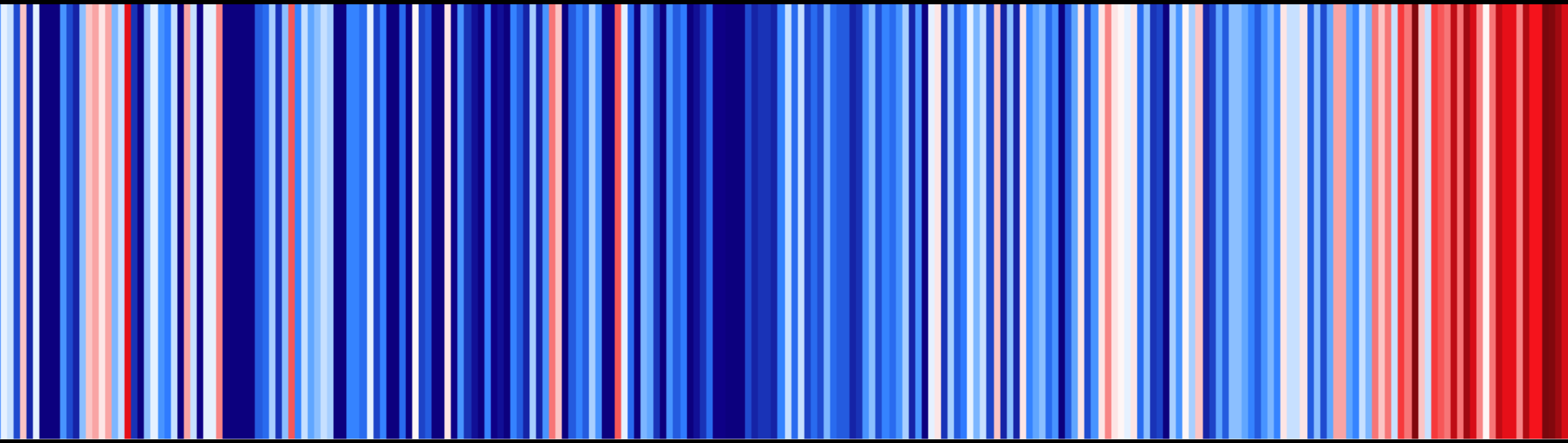
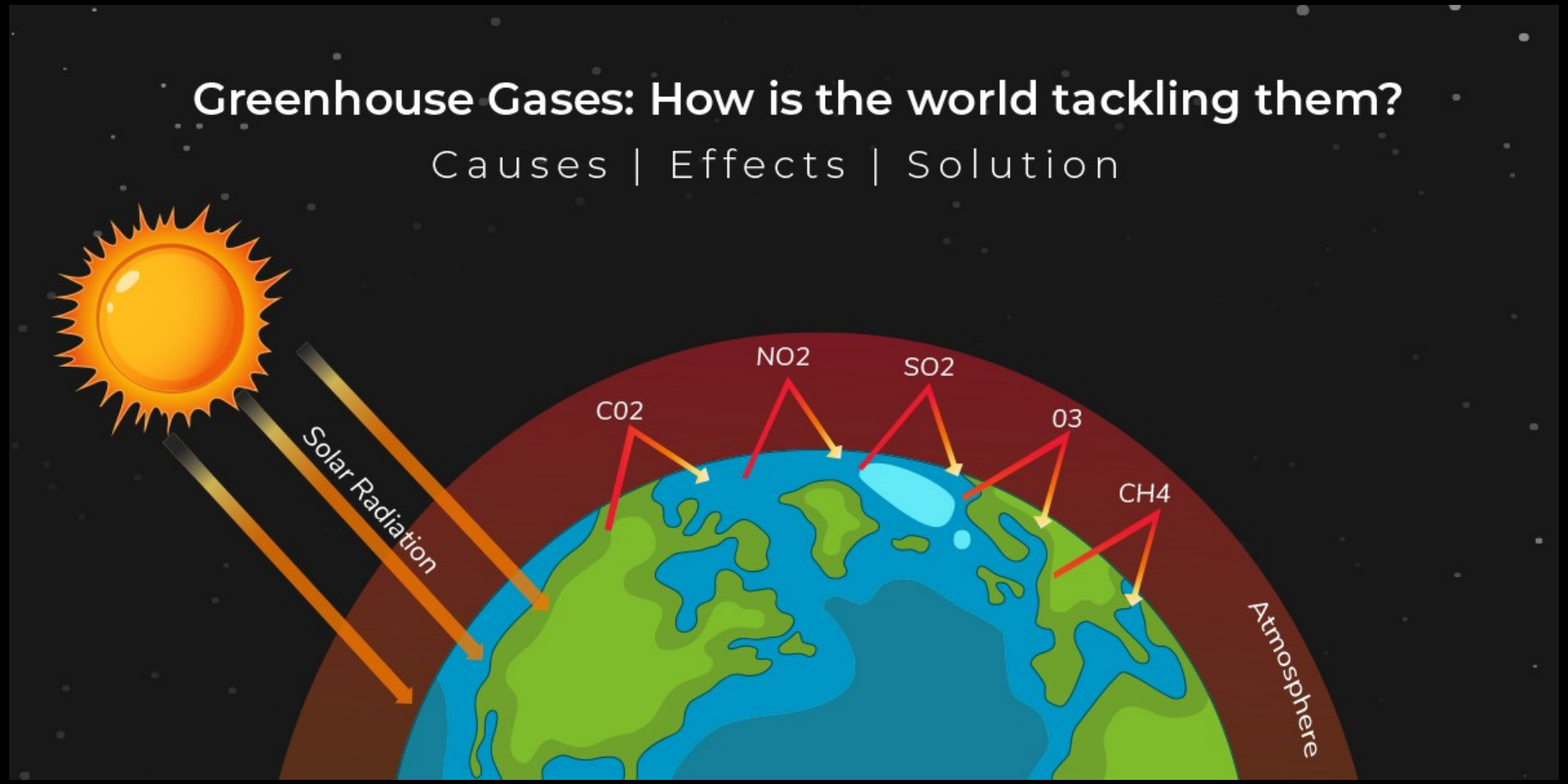
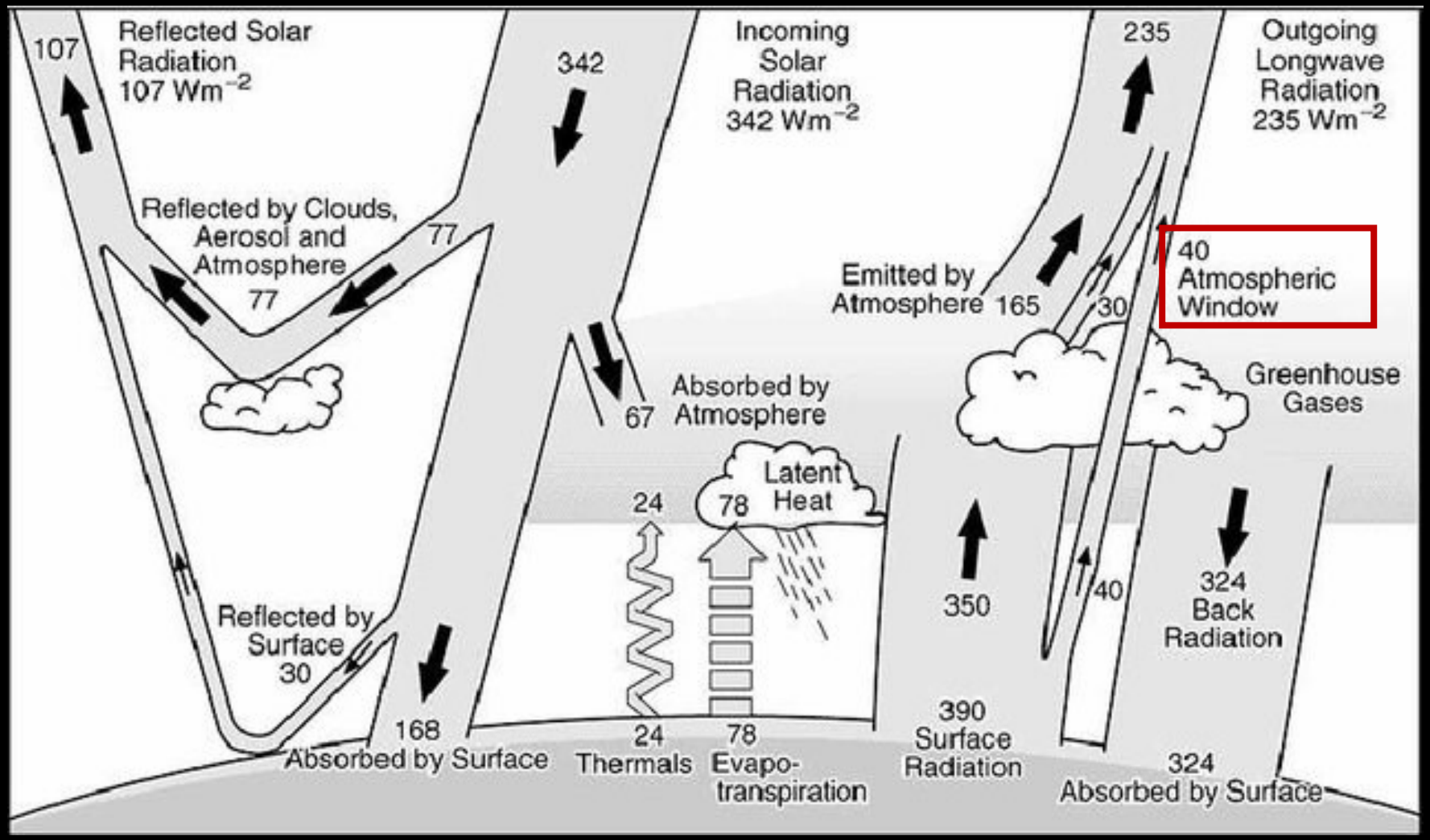


Present day and near future climate (change)

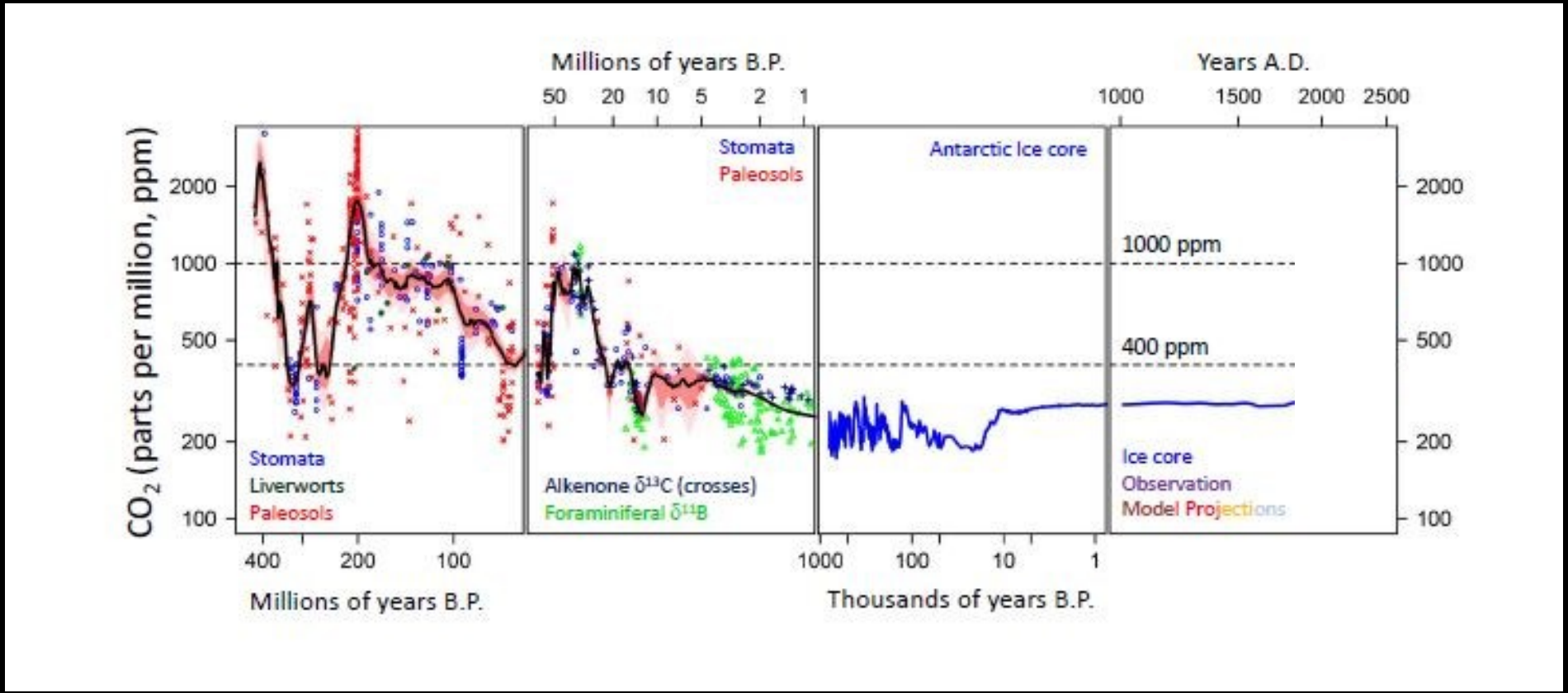
Wolfgang Gurgiser, University of Innsbruck



https://www.pranaair.com/blog/what-is-greenhouse-effect-its-gases-causes-solution/



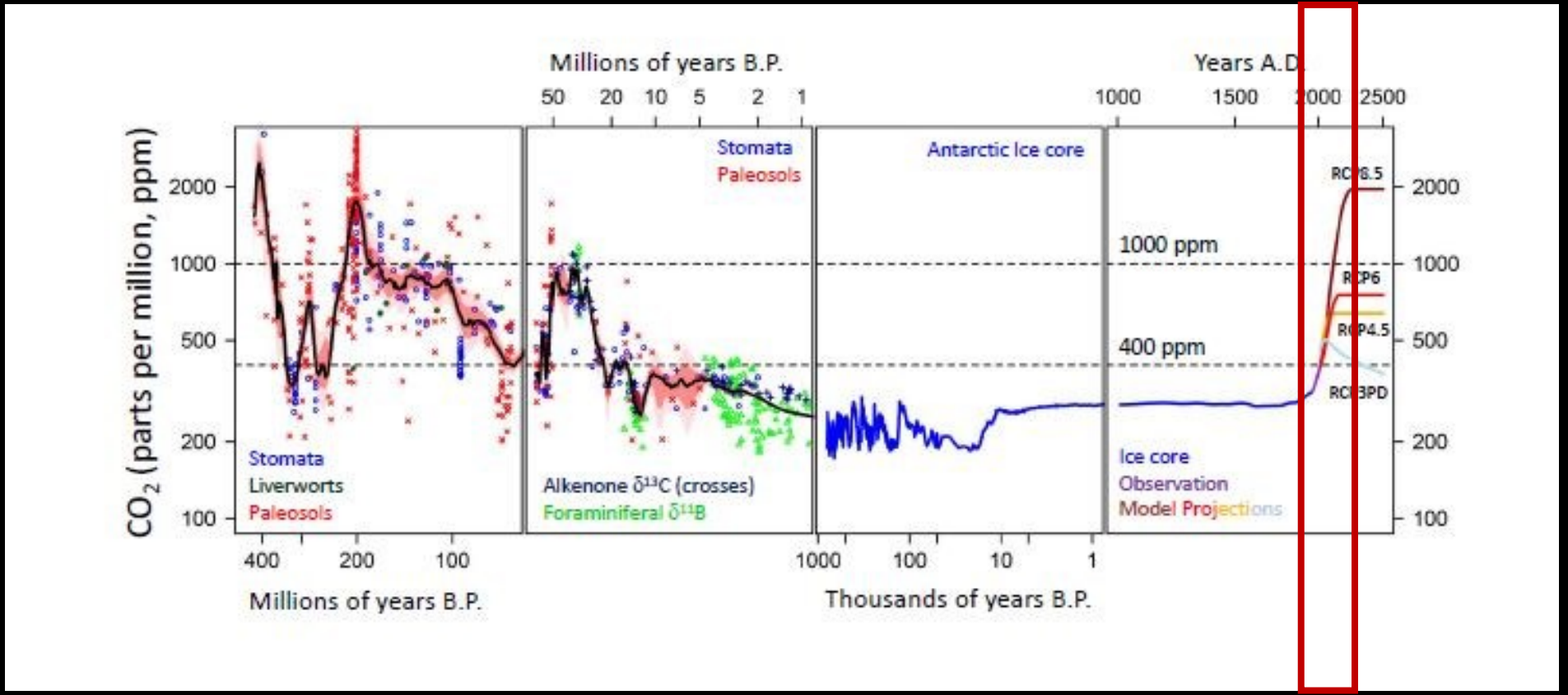
https://www.researchgate.net/publication/2172122_Environmental_Physics_Physical_Principles_and_Applications/figures?lo=1



https://skepticalscience.com/Past-and-Future-CO2.html

https://climatescience.org/advanced-climate-future-temperatures

Today's focus



https://skepticalscience.com/Past-and-Future-CO2.html

Todays topis

- Near past and current climatic changes
- Attribution of the changes
- Future perspectives

Near past and current climatic changes

On what variables do we focus?

- Essential climate variables

https://gcos.wmo.int/en/essential-climate-variables

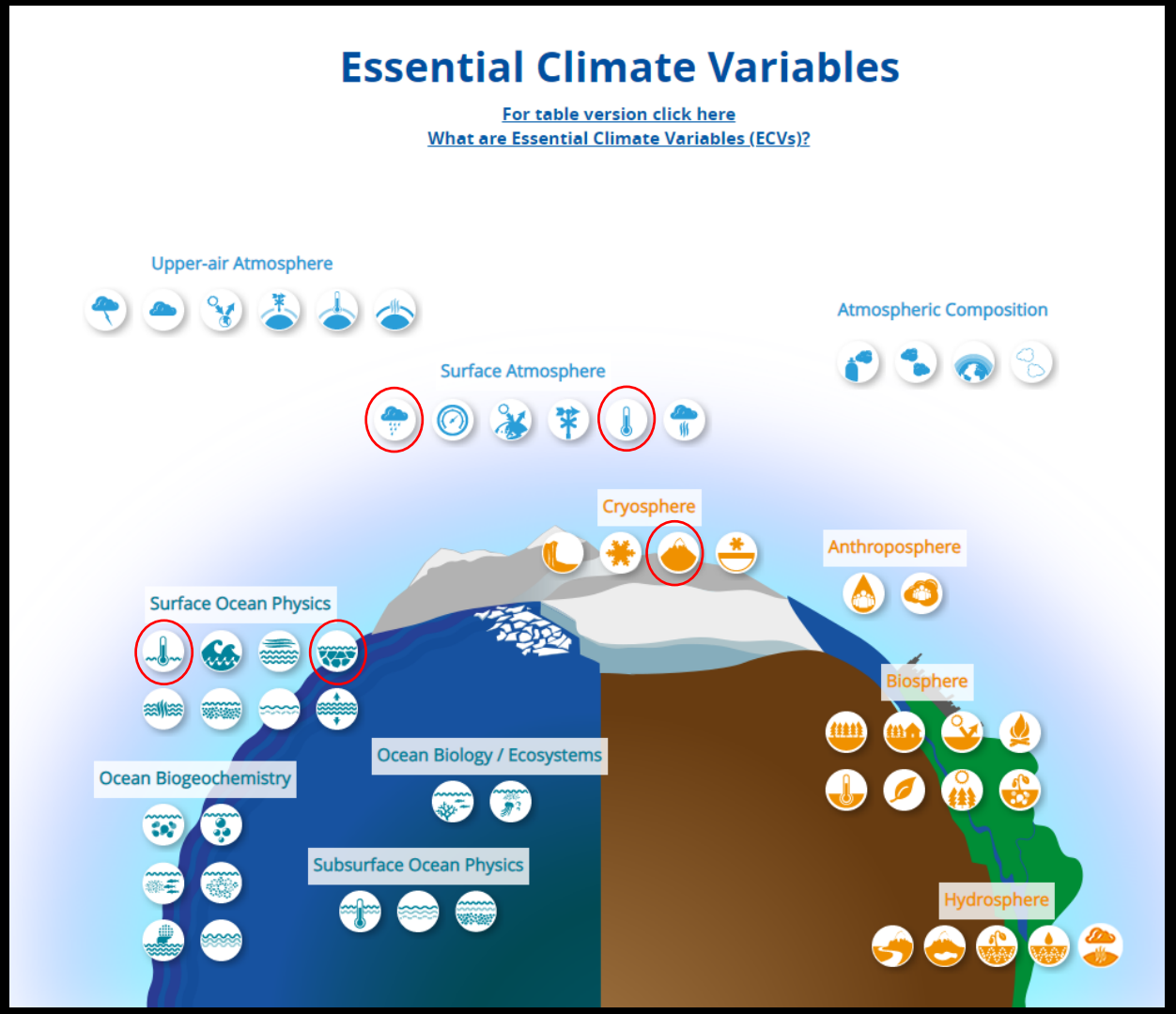
Definition:

An Essential Climate Variable (ECV) is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth' s climate.

Identification:

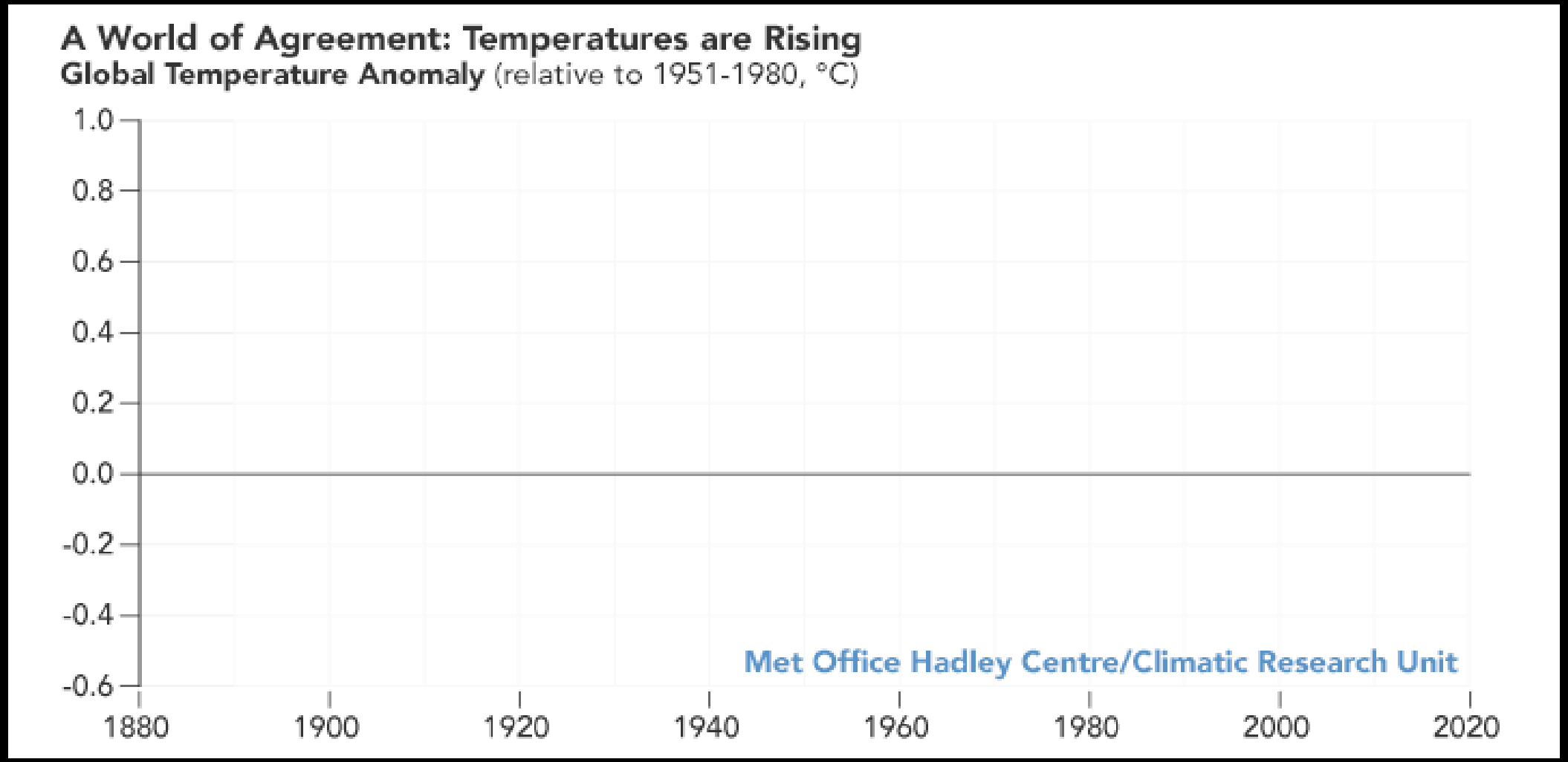
- Relevance: The variable is critical for characterizing the climate system and its changes.
- Feasibility: Observing or deriving the variable on a global scale is technically feasible using proven, scientifically understood methods.
- Cost effectiveness: Generating and archiving data on the variable is affordable, mainly relying on coordinated observing systems using proven technology, taking advantage where possible of historical datasets.

On what variables do we focus?



https://gcos.wmo.int/en/essential-climate-variables

Global temperature change



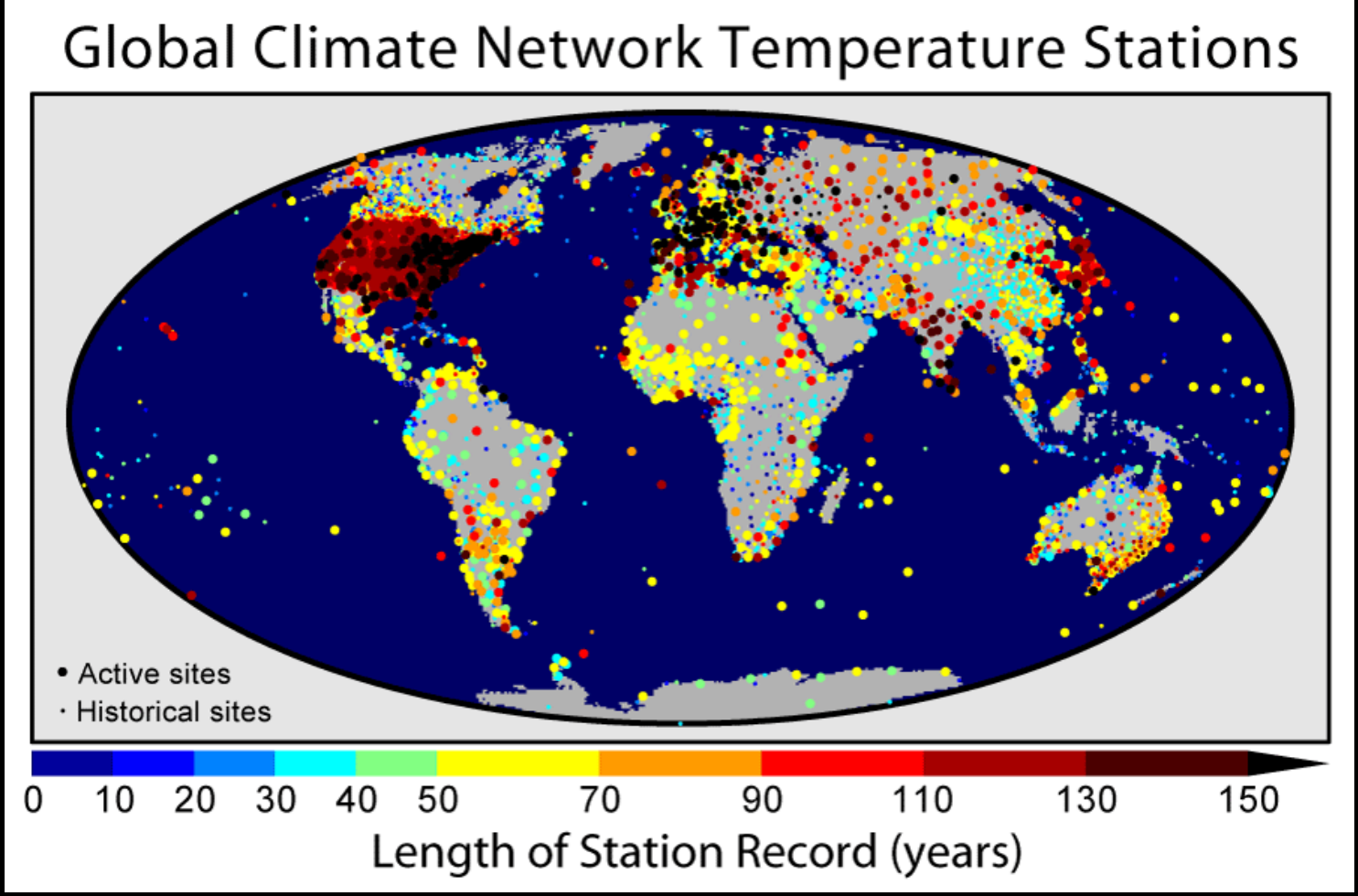
https://earthobservatory.nasa.gov/world-of-change/global-temperatures

Why 5 different curves?

- Reconstruction based on instrumental data
- Uncertainties due to
  - Measurement quality
  - Spatial coverage
  - Moving stations
  - Changes in the surrounding of stations (e.g. urban heat effect)

https://earthobservatory.nasa.gov/world-of-change/global-temperatures

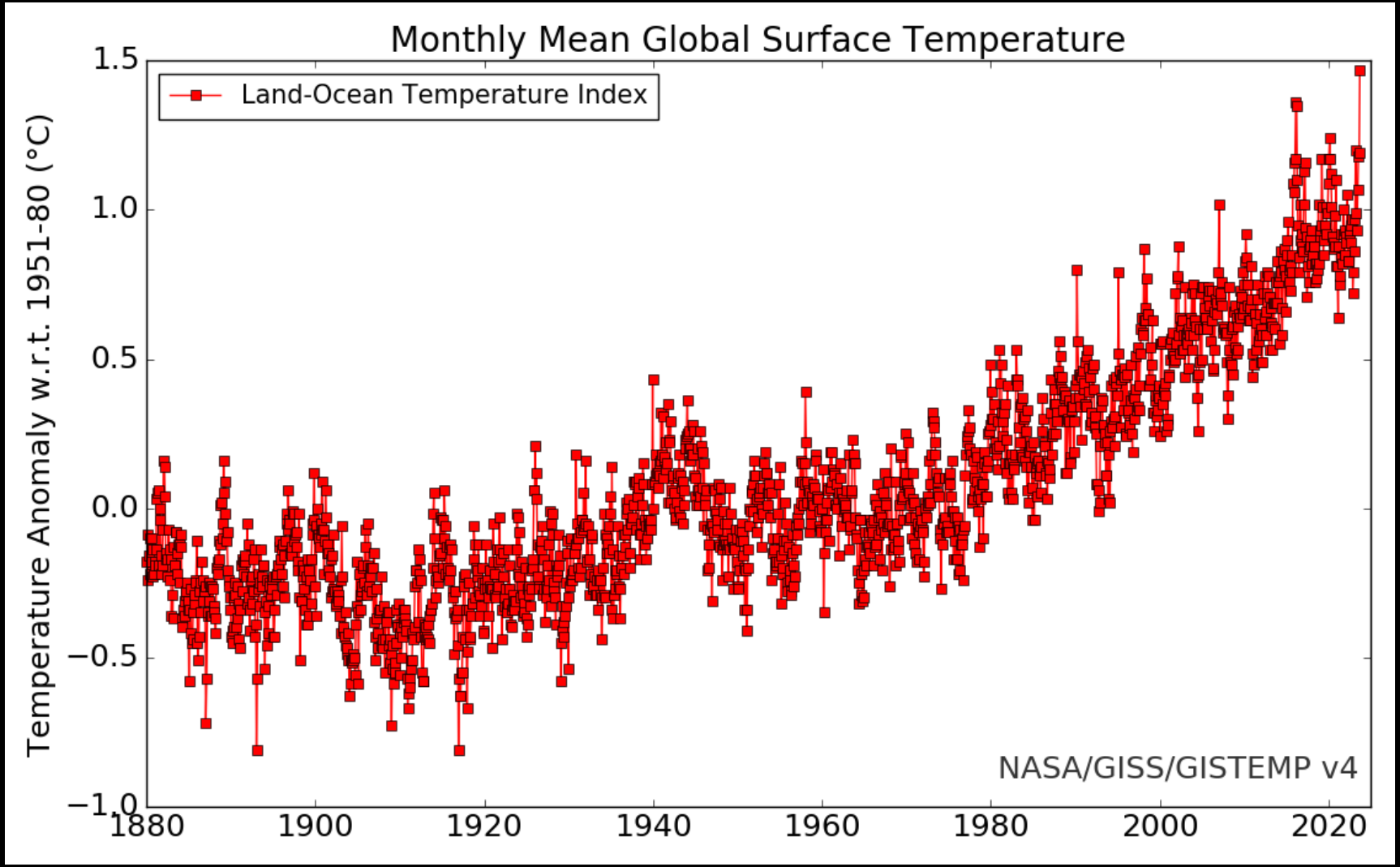
Spatial coverage of T measurements



https://en.wikipedia.org/wiki/Global_Historical_Climatology_Network#/media/File:GHCN_Temperature_Stations.png

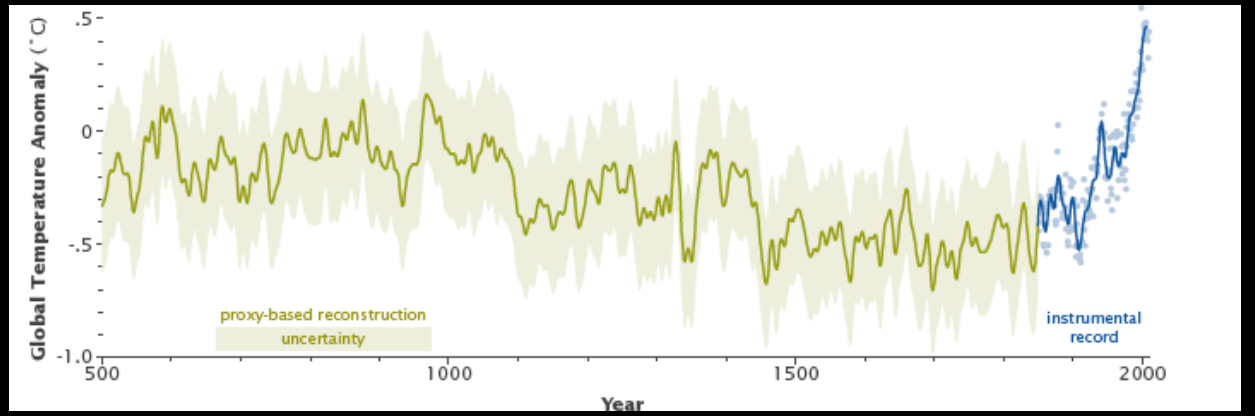
Global temperature change recent values

https://data.giss.nasa.gov/gistemp/graphs_v4/



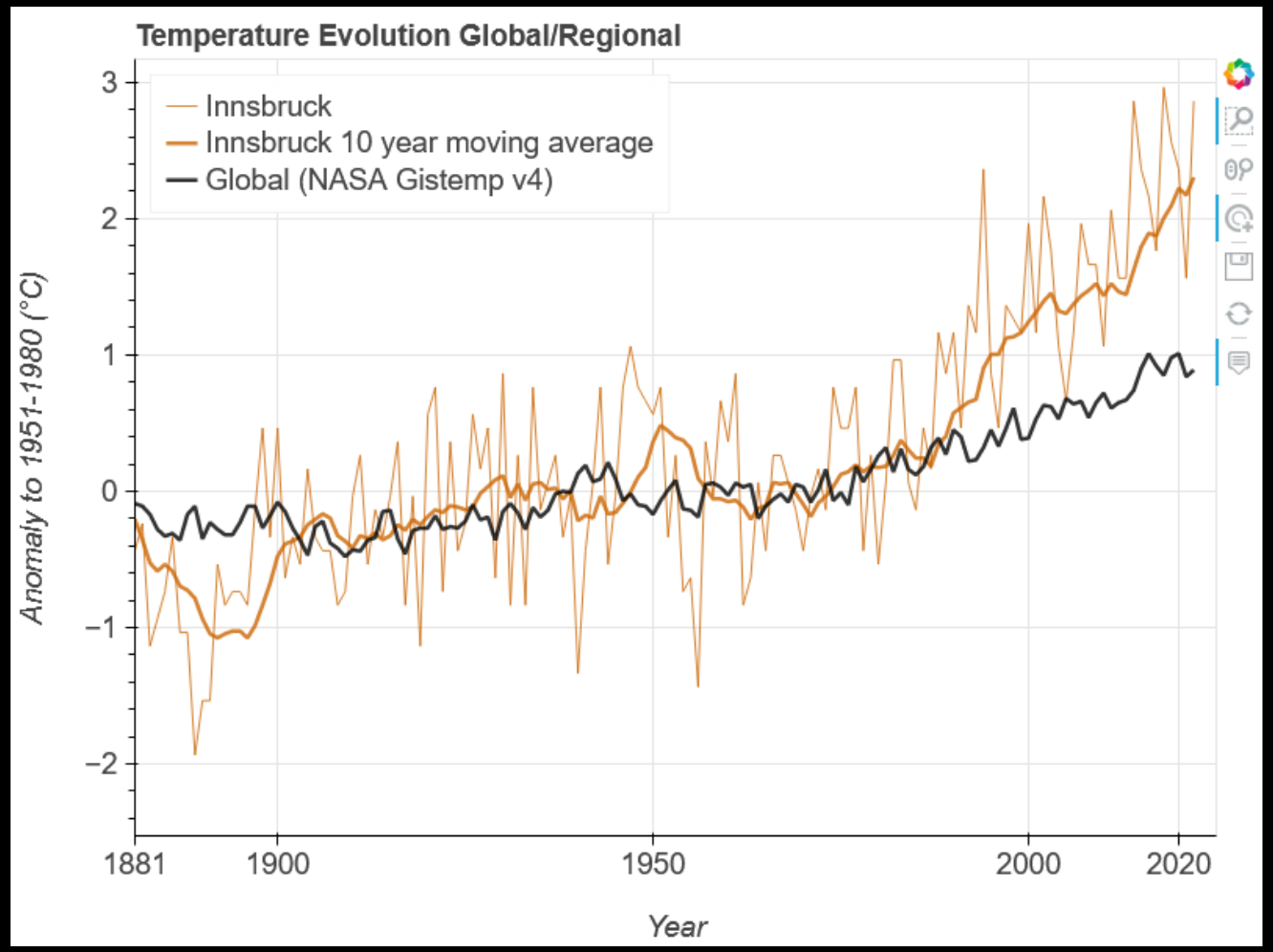
Rate of temperature change

"As the Earth moved out of ice ages over the past million years, the global temperature rose a total of 4 to 7 degrees Celsius over about 5,000 years. In the past century alone, the temperature has climbed 0.7 degrees Celsius, roughly ten times faster than the average rate of ice-age-recovery warming."



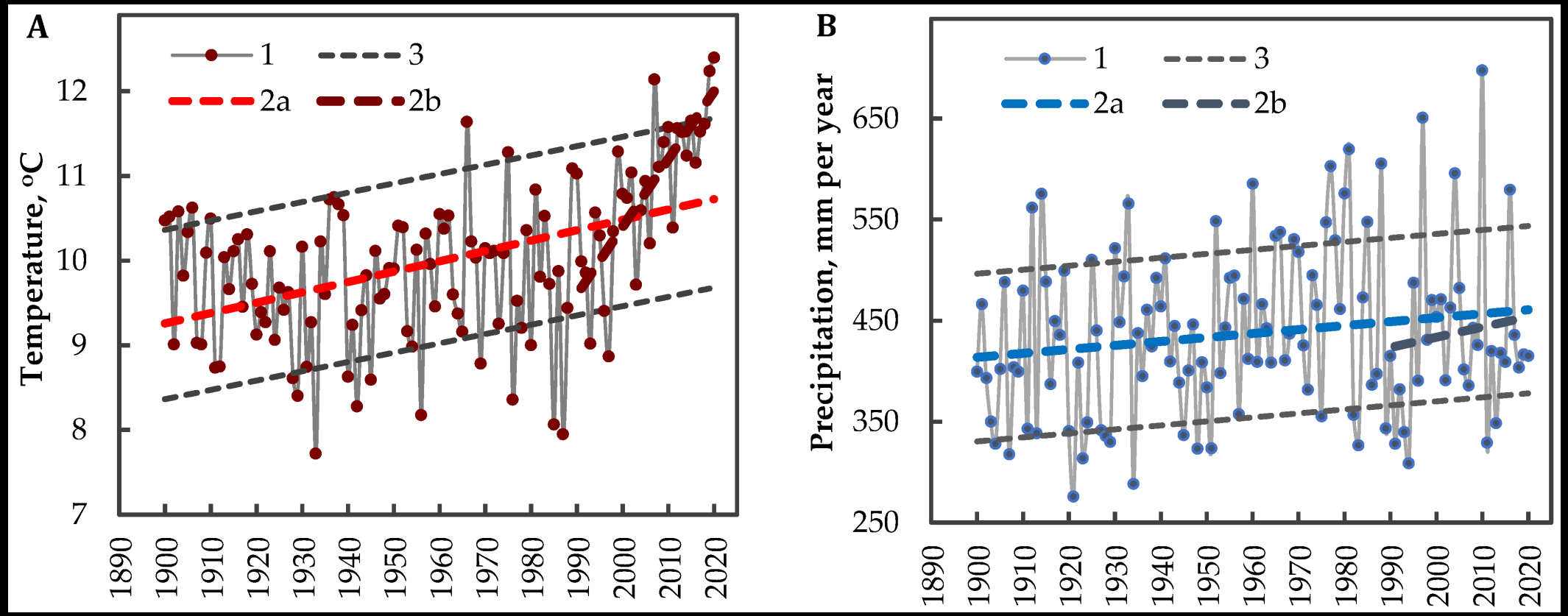
https://earthobservatory.nasa.gov/features/GlobalWarming/page3.php

Global change vs. regional change



Temperature Data Innsbruck: Zamg Histalp

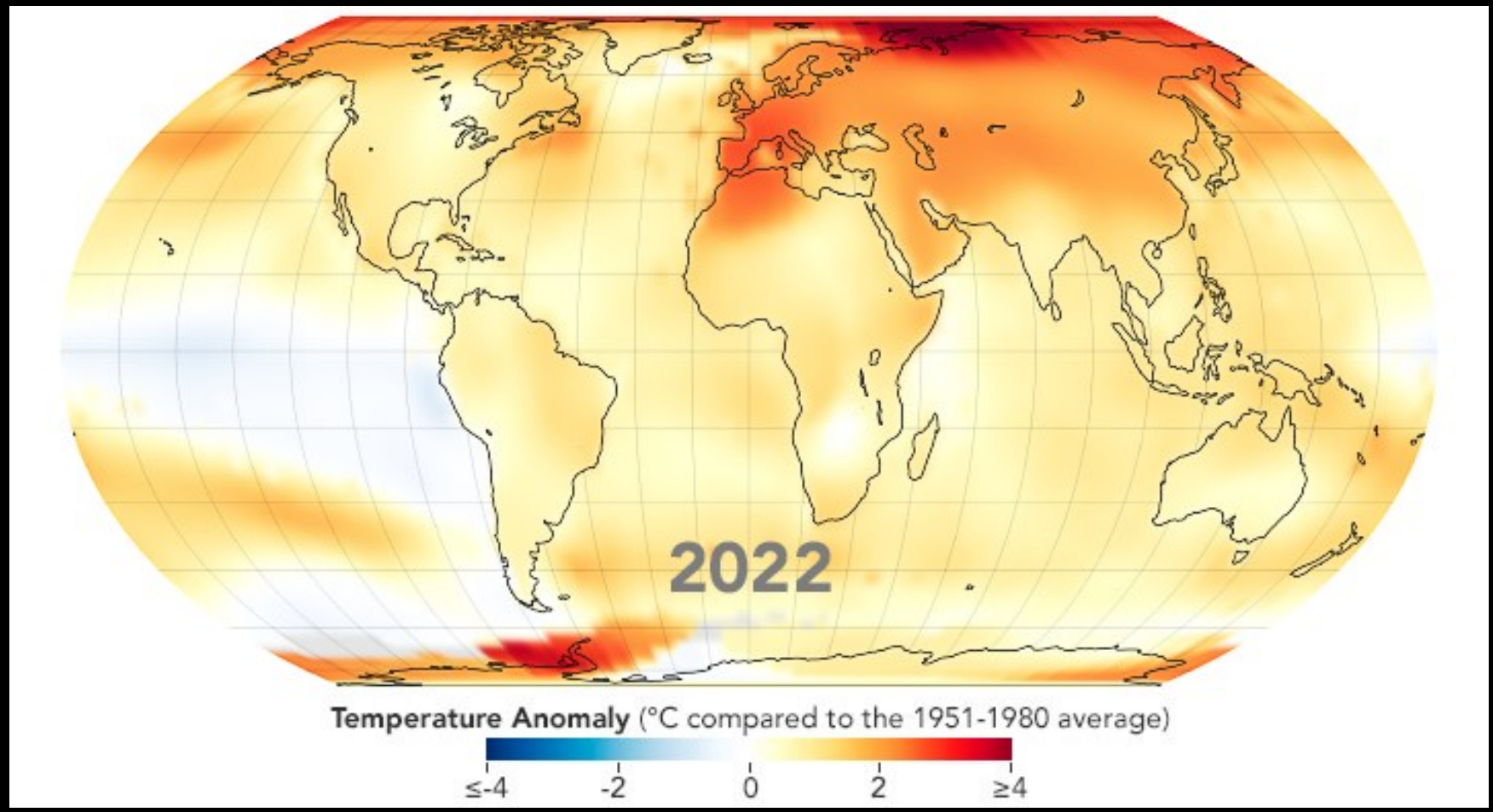
Regional temperature and P change Southern Ukraine*

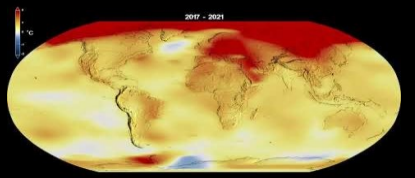


Kherson, Mikolaiv, Odesa, and Zaporizhzhia

https://doi.org/10.3390/su14095664

Regional T change on a global scale

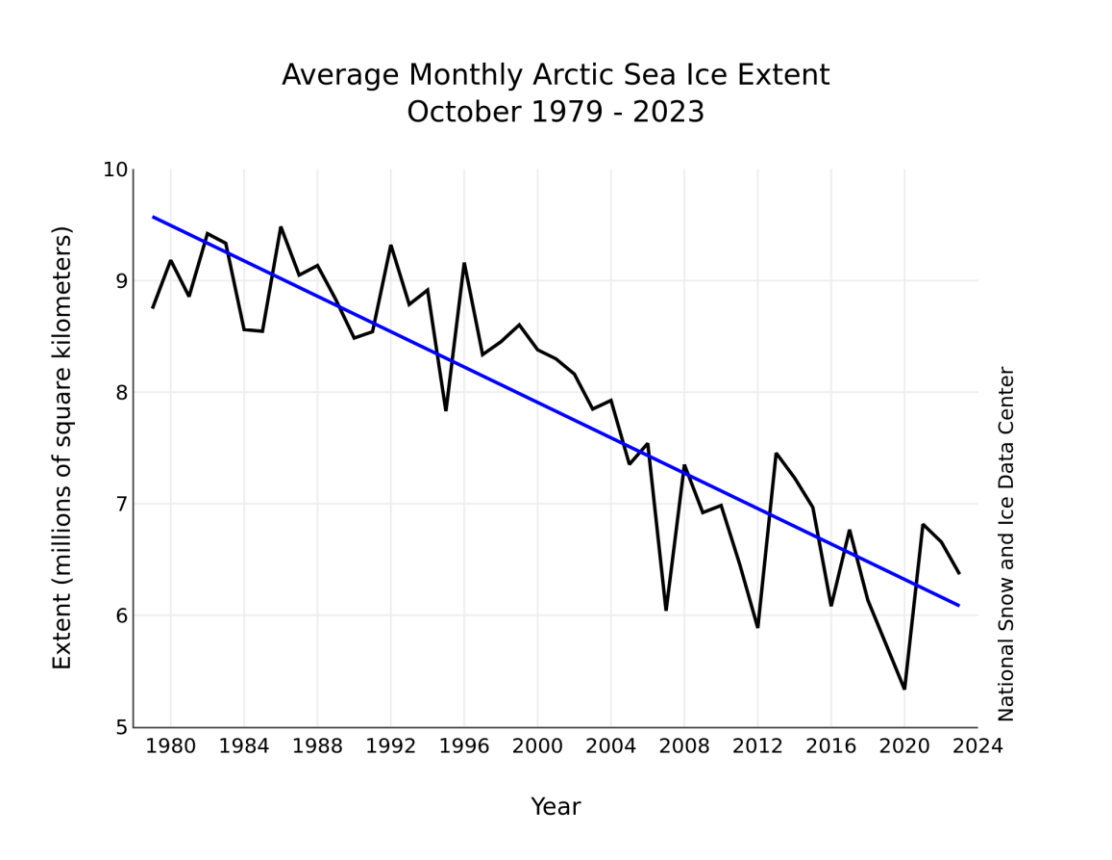




https://youtu.be/haBG2IIbwbA

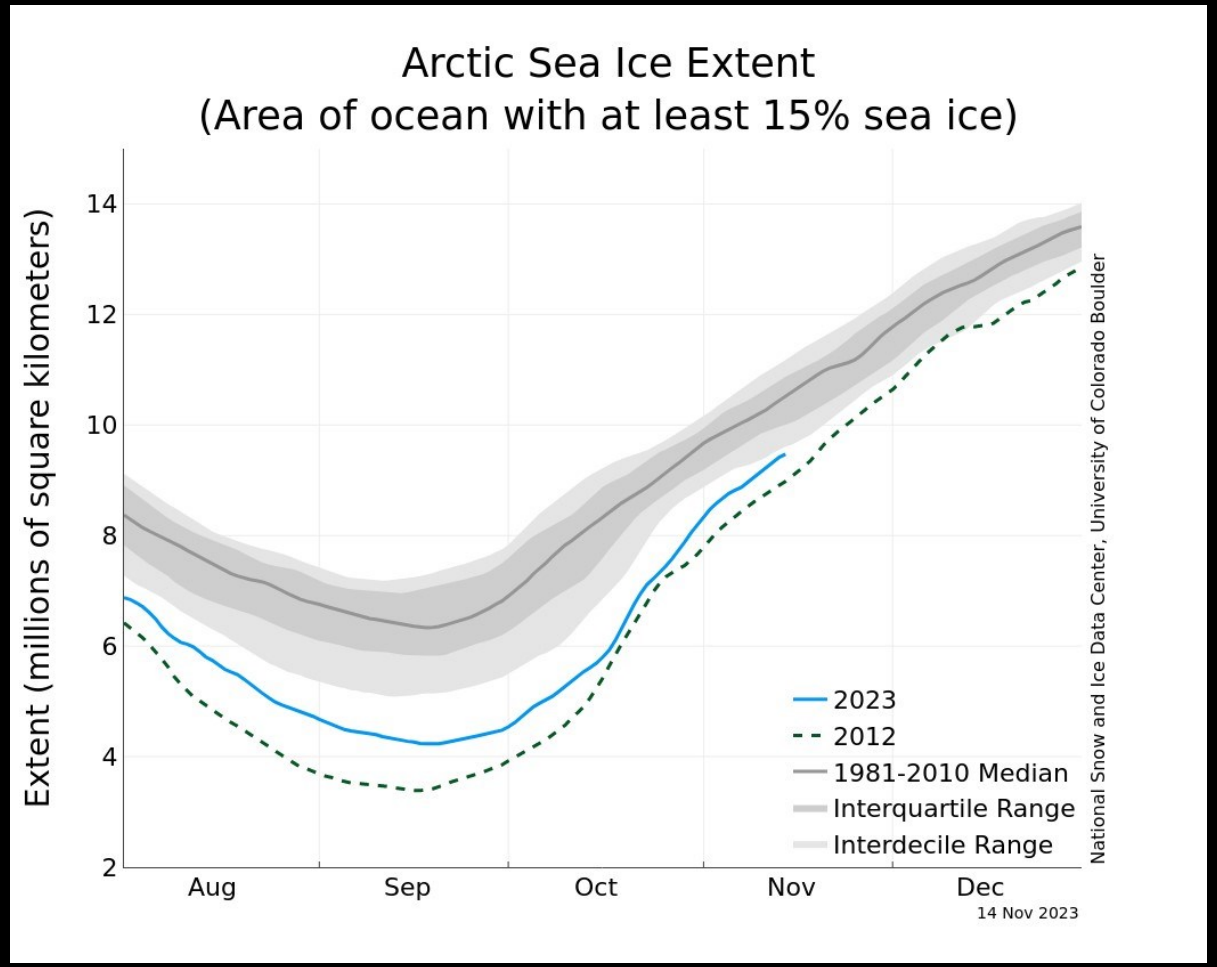
https://earthobservatory.nasa.gov/world-of-change/global-temperatures

Consequences of Regional T change



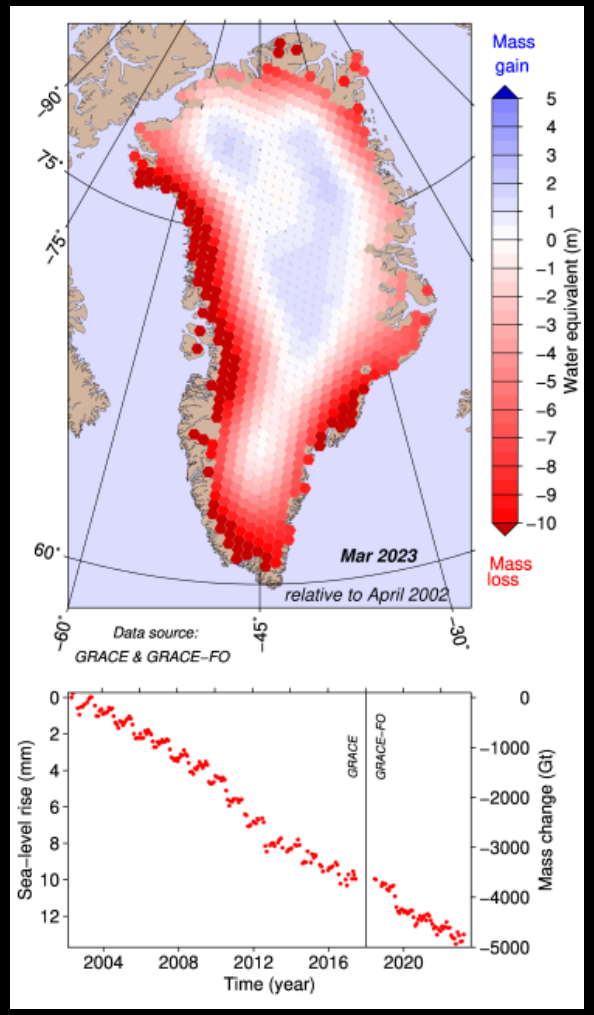
http://nsidc.org/arcticseaicenews/

Consequences of Regional T change



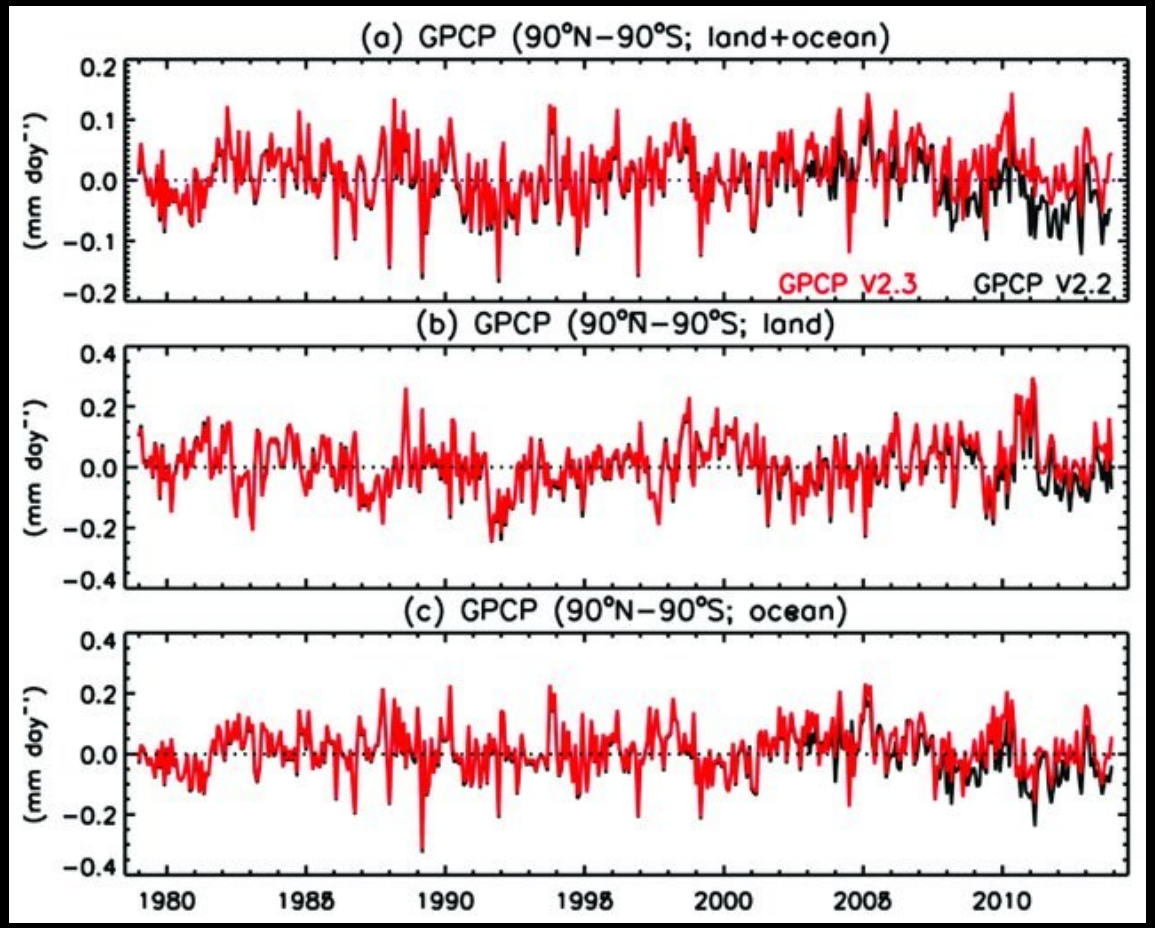
http://nsidc.org/arcticseaicenews/

Consequences of Regional T change



http://polarportal.dk/en/greenland/mass-and-height-change/

Evolution of precipitation globally



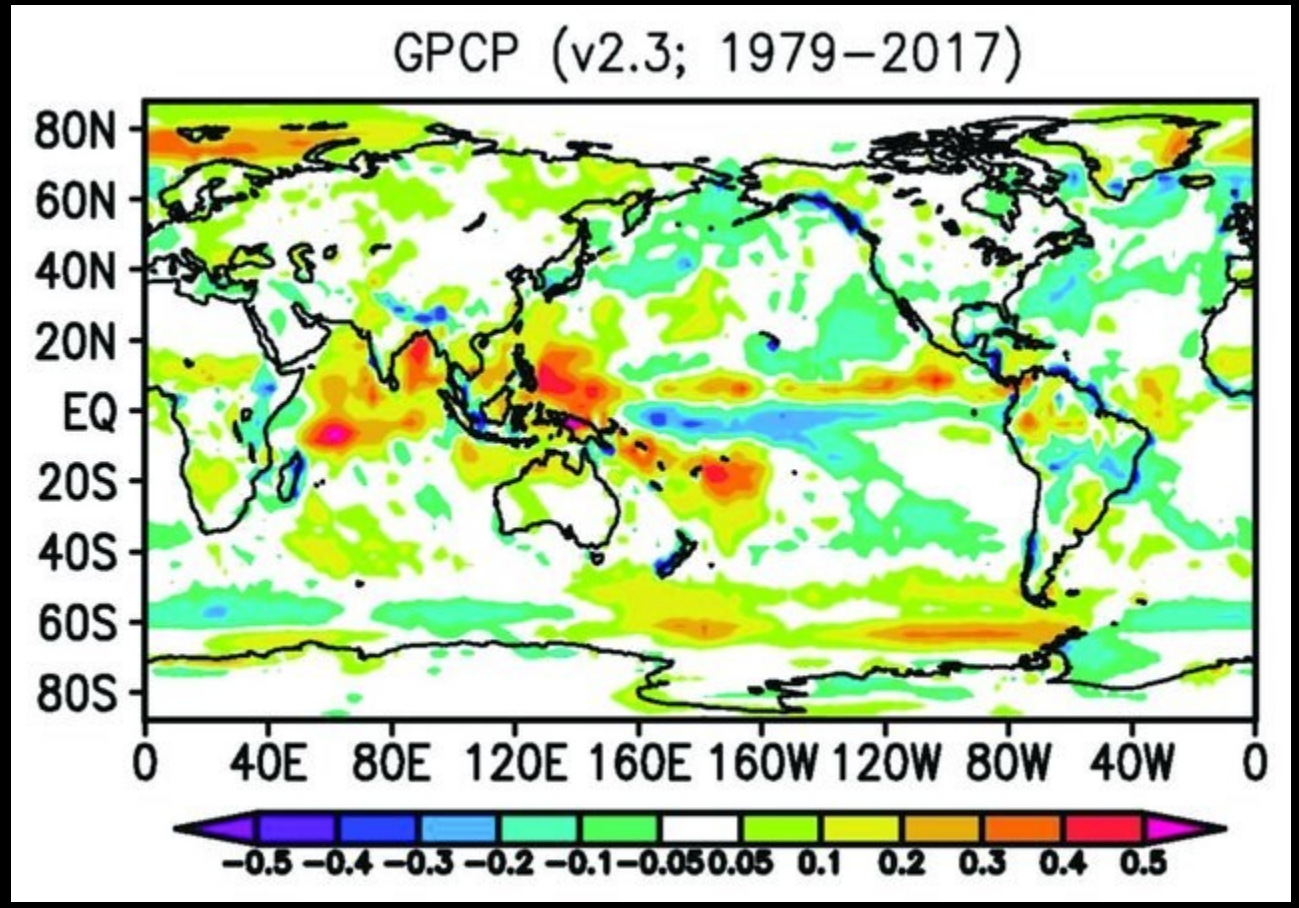
https://www.researchgate.net/publication/324427078_The_Global_Precipitation_Climatology_Project_GPCP_Monthly_Analysis_New_Version_23_and_a_Review_of_2017_Global_Precipitation

Precipitation globally:

- Much more complex to assess than temperature
- Satelites provided strong improvements although there are still substantial uncertainties

Evolution of precipitation regionally

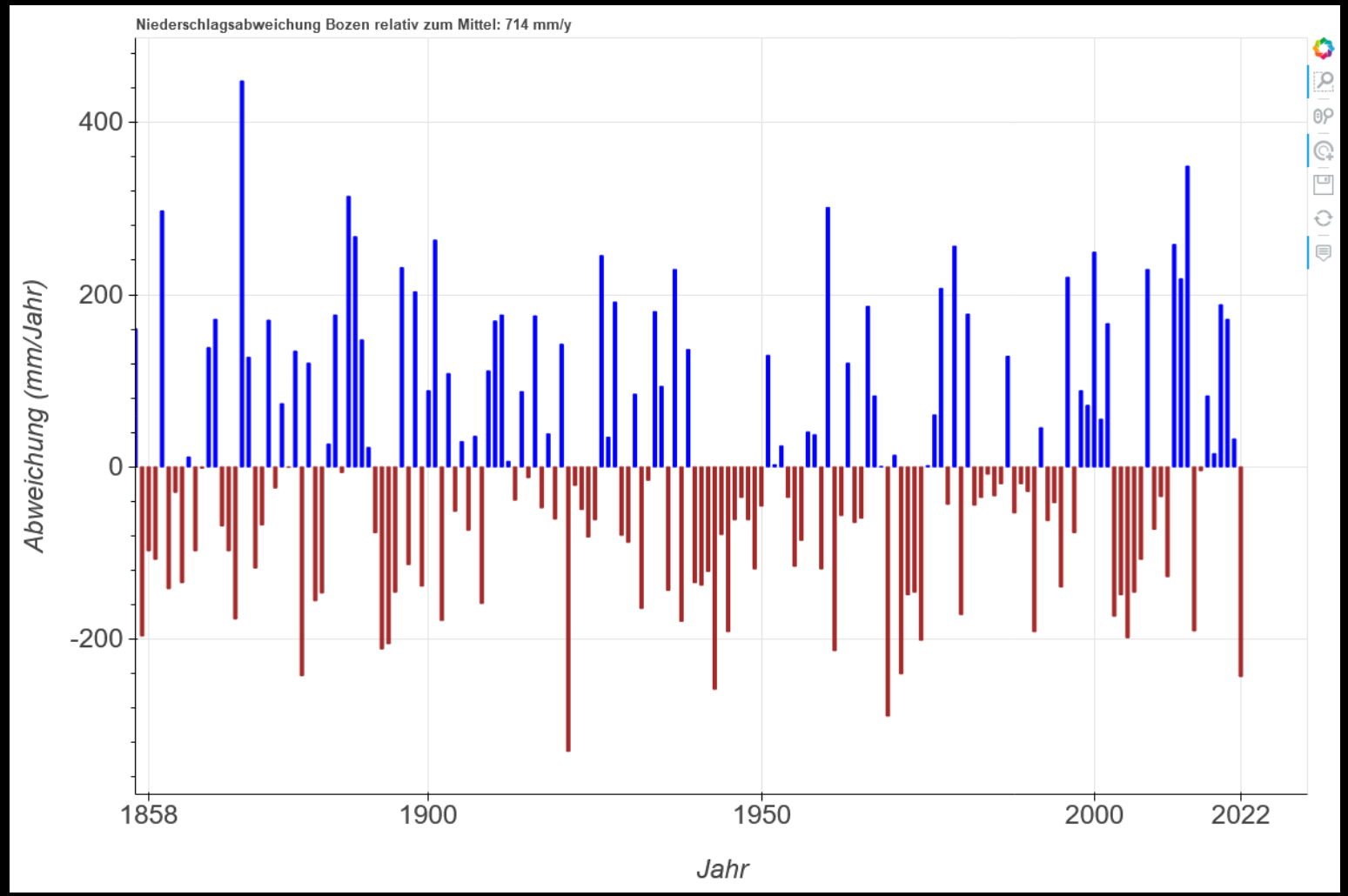
Linear trend of GPCP precipitation (mm day −1 decade −1) from 1979-2017.

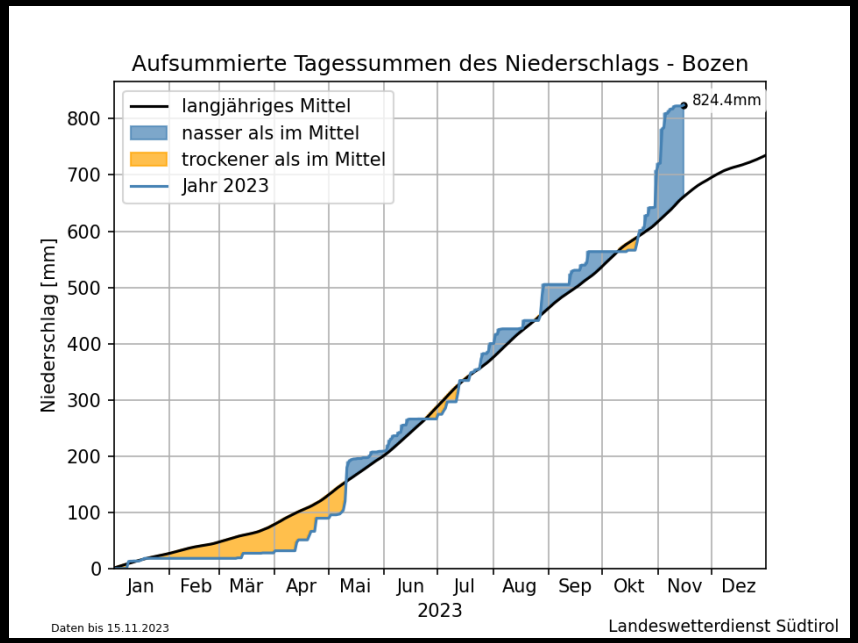


https://www.researchgate.net/publication/324427078_The_Global_Precipitation_Climatology_Project_GPCP_Monthly_Analysis_New_Version_23_and_a_Review_of_2017_Global_Precipitation

Evolution of precipitation regionally

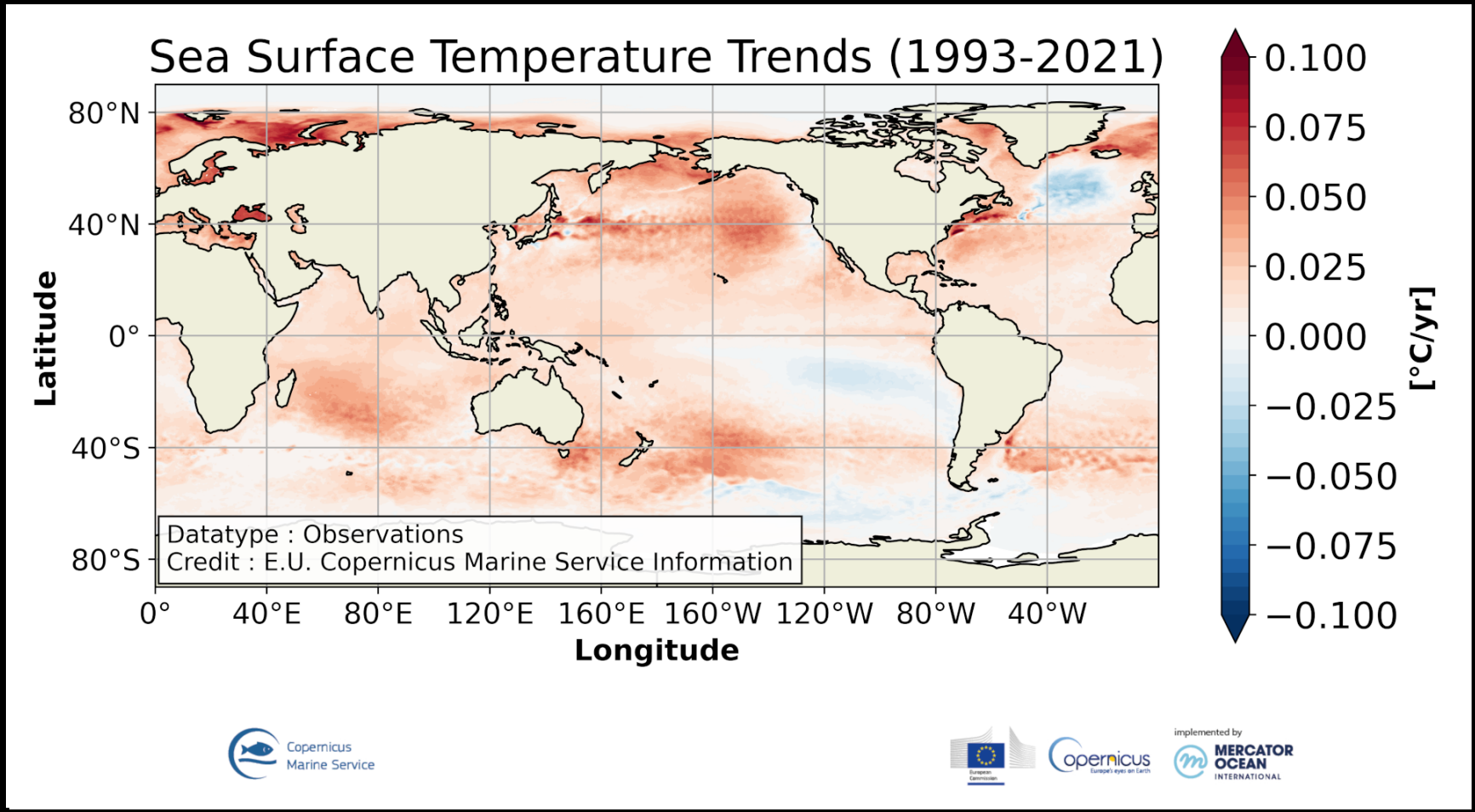
Data Source: Zamg Histalp & Hydrographischer Dienst Südtirol





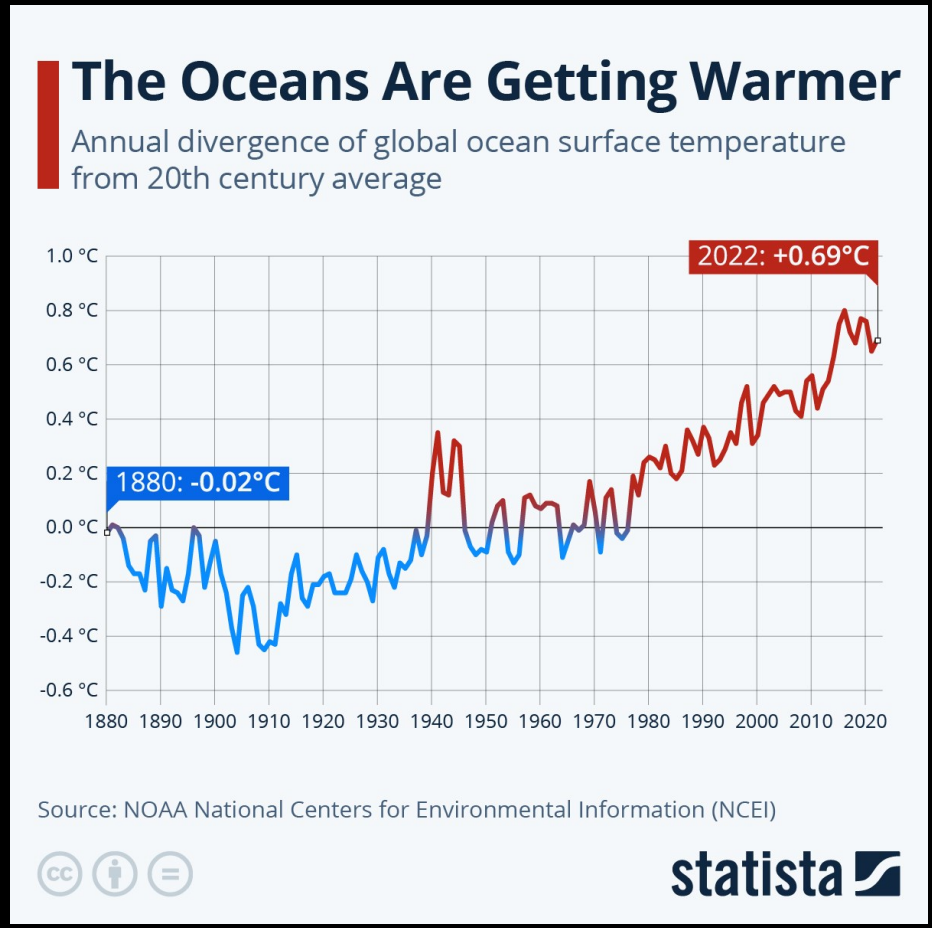
https://wetter.provinz.bz.it/klimadiagramme.asp

Evolution of sea surface temperature



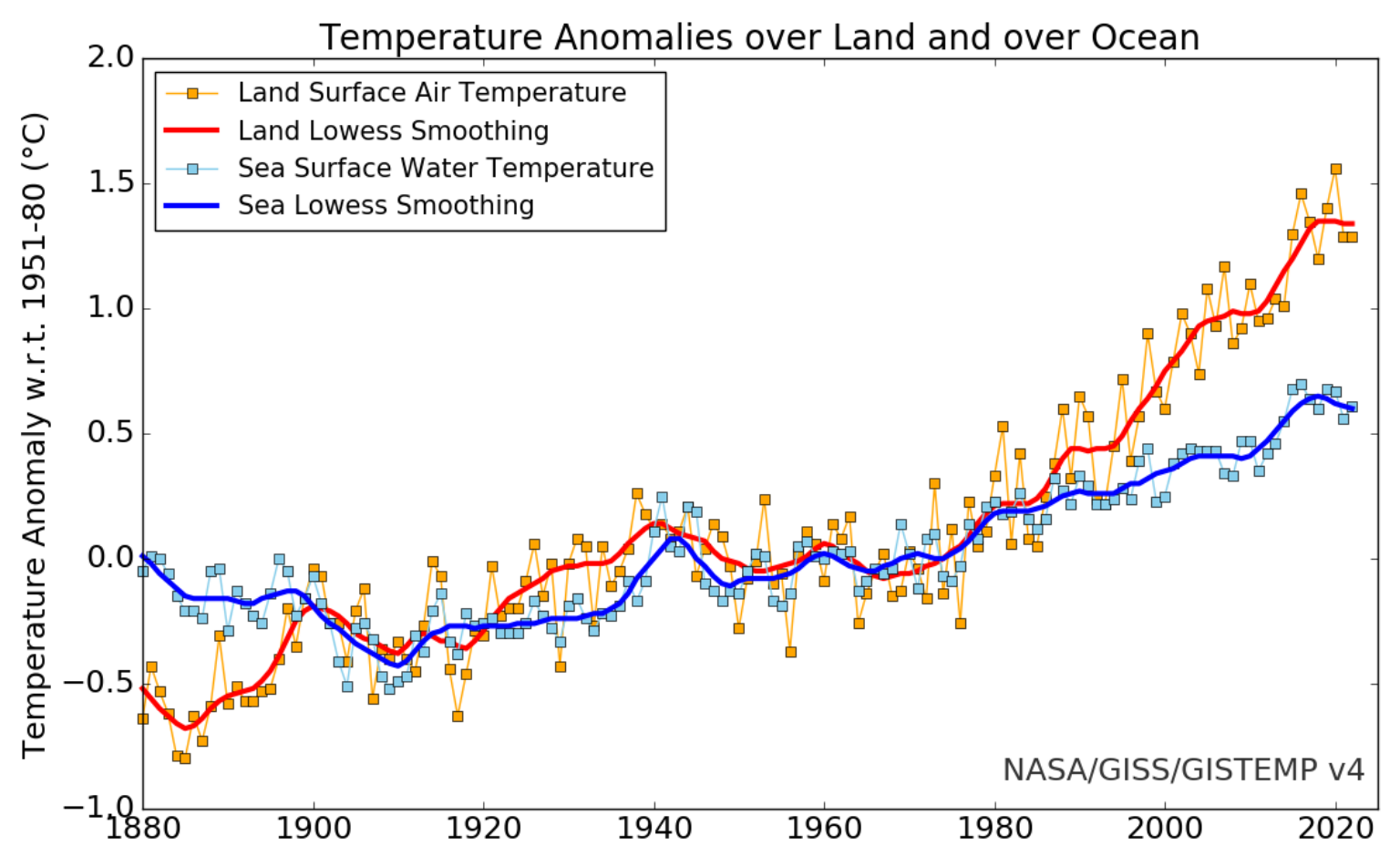
https://marine.copernicus.eu/access-data/ocean-monitoring-indicators/global-ocean-sea-surface-temperature-trend-map-observations

Evolution of sea surface temperature



https://www.statista.com/chart/19418/divergence-of-ocean-temperatures-from-20th-century-average/

Evolution of ocean vs. land surface temperature



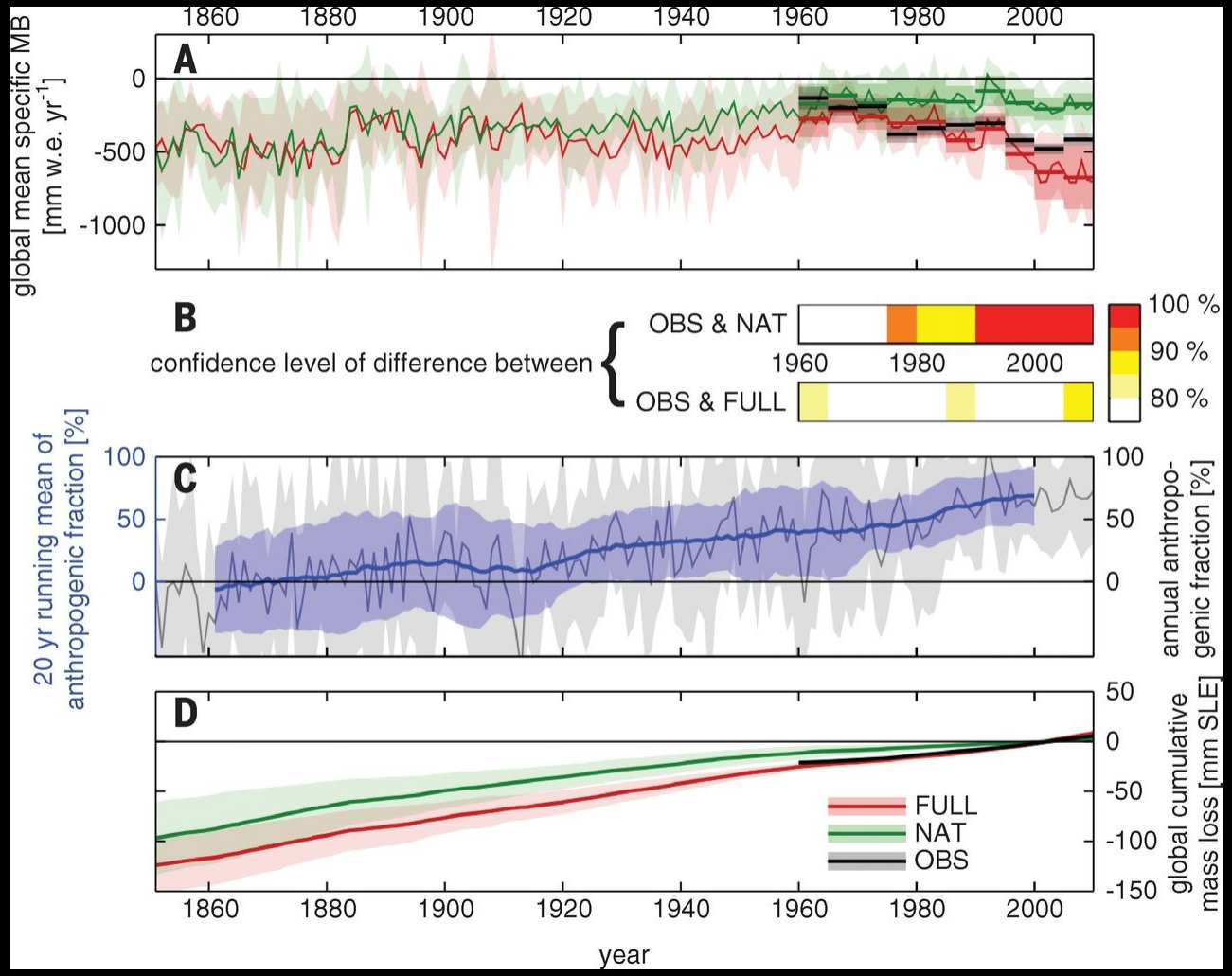
https://data.giss.nasa.gov/gistemp/graphs_v4/

Recap Block 2:
90% of additional heat absorbed by the ocean

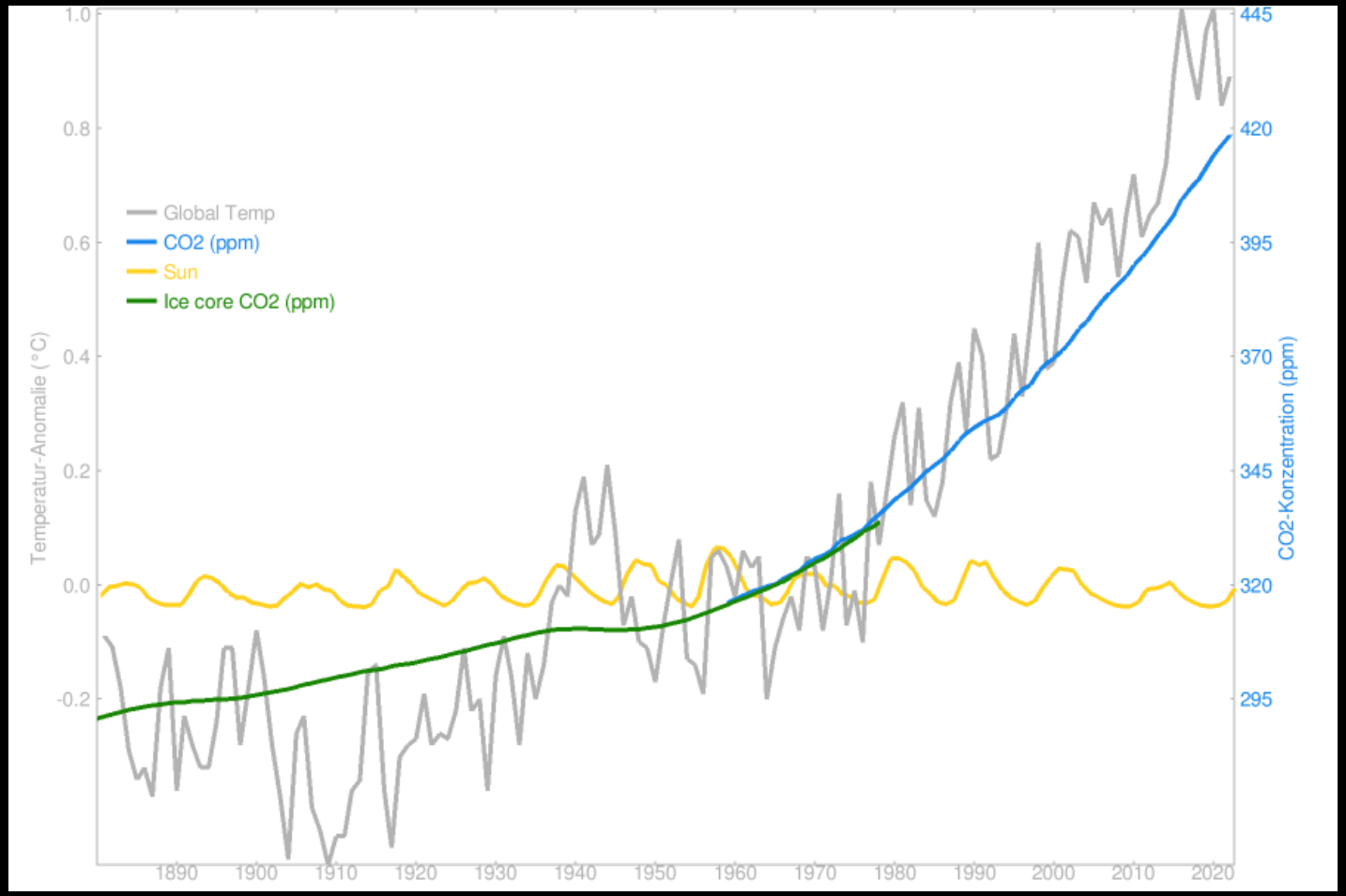
Attributions and contributions

Attributions natural/anthropogenic: Example glaciers

https://www.science.org/doi/10.1126/science.1254702

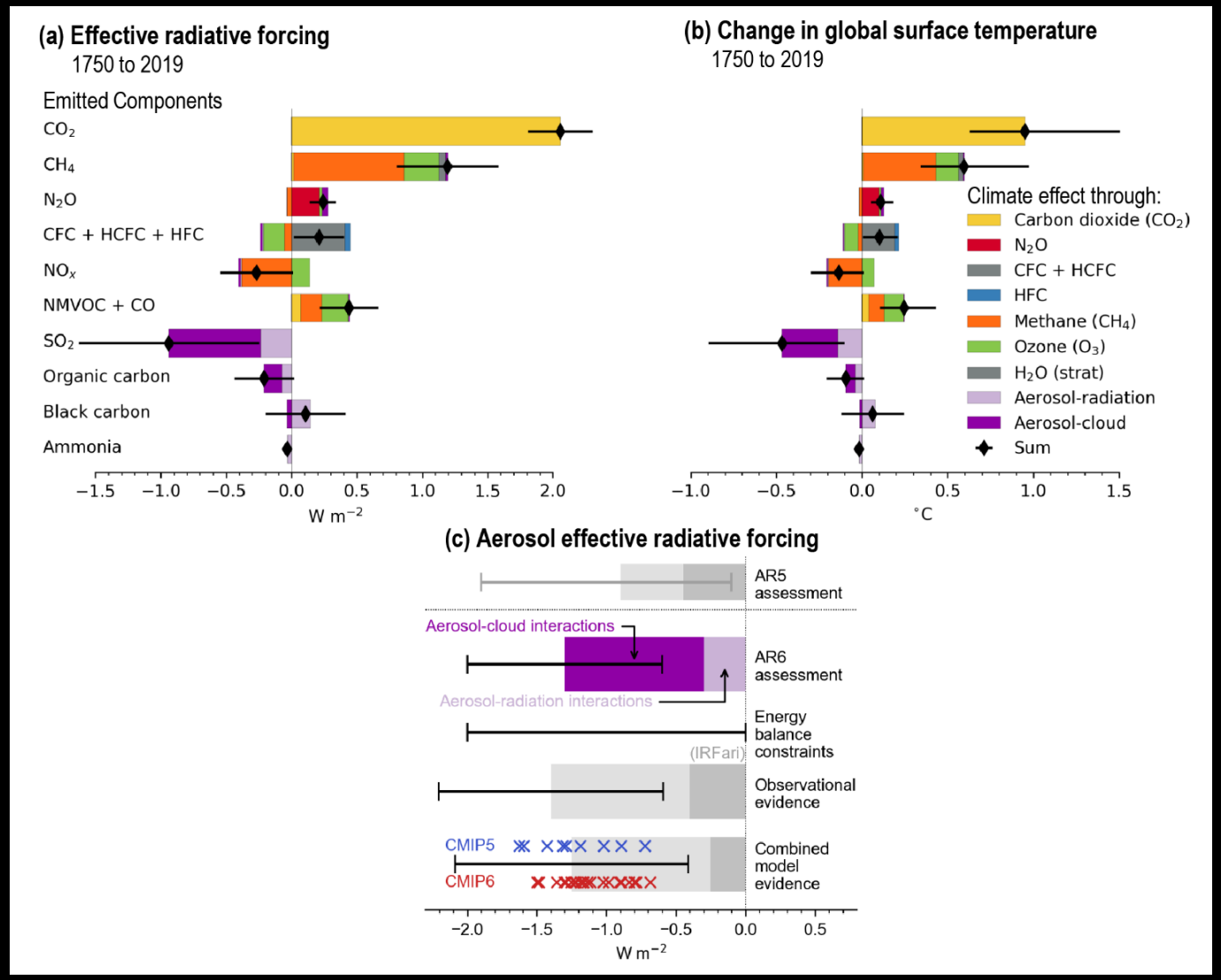


Contribution: CO2 from comparing curves (recap Block 2)



http://herdsoft.com/climate/widget/image.php?width=900&height=600&title=&temp_axis=Temperatur-Anomalie+%28%B0C%29&co2_axis=CO2-Konzentration+%28ppm%29&start_year=1880
https://www.realclimate.org/index.php/archives/2016/11/record-heat-despite-a-cold-sun/

Contribution: Individual gases



https://www.ipcc.ch/report/ar6/wg1/figures/chapter-6/figure-6-12

Future scenarios

2°C scenario

1.5°C scenario

MCC

https://www.mcc-berlin.net/forschung/co2-budget.html

How big is a country's carbon budget, when divid

Country carbon budget for Austria

Limit warming above pre-industrial levels to 1.5°C

Global Carbon Budget: 400 $GtCO_2$

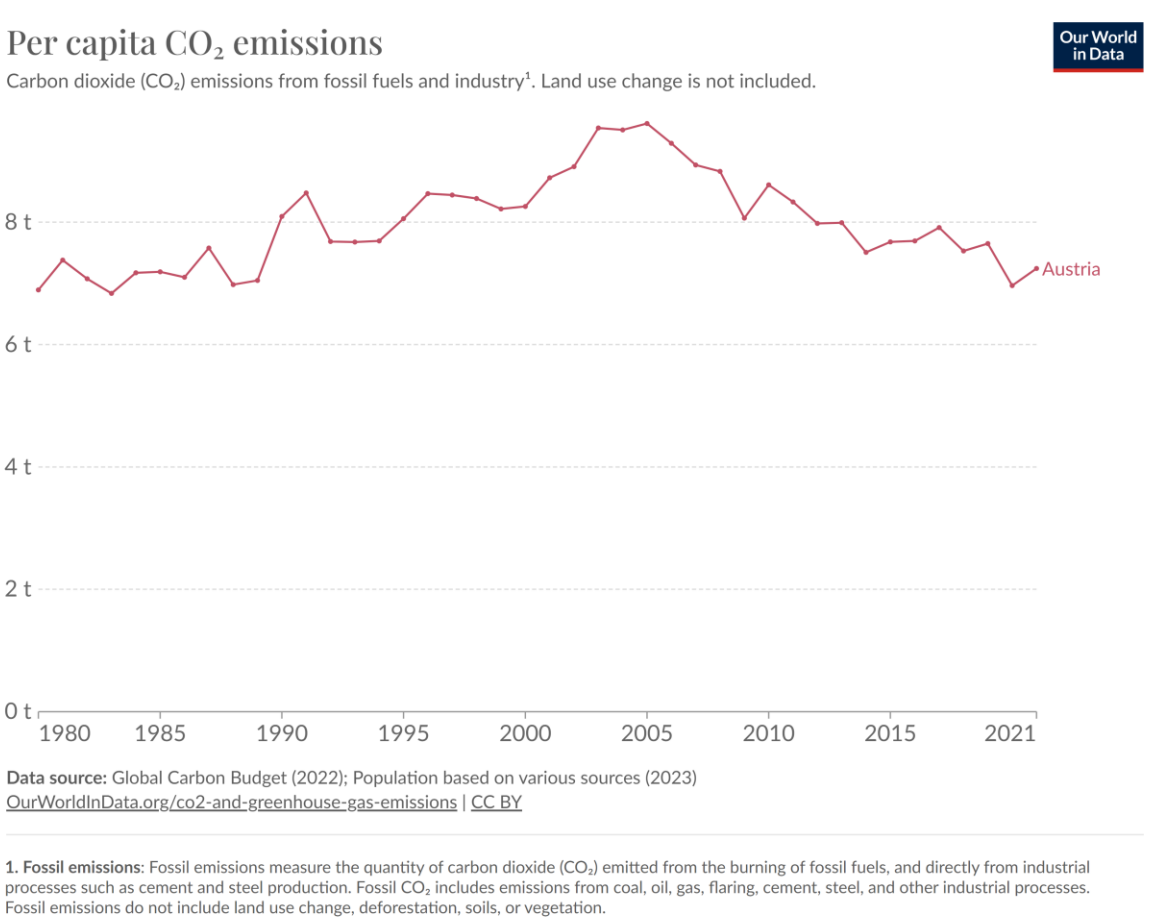
Global Fossil Carbon Budget: 360 $GtCO_2$

Per Person Fossil Carbon Budget: **45.57 tCO_2**

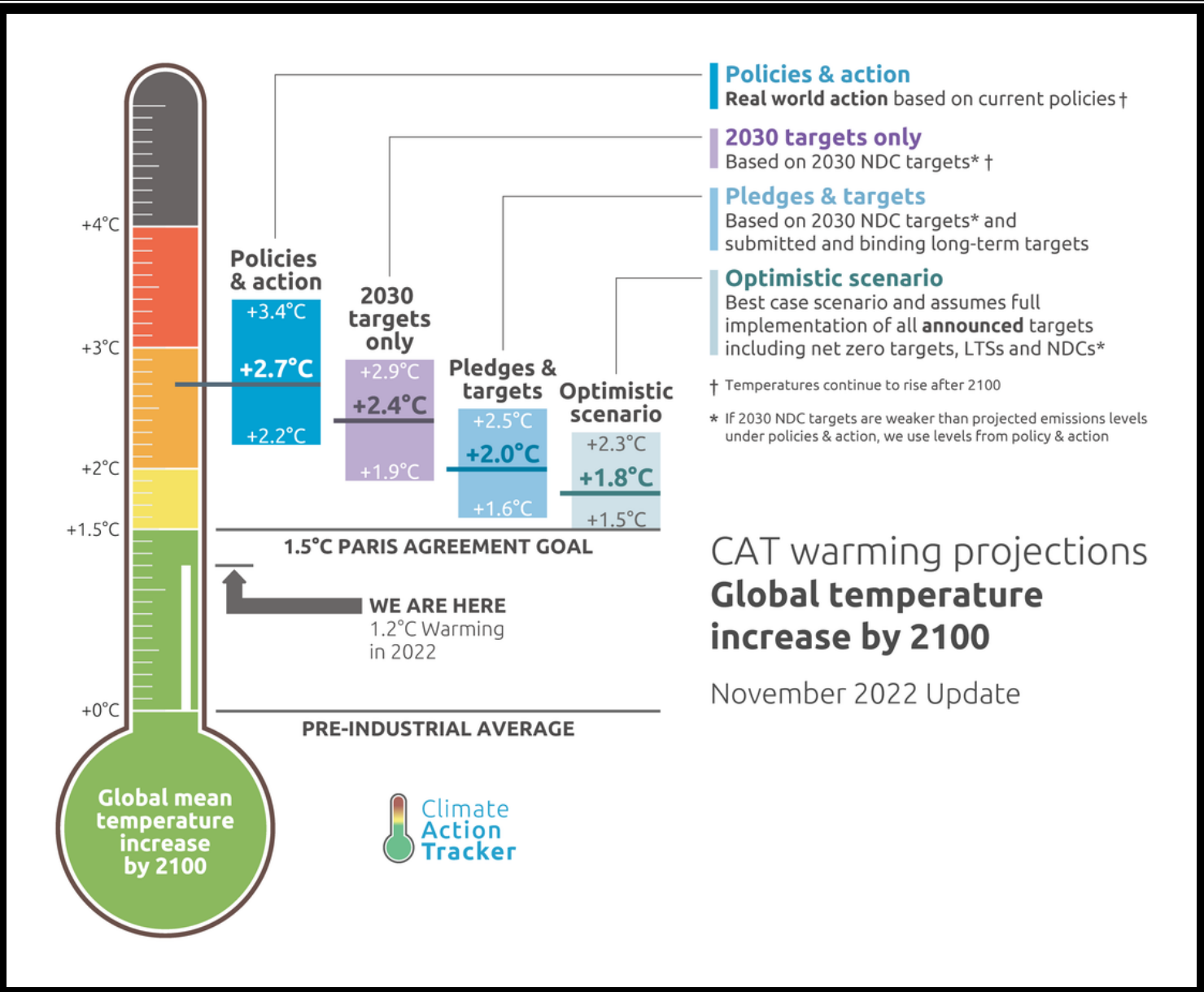
Country population: 9,006,398

Fossil Country Carbon Budget: **410.42 $MtCO_2$**

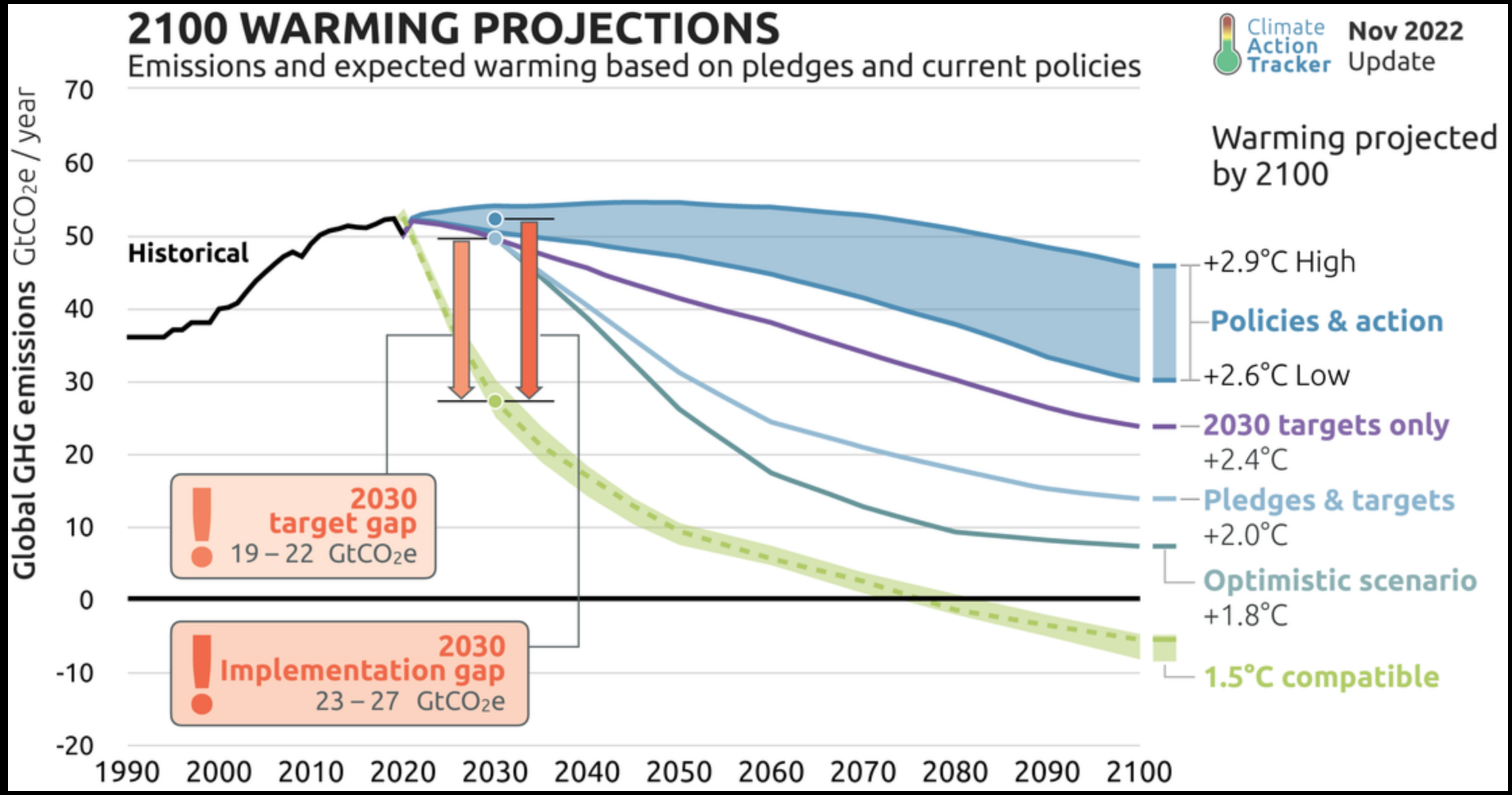
Country Carbon Emissions (fossil fuels and cement production) per year (2019): 67.96 $MtCO_2$



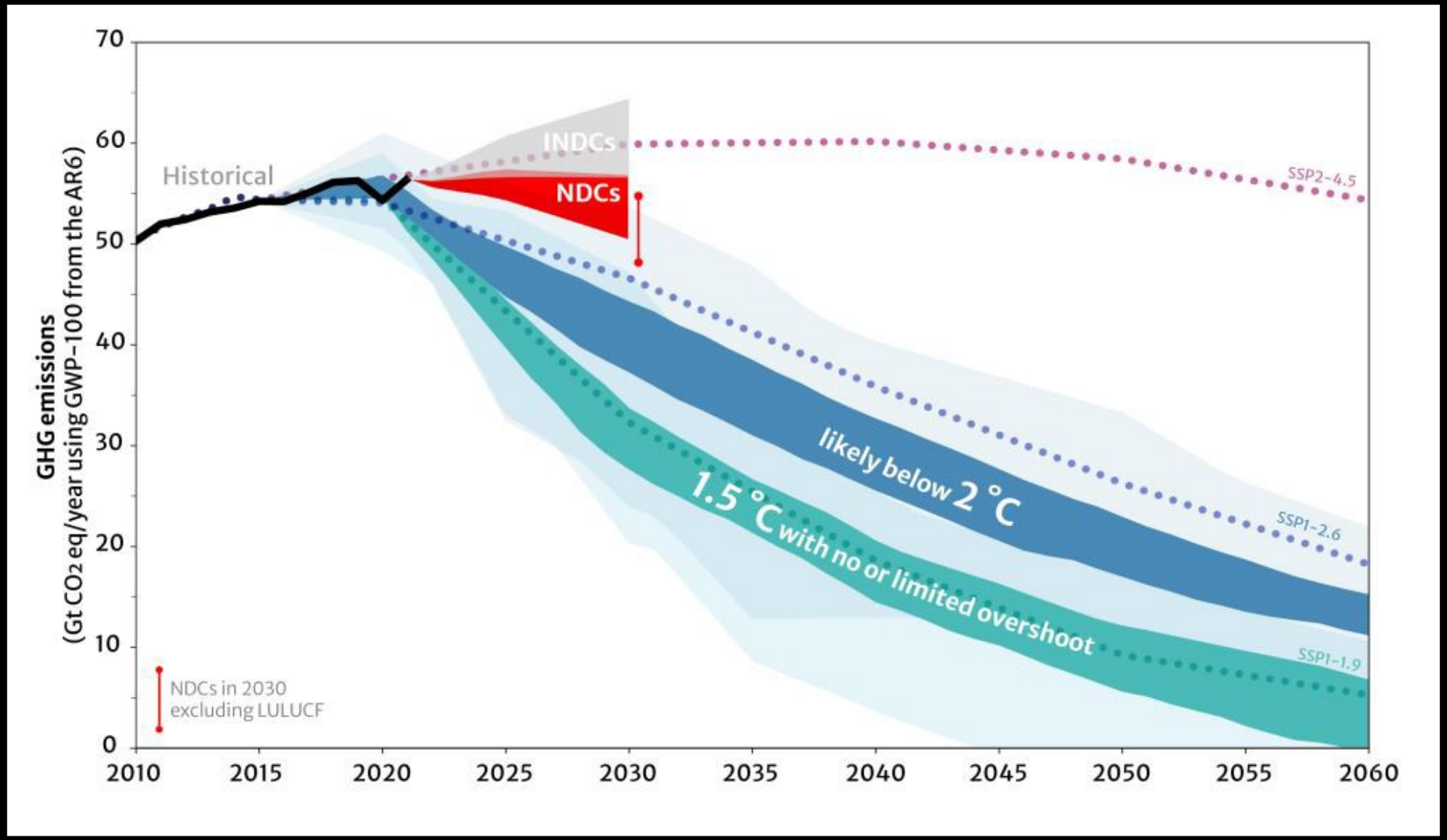
https://carbonbudgetcalculator.com/country.html?country=Austria



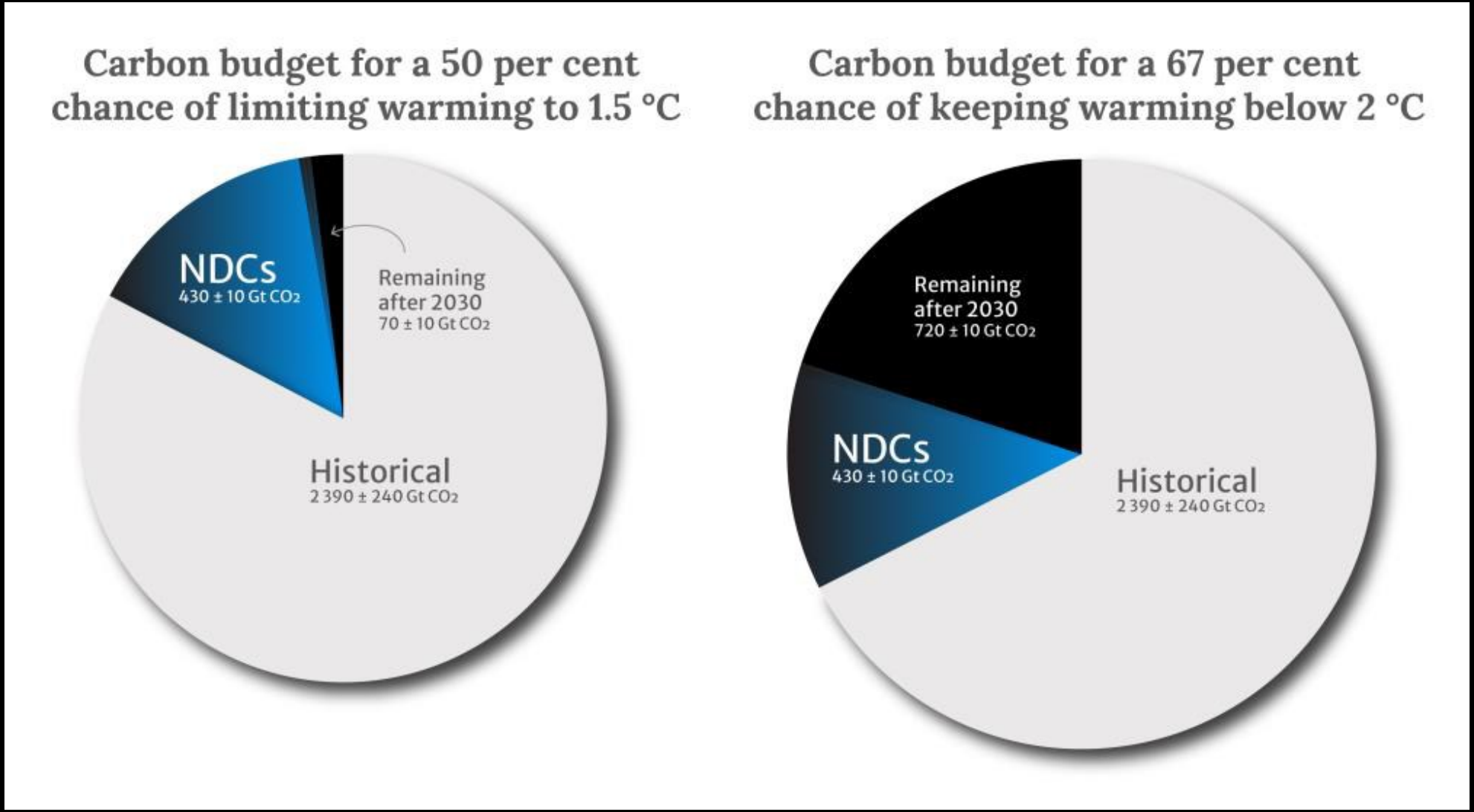
https://climateactiontracker.org/global/cat-thermometer/



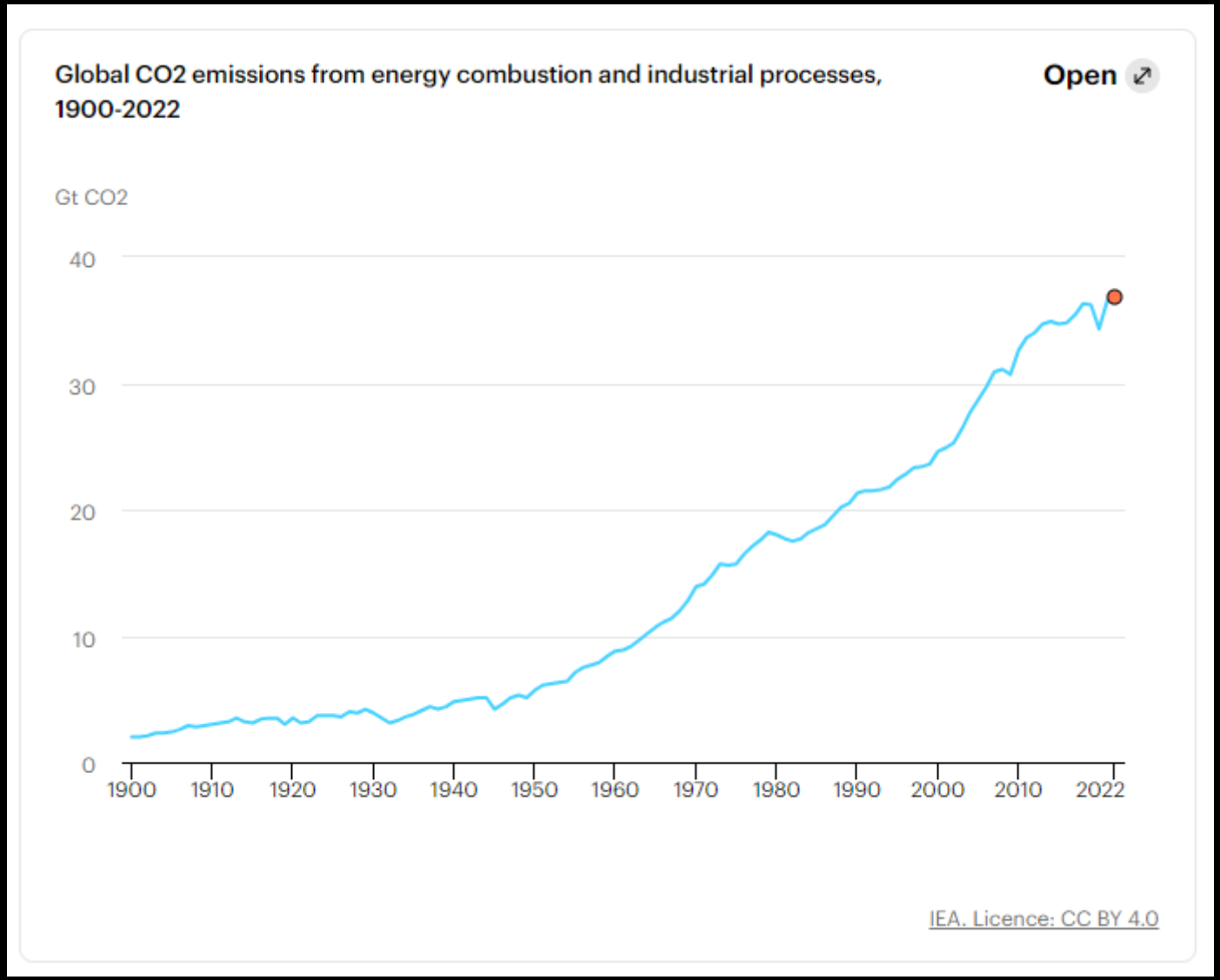
https://climateactiontracker.org/global/cat-thermometer/



https://unfccc.int/documents/632334



https://unfccc.int/documents/632334

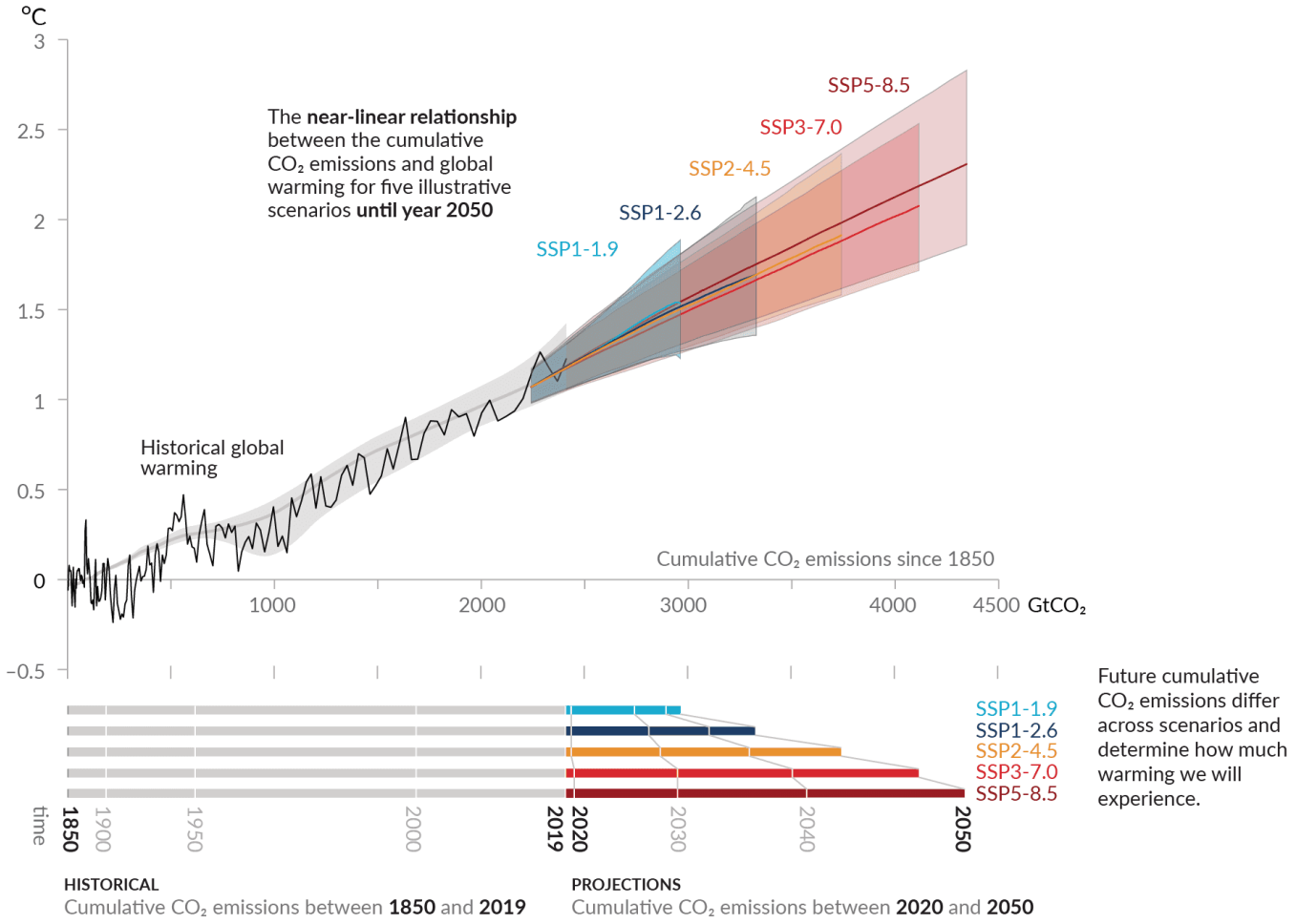


https://www.iea.org/reports/co2-emissions-in-2022

Global temperature change

Every tonne of CO_2 emissions adds to global warming

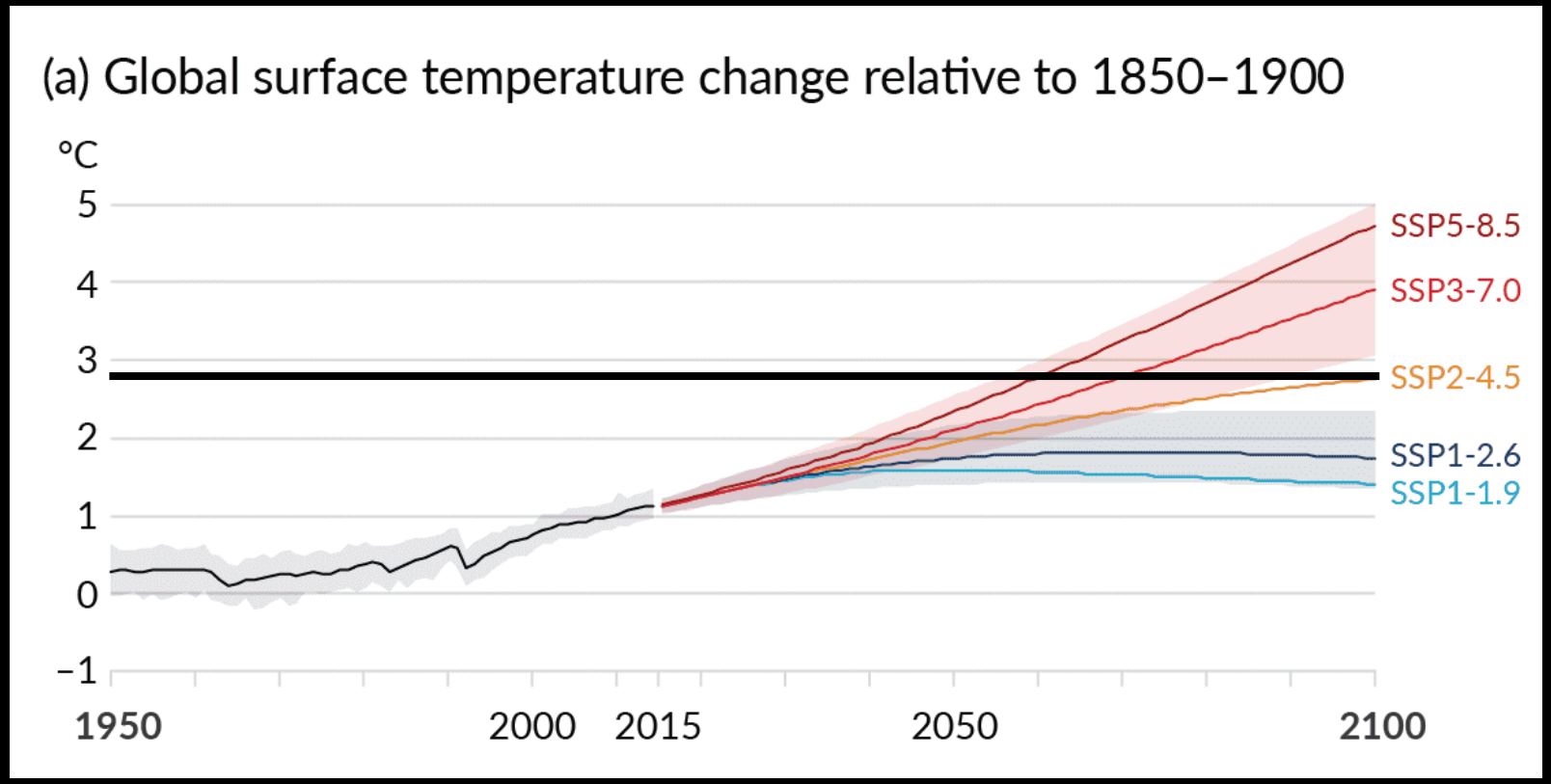
Global surface temperature increase since 1850–1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Future cumulative CO_2 emissions differ across scenarios and determine how much warming we will experience.

https://www.ipcc.ch/report/ar6/wg1/figures/summary-for-policymakers

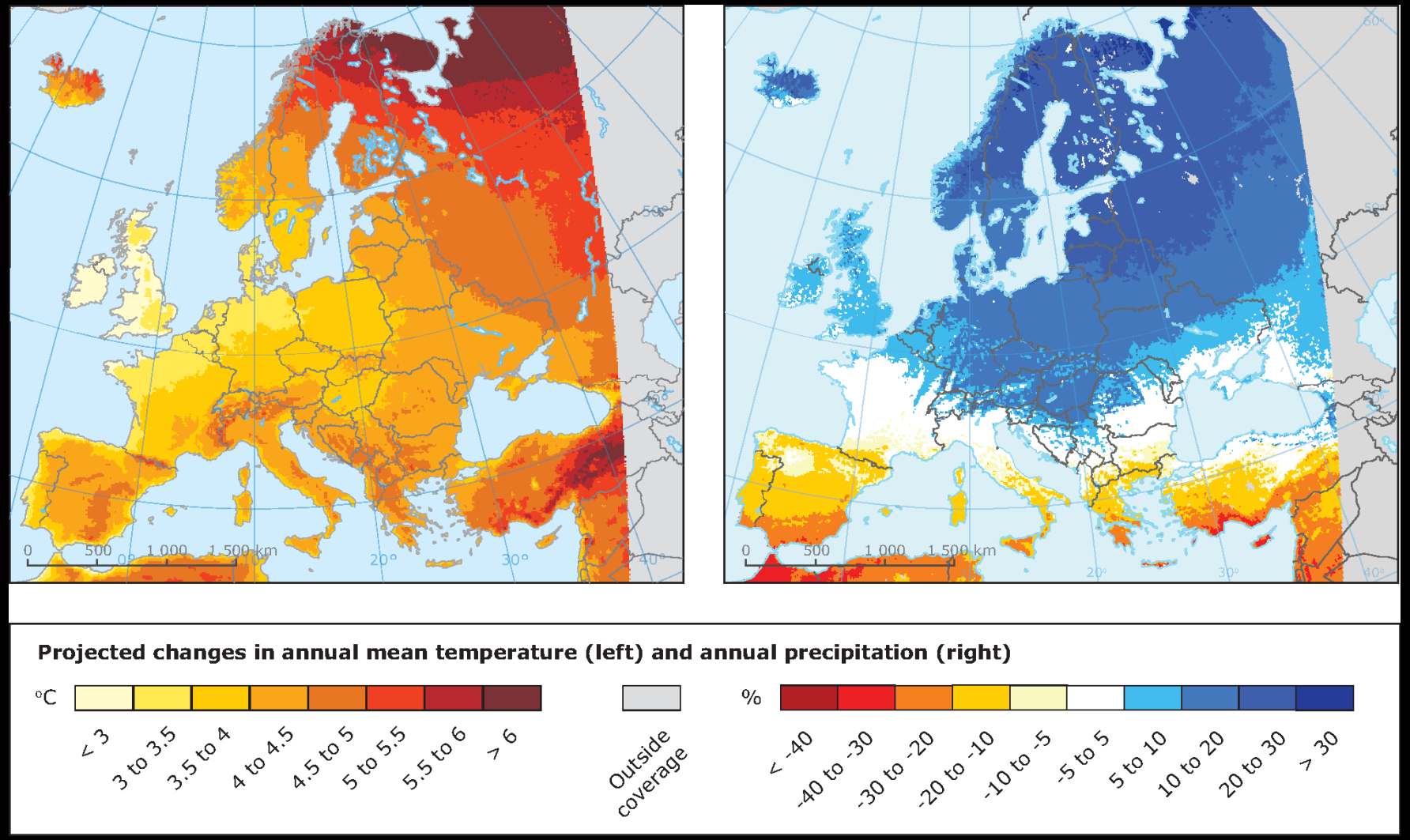
Global temperature scenarios



Currently realistic

https://www.ipcc.ch/report/ar6/wg1/figures/summary-for-policymakers/

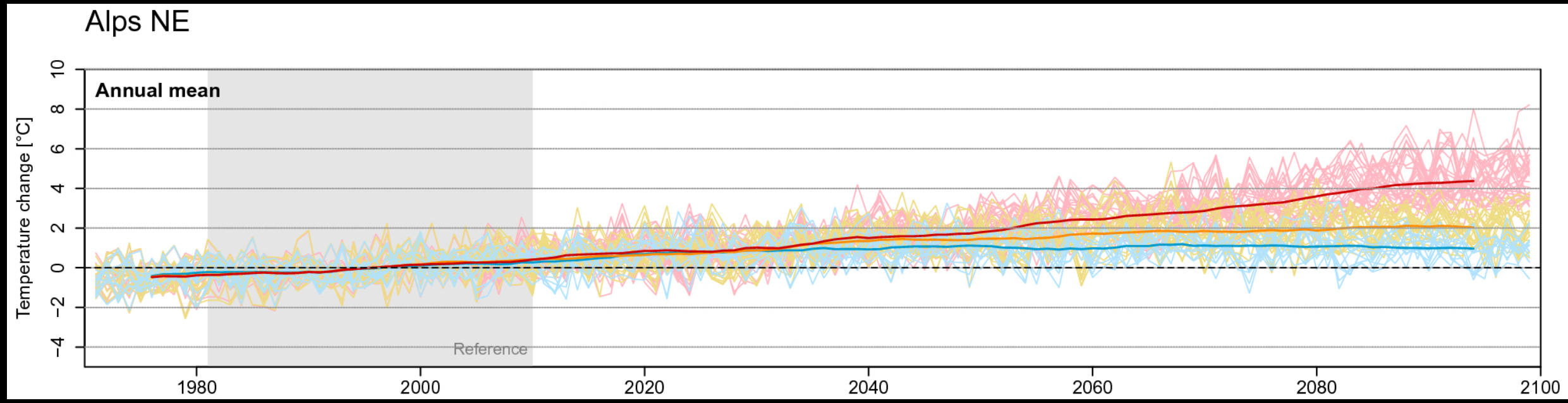
Regional temperature/precipitation scenarios RCP 8.5



https://www.eea.europa.eu/soer/2015/europe/climate-change-impacts-and-adaptation

Regional temperature scenarios Alps

https://doi.org/10.1007/s00382-022-06303-3

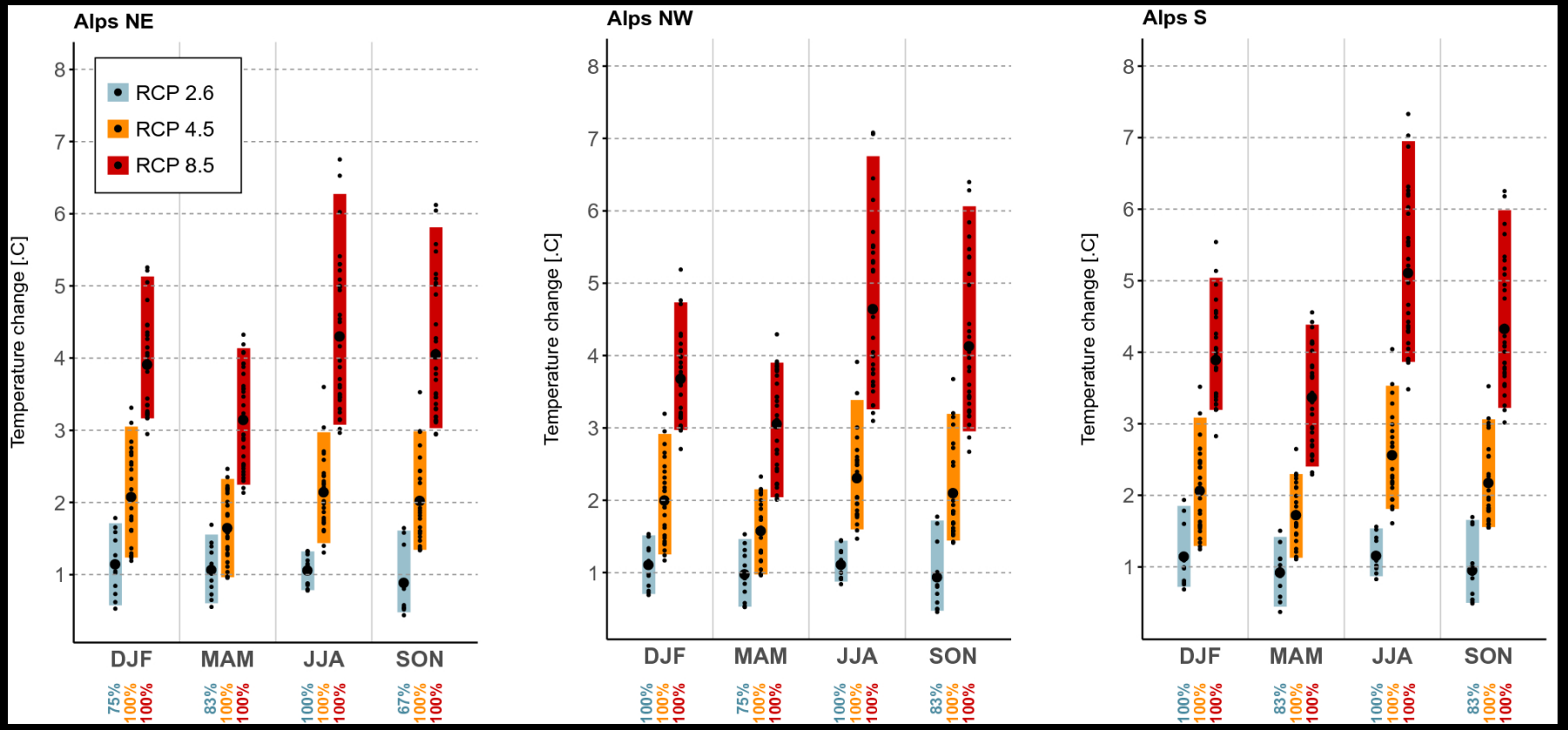


RCP 4.5:

- +1.5° compared to current conditions (approx. +4°C compared to preindustrial)

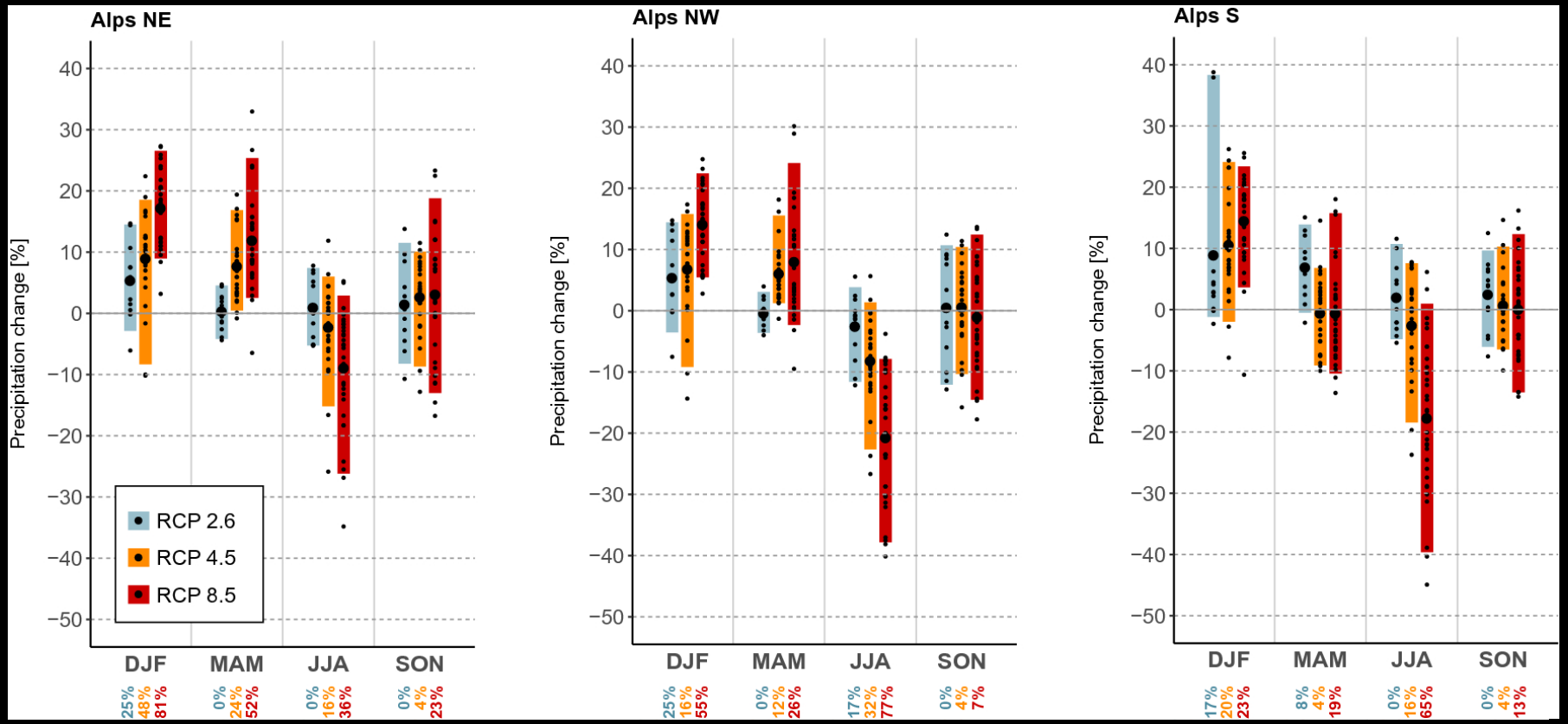
Regional temperature scenarios Alps seasons

https://doi.org/10.1007/s00382-022-06303-3

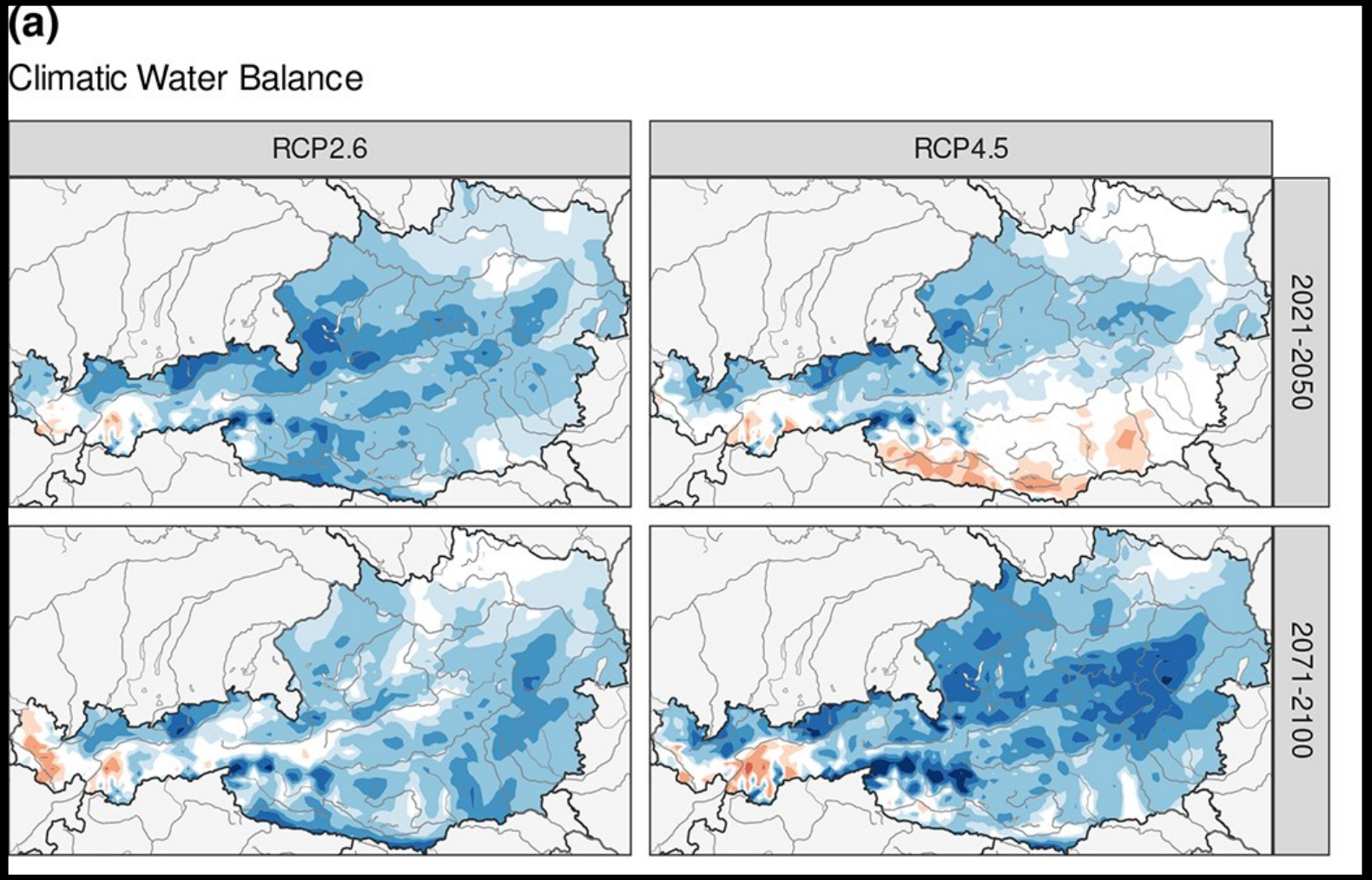


Regional precipitation scenarios Alps seasons

https://doi.org/10.1007/s00382-022-06303-3

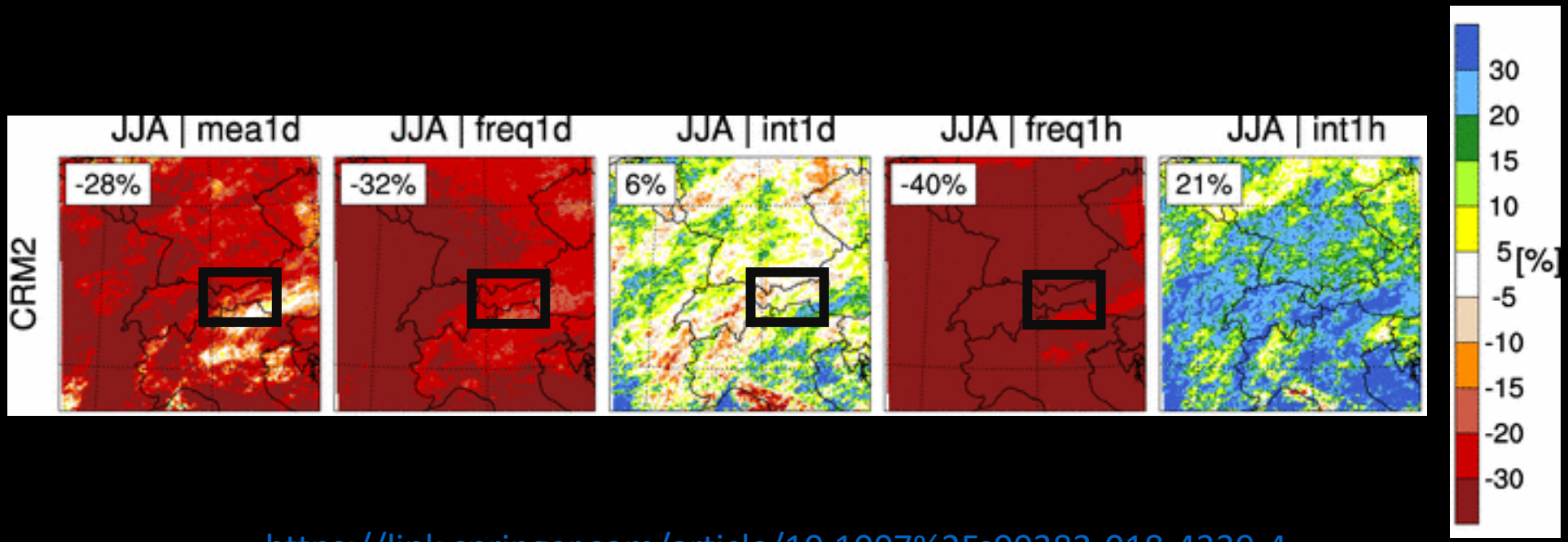


Regional water balance



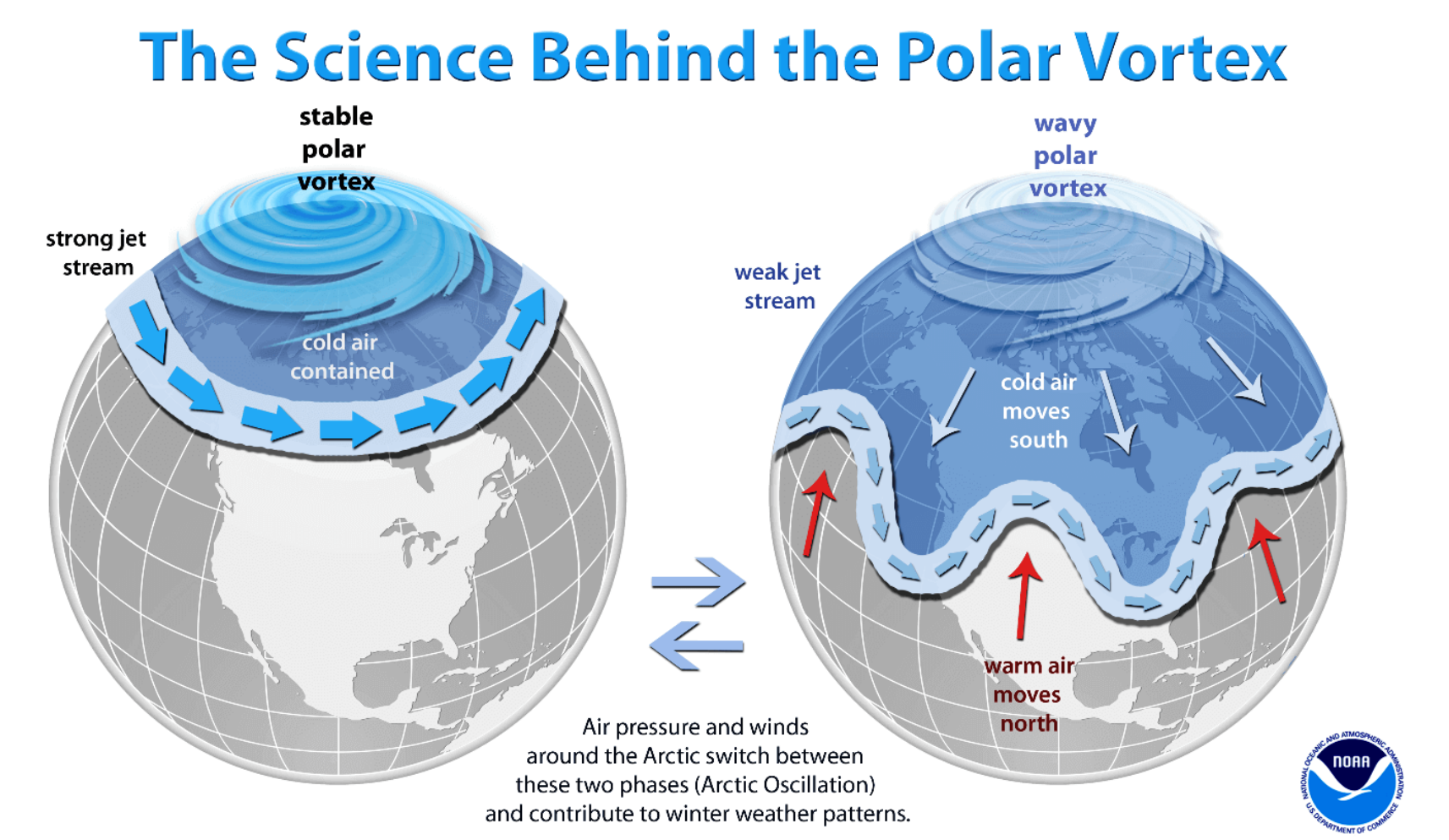
https://nhess.copernicus.org/articles/23/2749/2023/

Future Precipitation characteristics Alps



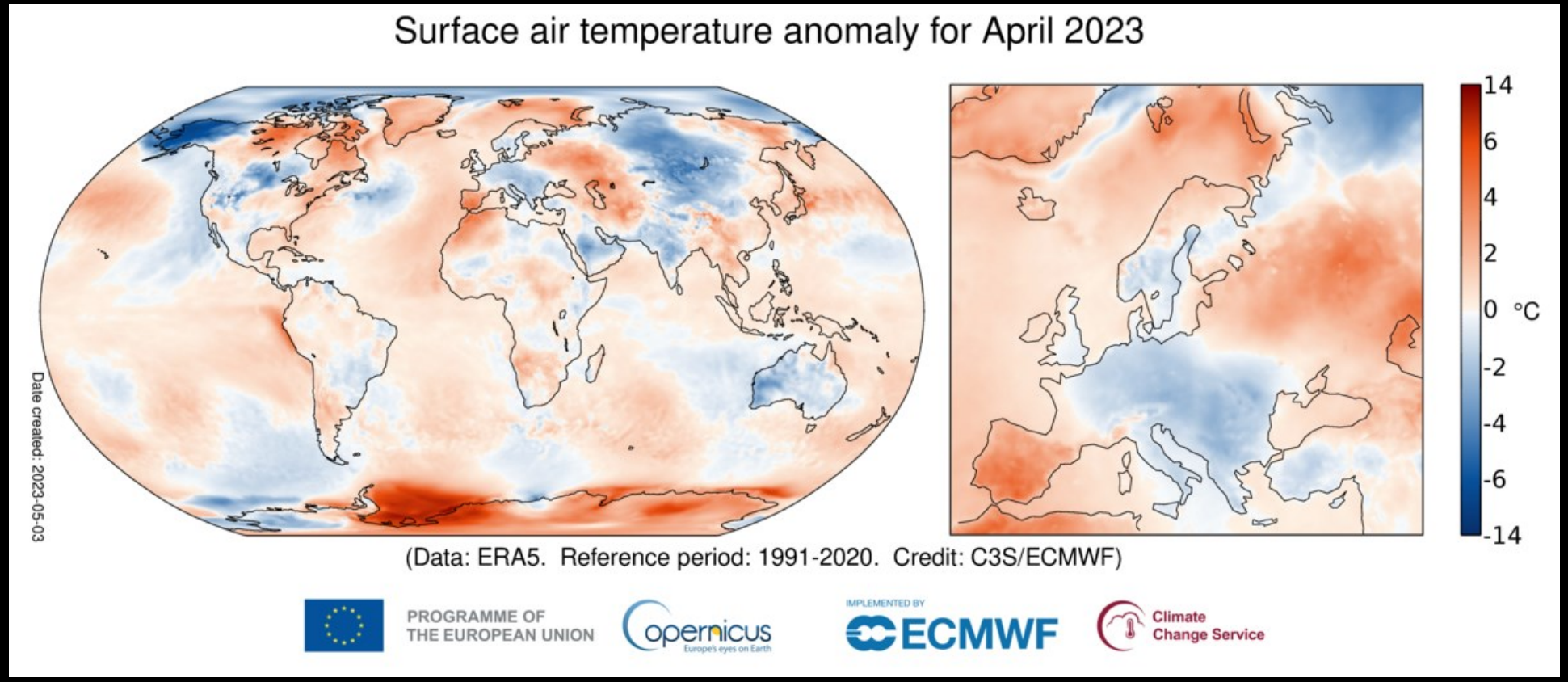
https://link.springer.com/article/10.1007%2Fs00382-018-4339-4

Regional Uncertainties: Frequencies of weather patterns



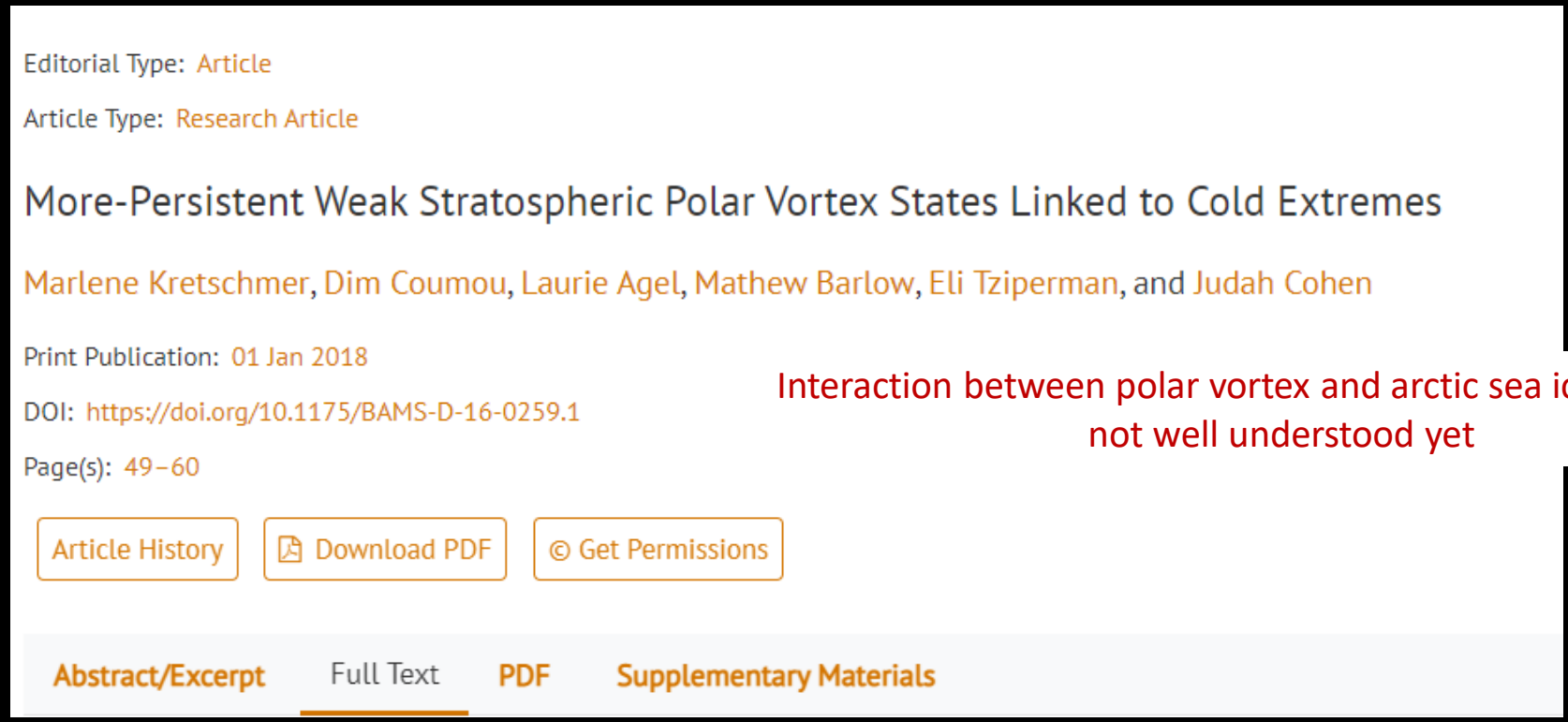
https://www.severe-weather.eu/global-weather/strong-polar-vortex-unusual-weather-united-states-cold-forecast-pattern-fa/

Regional Uncertainties: Frequencies of weather patterns



https://climate.copernicus.eu/surface-air-temperature-april-2021

Regional Uncertainties: Frequencies of weather patterns



Editorial Type: Article

Article Type: Research Article

More-Persistent Weak Stratospheric Polar Vortex States Linked to Cold Extremes

Marlene Kretschmer, Dim Coumou, Laurie Agel, Mathew Barlow, Eli Tziperman, and Judah Cohen

Print Publication: 01 Jan 2018

DOI: https://doi.org/10.1175/BAMS-D-16-0259.1

Page(s): 49–60

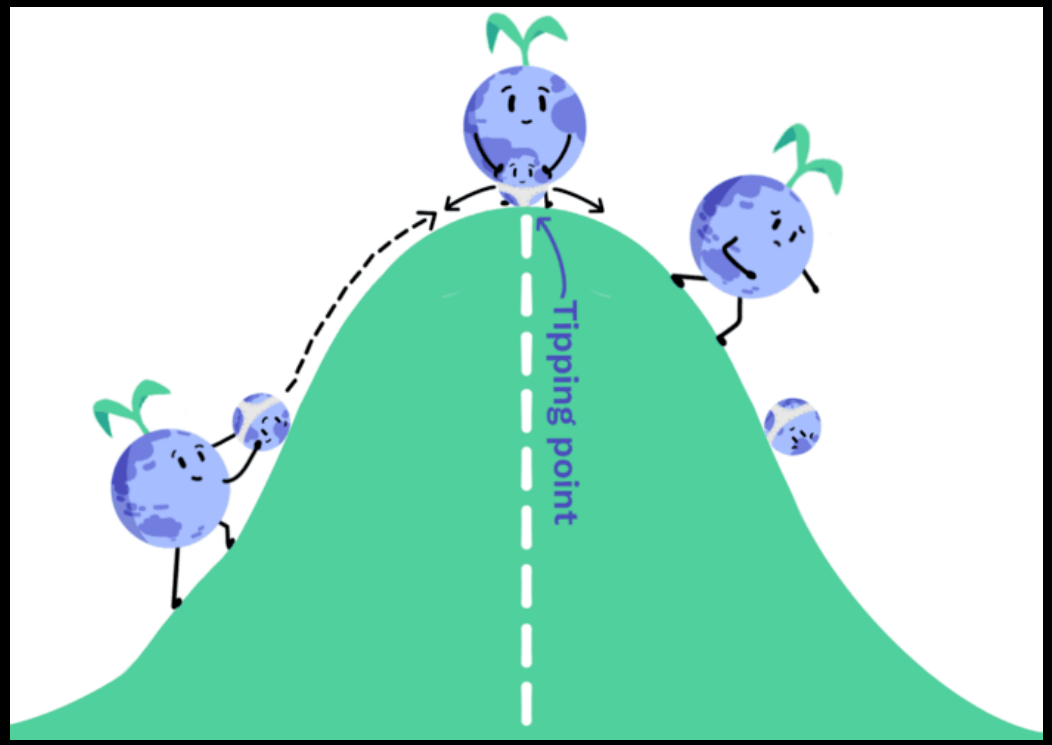
Article History | Download PDF | © Get Permissions

Abstract/Excerpt | Full Text | PDF | Supplementary Materials

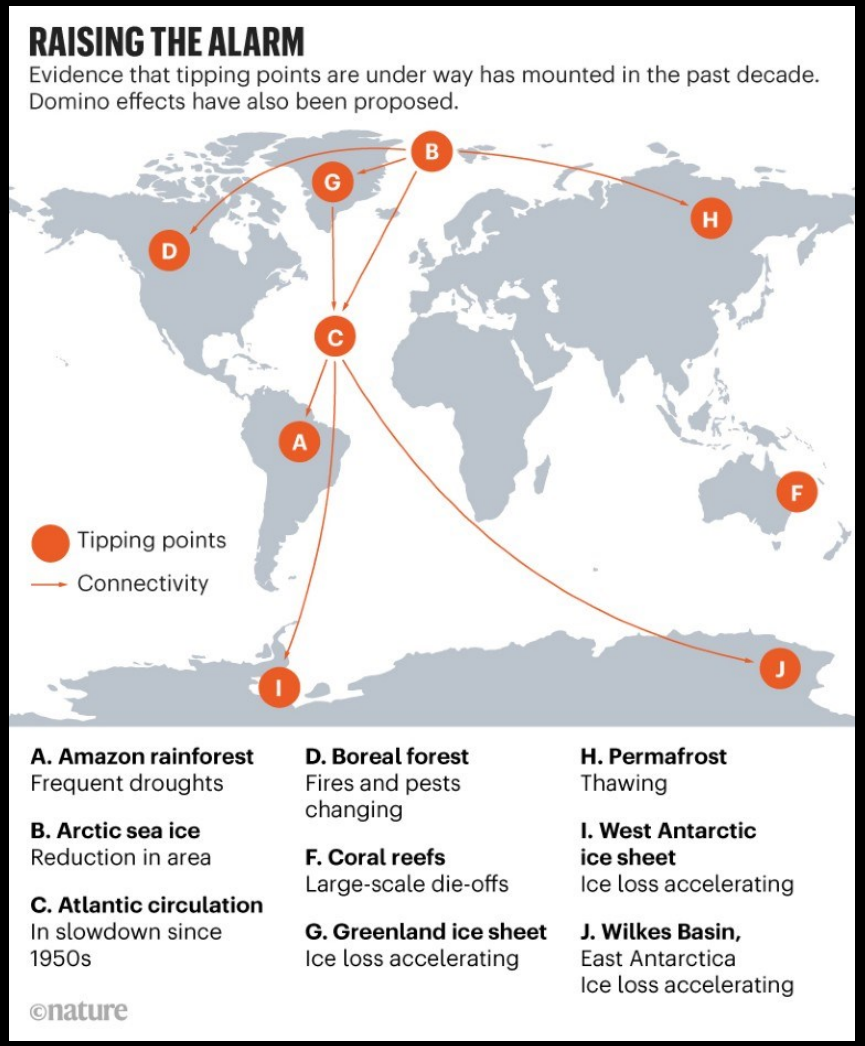
Interaction between polar vortex and arctic sea ice (decrease) not well understood yet

https://journals.ametsoc.org/view/journals/bams/99/1/bams-d-16-0259.1.xml

Uncertainties /Risks for evolution 2100+: Tipping points

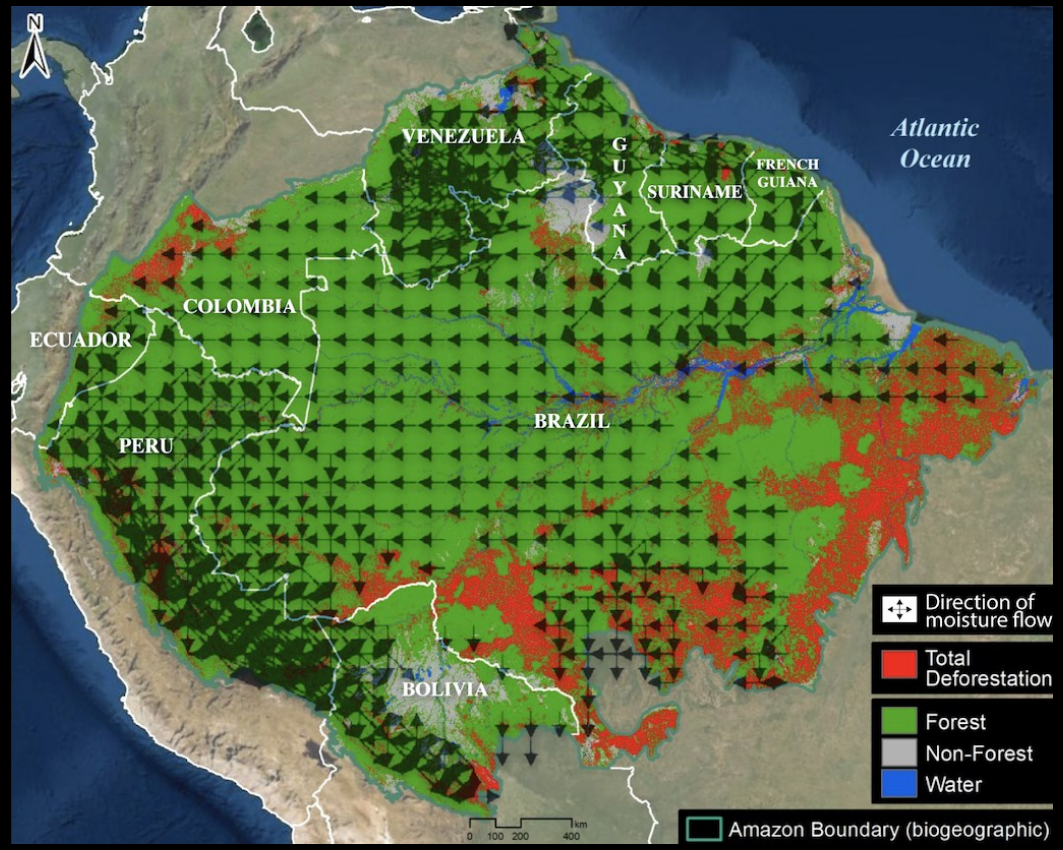


https://climatescience.org/advanced-climate-climate-tipping-points



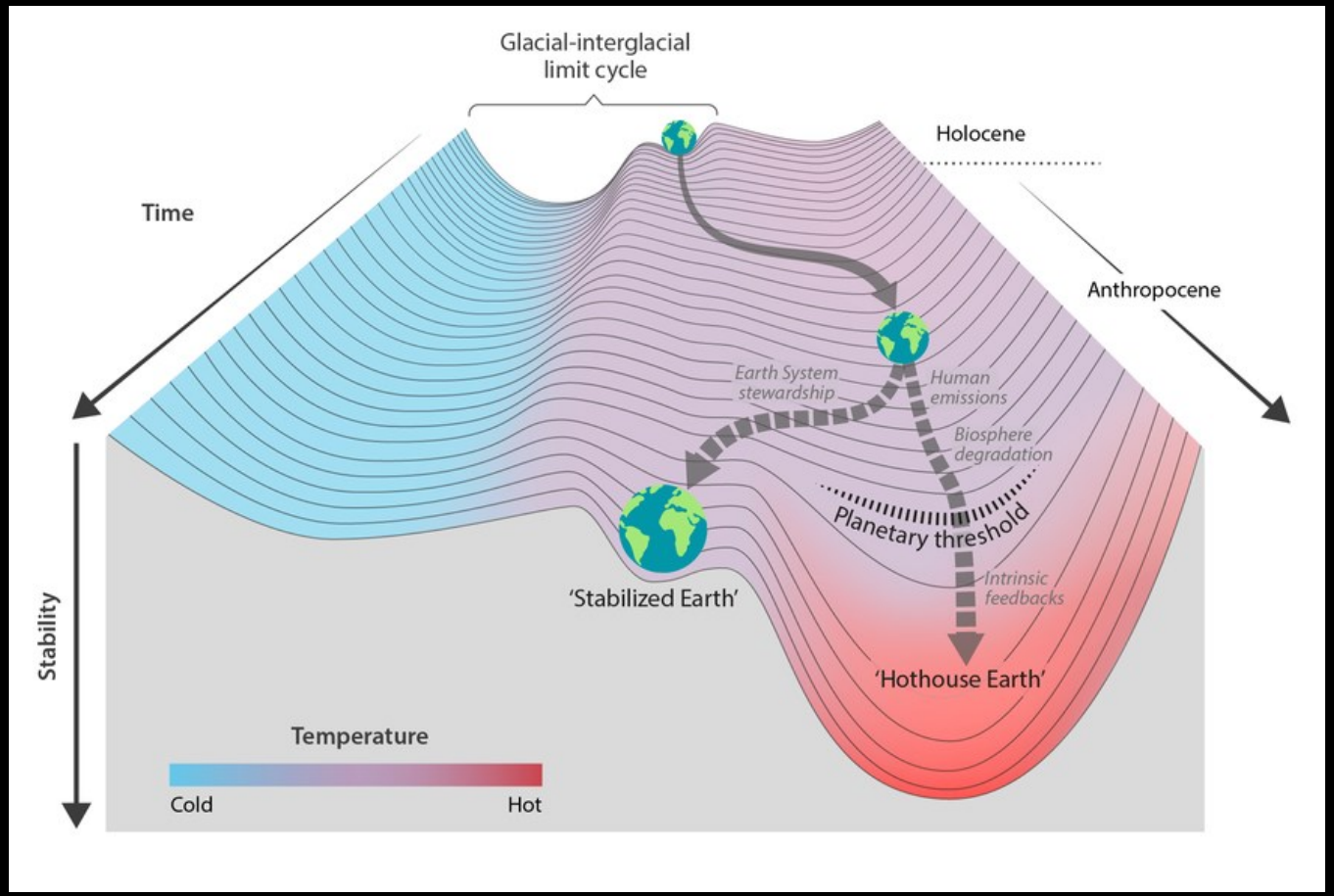
Uncertainties /Risks for evolution 2100+: Tipping points

https://www.eurekalert.org/news-releases/691405



https://news.mongabay.com/2022/09/how-close-is-the-amazon-tipping-point-forest-loss-in-the-east-changes-the-equation/#:~:text=Scientists%20warn%20that%20the%20Amazon,of%20the%20forest%20is%20lost

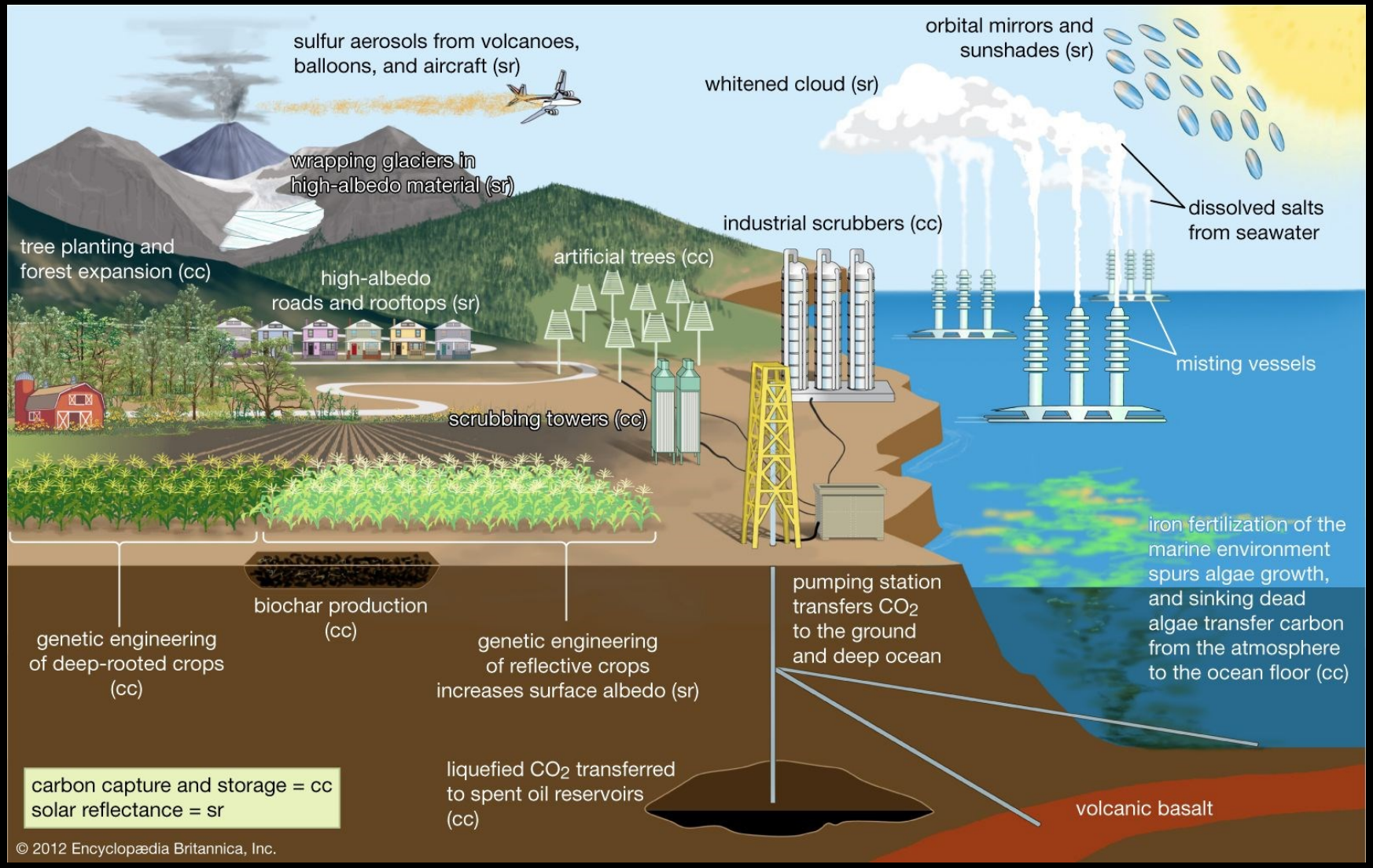
Uncertainties /Risks for evolution 2100+



https://www.pnas.org/doi/full/10.1073/pnas.1810141115

„Hothouse Earth“ – will Geoengineering safe us?

https://www.britannica.com/science/geoengineering



„Hothouse Earth“ – will Geoengineering safe us?

OPEN LETTER

We Call for an International Non-Use Agreement on Solar Geoengineering

We call for immediate political action from governments, the United Nations, and other actors to prevent the normalization of solar geoengineering as a climate policy option. Governments and the United Nations must assert effective political control and restrict the development of solar geoengineering technologies at planetary scale. Specifically, we call for an International Non-Use Agreement on Solar Geoengineering.

https://www.solargeoeng.org/non-use-agreement/open-letter/

https://www.klimareporter.de/technik/soll-geoengineering-verboten-werden

Initiative von 50 Wissenschaftlern 18.01.2022

Sollte Geoengineering verboten werden?

Ob die Klimaerwärmung bei 1,5 Grad gestoppt werden kann, ist zweifelhaft. Doch was dann? Einige Wissenschaftler schlagen vor, das Klima mit Aerosolen zu kühlen. Andere fordert jetzt ein Abkommen, um das Dimmen der Sonne zu verbieten. Ein Konsens ist nicht in Sicht.

von **Christoph Müller, Jörg Staude**

Summary

- Globally, temperature has increase around 1.3°C compared to pre-industrial values
- Regionally and/or over land, the temperature increases are stronger (e.g. currently ~2.5°C in Innsbruck compared to pre-industrial)
- It‘s human greenhouse gas emissions that are causing the exceptional fast temperature increase
- Future scenarios strongly depend on future emissions – current politics might yield almost +3°C (compared to pre-industrial) warming until 2100
- Regionally, changes in temperature are expected to still be amplified – e.g. +4°C (compared to pre-industrial) in the Alps expected (similar for parts of Ukraine)
- Multiple feedbacks between the components of the climate system – risk of crossing tipping points!