Atmospheric Science

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Chair: Dr. John Mecikalski, Professor (https://www.uah.edu/science/departments/atmospheric-science/faculty-staff/john-mecikalski/)

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

- Earth System Science, BS - Atmospheric Science/Meteorology Concentration (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-system-sciences-bs-atmospheric-science-meteorology-concentration/)
- Earth System Science, BS - Geographic Information Systems (GIS) & Remote Sensing Concentration (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-system-sciences-bs-geographic-information-systems-gis-remote-sensing-concentration/)
- Earth System Science, BS - Human Dimensions - Societal Impacts (HDSI) Concentration (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-system-sciences-bs-human-dimensions-societal-impacts-concentration/)

Program Objectives

The two primary objectives of the AES program are to meet important national, regional and statewide needs for highly technically-educated professionals who understand the Earth as a system, and to produce graduates who will be 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

Majors in Atmospheric and Earth System Science

- `Earth System Science, BS - Atmospheric Science/Meteorology Concentration (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-system-sciences-bs-atmospheric-science-meteorology-concentration/)`
- `Earth System Science, BS - Geographic Information Systems (GIS) & Remote Sensing Concentration (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-system-sciences-bs-geographic-information-systems-gis-remote-sensing-concentration/)`
- `Earth System Science, BS - Human Dimensions - Societal Impacts (HDSI) Concentration (http://catalog.uah.edu/undergrad/colleges-departments/science/earth-system-sciences/earth-system-sciences-bs-human-dimensions-societal-impacts-concentration/)`

ATS 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.

ESS 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®.

ESS 101 - EXPLORING SPACE SC & ENGR
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 group may be taken for credit. The courses are offered through distance learning.

ESS 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.

ESS 103L - LABORATORY
Semester Hours: 0

ESS 104 - WEATHER & CLIMATE CHANGE
Semester Hours: 4

Intro 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.

ESS 104L - LABORATORY
Semester Hours: 0

ESS 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.

ESS 110 - PRINCIPLES OF HUMAN GEOGRAPHY
Semester Hours: 3

This course serves as an introduction to geography as the science of location, emphasis on spatial patterns of human activities. 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.

ESS 111 - WEATHER, CLIMATE & GLOBAL CHNG
Semester Hours: 4

Intro to the atmosphere and climate system, including weather systems, climate extremes, and natural / human-induced changes in the atmosphere - climate system. Major topics discussed include greenhouse effect, solar impacts on climate, El-Nino, climate change, atmospheric and ocean circulations, cyclones, hurricanes, thunderstorms, and tornadoes. Course changed to ESS 104 effective Fall 2020.

ESS 111L - LABORATORY
Semester Hours: 0

Course changed to ESS 104L effective Fall 2020.

ESS 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.

ESS 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.

ESS 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. Prerequisite: ESS 104 or ESS 111.

ESS 212L - LABORATORY
Semester Hours: 0

Laboratory. Prerequisite: ESS 104 or ESS 111.

ESS 301 - INTRO TO EARTH & ATMOSPHC PHYS
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: ESS 103, (ESS 104 or ESS 111), (MA 120 or MA 171), and (PH 101 or PH 111).

ESS 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.

ESS 303 - CLASSI & PHYSICAL CAUSES CLIM
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: ESS 103, (ESS 104 or ESS 111), (MA 120 or MA 171), and (PH 101 or PH 111).

ESS 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: ESS 103, (ESS 104 or ESS 111), (MA 120 or MA 171), and (PH 101 or PH 111).

ESS 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. Investigated in this course includes climate modeling, remote sensing, and GIS. Prerequisite: ESS 103.

ESS 312 - PRINCIPLES OF ECOLOGY
Semester Hours: 4

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 121. Prerequisite: BYS 120.

ESS 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: ESS 103. Choose 1: CS 102, CS 103, or CS 104.

ESS 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: ESS 103, (ESS 104 or ESS 111), (MA 120 or MA 171), (CH 101 or CH 121), and (PH 101 or PH 111).

ESS 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: ESS 301 and Choose 1: CS 102, CS 103, or CS 104. Prerequisites with concurrency: MA 201, PH 112.

ESS 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, ESS 301, (CS 102 or CS 103 or CS 104), and MA 201 (with concurrency).

ESS 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. Prerequisite: ESS 212, ESS 341, ESS 351.

ESS 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: ESS 103, (ESS 104 or ESS 111), (MA 120 or MA 171), (PH 101 or PH 111), and (CS 102 or CS 103 or CS 104).

ESS 402 - SCI & SOC ASPTS NATRL DISASTER
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, with course case studies. Prerequisites: ESS 103 and (ESS 104 or ESS 111).

ESS 407 - ENV THRTS, PUB POLY, & DEC MKG
Semester Hours: 3

Researchers, policymakers and environmental campaigners have identified 25 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: ESS 103.

ESS 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: ESS 313.

ESS 409 - SCI PROGRMNG FOR EARTH & ATMOS
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); ESS 301; MA 172; (PH 112 and PH 115).

ESS 410 - OPERATIONAL WEATHER FORECAST'G
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: ESS 341, ESS 351, ESS 352.

ESS 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: ESS 313.

ESS 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: ESS 414.

ESS 420 - INTRO ATMOSP CHEM & AIR POLLU
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: PH 112, PH 115, CH 121, ESS 301 and ESS 321.

ESS 441 - ATMOSP THERMODY & CLOUD PHYSIC
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: ESS 341, MA 238, PH 112 and PH 115.

ESS 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: ESS 351, MA 238, PH 112 and PH 115.

ESS 454 - FORECASTING MESOSCALE PROC
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: ESS 352.

ESS 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: ESS 301, MA 238, PH 112 and PH 115.

ESS 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. Prerequisite: ESS 341, ESS 409.

ESS 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: ESS 212 and ESS 370. Prerequisites with Concurrency: ESS 408 or ESS 409.

ESS 490 - SPEC TOPICS EARTH & ATMOSPH SC
Semester Hours: 1-3

Special offerings to students in areas of interest not covered in the present curriculum. Prerequisite: permission of instructor.

ESS 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.

ESS 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.

ESS 498 - RESEARCH & PROF DEV 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.

ESS 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.

ESS 501 - SURVEY ATMOSPHERIC SCIENCE
Semester Hours: 3

General survey of the field of atmospheric science includes thermodynamics, atmospheric dynamics, cloud physics, and atmospheric radiation. Quantitative examination of atmospheric properties including atmospheric composition, structure and dynamics.

ESS 502 - SCI & SOC ASPTS NATRL DISASTER
Semester Hours: 3

Examination of the physical causes of major natural geophysical hazards and their impact on the natural and built environment, society and the economy. Evaluation of the ability to forecast events, and develop sound mitigation and recovery measures. Specific case studies are considered.

ESS 507 - ENVRNMTL THRTS PBL PY DEC MKG
Semester Hours: 3

Researchers, policymakers and environmental campaigners have identified 25 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.

ESS 508 - PYTHON FOR ID ESS APPLICATIONS
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.

ESS 509 - SCI PROGRMNG FOR EARTH & ATMOS
Semester Hours: 3

Survey of data types and languages commonly used in the meteorological community along with practical application to meteorology. Course is designed to prepare students for graduate work and research in atmospheric science.

ESS 510 - OPERATIONAL WEATHER FORECAST'G
Semester Hours: 3

Operational Meteorology covers subjective and objective methods of atmospheric prognosis, including techniques for forecasting operationally-important weather elements. Course explores interpretation, use and systematic errors of computer-generated products, human factors within forecasting, and application of meteorological theory in an operational setting. Course instruction is accomplished through analysis of various weather events from beginning to completion.

ESS 514 - 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.

ESS 515 - 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: ESS 514.

ESS 561 - ATMOSPHERIC RADIATION I
Semester Hours: 3

ESS 590 - SPECIAL TOPICS IN ESS
Semester Hours: 3

Selected topics of interest not included under other courses.

ESS 610 - LAND USE APP & SUSTAINABILITY
Semester Hours: 3

Study of land use and sustainability issues using satellite image processing and GIS. International examples of urbanization, agriculture, transportation, water management, and natural resources exploitation. Discussions of current literature and quantitative analyses of satellite and situ data. Prerequisite: ESS 515 or consent of instructor.

ESS 612 - ADV GIS EARTH ATMOSPHERE PROBL
Semester Hours: 3

Advanced GIS and remote sensing/image processing. Discussion, guided readings, and group labs to interact with student peers and instructor to develop geospatial solutions to problems relevant to their thesis research including appropriate research design, data collection, and analysis. Prerequisites: ESS 515 and ESS 610.

ESS 625 - AIR POLL APP & DEC MAKG REMOTE
Semester Hours: 3

Course will review principles of air pollution, measurement methods, regulation, national and international standards and how research is used to make decisions regarding air quality. The course will use ground-based, satellite, and numerical modeling information through a case study approach. Prerequisites: ESS/ATS 501.

ESS 630 - PHYSICAL CLIMATOLOGY
Semester Hours: 3

This course examines the physical aspects of the global climate system, including the global energy balance, surface energy balance, hydrologic cycle, climate classification, ocean circulation, natural and anthropogenic climate change and other selected topics such as climate sensitivity. Prerequisites: ATS 501 or ATS 541.

ESS 632 - ENERGY, CLIMATE, ENVIRONMENT
Semester Hours: 3

This course focuses on energy and its impact on the environment including climate change and air pollution. Specific energy forms, such as fossil fuels, nuclear energy, solar energy, are discussed.

ESS 670 - SATELLITE REMOTE SENSING I
Semester Hours: 3

Using a hands on approach, this course covers a broad range of topics concerning digital image processing applied to the remote sensing of atmospheric, cloud and surface properties using various satellite data sets. Prerequisites: ESS 509.

ESS 676 - REMOTE SENSING OF ENVIRONMENT
Semester Hours: 3

This course pursues both basic and advanced concepts in radiative transfer processes and retrieval algorithms of land surface biophysical variables from remote sensing observations, with an emphasis on the hands-on experience of data preprocessing and information extraction by using ENVI. Prerequisite: ESS 514.

ESS 680 - NUMERICAL MOD APPL ESS
Semester Hours: 3

This course will provide the physical basis for numerical model applications in the earth-atmosphere system including spatial and temporal scales. Prerequisites: ESS 501 and ESS 509.

ESS 690 - SPECIAL TOPICS IN ESS
Semester Hours: 3

Selected topics of interest not included under other courses.

ESS 698 - MASTERS CAPSTONE
Semester Hours: 3

An extended research project resulting in a substantive paper that involves the original collection, analysis and/or interpretation of scientific data and/or results. Conducted under the guidance of an advisor. Required for MS ESS non-thesis option.

ESS 699 - MASTER'S THESIS
Semester Hours: 3-6

A minimum of six thesis credit hours is required for MS degree.

ESS 780 - SEMINAR
Semester Hour: 1

Speakers are invited to report on research relevant to the field of Atmospheric and Earth System Science. Students are expected to attend at least twelve seminars and to write short descriptions of the presentations.

ESS 781 - STUDENT SEMINAR
Semester Hour: 1

Guest speakers reports on research relevant to the fields of Atmospheric and Earth System Science. Students are expected to attend weekly seminars, submit a paper based on at least ten talks, and make a 15 minute conference-type presentation on a research topic in atmospheric science selected in agreement with their advisor.

ESS 782 - PROFESSIONAL DEVELOPMENT
Semester Hour: 1

Topics concerning professional ethics, writing scientific journal articles, proposals and resumes, preparing budgets, networking, time management, conference presentations, research administration, funding agencies, stress and burnout will be discussed.