MUNI
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08 A matter of climate change

Lukáš Dolák, MSc, PhD

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1. Climate change and global warming
2. Negative impacts of recent climate change
3. Positive impacts of recent climate change
4. Future outlook

Question of the day

Why should we take care about current climate change when much greater changes have occurred in the past?

And is it better to mitigate the negative impacts of climate change or to adapt to them?

Climate change and global warming

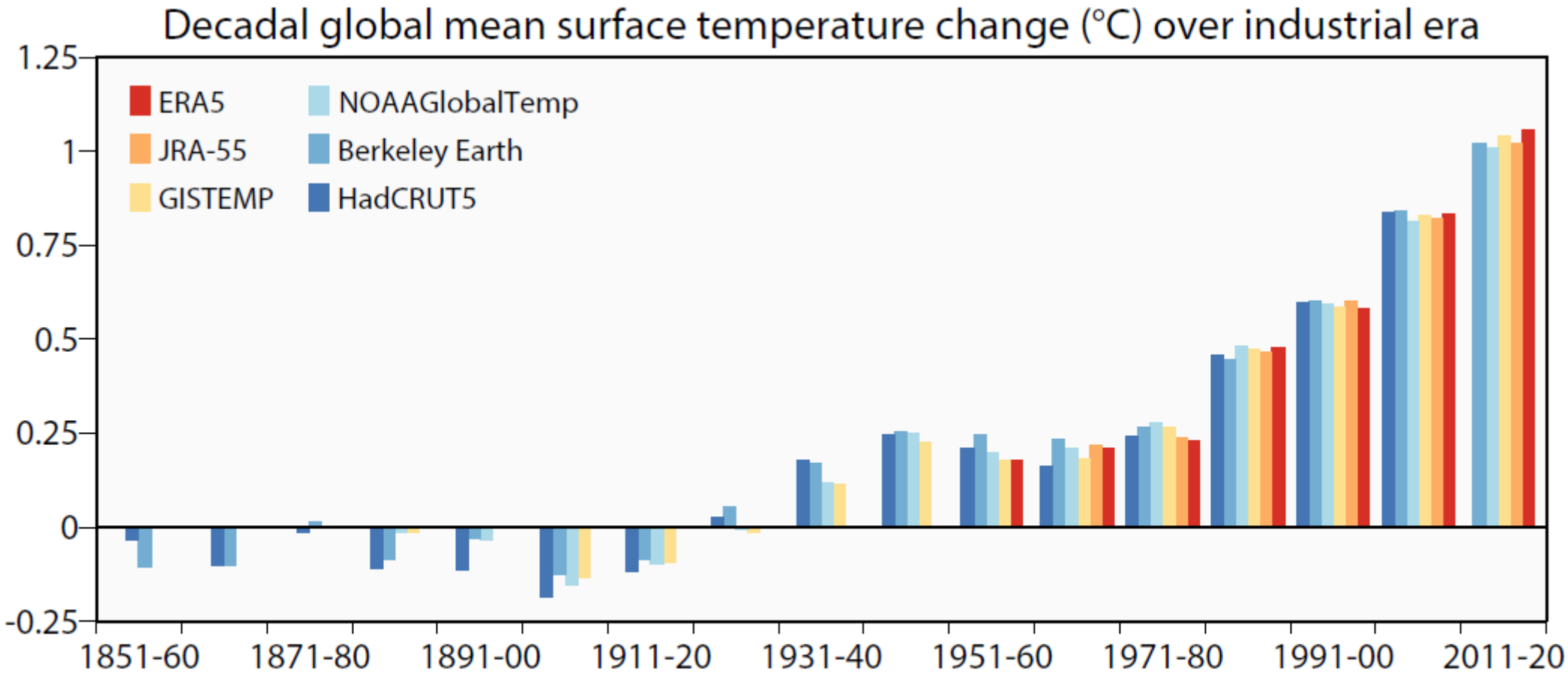
Climate change

- Any **long-term changes** caused by both **natural climate variability** and **human activity**
- The **main impacts** of the recent climate change – global warming and related processes:
  - global increase in mean air temperature,
  - rise in global sea levels,
  - change in the frequency and distribution of precipitation,
  - increasing number and intensity of natural disasters,
  - changes in phenological phases, etc.

Recent climate change

- The **most serious current environmental problem**
- Caused primarily by the **enhanced greenhouse effect** from the increase in greenhouse gases emitted by the burning of fossil fuels and land use change
- **Acceleration** of **air temperature** rise **since the 1970s**
- **1988**: climate change viewed as a major public, political and environmental issue (testimony of J. Hansen before the US Senate)

Global warming



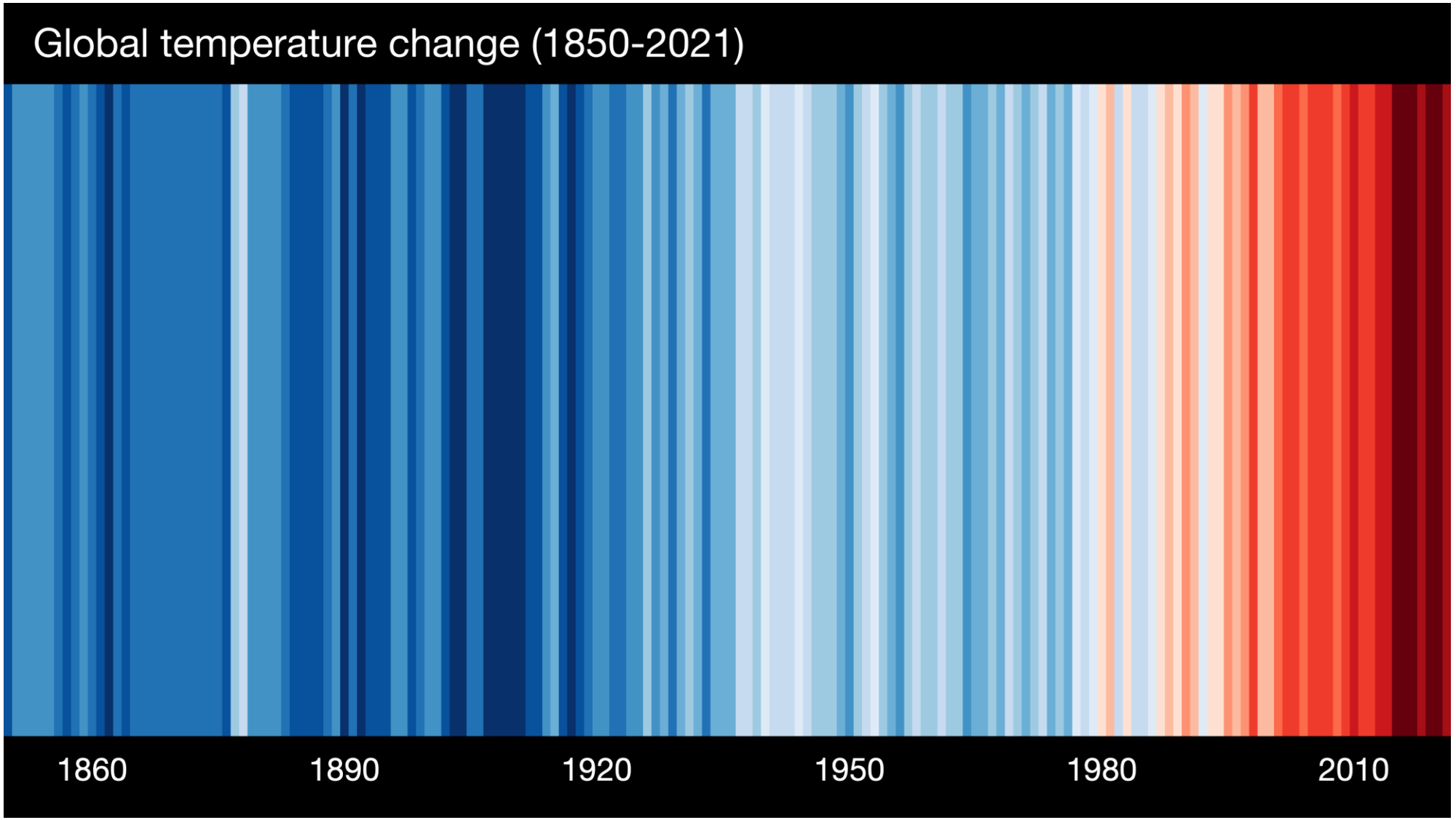
European Commission

opernicus
Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Climate Change Service
climate.copernicus.eu

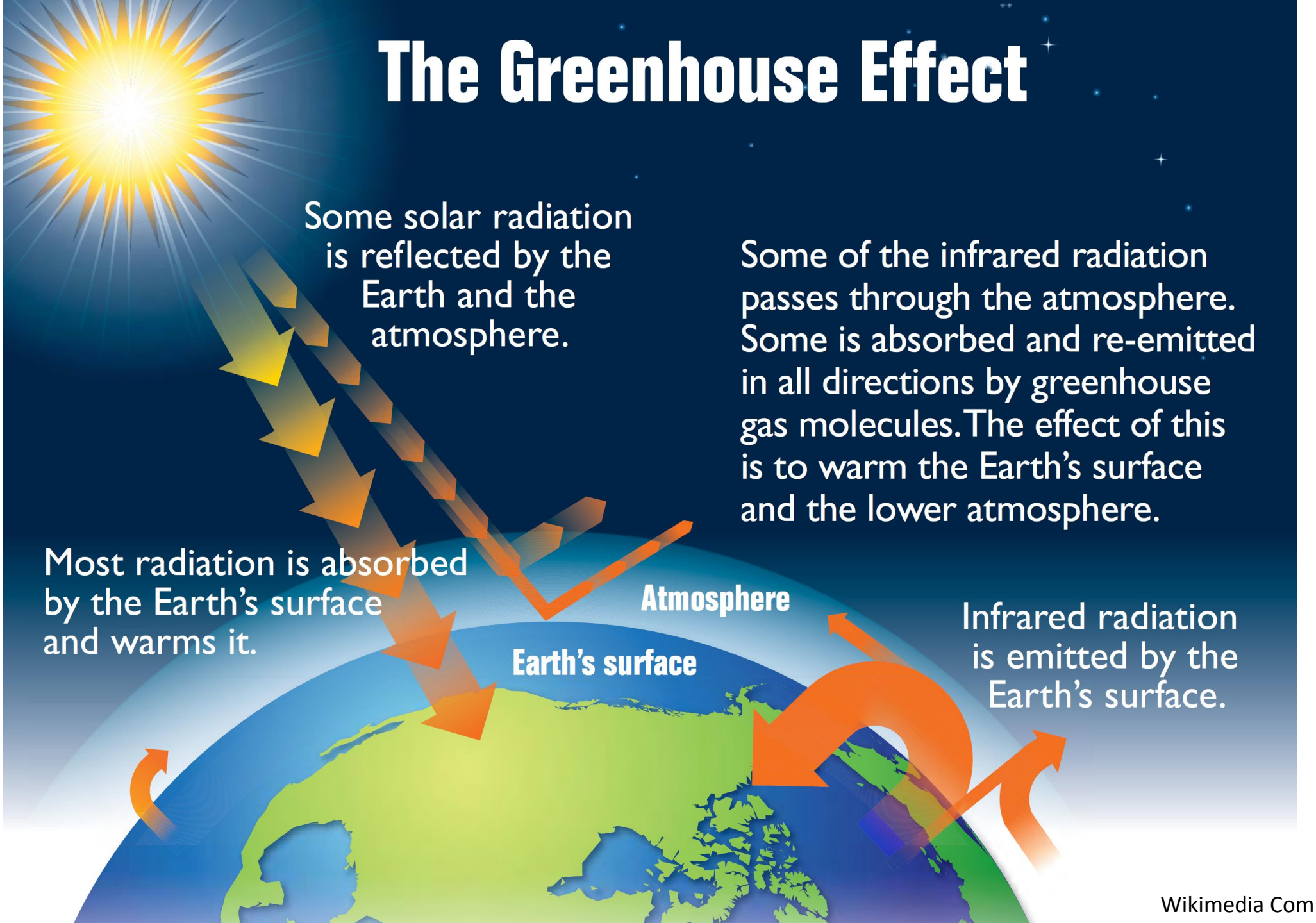
Global mean temperature change



showyourstripes.info, 2020

Greenhouse effect

- **Natural process** warming the Earth´s lower atmosphere by ca. 33°C – beneficial
- Transmission of **shortwave solar radiation** through the atmosphere, increasing the Earth´s surface temperature and **inhibiting backward longwave radiation** by greenhouse gasses (GHGs)

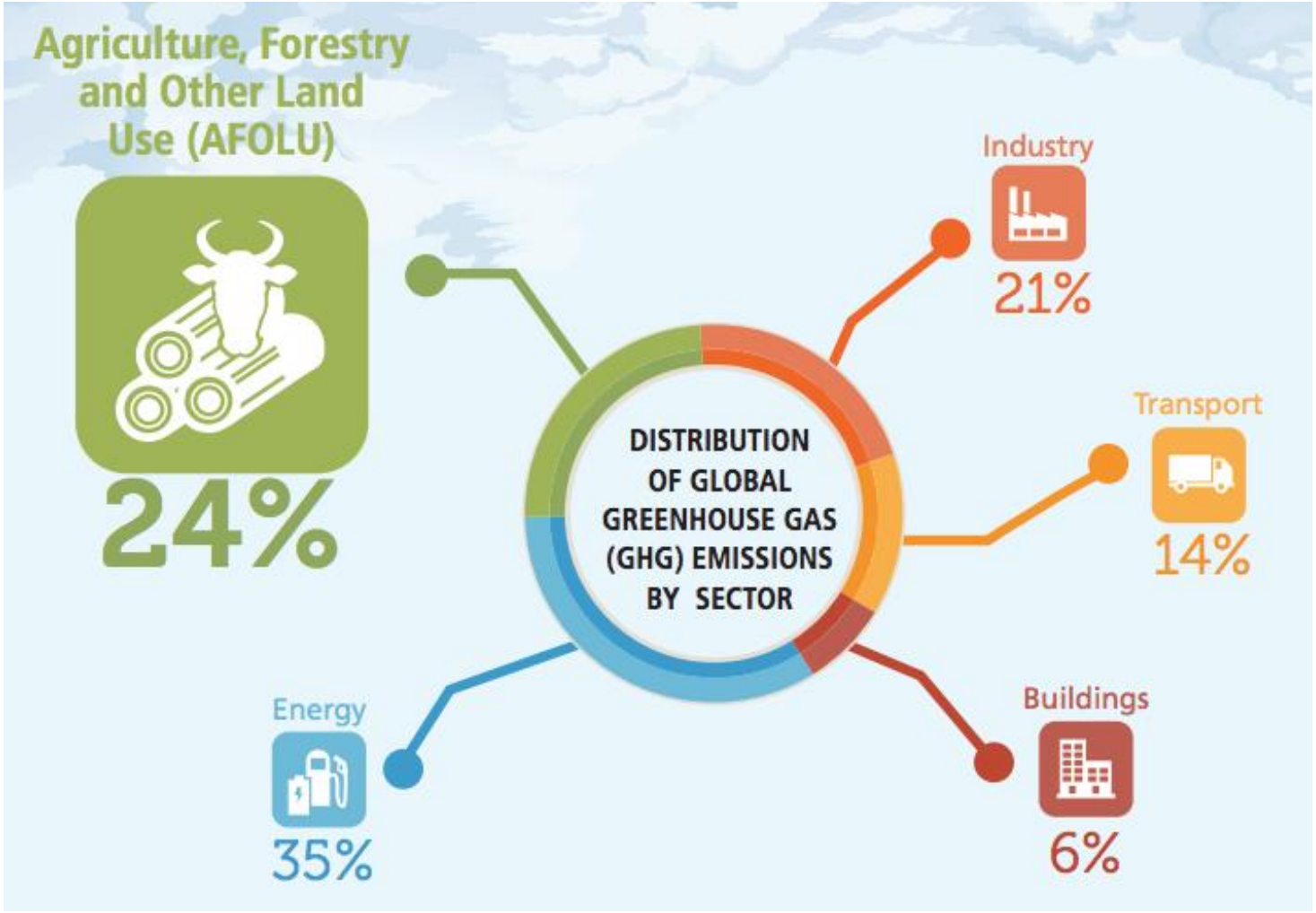


Wikimedia Commons 2015

Global warming

- One of the **main impacts** of recent climate change
- **Enhanced greenhouse effect**
  - increased concentration of GHGs as the result of human activities
  - amplified inhibition of backward longwave radiation by GHGs – warming effect – disadvantageous
  - change of the global energy balance of the atmosphere

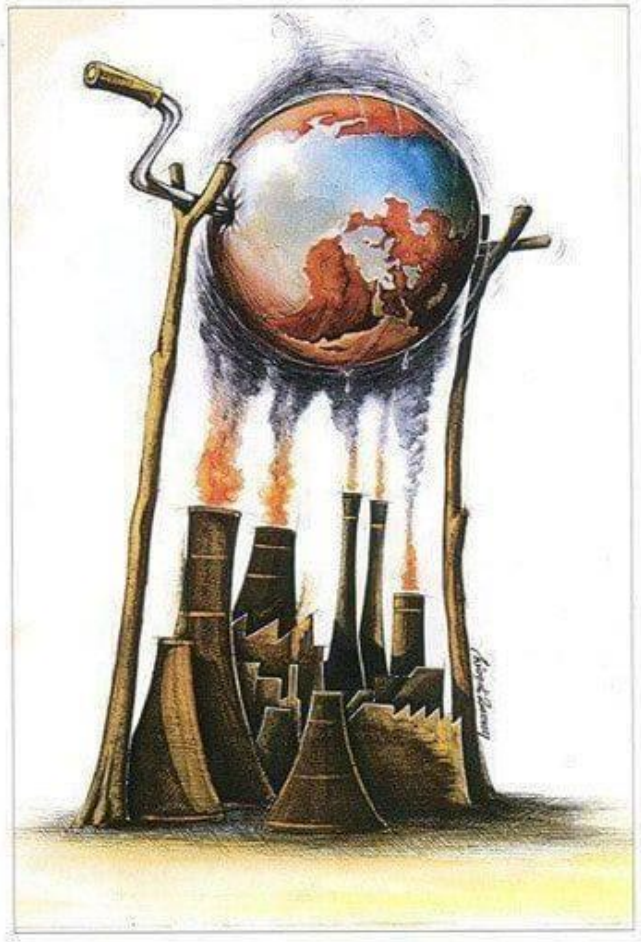
Global warming – sources of anthropogenic CO_2



ecowarriorprincess.net, 2016

Global warming

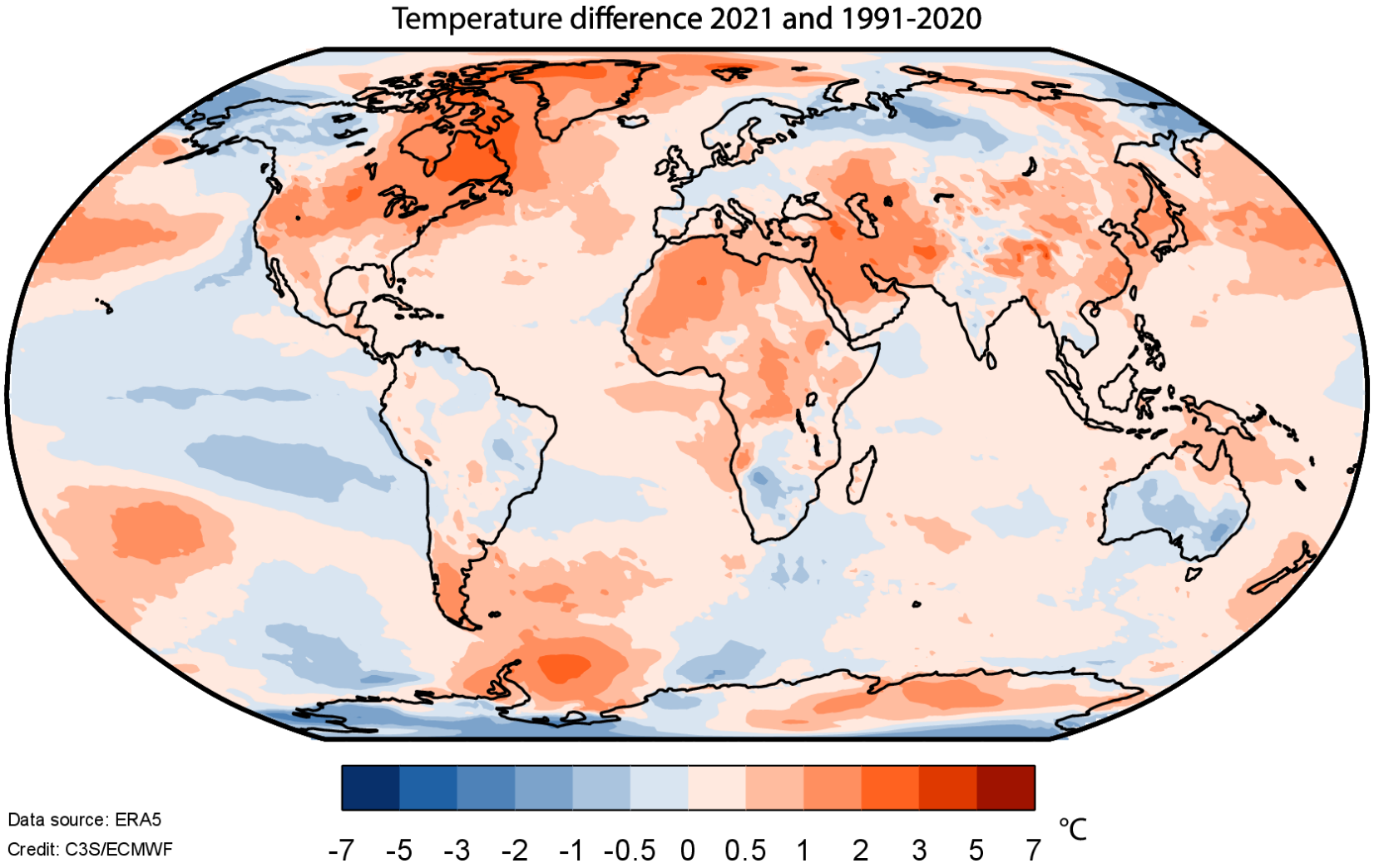
- A **1.2°C increase** in global mean air temperature since the start of the Industrial Revolution
- About **93–97%** of **heat** trapped by the world's **oceans**, the remaining 3% by greenhouse gases
- Significant **human contribution** (fossil fuel burning, industry, transport, agriculture, deforestation, population growth, etc.)



Mundo desconocido, 2017

Deviation of mean air temperature

Mankind has accelerated **50 times** the **rise** in **air temperature** compared to the rise in temperature between the last glacial and interglacial



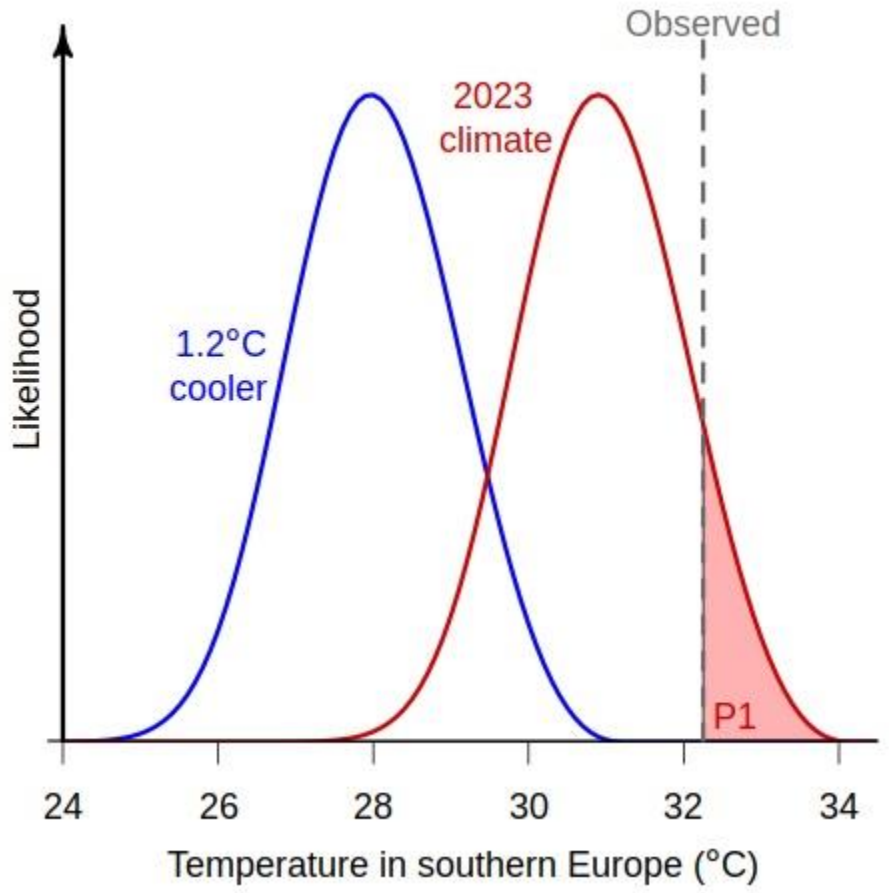
WMO, 2022

Other causes of climate change

- **Solar activity**
  - 1.3–14% effect on temperature change
- **Volcanic activity**
  - short-term effect
- **Milankovitch cycles**
- **Feedbacks**
- **Ocean-atmosphere interaction (ENSO)**

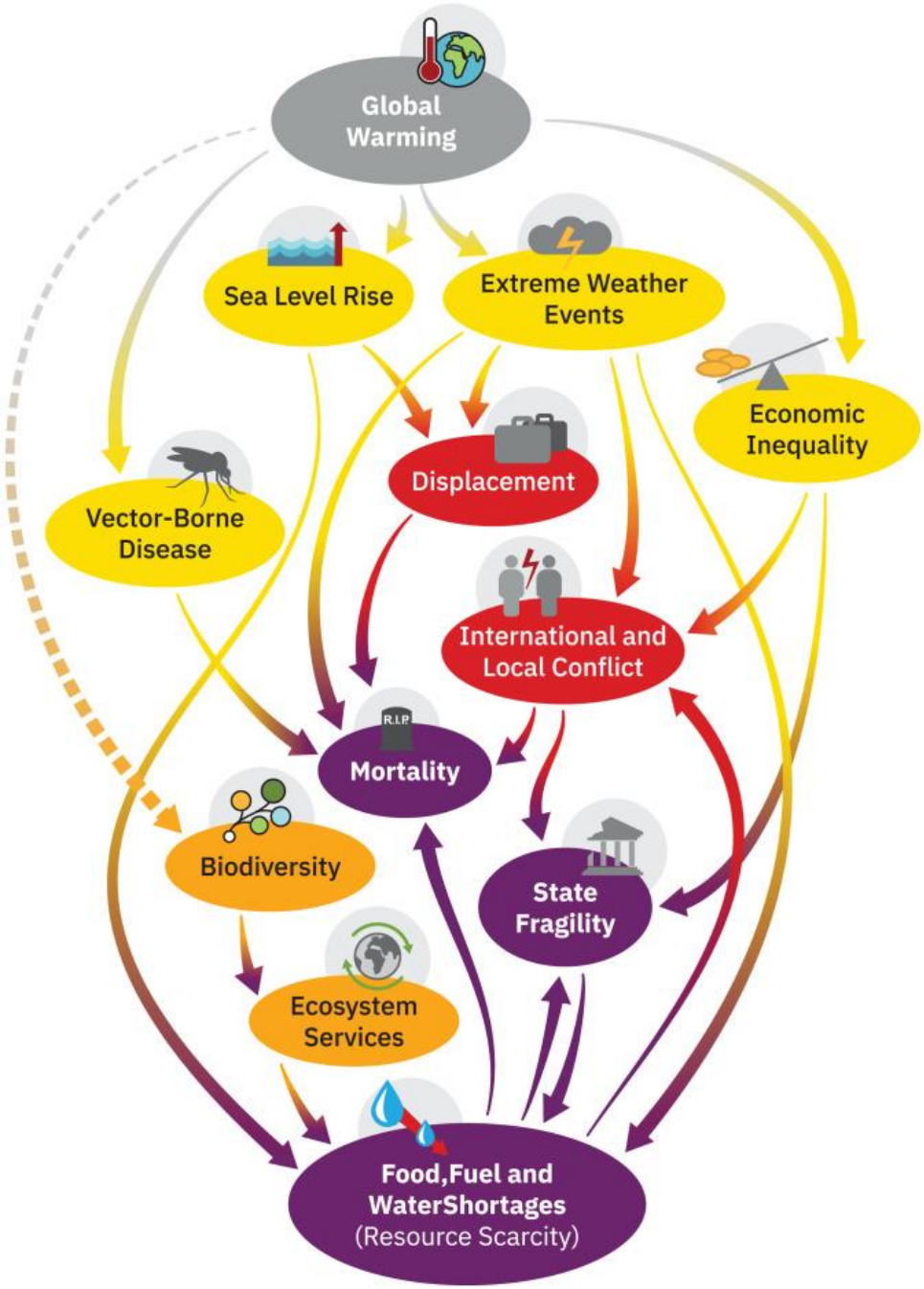
Negative impacts of recent climate change

Extreme climate conditions



Friederike Otto 2023

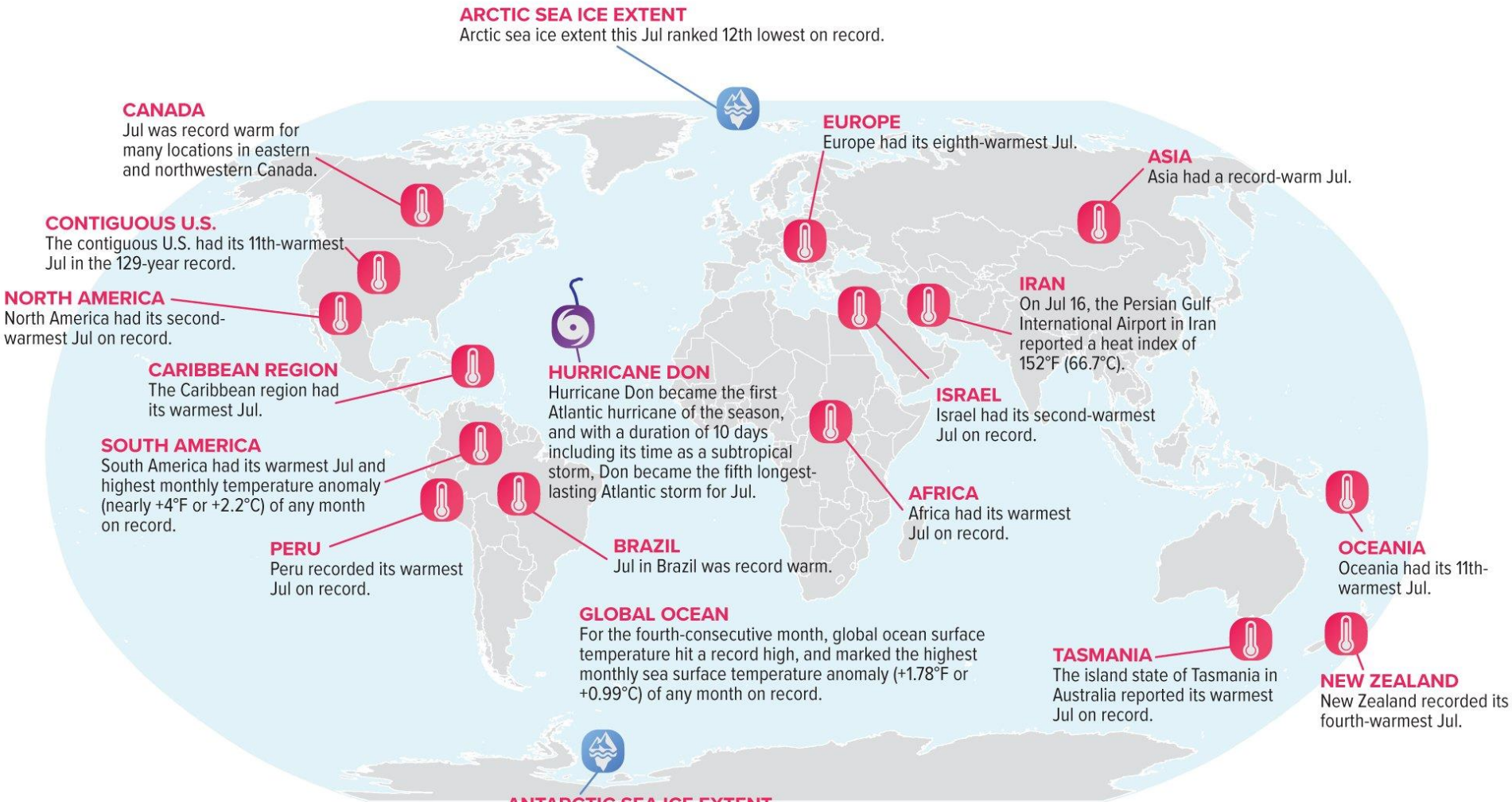
Cascading global climate failure



Kemp et al. 2022

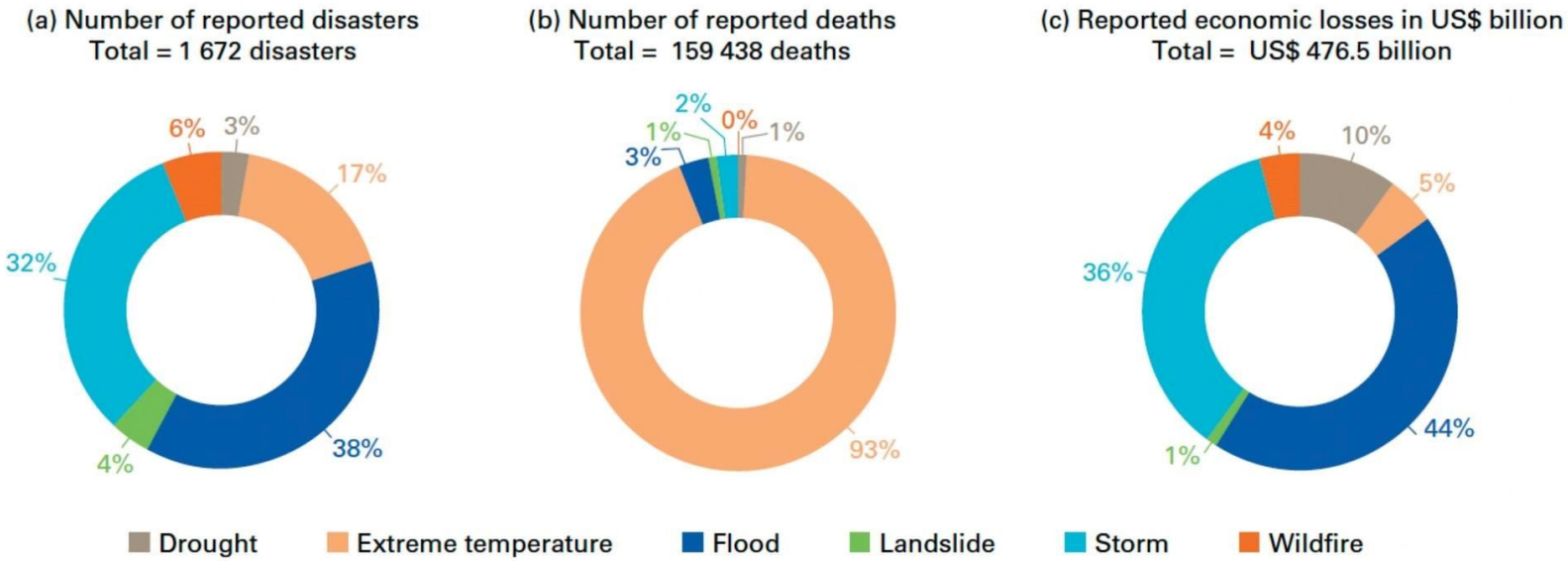
Selected Significant Climate Anomalies and Events: July 2023

GLOBAL AVERAGE TEMPERATURE
Jul 2023 average global surface temperature ranked highest for Jul since global records began in 1850.



Please note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/

Climate-related impacts and risks



Source: Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019) (WMO-No. 1267)

WMO

WHO 2020

Economic impacts relating to the recent climate change

Heat stress
Lost labor productivity from extreme heat

Sea-level rise
Lost productive land, both agricultural and urban

Damaged capital
Stalling productivity and investment

Human health
Increased incidence of disease and mortality

Lost tourism
Disrupted flow of global currency

Agriculture loss
Reduced agricultural yields from changing climate patterns

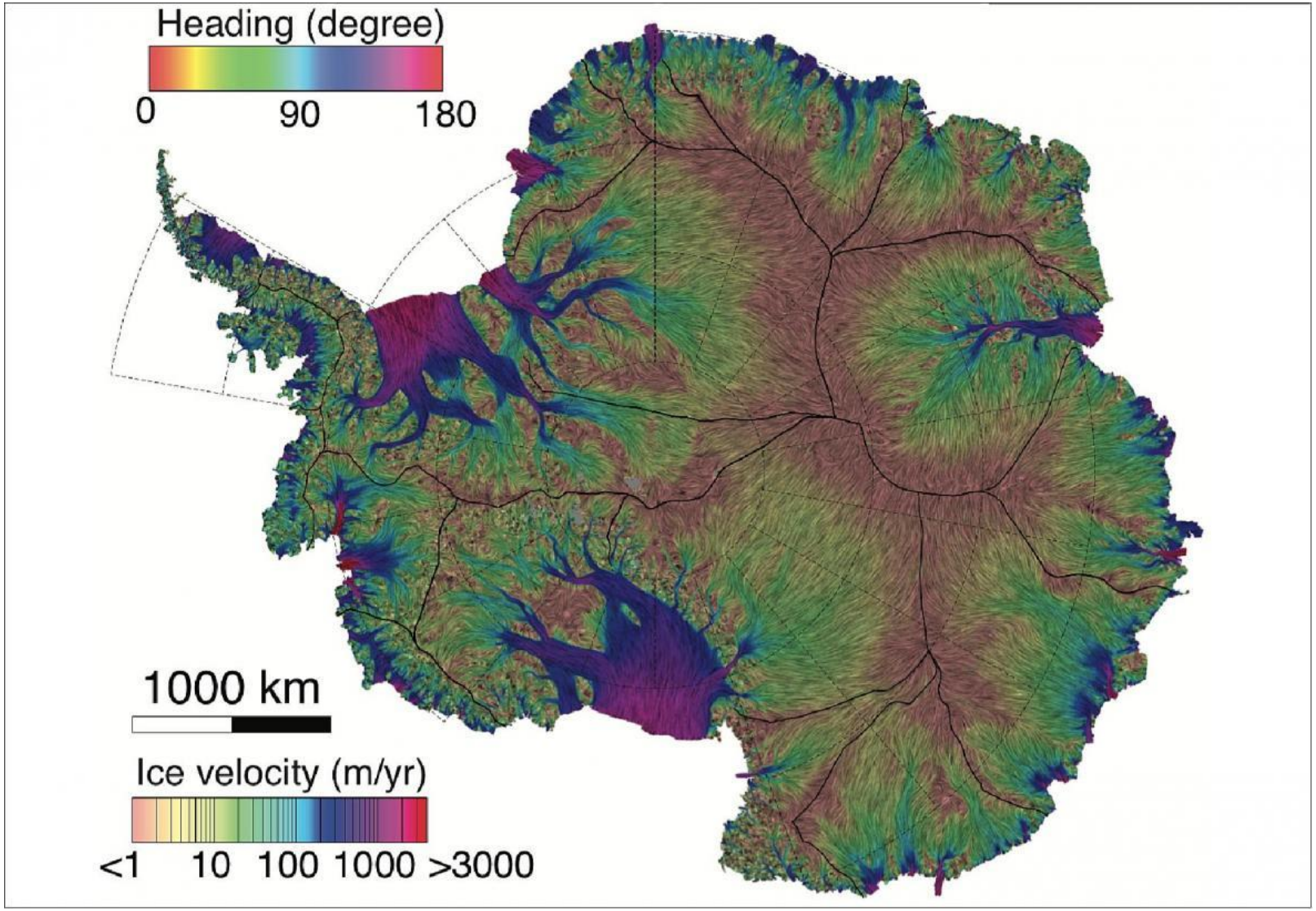
Delloite 2022

Retreat of mountain glaciers

Alpine glaciers have lost up to 30 m in thickness between 1997 and 2021

Aletsgletscher (the largest mountain glacier in the Alps, Switzerland)

Antarctica



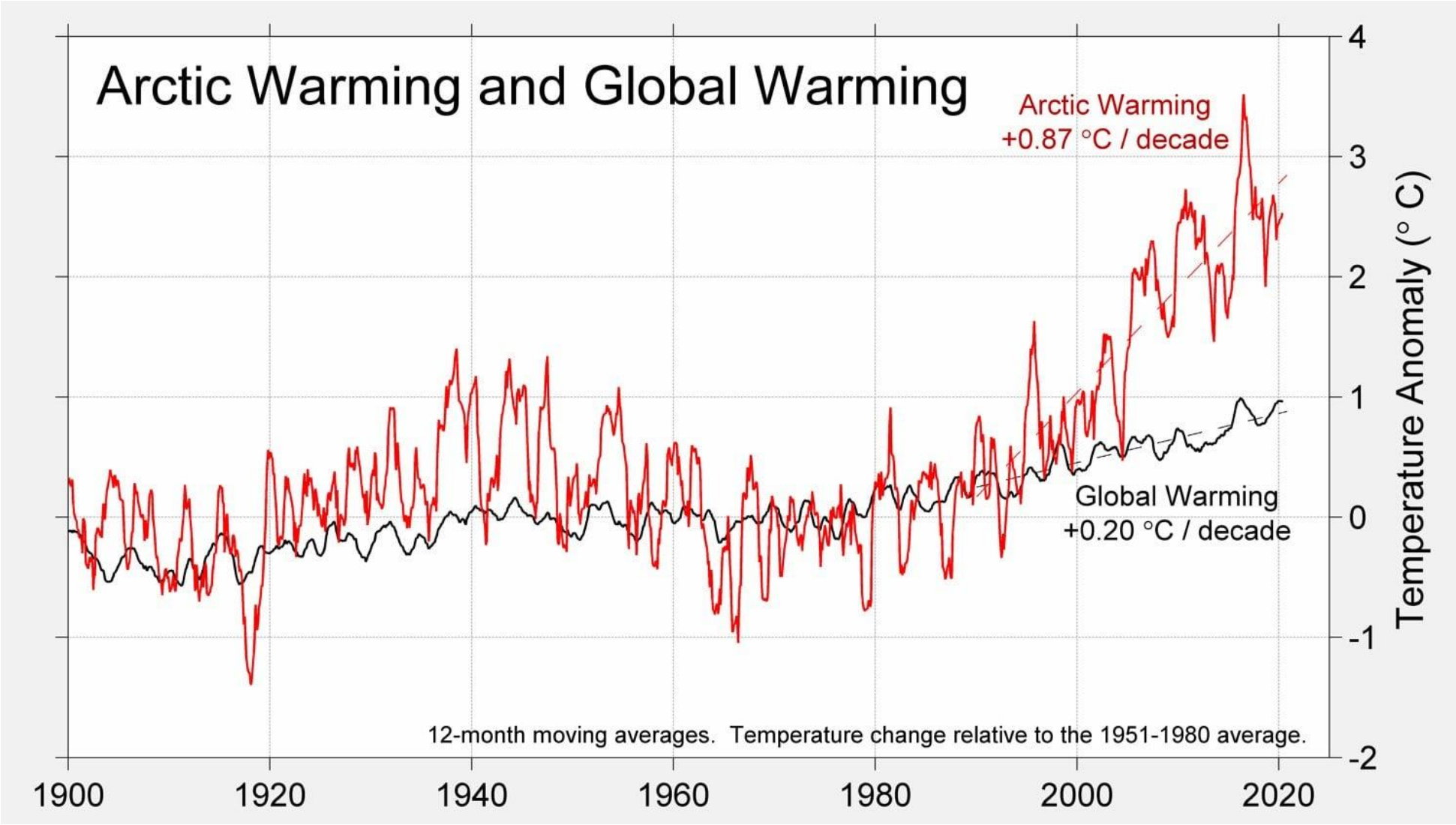
NASA, 2020

Antarctica

Future?

wikimedia.org, 2004; National Geographic Society, 2013

Arctic



Rohde, 2022

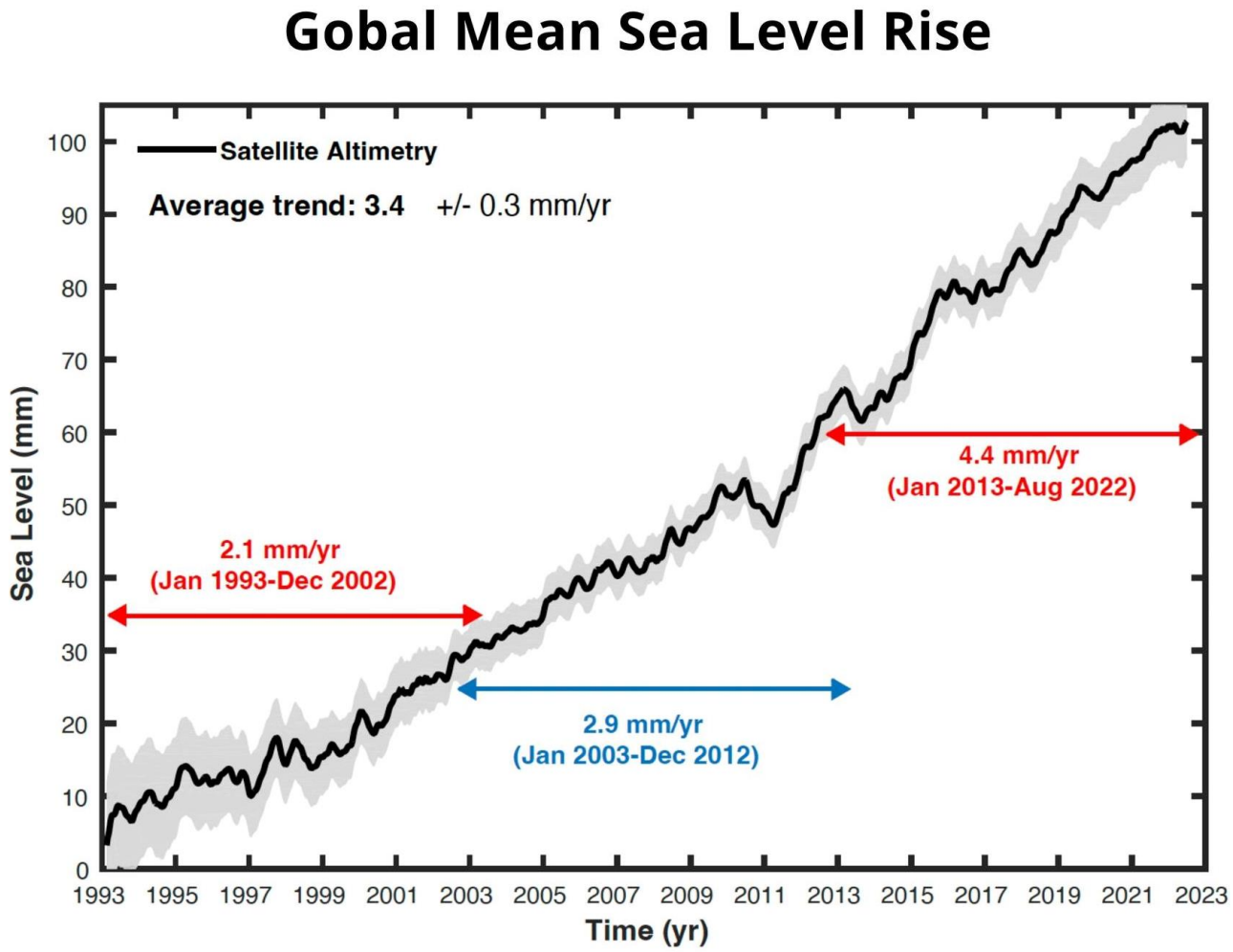
Melting permafrost

Melting permafrost

Sea level rise

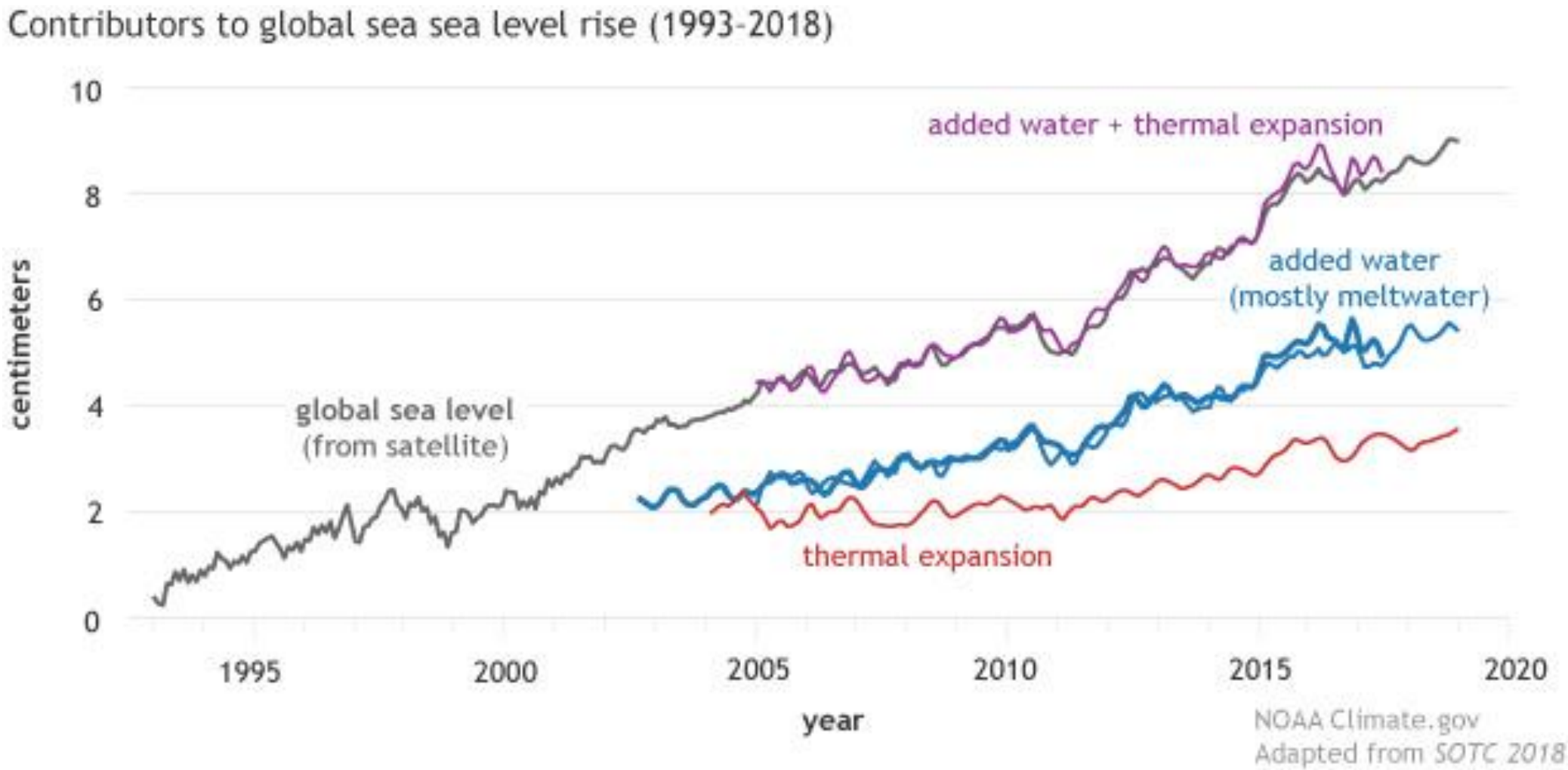
- **Until 1870**: 0.4-1 mm/year
- **Since 1870**: 1,4 mm/year

- **Total increase since 1901**: approx. 178 mm
- **Probable scenario in 2100**: 100 cm increase (T = 3 °C)



WMO, 2022

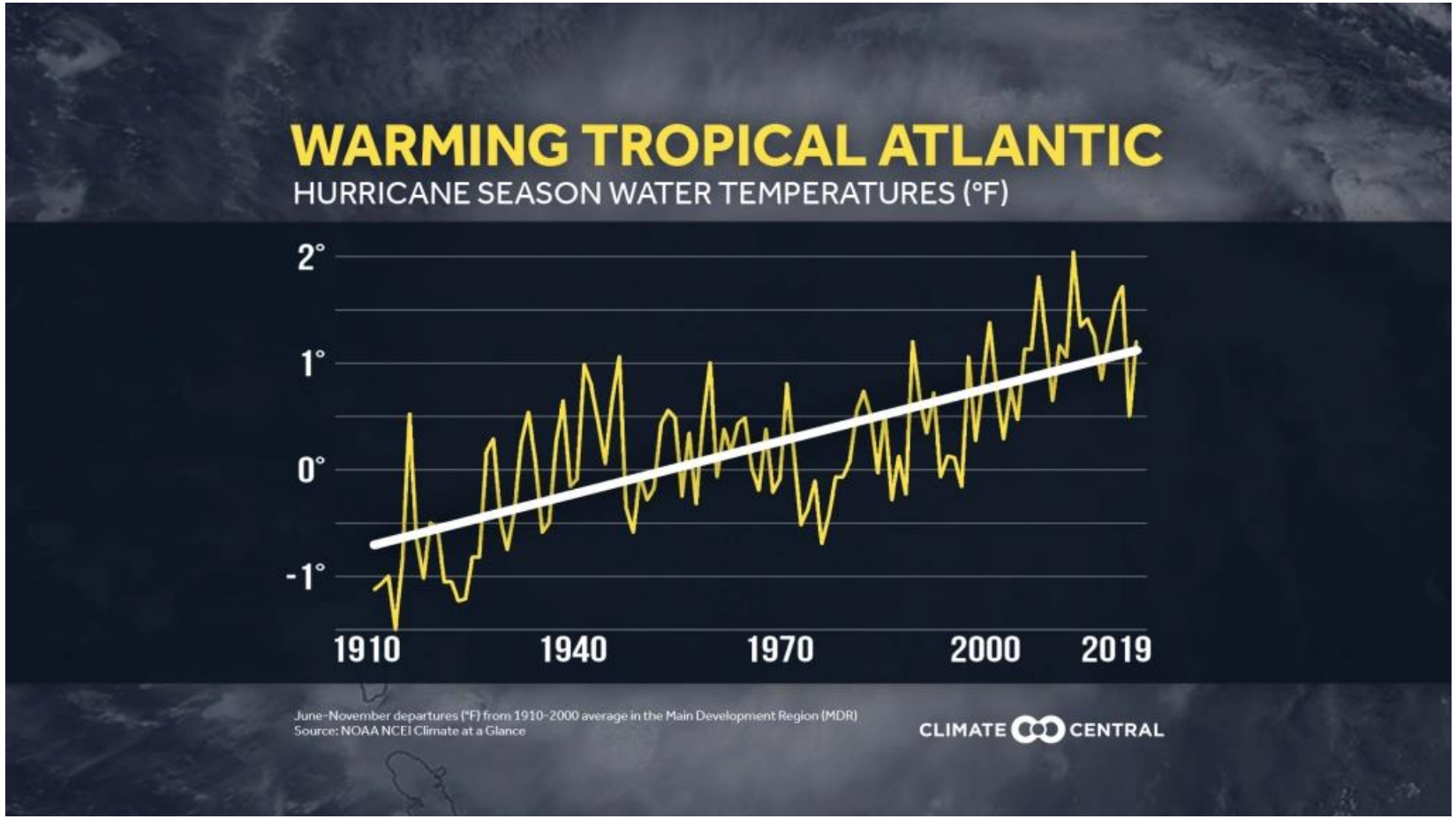
Sea level rise



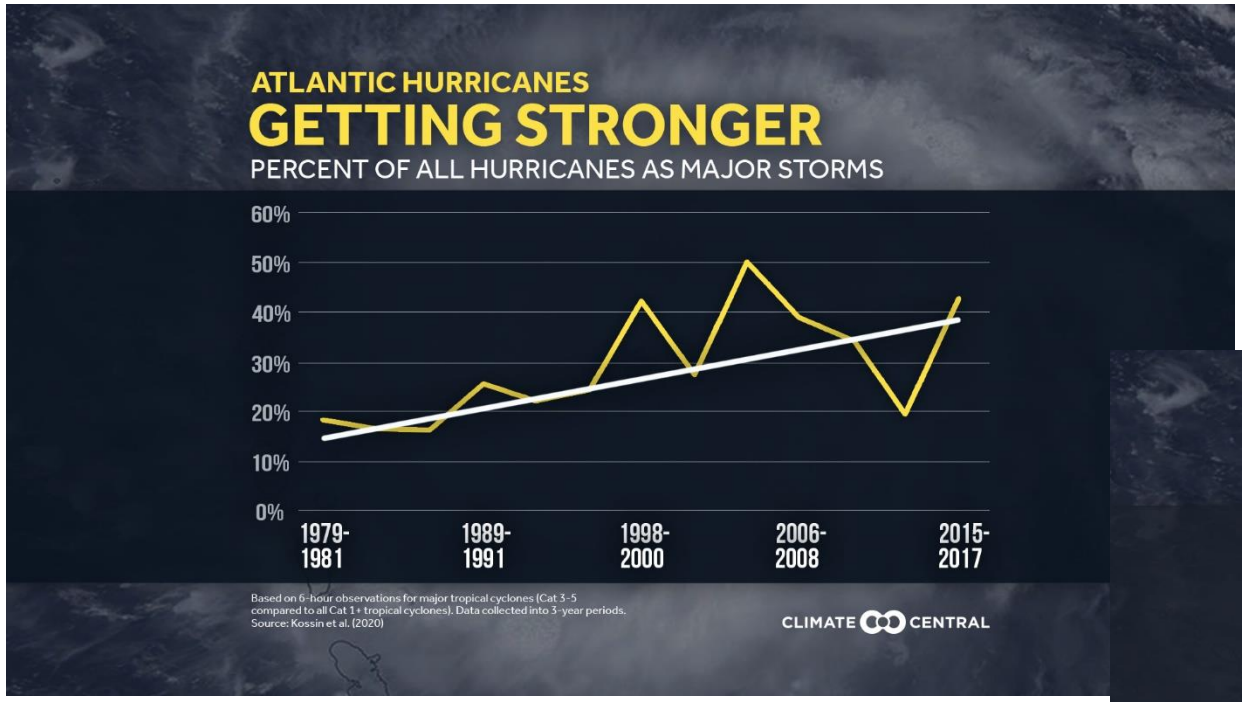
Sea level rise

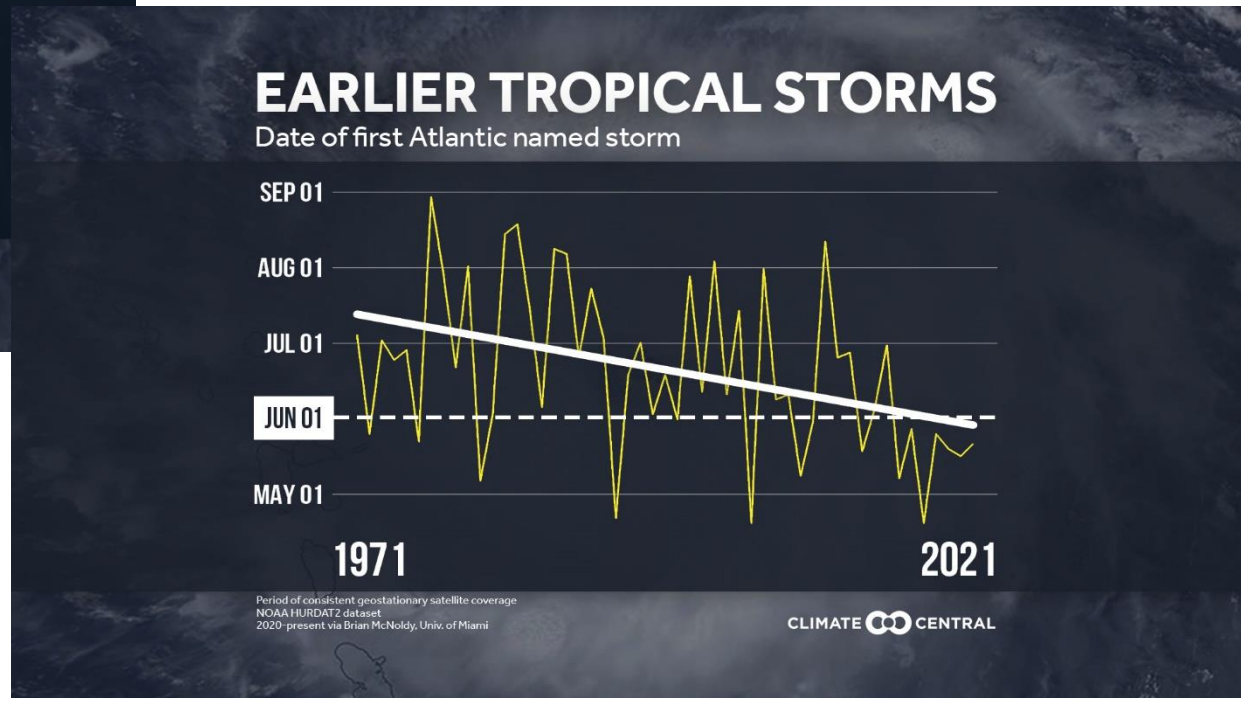
up to 50% of sandy beaches may disappear by 2050

Hurricanes in Atlantic



Hurricanes in Atlantic

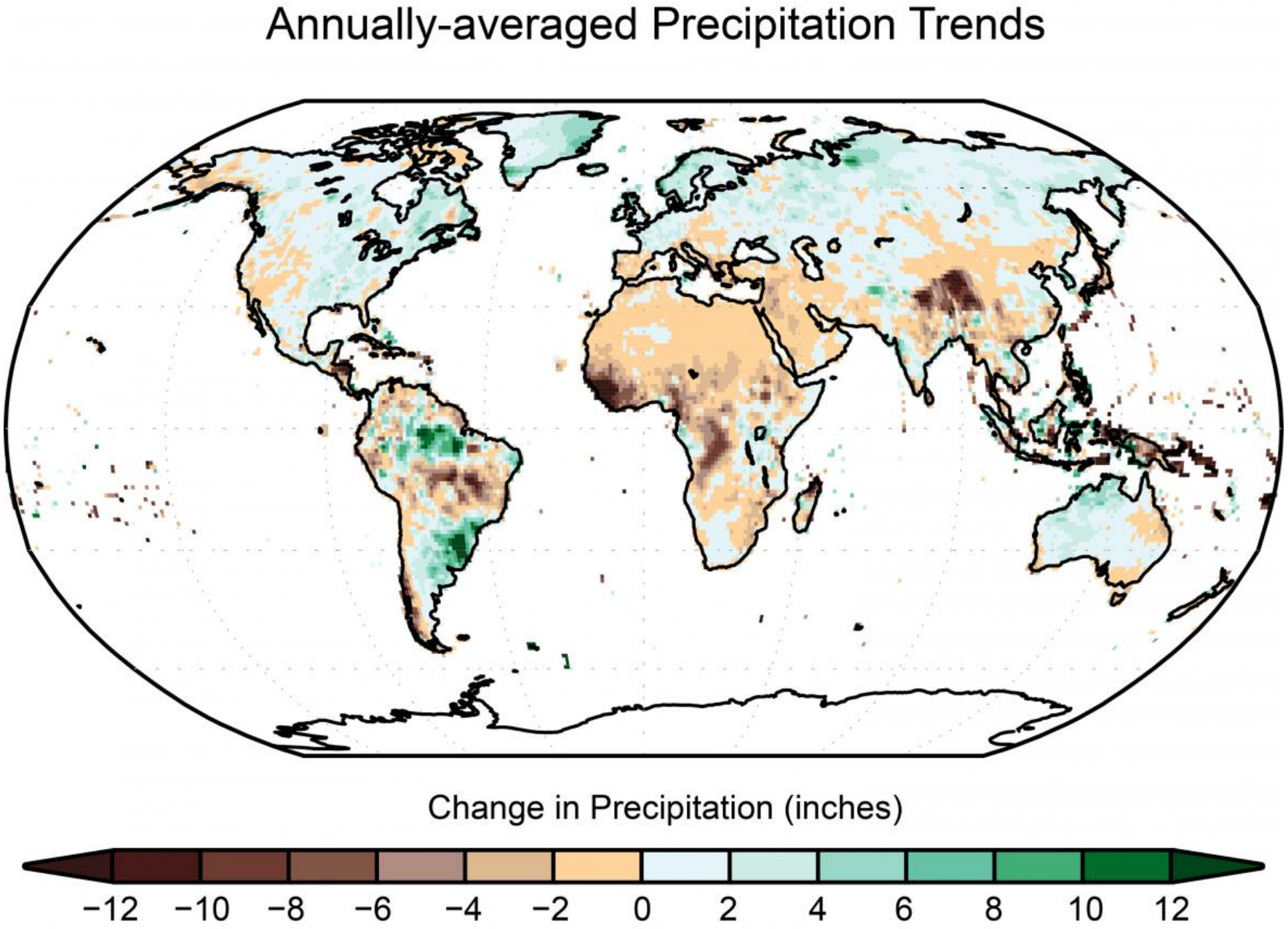




Drought

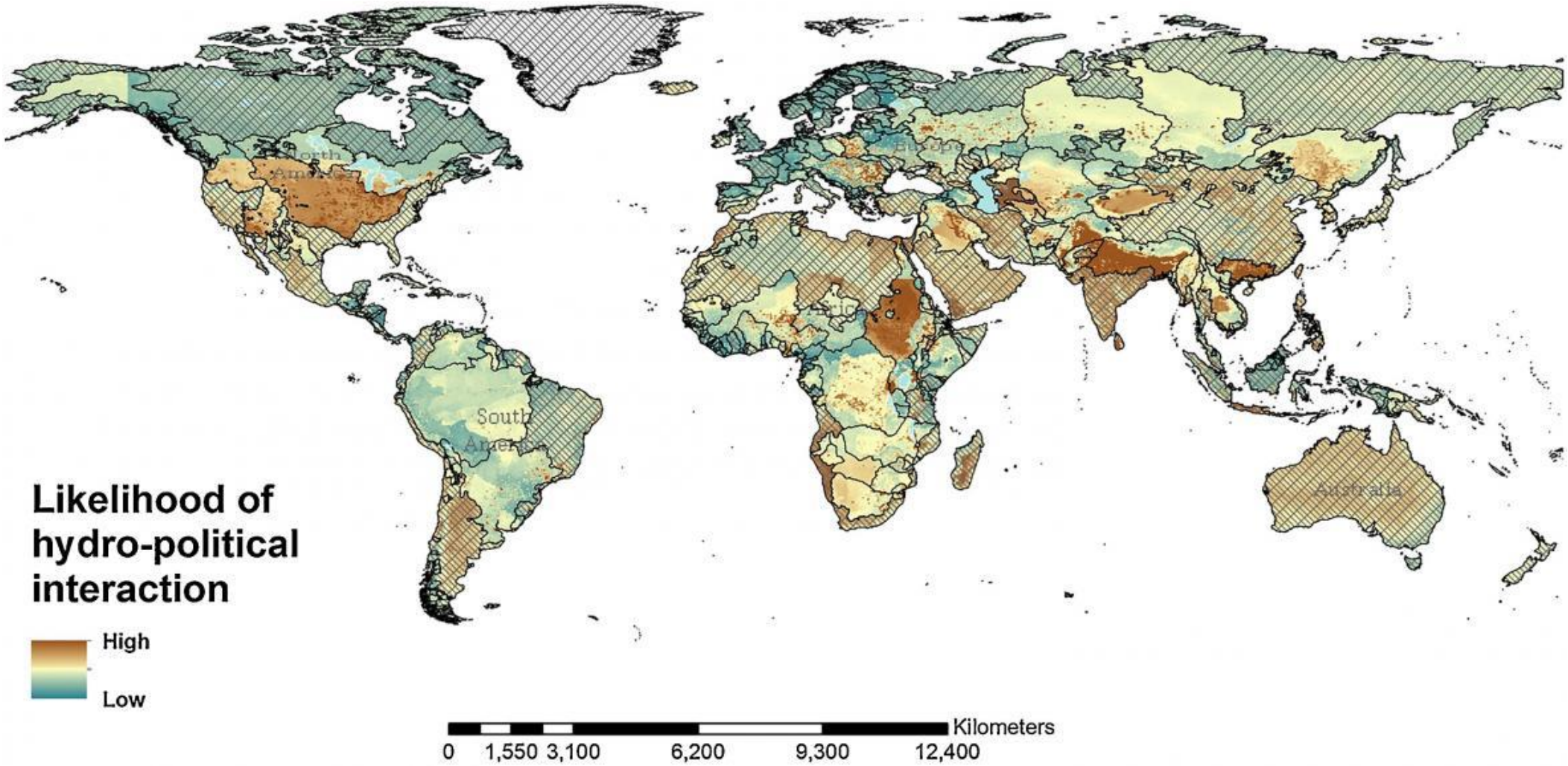
- **Drying up** of source **rivers** (Himalayas, Tibet) supplying regions in Pakistan, northern India and China
- Increasing frequency of **drought episodes** in the Mediterranean, the Middle East and the Gulf of Guinea
- On the continents, **15–20%** of areas with **drought** in 2100 without human contribution, up to **50%** with **human contribution**
- Increasing risk of **conflicts over water**

Change in precipitation totals 1986-2015 (compared to 1901–1950)



Zdroj: Climate Science Special Report

Probability of future conflicts over water

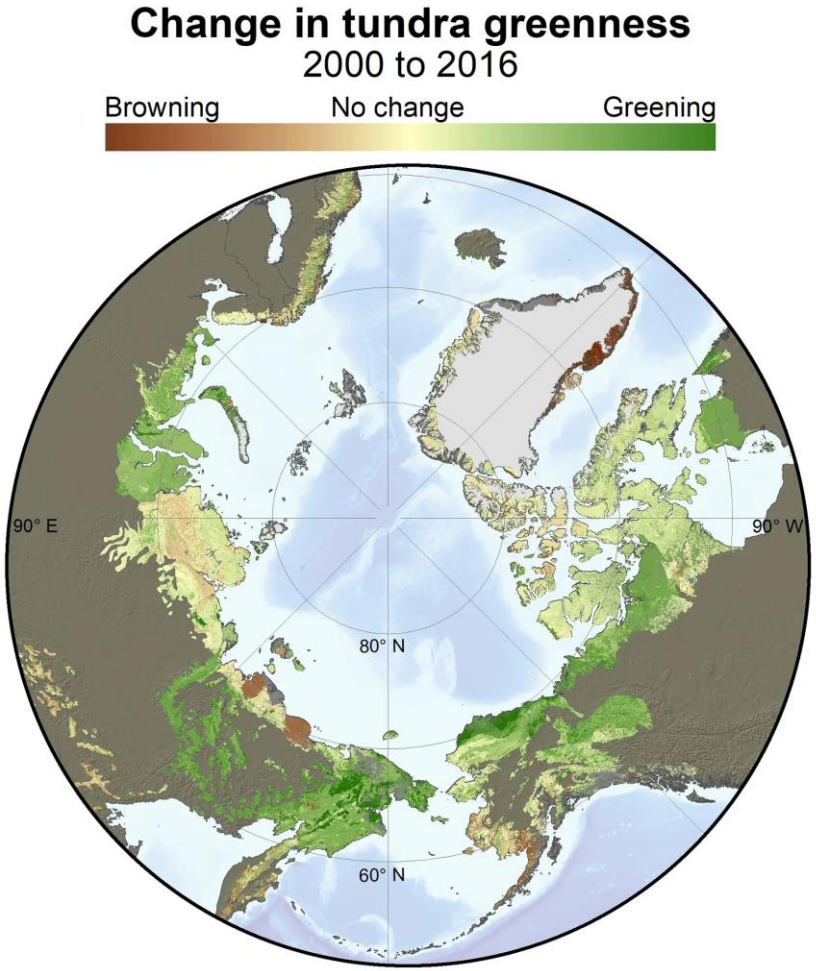


ScienceDirect, 2020

Positive impacts of recent climate change

Positive impacts

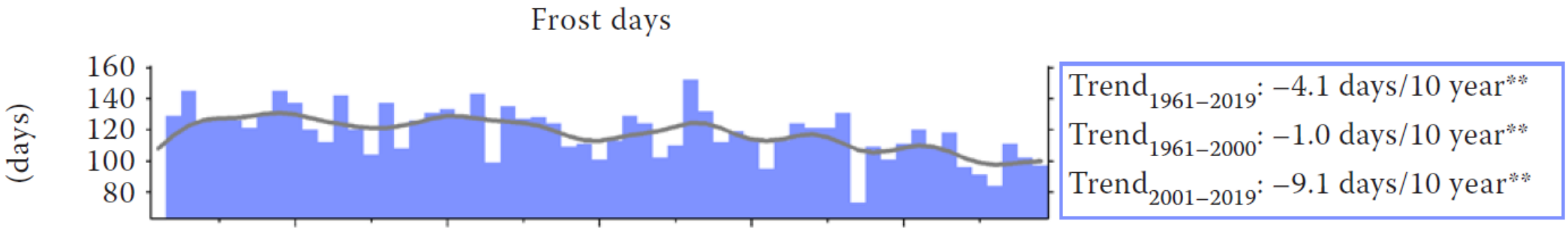
- **Spread** of new (economically beneficial) species
- **Greening**: acceleration of vegetation growth (tundra)



scitechdaily.com 2017

Positive impacts

- **Mid-latitudes**:
  - faster development of deciduous forests
  - increase in crop yields (effect of increased CO_2 (+12%)
  - extension of the growing season (+ approx. 18 days/30 years)
  - decrease in the number of frost, ice and arctic days



Trnka et al. 2021

Positive impacts

- Reduction in winter **heating costs**
- Lower road **maintenance costs** (milder winter seasons)
- **Extension** of the (summer) **tourist season**

blog.ecohotels.com, 2023

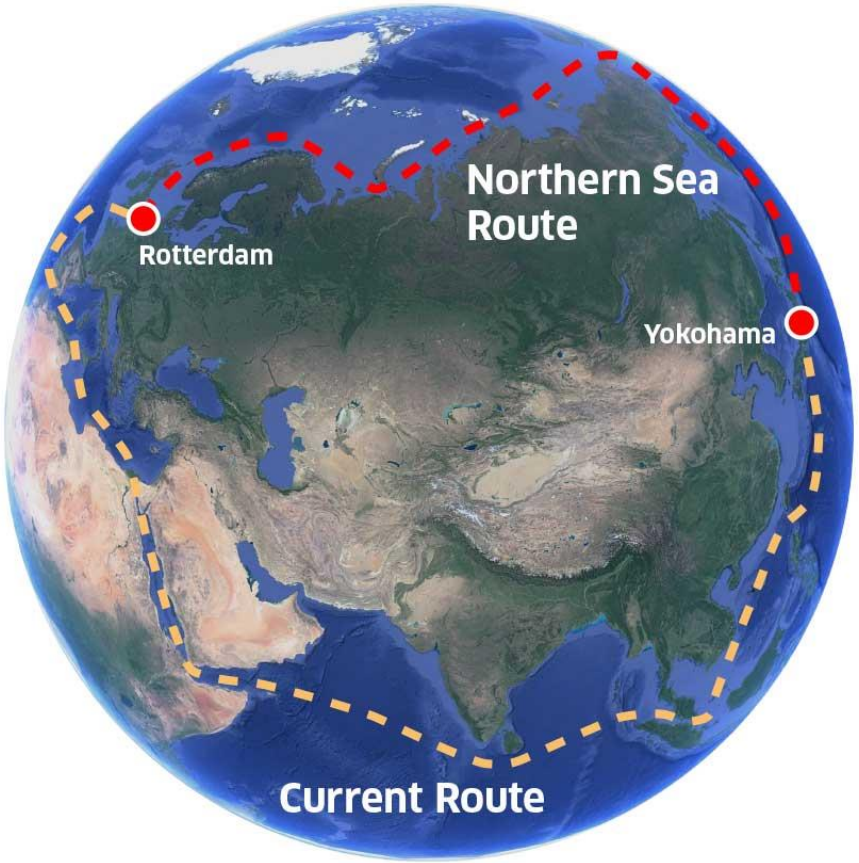
Positive impacts

- Increased **availability of water** in glacial rivers
- GHG reduction – **decrease** in SO_2 and **air pollution**
- **Higher fishing catches** in the north Atlantic as a result of species migrating north
- **Glacier archaeology**

Glacier Archaeology Program, 2022

Positive impacts

- **Extending** the use of **sea routes** by ships without icebreakers



discoveringthearctic.org.uk, 2023

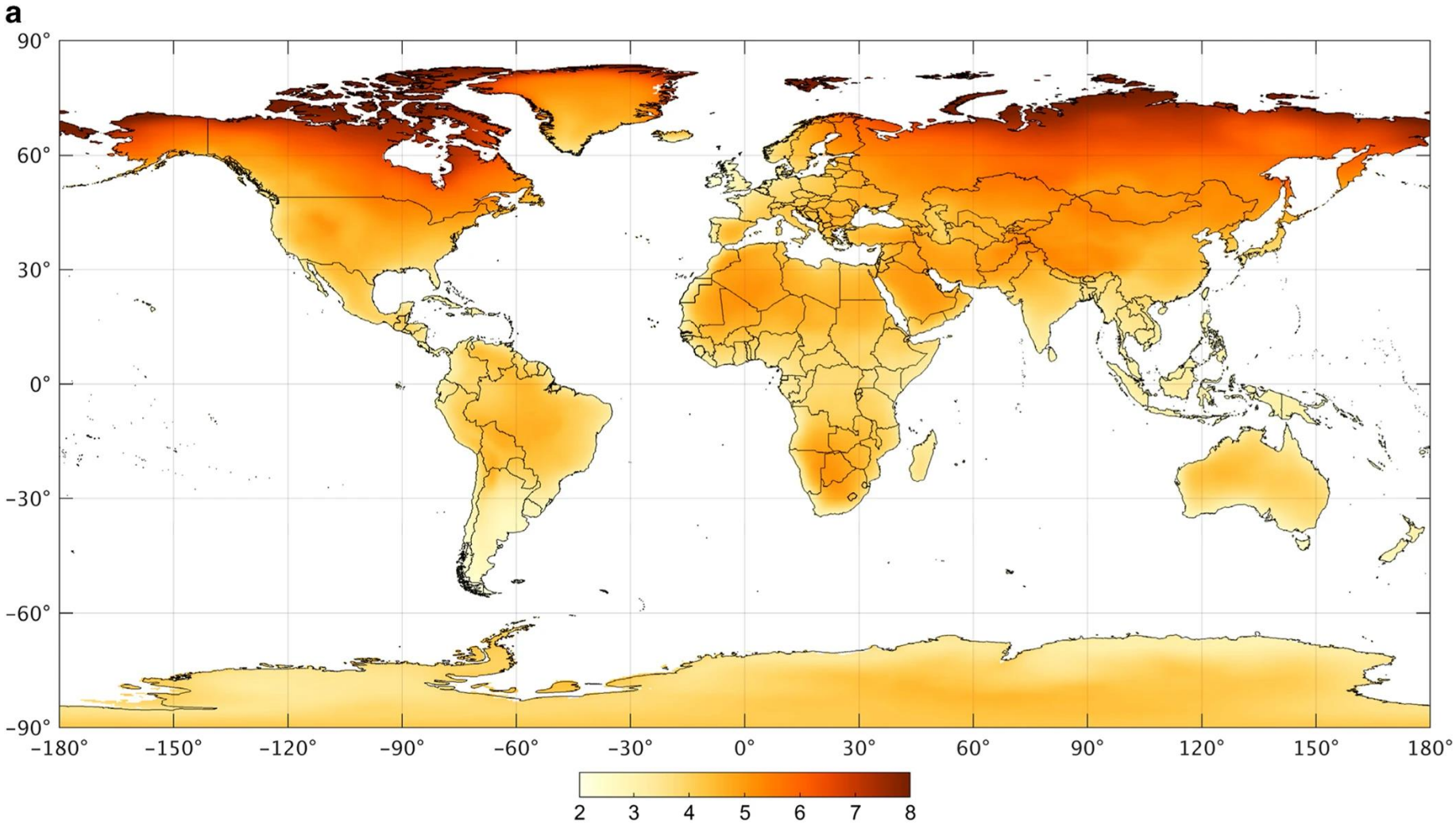
Positive impacts

- New **mineral deposits** in the Arctic:
  - expected oil and gas reserves in the Arctic (2018):
    - 97 billion barrels of oil
    - 47 billion m^3 of gas (80% in territory claimed by Russia)
- Decline in some parasites and pests?
- New **mammoth deposits** under melting permafrost in Siberia

Anjar 2014

Future outlook

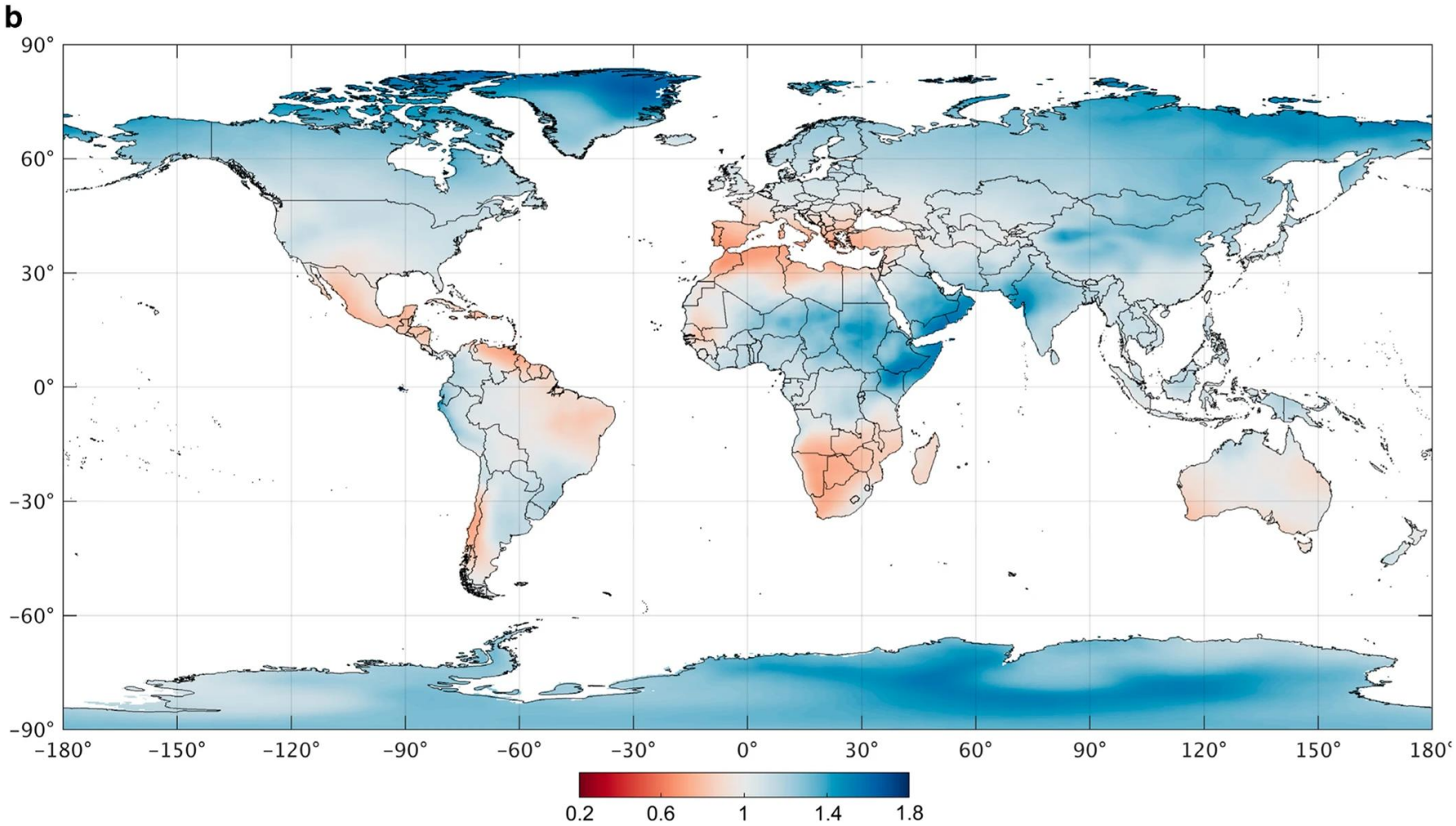
Air temperature change



situation in the period 2071–2100 compared to 1980–2016

IPCC, 2013

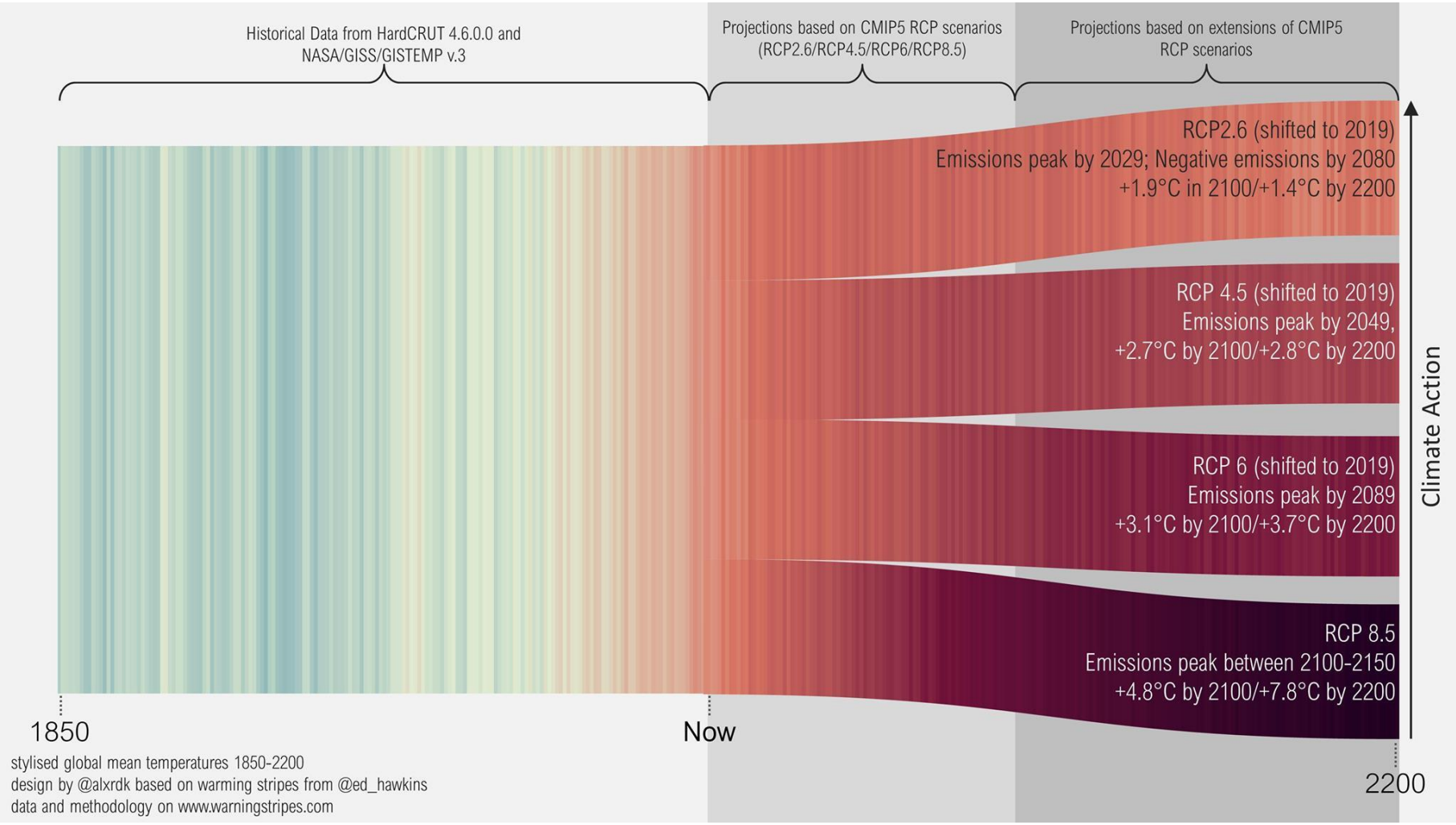
Precipitation change



situation in the period 2071–2100 compared to 1980–2016

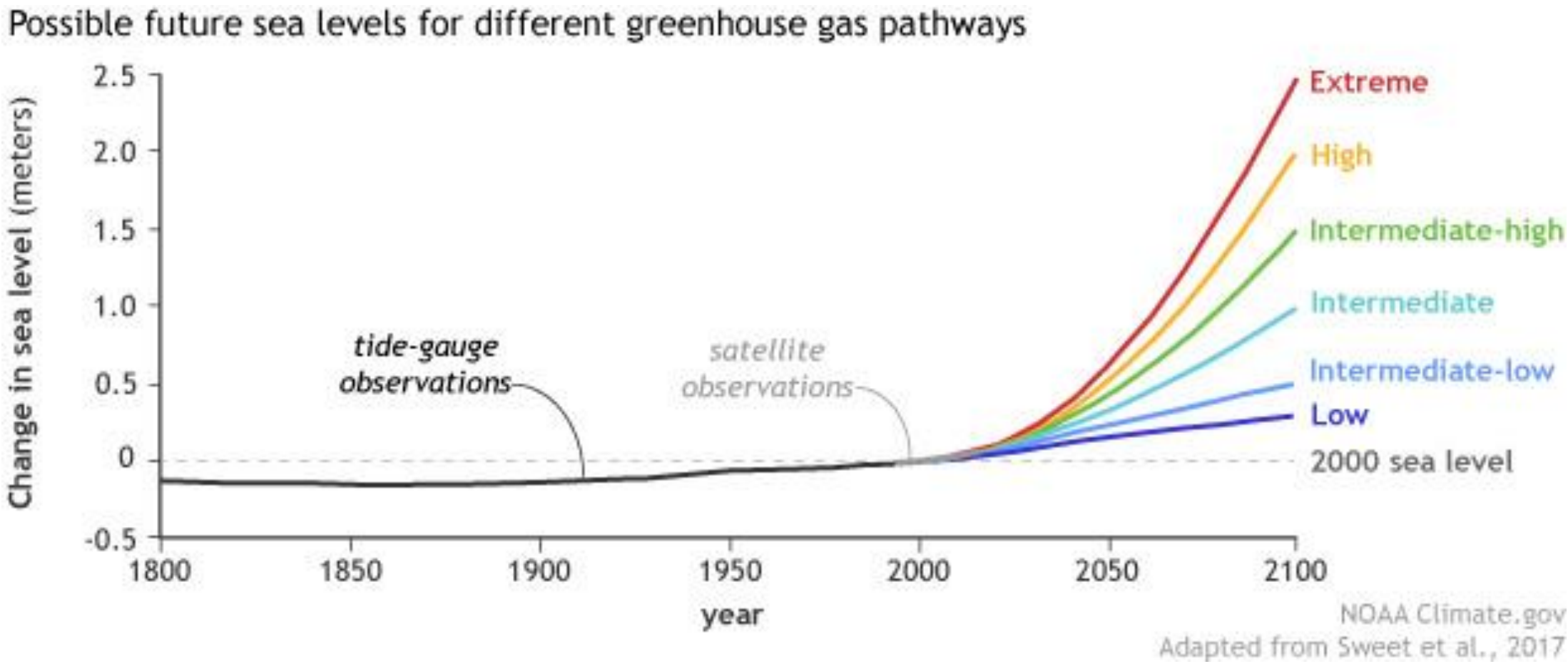
IPCC, 2013

Predictions of global mean air temperature by 2200

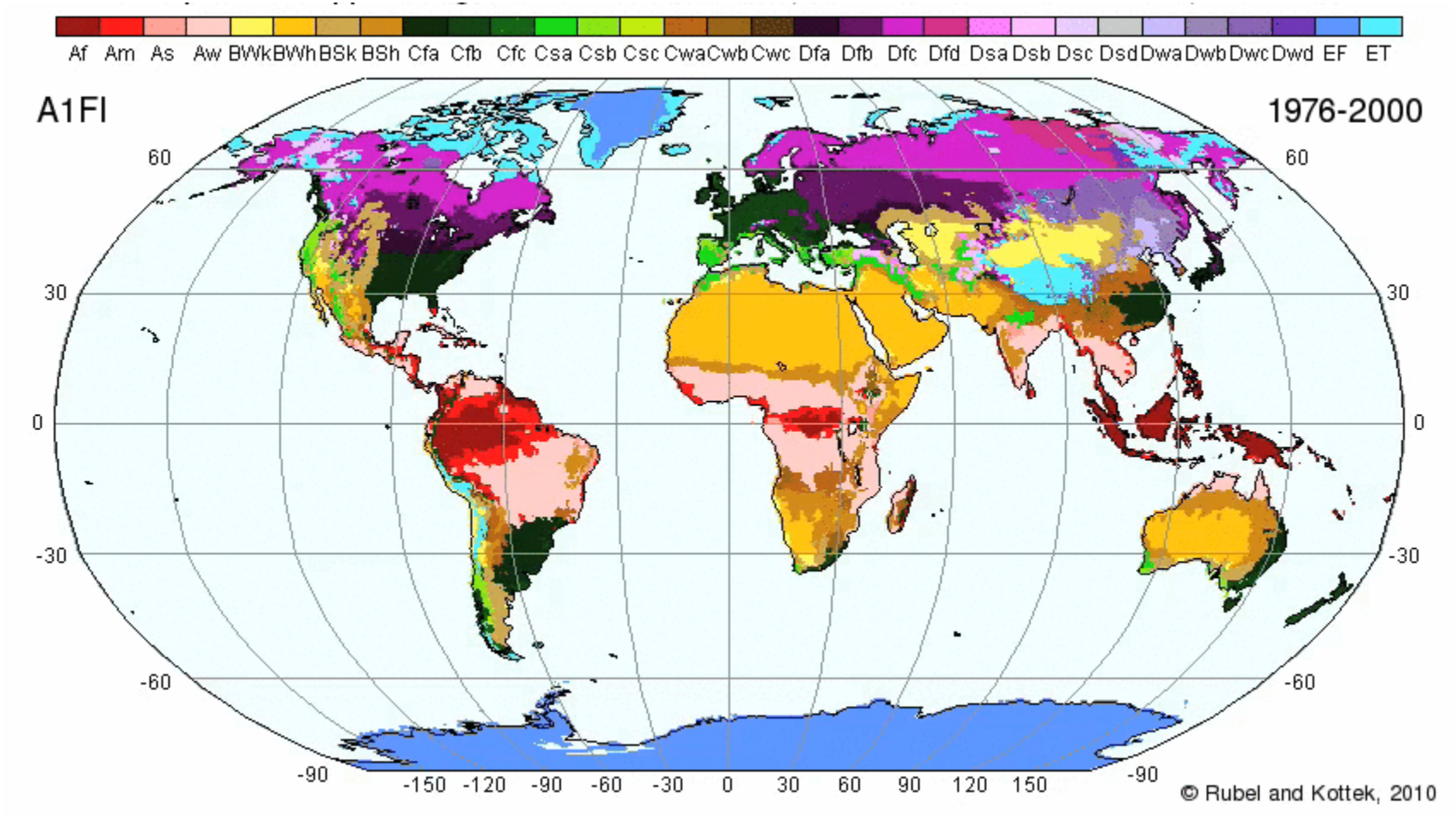


IPCC, 2021

Sea level changes



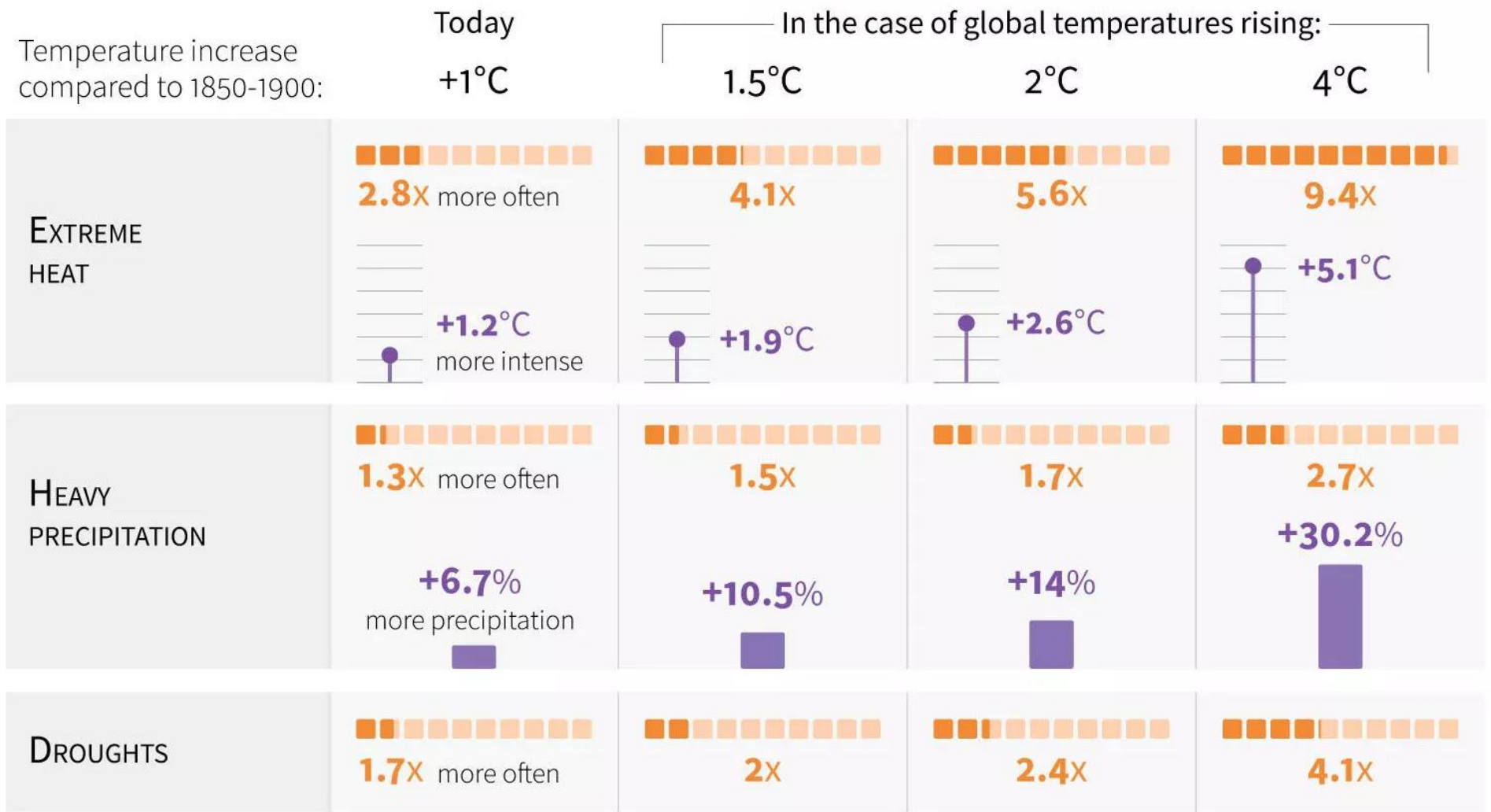
Change of climate zones according to the Köppen-Geiger climate classification



koeppen-geiger.vu-wien.ac.at, 2010

Climate change: more frequent and intense extreme events

For events that had a probability of occurring once every 10 years before the onset of climate change (1850-1900), the increase in the probability and intensity:



Source: Intergovernmental Panel on Climate Change (IPCC)

AFP

Question of the day

Why should we take care about current climate change when much greater changes have occurred in the past?

And is it better to mitigate the negative impacts of climate change or to adapt to them?

References

- Hess, D. (2014): McKnight's physical geography: a landscape appreciation. 11th ed. Harlow: Pearson. Pearson new international edition. ISBN 978-1-292-02091-4
- Masson-Delmotte et al. (2021): IPCC, 2021: Summary for Policymakers. 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 Cambridge, Cambridge University Press.

Thank you for your attention