Proposal: Bachelor of Science in Atmospheric Sciences

I. GENERAL INFORMATION

1. Give the name of the proposed major.

Atmospheric Sciences

2. State what degree students competing the major will receive.

Bachelor of Science in Atmospheric Sciences

3. State the proposed implementation date.

Autumn 2009

4. Identify the academic units (e.g. department, college, etc.) responsible for administrating the major program.

Department of Geography, College of Social and Behavioral Sciences, Colleges of the Arts and Sciences

II. RATIONALE

5. Describe the rational/purpose of the major.

The atmosphere affects Ohio in a number of ways. Blizzards snarl transportation and affect utilities. Floods threaten life and infrastructure. Droughts reduce agricultural production and heat waves cause the demand for electricity to spike. Hail and high winds damage property and increase insurance rates. Even sunshine can increase the formation of haze and smog. In addition, climate change may alter the severity and location of all these events.

Other states and universities understand the importance of the atmospheric sciences and offer comprehensive degrees in this area. Regionally, Penn State, the University of Michigan, Purdue University, and the University of Illinois offer B.S. degrees with majors in meteorology/atmospheric sciences. Some schools are in the process of revising their atmospheric sciences offerings in order to cope with increased demand. For instance, Purdue University recently revised and enhanced its major in Atmospheric Science. The University of Illinois likewise approved a new undergraduate major in Atmospheric Sciences during the 2007-2008 academic year. In contrast, no university in Ohio currently offers a B.S. with a major in meteorology/atmospheric sciences. Students at Ohio State who want to focus on atmospheric sciences currently pursue a B.S. degree with a major in Geography and complete the requirements of the Atmospheric and Climatic Studies (ACS) track.

Our ACS graduates are successful when they apply to top graduate programs as well as to jobs in the public or private sector. However, many current students, alumni and prospective students (and their parents) have indicated strongly that they would prefer to major in atmospheric sciences if they had that option. In particular, our undergraduates tell us that they find it difficult to understand why graduate students may choose either Geography or Atmospheric Sciences given that they do not have the same option. Their feeling is that students with a specialized B.S. in Atmospheric Sciences will be in a much better position to market themselves upon graduation. Our faculty are agreed, and also believe that a stand alone B.S. in Atmospheric Sciences in the Department of Geography is required in order to keep up with our peer institutions as well as fill state, regional and national demand for undergraduate education in the atmospheric sciences.

Geography at Ohio State has an almost ninety year tradition of research and teaching in the atmospheric sciences. Following a 1920 address to the American Meteorological Society, Eugene Van Cleef was invited to establish a climatology program at the Ohio State University in 1921. Van Cleef became a member of the Department of Geography when it was formed and served as a faculty member here until 1973. As a result of this longstanding focus on climatology and physical geography, the department is recognized internationally as top-ranked in atmospheric sciences-based research and teaching. At the undergraduate level the climatology program has evolved into the ACS track, leading to a B.S. in Geography. The Atmospheric Sciences was established as a Graduate Program at Ohio State in 1971, offering both M.S. and Ph.D. degrees. The Atmospheric Sciences Program was co-located with the Department of Geography in 1986.

The topics of study in the atmospheric sciences have expanded considerably since the inauguration of atmospheric sciences in Geography at the Ohio State University. Climatology is now just one important component in a much broader landscape of research and teaching. Current faculty in the Department of Geography offer a wide range of courses, touching on topics such as global warming, climate change, El Niño, hurricanes, floods and other aspects of severe weather.

Our proposed B.S. in Atmospheric Sciences complements the existing B.S. degree in Geography which is undergoing concurrent revisions. It also potentially feeds into our existing M.S. and Ph.D. programs in Geography and in Atmospheric Sciences and it will provide benefits to students in the Department of Geography and the university. The primary reasons for this proposal are that it

1) responds to an existing demand at the undergraduate level for a major in Atmospheric Sciences;
2) fills a need that exists at Ohio State and in the state of Ohio;
3) takes full advantage of the expanded expertise of recent faculty hires; and
4) accurately reflects the broadened nature of the atmospheric sciences. The proposed new major is designed to be consistent with the American

Meteorological Society's Policy Statement on *Bachelor's Degree in Atmospheric Science*.

6. Identify any unique characteristics or resources that make it particularly appropriate for Ohio State to offer the proposed major.

The Ohio State University has a number of unique resources that make it the perfect place for a major in Atmospheric Sciences. The Department of Geography has eight full-time tenure track faculty who teach courses in the atmospheric and related sciences. These faculty and their specializations are listed in Appendix A. One of the faculty, Dr. Jeff Rogers, is the State Climatologist for Ohio. The cluster of faculty at Ohio State and the range of their expertise in the atmospheric sciences exceeds those at any other university in Ohio. In addition the department has another cluster of faculty with expertise in Geographic Information Science (GIS) and remote sensing, which are topics central to the analysis and forecasting of atmospheric conditions. The Department of Geography already offers the courses that are required in the proposed major. The department has computer labs for teaching and research in the atmospheric sciences. Derby Hall 1066 serves as the Synoptic Meteorology Laboratory and home to the Meteorology Club. The department maintains a collection of instruments for field research and teaching that offers students "hands-on" experience with data collection and analysis. The department hosts Twister, the Ohio State University Weather Server, which provides real-time meteorological data for educational and informational uses. Twister is highly visible and many official meteorological web sites, including the National Hurricane Center, maintain links to it.

The Meteorology Club supported by the Department of Geography and the Office Student Activities organizes and hosts an Ohio Severe Weather Symposium (OSWS) every April. The OSWS brings in experts from around the U.S. and the state of Ohio to discuss the causes and effects of severe weather. It provides students an excellent opportunity to interact with professionals in the field and to develop their communication and personal skills.

The university has other unique resources that make it particularly appropriate to offer a major in atmospheric sciences. The university is a member of the University Corporation for Atmospheric Research (UCAR), which consists of approximately 60 universities in the U.S. and Canada that offer Ph.D. degrees in the atmospheric and related sciences. The recently completed review of Doctoral Programs at Ohio State rated the program in Atmospheric Sciences as "Strong". The university is the home of the Byrd Polar Research Center (BPRC), which is a world class facility for research and education in polar meteorology and climate change. The excellent people and extensive facilities at the BPRC provide students with a wide range of opportunities for mentoring and research. The proposed new major also complements the Climate Water Carbon Targeted Investment in Excellence. The Great Lakes Forecasting System (GLFS) was developed as a result of a collaboration between members of the Department of Civil and Environmental Engineering and Geodetic Sciences and the Atmospheric Sciences Program.

The central location of the university is also a valuable asset for the new major. Students have opportunities for internships at the National Weather Service Forecast Office in Wilmington, at some state agencies, in the private sector with companies like NetJets, and at local media outlets.

7. Cite the benefits for students, the institution, and the region or state.

The purpose of the proposed major is to provide students with the education and experience necessary for them to be successful upon graduation. The specific benefits for the students include

1) an excellent liberal arts education preparing them for career paths in the atmospheric sciences and other fields;
2) a foundation in atmospheric and related sciences necessary for success in a range of career paths;
3) enhanced opportunities for involvement in research, internships and other learning activities; and
4) a major that clearly identifies the nature of their education and interest.

However, by far the biggest benefit for students is that the proposed new major is tailored specifically to fit the needs of students who want to pursue careers in the atmospheric sciences. It is organized to provide the foundation and skills necessary with a clear path to graduation. The major includes sufficient flexibility that the professional undergraduate advisor in Geography can help students choose the courses to satisfy the requirements of the General Education Curriculum (GEC) and their electives to match their specific goals. Students who complete the proposed major will be well positioned to take the next step after they graduate. An additional benefit is that the students' major will be clearly identified as Atmospheric Sciences, which is something that students and alumni have been requesting for a long time.

The benefits of the proposed major to the Department of Geography are

1) it expands and enhances the existing undergraduate major, which is being modified in a concurrent proposal;
2) it aligns the departmental offerings with the interests of the field and current faculty; and
3) it responds affirmatively to the requests of undergraduates and alumni.

The benefits of the proposed major to the university are

1) it clearly establishes Ohio State as the center for undergraduate education in atmospheric sciences in Ohio;

2) it will help recruit high quality students who would have gone out of state to major in meteorology/atmospheric sciences,; and
3) it complements other university activities such as the Carbon, Water, Climate (CWC) Targeted Investment in Excellence (TIE).

The principle benefit to the university is that the proposed new major will attract some high quality students that would otherwise attend other universities, particularly the regional universities identified above. Prospective students who insist on pursuing a major called Meteorology/Atmospheric Sciences currently do not choose Ohio State, because the university does not offer that major. In addition to adding to the intellectual vitality of the university some of the best students may also choose to continue at Ohio State and do their graduate work in the Atmospheric Sciences Program. The University of Illinois recently recognized the benefits of a similar proposal and approved a new undergraduate major in Atmospheric Sciences. Another benefit for both students and the university is that it would make it easier for students in related disciplines to do double majors.

The principle benefit to the state of Ohio is that the proposed new major would keep more bright and motivated undergraduate students in the state. There is no university in Ohio that currently offers an undergraduate major in meteorology/atmospheric sciences. Thus, any students who insist on a major with that title leave Ohio to go to a university that offers such a major. The proposed new major would also provide a source of potential employees for businesses that require people who can forecast weather or analyze the risk posed by severe and major events. Major insurers like Nationwide Insurance need people who can analyze the potential risk from severe weather and estimate losses after it occurs. Major utilities like American Electric Power need expert forecasters to help predict load demand and to anticipate the need for repair crews when severe weather threatens their service areas. Transportation companies like NetJets employ meteorologists because they require accurate forecasts for route planning, logistical and safety considerations.

8. List similar majors offered in both public and private institutions in Ohio and the U.S. Explain how these majors compare to the one proposed.

No similar majors are offered by any institution within the state of Ohio. Based on information available on the American Meteorological Society's web site, approximately 29 public and private institutions offer B.S. majors in either Atmospheric Sciences or Meteorology. Penn State and Michigan offer B.S. majors in Meteorology, and Purdue and Illinois offer B.S. majors in Atmospheric Sciences. A list of the universities that offer similar majors is contained in Appendix B. A few of the majors are offered at institutions that only have undergraduate programs. Many of the majors are offered by programs that also offer M.S. and Ph.D. degrees in Meteorology/Atmospheric Sciences.
That will be the situation at Ohio State, if the proposed major is approved.

The American Meteorological Society Council adopted a policy statement on the *Bachelor's Degree in Atmospheric Science* on 29 April 2005. The policy statement, which is contained in Appendix G, describes the attributes that should characterize such a degree program. The 29 degree programs listed in Appendix B conform to the policy statement and the attributes listed in it were followed in the design of the proposed major. The proposed major is very similar to a major in Atmospheric Sciences recently approved at the University of Illinois. The primary differences between the proposed major and the similar majors at other institutions are found in the electives available to students. No institution attempts to cover all of the specializations in the atmospheric sciences. Institutions tend to cluster faculty in a few specializations that represent their areas of emphasis. The electives in the proposed major reflect the expertise and areas of emphasis of the faculty at Ohio State.

9. Cite the enrollment patterns of similar majors in Ohio or in the United States.

Periodic surveys conducted by the American Meteorological Society and the University Corporation for Atmospheric Research reveal that approximately 1000 undergraduates in the U.S. are pursuing a B.S. in Meteorology/Atmospheric Sciences at any given time. This number has remained relatively steady over the past 10-15 years. The specific enrollment data cited in this proposal were gathered from the American Meteorological Society's web site and from requests to specific well-regarded programs in the Big Ten and the U.S. The available data are contained in Appendix B.

As can be seen in Appendix B, the enrollments range from 20-30 students in the smaller programs to approximately 300 students at Penn State and the University of Oklahoma. Typical programs have roughly 50-150 undergraduates in their majors. The programs with the fewest number of majors tend to be at private institutions or in programs that only offer B.S. degrees. The programs with the larger number of major tend to be at public institutions and offer M.S. and Ph.D. degrees as well as a B.S.

10. Describe career opportunities and/or opportunities for graduate or professional study available to persons who complete the major.

Undergraduates who complete the proposed major will have the foundation to apply successfully to highly regarded graduate programs in meteorology/atmospheric sciences. The requirements of the proposed major exceed the entrance requirements of those graduate programs. Students who indicate an interest in graduate study will be advised to maximize their opportunities through involvement in internships and summer programs, and will be strongly encouraged to participate in research projects.

The proposed major contains the courses necessary for undergraduates who are interested in a career as a weather forecaster. Students who complete the major will fulfill all of the Federal Civil Service Requirements for Meteorologist Positions (GS 1340). This will qualify the students for meteorology positions in the National Weather Service, the Federal Aviation Administration or any other Federal agency. Students in ROTC will be qualified for meteorology positions in their respective branch of the Armed Services. Students will also be qualified for weather forecasting positions in the private sector, since most private companies base their expectations on the Federal GS 1340 requirements. Students who indicate interest in careers in weather forecasting will be strongly advised to participate in internships at the National Weather Service Forecast Office in Wilmington or at private companies in order to acquire additional practical experience. Students currently prepare a daily local forecast that appears on the front page of The Ohio State University Weather Server – Twister. The nature of the rotating shifts worked by forecasters in both the public and private sector and the need to forecast the weather 24 hours a day, seven days a week ensures a constant turnover and job opportunities. Organizations like the American Meteorological Society and the National Weather Association regularly post new announcements of openings for weather forecasters on their web sites.

Undergraduates who are interested in a career as an on-air meteorologist will receive an excellent background in the fundamentals of meteorology and in the techniques used to analyze and display meteorological information. Students who indicate an interest in becoming an on-air meteorologist will be advised to take Communications and other courses to supplement their meteorological training. They will also be strongly encouraged to participate in internships with local media in order to get valuable practical experience and make necessary professional contacts. Persons entering the field of on-air meteorology generally begin in smaller markets at modest salaries. Individuals with talent, skill and motivation can quickly progress to larger markets with much higher salaries.

The proposed major contains sufficient flexibility for undergraduates who are interested in careers in environmental monitoring, consulting, applications development or some aspect of the atmospheric sciences besides weather forecasting and on-air meteorology.

The American Meteorological Society, the University Corporation for Atmospheric Research and other organizations periodically conduct surveys of starting salaries for atmospheric scientist. Estimated starting salaries based on a compilation of those data for three career paths are presented in Table 1.

Table1
Estimated Starting Salaries for Atmospheric Scientists

Degree	B.S.	M.S.	Ph.D.
Private Sector	$18,000.- $30,000.	$30,000.- $40,000.	$40,000.- $60,000.
Government	$28,000. - $34,500.	$42,000. – $54,000.	$70,000. -
Academic			$45,000. - $80,000.

11. Describe any licensure or certification for which this major will prepare students.

The American Meteorological Society (AMS) has programs that certify the credentials of meteorologists/atmospheric scientists in two career paths. The Certified Broadcast Meteorologist Program awards the AMS Seal of Approval to those individuals who fulfill the requirements of that program. Completion of the proposed major will fulfill one of the requirements for the Seal of Approval. The AMS Certified Consulting Meteorologist Program is available for meteorologists who work as consultants in the private sector. Completion of the proposed major will fulfill one of the requirements for that certification and will prepare students for the written and oral exams they will have to pass to become certified.

III. GOALS/OBJECTIVES/EVALUATION

12. Provide a learning outcomes assessment plan for the major program.

A. State the general and specific educational goals and objective for the major.

The goal of the proposed major is to provide students with a foundation in basic atmospheric and related sciences, mathematics and statistics, while providing sufficient flexibility and breadth so students can pursue a number of different career paths. It is designed to allow students to acquire an appropriate combination of fundamental knowledge, core competencies and skills for their chosen goals. The courses required for the major are chosen to provide students opportunities to develop critical thinking and communication skills including problem solving, reasoning, analytical and other relevant professional skills.

Students who want to major in atmospheric sciences typically have the following goals:

1) to pursue graduate education in the atmospheric sciences and become research scientists;
2) to become weather forecasters in either the public or private sector;
3) to become on-air meteorologists; or
4) to acquire a more broadly based liberals arts education focused on their interest in the atmospheric sciences.

This proposed major is designed to provide the rigor and foundation for students who want to do research and to provide the flexibility, knowledge and skills for those students who want pursue other opportunities.

The general educational goals of the proposed major are:

1) to provide students with a core foundation of knowledge in the atmospheric and related sciences;

2) to prepare students for graduate study in atmospheric science or a closely related field through advanced education with a focus on critical thinking and problem solving; and
3) to prepare students for a successful career through advanced education and training in the relevant professional skills.

The specific educational goals for the proposed major are:

1) to provide students with the theoretical basis for fundamental atmospheric processes and systems;
2) to develop students' ability to solve problems faced by atmospheric scientists;
3) to introduce students to computational and other forms of technology used in the atmospheric sciences.

B. Indicate the methods that will be used to assess whether the educational goals and objectives are being met.

The Department of Geography currently has an assessment plan that includes suite of outcome monitoring methods that allows us to gauge whether or not it is meeting pedagogical goals and to make necessary corrections. The plan is reviewed annually by the College of Social and Behavioral Sciences, and it is managed by the department's professional undergraduate advisor. The plan consists of two indirect assessment methods and one direct method. The assessment methods include:

1) embedded questions in the exams given in one regularly offered and popular upper division undergraduate course;
2) informal focus groups with students in the major (e.g. In the 2007-2008 academic year there were four focus groups representing each of the specializations within the major); and
3) an exit survey of graduating seniors, which includes questions about the major regarding their overall educational experience, classroom experience, research and internship participation, and placement in jobs and in graduate schools.

The Department of Geography is conducting a concurrent revision to its undergraduate major and is developing an improved assessment strategy. The department is in the process of refining the methods it uses for assessment. The intention is to take the information gained during the assessment process to date and to improve the preparation of students for graduate studies and the job market. In addition the department is gaining experience with the methods of assessment and an ongoing evaluation of those methods will lead to better assessment of the major.

Because the proposed major will be within the Department of Geography it will be able to take advantage of the experience the department has with assessment. The initial assessment plan consists of similar elements to those already used by Geography. They include:

1) the use of existing questions in Atmospheric Sciences 638;
2) informal focus groups with undergraduate majors and members of the Meteorology Club; and
3) exit interviews with graduating seniors.

Atmospheric Sciences 638 (Dynamic Meteorology II) is a course that many students will take as one of the last courses required for their major. Most students will have already taken courses dealing with synoptic meteorology and boundary layer processes. Some of the topics covered in Atmospheric Sciences 638 include the derivations of the theoretical bases for many important concepts in synoptic meteorology. There are also discussions of the assumptions made during the derivations and the limitations imposed by those assumptions on the applications of the resulting concepts. In addition some of the material covered in Atmospheric Sciences 638 links the processes in the boundary layer to the processes operating in the rest of the large scale atmosphere. Thus, some of the questions on examinations in Atmospheric Sciences 638 provide an opportunity to assess students' acquisition of a core foundation of knowledge in the atmospheric sciences. The performance of the students on specific questions will be reviewed by faculty who teach courses in the proposed major and curriculum changes will be discussed and implemented as necessary. Those faculty already meet both formally and informally to discuss curriculum issues.

Focus groups will be conducted without faculty present in order to encourage students to feel free to be open with their opinions. Students' opinions on individual courses required for the proposed major and on the structure and requirements of the major will be solicited. The results of the focus groups will be conveyed to the faculty and changes to the major will be considered as appropriate.

Exit interviews will include questions about the future plans of graduating seniors. In addition to providing additional opinions on the structured and requirements of the proposed major, the exit interviews will provide data in the ability of graduating seniors to get into graduate programs and to find employment. This information will enable the department to assess if the proposed major is meeting its goal of preparing students for those options. The information gathered during the exit interviews will be reviewed and discussed by the faculty and changes to the major will be considered as appropriate.

C. Provide the time over which the assessment plan will be implemented.

Because this will be a new major, the implementation of the assessment methods will be introduced gradually.

Year 1 – Focus groups

Year 2 – Focus groups, assess questions in Atmospheric Sciences 638

Year 3 – Focus groups, assess questions in Atmospheric Sciences 638, exit interviews,

Year 4 – Focus groups, assess questions in Atmospheric Sciences 638, exit interviews, review assessment plan.

IV. RELATIONSHIP TO OTHER PROGRAMS

13. Describe current major and minor programs in the department(s) and how they relate to the proposed major.

The current major in Geography contains an Atmospheric and Climatic Studies (ACS) track. The details of the current major are contained in Appendix C. The current structure of the ACS track contains two paths in Atmospheric Sciences and in Climatic Studies. The Climatic Studies path represents an evolution of the Geography's original specialization in climatology and it is a path typically found in many Geography departments around the U.S. Students in the Climatic Studies path are provided with the foundation necessary to analyze climate and climate change and are exposed to a broader geographical education. The Atmospheric Sciences path was developed in attempt to address the needs and requests of students who wanted to pursue graduate education or other career opportunities in the atmospheric sciences. The Atmospheric Sciences path requires students to complete three additional Mathematics courses (i.e. through differential equations), and requires students to complete courses providing a thorough theoretical foundation in atmospheric sciences. The Atmospheric Sciences path was designed using all of the relevant courses offered by the Department of Geography at the time it was created.

The Department of Geography has subsequently hired additional faculty in the atmospheric sciences and has expanded both the range and level of the courses it offers in that area. The department is undertaking a thorough re-examination and modification of all of the undergraduate tracks in a separate proposal being developed concurrently with this proposal. The existing Atmospheric and Climatic Studies (ACS) track in Geography is being completely revamped and will become the Climatology and Physical Geography (CPG) track. The details of proposed CPG track are contained in a separate proposal and are listed in Appendix D. The Atmospheric Sciences path is being eliminated in the proposed revisions to the Geography major, contingent upon approval of this proposal.

The requirements of the proposed new major in Atmospheric Sciences are more rigorous than those for the current Atmospheric Sciences path. Students will be required to take an additional physics course (Physics 133), a Chemistry course (Chemistry 121), and two additional courses in their major (chosen from a list of electives in the major). These additional requirements will make the proposed major consistent with the attributes listed in the American Meteorological Society's Policy Statement on *Bachelor's Degree in Atmospheric Science* and will make students who complete the major competitive with graduates of other universities around the U.S.

The proposed major differs from the existing M.S. in Atmospheric Sciences in both the required level knowledge and skills. Students pursuing a M.S. degree must take graduate- only seminars in addition to their other coursework. Students who successfully complete a M.S. degree must demonstrate a higher level of knowledge in specific areas in comprehensive written and oral examinations and demonstrate research competency by writing a Thesis

14. Identify any overlaps with other programs or departments within the University. Append letters of concurrence or objection form related units.

There is no overlap with other majors or programs within the university.

15. Indicate any cooperative arrangement with other institutions and organizations that will be used to offer this major.

None.

16. Specify any articulations arrangements (direct transfer opportunities) with other universities that will be in effect for the major.

None.

17. Provide information on the use of consultants or advisory committees in the development of the major. Describe any continuing consultation.

Initial consultations were held with all members of the Department of Geography who teach courses in the current Atmospheric and Climatic Studies (ACS) track. Ideas about the content and structure of the proposed major were discussed. The opinions of some alumni were solicited. Consultations continued with the faculty and a consensus was achieved about the content and structure of the major. A focus group of undergraduates in the current ACS track or in the Meteorology Club was convened in Spring Quarter of 2007. The focus group strongly favored the proposed major and responded positively to its content and structure. The proposed major was discussed by the Undergraduate Curriculum Committee in Geography and at a subsequent departmental faculty meeting. Minor modifications to the proposal were made and unanimously endorsed by the faculty in the ACS track. If substantial modifications to the structure and content of the proposed major are required, the faculty will be consulted and their endorsement will be sought.

18. Indicate whether this major or a similar major was submitted for approval previously. Explain at what stage and why that proposal was not approved or was withdrawn.

This proposed major has never been submitted previously for approval.

19. Indicate where students will be drawn from, e.g. existing academic programs, outside the university, etc. Estimate the mix of students entering the major internally and externally.

The projections in this section are based on discussions with current undergraduate students in the Atmospheric and Climatic Studies (ACS) track and the professional undergraduate adviser in the Department of Geography. It is projected that a large percentage of undergraduates currently in the ACS track will switch to the proposed major. The projection is that 51 students will switch from the ACS track to the proposed major. In addition we project 5 new students will choose the proposed major. As the proposed major becomes more widely known, it is anticipated that the number of new students choosing the major will increase, as indicated by the projections in the answer to Question 20. Most of the increase in entering students who choose the proposed major will be comprised of students who will not attend Ohio State, if the proposed major is not available. There will likely be 1-3 students each year who change majors and choose the proposed major, but most of the new majors will arrive from outside Ohio State. Many students who choose to major in the meteorology/atmospheric sciences at other universities declare that major as incoming freshman. It is anticipated that a similar pattern will occur at Ohio State. It is anticipated that the number of undergraduates in the proposed major will level off at between 90-120 students. This projection is consistent with the enrollment in similar majors at other universities and would be an appropriate size for the proposed major.

V. STUDENT ENROLLMENT

20. Indicate the number of students you anticipate will be admitted to the major each year.

Student type	Year 1	Year 2	Year 3	Year 4
Full time (new entering)	56	9	11	15
Full time (cumulative)	56	65	76	91
Summer enrollment	4	4	5	5

VI. REQUIREMENTS

21. List the courses (department, title, credit hours, description) which constitute the requirements and other components of the major. Indicate which courses are currently offered and which will be new. Append a quarter-by-quarter sample program and all New Course, Course Change, and Course Withdrawal forms necessitated by the implementation of the proposed major.

The requirements for the major are contained in Appendix E. A quarter-by-quarter sample program is contained in Appendix F. The curriculum consists of 181 credit hours including the required one credit hour university survey course. The Required Prerequisites and Supplements to the major consist of 50 credit hours, but 35 of those hours may also be applied to the General Education Curriculum (GEC) requirements for B.S. degrees in the Colleges of the Arts and Sciences. The Core Courses in the major consist of 43 credit hours. The Major Electives consist of 8-10 credit hours depending on which courses students choose. Thus, there are 51-53 total credit hours required in the proposed major. The GEC for B.S. students consists of 100 credit hours, but 35 of those credit hours overlap with the Required Prerequisites and Supplements to the major. Therefore, a student will have 12-14 credit hours of Free Electives unencumbered by the other requirements for graduation. Students will be advised about which GEC courses and Free Electives are most appropriate for their interests and career aspirations.

Three new courses are being proposed as part of the new major. Atmospheric Sciences 689 (Student Internship in Atmospheric Sciences), Atmospheric Sciences 699 (Undergraduate Research in Atmospheric Sciences) and Atmospheric Sciences H783 (Honors Research) are being proposed as a result of input from students and alumni that indicated they wanted something on their transcripts that clearly indicated their internships or research were in atmospheric sciences. Copies of the proposals for these new courses are attached to this proposal. The major also includes a new course, Geography 684 (Geographic Applications of Remote Sensing), that is being proposed by the Department of Geography as a part of the revision to the B.S. major in Geography.

22. State the minimum number of credit required for completion of the major.

The minimum number of credit hours required for the major is 51.

23. State the average number of credits expected for a student at completion of their major.

We expect most students to have 53 major credit hours when they graduate, based on the average number of credits in the elective courses.

24. Give the average number of credits taken per quarter by a typical student. Estimate the average for each year.

A typical student takes an average of 15 credit hours per quarter. A typical student takes an average of 45 credit hours per year.

25. Given the number of credits a student is required to take in other departments.

Students are not required to take any credit hours in their major in other departments. Students may choose to take 5 credit hours in Geological Sciences or 4-8 hours in Civil Engineering if they choose those courses for their Major Electives. Students are required to take 25 credit hours in Mathematics, 15 credit hours in Physics, 5 credit hours in Chemistry and 5 credit hours in Statistics as part of their Required Prerequisites and Supplements to the Major.

26. Give the number of credits a typical student might take as electives in other departments.

The typical student might take 12-30 credit hours as electives in other departments. The number of credit hours and specific courses taken by an individual student will depend the student's career goals and area of interest within the atmospheric sciences.

27. Describe other major requirements in addition to course requirements, e.g., examinations, internships, final projects.

None.

28. Identify from which specialized professional association(s) accreditations will be sought. List additional resources that will be necessary to gain such accreditation.

No accreditation will be sought form professional associations. Although the American Meteorological Society has discussed the possibility of developing an accreditation program from time to time, it has always decided against doing so.

29. Describe the number and qualifications of full-time or part-time faculty. List current faculty and areas of expertise. Describe the number and type of additional faculty needed.

There are eight full time tenure track faculty who will teach courses in the proposed major. The list of the faculty and their areas of expertise are listed in Appendix A. In addition to the specializations listed in Appendix A Dr. Rogers is the State Climatologist for Ohio. Dr. Mosley-Thompson has received numerous awards for her distinguished work in paleoclimatology and climate change and Dr. Hobgood received an Alumni Distinguished Teaching Award in 1996. So, the faculty who will be teaching courses and mentoring students in the proposed major are extremely well-qualified to do so. No new faculty are required for the establishment of this major. If opportunities arise to hire additional faculty who can contribute to this proposed major, the major will be revised appropriately.

30. Describe existing facilities, equipment, and off-campus field experiences to be used. Indicate how the use of these facilities, equipment, etc. will impact other existing programs.

The Department of Geography has computer labs for teaching and research in the atmospheric sciences. There are sufficient resources in the labs to handle any additional students in courses taught in those labs generated by the proposed new major. Derby Hall 1066 already serves as the Synoptic Meteorology Laboratory and home to the Meteorology Club. There is sufficient space in that room to accommodate the increased number of students projected for the new major. The Department of Geography maintains a collection of instruments for field research and teaching that offers students "hands-on" experience with data collection and analysis. The department has sufficient resources to acquire additional instruments if the number of students in the new major exceeds expectations. Thus, the additional students generated by the proposed major should not have a major impact on existing facilities and equipment.

Specifically, the Department of Geography uses Derby 0140 as its primary instructional computer laboratory. Several of the courses required in the proposed major are already being taught in that lab. There are open seats available when those courses are taught. Derby 0140 contains 50 state-of-the-art workstations and each is equipped with a full complement of relevant software. The lab is managed by two full-time technical staff and a graduate student. The department is confident that its existing staff will be able to manage the increased usage of the lab. There is sufficient space in the lab to expand the number of workstations by 30%, if the number of majors increases beyond the projections. Undergraduates are free to use the workstations in Derby 0140 for class assignments and research projects when no classes are being taught in the lab. This generally means that students have access to those machines at most times between 5:00 p.m. and 9:00 a.m.

The Department is preparing a spacious new undergraduate student resource center. The designation of this space specifically for undergraduates will give students in the proposed major a dedicated space, when they need to work in Derby. Computers will be installed in the center, which will further increase the number of machines available to undergraduates working on class assignments or research projects. The resource center will supplement the space in the Synoptic Meteorology Laboratory in Derby 1066 for the Meteorology Club. Undergraduates in the proposed major will have multiple places in Derby Hall where they can work.

31. Describe additional University resources, including libraries that will be required for the new major.

None.

32. Describe the major as it would appear in the appropriate college bulleting.

The undergraduate Atmospheric Sciences major examines atmospheric processes and systems that occur at many spatial and temporal scales. A fundamental understanding of the theoretical basis of atmospheric transfers of matter and energy provides the foundation necessary to analyze systems of varying sizes and intensities. These theories provide the framework used to analyze current patterns of weather and climate and to predict future changes of weather and climate. Numerical models of the atmosphere solve equations based on these theories and are used to provide forecasts at many scales.

The major is designed to prepare students for a variety of career paths. The major emphasizes a strong fundamental background to prepare students for a lifetime of learning as knowledge about weather and climate advances. The strong background will serve students who desire a career in research and those who are more interested in operational meteorology well. Applications of computers and other technology in the atmospheric sciences continue to expand. Students are introduced to technology used by atmospheric scientists and are encouraged to develop their computational skills. The requirements for the major and the available electives provide sufficient flexibility for students to be able to tailor a program of study for their particular interests.

Students graduating with a major in Atmospheric Sciences will be well prepared to compete for admission to graduate programs in meteorology or atmospheric sciences and to find gainful employment in the public and private sector. Students who desire advanced training at the graduate level will have the foundation necessary to contribute to research projects and be successful. Students who are interested in jobs in operational or broadcast meteorology will have the knowledge and training to be able to negotiate successfully the challenges of those professions. Graduates will have the background to enable them to add value and make positive contributions to their chosen endeavors.

Appendix A
Faculty

Box, Jason (Assistant Professor), Global Energy and Mass Balances, Climate Change.

Bromwich, David (Professor), Polar Meteorology and Climatology, Climate Theory: Modeling and Diagnostics, Cryosphere, Mesoscale Meteorology and Modeling, Precipitation, Operational Weather Prediction.

Hobgood, Jay (Associate Professor), Hurricanes, Tropical Cyclones, Atmospheric Thermodynamics, Dynamic Meteorology.

Lin, Jialin (Assistant Professor), Global Climate Modeling, Tropical Dynamics, Tropical Convection and Clouds.

Mark, Bryan (Assistant Professor), Climatology, Paleoclimatology, Mountain Climate, Tropical Glaciers, Glacier-Climate Dynamics, Climate-Change Impacts.

Mosley-Thompson, Ellen (Professor), Paleoclimatology, Ice Cores, Climate variability and Change, Abrupt Climate Change, Volcanic Aerosols, Polar Climatology.

Porinchu, David (Assistant Professor), Global Change, Paleoclimatology, Paleoecology, Biogeography, Climate Change.

Rogers, Jeffery (Professor), Climatology, Climatic Change, Synoptic Meteorology.

Appendix B
Similar Majors at Other Universities in the U.S.

University	Degree Offered	Estimated Enrollment
Univ. of California at Davis	B.S. Atm. Sc.	25
UCLA	B.S. Atm. Sc.	35
Creighton Univ.	B.S. Atm. Sc.	20
Florida St. Univ.	B.S. Meteor.	160
Georgia Tech.	B.S. Earth and Atm. Sc.	60
Univ. of Hawaii at Manoa	B.S. Meteor.	20
Univ. of Illinois	B.S. Atm. Sc.	New major
Iowa State Univ.	B.S. Meteor.	NA
Lyndon St. Col.	B.S. Meteor.	55
Univ. of Missouri-Columbia	B.S. Atm. Sc.	70
Univ. of Michigan	B.S. Meteor.	NA
Univ. of Nebraska-Lincoln	B.S. Meteor.	65
North Carolina St. Univ.	B.S. Meteor.	125
University of Nevada-Reno	B.S. Atm. Sc.	NA
Univ. of North Carolina-Asheville	B.S. Atm. Sc.	100
Northern Illinois Univ.	B.S. Meteor.	NA
SUNY at Albany	B.S. Atm. Sc.	NA
Oklahoma Univ.	B.S. Meteor.	310
Penn. St. Univ.	B.S. Meteor.	300
Purdue Univ.	B.S. Atm. Sc.	60
San Jose St. Univ.	B.S. Meteor.	NA
S. Dakota School of Mines and Tech.	B.S. Atm. Sc.	NA
Texas A&M Univ.	B.S. Atm. Sc.	150
Texas Tech. Univ.	B.S. Atm. Sc.	NA
Univ. of Utah	B.S. Meteor.	90
Univ. of Wisconsin-Madison	B.S. Atm. Sc.	120
Univ. of Washington	B.S. Atm. Sc.	NA
Univ. of North Dakota	B.S. Atm. Sc.	75
Rutgers	B.S. Atm. Sc.	50

NA – The estimated enrollment was Not Available.

Appendix C. Current Atmospheric and Climatic Studies Curriculum

Part A. Required Prerequisites or Supplements to the Major

1. Atmospheric Sciences path
    - Math 151, 152, 153, 254, 415
    - Physics 131, 132
    - Statistics 245
2. Climatic Studies path
    - Math 151, 152
    - Physics 131, 132
    - Statistics 245

Part B. Core Requirements

1. For both Atmospheric Science and Climatic Studies paths
    - Basic Meteorology AS 230 OR Climatology Geog 520
    - Synoptic Meteorology Laboratory AS/Geog 620
    - Boundary Layer Climatology Geog 622.01
    - Microclimatological Measurements Geog 622.02
    - Synoptic Analysis and Forecasting Geog 623.01
    - Severe Storm Forecasting 623.02
2. Additional for the Atmospheric Science path
    - Atmospheric Thermodynamics AS 631
    - Dynamic Meteorology I AS 637
    - Dynamic Meteorology II AS 638
3. Additional for the Climatic Studies path
    - Introduction to Cartography Geog 580
    - Undergraduate Seminar in Applied Geography Geog 695 OR Seminar in Geography Geog 795
    - Any Human Geography course 600-level or higher

Part C. Electives within the Major

- NA

Appendix D. Proposed Climatology and Physical Geography Curriculum

Part A. Required Prerequisites or Supplements to the Major

1. For Climatic Studies path
    - Math 151, 152, 153
    - Physics 131, 132
    - Statistics 245
2. For the Physical Geography path
    - Math 151, 152
    - Physics 131
    - Statistics 245

Part B. Core Requirements

1. For Climatic Studies path
    - Basic Meteorology AS 230 OR Climatology Geog 520
    - Synoptic Meteorology Laboratory AS/Geog 620
    - Boundary Layer Climatology Geog 622.01
    - Microclimatological Measurements Geog 622.02
    - Synoptic Analysis and Forecasting Geog 623.01
    - Severe Storm Forecasting 623.02
2. For Physical Geography path
    - Introduction to Physical Geography Geog 220
    - Global Climate Change: Causes and Consequences Geog 420
    - Biogeography: An Introduction to Life on Earth Geog 490
    - Basic Meteorology AS 230 OR Climatology Geog 520
    - Integrated Earth Systems: Confronting Global Change Geog 597.02
    - Geomorphology Earth Sci 550

Part C. Electives within the Major

1. For Climatic Studies path. Choose five of the following courses:
    - Climate System Modeling: Basics and Applications AS 629
    - Atmospheric Thermodynamics AS 631
    - Dynamic Meteorology I AS 637
    - Dynamic Meteorology II AS 638
    - Physical Geography and Environmental Issues Geog 210
    - Global Climate Change: Causes and Consequences Geog 420
    - Biogeography: An Introduction to Life on Earth Geog 490
    - Introduction to Cartography Geog 580
    - Integrated Earth Systems: Confronting Global Change Geog 597.02
    - Fundamentals of Geographic Information Systems Geog 607
    - Undergraduate Research and Professionalization Seminar Geog 695 OR Seminar in Geography Geog 795

2. For Physical Geography path. Choose five of the following courses (at most one may be from Earth Sciences):
    - Physical Geography and Environmental Issues Geog 210
    - Introduction to Cartography Geog 580
    - Computer Cartography and Geographic Visualization 680
    - Fundamentals of Geographic Information Systems Geog 607
    - Intermediate Geographic Information Systems Geog 685
    - Undergraduate Research and Professionalization Seminar Geog 695 OR Seminar in Geography Geog 795
    - One Human Geography course 600-level or higher
    - Synoptic Meteorology Laboratory AS/Geog 620
    - Boundary Layer Climatology Geog 622.01 (note: has prerequisite of Physics 132, which has a prerequisite of Math 153)
    - Microclimatological Measurements Geog 622.02 (note: has prerequisite of Physics 132, which has a prerequisite of Math 153)
    - Synoptic Analysis and Forecasting Geog 623.01 (note: has prerequisite of Physics 132, which has a prerequisite of Math 153)
    - Severe Storm Forecasting 623.02 (note: has prerequisite of Physics 132, which has a prerequisite of Math 153)
    - Climate System Modeling: Basics and Applications AS 629
    - Atmospheric Thermodynamics AS 631 (note: has a prerequisite of Math 153)
    - Dynamic Meteorology I AS 637 (note: has prerequisite of Math 255)
    - Dynamic Meteorology II AS 638
    - Principles of Oceanography Earth Sci 206
    - Water in the Basin Hydrologic Cycle Earth Sci 410
    - Glaciers and Landscapes Earth Sci 650

Part D. Internship

1. After students have completed 20 hours of coursework in Geography, they are eligible for an internship and receive credit for it through the department.

Appendix E. Proposed Atmospheric Sciences Major

Atmospheric Sciences Major

The Atmospheric Sciences major provides core foundation of knowledge in the atmospheric sciences with emphases on theoretical concepts and techniques of analysis and problem solving.

Part A. Required Prerequisites or Supplements to the Major. (Do not count toward the credit hours required in the major)

Courses	**Credit Hours**
Math 151 – Calculus and Analytic Geometry I	5
Math 152 – Calculus and Analytic Geometry II	5
Math 153 – Calculus and Analytic Geometry III	5
Math 254 – Calculus and Analytic Geometry IV	5
Math 255 – Differential Equations and Their Applications	5
Physics 131 – Introductory Physics: Particles and Motion	5
Physics 132 – Introductory Physics: Electricity and Magnetism	5
Physics 133 – Introductory Physics: Thermal Physics, Waves and Quantum Physics	5
Chemistry 121 – General Chemistry	5
Statistics 245 – Introduction to Statistical Analysis	5

Part B. Core Requirements. (43 hours)

Courses	**Credit Hours**
Atmospheric Sciences 230 – Basic Meteorology	5
Or	
Geography 520 – Climatology	5
Atmospheric Sciences/Geography 620 – Synoptic Meteorology Laboratory	3
Geography 622.01 – Boundary Layer Climatology	5
Geography 622.02 – Microclimatological Measurements	5
Geography 623.01 – Synoptic Analysis and Forecasting	5
Geography 623.02 – Severe Storm Forecasting	5
Atmospheric Sciences 631 – Atmospheric Thermodynamics	5
Atmospheric Sciences 637 – Dynamic Meteorology I	5
Atmospheric Sciences 638 – Dynamic Meteorology II	5

Part C. Major Electives (Choose two courses from the list below)

Courses	**Credit Hours**
Atmospheric Sciences 629 – Climate System Modeling: Basics and Applications	5
Geography H410 – Global Climate and Environmental Change	5
Or	
Geography 420 Global Climate Change: Causes and Consequences	5
Geography 597.02 – Integrated earth Systems: Confronting Global Change	5
Geography 607 – Fundamentals of Geographic Information Systems	5
Geography 684 – Geographic Applications of Remote Sensing	5
Geological Sciences 206 – Principles of Oceanography	5
Civil Engineering 603 – Remote Sensing	4
Civil Engineering 613 – Principles of Applied Hydrology	4

Appendix F. Sample Four Year Plan

Sample four year plan B.S. Atmospheric Sciences			
Year 1			
Autumn	**Winter**	**Spring**	**Summer**
English 110	Math 151(Pre-major and GEC)	Math 152(Pre-major and GEC)	
Math 150	First Foreign Language course	Physics 131 (Pre-major and GEC)	
First GEC Social Science course	First GEC Arts and Humanities	Second Foreign Language course	
University Survey course (1 hour)			
Year 2			
Autumn	**Winter**	**Spring**	**Summer**
Math 153	Math 254	Math 255	
Physics 132 (Pre-major and GEC)	Physics 133 (Pre-major)	Atmospheric Sciences 230 (or	
Third Foreign Language course	Fourth Foreign Language course	Geography 520)	
		GEC Second Writing course	
Year 3			
Autumn	**Winter**	**Spring**	**Summer**
Atmospheric Sciences 631	Geography 622.01	Geography 623.01	
Geography 620	Geography 623.01	Chemistry 121 (Pre-major and GEC)	
Statistics 245	Second GEC Social Science course	Second GEC Arts and Humanities	
Year 4			
Autumn	**Winter**	**Spring**	**Summer**
Geography 622.02	Atmospheric Sciences 637	Atmospheric Sciences 638	
Civil Engineering 206(M.Elective)	Earth Sciences 206 (M.Elective)	Fourth GEC Science course(must	
First GEC Historical Study	Second GEC Historical Study	be a Biological Science)	
		Elective	

Appendix G. AMS Policy Statement on Bachelor of Science in Atmospheric Science

Bachelor's Degree in Atmospheric Science

(Adopted by AMS Council on 29 April 2005) *Bull. Amer. Met. Soc.*, **86**

1. Introduction

The primary purpose of this statement is to provide guidance to university faculty and administrators who are seeking to establish and maintain undergraduate programs in atmospheric science. This statement describes the minimum curricular composition, faculty size, and facility requirements recommended by the American Meteorological Society for an undergraduate degree program in atmospheric science[1]. It also provides information that may be helpful to prospective students who are exploring educational alternatives in atmospheric science. Although the focus of this statement is deliberately on curricular composition and course offerings, it must be recognized that the content, format, and methods used for teaching those courses are important factors in student outcomes and their preparedness for future careers. For example, courses with more hands-on experiences can have a considerable impact on student learning.

A contemporary academic program in atmospheric science must provide students with a fundamental background in basic atmospheric and related sciences, mathematics, and statistics. It must also provide flexibility and breadth so that students can prepare to pursue a variety of professional career paths. Along the way to their graduation, students must acquire an appropriate mix of fundamental knowledge, core competencies, and skills needed to compete and succeed in a variety of atmospheric science-related careers. While emphasizing fundamental knowledge in atmospheric science, the curriculum should also consider the fact that many of the significant problems facing the world today deal with the interaction of processes that span multiple domains in natural, physical, and mathematical sciences. Atmospheric science courses must also provide students ample opportunity for developing communication and critical thinking skills, including problem solving, reasoning, analytic and other relevant professional skills.

Computers and information technologies are now playing a central role in this complex and ever-changing world in which we live and work, with the Internet reshaping almost every aspect of life, including education and commerce. More than ever, educators, students and their future employers recognize the importance of computer literacy and information technology (IT) skills. To meet those expectations, atmospheric science programs must help students build a seamless pathway from the classroom to productive careers in atmospheric and related fields and prepare them for today's increasingly IT-driven and global society. Specifically, computer programming and other computer-related skills should be integrated, as appropriate, into as many atmospheric science courses as feasible.

Also due to the rapid advances in computer and communication technologies, students will encounter frequent and inevitable changes in the types and forms of technologies with which they will interact and the ways in which they will use them when they join the workforce. Undergraduate atmospheric science education, therefore, should also be designed to develop student talents that provide them the necessary versatility for long-term success in an evolving profession.

The program attributes listed in section 2 are those common to any career in atmospheric science. Additional coursework may be helpful for gaining entry to some specific career paths; suggestions are given in Appendix A for a few selected careers.

While many similarities exist, the curricular program described in section 2 differs from that required for employment as a meteorologist by the federal government (see Appendix B for current federal civil service requirements). Although the federal requirements provide excellent guidelines for preparation for a career in operational weather forecasting, university academic requirements are designed to support a broader spectrum of career options.

2. Attributes of bachelor's degree programs

a. General objectives

The objectives of a bachelor's degree program in atmospheric science should include strong preparation for:

1) a successful career in atmospheric science or a closely related field through a combination of in-depth education and the development of a range of relevant professional skills; *or*

2) graduate study in atmospheric and related sciences through in-depth education

and focus on critical thinking, problem solving, reasoning, and analytic and other scientific skills.

b. Course offerings

A curriculum leading to a Bachelor of Science or Bachelor of Arts degree in atmospheric science should contain

1) at least 24 semester hours[2] of credit in atmospheric science courses that include the following:

• 12 semester hours of lecture and laboratory courses, with calculus as a prerequisite or corequisite 3, in atmospheric thermodynamics and dynamic, synoptic, and mesoscale meteorology that collectively provide a broad treatment of atmospheric processes at all scales;

• 3 semester hours of atmospheric physics, with emphasis on cloud/precipitation physics and solar and terrestrial radiation[3];

• 3 semester hours of atmospheric measurements, instrumentation, or remote sensing, including both lecture and laboratory components;

• at least 3 semester hours in applied/specialty meteorology topics such as:

• advanced dynamics, agricultural meteorology, air pollution meteorology, applied climatology, aviation meteorology, broadcast meteorology, hydrology or hydrometeorology, physical oceanography, tropical meteorology, and weather forecasting;

• up to 3 semester hours of a synthesizing experience[4] such as

- an undergraduate research project
- a capstone course;
- an internship focused on a career in atmospheric science or a closely related field; or
- work experience closely related to the atmospheric sciences;

2) a minimum of a three-semester sequence of calculus that includes vector calculus and ordinary differential equations, in courses designed for majors in either mathematics, physical sciences or engineering;

3) a one-year sequence in physics lecture and laboratory courses, with calculus as a prerequisite or corequisite;

4) at least one course (3 semester hours) in chemistry appropriate for physical science majors;

5) a course with a multi-disciplinary and/or integrative approach to an environmental topic, such as a course on climate change;

6) an appropriate level of coursework or demonstrated competency in the following areas:

- computer science or information technology appropriate for physical science majors, including a course that teaches scientific, structured programming skills;
- statistics appropriate for physical science majors;
- technical, scientific, and professional writing, and oral communication;

Whenever possible and where appropriate, course requirements should include components that utilize modern computer and instrumentation labs and facilities.

As in any science curriculum, students should have the opportunity and be encouraged to supplement minimum requirements with additional course work in the major and supporting areas. This supplemental course work may include courses designed to broaden the student's perspective on the earth as a system, the environmental sciences, science administration, ethics, history of science, and policy making, as well as additional courses in the basic sciences, mathematics, statistics, and engineering. Also, students should be strongly urged to supplement their atmospheric science course work with additional courses or other activities designed to develop effective communication skills, both written and oral.

The use of computers and numerical models in the atmospheric sciences has increased dramatically in recent years. Students should be strongly encouraged to build skills in computer programming, graphic and web design, data manipulation, statistics, and numerical modeling. Students with strong backgrounds in statistics and computer science will be especially well-positioned to contribute to the advancement of the atmospheric sciences within most specialty areas.

Finally, as noted in the introduction, the curriculum described above differs from federal civil service requirements (see Appendix B). However, it is recommended that courses required to fulfill federal employment requirements-even if not required for the curriculum-be made available. Further, if the offering of such courses is not consistent with the educational objectives of the program, then the institution has an obligation to inform prospective students that the completion of their undergraduate degree will not fully qualify them for entry-level employment in federal agencies.

c. Faculty

There should be a minimum of three full-time regular faculty with expertise sufficiently broad to address the subject areas identified in item 1 in section 2b. This recommendation assumes a regular faculty teaching load of three or more courses per semester. For those departments where atmospheric science faculty are expected to carry out an active research program, it is recommended that the minimum number of departmental faculty be increased concomitant with the university's research expectations. University administrators should also bear in mind when considering the desired number of atmospheric faculty at their institution the integral role of atmospheric science in the physical and environmental sciences and the considerable potential for extramural support in the atmospheric sciences.

The faculty role should extend beyond teaching and research to include mentoring of students with diverse educational and cultural backgrounds. Departments and programs are also encouraged to emphasize increasing the diversity of their faculty, as an important and visible component of an overall commitment to diversity.

d. Facilities

There should be sufficient and coherent space for the atmospheric science program and its students. Contained within this space should be instructional labs and facilities to foster excellence in teaching and learning and to accommodate the changing needs of today's student population. Atmospheric science programs should maintain labs where real-time and archived meteorological data can be accessed through computer-based data acquisition and display systems, along with indoor and outdoor facilities suitable for teaching meteorological observation, instrumentation, and measurement techniques.

- Whenever possible, faculty should make use of modern instructional facilities, either within their department or elsewhere within the institution, that contain computerized instructional aids, internet connectivity, and appropriate projection equipment for teaching their courses. Such facilities allow faculty to use the rapidly expanding suite of multi-media offerings now available either on the World Wide Web or on CD-ROMs for teaching atmospheric science courses.

To support the courses in section 2b, the atmospheric science program should provide students with appropriate tools, applications software, and simple or idealized computer models suitable for learning about dynamical and physical processes in the atmosphere.

e. Student recruitment and retention

The number of students from traditionally underrepresented groups in the atmospheric sciences continues to be alarmingly low. Ideally, atmospheric science programs should reflect the full diversity of the general population. To that end, atmospheric science programs should work with their institutions, community colleges, and secondary schools to develop resources and procedures that support recruitment and retention of diverse students. Programs should nurture and promote an academic culture that is deeply supportive of and committed to diversity. Efforts aimed at increasing the participation of traditionally under-represented students in the atmospheric sciences, such as identification and implementation of best practices and procedures that most successfully result in achieving the diversity goals, should become a continuing priority.

Appendix A: Preparation for selected careers in atmospheric science

This section provides advice about additional courses that could be useful for those students who wish to pursue a specific career path in atmospheric science. The careers listed cover only a small fraction of the professional employment opportunities in atmospheric science. Since this statement is concerned with the bachelor's degree and students already have many course requirements, only a few additional courses are listed per career. It is not intended to be an exhaustive list of all courses that could be useful for a particular career.

Students should keep in mind that many of the suggested courses may have prerequisites that are not listed here and that may vary from institution to institution.

As a general rule, performing an internship in the area of interest and/or completion of an undergraduate research project on a topic in the area are excellent complements to the additional courses listed here and fulfill the recommended synthesizing experience listed under item 2b.

a. Weather forecasting careers

Students intending to enter this career field should consider including the following course work or types of experiences in their program of study:

1) three courses in synoptic and mesoscale meteorology, to include an introduction to numerical weather prediction (these courses would include courses recommended in basic requirements under item 1 of section 2b);

2) a course in operational weather analysis and forecasting techniques that includes a laboratory component; and

3) a remote sensing course in either satellite or radar meteorology that includes a laboratory component (such a course would also meet the basic requirements under item 1 of section 2b).

b. Media careers, including those in Broadcast Meteorology

Students intending to enter this career field should consider including the following course work or types of experiences in their program of study:

1) a course in operational weather analysis and forecasting techniques;

2) one or more courses in communication, journalism, writing, and speech; and

3) one or more courses in publishing or broadcast media and broadcasting.

- In addition, students pursuing a Broadcast Meteorology career track should become familiar with the requirements and procedures for gaining certification, such as the American Meteorology Society's Certified Broadcast Meteorologist program.

c. Hydrometeorology careers

Students intending to enter this career field should consider including the following course work or types of experiences in their program of study:

1) a course in hydrology, fluid mechanics or fluid dynamics;

2) a course in hydrometeorology or precipitation processes;

3) a course in radar meteorology that includes radar observations of meteorological phenomena; and

4) a course in Geographic Information Systems.

d. Environmental monitoring careers

Students intending to enter this career field should consider including a select subset of the following course work or types of experiences in their program of study:

1) an additional chemistry course (in most schools this course would be a continuation of the course used to meet the requirement for a chemistry course in item 4 of section 2b);

2) a course in atmospheric or environmental chemistry;

3) a course in atmospheric turbulence, micrometeorology, or boundary layer meteorology;

4) an air pollution meteorology course having courses such as items 2 and 3 above as prerequisites;

5) a course involving dispersion analysis and the use of air quality models;

6) a course in climate change or climatology; and/or

7) a course in earth-system science, biometeorology, or oceanography.

e. Careers in Support of Transportation, including Aviation Meteorology

Students intending to enter this career field should consider including the following course work or types of experiences in their program of study:

1) a course in fluid mechanics;

2) a course in aviation meteorology, including a basic understanding of turbulence and aircraft icing;

3) a course in weather analysis and forecasting;

4) a course in weather information systems or aircraft systems and instruments; and

5) an additional course in advanced thermodynamics or physical meteorology.

f. Business-related careers

Students intending to have a career in private sector or commercial meteorology should consider the following coursework:

- a course in economics;

- a course in marketing;
- a course in organization principles and management;
- a course in information systems;
- either a course in organizational behavior and human behavior, or one in entrepreneurship or small business management; and
- a course in strategic planning, program evaluation, or budget formulation and execution.

g. Preparation for graduate studies and research positions

Students intending to continue their academic careers with a graduate degree (MS or PhD) before pursuing a career should consider including the following course work or types of experiences in their program of study:

1) additional mathematics courses, such as advanced calculus, partial differential equations, and linear algebra;

2) additional atmospheric science courses in dynamics, physical meteorology, mesoscale and synoptic meteorology, climate change, or remote sensing;

3) a course in numerical methods or computational fluid dynamics;

4) a course in statistics and probability theory; and

5) additional scientific computer programming courses. It should be noted that FORTRAN continues to be the preferred programming language for developing many atmospheric science applications, including numerical modeling and data assimilation.

h. K-12 teaching careers

Students intending to enter the teaching profession should consider elective coursework related to their chosen area of specialization, which might include earth science, physical science, general science, or mathematics. Students may pursue provisional middle- or high-school teaching certification with the BS degree in Atmospheric Sciences, as determined by state education rules. Students could include the following coursework or types of experiences in their program of study:

- Educational foundations, theory, and practice; educational psychology

(appropriate for level, following state guidelines)

- General Science: coursework in Biology and expanded coursework in Chemistry, Geoscience, and/or Physics

- Earth Science: additional coursework in geology, hydrology, oceanography, and astronomy

- Physical Science: additional coursework in chemistry, physics, and astronomy

- Mathematics: additional coursework in mathematics such as geometry, logic, linear algebra

i. Military Weather Officer careers

Military Weather Officers initially work in forecast intensive assignments, then enter a graduate school MS program and work in more management and leadership roles in the later stages of their military career. Students intending to enter the military, as an Air Force Weather Officer or Navy Meteorology and Oceanography (METOC) Officer, should consider including some of the course work outlined in section a. (Weather forecasting careers) and section i. (Preparation for graduate studies and research positions) in their program of study. A course in Physical Oceanography would be helpful for those students most interested in the Navy METOC program.

Appendix B: Federal civil service requirements for meteorologist positions (GS

1340, effective 1 March 1998)

The requirements for federal employment as a meteorologist are given below. To meet these requirements, students should ensure that the 12 credits of course work in atmospheric thermodynamics and dynamics and weather analysis and forecasting recommended in section 2 of this statement include six semester hours of dynamic meteorology and six semester hours of weather analysis and forecasting.

A. A degree in meteorology, atmospheric science, or other natural science major that includes the following:

1) At least 24 semester hours (36 quarter hours) of credit in meteorology/atmospheric science, including a minimum of

a) 6 semester hours in atmospheric dynamics and thermodynamics[5],

b) 6 semester hours in analysis and prediction of weather systems (synoptic/mesoscale),

c) 3 semester hours of physical meteorology, and

d) 2 semester hours of remote sensing of the atmosphere and/or instrumentation;

2) 6 semester hours of physics, with at least one course that includes laboratory session[5];

3) 3 semester hours of ordinary differential equations[5]; and

4) at least 9 semester hours of course work for a physical science major in any combination of three or more of the following: physical hydrology, chemistry, physical oceanography, physical climatology, radiative transfer, aeronomy, advanced thermodynamics, advanced electricity and magnetism, statistics, light and optics, and computer science.

Or

B. A combination of education and experience-course work shown in A above, plus appropriate experience or additional education.

1 For the purposes of this document, the terms "atmospheric science" and "meteorology" are taken to be equivalent.

2 Some institutions use a quarter system rather than the semester system.

Normally, two semester hours equates to three quarter hours. In some cases, the recommended credits in section 2b may convert to noninteger numbers of quarter hours. In such cases, the institutions may combine a course with an appropriate portion of another course to meet the recommendation.

3 There is a prerequisite or corequisite of calculus for course work in atmospheric dynamics and thermodynamics, physics, and differential equations. Calculus courses must be appropriate for a physical science major. The preferred sequence of courses is for students to enroll in atmospheric thermodynamics and dynamics courses after completing at least two semesters of calculus.

4 This requirement is assigned a range of credit hours (i.e., 0-3 credits) in acknowledgement that many cooperative and internship experiences, such as the NWS Student Career or Temporary Employment Programs that offer participants work experience directly related to their academic field of study, are salaried and consequently at most colleges and universities students cannot earn credit hours for these synthesizing and capstone work experiences.

5 There is a prerequisite or corequisite of calculus for course work in atmospheric dynamics and thermodynamics, physics, and differential equations. Calculus courses must be appropriate for a physical science major.

Appendix H
Syllabi for Courses in the proposed Atmospheric Sciences Major

(Syllabi start on the next page.)

Course Syllabus

Atmospheric Sciences 230: Basic Meteorology
Class Meetings: MTWRF 12:30-1:18 pm.
Classroom: Derby Hall 1080

Instructor: Jay Hobgood
Office: Room 1100 Derby Hall
Office phone: 292-3999
Office hours: by appointment
Email: hobgood.1@osu.edu

Course Prerequisites: Math 152 and Physics 132

Course Objectives: The basic objective of this course is to introduce students to the fundamentals of meteorology. Students will be introduced to the physical laws that form the basis for our understanding of atmospheric processes. The physical processes will be integrated to explain basic atmospheric phenomena. Knowledge of the physical laws and their applications to meteorology will facilitate students' comprehension of meteorological processes that determine the weather. The increased comprehension of important physical processes will improve students' ability to analyze and to forecast the state of the atmosphere. It will enable students to understand more clearly atmospheric phenomena on many temporal and spatial scales.

Course Structure: The class will meet five days per week for 48 minutes each day. Lectures during the classes will present material on thermodynamic processes and their application to atmospheric situations. Important equations will be derived and the implications of assumptions will be discussed. Examples of meteorological problems will be discussed. Homework problems that involve the application of material introduced in class will also be assigned and discussed in class.

Textbook: C. Donald Ahrens, *Meteorology Today: An Introduction to Weather, Climate And the Environment,* 8th edition, Thompson Brooks/Cole.

Course requirements:

1. The **first examination** will occur on **April 15, 2008** and will comprise 20% of the course grade.

2. The **second examination** will occur on **May 13, 2008** and will comprise 20% of the course grade.

3. The **final examination** will occur at 11:30-1:18 on **Monday June 2, 2008** and will comprise 25% of the course grade.

4. Sets of **problems** will be assigned in class and will comprise 20% of the final grade.

5. A **book review**, that is not a review of a textbook, on some aspect of meteorology. The book review should be between two and five double-spaced pages in length and is due in its final form on **Friday May 23, 2008.** The book review will comprise 10% of the final grade.

6. A **review** of one of the presentations given at the 12th Ohio Severe Weather Symposium that is to be held in the Fawcett Center on April 11, 2008. The symposium review should be between two and five double spaced pages in length. The final draft of the review is due on **Tuesday May 6, 2008.** The review of a symposium presentation will comprise 5% of the final grade.

Examination format: Each examination will begin with a series of terms to define in one or two sentences. You will have a choice of which terms you choose to define. The remainder of the examination will consist of short answer questions, short essay questions that you can answer with a few sentences and problems like the problems that will be assigned as homework. The examinations are designed to test your comprehension and understanding of the material, as well as your ability to recall basic meteorological principles.

Homework assignments: The homework assignments are designed to accomplish several goals. The first goal is to give students some experience solving basic meteorological problems using concepts introduced in class. A second goal is to make students think about the physical processes that occur in certain atmospheric phenomena. More challenging problems may require students to combine physical principles in order to arrive at the solution to the problem. Some problems will be similar to the tasks require of operational meteorologists. Other problems will deal with fundamental principles and calculations that are used to develop meteorological models and software. Homework assignments are expected to be the work of the student whose name appears on them. Copying another student's work is *plagiarism* and is considered to be *academic misconduct.*

Units: Numerical answers are incomplete unless they are accompanied by the correct units. Students will lose points on examinations and homework assignments if the units are incorrect or missing.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

List of Topics

Part I: Introduction (0.5 weeks)
(Chapter 1)

Part II: Radiation and the Energy Balance (1 week)
(Chapter 2)

Part III: Atmospheric Temperature (1 week)
(Chapter 3)

Part IV: Atmospheric Thermodynamics (1 week)
(Chapter 7)

Part V: Clouds and Precipitation (1.5 weeks)
(Chapters 5, 6 and 8)

Part VI: Atmospheric Dynamics (1 week)
(Chapters 9, 10, and 11)

Part VII: Air Masses, Fronts and the Extratropical Cyclone (1 week)
(Chapters 12 and 13)

Part VIII: Thunderstorms, Tornadoes and Hurricanes (1 week)
(Chapters 15 and 16)

Part IX: Weather Forecasting (1 week)
(Chapter 14)

Part X: Climate and Climate Change (1 week)
(Chapters 17, 18 and 19)

Review of a Symposium Presentation

On April 11, 2008 the Meteorology Club will host the 12th Annual Ohio Severe Weather Symposium. Additional materials on the schedule and a list of Speakers at the symposium will be given out in class. I encourage you to attend as many of the presentations as you can because many of the speakers are experts in their field. Class will not meet at that day in order for you to be able to attend the symposium. In your review I want you to summarize the presentation and to include your own opinions about the effectiveness of the presentation. You will have only had two weeks of meteorology by the date of the symposium and I don't expect to be able to understand complex theories that we have not yet discussed in class. However, the presentations should be sufficiently general so that you can understand most of the material. In your review you should:

1. Summarize the main points made by the speaker.

2. Discuss your ability or inability to understand the points the speaker was trying to make.

3. Discuss the overall effectiveness of the presentation including the reaction of the the audience listening to the talk.

In order to help you write the review, you are welcome to give me a first draft of your review by April 21, 2008. I will return the review with my comments to you in class on Thursday April 24, 2008. The final draft of the review is due on Tuesday May 6, 2008.

Book Review

You should review a book on some aspect about meteorology that is not a textbook. You will enjoy writing the review much more if you choose a book on an aspect of meteorology that interests you. I will supply you with some examples of different styles of book reviews that have been published in the *Bulletin of the American Meteorological Society.* You cannot choose to review a book that is reviewed in one of the samples given out in class. In the book review you should:

1. Summarize the contents of the book.

2. Discuss the ease or difficulty you had in reading the book.

3. Discuss whether or not you would recommend the book to other meteorology students and give your reasons for the recommendation.

In order to help you write the review, you are welcome to give me a first draft by May 16, 2008. I will return the review with my comments to you in class on Tuesday May 20, 2008. The final draft of the review is due on Friday May 23, 2008.

GEOG 520, CLIMATOLOGY

Spring Quarter 2008, 5 credits, call number: 10196
M-W-F 10:30 AM - 11:48 AM, Derby Hall, Rm. 1080

Instructor: Prof. Jialin Lin
Email: lin.789@osu.edu This is the best way to reach me.
Telephone: 614-292-6634
Office: 1105 Derby Hall
Office Hours: Wednesday and Friday 4:00-5:00 PM, or by appointment

Teaching Assistant: Mike Davis
Email: davis.2425@osu.edu
Telephone: 292-1333
Office: Derby Hall 0135
Office Hours: Tuesday and Thursday 12:30-1:30 PM

Textbook: "Understanding Weather and Climate" (4th ed.) by E. Aguado and J. Burt (published by Prentice Hall).
(has been ordered in the Central Classroom Building bookstore)

Course Objectives:

This course is designed to provide a broad introduction to *climatology*, the study of the average state of weather on planet Earth. Emphasis is made of planetary energy budgets, regional climates, climate change, and past and future climates. Energy budgets include the solar energy receipt, infrared radiation loss, turbulent heat fluxes, and the redistribution in the earth-atmosphere system as well as the role of atmospheric moisture, its global spatial distribution, and its importance in energy exchange, and cloud and precipitation formation. Course lectures will describe the causes, and the spatial distribution, of climates of the world as well as the physical mechanisms of some observed weather phenomena. The physical causes of and spatial variations in small- and large-scale motions of the atmosphere will be described. The distribution and causes of 21st century climate will be explained and the distributions of past climates, methods for reconstructing them, and the potential explanations for them will be discussed. The course will also consider how humankind has both intentionally and unintentionally become a factor in the physical processes of weather and climate. Many students will find the basic concepts and ideas discussed in the course will have applications in their fields of interest as well as applications to their daily lives.

Upon successful completion of this course, students should (1) be able to describe the structure and composition of the atmosphere and how it has changed with time; (2)

know the factors causing solar radiant energy variations on earth and be able to describe global radiation balance; (3) be able to explain the physical processes leading to the formation of atmospheric features including clouds, precipitation, winds and storms; (4) have a good understanding of the physical behavior of gases, and of the different forms of energy and their role in atmospheric motion and weather systems; (5) have a good understanding of environmental issues pertaining to the atmosphere including the "greenhouse effect", ozone depletion, air pollution and urban climate modification; and (6) be able to describe the general distribution on the world of temperature, precipitation and climates - and the factors and physical mechanisms which cause these distributions to occur as they do.

Methods for accomplishing these objectives:

The objectives of the course will be accomplished through the lectures, homeworks/assignments, in-class presentations, and examinations. The lectures will include some material not covered in the textbook and may incorporate math to the level of algebra. Determination of your grade will be as follows:

Homeworks or in-class assignments/quizzes
(one per week – 7 total – will drop your worst score) 35%
One in-class presentation (10 minutes) 10%
Attendance, professionalism, and active participation 10%
Two midterms and one final exam
(3 total – will drop your worst exam score) 45%

- This means each midterm is worth 22.5% of your grade. If you do well on both, you can skip the final exam! The midterms will cover only the recent material, while the final will be comprehensive. All exams will be multiple-choice (50 questions for each exam).

The grading scale is as follows: 100-93% A, 92-90% A-, 89-87% B+, 86-83% B, 82-80% B-, 79-77% C+, 76-73% C, 72-70% C-, 69-67% D+, 66-63% D, 62-60% D-, 59% and below E.

Please take note that a large portion of the materials that appear on the midterm and final exams will be covered in lecture only. Therefore, *you are strongly encouraged to attend all classes or your final grade will suffer*. The grading policy is very forgiving: the lowest scores on both the homeworks/assignments and exams will be dropped when calculating your final grade. Therefore, no make-up exam will be given. Proof of a medical problem is necessary to excuse an absence on an examination date. The paper may not be handed in late. The in-class presentation can be on *any topics that you are interested in* and are related to weather, climate or climate change, which is designed to encourage you to surf the climate-related websites and do your own research. Attendance is required for all in-class presentations and will count for 10% of your final grade (can improve your grade from C to B or from B to A!). **If you attend all classes and finish all the homeworks/assignments, you will likely do well on the exams.** Lecture notes will be posted on the course website.

Academic Misconduct It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

Cell Phones Like on airplanes, interfere with navigation of the course, therefore, cell phones and pagers must be turned *OFF* during class as they interfere with the navigation of the course.

Some Tips for Doing Well:

1. Attend classes – 55% of your grade is based on in-class assignments and attendance/professionalism/participation.
2. Actively participate in the in-class presentations and discussions.
3. Check the course website frequently for updates.
4. Have fun.

Final Exam: June 4, 9:30-11:18am

The schedule may change, probably only slightly, as the class evolves. Instructor will alert students if/when schedule changes.

Course website **http://lightning.sbs.ohio-state.edu/geo520/index.htm**

COURSE LECTURE OUTLINE

Date LECTURE (click the title of each lecture to download the powerpoint file)
03/24 Atmospheric Sciences at a Glance I
03/26 Atmospheric Sciences at a Glance II
03/28 In-class assignment I: Ice Man – The story of Lonnie Thompson

03/31 Composition and Structure of the Atmosphere
04/02 Global Energy Balance I: Solar Radiation and the Seasons
04/04 In-class assignment II: Mitigation of global warming

04/07 Global Energy Balance II: Greenhouse Effect
04/09 Atmosphere Pressure and Winds
04/11 In-class assignment III: The magic of water vapor

04/14 Midterm I Review
04/16 MIDTERM I
04/18 Preparation of in-class presentation

04/21 General Circulation of the Atmosphere and Oceans
04/23 Global Water Cycle I: Clouds and Fogs
HW#1: Find and plot climate datasets on the web
04/25 In-class presentation

04/28 Global Water Cycle II: Precipitation Processes
04/30 Global Water Cycle III: Organized Precipitation Systems (from hurricanes to tornadoes)
HW#2: Data collocation-Rainfall associated with major floods in U.S.
05/02 In-class presentation

05/05 Midterm II Review
05/07 MIDTERM II
05/09 In-class presentation

05/12 Tropical and Extratropical Climate
05/14 Modeling and Predicting the Global Climate System
HW#3: Forecasting the global impacts of El Nino/Southern Oscillation in 2008
05/16 In-class presentation

05/19 Global Climate Change I: Observed Climate Change
05/21 Global Climate Change II: Projections and Impacts
HW#4: Exploring the simulations of a global climate system model used for IPCC climate change projections
05/23 In-class presentation (current grades)

05/26 NO CLASS – Memorial Day
05/28 Final Exam Review
05/30 In-class presentation

06/02 NO CLASS (Final exam week)
06/04 **FINAL EXAM, 9:30-11:18am**

Some climate-related websites:

NASA's earth missions:
http://science.hq.nasa.gov/missions/earth.html

NOAA Watch – NOAA's All Hazard Monitor:
http://www.noaawatch.gov/

El Nino Theme Page:
http://www.pmel.noaa.gov/tao/elnino/nino-home.html

Hurricane Katrina
http://www.katrina.noaa.gov/

Intergovermental Panel on Climate Change (IPCC- 2007 Nobel Peace Prize Winner):
http://www.ipcc.ch/

Climate TimeLine (Exploring weather & climate change through the powers of 10):
http://www.ngdc.noaa.gov/paleo/ctl/

Course Syllabus

Atmospheric Sciences 620: Synoptic Meteorology Laboratory
Class Meetings: MW 2:30-3:48 am.
Classroom: Derby Hall 0140.

Instructor: Jay Hobgood
Office: Room 1100 Derby Hall
Office phone: 292-3999
Office hours: by appointment
Email: hobgood.1@osu.edu

Course Prerequisites: Concurrent Geography 520 or Atmospheric Sciences 230.

Note: This course is a prerequisite for Geography 623.01.

Course Objectives: the objectives of this course are to introduce students to the basic meteorological variables, the methods by which they are measured, and the techniques by which observations are gathered, analyzed and displayed for use in applications to weather forecasting. The specific aims of this course are to introduce: (1) the Automated Surface Observing System (ASOS), (2) the METAR code used to transmit the surface airways observations, (3) the rawinsonde, (4) the code used to transmit upper air observations, (5) methods of plotting surface and upper air observations, (6) the types of meteorological satellites, sensors, and imagery, (7) the characteristics and products of the WSR-88D weather radar, (8) standard techniques for the plotting and analysis of surface and upper air data, (9) the SKEWT thermodynamic diagram, (10) characteristics of meteorological models, (11) output from numerical models and (12) supplemental forecast products.

Course Structure: The class will meet for two days per week for 78 minutes each meeting. Material will be presented during the class that fulfills the basic course aims and objectives (see above). The course is divided into 12 topics that focus on data, analyses and graphics that convey vital information on the state of the atmosphere and which are needed to forecast accurately the future state of the atmosphere. A brief outline of the topics is given later in this syllabus. A heavy emphasis is placed on analysis of synoptic charts and diagrams and on a "hands on" learning of the analytical techniques. Much of the work in this course is therefore devoted to *individual* laboratory work and analysis of weather maps and charts.

Note: The National Weather Service undergoes a continual process of modernization and upgrades. The changes that occur as a result of the modernization and upgrades make obsolete many of the printed materials with technical information about the acquisition and dissemination of synoptic weather data. Any textbook on this material would be out of date before it appeared in print. Because of the ongoing and continual process of modernization supplemental material will be posted on the course web page and links to appropriate sources of online documentation will be provided.

Course requirements: Your grade in this course will be determined by two examinations and sets of homework problems.

1. The **first examination** will occur on **October 29, 2007** and it will comprise 35% of your final grade.

2. The *comprehensive* **final examination** will occur from **11:30-1:18 pm** on **Thursday December 6, 2007** and it will comprise 40% of your final grade.

3. The **homework assignments** will be distributed in class and will comprise 25% of your final grade.

Examination format: The questions on the examinations will represent a mixture of formats. The examinations will begin with a series of terms to define in one or two sentences. Some questions will be short answer (e.g. multiple choice, true/false, fill in the blank). Some questions may require short essays to answer them completely. Some questions will require the proper decoding of surface and upper air codes. Some questions will require the proper analysis of synoptic maps and charts. The examinations are designed to test your comprehension and understanding of the material, as well as your ability to recall specific information.

Homework assignments: The homework assignments are designed to accomplish several goals. The primary goal of the assignments is to give students practice with basic types of synoptic analyses. A second goal is to get students to think about the analyses in relationship to the atmospheric features and processes they have learned about in other courses. A third goal is to get student more familiar with information and sources of data online and to provide them with the opportunity to learn more about specific topics. Homework assignments are expected to be the work of the student whose name appears on them. Copying another student's work is *plagiarism* and is considered to be *academic misconduct*.

Units: Numerical answers are incomplete unless they are accompanied by the correct units. Students will lose points on examinations and homework assignments if the units are incorrect or are missing.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of students academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee

(Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the office for Disability Services will be appropriately accommodated, and should identify the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; **http://www.ods.ohio-state.edu/**.

Outline of Topics

1. The Automated Surface Observing System (ASOS), instruments and characteristics.

2. The METAR code, decoding surface airways observations, plotting the surface station model.

3. The rawinsonde, instruments and characteristics.

4. Decoding the upper air observations.

5. Basic plotting of surface and upper air observations.

6. Satellite types, sensors and imagery.

7. The WSR-88D weather radar, characteristics and products.

8. Analysis of surface maps, locating fronts, analysis of upper levels maps, locating warm and cold advection, advection of moist and dry air, vorticity, jet streams.

9. The SKEWT thermodynamic diagram, plotting vertical soundings, using the SKEWT diagram to determine certain stability parameters.

10. Characteristics of numerical models, types of models, horizontal and vertical resolution.

11. Output from numerical models.

12. Supplemental forecast products.

Geography 622.01: Boundary Layer Meteorology
Winter Quarter 2008, 5 credits, call number: 10114-1
M-W-F 1:30-2:48 PM, Derby Hall 1080

Instructor: Dr. Jason Box **Email:** box.11 [at] osu.edu **Telephone:** 247-6899 **Office:** 1148 Derby Hall **Office hours**: Monday and Wednesday 3-4 PM, or by appointment **Lab (0140) Door Code**: *see instructor* **LAB PC Login:** *see instructor*

Required Textbook: Arya, S. P. S., 2001: Micrometeorology, Academic Press, 2nd Ed., 307 pp., ISBN 0-12-059354-8

Recommended Textbooks (in order of importance to this course):

Oke, T.R., 1987: Boundary Layer Climates, 2nd Ed., Methuen, London, 435 pp, ISBN 0-415-04319-0

Stull, R. B., 1988: An Introduction to Boundary Layer Meteorology, Kluwer Publishers, 666 pp., ISBN: 9027727686

Garratt, J. R., 1992: The Atmospheric Boundary Layer. Cambridge University Press, 316 pp., ISBN 0521467454

Course Description and Goals: The surface boundary layer is the part of the atmosphere directly or indirectly affected by energetic interactions between the surface, the sub-surface, the overlying atmosphere, the sun, and space. Humans rarely exit the surface boundary layer. Meanwhile, atmospheric particulate matter (including pollutants) are concentrated near the surface and diffuse into the surface boundary layer and upper atmosphere by turbulence. The intensity of turbulent transfer is regulated by daily and seasonal cycles of surface net radiative heating (absorbed solar minus net vertical infrared flux), depending on surface properties, latitude, time of year, and regional to atmospheric motion driven by regional and planetary-scale horizontal pressure gradients, topography, and baroclinicity. Large scale atmospheric motions are largely attributable to surface energy exchanges. Students will gain the conceptual framework necessary for an understanding of surface atmosphere interactions and their effects on weather development and human livelihoods and related economic systems, including agriculture and building heating/cooling.

Course Expectations: Students are expected to meet course prerequisites which include a working knowledge of algebra, calculus (Math 152, i.e., at least Calculus 1) and physics (at least Newtonian. An understanding of electromagnetic radiation is very useful. You are strongly recommended to have already taken atmospheric thermodynamics. If you feel deficient in any of the aforementioned areas, you should consider taking this course after some of the aforementioned studies or study off-line to mitigate deficiencies. Your grade is

based on a midterm/final (comprehensive) exams and homework exercises. There will 8 homework exercises. Homework will incorporate computer-based exercises. Assignments may not be handed in late, and exams and assignments may not be made-up without instructor consent. Material covered in the exercises and exams will come from assigned readings and supplemental material introduced only during lecture. Note that it is necessary to keep up on reading. Be on time for class. Coming in late is disruptive and disrespectful to both students and instructor.

Disability Services: Students with disabilities that have been certified by the office for Disability Services will be appropriately accommodated, and should identify the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; **http://www.ods.ohio-state.edu/**.

Attendance: Certain materials that appear on the midterm and final exams will be covered in lecture only.

Cell phones and pagers are to be turned off during class, just like at the movies and on commercial aircraft.

Class Participation Please feel comfortable asking questions or commenting on the course material. Being active in class participation is to your advantage and may improve your final grade if you end up borderline between grades.

Grading: Your final grade will be based on 500 points. Three exams totaling 260 points are worth 80, 80, and 100 points, respectively.210 points are comprised of 8 exercises that are either in take-home or quiz format. The lowest exercise grade is dropped. A 30 pointcourse participation/professionalism grade includes occasional attendance surveys. The grading scale is as follows: 100-93% A, 92-90%A-, 89-87% B+, 86-83% B, 82-80% B-, 79-77% C+, 76-73% C, 72-70% C-, 69-67% D+, 66-63% D, 62-60% D-, 59% and below E.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of students academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Extra Credit No extra credit assignments are planned.

Major Relevant Texts

Arya, S. P. S., 1988: Micrometeorology, Academic Press, 307 pp., ISBN 0-12-059354-8 a very accessible advanced undergrad introduction to the subject, mostly focusing on surface layer.
micrometeorology

Brutsaert, W., 1988: Evaporation into the Atmosphere, ISBN 90-277-1247-6 an excellent reference for boundary layer physics related to the processes of surface water vapor exchanges.

micrometeorology

Garratt, J. R., 1992: The Atmospheric Boundary Layer. Cambridge University Press, 316 pp., ISBN 0521467454
Contains a list of other relevant books at the end of the first chapter, including historically important texts.

micrometeorology

Geiger, R., 1965: The Climate Near the Ground, Harvard University Press Kaimal, J. C. , J. J. Finnigan, 1994: Atmospheric Boundary Layer Flows: Their Structure and Measurement, Oxford University Press, 304 pp., ISBN 0195062396
micrometeorology

Monteith J. L., Unsworth, M.H., 1990: Principles of Environmental Physics, Edward Arnold Publisher, 2nd Ed., 291 pp., ASIN: 0713129816

Munn, R. E., 1966: Descriptive Micrometeorology, Academic Press, ISBN: 1124119973

Oke, T.R., 1987: Boundary Layer Climates, 2nd Ed., Methuen, London, 435 pp, ISBN 0-415-04319-0

microclimatology

Sorbjan, Z., 1989: Structure of the Atmospheric Boundary Layer. Prentice-Hall, 317 pp., ISBN: 0138535574

micrometeorology

Stull, R. B., 1988: An Introduction to Boundary Layer Meteorology, Kluwer Publishers, 666 pp., ISBN: 9027727686 idiosyncratic discussion of physics, but nice discussion of the methods, observational and computational tools used in boundary layer meteorology

micrometeorology

Click for Course Schedule

Geography 622.02: Microclimatological Field Methods and Data Analysis
5 credits, call number: 10302-1

When: M-W-F 4:30-6:15 PM
Where: Derby Hall 0140
Instructor: Dr. Jason E. Box
Email: box.11@osu.edu
Telephone: 247-6877
Office: 1148 Derby Hall
Office hours: M, W, 3-4 PM, or by appointment

Course Description and Goals: This course is designed to apply knowledge gained in 622.01 (Boundary Layer Meteorology), and experience the 'real-world' of instrumented field observations. Development of useful data products from the original data is an important goal. Small-scale (micro) meteorological instrumentation, experimental design, electronics, computer-aided data analysis, and logistics techniques are taught from a practical and introductory perspective.

Course Expectations: Exercise and improve attention to detail. Participate in course discussion and field logistics (25% of grade). Develop computer programming skills. Develop and maintain a highly detailed and organized 'field book' (15% of grade). This course includes outdoor experiments, at least one overnight, to exercise logistics skills in field-based data acquisition. A final report evaluates results from surface energy budget studies. Course projects require writing programs to plot and analyze data using the IDL language.

Books: No text book is required, however, Arya (2001)* from 622.01 and Oke (1987) are very useful.
* useful textbooks are listed at end of this document.

Field Experiments: Three field experiments are planned; 1) instrument calibration; 2) radiation balance, and 3) surface energy budget. Our field site is either the roof of Denny hall or the OSU airport .

Grading 25% class participation
30% course projects
15% field book
10% presentation
20% final report

Late assignments are accepted with valid excuse.

Prerequisites: 622.01 or equivalent microclimatology course, thermodynamics.

Attendance is critical to success in this course.

Class Participation is a significant fraction of your grade and involves:

- asking questions
- engaging in the logistics of field experiments
- taking turns in leadership roles

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

Useful Text Books (key texts in *italics*)

- *Arya, S. P. S., 1988: Micrometeorology, Academic Press, 307 pp., ISBN 0-12-059354-8*
    - *an accessible advanced undergrad introduction to the subject, mostly focusing on surface layer.*
    - *micrometeorology*
- Brutsaert, W., 1988: Evaporation into the Atmosphere, ISBN 90-277-1247-6
    - an excellent reference for boundary layer physics related to the processes of surface water vapor exchanges.
    - micrometeorology
- Garratt, J. R., 1992: The Atmospheric Boundary Layer. Cambridge University Press, 316 pp., ISBN 0521467454
    - Contains a list of other relevant books at the end of the first chapter, including historically important texts.
    - Micrometeorology

• Geiger, R., 2003: The Climate Near the Ground, Rowman & Littlefield Publishers, Inc.; 6th edition (July, 2003), 600 pp. ISBN 0742518574

• Kaimal, J. C. , J. J. Finnigan, 1994: Atmospheric Boundary Layer Flows: Their Structure and Measurement, Oxford University Press, 304 pp., ISBN 0195062396

  o micrometeorology

• Monteith J. L., Unsworth, M.H., 1990: Principles of Environmental Physics, Edward Arnold Publisher, 2nd Ed., 291 pp., ASIN: 0713129816

• Munn, R. E., 1966: Descriptive Micrometeorology, Academic Press, ISBN 1124119973

• *Oke, T.R., 1987: Boundary Layer Climates, 2nd Ed., Methuen, London, 435 pp, ISBN 0-415-04319-0*

  o *microclimatology*

• Sorbjan, Z., 1989: Structure of the Atmospheric Boundary Layer. Prentice-Hall, 317 pp., ISBN 0138535574

  o micrometeorology

• Stull, R. B., 1988: An Introduction to Boundary Layer Meteorology, Kluwer Publishers, 666 pp., ISBN 9027727686

  o idiosyncratic discussion of physics, but nice discussion of the methods, observational and computational tools used in boundary layer meteorology

  o micrometeorology

Schedule

See: http://geog-www.sbs.ohio-state.edu/courses/G622.02/Doc/schedule.htm

GEOGRAPHY 623.01
SYNOPTIC ANALYSIS AND WEATHER FORECASTING
WINTER 2008

Instructor: Dr Jeff Rogers Office: Derby Hall 1048
Phone: 292-0148 Office Hours: M, T, W 12:00-1:30 p.m.
e-mail: rogers.21@osu.edu or by appointment

Prerequisites: Geography 520, Geography 620, Math 152, Physics 132.
Course Website: http://carmen.osu.edu Class computer login: G623 pass: G623WI08

Course Objectives: The primary objective of this course is to serve as an introduction to the fundamentals of, and techniques involved in, synoptic-scale analysis of winter storms and the forecasting of their weather. Discussion of the fundamentals of weather forecasting includes understanding the physical models available to analyze synoptic-scale weather patterns, evaluation of the physical processes that create temperature change, vertical motions, precipitation, and those processes that lead to cyclones and fronts, causing them to evolve and produce weather. Techniques of synoptic weather analysis revolve around weather maps and methods used to analyze them in order to make to predict horizontal and vertical motions and make weather forecasts. Analysis of forecast output will be evaluated in order to compare precipitation and vertical motion forecasts among different models. Students will acquire the skills needed to make competitive weather forecasts and will learn to develop and present weather synopsis discussions.

Upon successful completion of the course, students will be able to use synoptic weather charts and numerical forecasting products, along with knowledge gained in the course, in order to make forecasts of temperature, precipitation and other meteorological conditions for 1-2 days in advance. You will have a good understanding of the conceptual models of wave cyclones, including those of their structure and evolution, and you will be able to explain the role of various physical processes, such as PVA, thermal advection, atmospheric stability, and diabatic heating, in the development and evolution of mid-latitude wave cyclones.

Your total grade (100%) will be determined as follows:
Mid-term exam: one-third of grade
Final Exam: one third of grade
Assignments: one-third of grade
The assignment grade will include:
1. Take-home assignments, including possible term projects.
2. Small point value in-class analyses, assigned and due at the end of each class (no make-ups)
3. Oral weather discussions in which you prepare and lead a class analysis of the day’s wx.

4. Assignments involving weather forecasts will occur over an extended period of time and will be issued 3 or 4 days a week. Forecasts will be issued for the same city locations being used simultaneously in the University of Oklahoma National Weather Challenge (to be announced).
Assignments must be done individually unless it is announced that the assignment is a group effort. Proof of a medical problem is necessary to excuse an absence on an exam day. There is no class on Monday January 21, 2008.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

Winter 2008 Synoptic Meteorology Topics

Introductory Topics: Geographic factors affecting North American Weather; Scales of atmospheric motion and the equations of motion; The Geostrophic wind and Gradient wind approximations; Rossby waves, upper air weather features, and weather spells; Streamlines and Trajectories.

Conceptual physical models of atmospheric storm systems: The classical Norwegian Cyclone Model. The Plains cyclone model and its main component: the cold front aloft; Conveyor belts and split fronts; The baroclinic wave instability theory model.

Thermal Characteristics of the Atmosphere: Temperature Forecasting: A short history of weather forecasting. Air masses, Air mass modification; Potential temperature and isentropic analysis; Thermal advection and vertical motion; Advection and solenoids on synoptic charts; The hydrostatic equation and 1000-500 mb thickness. Thickness and Thermal wind. Principles of Air temperature Forecasting; using MOS in forecasting.

Baroclinic and Barotropic Weather Features Topics: Baroclinic Lows and Associated Synoptic Weather Features; Baroclinic High Pressure Systems; Barotropic and Equivalent Barotropic Weather Features.

Atmospheric Vertical Motion and Winter Precipitation Forecasting: Numerical Model Output for Precipitation Forecasting. Atmospheric Divergence; The equation of continuity; Diffluence on Synoptic Charts; Heavy snow forecasting, Lake effect snow forecasting. Fog Forecasting. Weather ensemble forecasting: the basics.

Mid-term Examination Week 6

Atmospheric Vorticity and Baroclinic Development: Observed Distribution of Divergence & Vertical Motions in Weather Systems; Relative and absolute vorticity; Constant absolute vorticity trajectories; Vorticity advection on forecasting charts; Clouds and precipitation associated with vorticity maxima Conservation of Potential Vorticity; Association Between Divergence and Vorticity Advection. The Pressure Tendency Equation.

Baroclinic Instability and Cyclogenesis: Baroclinic Wave Instability Theory of Cyclones; Cyclogenesis - The Petterssen Development Equation; The self-development process; the Occlusion Process in Baroclinic Lows;

Jet Streams and Fronts Topics: Jet Streams; Characteristics of Cold and Warm Fronts; Coastal Fronts (& backdoor fronts); Conveyor Belts and the Split Front; Frontal Development.

Regional Storms Topics: Wave Cyclone and Cyclogenesis Climatology; Anticyclone and Anticyclone Track Climatology; Colorado Lows / Panhandle Hooks; East Coast Cyclones and "Bombs"; Texas/Gulf Coastal Storms; The Alberta Clipper.

Final Examination: Thursday March 13, 2008, 1:30 - 3:18 p.m. in Derby 140

Geography 623.02
Synoptic Meteorology: Severe Storm Forecasting by Radar and Satellite
Spring 2008

Instructor: Jeff Rogers Office: Derby 1048
e-mail: rogers.21@osu.edu Phone: 292-0148
Office Hours: M,W,F Noon to 2:00 p.m.
Course Prerequisites: Geography 623.01, Physics 132

Class Meetings: M, W 2:30 – 4:18 p.m. in Derby 0140 and F (Lab) 2:30-4:18 in Derby 0140

Access to course lecture materials: http://carmen.osu.edu and click on "Geog. 623.02".

Course Objectives:
The aim of the course is to introduce students to the methods of analysis and techniques of forecasting thunderstorms and severe weather. The course is divided into five components:
1. Introductory overview of the climatology of severe weather and basic cloud physics,
2. The meteorological ingredients for severe weather and the forecasting of severe weather,
3. Weather radar and satellites as tools in severe weather analysis,
4. Convection and the characteristics and features of mesoscale storms, and
5. Practice in severe weather forecasting through a series of exercises and assignments.
The initial course section focuses on the ingredients of, and synoptic setting in which, severe storms develop. The role of instability, moisture, low-level and upper-level synoptic scale uplift will be described as will means by which forecasters identify and categorize the importance of each of these. The subsequent segment of the course describes the ways in which weather radar and geostationary satellite imagery are used in the analysis and forecasting of severe weather. Some theory of radar and satellite imagery is covered but the emphasis is on the usage of these materials in preparing forecasts and in trying to understand the conditions that are ideal for severe weather development. In the final section of the course, we will describe the characteristics of air mass, multicell, and supercell thunderstorms as well as of mesoscale convective systems (MCSs, including squall lines) and mesoscale convective complexes (MCCs). We also examine features of these storms such as bow echoes, derechoes, tornadoes, macrobursts, microbursts, and lightning.

Course Requirements.
Your grade in this course will be determined based on the following:
1. One mid-term exam worth 30% of your grade

2. One Final Examination worth 30% of your grade, Wednesday June 4 at 1:30 p.m.

3. Course assignments and Laboratory assignments worth 40% of your grade. There will be one quiz and several small projects (with a small point-value) is to be completed during the class period. If you miss these in-class projects there will be no make-ups (which are time consuming and logistically difficult using real-time weather data).
A larger project in which you evaluate the meteorological causes of a historical severe weather event will also be part of the assignment grade. The historical events could be from 2008 or it can be based on events occurring in previous years, using stored data at the Storm Prediction Center.

Assignments will be graded as "zero" if they are not turned in by their due date. Medical excuses are needed in order to turn in late assignments or for a missed exam. Incompletes are issued only for extended medical illnesses late in the quarter (with proof).

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

Course Outline

Week Lecture Topic

Introductory Lectures: Severe Weather Climatology and Cloud Physics

1. Lecture 1. Climatology of thunderstorms, hail, tornadoes & high winds, with emphasis on their annual and diurnal cycle characteristics.

Lecture 2: Cloud and precipitation formation mechanisms. Processes controlling evaporation and condensation; Curvature & solute effects. Growth of cloud droplets and rain droplets by condensation, collision/coalescence and three phase processes. Ice crystals and their habits. Aggregation and riming processes; graupel and snowflakes. Hail formation processes; wet and dry growth.

The meteorological ingredients for severe weather.

2. Lecture 3: Synoptic processes contributing to severe weather. Low level convergence boundaries. Synoptic and mesoscale uplift aloft. Examples of synoptic-scale interactions in severe weather outbreaks of 2003.

Lecture 4: Analyzing atmospheric stability for severe thunderstorm settings. Atmospheric convection and parcel theory. Thermodynamic diagrams and sounding analysis. Severe Weather Air mass soundings.

3. Lecture 5: The hodograph. Stability indices use in severe wx forecasting – thermodynamic & dynamic.

Lecture 6: Moisture and its analysis in severe weather settings. θ_e: its calculation, map characteristics, stability analysis and forecasting applications. Moisture flux convergence: synoptic charts and interpretation of MFC. The Great Plains Low level jet: identifying the LLJ & other jets, factors causing the LLJ and its synoptic significance.

4. Lecture 7: Synoptics: Topics include the Dryline: appearance, climatology, its motion and role in convection; role of Gravity waves in severe weather. Use of Miller's (and other) severe weather checklists. General forecasting approaches for a severe weather day. Analysis of surface and upper air charts.

Weather radar and satellites as tools in severe weather analysis

4. Lecture 8: Weather radar systems & components; radar energy pulse and attenuation, beam

characteristics, anomalous propagation and the radar equation. Equivalent reflectivity and Z-R relationships.

5. Lecture 9: Radar scanning strategies, NEXRAD data products, Doppler radial velocities, spectrum & spectrum width. Radar echo arrangements (Bow echoes, LEWPS) and configurations (WER, BWER)
Lecture 10: Meteorological Satellite observations of severe weather features. Enhanced satellite imagery, detection of severe wx phenomena; outflow boundaries, the enhanced-V, leading edge gradients.
6. Lecture 11: Heavy precipitation and flash flooding
Mid-term examination

Convection and the characteristics and features of mesoscale storms
7. Lecture 12: Convection and convective cells. Elevated convection. Ordinary or air mass thunderstorms: evolution, radar structure. Multicell thunderstorms: structure, evolution, motion, links to flooding;
Lecture 13: MCS's (linear) and squall lines. Squall lines: types and morphology. Structure, evolution, relation to bow echoes and radar observed characteristics. Bow echoes and derechoes; characteristics, evolution.
8. Lecture 14: MCC's: basic characteristics and evolution. Heavy rains and flash floods. MCV's.
Lecture 15: Supercell thunderstorms: structure, evolution, supercell splitting & role of wind shear.
9. Lecture 16: . Supercell Tornadoes: evolution, tornado occlusion, boundary layer processes, swirl ratio, vortex breakdown, suction vortices. Non-supercell tornadoes, fujita scale, safety
Lecture 17: Downbursts, Macrobursts and microbursts.

10. Monday: Memorial Day, May 26, 2008 No class
Lecture 18: Lightning, characteristics, causes, detection, effects on humans.

FINAL EXAM: Wednesday June 4, 2008 1:30 p.m. - 3:18 p.m.

Course Syllabus

Atmospheric Sciences 637: Dynamic Meteorology I
Class Meetings: MTWRF 12:30-1:18 pm.
Classroom: Derby Hall 1080

Instructor: Jay Hobgood
Office: Room 1100 Derby Hall
Office phone: 292-3999
Office hours: by appointment
Email: hobgood.1@osu.edu

Course Prerequisites: Atmospheric Sciences 631, Math 254

Course Objectives: The basic objective of this course is to provide students with knowledge of the fundamentals of atmospheric dynamics. The knowledge will facilitate students' comprehension of meteorological processes that determine the weather. This increased comprehension of important physical processes will improve students' ability to analyze and to forecast the state of the atmosphere.

Course Structure: The class will meet five days per week for 48 minutes each day. Lectures during the classes will present material on thermodynamic processes and their application to atmospheric situations. Important equations will be derived and the implications of assumptions will be discussed. Examples of meteorological problems will be discussed. Homework problems that involve the application of material introduced in class will also be assigned and discussed in class.

Textbook: Holton, J.R., 2004: *An Introduction to Dynamic Meteorology,* fourth edition, Elsevier Academic Press.

Course requirements:

1. The **first examination** will occur on **January 29, 2008** and will comprise 25% of the course grade.

2. The **second examination** will occur on **February 19, 2008** and will comprise 25% of the course grade.

3. The **final examination** will occur at 11:30-1:18 on **Tuesday March 11, 2008** and will comprise 30% of the course grade.

4. Sets of problems will be assigned in class and will comprise 20% of the final grade.

Examination format: Each examination will begin with a series of terms to define in one or two sentences. You will have a choice of which terms you choose to define. The remainder of the examination will consist of short essay questions that you can answer with a few sentences and problems like the problems that will be assigned as homework. The examinations are designed to test your comprehension and understanding of the material, as well as your ability to recall basic dynamic principles.

Homework assignments: The homework assignments are designed to accomplish several goals. The first goal is to give students some experience solving basic dynamic problems using concepts introduced in class. A second goal is to make students think about the dynamic processes that occur in certain atmospheric phenomena. More challenging problems may require students to combine dynamic principles in order to arrive at the solution to the problem. Some problems will be similar to the tasks require of operational meteorologists. Other problems will deal with fundamental principles and calculations that are used to develop meteorological models and software. Homework assignments are expected to be the work of the student whose name appears on them. Copying another student's work is *plagiarism* and is considered to be *academic misconduct.*

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Units: Numerical answers are incomplete unless they are accompanied by the correct units. Students will lose points on examinations and homework assignments if the units are incorrect or missing.

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

List of Topics

Part I: Introduction to atmospheric dynamics (2 weeks)

a. The wind vector
b. Basic vector operations
c. Newton's Second Law of Motion
d. Fundamental forces
e. Apparent forces

Part II: The basic conservation laws (2 weeks)

a. The equations of motion in Cartesian coordinates
b. Scale analysis
c. The geostrophic wind
d. The continuity equation
e. The thermal energy equation
f. The mechanical energy equation
g. The thermodynamic energy equation

Part III: Some applications of the basic equations (3 weeks)

a. Types of balanced flow
b. Trajectories and streamlines
c. The use of pressure as a vertical coordinate
d. Vertical motion
e. The thermal wind

Part IV: Circulation and vorticity (3 weeks)

a. The circulation theorem
b. Vorticity
c. Potential vorticity
d. The vorticity theorem
e. Helicity

Course Syllabus

Atmospheric Sciences 638: Dynamic Meteorology II
Class Meetings: MTWRF 1:30-2:18 pm.
Classroom: Derby Hall 1080

Instructor: Jay Hobgood
Office: Room 1100 Derby Hall
Office phone: 292-3999
Office hours: by appointment
Email: hobgood.1@osu.edu

Course Prerequisites: Atmospheric Sciences 637, Math 255 or 415

Course Objectives: The basic objective of this course is to provide students with knowledge of the fundamentals of atmospheric dynamics. The knowledge will facilitate students' comprehension of meteorological processes that determine the weather. In this course the processes of atmospheric dynamics are linked to processes at work in the planetary boundary layer and on the synoptic scale of motion. The increased comprehension of important physical processes will improve students' ability to analyze and to forecast the state of the atmosphere.

Course Structure: The class will meet five days per week for 48 minutes each day. Lectures during the classes will present material on thermodynamic processes and their application to atmospheric situations. Important equations will be derived and the implications of assumptions will be discussed. Examples of meteorological problems will be discussed. Homework problems that involve the application of material introduced in class will also be assigned and discussed in class.

Textbook: Holton, J.R., 2004: *An Introduction to Dynamic Meteorology,* fourth edition, Elsevier Academic Press.

Course requirements:

1. The **first examination** will occur on **April 15, 2008** and will comprise 25% of the course grade.

2. The **second examination** will occur on **May 13, 2008** and will comprise 25% of the course grade.

3. The **final examination** will occur at 1:30-3:18 on **Tuesday June 3, 2008** and will comprise 30% of the course grade.

4. Sets of problems will be assigned in class and will comprise 20% of the final grade.

Examination format: Each examination will begin with a series of terms to define in one or two sentences. You will have a choice of which terms you choose to define. The remainder of the examination will consist of short essay questions that you can answer with a few sentences and problems like the problems that will be assigned as homework. The examinations are designed to test your comprehension and understanding of the material, as well as your ability to recall basic dynamic principles.

Homework assignments: The homework assignments are designed to accomplish several goals. The first goal is to give students some experience solving basic dynamic problems using concepts introduced in class. A second goal is to make students think about the dynamic processes that occur in certain atmospheric phenomena. More challenging problems may require students to combine dynamic principles in order to arrive at the solution to the problem. Some problems will be similar to the tasks require of operational meteorologists. Other problems will deal with fundamental principles and calculations that are used to develop meteorological models and software. Homework assignments are expected to be the work of the student whose name appears on them. Copying another student's work is *plagiarism* and is considered to be *academic misconduct.*

Units: Numerical answers are incomplete unless they are accompanied by the correct units. Students will lose points on examinations and homework assignments if the units are incorrect or missing.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

List of Topics

Part I: Circulation and Vorticity (1.5 weeks)

a. The circulation theorem
b. Absolute and relative vorticity
c. Conservation of absolute vorticity
d. Potential vorticity
e. Helicity

Part II: The planetary boundary layer and subgrid-scale processes (4.0 weeks)

a. Friction
b. Subgrid-scale transfers
c. The Boussinesq approximation
d. Turbulent Kinetic Energy
e. The Ekman approximation
f. Secondary circulations and spin down

Part III: Dynamics of midlatitude synoptic scale weather systems (3.5 weeks)

a. The quasigeostrophic approach
b. The geopotential tendency equation
c. The omega equation
d. Jet streaks
e. The ageostrophic wind

Part IV: Waves in the atmosphere (2 weeks)

a. Characteristics of waves
b. Sound waves
c. Shallow water gravity waves
d. Internal gravity waves
e. Rossby waves
f. Barotropic instability
g. Baroclinic instability

Syllabus

Atmospheric Science 629: Climate System Modeling: Basics and Applications
Spring Quarter 2005, 5 Credits.

Instructor: David H. Bromwich

Contact Information: Room 037A Scott Hall. Email: bromwich.1@osu.edu. This is the best way to reach me. I do not plan to have regular office hours but will meet by appointment whenever a meeting is requested.

Call Number: 02434-9.

Class Location and Times: Byrd Polar Research Center, Scott Hall Room 0140 on West Campus. Tuesday and Friday, 3-5 pm.

Course Description:

Atmospheric Science 629 will explore Climate System Models that are used to investigate the behavior of Earth's climate in the past, to understand contemporary climate variability, and to project future change, such as with "global warming". The detailed model components for the atmosphere, ocean, sea ice and land surface will be described; both parameterizations of physical processes and numerical methods will be considered. The NCAR Community Climate System Model (NCAR CCSM) version 3 will be the focus of attention. Strengths and weaknesses of climate system models in being able to simulate contemporary climate will be studied in some detail, as a benchmark with which to judge simulation reliability. A wide variety of applications will be surveyed. Hands-on-experiments with a global atmospheric model will be featured to illustrate how model scenarios are developed. The grade will be based upon one student presentation, two term projects performed in groups, and an individual term paper (tailored to each student's interests). There is no single textbook as the field continues to develop rapidly. Material will be drawn from online technical manuals, extensive readings from the contemporary literature, and the last Intergovernmental Panel on Climate Change (2001) report. The class will be run as a seminar.

Prerequisites: Atmospheric Science 230 or Geography 520 or equivalent; for atmospheric science students, the core sequence on thermodynamics and dynamics is useful background that can be taken at the same time as this course.

Course Objectives:

(1) To give expose to the foundations of one of the primary tools used to infer

changes in the global environment.
(2) To develop the ability to identify key strengths and weaknesses in climate system model projections.
(3) To provide hands-on experience with the simulation process to give the class material concrete grounding in practice.
(4) To provide an overview of the full range of potential applications of this powerful tool.

Evaluation:

Grading will be as follows:

Class Presentation: 15%
Class Project on NCAR CCSM Contemporary Performance: 20%
Class Project on Climate Model Simulations: 20%
Class participation: 10%
Term Paper: 35%

One presentation will be required from each student evaluating the contemporary literature on the climate system-modeling topic being considered that week. A written summary of the presentation will be prepared and distributed to the class at least 2 days prior to the presentation. The 20 minute presentation will be followed a class discussion of 20 minutes; active participation by all students in this part of the class is expected. All students are expected to read each paper before it is discussed in class. The instructor will assign a grade to each student (worth 10% of the final grade) at the end of the quarter for his or her level of participation in discussions.

Two class projects will be conducted during the quarter. The first will take output from a contemporary simulation by the NCAR CCSM to evaluate its ability to reproduce observed climate today. This will run for 4 weeks starting in week 2. Students will be divided into groups of 4-5 and will be tasked with investigating the performance for specific geographic areas. The results will be written up and distributed. The results will be presented to the class. Each student's grade for this part of the class (20% of the final grade) will be decided by the performance of their group. The second class project will be similarly organized, extending from weeks 6-9, and will examine the characteristics of a sensitivity simulation conducted with a global atmospheric model.

A term paper critiquing the contemporary literature on a climate system-modeling topic of the student's choosing from a wide range of potential topics will be the final requirement. This is expected to be a state-of-the-art assessment of at least 20-30 pages in length, including figures and references. This is analogous to a manuscript prepared for the refereed literature. This will be due last day of class Friday June 3, 2005, and will be worth 35% of the final grade.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

Schedule

Week 1: March 28-April1, 2005.

Tuesday: Lecture Reviewing Atmospheric and Oceanic Behavior.
Friday: Lecture on the NCAR CCSM.

Week 2: April 4-8, 2005.

Start class project on NCAR CCSM contemporary performance.

Tuesday: Atmospheric Modeling Lecture.
Friday: Student Presentations on Atmospheric Modeling.

Week 3: April 11-15, 2005.

Tuesday: Atmospheric Modeling Lecture (continued).
Friday: Student Presentations on Atmospheric Modeling.

Week 4: April 18-22, 2005.

Tuesday: Lecture on Ocean and Sea Ice Modeling.
Friday: Student Presentations on Ocean and Sea Ice Modeling

Week 5: April 25-29, 2005.

Tuesday: Lecture on Land Surface Modeling
Friday: Student Presentations on Land Surface Modeling

Week 6: May 2-6, 2005.

Class Project on Model Sensitivity Studies Starts

Tuesday: Lecture on Coupled Modeling and Performance.
Friday: Group Presentations on Class Project on NCAR CCSM Contemporary Performance

Week Seven: May 9-13, 2005.

Tuesday: Lecture on Climate Variability Simulations
Friday: Student Presentations on Climate Variability Simulations

Week Eight: May 16-20, 2005.

Tuesday: Lecture on Global Warming Projections.
Friday: Student Presentations on Global Warming.

Week Nine: May 23-27, 2005.

Tuesday: Lecture on Paleoclimate Simulations
Friday: Student Presentations on Paleoclimate Simulations

Week Ten: May 30-June 3, 2005.

Tuesday: Lecture on Regional Climate Modeling
Friday: Student Presentations on Class Project on Model Sensitivity Studies

Term Paper Due on June 3, 2005 at 5 pm.

Geography H410: Global Climate and Environmental Change
Spring 2008 Syllabus
Call # 10193-2, 5 credits, no prerequisites

Class: MW 08:30-10:18 AM 0140 Derby Hall (basement)

Instructor: Dr. Bryan G. Mark (mark.9@osu.edu)
1136 Derby Hall, 247-6180 (phone)
Office hours: by appointment; 10:30 AM – 12:00 PM (after class)

Teaching Assistant: Karin Bumbaco (bumbaco.1@osu.edu)
1145 Derby Hall, 292-6127 (phone)
Office hours: MW 10:30 am – 12:00 pm

Course Objectives: This course is taught in a lecture / seminar format and is designed to provide
a more thorough understanding of the scientific basis of both natural and anthropogenic (human
produced) climate and environmental changes. You will explore the key issues surrounding 20th
century climate change (popularly called global warming) and the role of human activities in
shaping the physical, chemical and biological characteristics of the environment that sustains life
on Earth. Through readings, lectures, discussions, student presentations, class debates and films
you will gain insight to how these anticipated changes are likely to affect your future and explore
actions by which you may contribute to solutions. You will gain experience using peer-reviewed
literature to research a topic and then summarize your findings both orally and in writing. A key
objective is to provide you with the knowledge base and skills to critically evaluate information
you read or hear concerning climate change and related environmental issues.

Prerequisites: This course has no prerequisites except that you must be officially admitted to the
University Honors Program.

GEC Requirements: This course meets B.A. and B.S. Degree GEC requirements for Natural
Science (Physical Science) and Social Sciences (Human, Natural, and Economic

Resources)

Textbooks (required):

1) Brown, Lester R.(2008). *Plan B 3.0 Mobilizing to Save Civilization*. W. W. Norton & Company, NY, 371 pp. **Will be provided compliments of the Geography Department**

2) Walker, Gabrielle and King, David (2008). *Hot Topic: What We Can Do About Global Warming* Harvest Books (Paperback), 288 pp. ISBN-10: 0156033186

Additional readings will come from:
Dessler, A. E. and E. A. Parson, *The Science and Politics of Global Climate Change: A Guide*
to the Debate. Cambridge Univ. Press, Cambridge, pp. 188, 2006. (out of print)

Selected journal articles and book chapters will be placed on electronic reserve for the class.
Throughout the quarter additional reading and reference materials may be required. You will be alerted in class about updates to either Carmen or the class web page. The schedule of activities (lectures, guest speakers, group discussions, field trips, debates, presentations, papers, and films) will be posted on the class web page on Carmen and will be updated as the class progresses. Lecture Power Point slides will be compiled into pdf and posted to Carmen. Except for the first week of the class, readings are assigned in the week prior to the presentation of the material. Note that the class schedule may change slightly as the quarter progresses and you will be alerted to these changes. Remember that this is a lecture/ seminar style course and thus you need to ***remain flexible*** so that we may capitalize on climate- and/or environment-related events and special speakers on campus.

Grading: Group presentations: 20% (two presentations – 10% each)
Individual research paper: 15%
Exercises: 20% (Exercise 1 – 5%; Exercise 2 – 7.5%; Exercise 3 – 7.5%)
Debates: 20% (two debates – 10% each)
Final examination: 15% (an essay)
Quizzes (3%), Participation (4%) and Attendance (3%): 10% This final part means attending all classes and field trips, turning in all work on time, participating in the discussions, asking
questions, being attentive and engaging with the class. You are allowed one un-excused absence.
An excused absence requires written documentation (doctor's excuse) or prior permission from
Dr. Mark to be absent. I consider your requests on a case by case basis. There will be a few
quick quizzes and they will be announced in advance.

Additional Class Materials: Additional materials will be placed on reserve throughout the
quarter. The list of these will be maintained on the class web page under Reserve Materials. All
materials (unless otherwise indicated) are on closed reserve in the Geology Library in Orton Hall
[the building with the bell tower on the south side the Oval]. All materials will be filed under
Geography H410 unless otherwise indicated. Additional class materials may be made available
throughout the quarter.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

Welcome to this Honors Seminar:
I look forward to working with you as a group and individually as you learn more about your
environment and the Earth's climate system - past, present and future.

GEOGRAPHY 420

Global Climate and Environmental Change

5 credits, no prerequisites

Instructor: Dr. Bryan Mark
Office: 1136 Derby Hall
Email: mark.9@osu.edu
Phone: 247-6180
Office hours: W, R 10:30-11:30 am, or by appointment

Course Objectives

The substantive material covered in this course requires that students attain knowledge from the physical sciences. Understanding the drivers of global climate and environmental change requires knowledge of the Earth system, its climate, the mechanisms that force climate, the human activities that affect the magnitude and direction of some of these forcing mechanisms, the economic drivers of human activities and consideration of the social, political, economic and physical forces that govern present and future human actions and choices regarding resource use.

This course meets GEC requirements in two areas - Natural Science, and Diversity: International Issues.

In the Natural Sciences: It is impossible to understand global climate and environmental changes without knowledge of the physical, chemical and biological processes that shape the Earth System. The course includes lectures on the Earth's energy balance, the movement of energy and mass by the atmosphere and ocean, the hydrologic cycle, air pollution and the nature of both renewable and non-renewable energy sources.

In Global Issues: Global climate and environmental change is a global issue of importance to all the inhabitants of our planet. A global problem requires global solutions. Students are introduced to the physical, biological and social forces behind unsustainable resource use by developed countries and underdeveloped countries (the forces are different and therefore the solutions must be different). Students will explore human population dynamics and the interactions among population growth, education, and opportunities for women, health care and nutrition that govern the human condition – a key ingredient in the design of sustainable future for the inhabitants of planet Earth.

Course Objectives continued

This course will require your **full** participation if you expect to do well. In order for you to take full advantage of the opportunities in this course and demonstrate that you have done so, I expect the following:

- Attentive and active participation in class discussions and activities;
- Thoughtful and timely reading of assigned materials;
- Completion of each short paper on time;
- Demonstration of critical thinking and an ability to integrate and synthesize diverse facts and ideas of the scientific and human-influenced processes underlying environmental change at different scales (local, regional and global); geographic perspectives on environmental issues;
- Open-minded, critical consideration of diverse viewpoints about human uses of natural resources and their consequences.

Evaluation

Student evaluation will be based on a combination of the following:

- Short papers: 20% = 100 points
- Presentation/Debates: 20% = 100 points
- Mid Term: 25% = 125 points
- Final 35% = 175 points

- **Total Points: 100%=500 points**

Course Policies

Student Code of Conduct webpage: http://studentaffairs.osu.edu/resource_csc.asp.

Disability Statement

Students with physical or learning disabilities requiring alternative accommodations for completing course requirements must make these arrangements in consultation with the University Office of Disability Services (150 Pomerene Hall, 2-3307) and the instructor **at the beginning of the quarter**.

Students who anticipate missing an exam must make arrangements with the instructor at least **one week prior**. Furthermore, no in-class activity or exam can be made up without special advanced notice, given at the instructor's discretion. *Documentation will be required for an excused absence.*

Topics

Part I: The Earth System

Week 1

- Introduction: What is Global Environmental Change?
- Basic Physiology of the Earth
    - discussion of *Physical Geography* and *Earth System Science* (ESS) and application of these conceptual frameworks to conduct local to global-scale analyses of past, present and future climate and environmental change
    - system equilibrium, thresholds and feedbacks (e.g. climate-biosphere)
    - discussion of how the interaction of human systems with these spheres is increasingly important
    - **Reading: The Lithosphere, Chapter 1**

Week 2

- Putting Environmental Change in Context: What can geologic, paleoecologic and historic records tell us?
    - discussion of phenomena (biological, physical, chemical) that are dependent on climate, i.e. use of proxy records to reconstruct climate and environmental change
    - discussion of global and regional climate models
    - identify mechanisms responsible for and causes of past climate change and feedbacks present in Earth-Atmosphere System (EAS)
    - **Reading: Chapter 11**
- Scales of variability (annual – orbital)
    - annual, decadal, centennial, millennial; acknowledge that societal focus on annual and decadal variation
    - discussion of multiple stable states/solutions (non-unique climate state) given a set of boundary conditions – Lorenz and Chaos Theory

Evaluation: Students will research, synthesize and write a paper describing a method (history of scientific techniques, technologic interdependence, etc.) used to reconstruct past environments. This exercise will provide insight to the operation of earth's atmospheric system and its complexity. A short presentation utilizing power point will be made. [50 points]

Part II: Human Dimension(s) of Global Change

Week 3

- Human Population Growth and Environmental Change
- Understanding demographic transition models
- Evaluating the earth's carrying capacity and sustainability
- **Reading: Chapter 7**

Week 4

- Land Degradation and Land Use: land conversion issues (forestry, agriculture, ranching, fisheries and aquaculture), effects of land conversion activities (soil erosion, biomass burning, use of pesticides), biodiversity
    - Discussion of habitat destruction, fragmentation and conversion
    - Biodiversity hotspots – endemic species role of human activity and extinction
    - International Union for Conservation of Nature (IUCN) – Red Books
    - Biodiversity conservation: species richness, habitat and/or ecosystem foci
    - Impact to energy balance
    - Ecosystem dynamics in relation to carrying capacity and biochemical cycling
    - Technological methods used to detect change in the natural environment
    - **Reading: Chapter 8**

Week 5

- Global Warming (natural climatic variability, greenhouse gases, oceans and ice cores, consequences).
    - Global warming causes and consequences
    - two issues: rate of warming and fragmentation
    - response of biomes to projected warming
    - shifts ecotonal environments such tree line/timberline
    - changes in natural fire frequencies
    - nature reserve design
    - **Reading: Chapter 11**

Evaluation: Mid-term exam covering the EAS, land-use change, population growth and global warming. These topics relate to knowledge and understanding of the earth and natural universe. [125 points]

Week 6

- Atmospheric Chemistry: ozone depletion and acid deposition
    - **Acid Deposition**
        - Review causes and effects
    - **Ozone Focus Study**
        - Vienna Convention (1985)
        - Montreal Protocol (1987)
        - London Agreement (1990)
        - Copenhagen Amendment (1992)
        - **Reading: Chapter 10**
        - **Case Study: Discovery of the ozone hole**

Evaluation: Students will research, synthesize and write a paper describing a specific human dimension of environmental change; e.g. nature reserve design, fisheries collapse, timber extraction, drought mitigation. A short presentation utilizing power point will also be made. [50 points]

Week 7

- Hydrologic Cycle:
    - discussion of various components: ocean evaporation and precipitation; terrestrial precipitation and evapotranspiration, reservoirs (ice, ground water), runoff and residence time
    - case studies: groundwater marine pollution, terrestrial/marine linkages, ENSO, sea level rise, freshwater eutrophication, desalinization
    - **Reading: Chapter 3**
    - **Field trip: Olentangy River 5th Avenue dam**

Part III: Global Change Science, Society and Policy

Week 8

- IPCC (Intergovernmental Report on Climate Change) which demonstrates the scientific process and process of scientific consensus, The Millennium Ecosystem Assessment Report, Arctic Climate Impact Assessment: outcomes and effectiveness
- **Reading: IPCC**

Week 9

- Alternative energy sources – nuclear, wind power generation, solar thermal and photovoltaic (supplemental readings: Appenzeller, Deffeyes, and Weaver)
- Approaches to limiting C-emission (Cap-and-Trade, C sequestration, re-forestation, carbon tax, international, regional and local agreements) etc).
- Utilization of the principles of the first and second laws of thermodynamics, including the first and second laws of efficiency. We will also employ climate circulation modeling; specifically limits of computing resolution and uncertainty.

Evaluation: Students will form groups of 3-4 and debate propositions outlined in "Debate Topics" appendix. This exercise stresses students' ability to present scientific evidence and interdependence of experiment and theory [100 points]

Week 10

- Projections: what does the future hold
  - sea-level rise (thermal expansion, change in terrestrially-held water)
  - soil-moisture (Palmer's drought severity index), agricultural productivity
  - changes in phenology (National Phenology Network)
  - frequency and magnitude of severe weather
  - epidemiology of vector-borne disease
  - **Readings: Chapter 12 and IPCC**
  -

Evaluation: Final exam covering Human dimensions of environmental change and global change science and its relationship to society and policy. [175 points]

Readings

Climate Change 2007: The Physical Science Basis http://www.ipcc.ch

One Planet Many People, Atlas of Our Changing Environment
http://na.unep.net/OnePlanetManyPeople/

The Millennium Ecosystem Assessment http://www.maweb.org/en/index.aspx

AAAS Atlas of Population & Environment http://atlas.aaas.org/

Appenzeller, T. 2004. The end of cheap oil. *National Geographic* 205: 80-109.

Barlow, M. and Clarke, T. 2002. Blue Gold: The Fight to Stop the Corporate Theft of the World's Water. The New Press: New York. pp. 278.

Carson, R. 1962. Silent Spring. Houghton Mifflin: New York. pp. 400.

Deffeyes, K. S. 2001. Hubbert's Peak. Princeton University Press: Princeton, NJ. pp. 208

Goudie, A. 1990. The Human Impact on the Natural Environment. Cambridge: MIT Press. pp. 1-22.

Murphy, D. E. 2004. Water Contract Renewals Stir Debate Between Environmentalists and Farmers in California. New York Times, December 15, 2004.

Resisner, M. 1986. Cadillac Desert: The American West and Its Disappearing Water. Penguin Books: New York. pp. 582. Hydrologic Cycle

Weaver, K. F. 1981. Special report on energy: our energy predicament. *National Geographic*, 2-23.

Yergin, D. 1991. The Prize: The Epic Quest for Oil, Money and Power. Simon and Schuster: New York. pp. 885.

Debate Topics

Vehicles powered by corn-based ethanol are good for the environment and should be promoted.
Pro: They are good for the environment due to lower emission
Con: They are bad for the environment due to environmental footprint of corn production

Nuclear power plants are on balance harmful to the environment and should not be built.
Pro: They are harmful because they produce nuclear waste
Con: They are helpful since the only emit steam from their smoke stacks

The best way to mitigate carbon emissions is with a Cap and Trade system.
Pro: Cap and trade is the best
Con: Strict cap is the best
Con: Incentives is the best

A price should be put on the goods and services provided by the world's ecosystem.
Pro: Everyone should pay the "true" value of a commodity, including its environmental costs.
Con: All commodities will be too expensive to afford, causing an economic disaster

The US should reprocess spent nuclear fuel.
Pro: nuclear waste should be used as many times as possible before it is placed in Yucca Mountain
Con: the hazards involved in the reprocessing have the potential to cause a major environmental disaster.

California's proposed conventional light bulb ban should become law.
Pro: more efficient light bulb use can prevent millions of tons of CO_2 from entering our atmosphere.
Con: Compact Fluorescent Light bulbs are very environmentally harmful during construction.

Syllabus

GEOGRAPHY 597.02: Integrated Earth Systems: Confronting Global Change
WINTER, 2007

Lecture: Derby Hall 1080: 9:00 - 10:18 a.m.: Tuesday and Thursday
Recitation: Derby Hall 140 (in basement): Thursday (10:30 - 11:48 am)

Professor: Dr. Ellen Mosley-Thompson (thompson.4@osu.edu)
Office: Derby Hall 1140; Telephone: 292-6662 or 292-2580
Office Hours: Tuesday and Thursday: 10:15 to noon or by appointment

Graduate Teaching Assistant: Karin Bumbaco
Office: 1145 Derby Hall (ph: 292-6127); email: bumbaco.1@osu.edu
Office hours: Tuesday: 9:30 to 11:30 am and Friday 9:30 to 11:30 am; or by appointment

Course Objectives: This course is taught in a lecture / recitation format and is designed to provide a basic understanding of both natural and anthropogenic (human produced) climate change. You will explore the key issues surrounding 20th century climate change (including global warming and sea level rise) and the role of human activities in shaping the physical, chemical and biological characteristics of the environment that sustains life on Earth. Lectures will provide an introduction to the mechanisms that control the Earth's climate regimes, basics of ecosystems interactions, and actions to help ensure sustainable supplies of water, energy, clean air, soils and food for the Earth's growing population. A key objective is to provide you with the knowledge base and skills to critically evaluate information you read or hear concerning climate change, global warming and related environmental issues.

Textbook and Recitation Materials (required): Note this text was used in 2005 so you may be able to find it used.

(1) *Sustaining the Earth*, G.T. Miller, Jr. Wadsworth Publishers, 2007 (8th Edition)
(2) The lecture syllabus, the recitation syllabus, your recitation exercises, computer tutorials and additional required reference materials will be available at the appropriate time on the class web page. You merely visit the class web page and print them at your convenience. I suggest that you bookmark the class web page in your internet browser. The class web address is **http://geog-www.sbs.ohio-state.edu/courses/G597.02/** If you have trouble getting to the web page by typing this in - log into the Geography Dept. web page [www.geography.ohio-state.edu] and from here click onto the classes and then on 597.02. Throughout the quarter additional reading and reference materials may be required. **ALL** reference materials (unless otherwise noted) will be placed on closed reserve in the **Geology Library in Orton Hall** [the building with the bell tower on the south side the Oval]. The materials will be filed under Geography 597.02 unless otherwise indicated.

Please Note: To be allowed to make up work or tests you **must** have a written note from your physician. Quizzes **WILL NOT** be available for makeup as they are given impromptu and answers are posted on the class web page virtually immediately. The lowest quiz score will be dropped so you can miss one quiz without affecting your grade.

Important additional resources for this class:
1) http://www.thomsonedu.com/biology/miller From this page select your text book and select "Companion Site" under Students. This web site offers tutorials, quizzes, etc. Also you may have access to Info Track (see below) if you bought your book new and with Info Track bundled.
2) Info Trac - this is a free online library available to you for 4 months after you activate it with the information provided with your textbook. Info Trac links you to many scientific articles related to the topics that you will cover in the textbook. To activate your follow the instructions that came with your textbook. Please see page "x" of your book for more details about the online study aids that are available. With regard to Info-Track resources, some of the publications are dated (meaning more than 2 years old). In climate change studies, our knowledge advances so rapidly that the results in a 2 year-old publication could possibly be obsolete. I will include links on the class web page to a few key papers in the peer-reviewed literature on the topics we will be covering throughout the quarter. You will be alerted as these materials are posted.

Weekly topics and reading assignments:

Week 1: January 3 (Wed) ***Topic 1:*** Key environmental issues facing us in the 21st Century: An overview. Key questions to be addressed include: What are Global Climate and Environmental Change (GCEC)? What is up with all the talk about global warming, climate change, stratospheric ozone depletion, and rising sea levels? In this course you will explore the many processes that are changing your environment. You will learn about other disruptions in the Earth system and consider why human resource usage is a critical driver of climate, social, political and economic changes. A**ssigned Reading:** Pages 1-4, Chapter 1 (all), Chapter 2 (pp. 20-28)

Week 2: January 8 (Monday) and January 10 (Wed) and **Week 3**: Jan 17 (Wed) ***Topic 2:*** The Earth as a System; Key questions to be addressed include: What has been the Earth's climate history? How does the Earth system work? How does the Earth stay warm? What is the natural Greenhouse Effect (GHE)? What is the enhanced Greenhouse Effect? What is the role of human activity in the enhancement of the GHE? **Assigned Reading:** Chapter 12 (pp. 252-254; 266-282); Also assigned is the Chapter entitled "Solar and Terrestrial Radiation" in the book "*The Atmosphere*" by Lutgens and Tarbuck. This paper is on electronic reserve through Carmen. Several copies of earlier editions of this book are on reserve in the Geology Library (Orton Hall). I also strongly recommend that you review the chapter entitled "Global circulation" in Edition 5 and "Circulation of the Atmosphere" in Edition 6 of the same book. This chapter is also available on the Electronic Reserves through Carmen. This augments the chapter on climate in your text that is deficient in some important concepts. For information about the Earth's climate history you should rely heavily on the information presented in the lectures. **Note that Monday Jan 15 is MLK day (no class).**

Week 4: January 22 (Mon) and 24 (Wed); ***Topic 3:*** Earth's Ecosystems: The Basics. Key questions to be addressed include: What are ecosystems? How do they function? What practical lessons can we learn from studying ecosystems? What is their role in the carbon cycle?
Assigned Reading: Chapter 2 (pp. 28-51); Chapter 3 (all); Chapter 4 (all)

Week 5: January 29 (Mon) and 31 (Wed); ***Topic 4:*** Ecology, deforestation, sustainability (approaches to sustaining biodiversity). **Assigned Reading:** Chapter 6 (all); Chapter 7 (all)

Week 6: Feb 5 (Monday) **Mid-Term examination: bring pencil, eraser**
Week 6: Feb 7 (Wed) ***Topic 5***: Human population and dynamics. Critical questions to be addressed include: Why is it important to understand population dynamics and human population growth? What are the basic characteristics of all populations? What dynamics drive human population growth and decline? **Assigned Reading:** Chapter 5 (all)

Week 7: February 12 (Mon) and 14 (Wed) ***Topic 6:*** Energy for Planet Earth. Questions to be addressed include: What are the primary renewable and non-renewable Earth resources? Why is their allocation and use so important? Can we use resources more efficiently? How?
Assigned Reading: Chapter 10 (all)

Week 8: February 19 (Mon) and 21 (Wed); ***Topic 7:*** Water for Planet Earth. Questions to be addressed include: Have you considered the quality of the water you drink? What is the hydrologic cycle? How is water distributed and used? **Assigned Reading:** Chapter 9 (all)

Week 9: Feb 26 (Mon) ***Topic 8:*** The Air You Breathe. Questions to be addressed include: What is the quality of the air you breathe? What are the health effects from air pollution? **Assigned Reading:** Chapter 12 (pp. 255-266); Feb 28 (Wed) ***Topic 9:*** Food and Soil. Questions to be addressed include: How are we going to feed the growing world population? How severe is the degradation of the Earth's soils? Is the use of pesticides creating a problem? What will be the long-term impact upon the ability of the Earth to feed its growing population? **Assigned Reading:** Chapter 8 (all) and review Chapter 2 (pp. 41-43)

Week 10: March 5 (Mon) and Mar 7 (Wed) ***Topic 10:*** Sustaining your environment. Questions to be addressed include: How can economies grow without depleting critical resources? What is the Kyoto Protocol and is it important? What are the different world views and are they sustainable? What is sustainability? Does it mean the same thing to everyone? Can it be achieved? How can you as an individual make a difference? **Assigned Reading:** Chapter 14 (all)

Final examination: Monday Mar 12 from 7:30 to 9:18 a.m. in Derby 1080

Grading:

Mid-term exam: 25% Recitation exercises: 25%

Final exam: 25% Final Project: 15%

Quizzes: 5%

There will be 6 to 8 impromptu quizzes; some will be at the beginning of lecture, some at the beginning of recitation (so be on time). There is no makeup for the quizzes.

Participation: 5%

Attendance will be taken by Ms. Bumbaco. You are allowed 2 unexcused absences from either lecture or recitation; after that you will lose participation points for each unexcused absence from class.

NOTE: Throughout the quarter there may be a few special lectures to attend for "extra quiz credit."

There will be a **Final Project**. This will be due before the end of the quarter and more details will be forthcoming during the recitation session in the third week of the quarter.

Additional Class Materials:

Additional materials will be placed on reserve throughout the quarter. The list of these will be maintained on the class web page under Reserve Materials. All materials (unless otherwise indicated) are on closed reserve in the ***Geology Library in Orton Hall*** [the building with the bell tower on the south side the Oval]. All materials will be filed under Geography G597.02 unless otherwise indicated. Other class related materials will be made available at the appropriate time, either from the class web page or in a binder that will be placed on reserve in Orton Library. Some material will be made available by electronic reserves that are now accessed through Carmen. You will be informed in class and by email regarding the location of any ancillary class materials.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

I look forward to working with you as a group and individually as you learn more about your environment and the Earth's climate system - past, present and future.

Geography 607
Spring 2008

Fundamentals of Geographic Information Systems

Instructor:
Dr. Mei-Po Kwan
Office: Room 1054, Derby Hall
Phone No: 614 – 292 – 9465
E-Mail: *kwan.8@osu.edu*
Office hours: By appointment

Time: Monday and Wednesday 10:30am - 11:48am in DB 0140

Lab Session Time: Friday (10205-7) 08:30am - 10:18am in DB 0140
Friday (10204-1) 10:30am - 12:18pm in DB 0140

GTA:
Ms. Hyowon Ban
Office: 0135 Derby Hall
Phone No: 614 – 292 – 1333
E-Mail: *ban.11@osu.edu*
Office hours: Friday 01:30pm – 03:30pm

Course objective

The course is designed to give students an understanding of geographic information systems, their capabilities, uses, and limitations. Relevant applications are demonstrated in the lecture and in the computer laboratory portion.

Format of the course

This course will rely heavily on lecture and discussion. Students will also be asked to gain hands-on experience in GIS applications by attending lab sessions, and working on lab assignments.

Textbook

S.J. Steinberg, and S.L. Steinberg, 2005. *Geographic Information Systems for the Social Sciences: Investigating Space and Place.* 1st edition, Sage Publications, Inc.

Course requirements

The distribution of your grade is as follows:

30% Two Mid-Term Examinations on April 21 and May 12 (15% each)
30% Final Examination on June 4 (Wed) 9:30 – 11:18am
40% Five Laboratory Exercises

We will be using mainly ArcGIS in the labs.

For lab assignments, there will be a **5%** penalty per day if late. Work handed in more than **2-days** late will **NOT** be accepted. Labs usually are due two weeks from when they are introduced (see attached table in this syllabus) and are due in the beginning of the students' enrolled lab session, otherwise it will be considered late. All lab reports are required to be submitted electronically through Carmen. Hardcopy submissions will not be accepted and lab grades will also be posted in Carmen grade book.

Academic Misconduct: It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).

Students also need to keep and handle their own lab work appropriately to avoid being copied by someone else. All the students are responsible for removing their own lab work from public-access hard drives and store the data in their own media (e.g., jump drive). Those who fail to protect their own work and result in copied lab work will also be treated as involvement in plagiarism.

.

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD292-0901; http://www.ods.ohio-state.edu/.

Spring 2008 Course Schedule*

	Monday	Wednesday	Lab Sessions
Week 1 March 24 and 26	Introduction: GIS	Introduction to Spatial Data	**Lab1:** Introduction to ArcGIS, Geodata, and Map Projections
Week 2 March 31and April 2	Maps and Map Analysis	Maps and Map Analysis	**Continue Lab 1**
Week 3 April 7 and 9	Vector GIS	Vector GIS	**Lab2:** Vector Data Operations **Lab1 DUE**
Week 4 April 14 and 16	Raster GIS (Dr. Carolyn Merry)	Raster GIS (Dr. Carolyn Merry)	**Continue Lab 2**
Week 5 April 21 and 23	**Mid Term Exam (April 21)**	Spatial Databases	**Lab3:** Raster Data Operations **Lab2 DUE**
Week 6 April 28 and	Spatial Databases	GIS Capabilities	**Continue Lab 3**
Week 7 May 5 and 7	GIS Capabilities	GIS Applications (Real Estate)	**Lab4:** Data Relations **Lab3 DUE**
Week 8 May 12 and 14	**Mid Term Exam (May 12)**	GIS Visualization (Guoxiang Ding)	**Continue Lab 4** **Lab5:** Applications of GIS – Final Project
Week 9 May 19 and 21	GIS Implementation	GIS Applications	**Lab4 DUE** **Continue Lab 5**
Week 10 May 26 and 28	Holiday (No Class)	Ethics and Future	**Lab5 DUE**
Final Exam week		**Final Exam (June 4 Wed 9:30 to 11:18am)**	-

* Check the course web site for the most updated schedule.