

Climate is Changing Day by Day – Comparing Rates of Climate Change in Past Day and Present-Day.

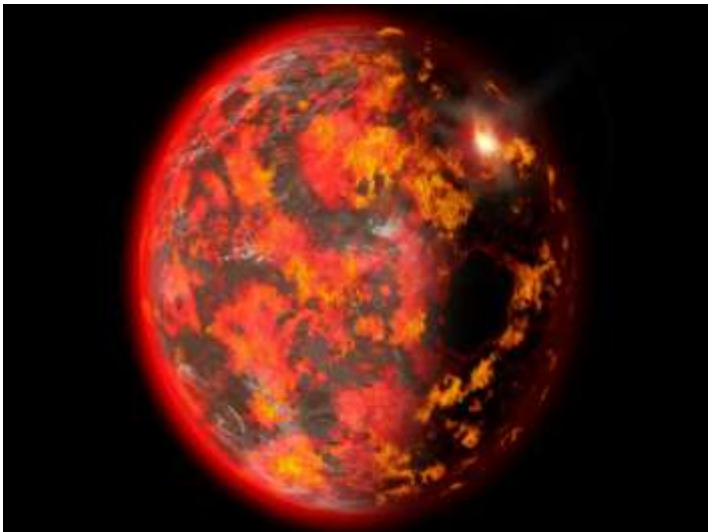
Ranu Sarkar

Introduction

Earth's climate has never been static. Over its 4.54-billion-year history, our planet has experienced dramatic shifts, oscillating between periods of extreme warmth and profound ice ages. These long-term climatic transformations are encapsulated within Earth's geological timescale, representing vast periods of change driven by natural processes. Crucially, these ancient shifts unfolded over immense durations, spanning millions to hundreds of millions of years. However, the climate changes of the present epoch stand in stark contrast to these deep-time fluctuations, characterized by an unprecedented rate and primary anthropogenic drivers."

The Earth when it was created

The Present Time of Earth



Climate

Climate describe to the long term of temperature, humidity, wind, precipitation and other atmospheric conditions in a place. It refers how the weather is typically behaving over extended periods. This is called climate. But climate change it is a long-term change in the average weather patterns. When the earth was created the climate was totally different from the today's Climate. But from the creation of the Earth the climate change but it took long term periods because it was natural way changed of climate.

The Geological Timeline

Eon → Era → Period → Epoch/Age

Eon	Era	Period	Epoch
Phanerozoic Today	<u>Cenozoic</u> Age of mammals and humans	Quaternary	Holocene (Today)
			Pleistocene
			Pliocene
		Neogene	Miocene
			Oligocene
			Eocene
		Paleogene	Paleocene
	<u>Mesozoic</u>		

	Age of reptiles and Dinosaurs	Cretaceous	
	Paleozoic	Jurassic	
		Triassic	
		Permin	
		Carboniferous	
		Ordovician	
		Cambrian	
Proterozoic	-----	-----	-----
Archean	-----	-----	-----
Hadean	-----	-----	-----

Climate Change in Past

In Earth history we have four (4) Eon Hadean Eon, Archean Eon, Proterozoic Eon, and Phanerozoic Eon. And in all eons, there were some major climate changing events happened but all the changes took long periods. The first eon is Hadean eon when the earth was created. And that time the earth was a molten ball of rock and has almost no atmosphere. All the material that would eventually form the planet was still swirling in dense cloud of gas and dust. The early period of earth was known as Hadean Eon. It was marked by volcanic activity, constant meteorite bombardments and surface was so hot. As the planet was cooled very slowly. After the formation the earth was cooled and solidified and a second atmosphere began to form. And this atmosphere was created by Volcanic Outgassing. sulfur dioxide and ammonia were entered in our earth. And the planet continued to cool, the water vapor condensed to the formation of the first oceans. But the earth was extremely so hot. After Hadean eon the Archean eon was started around 4.0 billion years ago. But in this eon the climate of earth was quite different from the Hadean eon. This Archean eon the atmosphere was reducing, rich in gases like methane, ammonia and carbon dioxide. And scientist also got witnessed of life. The earliest definitive evidence points to the existence of **prokaryotic, single-celled organisms** (bacteria and archaea) by at least 3.5 billion years ago. And also, in Archean Eon the small landmasses called cratons began to form and earth's crust was cooled to create continental plates. In this eon earth was cooling from its earlier extremely hot state in Hadean eon.

Then Archean eon was shifted to Proterozoic Eon (2.5 billion to 541 million years ago). And this eon earth faces major climate changes event which was took so many long periods. The first event was the Great Oxygen Event. Which was happened in 2.4 to 2.1 billion years ago when the atmosphere was shifted little and climate began with the emergence of photosynthetic organisms. These organisms started producing oxygen as byproduct of photosynthesis. This led the Great oxygen event which gradually increased the content of oxygen in the atmosphere. This event was an historic climate change moment for earth climate.

And then the next historical climate change moment was the Snowball Event. It is believed that the entire planet or nearly all of it was covered in ice and snow even at the equator. During the Neoproterozoic era, earth experience these huge changes. And the main reason of the event was low amount of carbon dioxide in the earth. The process started when the supercontinent Rodinia, formed 1.1 billion years ago, started to break into smaller continental plates. Rodinia was located near the equator, and the resulting continents also remained in the tropical band. The new continental configuration exposed enormous volumes of silicate rock to weathering, removing huge quantities of carbon dioxide from the atmosphere. Carbon dioxide dissolved by rainwater and suspended in rivers and clouds eventually reached the oceans, where it was sequestered in the seabed. When atmospheric carbon dioxide levels dipped to 200 parts per million, about half our current levels, ice sheets began to grow at both poles. As the ice sheets grew, they reflected more and more sunlight back to space, cooling the climate even further. Eventually, the whole planet was covered by ice. This snowball state eventually receded. When ice covered the entire planet, the hydrological cycle stopped, preventing more silicate weathering. Tectonics and volcanism remained active, however, and pumped carbon dioxide into the atmosphere, eventually warming the climate again.

After tens to hundreds of thousands of years, subtle changes in earth's orbit, axial tilt, and precession around the sun affect the amount and distribution of solar radiation reaching Earth. These "Milankovitch cycles" are a primary driver of Earth's

natural ice ages and warmer interglacial periods, like the cycles that have occurred over the last 800,000 years. And volcanoes can impact the climate change also. During the major explosive eruptions huge amount of volcanic gas, aerosol droplets, and ash are injected into the stratosphere. Injected ash falls rapidly from the stratosphere. And most of it is removed within several days to weeks and has little impact on climate change. But volcanic gases like sulfur dioxide can cause global cooling, while volcanic carbon dioxide, a greenhouse gas, has the potential to promote global warming. This is some of the event that plays a vital role to change climate since its foundation. Climate change has been a continuous process throughout the earth's long history, created by some natural factors. And this all-climate change process took very long years and even some changes took million years and that's all created by Earth and nature.

Climate change in Present (2020s to Now)

In the past time agriculture was focused but then we started to focus industry. Before 17th century wind power, wood, nature was our source of energy but since mid of 17th century energy was shortage due to expansion of British industry. And 17th and 18th century were the age of coal. Coal fired steam engine was used for railway and ship. And for industrial revolution coal become the main source of energy. And now We are living in a global climate crisis, and the effects of climate change are more visible and dangerous. And this time climate is changes by human activities and it is taking very small time. The present time, climate change was first noticed and understood as Global warming. First in 1896, the Swedish scientist Arrhenius suggested that burning coal could increase CO₂ and warm the Earth and it could increase earth temperature very soon. And in 1958, the Charles David keeling began measuring CO₂ in Hawaii. And the keeling curve showed a sharp rise. Between 1970s to 1980s scientists observed that global temperature is slowly raised, ice sheets and glaciers were shrinking and seasons are shifting but in 2000s scientists notice that more floods, droughts, wildfires, storms are happening because of Global warming. Even it is changing the rainfall pattern, ocean currents and ecosystems. That's why global warming is the biggest part of climate change. But in current time human activities are raising this global warming. IPCC (Intergovernmental panel on climate Change) reports with 99% confidence that humans are responsible for the warming since mid-20th century. In the past time natural resources like volcano, sun was the reason of temperature rising. And if we noticed the past times it took million times to change temperature but now days it is taking few years only. Human activities like burning fossil fuels, deforesting, industrial revolution and these actions are increasing greenhouse gases in atmosphere. Humans are using cars frequently which is releasing a massive amount of carbon dioxide in atmosphere. Humans are deforesting means cutting down trees and cleaning forests for population growths, resource demands like forests are cleared to build towns, highways and factories. And that's why it reduces Earth's ability to absorb CO₂. Tropical deforestation alone accounts for 10 to 15% of global emissions. Amazon Rainforest which is the world's largest tropical rainforest, is losing over 10,000 km² per year to farming and mining. Now cities are carrying over 70% of the global CO₂ emissions.

Table of Human Acts Causing Global Warming

Human Activity	Main Greenhouse gases	% of Global Emissions
Fossil Fuel burning	CO ₂	70%
Deforesting	CO ₂ , CH ₄	10-15%
Agriculture	CH ₄ , N ₂ O	20%
Industry	CO ₂ , CFC	20%
Waste	N ₂ O, CH ₄ ,	3-5%
Transportation	CO ₂	15%

Evidence that climate change is Accelerating

Temperature is rising over time

Time Period

Global Temperature Change

Past 100 years

+1.1 to +1.3 °C

Last 50 years

+0.8 °C

2015–2025

Fastest decadal rise ever

Also 2024 was the hottest year on record globally. And 13.23 °C was the average global temperature in Jan 2025.

The WMO warns that the annual global average temperature between 2025-2029 the temperature will increase 1.2°C to 1.9°C above the 1850-1900 pre-industrial average.

- There is a 70% chance that the average temperature for this five-year period will exceed the critical 1.5°C threshold.
- Additionally, there is an 86% chance that at least one year within this timeframe will temporarily surpass the 1.5°C limit, and an 80% chance that one of these years will be hotter than 2024, which is currently the warmest year on record.

And also, the Earth temperature has risen more in the last 50 years than in the previous 5,000 years combined.

Faster Melting of Ice Sheets and Glaciers

The first evidence is that the Greenland is losing 7x faster than in the 1990s. and the Antarctica is losing 150 billion tons of ice per year. Before 1950, ice mass was relatively stable for thousands of years. Now we are losing ice faster than time since Ice age.

Sea Level is rising over time

Time Period	Rate of Sea Level Rise
1901–1990	~1.4 mm/year
1993–2023	~3.3 mm/year (more than double)
2020–2025 (projected)	~4.5 mm/year

Sea level is rising over 20cm since 1900.

More Frequent and Intense Extrema weather changes

Then (pre-1970s) – The Heatwaves, floods and droughts were less frequent and weaker. But Now (2020s)- 2023 to 2025 heatwaves affected 4+ billion people with many lasting weeks. Rainfall extremes like in India, Brazil, Texas are now 2-10x more likely due to climate change. Wildfire have burned more land in the last 5 years than the average of the past 30 years. It's all happened due to climate change.

Oceans warming & Acidification

Oceans absorb more than 90% of the extra heat trapped by greenhouse gases. But in 2024 it was the warmest ocean temperature ever recorded. 2023 to 2025 it was the global coral bleaching event and coral bleaching is a very harmful process where coral lose their colours and become white due to stress from high ocean temperature.

Co2 Levels are the highest in 800,000+ Years

Time Period	Atmospheric CO ₂ (ppm)
Pre-industrial era (1750)	~280 ppm
1950	~310 ppm
2024	~424 ppm (record high)

CO₂ is increasing at the rate 100x faster than during the last natural warming event. IPCC 2023 to 2024 reports are saying that warming is “unequivocally human-caused” and progressing faster than is unnatural process.

Comparison of Past and Present Climate Change

Time Scale

Aspect	Past Climate Change	Present Climate Change
Time	Millions to thousand of years	Past 150-200 years (post-industrial era)
Speed of change	Over thousands of years	Rapid

Causes

Aspect	Past Climate change	Present Climate change
Natural reasons	Volcanic eruption, Solar radiation changes, ice age, tectonic matters	Human activates, deforesting, industries
CO ₂ Sources	Natural, such as volcanic activities	Anthropogenic such as burning coal, oil, gas

Sea Level Changes

Aspect	Past climate change	Present Climate change
Sea Level variation	Up to 120m lower during ice age	Rising 3.3mm/year approx. (satellite data since 1993)
Glacial Melting	Natural melting,	Accelerated ice sheet loss (Antarctica)

Conclusion

Climate change is the continuous process in our earth history. In the past time when the earth created, it was shaped by natural factors such as volcano activates, solar cycles and orbital shifts. And it all took so many times to change from one climate to another but in current time the changes of climate are unprecedented in both speed and intensity, largely driven by human activates such as fossil fuel combustion, deforesting, and industrialization. Historical climate changes occurred over thousands of years but modern climate change is taking few years. This study highlights the stark contrast between historical climate changes event and today's climate changes event. And it also highlights the present climate change problems we are facing now such as rising temperature, melting glaciers, weather events etc.

References (APA)

- MCC- 2021 Mitigating Climate change 2021 symposium and industry Summit
- **Paleoclimate Implications for Human-Made Climate Change"** by James E. Hansen & Makiko Sato (2011).
- **Global and Local Sea Level during the Last Interglacial: A Probabilistic Assessment"** (2009) by Kopp et al.
- IPCC Chapter "Paleoclimate" (2007)
- The Changing Climate: Past, Present, Future by M. Quante
- IPCC (2014) The IPCC's Fifth Assessment Report (AR5)