SYLLABUS

ATMO 412: METEOROLOGICAL ANALYSIS AND FORECASTING

Spring Semester 2018

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
Tyler Jewel | Office Hours: T/R 10:30-11:30 or by appt
Phone for TA: 956-7110 | HIG Room 370

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--1/9/17, last day of instruction--5/1/17.

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

Oral Weather Briefings	20%	O
Written Lab Assignments	20%	W
Forecast Contest	15%	W
Research paper & oral presentation	10%	W&O
Four Exams	30%	W
Total	100%	

Approximate Exam dates are: 2/1, 3/1, 4/5, and 5/1

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, (ii) forecasts, (iii) written sections in take-home exams, and (iv) written term paper. 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
Atmospheric Science: An Introductory Survey, Wallace and Hobbs, 2006.
Synoptic-Dynamic Meteorology in Midlatitudes, Vols. I&II - Howard B Bluestein, 1993
Mid-Latitude Weather Systems - Toby Carlson, 1991
An Introduction to Dynamic Meteorology, 3rd edition - J.R. Holton, 2004.
Numerical Prediction and Dynamical Meteorology - G.W. Haltiner and R.T. Williams, 1981.
Handbook of Applied Meteorology - Edited by D. Houghton, 1985.
Weather Analysis and Forecasting - Volume I and II - S. Petterssen, 1956.
Principles of Meteorological Analysis, W. Saucier, 1955.
Atmospheric Circulation Systems - E. Palmen and C.W. Newton, 1969.

Lecture Topics Outline

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

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

Approximate Exam dates are: 2/1, 3/1, 4/5, and 5/1

Student Learning Objectives (SLOs): This is a capstone class in which many fundamental concepts in atmospheric physics and dynamics are reviewed to give the student a solid overview of the field of meteorology. Upon completion of ATMO 412, the student should be able to:

1. Understand weather map analysis at the surface and aloft.
2. Understand the satellite products, including the use of enhancement curves.
3. Explain the application of visible vs infrared vs water-vapor channel imagery in forecasting.
4. Understand the steps involved in creating a numerical weather forecast.
5. Explain the advantages of global models and regional models.
6. Understand the limitations and challenges of numerical weather prediction.
7. Conduct a scale analysis of the equations of motion.
8. Understand various force balances and their application in describing winds in the atmosphere.
9. Explain the general circulation of the atmosphere.
10. Understand the dynamics of Rossby waves and Baroclinic instability and the interplay between the two.
11. Understand the terms in the quasi-geostrophic omega equation.
12. Explain the Norwegian cyclone model and how geography can modify ideal cyclone structure.
13. Understand the dynamics of jet streaks.
14. Explain the origin, characteristics, and modification of air masses.
15. Understand frontogenesis and the structure and morphology of fronts.
16. Explain the use of potential temperature in weather analysis, including cross sections and isentropic analyses.
17. Explain the ingredients needed for rapid cyclogenesis.
18. Understand the energetics, climatology, and hazards associated with polar lows.
19. Understand the morphology of rainbands in winter storms and their relationship with airflow and fronts.
20. Explain the basics of radars and the utility of radar reflectivity in weather forecasting.
21. Understand the basics of radar velocity data in weather forecasting.
22. Understand the basics of convection and instability in the atmosphere and the use of radiosonde data to document atmospheric vertical motions and thunderstorm potential.

23. Explain the stages in the life cycle of an airmass thunderstorm.
24. Explain the contrast between an environment that supports air mass thunderstorms and one that supports severe thunderstorms.
25. Understand the morphology of squall lines and multicell thunderstorms.
26. Understand the environments and structure of super-cell thunderstorms.
27. Use weather data, satellite imagery, and radar data to predicts severe thunderstorm activity.
28. Put together cogent weather briefings on the current and future weather, supported by weather maps, satellite and radar data, and imagery.

Title XI Statement:

The University of Hawai'i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the **confidential resources available here**:

http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support,

contact: Dee Uwono Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.