

# Atmospheric Sciences (ATM)

## College of Natural Science and Mathematics

Department of Atmospheric Sciences (<https://www.uaf.edu/atmos/>)  
907-474-7368

### ATM F101X Weather and Climate of Alaska (n)

4 Credits

Offered Spring

Focus on the atmosphere as an important part of our environment. Study of weather and climate that covers weather observation, composition and properties of the atmosphere, weather and circulation systems, forecasting weather based on fundamental laws of physics and chemistry. Students are required to make weather observations in Alaska.

**Prerequisites:** Placement in WRTG F111X; placement in MATH F105.

**Special Notes:** The students will use their local observations as a foundation and a vantage point to understand the regional and global behavior of the atmosphere (that is, "Observe locally and connect globally").

**Attributes:** UAF GER Natural Science Req

**Lecture + Lab + Other:** 3 + 3 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### ATM F401 Introduction to Atmospheric Sciences

3 Credits

Offered Fall

Fundamentals of atmospheric science. Includes energy and mass conservation, internal energy and entropy, atmospheric water vapor, cloud microphysics, equations of motion, hydrostatics, phase oxidation, heterogeneous chemistry, the ozone layer, fundamentals of biogeochemical cycles, solar and terrestrial radiation and radiative-convective equilibrium. Also includes molecular, cloud and aerosol absorption and scattering.

**Prerequisites:** CHEM F105X; CHEM F106X; MATH F302; PHYS F212X.

**Stacked with** ATM F601; CHEM F601.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### ATM F407 Atmospheric Thermodynamics

3 Credits

Offered Fall

Atmospheric thermodynamics covers internal energy, enthalpy and Gibbs free energy. It explores ideal gas properties, phase equilibria, nucleation of water and the Clausius-Clapeyron equation. It uses thermodynamic diagrams skew-T/log-P charts. Topics include frost and dew points, isenthalpic processes, wet-bulb temperatures and vertical stability, with a focus on potential instability.

**Prerequisites:** ATM F101X; MATH F252X; PHYS F211X; PHYS F212X.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### ATM F413 Atmospheric Radiation

3 Credits

Offered As Demand Warrants

Atmospheric radiation including the fundamentals of blackbody radiation theory and radiative properties of atmospheric constituents. Discussion of gaseous absorption including line absorption, broadening effects and radiative transfer. Includes scattering, radiative properties of clouds and radiation climatology.

**Prerequisites:** ATM F401 (may be taken concurrently).

**Cross-listed with** PHYS F413.

**Stacked with** ATM F613; PHYS F613.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### ATM F415 Cloud Physics

3 Credits

Offered Spring Even-numbered Years

Basic properties of condensed water vapor in the atmosphere. Formation and behavior of clouds including atmospheric aerosols, nucleation and growth of water droplets and ice crystals, the development of precipitation, nature of mixed-phase (water and ice) clouds, radiative transfer and experiments using AFARS Lidar, Microwave Radiometer and Satellite Remote sensing.

**Prerequisites:** ATM F401 (may be taken concurrently).

**Stacked with** ATM F615.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### ATM F425 Physical Hydrometeorology

3 Credits

Offered As Demand Warrants

Explores hydrometeorological processes, presents how to apply analysis techniques/skills to solve fundamental hydrometeorological questions (e.g. fire weather forecasting, drought forecasting, water resource management, flood forecasting). Subjects covered are hydrographs, radar images, meteograms, lysimeter, near-surface meteorology, surface energy and water budgets, stream response, groundwater, drought-indices, observational errors.

**Prerequisites:** ATM F401.

**Recommended:** 400-level Physics, Calculus I to III.

**Stacked with** ATM F625.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

### ATM F433 Atmospheric Remote Sensing

3 Credits

Offered Fall Odd-numbered Years

The course focuses on the physical principles of remote sensing and how atmospheric measurements are made with passive and active techniques from ground-, air- and satellite-based platforms. The course explores principles of absorption, emission and scattering. Students work with remote sensing data and explore specific techniques of interest to them.

**Prerequisites:** ATM F401 (may be taken concurrently).

**Stacked with** ATM F633.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**ATM F444 Weather Analysis and Forecasting**

3 Credits

Offered Spring Even-numbered Years

Weather systems and the techniques used to understand and predict their behavior. Topics include atmospheric observations, synoptic analysis techniques, satellite image interpretation, kinematics, fronts and frontogenesis, life cycles of extratropical cyclones, mesoscale phenomena, numerical weather prediction and interpretation of forecast products.

**Prerequisites:** ATM F401; ATM F445.**Stacked with** ATM F644.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F445 Atmospheric Dynamics**

3 Credits

Offered Fall Even-numbered Years

Examination of the fundamental forces and basic conservation laws that govern the motion of the atmosphere. Topics include momentum, continuity equations, circulation, vorticity, thermodynamics, the planetary boundary layer and synoptic scale motions in mid-latitudes.

**Prerequisites:** ATM F401 (may be taken concurrently).**Stacked with** ATM F645.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F446 Atmospheric Dynamics II: Climate Dynamics**

3 Credits

Offered Spring Odd-numbered Years

Continuation of ATM F445/ATM F645. Includes geophysical fluid dynamics as applied to the atmosphere. Topics include linear perturbation theory, energy balance, kinetic energy cycle, dynamics of zonally symmetric and varying flow, and tropical dynamics.

**Prerequisites:** ATM F445; senior standing.**Recommended:** experience with coding tools (for example, C++, FORTRAN, R, NCL).**Stacked with** ATM F646.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F456 Climate and Climate Change**

3 Credits

Offered Fall Odd-numbered Years

The climate of planet Earth and its changes with time. Radiative fluxes, greenhouse effects, energy budget, hydrological cycle, the atmospheric composition and climatic zones. Physical and chemical reasons for climatic change.

**Prerequisites:** ATM F401.**Stacked with** ATM F656.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F473 Micrometeorology with Focus on Subarctic and Arctic Ecosystems**

3 Credits

Offered Fall Even-numbered Years

This course provides a comprehensive explanation of micrometeorology, physical mechanisms, measurement procedures and methods. The course focuses on subarctic and arctic ecosystems. Students receive training in eddy-covariance data processing for ecosystem fluxes computation. The course is oriented to students of biology and wildlife, natural resources and environmental sciences and engineering.

**Prerequisites:** Senior standing.**Stacked with** ATM F673.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F478 Mesoscale Dynamics**

3 Credits

Offered As Demand Warrants

A comprehensive explanation of mesoscale air motions – their phenology, basic physics and mechanisms, why they build and how mesoscale motions interact with the micro and large scale. Classical and non-classical mesoscale circulations, super cell, single and multiple cell thunderstorm dynamics and tornado formation.

**Prerequisites:** ATM F401.**Stacked with** ATM F678.**Special Notes:** Recommend 400-level physics, calculus I to III.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F480 Climate Change Processes: Past, Present, Future**

4 Credits

Offered Fall Odd-numbered Years

This 'synthesis' course for Geography, NRM, or Natural Sciences undergraduates provides literacy in the rapidly developing field of climate-change science. Students will gain an understanding of climate dynamics and Earth's climate history and will be trained to critically evaluate the validity of paleoclimatic reconstructions and climate-model predictions.

**Prerequisites:** Junior or senior standing.**Cross-listed with** GEOS F480.**Stacked with** ATM F680, GEOS F680.**Lecture + Lab + Other:** 4 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F488 Undergraduate Research**

1-3 Credits

Advanced research topics from outside the usual undergraduate requirements.

**Recommended:** A substantial level of technical/scientific background.**Lecture + Lab + Other:** 0 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**Repeatable for Credit:** May be taken 3 times for up to 3 credits

**ATM F601 Introduction to Atmospheric Sciences**

3 Credits

Offered Fall

Fundamentals of atmospheric science. Includes energy and mass conservation, internal energy and entropy, atmospheric water vapor, cloud microphysics, equations of motion, hydrostatics, phase oxidation, heterogeneous chemistry, the ozone layer, fundamentals of biogeochemical cycles, solar and terrestrial radiation and radiative-convective equilibrium. Also includes molecular, cloud and aerosol absorption and scattering.

**Prerequisites:** Graduate standing.**Cross-listed with** CHEM F601.**Stacked with** ATM F401.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F606 Atmospheric Chemistry**

3 Credits

Offered Spring Odd-numbered Years

Chemistry of the lower atmosphere (troposphere and stratosphere) including photochemistry, kinetics, thermodynamics, box modeling, biogeochemical cycles and measurement techniques for atmospheric pollutants; study of important impacts to the atmosphere which result from anthropogenic emissions of pollutants, including acid rain, the "greenhouse" effect, urban smog and stratospheric ozone depletion.

**Prerequisites:** ATM F601.**Cross-listed with** CHEM F606.**Stacked with** CHEM F406.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F610 Analysis Methods in Meteorology and Climate**

3 Credits

Offered Spring Odd-numbered Years

Introduction to standard analysis topics in Atmospheric Sciences, including basic aggregate stats, time series work, eigenmode analysis, mixed models, and extreme value analysis. Focus on manipulation of very large data sets, especially weather/climate model output. Hands-on instruction in supporting computer topics. Student presentations will be emphasized.

**Prerequisites:** ATM F601; graduate standing.**Recommended:** Basic computer and mathematical knowledge to analyze and plot data.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F613 Atmospheric Radiation**

3 Credits

Offered As Demand Warrants

Atmospheric radiation including the fundamentals of blackbody radiation theory and radiative properties of atmospheric constituents. Discussion of gaseous absorption including line absorption, broadening effects and radiative transfer. Includes scattering, radiative properties of clouds and radiation climatology.

**Prerequisites:** ATM F601 (may be taken concurrently); graduate standing.**Cross-listed with** PHYS F613.**Stacked with** ATM F413; PHYS F413.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F615 Cloud Physics**

3 Credits

Offered Spring Even-numbered Years

Basic properties of condensed water vapor in the atmosphere. Formation and behavior of clouds including atmospheric aerosols, nucleation and growth of water droplets and ice crystals, the development of precipitation, nature of mixed-phase (water and ice) clouds, radiative transfer and experiments using AFARS Lidar, Microwave Radiometer and Satellite Remote sensing.

**Prerequisites:** ATM F601; graduate standing.**Stacked with** ATM F415.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F620 Climate Journal Club Seminar**

1 Credit

Offered Spring

The "Climate Group" is an informal meeting for researchers and graduate students. The seminars alternate between progress reports on ongoing research and journal club contributions. The main interests articles, formal and informal presentations by locals and visitors will be on the agenda. All students are encouraged to contribute and students taking the course for credit are required to lead the discussion for one session. This may include the presentation of a research plan/results, or a discussion of a journal article. Students will be graded on at least one presentation and participation in the class.

**Prerequisites:** Graduate standing.**Special Notes:** Participating students will be exposed to a free format discussion of modern ideas in climate related disciplines.**Lecture + Lab + Other:** 1 + 0 + 0**Grading System:** Pass/Fail Grades**ATM F621 Introduction to Computational Meteorology**

1 Credit

Offered Fall

Introduces the basic knowledge on how to apply software related to atmospheric sciences problems. This includes UNIX/LINUX, FORTRAN90, NCL, Python, MATLAB and how to read data-formats (e.g., NetCDF files, grib-files, etc) for climate and remote sensing datasets. Students will learn how to run a given software and produce software modifications.

**Prerequisites:** Graduate standing.**Lecture + Lab + Other:** 1 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F625 Physical Hydrometeorology**

3 Credits

Offered As Demand Warrants

Explores hydrometeorological processes, presents how to apply analysis techniques/skills to solve fundamental hydrometeorological questions (e.g. fire weather forecasting, drought forecasting, water resource management, flood forecasting). Subjects covered are hydrographs, radar images, meteograms, lysimeter, near-surface meteorology, surface energy and water budgets, stream response, groundwater, drought-indices, observational errors.

**Prerequisites:** ATM F401 or ATM F601 or graduate standing.**Recommended:** 400-level Physics, Calculus I to III.**Stacked with** ATM F425.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus

**ATM F631 Environmental Fate and Transport**

3 Credits

Offered Spring Even-numbered Years

Examination of the physical properties that govern the behavior, fate and transport of contaminants released into the environment. Topics include air-water partitioning and exchange, organic solvent-water partitioning, diffusion, sorption, chemical and biological transformation reactions, and modeling concepts.

**Cross-listed with** CHEM F631.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F633 Atmospheric Remote Sensing**

3 Credits

Offered Fall Odd-numbered Years

The course focuses on the physical principles of remote sensing and how atmospheric measurements are made with passive and active techniques from ground-, air- and satellite-based platforms. The course explores principles of absorption, emission and scattering. Students work with remote sensing data and explore specific techniques of interest to them.

**Prerequisites:** ATM F401 or ATM F601; graduate standing.**Stacked with** ATM F433.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F644 Weather Analysis and Forecasting**

3 Credits

Offered Spring Even-numbered Years

Weather systems and the techniques used to understand and predict their behavior. Topics include atmospheric observations, synoptic analysis techniques, satellite image interpretation, kinematics, fronts and frontogenesis, life cycles of extratropical cyclones, mesoscale phenomena, numerical weather prediction and interpretation of forecast products.

**Prerequisites:** ATM F601; ATM F645.**Stacked with** ATM F444.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F645 Atmospheric Dynamics**

3 Credits

Offered Fall Even-numbered Years

Examination of the fundamental forces and basic conservation laws that govern the motion of the atmosphere. Topics include momentum, continuity equations, circulation, vorticity, thermodynamics, the planetary boundary layer and synoptic scale motions in mid-latitudes.

**Prerequisites:** ATM F601 (may be taken concurrently); graduate standing.**Stacked with** ATM F445.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F646 Atmospheric Dynamics II: Climate Dynamics**

3 Credits

Offered Spring Odd-numbered Years

Continuation of ATM F445/ATM F645. Includes geophysical fluid dynamics as applied to the atmosphere. Topics include linear perturbation theory, energy balance, kinetic energy cycle, dynamics of zonally symmetric and varying flow, and tropical dynamics.

**Prerequisites:** ATM F645; graduate standing in Physics, Oceanography, Engineering, Natural Sciences or Atmospheric Sciences.**Recommended:** experience with coding tools (for example, C++, FORTRAN, R, NCL).**Stacked with** ATM F446.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F647 Fundamentals of Geophysical Fluid Dynamics**

3 Credits

Offered Fall Odd-numbered Years

Introduction to the mechanics of fluid systems, the fundamental processes, Navier-Stokes' equations in rotating and stratified fluids, kinematics, conservation laws, vortex motion, irrotational flow, laminar flow, boundary layer phenomena, waves, instabilities, turbulent flows and mixing.

**Prerequisites:** Graduate standing.**Cross-listed with** PHYS F647.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F656 Climate and Climate Change**

3 Credits

Offered Fall Odd-numbered Years

The climate of planet Earth and its changes with time. Radiative fluxes, greenhouse effects, energy budget, hydrological cycle, the atmospheric composition and climatic zones. Physical and chemical reasons for climatic change.

**Prerequisites:** Graduate standing; calculus, physics or related courses at F400-level, basic computer skills.**Recommended:** ATM F601 or ATM F401; basic computer knowledge to plot and analyze climate data.**Stacked with** ATM F456.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F657 Climate Change in the Arctic: Methods and Impact Assessment**

3 Credits

Offered As Demand Warrants

This course introduces graduate students to methodologies to study climate change and its environmental and, to a lesser degree, human impacts in the Arctic. Classroom study focus on boreal forest and arctic tundra, oceanic and coastal ecosystems topics, including characterization methods and impacts determinations.

**Prerequisites:** Graduate standing MA or PhD students including students in the Climate Security Certificate.**Special Notes:** Elements of statistical analysis and computational processing will be provided during classes.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus**ATM F658 Air-sea Interactions**

3 Credits

Offered Spring Even-numbered Years

Course covers the basic processes governing air-sea interactions at different temporal and spatial scales including; transfer of heat and momentum through air-sea surface, interactions of atmospheric and oceanic mixed layers, important examples of air-sea interactions; i.e. El Niño and interactions between high-latitude atmosphere and ocean.

**Prerequisites:** ATM F601; graduate standing.**Lecture + Lab + Other:** 3 + 0 + 0**Grading System:** Letter Grades with option of Plus/Minus

**ATM F662 Numerical Modeling and Parameterization Methods**

3 Credits

Offered Spring Even-numbered Years

Construction of models from fundamental equations and the necessity of parameterizations. Simplification and discretization of equations, numerical methods, model-grids, analytical modeling, boundary and initial conditions, parameterizations and evaluation of model results. Scale-dependency, limitations of parameterizations and coupled modeling are elucidated.

Students apply and code aspects of models themselves.

**Prerequisites:** Graduate standing; calculus, physics or related F400-level basic computer skills.

**Recommended:** ATM F601; basic knowledge in Fortran and UNIX/LINUX.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**ATM F673 Micrometeorology with Focus on Subarctic and Arctic Ecosystems**

3 Credits

Offered Fall Even-numbered Years

This course provides a comprehensive explanation of micrometeorology, physical mechanisms, measurement procedures and methods. The course focuses on subarctic and arctic ecosystems. Students receive training in eddy-covariance data processing for ecosystem fluxes computation. The course is oriented to students of biology and wildlife, natural resources and environmental sciences and engineering.

**Prerequisites:** Graduate standing.

**Stacked with** ATM F473.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**ATM F678 Mesoscale Dynamics**

3 Credits

Offered As Demand Warrants

A comprehensive explanation of mesoscale air motions – their phenology, basic physics and mechanisms, why they build and how mesoscale motions interact with the micro and large scale. Classical and non-classical mesoscale circulations, super cell, single and multiple cell thunderstorm dynamics and tornado formation.

**Prerequisites:** ATM F401 or ATM F601.

**Stacked with** ATM F478.

**Special Notes:** Recommend 400-level physics, calculus I to III.

**Lecture + Lab + Other:** 3 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**ATM F680 Climate Change Processes: Past, Present, Future**

4 Credits

Offered Fall Odd-numbered Years

This 'synthesis' course for Geography, NRM, or Natural Sciences undergraduates provides literacy in the rapidly developing field of climate-change science. Students will gain an understanding of climate dynamics and Earth's climate history and will be trained to critically evaluate the validity of paleoclimatic reconstructions and climate-model predictions.

**Prerequisites:** Junior or senior standing in major; ATM F401, GEOS F315, OCN F419 or OCN F481.

**Cross-listed with** GEOS F680.

**Stacked with** ATM F480, GEOS F480.

**Lecture + Lab + Other:** 4 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**ATM F688 Atmospheric Science Informal Seminar**

1 Credit

Review of ongoing research in atmospheric science to learn about research results, ideas and direction long before they are published in journals. Presentations cover the broad range of atmospheric sciences and links to other disciplines as required to answer questions on global variability, climate change and assessment studies.

**Prerequisites:** Graduate standing in physical sciences.

**Lecture + Lab + Other:** 1 + 0 + 0

**Grading System:** Pass/Fail Grades

**ATM F692 Seminar**

1-3 Credits

**Lecture + Lab + Other:** 0 + 0 + 0

**Grading System:** Letter Grades with option of Plus/Minus

**Repeatable for Credit:** May be taken unlimited times for up to 99 credits

**ATM F692P Seminar**

1-3 Credits

**Lecture + Lab + Other:** 0 + 0 + 0

**Grading System:** Pass/Fail Grades

**Repeatable for Credit:** May be taken unlimited times for up to 99 credits

**ATM F698 Non-thesis Research/Project**

1-12 Credits

**Lecture + Lab + Other:** 0 + 0 + 1-12

**Grading System:** Pass/Fail Grades

**Repeatable for Credit:** May be taken 98 times for up to unlimited credits

**ATM F699 Thesis**

1-12 Credits

**Lecture + Lab + Other:** 0 + 0 + 1-12

**Grading System:** Pass/Fail Grades

**Repeatable for Credit:** May be taken 98 times for up to unlimited credits