

Climate Science and Policy for Nonscientists

One picture is worth a thousand words.

TIPPING POINTS AND THE PARIS AGREEMENT GOALS

The primary driver of climate change is rising temperatures, and temperatures are rising at a relatively linear rate, so the responding climate changes tend to be linear, not accelerating or unstable, as proposed by the theory of Tipping Points.

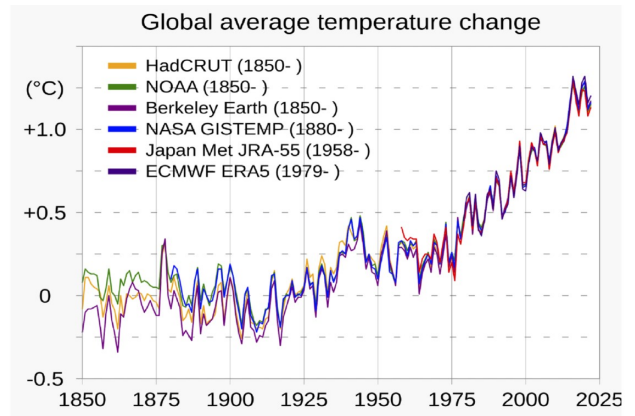
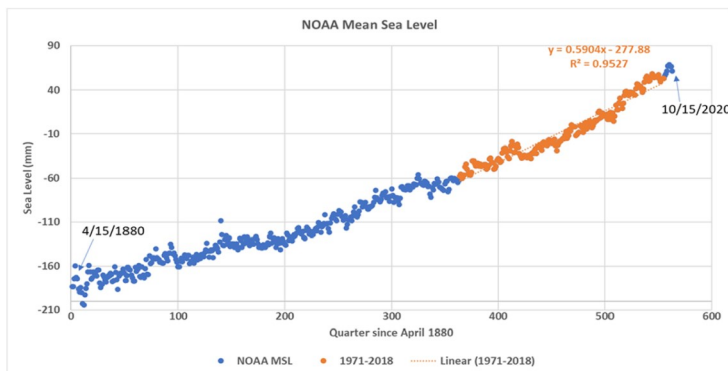
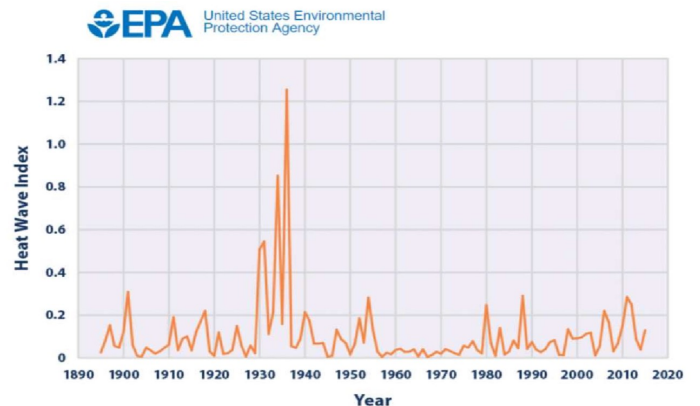


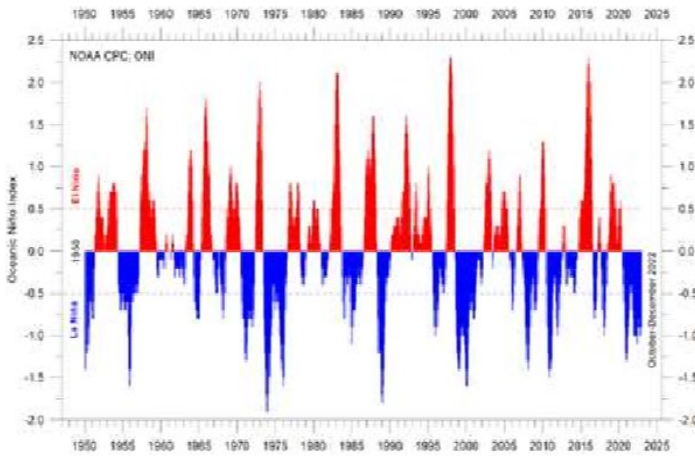
Figure 1 Global average temperature anomaly.



For example, sea levels have been rising at a relatively linear rate. Precipitation is projected to increase at 1-3% per degree C. (AR6 WGI p.615). Heatwave temperature extremes tend to increase linearly with global warming. (AR6 WGI p.1554).

When there is an extreme departure from the trend, such as with the US Heatwave Index in the mid-1930s, the climate does not “tip.” Rather it returns toward the mean in accordance with Le Chatelier’s Principle, which states that natural systems demonstrate negative feedbacks - they return towards the previous mean. The theory of Tipping Points is based on there being positive (accelerating or destabilizing) feedbacks in nature.





As shown with the El Niño index, the climate tends to move in cycles. There is no history of Tipping Points occurring in the past. Life first appeared on earth over three billion years ago, and, since then, climate history has demonstrated an “enduring habitability” for life.

The Paris Agreement of 2015 established the 1.5 C and 2 C temperature goals that are often mentioned in the media. It is obvious from the actual wording of the Agreement that these are targets to reduce the amount of risk, i.e. there is less risk if the world warms 1.5 C than if it warms 2 C, less risk if 2 C than if 2.5 C, etc. The 1.5 C and 2 C are political goals, or aspirational goals. There is no science showing that the risk suddenly accelerates if warming reaches 1.5 C or 2.0 C. The world has already warmed 1.2 C and will not hit some Tipping Point if it warms another 0.3 C.

Paris Agreement 2015, Art. 2, Sec. 1

This Agreement...aims to strengthen the global response to the threat of climate change...by

Holding the increase in the global average temperature to well below 2 C above pre-industrial levels and

pursuing efforts to limit the temperature increase to 1.5 C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.

Paris Agreement 2015, Art. 4, Sec. 1

Parties aim to reach global peaking of greenhouse gas emissions as soon as possible...

and to undertake rapid reductions...so as to achieve a balance between...emissions, and removals...in the second half of this century,

on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.

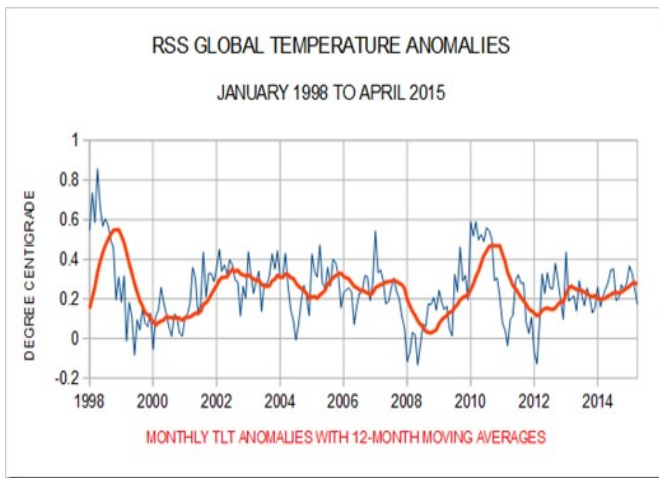
The Paris Agreement also vaguely established what has become known as the Net Zero goal. The actual text, shown here, is vague as to the actual goal and the timing of achieving the goal, but the phrasing of this goal has been twisted by commentators into “Net Zero by 2050.” Where did these Paris goals come from?

Copenhagen Accord 2009

We shall recognize “the scientific view that the increase in global temperature should be below 2 degrees Celsius, on the basis of equity and in the context of sustainable development.

We agree that deep cuts in global emission are required according to science, and as documented by the IPCC Fourth Assessment Report.”

The 2 C limit appears to go back to a 1977 to a study by an economist that concluded that the world’s temperature variability over the last many thousands of years has been around 2 C with the low point occurring in the Little Ice Age, now referenced as the Preindustrial Period. The 2 C goal first appeared in an international agreement in the Copenhagen Accord of 2009, which cited as a basis for the goal the IPCC’s Fourth Assessment Report of 2007 (“AR4”). In AR4 most of the models projected temperature increases by 2099 to be substantially in excess of 2 C. (AR4 WGI p.13)



But world temperatures from 1999-2015 were flat. This period became known among scientists as “The Pause,” or “The Hiatus.” Nevertheless a group of small island nations at the Cancun climate conference of 2010 started a push to have the 2 C goal reduced to 1.5 to prevent, supposedly, their nations from being inundated by sea level rise. As a compromise, the Paris Agreement in 2015 kept the 2 C goal but added the language about “pursuing efforts to limit the temperature increase to 1.5.”

**IPCC AR5 (2015) –
CONCLUSION ON CAUSATION (WGI p.17)**

“It is extremely likely that *more than half* of the observed increase in global average surface temperature from 1951-2010 was caused by the increase in greenhouse gas.” (italics added)

Due to “The Pause” the IPCC’s Fifth Assessment (AR5 2013) was forced to back off a number of the findings that appeared in AR4. In particular AR5 admitted in a back-handed way that up to half of the world’s warming since 1951 could have been caused by natural variability. (AR5 WGI p.17)

The Paris Agreement of 2015 could not cite AR5 for support, and it could no longer cite AR4, which had been superseded and modified by AR5. With respect to the 1.5 or 2.0 goal the Paris text makes no claim to a particular scientific basis, but states that achieving the 1.5 goal would “significantly reduce the risks and impacts” presumably in relation to a 2.0 temperature rise. It is undisputed that the risks of temperature increase with the temperature. But scientists disagree about how much risk (and how much benefit) there is with particular temperature rises.

Roger Pielke, Jr. – 2 C is an arbitrary round number that was politically convenient. So it became a sort of scientific truth. However, it has little scientific basis but is a hard political reality.

David Victor and Charles Kennel – There is little scientific basis for the 2 C figure, but it was a simple focal point, and it sounded bold and perhaps feasible while also being effectively unachievable.

Hans Schellenhuber – 2 C degrees is not a magical limit – it’s clearly a political goal.

Rupert Darwell – The 1.5 C limit has nothing to do with science and everything to do with politics and green ideology.

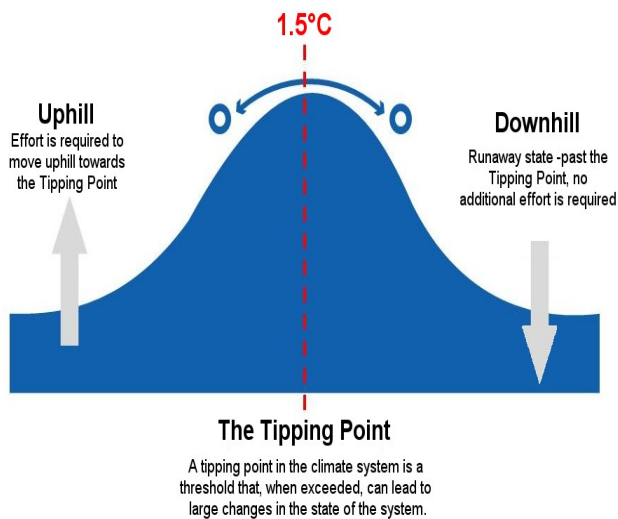
With the commonly stated goal of “Net Zero by 2050,” there is no scientific basis for the year 2050. It is difficult to find any scientific basis for any of the Paris goals, as has been pointed out by many scientists. Yet in 2018 the IPCC staff published a press release warning that, “Humanity has only 12 years left to prevent a global climate catastrophe if global warming can not be limited to 1.5 C.” And we have now already warmed 1.2 C. from preindustrial levels. (AR6 WGI p.5)

The media has long used the idea of Tipping Points to cause fear. For example, the Time magazine cover of April 3, 2006, warned, “Be very worried. ... Earth at the Tipping Point.”



The concept of a “tipping point” is taken from physics. If the center of gravity of a leaning object moves outside the object’s base, the force of gravity will bring the object crashing to the ground, which, if the object is a building, such as the Leaning Tower of Pisa, would destroy the building.

Tipping Point Effect



This image provides some examples of statements from the media linking Tipping Points with the Paris goals of 1.5 and 2 C.



Since the Paris Agreement, the media has attempted to link Tipping Points with the 1.5 and 2.0 numbers from that Agreement, such as with this image. But, if the Leaning Tower of Pisa fell, it would not fall due to some positive feedback. It would be pulled down by the force of gravity. The idea that the climate system is unstable and can “runaway” on its own (positive feedback) beyond some particular point (the Tipping Point) with no additional force being applied (“no additional effort” required) is scientifically flawed.

- If we pass 2 C, we risk hitting one or more major **tipping points**, where the effects of climate change go from advancing gradually to changing dramatically overnight reshaping the planet.
- Most major **tipping points** will be reached if Earth warms past 2 C.
- Climate **tipping points** may be triggered even if warming peaks at 1.5 C.
- Climate change will be sudden and cataclysmic. We need to act fast.
- For example, coral reefs could almost entirely vanish as the warming breaches the 1.5 C line.

Tipping Point: A critical threshold beyond which a system reorganizes, often abruptly and/or irreversibly.

Abrupt Change: A change in the system that is substantially faster than the typical rate of the changes in its history.

Irreversibility: A perturbed state of a dynamic system is defined as irreversible on a given time scale if the recovery from this state due to natural processes takes substantially longer than the time scale of interest.

And then the media claims that a “Tipping Point” is something leading to “catastrophic climate change.” But the actual scientific content of IPCC AR6 does not support these claims. The media commonly ignores the actual science set out in the IPCC reports, while claiming that the science supports them.

The IPCC in AR6 has watered down the definition of “tipping point” so that it can be used to mean nothing more than a change that is “substantially faster” than what is considered a “typical” rate. (AR6 WGI p. 2216, 2236, 2251). The scientists writing sections of AR6 use this definition. The definition of “irreversibility” is also vague and subjective.

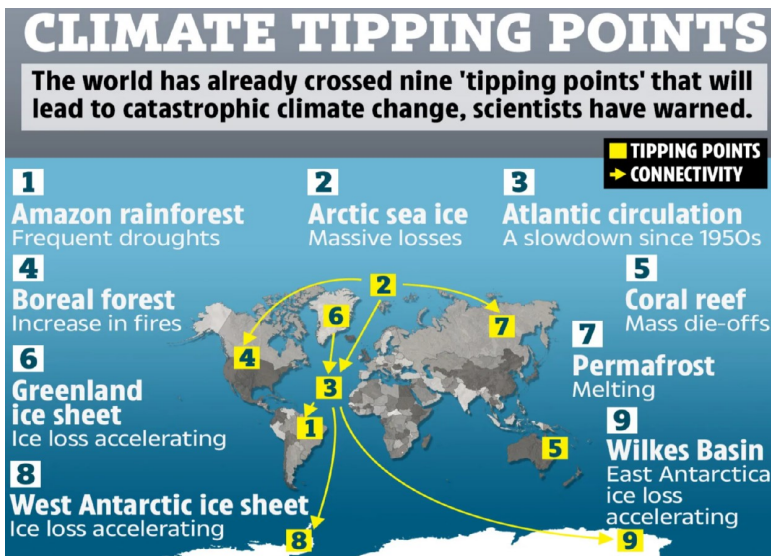
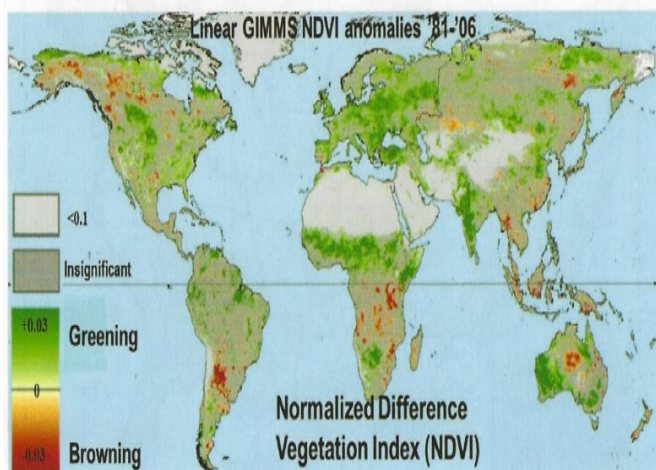


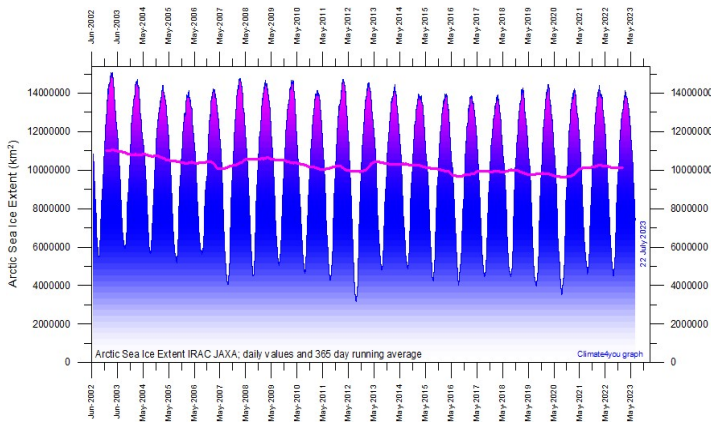
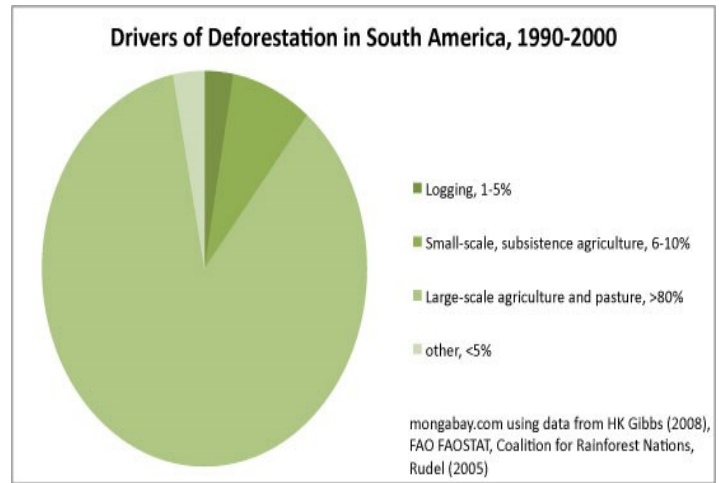
Figure II-3: Thanks to our changing climate, much of the world is greening.



(modified from de Jong 2011)

1. Amazon Rainforest - There are no “frequent” droughts. In general, world precipitation is increasing at about 1-3% per 1 C of warming (AR6 WGI p.615, 1057), and the world is greening (WGI p.292, 365-6, and see the CLISCIPO Science Topic Post: Greening World). The area of the Amazon is slightly greening with some slight browning, as shown. AR6 has “low confidence in broad patterns of future drying or wet trends...in the humid tropics, although drying trends have been detected and predicted in *parts* of the Amazon. (WGI p.1848 italics added). There have been “*periodic droughts in parts of the Amazon since the 1990s, partly attributed to climate change.*” (WGII p.50 italics added). When it comes to an Amazon tipping point, AR6 has “low confidence a change will occur by 2100.” (WGI p.1860).

The main driver of deforestation in South America is direct habitat destruction by human activity, which has nothing to do with climate change and everything to do with the environmental policies of South American governments, particularly Brazil. Deforestation can then lead to drought, as AR6 comments, “Increased deforestation leads to a drier climate, although not all models show a true tipping point. ... Abrupt Amazon dieback does not occur consistently across or even within Earth System Models.” (WGI p.1149).



2. Arctic Sea Ice - There are no “massive” losses. As shown, Arctic sea ice is down about 9% over the last 21 years. Concern has been greatest about the summer minimum that occurs in September. Since 1979 the summer minimum has been down 40% while the winter maximum (March) has been down 10%. (AR6 WGI p.5). Melting sea ice does not raise ocean levels.

In 2008 scientists claimed that we had already reached an Arctic tipping point, and that the Arctic would be free of ice in 5-10 years or by 2013-2018.

The Argus-Press • Owosso, Michigan • Tues., June 24, 2008

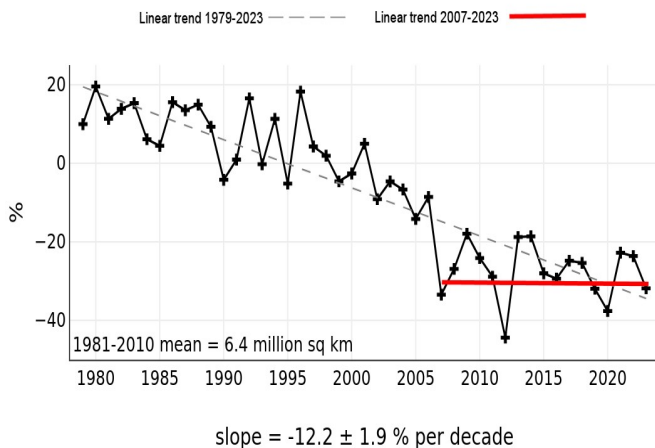
By SETH BORENSTEIN
AP Science Writer

NASA scientist: ‘We’re toast’

“We see a tipping point occurring right before our eyes,” Hansen told the AP before the luncheon. “The Arctic is the first tipping point and it’s occurring exactly the way we said it would.”

Hansen, echoing work by other scientists, said that in five to 10 years, the Arctic will be free of sea ice in the summer.

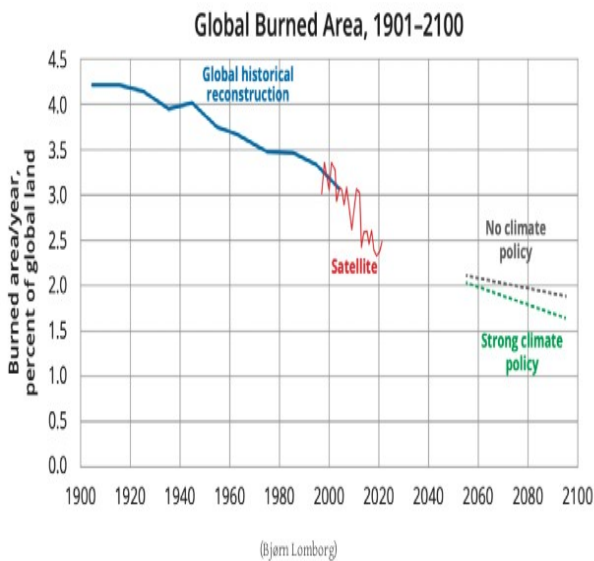
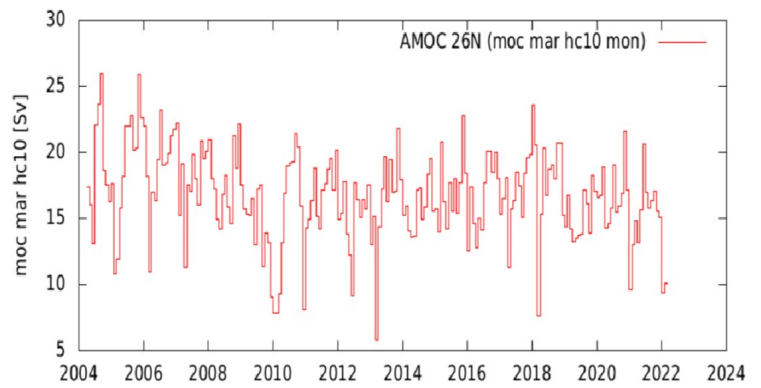
Northern Hemisphere Extent Anomalies Sep 1979 - 2023



National Snow and Ice Data Center, University of Colorado, Boulder

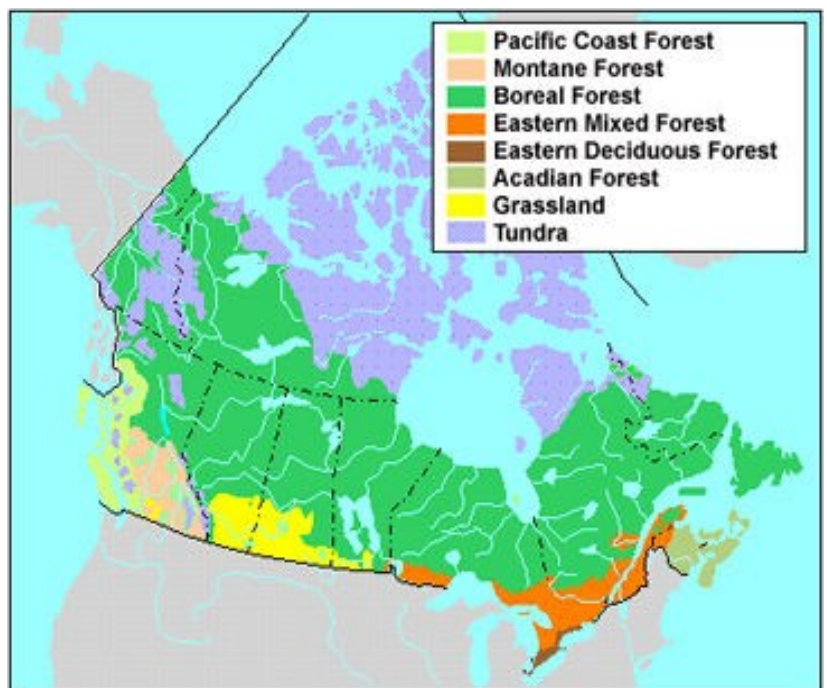
But for the 16 years since 2007 Arctic summer sea ice is unchanged. The downward trend has stopped. The IPCC says, “Arctic summer sea ice varies approximately *linearly* with global surface temperature, implying that there is no tipping point and observed/projected losses are potentially reversible.” (WGI p.76, 1215 italics added). As to Antarctic sea ice, AR6 finds no significant trend since 1979. (WGI p.76).

3. Atlantic Circulation - There is evidence that the Atlantic Meridional Overturning Circulation (AMOC) has slowed by 15% since 1950, but this is not significant. Good data goes back only to 2004, and this data shows a weakening from 2004 to 2008 but no particular trend since then. The AMOC is important, because the Gulf Stream, which warms Europe, is part of it. AR6 says that it is “very likely” that AMOC will weaken by 2100. (WGI p.1148). But there is “low confidence” that an AMOC-driven abrupt change in the water cycle will occur by 2100 (WGI p.1149), and, “While the AMOC is expected to slow in a warming climate, the Gulf Stream will not change much.” (WGI p.1320). There is “medium confidence that AMOC will not collapse before 2100.” (WGI p. 1059).



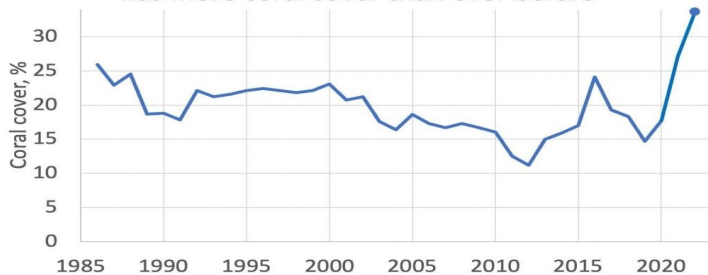
4. Boreal Forest - While wildfires are increasing in some regions, such as California, globally wildfires have been declining and are projected to decline in the future. AR6 defines “fire weather” as a combination of drought and higher temperatures. Thus AR6 concludes that, “*In many fire-prone regions...increased severity of future drought and heatwaves may lead to an increased frequency of wildfires.*” (WGI p.1600 italics added). But, in general, rainfall is slightly increasing, and the world is greening. There is a “difficulty” in attributing wildfires to climate change, because wildfires are also caused by human activity and vegetation changes. (WGI p.1838)

The claim of a tipping point is made only as to “boreal” or Northern forests, thus conceding that there is no Tipping Point as to the forests in the rest of the world. Such forests exist primarily in Canada and Siberia. As the world gets warmer and greener, vegetation expands and grows closer to the poles. In particular, tundra areas of Siberia melt and grow vegetation. This allows wildfires to occur in areas where they could not occur previously due to the absence of fuel. So AR6 notes that there is “increasing risk” of wildfires in boreal Siberia due to “increasing forest productivity.” (WGI p.1976).



Great Barrier Reef: Never Better

Since 1986, Australia has measured the reef every year
This year is unprecedented: Two-thirds of the reef has more coral cover than ever before

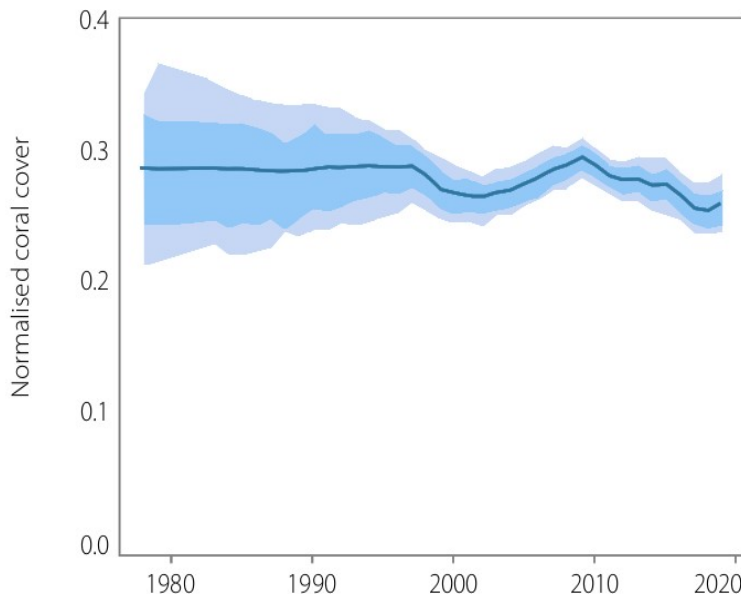


The Australian Institute of Marine Science publishes the official results for Northern, Central and Southern GBR for each year, <https://www.aims.gov.au/monitoring-great-barrier-reef/gbr-condition-summary-2021-22>. Here they find "36-year highs across two-thirds of the Great Barrier Reef." How they compute the full average is not disclosed. Here last two years estimated using weights on the three published sectors to minimize square difference to their latest GBR-wide data series from 1986-2020, published <https://www.thecourier.com.au/story/7069344/see-it-before-its-gone-a-fact-check-on-the-decline-of-our-biggest-coral-reef/>, twitter.com/bjornlomborg

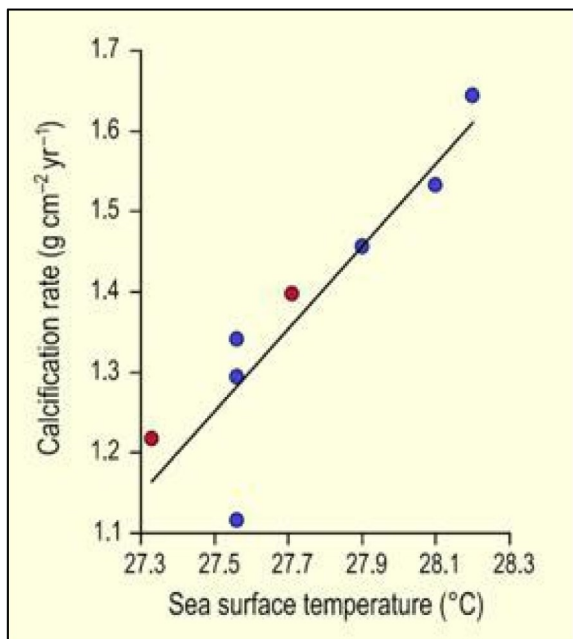
The limited data available shows little trend at all in the global coverage of hard coral since about 1977. It would take a huge increase in sea surface temperature to cause significant coral die-off.

Figure 8: Global cover of hard coral

Estimated global average cover of hard coral (solid line) and associated 80% (darker shade) and 95% (lighter shade) credible intervals, which represent levels of uncertainty. Graph redrawn from GCRMN data report. Note, data before 1998 has very high uncertainty due to low number of measurements and problems with randomisation of sampling sites.

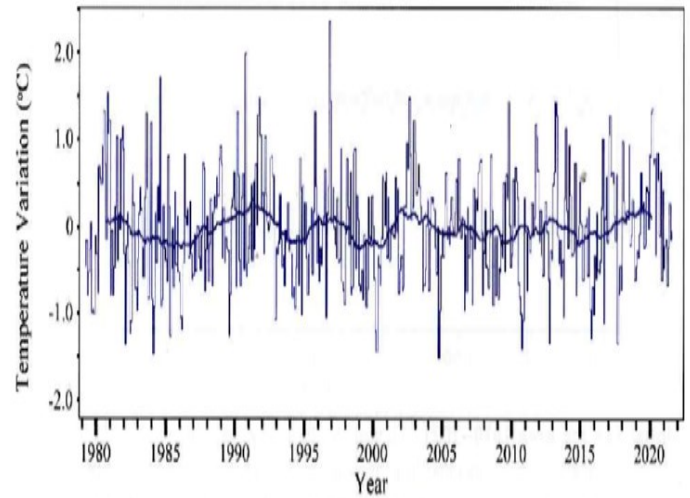


Positive impact of warmer temperatures on reef-building coral in the Caribbean



Without citation or estimate of likelihood, AR6 says that "70-90% of coral reefs are *projected* to decline at a warming level of 1.5 C." (WGI p.1966 italics added). The world has already warmed 1.2 C since the preindustrial period, and no significant negative effect on coral has appeared. Another 0.3 C warming will not cause 70-90% of coral reefs to decline. Rather in many parts of the world, such as the Caribbean, warming sea surface temperatures will result in greater coral growth, not coral die-offs. In general, corals grow about 15 per cent faster for every degree temperature rise, and most coral species can live in a range of water temperatures. Modern coral has existed for over 60 million years and has survived climates 5 C or more warmer than today.

6, 8, and 9. Greenland and Antarctic Ice Sheets - There has been ice loss, but it is not significant. As shown, Antarctic temperatures have not changed at all since 1980. The average temperature inland is -71 F. The average along the coast is 14 F. Ice melts at 32 F, so how much ice can melt? We care about the Greenland and Antarctic ice sheet, because, if they melt, this adds to sea level rise. AR6 concludes that Antarctic ice sheet melt over the period 1992-2020 added only 0.3 inches to the sea level (rate of 1.1 inch per century). Looking forward, AR6 expresses medium confidence that the ice sheet will *increase*, not diminish, in the future. (WGI p. 1267-8).



Antarctic Tropospheric Temperature Variation 1979–2021. Monthly Antarctic temperature data from MSU UAH satellites shows flat temperatures over the last 40 years. The thick line is a 37-month running average. (UAH, adapted from *Climate4You*, 2021)⁶⁸

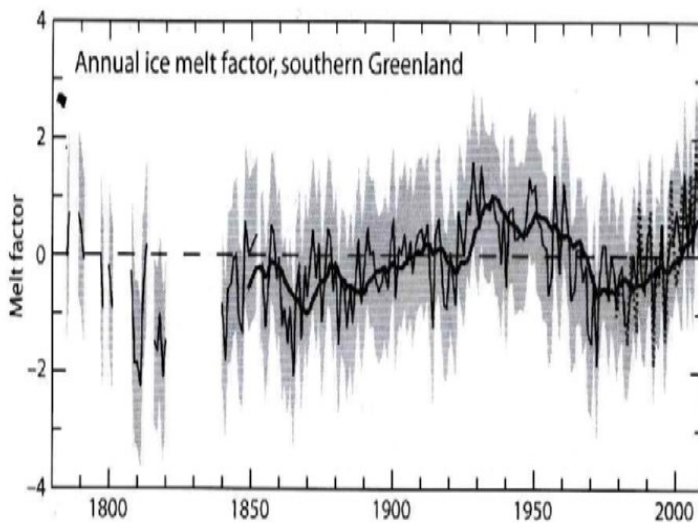
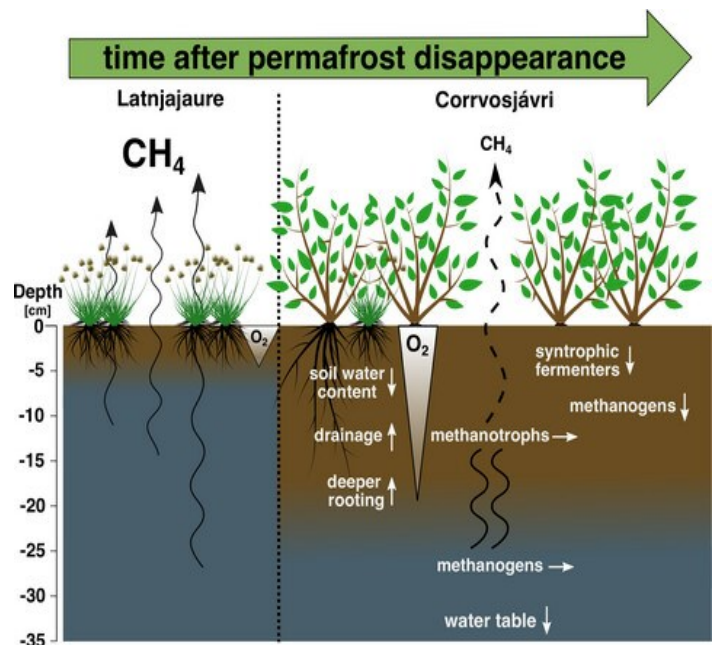
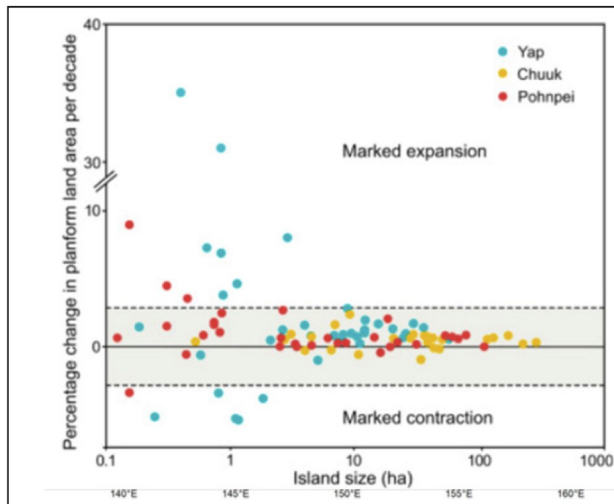


Figure 53 . Greenland ice melt rate reconstruction.

As to the Greenland ice sheet, the melt rate appears to be moving with the world temperature. AR6 says that scientists have difficulty modeling it, but that it is “virtually certain” the ice sheet will continue to lose mass through 2100. (WGI p. 1259-1260). AR6 expresses no opinion as to the amount of estimated future melting. The actual melting 1992-2020 added 0.53 inches to the world sea level rise, a rate of rise of 1.9 inch per century (WGI p.1251), a long-term concern but hardly a “catastrophe.”

7. Permafrost Melting - With global warming permafrost areas, such as in Canada and Siberia, are melting, which allows the expansion of vegetation and also releases some greenhouse gases, principally methane (CH₄). AR6 says that there is “large uncertainty” about the release of greenhouse gases from permafrost in the 21st century (WGI p.740), and that there is “low confidence” in the timing, magnitude, and linearity of the permafrost climate feedback. (WGI p.728). Further the “models do not identify any one amount of warming at which permafrost thaw becomes a ‘tipping point’ or threshold. (WGI p.773).





A 2019 global-scale analysis of 709 islands in the Pacific and Indian Oceans revealed 89% were either stable or growing in size, and that no island larger than 10 ha (and only 1.2% of islands larger than 5 ha) had decreased in size since the 1980s ([Duvat, 2019](#)).

A new analysis of post-2000 trends also indicates global-scale stable to expanding shorelines for hundreds of Pacific and Indian Ocean islands, with over half of the net growth (39 km² of 62 km²) occurring from 2013 to 2017.

Sea Level Threat to Small Island Nations - The 1.5 C goal was added to the Paris Agreement at the behest of a group of small island nations fearing inundation. But a recently-published massive survey paper (see above) summarized other papers that had studied in total 709 small low-lying islands. The survey concluded that 73% of the islands were stable in area, 15.5% increased in area, and only 11.4% decreased in area. AR6 cites this study and concludes that “over the past three to five decades, shoreline changes were dominated by stability on reef islands.” (WGII p.2055; and see the CLISCIPO Science Topics Post: Sea Levels).

CONCLUSION

Where are the peer-reviewed papers establishing a scientific basis for the Paris goals? If there were any, scientists and environmentalists would widely publicize them. They have not. Is it because they do not exist?

What so-called Tipping Points are supported by AR6, the latest IPCC Assessment Report (2021)? Most particularly, where is the scientific support for the idea that any Tipping Point will be reached if the world warms another 0.3 C to 1.5 C or another 0.8 C to 2 C above the preindustrial temperature?



Works Cited

- Intergovernmental Panel on Climate Change, Assessment Report 4, Working Group I, The Physical Science Basis (2007) (AR4 WGII)
- Intergovernmental Panel on Climate Change, Assessment Report 5, Working Group I, The Physical Science Basis (2013) (AR 5 WGI)
- Intergovernmental Panel on Climate Change Assessment Report 6, Working Group I, The Physical Science Basis (2021) (AR6 WGI)
- Intergovernmental Panel on Climate Change Assessment Report 6, Working Group II, Impacts, Adaptation and Vulnerability (2022) (AR6 WGII)