Department of Earth & Environmental Sciences
Undergraduate Program
Columbia University in the City of New York
About DEES

The Department of Earth and Environmental Sciences (DEES) at Columbia University hosts one of the top-rated earth and environmental science programs internationally. Faculty from all over the world bring their expertise and knowledge to our classrooms, preparing students to take on the most current challenges facing earth and humanity. With climate change rapidly reshaping the planet, it has never been a more crucial time to train the next generation of scientists in the earth and environmental science fields. Students will graduate with a degree that readies them to think critically and tackle the problems of Earth's unpredictable future.

Through Columbia College and the School of General Studies, the department offers undergraduate majors and concentrations in both Earth Science and Environmental Science, as well as a selection of elective courses that fulfill the College's science distribution requirement. Our department works closely with Barnard College's Environmental Science department, allowing students from both colleges to take classes and participate in activities hosted by either department.

The department shares staff and facilities with Columbia University’s world-renowned research institution, the Lamont-Doherty Earth Observatory. The Department and the Observatory work as partners to understand how planet Earth works, in all of its physical, chemical, and biological manifestations. Together, we are scientifically acclaimed throughout the world for our problem-solving innovation, our unique geological and climatological archives, and the outstanding achievements of our graduates.

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 students to participate in a wide variety of research programs. Summer employment, research and additional educational opportunities are available at Lamont, AMNH, and GISS. The department encourages majors to become involved in a research project by their junior year.

The department has facilities in Schermerhorn Hall on Columbia’s main campus in Morningside Heights, Manhattan, and on the Lamont campus, located about 15 miles north of Morningside in Palisades, NY. The University provides regular shuttle bus service between the Morningside and Lamont campuses.
MAJORS

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. The program instills a comprehension of how complex earth systems work at a level that will encourage students to think creatively about how to address multidisciplinary environmental problems.

The breadth of material covered provides an excellent foundational knowledge for those planning to enter the professions of law, business, scientific research, public policy, teaching, journalism, environmental consulting, geospatial analysis, data science/analysis, and more. At the same time, the program provides sufficient depth so that graduates will be prepared for graduate school in the earth and environmental sciences. The program can be adjusted to accommodate students with particular career goals in mind.

Earth Science Major
Bachelor of Arts

Environmental Science Major
Bachelor of Arts
The major in Earth Science provides an introduction to the study of the solid and fluid earth and its geological history.

The program is designed to provide students with a solid background of related science fields, then delve into particular fields in earth science in greater depth. The senior capstone experience is a culmination of what the student has learned throughout the major, in the form of a research thesis.

The senior capstone is a requirement of the major, and students can complete the research with any of the departments affiliated institutions (Lamont, NASA GISS, AMNH) or with any other institute/faculty they feel would best guide their research forward, with department approval.

The major also offers the possibility of an in-depth field experience through a six- to eight-week geology summer field course, as appropriate for students doing Geological Science as their Plan of Study. Interested students should consult the Director of Undergraduate Studies.

**Earth Science Major**
46 - 47 credits

I. **2 Foundational Courses:**
   Must take Earth’s Environmental Systems: Solid Earth System (UN2200)
   *then choose between either:*
   - Earth’s Environmental Systems: Climate System (UN2100) or
   - Earth’s Environmental Systems: Life System (UN2300)

II. **Math:** Must take Calculus I (Math 1101) or higher

III. **Science:** 3 courses in Chemistry and Physics

   - **Option 1:** Chemistry (Chem 1403-1404) & Physics (Phys 1201)
   - **Option 2:** Physics (Phys 1201-1202) & Chemistry (Chem 1403)

   **Note:** Higher level courses can substitute those listed in sections II & III.

IV. **Capstone Experience:**
   **Research and Thesis:** Students complete a research project and senior thesis under the guidance of a faculty mentor. One course, taken in each semester of the senior year, supports the thesis process. The course is **Senior Seminar** (EESC UN3901).

   **OR**

   **Summer Geology Field Course:** Student can complete a 6-8 week long summer geology field course rather than complete thesis research. Only students who are completing the Geological Science Plan of Study can replace the senior thesis with this option.

V. **18 credits in Depth, Breadth, & Related Fields:**
   Additional courses in earth science, environmental science, and related fields.

   **Depth** courses have an earth and environmental science focus that build on the foundational courses taken in requirements I, II, and III. A **minimum of 4 depth courses** must be taken, and students are required to take at least one of the courses below: 
   - **Geochemistry for a Habitable Planet** (UN3101)
   - **Solid Earth Dynamics** (UN3201)

   **Breadth and related fields** courses are relevant for an earth science major, but do not require an earth science background. Several of these courses are offered in the department at the 2000, 3000, and 4000 level, as well as at Barnard College. Courses in other sciences, mathematics, statistics, and engineering may count towards this requirement, with program approval.

**Plans of Study:** Students should discuss and develop individual plans of study with the Director of Undergraduate Studies. The box on the left lists focus areas for the plan of study. For courses in our department focused on these topics, see the Course Planning section.
Environmental Science Major
47.5 - 48.5 credits

I. 3 Foundational Courses:
   Earth's Environmental Systems: Climate System (UN2100)
   Earth's Environmental Systems: Solid Earth System (UN2200)
   Earth's Environmental Systems: Life System (UN2300)

II. Math: Must take Calculus I (Math 1101) or higher

III. Science: 3 courses in Chemistry, Physics, or Biology

   Option 1: Chemistry (Chem 1403-1404) & Physics (Phys 1201)
   Option 2: Physics (Phys 1201-1202) & Chemistry (Chem 1403)
   Option 3: Physics (Phys 1201), Chemistry (Chem 1403), and
   Environmental Biology (EEEB 2001)

   Note: Higher level courses can substitute those listed in sections II & III.

IV. Capstone Experience:

Research and Thesis: Students complete a research project and
senior thesis under the guidance of a faculty mentor. One
course, taken in each semester of the senior year, supports the
thesis process. The course is Senior Seminar (EESC UN3901).

V. 15 credits in Depth, Breadth, & Related Fields:

   Additional courses in earth science, environmental science, and
   related fields.

   Depth courses have an earth and environmental science focus
   that build on the foundational courses taken in requirements I,
   II, and III. A minimum of 3 depth courses must be taken, and
   students are required to take at least one of the courses below:
   Geochemistry for a Habitable Planet (UN3101)
   Solid Earth Dynamics (UN3201)

   Breadth and related fields courses are relevant for an
   environmental science major, but do not require an
   environmental science background. Several of these courses
   are offered in the department at the 2000, 3000, and 4000
   level, as well as at Barnard College. Courses in other sciences,
   mathematics, statistics, and engineering may count towards
   this requirement, with program approval.

Plans of Study: Students should discuss and develop individual
plans of study with the Director of Undergraduate Studies. The
box on the left lists focus areas for the plan of study. For
courses in our department focused on these topics, see the
Course Planning section.
CONCENTRATIONS

The program for concentrators serves students who want more exposure to earth and environmental science than is provided by introductory-level courses. It is 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 build a strong scientific background that leads them into various fields such as business, law, medicine, and journalism.

In addition to the environmental science and earth science concentrations, the department sponsors a special concentration in Environmental Science for Environmental Biology majors. There is also a special concentration in Environmental Biology for Environmental Science majors sponsored by the Department of Ecology, Evolution and Environmental Biology.
Earth Science Concentration
25 credits

I. 2 Foundational Classes:
   Must take the following course:
   Solid Earth System (UN2200)
   and choose between either:
   Climate System (UN2100)
   Life System (UN2300)

II. Math & Science:
   Two science or mathematics courses in
   Chemistry, Physics, or Calculus.

III. Advanced Courses:
   Three additional courses in earth science for
   a minimum of 10 credits. Geochemistry for a
   Habitable Planet (UN3101) or Solid Earth
   Dynamics (UN3201) must be taken. The
   courses can be selected from those suitable
   for earth science majors.

Environmental Science Concentration
25.5 credits

I. 3 Foundational Classes:
   Climate System (UN2100)
   Solid Earth System (UN2200)
   Life System (UN2300)

II. Math & Science:
   Two science or mathematics courses in
   Chemistry, Physics, Environmental
   Biology, or Calculus.

III. Advanced Courses:
   Two additional courses in
   environmental science for a minimum
   of 6 credits. Either Geochemistry for a
   Habitable Planet (UN3101) or Solid Earth
   Dynamics (UN3201) must be taken. The
   one additional course can be selected
   from those suitable for environmental
   science majors.

Environmental Science for
Environmental Biology Majors
31.5 credits

I. 3 Foundational Classes:
   Climate System (UN2100)
   Solid Earth System (UN2200)
   Life System (UN2300)

II. Math & Science:
   Two courses in Chemistry, Physics,
   Mathematics, and/or biology.

III. Advanced Courses:
   Four additional courses in environmental
   science at the 3000 level or above.
   Advanced courses used to fulfill the major
   in environmental biology cannot also
   count toward fulfillment of the special
   concentration in environmental science.
FIRST YEAR COURSES

Those pursuing the Earth or Environmental Science majors are recommended to take Solid Earth Systems (EESC UN2200), Chemistry (1403-1404), Physics (1201-1202), or Calculus I (M1101) or higher in their first year and second years. Those courses would begin to fill the basic science and math requirements of both the earth science and environmental science major. Find example semester for your first year below.

For those interested in the earth science and environmental sciences, but are unsure of joining the program, you can take the department’s 1000 level courses (the 1000 level offerings can be found on the following page). These cover a wide range of topics and are introductory. These courses count towards the general science requirements, but do not count as credits towards the major.

<table>
<thead>
<tr>
<th>First Year Fall</th>
<th>First Year Spring</th>
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</thead>
<tbody>
<tr>
<td>Core Class</td>
<td>Core Class</td>
</tr>
<tr>
<td>Core Class</td>
<td>EESC UN2100 - Climate System</td>
</tr>
<tr>
<td>EESC UN2200 - Solid Earth System</td>
<td>EESC UN2300 - Life System</td>
</tr>
<tr>
<td>CHEM 1403</td>
<td>CHEM 1404</td>
</tr>
<tr>
<td>PHY 1201</td>
<td>Calc I or higher (Math 1011)</td>
</tr>
</tbody>
</table>

This is just an example schedule. You can discuss courses to take with the DEES Director of Undergraduate Studies, or the DEES Undergraduate Program Manager. We suggest taking the fundamental courses and math and science courses required for the major as early as possible. This will allow for more freedom in taking specific courses to cater to your interests in the major, as well as provide freedom to take on research.
These are introductory, general interest courses. They are suggested to be taken in the first year/second year to fulfill the general science requirement, as well as introduce earth and environmental science topics to students. These courses only count towards the Columbia Core general science requirement, and not towards either of the DEES majors.

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall 2020</th>
<th>Spring 2021</th>
<th>Fall 2021</th>
<th>Spring 2022</th>
<th>Fall 2022</th>
<th>Spring 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinosaurs &amp; the History of Life (UN1001/UN1401)</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Global Warming (UN1002)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Geological Field Excursion (UN1010)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Earth Origin &amp; Evolution (UN1011/1411)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Oceanography (UN1030)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Environmental Risks &amp; Disasters (UN1201)</td>
<td>X</td>
<td></td>
<td></td>
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<td>X</td>
</tr>
<tr>
<td>Earth Resources &amp; Sustainable Development (UN1600)</td>
<td>X</td>
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<td>X</td>
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<td>X</td>
</tr>
</tbody>
</table>
FOUNDATIONAL COURSES FOR MAJORS & CONCENTRATORS

There are three foundational courses that are required for both majors and concentrators. Please refer to the majors & concentrations sections above to identify which courses are required for you. The table below outlines when these courses are offered over the next three years.

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall 2020</th>
<th>Spring 2021</th>
<th>Fall 2021</th>
<th>Spring 2022</th>
<th>Fall 2022</th>
<th>Spring 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Systems (UN2100)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Solid Earth Systems (UN2200)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Life Systems (UN2300)</td>
<td></td>
<td>X</td>
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<td>X</td>
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<td>X</td>
</tr>
</tbody>
</table>

UPPER LEVEL COURSES IN DEES

The department of Earth & Environmental Sciences offers over 50 undergraduate and graduate courses through Columbia College, the School of General Studies, and the Graduate School of Arts and Sciences.

Undergraduate students will typically take department courses between levels 2000-4000. 2000-3000 level courses are strictly undergraduate, and the 4000 level courses are considered advanced undergraduate courses, and introductory graduate courses. Both undergraduate and graduate students can take 4000 level courses. The offerings for the 2000-3000 level courses can be found on the following pages. For upper-level courses browse the department course list.
# 3000 Level Undergraduate Courses

These are upper level undergraduate courses that can fulfill the breadth and depth requirement of the major.

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall 2020</th>
<th>Spring 2021</th>
<th>Fall 2021</th>
<th>Spring 2022</th>
<th>Fall 2022</th>
<th>Spring 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Geology (UN3010)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hydrology (BC3025)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Geochemistry for a Habitable Planet (UN3101)</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Solid Earth Dynamics (UN3201)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Computational Earth Science (UN3400)</td>
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<td>X</td>
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</tr>
</tbody>
</table>

**Note:** Any class that begins with BC means it is being held at Barnard College, located across the street from the Morningside Campus, on Broadway.

# 4000 Level Undergraduate & Graduate Courses

These are advanced undergraduate courses/introductory graduate courses. Undergraduate and graduate students may both take these courses. These courses can fulfill the breadth and depth requirement of the major. For a full list of these courses, see the department course list, or the DEES Three Year Course Planner.
Since its founding in 1949, the Lamont Doherty Earth Observatory has been a leader in the earth sciences. The Observatory seeks fundamental knowledge about the origin, evolution and future of the natural world. Its scientists study the planet from its deepest interior to the outer reaches of its atmosphere, on every continent and in every ocean, providing a rational basis for the difficult choices facing humanity.

Its scientists were the first to map the seafloor and develop a computer model that could predict an El Nino weather event, the first to provide concrete proof for the theory of plate tectonics and to reveal the oceans’ role in triggering abrupt climate change.

Lamont also operates a federally funded research ship, the Marcus G. Langseth, which uses seismic data to map the subseafloor, highlighting hidden faults and other earthquake hazards. With each year, our understanding of earth improves. Yet, new discoveries await us. It is that next insight on the horizon that keeps our researchers excited to learn more about how and why earth changes as it does.

Nearly 200 Ph.D. level researchers work and teach here, and 80-100 graduate students are involved in research. Undergraduate students are encouraged to involve themselves in research as early as junior year. They can work under a professor, a graduate student, or one of the researchers at Lamont. There are also opportunities to intern at Lamont over the summer.

*A free bus service runs between the Morningside Campus & the Lamont Campus daily. Find the map here.
The Observatory has a wide-range of research being done in earth and environmental science. There are six divisions within the observatory, click below to learn more about them:

*Biology & Paleo Environment*

*Geochemistry*

*Marine Geology & Geophysics*

*Ocean & Climate Physics*

*Office of Marine Operations*

*Seismology, Geology, & Tectonophysics*
Our faculty have specializations in specific fields in which they have studied, conducted research, and taught. Some faculty may do work within multiple fields.

### Geology/Paleontology
- Nicholas Christie Blick
- Peter deMenocal
- Steven Goldstein
- Sidney Hemming
- Peter Keleman
- Alberto Malinverno
- Jerry McManus
- Yves Moussallam
- Meredith Nettles
- Mark Norell
- Paul Olsen
- Terry Plank
- Michael Purdy
- Maureen Raymo
- Joerg Schaefer
- Christopher Small
- Sean Solomon
- Marc Spiegelman
- Maya Tolstoy
- David Walker
- Spahr Webb
- Gisela Winckler

### Geophysics
- Jacky Austermann
- Roger Buck
- Goran Ekstrom
- James Gaherty
- Peter Keleman
- Jonathan Kingslake
- Kerry Key
- Arthur Lerner Lam
- Alberto Malinverno
- William Menke
- John Mutter
- Meredith Nettles
- Michael Purdy
- Paul Richards
- Christopher Scholz
- Christopher Small
- Sean Solomon
- Marc Spiegelman
- Maya Tolstoy
- Spahr Webb
- Renata Wentzcovitch

### Modern & Future Climate
- Ryan Abernathey
- Mark Cane
- Suzana Camargo
- Peter deMenocal
- Sonya Dyhrman
- Arlene Fiore
- Alessandra Giannini
- Lisa Goddard
- Arnold Gordon
- Kevin Griffin
- Barbel Honisch
- Douglas Martinson
- Galen McKinley
- Jerry McManus
- John Mutter
- Benjamin Orlove
- Dorothy Peteet
- Lorenzo Polvani
- Andrew Robertson
- Joerg Schaefer
- Adam Sobel
- Martin Stute
- Taro Takahashi
- Mingfang Ting
- Gisela Winckler

### Oceanography
- Ryan Abernathey
- Robert Anderson
- Mark Cane
- Peter deMenocal
- Sonya Dyhrman
- Steven Goldstein
- Arnold Gordon
- Sidney Hemming
- Barbel Honisch
- Douglas Martinson
- Galen McKinley
- Jerry McManus
- Ronald Miller
- Paul Olsen
- Dorothy Peteet
- Maureen Raymo
- Joerg Schaefer
- Martin Stute
- Andreas Thurnherr
- Gisela Winckler

### Atmospheric Science
- Roisin Commane
- Suzana Camargo
- Arlene Fiore
- Alessandra Giannini
- Lisa Goddard
- Ronald Miller
- Lorenzo Polvani
- Andrew Robertson
- Adam Sobel
- Mingfang Ting

### Paleoclimate
- Jacky Austermann
- Ryan Abernathey
- Jacky Austermann
- Mark Cane
- Peter deMenocal
- Hugh Ducklow
- Sonya Dyhrman
- Steven Goldstein
- Arnold Gordon
- Sidney Hemming
- Barbel Honisch
- Andrew Juhl
- Douglas Martinson
- Jerry McManus
- Dorothy Peteet
- Maureen Raymo
- Joerg Schaefer
- Taro Takahashi
- Gisela Winckler

### Biogeoscience
- Natalie Boelman
- Joel Cohen
- Roisin Commane
- Hugh Ducklow
- Sonya Dyhrman
- Peter Eisenberger
- Kevin Griffin
- Andrew Juhl
- Galen McKinley
- Mark Norell
- Dorothy Peteet
- Maureen Raymo
- Mingfang Ting

### Geochemistry
- Robert Anderson
- Peter deMenocal
- Sonya Dyhrman
- Denton Ebel
- Steven Goldstein
- Alex Halliday
- Sidney Hemming
- Barbel Honisch
- Peter Keleman
- Galen McKinley
- Jerry McManus
- Yves Moussallam
- Terry Plank
- Maureen Raymo
- Joerg Schaefer
- Marc Spiegelman
- Martin Stute
- Taro Takahashi
- David Walker
- Gisela Winckler

For more information on our faculty, click [here](#).
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