

# ATMOSPHERIC AND OCEANIC SCIENCES

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.

ATOC began offering an undergraduate degree in fall 2016. This baccalaureate degree is the first of its kind at CU Boulder for students interested in an in-depth understanding of the physical basis for the role of the atmosphere and oceans in Earth's climate system. In addition, ATOC offers a minor in atmospheric and oceanic sciences for students pursuing a bachelor's degree in another academic department.

ATOC also offers many courses approved for the Natural Science Distribution Area of the College of Arts & Sciences General Education Requirements.

For more information about ATOC programs and application procedures, call the ATOC office at 303-492-6633 or visit the Atmospheric and Oceanic Sciences (<http://www.colorado.edu/atoc/>) website.

**Course code for this program is ATOC.**

## Bachelor's Degree

- Atmospheric and Oceanic Sciences - Bachelor of Science (BA) (<https://catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/atmospheric-oceanic-sciences/atmospheric-oceanic-sciences-bachelor-arts-ba/>)

## Minor

- Atmospheric and Oceanic Sciences - Minor (<https://catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/atmospheric-oceanic-sciences/atmospheric-oceanic-sciences-minor/>)

## 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/](https://experts.colorado.edu/display/fisid_150027/))  
Associate Teaching Professor; PhD, University of Colorado Boulder

Cassano, John J. ([https://experts.colorado.edu/display/fisid\\_121781/](https://experts.colorado.edu/display/fisid_121781/))  
Professor; PhD, University of Wyoming

Friedrich, Katja ([https://experts.colorado.edu/display/fisid\\_133607/](https://experts.colorado.edu/display/fisid_133607/))  
Professor; PhD, Ludwig-Maximilians-Universität München (Germany)

Han, Weiqing ([https://experts.colorado.edu/display/fisid\\_115493/](https://experts.colorado.edu/display/fisid_115493/))  
Professor; PhD, Nova University

Jahn Hall, Alexandra ([https://experts.colorado.edu/display/fisid\\_155096/](https://experts.colorado.edu/display/fisid_155096/))  
Assistant Professor; PhD, McGill University

Karnauskas, Kristopher Benson ([https://experts.colorado.edu/display/fisid\\_155094/](https://experts.colorado.edu/display/fisid_155094/))  
Associate Professor, Associate Chair; PhD, University of Maryland, College Park

Kay, Jennifer E. ([https://experts.colorado.edu/display/fisid\\_153815/](https://experts.colorado.edu/display/fisid_153815/))  
Associate Professor; PhD, University of Washington

Keen, Richard A.  
Instructor Emeritus

Lemone, Margaret Anne  
Professor Adjoint

Li, Jianghanyang ([https://experts.colorado.edu/display/fisid\\_169049/](https://experts.colorado.edu/display/fisid_169049/))  
Assistant Professor; PhD, Purdue University

Lovenduski, Nicole Suzanne ([https://experts.colorado.edu/display/fisid\\_147557/](https://experts.colorado.edu/display/fisid_147557/))  
Associate Professor; PhD, University of California, Los Angeles

Moriarty, Julia ([https://experts.colorado.edu/display/fisid\\_165830/](https://experts.colorado.edu/display/fisid_165830/))  
Assistant Professor; PhD, William & Mary/Virginia Institute of Marine Science

Pilewskie, Peter Andrew ([https://experts.colorado.edu/display/fisid\\_134466/](https://experts.colorado.edu/display/fisid_134466/))  
Professor; PhD, University of Arizona

Randall, Cora Einterz ([https://experts.colorado.edu/display/fisid\\_102010/](https://experts.colorado.edu/display/fisid_102010/))  
Distinguished Professor Emeritus; PhD, University of California, Santa Cruz

Sanchez, Sara ([https://experts.colorado.edu/display/fisid\\_167959/](https://experts.colorado.edu/display/fisid_167959/))  
Assistant Professor; Ph.D., University of California- San Diego

Schmidt, Sebastian ([https://experts.colorado.edu/display/fisid\\_140121/](https://experts.colorado.edu/display/fisid_140121/))  
Associate Professor; PhD, Leipzig University (Germany)

Toohey, Darin W. ([https://experts.colorado.edu/display/fisid\\_110652/](https://experts.colorado.edu/display/fisid_110652/))  
Professor; PhD, Harvard University

Toon, Owen Brian ([https://experts.colorado.edu/display/fisid\\_110521/](https://experts.colorado.edu/display/fisid_110521/))  
Professor; PhD, Cornell University

Wang, Xinyue ([https://experts.colorado.edu/display/fisid\\_173884/](https://experts.colorado.edu/display/fisid_173884/))  
Assistant Professor; PhD, Purdue University

Weiss, Jeffrey B. ([https://experts.colorado.edu/display/fisid\\_102145/](https://experts.colorado.edu/display/fisid_102145/))  
Chair, Professor; PhD, University of California, Berkeley

Winters, Andrew ([https://experts.colorado.edu/display/fisid\\_165835/](https://experts.colorado.edu/display/fisid_165835/))  
Assistant Professor; PhD, University of Wisconsin-Madison

## Courses

### ATOC 1050 (3) Weather and the Atmosphere

Introduces principles of modern meteorology for nonscience majors, with emphasis on scientific and human issues associated with severe weather events. Includes description, methods of prediction, and impacts of blizzards, hurricanes, thunderstorms, tornadoes, lightning, floods, and firestorms.

**Additional Information:** GT Pathways: GT-SC2 -Natural Physical Sci:Lec Crse w/o Req Lab

Arts Sci Core Curr: Natural Science Sequence

Arts Sci Gen Ed: Distribution-Natural Sciences

MAPS Course: Natural Science

### ATOC 1060 (3) Our Changing Environment: El Nino, Ozone, and Climate

Discusses the Earth's climate for nonscience majors, focusing on the role of the atmosphere, oceans, cryosphere and land surface. Describes the water cycle, atmospheric circulations and ocean currents, and how they influence global climate, El Nino and the ozone hole. Discusses human impacts from climate change.

**Recommended:** Prerequisite ATOC 1050.

**Additional Information:** Arts Sci Core Curr: Natural Science Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 1070 (1) Weather and the Atmosphere Laboratory

Illustrates fundamentals of meteorology with laboratory experiments. Covers collection, analysis and discussion of data related to local weather. Uses computers for retrieval and interpretation of weather data from Colorado and across the U.S. Optional lab for ATOC 1050.

**Recommended:** Prerequisite or corequisite ATOC 1050.

**Additional Information:** GT Pathways: GT-SC1 - Natural Physical Sci:Lec Crse w/ Req Lab

Arts Sci Core Curr: Natural Science Lab

Arts Sci Gen Ed: Distribution-Natural Sci Lab

Arts Sci Gen Ed: Distribution-Natural Sciences

MAPS Course: Natural Science Lab or Lab/Lec

### ATOC 2050 (3) Introduction to Atmospheric Research

Uses real world data to investigate the basic physical processes that drive the coupled atmosphere-ocean system (e.g., energy distribution, phase changes, stability, winds and currents). Students will apply logic to predict how processes are impacted as different environmental characteristics change and develop skills in graphical literacy, investigative thinking, societal and personal relevancy, and communication.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 2500 (1-3) Special Topics in Atmospheric and Oceanic Sciences - Lower Division

Acquaints students at the lower division level 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. Recommended restriction: students with 0-56 credits (Freshmen or Sophomores).

**Repeatable:** Repeatable for up to 9.00 total credit hours. Allows multiple enrollment in term.

**Recommended:** Prerequisite or corequisite will vary depending on topic.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 3050 (3) Principles of Weather

Explores the processes that influence middle latitude weather including atmospheric thermodynamics, cloud and precipitation processes, atmospheric dynamics, air masses and fronts, and mid-latitude cyclones. Recitations and homework assignments will allow students to apply these concepts to real weather data through analysis of weather maps, thermodynamics diagrams and conceptual models.

**Recommended:** Prerequisites ATOC 1050 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 3070 (3) Introduction to Oceanography

Explores Earth's dynamic oceans. Discusses the disciplines of oceanography including marine geology, chemistry, biology and physical oceanography with emphasis on global change. Specific topics may include: tectonics, currents, biogeochemical cycles, ecology and global warming.

**Equivalent - Duplicate Degree Credit Not Granted:** GEOL 3070

**Recommended:** Prerequisite any 1000-level ATOC or GEOL course or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 3180 (3) Aviation Meteorology

Familiarizes students with a wide range of atmospheric behavior pertinent to air travel: rudiments of aerodynamics; aircraft stability and control; atmospheric circulation, vertical motion, turbulence and wind shear; fronts, clouds and storms.

**Recommended:** Prerequisite ATOC 1050 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 3300 (3) Analysis of Climate and Weather Observations

Discusses instruments, techniques and statistical methods used in atmospheric observations. Covers issues of data accuracy and analysis of weather maps. Provides application to temperature and precipitation records, weather forecasting and climate change trends. Uses computers to access data sets and process data.

**Equivalent - Duplicate Degree Credit Not Granted:** GEOG 3301

**Recommended:** Prerequisites ATOC 1050 or ATOC 1060 or ATOC 3600 or GEOG 3601 or ENVS 3600 or GEOG 1001 and one semester calculus.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

### ATOC 3500 (3) Air Chemistry and Pollution

Examines the composition of the atmosphere and sources of gaseous and particulate pollutants: their chemistry, transport and removal from the atmosphere. Applies general principles to acid rain, smog and stratospheric ozone depletion.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 3151

**Recommended:** Prerequisite one semester of college-level chemistry or one year of high school chemistry.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 3600 (3) Principles of Climate**

Describes the basic components of the climate system: the atmosphere, ocean, cryosphere and lithosphere. Investigates the basic physical processes that determine climate and link the components of the climate system. Covers the hydrological cycle and its role in climate, climate stability and global change.

**Equivalent - Duplicate Degree Credit Not Granted:** GEOG 3601 and ENVS 3600

**Recommended:** Prerequisites one semester of calculus and ATOC 1060 or ATOC 3300 or GEOG 3301 or GEOG 1001 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 3700 (3) Course-Based ATOC Research Experience**

In this course-based research experience in Atmospheric and Oceanic Sciences, students will learn about how scientific research works as well as gain first research experience in Atmospheric and Oceanic Sciences by working on an authentic research project. Specifically, students will learn how to understand scientific articles, how to develop subject-matter expertise, how to design a scientific research project, how to analyze and interpret data, and how to present their results to other scientists. Formerly offered as a special topics course.

**Recommended:** Prerequisite ATOC 1060 or ATOC 3600, and 1 semester of programming or equivalent self-study before the beginning of the class is required.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 3720 (3) Planets and Their Atmospheres**

Explores the physics and chemistry of the atmospheres of Mars, Venus, Jupiter, Saturn, and Titan. Examines evolution of the atmospheres of Earth, Venus, and Mars; and the escape of gases from the Galilean satellites, Titan and Mars; the orbital characteristics of moons, planets, and comets. Uses recent results of space exploration. Elective for APS major and minor.

**Equivalent - Duplicate Degree Credit Not Granted:** ASTR 3720

**Requisites:** Requires prerequisite courses of PHYS 1120 and (APPM 1360 or MATH 2300) and prerequisite or corequisite course of ASTR 2100 or MATH 2400 or APPM 2350 (all minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4020 (1) Seminar in Atmospheric and Oceanic Sciences**

Explores current research areas; students read selected papers, give presentations and participate in discussions; fellowship and internship opportunities; discussion on practical skills necessary for academic and professional life; career-building activities with outside speakers from academia and industry. May be repeated for a total of 6 credit hours within the degree as long as the topic is different. 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.

**ATOC 4200 (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 5200

**Recommended:** Prerequisites one semester of calculus and one semester of chemistry.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4215 (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.

**Requisites:** Restricted to students with 57-180 credits (Juniors or Seniors).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4500 (1-3) Special Topics in Atmospheric and Oceanic Sciences - Upper Division**

Acquaints students at the upper division level 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 18.00 total credit hours. Allows multiple enrollment in term.

**Recommended:** students with 57-180 credits (Juniors or Seniors).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4550 (3) Mountain Meteorology**

Investigating main processes that control weather and climate in the western United States and other mountain ranges around the world is the emphasis of this course. Provides an advanced survey of synoptic, mesoscale, and microscale meteorology in complex terrain including orographically modified cyclone evolution, front-mountain interactions, terrain and thermally driven flows, mountain waves, downslope winds, and orographic precipitation.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5550

**Recommended:** Prerequisite ATOC 1050 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4700 (3) Weather Analysis & Forecasting**

Utilizing a range of operational weather observations to analyze current weather conditions, providing hands-on experience interpreting observations and relating those observations to the physical principles that govern atmospheric behavior is the course emphasis. It focuses on how to read weather reports, analyze observations, and how to prepare weather maps to analyze current conditions and how to interpret numerical weather forecasts.

**Recommended:** Prerequisite ATOC 1050 or ATOC 1060 or ATOC 4720 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4710 (3) Introduction to Atmospheric Physics**

Provides a fundamental overview of the physics of Earth's atmosphere. Topics include atmospheric composition and structure, atmospheric radiation and optics (rainbows, halos and other phenomena), atmospheric thermodynamics, cloud physics and atmospheric electricity and lightning. Including both descriptive and quantitative approaches to the subject material. Where applicable, observations from the ATOC Skywatch Observatory will be introduced.

**Recommended:** Prerequisite one year of calculus and one year of physics with calculus.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4720 (3) Atmospheric Dynamics**

Introduces the fundamental physical principles that govern the atmospheric circulations across a range of spatial and temporal scales and provides a quantitative description and interpretation of a wide range of atmospheric phenomena. Topics include atmospheric forces, governing equations, balanced and unbalanced flows, atmospheric waves and mid-latitude cyclones.

**Recommended:** Prerequisite one year of calculus and one semester of physics with calculus.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4730 (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 Niño, 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 5730

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4740 (3) Dynamics of Past Climate Changes: Lessons for the Future**

Studies past changes in the Earth's climate and their application to predict future climate changes. Combines theoretical understanding of the climate system, computer models, and records of past changes from geological archives to understand drivers of past and future changes in climate. Emerging and inter-disciplinary area in climate research including paleoclimatology, climate theory, and modelling. Students work individually and in groups to formulate hypotheses that can be tested using paleoclimate records and model simulations. Formerly offered as a special topics course.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5720

**Recommended:** Prerequisite Prior college-level coursework in Chemistry and Physics, and least two of the following courses - ATOC 1060, ATOC 4730, ATOC 5730, GEOL 3040, GEOL 3070, GEOL 3820, GEOL 4060, or GEOL 4070.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4750 (3) Desert Meteorology and Climate**

Introduces students to the dynamic causes of deserts in the context of atmospheric processes and land-surface physics. Discusses desert severe weather, desert microclimates, human impacts and desertification, inter-annual variability in aridity (drought), the effects of deserts on global climate and the impact of desert climate on humans.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5750

**Recommended:** Prerequisites one semester of calculus and ATOC 1050 or ATOC 1060 or ATOC 3600 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4760 (3) Physics and Chemistry of Clouds and Aerosols**

Clouds and aerosols are important components of the climate system, impact remote sensing, affect human health, and are tightly coupled to radiation, chemistry and dynamics. This class covers the basic concepts in cloud and aerosol physics and chemistry in the context of the leading problems in climate, Earth history, air pollution, and weather. Examples include: dust storms; volcanic eruptions and climate; the extinction of the dinosaurs; nuclear winter; clouds and climate; thunderstorms, and lightning.

**Recommended:** junior and senior level students.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4770 (3) Renewable 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 5770

**Recommended:** Prerequisite ATOC 1050 or ATOC major.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4780 (3) Ice Sheets and Climate**

Covers the role of ice sheets in the climate system over a range of time (millions of years ago to the long-term future) scales, and presents the interactions between ice sheets, the ocean, and the atmosphere. Students will be introduced to, and work with, observational and modeling methods and data that conceptualize ice sheet climate and related topics.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5780

**Recommended:** Prerequisite Basic programming experience (python, Matlab, or equivalent), basic knowledge of calculus, basic knowledge of algebra and at least one ATOC course at the 1000, 2000, or 3000 level with a grade of C- or higher.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4800 (3) Policy Implications of Climate Controversies**

Examines controversial issues related to the environment, including climate change. Covers scientific theories and the intersection between science and governmental policy. Includes discussion, debate and critical reading of textual materials. Department enforced prerequisite: ATOC 1060 or ATOC 3600.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5000 and ENVS 5830

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4815 (3) Scientific Programming, Data Analysis and Visualization Laboratory**

Teaches programming in python, as well as analysis skills for accessing, analyzing and visualizing data that are commonly used in the atmospheric and oceanic sciences. Basic data analysis includes curve fitting and re-gridding/aggregation of satellite observations or meteorological data for global climatologies. The course content is primarily conveyed through hands-on code development. A final project, involving the independent analysis and visualization of a scientific data set, integrates skills acquired throughout the course.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5815

**Recommended:** Requisites prior experience with Python or a basic programming course such as CSCI 1300 or equivalent, basic knowledge of calculus and algebra.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences



**ATOC 4830 (3) Remote Sensing Lab**

Fundamentals of remote sensing of the atmosphere and ocean including fundamentals of atmospheric radiation and inverse methods for deriving geophysical variables from measurements. Principles of satellite and ground-based active (lidar and radar) and passive remote sensing methods, instrumentations, and applications. Lectures will include both descriptive and quantitative approaches to the subject material and include in-class demonstrations and measurements and data from the ATOC Skywatch Observatory and NASA satellites.

**Recommended:** Prerequisites one year of calculus and one year of physics with calculus.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4840 (3) Field Observations and Measurements Laboratory**

This course introduces students to all aspects of observing the atmospheric state including issues associated with observational and instrument errors, planning and executing measurement campaigns and analyzing and presenting results based on data collected during field campaigns. During the semester students will plan, conduct and analyze data from two atmospheric field campaigns conducted near Boulder, CO using a suite of meteorological sensors.

**Recommended:** Prerequisites ATOC 1050 or ATOC 3050.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4850 (3) Numerical Methods Laboratory**

Teach students how to convert physical descriptions of the earth system into numerical models. Students will learn how to make assumptions to simplify complex systems, how to discretize and code mathematical equations so they can be solved on a computer, and how to assess if the results are reasonable. The course content is primarily conveyed through hands-on code development in python. A final project integrates skills acquired throughout the course.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5850

**Recommended:** Prerequisites ATOC 4815 or ATOC 5815, Calculus 1, Calculus 2, Differential Equations, Linear Algebra, and a basic knowledge of/interest in atmospheric, oceanic, climatic, or cryospheric physics.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4860 (3) Data Science Lab**

The goals of this course are twofold: 1) providing a working knowledge of basic data science methods used for temporal and spatial analysis of atmospheric and oceanic data, to turn the data into clear insights via a computer program, 2) develop skills to work in a group and explain data science techniques to an audience with a broad range of expertise. The course covers: probability distributions and statistical indices; hypothesis testing; linear and multilinear regression; an intro to machine learning; an intro to Gaussian processes. This *learning-by-doing* course is recommended for senior level students. Formerly offered as a special topics course.

**ATOC 4870 (3) Climate Modeling Laboratory**

Climate models solve equations describing the earth system. This course provides an overview of climate modeling. Standard climate model approaches and experiments are presented, and then used in companion exercises. This course will provide students with real-world experience running a climate model used internationally for climate science and policy. This course is aimed at upper level undergraduate students. Recommended restriction: Junior or Senior ATOC students.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5870

**Recommended:** Prerequisite Experience with programming, Calculus, Differential Equations and Linear Algebra.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences  
Arts Sci Gen Ed: Distribution-Natural Sci Lab

**ATOC 4875 (3) Weather Modeling Laboratory**

In this laboratory course, students simulate the atmosphere using a numerical weather prediction model (WRF) and explore the physical and numerical basis of the system of equations that underpin numerical weather prediction models. In addition to developing technical skills with WRF and visualizing its output with python, students explore applications of numerical modeling of the atmosphere, such as land-sea breezes, hurricanes, mesoscale convective systems, and the daily cycle of the boundary layer. Recommended restriction: Junior or Senior class standing. Previously offered as a special topics course.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5875

**Requisites:** Requires prerequisite course of ATOC 1050 or ATOC 3050 or ATOC 4700 or ATOC 4710 or ATOC 4720 (all minimum grade C-).

**Recommended:** Prerequisite Experience with computer science and data visualization such as ATOC 4815 and some experience with Unix/Linux.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4880 (3) Mesoscale Meteorology**

Provides a comprehensive study of the structure, evolution, and dynamics of atmospheric phenomena on the mesoscale, which have horizontal scales ranging from a few to several hundred kilometers. Topics include land/sea breezes, horizontal convective rolls, drylines, deep convective storms, outflow boundaries, tornadoes, mesoscale convective systems, terrain induced airflows, mountain waves and the mesoscale aspects of extratropical cyclones. Previously offered as a special topics course. Recommended restriction: Senior or Fifth-Year Senior standing.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5880

**Recommended:** Prerequisites One year of Calculus, one year of Physics with Calculus, and at least one ATOC fundamental or core course, preferably ATOC 3050 or ATOC 4720.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**ATOC 4890 (3) Synoptic Dynamic Meteorology**

Weather conditions at middle latitudes are characterized by complex interactions between air masses, fronts, cyclones, and anticyclones. These interactions are governed by a set of elegant mathematical equations that describe the behavior of the atmosphere. Students will manipulate and apply these equations in real time in order to diagnose the development and evolution of a variety of synoptic-scale weather systems, including fronts, jet streams, and extratropical cyclones. Recommended restriction: Junior and Senior-level students. Previously offered as a special topics course.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 5890

**Recommended:** Prerequisite ATOC 3050, ATOC 4720, one year of Calculus, and one semester of Physics with Calculus.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences  
Arts Sci Gen Ed: Distribution-Natural Sci Lab

**ATOC 4900 (1-3) Independent Study**

Department enforced prerequisite: instructor consent.

**Repeatable:** Repeatable for up to 6.00 total credit hours.

**ATOC 4950 (1-3) Honors Thesis**

Students work independently on a research topic under the guidance of a faculty member. A written thesis and an oral presentation of the work are required. Registration by arrangement and with consent of faculty mentor. Department enforced prerequisite: minimum 3.00 GPA.

**Requisites:** Restricted to students with 57-180 credits (Juniors or Seniors).

**Additional Information:** Arts Sciences Honors Course

**ATOC 4990 (1-3) Internship**

This course is designed to provide junior and senior ATOC majors with the opportunity to work hands-on in the community and to gain practical knowledge and experience in both research and industry. Participation in the program requires both on-site and academic work. 0.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Recommended:** Students should have junior or senior standing (at the time of the internship) and have a minimum cumulative GPA of 2.