Understanding Global Warming and Its Environmental Impacts

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Introduction

Temperature data and the warming's numerous repercussions indicate that there has been a long-term increase in the Earth's climate system's average temperature, or global warming. The phenomena of rising average air temperatures close to the Earth's surface over the previous century or two is a global change. Since the middle of the 20th century, researchers studying climate have amassed extensive data on a range of climatic events, including temperature, precipitation, and storms, as well as other factors that affect climate, like ocean currents and the chemical makeup of the atmosphere. These statistics show that since the beginning of geologic time, Earth's climate has varied throughout almost every conceivable timescale. Additionally, the impact of human activities since the start of the Industrial Revolution has been intricately woven into the unique fabric of climate change.

The effects of future climate change will differ depending on the location. Rising sea levels, altered precipitation patterns, and the spread of deserts in the subtropics are among the current and projected effects. With glaciers, frozen ground, and sea ice continue to retreat, future warming is predicted to be larger over land than over oceans, with the Arctic seeing the largest warming. Additional predicted impacts include ocean acidification, a rise in the frequency of extreme weather events including heatwaves, droughts, wildfires, and heavy precipitation that causes floods and snowfall, as well as catastrophic extinctions of species brought on by shifting temperature regimes. The risk to food security posed by decreasing agricultural yields and the demise of populous areas as a result of rising sea levels are two effects that are important to people. Many of these effects will last for several centuries or decades, and others for thousands of years, because the climate system has a significant "inertia" and greenhouse gasses will linger in the atmosphere for a very long time.

The World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988 to give voice to an increasing body of scientific consensus. According to a 2013 IPCC report, there was a 0.9 °C (1.5 °F) rise in the average global surface temperature between 1880 and 2012. Comparing the increase to the before industrialization (i.e., 1750–1800) mean temperature, it is closer to 1.1 °C (2.0 °F).

GLOBAL WARMING CAUSES

The Earth's surface temperature is sustained by a delicate equilibrium between several types of direct sunlight and terrestrial rays. Because solar radiation has short wavelengths and relatively high frequencies that are near to the visible portion of the electromagnetic spectrum, it is frequently referred to as "shortwave" radiation. Conversely, because terrestrial radiation is located in the infrared region of the spectrum and has long wavelengths and relatively low frequencies, it is

frequently referred to as "longwave" radiation. Watts per square meter are commonly used to describe incoming solar energy.

The greenhouse effect adds to the complexity of Earth's energy balance. A portion of the infrared light emitted by the Earth's surface is absorbed by trace gases with particular chemical characteristics, referred to as greenhouse gases and mostly consisting of gases such as carbon dioxide, methane, or and nitrous oxide. Some of the initial energy does not escape straight into space as a result of this absorption. The overall result of absorption by atmospheric greenhouse gases is that it raises the total quantity of radiation emitted downwards toward Earth's surface and lower atmosphere because they emit the same amount of radiation that they absorb and because this energy is emitted equally in every direction (downward as much as upward).

The Earth's surface and lower atmosphere must radiate more energy than was initially received from the sun in order to keep the balance. The surface temperature needs to be greater as a result. Although the method used here is not precisely the same as how a real greenhouse functions, the result is comparable. In contrast to what would be predicted in the absence of greenhouse gases, a presence of greenhouse gases in the atmosphere causes the surface and lower atmosphere to warm (and the upper atmosphere to cool).

IMPACT OF RADIATION

It is clear from the previous explanation of the greenhouse effect that there are three possible ways to change the temperature of the Earth's surface and lower atmosphere:

1. Through a change in the quantity of greenhouse gases in the atmosphere,
2. Through a change in the fraction of radiation reaching the surface, and
3. Through a net increase in the solar radiation entering at the top of Earth's atmosphere.

The modifications in each situation can be viewed in terms of "radiative forcing." According to the IPCC, radiative forcing is a measurement of the impact of a certain climatic element on the quantity of radiant energy that impinges on the Earth's surface in a downward direction. After distinguishing between climate factors primarily resulting from human activity (e.g., aerosol and greenhouse gas emissions) and those resulting from natural forces (e.g., solar irradiance), forcing values are computed for each factor for the time interval spanning from 1750 to the present. While "negative forcing" is applied by elements that cool the Earth's surface, "positive forcing" is caused by atmospheric factors that facilitate surface warming. The overall net increase in surface radiation when all positive and negative radiative forcing values are added together and all interactions between climatic elements are taken into consideration.

HUMAN ACTIVITIES' EFFECTS

Through modifications to the radiative balance that governs the Earth on a variety of timescales and spatial scales, human activity has affected global surface temperatures. The rise in greenhouse gas concentrations in the atmosphere is the most notable and well-understood anthropogenic influence. Along with changing the Earth's surface land cover, humans also affect the aerosol and ozone concentrations, which in turn affects the climate.

Through altering the Earth's atmosphere's concentrations of greenhouse gases, aerosols (tiny particles), and clouds, human activity contributes to climate change. The combustion of fossil fuels releases greenhouse gases gas into the atmosphere, which is the largest known contribution. By modifying solar radiation that comes in and outgoing infrared (heat) radiation, which are components of Earth's energy balance, greenhouse gases and aerosols have an impact on climate. The climate system may warm or cool depending on changes in the atmospheric abundance or characteristics of various gases and particles.

All things considered, human activity has had a warming effect on the climate since the beginning of the industrial age (about 1750). This period of time has seen a far greater human impact on the climate than that of known changes in natural processes, like solar variations and volcanic eruptions.

CLIMATE AFFECTED BY NATURE

The climate of Earth is influenced by several natural factors. These variables include exogenous factors like violent volcanic eruptions, variations in the Sun's natural output, and slow shifts in how Earth's orbit around the Sun is arranged. Furthermore, the Earth's climate naturally fluctuates, changing patterns of precipitation, wind, and surface temperatures worldwide. El Niño/Southern Oscillation (ENSO), a combined atmospheric and oceanic event that takes place in the Pacific Ocean each three to seven years, is one example of such a phenomenon. Similar phenomena also takes place in the North Atlantic Ocean over decades, known as the Atlantic Multi-decadal Oscillation (AMO). Over eons or millennia, there could be other forms of oscillatory behavior that cause abrupt changes in climate.

IMPLICATIONS OF WORLD WARMING

It is anticipated that global warming would have far-reaching, protracted, and frequently disastrous effects on Earth. The slow increase in temperature of the Earth's surface, seas, and atmosphere, known as global warming, is a result of human activity. Burning fossil fuels releases greenhouse gases such as carbon dioxide (CO2) and methane into the atmosphere.

In a landmark report published on September 27, 2013, the Intergovernmental Panel on Climate Change (IPCC) declared that scientists are more certain than ever about the link between human activity and global warming, notwithstanding political arguments on climate change. Global warming is a real phenomenon that has been brought about by human activity, according to more than 197 major scientific organizations.

The effects of global warming are already being felt by the earth. "In many locations, we are able to witness this occurring in real time. Mountain glaciers and polar ice caps are both losing ice. Lakes all throughout the world, particularly Lake Superior, are warming extremely quickly; in certain situations, more quickly than the surrounding air. Josef Werne, an professor of geography and environmental science at the University of Pittsburgh, said in a statement to Live Science that "plants and animals are modifying the dates of activity, for example trees leafing out earlier in springtime and dropping them later in the fall."

A rise in both average and extreme temperatures

Global temperature rise is one of the most noticeable and direct effects of global warming. The National Oceanic and Atmospheric Administration (NOAA) estimates that during the past century, the average world temperature has grown by roughly 1.4 degrees Fahrenheit (0.8 degrees Celsius).

Based on data from NOAA and NASA, 2016 was the warmest year on record worldwide since record-keeping started in 1895. The average global temperature for the 20th century was 1.78 degrees Fahrenheit (0.99 degrees Celsius) higher than it was that year. Prior to 2016, 2015 was the world's hottest year ever recorded. And prior to 2015? It was, in fact, 2014. According to NASA, 16 of the 17 warmest years ever recorded have happened since 2001.

According to NOAA, 2016 was the second-hottest year on record for the contiguous United States and Alaska, and the 20th year in a row that the yearly average surface temperature surpassed the 122-year average since record-keeping started.

ANONYMOUS CLIMATE ACCIDENTS

A further consequence of global warming is extreme weather. A large portion of the US has been having colder-than-average winters in addition to some of the warmest summers on record. The polar jet stream, which separates warm tropical air from freezing North Pole air, can move south due to climate change, taking cold Arctic air with it. This explains why, even during the long-term trend of global warming, some states may experience an abrupt cold snap or a colder-than-normal winter, according to Josef Werne, an environmental science and geology professor at the University of Pittsburgh.

"The long-term average of the weather over a number of years is called a climate. A single warm or cold year or season doesn't significantly affect the climate as a whole. We begin to regard those cold (or warm) years as a shift in the climate rather than merely an anomalous year of weather when they become more and more common," he stated.

Beyond extremes in heat or cold, global warming may also cause other types of extreme weather. Storm patterns, for instance, will alter. Current climate models imply that tropical cyclones may become less frequent globally but more powerful, however this is still an active area of scientific inquiry.

"And even if they become less frequent globally, hurricanes could still become more frequent in some specific areas," stated atmospheric scientist Adam Sobel, who wrote "Storm Surge: Hurricane Sandy, Our Changing Climate, and Extreme Weather of the Past and Future" (HarperWave, 2014). "Moreover, scientists are confident that hurricanes will become more intense due to climate change." This is so because the temperature differential between the chilly upper atmosphere and the warm tropical water is what gives hurricanes their energy. That temperature differential rises with global warming.

"Hurricanes could become generally more destructive because the most damage is caused by the most extreme hurricanes, like Typhoon Haiyan in the Philippines in 2013," Sobel, a professor at Columbia University's areas of Earth and Environmental Sciences, Applied Physics, and Applied Mathematics, explained. (In the western North Pacific, hurricanes are referred to as typhoons; in the

South Pacific and Indian oceans, they are named cyclones.)

Another aspect of the weather that is impacted by global warming is lightning. A 2014 study estimates that if global temperatures continue to rise, there would be a 50% increase in lightning strikes in the United States by the year 2100. For every 1.8 degrees Fahrenheit (1 degree Celsius) increase in atmospheric warming, the researchers saw a 12% increase in lightning activity.

In order to monitor extreme weather events, NOAA created the U.S. Climate Extremes Index (CEI) in 1996. According to the CEI, during the past 40 years, there has been an increase in the amount of extreme weather occurrences that rank among the most exceptional in the historical record.

According to Climate Central, scientists predict that as a result of global warming, extreme weather events including heatwaves, flooding, blizzards, and rainstorms will continue to happen more frequently and with higher intensity. climatic models predict dramatic changes in global climatic patterns due to global warming. Significant alterations in wind patterns, yearly precipitation, and periodic temperature fluctuations are probably among these changes.

Furthermore, the U.S. Environmental Protection Agency (EPA) predicts that these effects will last for several decades or longer since high amounts of greenhouse gases are anticipated to remain in the atmosphere for many years. According to the EPA, climate change is predicted to result in more yearly precipitation in the northeastern United States and lower summer precipitation in the Pacific Northwest.

SEA LEVELS OCEAN ACIDIFICATION

Overall, ocean levels rise as ice melts. The World Meteorological Organization reported in 2014 that the global ocean level was generally rising at a rate of 0.12 inches (3 millimeters) per year. This is about twice as much as the average yearly rise in the 20th century, which was 0.07 in. (1.6 mm). Ocean levels are expected to rise as a result of melting ice sheets and icy masses in Greenland, North America, South America, Europe, and Asia, as well as softening polar ice in the Arctic and Antarctic. Additionally, individuals should typically point the finger at: Researchers studying the atmosphere stated in the Sept. 27, 2013, IPCC report that they are at least 95% certain that human activity is to blame for the changes that have been observed since the 1950s, such as rapidly melting ice, rising ocean levels, and hotter oceans.

Global sea levels have risen by around 8 inches since 1870, according to the EPA, and this increase must accelerate in the upcoming years. If current trends continue, many coastal areas—which are home to over half of all people on Earth—will be submerged.

According to experts, normal sea levels in New York City will rise by 2.3 feet (0.7 meters) by 2100, in Hampton Roads, Virginia, by 2.9 feet (0.88 meters), and in Galveston, Texas, by 3.5 feet (1.06 meters). According to an IPCC estimate, global ocean levels might rise by up to 3 feet (0.9 meters) by 2100 if ozone-depleting chemical releases continue unchecked. That gauge represents an increase over the estimated 0.9 to 2.7 feet (0.3 to 0.8 meters) for future ocean level rise that were predicted in the 2007 IPCC assessment.

The primary aspect of the oceans altering due to a global temperature shift is not the ocean level.

Seawater becomes more caustic as a result of the oceans holding onto some of the CO2 as its dimensions increase. Werne explains it as follows: "You obtain carbonic corrosive when you break apart CO2 in water. This is the same accurate thing that happens with soft drink jars. The pH of a Dr. Pepper container is 2, which is extremely acidic when you pop the best."

The EPA estimates that since the beginning of the Industrial Revolution in the mid-1700s, the acridity of the waters has increased by around 25%. "This is an issue in the seas, in substantial part, in light of the fact that numerous marine life forms make shells of calcium carbonate (think corals, clams), and their shells break up in corrosive arrangement," Werne stated. Therefore, the sea becomes more acidic as we add more CO2, dissolving an increasing amount of ocean animal shells. This is obviously detrimental to their wellbeing.

Coral reefs are expected to become increasingly rare in areas where they are currently prevalent, including most U.S. oceans, if flow marine fermentation patterns continue, according to EPA reports. Parts of Australia's Great Barrier Reef, a wonder where coral begins its harmonious green development, experienced fading in 2016 and 2017. Dying is a sign of stress from very warm waters, an unbalanced pH, or contamination; coral can recover from dying, but recovery becomes less certain with repeated exposures.

VEHICLES AND PLANTS

An increase in global temperature is predicted to have profound and wide-ranging effects on the planet's biological ecosystems. According to a National Academy of Sciences assessment, many plant and animal species are already shifting their range to higher altitudes or further north as a result of warmer temperatures.

They are traveling from the center of the earth toward the poles, not only northward. As the average world temperature rises, they are only moving toward the poles according to the range of tolerable temperatures, according to Werne. In the end, he claimed, this becomes problematic when the rate of change in the environment speed—that is, the speed at which a region changes when expressed in spatial terms—becomes quicker than the pace at which a large number of animals can move. As a result, a lot of animals can become extinct since they can't survive in the new environment.

Furthermore, the EPA reports that migratory birds and insects are increasingly reaching their summer eating and hatching grounds days or weeks ahead of schedule compared to the 20th century. Additionally, many disease-causing organisms that were previously limited to tropical and subtropical regions will spread their range due to warmer temperatures, resulting in the extinction of previously disease-resistant plant and animal species.

According to a 2013 study published in the journal *Nature Climate Change*, if these and other effects of global warming are not addressed, they might lead to the extinction of up to half of Earth's plant species and one-third of animal species from their existing distribution by 2080.

IMPACT ON SOCIETY

The predicted changes to human society could be much more disastrous than the predicted drastic impacts of environmental change on the natural world. It's conceivable that agricultural systems will suffer a severe blow. The combined effects of drought, extreme weather, lack of accumulated

snowmelt, increased quantity and diversity of pests, declining groundwater tables, and loss of arable land might result in significant crop failures and animal shortages globally, even though growing seasons will lengthen in some places.

Additionally, North Carolina State University observes that plant growth is impacted by carbon dioxide. While CO2 can promote plant development, it may also result in less nutritious plants. According to numerous studies from sources as diverse as the U.S. Department of Defense, the Center for American Progress, and the Woodrow Wilson International Center for Scholars, this loss of food security may, in turn, cause destruction in global food markets and could trigger famines, food riots, political instability, and civil unrest worldwide.

Along with less nutrient-dense food, there will likely be a significant negative effect of global warming on human health. The American Medical Association has noted a surge in chronic illnesses like asthma and mosquito-borne illnesses like dengue fever and malaria, which are probably directly related to global warming. The Zika virus outbreak in 2016 brought attention to the risks associated with climate change. When pregnant women contract the disease, it results in severe birth abnormalities in the fetus, and researchers fear that climate change may enable the mosquitoes that carry the sickness to establish permanent residence in higher-latitude regions. Tick-borne illnesses may also proliferate as a result of longer, hotter summers.

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