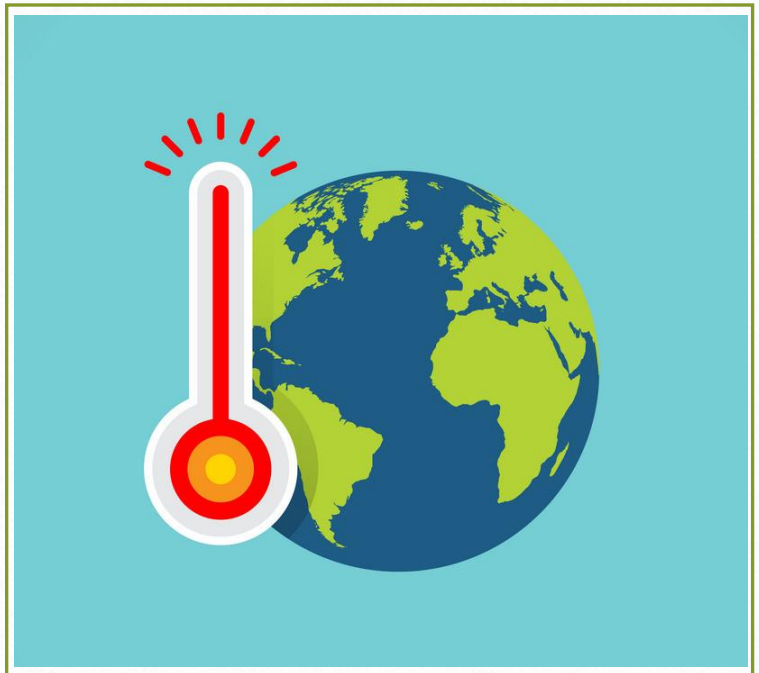
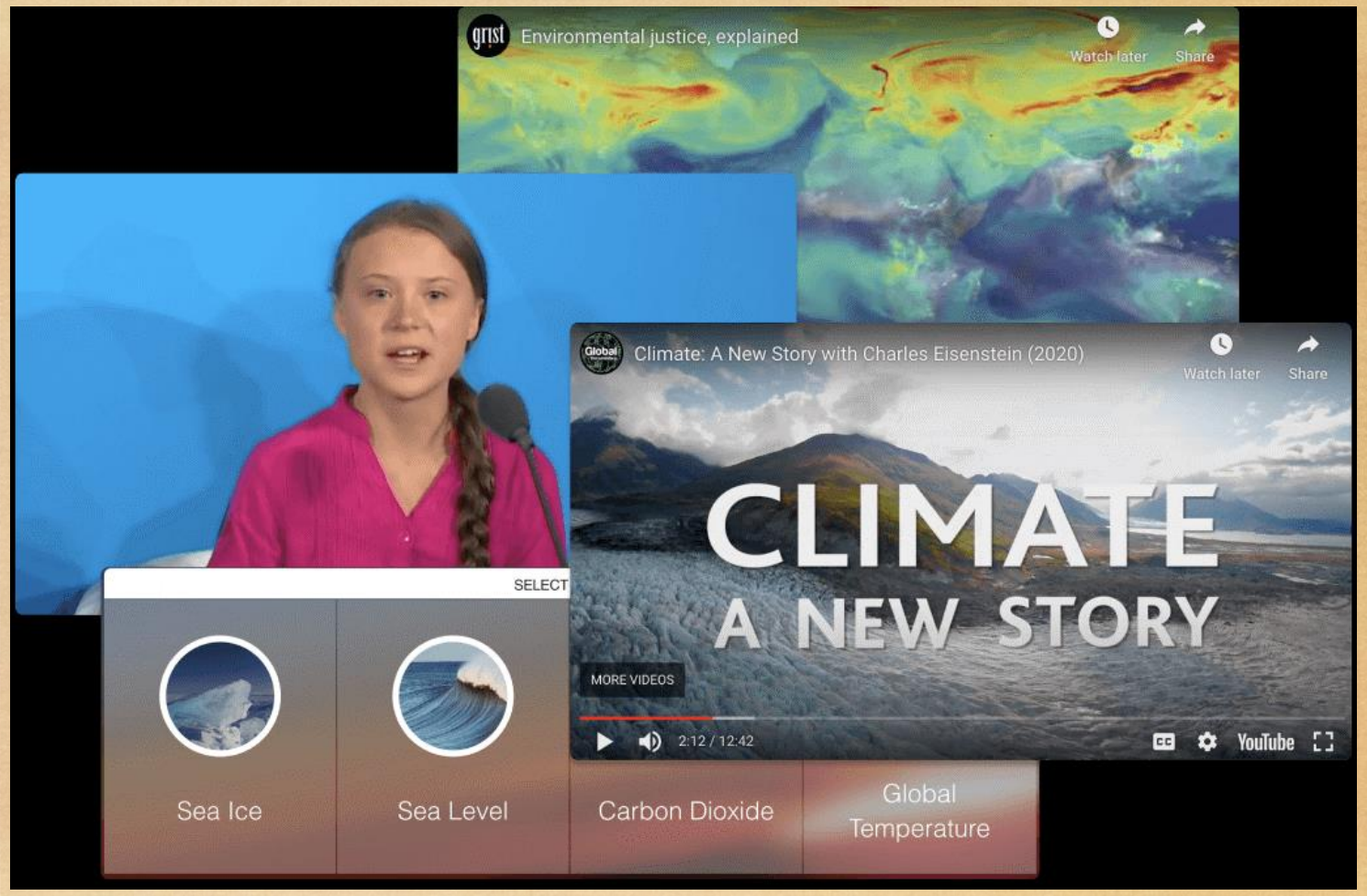


Is global warming a big problem?

Jan Ruis, PhD, biologist

May 2022



In this presentation, we first look at the properties of greenhouse gases and the climate of the past and present.

Then we consider the heat-trapping properties of CO_2 and the performance of the IPCC climate models.

Finally, we discuss the reports on climate-related disasters.

CO_2 is an invisible natural gas and no air pollution

Misunderstandings

Many people confuse climate with environment

&

climate change with environmental pollution:

"a clean climate"
"our climate is doing badly"
"towards a stable, safe climate"

Climate = the average weather over a longer period, e.g. 30 years. The driver behind the earth's climate is the Sun.

Climate change = change in average weather over a longer period. Present meaning: global warming due to emissions of greenhouse gases, in particular CO_2.

Environment = living environment of plants, animals and people.

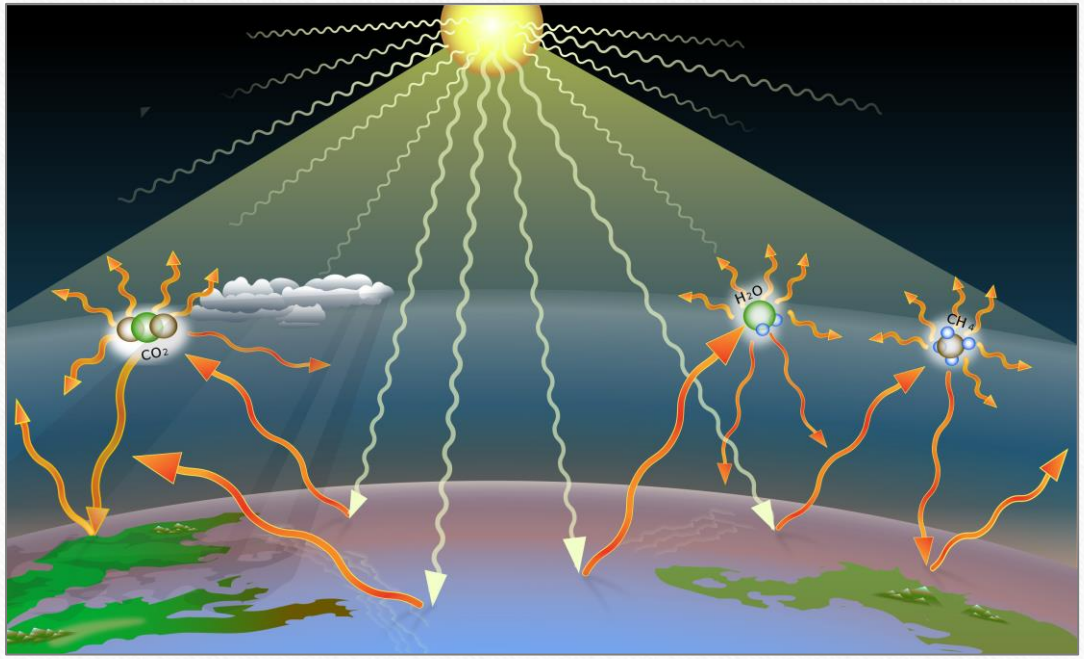
Environmental pollution = environmental degradation by humans, such as air pollution, water pollution and soil pollution.

Greenhouse gases (1)

The main greenhouse gas is H_2O, in the form of water vapor and clouds, and makes up 0-4% of the atmosphere. It is responsible for about 70-80% of the greenhouse effect that keeps the planet habitable.

Due to the short residence time in the atmosphere (before it precipitates), water vapor does not contribute to warming over a longer period of time (no *climate forcing*).

But because warmer air can retain more moisture, it is an important feedback process in those climate models: it amplifies or weakens the potential warming due to greenhouse gases that remain in the atmosphere for a long time, such as carbon dioxide (CO_2) and methane (CH_4). CO_2 contributes 10-20% to the greenhouse effect.



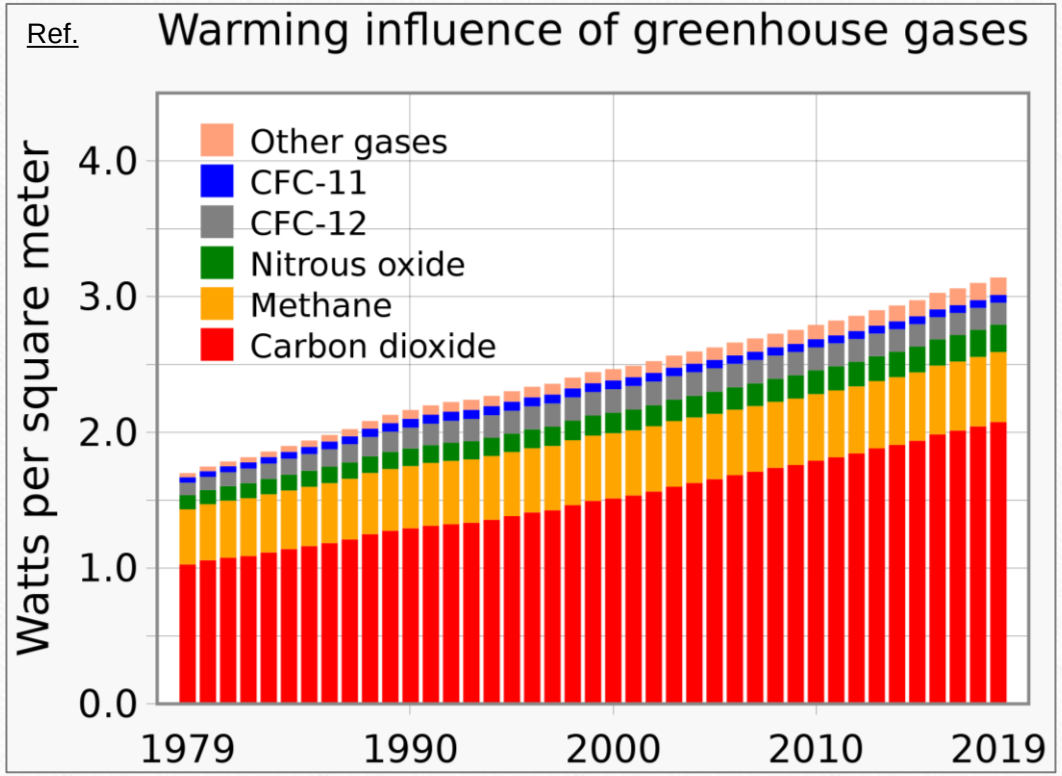
Greenhouse effect. Sunlight that reaches the earth's surface heats the surface which then emits heat radiation (Infrared) upwards. The greenhouse gases present in the atmosphere (H_2O, CO_2, CH_4) absorb that infrared radiation and then emit it in all directions, causing the atmosphere to heat up.

The CO_2 content has increased since the 18th century. Because this gas remains in the atmosphere for a long time, this causes the *enhanced greenhouse effect.*

Greenhouse gases (2)

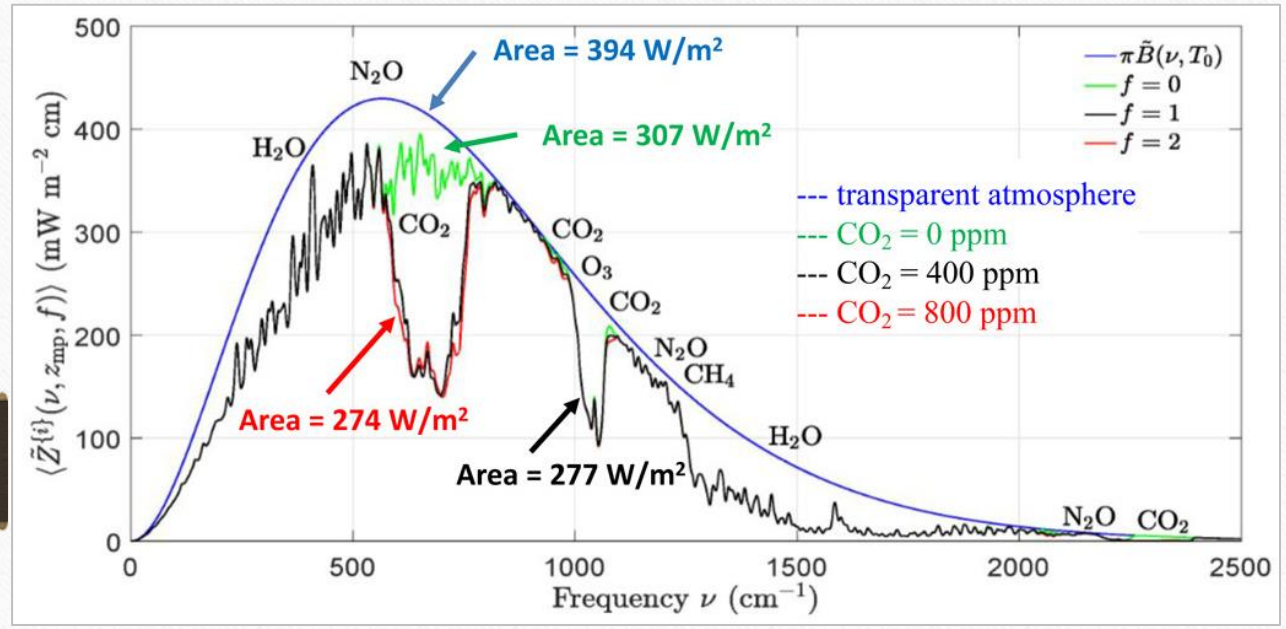
Although methane (CH_4) is a 30x stronger greenhouse gas than carbon dioxide (CO_2), the annual rate of increase of CO_2 is 300x greater. So the contribution of methane to annual climate forcing is one-tenth (30/300) that of carbon dioxide, or only about 0.002°C/year. (ref.).

The current strong restrictions on methane emissions, especially from livestock farming and rice cultivation (ref.), are not justified by these facts.



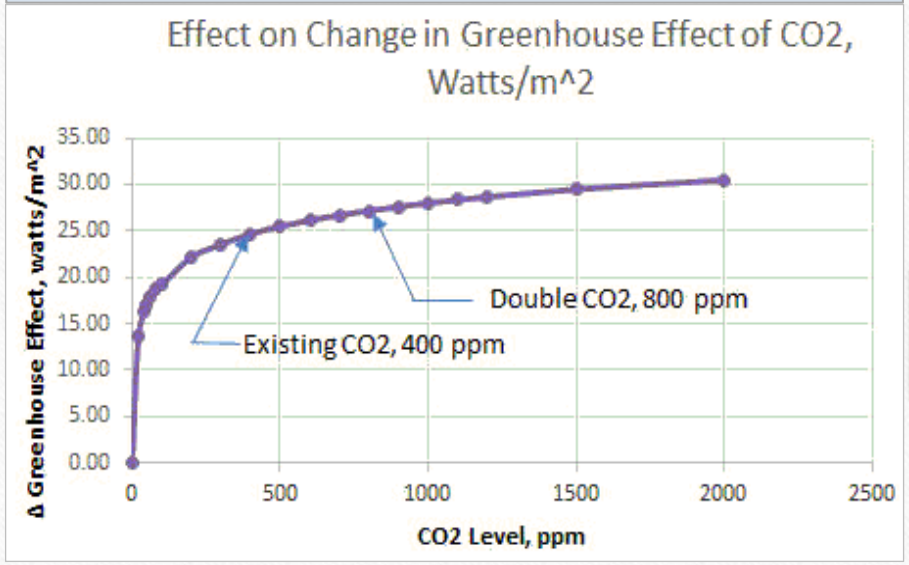
+1 Watt / m^2 = +0,4°C climate forcing

Outgoing radiation from Earth at 288.7K (15.5°C)



Doubling the standard CO_2 concentration from 400 ppm to 800 ppm results in an additional forcing of 3 W/m^2 (ref.): the area between the black curve (277 W/m$_2$) and the red curve (274 W/m$_2$) (ref.)

Why is the difference in forcing between 400 and 800 ppm CO_2 so small?

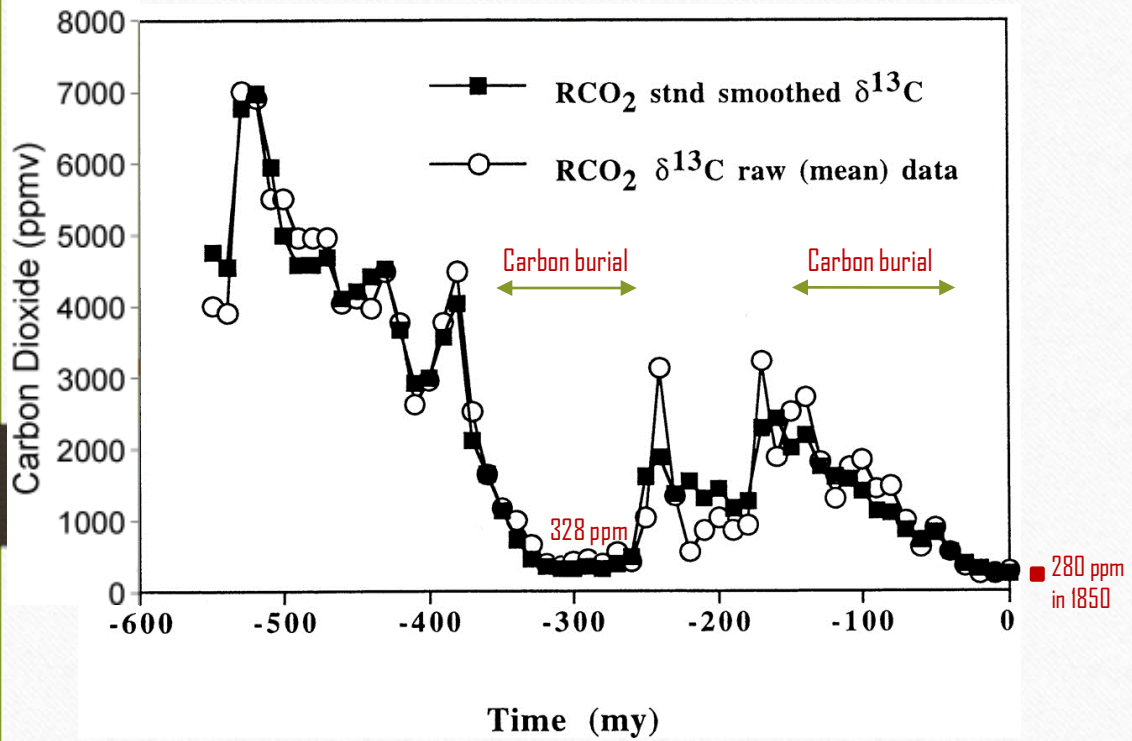


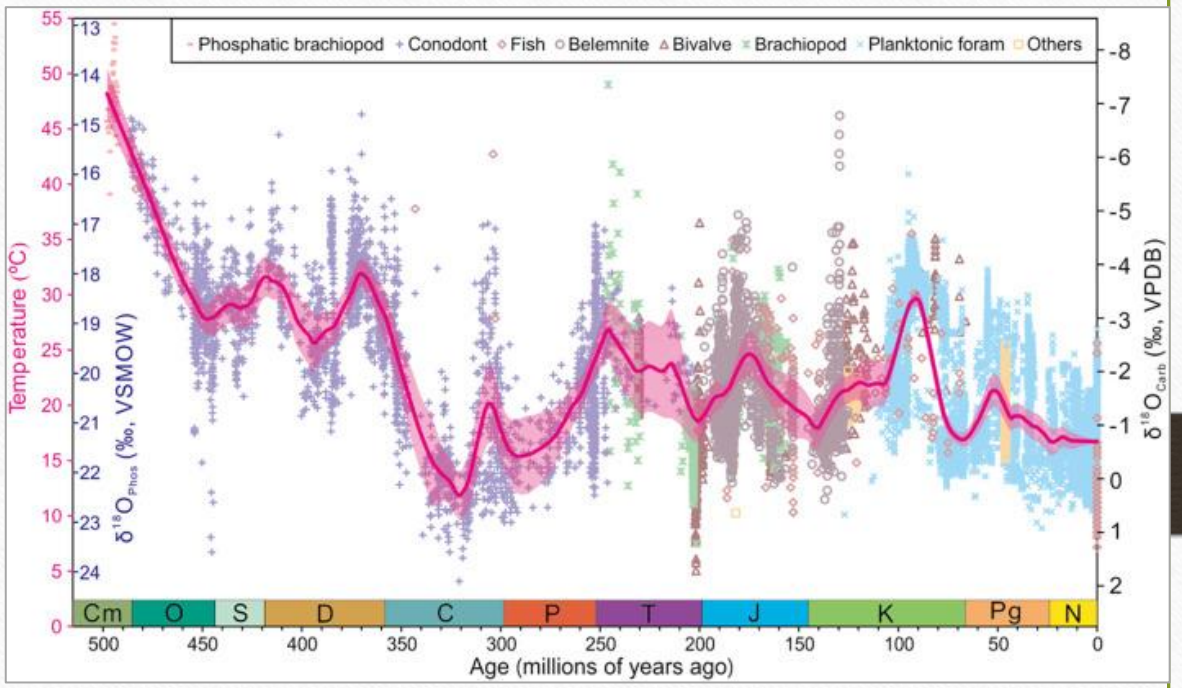
Because of the CO_2 saturation effect.

At a fixed absolute humidity, the surface heats up with 1,2°C per CO_2-doubling (ref.).

https://arxiv.org/abs/1911.10605

Atmospheric CO_2 and temperature over the past 500 million years





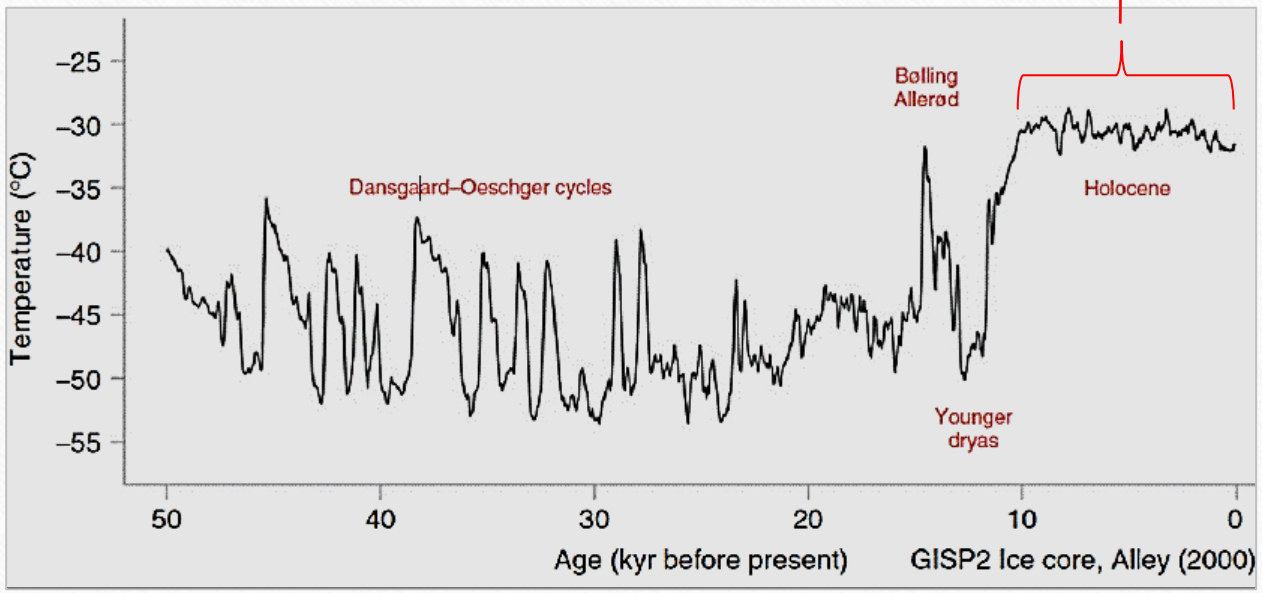
1. The Earth has suffered from a CO_2 deficiency for the last 20 million years, partly due to the formation of coal, oil and gas (carbon burial) and absorption of CO_2 in ocean water as a result of colder oceans.
2. The climate has never been constant.
3. The temperature in the last 20 million years has been relatively low.

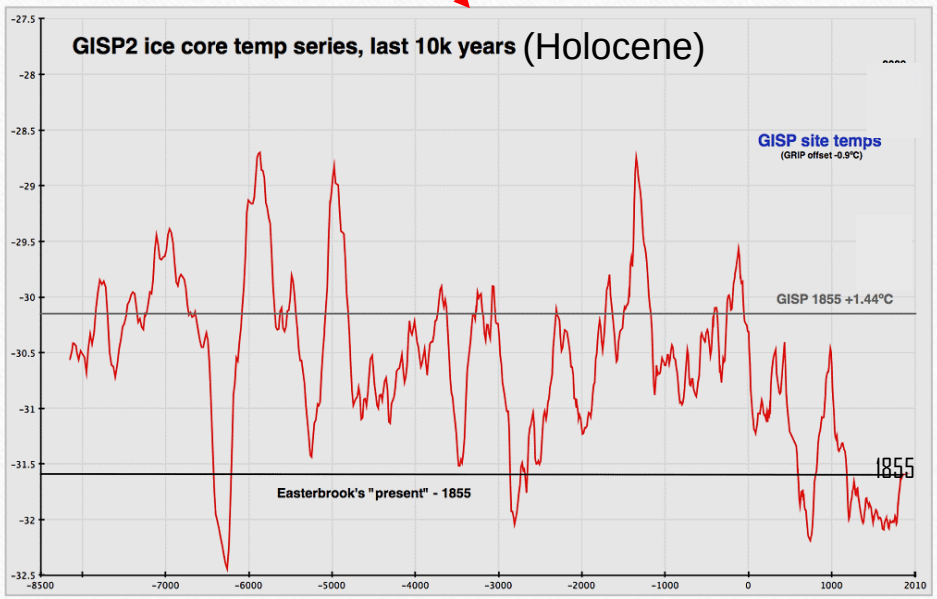
https://earthscience.rice.edu/wp-content/uploads/2017/08/Berner_nature-2003-1.pdf

https://www.sciencedirect.com/science/article/abs/pii/S0012825221000027

https://www.ajsonline.org/content/301/2/182

Reconstructed temperature over the past 50,000 years





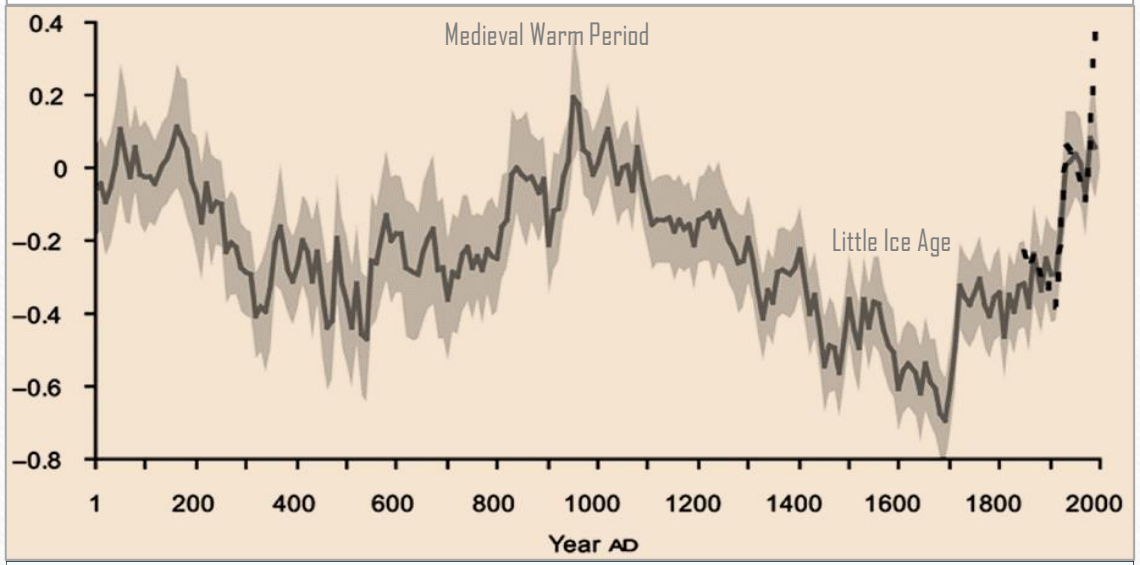
Temperature variations in the last 50k year (left) and last 10k year (Holocene, right) in the GISP2 ice core.

The Dansgaard-Oeschger cycles have an average period of 1470 years and an amplitude of an average of 8°C. CO_2 plays no causative role (ref.). The cycles may also occur in the Holocene (ref.) but with a much smaller amplitude.

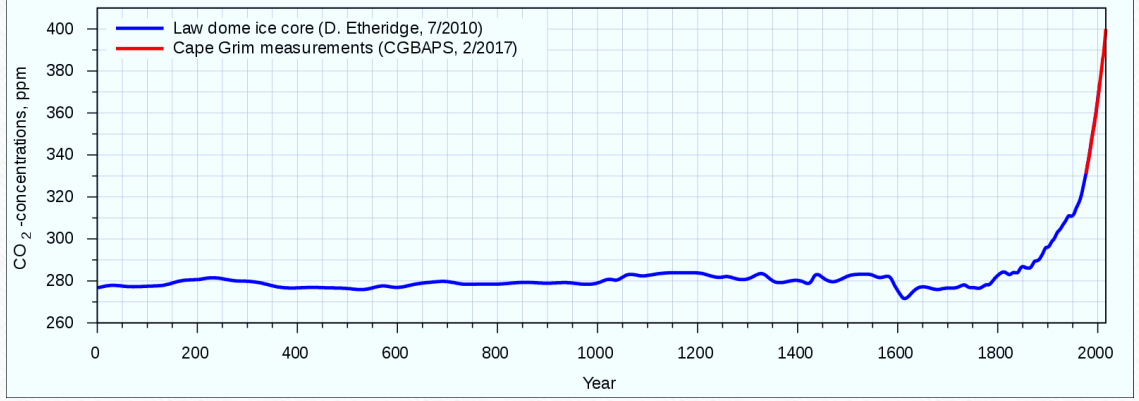
1. The major climate changes over the past 50k years were caused by natural factors.
2. The temperature in the current Holocene is relatively constant and our modern society is built on that circumstance.
3. The highest Holocene temperature to date was 6000-9000 years ago, higher than 2021 (ref.).

Reconstructed temperature and CO_2 in the past 2000 years

Ljungqvist NH temperature anomaly (30-90°N) relative to the 1961-1990 mean



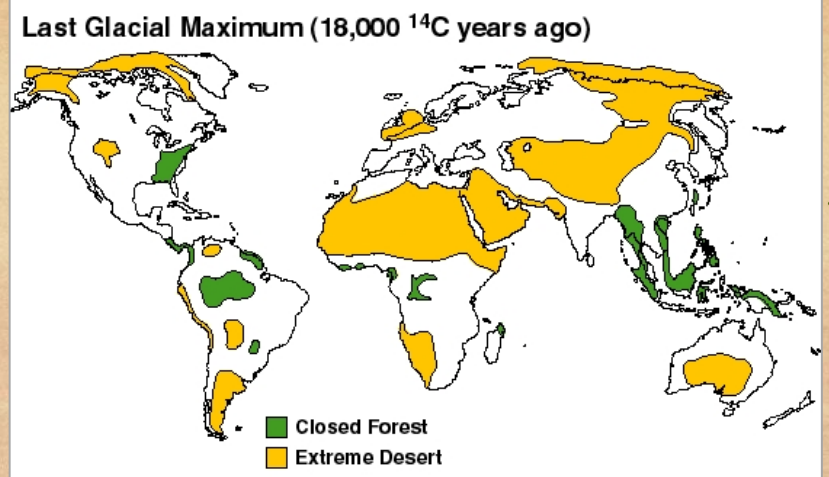
Carbon dioxide concentrations, 0–2016

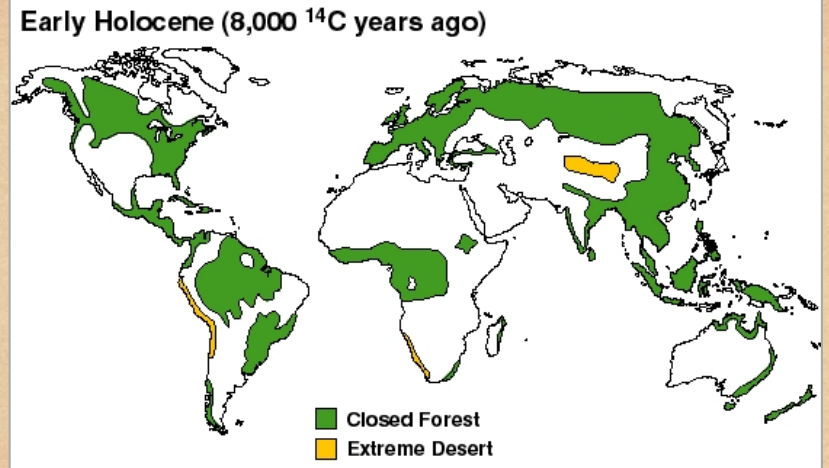


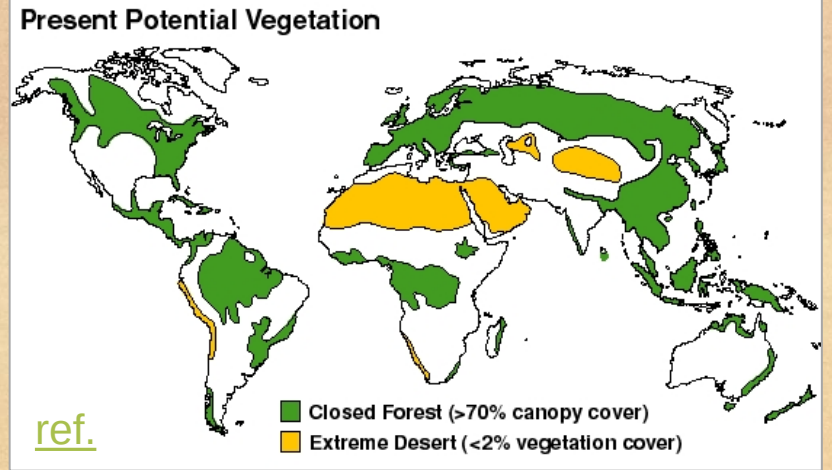
Natural factors other than CO_2 were responsible for warming 500-1000 AD and cooling 1000-1700 AD (ref.).

To what extent do natural factors contribute to recent warming?

Natural factors such as ice ages have a dramatic impact on ecosystems







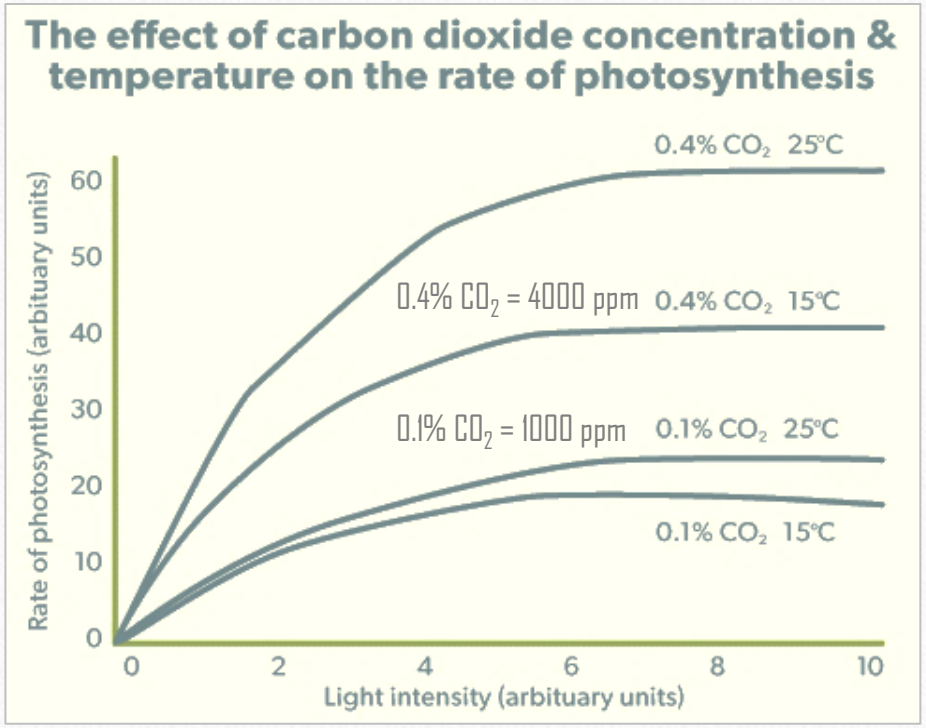
ref.

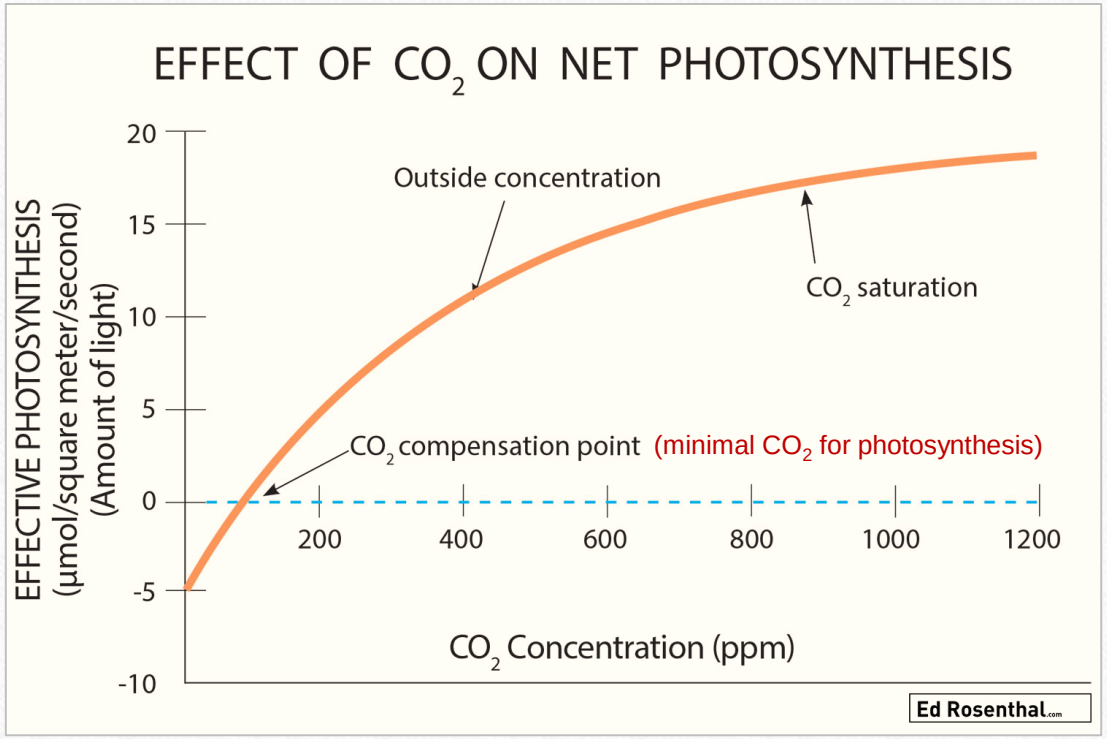
An ice age would be catastrophic for today's society, which is built on the constant Holocene interglacial.

The series of ice ages that occurred between 2.4 million and 10,000 years ago had a dramatic effect on the climate and life forms in the tropics.

During each ice age, the tropics became both cooler and drier, turning some areas of tropical rainforest into dry seasonal forest or savannah.

Both CO_2 and ambient temperature affect photosynthesis

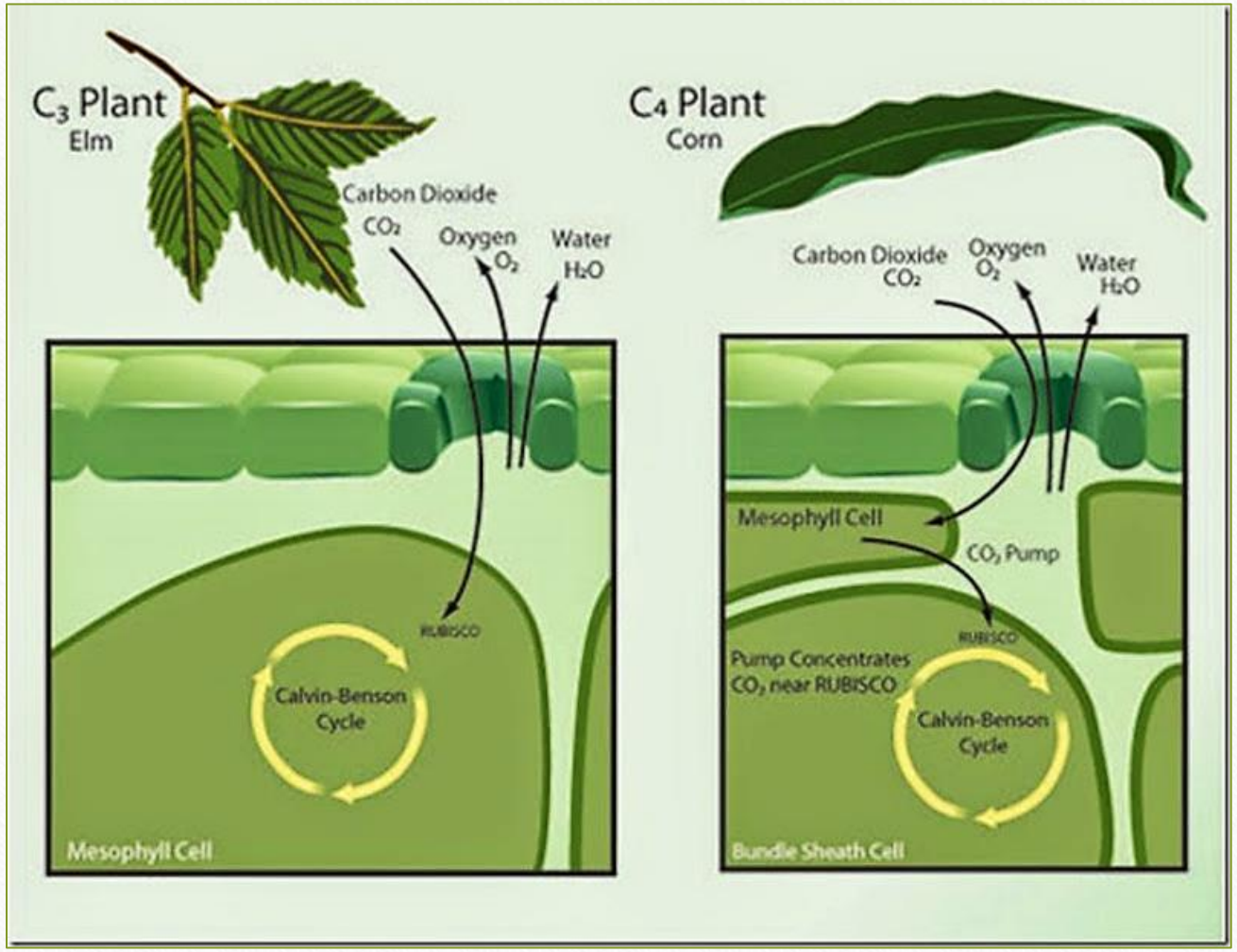




Both a higher CO_2 concentration and a higher temperature increase the rate of photosynthesis.
Current atmospheric CO_2 concentration: ± 0.04% = 400 ppm.

CO_2-compensation point: 150 ppm (0,015%). **Below 150 ppm CO_2, most life on earth dies**.
Atmospheric CO_2 over the past millions of years was 180-280 ppm, just above the CO_2-compensation point and far from optimal.

Photosynthesis with low and high CO_2



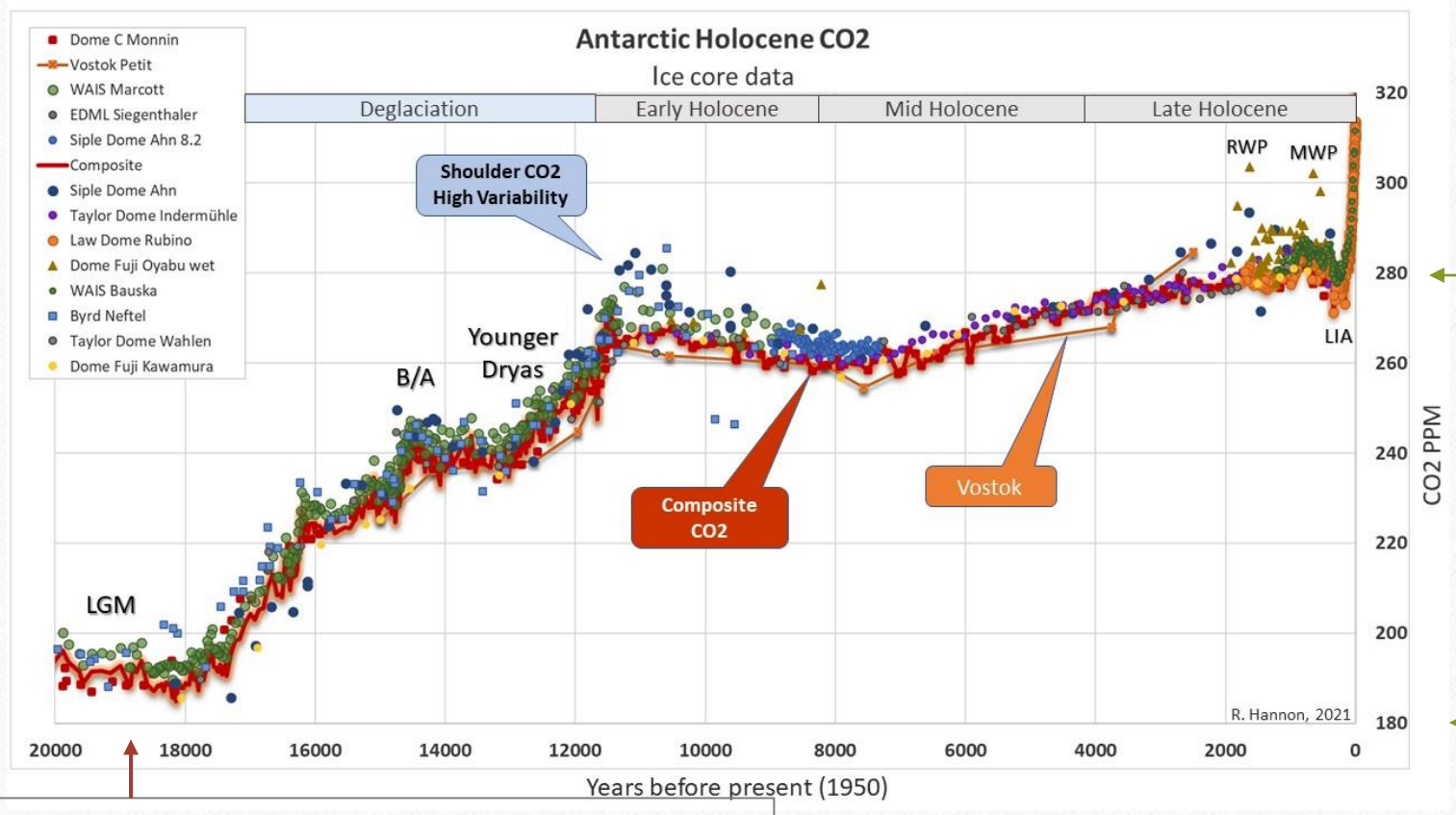
Plants inhale CO_2 and exhale O_2 and H_2O to produce glucose.
This can lead to dehydration that is compensated by fewer stomata: less evaporation. Because the CO_2 in the atmosphere is now increasing, plants will grow in drier areas.

But with low CO_2, C3 plants can breathe in O_2 instead of CO_2. Then the toxic H_2O is formed instead of glucose. The C4 plant solves this problem with the CO_2 pump (ref.)

More CO_2 benefits plants a lot because:

1. **They need less water if there is more CO_2.**
2. **More CO_2 suppresses harmful photorespiration.**

Atmospheric CO_2 in the Holocene



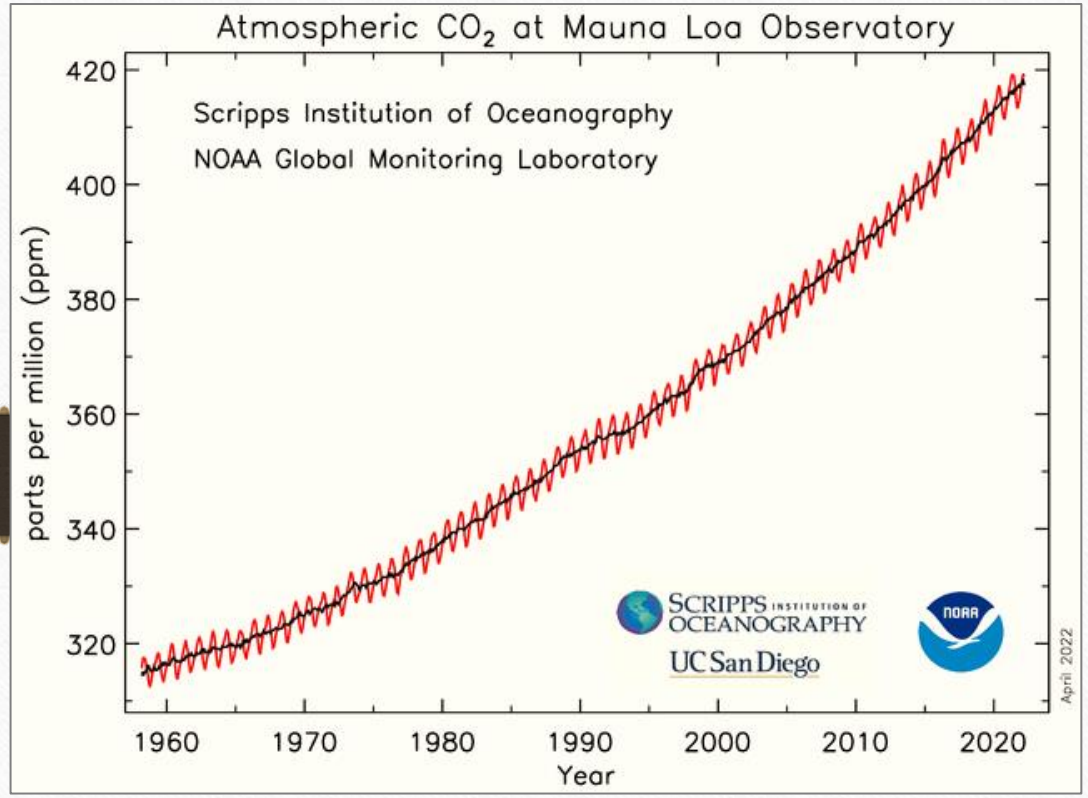
280ppm CO_2 in 1850

Just above minimum CO_2 for photosynthesis

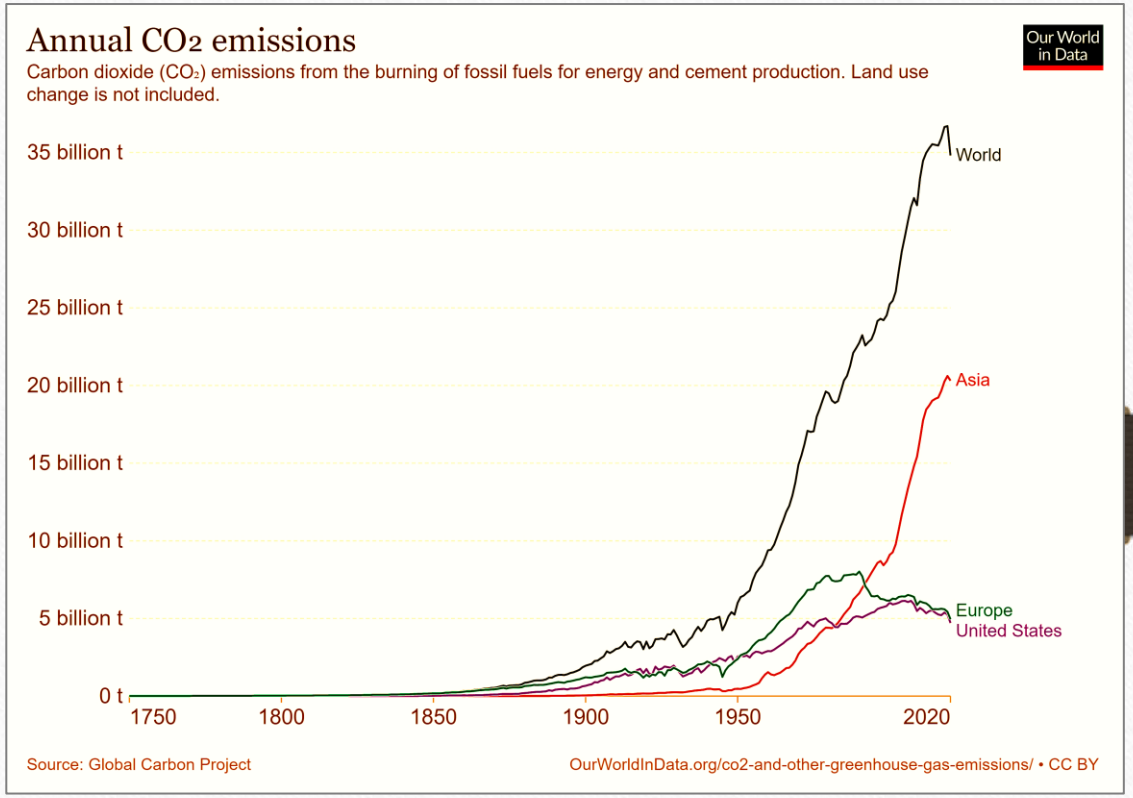
Very low CO_2 -> no vegetation on high plateaus -> dust storms -> dusty ice in Antarctica -> more absorption of sunlight -> more warming. This helped end the ice age that had already begun by the Milankovitch cycle. As a result, CO_2 increased due to outgassing from the warming oceans.

https://clintel.org/holocene-co2-variability-and-underlying-trends/

Current atmospheric CO_2 concentration and emissions

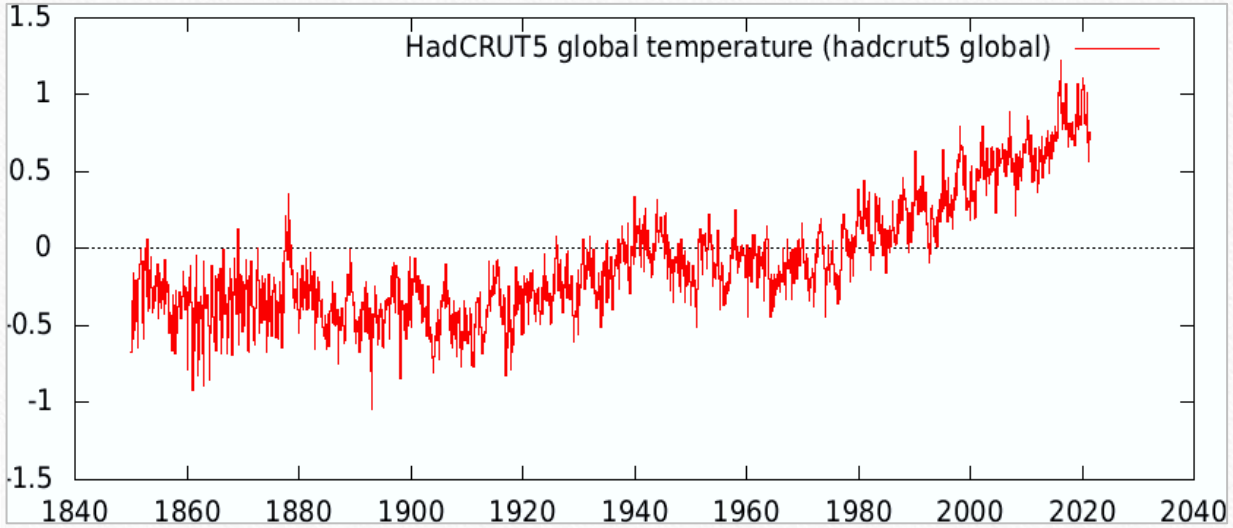


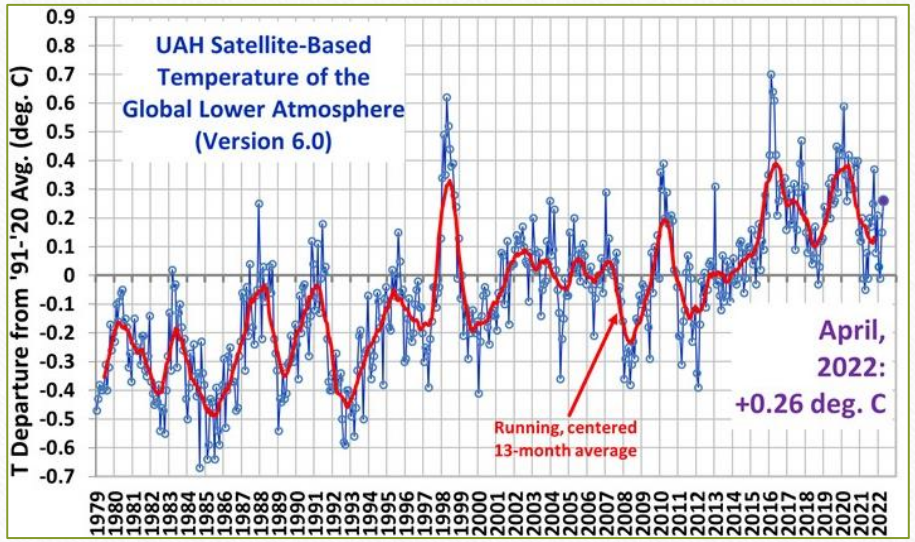
Atmospheric CO_2 concentration as measured in Hawaii (representative of the global average). Increase: 100 ppm in 60 years. Based on the changing atmospheric ratio of carbon isotopes it is assumed that this is mainly due to the global burning of fossil fuels and deforestation.



CO_2 emissions from fossil fuel combustion and cement production. Asia contributes 57%, the United States and Europe each contribute 14% to world emissions.

The measured global temperature

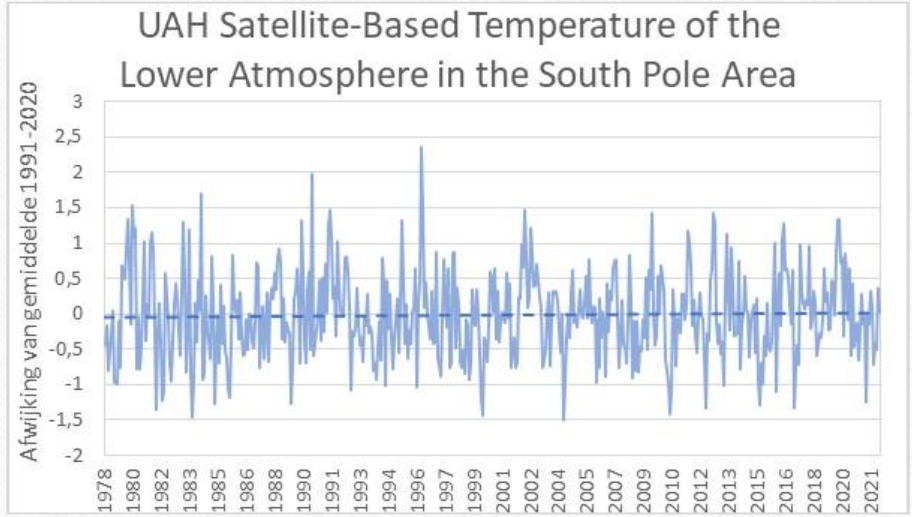




Above: global air temperature deviation (°C) since 1850 (ref.).
However, the weather stations used for this are unevenly distributed over the earth and the years. Especially with older data, the uncertainty is therefore high (ref.).

Top right: The global temperature trend since 1979 is 0.13°C per decade according to UAH satellites. The warming since 1979 is about 1/2°C.

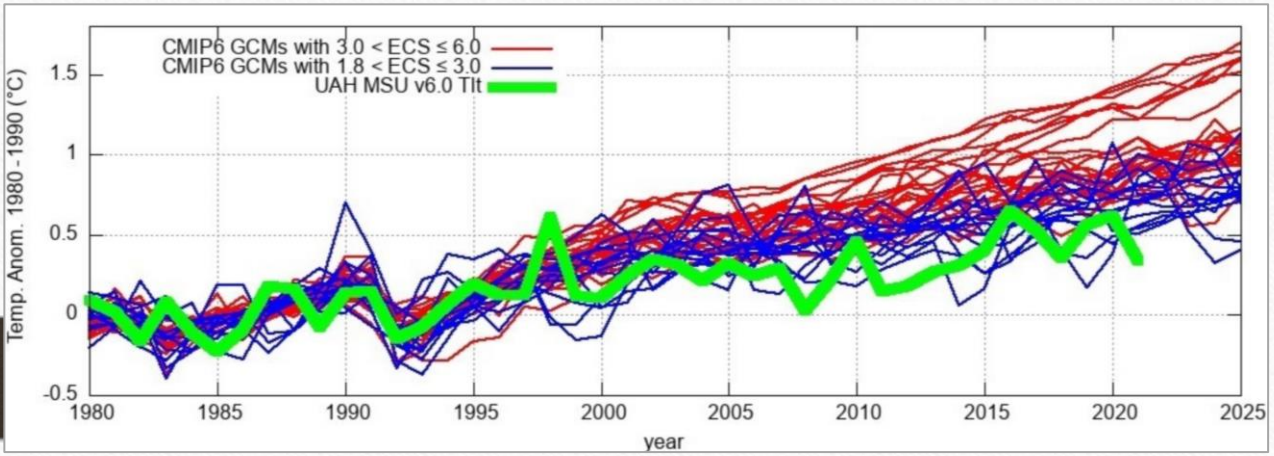
Bottom right: The Antarctic continent is not warming significantly (ref.) despite rising atmospheric CO_2 and not in accordance with climate models.



https://www.nsstc.uah.edu/climate/

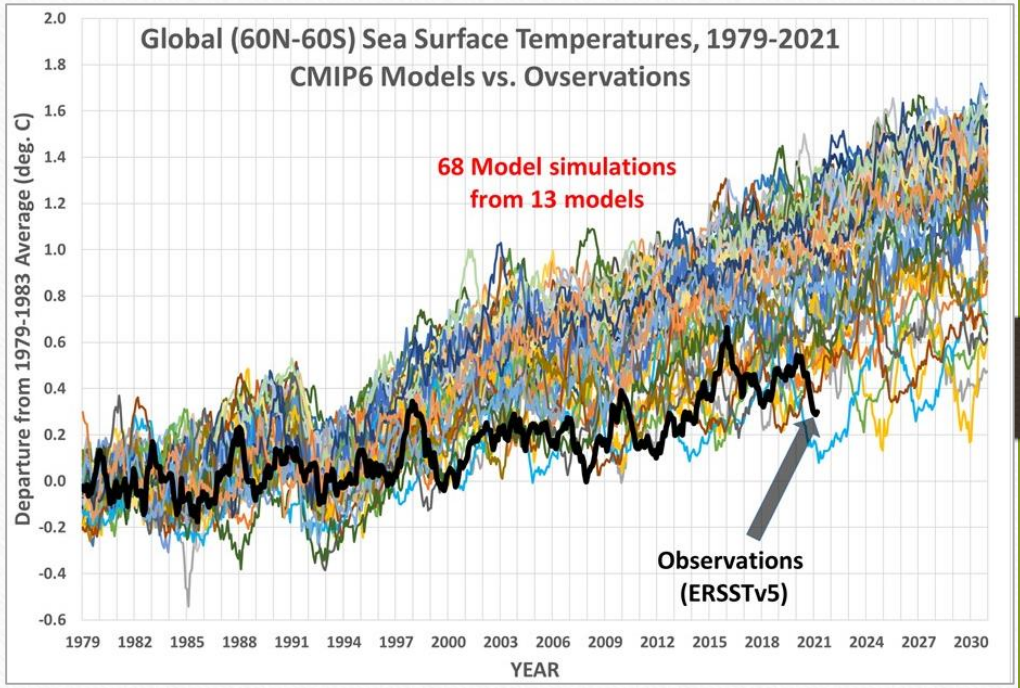
How much warming do the IPCC's climate models predict?

Climate models produce much more warming than the observations show



CMIP6 GCM global surface temperature simulations (red, models with ECS > 3; blue, models with ECS ≤ 3) against the temperature observations (green): UAH MSU Tlt.

This graph shows that measured global warming is 0.13°C per decade, while climate models show an average of 0.3°C per decade, which is 2.3 times greater (ref.).

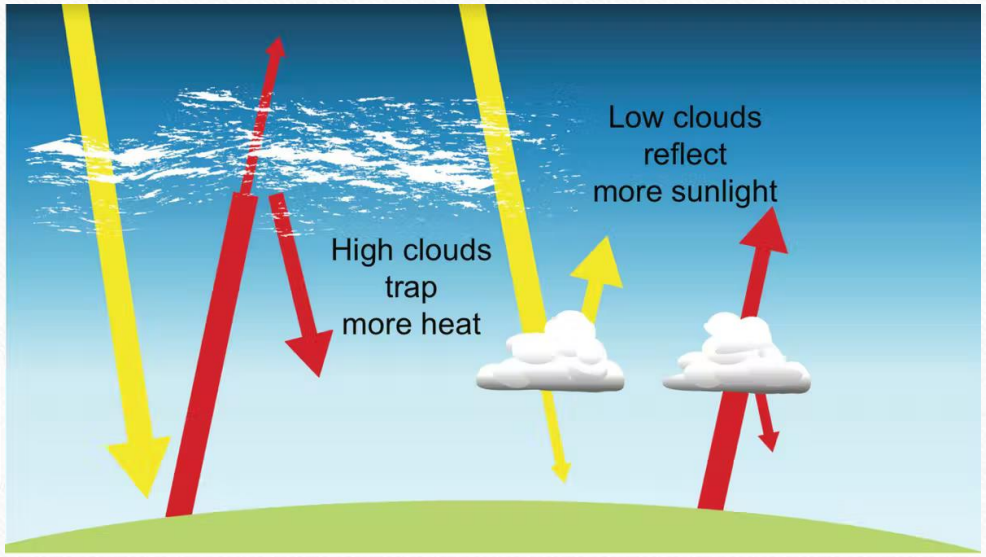


Science: “Use of ‘too hot’ climate models exaggerates impacts of global warming.”
Nature: “Climate simulations: recognize the ‘hot model’ problem.”

https://www.carbonbrief.org/in-depth-qa-the-ipccs-sixth-assessment-on-how-climate-change-impacts-the-world

https://t.co/bRCGi3cFXc

Why do climate models predict so much warming (1)?



The net effect of clouds is a cooling of 5°C (ref.). Since the 80s, low cloud cover has decreased by 4%, which will cause some warming (ref.). Since 2001, however, a strong negative cloud feedback has been observed (ref.) although most climate models assume a positive feedback.

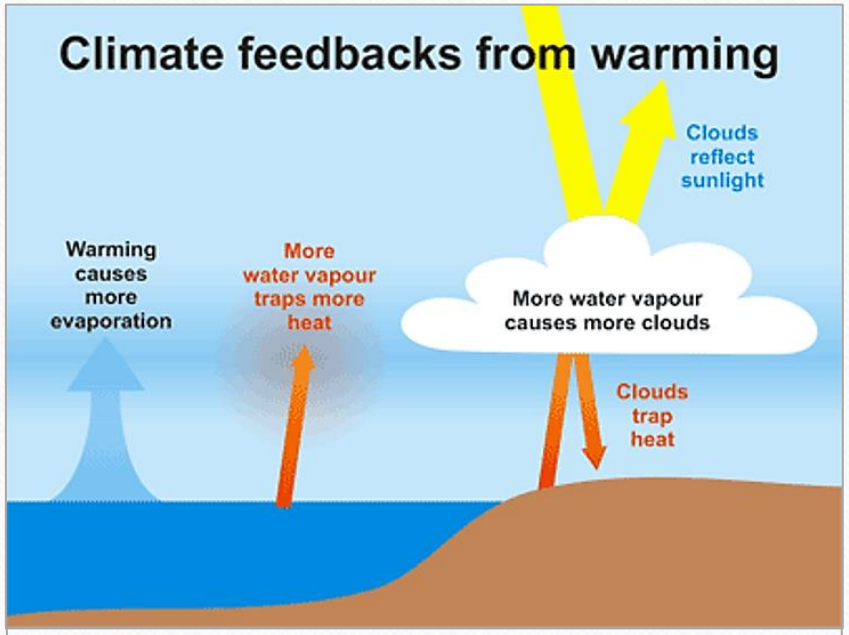
A doubling of atmospheric CO_2 yields only 1.2°C of warming, assuming that all other climate factors remain constant.

Climate models assume that the low warming by CO_2 is amplified by a factor of 3 (positive feedback) mainly because of more water vapor and the feedback from clouds. Water vapor can also lead to cloud formation, which makes the problem even more complicated.

Why is there such a wide range of warming estimates that models predict? This is due to the uncertain behaviour of clouds. In most climate models, clouds amplify warming. In others, they have a neutral effect or even dampen warming slightly.

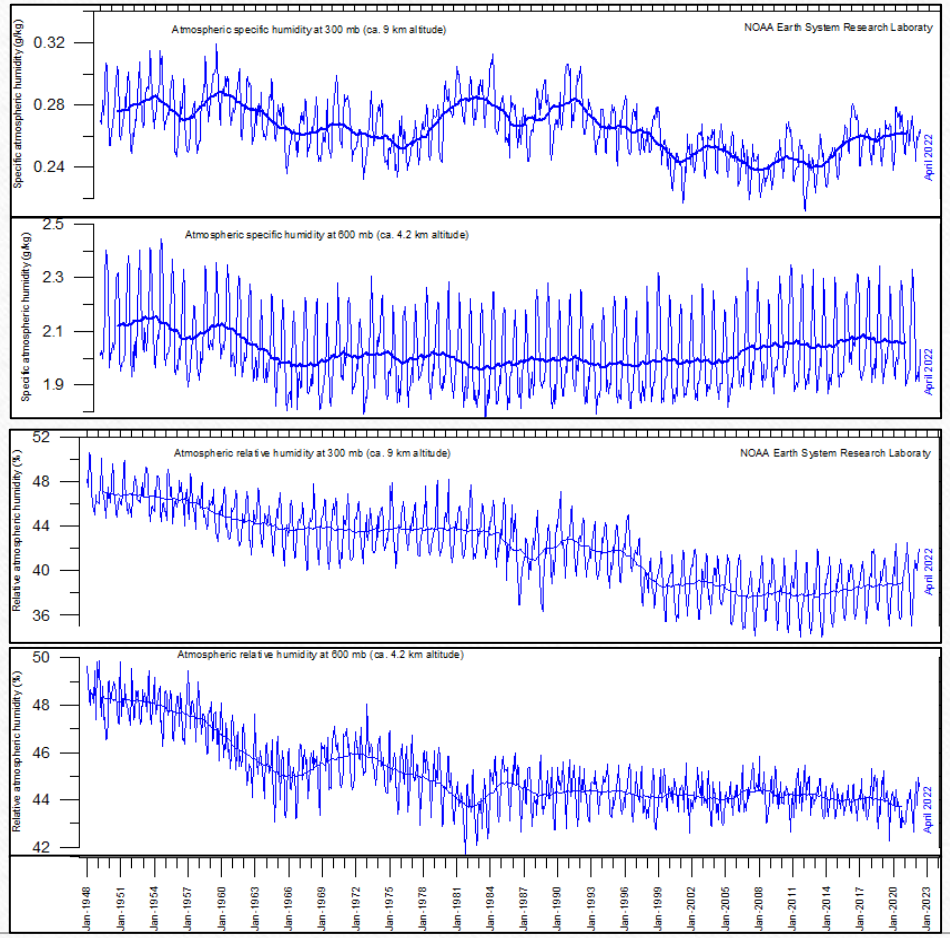
Clouds have a great effect on surface temperature, but are not well understood and usually ignored in climate reports (ref.).

Why do climate models predict so much warming (2)?



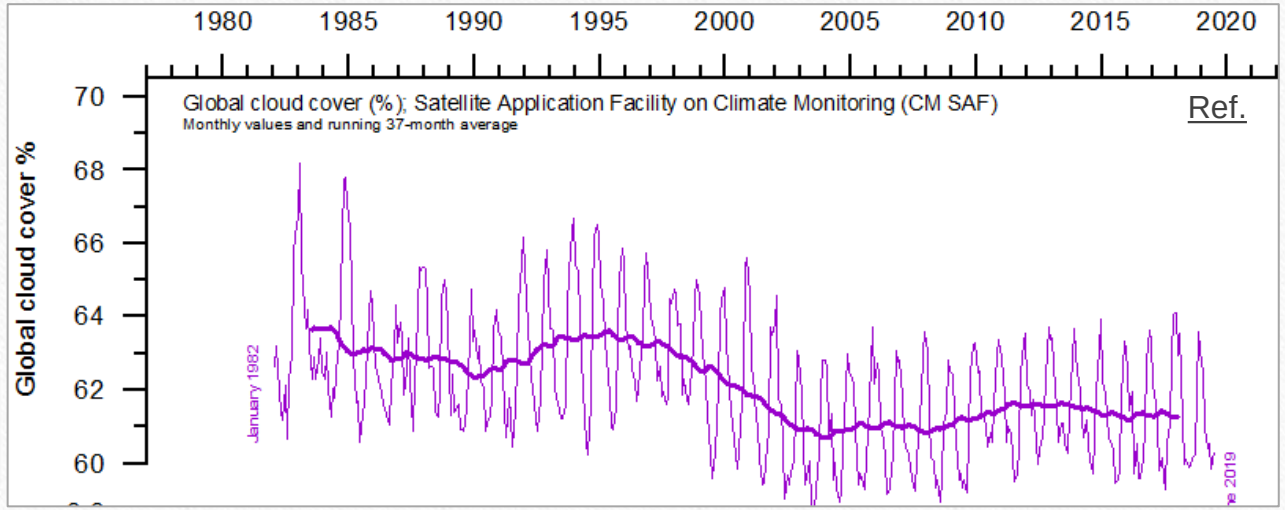
Climate models assume that the slight warming (of increasing CO_2 leads to more evaporation (the specific humidity level then increases). Because water vapor is a strong greenhouse gas, it leads to more warming (ref.). Water vapor can also lead to cloud formation.

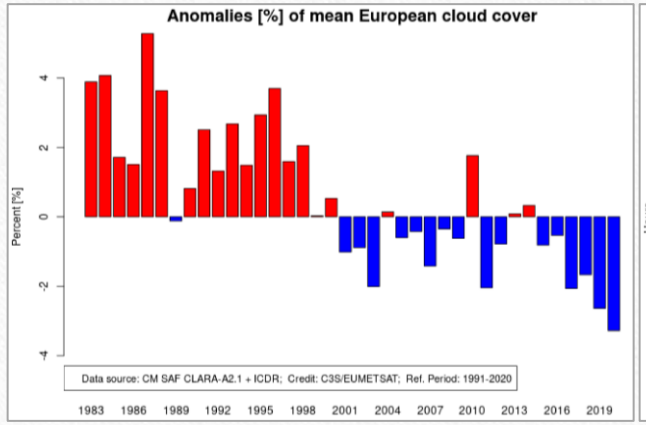
The relative tropospheric humidity should then remain more or less stable and the specific humidity in the upper troposphere should increase. →

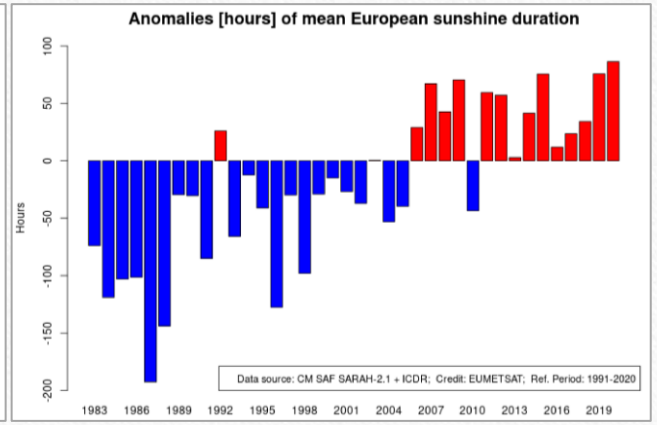


→ The graphs above show that this is not the case. Specific humidity in the upper troposphere does not increase (top 2 graphs) and relative humidity has decreased (lower 2 graphs) (ref.).

The effect of clouds on surface temperature







Clouds generally cool the Earth, but there are two types of cloud feedback.
High clouds have a net warming effect, because they block little incoming solar radiation and send little outgoing heat radiation back to the earth's surface. Low clouds have a net cooling effect. The net effect of both types of clouds is cooling.

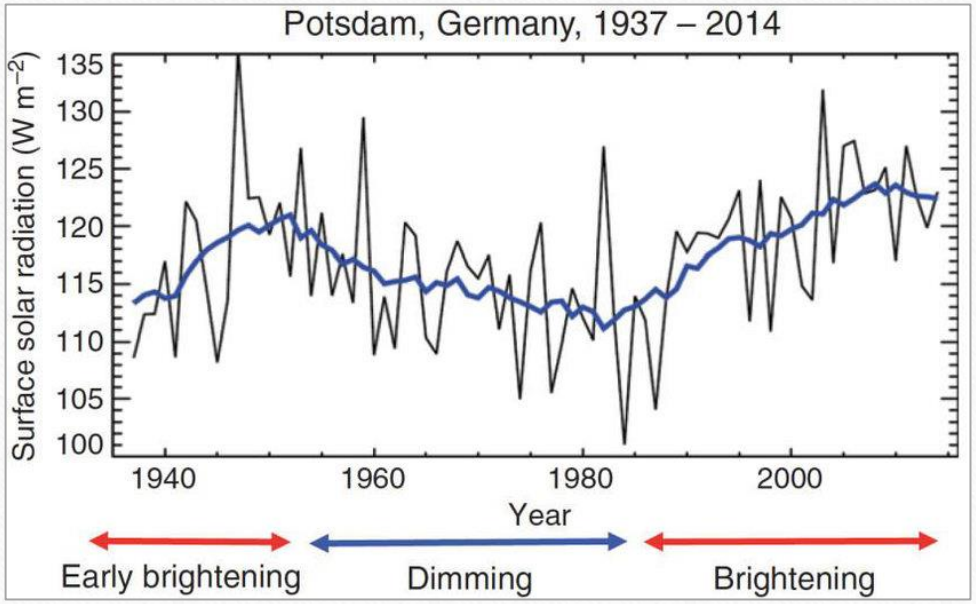
The recent global warming, measured in the upper ocean layer of 0-700 m, is not the result of more downward heat radiation warming the upper ocean layer (due to increasing greenhouse gases) but rather of blocking the upward heat transport from the ocean surface and thus more absorption of solar radiation (ref.).

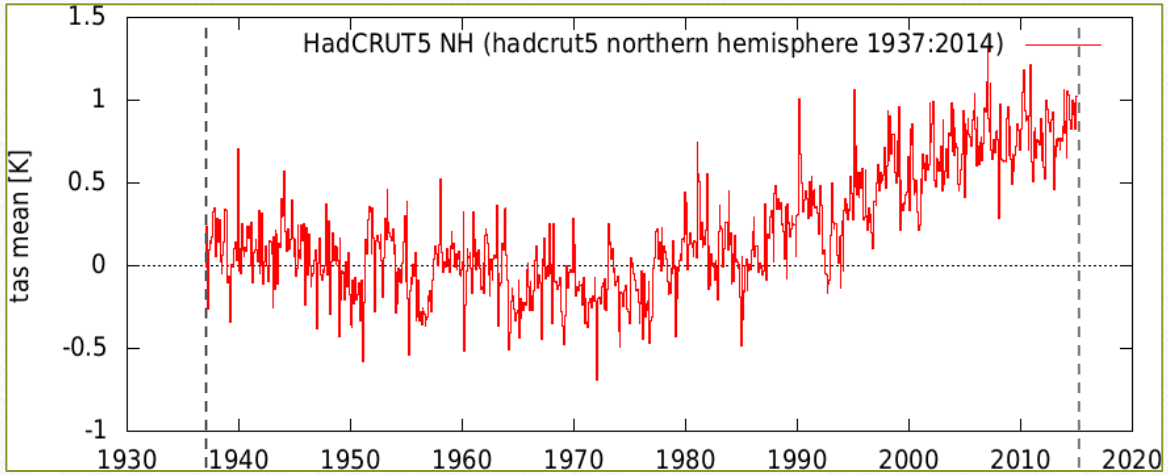
This warming due to increased incoming solar radiation is mainly due to the decrease in cloud cover, as the graph at the bottom left for Europe shows (ref.).

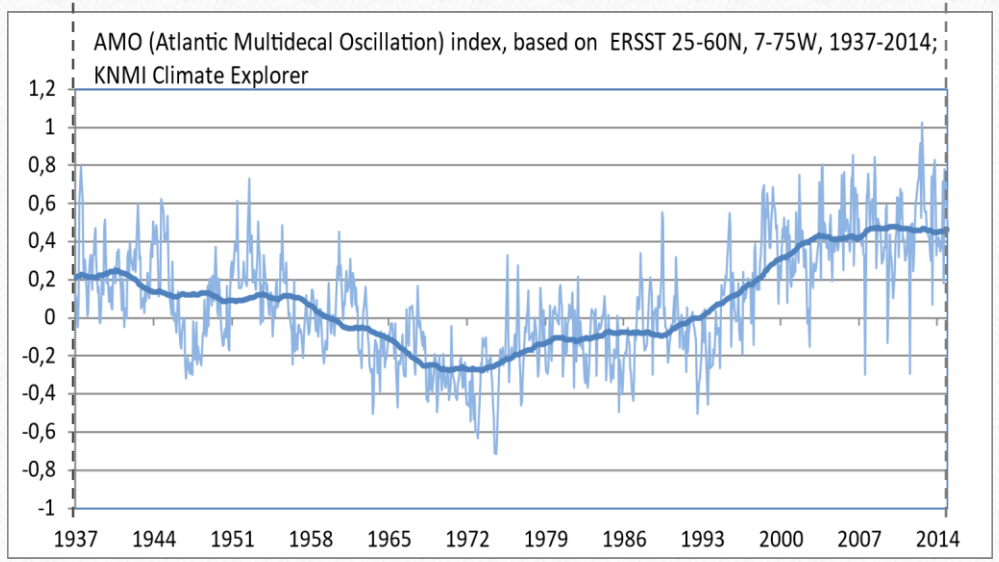
Every 1% reduction in cloud cover causes 0.07°C warming (ref.).

https://climate.copernicus.eu/esotc/2020/clouds-and-sunshine-duration
https://www.mdpi.com/2073-4433/12/10/1297/htm

Are natural changes in cloud cover partly responsible?







Above: indication of multidecadal changes in incoming solar radiation due to changes in cloud cover, as shown here for Potsdam, Germany. This wave pattern roughly corresponds to the temperature changes in the Northern Hemisphere (top right) and to the 60-70 year cycle of seawater temperature in the Atlantic Ocean (bottom right, shown only for the interval 1937-2014).

This pattern is absent in climate models. It is possible that these temperature changes are partly the result of natural changes in cloud cover (ref.).

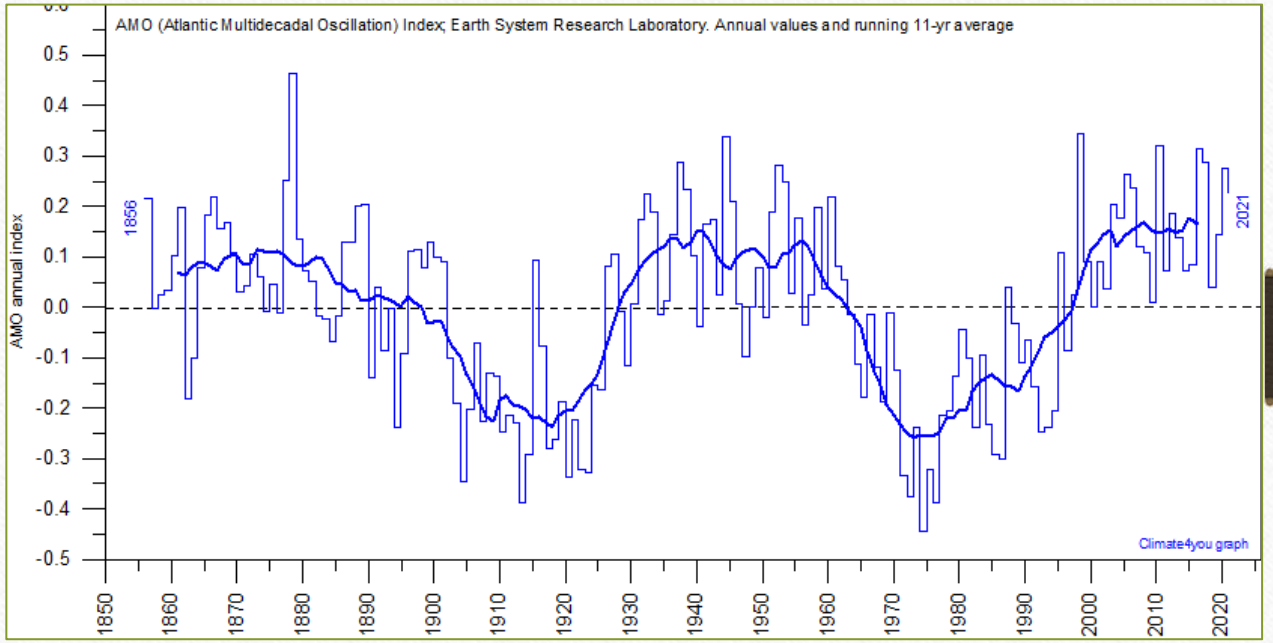
The role of Ocean Oscillations

The cloud hypothesis is confirmed in a recent study (ref.): since measurements began in 2001, clouds have become more permeable (thinner) to incident solar radiation. This radiation has reached the earth's surface and contributed to warming. The heat radiation upwards (the greenhouse effect) only contributed to a lesser extent to this warming.

The greenhouse effect of the sum of all greenhouse gases (water vapor, CO_2, etc.) was demonstrated under "clear sky" conditions. But that effect is overcompensated by the increasing outgoing heat radiation in the cloudy areas.

The cause of the changes in cloud cover may be the 60-70 year cycle of hot and cold ocean water in the Atlantic: the AMO (image on the right); ref.). The decrease in aerosols or a combination of factors may also play a role.

"*The warming of the last 20 years was caused more by changes in the clouds than by the classic greenhouse effect.*" (ref., see also this ref.).

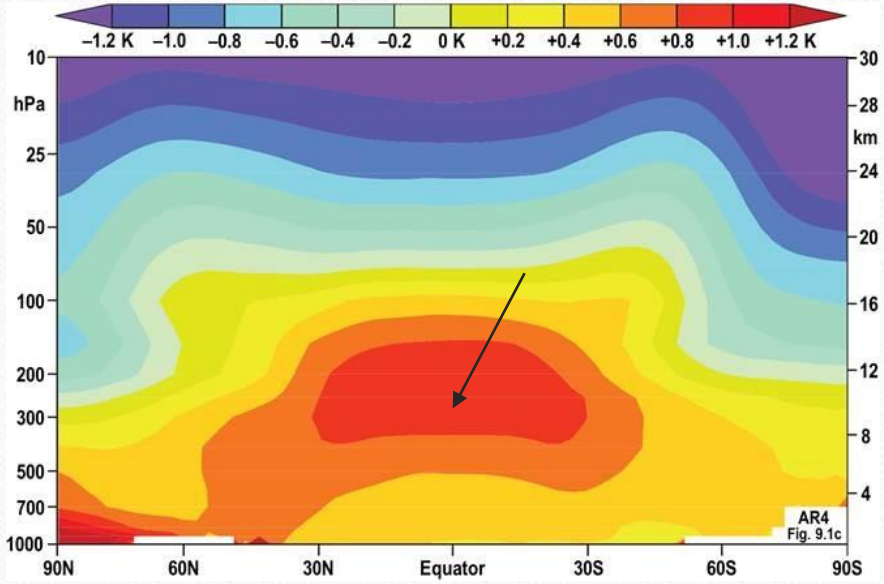


Do IPCC climate models fail the test?

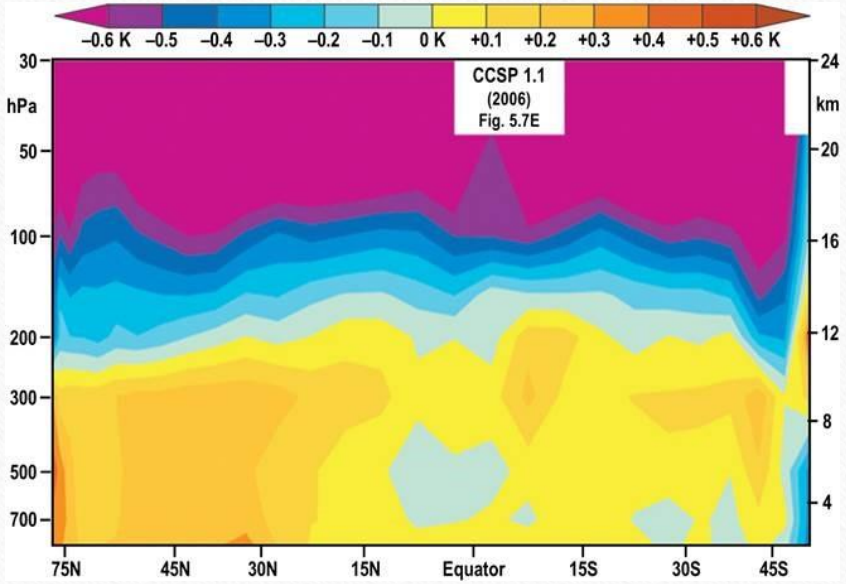
The predicted additional warming in the tropical troposphere is not confirmed by measurements.

Climate models predict an extra warm area in the tropics, higher up in the troposphere, as the result of extra water vapor due to an increase in anthropogenic greenhouse gases (the "Tropical Hotspot"). This is not confirmed by temperature measurements at various altitudes via satellites and weather balloons (ref.).

According to McKitrick and Christy, this test result invalidates the climate models and shows that they exaggerate global warming from greenhouse gases. This problem is recognized by the IPCC (AR6 p 3-162 and AR5, p 892).



The predicted tropical hotspot



Radiosonde measurements: no hotspot

https://iopscience.iop.org/article/10.1088/1748-9326/ab9af7
https://wattsupwiththat.com/2022/03/13/comparing-ar5-to-ar6/

Why is warming and increasing CO_2 considered a problem?

1. Because IPCC climate models predict strong sea level rise, which threatens society in low countries.
2. Because the IPCC summaries present models that predict extreme warming due to CO_2 emissions.
3. The IPCC summaries evoke fear in the public, and fear inhibits objective logical reasoning.
4. The Holocene climate is fairly constant and our society is built on it, so climate change is not welcome.

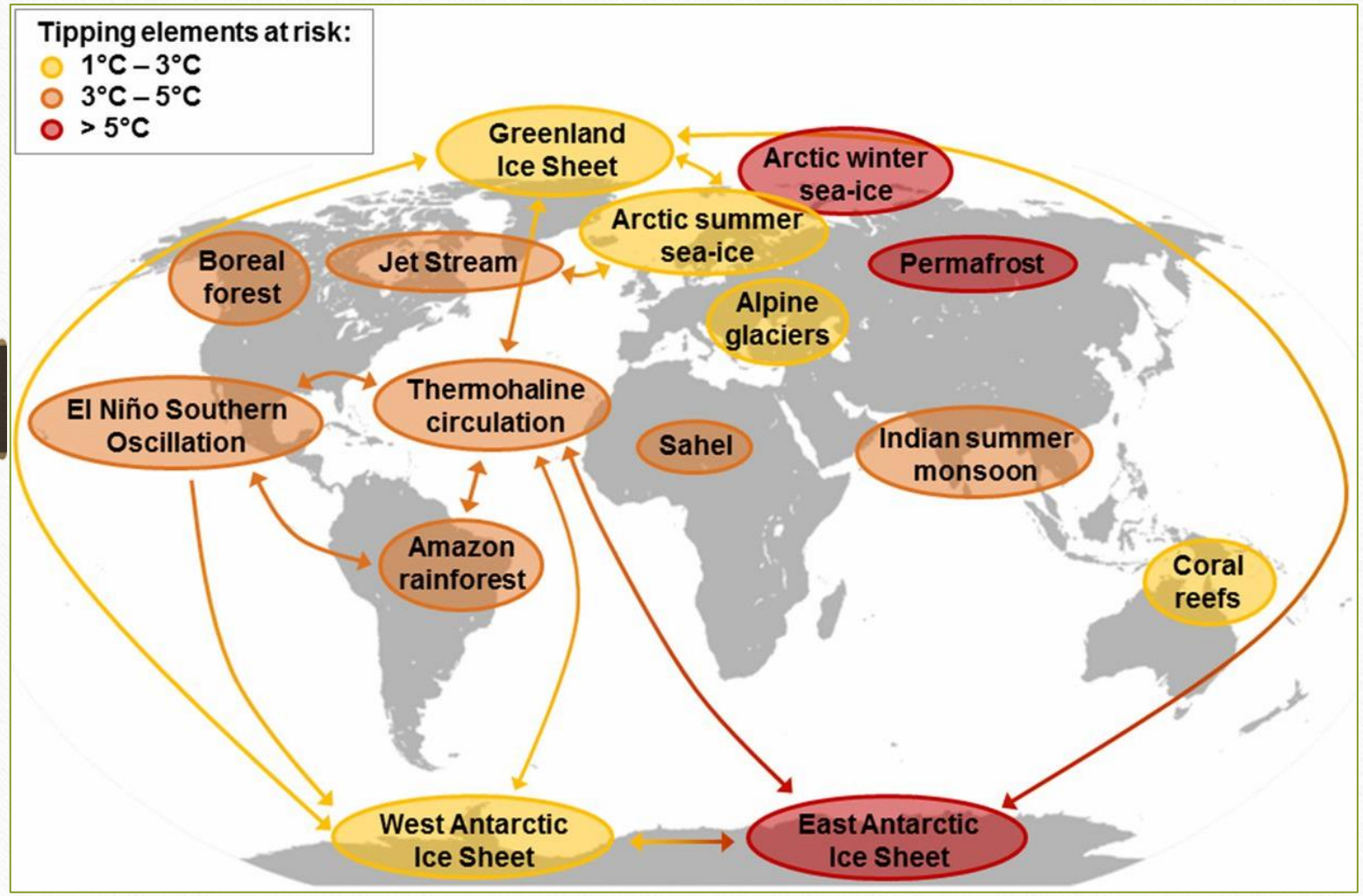
Re 1. The models appear to predict more sea level rise than is expected on the basis of the measurements.
Re 2. The IPCC model (RCP 8.5) with improbably high CO_2 emissions was presented as "business as usual".
Re 3. The public therefore considers global warming due to CO_2 to be life-threatening for their children.
Re 4. The climate in the past shows that the current temperature and CO_2 level are relatively low, not high, moreover climate change is the norm on earth (we're just lucky that the climate is relatively constant in the current Holocene).

Since the past millions of years show that CO_2 levels were suboptimal and global temperature relatively low, the question arises why we are not happy with more CO_2 and some warming. (see also this presentation by William Happer)

It is to be expected that as photosynthesis increases, natural ecosystems will largely benefit from it (apart from other factors that disrupt ecosystems). This is good for both nature and agriculture.

Another perspective: we bring back the carbon in the form of CO_2 taken out of circulation during the formation of fossil fuels that resulted in suboptimal CO_2 levels.

Alarm: climate feedbacks could push the Earth beyond thresholds (tipping points)



Global map of potential tipping points (colours) and cascades (arrows). (Ref.).

The risk for tipping (loss of) the East Antarctic Ice Sheet or the disappearance of Arctic winter sea-ice is proposed at >5°C of local warming from pre-industrial levels.

The warming itself is supposed to be mainly due to CO_2 from burning fossil fuels and the assumed climate feedbacks.

In the next slides we will investigate these claims.

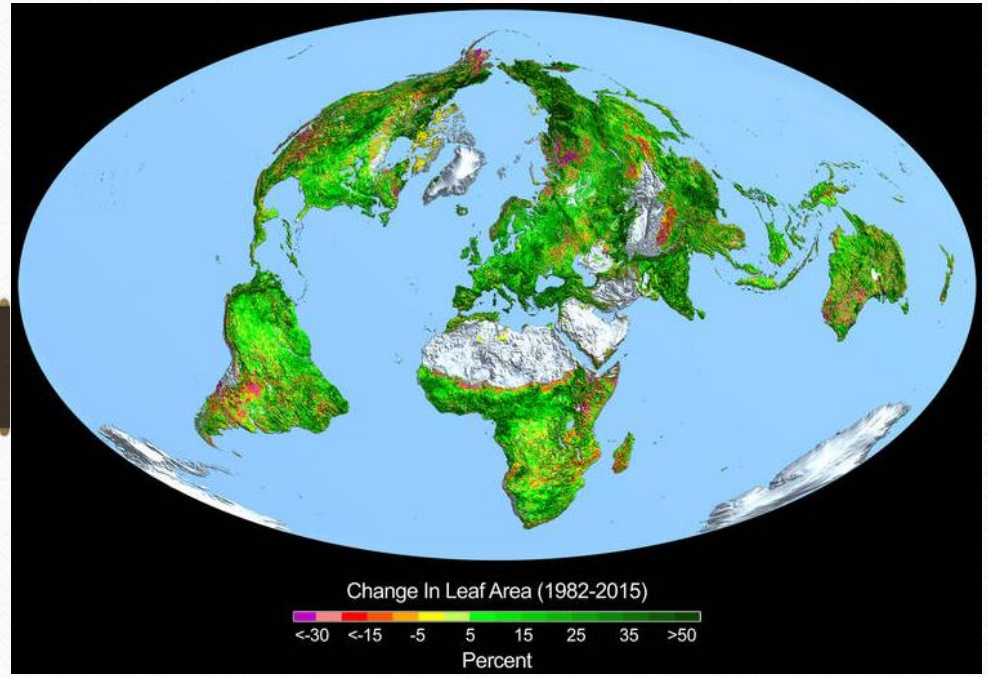
Where is the climate emergency?

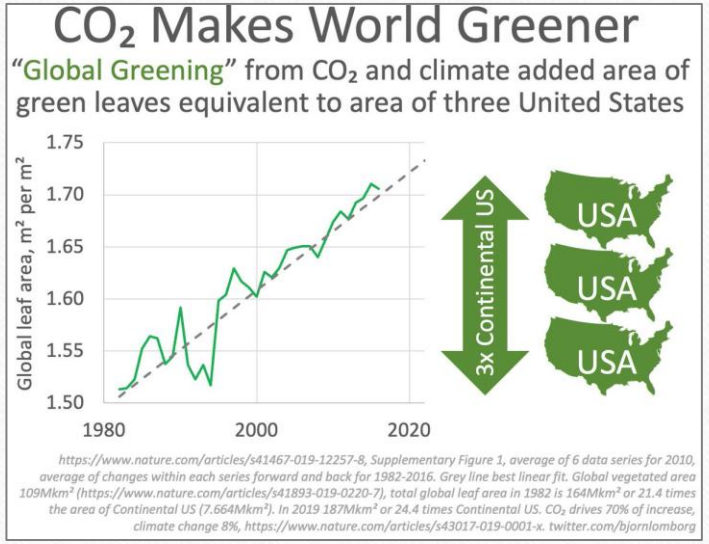
Latest IPCC report:

"The report emphasizes that extreme weather events, such as heatwave, wildfires, floods and droughts, are already becoming more frequent and intense – driving rising mortality rates" (ref.)

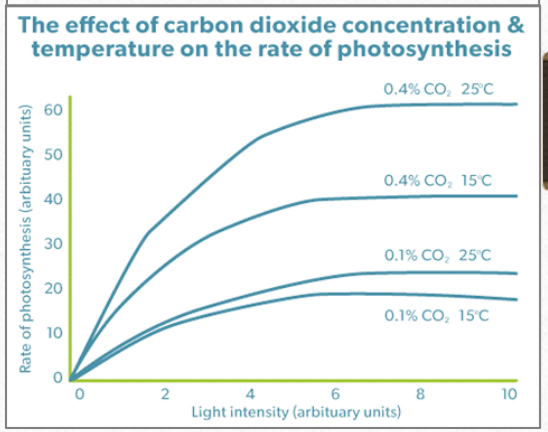
The following slides show some examples that contradict these claims, enumerated in this article by Willis Eschenbach and other sources.

Global greening





the cause of greening:

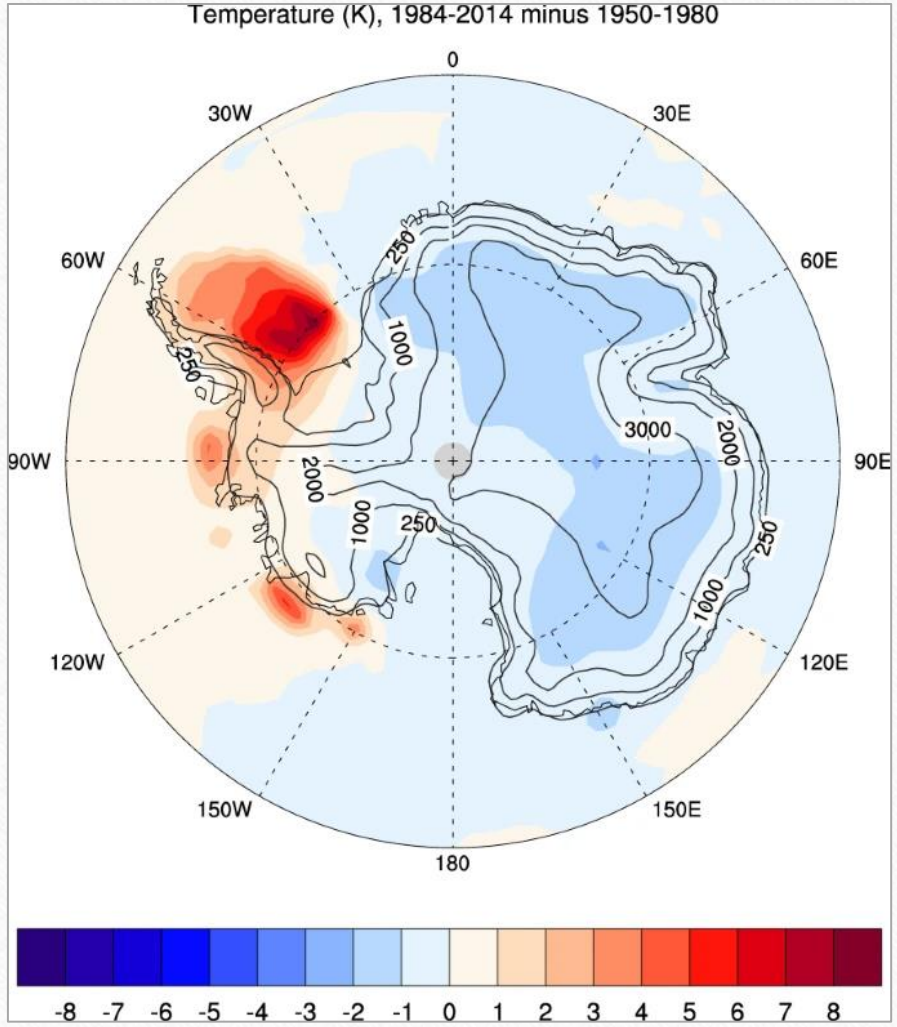


Temperature in Antarctica

"*The Antarctic continent has not warmed in the last seven decades, despite a monotonic increase in the atmospheric concentration of greenhouse gases*."
Nature Magazine

"*Despite all the hype and all the alarmism about how a melting Antarctica was going to raise sea levels by 20 feet (6 metres) and flood the world, Antarctica Has. Not. Warmed. In. The. Last. Seven. Decades*."
Willis Eschenbach

The warming in West Antarctica is probably partly the result of local deep-sea volcanism (ref.).

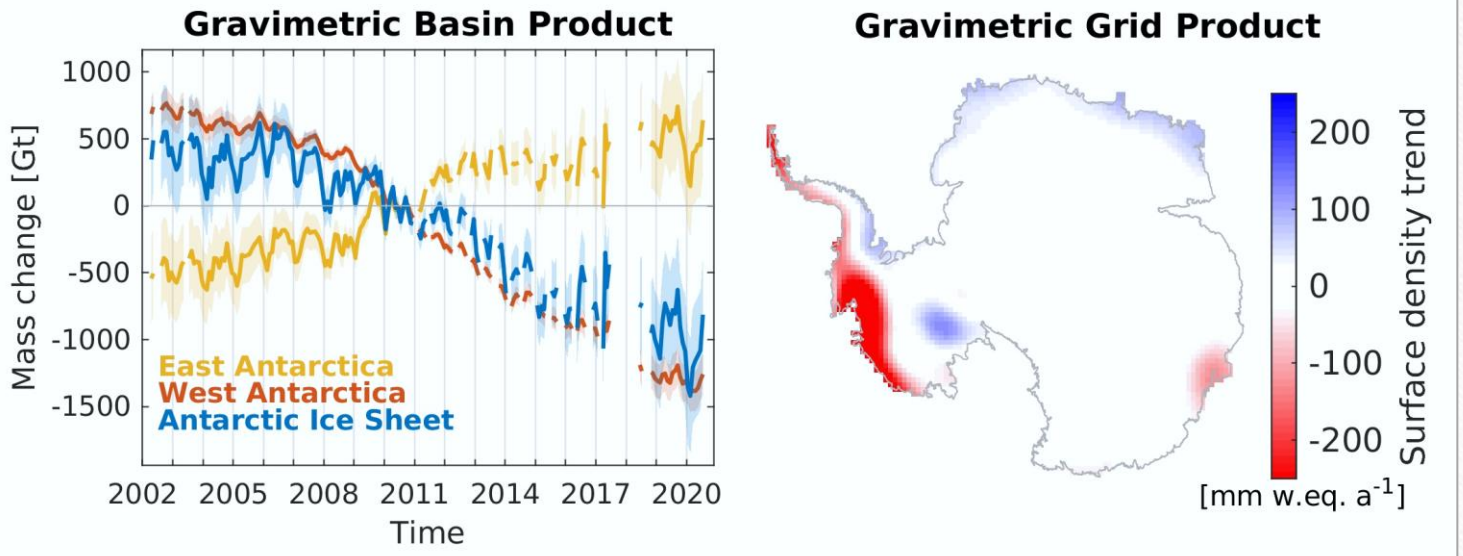


Mean surface temperature anomaly over years 1984–2014 (compared to the base period 1950–1980) over the Antarctic from the NOAA-MLOST regridded temperature product11.

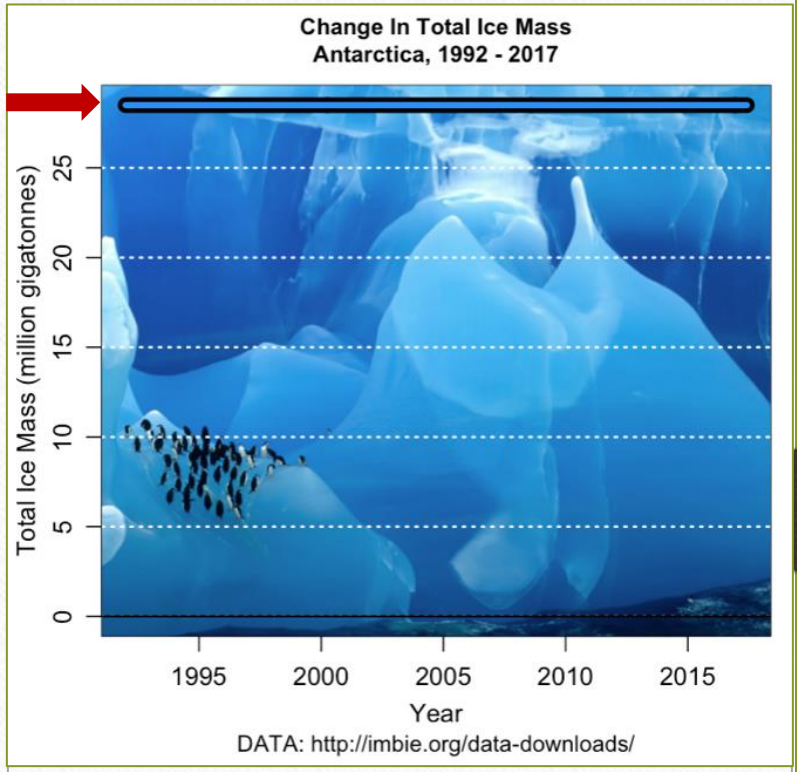
Artikel in Nature

https://klimaatgek.nl/wordpress/2021/08/03/de-temperatuur-op-antarctica/

Land ice in Antarctica

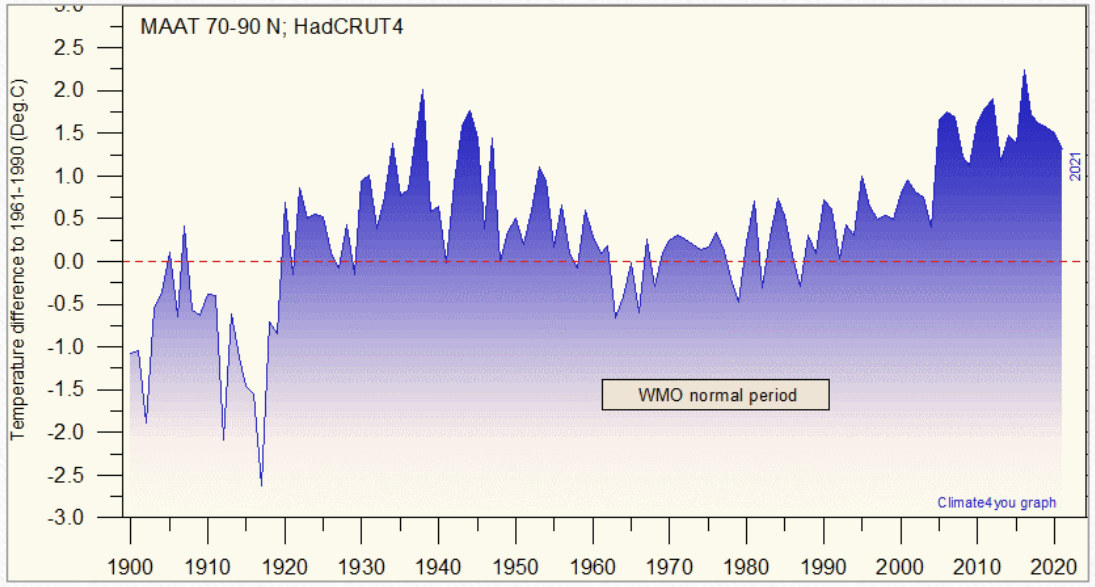


East Antarctica is gaining ice, West Antarctica is losing ice, and the overall decline is not accelerating (ref.).

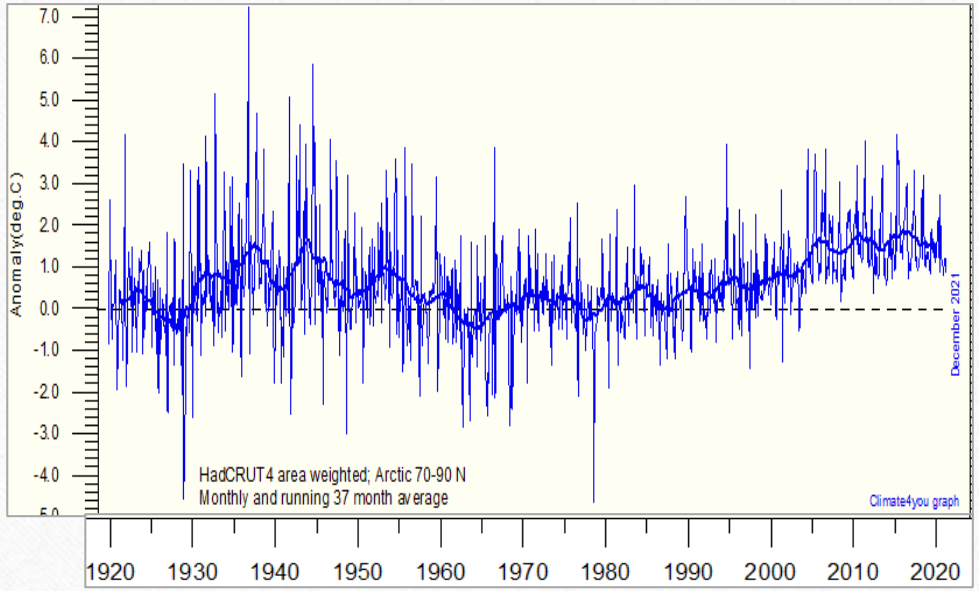


The graph on the left may give the impression that Antarctica is melting. But in reality, there is so much ice that the decrease is invisible (ref.).

Temperature in the Arctic zone



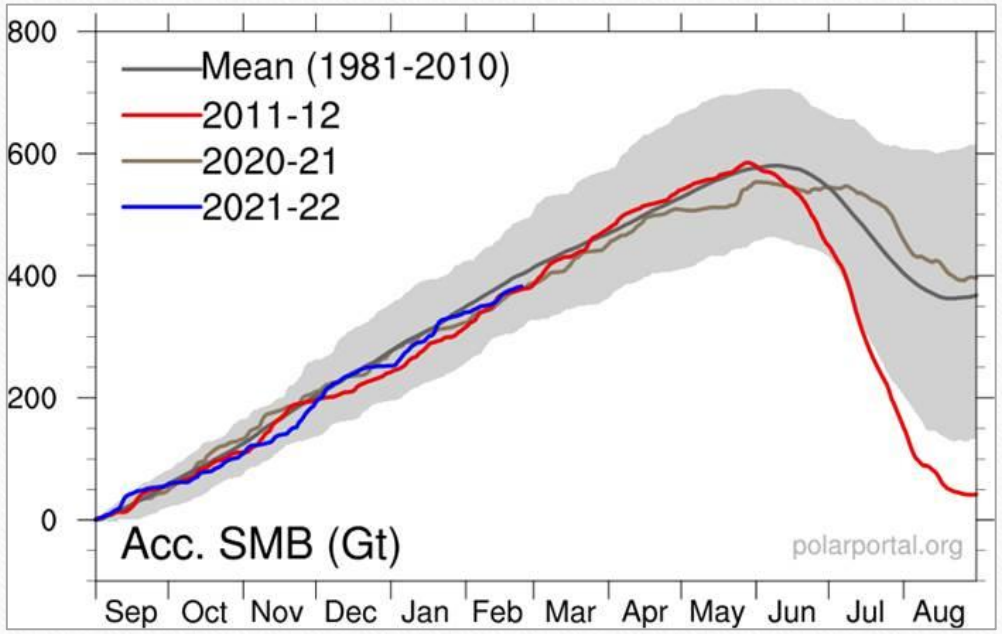
Anomaly of the annual air temperature 70-90°N from 1900 (ref.).



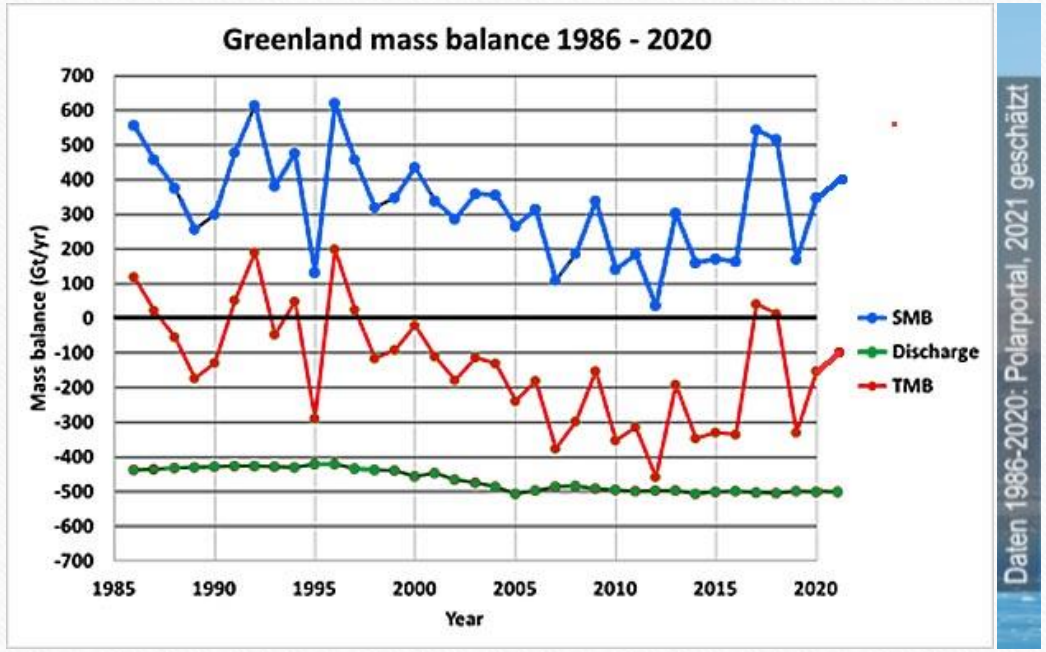
Anomaly of the surface-weighted monthly air temperature 70-90°N from 1920 (ref.).

Around 1930-1945 it was almost as warm in the Arctic as it is now.

Land ice on Greenland seems to be recovering



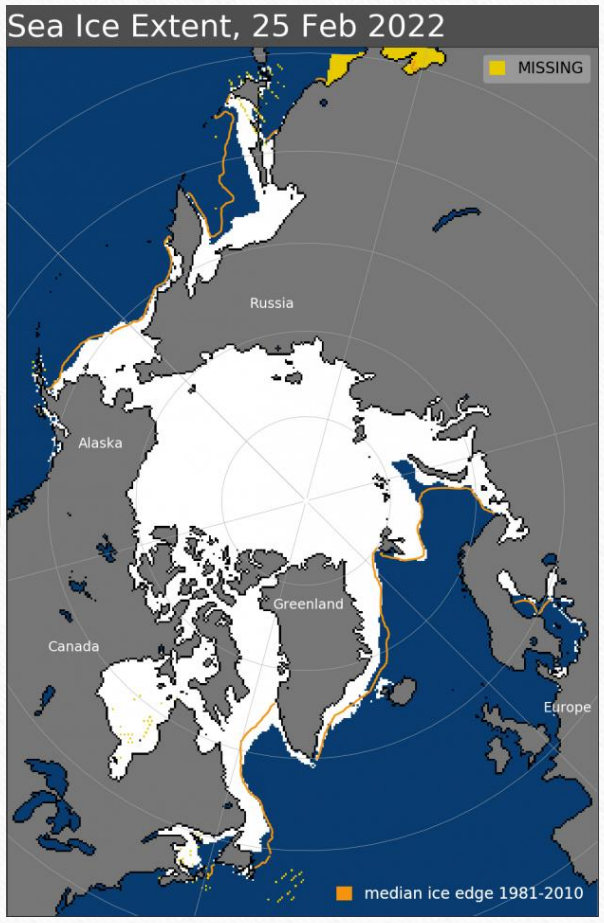
Sea level rise is caused by melting land ice, not by melting sea ice. Compared to the 1981-2010 average, there was a significant meltdown in the summer of 2011-12. In 2020-21, there was an increase in ice in the summer.



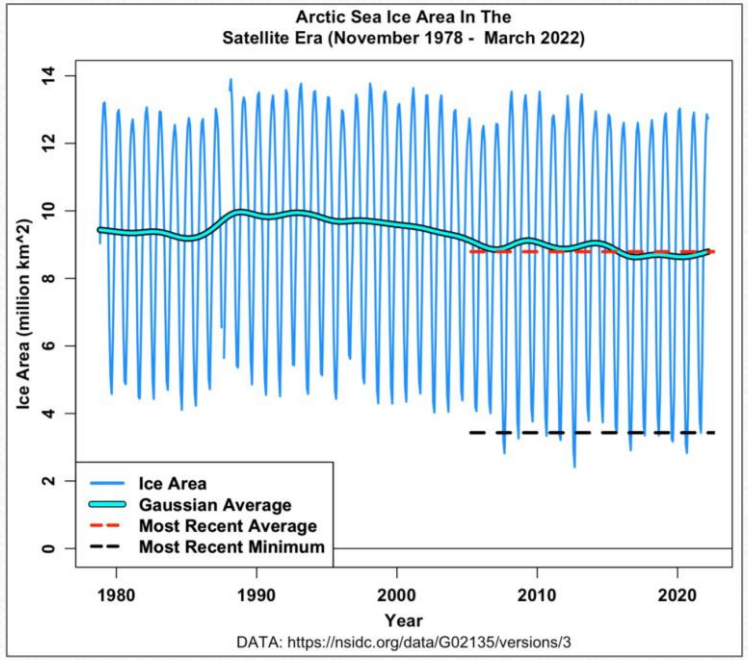
The land ice decreased until 2012, but then it started to grow again (ref.).

https://electroverse.net/greenlands-ice-loss-trend-has-now-reversed/

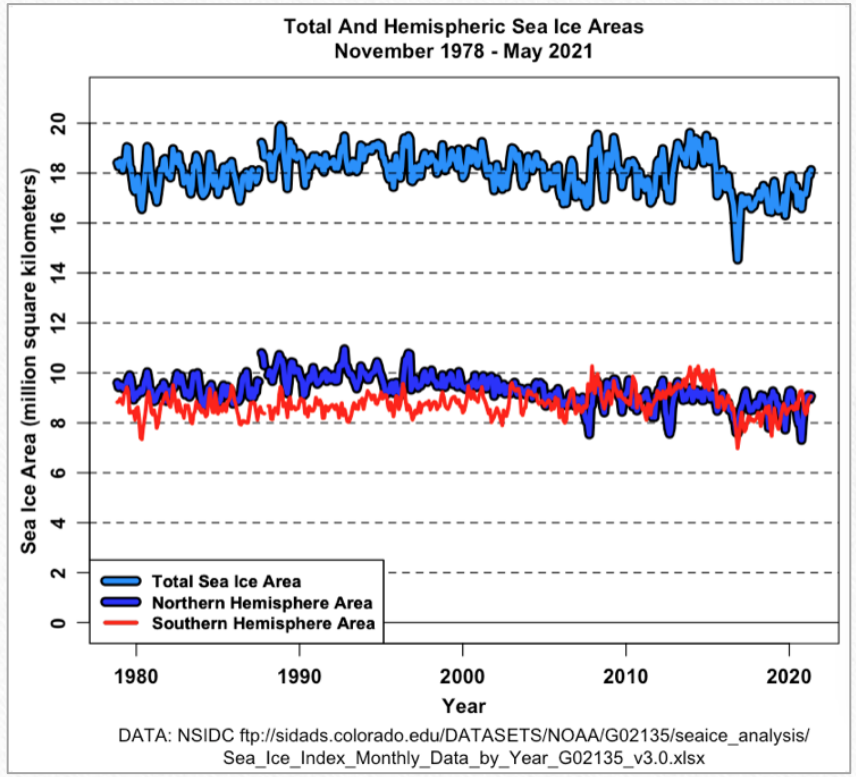
Sea ice at the poles



Maximum winter sea-ice extent (white) in comparison with the 1981-2010 mean (orange line).



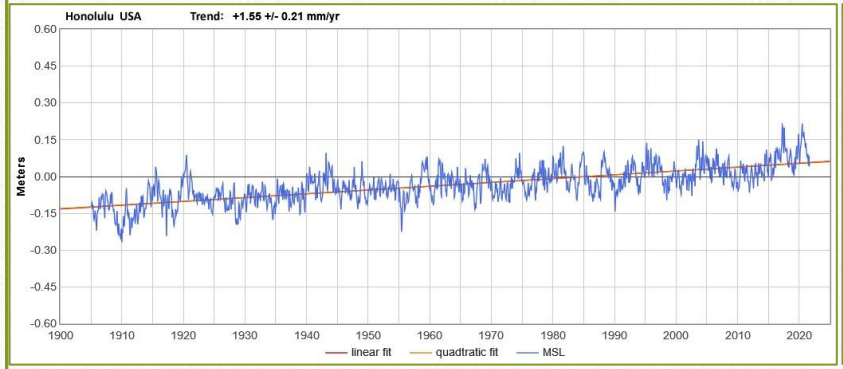
Left: arctic sea-ice surface on Feb 25, 2022 (maximum winter sea-ice).
Above: the decrease is 2.6% per decade in March (winter ice) and 12.7% in September (summer ice); however, in the last 14 years the decrease has been nil. (ref.)

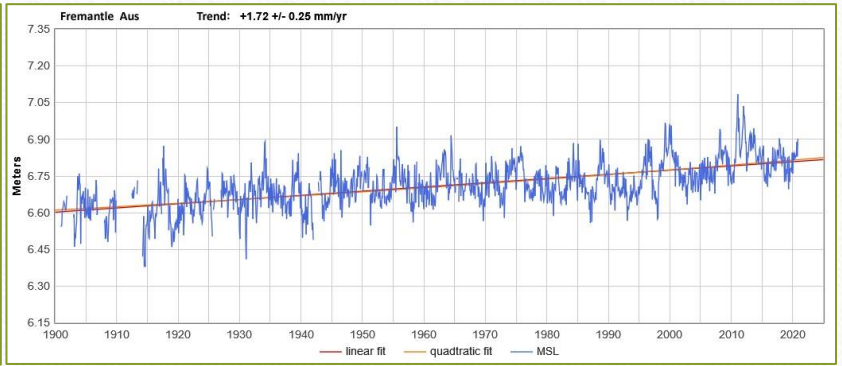


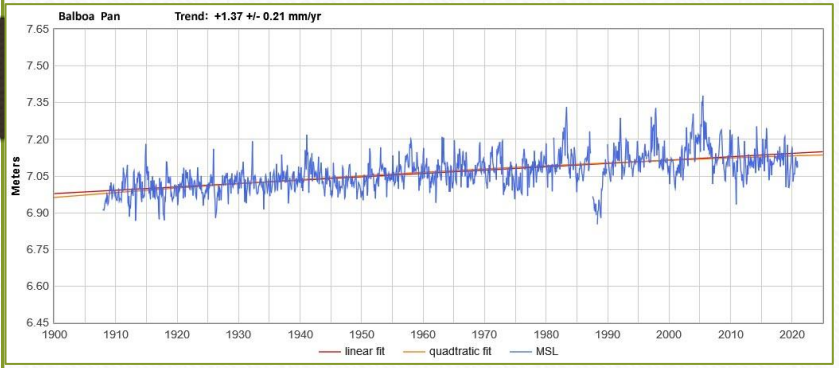
"The hyped reduction in Arctic sea ice is matched by a widely-unhyped increase in Antarctic sea ice, so the total global sea ice area is currently at the long-term average of 18 million quare kilometres."

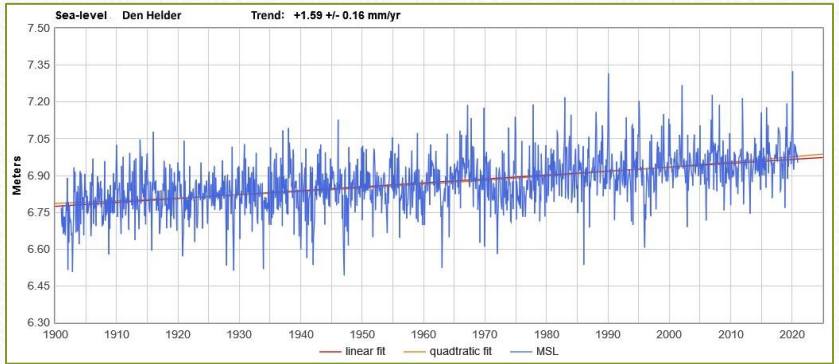
http://polarportal.dk/en/sea-ice-and-icebergs/sea-ice-thickness-and-volume/
https://nsidc.org/data

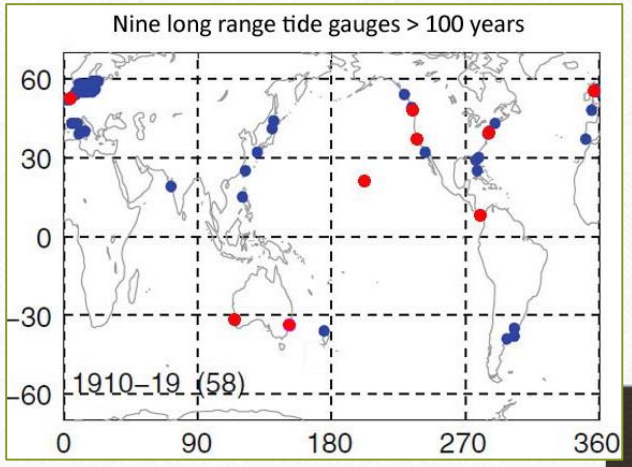
Sea level rise is mild and shows no accelerated increase (1)









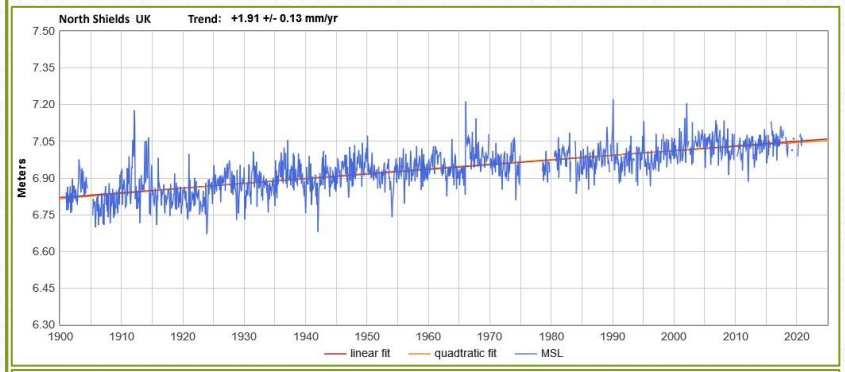


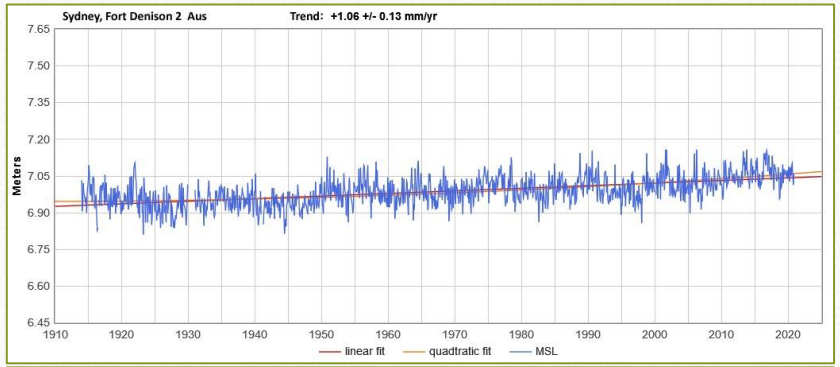
The above long-term series of tidal measurements spread over the earth {right picture (ref.)} show no acceleration and the average trend is 1.5-2 mm/year or 15-20 cm/century (ref.).

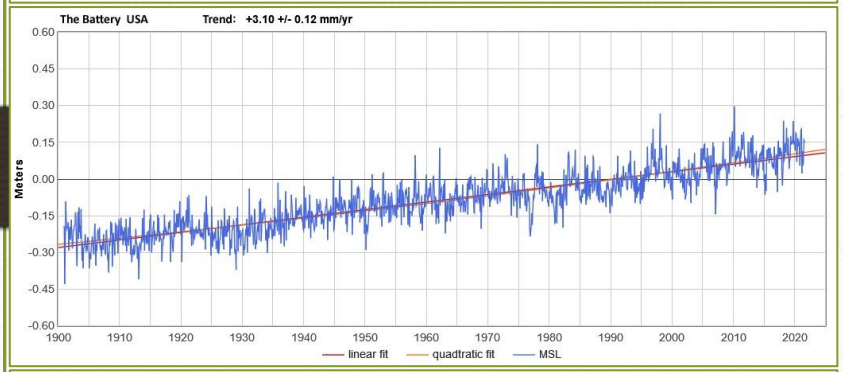
The differences in the trend are caused by locally rising or falling land.

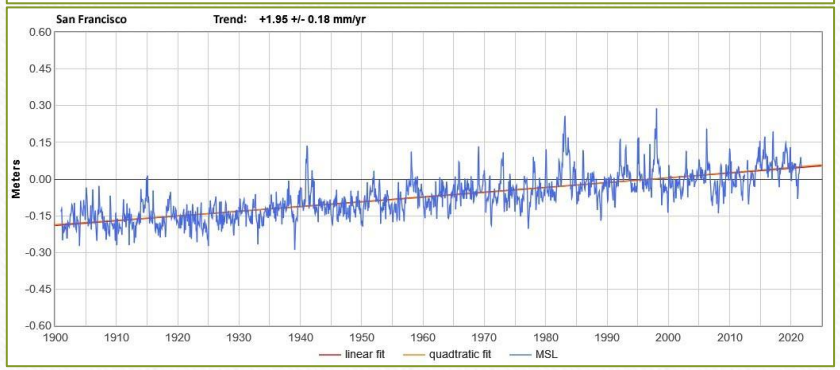
The rise in sea level on Earth is a result of two processes: the melting of ice caps and the thermal expansion of ocean water.

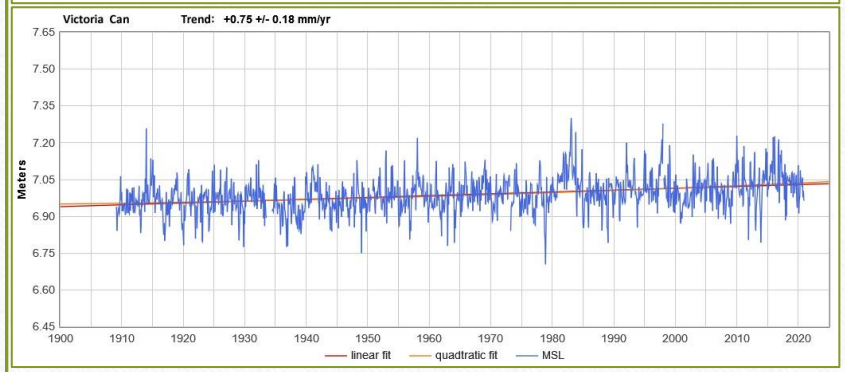
Sea level rise is mild and shows no accelerated increase (2)

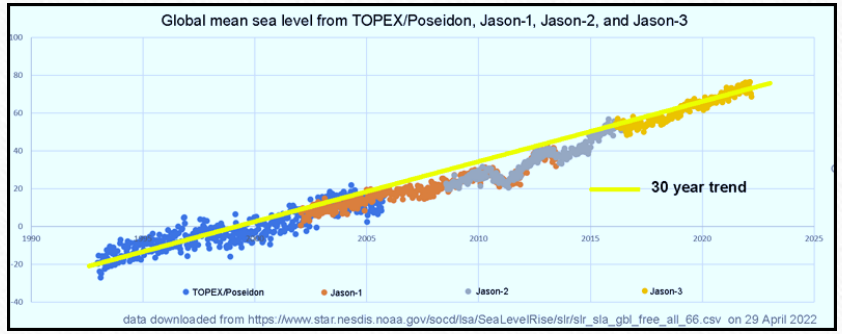








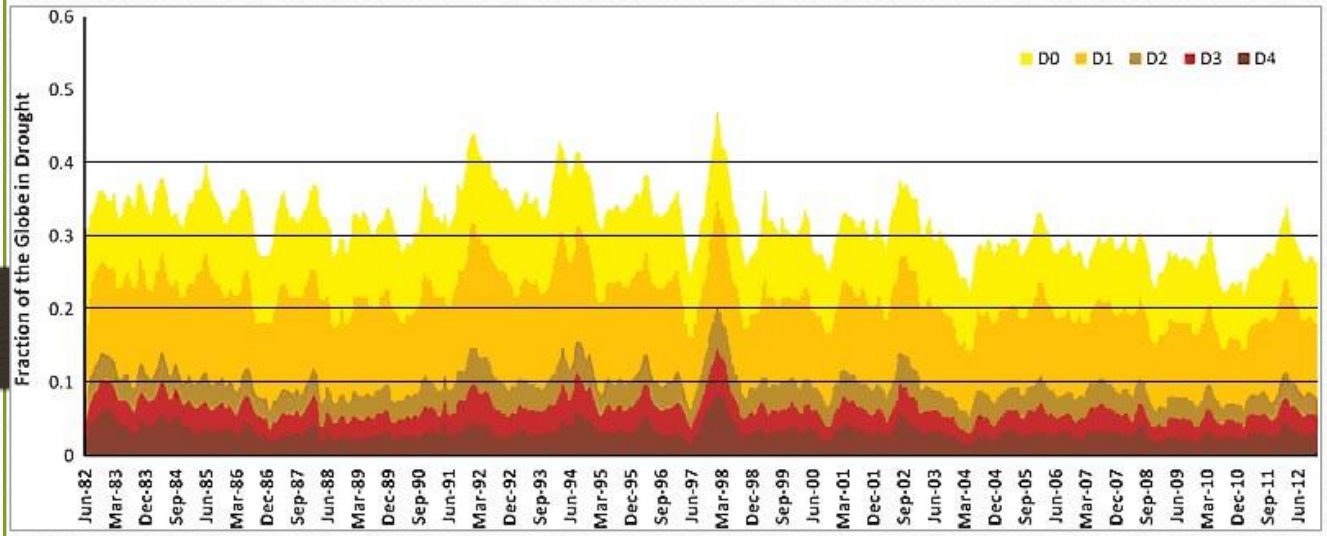




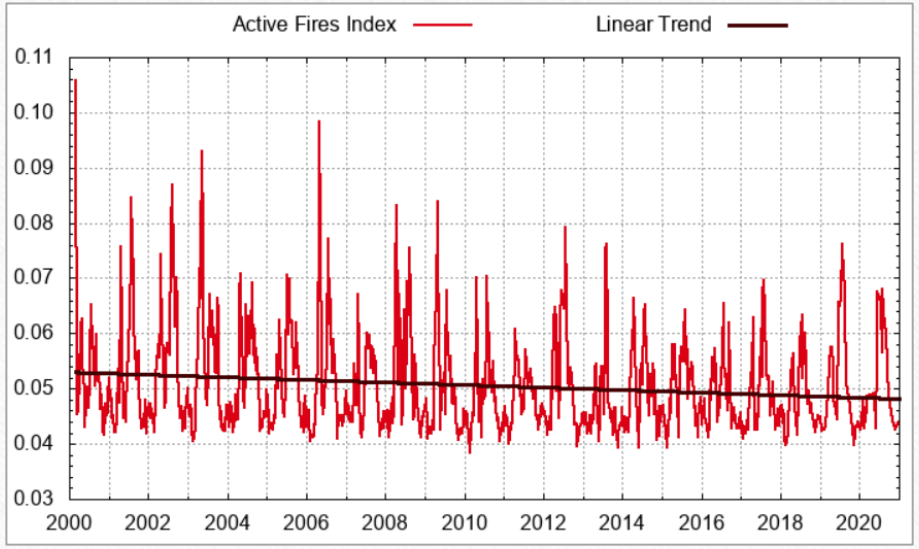
"It is striking that these time series show virtually no acceleration. Such an acceleration would be to be expected as the IPCC predicts dangerous sea level rise.." (ref.)

Left: satellite measurements since 1993 also show no acceleration (ref.).

Drought and forest fires are not increasing

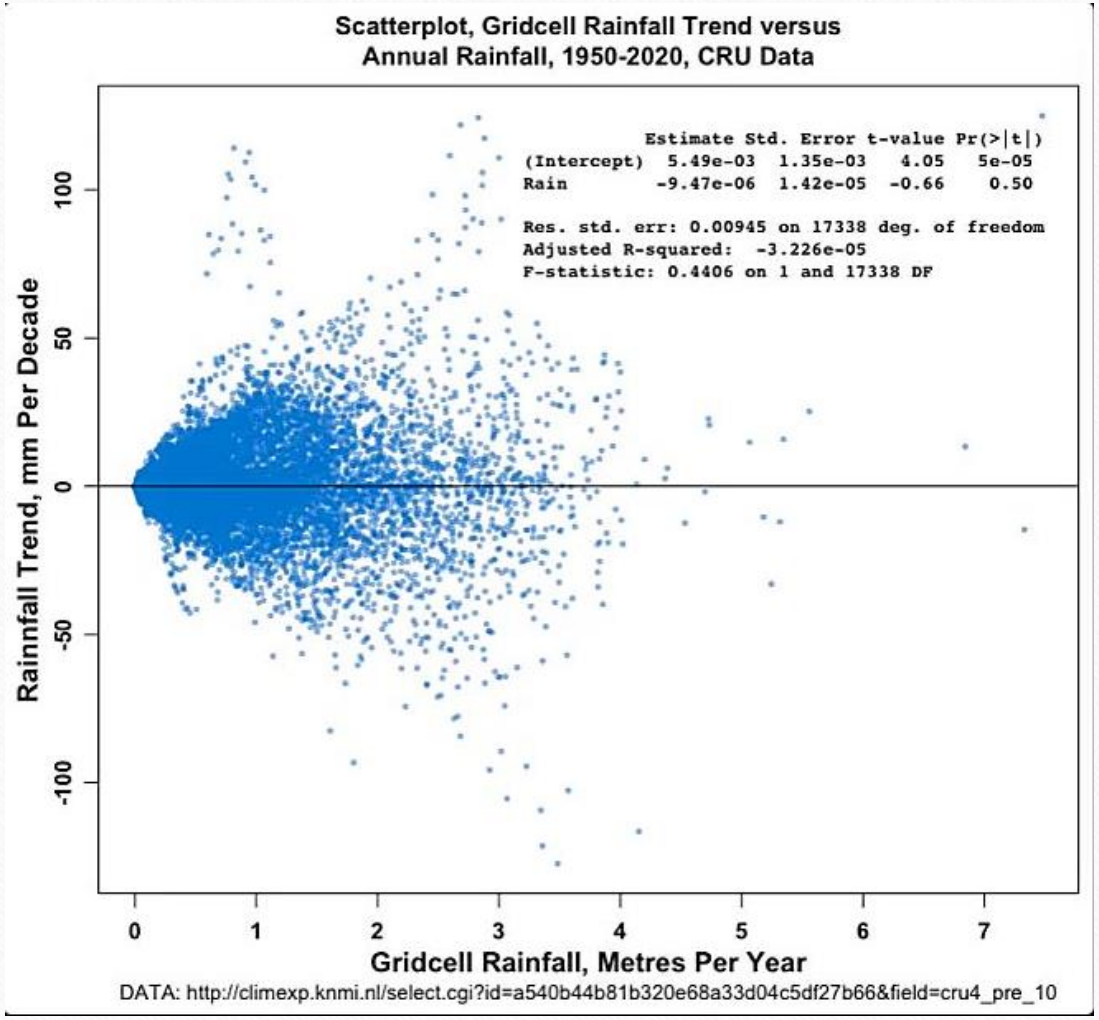


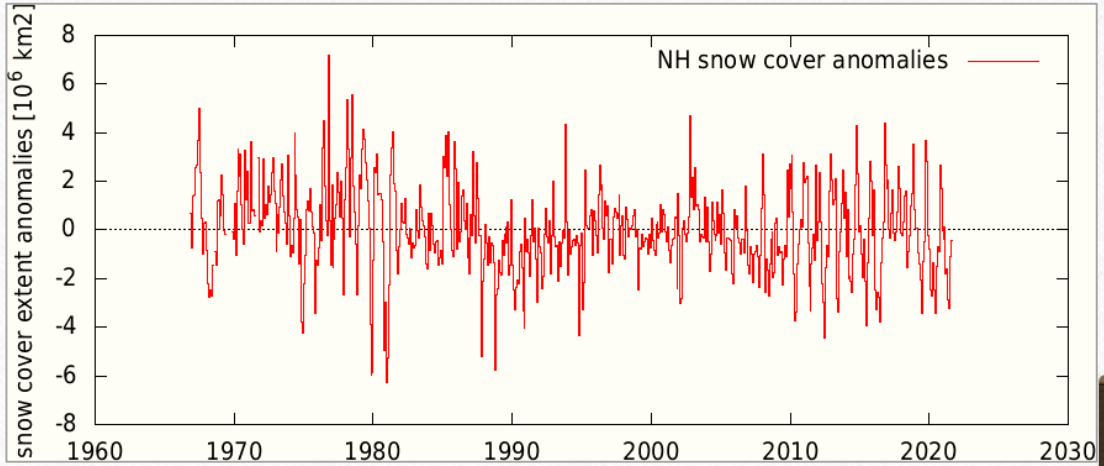
Fraction of the global country in D0 (abnormally dry), D1 (moderate), D2 (severe), D3 (extreme) and D4 (exceptional) drought.



https://www.nature.com/articles/sdata20141

Global precipitation: unchanged

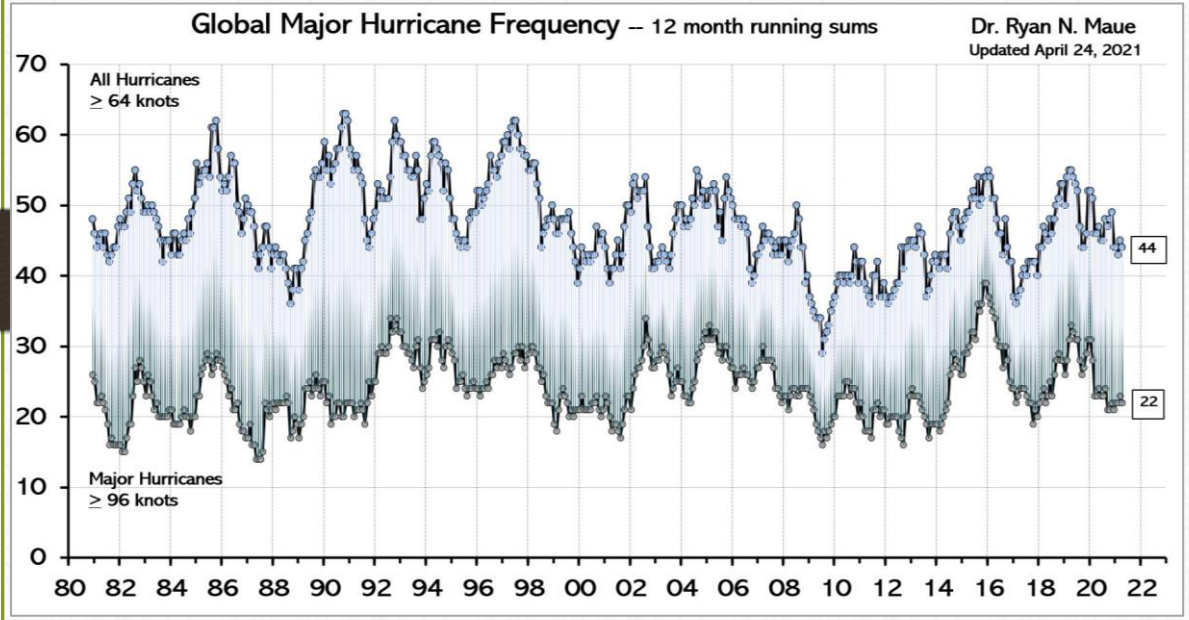




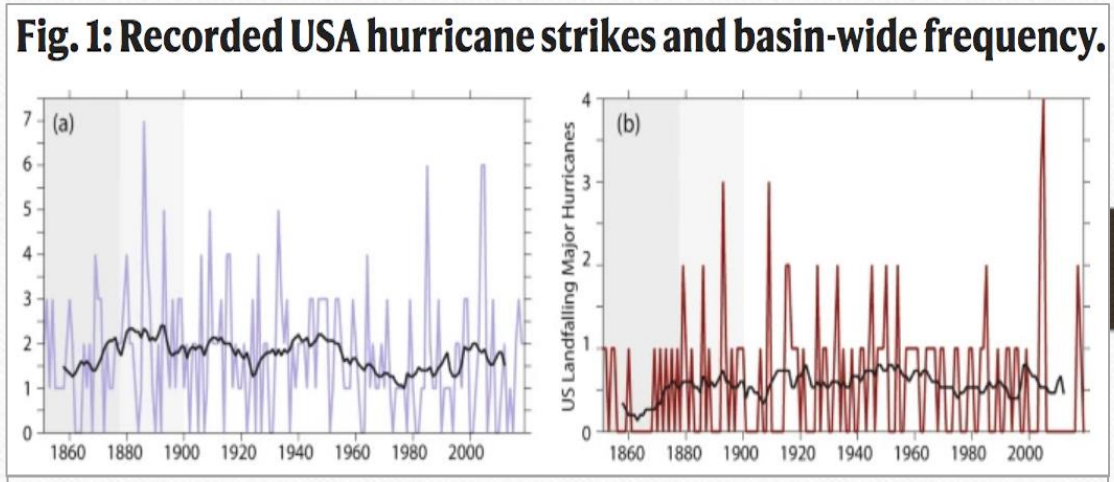
There is no trend in global rainfall and snow cover in the Northern Hemisphere.

Climate Explorer

Number of hurricanes does not increase



Major hurricanes show no increase worldwide



Records of all hurricanes (left) and major hurricanes (right) that made landfall in the U.S. over the past 150 years. NO increase. Ref.

http://climatlas.com/tropical/

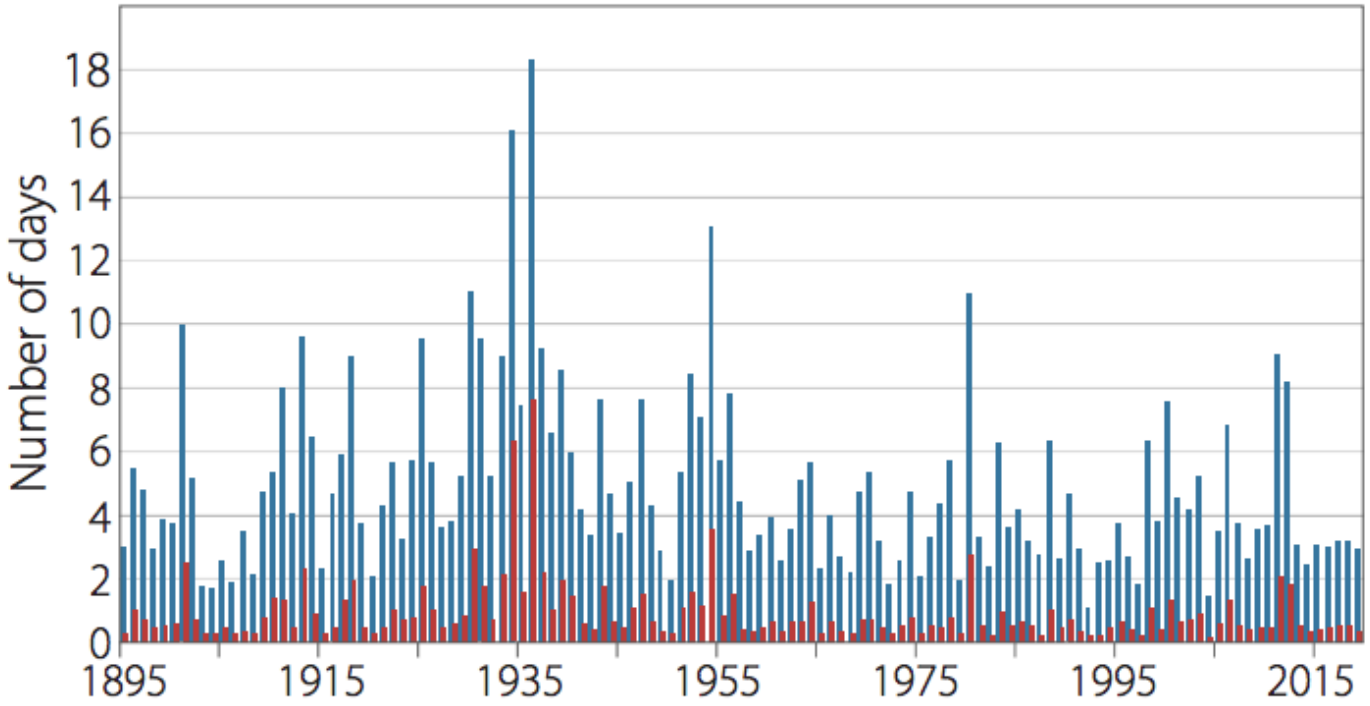
Number of very hot days in the US

Figure 8: Number of daily US maximum temperatures above 100°F and 105°F, 1895–2018.

Average over 982 USHCN stations.
Source: NOAA/NCEI, prepared by John R. Christy.[74]

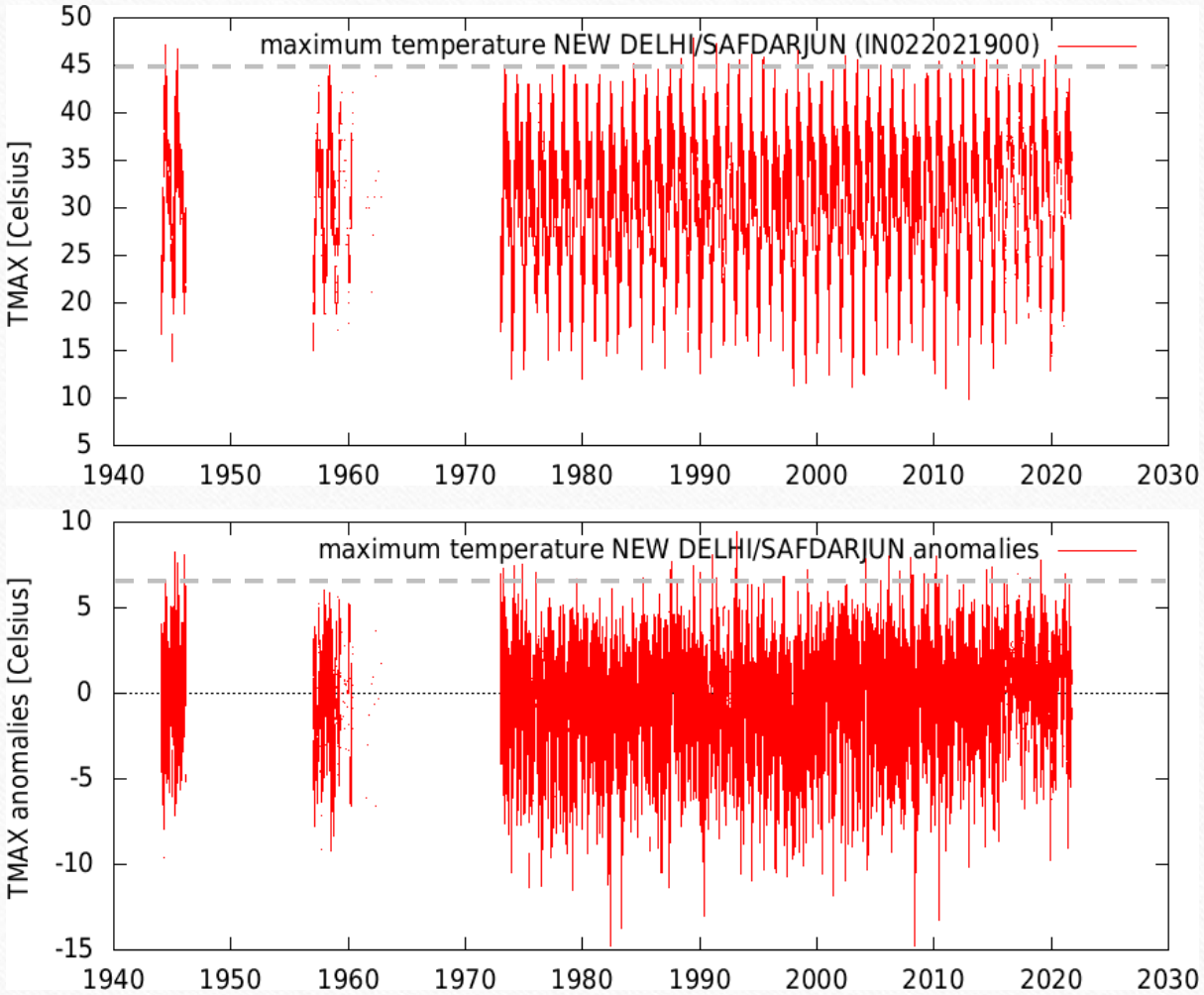
Number of days exceeding:

- 100°F (37.8°C)
- 105°F (40.6°C)



Very hot days in the US with more than 38°C were much higher in the thirties than at any other time in the past 125 years.

Heat waves in India are not getting worse

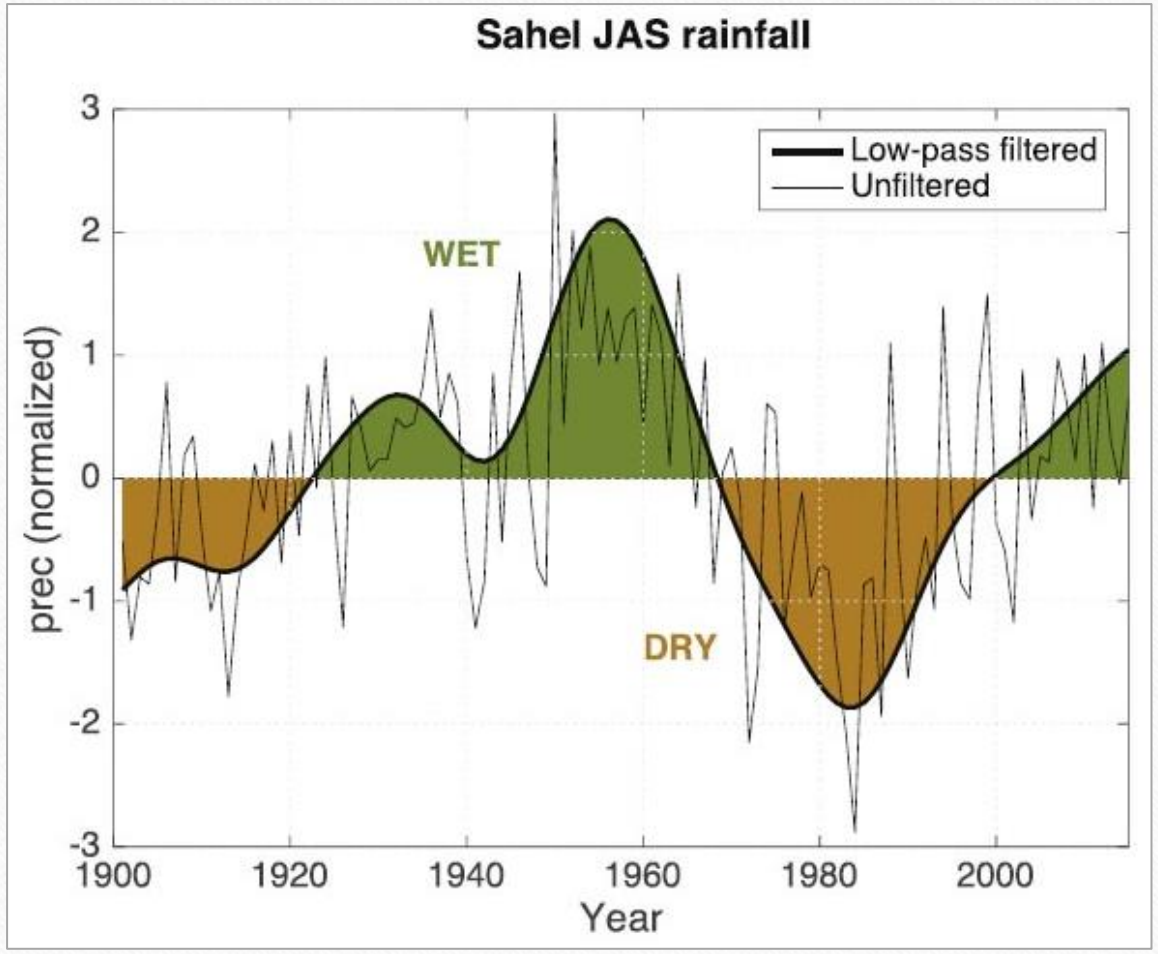


Top: temperatures above 45°C in New Delhi did not increase since the forties.

Bottom: no indication for an increasing trend in the hottest temperatures.

Media often confound weather with climate.
(Ref.)

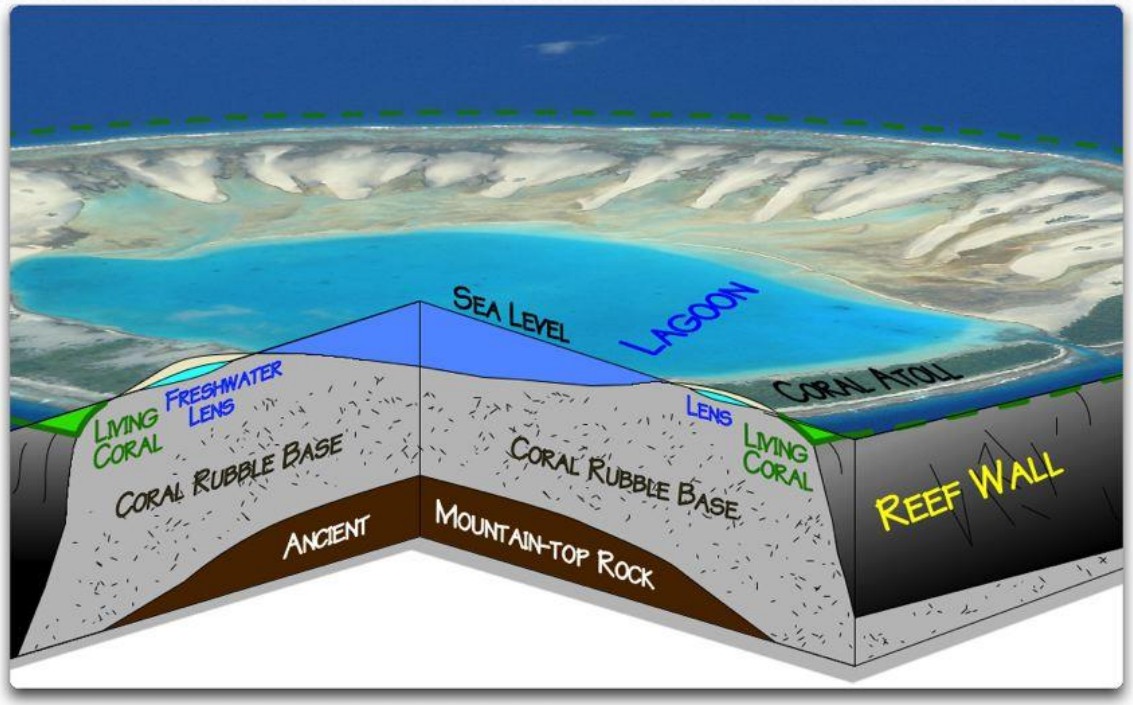
Rainfall in the Sahel is not steadily decreasing



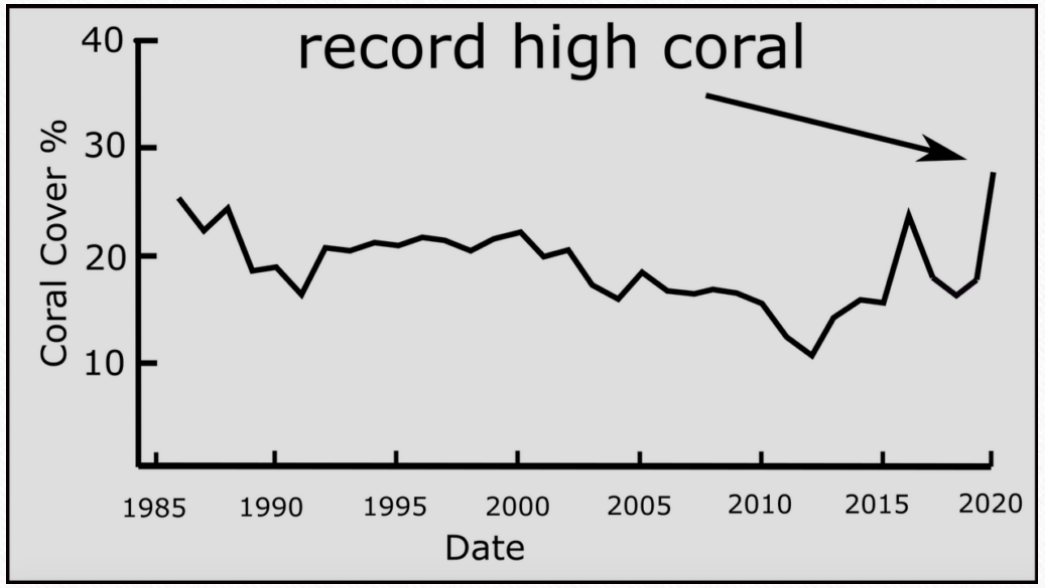
In the Sahel, the semi-arid zone Z of the Sahara and known for the images of many dying people in the eighties, more precipitation has fallen since 1985, making the Sahel greener.

There is a clear multidecadal rainfall variability in the Sahel region over the past century, possibly related to the Atlantic Multidecadal Oscillation: a natural pattern of warm/cold sea surface temperatures in the North Atlantic (AMO, see slide 21). (Ref.)

Coral atolls do not sink & Great Barrier Reef fully restored



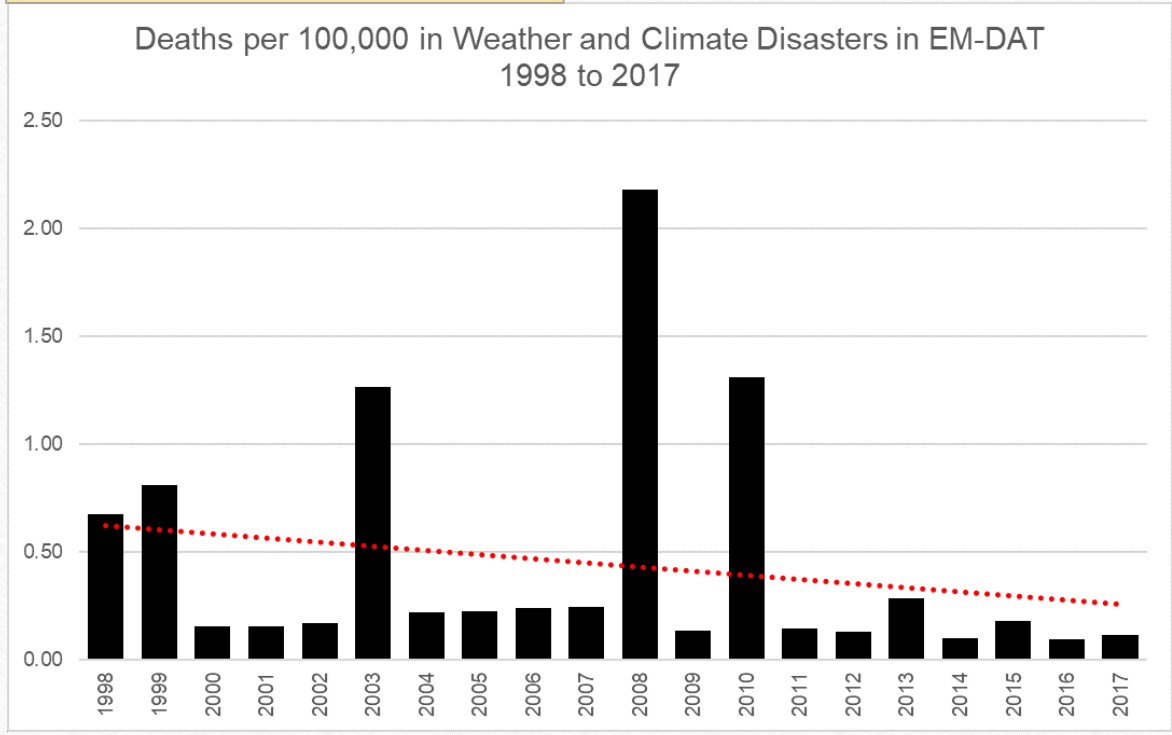
Coral atolls do not disappear under the sea, in fact many atolls actually increase in size (ref.).

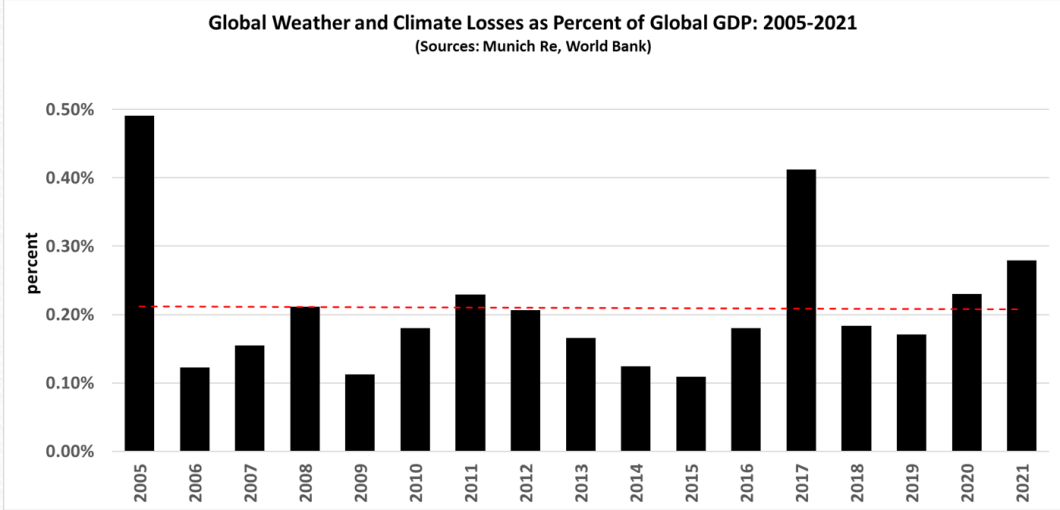


Record high Coral in Great Barrier Reef (Ref.)

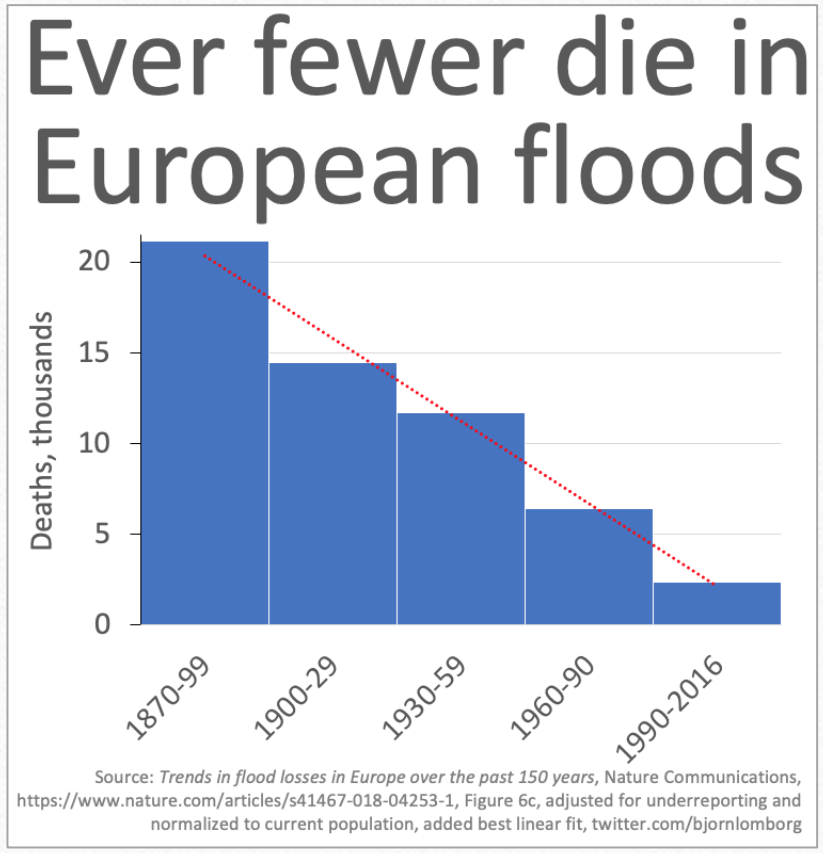
Deaths due to extreme weather have decreased (1)

@RogerPielkeJr
10 Jan 2022
Updated from: Pielke, R. 2019. Tracking progress on the economic costs of disasters under the indicators of the sustainable development goals. *Environmental Hazards*, **18**:1-6.

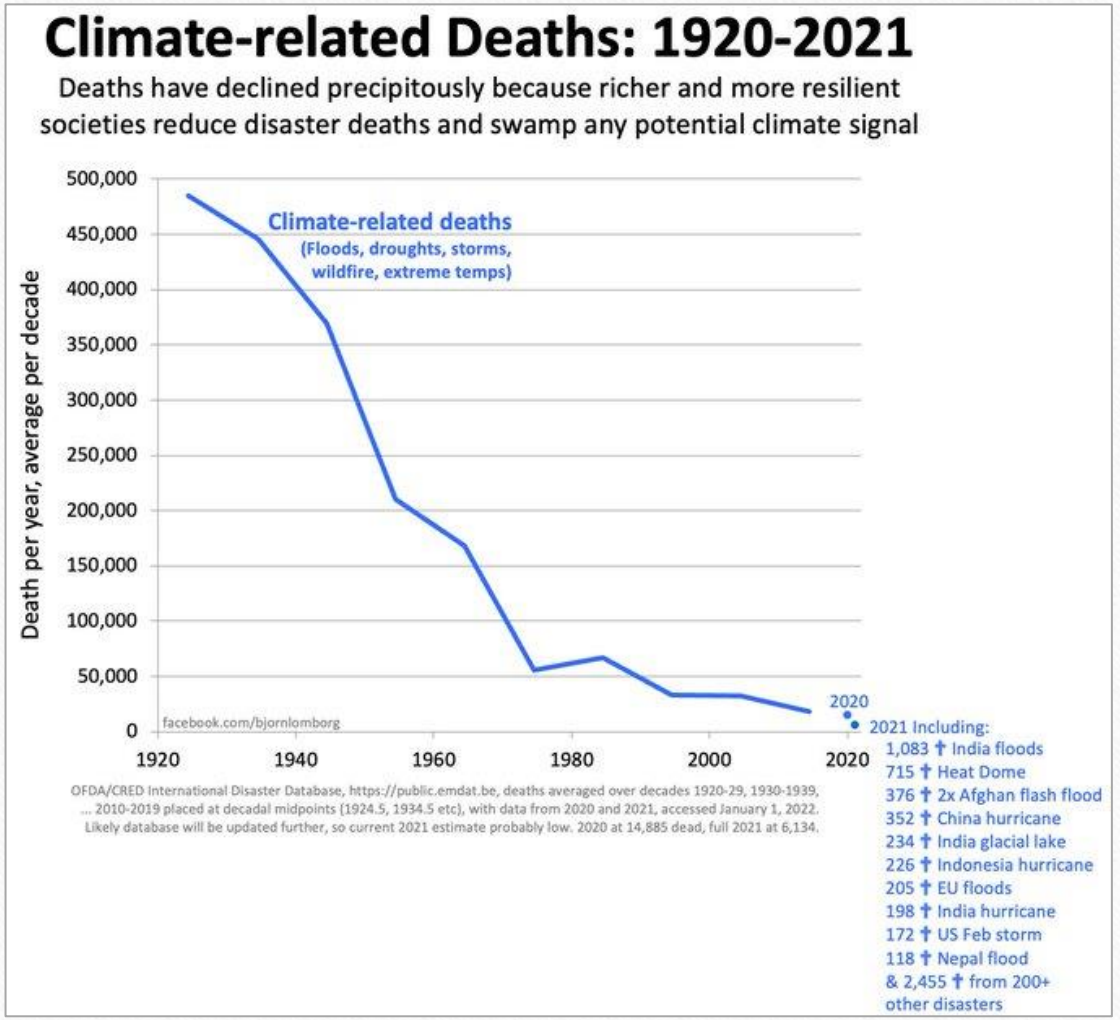




Deaths due to extreme weather have decreased (2)

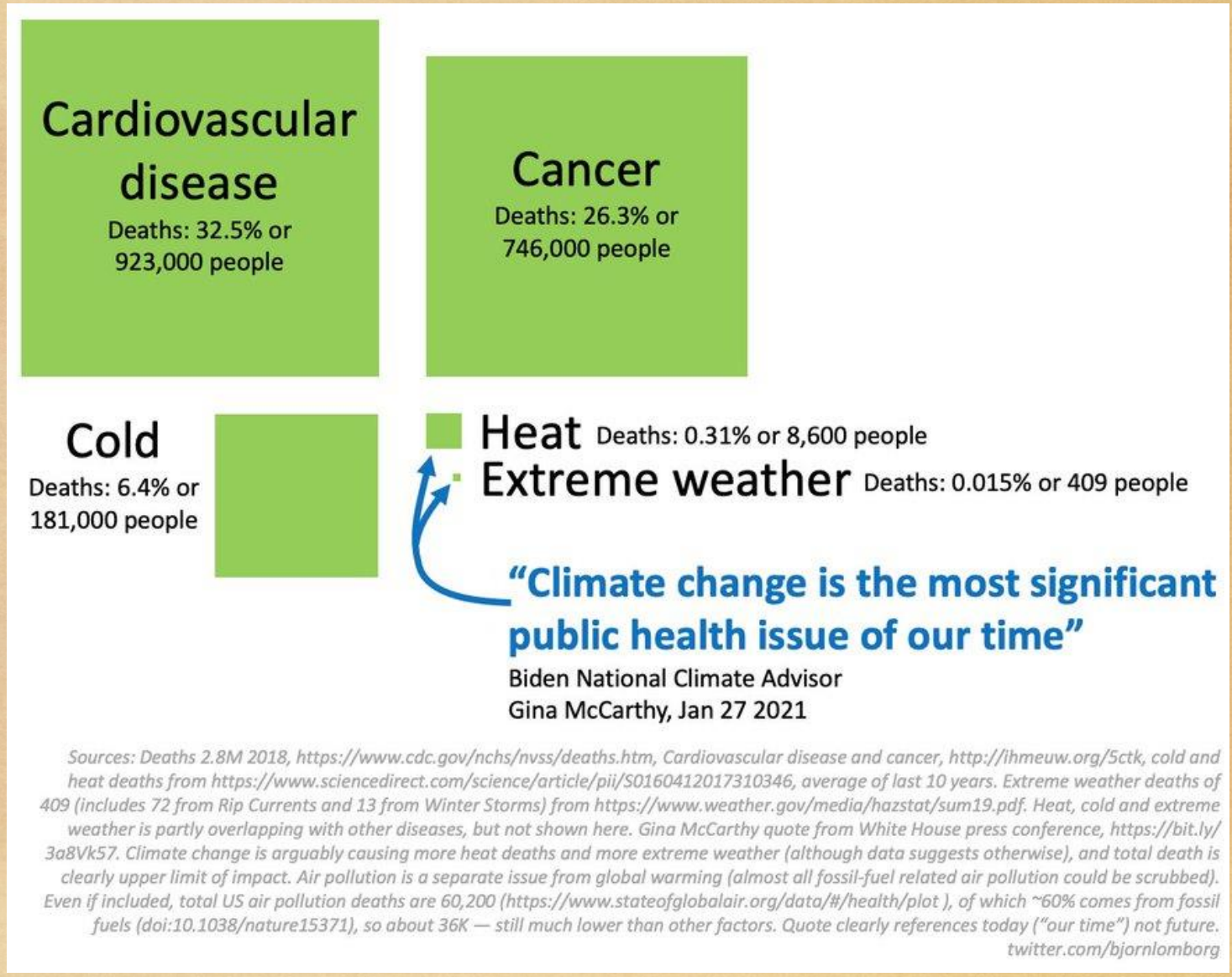


Source: *Trends in flood losses in Europe over the past 150 years*, Nature Communications, https://www.nature.com/articles/s41467-018-04253-1, Figure 6c, adjusted for underreporting and normalized to current population, added best linear fit, twitter.com/bjornlomborg

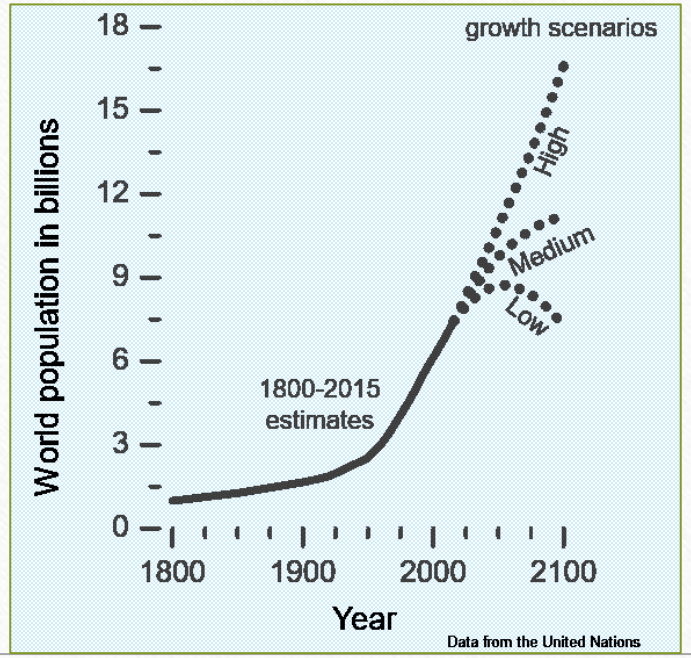


https://t.co/eEtRrsORDw

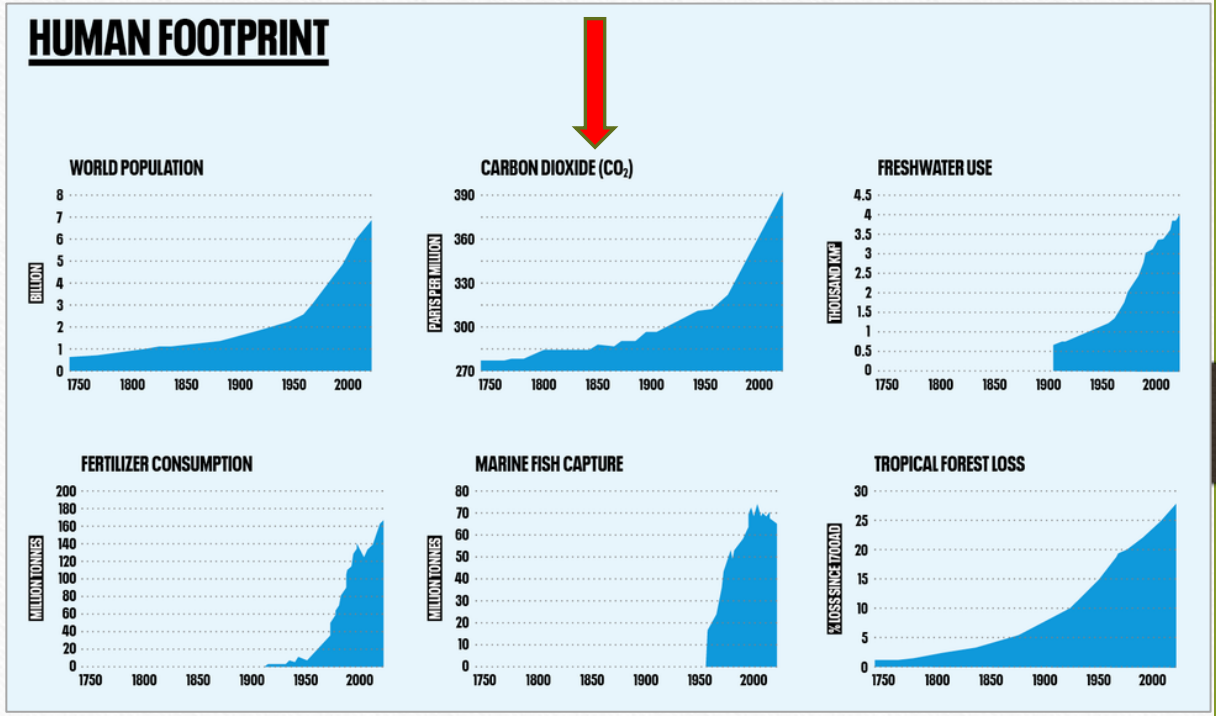
Global warming is not a public health problem



Are human CO_2 emissions and population growth a problem?

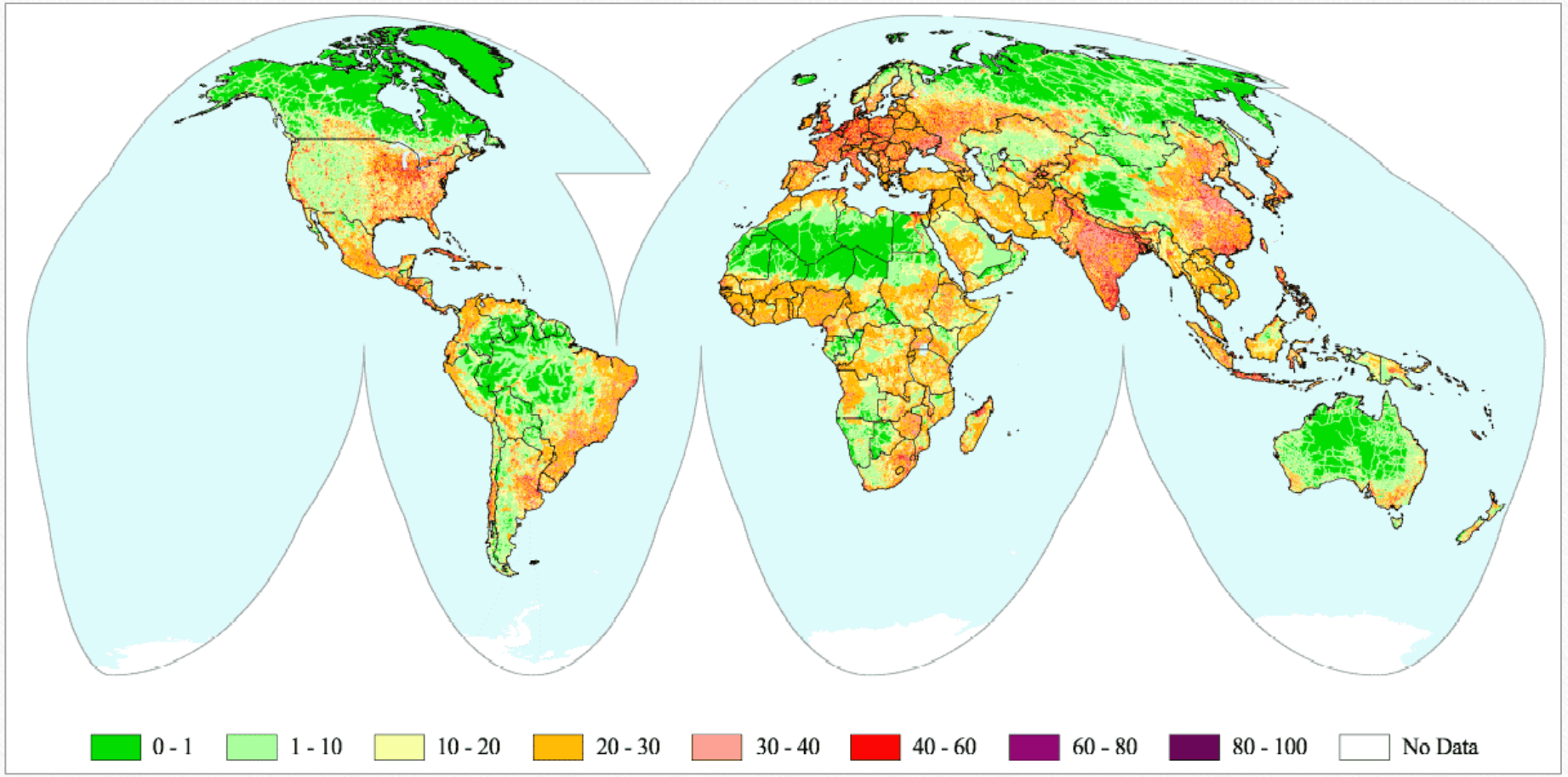


Since more CO_2 and moderate warming are beneficial for nature, it is more rational to blame the other issues in the Human Footprint (image on the right) on factors associated with population growth than on human CO_2 emissions.



Public and environmental organisations confuse climate and CO_2 with pollution and with nature and environmental issues.

https://populationmatters.org/the-issue



Human footprint. A score of 1 indicates the least human influence and 80-100 the maximum in the given biome. Four factors are used to measure human influence: population density, land transformation, human access, and energy infrastructure. Land transformation (deforestation, agriculture, urbanisation, infrastructure construction) is probably the biggest threat to biodiversity, resulting in loss and/or fragmentation of habitats. CO_2 does not play a causal role in this.

https://earthobservatory.nasa.gov/images/3254/map-of-the-human-footprint

Land use change causes drought and warming

Forests and grasslands evaporate water from the stomata of leaves. During evaporation, heat is extracted from the environment. Deforestation and the disappearance of grasslands for agriculture and buildings (cities, villages, infrastructure) therefore causes 3 effects:

1. Less CO_2 is absorbed because less photosynthesis.
2. Local warming and drought because there is less evaporation from leaves.
3. Local warming due to district heating (Urban Heat Island effect) as a result of increasing buildings (ref.).

Part of the global warming is therefore the result of land transformation.

About **1**% of the earth's habitable land area is cultivated, 38% is forested, 31% is used for livestock farming and 15% for crop cultivation and 14% are wild grasslands.

5000 years ago, 55% were forested and 44% consisted of wild grasslands and shrubs.