Midterm rough curve

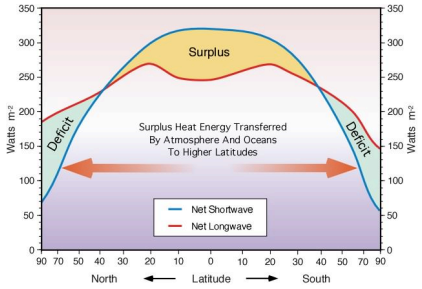
30 4.0
24 3.1
18 2.2
12 1.3
6.5 0.5
mean 24
High 32

"General Circulation"

- Usually described as the long term (climatological) averaged flow for a month, season or year
- The gross aspects of the essential General Circulation can be explained by considering a rotating planet the size of Earth and with roughly the same GH gases, without worrying about continents and mountain ranges

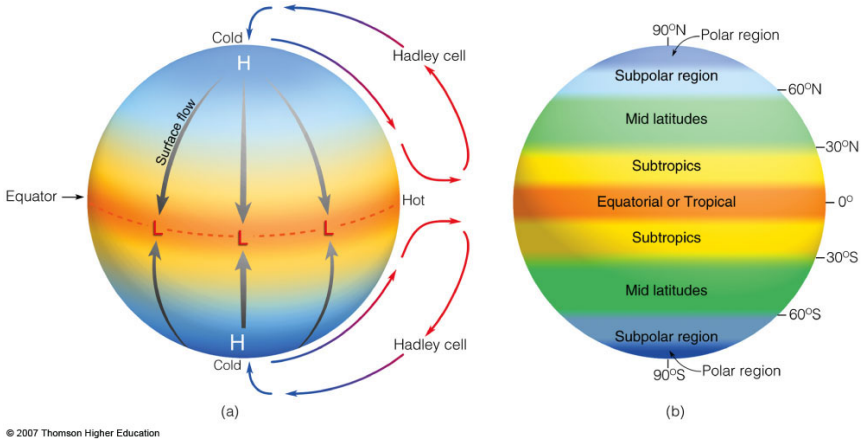
"General Circulation"

- More energy is absorbed in the tropics than is emitted to space.
- Less energy is absorbed in the polar regions than is emitted to space.



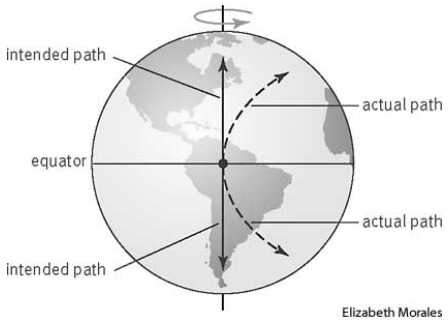
- As a result the tropics are warmer than the polar regions *and* the subsequent pressure gradients drive circulation that move the excess heat in the tropics to the poles

Slowly Rotating Earth



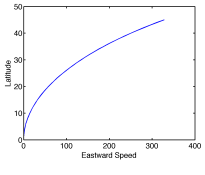
Like a *large scale* sea-breeze (hot tropics/cold poles)

Idealized Model of Realistic Rotating Earth (24hrs)



To conserve angular momentum, moving air at rest from the equator to X° N or S would have to be moving eastward at …

Latitude	Eastward Speed
Equator	0 m/s (540m/s as seen from space)
20°	58 m/s
45°	375 m/s



The Equator-to-Pole Cell is broken because conservation of angular momentum creates large shear in the flow, which wobbles and creates storms

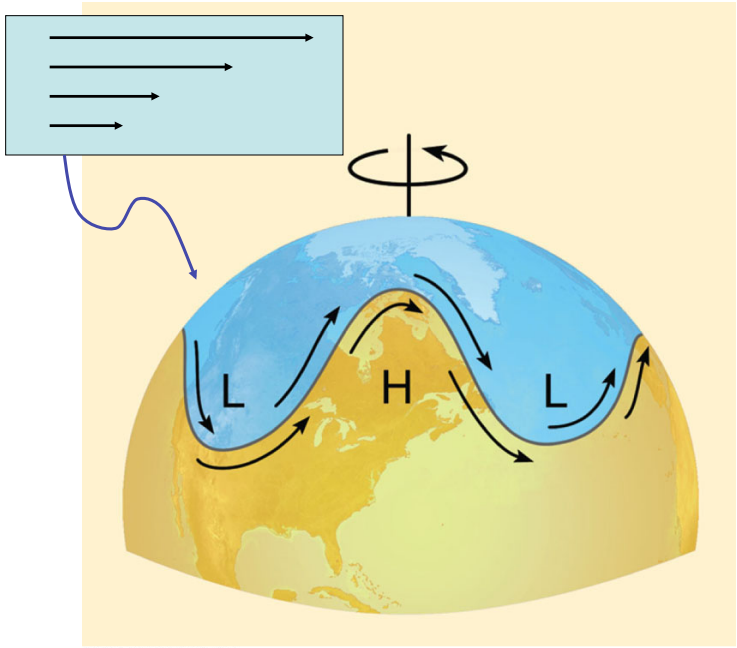
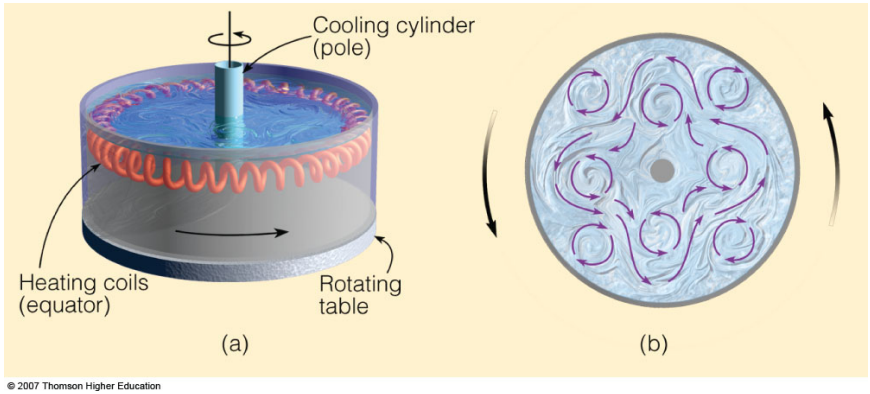


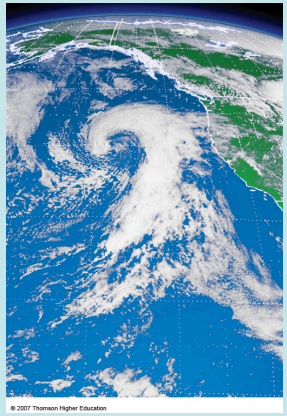
Fig. 3, p. 266



Watch the Movie
www.youtube.com/watch?v=ImNxEMv85IA

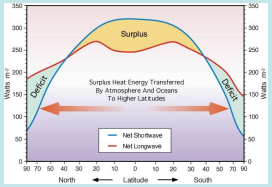
Fig. 2, p. 266

Storms like this one account for about 2/3 of the total heat moved from equator-to-pole by circulation



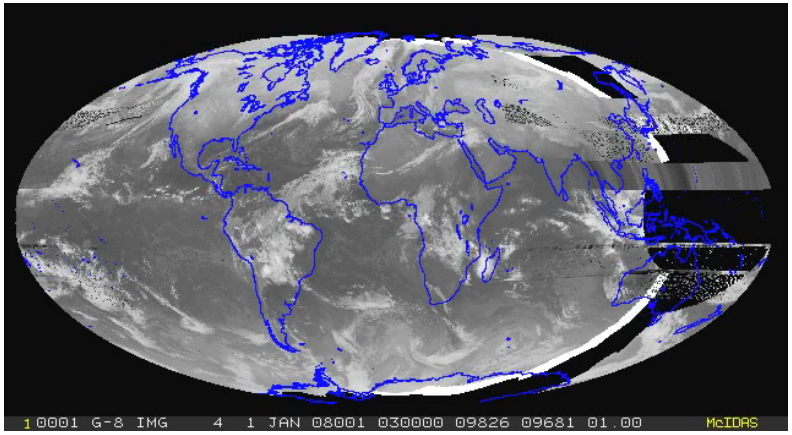
Typical mid-latitude cyclone

Hence, equator-to-pole differences in radiation give rise to equator-to-pole temperature differences and hence circulation.

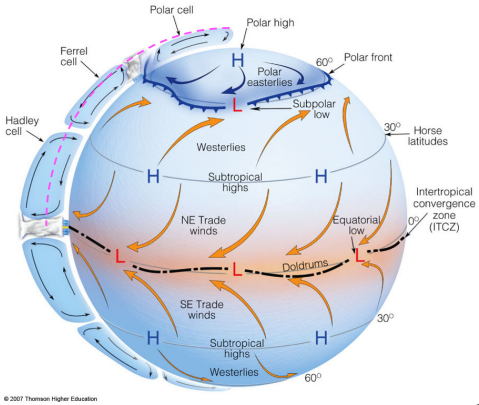


In turn, circulation moves excess energy from the equator to the poles (cooling the tropics and warming the poles)

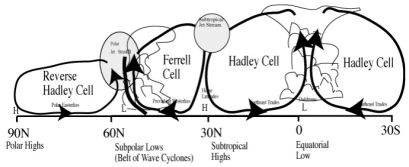
IR Movie



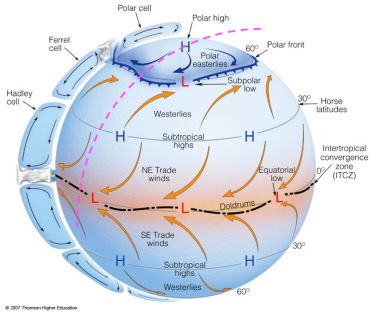
Idealized Model of Realistic Rotating Earth (24hrs)

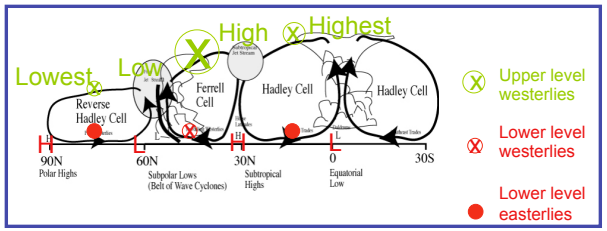


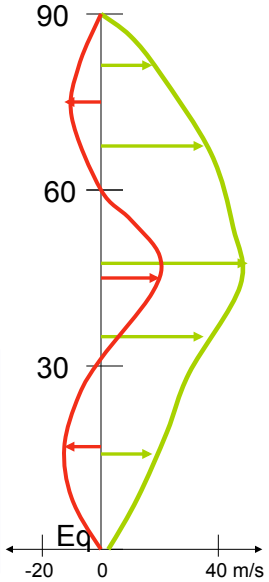
Rotation causes the circulation to form three "cells" in each hemisphere: Hadley, Ferrel and Polar Cells



Idealized Model of Realistic Rotating Earth (24hrs)

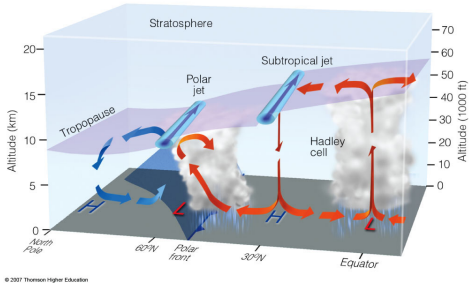






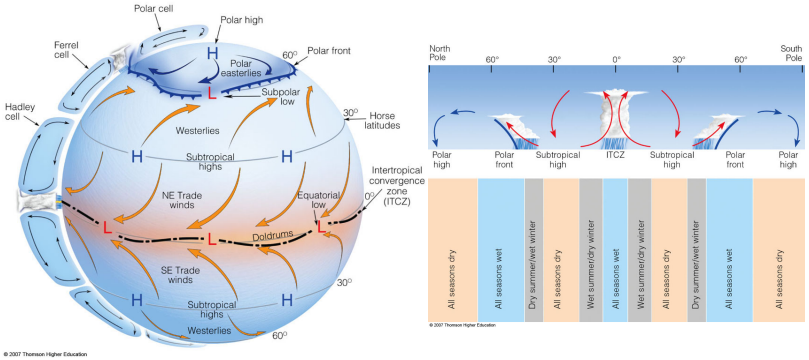
Idealized model of the "General Circulation"

- 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 in near the equator and at about 60º latitude, and sinking motion at 30º latitude and near the poles. Hence, the
  - deep tropics and 60º latitude are wet regions
  - subtropics (20-35º latitude) and polar region are dry regions



The Real World?

Idealized model of the “General Circulation”

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