Department of Atmospheric Sciences
UNIVERSITY OF WASHINGTON

GRADUATE PROGRAM GUIDE

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I. INTRODUCTION

Rapid growth of research in atmospheric sciences began in the late 1940s in response to needs and opportunities in weather forecasting. Thus, the Department of Atmospheric Sciences at the University of Washington was established in 1947. Today, intensive research is underway to extend the time scale over which useful forecasts can be made and to increase the amount of regional and temporal detail in short-range forecasts.

In addition, the atmospheric sciences now address a broad range of other problems of fundamental interest and importance. Examples include changes in climate that could result from increases in atmospheric carbon dioxide and other greenhouse gases, acid rain associated with industrial effluents, and the application of remote-sensing techniques to the monitoring and understanding of weather and climate.

Graduate students in the atmospheric sciences come from a variety of disciplines: physics, chemistry, engineering, atmospheric or geophysical sciences, and applied mathematics. Opportunities are broad enough that each of these backgrounds is valuable for specific fields within the atmospheric sciences. Students should nevertheless have in common a solid background in fundamental physics and applied mathematics. Research in the atmospheric sciences often extends beyond the strict limits of the subject into other areas of geophysical and environmental sciences. Depending upon their special interests, students may take courses in physics, mathematics, chemistry, oceanography, geophysics, engineering and other fields.

II. FACULTY MEMBERS

Academic Faculty

Thomas P. Ackerman, Ph.D. (University of Washington), Professor. Atmospheric Sciences and Director of Joint Institute for the Study of the Atmosphere and Ocean (JISAO), University of Washington. Radiative transfer; remote sensing of cloud properties; effect of clouds and aerosol on the global climate.

Becky Alexander, Ph.D. (University of California, San Diego), Assistant Professor. Paleoclimate; atmospheric chemistry; aerosols; stable isotope geochemistry.

David S. Battisti, Ph.D. (University of Washington), Professor. Large-scale atmosphere-ocean dynamics; tropical circulation; physics of natural variability in Arctic climate; climate dynamics; paleoclimate.

Cecilia M. Bitz, Ph.D. (University of Washington), Associate Professor. High latitude climate dynamics; climate change; paleoclimate; climate modeling; sea ice modeling.

Christopher S. Bretherton, Ph.D. (Massachusetts Institute of Technology), Professor. Atmospheric Sciences and Applied Mathematics. Role of clouds in atmospheric convection and climate; boundary layer meteorology; numerical modeling; tropical meteorology.
Dale R. Durran, Ph.D. (Massachusetts Institute of Technology), Professor. Atmospheric dynamics; numerical methods and atmospheric modeling; mountain meteorology; mesoscale meteorology.

Dargan M. W. Frierson, Ph.D. (Princeton University), Assistant Professor. Atmospheric general circulation; water vapor; climate change.

Qiang Fu, Ph.D. (University of Utah), Professor. Atmospheric radiation; cloud/aerosol/radiation/climate interactions, remote sensing.

Gregory J. Hakim, Ph.D. (University at Albany, State University of New York), Associate Professor. Synoptic and mesoscale meteorology; atmospheric dynamics; data assimilation; turbulence.

Dennis L. Hartmann, Ph.D. (Princeton University), Professor. Climate change; dynamic meteorology; radiation and remote sensing.

Robert A. Houze, Ph.D. (Massachusetts Institute of Technology), Professor. Mesoscale meteorology; cloud physics and dynamics; radar meteorology; tropical and mountain meteorology.

Lyatt Jaeglé, Ph.D. (California Institute of Technology), Professor. Atmospheric chemistry; tropospheric and stratospheric photochemistry; chemical modeling of atmospheric observations; influence of human activities on the composition of the atmosphere.

Daniel Jaffe, Ph.D. (University of Washington), Professor. Science and Technology (UW Bothell) and Atmospheric Sciences (UW Seattle). Atmospheric chemistry; air pollution; long range transport of pollutants; photochemistry.

Clifford F. Mass, Ph.D. (University of Washington), Professor. Synoptic and mesoscale meteorology.

Peter B. Rhines, Ph.D. (Trinity College, University of Cambridge, United Kingdom), Professor. Oceanography and Atmospheric Sciences. Theoretical physical oceanography; geophysical fluid dynamics; general circulation of the atmosphere and ocean.

Joel Thornton, Ph.D. (University of California, Berkeley), Associate Professor. In situ and laboratory studies of homogeneous and heterogeneous atmospheric chemical processes; air pollution; atmosphere-biosphere interactions.

John Michael Wallace, Ph.D. (Massachusetts Institute of Technology), Professor. Atmospheric general circulation; climate variability.

Stephen G. Warren, Ph.D. (Harvard University), Professor. Atmospheric Sciences and Earth & Space Sciences. Atmospheric radiation; radiative properties of clouds, snow, and sea ice; Antarctic climate; global cloud climatology.

Robert Wood, Ph.D. (University of Reading), Associate Professor. Boundary layer cloud structure, cloud microphysics, remote sensing.

**Research Faculty**

Theodore L. Anderson, Ph.D. (University of Washington), Research Associate Professor. Aerosols and climate; aerosol instrumentation; satellite remote sensing.

Dean A. Hegg, Ph.D. (University of Washington), Research Professor. Atmospheric chemistry; cloud physics.

Jérôme Patoux, Ph.D. (University of Washington), Research Assistant Professor. Planetary boundary layer modeling; air-sea interaction; satellite remote sensing; synoptic meteorology.
**Emeritus Faculty**


Robert A. Brown, Ph.D. (University of Washington), Research Professor Emeritus. Geophysical fluid dynamics; planetary boundary layers; air-sea interaction; turbulence; satellite remote sensing.

Joost A. Businger, Ph.D. (State University, Utrecht, the Netherlands), Professor Emeritus. Air-sea interaction; boundary layer meteorology; atmospheric turbulence.

Robert J. Charlson, Ph.D. (University of Washington), Professor Emeritus. Atmospheric Sciences and Chemistry. Atmospheric chemistry; aerosol physics; aerosol/cloud/climate interaction; aerosol and cloud instrumentation.

David S. Covert, Ph.D. (University of Washington), Research Professor. Atmospheric chemistry; aerosol physics, chemistry and optics; aerosol instrumentation; climate effects and global distributions of aerosols.

Robert G. Fleagle, Ph.D. (New York University), Professor Emeritus. Air-sea interaction; science policy.

Thomas C. Grenfell, Ph.D. (University of Washington), Research Professor. Atmospheric radiation; radiative transfer; microwave remote sensing; sea ice and snow optics; microwave theory.

Halstead Harrison, Ph.D. (Stanford University), Associate Professor Emeritus. Atmospheric chemistry; dispersion modeling; radiative transfer.

Gary A. Maykut, Ph.D. (University of Washington), Research Professor Emeritus, Atmospheric Sciences and Geophysics. Polar air-sea-ice interaction; radiative transfer in ice and snow.

Edward S. Sarachik, Ph.D. (Brandeis University), Professor Emeritus. Atmospheric dynamics; large-scale atmosphere-ocean interactions; greenhouse warming; equatorial dynamics; El Niño/Southern Oscillation; climate change.

James E. Tillman, M.S. (Massachusetts Institute of Technology), Research Professor Emeritus. Mars meteorology: global oscillations, great dust storms and planetary boundary layer of Earth and Mars; humidity, temperature and wind instrumentation; K-12 and public outreach programs.

Norbert Untersteiner, Ph.D. (Innsbruck University, Austria), Professor Emeritus. Atmospheric Sciences and Geophysics. Sydney Chapman Professor of Physical Sciences, University of Alaska. Air-sea-ice interaction; polar climatology; sea ice physics.
III. FIELDS OF GRADUATE STUDY AND RESEARCH

The faculty, staff and students in the Department of Atmospheric Sciences at the University of Washington are engaged in the study of a broad range of atmospheric phenomena and processes, using methods ranging from mathematical analysis to field experimentation. Research projects range in size from small studies involving individual scientists to large national and international programs involving teams of scientists.

Research groups in the department are concerned with Atmospheric Chemistry, Atmospheric Dynamics, Boundary Layer Processes, Cloud and Aerosol Research, Glaciology and Planetary Atmospheres, Cloud Dynamics, Precipitation Processes, Storms, Weather Analysis and Forecasting, Climate, Global change, Airflow over mountains, and other topics. Some groups maintain special research facilities for the use of their students. In some of these activities, there is close cooperation with the nearby Pacific Marine Environmental Laboratories at the National Oceanic and Atmospheric Administration (NOAA) Regional Center through the Joint Institute for the Study of the Atmosphere and Ocean (JISAO). Faculty members often have interests in more than one area, and research projects frequently involve questions of broad scope which do not fall neatly into a single category. This is particularly true of research projects directed toward understanding the chemical and physical modification of the environment by human activities.

The major research groups within the Department are described below. A number of specific research topics currently under study are also highlighted.

Atmospheric Chemistry

The atmosphere is chemically complex and evolving due to natural events, biological and anthropogenic activities; it has fundamental chemical links to the oceans, the solid earth and the biota. Anthropogenic perturbations such as land-use and industrial activities have profoundly modified the chemical composition of the troposphere and stratosphere, with potentially important consequences on future climate and living organisms. Examples of such changes include the formation of an ozone hole over Antarctica since the late 1970s, the observed trends in long-lived greenhouse gases, the change in the concentrations of tropospheric ozone and acidic deposition due to growing emissions of hydrocarbons, nitrogen oxides and sulfur dioxide in industrialized regions.

Laboratory studies, in situ experiments and modeling activities by atmospheric chemists at the University of Washington are directed at determining chemical composition and chemical processes in the atmosphere and in turn their effects on the atmosphere, and on a larger scale the biogeochemistry of the earth. The laboratory and experimental research deals with trace gas measurements and physical, chemical and optical properties of particles. Global models of atmospheric chemistry and climate use these observations to improve their predictions of future changes in atmospheric composition, and also guide the development of analytical techniques and the logistics of large-scale field measurement programs.
Atmospheric Dynamics

Atmospheric dynamics involves observational and theoretical analysis of all motion systems of meteorological significance, including such diverse phenomena as thunderstorms, tornadoes, gravity waves, tropical hurricanes, extratropical cyclones, jet streams, and global-scale circulations. The immediate goal of dynamical studies is to explain the observed circulations on the basis of fundamental physical principles. The practical objectives of such studies include improving weather prediction, developing methods for prediction of short-term (seasonal and interannual) climate fluctuations, and understanding the implications of human-induced perturbations (e.g., increased carbon dioxide concentrations or depletion of the ozone layer) on the global climate.

The Department has active research programs studying problems on the global scale, the synoptic scale, and the mesoscale. Research on global-scale problems includes many topics related to climate change and climate variability, stratospheric dynamics, and the general circulation. Research on the synoptic scale focuses on the development of extratropical cyclones, the dynamical influence of the tropopause, rotating stratified turbulence, and data assimilation. On the mesoscale our efforts are concentrated on topographically induced flows, orographic precipitation, gravity waves and stratospheric-troposphere exchange through mixing at the top of deep cumulonimbus clouds. These problems are attacked with a combination of theory, numerical simulation and observational analysis.

Boundary Layer Research

The structure and dynamics of the lowest layer of the atmosphere which comprises the planetary boundary layer (PBL) are of vital importance for the understanding of weather and climate, the dispersion of pollutants, and the exchange of heat, water vapor and momentum with the underlying surface. Processes of special interest within the PBL include the vertical transfer of momentum, heat and water vapor by turbulence, and the absorption and emission of radiation at the surface and within the atmosphere. One focus of the Boundary Layer Research Group's efforts is on the development and testing of instrumentation for measuring the turbulent fluctuations of velocity components, temperature and humidity. Another focus is on the theoretical analysis and interpretation of turbulent statistics and flow dynamics. The importance of instabilities, secondary flows, and coherent structures has been an important part of this study. The area of air-sea interaction has been a primary area of research. Several large experiments have been conducted by the department. Present emphasis is on the role of the boundary layer in the growth and decay of cyclones and satellite capabilities in ocean measurements.

Faculty and students are engaged in a variety of field and theoretical projects including the study of surface fluxes, mesoscale variations in boundary layer structure, and effects of variable terrain and variable seastate. Observations have been made from fixed towers, floating buoys, ships, tethered balloons, aircraft and satellites. Data from satellite instruments such as scatterometers and multichannel scanning microwave radiometers are being used to infer the global structure of
the marine planetary boundary layer. Field studies are made jointly with teams from other universities and research institutes. Departmental researchers have participated in many international research programs in many parts of the globe, from the tropics to the Arctic.

**Climate Fluctuations and Change**

As human activity continues to alter atmospheric composition and begins to change climate on a global scale, the challenge of understanding the global system comprised of the atmosphere, oceans, ice and vegetation takes on a heightened sense of urgency. Climate research is also motivated by substantial economic benefits from improved weather and climate prediction on time scales ranging from weeks to seasons or longer.

Faculty and students in the department are engaged in a number of projects directed toward a better understanding of climate variability and long-term climate change, including: dynamics of atmospheric variability on time scales of weeks or longer and its relation to extreme events such as droughts and unseasonable warmth or cold; the El Nino phenomenon in the equatorial Pacific and its effects on global climate; decadal and century variability in the mid-latitude and polar regions; the predictability of El Nino and other natural climate phenomenon; long term variability of the deep ocean circulations driven by gradients of heat and salt and their role in the uptake of heat and carbon; the role of clouds, aerosols, sea-ice and land vegetation in determining the sensitivity of the climate system; the problem of distinguishing between natural climate variability and climate change induced by human activity; and climates of the past including ice ages and equable warm climates. The research involves the analysis of global data sets of all kinds, including in situ data, remotely sensed data, and data that have been assimilated into a model in order to produce a consistent global analysis; testing and improvement of global climate system models; and experiments with an array of numerical models of the various components of the climate system.

**Cloud and Aerosol Research**

Cloud and Aerosol Research is concerned with three broad areas of research that overlap in many important ways: atmospheric aerosols and trace gases, the physics and chemistry of clouds and precipitation, and mesoscale processes associated with cloud and precipitation systems.

The atmospheric aerosol and trace gas studies are concerned with the origins of various particles and gases in the air and their effects on the atmosphere on local, regional and global scales. This has involved the group in airborne measurements in many locations around the world and in studies of the emissions of particles and gases from the ocean, volcanos, forest fires and industries. Recent field projects have been carried out in Brazil, the Arctic, the Marshal Islands, Southern Africa, as well as North America.

For many years the department has been engaged in studies of the structures of clouds and the various processes that can lead to precipitation. Although rooted in field observations, this work includes conceptual and numerical model development. Current studies include the effects of clouds on the radiative balance of the earth and climate as well as mesoscale studies of cloud
and precipitation systems. One of the unique aspects of these studies is the blending of synoptic, mesoscale and microscale analyses. These studies have led to new conceptual models for the structures of winter cyclones on the west coast, east coast and central United States. Current projects include the analysis of a large data set on the structure of clouds in the pacific Northwest with the goal of improving the representation of cloud and precipitation processes in mesoscale models (The IMPROVE Project).

**Cloud Dynamics, Precipitation Processes and Storms**

These studies are concerned with the organization of air motions and precipitation processes in all types of clouds, ranging from oceanic stratus clouds to tropical convection to fronts passing over mountain ranges. This area of research emphasizes the analysis of observations of storms by aircraft, radar and satellite and interpretation of the data via numerical modeling of the clouds. These studies aim to help understand the role of clouds and precipitation in the global atmospheric circulation and climate and to improve the forecasting of precipitation and severe weather.

Students and faculty often participate in field experiments to study precipitating cloud systems in various locations around the world. Recent projects in midlatitudes focus on the physics and dynamics of rainfall over the European Alps and the Oregon Cascades. Current work on tropical precipitation includes analysis of observations with satellite-borne radars and microwave sensors on the TRMM satellite. Ground based observations at Kwajalein Atoll in the Marshall Islands are being used to validate and understand the satellite observations. Shipborne radar is being used to study precipitation in the Indian Monsoon and the Intertropical Convergence Zone. A project is planned to use aircraft radar data to study rainband/eyewall interactions in hurricanes.

**Glaciology**

The glaciological research in the Department is aimed at understanding local and small-scale processes related to snow and ice and predicting their role in regional and global climate. The structural and optical properties of snow, sea ice, and pure ice and their interaction with radiation across the solar spectrum and the thermal infrared are being studied in cold-room laboratories and field projects carried out in both the Arctic and Antarctic. Microwave properties of sea ice are being investigated experimentally and theoretically for application to satellite remote sensing. The heat and mass exchanges involved in the growth and decay of sea ice, and air/sea interaction in the presence of an ice cover, are studied by experiments in the Arctic Ocean and by computer modeling. The wind-driven circulation of sea ice is studied using drifting buoys. Changes in the statistical distribution and overall thickness of Arctic sea ice are being investigated using upward-looking submarine sonar observations. Researchers from the Department have been conducting multidisciplinary fieldwork in the Arctic Ocean and adjacent seas since 1957.

Students in the Department are part of the large and active glaciological community at the University, which includes members in the Department of Earth and Space Sciences (glacier dynamics), the Quaternary Research Center (glacial geology, permafrost, isotope chemistry of polar ice cores), and the Oceanography Department (polar oceanography). The Polar Science
Center, a branch of the Applied Physics Laboratory, is dedicated to research in high-latitude oceanography, sea ice processes, air-sea-ice interaction, and remote sensing of ice and snow, and climate change.

**Mesoscale Meteorology**

Mesoscale meteorology is the study of atmospheric phenomena with typical spatial scales between 10 and 1000 km. Examples of mesoscale phenomena include thunderstorms, gap winds, downslope windstorms, land-sea breezes, and squall lines. Many of the weather phenomena that most directly impact human activity occur on the mesoscale. Research in mesoscale meteorology has been spurred by recent advances in observational and numerical modeling capabilities that have greatly improved the tools used by atmospheric scientists to study mesoscale weather systems.

Faculty and students in the department are actively involved in a large number of different research projects in mesoscale meteorology. These include studies of convective cloud clusters and squall lines in the tropics and mid-latitudes, studies of precipitation bands along fronts, the investigation of marine stratus and strato-cumulus over the sub-tropical oceans, and research on topographically forced flows such as downslope windstorms, the blocking and channeling of the winds by orography, mountain-wave induced rotors, and the prediction of precipitation in complex terrain. These phenomena are studied using in situ observations, remote sensing, and both idealized and highly realistic mathematical models. Many local weather phenomena of the Pacific Northwest are also under study in the department, where a very high resolution weather forecast model for the Puget Sound region is run twice daily on an operational basis.

**Middle Atmosphere Meteorology**

The middle atmosphere (stratosphere and mesosphere) is the region of the atmosphere between about 12 and 80 km altitude. Studies of dynamical and chemical processes in this region have greatly expanded in recent years owing to the impact of human activities on the stratospheric ozone layer, and the coupling between stratospheric changes and surface climate. The University of Washington has a distinguished record of research on the meteorology of the middle atmosphere. Research efforts are divided between analysis of observational data and theoretical studies based on numerical models. A primary area of emphasis is study of the dynamical interactions between the troposphere and the stratosphere, including the transfer of momentum and trace constituents across the tropopause. This effort requires understanding of the influence of both large- and small-scale wave motions on the momentum balance and mass circulation of the middle atmosphere. Members of the department are active in analysis and interpretation of middle atmosphere data from NASA research satellites. Students and faculty also employ a variety of models, ranging from global scale circulation models to mesoscale convective storm models, to study the links between the troposphere and the stratosphere.
**Planetary Atmospheres**

The behavior of the atmospheres of other planets is of interest in its own right and may provide insights of value in the study of our own atmosphere and climate system. Efforts are focused primarily on Mars. We use computer models and data from recent spacecraft (such as NASA's Mars Global Surveyor) to improve our understanding of the atmospheric dynamics and climate system of Mars. A small effort is also devoted to developing instrumentation for future space missions to measure Martian weather and climate.

The evolution of planetary atmospheres is a further area of research. Here the goal is to understand the nature of past atmospheres from the signatures they have left behind. These signatures can be physical or chemical. For example, on Mars such signatures arise from the effects of wind erosion of the planet's surface, chemical interaction of the atmosphere with the surface, and atmospheric loss to space. The chemical evolution of the Earth's atmosphere is also studied within such a broad, planetary context. The Earth's atmosphere is chemically coupled to the biosphere because all the important atmospheric gases, with the sole exception of argon, are biologically mediated to some extent. Computer models that incorporate climate and biogeochemical feedbacks are being developed to understand the past evolution of Earth's atmosphere. This effort is part of the cross-campus Astrobiology (AB) Program and benefits from the expertise of AB Program faculty, which covers a wide variety of relevant disciplines from astronomy to oceanography to microbiology.

**Radiative Transfer and Remote Sensing**

The rapid growth in atmospheric radiation studies in recent years is a result both of the increasing use of satellites to monitor atmospheric phenomena and of the increased emphasis on climate modeling. Because satellites measure only radiation, the interpretation of their data requires the study of radiative transfer in the atmosphere. Because the transfer of solar and terrestrial radiation represents the prime physical process that drives the circulation of the atmosphere and the ocean, an understanding of climate and the mechanisms of climatic changes also requires detailed understanding of radiative processes and the radiative energy balance in the earth-atmosphere system.

Current and recent research projects include the use of satellite data for microwave remote sensing of sea-surface temperatures, winds, humidity and liquid and ice water content of clouds, infrared remote sensing of upper atmosphere composition and dynamics, evaluation of the influence of clouds on the regional and interannual variations of the earth's radiation budget, and investigation of cloud-radiation interactions and their feedback to the climate system. Surface and aircraft fieldwork includes studies of solar and infrared radiation over the sea surface, microwave properties of sea ice, and light-absorption properties of atmospheric aerosols as well as the evaluations of GCM cloud and radiation parameterizations using ground-based remote sensing and in-situ aircraft observations. Theoretical work is underway to understand the light scattering by nonspherical ice particles and aerosols, to explain the radiative properties of snow and sea ice surfaces, to examine radiative processes in the upper atmosphere, and to study the influence of radiation on the maintenance of stratus clouds.
Synoptic Meteorology

Synoptic meteorology has traditionally been concerned with the analysis and prediction of large-scale weather systems, such as extratropical cyclones and their associated fronts and jet streams. An important aim of synoptic training is to acquaint the student with the structure and behavior of the real atmosphere. This is accomplished formally through coursework and informally through the maintenance of a facility for display of weather information including station reports, satellite pictures and a wide variety of weather maps and prognostic charts. An expanding interactive computer system allows convenient display and manipulation of meteorological data. The department maintains an extensive archive of weather maps, satellite imagery and station reports.

Recent synoptic research in the Department has dealt with such diverse subjects as the large-scale tropical and subtropical disturbances, extratropical cyclones, polar lows, the interactions between tropical and extratropical systems, and the large-scale effects of volcanic eruptions. Modeling and observational analyses are combined in an integrated approach to synoptic meteorology.
IV. RESEARCH ASSISTANTSHIP AND APPLICATION INFORMATION

Admission as a graduate student in Atmospheric Sciences is competitive. A minimum undergraduate grade-point average of 3.0 (B average) is required. The Department requires that all applicants take the Aptitude Test portion of the Graduate Record Examination. Information concerning the GRE may be obtained by going to: http://www.ets.org/gre/.

The Application for Graduate Admission should be completed online at: https://www.grad.washington.edu/applForAdmiss/. There is also an application fee which should be paid online. Online application includes Statement of Interests, current resume, and designation of three (3) letters of recommendation.

All other materials for admission to the Atmospheric Sciences program should be sent directly to the Department. The materials are:

• The Graduate Record Examination (GRE) scores,
• An official copy of the transcripts,

Applications for admission to the Autumn Quarter (the only quarter for which students are admitted) must be made prior to 15 January.

Students whose native language is not English must take the Test of English as a Second Language (TOEFL). Successful applicants with a score of less than 580 will be required to take an English as a Second Language course during their first quarter of residence. Please note that before a student can be admitted we must have the original copy of both the GRE and TOEFL scores.

Stipends for beginning Research Assistants for the 2011-12 year are approximately $1,799 per month during the academic year, and approximately twice that amount per month for 2.5 summer months, for an annual total of $25,186. The stipend increases as a student advances through the program, to a current maximum of $27,678 per annum for students who have passed the General Examination. Out-of-state tuition is waived and in-state tuition is paid for Research Assistants, as is medical, visual and dental insurance. Students are expected to work half-time, 20 hours per week, on research during the academic year, and fulltime during the summer.

Graduate students are required to serve as Teaching Assistants for one or two quarters. The first quarter in which a student serves as a TA usually occurs during their second graduate year. The TA stipend will be at the same rate as the student's research assistantship.
V. INITIAL PROGRAM OF STUDY

The Department of Atmospheric Sciences offers programs of graduate study leading to the degrees of Master of Sciences (M.S.) and Doctor of Philosophy (Ph.D.). The Department also cooperates in offering studies leading to degrees of M.S. and Ph.D. under the interdepartmental Program on Climate Change and Program on Astrobiology and under less formal arrangements with other degree-granting units on campus.

While the graduate program has no specific prerequisites, it is generally recommended that at least two years of mathematics (beginning with calculus and going through differential equations) be taken prior to applying for admission into the program, as well as one and one half years of calculus based physics. Other courses in mathematics, computer science and the various physical sciences would also be appropriate, depending upon a student's interest in a specific aspect of the atmospheric sciences. (A student interested in atmospheric chemistry might, for example, take additional courses in chemistry).

After admission into the program, each student must confer with the Graduate Program Coordinator prior to registration for the first quarter. Full-time students normally register for 18 credits (including research and seminar credits) in each quarter of the first year.

For most students, the first year of graduate study is devoted largely to basic courses in atmospheric sciences and mathematical methods. Research projects and graduate courses in the Department of Atmospheric Sciences are closely related, and the well-prepared graduate student may expect to begin research work rather quickly. Virtually all advanced students devote at least half-time to research that may include experimental laboratory work, observations in the field, data analysis, numerical simulation, and mathematical analysis.

Graduate students entering the Department of Atmospheric Sciences will be assigned a primary faculty advisor. A supervisory committee will be established with the primary faculty advisor as chairman, by the end of the first year in residence.

End of First Summer Seminar

Faculty advisors are expected to meet frequently with their first-year students during the summer to help them begin their thesis research, and, for masters students, to establish a focused plan for the master's thesis. All first-year students are required to give a 20-minute presentation in a one-day seminar at the end of the summer quarter of their first year of study. The presentation should describe their progress toward defining a thesis topic and on articulating the goals and proposed methodology that will be used to carry out their research. Preliminary results, if available, can also be presented, but students are not expected to have actually obtained significant results at this early stage of their studies. This seminar usually takes place the week before Fall-quarter classes begin. To keep the presentations casual and low-key, only professors, the class of incoming graduate students and the presenters are invited to attend the seminars.
VI. THE DEGREE OF MASTER OF SCIENCE

Objective: The program leading to the degree of Master of Sciences is intended to enable the student to grow with his field throughout his scientific career, to recognize and understand new concepts, and to master new procedures as they emerge in the literature.

Achievement of this objective requires that the student understand the fundamental principles of physics that are relevant to the atmosphere, acquire a thorough and comprehensive knowledge of atmospheric properties and behavior, and develop critical facilities.

M.S. Requirements

1. A minimum of 36 quarter credits (27 graded course credits and a minimum of 9 credits of thesis) must be presented, of which at least 3 credits must be in approved applied mathematics courses and 24 must be in atmospheric sciences courses numbered above 500 (exclusive of seminars, colloquia or research credits).

2. The Graduate School accepts numerical grades in (a) approved 400-level courses accepted as part of the major, and (b) in all 500-level courses. A minimum cumulative grade point average of 3.0 is required for a graduate degree at the University. A minimum grade of 2.7 must be earned in each course presented to satisfy the required 24 credits of atmospheric sciences courses numbered above 500 (exclusive of research or thesis) and the 3 credits in applied mathematics.

3. By the end of November of the fall quarter of each Master’s student’s second academic year, the student should form an M.S. Supervisory committee (consisting of a faculty adviser and two additional graduate faculty in Atmospheric Sciences) and meet with the committee to review their M.S. research proposal. During spring quarter, the student and the faculty advisor must submit a coauthored thesis plan to the student’s M.S. committee. An informational copy will also be filed with the departmental office. The plan should be only a few pages long; it should concisely present the questions to be addressed and the methodology that will be used in the thesis research. The plan should include a nominal timetable, indicating milestones against which the next year’s progress can be measured. This plan must be approved by the student’s thesis committee and submitted to the Student Services Coordinator with written feedback from the committee chair by the end of spring quarter of the student’s second year. There are no automatic penalties for deviations from this plan or failure to meet the estimates in the timetable. The thesis plan simply provides a well-defined launching point for the remainder of the thesis research.

4. The M.S. thesis should be directed toward the solution of a problem of substantial scientific importance and should demonstrate the student's ability to use research methods in a limited area and to discuss critically the student's own and other investigators' work. The student must submit a graduation application via the Graduate School’s website by the end of the 8th week of the quarter (6th week in summer quarter). The thesis must be prepared in accordance with the rules and procedures of the Graduate School, and must be approved by the Supervisory Committee, presented orally to the faculty and students, and defended in discussion.
In addition to the two copies of each thesis that must be submitted to the Graduate School, one copy must be filed with the Chairman of the Supervisory Committee and one with the Department.
VII. PROCEDURES FOR PH.D. QUALIFICATION

All students admitted into the Atmospheric Sciences graduate program will be admitted initially to the M.S. track of study.

A student who wishes to be considered by COGS must first write a letter to the Academic Counselor, Samantha Scherer, and also to his/her M.S. committee, requesting admission into the Ph.D. program, and choosing one of the following evaluation options:

(1) A student may submit a completed draft of his/her M.S. thesis for evaluation by the COGS. The thesis draft must have been read and approved by the student’s supervisory committee prior to submission to the COGS (committee will confirm this in their letter of recommendation.) The M.S. draft must be submitted to the COGS by Monday of the second week of winter quarter in the student’s third academic year. The final thesis must be submitted to the Graduate School no later than spring quarter in order to meet the graduation deadline.

(2) A student entering the department, having already earned an M.S. degree in Atmospheric Sciences or a closely related discipline, may submit his/her thesis for evaluation by the COGS in the winter quarter of the student’s second year. This must be done with written concurrence of the faculty adviser. Written notice to the Student Services Coordinator and the COGS must be given by Monday of the second week of winter quarter in the student’s second academic year. The student will be expected to present a departmental seminar on the thesis material.

Course Requirement

A student who wishes to enter the Ph.D. program through option 1 must finish the required graduate courses listed on page 19 prior to evaluation by COGS.

Students who have already taken equivalents of some of the required graduate courses may petition COGS to skip these courses. This may require an oral examination by a COGS-selected faculty member to test the student's proficiency in the required course material and/or documentation of the contents and student performance in the previously taken courses. For a student proceeding through option 1, such petitions must be approved by the COGS at least one year before the COGS evaluates the student's entry into the Ph.D. program.

Seminar Requirement

Regardless of the basis for evaluation, the student will be expected to give a public defense of his/her research prior to evaluation by COGS. The seminar should be given no later than winter quarter in the student’s third academic year (second year for students petitioning through option...
2), on a date chosen in coordination with COGS and the student’s M.S. committee. The student will give an oral presentation (of 30-40 minutes) and answer questions in a public defense open to all faculty and students. Immediately after the public defense, members of the student’s M.S. committee and of COGS will meet with the student for more detailed questions. The chair of COGS will lead this closed-door part of the defense. At least two members of COGS and two members of the student’s M.S. committee must be present.

**Evaluation by the COGS**

Evaluation by the COGS will take into account the student's research potential and academic record. The evaluation of the academic record will be based mainly on the level of difficulty and breadth of the courses taken and the grades earned in those courses, with particular emphasis on the required atmospheric sciences core courses. The COGS has no set threshold for a minimum GPA in core ATMS courses, but students can consult the distribution of GPAs of students who have successfully passed COGS. The research potential will be evaluated from the M.S. thesis and the seminar presentation. In addition, for option 1, COGS will be strongly influenced by the M.S. supervisory committee's written evaluation of the thesis, and the committee’s recommendation as to whether it constitutes sufficient evidence of research capability to qualify the student for the PhD program. This recommendation letter should describe in detail the ideas in the thesis that came from the student. The letter should also give examples that demonstrate creativity, independent thought, initiative, and critical thinking in the student’s work. The COGS may solicit comments concerning the student’s academic or research performance from individual departmental faculty members. In the event of a negative decision, the COGS will consider one subsequent request for reevaluation provided that second request is made prior to exceeding the time limitation described below.
## COGS Timeline

*The typical student timeline/deadlines from entry into the program until COGS decision*

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>September, Yr 1</td>
<td>Entry into program</td>
</tr>
<tr>
<td>September, Yr 2</td>
<td>Present end of Year 1 report</td>
</tr>
<tr>
<td>October/November, Yr 2</td>
<td>Form M.S. committee (submit names to S. Scherer by November 30) and meet to review research proposal</td>
</tr>
<tr>
<td>End of Spring Quarter, Yr 2*</td>
<td>Meet with committee to review progress based on a research summary (1-2 pages) provided by the student; the committee should provide feedback to the student and the committee chair should provide a brief summary (1-2 paragraphs) to be placed in the student’s file along with the student’s research summary. (This meeting may take place during the summer if committee members are available but no later than August)</td>
</tr>
<tr>
<td>January, Yr 3 (Yr 2 for Option 2 applicants)</td>
<td>Deadline for provision of written material to committee [by Monday of the second week of Winter quarter]</td>
</tr>
<tr>
<td>Winter Quarter, Yr 3 (Yr 2 for Option 2 applicants)</td>
<td>Present departmental COGS seminar</td>
</tr>
<tr>
<td>End of April, Yr 3 (Yr 2 for Option 2 applicants)</td>
<td>All COGS decisions completed</td>
</tr>
</tbody>
</table>

* Not required for students applying to COGS using prior M.S. thesis

## Time Limitation

A student may be considered for acceptance into the departmental PhD program for up to three years from the time of entry into the Atmospheric Sciences graduate program, not including academic quarters in which the student is (a) on leave from the university, (b) predominantly occupied with field (or other research projects) that are not directly thesis related, or (c) predominantly devoted to satisfying course requirements for extra-departmental academic programs in which the student is registered. It is expected that most students will serve for one or two quarters as a teaching assistant during this three-year period. Quarters not counted toward the three-year limit are subject to the approval by the COGS and in the case of (b) and (c) COGS approval must be requested during the academic quarter(s) in question. For a student entering the department during the autumn quarter and not granted any extensions, the formal deadline for submission of materials for evaluation by COGS will be the Monday of the 2nd week of winter quarter of the student’s third year in residence. The COGS will usually meet during the first or second week of each quarter. The student should notify Samantha Scherer of his/her intention to be considered by COGS at least one month before the end of autumn quarter. This will allow scheduling of the seminar during winter quarter.
Students who have completed an M.S. thesis but are still awaiting a COGS decision should continue to register for ATM S 700 research credits. They are allowed to do this for one quarter after the M.S. has been granted.

**COGS Guidelines**

Final decisions concerning admission to PhD candidacy will be delegated to the COGS, without the requirement for ratification by a vote of the entire departmental faculty; however, COGS decisions may be overruled by a 2/3 vote of the entire department faculty if there is an appeal by the student or his/her advisor.

The COGS is composed of five faculty members (with a quorum of four for meetings). COGS members will be excused from the COGS evaluation of students that they supervise. Academic faculty members chosen from a ranked list may be asked to substitute for regular COGS members if this is necessary to achieve a quorum for a timely COGS meeting. The terms of the members are three years and are staggered, so that there is memory from one year to the next. When the three-year term of the COGS chair is completed, one of the existing COGS members (after already serving on COGS for 1-3 years) will be appointed to a three-year term as new chair.
VIII. THE DEGREE OF DOCTOR OF PHILOSOPHY

Objective: The degree of Doctor of Philosophy signifies understanding of the nature of knowledge normally attained only through the original solution of a problem of substantial scientific importance.

Requirements

A student must qualify for study toward the PhD by presenting an exceptional master's thesis and then by being nominated to COGS by the M.S. supervisory committee and then approved by COGS for admission into the Ph.D. program. A Ph.D. student must normally be accepted as a research student by a member of the faculty of the Department. Immediately upon qualifying for PhD study, the student will set up a Supervisory Committee of not less than five members. The student and the Supervisory Committee will jointly plan the remainder of his/her academic program. The Supervisory Committee will normally meet with the student at least annually.

Students are required to take supporting courses outside their areas of specialization. At least 6 credits must be earned in approved courses in mathematics or the physical sciences other than Atmospheric Sciences. An additional 36 graded credits in Atmospheric Science courses numbered above 500 (excluding seminars and colloquia) must be earned before the Final Examination. Courses at the 500 level in science or mathematics may be substituted, subject to the approval of the supervisory committee, for some of these additional units.

A total of 27 credits of the required Atmospheric Sciences and out-of-department course work should be completed in the student's first year. The remaining credits should be earned during the second and third years of residence by taking courses at a nominal rate of one class per quarter.

A minimum grade of 2.7 must be presented for each course used to satisfy the above requirements. A cumulative GPA of at least 3.00 is required for a graduate degree.

General Examination

The General Examination will either be taken no later than one year after admission into the Ph.D. program, or will conform to a timetable established by the COGS. The student must apply to take the exam at least three weeks in advance of the exam date. Prior to submitting the request for exam online with the Graduate School, the student must have approval from all supervisory committee members either in writing or via email. The exam will consist of a substantial thesis proposal which includes a review of the pertinent literature, preliminary results on the subject of the student's research, and proposed future research and methodology.

In the event a student does not pass the General Examination, it may be retaken once, by the end of the second quarter after the first exam.
The General Examination itself normally consists of an oral examination that tests the student's understanding of an area of specialization (e.g., synoptic or dynamic meteorology, cloud physics, energy transfer, etc.) with emphasis on the subject of the student's intended thesis. Students who pass the General Examination are admitted as candidates for the Ph.D. degree.

Following the General Examination, the student normally continues research and thesis work. The student may, however, pursue such advanced course work directed toward an area of specialization as may be recommended by the Supervisory Committee. Neither grades earned in courses nor total credits are sufficient evidence of eligibility for the Ph.D. degree; they may, however, be used as guides in planning a program and as indicators of minimum standards.

**Dissertation Defense**

The dissertation is an important part of the candidate's program; it must represent an original contribution toward understanding a problem of substantial scientific importance. The dissertation must be prepared in accordance with the rules and procedures of the Graduate School. A Reading Committee consisting of three members of the supervisory committee will be appointed. A complete copy of the dissertation must be given to this Committee at least four weeks prior to the Final Exam (aka dissertation defense), and it must be presented orally and defended at a Department of Atmospheric Sciences colloquium. The Final Examination is conducted following the oral presentation of the dissertation and is limited to the subject of the dissertation. The student must submit a formal request to defend at least one week in advance of the defense date. Prior to submitting this request online with the Graduate School, the student must have approval from all supervisory committee members either in writing or via email. In addition to the two copies that must be submitted to the Graduate School, one copy of the final dissertation must be filed with the Department and one copy presented to the Supervisory Committee chairperson.
IX. REQUIRED COURSEWORK

Required Graduate Coursework

The required classes for all entering graduate students are:

ATMS 501 (5) Fundamentals of Physical Meteorology. (A)
ATMS 502 (3) Introduction to Synoptic Meteorology. (A)
ATMS 532 (3) Radiation (Introductory) (W)
ATMS 535 (3) Cloud Physics (Sp)
ATMS 558 (3) Atmospheric Chemistry (Introductory) (Sp)

and either of the following sequences

ATMS 505 (4) Introduction to Fluid Dynamics. (A)
ATMS 509 (4) Geophysical Fluid Dynamics (W)
ATMS 542 (3) Dynamic Meteorology of Mid-Latitude Weather Systems (Sp)

or

ATMS 503 (3) Atmospheric Motions I (A)
Two ATMS courses in students’ own disciplines

The 2nd sequence is intended for those whose research specialty will be well outside the realm of dynamic meteorology. Most students are encouraged to take the three-course sequence in dynamics. The students who take the 2nd sequence are encouraged to take ATMS 504 (5) Atmospheric Motions II (W) in addition to one course from their own disciplines. The total units for these required courses are from 26 to 28.

Ph.D students are required to take a minimum of 36 units of ATMS classes 500 or higher (excluding seminars and colloquia), as well as 6 credits of related coursework outside the department. (Note that for PCC students the series of 9 credits is easily accommodated).

Master's students need 36 units to graduate - 27 graded course credits (excluding seminars and colloquia) and a minimum of 9 credits of thesis - with 24 of those units in Atmospheric Sciences courses above 500. However, those students intending to pursue a Ph.D should take all of the courses required above.
FIRST TWO YEARS
The required courses are distributed over a student’s first two years as follows:

AUTUMN QUARTER YEAR 1 (18 credits total):

ATMS 505 (4) Introduction to Fluid Dynamics.
(ATMS 503 Atmospheric Motions I)
ATMS 520 (1) Atmospheric Sciences Colloquium
Seminar (1)
Elective
ATMS 600 (up to 10 credits, to bring total quarter credits to 18)

WINTER QUARTER YEAR 1 (18 credits total):

ATMS 532 (3) Radiation (Introductory)
ATMS 509 (4) Geophysical Fluid Dynamics
(ATMS 504 Atmos Motions II or a course in students’ own disciplines as a required course)
ATMS 520 (1) Atmospheric Sciences Colloquium
Seminar (1)
Elective
ATMS 600 (up to 10 credits, to bring total quarter credits to 18)

SPRING QUARTER YEAR 1 (18 credits total):

For those who took 503:
ATMS 535 (3) Cloud Physics
ATMS 558 (3) Atmospheric Chemistry (Introductory)

For those who took 505-509:
ATMS 542 (3) Dynamic Meteorology of Mid-Latitude Weather Systems
And one of the following:
ATMS 535 (3) Cloud Physics
ATMS 558 (3) Atmospheric Chemistry (Introductory)

And all of the following:
ATMS 520 (1) Atmospheric Sciences Colloquium
Seminar (1)
Elective
ATMS 600 (up to 10 credits, to bring total quarter credits to 18)
AUTUMN QUARTER YEAR 2:

ATMS 502 (3) Introduction to Synoptic Meteorology.
ATMS 700 (10) Research Credits
ATMS 520 (1) Atmospheric Sciences Colloquium Seminar (1)

WINTER QUARTER YEAR 2:

Elective (3)
ATMS 700 (10) Research Credits
ATMS 520 (1)
Seminar (1)

SPRING QUARTER YEAR 2:

For those who took 503:
A course in students’ own disciplines as a required course

For those who took 505-509: One of
ATMS 535 (3) Cloud Physics
ATMS 558 (3) Atmospheric Chemistry (Introductory)

And also the following:
ATMS 700 (10) Research Credits
ATMS 520 (1)
Seminar (1)

Electives

Normally, at least two elective courses during the first year of graduate study should be in relevant mathematical methods. It is recommended that incoming students who have not had vector analysis should take AMATH 501 (vector analysis and complex variables) in their first quarter, while other students should take AMATH 581 (scientific computing using Matlab). Other recommended applied mathematics classes include AMATH 502 (dynamical systems and chaos), 503 (partial differential equations), 568 (approximate perturbation and asymptotic methods for ordinary differential equations), 584 (numerical linear algebra), 585 (numerical methods for boundary-value problems) and ATM S 581/AMATH 586 (numerical analysis of time-dependent PDEs). Those students interested in numerical modeling should take ATM S 581/AMATH 586 as an elective in the spring of their first year.
ATM S 552 (Objective Analysis) is highly recommended as a Matlab-based course in data analysis and applied statistics for all students with some previous undergraduate background in probability. For those needing basic background in probability, EE 505 (Probability and Random Processes) is also a good option.

Students should consult with their advisor to optimize their selection of other ATM S and out-of-department elective courses.
X. DESCRIPTION OF COURSES IN ATMOSPHERIC SCIENCES

Undergraduate Courses Which May Count Toward Graduate Work

431  ATMOSPHERIC PHYSICS (5) (A)
Energy transfer processes: solar and atmospheric radiation, turbulence and boundary layer structure, applications.
Prerequisites: 340 or PHYS 224.

451W INSTRUMENTS AND OBSERVATIONS (5) Sp
Principles of operating instruments for measuring important atmospheric parameters (e.g., temperature, humidity, aerosol concentration). Concepts of sensitivity, accuracy, representativeness, time response. Manipulation of output data including signal processing, and statistical analysis. Experimental design and implementation of the design in actual field experiments is included.
Prerequisites: STAT 311.

452  FORECASTING LABORATORY (5) Sp
Prerequisites: 370 and 442.

458  GLOBAL ATMOSPHERIC CHEMISTRY (4) A
Global atmosphere as a chemical system; Physical factors and chemical processes. Natural variabilities and anthropogenic change. Cycling of trace substances. Global issues such as climate change, acidic deposition, influences on biosphere. Offered jointly with CHEM 458.
Prerequisite: either ATM S 358 or CHEM 456.

480  AIR QUALITY MODELING (3) W
Evaluation of air quality models relating air pollution emissions to environmental concentrations. Topics include meteorological dispersion models and various "receptor" models based on chemical "fingerprinting" of sources. Emphasizes current problems. Offered jointly with CIVE 480.
Prerequisite: 458/CHEM 458 or CIVE 490 or permission of instructor.
503  ATMOSPHERIC MOTIONS I  (3)  A
The basic equations governing atmospheric motions and their elementary applications; circulation and vorticity; basic dynamics of midlatitude disturbances.
Prerequisite:  AMATH 353 or MATH 309; MATH 324.

504  ATMOSPHERIC MOTIONS II  (5)  W
Wave dynamics, numerical prediction, the development of midlatitude synoptic systems, and the general circulation.
Prerequisite: ATM S 441/503.

Courses for Graduates Only

501  FUNDAMENTALS OF PHYSICS AND CHEMISTRY OF THE ATMOSPHERE  (5)  A
Fundamentals of hydrostatics, thermodynamics, radiation, cloud physics and atmospheric chemistry.

502  INTRODUCTION TO SYNOPTIC METEOROLOGY  (3)  A
Overview of weather systems; atmospheric observations and data assimilation. Elementary manual and computer aided synoptic analysis techniques. Interpretation of satellite and ground based observations. Kinematics. Fronts and frontogenesis; life cycles of extratropical cyclones; related mesoscale phenomena. Numerical weather prediction; interpretation of forecast products.

505  INTRODUCTION TO FLUID DYNAMICS  (4)  A
Eulerian equations for mass, motion; Navier-Stokes equation for viscous fluids, Cartesian tensors, stress, strain relations; Kelvin's theorem, vortex dynamics; potential flows, flows with high, low Reynolds numbers; boundary layers, introduction to singular perturbation techniques; water waves; linear instability theory. Offered jointly with AMATH 505, OCEAN 511.
Prerequisites: AMATH 403 or permission of instructor.

508  GEOCHEMICAL CYCLES  (4)  Sp
Descriptive, quantitative aspects of earth as biogeochemical system. Study of equilibria, transport processes, chemical kinetics, biological processes; their application to carbon, sulfur, nitrogen, phosphorus, other elemental cycles. Stability of biogeochemical systems; nature of human perturbations of their dynamics. Offered jointly with CHEM 523, OCEAN 523.
Prerequisites: permission of instructor.

509  GEOPHYSICAL FLUID DYNAMICS I  (4)  W
Dynamics of rotating stratified fluid flow in the atmosphere/ocean and laboratory
Prerequisite: ATM S/AMATH 505/OCEAN 511.

510 PHYSICS OF ICE (3) W
Structure of the water molecule. Crystallographic structures of ice. Electrical, optical, thermal and mechanical properties of ice. Growth of ice from the vapor and liquid phases. Physical properties of snow. Offered jointly with ESS 531. (Offered alternate years).

511 FORMATION OF SNOW AND ICE MASSES (3) A

512 DYNAMICS OF SNOW AND ICE MASSES (3) Sp
Rheology of snow and ice. Sliding and processes at glacier beds. Thermal regime and motion of seasonal snow, glaciers, and ice sheets. Avalanches and glacier surges. Deformation and drift of sea ice. Response of natural ice masses to change in climate. Offered jointly with ESS 533. Offered alternate years. Prerequisite: Permission of instructor.

513 STRUCTURAL GLACIOLOGY (3) W
Physical and chemical processes of snow and stratigraphy and metamorphism. Interpretation of ice sheet stratigraphy in terms of paleoenvironment. Dynamic metamorphism from ice flow. Structures formed at freezing interfaces. Structure of river, lake and sea ice. Relationship between structures and bulk physical properties. Offered jointly with ESS 534. (Offered alternate years.) Prerequisites: Permission of instructor.

514 ICE AND CLIMATE (3)
Examines the role of ice and snow in climate. Polar climate dynamics. Polar-global interactions. Modeling snow cover, sea ice, and ice-sheet mass balance and flow in the climate system. Offered jointly with ESS 535. (Offered alternate years.) Prerequisite: Permission of instructor.

520 ATMOSPHERIC SCIENCES COLLOQUIUM (1) AWSp
Seminars on current research in advanced topics related to atmospheric sciences; conducted by faculty and visiting scientists/professors. Includes presentations of doctoral dissertations by department graduate students. For Atmospheric Sciences graduate students only. CR/NC Prerequisite: Permission of department.
521  SEMINAR IN ATMOSPHERIC AND CLIMATE DYNAMICS  (*)  AWSp  
Directed at current research in the subject. For advanced students. CR/NC  
Prerequisite: Permission of instructor.

523  SEMINAR IN ATMOSPHERIC PHYSICS AND CHEMISTRY  (*)  AWSp  
Directed at current research in the subject. For advanced students. CR/NC  
Prerequisite: Permission of instructor.

524  SEMINAR IN CLIMATE DYNAMICS AND ENERGY TRANSFER  (*)  A  
Directed at current research in the subject. For advanced students. CR/NC  
Prerequisite: Permission of instructor.

525  SEMINAR - TOPICS IN ATMOSPHERIC CHEMISTRY  (1-3, max. 6) W  
Seminar for atmospheric scientists, chemists, and engineers in problems associated with  
the chemical composition of the atmosphere. Topics range from the natural system to  
urban pollution and global atmospheric change. Faculty lectures and student  
participation. Offered jointly with CEE 553. CR/NC  
Prerequisite: CEE 301 or permission of instructor.

532  ATMOSPHERIC RADIATION: INTRODUCTION  (3) W  
Fundamentals of radiative transfer; absorption and scattering by atmospheric gases;  
elementary applications to constraints on the thermal structure, photochemistry, and  
remote sensing.  
Prerequisite: PHYS 323 or permission of instructor.

533  ATMOSPHERIC RADIATION: ADVANCED  (3) A  
Optical properties and particle absorption and scattering; solutions of radiative transfer  
equation in multiple scattering atmospheres; applications to atmospheric and surface  
energy balance and remote sensing.  
Prerequisite: ATMS 532/ESS 571 or permission of instructor.

534  REMOTE SENSING OF THE ATMOSPHERE AND CLIMATE SYSTEM  (3)  
Satellite systems for sensing the atmosphere and climate system. Recovery of  
atmospheric and surface information from satellite radiance measurements. Applications  
to research. (Offered alternate years.)  
Prerequisites: 532 or 533.

535  CLOUD MICROPHYSICS AND DYNAMICS  (3) Sp  
Basic concepts of cloud microphysics, water continuity in clouds, cloud dynamics, and  
cloud models. Offered jointly with ESS 573.  
Prerequisite: 501 or permission of instructor.

536  MESOSCALE STORM STRUCTURE AND DYNAMICS  (3) Sp  
Techniques of observing storm structure and dynamics by radar and aircraft, observed  
structures of precipitating cloud systems, comparison of observed structures with cloud
models. (offered alternate years)
Prerequisite: 535/ESS 573.

542 SYNOPTIC AND MESOSCALE DYNAMICS (3) Sp
Quasi-geostrophic theory, baroclinic instability, symmetric instability, tropical
disturbances, frontogenesis, orographic disturbances, convective storms.
Prerequisites: 509/OCEAN 512 and AMATH 402 or equivalents.

544 DESIGN AND APPLICATION OF ENSEMBLE PREDICTION SYSTEMS (3) SP
Covers the fundamental of chaos theory to help compare and contrast traditional,
deterministic forecasting versus ensemble forecasting. Explores the various components
of an ensemble prediction system. Introduces decision science to show how to apply
probabilistic weather information in optimal decision making.
Prerequisite: ATM S 501; ATM S 502; and ATM S 552 or permission of instructor.

545 GENERAL CIRCULATION OF THE ATMOSPHERE (3) Sp
Requirements of the global angular momentum heat, mass and energy budgets upon
atmospheric motions as deduced from observations. Study of the physical processes
through which these budgets are satisfied.
Prerequisite: 509/OCEAN 512 or permission of instructor.

547 BOUNDARY LAYER METEOROLOGY (3) Sp
Turbulence, turbulent fluxes, averaging. Convection and shear instability. Monin-
Obukhov similarity theory, surface roughness. Wind profiles. Organized large eddies.
Energy fluxes at ocean and land surfaces, diurnal cycle. Convective and stable stratified
modeling and parameterization. (Offered alternate years)
Prerequisite: 505; AMATH 505 or OCEAN 511.

551 ATMOSPHERIC STRUCTURE AND ANALYSIS I: SYNOPTIC SCALE SYSTEMS (4)
Diagnosis of vertical motions. Fronts and frontogenesis. (Offered alternative years).
Prerequisite: 502 and 509 or OCEAN 512.

552 OBJECTIVE ANALYSIS (3) W
Review of objective analysis techniques commonly applied to atmospheric problems;
examples from the meteorological literature and class projects. Superposed epoch
analysis, cross-spectrum analysis, filtering, eigenvector analysis, optimum interpolation
techniques.

553 ATMOSPHERIC STRUCTURE AND ANALYSIS II: NON-CONVective
MESOSCALE CIRCULATION (3) W
Thermally forced circulation systems, including sea/land breezes and mountain/valley
winds. Topographic deflection, channeling and blocking in mesoscale flows. Analysis
and forecasting of local mesoscale phenomena. (Offered alternate years.)
554 PALEOCLIMATE PROXIES (3)
Provides a critical evaluation of the most commonly applied paleoclimate proxies from the ocean, land, and ice sheets. Offered: jointly with ESS 554/OCEAN 554; alternate years.

555 PLANETARY ATMOSPHERES (3) A or W
Problems of origin, evolution and structure of planetary atmospheres, emphasizing elements common to all; roles of radiation, chemistry and dynamical processes; new results on the atmospheres of Venus, Mars, Jupiter and other solar system objects in the context of comparative planetology. Offered jointly with ASTR 555/ESS 581. (Offered alternate years.)

556 PLANETARY SCALE DYNAMICS (3) Sp
Zonally symmetric circulations, planetary waves, equatorial waves, dynamics of the middle atmosphere, trace constituent transport, nonlinear aspects of atmospheric flows. (Offered alternate years.)
Prerequisites: 542 or permission of instructor.

558 ATMOSPHERIC CHEMISTRY (3) Sp
Photochemistry of urban, rural, and marine tropospheric air, and of the natural and perturbed ozone in the middle atmosphere. Unity of the chemistries in these apparently different regimes.
Prerequisites: 458 or 501 or CHEM 457 or permission of instructor.

559 CLIMATE MODELING (3) Sp
Prerequisite: either ATM S/OCEAN/ESS 587, ATM S 504 or ATM S 505. Offered jointly with ESS 559/OCEAN 558. (Offered alternate years.)

560 ATMOSPHERE/OCEAN INTERACTIONS (3) Sp
Observations and theory of phenomena of the coupled atmosphere-ocean system. El Nino/Southern Oscillation; decadal tropical variability; atmospheric teleconnections; midlatitude atmosphere-ocean variability. Overview of essential ocean and atmospheric dynamics, where appropriate.Offered jointly with OCEAN 560. CR/NC.
Prerequisites: 509/ OCEAN 512. Alternate years.

564 ATMOSPHERIC AEROSOL AND MULTIPHASE ATMOSPHERIC CHEMISTRY (3) W
Physics and chemistry of particles and droplets in the atmosphere. Statistics of size distributions, mechanics, optics and physical chemistry of atmospheric aerosols. Brownian motion, sedimentation, impaction, condensation and hydroscopic growth. (Offered alternate years.)
Prerequisite: Permission of instructor.
571 ADVANCED PHYSICAL CLIMATOLOGY (3) A
Prerequisite: Permission of instructor.

575 LARGE SCALE DYNAMICS OF THE TROPICAL ATMOSPHERE (3) W
Observations and underlying dynamics of large-scale tropical circulations. Factors that determine regions of large-scale persistent precipitation in the tropics, thermal forcing of atmospheric circulations by these regions, and temporal variability of the forcing and response. (Offered alternate years.) CR/NC
Prerequisites: 509/ OCEAN 512 and 542.

581 NUMERICAL ANALYSIS OF TIME DEPENDENT PROBLEMS (5) Sp
Prerequisite: Familiarity with partial differential equations and Matlab. AMATH 581 or AMATH 584 strongly recommended.

582 ADVANCED NUMERICAL MODELING OF GEOPHYSICAL FLOWS (3)
Prerequisite: 581 and AMATH 586 or MATH 586.

585 CLIMATE IMPACTS OF THE PACIFIC NORTHWEST (4) Sp
Knowledge of past/future patterns of climate to improve Pacific Northwest resource management. Topics include the predictability of natural/human-caused climate changes; past societal reactions to climate impacts on water, fish, forest, and coastal resources; how climate and public policies interact to affect ecosystems and society. Offered jointly with ESS/ENVIR/SMA 585.

586 CURRENT RESEARCH IN CLIMATE CHANGE (2)
Weekly lectures focusing on a particular aspect of climate (topic to change each year) from invited speakers (both UW and outside), plus one or two keynote speakers, followed by class discussion. Offered jointly with OCN 586 and ESS 586.

587 CLIMATE DYNAMICS (3) A
Description of Earth’s climate system; distribution of temperature, precipitation, wind, ice, salinity and ocean currents; fundamental processes determining Earth’s climate; energy and constituent transport mechanisms; climate sensitivity; natural climate variability on interannual to decadal time scales; global climate models; predicting future climate. Offered jointly with OCEAN 587 and ESS 587.
THE GLOBAL CARBON CYCLE AND CLIMATE (3) W
Oceanic and terrestrial biogeochemical processes controlling atmospheric CO₂ and other greenhouse gases. Records of past changes in the earth’s carbon cycle from geological, oceanographic and terrestrial archives. Anthropogenic perturbations to cycles. Develop simple box models, discuss results of complex models. Offered jointly with OCEAN 588 and ESS 588.

PALEOCLIMATOLOGY: DATA MODELING AND THEORY (3) Sp

SPECIAL TOPICS IN ATMOSPHERIC SCIENCES (1-4, max. 9) AWSp
Lecture series on topics of major importance in the atmospheric sciences. Prerequisite: Permission of instructor

CLIMATE SCIENCE SEMINAR (1) W
Focuses on how to communicate climate science to many different audiences through careful construction of figures and through written and oral communication. Credit/no credit only. Offered: jointly with ESS 593/OCEAN 593.

CLIMATE SCIENCE CAPSTONE PROJECT (1-5, max. 5) AWSpS
Climate capstone directed by a mentor, may be a group effort, and may encompass curriculum development, internships, workshop organization, etc., capturing interdisciplinary aspects of climate science and effective communication of climate science. Offered: jointly with ESS 596/OCEAN 596.

Independent Research (*) CR/NC

Master’s Thesis (*)

Doctoral Dissertation (*)

*variable credit
General Timeline of Study (for students entering Aut 2011 or later)

*Students who entered the program prior to Aut 2011 should reference the older version of this timeline.*

This timeline is intended as a general guideline to be used only as a reference and planning tool – it is not a substitute for the more detailed policies and procedures outlined in the Grad Program Guide. All grad students are responsible for being familiar with the content of the GPG which is available in pdf format on the Grad Program website.

**First Year of Study**

**Autumn – Spring**
During the first three quarters, students will be engaged in taking core classes, and beginning to explore a research problem. Towards the end of the first year, students should begin thinking about a summer research plan and a presentation to be given at the end of summer.

**Summer**
During summer quarter, students conduct independent research. Progress and plans for Masters Thesis research are presented at the end of the summer quarter at the First Year Research Presentations. These presentations are generally given during the week preceding the first week of classes of autumn quarter (late September). This is an all day event during which each first year graduate student gives a twenty-minute presentation on their research to date, followed by questions and answers. The audience for these reports consists of first year graduate students, the incoming class of new graduate students, and Atmospheric Sciences faculty.

**Second Year of Study**

During the second year, students continue to take core and elective courses but focus primarily on independent research. Additionally, students will serve as a TA for one quarter.

**Autumn**
By the end of November, students set up a Masters Thesis committee. This committee consists of a minimum of three graduate faculty in Atmospheric Sciences, one of whom must be the student’s faculty adviser. To set up the MS committee, students must send an email to the Student Services Coordinator listing the committee chair and additional members.

Also by the end of November, students should meet with their new supervisory committee to review a research proposal.

**Winter**
Students applying for entry into the PhD program with a prior M.S. thesis should plan on applying in winter quarter of their second year of study (see application steps listed in “Third Year of Study” below).

**Spring**
During spring quarter, students should meet with their supervisory committee for feedback on a research proposal, coauthored with their faculty adviser. This proposal is a brief document (usually 2-3 pages but may be longer) that addresses the Masters Thesis research. The plan must include an overview, methodology, and anticipated timeline. Examples of past Masters Thesis proposals are available in the Students Services Office in ATG 416.

By the last day of spring quarter, students should submit this proposal – complete with written feedback from committee chair - to the Student Services Coordinator.
Third Year of Study

For students who entered the program in Autumn 2011 or later and who intend to apply for entry into the PhD program, the last quarter that they may apply for entry is winter quarter of their third year. Students applying to the COGS with a prior M.S. thesis should plan on completing the following steps in winter quarter of their second year of study. Graduate students who entered the program prior to Autumn 2011 must apply to the COGS via the old guidelines. Procedures detailing application to the COGS can be found in the Grad Program Guide; procedures, deadlines and a checklist are also available on the Grad Program website.

During the third year, students should complete any core and/or elective courses needed to fulfill the course requirement. The bulk of the third year will be devoted to research, preparing the Masters thesis, and preparing to apply to the COGS (for entry into the PhD program) in winter quarter. Students who will stop at a Masters degree and who do not intend to apply to the COGS should plan to give their public seminar in the quarter in which they intend to graduate.

Winter
For students applying to the COGS, written materials are due no later than the second Monday of winter quarter.

Public COGS seminar must be given during winter quarter.

Spring
COGS decisions will be announced by the end of April.

After Entry Into the PhD Program

Upon entry into the PhD program, students focus almost exclusively on research and preparing for the general exam and doctoral thesis. Elective courses may also be taken to satisfy degree requirements and/or to support research. Students may also be required to TA a second quarter.

Students should set up their doctoral committee within one month of entry into the PhD program. The doctoral committee must consist of a minimum of five members, to include a Faculty Adviser/committee chair, three Graduate faculty in Atmospheric Sciences, and a Graduate School Representative (GSR). More information on the doctoral committee may be found on the Graduate School’s website: http://www.grad.washington.edu/stsv/doccommroles.htm. In order to set up the committee, students must email the Student Services Coordinator with the names of their committee members and their roles.

The nominal timeline for taking the general exam is no more than one year after gaining entry into the PhD program.

The nominal timeline for taking the final exam is one year after successfully passing the general exam, although this time varies.
MS Procedures Checklist

Before beginning the MS Degree process, please be sure to familiarize yourself with the UW Graduate School’s Master’s Degree Policies: [http://www.grad.washington.edu/policies/masters/index.shtml](http://www.grad.washington.edu/policies/masters/index.shtml). You are responsible for knowing this information.

**At least one quarter prior to MS degree:**

- Complete credit requirements for degree: [http://www.atmos.washington.edu/academics/grads/reqcourses.shtml](http://www.atmos.washington.edu/academics/grads/reqcourses.shtml)
  - Minimum 36 cr to include:
    - 24 cr ATM S 500-level (excl seminar & colloquia)
    - 3 cr approved AMath
    - 9+ cr ATM S 700
- 3.0 minimum cumulative GPA
- M.S. Supervisory Committee - minimum of three members, consisting of a Faculty Adviser/committee chair, and 2 Graduate faculty in Atmospheric Sciences.
  To set up your MS committee, email Sam with the following:
  - Faculty adviser/chair
  - 2 Graduate faculty in Dept. of Atmospheric Sciences
  - Must be set up by the end of the first year in residence (typically, the first week in autumn quarter)

**During quarter of MS degree:**

- Present thesis in public seminar during the quarter of degree request
  - Notify Student Services of the date, time, location of public seminar at least three weeks in advance
- Submit Master’s Degree Request online: [http://www.grad.washington.edu/student/mastapp.aspx](http://www.grad.washington.edu/student/mastapp.aspx)
- After submitting request form, email Sam to confirm submission

**MS Warrant:**

Once the Student Services Coordinator has received confirmation of submission of Masters Degree Request, she will print the warrant and give it to the student’s faculty adviser/committee chair. The chair will have until the last day of the quarter of graduation to make a degree recommendation and collect committee signatures. Once the warrant is returned to Sam, she will enter the recommendation online at which time a system-generated email will be sent to the student.

**Masters Thesis:**


- At least three weeks prior to final submission, submit title and signature pages of thesis to Graduate School via email for prelim review
- Submit final thesis to Graduate School
  - Deadline end of quarter of graduation
- Submit copies of final thesis to Sam, as follows, by the end of the quarter of graduation:
  - Required: one (1) unbound hardcopy - will be bound and placed in the department thesis library
COGS Procedures Checklist (effective Autumn Quarter 2011)

Students who entered the program prior to Aut 2011 must follow old procedures (pre-Sept 2011)

September, Year Two:

☐ Present End of Year One report (presentations coordinated by Student Services Coordinator)

November 30th or earlier, Year Two:

☐ M.S. Supervisory Committee - minimum of three members, consisting of a Faculty Adviser/committee chair, and 2 Graduate faculty in Atmospheric Sciences.

To set up your MS committee, email Sam with the following:

- Faculty adviser/chair
- 2 Graduate faculty in Dept. of Atmospheric Sciences

☐ Meet with committee to review research proposal.

End of Spring Quarter, Year Two (not required for students applying to COGS using prior M.S. thesis):

☐ Meet with supervisory committee for feedback on 1-2 page research summary (provided by student)

☐ Submit research summary (with written feedback from committee chair) to Student Services Coordinator

At least one quarter prior to applying to the COGS:

☐ Complete credit requirements for degree: http://www.atmos.washington.edu/academics/grads/reqcourses.shtml

- Minimum 36 cr to include: 25-28 cr ATM S core courses (excl seminar & colloquia)
  3 cr approved AMath
  9+ cr ATM S 700

☐ 3.0 minimum cumulative GPA

☐ Submit Letter of Application to supervisory committee and Student Services (Sam), requesting admission into the PhD program (may be submitted as email)

- Letter must state the following:
  - Quarter in which admission is requested
  - Choice of evaluation option (ie. M.S. draft or prior M.S. degree)

Public Seminar & Defense – Winter Quarter, Year Three (Year 2 for students with prior M.S. thesis)

☐ Public seminar & defense – usually given in quarterly seminar; closed-door defense immediately after with ONLY the student, MS committee and the COGS in attendance

- Email Sam by last day of Autumn Quarter with the date and time of the seminar.
- At least two members of the COGS and two members of your M.S. supervisory committee must be present at this seminar

Guidelines on scheduling a seminar: http://www.atmos.washington.edu/academics/grads/cogsseminar.shtml
PhD Procedures Checklist - General Exam

Before beginning the General Exam process, please be sure to familiarize yourself with the UW Graduate School’s Doctoral Degree Policies: [http://www.grad.washington.edu/policies/doctoral/index.shtml](http://www.grad.washington.edu/policies/doctoral/index.shtml). You are responsible for knowing this information.

**Within one month of entering the PhD program (passing COGS):**

- Set up Doctoral Supervisory Committee - minimum of five members, consisting of a Faculty Adviser/committee chair, 3 Graduate faculty in Atmospheric Sciences, and a GSR.

  To set up your PhD committee, email Sam with the following:
  - The name(s) of your faculty adviser or co-advisers
  - The names of three graduate faculty in Atmos Sci who have agreed to be on your committee
  - The name of the GSR who has agreed to be on your committee
  - The quarter in which you plan on taking the General Exam - this can change however the committee can't be set up without this information

**At least one quarter prior to General Exam:**

- Complete credit requirements for degree: [http://www.atmos.washington.edu/academics/grads/regcourses.shtml](http://www.atmos.washington.edu/academics/grads/regcourses.shtml)
  - Minimum 90 cr to include: 36 cr ATM S 500-level (25-28 cr should be required courses)
    - 6 cr math/phys sci 500-level
    - 27+ cr ATM $ 800

- 3.0 minimum cumulative GPA

- Doctoral Supervisory Committee - minimum of five members, consisting of:
  - Faculty adviser/chair
  - 3 Graduate faculty in Dept. of Atmospheric Sciences
  - GSR

  Committee should have been set up within one month of passing the COGS; if membership has changed, email Sam with changes.

**At least three weeks prior to General Exam date:**

- Obtain explicit approval from all supervisory committee members (in writing or via email) of intent to take General Exam on the date you propose.
  - Approvals must be submitted to the Student Services Coordinator prior to submitting the Request for General Exam – if approvals are via email, you may forward them to Sam or have your supervisory committee members reply to me, provided the email explicitly states that they approve your request for the General Exam on the date you propose.

- Schedule a room for exam (usually ATG 406 or 627 - only you and your committee will be present )

- Submit Request for General Exam ([http://www.grad.washington.edu/mygrad/student.htm](http://www.grad.washington.edu/mygrad/student.htm))

- After submitting request form, email Sam to confirm submission - include the date, time and location of exam

**General Exam warrant:**

Once the Student Services Coordinator has received confirmation of supervisory committee approval, she will approve the request online (a system-generated email will be sent to student and all members of committee) and print the warrant. The warrant is kept in the student's file until the day before the exam at which time the file and warrant are given to the student's faculty adviser/committee chair.
## PhD Procedures Checklist - Final Exam & Doctoral Thesis

Before beginning the Final Exam process, please be sure to familiarize yourself with the UW Graduate School’s Doctoral Degree Policies: [http://www.grad.washington.edu/policies/doctoral/index.shtml](http://www.grad.washington.edu/policies/doctoral/index.shtml). You are responsible for knowing this information.

### Should already be completed (at time of General Exam):

- Complete credit requirements for degree: [http://www.atmos.washington.edu/academics/grads/reqcourses.shtml](http://www.atmos.washington.edu/academics/grads/reqcourses.shtml)
- 3.0 minimum cumulative GPA
- Doctoral Supervisory Committee - minimum of five members, consisting of:
  - Faculty adviser/chair
  - 3 Graduate faculty in Dept. of Atmospheric Sciences
  - GSR

  *Committee should have been set up for General Exam; if membership has changed, email Sam with changes.*

### At least four weeks prior to Final Exam:

- Set up Reading Committee - minimum of three members, consisting of:
  - Faculty adviser/committee chair
  - 2 members of doctoral supervisory committee (not to include GSR)

  *To set up committee, send an email to Sam including names of Reading Committee members*

- Confirm in writing (emails will not be accepted) that a complete draft of your dissertation has been given to Reading Committee (per Grad School policy, the Reading Committee must have read a draft of your thesis prior to submitting the Request for Final Exam, [http://www.grad.washington.edu/policies/doctoral/final-exam.shtml](http://www.grad.washington.edu/policies/doctoral/final-exam.shtml)). Confirmation may be made via the form at the bottom of this checklist.

- Schedule a room for exam
  - To give final exam during Colloquium, see the Colloquium coordinator to schedule a date
  - To give final exam at an alternate time, see Sam for assistance in scheduling a room for a Special Seminar

### At least one week prior to Final Exam:

- Obtain explicit approval from all supervisory committee members (in writing or via email) of intent to take Final Exam on the date you propose.
  - Approvals must be submitted to the Student Services Coordinator prior to submitting the Request for Final Exam – if approvals are via email, you may forward them to Sam or have your supervisory committee members send them directly to her, provided the email explicitly states that they approve your request for the Final Exam on the date you propose.

- Submit Request for Final Exam ([http://www.grad.washington.edu/mygrad/student.htm](http://www.grad.washington.edu/mygrad/student.htm))

- After submitting request form, email Sam to confirm submission - include the following information:
  - Date, time, location of final exam
  - Title of defense seminar

### Final Exam warrant:

Once the Student Services Coordinator has received confirmation of supervisory committee approval, she will approve the request online (a system-generated email will be sent to student and all members of committee) and print the warrant. The warrant is kept in the student’s file until the day before the exam at which time the file and warrant are given to the student’s faculty adviser/committee chair.
Doctoral Thesis:


- Submit final dissertation to Graduate School
  - Deadline 60 days from final exam or end of quarter of graduation, whichever is first

- Submit copies of final dissertation to Sam, as follows, by the end of the quarter of graduation:
  - Required: one (1) unbound hardcopy - will be bound by dept and placed in the department thesis library
  - Optional (encouraged): one (1) pdf copy - submit online: http://www.atmos.washington.edu/academics/grads/submitthesis.php

Confirmation of Dissertation Draft

At least four weeks prior to your final exam date, complete and sign the form below and present it to the Student Services Coordinator, who will initial and make a copy for your student file. Request for Final Exam will not be approved without completing this step.

By signing below, I confirm that I have given a complete draft of my PhD dissertation to my Reading Committee (RC) at least four weeks prior to the proposed date of my Final Exam.

Dissertation given to RC on: _________________________

Date of Final Exam: _________________________

I will also obtain explicit approval from all supervisory committee members (in writing or via email) of intent to take Final Exam on the date proposed above. Signatures or email will be provided to the Student Services Coordinator prior to submitting the Request for Final Exam online.

_____________________________________________________________________________________________
Signature Date
_____________________________________________________________________________________________
Printed Name

To be Completed by Student Services Coordinator:

- Confirmation of dissertation draft submission received on: _________________________
Recommendation Letter from Supervisory Committee:

Upon receipt of the letter of application, the Student Services Coordinator (S. Scherer) will contact the student's supervisory committee chair with a request for a letter from the committee in support of the student's application. The student's committee chair is responsible for submitting the recommendation letter by the materials deadline (below).

Submitting materials to the COGS – Monday of 2nd Week, Winter Quarter, Year Three (Year 2 for students with prior M.S. thesis):

Deadline: 3pm on the Monday of the 2nd week of Winter Quarter, Year 3. For a list of quarterly deadlines, go to http://www.atmos.washington.edu/academics/grads/cogsdeadlines.shtml

☐ Submit a hard copy of one of the following to Sam, room 416:

- Completed draft of M.S. thesis
  - Draft must have been read and approved by the M.S. supervisory committee prior to submission (committee will confirm this in their letter of recommendation.)
  - This may be a preliminary draft with substantial progress towards the final (final draft of the thesis must be turned in to the Graduate School separately no later than Spring qtr, year 3)
- Students entering the program with an M.S. in Atmos Sci or closely related discipline may submit a prior M.S. thesis for evaluation (with written concurrence of the faculty adviser).
  - Written notice must be given to the COGS and the Student Services Coordinator by Monday of the 2nd week of Winter quarter, year 2.

Submit MS Thesis to Graduate School for Degree – End of Spring Quarter, Year Three:


☐ Submit Master's Degree Request online: http://www.grad.washington.edu/student/mastapp.aspx

☐ At least three weeks prior to final submission, submit title and signature pages of thesis to Graduate School via email for prelim review

☐ Submit final thesis to Graduate School

- Deadline end of quarter of degree request

☐ Submit copies of final thesis to Sam, as follows, by the end of the quarter of degree request:

- Required: one (1) unbound hardcopy - will be bound and placed in the department thesis library
- Optional (strongly encouraged): one (1) pdf copy - submit online: http://www.atmos.washington.edu/academics/grads/submitthesis.php

COGS Decision

All COGS decisions will be complete by the end of April, Year 3 (Year 2 for students with prior M.S. thesis).