The Heat Goes On

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Obserwacje

Mechanizmy

Projekcje

Co można zrobić?

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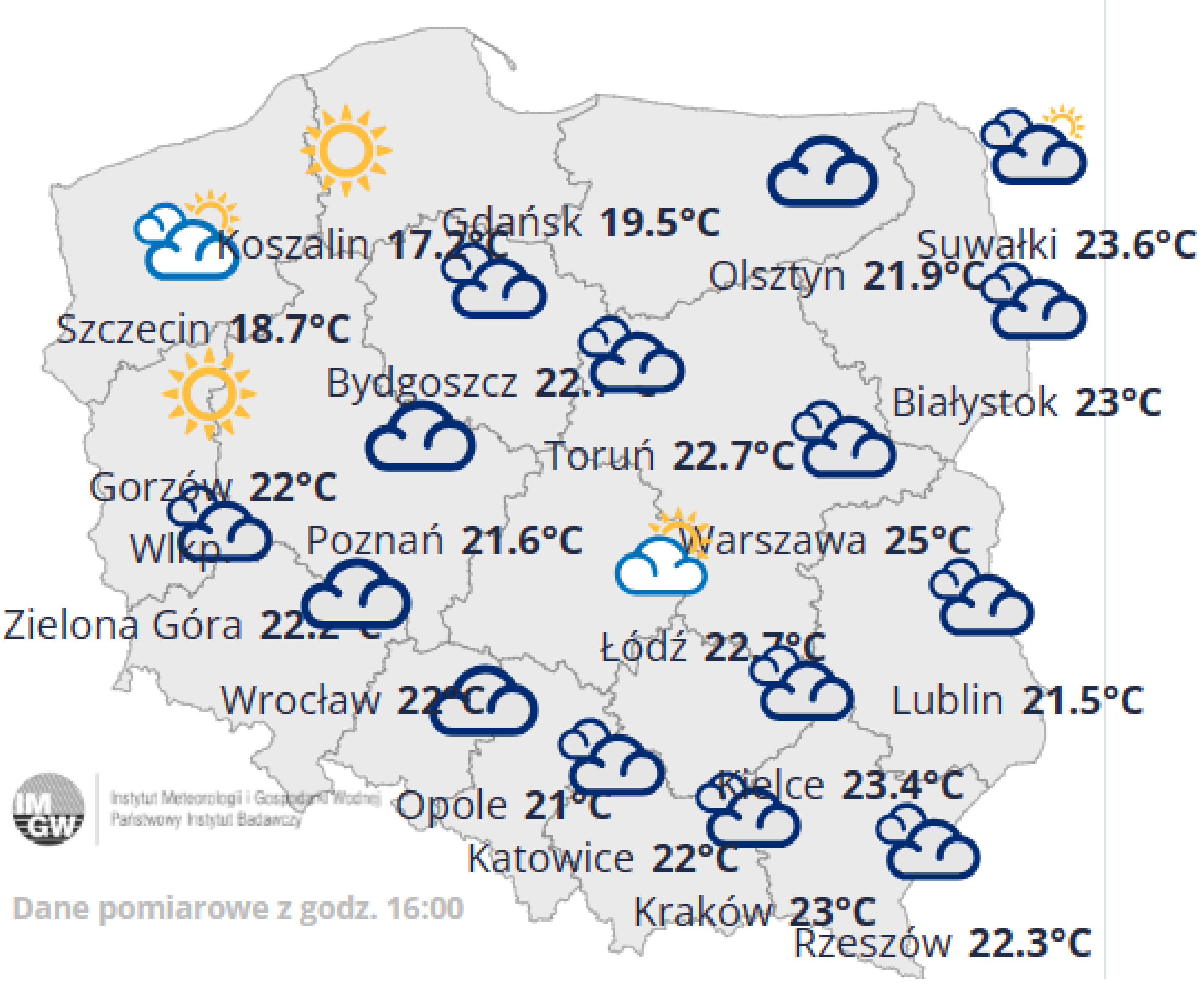
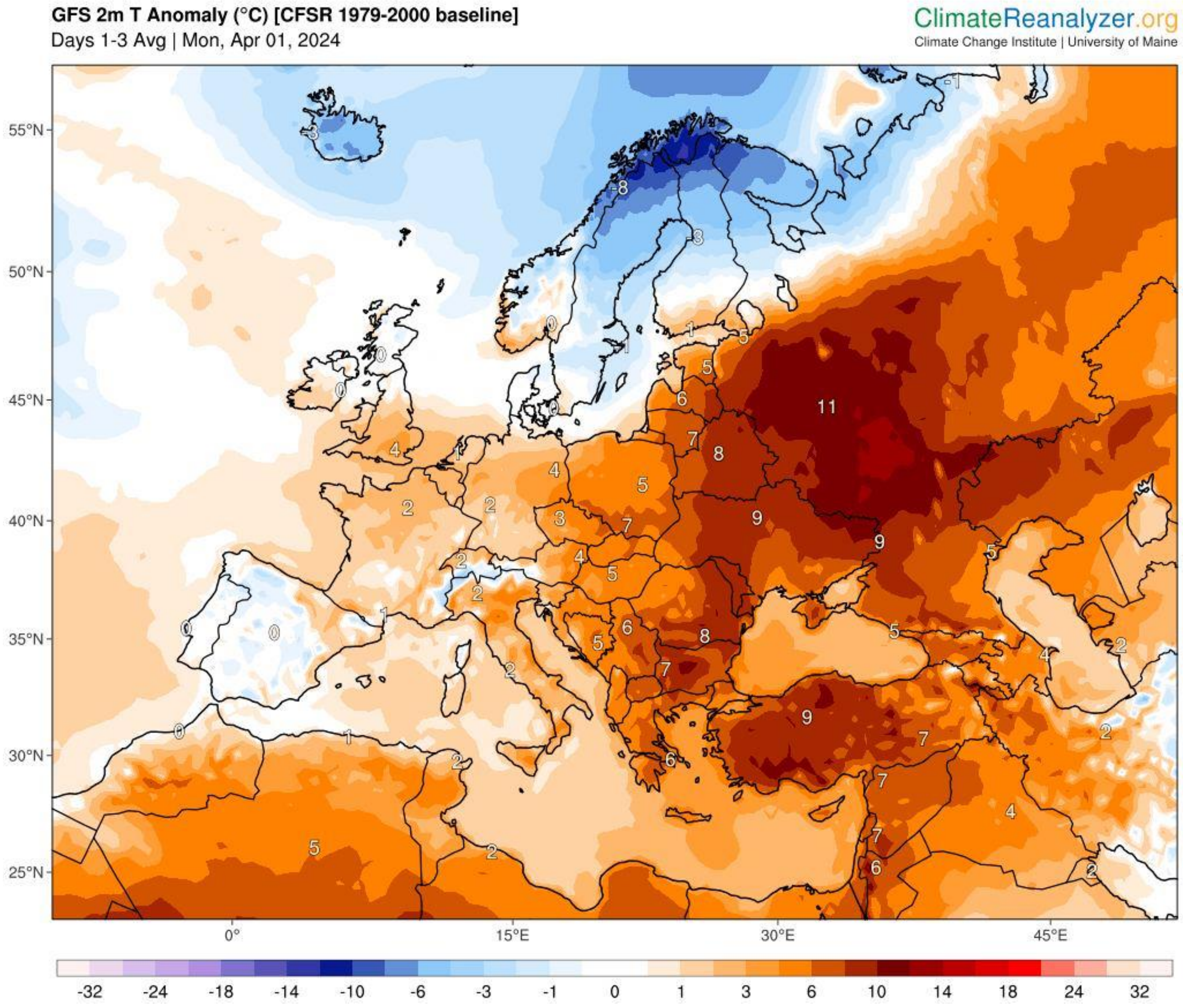
Temperatura powietrza 31 marca 2024 godz. 16

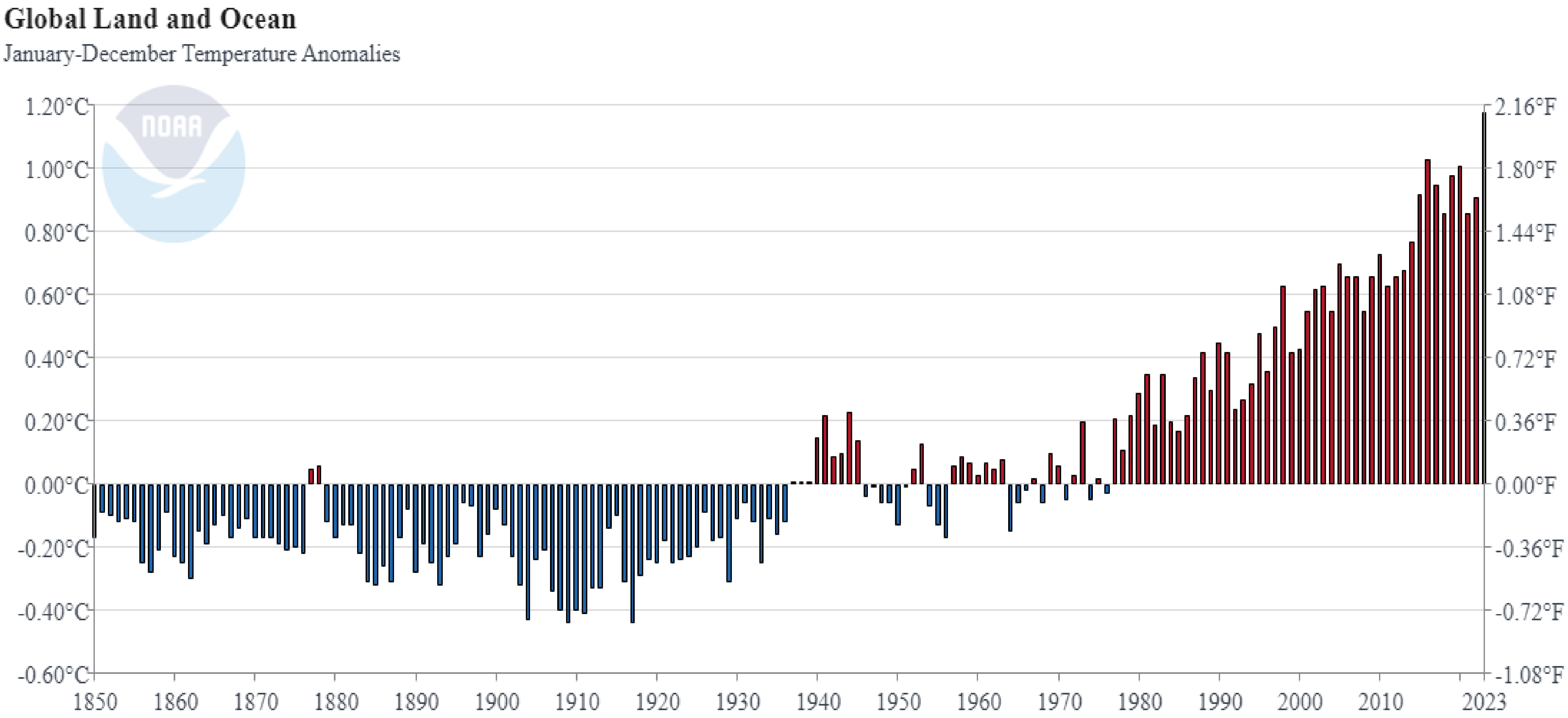
W sobotę 30 marca 2024 o godzinie 12.50 w Tarnowie (woj. małopolskie) na stacji telemetrycznej zarejestrowana została temperatura **26,4 oC**.

Źródło mapy: IMGW




GFS 2m T Anomaly (°C) [CFSR 1979-2000 baseline]
Days 1-3 Avg | Mon, Apr 01, 2024
ClimateReanalyzer.org
Climate Change Institute | University of Maine
55°N
50°N
45°N
40°N
35°N
30°N
25°N
0°
15°E
30°E
45°E
-32
-24
-18
-14
-10
-6
-3
-1
0
1
3
6
10
14
18
24
32


Anomalia temperatury
MARZEC 2024
4.7°C
Jelenia G.
2.4°C
Hel
Opracowano na podstawie danych operacyjnych ze stacji synoptycznych.
Prezentowane wartości w procesie kontroli i weryfikacji mogą ulec zmianie
Wartość anomalii obliczona względem normy dla całego miesiąca
Wizualizacja danych: dr Alan Mandal
MODELE
IMGW-PIB
modele.imgw.pl
GUINNESS

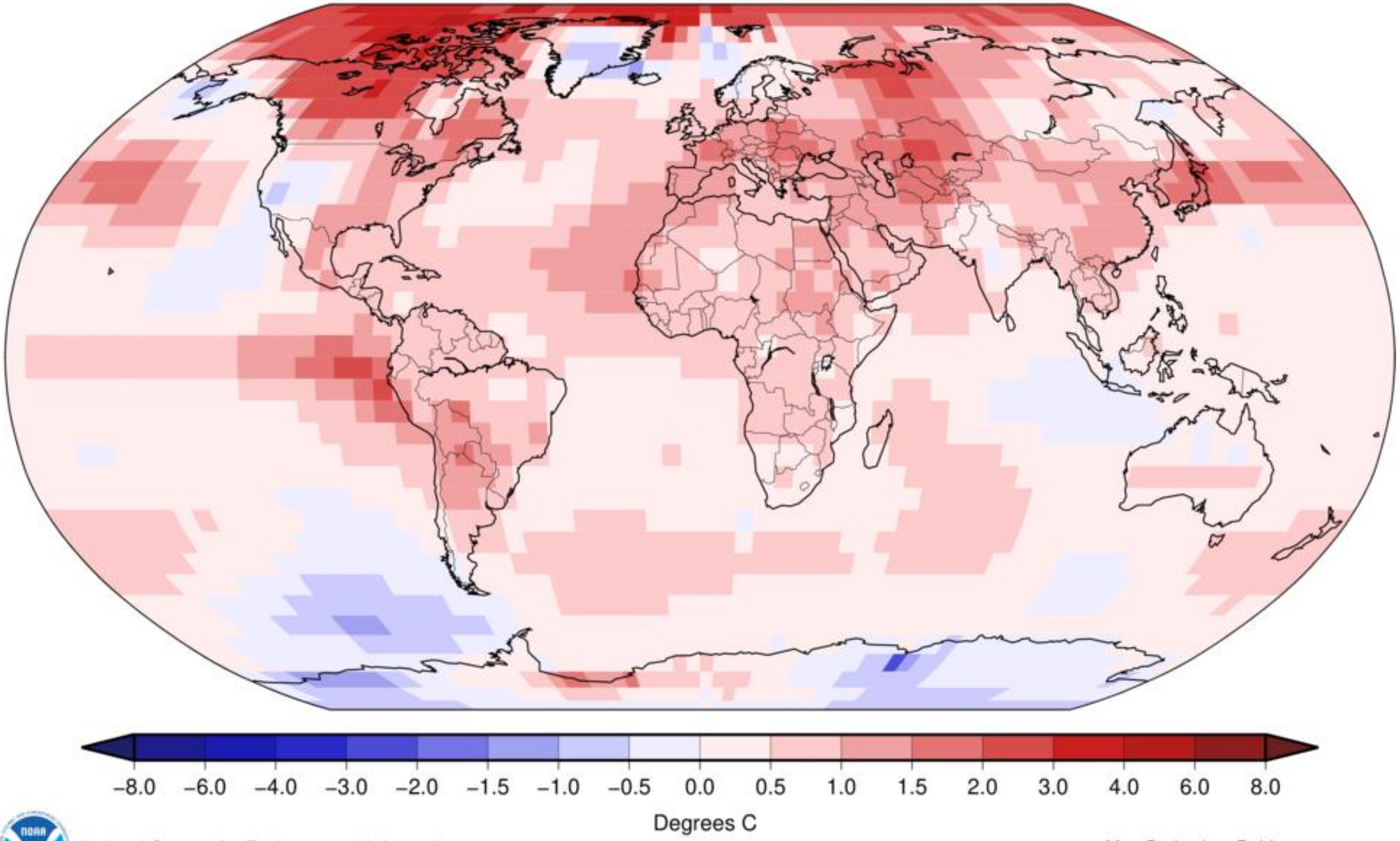

Global Land and Ocean
January-December Temperature Anomalies
1.20°C
1.00°C
0.80°C
0.60°C
0.40°C
0.20°C
0.00°C
-0.20°C
-0.40°C
-0.60°C
2.16°F
1.80°F
1.44°F
1.08°F
0.72°F
0.36°F
0.00°F
-0.36°F
-0.72°F
-1.08°F
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2023

Źródło: NOAA

Land & Ocean Temperature Departure from Average Jan–Dec 2023

(with respect to a 1991–2020 base period)

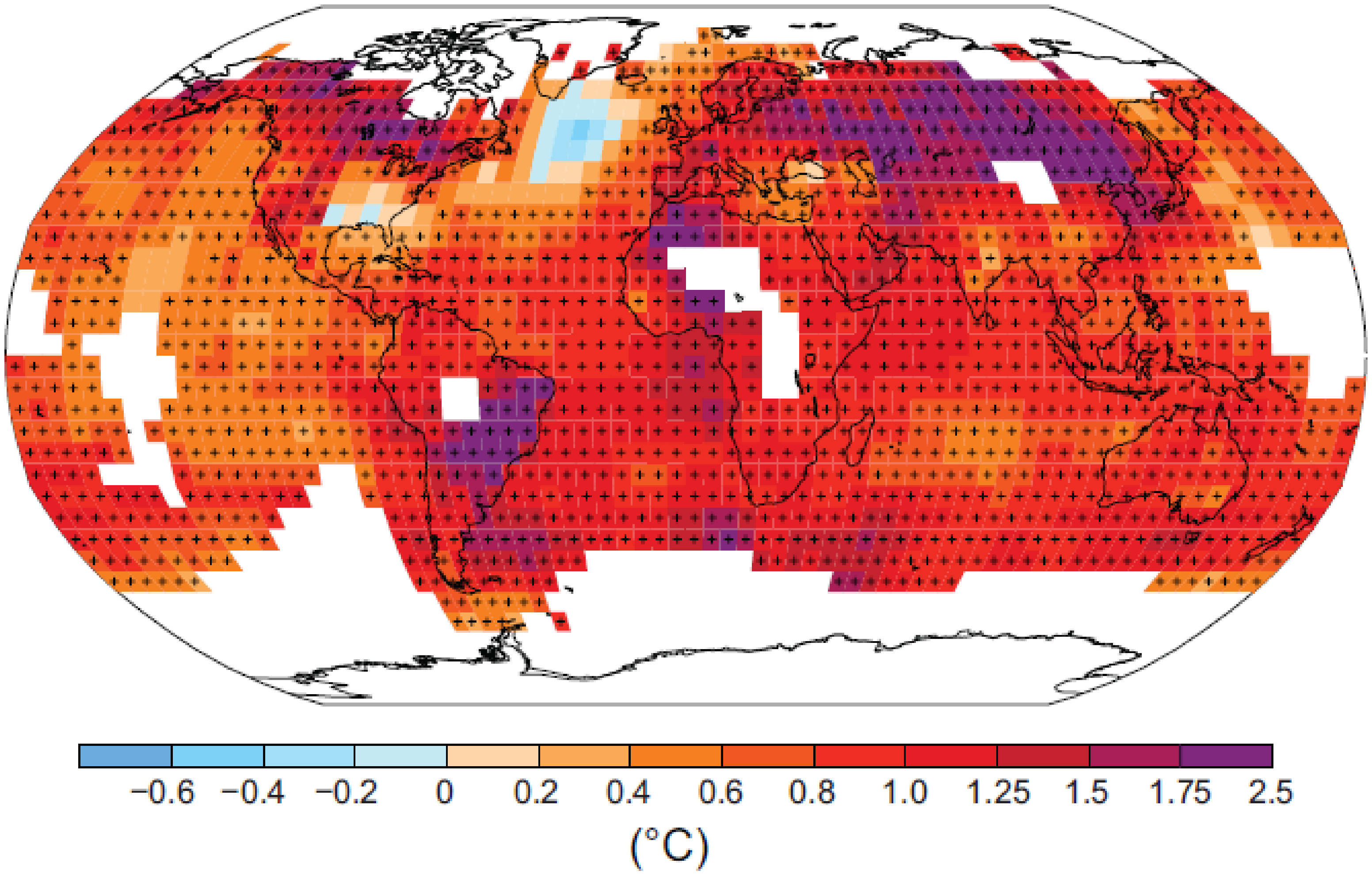
Data Source: NOAAGlobalTemp v5.1.0–20240108



National Centers for Environmental Information

Map Projection: Robinson

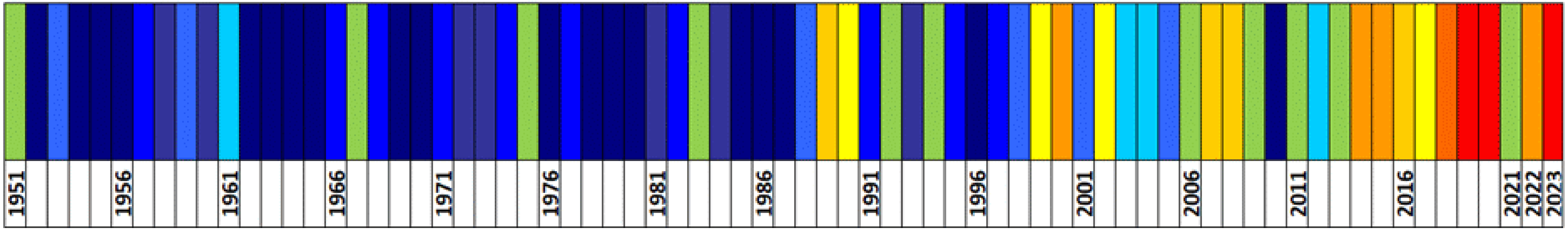
Observed change in surface temperature 1901–2012



Source: IPCC AR5 WGI (2013)

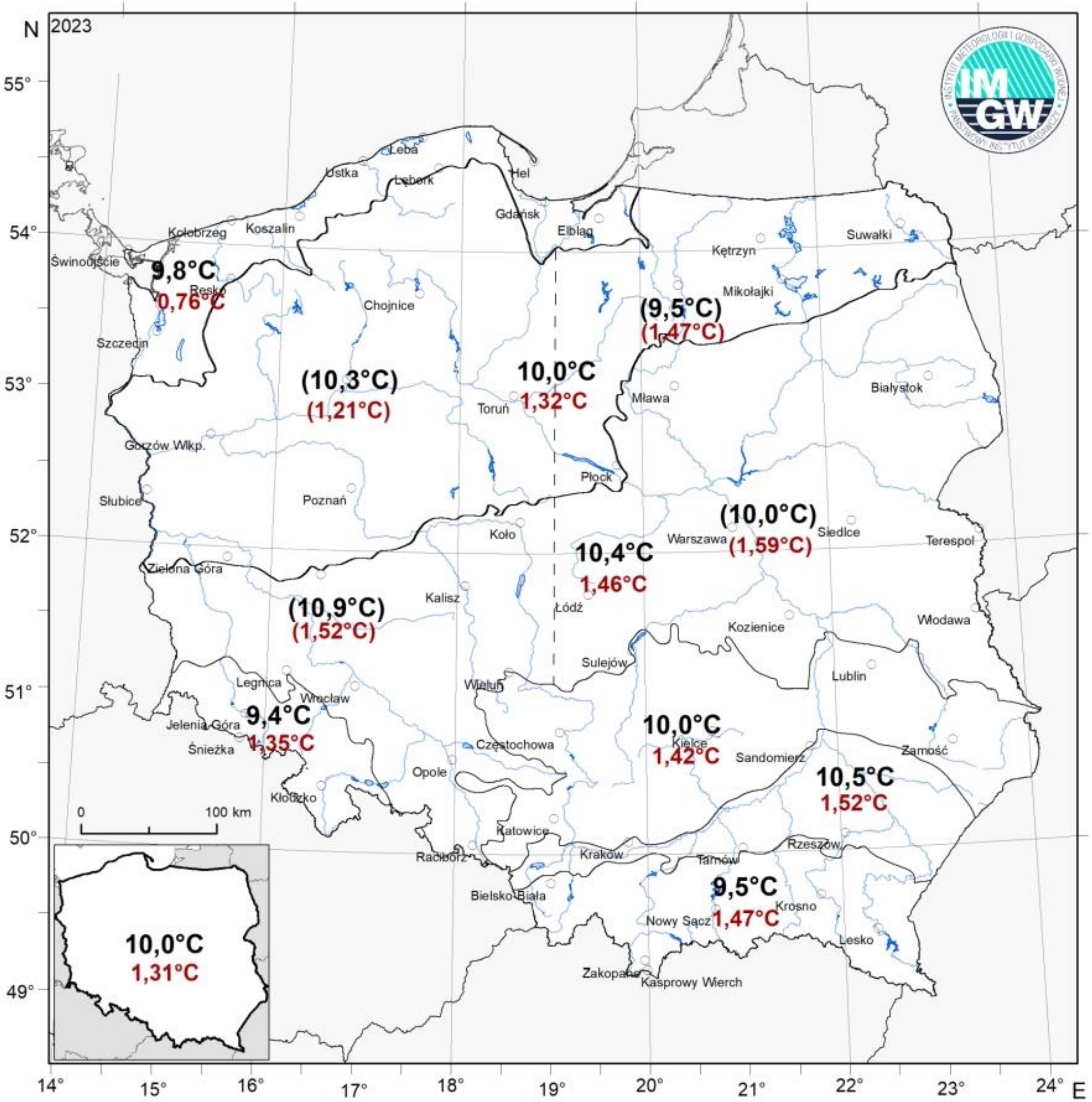
Anomalie średniej temperatury globalnej (lądy i oceany) dla kolejnych przesuwanych okresów trzydziestoletnich, od 1880-1909 do 1990-2019, dla trzech zbiorów danych (NASA, NOAA, CRU).
Źródło: Kundzewicz et al. (Science of the total Environment, 2020).

Przedział czasowy	**Źródło danych**		
	NASA	NOAA	CRU
	Zmiana (°C/100 lat)	Zmiana (°C/100 lat)	Zmiana (°C/100 lat)
1880–1909	−0.58	−0.64	−0.52
1890–1919	−0.45	−0.27	−0.03
1900–1929	0.23	0.36	0.71
1910–1939	1.00	1.00	1.27
1920–1949	1.20	1.25	1.06
1930–1959	0.32	0.35	0.28
1940–1969	−0.42	−0.42	−0.25
1950–1979	0.44	0.44	−0.04
1960–1989	1.27	1.20	0.69
1970–1999	1.69	1.69	1.71
1980–2009	1.68	1.55	1.78
1990–2019	2.10	1.98	1.72

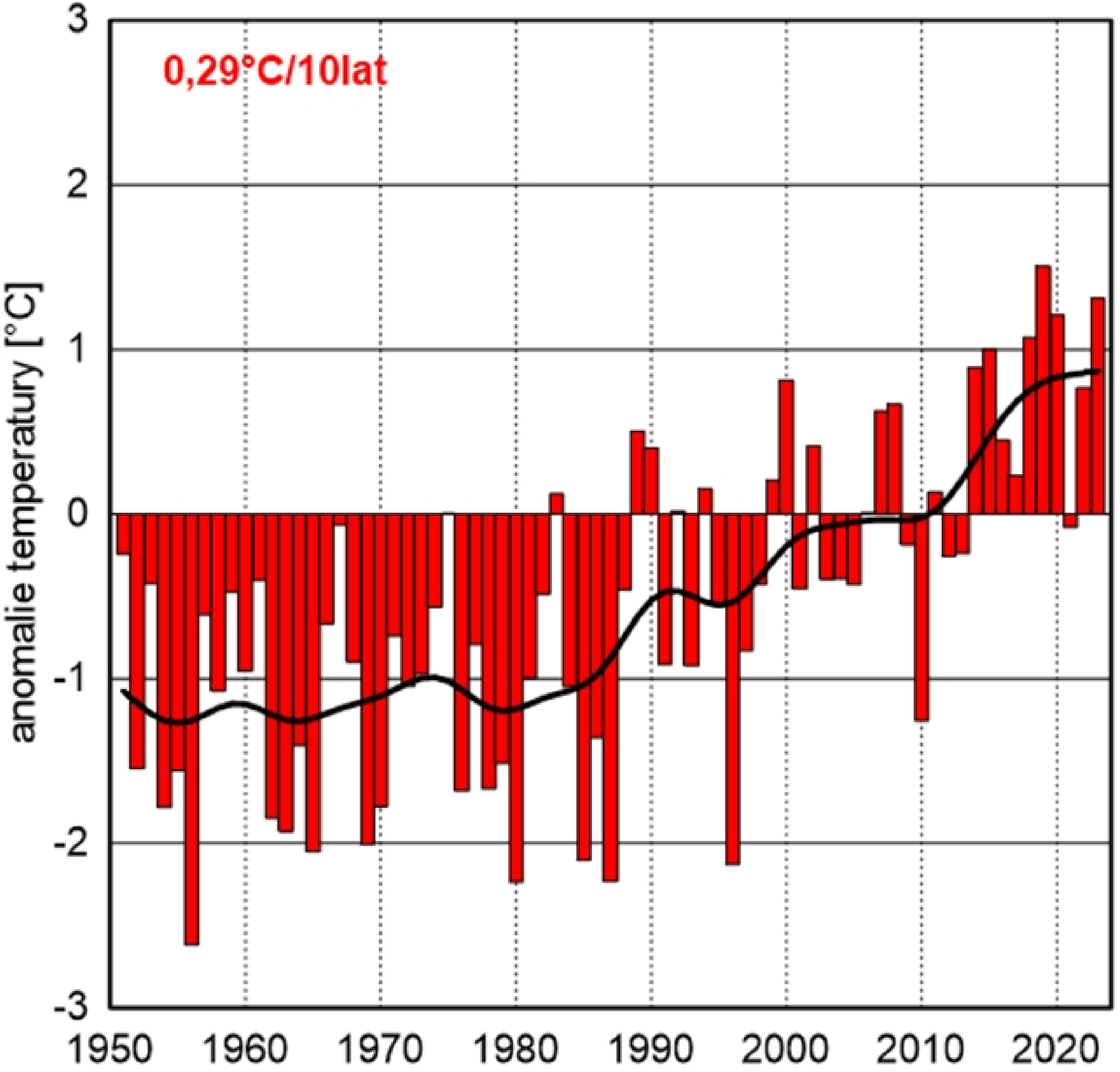


Reference: 1991-2020, 2019 warmest (**10.2 C**), 2023 – 2nd warmest (**10.0 C**) vs **6.1 C** in 1956

https://www.imgw.pl/wydarzenia/charakterystyka-wybranych-elementow-klimatu-w-polsce-w-2023-roku-podsumowanie



2023
9,8°C
0,76°C
(9,5°C)
(1,47°C)
(10,3°C)
(1,21°C)
10,0°C
1,32°C
(10,0°C)
(1,59°C)
10,4°C
1,46°C
(10,9°C)
(1,52°C)
9,4°C
1,35°C
10,0°C
1,42°C
10,5°C
1,52°C
9,5°C
1,47°C
10,0°C
1,31°C
Świnoujście
Kołobrzeg
Koszalin
Ustka
Łeba
Lębork
Hel
Gdańsk
Elbląg
Kętrzyn
Suwałki
Mikołajki
Resko
Szczecin
Chojnice
Toruń
Mława
Białystok
Gorzów Wlkp.
Słubice
Poznań
Płock
Koło
Warszawa
Siedlce
Terespol
Zielona Góra
Kalisz
Łódź
Kozienice
Włodawa
Legnica
Wrocław
Wieluń
Sulejów
Lublin
Jelenia Góra
Śnieżka
Częstochowa
Kielce
Sandomierz
Zamość
Opole
Kłodzko
Katowice
Racibórz
Kraków
Tarnów
Rzeszów
Bielsko-Biała
Nowy Sącz
Krosno
Lesko
Zakopane
Kasprowy Wierch
0
100 km
N
E
55°
54°
53°
52°
51°
50°
49°
14°
15°
16°
17°
18°
19°
20°
21°
22°
23°
24°


0,29°C/10lat
anomalie temperatury [°C]
3
2
1
0
-1
-2
-3
1950
1960
1970
1980
1990
2000
2010
2020

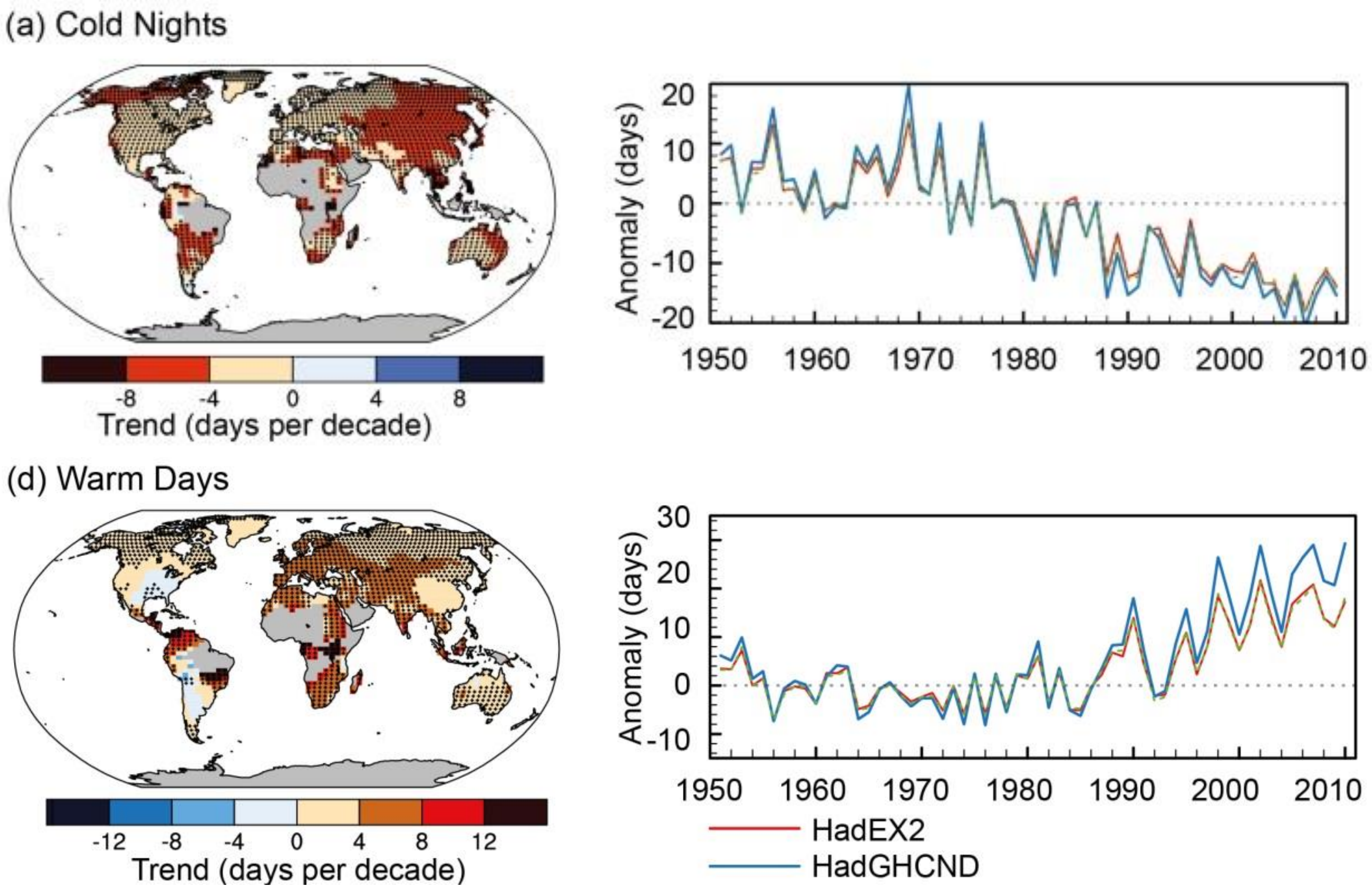
Dni z temperaturą dobową maksymalną ponad 30^{o}C w lecie 2019 w Poznaniu

Dzień	Tmax
04.06	30
05.06	30
10.06	32
11.06	34
12.06	34
15.06	35
19.06	32
20.06	32
25.06	33
26.06	38 ☼!
29.06	30
30.06	37 ☼!

Dzień	Tmax
25.07	32
28.07	32
29.07	34
30.07	30

Dzień	Tmax
06.08	30
09.08	30
26.08	32
27.08	32
28.08	32
29.08	32
30.08	30
31.08	32
01.09	32
Źródło danych:	Accuweather

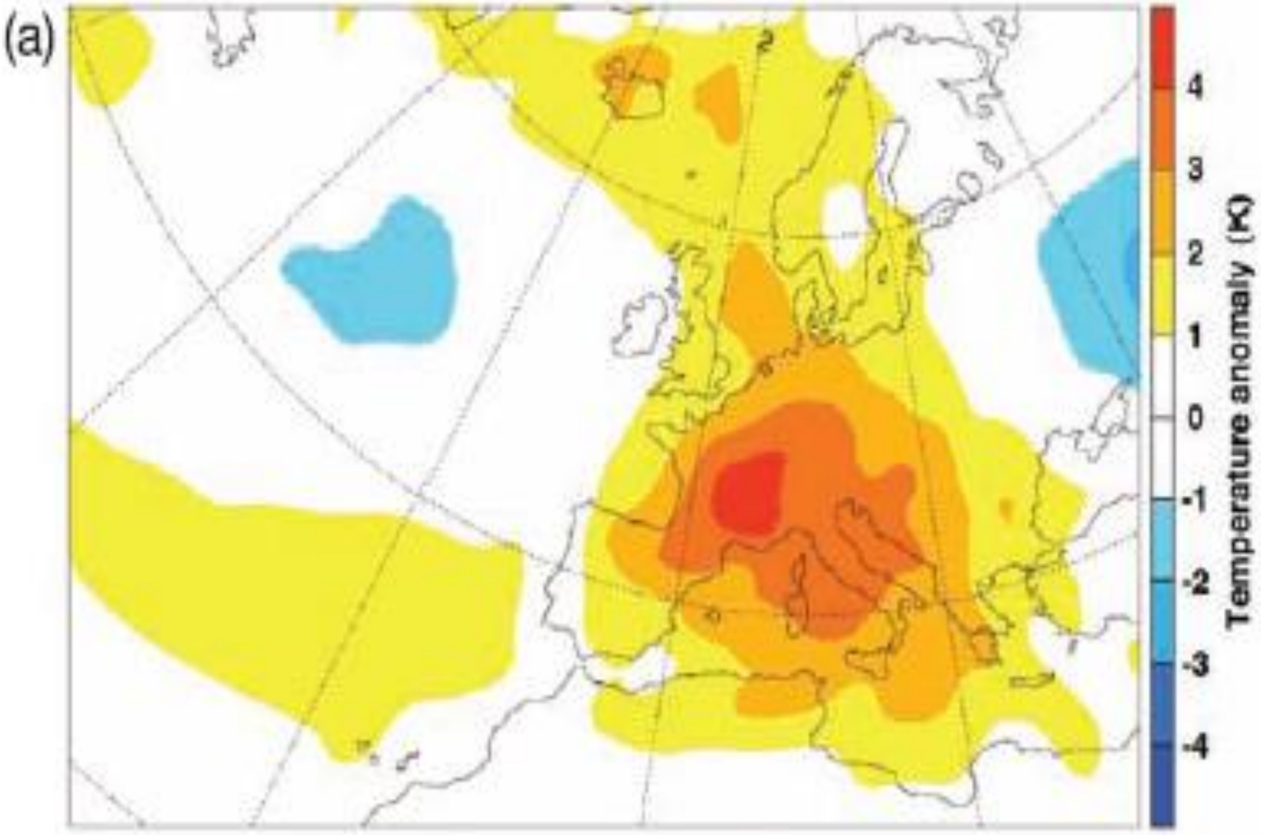
Observed Changes in Unusually Cold Nights and Warm Days

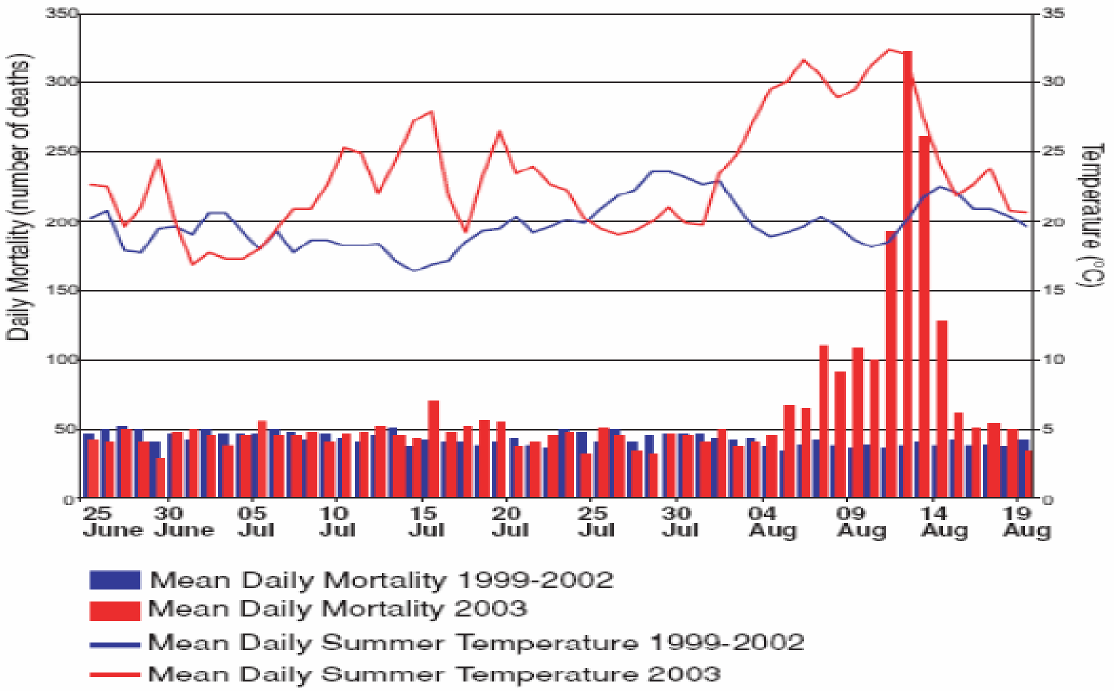


Źródło: IPCC

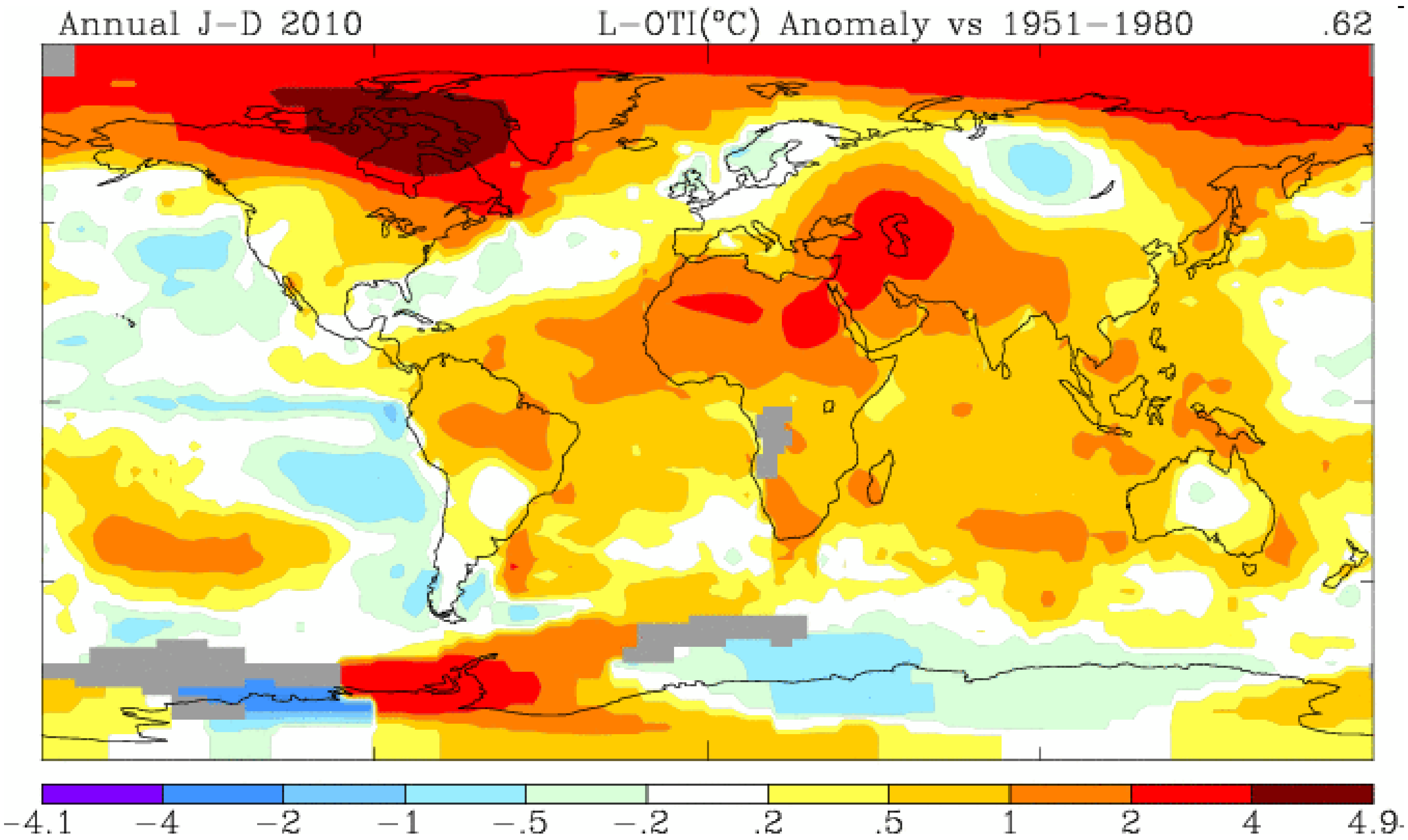
Temperature anomalies during hot summer (June-Aug) 2003 in Europe [IPCC AR4, 2007]

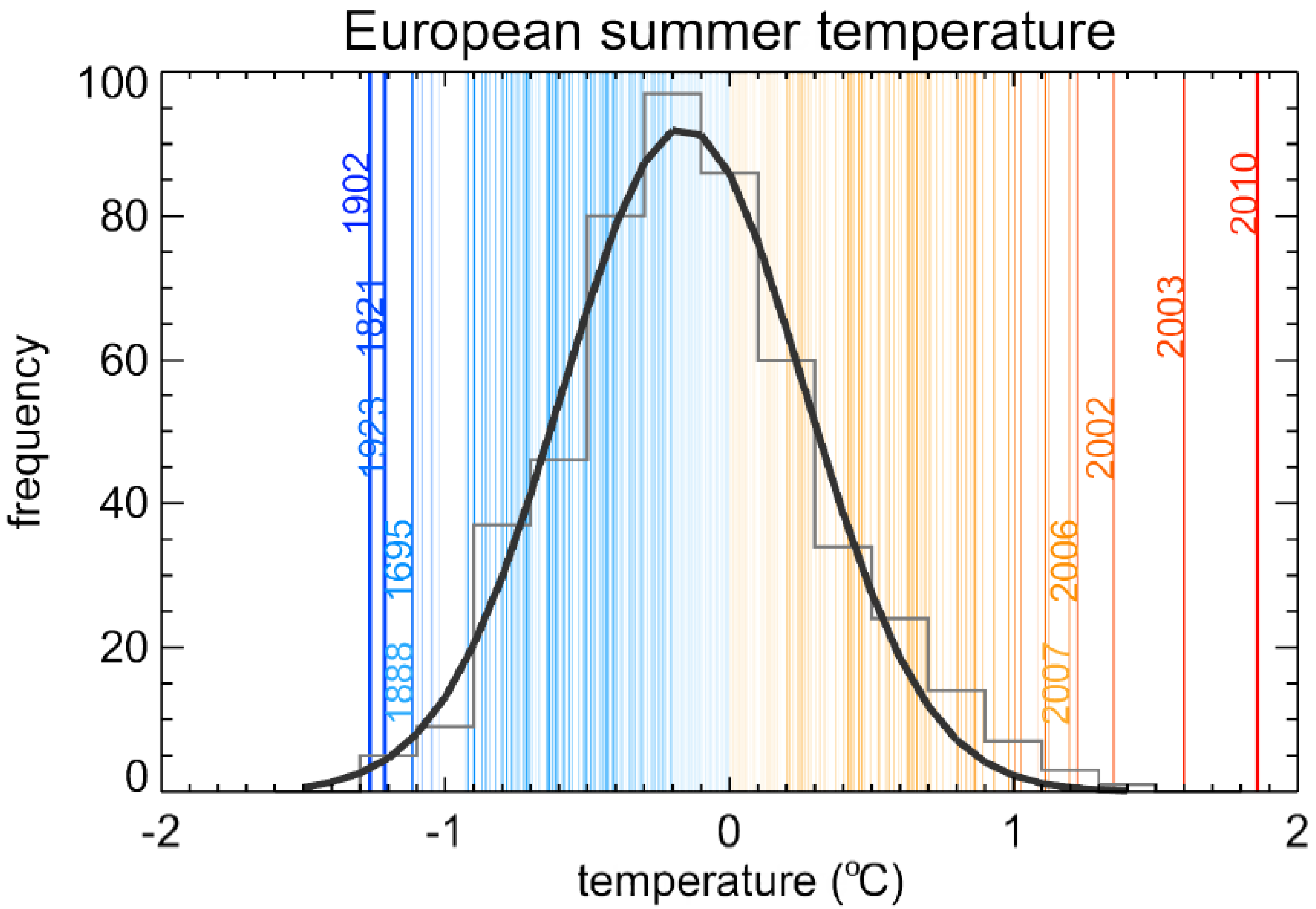
Mortality during the heat wave in Paris in summer 2003 [Koppe et al., 2004]



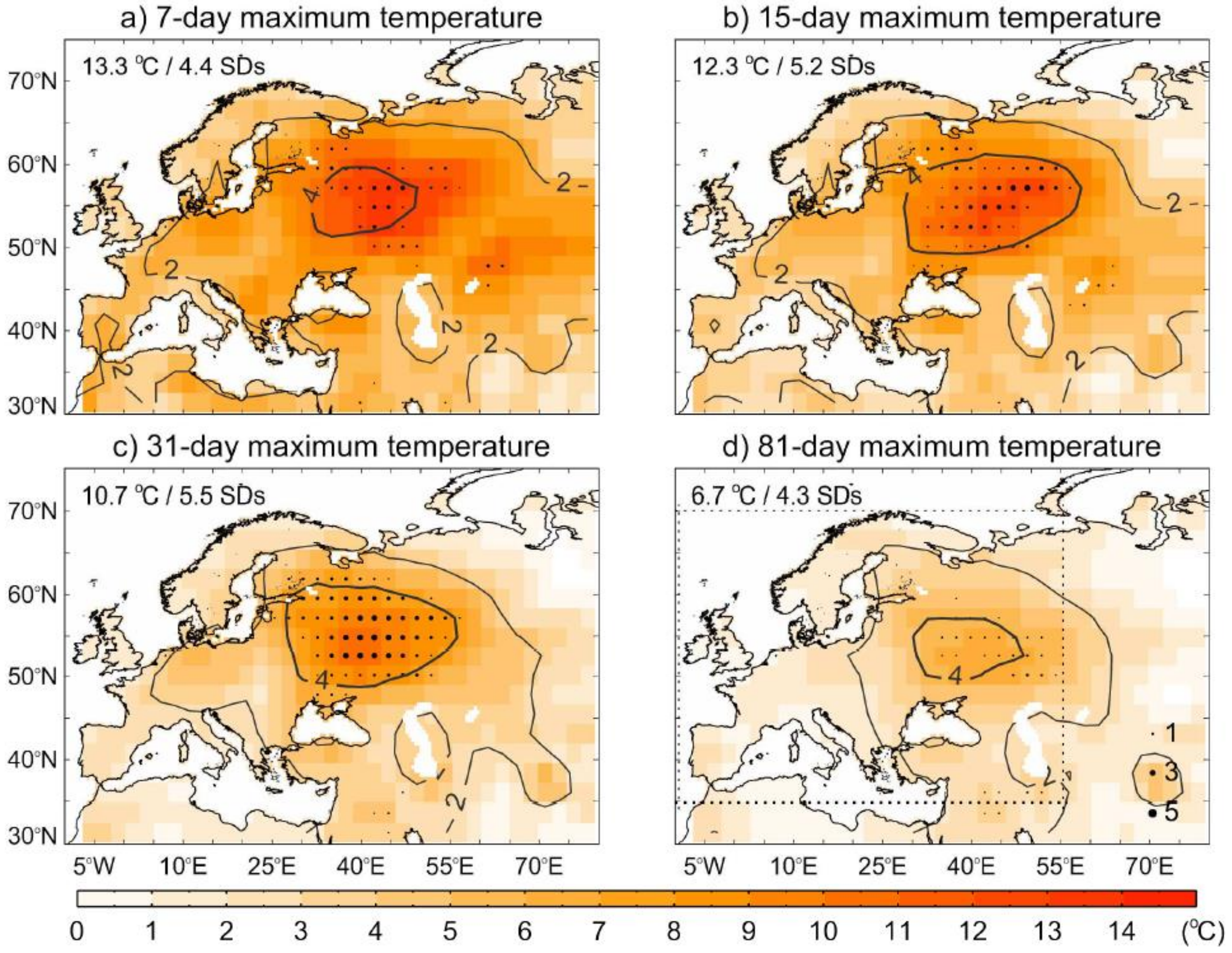


Temperature anomaly for 2010 (vs 1951-1980) NASA – GISS





Source: Barriopedro et al., 2011



Source: Barriopedro et al., 2011 (2010 relative to 1970-1999)

Killing heat waves in Europe

Summer 2003: 70 thousand heat-wave fatalities in 12 countries in Europe (Robine *et a*l., 2008)

Summer 2010: 56 thousand heat-wave fatalities only in Russia (Munich Re, 2011)

Summer 2022: 61 thousand heat-wave fatalities in Europe

Tuesday, April 02, 2024
11:03 am (Paris)

Le Monde

FRANCE • HEAT WAVES

France recorded over 5,000 deaths due to summer 2023 heat

Around 3,700 of the deaths were people aged over 75. Extreme heat has been straining healthcare systems, hitting older people, infants and children.

Heat Extremes in Gulf Region: Mecca

2014: Millions of pilgrims at Mount Arafat, near Mecca

Obserwacje

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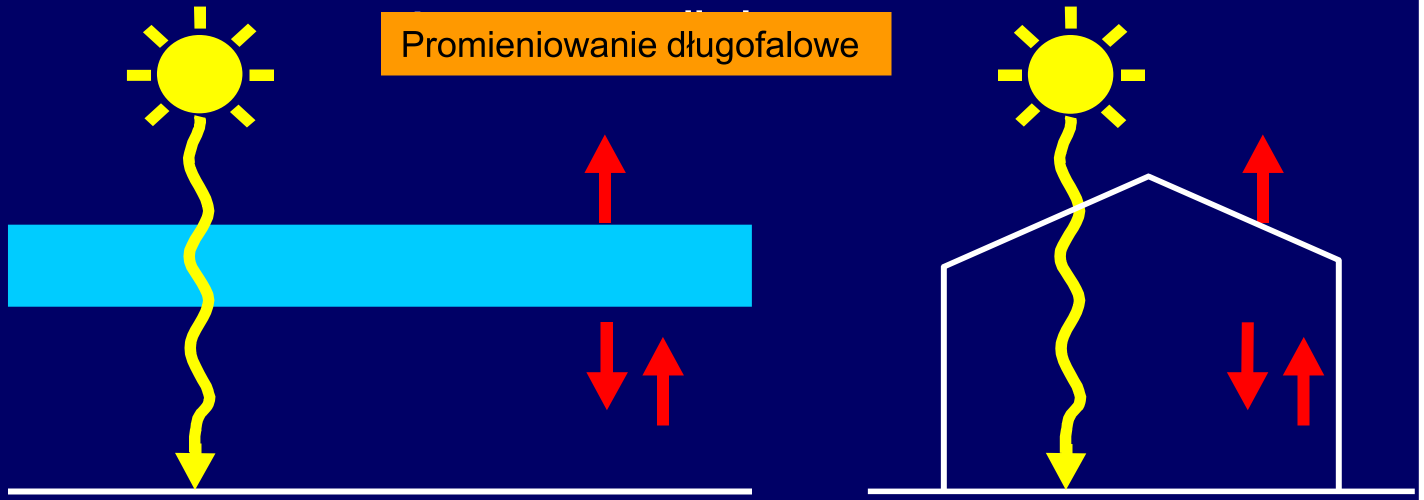
Efekt cieplarniany

Promieniowanie słoneczne

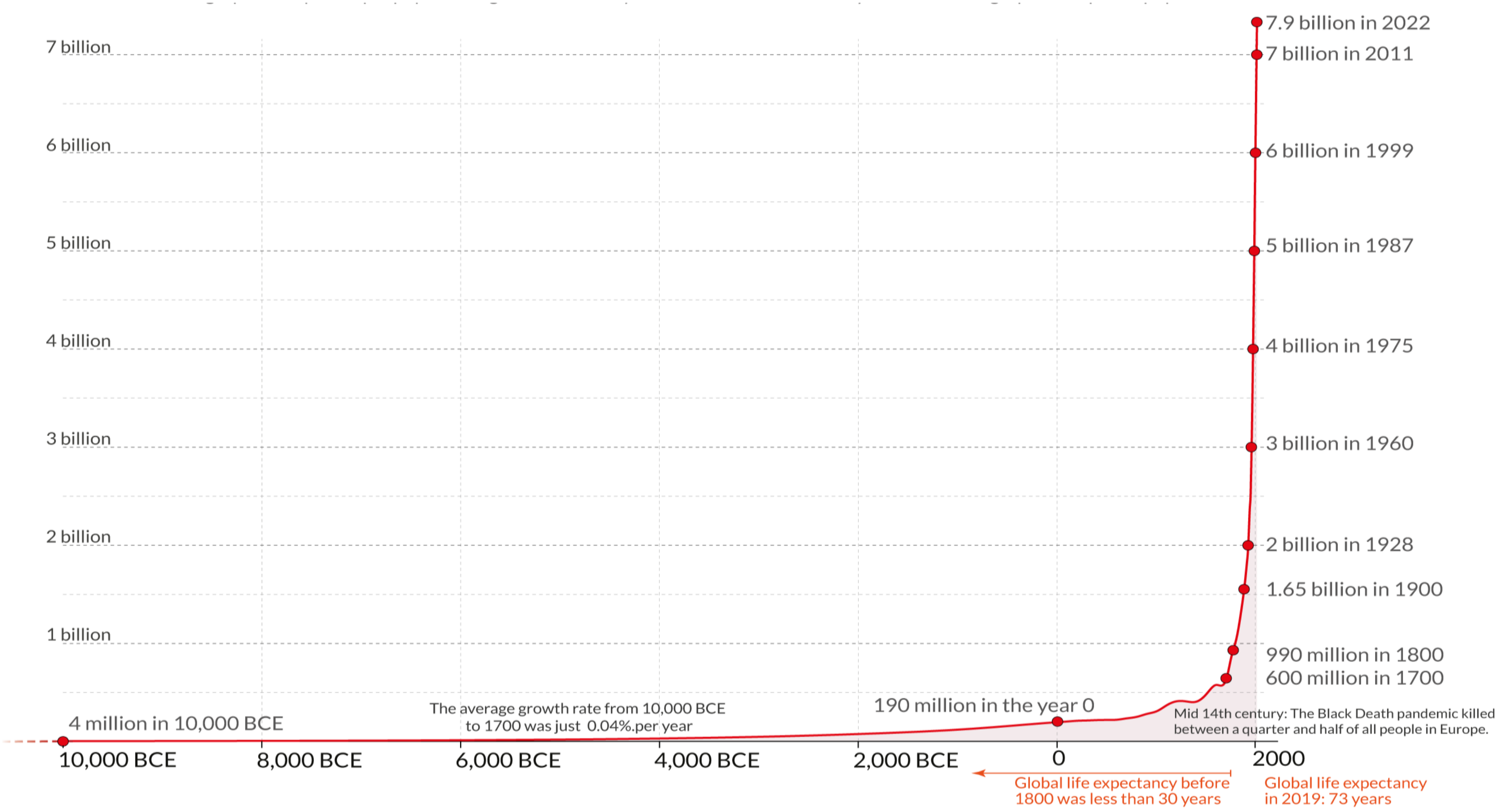


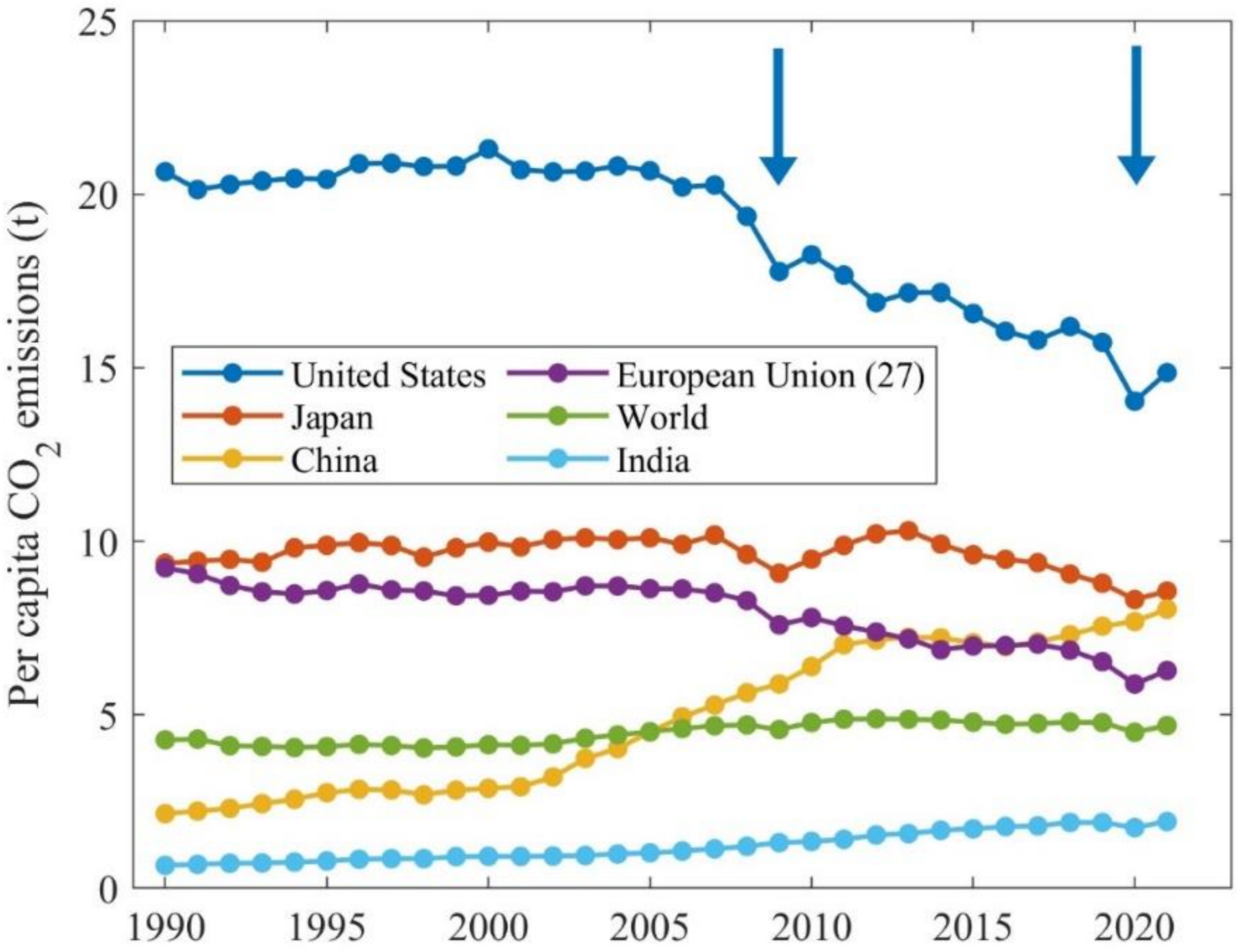
JTH 17-07-2001 12 COP6bis/SBSTA

Słońce podgrzewa Ziemię do	– 18 ^oC
Efekt cieplarniany dodaje	33 ^oC
Średnia temperatura globalna	15 ^oC

Zmiany wielkości światowej populacji w czasie.
Źródło: Our World in Data.

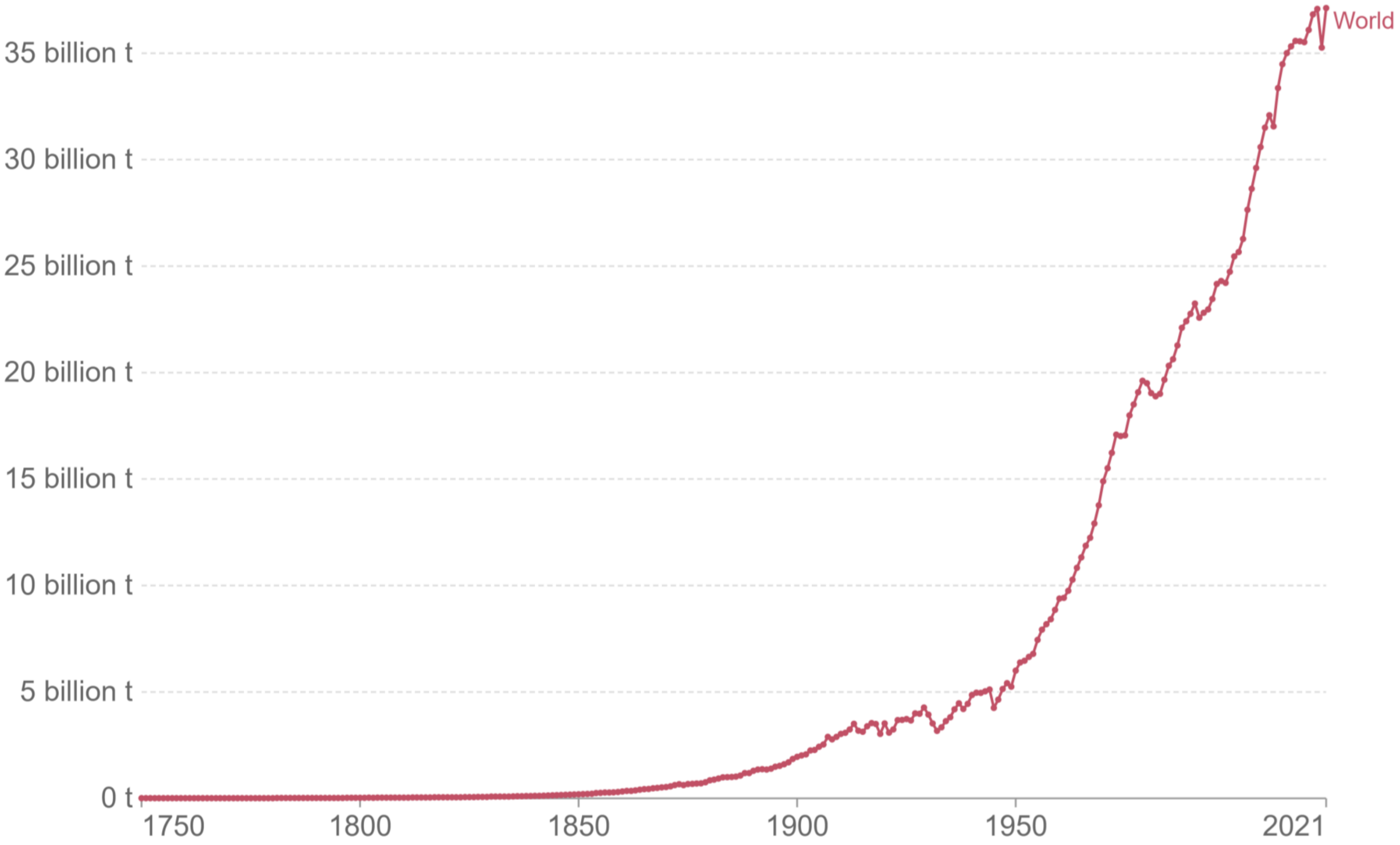
8 miliardów w 2023

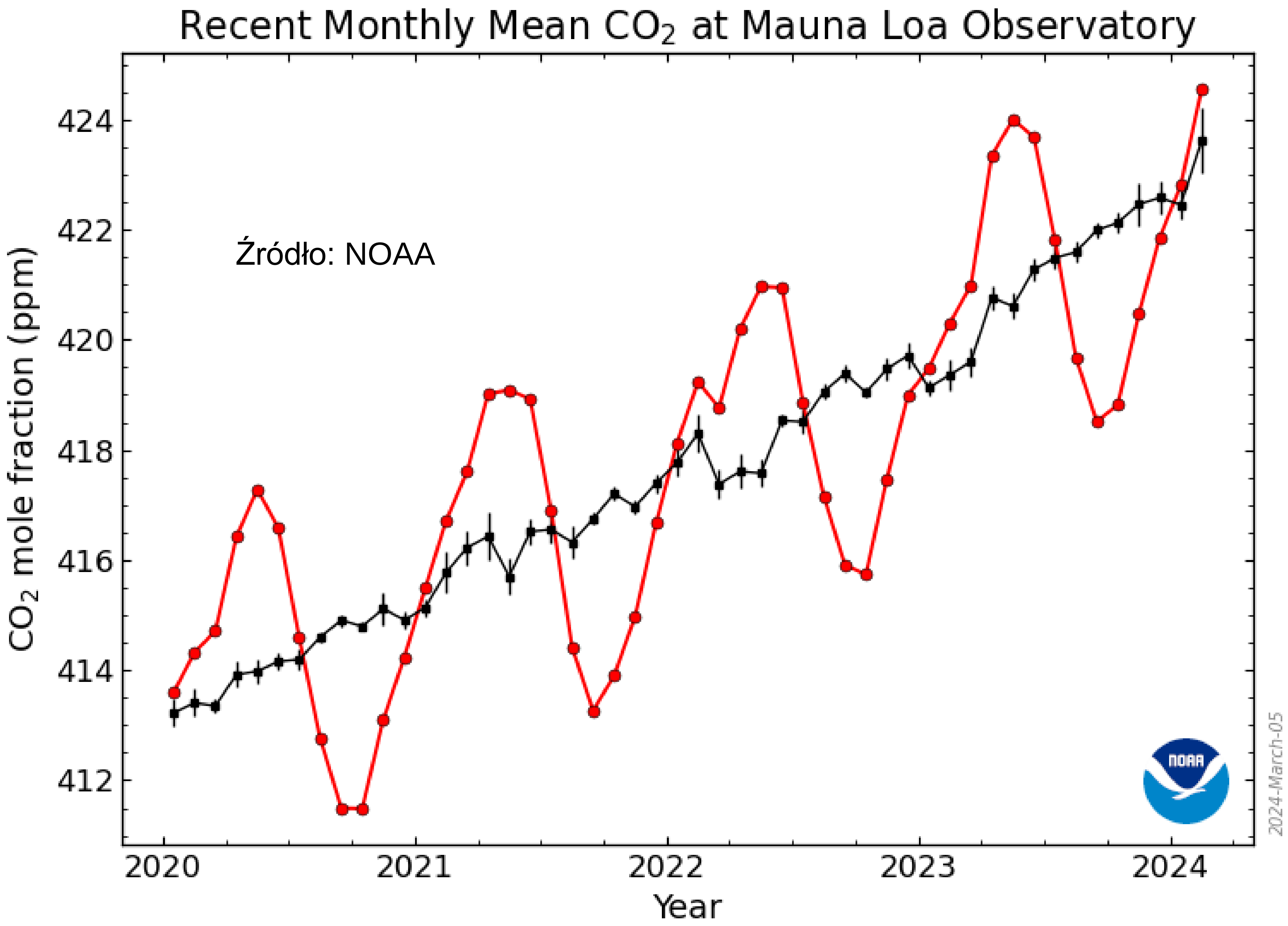




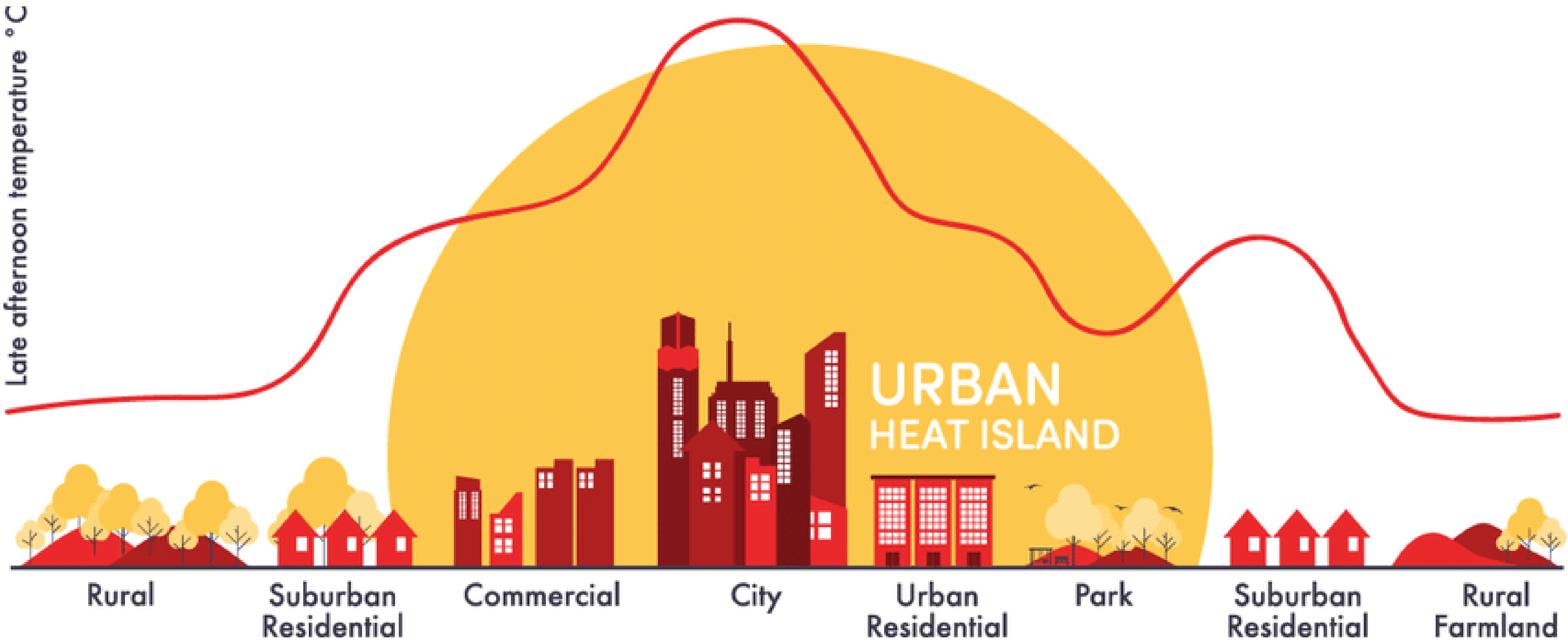
Źródło: Our World in Data.

Roczne globalne emisje CO2 w miliardach ton.
Źródło: Global Carnon Budget, Our World in Data.





Recent Monthly Mean CO2 at Mauna Loa Observatory
Źródło: NOAA
CO2 mole fraction (ppm)
424
422
420
418
416
414
412
2020
2021
2022
2023
2024
Year
2024-March-05



Late afternoon temperature °C
URBAN
HEAT ISLAND
Rural
Suburban
Residential
Commercial
City
Urban
Residential
Park
Suburban
Residential
Rural
Farmland

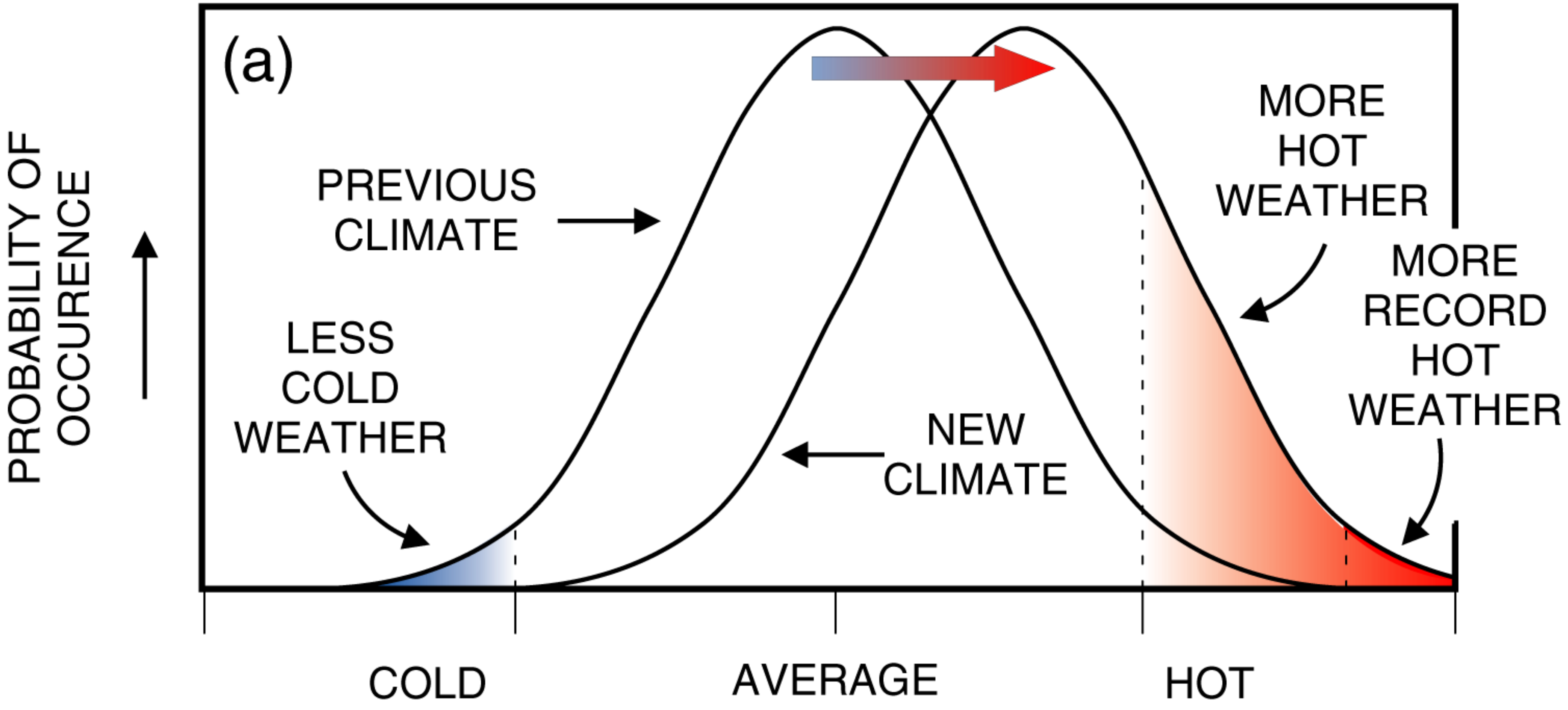
European Academies Science Advisory Council (EASAC) (2019) **The imperative of climate action to protect human health in Europe.** Opportunities for adaptation to reduce the impacts and for mitigation to capitalise on the benefits of decarbonization, Reports and statements Biosciences https://easac.eu/publications/details/the-imperative-of-climate-action-to-protect-human-health-in-europe

Table 3.1 Mortality per one million people attributed to extreme weather events for 1991–2015

Region of Europe	Heatwave	Cold	Flooding and landslides	Storm	Wildfire[14]
Eastern	11.4	28.3	8.6	1.7	0.54
Northern	11.2	1.7	1.0	2.5	0.01
Southern	178	0.9	6.8	1.2	0.97
Western	192	0.9	2.1	2.8	0.04

Table is adapted from EEA (2017a), using data from EM-DAT (http://www.emdat.be/database), Eurostat (http://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-data) and WHO (http://www.euro.who.int/en/data-and-evidence). Country groupings are listed in EEA (2017a) and include, for example, Balkan States in the southern region as well as EU Member States.

INCREASE IN MEAN



Large percentage change in extremes

Vicedo-Cabrera, A.M., Scovronick, N., Sera, F. *et al.* The burden of heat-related mortality attributable to recent human-induced climate change. *Nat. Clim. Chang.* **11**, 492–500 (2021). https://doi.org/10.1038/s41558-021-01058-x

Empirical data from 732 locations in 43 countries were used to estimate the mortality burdens associated with the additional heat exposure that has resulted from recent human-induced warming in 1991–2018. Across all study countries, authors found that **37.0%** (range 20.5–76.3%) **of warm-season heat-related deaths can be attributed to anthropogenic climate change** and that **increased mortality is evident on every continent**. The findings support the urgent need for more ambitious mitigation and adaptation strategies to minimize the public health impacts of climate change.

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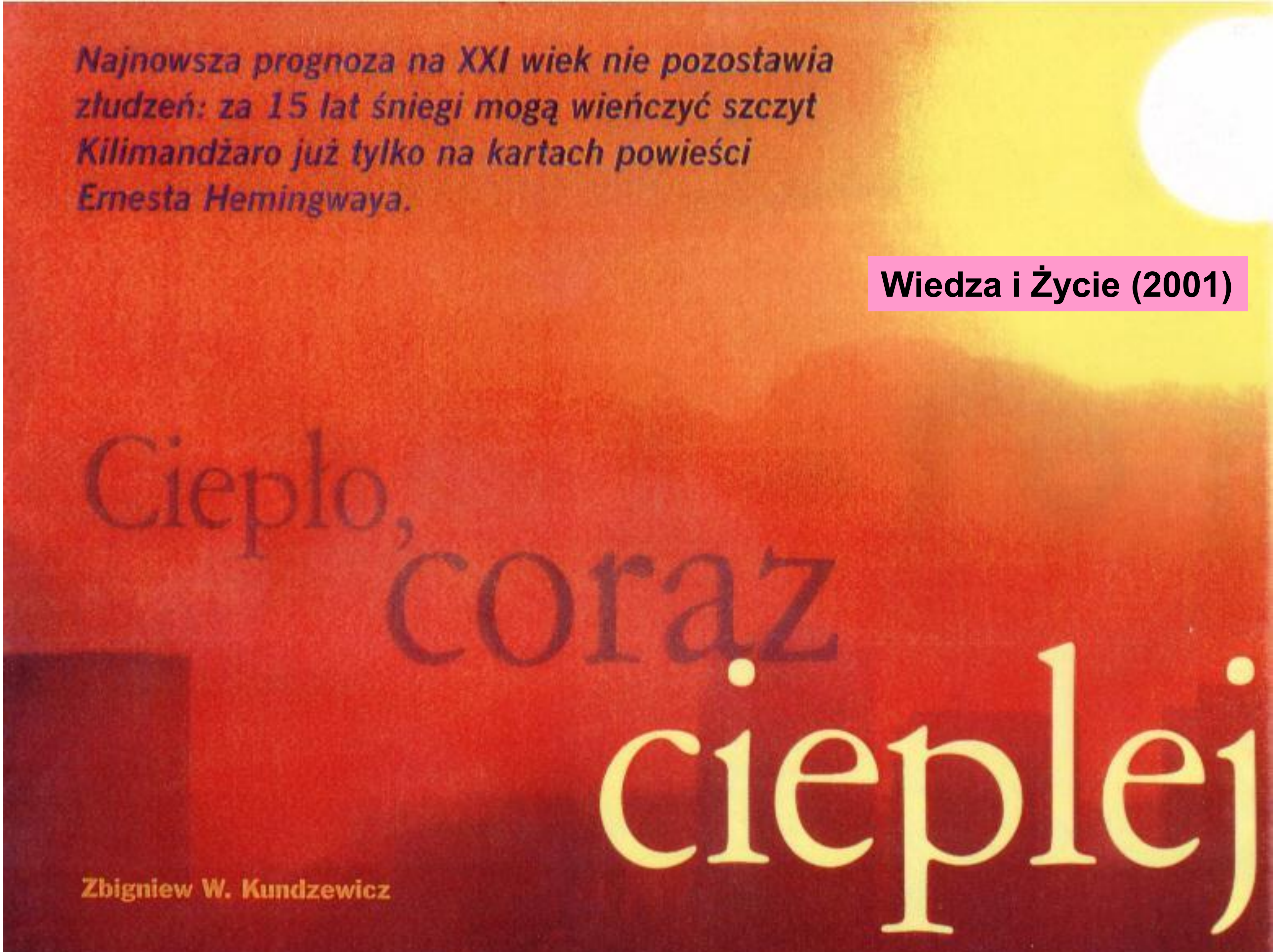
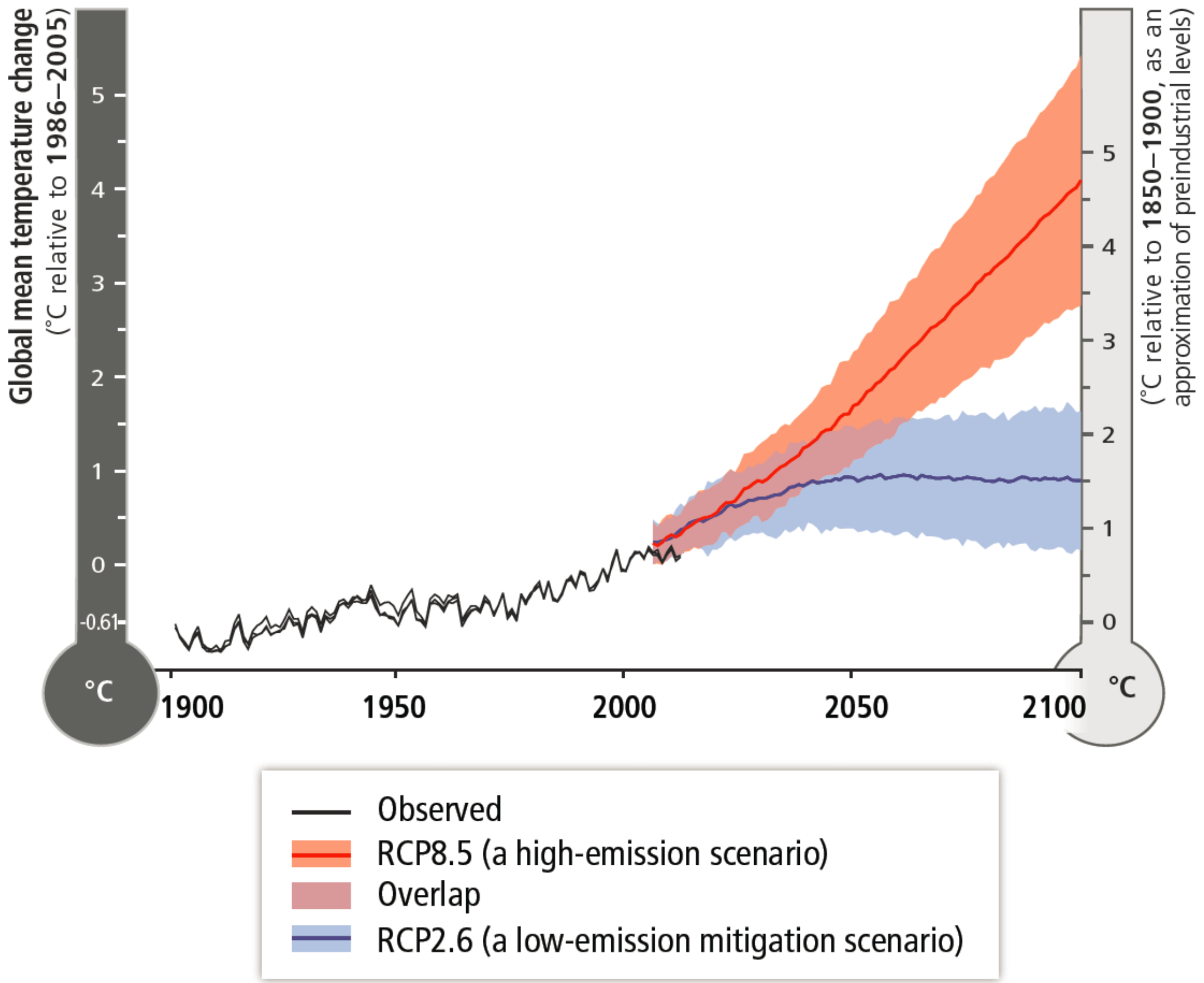
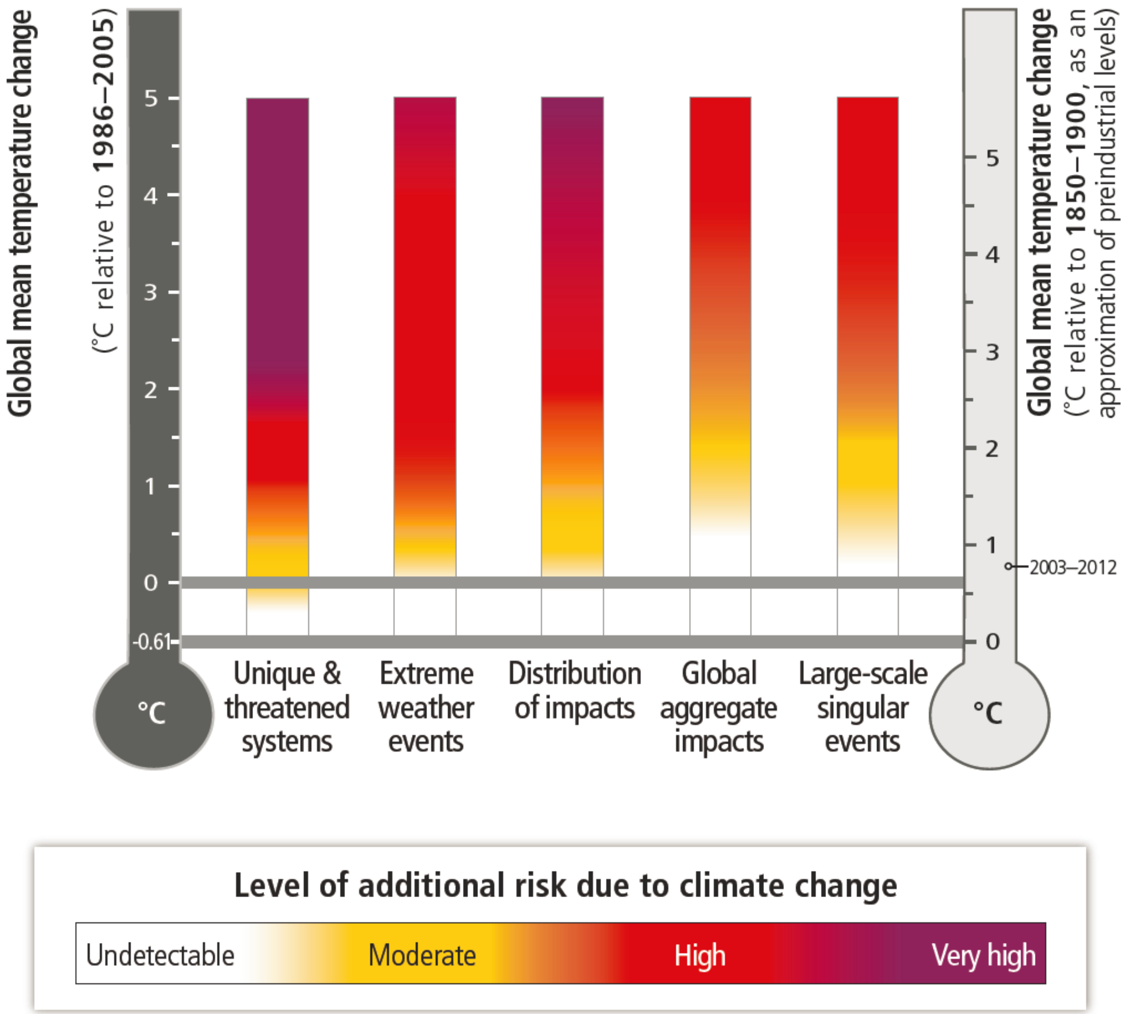

Najnowsza prognoza na XXI wiek nie pozostawia złudzeń: za 15 lat śniegi mogą wieńczyć szczyt Kilimandżaro już tylko na kartach powieści Ernesta Hemingwaya.

Ciepło, coraz cieplej

Zbigniew W. Kundzewicz

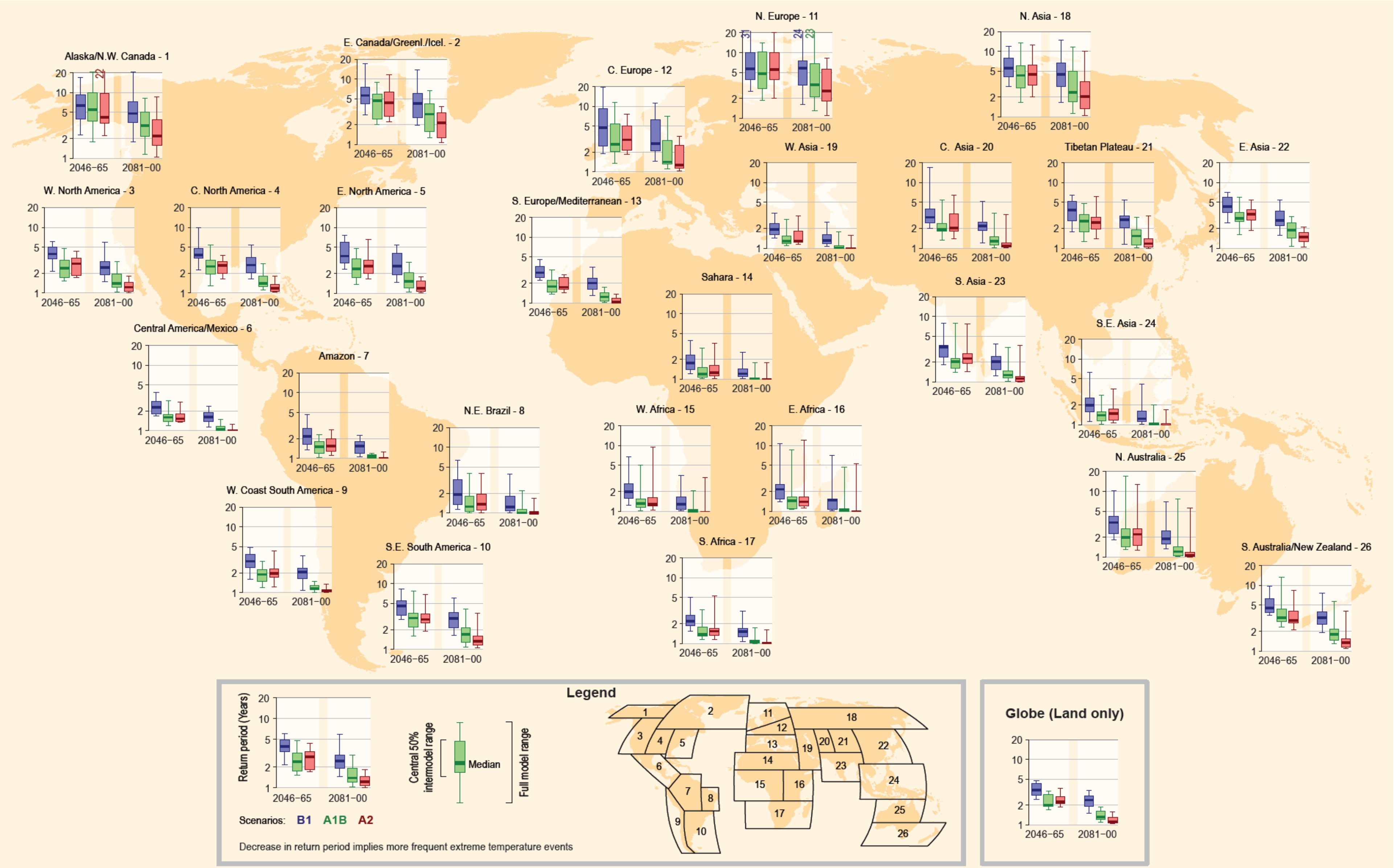
Wiedza i Życie (2001)





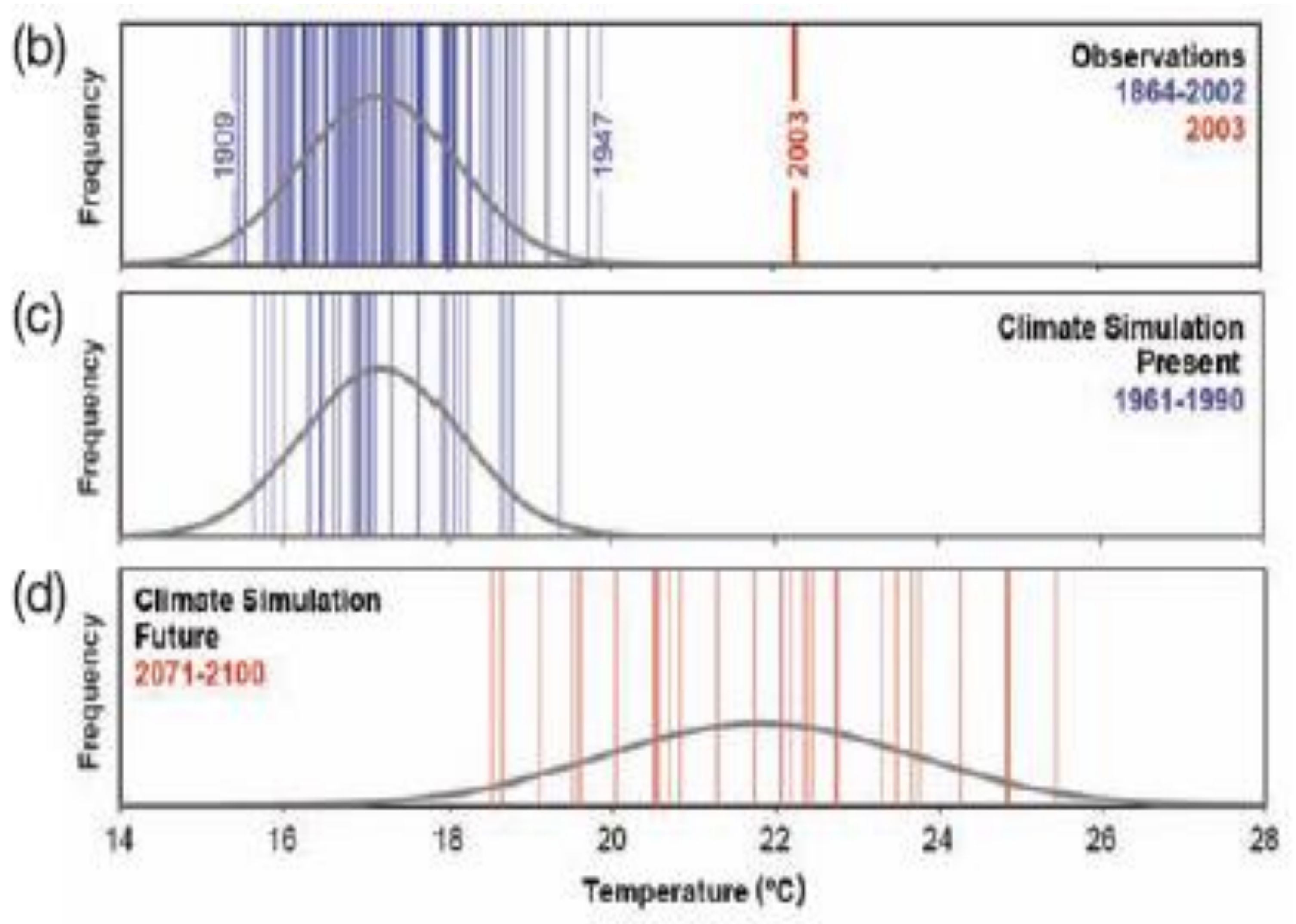
ipcc
INTERGOVERNMENTAL PANEL ON climate change

Projected Changes in Return Period: hot days with late 20th century return period of 20 years. Source: IPCC



Source: IPCC

- “…a 1-in-20 year hottest day is *likely* to become a 1-in-2 year event by the end of the 21st century in most regions…”



Temperature anomalies for Switzerland;

(b) observations for 1864-2003;

(c) simulations for 1961-1990;

(d) simulatiobs for 2071-2100 (SRES A2).

[IPCC AR4, 2007]

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-019-11283-w OPEN

Tens of thousands additional deaths annually in cities of China between 1.5 °C and 2.0 °C warming

Yanjun Wang[1], Anqian Wang[2,3], Jianqing Zhai[4], Hui Tao[2], Tong Jiang[1], Buda Su[2], Jun Yang[5], Guojie Wang[1], Qiyong Liu[6], Chao Gao[7], Zbigniew W. Kundzewicz[1,8], Mingjin Zhan[9], Zhiqiang Feng[10] & Thomas Fischer[11]

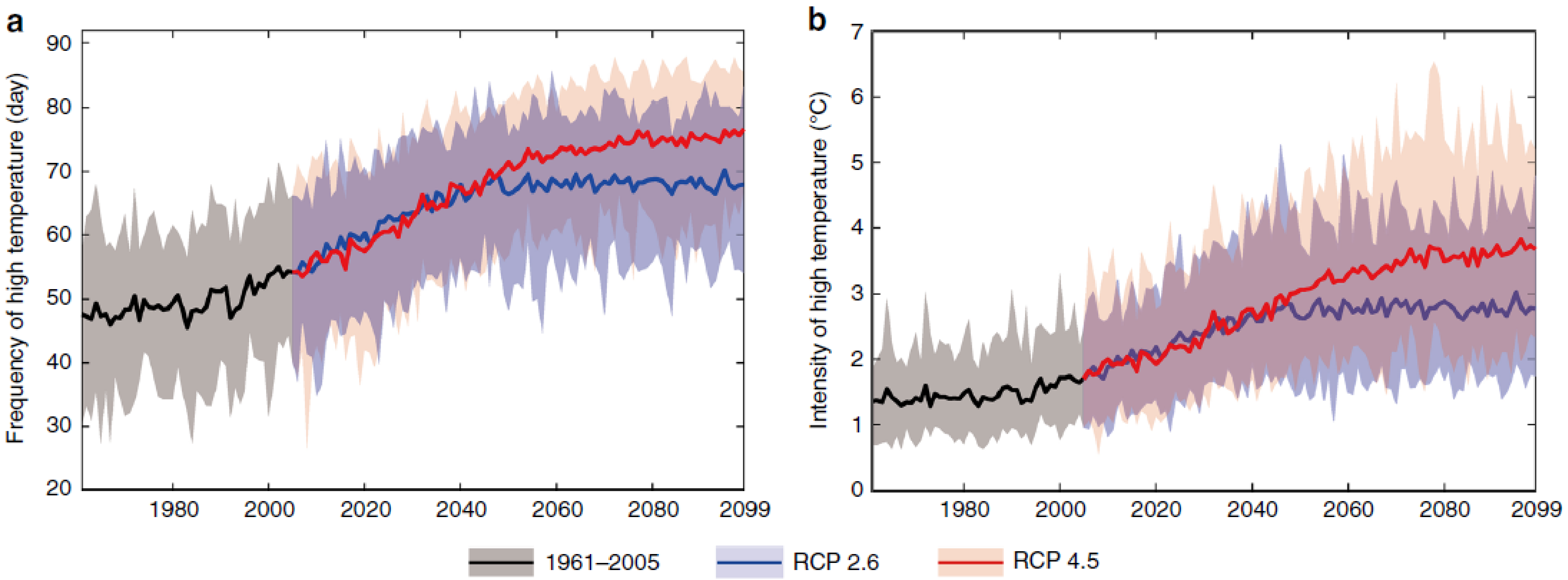


Fig. 1 Frequency and intensity of high temperature in China metropolises for 1961–2099. Curves and shadows denote ensemble mean and range of 31 GCMs, respectively. Frequency (a) and intensity (b) of high temperature in China metropolises for the reference period 1961–2005 (gray) and for the future period 2005–2099 with RCP 2.6 (blue) and RCP 4.5 (red). [Wang et al., 2019]

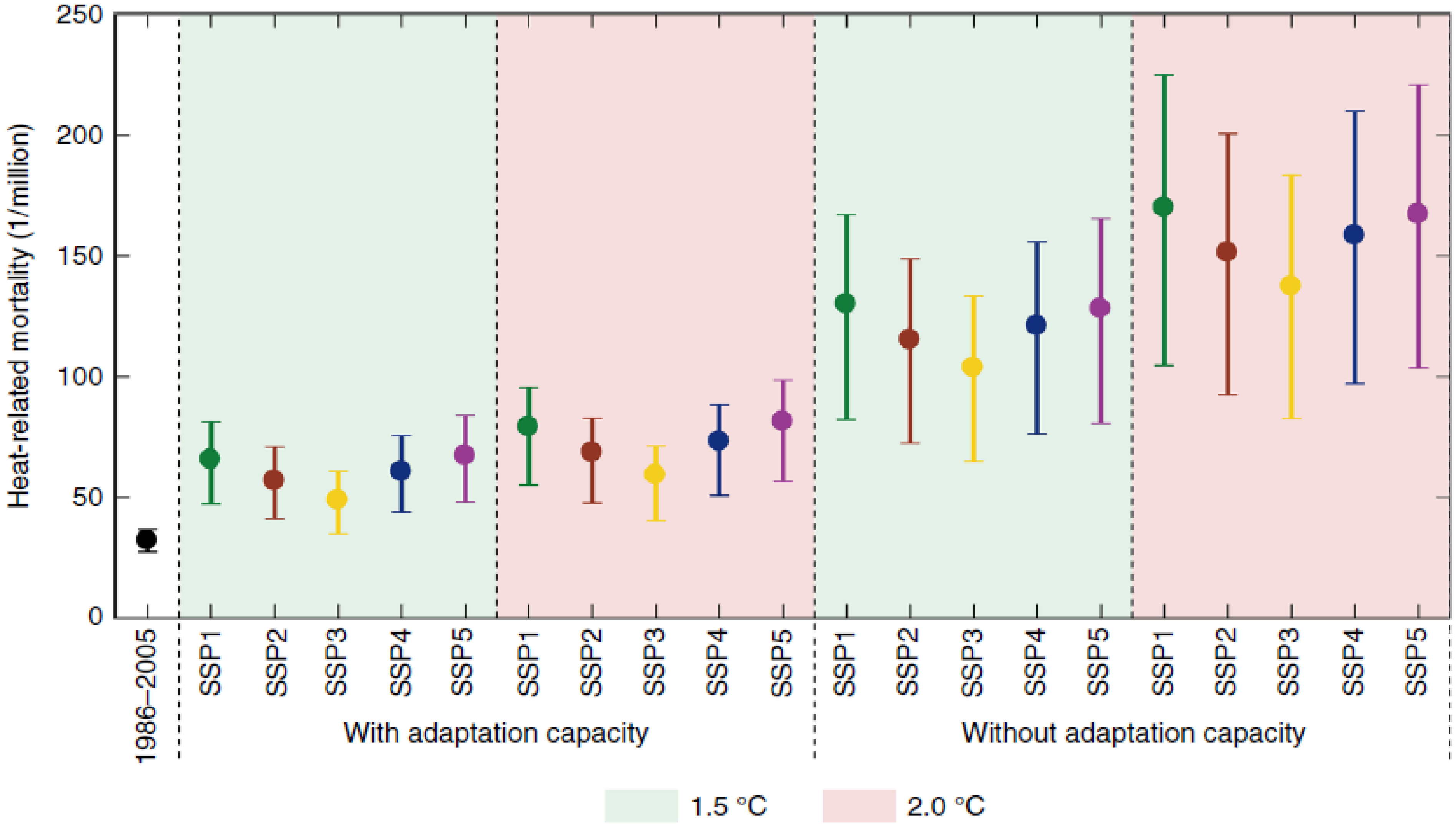


Fig. 2 Comparison of annual heat-related mortality at 1.5 °C and 2.0 °C global warming under SSPs and the reference period (1986–2005). Future projection of mortality considers two scenarios—with and without improved adaptation capacity. Dots and straight lines denote the ensemble mean and range of mortality estimated by multiple GCMs. [Wang et al., 2019]

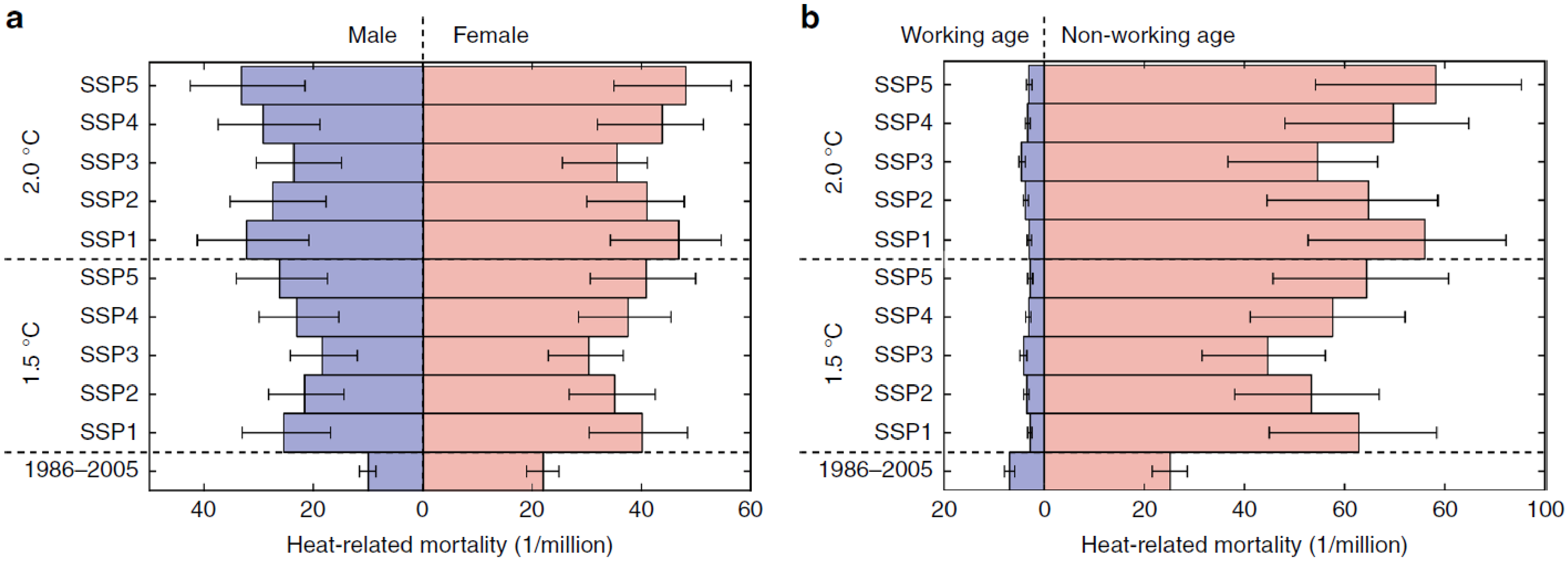
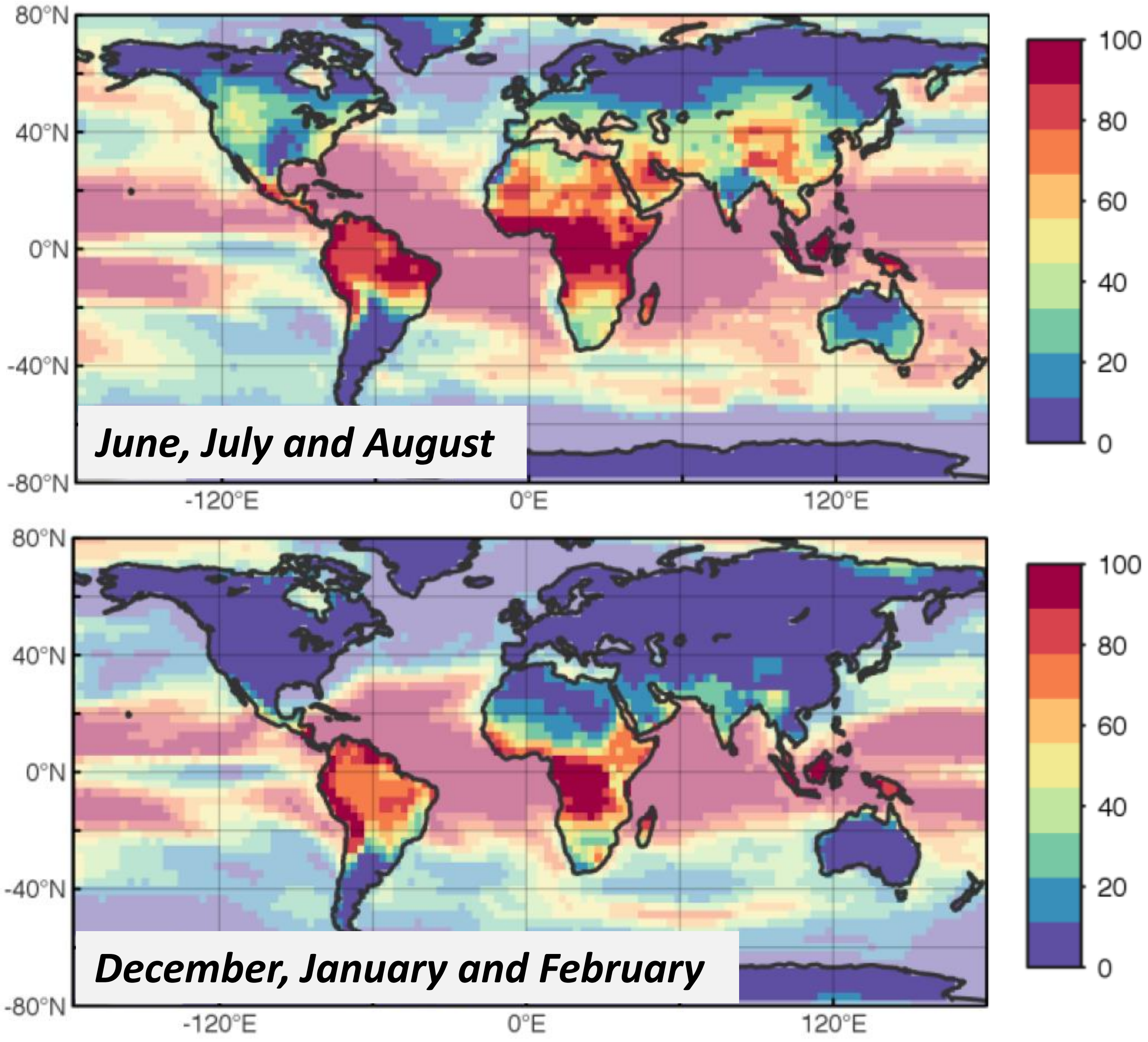


Fig. 3 Comparison of annual gender and age-specific heat-related mortality at 1.5 °C and 2.0 °C global warming under SSPs and the reference period (1986–2005). Comparison of annual gender (**a**) and age (**b**) specific heat-related mortality at 1.5 °C and 2.0 °C global warming under SSPs and the reference period (1986–2005). Colored bars and black straight lines denote the ensemble mean and range of mortality estimated by multiple GCMs. Source data are provided as a Source Data file

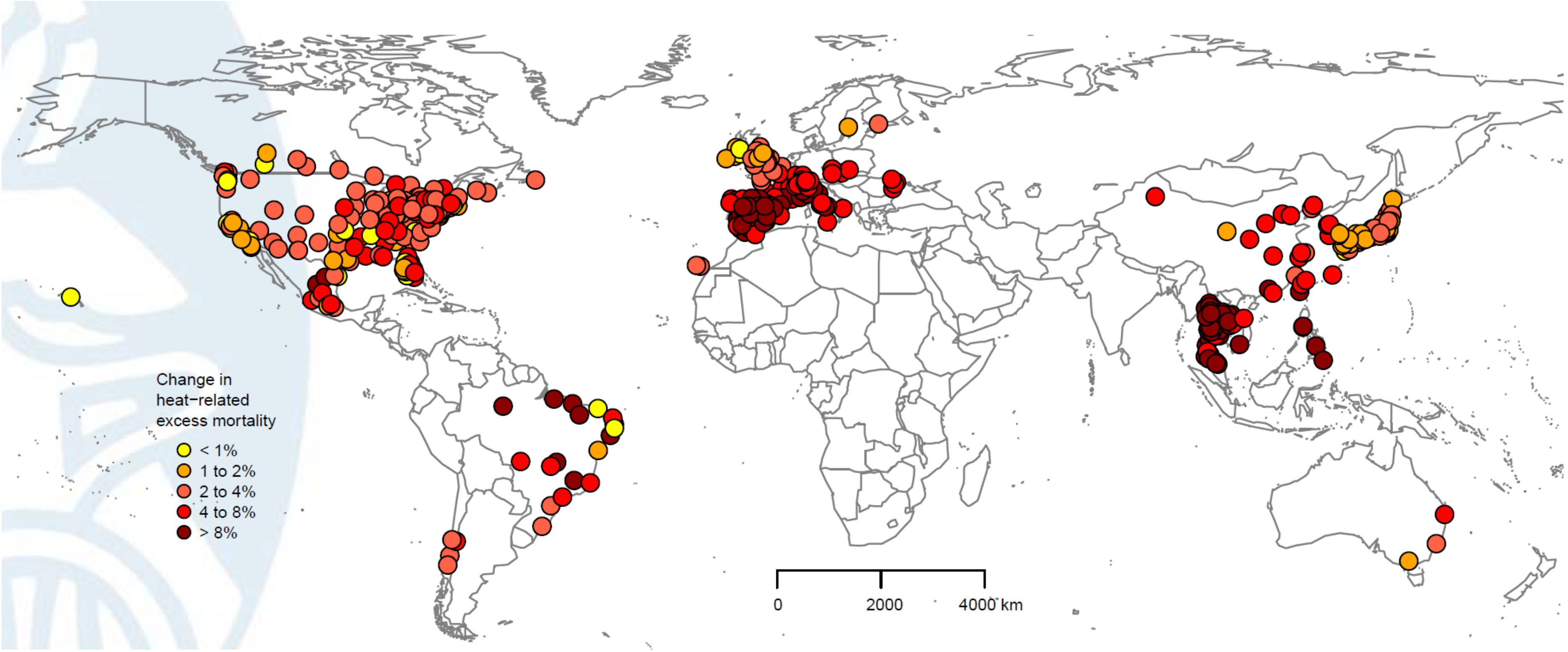
[Wang et al., 2019]

Projected Frequency of Extremely Hot Months



Percentage of months being warmer in 2080-2100 than today by at least 5-sigma.

Source: Schellnhuber et al. 2012
Turn Down the Heat – Why a 4°C Warmer World Must be Avoided



Change in Heat-Related Excess Mortality under RCP 8.5 [% change: 2090-99 compared to 2010-19, based on mortality and temperature time-series in **451 cities].** Source: Gasparrini et al., *Lancet Planetary Health* (2017)

Rekordowe upały mogą sprawić, że nad Zatoką Perską nie będzie można żyć

nature climate change

LETTERS

PUBLISHED ONLINE: 26 OCTOBER 2015 | DOI: 10.1038/NCLIMATE2833

Future temperature in southwest Asia projected to exceed a threshold for human adaptability

Jeremy S. Pal[1,2] and Elfatih A. B. Eltahir[2*]

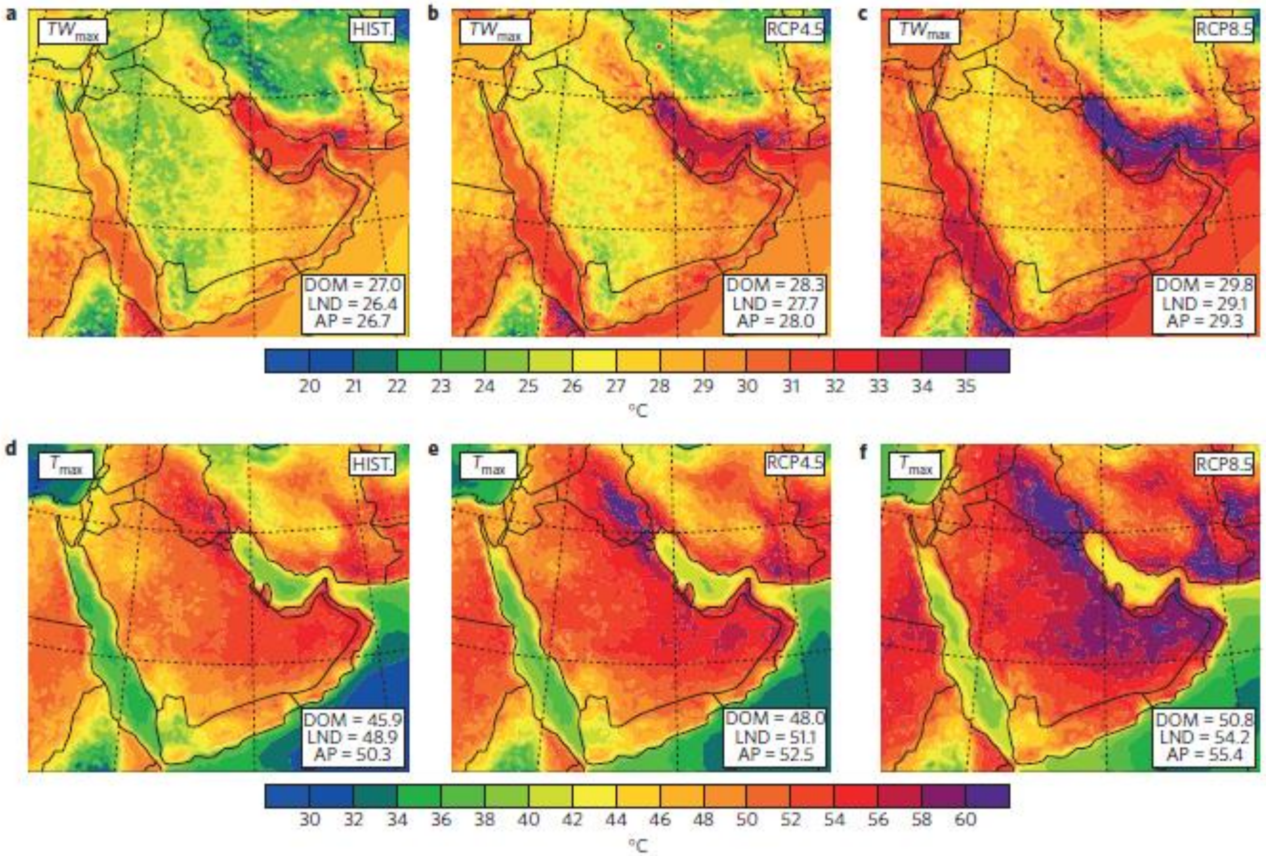
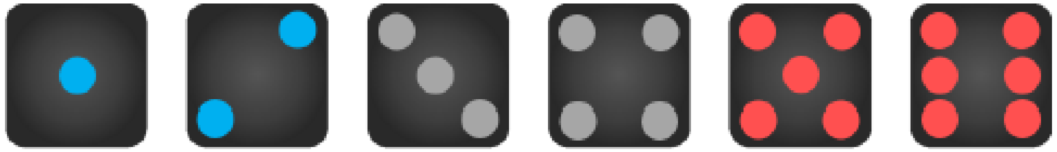
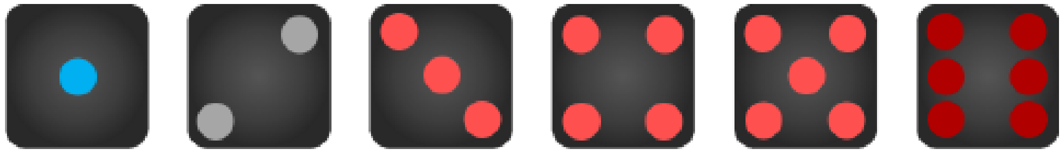


Figure 1 | Spatial distributions of extreme wet bulb temperature and extreme temperature. a–f, Ensemble average of the 30-year maximum TW_{max} (**a–c**) and T_{max} (**d–f**) temperatures for each GHG scenario: historical (**a**,**d**), RCP4.5 (**b**,**e**) and RCP8.5 (**c**,**f**). Averages for the domain excluding the buffer zone (DOM), land excluding the buffer zone (LND) and the Arabian Peninsula (AP) are indicated in each plot. TW_{max} and T_{max} are the maximum daily values averaged over a 6-h window.

Temperatura - wczoraj i dziś



Jutro



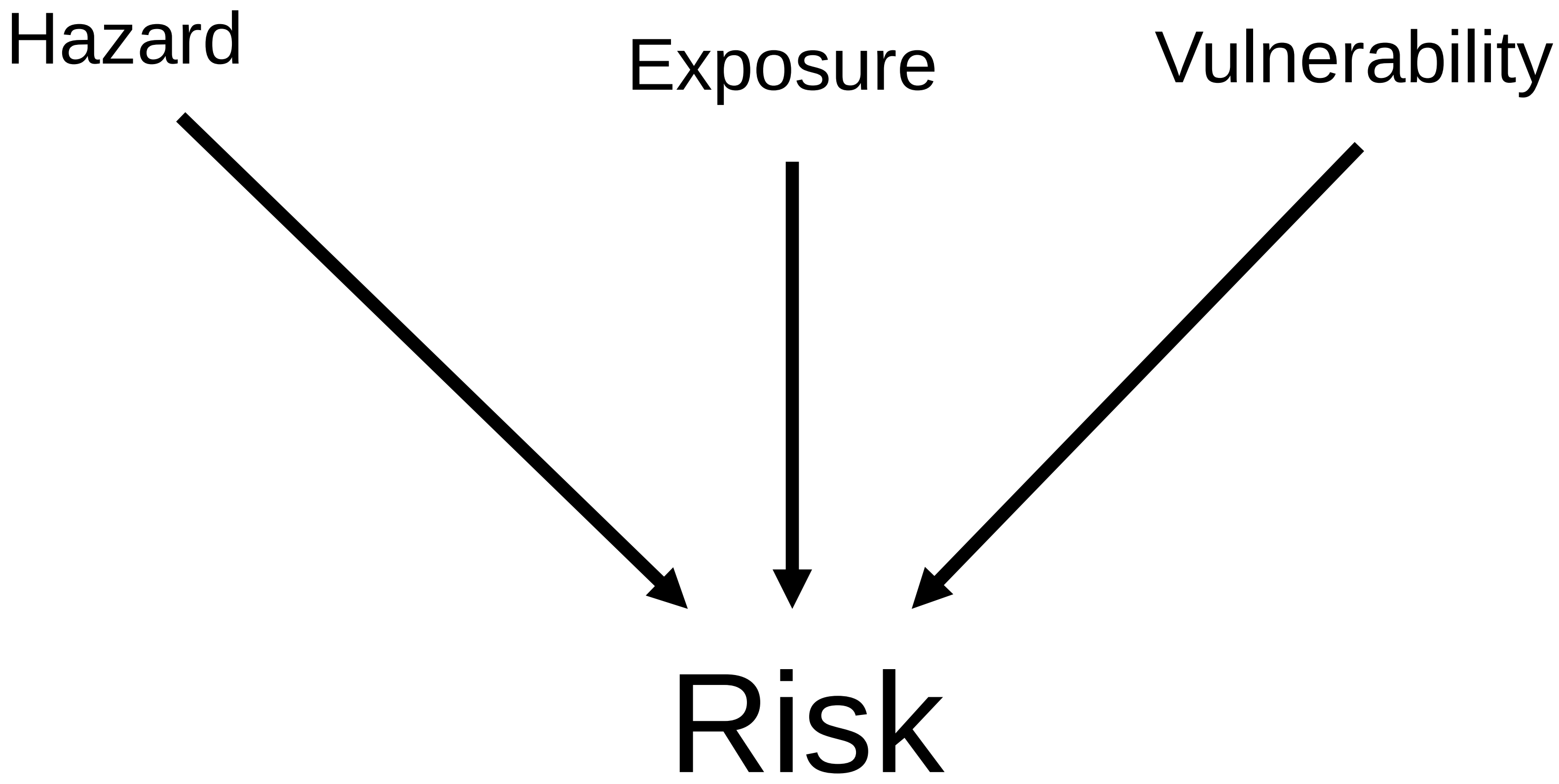
Źródło: Popkiewicz M., Kardaś A., Malinowski Sz. (2018) *Nauka o klimacie*. Warsaw: Post Factum, Sonia Draga, Wyd. Nieoczywiste, str.: 280 and 282. Za: Hansen, J., Sato, M., Ruedy, R. (August 2012) The New Climate Dice: Public Perception of Climate Change. https://www.giss.nasa.gov/research/briefs/hansen_17/

Obserwacje

Mechanizmy

Projekcje

Co można zrobić?

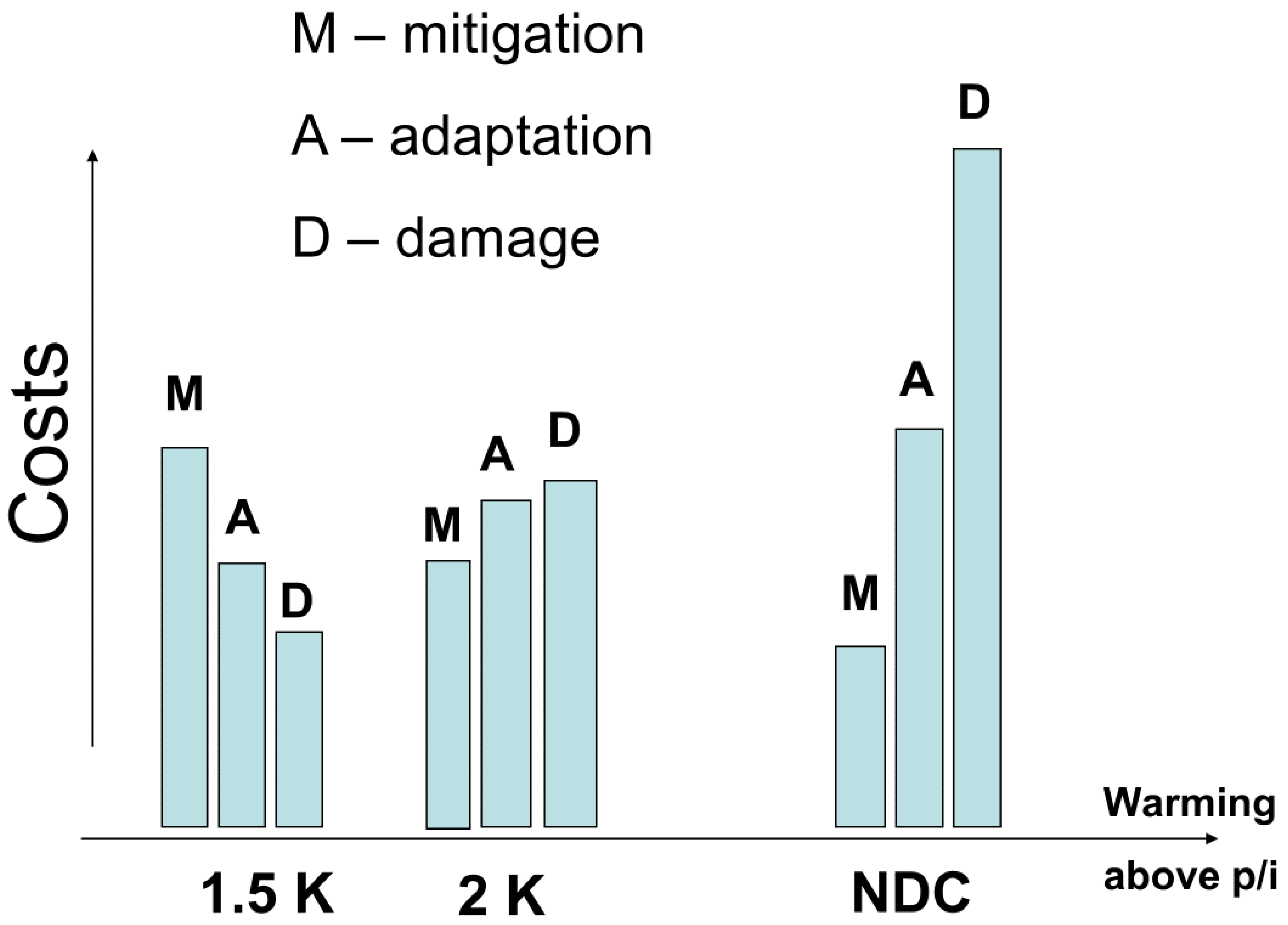

Hazard
Exposure
Vulnerability
Risk

What can be done?

mitigate

adapt

suffer


M – mitigation
A – adaptation
D – damage
Costs
M
A
D
M
A
D
M
A
D
Warming
above p/i
1.5 K
2 K
NDC

Global Risks Report 2023

Top 10 Risks

WORLD ECONOMIC FORUM

"Please estimate the likely impact (severity) of the following risks over a 2-year and 10-year period"

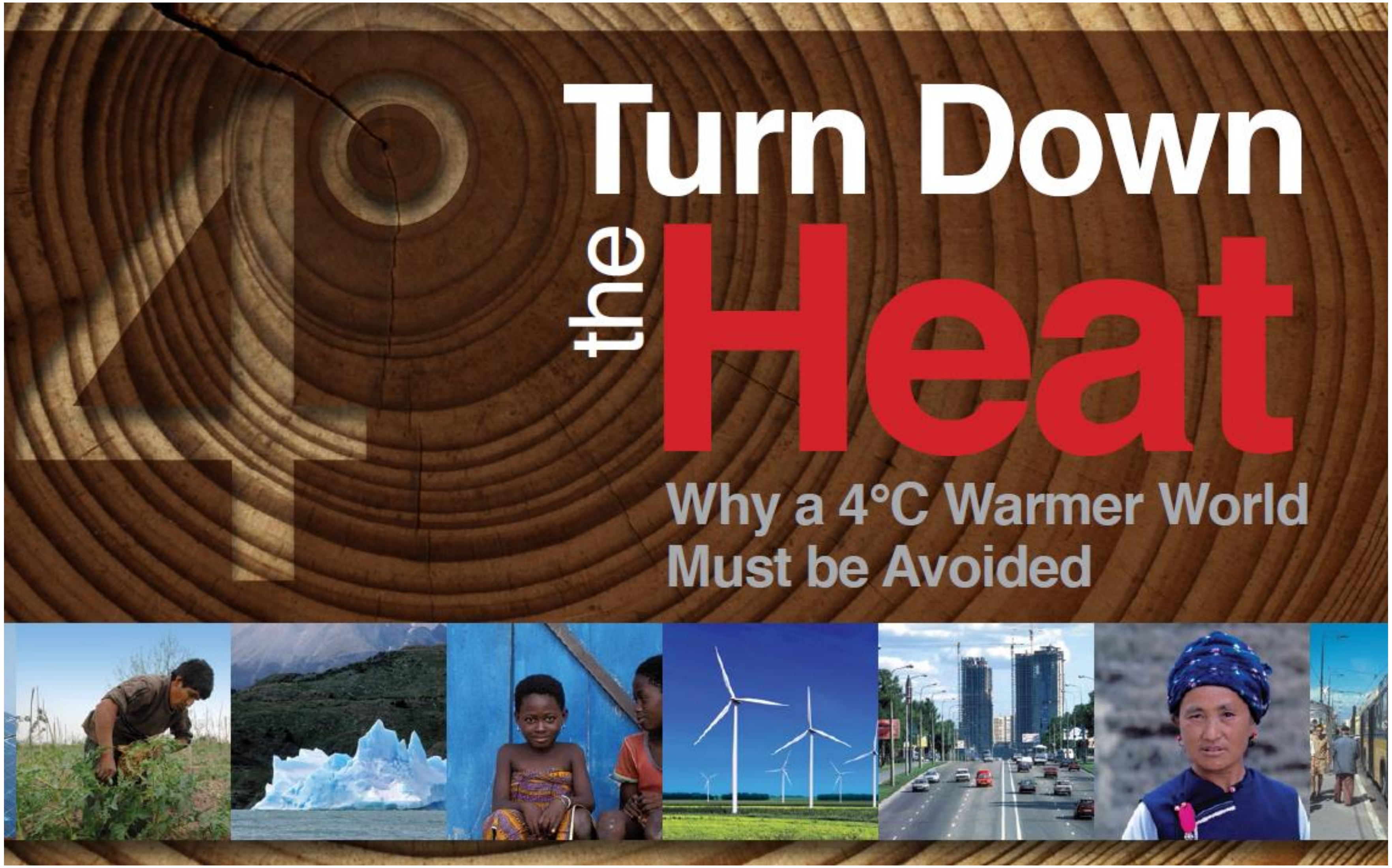
	2 years		10 years
1	Cost of living crisis	1	Failure to mitigate climate change
2	Natural disasters and extreme weather events	2	Failure of climate-change adaption
3	Geoeconomic confrontation	3	Natural disasters and extreme weather events
4	Failure to mitigate climate change	4	Biodiversity loss and ecosystem collapse
5	Erosion of social cohesion and societal polarization	5	Large-scale involuntary migration
6	Large-scale environmental damage incidents	6	Natural resource crises
7	Failure of climate-change adaption	7	Erosion of social cohesion and societal polarization
8	Widespread cybercrime and cyber insecurity	8	Widespread cybercrime and cyber insecurity
9	Natural resource crises	9	Geoeconomic confrontation
10	Large-scale involuntary migration	10	Large-scale environmental damage incidents

Risk categories

Economic · Environmental · Geopolitical · Societal · Technological

Source: World Economic Forum, Global Risks Perception Survey 2022-2023

A Report for the World Bank
by the Potsdam Institute for
Climate Impact Research and
Climate Analytics



Even with efficient climate mitigation policy, climate change will continue for many decades, so that **adaptation** to its impacts will be **increasingly necessary**.

https://www.lemonde.fr/en/france/article/2023/08/03/how-france-has-adapted-since-the-deadly-2003-heatwave_6078150_7.html

How France has adapted since the deadly 2003 heatwave

Twenty years ago, an extreme heat episode claimed the lives of 15,000 people, exposing the authorities' failures.

By Marie Pouzadoux

Published in Le Monde on August 3, 2023

It was an **unprecedented heatwave**, which saw **hospital services overwhelmed**, **fatalities rapidly counted by the hundreds – in hospitals and retirement homes**, a **health minister procrastinating** at his holiday resort, and a **government was slow to act.** Twenty years ago, from August 2 to 17, 2003, France experienced its most prolonged and intense heatwave in the hottest summer since 1950. It was also the most deadly, claiming the lives of 15,000 people in a fortnight.

In retrospect, the devastating human toll uncovered the **public authorities' lack of awareness of the mortality risks** associated with heat exposure and the **unconsidered political dimension** such episodes conveyed. The **lack of preparation and foresight** was highlighted a few months later, during the winter of 2004, in a report released by an investigative committee at the Assemblée Nationale.

https://sante.gouv.fr/IMG/pdf/pnc_actualise_2017.pdf

PLAN NATIONAL CANICULE 2017

PLAN NATIONAL CANICULE
2017

https://www.epa.gov/green-infrastructure/reduce-urban-heat-island-effect

To reduce the urban heat island effect:

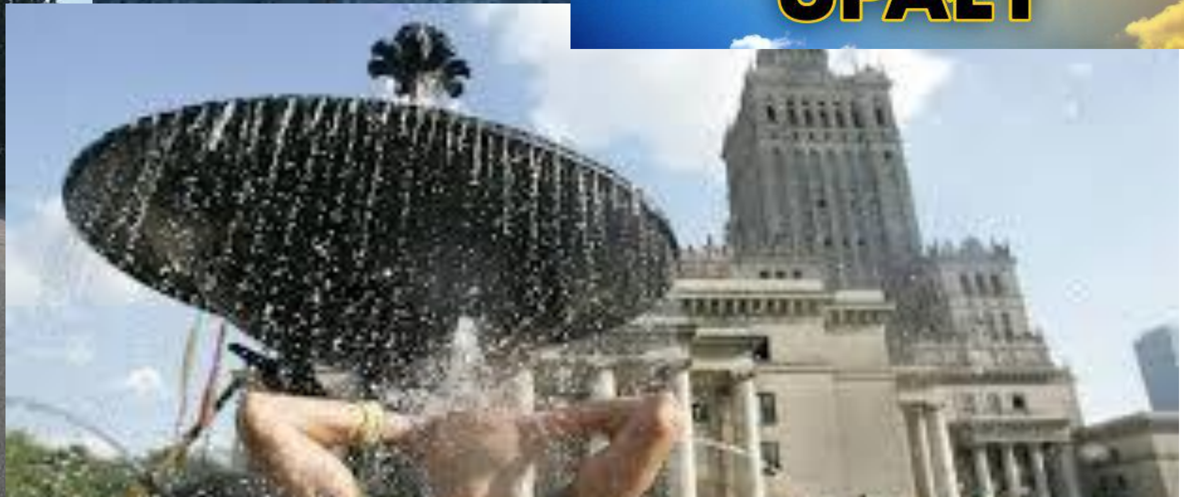
- Build **green infrastructure improvements** into regular street upgrades and capital improvement projects to ensure continued investment in heat-reducing practices throughout your community.
- **Plant trees and other vegetation**—Space in urban areas might be limited, but you can easily **integrate small green infrastructure practices into grassy or barren areas, vacant lots, and street rights-of-way**.
- Make traditional water quality practices serve double duty by **adding trees** in or around roadside planters and other green infiltration-based practices to **boost roadside cooling and shading**.
- Transform your community one project at a time by **planting native, drought-tolerant shade trees and smaller plants such as shrubs, grasses, and groundcover** wherever possible.
- Build **green roofs**—Green roofs are an ideal heat island reduction strategy, **providing both direct and ambient cooling effects**. In addition, green roofs improve air quality by reducing the heat island effect and absorbing pollutants.






UPAŁY W POLSCE
32°C SZCZECIN
33°C SUWAŁKI
36°C ŁÓDŹ
37°C WROCŁAW
35°C
32°C SZCZECIN
37°C ŁÓDŹ
39°C WROCŁAW
SOBOTA

UWAGA!
UPAŁY



Air conditioning:

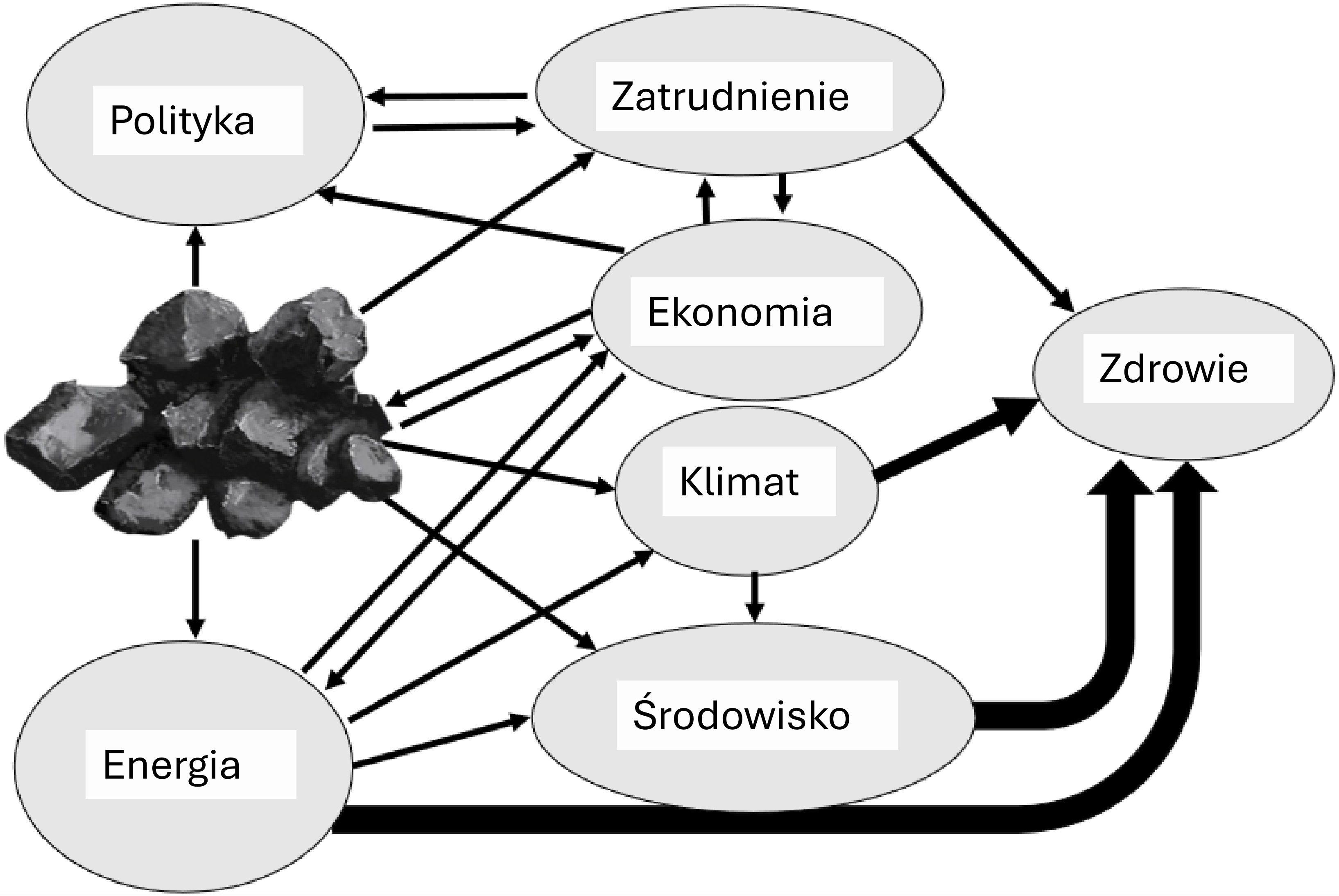
Dobre dla adaptacji

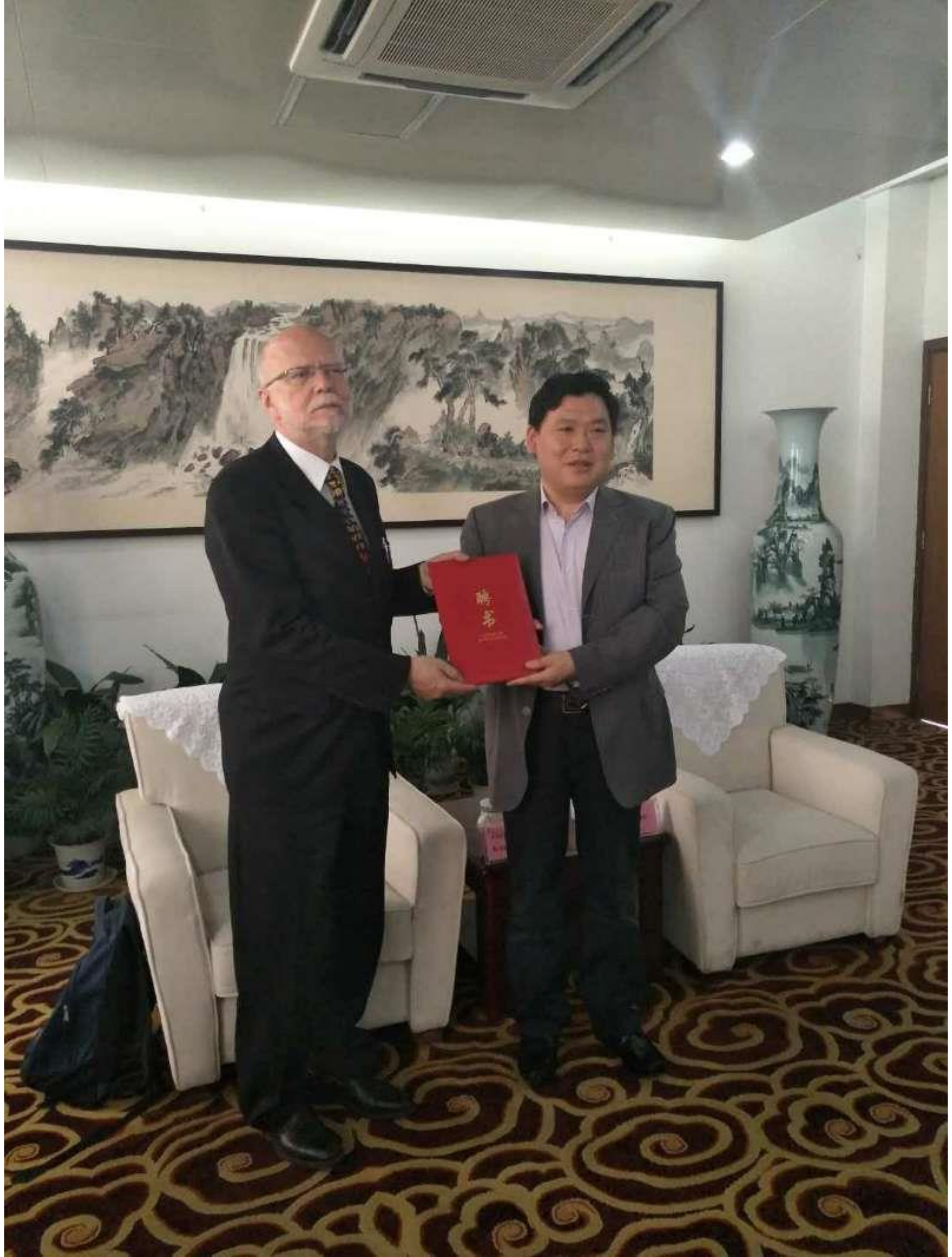
A+

Złe dla mitigacji (chyba że elektryczność nie jest wytwarzana z użyciem paliw kopalnych)

M –

Kundzewicz, Z.W.; Olejnik, J.; Urbaniak, M.; Ziemblińska, K. Storing Carbon in Forest Biomass and Wood Products in Poland—Energy and Climate Perspective. Energies 2023, 16, 5788. https://doi.org/10.3390/en16155788





ZBIGNIEW W. KUNDZEWICZ RECEIVES HONORARY PROFESSORSHIP FROM RECTOR MAGNIFICUS OF **THE NANJING UNIVERSITY OF INFORMATION SCIENCE AND TECHNOLOGY (NUIST)**

NANJING (CHINA), APRIL 2018

Nanjing: Tong Jiang,
Buda Su,
Jinlong Huang,
Yanjun Wang,
i wielu innych

Poznań: Zbigniew W. Kundzewicz,
Iwona Pińskwar,
Małgorzata Szwed

COP 28: Challenge of coping with climate crisis

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The Innovation, 2024, 100559.

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谢谢