Atmospheric and Earth Science

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

The Atmospheric and Earth Science department offers the following graduate degree programs:

Master of Science - Atmospheric Science (http://catalog.uah.edu/grad/colleges-departments/science/atmospheric-science/atmospheric-science-ms/)
Master of Science - Earth Systems Science (http://catalog.uah.edu/grad/colleges-departments/science/earth-system-science/earth-system-science-ms/)
Doctor of Philosophy - Atmospheric Science (http://catalog.uah.edu/grad/colleges-departments/science/atmospheric-science/atmospheric-science-phd/)

The Atmospheric and Earth Science department offers the following graduate degree certificate:

Graduate Certificate in Geographic Information Systems & Remote Sensing (http://catalog.uah.edu/grad/colleges-departments/science/atmospheric-science/gradcert-gis_rs/)

Admission Requirements
Refer to the Graduate Program Admission Requirements webpage (https://www.uah.edu/science/departments/atmospheric-earth-science/aes-graduate-programs/admission-requirements/) for general admission and degree requirements. The applicant should have training through a calculus sequence (including the calculus of vector-valued functions), a course in linear algebra, and courses in ordinary and partial differential equations. He or she should also have completed at least two semesters of chemistry, two semesters of calculus-based physics and have demonstrable computer proficiency in at least one high-level programming language.

Program Objective
The Atmospheric Science Department’s first objective is to produce graduates who are successful in writing scientific research papers in peer-reviewed scientific journals and in making presentations at national or international scientific conferences and workshops. Our second objective is to produce graduates who successfully obtain employment as research scientists in a research center, government lab, or corporation, or in academic positions at a university.

Learning Outcomes
Students will demonstrate:

• Knowledge of the reviewed literature in atmospheric science that is relevant to their specific research
• Proficiency in scientific methodology while successfully carrying out a research project from concept to completion
• Effective oral communication skills in reporting the results of their scientific research

Graduate Certificate
• Graduate Certificate in Geographic Information Systems & Remote Sensing (http://catalog.uah.edu/grad/colleges-departments/science/atmospheric-science/gradcert-gis_rs/)

Master's Programs in Atmospheric Science
• Atmospheric Science, MS (http://catalog.uah.edu/grad/colleges-departments/science/atmospheric-science/atmospheric-science-ms/)
• Earth System Science, MS (http://catalog.uah.edu/grad/colleges-departments/science/earth-system-science/earth-system-science-ms/)

Doctoral Program in Atmospheric Science
• Atmospheric Science, PhD (http://catalog.uah.edu/grad/colleges-departments/science/atmospheric-science/atmospheric-science-phd/)
AES 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.

AES 502 - SCIENTIFIC & SOCIETAL ASPECTS OF NATURAL DISASTERS  
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.

AES 507 - ENVIRONMENTAL THREATS, PUBLIC POLICY, & DECISION MAKING  
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.

AES 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.

AES 509 - SCIENTIFIC PROGRAMMING FOR EARTH & ATMOSPHERIC SCIENTISTS  
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.

AES 510 - OPERATIONAL WEATHER FORECASTING  
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.

AES 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.

AES 515 - ADVANCED TOPICS IN GIS  
Semester Hours: 3  
Advanced special topics: visualization of GIS and remote sensing data, landscape characterization (pattern vs. process), multitemporal analysis, aggregation of data types, developing an integrated GIS environment for performing complex space-time modeling analyses, and land-atmosphere interactions. Same as AES 415.

AES 520 - INTRODUCTION TO ATMOSPHERIC CHEMISTRY & AIR POLLUTION  
Semester Hours: 3  
An introduction designed to provide students with the basics of atmospheric chemistry and air pollution concepts. Topics include air pollutants, air-pollution meteorology, atmospheric gases and aerosols, and atmospheric processes.

AES 541 - ATMOSPHERIC THERMODYNAMICS & CLOUD PHYSICS  
Semester Hours: 3  
Thermodynamic & cloud physical processes in the atmosphere. Atmospheric statics & stability. Role of aerosols in nucleation of cloud and ice particles. Physical processes that produce the growth of hydrometeors in cold and warm clouds. Applicable measurement techniques.

AES 551 - 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.
AES 554 - 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. Prerequisites: AES 551.

AES 561 - 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, and transmittance along an inhomogeneous path.

AES 571 - INTRODUCTION TO RADAR METEOROLOGY  
Semester Hours: 3  
Introduction to principles of radar meteorology, including radar operations, hardware, interpretation, and analysis. Topics covered include doppler, dual-polarization and dual-wavelength radar theory, methods, and applications. Prerequisite: AES 541.

AES 572 - 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 508 or AES 509.

AES 590 - SPECIAL TOPICS IN AES  
Semester Hours: 1-3  
Selected topics of interest not included under other courses.

AES 603 - CLIMATE DYNAMICS  
Semester Hours: 3  
Origin and evolution of the climate system including underlying causes for past climates such as occurred during the ice ages. Statistical processing of various time series to extract climactic signals in the data. Determination of global-scale forcing mechanisms, which impact climate. Prerequisites: AES 541 and AES 551.

AES 606 - DATA ANALYSIS ATMOSPHERIC SCIENTISTS  
Semester Hours: 3  
A theoretical and practical introduction to various data analysis methods commonly used in atmospheric science. Topics include forecasting techniques to generate models to fit data, model assessment using parametric tests, probability theory, and Monte Carlo methods to solve a variety of problems. Prerequisite: AES 509.

AES 610 - LAND USE APPLICATIONS & 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: AES 515 or consent of instructor.

AES 612 - ADVANCED GIS FOR EARTH AND ATMOSPHERE PROBLEMS  
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: AES 515 and AES 610.

AES 620 - ATMOSPHERIC CHEMISTRY & AEROSOLS  
Semester Hours: 3  
Primary processes, thermodynamics, photochemistry, kinetics, models, and measurements applied to troposphere and stratosphere; natural and anthropogenic; chlorine, nitrogen, hydrogen, and oxygen catalytic cycles; ground- and satellite-based observations of trace species. Prerequisite: AES 520.
AES 622 - AIR POLLUTION MODELING
Semester Hours: 3

Air pollution Lagrangian and Eulerian modeling concepts and methods from micro to synoptic scales; plume, large eddy simulations and urban-regional models in research and regulatory applications; transport, dispersion, chemistry, clouds, aerosols, and wet/dry deposition. Prerequisites: AES 520 and AES 551.

AES 624 - AEROSOLS AND CLOUDS
Semester Hours: 3

Principles of atmospheric aerosols and clouds, including chemistry, physics, dynamics and their roles on climate and air quality. Prerequisites: AES520.

AES 625 - AIR POLLUTION APPLICATIONS & DECISION MAKING
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. Prerequisite: AES 501.

AES 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, and ocean circulation, natural and anthropogenic climate change and other selected topics such as climate sensitivity. Prerequisite: AES 501 or AES 541.

AES 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, and solar energy, are discussed.

AES 635 - GENERAL CIRCULATION
Semester Hours: 3

Detailed examination of the observed dynamic, thermodynamic and chemical structure of the atmosphere, including mid-latitude baroclinic systems, tropical systems, global-scale energy, mass and momentum budgets, and the fundamental climatology of the atmosphere. Prerequisites: AES 541 and AES 551.

AES 642 - PRECIPITATION PHYSICS FOR RADAR
Semester Hours: 3

Cloud microphysics theory, models, in-situ and radar observations of hydrometers will be utilized together to explore advanced concepts in precipitation physics and their connection to radar meteorology, including coalescence, break-up, freezing, size sorting, aggregation, rimming, and melting. Prerequisites: AES 541 and AES 571.

AES 651 - ATMOSPHERIC FLUID DYNAMICS II
Semester Hours: 3

Wave motions in the atmosphere with emphasis of Rossby, Kelvin and gravity waves. Systematic scaling of primitive equations to develop quasi-geostrophic and Ekman-layer theory. Shallow water theory, stratified flows, and barotropic and baroclinic instability. Prerequisite: AES 551.

AES 652 - ADVANCED SYNOPTIC METEOROLOGY
Semester Hours: 3

Analysis, interpretation, and forecasting synoptic-scale, and mesoscale phenomena, including air masses, frontal systems, cyclones, anticyclones, and waves toward understanding process dynamics. Emphasize the use of observational, satellite and numerical model data, including radars and profilers. Prerequisites: AES 541 and AES 551.

AES 655 - BOUNDARY LAYER METEOROLOGY
Semester Hours: 3

Survey of atmospheric boundary layer (ABL) properties. Review of turbulence, convective and stable boundary layers, surface forcing, boundary layer discontinuities, and singular phenomena within the ABL. Atmospheric field measurements are used to enhance understanding of ABL process. Prerequisites: AES 541 and AES 551.
AES 656 - TROPICAL METEOROLOGY  
Semester Hours: 3  
Overview concepts of the dynamics and climatology of the tropics and of significant tropical precipitation systems. Topics also include Kelvin waves, equatorial flows, convective scale dynamics, island meteorology, tropical cyclones, ENSO, radiative-convective equilibrium, and gregarious cloud systems. Prerequisites: AES 541 and AES 551.

AES 657 - NOWCASTING THEORY METHODS  
Semester Hours: 3  
Theory, methods and applications of 0-6 hour weather and ecological prediction, which is a forecast time period when numerical prediction models have low skill. Topics include predictability, data assimilation, statistical methods, and algorithms using Earth and atmospheric science observations.

AES 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. Prerequisite: AES 509.

AES 671 - GROUND BASED REMOTE SENSING  
Semester Hours: 3  
Principles and measurement capabilities of active and passive ground-based remote sensing systems: radar, wind profiler, lidar, sodar, and passive radiometer systems. Integration of remote sensing measurements to retrieve properties of atmospheric phenomena. Hands-on usage and field measurements. Prerequisite: AES 541.

AES 672 - DUAL POLARIZATION RADAR METEOROLOGY  
Semester Hours: 3  
Theory, analysis, and interpretation of dual polarization radar for meteorological applications. Course covers dual polarization radar system hardware; the basic theory underlying polarimetric radar data and methodology; analysis, interpretation and application of polarimetric radar variables; and dual meteorological and convective weather applications; specifically, precipitation measurement and hydrometeor identification. Example applications include rain rate estimation, drop size determination, hail identification, tornado detection, snow vs rain delineation, and cloud electrification studies. Prerequisite: AES 571.

AES 673 - LIGHTNING  
Semester Hours: 3  
An introduction to lightning. Topics include qualitative and quantitative description of lightning discharges; electrification of thunderstorms; temporal and spatial variation of lightning on multiple scales; various types of lightning; basic lightning models; current methods of measuring lightning. Prerequisite: AES 509.

AES 675 - ATMOSPHERIC DATA ASSIMILATION  
Semester Hours: 3  
Data assimilation methods and concepts including objective analysis and initialization as relevant to numerical weather prediction. Emphasis on a variation of methods, successive correction, optimal interpolation, adjoin and gradient concepts, singular vectors, Kalman filters, and nudging. Prerequisites: AES 541 and AES 551.

AES 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: AES 514.

AES 680 - NUMERICAL MODELING APPLICATIONS 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: AES 501 and AES 509.

AES 681 - NUMERICAL ATMOSPHERIC MODELING  
Semester Hours: 3  
Introduction to numerical methods applied to simulation of the atmosphere. Basic numerical solution techniques, along with filtering, radiative parameterizations, thermodynamics, turbulent parameterization, initialization, and coordinate transformation. Prerequisite: AES 551.
AES 690 - SPECIAL TOPICS IN ESS  
Semester Hours: 3  
Selected topics of interest not included under other courses.

AES 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.

AES 699 - MASTER'S THESIS  
Semester Hours: 1-6  
A minimum of six thesis credit hours is required for MS degree.

AES 740 - CLOUD PROCESSES  
Semester Hours: 3  
Theory and observations of the bulk microphysics and kinematic structures of clouds. Topics include: interactions among dynamical, microphysical and thermodynamic processes within cloud systems, the dynamics of organized convective systems, and remote sensing of clouds and precipitation features. Prerequisites: AES 541 and AES 551.

AES 761 - ATMOSPHERIC RADIATION II  
Semester Hours: 3  
Advanced topics in atmospheric radiative transfer. Specific topics include Maxwell equations, Mie theory, polarization and radiative transfer in a scattering atmosphere. Prerequisite: AES 561.

AES 770 - SATELLITE REMOTE SENSING II  
Semester Hours: 3  
Using various satellite data sets and radiative transfer models, this course will train students to calculate and study cloud, aerosol, ocean and land surface properties to assess the radiative energy budget of the earth-atmosphere system. Prerequisite: AES 670.

AES 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.

AES 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.

AES 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.

AES 790 - SELECTED TOPICS IN ATMOSPHERIC SCIENCE  
Semester Hours: 1-4  
Selected topics of interest not included under other courses.

AES 799 - DOCTORAL DISSERTATION  
Semester Hours: 9  
Required each semester student is enrolled and receiving direction on a doctoral dissertation.