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Facts and trend of Climate Change - with reference to Geological time frame

Review Article

Vinay Kumar Pandey[1]* and Ajai Mishra[2]

1 GIPL, Energy division, 5^{th} floor, Orbit Plaza, New Prabhadevi road, Prabhadevi, Mumbai, Maharastra, India.

2 Department of Geology, University of Lucknow, Lucknow-226007, U.P., India.

Abstract: The Earth is a dynamic planet, constantly undergoing change, driven by internal and external forces. The Paleoclimatic studies have confirmed that climatic change is a natural process in Earths history with a variation in atmospheric Carbon dioxide (CO_2) concentration. It is also observed that the Earth's average temperature was much higher in the past than the present average temperature. In the Late Ordovician Period (450 Ma) which was a cold phase at that time the CO_2 concentration was nearly 12 times higher than today i.e. 4400 ppm. Only the Carboniferous Period (350 Ma) had witnessed the concentration of CO_2 levels less than 400 ppm in the last 600 million years of Earth history.
The studies had shown that last 4500 years, there were 75 major temperature swings. There was sudden cooling started in the year 2200 BC and due to Volcanic eruptions at Italy, Pacific, Columbia, Alaska and Iceland, again increased the global temperature. The year 1100 BC was much warmer then present time. The year between 1350-1800 AD was marked with Litter Ice age after that temperature increased again. Thus in the present study we synthesis and analysed the causes of climatic change in the past, change in atmospheric CO_2 concentrations in the present time and its trends leading towards the change in climate of planet Earth.

Keywords: Global Climatic Change, Solar activities, Warm and cold phase, Green house gases, Solar Irradiance.

1. Introduction

The majority of researchers, scientists, and environmentalists are expressing their concerns about changes in the overall climate of the Earth. Some believe that a dramatically dangerous warming is taking place in the overall global climate, a problem that is referred to as "global warming." In the pre-industrial era any kind of natural calamities or disasters and any significant change in the environment used to be considered as act of the divine. The 19th century and onwards, with the advent of the stability and statistics the climatic data series utilised as powerful basis for risk management. The system post-1970s was revolutionized with the arrival of Satellites which boosted the science of climate system and global monitoring. Today we have the sophisticated Global Circulation Models with better resolution Regional Circulation Models (viz. PRECIS) [1]. The change in climate is a normal process in Earth's history. The Earth has beard many cold and warm phases with very high atmospheric CO2 concentration. These concentration percentages were also varied from time to time

* *E-mail: vinay78pandey@gmail.com*

depending on the various factors. It was noticed that from 2.7 to 2.3 billion years ago, there were evidences for two major periods of glaciations. The Late Ordovician Period (450 my) was marked with a cold phase, high sea level (Fig 1) and a CO_2 concentration nearly , 4400 ppm[2]. The Silurian and Devonian Periods (410 to 345Ma), there was no evidence for glaciation[3]. The Palaeozoic era marked a second cold phase during the Carboniferous Period (about 305Ma), and continued well up to the Permian[4]. The early Mesozoic/Triassic Period, marked with the combination of a gigantic landmass and lowering global sea level (associated with reduced rates of tectonic movement) should have resulted in extremely continental climates, with associated aridity. There were geological evidences[5],[6] that the warmth of the Triassic and Jurassic Periods continued up to the Cretaceous (136 to 65Ma). The late Cretaceous temperatures were cooler than the mid-Cretaceous thermal maximum (120 to 90 Ma), values remained relatively high up to the early Cenozoic. The evidences from oxygen isotope records[7] were revealed that deep sea ocean temperatures were at least 10C to 15C warmer than they are today. The early Cenozoic sea surface temperatures around Antarctica were also considerably warmer than today[8]. The early Eocene (55 to 50Ma) was the warmest period during the Cenozoic. The ice core data over the past 800,000 years shows that carbon dioxide has varied from 180 ppm to the level of 270 ppm. The Vostok Ice Cores and Greenland Ice Cores was depicted that many phases of warm and cold periods there was 75 major temperature swings marked in a span of 4500 years[9]. There had been a correlation between cold phase and volcanic activities, that whenever was a cold phase, there were series of volcanic eruptions and ended with a warm phase i.e. the year 1100BC was much warmer then present time. The climate change in the context of present studies refer to the causes of changes in the Earth's climate with reference to the geological history of the Earth and with relation to the solar cycle, plate tectonic and role of atmospheric CO_2 concentration percentages at the global scale.

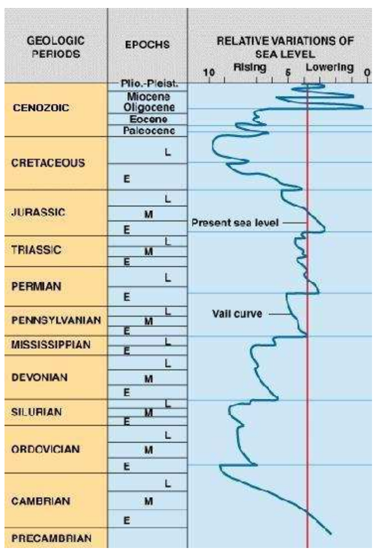

Figure 1. **Global sea level changes in Past [10].**

2. Objective and Methodology

Global Warming is currently the hot topic for discussions and many international as well as national level planning's are running to reduce the atmospheric CO2 and green house gases. To explore the climate changes following methodology have been adopted:

(i) To search the possible causes for climatic change in the priory literature

(ii) To study the climate change during Earth's history and the fluctuations of atmospheric CO2.

(iii) To study the effect of Extraterrestrial factors, solar radiation, atmospheric and tectonic factors on climatic change.

(iv) To analyse the Present trend of climate.

3. The Factors influencing Earths Climate

The Earth is a dynamic planet, constantly undergoing change driven by internal and external forces. The currents of magma within our planet move the plates that form the continental crust in a constant process that builds mountains and creates valleys. These valleys may eventually become lakes, seas, and oceans. On the surface, the greatest factor affecting Earth is Sunlight. The Sun provides energy for living organisms, and it drives our planet's weather and climate by creating temperature gradients in the atmosphere and oceans[11]. The temperature of Earth as a whole is determined by the balance between incoming and outgoing energy. The climate change arises largely from changes to the Earths heat balance. Many of these factors are inter-related, with atmosphere, ocean and land interactions involve in a complex feedback mechanisms that either enhance or dampen the changes to the climate system. The main factors influencing the Earth's climate are following:

(1) Extraterrestrial Factors

(2) Atmospheric Factors

(3) Tectonic Factors

3.1. Extraterrestrial Factors

Earth is the third planet in the solar system having a unique position. The life was possible only in this planet because of its unique position in the solar system. Though there are several factors that are influencing the Earths climate but only two factors are very inferring to influence its climate in this category.

(1) Changes in Earth position in solar system

(2) Variability of Solar radiation/output

3.1.1. Changes in Earth position in Solar System

The Serbian Mathematician, Milutin Milankovi, In 1930s, was described the changes in the orbital path of Earth around the Sun. These changes known as Milankovich cycles, have defined the sequences of cold phases and warm phases. They have considered three variations in the orbit of the Earth around the Sun (Ref fig 2).

(i) The Earths orbit changes from being nearly circular to slightly elliptical (eccentricity). This cycle was affected by other planets in the solar system and had a period of around 1, 00,000 years.

(ii) The angle of tilt of the Earths axis changes from 22.1 to 24.5 (obliquity). This cycle had a period of 41,000 years. The tilt is currently 23.44 degree.

(iii) The direction of the tilt of the axis changes (precession) on a cycle of 26,000 years.

(iv) The inclination of Earth's orbit drifts up and down relative to its present orbit. Milankovitch did not study this three-dimensional movement. This movement is known as "precession of the ecliptic" or "planetary precession". The inclination of Earth's orbit drifts up and down relative to its present orbit with a cycle having a period of about 70,000 years. The inclination of the Earth's orbit has a 100,000-year cycle relative to the invariable plane

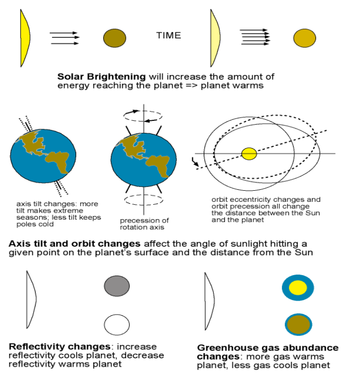

Figure 2. **Change & Effect of Earth Position on Climate[12].**

These changes influence the length of the seasons and the amount of solar radiations received by the Earth and defines the sequence of cold phases and warm phases.

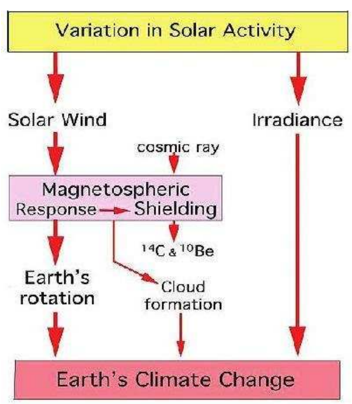

Figure 3. **Effect of Solar Activity on Earth Climate[13].**

3.1.2. Variable Solar radiation/output

The Solar variation is the change in the amount of radiations emitted by the Sun and in its spectral distribution over years to millennia. These variations have periodic components, the main one being the approximately 11-year solar cycle (or Sunspot cycle). The variation in Solar activity lead to change in the Solar wind and in Solar irradiance (fig 3), both of which may affect Earths climate. The variations in irradiance are known to be small or even minute. The variations in Solar Wind are large and strong, via the interaction with the Earths magnetosphere, it affects rate of rotation of the Earth, by that forcing several different terrestrial variables like the Gulf Stream heat in the North Atlantic. Simultaneously, the shielding capacity affects the concentration of cosmogenic nuclides [14] like the aa-index. At any rate, there are two different ways for hoe changes in Solar activity may affect Earths climate; via irradiance or via the Solar Wind.

3.2. Atmospheric Factor

Atmospheric circulation is the global movement of the air, distributing the heat received from solar radiation from warmer to cooler regions. The rotation of the Earth, the tilt of its axis, Surface features, ocean currents and local weather patterns all affects global atmospheric patterns. Instead of winds flowing in a straight line, the rotation of the Earth causes them to bend [15]. Two main atmospheric factors that affect climate are Albedo (reflectivity) effects and Greenhouse gases, described below:

3.2.1. Albedo (reflectivity) Effects

The albedo affects climate and drives weather. All weather phenomenon are a result of the uneven heating of the Earth caused by different areas of the planet having different albedos. Essentially, for the driving of weather, there are two types of albedo regions join Earth: Land and ocean. Land and ocean regions produce the four basic different types of air masses, depending on latitude and therefore insulation. The average overall albedo of Earth, its planetary albedo, is 30 to 35% because of cloud cover, but widely varies locally across the surface because of different geological and environmental features[16]. When an area's albedo changes due to snowfall, a snowtemperature feedback results. A layer of snowfall increases local albedo, reflecting away Sunlight, leading to local cooling. In principle, if no outside temperature change affects this area (e.g. a warm air mass), the lowered albedo and lower temperature would maintain the current snow and invite further snowfall, deepening the snowtemperature feedback[17].

3.2.2. Green House Gases

Our atmosphere consists of many gases. Some of these gases, such as CO_2 and water vapor, naturally absorb long-wave radiation that is emitted from the Earth's surface. The Short-wave solar radiation enters the Earth's atmosphere and is absorbed by the Earth's surface. This radiation is then recycled and emitted as long wave terrestrial radiation. The Gases such as water vapor and CO_2 absorb this radiation, hold it in the atmosphere, and keep the temperature of the Earth warmer than otherwise there wasn't an atmosphere. This is what meteorologists refer to as the "natural greenhouse effect". The major non-gas contributor to the Earth's greenhouse effect, the clouds, also absorb and emit infrared radiation and thus have an effect on radiative properties of the atmosphere[18](Ref Fig 4). The strengthening of the greenhouse effect through human activities is known as the enhanced (or anthropogenic) greenhouse effect[19]. This increase in radiative forcing from human activity is attributable mainly to increased atmospheric CO_2 levels. Since the industrial revolution (about 150 years ago), human activities have led to emissions and an increase in the levels of greenhouse gases. The increase in these gases in the atmosphere means the atmosphere traps more heat and allows less heat to escape to space, leading to an increase in the average temperature of the Earth's surface, causing warming.

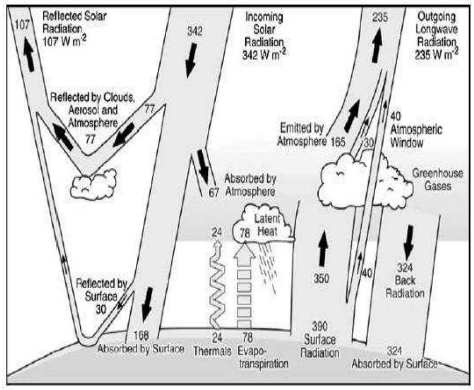

Figure 4. **Earth's greenhouse effect on radiative properties of the atmosphere[18].**

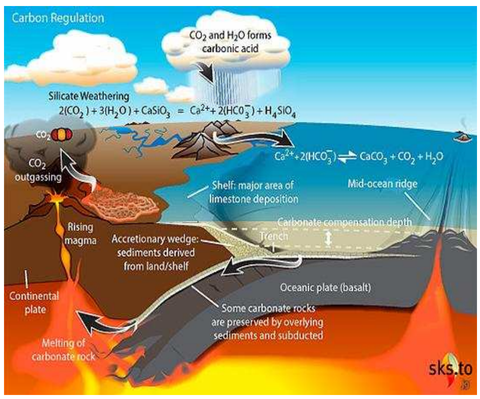

Figure 5. **Natural Carbon Cycle[22].**

3.3. Tectonic Factors: Plate Tectonics and Greenhouse effects

According to the plate tectonic model, the surface of the Earth consists of a series of relatively thin, but rigid, plates which are in the constant motion. Most of the Earth's tectonic, seismic and volcanic activity occurs at the boundaries of neighboring plates. Over the course of millions of years, the motion of tectonic plates reconfigures global land and ocean areas and generates topography. This can affect both global and local patterns of climate and atmosphere-ocean circulation[20] . The position of the continents determines the geometry of the oceans and therefore influences patterns of ocean circulation. The locations of the seas are important in controlling the transfer of heat and moisture across the globe, and therefore, in determining global climate. The Geologic evidences points to a "mega-monsoonal" circulation pattern during the time of the supercontinent Pangaea, and climate modeling suggests that the existence of the supercontinent was conducive to the establishment of monsoons[21] . Plate tectonics and the carbon cycle (fig 5), also have major effect on climate change. The stages of breakup of Pangea are a prime example of this relationship.

The breakup of Pangea about 220 Ma ago left many small continents scattered around the globe. These broken areas of land masses became surrounded by plentiful sources of moisture (e.g. oceans). The increased rainfall takes CO2 out of the air, making the erosion and weathering of continental rocks occur at a faster rate. This has in turn reduces the amount of CO2 in the atmosphere which results in a fall of global temperature. As the temperature falls, glaciation occurs in the polar oceans. The white ice has a high albedo and thus reflects more solar energy back into space. This creates a positive feedback which continues to reduce global temperature[23] .

As the cooling continues, the cold dry air eventually halts the further growth of glaciation, creating deserts. The air becomes so dry that no rainfall occurs so the CO2 released through volcanoes is kept in the atmosphere. The atmospheric carbon then accumulates and begins to trap the infrared waves of the Sun in the greenhouse effect, eventually increasing the global temperature. As the planet grows warmer, moisture from the sea ice refreezes at a higher elevation due to the difference in isostacy. The open waters that are left around the equator absorb more solar energy and help to increase the global temperature. The large amount of carbon in the atmosphere can now combine with the water being evaporated into the atmosphere and form carbonic acid. This rain erodes and weathers rock formation. Water then carries the bicarbonate and the other ions into the ocean where they formed carbonate sediments[24].

4. Inferences/Discussions

4.1. Evidences of Past Global Climate Changes

There is no single instrument for measuring climate change. Instead there are thousands of measuring devices spread across the globe, on land, under the sea and in the air. According to Budyko[25] (1982), information on the climates of remote epochs has been obtained by the analysis of natural conditions in the past. The some of these natural conditions examined are sediment formation, rock weathering, formation of water reservoirs, the existence of living organisms, ocean sediments, analysis of ice cores, tree rings, lake sediments and glaciers. These natural conditions all depend upon atmospheric factors and are appropriate in researching our past climate. Further, the palaeographic data and information on the palaeo-temparatures obtained by isotropic analysis of organic remains appears to be very helpful in the study of ancient climates.

4.1.1. Paleoclimatic Studies

The pre-Quaternary span covers a duration of 99.95% of Earth History (Fig 6). Nevertheless, the data and knowledge of pre-Quaternary climates is significantly poorer than that of the last 2 Ma. Further, going back in time, more and more evidences for past climate change will have been removed by subsequent climatic episodes.

4.1.1.1 Precambrian Climates

The Precambrian comprises 85% of Earth history, yet very little can be said about palaeoclimates from these ancient times, and what is known is not known with any degree of confidence. In passing, The era has been marked with the evidences for two major periods of glaciations, one at 2.7 to 2.3 billion years (Ga) the other more recently at 0.9 to 0.6Ga[2],[26] . The former of these occurred at a time when the current tectonic regime of continental drift was in early growth. There appears to be no evidence for glaciation at other times during the Precambrian, a feature that has puzzled palaeoclimatologists, since it is generally assumed that the Sun was considerably fainter at that time.

4.1.1.2 Palaeozoic Climates

The early Palaeozoic, about 530 Ma, the Northern Hemisphere was marked by oceanic north of about 30N palaeo-latitude. The today's Southern Hemisphere continents (India, Antarctica, Australia, Africa, South America) had formed a super-continent known as Gondwanaland. The sea levels were at near or all time high, perhaps reflecting increased volcanic activity/oceanic ridges expansion after the break-up of a postulated late Precambrian supercontinent[27] .

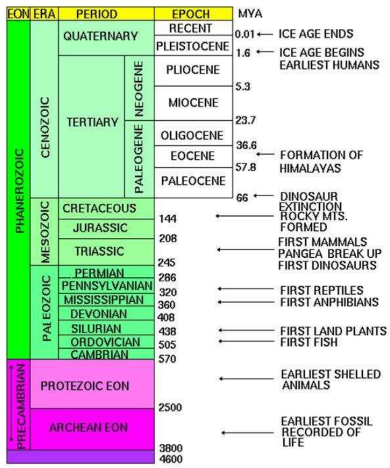

Figure 6. **Geological time scale with main earth activities[28].**

In response to the increased tectonic activity, atmospheric carbon dioxide may also have been significantly higher during the early Palaeozoic. The Wilkinson and Given[29] (1986) have estimated that the atmospheric concentration of carbon dioxide may have been 10 times higher during the early Palaeozoic than at present. Frakes, 1979 had surprising to find evidence of global ice growth during the Ordovician Period (about 440Ma), at a time when sea levels were at their highest levels (Figure 1), with the presumption that the CO_2 concentrations higher as well. The considerable expansion of ice sheets occurred over northern Africa, at that time situated in the vicinity of the South Pole. The Silurian and Devonian Periods (410 to 345Ma), there was no evidences for glaciations[3] . The Devonian was marked by increase seasonality and summer temperatures, thereby preventing the formation of ice sheets and expansion of land plants also occurred[30] . The newly vegetated areas would decrease surface albedo[31] allowing increased absorption of short-wave radiation. The intensification of the hydrological cycle would also influence the climate[32].

The larger cold phase began towards the end of the Palaeozoic during the Carboniferous Period (about 305Ma), and continued well into the Permian[4] have postulated that orogenic uplift in Australia and South America triggered the climatic events. The highest concentrations of CO_2 during all of the Paleozoic Era occurred during the Cambrian Period, nearly 7000 ppm about 18 times higher than today. The atmospheric concentrations of CO_2 in the Early Carboniferous Period were approximately 1500 ppm, but by the Middle of Carboniferous had declined to about 350 ppm comparable to average CO2 concentrations with today. The last 600 million years of Earth's history only the Carboniferous Period and our present age, the Quaternary Period, have witnessed CO_2 levels less than 400 ppm (fig 7).

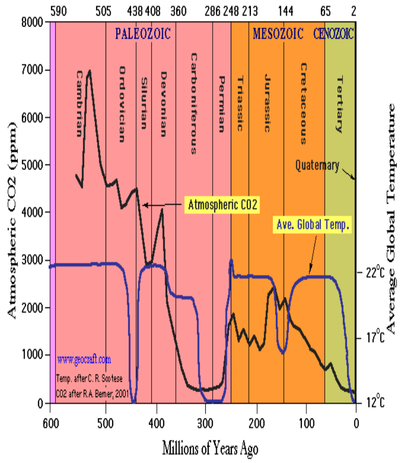

Figure 7. **Relationship between Atmospheric CO_2 and Global temperature[33].**

Such a combination of modeling research and empirical reconstruction of Palaeozoic climate, appears to favour the hypothesis that climate change was driven by tectonic movements. Additionally, sea levels were at that time falling, associated with a slowing down of sea-floor spreading, and presumably a lowering of $_pCO_2$ (and greenhouse forcing), as all the continents began to converge.

4.1.1.3 Mesozoic Climates

The early Mesozoic/Triassic Period, the final suturing of all continents to form Pangea was completed (about 220Ma). The combination of a gigantic landmass and lower global sea level (associated with reduced rates of tectonic movement) should have resulted in extremely continental climates, with associated aridity. During the Jurassic Period (200 Ma), the average CO_2 concentrations were about 1800 ppm or about 4.7 times higher than today. The postulated warmth of the Triassic and Jurassic Periods continued based on the geological evidences into the Cretaceous (136 to 65Ma) [5], [6]. During the Jurassic and Cretaceous, the global sea level rose again (Figure 1), presumably associated with increased sea-floor spreading as Pangea began to break up. There were also considerable geological evidences for warmer temperatures in higher latitudes during the mid-Cretaceous [34]. The oxygen isotope records, Savin[6] (1977) had indicated that deep water temperatures at 100Ma may have been as high as 20C. The comparison between the present day surface temperatures and those during the Cretaceous estimated empirically.

The Various explanations have been proposed for the discrepancy, and subsequently incorporated into further modeling. The two of these include ocean circulation changes and the role of CO_2. The high atmospheric CO2 concentration could come close to reconciling the models with geological evidences. The High levels of CO2 do not altogether seem unreasonable, considering the high global sea level and ensuing break-up of Pangea (presumably due to increased tectonic activity) [35]. In addition to increased outgassing of CO_2, the reduced continental area (due to the global marine transgression) would result in a decreased rate of weathering of silicates and removal of CO_2 from the atmosphere.

Unfortunately, there was little reliable evidence to support the CO_2 model. The Bond et. al[27] (1984) has estimated that average rates of the velocities of major tectonic plates were higher in the late Cretaceous and ocean ridges volumes were greater. In addition, Cretaceous sea beds were dominated by calcite minerals[36], implying higher aqueous, and consequently atmospheric, CO_2 concentrations. Further the inter comparison of different CO_2 proxy records was necessary to evaluate the CO_2 concentrations to resolve the Cretaceous climate paradigm.

4.1.1.4 Cenozoic Climates

The Cenozoic Era was divided into the Tertiary (65 to 2Ma) and Quaternary (2Ma to present) periods. The ensuing discussion will serve as a useful introduction to the cold phase climates of the Quaternary and their orbital forcing mechanisms. Although the late Cretaceous temperatures were cooler than the mid-Cretaceous thermal maximum (120 to 90Ma), values remained relatively high into the early Cenozoic. The particular evidences from oxygen isotope records[7] has revealed that deep sea ocean temperatures were at least 10C to 15C warmer than they are today. The Early Cenozoic sea surface temperatures around Antarctica were also considerably warmer than today[8]. The early Eocene (55 to 50Ma) was the warmest period during the Cenozoic. It has been suggested that the early Eocene warming may have resulted from an increase in atmospheric CO_2, due to a significant reorganization in tectonic plate motion, as the North America separated from the Eurasian plate[35] .

The late Eocene and Oligocene Epochs (40 to 25Ma) a transition occurred between the warm periods of the early Cenozoic and the cold periods of the later Cenozoic. The Antarctic glaciations may have been initiated at about this time. The evidences of ice-rafted debris in the Southern Ocean has been dated at 34 Ma[37]. The significant cooling transition has occurred during the Miocene (15 to 10Ma). The dramatic increase in the d18O record between 14 and 15Ma has been interpreted both as the rapid growth of the Antarctic ice sheet[8] and a deep water cooling event (4 to 5C) [38]. Both the Oligocene and Miocene cooling events reveal themselves in the sea level record[39]. The rapidity of these falls in sea level precludes the possibility that changes in ocean bathymetry were the cause, rather, increases in continental ice volume as proposed.

The exact timing of the onset of mid-latitude Northern Hemisphere Glaciations were uncertain, but some oxygen isotope records has suggested that a date towards the end of the Pliocene (3 to 2Ma). The variations in planktonic abundances indicated that large changes in sea surface temperature were occurring prior to 2.4Ma [40] while ice-rafted debris from the Norwegian Sea has been dated at 2.8 to 2.6Ma [41]. The Northern Hemisphere glaciations have been proceeded throughout the Pleistocene i.e. Quaternary Period.

The number of hypotheses have been proposed to account for the Cenozoic cooling. The changes in land-sea distribution have been extensively modeled using General Circulation Modals (GCMs). However, the increase in high latitude land masses (with initiation of ice-albedo feedbacks) and the decrease in continentality (with accompanying decreases in seasonality and summer temperatures) do not seem to account for all of the temperature changes [42].The variations in ocean circulation due to changes in continental positions have also been considered as a causal mechanism for Cenozoic climate change. Indeed, geologists have long been interested in the effects of ocean gateways (between two continental land masses) on past climates. The experiments with ocean circulation models [43] also indicate that changing continental position can have a significant effect on ocean heat transport. The changes in the continental topography during the Cenozoic have been proposed as another cause of the long-term climatic deterioration [44]. Accompanying the global escalation in orogenic uplift (during a period which witnessed the building of the Alpine and the Himalayan mountain chains) was an increase in the rate of weathering of silicate rocks [45]. The CO_2 is removed from the atmosphere during this geochemical process. The cenozoic mountain building may therefore have indirectly reduced the greenhouse forcing of the Earth-atmosphere system, enhancing the global cooling. It was recognized in earlier sections that atmospheric CO_2 concentration was probably several times greater than at present, but little reliable proxy data exist to constrain the timing and magnitude of the postulated fall in CO_2.

In summary, it was likely that a combination of processes - changes in land-sea distribution, ocean heat transport, orography and CO_2 were involved in the long-term evolution of the Cenozoic climate, and probably the climates of the earlier Phanerozoic. These processes operate over time scales involving tens or even hundreds of millions of years. It was evident that model simulations were sometimes in disagreement with the proxy climatic records, while the validity of such records may often be questioned. If a thorough and unequivocal reconstruction pre-Quaternary climate is to be achieved, these problems will need to be addressed by future researchers in palaeoclimatology.

4.2. Global Temperature variation in last 4500 year

The small scale (2500 B.C. to 2007 A.D.) Global temperature variation has suggested that at least 75 major temperature swings in the last 4500 years (Figure 8.). It could be interpreted from the above figure that, whenever is cold phase, there was a series of volcanic eruptions and reached in warm phase. The Sea level estimates from isotope analysis reconstructions [46] bear a striking resemblance to palaeo-temperature and ice volume curves. Today, it is generally accepted that the glacial-interglacial transitions of the Pleistocene Epoch are driven by variations in the Earth's orbit around the Sun.

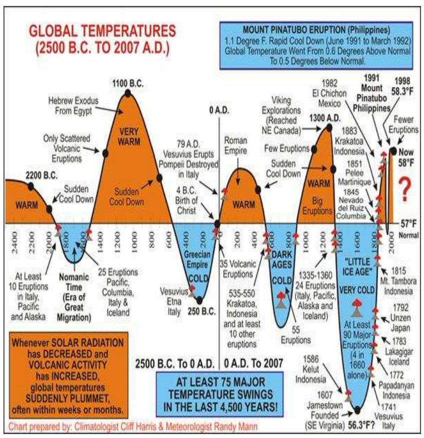

Figure 8. **Global Temperature from last 2500 B.C. to 2007 A.D. [47].**

4.3. Solar Cycle and Global Temperature

The Suns activities are complex, but the historical temperature data since 1850 are probably sufficient to demonstrate how strongly the Suns behaviour affects our global climate. There was a natural underlying warming trend since 1850 when the 1550-1850 mini cold phase ended but there were also cyclical patterns in the global temperature readings. The Sun is a seething mass of nuclear fusion. The Sun turns through 180 degree every 11 years and our Earth orbit comes close to the same parts of the Sun that it came close to 11 years earlier. The twentieth century was almost as warm as the centuries of the Mediaeval Warm Period (1450-1300 BC), an era of great achievement in European civilisation. The recent warm period, 1976-2000, appears to have come to an end and astro-physicists who study the Sunspot behaviour predict that the next 25-50 years could be a cool period similar to the Dalton Minimum of the 1790s-1820s [48].

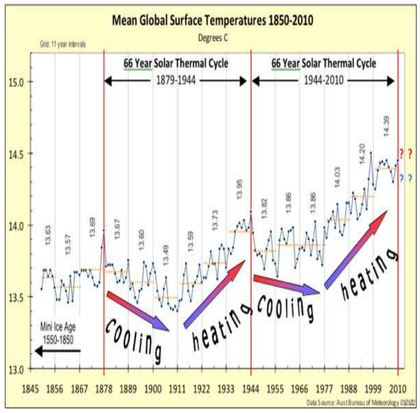

Figure 9. **Mean Global Surface Temperature from 1850 to 2000[49].**

The analysis of figure 9 indicates that the year 2010, will be followed by 33 years of relative cooler or non-warming years as the Sun moves through its 66 years seasonal thermal cycle. This graph also appears to be some flaws in the human induced CO_2 hypothesis, including the following[50]:

- Human induced CO_2 increased strongly from 1878 to1911 but global temperatures fell quite strongly for 33 years- these 33 years of non- correlation between human induced CO_2 build up and falling global temperature for 33 years cannot be ignored as a minor aberration.

- Human induced CO_2 increased strongly from 1944 to 1977 but global temperature did not rise. These 33 year period of non correlation with CO_2 cannot be ignored.

There are two thoughts with competing the theories which seek to explain the causes of Minoan Warm Period 1450-1300 BC, a Roman Warm Period 250-0 BC, the Mediaeval Warm Period 800-1100AD, the Little Ice age and the late 20th Century warm phase 1900-2010 AD. Those who follow Milankovitch argue that periodic changes in the Earths position and inclination relative to the Sun provide sufficient cause for the glacial and interglacial cycles. The others argue that these manifestations of huge energy change in the state of the Earth can only be arise from perturbations in the state of the Sun and the other giant planets of the solar system, Jupiter and Saturn particularly, and the impact which these perturbations have on the Earth [51].

4.4. Present and Future Climate Trend

The global plot of temperature and atmospheric CO_2 concentrations for the period 1970-2000 infer a good correlation, and it appears plausible to argue that anthropogenic emissions are causing global warming. The good correlation, however, does not prove causality between the two variables, and even more importantly, if the time scale of plot extended and fossil fuel consumption against temperature changes from 1860 to 2000, there are no correlation at all (Figure 10).

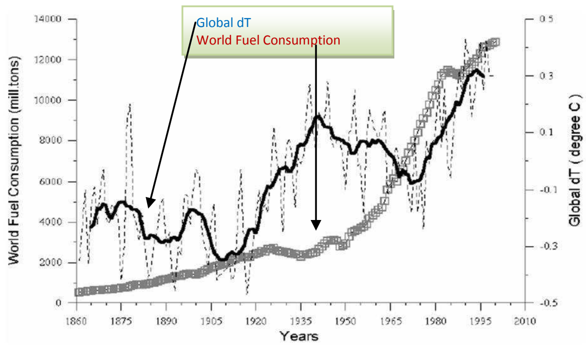

Figure 10. **Graph between World Fuel consumption and Global temperature[52].**

Here , that the global temperature rose from 1860 to 1875, then cool down until 1890, rose until 1903, fell until 1918 and then rose dramatically until 1941-42. Then we experience the long cooling until 1976, the year of the Pacific Decadal Oscillation and since then temperature have risen by about 0.4 C. There was essentially no correlation between the temperature curve and the anthropogenic CO_2 curve over this 140 year period [53]. The CO_2 is necessary for the life on the Earth and increasing atmospheric concentrations are beneficial to plant growth, particularly in arid conditions. The CO_2 cycles naturally through the atmosphere, the Earths landmass and the Oceans. The huge volume of CO_2 are injected into the ocean and atmosphere during plate tectonic activities as Earthquake and Volcanoes. The amount of carbon contained in atmospheric CO_2 is about 730,000 million tonnes (730 Gigatonnes of Carbon GtC). The annual transported of carbon to & from the land surface and the atmosphere. The ocean and the atmosphere is estimated 120 GtC (Gigatonnes of Carbon) and 90 GtC respectively, and total natural emission is 210 GtC[54]. The annual emission of CO_2 to the atmosphere resulting from human activity is, by comparison, about 7 GtC (about 1% of total atmospheric carbon mass, and less than 4% of the natural annual emissions from the biosphere and the ocean).

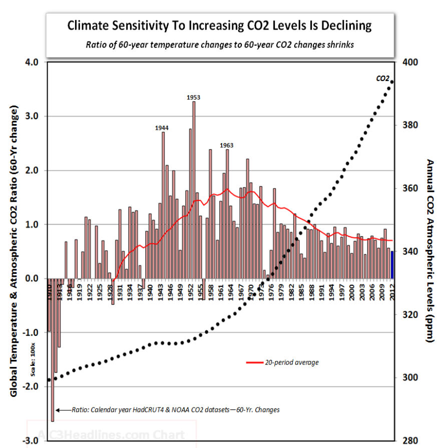

Figure 11. **Graph between Global temperature and CO_2.**

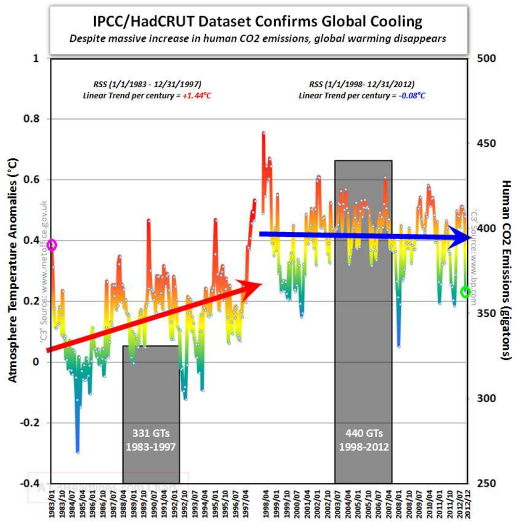

Figure 12. **Anthropogenic CO_2 and Global temperature (Year Jan 1983 to Dec 2012)**

Figure 11 shows the relationship between global temperature and CO_2. The reddish columns represent a plot of global temperature sensitivity to CO_2. Specifically; they represent 60-year changes in global temperature divided by the corresponding 60-year change in atmospheric CO_2 levels, a ratio (ppm). The bright red curve is a simple 20-period average of that ratio, which has been declining since the 1950's.

Finally, the rapid growth of total atmospheric CO_2 levels is shown by the black dots. When it's all put together, the red columns should be gaining in height as the years pass due to the accumulation of CO_2 emissions in the atmosphere and grow. The taller columns means that the ever increasing amounts of emissions are causing an even greater temperature change. Clearly, the empirical evidence reveals that as atmospheric CO_2 levels have grown, the impact on 60-year temperature changes has shrunk. From a high in the 1950s, to a very low impact as of 2012 (fig 11, blue column).

As anthropogenic CO_2 emissions continue to increase in the future, the resultant global warming will be smaller and smaller, and will continue to be overwhelmed by natural climate variation [55]. The global average temperature from year 1983 to 2012 indicate with anthropogenic CO2 emission, atmospheric percentage of CO_2 and climatic prediction by IPCC, Figure 12 , It is estimated that some 440 gigtons of human CO_2 emissions have been produced over the last 15 years, in contrast to the estimated 330+ tons during the previous 15-year period ending 1997.

As it can be seen, over the first 15-period, prior to 1998, there was a strong warming trend (+1.4 degrees per century). As a result, the experts said human CO_2 was the cause. As the chart depicts, the last 15 years ending 2012 has seen a very slight decline (-0.08°C) in temperatures, wiping out the strong positive warming trend completely. This small cooling trend in surface temperatures is also supported by the satellite observations of the atmosphere. The global warming was wiped out even though total human CO_2 emissions were a third larger 110 billion tons more than prior 15-year span.This empirical evidence has become so convincing that the cooling deniers are even starting.

The analysis of satellite temperature dataset (figure 13), through February 2014, identifies only two 5-year periods having significant warming and five periods that exhibit either zero warming or cooling. This data indicated that despite a near

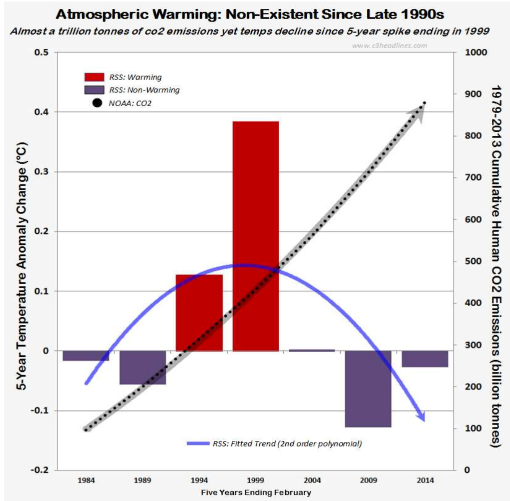

Figure 13. **Trend of Global temperature and CO_2 through to Feb 2014.**

Trillion Tonne human CO_2 surge, global atmosphere warming goes low. As the chart suggests, a brief global warming spike has morphed into an extended global cooling phase[55].

Now by the Remote Sensing techniques, we recently know that the change in tilting of Earth axis (National Institute of Geophysics and Volcanology in Italy) by the 8.9 magnitude Earthquake in Japan in April 15, 2011; shifted the planet on its axis by nearly 4 inches (10 centimetres) and main island of Japan by 8 feet (2.4 meter) [56]. This change in Earth axis may affect the solar radiation which may receive by Earth and it may affect the Earth climate.

4.5. Evidence of Milankovitch Cycles in other planets in the Solar System

The other planets in the Solar System have been discovered to have Milankovitch cycles. These cycles mostly are not as intense or complex as the Earth's cycles, but do have a global geological impact with respect to the movement of mobile solids like Water or Nitrogen ices or hydrocarbon lakes.

- Mars's polar caps vary in extent due to orbital instability related to a latent Milankovitch cycle [57], [58], [59].
- Saturn's moon Titan has a ∼60,000-year cycle that changes the location of the methane lakes[60].
- Neptune's moon Triton has a similar variation to Titan with respect to migration of solid nitrogen deposits over long time scales[61], [62], [63].

5. Conclusions

The present synthesis and analysis of available data on climate change indicates that climate change is a natural phenomenon for planet Earth. If we look at small time frame such as 100-150 years then it may indicate that CO_2 is main factor of present Climate change but as we go through the past earth history where were many cold phases of earth with very high CO_2 percentage in atmosphere & it seems that Extraterrestrial and tectonic factors are main causes of climate change.

There are few indications that from 66 years of Solar Thermal cycle, Milankovitch Cycles and present decreasing of global temperature that we are heading towards in a little cold phase instead of emission of high anthropogenic CO_2. It is also needs to analysis and gathers the data for extraterrestrial activities and circulation oceans (hydrosphere) in research for Climatic change.

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