

Global Climate Change Project

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Ozone Depletion

Montreal Protocol

The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production of substances that are responsible for ozone depletion.

There are trade provisions that limited signatories to trade only with other signatories over the ozone depleting products. The chemical companies are now innovating cleaner products that do not affect the ozone.

Ground-level and stratospheric ozone

Ground-level ozone is an air pollutant and is harmful to animals, as produces respiratory problems whereas stratospheric ozone protects us from the harmful ultra violet radiation of the sunlight by absorbing it. Unlike the ozone that occurs naturally in the stratosphere, tropospheric ozone is man-made.

	Ground Level	Stratospheric
Health Effects	It impacts the air quality in urban areas. Smog produces eye, nose and throat irritations and in the short term can cause coughing, chest pain and other respiratory discomforts. Over the long term, exposure to the ozone can damage lung tissue and add to lung disease and reduce life expectancy.	Increased ultraviolet radiation can cause sunburn, skin cancer, eye aging and suppression of the immune system.
Environmental Effects	Crops such as wheat, corn and beans are prone to damage from smog. Leaves are damaged and growth reduced; susceptibility to insects and disease increases. Ground-level ozone is a greenhouse gas that affects air quality. Higher concentrations will add to global warming.	Absorbs and filters the sun's ultraviolet rays, protecting the earth from harmful radiation.

Solutions to Ground Level Ozone

- Clean Air Interstate Rule that permanently capping emissions of sulfur dioxide and nitrogen oxides.
- Mercury and Air Toxics Standards reduces mercury and other toxic air pollutants from power plants, and these standards will reduce emissions of sulfur dioxide and fine particles.
- Clean Air Visibility Rule require emission controls for industrial facilities emitting air pollutants that reduce visibility.
- Clean Air Nonroad Diesel Rule set emission standards for the engines used in most construction, agricultural, and industrial equipment to reduce the amount of sulfur allowed in the fuel they use.
- Tier 2 Vehicle Emission Standards and Gasoline Sulfur Program treats all passenger vehicles and the fuels they use as a system, setting tailpipe emissions standards for all passenger vehicles and requires reduced levels of sulfur in gasoline.

Hole in the Ozone

This hole is located over Antarctica. In the winter, a vortex of winds develops around the pole and isolates the polar stratosphere. When temperatures drop below -109°F, thin clouds form of ice, nitric acid, and sulphuric acid mixtures. The chemical reactions on the surfaces of ice crystals in the clouds release active forms of ozone depleting chemicals. This is when the “hole” can be found.

One solution to mending the hole would be to remove the excess chlorine and bromine from the stratosphere, and the only way to do that is to stop making chlorofluorocarbon products. This is where the Montreal Protocol comes into effect.

Causes of Global Climate Change

Greenhouse Gases

Greenhouse gases are chemical compounds that trap heat in the atmosphere causing the Earth to become warmer. Some of these compounds are carbon dioxide, methane, nitrous oxide and others. Carbon dioxide comes from burning fossil fuels, solid waste, trees, wood, and other chemical reactions. Methane comes from landfills, coal mines, oil and natural gas operations, the use of nitrogen fertilizers, burning fossil fuels, and from certain industrial and waste management processes. Carbon dioxide makes up 82% of greenhouse gas. Methane makes up 10%. Nitrous Oxide makes up 5% and fluorinated gases make up the other 3%. The greenhouse effect happens when the atmosphere becomes thick with these gases and that trap the sun's radiation, making the Earth warmer. This is modernly known as global warming.

EPA's regulated air pollutants

1. Ozone- Breathing ground level ozone can trigger a variety of health problems and has harmful effects on sensitive vegetation and ecosystems.
2. Particulate Matter- The particles that pass through the throat and nose and enter the lungs can cause premature death, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function. To the environment, it produces low visibility haze.
3. Carbon Monoxide- CO can cause harmful health effects by reducing oxygen to the body's organs. At extremely high levels, CO can cause death.
4. Nitrogen Oxides- Some health effects include airway inflammation and increased respiratory symptoms in people with asthma.
5. Sulfur Dioxide- These particles affect sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis. It can also aggravate existing heart disease.
6. Lead- It can affect the nervous system, kidney function, immune system, the cardiovascular system, and reproductive and developmental systems. Lead exposure also affects the oxygen capacity of the blood.

El Nino & La Nina

Both El Niño and La Niña are opposite effects of the same phenomenon called the El Niño Southern Oscillation). They contribute to the atmospheric pressure, rainfall and ocean temperature in the eastern equatorial Pacific region.

La Niña is when the up-swellings from the seabed brings nutrients up to the plankton to feed on and in turn abundance of plankton is beneficial to marine life up the food chain. La Niña adds to milder winters in Northern Europe and colder winters in southern/western Europe. It also contributes to stronger winds along the equatorial region, especially in the Pacific. Lastly, this phenomenon creates conditions more favorable for hurricanes in the Caribbean and central Atlantic.

El Niño is when that swelling does not occur so the plankton is reduced which causes the fish failure to reproduce. In Europe, El Niño years reduces hurricanes in the Atlantic. It also creates a mild winter over western Canada and north western America. Another thing it contributes to is above average precipitation in the Gulf Coast.

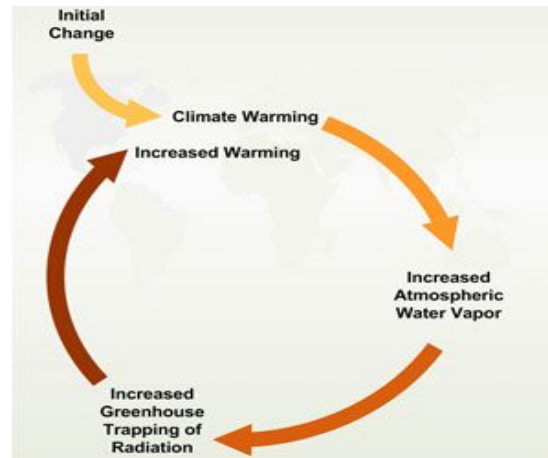
Major Fuel Types

Fuel	Pro	Con
Oil	Oil deposits are abundant. Can be burned to produce electricity and heat. The chemicals from petroleum can be used to make plastics, medicines, fertilizers, etc.	When petroleum is burned in releases harmful emissions. If oil is spilled into the water or on land it can damage an environment.
Natural Gas	It is the cleanest burning fossil fuel. It can be used to produce peak load electricity.	Fire and explosions can occur from leaks in pipelines. Increases greenhouse gas.
Coal	Cleaner coal technologies require less coal to produce the same amount of electricity. Surface mines can be restored to grasslands or parks after the coal is removed.	The water that filters through abandoned mines can pick up chemicals that pollute the water if the mines are not closed correctly. Large amounts of land are disturbed in the process of surface mining.

Effects of Climate Change

Positive Feedback Loop

During the positive feedback loop, carbon dioxide gets added to the air to increase the temperature of the atmosphere, causing global warming. The warmer atmosphere causes the surface water to evaporate and become water vapor. Since water vapor is a greenhouse gas the atmosphere tends to warm even more as the vapor increases. This continues the cycle of climate change.



Industrial versus Photochemical Smog

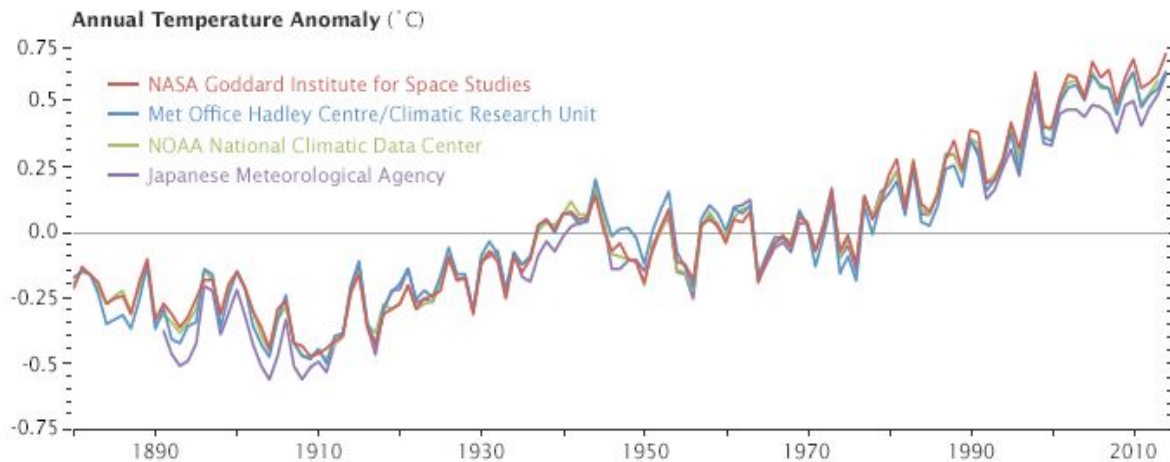
They both can damage lung tissue and can lead to decreased immune system.

Industrial	Photochemical
This occurs in urban areas where factories burn coal. This creates sulfur dioxide and other particles, that include dust and soot from burning the coal. These mix with fog droplets to create a blanket of haze near the ground and also produces acid rain. The creation of industrial smog is most intense in the early morning.	This happens in drier, sunny areas and is created because of usage of gasoline, and the burning of trees and organic waste. These emissions create a combination of pollutants that create nitrogen oxides in the sunlight. This can lead to the creation of noxious gases like carbon monoxide. If inhaled too much it can lead to decreased oxygen in the bloodstream and potentially death. The production of this smog peaks midday.

Temperature Change

A one degree global change is significant because it takes extreme amounts of heat to warm all the oceans, atmosphere, and land. In the past, a one to two degree drop was what plunged the Earth into the Ice Age.

In the graph below, they show how various regions of the world have warmed or cooled over 1951-1980. The global mean surface air temperature for that period was about 57°F. The maps show how much warmer or colder a region is compared to its normal temperature between 1951-1980. This graph was recorded by NASA, NOAA, the Japan Meteorological Agency, and the Met Office Hadley Centre (United Kingdom). Although there are minor changes from year to year, all four records show alterations in sync with each other. All of them show rapid warming in the past few decades, and they all detail that the last decade as the warmest.



On another account, NOAA has reported that although warming has not been uniform across the planet, the trend in the globally averaged temperature shows that more areas are warming than cooling. They have recorded that since 1976, every year has had an average global temperature warmer than the long-term average. Over this time period, temperature has warmed at an average of 0.50 °F per decade over land and 0.22 °F per decade over the ocean.

Changes In Precipitation

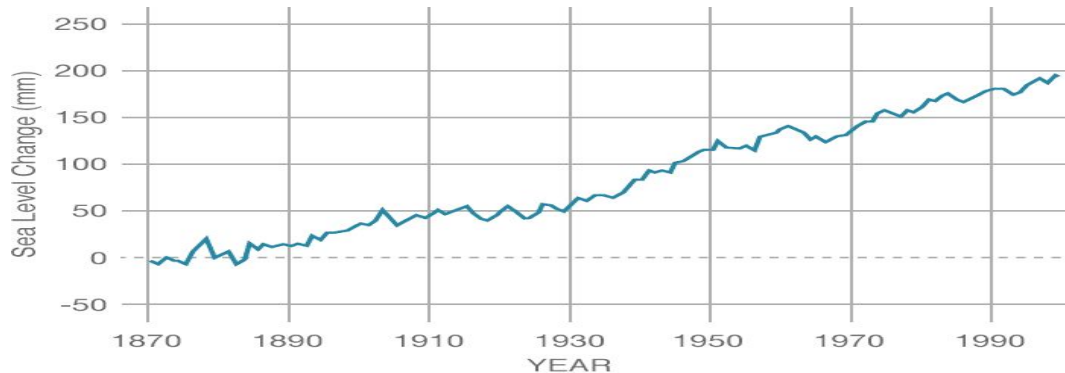
Since 1900, average annual precipitation over the US has increased by roughly 5 percent. This increase reflects in the major droughts of the 1930s and 1950s. There are regional differences. For instance, precipitation increased in the Northeast by 8 percent, Midwest by 9 percent, and southern Great Plains by 8 percent. As a result, it is projected that the the wet areas will get wetter and the dry areas will get drier.

According to the Intergovernmental Panel on Climate Change (IPCC), precipitation will be directly impacted by changes in increases in water vapor and evaporation caused by warmer temperatures. Overall, this will cause an overall increase in international precipitation.

Changes precipitation can result in various impacts for water resources that depend on snowpack for water supply. The change can increase flooding, a decrease in summer water supply, and change to both groundwater and surface water quality. These changes may require water resources to develop alternative sources of water supply, water treatment and invest in new flood infrastructure.

Sea Level Changes

Sea level rise is caused by two factors of to global warming: the added water from melting land ice and the expansion of seawater as it warms. The chart below depicts the change in sea level from 1870 to 2000 as observed by satellites.



Over the past century, most of the world's mountain glaciers and ice sheets that have lost mass come from Greenland and Antarctica. This glacial retreat has increased the water volume to the oceans. Mount Kilimanjaro, in Africa, is the one of the best documented examples of glacial retreat. Over the past century, the volume of Mount Kilimanjaro's glacial ice has decreased by about 80 percent.

Aside from the melting back of sea ice leads, an increase in water mass leads to the reduction water surface reflectivity and allows for greater absorption of solar radiation. More solar radiation being absorbed will accelerate warming, thus increasing the melting back of snow and ice on land.

Based on the second factor, thermal expansion is likely to have contributed to about 2.5 centimeters of the sea level to rise. This is because water expands as its temperature increases.

Changes In Global Ice

Sea ice begins to form when water temperature goes just below 28.8°F. It grows into small sheets that eventually merge together to form sheets that can span miles.

A study was published in 2007 that measured the amount of multi-year ice in the Arctic meaning that the ice has survived many summers without melting. In 1987, 57 percent of the observed ice pack was at least 5 years old, and around 25 percent of it was at least 9 years old. When they surveyed the Arctic again in 2007, only 7 percent of the ice pack was at least 5 years old, and the ice that was at least 9 years old had vanished.

Other studies have shown that the amount of summer ice in the Arctic Ocean in recent years was the smallest it has been since scientists started using satellites to measure the area covered by ice back in the 1970s. The ice is also getting thinner.

A NASA scientist reported that "in some ways it's a bit counterintuitive for people trying to understand how global warming is affecting our polar regions, but in fact it's actually completely in line with how climate scientists expect Antarctica and the Southern Ocean to respond. Particularly in respect to increased winds and increased melt water."

Changes In Biota

Climate change is projected to change food webs, biodiversity, and land masses. Once the oceans rise, there will be less land for mammals to live. The food webs of aquatic animals will expand whereas land animals will lose area to grow and hunt. One example of this is that the melting ice caps takes away land for the polar bears to live and hunt on.

Other than rising oceans, plants have sensitive growing conditions. Once the climate changes, some plants will not be able to flourish as they have in the past. This decreases food production and creates a domino effect unto food webs.

Aside from plants and loss of landmass, human health is affected by climate change. With the increase in emissions, they breathe in noxious gases that damage lung and brain tissue. Extended exposure can lead to permanent damage and even death.

Proxy Indicators

- Ice cores- The ice encloses small bubbles of air that contain a sample of the atmosphere. Once studying these bubbles it is possible to measure the past concentration of gases in the atmosphere.
- Tree cores- Each year trees add growth rings. These indicate what sort of growing season the tree experienced. The rings are more than a temperature indicator, they also tell the researcher about moisture and cloudiness. In order to know more about climate over a longer period of time, in some cases thousands of years, it is possible to look at dead trees of an unknown age that are still well preserved.
- Ocean sediment- Oceanographers have mapped the layout of sediment around the globe and have learned that at any given location the sediments provides important information of the history of the ocean as well as the overall state of climate on the Earth's surface.
- Coral- Warmer water temperatures brought on by climate change stress corals because they are very sensitive to changes in temperature. Climate change alters ocean chemistry leading to ocean acidification. If the ocean becomes too acidic then the reefs die.
- Pollen- Since pollen grains are well preserved in the sediment layers in the bottom of a pond, lake or ocean, an analysis of the pollen grains tell us what kinds of plants were growing at the time the sediment was made. By analysing the pollen and studying the biota, scientists can understand how the climate was based on the successfulness of growth in the existing plants.

Solution to Climate Change

Kyoto Protocol

The Kyoto Protocol is an international treaty that commits to reduce greenhouse gases emissions, based on the premise that global warming exists and man-made CO₂ emissions have caused it. The debate is over a vast amount of questions that cannot seem to be answered. They include, whether the Kyoto Protocol is a good model for reducing greenhouse gas emissions? Are mandatory emission regulations generally a good idea? Has the Protocol succeeded in reducing greenhouse gas emissions? If Kyoto has done poorly at cutting emissions, is the absence of US involvement in the treaty to blame? Would US involvement have meant success? Is the Kyoto Protocol important to the fight against global climate change? Is it acceptable that China, India, and other developing countries are exempt from the emission targets of the Kyoto Protocol?

Carbon Offsets

A carbon offset is a reduction in emissions of carbon dioxide or greenhouse gases made in order to compensate for or to offset an emission made elsewhere. Carbon offsetting is the use of carbon credits businesses to compensate for their emissions, meet their carbon reduction goals and support the move to a low carbon economy. Carbon offsetting delivers finance to essential renewable energy, forestry and resource conservation projects which generate reductions in greenhouse gas emissions.

Renewable Fuel Types

	Pro	Con
Tidal	The energy density of tidal energy is higher than other renewable energy sources. Does not produce greenhouse gas.	There are very few ideal locations for plants. Influences aquatic life adversely and can disrupt migration of fish.
Geothermal	Little damage to the environment	Contain harmful chemicals in high concentrations. Dry stream reservoirs are efficient but rare.
Wind	No air or water pollution. Can generate about the same electricity as coal fired plants.	Not always reliable. Can injure birds that fly into spinning blades.
Solar	Photovoltaic cells can convert radiant energy from the sun directly into electricity. Solar energy does not pollute the air.	Harnessing radiant energy from the sun is hard because the energy that reaches Earth is spread out. Solar fields take up large amounts of land.
Hydropower	One of the cleanest and cheapest energy resources. It is also reliable.	Dams disturb migration and spawning of fish . When a dam is built it destroys thousands of acres of land by flooding
Biofuel	Can be made into ethanol that is cleaner burning than unleaded gasoline. As biomass decays, more energy is for use as fuel	Burning biomass produces odors and emissions. Difficult to store and transport because it decays.

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Ozone

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Causes Of Climate Change

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Effects of Climate Change

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Solutions to Climate Change

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