Climate Change

- Stratosphere made up of gases that trap radiation (heat) from earth's surface, causing it to be warmer than otherwise
- Acts like greenhouse, sunlight let in but not all radiation let out
- Natural effect that is vital to human life
- Without greenhouse effect , earth's average temperature would be roughly -18°C (-0.4°F); instead of its current +15°C (59°F)



- Carbon Dioxide is the most important gas in stratosphere generating greenhouse effect
- CO₂ in the atmosphere has grown by 20% over the last 250 years
- In the last 30 years alone it has grown 8%.

Greenhouse gases

- Scientists link increase in greenhouse gases to human activity
- Many human activities (such as exhaling) involve emission of greenhouse gases
- Increase in greenhouse gases linked mainly to economic activity involving burning of fossil fuels

Greenhouse Gas	Major Source
Carbon Dioxide	Fossil fuel combustion; Deforestation; Cement production
Methane	Fossil fuel production; Agriculture; Landfills
Nitrous Oxide	Fertilizer application; Fossil fuel and biomass combustion; Industrial processes
Chlorofluorocarbon-12	Refrigerants
Hydrofluorocarbon-23	Refrigerants
Sulfur Hexafluoride	Electricity Transmission
Nitrogen Trifluoride	Semiconductor manufacturing

- Increasing greenhouse gases are related to an estimated warming of the earth of 0.3 degrees (celsius) per decade.
- This is much greater than estimated rate of change during previous periods of warming and cooling 0.05 degrees celsius

Effects Climate Change

- Large uncertainty regarding effects
- Effects anticipated to differ greatly across regions, countries
- In general richer countries expected to be less effected then poorer
 - Wealthier countries are in cooler climate areas, and have more resources to use to adapt

Effects Climate Change (Damage)

- 1. Sea levels may rise by 1 to 4 feet by year 2100 due to <u>melting ice in polar regions</u>
 - Coastal regions forced to adapt
 <u>Island Nation</u>
 Flooding

2. Changes in agriculture; rising temperature may change location of crops

- Many poor countries largely dependent on agriculture
- Effects expected to be negative but actual changes are unknown
- 3. Changes in weather patterns and weather events

Cost of Climate Change

- Extremely difficult to measure the damage of marginal ton of CO₂ emitted
- Effect of CO₂ takes on a time dimension
 - Effect of warming caused by emissions will be felt mainly by future generations
 - Future generations may arrive at solutions that will have made present actions less necessary

A country's total CO₂ production =

Population × GDP/Pop × Energy/GDP × CO₂/Energy

- GDP/Pop: Wealthier countries tend to produce more greenhouse gases
 - Consume more goods and services whose production/consumption generates CO₂
- Energy/GDP Countries that produce/use energy as large proportion of GDP produce more greenhouse gases
 - People may commute great distances; or use a lot of resources to stay warm or cool

- CO₂/Energy Countries that rely on certain energy technology will produce more CO₂
 - <u>Reliance on coal for energy</u> produces CO₂; reliance on nuclear produces less CO₂

2015 Emissions by country

Climate Change

Equity and economic efficiency of proposed policies on CO2 emissions

- Each country decrease emissions by equal proportion
- Countries should adjust so that emissions per capita would be equalized
- Countries should adjust such that emissions per dollar of GDP is equalized (each would be equally energy efficient)

Kyoto Protocol

- 1997 agreement provides targets for developed countries to reduce greenhouse emissions
- Ratified and came into force in 2005
- Under agreement many developing countries would not have to limit emissions

Kyoto Protocol

- Agreement set targets that were to be met over the years 2008 to 2012
- In 2012, an amendment to Kyoto was adopted (<u>Doha Amendment</u>) that set greenhouse gas targets through 2020
- The agreement will enter into force if 144 countries agree to accept it. As of February 2019, 126 countries have agreed to it.
- US did not sign onto Kyoto protocol or the Doha Amendment

Montreal Protocol and Climate Change

- Protocol called for elimination of products using mainly CFC's that contributed to thinning of ozone layer
- There is a provision in the protocol anticipating future environmental problems caused by substitutes for CFC's
- Many countries switched from CFC's to hydrofluorocarbons, or HFCs, for use in airconditioners and refrigerators.

Montreal Protocol and Climate Change

- HFC's are a small percentage of greenhouse gases in the atmosphere
- But they have a 1000 times the heat-trapping potency of carbon dioxide
- The amendment to Montreal is expected to lead to the reduction over time of the equivalent of 70 billion tons of carbon dioxide from the atmosphere
- Roughly two times the carbon pollution produced annually by the entire world

Montreal Protocol and Climate Change

- Richer countries will eliminate HFC's more quickly than poorer countries
- This is an amendment to a treaty that has already been ratified

- International agreement binding all countries to decrease greenhouse gases, including poor nations
- Accord calls for some subsidy by rich countries to developing countries
- Each of 186 countries required to put forth individual plan to cut greenhouse emissions
- The specifics of each country's plan are voluntary

- The US plan pledges to cut within 10 years greenhouse emissions by roughly 26% of the country's 2005 level
- US is still under the agreement; it can break out of it only at the end of 2020
- Each country is required to make plan more stringent over time

- Accord is meant to keep the increase in global temperatures "well below" 2 degrees Celsius, or 3.6 degrees Fahrenheit, over preindustrial levels
- Paris Accord entered into force November 2016 when at least 55 countries representing 55% of greenhouse gas emissions signed on

- Countries legally required to meet every five years to detail changes in plans
- Requirement to publicly monitor and update plans is used as way to induce countries to follow through
- Countries met in Poland in 2018 acknowledging that the goals of the agreement are not being met

- The agreement lacks structure and enforcement
- There is no agreed upon emissions reporting process by country
- No rules stating how countries can pledge to cut emissions.
- For instance, some countries, such as Indonesia, have pledged to reduce their emissions below a "business as usual" trajectory.

- Worldwide greenhouse gas emissions expected to increase by approximately 2.7% in 2018
- Emissions rose by 1.6% in 2017
- The previous three years, worldwide growth was flat
- The switch from coal has been overwhelmed by increases in transportation and the use of natural gas and oil