## I. Objectives

1. Define terms related to *synoptic-dynamic* meteorology.
2. Demonstrate ability to decipher and interpret basic weather forecasting maps.
3. Investigate the principles and practice of modern numerical weather prediction.

## II. Introduction

Meteorology is a sub-field of the atmospheric sciences concerning itself with the processes within the bottom layer of the atmosphere, the *troposphere*, where, what we call "weather." occurs.Historically, meteorology has always been limited to general forecasting of weather patterns, with a reliance on tools and methods which were as much "art" as they were "science." Beginning by about mid-20$^{th}$ century, meteorology has continued to grow rapidly into a highly computer-oriented branch of the atmospheric sciences. It is now a mathematically-intensive science making use of elaborate equations which govern fluid dynamical, thermodynamic, and energy processes occurring in the Earth's atmosphere See the following website to get an appreciation of the complicated mathematical formulations of dynamical meteorology: http://www-history.mcs.st-and.ac.uk/HistTopics/Weather_forecasts.html

University graduate school programs therefore today often divide atmospheric science study into 2 main areas ─ *dynamic* meteorology and *physical* meteorology. Dynamic meteorology uses highly complicated theoretical descriptions of the motions of air parcels to help weather forecasters better predict changes in the state of the atmosphere from day-to-day. Obtaining daily "snapshots" of the weather over a given locale, then, is the subject of *synoptic* meteorology. Since it is so closely dependent on the theoretical models of dynamics, it is often termed *synoptic-dynamic* meteorology. Modern weather forecasting continues to make good use of weather maps. However, today's versions are constructed as much by computer as they were "hand-drawn" during earlier eras. In the exercises presented in this lab, you should acquire a familiarity with weather maps and weather forecasting.

## III. Prelab Definitions

1. air mass

2. front

3. cyclone model

4. Zulu time [Z]

5. air parcel

6. pressure gradient force

7. jet stream

8. dew point

9. isotherm

10. isobar

## IV. Lab Discussion

1. In the context of meteorological studies, explain the term “synoptic.”

2. What is the typical spatial extent, in kilometers, for a mid-latitude synoptic system in the Northern Hemisphere?

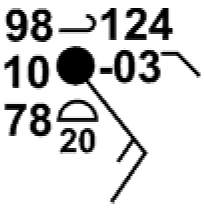
3. Describe 2 distinct ways in which mid-latitude synoptic systems [i.e., cyclonic low pressure weather systems] are different from hurricanes.
   a.

   b.

4. Draw a sketch below to help illustrate what you verbally expressed in the two previous questions above. Begin with a rudimentary outline of the continental United States, and then depict within that space a “surface map,” showing where a typical mid-winter U.S. storm might be located compared with the geographic position of an Atlantic Basin hurricane in summer or fall. Show the direction of spin for each type of weather system.

*Multiple choice questions 5 through 8 below, as well as the associated weather station plot, are adapted from the online review quiz [questions 13-16 as numbered there] given on the National Weather Service webpage: http://www.srh.noaa.gov/jetstream/synoptic/synoptic_review.htm Information from that site is in the public domain.*

Use the station plot, shown immediately below to answer the following questions.




5. The temperature at the station is:
   a. 78°F
   b. 98°F
   c. 124°F
   d. 78°C

6. The dewpoint at the station is:
   a. 78°F
   b. 98°F
   c. 124°F
   d. 78°C

7. The pressure at the station is:
   a. 998 mb
   b. 978 mb
   c. 912.4 mb
   d. 1012.4 mb

8. The wind direction and speed is:
   a. southeast at 15 kt
   b. northwest at 10 kt
   c. southeast at 20 kt
   d. northwest at 15 kt

9. Describe what is entailed in the development of numerical weather prediction [NWP] techniques as they are used by modern meteorologists

10. Why is it necessary to make use of today's supercomputers in order to accurately implement NWP models?

11. What factors contribute to make it exceedingly difficult, if not impossible, to continually extend the accuracy (known as “forecast skill”) of NWPs? Discuss.

12. For how many days into the future is a typical NWP accurate?

13. In the actual parameters used in the computation of modern weather forecasts, what is meant by “time steps”?

14. What is a typical numerical value for a time step in a global weather model?

15. List and briefly describe 3 other geoscience research areas in which applications of numerical prediction modeling are used.
    a.

    b.

    c.

Lab courtesy of Dr. Dana Kerola