ATS 735
Mesoscale Dynamics

(3 cr)

Spring Semester 2014

Instructor: Richard H. Johnson, Room ATS 305 (johnson@atmos.colostate.edu)
Class hours: TuTh 1:00-2:15 pm
Location: ACRC 212B

Reading materials: There are no required texts. The recent book *Mesoscale Meteorology in Midlatitudes* by Markowski and Richardson covers a number of topics in the course. It may be a useful addition to your library if you are involved with mesoscale-related research.

A set of notes will be made available for the course, although we will not cover all of the material in them. An initial version will soon be posted at http://johnson.atmos.colostate.edu/teaching (username and password will be given at first class).

Based on the interests of those enrolled in the class, certain topics in mesoscale dynamics may be emphasized more than others.

Although basic concepts will be introduced, a primary objective of the course will be to explore new advances concerning the topics in the outline below by reviewing recent papers on these subjects. In addition, there may be several guest lectures on some of the topics.

Several books that are relevant to the course are:

Cloud Dynamics, 1993 (R. A. Houze, Jr.)

Atmospheric Convection, 1994 (K. A. Emanuel)

Severe Convective Weather, 2001, AMS Monograph (C. Doswell, Ed.)

Mesoscale Dynamics, 2007 (Y.-L. Lin)

Mesoscale Meteorology in Midlatitudes, 2010 (P. Markowski and Y. Richardson)

Course Outline (topics covered may be revised depending on class interests)

1. Definitions of mesoscale
2. Energy spectra considerations
3. Jets and fronts
4. Instability mechanisms and other processes leading to mesoscale phenomena
    - Rayleigh or shearing instability
    - Kelvin-Helmholtz instability
    - inertial instability
    - dry symmetric instability and conditional symmetric instability (CSI)
    - conditional, convective instability
    - slantwise convection
5. Moist convection, mesoscale convective systems
    - definitions/classifications, environmental factors influencing type of convection
    - structure, organization and life cycle characteristics of mesoscale convective systems
    - mesoscale processes associated with convection
        - mechanisms for environment preconditioning and triggering of convection
            * boundary layer processes
            * low-level convergence zones
            * gravity currents, waves, bores, and solitary waves
            * mesoscale processes along fronts and drylines
            * jets and jet streaks
            * mesoscale instabilities
        - theory of squall lines, bow echoes
        - mesoscale convective vortices
        - modification of environment by convection
            * generation of gravity currents, waves; impact on future convection
            * upper-tropospheric effects
            * radiative and microphysical effects
            * momentum transport
            * mesoscale pressure fields

- mesoscale precipitation features in hurricanes, the MJO, tropical waves

6. Orographic effects

Course structure and grading:

Course will consist of lectures as a lead-in to various topics. Then relevant key papers on the topics, in most cases recent articles, will be reviewed. All will participate in reading the papers, but lead discussants will be assigned to each for in-class review and analysis. Topics will be selected and finalized in the first three weeks of class.

In addition, grades will also be based on $\sim$ 5 page (double-spaced, not counting figures) paper and $\sim$ 10 minute oral presentation at the end of the semester of an analysis, modeling, or theoretical study of a mesoscale or subsynoptic-scale weather phenomenon or event (e.g., convective phenomena, mesoscale aspects of tropical or extratropical cyclones, orographic precipitation event, localized windstorm, etc.) using operational or research data networks. Examples of data that can be used are (1) operational data: WSR-88D radar data, satellite data, data from surface mesonetworks, data from wind profilers and soundings, etc., or (2) field experimental data: DYNAMO, PREDICT, VORTEX, PLOWS, VOCALS-REX, TiMREX, MC3E, etc. (see http://www.eol.ucar.edu/deployment/archived-pages/past for a list of projects in the past 5 years supported by NCAR/UCAR).

Learning outcomes

After completion of this course, students are expected to have gained an understanding of the fundamentals of mesoscale dynamical processes in the atmosphere as well as the key recent advances in this field based on recently published journal articles.

Expectations for homework and outside reading

Averaged over the semester, at least two hours of effort are expected related to readings and class project research outside of class for each hour of class time.

Honor pledge

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf) and the Student Conduct Code (http://www.conflictresolution.colostate.edu/conduct-code). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.