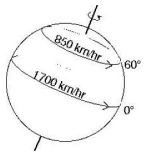
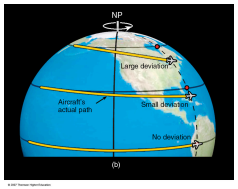
Coriolis Effect

- If the *horizontal* pressure gradients last long enough (longer than several hours) or the air displacement is large enough (1000s of km), rotation of the earth greatly affects the motion …

- In these cases, the air experiences the Coriolis Effect (or Force) which is a frame-of-reference effect
- The Coriolis Force is the combined effect of
  - Observer's reference frame (on earth) is rotating
  - Gravity acting to keep air on the spherical Earth

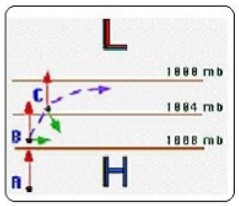


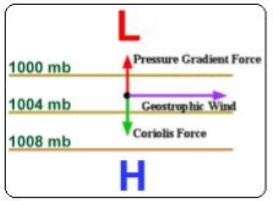


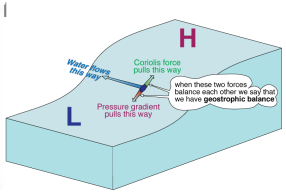
In the net, air moving in the northern hemisphere experiences an *apparent force* to the right of motion

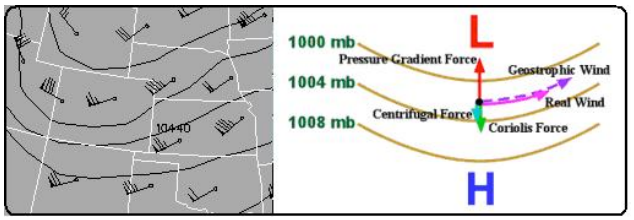
The Horizontal Wind is nearly Geostrophic

Geostrophic





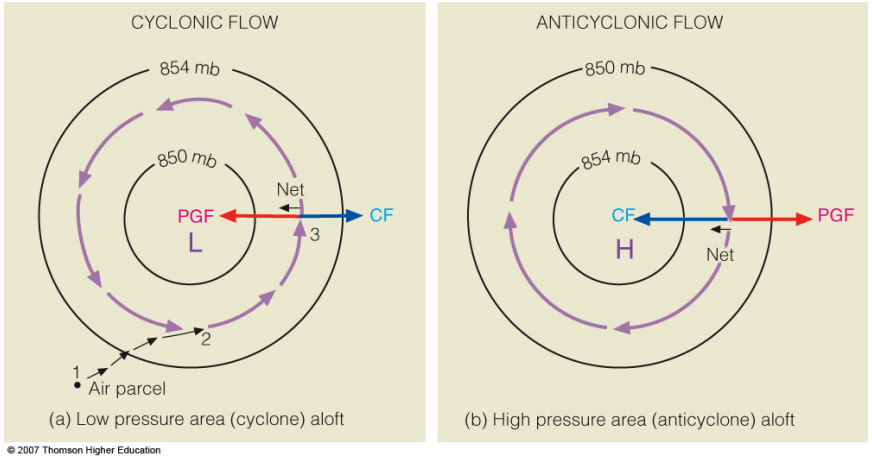




Nearly Geostrophic Flow
(it is curved)

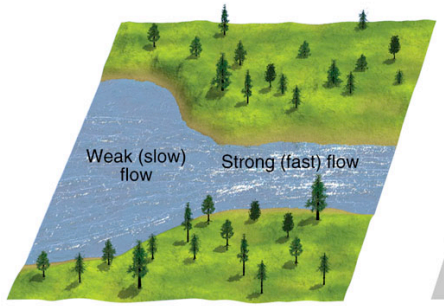
Northern Hemisphere

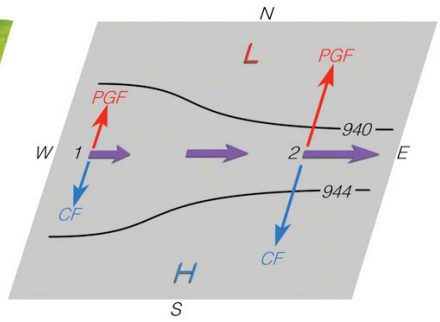
The Horizontal Wind is nearly Geostrophic



Northern Hemisphere

Geostrophic Wind

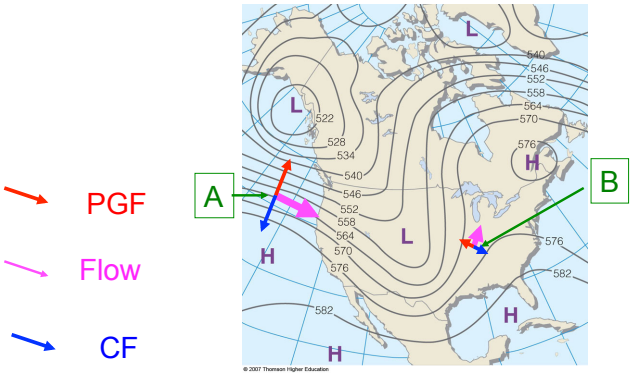




The stronger the PGF_v, the stronger the CF (hence, the stronger the wind)

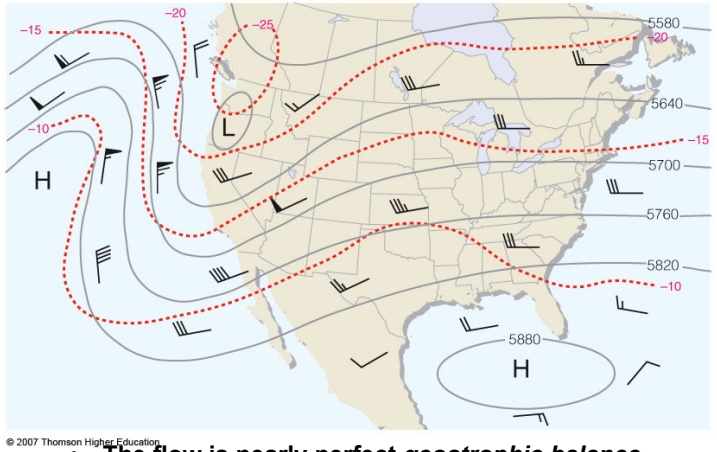
Mapping Pressure Gradients

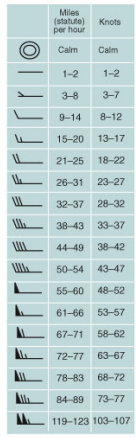
The height of the 500mb contour on this day



- Read this just like a pressure map on constant elevation
  - flow is along a line of constant height
  - flow is strongest where the lines are closest together (stronger gradients = stronger CF ~ stronger wind)

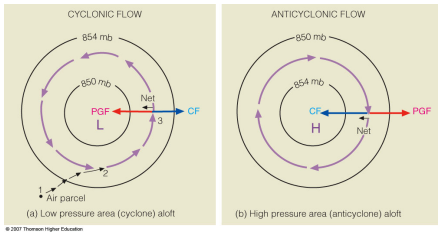
The flow at ~ 5.6km is nearly Geostrophic



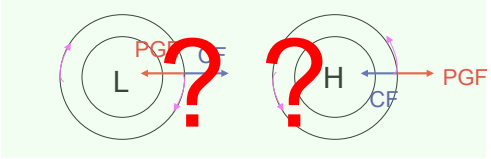


- **The flow is nearly perfect *geostrophic balance***
  - ✧ the *horizontal* pressure gradients are balanced by Coriolis Force, and the wind blows along a line of *constant* pressure
- **E.g.,day to day weather, mid-latitude storms, jet stream, monthly flows , seasonal flows ..**

The Horizontal Wind is nearly Geostrophic



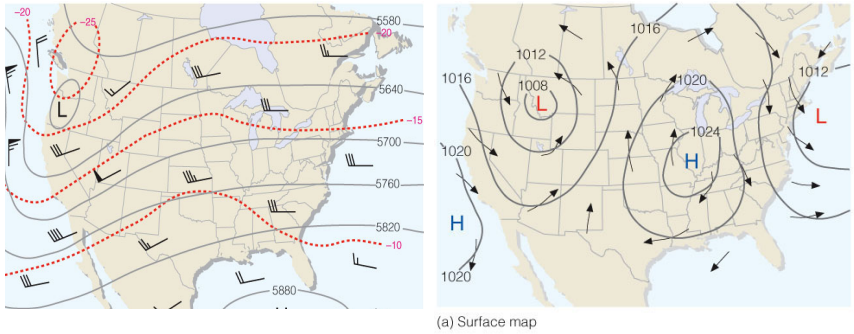
Northern Hemisphere



Southern Hemisphere

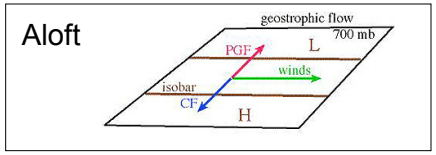
The CF acts to accelerate the air to the left of the motion in the Southern Hemisphere

Horizontal Forces & Circulation



- Aloft, the flow is nearly in perfect geostrophic balance (PGF balanced by CF), so the flow is along an isobar- a line of constant pressure.
- What about the flow near the surface? Is it in geostrophic balance?

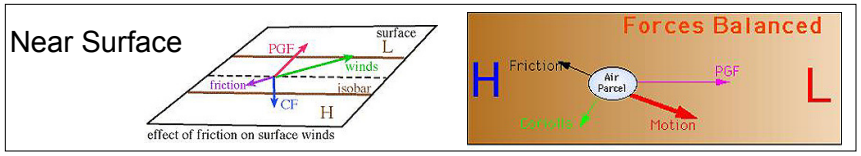
Near Surface Winds



Away from the surface, winds are nearly geostrophic

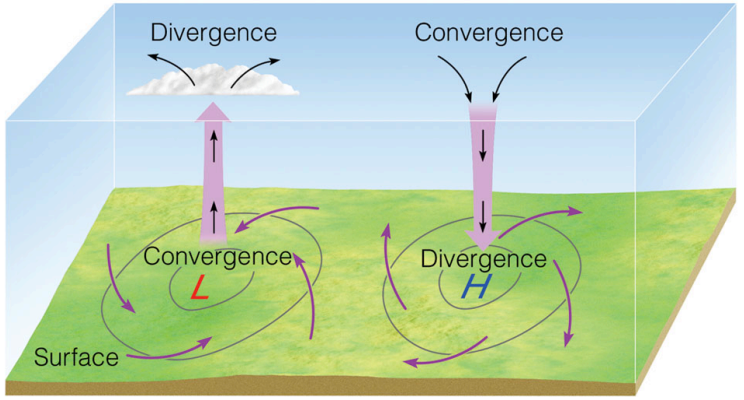
$PGF_H = CF$

But near the surface, winds feel PGF_H, CF *and* friction



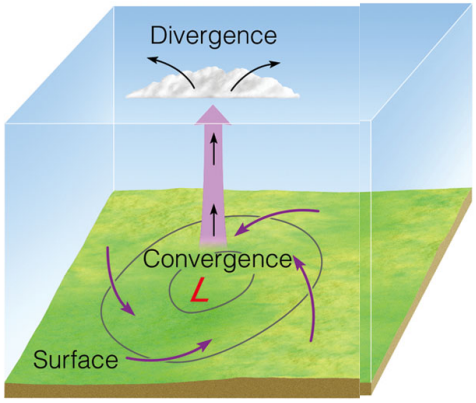
Averaged over many hours, the net force balance is zero. Hence, at the surface there is a small component to the wind that blows toward the low pressure.

Hence, air tends to flow out of a surface high, causing sinking motion and convergence aloft (fair weather)

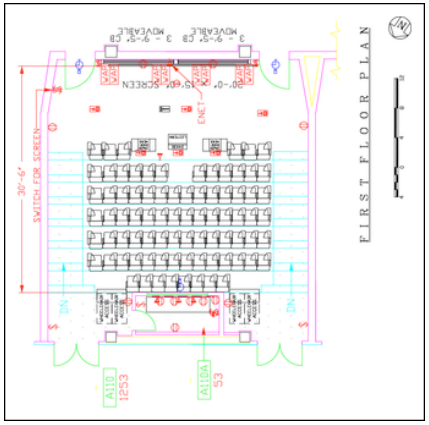


Conversely, air tends to flow into of a surface low, causing convergence and rising motions aloft (cloudy)

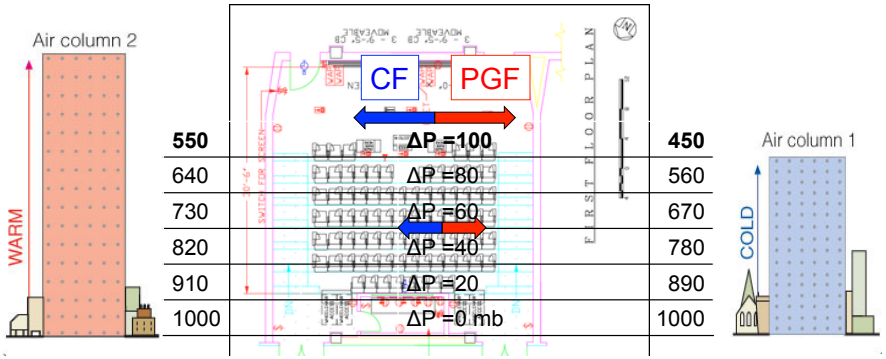
A very good analog for the Surface Low



Why are there atmospheric jets?



Why are there atmospheric jets?

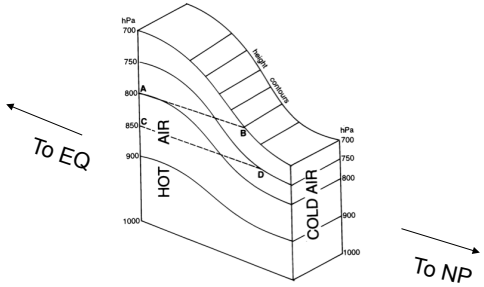


Geostrophic balance, so wind is out of the page (NH)

ΔP increases and density decreases as you go up → increasing PGF → increasing CF → increasing wind speed as you go up

Jets

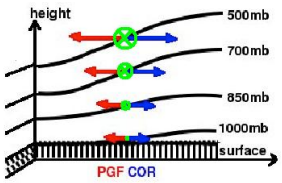
- The air column in the tropics is warmer than that at the poles → density is less in the tropics. Hence, going up into the atmosphere, pressure drops more slowly in the tropics than in the polar regions

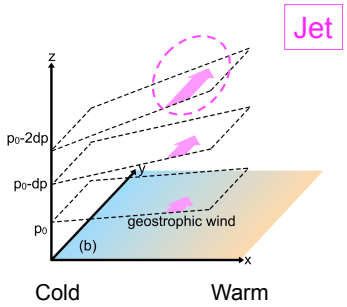


- Hence, a poleward pressure gradient develops as you go up from the surface

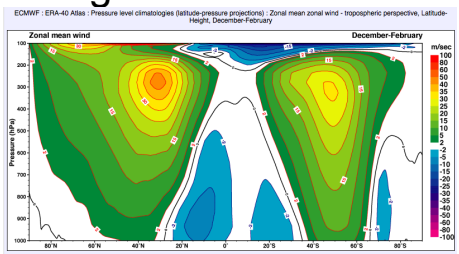
Jets

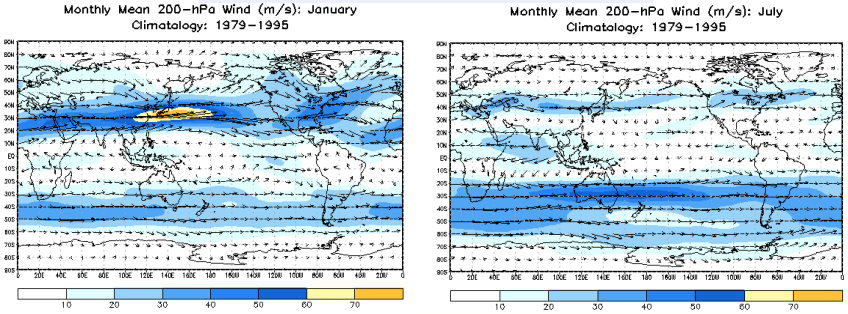
- A poleward horizontal pressure gradient develops and strengthens as you go up
- Air density decreases too, so the PGF_H becomes huge. Hence, the winds increase as you go up.





Climatological Winds at 200mb up





Movie http://www.cpc.ncep.noaa.gov/products/precip/CWlink/climatology/200wind/200windloop.gif