

# Earth System Science

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**Chair:** Larry Carey, Associate Professor

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The Earth System Science department offers the following graduate degree programs:

- Master of Science - Atmospheric Science
- Master of Science - Earth Systems Science
- Doctor of Philosophy - Atmospheric Science

**The Earth System Science program is administered by the Department of Atmospheric Science.**

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## Admission Requirements

Refer to the appropriate section of the Graduate Catalog for general admission and degree requirements. Students should have an appropriate foundation with at least two semesters of calculus, two semesters of physics, an introductory course in computer programming, and preferably chemistry before entering the program. Please consult the department for guidance.

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## Program Objective

The M.S. in Earth System Science program specifically enables students to gain not only an understanding of the physics of the climate system and the environment but also a working hands-on knowledge of how data and information is used to aid decision makers. Our graduates will be successful in writing or presenting a scientific research paper in a peer-reviewed scientific journal, book chapter, or at a national or international scientific conference or workshop. Our final objective is to produce graduates who successfully obtain professional employment in the Earth System Science field within one year of graduation.

## Learning Outcomes

Students will demonstrate

- Knowledge of the reviewed literature in the earth system sciences that is relevant to their specific research
- Effective use of remotely sensed environmental data, image processing and GIS toward decision making or policy related applications in the earth system sciences
- Effective oral communication skills in reporting the results of their scientific research

## Master's Program in Earth System Science

[http://nsstc.uah.edu/ess/ess\\_ms.html](http://nsstc.uah.edu/ess/ess_ms.html)

**The Earth System Science program is administered by the Department of Atmospheric Science.**

Degree Requirements:

- To earn a master's degree in Earth System Science, each student must satisfy all requirements of the School of Graduate Studies and of the Atmospheric Science Department.
- Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, **before the end of the second semester.**
- Students must maintain a cumulative GPA of at least 3.0.

## Option 1 - Thesis

Minimum degree requirements under this plan include completion of at least 24 credit hours of core (9 credit hours) and elective (15 credit hours) course work and at least 6 credit hours of thesis research. At least 50% of the required 24 semester hours must be from 600 level (or higher) courses. In addition, all MS in ESS students are required to take 6 credit hours of supporting courses, which do not count toward minimum degree requirements.

**Required Core Courses**<sup>1</sup>

ESS 507	ENVRNMTL THRSTS PBL PY DEC MKG <sup>2</sup>	3
ESS 514	GEOSPATIAL APPLICATIONS <sup>2,3</sup>	3
ESS 630	PHYSICAL CLIMATOLOGY	3

**Required Supporting Courses**

ESS 508 or ESS 509	PYTHON FOR ID ESS APPLICATIONS APPLI COMPUTERS IN METEOROLOGY	3
ESS/ATS 780	SEMINAR	1
ESS/ATS 781	STUDENT SEMINAR	1
ESS/ATS 782	PROFESSIONAL DEVELOPMENT	1

**Elective Courses**

Select 15 semester hours of electives <sup>4,5</sup>		15
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**Thesis Credits**

ESS 699	MASTER'S THESIS	6
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<b>Total Semester Hours</b>		<b>36</b>
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- Students must earn a B or above in core courses.
- Students who have earned a B or better in the undergraduate equivalent of ESS 507, ESS 508 (or ESS 509) and ESS 514 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours to replace ESS 507 and ESS 514 at an appropriate level approved by their advisor and chair of the department.
- If a student has advanced GIS experience, the ESS 514 core may be replaced with an advanced course at the discretion of the Department Chair.
- 9 of these Elective semester hours must be from 600 level (or higher) courses.
- Three Elective semester hours **may be** outside of the ESS/ATS only with advisor's approval.

**Additional Information**

One of the goals of this program is to train the student in transitioning research and observational products related to Earth System Science into public policy and decision-making arenas. Therefore, it is necessary that the student spend time working with a decision-making organization. The student must submit a 5 page thesis proposal to be approved by the advisor and committee by the **end of the third full semester**.

**Option 2 - Non-Thesis**

Minimum degree requirements under this plan include completion of at least 30 semester hours of graduate course work, which includes core (12 CH) and elective courses (18 CH). At least 50% of the required 30 credit hours must be from 600 level (or higher) courses. Students are also required to take 6 credit hours of supporting courses. The supporting courses do not count toward minimum degree requirements.

**Required Core Courses**<sup>1</sup>

ESS 507	ENVRNMTL THRSTS PBL PY DEC MKG <sup>2</sup>	3
ESS 508 or ESS 509	PYTHON FOR ID ESS APPLICATIONS <sup>2</sup> APPLI COMPUTERS IN METEOROLOGY	3
ESS 514	GEOSPATIAL APPLICATIONS <sup>2,3</sup>	3
ESS 632	ENERGY, CLIMATE, ENVIRONMENT	3

**Elective Courses**

Select 3 semester hours from 500 or 600 level courses within ESS/ATS		3
Select 3 semester hours from 600 level courses within ESS/ATS		3
Select 3 semester hours from 500 or 600 level courses and may be outside of ESS/ATS <sup>4</sup>		3
Select 9 semester hours from 600 level courses and may be outside of ESS/ATS <sup>4</sup>		9

**Required Supporting Courses**

ESS 780	SEMINAR	1
ESS 781	STUDENT SEMINAR	1
ESS 782	PROFESSIONAL DEVELOPMENT	1

ESS 690	SPECIAL TOPICS IN ESS <sup>5</sup>	3
<b>Total Semester Hours</b>		<b>36</b>

- 1 Students must earn a B or above in core courses.
- 2 Students who have earned a B or better in the undergraduate equivalent ESS 507, ESS 508 (or ESS 509), and ESS 514 at UAH do not have to re-take the course at the graduate level. However, their Program of Study must include alternative semester hours at the appropriate level approved by their advisor and chair of the department.
- 3 If a student has advanced GIS experience, the ESS 514 core may be replaced with an advanced course at the discretion of the Department Chair.
- 4 Course selection from outside the department and colleges must be done with approval and guidance from faculty mentors and the department chair; faculty mentors will guide the student to pursue a coherent suite of complementary courses outside ESS.
- 5 ESS 690 Special Topics course will be replaced by ESS 690, Internship/MS Capstone course.

### Additional Information

Non-thesis students will pursue approved external internship programs with the help of their mentor; in the event that a student does not receive an external internship, they will be required to do a capstone project with an ATS faculty member or approved ESSC scientist/researcher.

### M.S. Supervisory Committee

The committee must consist of a minimum of three members and be approved by the Department Chair. Two of the three members must be full-time, tenured or tenure-earning, or emeritus faculty members in the department. The other member must be from a decision-making/end-user organization. The student must work closely with the advisor and the committee members to select a thesis topic. Advisors have the responsibility to shape the research and ensure that a thesis can be written and defended within the time needed for graduation.

### Comprehensive Examination/Thesis Defense

A final comprehensive examination is required of all candidates for a master’s degree. In accordance with the Graduate Studies Dates and Deadlines, a written notice of the time and place of the examination/defense must be sent to the Graduate Dean. After approval by the Graduate Dean, the Department Chair sends a copy of the written Notification of Oral Examination/Defense to the candidate and each member of the committee. The candidate will be examined primarily on the thesis but they may also be tested on relevant course work. The examination is conducted by a committee of at least three faculty members appointed by the Department Chair and approved by the Graduate Dean. The examination must be given at least six weeks before the end of the semester in which degree requirements are expected to be completed, and the results reported within two working days to the Graduate Dean. A student may take the examination only twice.

- **Thesis** candidates will be examined *primarily* on the thesis by a committee of at least three faculty members appointed by the Department Chair and approved by the Graduate Dean.
- **Non-thesis** students will write up a Masters-level research capstone project, present their findings in a formal presentation, and respond to questions from their faculty mentor, other faculty, and the public; successful and approved completion of this, as determined by the faculty mentor and department chair, will result in a pass for the non-thesis option.

### Paperwork

- Students must formulate an appropriate Program of Study (POS), in consultation with a faculty advisor and chair, before the end of the second semester.
- Application for Graduate Degree according to Graduate Studies *Dates & Deadlines*.
- Notification of Oral Examination/Defense according to Graduate Studies *Dates & Deadlines*.

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 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 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.