Fall 2020 Course Descriptions as of 04/05/2020 08:10 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: **http://rcs.registrar.arizona.edu/course_descriptions_key**.

Atmospheric Sciences (ATMO)

ATMO 170A1: Introduction to Weather and Climate (3 units)
Description: An introduction to the science of weather processes and climate, including the genesis of fronts and cyclones, precipitation processes, the wind systems of the world, severe storms, and weather forecasting. Special emphasis will be given to natural phenomena which have strong impacts on human activities including tornadoes, hurricanes, El Nino, global warming, ozone depletion, and air pollution. The fundamental importance of physics, chemistry, and mathematics to atmospheric science will be stressed.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

Enrollment requirement: Enrollment not allowed if you have previously taken NATS 101 "Introduction to Weather and Climate" (Topic 8).
General Education: NATS 101

ATMO 171: Introduction to Meteorology and Climatology (3 units)
Description: An introduction to weather processes and climate, including discussions of fronts and cyclones, precipitation processes, the wind systems of the world, severe storms, and weather modification.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Lecture — Required
Equivalent to: GEOG 171

ATMO 325: Understanding and Forecasting the Weather (3 units)
Description: This course is designed to teach students the basics of weather and weather forecasting.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture — Required
Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).
General Education: Tier 2 Natural Sciences

ATMO 336: Weather, Climate and Society (3 units)
Description: The course examines basic weather phenomena, climate and climate change, and the associated effects on individuals and societies in the past and present. The possibility and effects of human-caused changes in the climate system are also discussed.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C).
General Education: Tier 2 Natural Sciences

ATMO 350: Atmospheric Measurements (3 units)
Description: Theory and use of meteorological instruments; laboratory and field demonstrations and practices.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory May Be Offered
Lecture Required
Recommendations and additional information: PHYS 142, PHYS 241, MATH 254.
Field trip: Field trip
Writing Emphasis: Writing Emphasis Course

ATMO 412A: Ocean Sciences (3 units)
Description: This course offers an overview of the ocean sciences for undergraduate students with some scientific background. This course will broaden the exposure of UA undergraduates to marine science in a cross-disciplinary context. Students considering a career or graduate school in marine science will find this class a useful preview of the different areas of marine science, and students interested in natural or environmental sciences will gain a better understanding of the many linkages between the ocean and the broader natural world. We will cover the role of the ocean in diverse components of the Earth system, including geological, biological, climatic, and human aspects.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: ECOL 412A, ENVS 412A, GEOS 412A
Recommendations and additional information: One year of science, or consent of instructor.
Home department: Geosciences

ATMO 421: Physical Climatology (3 units)
Description: The class is aimed primarily at upper level undergraduate and graduate students in all areas of the Earth sciences, including Atmospheric Sciences, Hydrology sciences, Geosciences, Geography, Planetary sciences, and environmental sciences. This is a synthesis course to introduce the earth as a system: atmosphere, oceans, land, cryosphere, and solid earth, and to inculcate deeper scientific understanding of the components of the Earth system, their interactions, and the consequences of changes in the Earth system for life. These interactions occur on a continuum of temporal and spatial scales ranging from short-term weather to long-term climate and motions of the solid Earth, and from local and regional to global. We know that climate has natural variability and has changed dramatically in the past. Recent studies of climate change have generated large controversy about the possibility of human induced climate change. Are we entering a period of global warming? What drives the long-term evolution of climate? How does the current climate system work? Can we predict how it will change in the future? The central underlying theme of the class will be the relative roles of the atmosphere, ocean, land surface, and cryosphere in driving climate variability at different time and space scales. This class will provide a solid understanding for the individual components of climate, and the physical processes taking place in and among these components.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 521
Course typically offered:
Main Campus: Spring (odd years only)
Online Campus: Spring (odd years only)

Enrollment requirement: Must not have taken GEOG 430 or GEOG/ARL/GC 530.

ATMO 423: Hydrology (3 units)
Description: Discussion and analysis of major topics of the hydrologic cycle and their interrelationship, such as rainfall, infiltration, evaporation, and runoff. Statistical and probabilistic methods in water supply and flood hydrology.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: HWRS 423, HYDR 423
Also offered as: CE 423, HWRS 423
Co-convened with: ATMO 523
Course typically offered:
Main Campus: Spring

Home department: Civil and Architectural Engineering and Mechanics
Enrollment requirement: Adv Standing: Engineering. CE 218.

ATMO 430: Computational Methods in the Atmospheric Sciences (3 units)
Description: An introduction to the computational methods used to solve problems in the atmospheric sciences with emphasis on numerical schemes widely used in numerical weather prediction and climate models. Statistical analysis of observational data and model output will also be introduced.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall (odd years only)
Online Campus: Fall (odd years only)

Recommendations and additional information: MATH 254.

ATMO 436A: Fundamentals of the Atmospheric Sciences (3 units)
Description: Broadly covers fundamental topics in the atmospheric sciences. Topics include composition of the atmosphere, atmospheric thermodynamics, atmospheric chemistry, cloud physics, radiative transfer, atmospheric dynamics, and climate.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: GEOG 436A, GEOS 436A, HWRS 436A, PHYS 436A, SWES 436A
Co-convened with: ATMO 536A
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: MATH 223, PHYS 141 or consent of instructor.

ATMO 441A: Dynamic Meteorology I (3 units)
Description: Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: PTYS 441A
Co-convened with: ATMO 541A
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: MATH 223 (Vector Calculus), preferably MATH 254 (Ordinary Differential Equations), PHYS 141/142 or 151/152 (General Physics w/Calculus Applications); ATMO 436A or instructor's permission.

ATMO 441B: Dynamic Meteorology II (3 units)
Description: Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: PTYS 441B
Co-convened with: ATMO 541B
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: ATMO 441A, PHYS 426 or consent of instructor.

ATMO 451A: Physical Meteorology I (3 units)
Description: Introduction to atmospheric physics that includes the composition and chemistry of the atmosphere, kinetic theory, the mechanics of ideal and real fluids, aerosol mechanics, atmospheric acoustics, atmospheric radiation, scattering, radiative transfer, atmospheric optics, cloud physics, and atmospheric electricity.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 551A
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: PHYS 426 or consent of instructor.

ATMO 451B: Physical Meteorology II (3 units)
Description: Introduction to atmospheric physics that includes the composition and chemistry of the atmosphere, kinetic theory, the mechanics of ideal and real fluids, aerosol mechanics, atmospheric acoustics, atmospheric radiation, scattering, radiative transfer, atmospheric optics, cloud physics, and atmospheric electricity.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 551B
Course typically offered:
Main Campus: Spring

Recommendations and additional information: PHYS 426, ATMO 451A or consent of instructor.

ATMO 455: Introduction to Atmospheric and Hydrology Remote Sensing (3 units)
Description: The purpose of this course is to introduce the basic remote sensing techniques and their applications to the atmosphere, hydrology and other fields. This includes understanding the basic concepts of radiation transfer, passive and active remote sensing, satellite and ground-based remote sensing and their retrieval techniques. Finally, inversion techniques in remote sensing will be briefly introduced and the uncertainties/errors of the retrieved cloud and precipitation properties will be estimated.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 555
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Enrollment requirement: ATMO 436A and (PHYS 142 or 143 or 241) and MATH 223, or consent of instructor.

ATMO 469A: Air Pollution I: Gases (3 units)
Description: An introduction to the chemistry and physics of the troposphere and stratosphere. Topics include natural biogeochemical cycles; atmospheric photochemistry; stratospheric ozone; urban ozone and particulate matter; atmospheric visibility; acid deposition; air pollution meteorology; Gaussian plume model; photochemical model; air quality regulations.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: CHEE 469A
Co-convened with: ATMO 569A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MATH 223. ATMO 469A is not prerequisite to ATMO 469B but is recommended.

ATMO 469B: Air Pollution II: Aerosols (3 units)
Description: An introduction to the chemistry and physics of atmospheric aerosols. Topics include aerosol sources and sinks; basic aerosol properties; single aerosol mechanics; aerosol population dynamics; atmospheric aerosol optics; aerosols and climate; aerosols and health; regional haze; aerosol measurement techniques.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: CHEE 469B, SWES 469B
Co-convened with: ATMO 569B
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: MATH 223. ATMO 469A is not prerequisite to ATMO 469B but is recommended.

ATMO 471: Synoptic Meteorology (1 unit)
Description: Principles of meteorological analysis; fundamental concepts of dynamic meteorology. Structure and dynamics of mid-latitude cyclones and fronts. Use of computer driven graphical displays.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory May Be Offered
Lecture Required
Co-convened with: ATMO 571
Recommendations and additional information: ATMO 441A; Prerequisite or Concurrent registration, ATMO 350, ATMO 441B, and ATMO 470.

ATMO 472: Weather Analysis and Forecasting (1 unit)
Description: Advanced analysis techniques. Principles of weather forecasting and actual forecasting experience.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 572
Recommendations and additional information: ATM0 471; Concurrent registration, ATM0 470.

ATMO 474A: Weather Analysis and Forecasting I (3 units)
Description: This course overview fundamental atmospheric processes involved in the day-to-day behavior of synoptic scale and mesoscale mid-latitude weather. The objective is to provide students an understanding of how observed meteorological information can be analyzed and interpreted to create informed weather forecasts, commiserate with operational practices in the United States.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 574
Course typically offered:
Main Campus: Fall (even years only)
Online Campus: Fall (even years only)

Recommendations and additional information: ATMO 441A

ATMO 474B: Weather Analysis and Forecasting II (3 units)
Description: This course is for senior undergraduate and graduate students. The overall goal of this course is to apply the fundamental theoretical principles of synoptic-dynamic and mesoscale meteorology to the real atmosphere through a discussion of ensemble weather forecasting, an application of quasi-geostrophic principles and potential vorticity thinking to weather and forecasting, an overview of the dynamics of convective storms, and a real-time severe weather and quantitative precipitation forecasting exercise.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: ATMO 574B
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ATMO 474A/574A, or ATMO 441A/541A and ATMO 441B/541B, or permission of instructor.

ATMO 489: Atmospheric Electricity (3 units)
Description: Introduction to sources and chemistry of atmospheric ions, fair weather electricity, the global circuit, electrical structure of clouds, thunderstorm electrification, lightning, lightning electromagnetic fields, mechanisms of lightning damage and lightning protection.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory — May Be Offered
Lecture — Required
Equivalent to: ECE 489
Co-convened with: ATMO 589
Course typically offered:
Main Campus: Spring (odd years only)
Online Campus: Spring (odd years only)

Recommendations and additional information: PHYS 241, MATH 322, or consent of instructor.

ATMO 490: Remote Sensing for the Study of Planet Earth (3 units)
Description: Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Lecture — Required
Equivalent to: ARL 490, ATMO 490, GEN 490, GEOG 490, GEOS 490, HWRS 490, MNE 490, OPTI 490, RNR 490, SW 490, SWES 490
Also offered as: ENVS 490, GEOG 490, GEOS 490, HWRS 490, OPTI 490, REM 490, RNR 490
Co-convened with: ATMO 590
Course typically offered:
Main Campus: Fall

Home department: Committee on Remote Sensing and Spatial Analysis
Enrollment requirement: GEOG/GEN/GEOS/ENVS/WSM/GIST 330.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

ATMO 493: Internship (1 - 6 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 6 units.
Course typically offered:
Main Campus: Fall, Spring

ATMO 499: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Winter, Spring, Summer
Online Campus: Fall, Winter, Spring, Summer

ATMO 499H: Honors Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Winter, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

ATMO 510: Mesoscale Meteorology (3 units)
Description: This course teaches the structure and dynamics of convective and mesoscale phenomena, including mesoscale convective systems, severe thunderstorms, tornadoes, low-level jets, mountain waves and tropical cyclones. For most of these phenomena, the course discusses their general behaviors and characteristics, the dynamics of their formation and development, and the types of weather and hazards they produce, and in some cases their prediction. Specific topics are given below.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: HWRS 510
Recommendations and additional information: ATMO 541B.
Interdisciplinary Interest Area: GEOS - Geosciences

ATMO 521: Physical Climatology (3 units)
Description: The class is aimed primarily at upper level undergraduate and graduate students in all areas of the Earth sciences, including Atmospheric Sciences, Hydrology sciences, Geosciences, Geography, Planetary sciences, and environmental sciences. This is a synthesis course to introduce the earth as a system: atmosphere, oceans, land, cryosphere, and solid earth, and to inculcate deeper scientific understanding of the components of the Earth system, their interactions, and the consequences of changes in the Earth system for life. These interactions occur on a continuum of temporal and spatial scales ranging from short-term weather to long-term climate and motions of the solid Earth, and from local and regional to global. We know that climate has natural variability and has changed dramatically in the past. Recent studies of climate change have generated large controversy about the possibility of human induced climate change. Are we entering a period of global warming? What drives the long-term evolution of climate? How does the current climate system work? Can we predict how it will change in the future? The central underlying theme of the class will be the relative roles of the atmosphere, ocean, land surface, and cryosphere in driving climate variability at different time and space scales. This class will provide a solid understanding for the individual components of climate, and the physical processes taking place in and among these components.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ATMO 421
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: PHYS 142, PHYS 143, and MATH 223.
Enrollment requirement: Must not have taken GEOG 430 or GEOG/ARL/GC 530.

ATMO 523: Hydrology (3 units)
Description: Discussion and analysis of major topics of the hydrologic cycle and their interrelationship, such as rainfall, infiltration, evaporation, and runoff. Statistical and probabilistic methods in water supply and flood hydrology. Graduate-level requirements include a project paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ARL 523, ARL 523, HWRS 523, HYDR 523
Also offered as: ARL 523, CE 523, HWRS 523
Co-convened with: ATMO 423
Course typically offered:
Main Campus: Spring

Home department: Civil and Architectural Engineering and Mechanics

ATMO 524: Hydroclimatology (3 units)
Description: Precipitation formation processes, the surface and atmospheric branch of the hydrologic cycle, land surface-atmosphere interaction, surface energy balance, evapotranspiration, heat and moisture fluxes into the soil and atmospheric boundary layer.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ATMO 524
Also offered as: HWRS 524
Course typically offered:
Main Campus: Spring

Home department: Hydrology and Atmospheric Sciences

ATMO 529: Objective Analysis in the Atmospheric and Related Sciences (3 units)
Description: This graduate course provides an overview of statistical methods used to interpret datasets in the atmospheric and related sciences. The objective is to provide a working knowledge of the statistical tools most commonly used. Topics include application of basic statistics (composite analysis; significance testing; curve fitting; regression analysis; correlation; and non-normal distributions), non-parametric statistical significance testing (e.g. Monte-Carlo methods and field significance), matrix methods (principal component analysis; SVD analysis; CCA), and time series analysis (harmonic analysis; power spectra; data filtering; cross-spectrum analysis; singular spectrum analysis; and wavelet analysis).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: GEOG 529, GEOS 529, HWRS 529
Also offered as: GEOG 529, GEOS 529, HWRS 529
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: Undergraduate level statistics course and linear algebra required. Computer programming skills (C, Fortran, Matlab) and knowledge of graphical display packages needed or consent of instructor.

ATMO 530: Micrometeorology (3 units)
Description: Theoretical aspects of atmospheric turbulence, including discussions of laminar flow, turbulent flow, the mechanical energy equations, and the shearing stress and the wind profile.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Recommendations and additional information: ATMO 541B.

ATMO 536A: Fundamentals of the Atmospheric Sciences (3 units)
Description: Broadly covers fundamental topics in the atmospheric sciences. Topics include composition of the atmosphere, atmospheric thermodynamics, atmospheric chemistry, cloud physics, radiative transfer, atmospheric dynamics, and climate. Graduate-level requirements include additional questions on homework and exams plus a term paper on a specialized research topic.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: GEOG 536A, GEOS 536A, HWRS 536A, PHYS 536A, SWES 536A
Also offered as: ENVS 536A, GEOG 536A, HWRS 536A
Co-convened with: ATMO 436A
Course typically offered:
Main Campus: Spring

Interdisciplinary Interest Area: GEOS - Geosciences
Interdisciplinary Interest Area: PHYS - Physics

ATMO 537: The Physics of the Sun (3 units)
Description: The purpose of this course is to present an introduction to the physics of the Sun. The course begins with a discussion of the standard solar model, the solar-neutrino problem, and observational techniques. Long-term variability in the total irradiance, sunspot number, and diameter, and its effect on Earth's climate will be addressed in some detail. Other topics include the physics of the solar interior, solar oscillations, and solar composition. This course will also introduce the equations of magnetohydrodynamics and apply them to important solar-physics problems, such as: the solar magnetic dynamo, stability of prominences, physics of sunspots and flares, and heating of the solar atmosphere. The emphasis throughout will be on basic physical processes and the various approximations used in their application to concrete problems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ASTR 537, ATMO 537, PHYS 537
Also offered as: ASTR 537, PHYS 537, PTYS 537
Home department: Planetary Sciences

ATMO 541A: Dynamic Meteorology I (3 units)
Description: Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: PTYS 541A
Also offered as: PTYS 541A
Co-convened with: ATMO 441A
Course typically offered:
Main Campus: Fall

ATMO 541B: Dynamic Meteorology II (3 units)
Description: Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: PTYS 541B
Also offered as: PTYS 541B
Co-convened with: ATMO 441B
Course typically offered:
Main Campus: Spring

ATMO 544: Physics of High Atmospheres (3 units)
Description: Physical properties of upper atmospheres, including gaseous composition, temperature and density, ozonosphere, and ionospheres, with emphasis on chemical transformations and eddy transport.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ATMO 544
Also offered as: PTYS 544
Home department: Planetary Sciences

ATMO 545: Introduction to Data Assimilation (3 units)
Description: Data assimilation (DA) involves combining information from observations and ¿models¿ of a particular physical system in order to best define and understand the evolving state of the system. It is currently applied across a wide range of Earth sciences, including weather forecasting, oceanography, atmospheric chemistry, hydrology, and climate studies. This course provides an introduction to the theory and applications of DA in atmospheric and related sciences. Topics include common DA methods like optimal interpolation, Kalman filtering and variational schemes within the context of estimation theory. The course is designed as a hands-on approach to key DA concepts that are currently used today.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: HWRS 545
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: Linear algebra, elementary statistics. Basic programming skills (C, Fortran, Matlab) is needed or consent of instructor.
Interdisciplinary Interest Area: GEOS - Geosciences

ATMO 551A: Physical Meteorology I (3 units)
Description: Introduction to atmospheric physics that includes the composition and chemistry of the atmosphere, kinetic theory, the mechanics of ideal and real fluids, aerosol mechanics, atmospheric acoustics, atmospheric radiation, scattering, radiative transfer, atmospheric optics, cloud physics, and atmospheric electricity. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ATMO 451A
Course typically offered:
Main Campus: Fall

ATMO 551B: Physical Meteorology II (3 units)
Description: Introduction to atmospheric physics that includes the composition and chemistry of the atmosphere, kinetic theory, the mechanics of ideal and real fluids, aerosol mechanics, atmospheric acoustics, atmospheric radiation, scattering, radiative transfer, atmospheric optics, cloud physics, and atmospheric electricity. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ATMO 451B
Course typically offered:
Main Campus: Spring

ATMO 555: Introduction to Atmospheric and Hydrology Remote Sensing (3 units)
Description: The purpose of this course is to introduce the basic remote sensing techniques and their applications to the atmosphere, hydrology and other fields. This includes understanding the basic concepts of radiation transfer, passive and active remote sensing, satellite and ground-based remote sensing and their retrieval techniques. Finally, inversion techniques in remote sensing will be briefly introduced and the uncertainties/errors of the retrieved cloud and precipitation properties will be estimated.Graduate students will do some homework, but primarily work on processing and analyzing the aircraft, ground-based and satellite remote sensing data collected from instructors research projects. Graduate students will get hands-on experience by doing these projects using IDL, MATLAB, FORTRAN, or other programs. For some projects, I may provide key codes as a reference.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ARL 555, ENVS 555, GEOS 555, HWRS 555, OPTI 555, REM 555
Co-convened with: ATMO 455
Course typically offered:
Main Campus: Spring

ATMO 558: Mesoscale Meteorological Modeling (3 units)
Description: This course provides an overview of mesoscale meteorological modeling, emphasizing limited area models. It is a modified version of a course originally developed by Professor Roger Pielke, Sr., and currently taught at the University of Colorado. The objective is to provide students a framework for understanding limited area models commonly used in the atmospheric science community, either as numerical weather prediction models or regional climate models. Topics include conservation equations of the atmosphere; methods of solution; boundary and initial conditions; coordinate systems; parameterization schemes; and model application and evaluation. Particular emphasis will be placed on the Weather Research and Forecasting (WRF) model, as this is used in the UA Department of Atmospheric Sciences.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: GEOS 558, HWRS 558
Also offered as: HWRS 558
Course typically offered:
Main Campus: Spring (even years only)

Recommendations and additional information: ATMO 541A, ATMO 541B or consent of instructor.
Interdisciplinary Interest Area: GEOS - Geosciences

ATMO 569A: Air Pollution I: Gases (3 units)
Description: An introduction to the chemistry and physics of the troposphere and stratosphere. Topics include natural biogeochemical cycles; atmospheric photochemistry; stratospheric ozone; urban ozone and particulate matter; atmospheric visibility; acid deposition; air pollution meteorology; Gaussian plume model; photochemical model; air quality regulations. Graduate-level requirements include additional homework and other exercises.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CHEE 569A
Also offered as: CHEE 569A
Co-convened with: ATMO 469A
Course typically offered:
Main Campus: Fall

ATMO 569B: Air Pollution II: Aerosols (3 units)
Description: An introduction to the chemistry and physics of atmospheric aerosols. Topics include aerosol sources and sinks; basic aerosol properties; single aerosol mechanics; aerosol population dynamics; atmospheric aerosol optics; aerosols and climate; aerosols and health; regional haze; aerosol measurement techniques. Graduate-level requirements include additional homework and other exercises.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CHEE 569B, CHEE 596B, SWES 569B
Also offered as: CHEE 569B, ENVS 569B
Co-convened with: ATMO 469B
Course typically offered:
Main Campus: Spring (odd years only)

ATMO 571: Synoptic Meteorology (1 unit)
Description: Principles of meteorological analysis; fundamental concepts of dynamic meteorology. Structure and dynamics of mid-latitude cyclones and fronts. Use of computer driven graphical displays. Graduate-level requirements include a more quantitative and thorough understanding of the subject matter.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory May Be Offered
Lecture Required
Co-convened with: ATMO 471
Recommendations and additional information: ATMO 541A; Concurrent registration, ATMO 541B, ATMO 570.

ATMO 572: Weather Analysis and Forecasting (1 unit)
Description: Advanced analysis techniques. Principles of weather forecasting and actual forecasting experience. Graduate-level requirements include a survey paper on some aspect of weather prediction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ATMO 472
Recommendations and additional information: ATMO 471; Concurrent registration, ATMO 570.

ATMO 573: Earth System Modeling (3 units)
Description: This course will focus on use of numerical methods to solve partial differential equations of geophysical fluid dynamics; computational design and working of the Earth system model and its critical components; procedures to run and modify the Earth system model; model applications to important climate issues.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: GEOS 573
Recommendations and additional information: ATMO 441A, computer programming skills (C, Fortran, Matlab)
Home department: Geosciences

ATMO 574A: Weather Analysis and Forecasting I (3 units)
Description: This course overview fundamental atmospheric processes involved in the day-to-day behavior of synoptic scale and mesoscale mid-latitude weather. The objective is to provide students an understanding of how observed meteorological information can be analyzed and interpreted to create informed weather forecasts, commiserate with operational practices in the United States.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: ATMO 474
Course typically offered:
Main Campus: Fall (even years only)

Recommendations and additional information: ATMO 541A

ATMO 574B: Weather Analysis and Forecasting II (3 units)
Description: This course is for senior undergraduate and graduate students. The overall goal of this course is to apply the fundamental theoretical principles of synoptic-dynamic and mesoscale meteorology to the real atmosphere through a discussion of ensemble weather forecasting, an application of quasi-geostrophic principles and potential vorticity thinking to weather and forecasting, an overview of the dynamics of convective storms, and a real-time severe weather and quantitative precipitation forecasting exercise.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: HWRS 574B, PHYS 574B
Co-convened with: ATMO 474B
Course typically offered:
Main Campus: Spring (odd years only)
Online Campus: Spring (odd years only)

Enrollment requirement: ATMO 474A/574A, or ATMO 441A/541A and ATMO 441B/541B, or permission of instructor.

ATMO 579: Boundary Layer Meteorology & Surface Processes (3 units)
Description: Designed for students in the atmospheric sciences, hydrology and related fields. It provides a framework for understanding the basic physical processes that govern mass and heat transfer in the atmospheric boundary layer and the vegetated land surface. In addition to the theoretical part of the course, there is a strong focus on modeling and students will be required to program numerical codes to represent these physical processes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Also offered as: ENVS 579, HWRS 579, PTYS 579, WSM 579
Course typically offered:
Main Campus: Spring (even years only)

Recommendations and additional information: MATH 223, PHYS 141, PHYS 253.

ATMO 580: Tropical Meteorology (3 units)
Description: An introduction to fundamentals of meteorology in the tropics. Topics include atmospheric processes in the tropics; mass, heat, energy, momentum, and water vapor budgets, cumulus convection, hurricanes and other disturbances.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: ATMO 436A, ATMO 541A or consent of instructor.

ATMO 589: Atmospheric Electricity (3 units)
Description: Introduction to sources and chemistry of atmospheric ions, fair weather electricity, the global circuit, electrical structure of clouds, thunderstorm electrification, lightning, lightning electromagnetic fields, mechanisms of lightning damage and lightning protection. Graduate-level requirements include different homework assignments and tests.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 589
Also offered as: ECE 589
Co-convened with: ATMO 489
Course typically offered:
Main Campus: Spring (odd years only)

ATMO 590: Remote Sensing for the Study of Planet Earth (3 units)
Description: Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $50
Course Components: Lecture Required
Equivalent to: ARL 590, ARL 590, ATMO 590, GEN 590, GEOG 590, GEOS 590, HWRS 590, MNE 590, OPTI 590, RNR 590, SW 590, SWES 590
Also offered as: ARL 590, ENVS 590, GEOG 590, GEOS 590, HWRS 590, MNE 590, OPTI 590, REM 590, RNR 590
Co-convened with: ATMO 490
Course typically offered:
Main Campus: Fall

Home department: GIDP on Remote Sensing and Spatial Analysis

ATMO 595B: Global Climate Change (3 units)
Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.
Grading basis: Regular Grades
Career: Graduate
Course Components: Colloquium Required
Repeatable: Course can be repeated for a maximum of 6 units.
Equivalent to: GEOS 595B, HWRS 595B, HYDR 595B
Also offered as: HWRS 595B
Interdisciplinary Interest Area: GEOS - Geosciences

ATMO 595C: General Circulation Observations and Modeling (1 - 3 units)
Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.
Grading basis: Regular Grades
Career: Graduate
Course Components: Colloquium Required
Equivalent to: GEOS 595C, HWRS 595C
Also offered as: HWRS 595C
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: ATMO 541A, ATMO 551A, ENGR 170.
Interdisciplinary Interest Area: GEOS - Geosciences

ATMO 599: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Winter, Spring, Summer

ATMO 641: Advanced Atmospheric and Oceanic Fluid Dynamics (3 units)
Description: Fundamentals and theory of the large-scale circulation of the atmosphere and oceans. Hierarchy of equation sets used in geophysical fluid dynamics. Concepts of balance, vorticity, potential vorticity. Barotropic and baroclinic instability. Wave mean-flow interactions. Atmosphere/ocean turbulence. Dynamics of Hadley cells and jet streams; role of Rossby waves, gravity waves, and baroclinic eddies in helping to maintaining the mean flow. Applicaiton of this theory to understand the fundamental mechanisms controlling the tropospheric and stratospheric circulation of the Earth and other planets. Basics of oceanic circulation, including wind-driven gyres, buoyancy-driven (overturning) circulation, and thermocline dynamics.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: PTYS 641
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: Students must have familiarity with calculus, differential equations, and basic atmospheric dynamics at the level of ATMO 541A or equivalent.

ATMO 656A: Atmospheric Radiation and Remote Sensing (3 units)
Description: Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 656A, PTYS 656A
Also offered as: OPTI 656A, PTYS 656A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MATH 254.

ATMO 656B: Atmospheric Radiation and Remote Sensing (3 units)
Description: Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 656B
Also offered as: OPTI 656B, PTYS 656B
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MATH 254.

ATMO 900: Research (1 - 6 units)
Description: Individual research, not related to thesis or dissertation preparation, by graduate students.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Winter, Spring, Summer

ATMO 910: Thesis (1 - 6 units)
Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Winter, Spring, Summer

ATMO 920: Dissertation (1 - 9 units)
Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Winter, Spring, Summer