Problems in climate science from the viewpoint of an historical geologist.

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Abstract
The climate system is vast with the interaction of forces we do not fully understand. Linking recent and future global warming to increasing carbon dioxide levels is problematic. Historical data exposes serious flaws in the IPCC reports with respect to, for example: the predictions of future sea levels; the relationship between carbon dioxide levels and temperature; the frequency and severity of storms. Applying the word 'unprecedented' to certain events shows an ignorance of the Earth's geological and environmental history. Climate change cannot be assumed to be geocentric without influence from cosmic and solar weather. Climate models are on steroids with respect to their estimate of what is called the Equilibrium Climate Sensitivity Index; that is, the estimate of future temperatures if carbon dioxide levels double. We cannot forget this statement:- *'we are dealing with a coupled chaotic nonlinear system and therefore the prediction of future climate states is not possible..'* IPCC Report 2001 (14.2.2.2).

Introduction

My background is in geology. We palaeontologists and field geologists try to squeeze information from rocks and the landscape to tell the climate story of the past. We are basically story tellers with a serious obligation to revise our climate story as more factual data comes to light. But, we are not the only climate story-tellers. There is another world of climate story-telling constructed by computer climate modelling. It is hard to see how modern climate science can develop if these two groups of story tellers do not communicate and try to reconcile conflicting views.

This lecture outlines my story telling. It is at odds with the projections of many climate scientists. Unfortunately, many engineers and politicians are basing their climate views on a consensus they do not understand; their comments are oversimplistic by any standard. More seriously there are the climate modellers who dominate the scientific views expressed in the IPCC reports; in my view their models are on steroids.

Complex natural forces defy simplistic logic

An excellent example of simplistically flawed thinking in climate science and its practical ramifications can be found in reports prepared for the Shoalhaven City Council in 2008-2009 by the Snowy Mountains Electrical and Engineering Consultants (SMEC). Their brief was to produce maps with erosion lines showing cliff retreat and beach retreat along the NSW Coast from Shoalhaven Heads to Batemans Bay if sea level rose 90 cms by 2100.

In the report on cliff erosion, the SMEC engineers did not talk to geologists and did not know that over millions of years geological uplift had raised the Sydney Basin coast above sea level. The landscape was tilted inland. Rivers such as the Nepean and Hawkesbury could only find their way to the sea along faults. With help from the chief surveyor for the Shoalhaven City Council, the Penguin Head rock platform was surveyed and it had a survey height around 1.8 metres above mean sea level. Other cliffs were inspected; all similar. Such cliffs are easily protected from an IPCC sea level rise projection of 90 cm by these fringing rock platforms that are around 1.8 metres above present mean sea level.

Figure 1: The photo above shows Penguin Head, Culburra Beach at high tide. Some waves will push some water onto the rock platform but strong waves will only get to the cliffs occasionally during a large storm. It should be noted that the Penguin Head cliff would have been battered during the last interglacial period 120,000 years ago as sea levels at that time were around 4 metres above those of today, and so at least 2 metres higher than the present rock platform.

The SMEC report on beaches was also totally flawed. In order to draw erosion and retreat lines along beachfronts as sea level rose 90 cms the engineers turned to the Bruun Rule. In 1954 Peter Bruun, an American engineer, proposed that the profile of a near shore beach-dune system was in an equilibrium that would be maintained during a rise or fall in sea level. For example, as sea level rises sand is taken from the dune system by wave action and redistributed on the nearby sea floor. At the same time wind contributes sand to the dune system that is now reformed landward of the old dune system. Over a period of time the old profile is restored, the near shore water depth is unchanged, and the only difference is that the former beach profile has shifted landwards. The model presumes an infinitely straight beach with all forces at right angles to it. Inputs to the Bruun equations are:-

- The angle of the beach profile to the horizontal;
- The distance to the offshore limit of most sand deposition:-an offshore theoretical ‘sand fence’;
- The grain size and the height of the main dune system;
- The projected sea level rise.

As an estimate the Bruun Rule predicts 40-100 metres of coastal retreat on a 1 metre rise of sea level.

An examination of annual aerial photographs taken along the Shoalhaven coast was undertaken to test the validity of the Bruun Rule. If that Rule could not describe past beach movements, it could not predict future movement. The aerial photographs clearly showed that the Shoalhaven beaches, such as the Warrain and Culburra beaches, had grown slightly seawards since WW11; a movement absolutely opposite to that predicted by the Bruun Rule. Aerial photographs showed there had been an explosion of foredune plant vegetation that had turned the foredune into a very efficient and an effective sand trap. There was now a cycle of seaward advancement through vegetation growth and seaward retreat due to the occasional storm surge destroying part of the fore-dune; such as the significant storm surges in this region of 1974 and 1986.

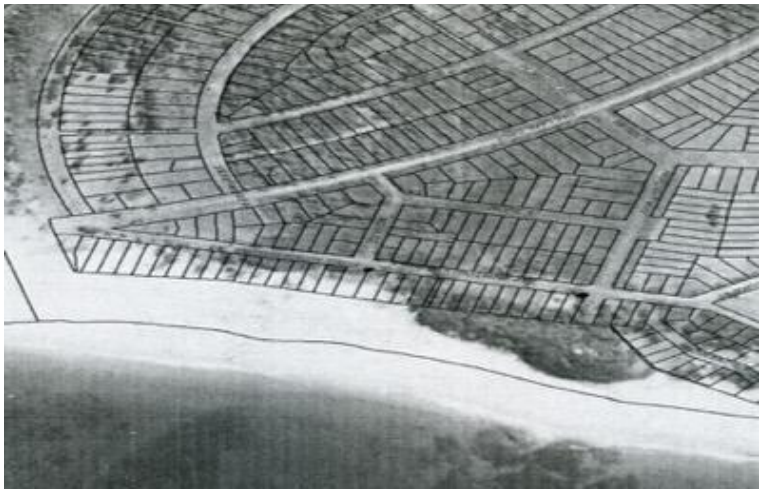

Figure 2 and 3:- The aerial photos above show the explosion of foredune vegetation at Warrain Beach, Culburra between 1948 (top) and 2008 (bottom).

Figure 4: This photo shows complex shoreline behaviour in the foredune at Kinghorn Point, New South Wales, Australia (Photo, H. Brady, 2012). The vegetation in the foredune is flourishing and trapping so much sand that this beach, like others in this region, is actually advancing seawards like an oncoming wave as sea level rises. When there are storm surges, such as in May/June 1974, the foredunes on such beaches are destroyed, but afterwards the foredunes re-establish and then the advance of the foredunes restarts.

Because the Bruun Rule did not seem to work, I contacted a world expert on dynamic beach processes- Professor Andrew Cooper of the Northern Ireland Coastal Forum. He stated that:

> *The Bruun Rule has no basis in scientific fact nor reasoning given what we now know of the complexity of the shore response to changing sea level* (pers. comm. March 2010).
>
> *Several assumptions behind the Bruun Rule are known to be false and nowhere has the Bruun Rule been adequately proven; on the contrary several studies disprove it in the field. The Bruun Rule has no power for predicting shoreline behaviour under rising sea level and should be abandoned* (Cooper and Pilkey (2004).

Another beach expert, Dr Wayne Stephenson of the University of Otago, commented to me on the phone:-

> *I have not found a beach in New Zealand to which the Bruun Rule could be applied* (pers. comm. March 2010).

In addition to comparative aerial photography for the period after WW11 another historical check was possible in the Shoalhaven region. The boundary title markers of beachfront homes under NSW Law could not encroach within 100 feet of the high water mark. This meant that the position of the high water mark was known when coastal villages such as Callala Beach or Collingwood Beach in Jervis Bay were surveyed and that position could then be compared with the present high water mark. A retired surveyor was co-opted to keep the daily high water mark for 6 months with reference to his property title at Callala Beach. This small village was developed in the 1950s when the property developer built fibro cottages after bulldozing the dunes. The surveyor's data showed that in 2010 the high water mark at Callala Beach was still within one metre of the estimated high water mark in the 1950s. This meant that the beach had recovered from severe retreat due to the destruction of the foredune by storm surges in 1974 and 1986. It had then grown seawards again due to the sand trapping of vegetation in the foredune.

These two SMEC reports have been analysed in some detail. Climate science is often riddled with similar flawed simplistic assumptions that are contradicted by dynamic historical processes. The errors in these SMEC reports occurred because engineers applied simplistic assumptions and faulty modelling before understanding the dynamics of the Shoalhaven landscape and its coastline. While not addressed in this paper, similar simplistic assumptions are used to describe the behaviour of reef island shorelines in mid-Pacific islands. Comparative historical photogrammetry of South Pacific Islands, such as Tuvulu, exposes a false storyline that presumes receding beaches and sea level inundation while, in fact, the islands are dynamically stable due to complex reef processes. For example, of the 101 Tuvulu islands examined there had been a 3% increase in land area in a 40-year period, and 73 islands were larger than they were in the 1980s. This research was done by Professor Kench, Head of the School of the Environment, Auckland University and Dr Arthur Webb, U.N. Development Program, Tuvulu Adaptation Project (Webb, Kench,2010).

Figure 5: South Pacific Islands undergo continual dynamic shoreline changes due to reef development They are not being inundated by sea level rise. This small atoll has shifted from the yellow position (1971), to the blue position (1984), and reverted to the south-east position red by 2014. The majority of the larger islands have expanded in area. Some areas will revert to the sea, while in other areas the islands grow. (Webb, Kench 2010).

Sea Level science at the cross-roads

The Shoalhaven controversy spurred further examination of climate science and a forensic examination of the current sea level rise projections in IPCC reports. There were significant discrepancies between trends in historical data and the projections of current computer modelling. This was outlined in the book: *Mirrors and Mazes: A guide through the climate debate* (Brady 2018).

In 1990, the first meeting of the IPCC sea level committee of 13 experts was chaired by Professor Warrick (University of East Anglia) and Professor Oerlemans (University of Utrecht, Holland). They stated that they could find no acceleration of sea level rise in the 20th Century tide gauge data despite the rise of carbon dioxide during that time even though climate models were predicting the acceleration of sea level rise. The committee had the PSMSL database for reference (Figure 6).

> *There is no firm evidence of acceleration in sea level rise during this century, although there is some evidence that sea level rose faster in this century compared to the previous two centuries* (Chapter 9. pp. 262).

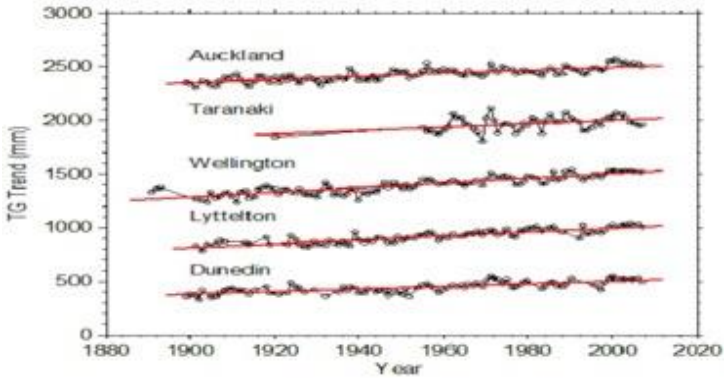

Figure 6: Tide gauges from the North and South Island of New Zealand show the linear increase in sea level during the 20th century. This trend can be observed in tide gauge data from all over the world kept by the large database at the Permanent Service of Sea Level at the National Oceanographic Centre, Liverpool England (PSMSL).

The 1995 IPCC sea level committee of 24 experts also reported:

> *There is as yet no evidence for any acceleration of sea level rise this century, nor would any be expected from the observed climate change to date (*Chapter 7. Climate Change. pp366).

The 2001 IPCC sea level committee of 36 experts tried to desperately reconcile the sea level tide gauge data with the models stating that sea level rise acceleration could be present, but it was below natural variability. Somehow, it was there but could not be seen.

> *There is no evidence for any acceleration of sea level rise in the data from the 20th Century data alone…models of ocean thermal expansion indicate an acceleration through the 20th century but when the model is sub-sampled at the location of tide gauges no significant acceleration can be detected because of the greater level of variability. Thus, the absence of acceleration in the observations is not necessarily inconsistent with the model results* (Chapter 11.3.2.2).

The IPCC 2007 sea level committee of 70 experts was the first to examine the satellite-based sea level rise data that was now available for the period 1992-2005. Since the satellite data reported sea level rise at twice the rate of tide gauges the committee took the satellite data as the most reliable and saw the data as proof of the acceleration predicted by the models. The 2007 report concluded that sea level rise was at linear trajectory of 15-18cm/100 years between 1900 -1990 but then the rate suddenly accelerated to 30 cms/100 years between 1990 and 2005. There was even talk of a recent higher rate of 40 cms/100 years.

Since 2007 the satellite data has been consistently quoted by IPCC reports as showing sea level acceleration beginning late in the 20th century. However, in 2011 Professor Houston of the US Army

Corp of Engineers and Professor Dean of the University of Florida pointed out technical problems with the satellite telemetry:

> *… altimeter and tide gauge measurements were in good agreement up until 1999 and then began to diverge with the altimeters recording a significantly higher sea-level trend than worldwide tide gauge records* (Houston and Dean, 2011).

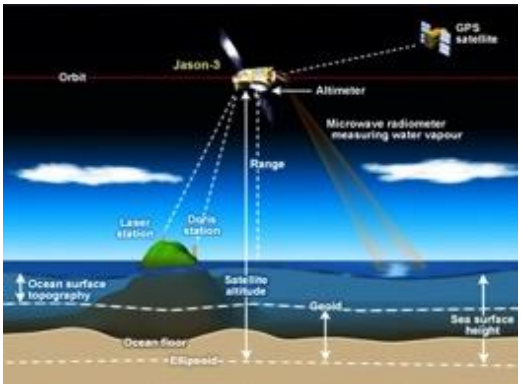

Figure 7: A Jason satellite at 1300 kms above the Earth talks to GPS satellites, ground stations, and refers its measurements of sea level to a theoretical shape of the Earth known as a Terrestrial Geoid. The whole ocean is surveyed every 10 days and the accuracy is approximately +/-3 cms.

In 2012 the NASA engineers who designed the Jason sea level satellite system admitted there were serious telemetry problems and a need for a satellite in space that would provide an accurate surveying benchmark that would enable the sea level satellite system to correct and improve its accuracy. This proposed system was called Geodetic Reference Antennae in Space (Figure 8:-GRASP).

> *Thus, we assess that the current state of the art reference frame errors is at roughly the mm/yr. level (one mm/yr. is an error of 10 cm/100 years, and so forth) making observation of global signals of this size very difficult to detect and interpret. This level of error contaminates climatological data records, such as measurements of sea level height from altimetry missions, and was appropriately recognised as a limiting error source by the NRC Decadal Report and by the Global Geodetic Observing System* (Yoaz Bar-Server et al., 2012. Jet Propulsion Lab. Caltech under contract to NASA).

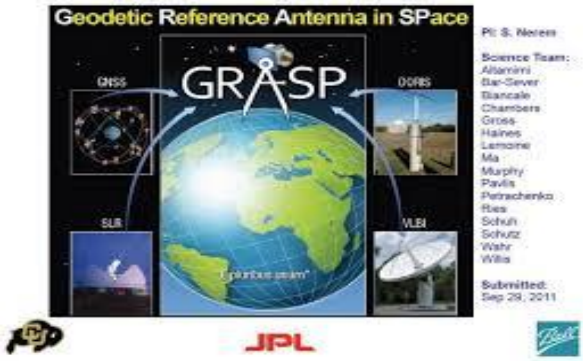

Figure 8: NASA's proposed reference satellite, Geodetic Reference Antennae in Space (GRASP) that satellites could use to get their accuracy to the mm level. The service would be available to the sea level satellites (Jason series) or those measuring polar ice loss and other phenomena (e.g. IceSat-2, Crysat-2).

In 2016 some scientists from the Colorado University Sea Level Unit that manages the sea level satellite system on contract to NASA examined the satellite data to see if there was any coherent evidence within its data-sets that would prove sea level rise acceleration. Their analysis surprised as it determined there had been deceleration of sea level rise in the last decade. In desperation the authors found an excuse.

> *Global mean sea level rise estimated from satellite altimetry provides a strong constraint on climate variability and change and is expected to accelerate as the rates of both ocean warming and cryospheric mass loss increase over time. In stark contrast to this expectation however, current altimeter products show the rate of sea level rise to have decreased from the first to second decades*

> *of the altimeter era. Here, a combined analysis of altimeter data and specially designed climate model simulations shows the 1991 eruption of Mt Pinatubo to likely have masked the acceleration that would have otherwise occurred. This masking arose largely from a recovery in ocean heat content through the mid to late 1990 s subsequent to major heat content reductions in the years following the eruption. A consequence of this finding is that barring another major volcanic eruption, a detectable acceleration is likely to emerge from the noise of internal climate variability in the coming decade* (Fasullo et al. 2016)

It was illogical that the authors of the Fasullo paper proposed that a cooling event due to the 1991 volcanic eruption of Mt Pinatubo in the Philippines had lasted for 20 years and had delayed the sea level acceleration that would eventually emerge from the noise of internal climate variability in the coming decade *'barring another major volcanic eruption'*. In fact, large volcanic explosions, such as at Mt Pinatubo, mainly affect climate around their latitude for several years. There is no evidence that other similar 20th century volcanic eruptions such as Santa Maria (Guatamala,1902) or Novarupta (Alaska, 1912) produced cooling climate effects over a 20 year period.

After the controversy of the Fasullo paper retraction occurred in 2018 when an article examining the same data, and with some of the same scientists as authors, reported that sea level rise acceleration had now been detected *'based only on the satellite observed changes over the last 25 years..'* (Nerem et al., 2018).

Against all this in the year the Fasullo paper was released, extensive tide gauge data was released by the National Oceanographic and Atmospheric Administration of the USA (NOAA 2016). This data showed a steady rise in sea level without any acceleration of sea level rise and came from more than 200 measurement stations that were coastal locations along the West Coast, East Coast and Gulf Coast of the USA, as well as seven Pacific island groups and six Atlantic island groups. This dataset placed serious question marks, not only over articles claiming sea level rise acceleration but also on several peer reviewed articles claiming recent and significant accelerating ice sheet losses in Greenland and Antarctica. Logically, if these ice-sheet losses were as large as alleged then extra meltwater pouring off polar ice caps into the ocean should have caused sea level rise acceleration that was detectable in both the tide gauge and satellite sea level rise data.

In summary, sea level science is in disarray. The recent IPCC reports supported modelling linking rising carbon dioxide levels with even higher sea level rises in the 21st century; and these forecasts were made without reference to empirical tide gauge data that still showed no sea level rise acceleration during the last 120 years. Unfortunately, the GRASP satellite has not been funded as the proposed satellite system would have provided more accurate positioning to the sea level satellites (e.g. Jason 4 at present) and various satellites attempting to measure ice loss in polar regions. The clash between the world-wide tide gauge and the sea level satellite data should be able to be resolved by improved instrumentation.

The weak link between rising carbon emissions and the temperature of the Earth

Central to the modern climate debate are calculations of the theoretical warming of the Earth if carbon dioxide levels double. Before examining modern computer modelling of this 'warming' it is worthwhile to examine the historical development of climate science. In the 1820s the great French mathematician, Jean Baptiste Fourier, developed the mathematics of heat transfer in solids. He saw the Earth's temperature in relation to a base temperature in space, a heat input from the Sun, a small output from the hot interior of the Earth and the trapping of some outgoing radiation from the Earth's surface by the atmosphere. He speculated that without this precious atmosphere Planet Earth would lose heat into space and be a frigid place.

In 1859 it was an Irish physicist, John Tyndall, who examined the atmospheric gases in detail to see which could be absorbing some of the long wave radiation emanating from the Earth's surface. Tyndall was at the Royal Institution of Great Britain at the behest of Michael Faraday. Prince Albert, Queen Victoria's consort, was a great supporter and he chaired the lecture meeting when Tyndall announced

the results of his experiment on the absorption of radiation by atmospheric gases. At that time this radiation was called *calorific rays* or *hidden heat*. To his surprise Tyndall found the major atmospheric gases that made up around 99% of the Earth's atmosphere - nitrogen (N_2) and oxygen (O_2) - were not involved. The minor players were molecules of methane (CH_4), ozone (O_3), nitrous oxide (N_20), and carbon dioxide (CO_2), but the major player, by far, was the water vapour molecule (H_20). We know today that these 'greenhouse' molecules have vibrating or rotating dipole moments (separated positive and negative parts) that enable each to absorb long-wave radiation at specific wavelengths. In contrast, the symmetric diatomic molecules of oxygen and nitrogen do not have such dipole moments.

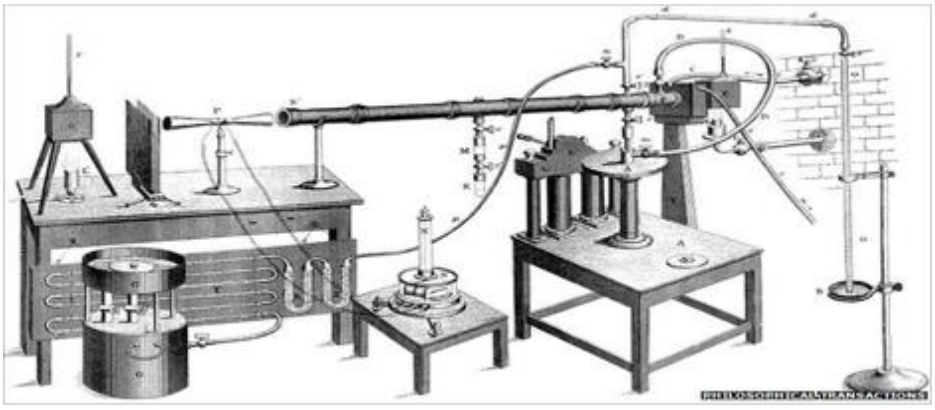

Figure 9: Tyndall's famous experiment in 1859. An iron box containing boiling water is the constant heat source situated at the right end of the tube. To the extreme left there is another hot box transferring heat to the right. Varying this heat will enable the galvanometer on the small table to be zeroed prior to the start of the experiment. A metal cylinder (left front) introduces a gas into the main tube. This gas is passed through two U-tubes filled with desiccating salts to remove any water vapour that would distort the result (except in the case water vapour is being considered).

Today there is common agreement that water vapour is by far the major player and accounting for around 67% of the so called '*greenhouse effect'*. Tyndall was correct. In his Rede lecture at the University of Cambridge on May 16th, 1865 he reported that despite the minor gaseous players without 'aqueous' vapour the Earth would still lose heat and not be able to sustain plant and animal life.

> *We were led thus slowly up to the examination of the most widely diffused and most important of all vapours—the aqueous vapour of our atmosphere, and we found in it a potent absorber of the purely calorific rays. The power of this substance to influence climate, and its general influence on the temperature of the earth, were then briefly dwelt upon. A cobweb spread above a blossom is sufficient to protect it from nightly chill; and thus the aqueous vapour of our air, attenuated as it is, checks the drain of terrestrial heat, and saves the surface of our planet from the refrigeration which would assuredly accrue, were no such substance interposed between it and the voids of space* (Tyndall, 1865).

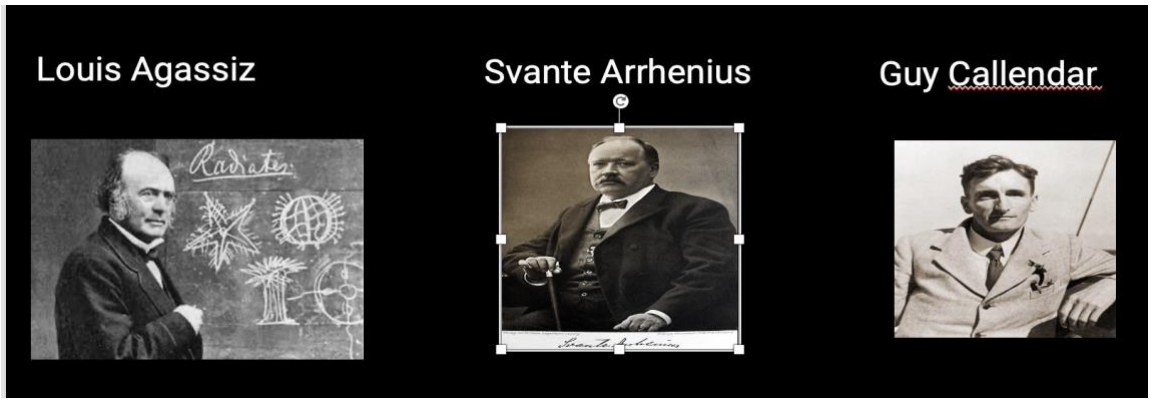

Figure 10: Louis Agassiz proved the existence of an ice age, Arrhenius wrongly proposed past high carbon dioxide levels as a cause of ice ages, Callendar used weather records to prove the Earth warmed from 1890 to the 1930s.

After Tyndall's work carbon dioxide as a 'greenhouse' gas was not highlighted until the last decade of the 19th century. Svante Arrhenius, a Swedish physicist, was trying to solve the 'climate problem' of the late 19th century; namely how could the Earth have endured the ice age that had been clearly proven by the field work of Jean Louis Agassiz in Europe, in the British Isles and in North America. With his background proving that solid soluble salts disassociated in water as charged ions Arrhenius speculated on the origin of the huge limestone deposits in Scandinavia and Europe . He argued that their deposition pointed to a high concentration of carbonate and bicarbonate ions in the ocean that must also be associated with very high concentrations of CO_2 in the atmosphere. In looking at the relationship between dissolved gaseous ions in solution with an adjoining gas Arrhenius was using Henry's Law, formulated 100 years early by William Henry in 1803, and speculating that very high CO_2 levels could explain ancient hot house conditions while low CO_2 levels would led to ice age conditions.

Today Arrhenius is often commended as he thought rising carbon dioxide levels from the burning of coal would heat the Earth and even protect it from an ice age. However, his basic theory about the past was totally wrong. There was an ice age 400 million years ago at the time of his Ordovician limestone deposition with high carbon dioxide levels around ten times higher than today. There was also another ice age with carbon dioxide levels around four time those of today at the time of the dinosaurs. Historical empirical data has also revealed ice ages with both high or low carbon dioxide levels and hot house conditions with varying carbon dioxide levels; so much for a strict deterministic relationship between temperature and carbon dioxide levels. Indeed, the historical warming role Arrhenius attributed to high carbon dioxide levels was not there. Today, despite this historical fact, it is still assumed that if carbon dioxide levels rise during the 21st century the Earth will necessarily warm. A projection very much disputed by many solar and atmospheric physicists.

Following Arrhenius there was another engineer who argued that carbon dioxide levels were the major driver of the modern warming. This person was a brilliant English steam physicist, Guy Stewart Callendar. To Callendar's credit he examined world temperature records kept by the Smithsonian Institute as well as some kept by English and European institutions. His careful research showed that world temperatures had increased between the late 19th century and the 1930s. He estimated the rise around 0.005ºC per year. He equated this change with rising levels of carbon dioxide from the burning of coal and became increasingly cynical about those who disagreed with him on what seemed so 'obvious'. Unfortunately, Callendar's research was conducted during a warming period between 1910 and 1940 when carbon dioxide levels and temperature seemed to be rising in tandem. Callendar's problem only became evident after WW11 as between 1940 and 1970, carbon dioxide levels continued to rise at a faster rate than in the 1930s and yet the Earth's temperature cooled. In this period even the CIA was warning the US President of an impending ice age. And close to Callendar's death in 1964, the English winters of the early 1960s were the coldest since the early 18th century.

An examination of the 20th century temperature profile as reported in the first IPCC reports further dispels a simple link between carbon dioxide levels and temperature. There were warming periods between 1910-1940 and 1970-2000 with nearly identical warming gradients; that is, a steady gradient around 0.16ºC/decade (cf. Figure 11). But in these two periods the decadal rises in carbon dioxide were vastly different; around 4-5 ppm/decade in the 1910-1940 period and around 15 ppm/decade in the 1970-2000 period. This suggested, at the very least, that other forces easily overrode any warming due to increasing carbon dioxide levels or that periodic warming trends were independent from changing carbon dioxide levels. To highlight this problem when carbon dioxide levels rose around 6ppm/decade between 1940-1970 world temperatures declined. Attempts to explain these discrepancies by varying pollution levels do not make sense. There was no great rise in coal production in struggling economies post WW11; economic recovery started to accelerate in the 1970s.

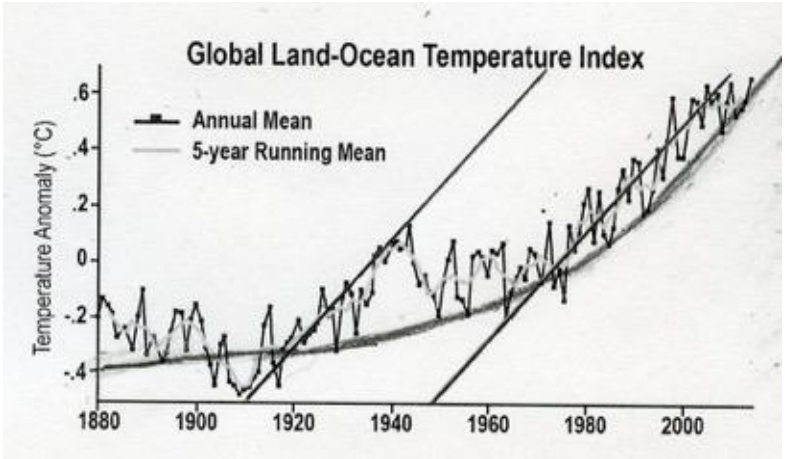

Figure 11: The parallel lines shows equal temperature gradients in two periods 1920-1940 and 1940-1970 even though the rise in CO2 levels in the second period was around 3 times that of the first period. The graph also shows the cooling temperatures between 1940 and 1970 despite the continuing rise in C02 levels. The lack of any change in the heating gradients in the above two periods raised a surprising possibility. Namely, that carbon dioxide had already reached its limits as a greenhouse gas and has had little warming effect above 285 ppm (Figure supplied by Professor M. Asten, Monash University, Melbourne).

An examination of the relationship between carbon dioxide levels and temperature over a much longer period also shows that any relationship between them is constantly swamped by other climate forces. Figure 12 shows estimates for carbon dioxide levels and the Earth's average temperature over 600 million years.

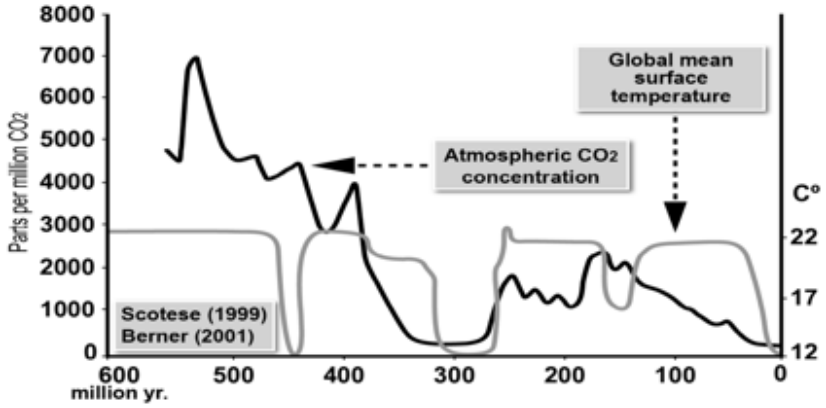

Figure 12: Temperature and carbon dioxide levels over the past 600 million years (based on Scotese, 1999 and Berners, 1990). Ice-age conditions occurred with widely different carbon dioxide levels. Our present carbon dioxide levels are around 410 parts per million. The ice age 430 million years ago had carbon dioxide levels around 4500 parts per million; the ice age around 300 million years ago had carbon dioxide levels close to present levels; the ice age around 140 million years ago had levels around 2000 parts per million. These variations clearly show that the greenhouse effect of high concentrations of carbon dioxide is highly exaggerated and that carbon dioxide is not the control knob of Earth's climate.

Carbon dioxide levels have risen from about 285 ppm in 1850 to about 410 ppm in 2020. There has been global warming since the early 18th Century. But the absence of significant changes in the warming effect as carbon dioxide levels have risen and fallen is clear from Figure 11 (the late 19th century and the entire 20th century to the present) and Figure 12 (the last 600 million years). This needs serious comment. There are programs designed to model the atmospheric propagation of electromagnetic radiation. For example, the well-respected Modtran 6 program can be used to model the upward diffuse flux (watts/square metre) at 100km above the Earth's surface. Surprisingly, the radiation escaping to space at carbon dioxide levels around 400 ppm is indistinguishable from that at the lower level of 285 ppm and a further doubling from 400 ppm to 800 ppm shows only a slight warming as the reduction in escaping flux is about 0.4%. So, this program indicates that there has

been no critical increase in any warming effect due a 40% increase in carbon dioxide levels since the middle of the 19th century. This result, opposite to the present consensus and the underlying thrust of the IPCC reports, indicates that the cause or causes of the recent warming have to be found elsewhere.

Similar results to the Modtran 6 program have been reported by Emeritus Professor William Happer, the Cyrus Fogg Brackett Professor of Physics, and Professor William Van Wijngaarden, both from Princeton University. These scientists analysed thousands of molecular absorption lines from the HITRAN database (Happer and Wijngaarden, 2020, Figure 13). Their studies show the difference in warming if carbon dioxide levels double is very small; that is, only a few watts per sq. metre. In addition, their studies also explain why the warming gradients in Figure 11 in the periods between 1910- 1940 and 1970-2000 are similar as the warming effects of such different carbon dioxide levels this century are indistinguishable. Their analysis, also explains why there have been ice ages in the Earth's past when carbon dioxide levels ranged at levels much higher than today; for example, from 4 to 10 times higher.

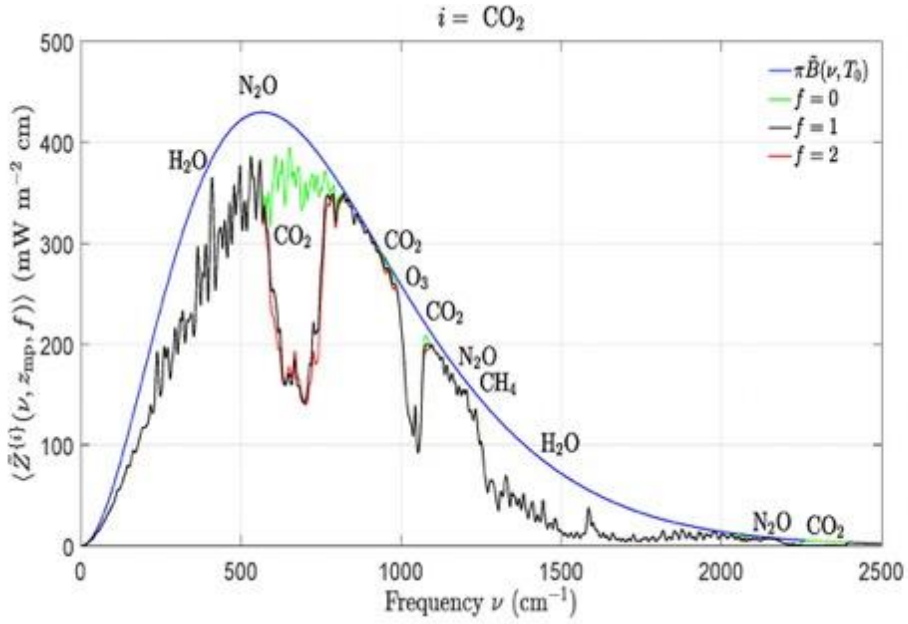

Figure 13: This figure shows the radiation emitted from the Earth into space at 86km and at the Earth's average surface temperature of 288ºK (15ºC). The blue line shows the radiation being emitted if there was no atmosphere. The black line shows the radiation emitted when all present 'atmospheric' gases are present and also wavelengths where they absorb radiation. The green line shows what would happen if carbon dioxide was absent. The red line shows the small difference in absorption between carbon dioxide at present values around 400 parts per million and at values of 800 parts per million. The difference is hardly noticeable and amounts to a decrease of radiation to space of about 3 watts per square meter for doubling CO2 concentrations from 400 ppm to 800 ppm (parts per million). Climate fanatics want to impoverish much of the world on the basis of the slight difference between the black and red curves on this figure. And to double CO2 concentrations at current emissions rates, and produce the red curve, would take more than a century (Happer, Van Wijngaarden 2020).

For these physicists the "consensus" that carbon dioxide is the "control knob" of Earth's climate is not supported by their analysis. Their careful calculations imply that we have nothing to fear from rising carbon dioxide levels in the 21st century as the reasons for the recent global warming have to be found elsewhere; more probably in the Sun with its many different and very complicated interactions with the Earth.

And the simple corollary that flows from the Happer-Van Wijngaarden analysis and Modtrans 6 program is that any reductions in global carbon emissions from the present levels will have no cooling effect on the Earth's global climate and so are simply an expensive waste of time and money.

The myth of increasing storm frequency and severity.

Serious storms such as hurricanes and typhoons provide an excuse for politicians to warn the populace of impending climate change. Since this is part of popular climate folklore it requires some comment in this seminar even though such a position is not supported by historical data nor by the latest 2014 IPCC report.

Barack Obama, with all his eloquence, made this false statement to Queensland university students in November 2014:-

> *A climate that increases in temperature will mean more extreme and frequent storms, more flooding, rising seas that submerge Pacific islands* (Obama, Brisbane 2014).

The American catastrophist Dr James Hansen made the same point in his book:- *Storms of my Grandchildren:-*

> *However, because a warmer atmosphere holds more water vapour, global warming must also increase the intensity of the other extremes of the hydrologic cycle – meaning heavier rains, more extreme floods, and more intense storms driven by latent heat, including thunderstorms, tornadoes, and tropical storms* (James Hansen, 2009).

The IPCC 2014 report rejected the views expressed above. It made statements to the effect that:

- globally there was *low confidence* in the attribution of changes in tropical cyclone activity to human influence;
- the conclusion in the 2007 IPCC report regarding increasing trends in hydrological droughts since the 1970s was not longer supported;
- there was now *low confidence* regarding trends in the magnitude and frequency of floods on a global scale.

An examination of historical data shows no relationship between the continual rise of carbon dioxide levels and severe tropical storms, mid-latitude tornadoes or tropical wind intensity. Such an examination shows the huge dichotomy between empirical data and what we might call the false logic of populist climate science. The data charted in Figures 14-17 show no trend at all between rising carbon dioxide levels and various storm patterns such as;

- strong to violent tornado frequency in the US;
- a tropical wind intensity index based on winds every 6 hours in the tropics since 1972;
- the frequency of hurricane hitting the east coast of the USA since 1851;
- the frequency of hurricanes hitting the east coast of Australia since 1969.

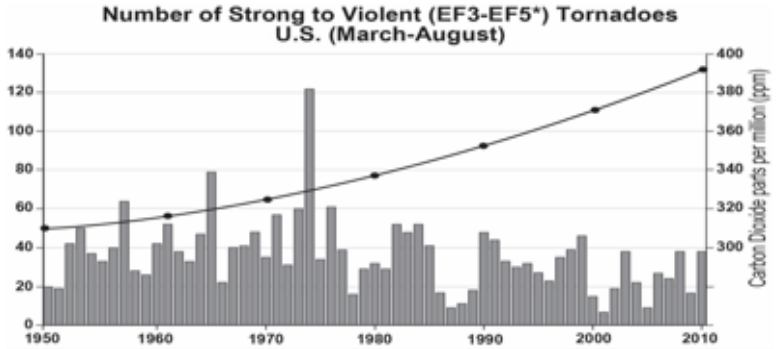

Figure 14

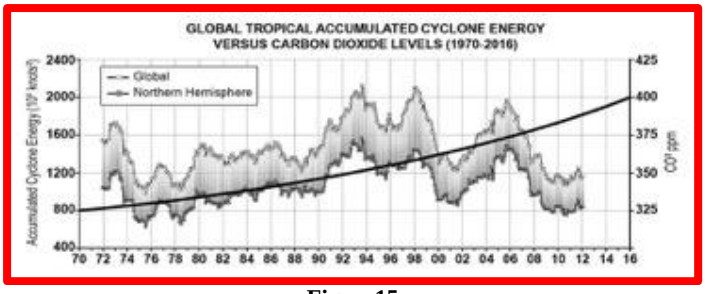

Figure15

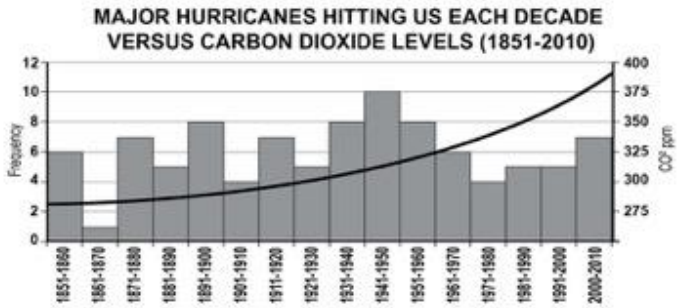

Figure 16

Australian cyclones - East Coast since 1959 v CO2 levels

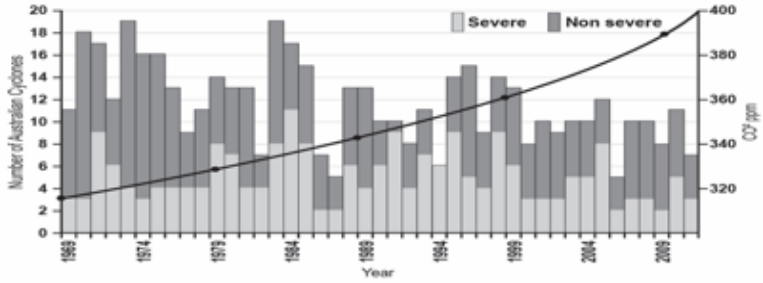

Figure 17

It is clear that increasing storm damage is a function of the rise in populations. In Australia there was a population around 45,000 in 1946 along the Gold Coast between Southport and Tweed Heads. Today the population of the Gold Coast exceeds 500,000 so serious storms now occurring along the Gold Coast would cause much more damage than in 1946.

Apart from storylines about more frequent and severe storms, other populist storylines link storm surges with the threat of rising sea levels. When a storm surge occurs the media and ill-informed public figures raise the spectre of rising sea levels. However, storm surges always cause local, temporary sea level rises. A drop in atmospheric pressure causes some of the sea level rise and the main rise is due to the water pushed along by the moving and violent storm system (cf. Figure 18, below).

In Australia the largest surge hitting the coast was 12 metres high and occurred at Bathurst Bay, Cape York in 1898. Calculations indicate that between one and two metres of this surge height was due to the low pressure of the storm system. The rest of the storm surge height was due to water pushed along by the storm system with winds estimated to be well above 200 kms/hour. This storm surge killed over 300 people in that small pearling settlement. Shark and dolphin bodies were found 40 kms up local creeks or on the top of cliffs. In NSW the most recent severe surge was in May 1974 on the south coast of NSW in the Jervis Bay region. Offshore ocean wave heights were around 9 metres, but the actual surge hitting the coast was around 2-3 metres

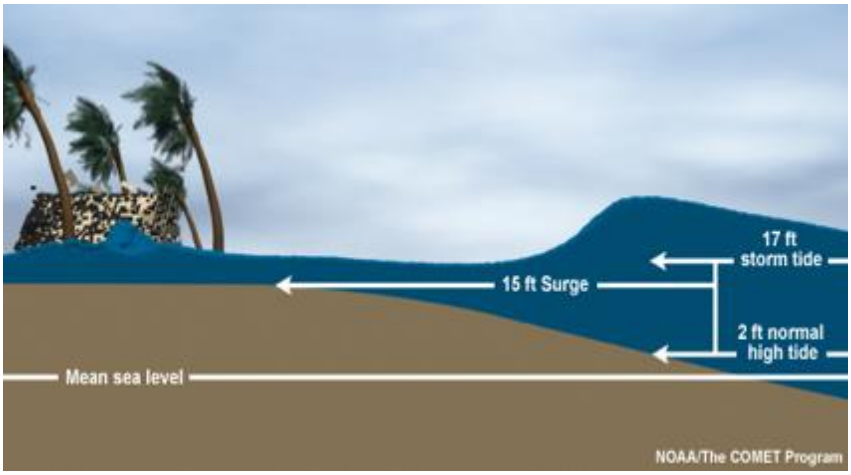

Figure 18: The low-pressure system causes high winds and sea level to rise. But the main rise is due to the violent storm vortex pushing water as it advances forward.

Finally, the conjectures of the great English historical climatologist -Professor Hubert Lamb - should be mentioned. He was of the opinion that storms were more severe and frequent during cold periods and ice ages, but he did not have enough statistical data to prove this conjecture (Lamb,1991). He could, however, point to:

- The storm called 'The Great Drowning', Denmark 1363; the sea went inland 15 kms; 67 villages were wiped out; the death toll was estimated to be around 25,000;
- The storm called the 'All Saints Storm' Ist November 1570; estimated death toll around 100,000 in Holland, Belgium and Northern France;
- The 'Great Storm', England 1703; over 700 ships pushed up the Thames so that its western end was a pile of smashed timber; over 1000 sailors drowned on the Goodwin sand banks near the mouth of the Thames; 2000 chimneys and 400 windmills destroyed; 30 ships destroyed in Wales along with 5 of their man-of-war escorts. In shock, Daniel Defoe wrote his book *The Storm* (July 1704).

There is now more historical evidence to back up Professor Lamb's conjecture. The evidence comes from China. Professor Kam-Biu Liu of Louisiana State University and his colleagues have shown that the semi-official local government gazettes (jufeng) from Guangdong record 571 typhoons in a 935-year period from 975 AD to 1909 AD. During that time, the most active typhoon periods were during the Little Ice Age in 1660–1680 and in the cold period 1850–1880 (Kam-biu Liu at al., 2001). Looking at the lack of evidence for increased storm activity, how cynical can we be when we see a worldwide insurance company like Munich Re making comment that would bolster its business and its premiums:-

> *The number of extreme weather events seems to have quintupled since the 1950s, according to the insurance company Munich Re* (Monbiot, 2006).

Do we really live in *unprecedented* times?

The word *unprecedented* is almost a slogan in modern climate science. It suggests that we are now in a new era so unique that historical comparisons with the past are virtually meaningless. We are now in *The Anthropocene* : *the age of humans.*

Much is made in IPCC reports of the probable fact that the present levels of carbon dioxide (around 410 ppm) are the highest in the last 800,000 years and so determined to be *unprecedented*. The ice cores taken in Greenland and Antarctica show carbon dioxide variations between 170ppm and 300ppm throughout that period. Indeed, the present levels of carbon dioxide around 410 ppm may be the highest from sometime within the Cenozoic period that began around 66 million years ago. At the start of that period carbon dioxide levels, as estimated by recent Swedish research, were around 600 ppm but

throughout the Cenozoic period the trend in carbon dioxide levels was generally downwards. Realistically, this period represents less than 1/70 of Earth's geological time.

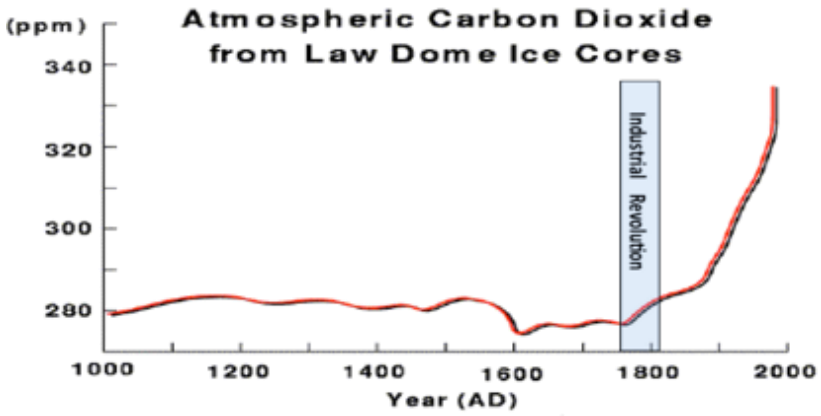

Figure 19. A 1000 year record of carbon dioxide levels from an ice core taken at Law Dome, Antarctica. The fact that these readings agree with the readings of carbon dioxide measuring stations at Mauna Loa, Hawaii (since 1958) or Cape Grim, Tasmania (since 1976), provides some confidence in the general accuracy of past carbon dioxide readings over the last 800,000 years as measured in deeper ice cores in Greenland and Antarctica that are often questioned by some sceptics (e.g. the CAMP CENTURY ice cores in Greenland, or the EPICA and VOSTOK ice cores in Antarctica).

In perspective there are some highly respected scientists such as Professor Happer (Princeton) or Dr Patrick Moore (an early leader within Greenpeace) who are of the opinion that the recent rise in carbon dioxide levels is rescuing the Earth from a potential carbon dioxide drought. This group is known as the *C02 Coalition*. A rise in carbon dioxide is a blessing not to be feared. The Earth has already began to benefit from higher carbon dioxide levels stimulating the food production needed to feed the Earth's burgeoning populations. And the increase in carbon dioxide levels is not harmful to human health as carbon dioxide is not a poisonous gas. This is shown by the health safety limits for carbon dioxide levels set in submarines. These are set around 5000 parts per million; a level that is 12 times the present atmospheric concentration of carbon dioxide.

The *unprecedented* word is also used with respect to climatic change in polar regions. Al Gore wrongly predicted the Arctic would be ice free by now as if that was a sign of impending catastrophe. But even if it was, the Arctic was sometimes ice free 8000 years ago during a warm period we now call the Holocene Thermal Maximum. So, what is *unprecedented*? That warming proved no threat to the polar bears that Al Gore saw in imminent danger. And Al Gore and others have also made much of the *unprecedented* retreat of Greenland glaciers such as the Jacobshvn. However, 8000 years ago that glacier retreated even further and the Greenland Ice cap warmed and retreated to be smaller than it is today (Axford et al., 2019). There are similar opinions about the retreat of Antarctic glaciers, such as the Thwaites and Pine Island glaciers. But a number of geologists led by Dr Johnson of the British Antarctic survey from the Scott Polar Institute, Cambridge have recently shown these glaciers retreated more 8000 years ago (Johnson et al., 2014). So again, what is *unprecedented*?

The media wrongly presumes that large icebergs breaking away from Antarctica are the portent of a dramatic rise in sea level. However, a sea level rise of one metre would require Antarctica to shed an iceberg that stretches 3600 kms from Sydney to Perth, be 100km wide and 1 km deep. While one can forgive the media for ignorance of such basic ice volumetrics it is harder to forgive scientists who report recent ice losses as dramatic; especially when the present ice losses from Greenland and Antarctica are much less than during the Holocene Thermal maximum 8000 years ago.

The use of the word *unprecedented* is also frequently used with respect to allegations that recent temperatures are the highest in the temperature records even though the mercury thermometer database only goes back a few hundred years. Unfortunately, the temperature records held by national meteorological institutes are distorted as the data is often presented after being homogenised by

averaging temperature data over wide areas. In Australia, the homogenisation by the Bureau of Meteorology (BOM) has come in for extensive criticism. What is needed is the separation of rural and urban temperature records because the urban temperatures are increased by night-time long-wave radiation from thousands of square kilometres of concrete and bitumen and are often further distorted by the placement of the Stevenson screens near airport runaways and large buildings.

A thorough analysis of urban and rural temperature records for the 19th and 20th Centuries in rural China, rural North America, and rural Western Europe has been done by Dr Willie Soon (Smithsonian Institute) and two Irish statisticians -Ronan and Michael Connolly. For example, in China they estimated the average global warming from rural stations had been around 0.025ºC per decade and for urban stations a much higher rate of 0.119ºC per decade. The rural warming in the 1930s was equivalent to the modern rural warming between 1980 and 2000. The rural cooling between 1950 and 1970 was pronounced in all datasets. The variability of their revised temperature profile correlates well with solar variability datasets for the period that are not considered by the Coupled Model Intercomparison Project 5 (CMIP5) climate models used in the IPCC reports (Soon, Connolly and Connolly, 2015). Their work clearly shows that recent global warming is overestimated due to the inclusion of the urban heat island effects in most temperature datasets. This lower estimate for global warming is now within the ambit of changes in solar radiation reaching the Earth's surface. At last, the climate change and global warming of the last few centuries are no longer divorced from Father Sun.

Finally, anyone who follows climate science cannot forget Michael Mann's famous hockey stick that was so promoted in the IPCC reports of 2001 and 2007. The IPCC reports in 1990 and 1995 mentioned the Minoan, Medieval and Roman Warm Periods. Many had seen the modern warming as another cyclical warming period in synchroneity with those warmings both in its periodicity and extent. Mann's statistical analysis of tree rings reduced the Medieval Warm Period (MWP) to a local Northern Hemisphere event. Suddenly the Earth's temperature record was flattened and the recent warming highlighted as *unprecedented* in the last 2000 years. Mann's hockey stick paper was helped by ample evidence for the MWP in Northern Hemisphere mid-latitudes from 50ºN to 70ºN while there was little historical temperature data from equivalent latitudes in the Southern Hemisphere that were literally in the ocean.

Historical data has now disproved Mann's hockey stick. For example, Professor Yair Rosenthal from Columbia University, New York, and other scientists have analysed different isotopes of oxygen in microfossil shells from sediments collected from the Pacific Ocean floor (Rosenthal et al., 2013).The data show that Deep Water masses in the North Pacific Ocean (Northern Hemisphere) and the South Pacific Ocean (Southern Hemisphere) were both 0.9°C warmer during the Medieval Warm Period than during the following Little Ice Age, and even 0.65°C warmer than today. This Deep Water comes from the Antarctic region where, as pack ice freezes, the resulting ice is less salty and the remaining heavier, saltier water sinks and gradually covers the deep ocean floor all the way past the equator. This process has continued since Antarctica was separated from Australia and South America over 30 million years ago. Consequently, the Deep Ocean Water now makes up about 90% of the volume of the Earth's oceans. So, the Deep Ocean Heat Content in both hemispheres today is not only less than in the Medieval Warm Period, but it is well below the Deep Ocean Heat Content in the very warm period scientists call the Middle Holocene Thermal Maximum, which occurred 10,000 years ago. So how can we call the recent warming of the Earth *unprecedented?*

How can the Sun and the Cosmos be sidelined?

The politico-scientific body called the Intergovernmental Panel on Climate Change (IPCC) was formed in 1988 as a merger between the World Meteorological Organisation and the United Nations Environmental Programme. Its charter was to supply global reports on climate and coordinate a response to 'man-made' climate change. The focus on recent climate change as a human construct immediately introduced a bias into climate science as it implied that the origin of recent climate change was man-made. The Earth was effectively divorced from its solar and cosmic environment.

There are slight variations of the Sun's distance from the Earth due to the gravitational pulls of the large planets that cause slight variations in solar radiation reaching the Earth. The cycle has been described by the famous Australian geologist Rhodes Fairbridge and is called an epitrochoid cycle with a cycle length of 180 years (Fairbridge et al., 1987). Other possible changes in the Sun's output can be related to changes in the sun's surface area. Russian scientists have an instrument on the International Space Station measuring pulsations in the size of the Sun that alter its surface area by more than a billion square kms, and consequently cause small variations in the solar radiation reaching the Earth's surface (Project Astrometria). While these changes are real and based on observations, it is changes in the Sun's sunspot and magnetic activity that may well determine the Earth's climate in the remaining years of the 21st Century.

There is a body of data from the early 17th century describing the sunspot numbers on the Sun and the existence of sunspot cycles. These have been numbered since 1755 and the present sunspot cycle is number 25 that began in December 2019. There is an inverse relationship in these cycles between sunspot numbers and cosmic intensity as low sunspot numbers are associated with a lower magnetic intensity and a higher cosmic ray flux. This means that the Sun's magnetic field has a gatekeeping role modulating the variations in cosmic rays reaching the Earth's surface during each short 11-13 year sunspot cycle. Figure 20, below, is an historical total solar irradiance reconstruction from 1600 AD published by NASA. Note that low sunspot activity and high cosmic activity is co-related with cold snaps called the Maunder Minimum between 1640 and 1715 and the Dalton Minimum between 1795 and 1825.

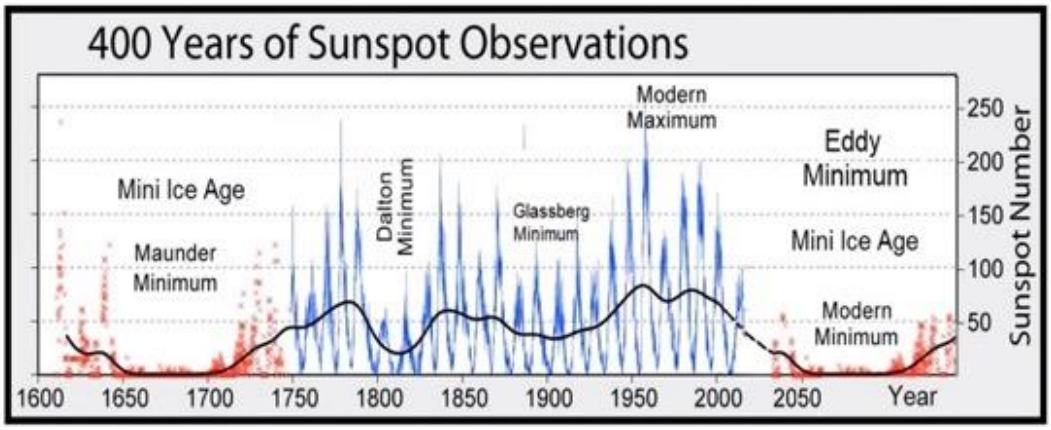

Figure 20: A chart of sunspot numbers since 1600 AD. There was an absence of sunspots called the Maunder Minimum during the Little Ice Age between 1640 and 1715. Low sunspot numbers also occurred in a cold period called the Dalton Minimum between 1795 and 1825. Napoleon certainly chose the wrong time to invade Russia and face the Russian winter in the second half of 1812. Sunspot numbers reached a high in the 2nd half of the 20th Century but have been trending down since cycle 21. The current cycle 25 began in 2019. A concurrence of low sunspot numbers and a cold period is projected by many solar physicists later in the 21st Century.

Isotope scientists have also collected data that suggest a significant cosmic influence on the Earth's weather over much longer periods of time. One of the most pre-eminent isotope geochemists in the world, Jan Veizer, did his PhD in isotope geology at the Australian National University (ANU) in 1971. He stresses the pre-eminence of water vapour as the main greenhouse gas. He downplays the importance given by modern climate scientists to carbon dioxide as a greenhouse gas. Veizer points to clouds as critical solar reflectors in the climate system, noting that the difference during the day between a cloudy and a cloudless sky is 28 watts/sq metre; enough to account for the energy discrepancies in the climate debate.

Veizer's main contribution to climate science has been gathering data to track the surface temperature of the Earth's ocean over 500 million years by the analysis of Oxygen 16 and Oxygen 18 isotopes in 25,000 microfossils. This large empirical database showed that periods of cold ocean temperatures coincided with ice age periods of high cosmic radiation that had also been identified by Professor Nir

Shaviv of the Racah Institute of Physics, Jerusalem (Veizer 2005, Shaviv et al., 2014). While Veizer's large database came from microfossils, Shaviv's data came from his analysis of beryllium and carbon isotopes in meteorites over the last 3 billion years. Since Veizer's database only covered 500 million years the research of both scientists, conducted independently, indicated that every period of ice ages over the last 500 million years coincided with transits of the solar system through an arm of the Milky Way (Figure 21). The coincidence between solar system transits through arms of the Milky Way prior to 500 million years depended on Shaviv's data.

The Shaviv-Veizer research pointed to the role of the Sun's magnetic field as the Earth's gatekeeper against invading cascades of cosmic nuclides as they collide in the atmosphere with nitrogen atoms to produce the isotope carbon 14 (^{14}C), or with oxygen and nitrogen atoms to form the isotope beryllium 10 (^{10}Be). However, this gatekeeper role of the Sun's magnetic field enveloping all the planets of the solar system is less effective when the solar system transits through the arms of the Milky Way where there are much higher concentration of stars and therefore much higher cosmic ray densities.

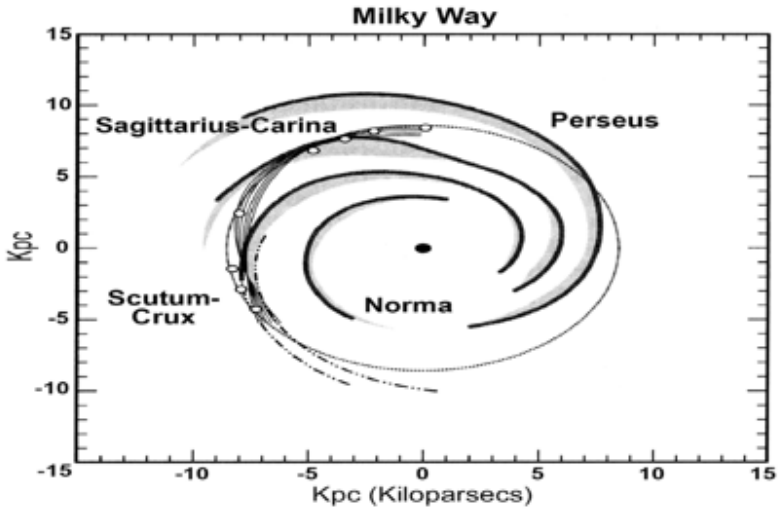

Figure 21: A diagram showing the orbital path of the solar system through the Milky Way (A. Ollila, website, www.ClimatExam.com).The solar system's orbit crosses through the arms of the Milky Way. The scale is in kiloparsecs, an astronomical measurement, where one parsec is about 3.26 light years, or about 31 trillion kilometres. Shaviv's theory links each transit of an arm of the Milky Way with higher cosmic ray radiation due to the higher number of nearby stars. This radiation increases cloudiness, that in turn, reflects more of the Sun's incoming radiation into space; so significant increases in cloud put the Earth into an ice-house condition.

The ideas of Shaviv and Veizer are being reinforced by research directed by Henrik Svensmark at the Danish Space Institute. Svensmark researches the role of sub-atomic charged particles such as muons in cloud chambers. Muons are generated in the Earth's upper atmosphere by cosmic rays (high energy protons) colliding with atomic nuclei of molecules in the air. It is Svensmark's view that such muons can help seed lower cloud formation. He infers that variations in the Sun's magnetic field can, in turn, vary solar radiation reaching the Earth's surface, vary muon production, and vary cloud formation. The nature of this cloud-chamber research is difficult as it is at the sub-atomic level. Nevertheless, real data show the cyclicity of sunspots, the cyclicity of the Sun's magnetic field, and the concurrence of cold periods with high cosmic activity. While concurrence does not always infer causality, this research is exciting and more than warranted (Svensmark et al., 1997, Svensmark, 2007).

The projections of cyclical climate patters into the future

It should be noted that there are cyclical patterns in climate science. The question needs to be asked. If historical cyclical trends are real why not extend those cyclical patterns into the future as predictive tools. In this exercise the question as to whether we understand a cycle is irrelevant as each cycle has been determined and shaped by nature not by us, and so it contains a non-linearity impossible to be mathematically expressed in a computer model. We then need to decide what weight we give to an

historical model projected into the future versus a computer climate model. Surely the historical model, if at odds with CMIP5 or CMIP6 models used by the IPCC, should be preferred. The great French mathematician Pierre-Simon Laplace noted this type of logic in his famous essay on probability in 1814:

> *We are so far from knowing all the agents of nature and their diverse modes of action that it would not be philosophical to deny phenomena solely because they are inexplicable in the actual state of our knowledge. But we ought to examine them with an attention all the more scrupulous as it appears more difficult to admit them* **(** Laplace, 1814).

A case in point is the Milankovitch cycles, one of which explains the cyclicity of ice ages every 100,000 years. In the deep ice cores drilled in Antarctica, such as the EPICA Core, there are clearly 8 ice ages in the last 800,000 years. Even if Milanovich's mathematical analyses of changes in the elliptical path of the Earth were not known it could be argued that another ice age will occur at some time in the next 10,000 to 30,000 years; and that this new ice age will also last around 100,000 years.

There is another 60-year cycle noted in IPCC reports. World-wide temperature data in the last 200 years show the existence of 60-year cycles each with an approximate 30 year warming period followed by an approximate 30 year period during which temperature changes are low or even down slightly. An example is the warming between 1910 and 1940 and the cooling between 1940 and 1970 OR the warming between 1970 and 2000 and temperatures slowing between 2000 and the present.

A case in point is the chart below prepared by Professor Syu-Ichi Akasofu the founding director of the International Arctic Research Centre (Figure 22). Akasofu especially studied the Earth's ionosphere and its relation to the Earth and Sun's magnetic fields, the solar wind and cosmic rays. Agasofu made an assumption that the 60-year temperature cycle could reflect both input and output heat exchanges between the ocean and the atmosphere. He was also aware of a 60-year oceanic temperature cycle in the Northern Pacific Ocean called the Pacific Decadal Oscillation. Here the surface temperatures switch between the East and West Northern Pacific Ocean every 30 years.

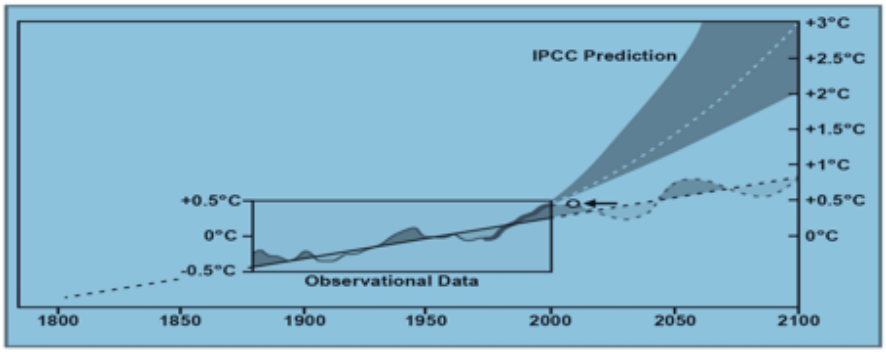

Figure 22: Akosofu assumed a long-term warming trend around 0.05°C per decade and then superimposed temperature gains and losses when the ocean acted as a heat sink or alternatively exchanged heat with the atmosphere. These gains and losses are calculated as +0.07°C per decade in 30 years of warming and –0.07°C per decade for the other 30 years in a 60-year cycle. The end-result is a slightly negative trend of 0.02°C/decade every 30 years and a positive trend of 0.12°C/decade for the other 30 years of the cycle. The result is an oscillating graph, but there is still an underlying cyclical warming trend over the past 150 years (Akasofu 2009).

One can disagree with some of the assumptions used by Akasofu to produce the amplitudes in his chart but the cyclical trends are real. Projecting them indicates a cool period in the 21st Century in synchroneity with the 1940-1970 cooling period; a cooling period that is also suggested by recent analyses of variations in the Sun's magnetic field discussed later in this seminar paper. And, with respect to the 60-year cycles, they are also evident in some West Antarctic ice cores where there has been sufficient snowfall to allow for annual resolution of data; for example, a Bryan coast ice core with a 308 year history (Thomas et al., 2013).

While the existence of such cycles in the recent past is clear we do not have enough historical resolution to decipher them further back into the past. While some long-term relationships between the Sun and

the Earth's land, oceans and atmosphere may be related to these climatic patterns, they are not understood. Some cycles could be effects of changes that have occurred over eons. Concurrence may be fortuitous. Some changes may be just due to the natural variability and quirkiness in complex nonlinear, chaotic systems. Some cycles, seemingly related to each other, might be driven by other unknown forces or even resonating in their periodicity with other drivers in the climate system.

> *... Natural climate excursions may be much larger than we imagine. So large, perhaps, that they may render insignificant the changes, human-induced or otherwise, observed during the last Century* (Cohn and Lins, 2005).

The Climate Sensitivity Index and Model-land

Some concluding remarks are warranted about the Equilibrium Climate Sensitivity Index as this Index has been central to the climate debate since the development of the first climate computer programs. In the 1960s the first climate computer models were developed by Sykuro Manabe, a Japanese scientist working in the USA. His computer's RAM was half a megabyte and his computer programs took a month to run. Manabe's first model was an Earth section being 120 degrees of longitude with 50% ocean and 50% land. He was soon joined by Richard Wetherald and Kirk Bryan.

In 1979 a US Academy of Science committee met in Washington to discuss estimates for the warming of the Earth if carbon dioxide doubled. Even at this time the only models available were a few from Sykuro Manabe and from the American Dr James Hansen. The key components in the models were:

- Carbon dioxide levels
- Relative humidity
- Cloud cover of the Earth
- The albedo of the Earth (the Earth' surface reflection of solar radiation varied with snow and ice cover)

The committee noted that Manabe's estimate of warming due to a doubling of carbon dioxide levels was 1.5ºC and Hansen's estimate was around 4ºC. Noting the complexity of the problem the committee reported a range from 1.5ºC to 4ºC. Surprisingly this range is still quoted today despite the huge advances in computing power over the last 40 years. And within this Equilibrium Sensitivity Index, the most debatable and uncertain forcing in IPCC reports is *cloud cover.* The IPCC reports that :

> *Cloud feedbacks remain the largest source of uncertainty in climate sensitivity estimates* (IPCC 2007. Section 8.6.3.2).

Today super computers are running climate models but there are still problems with their resolution. As a rule of thumb halving the size of their data cells requires a 10-fold increase in computing power. Just a few of the many problems with the climate models are:

1. What should be the start date? Many start at 1750 AD;
2. What average parameters can we insert for 1750 AD? (e.g. the standard atmosphere in 1750 AD, what water vapour and relative humidity assumptions should be used);
3. There are limitations with one reading for a particular variable within the large area of one cell (e.g. the temperature lapse rate with altitude, the cloud cover at various altitudes and latitudes);
4. The mathematic equations for heat transfer in turbulent conditions in the atmosphere and ocean have not been solved (the Navier-Stoke Equations);
5. The difficulty of modelling ocean currents both at the surface and depth;

At the end of the day there has to be a certain amount of tuning in model-land. To get the models to work, best estimates or what are called parameters for various complex factors have to be inserted into the models, and even then these estimates are varied while the models are running. This is called tuning. The insertion of parameters into the models enables the models to approximate what is happening in the real world. There is a certain amount of circular reasoning in this tuning. So, a model is not necessarily correct just because it predicts how phenomena are behaving. That correctness may just be the result of tuning.

The tuning of models is not new. Over 2000 years ago the Greek astronomers tuned their celestial models. Eudoxus of Cnidus in the 4th century BC attached all the planets to giant glass spheres rotating at different angles and speeds because at certain times Mars seemed to be going backward in the sky; a phenomenon we know today that is due to differential speeds of planets in their elliptical orbits. The Eudoxus model had 27 glass spheres, but then his student Callippus of Cyzicus found anomalies and so he added seven more spheres to better TUNE the model.

While the models are useful in showing how certain forces may interact they are not predictive tools. They cannot can mimic the non-linearity of the climate system nor project forward the cyclical behaviour of past climate cycles. Even the IPCC has acknowledged this:

> *..we are dealing with a coupled chaotic nonlinear system and therefore the prediction of future climate states is not possible..'* IPCC Report 2001 (14.2.2.2).

In Figure 23, Dr John Christy of the University of Huntsville, Alabama compared the temperature projections of 102 climate models between 1979 and 2016 with actual temperature data recorded by balloon instruments and a NASA satellite program. There seemed to be some congruence in both data sets between 1985 and 1995, but after that historical data and model projections diverged significantly. On any level the models overestimated temperature trends. It is not unfair to say that the models are on steroids.

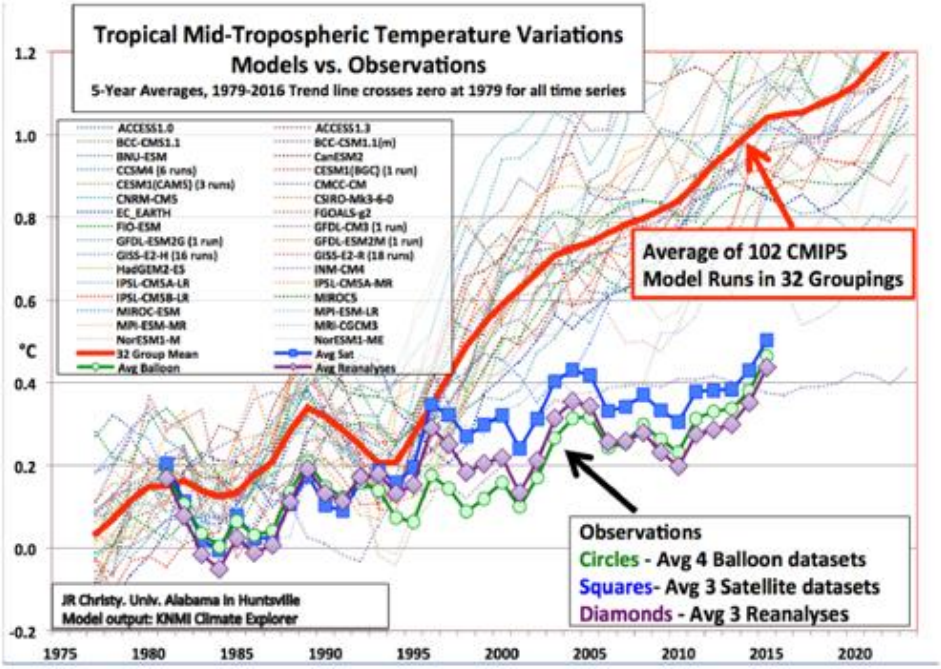

Figure 23:Mid-tropospheric temperature variations between 102 CMIP5 (the Coupled Model Intercomparison Project 5) computer climate models and actual empirical satellite and balloon temperature measurements as charted by Dr John Christy from the University of Alabama, Huntsville. The satellites carry microwave instruments that measure how much heat is given off by oxygen molecules, from which scientists can work out the air temperature. There is good agreement between the temperature data collected from balloons and the temperature data collected from the satellites. The latest computer models (CMIP6) have been reported to project even higher warming in the 21st century than CMIP5 models.

Conclusion

As historical geologists we are like children at a toyshop looking with wonder through a cosmic shop window. We only glimpse some of the interactions of forces operating in over lapping spaces through different timescales over billions of years. However, the more we understand and research historical data, the more we will have a database of patterns and cycles that we can present to climate modellers as a sober reality check on their modelling. The forward projections of these historical cycles must be allowed to speak and be given pre-eminence over model-land.

At the moment many climate scientists are living like actors in the unreal world of model-land. They are much like Truman Burbank played by James Carey in the film -the Truman Show directed by the brilliant Hollywood director Peter Weir. Truman was the one 'true man' who was completely unaware that he was divorced from the real world and actually living within a huge film-set (i.e. the Burbank studios). The climate prophets of model-land live in such a film-set constructed by computer model-land. It is hard to comprehend how climate prophets, such as Tim Flannery in Australia, James Hansen in the USA, Peter Wadhams in England, Hans Joachim Schellnhuber in Germany, are continually forgiven for their failed predictions and yet allowed to keep shifting out their doomsday prophecies by a decade or two. Surely their absurd and failed predictions convey a message to the science establishment and the general public that climate science based on the existing models has completely failed.

The words of James Lovelock are a fitting conclusion to this seminar. Lovelock had the courage, to change his mind, to criticise the computer generated model-land film-set, and to re-enter the real world:-

> *The problem is we don't know what the climate is doing. We thought we knew 20 years ago. That led to some alarmist books – mine included– because it looked clear-cut, but it hasn't happened. The climate is doing its usual tricks. There's nothing much really happening yet. We were supposed to be halfway toward a frying world by now* (Lovelock, 2014 -A Rough Ride to the Future).

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Bibliography

Astrometria – Russian Academy of Science Pulkovo Observatory.
http://www.gao.spb.ru/english/astrometr/index1_eng.html

Axford.Y, Lasher.G, Kelly.M, Osterberg.E, Landis.J, Schellinger.G, Pfeiffer.A, Thompson.E, Francis.D, 2019. *Holocene temperature history of northwest Greenland – with new ice cap constraints and chironomid assemblages from Deltasø.* Quaternary Science Reviews.Vol.215, pp160-172.

Bar-Server, Y et al., 2012. *Geodetic Reference Antenna in Space (GRASP): A mission to enhance Space Geodesy.* (Paper, Jet Propulsion Lab. Caltech under contract to NASA).

Berner, R., Kothavala.Z, 1991. *Geocarb 111: A revised model of the atmospheric CO2 over Phanerozoic time*. American Journal of Science, Vol.301,pp182-204.

Brady. H, 2018. *Mirrors and Mazes: a guide through the climate debate.* https://www.mirrorsandmazes.com.au

Bruun, P., 1988. *The Bruun Rule of erosion by sea level rise: A discussion of two and three-dimensional uses*. Journal of Coastal Research. Vol. 4. No.4. 627–628.

Chylek, P., Dubey, M., Lesins, G., 2006. *Greenland Warming of 1920–1930 and 1995–2005*. Geophysical Research Letters. Vol. 33.

Cooper, J.A.G, Pilkey, O.H., 2004. *Sea level rise and shoreline retreat: time to abandon the Bruun Rule*. Global and Planetary Change 43. 157–171.

Danish Meteorological Institute, 2018, *'Arctic Sea Ice Charts 1893–1965'*, viewed April 2019, *https://nsidc.org/data/g02203.*

Fairbridge, R., Shirley, J, 1987. *Prolonged minima and the 179-yr. solar inertial cycle*. Solar Physics, Vol. 110, 191–210.

Fasullo, J, Nerem, R, Hamlington, B, 2016. *Is the detection of accelerated sea level rise imminent? Scientific Reports*, Vol.6, Article number 31245.

Hansen, J, 2009. *Storms of my grandchildren. The truth about coming climate catastrophe and our last chance to save humanity*. Bloomsbury Press.

Happer.W, Van Wijngaarden. W, 2020. arXiv, Cornell University.
http://arxiv.org/abs/2006.03098

Houston, J.R., Dean, R.G., 2011. *Sea-level acceleration based on US tide gauges and extensions of previous global-gauge analyses.* J. Coast. Res. 27, 409–417.

Johnson, J, Bentley, M, Smith, J, Finkel, R, Rood, D, Gohl, K, Balco, G, Larter, R & Schaefer, J, 2014, *Rapid Thinning of Pine Island Glacier in the Early Holocene*, Science, vol. 343, pp. 999-1001.

Kam-biu Liu, Caiming Shen, Kin-sheun Louie., 2001. *A 1,000-Year History of Typhoon Landfalls in Guangdong, Southern China, reconstructed from Chinese Historical Documentary Records.* Annals of the Association of American Geographers. Vol. 91, No. 3 (Sep., 2001), pp. 453–464

Kench, P, Brander, R, 2006. *Response of reef island shorelines to seasonal climate oscillations.* Journal of Geophysical Research. Vol. 111.

Lamb, H, 1991. *Historic Storms of the North Sea, British Isles and Northwest Europe*. Cambridge University Press.

Laplace. P, 1814. *Essai philosophique sur les probabilités.* https://archive.org/details/philosophicaless00lapliala

Lovelock, J, 2014. *A rough ride to the future*. Publisher – Allen Lane, an imprint of Penguin Books.

Li. Q, Liu.Y, Nakatsuka.T, Lie.R, Cai.Q, Song.H, Wang.S, Sun. C, Fang.C, 2020. *Delayed warming in Northeast China: Insights from an annual temperature reconstruction based on tree-ring* $\delta^{18}O$. Science of the Total Environment Volume 749.

Monbiot, G., 2006. *Heat, how we can stop the planet burning*. Allen Lane publishers.

Nerem, R. S., Beckley, B.D., Fasullo, J.T., Hamlington, B., Masters, D., Mitchum, G, 2018. *Climate-change–driven accelerated sea-level rise detected in the altimeter era*. Proceedings of the National Academy of Sciences.

NOAA website (2020) :*http://tidesandcurrents.noaa.gov/sltrends/sltrends_us.htm*

Rosenthal, Y, Braddock, L, Oppo, D, 2013. *Pacific Ocean heat content during the past 10,000 years*. Science Vol. 342, No.6158, 617–621.

Ollila, A., 2015. Website:- *www.climatexam.com*

Scotese, C. 1999. website of palaeotemperature maps. *http://www.scotese.com/climate.htm*

Shaviv, N, Prokoph, A, Veizer, J, 2014. *Is the solar systems galactic motion imprinted in the Phanerozoic climate*? Scientific Reports 4, No.6150.

Soon, W, Connolly. R, Connolly M, 2015. *Re-valuating the role of solar variability on Northern temperature trends since the* 19^{th} *century*. Earth Science Reviews :- https://doi.org/10.1016/j.earscirev.2015.08.010

Svensmark, H., Friis-Christensen, E., 1997. *Variation of cosmic ray flux and global cloud coverage – a missing link in solar climate relationships* J. Atmos. Sol.-Terr. Phys. 59. 1225ff.

Svensmark, H., 2007. *Astronomy and Geophysics Cosmoclimatology: a new theory emerges.* Astronomy and Geophysics. Vol. 48(1).

Thomas, E, et al., 2013. *A 308 year record of climate variability in West Antarctica*. Geophysical Research Letters. Vol. 40.

Thomas, E, et al., 2015, *Twentieth Century increase in snowfall in coastal West Antarctica.*, Geophysical Research Letters. Vol. 42.

Veizer, J, 2005. *Celestial climate driver: a perspective from four billion years of the carbon cycle.* Geosciences Canada Vol. 32. No.1. 13–30.

Webb, A., Kench, P., 2010. *The dynamic response of reef islands to sea level rise: evidence from multi-decadal analysis of island change in the Central Pacific.* Global and Planetary Change. Vol. 72: 234–246.