

Exceptional Icy Cold Waves that Swept Across Different Parts of the World during the Current and Previous Rainy Seasons

Khaled Abdel-Kader Ouda

Geology Department, Faculty of Science, Assiut University, Assiut, Egypt

ABSTRACT

The unprecedented cold, snowy waves that swept across different parts of the globe during the winter of 2021-2022 cannot be attributed to the climatic changes that the world is currently witnessing. Rather, its cause is due to the thousands of tons of sulfur gases that were emitted from the ground volcano Cumbre Vieja on the Spanish island of La Palma, which lies to the west of the Maghreb and which lasted for a period of three full months, starting from September 19, 2021 until December 13, 2021, as well as the sulfur gases that were emitted from the submarine volcano Hunga Tonga-Hunga Ha'apai Volcano, which is located in the middle of the Pacific Ocean on January 15, 2022. The force of the explosion of the last volcano is believed to be the largest volcanic eruption recorded anywhere on the planet in 30 years, as the volcanic eruption was strong enough to inject volcanic material into the stratosphere, which can lead to a cooling effect on global temperatures. The sharp cold waves were not limited to this winter, but also during the winter and spring of 2020-2021 there were very cold waves due to the explosion of La Soufrière volcano on the Caribbean island of Saint Vincent, which began its eruption on December 27, 2020 and then exploded on April 9, and the explosion continued until noon April 11, 2021. This volcano released into the upper atmosphere the highest level of sulfur dioxide ever recorded after satellites began monitoring the Earth's atmosphere in the mid-20th century. Thus, it can be said that this exceptionally icy cold waves is due to the release of large quantities of sulfur dioxide gas from volcanoes and which led to blocking the sun's rays from the earth due to the formation of aerosol in the stratosphere.

KEYWORDS: *Volcanoes, Sulfur dioxide gas, Snowy waves, Climate change*

1. Historical Review

1.1. The Cumbre Vieja volcano on the island of La Palma, Spain.

On September 19, 2021, a volcanic eruption occurred in the Cumbre Vieja volcanic mountain range, which includes the southern half of the Spanish island of La Palma in the Canary Islands. It was the first eruption on the island after half a century since the eruption of Tinjia volcano in 1971. The lava flow covered more than 1,000 hectares. The lava is about 3.5 kilometers wide at its widest point, about 6.2 kilometers long and has reached the sea, destroying more than 3,000 buildings, cutting off the coastal highway and forming a new peninsula (20 minutos, October 4, 2021; Majorica Daily Bulltein, Sep. 28, 2021; Wikipedia, the free encyclopedia, Mars 2022).

The eruption continued for 85 days (from September 19 to Dec. 13, 2021) and thus can be considered as the longest eruption in the La Palma Islands (AP News, Dec. 12, 2021). It is the most affected volcanic eruption on these islands since records began (Canarian Weekly, Oct. 20, 2021). Traces of sulfur dioxide emissions from this volcano have been detected in the upper stratosphere as far north as Scandinavia (Canariasahora elDiario.es, Sep. 29, 2021). The total damage caused by the volcano amounts to €843 million according to the calculation of the Canary Islands government (Europa Press, Dec. 4, 2021).

How to cite this paper: Khaled Abdel-Kader Ouda "Exceptional Icy Cold Waves that Swept Across Different Parts of the World during the Current and Previous Rainy Seasons" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-3, April 2022, pp.1641-1651, URL: www.ijtsrd.com/papers/ijtsrd49764.pdf



IJTSRD49764

Copyright © 2022 by author (s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



Satellite imagery has helped the authorities monitor and manage the crisis. The Sentinel 5 satellite monitored the arrival of plumes of nitrogen dioxide (SO₂) emitted into the atmosphere on Sunday at the Italian border. The column is much larger but much of the image obtained by the ADAM platform is covered in clouds. Combining satellite data and meteorological models, the Copernicus Atmospheric Monitoring Service was able to monitor the arrival of a plume of sulfur dioxide in the following days into the Arctic Ocean through southern Spain, Italy and the Balkans before heading to the Atlantic (Rafael Cereceda, 2021). By following the continuous emissions from the eruption of the Cumbre Vieja volcano in the Canary Islands, large plumes of sulfur dioxide have been transmitted over North Africa and Europe. These plumes traveled mainly through North Africa and southern European countries, including Spain and Portugal, and eventually reached Belgium and the Netherlands, affecting the air quality in these countries (Euobserver, Oct. 22, 2021).

Satellite observations indicate that Cumbre Vieja has released about 0.5 teragrams (Tg) of sulfur dioxide since the eruption began., enough to make it one of the 50 most significant SO₂-emissions events since satellites began measuring volcanic eruptions in 1978 (NASA Earth Observatory, Oct. 18, 2021). The transport of the SO₂ sulfur column as observed by TROPOMI is shown over North Africa, Southern Europe and the Atlantic Ocean from September 19 to October 20, 2021 as the column was transported to Portugal, Spain, France and the United Kingdom. On October 20, 2021, NASA's Aqua satellite captured images showing a very thin horizontal plume a few hundred kilometers wide (atmospheric river) bringing sulfur dioxide toward Germany, Switzerland, Italy and Poland (Royal Belgian Institute for Space Aeronomy Oct. 30, 2021). "This plume is widespread enough that I would expect minimal effects on surface air quality and minimal acid rain over Europe compared to local sources of air pollution," said Michigan Tech volcanologist Simon Karn (NASA Earth Observatory Oct. 18, 2021)

The volcanic emissions of Cumbre Vieja did not stop since its eruption on September 19 until December 13, 2021, with about 50 kilotons of sulfur dioxide emitted per day. On December 12, the volcanic eruption broke the local record, when it reached 85 days of continuous activity. On December 13, the volcano released large amounts of toxic sulfur dioxide gas. As a result, the authorities have ordered 30,000 residents of three municipalities to stay at home (ABC Canarias. Dec. 14, 2021). on the same day, the eruption stopped (Aritz and Barry, Dec. 15, 2021)

1.2. The Hunga Tonga-Hunga Hapai volcano in the Pacific Ocean.

On January 14, 2022, the Hunga Tonga-Hunga Hapai volcano, north of Tongatapu, erupted unexpectedly. The initial eruption lasted more than 12 hours, with volcanic ash and gases reaching more than 25 miles (44 km) in the air. While this was the latest in a series of eruptions, according to NASA researchers, this volcanic eruption triggered a 4-18 megaton blast of TNT. which is 1,000 times more powerful than the bomb dropped on Hiroshima (Jim Garvin, chief scientist at NASA's Goddard Space Flight Center). This number depends on how much rocks has been removed, how resistant the rock is, and how high the blast cloud is in the atmosphere at a range of velocities. (CDP, Jan. 15, 2022). It is believed to be the largest volcanic eruption ever recorded anywhere on the planet in 30 years (ESA, January 20, 2022).

The eruption of the massive volcano in Tonga, on Saturday, caused a tsunami that spread across the Pacific Ocean within hours, where waves hit Australia, New Zealand, Japan as well as the western coasts of North and South America. An air shock wave was detected all over the world. The explosion was heard across the Pacific Ocean, from Fiji to Alaska. The tsunami waves took less than five hours to reach New Zealand, and about 10 hours to reach Alaska (BBC News, Jan. 18, 2022)

The volcanic eruption in Tonga caused so much damage that satellites can see it from space. It was the volcano's second eruption in two months, and this volcanic eruption was seven times more powerful than the previous eruption in December, with repercussions reaching thousands of miles across the planet. A volcanic plume was released into the stratosphere and extending radially to cover all the Tonga islands, resulting in tsunami waves up to 15 meters high. The effects of this submarine eruption were felt as far away as the United States and Japan. A sonic penetration of the eruption was heard across the Pacific Ocean and far from Alaska, more than 9,000 km away, and the shock wave led to a noticeable jump in atmospheric pressure around the world. The dangerous ash also choked the island of Tonga, causing an unprecedented disaster (ESA, Jan. 20, 2022)

In new satellite imagery from satellites operated by Maxar Technologies, the devastation of the volcanic eruption can be seen. While the damage is evident in these images of Tonga, which is made up of 170 different islands, the eruption also had a serious impact on Australia and New Zealand. In addition to the ash plumes coming from the volcano, it also

caused a tsunami that extended as far as Los Angeles in the United States (Chelsea Gohd, 2022)

The sheer force of the eruption was quickly demonstrated in satellite images as a huge mass of material created what volcanologists call a crescent-shaped shockwave cloud with a large number of lightning strikes. 500 kilometers (300 miles) at its maximum." "This is similar to the Pinatubo eruption. The eruption was powerful enough to inject volcanic material into the stratosphere, which could exert a cooling effect on global temperatures. (Nasa Earth Observatory, Jan.15, 2022). According to the DLR (Earth Observation Center Jan. 19, 2022) report, huge amounts of sulfur dioxide (SO₂) were expelled after the explosion on January 15, 2021, about 0.4 million tons, and distributed to a large part of the atmosphere.

No additional eruptive events were detected at Hunga Tonga-Hunga Ha'apai after the big and explosive eruption of January 15th. The plume of gas, steam and ash produced during that eruption rose into the stratosphere and drifted westward over Australia. The horizontal extension of the shaft grew from 18,000 square kilometers on January 15 to 12 million square kilometers by January 19. The column continued to drift W at altitudes between 12.8 and 19.2 km. During the period from January 19 to 22 the ash was diffuse and difficult to distinguish from meteorological clouds, although the sulfur dioxide signal was stronger (Smithsonian Institution Recent Bulletin Report, Feb. 2022). By January 22, the leading edge of the column reached Madagascar and the eastern coast of Africa (Volcano Discovery Jan. 22, 2022)

1.3. La Soufrière volcano in the Caribbean island of Saint Vincent

Sharp cold waves were not limited to the winter and spring of 2021-2022, but also during the spring of 2021 there was a very cold wave due to the eruption of the La Soufrière volcano on April 9, 2021, when this volcano erupted explosively for the first time in more than 40 years and it is a stratified volcano in the Caribbean island of Saint Vincent in the State of Saint Vincent and the Grenadines, and ejected from its crater a column of ash that reached a height of 10 kilometers into the sky (La Soufrière volcano, The *Guardian*, April 11, 2021).

The eruption of this volcano began on December 27, 2020 as the eruption formed a new lava dome inside the crater. In February 2021, the lava dome was still actively growing, releasing plumes of gas and steam from its summit (RTE, April 9, 2021). By March 22, 2021, the lava dome measured 105 meters long, 243 meters wide, and 921 meters high. Sulfur dioxide emissions were generated from the top of the dome (News784. 9 April 2021) on 8 April 2021, after a

steady increase in volcanic and seismic activity during the previous days. A volcanic eruption occurred at 8:41 AM local time the following day 9 April, with the ash plume reaching 10,000 m and drifting east towards the Atlantic Ocean (Hodgson, April 9, 2021; COTO, April 12, 2021). The explosion continued until noon on April 11, 2021.

The April 10 volcanic eruptions were active enough to be recorded by the plumes 20 kilometers above the Earth's surface by the Multi-Angle Radiometer Spectroradiometer on NASA's Terra satellite. NASA scientists have found evidence of sulfate aerosol particles (a precursor of sulfuric acid) entering the stratosphere, the second layer of Earth's atmosphere. Sulfur dioxide (SO₂) emissions from the eruption of the La Soufrière volcano in the Caribbean have reached India, the World Meteorological Organization tweeted on April 16. This has raised fears of increased pollution levels in the northern parts of the country and acid rain. Sulfur dioxide reacts with water to form sulfuric acid, which can come off with precipitation (Akshit Sangomla 17 April 2021).

Of the 45 volcanoes currently erupting on Earth, La Soufrière is among the most concerning to volcanologists," says the NASA Earth Observatory website. This is due to the "irregular explosive style". "Scientists are closely monitoring the arrival of emissions into the relatively dry stratosphere because the particles last longer and travel much farther than if they stayed in the lower, wetter troposphere," NASA added on its website. This may be why the particles reached as far afield as India and are likely to travel as far as Southeast Asia. La Soufrière delivered about 0.4-0.6 Tg of sulfur dioxide into the upper atmosphere, the highest ever recorded after satellites began observing Earth's atmosphere in the mid-20th century.

Dust and ash forced 16,000 people in the Caribbean to evacuate their homes, especially with the spread of sulfur dioxide. However, the impact of this volcano did not include the site of its eruption only, but extended to many European countries and North and West African countries, including Morocco. According to the Wendy website, which specializes in weather and climate conditions, the effects of this volcano crossed the Atlantic Ocean and reached the continents of Europe and Africa, where volcanic emissions spread unevenly in Spain, Portugal, Italy and southern France, but their quantities were greater in North and West Africa, specifically in Morocco, Mauritania, Mali and Algeria. Tunisia, Libya and Egypt, before reaching, to a lesser extent, the Levant, Iraq and the Gulf state (Hamza El Metewi, Al Saheefa, April 13, 2021). According to the same source, which

is based on the results of several accredited centers, including the European Center for Medium-Range Weather Forecasts, the remnants of the volcano have already arrived in Morocco since midnight Monday - Tuesday from the farthest southern provinces, and at six o'clock this evening the winds loaded with large quantities of Sulfur dioxide gas has exceeded the city of Essaouira in the north direction. For its part, the Spanish Meteorological Center announced that the clouds of the eruption of the volcano have already reached the country.

2. Discussion

Climate changes that have swept the world since the beginning of the industrial revolution, which are due to the increase in the concentration of carbon dioxide in the atmosphere as a result of emissions arising from burning fossil energy products (coal - petroleum - natural gas), have nothing to do with the cold snowy climate that swept many countries of the world during Winter and Spring 2020-2021 and Winter and Spring 2021-2022, including the countries of the Middle East, some Far East countries, Central Asia, North Africa, southern and northern Europe and eastern North America. These areas witnessed very cold waves accompanied by snowfall, which has not happened for decades. These icy cold global waves were caused by the emission of large amounts of sulfur dioxide from La Soufrière volcano from December 27, 2020 until noon on April 11, 2021, Cumbre Vieja volcano from September 19, 2021 to December 13, 2022, and Tonga-Hunga Ha'apai volcano on January 14, 2022. This is in addition to the Aetna volcano in Italy, which erupted nineteen times between February 2021-May 2021, all of which delivered ash near the stratosphere. Also, Taal volcano erupted in the Philippines on November 1, 2021, with a force of four degrees, and its ash reached the stratosphere. All of these volcanoes have contributed to making the winter of the world historic and filled with snow storms (Arab Climate Center January 31, 2022).

These snow waves are very similar to the snow waves that affected the world as a result of the second largest volcanic eruption of this century at Mount Pinatubo in the Philippines on June 15, 1991. This eruption resulted in high-speed avalanches of hot ash and gas, a giant mud, and a cloud of volcanic ash across hundreds of miles. Thousands of tons of harmful sulfur dioxide gas were also emitted from the volcano. An ash cloud from this atomic eruption rose 22 miles (35 kilometers) into the air. At lower altitudes, ash was exploding all over the world, and satellites tracked the ash cloud multiple times around the world. Approximately 20 million tons of sulfur

dioxide was injected into the stratosphere in the 1991 eruptions of the Pinatubo volcano. The spread of this gas cloud around the world temporarily lowered global temperatures (1991 to 1993) for three years after the eruption, by as much as 1.3 Fahrenheit at peak effect (The USGS Fact Sheet 113-97, 1997).

The Manaro Voui volcano on Ambae Island in the South Pacific nation of Vanuatu also set exceptional records for 2018. A NASA-NOAA satellite confirmed that Manaro Voui had the largest sulfur dioxide eruption that year. The volcano injected 400,000 tons of sulfur dioxide into the upper troposphere and stratosphere during its most active phase in July, and a total of 600,000 tons in 2018. That's three times the amount released from all global eruptions combined in 2017. Measurements showed the results of a powerful blast of energy that pushed gas and ash into the upper troposphere and into the stratosphere, at an altitude of 10.5 miles. (Jenny Marder, NASA's Goddard Space Flight Center, Feb. 28, 2019). According to the same source sulfur dioxide is short-lived in the atmosphere, but once it penetrates the stratosphere, where it combines with water vapor to turn into sulfuric acid aerosols, it can persist for much longer—weeks, months, or even years, depending on altitude.

The Kīlauea volcano on the island of Hawaii has also released between 500 and 14,000 metric tons of sulfur dioxide (SO₂) per day during almost continuous eruptions since 1983. Changes in SO₂ release have led to changes in vent site, volcanic character, and volcanic vitality (Elias and Sutton, 2012). During lava eruptions from the same volcano in 2018 in the Kīlauea Near East Rift Zone, sulfur dioxide emissions were more than 100,000 metric tons per day. . Kīlauea Volcano contains one of the longest-recorded volcanic sulfur dioxide (SO₂) emission rate databases. It has been measured on a regular basis since 1979 (Elias and Sutton, 2017). Local and regional atmospheric studies show that the contemporary Kīlauea degassing system, although non-explosive, has the potential to influence climate and weather. (Beirle et al., 2014).

The emission of sulfur dioxide from La Soufrière, Cumbre Vieja and Tonga-Hunga Ha'apai volcano has had an impact on the climate in large areas of the earth during the rainy seasons of 2020-2021 and 2021-2022. In the previous year a large-scale cooling of temperatures had occurred in the central and eastern tropical Pacific. The severe cold waves that swept across large areas in the northern half of the earth during the month of December 2020 also resulted in recording unprecedented records in terms of temperatures and the thickness of the falling snow,

as happened in Russia, South Korea, Japan, Siberia, Kazakhstan, Pakistan, and parts of China. , Iceland, the Italian Alps, Canada, as well as the American states of Pennsylvania and Alaska (George Karam 2021).

In the prime of spring (April 20, 2021), a very cold air mass swept across the central and eastern United States. As a result, snow fell and temperatures set records for this time of year, as in Oklahoma City, where the temperature fell on the morning of April 21, reaching -1.1 degrees Celsius, surpassing the previous record of 1.1 degrees Celsius in 1966. The scientific community considered April of the year 2021 to be the coldest month for several years in a number of European countries. It was the coldest month in the Netherlands in thirty years, in Austria since 1997, and in England since 1922. It was striking what happened in Greenland last May 25, when this island was covered, according to data provided by the Danish Meteorological Institute (DMI), with large amounts of snow at an unprecedented level (George Karam 2021). This happened after the ice extent in the Arctic declined in 2020, according to satellite images announced by the National Snow and Ice Data Center in the United States of America (NSID).

As for the rainy season for the current year 2021-2022, the British Meteorological Authority issued forecast maps for the winter in November 2021, and according to these forecasts, the surface temperatures for the months of December 2021 and January and February 2022 in the Levant, Egypt, Iraq, and northern and central Saudi Arabia will be lower than their general rates during the winter. And that the various Arab countries bordering the Mediterranean Sea (from the Levant to the east of the Maghreb) will be exposed to degrees lower than the general rates in this layer, and this means the possibility of cold waves occurring at a higher rate than usual, as well as for Iraq, Egypt and northern Arabia: It is expected Winter is colder than usual, with higher than normal rainfall. Indeed, throughout these months, in the various governorates of the Republic, Egypt witnessed a state of bad weather, with heavy rain falling on the northern coasts, accompanied by the exciting wind activity of sand, dust and snow falling on it and on St. Catherine, to decorate those areas in white, giving the features of the expectations of winter 2022 (Climate Change Center, Nov. 28, 2021).

Commenting on the very cold weather and snow storms that Europe is witnessing, Dr. MagdyAllam, Global Climate Program Adviser (Sada El Balad Newspaper, November 30, 2021), said that the weather is witnessing a state of unbridled phenomena. He added, "What happened in Aswan was violent and

is an example of extreme phenomena." He continued: Alexandria witnessed rain equivalent to nine years of rain, commenting: "It was a wild phenomenon.

Shaker Abu Al-Maati, Professor of Climate, Head of the Meteorology Department at the Central Laboratory for Agricultural Climate, warned of climatic instability during the winter 2022 period, adding that the most affected governorates are the coastal areas. Abu Al-Maati added that "Upper Egypt areas are exposed to cold Severe this year, as happened last month in the Aswan Governorate from torrential rain and snow", and he stressed that "the various governorates of Egypt are exposed to a rush of cold blocks and depressions across eastern Europe towards the eastern Mediterranean, so that Egypt will receive rain and snow in batches" (Al-Watan, Dec. 3, 2021).

An unprecedented snow wave swept the Middle East, where it covered a white suit at the end of January 2022. Residents of Israel, the occupied West Bank and Jerusalem awoke to a snowy white after an unprecedented cold storm hit the Middle East, slowing movement in general. The cold storm, which caused major disturbances in Athens and Istanbul, brought heavy snowfall in areas known for their mild climate and hot summers. Heavy snow also fell on 14 provinces in Algeria, where temperatures were below zero. Snow also fell in Jabal Al-Lawz in Tabuk, Saudi Arabia (RT ONLINE, Jan. 1, 2022).

In Jordan, heavy snowfall at the end of January 2022 closed roads in the capital, Amman, and most other governorates, disrupting movement. The Meteorological Department expected the temperature to drop to one degree below zero in Amman, while it may reach four degrees below zero in the south of the Kingdom. It also expected that snow would continue to fall over the mountainous heights, which are more than 900 meters above sea level. In Syria, temporary camps in the northwest of the country, which are controlled by militant organizations, witnessed days of heavy snowfall and covered them, and families gathered together inside tents of cloth and tarpaulins, fearing that they would freeze to death in sub-zero temperature. Egypt experienced its coldest winter in a decade, with temperatures down seven or eight degrees from normal, according to meteorological authorities. The coastal city of Alexandria also witnessed an unprecedented cold wave and unprecedented snowfall in the city in early January (France 24, Jan. 27, 2022).

On March 14, 2022, the Arab Climate Center (Ahmed Al-Arbeed) announced that a historical cold wave hit the Levant, northern Egypt, Iraq and Saudi Arabia in the second week of March 2022, and snow fell over most areas. The countries of the north of the Middle East were

affected by a very cold, unusual air mass for this time of the year, which led to heavy rain and snow over the mountainous heights in the Levant, in addition to a great activity of wind speed so that the speed of its gifts exceeded the 100 km / h barrier in Jordan, Palestine, Syria and Lebanon and northwestern Egypt. This cold wave is considered a very rare event, and it is characterized by its coldness that exceeds the previous cold waves in stages, especially in the middle of the second week of March, in addition to the relatively long duration of its impact, which exceeds seven days, and this makes it among the most rare cold wave classifications even in winter. The regions of Jordan, Palestine, Syria, Lebanon and Egypt also witnessed a significant decrease in temperatures in all cities that exceeded the cold waves that affected the region during January 2022, making it the coldest wave in the history of the region, thus setting a record for low temperatures during the month of March 2022 since the start of records climatic..Egyptian meteorologists have recorded torrential rains, thunderstorms, and snowfalls in Sharm El-Sheikh, New Cairo, Damietta, Alexandria, Sinai, the North Coast and Saint Catherine (Akhbar Al-Youm, March 31, 2022).

There are researchers (e.g. Alexei Oskin, Moscow University RT Online, June, 2021) who attribute this exceptional cold during the winter of 2020-2021 to the decrease in solar activity in the last solar cycle (No. 24) that lasted from 2008 to 2019. Also the American space agency "NASA" expected that the current solar cycle (No. 25) will also be a weak cycle, which will cause a decrease in the temperature of the universe (George Karam, 2021). The British Astronomical Society also expected that solar activity would decrease by 60% from 2030 to 2040. The same researchers favor this interpretation on the glacial period known as the Dalton Minimum that occurred during the period from 1790 to 1830, and the previous glacial period known as the Maunder Minimum that occurred during the period from 1645 to 1715 (According to the conclusions of the astronomer Edward Maunder, who studied at the end of the nineteenth century, the records of previous astronomers (RT Online, June, 2021).

However, this explanation lacks compelling scientific evidence, and the majority of what is written about it are press articles other than scientific journals. In this regard, Alexey Oskin, a researcher at Moscow University, says: "He did not determine the existence of a direct relationship between solar activity and temperatures on Earth, and that many scientists consider The minimal coincidence of the astronomer Edward Maunder, who at the end of the nineteenth century studied the records of earlier astronomers, is

just a coincidence" (RT Online, June, 2021). Oskin believes that the relationship between the Sun and the Earth is a "complex issue", as "very subtle phenomena" can change the weather on Earth. On the other hand, it has been proven with certainty by studies, measurements and scientific evidence that the global average temperature of the planet has increased continuously from +0.2 in 1980 to +1.0 degrees in 2020 without any consideration for the decrease in solar activity from 2008 to the current year

This interpretation also contrasts with the sudden hot waves that swept Canada and the United States of America, which were exposed to record cold waves during the winter season, and were swept by a historical and record heat wave in the last days of last June 2021. This wave has not been seen in the region since the beginning of climate records, as the temperature was recorded in Lytton - British Columbia, 49.6 degrees Celsius, resulting in many fires and deaths. The heat wave also extended to the northwestern United States, also recording a record temperature, according to the US Weather Service, 46.1 degrees Celsius at Portland Airport in Oregon. In conjunction with the phenomenon of hot waves in June 2021, Siberia witnessed record temperatures that reached the limits of 48 degrees Celsius, and Moscow recorded on June 23 the highest temperature ever, which reached 34.8 degrees Celsius. In the months of December and January 2021, the snow cover was almost completely absent from the heights of the western and eastern mountains of Lebanon, while it was exposed to a severe cold wave in February of the same year (George Karam, 2021).

3. Conclusion

It can be said that if the increase in the concentration of carbon dioxide emissions in the atmosphere is the main reason for the increase in the global temperature rate, then the sulfur dioxide gas may, if it accumulates in the stratosphere, cause a decrease in the global average temperature. Both types of gases come out of the terrestrial and marine volcanoes in varying proportions during the geological history, causing the global climate to vary in different periods, epochs and ages. This discrepancy led to the different types of life during geological history before the emergence of man, the most important of which was the occurrence of a semi-mass extension of marine life at the end of the Permian period, the mass extinction of the giant reptiles at the end of the Cretaceous, and the sudden emergence of new types of life, the most important of which were forests and coal swamps in the Carboniferous period, mammals and herbs In the Eocene era. All these biological changes occurred because of the climatic changes that prevailed

on the earth at that time. One of the evidence of these climatic changes occurred during the Quaternary (Pleistocene) Period, when the globe alternated four glacial periods interspersed with three periods of global warming between glaciers with a total age of 1.5 million years. The last glacial period ended about 11700 BC, when modern humans (*Homo sapiens*) appeared.

Since the appearance of man on Earth until approximately 1860, the proportion of carbon dioxide in the air did not exceed 280 parts per million. The most direct way to measure historical carbon dioxide concentrations in the atmosphere is to measure air bubbles (liquids and gases trapped within crystals) trapped under ice sheets in Antarctica and Greenland. Research accepted in the academic community is based on the study of ice core samples from these Antarctic traps. These studies indicate that carbon dioxide concentrations in the atmosphere were about 260-280 ppm before the onset of human-made emissions, and this ratio has remained nearly constant over the previous 10,000 years (Etheridge et al.1998).

The longest ice core record has been discovered in East Antarctica, taking samples of ice up to 800,000 years old (Yoshiyuki 2006). It appears from this sample that the concentration of carbon dioxide in the atmosphere ranged between 180-210 ppm during the glacial ages, and rose to 280-300 ppm during the interglacial warm ages (Hileman, 2005). But after this date, this percentage began to increase annually until it reached 413 parts per million in 2019. Scientists explain this increase due to the increasing demand for humans to burn fossil energy sources such as coal, oil and natural gas to produce energy for running factories and means of transportation and communications since the beginning of the history of the industrial revolution until now. Carbon dioxide also comes out as a product of forest fires in the world, which has been growing during the twenty-first century. The gas in this case represents a direct positive product as a result of the carbon buried in trees leaving the air - in addition to the indirect negative increase of carbon dioxide circulating in the air due to the lack of vegetation cover to absorb it, and thus the loss of vegetation cover in the ground is a cause of the double increase in the proportion of carbon dioxide in the air.

Therefore, the international interest in increasing the proportion of afforestation in the countries of the world and protecting the current forests will lead to more positive results than the claims to stop the use of fossil energy means. Because all the different countries of the world have not yet reached a sufficient level of alternative sustainable energy means, which will take many decades to replace fossil energy means. Also, nuclear energy is no longer safe for peoples because of its dangers and the dangers of its products to the

population in the event of wars, as is the current incident between Russia and Ukraine, or because terrorists resort to detonating the enrichment products, which is known as the dirty bomb, or because of malfunctions and accidents, such as what happened to the Chernobyl reactor in Ukraine and the nuclear reactor Yokshima in Japan. All countries should also be encouraged to establish algae farms next to all industrial facilities that emit carbon dioxide from their chimneys, especially cement factories, so that the carbon can be buried as soon as it is released. Algae breathe carbon dioxide and produce oxygen, which helps reduce the proportion of carbon in the atmosphere.

The matter is not limited to fires arising from forests, but also fires that ignite in industrial, agricultural and civilian areas in cities and villages as a result of bombing buildings, facilities and factories during wartime. It suffices to say that the index of the increase in the global average temperature began to increase clearly in 1938, as the average ranged between -0.2 and +0.2 until 1980, a period characterized by a world war and nuclear explosions on the Earth's surface (Ouda, 2010). Then the global average began to increase steadily from 1980 until it reached +1.0 degrees in 2020. The reason for this is the intense global competition to increase the rates of development between countries, as well as China's entry into the field of industrialization and free economy, and then the intense demand for fossil energy means.

Carbon dioxide also comes out of the approximately 1,500 surface active volcanoes around the world, in addition to the continuous chains of volcanoes that occur on the ocean floor at centers of spread such as the Mid-Atlantic Ridge, where about 500 volcanoes have erupted, resulting in the formation of many of them along the edge of the Pacific Ocean in the Ring of Fire region (RolaDomyati Sep. 17, 2021). Although carbon dioxide gas released from volcanoes was the main cause of the warming that the world witnessed in some eras during geological history before the emergence of man, which resulted in some global extinctions, the release from it in contemporary volcanic eruptions did not cause a global warming that can be detected. in the atmosphere. In 2010 human activities were responsible for 35 billion metric tons (gigatons) of carbon dioxide emissions. While all studies and global estimates published so far on the rate of global volcanic carbon dioxide emissions indicate that all volcanoes located on the Earth's surface and submerged release from 0.13 gigatons to 0.44 gigatons per year (CAP, December 14, 2021). That is, 2010 human carbon dioxide emissions are about 80 to 270 times greater than the annual maximum and minimum estimates of global volcanic carbon dioxide emissions.

There is no doubt that very large volcanic eruptions can pump large amounts of carbon dioxide into the atmosphere. The 1980 eruption of Mount Saint Helens released nearly 10 million tons of carbon dioxide into the atmosphere in just 9 hours. However, it currently takes humanity only 2.5 hours to excrete the same amount. While large volcanic eruptions like this are rare and only occur globally every 10 years or so, humanity's emissions do not stop and are increasing every year (The USGS article, "Volcanoes Can Affect Climate").

Thus, it can be said that the carbon dioxide gas released from contemporary volcanoes does not play a major role in global warming that the world is currently witnessing, but it only enhances global warming, while other volcanic gases such as sulfur dioxide can cause global cooling. The most significant climatic impacts from volcanic injection into the stratosphere come from the conversion of sulfur dioxide into sulfuric acid, which rapidly condenses in the stratosphere to form fine sulfate aerosols. Aerosols increase the reflection of radiation from the Sun back into space, cooling the Earth's lower atmosphere or troposphere and so volcanoes can affect climate change.

Sulfur dioxide released by several volcanic eruptions over the past century has caused the average surface temperature to drop by as much as half a degree (the Fahrenheit scale) for periods of one to three years. The eruption of Mount Pinatubo on June 15, 1991, was one of the largest eruptions of the 20th century and injected a 20-million-ton (metric scale) cloud of sulfur dioxide into the stratosphere more than 20 miles high. The Pinatubo cloud has been the largest SO₂ cloud ever observed in the stratosphere since the beginning of these satellite observations in 1978. It caused what is believed to be the largest stratospheric aerosol disturbance of the 20th century. As a result, it was notable for its climate impact and cooled the Earth's surface for three years after the eruption, by as much as 1.3 degrees Fahrenheit at the peak of the impact. The Great Laki Fissure eruption of 1783-1784 in Iceland also released an astonishing amount of sulfur dioxide than Pinatubo (about 120 million tons vs. 20). Although the two eruptions were significantly different in length and style, added sulfur dioxide in the atmosphere caused regional cooling of Europe and North America in similar amounts for similar time periods. (The USGS article, "Volcanoes Can Affect Climate").

Until the world reaches the point of dispensing with fossil energy sources and replacing them with technology with clean sustainable energy sources, the world's climate will witness a continuous rise in the global average temperature, resulting from the steady increase in the proportion of carbon gases emitted from the burning of fossil energy means by human knowledge

and forest fires. This rise is punctuated by periods ranging from several days to a few weeks or months, a sharp drop in the global average temperature in many parts of the world resulting from the release of large quantities of sulfur dioxide gas in the stratosphere, which emanates from contemporary active volcanoes or those whose activity is renewed above the surface and under the surface of the water. Thus, it is expected that the coldness and its severity will increase during the winter season, and the global warming will increase in severity and intensity in the summer, while the spring and autumn seasons are punctuated by waves of very cold air masses accompanied by thunderstorms and snowfall, alternating with waves of hot storms accompanied by floods, desertification and drought.

References

- [1] ABC Canarias es. (14 December 2021). El volcán desconcierta con el temblor «desaparecido» y la columna de emisión más alta registrada" (in Spanish).
- [2] Akhbar Al-Youm newspaper (31 March 2022) snow fall. <https://akhbarelyom.com/News/Search/1/1?JournalID=1&query=%D8%B3%D9%82%D9%88%D8%B7+%D8%A7%D9%84%D8%AB%D9%84%D9%88%D8%AC>
- [3] Akshit Sangomla (17 April 2021). Sulphur dioxide from Caribbean volcano reaches India, WMO confirms. <https://www.downtoearth.org.in/news/natural-disasters/sulphur-dioxide-from-caribbean-volcano-reaches-india-wmo-confirms-76547>
- [4] Al Watan Newspaper (3 December 2021). Meteorologist: Winter 2022 is the coldest on the coast of Egypt due to climate change <https://www.elwatannews.com/news/details/5834275>
- [5] AP News (Associated Press) (12 December 2021). Spanish island volcano eruption hits local record of 85 days". <https://apnews.com/article/science-business-environment-and-nature-canary-islands-spain-eade125082d77bc1c8c1bebbde78b04a>
- [6] Arab Climate Center - Eng. Ahmed Al-Arbeed ' (14 Mars 2022). A historical cold wave that hits the Levant, northern Egypt, Iraq and Saudi Arabia, and snow showers over most areas <https://www.arab4climate.com/%D8%A7%D9%84%D9%85%D8%B1%D9%83%D8%B2-%D8%A7%D9%84%D8%B9%D8%B1%D8%A8%D9%8A%D9%84%D9%84%D9%85%D9%86%D8%A7%D8%AE.html>

- [7] Aritz Parra, Barry Hatton (15 December 2021). "After 3 tense months, Spanish volcano eruption may be over". AP NEWS. Retrieved 20 December 2021.
- [8] BBC News (18 January 2022) Tonga eruption: How its impact spread so widely and violently. By The Visual Journalism Team. <https://www.bbc.com/news/world-australia-60027360>
- [9] BBC News (25 December 2021). Spain's La Palma volcano eruption declared over after three months". <https://www.bbc.com/news/world-europe-59791541>
- [10] Canarian Weekly (20 October 2021): The new volcano is the most damaging among the historical eruptions on La Palma".
- [11] CanariasahoraDiario.es (29 September 2021). La lava del volcán de La Palma alcanza el mar. Archived from the original on 29 September 2021. https://www.eldiario.es/canariasahora/lapalmaa-hora/sociedad/colada-lava-volcan-palma-alcanza-mar_1_8326032.html
- [12] CAP (Climate Adaptation Platform) (14 December 2021) : Effects of Volcanic Eruptions on the Climate. Home / Climate Articles and News / <https://climateadaptationplatform.com/effects-of-volcanic-eruptions-on-the-climate/>
- [13] CDP (Center for Disaster Philanthropy) (25 January 2022). Hunga Tonga-Hunga Ha'apai Volcano. https://disasterphilanthropy.org/disaster/hunga-tonga-hunga-haapai-volcano/?gclid=EAIaIQobChMIIm_mcu_7q9QIV0uR3Ch2N1wjFEAAAYASAAEgIgUfD_BwE
- [14] Chelsea Gohd (18 January 2022). Lasting devastation from Tonga volcano eruption revealed in satellite images. Space, <https://www.space.com/tonga-volcano-eruption-damage-satellite-images>
- [15] Climate Change Center, Ministry of Agriculture (28 November 2021). The winter of this year is low in temperature and may be interspersed with frost waves. AlyawmAlsaabie newspaper <https://www.youm7.com/story/2021/11/28/%D9%85%D8%B1%D9%83%D8%B2-%D9%85%D8%B9%D9%84%D9%88%D9%85%D8%A7%D8%AA%D8%AA%D8%BA%D9%8A%D8%B1%D8%A7%D9%84%D9%85%D9%86%D8%A7%D8%AE%D8%B4%D8%AA%D8%A7%D8%A1%D9%87%D8%B0%D8%A7%D8%A7%D9%84%D8%B9%D8%A7%D9%85%D9%85%D9%86%D8%AE%D9%81%D8%B6%D8%A7%D9%84%D8%AD%D8%B1%D8%A7%D8%B1%D8%A9%D9%88%D9%82%D8%AF/5557169>
- [16] Coto, Dánica (9 April 2021) "Explosive eruption rocks volcano on Caribbean's St. Vincent". abc NEWS. <https://abcnews.go.com/International/wireStory/st-vincent-warns-volcanic-eruption-orders-evacuations-76958379>
- [17] Earth Observation Center (19 January 2022). Sulphur dioxide cloud from Hunga Tonga Hunga Ha'apai. https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-18220/29005_read-76371/admin-1/
- [18] Elias T. , Sutton A.J., (2012): Sulfur Dioxide Emission Rates from Kīlauea Volcano, Hawai'i, 2007–2010.USGS Open-File Report 2012–110. <https://pubs.usgs.gov/of/2012/1107/>.
- [19] Elias T. , Sutton A.J. (2017) Volcanic air pollution hazards in Hawaii. USGS Fact Sheet 2017-3017: <https://doi.org/10.3133/fs20173017>
- [20] ESA (European Space Agency) (20 January 2022).Sulfur Dioxide From Massive Volcanic Eruption Near Tonga Spreads Over Australia. European Space AgencyGeographyTsunamiVolcano
- [21] Etheridge, D.M., Steele, L.P., Langenfelds, R.L., Francey, R.J., Barnola, J.-M. , Morgan,V.I. (1998) Historical CO2 Records from the Law Dome DE08, DE08-2, and DSS Ice Cores. In: Trends: A Compendium of Data on Global Change, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, 1-3. <https://doi.org/10.3334/CDIAC/atg.011>
- [22] Euobserver (22. October 2021). Emissions from La Palma volcano reach Brussels. <https://euobserver.com/tickers/153305>
- [23] Europa Press (in Spanish)(4 December 2021).Canarias remite al Gobiernouna evaluación de daños del volcán de La Palma por 842,33 millones.
- [24] France 24(27 January 2022). Exceptional snow wave sweeps the Middle East <https://www.france24.com/ar/%D8%A7%D9%84%D8%A3%D8%AE%D8%A8%D8%A7%D8%B1%D8%A7%D9%84%D9%85%D8%B3>

- %D8%AA%D9%85%D8%B1%D8%A9/20220127-%D9%85%D9%88%D8%AC%D8%A9-%D8%AB%D9%84%D8%AC%D9%86%D8%A7%D8%AF%D8%B1%D8%A9%D8%AA%D8%B9%D9%85%D8%A7%D9%84%D8%B4%D8%B1%D9%82%D8%A7%D9%84%D8%A3%D9%88%D8%B3%D8%B7
- [25] George Karam (2021): Planet Earth: Is it really approaching a mini ice age? An-Nahar, 16/7/2021. <https://www.annahar.com/arabic/section/4/%D8%B9%D9%84%D9%88%D9%85%D8%AA%D9%83%D9%86%D9%88%D9%84%D9%88%D8%AC%D9%8A%D8%A7/08072021023258420#:~:text=%D9%81%D8%A7%D9%84%D8%AC%D9%85%D8%B9%D9%8A%D8%A9%20%D8%A7%D9%84%D9%81%D9%84%D9%83%D9%8A%D9%91%D8%A9%20%D8%A7%D9%84%D8%A8%D8%B1%D9%8A%D8%B7%D8%A7%D9%86%D9%8A%D8%A9%20%D8%AA%D9%88%D9%82%D8%B9%D9%91%D8%AA%20%D8%A3%D9%86,%D8%B9%D8%B5%D8%B1%20%D8%AC%D9%84%D9%8A%D8%AF%D9%8A%20%D9%85%D8%B5%D8%BA%D9%91%D8%B1%20%D8%A3%D8%AA%D8%AA%20%D8%A5%D9%8A%D8%AC%D8%A7%D8%A8%D9%8A%D9%91%D8%A9>
- [26] Hamza El Metewi (13 April, 2021). Its fumes carry poisonous sulfur dioxide gas.... The remnants of the eruption of the "La Soufriere" volcano in the Caribbean reach Morocco AlSaheefa. <https://www.assahifa.com/%D8%A3%D8%AF%D8%AE%D9%86%D8%AA%D9%87-%D8%AA%D8%AD%D9%85%D9%84-%D8%BA%D8%A7%D8%B2%D8%AB%D8%A7%D9%86%D9%8A%D8%A3%D9%83%D8%B3%D9%8A%D8%AF%D8%A7%D9%84%D9%83%D8%A8%D8%B1%D9%8A%D8%AA-%D8%A7%D9%84%D8%B3/>
- [27] Hileman B. (2005). "Ice Core Record Extended: Analyses of trapped air show current CO at highest level in 650,000 years". Chemical & Engineering News. 83 (48): 7. doi:10.1021/cen-v083n048.p007. ISSN 0009-2347
- [28] Hodgson, Martin (9 April 2021). "St Vincent rocked by explosive eruptions at La Soufrière volcano". The Guardian. <https://www.theguardian.com/world/2021/apr/09/st-vincent-volcano-eruption>
- [29] Majorica Daily Bulltein (28 September 2021). "Spain declares volcano hit La Palma as disaster zone". By Reuter, <https://www.majorcadailybulletin.com/news/international/2021/09/28/90129/>.
- [30] Marder, Jenny, NASA's Goddard Space Flight Center (28 February. 2019). 018's Biggest Volcanic Eruption of Sulfur Dioxide. <https://www.nasa.gov/feature/goddard/2019/2018-s-biggest-volcanic-eruption-of-sulfur-dioxide>
- [31] NASA Earth Observatory (18 October 2021). Sulfur Skies over La Palma <http://earthobservatory.nasa.gov/images/148978/sulfur-skies-over-la-palma>
- [32] NASA Earth Observatory (15 January 2022). Hunga Tonga-HungaHa'apai Erupts. <https://earthobservatory.nasa.gov/images/149347/hunga-tonga-hunga-haapai-erupts>
- [33] News784 (9 April 2021) "La Soufriere Volcano Erupts On The Caribbean Island Of St Vincent". In Wikipedia Feb 21, 2022.
- [34] Ouda, Kh. A.K., 2010. Atlas of risks of climate change on the Egyptian coasts and defensive policies. Publisher: Assiut University, Assiut 71516, Egypt, 2 volumes, 955 p., 734 pl. Registration Number 10847/2010. International numeration 977-17-9006-4.
- [35] Rafael Cereceda(2021). La Palma volcano: How satellite imagery is helping us understand the eruption. Euronews 30/09/2021. <https://www.euronews.com/2021/09/29/la-palma-volcano-how-satellite-imagery-is-helping-us-understand-the-eruption>
- [36] RolaDomyati (17 September 2021). How many volcanoes are there on earth?. Geology. <https://geolougy.com/k/%D9%83%D9%85%D8%B9%D8%AF%D8%AF%D8%A7%D9%84%D8%A8%D8%B1%D8%A7%D9%83%D9%8A%D9%86%D8%B9%D9%84%D9%89%D8%B3%D8%B7%D8%AD%D8%A7%D9%84%D8%A3%D8%B1%D8%B6>
- [37] Royal Belgian Institute for Space Aeronomy (30 October 2021). Tracking CumbreVieja volcanic sulphur dioxide from space. <https://www.aeronomie.be/en/news/2021/tracking-cumbre-vieja-volcanic-sulphur-dioxide-space>
- [38] RT Online (11 June, 2021): An astronomer does not rule out the beginning of a new ice age. <https://arabic.rt.com/technology/1240943-%D8%B9%D8%A7%D9%84%D9%85%D9%81%D9%84%D9%83%D9%84%D8%A7%D9%8A%D8%B3%D8%AA%D8%A8%D8%B9>

- [39] RT Online (1 Jan, 2022): Snow covers Jabal Al-Louz in Tabuk, Saudi Arabia. https://arabic.rt.com/middle_east/1310437%D8%A7%D9%84%D8%AB%D9%84%D8%AC-%D9%8A%D8%BA%D8%B7%D9%8A%D8%AC%D8%A8%D9%84%D8%A7%D9%84%D9%84%D9%88%D8%B2%D9%81%D9%8A%D8%AA%D8%A8%D9%88%D9%83%D8%A8%D8%A7%D9%84%D8%B3%D8%B9%D9%88%D8%AF%D9%8A%D8%A9
- [40] RTE (Radio and Television Ireland) (9 April 2021). "Volcano threat forces evacuation on Caribbean island". In Wikipedia Feb 21, 2022.
- [41] S. Beirle, C. Hörmann, M. Penning de Vries, S. Dörner, C. Kern, T. Wagner (Aug. 19 2014). Estimating the volcanic emission rate and atmospheric lifetime of SO₂ from space: a case study for Kīlauea volcano, Hawai'i. European Geosciences Union <https://acp.copernicus.org/articles/14/8309/2014/>
- [42] Sadaaabaladnewspaper(30 November 2021). Will winter 2022 be the hardest and coldest In Egypt?..Expert clarifies (Dr. MagdyAlam). <https://www.elbalad.news/5066457>
- [43] Smithsonian Institution Recent Bulletin Report (Febuary 2022): Hunga Tonga-HungaHa'apai. <https://volcano.si.edu/volcano.cfm?vn=243040>
- [44] The Guardian (11 April 2021).La Soufrière volcano "St Vincent hit by power cuts after another 'explosive event'". <https://www.theguardian.com/world/2021/apr/11/st-vincent-volcano-la-soufriere-explosive-event-power-cuts>
- [45] The USGS article, "Volcanoes Can Affect Climate"<https://www.usgs.gov/programs/VHP/volcanoes-can-affect-climate>
- [46] The USGS, Frequently asked questions (natural hazards) How much sulfur dioxide (SO₂) gas does Kīlauea emit? <https://www.usgs.gov/faqs/how-much-sulfur-dioxide-so2-gas-does-kilauea->
- [47] The USGS Fact Sheet 113-97 (1997):The Cataclysmic 1991 Eruption of Mount Pinatubo, Philippines <https://pubs.usgs.gov/fs/1997/fs113-97/>
- [48] 20minutos (4 October 2021). Últimasnoticias de laserupcionesvolcánicas en La Palma. www.20minutos.es – ÚltimasNoticias (in Spanish).
- [49] Volcano Discovery (22 January 2022).Hunga Tonga-HungaHa'apai volcano (Tonga) activity update: SO₂ plume reached Madagascar and East Africa today.<https://www.volcanodiscovery.com/hunga-tonga-hunga-haapai/news/170951/Hunga-Tonga-Hunga-Ha-apai-volcano-Tonga-activity-update-SO2-plume-reached-Madagascar-and-East-Africa.html>
- [50] Wikipedia, the free encyclopedia (21 February 2022). La Soufrière (volcano)[https://en.wikipedia.org/wiki/La_Soufriere%C3%A8re_\(volcano\)](https://en.wikipedia.org/wiki/La_Soufriere%C3%A8re_(volcano))
- [51] Wikipedia, the free encyclopedia (31 Mars 2022). Cumbre Vieja volcanic eruption (2021), https://en.wikipedia.org/wiki/2021_Cumbre_Vieja_volcanic_eruption
- [52] Wikipedia, the free encyclopedia (6 April 2022) Hunga Tonga–HungaHa'apai.https://en.wikipedia.org/wiki/Hunga_Tonga%E2%80%93Hunga_Ha%27apai
- [53] Yoshiyuki Fujii (2006). "A new 3000 m deep ice core drilled at Dome Fuji, Antarctica". *PAGES news*. 14 (1): 28–29. <https://doi.org/10.22498/pages.14.1.28>