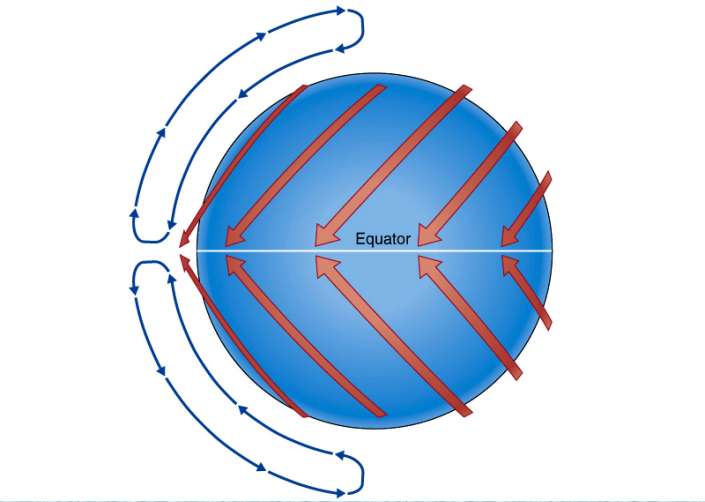
Chapter 8 – Atmospheric Circulation and Pressure Distribution

Understanding Weather and Climate
Aguado and Burt

Single Cell Model

- Strong heating at the equator caused air to rise, diverge towards the pole, sink back to the surface and returned to the equator.
- Due to the Earth's rotation the winds would move east to west.

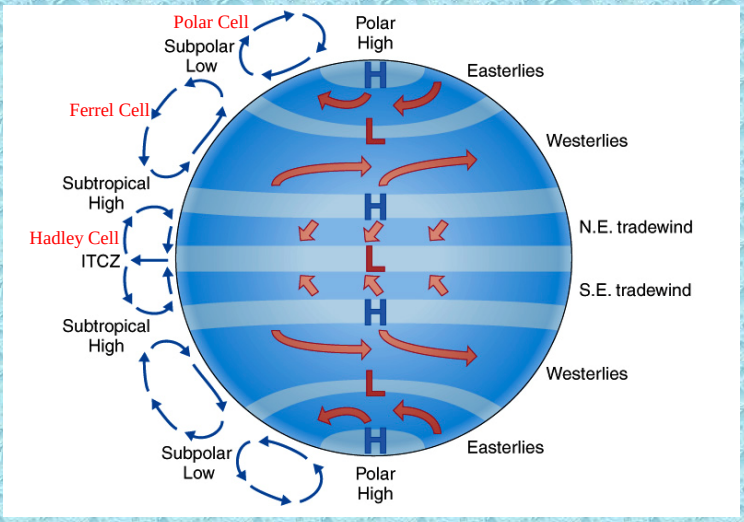
Single Cell Model



Three Cell Model

- Divides the circulations in each hemisphere into three cells:
  - Hadley Cell (tropics/subtropics)
  - Ferrel Cell (middle latitudes)
  - Polar Cell

Three Cell Model



Hadley Cell

- Strong solar heating leads to rising air which diverges towards the poles.
  - Creates Intertropical Convergence Zone (ITCZ)
- Aloft, air moves poleward but acquires a west to east motion.
- Air descends at 20°-30° latitude to form subtropical highs.
  - Creates desert conditions
- Air moves towards the equator at the surface and a weak Coriolis force creates the NE trade winds.

Ferrel Cell

- Indirectly caused by the turning of the Hadley and Polar cells.
- Air flows north away from the subtropical high towards the subpolar lows, and acquires a large westerly component
  - westerlies

Polar Cell

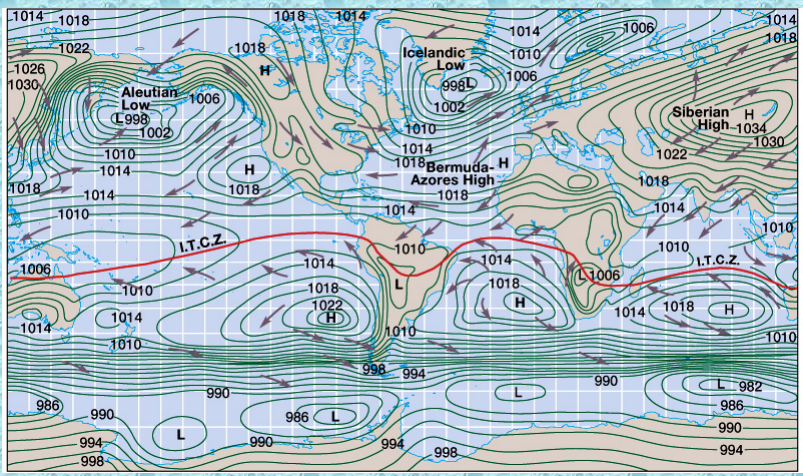
- Surface air moves from polar highs to subpolar lows.
  - Subpolar lows are relatively warm
  - Polar highs are relatively cold
- Coriolis forces directs the surface winds to the west creating the polar easterlies.

Semi-Permanent Pressure Cells

- Areas of high/low pressure that undergo seasonal changes in position and strength.

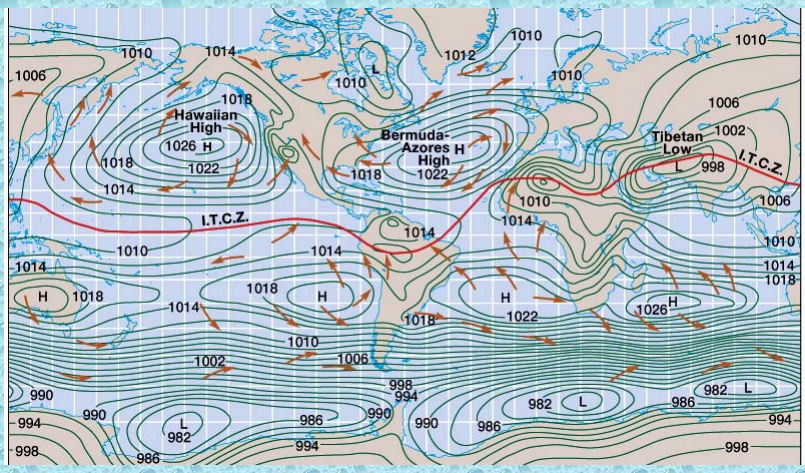
Semi-Permanent Pressure Cells

- January



Semi-Permanent Pressure Cells

- July

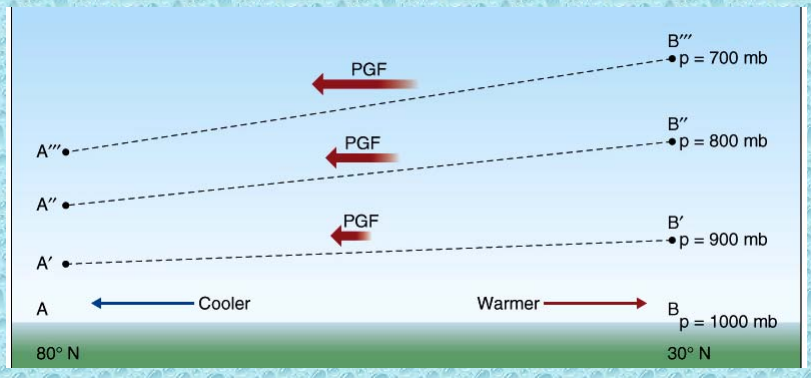


Semi-Permanent Pressure Cells

Winds in the Upper Troposphere

- Winds increase with height
  - Friction is reduced or eliminated
  - Pressure gradient force is increased with height
    - Strongest in the winter
- Winds move west to east (parallel to height contours)

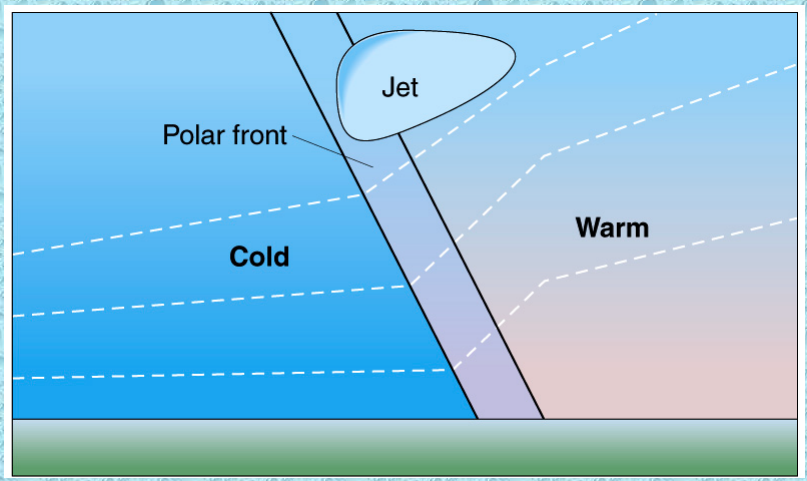
Winds in the Upper Troposphere



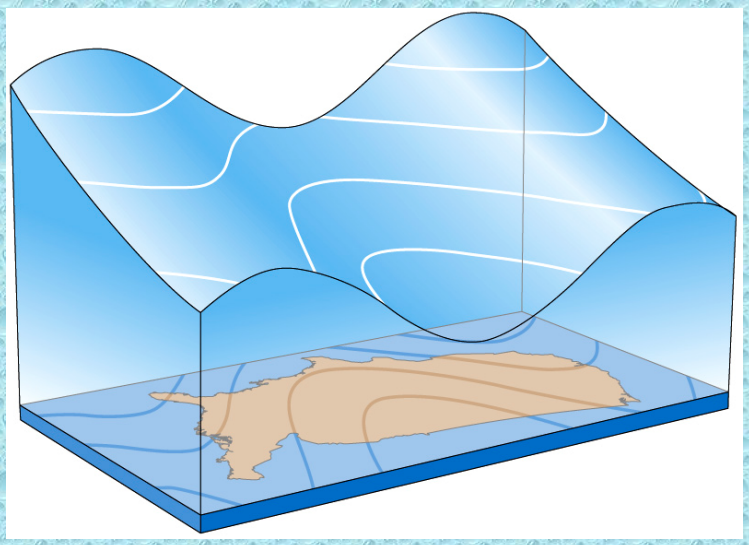
Polar Front / Jet Stream

- Narrow, strongly sloping boundaries between warm and cold air (polar front)
- Leads to strong temperature gradients, pressure gradient forces, and the formation of the polar jet stream.

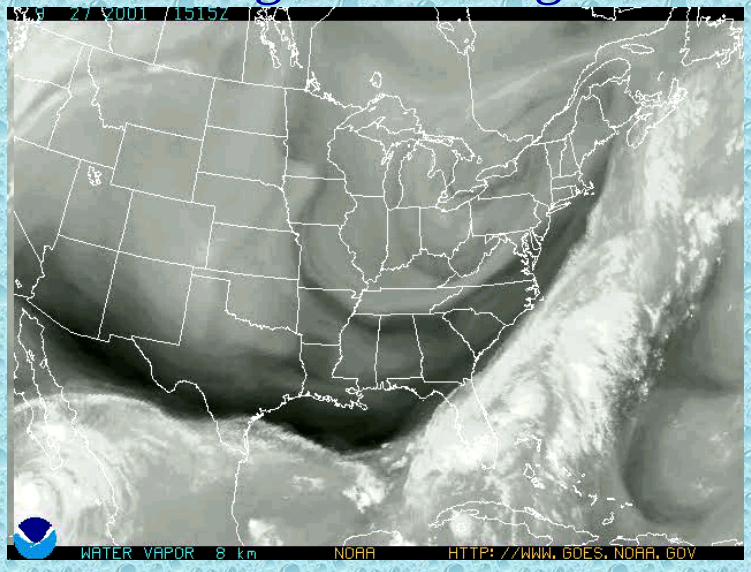
Polar Front / Jet Stream



Troughs and Ridges



Troughs and Ridges



Rossby Waves

- Longest waves
- Typically 3-7 Rossby waves circling the globe
- Longer wavelengths, stronger winds, and fewer in number in the winter
- Migration speed affected by:
  - Wind speed and wavelength
  - Transport warm air poleward and cold air towards the equator.
- Lead to divergence and convergence aloft

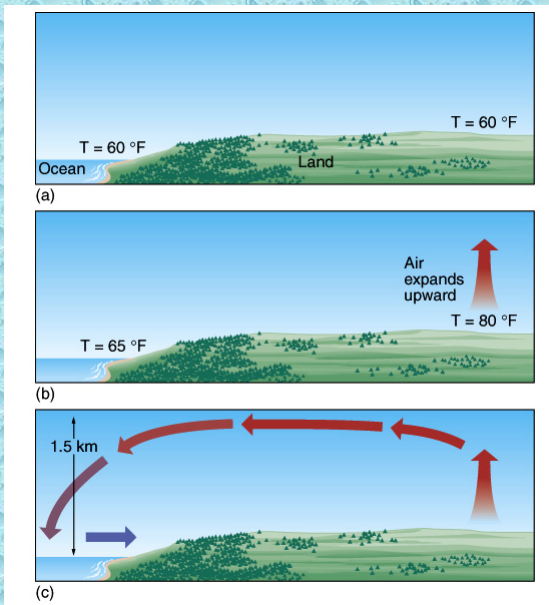
Scaling the Atmosphere

- Global Scale
- Synoptic Scale
- Mesoscale
- Microscale

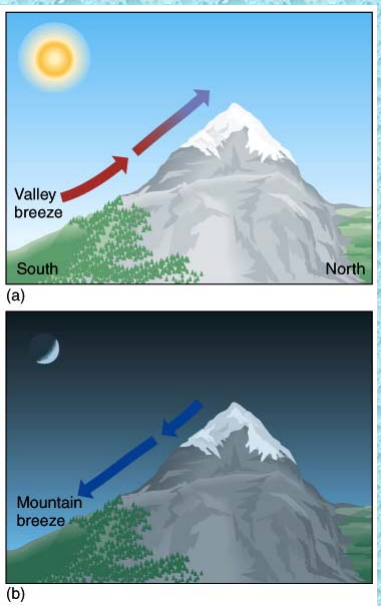
Major Wind Systems

- Monsoons
- Foehn, Chinook, Santa Ana Winds
- Katabatic Winds
- Sea and Land Breeze
- Valley and Mountain Breeze

Sea and Land Breeze



Valley and Mountain Breeze



Air-Sea Interaction

- El Nino / La Nina
  - Closely related to ENSO events
  - Provides warmer / cooler waters in the eastern Pacific off the coast of Peru
  - General 2-5 year cycle
  - Created by strengthening / relaxation of the easterly trade winds