Temperature and Greenhouse Gas Emissions

A Summary of key findings from the United Nations **Intergovernmental Panel on Climate Change's** (IPCC) Sixth Assessment Report (AR6) on the Physical Science Basis

The world is *EXTREMELY LIKELY* to exceed

2°C warming

during the 21st century if greenhouse gas emissions do not start to decline significantly before 2050

The land and ocean CO_2 sinks have a **reduced capacity to remove** further emissions

To limit warming to 1.5°C or 2°C, **rapid emissions reduction (mitigation)** assisted by **carbon dioxide removal (sequestration)** is needed

Global temperatures are set to exceed

1.5°C of warming

earlier than previously projected **in the early**

2030s

Atmospheric CO_2 concentrations reached

410 ppm

in 2019, the highest level in **2 million years**

The Pacific will face

INCREASED HEAT STRESS

with an increased number of days where combined heat and humidity are harmful to human health

AND MARINE

heatwave events will continue to increase in **frequency, duration and intensity**

annual mean marine heatwave duration

30 days	**100** days	**200** days
Now	**1.5°C warming**	**2.5°C warming**

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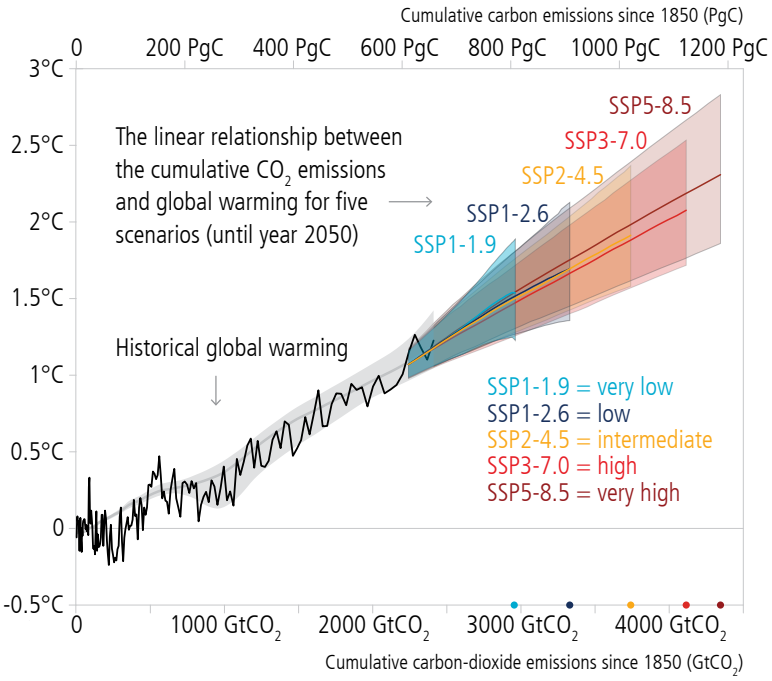
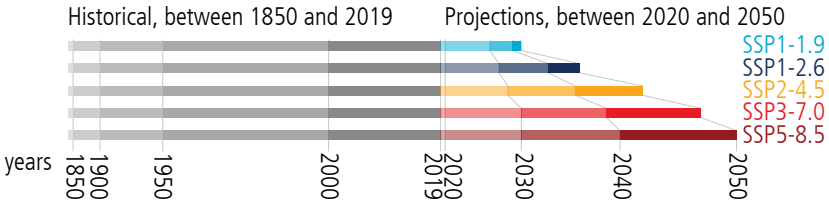
Global temperatures are set to exceed 1.5°C of warming earlier than previously projected - in the early 2030s.[1]

Global mean temperature increase since 1850-1900 (°C)



Progression of cumulative CO_2 emissions



The progression of cumulative CO_2 emissions differs across Shared Socio-economic Pathways (SSP) emission scenarios. Our emission scenario determines how much warming we will experience by 2050. Excerpt from Figure SPM.10 from the IPCC's *AR6 Physical Science Basis* report.

CHANGES SO FAR

The Pacific is continuing to warm along with the rest of the planet. Greenhouse gas emissions from human activity are the primary cause. The global surface temperature was on average 1.09°C warmer in the past decade than in pre-industrial times, with the *likely* range of net human-caused warming between 0.8°C to 1.3°C.[2] It is *very likely* that the tropical Western Pacific has warmed at 0.18°C per decade from 1961 to 2011 (0.9°C total).[3]

FUTURE PROJECTIONS

The temperature increase due to a doubling of CO_2 concentrations (known as the equilibrium climate sensitivity) is now estimated with a higher *likely* baseline than in previous IPCC reports at 2.5°C – 4.0°C, up from 1.5°C – 4.5°C.[4] This means that it is not possible to achieve the low level of warming aimed for in the Paris Agreement under a very high-emission scenario. Improved understanding of climate feedbacks, past climate states and observed energy gain have contributed to these estimates.[5]

If greenhouse gas emissions do not decline significantly before 2050, the world is *extremely likely* to exceed 2°C warming during the 21st century.[6] It is *very likely* that the Pacific will continue to warm in the coming decades at a level slightly lower than the global average. This is because the ocean warms more slowly than the land, as oceans can bury surface warming at depth due to ocean circulation. In the Western Pacific, temperatures are projected to increase by between 2.0°C and 4.5°C by the end of the 21st century relative to 1961–1990.[7]

Content sourced from the IPCC's AR6 Physical Science Basis report:

1 4.3.4 2 A.1.2, A.1.3 3 Atlas.10.2 4 A.4.4 5 A.4 6 B.1.2 7 Atlas.10.4

Both land and marine heatwave events will continue to increase in frequency, duration and intensity with further warming. Over the rest of the 21st century, compared with current rates, the projected rate of ocean warming could double in a low-emission scenario and be up to eight times higher in a very high-emission scenario.[8] Marine heatwaves are projected to be more intense and prolonged, with the Equatorial Pacific seeing an annual mean marine heatwave duration increasing from 30 days now to 100 days with 1.5°C of warming, reaching 200 days in average duration at 2.0°C.[9] Marine heatwaves contribute to coral bleaching events in the Pacific and changes in marine productivity and the location of fish populations that are essential to food security and local economies.

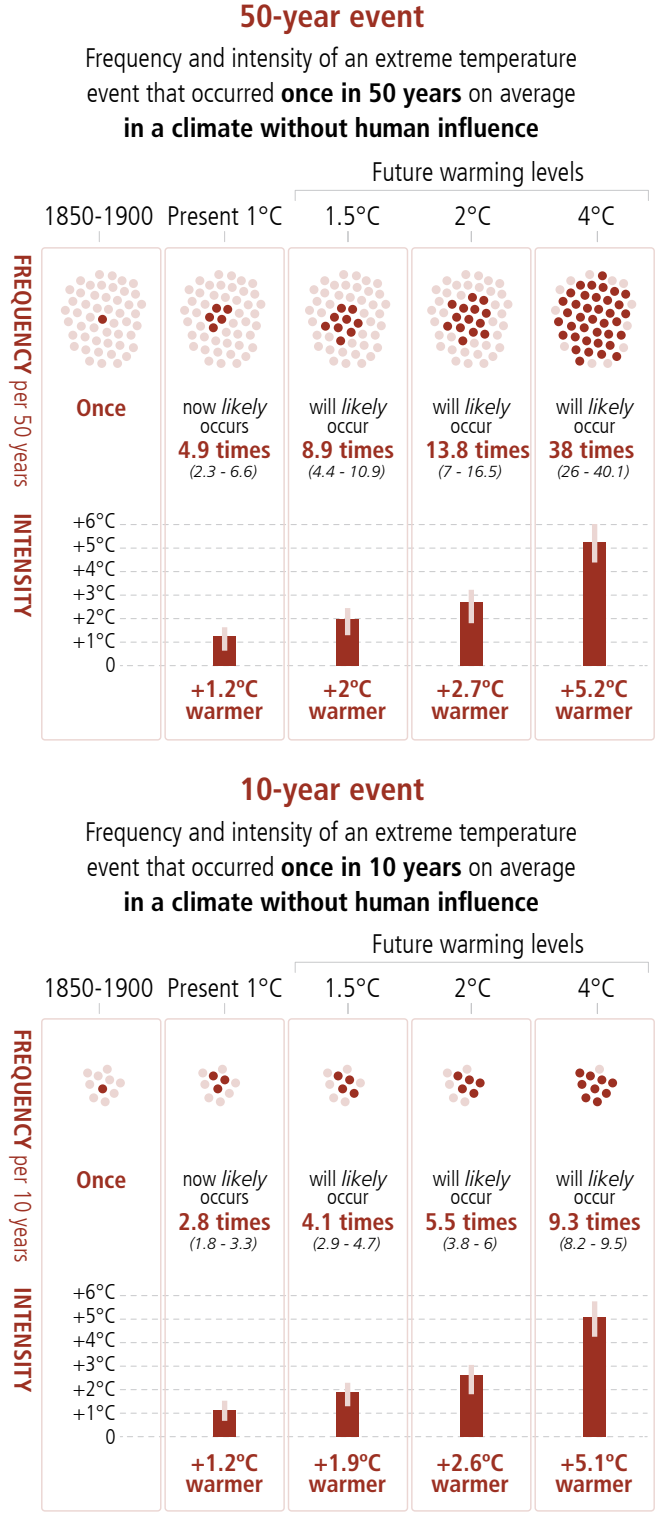
The Pacific will face increased heat stress in the future under further warming. The Pacific can expect an increase in the number of days with an apparent temperature (a temperature index of combined humidity and air temperature) at levels dangerous to human health (>41°C) by the end of the 21st century under a very high-emission scenario.[10]

Because land and ocean CO_2 sinks have removed over half of all human-emitted CO_2 emissions over the past six decades, their capacity to remove further emissions in the future is reduced and a higher proportion of emitted CO_2 will remain in the atmosphere.[11] The IPCC notes that atmospheric CO_2 concentrations reached 410 ppm in 2019 which may be the highest level in 2 million years.[12] In 2021, atmospheric CO_2 concentrations as high as 419 ppm were observed at the NOAA's Mauna Loa observatory in Hawai'i.[13] If global warming is to be limited to 1.5°C or 2°C rapid emissions reduction (mitigation) assisted by carbon dioxide removal (sequestration) is needed.

In the Western Pacific, temperatures are projected to increase by between 2.0°C and 4.5°C by the end of the 21st century relative to 1961–1990.[7]

Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

Extreme temperature over land



Excerpt from Figure SPM.6 from the IPCC's *AR6 Physical Science Basis* report

8 B.5.1
9 12.4.7.4
10 12.4.7.1
11 A.1.1, B.4
12 A.1.1, A.2.1
13 NOAA Research News, (2021), Carbon dioxide peaks near 420 parts per million at Mauna Loa observatory, https://research.noaa.gov/article/ArtMID/587/ArticleID/2764/Coronavirus-response-barely-slows-rising-carbon-dioxide