The Department of Earth Sciences offers programs of study leading to the following degrees:

- B.S. in geology (B.S. GEOL) with an option in environmental geology;
- B.S. in meteorology (B.S. MET);
- B.S. in ocean sciences and coastal studies (B.S. OSCS) with an option in physical oceanography;
- B.A. in the earth sciences (B.A. ESCI);
- and B.S. in Education (B.S.Ed.) in earth sciences with a secondary education teaching certification in earth and space sciences.

The B.S. GEOL, B.S. MET, and B.S. OSCS are designed to prepare students for the professional workforce or advance to graduate education with qualifications and skills that will ensure success. The meteorology curriculum conforms to the American Meteorological Society's (AMS) guidelines for a B.S. in atmospheric science/meteorology, and the GS-1340 civil service requirements for government employment (e.g., National Weather Service, NOAA). The geology curriculum prepares every student for their Professional Geologist License. The ocean sciences and coastal studies program has ocean/bay access at the Chincoteague Bay Field Station (CBFS) at the Wallops Island Marine Science Consortium, where students have opportunities for hands-on, feet-wet experiences, including research vessels. Academic minors in areas where the workforce is strong or emerging, such as data science including AI and machine learning, emergency management, mathematics, broadcast communication, government and political affairs, and heliophysics and space weather, are encouraged but not required.

Millersville University is a senior partner of the CBFS, institutional member of the University Corporation for Atmospheric Research (UCAR), American Meteorological Society (AMS), American Geophysical Union (AGU), American Geosciences Institute (AGI), and the National Weather Association (NWA), an educational partner of the Weather Risk Management Association (WRMA), and a member of the International Association of Emergency Managers (IAEM). The University is a participant in the National Weather Service (NWS) StormReady® program and the Mid-Atlantic Regional Association Coastal Observing System, and the AMS Student Chapter is a member of the Weather-Ready Nation (WRN). For more information, see www.millersville.edu/esci/

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**the programs**

- Earth Sciences Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/earth-sciences/earth-sciences-minor/)
- Geology Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/earth-sciences/geology-minor/)
- Hydrology Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/earth-sciences/hydrology-minor/)
- Meteorology Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/earth-sciences/meteorology-minor/)
- Meteorology, B.S. (https://catalog.millersville.edu/undergraduate/college-science-technology/earth-sciences/meteorology-bs/)
- Oceanography Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/earth-sciences/oceanography-minor/)

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**the faculty**

**Blumberg William,** Assistant Professor
College of Science and Technology
B.S., University of Oklahoma, 2011; M.S., Ibid., 2013; Ph.D., Ibid., 2018

**DeCaria Alex,** Professor
College of Science and Technology
B.S., University of Utah, 1985; M.S., Naval Postgraduate School-Monterey, 1992; Ph.D., University of Maryland, 2000

**Earman Samuel,** Associate Professor
College of Science and Technology
B.A., Macalester College, 1989; M.S., University of Nevada, 1996; Ph.D., New Mexico Institute of Mining and Technology, 2004

**Hagelgans Duane,** Professor
College of Science and Technology
B.S., Millersville University, 1998; Ph.D., Widener University School of Law, 2003

**Kumar Ajoy,** Professor
College of Science and Technology
B.S., University of Madras (India), 1985; M.S., Ibid., 1987; Ph.D., Old Dominion University, 1996

**Marquez Lynn,** Professor
College of Science and Technology
B.A., DePauw University, 1991; M.S., Northwestern University, 1994, Ph.D., Ibid., 1998

**Sikora Todd,** Professor
College of Science and Technology
B.S., The Pennsylvania State University; M.S., Ibid., 1992; Ph.D., Ibid., 1996

**Vaillancourt Robert,** Associate Professor
College of Science and Technology
Ph.D., University of Rhode Island, 1999

**Walsh Talor,** Associate Professor
College of Science and Technology
B.A., Oberlin College, 2007; M.S., University of Rochester, 2012; Ph.D., Ibid., 2015

**Yalda Sepideh,** Professor
College of Science and Technology
B.S., Saint Louis University, 1991; M.S., Ibid., 1993; Ph.D., Ibid., 1997
the courses

ENVI 330: 3 s.h.
Environmental Statistics & Risk Assessment
Methods of statistical analysis and risk assessment applied to environmental science, including characteristics of environmental quality data; statistical measures and distributions; identifying system changes; hypothesis testing of environmental quality; risk, hazards and exposures; bioassays. Team-taught. Offered periodically.

ENVI 495: 3 s.h.
Environmental Clinic
A capstone course devoted to the definition and assessment of an environmental problem from watershed, airshed, biodiversity and human health perspectives. Case studies will be used as models of how environmental problems can be defined/documentured and solutions can be implemented. Student teams will define a problem and implement a solution using interdisciplinary approaches while working with a faculty team. Students are encouraged to take this course at the conclusion of the minor. Offered periodically. Prereq: 12 credits of environmental science minor.

ESCI 101: 3 s.h.
Earth Systems & Natural Hazards (G2)
The scientific understanding of Earth systems as the causes of natural disasters, such as earthquakes, volcanoes, landslides, hurricanes, tornadoes, floods and tsunamis. 3 hrs. lec. Does not count toward any ESCI major. Offered fall, spring and periodically in summer.

ESCI 102: 3 s.h.
Origin and Evoltn of the Earth (G2)
The origin and evolutionary development of the universe, solar system and planet Earth. Geophysical behavior of the solid earth, including volcanism, mountain building and other manifestations of the Earth's dynamic interior. 3 hrs. lec. Does not count toward any ESCI major. Offered in fall, spring and periodically in summer.

ESCI 103: 3 s.h.
The Science of Evolution (G2)
Evolutionary theory through an integrated perspective of both biology and geology. 3 hrs. lec. No credit for biology and earth sciences majors. Prereq: 15 credit hours recommended.

ESCI 104: 3 s.h.
The World Ocean (G2)
A broad overview of the biological, chemical, geological and physical characteristics of the ocean, the importance of the oceans to mankind and the environment. Does not count toward any ESCI major. 3 hrs. lec. Offered in fall, spring and periodically in summer.

ESCI 104H: 3 s.h.
Hnrs:The World Ocean (G2)

ESCI 105: 1 s.h.
World Ocean Laboratory (G2)
Methods and techniques used in the marine sciences, including introduction to navigation, plotting and evaluation of data pertaining to salinity, temperature, dissolved oxygen, primary productivity and current velocity. 2 hrs. lab. Optional field trip. Mandatory coreq: ESCI 104. ESCI 104/105 together constitute a single laboratory course in earth sciences for purposes of the general education curriculum. Does not count toward any earth sciences major. Offered in fall, spring and periodically in summer.

ESCI 107: 3 s.h.
The Atmosphere (G2)
Origin and evolution of the atmosphere; solar and terrestrial radiation; horizontal and vertical structure of the atmosphere; temperature, pressure and water in the air; vertical motion; cloud formation and cloud type; circulation systems, severe weather, climate and climate change. 3 hrs. lec. Does not count toward any earth sciences major. Offered in fall, spring and online in summer and winter. Credit may not be received for ESCI 107 if ESCI 109 is taken, these are equivalent courses and will be treated as repeated course credit.

ESCI 107H: 3 s.h.
Hon: The Atmosphere (G2)

ESCI 109: 4 s.h.
Atmosphere with Lab (G2)
Origin and evolution of the atmosphere; solar and terrestrial radiation; horizontal and vertical structure of the atmosphere; temperature, pressure and water in the air; vertical motion; cloud formation and cloud type; circulation systems, severe weather, climate and climate change. 3 hrs. lec., 2 hrs. lab. Does not count toward any earth sciences major. Offered in fall, spring and online in summer and winter. Credit may not be received for ESCI 109 if ESCI 107 is taken, these are equivalent courses and will be treated as repeated course credit.

ESCI 120: 3 s.h.
Environmental Geology (G2)
Exploration of Earth systems and their relation to society, with focus on natural hazards and natural resources. Does not count toward any ESCI major. 3 hrs. lec. Offered in fall, spring and periodically in summer.

ESCI 121: 1 s.h.
Environmental Geology Lab (G2)
Laboratory exploration of Earth system impacts on society, human influences on Earth. Mandatory coreq: ESCI 120. ESCI 120/121 taken concurrently constitute a single laboratory course in earth science for purpose of the general education curriculum. Does not count toward an ESCI major. 2 hrs. lab. Offered in fall, spring and periodically in summer.

ESCI 121H: 1 s.h.
Hon: Environ Geology Lab (G2)

ESCI 179: 3 s.h.
Experimental
Experimental

ESCI 202: 3 s.h.
The Earth in Space (G2)
A scientific experience directed toward an understanding of the dynamic earth, its origin and evolution and its place in the universe. Physical concepts from classical and modern physics, astronomy, cosmology, and the earth and atmospheric sciences, couched in the language of algebra and supported by observation, experiment and theory. 3 hrs. DL delivery format. Prereq: MATH 101 with C- or higher or MPT 151 with C- or higher, or MATH 151 or MATH 161 or MATH 163 or MATH 204 (151, 161, 163, 204, grade of C- or higher) or permission of instructor.

ESCI 221: 4 s.h.
Physical Geology (G2)
The nature and distribution of materials of the solid Earth - the dynamic processes by which they are formed and modified and the character of resulting geologic structures. 3 hrs. lec., 2 hrs. lab. Offered in fall, spring.

ESCI 221H: 4 s.h.
Hnrs:Physical Geology (G2)
ESCI 222: 4 s.h.
Historical Geology (G2, W)
Methods of interpreting the geologic rock record, chronologic study of earth history and study of fossils as records of ancient life. Emphasis on the history of North America. 3 hrs. lec., 2 hrs. lab, field trips required. Offered in spring. Prereq: C- or higher in ESCI 221.

ESCI 222H: 4 s.h.
H:Historical Geology (G2)

ESCI 225: 3 s.h.
Geomorphology
Processes of landscape development in theory and in the context of the regional geomorphology of North America. 3 hrs. lec. Offered in fall of odd years. Prereq: C- or higher in ESCI 221.

ESCI 226: 3 s.h.
Geological Earth and Energy Resources (G2)
Investigation of the geologic origin of Earth resources important to society (including energy resources, metals, industrial materials and evaporites); methods of resource evaluation, extraction and processing; and environmental impacts of resource extraction/use. 3 hrs. lec. Offered spring of even years.

ESCI 241: 4 s.h.
Meteorology (G2)
Atmospheric structure and motions; physics of weather processes; weather and motion systems. 3 hrs. lec., 2 hrs. lab. Offered in fall and in spring as needed. Coreq or Prereq: C- or higher in MATH 161 or 163

ESCI 245: 3 s.h.
Environmental Meteorology (G2)
Practical meteorological problems in air pollution, atmospheric experimentation and other aspects of the human environment. Instrumentation and data analysis methods in applied meteorology. 2 hrs. lec., 2 hrs. lab. Offered in spring and online in summer. Prereq: C- or higher in MATH 110 or 160 or 161 or 163H

ESCI 261: 4 s.h.
Introduction to Oceanography (G2)
A survey of the field of oceanography including modern topics in the four subdisciplines of physical, geological, chemical, and biological oceanography. 3 hrs. lec., 2 hrs. lab. Overnight field trip may be required at discretion of professor. Prereq: C- or higher in MATH 101 (college algebra) or math placement into MATH 160 or higher.

ESCI 267: 3 s.h.
Field Methods in Oceanography
Work on board small research vessels in the dynamic marine environment; use and application of standard oceanographic instruments and sampling devices; opportunities for independent research. 1 hr. lec., 4 hrs. lab. Offered only in summer at the Marine Science Consortium field station. Prereq: C- or higher in ESCI 261.

ESCI 279: 3 s.h.
Experimental
Experimental

ESCI 281: 3 s.h.
GIS Applications for Earth Sci
Introduction to the basic concepts of geospatial information systems applications for earth sciences students. Emphasis is on the use of GIS applications for solving problems in the earth sciences. Limited to earth sciences majors or minors who have completed one of the introductory earth sciences courses for majors. ESCI 281 and GEOG 295 may not both be taken for credit. 3 hrs. lec. Offered in fall of even years. Prereq: ESCI 221, 241 or 261.

ESCI 282: 3 s.h.
FORTAN Programming for Earth Sciences Applications
Programming in computational methods emphasizing FORTRAN applied to the earth sciences; numerical solution of equations of motion; statistical properties of digital images; analysis of periodical phenomena; use of National Center for Atmospheric Research graphics library. 2 hrs. lec., 2 hrs. lab. Offered in fall. Prereq: MATH 211 and PHYS 231.

ESCI 300: 3-12 s.h.
Co-Op Ed Experience in ESCI
Co-Op Ed Experience in ESCI

ESCI 321: 4 s.h.
Structural Geology
Recognition, interpretation and illustration of geological structures; kinematic and dynamic analysis of rock deformation; stress, strain and deformation mechanisms. 2 hrs. lec., 3 hrs. lab., field trips required. Offered in fall of even years. Prereq: C- or higher in ESCI 221 and completion of MATH 160.

ESCI 322: 3 s.h.
Environmental Hydrology
Theory and practice of quantifying hydrologic phenomena; field methods, data manipulation and environmental applications. 2 hrs. lec., 2 hrs. lab. Offered spring. Prereq: minimum of 45 credits, C- or higher in MATH 101 and any 200-level science course that counts towards a science degree, or permission of instructor.

ESCI 326: 4 s.h.
Sedimentation and Stratigraphy (W)
The origin and composition of sediments and sedimentary rocks, study of the processes involved in the sedimentary cycle, environments of deposition, and the interpretation of ancient environments from sedimentary rocks. 3 hrs. lec., 2 hrs. lab, field trips required. Offered in spring of odd years. Prereq: ESCI 221 and ENGL 110

ESCI 327: 4 s.h.
Earth Materials
Identification, crystal chemistry, crystallography and occurrence of common minerals; optical theory and interaction of light with crystals; mineral and rock identification through use of transmitted polarized light; identification, formation, and occurrence of common rocks. 3 hrs. lec., 3 hrs. lab. Offered fall of odd years. Prereq: C- or higher in 221.

ESCI 328: 4 s.h.
Petrogr/Igns and Mtmrh Petrol (W)
Optical characteristics and identification of igneous and metamorphic rocks; petrogenesis of igneous and metamorphic rocks; introductory thermodynamics and phase equilibria as applied to igneous and metamorphic systems. 3 hrs. lec., 2 hrs. lab. Offered in spring of even years. Prereq: C- or higher in ESCI 327 (formerly 227); ENGL 110

ESCI 329: 3 s.h.
Aqueous Geochemistry (W)
Inorganic chemistry of surface waters; equilibrium thermodynamics, solubility and stability relationships of silicates and calcium carbonates; kinetics, acid-base reactions, redox equilibria; contaminants transport in natural waters; surficial materials weathering. 3 hrs. lec. Offered spring of odd years. Prereq: ESCI 221, CHEM 112; ENGL 110.
ESCI 340: 3 s.h.  
**Cloud Physics & Precip Process**  
Cloud types and physical characteristics; cloud formation processes; precipitation types and formation processes; vertical stability and its relation to types of cloud and precipitation formation; lightning and other forms of atmospheric electricity; atmospheric optical phenomena such as rainbows, halos, mirages, etc. 3 hrs lec. Offered spring. Prereq: C- or higher in ESCI 241, or PHYS 231. Coreq or Prereq: MATH 211.

ESCI 340H: 3 s.h.  
H:Physical Meteorology

ESCI 341: 3 s.h.  
**Atmospheric Thermodynamics**  
First and second principles of thermodynamics, water-air systems, equilibrium of small droplets and crystals, thermodynamic processes in the atmosphere, atmospheric statics, vertical stability and aerological diagrams. 3 hrs lec. Offered in fall. Prereq: C- or higher in ESCI 241. Coreq or Prereq: MATH 311.

ESCI 342: 3 s.h.  
**Atmospheric Dynamics 1**  
Centered difference approximations, total derivative, and basic kinematics; fundamental and apparent forces; mass and momentum conservation; equations of motion and their applications; circulation, vorticity, and divergence. Offered fall. Prereq: C- or higher in ESCI 241 and PHYS 231. Coreq or Prereq: MATH 311.

ESCI 343: 3 s.h.  
**Atmospheric Dynamics 2**  
Ageostrophic wind; quasi‐geostrophic theory; theory and properties of atmospheric waves, including gravity waves, sound waves, internal waves, inertial‐gravity waves; geostrophic adjustment; atmospheric instabilities, including inertial/slatwise instability, barotropic and baroclinic instability. 3 hrs lec. Offered in spring. Prereq: ESCI 342.

ESCI 344: 3 s.h.  
**Tropical Meteorology**  
General circulation of the tropics; energy balance; boundary layer; cumulus convection; survey of tropical disturbances including tropical cyclones. 3 hrs lec. Offered in fall of odd years. Prereq: C- or higher in ESCI 341, 342.

ESCI 344H: 3 s.h.  
H:Tropical Meteorology  
H:Tropical Meteorology

ESCI 345: 3 s.h.  
**Atmospheric Radiative Transfer**  
Quantitative description and analysis of atmospheric radiation and its interaction with atmospheric constituents (gases, aerosol, and clouds) and the land and ocean surfaces. Topics include properties of radiation, the electromagnetic spectrum, reflection and refraction, radiative properties of natural surfaces, thermal emission, atmospheric transmission, atmospheric emission (the Schwarzschild Equation) and absorption, scattering and absorption by molecules and particles, radiative transfer with multiple scattering, numerical modeling of atmospheric radiation, relevance for climate and weather. Prereq: C- or higher in ESCI 241, or PHYS 231. Coreq or Prereq: MATH 311.

ESCI 347: 3 s.h.  
**Satellite Meteorology**  
Orbital and radiative transfer physics applied to satellite meteorology systems. Contemporary applications of satellite remote sensing of the atmosphere, including the retrieval of cloud microphysics and precipitation, the generation of atmospheric vertical profiles of temperature and moisture, the retrieval of wind, and image interpretation in the context of weather forecasting. 3 hrs. Offered in fall of even years. Prereq: ESCI 241; MATH 161 or MATH 163.

ESCI 347H: 3 s.h.  
H:Satellite Meteorology

ESCI 348: 2 s.h.  
**Broadcast Meteorology**  
Preparation and presentation of weather information to the public; graphics preparation, television and radio weathercasting; video production. 1 hr lec. 2 hrs studio. Offered in spring. Prereq: C- or higher in ESCI 241 or COMM 320.

ESCI 349: 3 s.h.  
**Chemistry of the Atmosphere (P)**  
Theory, application, methods of analysis and instrumentation relevant to a study of the chemistry of the atmosphere. 3 hrs. of integrated lecture/lab/working group activities. May be used as an elective in meteorology and environmental chemistry if not counted as "P" course. Offered in spring of odd years. Prereq: Minimum of 36 credit hours, COMM 100, ENGL 110; junior status; CHEM 104 or CHEM 111; and PHYS 132 or PHYS 232.

ESCI 349H: 3 s.h.  
H:Chem of the Atmosphere (P)

ESCI 350: 3 s.h.  
**History of Meteorology (D, P)**  
Overall intellectual and institutional development of meteorology from Aristotle to present, with emphasis on the 20th century. Historical overviews of dynamic meteorology and numerical weather prediction, observational tools (the history of radar and satellites) and computational devices, cloud microphysics and dynamics, hurricanes, convective storms and climatology. Spotlights key scientists and their role in the advancement of atmospheric sciences. 3 hrs. lec. Prereq: ESCI 107, 109, or ESCI 241; and HIST 101 or 102 or 106, or 340; COMM 100, ENGL 110 and junior status.

ESCI 350H: 3 s.h.  
H:History of Meteorology (P)

ESCI 362: 3 s.h.  
**Marine Geology**  
Sedimentary and tectonic characteristics of the continental margins and deep ocean basins; principles and processes of sediment transport and deposition in the marine environment; applications of geophysical methods at sea; marine mineral resources. 3 hrs lec. Offered only in summers of even years at the Marine Science Consortium field station. Prereq: C- or higher in ESCI 261 or 221.
ESCI 363: 3 s.h.
Chemical Oceanography
Oceanic chemical phenomena, including structure of water, salinity, sources and sinks of chemical constituents; chemical interactions at interfaces between hydrosphere and atmosphere, lithosphere and biosphere; geochemical processes at spreading centers; biogeochemical cycles of nutrients; applications of geochronology and tracers; the carbon-dioxide-carbonate system; origin and history of seawater; anthropogenic effects. 3 hrs. lec. Offered in spring of odd years. Prereq: C- or higher in ESCI 261 and CHEM 112.

ESCI 366: 3 s.h.
Marine Resources and Policy (D, P)
This course will give the student a broad background in Marine Resources including biological, transportation, oil and gas, methane hydrates, minerals and freshwater, recreation, endangered species, energy and waste disposal. The course will also give an overview on National and International Law Applied to the marine environment. Topics on Marine policies including marine environmental policy, International fisheries policy, Marine transportation and safety policy, etc. will be discussed and related to geographical, socio-economic and political issues affecting Marine Resources, Sustainability and Marine Conservation. News clips, articles in journals, case studies of issues relevant to the topics above will be discussed in an open, free and debate like atmosphere that is designed to develop student's critical thinking skills in a deliberate and structured way. Offered in spring of even years. Prereq: COMM 100 or 100H, ENGL 110 or 110H, junior standing and any 200-level course in ESCI, BIOL or GEOG.

ESCI 366H: 3 s.h.
Hon: Marine Resources/Policy (D, P)

ESCI 369: 3 s.h.
Physical Oceanography and Climate
Physical properties of seawater; mass and energy budgets of the ocean; typical distribution of water characteristics, global balances; the conservation equations; equations of motion; fluid motion in rotating systems. Conservation of vorticity; wind and thermohaline circulation; currents and eddies; wind-generated waves; tides and other waves; Exchange of buoyancy and heat fluxes in the atmosphere-ocean boundary layer; Climate Change and the Ocean. A required course for Ocean Sciences and Coastal Studies majors and elective for other earth sciences programs. Combination of lecture and laboratory exercises. 2 hrs. lec., 2 hrs. lab. Offered in fall of odd years. Prereq: ESCI 261 or ESCI 241; MATH 161, PHYS 131 or PHYS 231, or permission of Instructor. 3.000 Credit hours 2.000 Lecture hours 2.000 Lab hours.

ESCI 379: 1-4 s.h.
Experimental
Experimental

ESCI 380: 3 s.h.
Remote Sensing & Image Interpretation
Principles of remote sensing; fundamentals of image visualization; radiative transfer equation; use of environmental, meteorological and oceanographic satellites; satellite algorithm and parameter estimation; use of Environment for Visualizing Images (ENVI) software for image analysis and interpretation. Basic computer literacy is assumed. 2 hrs. lec., 2 hrs. lab. Research project is required. Prereq: ESCI 221 or 241 or 261.

ESCI 382: 3 s.h.
Water Wars: Science and Policy (D, P)
Interdisciplinary investigation of the causes and solutions of water crises. Topics such as the sources of fresh water, the use and consumption of water, and regional and international conflict over water rights will be discussed. Current water crises from across the globe will be used to highlight societal differences in water use and preservation. Offered in the fall of even years and periodically in winter and summer sessions. Prereq: Minimum of 60 credits, ENGL 110 and any ESCI course or permission of instructor.

ESCI 385: 3 s.h.
Global Climate Change: Sci & Policy (P)
Evolution of the Earth's habitable atmosphere and oceans; mechanisms that control climate processes and change; past global climate change as deciphered through paleoclimatic and paleoceanographic methods; recent rapid climate fluctuations and possible future changes. 3 hrs. lec. Offered fall of odd years. Prereq: ENGL 110; ESCI 241 or 261 or GEOG 230.

ESCI 385H: 3 s.h.
H: Climate Chng: Sci & Polcy (P)

ESCI 386: 3 s.h.
Sci Prg Lang:
Use of scientific programming languages for analysis and display of data. Topics include: data types; syntax and control statement; use of plotting and graphics libraries; reading and writing data sets in ASCII, binary, NetCDF, and other formats; spectral analysis; statistical operations; matrix operations. 2 hrs. lec., 2 hrs. lab. Offered in spring. Prereq: ESCI 282 or CSCI 161; MATH 211 and PHYS 231.

ESCI 390: 1-4 s.h.
Topics in the Earth Sciences
Detailed investigation of a topic of current research interest. Topic to be announced each time course is offered. Credit and meeting hours variable, depending on topic offered. Offered infrequently. Prereq: completion of 60 credits.

ESCI 390H: 1-4 s.h.
Hon: Topics in Earth Science

ESCI 400: 3-12 s.h.
Co-Op Ed Experience in ESCI
Co-Op Ed Experience in ESCI

ESCI 421: 2 s.h.
Advanced Geology (W)
Part one of a two-course capstone sequence for geology majors. In-depth discussion of current geological research incorporating approaches from multiple geological subdisciplines. Synthesis and integration of knowledge through student-led exploration of current developments in geology. Combination of lecture and seminar, with students responsible for interpreting and discussing pertinent geological research, including the role of science in society. Prereq: ENGL 110, ESCI 222, 422; Prereq or coreq: ESCI 321, 327, 423; or permission of instructor; open only to BS-Geology and BS-Geology (Environmental Geology option), and BA-Earth Sciences (Geology option) students with senior status.

ESCI 422: 3-6 s.h.
Geological Field Mapping
Examination and interpretation of geologic materials and structures in the field. Students prepare a geologic map, stratigraphic column and structural cross-sections of an assigned field area. Offered infrequently. Prereq: C- or higher in ESCI 321.
ESCI 340: 3 s.h.
Applied Geophysics
Geophysical methods applied to environmental assessment, resource exploration and civil engineering issues. Topics covered include seismic refraction and reflection, ground-penetrating radar, electrical resistivity, gravity, and geomagnetism. 2 hrs. lec., 2 hrs. lab. Offered fall of even years. Prereq: minimum of 60 credits, C- or higher in MATH 101 and any 200-level science course that counts towards a science degree, or permission of instructor.

ESCI 341: 3 s.h.
The Extratropical Cyclone
Mesoscale vertical motions, the circulation at fronts and the life cycle of meteorological processes. Topics include the diagnosis of synoptic-scale atmospheric conditions, the use of satellite imagery and numerical models for forecasting, and the application of atmospheric physics to the study of weather systems. 3 hrs. lec.. Offered in fall. Prereq: ESCI 340 or 365.

ESCI 343: 3 s.h.
Hon: Space Weather/Environment
Space Weather and Environment
In-depth study of the space environment between the earth and sun; solar-terrestrial interactions; physics of the sun and space weather; observational and prediction of space weather events; effects on life, property and infrastructure. 3 hrs. lec. Offered in spring of even years. Prereq: ENGL 110, ESCI 222 and CHEM 111.

ESCI 422: 3 s.h.
Planetary Geology (W)
Terrestrial geology in the context of the solar system; geochemical evolution of the solar nebula; planetary formation and evolution; comparative planetology, meteoritics; asteroid/cometary impact phenomena. 3 hrs. lec. Offered infrequently. Prereq: ENGL 110, ESCI 222 and CHEM 111.

ESCI 428: 3 s.h.
Space Weather and Environment
In-depth study of the space environment between the earth and sun; solar-terrestrial interactions; physics of the sun and space weather; observational and prediction of space weather events; effects on life, property and infrastructure. 3 hrs. lec. Offered in spring of even years. Coreq: MATH 365; Prereq: ESCI 342 and either ESCI 340 or PHYS 232 or permission of instructor.

ESCI 440H: 3 s.h.
Hon: Space Weather/Environment

ESCI 441: 3 s.h.
Synoptic Meteorology Lecture-Laboratory
Application of atmospheric dynamics and atmospheric physics to the theoretical and empirical investigation of mid-latitude synoptic-scale meteorological processes. Topics include the diagnosis of synoptic-scale vertical motions, the circulation at fronts and the life cycle of the extratropical cyclone. 3 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: ESCI 340, 341, 343.

ESCI 442: 2 s.h.
Adv Wthr Anlys/Forecstng Pract
Advanced synoptic and mesoscale weather analysis and forecasting skills. Students perform weather analysis exercises designed to complement the forecast process. Students prepare probabilistic meteorological forecasts and lead post-forecast discussions focused on lessons learned. 1 hr. lec., 2 hrs. lab. Offered in spring. Prereq: C- or higher in ESCI 441 and one semester of Campus Weather Service or by permission of instructor. Coreq: ESCI 444.

ESCI 443: 3 s.h.
Climate Dynamics
A comprehensive treatment of the components of the climate system, feedback mechanisms and interactions; mean state of the climate system; a detailed and in-depth treatment of the earth-atmosphere radiation balance and general circulation; natural and anthropogenic forcings and their effect on the climate system; climate models; and the current state of climate-observing networks and model validation. 2 hrs. lec., 2 hrs. applications and analysis. Offered in spring. Prereq: ESCI 343 or 369, ENGL 110.

ESCI 444: 4 s.h.
Mesoscale Meteorology
Application of atmospheric dynamics and atmospheric physics to the theoretical and empirical investigation of mid-latitude mesoscale meteorological processes. Topics include atmospheric sounding analysis, pressure perturbations, mesoscale instabilities, the atmospheric boundary layer, air mass boundaries, convection initiation, organization of convection and tornadoes. 4 hrs. lec. Offered in spring. Prereq: ESCI 441.

ESCI 445: 3 s.h.
Num Modeling of Atmos and Oceans
Methods and mathematical concepts of numerical weather and ocean prediction models. Students must be able to program in one of the following languages: Fortran, C++, or IDL. 3 hrs. lec. Offered in spring of odd-numbered years. Prereq: ESCI 282 or CSCI 161. Coreq or Prereq: ESCI 343 or 365.

ESCI 446: 3 s.h.
Stats & Decision Making in Earth Science
Descriptive and inference statistics, uncertainty, review of probability, empirical distributions, exploratory data analysis, parametric probability distributions, frequency and Bayesian inference, statistical forecasting and forecast verification, statistics in decision making, time series, multivariate statistics and normal distribution (MVN), principal component analysis (EOF), canonical correlation analysis (CCA), discriminant analysis, cluster analysis, thriving on the edge of chaos, effective complexity. Pre-req: C- or higher in MATH 211

ESCI 447: 3 s.h.
Meteorological Instrumentation (W)
Devices and platforms used to gather meteorological data; methods of data acquisition, reduction, error analysis and quality assurance; description of instrumentation, measurement techniques, observing systems and their deployment. 2 hrs. lec., 2 hrs. lab. Offered in fall of odd years. Prereq: ENGL 110, PHYS 232 and MATH 235.

ESCI 447H: 3 s.h.
H: Meteorological Instrumentation (W)
ESCI 448: 3 s.h.
**Boundary Layers and Turbulence**
Mean boundary layer characteristics; turbulence and its spectrum; governing equations to turbulent flow; prognostic equations for turbulent fluxes and variances; TKE; turbulence closure schemes; similarity theory; simulation techniques; convective and stable boundary layers; boundary layer clouds. 3 hrs. lec. Offered in spring of even years. Prereq: C- or higher in ESCI 342 and MATH 211.

ESCI 449: 3 s.h.
**Radar Meteorology**
Algorithms used in the display and interpretation of weather radar data; theory of electromagnetic radiation, principles of radar operation, Doppler radar and interpretation techniques; wind velocity, rainfall rates and detection of individual cells, multiple cells and turbulence. 3 hrs. lec. Offered in spring of even years. Prereq: C- or higher in ESCI 241, MATH 311. Coreq or Prereq: ESCI 342.

ESCI 449H: 3 s.h.
Hon: Radar Meteorology

ESCI 464: 3 s.h.
**Ocean Ecosystems (W)**
Advanced ocean sciences course investigating the physical, chemical and biological characteristics of the major pelagic ocean biomes from the polar through equatorial regions of the world ocean. Emphasis will be on the important marine plankton functional groups and how their abundances and rates of production are controlled by the circulation patterns of the ocean, ocean turbulence, food web structure, density stratification, the supply of nutrients and the availability of sunlight, and water transparency. 3 hrs. lec. Offered in fall of odd years. Prereq: ESCI 363 and ESCI 369 or permission of instructor.

ESCI 465: 3 s.h.
**Biological Oceanography**
Intensive summer lecture and field course teaching the physical, chemical and biological factors controlling the structure and dynamics of marine ecosystems. Classroom instruction focuses on theoretical principles concerning the environmental control of phytoplankton communities by sunlight, nutrients and grazing. The dynamics and complexity of marine food webs including the phytoplankton, zooplankton and upper trophic levels. Laboratory and field instruction focuses on ocean monitoring and sampling from research vessels, biomass determination and identification of key plankton species, measurement of the rates of net and gross primary production using oxygen light-dark bottle experiments, and optical and chemical techniques of determining phytoplankton biomass and species composition. Approximately 40-50% of course time is spent in field. Prerequisites: C- or higher in ESCI 261 and completion of BIOL (211 or 221), or permission of instructor.

ESCI 466: 3 s.h.
**Environmental Oceanography**
A comprehensive examination of some of the pressing ocean-related environmental issues of the 21st century using critical thinking and quantitative approaches. Emphasis on how human activities are changing ocean ecosystems and environments, and how sound scientific reasoning can reveal true cause-and-effect relationships that then may lead to viable solutions. Includes field and laboratory projects teaching modern techniques of water quality analysis, and case studies of provocative real-world marine environmental problems. 2 hrs. lec., 2 hrs lab. Prereq: ESCI 261 or permission of the instructor.