EARTH SYSTEM SCIENCE M.S.

Admission Requirements

Complete the following admission requirements:

University Admission criteria apply to Earth System Science, notably, that incoming students must have an undergraduate degree in a suitable field of study. Admission to Earth System Science (without concentration) is determined by an admissions committee. Admission to Earth System Science with concentration is determined by an admissions committee established within each concentration. Furthermore, the following concentrations have specific admission requirements:

- Hydrology: 1 year calculus, 1 year physics, and 1 year of either geology, chemistry, biology, or engineering
- Atmospheric and Climate Sciences: 1 year calculus, differential equations, chemistry
- Cryosphere and Solid Earth Geophysics: 1 year calculus, differential equations, and linear algebra (recommended: partial differential equations, computational physics)

Program Requirements

< Back to Department (http://catalog.uaf.edu/academic-departments/earth-system-science/)

Minimum Requirements for Earth System Science M.S.: 30 credits

CONCENTRATIONS: SUSTAINABILITY (P. 2), ECOSYSTEMS (P. 2), HYDROLOGY (P. 3), ATMOSPHERIC AND CLIMATE SCIENCES (P. 3), CRYOSPHERE (P. 4), SOLID EARTH GEOPHYSICS (P. 4), GEOSCIENCE (P. 4), GEOSPATIAL SCIENCE (P. 4)

Code	Title	Credits
General University Requirements		
Complete the graduate general university requirements. (http://catalog.uaf.edu/masters/#gurmastersdegreestext)		
Master's Degree Requirements		
Complete one of the following:		6-12
Complete the master's degree requirements. (http://catalog.uaf.edu/masters/#masterofsciencethesis) [1]		
Complete the master's degree requirements. (http://catalog.uaf.edu/masters/#masterofscienceproject) [2]		
Earth System Science Program Requirements		
Complete the following:		
ESS F601	Introduction to Earth System Science	3
ESS F602	Best Practices for Research in Alaska	1
ESS F692P	Seminar	1
Concentration		
Complete one of the following:		13-19
Sustainability Concentration [2]		
Ecosystems Concentration		
Hydrology Concentration		
Atmospheric and Climate Sciences Concentration [2]		
Cryosphere Concentration		
Solid Earth Geophysics Concentration		
Geoscience Concentration		
Geospatial Science Concentration [2]		
13 credits of approved electives [3]		
Total Credits		**30**

1. Requires 12 thesis credits.
2. Master's degree with project (6 project credits) can be completed with the following concentrations: sustainability, atmospheric and climate sciences, or geospatial science.
3. Recommended courses from any of the concentrations or the methods and cross-cutting list.

METHODS AND CROSS-CUTTING COURSE LIST

Code	Title	Credits
Methods and Cross-cutting courses:		
ACNS F629	Geography of the Arctic and Circumpolar North	3
ATM F601	Introduction to Atmospheric Sciences	3
ATM F610	Analysis Methods in Meteorology and Climate	3
ATM F625	Physical Hydrometeorology	3
ATM F680	Climate Change Processes: Past, Present, Future	4
BIOL F602	Research Design	3
BIOL F604	Scientific Writing, Editing and Revising in the Biological Sciences	3
BIOL F680	Data Analysis in Biology	3
CCS F612	Traditional Ecological Knowledge	3
FISH F646	Freshwater Habitat Dynamics	3
GEOS F422	Geoscience Applications of Remote Sensing	3
GEOS F605	Geochronology	3
GEOS F606	Volcanology	3
GEOS F618	Introduction to Geochemistry	3
GEOS F622	Digital Image Processing in the Geosciences	3
GEOS F627	Inverse Problems and Parameter Estimation	3
GEOS F631	Foundations of Geophysics	4
GEOS F633	Aqueous and Environmental Geochemistry	3
GEOS F636	Programming and Automation for Geoscientists	2
GEOS F639	InSar and Its Applications	3
GEOS F653	Palynology and Paleopalynology	4
GEOS F654	Visible and Infrared Remote Sensing	3
GEOS F657	Microwave Remote Sensing	3
GEOS F658	Big Geospatial Data	3
GEOS F660	The Dynamic Alaska Coastline	3
GEOS F670	Selected Topics in Volcanology	2

GEOS F681	Snow in the Environment	3
NRM F435	GIS Analysis	4
NRM F647	Sustainability in the Changing North	3
NRM F613	Resilience Internship	2
NRM F638	GIS Programming	3
NRM F641	Natural Resource Applications of Remote Sensing	3
PHYS F628	Digital Time Series Analysis	3
PHYS F647	Fundamentals of Geophysical Fluid Dynamics	3
STAT F401	Regression and Analysis of Variance	4
STO F666	Scientific Teaching	2

Concentrations

SUSTAINABILITY

This concentration encompasses scholarly and practical aspects of sustainability and society in Earth System Science with a specific emphasis on Alaska and the Arctic. The vision is to provide graduate training in interdisciplinary research to solve real-world problems, especially in building mutually respectful research partnerships with groups, organizations, and communities outside the University.

Sustainability Concentration with Thesis

Code	Title	Credits
Sustainability Concentration with Thesis Requirements:		
Complete the following:		
CCS F612	Traditional Ecological Knowledge	3
NRM F613	Resilience Internship	2
NRM F647	Sustainability in the Changing North	3
Complete 6 credits from the following disciplinary courses:		6
ACNS F600	Perspectives on the North	
ACNS F601	Research Methods and Sources in the North	
ACNS F610	Northern Indigenous Peoples and Contemporary Issues	
ACNS F629	Geography of the Arctic and Circumpolar North	
ACNS F652	International Relations of the North	
ACNS F657	Comparative Indigenous Rights and Policies	
ACNS F662	Alaska Government and Politics	
ACNS F669	Arctic Politics and Governance	
ACNS F683	20th-century Circumpolar History	
CCS F602	Cultural and Intellectual Property Rights	
CCS F608	Indigenous Knowledge Systems	
FISH F611	Human Dimensions of Environmental Systems	
FISH F613	Human-environment Research Methods	
FISH F675	Political Ecology	
NRM F630	Resource Management Planning	
NRM/CCS F656	Sustainable Livelihoods and Community Well-being	
NRM F692	Graduate Seminar	
STO F601	Communicating Science	
Thesis		
Complete 12 thesis credit hours of the following:		
CCS F699	Thesis	
or NRM F699	Thesis	
Total Credits		**14**

Sustainability Concentration with Project

Code	Title	Credits
Sustainability Concentration with Project Requirements:		
Complete the following:		
CCS F612	Traditional Ecological Knowledge	3
NRM F613	Resilience Internship	2
NRM F647	Sustainability in the Changing North	3
Complete 6 credits from the following disciplinary courses:		6
ACNS F600	Perspectives on the North	
ACNS F601	Research Methods and Sources in the North	
ACNS F610	Northern Indigenous Peoples and Contemporary Issues	
ACNS F629	Geography of the Arctic and Circumpolar North	
ACNS F652	International Relations of the North	
ACNS F657	Comparative Indigenous Rights and Policies	
ACNS F669	Arctic Politics and Governance	
ACNS F683	20th-century Circumpolar History	
CCS F602	Cultural and Intellectual Property Rights	
CCS F608	Indigenous Knowledge Systems	
FISH F611	Human Dimensions of Environmental Systems	
FISH F613	Human-environment Research Methods	
FISH F675	Political Ecology	
NRM F630	Resource Management Planning	
NRM/CCS F656	Sustainable Livelihoods and Community Well-being	
NRM F692	Graduate Seminar	
STO F601	Communicating Science	
Complete 5 credits of advisory committee-approved electives		5
Project		
Complete 6 project credits of the following:		
CCS F698	Non-thesis Research/Project	
or NRM F698	Non-thesis Research/Project	
Total Credits		**19**

ECOSYSTEMS

The Ecosystems concentration in Earth System Science addresses the interactions of organisms with the transformation and flux of energy and matter. Ecosystem science is inherently interdisciplinary, including ecology, natural history, statistics, chemistry, geology, geography, and hydrology. Students will therefore benefit from shared courses and seminars with other concentrations. Students enrolling in the Ecosystems concentration will pursue research and training in observing, modeling, and predicting processes including fluxes of water, energy, carbon, and nutrients, and many will focus on high-latitude ecosystems

Code	Title	Credits
Ecosystems Concentration Requirements		
Complete 13 credits from the following courses or the Methods and Cross-cutting course List		13
BIOL F618	Biogeography	
BIOL F646	Freshwater Habitat Dynamics	
BIOL F669	Landscape Ecology and Wildlife Habitat	
BIOL F673	Ecosystem Ecology (Ecosystem Ecology (course in progress))	
BIOL F686	Vertebrate Paleontology	
BIOL F688	Arctic Vegetation Ecology: Geobotany	
BIOL F689	Vegetation Description and Analysis	
Thesis		
Complete 12 thesis credit hours of the following:		
BIOL F699	Thesis	
Total Credits		**13**

HYDROLOGY

Understanding how water cycles through the Earth's many systems fundamentally links hydrology to a broad range of scientific disciplines and societal needs. Focusing on water movement and storage in the Arctic brings particular intrigue and challenge in terms of interactions with frozen ground, glacier runoff, freeze-thaw cycles, snowmelt, and river and lake ice dynamics. Career opportunities for graduates of the Hydrology Concentration in Earth System Science include river flood forecasting, field and remote sensing hydrologist, water quality specialist, water resources management and policy, water supply treatment and distribution, stream and fish habitat restoration, and the opportunity to work as a cold-regions hydrologist with interdisciplinary science and resource management teams in Alaska and other northern regions. Graduates are prepared to hold positions in government, industry, consulting or academia.

Code	Title	Credits
Hydrology Concentration Requirements		
Complete the following:		
CE F665	Watershed Hydrology	3
Complete 10 credits from the following:		10
CE F663	Groundwater Hydrology	
CE F662	Open Channel and River Engineering	
Methods and Cross-cutting course list		
One graduate-level course approved by the student's advisory committee		
Thesis		
Complete 12 thesis credit hours of the following:		
CE F699	Thesis	
Total Credits		**13**

ATMOSPHERIC AND CLIMATE SCIENCES

The field of atmospheric and climate science covers a wide variety of disciplines involving the physical and chemical properties and processes of the atmosphere. Current research in atmospheric sciences focuses on atmospheric dynamics, chemistry and biogeochemistry, air-sea-ice interactions, climate modeling, cloud and aerosol physics, radiative processes, mesoscale modeling, numerical weather prediction, aviation weather, and the upper atmosphere (stratosphere and mesosphere). The faculty are well-positioned to be a vibrant part of cross-cutting education and research in the Earth System Science Program.

Graduate students are an essential component of a research university and an integral component of the research activities across the campus at UAF, both in the experiments in the laboratory and the field as well as in data sciences, which includes modeling and analysis of weather and climate data. Research institutes and the CNSM provide excellent environments for research in atmospheric and climate sciences as well as multidisciplinary research with researchers spanning diverse expertise.

Atmospheric and Climate Sciences Concentration with Thesis

Code	Title	Credits
Atmospheric and Climate Sciences Concentration with Thesis Requirements:		
Complete three of the following:		9
ATM F601	Introduction to Atmospheric Sciences	
ATM F613	Atmospheric Radiation	
ATM F615	Cloud Physics	
ATM F645	Atmospheric Dynamics	
ATM F646	Atmospheric Dynamics II: Climate Dynamics	
Complete one of the following:		3
ATM F644	Weather Analysis and Forecasting	
ATM F658	Air-sea Interactions	
ATM F673	Micrometeorology with Focus on Subarctic and Arctic Ecosystems	
One graduate-level course approved by the student's advisory committee		
Complete any 1-credit seminar.		1
Thesis		
Complete 12 thesis credit hours of the following:		
ATM F699	Thesis	
Total Credits		**13**

Atmospheric and Climate Sciences Concentration with Project

Code	Title	Credits
Atmospheric and Climate Sciences Concentration with Project Requirements:		
Complete the following:		
ATM F601	Introduction to Atmospheric Sciences	3
ATM F613	Atmospheric Radiation	3
ATM F645	Atmospheric Dynamics	3
ATM F646	Atmospheric Dynamics II: Climate Dynamics	3
Seminar course		1
Complete 6 credits from the following disciplinary courses:		6
ACNS F600	Perspectives on the North	
ACNS F601	Research Methods and Sources in the North	
ACNS F610	Northern Indigenous Peoples and Contemporary Issues	
ACNS F629	Geography of the Arctic and Circumpolar North	
ACNS F652	International Relations of the North	

ACNS F657	Comparative Indigenous Rights and Policies
ACNS F669	Arctic Politics and Governance
ACNS F683	20th-century Circumpolar History
CCS F602	Cultural and Intellectual Property Rights
CCS F608	Indigenous Knowledge Systems
FISH F611	Human Dimensions of Environmental Systems
FISH F613	Human-environment Research Methods
FISH F675	Political Ecology
NRM F630	Resource Management Planning
NRM/CCS F656	Sustainable Livelihoods and Community Well-being
NRM F692	Graduate Seminar
STO F601	Communicating Science
Project	
Complete 6 credits of the following:	
ATM F698	Non-thesis Research/Project
Total Credits	**19**

CRYOSPHERE

The Cryosphere Concentration is located within the geosphere cohort of ESS tracks. This concentration focuses on snow, sea-ice, glaciers, and permafrost. Research within the Cryosphere Concentration is grounded in physics, mathematics, numerical modeling and data science. Methods and applications in the Cryosphere seek to understand earth surface processes at high latitudes and how they are responding to ongoing climate change as well as associated impacts on both the built and natural environment. The courses and research associated with snow, sea-ice, glaciers, and permafrost connect with the full spectrum of topics in the Earth System Science curriculum, including geospatial sciences, geosciences, climate science, hydrology, ecology, and sustainability. The Cryosphere Concentration at UAF is strengthened by the expansive natural laboratory and faculty expertise. Ph.D. and MS coursework and graduate research will be conducted closely with the Geophysical Institute.

Code	Title	Credits
Cryosphere Concentration Requirements		
Complete the following:		
GEOS F631	Foundations of Geophysics	4
Complete 1 course from the Methods and Cross-cutting course List		3-4
Complete two of the following:		6
GEOS F615	Sea Ice	
GEOS F616	Permafrost	
GEOS F617	Glaciers	
GEOS F681	Snow in the Environment	
PHYS F614	Ice Physics	
One graduate-level course approved by the student's advisory committee		
Thesis		
Complete 12 thesis credit hours of the following:		
GEOS F699	Thesis	
Total Credits		**13-14**

SOLID EARTH GEOPHYSICS

The Solid Earth Geophysics concentration of Earth System Science includes the disciplines of seismology, geodesy, volcanology, and infrasound, and it is grounded in physics, mathematics, computing, and data science. Methods and applications in Solid Earth Geophysics seek to characterize dynamic Earth processes and associated natural hazards relevant to Alaska and surrounding regions, including earthquakes, tsunamis, volcanoes, and landslides. Continuously recording instruments used in Solid Earth Geophysics, such as seismometers and GPS, capture a wide range of environmental activities and phenomena relevant to Earth System Science, in addition to human-caused events such as nuclear explosions.

Code	Title	Credits
Solid Earth Geophysics Concentration Requirements:		
Complete the following:		
GEOS F631	Foundations of Geophysics	4
Complete 9 credits from the following:		9
GEOS F604	Seismology	
GEOS F606	Volcanology	
GEOS F626	Applied Seismology	
GEOS F669	Geodetic Methods and Modeling	
GEOS F670	Selected Topics in Volcanology	
GEOS F692	Geol/Geophys Seminar	
Methods and Cross-cutting course list		
One graduate-level course approved by the student's advisory committee		
Thesis		
Complete 12 thesis credit hours of the following:		
GEOS F699	Thesis	
Total Credits		**13**

GEOSCIENCE

The Geoscience concentration falls within the geosphere cohort of ESS tracks with a focus on tectonics, paleontology, and petrology of sedimentary, igneous, and metamorphic rocks. Methods and applications include reconstruction of past climates, ecosystems, and plate configurations, dating of geologic specimens, and locating economically valuable mineral deposits.

Code	Title	Credits
Geoscience Concentration Requirements:		
Complete 13 credits from the following courses or the Methods and Cross-cutting course list:		13
GEOS F621	Advanced Petrology	
GEOS F647	Advanced Sedimentology and Stratigraphy	
One graduate-level course approved by the student's advisory committee		
Thesis		
Complete 12 thesis credit hours of the following:		
GEOS F699	Thesis	
Total Credits		**13**

GEOSPATIAL SCIENCE

The Geospatial Science concentration of Earth System Science includes the disciplines of visible to infrared and microwave (SAR and

InSAR) remote sensing, Geographic Information Systems, and their applications in the area of geosciences, natural resource management, and environmental monitoring. It is grounded in geographic science, mathematics, computer science, and data science. Methods and applications in the Geospatial Science concentration seek to characterize our changing environment, inventory and management of natural resources, and mitigate risks from geo-hazards relevant to Alaska and surrounding regions. Continuous geospatial observations of our ever-changing environment and geo-hazards from space and air are essential components of Earth System Science, as they allow for detailed studies of processes and events across scales relevant to the associated disciplines.

Geospatial Science Concentration with Thesis

Code	Title	Credits
Geospatial Science Concentration with Thesis Requirements:		
Complete 13 credits from the following:		13
GEOS F622	Digital Image Processing in the Geosciences	
GEOS F629	Geologic Hazards and Natural Disasters	
GEOS F639	InSar and Its Applications	
GEOS F654	Visible and Infrared Remote Sensing	
GEOS F657	Microwave Remote Sensing	
GEOS F658	Big Geospatial Data	
NRM F435	GIS Analysis	
NRM F638	GIS Programming	
NRM F641	Natural Resource Applications of Remote Sensing	
Thesis		
Complete 12 thesis credit hours of the following:		
GEOS F699	Thesis	
or NRM F699	Thesis	
Total Credits		**13**

Geospatial Science Concentration with Project

Code	Title	Credits
Geospatial Science Concentration with Project Requirements:		
Complete 13 credits from the following disciplinary courses:		13
ACNS F600	Perspectives on the North	
ACNS F601	Research Methods and Sources in the North	
ACNS F610	Northern Indigenous Peoples and Contemporary Issues	
ACNS F629	Geography of the Arctic and Circumpolar North	
ACNS F652	International Relations of the North	
ACNS F657	Comparative Indigenous Rights and Policies	
ACNS F669	Arctic Politics and Governance	
ACNS F683	20th-century Circumpolar History	
CCS F602	Cultural and Intellectual Property Rights	
CCS F608	Indigenous Knowledge Systems	
FISH F611	Human Dimensions of Environmental Systems	
FISH F613	Human-environment Research Methods	
FISH F675	Political Ecology	
NRM F630	Resource Management Planning	
NRM/CCS F656	Sustainable Livelihoods and Community Well-being	
NRM F692	Graduate Seminar	
STO F601	Communicating Science	
Complete 6 credits from other courses approved by the student's advisory committee.		6
Project		
Complete 6 project credits of the following:		
GEOS F698	Non-thesis Research/Project	
or NRM F698	Non-thesis Research/Project	
Total Credits		**19**

Road Maps

< Back to Department (http://catalog.uaf.edu/academic-departments/earth-system-science/)

Road Maps are recommended semester-by-semester plans of study for programs and assume full-time enrollment unless otherwise noted.

Some courses and milestones must be completed in the semester listed to ensure timely graduation. Transfer credit may change the road map.

This road map should be used in conjunction with regular academic advising appointments. All students are encouraged to meet with their advisor or mentor each semester. Requirements, course availability and sequencing are subject to change.

EARTH SYSTEM SCIENCE M.S. - SUSTAINABILITY CONCENTRATION

Course	Title	Credits
First Year		
Fall		
NRM F647	Sustainability in the Changing North	3
FISH F613	Human-environment Research Methods	3
	Credits	**6**
Spring		
CCS F612	Traditional Ecological Knowledge	3
ACNS F662	Alaska Government and Politics	3
	Credits	**6**
Second Year		
Fall		
NRM/CCS F613	Resilience Internship	2
FISH F611	Human Dimensions of Environmental Systems	3
	Credits	**5**
Spring		
ACNS F662	Alaska Government and Politics	3
	Credits	**3**
Third Year		
Fall		
CCS/NRM F656	Sustainable Livelihoods and Community Well-being	3
	Credits	**3**

Spring		
STO F601	Communicating Science	2
	Credits	**2**
	Total Credits	**25**

EARTH SYSTEM SCIENCE M.S. - SOLID EARTH GEOPHYSICS CONCENTRATION

Course	Title	Credits
First Year		
Fall		
GEOS F631	Foundations of Geophysics	4
GEOS F636	Programming and Automation for Geoscientists	2
	Credits	**6**
Spring		
GEOS F627	Inverse Problems and Parameter Estimation	3
GEOS F692	Geol/Geophys Seminar	1-6
	Credits	**4-9**
Second Year		
Fall		
GEOS F669	Geodetic Methods and Modeling	3
	Credits	**3**
Spring		
GEOS F626	Applied Seismology	4
GEOS F657	Microwave Remote Sensing	3
GEOS F692	Geol/Geophys Seminar	1-6
	Credits	**8-13**
Third Year		
Fall		
GEOS F631	Foundations of Geophysics	4
GEOS F636	Programming and Automation for Geoscientists	2
	Credits	**6**
Spring		
GEOS F627	Inverse Problems and Parameter Estimation	3
GEOS F692	Geol/Geophys Seminar	1-6
	Credits	**4-9**
	Total Credits	**31-46**