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EDUCATIONAL OPPORTUNITIES

IN THE

ATMOSPHERIC SCIENCES

DEPARTMENT OF METEOROLOGY

UNIVERSITY OF WISCONSIN

OCTOBER 1979

The Department of Meteorology of the University of Wisconsin

During the past decade the atmospheric sciences have experienced a phenomenal growth. As a result of major advances in the basic knowledge of the atmosphere, the atmospheric sciences have become an increasingly effective tool for the benefit of man. There are better and faster weather forecasts than a decade ago. There have been successful attempts to produce small-scale weather modifications. Meteorological applications in general have increased in number and scientific quality, and represent opportunities important for both scientists and society. In certain regions food production has increased because of an increased recognition of the importance of the interplay between the atmosphere and the earth's surface.

Yet today the atmospheric sciences face an even more exciting future. The advent of the meteorological satellite which can observe the atmosphere of the entire earth, the development of larger and faster computers, and the advances in theoretical modelling of the atmosphere combine to put man within reach of longer range forecasts of the large-scale weather features over the entire earth. At the same time improved communications and observational capabilities will soon make it possible to describe and forecast for a relatively short period of time the smaller, but extremely important features such as thunderstorms and tornadoes. Of even greater importance is the role the atmospheric sciences must play in the efforts to rescue and preserve the environment. The effect of pollution on the earth's climate and man's activities and the optimal planning of cities are examples of the many questions with which the atmospheric sciences must deal.

At Wisconsin the Department of Meteorology (established in 1948) is the academic home for the teaching and research activities in the Atmospheric Sciences. It is also the home for several physical oceanography courses which are part of the Meteorology curriculum and the Oceanography and Limnology Ph.D. Program. It offers undergraduate and graduate studies opportunities by means of formal courses, independent studies and (chiefly for graduate students) participation in the various research activities described in this booklet.

Students interested in this field should contact the departmental office (Room 849) in the Meteorology and Space Science Building, 1225 West Dayton Street, Madison, Wisconsin 53706.

Academic Degree Programs in Meteorology:

Master of Science
Doctor of Philosophy

Educational programs leading to both degrees are offered within the department. They are integral with the broad research program of the department, and all graduate students are expected to participate in these programs. A Major Professor from the academic staff of the department will guide the student's academic and research program and ensure that the student makes satisfactory progress toward his chosen degree.

General Requirements for Admissions

Details of the admission requirements may be obtained by writing to:

Office of the Graduate School
University of Wisconsin
Madison, Wisconsin 53706

A minimum over-all grade point average of 3.00 or above on a scale of 4.00 is usually required for admission to the graduate program in the Department of Meteorology. No previous course work or job experience in meteorology is required. Instead, a basic preparation in mathematics and physical science (which may include meteorology) is expected. The minimum preparation should include:

- a) Mathematics: the basic calculus sequence for science majors plus one additional course (such as differential equations, linear math, etc.); a course from another mathematical discipline such as computer science or statistics may be used, providing it is at an equivalent level).
- b) Physics: one year of college physics; the courses should be those intended for science majors and calculus-based, such as General Physics 207-208 at the University of Wisconsin.
- c) Chemistry: a course in general chemistry.

Grades in science courses and GRE scores should indicate an expectation of successful graduate work.

A. The Master's Degree Program

1. Purpose: to give the student a broad background in the field of Meteorology and acquaint him or her with the methods of scientific research.
2. Requirements:
 - a. Admission to the Graduate School.
 - b. General requirements as listed in the Bulletin of the Graduate School.

c. Removal of deficiencies: The following courses must be completed before the Master's Degree will be awarded:

- 1) Mathematics, physics, and chemistry courses described above.
- 2) Meteorology 321, 322, and 323; or 501, 502; or equivalent courses from another University.

Credits earned in removing these deficiencies are not counted toward the residence requirement. Meteorology 501-502 is a first year sequence for graduate students new to meteorology.

d. Eighteen credits approved by the major professor. These credits may include research credits and credits earned in other departments.

e. Written Examination: The student must pass the comprehensive written examination of intermediate depth. It may be attempted two times.

f. A Master's Thesis is required:

The purpose of the thesis is to demonstrate familiarity with the research procedures in meteorology. It must be a well-organized piece of work written in clear English. The thesis must be approved by the major professor and one additional faculty member designated by the major professor.

The final copy of the master's thesis must be submitted to the major professor and the second thesis reader not later than one week prior to the commencement date at the end of the second year of full-time graduate study in meteorology (including any semesters not at Wisconsin). In extraordinary circumstances: e.g., where the student had to make up serious deficiencies, an extension for one more semester may be approved by the major professor.

g. The student's warrant recommending that he be granted the MS degree must be signed by three faculty members (the major professor, the second reader, and one other faculty member).

3. A student entering with an adequate background can obtain the master's degree in one year, but in many cases about 1-1/2 to 2 years is needed. No fixed curriculum is prescribed. Each course of study is adjusted to the specific needs and interests of the individual student.

B. The Ph.D. Program

1. Prologue

The Ph.D. in Meteorology is granted only upon the basis of evidence of a high degree of research competency and not solely upon any graduate course program.

Each student together with his advisor and Ph.D. Committee develops the program best suited for his needs and interests; many students pursue basic research in atmospheric science. Because of the increasing interaction between meteorology and a broad spectrum of disciplines, the department also encourages the development of a professional interdisciplinary program.

2. Admission to Program

Admission is given to those students whose records show good potential for creative research of high quality. Normally the Master's degree precedes application. Evidence which is considered includes past course work, research, professional experience, performance on the comprehensive examination, and letters of recommendation. Formal acceptance to the program is contingent upon the establishment of a full Ph.D. Committee, chaired by the student's major professor.

The student is admitted to candidacy for the Ph.D. upon the satisfactory completion of the preliminary examination.

3. Program Requirements

a. **Minor:** the general and minor requirements for the Ph.D. degree listed in the Bulletin of the Graduate School.

b. **Departmental Requirements**

- 1) **Written Comprehensive Exam:**
Graduate students must pass the Department's comprehensive exams if it has not previously been taken under the M.S. program in the Department. Results are used to diagnose the strengths and weaknesses of the student.
- 2) Completion of one semester of Meteorology 900, a seminar in current and classical problems in meteorology.
- 3) Additional requirements to be designated by the student's Ph.D. Committee. These will be established in consultation with the student with the intent to develop meaningful skills related to the interests and abilities of each student.

Suggested possibilities include:

- a) Augmented minor or other courses related to the Ph.D. research
- b) Foreign language skill
- c) Field or professional experience
- d) Interdisciplinary courses at the professional level.

4) Satisfactory performance in the preliminary exam

In this exam the student presents his research proposal and demonstrates his general competence and depth of understanding in the atmospheric sciences, especially in his research area.

5) Original meteorological research presented in the form of a written dissertation. The thesis must be presented at a departmental seminar and satisfactorily defended in an oral exam before the student's Ph.D. Committee.

4. Responsibility of Ph.D. Committee

The Ph.D. Committee (plus the minor professor when necessary) has the authority to:

- a. Establish the scope and content of the departmental additional requirements for the student;
- b. Accept the student into candidacy for the Ph.D. on the basis of the preliminary exam (the form of the exam will be determined by the student's Ph.D. Committee);
- c. Approve the dissertation;
- d. Certify that the student has completed all requirements for the degree.

5. Program Guidelines

a. Written Comprehensive Exam

Satisfactory performance in this exam is determined by the student's Ph.D. Committee. In no case will the performance be considered satisfactory if it was judged unsatisfactory for the M.S. program. The results of this test are to be used to identify the weaknesses and strengths of the student and to assist the major professor in deciding whether or not he wishes to sponsor the student in the Ph.D. program.

b. Additional Departmental Requirements

Each Ph.D. Committee has the responsibility to ensure that meaningful and useful requirements are established for the student.

c. Preliminary Examination

Students are encouraged to take their preliminary examination within approximately one year of completion of their comprehensive exam. The student's exam should include questions which ascertain that he possesses a general competence in meteorology

and is knowledgeable in his research area. The form of the preliminary examination is determined by the student's Ph.D. Committee. The exam may be either oral or both oral and written. Questions should be included in the exam which provide evidence that the proposed thesis will be a meaningful contribution.

- d. "A Guide to Our Ph.D. Program Procedures" is available for graduate students in the Ph.D. program. It contains a "quick look" reference to detailed procedures and rules, presented in their most common order.

Responsibility of Ph.D. Committee

The Ph.D. Committee (plus the minor professor when necessary) has the authority to:

- a. Establish the scope and content of the departmental additional requirements for the student;
- b. Accept the student into candidacy for the Ph.D. on the basis of the preliminary exam (the form of the exam will be determined by the student's Ph.D. Committee);
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Program Guidelines

- a. Written Comprehensive Exam
Satisfactory performance in this exam is determined by the student's Ph.D. Committee. In no case will the performance be considered satisfactory if it was judged unsatisfactory for the M.S. program. The results of this test are to be used to identify the weaknesses and strengths of the student and to assist the major professor in deciding whether or not he wishes to sponsor the student in the Ph.D. program.

Additional Departmental Requirements

- b. Each Ph.D. Committee has the responsibility to ensure that meaningful and useful requirements are established for the student.
- c. Preliminary Examination

Students are encouraged to take their preliminary examination within approximately one year of completion of their comprehensive exam. The student's exam should include questions which ascertain that he possesses a general competence in astronomy.

General Policies

A. Graduate Record Examination:

Students applying for admission to Graduate School and/or a fellowship or assistantship must include the results of their Graduate Record Examination with their application to the department.

B. Removal of Deficiencies:

In some cases, it may not be necessary for a student to do the day by day course work to receive credit for a course. A student may take any courses by examination with the approval of the professor in charge of the course. However, it should be emphasized that this approval will be given only in exceptional cases where the student appears to be well qualified in the subject matter of the course. The examination will be given only at the time of the regularly scheduled final examination in the course. The substitution of reading courses for courses normally offered is discouraged.

C. Major Professor:

The selection of a student's major professor is determined through mutual agreement between the professor and the student. In cases where an assistantship is involved, the major professor will generally be the professor who directs the assistantship work. However, a student does not necessarily have to do his thesis under the professor directing his assistantship work. At the end of each semester, a student may change major professors without prejudice, provided he has coordinated this change with both professors involved.

Financial Assistance for Graduate Students

A large majority of Meteorology graduate students receive financial assistance. The most common form of support is through an appointment for one-half time as a Research Assistant. In some cases the fractional time of the appointment is increased after a Ph.D. student passes his Preliminary Examination. There is also a possibility for both M.S. and Ph.D. candidates to hold somewhat larger appointments during the two summer months. At the present time, research assistant income is not subject to Federal and State income tax. In addition, research assistant recipients who are not Wisconsin residents pay only the same fees as Wisconsin residents if their appointment is at least for 1/3-time.

Most Meteorology graduate students are encouraged to obtain some teaching experience in the Department. A graduate student who holds a Teaching Assistantship as well as a Research Assistantship can receive extra compensation.

There are a number of other appointments available to graduate students on a competitive basis. Employment at hourly rates is frequently available to undergraduate majors and graduate students who lack other support.

The University provides low-rent housing for married graduate students and relatively low-cost dormitory housing for unmarried students who desire it.

There is no discrimination in the awarding of the above appointments on the basis of race, sex, religion or national origin.

For additional information write:

Chairman, Department of Meteorology
1225 West Dayton Street
University of Wisconsin
Madison, Wisconsin 53706

Courses Offered

Courses numbered under 299 are open only to undergraduates. 300-699 may be elected by upper-class undergraduates and graduates, while those numbered 700 and over are open only to graduate students.

640 (CURRICULAR AREA NUMBER)

- 100 Weather and Climate. I, II; 3 or 4 Cr. Introduction. Nature and causes of wind, clouds and precipitation. Atmospheric composition, air pollution. Storm systems and fronts. Thunderstorms, tornadoes. Weather maps and forecasting. The earth's changing climates. Prereq: Open to Fr. Staff
- 105 Survey of Oceanography. Geology 130, cross listed as Meteorology 130. I, II; 3 or 4 Cr. A survey course covering fundamental topics and contemporary problems in the science of the sea including the ocean basins, properties of sea water, currents and circulation, sediments on the sea floor, economic resources of food, minerals, energy and water, and oceanographic factors bearing on modern social, commercial, legal, international, and exploitation problems of the world ocean.
- 110 Concepts of Atmospheric Sciences. II; 2 Cr. For students interested in natural science. Stresses the interrelation between meteorology, the physical-mathematical disciplines, and the other environmental fields. Prereq: Open to Fr and So only. Con reg in basic math and/or physics.
- 121 Atmospheric Environment of Man. (Same as Geog., Env. St. 121.) I, II; 2 Cr. The changing interactions between man, other animals and plants, and the atmospheric environment are investigated, both in time and space. Prereq: Open to Fr.
- 122 Climate Environments of the Past. (Same as Geog., Env. St. 122.) II, 2 Cr. Climate trends and patterns of the most recent 10,000 years are examined. Studies are based upon a wide variety of surrogate climatic information.
- 161 Weather for Sailors. Sem; 2 Cr. Surface wind speed and direction variations, sea/land breezes, and other diurnal variations, gusts and thunderstorms, shore effects, global winds and migratory weather systems, interpreting weather maps, wind driven water waves. Open to Fr.
- 162 Weather for Winter Sports. Sem; 2 Cr. Important aspects of weather for winter recreation -- down-hill and cross-country skiing, snowmobiling, ice boating and fishing. Snow storms, low temperatures, freezing of lakes and snow cover. Principles of meteorology and climatology used to determine the impact of snow storms, low temperatures, freezing of lakes and snow cover properties on these activities. Open to Fr.
- 163 Weather for Sport Flying. Sem; 2 Cr. Basic meteorological concepts for pilots of powered aircraft and gliders, winds near the surface and in the free atmosphere; weather systems, vertical motion of air, thermals, mountain winds, topics for balloonists and sky divers, use of weather services. Open to Fr.
- 321 Atmospheric Science I. I; 4 Cr. Large-scale setting of the atmospheric system; basic physical characteristics and variables. Thermodynamics of the atmosphere; physics of clouds and precipitation. Prereq: Physics 208 or con reg and Math. 223 or con reg.

- 322 Atmospheric Science II. II; 5 Cr. The use of vector analysis to treat atmospheric forces, equation of motion in different coordinate systems. Various types of atmospheric flow. The vorticity equation. Scale analysis. Wind in friction layer. Prereq: Meteor. 321.
- 323 Atmospheric Science III. I; 5 Cr. The global energy budget. Wave motions barotropic and baroclinic instabilities. Storm systems, fronts and air masses. Methods of prediction. General circulation and climatology. Prereq: Met. 322.
- 330 Solar Radiation and Wind Energy. Sem. 3 Cr. Solar energy in terms of the geometry of the earth-sun system, the effect of the atmosphere on solar energy, and the net energy available. Measuring methods and the use of climatological information for studying the net energy available. Wind energy, initially arising from differential heating of the earth's surface by the sun, in terms of the height and time variation of the wind speed and direction, and the turbulent characteristics of the wind. Climatology for windmills. Prereq. Two semester of calculus, Physics 207 or equivalent, or cons of instr.
- 352 Synoptic Lab I: The Frontal Cyclone. I; 3 Cr. Review of cyclone and frontal theory; case studies illustrating the structure and evolution of the frontal cyclone, diagnostic techniques include interpretation of satellite photographs, preparation of vertical cross sections and isentropic analysis. Prereq: Met. 322 or cons instr.
- 353 Synoptic Lab II: Severe Local Storms. II; 3 Cr. Review of thunderstorm models and basic convection theory; summary of techniques used in forecasting severe local storms, current weather analysis of subsynoptic scale systems, interpretation of satellite and radar information. Prereq: Met. 322 or cons instr.
- 360 Climatic Principles for Engineering and Environmental Design. Sem; 3 Cr. (P-1) Introduction to the physical processes occurring at the land-surface interface and presentation of methods for determining the near-surface climate as function of surface properties and larger-scale climatic parameters. Applications to plant communities, cities, structures, hydrology and natural resource planning. Prereq: 1 Sem college physics and 1 Sem calculus. Not open to Fr.
- 403 Micrometeorology. II; 3 Cr. The roles of friction, radiation, convection, and evaporation in the physics of the layer of air near the ground. Prereq: Met. 322 or cons instr.
- 404 Physical Meteorology. I; 3 Cr. Physics of the atmosphere with emphasis on optical, acoustical, and electrical phenomena; physics of clouds and hydrometeors; radar meteorology. Prereq: General physics.
- 405 Basic Aeronomy. I; 3 Cr. Physics, chemistry and dynamical characteristics of the stratosphere, mesosphere and ionosphere, including techniques of investigation. Prereq: Calculus, basic physics, and cons instr.
- 406 Radiation in the Atmosphere. I; 3 Cr. Solar radiation distribution, theory of transmission and emission of radiation in the atmosphere, computation of non-adiabatic heating rates. Remote sensing of atmospheric characteristics. Prereq: Basic physics and calculus and cons instr.
- 407 Cloud Physics. II; 3-5 Cr. Processes of cloud formation growth and dissipation from the standpoint of the individual particles composing the cloud and from the behavior of the cloud itself as a dynamic entity. Prereq: Met. 322 or con reg.

- 408 Cloud Dynamics. II; 3 Cr. Macroscale features of stratiform and cumuliform clouds and cloud systems from the standpoint of cloud circulation and precipitation models based on theoretical and experimental arguments; cloud electrification and other severe storm phenomena. Prereq: Met. 322 or cons instr.
- 420 Meteorological Instrumentation. I; 4 Cr. Theory and practice of meteorological observations, elements of measuring systems, sampling problems and system errors. Prereq: Met. 322 or con instr.
- 440 Tropical Meteorology. I; 3 Cr. Characteristics of the tropical atmosphere; local and diurnal phenomena; tropical synoptic systems; general circulation and energetics of the tropics. Prereq: Met. 322 or cons instr.
- 450 Operational Forecasting Procedures. Summer Session; 2 Cr. Applications of synoptic training to actual real-time forecasting under simulated operational conditions. Prereq: Met. 352 and 353, or cons instr.
- 460 Physical Oceanography I. I; 3 Cr. Nature of oceans, properties of sea water, currents, types of motion, western boundary currents, equatorial circulation, waves, and tides, estuaries, biochemical cycle of oceans. Prereq: Basic physics.
- 461 Physical Oceanography II. II; 3 Cr. Ocean circulations, thermohaline circulation, waves, air-sea interaction, heat budgets, estuaries, density currents. Prereq: Calculus and basic physics, Met. 460.
- 501 General Meteorology I. I; 5 Cr. The atmospheric system, basic characteristics and variables. Equations of mass, momentum and energy. Vorticity and circulation. Wind in the friction layer. Application of these concepts in synoptic meteorology and climatology. Prereq: Calculus 223, Physics 208 and cons instr.
- 502 General Meteorology II. II; 5 Cr. Atmospheric thermodynamics. Physics of clouds and precipitation. Radiation in the atmosphere. Energy budget, Wave and tidal motions. Dynamic instabilities. Storm systems. The general circulation. Prereq: Met. 501.
- 503 Climatonomy. I; 3 Cr. Numerical modeling of climate based on regional supply of solar energy. Model applications emphasize drought predicition, irrigation efficiency, frost damage, pollution effects: possibilities of control or inadvertent modification of local climates. Prereq: Cons instr.
- 510 Dynamic Climatology I. I; 3 Cr. Mathematical and statistical tools applicable to the investigation of meteorological problems; nature and treatment of meteorological data. Prereq: Met. 322 or cons instr.
- 511 Dynamic Climatology II. II; 3 Cr. General circulation climatology and its seasonal changes. Climates of the various regions of the earth are discussed within the context of the planetary and synoptic scale circulations. Prereq: Met. 323 or equiv, or cons instr.
- 520 Bioclimatology. I; 3 Cr. Application of climatological and meteorological principles to problems in biology; ecological approach stressed. Prereq: Cons instr.

- 528 Past Climates and Climatic Change. (Same as Geog., Env. St. 528.) Sem. 2 Cr. Climate change throughout geologic time, especially the last 10 millennia; mechanics of change, evidence, and criteria, paleography and paleoclimatology. Prereq: cons instr.
- 531 Climates of the Continents. (See Geog. 531.) II; 3 Cr.
- 532 Microclimatology. (Same as Soil Sci. 532.) I; 3 Cr. Microclimate and its relation to the energy and water balance of organisms with particular reference to plants, applications of microclimatic techniques to agriculture and biology. Prereq: cons instr.
- 535 Atmospheric Dispersion and Air Pollution. (Same as Env. St. and M.E. 535.) II, 3 Cr. 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 instr.
- 551 Geophysical Fluid Dynamics. Sem; 3 Cr. Fluid motions of various scales in the atmosphere and hydrosphere. Effects of density stratification and earth's rotation; meso-scale dynamics. Gravity waves, boundary layer motions, land-sea breezes, incompressible flows, and filtered models. Prereq: Met. 323 or 501, or cons instr.
- 601 Challenging Problems of Atmospheric Science. Sem; 2-3 Cr. Individual staff members weave detailed subjects into the general fabric of the physical environment. Prereq: Cons instr.
- 611 Dynamics of Large-Scale Motions. Sem; 3 Cr. Dynamics of synoptic-scale circulations. Quasigeostrophic motions, adjustment theory; Rossby waves, barotropic, baroclinic, and tropical instabilities; effects of heat sources and mountains. Prereq: Met. 323, 501, or cons instr.
- 622 Meteorological Satellite Applications. Sem; 2-3 Cr. Use of satellite imagery and measurements in meteorological research and operations; orbital characteristics; navigation, instrumentation. Prereq: Cons instr.
- 623 Electronic Aids to Measurements. (See Physics 623.) II; 4 Cr. Prereq: Physics 321 or cons instr.
- 641 Numerical Modeling in Meteorology. Sem; 3 Cr. 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: Met. 323 and Comp. Sci. 412 or cons instr.
- 651 Synoptic-dynamic Laboratory. Sem; 3 Cr. Laboratory applications of atmospheric dynamics and thermodynamics to synoptic systems. Upper-air wind maxima, cyclone development, global air motions, performance of numerical prediction models, local surface forecasting. Prereq: Met. 502 or equiv. and cons instr.

- 662 Air-Sea Interaction. (Same as CEE 512.) I; 2 Cr. Various aspects of small-scale air-sea interactions and transfers of momentum, mass and heat. Wind-wave generation theories; wave forecasting techniques. Langmuir circulations, diurnal and seasonal thermoclines. Theories of wind-generated ocean currents. Prereq: Met. 322, or 501, or CEE 511.
- 663 Fundamentals of Oceanic and Atmospheric Convection. II; 2 Cr. Physical processes in buoyancy driven fluid flows; entrainment. Bernard convections, vertical plumes, and density flows. Meteorological and oceanographic examples. Prereq: Met. 662.
- 681 Senior Honors Thesis. I; 3 Cr. Prereq: Cons. instr.
- 682 Senior Honors Thesis. II; 3 Cr. Prereq: Cons. instr.
- 698 or 699 Advanced Independent Reading. I, II; *Cr.
- 712 General Circulation of the Atmosphere. Sem; 3 Cr. The theory of the general circulation with emphasis on the sources, sinks, and transport of mass, angular momentum, and energy that serve to maintain the circumpolar vortex. Prereq: Cons instr.
- 720 Glaciology (also Geology 720) II; 3 Cr. Prereq: Physics 208, Math 223.
- 750 Problems in Oceanography. (Same as Geology, Zoology 750 and CEE 810.) II; 3 Cr. Techniques in the study of the chemistry, geology and physics of the marine environment. Prereq: one course in oceanography or cons instr.
- 803 Atmospheric Turbulence. I; 2 Cr. Classification of winds; turbulence and mean profiles in the atmospheric boundary layer, convection; eddy fluxes of various scales; turbulence, and diffusion in the upper atmosphere. Prereq: Met. 403 or cons instr.
- 806 Atmospheric Chemistry. I; 2 Cr. Abundance relationships of elementary gases, gaseous compounds, and nuclei in the atmosphere, processes of generation and decay, transport by air currents, and diffusions. Prereq: Cons instr.
- 861 Problems of Viscous Flow. (See CEE 711) I; 2 or 3 Cr.
- 862 Problems of Turbulent Flow. (Same as CEE 712) II; 2 or 3 Cr. Transition from laminar to turbulent flow, statistical parameters of turbulence, variance spectra, instability theories, transport mechanism, and energy transformation in turbulent flow. Prereq: Met. 861 or cons instr.
- 863 Theory of Water Waves. (Same as CE 811) II; 3 Cr. Free surface, gravity flow from mathematical viewpoint, analysis of gravity waves using potential theory; unsteady open channel flow; flood routing; applications to design. Prereq: CE 611 or cons instr.
- 900 Seminar: Current and Classical Problems in Meteorology. Sem; 1-2 Cr.
- 901 Seminar: Dynamics. Sem; 1-2 Cr.
- 902 Seminar: Synoptic Problems. Sem; 1-2 Cr.

- 903 Seminar: Regional Meteorology. Sem; 1-2 Cr.
- 904 Seminar: Cloud Physics. Sem, 1-2 Cr.
- 905 Seminar: Upper Atmosphere. Sem; 1-2 Cr.
- 906 Seminar: Meso-micrometeorology. Sem; 1-2 Cr.
- 909 Seminar: Atmospheric Chemistry. Sem; 1-2 Cr.
- 910 Seminar: Climatology. (Same as Env. St. 910) Sem; 1-2 Cr.
- 911 Seminar: Oceanography and Limnology. (Same as Bact., Bot., CEE, IES, Geol., Zool. 911) Sem; 1 Cr.
- 920 Seminar: Applied Meteorology. Sem; 1-2 Cr.
- 960 Seminar: Oceanography. Sem; 1-2 Cr.
- 990 Research. I, II, *Cr.
- 999 Advanced Independent Study. I, II, *Cr. Prereq: Cons instr.

*Courses 681, 682, 698, 699, and all 900 level courses require consent of instructor.

Staff of the Department

Anderson, Charles E., Professor of Meteorology

Ph.D. Massachusetts Institute of Technology, 1960 (Meteorology)

Joined staff in 1966. Also active in Afro-American Studies. Previously employed in various Federal and private positions as atmospheric scientist and science administrator. Special areas of interest: General area of physical meteorology, emphasis on cloud physics and dynamics and severe local storms and tornadoes.

Bryson, Reid A., Professor of Meteorology, also Director of Institute for Environmental Studies and Professor of Geography

Ph.D. University of Chicago, 1948 (Meteorology)

Sc.D. (hon.) Denison University, 1971

Joined University of Wisconsin faculty in 1946 with joint appointment in Geology and Geography. Founded Department of Meteorology in 1948 and has been associated with it since then. Active in wide variety of University activities. Special areas of interest: Climatology, paleoclimatology and interdisciplinary studies related to the environment of man.

Green, Theodore III, Professor of Meteorology and Civil Engineering and Director of Marine Studies Center

Ph.D. Stanford University, 1965 (Engineering Mechanics)

Joined staff in 1969. Previously Assistant Professor (Oceanography) at U.S. Naval Postgraduate School, Monterey. Also active in the Sea Grant Program. Special areas of interest: Sea-air interaction and dynamics of water surfaces, ocean waves and general fluid motions.

Hastenrath, Stefan L., Professor of Meteorology

Ph.D. University of Bonn (Germany) 1959 (Meteorology)

Joined staff in 1967. Previously Assistant Professor, University of Cologne 1959/60 National Meteorological Service of El Salvador 1960/63, Project Associate, this Department 1963/65, Associate Professor, University of Wisconsin at Milwaukee 1965/67. Special areas of interest: climate, tropics and glaciers.

Herman, Gerald F., Assistant Professor of Meteorology

Sc.D. Massachusetts Institute of Technology, 1975 (Meteorology)

Joined staff in 1977. Also Faculty Research Associate, NASA Goddard Laboratory for Atmospheric Science. Special areas of interest: Boundary layer dynamics; radiative transfer; Arctic meteorology; stratospheric meteorology; general circulation modelling.

Horn, Lyle H., Professor of Meteorology

Ph.D. University of Wisconsin, 1960 (Meteorology)

Joined staff in 1960. Four years USAF Weather Service. Special areas of interest: Synoptics and atmospheric energetics, climatology. Use of satellite data in synoptic and climatological studies.

Houghton, David D., Professor of Meteorology

Ph.D. University of Washington, 1963 (Atmospheric Sciences)

Joined staff in 1968. Previously in research position at National Center for Atmospheric Research, Boulder. Special areas of interest: Atmospheric dynamics, numerical modeling of general circulation, synoptic-scale and mesoscale; initialization; gravity waves, satellite mesoscale cloud wind and temperature data; seasonal cycle dynamics.

Johnson, Donald R., Professor of Meteorology

Ph.D. University of Wisconsin, 1965 (Meteorology)

Joined staff in 1964. Previously for seven years weather office, USAF. Special areas of interest: Dynamics of large-scale atmospheric motions, statistical techniques and synoptic applications.

Kutzbach, John E., Professor of Meteorology and Environmental Studies

Ph.D. University of Wisconsin, 1966 (Meteorology)

Joined staff in 1966. Currently Chairman of the Department of Meteorology. He is also Director of the Center for Climatic Research in the Institute for Environmental Studies. Research Fellowship at University of Bonn (1978) and British Meteorological Office (1968) and served as weather officer, USAF (1961/63). Special areas of interest: Dynamic climatology, paleoclimatology and climatic change.

Lettau, Heinz H., Increase A. Lapham Professor of Meteorology and Professor of Civil Engineering

Ph.D. University of Leipzig (Germany), 1931 (Geophysics and Meteorology)
Ph.D. habil, University of Leipzig, 1937 (Geophysics)

Joined staff in 1958. Previously Professor in Leipzig and in Konigsberg, Germany. Research Scientist AF Geophysics Research Directorate. Special areas of interest: Micrometeorology, boundary layer problems, climatology, physical meteorology.

Mitchell, Val L., Associate Professor of Meteorology and State Climatologist in the Geological and Natural History Survey - Extension

Ph.D. University of Wisconsin, 1969 (Meteorology)

Joined staff in 1974. Previously Associate Professor at Montana State University. Former consultant on climatology for University of Montana School of Forestry, Ski Yellowstone, Inc., and University of Michigan School of Natural Resources. Special areas of interest: Weather modification and air pollution research; environmental impact of weather modification.

Ragotzkie, Robert A., Professor of Meteorology and Environmental Studies
Director, Sea Grant Institute, University of Wisconsin-Madison

Ph.D. University of Wisconsin, 1953 (Meteorology and Zoology)

Joined staff in 1958. Before that, Director, Marine Institute, University of Georgia. Also directly involved in Graduate School Ph.D. program for Oceanography and Limnology and in various interdisciplinary activities at University of Wisconsin. Special areas of interest: Physical oceanography; limnology and physical-biological interrelations in lakes and coastal areas.

Schwerdtfeger, Werner, Professor of Meteorology

Ph.D. University of Leipzig, Germany, 1931 (Geophysics and Meteorology)
Ph.D. habil, University of Konigsberg, 1936 (Meteorology)

Joined staff in 1962. Previously Professor at Universities at Konigsberg, Vienna, Munich, Buenos Aires and Melbourne. Nine years experience in weather reconnaissance flights in Europe and twelve years as science advisor in Argentina. Special areas of interest: Circulation of the atmosphere and synoptics with special emphasis on polar weather and climate.

Sechrist, Frank S., Associate Professor of Meteorology

Ph.D. Penn State University, 1967 (Meteorology)

Joined staff in 1967. Previous work in hurricane hunter aircraft with U.S. Navy (1956/60). Special areas of interest: Synoptic meteorology, structure and energetics of extratropical cyclones, forecast dissemination and public service role of meteorologists.

Smith, William A., Adjunct Professor of Meteorology and Associate Director of Space Science and Engineering Center

Ph.D. University of Wisconsin, 1966 (Meteorology)

Currently Chief of the Mesoscale Applications Branch of the National Environmental Satellite Service (NESS), located at the University of Wisconsin-Madison since 1977. Principal Investigator of the Earth Radiation Budget radiometer flown on the Nimbus-6 satellite.

Stearns, Charles R., Professor of Meteorology

Ph.D. University of Wisconsin, 1966 (Meteorology)

Joined staff in 1965. Previous work in private meteorological/technical company and as project associate in Department, in charge of various experimental and field programs. Special areas of interest: Boundary and surface layer meteorology, micrometeorological processes, instrumentation, environmental measurement devices.

Stull, Roland B., Assistant Professor of Meteorology

Ph.D. University of Washington, 1975 (Atmospheric Sciences)

Joined staff in 1979. Served four years as numerical prediction meteorologist in USAF. Special areas of interest: Turbulence, diffusion, air pollution, boundary layer dynamics, micrometeorology, atmospheric gravity waves, cumulus dynamics, aeronautical meteorology.

Suomi, Verner E., Professor of Meteorology and Director of Space Science and Engineering Center

Ph.D. University of Chicago, 1953 (Meteorology)

Joined staff in 1948. Member of the U.S. Academy of Engineering and Foreign Academies. Chairman of U.S. Committee for GARP. Wexler Professorship. Instrumental in developing U.S. weather satellites and radiometric instrumentation. Special areas of interest: Development and utilization of global satellite experiments, atmospheric radiation, problems in forecasting.

Tanner, Champ B., Professor of Meteorology and Soils

Ph.D. University of Wisconsin, 1950 (Soils)

Main department is Soils in College of Agriculture and Life Sciences. Truog Professorship. Teaches in our Department. Special areas of interest: Micro-climatology and processes of heat, moisture and momentum flux at the soil-plant-atmosphere interface.

Wahl, Eberhard W., Professor of Meteorology

Ph.D. University of Berlin, Germany, 1937 (Astronomy)

Joined staff in 1963. Previous work at University of Berlin, N.W. German Weather Service, U.S. Air Force Geophysics Research Directorate (1949/58) and USAF Project Space Track (Senior Scientist and Technical Director 1958/63). Special areas of interest: Dynamic climatology and large-scale circulation processes. Application of statistical methods to extended range forecasting.

Weinman, James A., Professor of Meteorology

Ph.D. University of Wisconsin, 1957 (Physics)

Joined staff in 1963. Previous work at Carnegie Institute and with high-energy physics group at Argonne National Laboratory. Special areas of interest: Atmospheric radiation and optics, lidar systems, particulate loading of atmospheric layers, physical meteorology.

Young, John A., Professor of Meteorology

Ph.D. Massachusetts Institute of Technology, 1966 (Meteorology)

Joined staff in 1966. Previously postdoctoral fellowship at University of Oslo, Norway (1965/66) and summer research with the U.S. Weather Bureau. Special areas of interest: Atmospheric dynamics and numerical modeling; boundary layers, monsoons and ocean interactions; research aircraft observations.

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Close operation in matters related to Atmospheric Sciences is maintained with staff members of the Institute for Environmental Studies (IES), especially the groups in the Center for Climatic Research (CCR) and the Marine Studies Center (MSC) which are housed in the same building. The Sea Grant Program, a U.W. system-wide organization directed by Professor Ragotzkie, the Space Science and Engineering Center directed by Professor Suomi, and the office of the State Climatologist for Wisconsin are also housed in our Meteorology Building.

The departmental office is supervised by Mrs. Margaret Hundt, assisted by Mrs. Jane Rieder, Mrs. Elaine Finn, Mrs. Eva Singer and Ms. Karin Hood.

Research Programs and Facilities

The Department of Meteorology, which is housed in the 15-story Meteorology and Space Science Building, has a variety of research programs. Excellent computing facilities are available within the building. Terminals can be used as access to the University's UNIVAC 1110 computer and the NCAR 7600 and CRAY Computers at Boulder, Colorado and the NASA AMDAHL at Greenbelt, Maryland.

1. Satellite Meteorology Research Program

The research program at Wisconsin ranges from satellite experiment design and development through data reduction and application. The program is allied with the University's Space Science and Engineering Center and the National Environmental Satellite Service's Mesoscale Applications Branch, both of which are in the building housing the Department of Meteorology. Satellite experiments have been developed for measuring the radiation budget of the earth and other planets and for sensing the wind, temperature and moisture distribution of the earth's atmosphere. Particular emphasis is placed on the application of these satellite data to the improvement of our theoretical understanding of planetary atmospheres as well as to real-time operational weather forecasting. A unique Man-Computer Interactive Data Access System (McIDAS) has been developed and implemented to enable researchers to analyze and apply satellite and other types of data in a most effective manner. The system possesses video monitors for displaying imagery and graphics and computer hardware to give the researcher a real-time interactive data processing capability.

2. Atmospheric Radiative Properties Research Programs

Investigation of the radiative properties of atmospheric constituents is being conducted in the visible infrared and microwave part of the spectrum. The optical properties of fogs, rain, dust and air and water pollution are being investigated by means of a pulsed ruby laser and the effect which these airborne particles produce on sunlight. Scattering of laser light by inhomogeneities in dust density is being used to remotely measure winds and convective eddies in the boundary layer. A high spectral resolution lidar system is under development in cooperation with members of the Physics Department. This instrument may allow the global distribution of aerosols and water pollution to be remotely measured from the Shuttle spacecraft. Microwave radiation emitted by precipitation can be measured from satellites. A program of theoretical modelling and reduction of data obtained from Nimbus 6-ESMR, and the SMMRs on Nimbus 7 and SEASAT is being pursued to map the distribution of precipitation.

3. Climatology Research Program

The interdisciplinary program of climatic research in the University of Wisconsin Department of Meteorology involves research in three broad and interrelated areas: diagnostic studies of past climates, diagnostic studies of present climates, and climate impact assessment. It is carried out jointly with the Institute for Environmental Studies.

a. Diagnostic Studies of Past Climates

The climatology program is concerned with the reconstruction of past climate starting with most recent climatic history (last 200 years) and extending backward about 20,000 years. This project offers many opportunities for interdisciplinary cooperation with other departments such as anthropology, biology, and geology. Special facilities include a pollen analysis lab, a carbon-14 dating lab, and a tree-ring lab. One goal of this research is to provide estimates of the nature of future climates via improved understanding of climate dynamics. Climate models are developed and tested, with field observations being used for validation.

b. Diagnostic Studies of Present Climate

The goal of diagnostic studies of present climate is a better understanding of global climate and the mechanisms of climate change. Investigations include the mathematical modelling of spatial and temporal variations of basic climatic elements, the diagnosis of space scales and structure of climate variability on time scales ranging from weeks to years, and the study of the external forcing of climate due to variations in solar radiation, volcanic activity and axial wobble. Studies of tropical circulation using cloud winds (as determined from satellite data) and studies of land surface processes (runoff, evaporation, soil moisture storage) at regional space scales are also in progress.

c. Climate Impact Assessment

The impact of climate variations on crop yields have been studied for regions of N. America, and Asia. We have also been involved in efforts to develop a State Climate Program that would initiate and coordinate efforts to make better use of climate information in industrial, agricultural and recreational activities.

4. General Circulation Modelling and Climatonomy

The general circulation modelling program involves development and applications of the GLAS (Goddard Laboratory for Atmospheric Science) model. Model development is advancing in areas of radiative transfer, and interactive sea ice modelling. Applications involve cloud radiative-dynamical interactions, and model sensitivity to surface anomalies such as sea ice margin.

Investigations in climatonomy include the mathematical modelling of spatial and temporal variations of basic climatic elements in terms of physical forcing function.

5. Meso-micrometeorology

This is an investigation into the three-dimensional structure of the planetary boundary layer with special attention to turbulence structure and the horizontal variations of the boundary exchanges of masses, momentum, and energy. Field experiments and measurements are made over a number of surface types to clarify the role of the surface characteristics in problems of physical climatology.

6. Atmospheric Diagnostics and Dynamics

Several of the Department of Meteorology's research programs are concerned with atmospheric motion. The diagnostic studies employ vast amounts of routine weather information, as well as meteorological satellite data, in an attempt to describe weather systems. Theoretical studies involving the mass, momentum and energy budgets of systems are being conducted to explain their development, maintenance and decay. Other studies are concerned primarily with certain features of the Southern Hemisphere, particularly meteorological conditions in and around Antarctica.

Investigations into the dynamics of atmospheric motions involve theoretical and numerical studies of both tropical and mid-latitude phenomena. The goal of these studies is to provide physical understanding of the observed dynamical processes in the atmosphere. Topics include thermal convection, large-scale wave motions, mesoscale dynamics, boundary layer dynamics, initialization, and adjustment theory of cyclones. There is also a continuing research program involving the dynamics of the cloud-covered Arctic planetary boundary layer. Experimental programs and theoretical studies focus on the numerous interactions of the coupled ice-atmosphere-ocean system.

7. Agricultural Climatology

Studies in this area are conducted together with the Department of Soils. The programs include energy balance of plants and animals, the water transfer in the soil-plant-atmosphere layers and the relation to plant growth, water relations of plants and microorganisms.

8. Cloud Physics

The department offers an opportunity for specialization in cloud physics and the related area of weather modification. In addition to formal courses in cloud and precipitation physics, research in condensation, nucleation, and particle growth is possible in specially furnished laboratories. Cloud probing is possible using lidar equipment. Opportunities are available to study cloud behavior by means of satellite imagery as well as ground based photography.

9. Synoptic Meteorology

At the University of Wisconsin-Madison, synoptic meteorology is closely related to the dynamic and satellite meteorology programs. The equations of atmospheric dynamics and thermodynamics are used to diagnose and, sometimes to forecast, various weather producing phenomena. The phenomena range from very large-scale flow patterns to the environment which favors the outbreak of severe local weather. A vast array of observations made from meteorological satellites are used to aid in the study of weather systems. Facilities available to the synoptic program include: 1) A facsimile circuit which provides a full-complement of current and forecast weather charts; 2) teletype circuits which provide North American hourly weather observations, radiosonde observations from the entire world, and midwestern U.S. weather forecasts; 3) a facsimile circuit which portrays a current radar scope; 4) a very advanced video-graphics/computer system capable of portraying both current and past satellite images of the earth, and which can also be used for preparing and displaying numerous analyses of both satellite and conventional weather observations; 5) access to the University's UNIVAC 1110 computer system with software available for various case studies of weather phenomena; 6) a computer terminal which links the Department of Meteorology to larger computers at the National Center for Atmospheric Research and Goddard Space Flight Center at NASA. In addition, an applications group of the National Environmental Satellite Service (NOAA), is located within the same building, and works closely with some parts of the synoptic program. Also, a library in the Space Science and Engineering Center contains an extensive array of satellite pictures.

10. Severe Storms and Tornadoes

The phenomena of severe local storms including tornadoes is being pursued in the department in several directions. Satellite imagery is used to study the formation and growth of squall lines, large storm complexes, and giant individual storms. This imagery is being adapted to the detection and monitoring of tornadic storms as well. Assisting in this research is the McIDAS computer which is capable of integrating satellite imagery with radar and conventional weather information. Numerical simulations of severe storms are carried out on the UNIVAC 1110 computer and on the CRAY-1 and CDC 7600 computers at NCAR. The department participates in several large scale field programs such as NHRE and SESAME.

11. Tropical Meteorology

The dynamics of monsoon circulations are being studied using (a) geostationary satellite wind fields, (b) research aircraft probe data, and (c) numerical modeling of low-level jet inflows.

Characteristics of the tropical atmosphere; local and diurnal phenomena; dynamics and climatology of the large-scale circulation; energetics; weather systems; mechanisms of tropical climate anomalies.

12. Solar Radiation and Wind Energy

The present shortage of conventional fuels is encouraging the consideration of solar radiation and wind as energy sources for space and water heating and electrical generation. The available solar and wind energy is determined at several sites within Wisconsin. The resulting data are used to show the feasibility of these energy sources in relation to conventional fuels and to study the time interactions between conventional fuels and these alternative sources. One research project involves a community on Washington Island in Lake Michigan which is considering the community-wide use of solar and wind energy.