Geography 5942
Synoptic Meteorology: Severe Storm Forecasting
Spring 2020

Instructor: Jeff Rogers, Prof. Emeritus
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Office Hours: M, W 11:00-12:30p.m.
Course Prerequisites: Geography 5941, Physics 1250
Class Meetings: M, W, 12:45 – 2:05 p.m. in Db 0140

Access to course lecture materials: http://carmen.osu.edu.

Suggested Textbook: ***Mesoscale Meteorology in Midlatitudes*** by Paul Markowski and YvetteRichardson. Order through websites such as Amazon, it has **not** been ordered for the OSU bookstores.

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 exams worth 25% of your grade.

2. The Final Examination worth 30% of your grade, Tuesday April 28 at noon

3. Course assignments and Laboratory assignments worth 45% 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 group 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 2018, 2019 or based on events occurring in previous years, using stored data at the Storm Prediction Center. Your analysis will be presented orally to the class.

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).

Course Outline

Lecture Topics	Markowski readings

Introductory Lectures:

Climatology of thunderstorms, hail, tornadoes & high winds, annual and diurnal cycle characteristics.
Winter mesoscale Great Lakes weather: Lake effect precipitation processes — Chap. 4.4 – 4.5
Evaporation, condensation, cloud and precipitation formation mechanisms. Curvature & solute effects. Ice crystals and their habits. Aggregation and riming processes; graupel and snowflakes. Wet and dry hailstone growth.

Tools of mesoscale meteorology:

The hodograph . . . . Chapter 2.7
Thermodynamic diagrams & stability analysis . . . . Ch. 2.6; 2.1; 2.3.3, & 3.1
Atmospheric convection and parcel theory. Sounding analysis
Convective initiation . . . . Chap. 7.1, 7.2
Meteorological Radar; theory and applications . . . . Appendix A pp. 369-387
Weather radar systems & components; anomalous propagation; radar equation.
Equivalent reflectivity and Z-R relationships. Radar scanning strategies, NEXRAD data products, Doppler radial velocities, spectrum & spectrum width. Radar echo arrangements
Weather satellites in severe weather detection, analysis, & applications

Meteorological Analysis of severe weather

Moisture convergence and elevated convection . . . . Chap. 7.3 & 7.4
Synoptic-scale fronts & interactions in severe weather outbreaks; 1974, 2003 . . . . Chap. 5.1
Synoptic Upper level support mechanisms, jet streaks . . . . Chap. 2.2
The dryline; appearance, climatology, its motion and role in convection . . . . Chap. 5.2
Mesoscale outflow boundaries . . . . Chap. 5.3
Sea breeze and coastal fronts . . . . Chap. 5.4
Gravity waves in severe weather formation . . . . Chap. 6.1 & 6.4
The Great Plains Low level jet: identification, other jets, causal factors, synoptics . . . . Chap. 4.7

Severe Weather and Severe Storms: Processes and Prediction

Single cell and multicellular convection . . . . Chap. 8.1 to 8.3
Heavy precipitation and flash flooding . . . . Chap. 10.4
Squall lines: types, morphology, evolution, bow echoes & derechoes. . . . . Chap. 9.1 to 9.4
Mesoscale Convective Complexes: basic characteristics and evolution; MCV's. . . . . Chap. 9.5
Supercell thunderstorms: structure, evolution, supercell splitting & role of wind shear. . . . . Chap. 8.4
Supercell Tornadoes: morphology, Fujita scale, evolution, physical processes. . . . . Chap.10.1 & 10.3
Non-supercell tornadoes, gustnadoes, landspouts, waterspouts
Downbursts, Macrobursts and microbursts. . . . . Chap 10.2
Lightning, characteristics, causes, detection, effects on humans.

Final Group Oral Presentations on Monday April 20 and possibly also April 15

FINAL EXAM: Tuesday April 28, 2020 at 12:00 p.m. to 1:45 p.m.