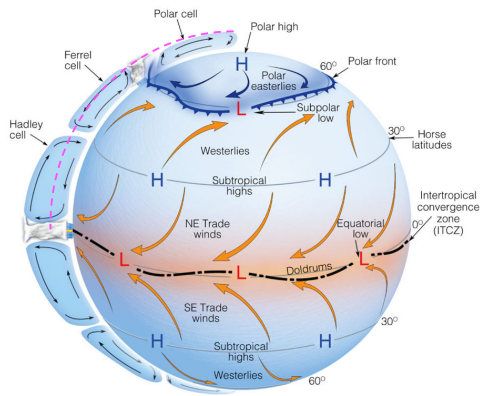
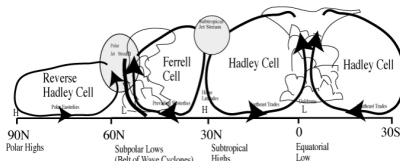


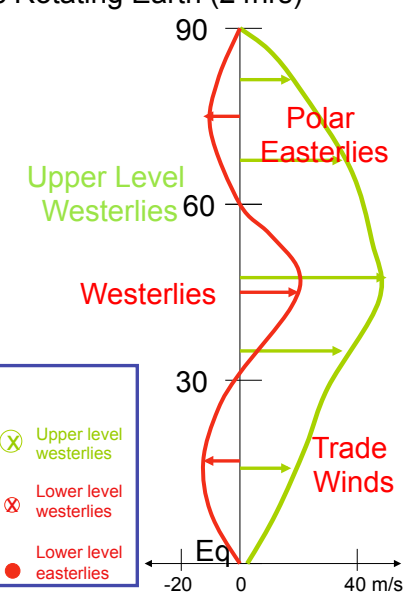
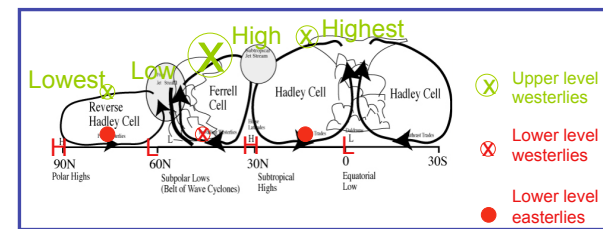
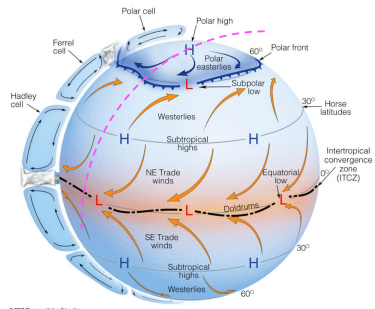
Idealized Model of Realistic Rotating Earth (24hrs)



Rotation causes the circulation to form three “cells” in each hemisphere: Hadley, Ferrel and Polar Cells

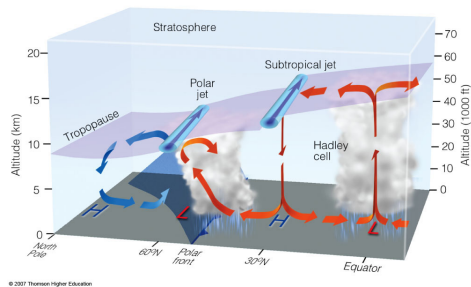


Idealized Model of Realistic Rotating Earth (24hrs)



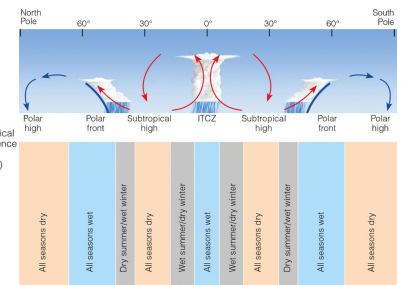
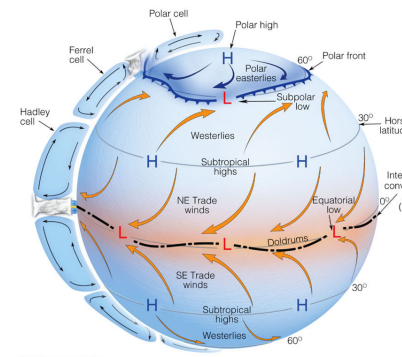
Idealized model of the “General Circulation”

- Hadley Cell in tropics is similar to the land-sea breeze, but CF matters (why?)
 - Hence, surface flow is westward (easterly) at surface and eastward (westerly) aloft
- The largest north-south temperature gradients are in the midlatitude (between the tropics and the polar regions)
 - Hence, the largest equator-to-pole pressure gradient is in the midlatitude. Westerly JETS are located here



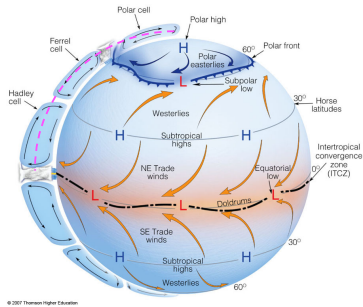
Idealized model of the “General Circulation”

- In general, there is rising motion near the equator and at ~60° latitude, and sinking motion at 30° latitude and near the poles. Hence, the
 - deep tropics and 60° latitude are wet regions
 - subtropics (20-35° latitude) and polar region are dry regions



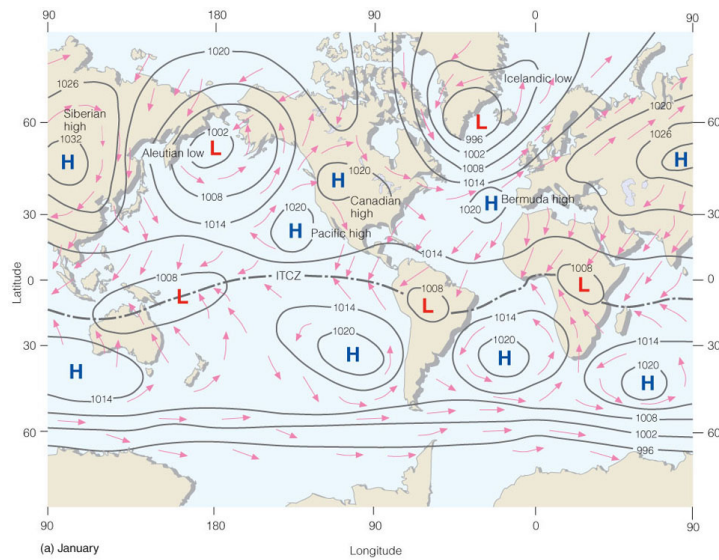
Idealized model of the “General Circulation”

- Near the surface, in general, there are
 - easterlies (Trade Winds) in the tropics and subtropics (25°S-25°N)
 - westerlies in the midlatitudes (30-60° latitude)
 - easterlies in the polar regions (60-90° latitude)
- Aloft (near the tropopause) there are westerlies everywhere, but strongest westerlies are in the midlatitudes



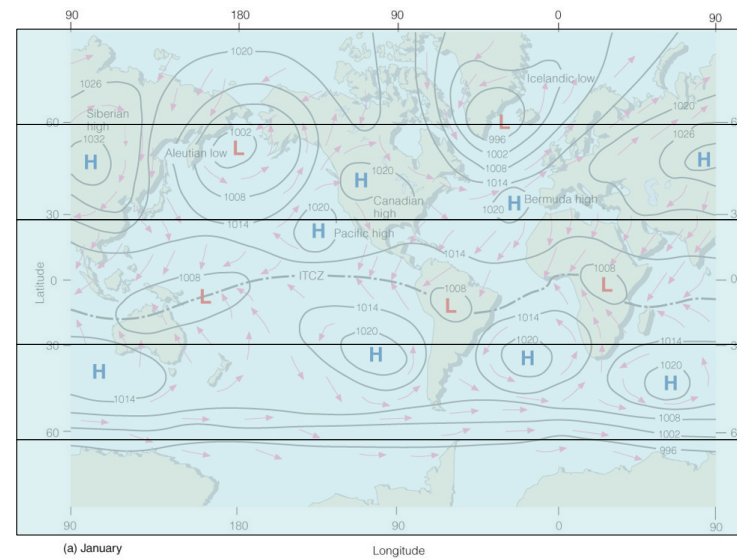
The Real World?

Climatological sea-level pressure and surface wind-flow patterns for January



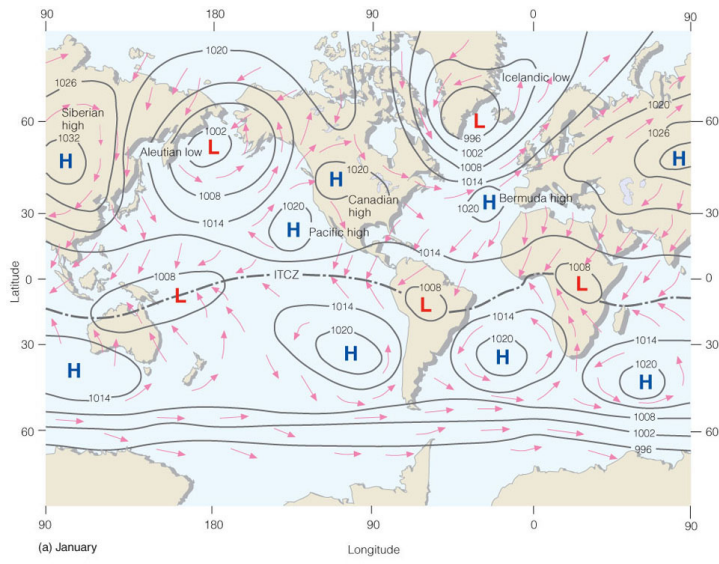
(a) January The heavy dashed line represents the position of the ITCZ/surface Low Pressure

Climatological sea-level pressure and surface wind-flow patterns for January



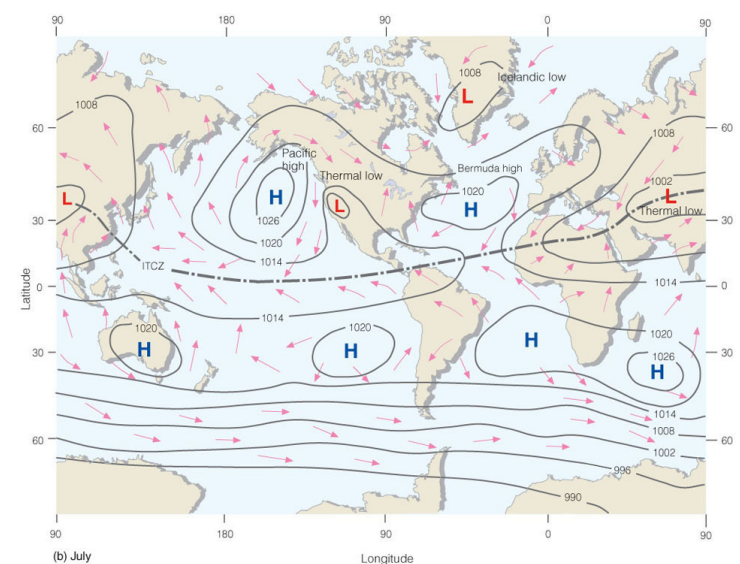
(a) January The heavy dashed line represents the position of the ITCZ/surface Low Pressure

Climatological sea-level pressure and surface wind-flow patterns for January



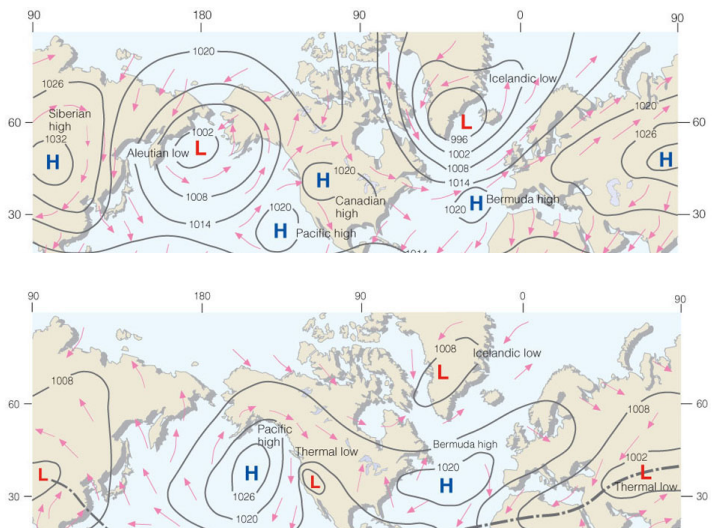
(a) January
The heavy dashed line represents the position of the ITCZ/surface Low Pressure

Climatological sea-level pressure and surface wind-flow patterns for July



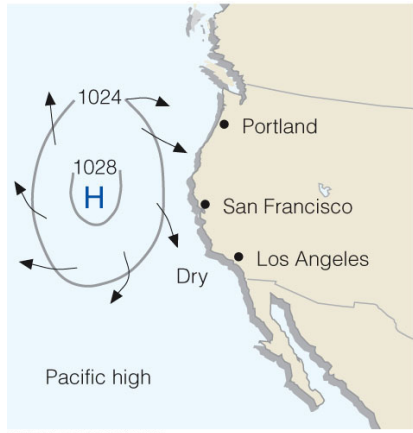
(b) July
The heavy dashed line represents the position of the ITCZ/surface Low Pressure

Look at East-West Differences in midlatitude NH

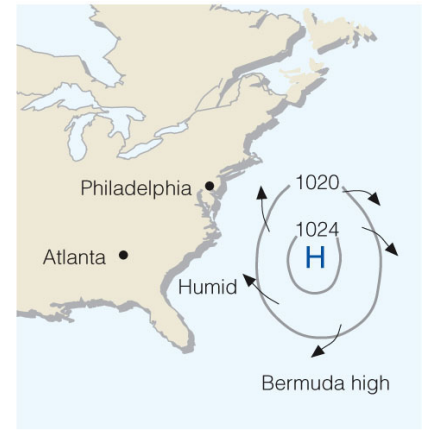


January
July

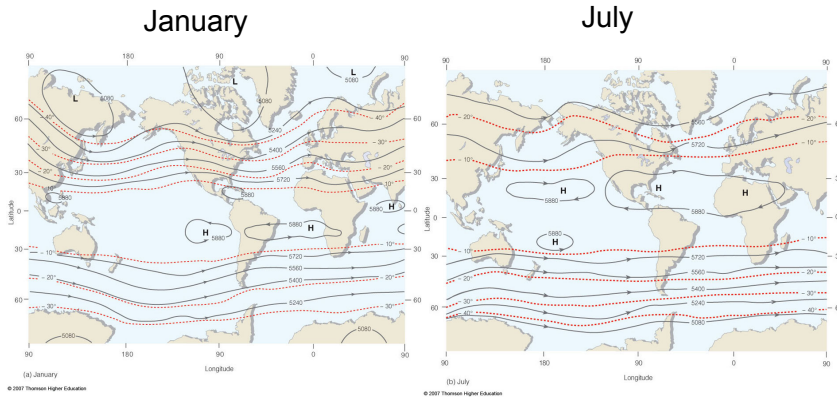
What Season is this?



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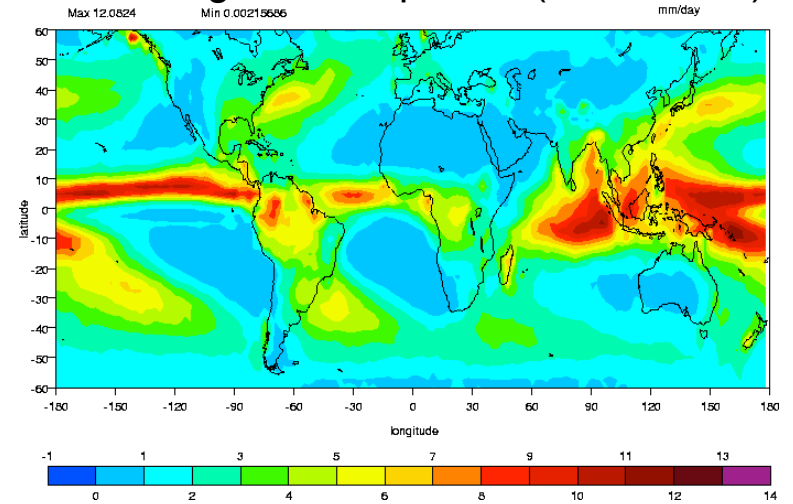


Climatological height of 500mb surface, temperature at 500mb, and wind direction



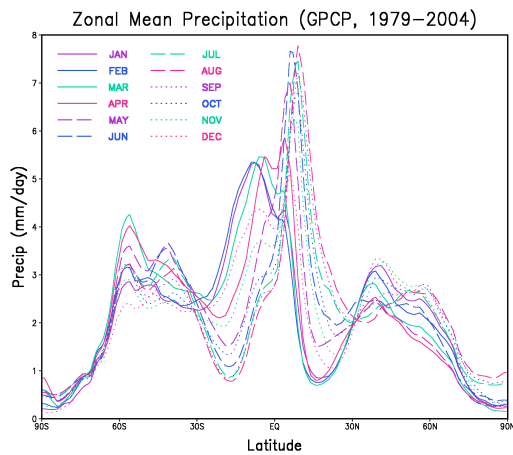
Largest north-south temperature gradients in winter months. Hence, strongest westerlies in midlatitudes of *both* hemispheres in winter!

Climatological Precipitation (annual ave)



Where are the deserts? Where are the wet regions?

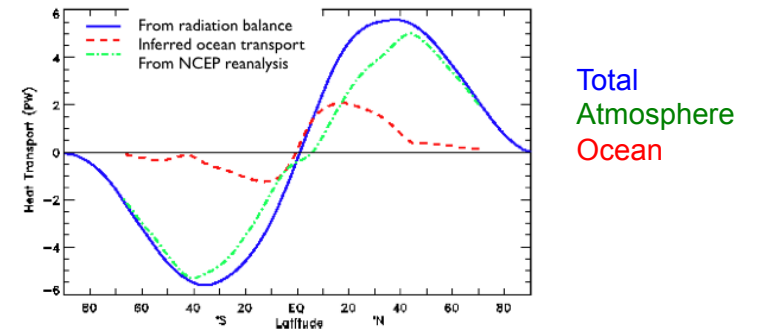
Precipitation Climatology (zonal average)



(zonal = east to west)

Circulation moves excess energy from Equatorial to polar regions

Northward Energy Transport



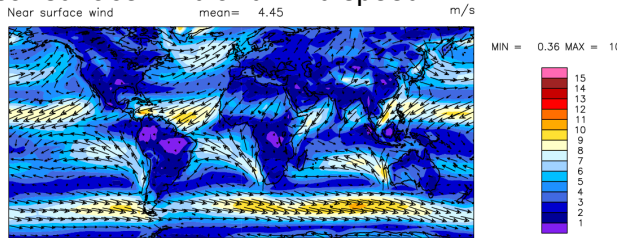
Ocean does most of the transport in the deep tropics (15°S-15°N)

Atmosphere (midlatitude storms) does most of the transport poleward of 30°N,S

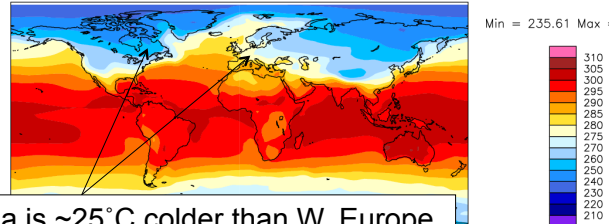
Role of the Major Mountain Ranges

Observed near surface wind and wind speed

Observed DJF near surface wind

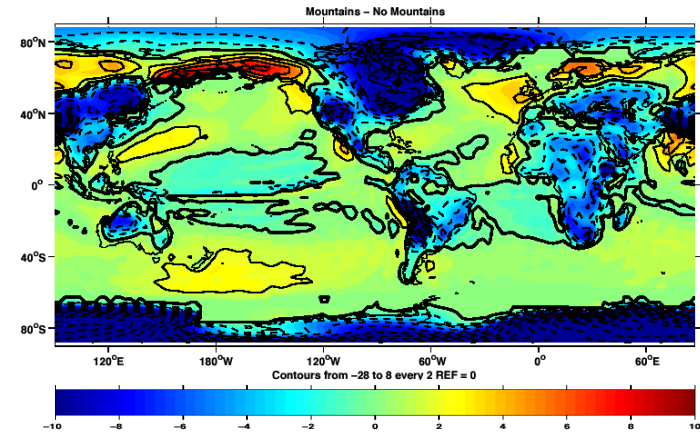


Observed DJF surface temperature



E. Canada is ~25°C colder than W. Europe

The impact of mountains on DJF temperature



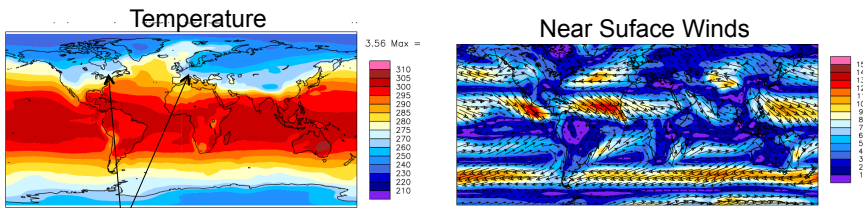
Without the Rockies, the Northeast US would be ~12°C warmer and Alaska would be 8-10°C colder

Europe is "warm" in winter because of the Rockies and atmospheric heat transport

Seager et al 2002

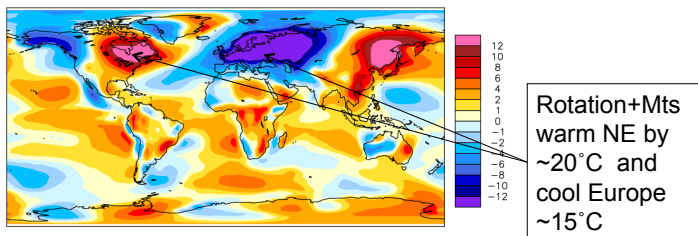
Mountains and Rotation of Earth Matter

DJF Climate on a Backward Rotating Earth



NE US is ~10°C warmer than W. Europe

Backward minus Forward



Rotation+Mts warm NE by ~20°C and cool Europe ~15°C

Why is Europe warm in winter (compared to New England)?

Europe minus New England Temperature (DJF)

Observed	25°C
The Rockies	12°C
Westerlies blowing over wet motionless ocean	12°C
Gulf Stream (ocean currents)	1°C
Total	25°C