## Master of Science (M.S.)

There are two M.S. degree options: thesis and nonthesis. Students can change their option at any time, but must declare which option they are pursuing. They should also first coordinate any changes with their advisor.

For both the thesis and nonthesis options there is a set of six core courses which are highly recommended as a good foundation for graduate degrees in the Department of Atmospheric and Oceanic Sciences. A GPA of 3.0 must be maintained for both options.

The timeline for receiving a Master's degree is approximately 2 to 3 years.

The following is a listing of the core courses:

ATM OCN 610: Geophysical Fluid Dynamics 1 (3 credits)

ATM OCN 611: Geophysical Fluid Dynamics 2 (3 credits)

ATM OCN 630: Introduction to Atmospheric Physics (3 credits)

ATM OCN 640: Radiation in the Atmosphere & Ocean (3 credits)

ATM OCN 650: Analysis of Atmospheric Systems (3 credits)

ATM OCN 660: Physical Oceanography (3 credits)

Every student seeking an M.S. degree will, in consultation with their advisor, design a curriculum which must be approved by their advisor.

# Degree Requirements

## Thesis Option

The student conducts research supervised by their major professor. Results of the research are written into a master's thesis, following guidelines set by the Graduate School, library, department, thesis committee, and major professor. While conducting the research and writing the thesis, the student may want to (but is not required to) register for research credits (ATM OCN 990). The student must have a major professor to utilize the thesis option. Additional course work is required.

**Thesis.** The thesis must be a well organized piece of work written in clear English. The thesis is approved by the major professor and two additional faculty members. A public oral presentation of the thesis research is required.

**Course Credits.** Total of 24 credits of courses numbered 400 or above, is required.

12 of the credits must be taken in our department as lecture courses (seminars, research, independent study or directed reading courses do not satisfy this requirement). A grade of B or greater is required for these 12 credits. The additional 12 credits may be taken in or out of our department. Credits can include seminars, core courses, and other courses taken as a graduate student (graduate level courses taken as an undergraduate student or special student don't count). Research credits do not count toward the 24 credit requirement. A GPA of 3.0 must be maintained.

## Nonthesis Option

The student must demonstrate technical writing skill, gain an interdisciplinary background with courses outside the department, and can utilize professional experience, internships, or other courses to round out their education. The grad chair will serve as academic advisor unless the student finds another faculty member willing to serve as advisor.

**Writing Requirement.** Each student must write a paper demonstrating technical writing skill. The student can write this paper by working individually with a professor in a directed research setting, or as part of a seminar class. The professor in charge of the directed research or seminar class will decide on the acceptance of that paper and indicate so by signing the paper. The accepted paper should be given to the grad coordinator or grad chair to be filed with the student's record.

**Course Credits.** A total of 36 credits and a GPA of 3.0 are required. At least 12 of the credits taken in our department must be B or greater. All credits must be earned as a graduate student (graduate level courses taken as an undergraduate student or special student don't count).

18 - 24 are nonseminar course credits numbered 400 or above in our department. Department core courses count toward this requirement.

6 - 12 are nonseminar courses outside our discipline.

6 - can be course or seminar credits in any department. Research credits are only allowed if approved by your advisor. Some of these remaining 6 credits may be awarded for prior professional experience, or by an internship conducted as part of the M.S. program. Only 2 credits for an internship can be used.

### Courses Outside of AOS

Here is a listing of courses that students have taken outside of the department to satisfy degree requirements.

**Note:** Some 300 level courses in other departments may be acceptable for both options. You must receive approval of your advisor to use a 300 level course for

degree requirements. Courses in our department must be at or above the 400 level.

## Progress and Completion Guidelines

At the start of the graduate work, the student should declare which option will be pursued, and acquire from the grad coordinator a copy of the appropriate M.S. warrant request form. The student can record on this form the courses taken and grades received, and use it as a check list to monitor their own progress toward the degree. The M.S. degree should be completed within three years.

All students normally take a full load of 8 to 12 credits during each of the first two semesters. International students might take fewer credits if necessary to allow time to improve their English.

Each student must make satisfactory progress, as specified by the departmental and Graduate School satisfactory progress guidelines, which are available from the grad chair or grad coordinator. Failure to maintain satisfactory progress may result in probation, or dismissal from the department. The cumulative GPA in Graduate School must be no less than 3.0.

When the student and his/her advisor determine that all degree requirements will be met during the current semester, they submit a Warrant Application to the graduate coordinator. This is done approximately three weeks before the degree deadline for the current semester. If all requirements have been met, the grad coordinator orders the warrant from the Graduate School. The warrant is signed by the student's major professor, thesis committee, or advisor as appropriate. The graduate coordinator then returns the warrant to the Graduate School and they issue the official degree.

The Graduate School has a document on their web site that will answer questions on procedures. Information on thesis preparation is also available. Our department does not have any formatting requirements and you can follow the Graduate School guidelines.

Thesis students must deposit an unbound copy of the thesis at the Memorial Library by the degree deadline. This copy should be on bond paper. You must also provide the graduate coordinator with a hardbound copy of your thesis. The hardbound copy must be received within one month of the degree deadline.Your key deposits will not be returned until the department has the hardbound copy.

For information on commencement, you can call the Commencement Information Hotline at 262-9076. You can also get information on the web site for the Secretary of the Faculty.

If you have an assistantship, it will end on the date that you deposit your thesis in the Memorial Library.

## Doctor of Philosophy (Ph.D.)

While earning a Ph.D. degree, students acquire an advanced level of knowledge in a specialty of atmospheric or oceanic sciences, and demonstrate an ability to conduct independent research on current problems. They also refine their ability to present and defend their work both orally and in writing.

## Steps

Steps necessary to complete this degree include: (1) qualifying examination passage to demonstrate potential to conduct independent research. For information regarding this topic please visit Qualifying Exam FAQ's; (2) formation of a Ph.D. committee; (3) completion of general background in atmospheric/oceanic sciences; (4) broadening your educational experiences (two requirements: minor and supplemental); (5) acquisition of focused knowledge on the particular research topic; (6) preliminary examination; (7) original research; (8) dissertation writing; and (9) oral presentation and final defense.

A major professor guides the student along these steps. The major professor must be identified before the student can be admitted into our Ph.D. program.

The timeline for receiving a PhD degree is approximately 4-5 years.

## Progress Guidelines

Students normally take a full time credit load of 8 to 12 credits each semester prior to the preliminary examination. During this time they complete the minor course requirements, the ATM OCN 900 course requirements, and any other required courses. As time continues, a larger percentage of the credits each semester are research and/or seminar credits, as recommended by the major professor and Ph.D. committee.

After the preliminary exam, the student need take only 3 credits each semester as a dissertator.

Each Ph.D. student must meet annually with their committee to discuss degree progress. A written summation of the meeting should be given to the grad coordinator for the student's file.

Each student must make satisfactory progress, as specified by the departmental

and Graduate School satisfactory progress guidelines, which are available from the grad chair or grad coordinator. Failure to maintain satisfactory progress may result in probation, or dismissal from the department. The Ph.D. degree should be completed within five years. All grades must be C or better to count towards the degree. The cumulative GPA in Graduate School must be no less than 3.0.

## 1. Ph.D. Qualifying Exam

This written exam, offered each fall semester, tests the candidate's ability to formulate problems, suggest logical methods of solution, and synthesize diverse aspects of problems relevant to the atmosphere and/or ocean, as is necessary for conducting original research. A fundamental background in general atmospheric sciences including dynamics, as well as college calculus, physics, and chemistry is assumed. This background is normally obtained by completing an M.S. degree, or approximately two semesters of full time graduate study in the atmospheric and oceanic sciences.

The results of the departmental qualifying exam, along with other information, will be used by faculty members to determine if they are willing to form a formal Ph.D. committee and administer a preliminary exam.

The exam should be taken within one year of completion of the MS degree or within two years of beginning graduate studies at UW-Madison if student already has MS or intends to go directly for the Ph.D. For more information regading this topic please visit Qualifying Exam FAQ's

The exam will consist of a formal written exam. The exam will be administered over a two day period at the start of the fall semester. The exam will be prepared from faculty input by an examination committee appointed by the Chair.

Each question will be graded by at least two faculty members. The graders will not know the identity of the candidates. The examination committee will provide a clear pass/fail determination for each question. The results of the exam grading will be presented to and discussed with the entire faculty. The advisor will meet with the student after this faculty meeting to discuss the results of the exam. Candidates who fail may take the exam once more.

## 2. Formation of a Ph.D. Committee

The candidate, under the guidance of the major professor, must form a committee of five professors to supervise and evaluate their work. The committee consists of the major professor, three other professors from our department, and one professor from outside our department (often from the minor department).

Additional members may be added if appropriate. Adjunct faculty CAN now be included in the five committee members. If the committee dissolves for any reason, the candidate cannot continue in the Ph.D. program unless a new committee is formed.

The first meeting of this committee should normally occur after the Qualifying Exam, but within the same semester. During this first meeting, the committee reviews the student's professional history and general research plans, recommends any additional courses or activities that might be needed, agrees on a minor, specifies any additional or supplemental requirements, and sets a date for the preliminary exam. Results from this meeting are submitted in writing to the grad chair to be filed with the student's academic record. This letter indicates that a committee has indeed been formed.

## 3. Completion of General Atmospheric or Oceanic Background

At the first Ph.D. committee meeting, the committee specifies how the following requirements are to be (or have been) met:

Atmospheric and Oceanic Sciences Breadth. Specific requirements are determined by the Ph.D. committee during its first meeting. Generally, atmospheric and oceanic sciences breadth includes a background in dynamics, weather and climate, physical meteorology/oceanography, and observation techniques, equivalent to that required by the M.S. core courses.

Credit Requirement. The student must take and pass at least 15 credits of lecture courses numbered 600 and higher in our department. Seminars and audited courses are not included. Courses taken while working on an M.S. count toward this requirement. The Graduate School requires 32 graduate level credits (300 or above) earned at the UW-Madison. They will not allow transfer credits from another school to satisfy this requirement. Since not all 300 level courses are acceptable by the department, check with your advisor before taking any of these courses.

Current and Classical Problems in Meteorology. Students must take and pass this course, ATM OCN 900.

**Courses Outside of AOS**

Here is a listing of courses that students have taken outside of the department to satisfy degree requirements.

## 4. Broadening Requirements

At the first committee meeting, the committee specifies how the following two

broadening requirements will be satisfied:

Minor Requirement. A minor program consists of Option A (external) 10 or more course credits in one discipline or Option B (distributed) 10 or more credits in one or more departments and can include course work in the major department. Selection of Option A requires approval of the minor department. Selection of Option B requires approval of the major department. The department monitors minor requirements.

**Supplemental Requirement**. Possibilities include:

- an augmented minor, consisting of more than the minimum number of courses required by the Graduate School;

- substantial foreign language skill;

- significant field or professional experience: or

- interdisciplinary courses, or other courses related to the Ph.D. research, at the professional level.

Some of these possibilities can be met by prior experience.

5. Focused Knowledge, and the Research Proposal

The student conducts a literature search to gain state-of-the-art knowledge in the chosen research area. During this literature search, potential new research topics are identified. The student works with the major professor to focus this knowledge and define an appropriate research topic. This topic is written into a several page research proposal that is given to the Ph.D. committee members a few weeks prior to the preliminary examination.

# 6. Preliminary Examination

The Ph.D. committee administers an oral preliminary exam that is essentially a defense of the research proposal. It is normally taken within about one year after completion of the qualifying exam, which roughly coincides with the time when all of the other course requirements are completed. About three weeks before the exam, the candidate requests the Minor Agreement Form and the Ph. D. Preliminary Exam Warrant Application from the grad coordinator of our department. After the forms are returned, the grad coordinator will request the Preliminary Warrant from the Graduate School. The candidate should bring the warrant to the examination.

## Catalog: Courses for Graduate Students

Other Courses Taught by AOS Faculty

**AOS 508: Teacher Workshop (1-2 credits)** This workshop is designed to address the professional development needs for K-12 science teachers. See Fall 2007 Syllabus

**AOS 509: Distance Learning courses in Earth System Science - Web (1-3 credits)** These courses are designed to address the professional development needs for K-12 science teachers in the earth and space sciences. Topics will be designed to meet the Wisconsin State Science standards and be presented by science and education experts. Prereq: Cons. inst. See Summer 2008 syllabus.

**AOS 520: Bioclimatology (3 credits) (Same as Env. St. 520)** Application of climatological and meteorological principles to problems in biology; ecological approach stressed. Prereq: Jr. st and one course in either basic biology or basic meteorology. See Fall 2006 syllabus.

**AOS 522: Tropical Meteorology (3 credits)** Characteristics of the tropical atmosphere; local and diurnal phenomena; tropical synoptic systems; circulation and energetics; mechanisms of tropical climate variations. P: Atm Ocn 311, 340. See Spring 2006 syllabus.

**AOS 528: Past Climates and Climatic Change (2 credits) (Also Geog., Env. St. 528)** Climatic change throughout geologic time, especially the last 10 millennia; mechanics of change, evidence, and criteria, paleography and paleoclimatology, climate models. Prereq: Jr. st or one year calculus-based college physics or introduction to weather and climate; or cons. inst. See Fall 2006 syllabus. **AOS 531: Global Climates (3 credits) (Also Geography 531)** Special topics in climatology; a descriptive and explanatory analysis of the climatic characteristics of each continent, with emphasis on deviations from the world pattern. Prereq: Geog 321 or equiv or con st.

**AOS 532: Environmental Biophysics (3 credits) (Also Soil Sci. 532)** Plant-environment interactions with particular reference to energy exchanges and water relations. Models are used to provide a quantitative synthesis of information from plant physiology, soil physics, and micrometeorology with some consideration of plant-pest interactions. Prereq: Intro calculus, Physics 103, Botany 130 and computer programming, or cons. inst. See Fall 2006 syllabus.

**AOS 535: Atmospheric Dispersion and Air Pollution (3 credits)** Physical principles of atmospheric transport processes. Variation of transport in time and place. Local and regional concentrations of pollutants. Environmental implications of air pollution and control strategies. Prereq: Math 212, Physics 202, or cons. inst.

See Spring 2007 syllabus.

**AOS 559: Weekly Weather Watch (1 credit)** Weekly discussion and diagnoses of the recent and current weather as well as forecast of the future weather. Topics in large and synoptic-scale dynamics, thermodynamics, and air-sea interaction are discussed depending on the phenomena of interest. Prereq: Either ATM OCN 310, 330, 311, and 340 (as a sequence), or ATM OCN 610 and 630 as a sequence.

**AOS 575: Climatological Analysis (3 credits)** Mathematical and statistical tools applicable to the investigation of meteorological problems: nature and treatment of meteorological data. Prereq: ATM OCN 311 and 340, or cons. inst. See Fall 2006 syllabus.

**AOS 601: Challenging Problems of Atmospheric and Oceanic Sciences (2-3 credits)** Individual staff members weave detailed subjects into the general fabric of the physical environment. Prereq: cons. inst. See Fall 2006 syllabus.

**AOS 610: Geophysical Fluid Dynamics I (3 credits)** Basic dynamic concepts: equations of motion, basic approximations, Coriolis force, wave motions, normal modes, gravity waves, frictional, turbulence and convective processes, geostrophic adjustments, scaling argument, effects of rotation on wave motions. Vorticity and potential vorticity. Prereq: Physics 208, Math 234 and cons. inst. See Fall 2006 syllabus.

**AOS 611: Geophysical Fluid Dynamics II (3 credits)** Quasi-geostrophic motion, potential vorticity equations, E-P fluxes, Rossby waves, boundary layer processes, wind- driven ocean circulation and western boundary currents, barotropic and baroclinic instability, tropical flows. Prereq: ATM OCN 610 or cons. inst. See Spring 2007 syllabus.

**AOS 623: Electronic Aids to Measurement (4 credits) (Also Physics 623).** Fundamentals of electronics, electronic elements, basic circuits; combinations of these into measuring instruments. Three lectures and one three hour lab per week. Prereq: Physics 321 or cons. inst. See Fall 2006 syllabus.

**AOS 630: Introduction to Atmospheric and Oceanic Physics (3 credits)** Graduate level core course covering thermodynamics theory of multiphase systems, thermodynamic analysis of atmosphere, microphysical processes in the atmosphere, atmospheric and oceanic chemical processes, conduction of heat and moisture into the atmosphere from ocean and land surface. Prereq: Physics 208, Math 234 cons. inst. See Fall 2006 syllabus.

**AOS 637: Cloud Physics (3-4 credits)** Processes of cloud formation, growth, and dissipation from the standpoint of both the cloud particles and the whole cloud as a dynamic entity. Prereq: ATM OCN 311 and 340, or cons. inst. See Fall 2006

syllabus.

**AOS 638: Atmospheric Chemistry (3 credits)** Evolution of the atmosphere, chemical structure, instrumental analysis, trace gases, aerosol mechanics, chemical processes. Prereq: One year calculus-based college physics, chemistry, and calculus for science majors, or cons. inst. See Spring 2007 syllabus.

**AOS 640: Radiation in the Atmosphere and Ocean (3 credits)** Graduate level core course in radiation. Introduction to basic laws, radiative transfer under clear sky conditions, scattering by individual particles, multiple scattering, radiative properties of clouds and aerosols, energy budget, miscellaneous applications. Prereq: Physics 208, Math 234 and cons. inst. See Spring 2007 syllabus.

**AOS 650: Analysis of Atmospheric Systems (3 credits)** Graduate level core lab and lecture course designed to quantitatively analyze, descriptively define and physically interpret atmospheric structures, climate and flow systems depicted by observations on scales ranging from the global circulation to those of turbulence in the planetary boundary layer. Observation and analysis strategies. Prereq: ATM OCN 610, 630, or cons. inst. See Spring 2007 syllabus.

**AOS 651: Synoptic-Dynamic Laboratory (3 credits)** Quantitative lab applications of atmospheric dynamics and thermodynamics to synoptic systems. Jet stream systems, cyclone development, global air motions, performance of numerical prediction models, local surface forecasting. Prereq: ATM OCN 610 and 630 and cons. inst. or ATM OCN 650. See Fall 2006 syllabus.

**AOS 660: Introduction to Physical Oceanography (3 credits)** Physical properties of sea water: ocean climatology, water, salt and heat budget, measurement, ocean circulation and water mass of the world ocean, thermocline, thermohaline, equatorial and southern ocean. Prereq: Physics 208, Math 234 and cons. inst. See Fall 2006 syllabus.

**AOS 681: Senior Honors Thesis (3 credits)** Prereq: Cons. inst.

**AOS 682: Senior Honors Thesis (3 credits)** Prereq: Cons. inst.

**AOS 691: Senior Thesis (2-3 credits)** Prereq: A) Atm Ocn major; B) Atm Ocn 311, 340 or con reg; C) approval Assoc. Chairman of Undergrad Affairs. Cons. inst.

**AOS 692: Senior Thesis (2-3 credits)** Prereq: A) Atm Ocn major; B) Atm Ocn 311, 340 or con reg; C) approval Assoc. Chairman of Undergrad Affairs. Cons. inst.

**AOS 698: Advanced Independent Reading (1-5 credits)** Prereq: Jr. or Sr. st.; requires cons. inst.

**AOS 699: Advanced Independent Reading (1-5 credits)** Prereq: Jr. or Sr. st.

Graded on a lettered basis; requires cons. inst.

**AOS 705: Middle Atmosphere (3 credits)** Dynamics, chemistry and radiation of the stratosphere and mesosphere. Structure and composition. Observing techniques. Gravity, Rossby, and Kelvin waves. Wave-mean flow interaction. Instabilities. Tracer transport. Modeling the middle atmosphere. Ozone layer. Greenhouse effect. Prereq: ATM OCN 610, 630 or equivalent. See Fall 2006 syllabus. **AOS 712: General Circulation of the Atmosphere (3 credits)** The theory of the general circulation with emphasis on the sources, sinks, and transports of mass, angular momentum, and energy that serve to maintain the circumpolar vortex. Prereq: ATM OCN 610, 630 or equivalent. See Fall 2006 syllabus.

**AOS 718: Dynamics of Moist Convective Systems (3 credits)** Governing equations for non-hydrostatic dynamics, mixed phase thermodynamics and microphysics. Cumulus parameterization and scale interactions. Application to theoretical and numerical models of thunderstorms (and attendant weather phenomena) and Mesoscale Convective Systems in the extra tropics and tropics. Prereq: ATM OCN 610, 630. See Fall 2006 sylabus.

**AOS 720: Glaciology (3 credits) (Also Geology 720)** Physical properties of snow and ice; mass and energy balance and structure of glaciers and ice sheets; glacier dynamics; applications of geophysics and geochemistry; glacial hydrology. Prereq: Physics 208, Math 223.

**AOS 740: Advanced Atmospheric Radiation (3 credits)** The course deals with advanced topics in radiative transfer. These include numerical methods to solve the radiative transfer equation, theory of scattering by spherical and non-spherical particles and advanced topics in gas absorption. Prereq: ATM OCN 640. See Fall 2006 syllabus.

**AOS 745: Meteorological Satellite Applications (2-3 credits)** Use of satellite imagery and measurements in meteorological research and operations: orbital characteristics, navigation, instrumentation, remote sensing techniques. Prereq: ATM OCN 640 or one year calculus-based college physics or Math 234. See Spring 2007 syllabus.

**AOS 750: Problems in Oceanography (3 credits) (Also Env. St., Geol. and Zoology).** Introduction to techniques used in the study of the biology, chemistry, geology, and physics of the marine environment. Prereq: one course in oceanography or cons. inst. See Fall 2006 syllabus.

**AOS 760: Large-Scale Ocean-Atmosphere Coupling (3 credits)** Various aspects of global ocean-atmosphere coupling and climate variability; global surface flux distribution; mixed layer dynamics; tropical dynamics and El Nino and Southern

Oscillation; extratropical ocean-atmosphere coupling; interannual to interdecadel climate variability. Prereq: ATM OCN 611, 660, or cons. inst. See Spring 2007 syllabus.

**AOS 761: Dynamics of Ocean Circulation (3-4 credits)** Theories of general oceanic circulation: Sverdrup flow, western boundary layer; thermocline circulation, recirculation theory, ventilated thermocline theory, thermohaline circulation, abyssal flow, thermohaline instability and multiple equilibria. Prereq: ATM OCN 610, 660. See Fall 2006 syllabus.

**AOS 771: Numerical Modeling in Meteorology(3 credits)** Techniques for development of meteorological numerical models. Survey of existing models for general circulation, operational weather prediction, mesoscale, convection and turbulence with emphasis on numerical methods and solution accuracy. Prereq: ATM OCN 610, 630 or cons. inst. See Fall 2006 Syllabus.

**AOS 773: Boundary Layer Meteorology (3 credits)** Observations of and theories for boundary layers, turbulence, spectra, plumes, dust devils, convection, terrain effects, and other phenomena in the lowest 2 km of the atmosphere. Prereq: ATM OCN 311, 340, or 610, 630. See Fall 2006 syllabus.

**AOS 801: Topics in Theoretical Meteorology (2-3 credits)** Advanced level subjects in dynamics, synoptics, climate-dynamics and atmospheric physics including recent advances. Prereq: Grad level general meteorology and cons. inst. Fall 2006 syllabus.

**AOS 900: Seminar - Meteorology (1-2 credits)** Prereq: Grad St. See Spring 2007 syllabus.

**AOS 911: Seminar - Oceanography and Limnology (1 credit)** (Also Civ. Engr., Bact., Botany, Env. St., Geology, and Zoology 911). Prereq: Grad St. in oceanography & limnology or cons. inst. See Spring 2007 syllabus.

**AOS 915: Seminar - Dynamics (1-2 credits)** Prereq: Grad St. See Spring 2007 syllabus.

**AOS 925: Seminar - Climatology (1-2 credits)(Same as Env. St. 925)** Historical climatology with emphasis on the last few centuries. Prereq: Grad St. See Fall 2006 syllabus.

**AOS 935: Seminar - Physical Meteorology (1-2 credits)** Topics in physical meteorology are explored at an advanced graduate level, including severe storms, cloud physics and atmospheric chemistry, depending on instructor Prereq: Grad St. See Fall 2006 syllabus.

**AOS 945: Seminar - Radiation and Remote Sensing Seminar (1-2 credits)** Topics in radiation and remote sensing of the atmosphere and ocean. Emphasis will be on current and classical problems in radiative transfer and remote sensing. Prereq: Grad St. See Fall 2006 syllabus.

**AOS 955: Seminar - Weather Systems (1-2 credits)** Topics in weather systems are explored at an advanced graduate level, including problems in synoptics, mesoscale, and micrometeorological weather phenomena, depending on instructor. Prereq: Grad St.

**AOS 965: Seminar - Oceanography (1-2 credits)** Prereq: Grad St. See Fall 2006 syllabus.

**AOS 975: Seminar - Numerical Modeling/Data Assimilation (1-2 credits)** Topics in numerical modeling and data assimilation are explored at an advanced graduate level. Prereq: Grad St.

**AOS 980: Seminar - Earth-System Science (1 credit) (Also Botany, Env. St., Forest, Geol., Geog., and Zoology).** Topics in earth system science. Emphasis on the coupling between atmospheric, oceanic and land surface systems, involving physical geochemical and biological processes, and including interactions with human systems. Prereq: Grad St. See Spring 2006 syllabus.

**AOS 990: Research (1-12 credits)** Prereq: Grad St.

**AOS 999: Advanced Independent Study (1-6 credits)** Prereq: Grad St. and cons. inst.