MAR 598 Synoptic and Mesoscale Meteorology

Instructor:
Professor Brian Colle, 135 Endeavour Hall, SoMAS
632-3174, brian.colle@stonybrook.edu

Office Hours: TBA or by appointment

Class Web Site: http://atmos.msrc.sunysb.edu/~colle/MAR598/

Class Hours: 4 credits, M,W 10:00-12:00 PM
Lectures generally 10-11:10 AM
Labs 11:15 to 12:00 PM


Other good references:
Markowski and Richardson, 2010: Mesoscale Meteorology in Midlatitudes
Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes
Martin, J., 2006: Mid-Latitude Atmospheric Dynamics
Bosart and Bluestein, 2008: Synoptic-Dynamic Meteorology and Weather Analysis and Forecasting: A Tribute to Fred Sanders
Houze, R., 1993: Cloud Dynamics

Learning Objectives:

◦ Explain the structure and evolution of synoptic cyclones, fronts, and convective systems
◦ Apply fundamental synoptic dynamic principles to the development of cyclones and fronts
◦ Understand the physical mechanisms and processes associated with convective systems, gravity waves, and terrain-coastal circulations
◦ Utilize model and observations to diagnose the daily weather changes and an individual project on a particular storm event

Grading:
30%: Three quizzes (10% each)
30%: Class Project
30%: Labs and homework
10%: Participation: In class and/or weather discussion (most Fridays 2:30PM).
**Project:** Student diagnosis of a synoptic/or mesoscale problem related to your own research/interest using model and/or observed data. Past topics: Interaction of baroclinic wave with topography, synoptic/mesoscale analysis of a major storm event, gravity wave genesis in relation to synoptic disturbances orography, cyclone structure and climatology within GCM, tropical connections to extratropical circulation, surface fluxes within nor-easter, wave packets, etc... Please decide by 4th week.

**Course description:** Course examines the structure and evolution of synoptic and mesoscale systems using observations and modern dynamical approaches. Diagnosis of synoptic systems includes applications of quasi-geostrophic theory to baroclinic waves; jet stream and frontal circulations. A survey of the concepts of mesoscale systems includes banded precipitation structures, gravity waves, and orographic flows/precipitation, and organized convection.

**Schedule of lectures and labs:**

**Week 1 History and Background (Lackmann: Chapter 6)**
- a. Evolving ideas regarding cyclone and frontal structures.
- b. Zero order frontal equation.
- c. Surface and upper air analysis techniques.
  Lab #1: 500 mb analysis
  Lab #2: 500 mb analysis: part 2

**Weeks 2-3 Fronts and Frontogenesis (Lackmann: Chapter 6)**
- a. Basic frontal relationships and dynamics. First order frontal relationships
- b. The frontogenetical equation
- c. Secondary circulations: the Sawyer-Eliassen equation
- d. Observations of fronts and frontogenesis
- e. Upper-level fronts
  Lab #3,4: Frontal identification: Surface analysis

**Week 4 Brief Review of Diagnosis of Synoptic Systems. (Lackmann: Chapter 2)**
- a. Quasi-geostrophic w-equation, Q-vectors, and Sutcliffe/Pettersen/Trenberth approaches
- b. Jet streak theory and application.
  Lab #5: Frontogenesis lab.
  Lab #6: Q-vector calculations.

**Week 5-6 Cyclogenesis (Lackmann: Chapters 5 and 4)**
- a. Peterssen type A and B development
- b. Explosive cyclogenesis
- c. Modal and non-modal development
- d. PV view of cyclogenesis
  Lab #7: PV evolution for a developing cyclone.

**Weeks 7-8 Three-dimensional Structural Evolution of Midlatitude Cyclones:**
a. Conceptual models of cyclone structural evolution. Norwegian cyclone model, split fronts, cold fronts aloft, etc.
b. Simulated structures and airflows
Lab #8: Cyclone Airflow

**Weeks 9-13 Select Topics in Mesoscale Meteorology:**
a. Symmetric instability and banded precipitation structures
b. Large-amplitude gravity waves
c. Orographic flows and precipitation
d. Organized convection

**Week 14 Student Project Presentations:**