Environmental Sciences

Patrick S. Market, Degree Program Coordinator
Environmental Sciences
School of Natural Resources
College of Agriculture, Food, and Natural Resources
331 Anheuser-Busch Natural Resources Building
(573) 882-7045

Earth's environment provides conditions conducive for life: an oxygenated atmosphere; water resources; and soil as a medium for plant growth. Environmental processes occurring on the planet govern the movement of air, energy, matter, and water. Through the study of Environmental Sciences, students will learn the science and experience the beauty of the outdoor environment. This degree program addresses how human activities can adversely alter some environmental processes and environmental quality, techniques to improve environmental quality, and practices that minimize human impacts on the environment.

The Environmental Sciences degree provides a strong science foundation through general science coursework and specialized studies of the atmosphere, land and soil, water, and environmental outreach and education. The degree combines interests in predicting and understanding weather patterns, monitoring environmental change, conserving and managing soil and biological organisms, assuring healthy streams and adequate water supplies, and improving environmental quality with the shaping of new policies and educating others about the natural environment and environmental issues. Example careers include Atmospheric Scientist, Climatologist, Environmental Specialist, Environmental Technician, Hydrologist, Land Manager, Meteorologist, Soil Scientist, and Water Quality Specialist. Employment may occur in a variety of sectors, including federal, state, county and city government agencies, non-government agencies (NGOs), and private consulting firms.

Faculty

Professor Emeritus C. J. Gantzer**, S. E. Mudrick
Associate Professor N. I. Fox**, K. W. Goyne**
Associate Professor Emeritus R. J. Miles **
Adjunct Associate Professor C. Baffaut*, F. Eivazi*, R. N. Lerch**, I. I. Mokhov, J. Yang*
Adjunct Assistant Professor J. O. Adegoke*, T. Eichler, S. Lack, B. Myers, M. Nathan, B. Pettigrew, F. J. Young*
Associate Research Professor R. P. Udawatta**
Assistant Professor A. Argerich, C. J. Li, R. North
Instructor E. Aldrich, D. Freeman, P. Quackenbush
Extension Assistant Professor P. E. Guinan**

* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.

** Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

- BS in Environmental Sciences (http://catalog.missouri.edu/graduate/collegeofagriculturefoodandnaturalresources/environmentalsciences/bs-environmental-sciences)
  - with emphasis in Atmosphere (http://catalog.missouri.edu/graduate/collegeofagriculturefoodandnaturalresources/environmentalsciences/bs-environmental-sciences-emphasis-atmosphere)
  - with emphasis in Land and Soil (http://catalog.missouri.edu/graduate/collegeofagriculturefoodandnaturalresources/environmentalsciences/bs-environmental-sciences-emphasis-land-soil)
  - with emphasis in Outreach and Education (http://catalog.missouri.edu/graduate/collegeofagriculturefoodandnaturalresources/environmentalsciences/bs-environmental-sciences-emphasis-outreach-education)
  - with emphasis in Water (http://catalog.missouri.edu/graduate/collegeofagriculturefoodandnaturalresources/environmentalsciences/bs-environmental-sciences-emphasis-water)

Dual Degree - Geological Sciences and Environmental Sciences

The Department of Soil, Environmental and Atmospheric Sciences and the Department of Geological Sciences offer a dual BS in Geological Sciences and in Environmental Sciences. The dual degree program requires 132 credits for graduation. For more information on the dual degree program, contact an advisor in the Department of Soil, Environmental and Atmospheric Sciences or the Department of Geological Sciences.

Dual Degree - Biochemistry and Environmental Sciences

The Department of Soil, Environmental and Atmospheric Sciences and the Division of Biochemistry offer a dual BS degree in Biochemistry and in Environmental Sciences. The dual degree program requires 134 credits for graduation. For more information on the dual degree program, contact an advisor in the Department of Soil, Environmental and Atmospheric Sciences or the Division of Biochemistry.

Dual Degree - Forestry and Environmental Sciences

The Department of Soil, Environmental and Atmospheric Sciences and the Department of Forestry offer a dual degree in Forestry and in Environmental Sciences. The dual degree requires 136 credits for graduation. For more information on the dual degree program, contact an advisor in the Department of Soil, Environmental and Atmospheric Sciences or the Department of Forestry.

Graduate

School of Natural Resources
Soil, Environmental and Atmospheric Sciences
302 Anheuser-Busch Natural Resources Building
Graduate study at the University of Missouri (MU) in soil, environmental, and atmospheric sciences is designed to prepare students for professional careers in research, teaching or practical application of the principles of soil, environmental and atmospheric sciences (SEAS).

As of the fall 2013 semester, options for graduate study in SEAS will be offered through the MS in Natural Resources with an emphasis in SEAS (http://catalog.missouri.edu/undergraduategraduate/colleg eofagriculturefoodandnaturalresources/naturalresources/ms-soil-environmental-atmospheric-sciences) and the PhD in Natural Resources with an emphasis in SEAS (http://catalog.missouri.edu/undergraduategraduate/colleg eofagriculturefoodandnaturalresources/naturalresources/phd-soil-environmental-atmospheric-sciences). Focus areas in soil science, environmental science or atmospheric science are available through these options. Details on both degree programs, including recommended preparation, admission criteria, required application materials, degree requirements and financial aid, are provided in the graduate tab of the Natural Resources section (http://catalog.missouri.edu/undergraduategraduate/colleg eofagriculturefoodandnaturalresources/naturalresources/#graduatetext) of the catalog under the College of Agriculture, Food and Natural Resources.

Graduate Focus Areas

Atmospheric Science

Atmospheric science students participate in an area of research such as dynamic and physical meteorology, general circulation, global climate change, severe storms, remote sensing and applied climatology with emphasis on environmental and socioeconomic impacts.

The program has a specialized computer laboratory that includes significant hardware and software to support thesis and dissertation research. There are also occasional opportunities for joint research programs with the National Center for Atmospheric Research.

Environmental Science

Environmental science students may participate in environmental quality, hydrology, watershed management, and water quality focus areas. State-of-the-art equipment for chemical, biological and physical analysis of water and earth materials is available for use in laboratories maintained by the SEAS Department in the School of Natural Resources. The program has a working scale-nested watershed study spanning native lands as well as agricultural, and urban environments, thus supplying an excellent outdoor teaching and research laboratory.

Soil Science

Soil science students may participate in one of the following focus areas: environmental quality, pedology, soil chemistry and biochemistry, soil microbiology, soil physics and conservation, soil management, or soil fertility and plant nutrition.

State-of-the-art equipment for chemical, biological and physical analysis of soils is available for use in laboratories maintained by the SEAS Department in the School of Natural Resources. Access to additional chemical analysis equipment, computing facilities, digital imaging equipment, field facilities, greenhouse space, radiochemistry and scanning electron microscopes is available within the University of Missouri.

Financial Aid from the Program

Check the program website (http://www.snr.missouri.edu/seas/academics/graduate-program.php) or contact the program for details on scholarships or graduate assistantships that may be available.

ATM_SC 1050: Introductory Meteorology
(same as GEOG 1050). Physical processes of atmosphere in relation to day-to-day changes in weather.

Credit Hours: 3

ATM_SC 2100: Introduction to Atmospheric Science
Physical process of the atmospheric and climate system will be related to day-to-day weather changes. Students will be introduced to the laws of motion and thermodynamics that govern motions in geophysical fluid. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: MATH 1160 or concurrent enrollment in MATH 1500

ATM_SC 2150: Natural Hazards
A survey of natural hazards, including severe thunderstorms, tornadoes, flooding, tropical storms, ocean movements, earthquakes, tsunamis, volcanoes, asteroids, solar weather, managing risk and human impacts. Graded on A-F basis only.

Credit Hours: 3

Prerequisites: ATM_SC 1050 or equivalent

ATM_SC 2720: Weather Briefing
Student participation in daily discussions of current weather patterns and forecasts and their applications to weather sensitive activities including aviation, agriculture and industry.

Credit Hour: 1

Prerequisites: ATM_SC 1050

ATM_SC 2792: Weather Communication
Methods of surface and upper air weather observation. How such data are distributed to users in the meteorological community is also addressed.

Credit Hour: 1

Prerequisites: ATM_SC 1050; sophomore standing

ATM_SC 3000: Independent Study in Atmospheric Science
Independent study of a topic dealing with meteorological theory or application of meteorological science to the solution of relevant problem.

Credit Hour: 1-3

Prerequisites: ATM_SC 1050

Emphasis Area Coordinator for Graduate Program:
Dr. Stephen Anderson
Department of Soil, Environmental and Atmospheric Sciences
University of Missouri
302 Anheuser-Busch Natural Resources Building
Columbia, MO 65211 USA
Tel. no. (573) 884-6303
Email: andersons@missouri.edu

Tel. no. (573) 884-6303
Email: andersons@missouri.edu

Tel. no. (573) 884-6303
Email: andersons@missouri.edu

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Recommended: Upper level standing

ATM_SC 3600: Climates of the World
(same as GEOG 3600). A study of the world distribution of climates based on "cause and effect" relationships. Special attention is given to the impacts of climate on humanity.

Credit Hours: 3
Prerequisites: ATM_SC 1050 or graduate standing

ATM_SC 4001: Topics in Atmospheric Science
Development of theory and applications for selected topics in atmospheric science.

Credit Hour: 1-99
Prerequisites: junior standing and instructor's consent

ATM_SC 4110: Broadcast Meteorology I
An introduction to broadcast meteorology including the business of media, use of meteorological data to produce a forecast, and television and radio presentation skills. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: ATM_SC 1110, ATM_SC 2720, or equivalents
Corequisites: ATM_SC 4710. Restricted to Atmospheric Science majors or instructor's consent

ATM_SC 4310: Atmospheric Thermodynamics
(cross-leveled with ATM_SC 7310). Thermodynamics of dry and moist air, atmospheric hydrostatics, convection, and development of the fundamental equations of geophysical fluid dynamics.

Credit Hours: 4
Prerequisites: ATM_SC 1050, MATH 1700 (C or better), and one physics course

ATM_SC 4320: Atmospheric Dynamics

Credit Hours: 4
Prerequisites: ATM_SC 4310 or ATM_SC 7310

ATM_SC 4350: Mesoscale Meteorology and Dynamics
(cross-leveled with ATM_SC 7350). Survey of mesoscale phenomena, observing systems, analysis techniques, and modeling. Topics include fronts, jet streaks, gravity waves, organized convection, tornadoes, and severe local storm forecasting and structure.

Credit Hours: 3
Prerequisites: ATM_SC 4720 or ATM_SC 7720 and MATH 2300

ATM_SC 4400: Micrometeorology
(cross-leveled with ATM_SC 7400). Study of transport processes in the surface boundary layer. Important applications in pollution will be discussed.

Credit Hours: 3
Prerequisites: ATM_SC 4310 or PHYSCS 2760, MATH 2300

ATM_SC 4500: Advanced Meteorological Observation and Instrumentation
Automated weather observation and instrumentation used in networks of remote automated weather stations. Emphasis on electronic instrumentation, datalogger programming, data collection and data management, generating dynamic reports on the World Wide Web. May be repeated for credit.

Credit Hours: 3
Prerequisites: ATM_SC 1050

ATM_SC 4510: Remote Sensing for Meteorology and Natural Resources
(cross-leveled with ATM_SC 7510). Principles of remote sensing with emphasis on the properties of atmosphere and the earth's surface from airborne and satellite sensors. The techniques for using geosynchronous and orbiting satellite platforms for assessing weather and natural resource features.

Credit Hours: 3
Prerequisites: ATM_SC 1110, MATH 1500, junior standing or instructor's consent

ATM_SC 4520: Environmental Biophysics
(same as GEOG 4520; cross-leveled with ATM_SC 7520, GEOG 7520). Students will learn techniques and principles used to describe the microenvironment of living organisms and use quantitative expressions to estimate missing values, and mass transfer laws to estimate flux of energy, water and gas.

Credit Hours: 3
Prerequisites: College Physics and Calculus I

ATM_SC 4550: Atmospheric Physics
(cross-leveled with ATM_SC 7550). Physics of atmospheric nucleation-condensation, cloud droplet and precipitation formation, associated electrical phenomena, radiation transfer and remote sensing. Recommended: 1 year of college Physics

Credit Hours: 3
Prerequisites: MATH 1700

ATM_SC 4590: Radar Meteorology
(cross-leveled with ATM_SC 7590). Course concerns the theory and application of radar in meteorology. May be repeated for credit.

Credit Hours: 3
Prerequisites: ATM_SC 1110, MATH 1700, PHYSCS 2750

ATM_SC 4650: Long-Range Forecasting

Credit Hours: 3
Prerequisites: ATM_SC 4050 or ATM_SC 7050 or ATM_SC 3600

ATM_SC 4710: Synoptic Meteorology I
(cross-leveled with ATM_SC 7710). Meteorological Data. Basic techniques for surface and upper air analysis, using selected examples of weather patterns.
ATM_SC 4720: Synoptic Meteorology II
(cross-leveled with ATM_SC 7720). Graphical analysis and interpretation of physical, kinematical and dynamical properties of the atmosphere. Analysis techniques applicable to atmospheric research.

Credit Hours: 4
Prerequisites: ATM_SC 1050, MATH 1700 (C or better)
Recommended: one physics course

ATM_SC 4720W: Synoptic Meteorology II - Writing Intensive
(cross-leveled with ATM_SC 7720). Graphical analysis and interpretation of physical, kinematical and dynamical properties of the atmosphere. Analysis techniques applicable to atmospheric research.

Credit Hours: 4
Prerequisites: ATM_SC 4710 or ATM_SC 7710

ATM_SC 4730: Advanced Forecasting Laboratory
Advanced principles of weather forecasting will be addressed via online electronic modules and weekly laboratory exercises. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ATM_SC 4720

ATM_SC 4800: Numerical Methods in Atmospheric Science and Natural Resources
(cross-leveled with ATM_SC 7800). Examines numerical methods used in solving differential equations, filtering data sets, and Fourier decomposition of discrete data sets.

Credit Hours: 3
Prerequisites: senior standing
Recommended: Math through Calculus III

ATM_SC 4949: Internship in Meteorology
Practical professional work experience with professional or scientific meteorologists in off-campus work environment. Graded on S/U basis only.

Credit Hour: 1-6
Prerequisites: junior standing
Recommended: Math through Calculus III

ATM_SC 4990: Daily Analysis and Forecast Interpretation
A Capstone experience. In depth daily analysis and interpretation by students of the current and forecast states of the atmosphere. Discussions of implications to specific weather sensitive activities.

Credit Hours: 3
Prerequisites: ATM_SC 1050, MATH 1700 (C or better) and one physics course

ATM_SC 7001: Topics in Atmospheric Science
Development of theory and applications for selected topics in atmospheric science.

Credit Hour: 1-99
Prerequisites: instructor's consent

ATM_SC 7310: Atmospheric Thermodynamics
(cross-leveled with ATM_SC 4310). Thermodynamics of dry and moist air, atmospheric hydrostatics, convection, and development of the fundamental equations of geophysical fluid dynamics.

Credit Hours: 4
Prerequisites: ATM_SC 1050, MATH 1700 (C or better), and one physics course

ATM_SC 7320: Atmospheric Dynamics
(cross-leveled with ATM_SC 4320). Dynamics and kinematics of atmospheric flow. Manipulation of fundamental equations, numerical modeling of atmosphere.

Credit Hours: 4
Prerequisites: ATM_SC 4310 or ATM_SC 7310

ATM_SC 7350: Mesoscale Meteorology and Dynamics
(cross-leveled with ATM_SC 4350). Survey of mesoscale phenomena, observing systems, analysis techniques, and modeling. Topics include fronts, jet streaks, gravity waves, organized convection, tornadoes, and severe local storm forecasting and structure.

Credit Hours: 3
Prerequisites: ATM_SC 4720 or ATM_SC 7720 and MATH 2300

ATM_SC 7400: Micrometeorology
(cross-leveled with ATM_SC 4400). Study of transport processes in the surface boundary layer. Important applications in pollution will be discussed.

Credit Hours: 3
Prerequisites: ATM_SC 4720 or ATM_SC 7720

ATM_SC 7510: Remote Sensing for Meteorology and Natural Resources
(cross-leveled with ATM_SC 4510). Principles of remote sensing with emphasis on the properties of atmosphere and the earth's surface from airborne and satellite sensors. The techniques for using geosynchronous and orbiting satellite platforms for assessing weather and natural resource features. Graduate student credit is dependent upon completion of additional advanced research assignments. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: ATM_SC 4050 or ATM_SC 7050

ATM_SC 7520: Environmental Biophysics
(same as GEOG 7520; cross-leveled with ATM_SC 4520, GEOG 4520). Students will learn techniques and principles used to describe the microenvironment of living organisms and use quantitative expressions to estimate missing values, and mass transfer laws to estimate flux of energy, water, and gas.
ATM_SC 7550: Atmospheric Physics
(cross-leveled with ATM_SC 4550). Physics of atmospheric nucleation-condensation, cloud droplet and precipitation formation, associated electrical phenomena, radiation transfer and remote sensing.
Credit Hours: 3
Prerequisites: college physics, calculus I

ATM_SC 7590: Radar Meteorology
(cross-leveled with ATM_SC 4590). Course concerns the theory and application of radar in meteorology. Graduate students will be required to conduct an independent research project using radar, in addition to the undergraduate requirements for the class. May be repeated for credit.
Credit Hours: 3
Prerequisites: 1 year of college Physics and MATH 1700

ATM_SC 7650: Long-Range Forecasting
Credit Hours: 3
Prerequisites: ATM_SC 4050 or ATM_SC 7050 or ATM_SC 3600

ATM_SC 7710: Synoptic Meteorology I
(cross-leveled with ATM_SC 4710). Meteorological Data. Basic techniques for surface and upper air analysis, using selected examples of weather patterns.
Credit Hours: 4
Prerequisites or Corequisites: one physics course
Prerequisites: ATM_SC 1050, MATH 1700 (C or better)

ATM_SC 7720: Synoptic Meteorology II
(cross-leveled with ATM_SC 4720). Graphical analysis and interpretation of physical, kinematical and dynamical properties of the atmosphere. Analysis techniques applicable to atmospheric research.
Credit Hours: 4
Prerequisites: ATM_SC 4710 or ATM_SC 7710

ATM_SC 7800: Numerical Methods in Atmospheric Science and Natural Resources
(cross-leveled with ATM_SC 4800). Examines numerical methods used in solving differential equations, filtering data sets, and Fourier decomposition of discrete data sets.
Credit Hours: 3
Prerequisites: Math through Calculus III

ATM_SC 8001: Topics in Atmospheric Science
Development of the theory with its application for selected topics in atmospheric science.
Credit Hours: 3

ATM_SC 8085: Problems in Atmospheric Science
Independent study by graduate students in atmospheric science.
Credit Hour: 1-99

ATM_SC 8090: Masters Research in Atmospheric Science
Original investigation in atmospheric science in support of a master's thesis. Graded on S/U basis only.
Credit Hour: 1-99

ATM_SC 8400: Atmospheric General Circulation
Comprehensive review of dynamical theories of general circulation with intensive discussion of current problems.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320

ATM_SC 8450: Tropical Meteorology
Study of the synoptic and dynamic character of the atmosphere in the tropical regions, including an examination of the general circulation and tropical storms.
Credit Hours: 3
Prerequisites: ATM_SC 4710 or ATM_SC 7710, ATM_SC 4720 or ATM_SC 7720 and MATH 2300; instructor's consent. Graded on A-F basis only

ATM_SC 8500: Radiation in the Atmosphere
Physics of solar and infrared radiative transfer in the atmosphere, including energy conversion effects, atmospheric optics, and photochemical processes.
Credit Hours: 3
Prerequisites: one year College Physics and MATH 1700

ATM_SC 8550: Nowcasting
Students will learn the science of nowcasting through the study of the various methods used and apply their knowledge in the design of the elements of a nowcast system and practical nowcasting exercises.
Credit Hours: 3
Prerequisites: ATM_SC 8500, instructor's consent

ATM_SC 8600: Advanced Climate Dynamics
Study of global climate; application of large scale atmospheric dynamics; conservation of various forms of energy, climatic evaluation, large scale climatic modification.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320 and ATM_SC 8400 or ATM_SC 3600

ATM_SC 9001: Topics in Atmospheric Science
Development of the theory with its application for selected topics in atmospheric science.
Credit Hour: 1-99

ATM_SC 9085: Problems in Atmospheric Science
Independent study by graduate students in atmospheric science.
ATM_SC 9087: Seminar in Atmospheric Science
Seminar in Atmospheric Science.
Credit Hour: 1-99

ATM_SC 9090: Doctoral Research in Atmospheric Science
Original investigation in atmospheric science in support of a doctoral dissertation. Graded on S/U basis only.
Credit Hour: 1-99

ATM_SC 9300: Introduction to Chaos Theory
Atmospheric predictability and related topics are examined as they relate to governing equations of motion and their non-linear solutions.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320, MATH 4100

ATM_SC 9350: Advanced Dynamic Meteorology
Application of perturbation dynamics, advanced dynamics, and numerical methods to study of atmospheric circulations.
Credit Hours: 3
Prerequisites: ATM_SC 4320 or ATM_SC 7320

ATM_SC 9590: Advanced Applications of Weather Radar
This course will investigate quantitative uses of weather radar data that go beyond standard reflectivity and velocity image interpretation, particularly those that use new techniques such as dual-polarization. Students will develop methods to analyze and display meteorological radar data. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: Instructor's consent
Recommended: MATH 1700, PHYSICS 2760, INFOTC 1040 or equivalent, ATM_SC 4590

ATM_SC 9700: Advanced Synoptic Meteorology
Detailed examination of vertical motions, their forcing, and how each is diagnosed (quasigeostrophic theory, the Trenberth approximation, Q-vectors). Current issues in synoptic meteorology and operational forecasting are discussed.
Credit Hours: 3
Prerequisites: ATM_SC 4720 or ATM_SC 7720

ATM_SC 9712: Convection and Lightning
Cumulus convection and cloud physics topics that will facilitate a deeper understanding of cloud electrification and lightning production are studied. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: ATM_SC 4710 or ATM_SC 7710, ATM_SC 4720 or ATM_SC 7720, MATH 2300; instructor's consent

ATM_SC 9800: Numerical Weather Prediction
Examination of finite difference and objective analysis techniques, basic physical concepts, and parameterization of physical processes. Experience with a range of models (1-D cloud to operational PE models) stressed.
Credit Hours: 3
Prerequisites: instructor's consent

ENV_SC 1001: Topics in Environmental Science - General
Organized study of selected topics in environmental science.
Credit Hour: 1-99

ENV_SC 1100: Introduction to Environmental Science
This class provides an opportunity to develop an understanding of environment, physical and social causes of environmental problems, their impacts, and strategies to manage these issues.
Credit Hours: 3
Prerequisites: Enrollment restricted to College of Agriculture, Food and Natural Resources undergraduates and students minoring in Environmental Science

ENV_SC 2001: Topics in Environmental Science - General
Organized study of selected topics in environmental science.
Credit Hour: 1-99

ENV_SC 2002: Topics in Environmental Science - Biological/Physical/Mathematical
Organized study of selected topics. Subjects and credit may vary from semester to semester.
Credit Hour: 1-99

ENV_SC 3001: Topics in Environmental Science - General
Organized study of selected topics in environmental science.
Credit Hour: 1-99

ENV_SC 3085: Problems in Environmental Science
Special individualized projects or readings in environmental science.
Credit Hour: 1-99

ENV_SC 3250: Pollutant Fate and Transport
(same as CV_ENG 3250). Introduction to concepts governing pollutant fate and transport in the environment, including pollutant interactions within and migration through environmental systems, as well as analytical techniques and tools necessary to quantify conditions and movement.
Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100 or CV_ENG 3200; and CHEM 1320

ENV_SC 3290: Soils and the Environment
(same as SOIL 3290). Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.
Credit Hours: 3
Prerequisites: SOIL 2100, ENGLSH 1000. Recommended 3 hours of CHEM courses

ENV_SC 3290W: Soils and the Environment - Writing Intensive
(same as SOIL 3290). Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.

Credit Hours: 3
Prerequisites: SOIL 2100, ENGLSH 1000. Recommended 3 hours of CHEM courses

ENV_SC 3330: Environmental Land Use Management
An introduction to environmentally sustainable use and management of land.

Credit Hours: 3

ENV_SC 3500: Pollutant Fate and Transport
This course introduces students to concepts governing pollutant fate and transport in the environment, and it provides students with the quantitative tools necessary to estimate the fate and transport of pollutants in the environment.

Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100, and CHEM 1320

ENV_SC 4001: Topics in Environmental Science - General
Organized study of selected topics in environmental science.

Credit Hour: 1-99

ENV_SC 4024: Foundations of Environmental Education
(same as NAT_R 4024; cross-leveled with NAT_R 7024) This course provides a theoretical foundation to environmental education (EE). The purpose of this course is to develop the knowledge and skills for developing quality, age-appropriate EE for students in both formal and non-formal education setting. The emphasis is on EE curriculum materials, resources, and programs that can be used with students in settings at classrooms, nature centers, museums, and parks. This course involves training in the Missouri Department of Conservation Discover Nature School educational materials, and in observing and teaching EE lessons in a local nature center. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 1010 or ENV_SC 1100 or NAT_R 1060 or NAT_R 1070 or NAT_R 2160 or Instructor's consent

ENV_SC 4085: Problems in Environmental Science
Special individualized research projects or readings in environmental science.

Credit Hour: 1-99

ENV_SC 4305: Environmental Soil Physics
(same as SOIL 4305). Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.

Credit Hours: 3
Prerequisites: SOIL 2100
Recommended: PHYSCS 1210 or equivalent

ENV_SC 4306: Environmental Soil Physics Laboratory
(same as SOIL 4306). Introduction to the methodology and equipment for measurement of soil physical properties and processes.

Credit Hours: 2
Prerequisites or Corequisites: ENV_SC 4305

ENV_SC 4312: Environmental Soil Microbiology
(same as SOIL 4312). Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic transformation bioremediation, etc.

Credit Hours: 3
Prerequisites: SOIL 2100
Recommended: general microbiology

ENV_SC 4318: Environmental Soil Chemistry
(same as SOIL 4318 and GEOL 4318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.

Credit Hours: 3
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330; junior standing or instructor's consent

ENV_SC 4396: Agroforestry for Watershed Restoration
Agroforestry for watershed restoration will focus on integrated approaches for improved water quality, soil health, and economic benefits. Students will learn principles and practices, critical analysis and application of agroforestry practices to improve overall environmental quality. May be repeated for credit. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: FOREST 4385 or FOREST 7385

ENV_SC 4940: Environmental Science Internship
Supervised professional experience with an approved public or private organization. Graded on S/U basis only.

Credit Hour: 1-99

ENV_SC 4950: Undergraduate Research in Environmental Science
Research apprenticeship with a faculty mentor. Students are expected to develop initial concept for the research, design experiments, collect data, and analyze data with faculty input, oversight, and guidance. Prerequisites: ENV_SC 1100, STAT 2530
Credit Hour: 1-4
Recommended: 9 hours of Environmental Science with at least 3 hours above the 3000-level

ENV_SC 7001: Topics in Environmental Science
Organized study of selected topics in environmental science. Intended for graduate students.
Credit Hour: 1-99

ENV_SC 7085: Problems in Environmental Science
Special individualized non-thesis research projects or readings in environmental science.
Credit Hour: 1-99

ENV_SC 7305: Environmental Soil Physics
(same as SOIL 7305). Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.
Credit Hours: 3
Prerequisites: SOIL 2100, PHYSCS 1210 or equivalent

ENV_SC 7306: Environmental Soil Physics Laboratory
(same as SOIL 7306). Introduction to the methodology and equipment for measurement of soil physical properties and properties and processes. Prerequisites or Corerquisites: SOIL 4305.
Credit Hours: 2

ENV_SC 7312: Environmental Soil Microbiology
(same as SOIL 7312). Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic degradation and bioremediation, soil quality and pathogen regulation in the environment. Nitrogen fixation, mycorrhizal processes are discussed.
Credit Hours: 3

ENV_SC 7318: Environmental Soil Chemistry
(same as SOIL 7318 and GEOL 7318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals, and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.
Credit Hours: 3
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330

ENV_SC 7320: Hydrologic and Water Quality Modeling
(same as NAT_R 7320). Introduction to models for simulating hydrologic and water quality processes. Emphasis is placed on watersheds to provide experience with the use of simulation models for natural resource decision making.
Credit Hours: 3
Prerequisites: ENV_SC 1100 or SOIL 2100 or equivalent

ENV_SC 7396: Agroforestry for Watershed Restoration
Agroforestry for watershed restoration will focus on integrated approaches for improved water quality, soil health, and economic benefits. Students will learn principles and practices, critical analysis and application of agroforestry practices to improve overall environmental quality. May be repeated for credit. Graded on A-F basis only.
Credit Hours: 3
Prerequisites: FOREST 4385 or FOREST 7385 or permission of instructor

ENV_SC 8001: Topics in Environmental Science
Organized study of selected topics in environmental science. Intended for graduate students.
Credit Hour: 1-99

ENV_SC 8085: Problems in Environmental Science
Special individualized non-thesis research projects or readings in environmental science.
Credit Hour: 1-99

ENV_SC 8090: Masters Research in Environmental Science
Original investigations in environmental science for presentation in a thesis. Graded on S/U basis only.
Credit Hour: 1-10

ENV_SC 8400: Solute Transport in the Vadose Zone
(same as SOIL 8400). Transport of water and solutes in geomedia with emphasis on development of the equations of flow. Evaluation of analytical and numerical solutions to equations describing transport phenomena.
Credit Hours: 3
Prerequisites: ENV_SC 7305 or SOIL 7305

ENV_SC 8500: Chemistry of the Vadose Zone
(same as SOIL 8500). Chemical reactions occurring in geomedia with emphasis on understanding molecular scale processes occurring at the solid-water interface, aqueous geochemistry, and soil organic matter.
Credit Hours: 3
Prerequisites: SOIL 7318 or GEOL 7300 or instructor's consent

ENV_SC 9001: Topics in Environmental Science
Organized study of selected topics in environmental science. Intended for graduate students.
Credit Hour: 1-99

ENV_SC 9085: Problems in Environmental Science
Special individualized non-thesis research projects or readings in environmental science.
Credit Hour: 1-99

ENV_SC 9087: Seminar in Environmental Science
In-depth development of advanced aspects of environmental science through reviews of results of research in progress and current scientific publications.
Credit Hour: 1
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Credit Hours</th>
<th>Prerequisites</th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENV_SC 9090</td>
<td>Doctoral Research in Environmental Science</td>
<td>Original investigations in environmental science for presentation in a dissertation. Graded on S/U basis only.</td>
<td>1-10</td>
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<tr>
<td>ENV_SC 9407</td>
<td>Advanced Environmental Soil Physics (same as SOIL 9407).</td>
<td>Transport of mass and energy through soil with emphasis on development of the equations of flow. Evaluation of analytical and numerical solutions to differential equations describing transport phenomena.</td>
<td>3</td>
<td>SOIL 7305, MATH 4100 or MATH 7100, or equivalent</td>
<td></td>
</tr>
<tr>
<td>ENV_SC 9418</td>
<td>Advanced Environmental Soil Chemistry (same as SOIL 9418).</td>
<td>Linking molecular-scale solution-phase and surface reactions with macroscopic chemical processes. Fundamentals of aqueous surface and colloid chemistry will be discussed.</td>
<td>3</td>
<td>SOIL 7318 or GEOL 7300, and CHEM 3300</td>
<td></td>
</tr>
<tr>
<td>SOIL 2100</td>
<td>Introduction to Soils (same as PLNT_S 2100).</td>
<td>Introduction to soil sciences with emphasis placed on physical, biological, and chemical properties and application to land use, plant growth and environmental problems.</td>
<td>3</td>
<td></td>
<td>3 hours of Chemistry</td>
</tr>
<tr>
<td>SOIL 2106</td>
<td>Soil Science Laboratory</td>
<td>Laboratory application of fundamental soil science concepts.</td>
<td>2</td>
<td>SOIL 2100</td>
<td></td>
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<tr>
<td>SOIL 3001</td>
<td>Topics in Soil Science</td>
<td>Organized study of selected topics in soil science.</td>
<td>1-99</td>
<td></td>
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<tr>
<td>SOIL 3085</td>
<td>Problems in Soil Science</td>
<td>Special individualized research projects or readings in soil science.</td>
<td>1-99</td>
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<tr>
<td>SOIL 3290</td>
<td>Soils and the Environment</td>
<td>Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.</td>
<td>3</td>
<td>SOIL 2100 and ENGLISH 1000</td>
<td>3 hours of chemistry</td>
</tr>
<tr>
<td>SOIL 3290W</td>
<td>Soils and the Environment - Writing Intensive (same as ENV_SC 3290).</td>
<td>Addresses the role of soils and soil properties on environmental pollution and management. Emphasis will be placed on carbon, nitrogen, phosphorus, and sulfur transformations and transport in natural and disturbed ecosystems and soil management practices and technology to prevent or remediate environmental pollution.</td>
<td>3</td>
<td>SOIL 2100 or instructor's consent</td>
<td></td>
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<tr>
<td>SOIL 4001</td>
<td>Topics in Soil Science</td>
<td>Organized study of selected topics in soil science.</td>
<td>1-99</td>
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<tr>
<td>SOIL 4085</td>
<td>Problems in Soil Science</td>
<td>Special individualized non-thesis research projects or readings in soil science.</td>
<td>1-99</td>
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<tr>
<td>SOIL 4305</td>
<td>Environmental Soil Physics (same as ENV_SC 4305).</td>
<td>Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.</td>
<td>3</td>
<td>SOIL 2100</td>
<td></td>
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<tr>
<td>SOIL 4306</td>
<td>Environmental Soil Physics Laboratory (same as ENV_SC 4306).</td>
<td>Introduction to the methodology and equipment for measurement of soil physical properties and processes.</td>
<td>2</td>
<td>SOIL 4305</td>
<td></td>
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<tr>
<td>SOIL 4308</td>
<td>Soil Conservation</td>
<td>Conservation of soil with respect to topsoil, soil productivity, and fertility.</td>
<td>3</td>
<td>SOIL 2100</td>
<td>AG_S_M 4420</td>
</tr>
<tr>
<td>SOIL 4312</td>
<td>Environmental Soil Microbiology (same as ENV_SC 4312).</td>
<td>Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic transformation bioremediation, etc.</td>
<td>3</td>
<td>SOIL 2100</td>
<td>general microbiology</td>
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<tr>
<td>SOIL 4313</td>
<td>Soil Fertility and Plant Nutrition (same as PLNT_S 4313).</td>
<td>Explanation of principles of delivery of plant nutrients to plants, discussion of the role of each essential nutrient in crop plants and introduction to the management of soil amendments.</td>
<td>3</td>
<td>SOIL 2100</td>
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</tr>
<tr>
<td>SOIL 4314</td>
<td>Soil Fertility and Plant Nutrition Laboratory (same as PLNT_S 4314).</td>
<td>The application of elementary analytical procedures to the evaluation of the nutrient status of soils and crop plants.</td>
<td>3</td>
<td>SOIL 2100 or instructor's consent</td>
<td></td>
</tr>
</tbody>
</table>
SOIL 4318: Environmental Soil Chemistry
(same as ENV_SC 4318 and GEOL 4318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals, and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.

Credit Hours: 3
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330; junior standing or instructor's consent

SOIL 4320: Genesis of Soil Landscapes
The co-evolution of soil landscapes. The role of water in the accumulation of parent materials and development of soil horizons. Factors and processes of soil genesis. Distribution of soil in their natural settings.

Credit Hours: 4
Recommended: introductory soil science or introductory geology course

SOIL 4360: Precision Agriculture Science and Technology
(same as AG_S_M 4360, PLNT_S 4360; cross-leveled with SOIL 7360, AG_S_M 7360, PLNT_S 7360). Precision agriculture is an information-based approach to farming whereby variability is managed to optimize crop production and reduce environmental pollution. This course provides an overview of precision agriculture technologies (like GIS, GPS, remote sensing), mapping methods, and case studies illustrating decisions and management.

Credit Hours: 3
Prerequisites: PLNT_S 2100 or SOIL 2100, or PLNT_S 2110, or instructor's consent

SOIL 4940: Soil Science Internship
Supervised professional experience with an approved public or private organization. Course may be repeated for credit. Graded on S/U basis only.

Credit Hours: 1-12
Prerequisites: Soil and Atmospheric Sciences majors only, instructor's consent

SOIL 4950: Undergraduate Research in Soil Science
Research apprenticeship with a faculty mentor. Students are expected to develop initial concept for the research, design experiments, collect data, and analyze data with faculty input, oversight, and guidance.

Credit Hours: 1-4
Prerequisites: SOIL 2100 and SOIL 2106, STAT 2530, or instructor's consent
Recommended: 9 hours of Soil Science with at least 3 hours above the 3000-level

SOIL 7001: Topics in Soil Science
Organized study of selected topics in soil science. Intended for graduate students.

Credit Hours: 1-99

SOIL 7085: Problems in Soil Science
Special individualized non-thesis research projects or readings in soil science.

Credit Hour: 1-99
Prerequisites: graduate standing

SOIL 7305: Environmental Soil Physics
(same as ENV_SC 7305). Study of soil physical properties and processes important in solving environmental problems. Topics include soil solids, water content and energy, and transport of water, solutes, gas and heat.

Credit Hours: 3
Prerequisites: SOIL 2100, PHYSCS 1210 or equivalent

SOIL 7306: Environmental Soil Physics Laboratory
(same as ENV_SC 7306). Introduction to the methodology and equipment for measurement of soil physical properties and properties and processes.

Credit Hours: 2
Prerequisites or Corequisites: SOIL 4305

SOIL 7308: Soil Conservation
Conservation of soil with respect to topsoil, soil productivity, and fertility.

Credit Hours: 3
Prerequisites: SOIL 2100
Recommended: AG_S_M 4420

SOIL 7312: Environmental Soil Microbiology
(same as ENV_SC 7312). Microbiology/ecology of life in the soil ecosystem. Emphasis is placed on the role of microbes in nutrient cycling, microbial pesticide/xenobiotic transformations bioremediation, etc.

Credit Hours: 3
Prerequisites: general microbiology, SOIL 2100, or instructor's consent

SOIL 7313: Soil Fertility and Plant Nutrition
(same as PLNT_S 7313). Explanation of principles of delivery of plant nutrients to plants, discussion of the role of each essential nutrient in crop plants and introduction to the management of soil amendments.

Credit Hours: 3
Prerequisites: SOIL 2100 or instructor's consent

SOIL 7314: Soil Fertility and Plant Nutrition Laboratory
(same as PLNT_S 7314). The application of elementary analytical procedures to the evaluation of the nutrient status of soils and crop plants.

Credit Hours: 2
Prerequisites or Corequisites: SOIL 7313

SOIL 7318: Environmental Soil Chemistry
(same as GEOL 7318 and ENV_SC 7318). Study of chemical constituents and processes occurring in soils. Topics include soil minerals, and weathering processes, organic matter, solution chemistry, oxidation-reduction reactions and adsorption processes.

Credit Hours: 3
Prerequisites: SOIL 2100 or GEOL 2400, CHEM 1320 and CHEM 1330; junior standing or instructor's consent

SOIL 7320: Genesis of Soil Landscape
The co-evolution of soil landscapes. The role of water in the accumulation of parent materials and development of soil horizons. Factors and processes of soil genesis. Distribution of soil in their natural settings.
Credit Hours: 4
Prerequisites: introductory soil science or introductory geology or permission of instructor

SOIL 7360: Precision Agriculture Science and Technology
(same as AG_S_M 7360 and PLNT_S 7360; cross-leveled with SOIL 4360, AG_S_M 4360, PLNT_S 7360). Precision agriculture is an information-based approach to farming whereby variability is managed to optimize crop production and reduce environmental pollution. This course provides an overview of precision agriculture technologies (like GIS, GPS, remote sensing), mapping methods, and case studies illustrating decisions and management.
Credit Hours: 3
Prerequisites: SOIL 2100, PLNT_S 2110 or instructor's consent

SOIL 8001: Topics in Soil Science
Organized study of selected topics in soil science. Intended for graduate students.
Credit Hour: 1-99

SOIL 8085: Problems in Soil Science
Special individualized non-thesis research projects or readings in soil science.
Credit Hour: 1-99

SOIL 8090: Masters Research in Soil Science
Original investigations in soil science for presentation in a thesis. Graded on S/U basis only.
Credit Hour: 1-10

SOIL 8400: Solute Transport in the Vadose Zone
(same as ENV_SC 8400). Transport of water and solutes in geomedia with emphasis on development of the equations of flow. Evaluation of analytical and numerical solutions to equations describing transport phenomena.
Credit Hours: 3
Prerequisites: ENV_SC 7305 or SOIL 7305

SOIL 8450: Nonthesis Research in Soil Science
Research not expected to terminate in dissertation.
Credit Hour: 1-9

SOIL 8500: Chemistry of the Vadose Zone
(same as ENV_SC 8500). Chemical reactions occurring in geomedia with emphasis on understanding molecular scale processes occurring at the solid-water interface, aqueous geochemistry, and soil organic matter.
Credit Hours: 3