MET 3003

Lecture 8, EXAM #1 Review, 7FEB07

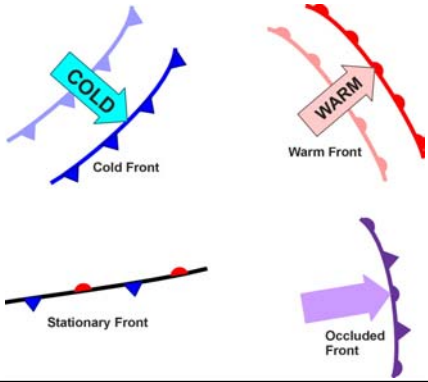
Lecture 1

- Know the definition of ***Meteorology*** and what its principal subfields are.
- Understand the scientific method.
- Know definitions of **System**, ***Open*** and ***Closed*** system, and ***Positive*** and ***Negative Feedbacks***
- Know the definitions of the various "spheres" in the Earth System
- Know the definition of ***Weather Element*** and be able to cite examples.
- Be able to describe how the wind blows around cyclones (low *p*) and anticyclones (high *p*) in the northern and southern hemispheres
- Be able to recognize and describe ***Cold***, ***Warm***, ***Stationary*** and ***Occluded Fronts***

"Spheres" in the Earth System

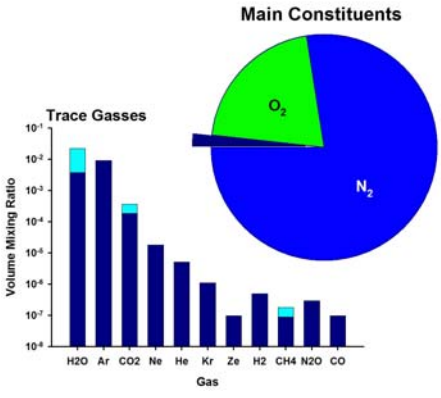
- **Geosphere** or **Lithosphere**—Rock
  - 6371 km radius
  - Core, Mantle, Crust
- **Hydrosphere**—Water
  - Seas covers 71% of surface
  - Average depth 3.8 km
- **Cryosphere**—Ice
  - Covers about 8% of Earth
  - Sometimes > 20 % of NH covered
- **Atmosphere**—Air
  - 100 km deep, by definition
- **Biosphere**—Life

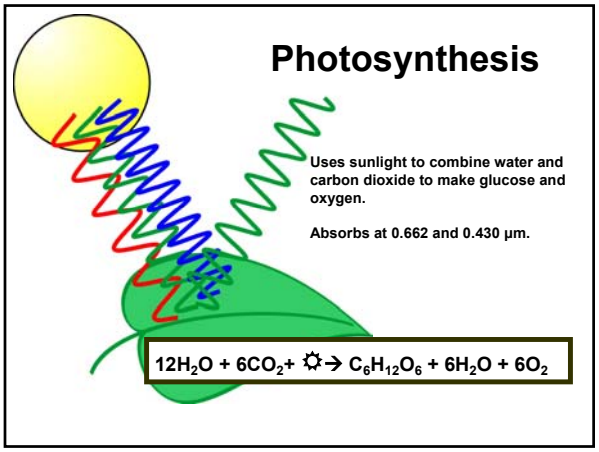
Fronts: Boundaries, often moving, separating air with different temperature and moisture content

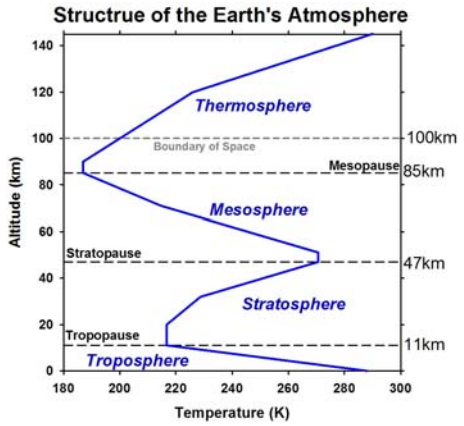


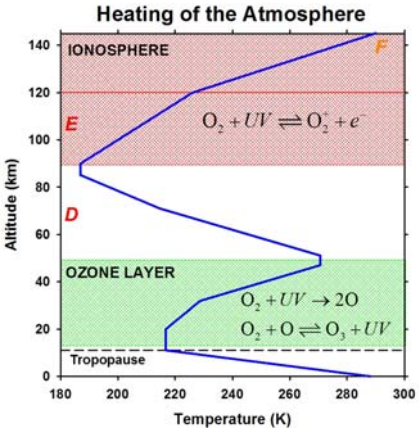
Lecture 2

- Be familiar with basic SI units
- Know the quantitative characteristics of the standard atmosphere in the troposphere and lower stratosphere.
- Be familiar with the chemical history of the Earth's early atmosphere
- Be able to compare the composition of Earth's atmosphere with that of Mars and Venus.
- Be able to describe the composition of the Earth's atmosphere including percentages of the most abundant gases (to He & Ne)
- Be able to name the two most important greenhouse gasses
- Know the chemistry of ozone
- Know the variation of carbon dioxide over time and the reason for it.
- Be able to draw an explain the the Atmosphere's thermal structure below 150 km, including the ***"spheres" & "pauses."***
- Know the definitions of ***Lapse Rate*** and and ***Inversion***
- Be able to explain how the ionosphere and ozonosphere cause the observed vertical variations of temperature.









Lecture 3

- Understand the definitions of and relationships among **force**, **energy**, **work**, **heat** and **pressure**
- Understand the universal gas law and its application to dry air and water vapor
- Be able to calculate density of dry air from temperature and pressure
- Understand the effect of water vapor on density
- Know the definition of **Virtual Temperature** and why it is used
- Be thinking about buoyancy since we will encounter it again

Density of Air

- The density of a gas is defined as m/V so that the gas law can be written:

$$\frac{p}{\rho} = p\alpha = R_d T,$$

where $\rho = m_d / V$ is the density, and

α is the "specific volume" = $1/\rho$

Calculation of Density

- Pressure is measured in millibars (mb), or equivalently, hPa = 100 Pascals
  - 1 mb = 100 Nt m^{-2} = 100 kg m^{-1} s^{-2}
- Calculate density of dry air at 1000 mb and 20°C

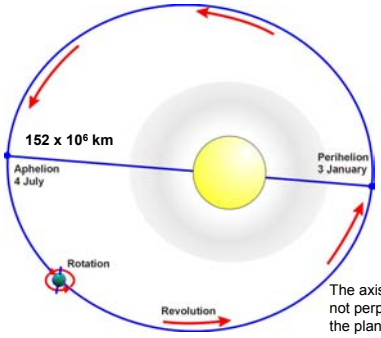
  ρ = (1000 x 100 kg m^{-1} s^{-2})/[287 m^2 s^{-2} deg^{-1} x (273.16 + 20 deg)]

  = 100000/(287x293.16) = 1.19 kg m^{-3}

Lecture 4 & 5 (1)

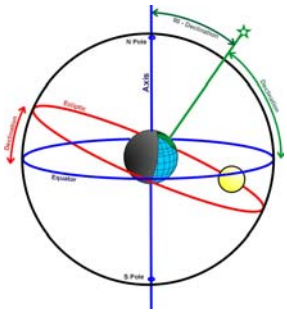
- Know the general characteristics of the Sun. Memorize surface temp & distance
- Know what ***Solar Irradiance*** is and it's value above the atmosphere
- Know the general characteristics of the Earth's orbit
- Be able to define ***Rotation*** and ***Revolution*** as applied to the Earth
- Understand the motion of the Sun throughout the year and of celestial bodies in general each day.
- Be able to define ***Declination***
- Know how the Earth's Axial Tilt (Inclination) produces the seasons
- Be able to define ***Solstice***, ***Equinox***, ***Tropics of Capricorn and Cancer***
- Be able to define and calculate noon ***Sun Angle***
- Know how sun angle effects the amount of solar heating per unit area.
- Know the definitions of ***Scattering*** and ***Reflection***
- Know how ***Optical Path*** changes with sun angle and its effect on solar heating
- Know how both temperature and temperature range vary with latitude and why

Earth's Orbit



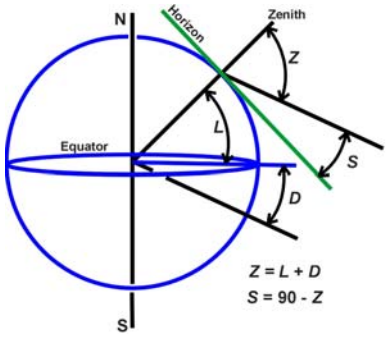
The axis of rotation is not perpendicular to the plane of the orbit

Latitude and Declination

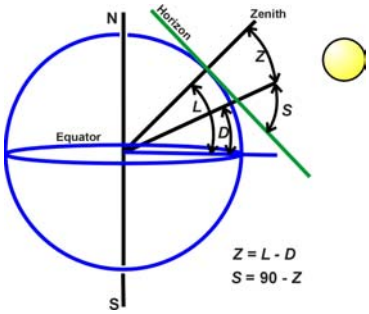


- **Equator:** a circle around the Earth in a plane perpendicular to the axis and passing through the center
- **Latitude:** Angular distance north or south of the Equator *for a place on the surface*
- **Declination** Angular distance north or south of the Equator *for an object in the sky*
- Axis always points in the same direction relative to the stars
- Because the axis is inclined 23½° to the plane of the orbit, the Sun's declination appears to change as the Earth circles it on the ***Ecliptic***
  - North of the equator in NH summer
  - South of the Equator in NH winter

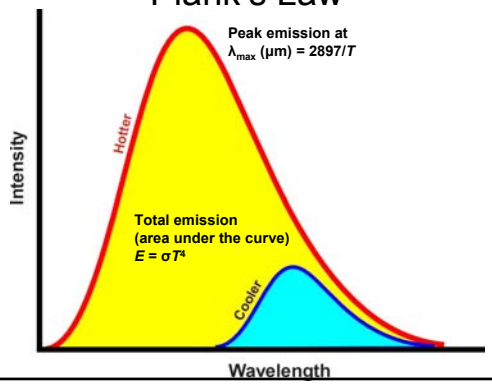
Sun Angle With Position and Sun in *Different Hemispheres*



Sun Angle With Position and Sun in the *Same Hemisphere*



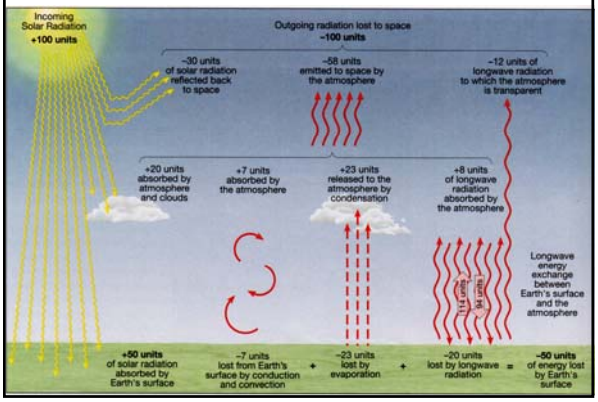
Plank's Law



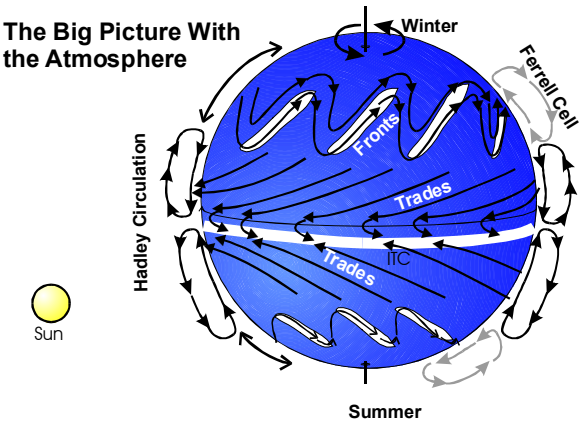
Lecture 4 & 6 (2)

- Be able to define ***Potential***, ***Kinetic*** and ***Heat Energy***
- Understand heat transport by ***Conduction***, ***Convection, Advection*** and ***Radiation***
- Know the general characteristics of EM radiation including mechanism and speed of propagation in a vacuum
- Be able to identify ***Ultraviolet***, ***Visible***, and ***Infrared*** EM radiation by wavelength
- Understand how Rayleigh scattering causes blue skies and red sunsets
- Know generally what Plank's Law is and how it relates to ***Wien's Law*** and the ***Stefan-Boltzman Law***
- Be able to calculate wavelength of peak emission and total emitted radiation using Wien's Law the Stefan-Boltzman Law.
- Be able to define ***Blackbody***, ***Grey body***, ***Albedo, Radiative Equilibrium Temperature, Emissivity, Absorptivity***
- Understand how the characteristics of emitted radiation vary with temperature and wavelength.
- Understand absorption of EM radiation by the atmosphere and know the wavelengths of the two atmospheric windows.
- Know a few albedo values generally, i.e., snow, clouds, soil, vegetation, the sea. Also know that most ordinary objects are nearly black bodies in the IR
- Be able to draw and explain the Earth's heat Balance
- Understand how the annual heat balance varies with latitude and how it relates to the Big Picture

Earth's Heat Balance



The Big Picture With the Atmosphere



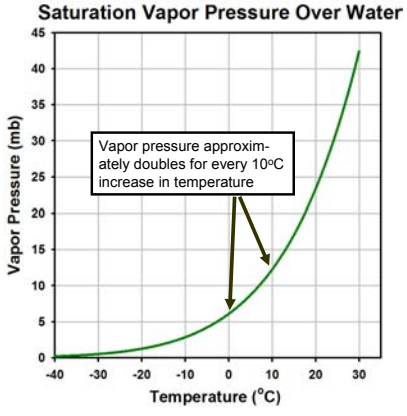
Lecture 6

- Be able to work with Celsius, Fahrenheit & Kelvin temperatures
- Understand Daily, Monthly, and Annual mean temperatures and ranges
- Understand the typical daily cycle of temperature
- Understand how the following factors control temperature at localities
  - Soar Radiation
  - Land & Water Surfaces
  - Altitude and Geographic Settings in General
  - Ocean Currents
  - Clouds and Albedo
- Understand the factors that control the global distributions of temperature in winter and summer
- Know how temperature is measured with
  - Mercury-in-glass thermometer
  - Maximum and minimum thermometers
  - Thermograph
- Understand and be able to calculate Heating, Cooling, and Growing Degree days
- Know how heat affects human comfort, including definitions of
  - Wind Chill
  - Hypothermia and Hyperthermia
  - Frostbite

Lecture 7

- Know what the ***Hydrologic Cycle*** is and the proportions of global water in oceans, ice caps, runoff, ground water and in the air. Don't memorize percents.
- Know what specific heat is and the general ratios between specific heats of liquid water, ice, vapor, dry air and rock.
- Know what ***Latent Heat*** is and be able to use it in calculations
- Know the definitions of ***Evaporation, Condensation, Melting, Freezing, Sublimation***, and ***Deposition***
- Be able to describe the different molecular organizations of ice, liquid water, and vapor
- Understand the concept of ***Saturation***
- Understand how vapor pressure over liquid water varies with temperature
- Memorize the vapor pressure doubles for every 10°C increase in temepratrue rule
- Know that vapor pressure over ice is less than that over liquid water between 0° and -40°C
- Know the definitions of **Dew Point, Relative Humidity, Vapor Pressure, Dew-Point Depression, Mixing Rato,** and **Saturation Mixing Ratio**
- Know how to calculate **Dew Point, Relative Humidity, Vapor Pressure, Dew-Point Depression, Mixing Rato,** and **Saturation Mixing Ratio**, given one quantity, the pressure and a table of saturation mixing ratios as a function of temperature (**For Exam 2**)
- Know what "conservative" means and that mixing ratio is a conservative property during pressure changes
- Know how heat and humidity affect human comfort, including a understanding of Heat Index
- Know how humidity is measured with a ***Sling Psychrometer***

Saturation Vapor Pressure Over Water



Exam #1

- 11 AM, Monday 12 FEB 2007
- Counts as 100 points, or 20% of your grade.
- Part I
  - Short answer, multiple guess, maybe true-false or matching
  - Two points each, ie 25-30 questions
  - Counts for 50-60% of grade
- Part II
  - Short essay, 1-2 paragraphs, problems, or draw and explain.
  - Ten points each
  - 5 or 6 questions, answer 4 or 5
  - Counts 40-50% of grade
- Bring a calculator
- You will need to finish by 12:15, since there is another class in this room at 12:30