Investigation 1B

Surface Air Pressure Patterns and Winds Applications

During summer 2022, the western U.S. experienced both extreme heat, coupled with extreme dryness, and flooding conditions, consistently dominated by large areas of high pressure. In this activity, we investigate these pressure systems with weak wind fields across the U.S. This is typical of late-summer weather patterns across the U.S.

Surface Air Pressure

Figure 1B-1 is the "Pressures" map, acquired from the *Weather Studies Maps & Links*, Surface Maps, which reports surface air pressure (corrected to sea level) rounded to the nearest whole millibar (mb) on 15 August 2022 at 17Z UTC. Z time is 4 hrs ahead of Eastern Daylight Time (EDT), so the Figure 1B-1 map of 17Z on 15 August depicts conditions at local times of 1 p.m. EDT (and therefore 12 p.m. CDT, 11 p.m. MDT, 10 a.m. PDT, etc.).

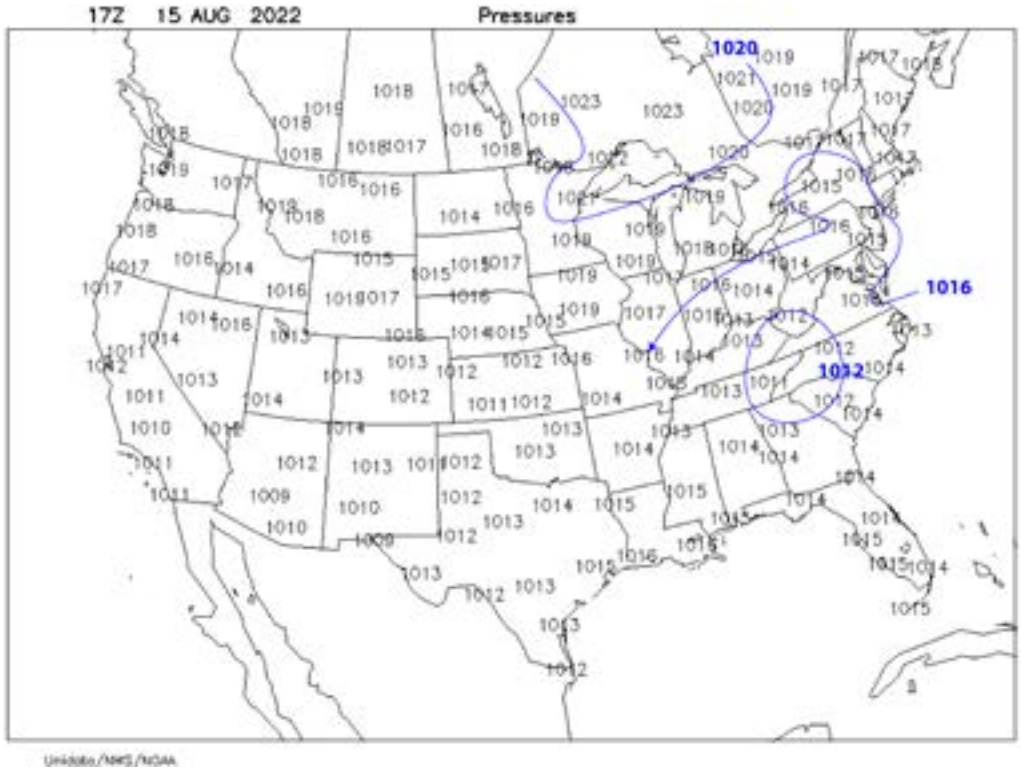

Figure 1B-1. Map of surface atmosphere pressure at selected stations at 17Z 15 AUG 2022.

Click on Figure 1B-1 to view and/print the full size image.

Most weather map products from the Weather Studies Maps & Links are created by the National Weath-

er Service's (NWS) National Centers for Environmental Prediction (NCEP) at the National Oceanic and Atmospheric Administration (NOAA), as noted in the lower image margin, Unidata/NWS/NOAA.

As the course proceeds, we will discuss the geographic regions across the United States. For your reference, common NWS terminology are found at Link 1B-1 for national geographic regions and Link 1B-2 for mountains, valleys, and waterways These can also be found on *Weather Studies Maps & Links*, Extras, "Geographic Region Maps."

1. The highest plotted air pressure in Figure 1B-1 is 1023 mb, observed in _____.

    a. North Dakota
    b. Florida
    c. Texas
    d. Ontario (Canada)

2. The lowest reported pressure was _____ mb in both Phoenix, AZ and El Paso, TX.

    a. 1019
    b. 1009
    c. 919
    d. 909

In Figure 1B-1, pressure measurements are analyzed by plotting isobars, or lines of equal pressure. This process reveals horizontal patterns on a surface weather map. Each isobar delineates values of higher pressure from values of lower pressure.

3. The isobars in the conventional series to complete the pressure analysis *between* the lowest and highest values on this map are _____ mb.

    a. 996, 1000, 1008
    b. 1012, 1016, 1020
    c. 1028, 1032, 1036
    d. 1016, 1024, 1032

To add the isobars for the larger copy of Figure 1B-1, refer to the **Tips on Drawing Isobars** in *Investigation 1A*. More than one isobar of the same value should be drawn if pressure values located in separate sections of the map require it. Consider each pressure value to be located at the center of the reported number. Isobars with values of 1012, 1016, and 1020 mb have already been *partially* drawn, but look for other areas that require the additional 1012, 1016, or 1020 mb isobars as well. The labels for the isobars are added at their ends, off the landmass or off the map. For closed isobar references in a circle, the number is placed in the line itself.

Draw and label isobars over the remaining portions of the U.S. and Canada. *Isobars with arrows were intentionally left incomplete*, and others may wind up being a closed circle or curve. After completing all the isobars, label the positions with the lowest value in the U.S. or Canada with an L. Label the highest pressure in the southeastern U.S. with an H.

4. In St. Louis, MO, the 1016-isobar runs parallel to the Missouri River, intersecting the border with

Illinois aligned mostly east-west. Given the 4-mb interval convention, this line will separate values where the lower values on the map remain to one side while higher values are on the other side. The pressure values of locations *north* of St. Louis are _____ 1016 mb.

a. less than
b. equal to
c. greater than

Figure 1B-2 is the analyzed surface pressure map from *Weather Studies Maps & Links* produced from NOAA's National Centers for Environmental Prediction (NCEP) for 17Z 15 August 2022. Figure 1B-2 shows the locations of isobars, air pressure system centers, and fronts at 15Z, 2 hrs before those on the Figure 1B-1. Compare your analyzed Figure 1B-1 map to Figure 1B-2.

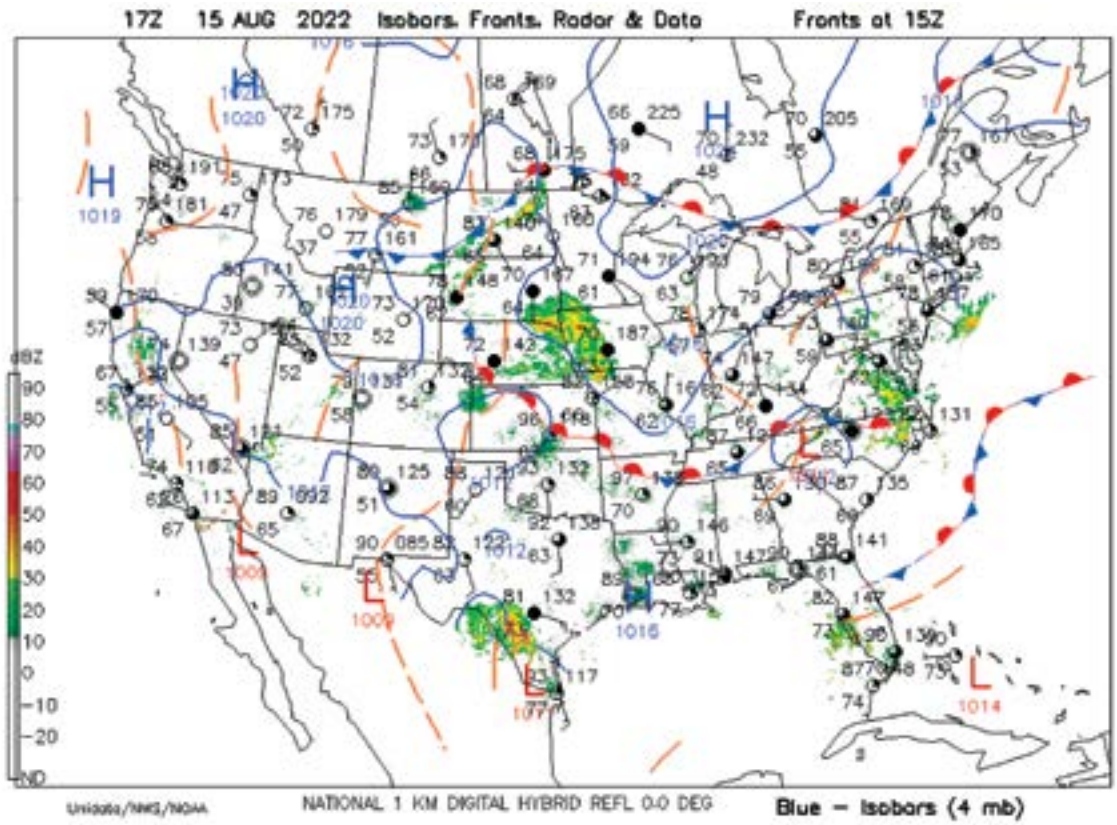

Figure 1B-2. Analyzed surface weather map for 17Z 15 AUG 2022 with isobars (blue lines), pressure systems, and precipitation.

5. The overall isobar patterns on the two maps, particularly for the Tennessee/North Carolina low and the Ontario high, are generally _____. Also included are shadings for precipitation around the country based on radar reports.

a. similar
b. very different

The isobars in Figure 1B-2 are computer generated and based on a more complete set of pressure values than those in Figure 1B-1. This resolution may account for some of the variations between your analysis

and that by the computer. The computer-based analysis is the source of some additional plotted H's, for more local marginally highs, and L's for lows. For example, in Figure 1B-2, the auto-generated plot is drawing in observational data from across the U.S.-Mexico border, indicating other areas of low pressure, while in Figure 1B-1 it is hard to pinpoint any broad area of low pressure in that region.

By analyzing the pressure values reported on weather maps to find pressure patterns, you can locate the centers of local highest and lowest pressures. We will see that these pressure centers often mark the midpoints of major weather systems, either regions of fair weather for highs or storms for lows.

Wind Flow

Figure 1B-3 is the "U.S. - Data" map from the *Weather Studies Maps & Links*, Surface Maps, for 17Z 15 August 2022. The data depict weather conditions at individual locations across the contiguous U.S. plotted using a coded format called the "surface station model." Station models will be examined in more detail in *Investigation 2A*.

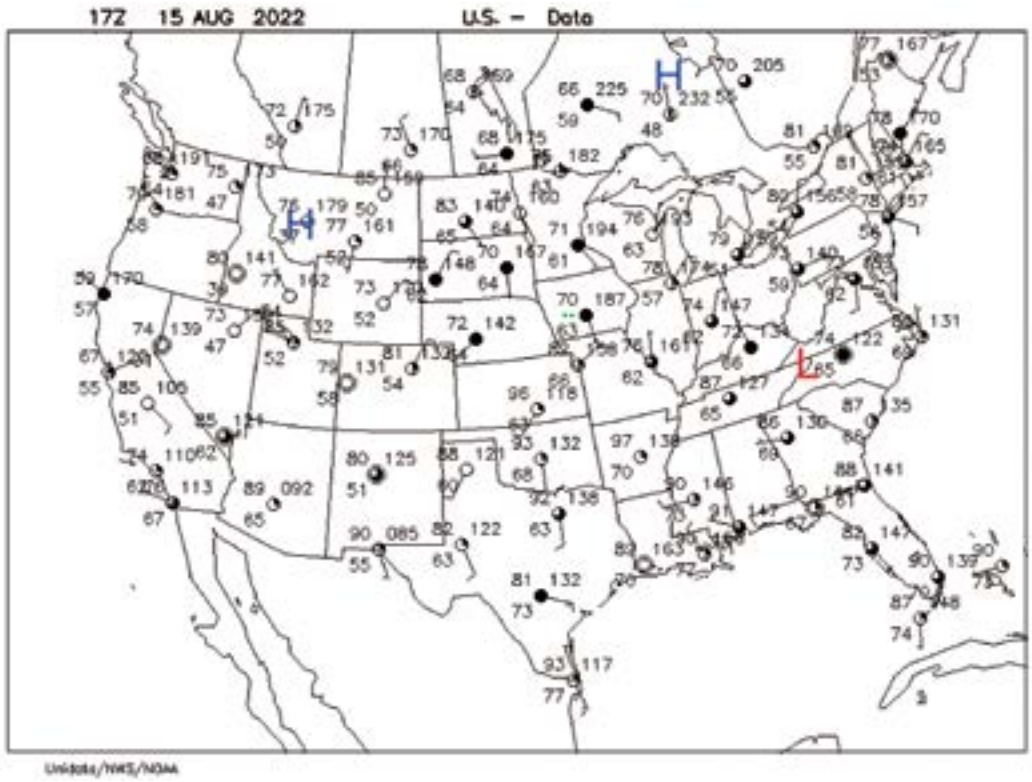

Figure 1B-3. Unanalyzed surface weather map for 17Z 15 AUG 2022 with station model plots conveying surface weather observations of temperature, moisture, pressure, cloud cover, wind speed, and wind direction. The centers of major high- and low-pressure systems are annotated with H and L respectively.

Select stations are shown as circles. The wind directions at those stations are portrayed with a line, which can be thought of as an arrow shaft, depicting the air flow *into* each circle reporting wind. In meteorology, wind at a station is identified by the direction the air is flowing *from* (air arriving at the station from the north is called a *north* wind).

6. The wind direction at St. Louis, MO in Figure 1B-3 was generally *from* the _____. (Assume north is toward the top for any map unless otherwise indicated.)

a. north
b. south
c. west
d. south

7. Knowing the direction *from* which the wind at St. Louis was blowing, it would be reported as a(n) _____ wind.

   a. north
   b. south
   c. west
   d. south

Wind speed is measured in knots; one knot (1 kt = one nautical mile per hour or 1 NM/hr) is about 1.2 land (statute) miles per hour. On a station model, wind speed is reported by a combination of long (10 kts) and short (5 kts) "feathers" attached to the direction shaft. At map time, St. Louis and Atlanta, GA both had a 5-kt sustained wind (one short feather). A double circle without a direction shaft, such as those seen in Reno, NV, Boise, ID, Las Vegas, NV, and Grand Junction, CO signifies calm conditions. A shaft plotted without feathers would denote 1–2 kts. A flag denotes winds of 50 kts.

8. A red L on the map marks the center of low pressure and a blue H, the high-pressure center. Compare the hand-twist model of a low to the wind directions at stations in the several-state area flanking the low-pressure center. Wind direction at these stations suggest that, as seen from Figure 1B-3, the air was circulating _____ around the Northern Hemisphere low-pressure center. (Refer to *Investigation 1A* for the hand-twist models of lows and highs.) Note: The station at Nags Head, NC is likely being affected by local weather, and not necessarily the larger scale low to its west.

   a. clockwise
   b. counterclockwise

9. The winds at stations in the several states around the low-pressure center indicated the air also spiraled _____ the low.

   a. outward from
   b. inward toward

10. This wind flow pattern with respect to the low is therefore _____ the hand-twist model of a low.

    a. consistent with
    b. contrary to

Further details for deciphering station data can be found in the "User's Guide" (linked from the Extras section of *Weather Studies Maps & Links*). The reporting surface weather stations plotted on course maps can be identified from the "Available Surface Stations" link under the site's Surface Maps section. You can also check a map of National Weather Service (NWS) offices (Link 1B-3).

Optional: *Weather Studies Maps & Links* routinely delivers unanalyzed ("Pressures") and analyzed ("Isobars & Pressures") surface pressure maps. Practice drawing isobars by calling up the unanalyzed

version.

Summary

The atmosphere is in continuous motion with air sinking and flowing clockwise and outward near Earth's surface in highs and flowing counterclockwise and inward near the surface and rising in lows. Surface weather maps of air pressure visualize the horizontal movements of pressure systems. Winds blow from high to low pressure and when plotted on a surface weather map visualize the movement of a weather system horizontally. Both horizontal and vertical air motion play large roles in determining the weather.