

## Climate Change and Ozone Depletion Chapter Nineteen

### Greenhouse Earth

- The \_\_\_\_\_ effect is the process in which greenhouse gases prevent the radiation of heat into space by trapping it in the troposphere. More greenhouse gases in the atmosphere create higher temperatures near the Earth.
- The atmosphere allows \_\_\_\_\_ rays to strike the Earth, heating it up. The Earth then radiates infrared rays (heat) back outward. The ability of the earth's surface to reflect light is called its \_\_\_\_\_.

### Greenhouse Gases

- The major greenhouse gases
  - water vapor (H<sub>2</sub>O)
    - naturally occurring
  - carbon dioxide (CO<sub>2</sub>)
    - burning of \_\_\_\_\_ fuels
  - nitrous oxide (N<sub>2</sub>O)
    - burning of fossil fuels, fertilizers
  - \_\_\_\_\_ (CH<sub>4</sub>)
    - burning of fossil fuels, wetlands, livestock
  - chloroflourocarbons (CFC's)
    - aerosols, refrigerants

### Global Warming – The Facts!

- Is global warming occurring? Yes.
- Does global warming occur naturally? Yes.
- Do human activities cause global warming? Yes.
- Are we all going to die? No.

### Global Warming

- As a result of the greenhouse effect, the average temperature of the Earth will rise at least \_\_\_\_\_ by \_\_\_\_\_. This predicted increase in temperature is called global warming.
  - The effects of this seemingly small increase in temperature could include:
    - weather change: stronger storms, more flooding in some areas, more droughts in other areas
    - the best farming areas would move northward
    - rise in sea level

### Global Warming is Naturally Occurring

- Layers of Antarctic ice provide the data for the past 900,000 years, and it is found that cycles of heating and cooling have occurred on a global basis.
- Each ice age lasts approximately 100,000 years and is followed by a period of warming that lasts 10,000 to 12,500 years.
- The warming period during the last 10,000 years has been a major factor in the development of \_\_\_\_\_, human civilizations, and population \_\_\_\_\_.

### Global Warming is caused by Human Activity

- The past 100 years have seen a significant increase in global mean temperature caused by a rapid increase in major classes of air pollutants/greenhouse gases. The primary source of these pollutants is the burning of fossil fuels. The second leading source is \_\_\_\_\_ (slash & burn). The biggest greenhouse gases are....\*
  - CO<sub>2</sub> – carbon dioxide - not as potent of a GHG, but lots of it. The good news: half of man-made CO<sub>2</sub> would be reabsorbed by plants and the ocean within 30 years if we stopped excess production.
  - CH<sub>4</sub> – methane - 20 times as potent as CO<sub>2</sub> over a 100 year period. The good news: we can capture CH<sub>4</sub> and use it as \_\_\_\_\_.
  - Particulates (aka soot, aka black carbon) - The good news: it is washed out of the atmosphere by \_\_\_\_\_ relatively quickly.

### **OMG! You didn't even mention Water Vapor!**

- Water vapor is the gas most responsible for the greenhouse effect, accounting for 60-70%. It is the most prevalent greenhouse gas by mass and volume.
  - Since water vapor comes from evaporation, rather than human activity, the current warming trend must be natural!
    - Not exactly. The amount of water vapor the atmosphere can hold is almost entirely a function of \_\_\_\_\_. As temperature rises, this causes more evaporation, and therefore more water vapor.
    - So, the emission of excess GHGs leads to warmer temperatures, which leads to more water vapor, which leads to warmer temperatures. It's a \_\_\_\_\_ feedback loop.
  - Clouds! Increased water vapor will make more clouds which will reflect light and cool the planet!
    - It's possible, but the jury is still out. However, most recent studies have suggested this is not the case.

### **10 Warmest Years on Record Global Surface Temperature Trend Glaciers Then and Now**

#### **So We Freak Out Now?**

- So global warming is happening and humans contribute. Now what?
  - The good news: doing the things that decrease greenhouse gases will help Americans in many ways
    - Reduce air \_\_\_\_\_, which will reduce negative effects to human health including asthma, lung cancer, bronchitis and emphysema
    - Reduce dependence on \_\_\_\_\_ energy sources
    - Reduces environmental effects such as habitat destruction from mining and acid rain.
    - Renewable energy sources save \_\_\_\_\_ in the long term
  - The bad news: it will cost money in the short term and political will for the long term

#### **The Kyoto Treaty**

- The Kyoto Treaty was the first major international agreement on \_\_\_\_\_ emissions. In December of 1997, the treaty was designed and agreed on by the major countries involved in the 1992 U.N. Earth Summit. This treaty would reduce emissions by 5% from 1990 levels by 2012.
- In March of 2001, President Bush withdrew U.S. support of Kyoto. In 2005, the treaty was ratified without the U.S. by every industrialized country. The Obama administration did not join Kyoto upon taking office in 2009 in anticipation of the Climate Summit in Copenhagen at the end of his first year in office.

#### **Copenhagen**

- The 15<sup>th</sup> United Nations Climate Change Conference took place in Copenhagen, Denmark in December \_\_\_\_\_. The conference ended with an agreement by the 194 countries to “cap temperature rise, reduce emissions, and raise finance to kick start action in the developing world to deal with climate change.” The emissions targets are meant to keep temperatures from rising more than \_\_\_\_\_° C. This was the basis for the next conference to occur in 2015.

#### **Paris**

- The 2015 UN Climate Change Conference, known as \_\_\_\_\_, was held in Paris, France. This conference was of particular importance because of significant contributions by the two largest carbon emitters – \_\_\_\_\_ and \_\_\_\_\_. In April of 2016, 174 countries signed the agreement and began implementing plans to limit global warming to 1.5° Celcius. This will require a target of zero emissions by sometime between 2030 and 2050.

### **Uncertainty**

- The election of Trump as U.S. President has led to uncertainty with regards to the Paris Summit. Trump has included the following within his “100-day action plan”:
  - Cancel U.S. involvement in the \_\_\_\_\_ Agreement and stop all payments of U.S. tax dollars to UN global warming programs
  - Cancel executive orders from the Obama administration regarding climate and \_\_\_\_\_, including the Climate Action Plan
  - Encourage Trans-Canada to renew its application for the Keystone XL Pipeline
  - Open onshore and offshore leasing of \_\_\_\_\_ lands, eliminating the moratorium on coal and shale energy deposits
  - Eliminate the EPA’s Clean Power Plan

### **The Boiled Frog Syndrome**

- As the story goes, a frog in a pot of water does not become alarmed as it is slowly heated. The frog does not perceive the situation as dangerous because the water the process is very \_\_\_\_\_, and the frog is alive from temperature increase to temperature increase. Eventually the frog dies because he has no evolutionary experience of the lethal effects. This cautionary tale against ignoring the accumulation of small changes over time is called the Boiled Frog Syndrome.

### **The Ozone Shield**

- Ozone is a form of oxygen with molecules of three \_\_\_\_\_ atoms
  - it is colorless and has a strong odor
  - in the \_\_\_\_\_, ozone absorbs the majority of ultraviolet radiation hitting the Earth ☺
  - in the troposphere, ozone contributes to air pollution ☹
- Different chemical reactions occur with ozone in the stratosphere and the troposphere
  - \_\_\_\_\_ destroy ozone in the stratosphere, and have created a thinning (hole is an incorrect term) in the ozone shield above the south pole
  - the burning of fossil fuels increases ozone in the troposphere

### **Why is ozone thinning seasonal?**

- Each sunless Antarctic winter, ice crystals in the air collect CFCs and catalyze the reaction that release Cl atoms and ClO. Without the \_\_\_\_\_ to catalyze ozone destruction, the ClO combine to form Cl<sub>2</sub>O<sub>2</sub>, which accumulates in the atmosphere.
- When sunlight and spring return the light breaks up the stored molecules, releasing large numbers of \_\_\_\_\_ atoms. This leads to a loss of 40-50% of the ozone in most areas – 100% in some.

### **Montreal Protocol**

- CFC’s (chlorofluorocarbons), a type of \_\_\_\_\_, were manufactured in the 1930’s as a refrigerant and spray can propellant.
- CFC’s were found to destroy stratospheric ozone in the 1970’s, which lead to The Montreal Protocol (1987). This international agreement phased out a series of substances, including CFC’s, responsible for ozone depletion.
- As a result, stratospheric chlorine levels in polar regions should return to 1980 levels by 2065. This is often cited as the largest global environmental success story.