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 Earth Science, Environmental Science, and Climate System 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 majors in earth, environmental, and climate system sciences provide an understanding of the natural functioning of our planet and consider 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

Bachelor of Arts

Environmental Science

Bachelor of Arts

Climate System Science

Bachelor of Arts

Earth Science Major

46 points minimum

The major in Earth Science provides an introduction to the study of the solid and fluid earth and it's 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.

Plans of Study

Geological Science
Geochemistry
Geophysics
Climate
Paleontology
Atmosphere & Ocean Science

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 points minimum

The major in Environmental Science focuses on the interaction between Earth's physical environment and the biosphere, on anthropogenic processes like pollution and global climate change, and on environmental remediation.

The program is designed to provide students with a solid background in related science fields, then delve into particular fields in environmental science in greater depth.

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.

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

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.

Plans of Study

Environmental Geology
Environmental Geochemistry
Hydrology
Climate Change
Energy & Resources

Climate System Science Major

43.5 points minimum

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.

All climate system science majors are required to complete a capstone experience, which can include a field course or an independent research project, typically at Lamont-Doherty Earth Observatory with guidance from a leading climate scientist.

Example tracks for the major include sea level change, decarbonization, and modern climate. These tracks 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.

Plans of Study

Decarbonization
Modern Climate
Sea Level Change

I. **Foundational Courses (7.5 points minimum):**

Required:

Earth's Environmental Systems: Climate System (UN2100)

And any one of:

Global Warming for Global Leaders (UN1009)
Oceanography (UN1030)
Environmental Risks & Disasters (UN1201)
Earth's Resources & Sustainable Development (UN1600 or GU4600)
Earth's Environmental Systems: Solid Earth System (UN2200)
Earth's Environmental Systems: Life System (UN2300)
Science for Sustainable Development (UN2330)

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

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

Physics I (UN1201)
Physics II (UN1202)
Chemistry I (UN1403)
Chemistry II (UN1404)
Evolutionary Biology I (UN2001)
Earth's Environmental Systems: The Life System (UN2300)

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

IV. **Climate System Core (15 points minimum):***

At least one: Paleoclimate Course
At least one: Modern Climate Course
Could include one: Other Climate System Course
Could include one: Supporting EESC Course

V. **Climate Solutions, Justice, Policy, Communication (6 points minimum):***

Any two courses in solutions, justice, policy, or communication

*See list of courses on our website

VI. **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).
Students may also take an approved field course (~6 weeks) focused on the climate system to satisfy this requirement.

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

Environmental Science Concentration

Environmental Science for Environmental Biology Majors

Environmental Biology for Environmental Science Majors (EEEB)

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. **Advanved 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.

COURSE PLANNING

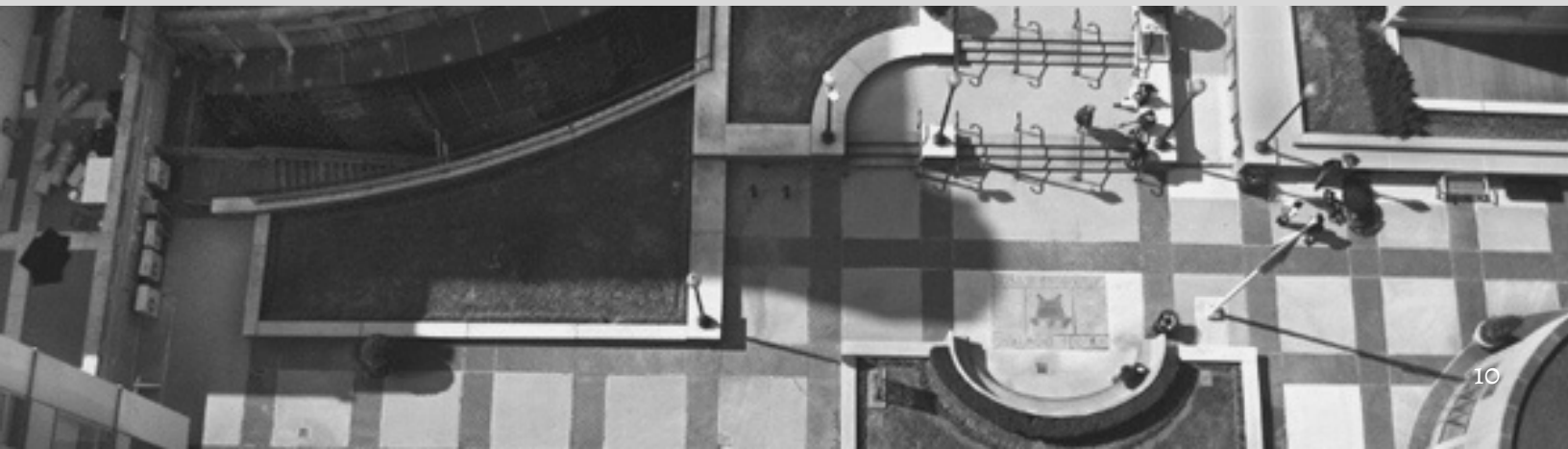
FIRST YEAR COURSES

Those pursuing the Earth, Environmental, and Climate System Science majors are recommended to take Solid Earth Systems (EESC UN2200) or Climate Systems (EESC UN2100), as well as 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 for the Earth Science, Environmental Science, and Climate System Science majors. Find example semester for your first year below.

First Year Fall	First Year Spring
Core Class	Core Class
Core Class	EESC UN2100 - Climate System
EESC UN2200 - Solid Earth System	EESC UN2300 - Life System
CHEM 1403	CHEM 1404
PHY 1201	Calc I or higher (Math 1011)

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.

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.



COURSE PLANNING

1000 LEVEL UNDERGRADUATE COURSES

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 any of the DEES majors.

1000 LEVEL COURSES

Dinosaurs & the History of Life
UN1001/1401

Global Warming for Global Leaders
UN1009

Geological Field Excursion to Death Valley
UN1010

Earth: Origin, Evolution, Processes, Future
UN1011/1411

Oceanography
UN1030

Environmental Risks & Disasters
UN1201

Earth Resources & Sustainable Development
UN1600

COURSE PLANNING

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.

Course	Fall 2023	Spring 2024	Fall 2024	Spring 2025	Fall 2025	Spring 2026
Climate Systems (UN2100)	X	X	X	X	X	X
Solid Earth Systems (UN2200)	X	X		X		X
Life Systems (UN2300)		X		X		X

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 3000 level courses can be found on the following pages. For upper-level courses browse the department course list.

COURSE PLANNING

3000 LEVEL UNDERGRADUATE COURSES

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

Couse	Fall 2023	Spring 2024	Fall 2024	Spring 2025	Fall 2025	Spring 2026
Field Geology (UN3010)		X		X		X
Hydrology (BC3025)						
Chemistry of Climate (UN3031)	X		X		X	
Geochemistry for a Habitable Planet (UN3101)	X		X		X	
Climate Physics (UN3109)		X		X		X
Solid Earth Dynamics (UN3201)		X				
Computational Earth Science (UN3400)	X					

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.

LAMONT-DOHERTY EARTH OBSERVATORY

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 sub-seafloor, 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 the earth and environmental sciences. There are five divisions within the observatory, click below to learn more about them:

Biology & Paleo Environment

Geochemistry

Marine Geology & Geophysics

Ocean & Climate Physics

Seismology, Geology, & Tectonophysics

DEES FACULTY

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
John Flynn
Steven Goldstein
Sidney Hemming
Peter Kelemen
Folarin Kolawale
Alberto Malinverno
Jerry McManus
Yves Moussallam
Meredith Nettles
Paul Olsen
Terry Plank
Maureen Raymo
Joerg Schaefer
Christopher Small
Marc Spiegelman
Maya Tolstoy
Felix Waldhauser
Spahr Webb
Gisela Winckler

Geophysics

Jacky Austermann
Anne Bécel
Roger Buck
Goran Ekstrom
Pierre Gentine
Peter Kelemen
Folarin Kolawale
Jonathan Kingslake
Arthur Lerner-Lam
Alberto Malinverno
William Menke
John Mutter
Meredith Nettles
Christopher Scholz
Christopher Small
Marc Spiegelman
Maya Tolstoy
Spahr Webb
Renata Wentzcovitch

Modern & Future Climate

Ryan Abernathy
Suzana Camargo
Sonya Dyhrman
Kevin Griffin
Barbel Honsich
Galen McKinley
Jerry McManus
John Mutter
Dorothy Peteet
Lorenzo Polvani
Andrew Robertson
Joerg Schaefer
Adam Sobel
Martin Stute
Gisela Winckler

Oceanography

Ryan Abernathey
Robert Anderson
Sonya Dyhrman
Steven Goldstein
Sidney Hemming
Barbel Honisch
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
Ronald Miller
Lorenzo Polvani
Andrew Robertson
Adam Sobel

Paleoclimate

Ryan Abernathy
Jacky Austermann
Sonya Dyhrman
Steven Goldstein
Sidney Hemming
Barbel Honisch
Andrew Juhl
Jerry McManus
Dorothy Peteet
Maureen Raymo
Joerg Schaefer
Gisela Winckler

Biogeoscience

Joel Cohen
Roisin Commane
Sonya Dyhrman
Peter Eisenberger
Kevin Griffin
Andrew Juhl
Galen McKinley
Dorothy Peteet
Maureen Raymo

Geochemistry

Robert Anderson
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
Gisela Winckler

For more information on our faculty, click *here.*

CONTACT US

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