Cryosphere, Climate, and Climate Change

Outline:

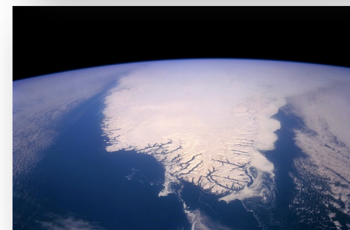
- Definitions (climate, climate change)
- State of the climate: past, present and future
- State of the cryosphere: past, present and future
- Snow cover – climate interaction, snow in a future climate

The (terrestrial) Cryosphere

Components:

- Snow (seasonal and perennial)
- Glaciers (alpine and polar), incl. ice caps
- Ice sheets (Greenland, Antarctica)
- Sea ice (Arctic, and Southern Ocean)
- Ice shelves and icebergs
- Permafrost (frozen ground)
- Lake and river ice








Definitions

Climate:

“Climate in a narrow sense is usually defined as the average weather, or more rigorously, **as the statistical description in terms of the mean and variability** of relevant quantities **over a** [sufficiently long] **period** ranging from months to thousands or millions of years. […] Climate in a wider sense is the state, including a statistical description, of the climate system. […]”

IPCC (2012) Glossary of terms

Note: climate is not weather.

Definitions

Climate change:

"A **change in the state of the climate** that can be **identified** (e.g., by using statistical tests) by changes in **the mean and/or the variability** of its properties and that persists for **an extended period**, typically decades or longer. Climate change may be due to **natural** internal processes or external forcings, or to persistent **anthropogenic** changes in the composition of the atmosphere or in land use."

IPCC (2012) Glossary of terms

RCP: Representative Concentration Pathways (used in earlier IPCC, AR)
SSP: Shared Socioeconomic Pathways (used in IPCC AR6, after 2023)
RCPs are greenhouse gas concentration trajectories, whereas
SSPs are socioeconomic narratives that describe how societies might develop.

Definitions

Forcing:

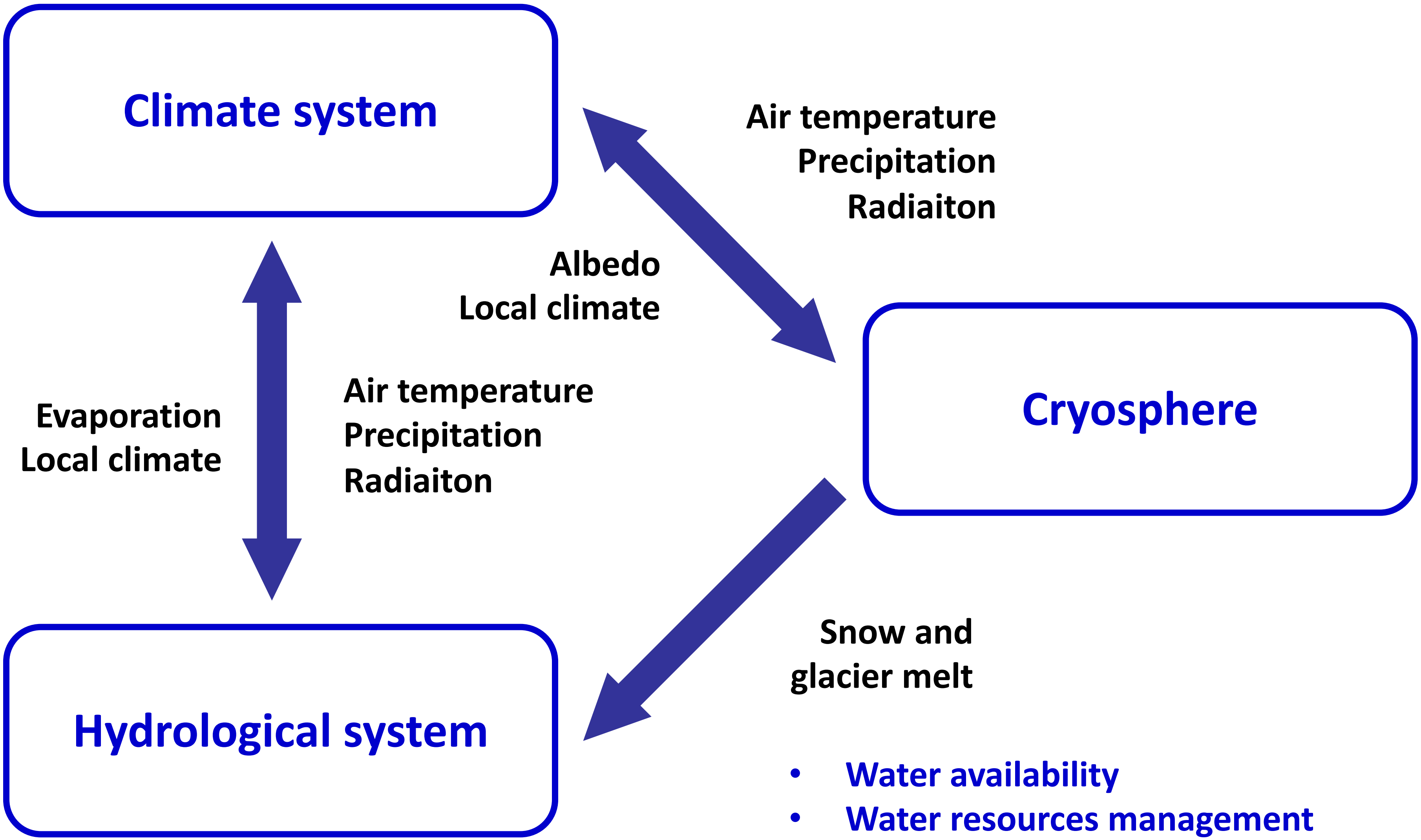
"A **physical influence** (or set of influences) acting (e.g.) on the earth climate system, on a variable, or on the energy balance".

(Example: Variation in solar radiation over time is an external forcing; increase of atmospheric water vapor is an internal forcing.)

Feedback:

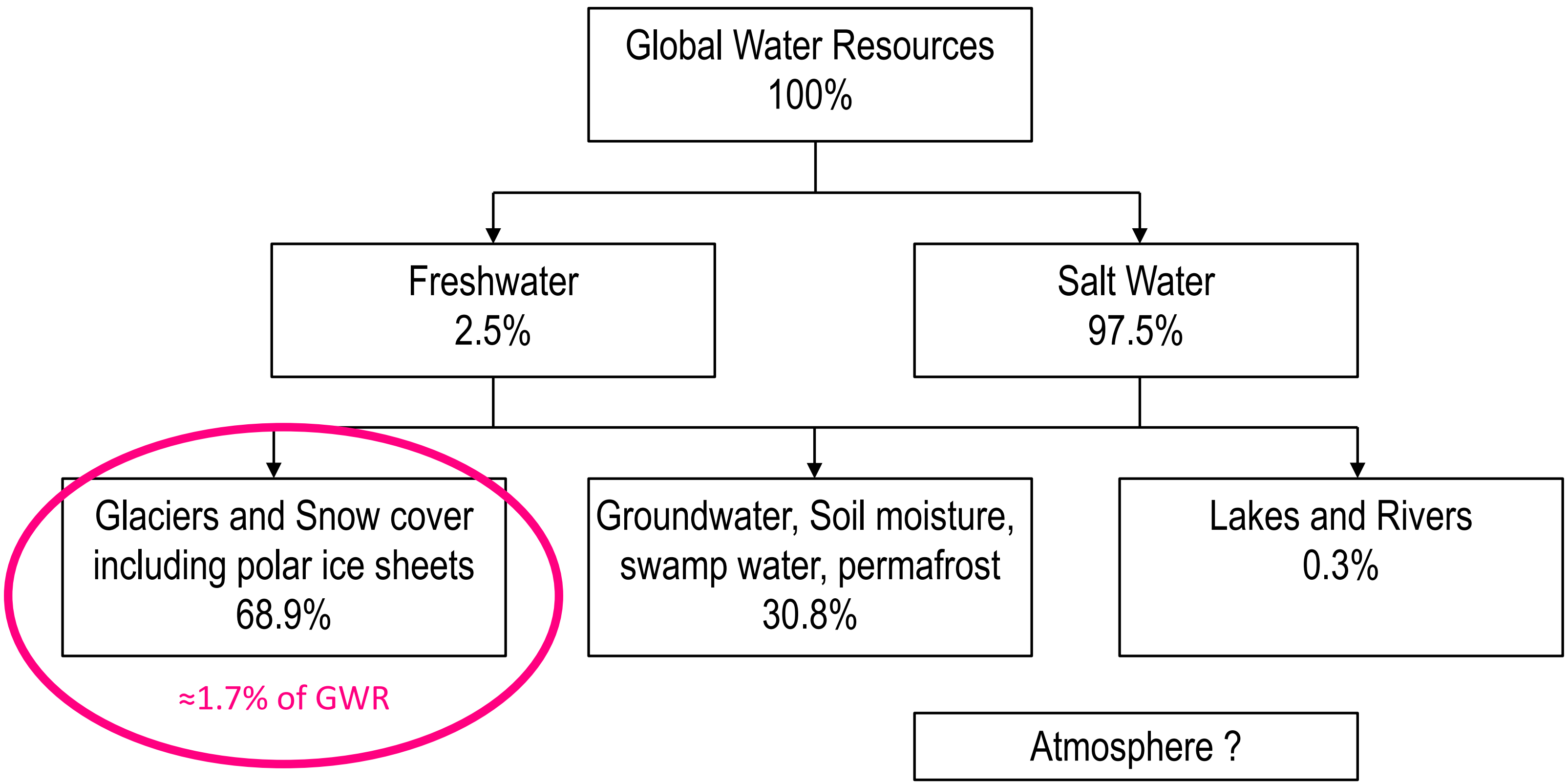
"**Response** to a forcing causes positive or negative change of a physical quantity to either **amplify or mitigate** a forcing (Example: Albedo-temperature feedback)".

Cryosphere – Climate feedback

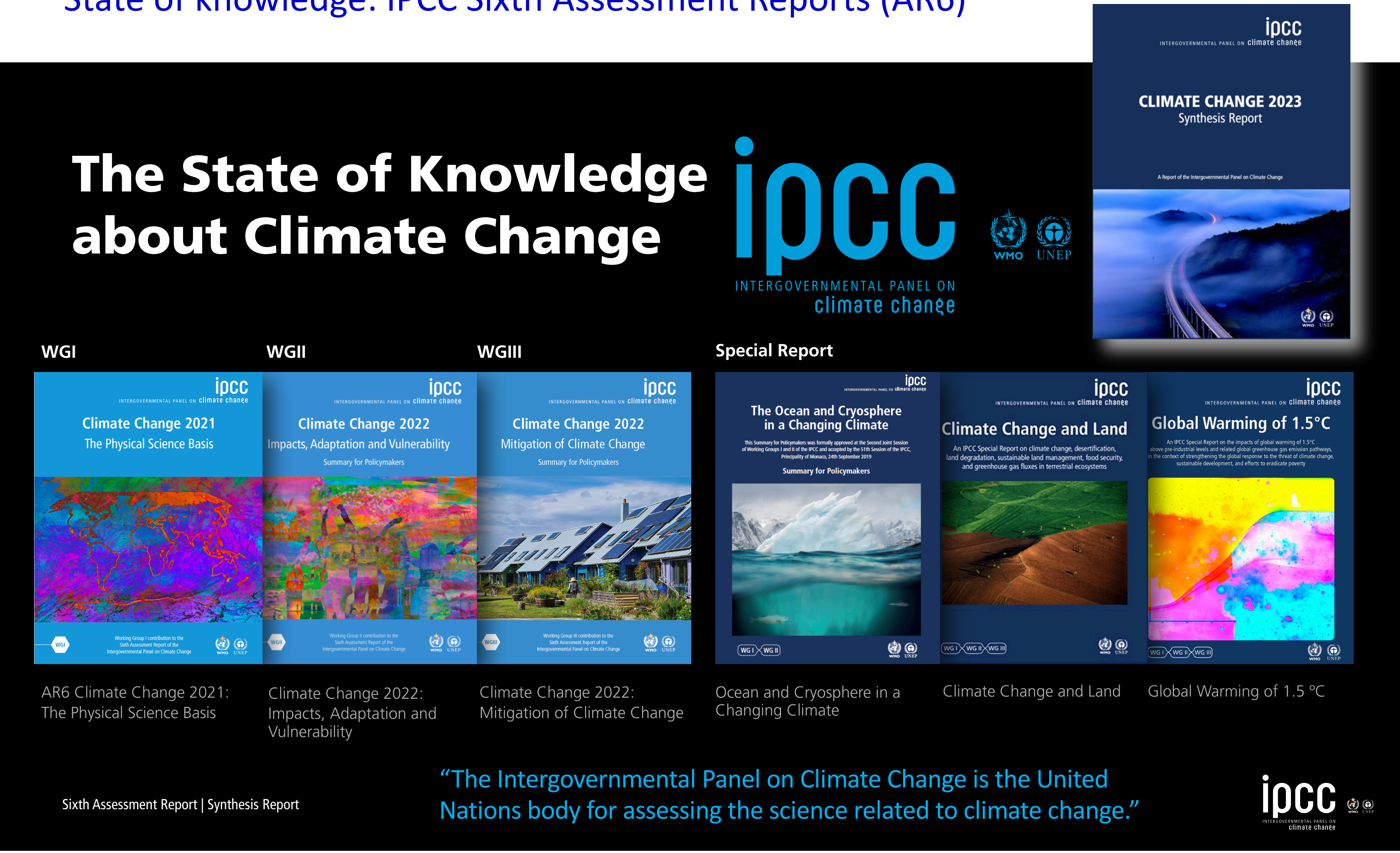


- Water availability
- Water resources management
- Sea level rise

Global water resources



State of knowledge: IPCC Sixth Assessment Reports (AR6)



https://www.ipcc.ch/

Dimensions and consequences of climate change

Why do scientists (and all of us) care about climate (change)?

Understanding the climate system and all its interactions is key to being able to reliably simulate and forecast changes and to propose solutions avoiding, reducing, and mitigating climate change.

State of the climate

Credit: WMO SoC, 2022

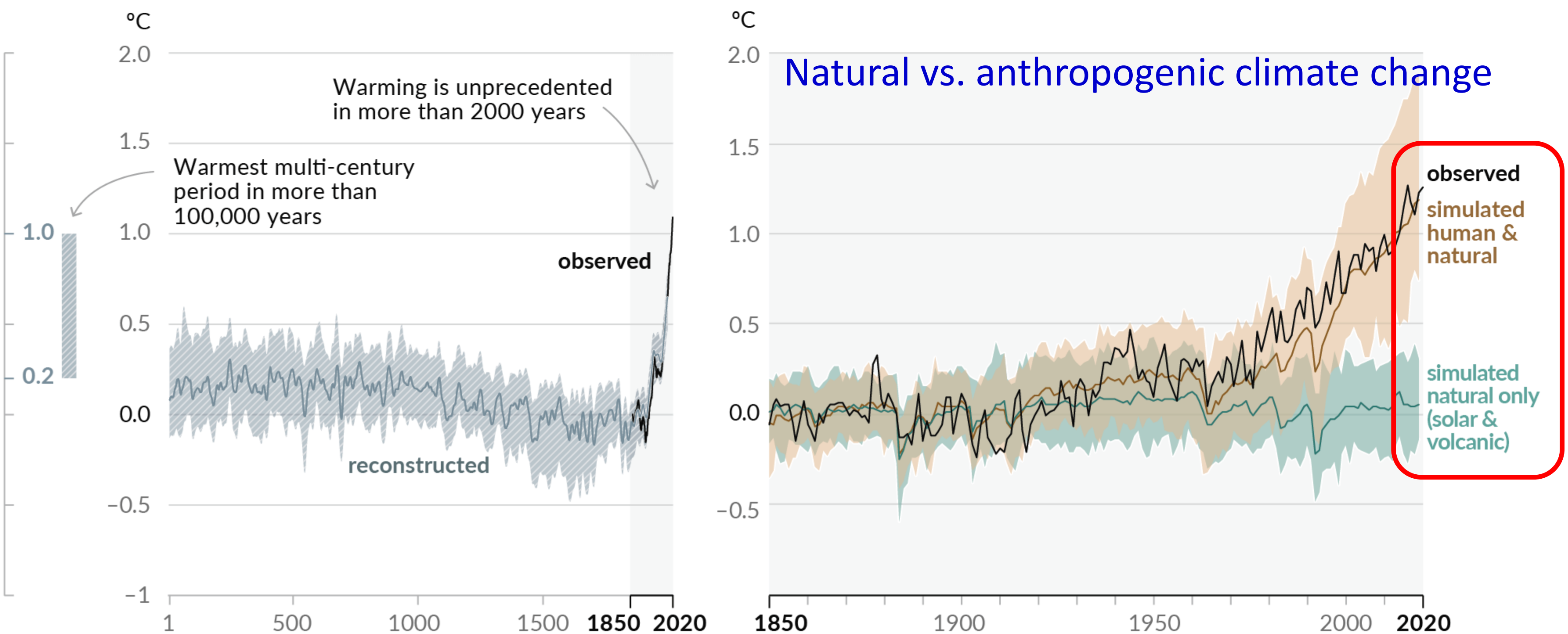
Past global temperature evolution

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850–1900

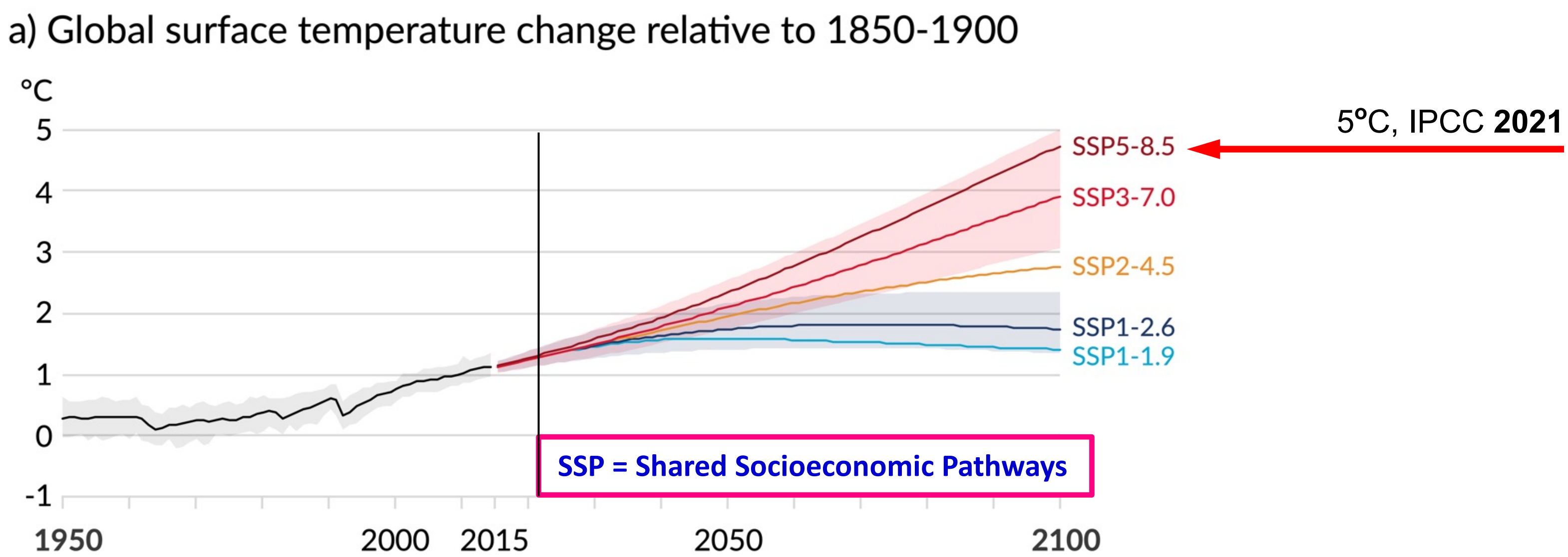
(a) Change in global surface temperature (decadal average) as reconstructed (1–2000) and observed (1850–2020)

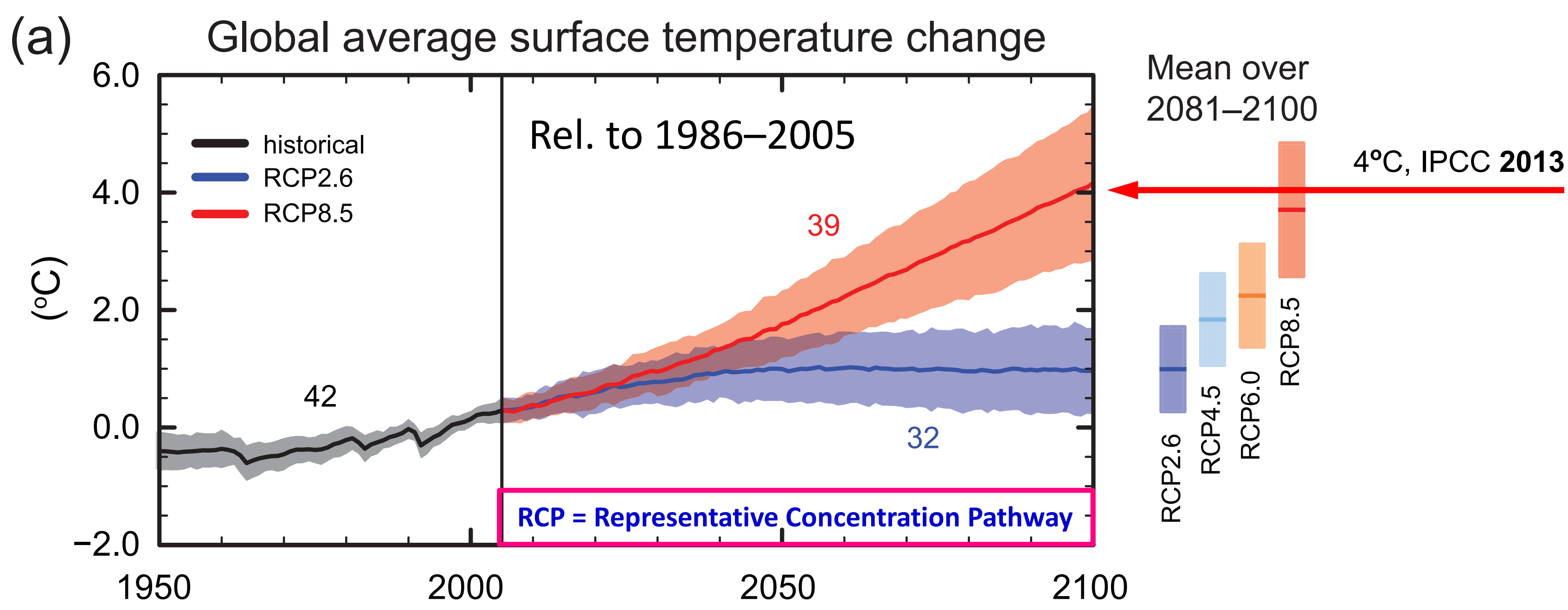
(b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850–2020)



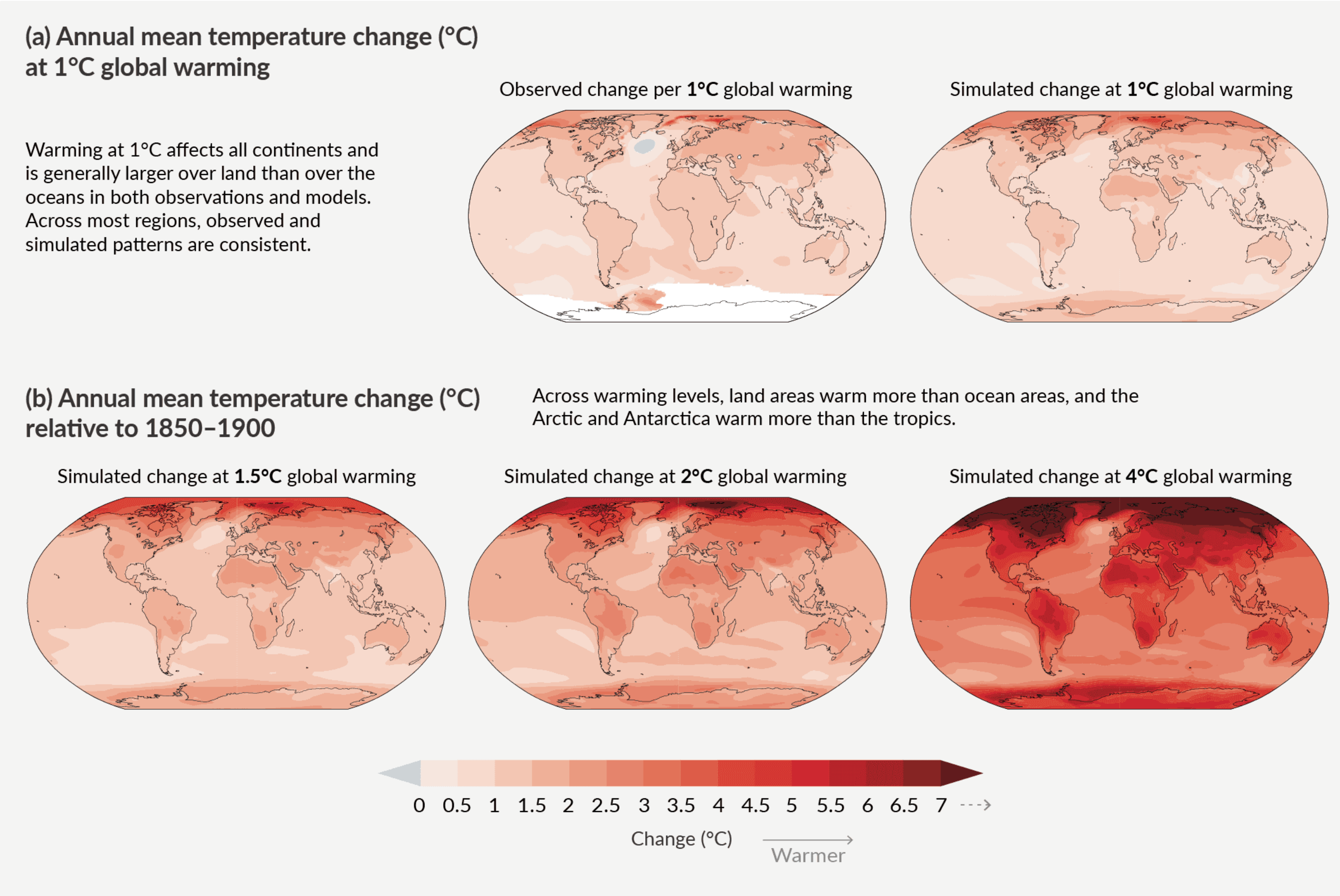
(IPCC AR6, WG1, SPM, F1, 2021)

Future global temperature evolution (RCP and SSP)





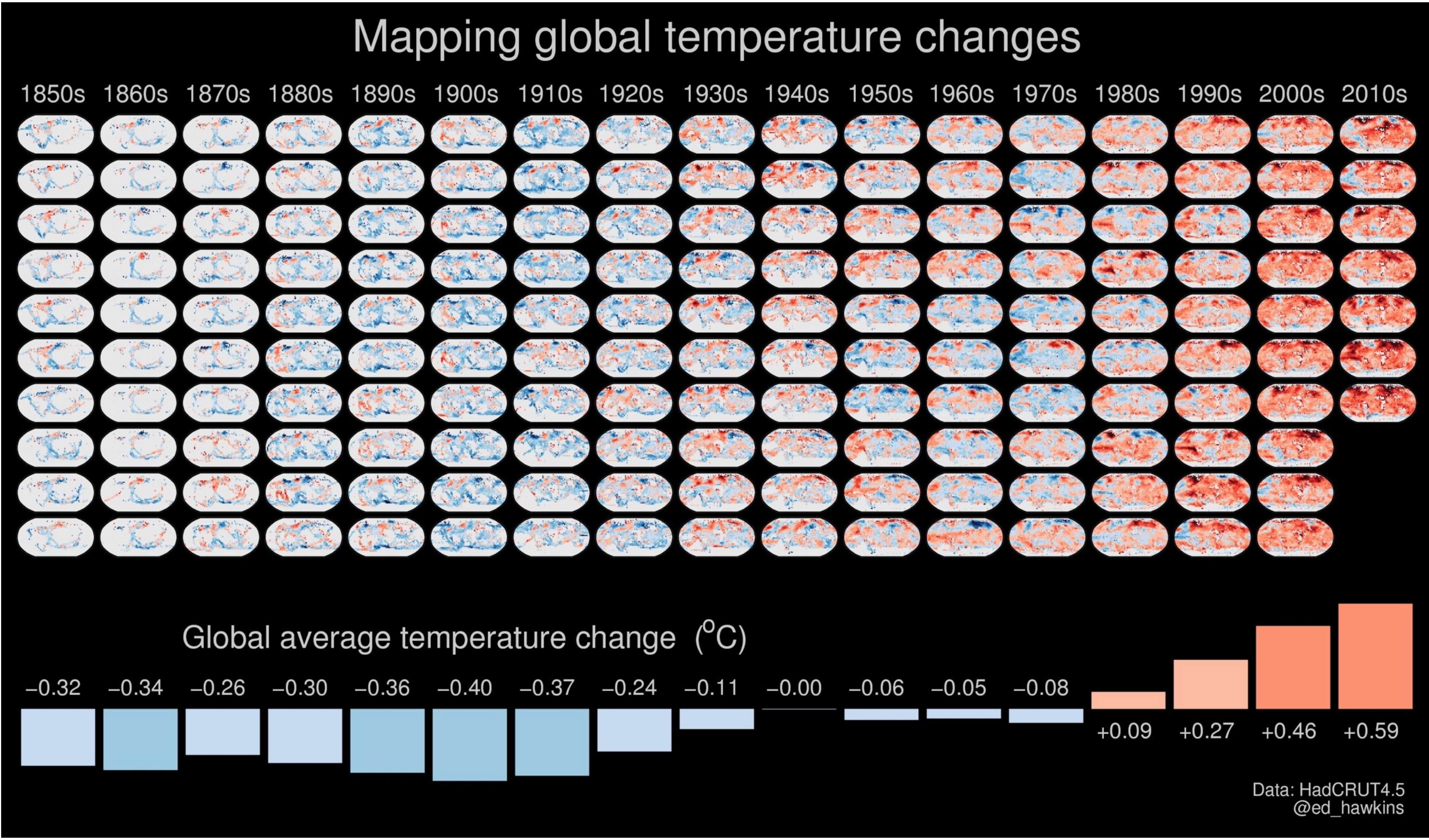
Future change in air temperature



→ Note: polar amplification!

(IPCC AR6, WG1, SPM, F5a, 2021)

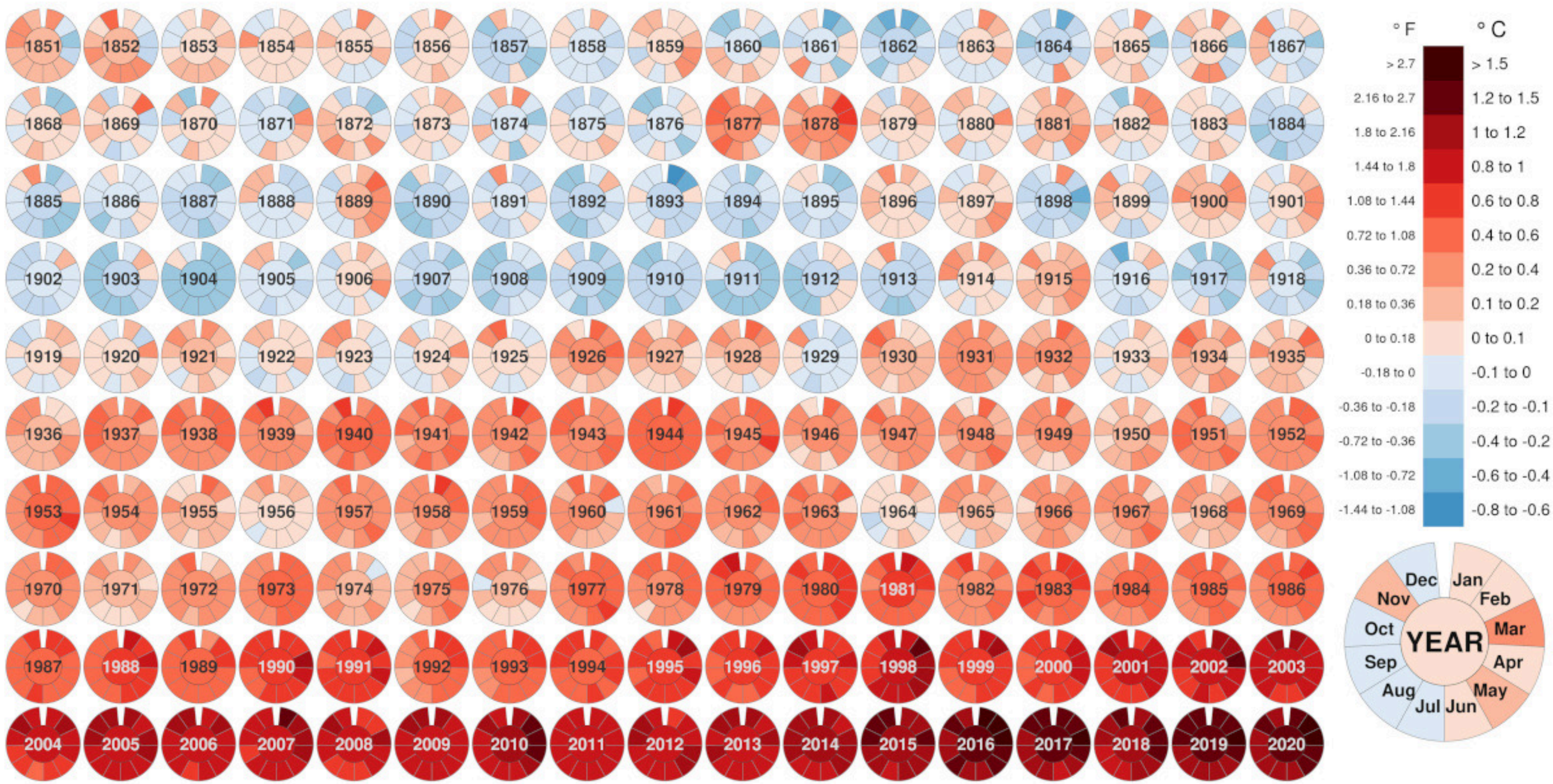
Global surface air temperature evolution, spatial



Ed Hawkins, Univ. Reading, UK

Global surface air temperature evolution, seasonal

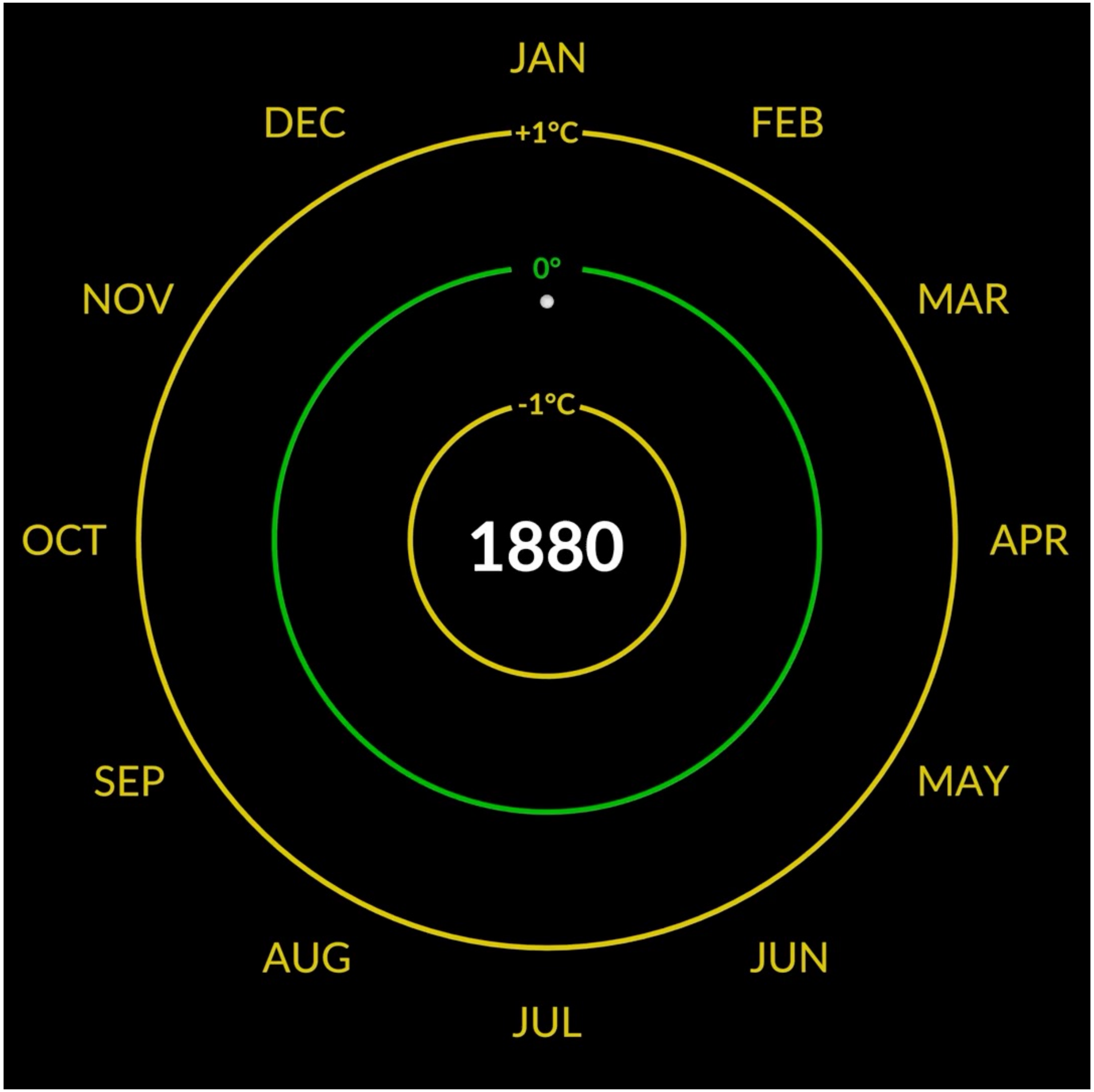
Monthly global mean temperature 1851 to 2020 (compared to 1850-1900 averages)



Data: HadCRUT5 - Created by: @neilrkaye

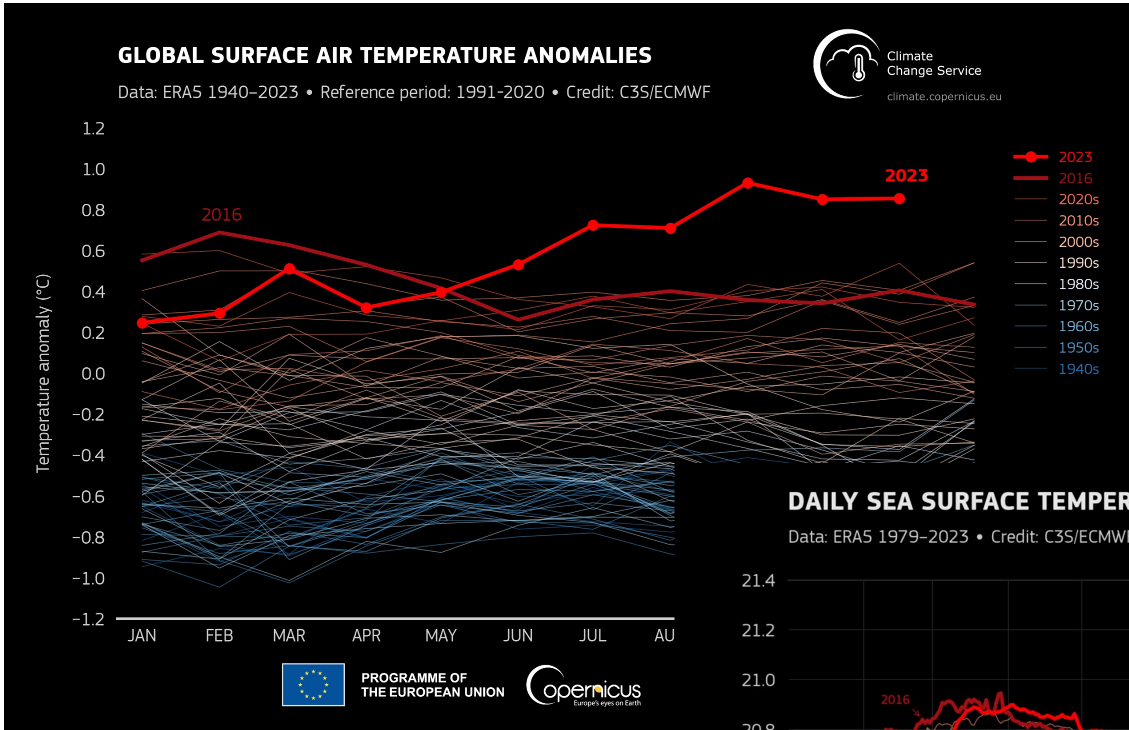
Neil Kaye, Met Office, UK

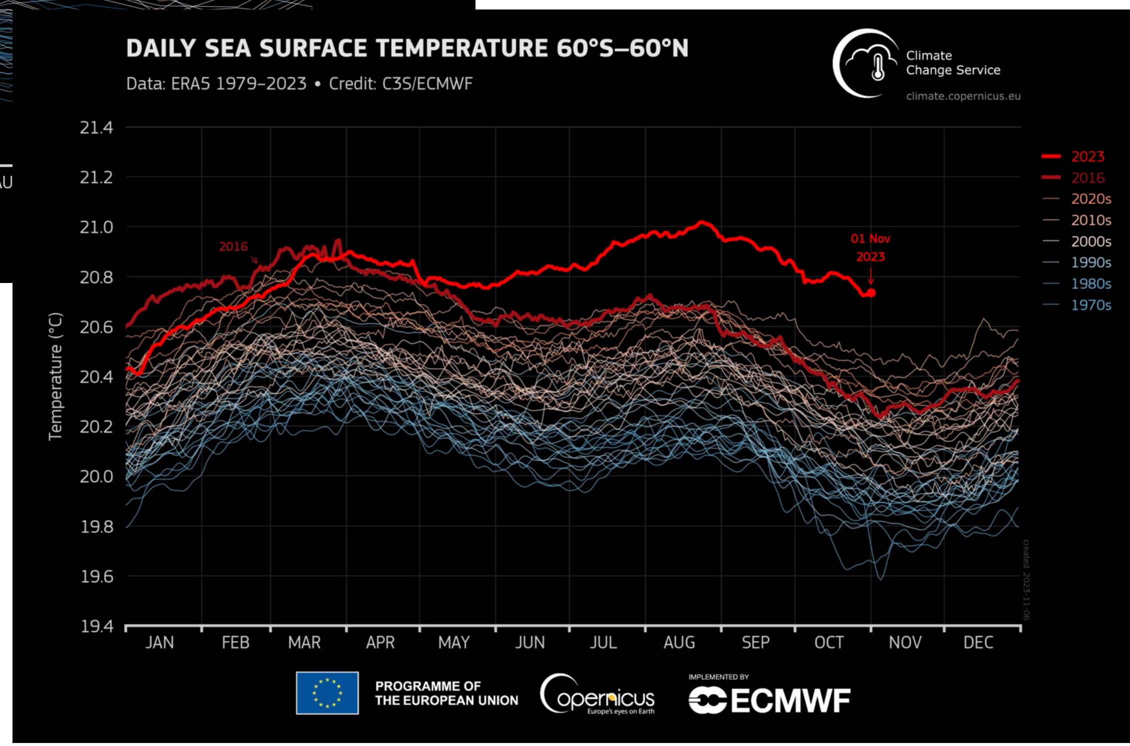
“Climate spiral”



NASA's Scientific Visualization Studio

Global surface air and sea surface temperature



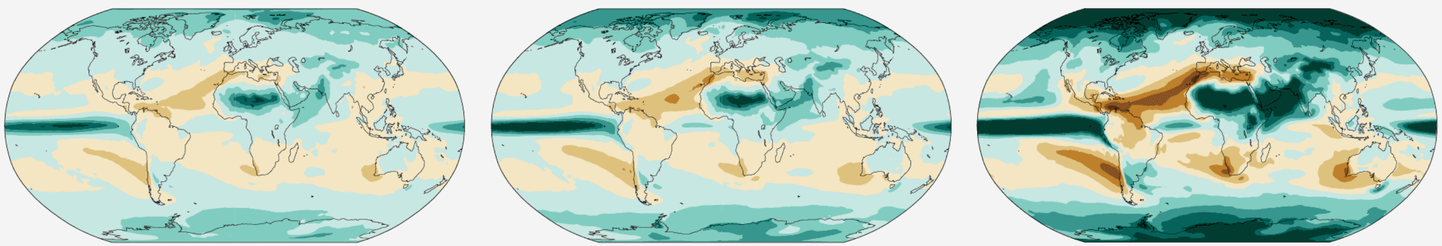


Future change in precipitation and soil moisture

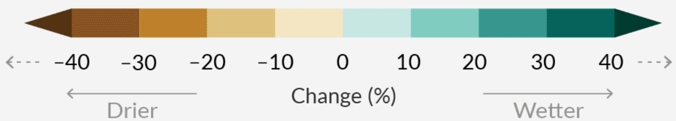
(c) Annual mean precipitation change (%) relative to 1850–1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

Simulated change at **1.5°C** global warming | Simulated change at **2°C** global warming | Simulated change at **4°C** global warming



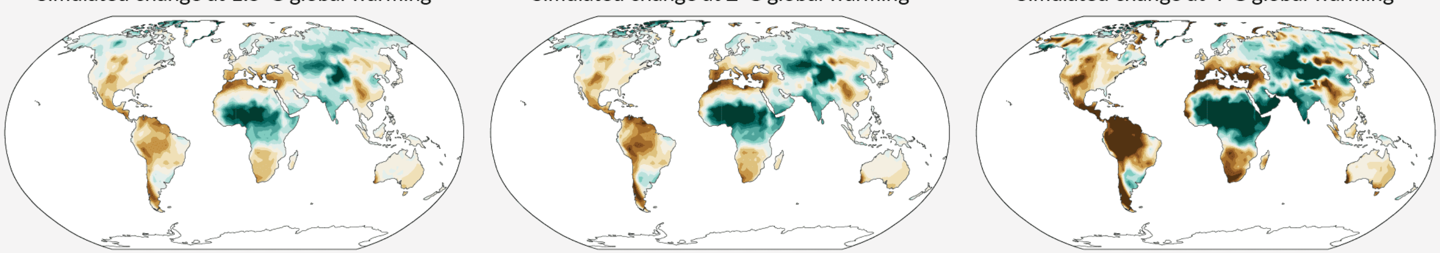
Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions



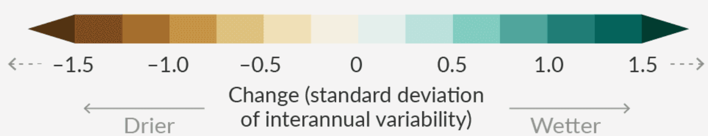
(d) Annual mean total column soil moisture change (standard deviation)

Across warming levels, changes in soil moisture largely follow changes in precipitation but also show some differences due to the influence of evapotranspiration.

Simulated change at **1.5°C** global warming | Simulated change at **2°C** global warming | Simulated change at **4°C** global warming

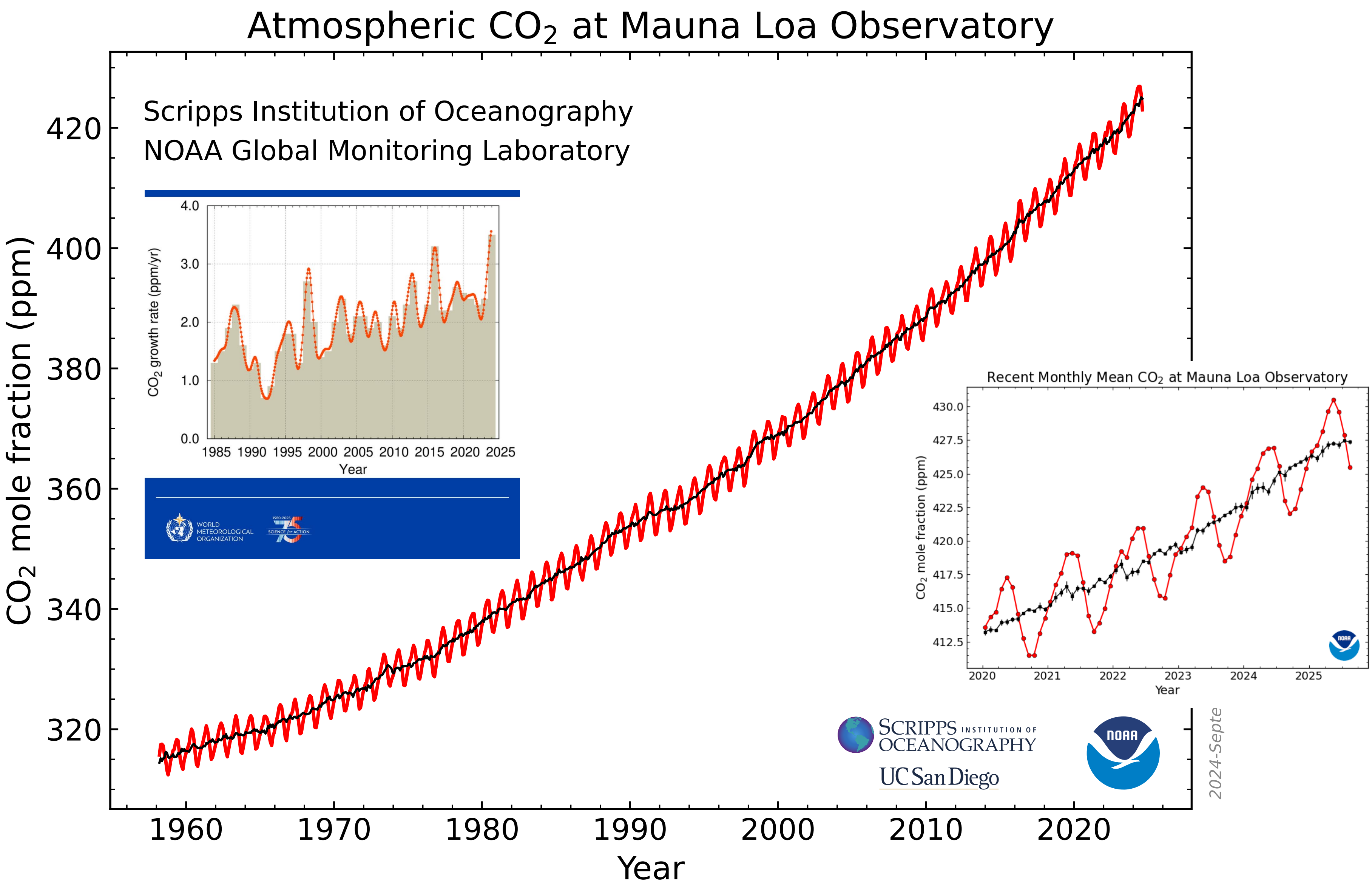


Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little interannual variability in baseline conditions



(IPCC AR6, WG1, SPM, F5b, 2021)

Causes of global warming: greenhouse gases, CO_2

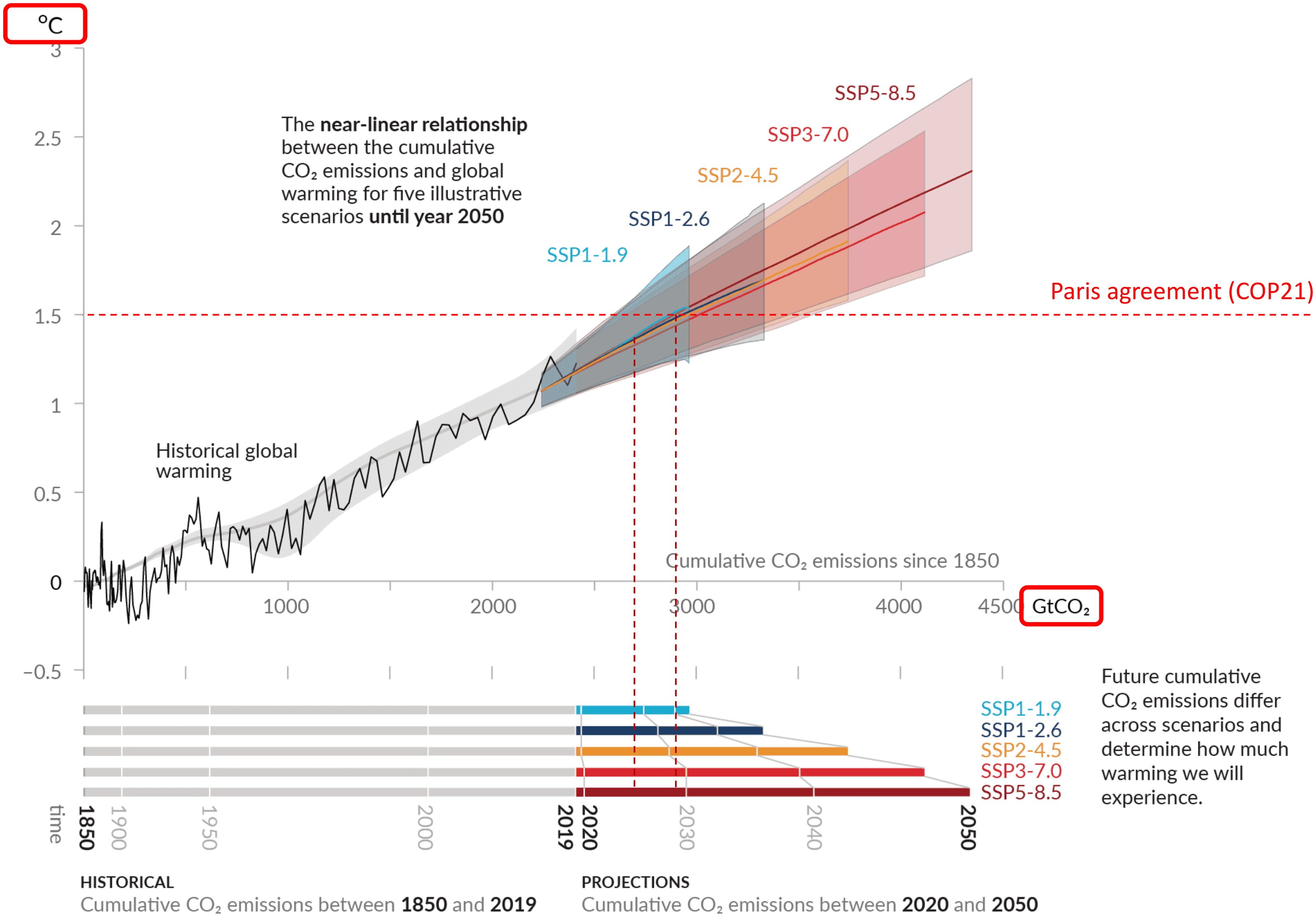


Source: NOAA

CO2 emission – annual cycle (2020-2021)

Future temperature evolution and CO_2 emissions

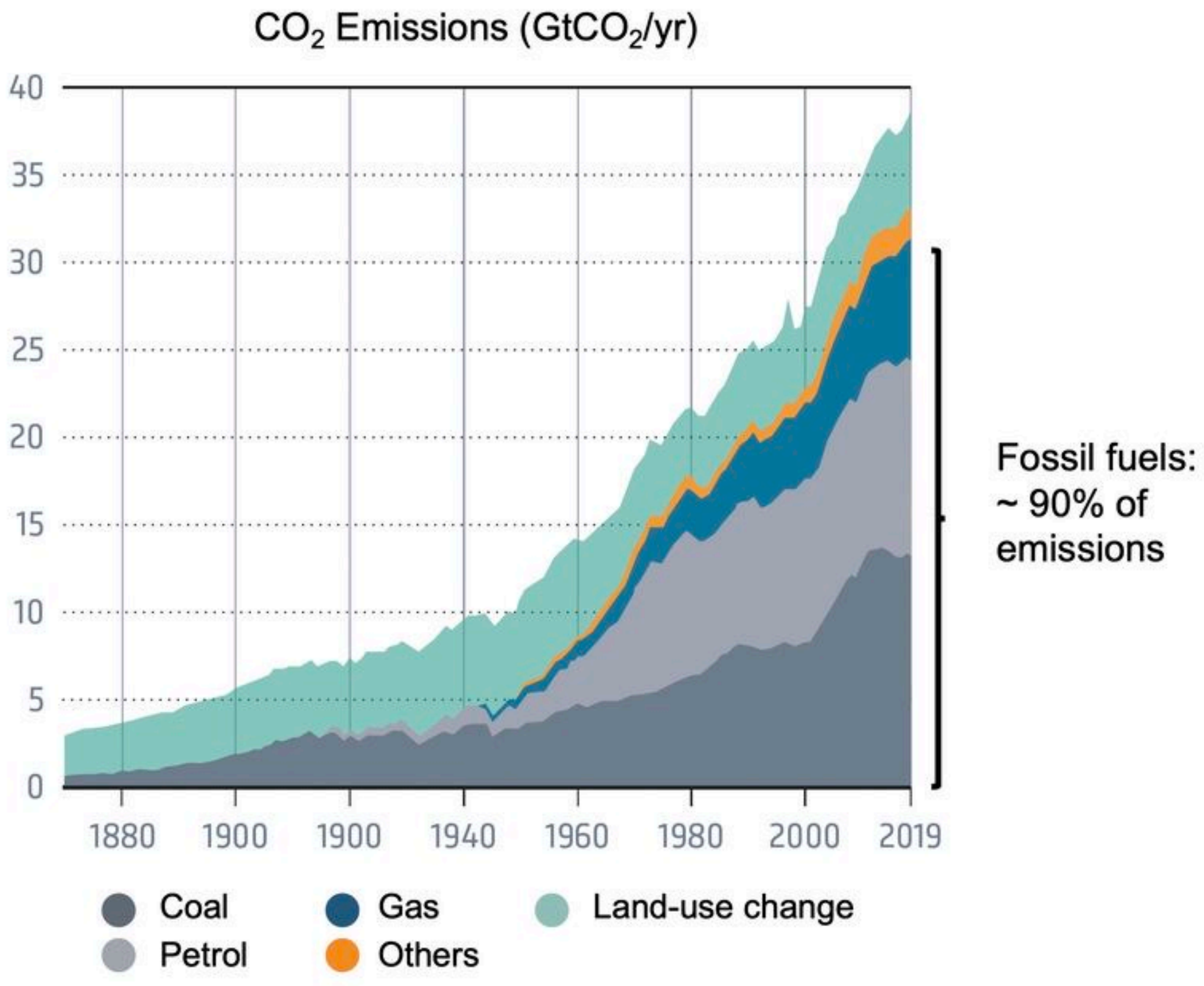
Global surface temperature increase since 1850–1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



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

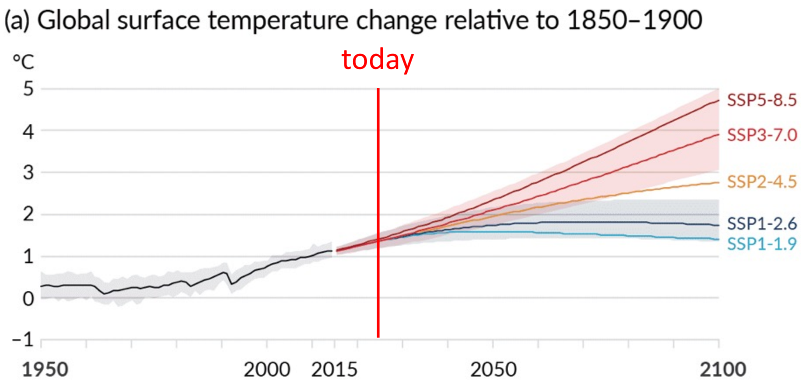
(IPCC AR6, WG1, SPM, F10, 2021)

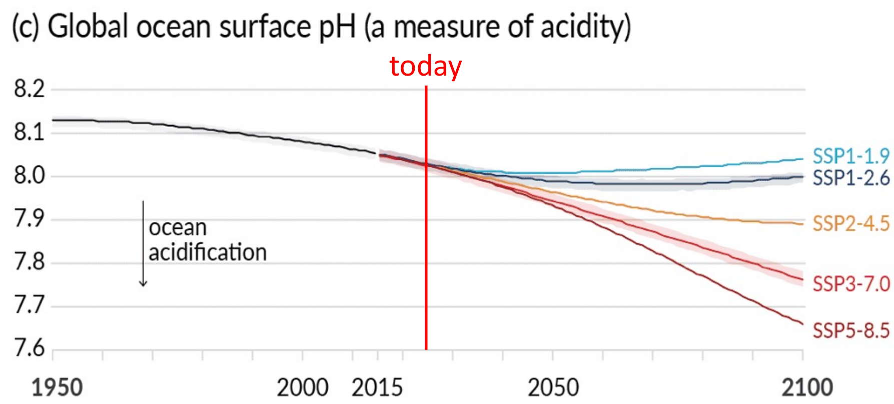
Fossil fuel consumption and related emissions

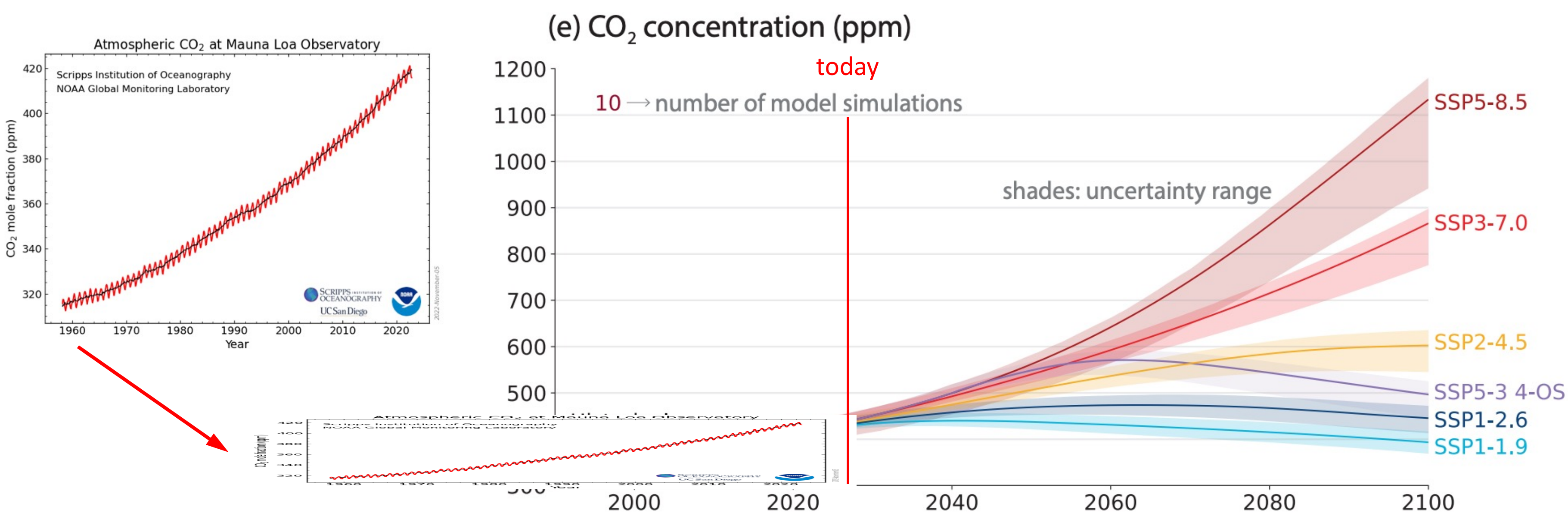


(Based on IPCC AR6, Fig. 5.5 & SCNAT: https://naturalsciences.ch/trendwende)

Projections of climate-relevant variables



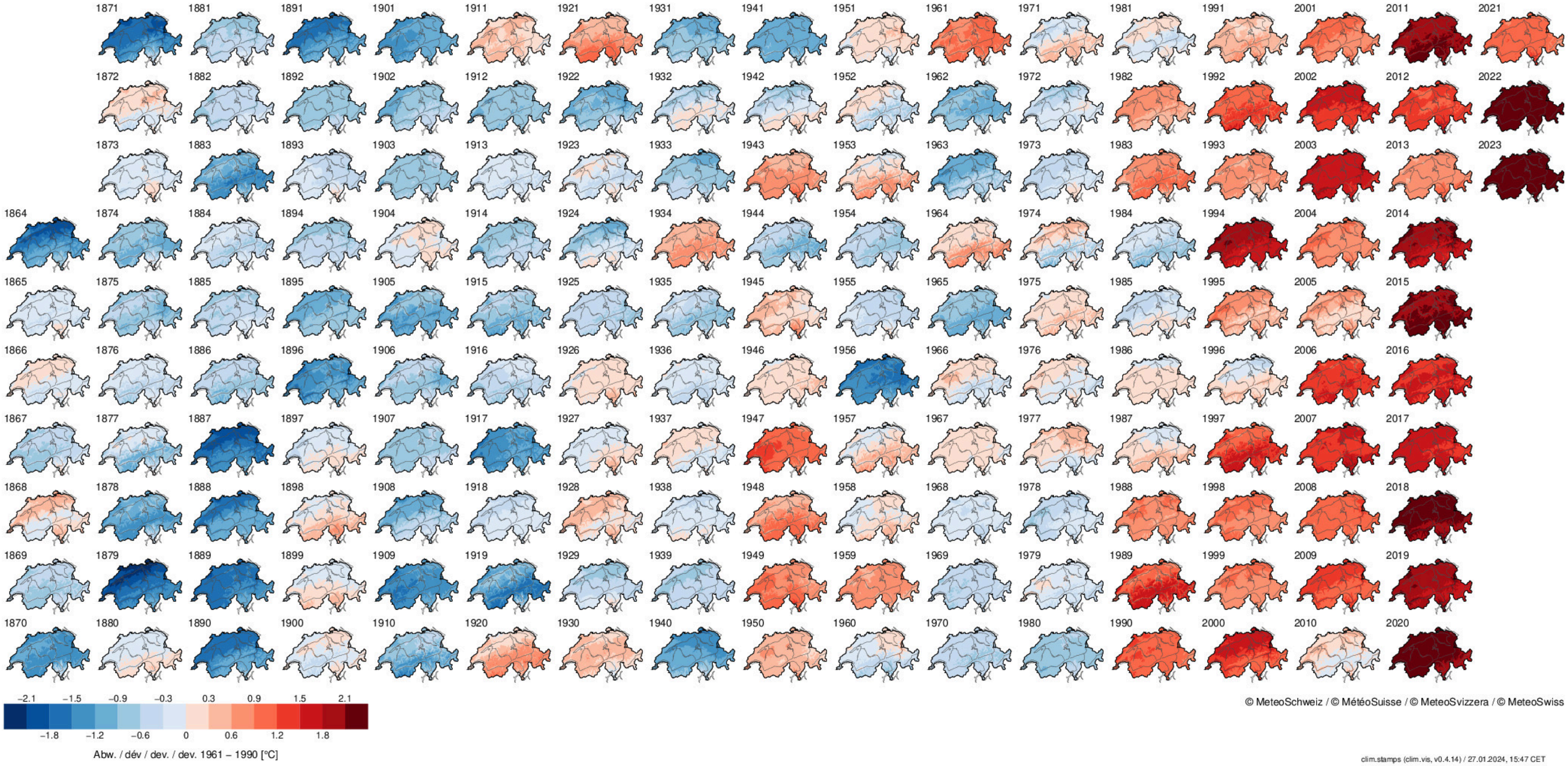




(IPCC AR6, WG1, SPM, F8, 2021)

Historic air temperature evolution in CH

Annual air temperature anomaly compared to the period 1961-1990

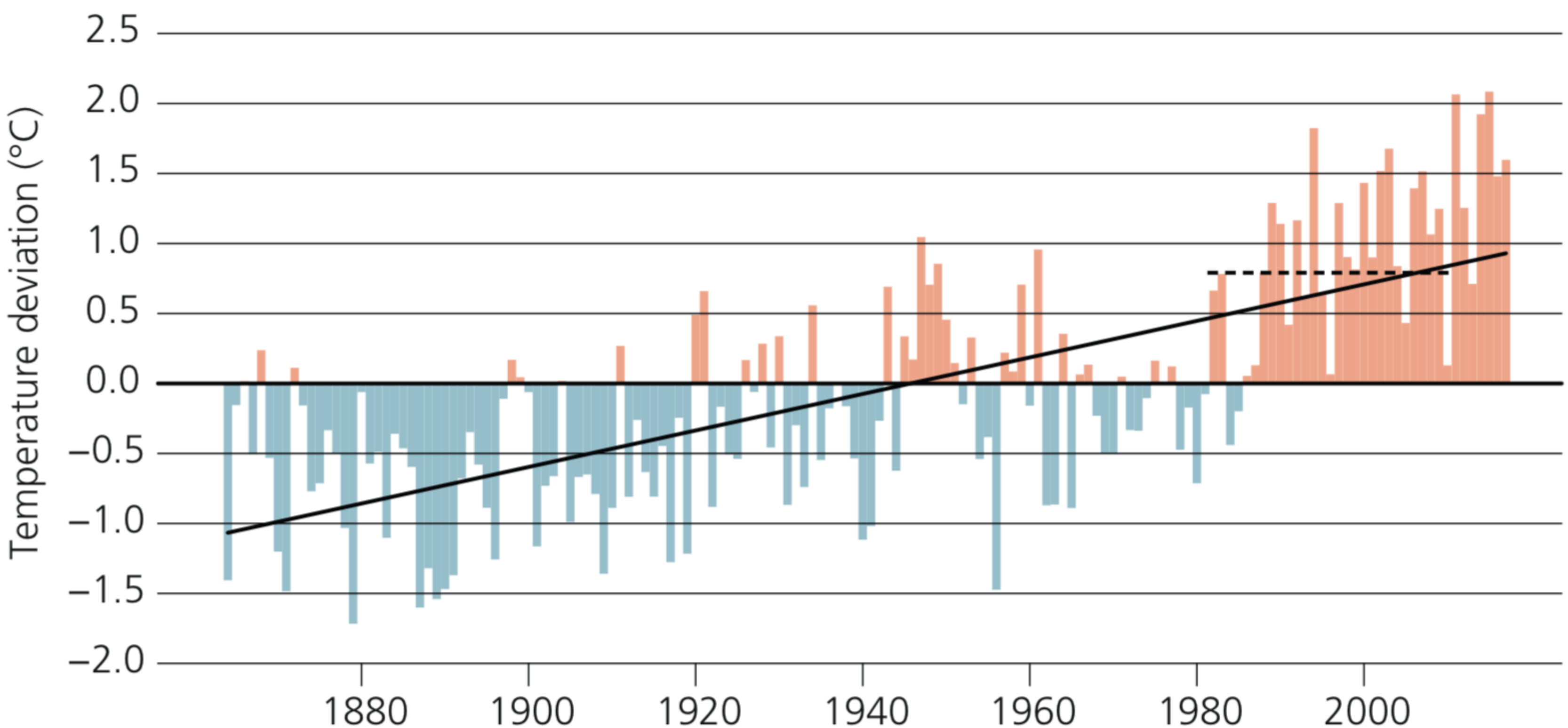


Historic air temperature evolution in CH

Annual mean temperature 1864–2017

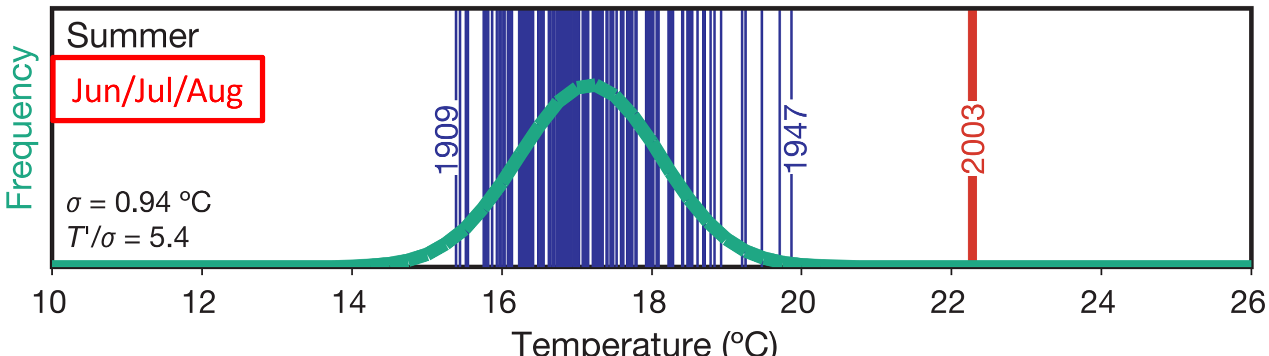
Deviation of average Swiss annual temperatures from the mean in the period from 1961 to1990

- Years above 1961–1990 average
- Years below 1961–1990 average
- Linear trend 1864–2017
- Average 1981–2010

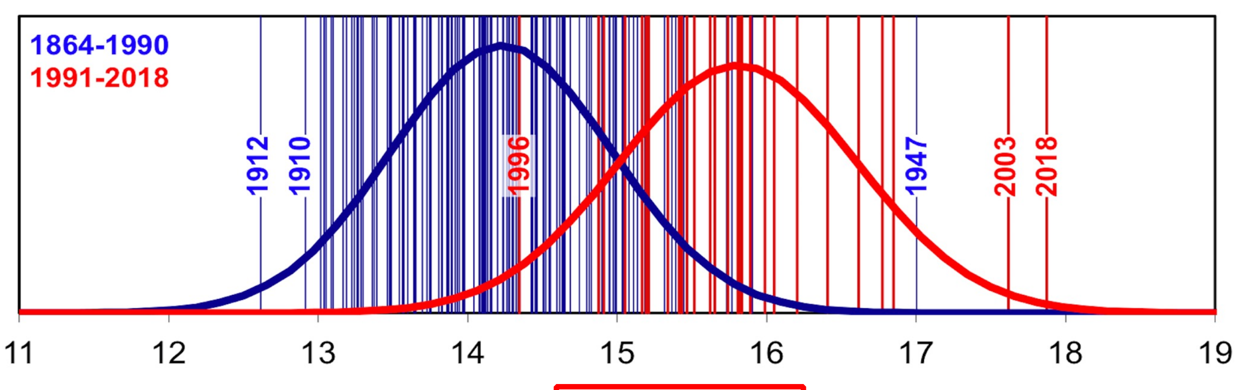


NCCS (Pub.) 2018: CH2018 - Climate Scenarios for Switzerland. National Centre for Climate Services, Zurich. 24 pp.

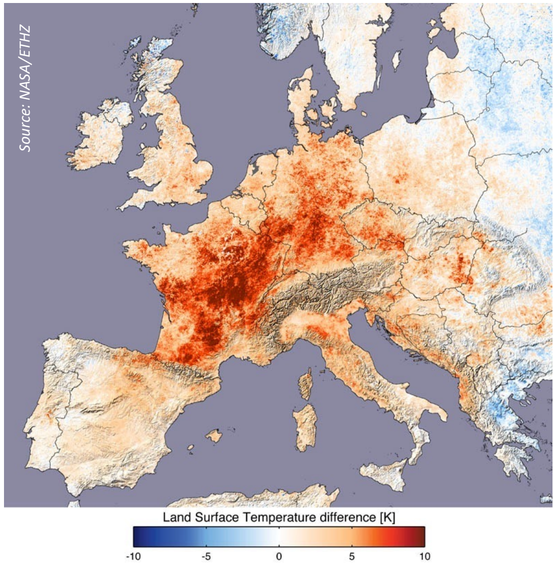
Summer temperature Europe (2003 heat wave)



Schär et al. 2004, Nature



Schär et al. (2019?), ETHZ based on MeteoSwiss data



Polar heat waves – Antarctica 2022 and 2024

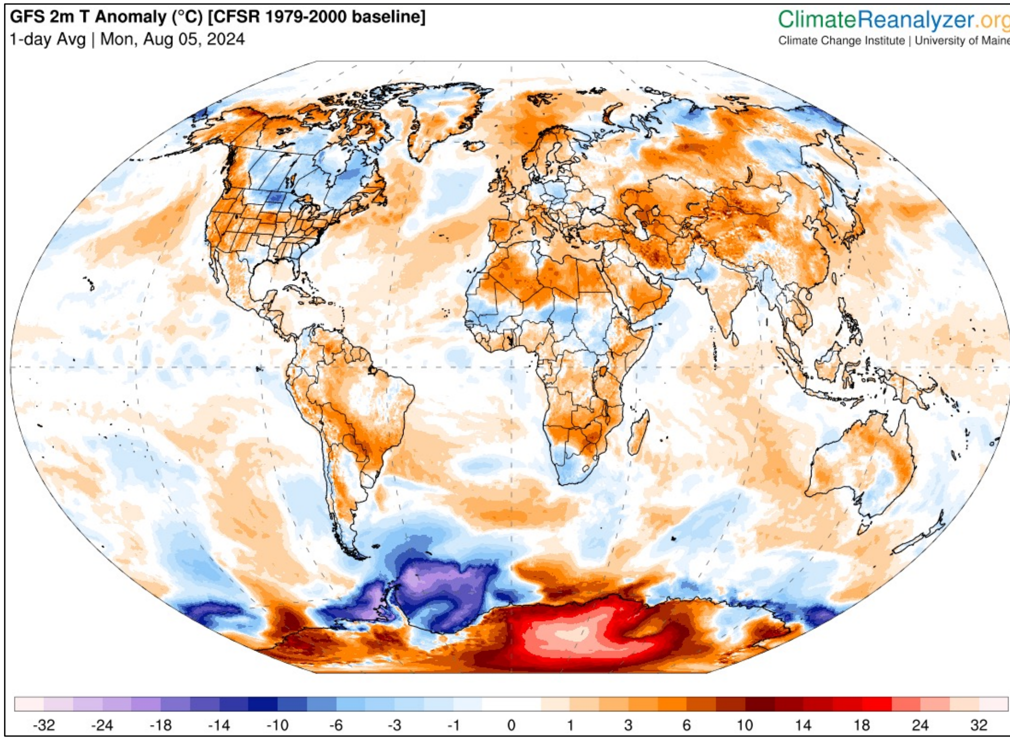
VOLUME 37 JOURNAL OF CLIMATE 1 FEBRUARY 2024

The Extraordinary March 2022 East Antarctica "Heat" Wave. Part I: Observations and Meteorological Drivers

Geophysical Research Letters

Research Letter | Open Access

The Largest Ever Recorded Heatwave—Characteristics and Attribution of the Antarctic Heatwave of March 2022



ENVIRONMENT

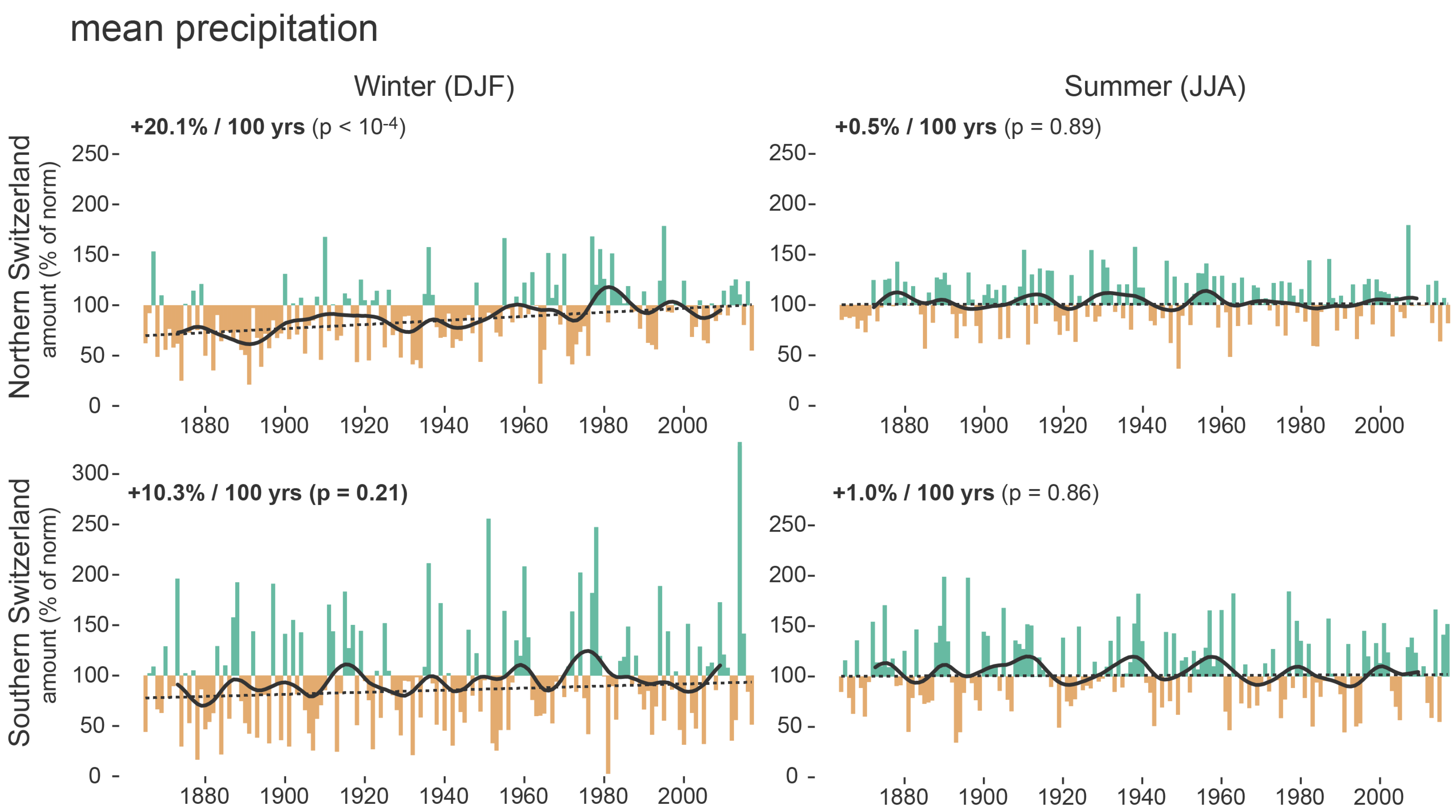
ca. 28 C above

Antarctic temperatures soar 50 degrees above norm in long-lasting heat wave

This historic warm spell in East Antarctica is an ominous example of the temperature spikes this polar climate could experience more of in a warming world.

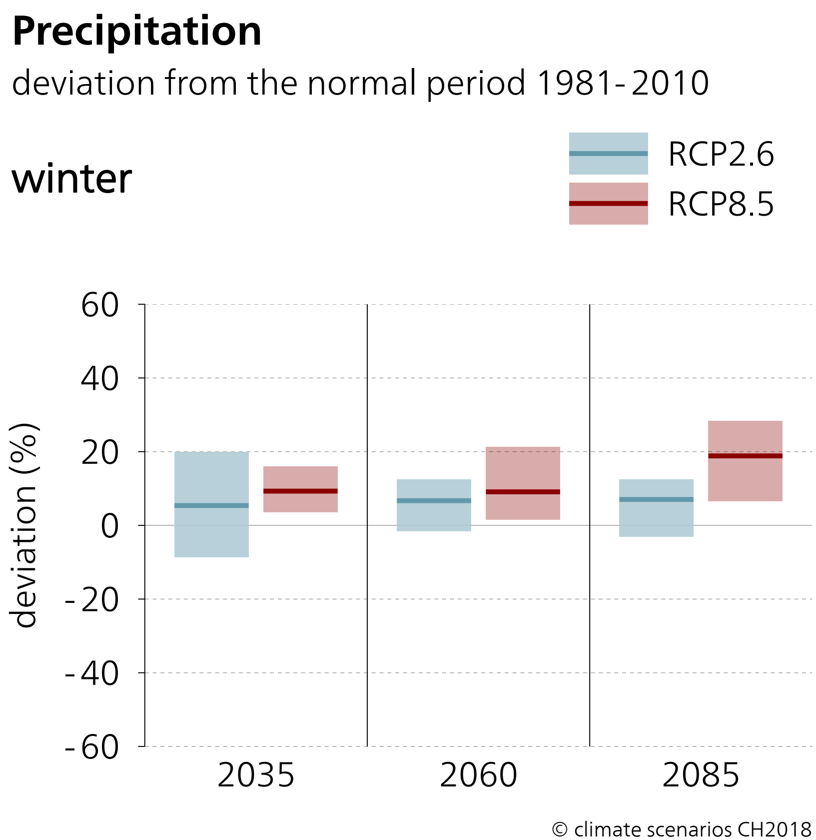
5 min 582

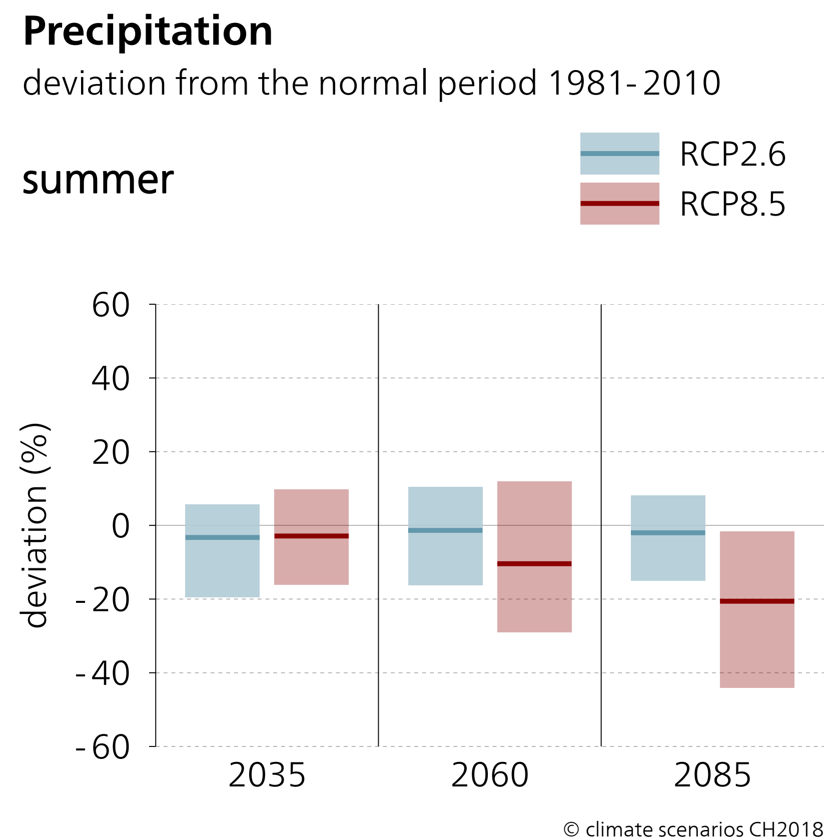
Historic precipitation evolution in CH



CH2018, NCCS (2018)

Future changes: Precipitation





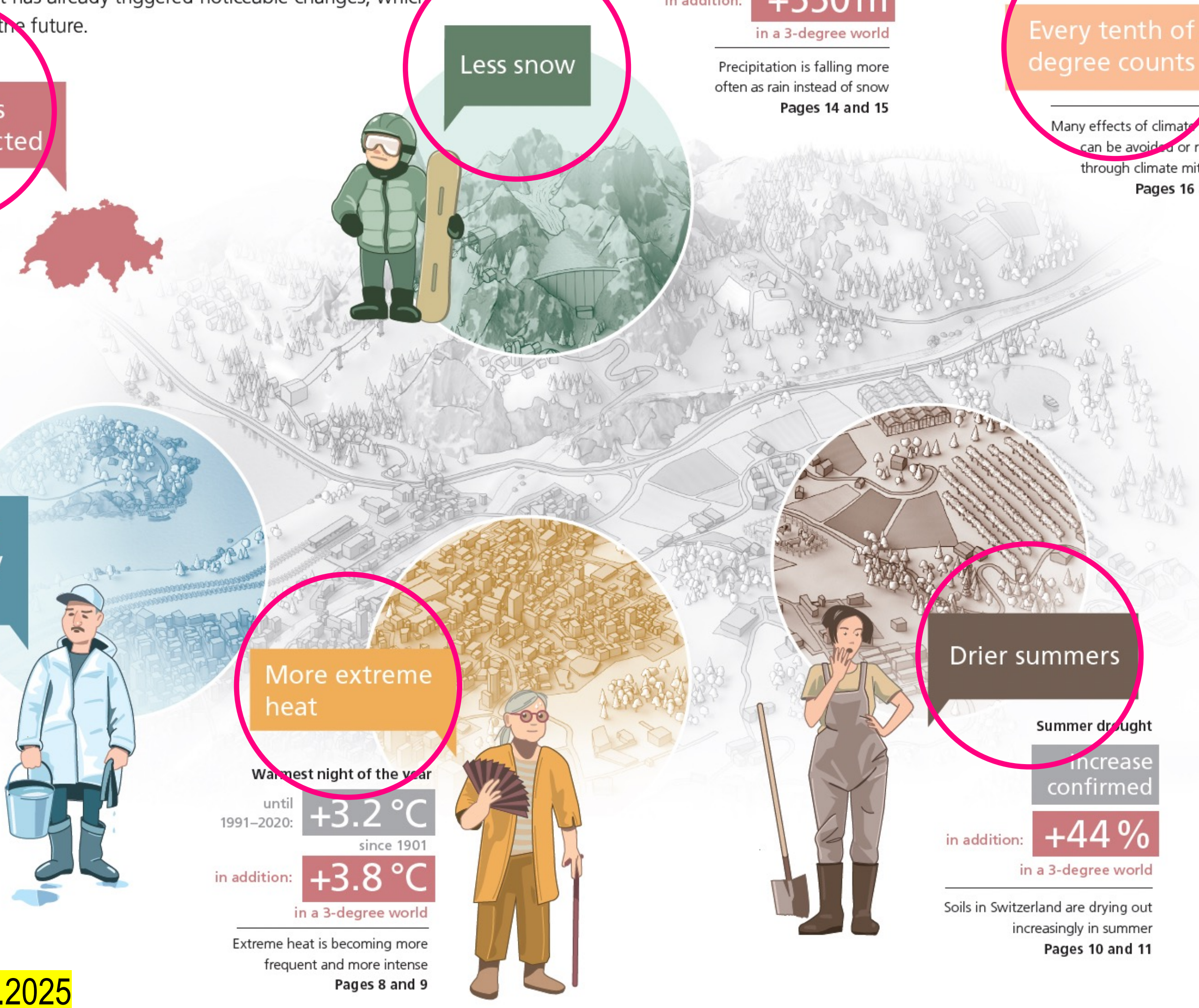
What do you expect for changes in the phase of precipitation?

CH2018, NCCS (2018)

Key messages of *Climate* CH2025 at a glance

Climate change is reality. This is confirmed by long-term climate observations in Switzerland and worldwide. Global warming is clearly caused by man-made greenhouse gas emissions. It has already triggered noticeable changes, which will continue to intensify in the future.

The overview shows the observed development up to 1991–2020 (above, in grey) and the expected development from 1991–2020 to a 3-degree world* (below, in red). The numbers are Swiss averages. Under the measures currently planned to reduce emissions, the world is heading for an increase of around 3 °C by the end of the century.



Switzerland is severely affected

Swiss average temperature

until 1991–2020: +2.0 °C since pre-industrial

in addition: +2.9 °C in a 3-degree world

Climate change is particularly evident in Switzerland

Pages 6 and 7

Less snow

Average zero-degree line in winter

until 1991–2020: +480 m since 1901

in addition: +550 m in a 3-degree world

Precipitation is falling more often as rain instead of snow

Pages 14 and 15

Every tenth of a degree counts

1/10 °C

Many effects of climate change can be avoided or reduced through climate mitigation

Pages 16 and 17

More frequent and more intense heavy precipitation

Intensity of a 1-day precipitation event with 50-year return period

until 1991–2020: Increase confirmed

in addition: +11 % in a 3-degree world

Heavy precipitation is becoming more frequent and more intense

Pages 12 and 13

More extreme heat

Warmest night of the year

until 1991–2020: +3.2 °C since 1901

in addition: +3.8 °C in a 3-degree world

Extreme heat is becoming more frequent and more intense

Pages 8 and 9

Drier summers

Summer drought

Increase confirmed

in addition: +44 % in a 3-degree world

Soils in Switzerland are drying out increasingly in summer

Pages 10 and 11

Global warming levels

The climate scenarios show possible futures for Swiss climate based on different levels of global warming

Page 6

In-depth information

Detailed information on various aspects of climate change in Switzerland

Pages 18 to 21

Always the latest climate scenarios

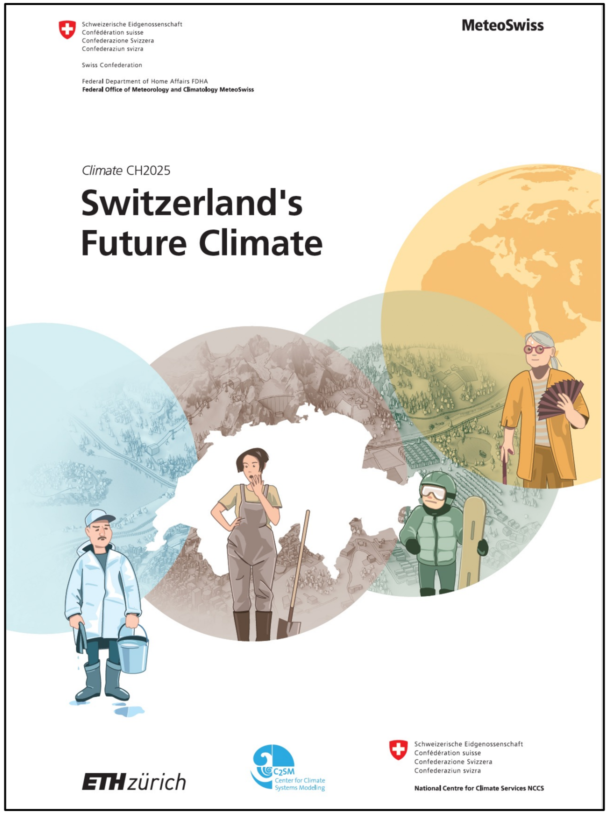
A look behind the scenes at how climate scenarios are created

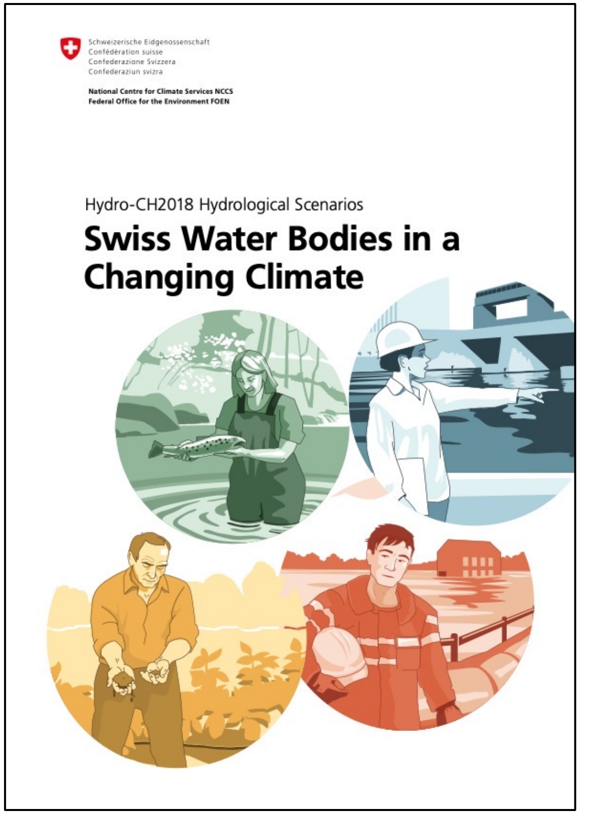
Pages 22 and 23

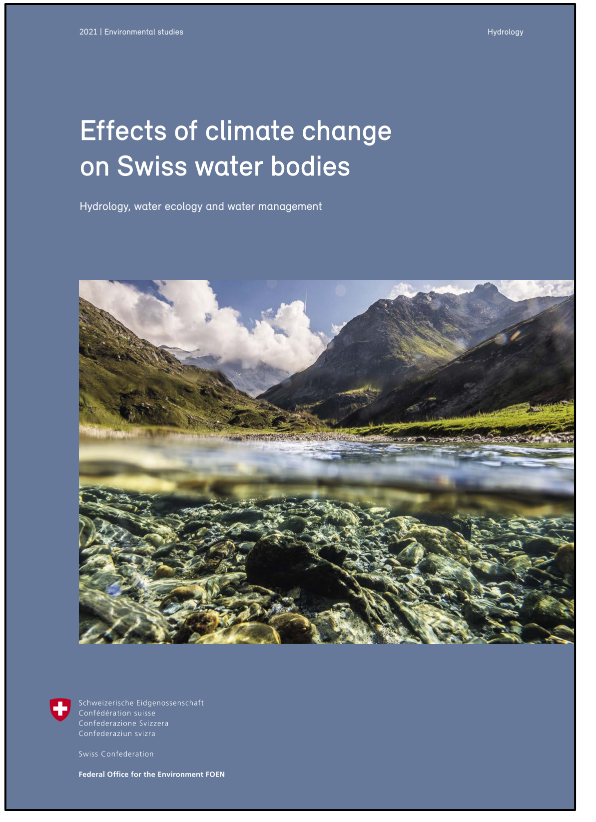
* Average global temperature increase of 3 °C compared to the pre-industrial period. More information on **page 6**

published on 04.11.2025

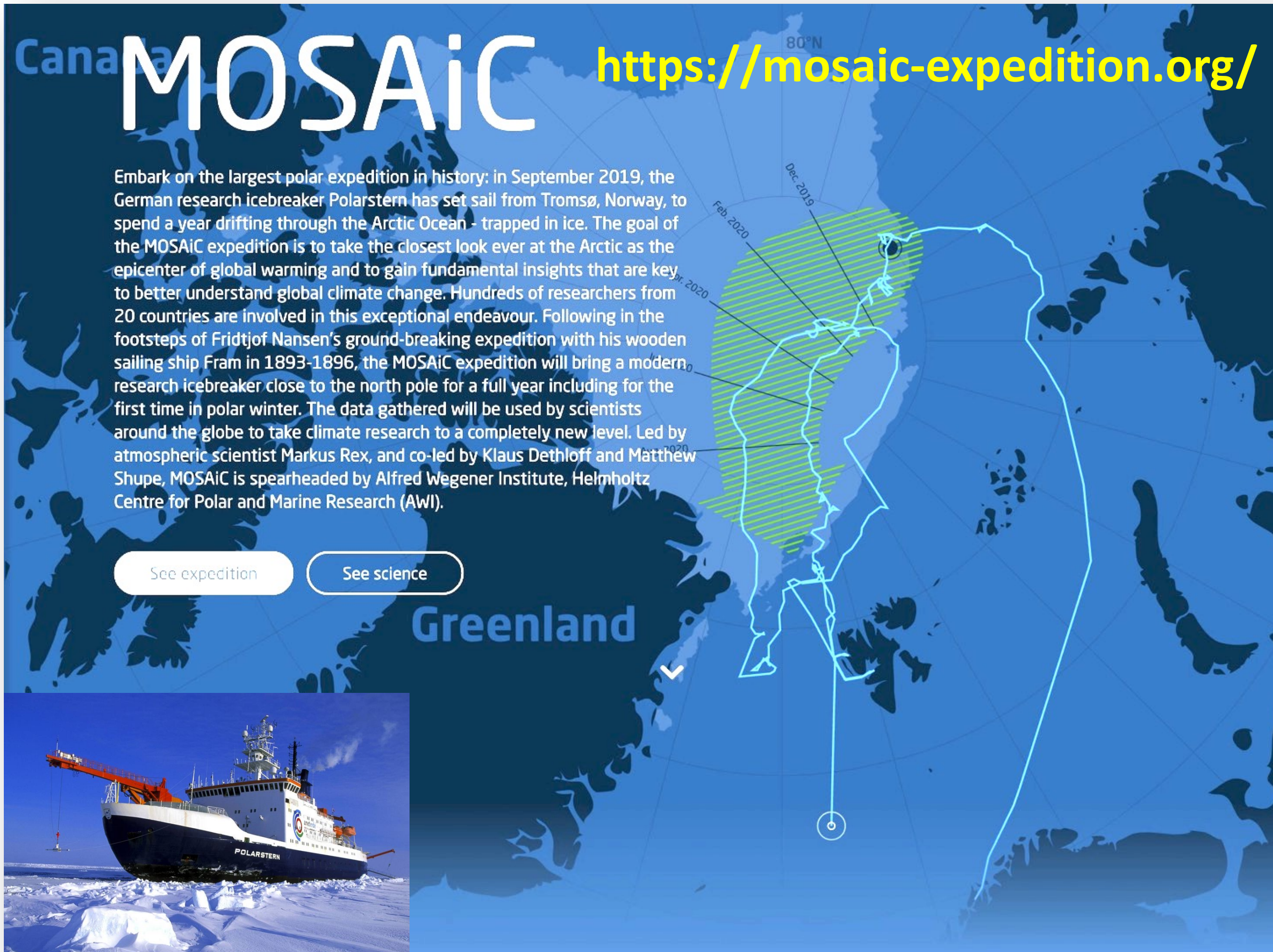
Hydro – CH2018: Impact of CC on hydrology

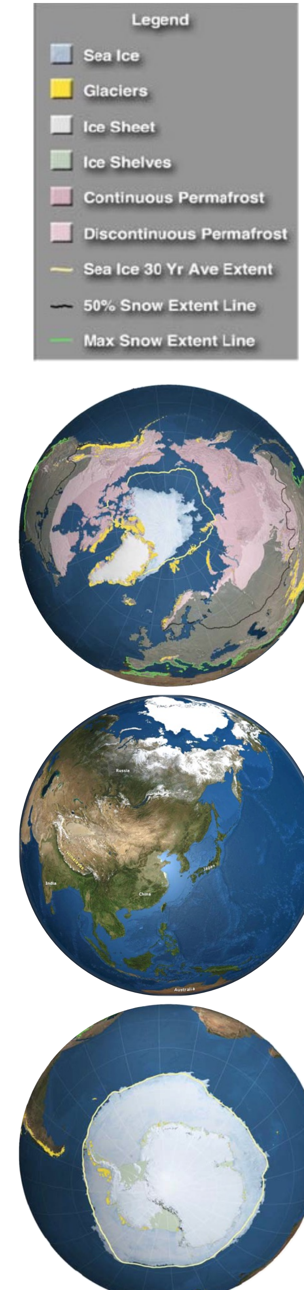






MOSAIC: Largest polar expedition in history !
September 2019 – October 2020





Arctic

Mountains

Antarctic

IPCC, AR5, WG1, CH4, Draft 07/2013, modified

Polar sea ice

Sea ice characteristics

- Forms (and melts) on the ocean surface
- Can be of seasonal or multi-year duration
- Forms when the ocean is at its freezing temperature (ca. -1.8° C) – Why?
- Most of the ocean water salt gets rejected during freezing
- Gets advected by winds (drag) and ocean currents
- Does not contribute to sea level rise – Why?
- Significantly changes the surface albedo and surface energy balance

Sea ice: the changing Arctic (situation 2009)

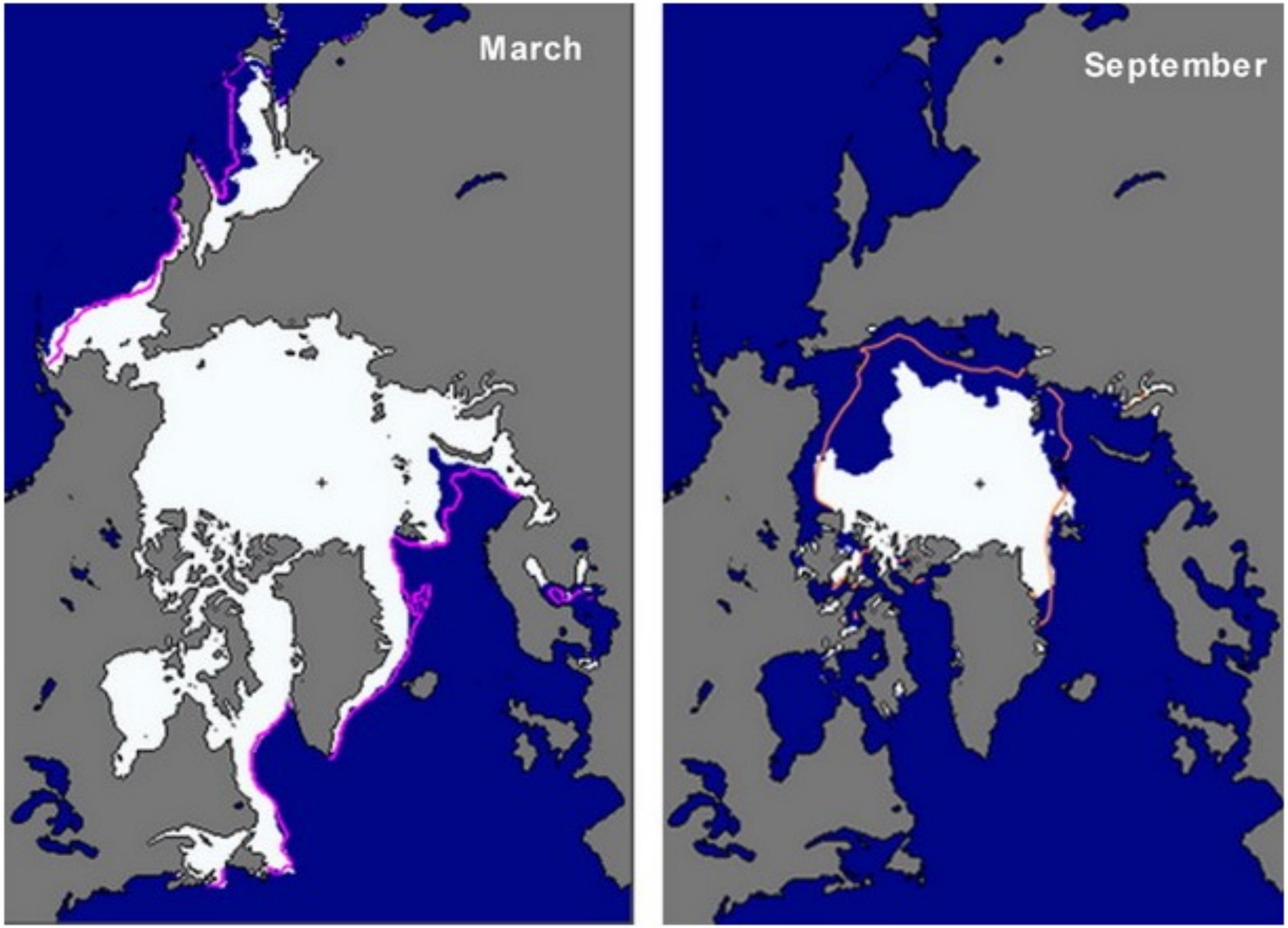
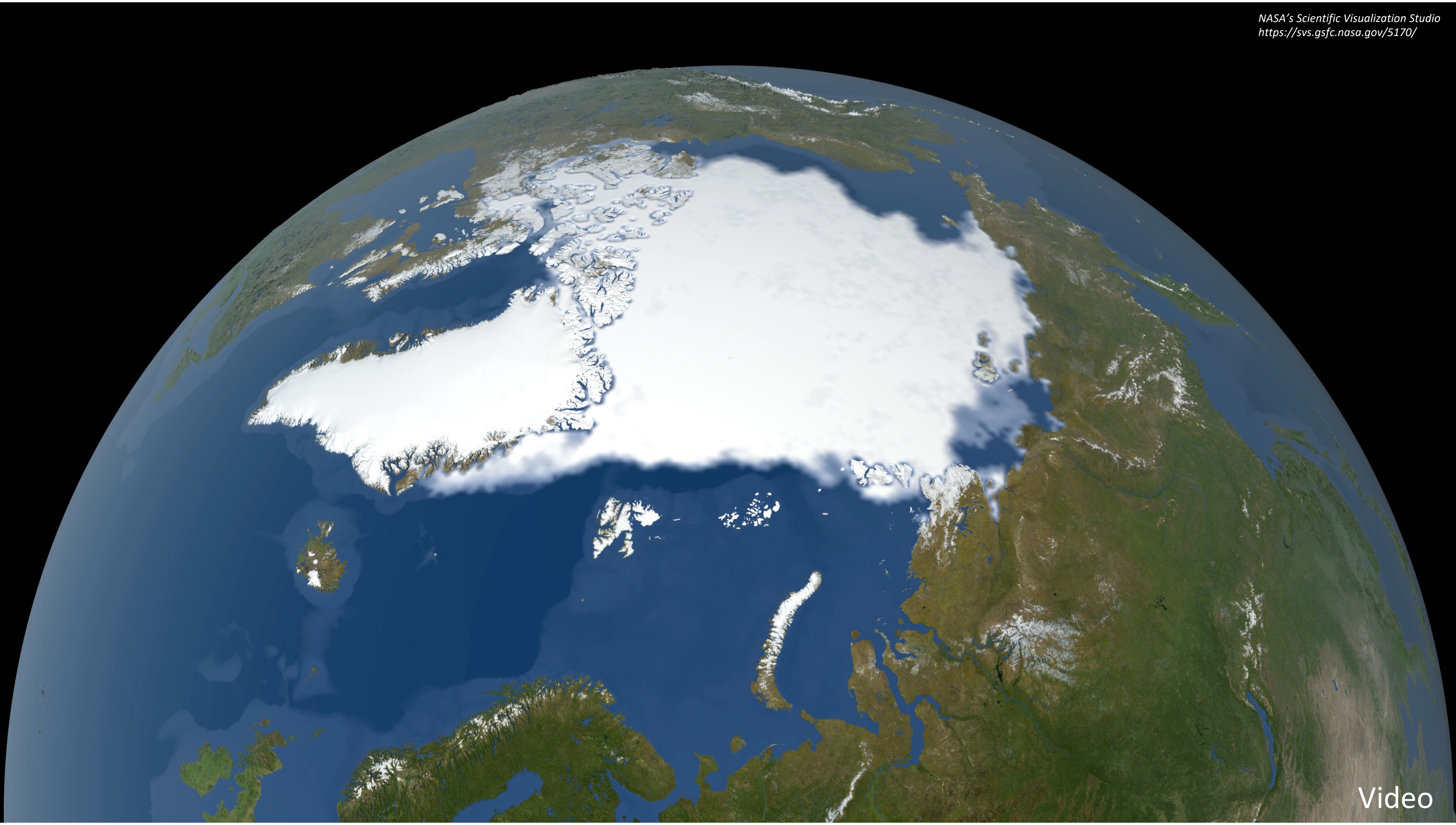


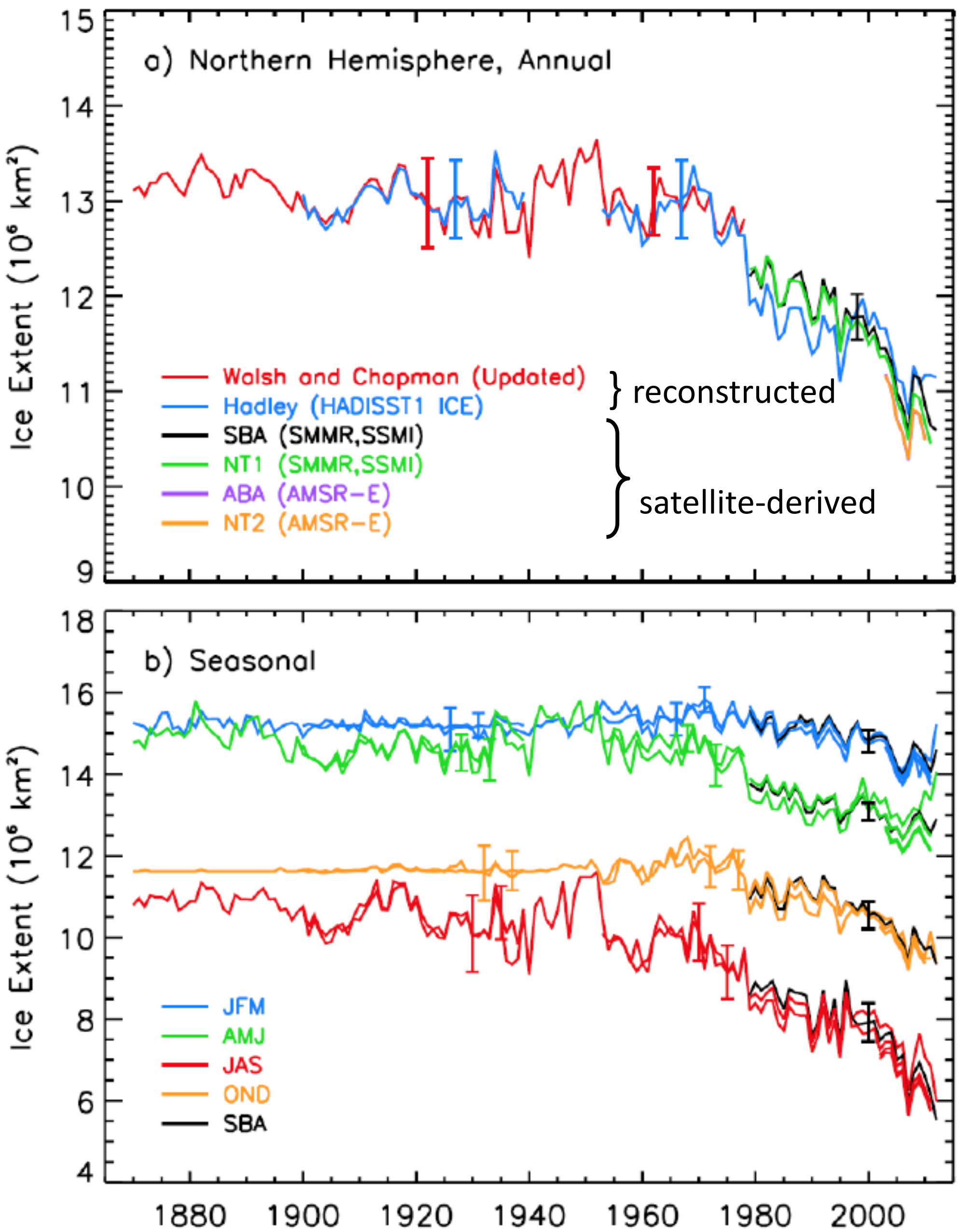
Figure S1. Sea ice extent in March 2009 (left) and September 2009 (right), illustrating the respective winter maximum and summer minimum extents. The magenta line indicates the median maximum and minimum extent of the ice cover, for the period 1979–2000. [Figures from the National Snow and Ice Data Center Sea Ice Index: nsidc.org/data/ seaice_index.]

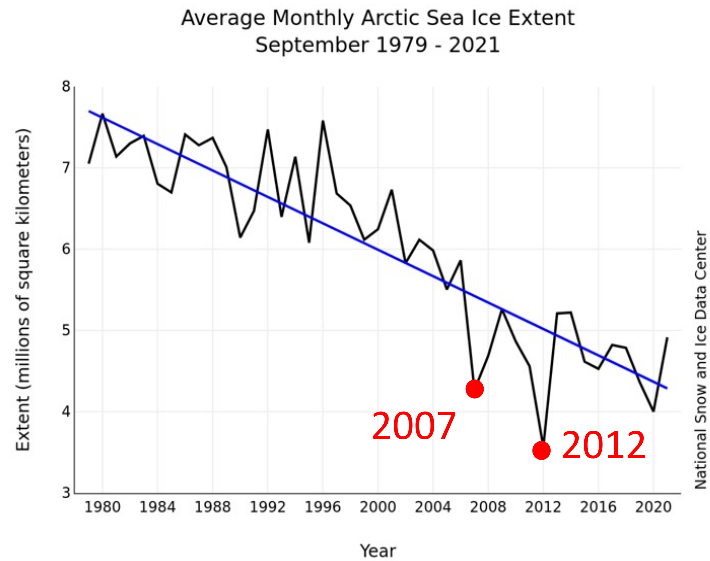
www.arctic.noaa.gov ; Perovich et al.,2009

Sea ice in a changing Arctic



Sea ice: Arctic sea ice extent





IPCC, AR5, WG1, CH4, Draft 07/2013, F4.3

Sea ice: Arctic Sea Ice Extent

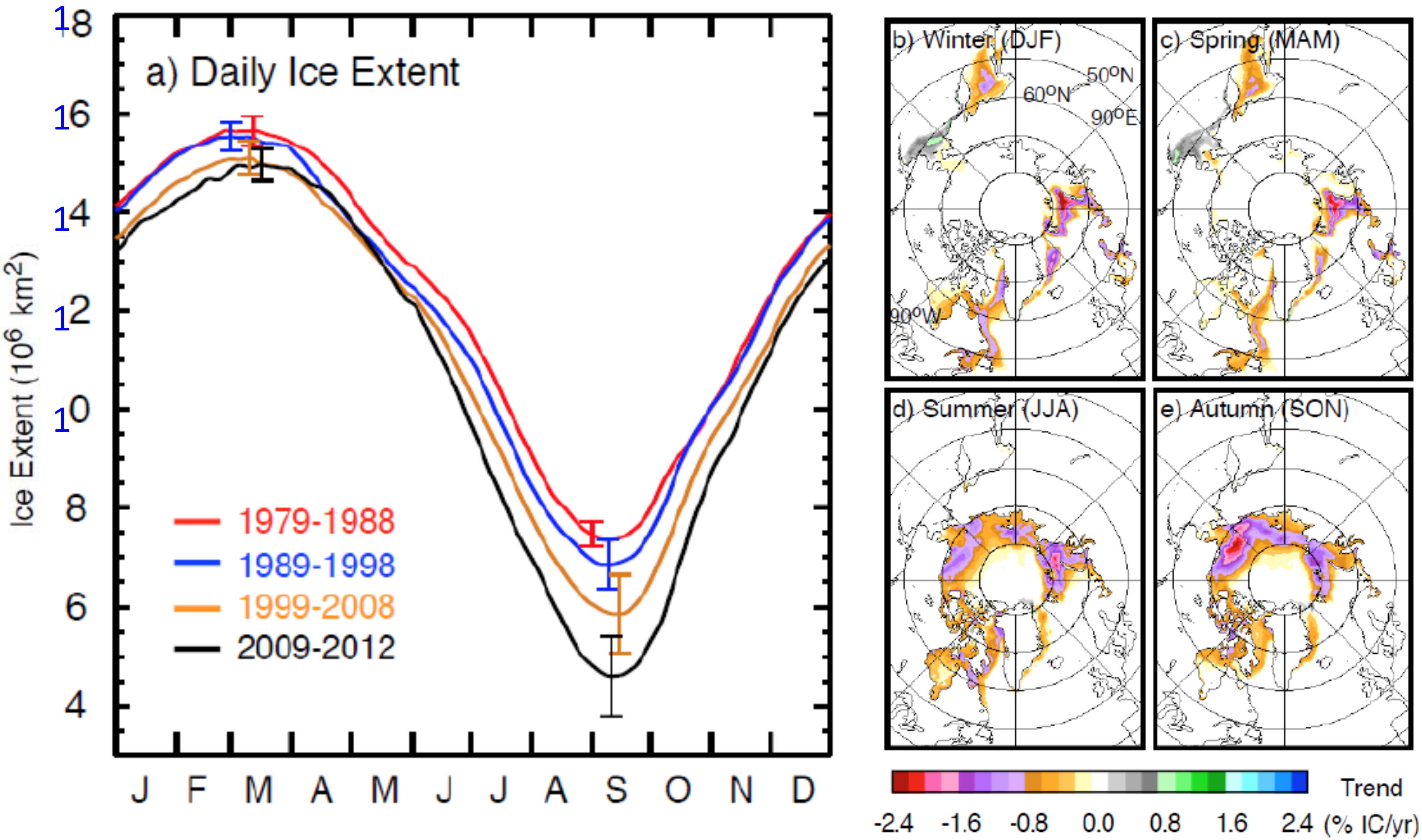
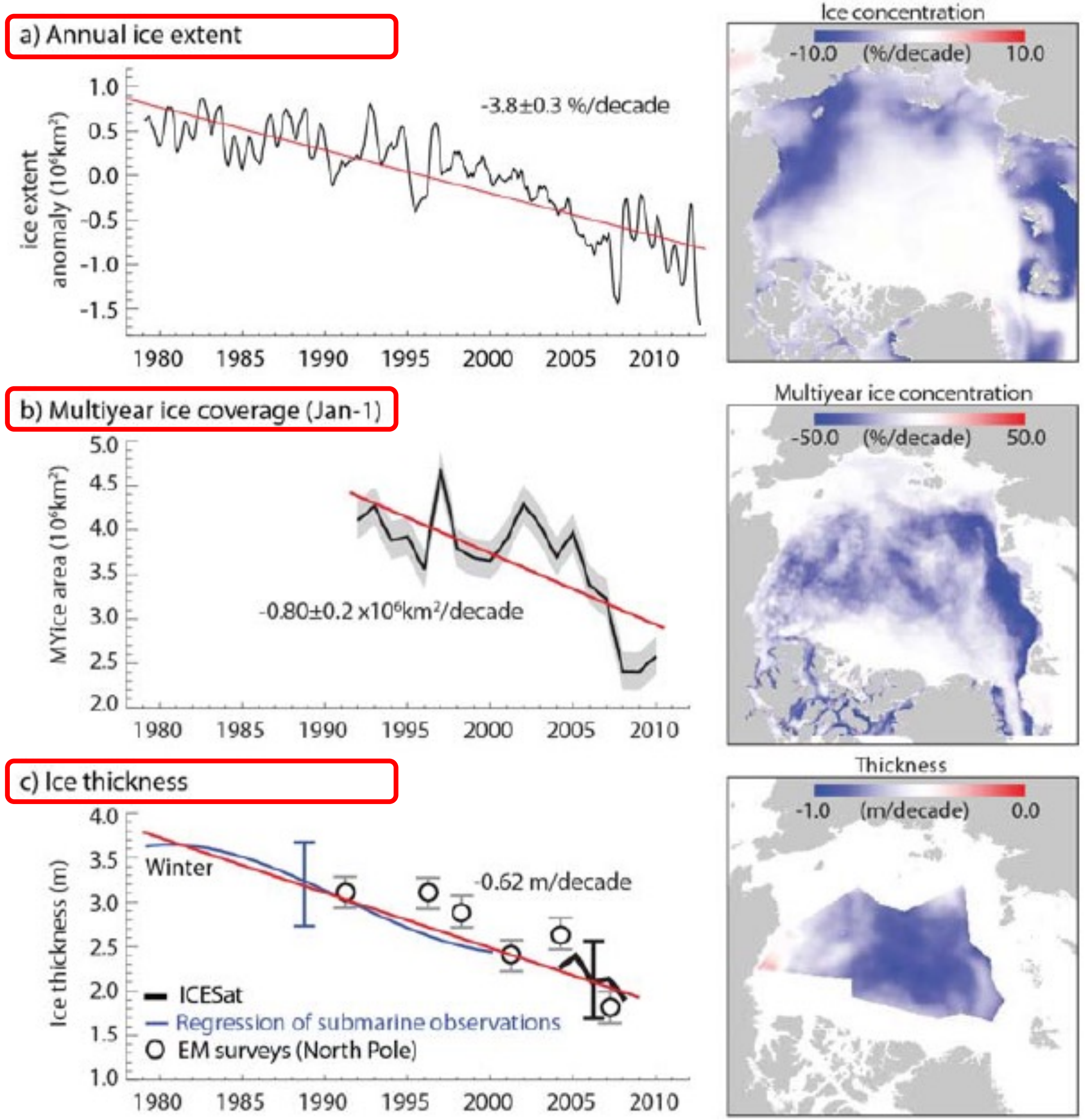


Figure 4.2: (a) Plots of decadal averages of daily sea ice extent in the Arctic (1979 to 1988 in red, 1989 to 1998 in blue, 1999 to 2008 in gold) and a four-year average daily ice extent from 2009 to 2012 in black. Maps ice concentration trends (1979–2012) in (b) winter, (c) spring, (d) summer and (e) autumn (updated from Comiso, 2010).

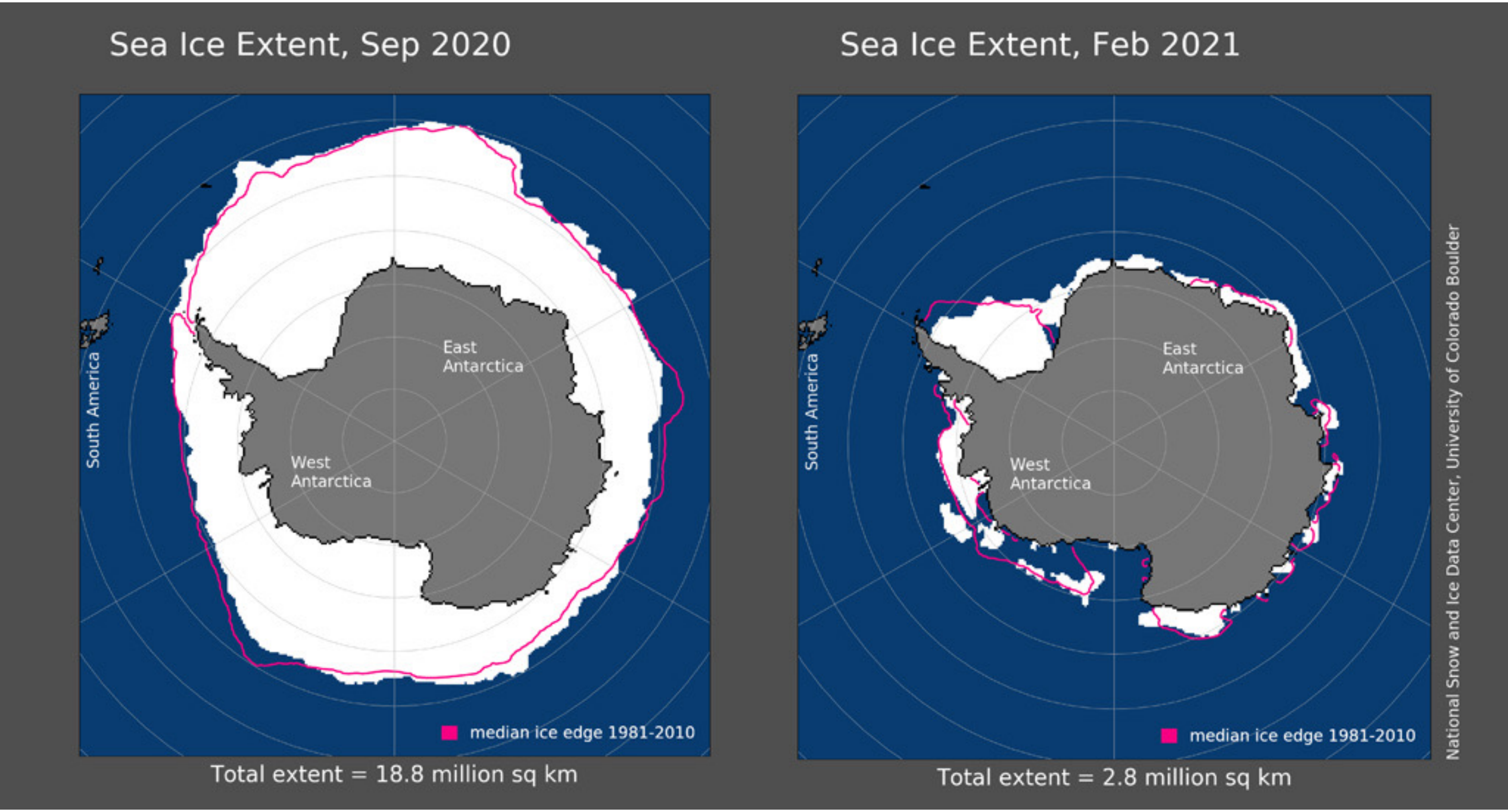
IPCC WG1, CH4, Draft 07/2013

Sea ice: Arctic sea ice evolution



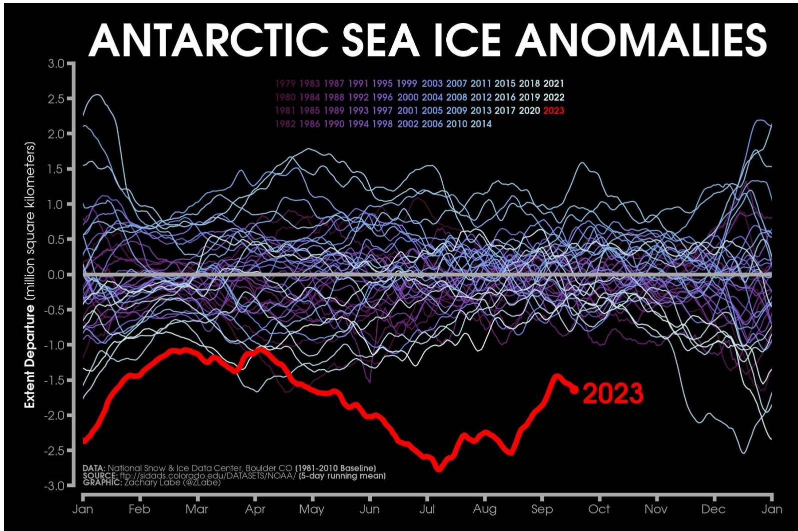
IPCC, AR5, WG1, CH4, Draft 07/2013

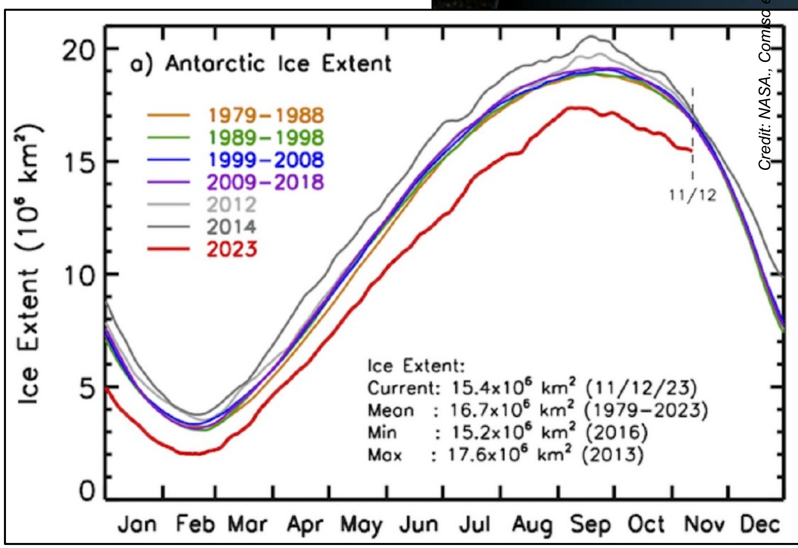
Sea ice: Antarctic sea ice extent (winter/summer)

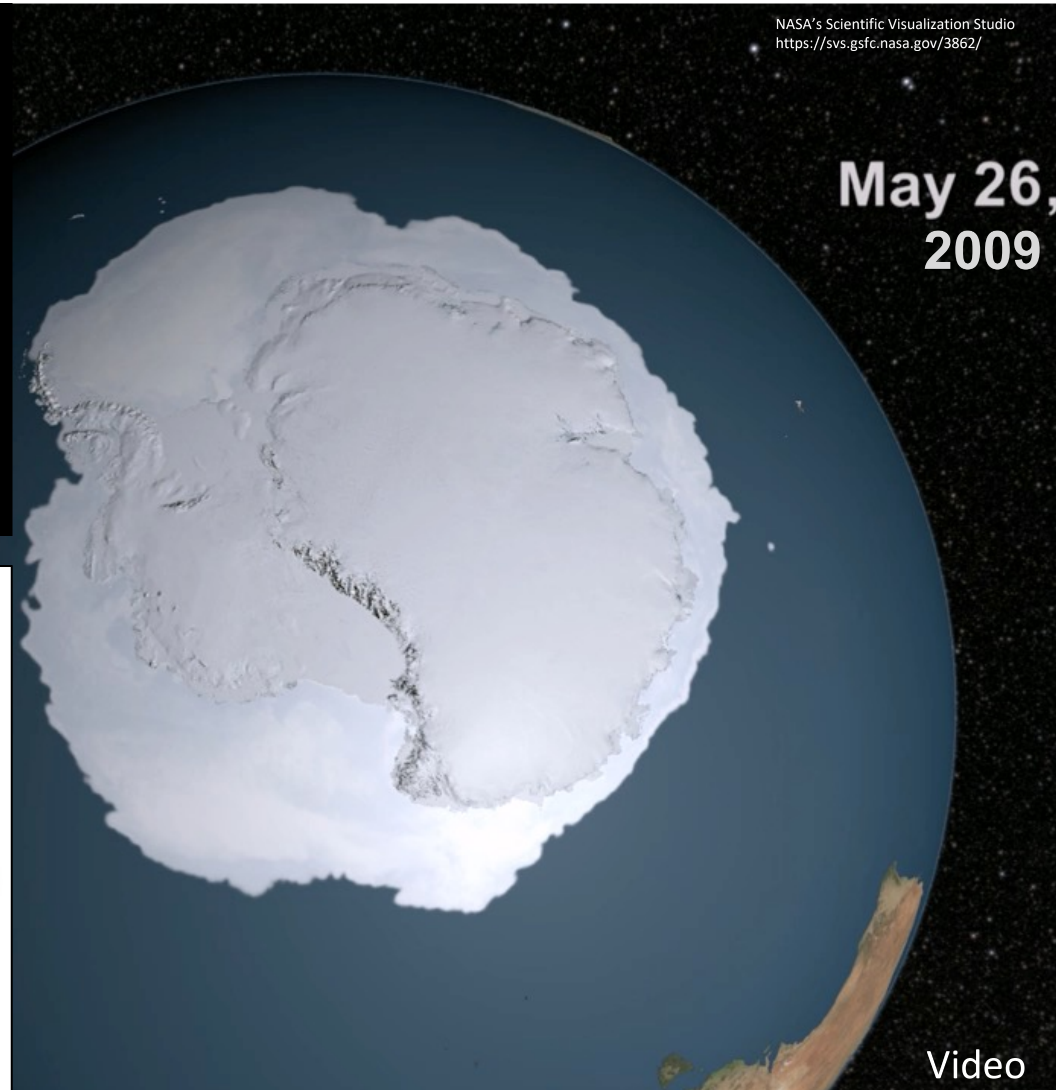


Maps of Antarctic sea ice extent at the most recent winter maximum on 28 September 2020 (left) and summer minimum on 21 February 2021 (right). The pink lines show the 1981-2010 average extent for that month. Credit: NSIDC.

Antarctic sea ice evolution







Sea ice: Antarctic sea ice extent

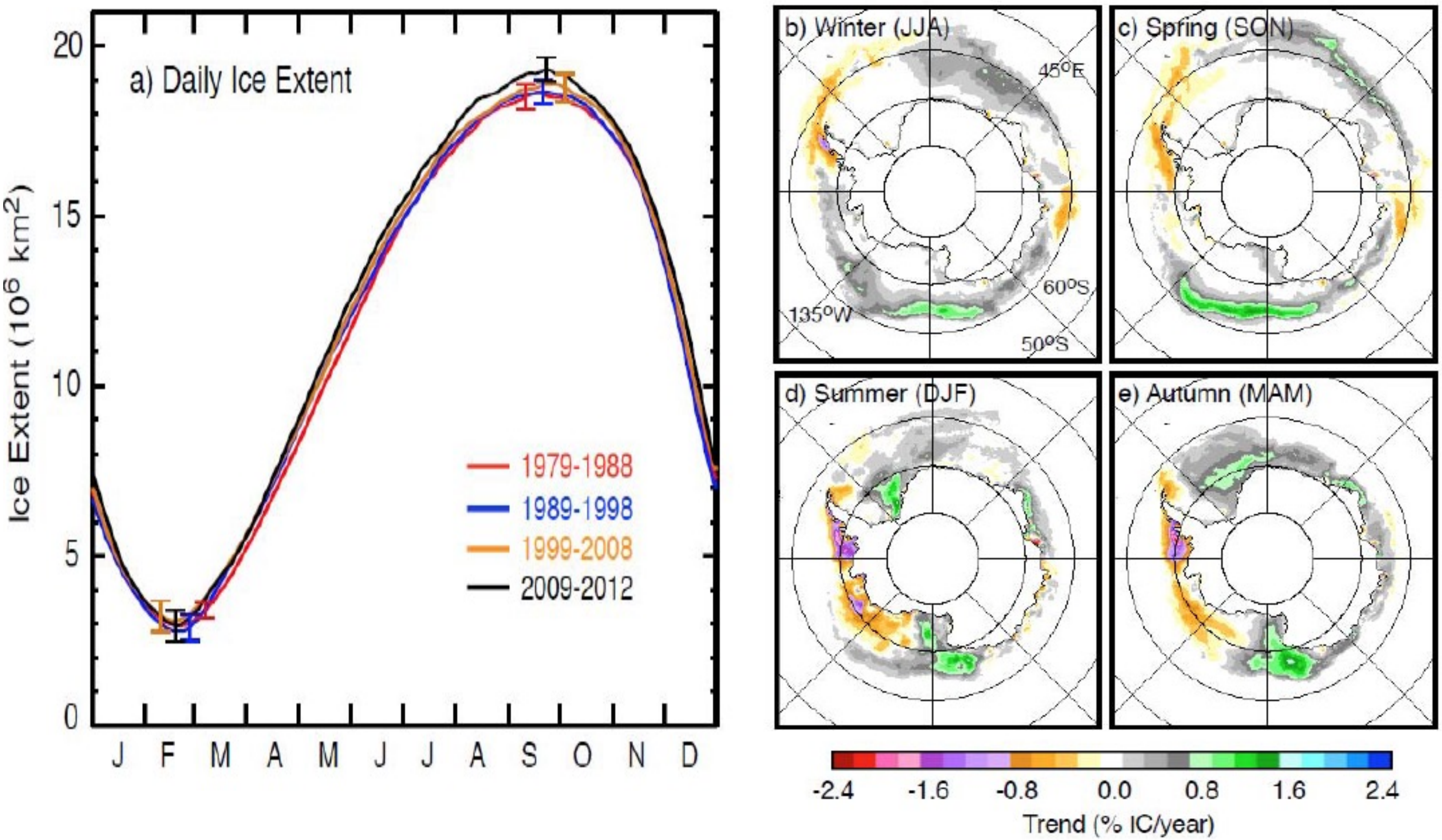
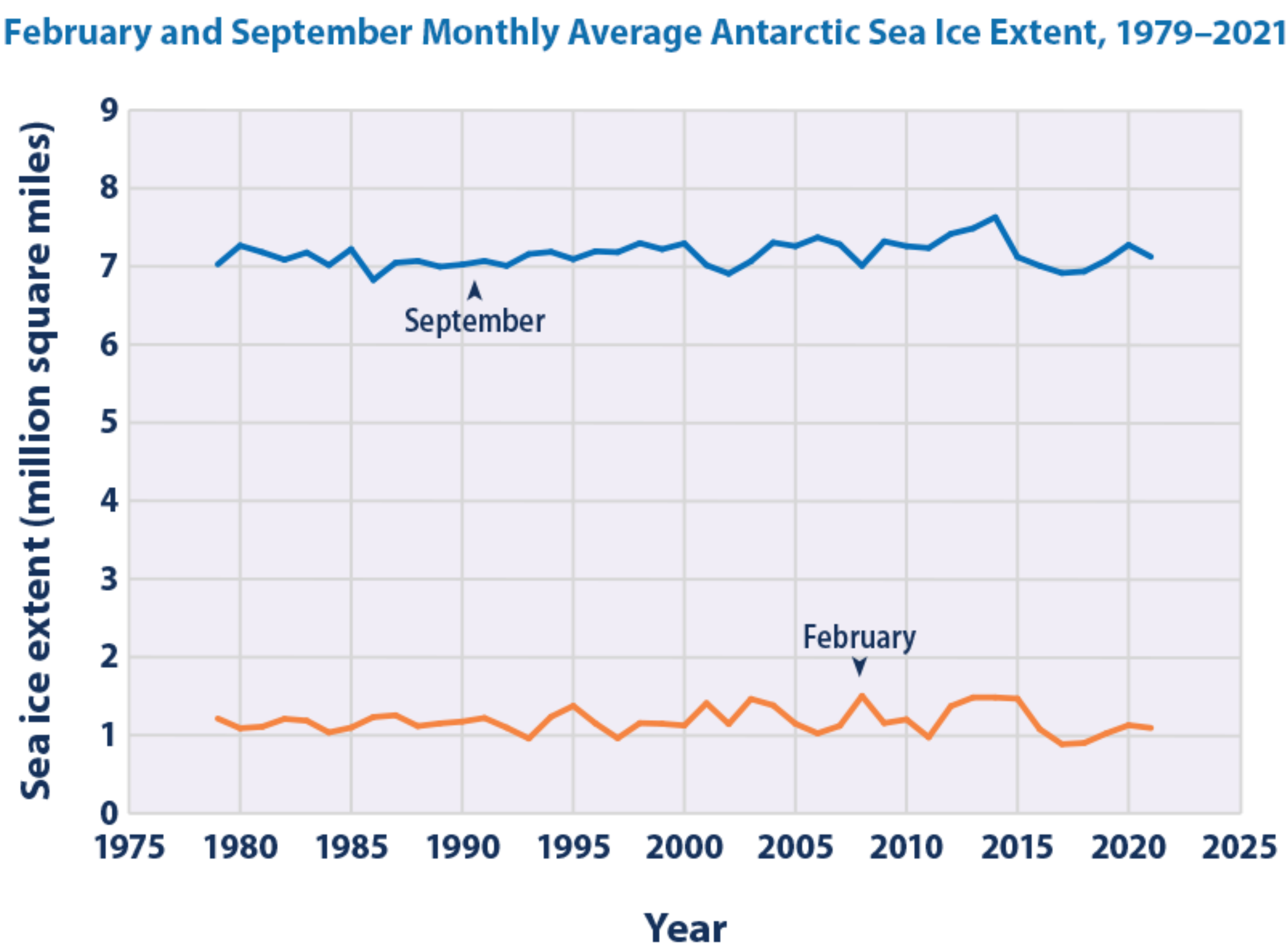


Figure 4.7: (a) Plots of decadal averages of daily sea ice extent in the Antarctic (1979 to 1988 in red, 1989 to 1998 in blue, 1999 to 2008 in gold) and a four-year average daily ice extent from 2009 to 2012 in black. Maps of ice concentration trends (1979–2012) in (b) winter, (c) spring, (d) summer and (e) autumn (updated from Comiso, 2010).

IPCC, AR5, WG1, CH4, Draft 07/2013

Sea ice: Antarctic sea ice extent



Data source: NSIDC (National Snow and Ice Data Center). 2022. Sea ice data and image archive. Accessed January 2022. https://nsidc.org/data/seaice_index/archives.

Sea ice: Comparison polar sea ice extent maxima

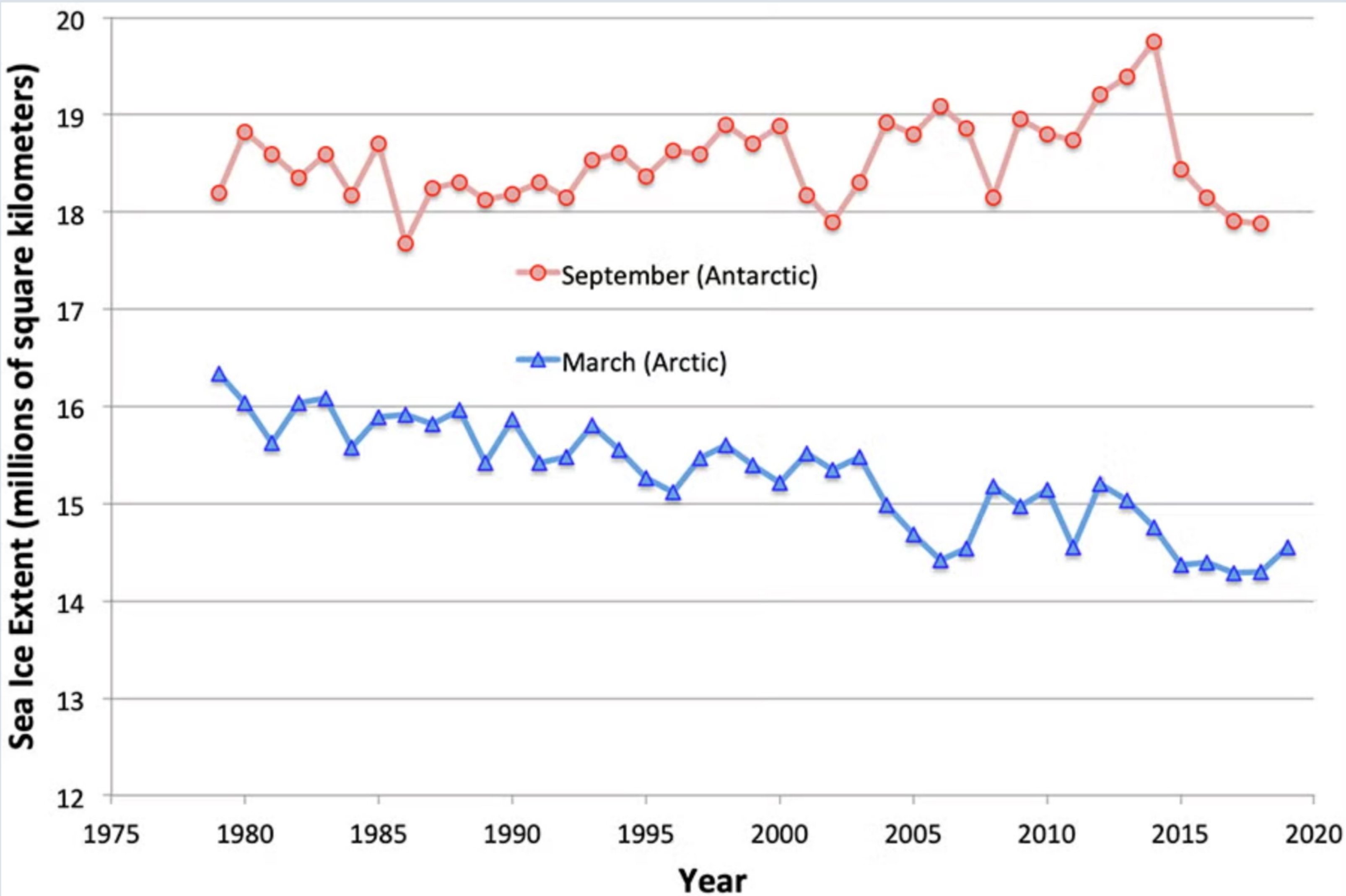


Figure 5: Annual Maximum Sea Ice Extent (all years)

Data: NSIDC

Sea ice: Comparison polar sea ice extent minima

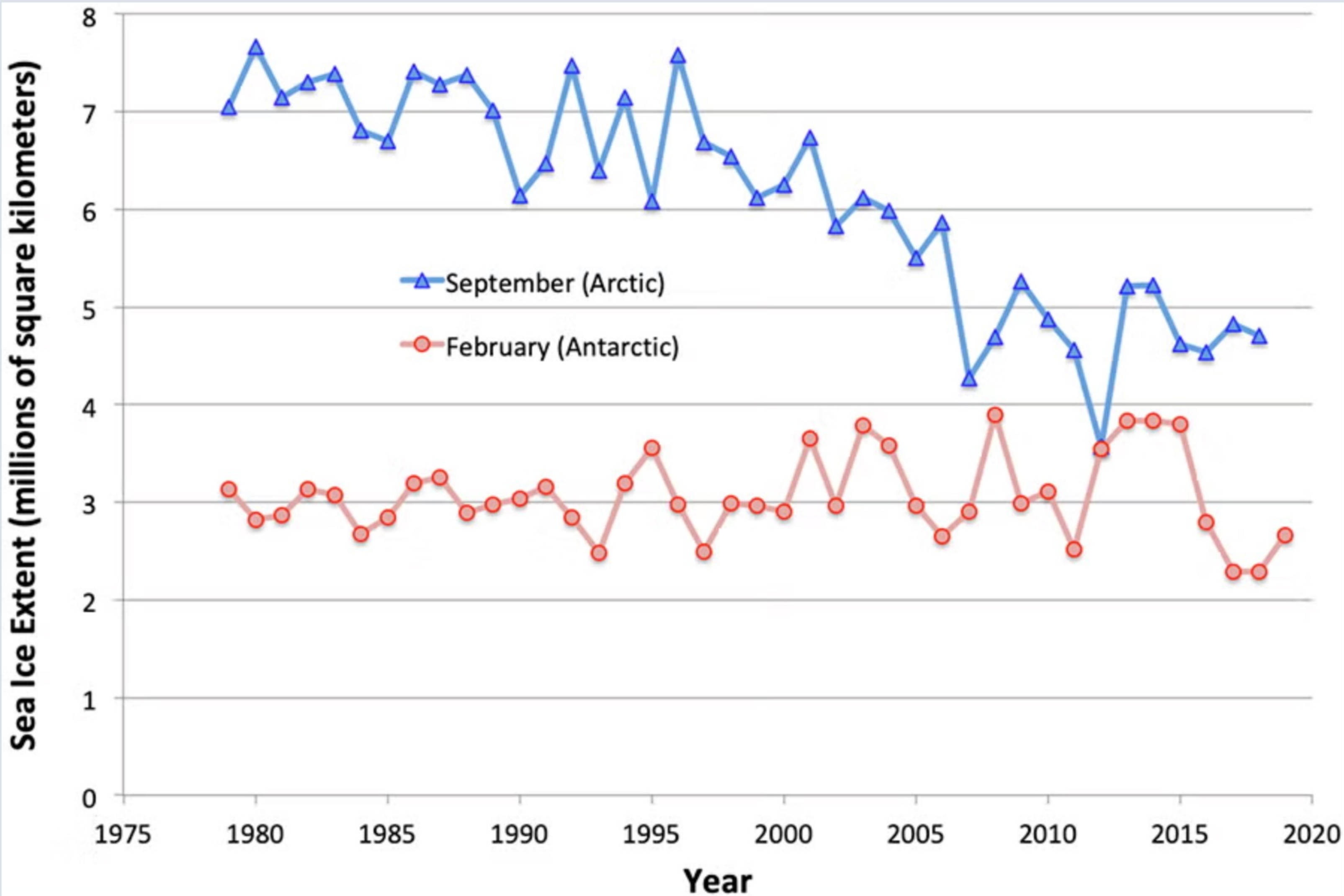


Figure 6: Annual Minimum Sea Ice Extent (all years)

Data: NSIDC

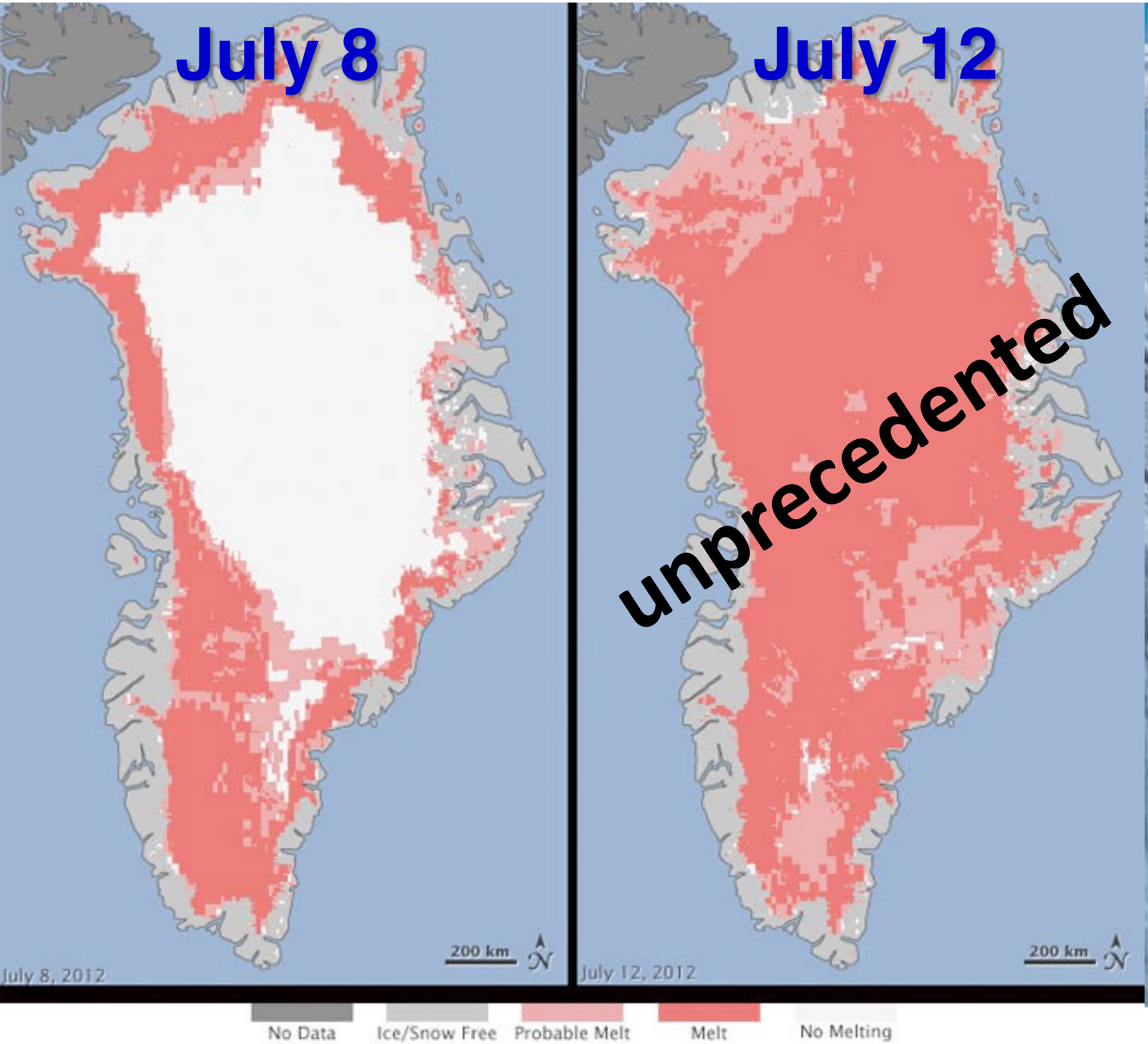
Ice sheets: Greenland Ice Sheet

Greenland Ice Sheet with melt water stream

Polar ice sheet characteristics

- Continental scale of thousands of km horizontal extent
- Up to 3km (Greenland) and 4km (Antarctica) vertical extent
- Ice flowing from the center to the edges where it melts or breaks off
- Oldest ice: 800’000 yrs (EPICA), up to 4M yrs recently estimated
- Forming ice sheets which release icebergs
- Essential component for stabilizing global climate
- Largest global freshwater reservoirs

Ice sheets: 2012 Greenland record melting



Ice sheets: Illulissat calving event 2012

State of the cryosphere: Greenland

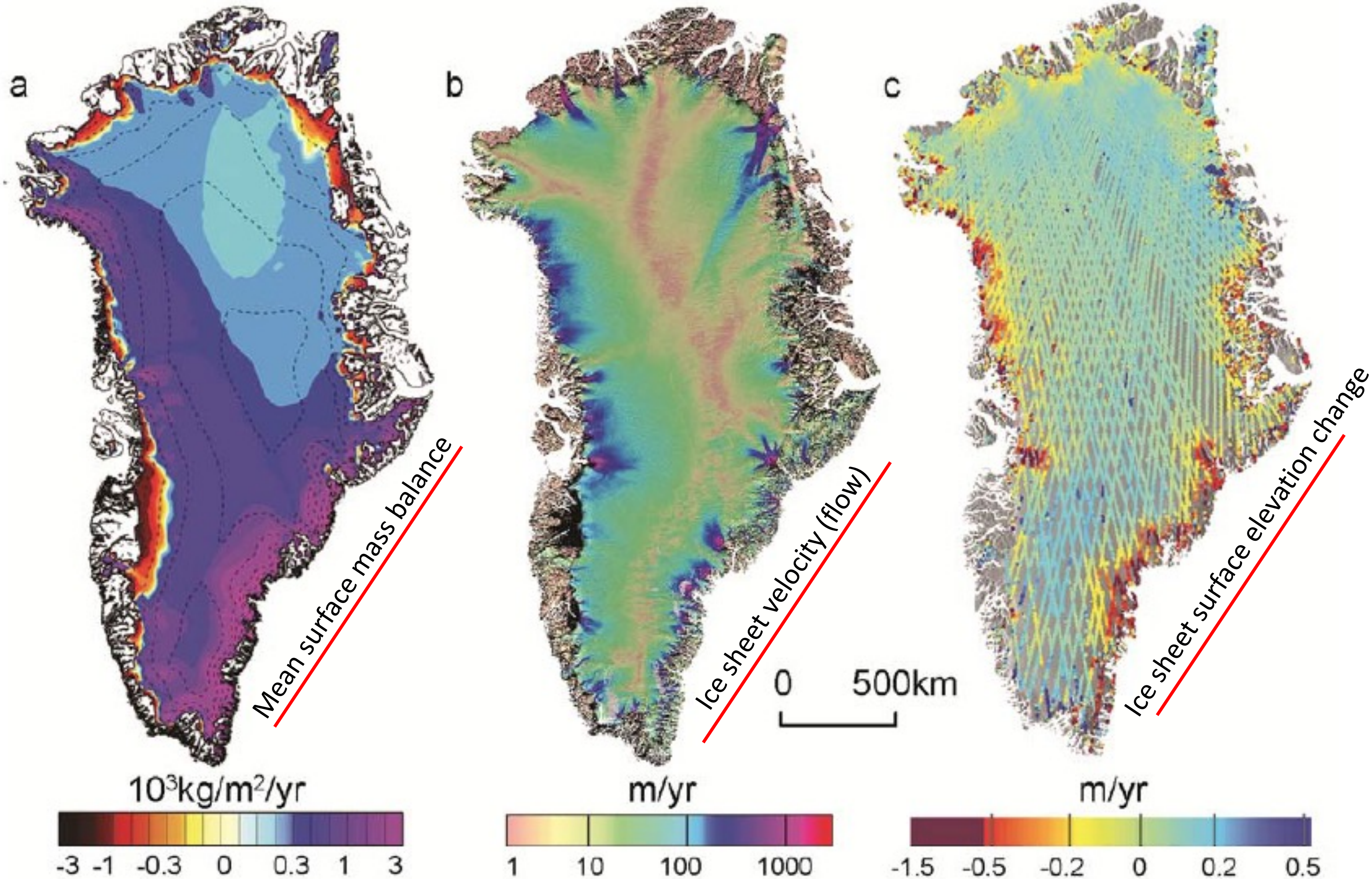


Figure 4.13: Key variable related to the determination of the Greenland ice sheet mass changes. (a) mean surface mass balance for 1989–2004 from regional atmospheric climate modelling (Ettema et al., 2009); (b) ice sheet velocity for 2007–2009 determined from satellite data, showing fastest flow in red, fast flow in blue, and slower flow in green and yellow (Rignot and Mouginot, 2012); (c) changes in ice sheet surface elevation for 2003–2008 determined from ICESat altimetry, with elevation decrease in red to increase in blue (Pritchard et al., 2009). (d-e) Temporal evolution of ice loss

IPCC, AR5, WG1, CH4, Draft 07/2013

State of the cryosphere: Greenland ice loss

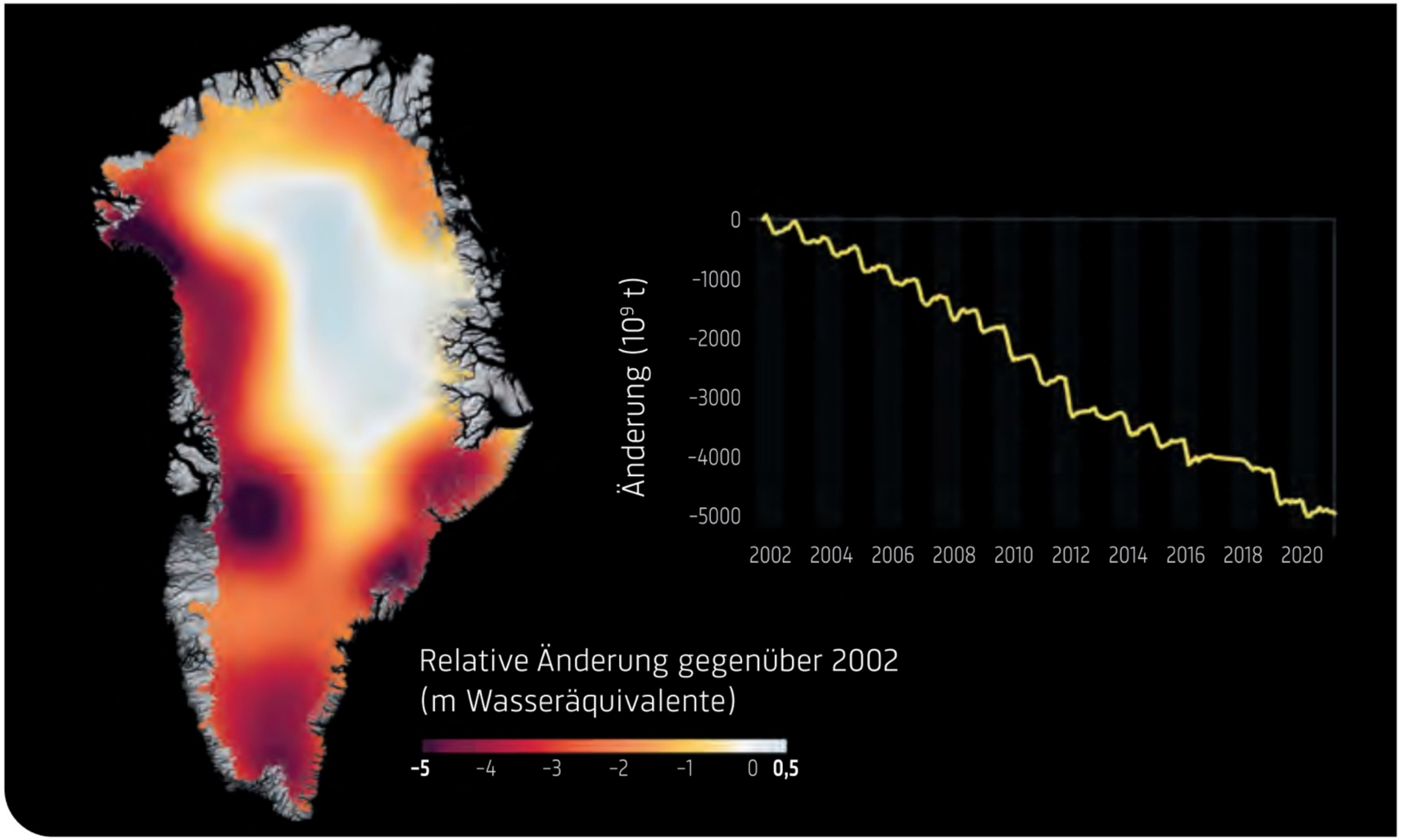


Abbildung 1: Veränderung der grönländischen Eismasse seit 2002 (rechts: totaler Massenverlust, links Änderung der Eisschildhöhe umgerechnet auf die Dichte von Wasser). Rekonstruktion anhand von Satellitendaten des Gravity Recovery And Climate Experiment. Quelle: NASA und JPL/Caltech

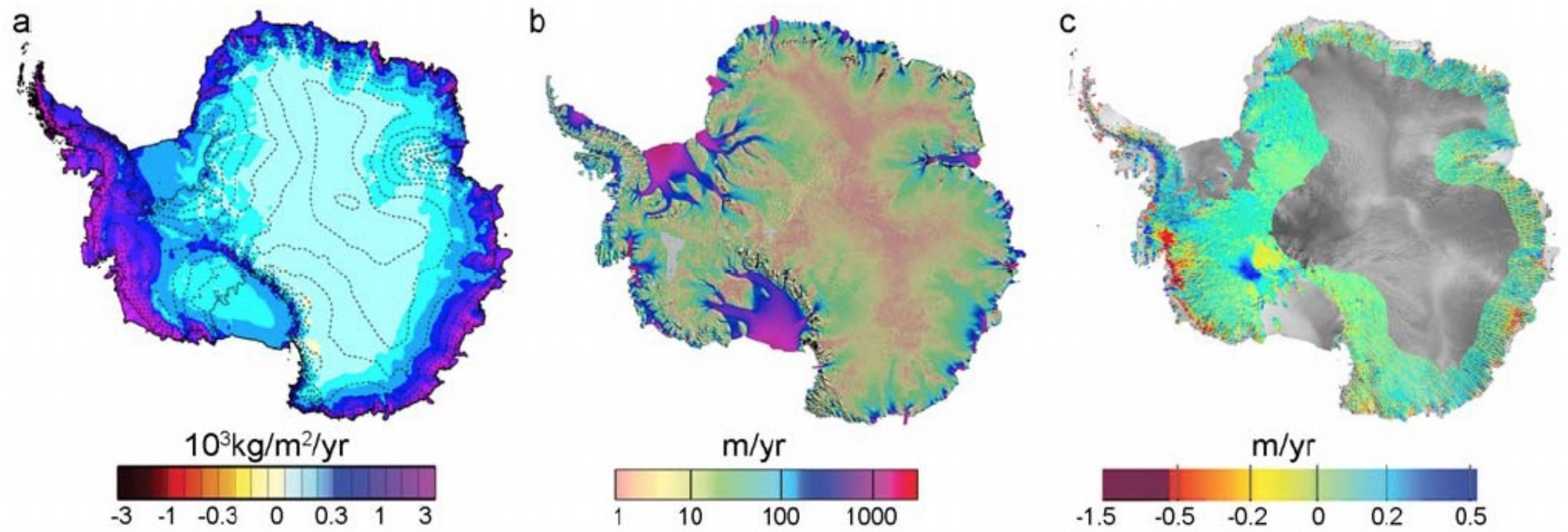
Figure from: Fischer H, Chanteloup L, Csonka Y, Holm P, Jaccard S, Schaepman-Strub G, Schmale J, Vieli A (2022)
Die Arktis unter Druck. Menschgemachter Wandel in der Arktis und die Rolle der Schweiz. Swiss Academies Reports 17 (4)

Ice sheets: Antarctica

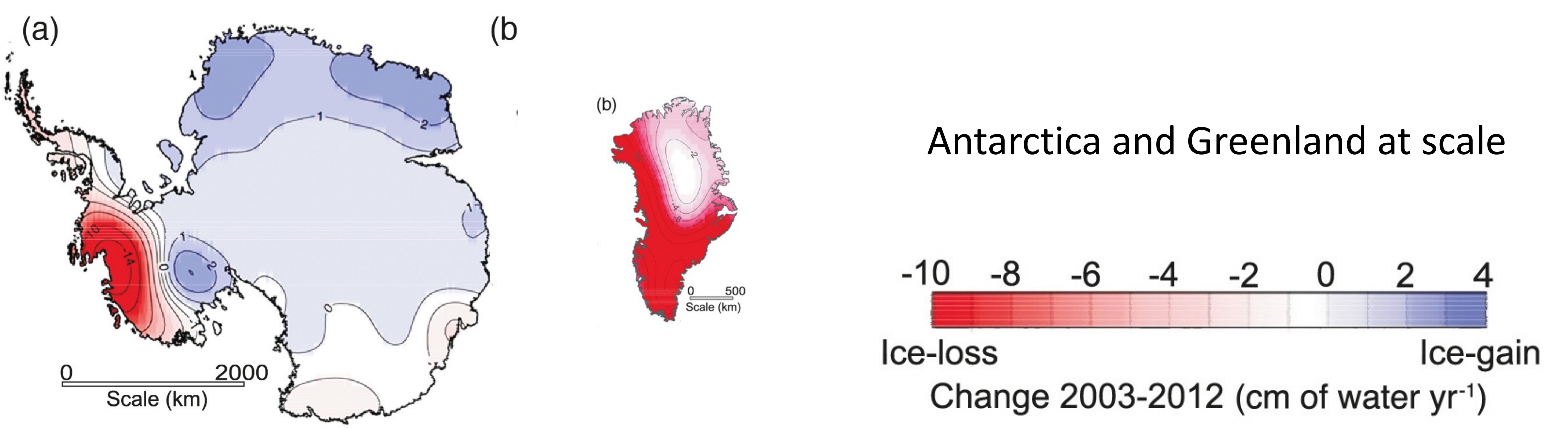
Credit: John Sonntag, Nature

Mass balance Antarctica – spatial distribution

mass balance | flow velocity | surface elevation



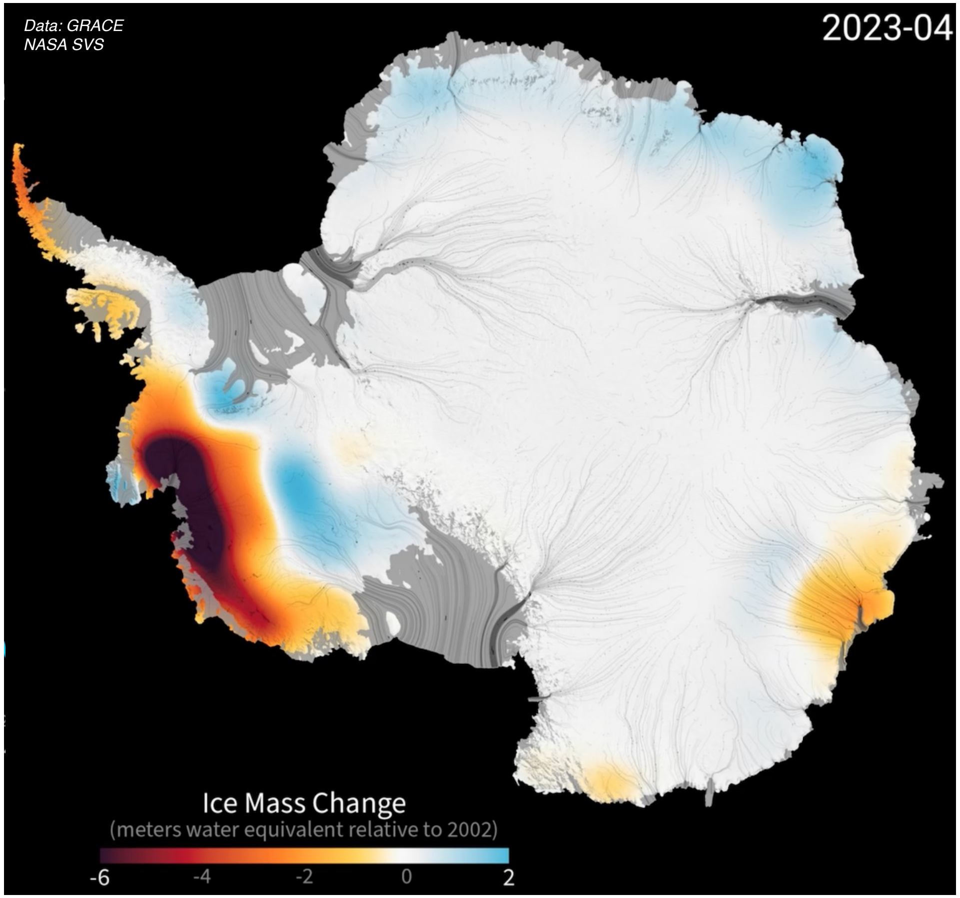
IPCC, AR5, WG1, CH4, F. 4.14, Draft 07/2013

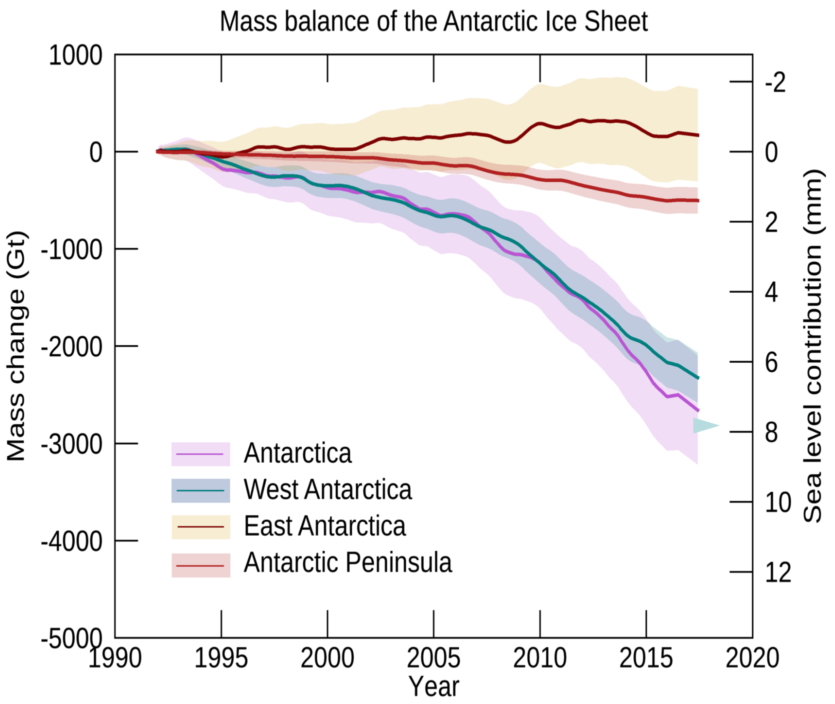


Antarctica and Greenland at scale

IPCC (2013), Assessment Report 5, Working Group I, Technical Summary , Figure TS.3, p.41, modified

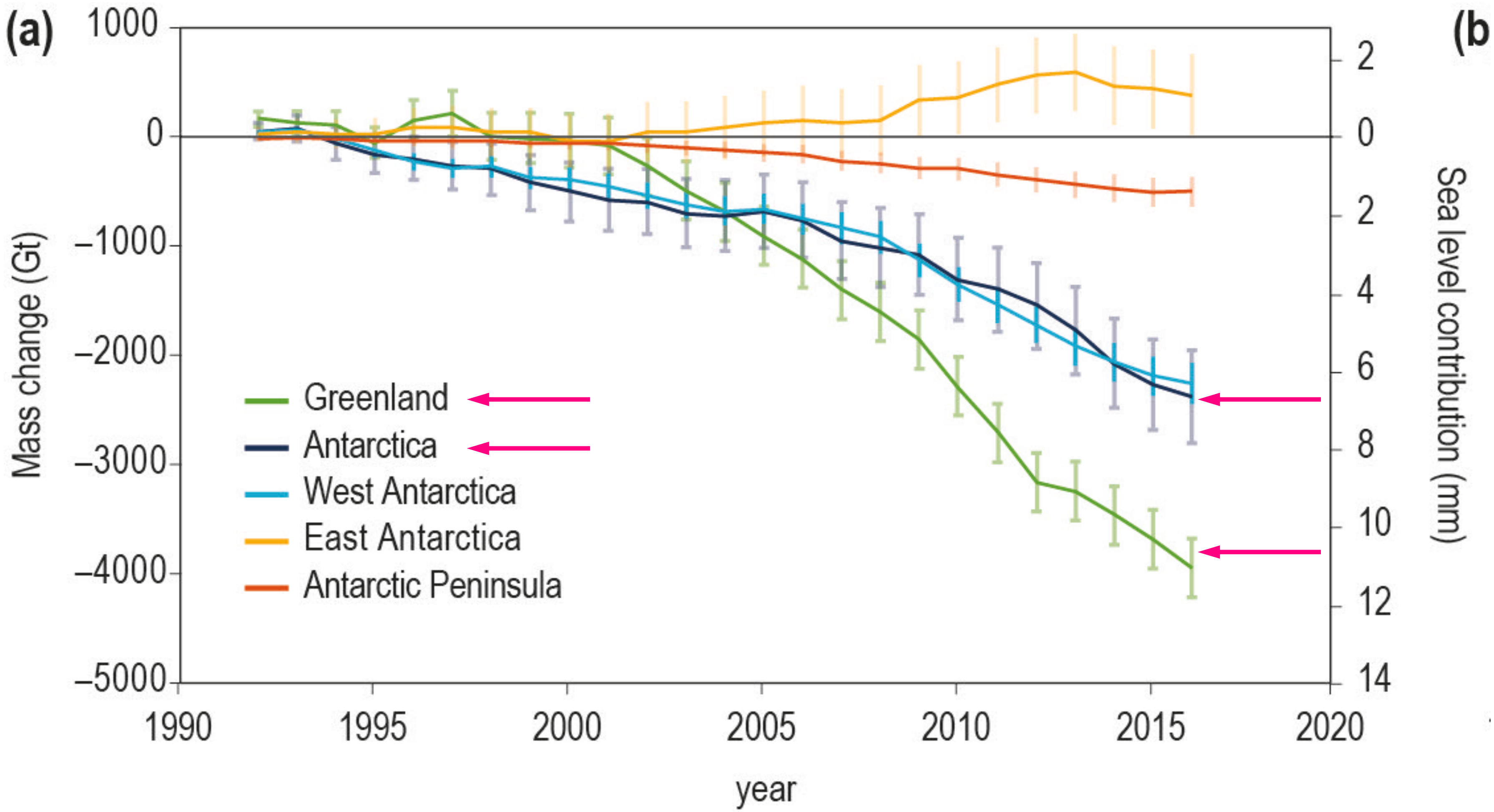
Antarctic land ice mass changes and sea level rise





Total cumulative Antarctic ice sheet mass.
Change relative to 1992.
Data source: IMBIE Shepherd et al., (2020)
Credit: IMBIE/ESA/NASA.

Ice sheets: Mass change and sea level rise

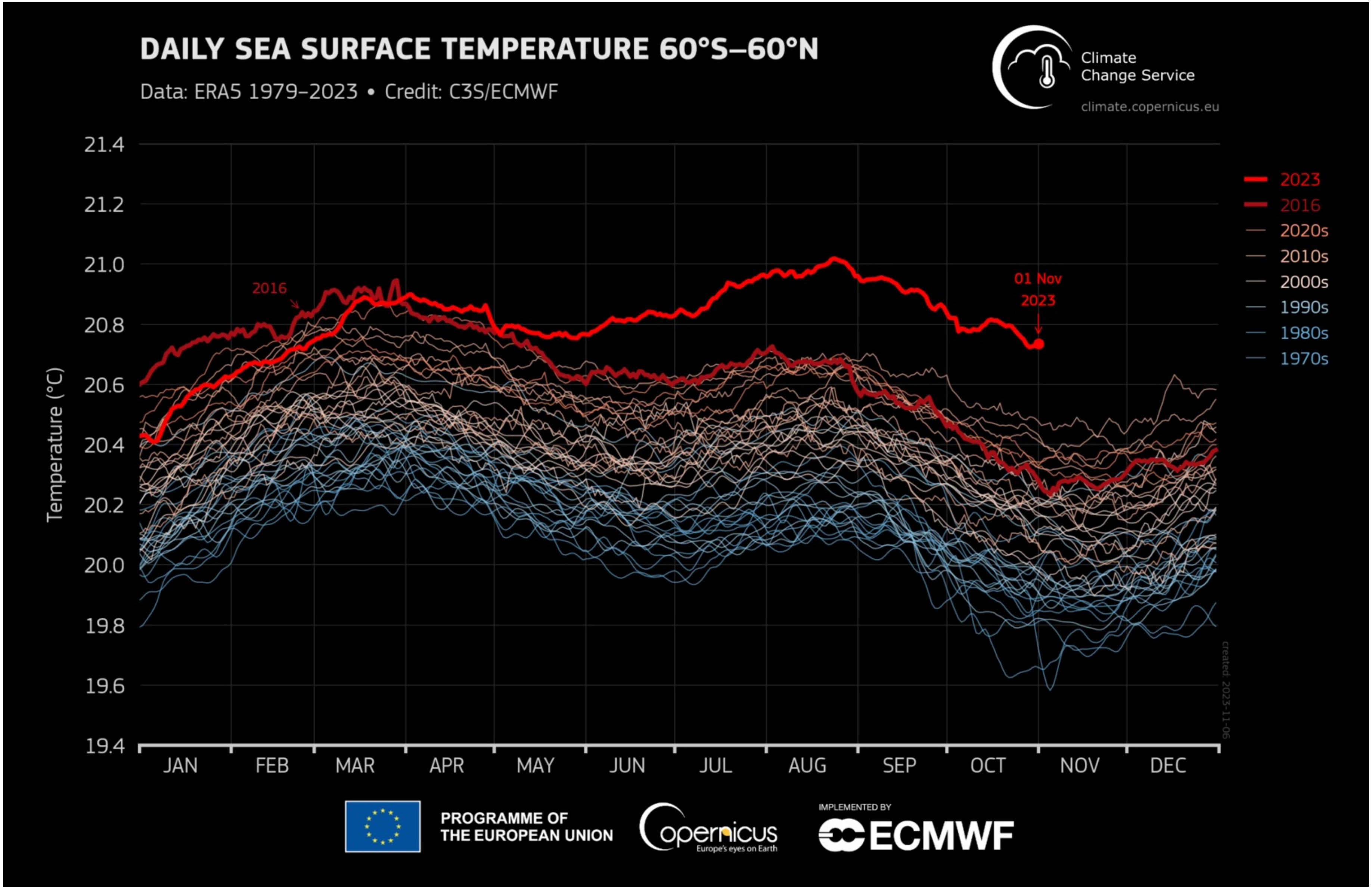


IPCC AR5 2014

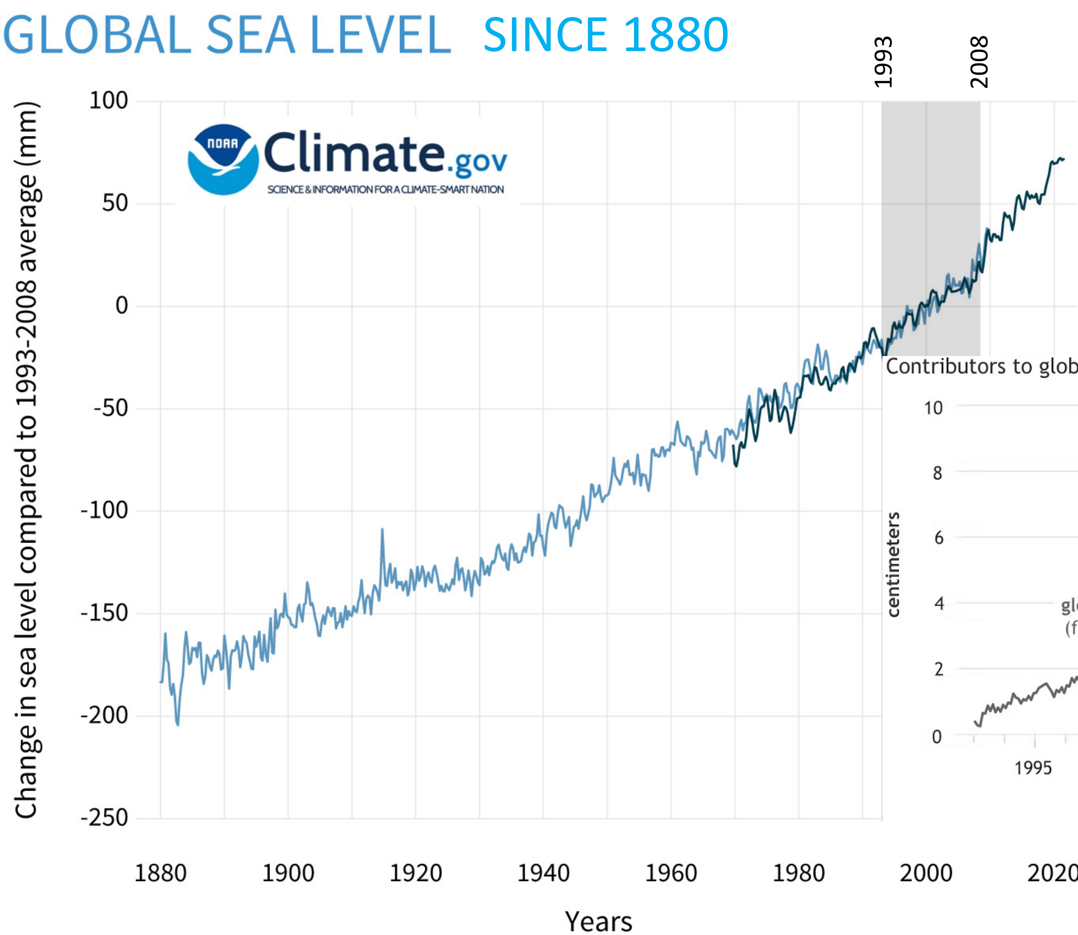
State of the cryosphere: Sea level rise

Miami – scenario, The Guardian

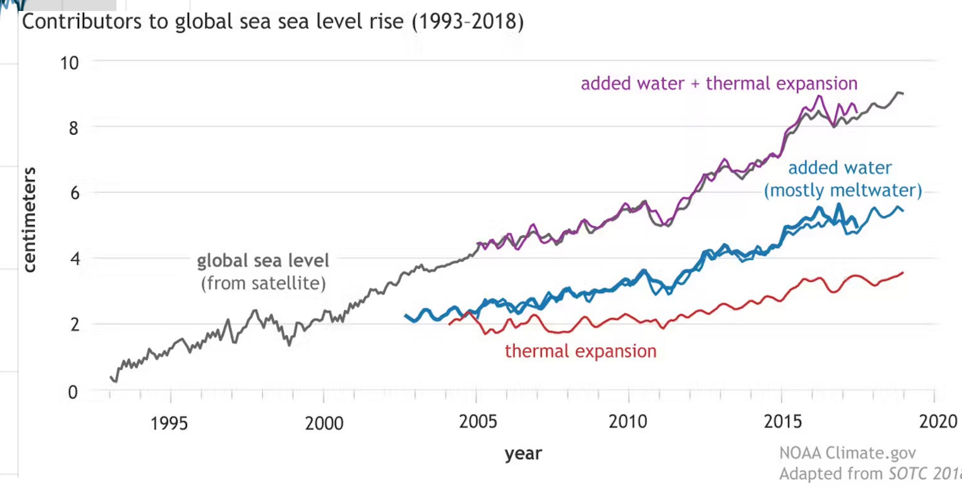
Sea surface temperatures



Sea level rise

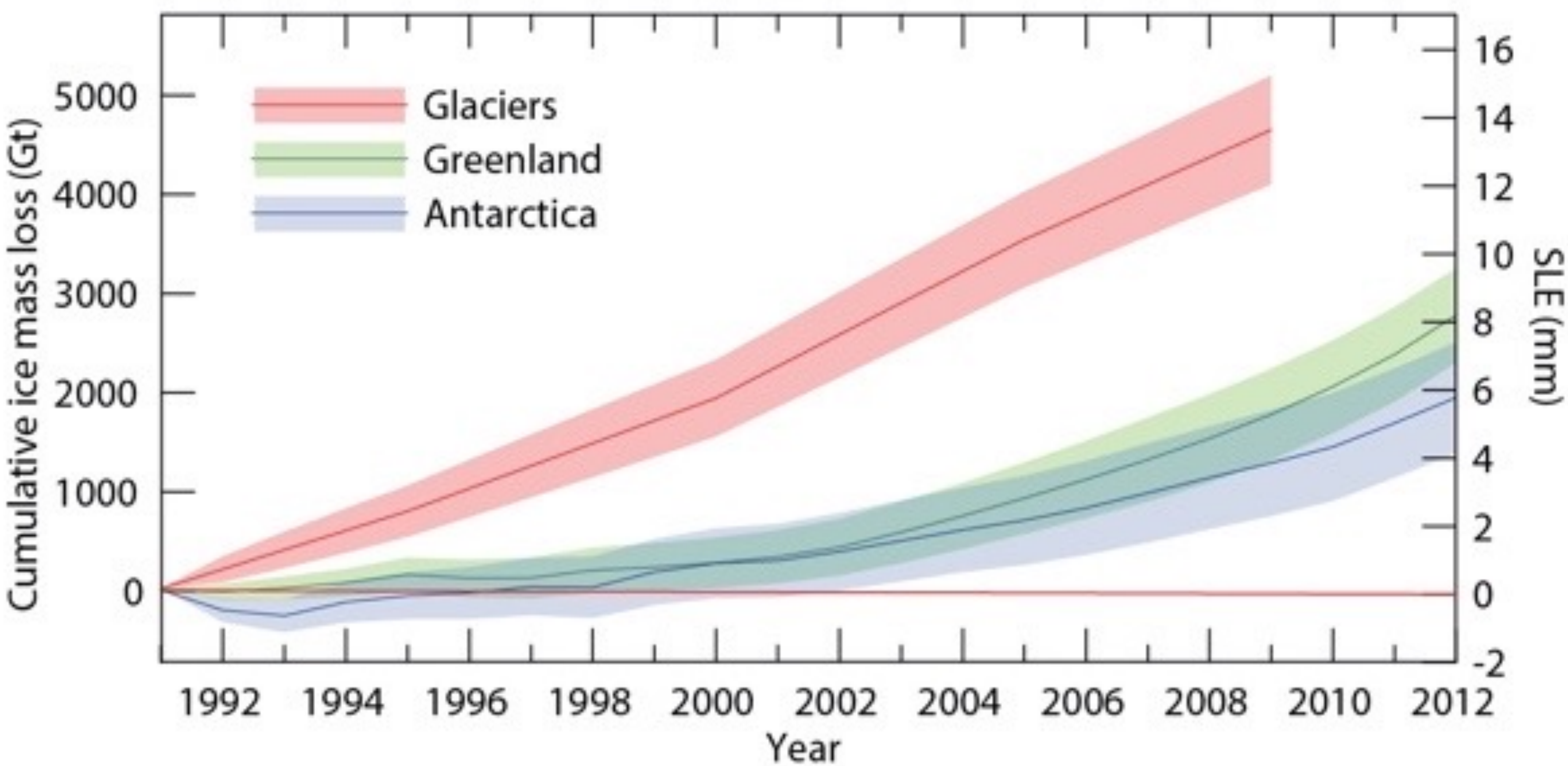


Seasonal (3-month) sea level estimates from Church and White (2011) (light blue line) and University of Hawaii Fast Delivery sea level data (dark blue). The values are shown as change in sea level in millimeters compared to the 1993-2008 average. NOAA Climate.gov image based on analysis and data from Philip Thompson, University of Hawaii Sea Level Center.



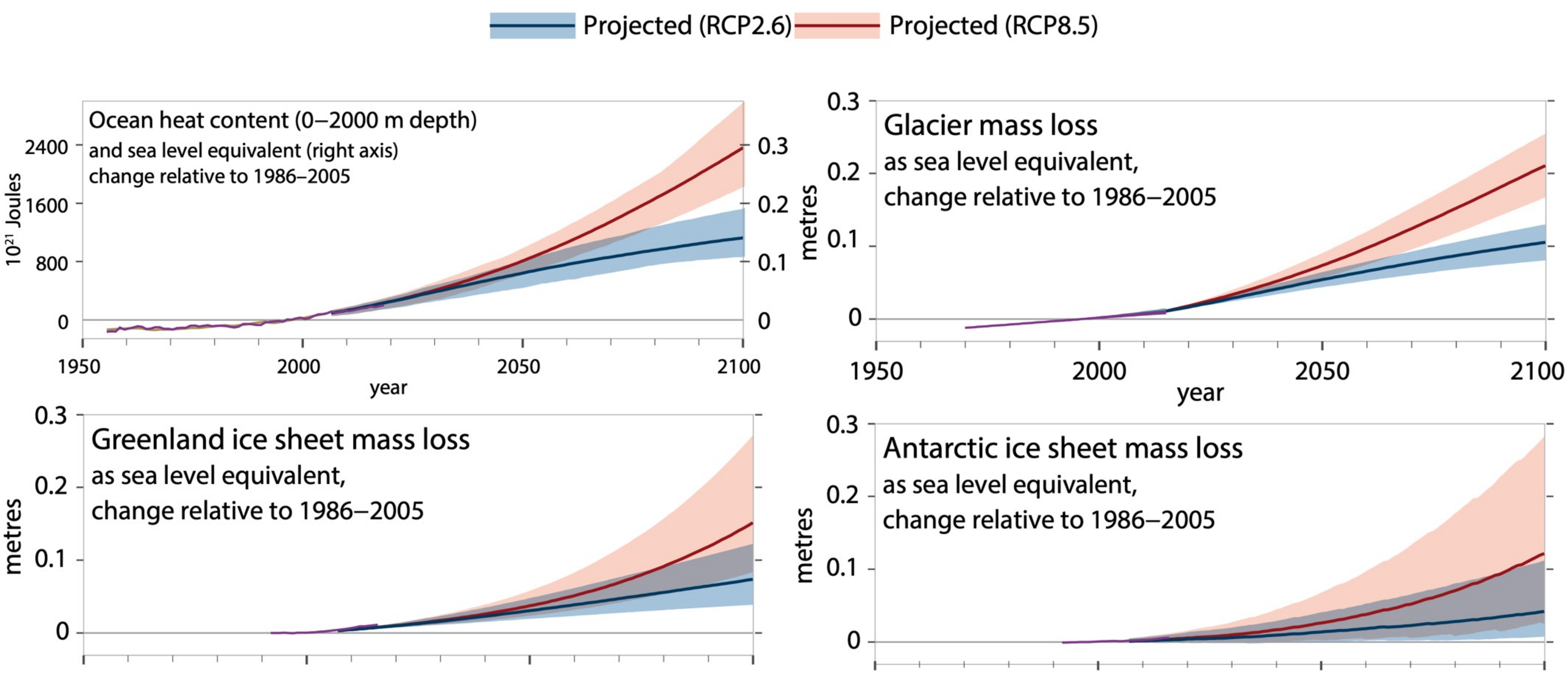
Also note:
Thermal expansion

Cumulative ice mass loss and corresponding uncertainty range
SLE = sea level equivalent



IPCC AR5 2014

Future change cryosphere and sea level



IPCC (2019)

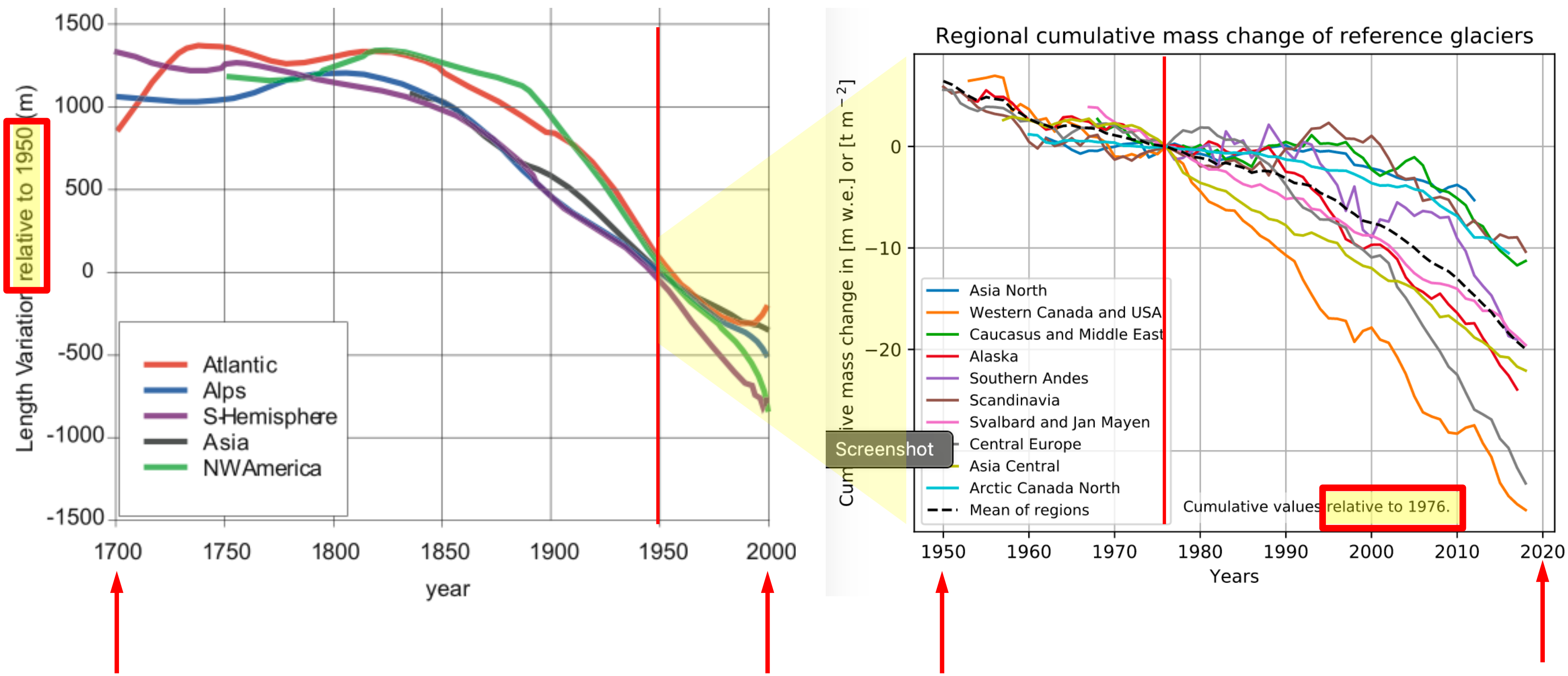
Alpine glaciers

Alpine and polar glacier characteristics

- Alpine glaciers have a temperature at the pressure melting point (temperate)
- Polar glaciers are “cold” ($< 0^{\circ}$ C) or “poly-thermal”
- Gravity driven ice flow, visco-plastic flow regime
- Basal gliding on loose or frozen sediment or on solid bedrock
- Feature a neutral mass balance when in equilibrium with present climate
- Reliable freshwater water reservoir (as long as they resist climate change)
- Flow velocity typically 10 to 500 m yr^{-1}

Glacier flow

Glaciers: Regional changes in glacier length

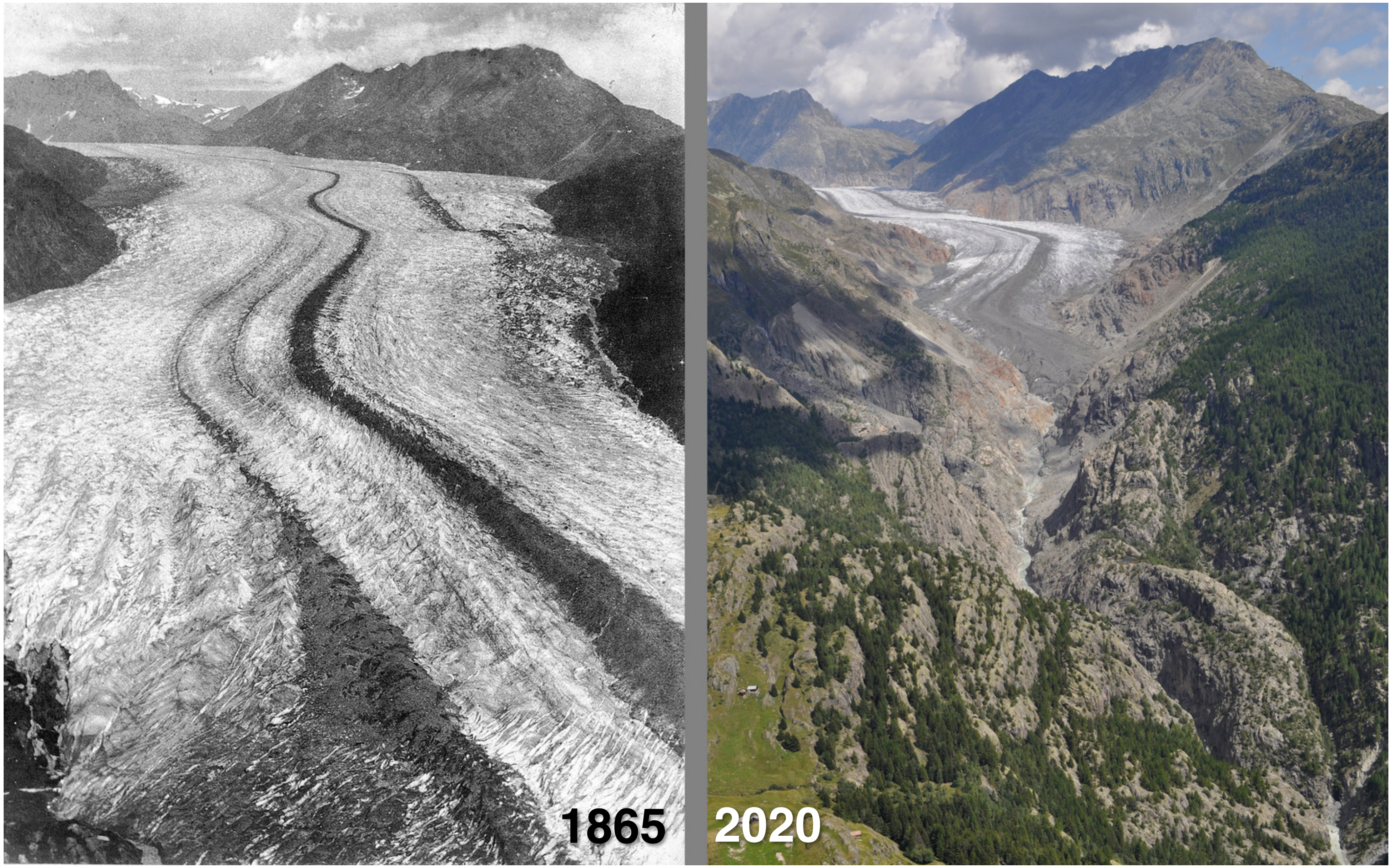


(from IPCC AR4, 2007; Chapter 4; based on Oerlemans, 2005)

(from WGMS)

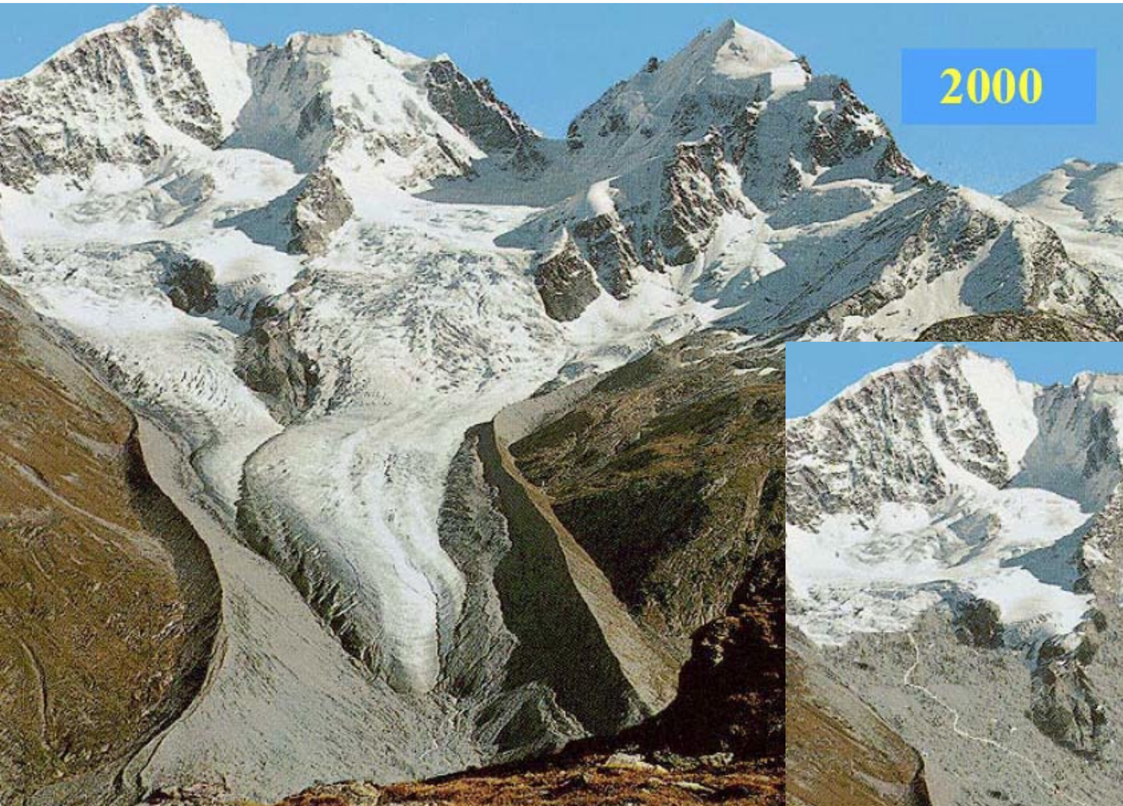
Glacier changes: Gorner and Rhône glacier (VS)

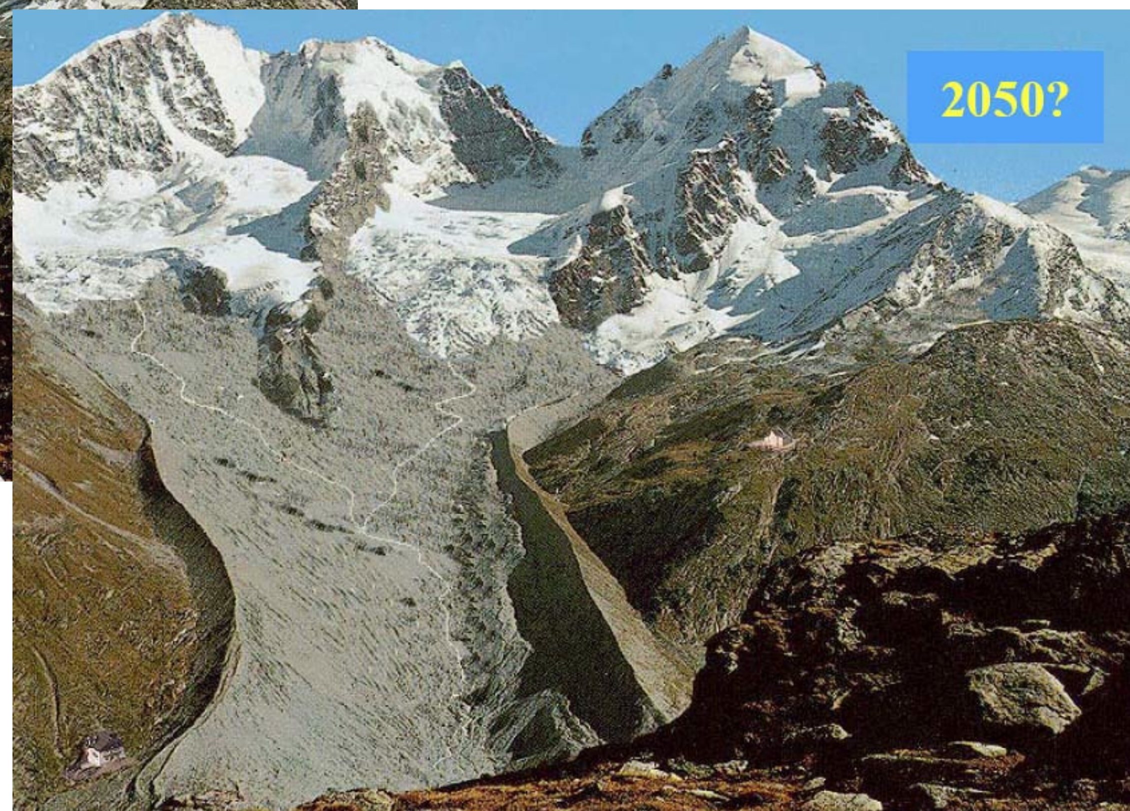
Glaciers: Aletsch glacier (VS)



ourheritage.ch

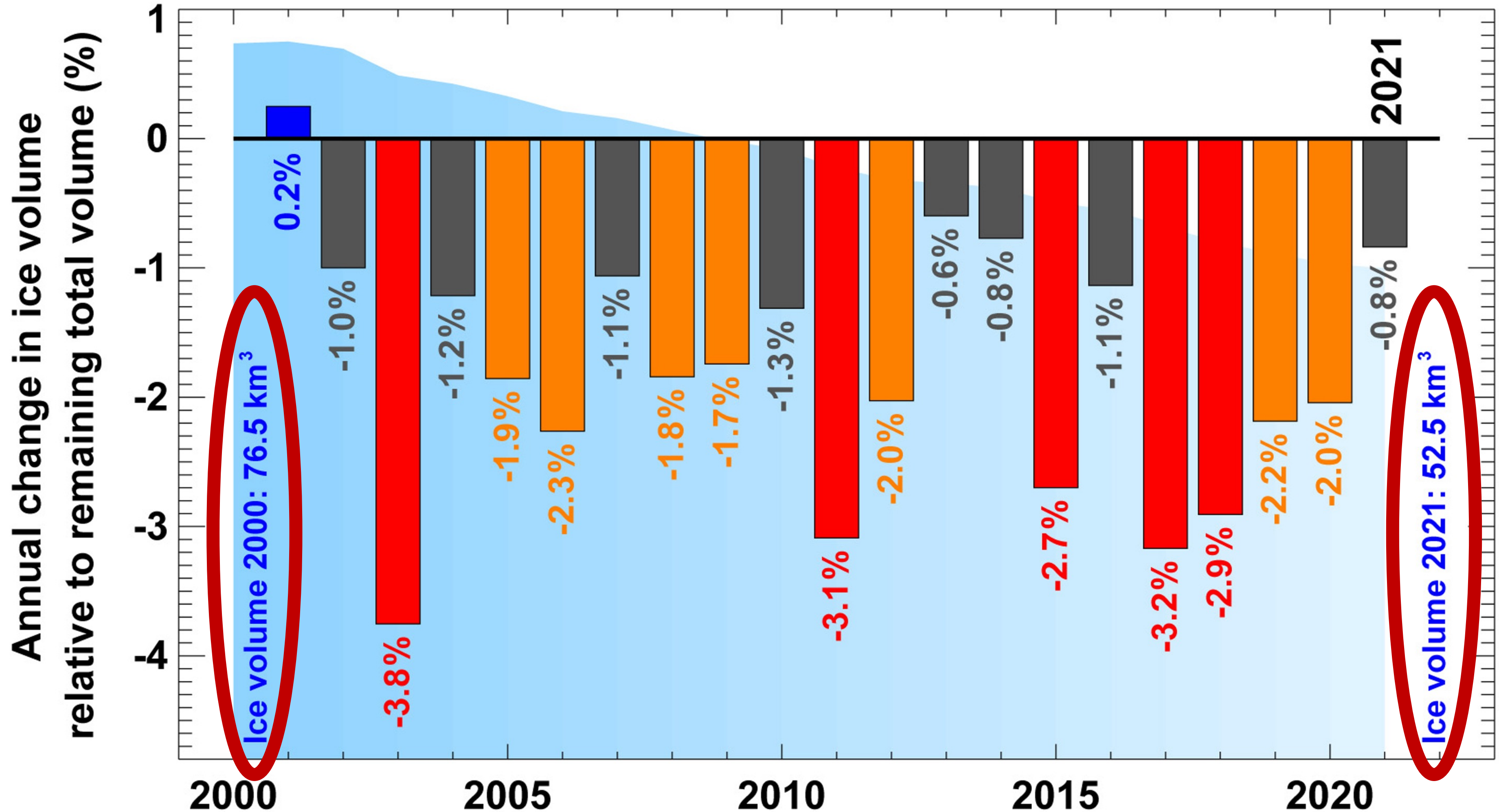
Glaciers: Tschierva glacier (GR)





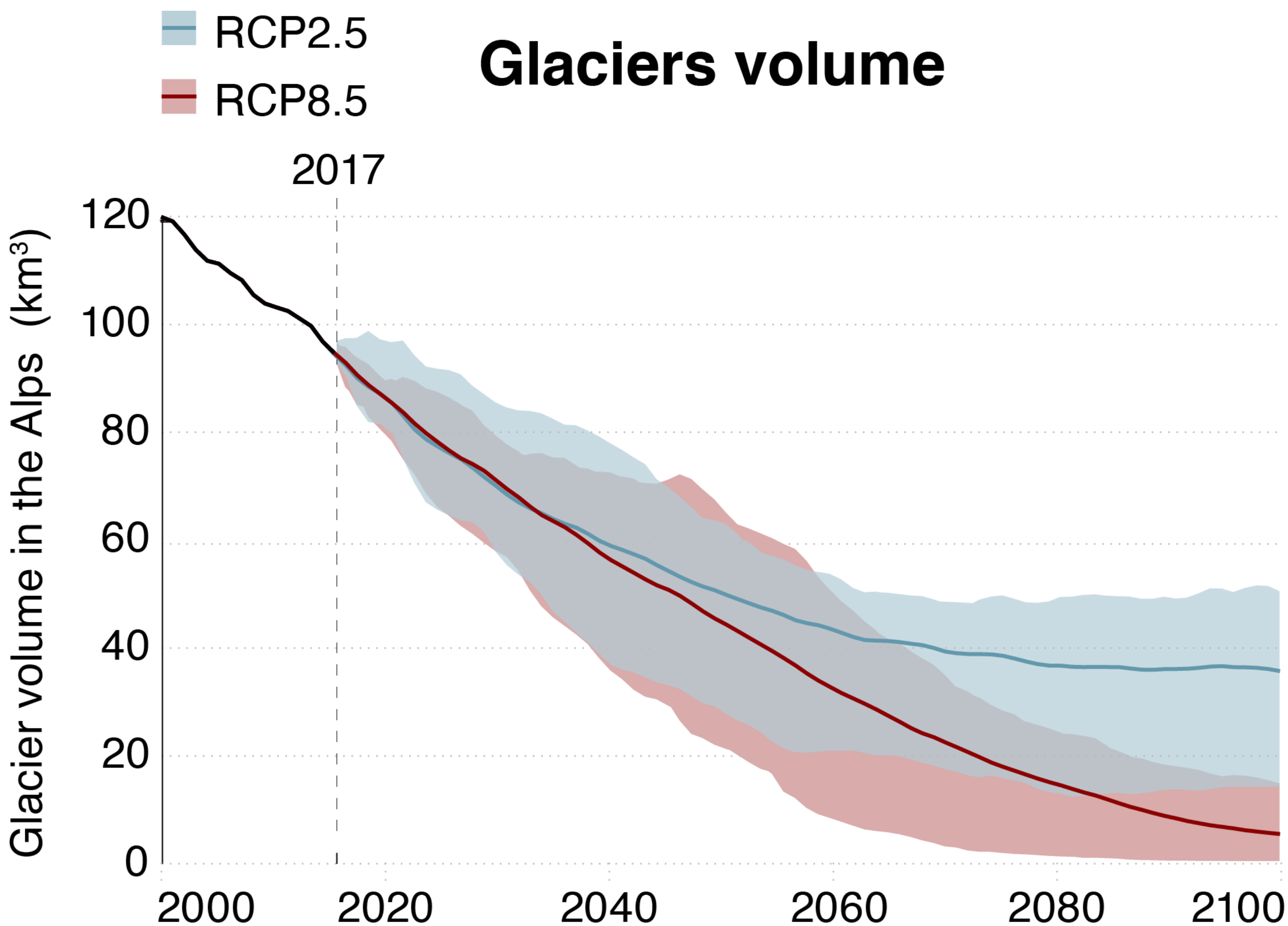
M. Maisch et al., UZH

Alpine glaciers: past changes in ice volume



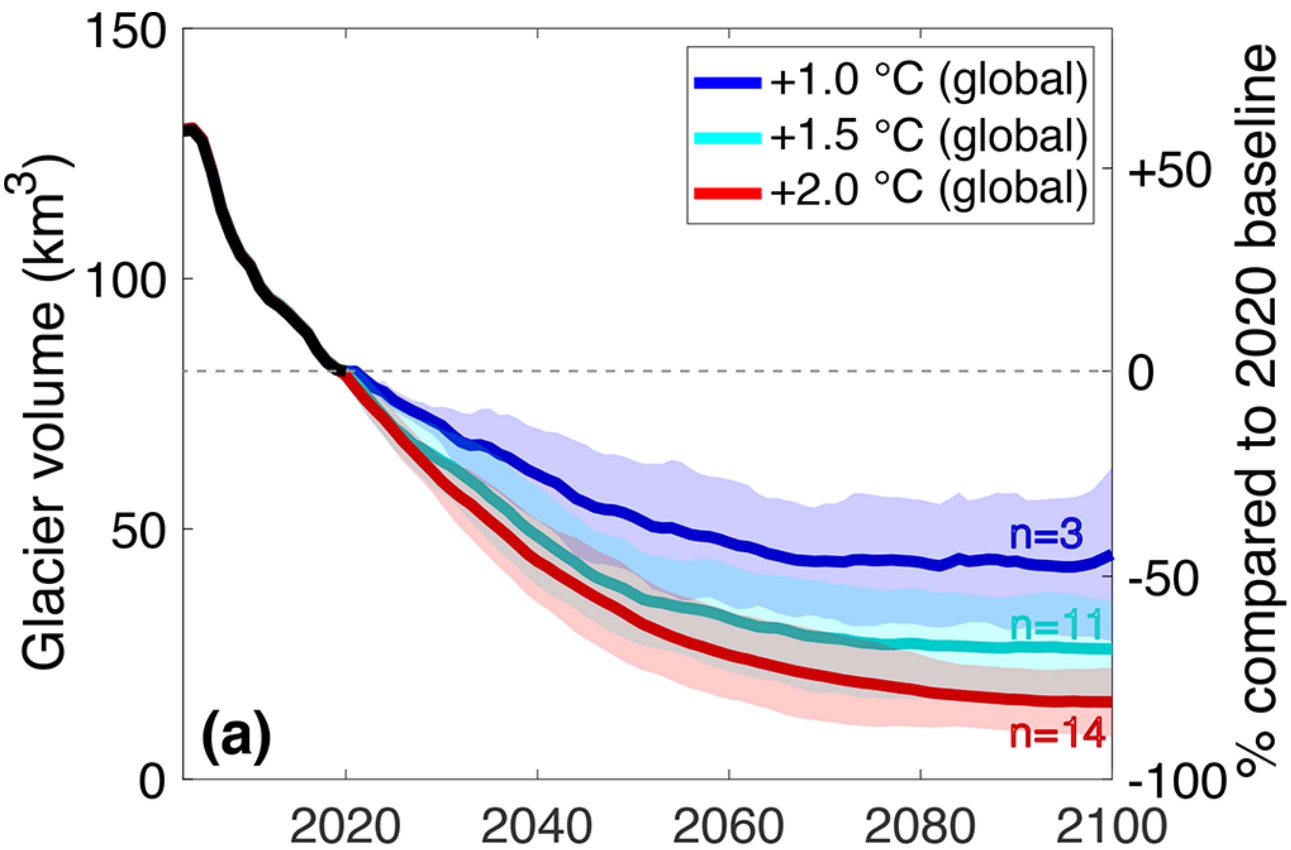
GLAMOS (2021)

Alpine glaciers: future changes in ice volume



Hydro-CH2018 (2021); Zekollari et al. (2020)

Glaciers: Future changes in ice volume



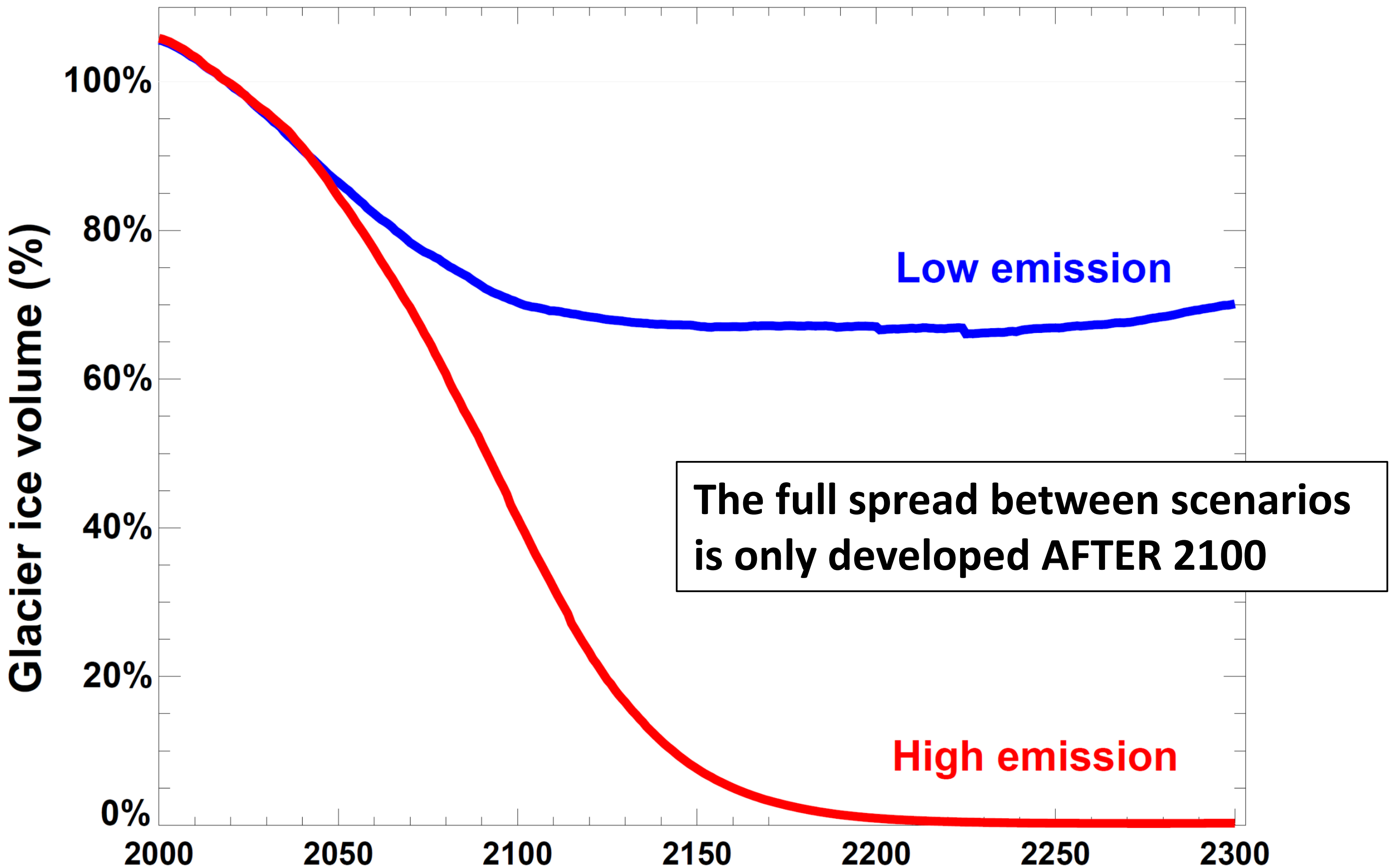
+1.0 ° C → -44%

+1.5 ° C → -68%

+2.0 ° C → -81%

Compagno et al. (2021)

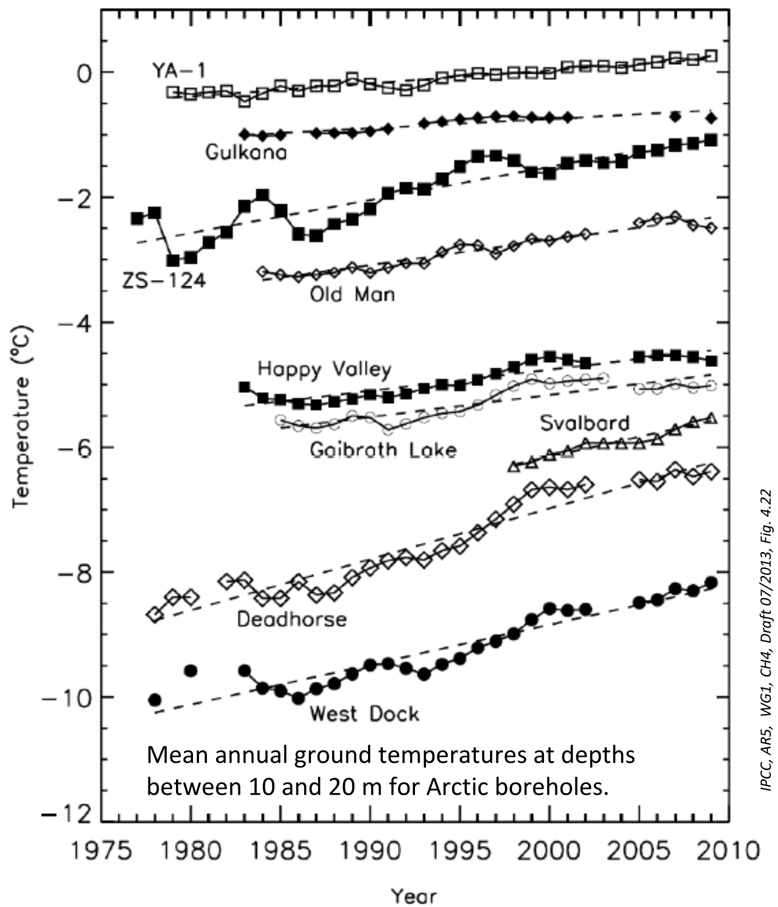
Glaciers: Future changes in ice volume



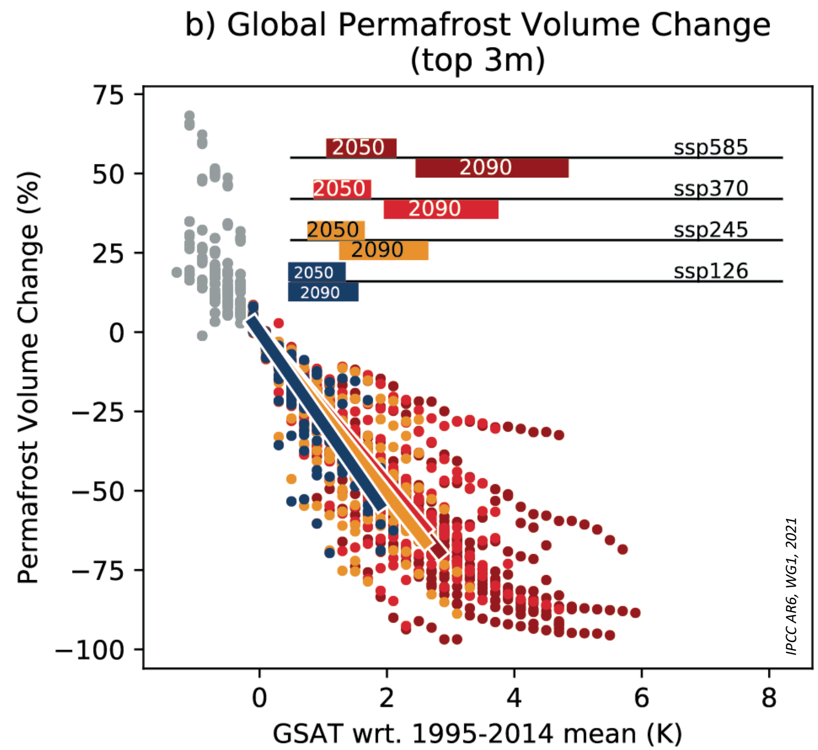
Marzeion et al. (2012), Huss & Hock (2015)

State of the cryosphere: Permafrost

Permafrost: evolution of temperature and area



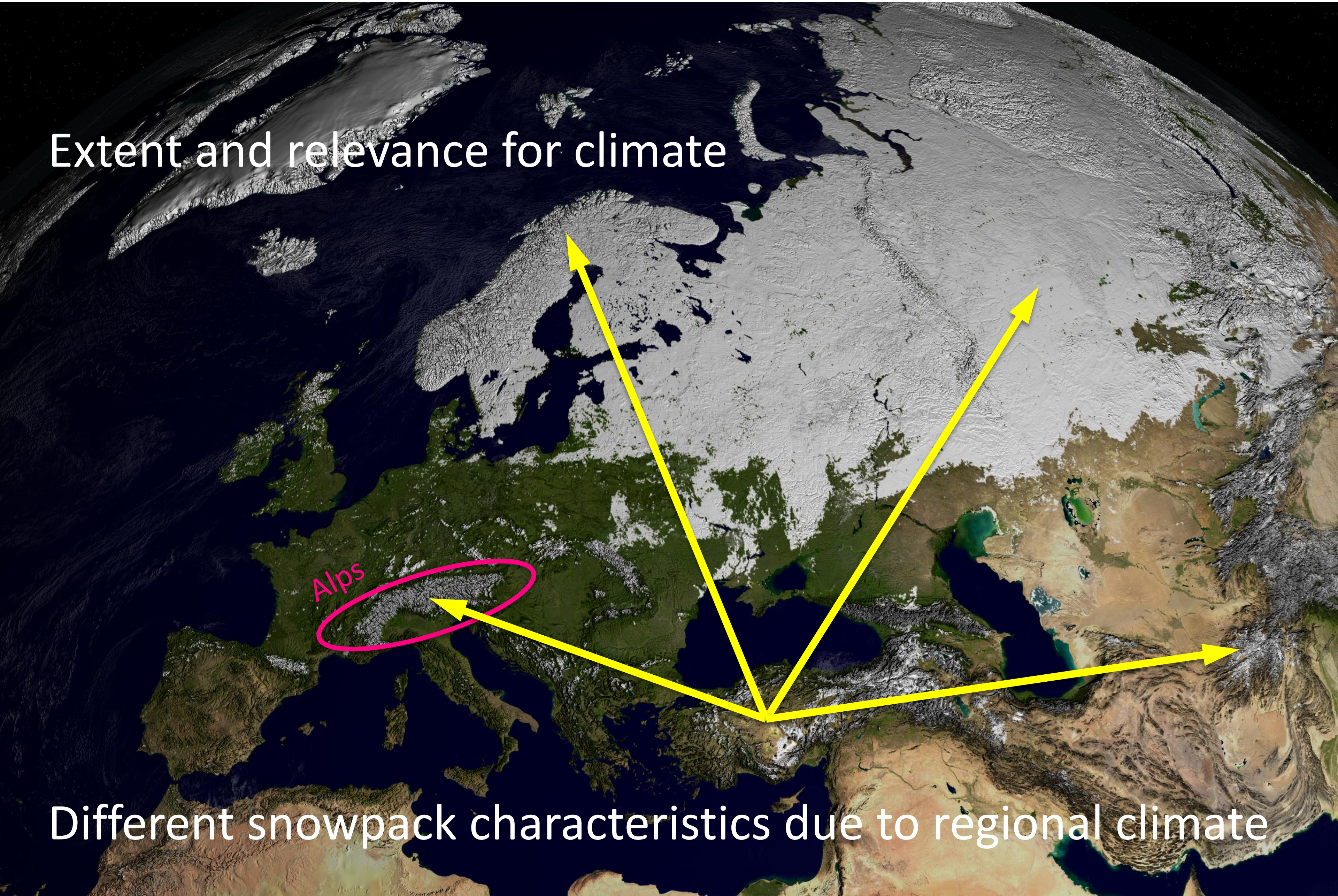
IPCC, AR5, WG1, CH4, Draft 07/2013, Fig. 4.22



Global Surface Air Temperature

State of the cryosphere: Seasonal or perennial snow

Hemispheric (large-scale) snow cover



Snow cover characteristics

- Seasonal (ephemeral) and permanent (perennial) snow cover
- Different characteristics due to regional climate
- Highly transformative medium, varies in space and time
- Highly reflective for solar radiation (visible light, VIS) – high albedo
- But, due to transmission and absorption, snow is still a radiative sink for VIS
- High emissivity and low reflectivity for infrared radiation (IR)
- Efficient thermal insulator → large vertical temperature gradients
- Reduces aerodynamic roughness of the landscape and thus atmospheric turbulence and mixing

Snow significantly changes the surface energy budget from local to global scale.

Climate change impacts on snow

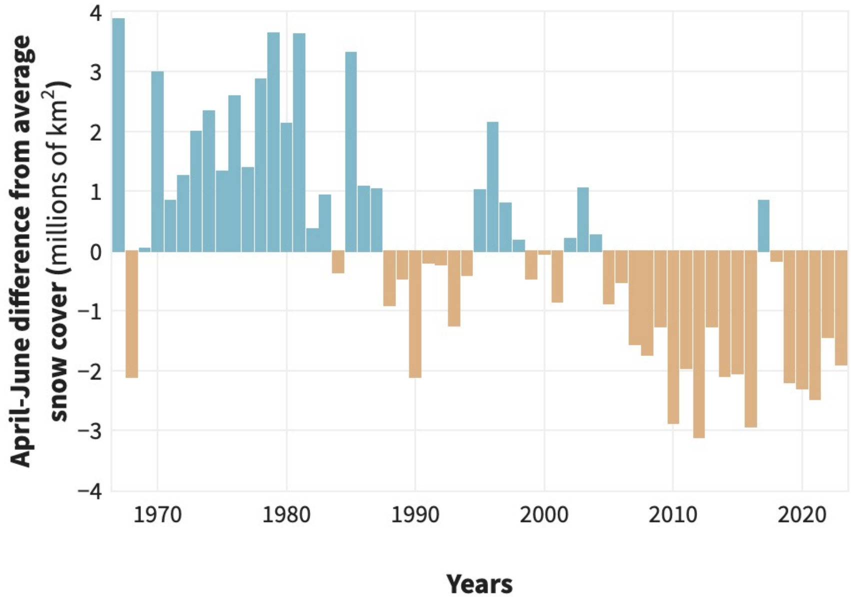
- **Less snow** at low elevations (below 1800 m)

  For every 1°C increase in temperature, there will be a ~150 m rise in snow line (more on south-facing slopes, less on north-facing slopes)

- **Shorter** snow cover duration (especially below 2000 m)
- Later winter and earlier spring (fewer freezing days)
- Higher frequency of **rain-on-snow** events
- Possible increase in snowfall at high elevations (local effect)
- **Water availability** will be adversely impacted

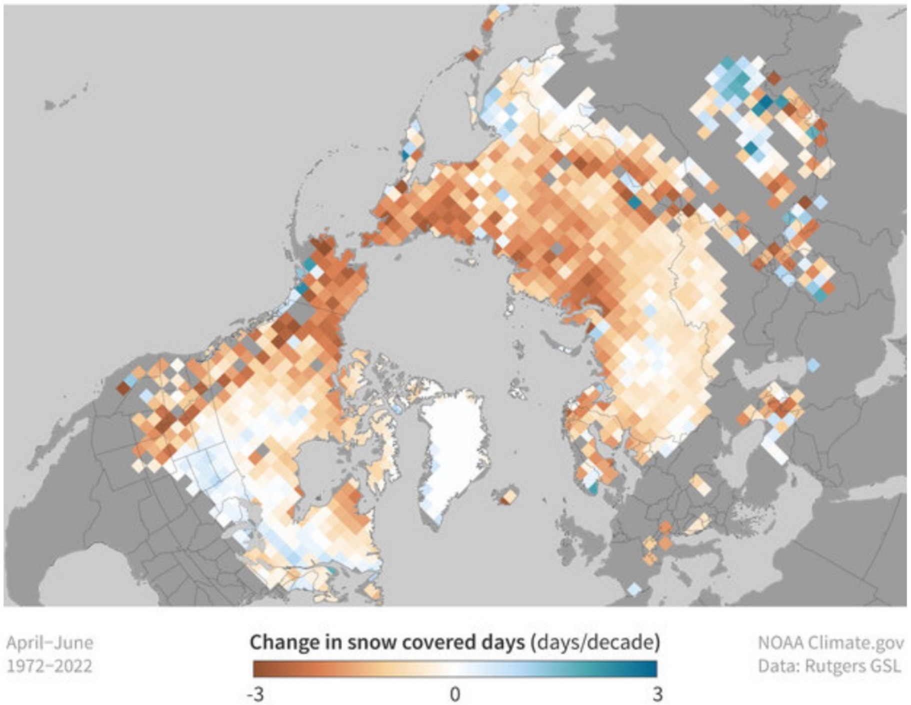
Northern hemisphere snow cover

SPRING SNOW COVER EXTENT



Area of snow-covered ground in the Northern Hemisphere each April-June compared to the 1981-2010 average. The area covered by snow in late spring has been below average throughout most of the past two decades. Data from Rutgers Snow Lab.

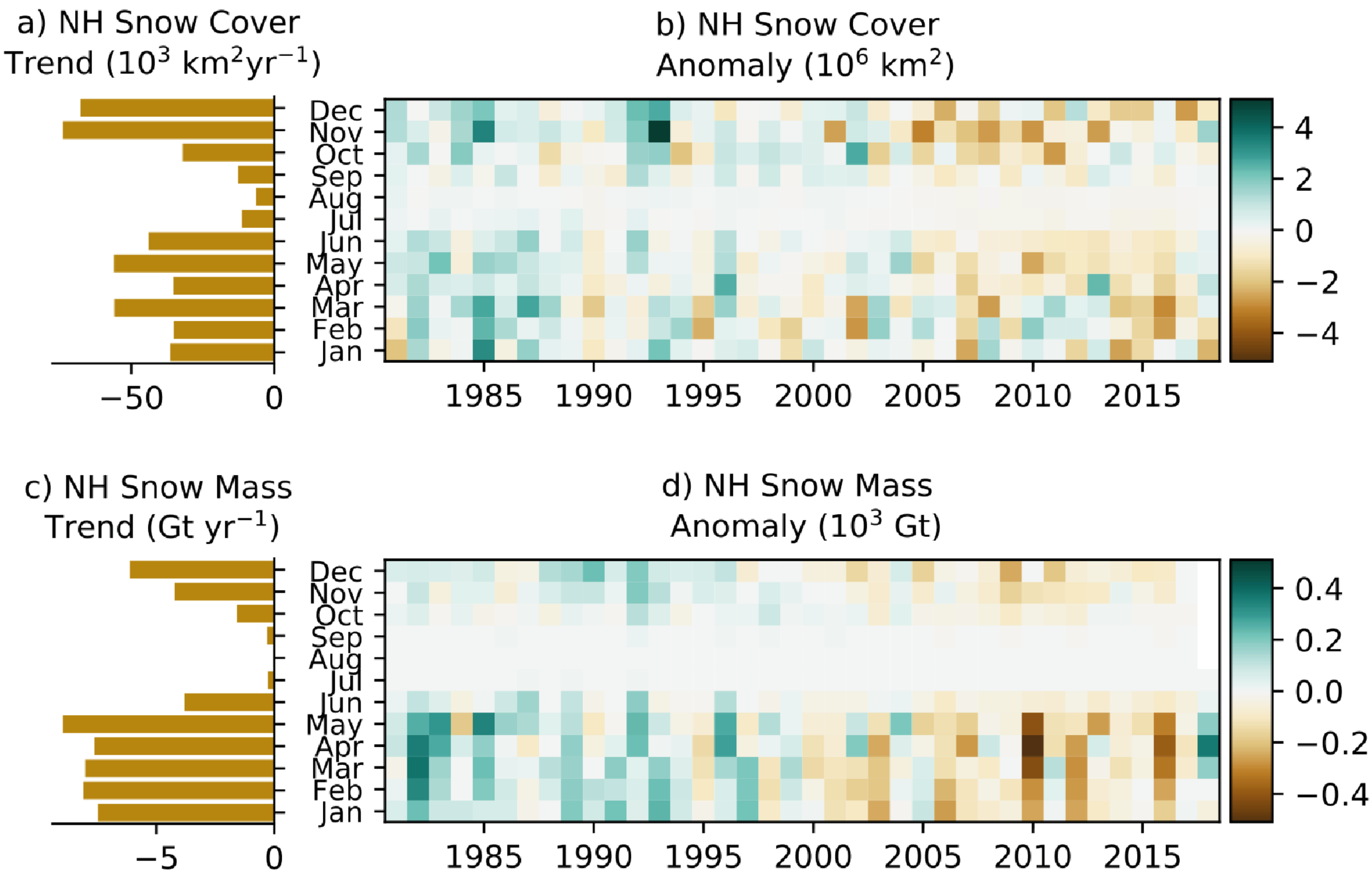
SNOW COVER TRENDS (1972-2022) DURATION



Change in the number of snow-covered days per decade in late spring (April–June) across the Northern Hemisphere. At most locations, late spring snow days are declining (brown). Data from Rutgers Snow Lab.

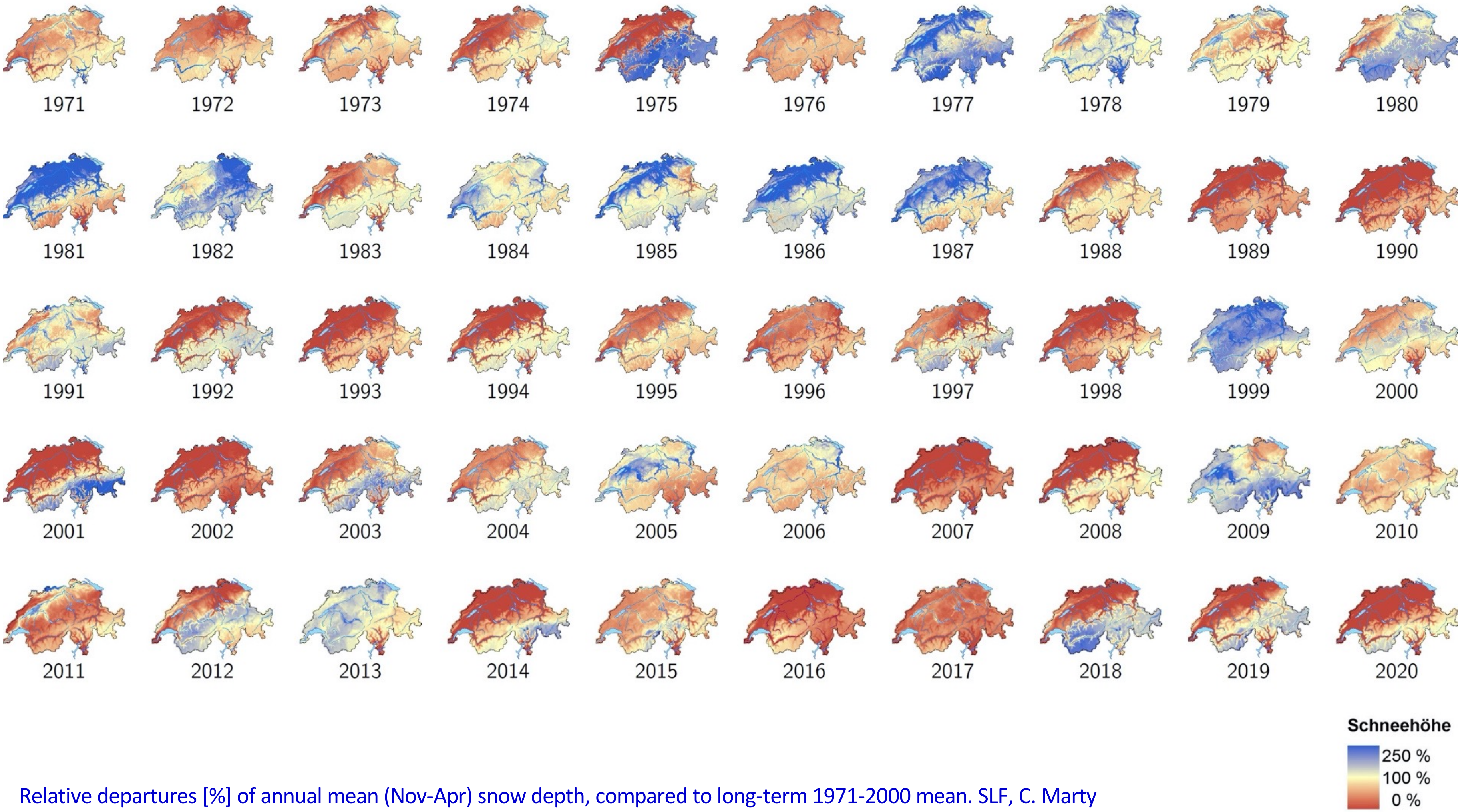
Climate.gov
SCIENCE & INFORMATION FOR A CLIMATE-SMART NATION

Snow cover: NH area and mass



IPCC AR6, WG1, 2021

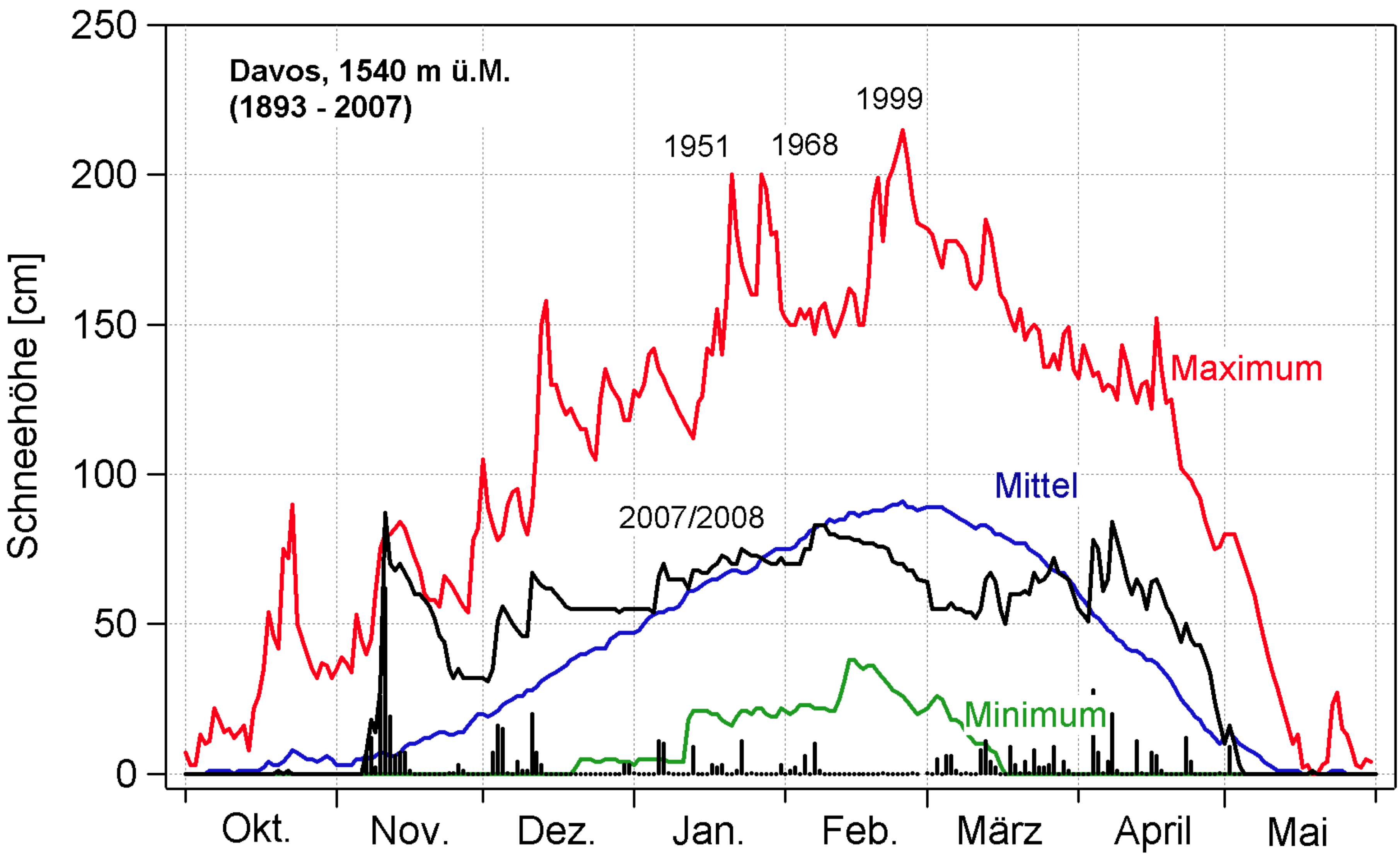
Snow cover: inter-annual variability – Switzerland



Relative departures [%] of annual mean (Nov-Apr) snow depth, compared to long-term 1971-2000 mean. SLF, C. Marty

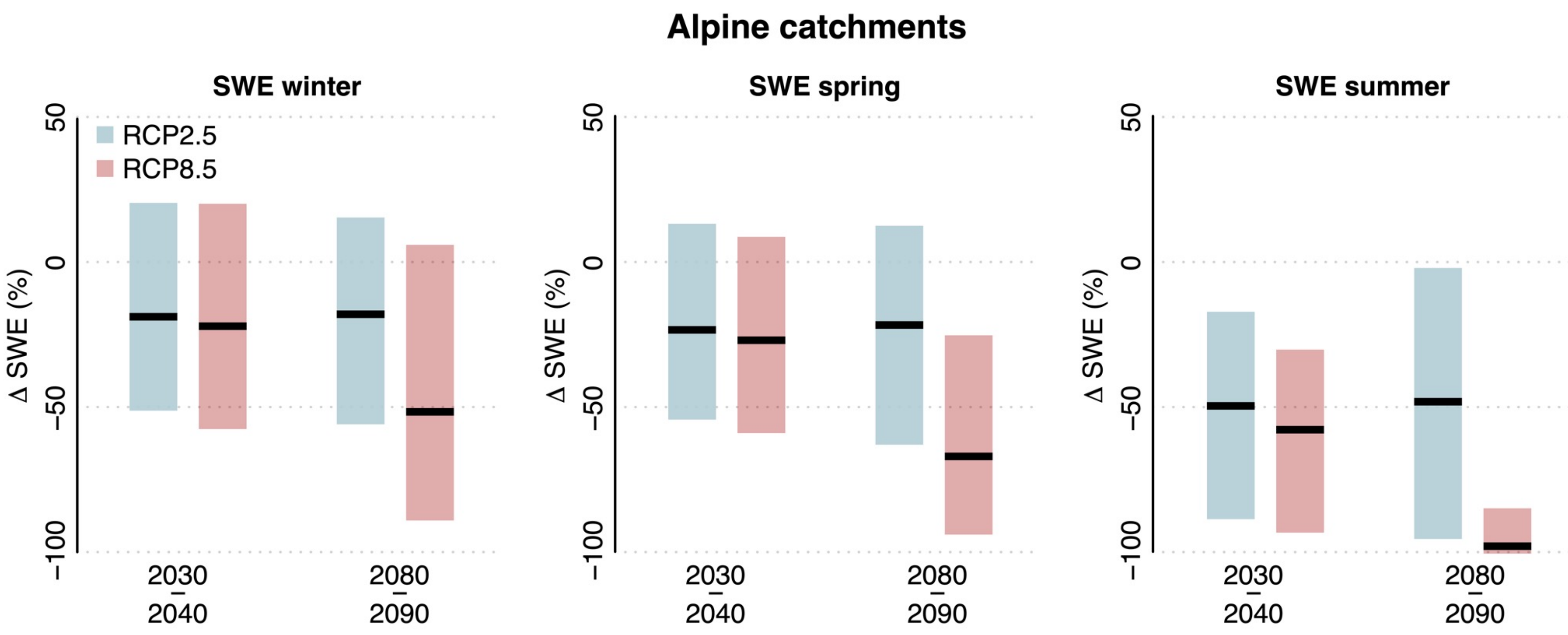
Snow cover: inter-annual variability

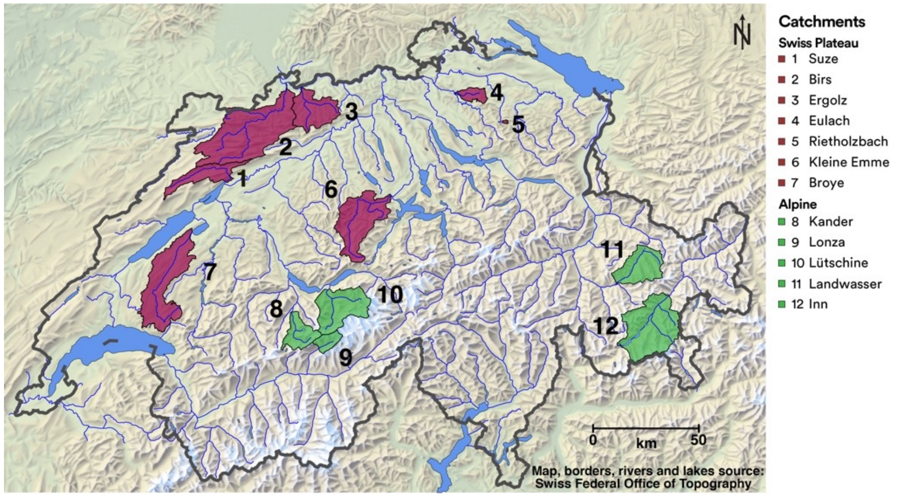
Example: Snow depth in Davos



Snow cover: inter-annual variability

Snow cover: future changes (Switzerland)





Hydro-CH2018 (2021);
Michel et al. (2021)

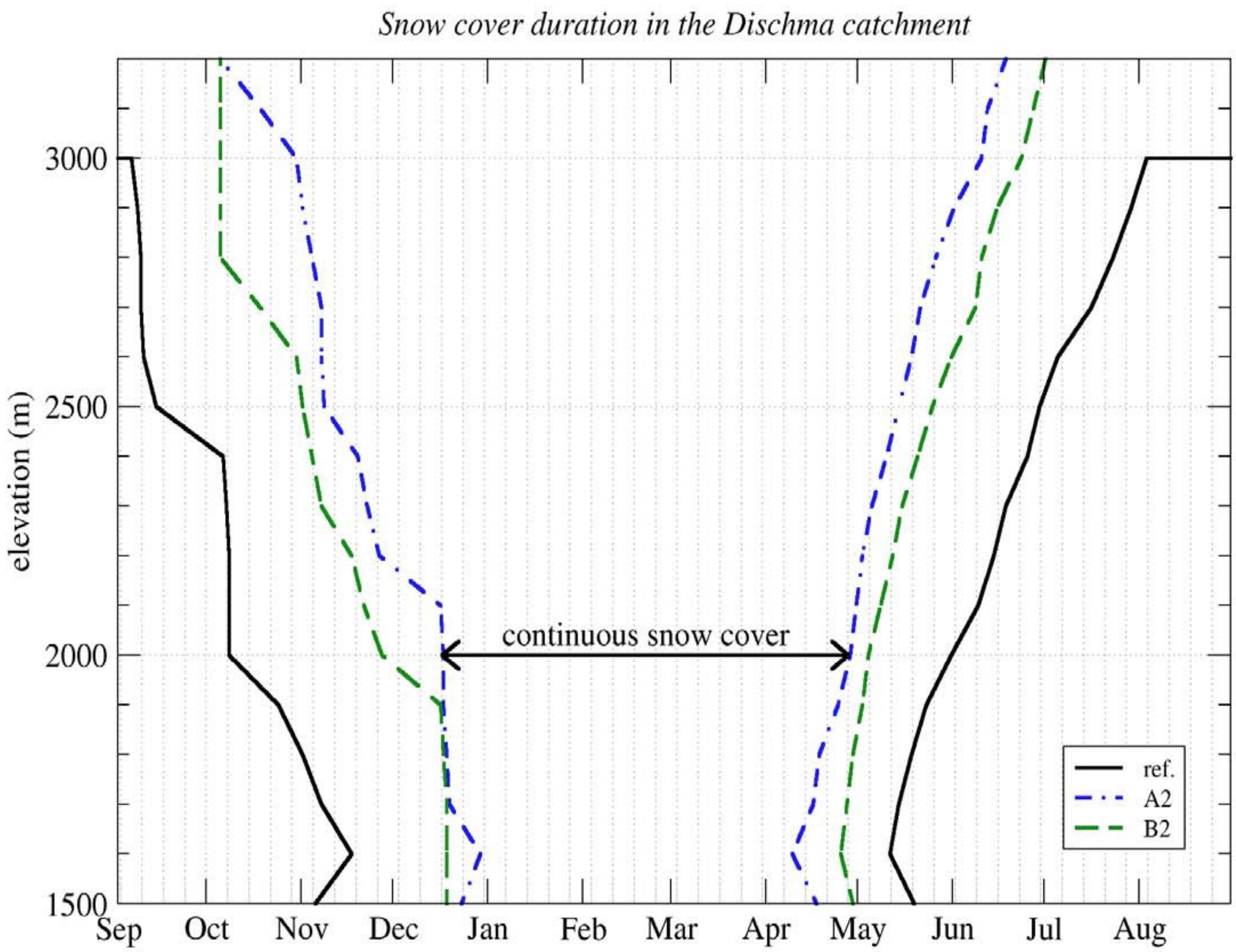
Climate change impacts on snow

- Less snow at low elevations (below 1800 m)

  Every 1^{o}C increase in air temperature, entails a ~150 m rise in snow line (more on south-facing slopes, less on north-facing slopes)

- Shorter snow cover duration (especially below 2000 m)
- Later winter and earlier spring (fewer freezing days, < 0^{o}C)
- Higher frequency of rain-on-snow events → floods
- Change in precipitation phase (shift from snow to rainfall)
- Possible increase in snowfall at high elevations
- Water and energy availability will be adversely impacted
- Increasing uncertainties due to non-linear system changes

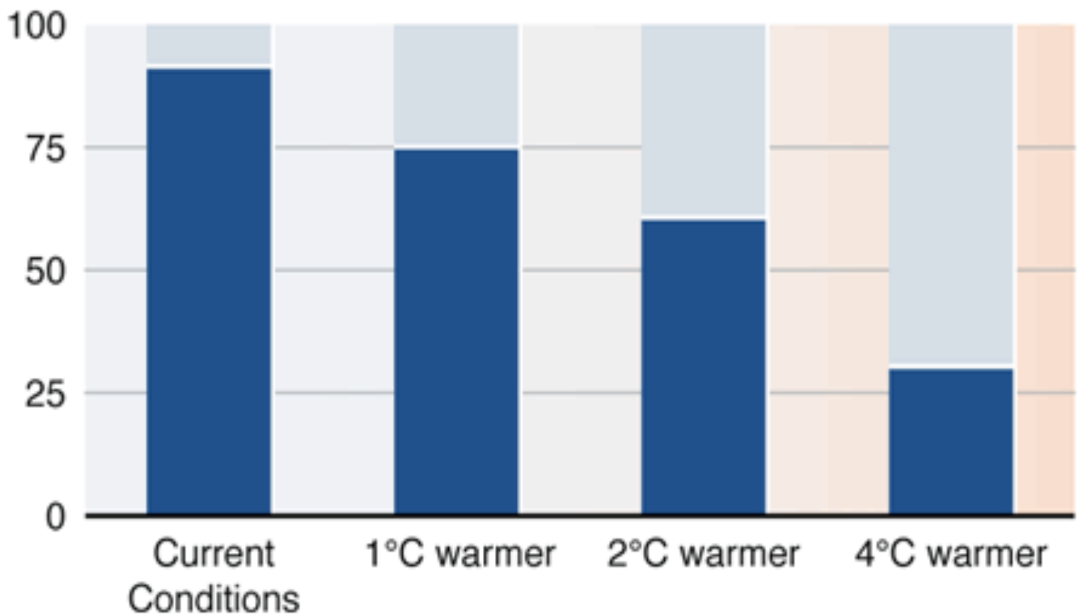
Changes in snow cover duration



M. Bavay & C. Marty

Changes for winter recreation

Reliability of snow conditions in ski resorts in the European Alps

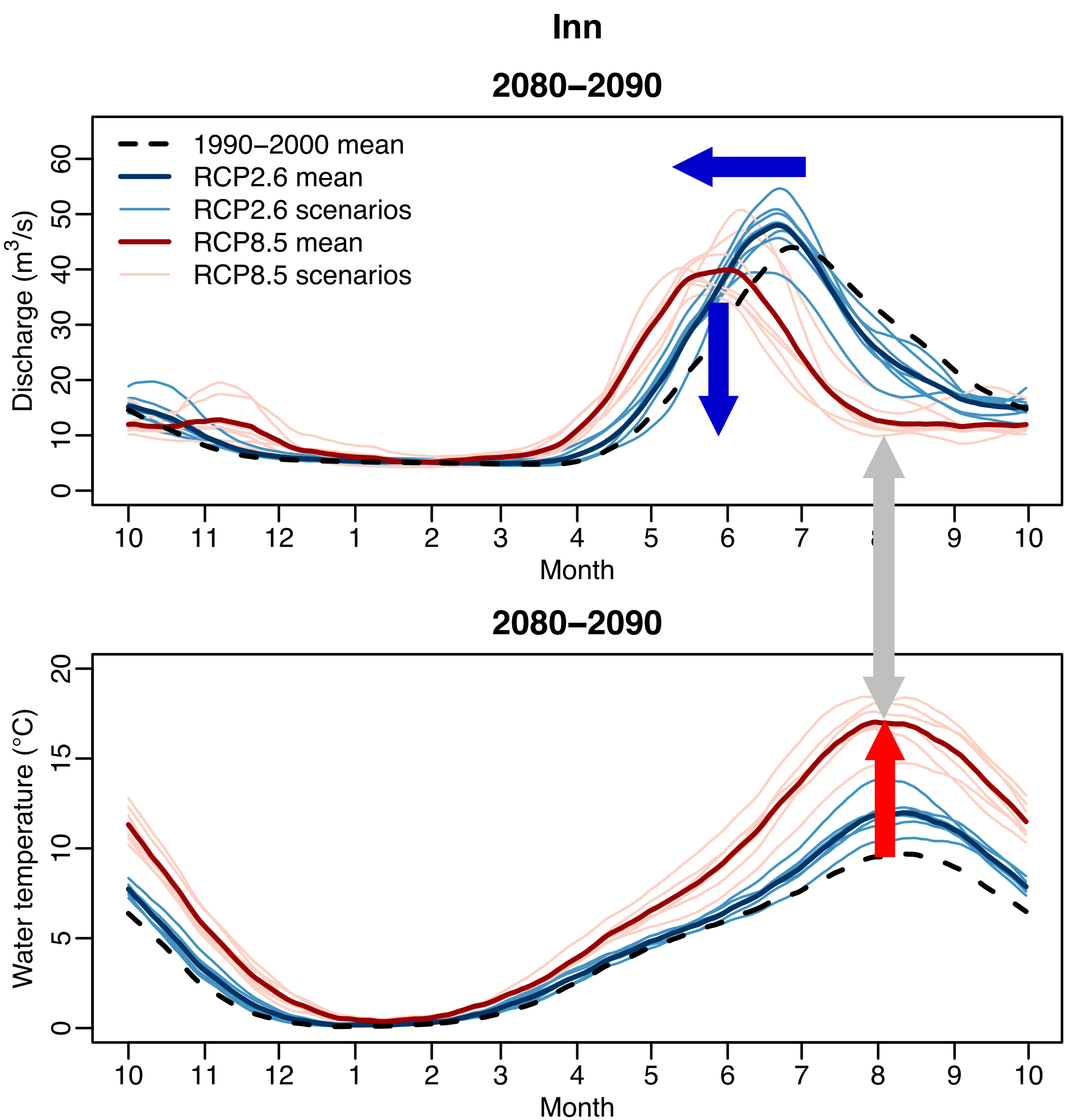


Dark blue is percentage of resorts with reliable snow conditions

Each degree warmer in the winter means poor snow conditions for more ski resorts.

Many low elevation ski resorts will be forced to shut down.

Changes in snow melt, discharge, hydrograph

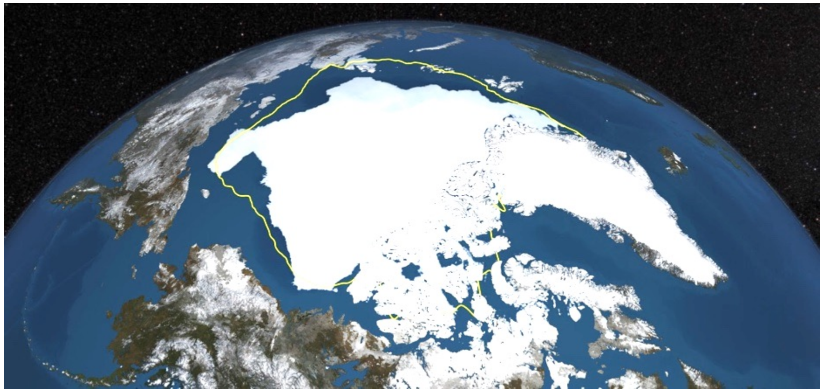


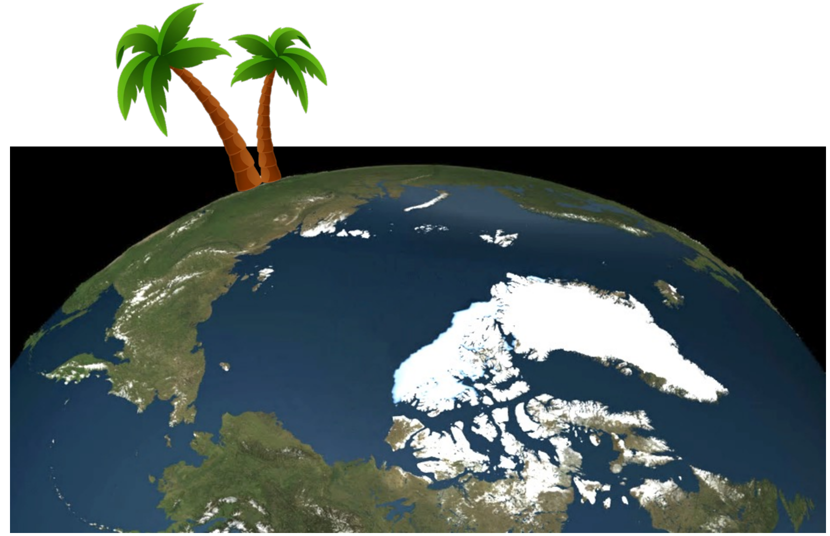
Hydro-CH2018 (2021); Michel et al. (2021)

Peak flows occur earlier, low flows are projected to be lower

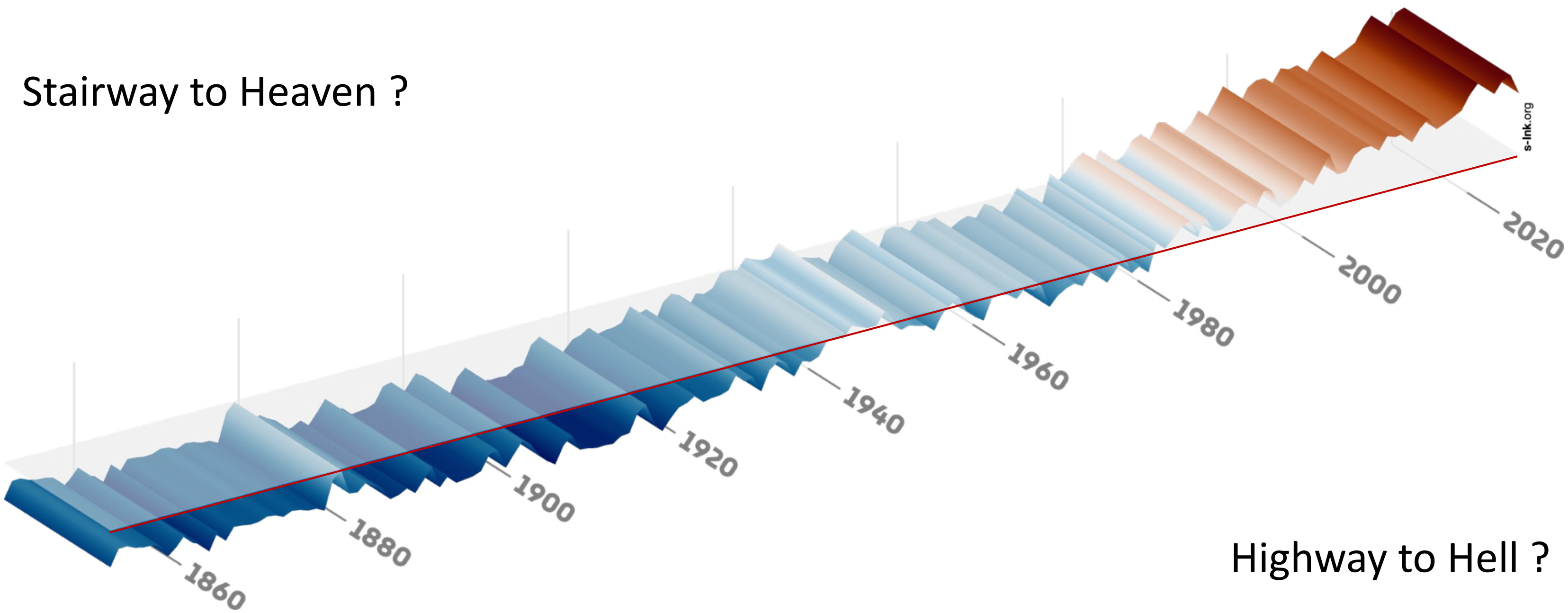
Shift in summer amplitude, temperature peak coincides with low discharge

Future Earth...





Stairway to Heaven ?



Highway to Hell ?

UN Climate Change Conferences

Science – Politics – Economy – Justice…

UN Framework Convention on Climate Change (UNFCCC)
UN Climate Change Conference of the Parties (COP)

RIO IN OUR HANDS EARTH SUMMIT '92 UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

UN-Klimakonferenz Berlin 1995

COP 2
1996
Geneva

Kyoto Japan, 1997

COP4 Buenos Aires, 1998

CoP5 United Nations Climate Change Conference Bonn, Germany Oct 25 - Nov 5, 1999

COP WORLD CONFERENCE CLIMATE CHANGE THE HAGUE 2000

COP7 Marrakech

COP 8 UN Conference Climate Change New Delhi 2002

COP9 Climate Change Convention Milano 2003

Convención sobre el Cambio Climático Climate Change Convention

Montréal 2005

UN Climate Change Conference Nairobi 2006

UN Climate Change Conference 2007 Bali - Indonesia

2008 United Nations Climate Change Conference Poznań 2008 Poland

COP15 COPENHAGEN UN Climate Change Conference 2009

COP16 CMP6 México2010 United Nations Climate Change Conference

COP17/CMP7 UNITED NATIONS CLIMATE CHANGE CONFERENCE 2011 DURBAN, SOUTH AFRICA

DOHA 2012 UN CLIMATE CHANGE CONFERENCE COP18·CMP8

KONFERENCJA NARODÓW ZJEDNOCZONYCH W SPRAWIE ZMIAN KLIMATU COP19/CMP9 WARSZAWA 2013

LIMA COP20 | CMP10 UN CLIMATE CHANGE CONFERENCE 2014

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

MARRAKECH COP22 | 2016 | CMP12 UN CLIMATE CHANGE CONFERENCE

COP23 FIJI UN CLIMATE CHANGE CONFERENCE BONN 2017

COP24·KATOWICE 2018 UNITED NATIONS CLIMATE CHANGE CONFERENCE

TIME FOR ACTION COP25 CHILE MADRID 2019 UN CLIMATE CHANGE CONFERENCE

UN CLIMATE CHANGE CONFERENCE UK 2021 IN PARTNERSHIP WITH ITALY

COP27 SHARM EL-SHEIKH EGYPT 2022

COP28 UAE

COP29 Baku Azerbaijan

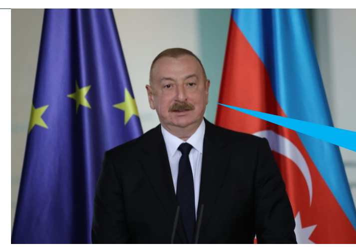
COP30 BRASIL AMAZÔNIA BELÉM 2025

Figure: H. Huwald

Conference of Parties – COP 29, COP 30

COP28: about 100’000 “climate savers” attended.
After 28 COPs and almost 30 years, delegates have relized, that there is a “*relation between global warming and fossil fuel burning*”. 🤓
The COP28 final declaration suggests a “*transitioning away from fossil fuels*”. No deadlines are mentioned. 👏

Not shown in the COP28 logo: 🛢 🏭 💰 ☢ ☠ 🏭 🚗



The host country president told at COP29 that oil and gas are …

“a gift of God”
(BBC, 12.11.2024)

COP29
Baku
Azerbaijan
UN CLIMATE CHANGE CONFERENCE

COP30
BRASIL
AMAZÔNIA
BELÉM 2025

DOE climate ‘assessment’

5 climate sceptics
hand-picked by the DOE

A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate

Climate Working Group
United States Department of Energy
July 23, 2025

Is seems that the U.S. climate ends at the Canadian border and at the wall to Mexico

Reference 1

nature

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nature › news › article

NEWS | 07 August 2025

Outrage over Trump team’s climate report spurs researchers to fight back

The authors welcome ‘serious’ scientific rebuttals to report that some say misrepresents decades of climate science.

By Jeff Tollefson

Nature | Vol 644 | 21 August 2025 | 591

US energy secretary Chris Wright recruited the report’s five authors, who question the scientific consensus on climate change. Credit: Kent Nishimura/Bloomberg via Getty

Reference 2

AMS
AMERICAN METEOROLOGICAL SOCIETY
45 Beacon Street, Boston, Massachusetts 02108-3693 USA
TEL: 617-227-2425
FAX: 617-742-8718
E-mail: amsinfo@ametsoc.org
Web: www.ametsoc.org

The Practice and Assessment of Science:
Five Foundational Flaws in the Department of Energy’s 2025 Climate Report

A Statement of the American Meteorological Society

(Adopted by the Executive Committee of the AMS Council on 27 August 2025)

Here we identify five foundational flaws in the Department of Energy’s (DoE’s) 2025 Climate Synthesis report[1]. Each of these flaws, alone, places the report at odds with scientific principles and practices. For the report to accurately characterize scientific understanding and to be useful as a basis for informed policy and decision making, the DoE must first rectify all five flaws and then conduct a comprehensive assessment of scientific evidence. Were DoE to do so, the result will almost certainly be conclusions that are broadly consistent with previous comprehensive scientific assessments of climate change, such as those from the National Academies of Sciences, Engineering, and Medicine (NASEM); American Association for the Advancement of Science (AAAS); Intergovernmental Panel on Climate Change (IPCC), American Meteorological Society (AMS), and a wide-range of other scientific organizations.

The Department of Energy’s recent attempt to synthesize climate science has five foundational flaws as a scientific effort:

1) **Lack of breadth across scientific fields.** The science of climate change spans dozens of fields and sub-fields within the physical, natural, and social sciences relating to the Earth and environment. These include (but are not limited to): atmospheric physics; atmospheric chemistry; oceanography (physical, chemical, and biological); cryology; glaciology; biology; physiology; biogeography;

[1] This document emphasizes overarching flaws with the process used in the development of the DoE report. Point-by-point rebuttals of specific evidence and conclusions also have value but are beyond the scope of this document (and are available from and being prepared by other climate scientists).

Reference 3

Factcheck: Trump's climate report includes more than 100 false or misleading claims

CarbonBrief

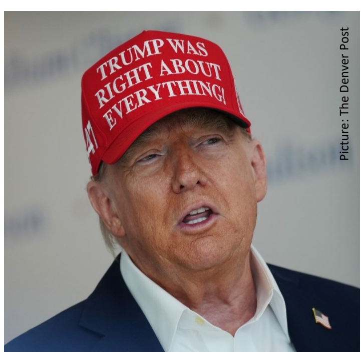
CLEAR ON CLIMATE

By

Ayesha Tandon,
Leo Hickman,
Celilia Keating,
Robert McSweeney

Design by Tom Prater

14 August 2025



Picture: The Denver Post

https://www.carbonbrief.org/

Happy Holidays !