GEOL 1060 Global Change: An Earth Science Perspective
Fall 2013, 2nd Hour Exam: Vocabulary and Concepts

Unit IV. Circulation of the Liquid Earth
Convergence: surface water tends to pile up at the center of gyres, where downwelling occurs. If HOT, salinity increases as surface water evaporates
Divergence: where ocean currents separate, upwelling occurs.

Upwelling: The rising of cooler, nutrient rich ocean water to the surface to replace warm, divergent surface water
Downwelling: The sinking of surface water caused by convergence and water accumulation at surface

Coriolis effect and resultant Ekman transport – surface currents are deflected to right (NH) or left (SH) of prevailing wind
Ekman Spiral: transfer of Coriolis effect down through the water column –
Ekman transport: Net effect: surface water moves at right angles to the wind. NH vs. SH

Salinity: how much salt is in the water
Temperature: temperature of the water
Density: for sea water density of controlled by temperature and salinity

Mixed layer
Deepwater or Bottom Water

Surface currents – driven by winds through the frictional coupling between atmosphere and sea surface

Deepwater formation: forms in the northern north Atlantic (very salty and cold) and Antarctica (not as salty, but colder leaving it denser)
Thermohaline circulation: Density driven vertical circulation

Primary Productivity: conversion of CO2 into organic matter by organisms through photosynthesis/chemosynthesis. Sunlight and nutrients control primary productivity or Net Primary Productivity

Nutrients: a substance that provides nourishment for essential growth

Monsoons – COME BACK
- Monsoons
  - summer wet/ winter dry
  - Strongest where:
    - large land mass adjacent to ocean
    - high elevations close to the sea

warm oceans, high evaporation
deep convection releases latent heat

Monsoons: seasonal reversal in surface winds
Summer heating of Tibetan Plateau causes high surface temperatures, low atmospheric pressure, and intense convection of air above the surface
Winter it reverses: High elevations and persistent snow cover enhance the continentally, producing even lower temperatures
Monsoons: (drivers) Variability on historical and longer time scales

Role of primary insolation, and how the positive feedbacks from latent heat release, ocean temperature and vegetation increase monsoon vigor

Unit V. Global Warming: The Evidence

Direct evidence: the instrumental temperature record: Total amount, identifying the first and second-order trends

Sources of uncertainty; "Heat island" effect, oceans vs land, geographic variability in thermometer records.

Arctic warming compared to global warming (does the planet warm equally in all areas?)
Is there a link between precipitation and global warming?
Indirect evidence of 20th century warming
Climate proxies: what are they?
Glaciers? Small glaciers and ice caps… Greenland and Antarctica
Ice shelves
Sea level rise: how much? Tide gauges and satellites Why is sea level rising… two reasons
Sea Ice, evidence for melting? Two large positive feedbacks from sea ice; one in summer and a different one in winter……. You will want to be able to explain these. How much sea level change from sea ice melt?
Permafrost: What is it, is there much, is it changing, and are there positive or negative feedbacks?
Permafrost Take Homes

- Arctic warming has resulted in permafrost thawing
- On land, carbon rom plants preserved in permafrost is then released as either CO2 or CH4, both GHG, producing positive feedbacks on warming
- Vast amounts of methane clathrates frozen

What is coming out from beneath melting snowbanks, ice caps and glaciers? What do they tell us about 20th Century warming? The Swiss Iceman, Alaskan snowbanks

Key questions from Unit V.
Is the planet warming?

How do we know? How confident are we?
If it is warming, where has it been warming, how long has it been warming and what is its
structure?

Unit VI. Global Warming: The Explanation
A. Greenhouse gases (GHG): are gases that are transparent to SW Solar radiation and absorb LW Earth radiation.
CO2 is a GHG.

The instrumental record of atmospheric CO_2
What controls the changes of CO_2 we observe in the troposphere? Why are the sampling spots where they are and what do we learn from records in such different places around the planet?

1_{st}-order trends: Regular increase in the level of CO2 in the atmosphere
2_{nd}-order trends: The Biosphere breathing: regular annual wiggles in the level of CO2 in the atmosphere

What are the roles of the following in the global carbon cycle?
- Primary production
- Photosynthesis
- Respiration
- Decomposition

Be able to explain why the observed CO_2 records from different points on Earth differ.
Why is CO_2 increasing in the atmosphere? Why is it not by the amount of fossil fuel burning?
The global carbon cycle: What is this and what can we learn from it?

Other Greenhouse gases: CH_4 (residence time, two primary sources), NOx, CFCs

Changes in GHG over time
- Instrumental record
- How can we reconstruct changes before direct measurements of the atmosphere? How do we calibrate?
- Last 1000 years:
- Last 800,000 years

Can changes in GHG fully explain the pattern of global warming of the past 100 years?

B. Solar Constant/Solar irradiance: Solar energy reaching Earth may change for several reasons, including:
Sun has been getting hotter throughout Earth History
Precession of the equinoxes and tilt of our spin axis
Solar irradiance measurements, sunspots, and sunspot cycles (30 yr of measurements and 100 yr of secure proxy record, through changes in sunspots. How do we know that suspots are a reliable proxy for solar irradiance?