The Department of Atmospheric and Oceanic Sciences (ATOC) is an interdisciplinary program that provides an educational and research environment to examine the dynamical, physical and chemical processes in the atmosphere, ocean and land surface, and the manner in which they interact. A major theme is the establishment of a physical basis for understanding, observing and modeling climate and global change.

Graduate students admitted to ATOC are eligible to receive an advanced degree in atmospheric and oceanic sciences. Graduate students outside of ATOC can pursue the graduate certificate in atmospheric and oceanic sciences while earning a graduate degree from another department at CU Boulder, or while taking course work as a non-degree-seeking student through Continuing Education’s ACCESS Program provided they have already earned a bachelor’s degree and meet the course prerequisites. In addition, students inside and outside the department may pursue a graduate certificate in oceanography. For more information on graduate certificate programs, see the Graduate School/Interdisciplinary Programs section.

For more information about ATOC programs and application procedures, call the ATOC office at 303-492-6633 or visit the Atmospheric and Oceanic Sciences website.

Course code for this program is ATOC.

Master's Degree

- Atmospheric and Oceanic Sciences - Master of Science (MS) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/atmospheric-oceanic-sciences/atmospheric-oceanic-sciences-master-science-ms)

Doctoral Degree

- Atmospheric and Oceanic Sciences - Doctor of Philosophy (PhD) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/atmospheric-oceanic-sciences/atmospheric-oceanic-sciences-doctor-philosophy-phd)

Certificates

- Atmospheric and Oceanic Sciences - Graduate Certificate (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/atmospheric-oceanic-sciences/atmospheric-oceanic-sciences-graduate-certificate)

- Oceanography - Graduate Certificate (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/atmospheric-oceanic-sciences/oceanography-graduate-certificate)

Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

Brown, Derek Philip (https://experts.colorado.edu/display/fisid_150027)
Instructor; PhD, University of Colorado Boulder

Cassano, John J. (https://experts.colorado.edu/display/fisid_121781)
Associate Professor; PhD, University of Wyoming

Forrest, Betsy Carroll (https://experts.colorado.edu/display/fisid_101645)
Lecturer; PhD, University of Colorado Boulder

Friedrich, Katja (https://experts.colorado.edu/display/fisid_133607)
Associate Professor; PhD, Ludwig-Maximilians Univ of Munich (Germany)

Han, Weiqing (https://experts.colorado.edu/display/fisid_115493)
Professor; PhD, Nova University

Hart, John E.
Professor Emeritus

Jahn Hall, Alexandra (https://experts.colorado.edu/display/fisid_155096)
Assistant Professor; PhD, McGill Univ (Canada)

Karnauskas, Kristopher Benson (https://experts.colorado.edu/display/fisid_155094)
Associate Professor; PhD, University of Maryland College Park Campus

Kay, Jennifer E. (https://experts.colorado.edu/display/fisid_153815)
Assistant Professor; PhD, University of Washington

Keen, Richard A.
Professor Emeritus

Lenaerts, Jan
Assistant Professor; PhD, Utrecht University

Lovenduski, Nicole Suzanne (https://experts.colorado.edu/display/fisid_147557)
Assistant Professor; PhD, University of California-Los Angeles

Lundquist, Julie Kay (https://experts.colorado.edu/display/fisid_147838)
Associate Professor; PhD, University of Colorado Boulder

Nigro, Melissa A (https://experts.colorado.edu/display/fisid_152154)
Instructor; PhD, University of Colorado Boulder

Pilewskie, Peter Andrew (https://experts.colorado.edu/display/fisid_134466)
Professor; PhD, University of Arizona

Randall, Cora Einterz (https://experts.colorado.edu/display/fisid_102010)
Professor; PhD, University of California-Santa Cruz

Toohey, Darin W (https://experts.colorado.edu/display/fisid_110652)
Professor; PhD, Harvard University

Toon, Owen Brian (https://experts.colorado.edu/display/fisid_110521)
Professor; PhD, Cornell University

Weiss, Jeffrey B (https://experts.colorado.edu/display/fisid_102145)
Professor; PhD, University of California-Berkeley
Courses

ATOC 5000 (3) Critical Issues in Climate and the Environment
Discusses current issues such as ozone depletion, global warming and air quality for graduate students in nonscientific fields. Provides the scientific background necessary to understand, follow scientific developments and critically evaluate these issues.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4800 and ENVS 5830
Requisites: Restricted to graduate students only.

ATOC 5050 (3) Atmospheric Thermodynamics and Dynamics
Covers atmospheric thermodynamics and dynamics and the underlying governing laws and mathematical and physical principles. Topics include atmospheric composition and thermodynamics, conservation laws and atmospheric governing equations, geostrophic balance and balanced flows, vorticity dynamics and boundary layers. ATOC graduate core course.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4800
Requisites: Restricted to graduate students only.

ATOC 5051 (3) Introduction to Physical Oceanography
Provides fundamental knowledge of observations, theory, dynamics and modeling in physical oceanography. Promotes critical thinking and the development of skills for data analysis and interpretation. ATOC graduate core course.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4200
Requisites: Restricted to graduate students only.

ATOC 5060 (3) Dynamics of the Atmosphere and Oceans
Examines large-scale motions in a stratified rotating atmosphere and ocean, and quasi-geostrophic flow, barotropic and baroclinic instabilities, cyclogenesis, global circulations and boundary layer processes. Ageostrophic motions, including Kelvin waves, internal gravity waves and the theory of frontogenesis are also considered. ATOC graduate core course.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4215 and ASEN 4215
Requisites: Restricted to graduate students only.

ATOC 5061 (3) Dynamics of Oceans
Explores theories of the large-scale ocean, including quasigeostrophic, planetary geostrophic and shallow water equations. Topics may vary to focus on ocean climate (e.g. thermocline, westward intensification), ocean waves (e.g. gravity, Rossby, and Kelvin) or ocean models (toy, analytic and numerical).
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5235
Requisites: Restricted to graduate students only.

ATOC 5151 (3) Atmospheric Chemistry
Reviews basic kinetics and photochemistry of atmospheric species and stratospheric chemistry with emphasis on processes controlling ozone abundance. Tropospheric chemistry focusing on photochemical smog, acid deposition, oxidation capacity of the atmosphere and global climate change. ATOC graduate core course.
Equivalent - Duplicate Degree Credit Not Granted: CHEM 5151
Requisites: Restricted to graduate students only.

ATOC 5152 (3) Advanced Atmospheric Chemistry
Follows Graduate Atmospheric Chemistry (ATOC 5151) and explores advanced topics in atmospheric chemistry, such as secondary aerosol formation, oxidant formation, the chemistry of global climate change and/or design of advanced laboratory experiments.
Equivalent - Duplicate Degree Credit Not Granted: CHEM 5152
Recommended: Prerequisite CHEM 5151 or ATOC 5151.
Grading Basis: Letter Grade

ATOC 5200 (3) Biogeochemical Oceanography
Provides a large-scale synthesis of the processes impacting ocean biogeochemistry. Transforms theoretical understanding into real-world applications using oceanographic data and models. Topics include: chemical composition, biological nutrient utilization and productivity, air-sea gas exchange, carbonate chemistry, ocean acidification, ocean deoxygenation, iron fertilization, biogeochemical climate feedbacks and more.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4200
Requisites: Restricted to graduate students only.

ATOC 5215 (3) Descriptive Physical Oceanography
Introduces descriptive and dynamical physical oceanography, focusing on the nature and dynamics of ocean currents and their role in the distribution of heat and other aspects of ocean physics related to the Earth's climate. Dynamical material limited to mathematical descriptions of oceanic physical systems.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4215 and ASEN 4215
Requisites: Restricted to graduate students only.

ATOC 5235 (3) Introduction to Atmospheric Radiative Transfer and Remote Sensing
Examines fundamentals of radiative transfer and remote sensing with primary emphasis on the Earth's atmosphere; emission, absorption and scattering by molecules and particles; multiple scattering; polarization; radiometry and photometry; principles of inversion theory, extinction- and emission-based passive remote sensing; principles of active remote sensing; lidar and radar; additional applications such as the greenhouse effect and Earth's radiative energy budget. ATOC graduate core course.
Department enforced prerequisites: one year of calculus-based physics, and math up through differential equations.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4215
Requisites: Restricted to graduate students only.

ATOC 5300 (3) The Global Carbon Cycle
Covers the role of the ocean, terrestrial biosphere, and atmosphere in the global carbon cycle. Specific topics include marine carbonate chemistry, biological production, terrestrial fluxes, anthropogenic emissions, and the evolution of the global carbon cycle in a changing climate.
Equivalent - Duplicate Degree Credit Not Granted: ASEN 5235
Requisites: Restricted to graduate students only.

ATOC 5400 (3) Introduction to Fluid Dynamics
Covers equations of fluid motion relevant to planetary atmospheres and oceans and stellar atmospheres; effects of rotation and viscosity; and vorticity dynamics, boundary layers and wave motions. Introduces instability theory, nonlinear equilibration and computational methods in fluid dynamics. Department enforced prerequisite: partial differential equations or equivalent.
Equivalent - Duplicate Degree Credit Not Granted: ASTR 5400
Requisites: Restricted to graduate students only.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 3070 or ATOC 3600 and one semester of calculus.

ATOC 5730 (3) Physical Oceanography and Climate
Introduces the field of physical oceanography, with emphasis on the ocean's interaction with the global atmosphere. Analysis of the ocean's heat, salt, and momentum budgets, wind-driven and thermohaline circulations, climate cycles including El Nino, and the ocean's role in climate change. Theory complemented by state-of-the-art observations and models. Department recommended prerequisites: ATOC 1060 or ATOC 3070 or ATOC 3600 and one semester of calculus.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4730

ATOC 5770 (3) Wind Energy Meteorology
Explores the complex interactions of the atmosphere and wind energy generation. Surveys wind turbine designs. Explores planetary boundary layer dynamics, traditional and novel wind measurement methods, forecasting methods, wind turbine and wind farm wakes, wind farm optimization, sound propagation from wind plants, climate change impacts on wind resources and the impacts of wind plants on local environments.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4770

ATOC 5810 (3) Planetary Atmospheres
Covers the structure, composition, and dynamics of planetary atmospheres. Also includes origin of planetary atmospheres, chemistry and cloud physics, greenhouse effects, climate, and the evolution of planetary atmospheres past and future.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4550

ATOC 5820 (3) Origin and Evolution of Planetary Systems
Reviews protoplanetary disks, condensation in the solar nebula, composition of meteorites, planetary accretion, comets and asteroids, planetary rings and extrasolar planets. Applies celestial mechanics to the orbital evolution of solar system bodies.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 4750

ATOC 5830 (3) Topics in Planetary Science
Examines current topics in planetary science, based on recent discoveries, spacecraft observations and other developments. Focuses on a specific topic each time the course is offered, such as Mars, Venus, Galilean satellites, exobiology, comets or extrasolar planets.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 5830 and GEOL 5830 Repeatable: Repeatable for up to 6.00 total credit hours.

ATOC 5835 (1) Seminar in Planetary Science
Studies current research on a topic in planetary science. Students and faculty give presentations. Subjects may vary each semester.
Equivalent - Duplicate Degree Credit Not Granted: ATOC 5835 and GEOL 5835 Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.

Prerequisite one semester of college-level chemistry and calculus-based physics and math up through differential equations.

Repeatable: Repeatable for up to 4.00 total credit hours.

Requisites:
Restricted to graduate students only.
ATOC 5900 (1-6) Independent Study
Students may register for more than one section of this course in the same semester.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.

ATOC 6020 (1) Seminar in Atmospheric and Oceanic Sciences
Studies an area of current research in the atmospheric and oceanic sciences. Students read selected papers from the literature. Students and faculty give presentations and participate in discussions. May be repeated for a total of 6 credit hours within the degree. May be repeated for a total of 3 credit hours within a semester.
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.

ATOC 6100 (3) Modeling Weather and Climate
Discusses background theory and procedures used for modeling climate on a variety of space and time scales. Includes numerical simulation of weather and climate with models in a hierarchy of complexity, assessments of error growth, prediction of circulations and impact of radiative and other influences. Explores various numerical methods, develops core computing skills and considers data handling and visualization. Consists of a combination of lectures and laboratory.
Requisites: Restricted to graduate students only.
Recommended: Prerequisite ATOC 5050 or calculus.

ATOC 6700 (1) Weather Forecasting and Discussion
Explores the techniques used to make short-term weather forecasts in the mid-latitudes using real-time weather observations, numerical forecast model output and conceptual models of mid-latitude weather phenomena. Students will be required to develop and defend conceptual models of the short-term evolution of the weather and will conduct detailed post-forecast analysis of successful and unsuccessful forecasts.
Repeatable: Repeatable for up to 3.00 total credit hours.
Requisites: Restricted to graduate students only.
Recommended: Prerequisite ATOC 5050.

ATOC 6950 (1-6) Master’s Thesis
Requisites: Restricted to graduate students only.

ATOC 7500 (1-3) Special Topics in Atmospheric and Oceanic Sciences
Acquaints students with current research in atmospheres, oceans, and climate. Topics may vary each semester. Students may register for more than one section of this course in the same semester.
Repeatable: Repeatable for up to 9.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.

ATOC 8990 (1-10) Doctoral Dissertation
All doctoral students must register for not fewer than 30 hours of dissertation credit as part of the requirements for the degree. For a detailed discussion of doctoral dissertation credit, refer to the Graduate School section.
Requisites: Restricted to graduate students only.