SYLLABUS

MET 412: METEOROLOGICAL ANALYSIS AND FORECASTING

Spring Semester 2014
Location: HIG room 310  13:30-17:30 T & Th
Professor: Steven Businger  Office Hours: by appointment
Email: businger@hawaii.edu  Office HIG 334  Phone 6-2569
Instructor: Tom Robinson  Email: ter@hawaii.edu
TA: Tom Winning  Email: twinning@hawaii.edu

Learning Outcomes
During this semester the science (and art) of synoptic analysis and forecasting will be emphasized in this capstone class. The course will utilize VisionLab in HIG 310. Lab exercises will focus on analysis of the processes that lead to the development of storm systems and severe weather. Lectures will include a forecasting perspective.

Students will prepare and deliver weather map briefings at the end of each lecture/lab period and a forecast contest will provide first hand experience in predicting near term (nowcasting) and short-range weather forecasts (1-5 days), using all available real-time operational weather data, satellite imagery, and NMC and custom prognostic products.

Attendance of WSFO-HNL weather briefings at 10:30 AM is required on Tue & Fri (barring class conflicts). A field trip to a local TV station will be arranged. Guest speakers from the WSFO at HNL will be invited to give special insights into forecast problems facing operational forecasters. First day of instruction--1/13/14, last day of instruction--5/7/14.

Lecture Outline

1. Introduction
   Purpose and general goals of course, structure of class time, course grade
   Introduction to weather forecasting

2. Meteorological Observations
   Types of observations, representativeness
   Modern observing systems

3. Intro to Weather Satellites and NWP in Forecasting
   Radiation Basics, Platform Types
   Imagery Types and Enhancement Curves
   Satellite Image Interpretation
   Components of NWP, data assimilation, parameterization, model types

4. Relation of Wind and Forces
   Momentum Equation
   Scale analysis of atmospheric circulations
   Force balances

5. Planetary-Scale Circulations
   Radiative Forcing and its seasonal variation
   General atmospheric and oceanic circulation
   Thermal wind and the development of the jet stream
   Rossby wave theory, mean trough position, retrogression, blocking,
   Applications to forecasting
6. Synoptic-Planetary Scale Interaction
   High impact weather systems
   Rossby wave trains
   Short waves/jet streak interaction with Rossby waves

7. Synoptic Scale Dynamics
   Baroclinic waves
   Quasi-Geostrophic theory
   Jet-streak dynamics

8. Air Masses and Fronts
   Air-mass characteristics, source regions, air-mass modification
   Frontogenesis Kinematics
   Dynamics of Frontogenesis and frontolysis
   Surface characteristics-locating surface fronts, symbol conventions
   Three dimensional frontal signatures (cross-section analysis)

9. Life cycle of Midlatitude Cyclones
   Cyclones and anticyclones - warm core and cold core
   Deepening vs intensification, pressure tendency equation
   Polar front theory-Norwegian cyclone model
   Baroclinic instability of the westerlies, Development equation
   Conveyor belt model, isentropic analysis
   Definition and climatology of rapid cyclogenesis, some famous explosive storms
   Rapid cyclogenesis over land
   Weather hazards associated with midlatitude cyclones

10. Cyclogenesis in Polar Air Masses
    Physical and synoptic characteristics of polar lows
    Explosive deepening with instant occlusions

11. Precipitation Structures in Midlatitude Cyclones
    Anafronts and Katafronts
    Rainbands
    Forecasting snowstorms, effects of orography, cold air damming

12. Radar Basics
    Radar reflectivity
    Estimation of rainfall
    Range folding
    Velocity estimation
    VAD method

13. Vertical Motion, Instability, and Convection
    Estimation of vertical motion
    Methods of evaluating convective instability
    Air mass thunderstorms-environment and life cycle
    Lightning

14. Severe thunderstorms
    Environmental characteristics and initiation mechanisms
    Dry lines, cold fronts aloft
    Multi-cell versus supercell, storm splitting
    Mesoscale convective complex (MCC), Squall lines
Mesoscale forecasting and nowcasting convective storm hazards
Microbursts, tornadoes, large hail

Grading
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<td>Oral Weather Briefings</td>
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<td>Written Lab Assignments</td>
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Exam dates are: 2/6, 3/6, 4/10, and 5/6

This class is Oral Intensive. See www.hawaii.edu/gened/oc/oc.htm. Oral weather briefings will be presented at the end of each lab period. The weather briefings and an oral research paper presentation will be critiqued and graded for clarity and accuracy in presentation and quality of delivery. Students must adequately complete all oral communication assignments to pass the course with a D grade or better. Students who do not complete all oral communication assignments will not earn O Focus credit.

This class is also Writing Intensive. See manoa.hawaii.edu/mwp/. The writing assignments fall into three categories, (i) written lab assignments (14 labs x 2 pages per lab), (ii) written sections in take-home exams, (8 pages) and (iv) written term paper (6 pages). Each of these will be graded for the quality of the technical writing (content and clarity), with drafts returned for revisions. Grades for each step are logged and used to determine a final writing grade for the course. Students must adequately complete all writing assignments to pass the course with a D grade or better. Students who do not complete all writing assignments will get a D- or an F and will not earn W Focus credit.

Reference Texts

Required Text – Midlatitude and Synoptic Meteorology by Gary Lackmann
Weather Analysis - Dusan Djuric, 1994
Synoptic-Dynamic Meteorology in Midlatitudes, Vols. I&II - Howard B Bluestein, 1993
Mid-Latitude Weather Systems - Toby Carlson, 1991
Weather Analysis and Forecasting - Volume I and II - S. Petterssen, 1956.


**Lecture Topics Outline**

Note: the lecture schedule may change as the semester progresses.

1. Introductory Lecture 1/13
2. Radiation and Satellite Image Analysis 1/15
3. Numerical Weather Prediction 1/21
4. Scale Analysis of the Equations of Motion 1/23
5. Planetary Scale Circulations 1/28
6. Rossby Waves 1/30
7. Synoptic Scale 2/4
8. **Review and Quiz** 2/6
9. Quasi-Geostrophic Theory 2/11
10. Winter Storms 2/13
11. Jet Streaks 2/18
12. Air Masses and Kinematics 2/20
13. Fronts and Frontogenesis 2/25
14. Isentropic Analysis 2/27
15. Bombs and their Hazards 3/4
16. **Review and Quiz** 3/6
17. Polar Lows 3/11
18. Rainbands 3/13
19. Radar Basics 3/18
21. Instability 4/1
22. Air Mass Thunderstorms 4/3
23. Severe Weather 4/8
24. **Review and Quiz** 4/10
25. Severe Weather Sounding Interpretation 4/15
26. Tornadoes 4/17
27. Squall Lines and Multicells 4/22
28. Super Cells 4/24
29. Storm Chasing 4/29
30. Severe Weather Forecasting 5/1
31. **Review and Quiz** 5/6
32. Paper presentations 5/13

Exam dates are: 2/6, 3/6, 4/10, and 5/6