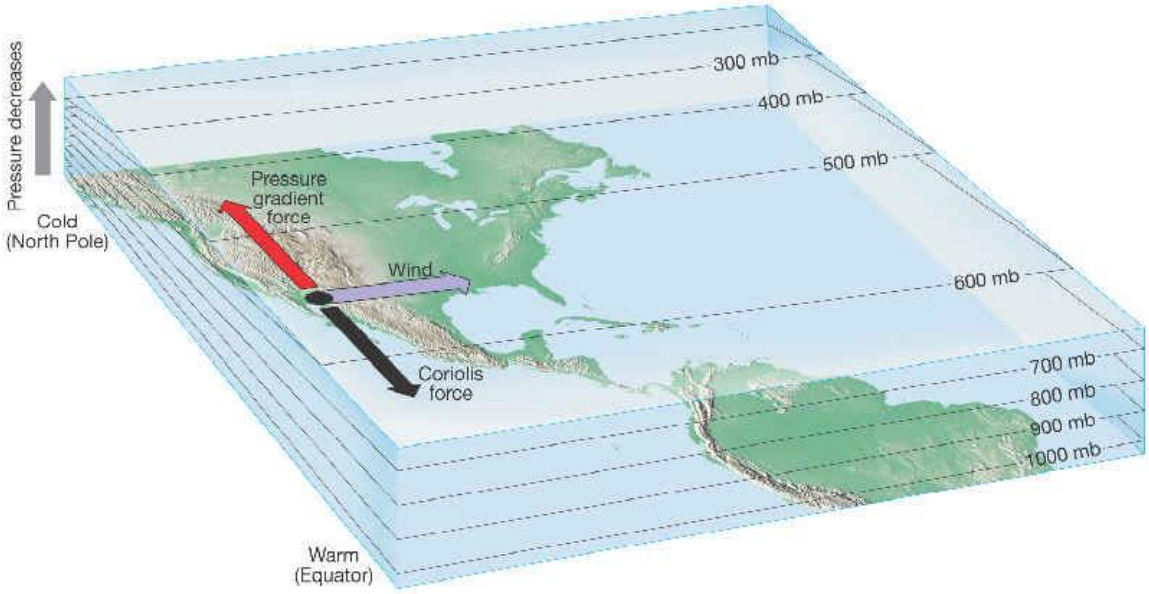
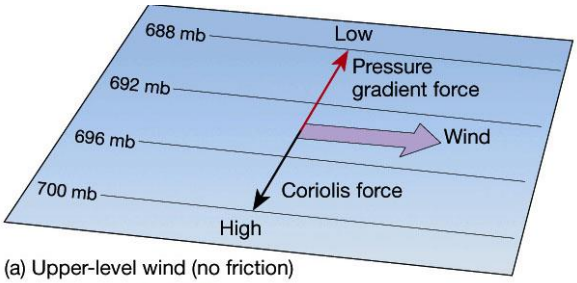
XII. A. THE JET SREAM

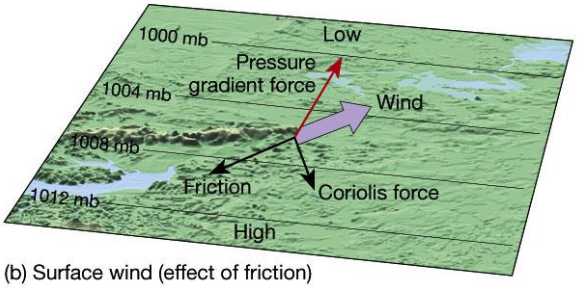
1. The temperature contrast between the poles and equator drives the westerly winds (westerlies) located in the middle latitudes.
   a. Over the equator, where temperatures are higher, air pressure decreases more gradually than over the cold polar regions.
   b. Consequently, at the same altitude above Earth's surface, higher pressure exists over the tropics and lower pressure is the norm above the poles.
   c. Thus, the resulting pressure gradient is directed from the equator (area of higher pressure) toward the poles (area of lower pressure).
   d. Once the air from the topics begins to advance pole-ward in responseto this pressure gradient force, the Coriolis force comes into play to change the direction of airflow.
   e. Eventually, a balance is reached and the Coriolis force to generate a wind with a strong wet-to-east component. (Geostrophic winds).



2. It can also be shown that the pressure gradient increases with altitude; as a result, so should wind speeds.
   a. The increase in wind speed continues only to the tropo-pause where it starts to decrease upward into the stratosphere.

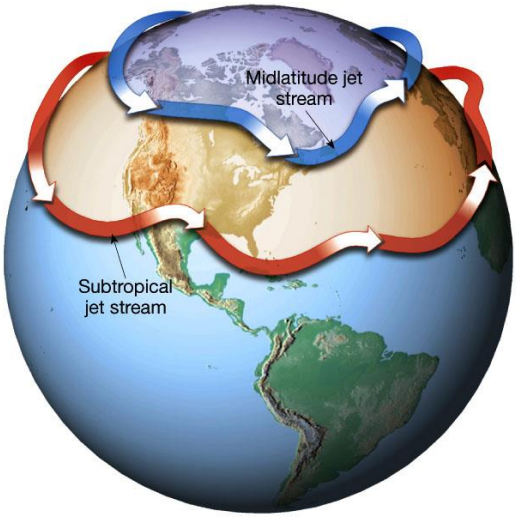


(a) Upper-level wind (no friction)



(b) Surface wind (effect of friction)

3. Imbedded within the westerly flow aloft are narrow ribbons of high-speed winds that meander for thousands of kilometers.

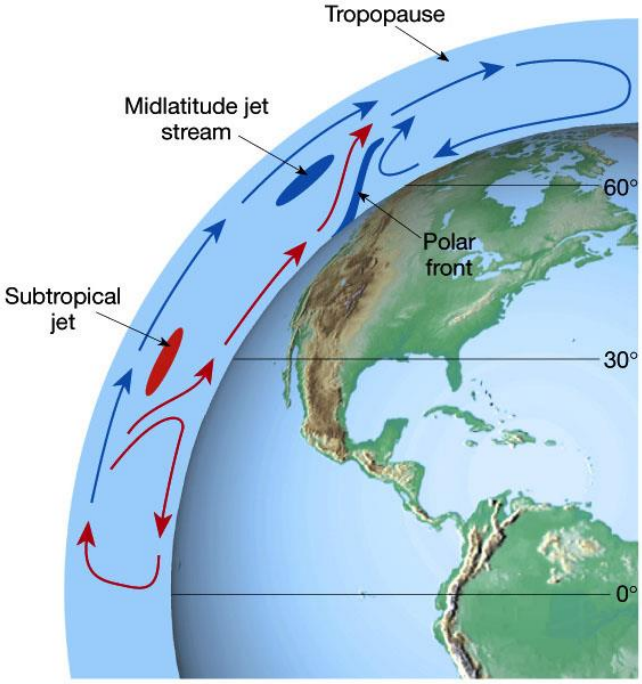


   a. These fast streams of air once were considered analogous to jets of water and thus were names **jet streams**.
   b. The best-known occurs in the middle latitudes at elevations between 7500-12,000 meters (25,000-40,000 ft) and is appropriately named the **midlatitude jet stream.**
      i) These high-speed air currents have widths that vary from less than 100 km- 500 km and a few kilometers thick.
      ii) Wind speeds are frequently in excess of 200-400 km/hr (120-240 miles/hr.)
   c. The key to the origin of mid-latitude jet streams is found in great temperature contrasts at the surface. In the region between 30°-70°, the mid-latitude jet stream occurs in association with the polar front.

i) The polar front is situated between the cool winds of the polar easterlies and the relatively warm westerlies.

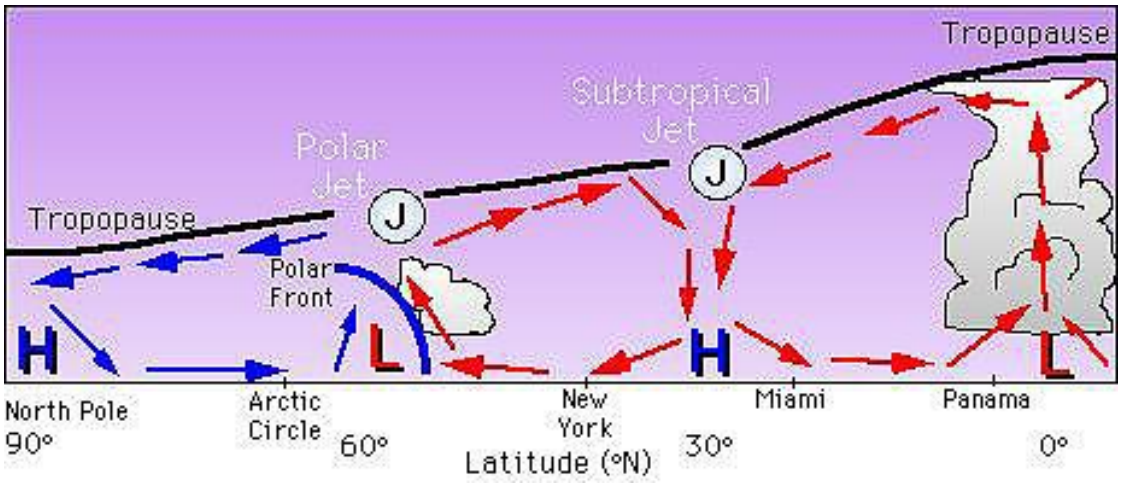
ii) Instead of flowing nearly straight west-to-east, the midlatitude jet stream usually has a meandering path.

iii) Sometimes it splits into two jets that may, or may not, region..



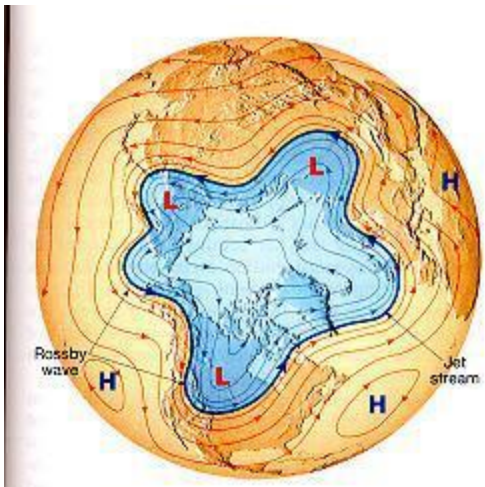
4. Occasionally, the mid-latitude jet exceeds 500 km/hr. On the average, however, it travels at 125 km/hr in the winter and roughly half that speed in the summer. This seasonal difference is due to the much stronger temperature gradient in the winter.

a. Because the location of the mid-latitude jet roughly coincides with that of the polar front, its latitudinal position migrates with the seasons.
b. Thus, like the zone of maximum solar heating, the jet moves northward during summer and southward in winter. (Winter 30°N and summer 50°N)
c. As the mid-latitude jet shifts northward, there is a corresponding change in the region where outbreaks of severe thunderstorms and tornadoes occur.

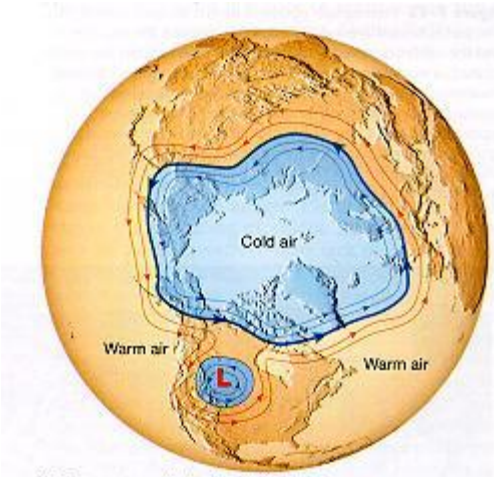


d. As you can see, the mid-latitude jet stream plays a very important role in the weather of the mid-latitude jet stream play a very important role in the weather of the mid-latitudes.
    i) In addition to supplying energy to the circulation of surface storms, it also directs their paths of movement.
    ii) Determining changes in the location and flow pattern of the mid-latitude jet is an important part of modern weather forecasting.

5. Other jet streams are known to exist, but none have been studied in as much detail as the mid-latitude jet streams.
    a. A semi-permanent jet exists over the subtropics and as such is called the **subtropical jet.**
    b. This jet is a wintertime phenomenon. (Absent in the summer due to the lack of strong temperature contrast in the subtropics).
6. Studies of upper-level wind charts reveal that the westerlies follow wavy paths that have rather long wavelengths.
    a. The longest wave patterns are called **Rossby Waves**.
    b. During periods when the flow aloft is relatively flat, little cyclonic activity is generated at the surface.

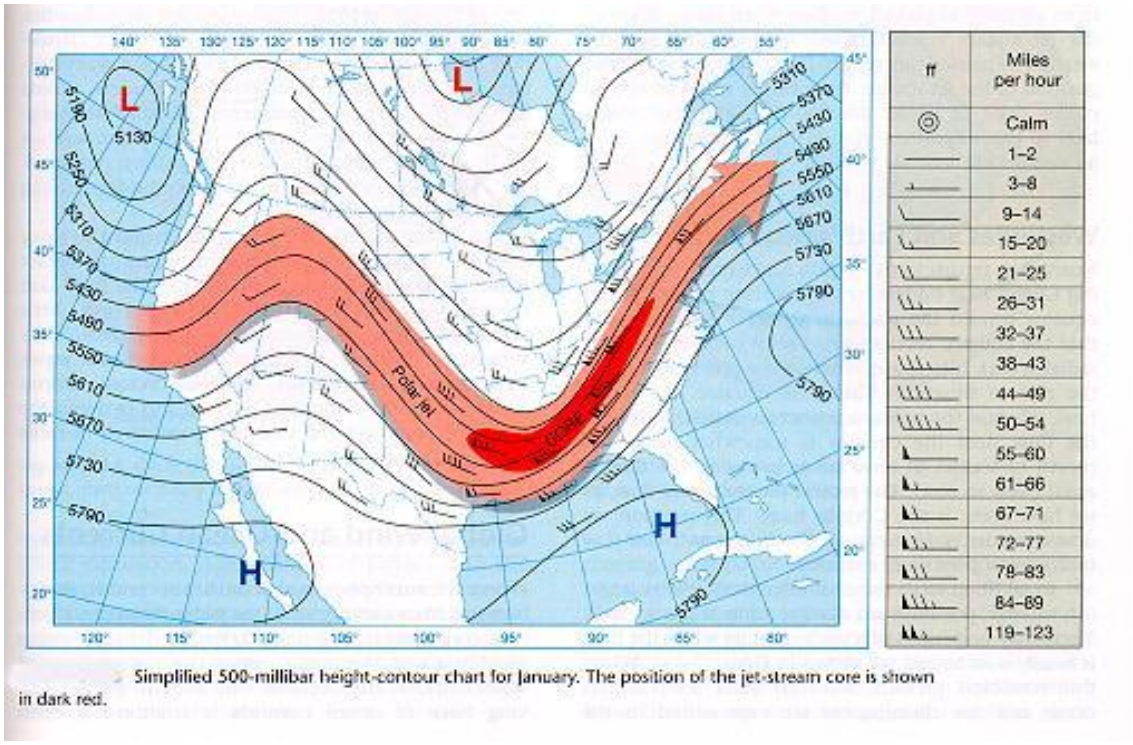


Idealized air flow of the westerlies at the 500-millibar level. The five long-wavelength undulations, called *Rossby waves*, compose this flow. The jet stream is the fast core of this wavy flow.



(d) Return to a period of flatter flow aloft

e. Conversely, when the flow exhibits large-amplitude waves having short wavelengths, vigorous cyclonic storms are created.
f. In addition to seasonal changes in the strength of its flow, the position of the mid-latitude jet also shifts from winter to summer.



Simplified 500-millibar height-contour chart for January. The position of the jet-stream core is shown in dark red.

g. The higher wind speeds in the cool season are depicted on upper-air charts by more closely spaced contour lines.
h. By midwinter, the jet core may penetrate as far south as central Florida.

i. When the position of the jet stream remains fixed for extended periods, weather extremes can result.

7. We now understand that the wavy flow aloft is largely responsible for producing surface weather patterns.
   a. During periods when the flow aloft is relatively flat (small-amplitude waves), little cyclonic activity is generated at the surface.
   b. Conversely, when the flow exhibits large-amplitude waves having short wavelengths, vigorous cyclonic storms are created.