**AOSC - ATMOSPHERIC AND OCEANIC SCIENCE**

AOSC213 Causes and Implications of Global Change (3 Credits)
Responsible policy and decision making on issues related to the global environment requires understanding of the basic scientific issues, relationships between the geophysical and biological sciences, the impacts on regional and global endeavors, and the political manner in which humans respond. This course embodies an integrated introduction to the broad scientific and social aspects of the global change problem. Cross-listed with GEOL123.

Credit Only Granted for: AOSC213, GEOG123, GEOL123, or METO123.
Formerly: METO123.

AOSC200 Weather and Climate (3 Credits)
Broad survey of the state of knowledge and problems of atmospheric science. Origin and structure of the atmosphere, meteorological observations, weather maps, forecasting, satellites, energetics, wind, general circulation, storms, severe weather, climate change, air pollution.

Prerequisite: MATH107, MATH110, or MATH115.
Recommended: Concurrent enrollment in AOSC201.
Formerly: METO200.

AOSC201 Weather and Climate Laboratory (1 Credit)
Laboratory exercises to supplement AOSC200, including weather observations, weather map analysis, use of the Internet, forecasting practice and climate modeling.

Corequisite: AOSC200.
Formerly: METO201.

AOSC247 Scientific Programming: Python (3 Credits)
A comprehensive introduction to scientific computation and visualization techniques with Python applied to data intensive questions in the Natural Sciences. The class emphasizes real-world applications, providing students with essential hands-on experience using Python for data analysis and visualization, developing analytical skills for observational and modeling data, and performing virtual experiments to distinguish data contributing factors. Students will gain an understanding of the scientific issues concerning the modern global warming debate on detection and attribution including: signal vs noise, trend vs periodicity, natural vs anthropogenic forcing, local vs remote response, mean vs extreme changes, and accuracy vs uncertainty.

Prerequisite: MATH140.
Recommended: Familiarity with basic descriptive statistics.

Credit Only Granted for: AOSC347 or AOSC358L.
Formerly: AOSC358L.

AOSC358 Special Topics in Atmospheric and Oceanic Science (1-4 Credits)
Special topics in atmospheric and oceanic science are given intensive study. The topic of concentration varies, from semester to semester and depends on student and faculty interests. Often, specialists from other institutions are invited to the campus on a visiting lectureship basis to conduct the course.

Repeatable to: 12 credits.

AOSC375 Introduction to the Blue Ocean (3 Credits)
Oceans are an important component of the Earth System and this course builds towards Earth System Science education. Oceanography is an intrinsically interdisciplinary subject with strong connections to astronomy (tidal forces), biology (ecosystems), geography (world climate), geology (sea floor tectonics), and physics (waves). We begin with the history of ocean exploration and origin of Earth and life and learn about properties of seawater, air-sea interactions, atmospheric and oceanic circulation, El Nino-Southern Oscillation, waves, tides, and tsunamis. Cross-listed with GEOL375.

Credit Only Granted for: GEOL375 or METO375.

AOSC386 Experiential Learning (3-6 Credits)
Restriction: Junior standing or higher; and must have a learning proposal approved by the Office of Experiential Learning Programs, faculty sponsor and student’s internship sponsor.
Formerly: METO386.

AOSC399 Independent Study in Academic Peer Mentoring (1-3 Credits)
Earn academic credit for the time spent supporting an AOSC course in the Academic Peer Mentoring Program (AMP).

Corequisite: TLTC333.
Repeatable to: 6 credits.

AOSC400 Physical Meteorology of the Atmosphere (3 Credits)
The application of basic classical physics, chemistry and mathematics to the study of the atmosphere. Composition of the atmosphere; energy sources and sinks (radiation in the atmosphere; radiative balance and radiative forcing of atmospheric processes); atmospheric thermodynamics; clouds and precipitation physics; atmospheric electricity and optics; mesoscale processes (e.g., orographic mesoscale phenomena and instabilities); air mass boundaries; severe weather, tropical cyclones; storms; global circulation.

Prerequisite: 1 course with a minimum grade of C- from (PHYS171, PHYS161, MATH141); or permission of CMNS-Atmospheric & Oceanic Science department.
Formerly: METO400.
AOSC401 Climate Dynamics and Earth System Science (3 Credits)
Introduction of the earth and global climate systems and their major components: atmosphere, land, ocean, biosphere and cryosphere. Key processes governing the function of the earth’s climate: Global energy balance and water cycle, climate dynamics (general circulation of the atmosphere and ocean) and climate physics (aerosol, cloud and rain), as well as climate variability and climate changes. Phenomena resulting from this coupled system including El Nino-Southern Oscillation, monsoons, and the hydrological cycle will be discussed, with a focus on how the Earth System responds to global warming.
Prerequisite: AOSC400 or AOSC200; and MATH141; and (PHYS161 or PHYS171). Or permission of instructor.

AOSC420 Physical Oceanography (3 Credits)
Prerequisite: MATH141 and PHYS141.
Recommended: AOSC200. Also offered as: GEOL670, AOSC670.
Credit Only Granted for: AOSC420, AOSC670, or GEOL670.

AOSC424 Remote Sensing of the Atmosphere and Ocean (3 Credits)
Many of the properties of the atmosphere, ocean, and land surface are most easily observed from satellite remote sensing. This course will provide students with a hands-on introduction to a variety of passive and active sensing techniques and sensors observing our changing environment. Topics include: orbital dynamics and electromagnetic properties of the atmosphere and surface; atmospheric emission characteristics and scattering; chemical composition and spectroscopy; temperature retrievals; detection and retrieval of aerosol, cloud and rain; ocean surface properties; sea surface temperature and color; active sensing of wind stress, sea level, and internal waves; time-dependent gravity; properties of vegetation and ice.
Prerequisite: 1 course with a minimum grade of C- from (PHYS171, PHYS161, MATH141); or permission of instructor.

AOSC431 Atmospheric Thermodynamics (3 Credits)
Classical thermodynamics applied to both the dry and the moist atmosphere. Composition; phase changes of water; stability concepts; Properties of aerosols and clouds, cloud nucleation and precipitation processes, atmospheric electricity, cloud and precipitation chemistry.
Prerequisite: 1 course with a minimum grade of C- from (PHYS171, PHYS161, MATH141).
Recommended: MATH246.
Credit Only Granted for: AOSC431 or METO431.
Formerly: METO431.

AOSC432 Dynamics of the Atmosphere and Ocean (3 Credits)
Prerequisite: AOSC431.
Corequisite: MATH246.
Credit Only Granted for: AOSC432, METO432, or AOSC632.
Formerly: METO432.

AOSC434 Air Pollution (3 Credits)
Production, transformation, transport and removal of air pollutants. The problems of photochemical smog, the greenhouse effect, stratospheric ozone, acid rain and visibility. Analytical techniques for gases and particles.
Prerequisite: MATH241; or permission of CMNS-Atmospheric & Oceanic Science department.
Formerly: METO434.

AOSC436 Principles of Biogeochemistry (3 Credits)
An introduction to the basic principles of biogeochemistry including aspects of organic geochemistry, biochemistry, microbiology, global geochemical cycles, the origin of life and paleoenvironmental evolution.
Prerequisite: MATH120 or MATH140; or must have completed MATH220. And (GEOL100 or GEOL120); and GEOL322. And CHEM131 and CHEM132; or (CHEM135 and CHEM136).
Restriction: Non-degree-seeking students require the permission of the instructor. Cross-listed with: GEOL436.
Credit Only Granted for: GEOL436 or AOSC436.

AOSC437 Global Climate Change: Past and Present (3 Credits)
A highlight to the fact that global climate change is part of the Earth's past as well as of its present and future. Changes in climate that have occurred in the geologic past can be viewed as the Earth's natural climate variability. These changes are different from, though could be linked with, historical and present anthropogenically-induced climate change. We will discuss the modern climate system, the factors capable of forcing climate change on various time scales, the geologic proxies of past climate change and what these proxies tell us. Finally, we will compare and contrast past climate change with what is understood (and not understood) about modern climate change.
Prerequisite: MATH115 or MATH140; and (GEOL100 or GEOL120); and (CHEM131 or CHEM135); and (CHEM132 or CHEM136).
Restriction: Non-degree seeking students require permission of the instructor.

AOSC447 Machine Learning in Earth Science (3 Credits)
A comprehensive introductory course designed to prepare undergraduate and graduate students for applying machine learning techniques to solve real-world problems in Earth science. It emphasizes practical solution implementation, providing students with essential hands-on experience using the most popular open-source analytics tools based on Python, a general-purpose programming language. The course works through all steps in machine learning, from problem specification, data analytics to analytical solution, and applies advanced statistical and analytical algorithms to uncover hidden data relationships and transform them into predictive understanding or decision support. The topics covered include: Python programming, SciPy and Scikit-learn utility, data engineering, visualization, classifiers, regression models, canonical correlation analysis, structural equation models, decision trees, random forests, boosting machines, support vector machines, clustering, dimensionality reduction, principal component analysis, and neural networks.
Prerequisite: Must have completed MATH140.

AOSC458 Advanced Topics in Atmospheric and Oceanic Science (1-4 Credits)
Special topics in atmospheric and oceanic science are given intensive study. The topic of concentration varies, from semester to semester and depends on student and faculty interests. Often, specialists from other institutions are invited to the campus on a visiting lectureship basis to conduct the course.
Repeatable to: 12 credits.
AOSC462 Ecohydrology (3 Credits)
Focuses on the study of hydrologically-controlled ecosystems, e.g., systems in which either excess and/or deficit of water and nutrients are determinants of its structure and function. Such systems have complex dynamic characteristics that depend on many interrelated links between climate, soil and vegetation.
Prerequisite: MATH240, MATH241 and MATH246; or permission of instructor. Jointly offered with: AOSC662.
Credit Only Granted for: AOSC462 or AOSC662.

AOSC463 Water and Climate Systems (3 Credits)
Focuses on exploring the relationships between water, climate, land, energy, and the economy (the so called "nexus") through an interwoven understanding of the physical, economic, and institutional relationships and constraints that influence management and decision-making processes in water supply, energy generation and food production. The course emphasizes the use of integrated assessment (IA) modeling tools as a way to formalize these relationships and explore their implications. Lectures will be complemented with online discussion sessions and applied modeling exercises to get hands-on knowledge of practical solutions to nexus challenges.
Prerequisite: MATH240, MATH241 and MATH246; or permission of instructor. Jointly offered with: AOSC663.
Credit Only Granted for: AOSC463 or AOSC663.
Additional Information: This course is offered through a joint effort of the Earth System Science Interdisciplinary Center (ESSIC, part of UMDb Sciences) and the Joint Global Change Research Institute (a collaboration between UMD and the US Dept of Energy Northwest National Laboratory).

AOSC470 Synoptic Meteorology (3 Credits)
Atmospheric properties and observations, meteorological analysis and charts, operational numerical forecasts. Application of quasigeostrophic theory, baroclinic instability, midlatitude and mesoscale weather systems. Tropical meteorology. Weather forecasting using numerical and statistical models. Prediction of weather phenomena on the global, synoptic, meso, and local scales. Analysis of surface and upper air data; Norwegian cyclone model; introduction to weather forecasting.
Prerequisite: Minimum grade of C- in AOSC431 and AOSC432.
Credit Only Granted for: AOSC470, AOSC600, or METO600.

AOSC472 Mesoscale Meteorology (3 Credits)
Survey a broad range of mesoscale meteorological features with emphasis on convection and associated phenomena. Define the mesoscale and understand its underlying principles; Introduce non-convective circulations and their importance for weather forecasting; Understand the precursors and occurrence of deep moist convection.
Prerequisite: AOSC432, AOSC600, AOSC610, or AOSC470.
Restriction: Non-degree-seeking students require the permission of the instructor. Jointly offered with AOSC602.
Credit Only Granted for: AOSC472 or AOSC6 02.

AOSC475 Carbon Cycle and Climate: Past, Present, and Future (3 Credits)
The fundamentals of the Earth's carbon cycle, a key biogeochemical cycle that controls Earth's climate and life. The changing characteristics of the carbon cycle on several timescales, ranging from geological, interannual, and the more recent anthropogenic influences on carbon cycle and climate. The carbon cycle in the atmosphere, land, ocean, and the biosphere. The underlying human activities such as fossil fuel burning and deforestation that are responsible for the increase in the atmosphere CO2 and our future options in dealing with the carbon problem such as alternative energy and carbon sequestration. Jointly offered with AOSC675.
Credit Only Granted for: AOSC475 or AOSC675.

AOSC479 Introduction to Earth System Science (3 Credits)
Focuses on exploring the relationships between the atmosphere, the oceans, water, climate, land, vegetation, energy, and human systems through an interwoven understanding of the physical, biogeochemical and socioeconomic relationships and constraints that influence management and decision-making processes in societal issues such as water supply, power generation, food production, ecosystem services and others. The course introduces integrated assessment (IA) science as a framework to formalize these relationships and explore their implications.
Prerequisite: MATH240, MATH241 and MATH246; or permission of instructor. Jointly offered with: AOSC680.
Credit Only Granted for: AOSC480 or AOSC680.
Additional Information: This course is offered through a joint effort of the Department of Atmospheric and Oceanic Science (AOSC) and the Earth System Science Interdisciplinary Center (ESSIC).

AOSC484 Climate System Modeling (3 Credits)
Fundamentals in building computer models to simulate the components of the climate system: atmosphere, ocean, ice, land-surface, terrestrial and marine ecosystems, and the biogeochemical cycles embedded in the physical climate system, in particular, the carbon cycle. Simple to state-of-the-art research models to tackle problems such as the Daisy World, El Nino and global warming. Jointly offered with AOSC684.
Credit Only Granted for: AOSC484 or AOSC68 4.

AOSC493 Senior Research Project I (3 Credits)
Technical writing and oral presentation skills. Planning, writing, and presenting a plan for research in the geosciences.
Prerequisite: Permission of CMNS-Atmospheric & Oceanic Science department.
Restriction: Must be in Atmospheric and Oceanic Science program; or permission of instructor.

AOSC494 Atmospheric and Oceanic Science Seminar (1 Credit)
Exposure to a wide range of contemporary topics in atmospheric, oceanic, and climate sciences, to foster research interests and promote critical thinking through the weekly AOSC departmental seminar series.
Prerequisite: Minimum grade of C- in AOSC431 and AOSC432.

AOSC498 Senior Research Project II (3 Credits)
The project will be based on the research or development plan created in AOSC493. It may be completed with the approval of a faculty advisor in conjunction with an internship. Final written thesis and oral defense will be expected.
Prerequisite: AOSC493.

AOSC499 Special Problems in Atmospheric Science (1-3 Credits)
Research or special study in the field of meteorology and the atmospheric and oceanic sciences.
Prerequisite: Permission of CMNS-Atmospheric & Oceanic Science department.
Repeatable to: 6 credits.
Formerly: METO499.