

Lecture 08 – Energy and Climate

1. Ecology
 - a. Study of interactions between organisms and the environment
 - b. Today, focus on energy and global systems, but we'll come back to this
2. Climate
 - a. Not the same as weather! Long term weather conditions in a given area
 - i. Considered over a period of >30 years
 - b. Biomes
 - i. Life zones classified by vegetation type
 - ii. Location highly influenced by climate, particularly temp and precip (those two factors together really determine where the various biomes are located)
 - c. What factors influence climate?
 - i. Unequal distribution of solar energy
 1. Most energy at equator
 - a. Due to curvature of earth
 - i. At high latitudes, energy spread out over larger distance
 - ii. Tilt of the earth
 1. Why seasons?
 - a. Tilt of earth
 - b. Northern or southern hemisphere tilted toward sun at different times of year—more direct sunlight = more solar energy = summer
 2. What does this do to air circulation?
 - a. Highest energy at equator—that warm air expands, rises, then cools at altitude
 - b. Cool air holds less water, so those areas are rainy and wet
 - c. Rainforest biome
 - i. High precip, consistent temp
 - ii. Very diverse ecosystem
 - d. “Hadley Cells” – air sinks back to earth around 30° N and S latitude, cycles back toward equator
 - e. Where air falls back to earth, it is dry -- ~30°N and S latitude
 - f. Desert Biome
 - i. Low precip, low insulation (hot days, cold nights)
 - ii. Lower biological diversity
 - iii. Spin of earth
 1. How does this affect wind direction?
 - a. Coriolis effect
 - i. Deflection of fluid motion due to spin of earth
 - ii. Because earth is sphere, it moves faster at equator than poles as it spins
 - iii. Air moving away from equator is moving FASTER than the ground beneath it, due to momentum
 1. Appears to blow east

- iv. Air moving toward equator is moving SLOWER than the ground beneath it, due to momentum
 - 1. Appears to blow west
- iv. Surface features
 - 1. Mountains
 - a. Rain shadow effect explains location of other desert biomes
 - 2. Bodies of water
 - 3. Rainfall (and other factors) influence other biomes, too
- v. Atmospheric Gases
 - 1. Composition of Air
 - a. ~78% nitrogen
 - b. ~20% oxygen
 - c. ~1% argon
 - d. Trace gases
 - i. ~0.05% carbon dioxide
 - 2. Greenhouse Gases
 - a. Examples:
 - i. Carbon dioxide
 - ii. Methane
 - iii. Water vapor
 - iv. Many others
 - b. Effect
 - i. Allow short wavelength visible light to pass through
 - ii. Long wavelength infrared is absorbed, some reflected back to earth
 - 1. CO₂ in atmosphere tightly linked to temperature
 - iii. This is *absolutely necessary*! We rely on greenhouse gases to maintain livable temperatures
 - c. Global Climate Change
 - i. Right now, greenhouse gases in atmosphere increasing at disturbingly rapid rate, accompanied by rapid increase in temp
 - 1. Keeling Curve
 - ii. Why is this happening?
 - 1. Carbon removed from global cycling into storage pools (fossil fuel stores)
 - 2. When we burn fossil fuels, release stored C into atmosphere
 - 3. Can tell increasing carbon due to human activity because:
 - a. Understanding of physical properties of atmospheric gasses, and knowledge of greenhouse gas output

- b. Close correlation between levels of carbon in the atmosphere and carbon released from storage by human activity
 - c. Carbon fingerprinting
 - i. Increase in “light” carbon isotopes, consistent with carbon from ancient storage
 - ii. (Decay of radioactive carbon isotopes)
 - iii. This carbon would be at high frequency in fossil fuel stores, as those are old plants
 - d. Climate models fail if human components not taken into account
- iii. Why does this matter?
- 1. Global climate has varied wildly (much hotter and colder than this), so who cares?
 - a. Human civilization built during the Holocene, period of stable temperatures for last ~12K years
 - b. Where our cities are, where we farm, what we farm, how we live, all built under these conditions... changing these conditions likely to be damaging
 - 2. Loss of arctic ice
 - a. Positive feedback loop: as arctic ice is lost, more heat is absorbed into the ocean, resulting in more ice melt...
 - 3. Species loss
 - i. Shrinking range of some species
 - ii. Expanding range of others (including some pests, disease causing organisms)
 - 4. Economic consequences
 - a. Severe economic disruption predicted for the future, and already ongoing
 - b. Losses due to declining agriculture, disease, wildfire, rising sea levels, etc.
 - c. Increased inequality
 - d. Increasing global hunger
- iv. What can we do?
- 1. Lifestyle changes
 - a. Drive less, travel more efficiently
 - b. Limit meat/dairy consumption

- c. Conserve energy
 - d. Buy less stuff
 - 2. Regulation and government action needed
- 3. Back to Biomes
 - a. Grassland Biome
 - i. Medium precip
 - ii. Broad temp range
 - iii. Something keeping trees out
 - b. Forest
 - i. Lots of trees
 - ii. Typically higher precip

1.

Focal Questions:

1. What are the 5 primary factors influencing climate across the earth?
2. Why is the equator warmer than higher latitudes?
3. How does the tilt of the earth affect temperatures across the year?
4. What are the four major terrestrial biomes we discussed? What determines their location across the earth's surface?
5. What are "Hadley cells" and how do they influence the location of earth's biomes?
6. How does the spin of the earth relate to wind direction?
7. What are greenhouse gases? Are they good or bad?
8. What is global climate change? Why is it occurring?
9. How do we know that global climate change is caused by humans?
10. What are the consequences of global climate change?