ATMOSPHERIC AND OCEANIC SCIENCES (ATM OCN)

ATM OCN 100 – WEATHER AND CLIMATE
3 credits.

Nature and variability of wind, temperature, clouds and precipitation. Storm systems, fronts, thunderstorms, tornadoes and their prediction. Air composition and pollution. Global winds, seasonal changes, climate and climatic change.
Requisites: Not open to students with credit for ATM OCN 101
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain the basic atmospheric science principles that describe weather and climate.
Audience: Undergraduate

2. Recognize and describe different types of weather, climate observations, and forecast models.
Audience: Undergraduate

3. Recognize and characterize natural variability of weather and climate.
Audience: Undergraduate

ATM OCN 101 – WEATHER AND CLIMATE
4 credits.

Nature and variability of wind, temperature, clouds and precipitation. Storm systems, fronts, thunderstorms, tornadoes and their prediction. Air composition and pollution. Global winds, seasonal changes, climate and climatic change. Includes map analyses and basic quantitative lab exercises.
Requisites: Not open to students with credit for ATM OCN 100
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain the basic atmospheric science principles that describe weather and climate.
Audience: Undergraduate

2. Recognize and describe different types of weather, climate observations, and forecast models.
Audience: Undergraduate

3. Recognize and characterize natural variability of weather and climate.
Audience: Undergraduate

ATM OCN/ENVIR ST/GEOSCI 102 – CLIMATE AND CLIMATE CHANGE
3 credits.

Describes the basic climate principles governing the climate system. It describes the climate and climate variability at present, climate evolution in the past, and the projected climate change into the future. The scientific principles underlying the natural and anthropogenic greenhouse effect and climate model forecasts are elucidated.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain how climate has changed in the past and is projected to change in the future.
Audience: Undergraduate

2. Describe how the different components of Earth System affect the climate and how global warming will impact them.
Audience: Undergraduate

3. Connect physical climate changes to impacts on the environment, ecosystems, and people.
Audience: Undergraduate

4. Describe different adaptation and mitigation strategies.
Audience: Undergraduate

5. Explain how scientists study the climate.
Audience: Undergraduate

6. Describe the debate around climate change.
Audience: Undergraduate

ATM OCN/GEOSCI 105 — SURVEY OF OCEANOGRAPHY
3-4 credits.

Nature and behavior of ocean water, interaction of oceans and atmosphere, structure of the ocean floor, life in the oceans, our relationship to the marine environment.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain the processes that created the ocean basins.
Audience: Undergraduate

2. Explain the formation of seafloor features and landforms.
Audience: Undergraduate

3. Describe the major physical processes within the ocean.
Audience: Undergraduate

4. Describe ocean chemistry and processes of nutrient cycling.
Audience: Undergraduate

5. Describe the major surface and deep currents in the oceans and explaintheir causes and locations.
Audience: Undergraduate

6. Describe the major distribution, abundance, and production of marinespecies within the ocean.
Audience: Undergraduate

7. Explain how physical and chemical factors in the ocean affect the climate inthe past, present, and future.
Audience: Undergraduate

ATM OCN/BSE/SOIL SCI 132 — WATER AND PEOPLE
3 credits.

Water is central to the functioning of planet Earth and is influential to shaping many historical and present-day cultures across the globe. As humans increase their impact on Earth's water cycle, our understanding of the multiple roles of water becomes critical to finding sustainable strategies for human and ecosystem health. Explore different perspectives around cultural significance of, engagement with, and access to water, with particular focus to case studies from the United States. Identify the human influence on water quality and quantity in a changing global climate, from local, regional, and global perspectives, and how different racial and ethnic communities in the United States are differentially impacted.
Requisites: None
Course Designation: Ethnic St - Counts toward Ethnic Studies requirement
Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Situate individual experiences with the water cycle in the broader context of different perspectives around the cultural significance of, engagement with, and access to water
Audience: Undergraduate

2. Summarize how historical circumstances/events have affected present day water resource policies, management, and standards, with a focus on the United States
Audience: Undergraduate

3. Apply knowledge of historical circumstances and current policies to describe how present-day communities are affected by water rights and management, and why
Audience: Undergraduate

4. Analyze the human influence on water quality and quantity under changing climate conditions from local, regional, and global perspectives
Audience: Undergraduate

5. Examine how different racial and ethnic communities, with particular focus on marginalized communities in the United States, are impacted by changes in water quality and quantity
Audience: Undergraduate

ATM OCN/GEOSCI 140 – NATURAL HAZARDS AND DISASTERS
3 credits.

An exploration of the science behind natural disasters including earthquakes, tsunamis, volcanic eruptions, landslides, tornadoes, hurricanes, and floods. Why, where, and when do these events occur, and why are some predictable but others are not? Addresses hazard assessment, forecasting, and mitigation to lessen their impact on society.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Identify the underlying physical earth processes causing hazards including extreme weather, earthquakes, volcanic eruptions, tsunamis, landslides among others.
Audience: Undergraduate

2. Define hazard and risk and explain the difference between the two concepts.
Audience: Undergraduate

3. Apply methods of hazard mitigation and quantitative risk assessment.
Audience: Undergraduate

4. Utilize probabilistic forecasting of extreme events and their relative risks.
Audience: Undergraduate

5. Recognize the effects of anthropogenic climate change on hazard and risk due to changes in severity or frequency of hazardous events.
Audience: Undergraduate

6. Evaluate the advantages, disadvantages, and trade-offs among different policy responses to perceived hazards.
Audience: Undergraduate

7. Recognize how extreme events are related to the physical and chemical processes that form and shape our planet.
Audience: Undergraduate

ATM OCN 141 – NATURAL HAZARDS OF WEATHER
2 credits.

Explores the basic science of weather hazards ongoing around the globe and practical issues of Prediction, Risk Reduction, Resilience and Vulnerability (PRRRV) associated with these hazards.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2021
Learning Outcomes: 1. Describe the underlying atmospheric physics for how weather hazards occur and the extent to which the hazards are understood and predictable.
Audience: Undergraduate

2. Explain the range and importance of societal issues that result from high-impact weather.
Audience: Undergraduate

3. Develop a roadmap with steps to improve prediction and reduce risk and vulnerability of society to weather hazards.
Audience: Undergraduate

ATM OCN/ENVIR ST 171 – GLOBAL CHANGE: ATMOSPHERIC ISSUES AND PROBLEMS
2-3 credits.

Atmospheric problems of global significance. Greenhouse warming, ozone layer, acid rain, climate change. Study based on elementary principles of atmospheric science. Systems approach applied to changing atmospheric composition. Interactions among geochemical cycles, anthropogenic inputs and other parts of the environment.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe the primary processes which govern our present climate system.
Audience: Undergraduate

2. Describe primary aspects of our past climate and how it is likely to change in the future.
Audience: Undergraduate

3. Summarize current issues regarding biodiversity, air quality, stratospheric ozone, the carbon cycle, and water cycle.
Audience: Undergraduate

4. Describe how human behavior is related to global change.
Audience: Undergraduate

5. Demonstrate skills in critical reading, logical thinking, and use of evidence.
Audience: Undergraduate

6. Identify and use relevant, reliable, and high-quality research sources.
Audience: Undergraduate

7. Present oral arguments to an audience with different points of view.
Audience: Undergraduate

ATM OCN 201 – EXPLORATIONS OF ATMOSPHERIC AND OCEANIC SCIENCES
2-3 credits.

Exploration of a field within atmospheric and oceanic sciences. Exposure to scientific principles, current findings, and career routes as it applies to topics such as meteorology, weather systems and weather forecasting, climate and climate change, atmospheric satellite remote sensing, oceanography, and professional careers in the discipline.
Requisites: ATM OCN 100, 101, 141, ATM OCN/GEOSCI 105, 140, SOIL SCI/ATM OCN/BSE 132, ATM OCN/ENVIR ST 171, or ATM OCN/ENVIR ST/GEOSCI 102
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026
Learning Outcomes: 1. Describe the basic scientific principles behind the concepts being explored and skills needed to further explore the topic
Audience: Undergraduate

2. Interpret how scientific articles, media stories, and reports advance our understanding of the topic
Audience: Undergraduate

3. Conduct and evaluate interviews of practitioners in the topic on their roles and professional development to understand future careers in this topic
Audience: Undergraduate

ATM OCN 310 – DYNAMICS OF THE ATMOSPHERE AND OCEAN I
3 credits.

Introduction to theory of fluid motions for atmosphere and ocean. Elementary kinematics, fundamental forces, effects of earth's gravity and rotation, concepts and applications of hydrostatic and geostrophic balance.
Requisites: (PHYSICS 202, 208, or 248 or concurrent enrollment in PHYSICS 202, 208, or 248) and MATH 234 or concurrent enrollment in MATH 234
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Apply basic vector mathematics to geophysical fluid flows.
Audience: Undergraduate

2. Derive and physically interpret the equations of motion.
Audience: Undergraduate

3. Recognize and describe the fundamental principles associated with the dynamics of geophysical fluid flows.
Audience: Undergraduate

4. Apply multiple coordinate systems to a problem and understand their usefulness.
Audience: Undergraduate

5. Apply diagnostic tools to diagnose, describe, and interpret the fundamental dynamical processes at work in large-scale circulations.
Audience: Undergraduate

ATM OCN 311 – DYNAMICS OF THE ATMOSPHERE AND OCEAN II
3 credits.

Intermediate theory of fluid motions for atmosphere and ocean. Emphasis on large scale applications and basic theory for geophysical wave types. Thermal wind shear, frictional flow, vorticity concepts, Rossby waves, Sverdrup ocean flow.
Requisites: ATM OCN 310
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe the importance of rotation and stratification in geophysical fluids.
Audience: Undergraduate

2. Recognize and describe the fundamental principles associated with the dynamics of geophysical fluid flows.
Audience: Undergraduate

3. Demonstrate the tools and skills required to analyze atmospheric and oceanic data sets.
Audience: Undergraduate

ATM OCN/ENVIR ST/GEOG 322 – POLAR REGIONS AND THEIR IMPORTANCE IN THE GLOBAL ENVIRONMENT
3 credits.

Reviews the past, present, and future of the Arctic and Antarctic regions. Covers the history, geography, atmospheric and ocean circulations, permafrost, ice sheets, glaciers, and future state of the Arctic and Antarctica as projected by earth system models. Also explores the role of the polar regions in the earth's system and associated global climatic feedbacks.
Requisites: Sophomore standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. Describe the history, geography, atmospheric and ocean circulations, permafrost, ice sheets, glaciers, and the future state of the Arctic and Antarctic Regions.
Audience: Both Grad & Undergrad

2. Explain the major theories and concepts of the Arctic and Antarctic regions.
Audience: Both Grad & Undergrad

3. Identify how interactions occur between the major components of each polar region and their influence on global processes and climate.
Audience: Both Grad & Undergrad

4. Recognize the need for multi-disciplinary research to further our understanding of the polar regions and their role in the global system.
Audience: Both Grad & Undergrad

5. Integrate thesis or dissertation research directly or indirectly with polar processes research, thereby gaining better insight into Arctic and Antarctic regions.
Audience: Graduate

ATM OCN 330 – PHYSICS OF THE ATMOSPHERE AND OCEAN I
3 credits.

Physical variables, laws, characteristics and direct measurements for atmosphere and ocean. Thermodynamics and moist atmospheric processes. Basic physics of clouds, precipitation, and chemical constituents.
Requisites: (PHYSICS 202, 208, or 248 or concurrent enrollment in PHYSICS 202, 208, or 248) and MATH 234 or concurrent enrollment in MATH 234
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. describe the vertical structure of the atmosphere and how atmospheric constituents are distributed from the surface to the ionosphere.
Audience: Undergraduate

2. derive thermodynamic equations and apply them to study the thermal structure of basic atmospheric phenomena.
Audience: Undergraduate

3. show how thermal energy and the first law of thermodynamics are applied to describe atmospheric thermal properties and structure.
Audience: Undergraduate

4. describe how entropy and the second law of thermodynamics are applied to basic thermal problems.
Audience: Undergraduate

5. describe the process of phase change in atmospheric phenomena.
Audience: Undergraduate

6. analyze atmospheric soundings using a thermodynamic diagram.
Audience: Undergraduate

ATM OCN/ENVIR ST/GEOG 332 – GLOBAL WARMING: SCIENCE AND IMPACTS
3 credits.

Offers a fundamental understanding of how and why global warming is happening and what to expect in the future. Investigate and discuss the evidence for change, the science that explains these observations, predicted impacts on humans and ecosystems, and the societal debate over proposed solutions.
Requisites: Sophomore standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe the physical basis by which CO2 and other greenhouse gases control atmospheric temperatures.
Audience: Undergraduate

2. Explain the trends and drivers of historical and future climate change using a combination of observational data, climate model simulations, and hands-on exercises with a simple layer model.
Audience: Undergraduate

3. Summarize the global carbon cycle, its major reservoirs and fluxes, and the role of natural and anthropogenic processes.
Audience: Undergraduate

4. Apply concepts of climate feedbacks and climate sensitivity both qualitatively and quantitatively.
Audience: Undergraduate

5. Discuss and evaluate impacts of anthropogenic emissions on the physical climate system, ecosystems, and human development.
Audience: Undergraduate

6. Evaluate current and proposed strategies for climate mitigation, adaptation, and geoengineering.
Audience: Undergraduate

ATM OCN/ENVIR ST/GEOG/GEOSCI 335 – CLIMATIC ENVIRONMENTS OF THE PAST
3 credits.

Climate change at timescales from the last several million years to the last 100 years, with emphasis on more recent timescales. Examines how climate variability arises from interplay between external forcings, feedbacks within the earth system, and (more recently) human activity.
Requisites: Sophomore standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Describe the major climatic events and trends during the Quaternary, spanning timescales from the last 50,000,000 years to the last 100 years.
Audience: Undergraduate

2. Identify the physical processes controlling the behavior of the earth system and its components (atmosphere, oceans, cryosphere, biosphere, etc.).
Audience: Undergraduate

3. Discuss how climatic variability results from a combination of external forcings and internal dynamics within the earth system.
Audience: Undergraduate

4. Recognize how paleoclimatologists collect, date, and analyze a staggering variety of paleoclimatic records, including ocean and lake sediment cores, ice cores, tree rings, corals, and speleothems.
Audience: Undergraduate

5. Analyze and critically evaluate climate experiments that are simulated by earth system models.
Audience: Undergraduate

6. Think and write critically, with particular attention to critically reading the scientific literature and critically employing the climate proxies and models used by paleoclimatologists.
Audience: Undergraduate

ATM OCN 340 – PHYSICS OF THE ATMOSPHERE AND OCEAN II
3 credits.

Radiation, energy budget, and cloud physics. Scattering, absorption, emission and diabatic heating by shortwave and longwave processes. Introduction to cloud physics including cloud nucleation processes, particle growth, precipitation development, and convective cloud processes.
Requisites: ATM OCN 330
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Explain the relevance radiation has for weather and climate and the basic properties of radiation and the electromagnetic spectrum.
Audience: Undergraduate

2. Describe reflection, refraction, and their relationship to optical phenomena.
Audience: Undergraduate

3. Summarize radiative properties exhibited by natural and artificial surfaces on the planet and the use of satellite imagery to detect them.
Audience: Undergraduate

4. Explain thermal emission, including blackbody radiation and emissivity.
Audience: Undergraduate

5. Describe atmospheric emission and transmission, including extinction, scattering, and absorption in a plane-parallel atmospheric formulation.
Audience: Undergraduate

6. Calculate radiative equilibrium and the balance at the Top of the Atmosphere (TOA).
Audience: Undergraduate

7. Explain principles of absorption of atmospheric gases and particles.
Audience: Undergraduate

8. Summarize main aspects of broadband fluxes and heating rates.
Audience: Undergraduate

ATM OCN/ENVIR ST 355 – INTRODUCTION TO AIR QUALITY
3 credits.

Links chemistry and meteorology to engineering, law, policy, and public health. Presents key ideas in air quality, with focus on reactive pollutants in the outdoor environment, especially gas and particle phase chemicals that react with human tissue to cause sickness and death. Discusses environmental impacts of these pollutants and regulatory approaches for their control in the U.S. and around the world. Indoor air quality will be included. Non-reactive pollutants, especially carbon dioxide, will be compared and contrasted with reactive air pollutants.
Requisites: Sophomore standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Build basic understanding of atmospheric pollutants affecting health, visibility, ecosystems, climate, and the ozone hold.
Audience: Undergraduate

2. Develop skills in analyzing air pollution data and related information, with a focus on evaluating and presenting original research on an air pollution episode of choice.
Audience: Undergraduate

3. Consider a single issue – air quality – from multiple disciplinary perspectives, including atmospheric science, engineering, policy, economics, and chemistry.
Audience: Undergraduate

ATM OCN 401 – TOPICS IN METEOROLOGY
2-3 credits.

Special topics to be given as the need and opportunity arise.
Requisites: ATM OCN 310 and 330
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Describe primary aspects of the topic and methods used.
Audience: Undergraduate

2. Summarize how the topic contributes to atmospheric and oceanic science.
Audience: Undergraduate

3. Explain the scientific principles behind the concepts being explored.
Audience: Undergraduate

4. Demonstrate critical thinking skills by identifying a problem, identifying the required information, and formulating and interpreting solutions.
Audience: Undergraduate

ATM OCN 404 – METEOROLOGICAL MEASUREMENTS
3 credits.

Practical experience in planning experiment implementation, performing instrument quality control, conducting computational data analysis, and writing and presenting of meteorological and climatological observations in a team setting.
Requisites: Consent of instructor
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Characterize principles of measurement, calibration, and uncertainty estimation of in situ meteorological instrumentation, including technologies for data acquisition.
Audience: Both Grad & Undergrad

2. Develop testable hypotheses of atmospheric phenomena and deploy instrumentation in lab or field settings to acquire observations for testing hypotheses.
Audience: Both Grad & Undergrad

3. Analyze and interpret collected observations and describe in oral and written form how observations help advance understanding of theories of atmospheric and oceanic sciences.
Audience: Both Grad & Undergrad

4. Share skills and techniques in project management, advanced data analysis, interpretation, and graphing with classmates.
Audience: Graduate

ATM OCN 405 – AOS SENIOR CAPSTONE SEMINAR
1 credit.

Provides synthesis and overview. Research on topic of the student's choosing is presented at the end.
Requisites: ATM OCN 310, 311, 330 and 340
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Demonstrate critical thinking skills by identifying a problem, identifying the required information, and formulating and interpreting solutions.
Audience: Undergraduate

2. Summarize and interpret current research areas in AOS.
Audience: Undergraduate

3. Demonstrate advanced skills in critical reading, logical thinking, and use of evidence.
Audience: Undergraduate

4. Demonstrate advanced skills in oral communication.
Audience: Undergraduate

ATM OCN 425 – GLOBAL CLIMATE PROCESSES
3 credits.

Overview of physical processes of the atmosphere and its coupling to the ocean and land. Understanding its seasonal climatology and variability. Synthesis through application of junior AOS core dynamics and physics to quantitatively understand diabatic, transport, and dissipative processes. Examples include global warming, air-ocean coupling, ENSO, ozone hole, tropospheric water and chemistry issues, diurnal to interannual time scales.
Requisites: ATM OCN 311 and 340
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Discuss the major components of the climate system and how they are relevant to climate change.
Audience: Undergraduate

2. Describe the uncertainties associated with anthropogenic climate change.
Audience: Undergraduate

3. Design and implement simple climate change experiments using the EZGCM climate model.
Audience: Undergraduate

4. Interpret results of model experiments.
Audience: Undergraduate

ATM OCN 441 – RADAR AND SATELLITE METEOROLOGY
3 credits.

Provides necessary knowledge about radar and satellite meteorology.
Requisites: ATM OCN 340
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Identify the unique fingerprints of various weather phenomena in weather radar and meteorological satellite measurements.
Audience: Undergraduate

2. Convey radar and satellite-derived weather information to broad audiences through modern web-based interfaces.
Audience: Undergraduate

3. Perform quantitative retrievals of atmospheric properties from active and passive measurement systems, analyze the output, and rigorously assess the accuracy of the results.
Audience: Undergraduate

ATM OCN 452 – SYNOPTIC LABORATORY I: THE FRONTAL CYCLONE
4 credits.

Cyclone and frontal theory; case studies illustrating the structure and evolution of the frontal cyclone; diagnostic techniques: interpretation of satellite photographs, preparation of vertical cross sections and isentropic analysis.
Requisites: ATM OCN 311 and 340
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Synthesize routine observational data along with the fundamentals of mid-latitude atmospheric dynamics and thermodynamics to understand the structure, development, life cycle and precipitation distribution associated with midlatitude cyclones.
Audience: Undergraduate

2. Use both historical and real-time observations and numerical model output to diagnose synoptic-scale phenomena both for research and operational forecasting purposes.
Audience: Undergraduate

3. Communicate assessments and diagnoses of current and near-term future weather events to both scientific and broad audiences.
Audience: Undergraduate

ATM OCN 453 – SYNOPTIC LABORATORY II: MESOSCALE METEOROLOGY
4 credits.

Local wind systems, thunderstorms, mesoscale convection systems, interactions with synoptic scale weather. Analysis, prediction, nowcasting and observation of mesoscale weather, including interpretation of satellite and radar information.
Requisites: ATM OCN 311 and 340
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Synthesize fundamentals of atmospheric dynamics, thermodynamics, and microphysics to understand how weather systems form and evolve on the mesoscale.
Audience: Undergraduate

2. Apply radar and satellite tools for interpreting mesoscale phenomena.
Audience: Undergraduate

3. Analyze observational data and numerical weather prediction products (archived and in real time) to assess and predict mesoscale phenomena.
Audience: Undergraduate

4. Communicate assessments of recent weather events and forecasts to scientific and broad audiences.
Audience: Undergraduate

ATM OCN 460 – FUNDAMENTALS OF PHYSICAL OCEANOGRAPHY
3 credits.

Introduction to the physics and thermodynamics of the ocean. Learn about the the physical characteristics and properties of the ocean and its circulation. Covers the basic equations of motion including the mathematics of Ekman transport, Sverdrup balance, thermal wind balance, ocean heat, salinity, and momentum conservation and budgets, waves, and tides.
Requisites: ATM OCN 311 and (MATH 319, 320, or 376), or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe the general physical characteristics and properties of the ocean and the relationships between them via the thermodynamic equation of state of seawater
Audience: Undergraduate

2. Write down the general equations that govern movement in the ocean including gyre circulations, the meridional overturning circulation, waves, and tides
Audience: Undergraduate

3. Understand how the ocean's physical characteristics, properties, and spatial structure arise from thermodynamics and the general equations of motion
Audience: Undergraduate

4. Describe the ocean's role in Earth's climate and apply concepts in the course to novel situations or further research
Audience: Undergraduate

ATM OCN/ENVIR ST 520 – BIOCLIMATOLOGY
3 credits.

How climate systems and biological organisms operate and interact at the global scale and the implications of this for climate change, ecosystem ecology and human land use.
Requisites: (ATM OCN 101, ENVIR ST/ATM OCN 171, or GEOG 323), (ZOOLOGY/BIOLOGY/BOTANY 152, BOTANY/BIOLOGY 130, ZOOLOGY/BIOLOGY 102, BIOCORE 381, or 485), and junior standing, or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Quantitatively analyze how ecosystem-relevant processes influence the climate system.
Audience: Both Grad & Undergrad

2. Evaluate spatiotemporal patterns of climate-relevant features that most affect organisms.
Audience: Both Grad & Undergrad

3. Critically interpret ongoing research on how the two interact with changing land use and climate.
Audience: Both Grad & Undergrad

4. Share skills and techniques in project management, advanced data analysis, interpretation, and graphing with classmates.
Audience: Graduate

ATM OCN 522 – TROPICAL METEOROLOGY
3 credits.

Characteristics of the tropical atmosphere; local and diurnal phenomena; tropical synoptic systems; circulation and energetics; mechanisms of tropical climate variations.
Requisites: ATM OCN 311 and 340, or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Recall and describe major atmospheric phenomena in the tropics.
Audience: Both Grad & Undergrad

2. Explain the differences between tropical and midlatitude dynamics.
Audience: Both Grad & Undergrad

3. Compare and interpret geophysical data, and use this data to answer specific scientific questions.
Audience: Both Grad & Undergrad

4. Interpret some classic scientific literature in tropical meteorology.
Audience: Both Grad & Undergrad

5. Create a literature review of several peer-reviewed papers on a topic of choice in tropical meteorology.
Audience: Both Grad & Undergrad

6. Share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN/PLANTSCI 532 – ENVIRONMENTAL BIOPHYSICS
3 credits.

Plant-environment interactions with particular reference to energy exchanges and water relations. Models are used to provide a quantitative synthesis of information from plant physiology, soil physics, and micrometeorology with some consideration of plant-pest interactions.
Requisites: (BIOLOGY/BOTANY 130, ZOOLOGY/BIOLOGY/BOTANY 152, or BIOCORE 381) and (MATH 211, 217, or 221) and (PHYSICS 103, 201, 207, or 247), or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Apply numerical models that describe radiation fluxes in natural environments and account for latitude and longitude, time of day and year, sun angle, direct and diffuse solar radiation, and radiative properties of natural surfaces
Audience: Both Grad & Undergrad

2. Apply numerical models that describe how soil and air temperatures vary across a continuum of temporal scales (from hourly to annual) and are impacted by varied physical environments
Audience: Both Grad & Undergrad

3. Calculate growing degree-days using different numerical models and demonstrate knowledge about phenological development of plants and insects
Audience: Both Grad & Undergrad

4. Apply numerical models that represent wind speed within and above vegetative canopies and account for atmospheric turbulence
Audience: Both Grad & Undergrad

5. Calculate heat and mass (water, carbon dioxide) transport between organisms, soils, plant canopies, and the atmosphere using numerical models that represent conductance, diffusion, convective transport of heat, infiltration of water and drainage in soil, evaporation, and transpiration
Audience: Both Grad & Undergrad

6. Apply numerical modeling to calculate transmission and interception of direct, diffuse, and scattered solar radiation in plant canopies
Audience: Both Grad & Undergrad

7. Demonstrate knowledge about different numerical approaches to calculate evapotranspiration and photosynthesis of plants from the leaf to canopy level
Audience: Both Grad & Undergrad

8. Demonstrate basic knowledge about environmental biophysics through application of numerical equations and/or a model to a scientific question developed in close collaboration with the course instructor
Audience: Undergraduate

9. Demonstrate advanced knowledge about environmental biophysics through the independent development of a research project that produces new information
Audience: Graduate

ATM OCN 573 – RESEARCH COMPUTING IN ATMOSPHERIC AND OCEANIC SCIENCES
3 credits.

Hands-on introduction to open-source research computing tools commonly used in the atmospheric and oceanic sciences. Covers Python basics, including standard data structures, environments, and packages that are useful for analyzing and visualizing a variety of observational and computational atmospheric and oceanic science datasets. Additional open-source tools for version control, sharing code, and collaborating on analysis are also introduced and open science best practice are discussed.
Requisites: (MATH 234 and COMP SCI 220) or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Become familiar with computing tools that are useful in managing, analyzing, and visualizing atmospheric and oceanic science data, including Unix, git, and Python
Audience: Both Grad & Undergrad

2. Understand multiple Python packages that are critical for atmospheric and oceanic science data analysis and use these packages to analyze and visualize atmospheric and oceanic science datasets
Audience: Both Grad & Undergrad

3. Develop proficiency in the use of version control and other elements of open science best practices
Audience: Both Grad & Undergrad

4. Implement a reproducible data analysis workflow that incorporates Python computing tools and version control and apply it to an unfamiliar dataset or new research topic
Audience: Graduate

ATM OCN 575 – CLIMATOLOGICAL ANALYSIS
3-4 credits.

Mathematical and statistical tools applicable to the investigation of climatological problems; nature and treatment of climatological data.
Requisites: ATM OCN 573, or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Test hypotheses about geoscientific processes by applying statistical methods to real-world data
Audience: Graduate

2. Apply appropriate statistical analyses that can be used to address specific problems in climatological analysis
Audience: Graduate

3. Carry out statistical analysis of digitized atmospheric, oceanic, and other geoscientific datasets, including parsing through and analyzing large data sets
Audience: Graduate

4. Critically evaluate the results of climatological data analyses including identifying alternate interpretations of the results, other techniques that could be applied to investigate results, and sources of independent data that could be used to corroborate results
Audience: Graduate

5. Critique the application of statistical analyses in existing climate literature
Audience: Graduate

6. Test hypotheses about geoscientific processes by applying statistical methods to existing data
Audience: Undergraduate

7. Identify appropriate statistical analyses to address specific problems in climatological analysis
Audience: Undergraduate

8. Carry out statistical analysis of atmospheric, oceanic, and other geoscientific datasets
Audience: Undergraduate

9. Evaluate the results of climatological data analyses of specific problems, including relating results to other statistical techniques or to alternate data sets
Audience: Undergraduate

10. Understand the application of statistical analyses in existing climate literature
Audience: Undergraduate

ATM OCN 610 – GEOPHYSICAL FLUID DYNAMICS I
3 credits.

Basic dynamic concepts: equations of motion, basic approximations, Coriolis force, wave motions, normal modes, gravity waves, frictional turbulence and convective processes, geostrophic adjustment, scaling argument, effects of rotation on wave motions. Vorticity and potential vorticity.
Requisites: (PHYSICS 202, 208, or 248) and MATH 234, or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Summarize the governing equations and how they are obtained from first principles.
Audience: Both Grad & Undergrad

2. Demonstrate how mathematical techniques are used to describe and solve problems.
Audience: Both Grad & Undergrad

3. Integrate visual and mathematical descriptions of phenomena.
Audience: Both Grad & Undergrad

4. Summarize geostrophic and thermal wind concepts.
Audience: Both Grad & Undergrad

5. Distinguish each major wave type.
Audience: Both Grad & Undergrad

6. Summarize fundamental aspects of different types of fluid instability.
Audience: Both Grad & Undergrad

7. Share skills and techniques in interpretation and analysis with classmates.
Audience: Graduate

ATM OCN 611 – GEOPHYSICAL FLUID DYNAMICS II
3 credits.

Quasi-geostrophic motion, potential vorticity equations, E-P fluxes, Rossby waves, boundary layer processes, wind-driven ocean circulation and western boundary currents, barotropic and baroclinic instability, tropical flows.
Requisites: ATM OCN 610 or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Use scale analysis to simplify the primitive equations for different types of geophysical flows.
Audience: Both Grad & Undergrad

2. Linearize and solve the wave equation for a variety of flow regimes.
Audience: Both Grad & Undergrad

3. Describe the strengths and weaknesses of the quasi-geostrophic equations.
Audience: Both Grad & Undergrad

4. Differentiate the governing processes of the midlatitudes versus the tropics.
Audience: Both Grad & Undergrad

5. Elucidate the importance of eddies in midlatitude weather and climate.
Audience: Both Grad & Undergrad

6. Share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN 630 – INTRODUCTION TO ATMOSPHERIC AND OCEANIC PHYSICS
3 credits.

Covers thermodynamics theory of multiphase systems, thermodynamic analysis of atmosphere, microphysical processes in the atmosphere, atmospheric and oceanic chemical processes, conduction of heat and moisture into the atmosphere from ocean and land surface.
Requisites: (PHYSICS 202, 208, or 248) and MATH 234, or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Describe the basic principles of atmospheric and oceanic thermodynamics.
Audience: Both Grad & Undergrad

2. Explain why water vapor is important to the thermodynamics of the atmosphere.
Audience: Both Grad & Undergrad

3. Describe the importance of the Clausius-Clapeyron equation in weather and climate.
Audience: Both Grad & Undergrad

4. Interpret Skew-T diagrams.
Audience: Both Grad & Undergrad

5. Share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN 637 – CLOUD PHYSICS
3-4 credits.

Processes of cloud formation, growth, and dissipation from the standpoint of both the cloud particles and the whole cloud as a dynamic entity.
Requisites: ATM OCN 311 and 340, or graduate/professional standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Identify cloud macrophysical properties.
Audience: Both Grad & Undergrad

2. Understand warm-rain and ice-based microphysical processes.
Audience: Both Grad & Undergrad

3. Relate cloud microphysical to macrophysical properties.
Audience: Both Grad & Undergrad

4. Use observational tools to identify cloud properties.
Audience: Both Grad & Undergrad

5. Identify key areas of ongoing research related to cloud physics.
Audience: Both Grad & Undergrad

6. Apply cloud physics concepts to their own research.
Audience: Graduate

ATM OCN 640 – RADIATION IN THE ATMOSPHERE AND OCEAN
3 credits.

Introduction to radiation: basic laws, radiative transfer under clear sky conditions, scattering by individual particles, multiple scattering, radiative properties of clouds and aerosols, energy budget, miscellaneous applications.
Requisites: (PHYSICS 202, 208, or 248) and MATH 234, or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Define and explain the key concepts, physical laws, and meteorological context of atmospheric radiative transfer processes.
Audience: Both Grad & Undergrad

2. Describe the physical principles of atmospheric absorption spectra, scattering, and absorption by atmospheric particles.
Audience: Both Grad & Undergrad

3. Analyze the radiative transfer problem, including approximate solutions to multiple scattering in a plane-parallel atmosphere and radiative balance in simple systems.
Audience: Both Grad & Undergrad

4. Identify major absorption bands in the cloud-free atmosphere and compare the absorption, reflection, and emission of radiation by homogeneous and natural surfaces.
Audience: Both Grad & Undergrad

5. Design methods to compute and evaluate radiative transfer phenomena in atmospheric systems.
Audience: Both Grad & Undergrad

6. Share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN 660 – INTRODUCTION TO PHYSICAL OCEANOGRAPHY
3 credits.

Physical properties of sea water: ocean climatology, water, salt and heat budget, measurements, ocean circulation and water mass of the world ocean, thermocline, thermohaline, equatorial ocean and southern ocean.
Requisites: ATM OCN 311 or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Describe the physical properties of seawater and the circulation of the global ocean.
Audience: Both Grad & Undergrad

2. Apply key oceanographic theories via derivation and calculation.
Audience: Both Grad & Undergrad

3. Analyze real-world oceanographic observation-based and climate model output.
Audience: Both Grad & Undergrad

4. Evaluate course material as presented in classic and recent oceanographic literature.
Audience: Both Grad & Undergrad

5. Share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN 681 – SENIOR HONORS THESIS
3 credits.

Individual mentored study for seniors completing theses for Honors in the Major as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Honors Only Courses (H)
Repeatable for Credit: No
Last Taught: Fall 2025

ATM OCN 682 – SENIOR HONORS THESIS
3 credits.

Individual mentored study for seniors completing theses for Honors in the Major as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Honors Only Courses (H)
Repeatable for Credit: No
Last Taught: Spring 2026

ATM OCN 691 – SENIOR THESIS
2-3 credits.

Individual mentored study for seniors completing theses, as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2024

ATM OCN 692 – SENIOR THESIS
2-3 credits.

Individual mentored study for seniors completing theses, as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2025

ATM OCN 698 – DIRECTED STUDY
1-5 credits.

Independent study as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2025

ATM OCN 699 – DIRECTED STUDY
1-5 credits.

Independent study as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

ATM OCN/CIV ENGR 701 – THE CHEMISTRY OF AIR POLLUTION
2 credits.

Covers background and modern research methods for the application of chemical analysis tools to understanding of the origin, composition, and the chemical transformations of pollutants that occur in the atmosphere. Emphasis will be directed at the pollutants impacting human health, climate change, and ecosystem degradation. Approximately half of the course materials will be taken from the scientific literature and will provide the opportunity to advance skills in the critical reading of journal articles. The course is directed at graduate students conducting research and interested in air pollution and environmental chemistry. Gain experiences in presenting scientific research methods and results related to course materials.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024

ATM OCN 712 – GENERAL CIRCULATION OF THE ATMOSPHERE
3 credits.

The theory of the general circulation with emphasis on the sources, sinks, and transport of mass, angular momentum, and energy that serve to maintain the circumpolar vortex.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Describe the primary characteristics of the general circulation.
Audience: Graduate

2. Summarize the historical development of understanding the general circulation.
Audience: Graduate

3. Analyze statistical properties of climatological data sets.
Audience: Graduate

4. Describe the fundamental role of heat fluxes and momentum fluxes.
Audience: Graduate

5. Distinguish forcing and behavior by synoptic and planetary scale waves.
Audience: Graduate

6. Describe wave - mean flow interaction using EP flux theory.
Audience: Graduate

7. Mathematically describe wave propagation and critical surface interaction.
Audience: Graduate

8. Summarize modes of climate variation including the QBO, ENSO, NAM, and SAM.
Audience: Graduate

ATM OCN 718 – DYNAMICS OF MOIST CONVECTIVE SYSTEMS
3 credits.

Governing equations for non-hydrostatic dynamics, mixed phase thermodynamics and microphysics. Cumulus parameterization and scale interactions. Application to theoretical and numerical models of thunderstorms (and attendant weather phenomena) and Mesoscale Convective Systems in the extra tropics and tropics.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2021

ATM OCN 722 – ADVANCED TROPICAL METEOROLOGY
3 credits.

Advanced treatment of the fundamentals of tropical meteorology, including moist thermodynamic processes, tropical deep convection, convective quasi-equilibrium, the weak temperature gradient approximation, the mean tropical circulations, convectively coupled waves, and tropical cyclones.
Requisites: (ATM OCN 522 or 630), ATM OCN 610, and graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Recognize the many ways in which tropical deep convection is fundamental to the tropical climate and its variability.
Audience: Graduate

2. Interpret the meaning and significance of the weak temperature gradient approximation.
Audience: Graduate

3. Recognize the fundamental role water vapor has in the tropics.
Audience: Graduate

4. Discuss similarities and differences among different types of tropical motions.
Audience: Graduate

ATM OCN/ENVIR ST 745 – METEOROLOGICAL SATELLITE APPLICATIONS
2-3 credits.

Use of satellite imagery and measurements in meteorological research and operations; orbital characteristics; navigation; instrumentation.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Use satellite imagery and measurements in meteorological research and operations.
Audience: Graduate

2. Describe orbital characteristics, navigation, instrumentation and remote sensing techniques.
Audience: Graduate

3. Perform quantitative retrievals of atmospheric properties from active and passive measurement systems and rigorously assess accuracy.
Audience: Graduate

4. Share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN/ENVIR ST/GEOSCI/ZOOLOGY 750 – PROBLEMS IN OCEANOGRAPHY
3 credits.

Introduction to techniques used in the study of the biology, chemistry, geology, and physics of the marine environment.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. use satellite imagery and measurements in meteorological research and operations.
Audience: Both Grad & Undergrad

2. describe orbital characteristics, navigation, instrumentation and remote sensing techniques.
Audience: Both Grad & Undergrad

3. perform quantitative retrievals of atmospheric properties from active and passive measurement systems and rigorously assess accuracy.
Audience: Both Grad & Undergrad

4. share skills and techniques in analysis and interpretation with classmates.
Audience: Graduate

ATM OCN 751 – THE FRONTAL CYCLONE
3 credits.

Application of fundamental dynamics and thermodynamics to cyclone and frontal theory; case studies illustrating the structure and evolution of the frontal cyclone; diagnostic consideration of vertical motions, frontogenesis and potential inversion; computational analysis of fundamental diagnostic equations, analysis of vertical cross sections.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Understand how thermodynamics and dynamics of the atmosphere are brought to bear on the broad problem of the mid-latitude cyclone.
Audience: Graduate

2. Acquire an understanding of the diagnosis of synoptic-scale vertical motions, frontal circulations, the process of cyclogenesis, and the potential vorticity perspective on cyclone life cycles.
Audience: Graduate

3. Communicate diagnosis of the current weather and forecasts of future weather to both scientific and broad audiences.
Audience: Graduate

4. Develop computer code to solve diagnostic second order differential equations that appear in modern cyclone and frontal theory.
Audience: Graduate

ATM OCN 753 – MESOSCALE METEOROLOGY
3 credits.

Synthesizes the fundamentals of atmospheric dynamics, thermodynamics and microphysics to explain the theory behind the structure, evolution and prediction of microscale, mesoscale and cloud scale weather. Learn the dynamics, and thermodynamics of mesoscale, fogs, cumulus, and severe storms (including tornadoes), mountain meteorology and convective tropical weather systems (including hurricanes and typhoons) and application of multi-scale numerical methods and models for analysis and prediction.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Synthesize fundamentals of atmospheric dynamics and thermodynamics to develop a state-of-the-art understanding of the theory behind how weather systems are formed, maintained, and evolve.
Audience: Graduate

2. Apply adjustment theory to understanding of multiscale weather structures.
Audience: Graduate

3. Analyze raw data and numerical prediction products directly available in real time or archived on the Internet to predict mesoscale and cloud scale weather.
Audience: Graduate

4. Apply unconventional state-of the art observation tools, including ground- based, surface-based and mobile Radar, Lidar, aircraft, and satellite observational systems to diagnose and predict weather systems.
Audience: Graduate

5. Identify clues regarding the substructure of weather, that conventional observations have neither the temporal or special resolution to resolve.
Audience: Graduate

6. Recognize how data assimilation methods help build the unresolved structures into an analysis through marriage of numerical models, conventional and unconventional data.
Audience: Graduate

7. Communicate diagnosis of current weather and forecasts of future weather to both scientific and broad audiences.
Audience: Graduate

ATM OCN 760 – LARGE-SCALE OCEAN-ATMOSPHERE COUPLING
3 credits.

Various aspects of global ocean-atmosphere coupling and climate variability; global surface flux distribution; mixed layer dynamics; tropical dynamics and El Nino and Southern Oscillation; extratropical ocean-atmosphere coupling; interannual to interdecadal climate variability.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Analyze the observed spatio-temporal structure of some coupled modes of variability in the climate system.
Audience: Graduate

2. Apply a wave perspective to explain dynamical adjustment to equilibrium.
Audience: Graduate

3. Understand how coupled dynamical and thermodynamic interactions between the atmosphere and ocean give rise to spatial and temporal structure of coupled climate variability.
Audience: Graduate

4. Understand and apply appropriate statistical analyses to ocean and atmosphere data sets to diagnose specific coupled dynamical processes and modes of variability.
Audience: Graduate

5. Review and synthesize existing literature to explore how coupled ocean atmosphere interactions are used to understand and model coupled climate variations.
Audience: Graduate

ATM OCN/GEOSCI 762 – ICE AND CLIMATE DYNAMICS
3 credits.

Introduction to the role of ice in the climate system. Review main components of the cryosphere (Arctic and Antarctic sea ice, Greenland and Antarctic ice sheets, mountain glaciers, snow cover, and permafrost), with particular focus on recent and future changes as documented in recent publications. Consider different methods to study the cryosphere and its role in the climate system, such as remote sensing and in situ observations, state estimates and reanalyses, with a particular focus on idealized and comprehensive global climate models. Covers fundamental physical concepts as well as unresolved research questions such as the debates surrounding potential instabilities in the climate system and uncertainties in future projections of ice loss, teleconnections, and sea level rise.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Differentiate between the main components of Earth's cryosphere and their respective roles in the climate system.
Audience: Graduate

2. Compare the range of methodologies used to study Earth's cryosphere, including in situ and remote sensing observations, theoretical considerations, and numerical models.
Audience: Graduate

3. Develop idealized models of sea ice, land ice, and snow and their interactions with the climate system.
Audience: Graduate

4. Carry out analysis of output from idealized and comprehensive ice and climate models.
Audience: Graduate

ATM OCN 773 – BOUNDARY LAYER METEOROLOGY
3 credits.

Observations of and theories for boundary layers, turbulence, spectra, plumes, dust devils, convection, terrain effects, and other phenomena in the lowest 2 km of the atmosphere.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Describe key features, governing equations, and parameterization of turbulence for the fluid atmosphere and ocean, including Reynolds averaging, similarity theory, and large-eddy simulation.
Audience: Graduate

2. Apply turbulence theories and surface energy balance to explain the evolution and development of the surface layer, entrainment zone, and neutral, convective, and stable atmospheric boundary-layers.
Audience: Graduate

3. Interpret how boundary-layer processes impact lower atmosphere phenomena such as flux measurement, air pollution dispersion, urban heat islands, sea breezes, terrain-induced flow.
Audience: Graduate

ATM OCN 775 – ADVANCED CLIMATOLOGICAL ANALYSIS
3 credits.

Application and analysis of advanced statistical, mathematical, and machine learning tools in Atmospheric, Oceanic, and Climate Sciences. Emphasizes application of statistical techniques to synthetic and real data; analysis of existing research in Atmospheric, Oceanic, and Climate Sciences; and exploration of new applications of statistical and machine learning techniques in relevant scientific literature. Knowledge of basic statistical methods and statistical programming [such as those introduced in 575] is required
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Learning Outcomes: 1. Identify and apply appropriate statistical, mathematical, and machine learning techniques for testing hypotheses using geophysical data
Audience: Graduate

2. Carry out, evaluate and interpret results from specific statistical analyses of atmospheric, oceanic, or climatic phenomena
Audience: Graduate

3. Identify alternate methods for evaluating or interpreting results from statistical analyses of atmospheric, oceanic, or climate phenomena
Audience: Graduate

4. Critically evaluate application of statistical, mathematical, and machine learning techniques in existing atmospheric, oceanic, and climate literature

Audience: Graduate

5. Identify and research new applications of statistical and machine learning techniques in atmospheric, oceanic, and climate sciences
Audience: Graduate

ATM OCN 801 – TOPICS IN THEORETICAL METEOROLOGY
2-3 credits.

Advanced level subjects in dynamics, synoptics, climate-dynamics and atmospheric physics including recent advances.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026
Learning Outcomes: 1. Describe primary aspects of the topic.
Audience: Graduate

2. Articulate, critique, and elaborate the theories, research methods, and approaches to scientific inquiry in the topic.
Audience: Graduate

3. Summarize how the topic contributes to atmospheric and oceanic science.
Audience: Graduate

4. Investigate a scientific problem through experimental design and the scientific process.
Audience: Graduate

5. Develop and defend a scientific argument.
Audience: Graduate

ATM OCN 810 – PRACTICAL TRAINING IN ATMOSPHERIC AND OCEANIC SCIENCES I
1 credit.

Practical training in atmospheric and oceanic sciences. Provides direct, hands-on exposure to careers in the discipline. Includes placement into student-designed or existing internship in atmospheric and oceanic science related companies, agencies, and organizations.
Requisites: Declared in Atmospheric and Oceanic Sciences MS
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Apply knowledge in the classroom to real-world atmospheric science programs
Audience: Graduate

2. Acquire direct hands-on experience in atmospheric science careers
Audience: Graduate

3. Develop portfolio materials necessary for the consulting meteorologist exam
Audience: Graduate

4. Work collaboratively in professional group and team settings
Audience: Graduate

ATM OCN 811 – PRACTICAL TRAINING IN ATMOSPHERIC AND OCEANIC SCIENCES II
2 credits.

Practical training in atmospheric and oceanic sciences. Provides direct hands-on exposure to careers in the discipline. Continues the internship in atmospheric and oceanic science related companies, agencies, and organizations. Develop a portfolio of items necessary for the American Meteorological Society Certified Consulting Meteorology exam.
Requisites: ATM OCN 810
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Apply knowledge in the classroom to real-world atmospheric science programs
Audience: Graduate

2. Acquire direct hands-on experience in atmospheric science careers
Audience: Graduate

3. Develop portfolio materials necessary for the consulting meteorologist exam
Audience: Graduate

4. Work collaboratively in professional group and team settings
Audience: Graduate

ATM OCN 900 – SEMINAR-METEOROLOGY
1-2 credits.

Discussion of the philosophy of science, communication, and history of atmospheric and oceanic science topics.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023

ATM OCN 901 – FOUNDATIONS OF ATMOSPHERIC AND OCEANIC SCIENCES RESEARCH
1 credit.

Discussions on adapting to graduate school and graduate-level research, history and future of discipline, research ethics, issues of diversity and inclusion.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Recognize and describe the evolution of fundamental principles and processes that make up atmospheric and oceanic sciences
Audience: Graduate

2. Demonstrate capability in graduate-level learning and research through practice of skills in research ethics, literature review, and scientific collaboration
Audience: Graduate

3. Investigate how discrimination and bias have influenced the history of atmospheric and oceanic sciences and what efforts have occurred to redress harm through diversity and inclusion efforts
Audience: Graduate

ATM OCN 902 – SCIENTIFIC COMMUNICATIONS IN THE ATMOSPHERIC AND OCEANIC SCIENCES
1 credit.

Written and oral communication about topics related to graduate research.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2026
Learning Outcomes: 1. Identify the purpose and structure of various genres of scientific writing and oral presentation in the atmospheric and oceanic sciences
Audience: Graduate

2. Describe and apply elements of effective science communication
Audience: Graduate

3. Evaluate and provide constructive feedback of written work through application of peer review practices
Audience: Graduate

4. Prepare written and presentation material that meets criteria for department advancement process and thesis requirements
Audience: Graduate

ATM OCN 903 – RESEARCH ADVANCES IN THE ATMOSPHERIC AND OCEANIC SCIENCES
1 credit.

Discussions on philosophy of science, literature review, development of ideas in Atmospheric and Oceanic Sciences, training in proposal writing, and preparation for Ph.D. dissertation proposal in advance of preliminary exam.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Appraise original papers of on atmospheric and oceanic sciences research to understand the evolution of approaches to solve problems
Audience: Graduate

2. Articulate unresolved research problems and formulate ideas beyond the current boundaries of knowledge within the atmospheric and oceanic sciences
Audience: Graduate

3. Formulate science problems and research questions and use these to evaluate experimental designs resources required to answer them
Audience: Graduate

4. Prepare dissertation proposals that meets criteria for department preliminary examination
Audience: Graduate

ATM OCN/BOTANY/CIV ENGR/ENVIR ST/GEOSCI/ZOOLOGY 911 – LIMNOLOGY AND MARINE SCIENCE SEMINAR
1 credit.

Sections in various fields of zoological research.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026
Learning Outcomes: 1. Explain important research in current limnology.
Audience: Graduate

2. Utilize different research presentation methods.
Audience: Graduate

3. Assess scientific information and ask thoughtful questions.
Audience: Graduate

ATM OCN/ENVIR ST 925 – SEMINAR-CLIMATOLOGY
1-2 credits.

Historical climatology with emphasis on the last few centuries.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2018

ATM OCN/AGROECOL/BOTANY/ENTOM/ENVIR ST/GEOG/ZOOLOGY 953 – INTRODUCTION TO ECOLOGY RESEARCH AT UW-MADISON
1-2 credits.

Introduction to diverse ecological research across the UW-Madison Campus. Discussions on adapting to graduate school and graduate-level ecological research, key topics in professional development, and research presentations by faculty members.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2025
Learning Outcomes: 1. Develop an appreciation for the foundations and legacy of ecology research and conservation science at UW-Madison
Audience: Graduate

2. Recognize the diversity and strength of current research in ecology at UW-Madison
Audience: Graduate

3. Differentiate expectations between undergraduate education and those of independent research for graduate degrees in ecology
Audience: Graduate

4. Develop appropriate expectations for advisors and advisees
Audience: Graduate

5. Reason through hypothetical ethical challenges and identify potential solutions based on professional codes of ethics
Audience: Graduate

6. Develop an understanding of the suite of skills associated with success in graduate school and in science
Audience: Graduate

ATM OCN 965 – SEMINAR-OCEANOGRAPHY
1-2 credits.

Advanced topics in oceanography.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2021
Learning Outcomes: 1. Summarize current issues in oceanographic research.
Audience: Graduate

2. Discuss advanced topics in oceanography.
Audience: Graduate

ATM OCN/BOTANY/ENVIR ST/GEOG/GEOSCI/ZOOLOGY 980 – EARTH SYSTEM SCIENCE SEMINAR
1 credit.

Topics in earth system science. Emphasis on the coupling between atmospheric, oceanic and land surface systems, involving physical geochemical and biological processes, and including interactions with human systems.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

ATM OCN 990 – RESEARCH
1-12 credits.

Research with atmospheric and oceanic science faculty advisors.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026

ATM OCN 999 – ADVANCED INDEPENDENT STUDY
1-6 credits.

Advanced independent study as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2026