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/)

Admission Requirements
Refer to the appropriate section of the Graduate Catalog 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 the 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

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/)

ATS 501 - 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.

ATS 509 - APPL COMPUTERS IN METEOROLOGY
Semester Hours: 3

Survey of scientific programming techniques used in atmospheric sciences. Various data types, control statements, and programming design using object oriented techniques are discussed with an emphasis on efficient programming. Course prepares students for graduate work and research in atmospheric science.
ATS 510 - OPERATIONAL WEATHER FORECASTING
Semester Hours: 3
Subjective and objective methods of atmospheric prognosis. Forecasting critical weather elements. Interpretation, use and systematic errors of computer-generated products, human factors, and application of meteorological theory in an operational setting.

ATS 513 - GIS & REMOTE SENSING
Semester Hours: 3
Hands-on approach to GIS and satellite remote sensing. Popular satellite data sets such as LANDSAT and AVHRR are coupled with GIS data sets to increase understanding of the earth system. Topics include satellite sensors, basic radiative transfer, orbits, raster formats, atmospheric correction, distortion, image corrections, rotations and mapping, spatial resolution, image interpretation, radiometric and geometric enhancement, multispectral transformations, and classifications. (Same as ATS 413, ES 413, ES 513.) Spring. Prerequisite: ATS 511 or ESS 511.

ATS 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 ATS 415, ES 415, ES 515.) Spring.

ATS 520 - INTRO ATMOS CHEM & 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.

ATS 522 - AIR POLLU:METEOROLOGY CONCEPTS
Semester Hours: 3

ATS 541 - ATM THERMODYN & 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.

ATS 551 - ATMOS 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.

ATS 553 - ATS RADIATN/REMOTE SENSING
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: ATS 551.

ATS 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.

ATS 571 - INTRO 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: ATS 541.

ATS 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: ESS 508 or ATS 509.
ATS 581 - ATS THERMODYNAMICS & CHEM  
Semester Hours: 3  

ATS 590 - SPECIAL TOPICS  
Semester Hours: 1-3  

Selected topics of interest not included in other courses.

ATS 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: ATS 541 and ATS 551.

ATS 606 - DATA ANALY ATMOSPHERIC SCNTS  
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. Prerequisites: ATS 509.

ATS 620 - ATMOSPHERIC CHEMISTRY & AEROSI  
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. Prerequisites: ATS 520.

ATS 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: ATS 520 and ATS 551.

ATS 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 change, and other selected topics such as climate sensitivity. Prerequisites: ATS 501 or ATS 541.

ATS 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: ATS 541 and ATS 551.

ATS 642 - PRECIP 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: ATS 531 and ATS 571.

ATS 651 - ATMOS 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. Prerequisites: ATS 551.

ATS 652 - ADV 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: ATS 541 and ATS 551.
ATS 654 - FORECASTING MESOSCALE PROCESSES
Semester Hours: 3

ATS 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: ATS 541 and ATS 551.

ATS 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: ATS 541 and ATS 551.

ATS 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.

ATS 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: ATS 509.

ATS 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. Prerequisites: ATS 541.

ATS 672 - DUAL POLARIZATION RADAR METROLOGY
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. Prerequisites: ATS 571.

ATS 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. Prerequisites: ATS 509.

ATS 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: ATS 541 and ATS 551.

ATS 681 - NUMERICAL ATMOS 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: ATS 551.

ATS 690 - SEL TOPICS IN ATMOS SCI
Semester Hours: 1-4

Selected topics of interest not included under other courses.
ATS 699 - MASTER'S THESIS
Semester Hours: 1-6

Required each semester a student is enrolled and receiving direction on a master's thesis.

ATS 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: ATS 541 and ATS 551.

ATS 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. Prerequisites: ATS 561.

ATS 762 - MICROPARTICLE OPT & RADIOMETRY
Semester Hours: 3


ATS 770 - SATELLITE REMOTE SENSING
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. Prerequisites: ATS 670.

ATS 780 - ATMOSPHERIC SCIENCE SEMINAR
Semester Hour: 1

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

ATS 781 - STUDENT SEMINAR
Semester Hour: 1

Guest speakers report 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. Prerequisite: ATS/ESS 780.

ATS 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. Selected topics of interest not included under other courses.

ATS 790 - SEL TOPICS IN ATMOS SCI
Semester Hours: 1-4

Selected topics of interest not included under other courses.

ATS 799 - DOCTORAL DISSERTATION
Semester Hours: 3-9

Required each semester student is enrolled and receiving direction on a doctoral dissertation.