

1A:

SURFACE AIR PRESSURE PATTERNS

Objectives:

Much of the weather we experience arises from air put into motion because of differences in air pressure over distance. Across a horizontal surface such as at sea level, whenever and wherever the air pressure varies from one place to another the wind tends to blow from locations with relatively high air pressure towards where the air pressure is relatively low. Knowing the patterns of pressure across the country and the air motion they produce is basic to understanding the weather taking place and predicting what the weather is likely to be. By analyzing the reported values of air pressure across the country, the locations of centers of high and low pressure can be identified on weather maps. The centers typically coincide, respectively, with fair and stormy weather systems.

After completing this investigation, you should be able to:

- Draw lines of equal pressure (isobars) to show the patterns of surface air pressures across the nation at map time.
- Locate regions of relatively high and low air pressures on the same surface map.

Introduction:

Air pressure at any point on Earth's surface or in the atmosphere is equal to the weight of the atmosphere above that point acting on a unit area. This means that air pressure decreases with increasing altitude. Hence, the higher the elevation of Earth's surface, the lower the surface air pressure at that location. Consequently, locating centers of high and low atmospheric pressure which help to identify weather systems require analysis of air pressure values determined at numerous locations at the same elevation.

Air pressures routinely reported on surface weather maps are values "corrected" to sea-level. That is, air pressure readings are adjusted to what they would be if all the reporting stations were actually located at sea-level. Adjustment of air pressure readings to the same elevation removes the influence of Earth's topographical relief on air pressure readings. This adjustment allows determinations of horizontal pressure differences and recognition of pressure patterns. These patterns reveal existing broad-scale pressure areas that have a major influence on the weather.

Horizontal air pressure patterns on a weather map are revealed by drawing lines representing equal pressure. These lines are called *isobars* because every point on the same line has the same air pressure (barometric) value. Each isobar separates stations reporting higher pressures from stations with lower pressures than that of the isobar.

The **Figure 1** surface map which follows shows air pressure in millibar (mb) units at various locations. [One millibar (the pressure unit commonly used for atmospheric pressure) is equal

1A - 2

to one hectopascal (hPa).] (Average midlatitude, sea-level air pressure is 1013.25 mb.) On the map, consider each pressure value to have been observed at the center of the plotted number.

1. On the Figure 1 map, the lowest plotted pressure is 1022 mb and the highest plotted value is [~~(1027)~~(1045)(1046)] mb.

The 1024-mb and 1028-mb isobars have been drawn. **Complete the pressure analysis by drawing the 1032-, 1036-, 1040- and 1044-mb isobars.** Label each completed isobar by writing the appropriate pressure value at its ends as shown.

2. By U.S. convention, isobars on surface weather maps are usually drawn using the same interval (the difference in air pressure between adjacent isobars) as that used on the Figure 1 map. The isobar interval is [~~(2)~~(4)(6)(8)] mb. The isobar interval is selected so as to provide what is generally the most useful resolution of the field of data; too small an interval (for example, 1 mb) would clutter the map with too many lines and too great an interval (for example, 10 mb) would ordinarily mean too few lines to adequately define the pattern.
3. Also by U.S. convention, isobars drawn on surface weather maps are a series of values that, when divided by 4, produce whole numbers (e.g., $1000 \div 4 = 250$). The progression of isobaric values can be found by adding 4 sequentially to 1000 and/or subtracting 4 sequentially from 1000 until the full range of pressures reported on the map can be evaluated. Which of the following numbers would not fit such a sequence of isobar values: [~~(996)~~(1000)(1004)(1008)(1010)(1012)]?
4. The change of pressure over distance is called the **pressure gradient**. On surface weather maps, the directions of the pressure gradients (most rapid pressure change over distance) are always oriented perpendicular to the isobars. And, the closer the isobars appear on a map, the stronger the pressure gradients. Where the 1024- and 1028-mb isobars exist on the Figure 1 map, the horizontal pressure gradient is stronger across [(central North Carolina)](western South Carolina)].

Tips on Drawing Isobars: Keep the following “rules” about drawing isobars in mind whenever you are analyzing air pressure values reported on a surface weather map.

- a. Always draw an isobar so that air pressure readings greater than the isobar’s value are consistently on one side of the isobar and lower values are on the other side.
- b. When positioning isobars, assume a steady pressure change between neighboring stations. For example, a 1012-mb isobar would be drawn between 1010 and 1013 about two-thirds the way from 1010.

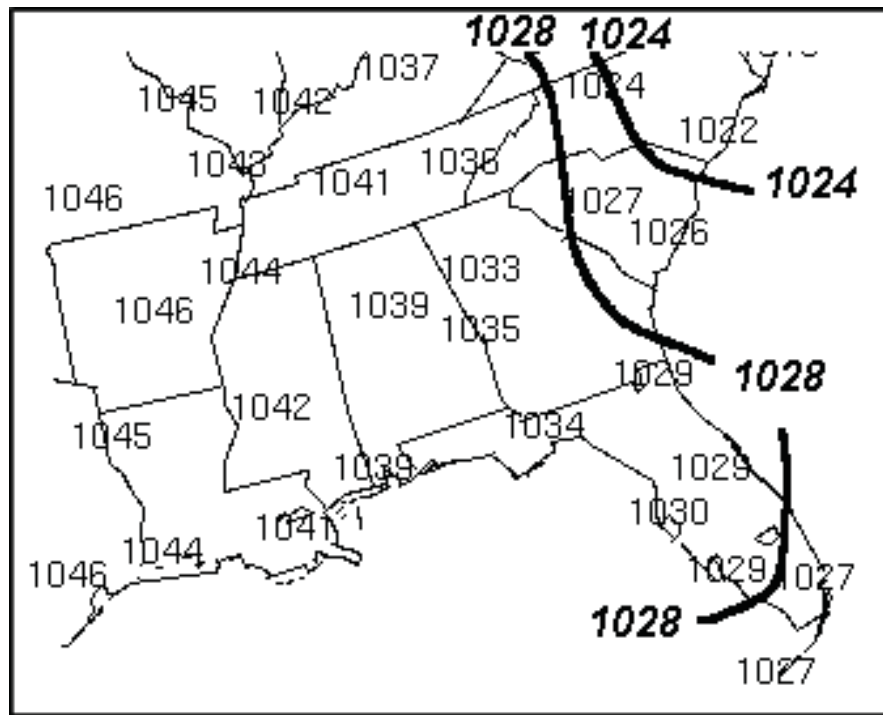


Figure 1
Surface weather map with pressures reported in whole millibar units.

- c. Adjacent isobars tend to look alike. The isobar you are drawing will generally align with the curves of its neighbors because horizontal changes in air pressure from place to place are usually gradual.
- d. Continue drawing an isobar until it reaches the boundary of the plotted data or “closes” to form a loop by making its way to its starting point.
- e. Isobars never stop or end within a data field, and they never fork, touch or cross one another.
- f. Isobars cannot be skipped if their values fall within the range of air pressures reported on the map. Isobars must always appear in sequence; for example, there must always be a 1000-mb isobar between the 996-mb and 1004-mb isobars even if corresponding numbers are not plotted.
- g. Always label all isobars.

Optional: If you are unsure about your isobar-drawing skills or just crave experiences drawing isopleths (lines of constant value, including isobars) before attempting analyses of real-world weather maps, go to: <http://cimss.ssec.wisc.edu/wxwise/contour/>. Try it, you will like it.

Please note that the Internet addresses appearing in this Investigations Manual can be accessed via the “Learning Files” section of the course website. Click on “Investigations Manual Web Addresses.” Then, go to the appropriate investigation and click on the address link. We recommend this approach for its convenience. It also enables AMS to update any website addresses that were changed after this Investigations Manual was prepared.

As directed by your course instructor, complete this investigation by either:

- 1. Going to the Current Weather Studies link on the course website, or*
- 2. Continuing to the Applications section for this investigation that immediately follows in this Investigations Manual.*

Investigation 1A: Applications

SURFACE AIR PRESSURE PATTERNS

In this portion of the investigation, we analyze the pressure pattern existing over the coterminous U.S. at a particular time.

5. **Figure 2** (“Pressures” map) was acquired from the course website and reports surface air pressures (corrected to sea level) rounded to the nearest whole millibar at 03Z 18 JAN 2009. The lowest plotted air pressure on the map is [~~(1002)~~(~~1004~~)(~~1007~~)] mb in the lower peninsula of Michigan.
6. The highest reported pressure is 1043 mb in [~~(Dallas, TX)~~(~~Missoula, MT~~)].
7. The map analysis utilizing the conventional 4-mb interval between isobars will require the drawing of isobars ranging from 1008 mb to [~~(1040)~~(~~1042~~)(~~1044~~)] mb. Note that although the lowest pressure on this particular map actually has the same value as an isobar that fits the interval series, the isobar is not being drawn as it occurs at a single point and there are no pressures less than its value reported. Also, more than one isobar having the same value (e.g., 1028 mb) will appear in a complete analysis of the pressures reported on the map. The isobaric patterns across the western quarter of the U.S. and covering parts of Florida, Georgia and South Carolina have already been drawn.

Using a pencil, follow the steps below to complete the pressure analysis in the eastern two-thirds of the map to determine the pressure pattern that existed at the time the observations were made. Consider each pressure value to be located at the center of the reported number.

8. Arbitrarily we might start by completing the 1040-mb isobar, the last of the series. In addition to those the isobar goes through, the value of “1040” also appears in western Montana. The two ends of this isobar will connect to surround the highest pressure reading. Note that this isobar has been labeled with its value, **1040**, on the isobar line. Place a bold **H** over the highest, enclosed pressure reading. Plotted pressure values outside of this closed isobar are [~~(less than)~~(~~equal to~~)(~~greater than~~)] 1040.

Continue drawing and labeling isobars by extending the ends of the already drawn isobar segments where they existed within the data pattern. Then add isobars where appropriate in the rest of the country until all those in the range of pressures indicated in Item 7 above have been properly placed. Note that isobars with the same values as some of those drawn in the western U.S. appear elsewhere on the map. As was shown across the West, label your isobars with their values at the ends that extend just beyond the data field or on the enclosing line as needed. Complete your pressure analysis by placing a bold **L** where the lowest pressure value was enclosed by an isobar and a bold **H** in the center of the closed 1028-mb isobar in the southeast.

1A - 8

9. **Figure 3** is the analyzed surface pressure map from the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Prediction (NCEP) for 03Z 18 JAN 2009. The Figure 3 map shows the location of air pressure system centers and fronts. The Figure 3 map [~~is~~ ***is not***] the same time and date as the Figure 2 map of pressures you have just analyzed.
10. NCEP surface analysis maps such as the one in Figure 3 often have segments of isobars which do not fit the conventional interval between isobars. Drawn as dashed lines, they are intended to show greater detail in the pressure fields. As shown in Figure 3, they produce a pressure analysis with a [~~1~~ ***2***]~~4~~ mb interval.

Compare your isobar pattern with that drawn on the Figure 3 map. The Figure 3 map is constructed by computer based on a much more complete set of pressure values. (This accounts for some of the variations between your analysis and that by the computers. The more detailed analysis is also the source of multiple plotted Hs denoting locally minimally higher pressure centers, such as those shown in Colorado and Nevada.)

Summary: Much of the weather we experience arises from air in motion because of differences in air pressure from place to place. Knowing the patterns of pressure across a region is fundamental to understanding existing weather and predicting future weather. Analysis of air pressures corrected to the same altitude (e.g. sea level) makes it possible to locate centers of high and low pressure on weather maps. These centers typically mark fair and stormy weather systems, respectively.

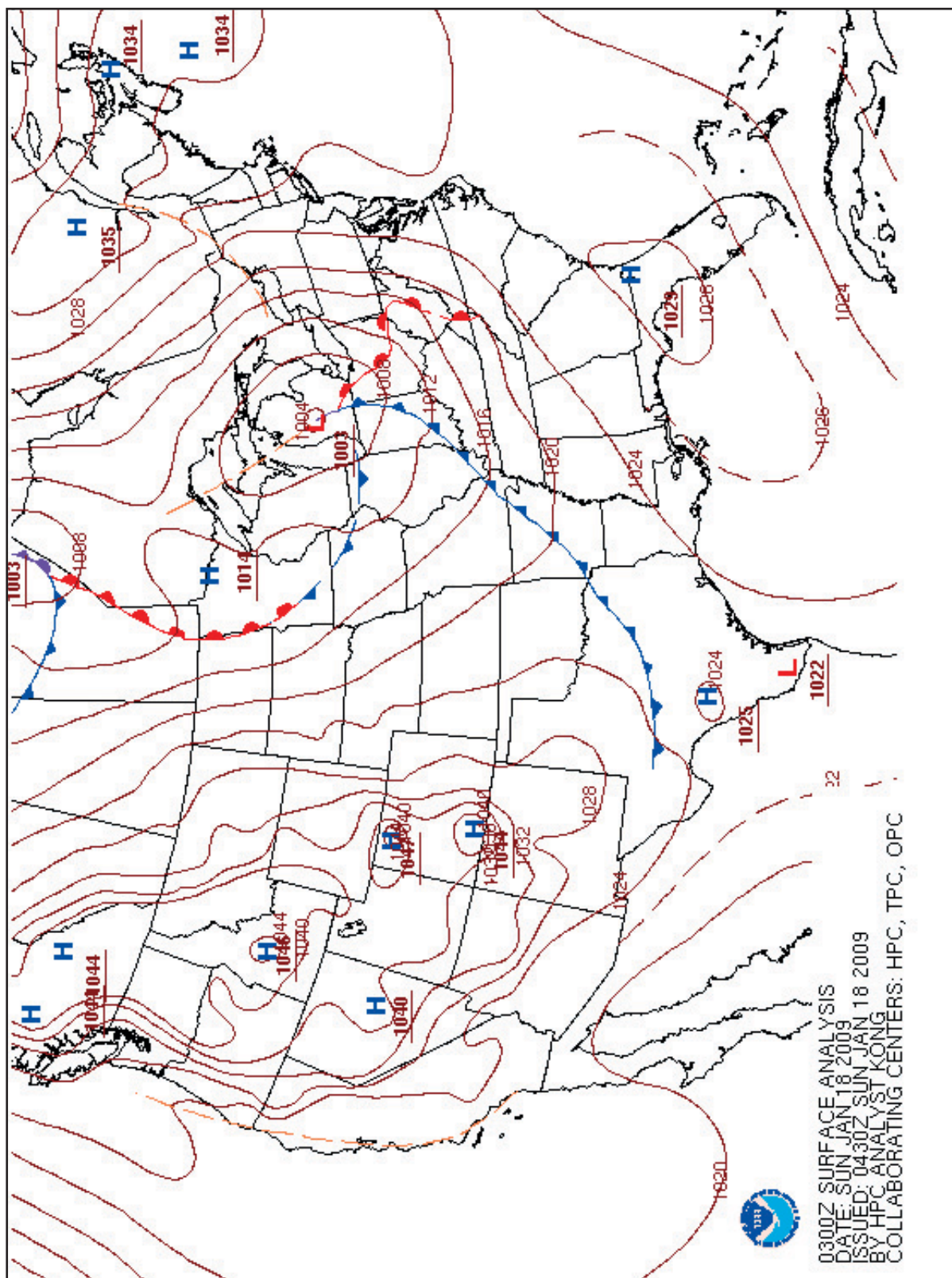


Figure 3
Analyzed NCEP surface weather map for 03Z 18 JAN 2009 showing weather systems and isobars.

