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CLIMATIC CHANGES: ANTHROPOGENIC INFLUENCE OR NATURALLY INDUCED PHENOMENON

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Abstract

By the end of the 18th century eminent scientists explained the climatic changes on the basis of temperature and the ensuing glacial retreat. This disturbing observation led many prominent scientists to send air balloons equipped with special devices to trap air from the lower atmosphere in order to measure CO_2 concentrations. Ninety thousand (90,000) measurements were carried out at 138 locations in 4 continents between 1810 and 1961. The data indicated that atmospheric CO_2 concentrations, during the 19th century varied between 290 and 430 ppm (with an average of 322 ppm for the pre-industrial period). For the 20th century, the average concentration is 338 ppm when combined with comparable CO_2 measurements carried out by Mauna Loa Observatory, Hawaii, USA (1958-2000). Measurement precision is ±3%.

Based on thermometric measurements, the mean average temperature increase from 1850 to the present is 0.75°C (0.44°C/100 years) with the following fluctuations. From 1850 to 1940 the temperature increased by +0.6°C, while from 1941 to 1975 temperature dropped by -0.2°C. From 1976 to 1998, the temperature rose by +0.35°C. From 1999 to 2006 temperature increase was nil. Finally, since 2007 the Mean Annual Temperature of Earth's surface has substantially decreased.

As far as CO_2 concentration in the air's atmosphere is concerned, it has been well documented that during the Holocene Epoch there is a substantial time lag between maximum temperatures recorded during the Interglacial periods and maximum CO_2 concentrations in the atmosphere. Moreover, the same time lag is documented between 1850 and 1980, where CO_2 concentrations in the atmosphere lag behind the increase of temperature for more than 100 years. A parallel increase of CO_2 concentrations in the atmosphere and temperature increase is observed only between 1981 and 1995. No correlation is seen thereafter. The divergence is substantial from 2003 to the present where CO_2 concentrations are increased while temperatures are decreased. These interpretations exclude any correlation between atmospheric CO_2 concentrations and temperature fluctuations. Hence, in order to explain the well documented climatic changes the influence of many natural climate drivers should be accepted.

Key words: *climatic changes, temperatures, CO_2 concentrations.*

1. Introduction

Climatic changes have been the subject of intensive research since the late 18th century by eminent scientists (Franklin, 1784; Fourier, 1824; 1827; Agassiz, 1840; Tyndal, 1861; 1863; Croll, 1864; Köppen, 1873; Czerney, 1881; Arrhenius, 1896; 1901). They developed theories to link the presence of erratic boulders in various places in the world to action of former glaciers as well as to explain the temperature rise.

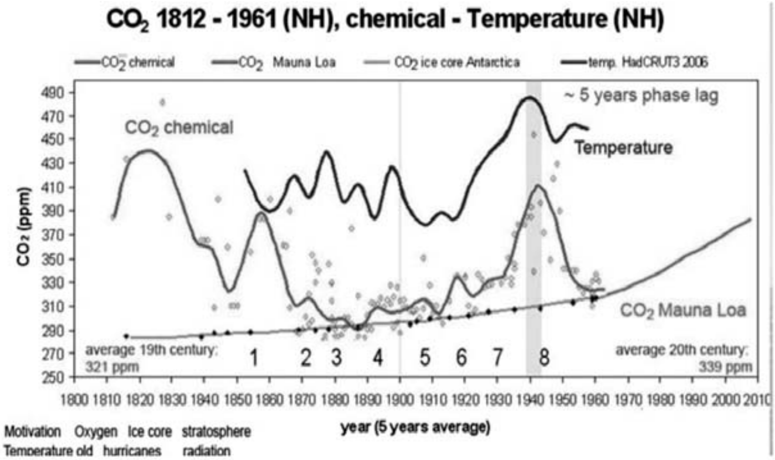

Fig. 1: Evidence of variability of atmospheric CO_2 concentration during the 20th century in the Northern Hemisphere (Beck, 2007).

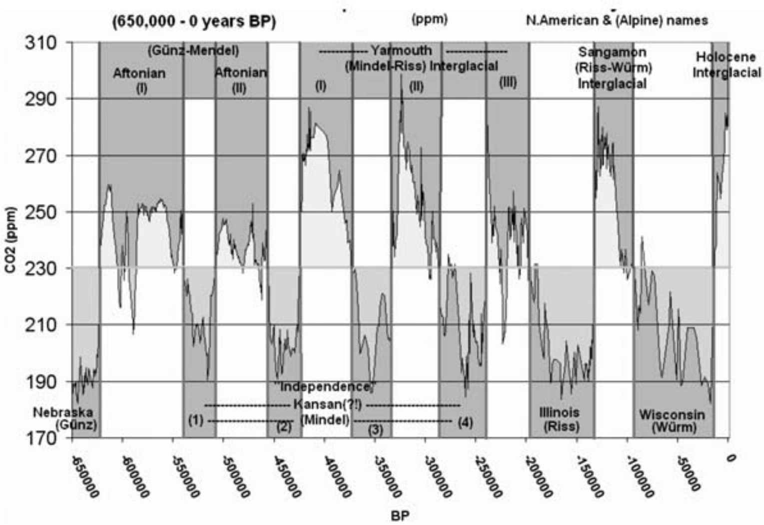

Fig. 2: Late Pleistocene Epoch: Atmospheric CO_2 and the Glacial Cycles. Time Line Glaciations, 2009. Pleistocene Climate Cycles. www.en.Wikipedia.org/wiki/Timeline-of-glaciation.

In addition to the various theories and observations, air balloons equipped with special devices to trap air from the lower atmosphere were sent from a number of European scientists (de Saussure, Bunsen, Pettenkoffer, Kroch[1] and Warburg[1]) in order to measure CO_2 concentrations (Beck, 2007). Ninety thousand (90,000) measurements were carried out at 138 locations in 4 continents between 1810 and 1961. The data indicated that atmospheric CO_2 concentrations varied between 290 ppm and 430 ppm during the 19th century (with an average for the pre-industrial period of 322 ppm), (Fig. 1).

[1] Nobel Prize Winners in Science, 1920 and 1931, respectively.

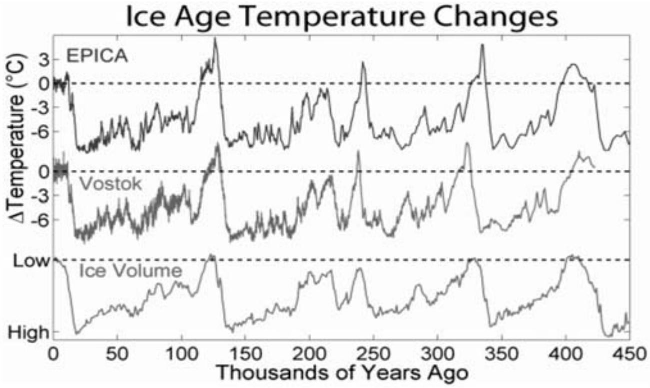

Fig. 3: Climatic changes as documented from Vostok-1 ice-core data (Petit et al., 1999) and EPICA ice-core data (EPICA, 2004), for the last 450,000 years. Worth noticing is the rise of temperature well above the today's one during the long interglacial periods without the complete melting of the ice caps.

For the 20th century, the average concentration is 338 ppm when combined with comparable CO_2 measurements carried out by Mauna Loa Observatory (1958-2009) (Atmospheric CO_2 at Mauna Loa Observatory, Hawaii, USA, 2009). Measurement precision was of the order of ±3%.

In addition to this intense research work, field geologists have mapped the Quaternary glaciations extent and their chronology in Europe as well as in North and South America. Altogether, it took several decades until the ice age theory was fully accepted. This happened on an international scale in the second half of the 1870's (Krüger, 2008). This work is summarized in Figure 2.

2. Analysis of existing climatic changes data

2.1 Middle Pleistocene to Holocene Epochs

Recent ice coring data from Vostok-1 (Petit et al., 1997; 1999) and EPICA (European Project for Ice Coring in Antarctica, Epica 2004) not only have concurred about the climatic changes but also show interglacial temperatures of 1°C to 2.5°C higher than the present Mean Annual Temperature of the Northern Hemisphere of 15°C, for thousands of years (Fig. 3). Since proxy temperature measurements of $\delta^{18}O$ were carried out on ice core samples, it means that even at temperatures well above those prevailing today's, polar ice caps did not melt. These large climatic changes were theoretically attributed to the eccentricity, tilting and wobbling of the earth (Milankovitch, 1940). Finally after three decades this theory was scientifically accepted (Hayes et al., 1974).

Geomagnetic polarity technique along with appropriate sampling has provided a direct assessment of glacial and interglacial environments (Barendregt and Duk-Rodkin, 2004). Through these studies, and $\delta^{18}O$ paleotemperature record from Site 607 in North America, over 100 glacial and interglacial periods were identified (Ruddiman et al., 1989; Raymo, 1992) (Fig. 4). Therefore, it is seen that from the Pliocene till the Holocene Epoch, climatic changes were the norm.

2.2.1 Holocene Epoch. Last Interglacial period

i. 12000 BC to 1850 AD

Climatic changes during this period are very well documented by Dansgaard et al. (1969) and Schon-

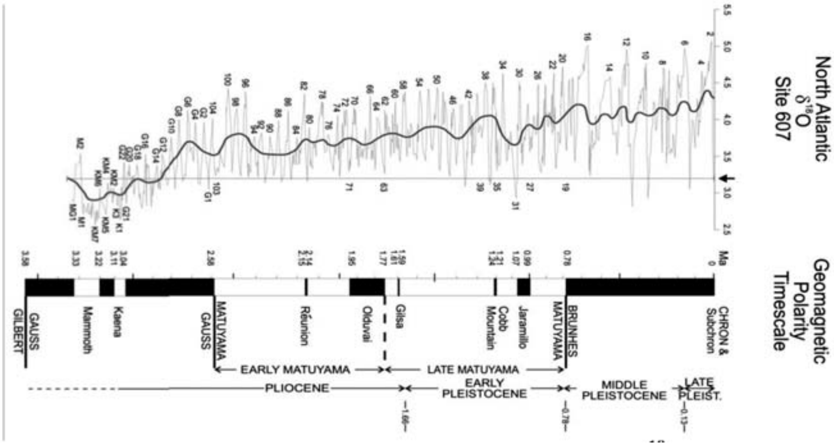

Fig. 4: Geomagnetic polarity scale (Candle and Kent, 1995) and $\delta^{18}O$ paleotemperatures record from Site 607 in the North Atlantic (Ruddiman et al., 1989; Raymo, 1992).

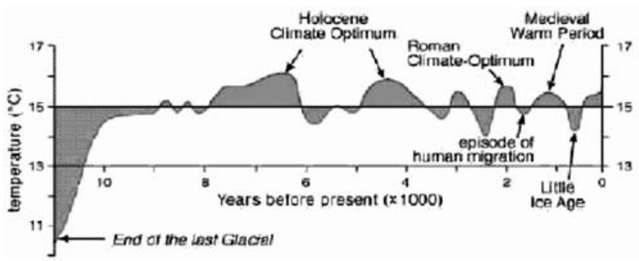

Fig. 5: Average near surface temperatures of the northern hemisphere during the past 11000 years (Dansgaard et al., 1969; Schonwiese 1995).

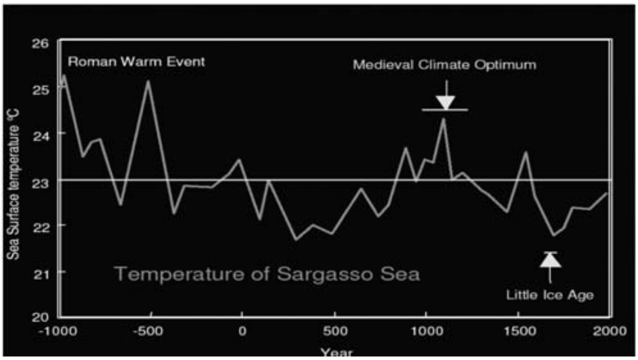

Fig. 6: Sea surface temperatures from the Sargasso sea during the last 3000 years based on oxygen isotopic ratios of *Globigerinoids rubber* (plankton) collected from a box core through 50 cm of bottom sediment (Keigwin, 1996).

wiese (1995), (Fig. 5). The recent glacial retreat began about 14000 years ago (12000 BC). This warming period was shortly interrupted by a sudden cooling, known as Younger Dryas, at about 10000 to 8500 BC. From 8000 BC to about 4000 BC the average global temperature reached its maximum level during the Holocene Epoch and was 1 to 2°C warmer than today's Mean Annual Temperature of the Earth's Atmosphere of 15°C (Pidwirny, 2006). Climatologists call this period the Climatic Optimum.

Worth noticing is that polar ice caps did not vanish between 8000 BC to 4000 BC, since ice core samples were recently collected and CO_2 concentrations were measured in air bubbles which were

Fig. 7: 2000 years of global temperatures based upon 30 year averages (Spencer, 2007).

trapped in the ice cores. Between the span of 4000 years, 2 minor cooling events took place, while a substantial cooling trend took place between 3500 BC and 2000 BC.

From 450 BC to 150 AD, Northern Europe was subjected to another warm period the so-called Roman Warm Period with average temperatures of 2.5°C higher than today's temperature (Keigwin, 1996; Holmgren et al., 1999; 2001; Idso and Idso, 2000; Olafsdottir et al., 2001; Grudd et al., 2002; Jiang et al., 2002; Berglund, 2003; Munroe 2003; D' Arrigo et al., 2004; Loehle, 2004; Fleitman et al., 2004; Hormes et al., 2004; Blundel and Barber, 2005; Linderholm and Gunnarson, 2005; Allen et al., 2007; Mariolakos, 2008) (Fig. 6). Again worth noticing is the fact that polar ice caps did not vanish during the 600 years time span since, again, temperatures were measured in ice core samples and CO_2 concentrations were measured in air bubbles trapped within the ice cores, as well. Subsequently, a cooling period has begun; the last one was until about 900 AD. At its height, the cooling caused the Nile River and the Black Sea to freeze, 829 AD and 800 AD to 801 AD respectively (Pidwirny, 2006).

The period from 900 to 1350 is called the Medieval Warm Period (MWP). During this period, temperatures fluctuated from +0.4°C above the today's (Soon and Baliunas, 2003; Moberg et al., 2005; Viau et al., 2006; Loehle, 2007; Loehle and Mc Culloch, 2008), (Fig. 7), to +0.8°C higher than today's (Seppa and Birks, 2001, 2002; Heikkila and Seppa, 2003). Their estimate was based on pollen data in order to reconstruct past climate thus studying Fennoscandian tree-line fluctuations. The existence of Medieval Warm Period was challenged by Mann et al. (1998; 1999) (Fig. 8) based upon proxy measurements of temperatures from the width of tree rings. However, tree ring data may not capture long-term climate changes (100+ years) because tree size, root/shoot ratio, genetic adaptation to climate, and forest density can all shift in response to pro- longed climate changes, among other reasons (Broecker, 2001; Falcon-Lang, 2005; Loehle, 2005; Moberg et al., 2005).

Most seriously, typical reconstructions assume that tree ring width is linearly related to temperature, but trees may be related in an inverse parabolic manner to temperature, with ring width rising with temperature to an optimal level and then decreasing with further temperature increase (Kelly et al., 1994; D'Arrigo et al., 2004). This response is most likely due to water limitation at higher temperatures due to increase of the evaporation rates. The result of this violation of linearity is to introduce tremendous uncertainty or bias into any reconstruction, particularly for temperatures outside the calibration range. For example, tree rings in many places show recent divergence from observed warming trends, even showing downward trends (Briffa et al., 1998a, 1998b; Pisaric et al., 2007). Other important facts that support the existence of a Medieval Warm Period are archaeological and agricultural data. It is well documented that Greenland was settled from 900 AD till 1350 AD and farming took place due to milder weather than today's (Brown, 2000).

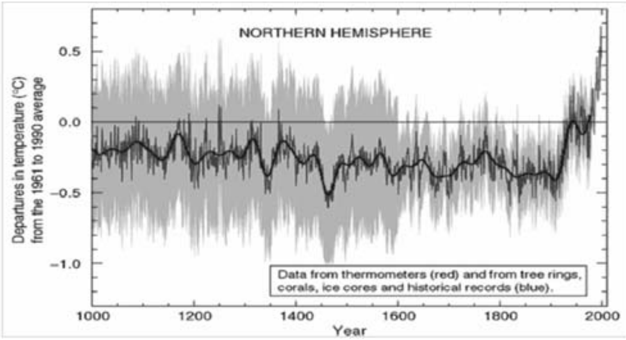

Fig. 8: Millennial Northern Hemisphere (NH) Temperature Reconstruction (blue line) and Instrumental Data (red line from 1000 to 1999 AD, Mann et al., 1999). The graph, "Hockey Stick" relies mainly on tree-rings studies which are annual cycles (high frequency). It is known from geophysics that it is difficult to obtain low frequency (centurial change) data where low frequency is filtered. This graph denies historical records of Medieval Warm Period and Little Ice Age well described by historians (Le Roy Ladurie, 1988; Lamb, 1995).

Also the mere fact that vineyards were extended to North and South England (Schmidt, 2006) during this period indicates, beyond any shadow of doubt, that the climate was much warmer at that time by at least +0.4°C. To have vineyards extending 450 km north of their present northerly growing limit, the climate had to be similar to the one we have today in Southern California, Greece, Italy, Spain etc. Hence, the Hockey Stick diagram (Mann et al., 1998) showing that the +0.4°C during the MWP is well below the acceptable Mean Annual Temperature of 15°C and more or less equivalent to the Little Age Temperatures while the today's +0.35°C is well above the acceptable Mean Annual Temperature of 15°C (Fig. 8), is completely unacceptable. Also unacceptable is the correlation of the proxy measurements of temperatures based on tree rings, 1000 AD to 1850 AD, with those obtained from thermometers, 1850 AD to 2008 AD.

From the above it is concluded that climatic changes were taking place in the past regardless the presence or absence of human beings on Earth, irrespective of atmospheric CO_2 concentrations and without the use of hydrocarbons. An excellent scientific review of thousands of papers along with new scientific data which refutes the alarmist mantra is presented by Singer and Idso (2009).

ii. 1850 AD to 2008 AD

From 1850 thermometric data indicating the Average Mean Annual Temperature of Earth's Surface become available (Jones, 2008; Hadley Meteorological Station, 2008) (Fig. 9). From 1850 to 1910 temperatures were more or less stable fluctuating between -0.4°C and -0.6°C below the optimum average of 15°C. Since 1910, temperatures increased by +0.6°C to reach the optimum of 15°C in 1940. According to NASA's newly published data the hottest year on record in the USA is 1934 and not 1998; three of the hottest years on record occurred before 1940 and six of the top 10 hottest years occurred before 1960[2]. Afterwards temperatures dropped by -0.2°C and stayed at this level, from 1940 to 1980. Subsequently, from 1980 to 1998 the Mean Annual Temperature increased by +0.35°C and remained at this level till 2007. From that date till January 2008 temperature dropped by -0.1°C (Fig. 9). One wonders if this temperature increase, few tenths of a degree, from either 1940 or from 1980 can be considered alarming when in the past much higher temperatures were noticed for extremely long periods without any real damage to either Earth or its inhabitants.

[2] http://data.giss.nasa.gov/gistemp/graphs/ Fig.D.Irg.gif

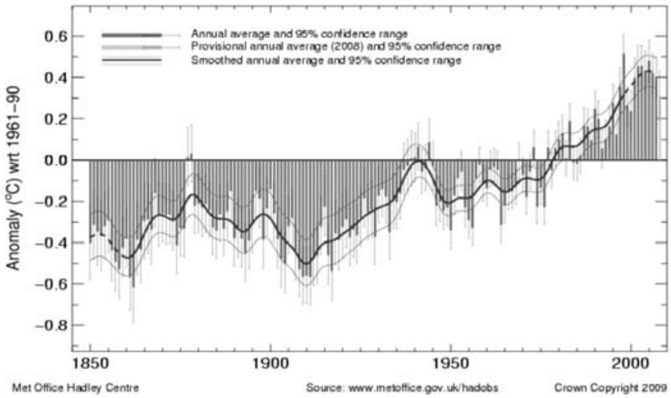

Fig. 9: Global temperature record 1850-2008 (Jones, 2008; http://hadobs.metoffice.com/hadcrut3/diagnostics/global/nh+sh/).

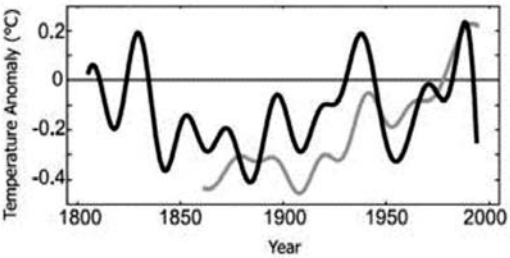

Fig. 10: A 200 year long Antarctic temperature reconstruction (dark line) based upon 200 years sub-annually resolved $\delta^{18}O$ and δD records from precisely dated ice cores obtained from Low Dome Station, Siple Station, Droning Maud Land Station and 2 West Antarctica Sites of the US component of the International Trans-Atlantic Scientific Expedition vs. Mean Temperature of the Southern Hemisphere (lighter line) (Schneider et al., 2006).

Recently (Schneider et al., 2006; see Fig. 10) a series of data suggested that temperatures in Antarctica were colder near the end of the 20th century than it was in the early decades of the 19th century when atmospheric CO_2 concentration was about 100 ppm less than it is currently. This is in agreement with a number of other analyses of Antarctic instrumental surface and air temperature data which also indicate the continent has recently experienced a net cooling, which likely began as early as the mid-1960s (Comiso, 2000; Doran et al., 2002; Thompson and Solomon, 2002).

3. Measurements of atmospheric CO_2 concentrations

Proxy measurements

Proxy measurements of atmospheric CO_2 are carried out using two methods: The first one relies on the relation between the density of stomata in leaves and atmospheric CO_2 concentrations. Paleobotanists can take fossilized leaves and count the number of stomata and therefore get a fairly good picture of how much carbon dioxide was in the atmosphere at the time the leaves died (Kurshner et al., 1996; Beerling et al., 1998; Wagner et al., 1999; 2004; Kouwenberg et al., 2003; Kouwenberg, 2004; Kouwenberg et al., 2005), (Figs 11, 12). The second one assumes that, over time, the concentrations of the various atmospheric gasses are locked when the air bubble is “trapped” in ice.

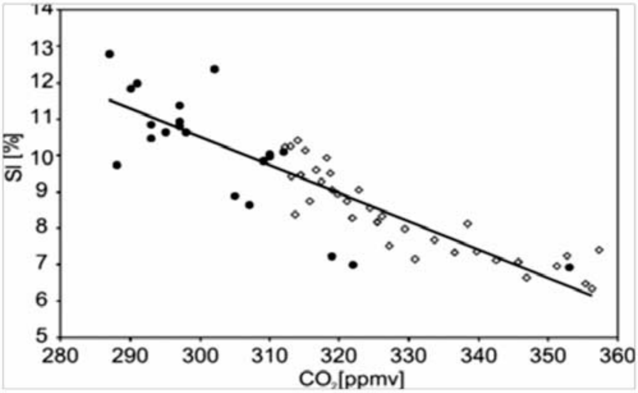

Fig. 11: Correlation of stomata frequency (stomata index=SI) to atmospheric CO_2 from fossil leaves of *B. pendula* (black circles) and *B. pubenscens* (white circles) in lake Little Grisbe, Danemark (Wagner et al., 2004).

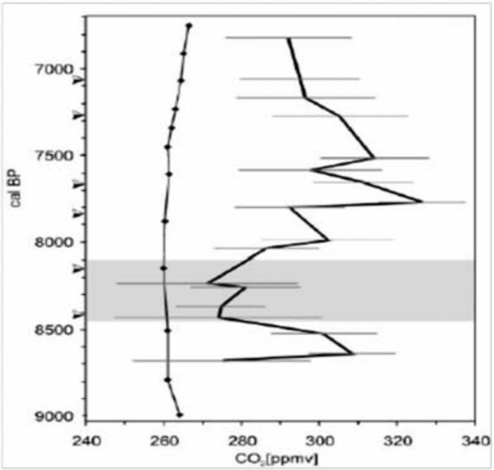

Fig. 12: Reconstruction of Holocene atmospheric CO_2 values from 8700 BC to 6800 BC based upon measurements a) in air bubbles inclusions from Taylor Dome ice core samples (www.ngdc.noaa.gov/paleo/ taylor.html) and b) stomata indices (SI) from fossilized leaves of *B. pendula* and *B. pubescens* (Wagner et al., 2004).

And therefore, as long as it can be determined when the air bubble was trapped, the concentration of CO_2 therein and state can be measured, with confidence, that the atmosphere itself had that same concentration at the time the air bubble was trapped.

However there are two wrong assumptions. Ice, though composed mainly of solid water, does still have some molecules that are in a liquid state. Whether a given molecule is in a solid or liquid (or even gaseous) state, at a given time, depends on how much energy that molecule has at that time. As a result, even at low temperatures, among the three main components of the atmosphere, carbon dioxide is seventy (70) times more soluble than nitrogen and thirty (30) times more soluble than oxygen. This means that, when an air bubble is trapped in ice, not only does the liquid in the ice continue to absorb gasses, but it does so selectively, favouring carbon dioxide, by a huge margin, over the other common gasses in the air bubble. Of course, every molecule of carbon dioxide that passes into a solution is removed from the air within the air bubble.

And therefore, since more carbon dioxide is removed, less carbon dioxide will appear in the re-

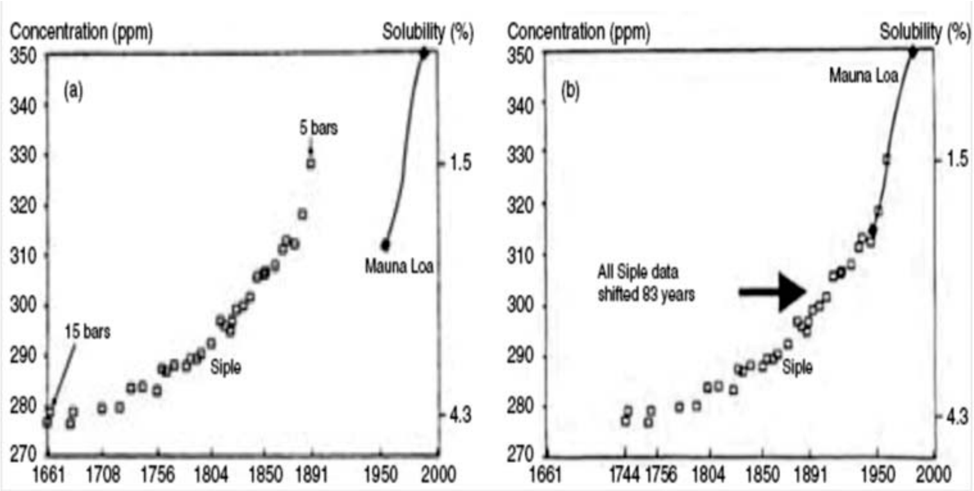

Fig. 13: Concentration of CO_2 in air bubbles from Siple ice core samples, Antarctica (open squares) and in the atmosphere, 1958-1986, Mauna Loa Observatory (solid line), In a) the original Siple data are given assuming an 83 years younger age of the air bubbles in respect to enclosing ice. In b) The same data after arbitrary shifting/correction of the air bubble age (Neftel et al., 1985; Friedli et al., 1986).

maining air. After thousands or millions of years, when that air bubble is tapped, and the gasses within it measured, the concentrations of the various gasses can no longer said to be the same as when that air bubble was trapped, all those years ago (Wiki, Answers, 2009).

Another problem with air bubbles is their dating with respect to the age of ice where trapped in. The consolidation of snow to ice necessary to trap the air takes place at a certain depth (the ‘trapping depth’) once the pressure of overlying snow is great enough. Since air can freely diffuse from the overlying atmosphere throughout the upper unconsolidated layer (the ‘firn’), trapped air is younger than the ice surrounding it. Trapping depth varies with climatic conditions, so the air-ice age difference could vary between 2500 and 6000 years (Barnola et al., 1983; 1987; 1991). This has been acknowledged even by the IPCC scientists by transposing the proxy CO_2 measurements from 1809 to 1892, to read concentrations from 1892 to 1975 (Neftel et al., 1985; Friedli et al., 1986), (Fig. 13). The transposed time was 83 years.

This raises the issue of how the pre-industrial background concentration of CO_2 at 280 ppm has been established (Callendar, 1958). Figure 13 indicates that CO_2 concentration in the atmosphere was not 292 ppm, as stated, but 335 ppm if all the data are considered (Slocum, 1955; Jaworowski et al., 1992). The same background concentration (332 ppm) for the pre-industrial period, is reported by Beck (2007) and Rutledge (2007). Calendar was prejudice in selecting from all his data roughly 30%, which showed concentration around 290 ppm, leaving the remaining 70% which showed concentrations over 300 ppm (Fig. 14).

It must be noted that the mixing of data from ice-core measurements with the direct and actual atmospheric measurements are questionable because the data obtained from the ice-core measurements are unreliable and they do not reflect paleoatmospheric CO_2 concentrations.

Another inconsistency is the past relation between CO_2 concentrations and temperatures based on the today’s existing and very accurate data. Currently, atmospheric CO_2 concentration measurements from Mauna Loa Observatory indicate that CO_2 concentrations increased from 315ppm to

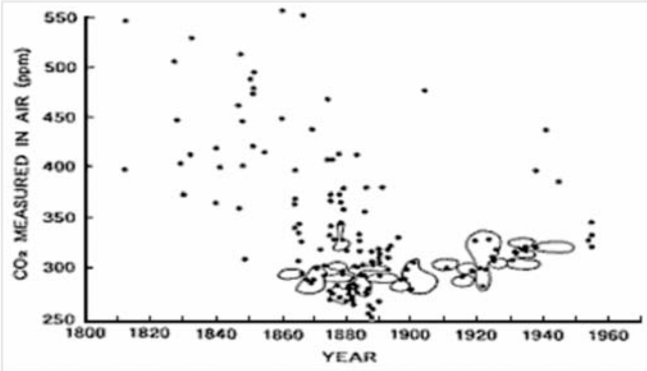

Fig. 14: Average atmospheric CO_2 concentrations measured in the 19th and 20th centuries (Calendar 1958). Calendar rejected both higher and lower values to arrive at the desired background CO_2 value of 290 ppmv. If he had considered all CO_2 values the concentrations would have been 320 ppmv for the 19th century (Jaworowski et al., 1992; Slocum, 1995).

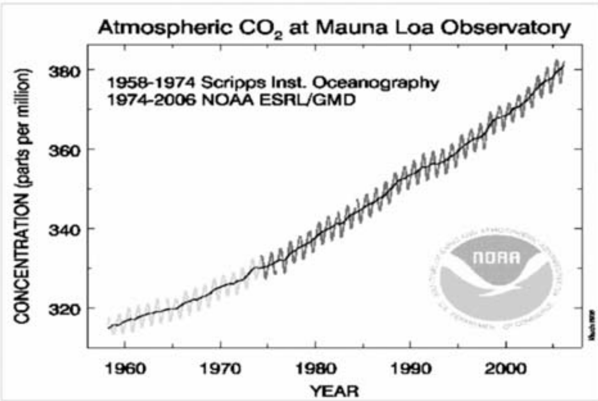

Fig. 15: Atmospheric CO_2 concentration from 1958, 315 ppmv, to 2008, 385 ppmv (Atmospheric CO_2 at Mauna Loa Observatory, Hawaii, USA, 2009).

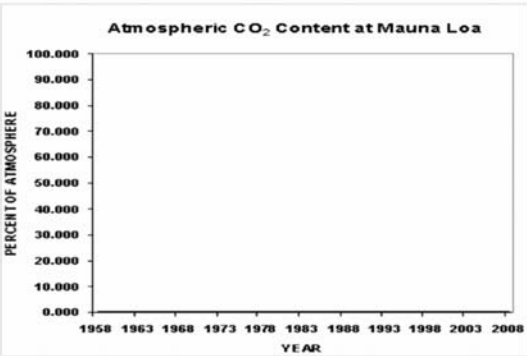

Fig. 16: Atmospheric CO_2 increase during the last 50 years expressed as a percent of the total air composition. It is the, non-discernible, blue line in the bottom (Spencer, 2007) www.jbs.org/jbs-news-feed/4333-fifty-years-of-hot-air-. When comparing the 2 proxy methods it seems that stomata indices (SI), are more reliable as paleoatmospheric CO_2 indicators.

385 ppm (70 ppm) from 1958 to 2008 (Figs 15, 16). From 1940 to date, temperatures, as reported by Jones (2008), increased by +0.35°C above the optimum temperature of 15°C (Fig. 9). One wonders, therefore, if CO_2 concentrations in the atmosphere are the driving force behind temperature in-

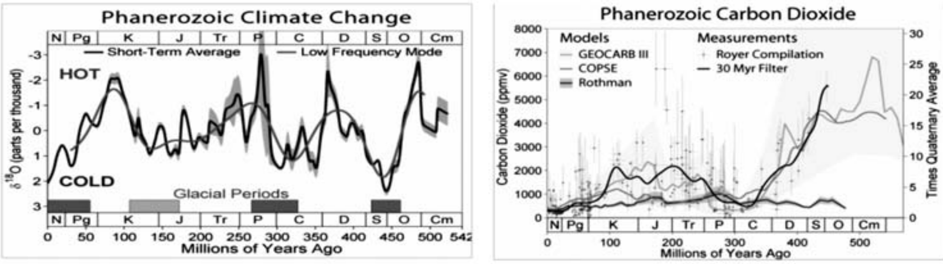

Fig. 17: A. Temperature fluctuation during the Phanerozoic Eon: 500 million years of climate change. en.wikipedia.org/wiki/Geologic-temperature-record. B. Phanerozoic Carbon Dioxide (Royer et al., 2004).

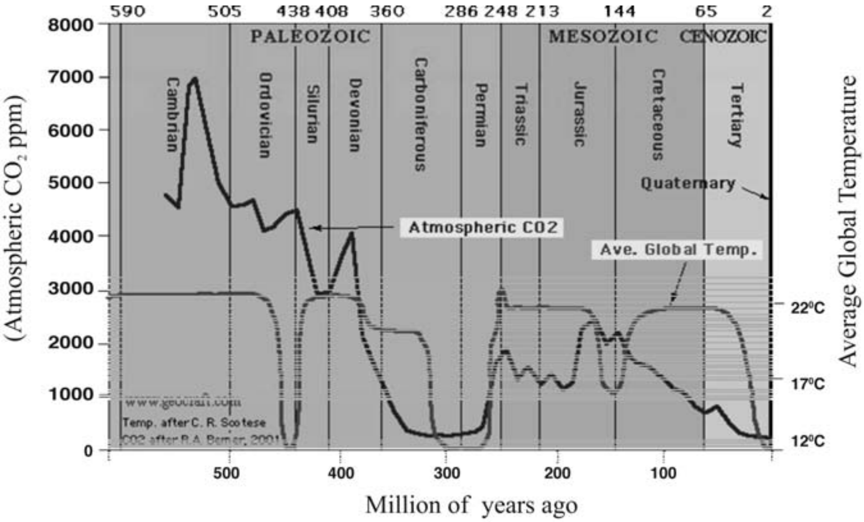

Fig. 18: Correlation of temperature and atmospheric CO_2 concentration over the Phanerozoic time (Berner and Kothavala, 2001; Scotese, 2002).

crease, then why is it that when paleotemperatures, at all interglacial periods, are reported at well over +1°C above the optimum temperature of 15°C, paleo CO_2 concentrations are only 285 ppm. They should have been 460 ppm. Or even higher, if paleotemperatures were +2°C, such as during the Eemian time. The same holds true for the Holocene Epoch period between 8000 AD and 4000 AD when temperatures were +1°C above the optimum temperature of 15°C and the paleoatmospheric CO_2 concentrations were 260 ppm. Henceforth, CO_2 paleoatmospheric concentrations obtained from bubbles yield lower values than stomata indices by 20% (Fig. 12), or by 50% when compared to actual CO_2 measurement concentrations in the atmosphere (Fig. 1).

When comparing the 2 proxy methods it seems that stomata indices (SI) are more reliable as paleoatmospheric CO_2 indicators.

4. The assumed correlation between atmospheric CO_2 and temperature

Examining the possible relationship between CO_2 concentration in the atmosphere, temperatures and presence of Polar ice throughout the Phanerozoic Eon (Fig. 17), it is obvious that such a rela-

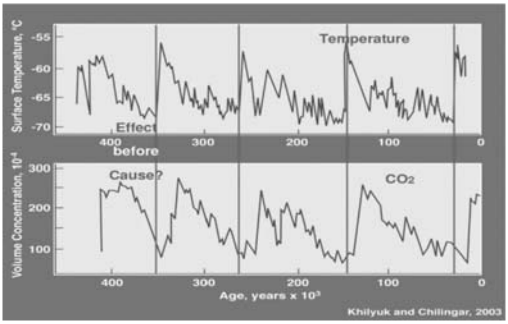

Fig. 19: Time lag between maximum temperatures and atmospheric CO_2 concentration during the Quaternary (Khilyuk and Chiilingar, 2003).

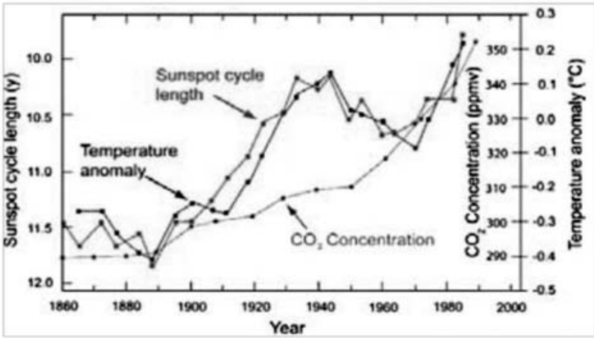

Fig. 20: Correlation between sunspot cycle length, temperature anomalies and atmospheric CO_2 concentration (Friss-Christiensen and Lassen, 1991).

tion does not exist. Polar ice existed from the end of the Silurian Period until the beginning of the Ordovician Period that is for 50 million years, while temperatures were low and the atmospheric CO_2 concentration was close to 4000 ppm, that is 10 times higher than today's (Fig. 18). Examining the relation between atmospheric CO_2 concentrations and temperatures during the Quaternary Period deglaciations periods, it is observed that CO_2 increases lags behind temperature increases by 600±400 years (Khilyuk and Chillingar 2003; 2006), (Fig. 19). The same is also reported by Fisher et al. (1999), Caillon et al. (2003) and Siegenthaler et al. (2005). So it seems that atmospheric CO_2 concentrations are the result of temperature increase rather than the driving force. Exactly the same behaviour is observed between 1850 and 1985 where the increase of atmospheric CO_2 concentration lags behind temperature increase (Friis-Christiensen and Lassen, 1991), (Fig. 20).

Between 1985 and 2000, the atmospheric CO_2 increased along with the temperature which was increased by +0.35°C. This geologically infinitesimal time period, has been used to forecast catastrophic events for mother earth by relating the CO_2 increase in the atmosphere to the rise in temperature. What was omitted was the parallel increase of sunspot numbers which, as will be discussed later, induces temperature increase. However, since 1999, the temperature remained stable until 2006 while CO_2 concentrations increased substantially by 57 billion tons. From 2007 to date, the temperature has been dropping while CO_2 concentrations have risen by an additional 32 billion tons (Fig. 21). An increase of 1 ppmv in the atmosphere requires 2.12 Gt of C. One Gt of C requires 3.667 Gt of CO_2.

Worth mentioning is the fact that during 2008, 35 Gt of CO_2 were emitted from earth (Kahn, 2009; Reuters, 2009), without counting the CO_2 derived from the animal kingdom, while the increase of CO_2 concentration in the atmosphere was only 13 Gt (1.66 ppmv, Mauna Loa Observatory). As a result only 37% of the emitted CO_2 from mother earth stays in the atmosphere. The remaining 22 Gt

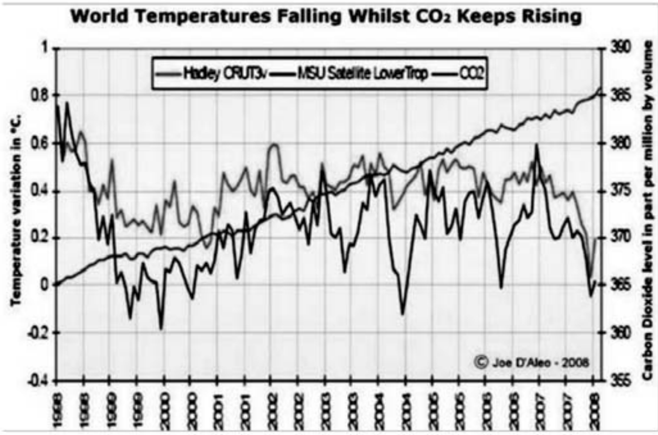

Fig. 21: World temperature is falling while atmospheric CO_2 is rising. Data for a) Average Mean Temperature of Earth's Surface: UK's Hadley Climate Research Unit CRUT3. b) Lower Troposphere Temperature Measurements: NASA's Microwave Sounding Unit (MSU). c) Atmospheric CO_2 concentration: Mauna Loa Observatory, Hawaii, USA (http://icecap.us/images/uploads/Correlation Last Decade pdf).

(63%) returns to earth. And this is done every year. According to NASA (Orbiting Carbon Observatories, OCO) some 66% of the emitted 35 Gt can be attributed to hydrocarbons.

This implies that hydrocarbons contribute roughly 23 Gt of CO_2 every year, roughly the amount that returns back to earth (22 Gt), and hence we have more than one source contributing to the atmospheric CO_2 concentration since the total sum is 35 Gt. The latter could have been easily deduced from the work done by the European scientists from 1812 to 1961 (Beck, 2007). Moreover, it is more than obvious that at least 10 Gt of CO_2 derived from hydrocarbons (43.5%), returns back to earth every year. In reality we do not know the exact CO_2 sources, hence their percent contribution, nor we know where the 22 Gt of CO_2 is disappearing, For this reason, NASA as well as Canada (Spears, 2009) sent, early this year, satellites to resolve these questions.

If we take into account that during the last 50 years, atmospheric CO_2 concentration has increased by 70 ppmv, that is by 0.007%, and that according to NASA OCO 2009 data, 66% of this amount is derived from hydrocarbons, that is 0.0046%[3], then one should wonder if this negligible amount (change of atmospheric air composition in the third decimal point) has caused the climatic change. Is it possible an increase of 2 or even 3 mole, of CO_2 in 100000 moles of other atmospheric gases (currently 39 CO_2 moles in 100000 moles to 41 or 42 CO_2 moles in 100000 moles), to cause a climatic change?

It is therefore seen that there is no relation between atmospheric CO_2 concentrations and small temperature perturbations. But even if there were correlations the influence of CO_2 concentration on temperature is very weak (Lindzen, 2006). Using a logarithmic relationship between the addition of CO_2 to the atmosphere and radiative heating, Lindzen estimated that the 100 ppm post industrial increase in CO_2 concentration (280 ppm pre-industrial to today's 380 ppm) has already caused about 75% of the anticipated I K (+0.37°C) warming, and finally an additional warming of few tenths of a degree occurs.

[3] CO_2 contribution from solid fuels is 40% of the 0.0046% that is less than 0.002%. The carbon capture sequestration (ccs) aims at reducing this 0.002% to 0.001%.

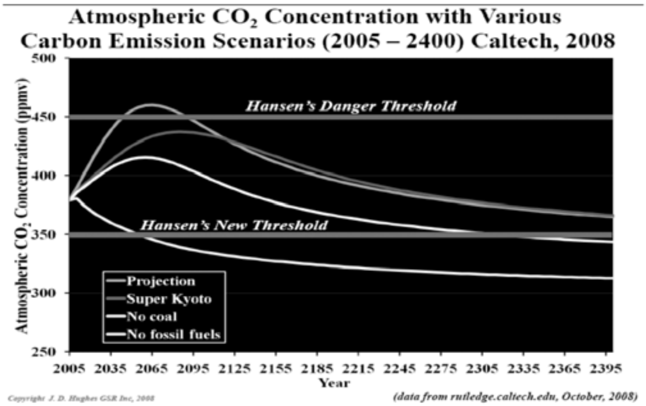

Fig. 22: Atmospheric CO_2 concentrations with various carbon emission scenarios from 2005 AD to 2400 AD, Caltech 2008. Data from rutledge.caltech.edu, October 2008. (Copyright, Hughes, 2009) Worth noticing is the background of 325 ppmv atmospheric CO_2 concentration without the use of hydrocarbons, the same as Beck (2007) and the same if all Calendar's, 1985, data are taken into account.

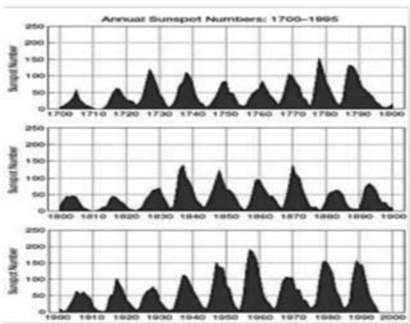

Fig. 23: Sun spot number variations from 1700 AD to 1995 AD (www.ngdc.noaa.gov/stp/SOLAR/SSN/ssn.html).

Sorokhtin et al. (2007) tried to explain the so called "Green House Effect" using the adiabatic theory. This theory is based on the observation that in the troposphere the heat transfer is mainly carried out by convection and the temperature distribution is close to adiabatic. Their reasoning is that air masses expand and cool while rising and compress and heat while descending. As a result, even if the CO_2 concentration in the atmosphere is doubled, that is going from 350 ppm to 700 ppm, the temperature at sea level will increase by 0.01^{o}C.

However, Rutledge (2007) as shown in Figure 22, calculated that of CO_2 concentrations derived from burning fossil fuels cannot exceed 450 ppm. An excellent discussion on the non existing relation between CO_2 concentration in the atmosphere and temperature is presented by Florides and Christodoulides (2009).

5. Relation of Temperature to Solar Activity

The question still remaining is how the small temperature perturbations can be explained when fluctuating between -0.5^{o}C, "The Little Ice Age", to +0.35^{o}C, today's increase. The answer can be found in the Sun's activity, the so called sunspots and solar winds (Svensmark and Friss-Christensen, 1997; Svensmark, 1998; 2007) (Fig. 23).

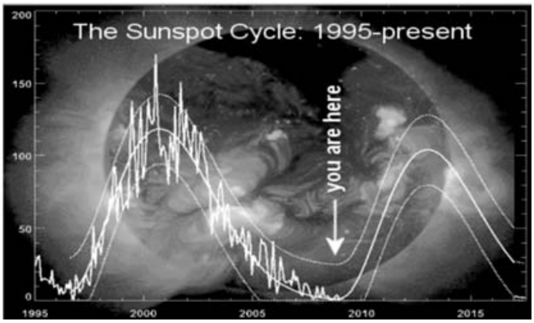

Fig. 24: Eleven (11) year sunspot cycle from 1995 to present. The fluctuation of sunspot numbers is characteristic, (Hathaway, 2008). The correlation with temperature drop Is characteristic (see Fig. 20).

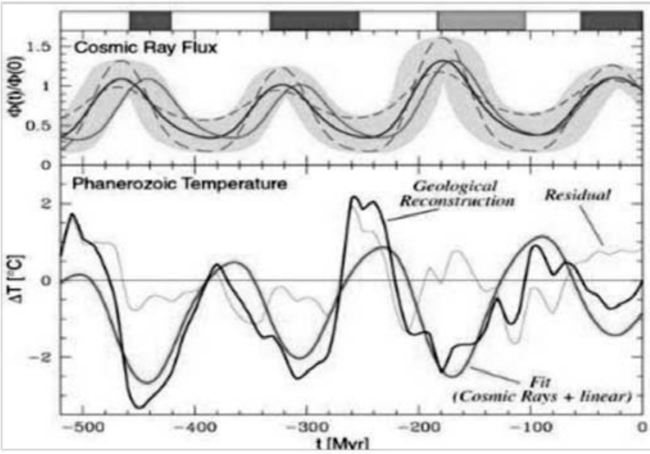

Fig. 25: Celestial drive of Phanerozoic Eon climate? The influence of cosmic ray flux related to temperature change for the last 500 million years with a cycle of about 200 million years, Wilson's cycles (Shaviv and Weiser, 2003).

Sunspots are storms on the sun's surface that are marked by intense magnetic activity and host solar flares and hot gassy ejections from the sun's corona. The number of spots on the sun cycles over time, reaching a peak, the so-called Solar Maximum, every 11 years, Figure 24. Solar winds, according to NASA's Marshall Space Flight Center, consist of magnetized plasma flares and in some cases are linked to sunspots. They emanate from the sun and influence the amount of galactic dust (Murad and Williams, 2002; Landgraf, 2003), which may in turn affect atmospheric phenomena on Earth, such as cloud cover.

It is calculated that when Solar activity is at a minimum, such as in 2009, 40000 tons of galactic dust/space debris (ESA/NASA mission Ulysses) reach the Earth's atmosphere inducing thecondensation of water vapours which leads to clouds formation (Svensmark et al., 2007). Clouds in turn affect the variations seen in temperatures (Shaviv and Weizer, 2003), (Fig. 25).

So the emphasis is on water vapour, which is the number one greenhouse gas, and not CO_2 whose concentration in the atmosphere is 100 times less than water vapour, H_2O. The correlation between sunspot number, the solar activity proxies and the ^{10}Be isotope concentration, which is an indicator of the amount of the galactic dust reaching earth, from 1600 AD until 2000 AD, is presented in Figure 26 (Beer et al., 1994; Hoyt and Schatten 1998a;b).

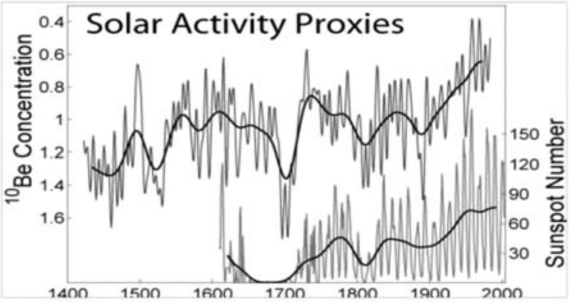

Fig. 26: Solar proxy activities based upon ^{10}Be concentration found n Dye-3, Greenland ice core (Beer et al., 1994). ^{10}Be originates from the incoming galactic dust. Relation to Sunspot number from 1600 AD to 2000 AD (Hoyt and Schatten, 1998a,b).

Another research work by McLean et al. (2009), shows that the surge in global temperature since 1977 can be attributed to a climate shift in the Pacific Ocean that is the relationship between El Nino South Oscillation (ENSO) effect and global temperature. The available data strongly suggests that future global temperatures will continue to change in response to ENSO cycling, solar radiation and volcanic activities.

6. Other Climatic anomalies

Various climatic changes such as the Dansgaard-Oeschger (DO) event have been recognized from ice cores taken from Greenland (GRIP/GISP2) which go back to the end of the last interglacial period, the Eemian Interglacial time. These events seem to have been globally synchronous, and they lasted 1500 years (Voelker, 2003). A lower frequency Bond cycle (Bond et al., 1999; Schulz, 2002; Braun et al., 2005) is characterized by unusually cold conditions that take place during the cold DO phase, the subsequent Heinrich event and the rapid warming phase that follows each Heinrich event (Heinrich 1988; Bond et al., 1992; Grousset et al., 2000). During each Heinrich event, massive fleets of icebergs are released into the North Atlantic, carrying rocks picked up by the glaciers far out to sea. Heinrich events are marked in marine sediments by conspicuous layers of iceberg-transported rock fragments.

Many of the transitions in the DO and Bond cycles were rapid and abrupt, and they are being studied intensively by paleoclimatologists and Earth system scientists to understand the driving mechanisms of such dramatic climatic variations that are not CO_2 driven. These cycles now appear to result from in- teractions between the atmosphere, oceans, ice sheets, and continental rivers that influence thermohaline circulation (the pattern of ocean currents driven by differences in water density, salinity and temperature rather than wind). Thermohaline circulation, in turn, controls ocean heat transport, such as the Gulf Stream which affects the climate of Northern Europe.

Table 1. Major glacial periods in earth's history Glaciations Periods During Paleoproterozoic and Neoproterozoic Ages and the Phanerozoic Eras (www.en.Wikipedia.org/wiki/Timeline-of-glaciation).

Name	Period (Ma)	Period	Era
Quaternary	30 - present	Neogene	Cenozoic
Karoo	360 - 260	Carboniferous and Permian	Paleozoic
Andean-Saharan	450 - 420	Ordovician and Silurian	Paleozoic
Cryogenian (or Sturtian-Varangian)	800 - 635	Cryogenian	Neoproterozoic
Huronian glaciation	2100 - 2400	Siderian and Rhyacian	Paleoproterozoic

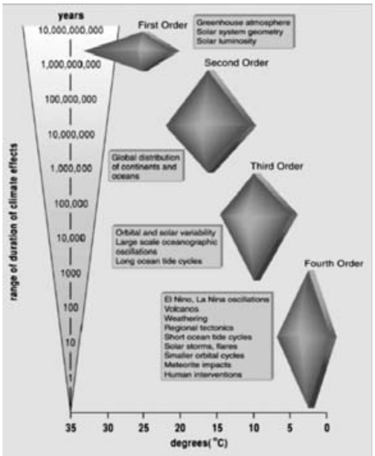

Fig. 27: Geologic constraints on global climate variability. Natural climate drivers ranked by intensity and duration. Human interventions meteorite impacts, volcanic eruptions, El Nino and others are considered the 4th Order affecting climatic variability (Gerhard, 2004).

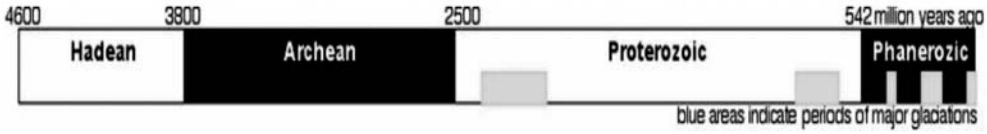

Fig. 28: Major glacial periods in earth's history (www.en.Wikipedia.org/wiki/Timeline-of-glaciation).

Climate, therefore, is driven by many natural processes which operate at many time scales with many scales of influence (Gerhard 2001), (Fig. 27). The mere fact that during the Huronian Glaciation, 2.4 billion years to 2.1 billion years, Paleoproterozoic Era and during the Cryogenian Period, 800 million years to 635 million years ago, Neoproterozoic Era, Earth was totally covered by snow (Tjeerd, 1994; Rieu et al., 2007; Table 1, Fig. 28), while atmospheric CO_2 concentrations were 10 times (Kan and Riding, 2007) to 200 times (Kaufman and Xiao, 2003) higher than today's, and the fact that during the Phanerozoic Era we have glaciations periods irrespective of atmospheric CO_2 concentrations, proves that there are many more natural drivers, besides the miniscule increases of atmospheric CO_2, sunspots and solar winds and Milankovitch cycles, that influence Earth's climate.

7. Conclusions

I. Climatic changes have been the subject of detailed studies for the last 200 years that is since the1800s and not only in the last 20 years.

II. Climatic changes were the norm throughout the Phanerozoic Era.

III. At least 100 glacial and interglacial periods have been measured during the Quaternary Period using Geomagnetic Polarity data.

VI. Climatic Changes during the Quaternary Period were not caused by *Homo sapiens* but by natural climate drivers.

V. During the Holocene Epoch and prior to 1850 AD many climatic changes were identified: The Climatic Optimum from 8000 BC to 4000 BC, with temperatures 1°C to 2°C above the optimum Mean Annual Temperature of 15°C; The Roman Warm Period from 450 BC to 150 AD with temperatures over 2.5°C above the optimum Mean Annual Temperature; and the Medieval

Warm Period from 900 AD to 1400 AD with temperatures over 0.4°C above the optimum Mean Annual Temperature. Homo sapiens who appeared 60000 years ago did not influence these climatic changes. The recent temperature Increase of +0.35°C above the optimum Mean Annual temperature of 15°C from 1980 to 1998 cannot be used to forecast catastrophic events, since from 1999 to date temperatures show a decreasing tendency. In addition, much higher temperatures have been recorded for longer time during the Holocene period without any damage to either earth or its population.

VI. The data, so far, do not support the relation between atmospheric CO_2 and temperature or other climatic changes. By looking into the more reliable and thus far overlooked chemical CO_2 methods for determining atmospheric concentrations one cannot be positive about a relationship between temperature difference and CO_2 concentration. The adiabatic theory suggests that global warming, and hence climatic changes, due to atmospheric CO_2 concentrations is impossible.

VII. Climatic changes are very difficult to assess because there are many natural climate drivers with various intensities and different durations. So, earth's climate system cannot be a function of one and only one factor, namely atmospheric CO_2 concentration.

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