Marine and Atmospheric Sciences (MAS)

Dean: David O. Conover, Endeavour Hall Room 145, (631) 632-8700
Graduate Program Director: Anne McElroy, Dana Hall Room 113, (631) 632-8488
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Degrees awarded: M.S. in Marine and Atmospheric Science; Ph.D. in Marine and Atmospheric Science; Graduate Certificate in Oceanic Science; Graduate Certificate in Waste Management

The Marine and Atmospheric Sciences (MAS) graduate program is located within the School of Marine and Atmospheric Sciences (SoMAS). Research activities within SoMAS are coordinated through the Marine Sciences Research Center (MSRC), and the Institute for Terrestrial and Planetary Atmospheres (ITPA). MSRC is the center for research, graduate education, and public service in the marine sciences for the entire State University of New York system. SoMAS faculty have active research programs in all major oceanographic and atmospheric disciplines and many focus on interdisciplinary approaches to understanding environmental processes and issues. Specific areas of cross-disciplinary focus include: biogeochemical transformation of energy and elements, conservation and management of marine resources, environmental health and contaminants, environmental modeling and prediction, and patterns and impacts of global climate change.

SoMAS is ideally situated for studies of a variety of coastal environments including barrier islands, continental shelf waters, estuaries, lagoons, and salt marshes. Long Island has a greater diversity of coastal environments in a limited geographical range than any other comparable area in the United States. The proximity of New York City and the burgeoning population of Long Island and Connecticut make New York coastal waters an excellent laboratory for assessing human impacts on the coastal seas, and understanding land/sea interactions at all levels. In addition to working on coastal issues, SoMAS scientists have active research programs on all the world's oceans and ITPA faculty examine atmospheric processes on the Earth and other planets.

SoMAS offers M.S. and Ph.D. degree programs in either oceanography or atmospheric sciences. Interested students should address inquiries to the graduate program director. Virtually all M.S. and Ph.D. students in good standing receive stipends and full tuition scholarships.

Facilities

The main laboratories and offices of SoMAS are housed in a cluster of buildings on South Campus with more than 8,000 square meters of usable floor space. Laboratories are well equipped for most analyses, and students and faculty have access, with special arrangements, to nearby Brookhaven National Laboratory (BNL) and Cold Spring Harbor Laboratory. Center and University computing facilities are excellent and include the new 100 TFlop IBM Blue Gene supercomputer recently installed at BNL. SoMAS is home to the Marine Animal Disease Laboratory, a diagnostic and research facility focused on the health of living marine resources, the Waste Reduction and Management Institute, the Living Marine Resources Institute, the Long Island Groundwater Institute, the New York Sea Grant College Program, and several analytical facilities. MASIC (the Marine and Atmospheric Sciences and Information Center) is the branch of the campus library system located at SoMAS. Officially designated as a prototype for technology-based branch libraries on the campus, MASIC offers students and faculty a core collection of journals and monographs relevant to the multidisciplinary pursuits of SoMAS and its affiliated institutes as well as a state-of-the-art computer teaching laboratory.

SoMAS manages the Flax Pond Marine Laboratory located on a 0.6-square-kilometer salt marsh approximately seven kilometers from campus. This facility provides flow-through seawater and space suitable for culture and experimentation on living marine resources. Part of the facility is in a greenhouse offering ambient light and temperature conditions. Laboratory and sea-table space are available to faculty and students at SoMAS and other collaborating University programs. SoMAS also manages the marine station at Stony Brook Southampton, located 46 miles away on the beautiful east end of Long Island. Several SoMAS faculty keep research laboratories at Stony Brook Southampton, and additional wet lab space is available for student and faculty research.

SoMAS also operates a fleet of research vessels, the largest of which is the R/V SEAWOLF, a 24-meter research vessel designed specifically for oceanographic research. The SEAWOLF is ideally suited for extended research trips, large-scale oceanographic sampling, and trawling. Several other smaller boats are available for local cruises out of either the Stony Brook or Southampton campuses.

Graduate Degree Program Descriptions

The M.S. Program in Marine and Atmospheric Science

The M.S. program offered by SoMAS consists of a rigorous interdisciplinary approach to oceanography and atmospheric sciences based on interdisciplinary course work and a research thesis. It is designed to prepare students for positions in environmental protection, management, research, and resource development. The program provides students with a firm basis for more advanced study. But, more importantly, it is designed to equip students with the background and tools needed for effective careers without additional training. Required course work is identical to the Ph.D. program, allowing M.S. students to continue on in the Ph.D. program provided they have demonstrated adequate performance and found a suitable faculty advisor.

Ph.D. Program in Marine and Atmospheric Science

The Ph.D. program is designed to prepare

students to independently identify and attack oceanographic and atmospheric problems. It builds on a series of core required courses (taken by both Ph.D. and M.S. students), and allows students to create their own course of advanced study, helping them to become effective, independent problem solvers. The Ph.D. in Marine and Atmospheric Science prepares students to compete effectively for academic positions, direct research programs at government or private laboratories, and direct research and assessment programs at non-governmental organizations. An M.S. degree is not required for admission to the Ph.D. program.

Admission Requirements

There are two tracks in the M.S. and Ph.D. programs—one in Oceanography and one in Atmospheric Sciences. Students should indicate which track they wish to pursue on their applications. All applications should be submitted electronically through the Graduate School.

For admission to either the M.S. or Ph.D. graduate programs in Marine and Atmospheric Sciences, the following, in addition to the minimum Graduate School requirements, are normally required:

A. B.A. or B.S. degree in atmospheric sciences, biology, chemistry, geology, mathematics, physics, or other suitable science discipline, the coursework equivalent to obtain such a degree;

B. Two semesters of coursework in mathematics through calculus, physics, and chemistry, and as appropriate to specialization area, biology or earth sciences, with advanced work in at least one of these disciplines;

C. Cumulative grade point average of at least 3.0 (B);

D. Acceptable scores on the Graduate Record Examination (GRE) General Test;

E. Acceptable scores on the TOEFL (paper: 600, computer: 230, iBT: 90) or IELTS (6.5)

F. Three letters of recommendation;

G. Official transcript(s);

Students should state why they wish to enter the SoMAS graduate program and provide an indication of both the specific research areas they would like to address and potential faculty advisors in their personal statement.

Certificate Programs

In addition to the M.S. and Ph.D. programs of study, certificate programs provide the opportunity for advanced study for students who do not wish to pursue a degree. Students interested in either of these programs should contact the Graduate Program Director.

Graduate Certificate Program of the Waste Reduction and Management Institute

MSRC is the home of the Waste Reduction and Management Institute, dedicated to lessening the impacts of a complex array of wastes through environmental assessment, policy analysis, public outreach, and research. A Graduate Certificate in Waste Management is administered by the School of Professional Development. The 18-credit program provides access to the most current expertise in waste management essential to working effectively in professional careers or public service. The certificate may also be incorporated into the degree of Professional Studies with a concentration in waste management. For further information refer to the School of Professional Development section in this *Bulletin*.

Advanced Graduate Certificate Program in Oceanic Science

The advanced graduate certificate program in Oceanic Science is designed to make the unique resources of the MSRC available to professionals as well as to scholars both within the SUNY system and at other institutions as well as other professionals. Students admitted to this program complete two full-time semesters (18 credits) of intensive, specialized graduate studies in our core curriculum, or the equivalent, under the supervision of a faculty sponsor. The program is intended to supplement a student's primary educational and professional goals. Qualified students are provided with a broad background in oceanography as well as opportunity for in-depth course work in highly specialized topics.

Faculty

Distinguished Professors

Aller, Robert C., Ph.D., 1977, Yale University: Marine geochemistry; marine animal-sediment relations.

Cess, Robert D., *Emeritus*, Ph.D., 1959, University of Pittsburgh: Atmospheric sciences.

Fisher, Nicholas S., Ph.D., 1974, Stony Brook University: Marine biogeochemistry of metals, marine pollution, phytoplankton, herbivore interactions.

Lee, Cindy, Ph.D., 1975, University of California, San Diego (Scripps): Marine geochemistry of organic compounds; organic and inorganic nitrogen cycle biochemistry.

Distinguished Service Professor

Bowman, M.J., Ph.D., 1971, University of Saskatchewan, Canada: Coastal dynamics; oceanic fronts; productivity and physical processes.

Professors

Aller, Josephine Y., Ph.D., 1975, University of Southern California: Marine benthic ecology; invertebrate zoology; marine microbiology; biogeochemistry.

Bokuniewicz, Henry J., Ph.D., 1976, Yale University: Nearshore transport processes; coastal sedimentation; marine geophysics.

Cochran, J. Kirk, Ph.D., 1979, Yale University: Marine geochemistry; use of radionuclides as geochemical tracers; diagenesis of marine sediments.

Conover, David O., *Dean of SoMAS*, Ph.D., 1981, University of Massachusetts: Ecology of fishes; fisheries biology.

Flagg, Charles, Ph.D., 1977, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution: Structure and dynamics of coastal oceans.

Flood, Roger D., Ph.D., 1978, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution: Marine geology; sediment dynamics; continental margin sedimentation.

Geller, Marvin A., Ph.D., 1969, Massachusetts Institute of Technology: Atmospherics dynamics; climate and the upper atmosphere.

Hameed, Sultan, *Coordinator of Atmospheric Sciences Program*, Ph.D., 1968, University of Manchester, England: Atmospheric sciences.

Lopez, Glenn R., Ph.D., 1976, Stony Brook University: Benthic ecology; animal-sediment interactions.

Scranton, Mary I., Ph.D., 1977, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution: Marine biogeochemistry; geochemistry of reduced gases; chemical cycling in anoxic systems.

Swanson, R. Lawrence, Ph.D., 1971, Oregon State University: Physical oceanography of coastal waters and estuaries; ocean dumping; coastal zone management.

Taylor, Gordon T., Ph.D., 1983, University of Southern California: Marine microbial ecology; microbial mediation of biogeochemical processes; biofouling.

Varanasi, Prasad, Ph.D., 1967, University of California, San Diego: Atmospheric spectroscopy; remote sensing; global warming.

Wang, Dong-Ping, Ph.D., 1975, University of Miami: Coastal ocean dynamics.

Zhang, Minghua, Ph.D., 1987, Institute for Atmospheric Physics, Academia Sinica, Beijing: Atmospheric sciences; modeling of climate.

Associate Professors

Armstrong, Robert A., Ph.D., 1975, University of Minnesota: Marine ecosystem ecology; marine biogeochemistry; population and community ecology.

Brownawell, Bruce J., Ph.D., 1986, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution: Biogeochemistry of organic pollutants in seawater and groundwater.

Cerrato, Robert M., Ph.D., 1980, Yale University: Benthic ecology; population and community dynamics; recolonization.

Chang, Edmund K.M., Ph.D., 1993, Princeton University: Atmospheric dynamics and diagnoses climate dynamics; synoptic meteorology.

Colle, Brian A., Ph.D., 1997, University of Washington: Synoptic meteorology; mesoscale numerical modeling and forecasting; coastal meteorology.

Gobler, Christopher, Ph.D., 1999, Stony Brook University: Phytoplankton; harmful algal blooms; estuarine ecology; aquatic biogeochemistry.

Khairoutdinov, Marat, Ph.D., 1997, University of Oklahoma: Climate modeling, high-resolution cloud modeling, cloud microphysics, super parameterization, massively parallel super-computing, cloud parameterization.

Lonsdale, Darcy J., Ph.D., 1979, University of Maryland: Zooplankton ecology with special interest in physiology; life history studies.

Lwiza, Kamazima, M.M., Ph.D., 1990, University of Wales: Structure and dynamics of shelf seas.

Mak, John E., Ph.D., 1992, University of California, San Diego (Scripps): Atmospheric chemistry and biosphere-atmosphere interactions; isotope geochemistry.

McElroy, Anne E., *Graduate Program Director*, Ph.D., 1985, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution: Aquatic toxicity, fate and effects of organic contaminants.

Wilson, Robert E., Ph.D., 1973, Johns Hopkins University: Estuarine and coastal ocean dynamics.

Assistant Professors

Allam, Bassem, Ph.D., 1998, University of Western Brittany: Diseases of shellfish.

Collier, Jackie L., Ph.D., 1994, Stanford University: Phytoplankton physiology and ecology; freshwater and marine plankton; molecular microbial ecology.

Fast, Mark D., Ph.D., 2005, Dalhousie University, Canada: Aquatic diseases and immunology.

Frisk, Michael, Ph.D., 2004, University of Maryland: Biology; life history; conservation of elasmobranches.

Munch, Stephen, Ph.D., 2002, Stony Brook University: Evolutionary ecology of growth and life history traits; evolution in harvested populations; applied population dynamics modeling; mathematical modeling and statistics.

Peterson, Bradley, Ph.D., 1998, University of South Alabama: Community ecology of seagrass dominated ecosystems.

Warren, Joseph, Ph.D., 2001, Massachusetts Institute of Technology, Woods Hole Oceanographic Institution: Acoustical oceanography; zooplankton behavior and ecology.

Joint Faculty

Akcakaya, Resit, Ph.D., 1989, Stony Brook University: Ecological risk assessment, metapopulation modeling, population viability analysis, threatened species assessment, uncertainty analysis.

Baines, Stephen, *Assistant Professor, Ecology and Evolution,* Ph.D., 1993, Yale University: Aquatic biogeochemistry of carbon and trace elements.

De Zafra, Robert. *Emeritus*, Ph.D., 1958, University of Maryland: Positron annihilation, physics.

Koppelman, Lee E., *Center for Regional Policy Studies,* Ph.D., 1970, Cornell University: Coastal zone management; planning; policy studies.

Levinton, Jeffrey, *Professor, Ecology and Evolution,* PhD., 1971, Yale University: Marine ecology.

Padilla, Diana, Ph.D., 1987, University of Alberta: Mollusc ecology; invasive species.

Reaven, Sheldon, Ph.D., 1975, University of California, Berkeley: Energy and environmental problems; waste management; science and society.

Adjunct Faculty

Buonaiuto, Frank, Ph.D., 1999, Stony Brook University: Coastal processes, numerical modeling of waves, tides and sediment transport.

Bowser, Paul, Ph.D., 1978, Auburn University: Fish pathology.

Chistoserdov, Andre Y., Ph.D., 1985, Institute of Genetics and Selection of Industrial Microorganisms, Russia: Marine microbiology; molecular genetics of methylotrophic bacteria; marine biotechnology and bioremediation.

Dove, Alistair, Ph.D., 1999, University of Queensland: Parasites and diseases of marine organisms.

Engel, Anga: Organic matter cycling marine gel particles, ocean acidification.

Espinosa, Emmanuelle pales, Ph.D., 1999, University of Nante, France: Shellfish physiology, particle selection mechanisms in suspension-feeding bivalves, algology.

Essington, Tim, Ph.D., 1999, University of Wisconsin-Madison: Marine fish ecology and biology, food web interactions, marine fisheries.

Ferson, Scott, Ph.D., 1988, Stony Brook University: Risk assessments and uncertainty analysis.

Fowler, Scott, Ph.D., 1969: Zooplankton ecology; biogeochemistry of metals; marine pollution; radioecology; ecotoxicology.

Goodbred Jr., Steven, Ph.D., 1999: Coastal and marine sedimentology; quaternary development of continental margins; salt-marsh processes and responses.

Letherman, Stephen P., 1975, University of Virginia: Coastal geomorphology.

Pikitch, Ellen, K., Ph.D., 1983, Indiana University: Fisheries science; conservation biology; marine policy.

Riemer, Nicole, Ph.D., 2002, University of Karlsruhe, Germany: Cloud microphysics; aerosol physics; chemistry.

Safina, Carl, *Adjunct*, Ph.D., 1987, Rutgers University: Marine vertebrates; fisheries policy; raising awareness of ocean change.

Sanudo-Wilhelmy, Sergio A., Ph.D., 1993, University of California, Santa Cruz: Chemical oceanography; coastal geochemistry; metal cycling in aquatic systems.

Waliser, Duane, Ph.D., 1992: Ocean-atmosphere interactions; tropical climate dynamics.

Degree Requirements

Requirements for the M.S. Degree in Marine and Atmospheric Sciences

In addition to the minimum Graduate School requirements, the following are required:

A. An overall B (3.0) average in the required core courses with no grade lower than a C. See details of required coursework below;

B. Seminar MAR 580 (two semesters);

C. An advisor by the end of the first year;

D. Master's research proposal due by end of first year, signed by advisor and two readers;

E. Sea experience or appropriate field experience for students in the oceanography track only; approved by the advisor;

F. Oral presentation of thesis work;

G. Submission of approved thesis.

The M.S. degree is 30 credits, made up of research credits in addition to required and elective course work.

Requirements for Ph.D. Degree in Marine and Atmospheric Sciences

In addition to the minimum Graduate School requirements, and general requirements for the M.S. degree, the following are required:

A. Comprehensive Examination: The primary purposes of the Comprehensive

Examination is to assess the student's knowledge of his or her field and the student's ability to relate his or her specific research interests to the broader field. The student must demonstrate a general knowledge of oceanography or atmospheric sciences, including an understanding of the current concepts of his or her field. Success on the examination implies the ability to use this information to address questions of a multidisciplinary nature;

B. Ph.D. degree dissertation proposal approved by a dissertation committee and oral preliminary examination;

C. Practicum in teaching;

D. Oral defense of dissertation;

E. Submission of approved dissertation.

Required Courses:

Marine Track:

A. Core Courses: MAR 501 Physical Oceanography, MAR 502 Biological Oceanography, MAR 503 Chemical Oceanography, and MAR 506 Geological Oceanography)

B. MAR 568 Scientific Communication;

C. A minimum of six credits in specialty courses (excluding MAR 501, 502, 503, 506, 547, 555, and 580) selected by the student and his or her advisor and approved by the advisor;

D. Sea experience or appropriate field experience.

Atmospheric Track:

A. Core courses: 1) MAR 541 and 542, Foundations of Atmospheric Sciences I and II; 2) One of the required oceanography core courses (MAR 501, 502, 503, or 506); and 3) Two or three out of the five following advanced courses, for M.S. and Ph.D. students, respectively: MAR 593 Atmospheric Physics, MAR 594 Atmospheric Dynamics, MAR 544 Atmospheric Radiation, MAR 596 Atmospheric Chemistry, and MAR 598 Synoptic and Mesocale Meteorology);

B. MAR 595 Graduate Seminar in Atmospheric Sciences (two semesters);

C. Minimum of 24 course credits for Ph.D. students.

Courses

Marine Science Courses

MAR 501 Physical Oceanography
Examines physics of ocean circulation and mixing on various scales with strong emphasis on profound effects of Earth's rotation on motions and distribution of properties. An introduction to physics of estuaries and other coastal water bodies.
Co-requisite: MAR 555 or permission of instructor
Fall, 3 credits, ABCF grading

MAR 502 Biological Oceanography
Examines biological processes in the ocean, and introduces major ocean biomes and groups of organisms. A broad treatment of energy and nutrient cycling in coastal and open ocean environments.
Prerequisite: Enrollment in Marine Environmental Sciences program or permission of instructor
Fall, 3 credits, ABCF grading

MAR 503 Chemical Oceanography
Introduction to chemical oceanography. Topics include origin and history of seawater, major and minor constituents, dissolved gases, the carbon dioxide system, distribution of properties in the world ocean, isotope geochemistry, and estuarine and hydrothermal vent geochemistry.
Prerequisite: Enrollment in the Marine Environmental Sciences program or permission of instructor
Spring, 3 credits, ABCF grading

MAR 506 Geological Oceanography
An introduction to the geological oceanography of the world ocean with emphasis on the coastal environment; discussions of the physical processes controlling the structure and evolution of the ocean basins and continental margins, the distribution of marine sediment, and the development of coastal features.
Prerequisite: Enrollment in Marine Environmental Sciences program or permission of instructor
Spring, 3 credits, ABCF grading

MAR 510 Modeling Techniques in Chemical Oceanography
Derivation of solutions to advection-diffusion-reaction equations for marine sediments and waters. One- and multi-dimensional models are developed for dissolved and solid-phase substances in cartesian, cylindrical, and spherical coordinates. Effect of imposing multiple layers on these systems is examined.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading

MAR 511 Benthic Ecology
This course focuses on the ecological interactions of benthic organisms and their habitat. Topics include life histories, the roles of competition, predation and disturbance, feeding adaptations and food webs, interactions between benthic organisms and water motion, sediment chemistry, and other abiotic factors, and evolutionary history of benthic ecological processes.
Spring, alternate years, 2 credits, ABCF grading

MAR 512 Marine Pollution
Review of the physical and chemical characteristics and speciation in the marine environment of organic pollutants, metals and radionuclides including bioavailability, assimilation by marine organisms, toxicity, and policy issues. Crosslisted as MAR 512 or HPH 671.
Prerequisites: MAR 502, MAR 503
Fall, 3 credits, ABCF grading

MAR 514 Marine Management
The course discusses waste management issues particularly affecting the marine environment. Topics include ocean dumping, sewage treatment fish kills, beach pollution, and nuisance algal blooms. Techniques for managing the waste stream are presented. Crosslisted as HPH 672 or MAR 514.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading

MAR 515 Phytoplankton Ecology
The biology and ecology of marine phytoplankton. Covered are life cycles, growth, nutrient uptake, grazing, and the effects of environmental factors on growth and survival of phytoplankton. The characteristics of various classes are examined and are related to environmental conditions.
Prerequisites: General biology
Fall, 3 credits, ABCF grading

MAR 516 Larval Ecology
This course examines (1) physical, chemical, and biological processes that regulate timing of reproduction, larval dispersal, and larval settlement, (2) selective forces in the plankton that shape life histories, and (3) ecological and evolutionary consequences of complex life cycles.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading

MAR 517 Waves
Theory and observations of surface waves, internal waves, and planetary waves; wave-wave, wave-current, and wave-turbulence interactions; surface wave prediction; beach processes.
Spring, alternate years, 3 credits, ABCF grading

MAR 518 Environmental Engineering
A technical, legal, and regulatory review of various aspects of environmental engineering. Problems of and solutions for managing water resources and air quality in an urban/suburban coastal environment are discussed.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading

MAR 519 Geochemistry Seminar
This course explores topics in low-temperature geochemistry as chosen by the instructors and participants. The seminar series is organized around a theme such as early diagenesis, estuarine geochemistry, or aquatic chemistry. Students are required to lead one of the seminars and to participate in discussions.
Prerequisite: MAR 503 or permission

of instructor
Fall, 1 credit, ABCF grading
May be repeated for credit

MAR 520 New Production and Geochemical Cycles
Consideration of oceanic new production for a variety of ecosystems. Quantitative examination of the impact of new production on the transport and cycling of major and minor elements and pollutants.
Pre- or corequisites: MAR 502, 503
Spring, alternate years, 2 credits, ABCF grading

MAR 521 Groundwater Problems
Discussion of the hydraulic processes and technologies that are central to the management and monitoring of groundwater resources including special problems of coastal hydrology and saltwater intrusion, as well as the fate of contaminants. Remediation approaches are also examined. Crosslisted as MAR 521 or HPH 673.
Prerequisite: Permission of instructor
Summer, 3 credits, ABCF grading

MAR 522 Environmental Toxicology and Public Health
Principles of toxicology and epidemiology are presented and problems associated with major classes of toxic chemicals and radiation to human and environmental health are examined in case study format.
Spring, 3 credits, ABCF grading

MAR 524 Organic Contaminant Hydrology
There are a host of chemical, biological, and physical processes that affect the transport and fate of organic chemicals in natural waters. This course concerns understanding these processes and the structure-activity relationships available for predicting their rates. The major focus of this class is on contaminant hydrology of soil and aquifer environments, and includes the principles behind remediation and containment technologies. This course is offered as both MAR 524 and GEO 524.
Prerequisite: GEO 526 or MAR 503 or permission of instructor
Spring, 3 credits, ABCF grading

MAR 525 Environment and Public Health Engineering/Sanitation
Review of the interactions of humans with the atmosphere and water resources, especially in the Long Island coastal community. An introduction is provided to the field of environmental health and the practices relevant to an urban/suburban and coastal setting. Crosslisted with HPH 675.
Prerequisite: Permission of instructor
Spring, every year, 3 credits, ABCF grading

MAR 526 Pollutant Responses in Marine Organisms
This course examines physiological, biochemical, and molecular responses of marine organisms to contaminant stress. Material will be examined through review lectures on the topic and group discussion of the current literature.
Fall, alternate years, 3 credits, ABCF grading

MAR 527 Global Change
The course examines the scientific basis behind questions of global change and some of the policy implications of changes to the region and country. Topics include evidence and courses of past climactic changes, greenhouse gases and the greenhouse effect, analogues with other planets, the Gaia hypothesis, climate modeling, and deforestation and the depletion of ozone.
Prerequisite: Permission of instructor
Fall, alternate years, 2 credits, ABCF grading

MAR 528 Ocean Atmosphere Interactions
This course discusses the fundamental physical mechanisms through which the ocean and atmosphere interact. These principles are applied to the understanding of phenomena, such as the El Nino Southern Oscillation, the effects of sea surface temperature on the distribution of low-level winds and development of tropical deep convection, and the effects of tropical deep convection and mid-latitude storms on the ocean's mixed layer. Both modeling and observational aspects are discussed. Material will be taken from selected textbooks, as well as recent literature.
Prerequisite: Permission of instructor
Spring, alternate years, 3 credits, ABCF grading

MAR 529 Isotope Geochemistry
This course deals both with the use of stable and radioisotope applications to the earth sciences.
Fall, 3 credits, ABCF grading

MAR 530 Organic Geochemistry
Introduction to the organic chemistry of the earth, oceans, and atmosphere. Topics include production transformation and fate of organic matter; use of organic biomarkers and stable and radioisotopes; diagenesis in recent sediments; oil and coal production and composition; dissolved and particulate organic matter in seawater.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits, ABCF grading

MAR 533 Instrumental Analysis
Fundamental principles of instrumental chemical analysis and practical applications of molecular spectroscopy and atomic spectroscopy. These two instruments are widely used in environmental problem solving. Lectures cover basic concepts of chemical analysis and the fundamental principles of the analytical techniques to be used. In the laboratory, students gain hands-on experience both by performing a series of required basic chemical determinations (nutrients and trace metals in sediments and in river water) and by undertaking special projects. Students prepare written reports describing the methods, the theory underlying those methods, results, and figures of merit. Students also present their results orally in brief presentations.
Prerequisites: Permission of instructor
Spring, 3 credits, ABCF grading

MAR 534 Aquaculture
Biological, economic, practical, social, and legal aspects of culturing marine and freshwater organisms, including plants, mollusks, crustaceans, and finfish. Basic principles of aquaculture and successes and failures with selected species. Field trips and the preparation and evaluation of aquaculture proposals.
Fall, 2 credits, ABCF grading

MAR 535 Physiological Ecology of Marine Organisms
An introduction to the physiological adaptations of marine organisms to environmental changes. Specific topics covered include responses to stress, temperature adaptation, genetic basis of physiological adaptation, resource partitioning, bioenergetics, and feeding models and resource limitation.
Prerequisite: Undergraduate courses in biology, particularly ecology, invertebrate zoology, and/or physiology
Fall, 3 credits, ABCF grading

MAR 536 Environmental Law and Regulation
This course covers environmental law and regulations from inception in common law through statutory law and regulations. The initial approach entails the review of important case law giving rise to today's body of environmental regulations. Emphasis is on environmental statutes and regulations dealing with waterfront and coastal development and solid waste as well as New York State's Environmental Quality Review Act (SEQRA) and the National Environmental Policy Act (NEPA). Crosslisted as MAR 536 or HPH 676.
Spring, 3 credits, ABCF grading

MAR 538 Modern Methods of Data Analysis in Atmospheric and Ocean Sciences—Part I
An introduction to basic statistical concepts and their applications to analysis of data in atmospheric and marine sciences. The topics include distribution, statistical estimation, hypothesis testing, analysis of variance, linear and nonlinear regression analysis, and basics of experimental design. In-depth class discussions of the theoretical concepts are accompanied by extensive applications to data sets supplied by the instructor and the students.
Prerequisites: MAR or OCN graduate standing or permission of instructor
Fall, alternate years, 3 credits, ABCF grading
May be repeated once for credit

MAR 540 Marine Microbial Ecology
An historical perspective of the field, aspects of nutrition and growth, microbial metabolism, and trophodynamic relationships with other organisms. Emphasis on roles of microorganisms in marine environments such as salt marshes, estuaries, coastal pelagic ecosystems, and the deep sea, as well as microbial contribution to geochemical cycles. Contemporary and classical methodologies covered.
Prerequisite: MAR 502 or permission of instructor
Fall, 3 credits, ABCF grading

MAR 541 Foundations of Atmospheric Sciences I
This course will first give an overview of the atmosphere and the climate system, including weather systems and atmospheric general circulations. It then introduces atmospheric thermodynamics and dynamics at the level appropriate to all students in atmospheric sciences.
3 credits, ABCF grading

MAR 542 Foundations of Atmospheric Sciences II
This course introduces cloud physics, atmospheric chemistry, boundary layer turbulence, and atmospheric radiation. This is the second course in a two-course series taught at the level appropriate to all students in atmospheric sciences.
Fall, every year, 3 credits, ABCF grading

MAR 544 Atmospheric Radiation
Discussion of the compositions and radiative components of planetary atmospheres. Blackbody and gaseous radiation with emphasis on the respective roles of electromagnetic theory and quantum statistics. Derivation of the equation of transfer and radiative exchange integrals, with application to energy transfer processes within the atmospheres of Earth and other planets.
Fall, alternate years, 3 credits, ABCF grading

MAR 545 Paleoceonography and Paleoclimatology
This course will provide an extensive overview of the methods used in paleoclimate research and an examination of important climate events during the Late-Mesozoic and Cenozoic eras. We will discuss proxies used to create paleoclimate reconstructions forcing mechanisms on interannual to million-year time scales, climate effects on geological and biological processes, and the modeling of present climate and extrapolation to past and future climates.
Fall, alternate years, 1-4 credits, ABCF grading

MAR 546 Marine Sedimentology
Study of sedimentology in the marine environment including an introduction to fluid mechanics, sediment transport theory, quantitative models of sedimentation, and dynamic stratigraphy.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits, ABCF grading

MAR 547 Dynamical Oceanography I
The first course in a two-course series on basic methods and results in dynamical oceanography. This course emphasizes unstratified fluids. Topics covered include but are not limited to basic conservation equations, effects of rotation, geostrophy, potential vorticity conservation, Ekman layers, and Ekman pumping.
Prerequisite: MAR 501 or permission of instructor
Spring, 3 credits, ABCF grading

MAR 548 Dynamical Oceanography II
Continuation of Dynamics I. Course covers some of the basic effects of stratification. Topics include potential vorticity for baroclinic motion and baroclinic instability.
Prerequisite: Dynamical Oceanography I
Fall, 3 credits, ABCF grading

MAR 549 Current Topics in Atmospheric Sciences
This course will discuss current research topics in atmospheric sciences and their connections with advanced course materials.
0-2 credits, S/U grading
May be repeated once for credit

MAR 550 Topics in Marine Sciences
This is used to present special interest courses, including intensive short courses by visiting and adjunct faculty and courses requested by students. Those given in recent years include Nature of Marine Ecosystems, Science and Technology in Public Institutions, Plutonium in the Marine Environment, and Problems in Estuarine Sedimentation.
Fall and spring, 1-4 credits, ABCF grading
May be repeated for credit

MAR 551 Special Topics in Management
This course involves in-depth examination and assessment of one or two topical problems and issues in the management of fisheries in the mid-Atlantic region. Fisheries management encompasses a diversity of disciplines and interests: biology, ecology, mathematics, law, policy, economics, analytical modeling, sociology, and anthropology. The class conducts a detailed and thorough review of one or two key fisheries management problems that incorporate component issues spanning this range of disciplines. Students form several teams, each team focusing on one aspect of the overall problem and preparing a report detailing that aspect and making recommendations on how management decisions can be improved.
Prereqisite: Permission of instructor
Fall, 1-4 credits, ABCF grading
May be repeated for credit

MAR 552 Directed Study
Individual studies under the guidance of a faculty member. Subject matter varies according to the needs of the students.
Prerequisite: Permission of instructor
Fall, spring, and summer, 1-12 credits, ABCF grading
May be repeated for credit

MAR 553 Fishery Management
Survey of the basic principles of and techniques for studying the population dynamics of marine fish and shellfish. Discussion of the theoretical basis for management of exploited fishes and shellfish, contrasting management in theory and in practice using local, national, and international examples. Includes lab exercises in the use of computer-based models for fish stock assessment.
Prerequisite: Calculus I or permission of instructor
Spring, alternate years, 3 credits, ABCF grading

MAR 554 Aquatic Animal Diseases
This course is designed to expose students to fundamental and current issues pertaining to host/pathogen interactions in aquatic environment. By the end of the course, students should have a basic understanding of disease processes in aquatic animals; knowledge of the tools used for disease diagnosis; and an appreciation of disease management tools available today. A particular accent is given to the role of the environment as an important factor in infectious and non-infectious diseases.
3 credits, ABCF grading

MAR 555 Introduction to Mathematics for Marine Scientists
Course is designed to develop quantitative thinking and approaches in marine sciences. Topics covered are differential equations, differential and integral calculus, (minimum) partial differential equations. Discussions include formulation of practical problems, i.e., application of differential equations.
Prerequisite: Calculus I or permission of instructor
Fall, 3 credits, ABCF grading

MAR 556 Biology of Fishes
Lectures and laboratories on comparative evolution, morphology, physiology, and ecology of fishes with emphasis on marine and estuarine forms.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits, ABCF grading

MAR 558 Remote Sensing
Theory and application of remote sensing and digital image analysis to marine research. Students use standard software and PCs for digital filtering, enhancement, and classification of imagery.
Prerequisite: MAR 501, 502, 504, 506, or permission of instructor
Spring, 2 credits, ABCF grading

MAR 559 Applied Groundwater Modeling
This seminar-style course will explore error estimation, uncertainty propagation, risk analysis, model validation, and decision analysis.
Fall, alternate years, 2 credits, ABCF grading

MAR 560 Ecology of Fishes
Introduction to current research in the ecology of fishes. Topics such as population regulation, migration, reproductive strategies, predator-prey interactions, feeding behavior, competition, life history strategies, and others are discussed.
Prerequisite: Familiarity with concepts of ecology or biological oceanography
Spring, alternate years, 3 credits, ABCF grading

MAR 562 Early Diagenesis of Marine Sediments
The course treats qualitative and quantitative aspects of the early diagenesis of sediments. Topics include diffusion and adsorption of dissolved species; organic matter decomposition and storage; and diagene-

sis of clay materials, sulfur compounds, and calcium carbonates. The effects of bioturbation on sediment diagenesis are also discussed. This course is offered as both MAR 562 and GEO 562.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits,
ABCF grading

MAR 563 Early Diagenesis of Marine Sediments II
The basic principles and concepts of diagenetic processes developed in MAR/GEO 562 are used to examine in detail early diagenesis in a range of sedimentary environments. These include terrigenous and biogenic sediments from estuarine, lagoonal, deltaic, open shelf, hemipelagic, oligotrophic deep-sea, and hydrothermal regions.
Prerequisite: MAR/GEO 562
3 credits, ABCF grading

MAR 564 Atmospheric Structure and Analysis
Real-world applications of basic dynamical principles to develop a physical understanding of various weather phenomena. Topics include the hypsomatric equation, structure and evolution of extratropical cyclones, fronts, hurricanes and convective systems, surface and upper air analysis techniques, radar and satellite interpretation, and introduction to operational products and forecasting.
Prerequisite: One year of calculus
Spring, 3 credits, ABCF grading

MAR 565 Global Atmospheric Change
An application of chemical principles to the analysis and prediction of climate changes on Earth. The course analyzes climates that have occurred in the Earth's past and uses this information to infer climate changes that are likely to occur in the near and distant future. Topics covered include atmospheric chemistry, paleoclimates, greenhouse warming, ozone changes, and urban pollution.
Prerequisite: One year of calculus
Spring, 3 credits, ABCF grading

MAR 566 Air Pollution and Its Control
A detailed introduction to the causes, effects, and control of air pollution. The pollutants discussed include carbon monoxide, sulfur oxides, nitrogen oxides, ozone, hydrocarbons, and particulate matter. The emissions of these bases from natural and industrial sources and the principles used for controlling the latter are described. The chemical and physical transformations of the pollutants in the atmosphere are investigated and the phenomena of urban smog and acid rain are discussed.
Spring, 3 credits, ABCF grading

MAR 568 Scientific Communication
This course is designed to provide first-year graduate students with an introduction to the standards and practices of both proposing and presenting results of oceanographic research. Students will develop skills in communicating in both oral and written formats, and have the opportunity to produce a draft thesis proposal.
2 credits, ABCF grading

MAR 570 Modern Methods of Data Analysis in Atmospheric and Ocean Studies—Part II
Sampling and experiment design considerations, time and frequency domain analysis, Fourier methods, related topics in probability and statistics. Course involves some computer work.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits,
ABCF grading
May be repeated once for credit

MAR 571 Zooplankton Ecology
The course is designed to acquaint the student with the theoretical problems and applied methodology in ecological studies of marine and freshwater zooplankton. Topics will include taxonomy, anatomy, physiology, life history strategies, population dynamics, and food chain interaction.
Prerequisites: MAR 502 and permission of instructor
Spring, alternate years, 3 credits,
ABCF grading

MAR 572 Geophysical Simulation
Basic equations and boundary conditions. Linear and nonlinear instabilities. Finite-difference and time integration techniques for problems in geophysical fluid dynamics. Numerical design of global atmospheric and ocean models.
Fall, alternate years, 3 credits,
ABCF grading

MAR 573 Special Topics: Chemical Oceanography
This course is designed for the discussion of topics of special interest on demand that are not covered in regularly scheduled courses. Examples of possible topics include carbonate chemistry, isotope chemistry, and microbial chemistry.
Prerequisite: Permission of instructor
Spring, 1-4 credits, ABCF grading
May be repeated for credit

MAR 574 Special Topics: Ocean Dynamics
Introductory dynamical oceanography, framework, and applications.
Summer, 1-4 credits, ABCF grading
May be repeated for credit

MAR 575 Special Topics: Geological Oceanography
The course proposes to take several views of the ecology and biogeochemistry of intertidal wetlands to see whether one or more of these views might be useful in reinvigorating interest in the study of wetland function for its own sake. Ecology and plant life history will be studied in addition to geology and wetlands management.
Spring, 1-4 credits, ABCF grading
May be repeated for credit

MAR 576 Special Topics: Biological Oceanography
The course is designed for the discussion of topics of special interest on demand that are not covered in regularly scheduled courses. Examples of possible topics include grazing in benthic environment, coastal upwelling, the nature of marine ecosystems, and marine pollution processes.
Prerequisite: Permission of instructor
Fall, 1-4 credits, ABCF grading
May be repeated for credit

MAR 577 Special Topics: Coastal Zone Management
The course is designed for the discussion of topics of special interest on demand that are not covered in regularly scheduled courses. Examples of possible topics include microcomputer information systems, environmental law, coastal pollution, dredge spoil disposal, science and technology in public institutions, and coastal marine policy.
Prerequisite: Permission of instructor
Fall and Spring, 1-4 credits, ABCF grading
May be repeated for credit

MAR 580 Seminar
A weekly series of research seminars presented by visiting scientists and members of the staff.
Fall and spring, 0 credit, S/U grading
May be repeated

MAR 581 Coastal Engineering Geology
Concepts of the mechanics of earth materials and the physics of surficial processes with applications to the coastal environment and engineering.
Prerequisites: Enrollment in MESP or OCN
Program or permission of the instructor
3 credits, ABCF grading

MAR 582 Advanced Atmospheric Dynamics
Application of the concepts of balanced flow and potential vorticity thinking—conservation and inversion—to study wave propagation, baroclinic instability, evolution of cyclones an baroclinic waves, and wave-mean flow interactions.
Prerequisite: MAR 594
Spring, 3 credits, ABCF grading

MAR 584 Applied Marine Ecology Seminar
This course provides an opportunity for advanced graduate students to practice presenting data on their thesis research in areas broadly related to how individuals and communities of marine organisms respond to changes in their environments. Each student will prepare an abstract of the work they plan to present and assign an appropriate review or research paper for the class to read. They will then prepare a formal presentation of their work suitable for a Departmental seminar. Faculy and students will provide constructive criticism of the presentation as well as participate in a discussion of the work.
Fall, every year, 1 credit, S/U grading
May be repeated for credit

MAR 585 Coastal Geology Seminar
An assessment of recent developments in coastal geology. Discussion of advances in the application of sedimentology, stratigraphy, and geomorphology to the study of coastal environments. Modern-ancient analogues are emphasized where appropriate.
Prerequisite: Stratigraphy and sedimentary marine geology
Fall, 2 credits, S/U grading
May be repeated for credit

MAR 586 Introduction to Ecological Modeling
This course will provide students with a familiarity with the major concepts, approaches, and underlying rationale for modeling in the ecological sciences. Topics will include reviews of theoretical and empirical models, the use of models in adaptive management, and how to confront models with data to evaluate alternative hypotheses. Roughly one-third of the course will be devoted to the use of models in management, focusing on the problems of fitting models to data and management pitfalls that follow. Course work will consist of readings, in-class exercises, and group assignments that involve the construction, analysis, and interpretation of ecological models.
Prerequisite: BEE 550, BEE 552; MAT 131 or equivalent; any statistics course
Spring, 3 credits, ABCF grading

MAR 587 Basics of Arc GIS
An introduction to the basic elements of GIS analysis with marine applications. The course includes "hands-on" exercises to familiarize students with Arc GIS capabilities and basics of a GIS toolbox. A project will be required with an emphasis on marine and coastal situations.
Spring, every year, 3 credits, ABCF grading

MAR 590 Research
Original investigation undertaken with the supervision of the advisor.
Prerequisite: Permission of instructor
Fall and spring, 1-12 credits, S/U grading
May be repeated for credit

MAR 591 Atmospheric Molecular Processes
Review of electromagnetic theory of scattering and spectroscopy in a manner appropriate for studies of planetary atmospheric phenomena involving gaseous molecules. A major portion is devoted to quantitative spectroscopic aspects of absorption of infrared radiation by planetary atmospheric gases. Spectral line shapes and band models.
Fall, alternate years, 3 credits,
ABCF grading

MAR 593 Atmospheric Physics
Advanced cloud physics. atmospheric convection, and other moist processes.
3 credits, ABCF grading

MAR 594 Atmospheric Dynamics
This course covers atmospheric waves, quasi-geostrophic theory, and atmospheric dynamic instability.
3 credits, ABCF grading

MAR 595 Graduate Seminar in Atmospheric Sciences
Discussion of special research topics centered on monographs, conference proceedings, or journal articles. Topics include climate change, atmospheric chemistry, radiation transfer, and planetary atmospheres. This course is intended primarily for students who have passed the written qualifying examination in atmospheric sciences, although other students may enroll with permission of the faculty seminar leader.
Fall and spring, 0-3 credits, ABCF grading
May be repeated for credit

MAR 596 Principles of Atmospheric Chemistry
The application of photochemistry and reaction kinetics to the atmospheres of the Earth and planets. The composition and structure of various regions of atmospheres, including the troposphere, stratosphere, and ionosphere. Incorporation of chemical rate processes and physical transport into models. Production of airglow and auroral emissions.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits,
ABCF grading

MAR 597 Climate Dynamics
Fundamentals of the observed climate system. Simple climactic models including energy balance models and radiative-convective models. Physical processes in the climate system and their quantitative simulations with emphasis on convection and clouds, radiation, soil temperature and moisture, snow and ice, etc. Introduction to numerical climate modeling.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits,
ABCF grading

MAR 598 Synoptic and Mesoscale Meteorology
Course examines the structure and evolution of synoptic and mesoscale systems using observations, modern dynamical analysis, and numerical weather prediction models. Diagnosis of synoptic systems includes applications of quasi-geostrophic theory to baroclinic waves; jet stream and frontal circulations. A survey of the concepts of mesoscale systems includes convective systems, gravity waves, and terrain-coastal circulations. The student will investigate such phenomena in the laboratory as well as individual projects.
Prerequisite: Permission of instructor
Spring, alternate years, 4 credits,
ABCF grading

MAR 600 Summer Research
Summer, 0 credit, S/U grading
May be repeated

MAR 650 Dissertation Research
Original investigation undertaken with the supervision of research committee.
Fall and spring, 1-9 credits, S/U grading
May be repeated for credit

MAR 655 Directed Study
Individual studies under the guidance of a faculty member. Subject matter varies according to the needs of the student.
Prerequisite: Permission of instructor
Fall, spring, and summer, 1-9 credits,
ABCF grading
May be repeated for credit

MAR 670 Practicum in Teaching
Fall and spring, 1-3 credits, S/U grading
May be repeated for credit

MAR 699 Dissertation Research On Campus
Research course exclusively for students who have been advanced to candidacy (G5). Major portion of research must take place on SB campus, at Cold Spring Harbor, or at the Brookhaven National Lab.
Fall, spring, and summer, 1-9 credits,
S/U grading
May be repeated for credit

MAR 700 Dissertation Research Off Campus —Domestic
Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place off-campus, but in the United States and/or U.S. provinces. Please note, Brookhaven National Labs and the Cold Spring Harbor Lab are considered on-campus. All international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor.
Fall, spring, summer, 1-9 credits,
S/U grading
May be repeated for credit

MAR 701 Dissertation Research Off Campus —International
Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place outside of the United States and/or U.S. provinces. Domestic students have the option of the health plan and may also enroll in MEDEX. International students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed. International students who are not in their home country are charged for the mandatory health insurance. If they are to be covered by another insurance plan they must file a waiver be second week of classes. The charge will only be removed if other plan is deemed comparable. All international students must receive clearance from an International Advisor.
Fall, spring, summer, 1-9 credits,
S/U grading
May be repeated for credit