Atmospheric and Earth Science

National Space Science and Technology Center
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Chair: Dr. John Mecikalski (https://www.uah.edu/science/departments/atmospheric-science/faculty-staff/john-mecikalski/)

The Atmospheric and Earth System Science department offers the following undergraduate degrees:


Program Objectives
The Department of Atmospheric & Earth Science provides academically rigorous programs to meet important national, regional, and statewide needs for highly technically-educated professionals who understand the Earth as a system and produces graduates who are able to perform a variety of functions in research centers and industry centered in our impact on the Earth system.

Learning Outcomes
Atmospheric and Earth System Science BS Graduates will:

- Demonstrate the ability to deal quantitatively with real-world problems
- Integrate knowledge from multiple disciplines to scientifically address Earth system issues quantitatively
- Work collaboratively in interdisciplinary teams
- Successfully carry out research projects to completion


- Atmospheric Science
- Earth Ecosystems (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-ecosystems-minor/)

The Atmospheric and Earth Science Department offers the following Undergraduate Certificate:

Geographic Information Systems & Remote Sensing Certificate

AES 100 - INTRODUCTION TO SPACE SCIENCE
Semester Hour: 1

Covers physiology in space, computer systems, and materials in space, robotics, thermodynamics, astrophysics, and solar physics. Laboratory experiments and simulated missions. Offered in cooperation with the U.S. Space & Rocket Center. Prerequisite: Available only to high school students with U.S. citizenship enrolled in Advanced Space Academy®.
AES 101 - EXPLORING SPACE SCIENCE AND ENGINEERING
Semester Hour: 1

Exploring Space Science and Engineering courses 1-9. Each course examines an aspect of space exploration including but not limited to space science, human factors, medicine, and engineering. Each course focuses on a single aspect. No more than three of the courses in the ESS 101 / AES 101 group may be taken for credit. The courses are offered through distance learning.

AES 103 - ENVIRONMENTAL EARTH SCIENCE
Semester Hours: 4

Principles and foundations of Earth and environmental science with lectures and labs on concepts in Earth system science. Applied science labs use applications and real-world examples from ecosystems, geology, soil science, water, pollution, agriculture, population, natural disasters, and energy.

AES 103L - LABORATORY
Semester Hours: 0

Laboratory instruction in support of material covered in AES 103.

AES 104 - WEATHER & CLIMATE CHANGE
Semester Hours: 4

An introduction to the atmosphere and climate system, including weather systems, climate extremes, and natural/human-induced changes in the atmosphere-climate systems. Major topics discussed include greenhouse effect, solar impacts on climate, El-Nino, climate change, atmospheric and ocean circulations, cyclones, hurricanes, thunderstorms, and tornadoes.

AES 104L - LABORATORY
Semester Hours: 0

Laboratory instruction in support of material covered in AES 104.

AES 105 - WORLD REGIONAL GEOGRAPHY
Semester Hours: 3

This course introduces the study of not only the location of places, but more importantly the physical and cultural features, economies, and population of the world's geographic regions. By exploring the interactions between people and their environment.

AES 110 - PRINCIPLES OF HUMAN GEOGRAPHY
Semester Hours: 3

This course serves as an introduction to geography as the science of location, through an emphasis on spatial patterns of human activities. The location of economic activities, location of cities as market and production centers, movement networks, and images and perceptions of landscapes form the core of the course.

AES 209 - DATA ANALYSIS TOOLS
Semester Hours: 2

Introduction to methods and techniques in data analysis for atmospheric and Earth system sciences. Using case studies and experts from multiple disciplines, students are exposed to GIS, scientific programming principles, satellite image processing, radar data and meteorological software. Course is lab-based, focused on computer software. Prerequisites: AES 103, AES 104 (minimum grade of C- required); CS 102 or CS 103 or CS 104 with concurrency.

AES 210 - COLLAPSE OF CIVILIZATIONS
Semester Hours: 3

This course will investigate why some cultures succeed and others fail. From archeological and historical records of past civilizations we will examine the factors which lead to collapse in an attempt to determine the future of current societies.

AES 212 - SEVERE WEATHER ANALYSIS
Semester Hours: 4

Meteorological analysis and beginning forecasting of weather systems, severe weather, snowstorms, hurricanes, and tornadoes through the interpretation of surface, upper air, satellite, and radar weather observations. Strong emphasis placed on unique observations of severe weather from UAH radar and profiling systems. Prerequisites: ESS 104 or ESS 111 or AES 104.

AES 212L - LABORATORY
Semester Hours: 0

Laboratory instruction in support of material covered in ESS 212 / AES 212.
AES 301 - INTRO TO EARTH & ATMOSPHERIC PHYSICS  
Semester Hours: 3  
This course will provide a survey of earth and atmospheric science for undergraduate students. Topics that will be covered will focus on how the earth-atmosphere system works in an integrated fashion. Prerequisites: AES 103, AES 104, (MA 120 or MA 171 or MA 171S), and (PH 101 or PH 111).

AES 302 - PEOPLE, PLANTS, & ENVIRONMENT  
Semester Hours: 3  
This course is designed to introduce students from multiple departments to the vital roles that plants have in our ecosystems through the study of basic plant and soil science. Special attention is placed on the impact plants have on our technology-based society. Sophomore standing or above.

AES 303 - CLASSIFICATION & PHYSICAL CAUSES OF CLIMATE  
Semester Hours: 3  
Basic atmospheric structure and physical processes, surface processes, climate history and climate change, land use and land change, microclimates, topoclimates, Ecoclimatology. Prerequisites: AES 103, AES 104, and (MA 120 or MA 171 or MA 171S), and (PH 101 or PH 111).

AES 305 - HYDROLOGY  
Semester Hours: 3  
Introduction to hydrologic cycles and concepts of how water interacts with the environment. Covers water properties, precipitation, groundwater and runoff, currents, waves, sediment processes, and conservation strategies. Prerequisites: AES 103, AES 104, and (MA 120 or MA 171 or MA 171S), and (PH 101 or PH 111).

AES 307 - ENVIRONMENTAL ARCHEOLOGY  
Semester Hours: 3  
Archeologists today need a wide range of scientific approaches in order to delineate and interpret the ecology of their sites. This approach is revolutionizing archeology making it relevant to the modern-day world. Climate modeling, remote sensing, and GIS are investigated in this course. Prerequisite: AES 103.

AES 312 - PRINCIPLES OF ECOLOGY  
Semester Hours: 3  
Lecture/Lab One 3 hour lab a week. Ecological principles controlling plant and animal populations. Development of ecosystems, communities and habitats. Field trips required. Strongly recommend CH 101 or CH 121. Prerequisite: BYS 120.

AES 313 - GEOGRAPHIC INFORMATION SYSTEMS  
Semester Hours: 3  
Introduction to scientific spatial analysis concepts and spatial data processing with focus on ESRI ArcGIS software. Basic concepts in GIS data management and creation, with topics including raster and vector data, projections, data query, data acquisition, and cartography. Prerequisites: AES 103 and choose 1: CS 102, CS 103, or CS 104.

AES 321 - POLLUTION PROBLEMS  
Semester Hours: 3  
Quantitative study of environmental conditions, processes, and problem-solving techniques related to specific pollution problems in air, water, and land. Prerequisites: AES 103, AES 104, (MA 120 or MA 171 or MA 171S), (CH 101 or CH 121), and (PH 101 or PH 111).

AES 341 - THERMODYNAMIC METEOROLOGY  
Semester Hours: 3  
Introduction to atmospheric thermodynamics with an emphasis on applications in meteorology, including the equation of state, Zeroth, First and Second Laws of Thermodynamics, adiabatic processes, moist processes, static stability, stability of moist air, and severe weather applications. Prerequisites: AES 209, AES 212, AES 301 and Choose 1: CS 102, CS 103, or CS 104. Prerequisites with concurrency: MA 201, PH 112.

AES 351 - DYNAMIC METEOROLOGY  
Semester Hours: 3  
Dynamics and kinematics of atmospheric flow. Meteorological coordinate systems. Fundamental governing equations of atmospheric motion, circulation, and vorticity. Prerequisites: PH 111, AES 301, Choose 1: CS 102 or CS 103 or CS 104. Prerequisites with concurrency: MA 201.

AES 352 - SYNOPTIC METEOROLOGY  
Semester Hours: 3  
Analysis, interpretation, and forecasting synoptic-scale and mesoscale phenomena, including air masses, frontal systems, cyclones, anti-cyclones, tropical cyclones, and associated mesoscale phenomena. Emphasis is placed on the use of remote sensing data from satellites, radars, and profilers using state-of-the-art workstations. Prerequisites: AES 212, AES 341, AES 351.
AES 370 - INTRODUCTION TO REMOTE SENSING
Semester Hours: 3

This course introduces the fundamental physics of remote sensing systems and incorporates hands-on exercises of image processing, information extraction and interpretation, and basic applications of airborne and satellite data in Earth System Science and Atmospheric Science. Prerequisites: AES 103, AES 104, (MA 120 or MA 171 or MA 171S), (PH 101 or PH 111), and (CS 102 or CS 103 or CS 104).

AES 402 - SCIENTIFIC & SOCIETAL ASPECTS OF NATURAL DISASTERS
Semester Hours: 3

Students will understand causes of major natural events and evaluate effects of disasters on populations and possible mitigation measures. GIS software will be used to show progression of events and/or their impacts using course case studies. Prerequisites: AES 103 and AES 104.

AES 407 - ENVIRONMENTAL THREATS, PUBLIC POLICY, & DECISION MAKING
Semester Hours: 3

Researchers, policymakers, and environmental campaigners have identified twenty-five potential future threats to the global environment. This course examines the nature and consequences of these threats and their potential impacts for the survival of the human race. Prerequisite: AES 103.

AES 408 - PYTHON FOR GIS
Semester Hours: 3

Introduction to GIS model building, Python programming, and automation of scripts for ArcGIS. Techniques in Model Builder, Python, and the methods for automation will be taught using data from numerous available data sources across the internet with heavy emphasis on the Earth Sciences. Prerequisite: AES 313.

AES 409 - SCIENTIFIC PROGRAMMING FOR EARTH & ATMOSPHERIC SCIENTISTS
Semester Hours: 3

Survey of data types and languages commonly used in the meteorological community along with practical applications to meteorology. Course is designed to prepare students for graduate work and research in atmospheric science. Prerequisite: (CS 102 or CS 103 or CS 104); AES 301; MA 172; (PH 112 and PH 115).

AES 410 - OPERATIONAL WEATHER FORECASTING
Semester Hours: 3

Subjective and objective methods of atmospheric prognosis. Techniques for forecasting critical weather elements. Interpretation, use and systematic errors of computer-generated products, human factors with forecasting, and application of meteorological theory in an operational setting. Prerequisites: AES 341, AES 351, AES 352.

AES 414 - GEOSPATIAL APPLICATIONS
Semester Hours: 3

An introductory look at the ways in which GIS can be put to use in different fields of study, drawing examples from Demography, Sociology, Archaeology, History, and Ecology. Focus on cartography and map creation principles and public geospatial data acquisition. Prerequisite: AES 313.

AES 415 - ADVANCED TOPICS IN GIS
Semester Hours: 3

Advanced continuation of concepts applied in Geospatial Applications. Students will learn through modules of real world scientific research how to use further tools in ArcGIS including: 3D Analyst, Spatial Analyst, Network Analyst. Topics include web data dissemination, spatiotemporal analysis and some basic spatial statistics measures. Prerequisite: AES 414.

AES 420 - INTRODUCTION TO ATMOSPHERIC CHEMISTRY & AIR POLLUTION
Semester Hours: 3

This self-contained introductory course in atmospheric chemistry and air pollution is designed to provide students the basics of atmospheric chemistry and air pollution concepts. Topics include air pollutants, air-pollution meteorology, atmospheric gases and aerosols, and atmospheric processes. Prerequisites: AES 301, AES 321, PH 112, PH 115, CH 121, CH 125.

AES 441 - ATMOSPHERIC THERMODYNAMICS & CLOUD PHYSICS
Semester Hours: 3

General aspects of thermodynamics and cloud physical processes occurring within the atmosphere; atmospheric statics and stability, saturation point analysis, aerosols, nucleation, and the behavior/growth of cloud particles and hydrometeors. Prerequisites: AES 341, MA 238, PH 112 and PH 115.

AES 451 - ATMOSPHERIC FLUID DYNAMICS I
Semester Hours: 3

Fluid dynamics in the atmosphere. Coriolis acceleration, scale analysis and appropriate approximations of the complete governing equations. Numerical analysis and interpretation of weather phenomena. Same as ATS 451. Prerequisites: AES 351, MA 238, PH 112 and PH 115.
AES 454 - FORECASTING MESOSCALE PROCESSES
Semester Hours: 3
Detection and forecasting of atmospheric mesoscale phenomena including the structure and evolution of clouds, precipitation (including floods), thunderstorms, and severe weather. Includes basics of instruments used to detect mesoscale phenomena, most notably satellite and radar. Prerequisite: AES 352.

AES 461 - ATMOSPHERIC RADIATION I
Semester Hours: 3
Fundamentals of terrestrial atmospheric radiation. Topics include: basic concepts, radiative transfer equation, gaseous absorption, scattering by molecules and particles, band models, transmittance along an inhomogeneous path. Prerequisite: AES 301, MA 238, PH 112 and PH 115.

AES 471 - RADAR METEOROLOGY
Semester Hours: 3
Introduction to principles of radar meteorology, including radar operations, hardware, interpretation and analysis. Doppler, dual-polarization and dual-wavelength radar theory, methods and applications are covered. Prerequisites: AES 341 (minimum grade of C-) and AES 408, AES 409 with concurrency.

AES 472 - SATELLITE METEOROLOGY
Semester Hours: 3
The goal for this course is to provide students in undergraduate and graduate-level Earth and Atmospheric Science a background in satellite meteorology. During all components of the course there will be a heavy emphasis on practical meteorological satellite interpretation with respect to land surface and especially atmospheric features. Prerequisites: AES 212 and AES 301. Prerequisites with Concurrency: AES 408 or AES 409.

AES 490 - SPECIAL TOPICS IN EARTH & ATMOSPHERIC SCIENCE
Semester Hours: 1-3
Special offerings to students in areas of interest not covered in the present curriculum. Prerequisite: permission of instructor.

AES 495 - DIRECTED STUDY
Semester Hours: 2-4
Supervised special study topics for undergraduates; often is offered to undergraduates who have senior standing. Individual students identify and obtain consent from a faculty mentor.

AES 497 - UNDERGRADUATE INTERNSHIP
Semester Hours: 3
Individual internships in fields directly related to atmospheric or Earth system science. Student must show acceptance into a formal internship program, and the course requires approval by department chair and consent by the internship supervisor.

AES 498 - RESEARCH & PROFESSIONAL DEVELOPMENT CAPSTONE
Semester Hour: 1
Applied concepts for professional and research development. Includes evaluation and discussion of published literature and department seminars, with focus on research synthesis and critique. Also includes development of professional and career skills focused on the Earth and Atmospheric Sciences. Junior or senior standing required.

AES 499 - UNDERGRADUATE RESEARCH
Semester Hours: 2-4
For advanced earth system science students. Individual investigations into earth systems science problems under direct supervision of a research mentor. Research is conducted and thesis-style paper is written and orally presented. Students identify and obtain consent from a faculty research mentor. Prerequisite: AES 498.