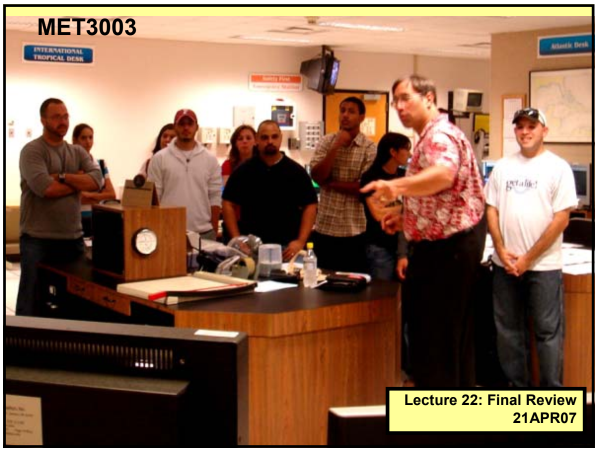
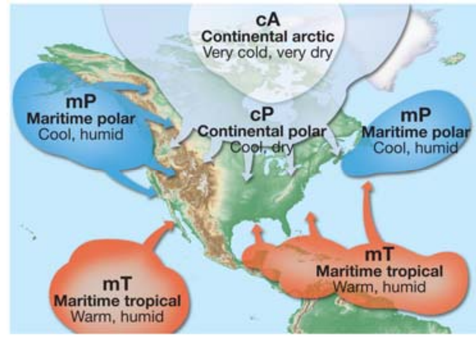
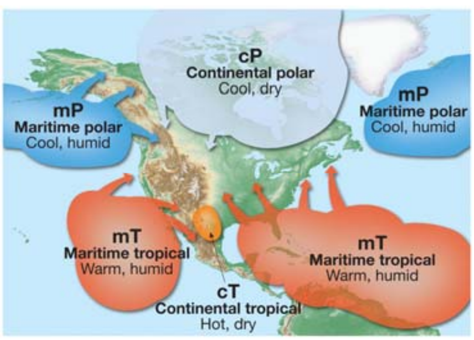


Wintertime Source Regions



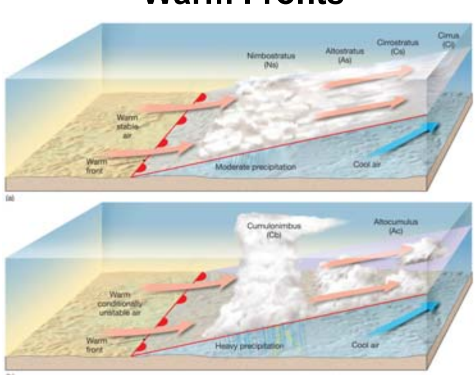
Summertime Source Regions



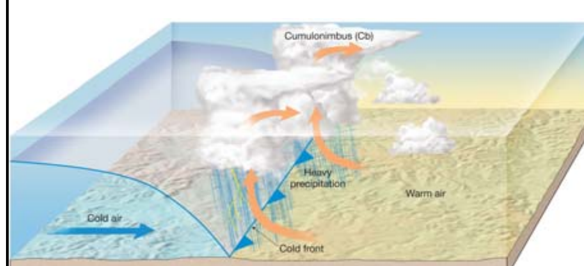
Summary

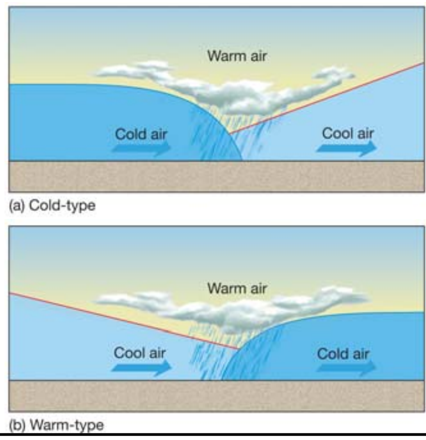
- ***Air Masses*** have uniform temperature and moisture over a large area
- Acquired from the **Source Region**
- Know characteristics of cA, cP, mP, cT & mT with k & w suffixes
- Know how air-mass modification works
- Know about ***Polar Outbreaks*** and ***Lake Effect Storms***
- Understand how mT air affects US summertime weather and its alternation with cP air affects wintertime weather
- Understand how mP air affect the weather in WA, OR & CA
- Be able to explain the SW US "Monsoon"
- For next time: **Read Chapter 9**

Warm Fronts

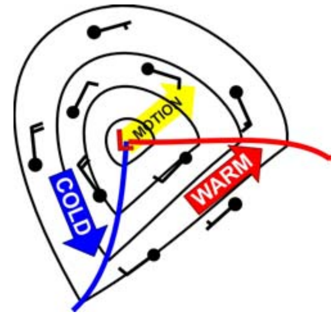


Cold Fronts





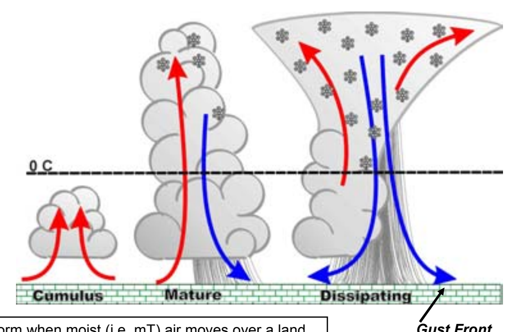
Baroclinic instability moves both heat and westerly momentum poleward



Summary

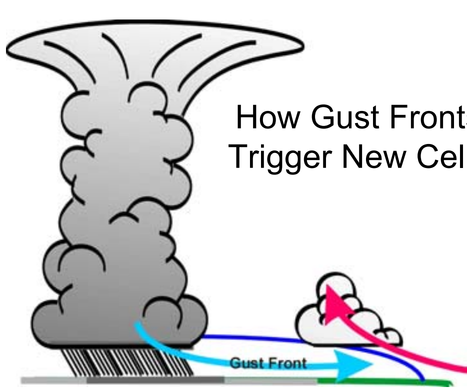
- Know the properties of ***Frontal*** or ***Mid-Latitude Cyclones***.
- Be able to draw and explain the structure and dynamics of ***Warm Fronts***, ***Cold Fronts***, ***Stationary Fronts***, and ***Occluded Fronts,*** including typical weather
- Know the definitions of ***Cyclogenesis*** and ***Baroclinic Instability, Blocking High, Nor'Easter, Alberta Clipper,*** and ***Polar Outbreak***
- Be able to draw and explain the structure of an open wave middle-latitude cyclone and an occluded cyclone
- Be able to draw and explain the life cycle of a typical frontal cyclone over North America
- Be able to relate frontal cyclone motion to the mid-level (500 mb) wind
- For Next Time: **Read Chapter 10**

Air-Mass Thunderstorm Life Cycle

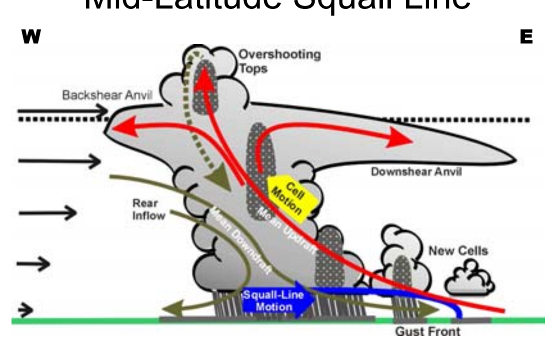


Form when moist (i.e. mT) air moves over a land surface and solar heating triggers convection

How Gust Fronts Trigger New Cells



Mid-Latitude Squall Line

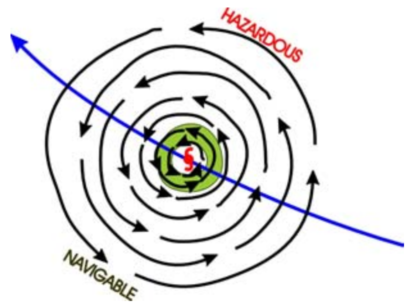


Backshear anvil can be much more extensive

Summary

- Know the definition of ***Severe Weather***
- Be able to draw and explain the life cycle of an Air Mass Thunderstorm
- Be able to draw and explain the evolution of a Lightning Stroke, illustrating the ***Stepped Leader, Return Stroke, Dart Leader*** and subsequent Return Strokes.
- Understand how gust fronts trigger new convection
- Know what a ***Microburst*** is and how it poses a hazard to low-flying aircraft
- Know why ***Wind Shear*** and ***Capping Inversions*** are important
- Be able to recognize, ***Middle-Latitude Squall Lines***, ***Tropical Squall Lines***, ***Mesoscale Convective Complexes*** and ***Supercell Thuderstorms*** and know their significance
- Know the general characteristics of tornadoes and their climatology including, maximum winds, size, number per year in the US, most dangerous month of the year or time of day, and motion
- Know generally what the ***Extended Fujita Scale*** is and what EF0-EF5 mean
- Understand how tornado forecasting works, including the definitions of ***Watch*** and ***Warning*** in this context.
- For next time: **Read Chapter 11**

Redfield & Reid Model



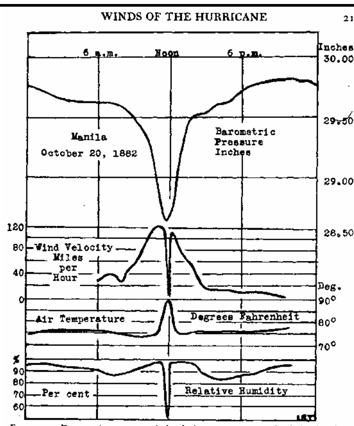
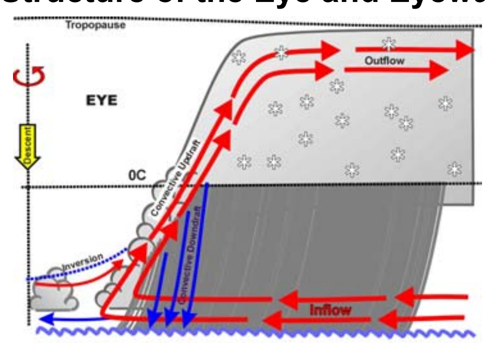
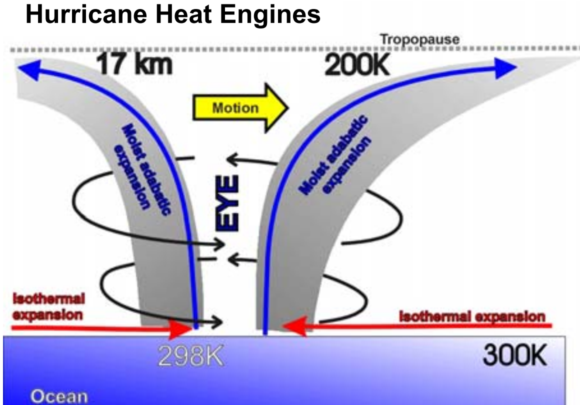


FIGURE 10. Barometric pressure, wind velocity, temperature and relative humidity during passage of typhoon over Manila on October 20, 1882.

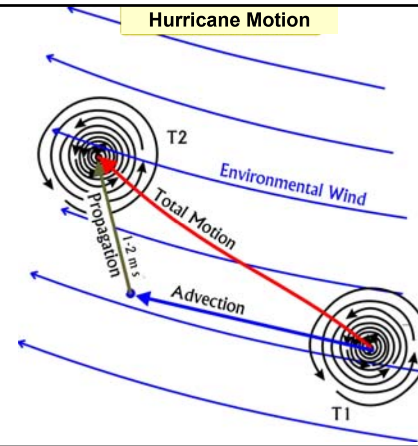
Structure of the Eye and Eyewall



Hurricane Heat Engines



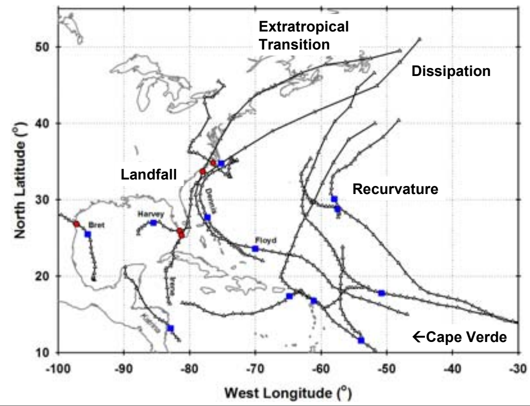
Hurricane Motion



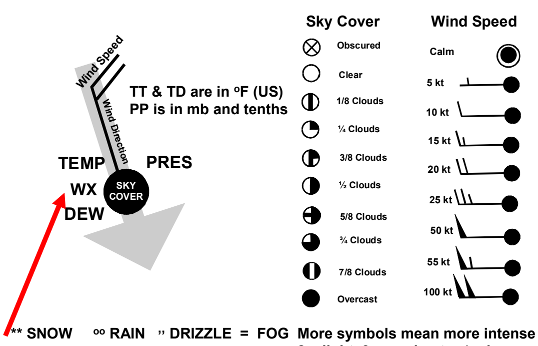
Summary

- Be able to draw and explain the Redfield-Ried Model.
- Be able to define: ***Hurricane, Typhoon, Tropical Cyclone (TC), Tropical Storm, Tropical Depression, Tropical Disturbance***
- Understand the ***Saffir Simpson Scale*** in general terms
- Understand the pressure, wind, thermal, and humidity structure of tropical cyclones
- Understand gradient balance in TCs and the ***Pressure-Wind Relation***
- Understand TC's ***Primary Circulation***, ***Secondary Circulation***, and radar reflectivity structure
- Understand the thermodynamics that determine TC ***Maximum Potential Intensity*** and the factors (shear, ocean cooling, encounters with land or cold water) that keep most TCs from reaching their MPI
- Know what ***Rapid Intensification*** is and why it is dangerous
- Know the necessary conditions for TC formation
- Memorize the annual average number of TCs (named storms) wordwide and the number of Hurricanes and named storms in the Atlantic
- Be able to compare and contrast deaths and economic losses due to hurricanes in the US
- For next time **Read Chapter 12**. The final reading assignment will be Chapter 14, The Changing Climate

1999 Hurricane Season



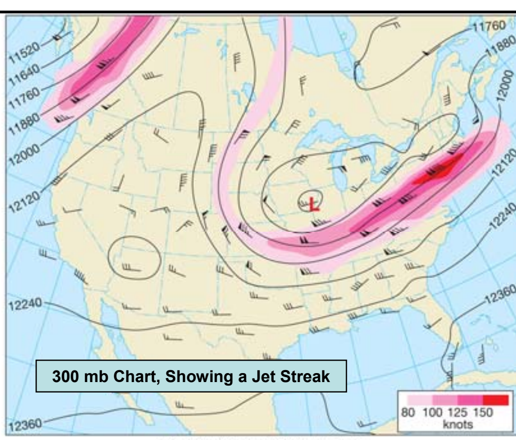
Surface Station Model (See Appendix B)



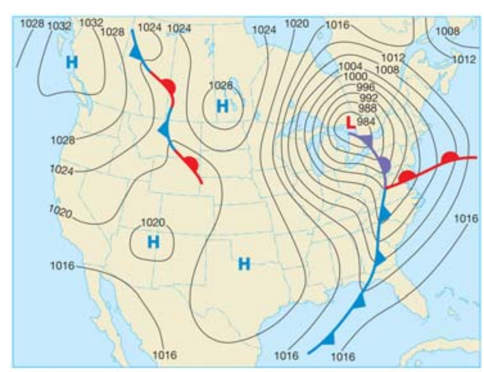
** SNOW °° RAIN ,, DRIZZLE = FOG More symbols mean more intense
2 = light, 3 = moderate, 4 = heavy

Upper-Air Charts in Forecasting

- **850 mb**
  - About 1500 m altitude
  - Used for temperature forecasting
  - Warm & cold advection
  - 0º C Isotherm is the boundary of snowfall
- **700 mg**
  - About 3000 m altitude
  - "Steering level" for air mass thunderstorms
  - If T_{700} > 14ºC don't expect thunderstorms
- **500 mb**
  - About 5500 m
  - Frontal cyclone move in the direction of the 500 mb flow
  - With about half its speed
- **200-300 mb**
  - At 9 and 12 km
  - Jet stream level
  - Jet streaks
  - Forced ascent in right entrance and left exit of straight streaks
  - Forced ascent in exit of troughs and entrance to ridges in curved streaks

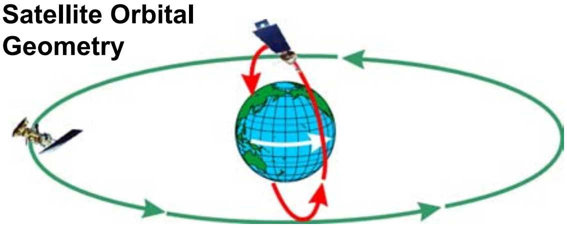


Resulting Occluded Cyclone



(f) Surface map February 4, 2003

Satellite Orbital Geometry

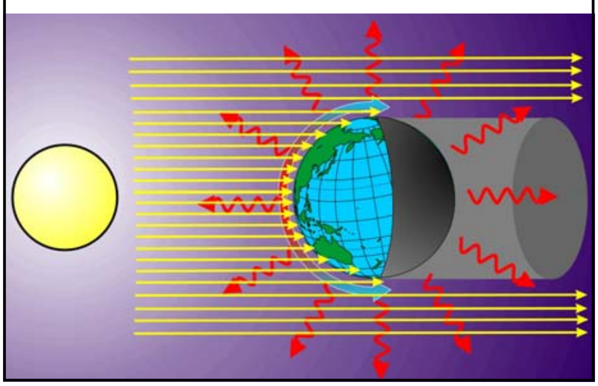


- Polar—TIROS, DMSP, POES & NPOES (since 1960)
  - Relatively low (~850 km)
  - Earth rotates under satellite
  - Satellite passes overhead once during the day once at night
  - Or sunrise and sunset
- Geosynchronous—GOES (since 1975, SMS in 1974)
  - High (35,000km)
  - Earth Rotates with satellite
  - Satellite remains above a fixed point on the surface

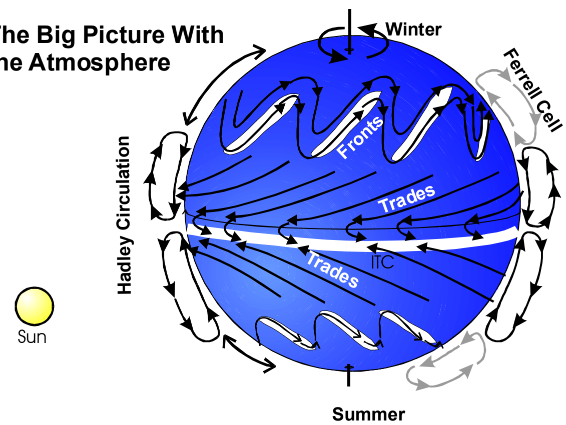
Book is wrong

Summary

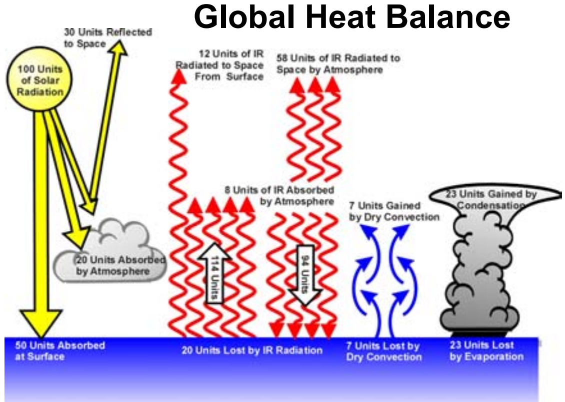
- Know the general organization of the NWS
- Know the components of forecasting: Observation, Analysis, Prediction & Dissemination
- Know how surface and upper-air obs are obtained
- Be able to interpret simple plotted surface observations
- Understand how upper-level flow controls surface weather in frontal cyclones
- Understand how Zonal and Meridional flow and the position of the long wave trough control medium-range and longer forecasts
- Know the difference between polar and geosynchronous orbits and the general characteristics of VIS, IR & WV imagery



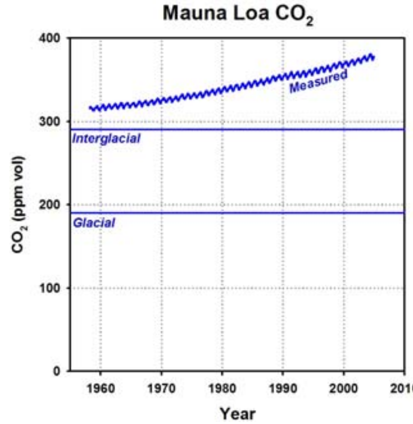
The Big Picture With the Atmosphere



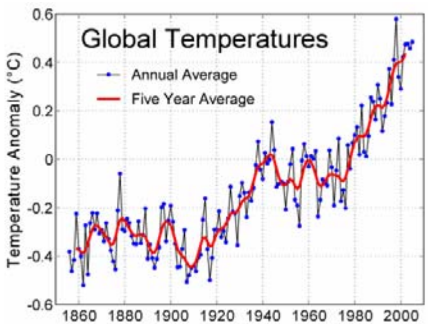
Global Heat Balance



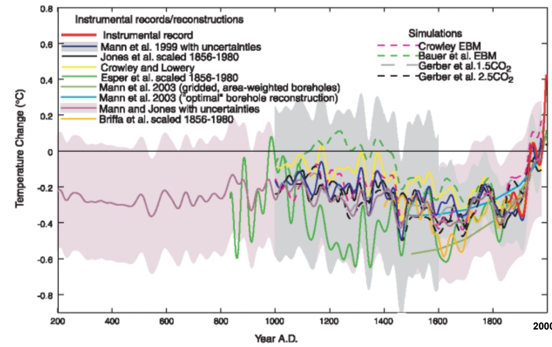
Mauna Loa CO_2

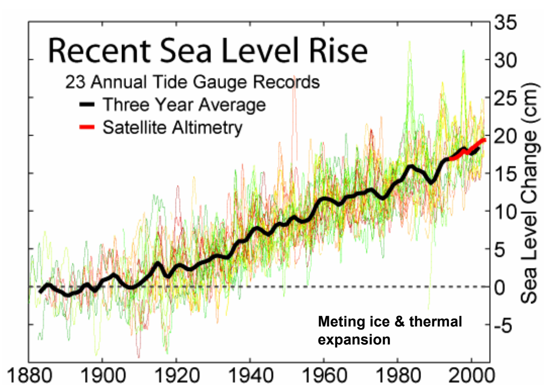


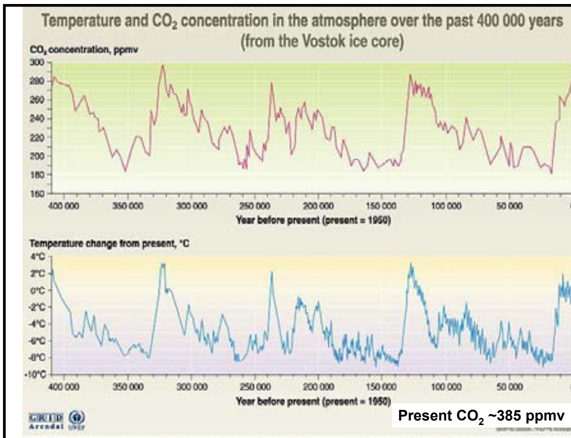
Focus on the Recent Past



The Notorious Hockey-Stick Diagram

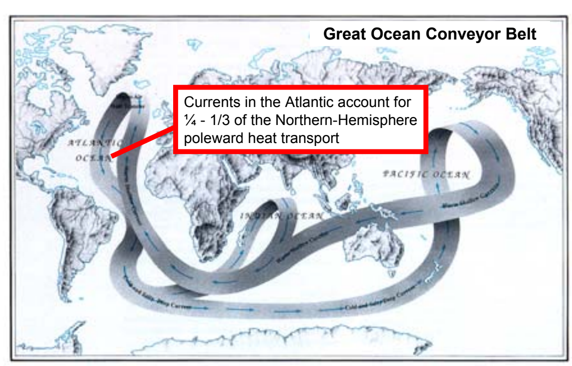




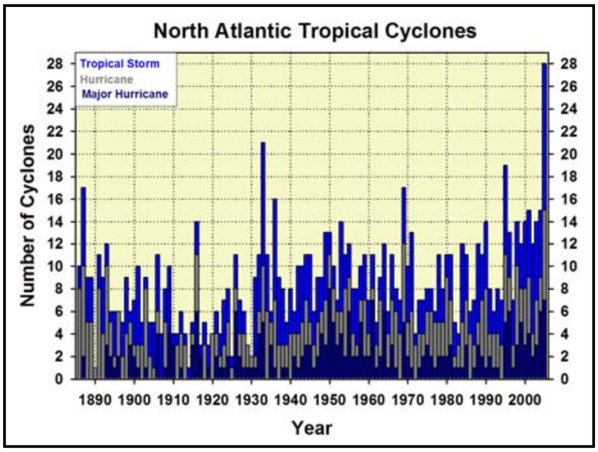


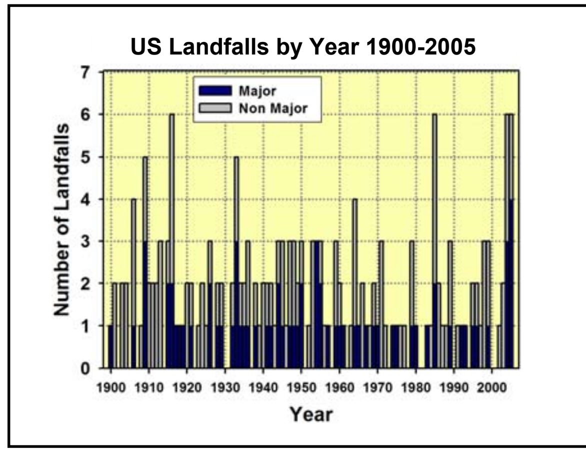
Summary

- Understand the review of solar heating and atmospheric poleward heat transport
- Understand the CO_2 budget and the reasons for increasing atmspheric CO_2 since the industrial revolution
- Be able to explain the "Hockey-Stick" diagram and know what the Little Ice age was.
- Know the significance of the Vostok Ice Cores and how ^{18}O can be use to reconstruct past temperatures
- Know that the Earth has warmed ~1°C since 1900 and that most of the warming has been in high latitudes
- Know that sea-level rose 15-20 cm during the last century and that it is currently rising at a rate of 3 cm per decade
- Be able to explain the components of Milankovitch cycles
  - Obliquity (Tilt) of the axis (41 kyr)
  - Precession of the equinoxes (21 kyr)
  - Changes in orbital eccentricity (~100 kyr)
- Know how temperature, green-house gasses, and orbital elements have evolved through time
- Be able to explain cloud-albedo and ice albedo feedback in the climate system
- **NEXT TIME:** **Climate and hurricanes**



The great ocean conveyor logo (Broecker, 1987). (Illustration by Joe Le Monnier, Natural History Magazine.)





Summary

- "Globe" is getting warmer
  - Primarily in high latitudes
  - But does effect tropics (0.5 C since 1970, 0.9ºC since 1900)
  - Almost certainly Anthropogenic
- Sea-level rise
  - Thermal expansion & melting ice
  - 15 cm last century
  - Accelerating, now 30 cm per decade
- Thermodynamic expectation of stronger storms
- El Niño, every 3-5 years, few hurricanes
- Atlantic Multidecadal Oscillation
  - 20-30 years in each phase
  - Thermohaline circulation
  - Warm phase, low shear, many hurricanes
- Chance: Random events produce clusters
- Which explanation is right????
- Landfall is when the vorticity hits the voters
- What if the climate shifts to some completely bizarre new mode?
- For next time **REVIEW FOR FINAL EXAM** (25APR07, 9:30-12:15)

The Exam

- Wednesday 25 APR 2007, 9:30AM-12:15PM. This room
- Review Exams #1 & #2
- Calculations
  - Air density
  - Blackbody Radiation
  - Humidity variables
  - Cloud identification
  - Wind & Pressure
  - Decoding surface observations
- Bring pencils & scientific calculator
- STUDY
- Good Luck