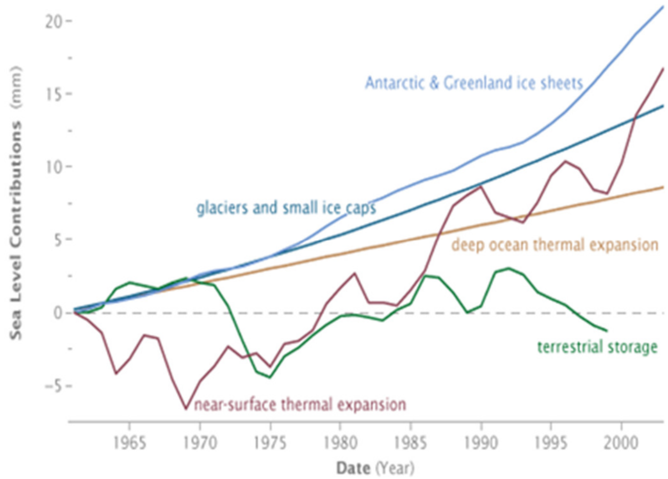
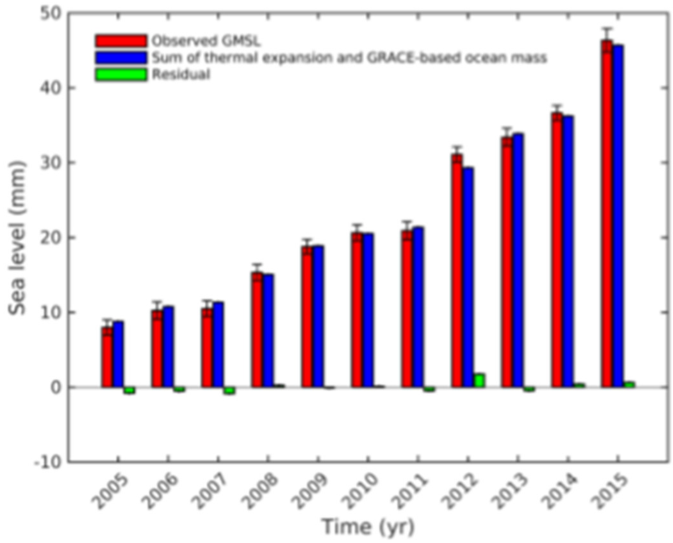
Global Warming Seven Times Faster Than Predicted

Any Climate Change Risk Assessment must start with total ocean rise due to thermal expansion (TORTE), which is a direct measure of the Earth's heat gain (EHG) caused by the presence of greenhouse gases which trap Earth's long wave radiation from returning to space. The graphs below show how TORTE has risen since 1960.

Total ocean rise due to thermal expansion (TORTE) since 1960



Source: NASA[1]



Source: Cazenave A et al. 2018[2]

The two graphs combined show that TORTE zigzagged between 1960 and 1997 with a minimal net rise of 10 millimetres. It accelerated from 1998 so that by 2015 it was 64 millimetres above the 1960 level, i.e. doubling every 7 years. In contrast, the rise in CO_2 levels in the atmosphere was much more modest: 317 parts per million (ppm) in 1960, 383 ppm in 1997 and 398 ppm in 2015. The excess CO_2 over the preindustrial level of 280 ppm should increase EHG in any one period by the average excess CO_2 level in that period multiplied by the number of years of exposure (see appendix). On that basis, the EHG due to CO_2 from 1998 to 2015 was only 80% above the previous period 1960 to 1997. However, the rise in TORTE from 10 mm to 64 mm showed a rise of 540%, 7 times faster than predicted by the CO_2 model.

It is highly doubtful that the continuing rise in CO_2 is now the main cause of global warming. CO_2 increase does not involve a positive feedback loop yet the exponential trend in TORTE in recent years is characteristic of a feedback mechanism.

An explanation lies in the research of PK Pal et al[3] who looked at the relationship between sea surface temperature (SST) in the tropics and upper atmosphere water vapour (UTH). From satellite observations, they derived the following equation:

$$\Delta(\text{GHF}) = 0.032 \times \text{SST} \times \Delta(\text{SST}) - 4.25 \times \Delta(\text{SST}) + 1.37 \times \Delta(\text{UTH})$$

Where ΔGHF is the increase in the greenhouse factor, ΔSST is the increase in SST and ΔUTH is the increase in UTH.

This equation predicts that when the SSTs in the tropics increase by 2°C, the greenhouse factor (GHF) will rise by 10% or 22 watts per m^2 continuously. Since tropical seas occupy 35% of the world's surface area (510 million km^2), this gives an average world increase of 7.7 watts per m^2.

At present the received wisdom is that global warming by 2018 was equivalent to an extra 3.1 watts per m^2 continuously for the whole surface area of the Earth. However, a recent report by Keeling et al[4] showed that the oceans were storing 60% more global warming than previously estimated. They based their research on the outgassing of oxygen and carbon dioxide into the atmosphere from the warmer world's oceans. This implies that the rate of extra heat per m^2 in 2018 was nearer to 5 watts per m^2. This is equivalent to festooning the world with 500 trillion 5-watt lightbulbs that are switched on continuously. However, if global warming is doubling every seven years, then by 2023, five years later, this figure will jump to 8 watts per m^2 which is very similar to PK Pal's estimate of 7.7 watts per m^2 for a 2°C rise in the tropics. On the same trend, by 2030 global warming would be causing 16 watts per m^2 continuously throughout the world's surface area.

It is important to note that even if carbon dioxide is still the main source of global warming and even if it levelled off in 2030, world temperatures will continue to rise until the loss of heat from the Earth equals the heat gained due to the presence of greenhouse gases. This rise can be inferred using the Stefan Boltzmann equation. In its simplest form, it reads as:

$$(\theta + \Delta\theta)^4/\theta^4 = (H + \Delta H)/H$$

Where θ is the Earth's average surface temperature in Kelvin (288°K), Δθ is the increase in temperature as a result of the Earth's heat gain, H is the original net heat from the Sun (220 watts per m^2) and ΔH is the heat gain by 2030 (16 watts per m^2).

To a first approximation, this boils down to the equation:

$$4\Delta\theta/288°\text{K} = 16/220$$

Which makes Δθ equal to 5°K. Nowhere in the IPCC literature does it mention the increasing temperature rise of the Earth due to the Stefan Boltzmann effect.

If TORTE continues to double every seven years, then by 2050 sea rise would be 2 metres due to thermal expansion alone and the temperature in the tropics more than 10°C higher than today. This trend may accelerate because, as PK Pal et al have confirmed, when SSTs exceed the threshold of 300 Kelvin (27°C) evaporation rates nearly treble, leading to strong positive feedback.

Total ocean rise due to ice melt (TORIM) is more difficult to predict. The energy required to raise the ocean level by 14 mm in one year through thermal expansion could also melt enough ice to raise world sea levels by 1 metre. Fortunately, the tropics are a long way from the polar ice caps. At present nearly all EHG is used up warming the oceans; less than 2% melts ice. But the long-term implications of increased ocean temperatures must be considered. The first graph showed that TORIM increased from 14 mm to 21 mm between 1997 and 2003, an increase of 50% over 6 years or doubling every 10 years. If this trend continues, this would produce a sea level rise of 0.5 metres by 2050 due to ice melt. Thus the total sea rise by 2050 would be in the order of 2.5 metres. However, if TORIM began to follow the pattern of TORTE doubling every 7 years this would suggest that by 2050 the total sea level rise would be 4.8 metres above present levels.

In a worst-case reasonable assessment, if the trend continues after 2050 all polar ice would have melted by 2078, raising world sea levels by over 70 metres. That is in 58 years' time: well within the lifespan of today's primary school children.

These estimates assume that ocean circulation patterns will remain the same. According to Schmitt[5], the NAD transfers 400 terawatts of heat continually from the tropics to the North Atlantic raising temperatures by 7°C. Any diminution in the Atlantic Meridional Overturning Circulation (AMOC) would simultaneously reduce temperatures in the North Atlantic while raising sea surface temperatures in the tropical Atlantic, increasing the probability that certain areas would exceed 300° Kelvin, the threshold value at which evaporation rates almost treble. This example is considered further in the appendix.

Although the NAD may decline, increased temperatures in the tropics could initially compensate by transferring water at a higher temperature or by the increased severity and frequency of tropical storm systems and heat waves. However, if the NAD was to cease altogether, this could precipitate a new ice age in the northern hemisphere while at the same time global warming continued until there was an increase in albedo due to increased snow cover (see appendix).

Reducing CO_2 levels will not now prevent increasing global warming but it should be noted that all fossil fuel burning produces extra water vapour: 1 tonne per tonne for oil, 2.25 tonnes per tonne of natural gas and up to 4 tonnes per tonne for wood, particularly in virgin forests. The final destination of this water vapour is important. Even in temperate zones, major cities are heat islands producing large quantities of hot water vapour generated by mass transport; jet engines flying in the upper troposphere inject heated water vapour directly into their flight path; while evaporative cooling of power plants, both fossil fuel and nuclear, assist clear water vapour to ascend. Replacing coal-fired power plants with nuclear would nearly double the waste heat produced per unit of electricity generated as nuclear power plants are less efficient. In any case, impending sea rise requires all coastal nuclear facilities to be removed as soon as possible to avoid widespread contamination of surrounding seas from radioactivity.

Runaway global warming may still occur leading to three possible scenarios for Planet Earth. The most benign would be the return of an Ice Age due to a changed pattern of ocean currents (see appendix). However, higher atmospheric temperatures could eventually lead to a new wave of volcanic eruptions to vent the build-up of heat in the Earth's crust. In the worst case scenario, the atmosphere itself could perish if higher temperatures in the troposphere induced the dissociation of heated water vapour into hydrogen and oxygen; the hydrogen would then be lost to space, leaving the surplus oxygen to combine with carbon in massive fires.

Planet Mars may have followed this route. Once it was warm and moist but now it is dead and cold with an atmospheric CO_2 concentration 30 times that of Earth.

Conclusion

The findings so far point to accelerating global warming which is not challenged by simply focusing on lowering CO_2 levels. Ways have to be found to prevent clear water vapour reaching the upper troposphere, whether it is man-made or produced by higher sea surface temperatures in the tropics. Failure to do so will lead to runaway global warming with disastrous consequences.

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[8] Bryden, Harry & Longworth, Hannah & Cunningham, Stuart. (2006). Slowing of the Atlantic Meridional Overturning Circulation at 25°N. Nature. 438. 655-7. 10.1038/nature04385.

Appendix: Calculations

Earth's Heat Gain (EHG) and the CO_2 model

The CO_2 model calculates EHG in any one period by multiplying the average excess CO_2 level over the pre-industrial level of 280 ppm by the number of years of exposure (ECO_2Y). In the 38 years between 1960 and 1997 inclusive, the average excess CO_2 level was 60 ppm so ECO_2Y=2280. In the 18 years between 1998 and 2015 inclusive, the average excess CO_2 was 102 ppm so in the latter period ECO_2Y=1836, 80% greater than in the previous period. In the latter period, TORTE increased by 540%.

Total Ocean Rise due to Ice Melt (TORIM)

Since the total surface area of the oceans is 361 million km^2, a one metre rise is equivalent to melting 361 trillion tonnes of ice. 91.2 kilowatt hours (KWh) will melt 1 tonne of ice therefore 1 metre of TORIM needs 33 million terawatt hours (TWh) which is equivalent to an EHG over the total world's surface of 3,758 terawatts or 7.37 watts per m^2. This is almost equal to the estimated 7.7 watts per m^2 generated by a 2°C rise in tropical waters according to PK Pal. However, as has been noted earlier, most of the EHG will not go into ice melt but into raising the temperature of the oceans.

Ocean circulation and heat transfer – example: the North Atlantic Drift (NAD)

The NAD is energised by the Broecker conveyor belt which is believed to start in the Fram Strait off Greenland. In 1997, Professor Peter Wadhams[7] aboard the British nuclear submarine HMS Tireless, observed several "whirlpools" or "chimneys" in the Fram Strait where cold saline water was sucked down to the ocean seabed 3,000 metres below, driving the continuing anti-clockwise circulation of the NAD. However, in 2001 he observed only two "chimneys" and concluded it was very unlikely there were any more. This reduction suggests that overall decline in NAD circulation is continuing. Bryden et al[8] concluded in 2005 that this decline could be as much as 30%. Schmitt calculates that the total heat transferred by the NAD equals 400 terawatts (TW). A 30% decline is equivalent to a loss of 120 TW in the North Atlantic but an equal gain in the tropical Atlantic. Since the area of the latter is around 40 million km^2, this amounts to a heat gain of 3 watts per m^2. This could be a minimum estimate as the return leg of the NAD picks up very cold water from the ocean bottom at 4°C. When it re-emerges in the Caribbean and mixes with warmer waters it clearly reduces surface water temperatures so a 30% reduction in the volume of the return leg would be equivalent to heat gain two or three times greater than 3 watts. In other words, a faltering NAD could have already contributed an extra heat gain to the tropical Atlantic of between 0.3°C and 1°C. The reduction of chimneys between 1997 and 2001may have signalled a dramatic decline in the NAD at that time with a consequent jump in tropical Atlantic temperatures which may have initiated the observed exponential increase in global warming.

A New Ice Age?

A study by Sikes et al[4] based on analysis of 30,000 years of phytoplankton production revealed that even during the height of the last Ice Age the decline in the temperature of the tropical Atlantic was very small. Since the last Ice Age was associated with a complete cessation of the Broecker conveyor belt, this should in itself have produced a warming in the tropical Atlantic of between 1° and 3°C. Its actual slight decline in temperature implies that whole Earth cooling was in the range of 1° to 3°C. This was most likely caused by an increased albedo due to greater coverage of ice in the northern hemisphere. If this pattern was repeated today, we could expect at least an additional 12% of the northern hemisphere being permanently covered by ice and snow. Scotland and northern England would be uninhabitable and so too would large parts of North America, northern Europe and northern Russia.

The accelerated melting of the Greenland icecap may bring about this abrupt change as increased ice melt could reduce the salinity in the Fram Strait necessary to drive the Broecker conveyor belt. There would then be an immediate and dramatic drop in temperature in north west Europe of up to 7°C. This colder climate would intercept excursions of warm, moist air from the tropics creating massive snowfall and rapid glaciation. There is a finite probability that by 2030 much of northern Europe's infrastructure will collapse due to an abrupt stoppage of the Broecker conveyor belt. Unfortunately, it will not be possible to prevent such an outcome but it is impossible at this stage to put a number on when and if it would occur.

Under the precautionary principle, this uncertainty should be addressed immediately by examining those projects where failure of continuous maintenance could occur with catastrophic results if a new Ice Age abruptly re-emerged. Near the top of the list must be the Sellafield nuclear reprocessing plant. At present it stores nuclear waste in both liquid and solid forms which has to be constantly cooled. The liquid waste is being drawn down through vitrification but spent fuel storage is continuing to increase with the most recent spent fuel posing the greatest threat if cooling failed. This could result in nuclear fires which could contaminate large areas of Europe. This threat is very real unless an alternative scenario can be constructed. In the meantime, nuclear power production may have to cease in order to minimise the heating effect in the cooling ponds.