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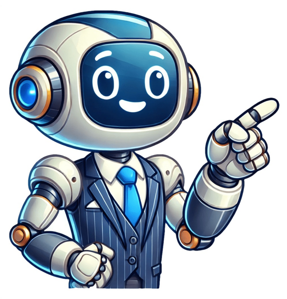

History The rate of change since the mid-20th century is unprecedented over millennia. Earth's climate has changed throughout history. Just in the last 800,000 years, there have been eight cycles of ice ages and warmer periods, with the end of the last ice age about 11,700 years ago marking the beginning of the modern climate era and of human civilization. Most of these climate changes are attributed to very small variations in Earths orbit that change the amount of solar energy our planet receives. This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.) Find out more about ice cores (external site). The current warming trend is different because it is clearly the result of human activities since the mid-1800s, and is proceeding at a rate not seen over many recent millennia.1 It is undeniable that human activities have produced the atmospheric gases that have trapped more of the Suns energy in the Earth system. This extra energy has warmed the atmosphere, ocean, and land, and widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere have occurred. Earth-orbiting satellites and new technologies have helped scientists see the big picture, collecting many different types of information about our planet and its climate all over the world. These data, collected over many years, reveal the signs and patterns of a changing climate. Scientists demonstrated the heat-trapping nature of carbon dioxide and other gases in the mid-19th century.2 Many of the science instruments NASA uses to study our climate focus on how these gases affect the movement of infrared radiation through the atmosphere. From the measured impacts of increases in these gases, there is no question that increased greenhouse gas levels warm Earth in response. "Scientific evidence for warming of the climate system is unequivocal."- Intergovernmental Panel on Climate Change Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that Earths climate responds to changes in greenhouse gas levels. Ancient evidence can also be found in tree rings, ocean sediments, coral reefs, and layers of sedimentary rocks. This ancient, or paleoclimate, evidence reveals that current warming is occurring roughly 10 times faster than the average rate of warming after an ice age. Carbon dioxide from human activities is increasing about 250 times faster than it did from natural sources after the last Ice Age.3 Evidence References References Header image shows clouds imitating mountains as the sun sets after midnight as seen from Denali's backcountry Unit 13 on June 14, 2019. Credit: NPS/Emily Mesner We know the world is warming because people have been recording daily high and low temperatures at thousands of weather stations worldwide, over land and ocean, for many decades and, in some locations, for more than a century. When different teams of climate scientists in different agencies (e.g., NOAA and NASA) and in other countries (e.g., the U.K.s Hadley Centre) average these data together, they all find essentially the same result: Earths average surface temperature has risen by about 1.8F (1.0C) since 1880. (bar chart) Yearly temperaturecompared to the twentieth-century average from 18502023. Red bars mean warmer-than-average years; blue bars mean colder-than-average years. (line graph) Atmospheric carbon dioxide amounts: 1850-1958 from IAC, 1959-2023 from NOAA Global Monitoring Lab. NOAA Climate.gov graph, adapted from original by Dr. Howard Diamond (NOAA ARL). In addition to our surface station data, we have many different lines of evidence that Earth is warming (learn more). Birds are migrating earlier, and their migration patterns are changing.Lobstersandother marine speciesare moving north. Plants are blooming earlier in the spring. Mountain glaciers are melting worldwide, and snow cover is declining in the Northern Hemisphere (Learn morehereandhere). Greenlands ice sheetwhich holds about 8 percent of Earths fresh wateris melting at an accelerating rate (learn more). Mean global sea level is rising (learn more). Arctic sea ice is declining rapidly in both thickness and extent (learn more). The Greenland Ice Sheet lost mass again in 2020, but not as much as it did2019. Adapted from the 2020 Arctic Report Card, this graph tracks Greenland mass loss measured by NASA's GRACE satellite missions since 2002. The background photo shows a glacier calving front in western Greenland, captured from an airplane during a NASA Operation IceBridgefield campaign. Full story.We know this warming is largely caused by human activities because the key role that carbon dioxide plays in maintaining Earths natural greenhouse effect has been understood since the mid-1800s. Unless it is offset by some equally large cooling influence, more atmospheric carbon dioxide will lead to warmer surface temperatures. Since 1800, the amount of carbon dioxide in the atmospherehas increasedfrom about 280 parts per million to 410 ppm in 2019. We know from both its rapid increase and its isotopic fingerprint that the source of this new carbon dioxide is fossil fuels, and not natural sources like forest fires, volcanoes, or outgassing from the ocean. Philip James de Loutherbourg's 1801 painting, Coalbrookdale by Night, came to symbolize the start of the Industrial Revolution, when humans began to harness the power of fossil fuelsand to contribute significantly to Earth's atmospheric greenhouse gas composition. Image from Wikipedia. Finally, no other known climate influences have changed enough to account for the observed warming trend. Taken together, these and other lines of evidence point squarely to human activities as the cause of recent global warming.ReferencesUSGCRP (2017). Climate Science Special Report: Fourth National Climate Assessment, Volume 1 [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi:10.7930/J0J964J6.National Fish, Wildlife, and Plants Climate Adaptation Partnership (2012):National Fish, Wildlife, and Plants Climate Adaptation Strategy. Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, D.C. DOI: 10.3996/082012-FWSReport-1IPCC (2019). Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. [H.-O. Portner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegria, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.NASA JPL: "Consensus: 97% of climate scientists agree."Global Climate Change. A website at NASA's Jet Propulsion Laboratory (climate.nasa.gov/scientific-consensus). (Accessed July 2013.) While Earths climate has changed throughout its history, the current warming is happening at a rate not seen in the past 10,000 years. According to the Intergovernmental Panel on Climate Change (IPCC), "Since systematic scientific assessments began in the 1970s, the influence of human activity on the warming of the climate system has evolved from theory to established fact."1 Scientific information taken from natural sources (such as ice cores, rocks, and tree rings) and from modern equipment (like satellites and instruments) all show the signs of a changing climate. From global temperature rise to melting ice sheets, the evidence of a warming planet abounds. Earth's climate has changed throughout history. Just in the last 800,000 years, there have been eight cycles of ice ages and warmer periods, with the end of the last ice age about 11,700 years ago marking the beginning of the modern climate era and of human civilization. Most of these climate changes are attributed to very small variations in Earths orbit that change the amount of solar energy our planet receives. The current warming trend is different because it is clearly the result of human activities since the mid-1800s, and is proceeding at a rate not seen over many recent millennia.1 It is undeniable that human activities have produced the atmospheric gases that have trapped more of the Suns energy in the Earth system. This extra energy has warmed the atmosphere, ocean, and land, and widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere have occurred. Earth-orbiting satellites and new technologies have helped scientists see the big picture, collecting many different types of information about our planet and its climate all over the world. These data, collected over many years, reveal the signs and patterns of a changing climate. 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Carbon dioxide from human activities is increasing about 250 times faster than it did from natural sources after the last Ice Age.3 Header image shows clouds imitating mountains as the sun sets after midnight as seen from Denali's backcountry Unit 13 on June 14, 2019. Credit: NPS/Emily MesnerImage credit in list of evidence: Ashwin Kumar, Creative Commons Attribution-Share Alike 2.0 Generic. Climate change is unprecedentedDownload the slides to present the visualisation SPM.1Download presentationClimate change is caused by humansDownload the slides to present the visualisation SPM.2Download presentationClimate change affects everyone, everywhereDownload the slides to present the visualisation SPM.3Download presentationMore warming, more changesDownload the slides to present the visualisation SPM.5Download presentationClimate change will affect us in many waysDownload the slides to present the visualisation SPM.9Download presentationLess future warming, less severe extremesDownload the slides to present the visualisation SPM.6Download presentationFuture emissions will determine future warmingDownload the slides to present the visualisation SPM.10Download presentationThe more we emit, the less nature can helpDownload the slides to present the visualisation SPM.7Download presentationSome changes in the climate can be slowed and even stoppedDownload the slides to present the visualisation SPM.8Download presentationWe can define our futureDownload the slides to present the visualisation SPM.4Download presentation In school, we were only told about climate change, its causes, and its consequences for our planet Earth and all the humanity that lives on the planet. But now, in the fall of 2022, we are seeing how climate change is affecting the environment as a whole, and we realize that it is happening very quickly. Everything we read about in books in high school, we are observing today and seeing with our own eyes. Have you ever tried to understand why climate change is happening faster every day? Why is the Earth experiencing more and more extreme weather? Why was it cooler last year, the same month of the year, than the same month this year? When did climate change begin on our planet? Warming today is of particular importance in light of the fact that the vast majority of it is very likely (more remarkably than a 96% probability) to be due to human activity since the middle of the 20th century, and has continued at a tremendous rate for a long time, up to millennia throughout human existence. Climate change is not something that happened yesterday or in the last few months or years. Our planet's climate has been completely changing for centuries. Climate change began about 12,000 years ago, and there have been seven cycles of glacial onset and retreat in all over the past 700,000 years, with the abrupt end of the last ice age occurring about 12,000 years ago and being the beginning of the modern climatic era - and the human civilization we still live in today. Orbiting Earth satellites and other advanced advances have allowed researchers to see a more accurate perspective, collecting different kinds of data about our planet and its atmosphere on a global scale. Through this information, collected over many years, signs of atmospheric change are being discovered. What is Climate Change? The definition of climate change is a definition referring to the environment of our planet Earth, a concept that defines extreme changes in climate over a period of time. NASA scientists have determined that the surface of planet Earth is getting warmer, and many of the warmest years in observational history have occurred in the last 10-20 years. Such rapid climate change is certainly problematic, and it is a consequence of global warming. The ozone layer is becoming thinner, causing extreme temperatures to be observed even in the coldest parts of our planet, although this has never happened there before. Causes of Climate Change The warming of cold parts of our planet, the melting of glaciers, the pollution of the air we all breathe - all these factors make the environment suffer and have the most adverse effect on our planet. We do not realize that what we do to the environment in turn affects us: smog, dirty breathing air, disease, extreme temperatures, and other such factors affect both humans and the environment. Ice cores taken from Antarctica, Greenland, and the ice masses of tropical mountains show that the atmosphere of planet Earth responds to changing levels of greenhouse gases. Ancient evidence can also be found in marine silt, tree rings, coral reefs, and sediment layers. This paleoclimate or ancient evidence shows that global warming is occurring about several times faster than the normal rate of warming caused by the recovery of the Ice Age. Carbon dioxide from human activities has been increasing many times faster than from conventional sources since the end of the last ice age in human history. All of these negligent actions lead to a decrease in the ozone layer and global warming, which has the greatest impact on climate change. And that's bad news for all of us. How do we prevent climate change? We all need to understand that human activities are causing so much damage to the environment, it is our civic duty to take care of the health of nature and our planet as a whole. The earth is slowly depleting every year due to the irresponsibility and carelessness of us humans living on the planet, but there are ways to change the situation and prevent climate change and deterioration. We need to start recycling today, start recycling our trash. Recycle all of our waste into new things and use recyclable materials. We must reduce the use of plastic at all costs because it takes tens or hundreds of years for one little piece of plastic to decompose in landfills and in the soil, and when it is incinerated it emits harmful substances that affect the air that people breathe and the ozone layer. We need to do away with plastic packaging, bottles, dishes and everything else - instead we should start using biodegradable packaging and storage boxes. We need to invest in energy-efficient energy sources instead of relying on electricity alone. We should use energy-efficient light bulbs and solar systems to generate electricity, and try to use natural sunlight during the day and keep the lights off during the day. Try to stop polluting the planet! We need to reduce air pollution from cars and smoke from factories, use public transportation efficiently, and use our personal cars less. Water pollution is very sad because it not only pollutes the water we consume, but it also kills marine life. Thousands of species live in the water, and our pollution from factory and other waste is killing them. Now is the time to be responsible not only for our planet, but also for animals and other living things. Examples of Climate Change Climate change is caused by each of us, we often think we are doing something insignificant, thereby causing minimal harm to nature, but we are not. Even small actions can cause tremendous harm to our planet, and we can see this if we analyze the physical evidence of climate change on planet Earth: Sea level rise: Over the past century, global sea level has risen about 8 inches (20 centimeters). In the past two decades, however, the rate has been almost twice what it was in the last century, and is accelerating slightly each year. Melting Glaciers:Glaciers in Antarctica, Switzerland, and Greenland are melting much faster as a result of global warming. Human activity produces more carbon dioxide than greenhouse gases, resulting in melting snow tops and ice sheets at the North Pole. Changes in Bird Migration Patterns: A study published in Nature Climate Change suggests that rising temperatures cause birds to migrate a little earlier each following spring. The study found that over each decade, the journey home shifts by a few days. Changes in precipitation and weather patterns: As temperatures rise and the air gets warmer, more moisture evaporates from the ground and water into the atmosphere. This happens because climate change causes shifts in air and ocean currents that can change weather patterns. Warming of the oceans: in 2022, the World Ocean has absorbed much of this increased heat, with the top 100 meters (about 328 feet) of the ocean showing a warming of more than 1 degree Fahrenheit (0.556 degrees Celsius) since 1970. The earth stores up to 90% of the extra energy in the ocean. Conclusions on the main causes of Climate Change It is elementary changes in our daily activities that will ultimately lead to such significant changes. Everyone needs to understand that climate change depends on each of us. Giving up plastic is easy: just stop buying plastic-wrapped water bottles, just fill your own containers at home. Don't shop in plastic bags, but bring your own bags or shop in paper brown bags. Save energy by turning off lights during the day, and conserve water. Small actions by everyone can help our planet heal and make it sustainable and livable for future generations! Science Earth Science, Geologic Time & Fossils Earth Sciences All historical sciences share a problem: As they probe farther back in time, they become more reliant on fragmentary and indirect evidence. Earth system history is no exception. High-quality instrumental records spanning the past century exist for most parts of the world, but the records become sparse in the 19th century, and few records predate the late 18th century. Other historical documents, including ships logs, diaries, court and church records, and tax rolls, can sometimes be used. Within strict geographic contexts, these sources can provide information on frosts, droughts, floods, sea ice, the dates of monsoons, and other climatic featuresin some cases up to several hundred years ago. Fortunately, climatic change also leaves a variety of signatures in the natural world. Climate influences the growth of trees and corals, the abundance and geographic distribution of plant and animal species, the chemistry of oceans and lakes, the accumulation of ice in cold regions, and the erosion and deposition of materials on Earths surface. Paleoclimatologists study the traces of these effects, devising clever and subtle ways to obtain information about past climates. Most of the evidence of past climatic change is circumstantial, so paleoclimatology involves a great deal of investigative work. Wherever possible, paleoclimatologists try to use multiple lines of evidence to cross-check their conclusions. They are frequently confronted with conflicting evidence, but this, as in other sciences, usually leads to an enhanced understanding of the Earth system and its complex history. New sources of data, analytical tools, and instruments are becoming available, and the field is moving quickly. Revolutionary changes in the understanding of Earths climate history have occurred since the 1990s, and coming decades will bring many new insights and interpretations. Join a climate-change research team collecting samples from the bottom of Greenland's Arctic lakesLearn how scientists collect lake bed sediment samples in Greenland for investigations of climate change.See all videos for this articleOngoing climatic changes are being monitored by networks of sensors in space, on the land surface, and both on and below the surface of the worlds oceans. Climatic changes of the past 200300 years, especially since the early 1900s, are documented by instrumental records and other archives. These written documents and records provide information about climate change in some locations for the past few hundred years. Some very rare records date back over 1,000 years. Researchers studying climatic changes predating the instrumental record rely increasingly on natural archives, which are biological or geologic processes that record some aspect of past climate. These natural archives, often referred to as proxy evidence, are extraordinarily diverse; they include, but are not limited to, fossil records of past plant and animal distributions, sedimentary and geochemical indicators of former conditions of oceans and continents, and land surface features characteristic of past climates. Paleoclimatologists study these natural archives by collecting cores, or cylindrical samples, of sediments from lakes, bogs, and oceans; by studying surface features and geological strata; by examining tree ring patterns from cores or sections of living and dead trees; by drilling into marine corals and cave stalagmites; by drilling into the ice sheets of Antarctica and Greenland and the high-elevation glaciers of the Plateau of Tibet, the Andes, and other montane regions; and by a wide variety of other means. Techniques for extracting paleoclimatic information are continually being developed and refined, and new kinds of natural archives are being recognized and exploited. It is much easier to document the evidence of climate variability and past climate change than it is to determine their underlying mechanisms. Climate is influenced by a multitude of factors that operate at timescales ranging from hours to hundreds of millions of years. Many of the causes of climate change are external to the Earth system. Others are part of the Earth system but external to the atmosphere. Still others involve interactions between the atmosphere and other components of the Earth system and are collectively described as feedbacks within the Earth system. Feedbacks are among the most recently discovered and challenging causal factors to study. Nevertheless, these factors are increasingly recognized as playing fundamental roles in climate variation. The most important mechanisms are described in this section. The luminosity, or brightness, of the Sun has been increasing steadily since its formation. This phenomenon is important to Earths climate, because the Sun provides the energy to drive atmospheric circulation and constitutes the input for Earths heat budget. Low solar luminosity during Precambrian time underlies the faint young Sun paradox, described in the section Climates of early Earth. imaging using ultraviolet lightThe Sun as imaged in extreme ultraviolet light by the Earth-orbiting Solar and Heliospheric Observatory (SOHO) satellite. A massive loop-shaped eruptive prominence is visible at the lower left. Nearly white areas are the hottest; deeper reds indicate cooler temperatures.Radiative energy from the Sun is variable at very small timescales, owing to solar storms and other disturbances, but variations in solar activity, particularly the frequency of sunspots, are also documented at decadal to millennial timescales and probably occur at longer timescales as well. The Maunder minimum, a period of drastically reduced sunspot activity between 1645 and 1715, has been suggested as a contributing factor to the Little Ice Age. (See below Climatic variation and change since the emergence of civilization.) Mount PinatuboA column of gas and ash rising from Mount Pinatubo in the Philippines on June 12, 1991, just days before the volcano's climactic explosion on June 15.Volcanic activity can influence climate in a number of ways at different timescales. Individual volcanic eruptions can release large quantities of sulfur dioxide and other aerosols into the stratosphere, reducing atmospheric transparency and thus the amount of solar radiation reaching Earths surface and troposphere. A recent example is the 1991 eruption in the Philippines of Mount Pinatubo, which had measurable influences on atmospheric circulation and heat budgets. The 1815 eruption of Mount Tambora on the island of Sumbawa had more dramatic consequences, as the spring and summer of the following year (1816, known as the year without a summer) were unusually cold over much of the world. New England and Europe experienced snowfalls and frosts throughout the summer of 1816. Volcanoes and related phenomena, such as ocean rifting and subduction, release carbon dioxide into both the oceans and the atmosphere. Emissions are low; even a massive volcanic eruption such as Mount Pinatubo releases only a fraction of the carbon dioxide emitted by fossil-fuel combustion in a year. At geologic timescales, however, release of this greenhouse gas can have important effects. Variations in carbon dioxide release by volcanoes and ocean rifts over millions of years can alter the chemistry of the atmosphere. Such changeability in carbon dioxide concentrations probably accounts for much of the climatic variation that has taken place during the Phanerozoic Eon. (See below Phanerozoic climates.) Watch Earth's continents move, from 650 million years ago to 250 million years in the futureA time-lapse representation of Earth changing through geologic time, from the late Proterozoic Eon (c. 650 million years ago) to the projected period of Pangea Proxima (c. 250 million years from now).See all videos for this articleTectonic movements of Earths crust have had profound effects on climate at timescales of millions to tens of millions of years. These movements have changed the shape, size, position, and elevation of the continental masses as well as the bathymetry of the oceans. Topographic and bathymetric changes in turn have had strong effects on the circulation of both the atmosphere and the oceans. For example, the uplift of the Tibetan Plateau during the Cenozoic Era affected atmospheric circulation patterns, creating the South Asian monsoon and influencing climate over much of the rest of Asia and neighbouring regions. Tectonic activity also influences atmospheric chemistry, particularly carbon dioxide concentrations. Carbon dioxide is emitted from volcanoes and vents in rift zones and subduction zones. Variations in the rate of spreading in rift zones and the degree of volcanic activity near plate margins have influenced atmospheric carbon dioxide concentrations throughout Earths history. Even the chemical weathering of rock constitutes an important sink for carbon dioxide. (A carbon sink is any process that removes carbon dioxide from the atmosphere by the chemical conversion of CO_2 to organic or inorganic carbon compounds.) Carbonic acid, formed from carbon dioxide and water, is a reactant in dissolution of silicates and other minerals. Weathering rates are related to the mass, elevation, and exposure of bedrock. Tectonic uplift can increase all these factors and thus lead to increased weathering and carbon dioxide absorption. For example, the chemical weathering of the rising Tibetan Plateau may have played an important role in depleting the atmosphere of carbon dioxide during a global cooling period in the late Cenozoic Era. (See below Cenozoic climates.) The orbital geometry of Earth is affected in predictable ways by the gravitational influences of other planets in the solar system. Three primary features of Earths orbit are affected, each in a cyclic, or regularly recurring, manner. First, the shape of Earths orbit around the Sun, varies from nearly circular to elliptical (eccentric), with periodicities of 100,000 and 413,000 years. Second, the tilt of Earths axis with respect to the Sun, which is primarily responsible for Earths seasonal climates, varies between 22.1 and 24.5 from the plane of Earths rotation around the Sun. This variation occurs on a cycle of 41,000 years. In general, the greater the tilt, the greater the solar radiation received by hemispheres in summer and the less received in winter. The third cyclic change to Earths orbital geometry results from two combined phenomena: (1) Earths axis of rotation wobbles, changing the direction of the axis with respect to the Sun, and (2) the orientation of Earths orbital ellipse rotates slowly. These two processes create a 26,000-year cycle, called precession of the equinoxes, in which the position of Earth at the equinoxes and solstices changes. Today Earth is closest to the Sun (perihelion) near the December solstice, whereas 9,000 years ago perihelion occurred near the June solstice. These orbital variations cause changes in the latitudinal and seasonal distribution of solar radiation, which in turn drive a number of climate variations. Orbital variations play major roles in pacing glacial-interglacial and monsoonal patterns. Their influences have been identified in climatic changes over much of the Phanerozoic. For example, cyclothemswhich are interbedded marine, fluvial, and coal beds characteristic of the Pennsylvanian Subperiod (323.2 million to 298.9 million years ago)appear to represent Milankovitch-driven changes in mean sea level. Detailed answer:There are many types of physical evidence for climate change. Here are the main ones:Ice cores: Ice cores are a record of past climate conditions stored in the ice sheets and glaciers. They provide information about temperature, wind patterns, and precipitation over time. The cores can be dated by comparing the ratio of oxygen isotopes in snowfall to the ratio found in the air at that time.Tree rings: Tree rings are used to determine past weather conditions because they reflect annual changes in moisture levels, temperature, and sunlight availability. Tree ring widths tend to be wider during wet years and thinner during dry years; this allows scientists to determine whether a particular year was wet or dry by measuring its width.Ocean sediments: Ocean sediments (or sediment cores) contain layers of material that have been deposited into oceans over time; these layers can be dated using radiometric methods like carbon-14 dating. These layers can provide information about sea level rise or fall over time, as well as other environmental conditions such as temperature change or changes in ocean circulation patterns.Coral reefs: Coral reefs are formed when tiny polyps build their skeletons around hardenings from dead coral polyps or shells from planktonic organisms."Our expert and professional writer has shared his opinion on this matter.Please tell us if you find this answer relevant and rate it."What Are The Major Types of Physical Evidence For Climate Change?. (2022, Sep 11). Retrieved from br>

What are the 3 major types of physical evidence for climate change. 2 what are the major types of physical evidence for climate change. What are the major types of physical and biological evidence for climate change.