

# Activity 1: The Polar-Front Jet Stream

The polar-front jet stream is like a high-speed river of air in the upper atmosphere. It separates warm and cold regions at Earth's surface. It may be several hundred miles across from north to south, 5,000 to 10,000 feet (1,500 to 3,000 meters) thick and at an altitude of 30,000 to 43,000 feet (9,000 to 13,000 meters). The polar-front jet stream generally flows from west to east, and is strongest in the winter when core wind speeds are sometimes as high as 250 miles (400 kilometers) per hour. Changes in the jet stream indicate changes in the circulation of the atmosphere and associated local weather.

Upon completing this activity, you should be able to:

- Determine the location of the polar-front jet stream based upon upper-atmosphere wind data.
- Describe influences of the polar-front jet stream on weather and aviation.

## Materials

- pencil

## Investigation

The highest upper-level wind speeds are frequently observed at altitudes of approximately 6 to 8 miles (9 to 13 kilometers) above sea level. **Figure 1** is an upper air chart displaying wind speeds and directions observed at 12Z (7 am EST) on 10 March 2011 at altitudes where the air pressure was 300 millibars. At map time, the actual altitudes at which the air pressure was 300 millibars varied from 29,320 to 31,290 feet (8940 to 9540 meters) above sea level. Upper-level data are routinely displayed on constant-pressure charts because of the usefulness of such charts to meteorologists. The data were acquired by tracking balloon-borne weather instruments, called radiosondes, which measure and transmit weather data as they rise through the atmosphere.

Wind information is depicted by “arrows” shot into locations on the map where radiosondes were launched. On the arrow, the straight line represents wind direction while the feathers represent wind speed. Winds are named for the direction from which they are blowing. For example in Figure 1, a northwest wind was reported at Minneapolis, Minnesota. Wind speed is reported in knots (1 knot equals 1.0 nautical mile per hour or 1.15 statute miles per hour); a full length feather represents 10 knots, a half feather stands for 5 knots, and a flag means 50 knots. The wind speed at Minneapolis, at 300 millibars was 70 knots from the northwest (flag plus two full feathers).

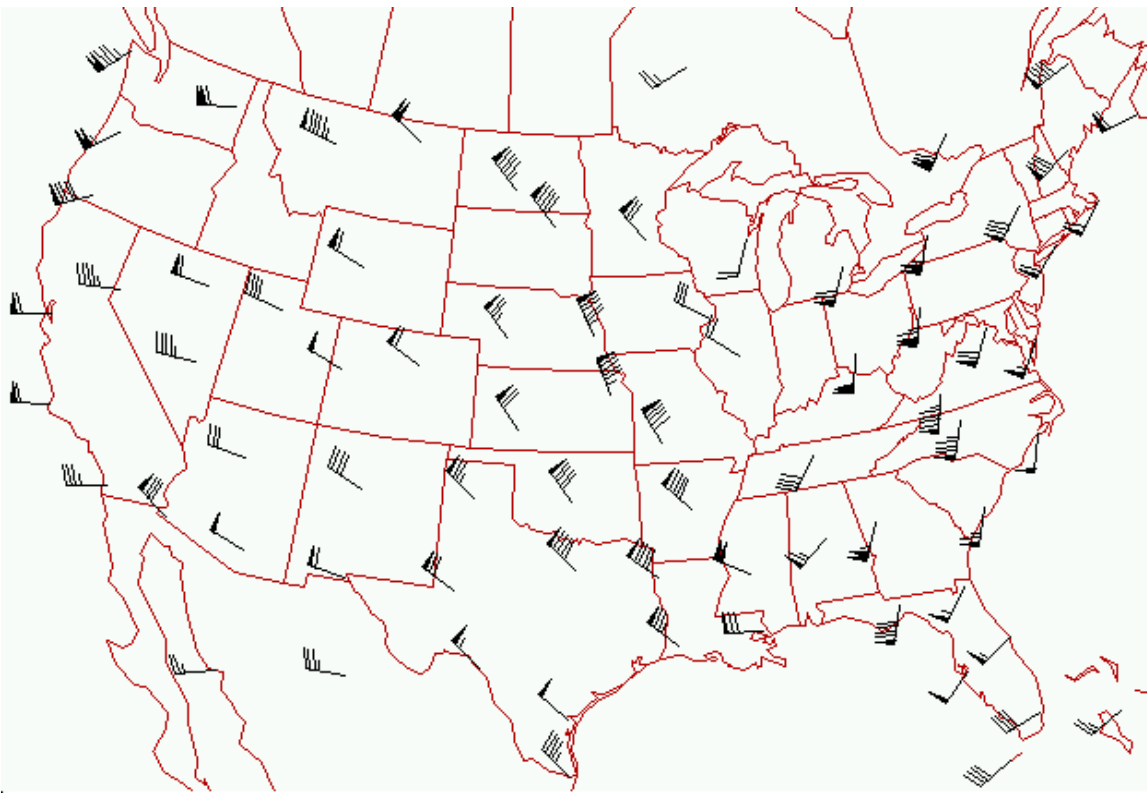


Figure 1. Map of 300-mb winds at 12Z 10 MAR 2011.

1. Look at the accompanying Figure 1. With a pencil, shade a small oval around each station where wind speeds are 60 knots or greater, such as San Francisco. Then shade the area between adjacent shaded stations where the wind speeds are also presumed to be 60 knots or more. Next draw lines along the northern and the southern boundaries to highlight the shaded area limits of the 60 knot or greater region. Finally, draw a heavy, smooth, curved arrow through the core of the shaded highest wind speeds. Add an arrow head to show wind direction.
  
2. The large arrow you drew on your map approximates the location of the existing polar-front jet stream across the United States. Now imagine that you are in a gondola attached to a helium-filled balloon that is located over central Washington State. Assuming your balloon stays at the 300-millibar level and travels with the air flow, draw your path as you travel across the country. Through what state or states are you likely to leave the United States?
   
  


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3. What is your approximate speed measured with respect to the surface of Earth?
   
  


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4. Even though the wind speed is 60 knots or greater, as measured relative to the ground, an anemometer attached to the gondola shows the wind to be almost calm. Explain why.  

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5. Look at winds on either side of the jet. The winds on either side of the jet are **[(slower)(faster)]** than the jet stream winds and have **[(the same)(a different)]** direction.
6. The polar-front jet stream varies considerably in location and strength from time to time. Examples of this variation can be seen in Figures 1 and 2. Both report upper-air wind information at the levels where speeds were generally very high.

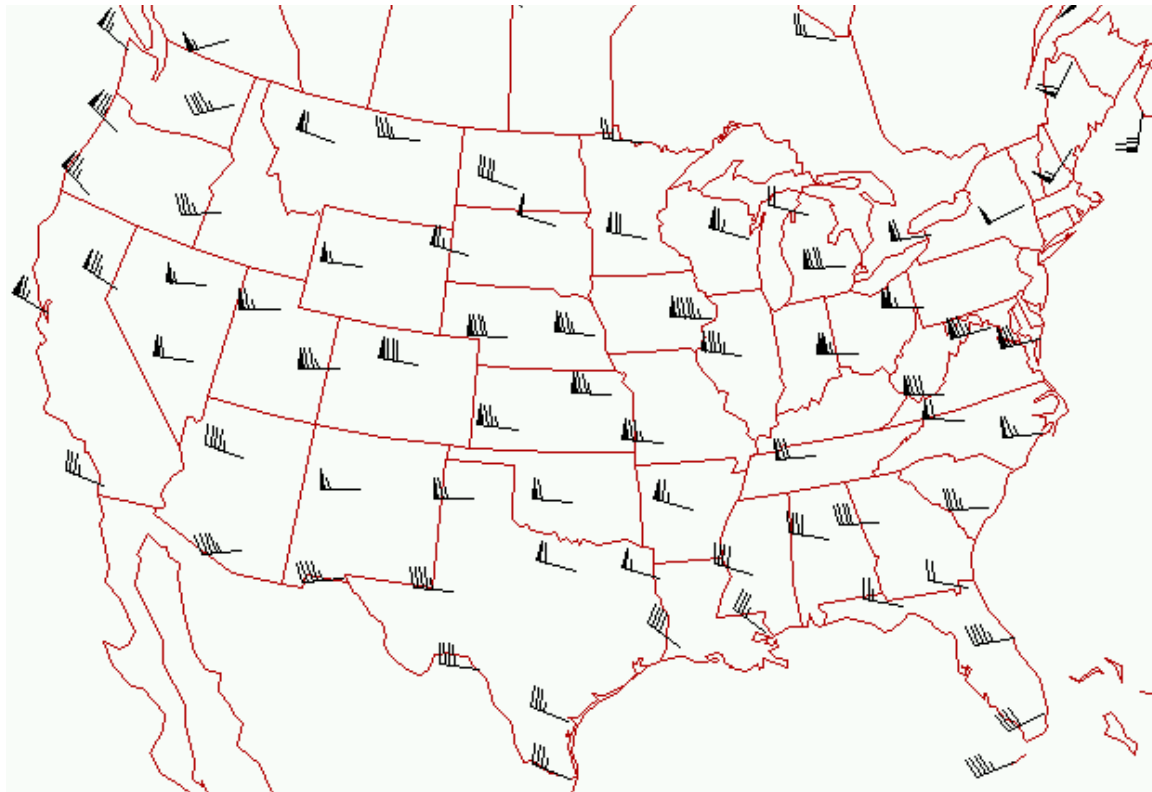
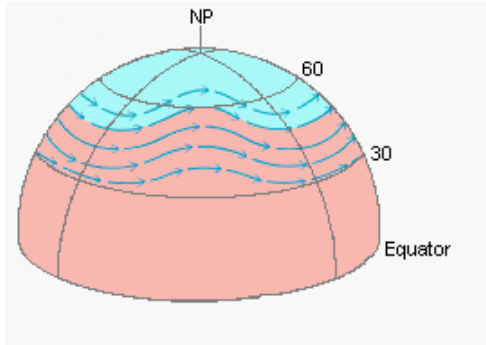


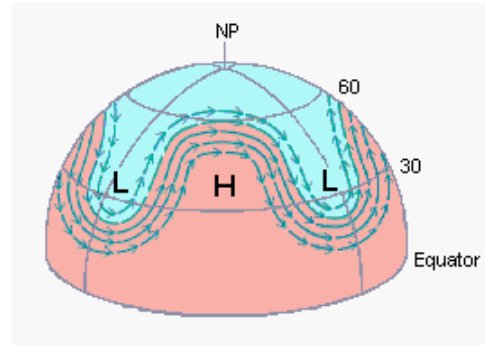
Figure 2. Map of 300-mb winds at 00Z 13 MAR 2011.

In **Figure 2** enclose the jet stream that existed at map time. As you did in Figure 1, lightly shade the enclosed area where winds are 60 knots or more and draw an arrow and arrow head to highlight the high-speed core of the jet stream winds.

7. The polar-front jet stream is like a “river” of high speed air embedded in the planetary-scale circulation of the atmosphere. The drawings below illustrate the wavy and generally eastward flow of air at upper levels in the middle latitudes of the Northern hemisphere (planetary-scale circulation). The wave pattern can vary considerably in amplitude (latitude range). Indicate which drawing better matches the upper-air flow of Figures 1 and 2.



Matches: **[(Figure 1)(Figure 2)]**



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8. The polar-front jet stream roughly aligns with the polar front separating high-latitude cold air from lower-latitude warm air. Wind information in Figure 1 suggests that surface temperatures across the coterminous United States are **[(low)(high)]** in the east-central U.S. compared to those in the west-central U.S.
9. Across the United States, storms tend to follow the path of the polar-front jet stream. In Figure 1, a storm in the Louisiana area at map time is likely to be moving towards **[(New England)(Florida)]**.
10. Knowledge of the location of the jet stream is very important to commercial aviation. Explain why at Figure 2 map time an airline flight from Washington, DC to San Francisco would take considerably more elapsed flying time than a flight from San Francisco to Washington, DC.

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