ATMO 352
Severe Weather and Mesoscale Forecasting
Spring 2007

Instructor

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Course Objectives

The objective of this class is to provide students with 1) a firm foundation in the underlying physical processes of severe convective storms and 2) working knowledge of state-of-the-art diagnostic, forecasting and observational tools and methodology in mesoscale meteorology. The study of severe convective storms covers a variety of topics, including but not limited to: supercells/tornadoes, hailstorms, convectively-driven straight-line wind events, mesoscale convective systems, lightning, and flash flooding. Theoretical and observational approaches will be employed to investigate the physical processes of convection. With an understanding of the underlying physics, the course then emphasizes the observation and forecasting of severe convective storms, including a discussion of operational systems (e.g., radars, satellites, and numerical weather models) and associated techniques. Results from the latest research efforts to understand and forecast severe storms will be presented.

Course Schedule

Lecture: MW 12:40 – 1:30 PM, O&M 103
Lab Sections: 501, R 2:20 – 4:20 PM, O&M 1201
502, F 11:30 – 1:30 PM, O&M 1201

Prerequisites

MATH 172. Although not currently a formal prerequisite, students are *strongly* encouraged to take ATMO 251 (Weather Observation and Analysis) *prior* to this class.

Recommended Textbook (recommended reading will accompany most lectures)

Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes Vol. II, Oxford University Press, New York.

Other Recommended Textbooks/Books

Bluestein, H. B., 1999: Tornado Alley: Monster Storms of the Great Plains. Oxford University Press, New York.

Doswell, C. A., 2001: Severe Convective Storms. Meteorological Monographs, Vol. 28, No. 50, American Meteorological Society, Boston.

Rauber, R. M., J. E. Walsh, and D. J. Charlevoix, 2006: Severe and Hazardous Weather. An Introduction to High Impact Weather. 2nd Edition, Kendall/Hunt Publishing Company, Dubuque, Iowa.

Ray, P. S., 1986: Mesoscale Meteorology and Forecasting. American Meteorological Society, Boston.

Laboratory Materials

- GARP and NSHARP meteorological analysis and data viewing software – installed on each PC in the 12th floor computer lab (1201); all students will be given a computer account and basic instruction in UNIX, GARP and NSHARP.
- The UCAR-COMET Meteorology and Education and Training (MetEd - http://meted.ucar.edu/index.htm) web-based training modules available on the Internet. Most of the necessary modules will come from either the "Convective Weather" (http://meted.ucar.edu/topics_convective.php) or the "Mesoscale Meteorology" (http://meted.ucar.edu/topics_meso.php) topic areas.
- Other approved Internet websites with useful meteorological data and information.

Tentative Course Outline

Week 1 - Convection in the Atmosphere
Buoyancy. CAPE (Convective Available Potential Energy) and convective updrafts – parcel theory. Limitations of parcel theory. NCAPE (Normalized Convective Available Potential Energy). Single-cell convection.

Week 2 - Sounding Analysis
The sounding diagram. Dry and moist adiabatic ascent. Moist convection. CAPE – graphical calculation and interpretation. Instability indices. Airmass types.

Week 3 - Relationship between Storm Environment and Structure
Convective storm structure and evolution (single cell, multicell, and supercell). Role of wind shear. Theory. Application - the hodograph.

Week 4 - Convective Storm Type Prediction

Convective storm type prediction using buoyancy, shear and associated combined indices (e.g., bulk Richardson number). Other advanced forecasting indices.

Week 5 - Interpretation of Operational Radar and Satellite Imagery

Radar reflectivity. Doppler velocity. WSR-88D radar network. Visible and infrared imagery of clouds. GOES (Geostationary Operational Environmental Satellites).

Week 6 - Severe Local Storms and the Storm Prediction Center (SPC)

Definition and climatology of severe convective weather - tornadoes, hail, and straight line wind events. SPC procedures and products - Convective outlooks, watches, warnings and mesoscale discussions.

Week 7 - Tornadoes

The supercell. Mesocyclogenesis. Tornado genesis, maintenance, and decay. Structure and intensity of tornadoes. Radar detection of mesocyclones. Indices for forecasting supercells and tornadoes. Tornadic vs. non-tornadic supercells. Non-supercell tornadoes. Case studies.

Week 8 - Hailstorms

Hail formation. Storm characteristics. Hailstone trajectories. Supercell vs. multicell. Radar detection. Case studies.

Week 9 - Convectively-Driven High Wind Events

Fundamentals of the downdraft. Types of downdrafts and resultant outflows. Detection and Forecasting. Case studies.

Week 10 - Mesoscale Convective Systems

Definitions. Climatology. Large-scale environment. Radar and satellite structure (e.g., squall lines, bow echoes, Mesoscale Convective Complexes). Relationship to severe weather. Derechos. Case studies.

Week 11 - Convective Rain Production and Flash Flooding

The physics of rain formation. Precipitation efficiency. Environmental and storm characteristics. Introduction to hydrometeorology. Forecasting and detection. Case studies.

Week 12 - Lightning

Climatology. Storm electrification and electrical structure. Lightning types (cloud-to-ground versus intra-cloud). Relationship of lightning to storm structure and characteristics. Forecasting and detection (National Lightning Detection Network, Lightning Detection and Ranging). Case studies.

Week 13 - Large-scale Processes Modulating Severe Weather

Quasi-geostrophic theory. Jet streaks. Feedback processes. Numerical Weather Prediction (NWP) models and forecasting.

Week 14 - Mesoscale Processes and Severe Local Storms Forecasting

Mesoscale preconditioning. Mesoscale triggering (e.g., terrain, land-sea breeze, dryline, gust fronts). Storm-generated mesoscale effects. Mesoscale models and forecasting. Human input to mesoscale and severe weather forecasting: Ingredients-based method versus chart pattern recognition.

Grading Policy

Percentage	**Assignment**	**Date**	**Comment**
20%	1st Examination	Mon, 26 February	Covers roughly first 1/3 of class material. Exam will be a mixture of short answer, word problem/problem solving/derivation, and multiple choice questions. No unexcused absences. All other absences must be arranged before the exam.
20%	2nd Examination	Wed, 11 April (* updated 3/20 *)	Same format and procedures as above *except* covers approximately second 1/3 of class material
30%	Final Examination	Mon, 7 May (10:30 AM-12:30 PM)	**Part I (20%).** Same format and procedures as above *except* covers approximately last 1/3 of class material. **Part II (10%).** Additional questions similar to real-world forecasting exercises in lab. Requires comprehensive knowledge of all class materials, especially from lab.
30%	Laboratory Assignments; nearly every week during lab (about 13 labs).	Typically due at start of next lab.	Unexcused late assignments will be penalized 10% per day until the start of the next lab after which no credit will be given.

Letter grades will be assigned based on the following approximate guidelines:

90 - 100%	A	Excellent
80 - 89%	B	Good
70 - 79%	C	Satisfactory
60 - 69%	D	Passing
<60%	F	Failing

Plagiarism Statement

The materials used in this course are copyrighted. These materials include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless permission is expressly granted.

As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even is you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions regarding plagiarism, please consult the latest issue of the *Texas A&M University Student Rules*, http://student-rules.tamu.edu, under the section "Scholastic Dishonesty."

Aggie Honor Code - "*An Aggie does not lie, cheat, or steal or tolerate those who do*."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: www.tamu.edu/aggiehonor/. By signing assignments and examinations at Texas A&M University, the following Honor Pledge shall be understood and thereby signed to by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

Accommodations

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room B118 of Cain Hall, or call 845-1637.