**MAR**

**Marine Sciences**

**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.

*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**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 MAS program or permission of instructor*

*Spring, 3 credits, Letter graded (A, A-, B+, etc.)*

**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 MAS program or permission of instructor*

*Spring, 3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 504: Statistics and Experimental Design**
This course has been devised to provide basic background and hands on experience to assist graduate students in developing key skills in an essential aspect of the research enterprise, namely statistics analysis and experimental design.

*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 505: General Circulation of the Atmosphere**
This course provides an introduction to the general circulation of the atmosphere, covering aspects in observations, data analyses, and basic theories.

*Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)*

**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 MAS program or permission of instructor*

*Spring, 3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 507: Marine Conservation**
The fundamental concepts of conservation science, a synthetic field that incorporates principles of ecology, biogeography, population genetics, systemsatics, evolutionary biology, environmental sciences, sociology, anthropology, and philosophy toward the conservation of biological diversity will be presented within the context of the conservation of marine resources. Examples drawn from the marine environment emphasize how the application of conservation principles varies in different environments.

*Prerequisite: Enrollment in MCP or MAS program or permission of instructor*

*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 508: Found Mar Sci 1: Biogeochemical**
This course provides an integrated view of the chemistry, geology and biology of the oceans, using the carbon cycle as an overarching theme to help students tie more specific concepts, mechanisms, and facts into a unified whole. Several other themes will also be embedded throughout the course, including other elemental cycles, timescales on which various processes operate, differences in how major ocean ecosystems (biomes) function, and the biogeochemical evolution of Earth.

*Prerequisite enrollment in MAS program or permission of instructor*

*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 509: Found Mar Sci 2: Physics of Oceans, Atmos, Climate**
Introduction to principles of physics governing the patterns of ocean and atmospheric properties. Discussion of the theoretical basis for energy exchange between the two environments and how it governs the spatial and temporal scales of the fluid dynamics includes how these processes interact with climate.

*Prerequisite enrollment in MAS program or permission of instructor*

*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**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, Letter graded (A, A-, B+, etc.)*

**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, Letter graded (A, A-, B+, etc.)*

**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.

*3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 513: Atmospheric Aerosols-Clouds, Climate, and Chemistry**
Atmospheric aerosol particles have been recognized to contribute the largest uncertainties to the global radiative forcing estimates and affect air quality. This course introduces graduate students to the physical and chemical properties of aerosol particles and how those affect the particles' role in the atmosphere. Knowledge of how these particles interact with their surroundings is crucial to assess the impact of aerosols on air quality and climate. This course covers the fundamental mathematical, physical, and chemical descriptions of aerosol particles such as particle size distributions, thermodynamics of aerosols, aerosol hygroscopicity, physical and chemical particle transformation, carbonaceous aerosol, aerosol cloud interaction (cloud condensation and ice nuclei), aerosol optical properties, aerosol climate effects, and gas-to-particle (heterogeneous) reactive processes.

*3 credits, Letter graded (A, A-, B+, etc.)*

**MAR 514: Environmental Management**
This is an introduction to environmental management, and will focus on the interplay...
between science and public policy. Concepts include problem identification and definition, collection and analysis of relevant data to produce information, and the roles of public perception and action in ultimately determining outcomes when consensus is not reached. Specific fields to which these concepts will be applied will be solid waste management and coastal management. Current local problems will be used to illustrate the broader conceptual issues. Offered as MAR 514, EST 540 and CEY 501. Prerequisite: Permission of instructor

**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, Letter graded (A, A-, B+, etc.)**

**MAR 516: Ecosystem Science for Fisheries Management**

This course will provide an overview of the science and mathematical models that are typically used to inform Ecosystem-based Fisheries Management (EBFM). The course will review single-species models, multispecies models and full system models! Advantages and disadvantages of implementing these approaches into management and policy will be explored. No modeling experience is necessary. The course requires familiarity with quantitative methods, but emphasizes current literature and case studies where EBFM has been or is being implemented as main learning elements.

**Offered in Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**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

**Spring, 1 credit, Letter graded (A, A-, B+, etc.) 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.

**Spring, alternate years, 2 credits, Letter graded (A, A-, B+, etc.)**

**MAR 521: Long Island’s Groundwater**

This course will cover basic groundwater concepts in unconsolidated sediments, and examine contamination issues in light of Long Island's particular hydrogeology, land use, and waste management history. Mathematical principles will be discussed but not stressed; scientific and technical papers discussing particular concepts or problems, including important local examples, will be closely read.

**Prerequisite:** Permission of instructor. Offered as MAR 521 or HPH 673.

**Offered in Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**MAR 522: Envir Toxicology & 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, Letter graded (A, A-, B+, etc.)**

**MAR 523: Marine Mammal Biology and Conservation**

This course provides an introduction to the basic biology of marine mammals, focusing particularly on various adaptations (e.g., morphological, physiological, acoustic) to life in the marine environment, as well as the ecology and behavior of marine mammals, and the conservation and management of marine mammal populations.

**3 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**MAR 525: Environment & Public Health**

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.

**3 credits, Letter graded (A, A-, B+, etc.)**

**MAR 526: Mechanisms of Pollutant Responses in Aquatic Organisms**

This course examines the molecular and biochemical basis for contaminant responses in aquatic organisms. Course will be taught in seminar format utilizing the current scientific literature as a basis for discussion. Prerequisite: Permission of instructor.

**Fall, alternate years, 2 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**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.
MAR 529: Isotope Geochemistry
This course deals both with the use of radio and stable isotope applications to the earth sciences.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAR 531: Long Island Marine Habitats
Focusing on six representative marine environments around Long Island, this course emphasizes the natural history of local marine communities, as well as quantitative ecology, hypothesis testing, and scientific writing. Students visit the sites, measure environmental parameters, and identify the distribution and abundance of common plants and animals. Using qualitative and quantitative methods in the field and laboratory, the class determines major factors that control the community structure in each habitat. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Summer, 3 credits, Letter graded (A, A-, B+, etc.)

MAR 532: Marine Protected Areas - Belize
Marine Protected Areas (MPAs) are parts of the ocean that are zoned to exclude activities that is potentially detrimental to the ecosystem. Marine reserves is a special type of MPA, in which the harvesting of marine wildlife is prohibited. MPAs are rapidly gaining traction worldwide as a tool to preserve or restore ecosystems, protect endangered species or sustain nearby commercial and recreational fisheries. This course is designed to provide students with a robust background in the science behind the design, implementation and expected outcomes of establishing MPAs. This field course will explore these issues in the context of the Belizean experience where students will travel to Belize and see a number of different MPAs and learn about the challenges, benefits and limitations of MPAs for marine conservation directly from local scientists, managers and rangers.
Summer, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

MAR 533: Instrumental Analysis
Fundamental principles of instrumental chemical analysis and practical applications of molecular spectroscopy, atomic spectroscopy, mass spectrometry and chromatography. These instruments are widely used in environmental and oceanography 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 seawater 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
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

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). This course is cross-listed with CEY 503.
3 credits, Letter graded (A, A-, B+, etc.)

MAR 537: Tropical Marine Ecology
The goal of this class is to teach students about the ecology of the tropical coral reef environments through lectures, field trips, snorkeling trips, SCUBA diving trips and student designed research projects. The first half of the course will be devoted to formal lectures, demonstrations, and instructor-led field trips to provide students with a basic knowledge of the common organisms and the roles they play in various coral reef ecosystem. During the second half of the course, with help from faculty, students will develop and carry out individual research projects examining organismal ecology of coral reefs.
4 credits, Letter graded (A, A-, B+, etc.)

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: Enrollment in MAS program or permission of instructor
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated 2 times FOR credit.

MAR 539: Economics of Coastal and Marine Ecosystems
Considering the socioeconomic implications of policy decisions involving environmental and natural resources has become increasingly important for ecosystem management. This course will view human interactions with coastal and marine ecosystems through the lens of economics. Topics will include the basics of welfare analysis, the concept of ecosystem services, the challenges associated with public goods, methods for economic valuation of non-market goods and services, and strategies for sustainable use of coastal and marine resources. In addition to exploring the fundamental principles of environmental economics, the course will also evaluate their real-world application through national and international policy examples.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAR 541: Foundations of Atmospheric Sciences I
This course is intended to introduce graduate majors to the foundations in the atmospheric sciences necessary for future, more specialized
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, 3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAR 545: Paleoceanography 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 Cenozoic 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, 3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAR 549: Current Topics in Atmospheric Sciences
This course will discuss current research topics in atmospheric sciences and their connections with advance course materials.

Semesters Offered:
Fall and Spring, 0-2 credits, S/U grading
May be repeated 1 times 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, Letter graded (A, A-, B+, etc.)

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.

Prerequisite: Permission of instructor
Fall and Spring, 1-4 credits, Letter graded (A, A-, B+, etc.)

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
Summer, 1-12 credits, Letter graded (A, A-, B+ +, etc.)

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, Letter graded (A, A-, B+, etc.)

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.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MAR 557: Case Study and Project Planning Seminar
This seminar will introduce students to case studies in marine conservation carried out regionally, nationally, and internationally through seminars given by professionals in the field. In addition students will be given direction on how to develop a plan for a case study as well as instruction on how to obtain, analyze, and present data. Students will be required to submit a written project plan for either their Capstone Project or Internship prior to the end of the semester.

Fall, 1 credit, S/U 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, 3 credits, Letter graded (A, A-, B+, etc.)**

**MAR 559: Risk Analysis, Error and Uncertainty**

This seminar style course will explore error estimation, uncertainty propagation, risk analysis, model validation, and decision analysis.

**Fall, alternate years, 2 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**MAR 561: Quantitative Fisheries Ecology**

The course covers quantitative models that are currently utilized to assess the status of fish stocks and academic pursuits of understanding single-species and ecosystem dynamics. The course builds on basic ecological models such as the density-independent exponential and density-dependent logistic models and introduces equilibrium and non-equilibrium production models and statistical-catch-at-age techniques. Recruitment and growth models commonly used in fisheries ecology are also covered. Least-squares, non-linear and likelihood methods are methods are utilized in model parameter estimation. Statistical techniques such as bootstrapping and Monte Carlo methods are used to assess uncertainty in models outputs. This course is useful for students that plan academic or management careers in fisheries and wildlife research.

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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 diagenesis 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, Letter graded (A, A-, B+, etc.)**

**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:** Permission of instructor

**Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)**

**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 hyspsometric 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:** 1 year of calculus.

**Spring, 3 credits, Letter graded (A, A-, B+, etc.)**

**MAR 566: Air Pollution and Its Control**

This course provides an overall picture of air pollution caused by gas phase species and airborne particulate matter. The sources of air pollution and their effect on air quality on an urban, regional, and global scale will be addressed. The causes of London type smog and modern photochemical smog are discussed. The health impacts of primary and secondary air pollutants are assessed. The causes and consequences of the stratospheric ozone hole and subsequent policy regulations are discussed. The natural greenhouse effect and our current understanding of global warming are addressed.

**Spring, 3 credits, Letter graded (A, A-, B+, etc.)**

**MAR 567: Chemical Sensors in Oceanography**

An introduction to chemical sensors and their application in oceanography with emphasis on in-situ sensing in coastal environments, discussions of the sensor principles and fabrication, and biogeochemical processes revealed by in-situ measurements.

**Spring, alternate years, 2 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**MAR 569: Statistics With R**

Essentials of conducting statistical analyses using software developed by the R Project for Statistical Computing. R is free software that has been developed by contributors around the world and is quickly becoming a standard environment for conducting scientific data analyses. The course will cover the basic language, data management, graphics, and the application of R to a variety of statistical techniques such as ANOVA, regression, MDS and PCA, GLMs and GAMs. The class is intended to explore the capabilities of R and a basic graduate understanding of statistics is required.

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**May be repeated 1 times FOR credit.**

**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, Letter graded (A, A-, B+, etc.)**

**May be repeated 2 times 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, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)

MAR 573: Special Topics-Chemical Oceanography
This course is designed for the discussion of topics of special interest on demand that is not covered in regularly scheduled courses. Examples of possible topics include carbonate chemistry, isotope chemistry, and microbial chemistry.

1-4 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAR 574: Special Topics: Ocean Dynamics
Introductory dynamical oceanography, framework and applications.

1-4 credits, Letter graded (A, A-, B+, etc.)
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.

1-4 credits, Letter graded (A, A-, B+, etc.)
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 is 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, Letter graded (A, A-, B+, etc.)
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 is 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, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAR 578: Bio & Conservation/Seabirds
This course provides an overview of the biology and conservation of seabirds, covering basic and applied aspects of seabird biology. We examine specific biological adaptations (e.g., morphological and physiological adaptations for diving and flying) in the first third of the course, and review population-level processes and behavioral patterns (e.g., population ecology and migration) in the second part of the course. The last third of the course applies this knowledge of seabird biology and ecology to current conservation issues and management efforts, both within the United States and internationally.

3 credits, Letter graded (A, A-, B+, etc.)

MAR 579: Bio & Conservation/Sea Turtles
This course provides an overview of the biology and conservation of sea turtles, and highlights different "solutions" to challenges these organisms face while living in the marine environment. We begin by discussing biological adaptations and ecological processes, and will then examine these concepts in relation to conservation and management issues facing different sea turtle species. This course will be primarily lecture-based, although we will take advantage of additional learning opportunities, such as necropsies conducted with the Riverhead Foundation.

3 credits, Letter graded (A, A-, B+, etc.)

MAR 580: Seminar
A weekly series of research seminars presented by visiting scientists and members of the staff.

Fall and Spring, S/U grading
May be repeated for credit.

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 and baroclinic waves, and wave-mean flow interactions.

Prerequisite: MAR 594
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MAR 584: Applied Marine Ecology Seminar
This course provides an opportunity for advanced graduate students to practice presenting data on their 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. Faculty and students will provide constructive criticism of the presentation as well as participate in a discussion of the work..

Fall, 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 of 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 1/3 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, Letter graded (A, A-, B+, etc.)

MAR 587: GIS: Display and Analysis of Environmental Data
Elements of Geographic Information Systems (GIS) with an emphasis on environmental applications, especially those related to marine and coastal systems. The course includes hands-on exercises to familiarize students with GIS capabilities. A project will be required.
MAR 588: Molecular Marine Ecology
DNA analysis offers a new window into the ecology of marine organisms, shedding light on aspects of their biology that are traditionally difficult to study, such as their evolutionary history, population structure, population demographic history and reproductive patterns. In this way, DNA analysis can help us better manage fisheries and conserve endangered marine species. This course is designed to expose graduate students to the burgeoning field of molecular ecology and the application of molecular analyses to fisheries management and conservation. Lectures will be supplemented by a group laboratory project, where students will apply techniques such as DNA extraction, polymerase chain reaction, DNA sequencing and computer based analysis of genetic data to address a contemporary marine conservation or fisheries issue.
3 credits, Letter graded (A, A-, B+, etc.)

MAR 589: Capstone Project in Marine Conservation and Policy
Students will conduct an in depth capstone study involving independent analysis of available data and produce an original synthesis paper based on a committee-approved, consequential topic in marine conservation. All students will also present their project at the annual Program Symposium.
Prerequisite: Permission of Instructor
Summer, 1-6 credits, S/U grading
May be repeated for credit.

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 592: Internship in Marine Conservation and Policy
Students will obtain practical work experience through an internship with local, state or federal agencies or not for profit organizations working in the area of marine conservation and policy. To complete the internship, students will prepare a written report on their activities and present their internship project at the annual Program Symposium.
Spring, Summer, 1-6 credits, S/U grading
May be repeated for credit.

MAR 593: Atmospheric Physics
Advanced cloud physics, atmospheric convection, and other moist processes.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MAR 594: Atmospheric Dynamics
This course covers atmospheric waves, quasi-geostrophic theory, and atmospheric dynamic instability.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)
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, Letter graded (A, A-, B+, etc.)

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.
Spring, alternate years, 4 credits, Letter graded (A, A-, B+, etc.)

MAR 599: Atmospheric Boundary Layer Processes
This course provides the theoretical foundation for a quantitative understanding of transport processes and chemical transformations in the atmospheric boundary layer. Topics covered in this course include the equations of motions for the lower troposphere; the budget of turbulent kinetic energy; turbulent fluxes of momentum, heat and mass; treatment of chemical transformations; and the representation of these processes in numerical models.
3 credits, Letter graded (A, A-, B+, etc.)

MAR 601: Dynamic model with Matlab
This course is designed to provide basic programming skills with the use of selected Matlab toolboxes to analyze marine and atmospheric science data, to perform challenging simulations, and to explore selected problems in marine and atmospheric and related fields. The course will emphasize functionalities and applications of the matrix manipulations, signal processing, statistical, and mapping toolboxes within the context of marine science problems. The goal is to give the students exposure to tools and programming techniques to enable them to work individually or in a group on a final project relevant to their research interest. Topics will include efficient Matlab programming techniques, simple numerical modeling and learning to build a classifier for recognition and measurement, separating and clustering data, graph and representation and spectral clustering.
2 credits, Letter graded (A, A-, B+, etc.)

MAR 602: Marine Invasive Alien Species in Tropical and Temperate Climates
The course is designed to instruct students in the biology and ecology of marine invasive species using real examples from the Caribbean and the temperate areas of the US Atlantic coast. Additionally, it will include management strategies to control current invasive species, as well as strategies to prevent future invasions. Topics in this course will span policy and legislative requirements, marine conservation and planning, scientific research, biological and ecological characteristics, survey and monitoring methods, public outreach and education strategies. These topics will enable the students to provide sound technical and scientific guidance to the management and prevention of marine invasive species in the Wider Caribbean and the Atlantic Regions.
0-3 credits, Letter graded (A, A-, B+, etc.)

MAR 603: Ocean Physics Seminar
This course explores topics in ocean physics as chosen by the instructors and participants. The seminar series is organized around themes such as estuarine physics, or coastal dynamics, ocean and climate, ocean circulation, etc. Students are required to lead at least one of the seminars and to participate in discussions. Prerequisite: MAR 509 or permission of instructor Fall and spring, 1 credit, ABCF grading, May be repeated for credit

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, 1-9 credits, Letter graded (A, A-, B+, etc.) 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 SBU campus, at Cold Spring Harbor, or at the Brookhaven National Lab. Fall and Spring, 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. Students in their home country are not covered by mandatory health insurance. If they are to be covered by another insurance plan they must file a waiver by 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, 1-9 credits, S/U grading May be repeated for credit.

MAR 800: Summer Research
Summer Research. 0 credits, S/U grading. May be repeated. S/U grading May be repeated 1 times FOR credit.