Chapter 10 – Climate Change

This chapter uses many diagrams and plots, but I will try to use words, since this is what will be required on an essay.

A very brief review of Earth atmosphere and climate

- The Earth's atmosphere is 78% N_2 (nitrogen), 21% O_2 (oxygen), argon, and a few other gases
- CO_2, carbon dioxide, is only 0.038% of the atmosphere (i.e., has a concentration of 380 parts per million or ppm) but plays an important role in regulation the temperature of the atmosphere
- Atmospheric temperature records
- The last 600,000 or more years of temperature records can be reconstructed from
    - Ice cores – isotopic composition of air bubbles trapped in glaciers
    - Sedimentary deposits – carbonate compounds in fossilized plankton
- Since 1850 – thermometer records
- CO_2, CH_4 (methane), and N_2O (nitrous oxide) are called Greenhouse gases due to their role in…

The Greenhouse Effect – light from the sun shines on the Earth. Some of the visible light is reflected from the Earth's surface and its atmosphere, but the rest is absorbed and warms the earth and the water and greenhouses gases in the atmosphere, to be emitted as IR radiation (heat). The atmosphere radiates some of its heat into space and some down onto the surface of the Earth. Some of the Earth's heat passes through the atmosphere and into space, but much of it is reflected and held near the Earth's surface by the greenhouse gases. This phenomenon acts much like the covering of a greenhouse which keeps the inside warmer and is thus called the greenhouse effect.

- The greenhouse effect has generally been a good phenomenon for life on Earth (including humans) because it keeps the Earth at an inhabitable temperature.

A temperature has fluctuated through time, so has CO_2, and this is natural

- CO_2 dissolves in or is emitted from the oceans depending on their temperature

All of human "civilization" from the development of agriculture onward has occurred in the last 12,000 years, during the interglacial period, when global temperatures have been approximately 10 ^oF warmer than the last ice age

Since 1850, climate has warmed by about 2 ^oF

- The warmest year ever was 1998

Scientists wondered why this apparent warming was occurring and searched for answers. What they observed was that over the last 1000 years

- For 800 years CO_2 was 280 ppm (0.028% of the atmosphere)
- Since 1800 (last 200 years) CO_2 has risen to 380 ppm

The potential correlation between observed temperature rise and increases in atmospheric CO_2 concentrations (which is higher now than it has ever been) and the possible implications for future warming caused responses ranging from concern, to panic to denial.

The potential global implications of this issue prompted the UN and World Meteorological Organization to form the Intergovernmental Panel on Climate Change (IPCC).

- IPCC Conclusion - we can say with 90% confidence that human emissions of CO2 have caused some or most of the warming observed since 1957 (1 ^{o}F)

Greenhouse climate models predict that the Arctic and Antarctic regions should warm the fastest due to the clearing of white snow/ice and more light being absorbed by dark ground underneath. But the timing and way in which these regions are warming does not fit global warming models and underlies our inability to predict the outcomes of global warming at this time.

Perceived changes to seasons, weather, and increased tornado and hurricane frequency and severity cannot be explained by global warming and are due to observational bias or "cherry picking"

Climate observations are at the very beginning of the period when human impact could be observed.

There are plenty of reserves of carbon-containing fossil fuels yet to be burned, held by countries already emitting a large amount of CO_2. Burning these fossil fuel reserves have associated political, economic, and non-climate environmental issues attached to them

The result of potentially dire future implications of climate change have led to a desire to mitigate climate change. This can be accomplished by the reduction of CO2 emissions achieved through

- Regulation
    - Kyoto protocol, 1998
    - correlation between income and energy use/ CO_2 emissions thus wealthier countries were asked to take action
    - would have committed the U.S. to a reduction of CO2 emissions to 7% below 1990 levels
    - signed by Vice President Al Gore, but not ratified by Congress
    - criticized for not requiring reductions from developing countries
        - that criticism was given ammunition when China surpassed the U.S. in CO2 emissions in 2006
- Technology
    - Conservation
    - Alternate Energy Sources
        - Biofuels
        - Nuclear power

    - Wind and solar power
- Carbon Capture and Sequestration (CCS) - “clean” coal