DEPARTMENT OF EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

The Department of Earth, Atmospheric, and Planetary Sciences offers a bachelor's degree in earth, atmospheric, and planetary sciences, and master's and doctoral degrees in atmospheric sciences, climate science, geology, geochemistry, geobiology, geophysics, and planetary sciences. In conjunction with the Computational Science and Engineering Program (CSE), the department offers a PhD in computational earth, atmospheric and planetary sciences (http://catalog.mit.edu/interdisciplinary/graduate-programs/computational-science-engineering). The department also participates in the MIT-WHOI Joint Program in Oceanography/ Applied Ocean Science and Engineering (http://catalog.mit.edu/interdisciplinary/graduate-programs/joint-program-woods-hole-oceanographic-institution) with doctoral degree programs in chemical oceanography, physical oceanography, biological oceanography, and marine geology and geophysics.

Departmental programs apply physics, chemistry, and mathematics to the study of the Earth and planets in order to understand the processes that are active in the Earth's interior, oceans, and atmosphere, as well as the interiors and atmospheres of other planets. The department also uses the basic sciences to understand the past history of the Earth and planets. By combining the past history with models of present physical, biological, and chemical processes, faculty and students work to develop an understanding of the dynamics of systems as diverse as the global climate system, regional tectonics and deformation, petroleum and geothermal reservoirs, and the solar system.

Research in the department is fundamental in nature, but underpins many of the most pressing societal questions of our time: climate and environmental change; natural hazards; natural resources; the origins of life both on Earth and elsewhere. Much of the research is interdisciplinary, so faculty, researchers, and students commonly cross discipline boundaries. Modern problems in these fields are approached by field measurements, laboratory studies, simulations, and theory. Experimental facilities for training and research are available not only in departmental laboratories such as the Earth Resources Laboratory, but also in MIT's interdepartmental laboratories such as the Center for Global Change Science, Kavli Institute for Astrophysics and Space Research, Lincoln Laboratory, Haystack Radio Observatory and Millstone Radar facility, and the Wallace Astrophysical and Geophysical Observatories (described in the section on Research and Study (http://catalog.mit.edu/mit/research)), and in cooperating institutions such as the Woods Hole Oceanographic Institution.

Undergraduate Study

Bachelor of Science in Earth, Atmospheric, and Planetary Sciences (Course 12)

The Earth, Atmospheric, and Planetary Sciences Department offers undergraduate preparation for professional careers in a wide range of fields in geoscience (which includes geology, geophysics, geobiology, and geochemistry), atmospheric science, climate science, environmental systems, and planetary science and planetary astronomy.

The curriculum for the Bachelor of Science in Earth, Atmospheric, and Planetary Sciences (http://catalog.mit.edu/degree-charts/earth-atmospheric-planetary-sciences-course-12) ensures a fundamental background through general departmental subjects and advanced study in a concentration area chosen by the student. The student and advisor plan an appropriate and relevant selection of electives. Students are also required to take field and/or laboratory subjects, and to complete an independent research project as part of the degree requirements.

Double Major

Studies in physics, chemistry, biology, applied mathematics, and electrical or civil engineering are directly relevant preparation for work in earth, atmospheric, and planetary sciences. Students from these departments can arrange a program of study in Course 12 leading to a second major with subjects that strengthen their undergraduate program.

Five-Year Program

Students with strong academic records from the departments of Earth, Atmospheric, and Planetary Sciences, Chemistry, Physics, Mathematics, Civil and Environmental Engineering, Electrical Engineering and Computer Science, or Chemical Engineering, should be able to complete a Master of Science in Earth and Planetary Sciences, in Atmospheric Sciences, or in Ocean Sciences in one year of additional study, particularly if programs are arranged for this purpose from the beginning of the fourth year.

Applications for graduate enrollment in the department are considered any time after the beginning of the fourth year. Students may receive the Bachelor of Science as soon as the requirements are completed, or may elect to defer the award for simultaneous presentation with the Master of Science.

Minor in Earth, Atmospheric, and Planetary Sciences

The Minor in Earth, Atmospheric, and Planetary Sciences provides an opportunity to complement or expand upon one's major by exploring in depth the natural processes that govern the structure and evolution of the Earth and planets. Areas of study include planetary surfaces, interiors, atmospheres, oceans, and biospheres. The EAPS Minor requires a solid foundation in two core subjects plus electives that create expertise in a particular area. Opportunities for
field work, laboratory work, and independent study are an essential component of the minor.

Core Subjects

Select two of the following:

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<th>Course</th>
<th>Title</th>
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<tr>
<td>12.001</td>
<td>Introduction to Geology</td>
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<tr>
<td>12.002</td>
<td>Introduction to Geophysics and Planetary Science</td>
</tr>
<tr>
<td>12.003</td>
<td>Introduction to Atmosphere, Ocean, and Climate Dynamics</td>
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<tr>
<td>12.007</td>
<td>Geobiology: History of Life on Earth</td>
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Select one of the following:

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<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics</td>
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<tr>
<td>18.03</td>
<td>Differential Equations</td>
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Restricted Electives

Select at least 24 units in Course 12 subjects, approved by the minor advisor, to provide a depth of understanding and expertise in an EAPS discipline.

Select an option from either the Laboratory or Independent Study group:

| Laboratory | 12.115 | Field Geology |
|            | 12.119 | Harnessing Power from Environmental Microbes and Chemical Gradients |
|            | 12.307 | Weather and Climate Laboratory |
|            | 12.335 | Experimental Atmospheric Chemistry |
|            | 12.410[J] | Observational Techniques of Optical Astronomy |

| Independent Study | 12.IND | Independent Study |
|                   | 12.UR  | Undergraduate Research |

Total Units 72-75

1 18.03 Differential Equations is also an acceptable option.

Minor in Astronomy

The Earth, Atmospheric, and Planetary Sciences Department jointly offers a Minor in Astronomy (http://catalog.mit.edu/interdisciplinary/undergraduate-programs/minors/astronomy) with the Department of Physics (Course 8). A detailed description and list of requirements for this minor is available under Interdisciplinary Programs.

Minor in Atmospheric Chemistry

The department also offers an interdisciplinary Minor in Atmospheric Chemistry (http://catalog.mit.edu/interdisciplinary/undergraduate-programs/minors/atmospheric-chemistry) with the Departments of Chemistry and Civil and Environmental Engineering. For a description of the minor, see Interdisciplinary Programs.

Inquiries

Additional information may be obtained from the department’s Education Office, Room 54-912, 617-253-3381.

Graduate Study

The Department of Earth, Atmospheric, and Planetary Sciences offers opportunities for graduate study and research in a wide range of fields:

- Atmospheric chemistry
- Atmospheric dynamics
- Biogeochemistry
- Climate chemistry
- Climate dynamics
- Computational earth, atmospheric, and planetary sciences (in conjunction with the Computational Sciences and Engineering Program)
- Geology
- Geobiology
- Geochemistry
- Geophysics
- Paleoclimate
- Planetary sciences

Study in chemical, physical, and biological oceanography, as well as marine geology and geophysics, is offered in cooperation with the Joint Program with Woods Hole Oceanographic Institution (http://mit.whoi.edu).

Coursework during the first two years is the usual prelude to a thesis demonstrating that the student is capable of independent and creative research. The department offers the following degrees: a Master of Science, a Doctor of Philosophy, or a Doctor of Science in the field of specialization.

A graduate thesis may have either a theoretical, experimental, or observational focus. Modern laboratory facilities, computers, instrumentation, and extensive collections of specimens and data are available to students. Field study is an essential part of the graduate curriculum in geology, geophysics, and geochemistry, and special arrangements may be made for summer employment and field research on departmental projects and with industrial organizations and government agencies. In atmospheric science and climate studies graduate study includes a mixture of theoretical and experimental studies sharing a common appreciation of the dynamics of the underlying processes.

Admission Requirements for Graduate Study

In addition to the general institute requirements for admission (http://catalog.mit.edu/mit/graduate-education) listed in the section on Graduate Education, the department requires preparation
equivalent to the curriculum for the Bachelor of Science in Earth, Atmospheric, and Planetary Sciences at MIT for graduate studies in that field. For atmospheric sciences, climate studies, meteorology, and oceanography, the most essential element is a sound preparation in mathematics and physics, supplemented if possible by some chemistry. Students taking their undergraduate work at other institutions are advised to include in their programs the equivalent of the mathematics and physics contained in the MIT undergraduate curricula. If students are not fully prepared in certain of the fields or required subjects, they usually are asked to extend their studies in these areas while pursuing advanced work. The doctoral program can be entered without a Master of Science as a prerequisite.

Master of Science in Earth and Planetary Sciences, in Atmospheric Science, or in Climate Physics and Chemistry
The General Degree Requirements (http://catalog.mit.edu/mit/graduate-education) for the degree of Master of Science in Earth and Planetary Science, in Atmospheric Science, or in Climate Physics and Chemistry are described under Graduate Education. An individual program of study and research is arranged to suit the special background, needs, and goals of each student. The program is worked out in detail by the student with his or her personal faculty advisor and a departmental committee. There are no foreign language requirements for the degree.

Doctor of Philosophy and Doctor of Science
A specialized program of study and research is tailored to each student’s background, needs, and goals by the student in consultation with a faculty advisor and a departmental committee. A doctoral candidate’s program should be broad and may include formal study in other departments in addition to the specialized subjects that prepare the candidate for thesis research. There is no foreign language requirement for the degree. Thesis research normally begins immediately after successful completion of the general examination by the end of the second year. The general examination is intended to test the candidate’s aptitude and preparation for independent research.

Thesis research is closely supervised by one or more faculty members interested in and knowledgeable about the research topic, who are chosen by the student and may be members of other departments. The thesis is expected to meet high professional standards, and to be a significant original contribution to the scientific field.

Interdisciplinary Programs
Computational Science and Engineering
The Computational Science and Engineering (CSE) doctoral program (https://cse.mit.edu/programs/phd) allows students to specialize in a computation-related field of their choice through focused coursework and a doctoral thesis through a number of participating host departments. The CSE PhD program is administered jointly by the Center for Computational Science and Engineering (CCSE) and the host departments, with the emphasis of thesis research activities being the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. For more information, see the full program description (http://catalog.mit.edu/interdisciplinary/graduate-programs/computational-science-engineering) under Interdisciplinary Graduate Programs.

Joint Program with the Woods Hole Oceanographic Institution
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail (http://catalog.mit.edu/interdisciplinary/graduate-programs/joint-program-woods-hole-oceanographic-institution) under Interdisciplinary Graduate Programs.

Financial Support
The department offers a considerable number of research and teaching assistantships each year. Research assistants work on one of the many research projects in the department, often related to the student’s thesis research. Teaching assistants assist in laboratory instruction or in the preparation of teaching materials and the grading of papers.

The department also offers several fellowships beyond normal teaching and research assistantships. Selection of individuals is based on the excellence of the applicant’s record.

Inquiries
Additional information regarding academic and current research programs in the department, admission requirements, assistantship appointments, and financial aid may be obtained by writing to the department’s Education Office, Room 54-912, 617-253-3381.

Research Laboratories and Programs
The department’s faculty, staff, and students are engaged in a wide variety of research projects in the laboratories of individual faculty members and in the departmental laboratories described below. Many also participate in the activities of interdisciplinary laboratories such as the Center for the Global Change Science and the Joint Program on the Science and Policy of Global Change, described in the section on Research and Study (http://catalog.mit.edu/mit/research).
Earth Resources Laboratory

The Earth Resources Laboratory (ERL) ([http://erl.mit.edu](http://erl.mit.edu)) is MIT's primary home for research and education focused on sub-surface energy resources. Through integration across disciplines, departments, and school boundaries, and with support from federal agencies and a consortium of energy companies, ERL addresses questions concerning hydrocarbon exploration and production, geothermal energy, CO₂ sequestration, and near-surface environments.

ERL's faculty, research staff, and students work with a variety of methodologies (including geophysical imaging, rock physics and chemistry, multiphase flow, geomechanics, microseisimics, and remote sensing) to obtain a holistic understanding of sub-surface reservoirs— their structure, the geological materials of which they are made, the fluids that flow through them, and changes that occur in response to production.

Building on a rich tradition, ERL aims to produce tomorrow's industry leaders through rigorous disciplinary education and broad exposure to the earth sciences, mathematics, and engineering.

Professor Laurent Demanet is the current director of ERL. For further information, please visit ERL website ([http://erl.mit.edu](http://erl.mit.edu)).

George R. Wallace, Jr., Astrophysical Observatory

The George R. Wallace, Jr., Astrophysical Observatory ([http://web.mit.edu/wallace](http://web.mit.edu/wallace)) is a versatile facility for research and teaching optical astronomy. The observatory located in Westford, MA, has several optical telescopes ranging from 24-in to 8-in diameters and modern instrumentation. The telescopes are used in formal instruction; faculty, staff, and student research projects; and as testbeds for instrumentation to be used with larger telescopes. Further information on the Wallace Observatory may be obtained by contacting Dr. Michael Person ([mjperson@mit.edu](mailto:mjperson@mit.edu)), 54-418, 617-452-2304.

George R. Wallace, Jr., Geophysical Observatory

The George R. Wallace, Jr., Geophysical Observatory is a unique research facility designed to monitor ground motions and to aid in the development and testing of new seismic and other geophysical instrumentation. It is also a key component of MIT's five-station seismic network in New England.

Located 35 miles north of Boston in Westford, MA, the observatory has a large, multi-room underground vault and a surface control room. The vault has a controlled temperature environment and instrument piers resting directly on the basement granite. The observatory contains sensitive seismometers and instruments for monitoring ground tilts and the earth's tidal motions. The surface building houses a work area and control and recording instruments. Data from the observatory are telemetered directly to the Earth Resources Laboratory of the Department of Earth, Atmospheric, and Planetary Sciences. The data from the observatory and the New England Seismic Network are recorded, displayed, and analyzed by three dedicated COMPAQ computers, which are also connected to workstations to facilitate data sharing and transfers. Data from the observatory along with the numerous resources of the department provide a unique facility for undergraduates, graduate students, and staff to pursue research concerning the interior of the earth.

Further information may be obtained by contacting EAPS Headquarters, 54-918, 617-253-2127.

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