CLIM-111
Review

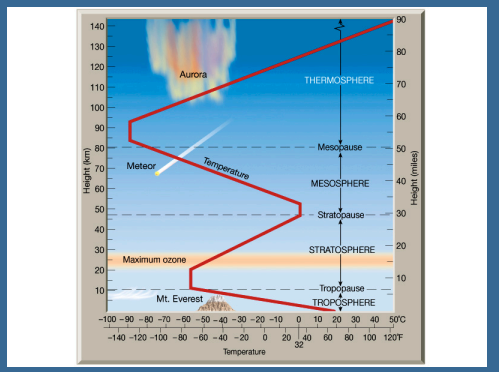
Composition and Structure of the Atmosphere

What is the difference between weather and climate?

What are the major chemical components of the atmosphere?

Atmospheric Layers and their major characteristics:

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere



Temperature profile of the atmosphere.

Composition of atmosphere

How carbon dioxide effect our climate?

Extent of the atmosphere

Vertical structure

What is the environmental lapse rate?

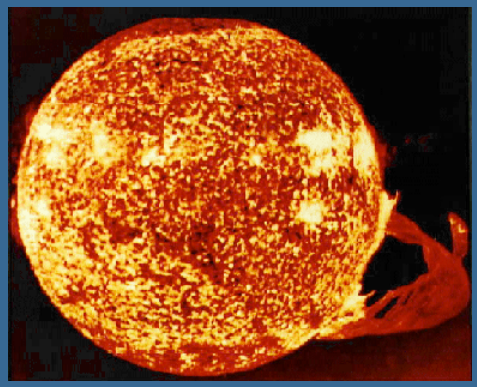
Pressure vs. altitude

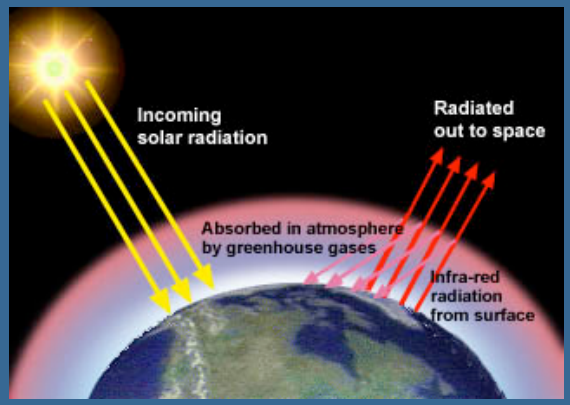


Relationship between pressure, density, and temperature and their vertical variations

Solar Radiation and the Seasons

What is blackbody radiation?
The Stefan-Boltzmann law
Earth-sun relationship (seasons)
Unequal temperature distribution
What is the difference between heat and temperature?
What are the energy transfer mechanisms?
Shortwave radiation vs. longwave radiation
Laws of radiation
Natural vs. man-made greenhouse gases
What happens to incoming solar radiation?

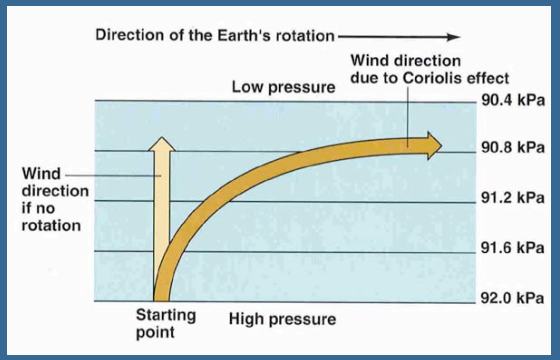


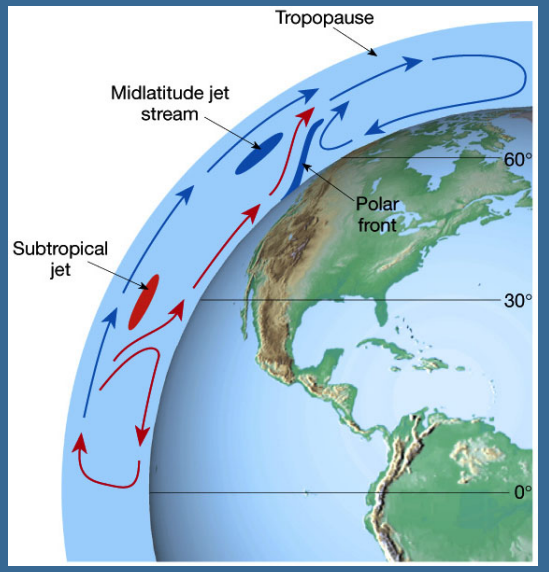


Atmospheric Pressure & Wind

Measuring pressure
Horizontal and vertical pressure variations
Hydrostatic equilibrium
Influence of temperature on air pressure
Influence of water vapor on pressure
Forces affecting wind
- Pressure gradient force
- Coriolis force
- Friction force

Geostrophic wind (winds in the upper atm.)
Gradient wind
Surface winds vs. winds aloft
How winds generate vertical air motion?





Energy Balance and Temperature

Temperature observations

What is the impact of cloud cover and albedo on temperature?

Gas law

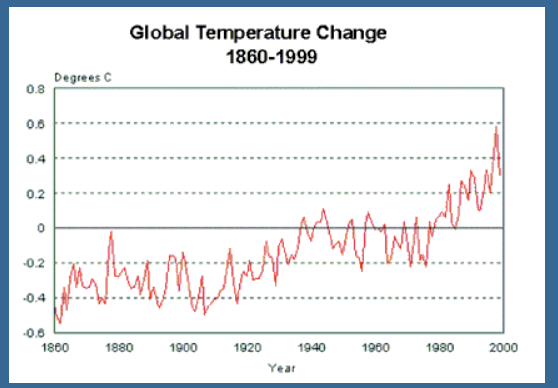
Laws of thermodynamics

Heating the atmosphere

Heat Budget

Convection vs. conduction

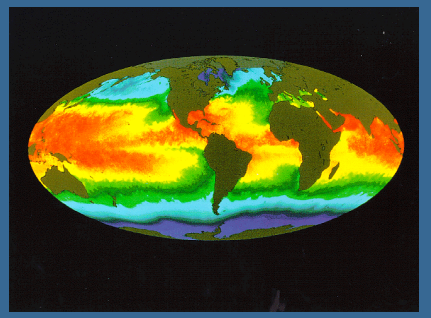
Sensible heat vs. latent heat



Why temperature vary?: The controls of temperature (land, water, oceans, altitude, ice cover)

World distribution of temperature

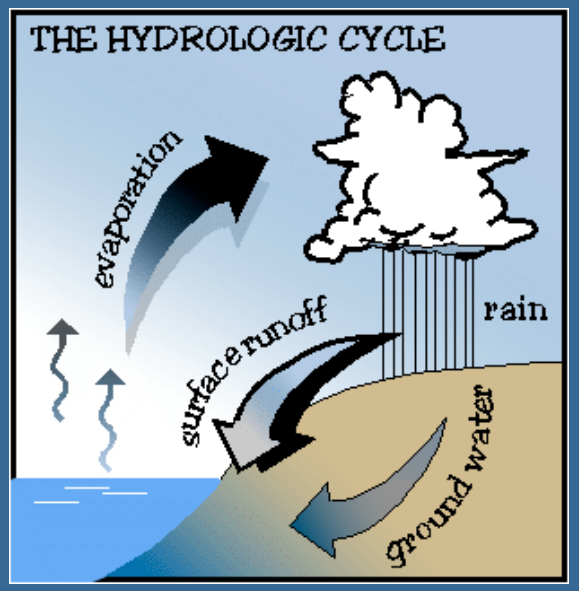
Diurnal cycle of temperature



Water in the Atmosphere

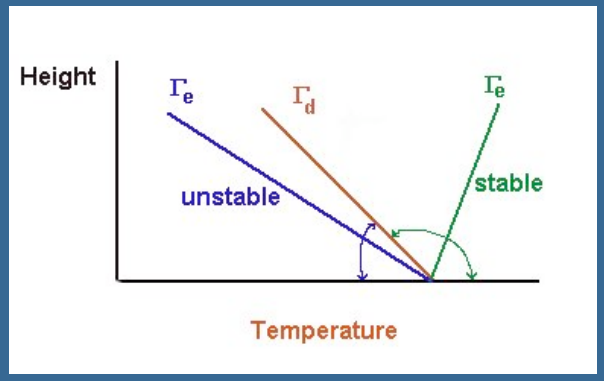
What is the hydrological cycle?
Water distribution on the Earth's surface
Properties of water,
Hydrogen bonding
Changes of state of water
Latent heat
Condensation
Melting, Freezing
Sublimation, Deposition
Types of humidity:
- Absolute humidity
- Relative humidity
- Mixing ratio

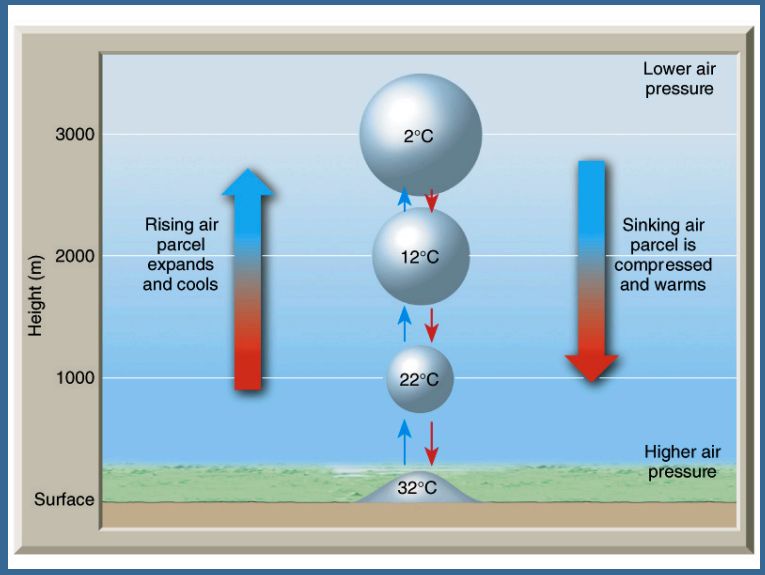
Dew point
Humidity dependence upon temperature, mass of water vapor
Saturation
Adiabatic processes



Moisture and Stability:

Adiabatic lapse rate
Lifting condensation level
Dry vs. wet lapse rate
Atmospheric stability: stable vs. unstable air
Processes that lift air
Adiabatic temperature changes
Vapor pressure and saturation
Humidity and relative humidity





Atmospheric Boundary Layer

What is PBL?

How temperature, moisture, and wind change within PBL?

What is the impact of cloud cover and albedo on temperature?

Diurnal cycle of temperature

Atmospheric boundary layer (ABL)

- Unstable ABL
- Stable ABL
- Neutral ABL

Turbulence generation

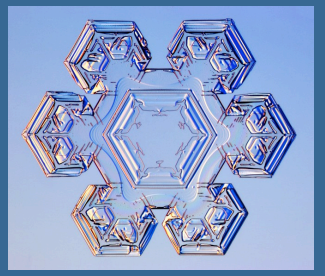
Surface layer vs. transition later.

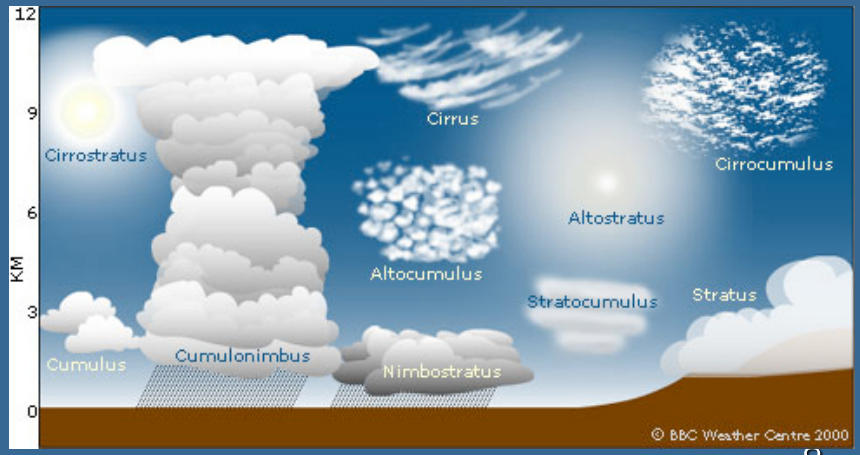
Significance of PBL

Surface characteristics and their impact on PBL structure

Cloud Development and Forms

Mechanisms that lift air
Static stability and the environmental lapse rate
Factors influencing the environmental lapse rate
How do clouds influence the atmospheric stability?
Condensation nuclei
What are clouds?
Major types of clouds
Characteristics of high, medium, low altitude clouds
How precipitation forms?
Forms of precipitation (rain, snow, sleet, glaze, hail)
Understanding the role of clouds in the climate system

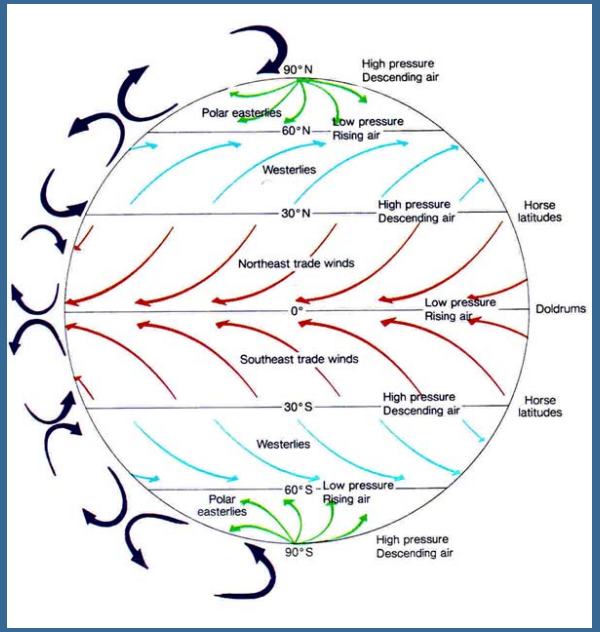


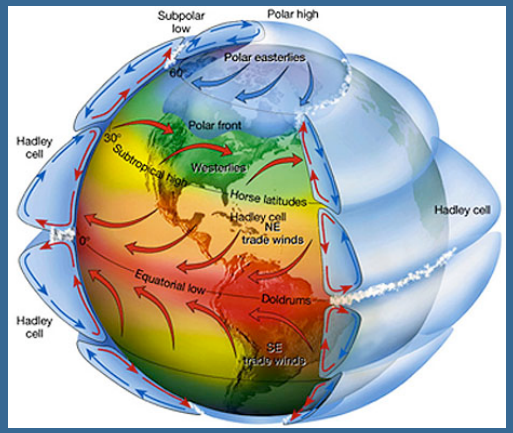


Atmospheric Circulation and Pressure Distribution

The Three-Cell Model
The Hadley cell
Westerly winds in the upper atmosphere
The polar front and jet streams
Troughs and Ridges
Rossby waves
Ocean currents
Major wind systems
- Monsoons
- Santa ana winds
- Katabatic winds
- Sea and land breeze
- Valley and mountain winds

Air-Sea Interaction
- El Nino, La Nina, and the Walker Circulation





Air Mass and Fronts

Formation of air masses

What are the requirements for an area to serve as a source region?

Where are the primary air mass source regions in North America?

Which of the air air mass type are likely to be stable or unstable?

Why air masses are more specific to mid-latitudes?

What are the roles of air masses?

Fronts and their structure

- Clod fronts
- Warm fronts
- Stationary fronts
- Occluded fronts
- Drylines

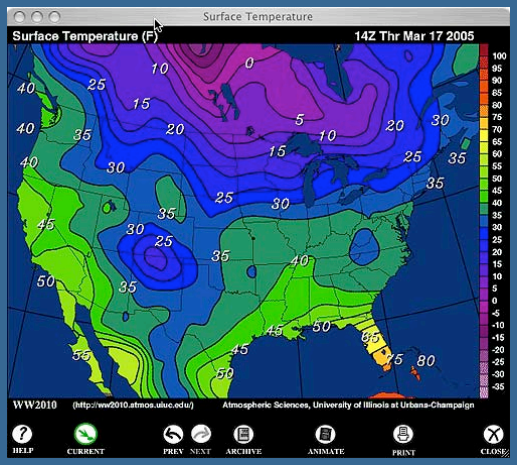


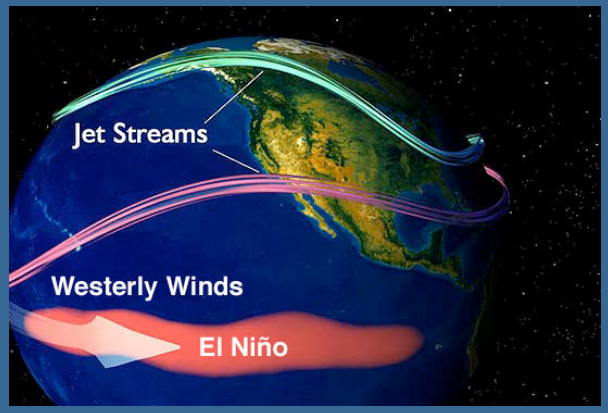
Why do cold fronts have steeper slopes than warm fronts?

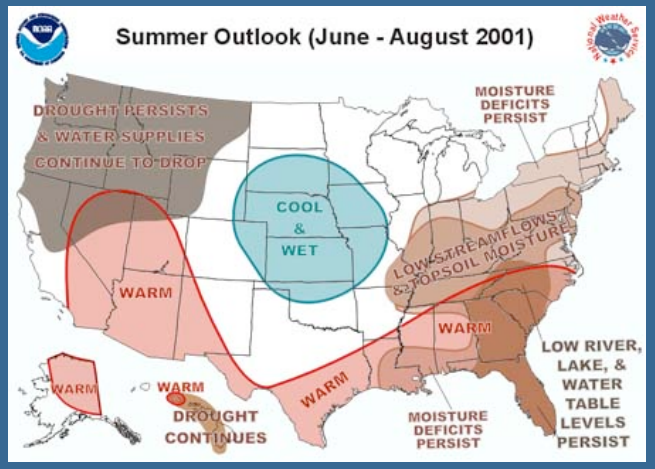
Why are occluded and drylines are important for North America weather?

Midlatitude Cyclones

The life cycle of a midlatitude cyclone
Where does cyclogenesis most commonly occur?
What are Earth, relative, and absolute vorticity?
Surface Fronts and Upper-level Patterns
Interaction of surface and upper-level conditions
Where are upper-level divergence and convergence most likely to occur?
Idealized weather of a midlatitude cyclone
Traveling cyclone







Lightning, thunder, and tornadoes

Processes of lightning formation

What causes thunder?

Thunderstorms

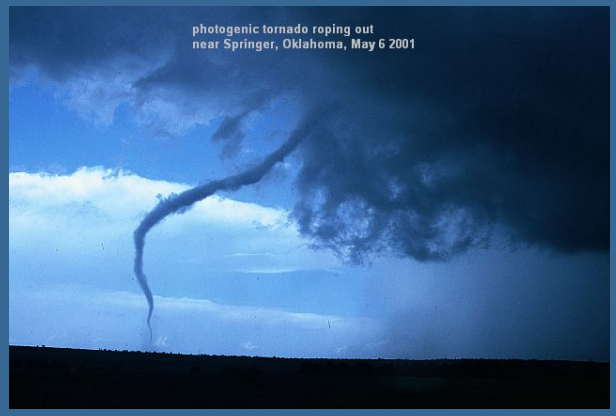
- Air mass thunderstorms
- What are the three stages of an air mass thunderstorm?
- Severe thunderstorms
- Supercell storms

Tornadoes

- Tornado characteristics and dimensions
- Tornado formation
- The location and timing of tornadoes in North America

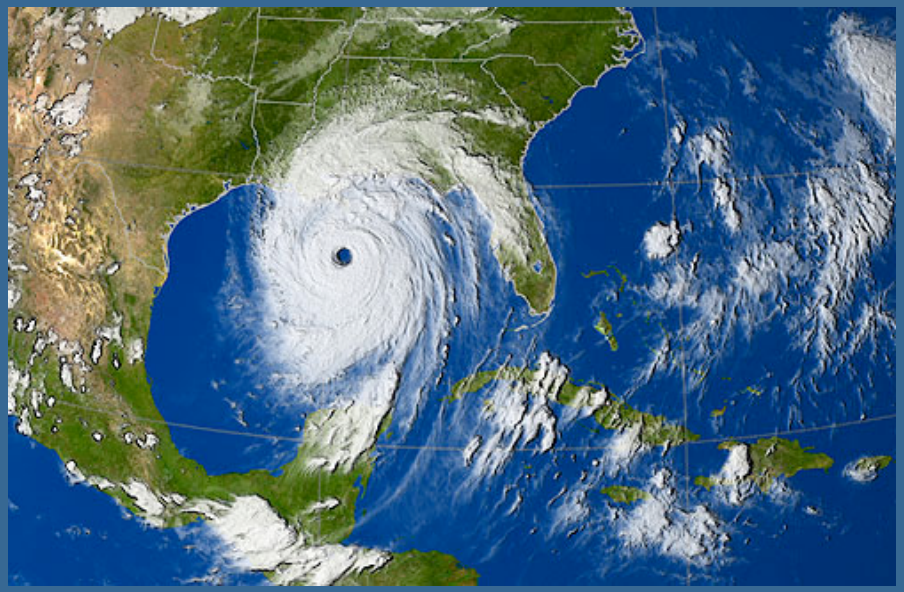
What is the difference between a tornado watch and a tornado warning?





Tropical storms and hurricanes

Hurricane characteristics
Hurricane structure
Hurricane formation
Hurricane movement and dissipation
Hurricane forecast (track and intensity)
Trends in hurricane activity



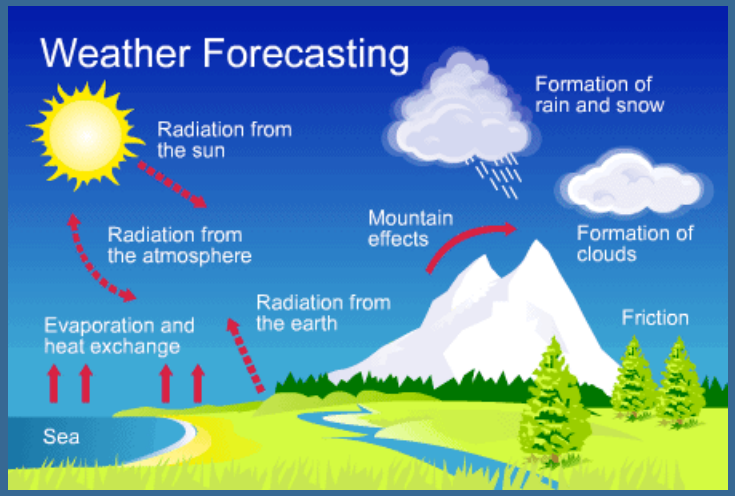


Weather forecasting and analysis

Why is weather forecasting imperfect?

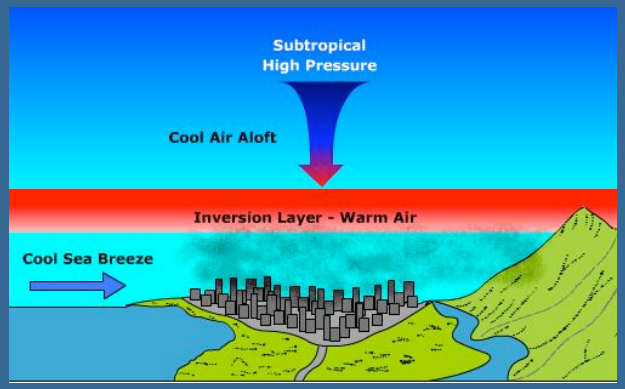
What are the analysis, prediction, and post-processing phases in numerical forecasting?

What are the importance of the 850 mb, 700 mb, 500 mb, 300 mb, and 200 mb maps in forecasting?



Human effects: air pollution and heat islands

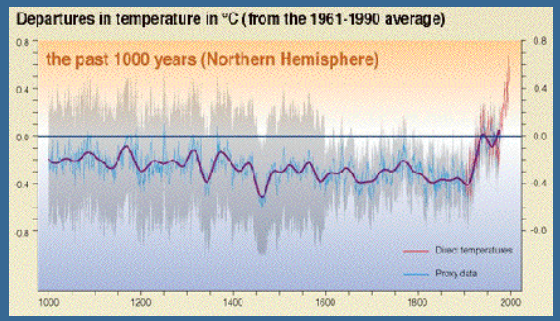
What is air pollution?
What are the major components of air pollution?
What are primary vs. secondary pollutants?
Examples of primary and secondary pollutants, and their sources.
Natural air pollution and some examples.
Acid rain and its cause.
Greenhouse gases, major and minor.
Trends in air quality.
Weather its effect on air pollution.





Current, Past, and Future Climates

What is climate?
What are the major components of the climate system?
Evidences for climate change in Earth histroy:
recent vs. long term change.
Climate dynamics: means, anomalies, and variability.
Types of climate variability.
Incoming solar and outgoing IR radiation vs. latitude (sketch)
Factors controlling present day climate.
Tree rings, recent climate, and the "hockey stick"
The last 10,000 years and climate proxies.
CO2, temperature, and climate.
The greenhouse effect and climate, global warming
Major causes of climate change.
Polar ice loss. Melting of floating ice.
Changes in variability – e.g. increasing severity of storms. Why?



Earth – The Water Planet

Is there anything in this picture that in not influenced by water?

Is there anything in this picture not influenced by life?

Is there anything in this picture not influenced by the atmosphere?

