ATS 735
Mesoscale Dynamics

(3 cr)

Spring Semester 2012

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).

This year's class will focus on mesoscale process associated with precipitation systems, both in the tropics and midlatitudes. One reason for this emphasis is that there have been a number of recent papers on this subject and field campaigns directed at this problem:

DYNAMO (Dynamics of the MJO), October 2011 − January 2012
PREDICT (Pre-Depression Investigation of Cloud-Systems in the Tropics), Summer 2010
MC3E (Midlatitude Continental Convective Clouds Experiment), Spring 2010
PLOWS (Profiling of Winter Storms), Winter 2009-10
VORTEX 2 (Verification of the Origins of Rotation in Tornadoes Experiment 2), Spring 2009

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 will 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

1. Definitions of mesoscale
2. Energy spectra considerations
3. 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
4. Mesoscale precipitation systems in extratropical cyclones
5. Moist convection, characteristics and mesoscale processes
    - 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
            * orographic effects
        - 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

6. Mesoscale precipitation features in hurricanes

7. Mesocale processes in the MJO, tropical waves

Tentative Course Schedule

Week	**Dates**	**Topics**
1	Jan 16-20	Introduction, Definitions
2	Jan 23-27	Energy spectra
3	Jan 30 - Feb 3	Mesoscale instabilities
4	Feb 6-10	Mesoscale instabilities
5	Feb 13-17	Mesoscale precipitation systems in extratropical cyclones
6	Feb 20-24	Mesoscale convective processes, organization of convective systems
7	Feb 27 - Mar 2	Environment preconditioning and triggering mechanisms
8	Mar 5-9	Environment preconditioning and triggering mechanisms
9	Mar 12-16	Spring Break
10	Mar 19-23	Dynamics of squall lines, bow echoes
11	Mar 26-30	Mesoscale convective vortices
12	Apr 2-6	Modification of environment by convection
13	Apr 9-13	Modification of environment by convection
14	Apr 16-20	Mesoscale precipitation features in hurricanes
15	Apr 23-27	Mesoscale processes in the MJO, tropical waves
16	Apr 30 - May 4	Class project presentations
17	May 7-11	Finals week

Course structure and grading:

Course will consist of lectures as a lead-in to various topics. Then relevant key papers on the topics, in many 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 on roughly a 2-week basis. Depending on the size of the class, these reviews may be conducted by groups of two. Topics will be selected and finalized in the first two weeks of class.

In addition, grades will also be based on $\sim$ 5 page (double-spaced) 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, 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, etc., or (2) field experimental data: DYNAMO, PREDICT, VORTEX, PLOWS, VOCALS-REX, TiMREX, 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).