Climate Change 2022: Where do we stand? What do we do?

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May 22, 2022

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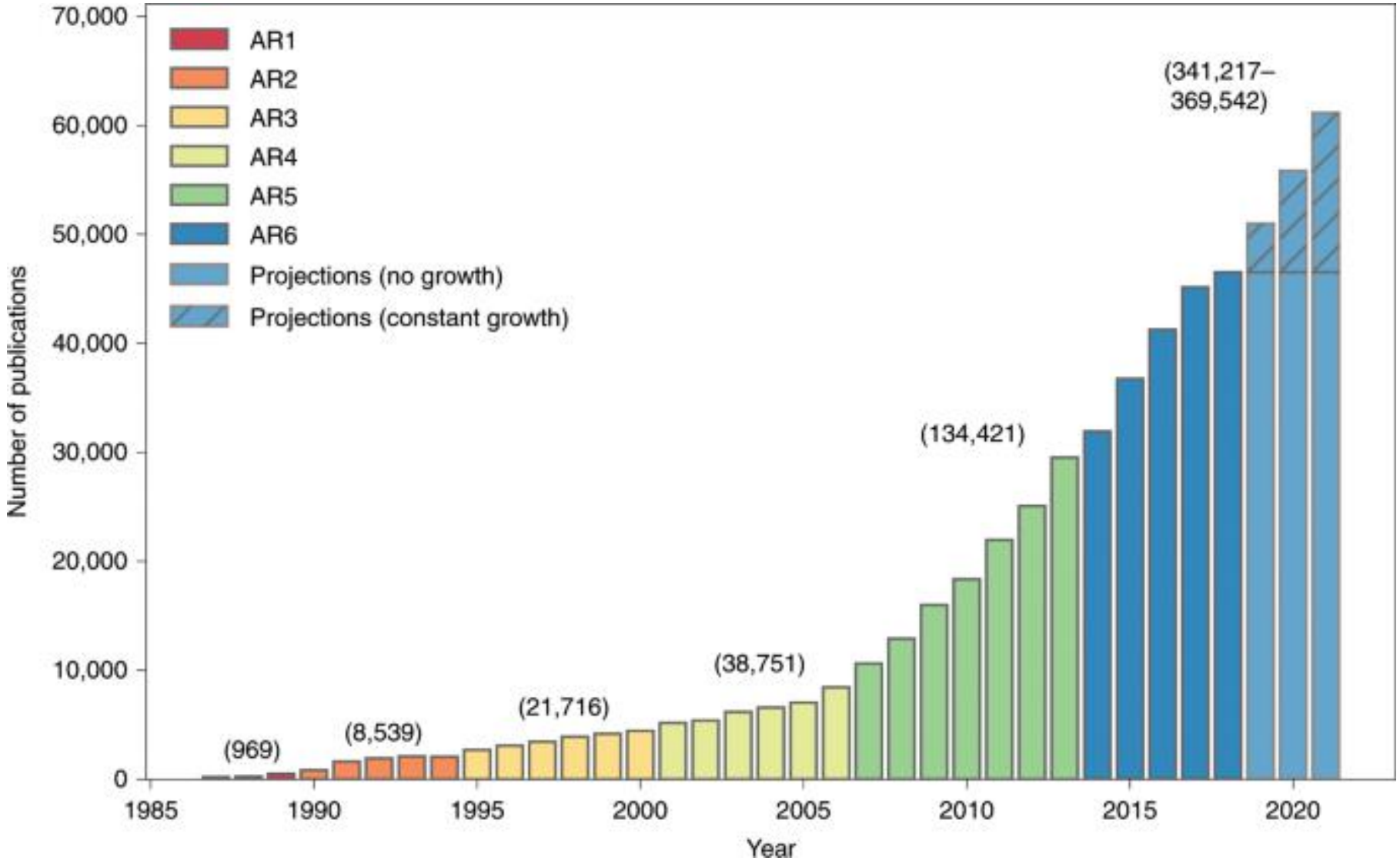
The Intergovernmental Panel on Climate Change (IPCC)

- Founded in 1988 by the UN and the WMO to assess the science related to climate change.
- Small professional staff
  - 13 members
  - 3 interns
- Work is done by volunteers from academia, research organizations, and governmental agencies in 3 working groups.
- Prepares a report every five to seven years.
  - All 195 nations who are a part to UNFCCC must sign off on the Summaries for Policy Makers and the Synthesis Report.
  - Reports are descriptive, not prescriptive or proscriptive.
  - Does not set policy.
- Began releasing the 6th Assessment Report in three parts starting in October 2021 and ending in Sept. 2022.

The IPCC's job gets harder each year.

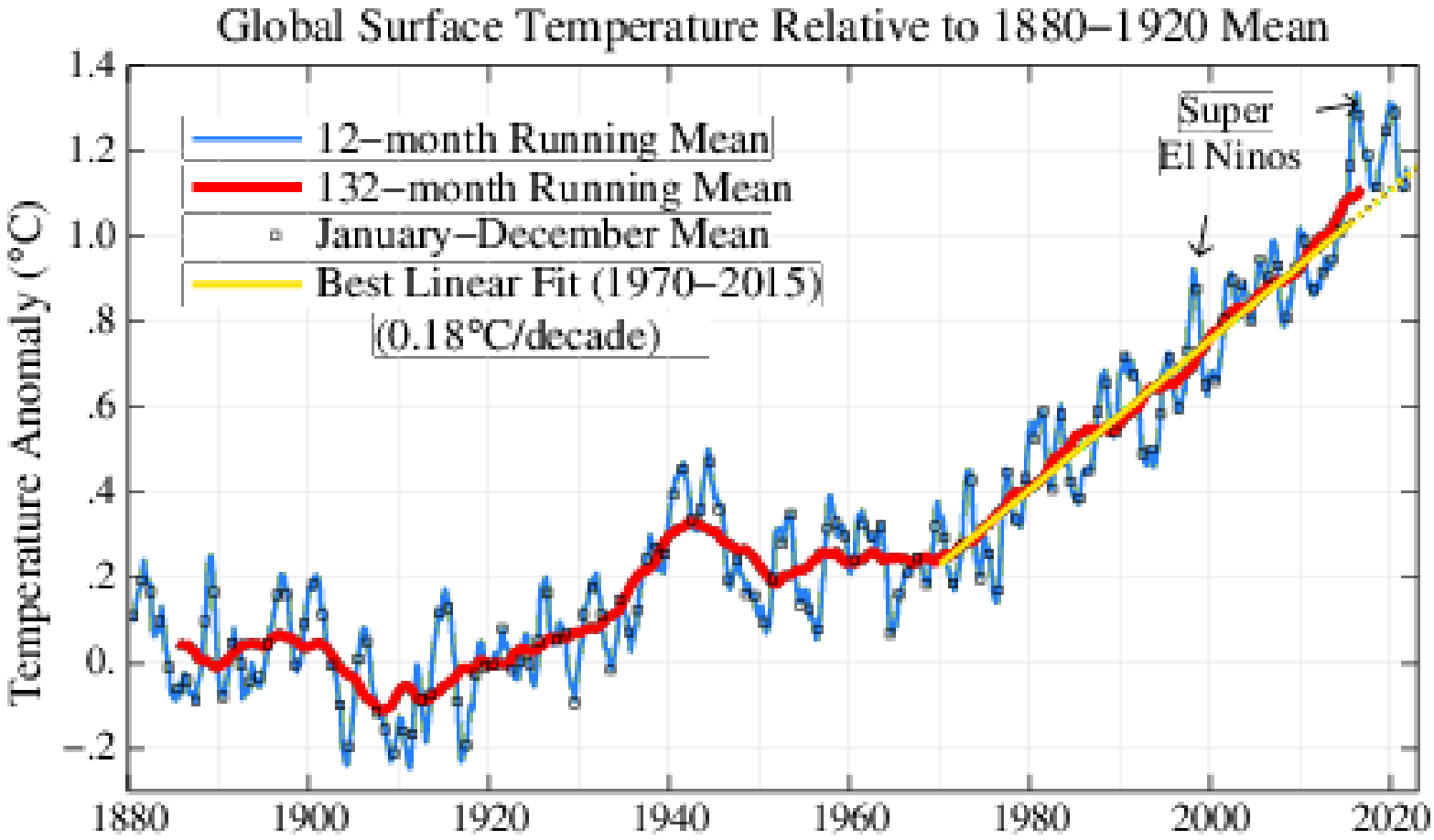


Source: Callaghan, M. W. et al., "A Topography of Climate Change Research", *Nature Climate Change*, **10**, 118, 2020

WG I - Climate and Climate Science

October 2021

Temperatures continue to rise while being influenced by natural variability.

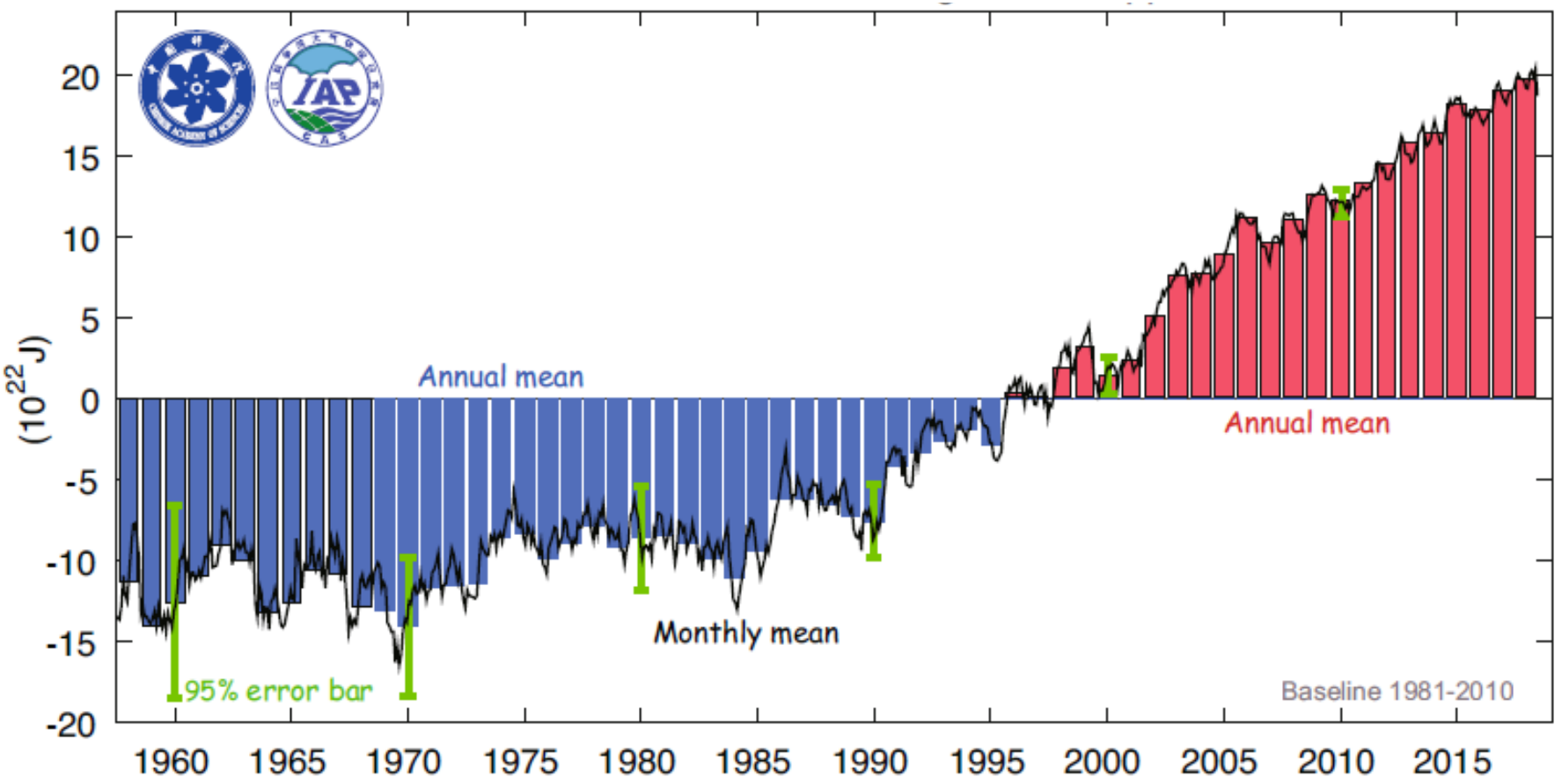


Based on GISTEMP analysis (mostly NOAA data sources, as described by Hansen, J. et al., Global surface temperature change, *Rev. Geophys*., **48**, RG4004, 2010). Last modified 2022/5/13.

Source: Climate Science, Awareness and Solutions, Earth Institute, Columbia University; http://www.columbia.edu/~mhs119/Temperature/

The oceans continue to absorb the bulk of the heat building up on Earth.

Global ocean heat content in the upper 2000 m relative to 1981-2010 mean



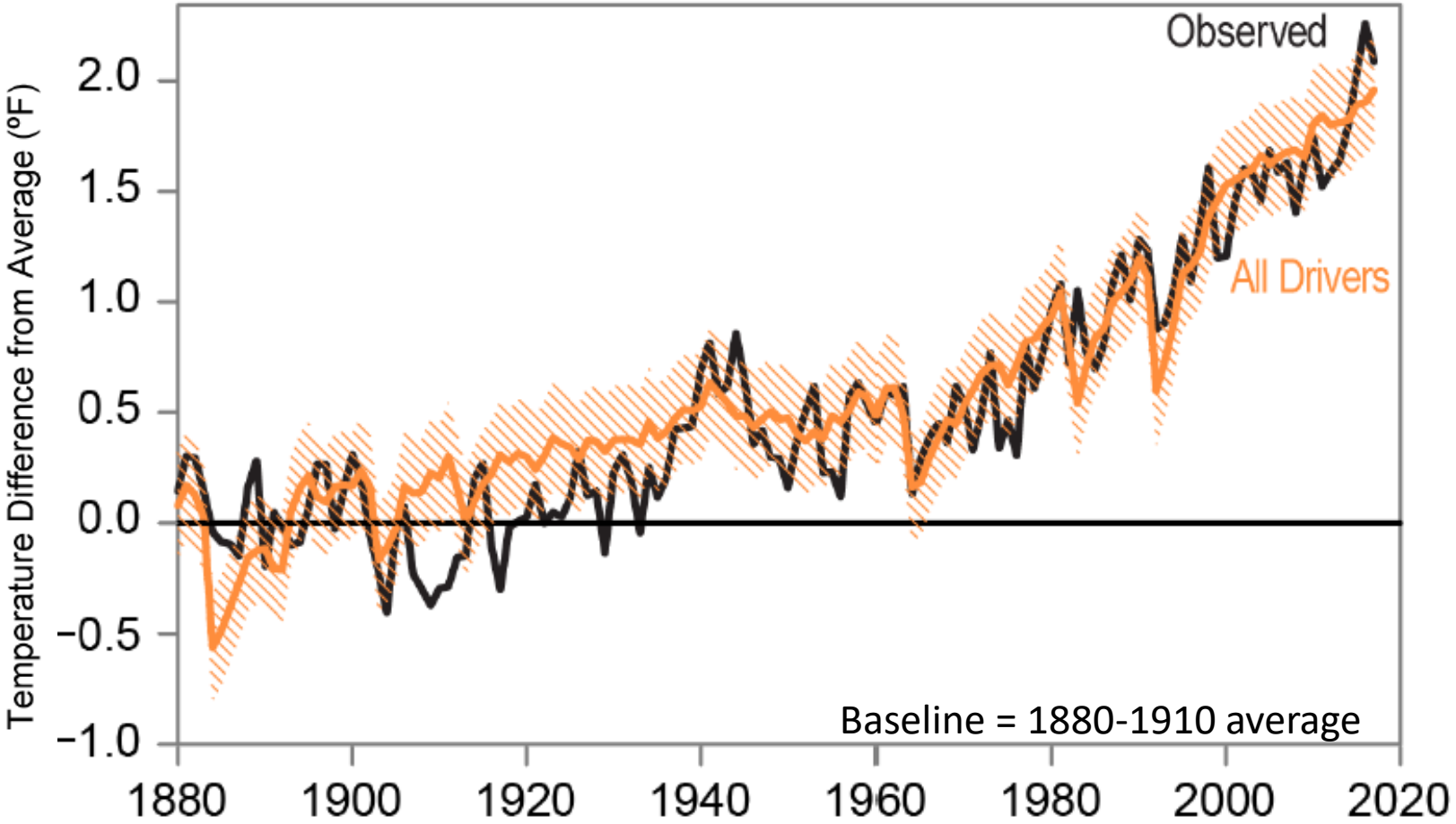
Cheng, L. et al, Continues Record Global Ocean Warming, *Advances in Atmospheric Sciences*, **36**, 249, 2019. https://link.springer.com/article/10.1007%2Fs00376-019-8276-x

Climate Change 2021: The Physical Science Basis

- More of the same, only more certain.
- It is unequivocal that human greenhouse gas [GHG (CO_2, CH_4, N_2O, etc.)] emissions have warmed Earth. The scientific question is settled.
- The scale of recent changes is unprecedented over many thousands of years.
- Since future emissions are unknown, scientists rely on modeling the effects of a range of possible future GHG emission scenarios to make projections about the future.

Reference: IPCC Working Group I, Summary for Policy Makers, October 2021

Climate models do an excellent job of simulating Earth's warming when given atmospheric CO_2 levels.



Source: Figure 2.1c in Hayhoe, K., et al.: Our Changing Climate. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., et al., (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144, 2018. doi: 10.7930/NCA4.2018.CH2

Climate Change 2021: The Physical Science Basis

- Global surface temperature will continue to increase until at least mid-century under all emissions scenarios considered.
- Global warming of 1.5°C and 2°C will be exceeded during this century unless deep reductions in CO_2 and other GHG emissions occur in the coming decades.
- Changes in the oceans, ice sheets, and sea level are irreversible for centuries to millennia.
- Limiting global warming requires limiting cumulative CO_2 emissions and reaching net zero emissions, along with strong reductions in other GHG emissions.

Reference: IPCC Working Group I, Summary for Policy Makers, October 2021

Earth's temperature increase depends on the total amount of CO_2 emitted.

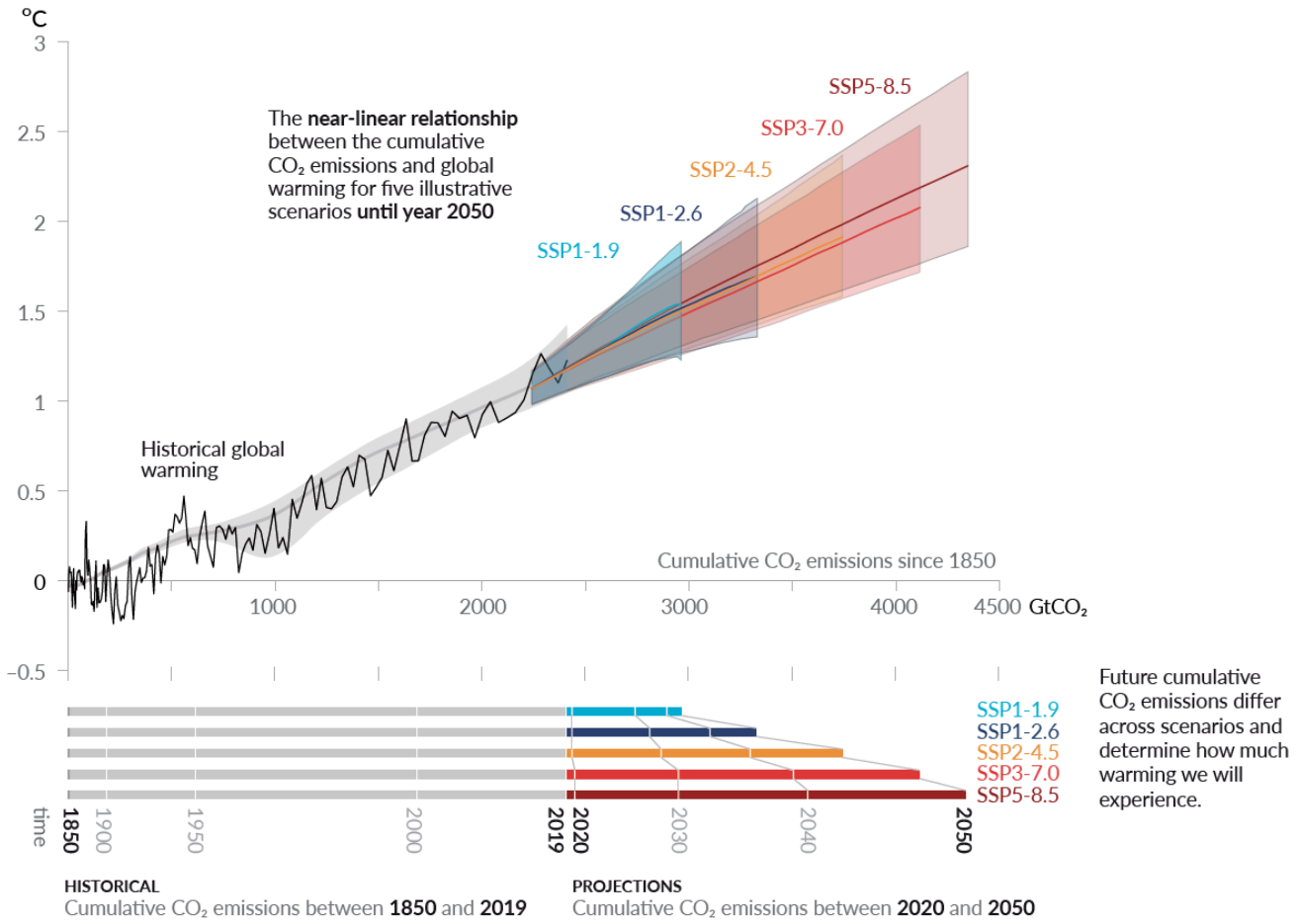
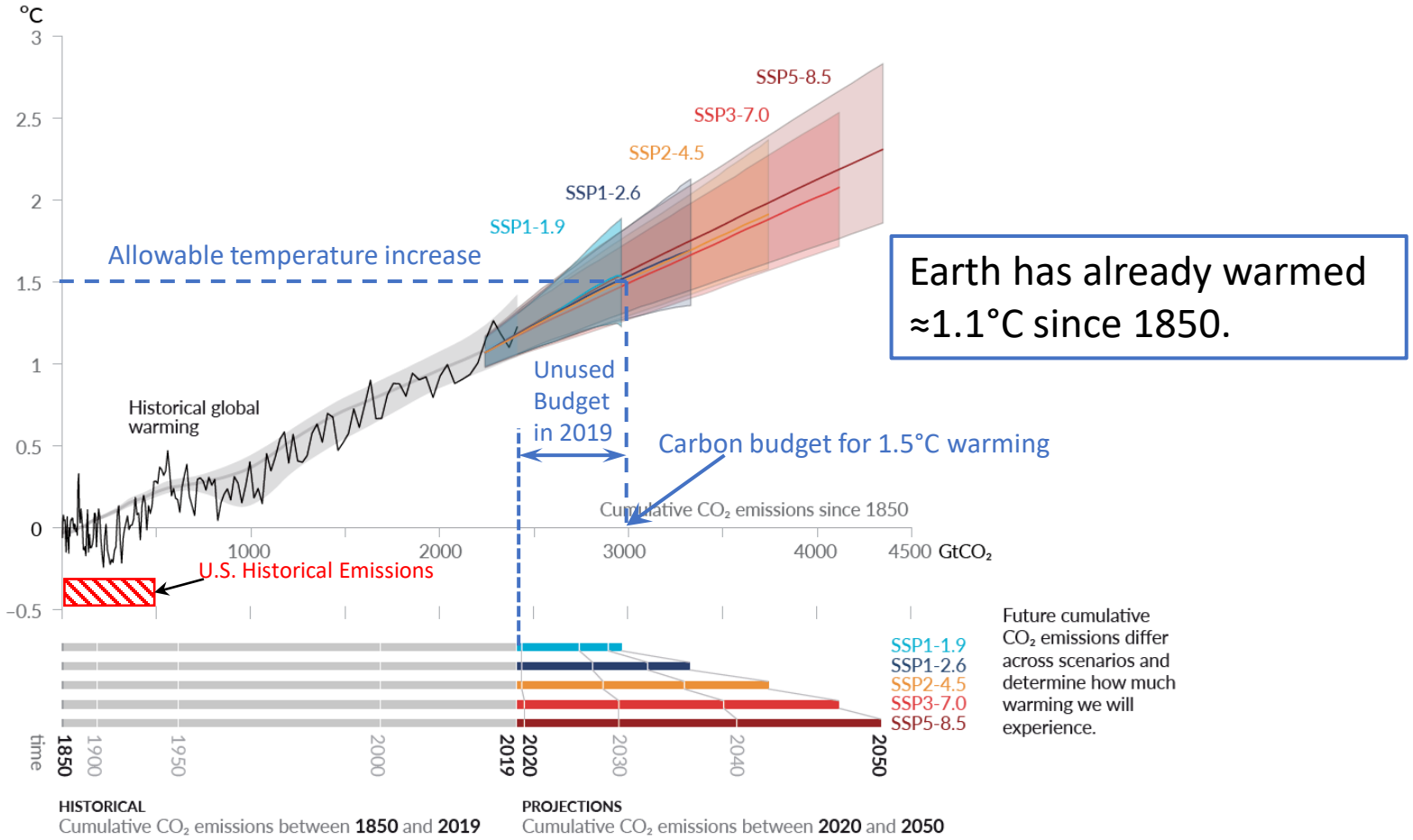


Figure adapted from Figure SPM.10, in Masson-Delmotte, V. et al., "Summary for Policy Makers" in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. In Press, 2021

An allowable temperature increase determines how much CO_2 can be emitted; called the Carbon Budget.



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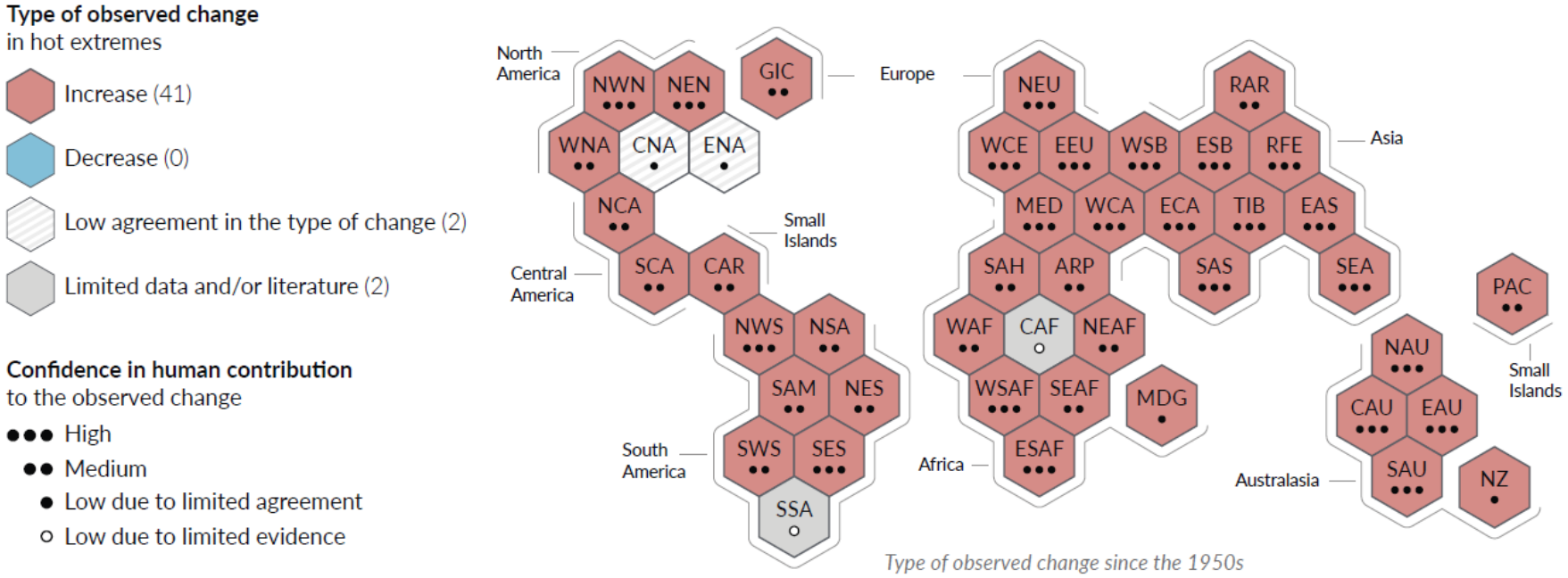
WG II - Impacts, Adaptation, and Vulnerability

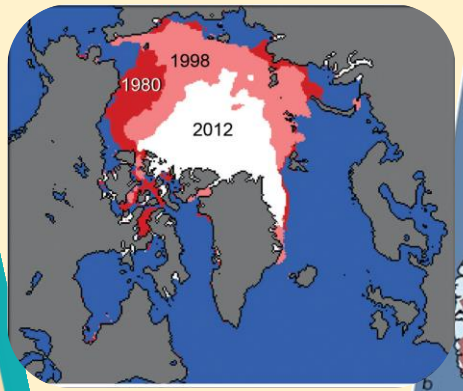
February 2022

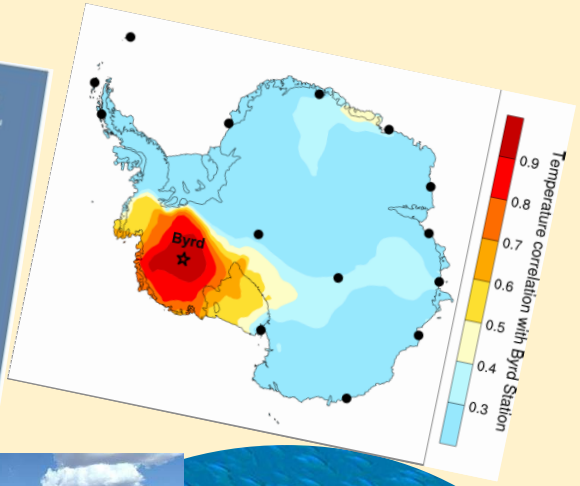
Climate change is already affecting hot extremes in every inhabited region across the globe. Expect more of the same.



North America: NWN (North-Western North America, NEN (North-Eastern North America), WNA (Western North America), CNA (Central North America), ENA (Eastern North America), **Central America**: NCA (Northern Central America), SCA (Southern Central America), CAR (Caribbean), **South America**: NWS (North-Western South America), NSA (Northern South America), NES (North-Eastern South America), SAM (South American Monsoon), SWS (South-Western South America), SES (South-Eastern South America), SSA (Southern South America), **Europe**: GIC (Greenland/Iceland), NEU (Northern Europe), WCE (Western and Central Europe), EEU (Eastern Europe), MED (Mediterranean), **Africa**: MED (Mediterranean), SAH (Sahara), WAF (Western Africa), CAF (Central Africa), NEAF (North Eastern Africa), SEAF (South Eastern Africa), WSAF (West Southern Africa), ESAF (East Southern Africa), MDG (Madagascar), **Asia**: RAR (Russian Arctic), WSB (West Siberia), ESB (East Siberia), RFE (Russian Far East), WCA (West Central Asia), ECA (East Central Asia), TIB (Tibetan Plateau), EAS (East Asia), ARP (Arabian Peninsula), SAS (South Asia), SEA (South East Asia), **Australasia**: NAU (Northern Australia), CAU (Central Australia), EAU (Eastern Australia), SAU (Southern Australia), NZ (New Zealand), **Small Islands**: CAR (Caribbean), PAC (Pacific Small Islands)

Climate change impacts with 1.1°C of warming.





Climate Change 2022 – Impacts, Adaptation, and Vulnerability

- The impacts of climate change are evident in every region of the world, but poor countries face greater challenges.
- Climate change is weakening the structure, functioning, and resilience of ecosystems, decreasing their ability to adapt.
- Climate change impacts will continue to increase in severity without drastic cuts in GHG emissions.
- With immediate action now, extreme impacts can still be prevented.
- Adaptation is essential but its effectiveness will decline with increased warming.

Source: https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_Overaching_OutreachFAQs.pdf

Difference in impacts of 1.5 and 2.0°C of warming - I

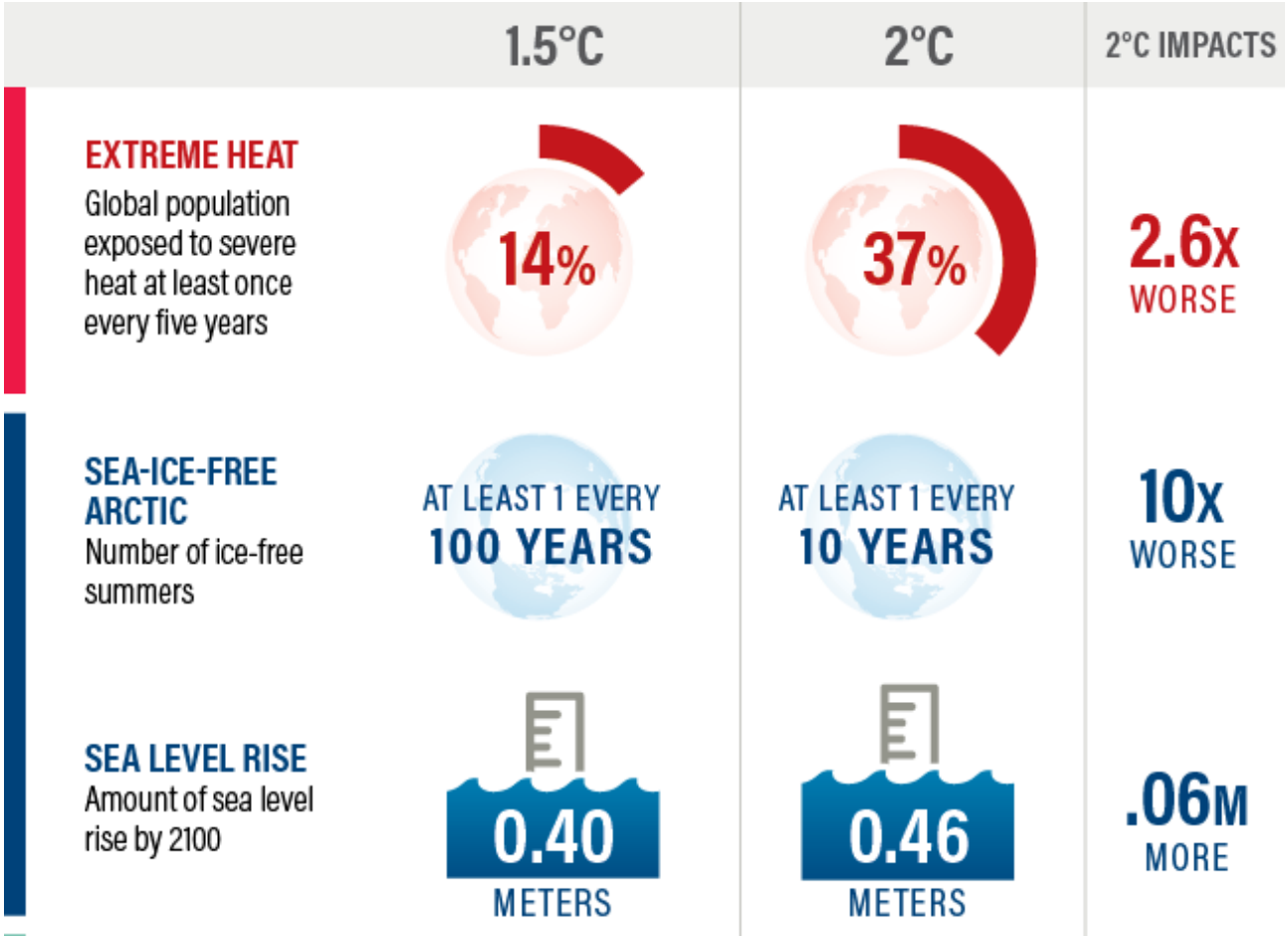
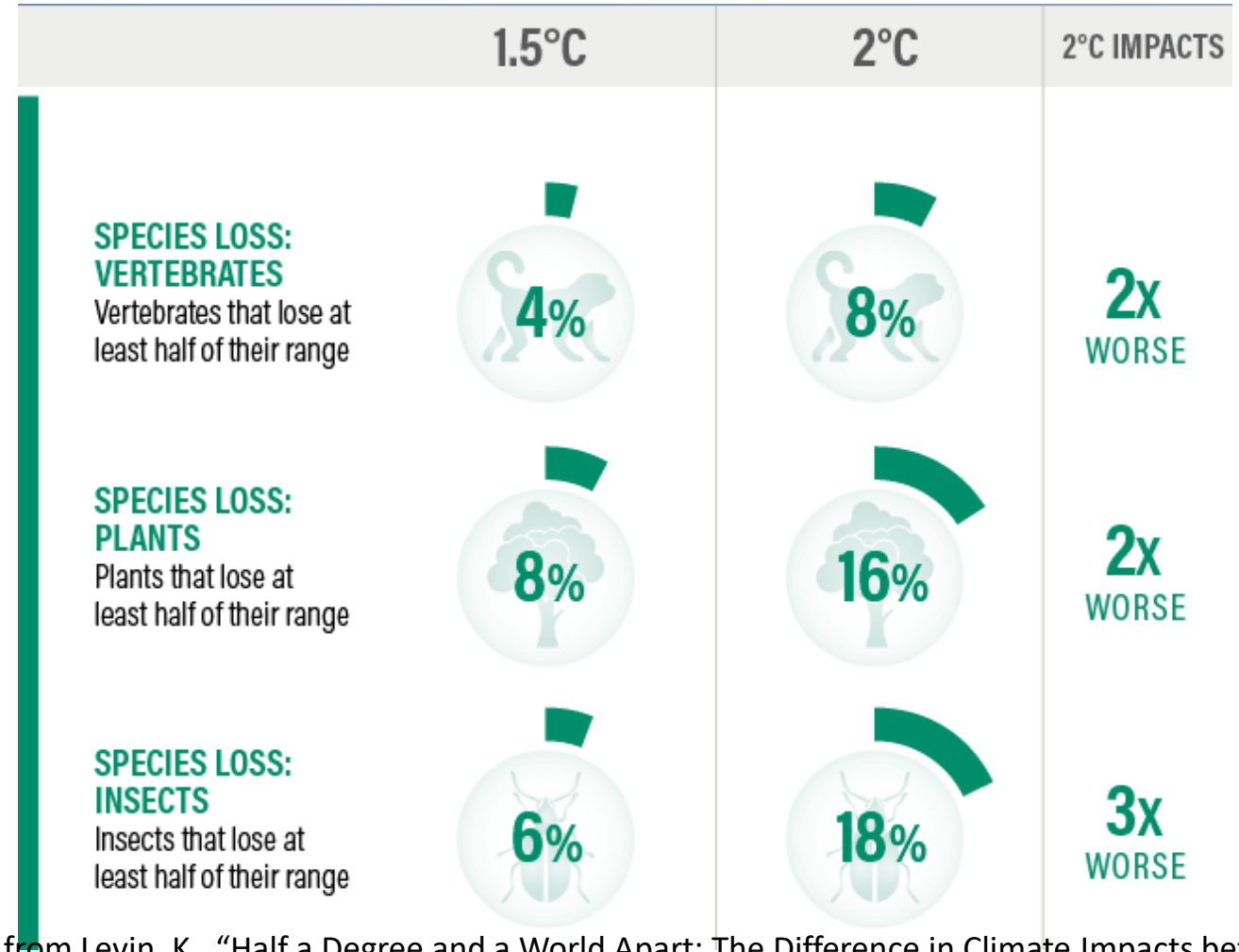


Figure adapted from Levin, K., "Half a Degree and a World Apart: The Difference in Climate Impacts between 1.5°C and 2°C of Warming, World Resources Institute, 2018-10-7 https://www.wri.org/blog/2018/10/half-degree-and-world-apart-difference-climate-impacts-between-15-c-and-2-c-warming

Difference in impacts of 1.5 and 2.0°C of warming - II



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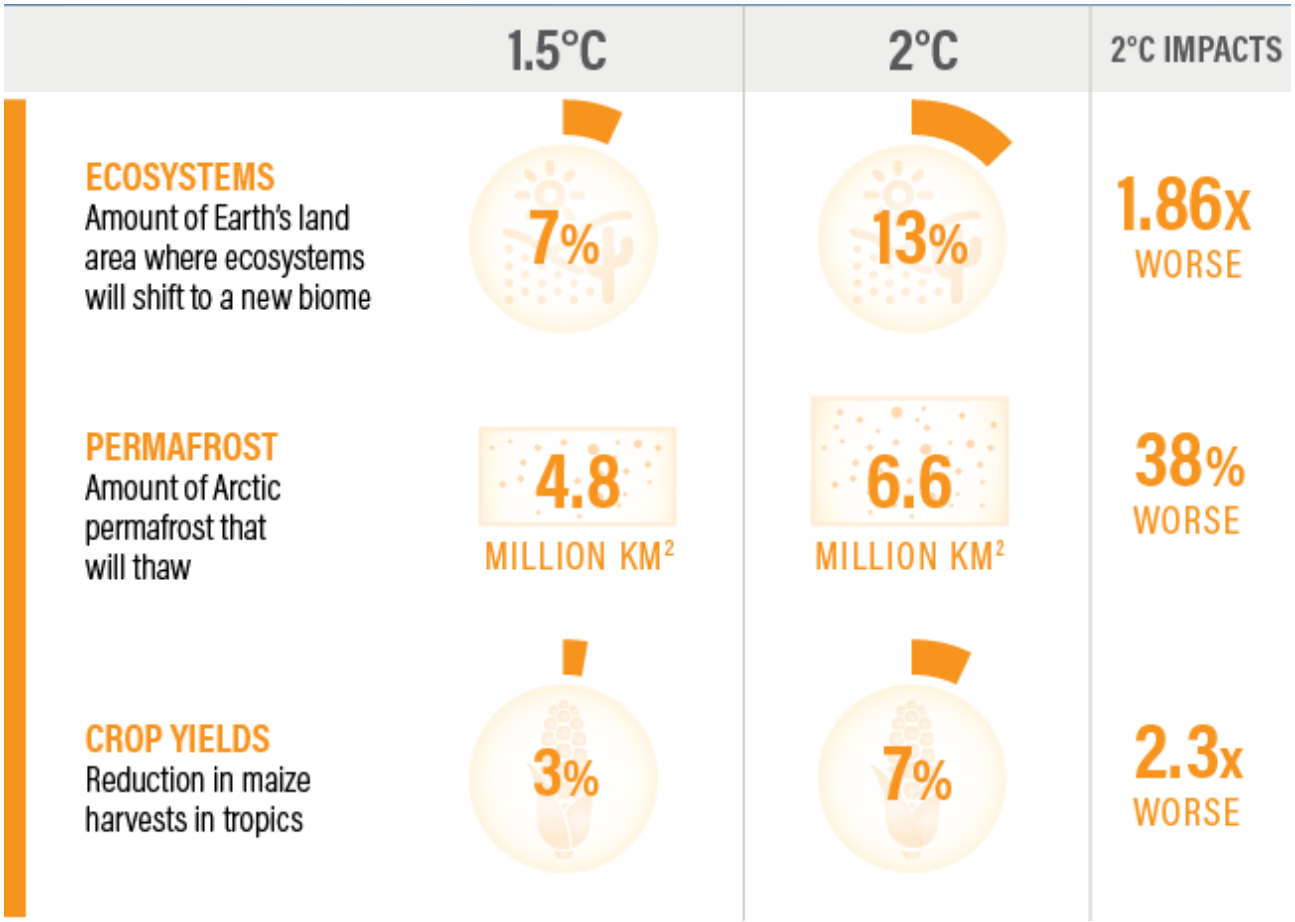
Difference in impacts of 1.5 and 2.0°C of warming - III



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Difference in impacts of 1.5 and 2.0°C of warming - IV

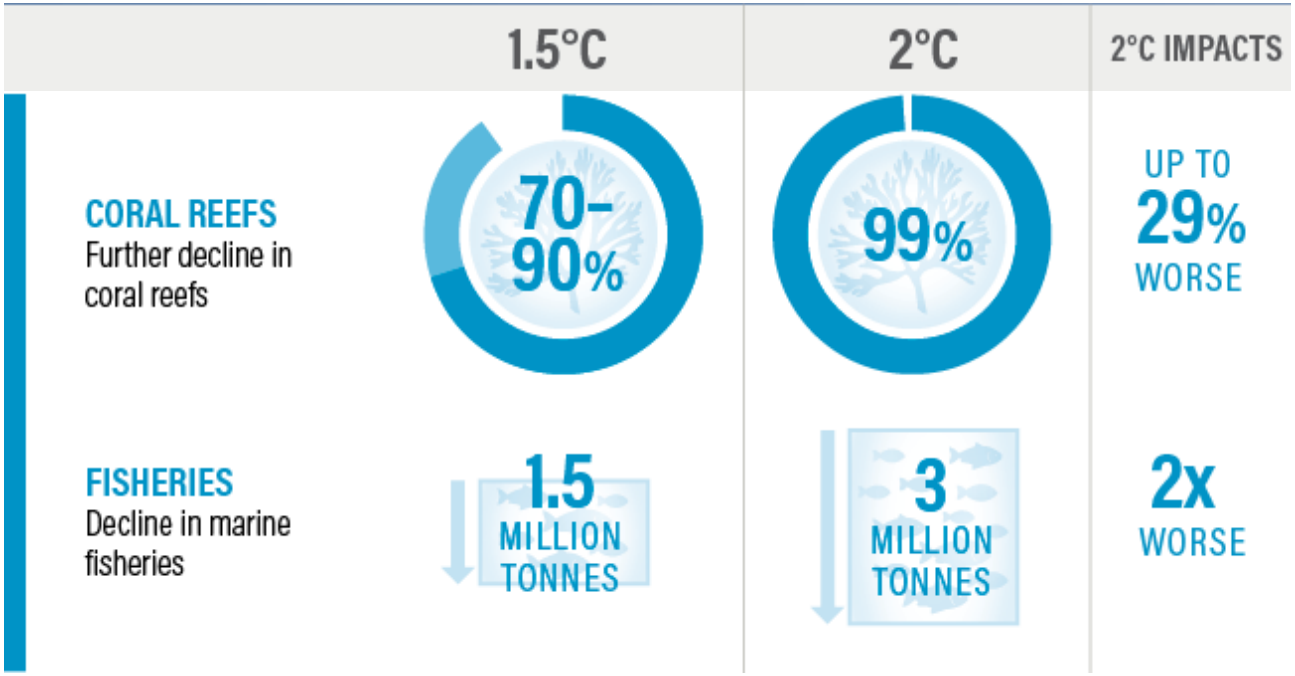
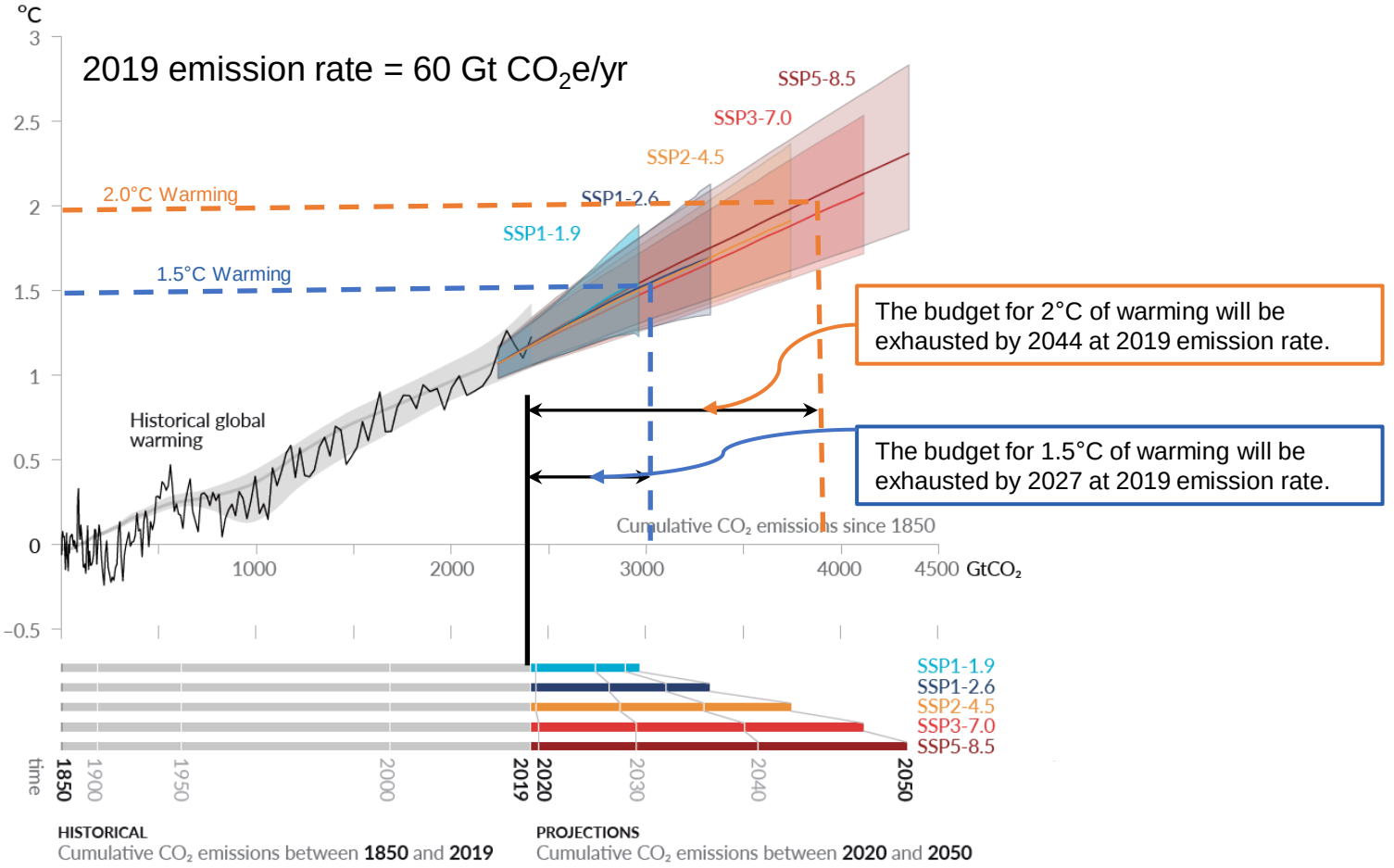


Figure adapted from Levin, K., "Half a Degree and a World Apart: The Difference in Climate Impacts between 1.5°C and 2°C of Warming, World Resources Institute, 2018-10-7 https://www.wri.org/blog/2018/10/half-degree-and-world-apart-difference-climate-impacts-between-15-c-and-2-c-warming

WG III - Mitigation of Climate Change

April 2022

At the current CO_2 emission rate, the budgets for both 1.5°C and 2.0°C of warming will soon be exhausted.



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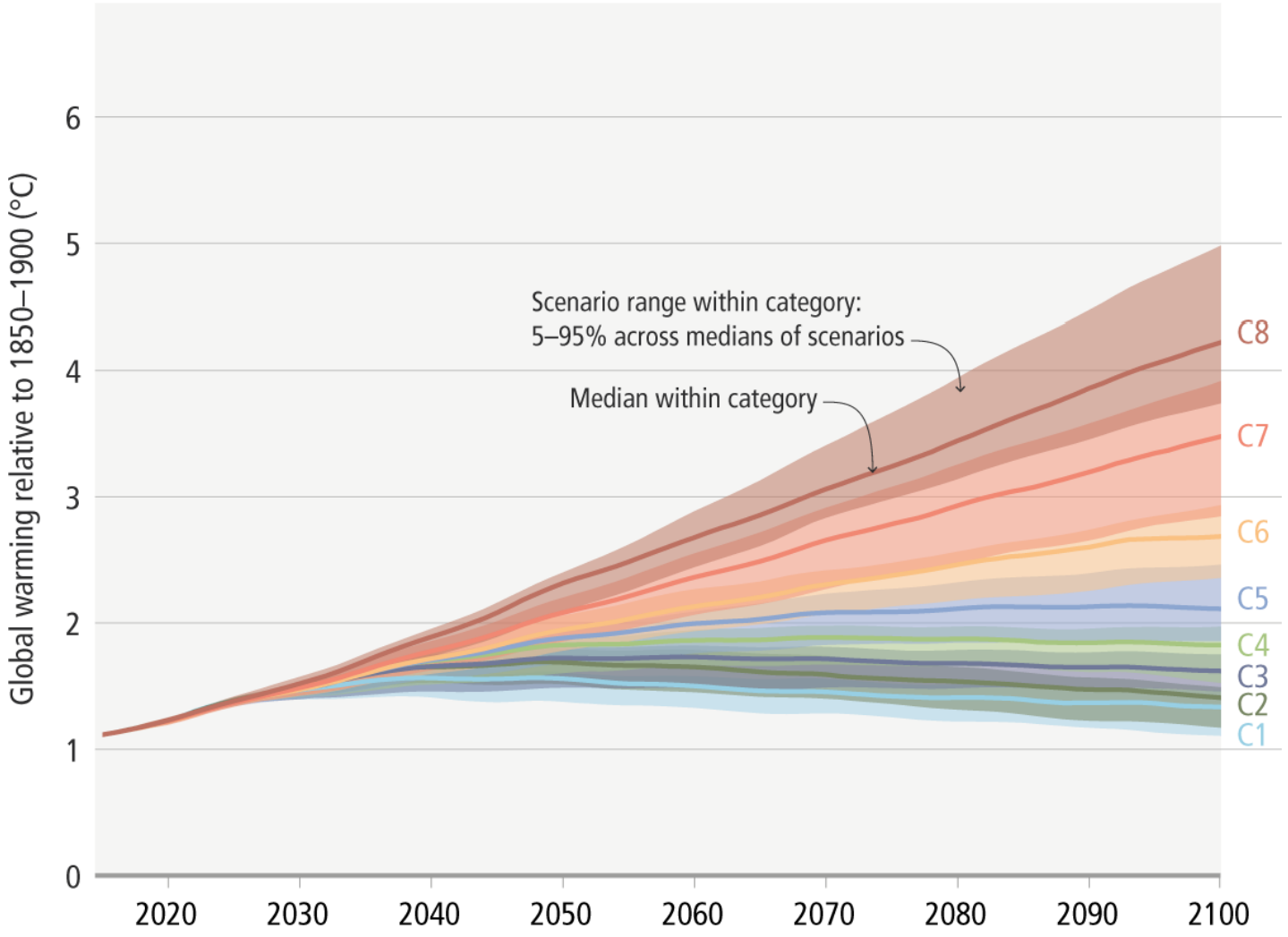
IPCC WG III modeled a large range of possible GHG emissions reduction scenarios.



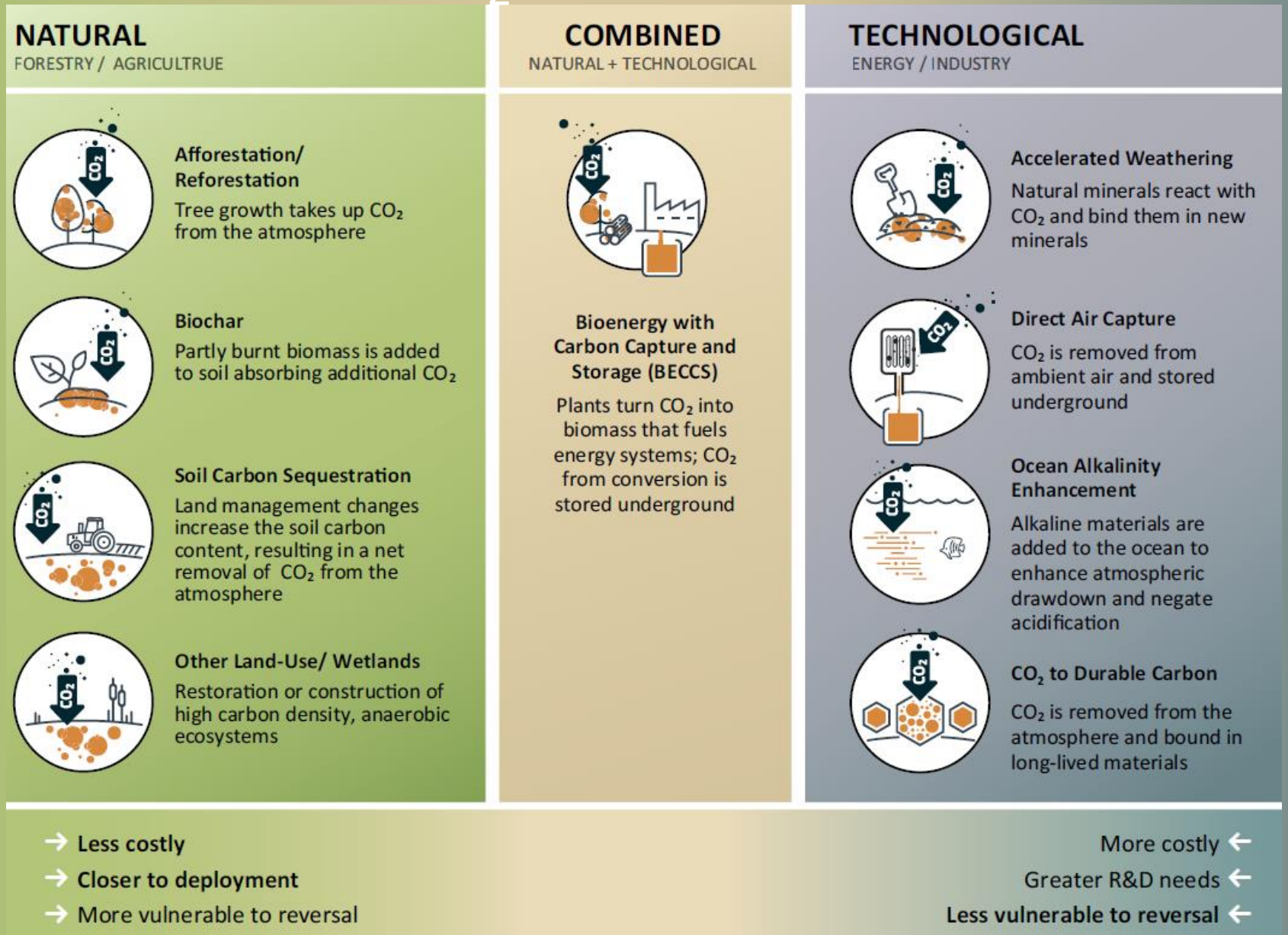
From: Skea, J. et al, *Climate Change 2022: Mitigation of Climate Change; Summary for Policy Makers*, Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, April 2022.

Climate Change 2022 - Mitigation of Climate Change

- Pledges made in Paris and Glasgow are insufficient to hold warming to less than 2°C.
- To limit warming to 1.5°C, global GHG emissions must peak by 2025 and reach net zero by 2050; 2070 for 2°C.
- Atmospheric CO_2 removal may be required after the point of net zero for both cases.
- Atmospheric CO_2 removal must be used to counterbalance hard-to-abate emissions if net zero is to be achieved.
- Most of the literature reported that the global economic benefit of limiting warming to 2°C exceeded the cost of mitigation.

From: Skea, J. et al, *Climate Change 2022: Mitigation of Climate Change; Summary for Policy Makers*, Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, April 2022.

Atmospheric CO_2 removal techniques



Source: Figure ES.3 in U.N. Environment Program, *The Emissions Gap Report 2017*
http://www.unenvironment.org/resources/emissions-gap-report

What to do?

Stop emitting CO_2 as soon as possible!

- Requires transformation of our energy system now.
- The U.S. pledge under the Paris Climate Agreement:
  - Reduce GHG emissions to 26% - 28% below 2005 level in 2025.
  - Reduce GHG emissions to 50% - 52% below 2005 level in 2030.
- A BIG job, but disaster is not inevitable!
- Climate change impacts will become increasingly severe the longer we wait to act.
- We must act now!
- Temperatures will stabilize within 3 to 5 years after greenhouse gas emissions are stopped.
- Some impacts are essentially irreversible.
- Adaptation is essential, but is more difficult for the poor.

CO_2-free electricity is possible.

Solar

Wind

Nuclear

Hydroelectric

Geothermal

Fossil fuel with carbon capture and storage

Things you can do!

Source: https://www.count-us-in.org/en-gb/