE GEOLOGY I
EESC GU4888  Stable Isotope Geochemistry
Climate Solutions, Justice, Policy and Communication

6 points minimum (any two courses below):

**Solutions Courses**
- EESC BC3045 RESPONDING TO CLIMATE CHANGE (Barnard College)
- ARCH UN3120 CITYLANDSCAPE, # ECOLOGY
- EAAE E2002 ALTERNATIVE ENERGY RESOURCES
- EAAE E2100 A BETTER PLANET BY DESIGN
- EAAE E4001 INDUST ECOLOGY-EARTH RESOURCES
- EAAE E4002 ALTERNATIVE ENERGY RESOURCES
- EAAE E4006 Field methods for environmental engineering
- EAAE E4300 INTRO TO CARBON MANAGEMENT
- EAAE E4302 CARBON CAPTURE
- EAAE E4301 CARBON STORAGE
- EAAE E4305 CO2 UTILIZATION AND CONVERSION
- CIEE E3250 HYDROSYSTEMS ENGINEERING
- MECE E4211 ENERGY SOURCES AND CONVERSION
- SDEV GU4250 CLIMATE CHANGE: RESILIENCE # ADAPTATION

**Climate Justice, Policy, Economics**
- ANTH BC3932 CLIMATE CH./GLOB. MIGRATION/HUMAN RIGHTS (Barnard College)
- ANTH V3861
- ARCH UN3400 ENVIRONMENTAL VISUALIZATIONS OF NYC
- ECON BC3039 ENVIRONMENTAL & NAT. RES. ECONOMICS (Barnard College)
- ECON BC3040 ENVIRONMENTAL LAW (Barnard College)
- ECON UN2257 THE GLOBAL ECONOMY
- ECON GU4750 GLOBALIZATION # ITS RISKS
- POLS UN3648 GOVERNING THE GLOBAL ECONOMY
- POLS GU4814 INTERNATIONAL POLITICAL ECONOMY OF DEVELOPING COUNTRIES
- SDEV UN3355 CLIMATE CHANGE AND LAW
- SDEV UN3360 DISASTERS AND DEVELOPMENT

**Climate System Capstone**

3 points minimum (one course):

- EESC 3xxx Undergraduate Research Project (course is under development)
- EESC UN3901 SENIOR SEMINAR (taken twice, in fall and spring)

or EESC BC3800 followed by EESC UN3901
- Approved Field Course focused on the Climate System ~6 weeks, must be proposed and then approved by DUS

Foundation Courses

<table>
<thead>
<tr>
<th>EESC UN2100</th>
<th>EARTH’S ENVIRO SYST CLIM SYST</th>
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<tbody>
<tr>
<td>or EESC UN2300</td>
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</tr>
<tr>
<td>EESC UN2200</td>
<td>EARTH’S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH</td>
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</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>EESC UN3101</th>
<th>Geochemistry for a Habitable Planet</th>
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</thead>
<tbody>
<tr>
<td>or EESC UN3201</td>
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</tbody>
</table>

One additional course chosen from those listed under Depth Requirement for the earth science major above.

The third 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 Science, Environmental Science, & Climate System Science Majors, Concentrators, and Special Concentrators above.

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

Foundation Courses

<table>
<thead>
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<th>EESC UN2100</th>
<th>EARTH’S ENVIRO SYST CLIM SYST</th>
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</tr>
<tr>
<td>EESC UN2300</td>
<td>EARTH’S ENVIRO SYST LIFE SYST</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>or EESC UN3201</td>
<td>SOLID EARTH DYNAMICS</td>
</tr>
</tbody>
</table>

One additional course chosen from those listed under either Depth Requirement or Breadth and Related Fields Requirement for the environmental science major above.

Concentration in Earth Science

Please read Guidelines for all Earth Science, Environmental Science, & Climate System Science Majors, Concentrators, and Special Concentrators above.

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

Foundation Courses

<table>
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<tr>
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</tr>
</tbody>
</table>

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 6 points (two courses) is required as follows:

<table>
<thead>
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<td>SOLID EARTH DYNAMICS</td>
</tr>
</tbody>
</table>

One additional course chosen 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 Science, Environmental Science, & Climate System Science 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 ENVIRO SYST: CLIM SYST
- EESC UN2200  
  EARTH’S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
- EESC UN2300  
  EARTH’S ENVIRO SYST: LIFE SYST

**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.

**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.

**Spring 2023**

**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 2023: EESC UN1010 Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment

| EESC 1010 | 001/11148 | F 7:30pm - 9:00pm  
  558 Ext Schermerhorn Hall  
  Nicholas Christie-Blick, Folarin Kolawole | 2.00 | 22/20 |
EESC UN2100 EARTH’S ENVIRONMENTAL SYSTEMS: CLIM SYST. 4.50 points.  
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.

Spring 2023: EESC UN2100

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
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<th>Instructor</th>
<th>Points</th>
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</tr>
</thead>
<tbody>
<tr>
<td>EESC 2100</td>
<td>001/11149</td>
<td>T Th 10:10am - 11:25am 603 Schermerhorn Hall</td>
<td>Mingfang Ting, Gisela Winckler</td>
<td>4.50</td>
<td>55/60</td>
</tr>
<tr>
<td>EESC 2100</td>
<td>001/11149</td>
<td>T 4:10pm - 7:00pm 555 Ext Schermerhorn Hall</td>
<td>Mingfang Ting, Gisela Winckler</td>
<td>4.50</td>
<td>55/60</td>
</tr>
</tbody>
</table>

Fall 2023: EESC UN2100

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<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>EESC 2100</td>
<td>001/13062</td>
<td>T Th 10:10am - 11:25am 603 Schermerhorn Hall</td>
<td>Jerry McManus, Suzana De Camargo</td>
<td>4.50</td>
<td>50/50</td>
</tr>
<tr>
<td>EESC 2100</td>
<td>001/13062</td>
<td>T 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Jerry McManus, Suzana De Camargo</td>
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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 2023: 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>
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<tbody>
<tr>
<td>EESC 2200</td>
<td>001/11150</td>
<td>T Th 2:40pm - 3:55pm 603 Schermerhorn Hall</td>
<td>Steven Goldstein, Sidney Hemming, Sedelia Rodriguez</td>
<td>4.50</td>
<td>55/53</td>
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<tr>
<td>EESC 2200</td>
<td>001/11150</td>
<td>T 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Steven Goldstein, Sidney Hemming, Sedelia Rodriguez</td>
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Fall 2023: EESC UN2200

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<th>Course Number</th>
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<th>Times/Location</th>
<th>Instructor</th>
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<tr>
<td>EESC 2200</td>
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<td>T Th 1:10pm - 2:25pm 603 Schermerhorn Hall</td>
<td>Jonathan Kingslake</td>
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<td>EESC 2200</td>
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<td>T 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
<td>53/53</td>
</tr>
</tbody>
</table>
EESC UN2300 Earth's Environ Syst: Life Syst. 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 reinstated.

Prerequisites: high school algebra. Recommended preparation: high school chemistry and physics.
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.

EESC UN2310 Earth Environ Syst-Life Syst-Lab. 0.00 points.
This three hour lab is required of all students who enroll in EESC UN2300.

EESC UN3010 Field Geology. 3.00 points.
Fee: to be determined.
This is a field geology course focusing on the Apennine Mountains of central Italy, where a developing "accretionary prism" (associated with oceanic crust subduction) can be observed directly. Students will learn how to interpret the evolution of paleo-environments from the sediment lithologies, textures, fossils, compositions; and the tectonic history from the present day spatial and structural relationships. The rocks range from early Mesozoic oceanic crust and sediments to late Cenozoic sediments impacted by the rise of the Alps. The course visits several classic geological localities, including the Gubbio site of the discovery that the dinosaur extinction was caused by a meteorite, a Carrara Marble quarry (favored by Michelangelo for his sculptures), evaporite sediments from the dry-down of the Mediterranean, the magnificent Frasassi Cave, and effects of recent earthquakes. Prerequisites: EESC 2200 The Solid Earth System is a prerequisite but can be taken concurrently. EESC 2100 The Climate System is recommended. Interested students who have not met these prerequisites require a waiver from the instructors. This course is open to junior and senior majors and concentrators in Earth Science or Environmental Science at Columbia and Barnard. If there is space, sophomores who plan to be Earth Science or Environmental Science majors may be permitted to enroll. Non majors/concentrators may also be allowed with permission of the instructors. By necessity (number of van seats) the course is limited to 20 or 21 students.

EESC UN3109 Climate Physics. 3.00 points.
This is a calculus-based treatment of climate system physics and the mechanisms of anthropogenic climate change. By the end of this course, students will understand: how solar radiation and rotating fluid dynamics determine the basic climate state, mechanisms of natural variability and change in climate, why anthropogenic climate change is occurring, and which scientific uncertainties are most important to estimates of 21st century change. This course is designed for undergraduate students seeking a quantitative introduction to climate and climate change science. EESC V2100 (Climate Systems) is not a prerequisite, but can also be taken for credit if it is taken before this course.
EESC UN3201 SOLID EARTH DYNAMICS. 3.00 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.
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 2023: EESC UN3201

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<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<td>EESC 3201</td>
<td>001/15132</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>William Menke 3.00</td>
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<td>603 Schermerhorn Hall</td>
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EESC UN3901 SENIOR SEMINAR. 3.00 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 2023: EESC UN3901

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<th>Course Number</th>
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<td>EESC 3901</td>
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<td>Sidney Hemming, Jacqueline Austermann</td>
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<td>16/40</td>
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Fall 2023: EESC UN3901

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<td>EESC 3901</td>
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EESC GU4040 CLIM THERMODYN/ENERGY TRANSFER. 3.00 points.
Given in alternate years.

Prerequisites: EESC GU4008, advanced calculus, and general physics, or the instructor's permission.
Thermodynamics of atmospheric and oceanic processes fundamental to the climate system. Physical mechanisms of vertical energy transfer: surface fluxes, boundary layers and convection.

Spring 2023: EESC GU4040

<table>
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<tr>
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<th>Section/Call Number</th>
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<tr>
<td>EESC 4040</td>
<td>001/11155</td>
<td>T Th 2:40pm - 3:55pm</td>
<td>Adam Sobel</td>
<td>3.00</td>
<td>9/25</td>
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<td>558 Ext Schermerhorn Hall</td>
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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.

Spring 2023: EESC GU4085

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<th>Course Number</th>
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<td>W Buck</td>
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<td>555 Ext Schermerhorn Hall</td>
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EESC GU4220 GLACIOLOGY. 3.00 points.
Prerequisites: At least a year of calculus and physics; any 1000-level or 2000-level EESC course. Recommended: EESC2100 (Climate System), EESC2200 (Solid Earth), EESC3201 (Solid Earth Dynamics). Experience using MATLAB.
Prerequisites: At least a year of calculus and physics; any 1000-level or 2000-level EESC course. Recommended: EESC2100 (Climate System), EESC2200 (Solid Earth), EESC3201 (Solid Earth Dynamics). Experience using MATLAB, Python/Numpy. This course examines processes controlling how glaciers and ice sheets grow, retreat, modify their landscape and interact with the rest of the Earth system. We focus on what controls surface mass balance, the transformation from snow to ice, ice deformation, basal sliding, the temperature and age of ice, the flow of water through ice sheets and glaciers, and the two-way interactions between ice and the oceans, atmosphere and solid earth. Weekly lectures are accompanied by practical computer sessions that equip students with key numerical and data analysis skills used in research of glacial processes.

Spring 2023: EESC GU4220

<table>
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<tr>
<th>Course Number</th>
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<th>Times/Location</th>
<th>Instructor</th>
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<tr>
<td>EESC 4220</td>
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<td>T Th 1:10pm - 2:25pm</td>
<td>Jonathan Kingslake</td>
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<td>555 Ext Schermerhorn Hall</td>
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</table>
EESC GU4235 SEA LEVEL CHANGE. 3.00 points.
Prerequisites: At least a year of calculus and physics; any 1000-level or 2000-level EESC course; basic programming experience (e.g. EESC3400 - Introduction to Computational Earth Science). Recommended: EESC2100 (Climate System), EESC2200 (Solid Earth), EESC3201 (Solid Earth Dynamics).
Prerequisites: At least a year of calculus and physics; any 1000-level or 2000-level EESC course; basic programming experience (e.g. EESC3400 - Introduction to Computational Earth Science). Recommended: EESC2100 (Climate System), EESC2200 (Solid Earth), EESC3201 (Solid Earth Dynamics).
The course aims to explore sea level changes that take place over a wide variety of timescales and are the result of multiple solid Earth and climatic processes. The course will link a series of solid Earth processes such as mantle convection, viscoelastic deformation, and plate tectonics to the paleoclimate record and investigate how these processes contribute to our understanding of past and present changes in sea level and climate. The course will step chronologically through time starting with long term sea level changes over the Phanerozoic, followed by Plio-Pleistocene ice age sea level variations and lastly modern and future sea level change. This is a cross-disciplinary course, which is aimed at students with interests in geophysics, cryosphere evolution, ocean dynamics, sedimentology, paleogeography, and past and present climate.

Spring 2023: EESC GU4235
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC4235 | 001/11190 | T Th 11:40am - 12:55pm | Austermann | 3.00 | 8/20
603 Schermerhorn Hall

EESC GU4630 AIR-SEA INTERACTION. 3.00 points.
Given in alternate years. Enrollment limited to 20. Priority based on seniority (graduate students, graduating seniors, etc.).

Prerequisites: solid background in mathematics, physics, and chemistry. Some background in fluid mechanics (as in EESC W4925/APPH E4200) or the instructor's permission.
Prerequisites: solid background in mathematics, physics, and chemistry. Some background in fluid mechanics (as in EESC W4925/APPH E4200) or the instructor's permission.
An overview of oceanic and atmospheric boundary layers including fluxes of momentum, heat, mass, (eg. moisture salt) and gases between the ocean and atmosphere; vertical distribution of energy sources and sinks at the interface including the importance of surface currents; forced ocean dynamics, the role of surface waves on the air-sea exchange processes and ocean mixed layer processes.

Spring 2023: EESC GU4630
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC4630 | 001/11191 | T Th 2:40pm - 3:55pm | Zappa | 3.00 | 6/20
417 Schermerhorn Hall

EESC GU4924 INTRO TO ATMOSPHERIC CHEMISTRY. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: Physics UN1201, Chem UN1403, & Math UN1201 (Calc III), or their equivalents. Recommended: EESC UN2100 or EESC GU4008.
Prerequisites: Physics W1201, Chemistry W1403, Calculus III, or equivalent or the instructor's permission. EESC W2100 preferred. Physical and chemical processes determining atmospheric composition and the implications for climate and regional air pollution. Atmospheric evolution and human influence; basics of greenhouse effect, photolysis, reaction kinetics; atmospheric transport of trace species; stratospheric ozone chemistry; tropospheric hydrocarbon chemistry; oxidizing power, nitrogen, oxygen, sulfur, carbon, mercury cycles; chemistry-climate-biosphere interactions; aerosols, smog, acid rain.

Spring 2023: EESC GU4924
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC4924 | 001/11192 | T Th 11:40am - 12:55pm | Commane | 3.00 | 9/40
417 Schermerhorn Hall

EESC GU4926 INTRO TO CHEMICAL OCEANOGRAPHY. 3.00 points.
Given in alternate years.
Prerequisites: Recommended preparation: one year of chemistry.
Prerequisites: Recommended preparation: one year of chemistry. Factors controlling the concentration and distribution of dissolved chemical species within the sea. The physical chemistry of seawater, ocean circulation and mixing, gas exchange and biogeochemical processes interact to influence the distribution and fate of elements in the ocean. The course examines in some detail the two-way interaction between marine ecosystems and their chemical environment, and the implications of these interactions for distributions in the ocean of carbon, nutrients and trace metals. Although this course does not cover specific strategies that have been proposed for Carbon Dioxide Removal (CDR) and ocean storage of carbon, it will cover the basic processes and principles underlying ocean CDR strategies.

Spring 2023: EESC GU4926
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC4926 | 001/11193 | T Th 11:40am - 12:55pm | Anderson | 3.00 | 14/50
555 Ext Schermerhorn Hall

EESC GU4930 EARTH'S OCEANS # ATMOSPHERE. 3.00 points.
Prerequisites: Recommended preparation: a good background in the physical sciences.
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 2023: EESC GU4930
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC4930 | 001/11194 | T Th 1:10pm - 2:25pm | Gordon | 3.00 | 15/25
417 Schermerhorn Hall
EESC GU4937 CENOZOIC PALEOCEANOGRAPHY. 3.00 points.
Given in alternate years. Enrollment limited to 20 students EESC (DEES) graduate students have priority.

Prerequisites: college-level geology helpful but not required. Prerequisites: college-level geology helpful but not required. Introduces the physical, chemical and biological processes that govern how and where ocean sediments accumulate. Major topics addressed are: modes of biogenic, terrigenous and authigenic sedimentation, depositional environments, pore fluids and sediment geochemistry, diagenesis, as well as biostratigraphy and sediment stratigraphic principles and methods. Second half of the semester focuses on major events in Cenozoic paleoceanography and paleoclimatology including orbital control of climate, long-term carbon cycle, extreme climate regimes, causes of ice ages in Earth's history, human evolution, El Niño evolution, and long-term sea level history

Spring 2023: EESC GU4937

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<tr>
<td>EESC 4937</td>
<td>001/11195</td>
<td>T Th 10:10am - 11:25am 417 Schermerhorn Hall</td>
<td>Maureen Raymo, Baerbel Hoenisch</td>
<td>3.00</td>
<td>13/30</td>
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<td>EESC 4937</td>
<td>AU1/19949</td>
<td>T Th 10:10am - 11:25am 0th Other</td>
<td>Maureen Raymo, Baerbel Hoenisch</td>
<td>3.00</td>
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Fall 2023

EESC UN1001 DINOSAURS AND HISTORY OF LIFE. 4.00 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 2023: EESC UN1001

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<td>EESC 1001</td>
<td>001/13223</td>
<td>M 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Paul Olsen</td>
<td>4.00</td>
<td>35/40</td>
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EESC UN1030 OCEANOGRAPHY. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Enrollment limited to 160.

Explore the geography 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

Fall 2023: EESC UN1030

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<td>EESC 1030</td>
<td>001/13126</td>
<td>T Th 11:40am - 12:55pm Room TBA</td>
<td>Baerbel Hoenisch</td>
<td>3.00</td>
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</table>
**EESC UN2100 EARTH’S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH. 4.50 points.**

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.

**Spring 2023: EESC UN2100**

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<th>Course Number</th>
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<tr>
<td>EESC 2100</td>
<td>001/11149</td>
<td>T Th 10:10am - 11:25am 603 Schermerhorn Hall</td>
<td>Mingfang Ting, Gisela Winckler</td>
<td>4.50</td>
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<tr>
<td>EESC 2100</td>
<td>001/11149</td>
<td>T 4:10pm - 7:00pm 555 Ext Schermerhorn Hall</td>
<td>Mingfang Ting, Gisela Winckler</td>
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**Fall 2023: EESC UN2100**

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<tr>
<td>EESC 2100</td>
<td>001/13062</td>
<td>T Th 10:10am - 11:25am 603 Schermerhorn Hall</td>
<td>Jerry McManus, Suzana De Camargo</td>
<td>4.50</td>
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<tr>
<td>EESC 2100</td>
<td>001/13062</td>
<td>T 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Jerry McManus, Suzana De Camargo</td>
<td>4.50</td>
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**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 2023: EESC UN2200**

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<th>Course Number</th>
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<tr>
<td>EESC 2200</td>
<td>001/11150</td>
<td>T Th 2:40pm - 3:55pm 603 Schermerhorn Hall</td>
<td>Steven Goldstein, Sidney Hemming, Sedelia Rodriguez</td>
<td>4.50</td>
<td>55/53</td>
</tr>
<tr>
<td>EESC 2200</td>
<td>001/11150</td>
<td>T 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Steven Goldstein, Sidney Hemming, Sedelia Rodriguez</td>
<td>4.50</td>
<td>55/53</td>
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**Fall 2023: EESC UN2200**

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<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<tr>
<td>EESC 2200</td>
<td>001/13130</td>
<td>T Th 1:10pm - 2:25pm 603 Schermerhorn Hall</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
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<tr>
<td>EESC 2200</td>
<td>001/13130</td>
<td>T 4:10pm - 7:00pm 603 Schermerhorn Hall</td>
<td>Jonathan Kingslake</td>
<td>4.50</td>
<td>53/53</td>
</tr>
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</table>

**EESC UN2330 SCIENCE FOR SUSTAINABLE DEVELOPMENT. 3 points.**

CC/GS: Partial Fulfillment of Science Requirement

The course provides students with the natural science basis to appreciate co-dependencies of natural and human systems, which are central to understanding sustainable development. After completing the course, students should be able to incorporate scientific approaches into their research or policy decisions and be able to use scientific methods of data analysis. The semester will highlight the climate system and solutions from both physical and ecological perspectives; water resources; food production and the cycling of nutrients; and the role of biodiversity in sustainable development. The course emphasizes key scientific concepts such as uncertainty, experimental versus observational approaches, prediction and predictability, the use of models and other essential methodological aspects.

**Fall 2023: EESC UN2330**

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<th>Instructor</th>
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<tr>
<td>EESC 2330</td>
<td>001/13131</td>
<td>T Th 2:40pm - 3:55pm Room TBA</td>
<td>John Mutter, Jenna Lawrence</td>
<td>3</td>
<td>118/120</td>
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</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.

Fall 2023: EESC UN3101
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 3101 | 001/13133 | T Th 11:40am - 12:55pm 603 Schermerhorn Hall | Terry Plank | 3 | 36/35

EESC UN3901 SENIOR SEMINAR. 3.00 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 2023: EESC UN3901
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 3901 | 001/11154 | Th 4:10pm - 6:00pm 530 Altschul Hall | Sidney Hemming, Jacqueline Austermann | 3.00 | 16/40

Fall 2023: EESC UN3901
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 3901 | 011/14060 | Th 4:10pm - 6:00pm None None | None | 3.00 | 11/50

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 2023: EESC GU4008
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4008 | 001/13134 | T 4:10pm - 6:40pm 417 Schermerhorn Hall | Lorenzo Polvani | 3 | 14/35

EESC GU4050 GLOBAL ASSMT-REMOTE SENSING. 3.00 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.

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

Fall 2023: EESC GU4050
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4050 | 001/13135 | Th 5:40pm - 6:55pm 417 Schermerhorn Hall | Christopher Small | 3.00 | 0/20
EESC 4050 | 001/13135 | F 9:00am - 10:45am Room TBA | Christopher Small | 3.00 | 0/20

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

Spring 2023: EESC GU4085
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
EESC 4085 | 001/11156 | T Th 2:40pm - 3:55pm 555 Ext Schermerhorn Hall | W Buck | 3.00 | 5/20
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 evolution. Minerals represent fundamental building blocks of the Earth system and planetary bodies. Minerals form through geological and biological processes such as igneous, metamorphic and sedimentary from high to low temperatures, from the deep interior to the Earth's surface and related to volcanism, tectonics, weathering, climate and life. Minerals are one of our most important sources of information on such processes through Earth's history. Minerals also represent important natural resources and are fundamental to the global economy and modern technology as we know it. The goal of this class is to (1) understand the physical and chemical properties of minerals, (2) learn techniques of mineral identification with an emphasis on optical mineralogy, (3) understand the relationship between minerals and the broader geological context.

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 GU4949 Introduction to Seismology. 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.

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.

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.

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
- EESC BC3200 Ecotoxicology
- EESC BC3300 WORKSHOP SUSTAINABLE DEVELOPMENT

Physics
- PHYS UN1018 WEAPONS OF MASS DESTRUCTION
## Generally Alternate Year Courses

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<td>DINOSAURS AND HISTORY OF LIFE</td>
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<tr>
<td>EESC UN1201</td>
<td>Environmental Risks and Disasters</td>
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<tr>
<td>EESC UN1401</td>
<td>DINOSAUR # HISTORY OF LIFE-LEC</td>
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<td>EESC UN3015</td>
<td>The Earth's Carbon Cycle</td>
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<td>EESC GU4009</td>
<td>CHEMICAL GEOLOGY</td>
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<tr>
<td>EESC GU4040</td>
<td>CLIM THERMODYN/ENERGY TRANSFER</td>
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<tr>
<td>EESC GU4085</td>
<td>GEODYNAMICS</td>
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<td>EESC GU4330</td>
<td>Introduction to Terrestrial Paleoclimate</td>
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<td>EESC GU4223</td>
<td>SEDIMENTARY GEOLOGY</td>
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<td>EESC GU4630</td>
<td>AIR-SEA INTERACTION</td>
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<td>EESC GU4701</td>
<td>Introduction to Igneous Petrology</td>
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<td>EESC GU4835</td>
<td>Wetlands and Climate Change</td>
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<td>EESC GU4885</td>
<td>CHEMISTRY OF CONTINENTL WATERS</td>
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<td>EESC GU4887</td>
<td>ISO TOPE GEOLOGY I</td>
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<td>EESC GU4888</td>
<td>Stable Isotope Geochemistry</td>
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<td>EESC GU4920</td>
<td>PALEOCEANOGRAPHY</td>
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<tr>
<td>EESC GU4926</td>
<td>INTRO TO CHEMICAL OCEANOGRAPHY</td>
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<td>EESC GU4937</td>
<td>CENOZOIC PALEOCEANOGRAPHY</td>
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<td>EESC GU4929</td>
<td>Mixing and Dispersion in the Ocean</td>
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<td>EESC GR6111</td>
<td>Modern analytical methods in geochmistry</td>
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<td>EESC GR6701</td>
<td>Igneous and metamorphic processes during the creation and evolution of the tectonic plates</td>
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<td>EESC GR6810</td>
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<tr>
<td>EESC GR6901</td>
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<td>EESC GR6909</td>
<td>Advanced Time Series Analysis</td>
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<td>EESC GR6920</td>
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