Atmospheric Science

NSSTC - Cramer Hall, Room 4044
Telephone: 256.961.7877
Email: chair@nsstc.uah.edu

Note: The Earth System Science degree programs are administered by the Atmospheric Science department.

Mission
The primary objectives of the ESS program are: 1) to meet important national, regional and statewide needs for highly technically-educated professionals who understand the Earth as a system, and 2) 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.

Specifically, that means that students will be trained with

1. the ability to deal quantitatively with real-world problems
2. the ability to integrate knowledge from multiple disciplines to scientifically address Earth system issues quantitatively, and
3. the ability to work in interdisciplinary teams.

Earth System Science B.S.
The BS degree in Earth System Science (ESS) consists of the University Charger Foundation general education requirements, the major core courses, the major elective courses, concentration courses, and ancillary requirements. Beyond these the student may elect other course work to attain 128 semester hours with at least 39 semester hours at the level of 300 or above. Some concentrations may require more than 128 semester hours of course work.

The B.S. in Program consists of:

• Major core
• Major electives
• Concentration Requirements
• BS General Education Requirements - Charger Foundations
• Ancillary requirements
• General electives

JUMP, Joint Undergraduate Master’s Program
http://www.uah.edu/graduate/admissions/jump

This program allows students to take up to 12 semester hours of graduate coursework that counts towards both the undergraduate and graduate degree.

See http://nsstc.uah.edu/ess/ess_jump_program.html to determine if you qualify.

Majors in Earth System Science


ATS 401 - SURVEY OF 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. Prerequisites: PH 112 and MA 172.
ATS 409 - APPS OF COMP IN METEOROLOGY
Semester Hours: 3
Survey of data types and languages commonly used in the meteorological community along with practical applications to meteorology. Prerequisites: ESS 301, CS 102, MA 172, PH 112 and PH 115.

ATS 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: ESS 111, ESS 112, ESS 301, MA 172, and PH 112.

ATS 411 - INTRO GEOGRAPHICAL INFO SYS
Semester Hours: 3
Introduces vector, raster and tabular concepts, emphasizing the vector approach. Topics include spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, application and availability of public data sets.

ATS 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. (Spring).

ATS 420 - INTRO ATMOS CHEM & AIR POLLUTI
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, CH 121, ESS 301, and ESS 321.

ATS 441 - ATMOS THERMODY & 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. Same as ESS 441. Prerequisites: ESS 301, PH 112 and MA 238.

ATS 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 ESS 451. Prerequisites: ESS 301, PH 112 and MA 238.

ATS 452 - 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: ATS 441 or ATS 451.

ATS 454 - FORECASTING MESOSCALE PROCESSE
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 451 or ATS 451.

ATS 456 - 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: ATS 441 or ATS 451.

ATS 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 and PH 112.

ATS 471 - INTRO TO 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: ESS/ATS 441, and ESS 301.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATS 490</td>
<td>SPECIAL TOPICS</td>
<td>3</td>
</tr>
<tr>
<td>ESS 100</td>
<td>INTRODUCTION TO SPACE SCIENCE</td>
<td>1</td>
</tr>
<tr>
<td>ESS 101</td>
<td>EXPLORING SPACE SC &amp; ENGR</td>
<td>1</td>
</tr>
<tr>
<td>ESS 102</td>
<td>PHYSICAL GEOLOGY</td>
<td>4</td>
</tr>
<tr>
<td>ESS 102L</td>
<td>PHYSICAL GEOLOGY LAB</td>
<td>0</td>
</tr>
<tr>
<td>ESS 103</td>
<td>ENVIR EARTH SCI FND &amp; APPLICA</td>
<td>4</td>
</tr>
<tr>
<td>ESS 103L</td>
<td>LABORATORY</td>
<td>0</td>
</tr>
<tr>
<td>ESS 110</td>
<td>PHYSICAL SCIENCE/CALHOUN</td>
<td>4</td>
</tr>
<tr>
<td>ESS 111</td>
<td>CLIMATE AND GLOBAL CHANGE</td>
<td>4</td>
</tr>
<tr>
<td>ESS 111L</td>
<td>CLIMATE &amp; GLOBAL CHG LAB</td>
<td>0</td>
</tr>
<tr>
<td>ESS 112</td>
<td>SEVERE &amp; HAZARDOUS WEATHER</td>
<td>4</td>
</tr>
<tr>
<td>ESS 112L</td>
<td>SEVERE &amp; HAZARD WEATHER LAB</td>
<td>0</td>
</tr>
<tr>
<td>ESS 210</td>
<td>COLLAPSE OF CIVILIZATIONS</td>
<td>3</td>
</tr>
<tr>
<td>ESS 301</td>
<td>INTRO TO EARTH &amp; ATMOSPHERIC SCI</td>
<td>3</td>
</tr>
</tbody>
</table>

Selected topics of interest not included in other courses.

Covers physiology in space, computer systems, materials, in space, robotics, thermodynamics, astrophysics, and solar physics. Laboratory experiments and simulated missions. Offered in cooperation with the Alabama Space and Rocket Center. Open only to students enrolled in Space Academy II.

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.

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.

Intro to climate system including natural and human-induced changes in this system. Includes greenhouse effect, ozone depletion, pollution, urban heat island processes, continental drift effects, glacial melting and sea level changes, atmospheric and ocean circulations, solar activity variability.

Weather systems, severe weather, hurricanes, weather forecasting, interpretation of current conventional surface-based, satellite and radar weather observations. Prerequisite: ESS 111.

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.

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 111, (PH 101 or PH 111), and (MA 120 or MA 171).
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 301.

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 301.

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 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 301 and either CH 101 or 121.

ESS 370 - INTRODUCTION TO REMOTE SENSING  
Semester Hours: 3  
This course investigates the basic physical principles of remote sensing systems and discuss the processing, interpretation, and applications of airborne and satellite data. Prerequisites: ESS 103, ESS 111, (MA 120 or MA 171), (PH 101 or PH 111), and CS 102.

ESS 401 - SURVEY OF ATMOSPHERIC SCIENCE  
Semester Hours: 3  

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.

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 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. Prerequisites: CS 102 and ESS 301.

ESS 409 - APPLI COMPUTERS IN METEOROLOGY  
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, ESS 301, MA 172, and PH 112. Or consent of instructor.
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 111, ESS 112, ESS 301, MA 172, and PH 112.

ESS 411 - INTRO TO GEOGRAPHICAL INFO SYS
Semester Hours: 3

Introduces vector, raster and tabular concepts, emphasizing the vector approach. Includes spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, applications and availability of public data sets. Prerequisite: CS 102.

ESS 413 - GIS & REMOTE SENSING
Semester Hours: 3

Spatial data processing with focus on ESRI ArcGIS and ENVI software. Basic concepts in GIS data management and creation and scientific use of satellite imagery. Topics include image interpretation, classification, transformations, raster and vector data, projections, data query, and cartography. Prerequisite: CS 102 and ESS 301.

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 301 and ESS 413.

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 301 and 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, 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. Same as ATS 441. Prerequisites: ESS 301, MA 238, PH 112.

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 301, MA 238, and PH 113.

ESS 452 - 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 301, ESS 441 and ESS 451.

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 301, and either ESS 451 or ATS 451.
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, and PH 112.

ESS 471 - INTRO TO 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 301 and ESS 441 or ATS 441.

ESS 490 - SELECTED TOPICS IN ENVIRON SCI
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
Specialized research for undergraduates often is offered to undergraduates who have senior standing.

ESS 498 - UNDERGRAD CAPSTONE PROPOSAL
Semester Hour: 1
Students will identify an Earth system science problem and formulate their capstone research proposal under the direct supervision of a research advisor during this first semester of this two-part capstone. Must be followed by ESS 499 to complete the capstone research project. Prerequisite: taken in senior year and with consent of department.

ESS 499 - UNDERGRADUATE RESEARCH
Semester Hours: 2
Individual investigations into Earth system science problems under direct supervision of a capstone research advisor. Research is conducted and thesis-style paper is written and orally presented. This course follows ESS 498 during which the research proposal was formulated. Prerequisite: ESS 498 with a grade of S; taken in senior year and with departmental approval.

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 - APPLI COMPUTERS IN METEOROLOGY
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 511 - INTRO GEOGRAPHICAL INFO SYS
Semester Hours: 3
Introduces vector, raster and tabular concepts, emphasizing the vector approach. Topics include spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, applications and availability of public data sets.

ESS 513 - GIS & IMAGE PROCESSING
Semester Hours: 3
Spatial data processing with focus on ESRI ArcGIS and ENVI software. Basic concepts in GIS data management and creation and scientific use of satellite imagery. Topics include image interpretation, classification, transformations, raster and vector data, projections, data query, and cartography.

ESS 514 - GEOSPATIAL APPLICATIONS
Semester Hours: 3
Advanced concepts in Earth science geospatial applications, primarily using ArcGIS. Topics can include geostatistical analysis, 3D terrain analysis, advanced data sources, raster manipulation, geodatabase design, suitability and network modeling.

ESS 515 - ADVANCED TOPICS IN GIS
Semester Hours: 3
Advanced concepts in Earth science geospatial applications, primarily using ArcGIS. Topics can include geostatistical analysis, 3D terrain analysis, advanced data sources, raster manipulation, geodatabase design, suitability and network modeling. Prerequisite: ESS 514 or consent of instructor.

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 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 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.