**УДК 551.583.3**

# ANTHROPOGENIC CLIMATE CHANGE, CLIMATE DISASTERS AND THE ROLE OF NATURE: WITH SPECIAL FOCUS ON THE YEAR 536

**Christensen C.S.**

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 Earth's 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 recent millennia. It is undeniable that human activities have produced abundance of gases in the atmosphere that have trapped more of the Sun's energy in the Earth system. This extra energy has earned the ocean and lands, which lead to widespread and rapid changes in the environment. In this paper there are analysed anthropogenic changes, nature's own role and climate disasters in comparing the results obtained into perspective with incidents in the year 536.

**Keywords:** climate changes, years 536-550, climate disasters, climate, global warming, volcanic eruption, Halley's Comet, Industrial Revolution, sediment cores, dendrochronology, Ice core, 536, Roman warm period.

# АНТРОПОГЕННОЕ ИЗМЕНЕНИЕ КЛИМАТА, КЛИМАТИЧЕСКИЕ КАТАСТРОФЫ И РОЛЬ ПРИРОДЫ: С ОСОБЫМ АКЦЕНТОМ НА 536 ГОД

**Христенсен К.С.**

Климат Земли менялся на протяжении всей истории человечества. Только за последние 800 000 лет было восемь циклов ледниковых периодов и более теплых периодов, причем окончание последнего ледникового периода около 11 700 лет назад ознаменовало начало современной климатической эры и

человеческой цивилизации. Большинство из этих климатических изменений связаны с очень небольшими колебаниями орбиты Земли, которые изменяют количество солнечной энергии, получаемой нашей планетой. Нынешняя тенденция к потеплению отличается тем, что она явно является результатом деятельности человека с середины 1800-х гг. и протекает с такой скоростью, которая не наблюдалась на протяжении последних тысячелетий. Нельзя отрицать, что деятельность человека привела к образованию значительного количества газов в атмосфере, которые удерживают большую часть солнечной энергии в земной системе. Эту дополнительную энергию получили океан и суша, что привело к широкомасштабным и быстрым изменениям в окружающей среде. В этой статье проанализированы антропогенные изменения, роль самой природы и климатические катастрофы в сопоставлении полученных результатов с инцидентами, произошедшими в 536 году.

**Ключевые слова:** климатические изменения, 536-550 гг., климатические катастрофы, климат, глобальное потепление, извержение вулкана, комета Галлея, промышленная революция, осадочные породы, дендрохронология, ледниковый период, 536 год, римский климатический оптимум.

**Prologue**

In October 2018 the International Panel of Climate Change of the United Nations ascertained that the temperature has risen one degree on a global level. Furthermore, the panel concluded that the future temperature within 25 years would be increased by 0,5 degree more to 1,5 degrees. The climate of the earth is definitively changing and with a speed that we have to go way back in history to find the like. However this is not a new phenomenon at all.

In the first centuries since the end of the last ice age about 12,000 years ago great changes took place in the landscapes. Huge glaciers melted away and plants, people and animals occupied the desolate areas. Not only did the ice disappear, but the land also began to rise. As the ice melted, more water entered the oceans and as the temperature rose, the oceans expanded, and the average temperature in certain

parts of the globe increased by more than 10 degrees after the abovementioned Ice Age.

The warmer and more stable weather was crucial for the revolutionary domestication of plants and animals. This brought about completely new opportunities to gather supplies and to improve health. Many agricultural societies were long extremely vulnerable to the fluctuations of the weather. Drought, cold or rain led to poor growth, hunger and bad years.

Agricultural production shares conditions with all other biological production. It's all about carbon almost entirely. Coal is part of all living organisms, and can basically be considered the basic element of life itself. In photosynthesis, green plants absorb carbon dioxide ($CO_2$) from the air and use the sun’s energy to combine it with water to form sugar and oxygen, which are released into the atmosphere. The sugars are then included in the formation of all the other chemical compounds that living organisms are made of, but oxygen is a prerequisite for all forms of combustion.

Combustion is actually a breakdown of organic carbon compounds and the waste product is exactly the $CO_2$ with which it all began. In other words, carbon is everywhere, but only 1% of it is found in living organisms, 11% is tied up in underground stocks of oil and coal, 3% in the soil and 82% in the oceans, which also retain a large part of the air’s excess $CO_2$. The last 2% is found in the atmosphere. In addition to carbon and water, energy is an indispensable condition for life and activity. From an earthly perspective, it is predominantly something that comes from the sun.

The atmosphere – an insulating mixture of certain gases, including carbon dioxide - and which at an altitude of up to a hundred kilometres ensures that the sun’s energy and the sun’s light rays can enter, but not all of its heat rays escape again. Without this protection, the Earth’s temperature would be 30-35 degrees lower than it is in 2024. The American climatologist and professor William Ruddiman believes that he can trace a slight increase in the emissions of $CO_2$ and methane gases already more than 8,000 years ago. Further, the climatologist claims that these early changes

in the atmosphere, the emissions of carbon dioxide have been a factor behind today's stable and human-friendly climate. Yes, maybe even prevented a new Ice Age.

**Forces of nature and three natural memory cards**

However, climate change is far from new. Earth was much colder 12,000-13,000 years ago than it is today and parts of the planet was in the grip of major Ice Age. During the Cretaceous Period 70 million years ago the average global temperature was several degrees warmer it currently is. In the 21st century, temperatures are on the rise again in a similar way. Earth is an ever-changing planet. Over the centuries forces inside Earth have caused mountains to rise and volcanoes to erupt. Wind and rain acting on the surface have carved out great canyons and worn down mountains to level plains.

On a shorter time scale animals and plants grow and die, the seasons come and go and weather changes almost every day. Weather is in this article referred to as the current condition of the atmosphere for a specific location on Earth, whereas climate refer to as a measure of the average weather conditions over a large region over a much longer period. And Earth perceived as a living organism – like the human body – that is trying to heal itself in that case that damage occurs.

Even though direct temperature measurements on Earth only go back about two centuries, it does not mean that climate scientists are totally in the dark when it comes to getting a handle on what the surface temperature was hundreds or even thousands of years ago. To get the data they need, scientists use a so-called proxy measurement. That is something that stands in for something else and provides the same type of information. Paleoclimatologists use to chart the temperature of the past with especially three proxies: ice cores, sediment cores and tree rings. All three proxies are a kind of memory card but also Earth's evidence that climate through history is very unstable and changeable. And that it has a fundamental influence on human life and actions.

Ice cores functions as a memory card because when it snowed in the past, the tiny ice crystals trapped bubbles that contain samples of the atmosphere at the time it snowed. When the air temperature gets cold, water vapour condenses to form rain or

snow. Because they are heavier, water molecules containing $O_{18}$ atoms tend to condense first. If the temperature continues to drop, then the lighter water molecules $O_{16}$ atoms condense. By comparing the relative number of $O_{16}$ atoms to the number of $O_{18}$ atoms in the ice, climate scientists can get an accurate reading what the temperatures were when the ice formed. However, this presupposes that in the last several thousand years there has not been a weather situation unknown to nowadays mankind [15, p. 57-58].

Sediment cores are similar to ice cores a memory card of Earth except that instead of being made of ice, they are long tubes of mud extracted from the bottom of oceans and lakes. Based on these studies, climatologists have shown that there has been a gradual shift of plant species from tropical regions to higher latitudes. The climate is getting warmer, but on the other hand 52 million years ago there was tropical forest on Antarctica. However, this also presupposes that in the last several thousand years there has not been a geological situation unknown to nowadays mankind [15, p. 58-60].

The last memory card is the so-called dendrochronology or tree rings dating. Every year that a tree is alive, it adds a new layer of wood to its trunk and branches. By counting and reading the rings from the outside in, a specialist in dendrochronology can estimate what the climate was hundreds or thousands of years ago. The tree’s rings grow faster in spring than in autumn and winter [15, p. 60-62].

Just like other climatological and botanical conditions can influence the thickness of the rings. However, there is a small but! Trees respond to changing environmental conditions in different ways. There comparison of for example a bristlecone pine and an oak is useless. Another problem is that individual trees show a great deal of variation in the way they grow and the environmental factors that affect their growth can change from tree to tree. The biggest problem is, however, the so-called carbon dioxide fertilization effect – that is the very fact that trees take in carbon dioxide from the atmosphere to grow. Carbon dioxide concentrations in the atmosphere have steadily increased the last 175 years. Are trees showing an increased

amount of growth because of warmer temperatures or is it due to increased levels of carbon dioxide in the air?

**Interpretation and meaning of the weather**

Since ancient times the term climate had been used for systematic constant differences in the weather conditions of geographical locations. However, not as the term is used in 2024. The climate in antiquity characterized places and peoples, and not surprisingly Aristotle and the author Theophrastus, among others, considered Greece and areas around the country to be the place on the globe with the most ideal climate. In the 1700s the French and English philosophers considered the countries around the English Channel as the place with the ideal weather. Furthermore, the weather with temperate temperatures near France and the British Isles promoted a very balanced behaviour according to the same philosophers.

The general perception of the explanation for climate change is significantly different from today. The connection between climate and culture and climate and civilization is remote for people today. In the 17th century many Europeans immigrated to North America, and here they had to prove that the climate in Europe and America was very much alike and promoted a balanced behaviour. However, the climate in North America is completely different from the European one. So the immigrants were considered a little like savages.

In the 18th century of the Enlightenment, people were also somewhat convinced of man’s superiority to nature. Humans could influence the climate by means of various actions. Some geographers believed that the colonization of North America would in the long term cause snow and ice to disappear on a global scale. In the USA, politicians and scientists concluded that a lot of cultivation of agricultural land would change the climate a lot – from rough to mild – on the American continent.

Meteorology is nowadays a branch of the atmospheric sciences with a major focus on the so-called weather forecasting. The study of meteorology dates back to Ancient Greece, where philosophers like for example Aristotle invented a kind of meteorology. Later, the Romans were to further develop Aristotle’s ideas about the

weather, though significant progress in meteorology did not begin until the 1700s. In the 1800s meteorological networks were formed across broad regions and modest progress was seen in the field. In the 18th century, the invention of the thermometer and barometer allowed for more accurate measurements of temperature and pressure, leading to a better understanding of atmospheric processes. Around 1780 the meteorological society and network Societas Meteorologica Palatina in Mannheim was created.

But these distinctive weather phenomena made mankind rediscover the sky. The priests' explanation was heard above, but now science also intervened in the debate. The scientists went about it differently. The Danish astronomer Tycho Brahe and the Italian astronomer Galileo Galilei, German astronomer Johannes Kepler and before them the Polish astronomer Nicolaus Copernicus were all interested in describing and explaining the sky and its influence on earth. And meteorology is also a science of the sky.

In Denmark, what could be called the first handbook in meteorology was published in 1591, otherwise perhaps more like a handbook in weather predictions. It was a record of the weather forecasts that people had gathered all over the globe over millennia. The author of the handbook was the scientific assistant of Tycho Brahe, Peder Flemløse. However, weather warnings regulated the life of common people in several hundred years. Right up to the present day.

**The Roman Warm Period (250 BC – AD 400)**

During almost the entire Roman period the temperature in the Mediterranean area and far up in central Europe was more than 2 degrees higher than today. In other words, the weather conditions were exceptionally favorable at the exact time when the Romans were defeating their neighbors and other enemies. At the same time an era where droughts were frequent. Another factor was that the volcanic activity was unusually low throughout the period with the exception of the eruption of Vesuvius in the year 79 [10, p. 173].

Everyone has probably seen pictures of the beautiful and huge Roman aqueducts that were built all over the Roman Empire. They were built to optimize the

distribution of water in the various parts of the empire. It was not only the most humid period in the past 4,000 years, but as pollen samples and samples from sediment cores in seas and lakes have shown, it was by far the most intensely productive period in the history of the Mediterranean area in recent times [10, p. 188].

Among other things, it led to a strong growth in agricultural yields in Southern Europe and North Africa, which in turn created population growth, provided labor for new conquests and provided the stability that helped the political authorities to legitimize and consolidate their own power during the process itself. The époque was called the Roman Warm Period [11, p. 32].

The Roman Warm Period is a climatic optimum, which had a key role in the development of the Roman civilization. This study provides new Mean Air Temperatures (MATs) inferred from the oxygen isotope composition of 80 bones and teeth apatite from 8 humans and 8 animals of the Gallic site of Thézy-Glimont, Picardie, France, dated between the 3rd and 2nd century BC. Various bones from the cephalic, axial and appendicular skeleton of three human individuals were sampled. All bones have similar phosphate O18 values for each individual, showing that the oxygen isotope signal of phosphate groups may be homogeneously recorded in bones. The sampled individuals were assumed to drink water from the nearby Arve River collecting local meteoric waters [11, p. 44].

**536-550 – the years of darkness**

The historians Procopius, Michael the Syrian and Flavius Cassiodorus report low temperatures with snow in the summer and crop failures for the year 536. Even at midday the sun only cast a dim shadow and the circumstances that usually accompany a solar eclipse lasted almost a year. The historian Procopius of Caesarea formulated it in this way: the sun, without radiance, shone all year long only like the moon and gave the impression that it was almost completely eclipsed. Moreover, its light was not pure and as usual. But since the sign was seen, neither war nor plague nor any other evil that brings death to people has ceased [6, p. 733].

The predominantly very cold years up to 550 probably caused crop failures in northern and high-altitude regions. In addition, even in the Mediterranean region, where plant growth is not limited to the same extent by temperatures, the reduced solar radiation itself may have reduced the photosynthesis capacity of the plants.

The 536–550 climate anomaly was a period of relatively low temperatures and other climatic anomalies across much of the Northern Hemisphere in late antiquity. It began with weak solar radiation and a marked cooling, the weather anomaly of 535/536, and lasted until the late 540s. Droughts occurred in some regions. This climate anomaly was probably caused by several volcanic eruptions, the first of which is dated to 535 or 536. The climatic event falls within a longer period of rather changeable or cool climate, especially in Europe and the North Atlantic region (the Pessimum of the Migration Period), and it marks the beginning of a period from 536 to 660 called the Late Antique Little Ice Age [1, p. 35].

The Eastern Roman official John Lydos wrote from Constantinople that the sun had been darkened for almost a year and the harvest had been destroyed. Bishop Zacharias of Mytilene, who attended a Synod in Constantinople in 536, reported that the sun and moon were darkened from March 536 to June 537 by stormy seas and harsh winters. Contemporary Chinese sources astronomers failed to observe Canopus, the second brightest star in the night sky, in 536 and Indonesian sources also mention unusual atmospheric events, so it was evidently a global phenomenon [14, p. 545].

An analysis of tree rings by dendrochronologist Mike Baillie of Queen’s University Belfast shows abnormally low growth of the Irish oak in 536 and, after an incomplete recovery, a further sharp decline in 542. Similar patterns are also known from growth rings of various tree species in Sweden, Finland, and California’s Sierra Nevada, as well as in the Alerce in southern Chile. In a 2015 comparison of cold events in the Northern Hemisphere over the past 1500 years using tree ring data, the 535/536 eruption was followed by a cold anomaly of around −1.4 °C, the second largest in the reconstruction. In Europe, summer temperatures in 536 and 541 were 1.5-2.7 °C colder than the previous 30-year period; the summers of the decade 536-545 were, on average, possibly the coldest in the past 1500 years.

The climate anomaly from 536 was probably caused by sulphate aerosols, ash and dust, which clouded the atmosphere and reduced solar radiation. It is fairly certain that these suspended particles came from two volcanic eruptions, although there are various theories as to which events caused a volcanic winter. Other volcanic eruptions and an impact winter after a comet impact have also been discussed as possible causes. A cataclysmic eruption from a volcano on Iceland is under suspicion. [1, p. 37].

Contemporary reports that indicate the actual cause are not known. It can therefore be assumed that the triggering event took place in a region of the world that was remote from the Eurasian and African written cultures of the time, but was not necessarily uninhabited before the event, and therefore did not appear in the records of that time.

**The Renaissance and the climate**

On Thursday 10 February 1625 the Danish priest Anders Pedersen Perlestikker in the town of Nakskov noted in his diary that in the morning there was a terrible weather with storm, hail and snow of an unprecedented dimension. Several houses in the town were completely destroyed on this Thursday and several residents lost their lives. In the afternoon, the small town was haunted by a small tsunami. The priest also noted that he was completely convinced that the climate disaster was fully man-made. It was God’s punishment because man became more and more sinful [5, s. 13-14].

In general, the Renaissance in Europe, which is largely the term for the 1500s and 1600s, was characterized by very bad and unstable weather. The northern hemisphere suffered from wet and stormy summers and for many years the grain harvest failed. The winters were so cold that all inland waters froze over and you could thus transport yourself across the water with horses and loaded wagons. For example, in Denmark in 1658-1659 the winter was so cold that at the end of January the Swedish king Karl X could go with his troops from Germany via Jutland and Funen to Zealand via the Danish belts on to Sweden [5, s. 14].

However, the bad weather of the Renaissance was far from unique at that time in Earth's history. The 16th and 17th centuries were characterized as one of the worst parts of the Little Ice Age (1300s-1800s). In addition to leading to political crises across Europe, the most significant social effects were primarily of an economic and social nature. Hunger, plague and poverty were widespread on the European continent.

But what caused this little ice age? It is of course difficult to give a clear answer. This severe climate change for humanity may have had various causes. However, one reason stands out. In the 17th century, there is much evidence that low activity on the surface of the sun led to a reduced emission of the particles that form the aurora when they meet the atmosphere, which in turn affected cloud formation on earth in a negative direction. And with fewer clouds in the sky, the radiation of heat from the earth's surface increased and the weather became cold.

The Renaissance was also the time of the great voyages of discovery. Europeans travelled the globe like never before. In particular, the rediscovery of America in 1492 led to a great interest in this continent. After all, the Europeans also brought with them diseases such as measles and chicken pox that were apparently not known in South and Central America. This caused mass death in America as the local populations did not have an immune system against these diseases. This also led to large parts of the continent becoming desolate, which made nature work. There was simply room for far more forests, and then as now, the forests tied up large amounts of carbon, which was extracted into the atmosphere, also a reason why the weather became cold.

**Industrial Revolution or the "Carboniferous" of Modern time**

Although a few innovations were developed as early as the 18th century, the Industrial Revolution began in earnest in the 1830s and 1840s in Great Britain and quickly spread to the rest of the world, including the United States. Modern historians often refer to this period as the First Industrial Revolution to distinguish it from another period of industrialization that occurred from the late 19th to the early 20th

century and saw rapid advances in steel, electricity and the automotive industry [4, s. 441-442].

And then there was the consumption of coal, which contains large amounts of energy, a form of energy that European societies badly need. Partly because traditional energy sources such as wood and peat were becoming scarce after centuries of overconsumption, and partly because a number of new forms of production required particularly concentrated energy, which until now had to be obtained by drying and degassing wood into charcoal. The consumption increased explosively all over the European continent. Industries and private households increasingly adopted coal. But soon there were complaints and criticism from the big cities. In the 19th century London was shrouded in jet black smoke and the air pollution meant that health worsened. Smog was born [3, p. 100].

The machines of industry got bigger and bigger and required more and more coal. Pollution became a real problem, especially in beginning of the 1900s. At the same time, weather measurements had become common and the idea of different and changing weather conditions in the past and going forward gained ground. With a more widespread understanding of climate change, scientists began to think about the causes of long-term weather changes. Two Swedish researchers, the geologist Arvid G. Högbom and the physicist Svante Arrhenius, began to put forward ideas that variations in the earth’s heat balance could be explained by the concentration of carbon dioxide in the atmosphere. However, the two Swedes considered the man-made release of greenhouse gases from more and more factory chimneys to be insignificant [5, s. 23].

In Modern time Industrialization, use of pesticides and nitrogen-based fertilizers, crop residues in agriculture, urbanization, forest fires, desert dust, and inadequate waste management have intensified environmental health risks and pollution, especially in low- and middle-income countries. At the same time, the global economy relies on deeply intertwined supply chains, sustained by more than 100 billion tons of raw materials entering the system each year. Intensive material consumption depletes natural resources and causes negative environmental impacts at

every stage of the product lifecycle including production, use phase, and end-of-life. Global waste is expected to increase to 3.4 billion tons by 2050.

Pollution of all types hinders development outcomes. Air pollution, exposure to lead and other chemicals, and hazardous waste including exposure to improper e-waste disposal, cause debilitating and fatal illnesses, create harmful living conditions, and destroy ecosystems. Pollution stunts economic growth, exacerbates poverty and inequality in both urban and rural areas, and significantly contributes to climate change [3, p. 88]

**Global warming – man-made or not?**

Global warming – colloquially also known as climate change, global warming or global heating – refers to the current increase in the average temperature of the Earth's atmosphere and oceans. It is a man-made climate change, which is a consequence of net greenhouse gas emissions that have arisen since the beginning of industrialization through the use of fossil energy resources and unsustainable forestry and agriculture. Greenhouse gas emissions increase the retention capacity for infrared heat radiation in the troposphere, thereby strengthening the natural greenhouse effect. The most important greenhouse gas in the current global warming is carbon dioxide, along with others such as methane and nitrous oxide. The average $CO_2$ concentration in the Earth's atmosphere measured by the Mauna Loa measuring station rose from around 280 parts per million before the start of industrialization to over 410 parts per million [2; 13, p. 77].

According to the International Panel of Climate Change, the temperature increase was about 1.1°C compared to 1850-1900 up to the 2010s. 2023 was the hottest year on record; temperatures were about 1.45°C above the average of the pre-industrial reference period. Since the 1980s, every decade has been warmer than the previous one. The past nine years are the nine hottest years on record. June 2024 was the thirteenth month in a row to set a global temperature record for the respective month [2].

A comparable temperature level was last seen at the end of the Eemian interglacial period 115,000 years ago. The International Panel of Climate Change

writes in its 2023 synthesis report that it is clear that human activities, including mainly the emission of greenhouse gases, have warmed the atmosphere, oceans and land masses. According to the IPCC's estimate 1.07°C of the 1.09°C warming of the Earth's surface between 1850 and 1900 and between 2011 and 2020 can be attributed to human activities. This statement is supported by other assessment reports; there has been a scientific consensus in science since the mid-1990s that the measured global warming is almost entirely caused by humans. The current warming is proceeding considerably faster than all known warming phases in the modern era, i.e. the last 66 million years. Without the current human influence on the climate system, the slight cooling trend that has prevailed for several millennia would most likely continue [7, p. 45].

However, one of the biggest challenges that scientists face when it comes to studies of global climate is having enough accurate data on which to base their analysis. Not all scientists are convinced that their data provides a totally accurate picture of what is happening on Earth. Some of them have also raised questions about the reliability of the temperature data. But they also have two points of criticism regarding the measurements and the location of the measurements in the past compared to today [9, p. 155].

First, they point out, temperature readings taken today at official weather stations are generally done using sophisticated digital probes that immediately log the data into a computer. Since the readings are taken automatically and are taken the same way each time, the data is very consistent and there is almost no room for human error less than 50 years ago that was not the case and in the past not at all. Readings were, furthermore missed and errors were made in the weather logs [9, p. 154].

Then there are problems with the location of the weather stations in the landscapes. Second, some scientists argue that the higher temperature readings that are being recorded at some of the weather stations today may not be giving an accurate measure of the true climate change; instead, the readings may just be recording a local temperature increase brought about by more pavements and less

open spaces. Other climate scientists are quick to point out that much of the global climate data being used today is based on sea surface temperatures, which is not impacted in any way by the heat island effect [8, p. 66; 12, p. 55].

**Conclusion**

In the year 2000 the Dutch meteorologist and atmospheric chemist Paul J. Crutzen proposed to introduce a new geological epoch designation called Anthropocene which replaces the current Holocene epoch. The idea of the Anthropocene epoch places the history of human society on the same scale as that of geology or astronomy, and one can no longer think about nature's role in long-term weather changes without thinking about the role of human beings.

Other scientists propose the alternative Capitalocene epoch. It is a critique of man versus nature thinking in climate politics. Frequently misunderstood as an alternative geological periodization to the Anthropocene proposal, the Capitalocene's leading proponents argue for the centrality of capitalism in the making of climate crisis. The Capitalocene is a way to understand capitalism as a geohistorical process, not a geological event as conventionally understood.

No one doubts that the climate is changing, and that too with a disturbingly fast pace. But the somewhat fictitious split discussion about switching to a new geological epoch characterizes the doubt that characterizes the climate discussion after all. Nature's own role in the climate changes, which is normal in the history of the earth, should perhaps be weighted a little higher in the discussion. There is also no doubt that humans influence the process, but the discussion itself tends to be politicized and to such an extent that when the major or minor climate catastrophes that occur soon every month somewhere on the globe take place, yes then you have no real countermeasures against fire, water and wind.

As can be seen from the above, the basis for comparison between today and 50,000 years ago is somewhat problematic. As long as there are written sources and that back to the Sumerians, man is on fairly solid ground as far as a basis for comparison is concerned, but when there are no sources there may well be long-lasting or very short-term weather changes of which humanity has no knowledge.

Having said all this, it is high time that humanity begins to stop its emissions of $CO_2$ and stop the completely uncontrolled pollution of fossil substances and plastics in the oceans. And introduce as many green initiatives as possible.

**Bibliography:**

1. Barras C. The year of darkness – what wiped out the summer of 536? // New Scientist. 2014. Issue 2952. P. 34-38.

2. Boehm S., Schumer C. 10 big findings from the 2023 IPCC Report on Climate Change [Web resource] // World Resources Institute. 23.03.2023. URL: https://goo.su/wvUVWYv (reference date: 07.10.2024).

3. Calhoun Y. Environmental Issues: Climate Change. Philadelphia: Chelsea House Pub, 2005. 128 p.

4. Frankopan P. Den foranderlige klode: en ufortalt historie. København: Kristeligt Dagblad, 2023. 657 s.

5. Fritzbøger B. Vildt vejr. Aarhus: Aarhus Universitetsforlag, 2019. 104 s.

6. Gibbons A. Eruption made 536 ‘the worst year to be alive’ // Science. 2018. Vol. 362. P. 733-734.

7. Goodell J. How to cool the planet: geoengineering and the audacious quest to fix earth’s climate. Boston: Mariner Books, 2010. 262 p.

8. Green K.P. Global warming: Understanding the debate. Berkeley Heights, NJ : Enslow Publishers. 2002. 128 p.

9. MacCracken M.C. Global warming: A science overview // Global warming and energy policy. 2001. New York: Kluwer Academic. P. 151-159.

10. McCormick M., et al. Climate change during and after the Roman Empire: Reconstructing the past from scientific and historical evidence // Journal of Interdisciplinary History XLIII. Vol. 43. Issue 2. 2012. P. 169-220.

11. McCormick M., Harper K. Reconstructing the Roman Climate // The Science of Roman History. Princeton: Princeton University Press, 2018, P. 11-52.

12. Miller D.A. Global Warming. Detroit: Greenhaven Press, 2008. 189 p.

13. Robinson M. American debates global warming: Crisis or myth? New York: Rosen Central, 2008. 76 p.

14. Sigl M., et al, Timing and climate forcing of volcanic eruptions for the past 2,500 years // Nature. 2015. Vol. 523. P. 543-549.

15. Tomecek S.M. Science foundation: Global warming and climate change. New York: Facts on File, Inc., 2012. 120 p.

**Data about the author:**

Christensen Carsten Sander – Doctor of History (PhD), Independent Researcher (Billund, Denmark).

**Сведения об авторе:**

Христенсен Карстен Сандер – доктор истории (PhD), независимый исследователь (Биллунд, Дания).

**E-mail:** arroyoinfancia74@gmail.com.