UNEDITED DRAFT

CLIMATE EMERGENCY INSTITUTE

The Health and Human Rights Approach to Greenhouse Gas Pollution

Is global climate change tracking the worst-case scenario?

The world economy has the world fixed on the worst-case climate change scenario (RCP8.5) - for almost all drivers and indicators

All indicators are increasing faster than ever, most accelerating

Peter Carter

4 May 2020

*See defined slide 7

Accelerating global temperature increase and atmospheric CO2 concentration

Current accelerating global temperature increase and atmospheric CO2 concentration is highly suggestive the world is on the worst-case climate change scenario

Global temperature increase for April 2010: +1.3°C

Latest data

Record high non El Nino April

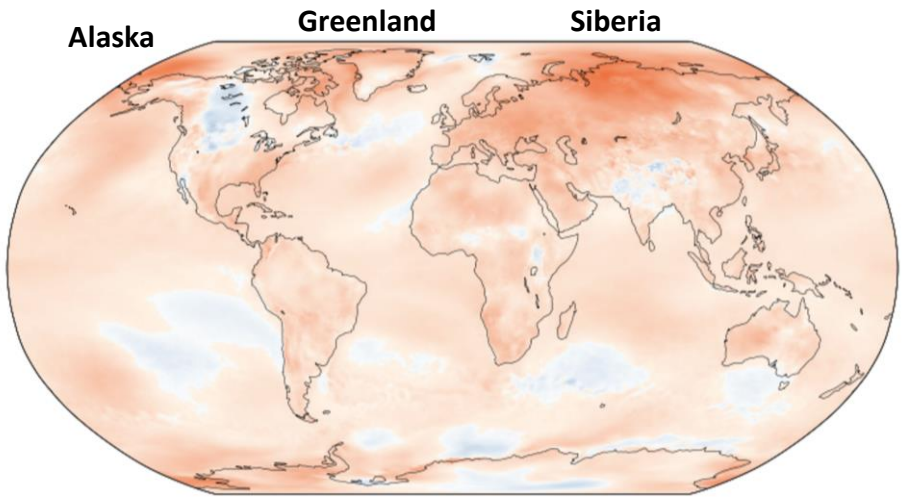
Copernicus May 2020

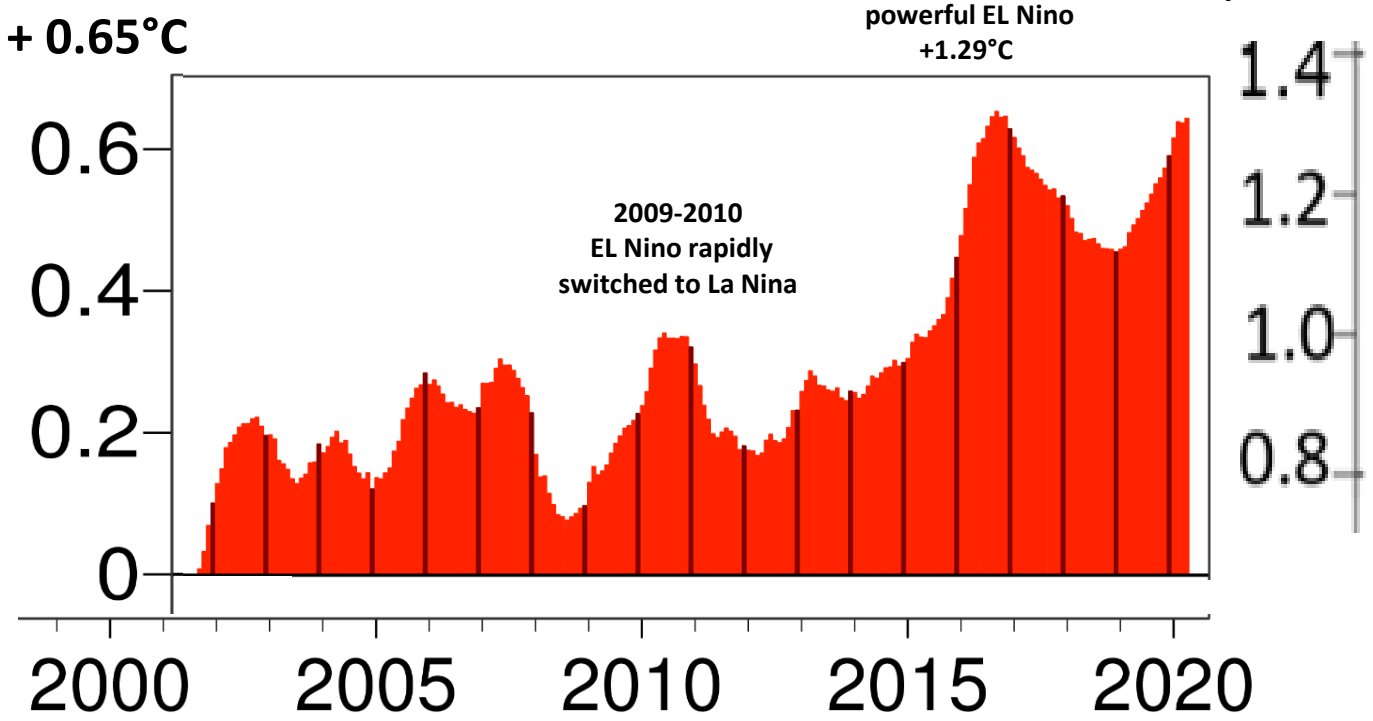
Acceleration from 2010

Virtually as high as the big El Nino record of 2016

The last 12 months - May 2019 to April 2020

12-months global surface air temperature anomalies (° C) relative to 1981-2010





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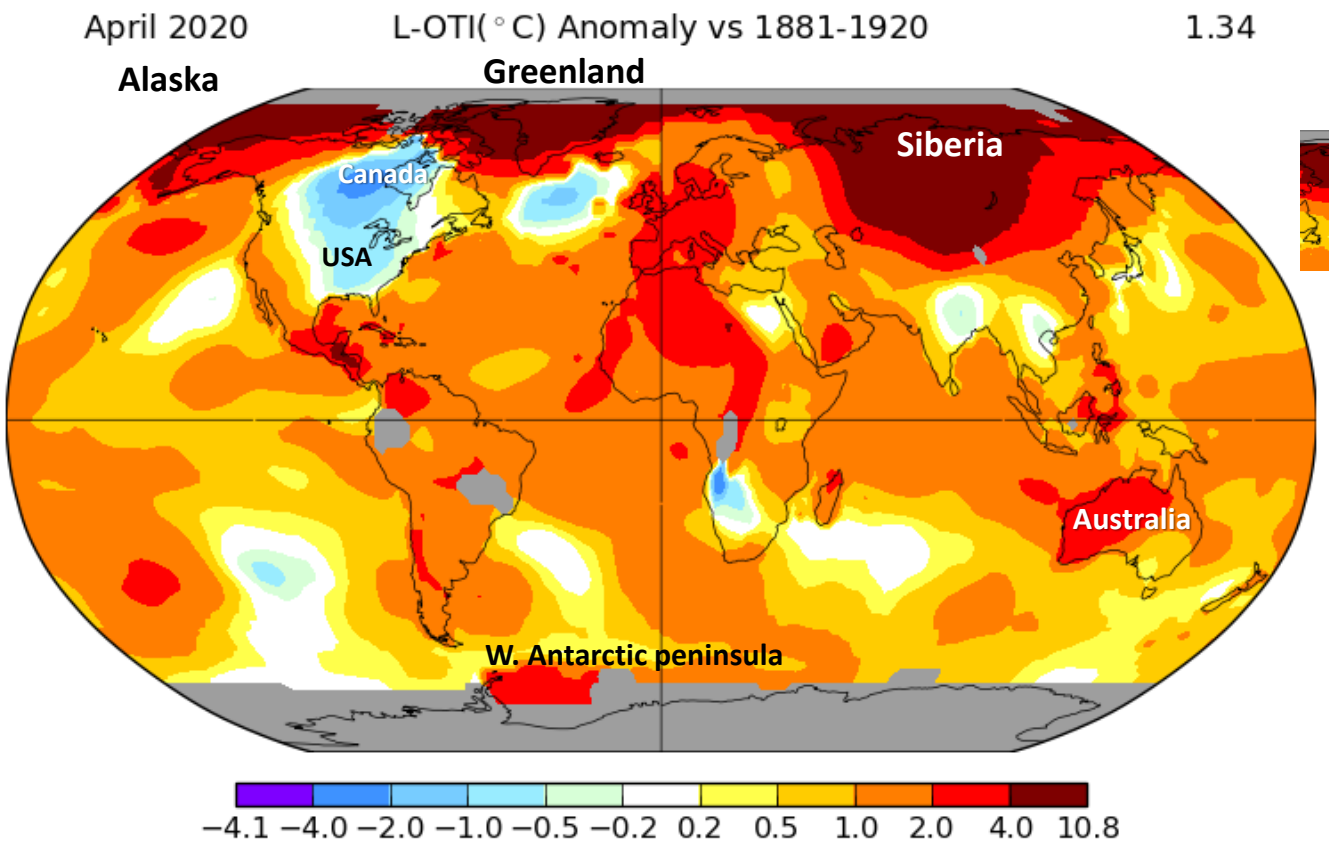
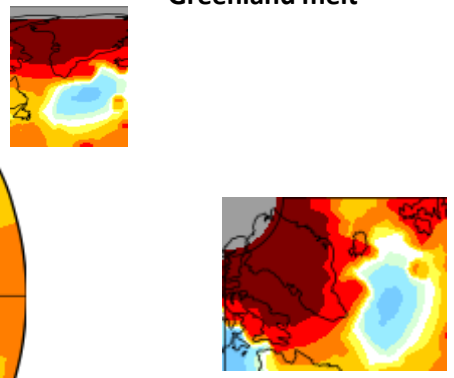
April 2020, NASA GISS : Dramatic global climate disruption at an extremely high April temperature of +1.34°C

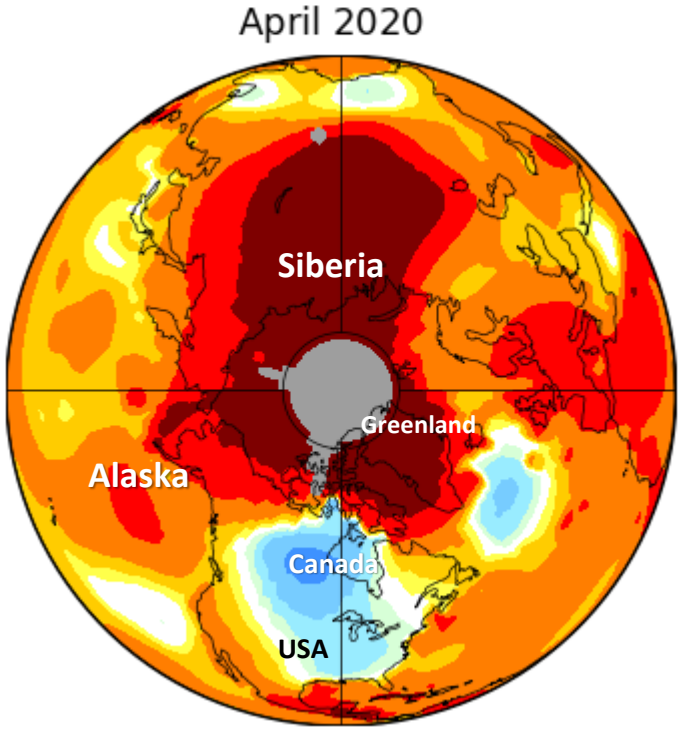
Latest data

(The record high April is 2016 at 1.43°C, boosted by powerful El Nino)



Cold fresh-water run-off from rapid massive Greenland melt





Note: The temperature increase data varies somewhat among the climate centers, due to slight differences in satellite data and computing

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Latest data

Ist. quarter of 2020 (Jan-March) global surface temperature increase:

+ 1.5°C !!!

NASA GISS April 2020

Global average temperature change from preindustrial (1881-1920)

https://data.giss.nasa.gov/gistemp/maps/

NASA GISS Surface Temperature Analysis (v4)
Global Maps

GISS Surface Temperature Analysis (v4)

Global Maps

Data Sources: Land Surface Air Temperature: GHCNv4
Sea Surface Temperature: ERSST_v5

or

Remote Sensed Surface Temperature Anomaly: none

Map Type: Anomalies

Mean Period: 1st Quarter (Jan-Mar)

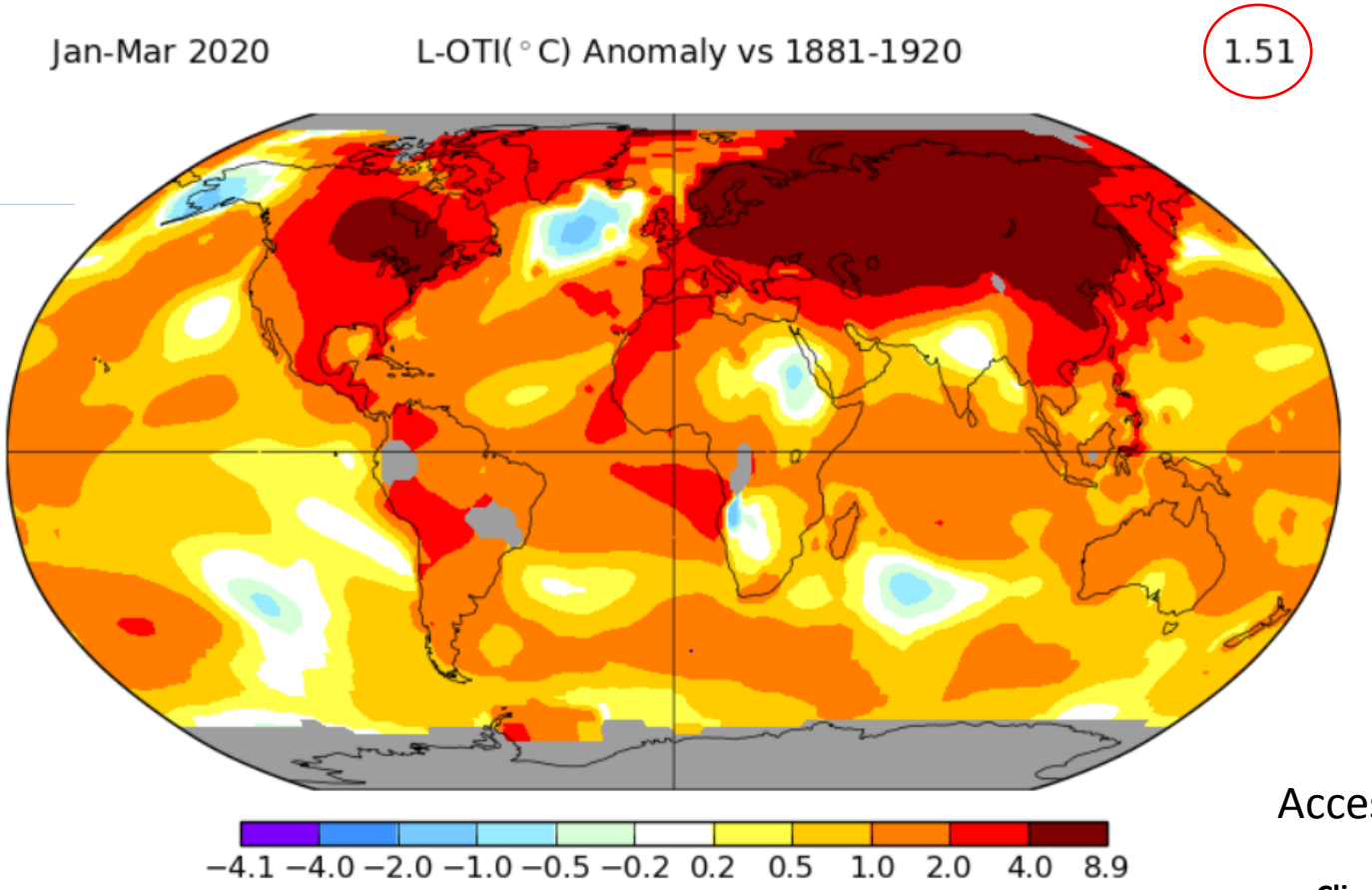
Time Interval: Begin 2020 — End 2020

Base Period: Begin 1881 — End 1920

Smoothing Radius: 1200 km

Map Projection: Robinson

Make Map



Accessed 29 April 2020

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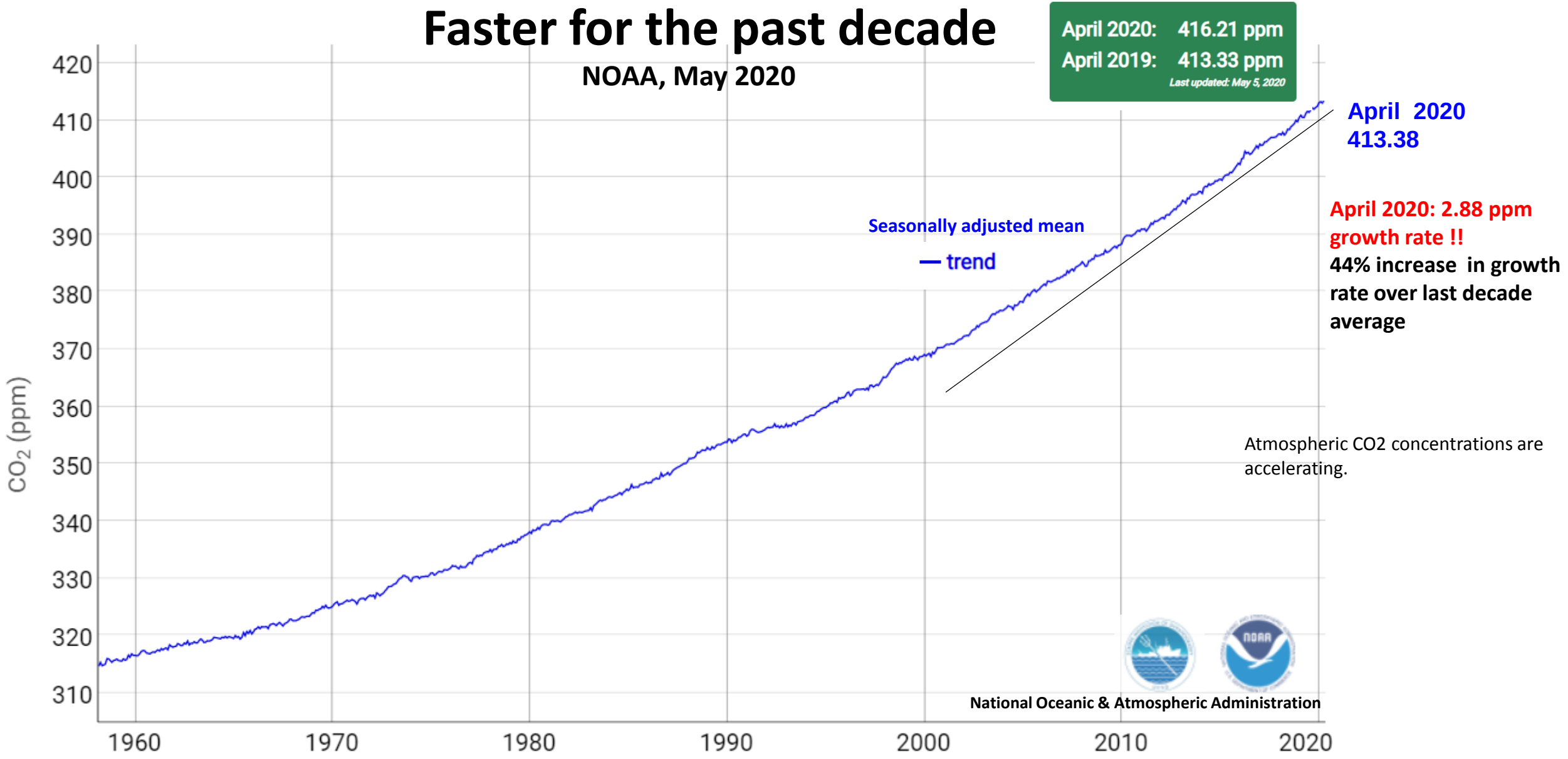
60-year trend of accelerating atmospheric CO2 increase

Faster for the past decade

NOAA, May 2020

Latest data



April 2020: 2.88 ppm growth rate !!

44% increase in growth rate over last decade average

Atmospheric CO2 concentrations are accelerating.

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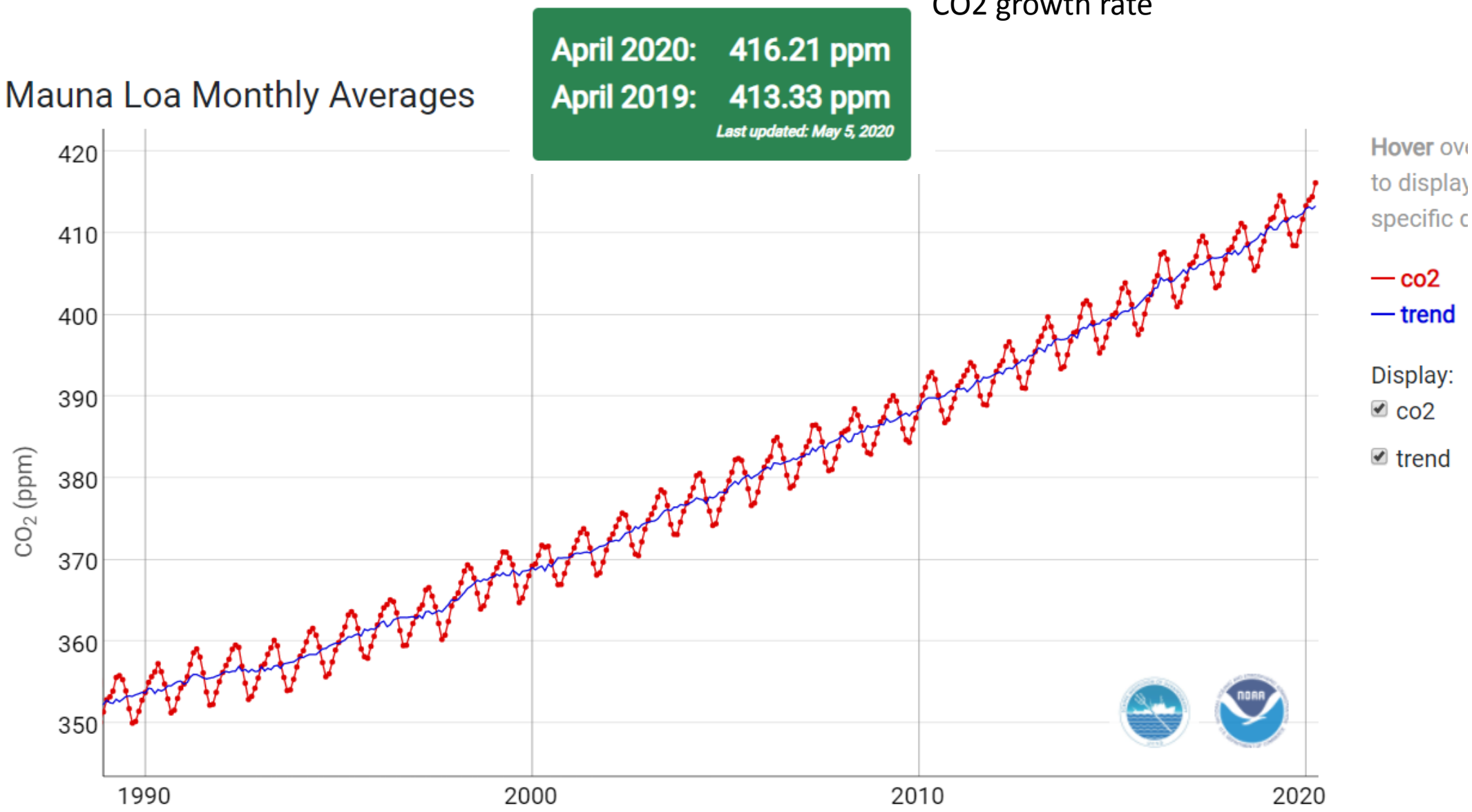
CO2 growth rate

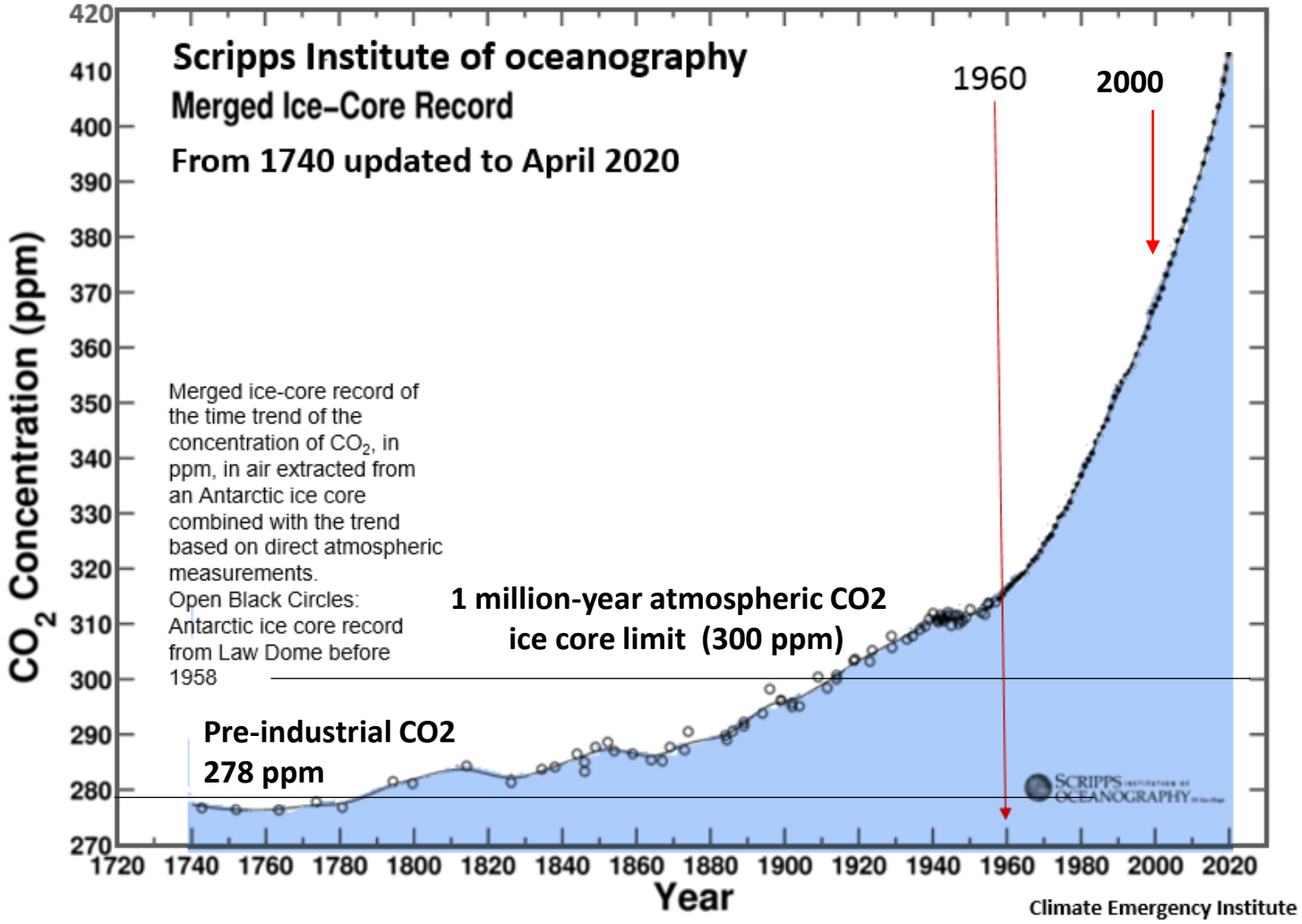


ACCELERATING ATMOSPHERIC CONCENTRATION from 1740 to April 2020

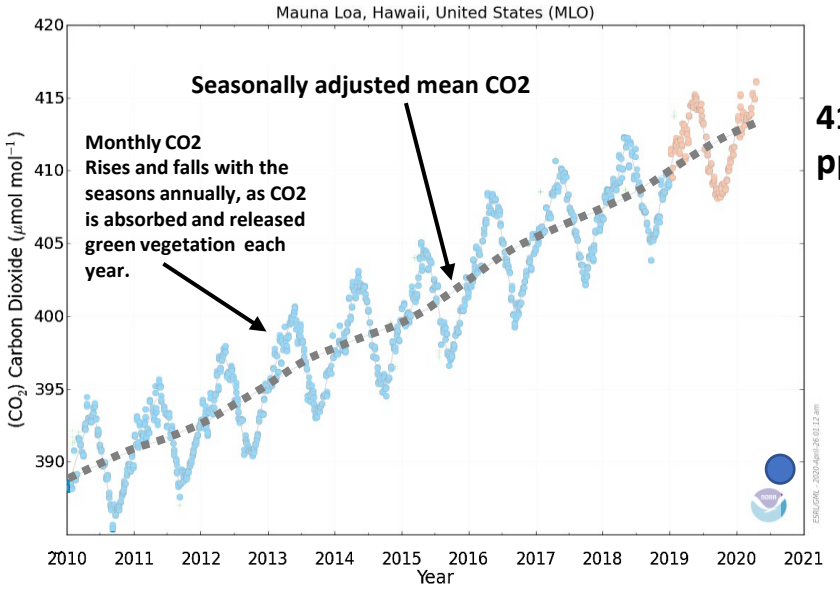
latest data

Increased acceleration rate from 1960

Explosive increase from 2000 to April 2020



NOAA, Mauna Loa



NOAA Atmospheric CO2, 26 April 2020: 413.3 ppm
no change from pandemic emissions reduction

National Oceanic & Atmospheric Administration

Global Monitoring Laboratory
Earth System Research Laboratories

https://www.esrl.noaa.gov/gmd/dv/iadv/

scrippsco2.ucsd.edu
Scripps CO2 Program: Home

scripps.ucsd.edu › programs › keelingcurve
The Keeling Curve - Scripps Institution - UC San Diego

Data Trends

(30 years or more)

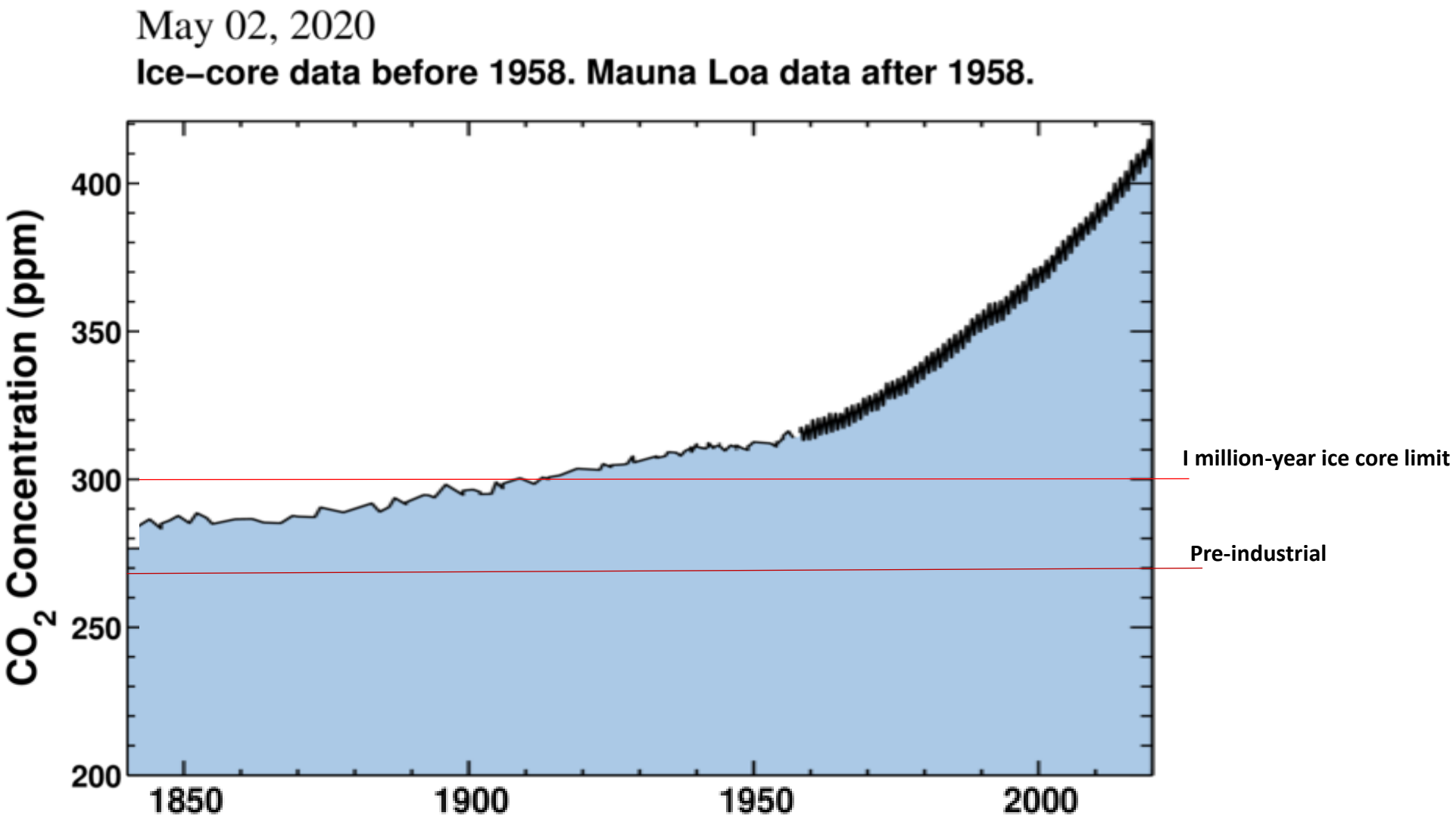
The IPCC

We have data trends to today for all indicators, but not for all RCP8.5 scenarios, because the deviation of worst-case and best-case for most indicators is only just starting. Yet, never has it been more vital that we know which direction global climate change is going.

ACCELERATING TRENDS In many cases the trends to today are extremely rapid and accelerating, from which we may be able to infer worst-case scenario to come.

Emissions of CO_2, methane, nitrous oxide, CO_2 equivalent (PBL)
Fossil fuel CO_2 emissions (GCP)
Atmospheric GHG concentrations (IPCC AR5)
Atmospheric CO_2 (NOAA)
Atmospheric methane (NOAA)
Atmospheric nitrous oxide (NOAA 20 year but accelerating)
Atmospheric CO_2 equivalent (NOAA)
Global average surface temperature increase (NASA GISS)
Sea level rise (NOAA)
Ocean heat (NOAA)
Sea surface temperature (Japan Met)
Ocean acidification (Japan Met)
Ocean deoxygenation (IPCC)
Arctic sea ice (IPCC,NOAA)
Arctic snow cover (IPCC, NOAA)

130 years of increasing to accelerating atmospheric CO2 concentration



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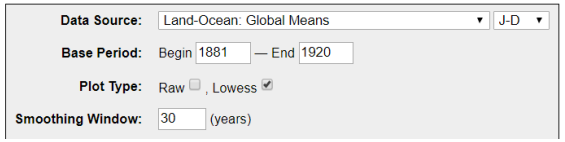
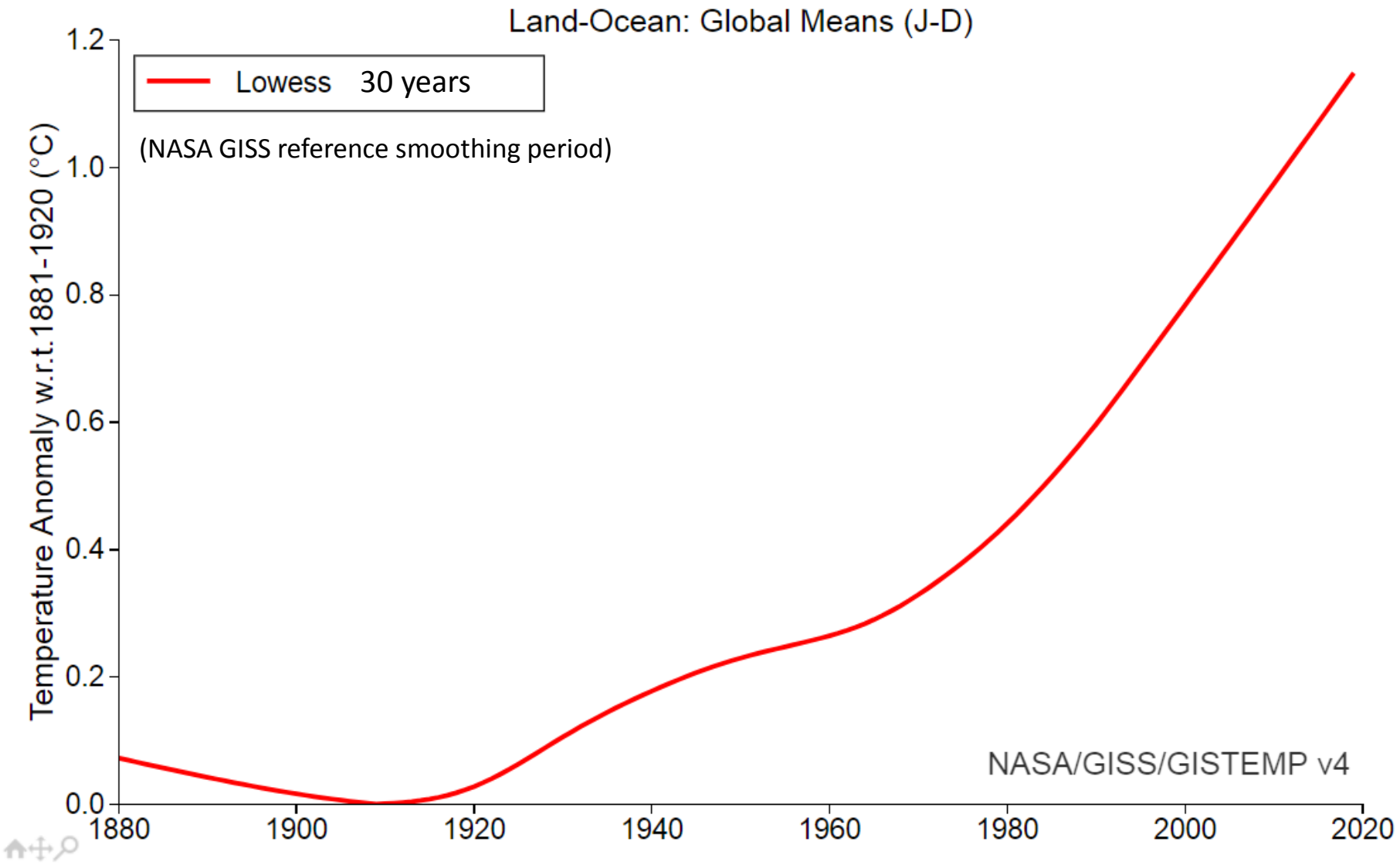
130 years of increasing to accelerating global average surface warming

base-line 1881-1920

2019, NASA GISS

GISS Surface Temperature Analysis
Additional Analysis Plots





GISS Surface Temperature Analysis Additional Analysis Plots

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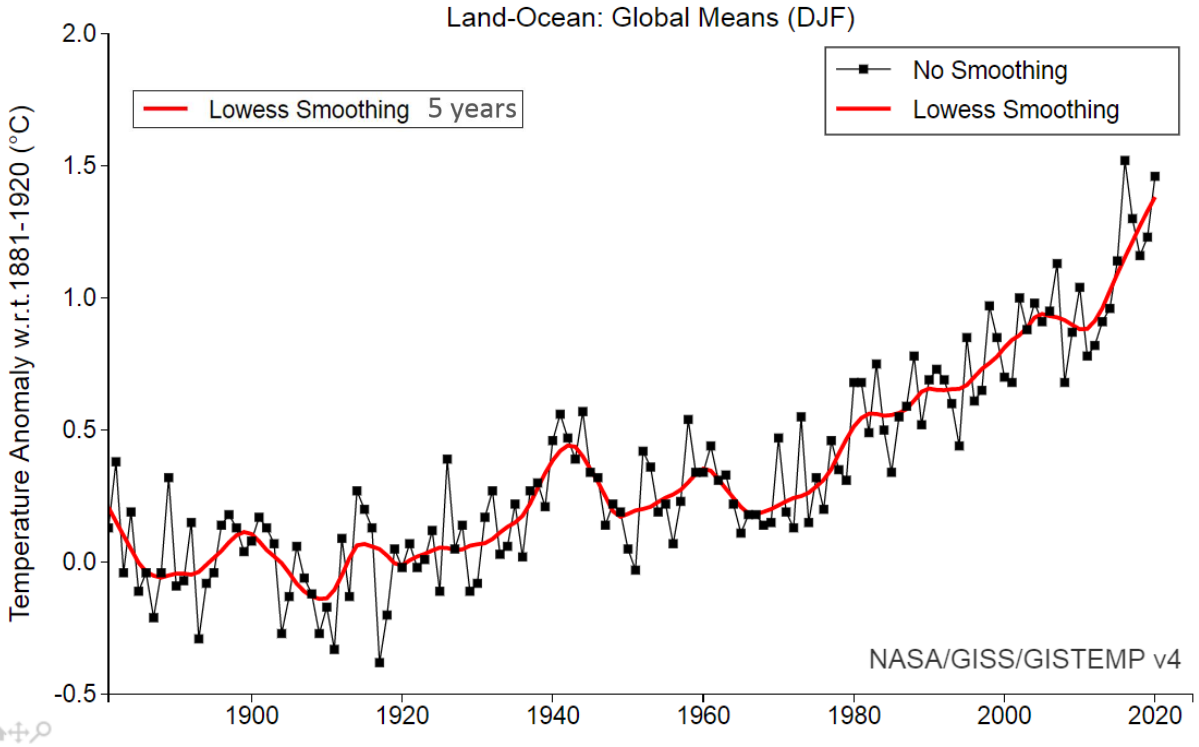
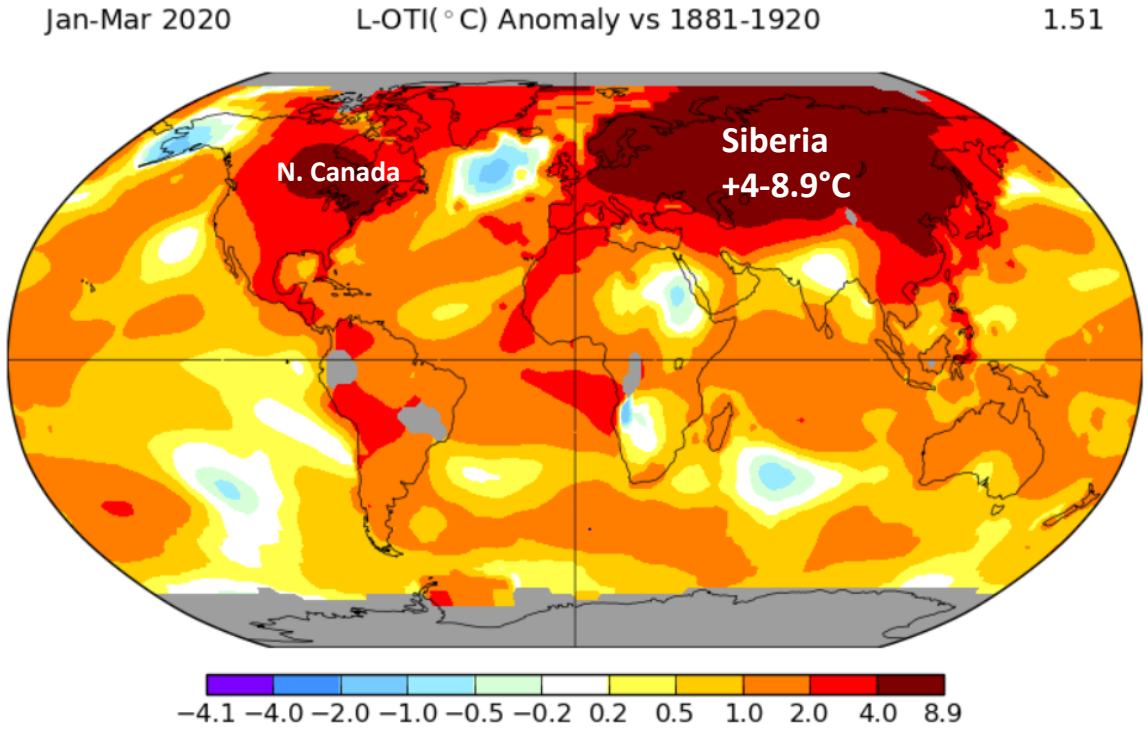
Accelerating Global surface heating
1st quarter of 2020 + 1.5°C

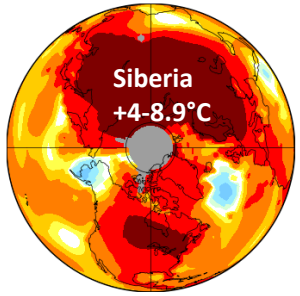
Note permafrost

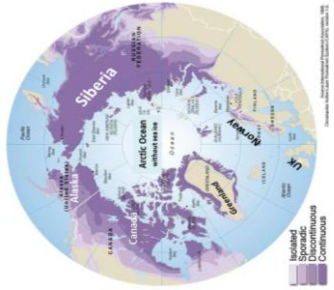
NASA GISS Surface Temperature Analysis
Additional Analysis Plots





Arctic polar view





Permafrost distribution

NASA GISS Surface Temperature Analysis (v4)
Global Maps

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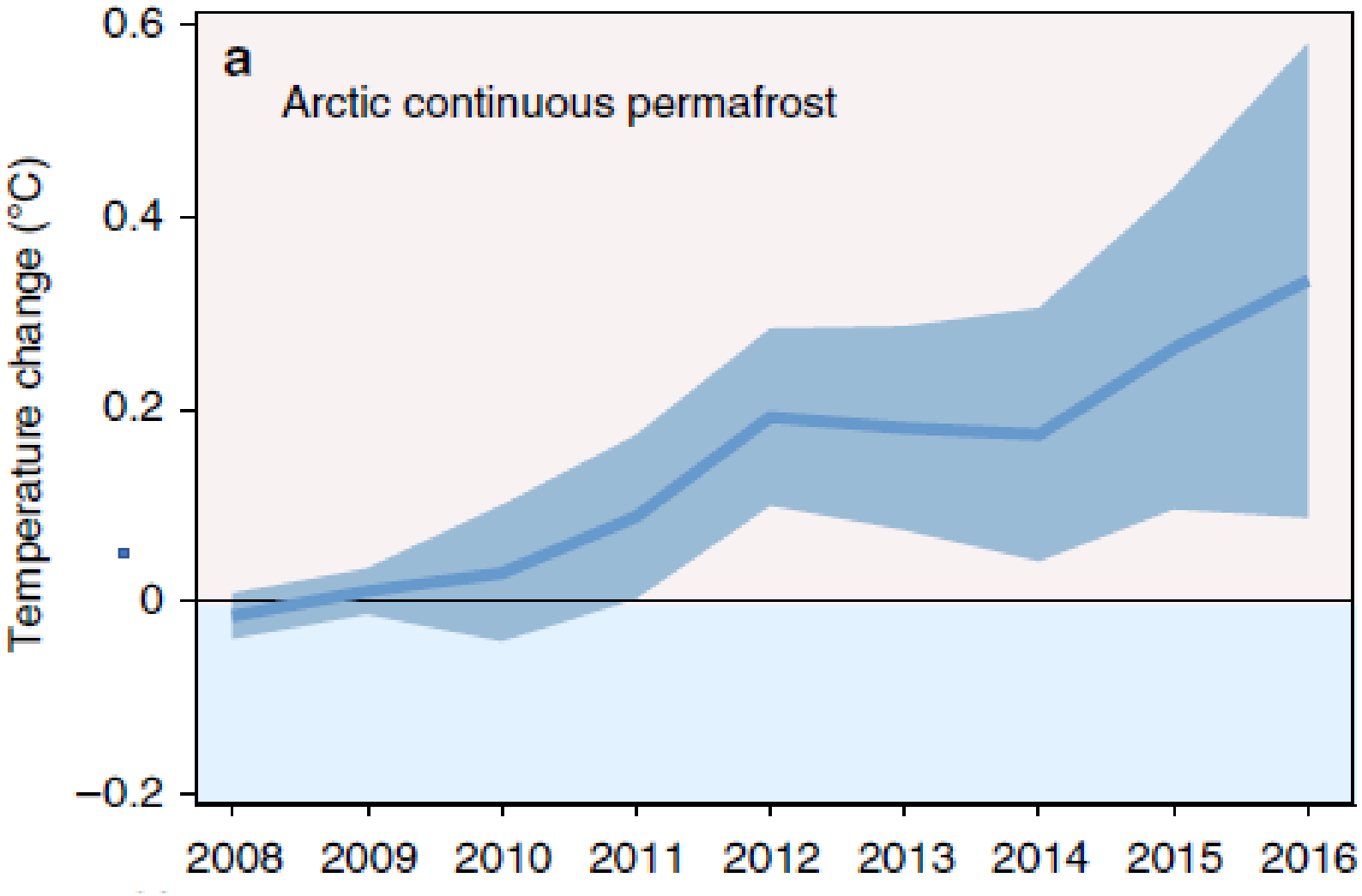
Acceleration of Arctic permafrost warming from 2008



Permafrost is warming at a global scale, Boris K. Biskaborn et al., Jan 2019

Worst-case scenario methodology

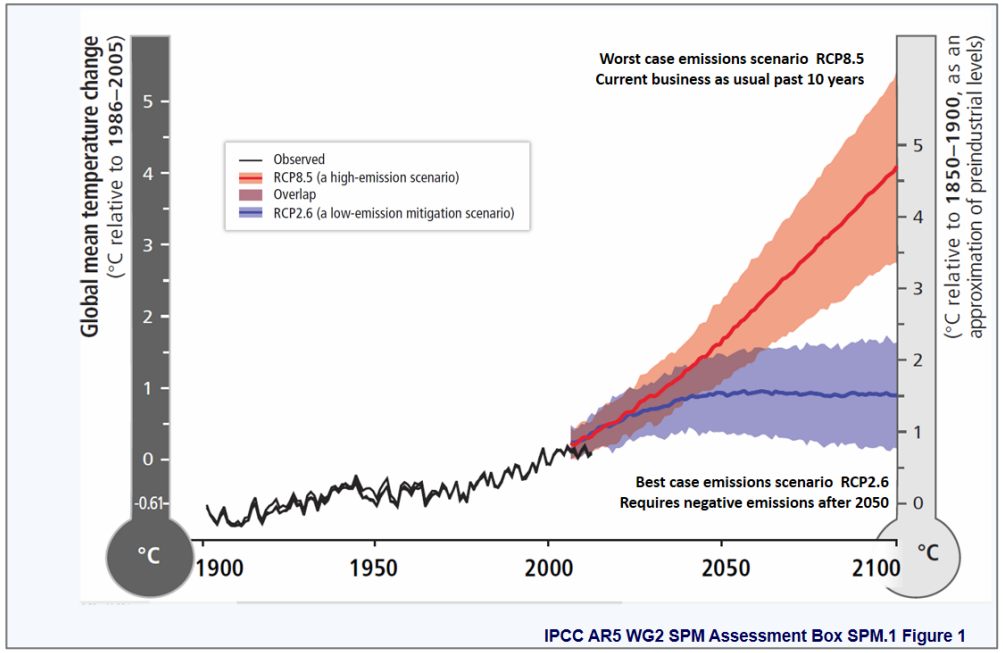
Tracking **as used here means clear or early divergence of the median observed parameter towards the worst-case scenario RCP 8.5**.

For all the indicators we have established trends (>30 years)

The solid line is the median projection used which is the projection using the single climate sensitivity of 3°C. (for 2X CO2 ppm). The shading above the below the solid line and are probability ranges. Recent research indicates the sensitivity is not below 3°C and may be above 3°C. This does not affect this presentation.

Current energy and climate policies and plans are drivers that will keep global climate and ocean changes on the worst case scenario.
There is no international policy agreement to limit atmospheric greenhouse concentrations (as the 1992 UNFCCC UN climate convention) nor to limit emissions. There is no agreement or discussion of ending fossil fuel energy. In fact the highest emitters are pursuing a policy of maximizing fossil fuel production, and practically all countries are still subsidizing fossil fuels.

It is the hope of this paper that if policy makers are advised of this situation , they will take immediate measures to ensure the immediate rapid reduction of global emissions.



IPCC AR5 WG2 SPM Assessment Box SPM.1 Figure 1

GLOBAL AVERAGE TEMPERATURE INCREASE

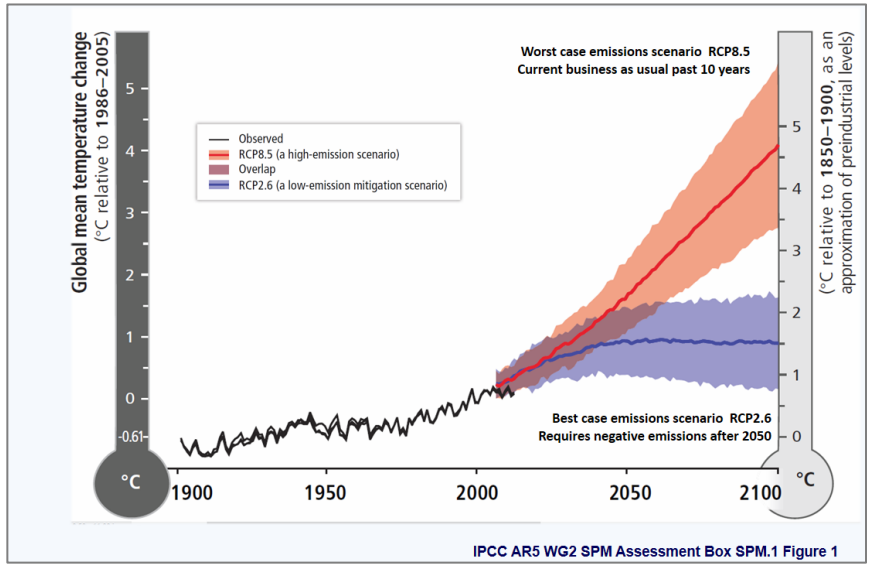
With worst-case scenario methodology

Example for methodology

In this presentation the comparison of the latest data to worst-case scenario (RCP 8.5) cases are shown, with the RCP8.5 year in question by the maroon dotted line. The plot of projections to 2100 is zoomed in / cut down to focus on the present. Closer grids are added for comparison accuracy. At this time the deviation of the scenarios is just discernable.

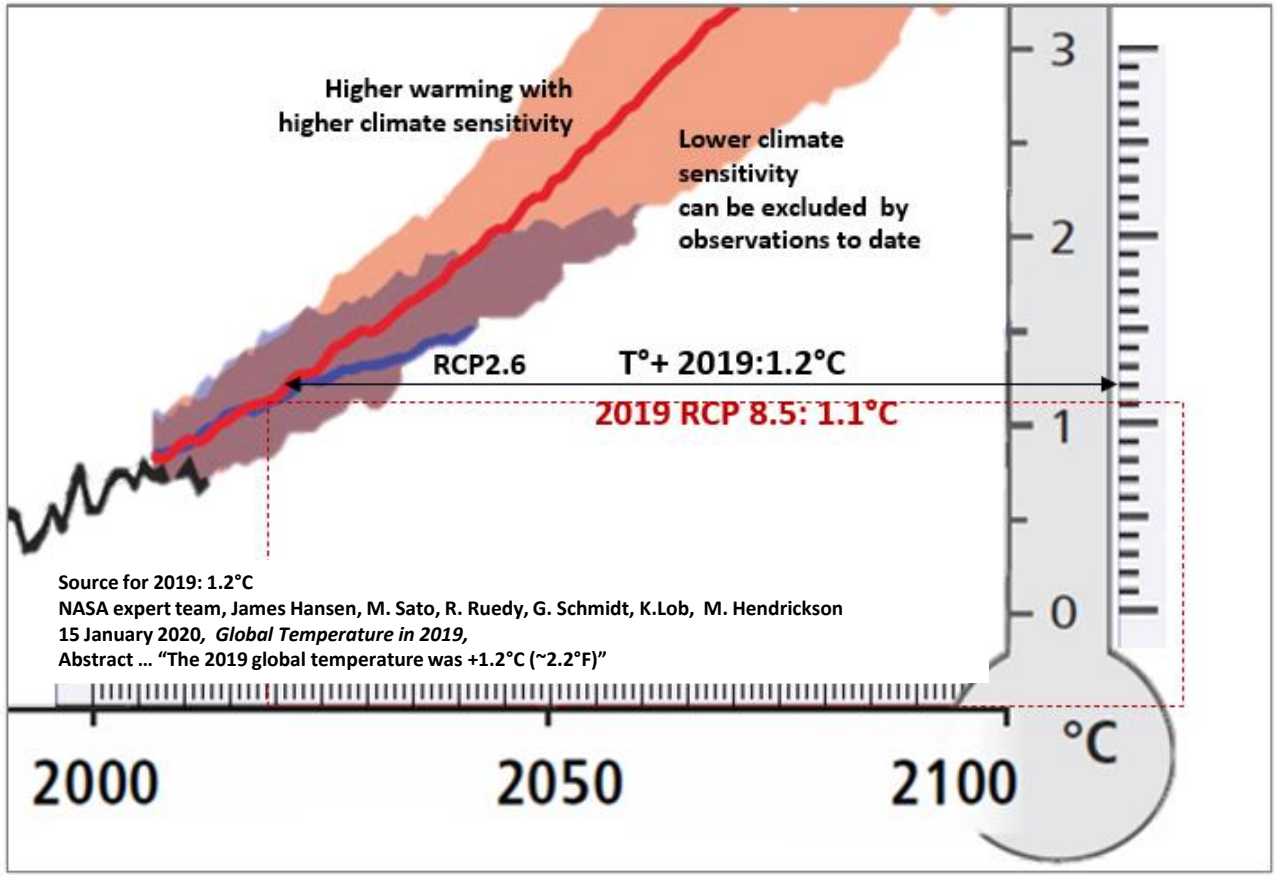
The RCP85 result is written in maroon and the current data result in black., as for the 2019 globa average temperature increase example below . All projections are median (most likely) but are based on a single static climate sensitivity of 3°C (2XCO2ppm), which may be higher making these results conservative

Original



Present day focus

2019 GLOBAL SURFACE TEMPERATURE INCREASE 1.2°C is tracking the worst-case



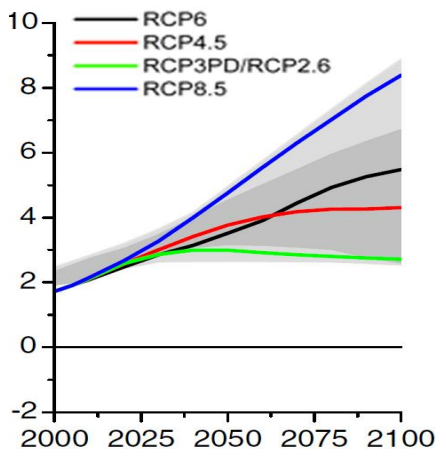
The RCP scenarios (IPCC 2014 5th assessment) were set by pre-determined radiative forcing up to 2100

RADIATIVE (HEAT) FORCING (2018) is tracking the worst-case scenario RCP8.5

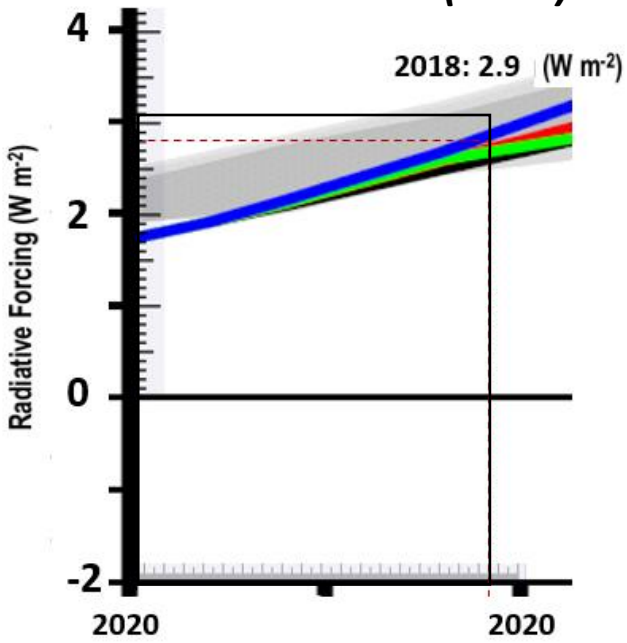
on an accelerating trajectory

Radiative (heat) forcing increased 43% from 1990 to 2019

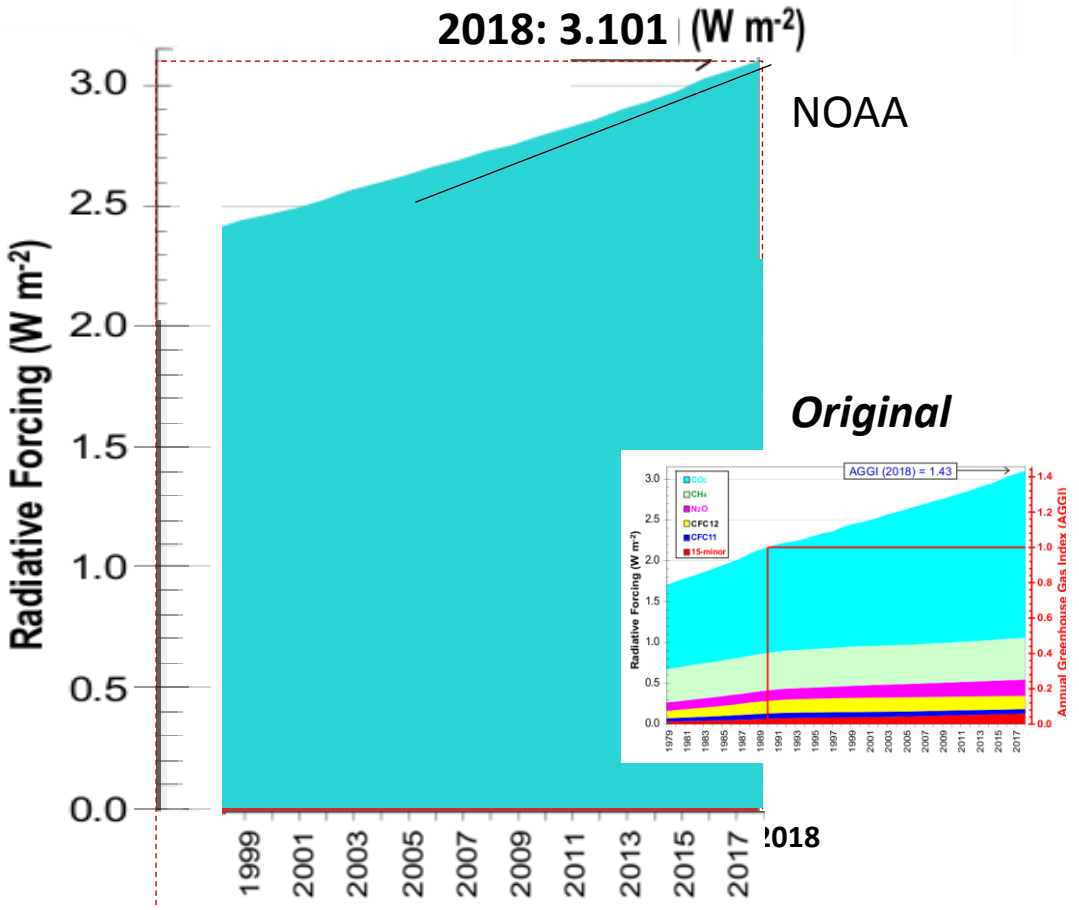
Original



Present day (2018) for RCP8.5 with actual RF (2018)



Actual present day



The representative concentration pathways: an overview, Detlef P. van Vuuren, 2011 (The 2014 IPCC 5th assessment RCP scenarios reference paper)

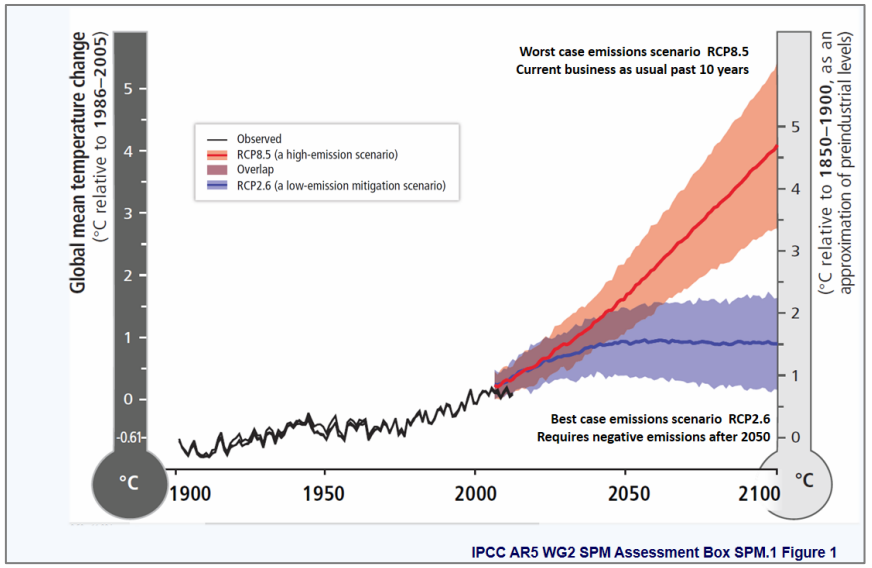
THE NOAA ANNUAL GREENHOUSE GAS INDEX (AGGI) NOAA Earth System Research Laborator James.H.Butler, Stephen.A.Montzka, Updated Spring 2019

GLOBAL SURFACE TEMPERATURE INCREASE (2019) is tracking the worst-case

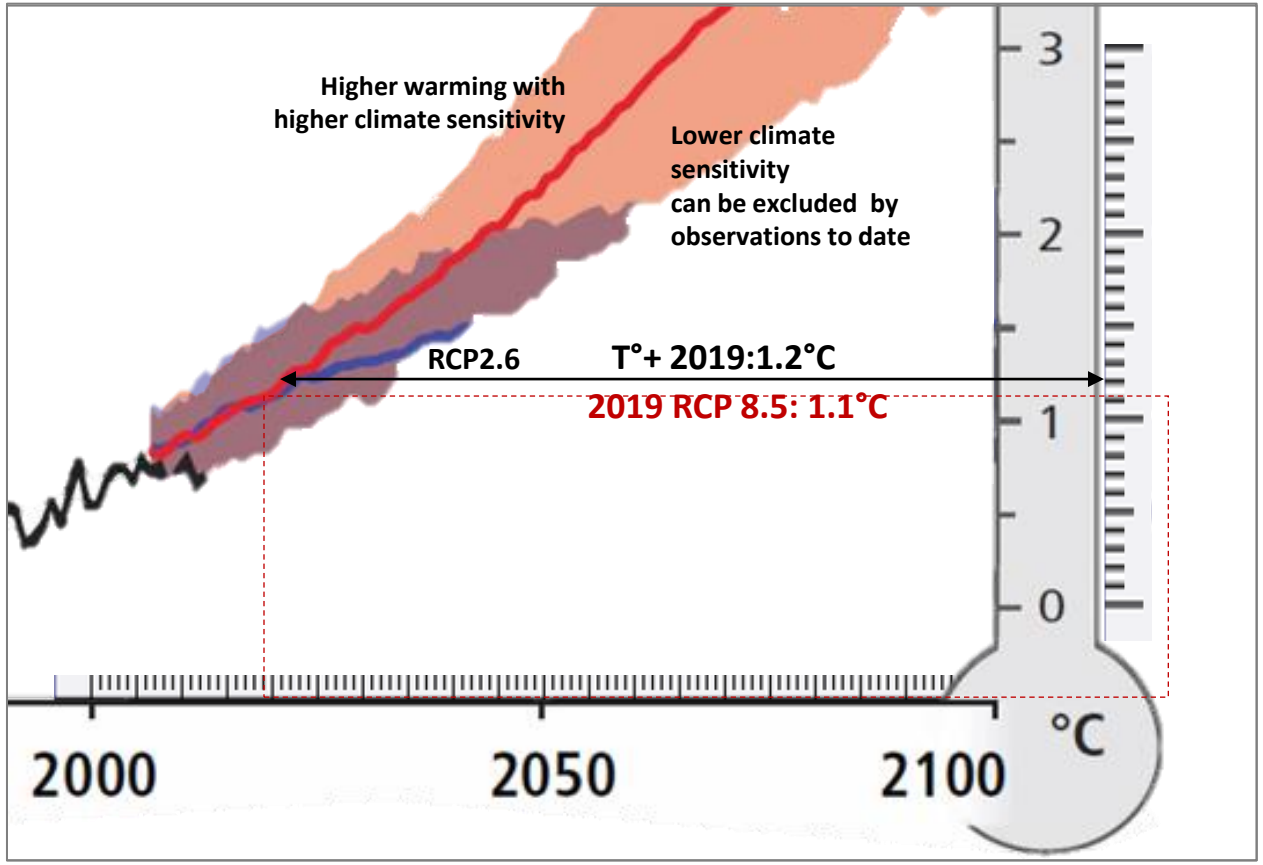
NASA expert team, James Hansen, M. Sato, R. Ruedy, G. Schmidt, K.Lob, , M. Hendrickson

Global Temperature in 2019,
15 January 2020
Abstract … The 2019 global temperature was +1.2°C (~2.2°F)

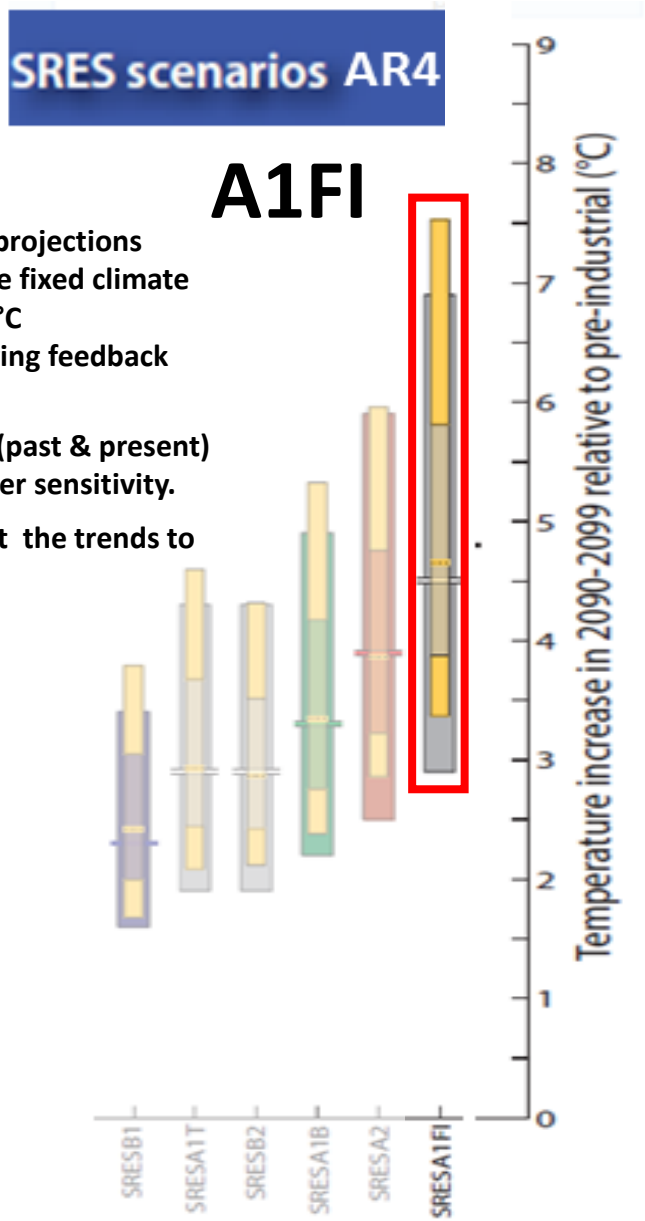
Original: IPCC 2014, WG2, Box SPM Figure 1



Present day focus



Worst-case IPCC Emissions Scenarios



Note all these projections
Assume a single fixed climate sensitivity of 3°C
and no amplifying feedback emissions.

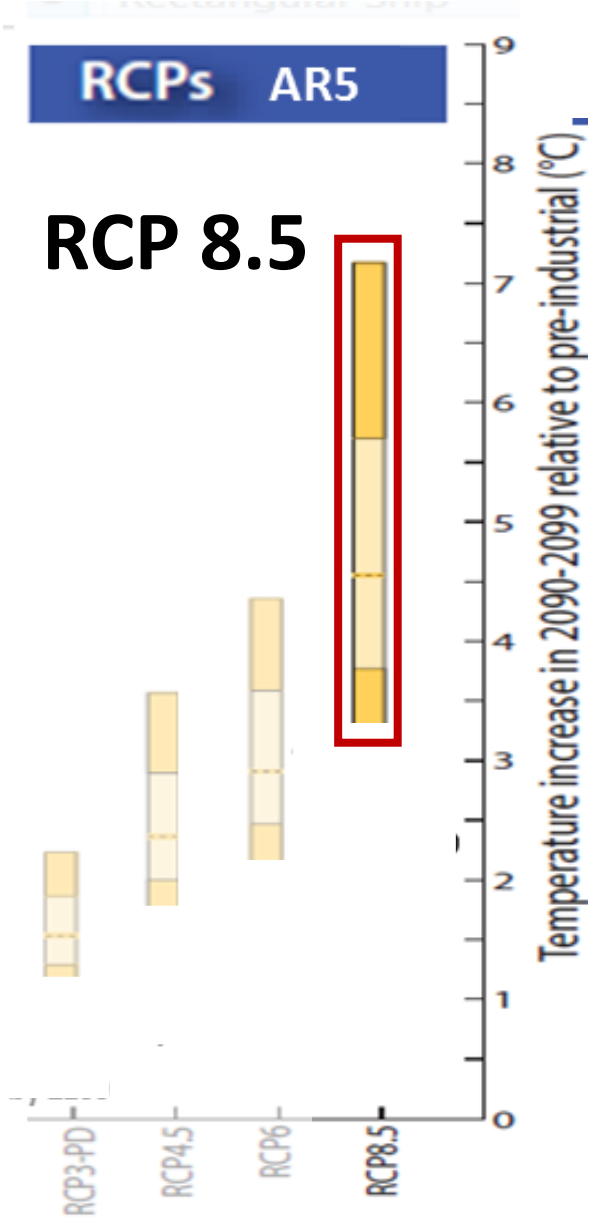
Many models (past & present) arrive at a higher sensitivity.

This does affect the trends to date.

Worst case
IPCC 2007 4th Assessment
SRES A1FI
(fossil fuel intensive)

By 2100
+4.5°C
up to a possible 7.5°C

The SRES scenarios are derived from socio-economic projections



Worst case
IPCC 2014 5th Assessment
RCP 8.5
(high radiative heat forcing)

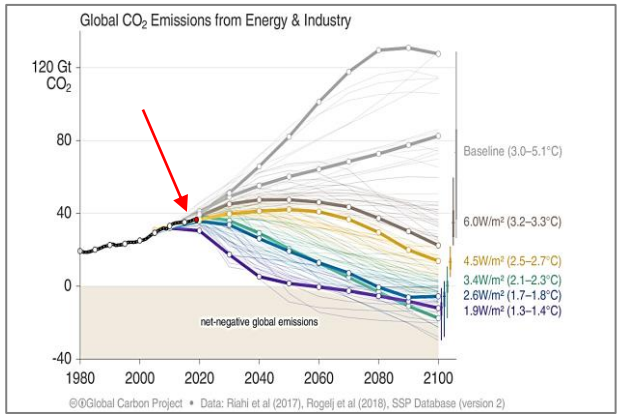
By 2100
+4.3°C
up to a possible 7.2°C

The RCP scenarios start with potential radiative heat forcings and backtrack to see if and how they are feasible

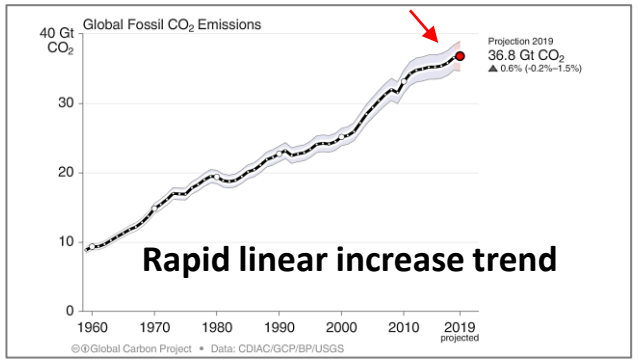
It is important to this project that the worst-case SRES and RCP scenarios are almost identical.

GLOBAL FOSSIL FUEL CO2 EMISSIONS (2019) are tracking close to the worst-case scenario (RCP 8.5)

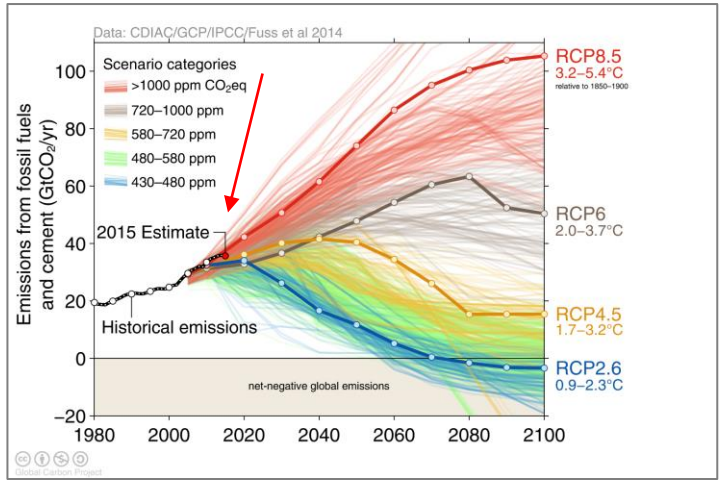
Global Carbon Project Annual Global Carbon Budget 2019 (new SSP emissions scenarios)

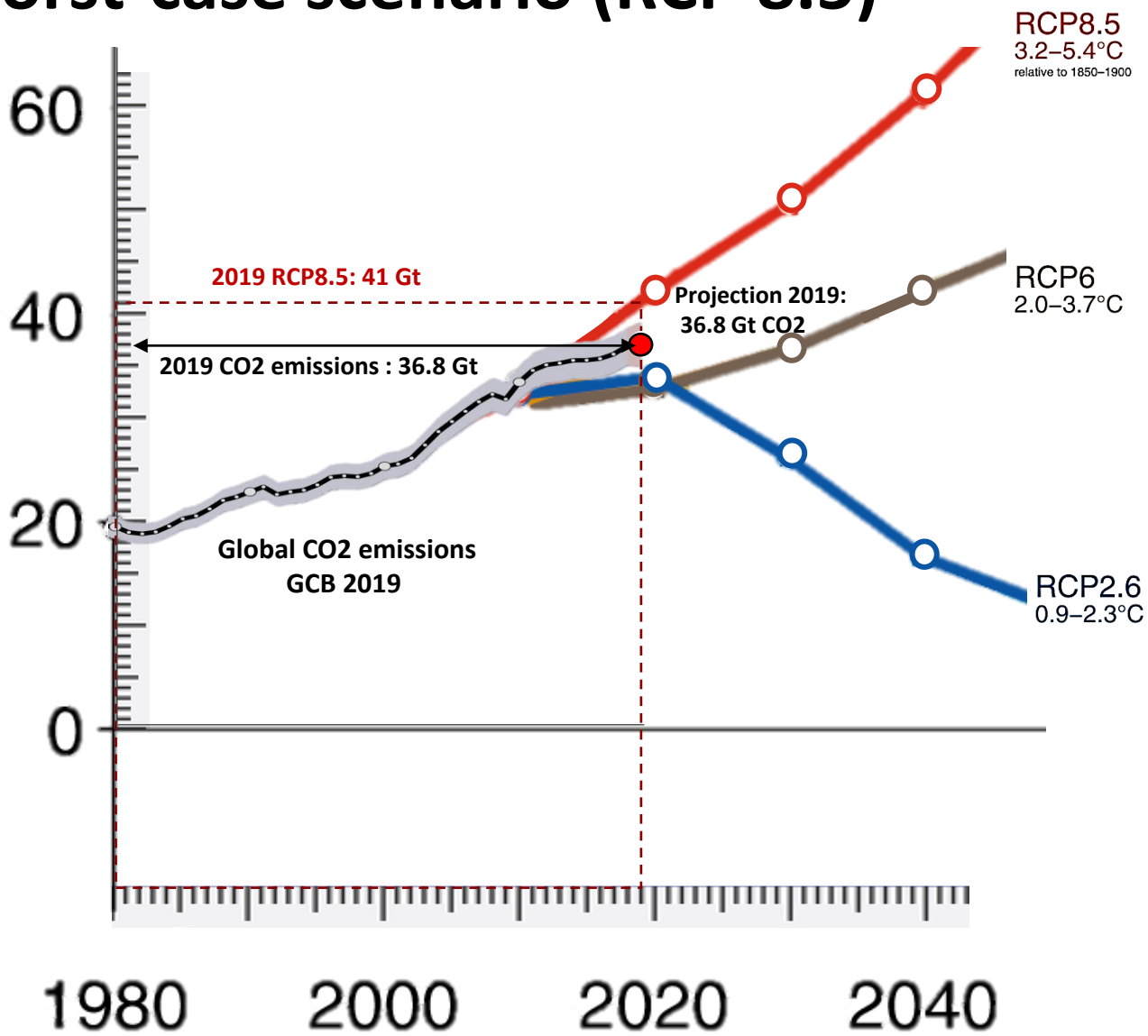


Global Carbon Project 2019



Global Carbon Project 2015 (for RCP emissions scenarios)





The RCP scenarios from GCB 2015

RCP2.6 Best case IPCC 5th assessment Global emissions decline from 2020

New SSP emissions decline from 2020 for 1.5°C and 2°C

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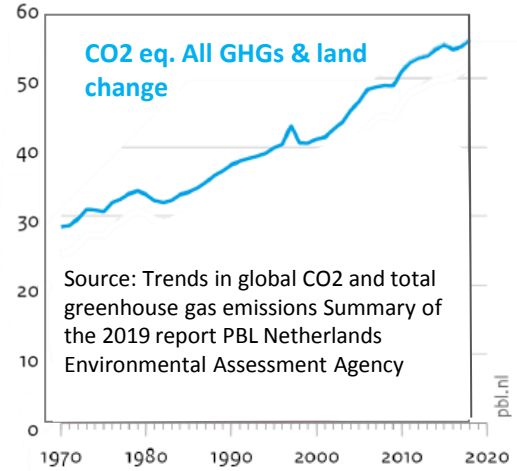
GLOBAL CO2 EQUIVALENT EMISSIONS (2018) are tracking above the worst-case scenario (RCP 8.5) with increasing divergence since 2010

(CO2 equivalent includes the other greenhouse gases, along with CO2)

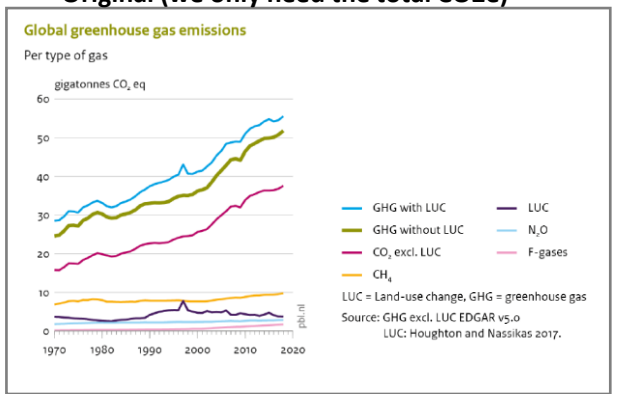
"The 2018 global greenhouse gas emissions amounted to 55.6 GtCO2 eq when also including those from land-use change"

Gt. CO2e

Actual present CO2eq

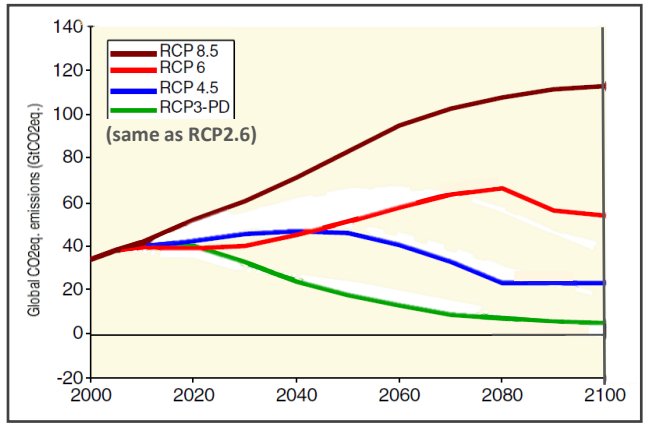


Original (we only need the total CO2e)

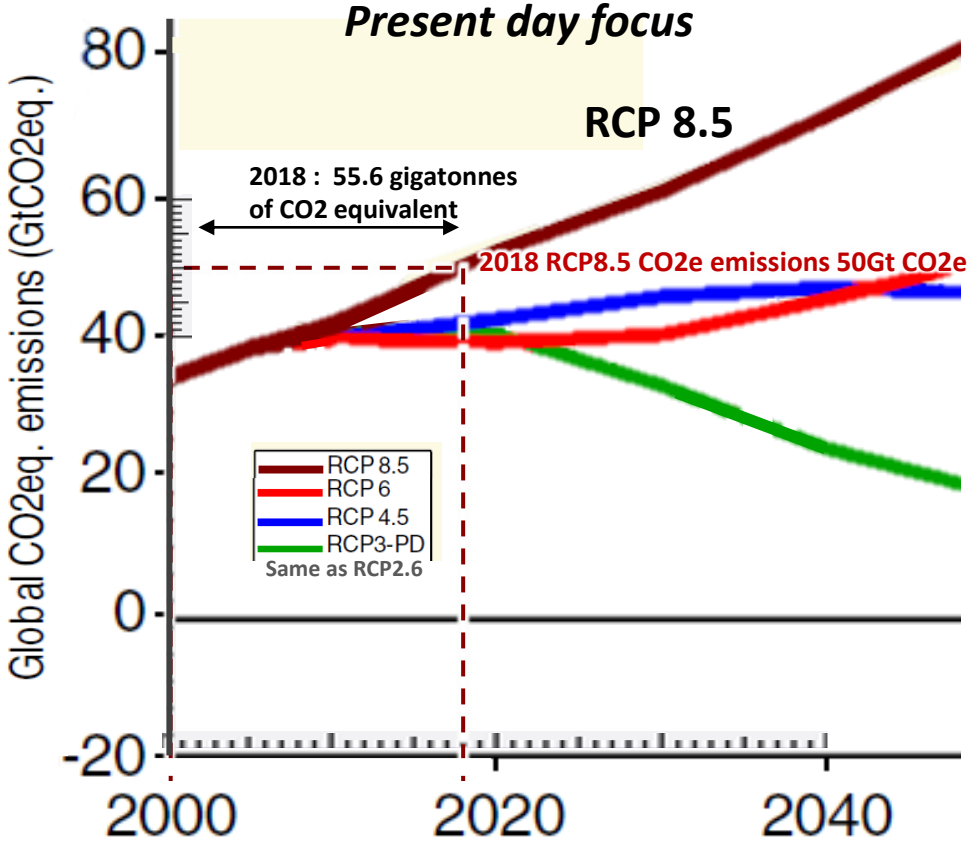


Original for RCP8.5

(with 2 extra non-IPCC AR5 scenarios removed)



Present day focus



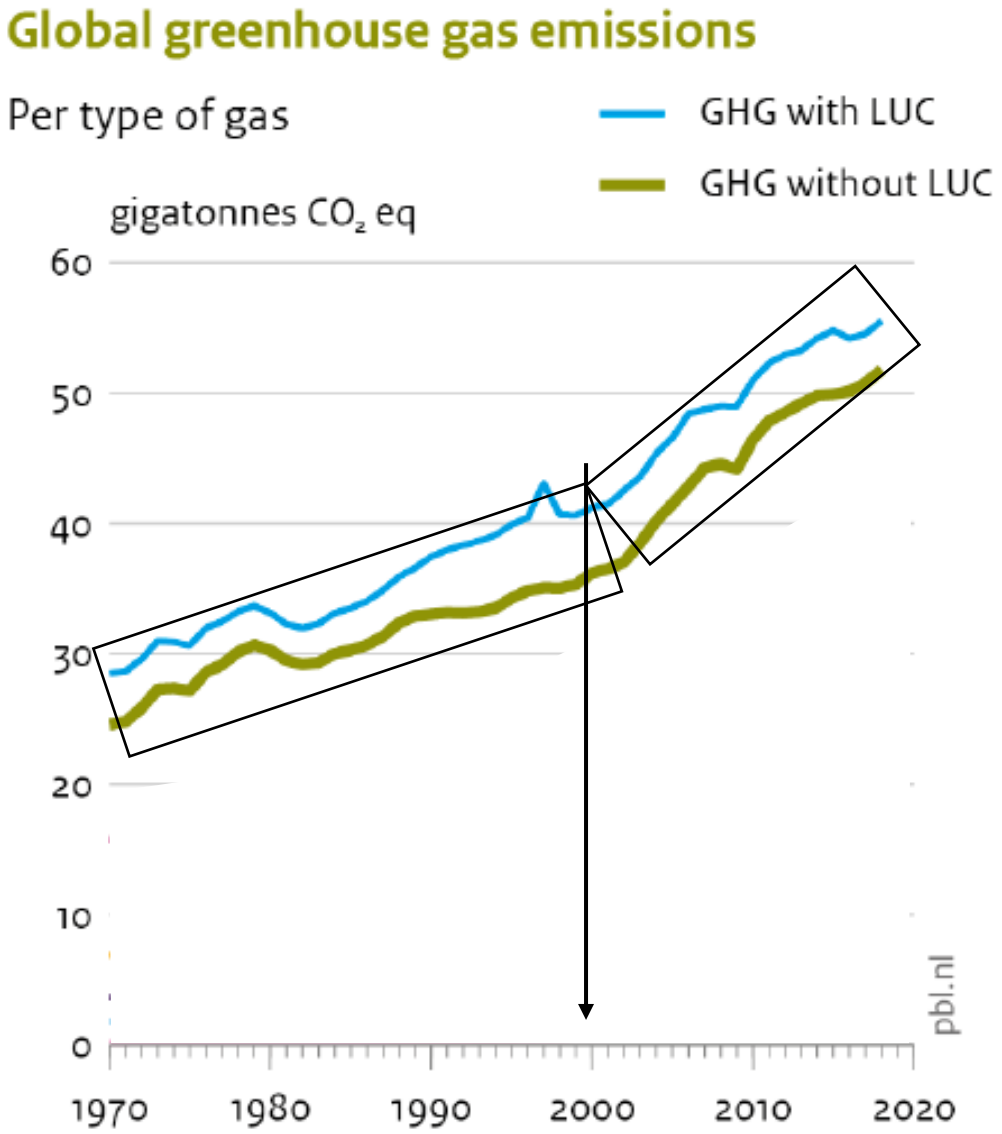
Riahi, K., Rao, S., Krey, V., Cho, C., Chirkov, V., Fischer, G., Kindermann, G., Nakicenovic, N., and Rafaj, P. (2011); "RCP 8.5 - A scenario of comparatively high greenhouse gas emissions", Climatic Change (2011) 109:33-57, doi: 10.1007/s10584-011-0149-y.

Large increase in rate of global CO2 eq emissions increase around 2000

Trends in global CO2 and total greenhouse gas emissions
Summary of the 2019 report PBL Netherlands Environmental Assessment Agency 2019

We are looking at data sets of indicators from 2000.

It is important to be aware that around 2000 there was a large increase in the increase rate of global greenhouse gas emissions, and therefor a large increase in the forcing of climate from 2000.



2020 ATMOSPHERIC CO2 CONCENTRATION is tracking the worst-case scenario (RCP 8.5) (1st example)

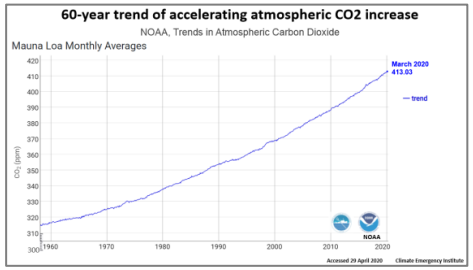
Actual present

NOAA Trends in atmospheric CO2, April update

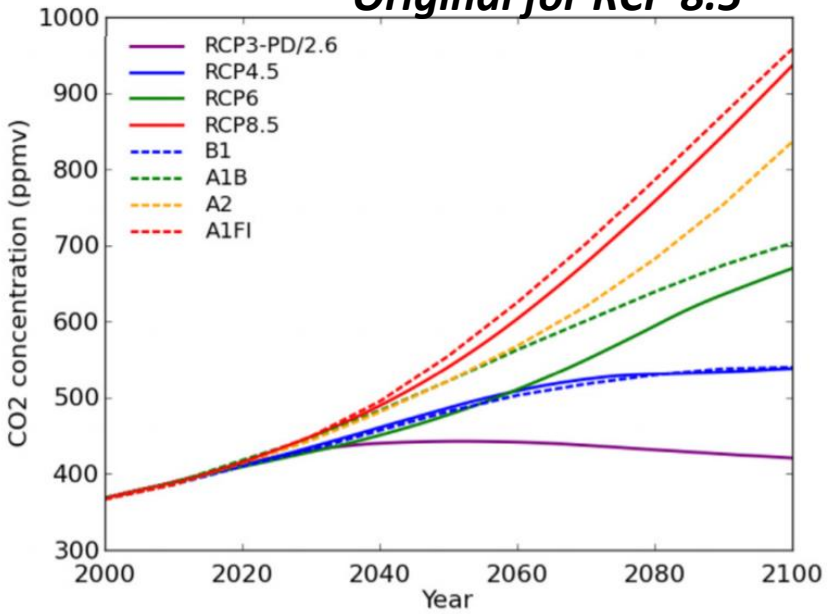
Monthly Average Mauna Loa CO_2

March 2020: 414.50 ppm
March 2019: 411.97 ppm
Last updated: April 6, 2020

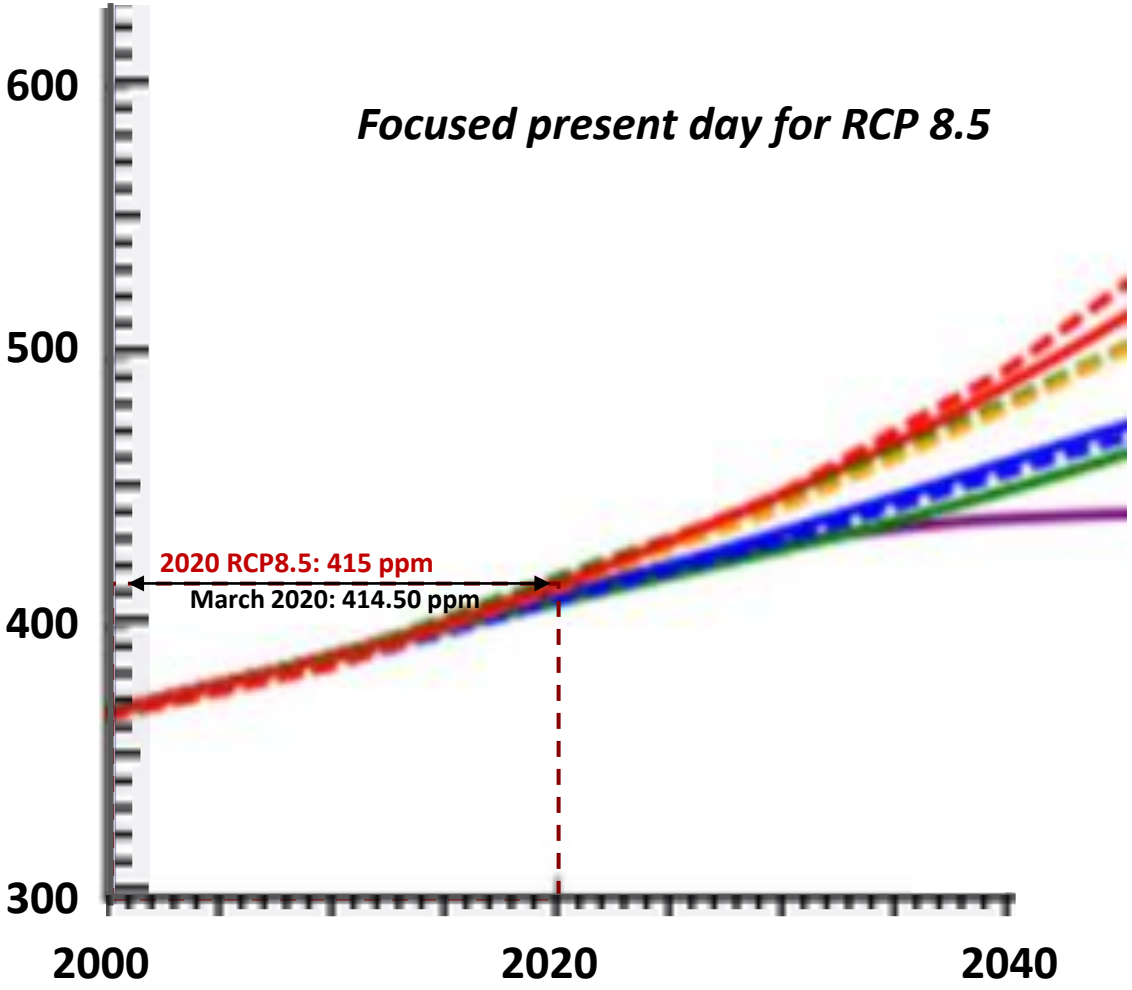
Note high annual growth rate and accelerating trend



Original for RCP 8.5



Focused present day for RCP 8.5



Australian Climate Change Science Program Information Paper

Representative Concentration Pathways (RCPs) Authors: Imogen Jubb, Pep Canadel, and Martin Dix

https://www.cawcr.gov.au/projects/Climatechange/wp-content/uploads/2016/11/ACCSP_RCP.pdf

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2020 ATMOSPHERIC CO2 CONCENTRATION is tracking the worst-case scenario (RCP 8.5) (2nd example)

Present day atmospheric CO2 ppm

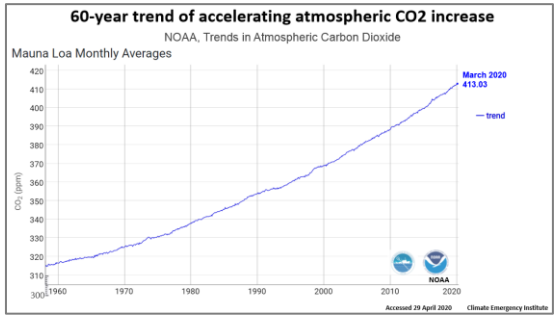
March 2020 atmospheric CO2 : 414.50 ppm

Monthly Average Mauna Loa CO_2

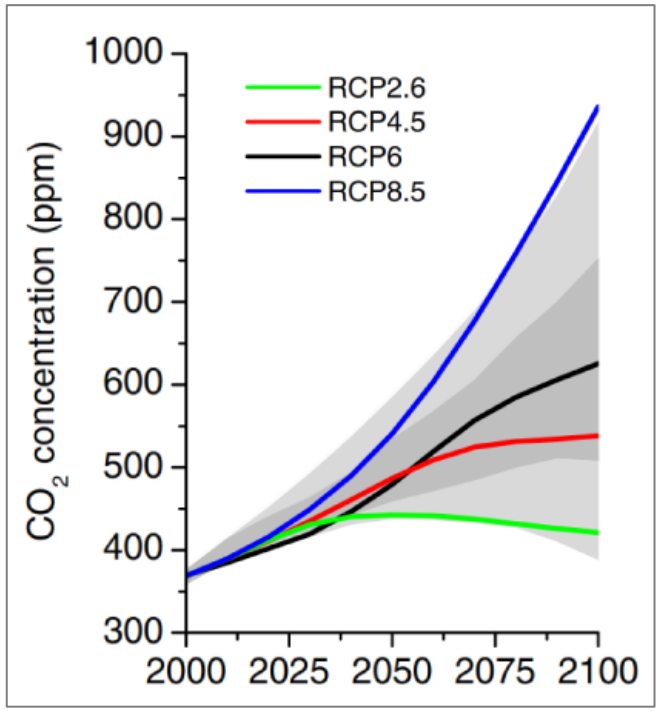
March 2020:	414.50 ppm
March 2019:	411.97 ppm

Last updated: April 6, 2020

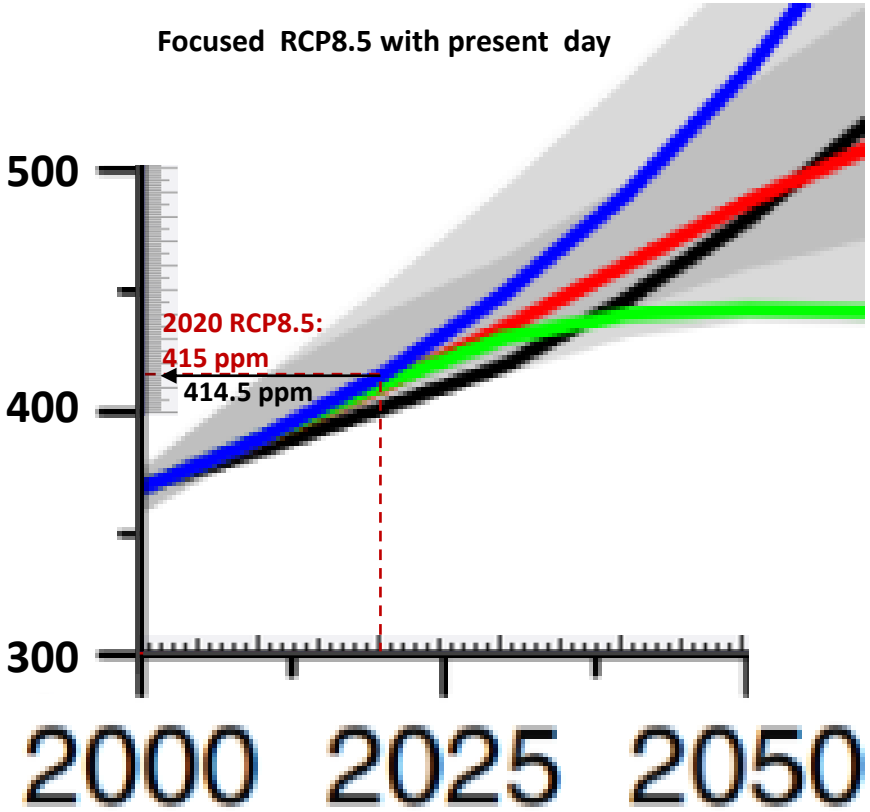
NOAA April 2020



Original for RCP8.5



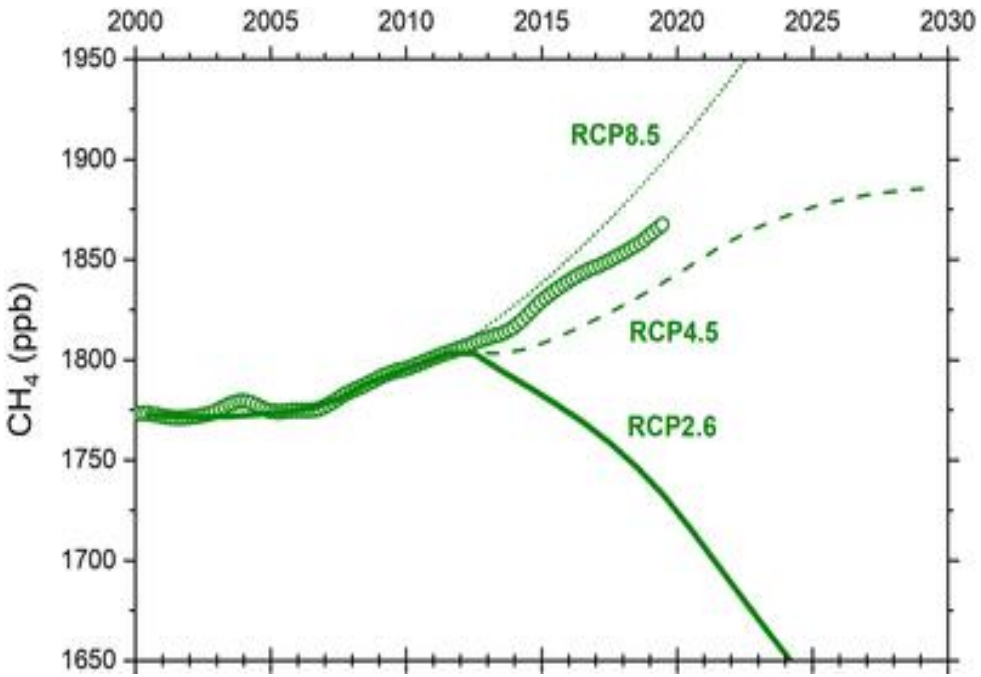
Focused RCP8.5 with present day



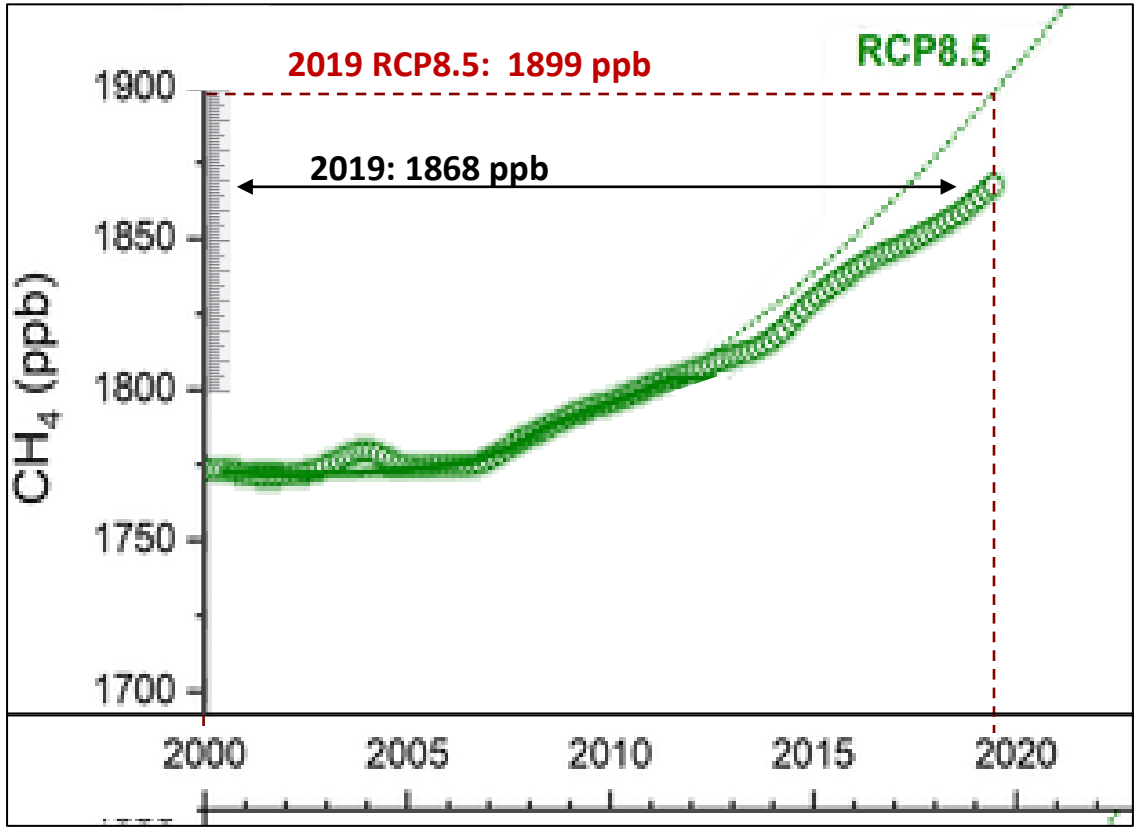
The representative concentration pathways: an overview, Detlef P. van Vuuren, 2011
(The 2014 IPCC 5th assessment RCP scenarios reference paper)

ATMOSPHERIC METHANE CONCENTRATION is tracking towards the worst-case scenario RCP 8.5

Original for RCP8.5 and present day



Focused for present day



Methane Mitigation: Methods to Reduce Emissions, on the Path to the Paris Agreement, E. G. Nisbet , Jan 2020

The figure is updated from that in Nisbet et al. (2019) using NOAA mole fraction data to June 2019.

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019RG000675

Climate Emergency institute

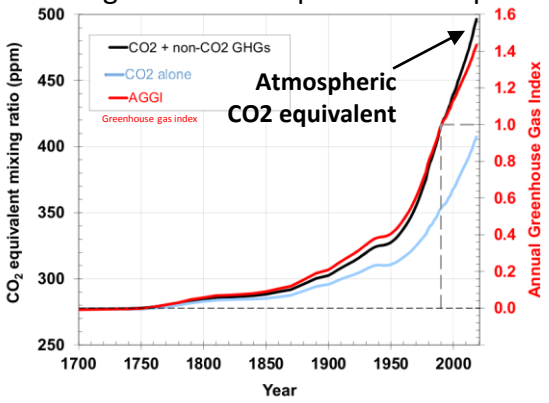
ATMOSPHERIC CO2 CONCENTRATION is tracking above the worst-case scenario RCP 8.5

NOAA's Annual Greenhouse Gas Index, 2019

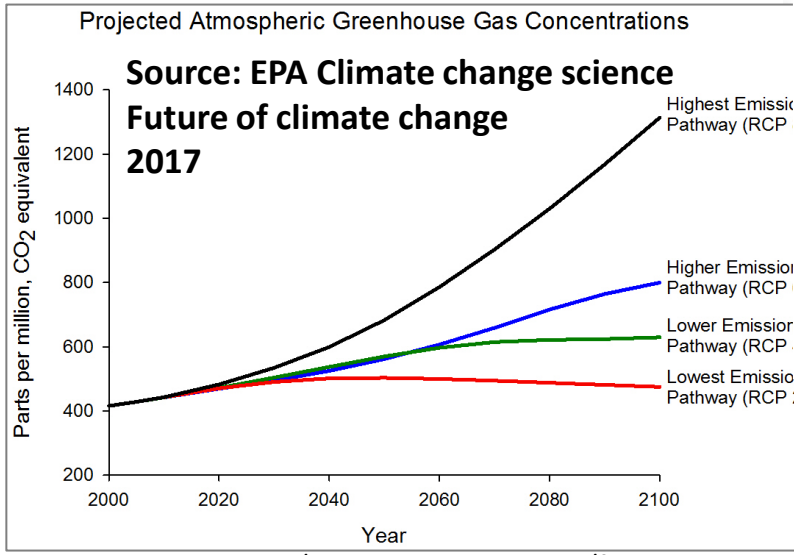
"In terms of CO2 equivalents, the atmosphere in 2018 contained 496 ppm, of which 407.4 is CO2 alone. The rest comes from other gases."

The CO2 equivalent includes the other greenhouse gases, so it is higher than CO2 alone. It is the metric used by the IPCC in mitigation calculations

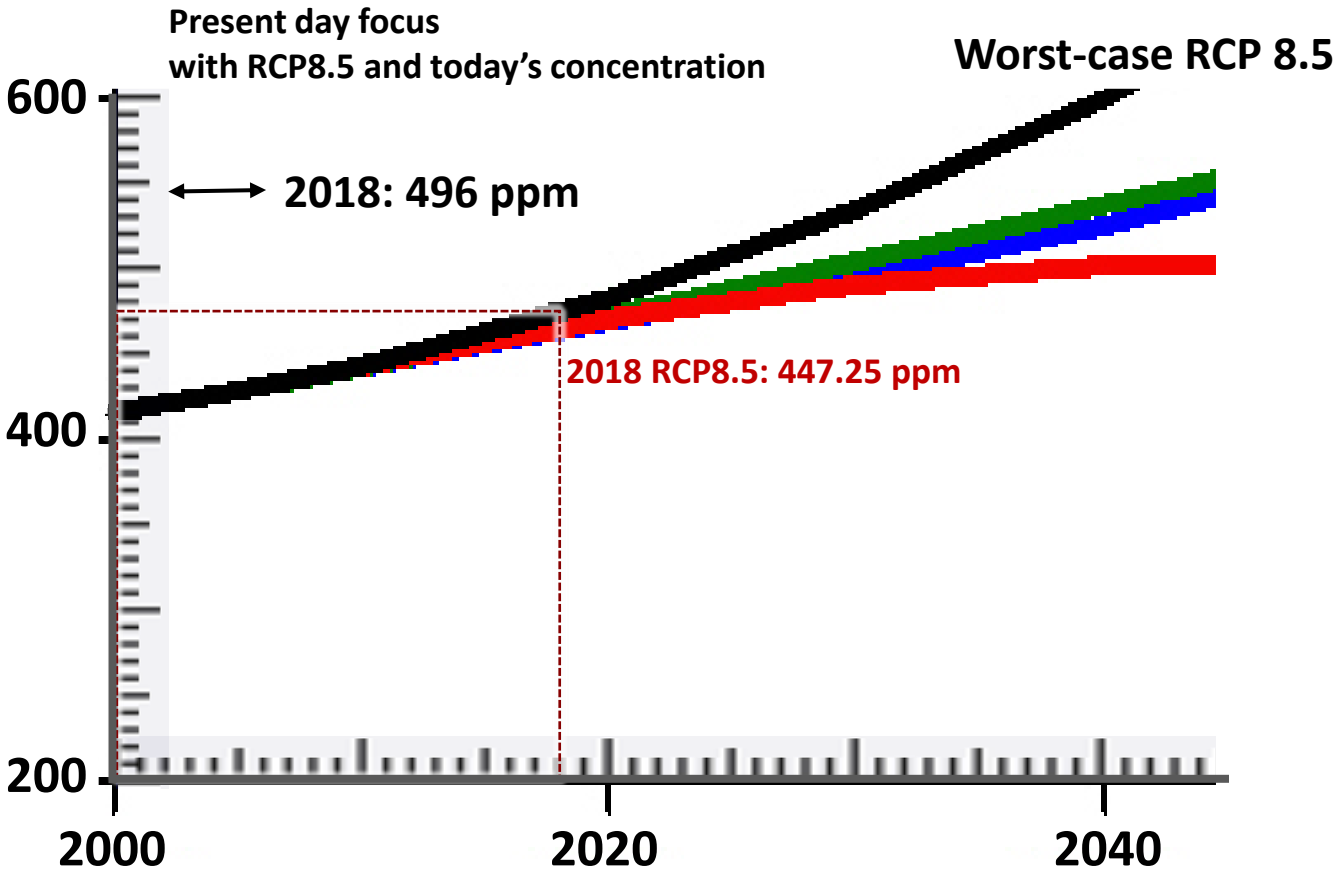
Original for atmospheric CO2 eq.



Original for RCP8.5



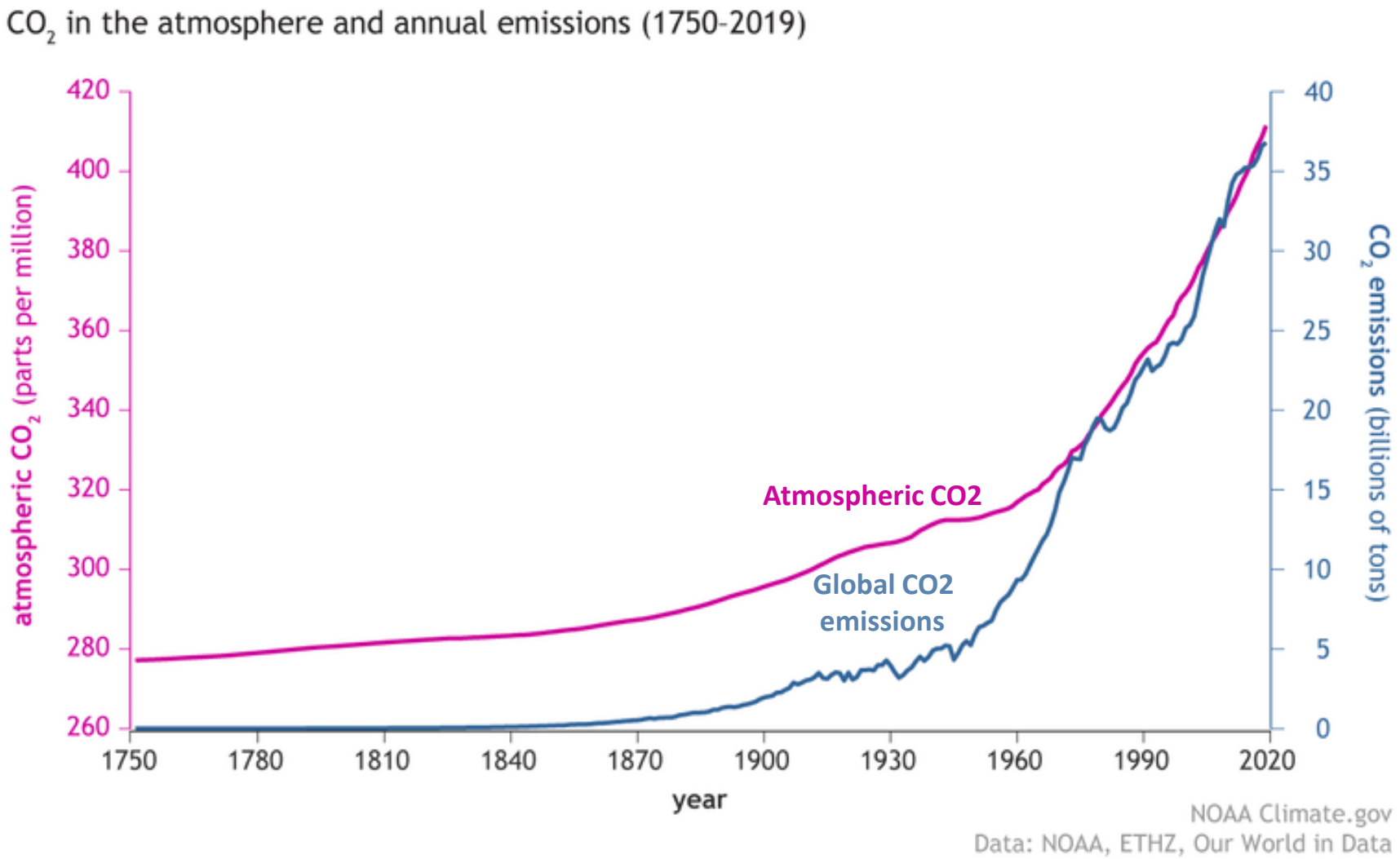
https://19january2017snapshot.epa.gov/climate-change-science/future-climate-change_.html



Climate Emergency institute

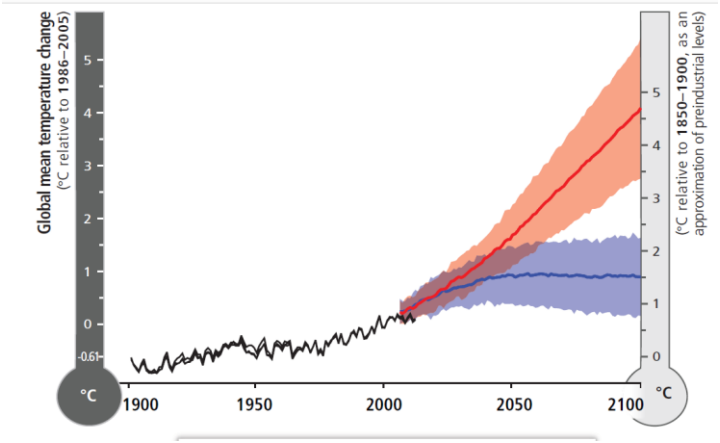
Acceleration of global CO2 emissions and atmospheric CO2

Global CO2 Emissions and Atmospheric CO2 Concentrations
are Tracking the Worst-Case Scenario
1750-2019

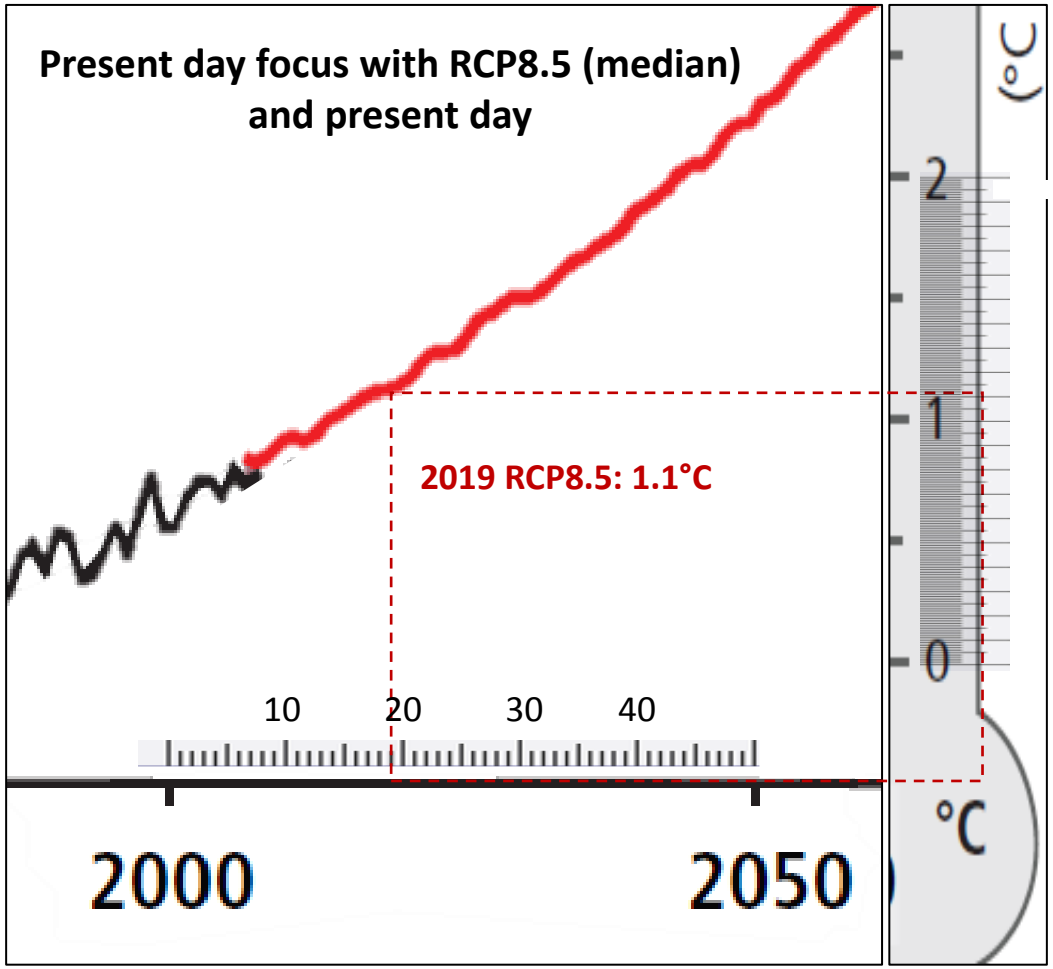


GLOBAL AVERAGE SURFACE TEMPERATURE INCREASE is tracking the worst-case scenario (RCP 8.5) 2019 increase from pre-industrial is 1.2°C*

Original for RCP8.5 from pre-industrial



IPCC 2014 5th assessment, WG2, Assessment Box SPM.1 Figure 1



***Global Temperature in 2019,**
15 January 2020
NASA expert team, James Hansen, M. Sato, R. Ruedy, G. Schmidt, K.Lob, , M. Hendrickson
Abstract … "The 2019 global temperature was +1.2°C (~2.2°F) "

GLOBAL AVERAGE SURFACE TEMPERATURE INCREASE is tracking the worst-case scenario (RCP 8.5) 2019 increase from pre-industrial is *1.2°C

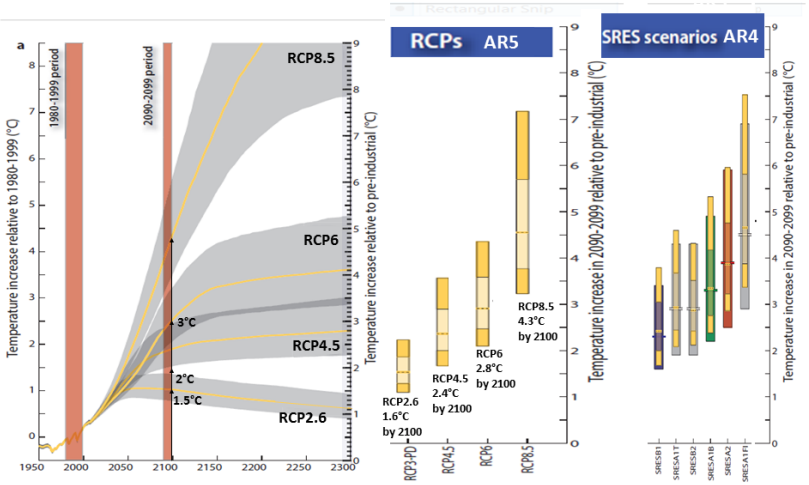
Example 1

Note: "Global temperature increase has accelerated over the past decade" (15 Jan 2020, NASA expert team Climate Awareness Science and Solutions)

*Global Temperature in 2019, 15 January 2020
NASA climate expert team, James Hansen, M. Sato, R. Ruedy, G. Schmidt, K.Lob, , M. Hendrickson
Abstract … "The 2019 global temperature was +1.2°C (~2.2°F) "

Original for RCP8.5

Global temperature increases by IPCC scenarios extended past 2100 to 2300

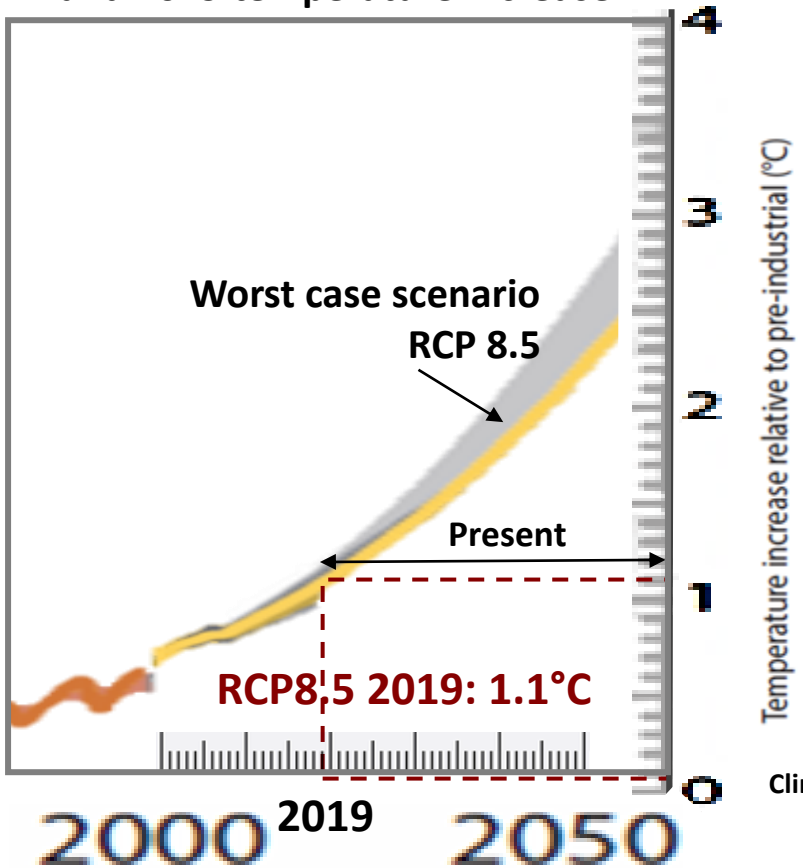


IPCC 2014 5th assessment, Figure 12.40, Time evolving temperature distributions

Source: from IPCC 2014 5th assessment Figure12.40

Chosen for preindustrial baseline and RCP 8.5 plot prominence

Present day focus showing RCP8.5 with upper range and 2019 temperature increase



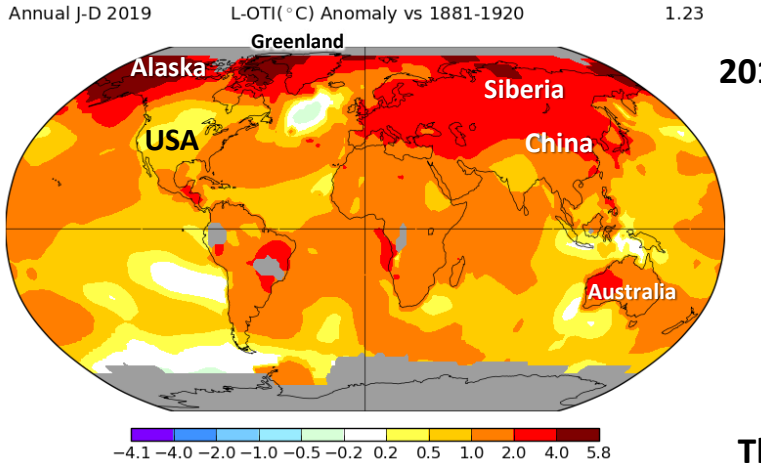
Climate Emergency institute

The RATE OF ACCELERATION has increased over the past 10 years

2019 global average surface temperature increase +1.2°C

Global average temperature change from preindustrial (1881-1920)

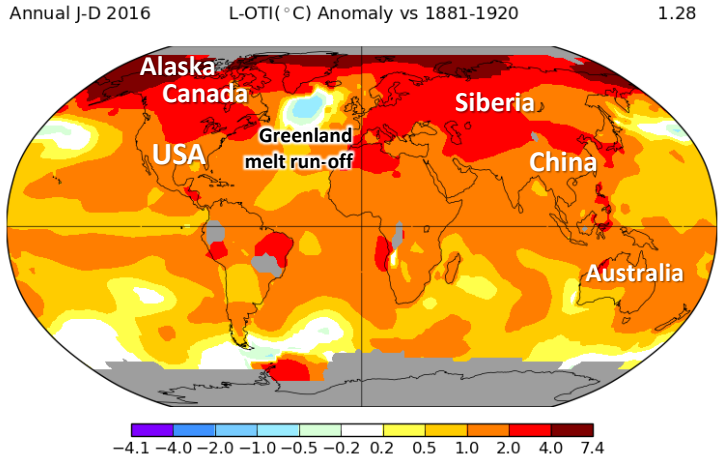
2019 no big El Nino



2019: 1.23°C

The 2016 record 1.28°C

2016 big El Nino

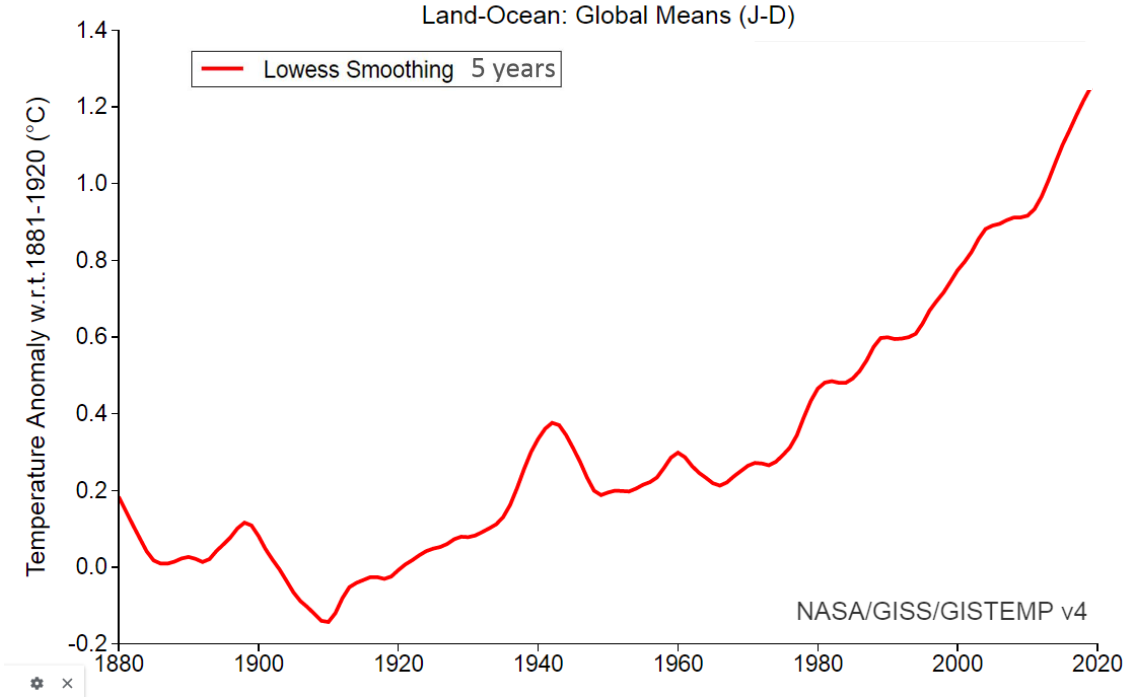


NASA GISS Surface Temperature Analysis (v4)
Accessed 24 April 2020

"The rate of global warming has accelerated in the past decade".

Source: Global Temperature in 2019, 15 January 2020
James Hansen, M. Sato, R. Ruedy Gavin Schmidt, K. Lob, M. Hendrickson
(NASA climate experts)

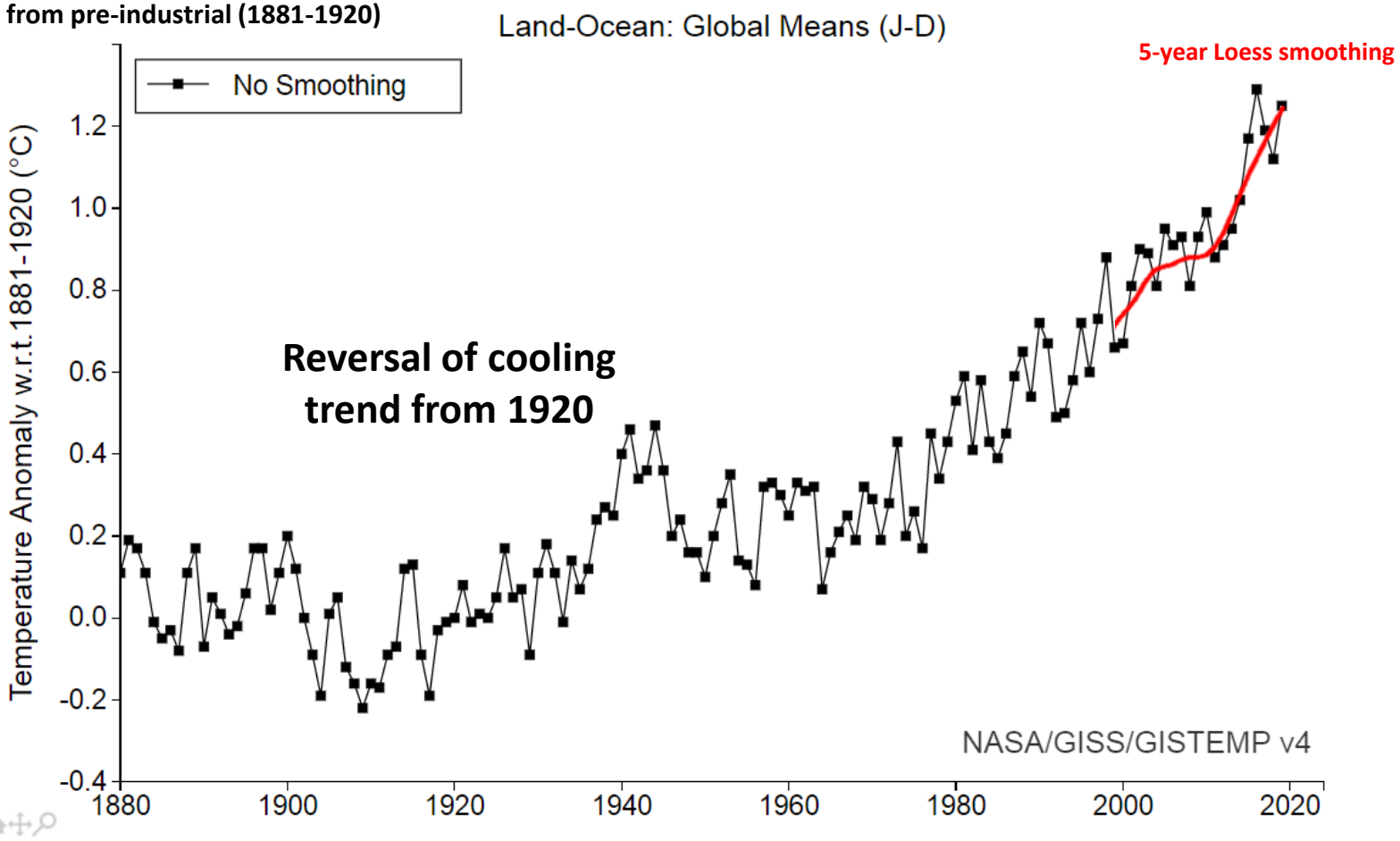
2019

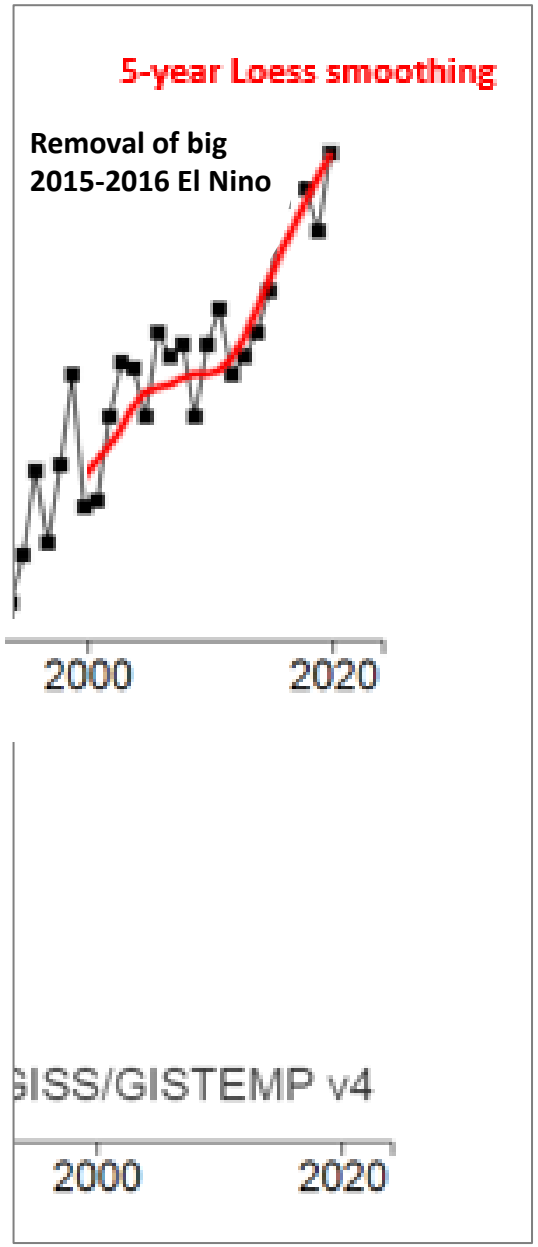


NASA GISS Surface Temperature Analysis
Additional Analysis Plots, accessed 24 April 2020

2019 is a RECORD NON-EL NINO YEAR & ACCELERATING FAST

Annual global temperature increase from pre-industrial (1881-1920)





Ist. quarter of 2020 (Jan-March) global surface temperature increase:

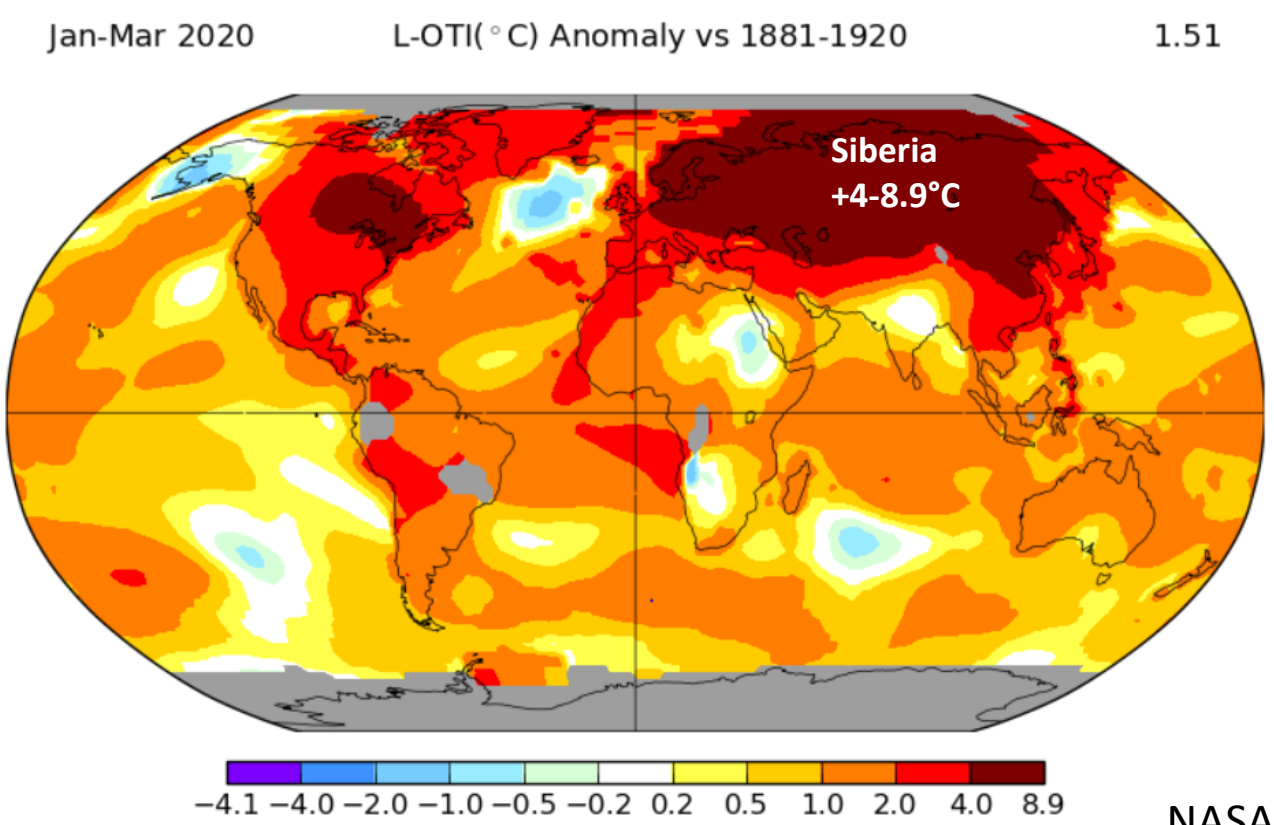
+ 1.5°C !!!

There is no El Nino in 2020

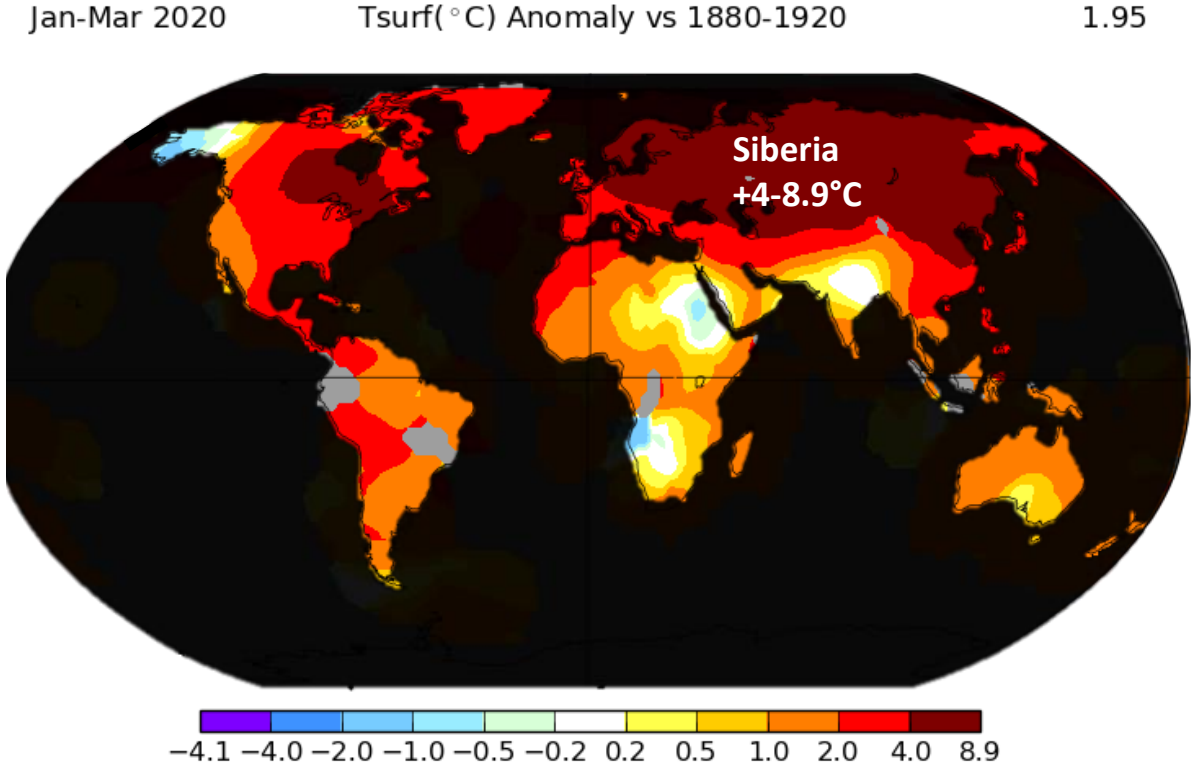
Global land temperature increase: +1.95°C

Global average temperature change from preindustrial (1881-1920)

Global average (land-ocean) temperature increase



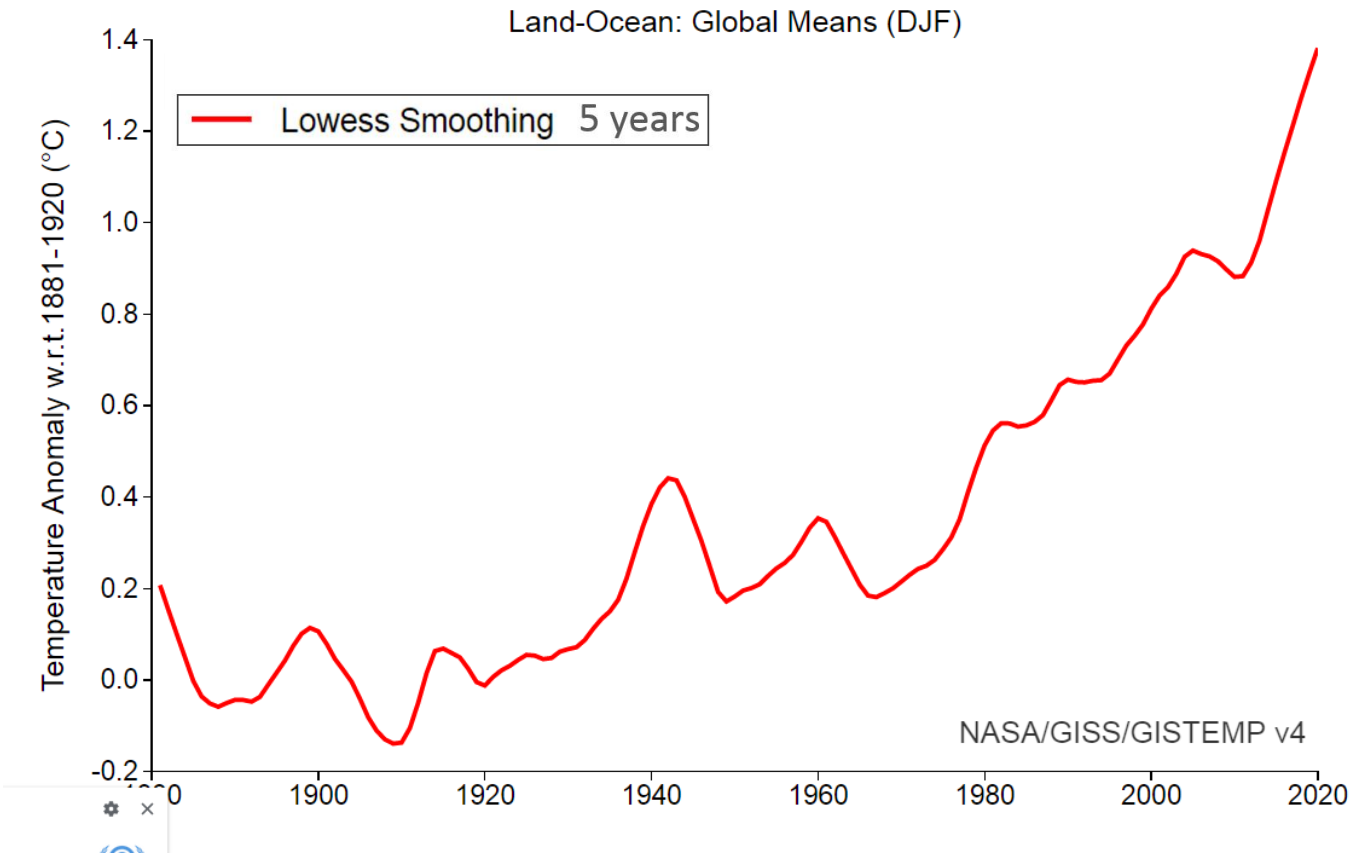
Global average LAND temperature increase



NASA GISS

EXTREME ACCELERATED WINTER TEMPERATURE INCREASE (Dec-Jan-Feb)

+1.38°C

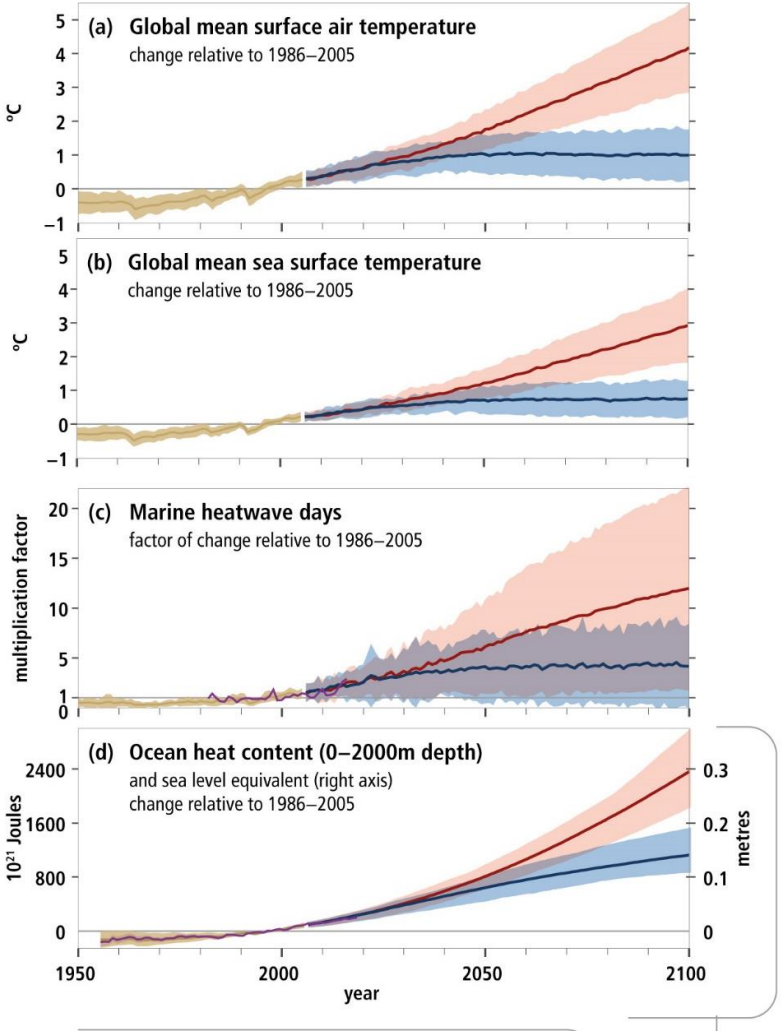


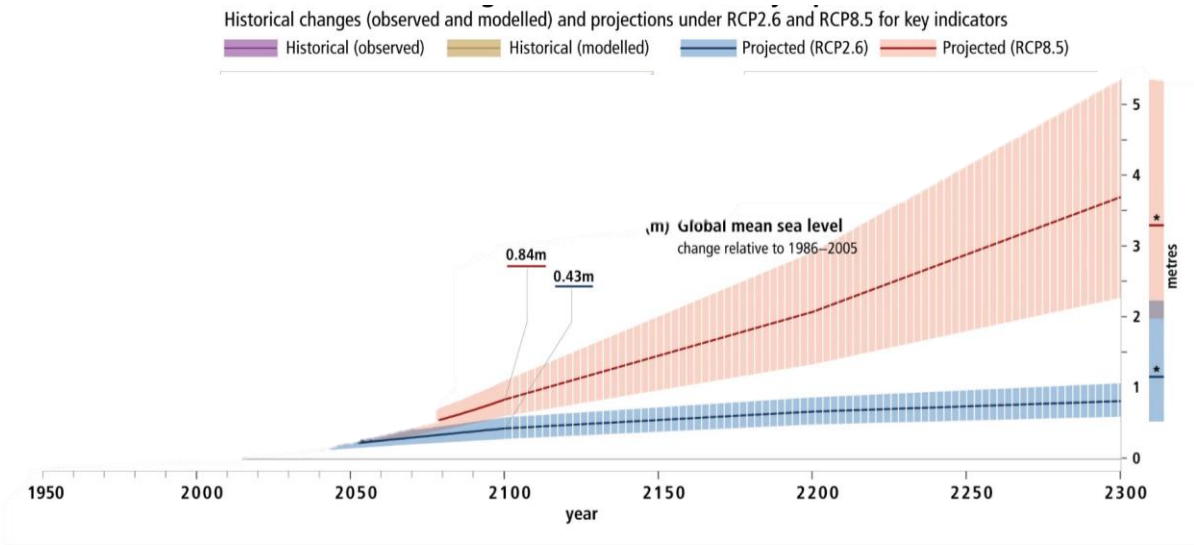
NASA GISS Surface Temperature Analysis
Additional Analysis Plots, accessed 24 April 2020

Past and future changes in the ocean

IPCC , 2019, Special Report on the Ocean and Cryosphere in a Changing Climate

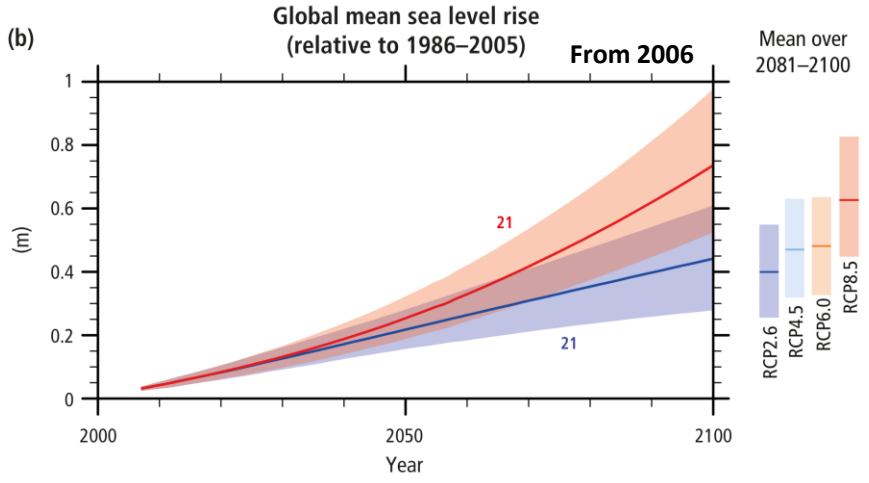
Figure SPM.1 |





SEA LEVEL RISE
is tracking above the worst-case scenario (RCP8.5)

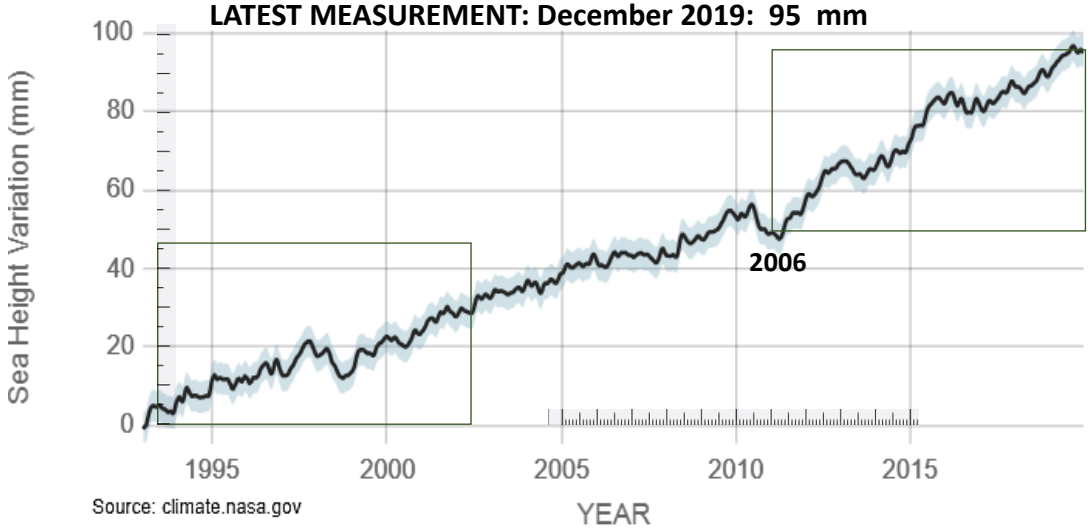
Original for RCP8.5



IPCC 2014 5th assessment Figure SPM.6 | Global average surface temperature change (a) and global mean sea level rise10 (b) from 2006 to 2100 as determined by multi-model simulations. All changes are relative to 1986–2005.

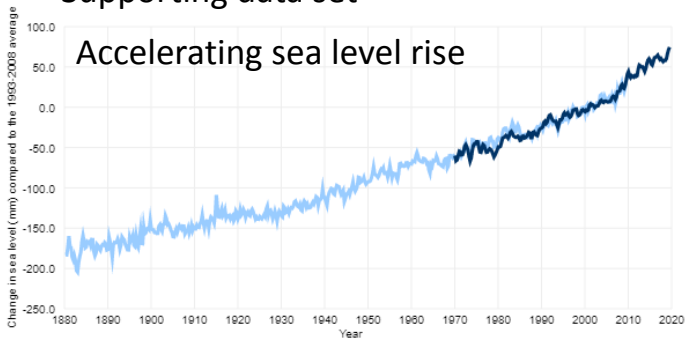
Change in sea level since 1993 as observed by satellites.

LATEST MEASUREMENT: December 2019: 95 mm



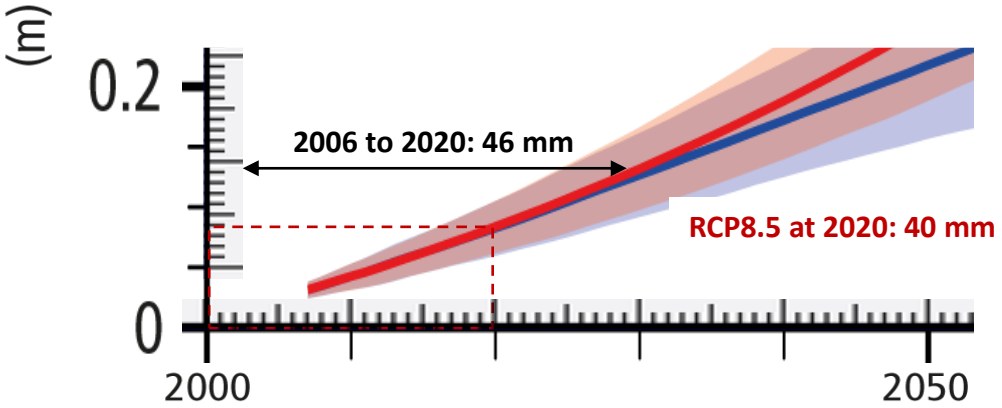
Source: NASA Climate Change Vital Signs

Supporting data set



NOAA, Climate Change: Global Sea Level Author: Rebecca Lindsey November 19, 2019

Present day focus



SEA LEVEL RISE ACCELERATION

IPCC 2019 Special Report

IPCC , 2019, Special Report on the Ocean and Cryosphere in a Changing Climate SPM.1

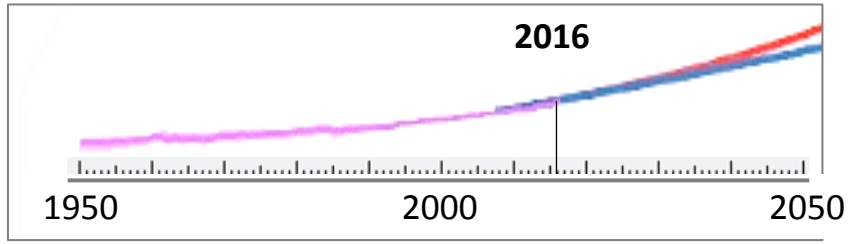
The impression is that sea level rise is tracking towards the worst-case

The IPCC 2019 Report shows historic sea level rise to 2016

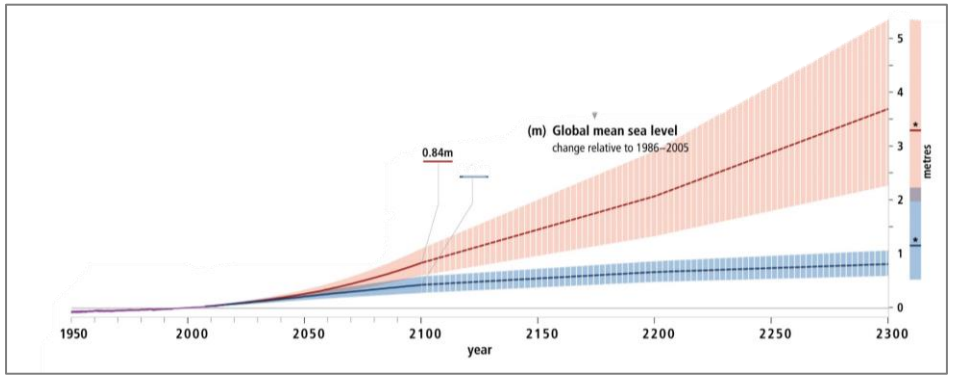
A.3.2 “Sea level rise has accelerated due to the combined increased ice loss from
the Greenland and Antarctic ice sheets (very high confidence).
Mass loss from the Antarctic ice sheet over the period 2007–2016 tripled relative to 1997–2006.
For Greenland, mass loss doubled over the same period “

A.3.3 “Acceleration of ice flow and retreat in Antarctica, which has the potential to lead to sea level rise of several metres within a few centuries, is observed in the Amundsen Sea Embayment of West Antarctica and in Wilkes Land, East Antarctica (very high confidence).
These changes may be the onset of an irreversible ice sheet instability.”

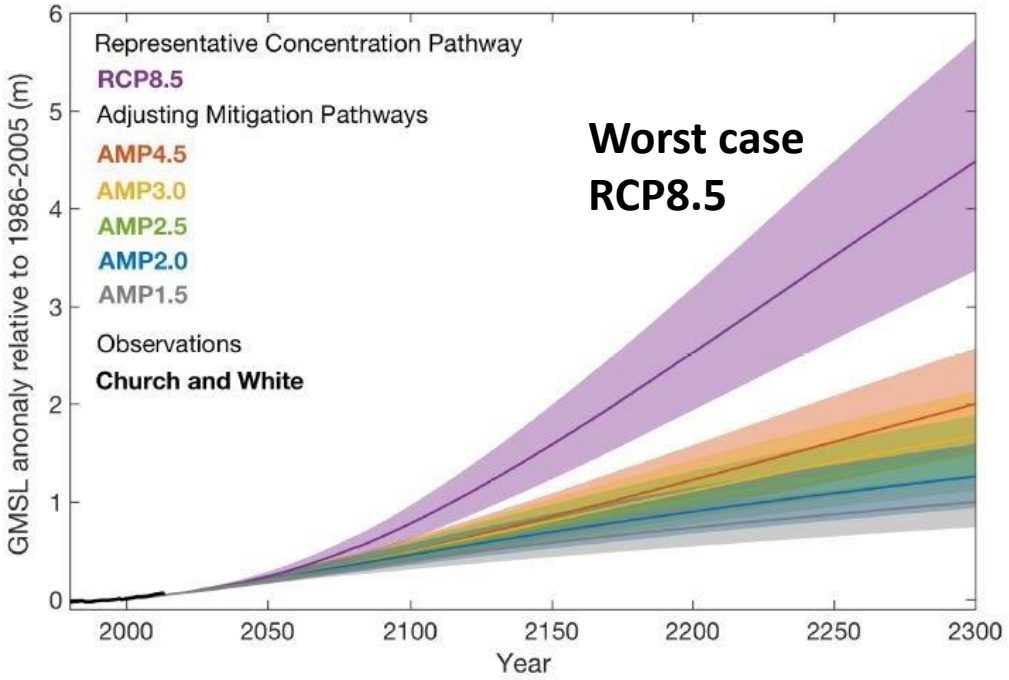
Focus to present day

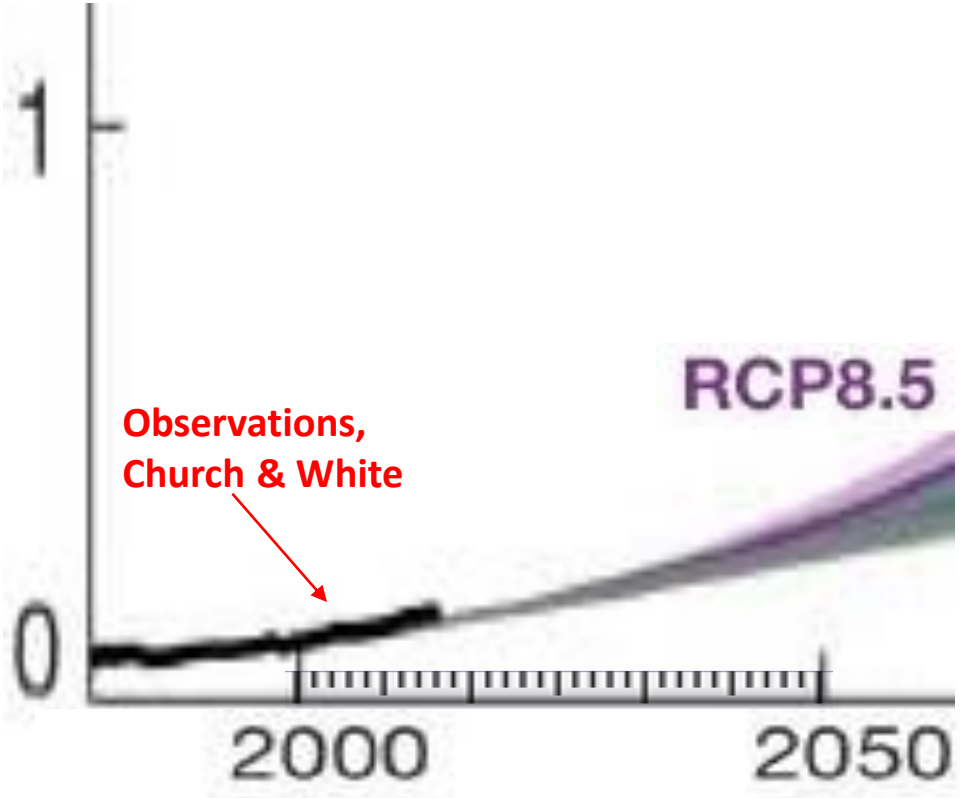


Original for RCP8.5



GLOBAL SEA LEVEL RISE
is tracking above the worst-case scenario RCP 8.5





APRIL 9, 2018

Early climate action has big effect on rising sea levels

by Larry O'hanlon, American Geophysical Union

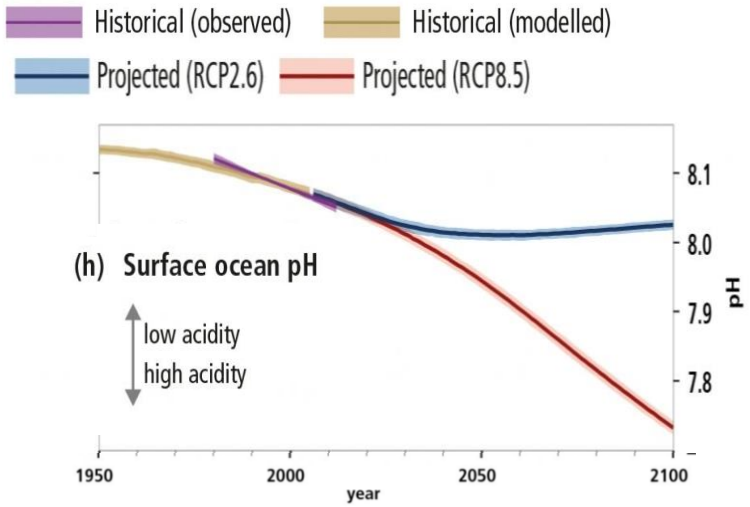
https://phys.org/news/2018-04-early-climate-action-big-effect.html

OCEAN ACIDIFICATION
is tracking the worst-case scenario (RCP8.5)

IPCC 2019 Ocean & Cryosphere Report
The Lower the pH- the Higher the acidity

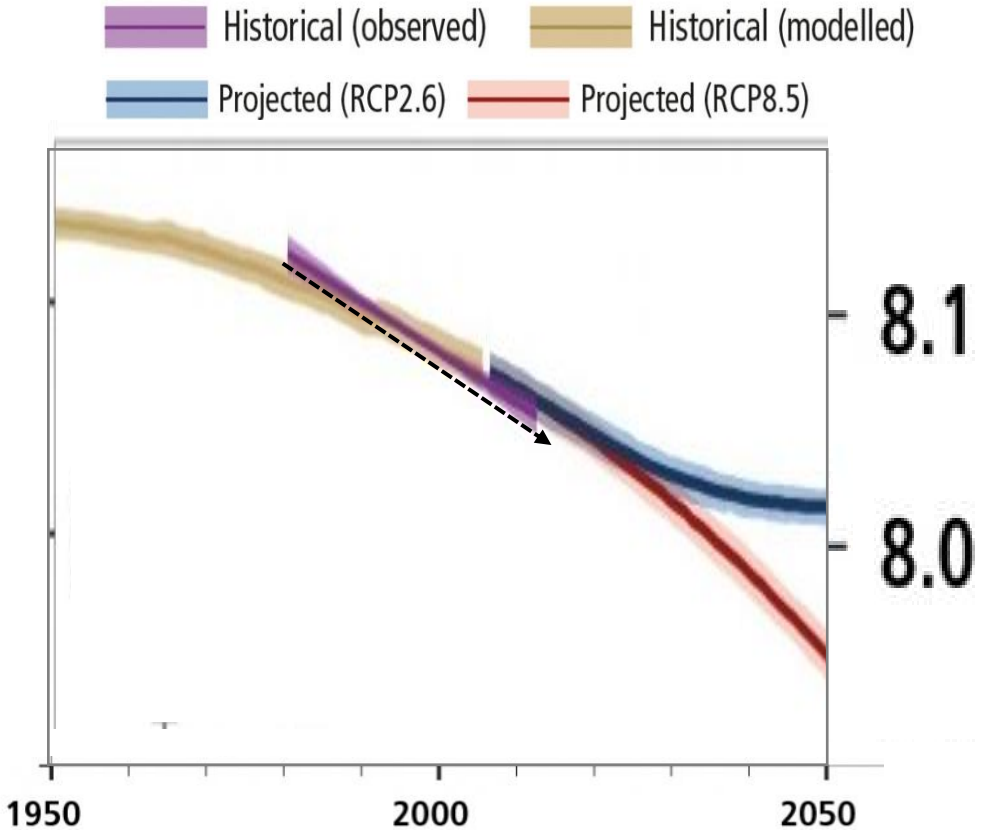
IPCC 2019 Ocean & Cryosphere Report Figure SPM.1 | Observed and modelled historical changes in the ocean and cryosphere since 1950, and projected future changes under low (RCP2.6) and high (RCP8.5) greenhouse gas emissions scenarios.

Original for RCP8.5l



The Lower the pH- the Higher the Acidity

Present day focus



https://www.ipcc.ch/srocc/chapter/summary-for-policymakers/

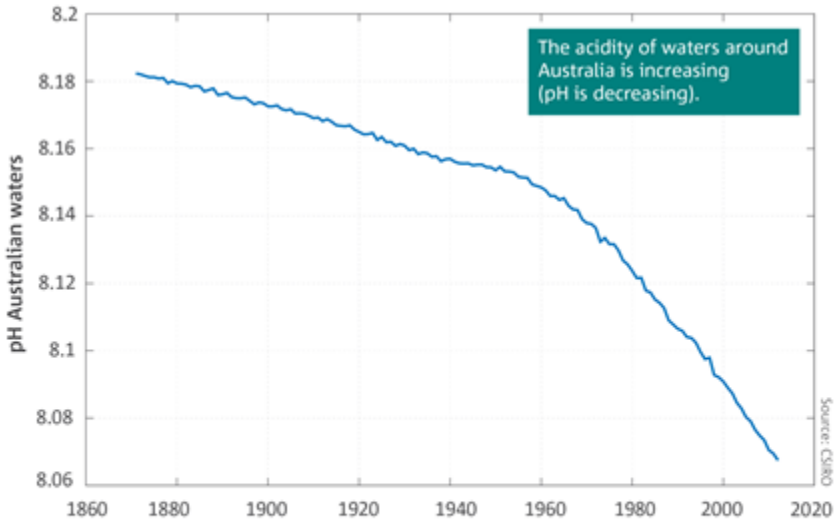
Ocean acidity is accelerating

2nd example

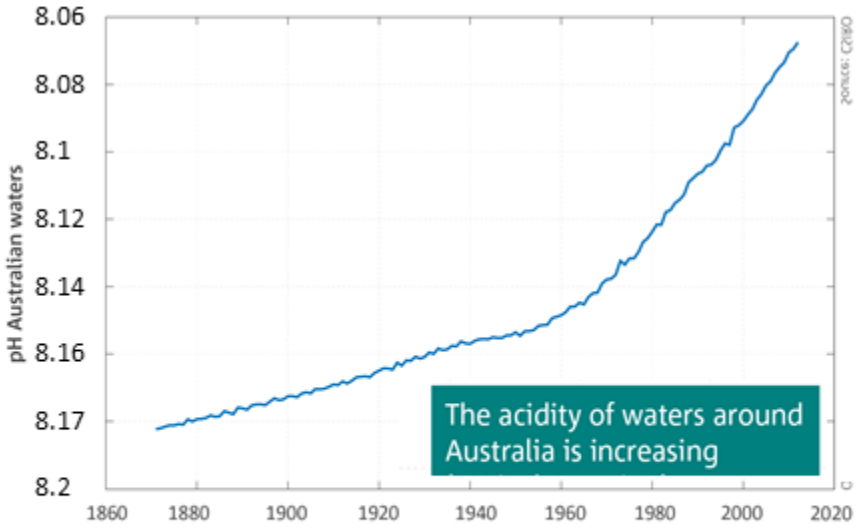
Ocean acidity (inverse of pH)

(1860-2016, around Australia)

pH (hydrogen ion potential)



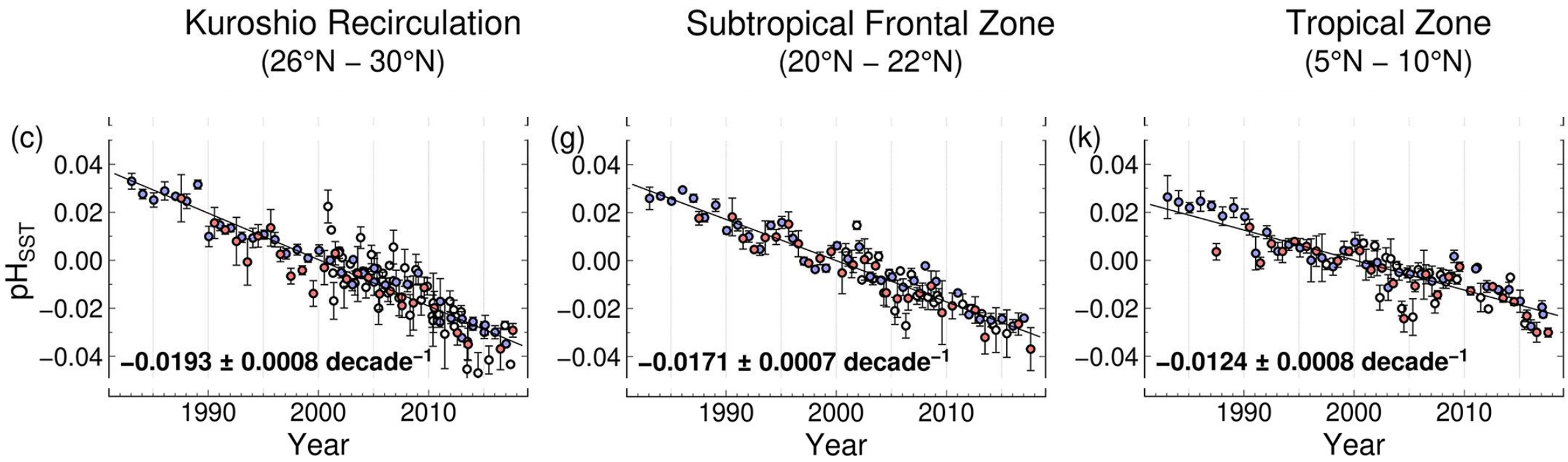
Inverse pH Relative acidity



From Australia's changing climate, Dec 2018,
The Commonwealth Scientific and Industrial Research Organisation (CSIRO)

OCEAN ACIDIFICATION ACCELERATION

Supporting recent research

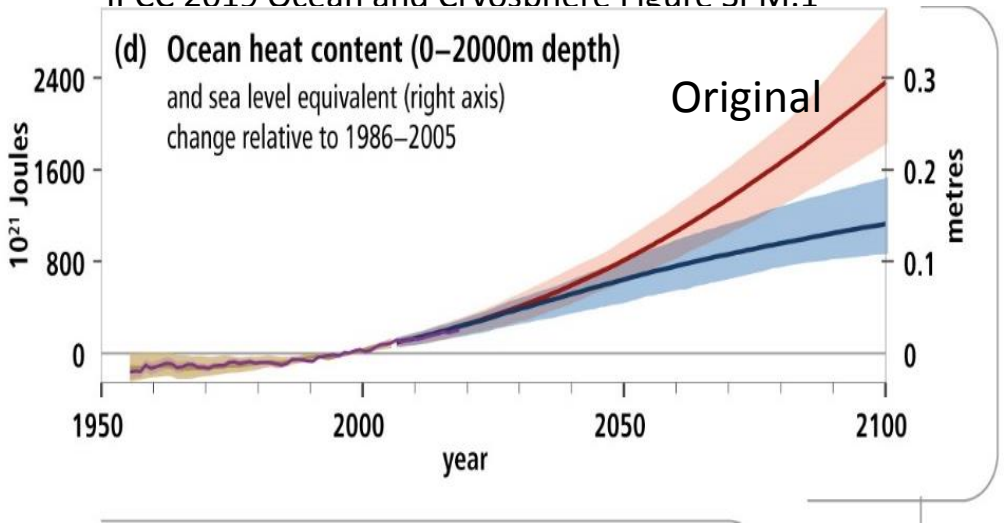


Acceleration of Ocean Acidification in the Western North Pacific
Hisashi Ono, et al, GRL, Nov 2019

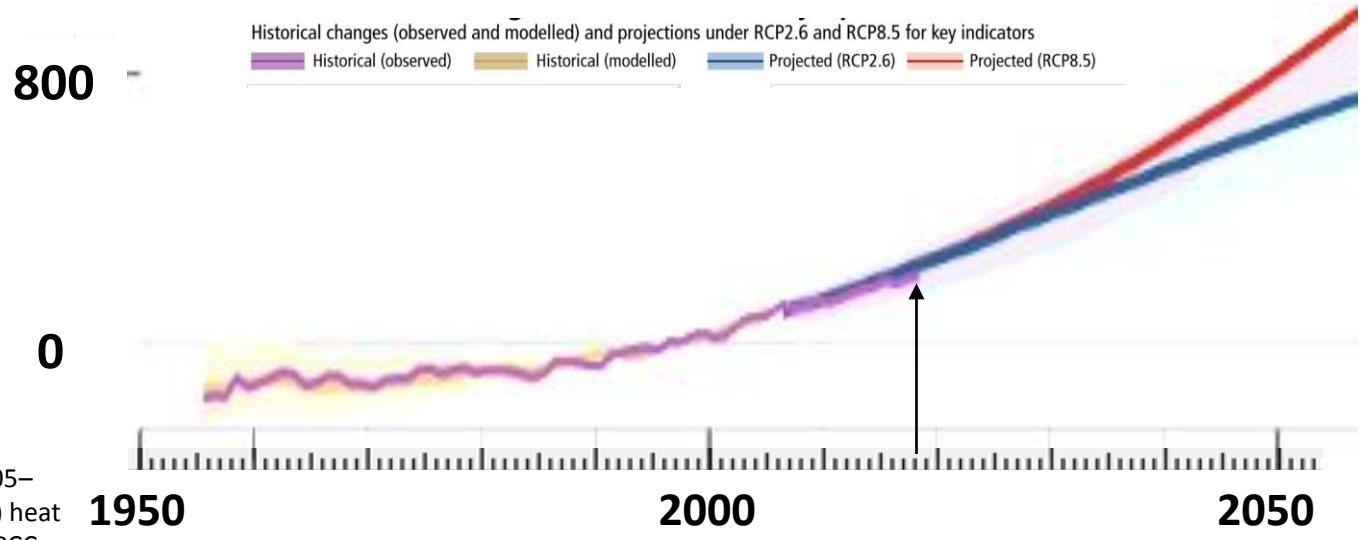
OCEAN HEAT (2018)
Tracking towards worst-case?

Though it is not possible to discern a deviation of the scenarios from the latest IPCC report data illustration, ocean heat is accelerating (Figure 5.1, see also next) which would be towards the worst-case.

IPCC 2019 Ocean and Cryosphere Figure SPM.1



A.2 "Since 1993, the rate of ocean warming has more than doubled"



The rate of heat uptake in the upper ocean (0–700 m) is very likely higher in the 1993–2017 (or 2005–2017) period compared with the 1969–1993 period (see Table 5.1). The deeper layer (700–2000 m) heat uptake rate is likely to be higher in the 1993–2017 period compared with the 1969–1993 period. (IPCC 2019 Oceans and Cryosphere Report 11.142)

Figure 5.1

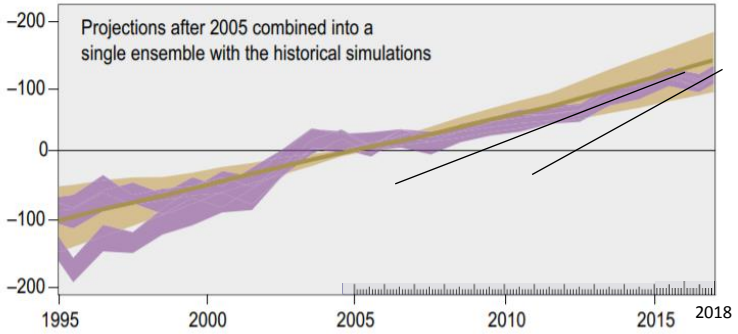
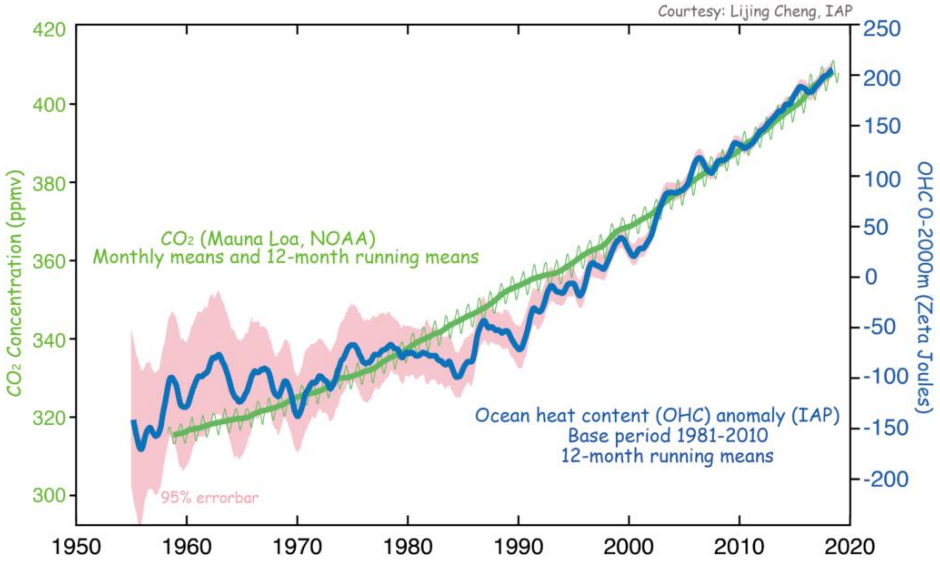


Table 5.1

	Ocean Heat Uptake Rate, ZJ yr^{-1}				Ocean Heat Uptake as Average Fluxes, W m^{-2}			
Period	**1969–1993**	**1993–2017**	**1970–2017**	**2005–2017**	**1969–1993**	**1993–2017**	**1970–2017**	**2005–2017**
Observationally Based Ocean Heat Uptake Estimates:								
0–700 m	3.22 ± 1.61	6.28 ± 0.48	4.35 ± 0.80	5.31 ± 0.48	0.20 ± 0.10	0.39 ± 0.03	0.27 ± 0.05	0.33 ± 0.03
700–2000 m	0.97 ± 0.64	3.86 ± 2.09	2.25 ± 0.64	4.02 ± 0.97	0.06 ± 0.04	0.24 ± 0.13	0.14 ± 0.04	0.25 ± 0.06
CMIP5 ESM Ensemble-mean Ocean Heat Uptake with 90% Certainty Range from Ensemble Spread:								
0–700 m	3.60 ± 1.92	7.37 ± 2.09	5.64 ± 1.90	7.85 ± 2.71	0.22 ± 0.12	0.46 ± 0.13	0.35 ± 0.12	0.49 ± 0.17
700–2000 m	1.32 ± 1.49	2.72 ± 1.41	1.99 ± 1.51	3.33 ± 1.75	0.08 ± 0.09	0.17 ± 0.09	0.12 ± 0.09	0.21 ± 0.11

OCEAN HEAT ACCELERATING

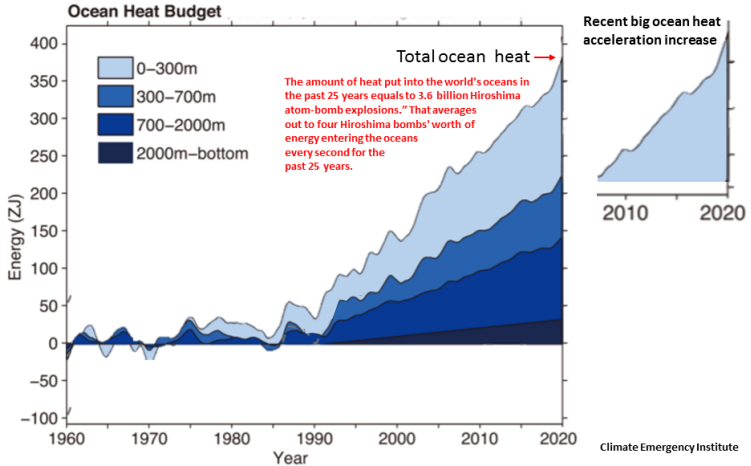
How fast are the oceans warming?
Lijing Cheng et al, Science 11 Jan 2019



Ocean heat acceleration at all depths, 1960-2019

Ocean heating is causing ocean deoxygenation

From Record-Setting Ocean Warmth Continued in 2019, Lijing CHENG, January 2020



ADVANCES IN ATMOSPHERIC SCIENCES, VOL. 37, FEBRUARY 2020, 137–142

Record-Setting Ocean Warmth Continued in 2019 Lijing CHENG

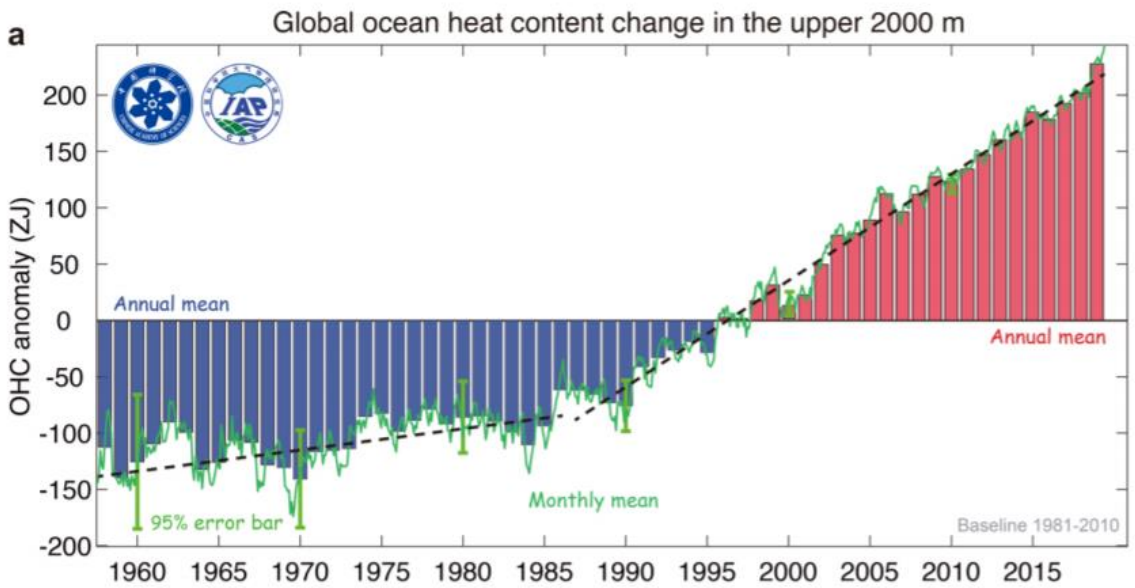


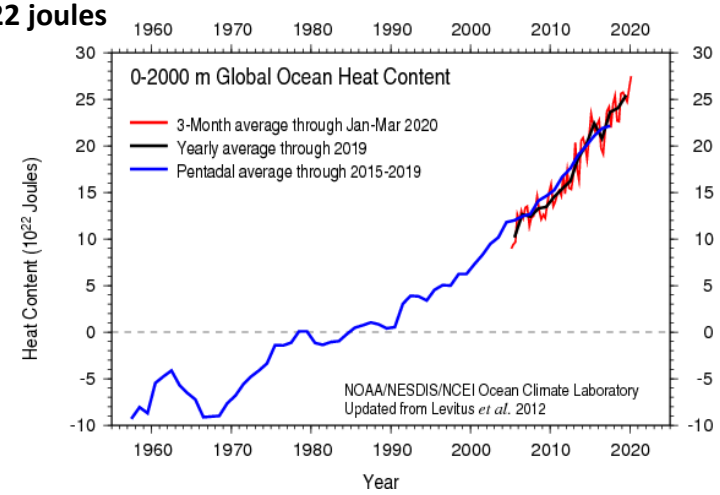
Fig. 1. (a) Upper 2000 m OHC from 1958 through 2019.

OCEAN HEAT (2020)
from this projection is tracking the worst-case scenario (RCP 8.5)
It is accelerating (NOAA)

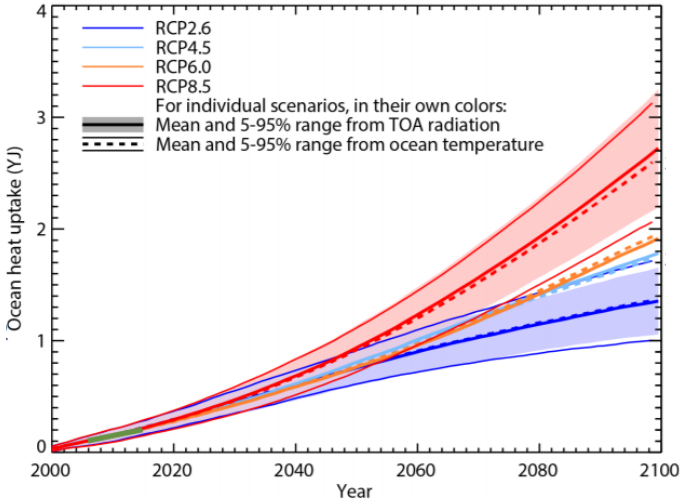
10 to power 22 joules

NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA, Global Ocean Heat and Salt Content



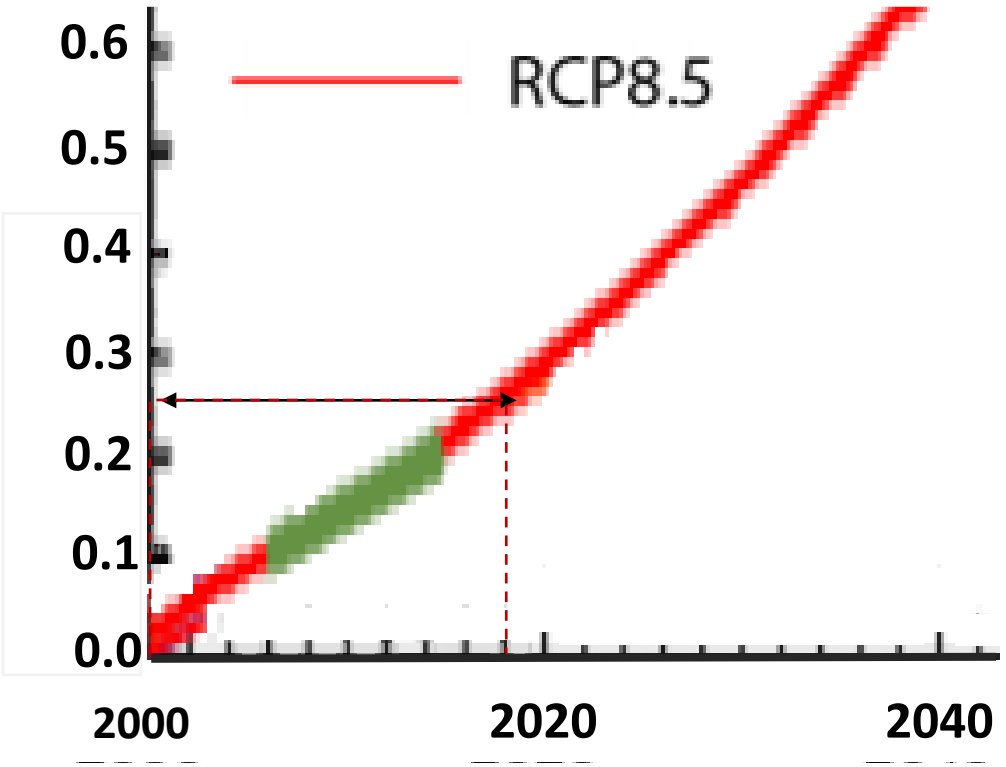
10 to power 24 joules **Original**



Church et al. 2013, IPCC WGI AR5 Ch13

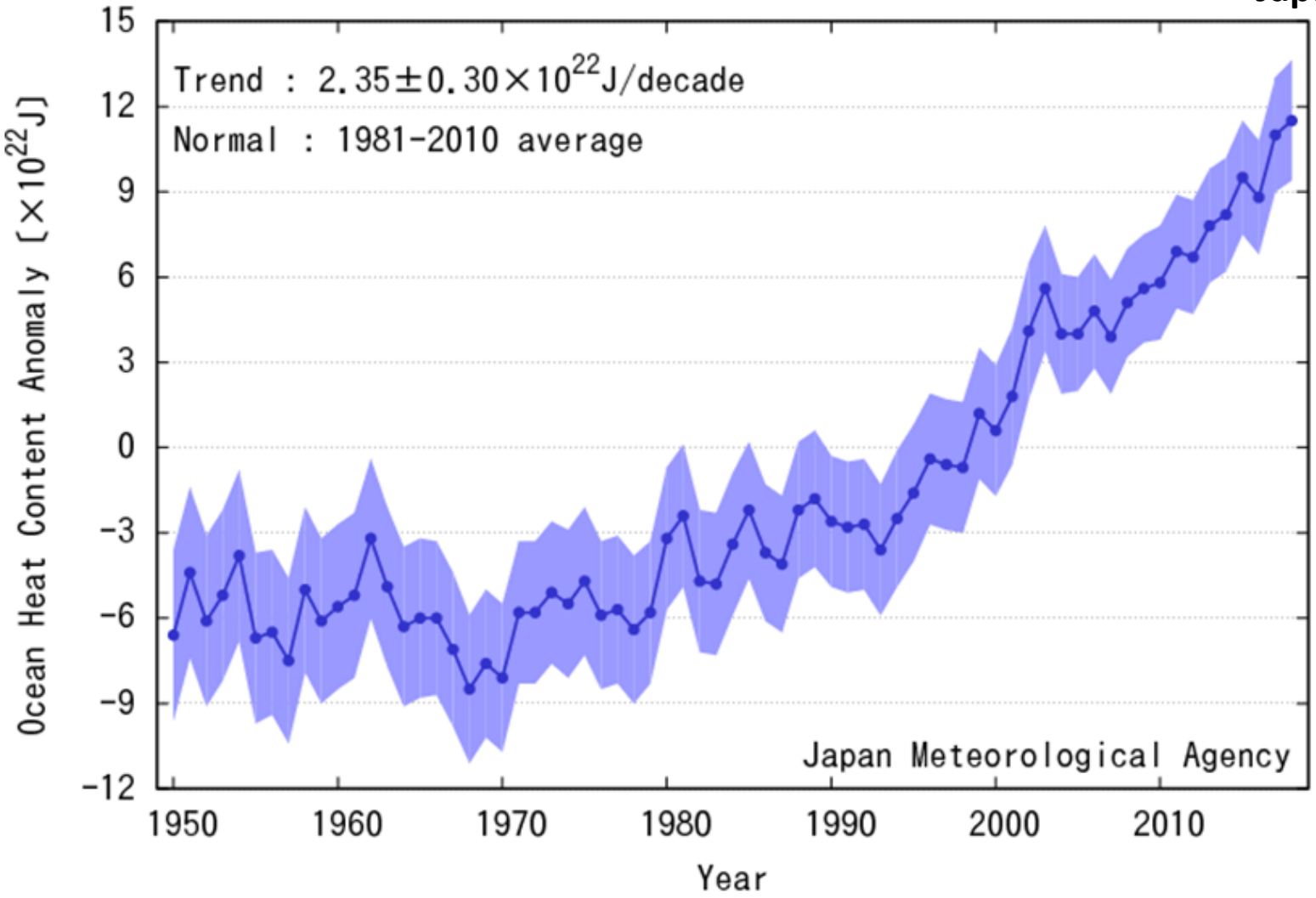
Church et al. 2013, IPCC WGI AR5 Ch13

10 to power 24 joules

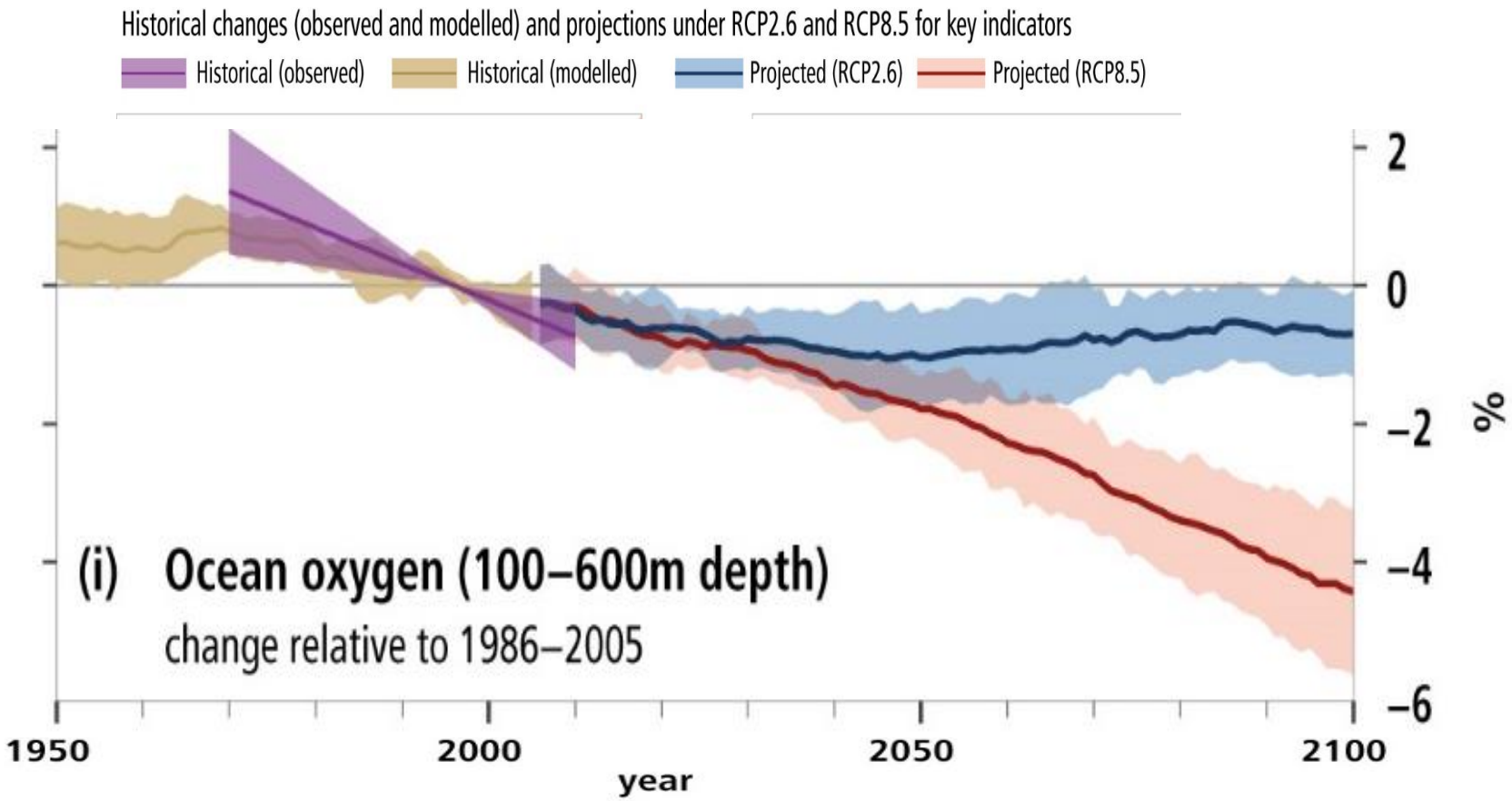


Accelerating Ocean Heating Causes Ocean De-oxygenation

Another data set example
Japan Met



OCEAN DEOXYGENATION
is tracking above the worst-case scenario

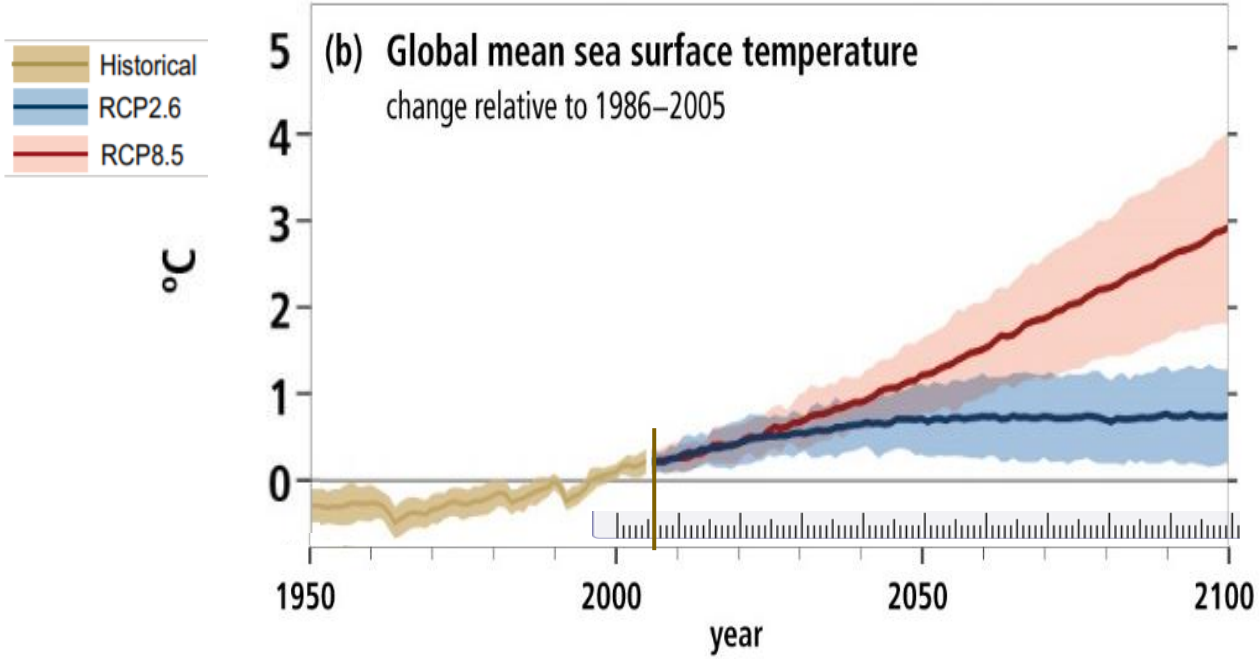


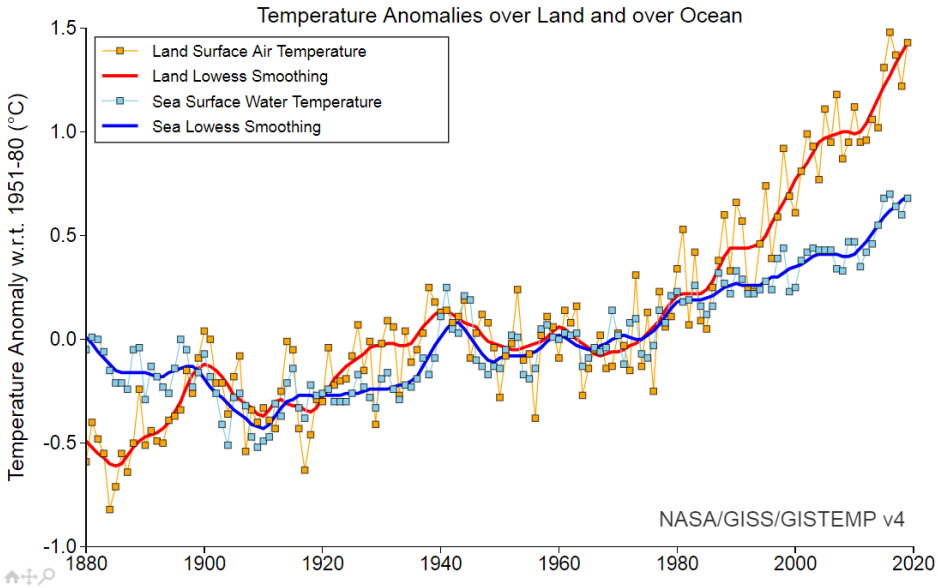
IPCC , 2019, Special Report on the Ocean and Cryosphere in a Changing Climate

RECENT SEA SURFACE TEMPERATURE INCREASE may be tracking the worst-case scenario

According to the IPCC, by 2005 a distinction between the scenarios is not established
However as there is big jump in SST from 2010, SST is assumed to be tracking the worst-case as is the global average surface temperature, and SST is accelerating

IPCC 2019 Oceans and Cryosphere report

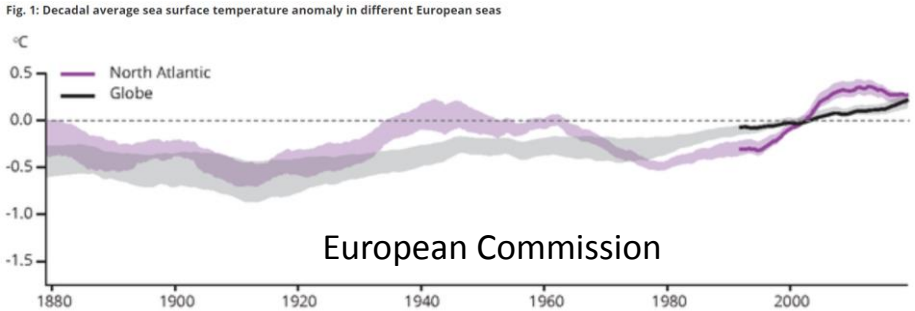




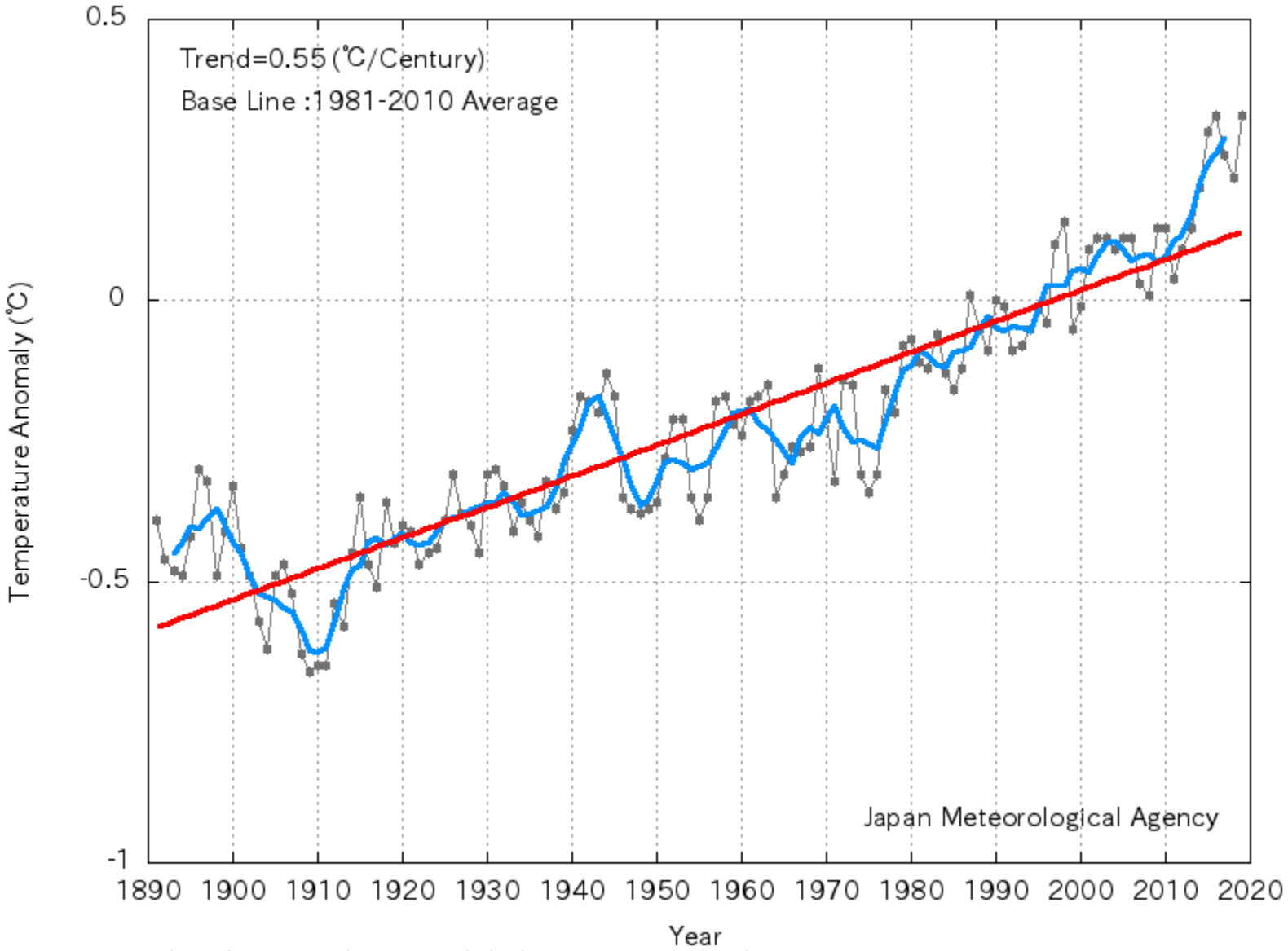
Annual (thin lines) and five-year lowess smooth (thick lines) for the temperature anomalies (vs. 1951-1980) averaged over the Earth's land area and sea surface temperature anomalies (vs. 1951-1980) averaged over the part of the ocean that is free of ice at all times (open ocean).

Sea surface temperature rise is accelerating

Is the global sea surface temperature rise accelerating? lH.Bâki Iz, 2018
https://doi.org/10.1016/j.geog.2018.04.002

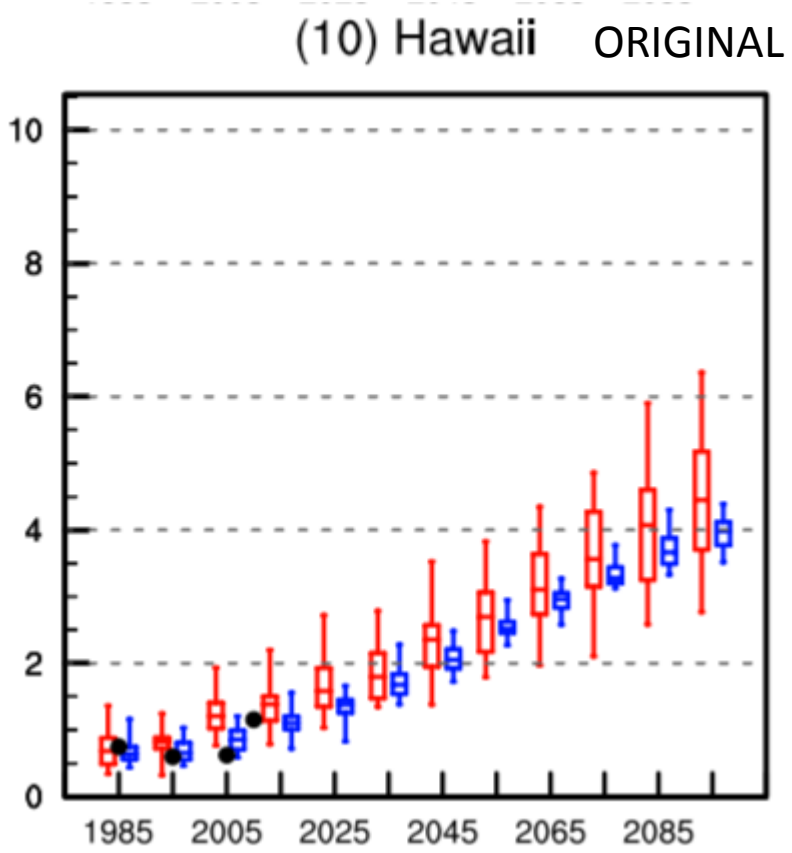


Supporting sea surface temperature data



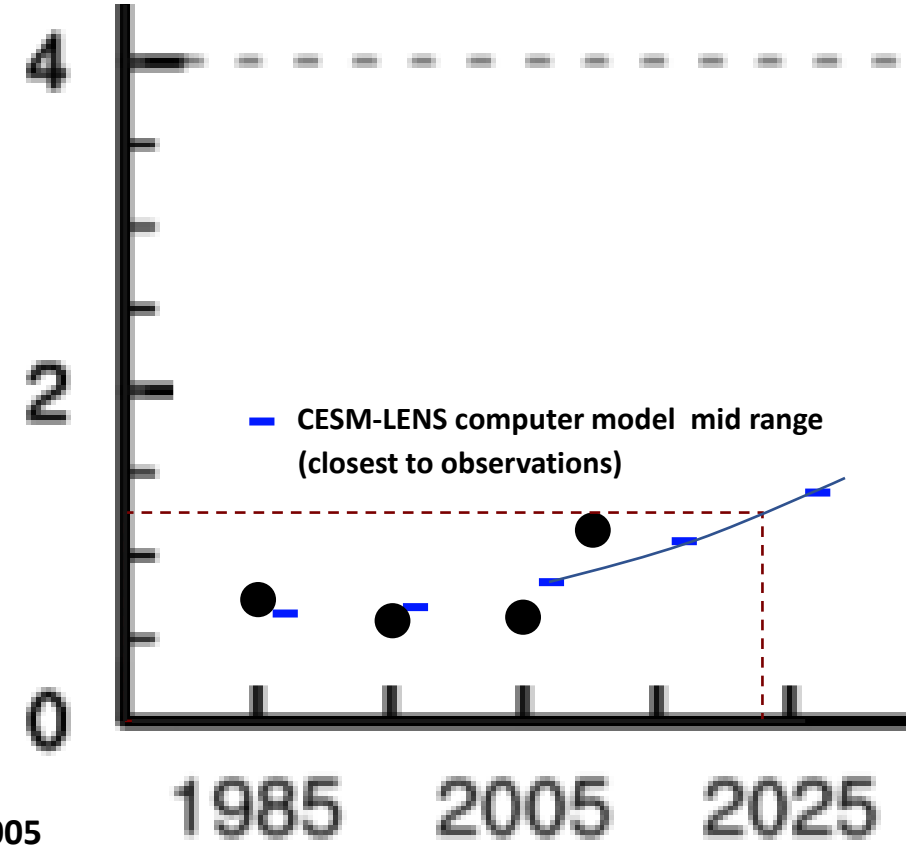
Updated on 17 Feb. 2020 Global Environment and Marine Department, Japan Met

SEA SURFACE TEMPERATURE INCREASE
and the worst-case scenario RCP 8.5



All of the simulations used the observed greenhouse gas concentrations for 1976–2005 and the RCP8.5 "business as usual" scenario

The anomalies are relative to the historical period (1976–2005). They were obtained from the individual CMIP5 (red) and CESM-LENS (blue) simulations.
The box boundaries are the inter-quartile range (25%–75%) and the median is the central line



Hadley SST observations are shown with black dots for the 1980s, 1990s, 2000s and the period 2006–2016.

Source: Projected sea surface temperatures over the 21st century, Michael A. Alexander et al , 2028

Arctic Albedo

The final data is the record of declining Arctic summer sea ice extent and Arctic snow cover, which requires explanation because of the effect on the global climate.

The vast area of white through the Arctic summer reflects in coming solar energy away from the Arctic surface back out to space. This property is called Arctic albedo. It is a key component of the stable climate.

There has been Arctic sea ice to some extent for the past 13-14 million years, with the largest sea ice extent for the past 2-3 million years.

The climate change issue here is Arctic albedo, which is a powerful cooling influence maintaining the cold climate of the Arctic , the year-round frozen Arctic regions, and the temperate climate regions of the northern hemisphere.

The current rapid decline of Arctic albedo has a global impact.

It boosts the rate of melting of the Greenland ice sheet and the rate of sea level rise.
It boosts the thawing of Arctic permafrost, which is already releasing all three major greenhouse gases from the Arctic soils: methane, CO2 and nitrous oxide.
This will turbo-charge the rate of global surface heating.

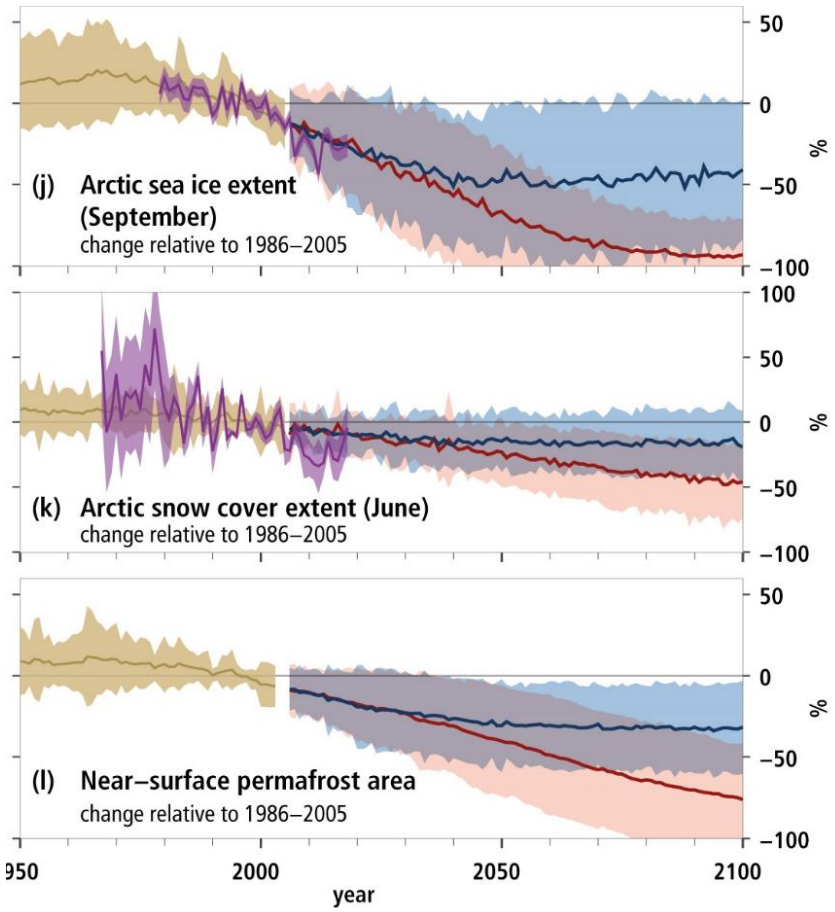
It will inevitably have a large effect on the northern hemisphere temperate climate, where the world's top agricultural food producing regions are located.

IPCC , 2019, Special Report on the Ocean and Cryosphere in a Changing Climate

Past and future changes in the cryosphere

Historical changes (observed and modelled) and projections under RCP2.6 and RCP8.5 for key indicators

Historical (observed) | Historical (modelled) | Projected (RCP2.6) | Projected (RCP8.5)



A.3.3 Acceleration of ice flow and retreat in Antarctica, which has the potential to lead to sea level rise of several metres within a few centuries, is observed in the Amundsen Sea Embayment of West Antarctica and in Wilkes Land, East Antarctica (very high confidence). These changes may be the onset of an irreversible ice sheet instability.

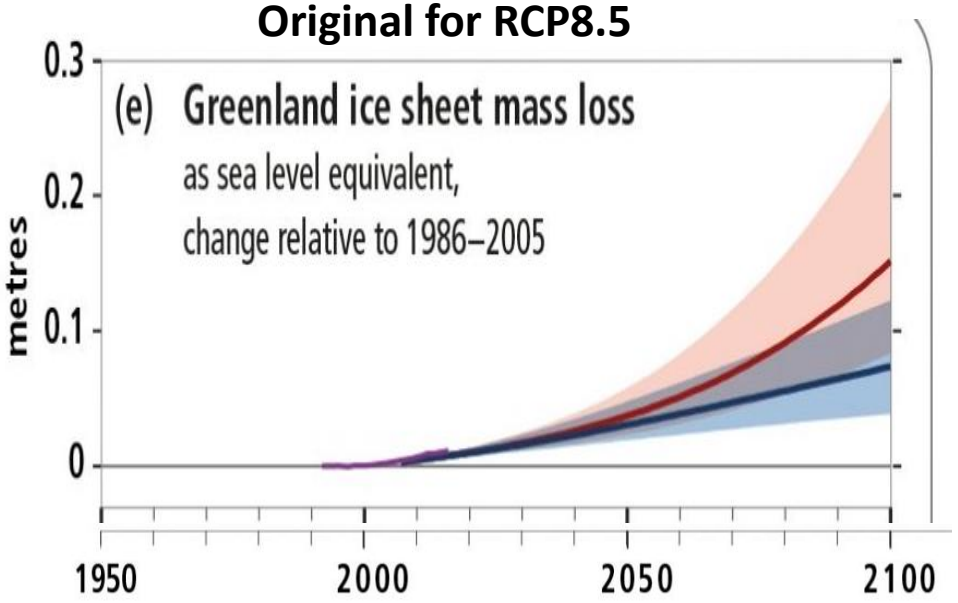
GREENLAND ICE SHEET mass loss is tracking the worst-case scenario RCP 8.5

Past and future changes in the ocean and cryosphere

Historical changes (observed and modelled) and projections under RCP2.6 and RCP8.5 for key indicators

Historical (observed) | Historical (modelled) | Projected (RCP2.6) | Projected (RCP8.5)

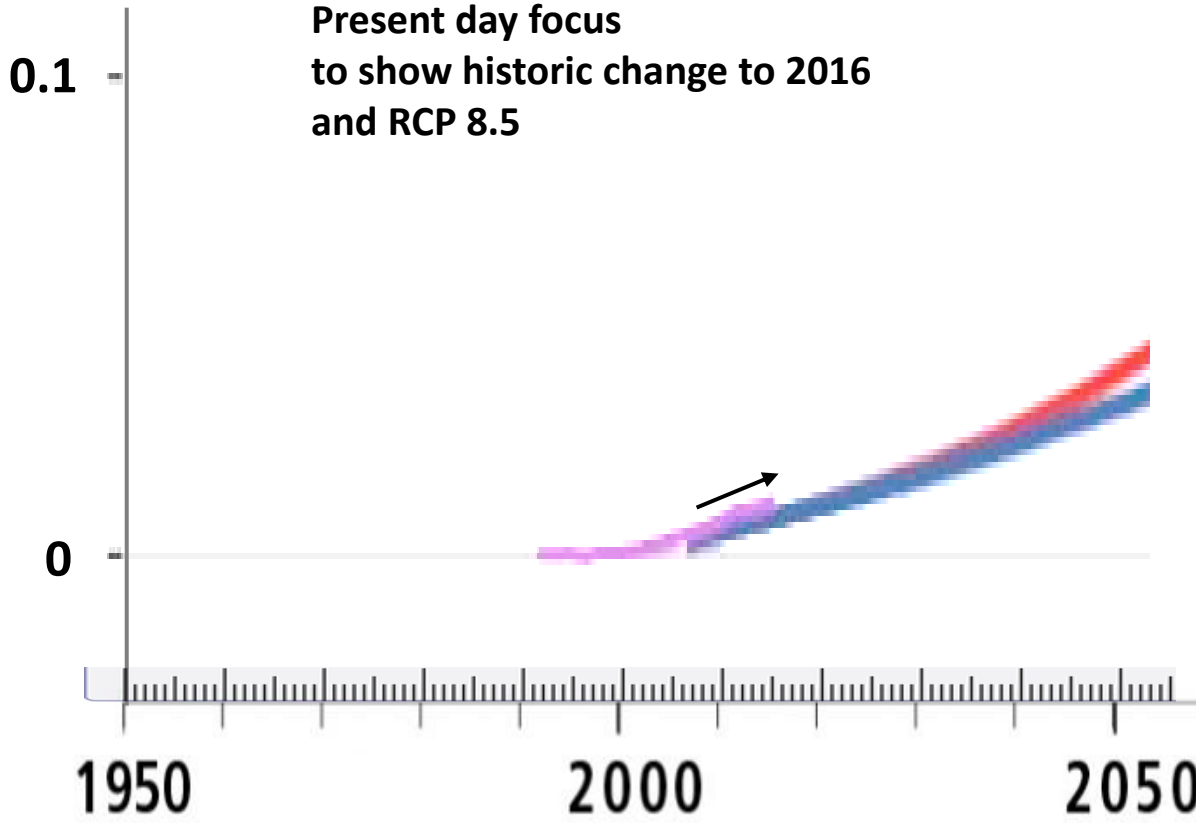
Original for RCP8.5



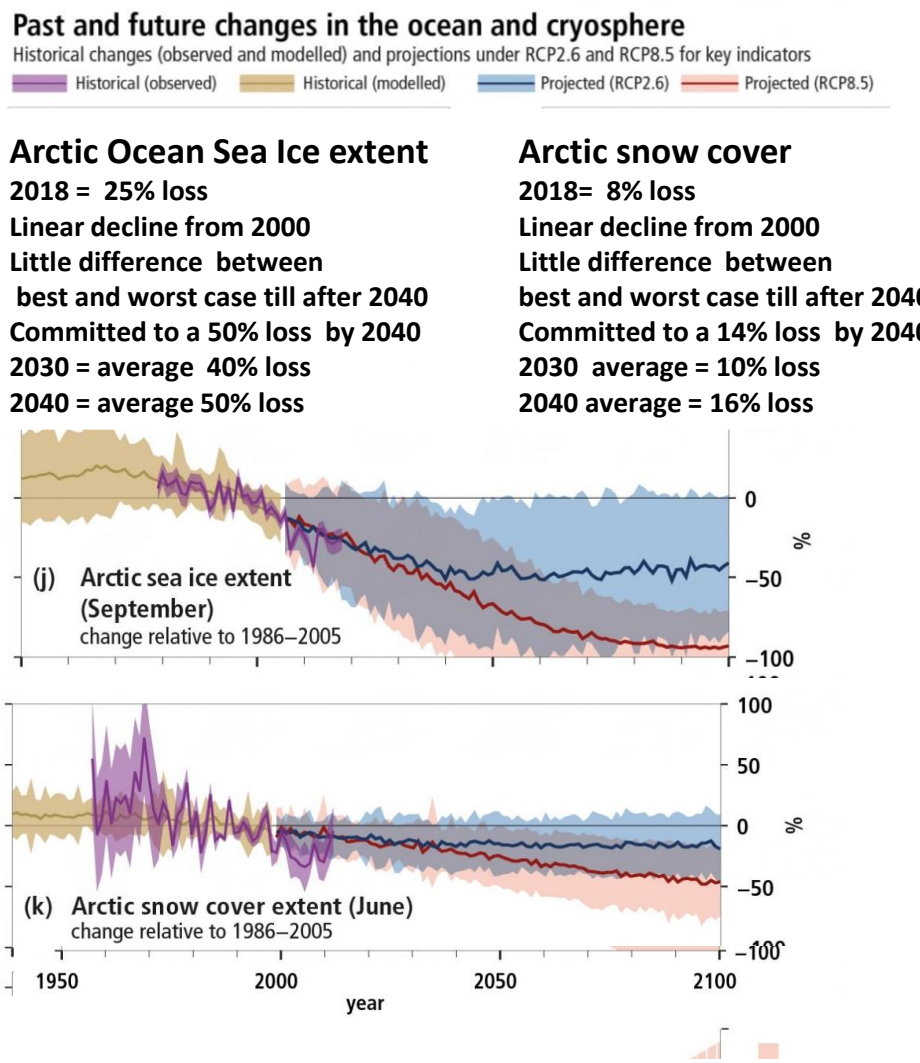
https://www.ipcc.ch/srocc/chapter/summary-for-policymakers/

IPCC 2019 Special Report Oceans & Cryosphere, Figure SPM.1 | Observed and modelled historical changes in the ocean and cryosphere since 1950, and projected future changes under low (RCP2.6) and high (RCP8.5) greenhouse gas emissions scenarios.

Present day focus to show historic change to 2016 and RCP 8.5



60 years trend (from 1960) of Arctic sea ice and snow decline

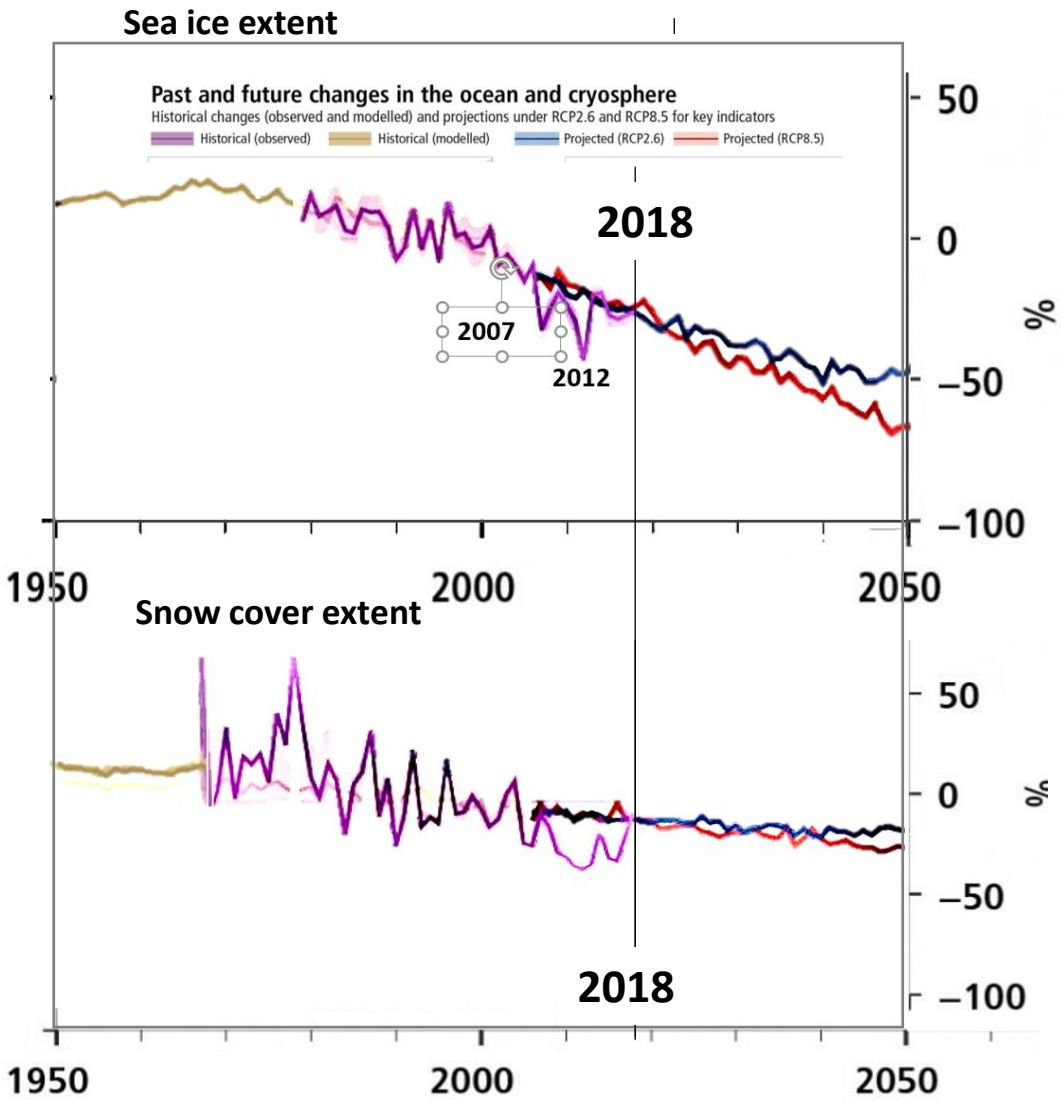


Arctic Ocean Sea Ice extent

2018 = 25% loss
Linear decline from 2000
Little difference between best and worst case till after 2040
Committed to a 50% loss by 2040
2030 = average 40% loss
2040 = average 50% loss

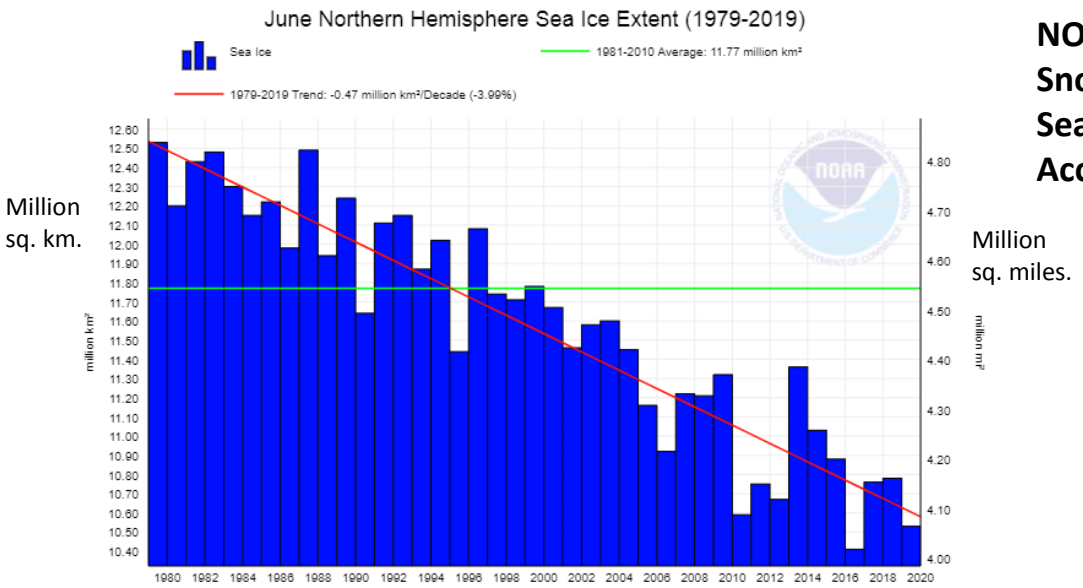
Arctic snow cover

2018= 8% loss
Linear decline from 2000
Little difference between best and worst case till after 2040
Committed to a 14% loss by 2040
2030 average = 10% loss
2040 average = 16% loss

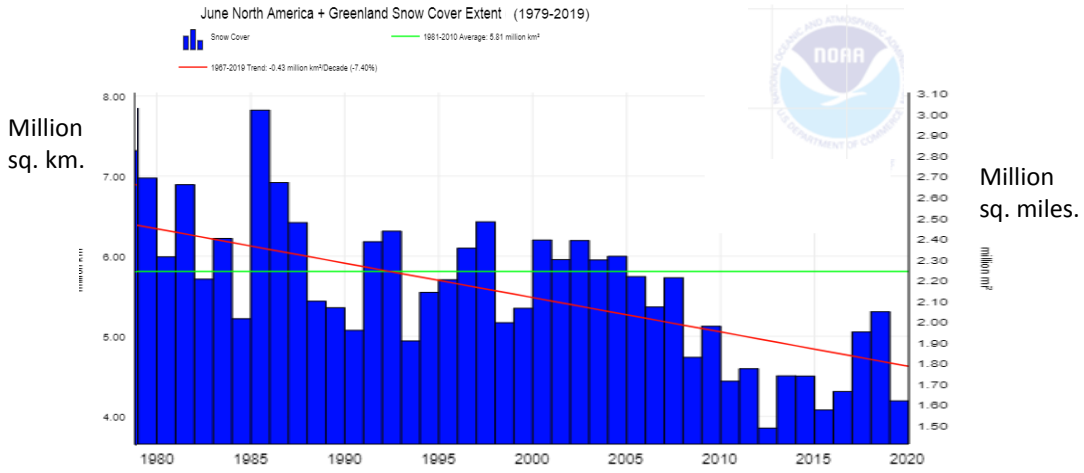


40-year trend of precipitous Arctic albedo (cooling) decline, to 2019

We have no RCPs projections for Arctic albedo, but there is a 40 trend of rapid decline.



NOAA, Climate Monitoring
Snow and Ice
Sea Ice and Snow Cover Extent
Accessed May 2020



Climate Emergency Institute

Conclusion

Though in some cases only just discernable, all indicators show that global climate change is tracking the worst-case scenario (RCP 8.5) or closest to the worst-case scenario, with a reasonable degree of certainty.

Trends of rapid increase and acceleration will predictably keep global climate change on the worst-case scenario, until Parties to the 1992 Framework Convention on Climate Change, cooperate to put global emissions into rapid decline.

Atmospheric greenhouse gas concentrations and trends are far above dangerous (dangerous interference with the climate system as defined by the 1992 Framework Convention on Climate Change, or any definition).