Laurea in Ingegneria per l’Ambiente ed il Territorio

CAMBIAMENTI CLIMATICI E ADATTAMENTI NEGLI ECOSISTEMI E NELLE SOCIETÀ

Docenti

Salvatore Pappalardo

Daniele Codato

Alessandro Ceppi (Politecnico di Milano)

Supporto didattico

Edoardo Crescini

- 6 CFU
- 48 ore
- 102 ore di studio individuale

Università degli Studi di Padova

ICEA

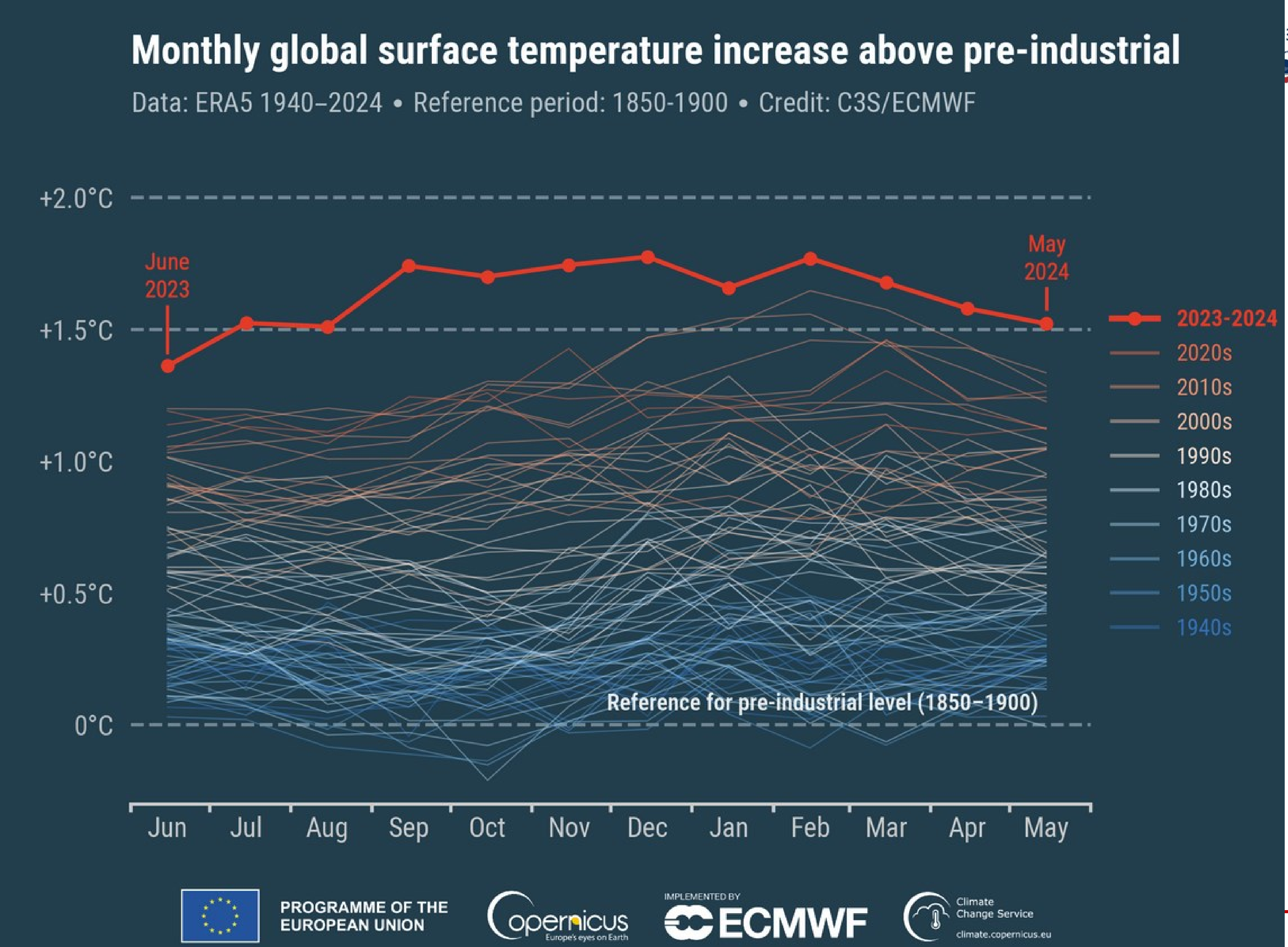
GIScience

Climate Justice
Centre of Excellence

Registrazione via form

LIVINGLAB CON QGIS- MAPPATURA DELLE ISOLE DI CALORE URBANO A PADOVA

https://mastergiscience.it/workshop-mappatura-delle-urban-heat-islands-a-padova



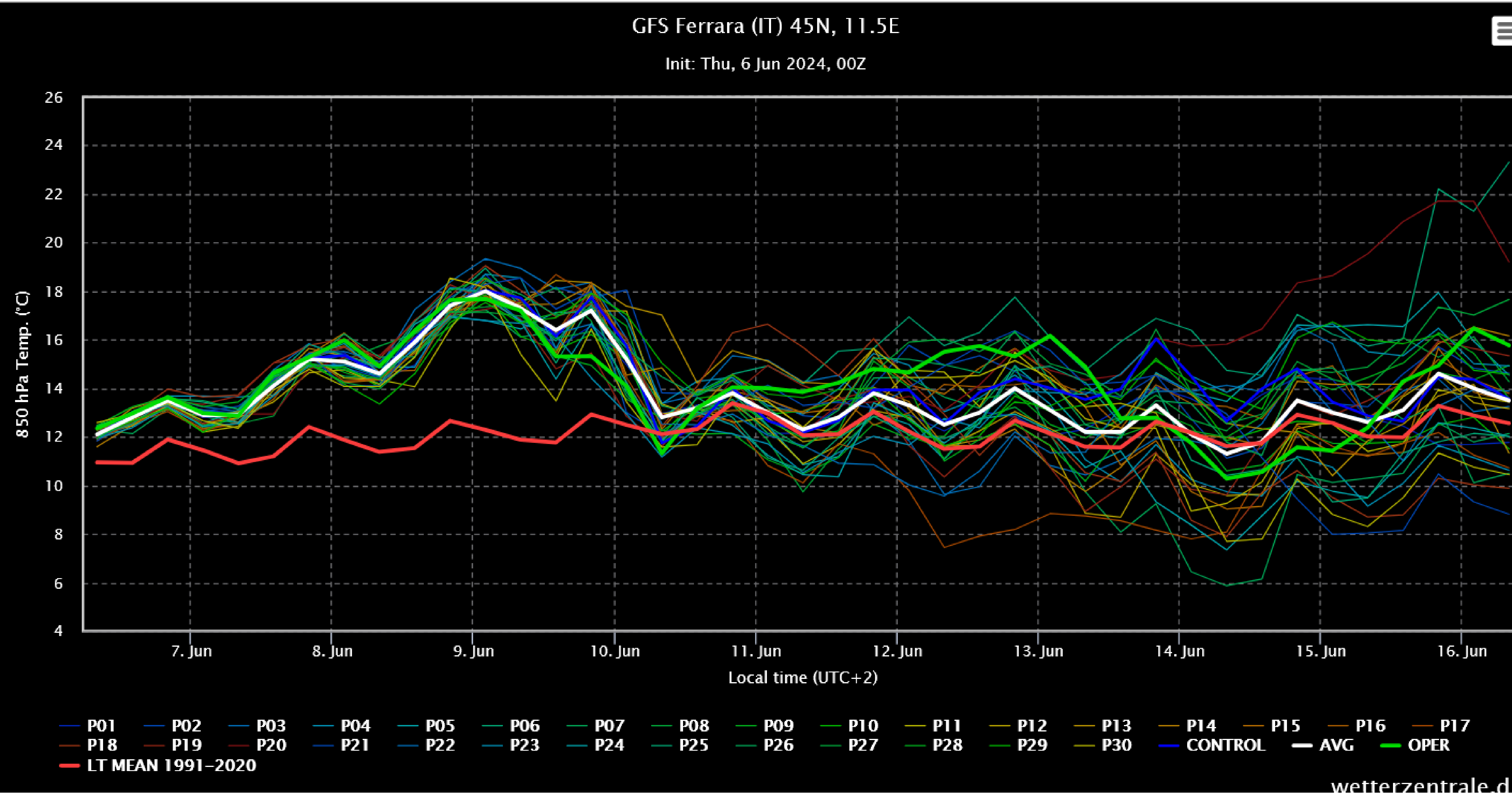
Climate Justice
Centre of Excellence

https://climate.copernicus.eu/copernicus-may-2024-12th-consecutive-month-record-high-temperatures

CLASSIFICA DEI MESI PIU' CALDI

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
	24	18	19	23	12	17	15	22	14	11	20	16	13	10	7	3	5	9	4	2	8	6	1	?	
GEN	30	12	14	19	15	22	5	39	18	16	23	28	17	13	9	2	4	10	6	3	11	7	8	1	GEN
FEB	29	12	21	14	20	15	16	38	24	11	27	26	19	23	8	2	4	10	6	3	17	7	5	1	FEB
MAR	25	12	23	21	16	20	17	15	27	9	19	24	18	14	8	2	6	11	4	5	10	7	3	1	MAR
APR	27	20	23	19	15	29	12	24	18	8	16	14	25	10	13	3	6	7	4	2	11	9	5	1	APR
MAG	20	16	19	26	17	23	13	22	15	12	21	11	18	5	9	2	4	8	6	1	10	7	3	1	MAG
GIU	23	21	25	27	15	14	19	24	17	12	18	16	11	13	6	7	10	8	4	3	5	2	1	?	GIU
LUG	19	14	22	36	15	23	18	17	9	13	11	21	16	20	10	6	8	7	2	5	4	3	1	?	LUG
AGO	22	21	18	25	20	12	19	24	14	15	11	16	13	7	9	2	5	10	4	6	8	3	1	?	AGO
SET	23	17	18	24	13	15	20	19	14	16	21	12	11	7	8	5	10	9	4	2	3	6	1	?	SET
OTT	24	23	13	21	12	15	22	17	18	14	19	11	16	10	2	8	7	3	4	9	5	6	1	?	OTT
NOV	17	21	24	16	15	13	22	18	12	10	23	11	8	19	3	6	7	9	4	2	5	14	1	?	NOV
DIC	18	27	12	22	14	10	23	20	15	26	16	21	13	11	2	7	4	5	3	9	6	8	1	?	DIC
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	

DATI: NASA GISS SURFACE TEMPERATURE ANALYSIS (GISTEMP V4) | CREDITS: @GALSELO PER CHPDB


GFS Ferrara (IT) 45N, 11.5E
Init: Thu, 6 Jun 2024, 00Z
850 hPa Temp. (°C)
26
24
22
20
18
16
14
12
10
8
6
4
7. Jun
8. Jun
9. Jun
10. Jun
11. Jun
12. Jun
13. Jun
14. Jun
15. Jun
16. Jun
Local time (UTC+2)
P01 P02 P03 P04 P05 P06 P07 P08 P09 P10 P11 P12 P13 P14 P15 P16 P17
P18 P19 P20 P21 P22 P23 P24 P25 P26 P27 P28 P29 P30 CONTROL AVG OPER
LT MEAN 1991–2020
wetterzentrale.d

Outline

- *Feedback loop*
- *Tipping points*
- Impatti del climate change: eventi meteo estremi
- Giustizia Climatica

Rapid adjustment e feedback loops

Rapid adjustments

aggiustamenti rapidi del sistema climatico su **scale temporali brevi** (settimane), attraverso meccanismi che non modificano direttamente il bilancio radiativo planetario e non inducono una variazione diretta della temperatura media superficiale terrestre.

Questo tipo di risposta si attiva quando i forzanti provocano, oltre ai cambiamenti dei flussi radiativi, anche **una variazione della copertura nuvolosa** o di altre componenti del sistema che, a loro volta, modificano il bilancio radiativo. In questo senso gli aggiustamenti rapidi sono caratterizzati da una interazione indiretta con il bilancio radiativo, che non è mediata da una variazione della temperatura media superficiale ma è dovuta a rapidi cambiamenti atmosferici e superficiali.

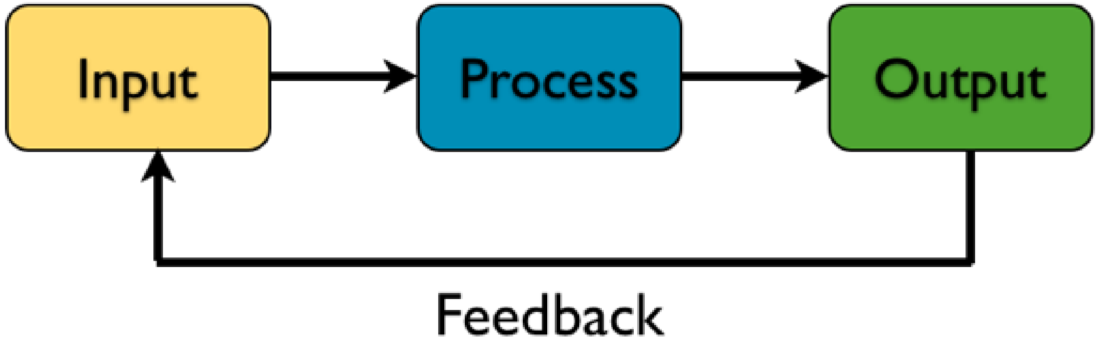
Feedback loops

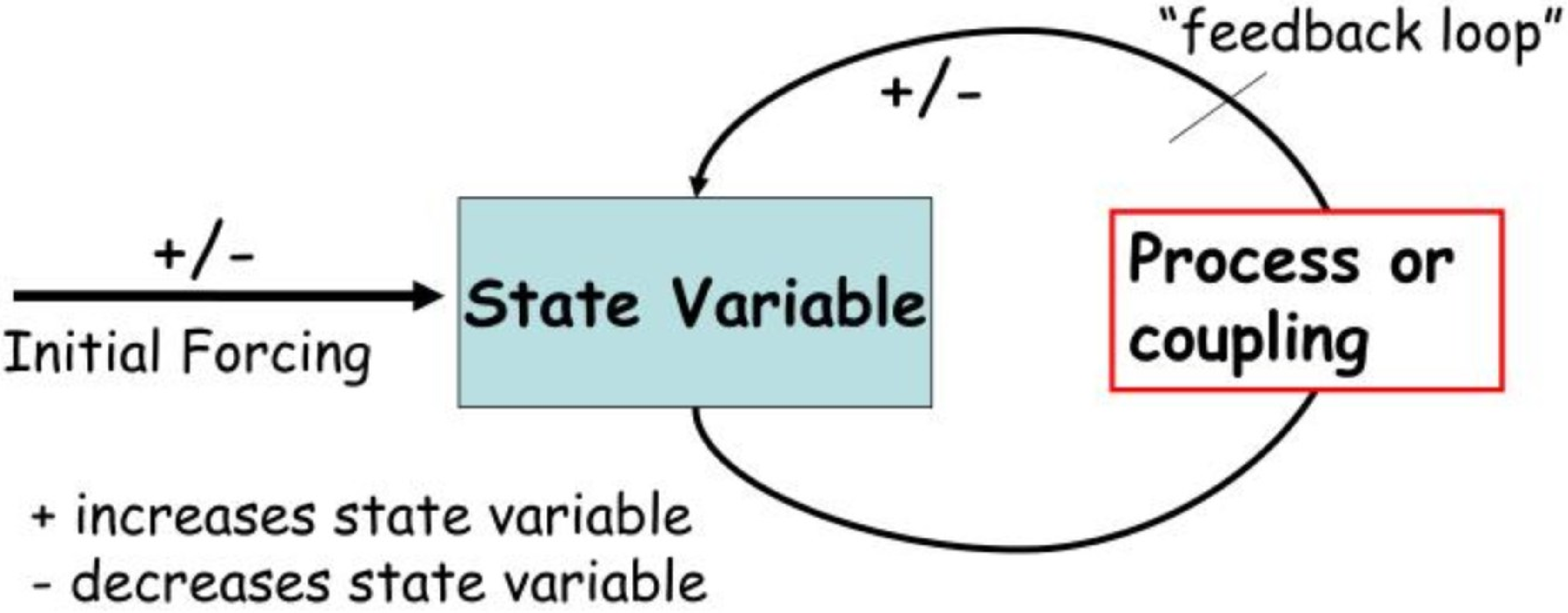
retroazioni climatiche ricorsive (positive o negative), tempi scala medio-lunghi

(Bagliani, 2019)

Feedback loops (retroazioni climatiche ricorsive)

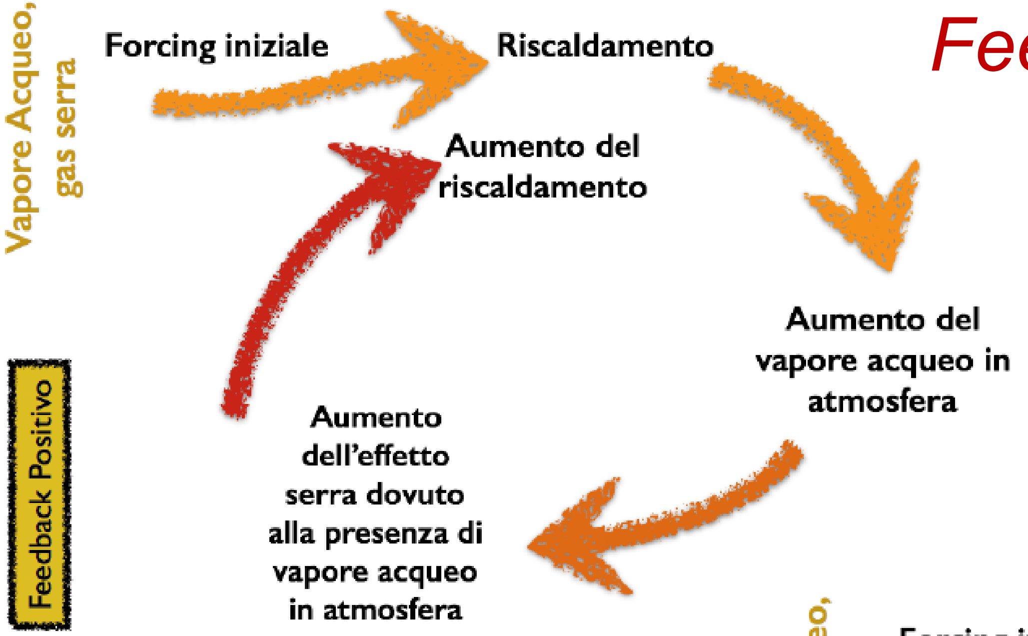
- Risposte del sistema climatico che agiscono **<u>direttamente</u>** sul **bilancio radiativo** inducendo modificazioni sulla T <u>media</u> superficiale terrestre
- Ricorsività
- *Feedback* positivi (amplificano il segnale, destabilizzano il sistema)
- *Feedback* negativi (riducono il segnale, stabilizzano il sistema)
- Tempi scala medio-lunghi (inerzia degli oceani)



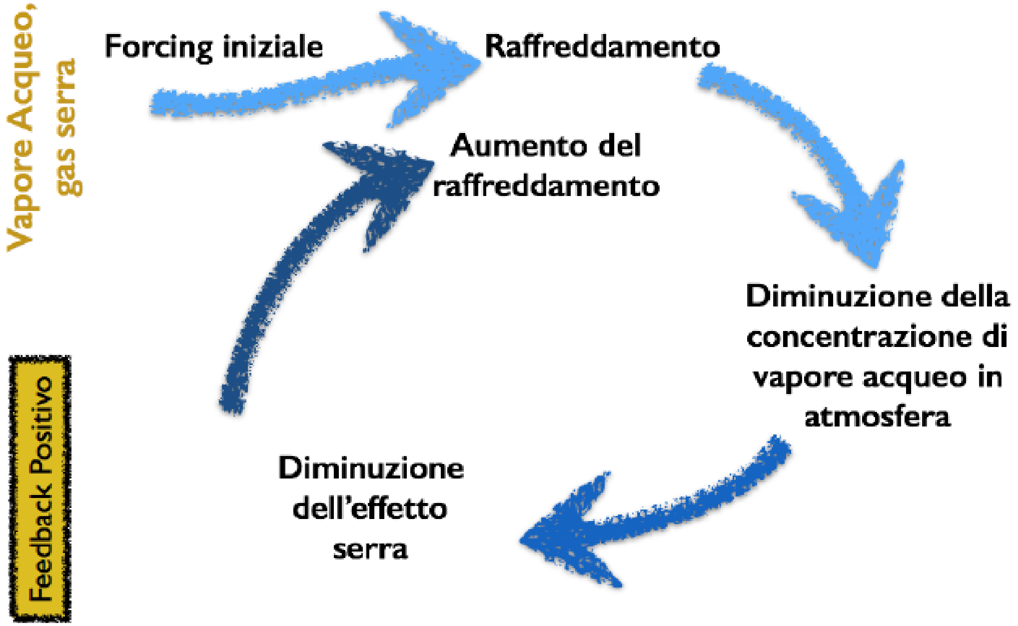

"feedback loop"
+/-
+/-
State Variable
Process or coupling
Initial Forcing
+ increases state variable
- decreases state variable

Feedback loops: il vapore acqueo

Positivo



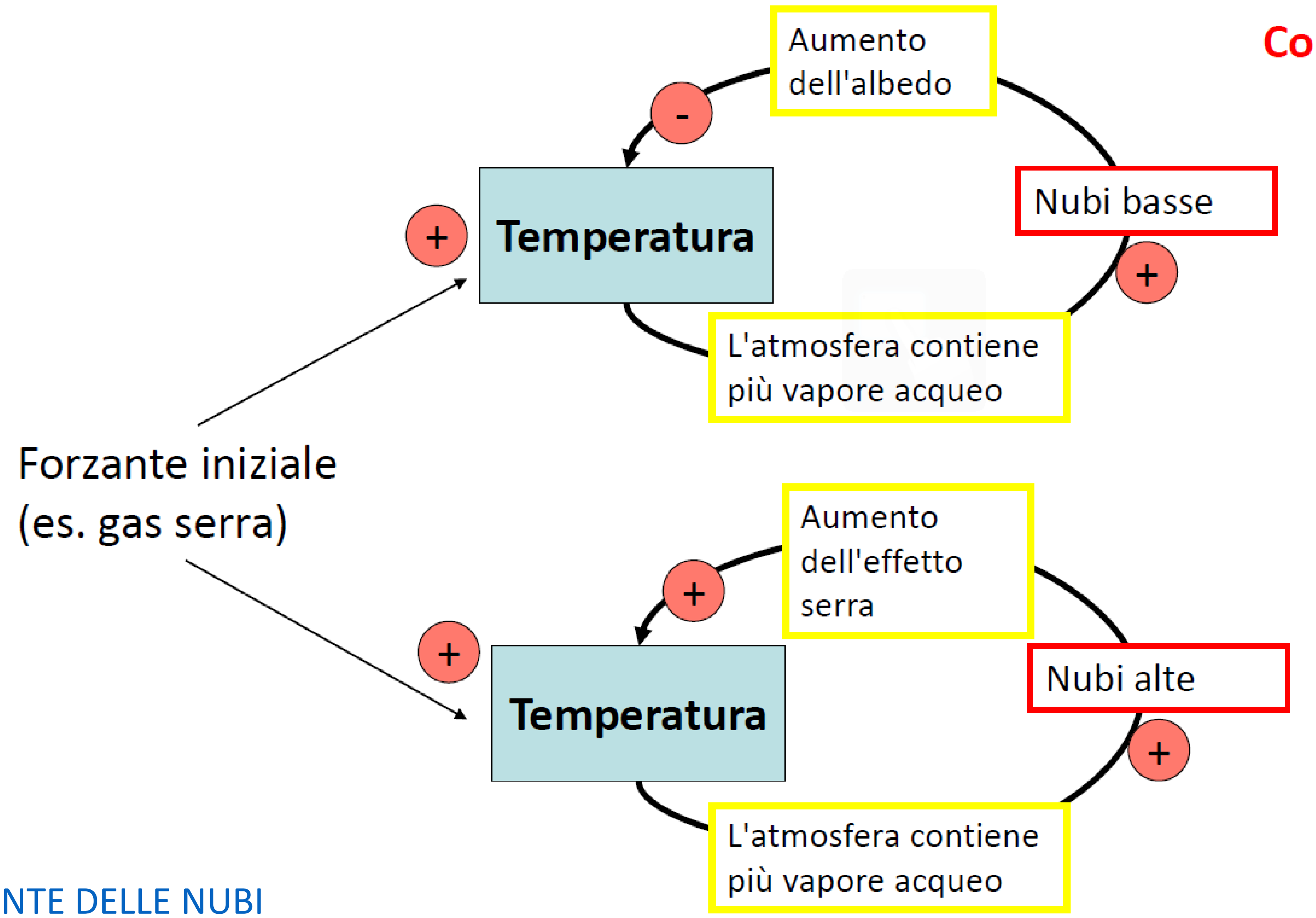
Positivo



(Bagliani, 2019)

Feedback loops delle nubi

Complessivamente incerto!



(cirrostrati)

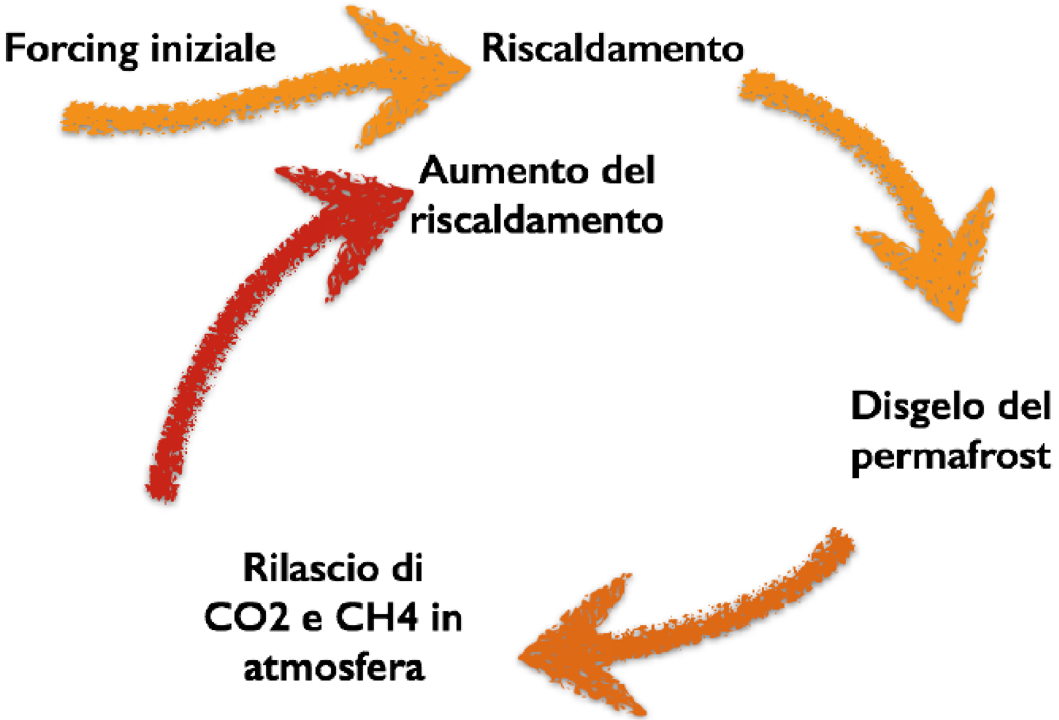
Negativo

Positivo

ATLANTE DELLE NUBI

(Cassandro, Unito 2022)

Feedback loop (+) metano-permafrost



nature communications

Article | Open Access | Published: 16 January 2019

Permafrost is warming at a global scale

Boris K. Biskaborn, Sharon L. Smith, ... Hugues Lantuit + Show authors

Nature Communications **10**, Article number: 264 (2019) | Cite this article

47k Accesses | **481** Citations | **993** Altmetric | Metrics

https://www.nature.com/articles/s41467-018-08240-4

https://e360.yale.edu/features/how-melting-permafrost-is-beginning-to-transform-the-arctic

Feedback loops atmosfera-biosfera (ciclo del C)

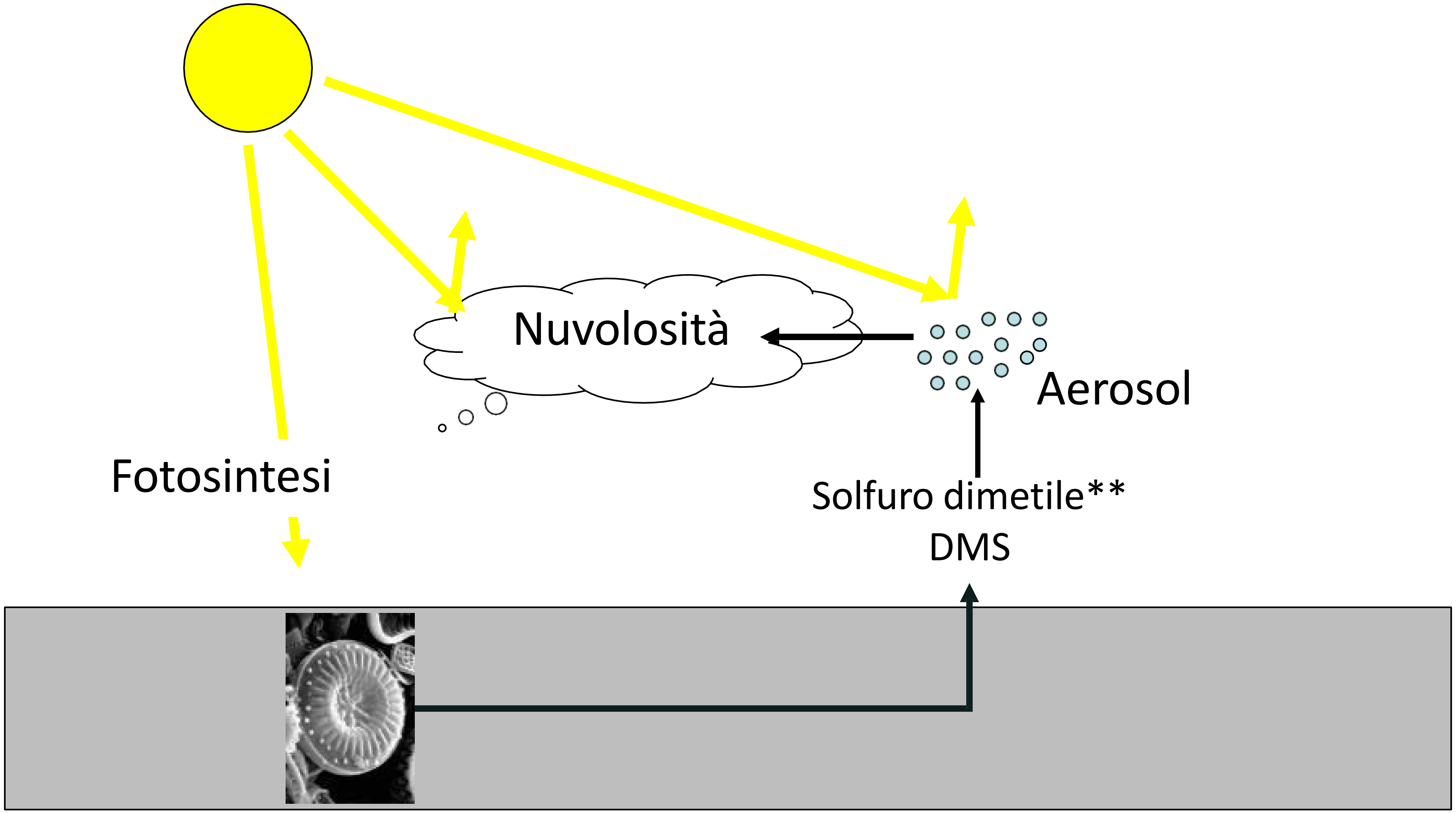
1) Aumento della decomposizione. Viene sottratto C dalla biomassa e rilasciato in atmosfera CO_2 e CH_4 (feedback positivo). Permafrost, torbiere, zone umide (LULC)

2) Aumento degli incendi forestali. Correlazione con innalzamento delle temperature (feedback positivo)

3) Fertilizzazione da aumento della CO_2. Aumento dell'attività fotosintetica e una minore traspirazione di vapore (feedback negativo).

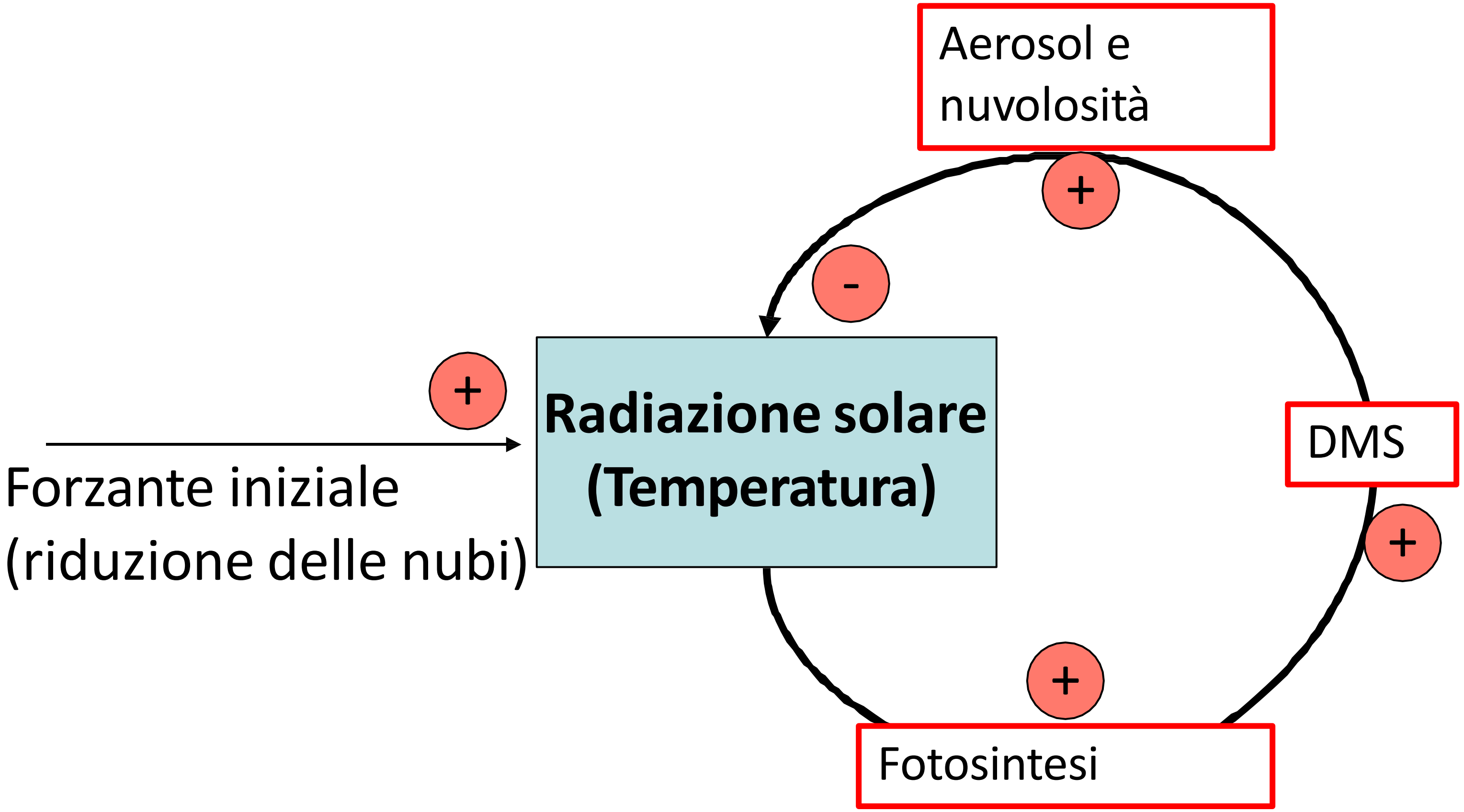
https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Biosphere-feedbacks-and-climate-change-Briefing-Paper-No-12v2.pdf

Fitoplancton — DMS: il feedback sulle nubi marine



**DMS non forma direttamente aerosol… → deve essere convertito in acido solforico

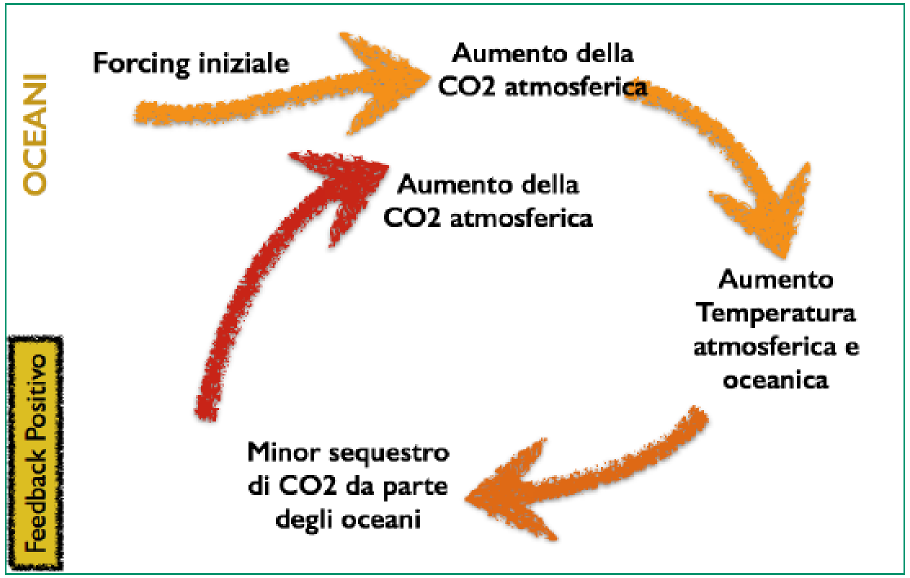
Fitoplancton — DMS: il feedback sulle nubi marine

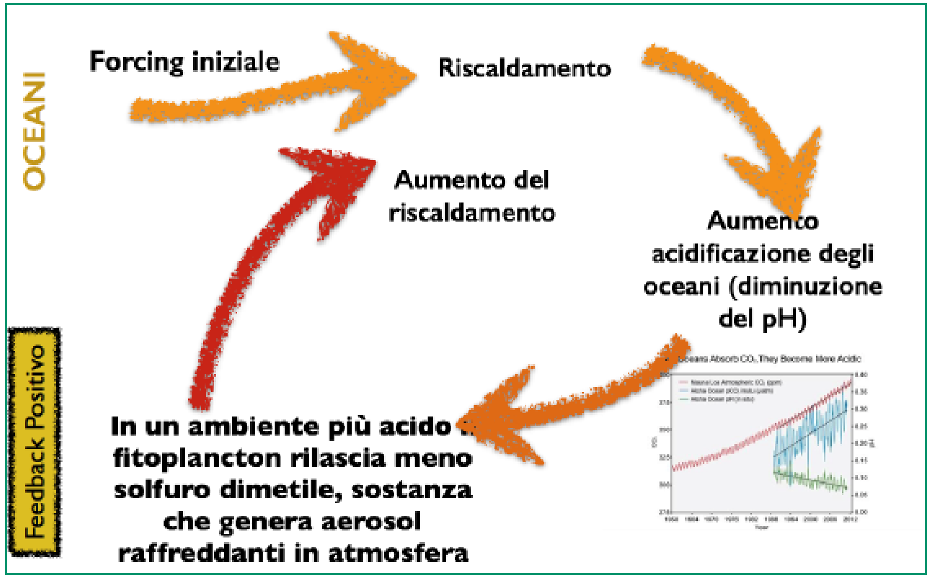


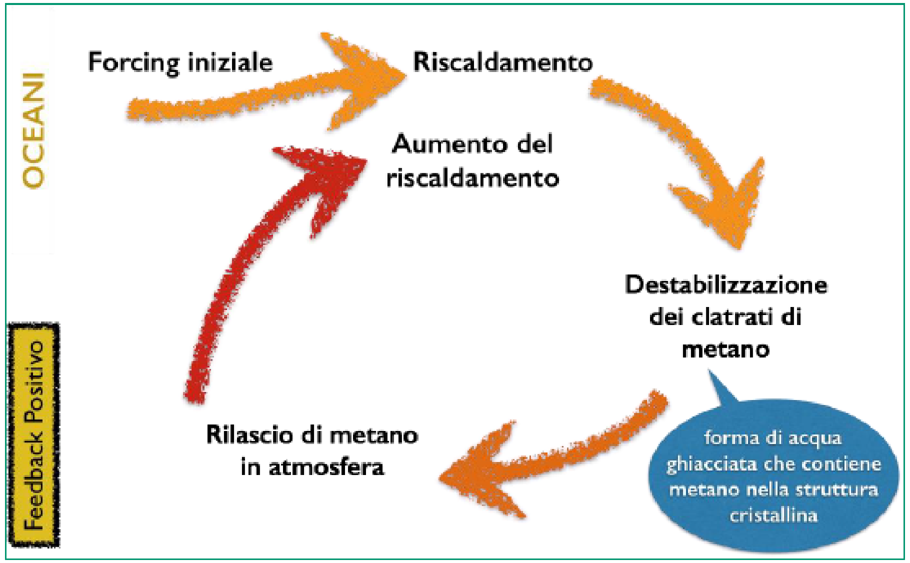
Charlson, Lovelock, Andrea, Warren - “C.L.A.W.” Hypothesis

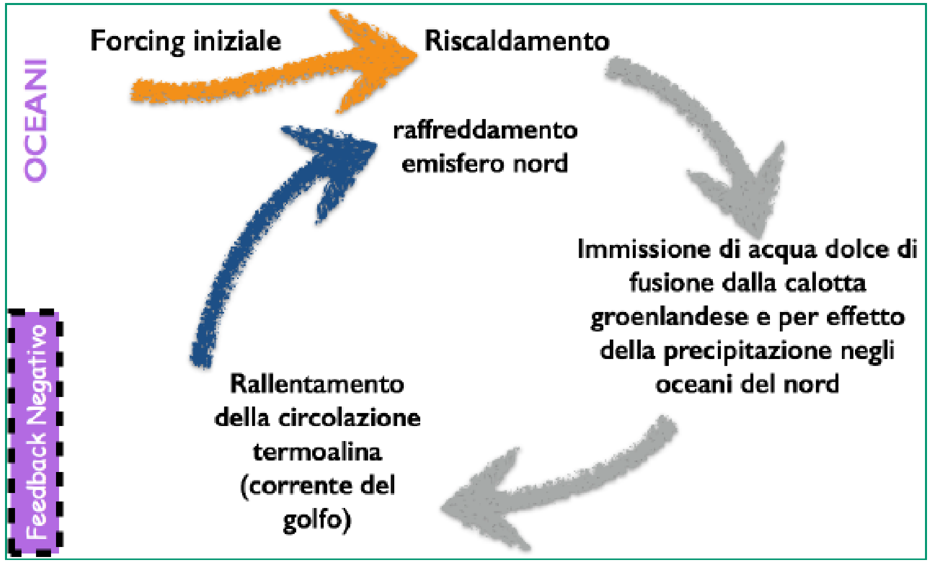
I microbi svolgono un ruolo importante nel ciclo dello zolfo (aerosol), nel ciclo del carbonio (CO_2), nell’O3 stratosferico, ...

Feedback loops legati agli oceani









Feedback loops: risorse web

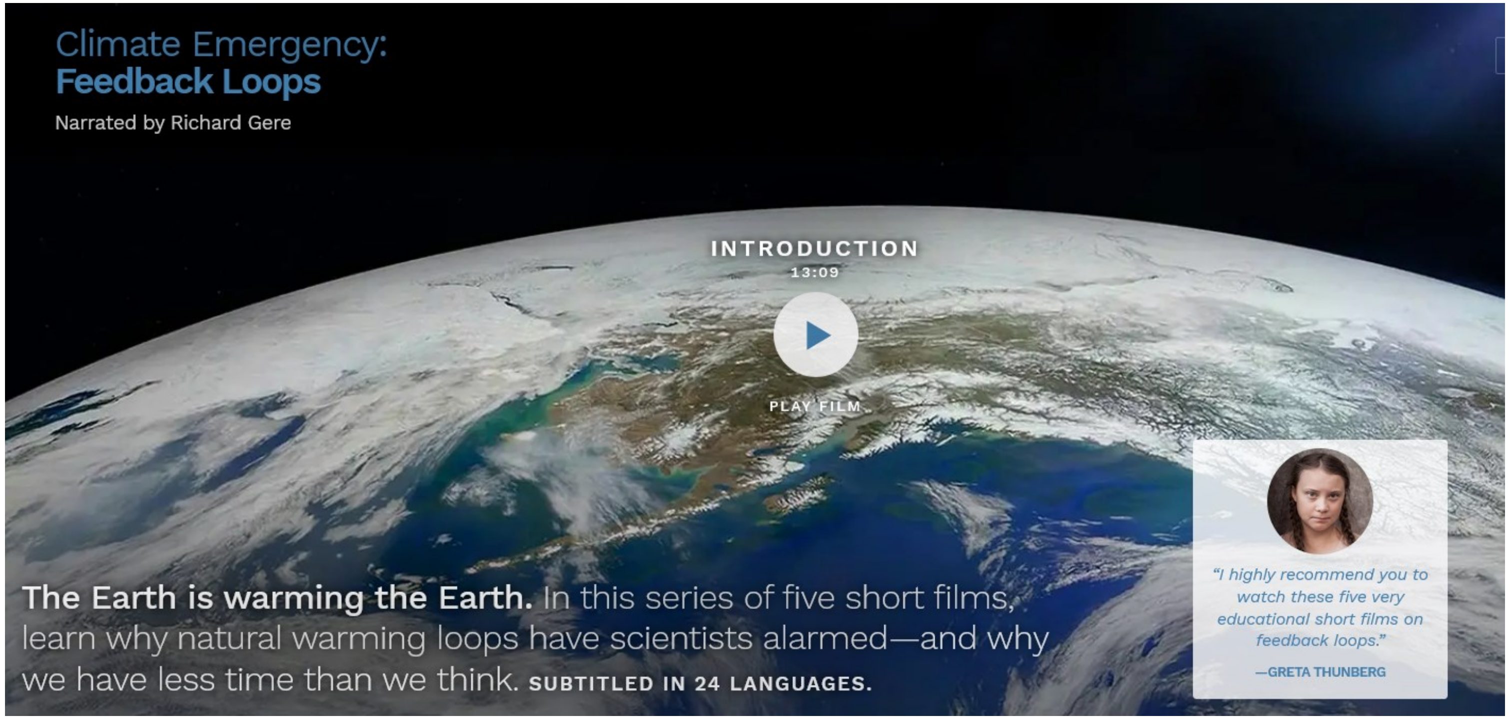
https://climate.nasa.gov/nasa_science/science/

https://feedbackloopsclimate.com/ (docu-film)

https://explainingclimatechange.com/lesson7/lesson7.html

https://www.climaterealityproject.org/blog/how-feedback-loops-are-making-climate-crisis-worse

https://earthhow.com/climate-feedback-loops/



Docu-film
Climate Emergency (Dec. 2021)

Tipping points (punti di non ritorno)

Tipping points (punti di non ritorno)

Caratteristiche delle dinamiche di sistemi NON lineari

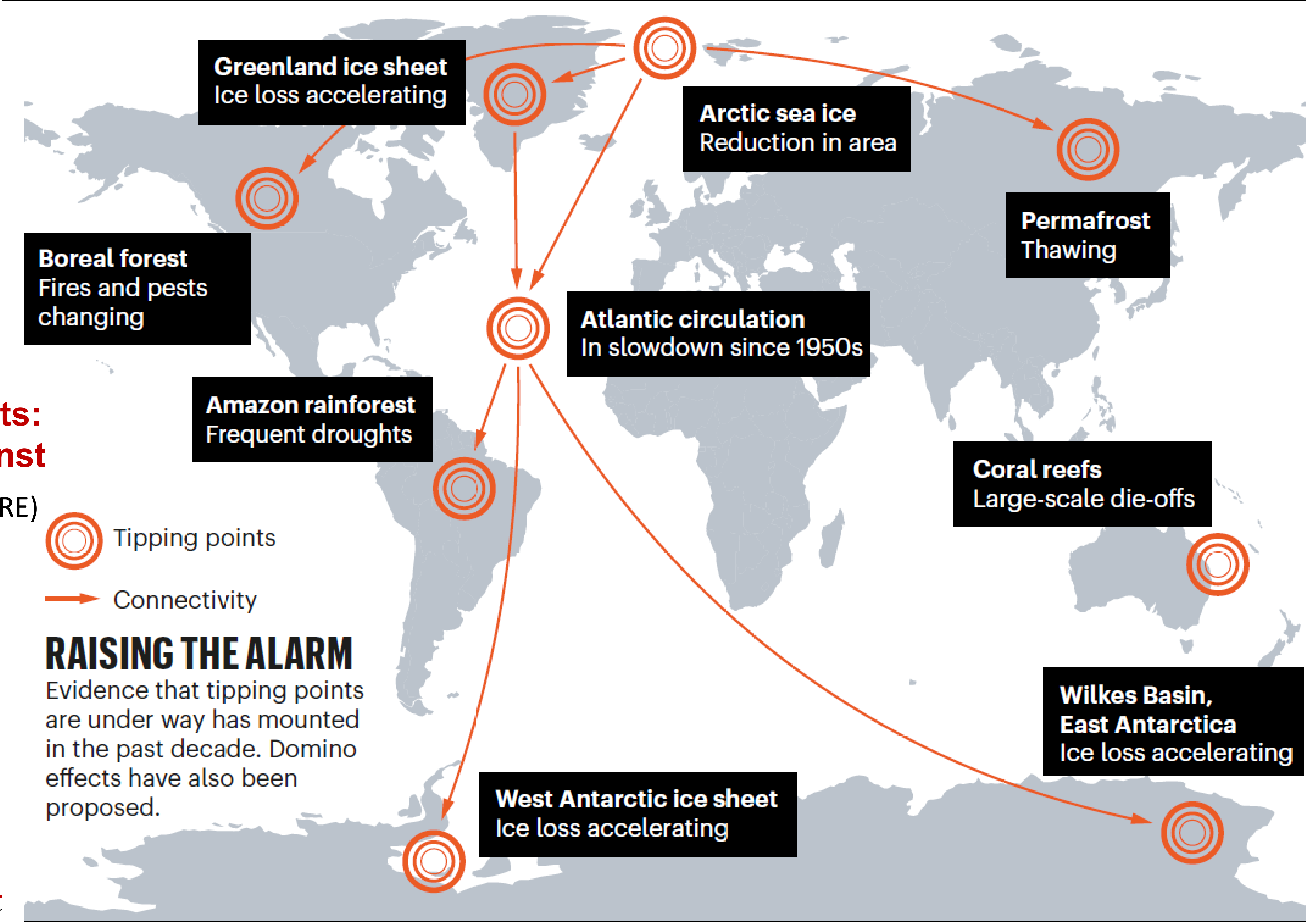
"Tipping Point – a position in a system where a small, additional increase in an external forcing factor triggers internal processes that drive system change – often rapid and unexpected, sometimes irreversible" (Steffen, 2008)

Tipping element: componenti che possono oltrepassare il *tipping point* in area >1000 km^2

Lenton et al. 2008; Steffen et al 2018

Climate tipping points: too risky to bet against

(Lenton et al 2019, NATURE)



Principali *tipping points* climatici

1) Ghiaccio marino artico

2) Calotta glaciale groenlandese

3) Circolazione termoalina nell'Atlantico (rallenta la Corrente del Golfo)

4) Calotta glaciale antartica occidentale (quella più piccola, più instabile)

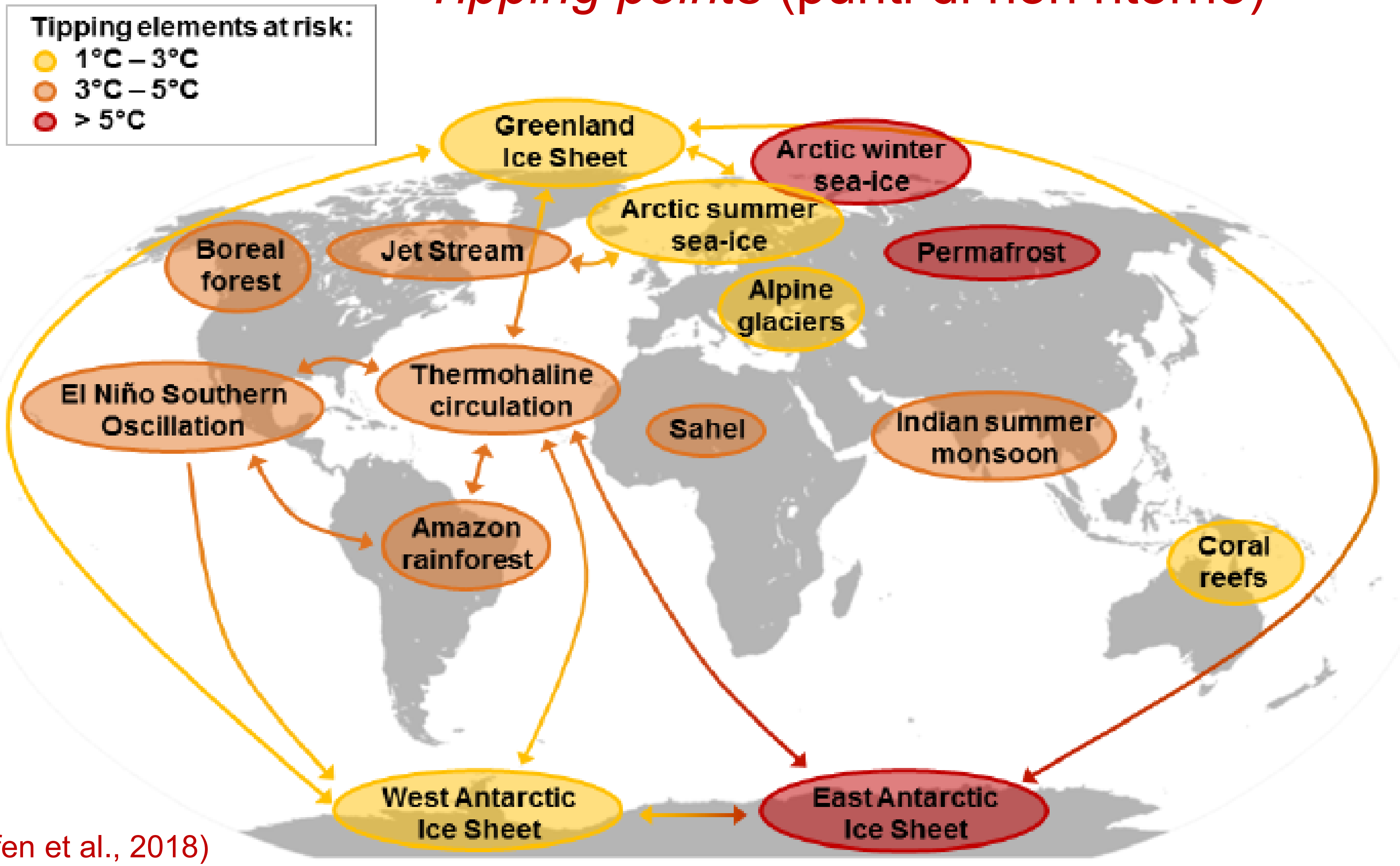
5) Monsone indiano estivo

6) Sahara e monsone occidentale africano

7) Foresta amazzonica .

8) Foresta boreale

Tipping points (punti di non ritorno)



Carta delle potenziali cascate di non ritorno, i cui elementi sono classificati in 3 gruppi, in base all'aumento della temperatura media

In giallo gli elementi più vicini all'aumento delle temperature attuale

(Steffen et al., 2018)

UNIVERSITÀ DEGLI STUDI DI PADOVA

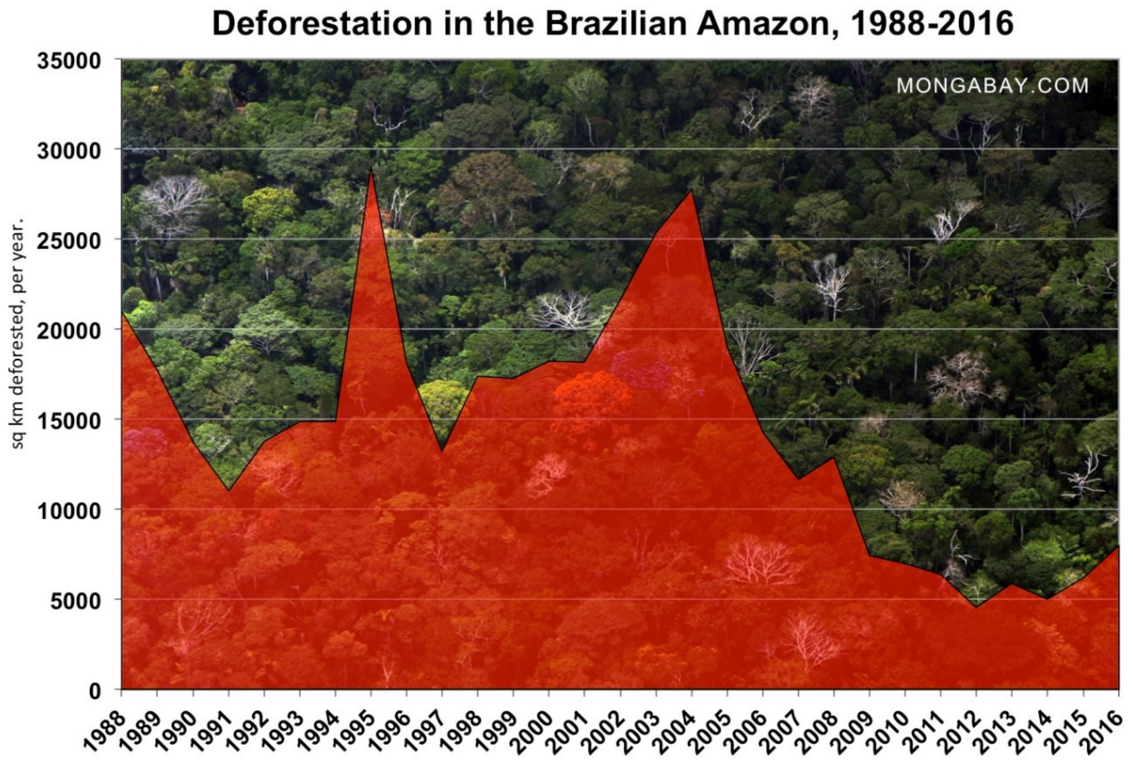
ICEA

GIScience

NEWS FEATURE | 25 February 2020

When will the Amazon hit a tipping point?

Scientists say climate change, deforestation and fires could cause the world's largest rainforest to dry out. The big question is how soon that might happen.

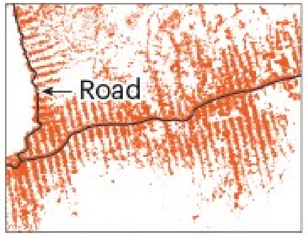


https://www.nature.com/articles/d41586-020-00508-4

Google Earth Pro

FOREST LOSS

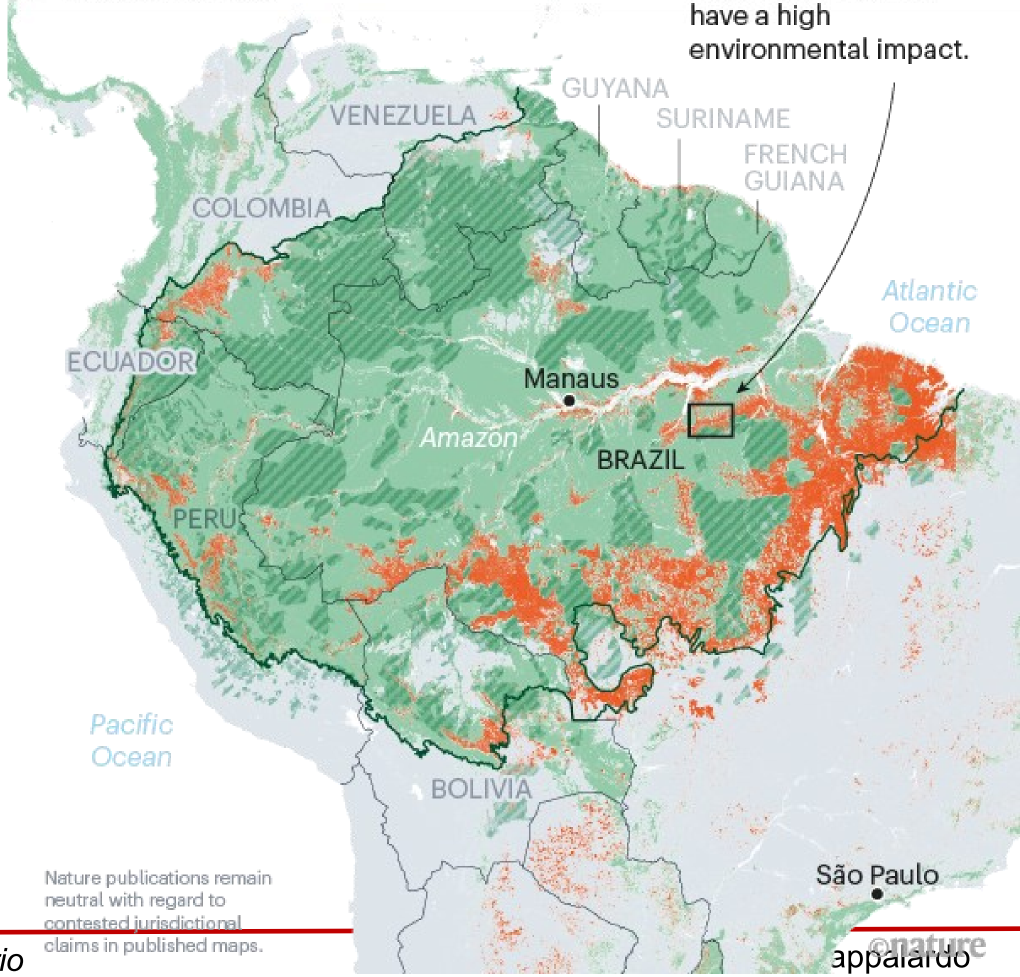
The Amazon rainforest covers some 5 million square kilometres of land across nine countries; more than half is in Brazil, where more than 19% of the forest has been cleared. Brazil reduced deforestation after 2004, but amid political turmoil tree clearing is rising again.



Deforestation often follows a fishbone pattern, as loggers clear trees perpendicular to main roads. Opening a single new road can have a high environmental impact.

Map key

- Deforestation (since 1988)
- Amazon rainforest biome
- Forest cover
- Indigenous territories



Nature publications remain neutral with regard to contested jurisdictional claims in published maps.

Tipping points: bioma amazzonico

ruolo cruciale nelle dinamiche globali:

- sistema climatico
- ciclo idrologico
- ciclo del carbonio (rilascio di 90 10^9 tCO_2)
- sistema circolazione generale atmosferica

  teleconnessioni e *atmospheric rivers*
- rete globale degli ecosistemi

Moisture produced by the world's forests generates rainfall thousands of miles away. RICHARD WHITCOMBE / SHUTTERSTOCK

https://e360.yale.edu/features/how-deforestation-affecting-global-water-cycles-climate-change
https://research.noaa.gov/News/ArtMID/451/ArticleID/2778/Deforestation-warming-flip-part-of-Amazon-forest-from-carbon-sink-to-source

Università degli Studi di Padova

ICEA

GIScience

Climate Justice
Centre of Excellence

Tipping points: bioma amazzonico

nature climate change

Article | Open Access | Published: 07 March 2022

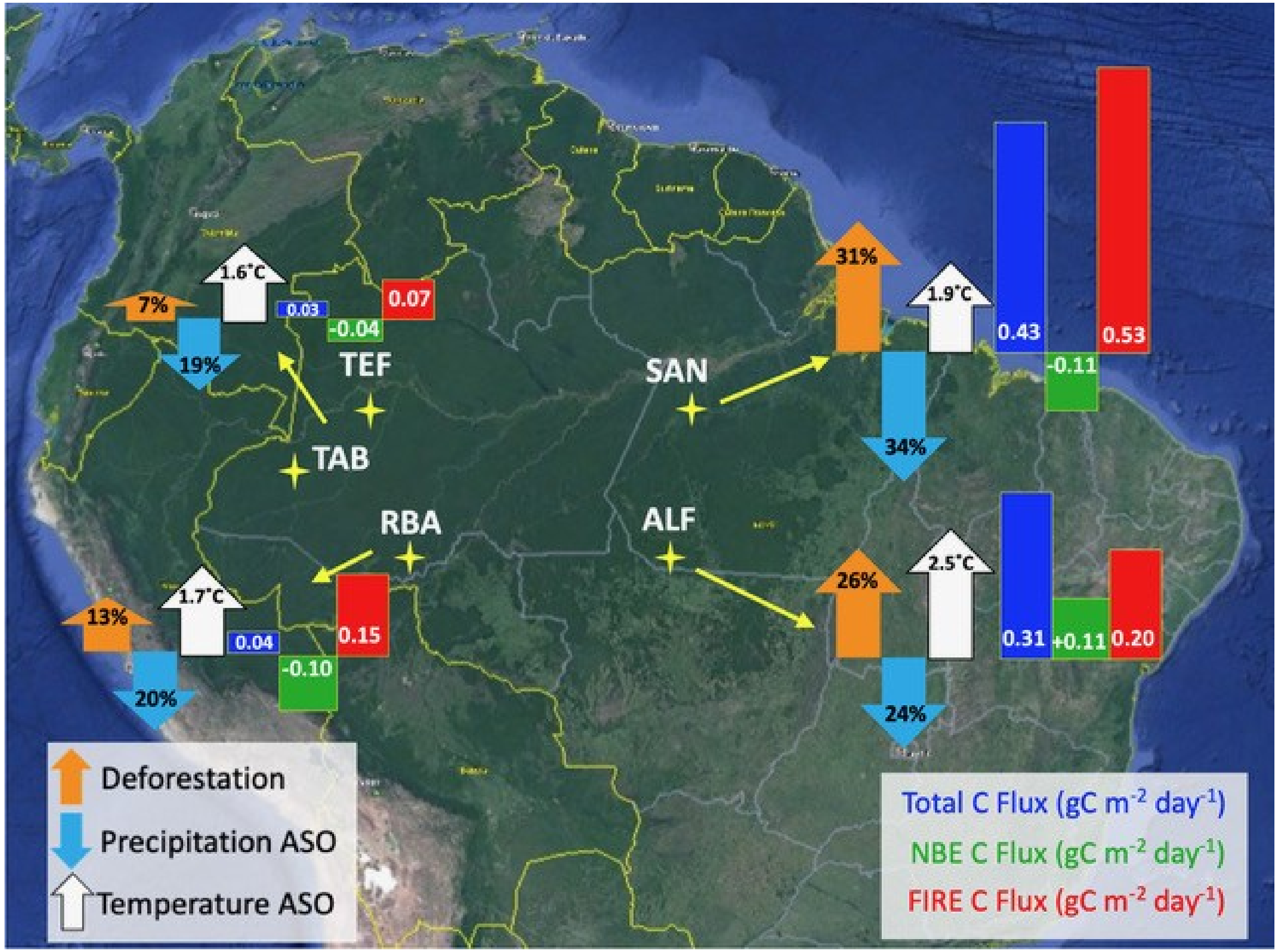
Pronounced loss of Amazon rainforest resilience since the early 2000s

Chris A. Boulton, Timothy M. Lenton & Niklas Boers

Nature Climate Change **12**, 271–278 (2022) | Cite this article

- Analisi dati satellitari (1991-2016)
- Diminuzione *carbon uptake flux*
- Feedback da : 1) estesi incendi (amplificazione siccità) 2) deforestazione e degradazione
- Diminuzione dei regimi pluviometrici regionali

- **oltre il 75% dell'Amazzonia ha perso capacità di resilienza dal 2000**
- *Dieback* entro 2100
- *Dieback* più ampio



(Luciana Gatti, Brazilian National Institute for Space Research, 2021)

https://www.nature.com/articles/s41558-022-01287-8

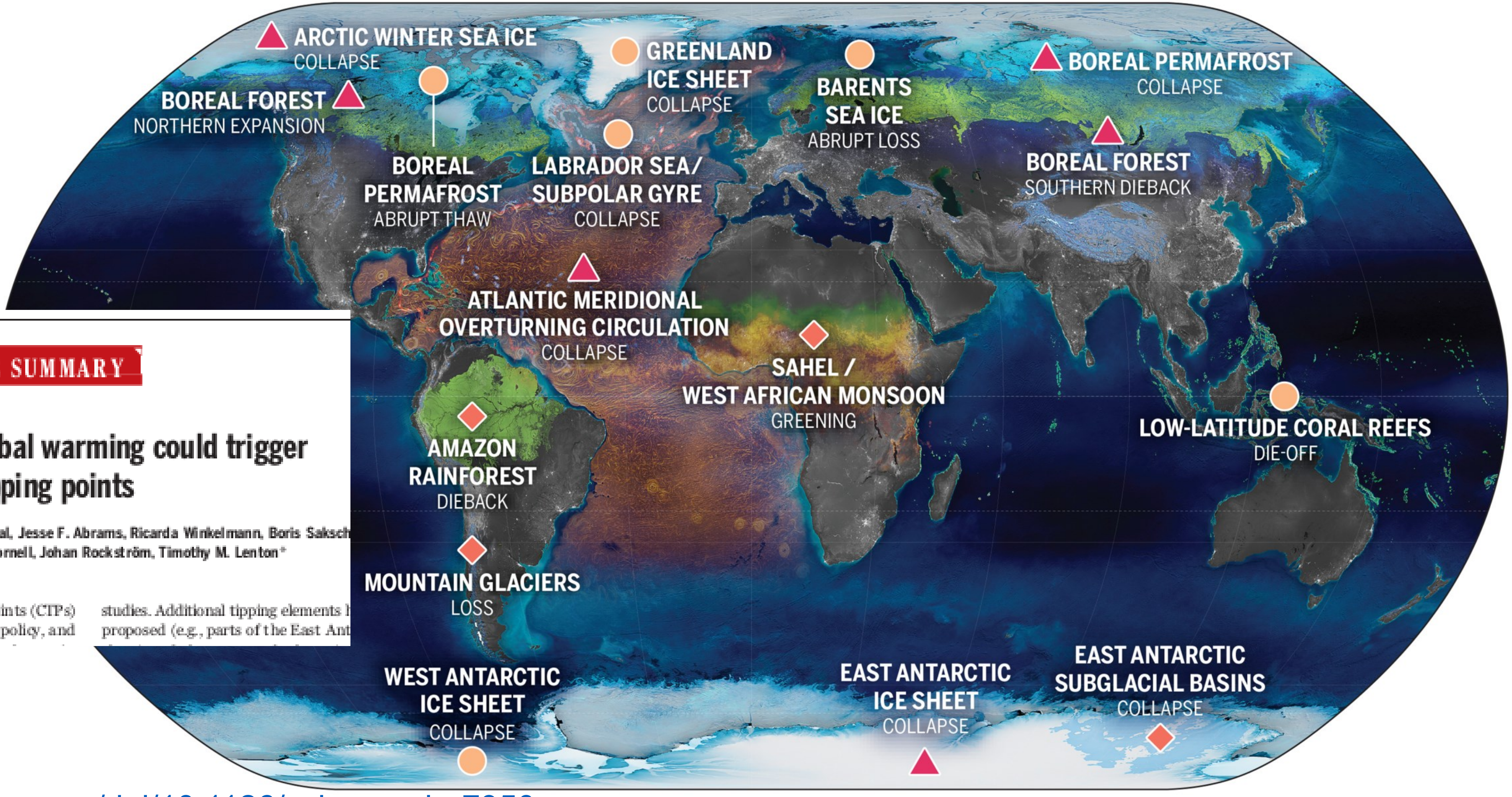
https://research.noaa.gov/News/ArtMID/451/ArticleID/2778/Deforestation-warming-flip-part-of-Amazon-forest-from-carbon-sink-to-source

Università degli Studi di Padova

ICEA

GIScience

Climate Justice
Centre of Excellence



RESEARCH ARTICLE SUMMARY

CLIMATE CHANGE

Exceeding 1.5°C global warming could trigger multiple climate tipping points

David I. Armstrong McKay*, Arie Staal, Jesse F. Abrams, Ricarda Winkelmann, Boris Sakschewski, Sina Loriani, Ingo Fetzer, Sarah E. Cornell, Johan Rockström, Timothy M. Lenton*

INTRODUCTION: Climate tipping points (CTPs) are a source of growing scientific, policy, and ... studies. Additional tipping elements ... proposed (e.g., parts of the East Ant...

https://www.science.org/doi/10.1126/science.abn7950

Università degli Studi di Padova | ICEA | GIScience | Climate Justice Centre of Excellence

PNAS PERSPECTIVE OPEN ACCESS

Climate Endgame: Exploring catastrophic climate change scenarios

Luke Kemp[a,b,1], Chi Xu[c], Joanna Depledge[d], Kristie L. Ebi[e], Goodwin Gibbins[f], Timothy A. Kohler[g,h,i], Johan Rockström[j], Marten Scheffer[k], Hans Joachim Schellnhuber[j,l], Will Steffen[m], and Timothy M. Lenton[n]

Edited by Kerry Emanuel, Massachusetts Institute of Technology, Cambridge, MA; received May 20, 2021; accepted March 25, 2022

Prudent risk management requires con
to-worst-case scenarios. Yet, for clima
potential futures are poorly understood
genic climate change result in worldwide
or even eventual human extinction? At
dangerously underexplored topic. Yet
reasons to suspect that climate change
global catastrophe. Analyzing the mech
extreme consequences could help galvani
resilience, and inform policy, including e

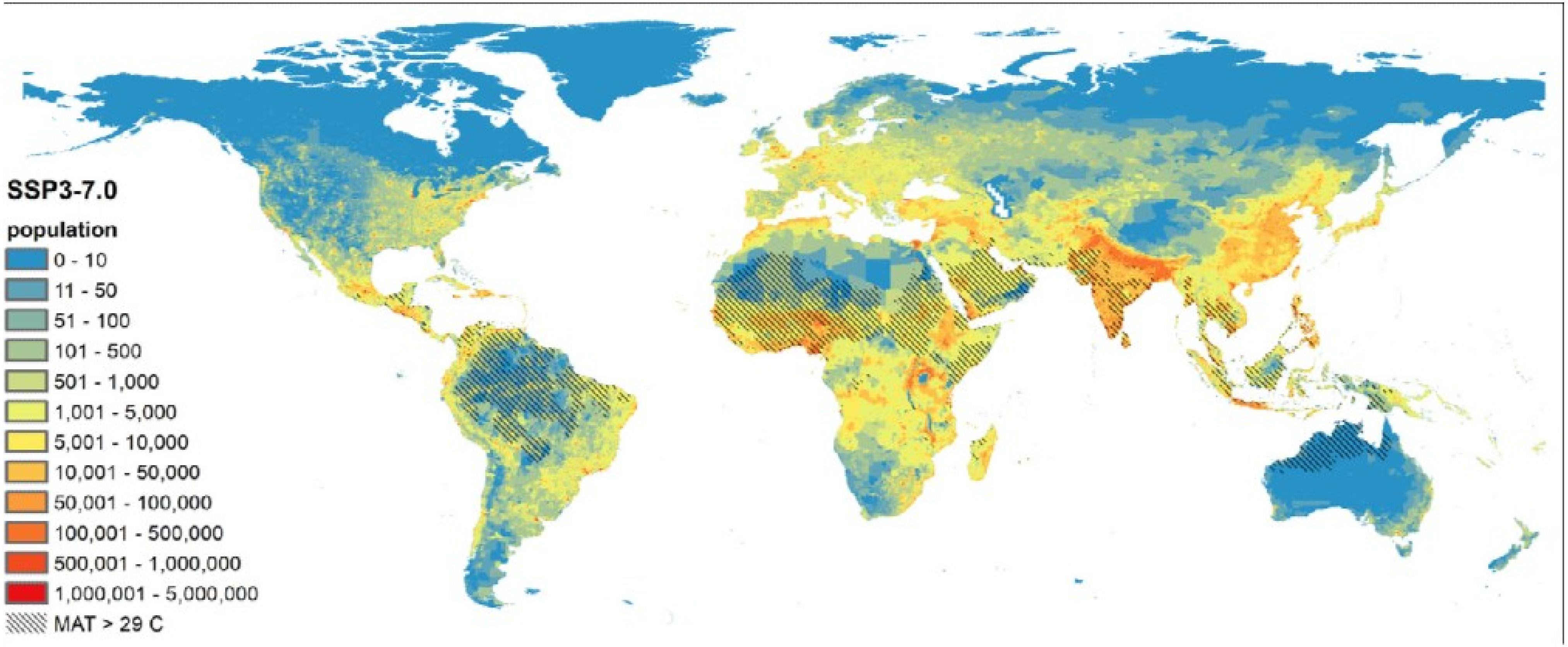


Fig. 1. Overlap between future population distribution and extreme heat. CMIP6 model data [from nine GCM models available from the WorldClim database (45)] were used to calculate MAT under SSP3-7.0 during around 2070 (2060–2080) alongside Shared SSP3 demographic projections to ~2070 (46). The shaded areas depict regions where MAT exceeds 29 °C, while the colored topography details the spread of population density.

Tipping points: risorse web

https://www.nationalgeographic.com/science/article/earth-tipping-point
https://e360.yale.edu/features/as-climate-changes-worsens-a-cascade-of-tipping-points-looms
https://futurism.com/stephen-hawking-we-are-close-to-the-tipping-point-where-global-warming-becomes-irreversible
https://www.unsdsn.org/leading-scientists-gather-before-the-un-climate-summit-to-highlight-the-sense-of-urgency-in-the-amazon
https://www.thesustainabilityagenda.com/podcast/episode-94-interview-with-will-steffen-climate-scientist/

Climate change: eventi meteorologici estremi
Climate extremes

UNIVERSITÀ DEGLI STUDI DI PADOVA

ICEA

GIScience

Climate Justice
Centre of Excellence

IPCC Sixth Assessment Report

Working Group 1: The Physical Science Basis

Chapter 11: Weather and Climate Extreme Events in a Changing Climate

https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-11/

IPCC Sixth Assessment Report

Working Group 1: The Physical Science Basis

Chapter 11: Weather and Climate Extreme Events in a Changing Climate

Methods and Data for Extremes

Since AR5, the confidence about past and future changes in weather and climate extremes has increased due to better physical understanding of processes, an increasing proportion of the scientific literature combining different lines of evidence, and improved accessibility to different types of climate models (*high confidence*). There have been improvements in some observation-based datasets, including reanalysis data (*high confidence*). Climate models can reproduce the sign (direction) of changes in temperature extremes observed globally and in most regions, although the magnitude of the trends may differ (*high confidence*). Models are able to capture the large-scale spatial distribution of precipitation extremes over land (*high confidence*). The intensity and frequency of extreme precipitation simulated by Coupled Model Intercomparison Project Phase 6 (CMIP6) models are similar to those simulated by CMIP5 models (*high confidence*). Higher horizontal model resolution improves the spatial representation of some extreme events (e.g., heavy precipitation events), in particular in regions with highly varying topography (*high confidence*). {11.2, 11.3, 11.4}

IPCC Sixth Assessment Report

Working Group 1: The Physical Science Basis

Temperature Extremes ▼

Heavy Precipitation and Pluvial Floods ▼

River Floods ▼

Droughts ▼

Extreme Storms, Including Tropical Cyclones ▼

Compound Events, Including Dry/Hot Events, Fire Weather, Compound Flooding, and Concurrent Extremes ▼

Low-likelihood, High-impact Events Associated With Climate Extremes ▼

IPCC Sixth Assessment Report

Working Group 1: The Physical Science Basis

The frequency and intensity of hot extremes (including heatwaves) have increased, and those of cold extremes have decreased on the global scale since 1950 (**virtually certain**). This also applies **at regional scale**, with more than 80% of AR6 regions1showing similar changes assessed to be at leastlikely . In a few regions, limited evidence (data or literature) prevents the reliable estimation of trends. {11.3, 11.9}

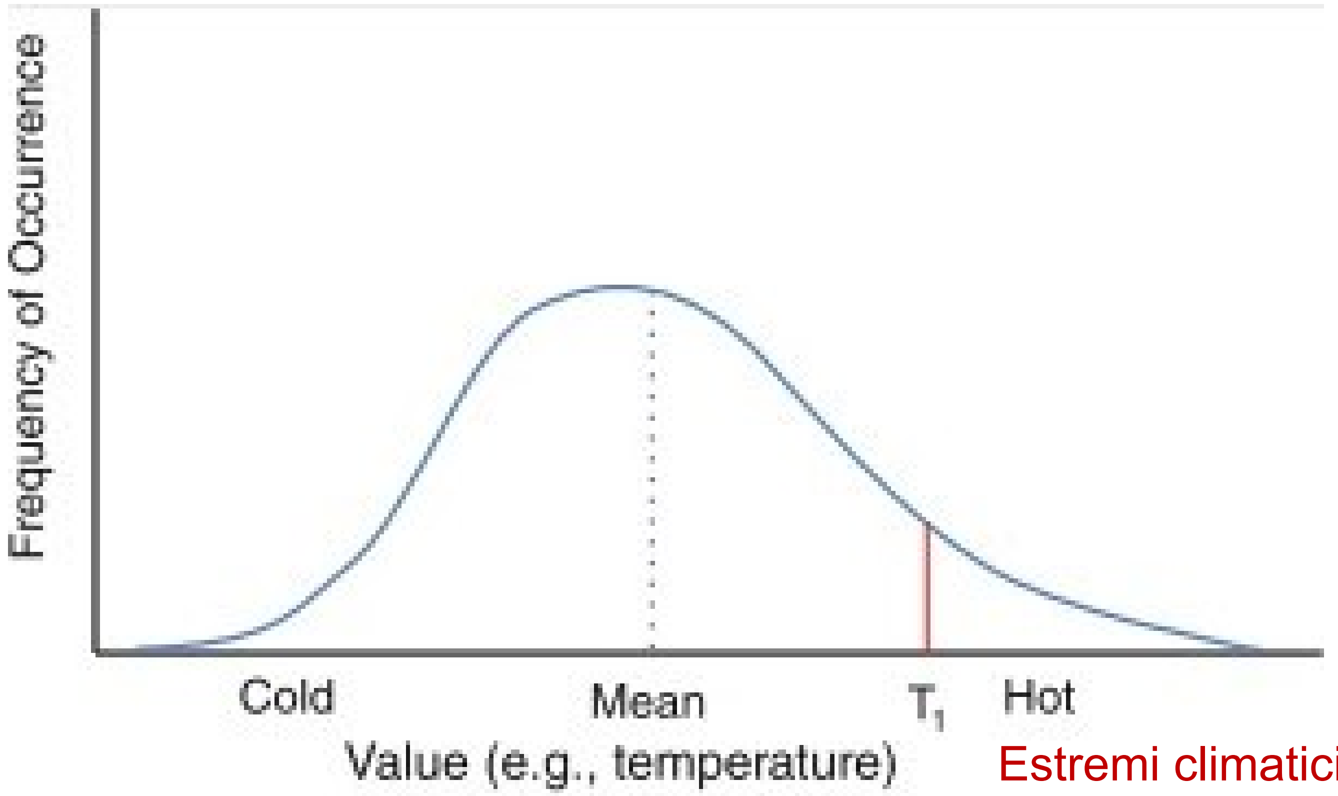
Human-induced greenhouse gas forcing is the main driver of the observed changes in hot and cold extremes on the global scale (virtually certain) and on most continents (very likely). The effect of enhanced greenhouse gas concentrations on extreme temperatures is moderated or amplified at the regional scale by regional processes such as soil moisture or snow/ice-albedo feedbacks, by regional forcing from land-use and land-cover changes, or aerosol concentrations, and decadal and multi-decadal natural variability. Changes in anthropogenic aerosol concentrations have likely affected trends in hot extremes in some regions. Irrigation and crop expansion have attenuated increases in summer hot extremes in some regions, such as the Midwestern USA (medium confidence). Urbanization has likely exacerbated changes in temperature extremes in cities, in particular for nighttime extremes. {11.1, 11.2, 11.3}

IPCC Sixth Assessment Report

Working Group 1: The Physical Science Basis

The frequency and intensity of hot extremes will continue to increase and those of cold extremes will continue to decrease, at global and continental scales and in nearly all inhabited regions1 with increasing global warming levels. **This will be the case even if global warming is stabilized at 1.5°C.**
Relative to present-day conditions, changes in the intensity of extremes would be at least double at 2°C, and quadruple at 3°C of global warming, compared to changes at 1.5°C of global warming.
The number of hot days and hot nights and the length, frequency, and/or intensity of warm spells or heatwaves will increase over most land areas (virtually certain).
In most regions, **future changes in the intensity of temperature extremes will very likely be proportional to changes in global warming, and up to two to three times larger** (high confidence). T
he highest increase of temperature of hottest days is projected in some mid-latitude and semi-arid regions and in the South American Monsoon region, at about 1.5 times to twice the rate of global warming (high confidence). The highest increase of temperature of coldest days is projected in Arctic regions, at about three times the rate of global warming (high confidence).
The frequency of hot temperature extreme events will very likely increase nonlinearly with increasing global warming, with larger percentage increases for rarer events. {11.2, 11.3, 11.9; Table 11.1; Figure 11.3}

La variabilità del clima

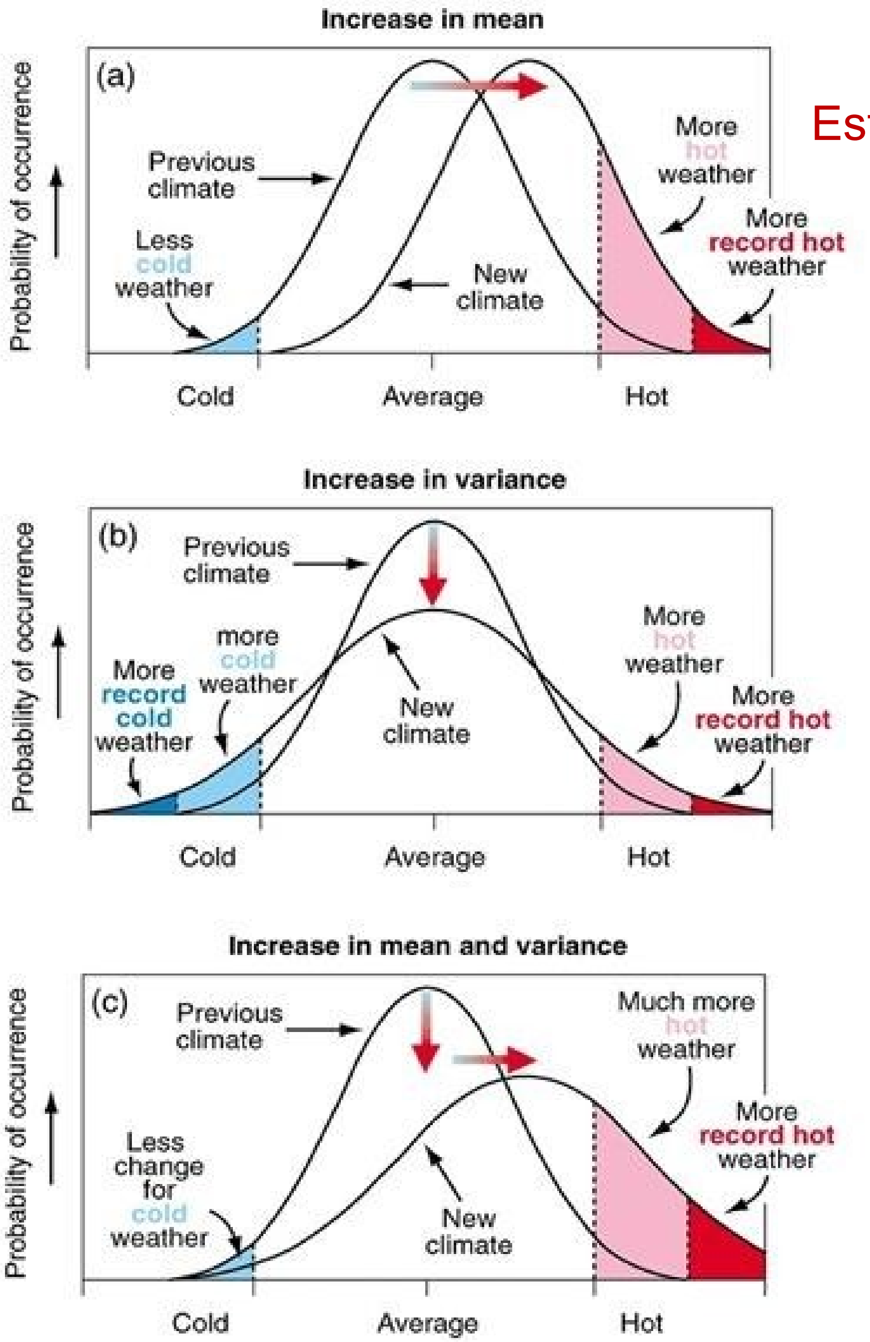


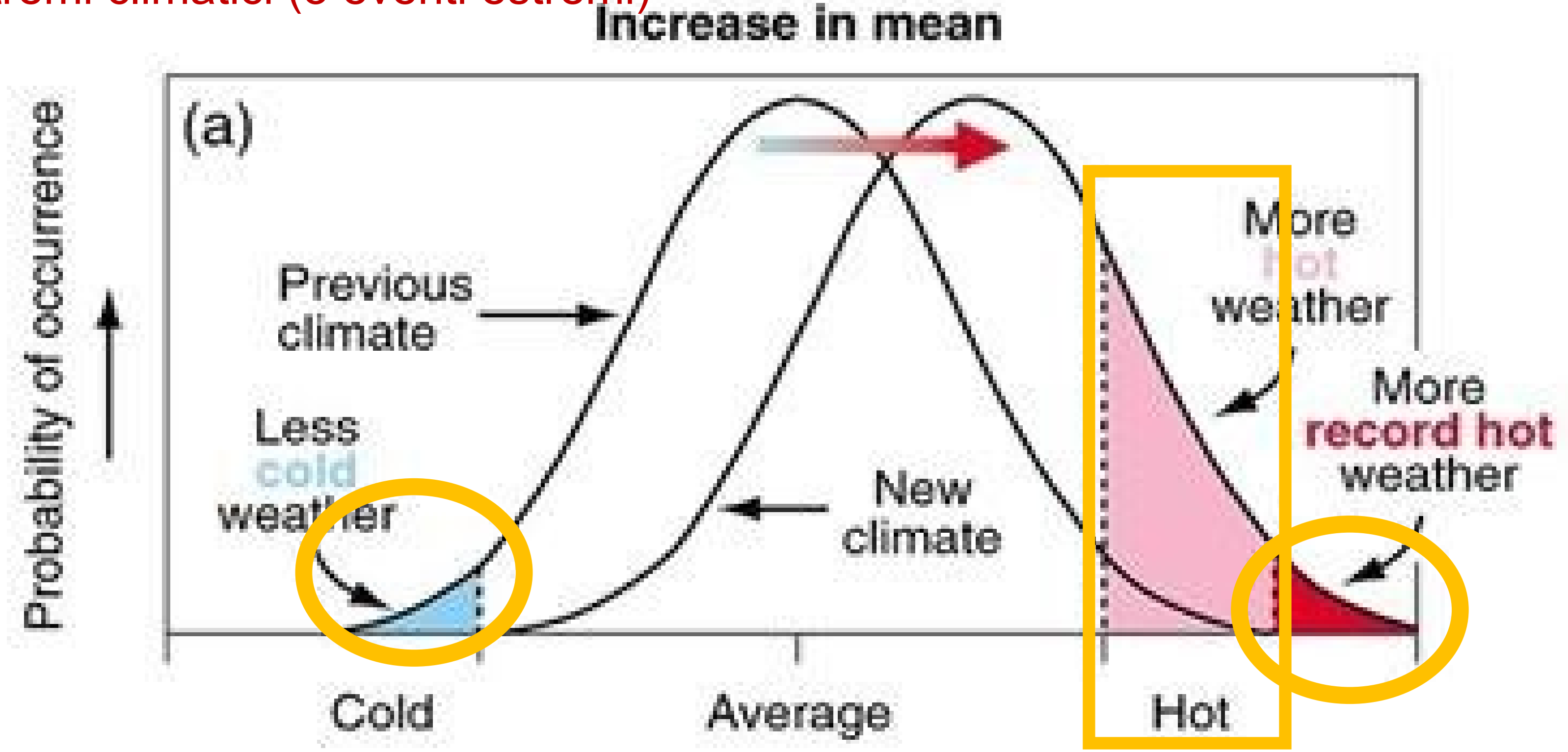
Estremi climatici (o eventi estremi)

Il clima è definito come il tempo meteorologico medio o, in maniera più rigorosa, come **la descrizione statistica in termini di media e variabilità di grandezze rilevanti**, nel corso di un periodo di tempo che va da mesi a migliaia o milioni di anni.

Il periodo classico per calcolare la media di queste variabili è trent'anni, secondo la definizione dell'Organizzazione meteorologica mondiale (WMO - World Meteorological Organization).

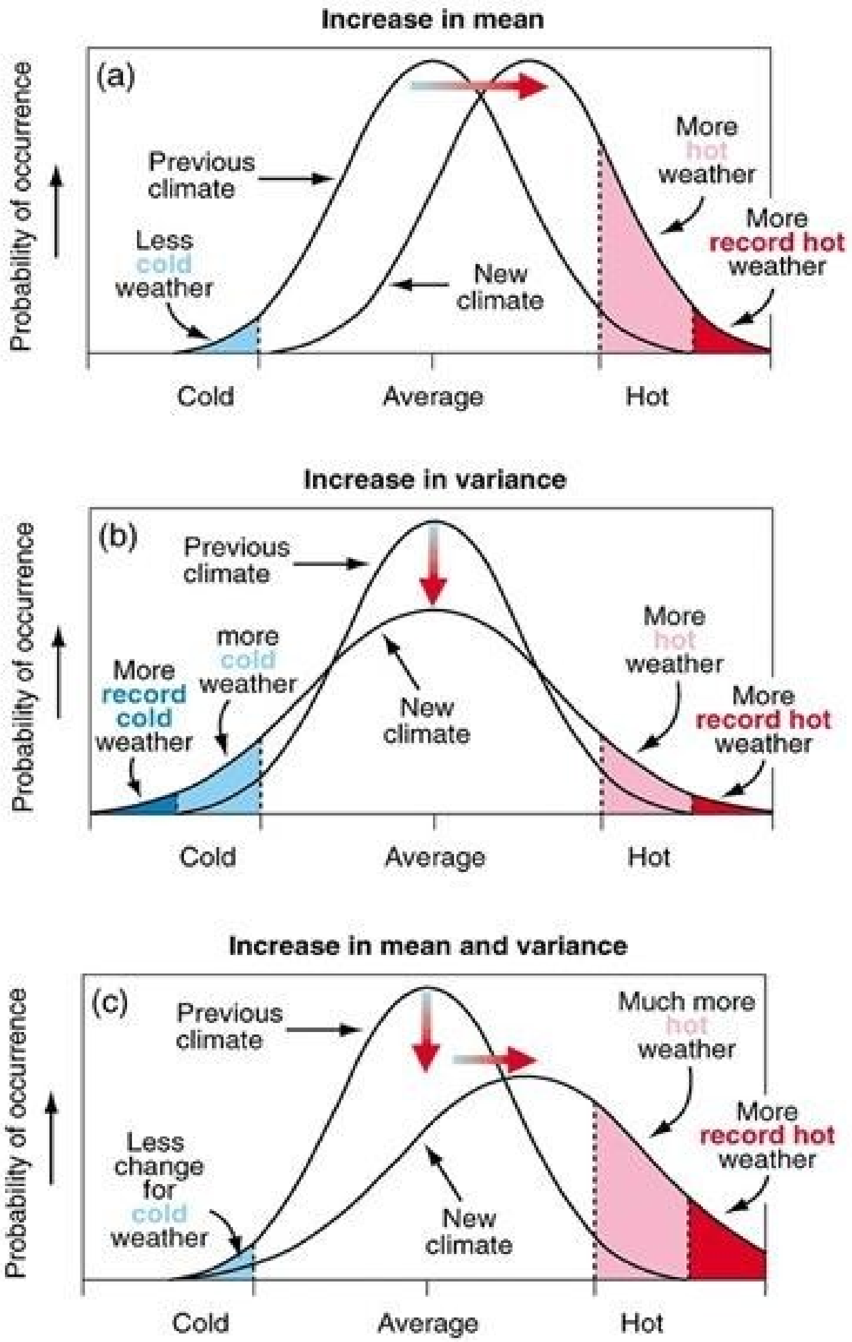
Estremi climatici (o eventi estremi)



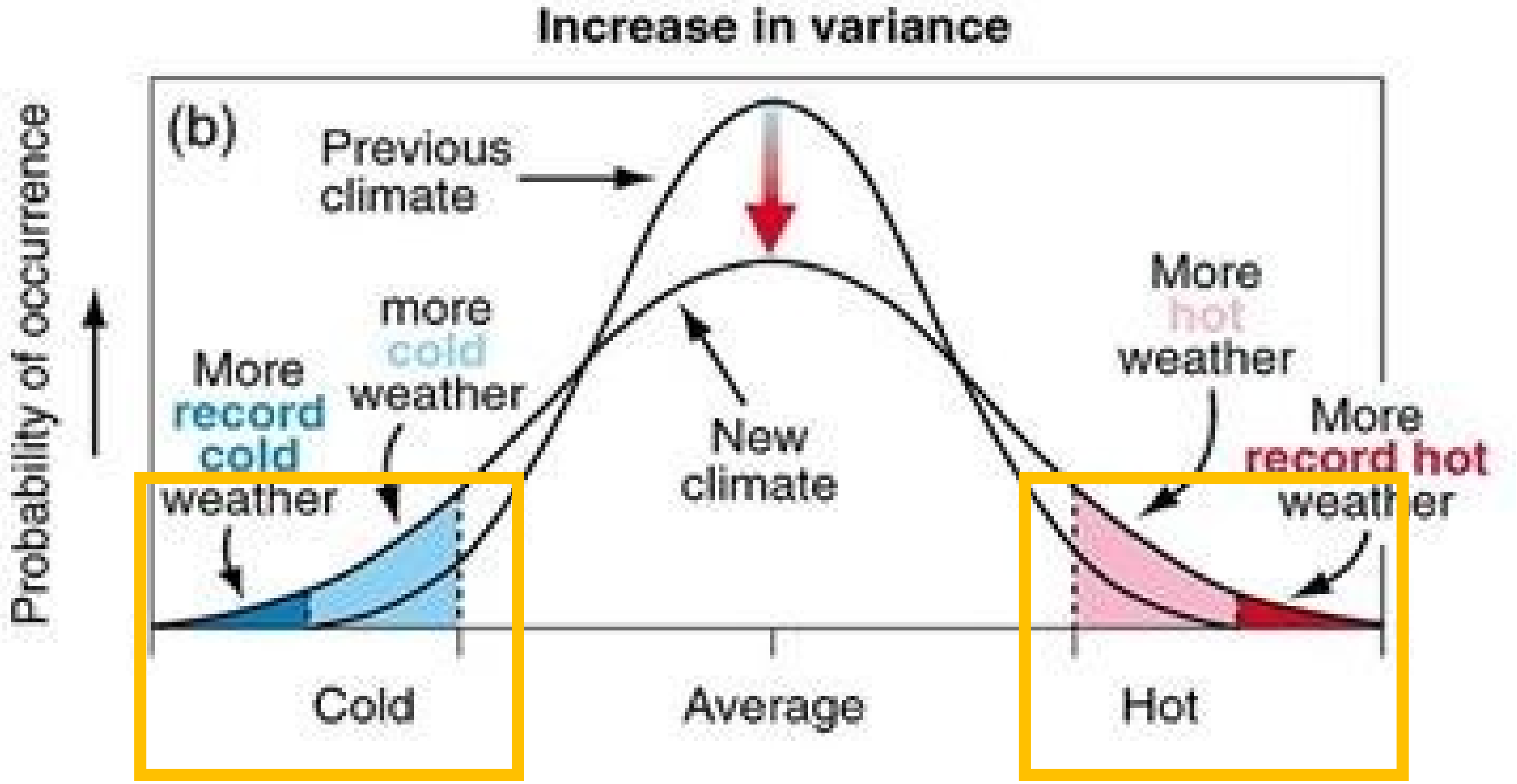


Aumento della T media:

i valori aumentano tutti della stessa quantità.
La distribuzione trasla verso valori maggiori ma mantiene la stessa forma
Risultato? Meno eventi estremi freddi, più eventi estremi caldi



Estremi climatici (o eventi estremi)

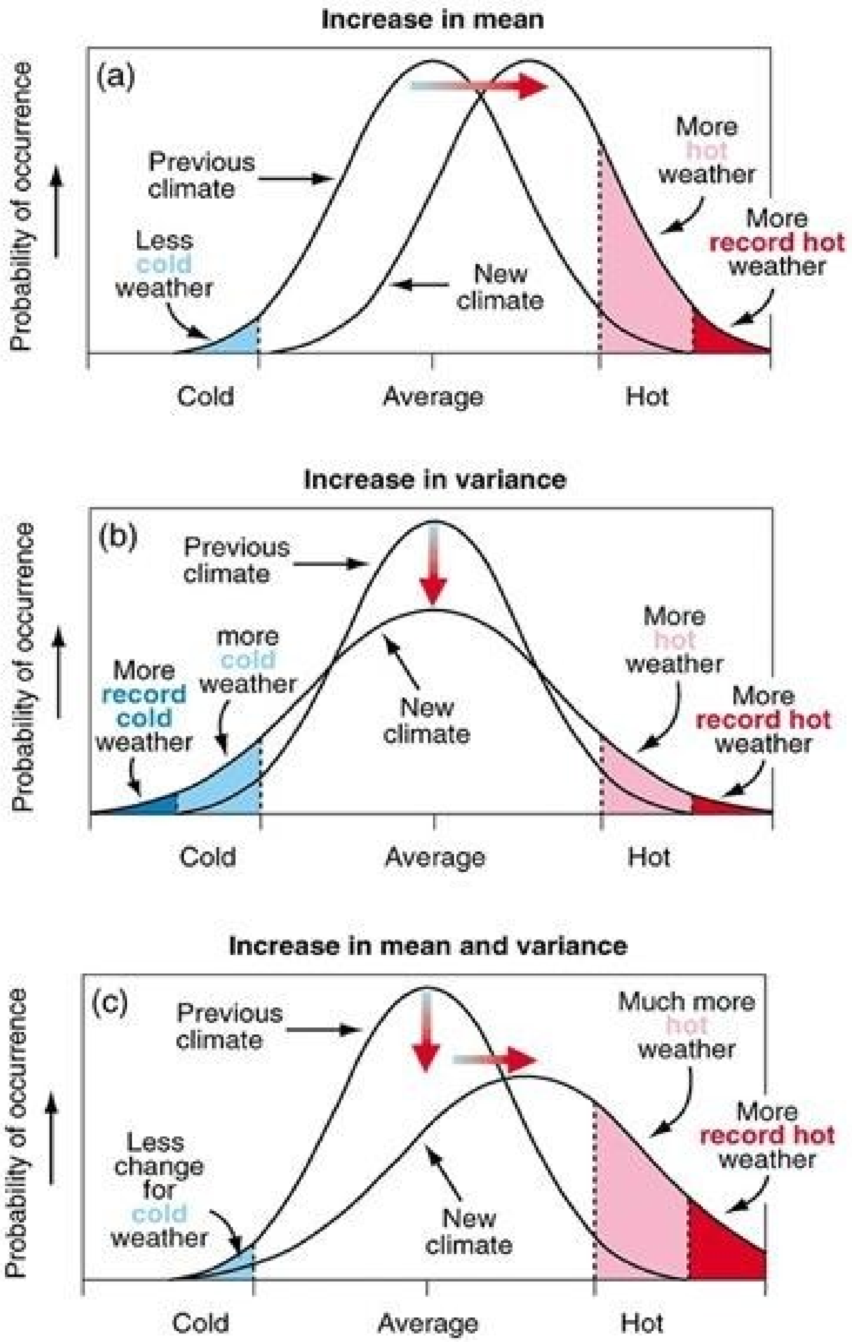


Aumento della varianza:

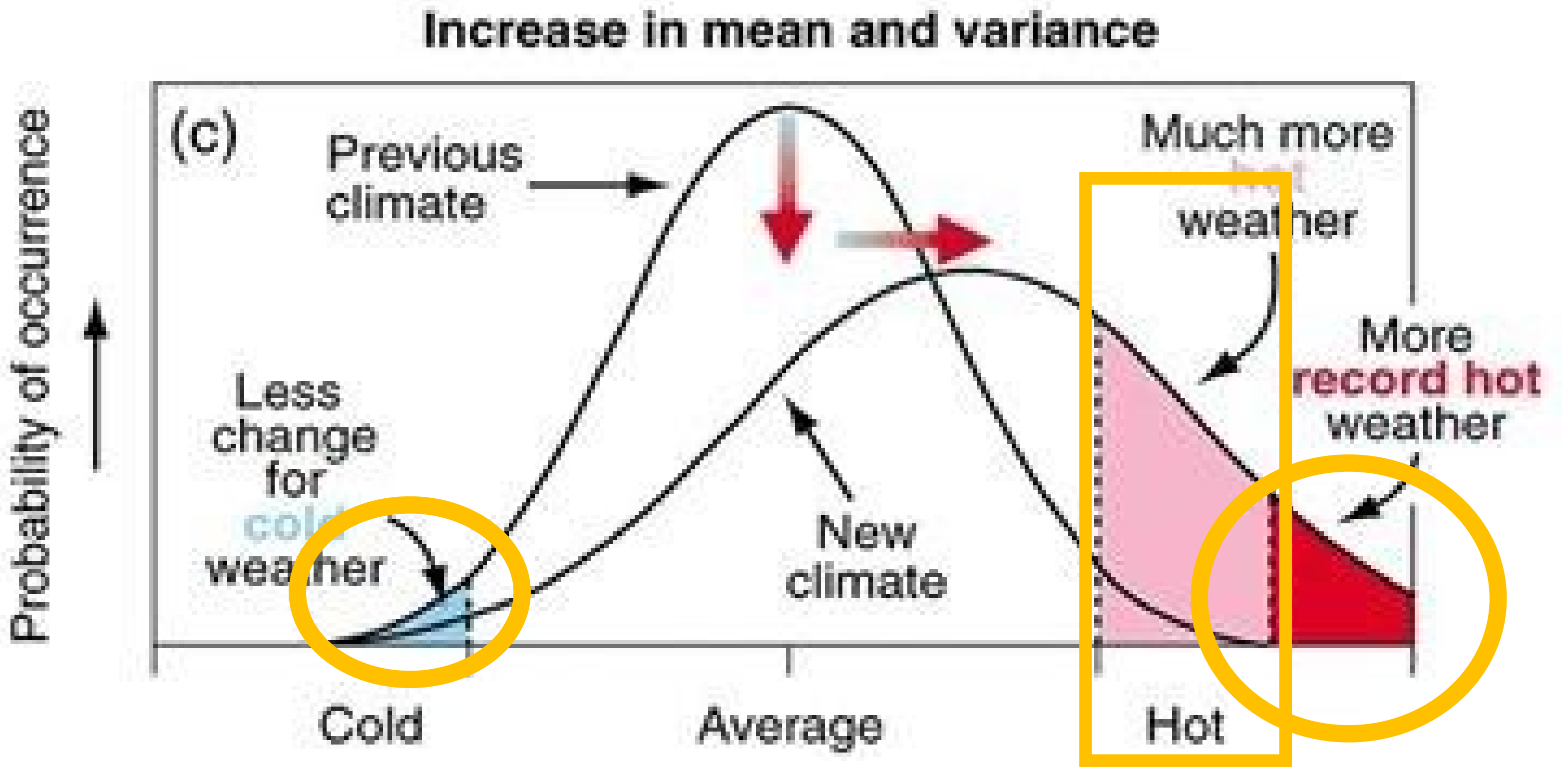
La distribuzione dei valori cambia forma, si «appiattisce»

La T media non cambia, ma le code sono più popolate

Risultato? Più eventi freddi, più eventi caldi



Estremi climatici (o eventi estremi)



Aumento della T media e della varianza («appiattimento»):
La distribuzione trasla verso valori maggiori e cambia forma
Risultato? Un po' meno eventi freddi, ma molti più eventi estremi caldi

Heatwaves (Ondate di calore)

Heat wave (also referred to as extreme heat event)
A period of abnormally hot weather. Heat waves and warm spells have various and, in some cases, overlapping definitions (IPCC, SR Glossary of terms in Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, **2012**)

A **UK heatwave** threshold is met when a location records a **period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold**.
The threshold varies by UK county (Met Office)

A heatwave occurs when the maximum and the minimum temperatures are unusually hot over a three-day period at a location. **This is considered in relation to the local climate and past weather at the location** (Australina Bureau of Meteorology)

A heat wave as a period during which the daily maximum temperature exceeds for more than five consecutive days the maximum normal temperature by 5 degrees Celsius, the normal period being defined as 1961–1990 (WMO 2021).

Misurare e comparare *Heatwaves* (ondate di calore)

Periodo di minimo tre giorni consecutivi in cui, in una determinata area, **la temperatura massima giornaliera supera il 90° percentile della distribuzione delle temperature massime registrate nel periodo di riferimento**, all'interno di una finestra mobile di 31 giorni centrata nel giorno di indagine

Heatwave Index (Russo et al. 2014)

$$D = \bigcup_{y=1992}^{2021} \bigcup_{i=giorno-15}^{giorno+15} Tmax_{y,i}$$

Con:

D = distribuzione da cui si è ricavato il 90° percentile

y = anno della serie ARPAV

i = giorno di indagine

$Tmax_{y,i}$ = massima temperatura registrata nel giorno i dell'anno y

Heatwave Magnitude Index (Russo et al. 2015)

$$M_d(T_d) = \begin{cases} \dfrac{T_d - T_{30y25p}}{T_{30y75p} - T_{30y25p}} & se\ T_d > T_{30y25p} \\ 0 & se\ T_d \leq T_{30y25p} \end{cases}$$

$$HWMId = \sum_{HWd=1}^{n} M_d$$

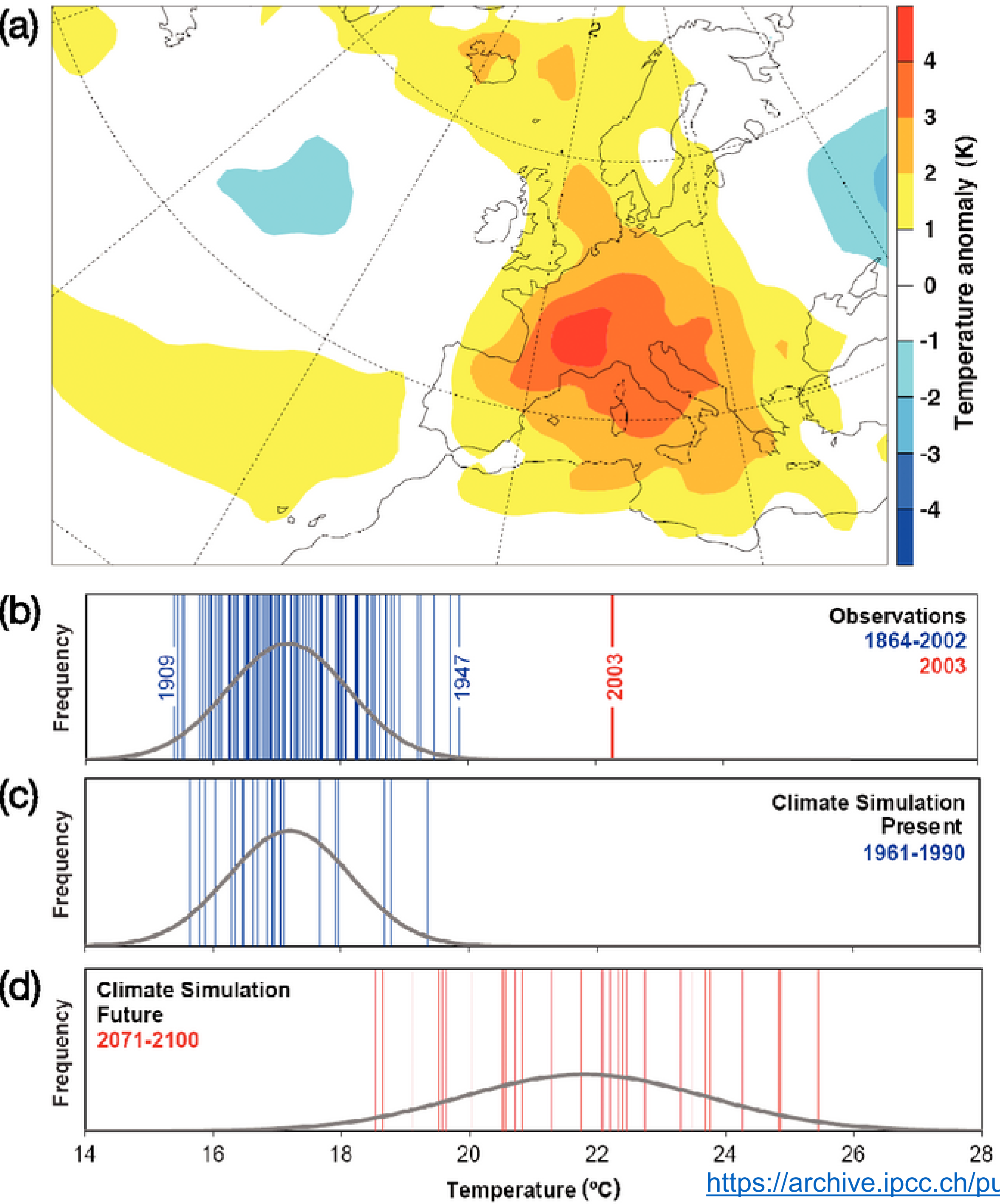
M_d = magnitudo giornaliera

T_d = temperatura massima giornaliera

T_{30y25p} = 25° percentile della distribuzione delle temperature massime giornaliere registrate dal 1992 al 2021

T_{30y75p} = 75° percentile della distribuzione delle temperature massime giornaliere registrate dal 1992 al 2021

HWd=giorno di ondata di calore



Heatwave 2003 in Europa

a. Anomalia della temperatura JJA (media 1961-1990)

b) T medie JJA in Svizzera nel periodo 1864-2003

c) T simulate utilizzando un modello climatico regionale del clima nel periodo 1961-1990

d) Temperature simulate con lo stesso modello nel **periodo 2071-2100** per un possibile scenario futuro

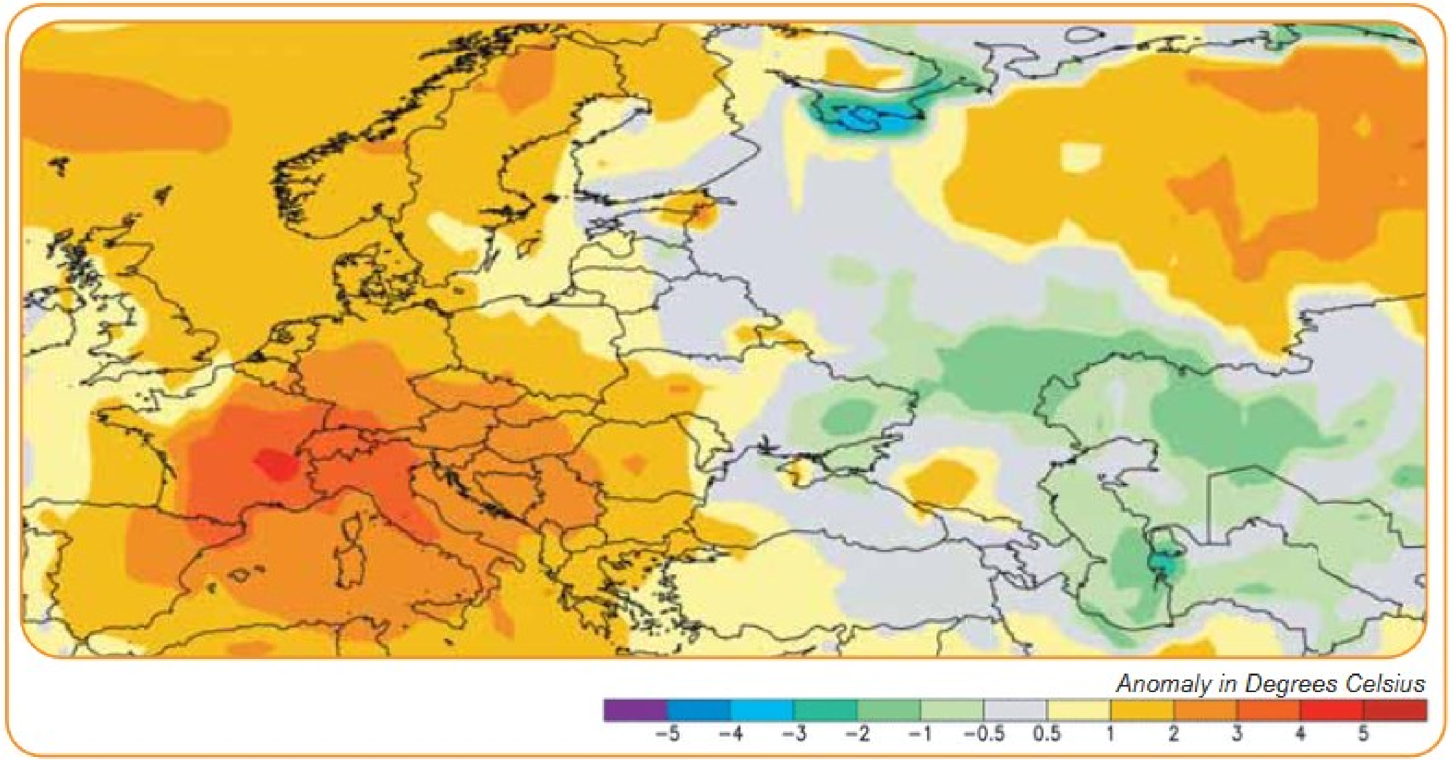
https://archive.ipcc.ch/publications_and_data/ar4/wg2/en/figure-c1-1.html

Heat wave 2003 in Europe (‘the days after’…)

- 30.000 morti per *heat-stress* (14.000 in Francia, 4.000 in Italia)
- Uno tra i 10 disastri più fatali in Europa negli ultimi 100 anni, il peggiore negli ultimi 50
- Heat-risk: vulnerabilità differenziate (
- Impatti sulla produzione agricola
- Impatti sugli ecosistemi urbani

(vegetation-stress,

da carbon sink a carbon source)



This map, produced from both in situ and satellite information (NDC/NOAA), shows the extreme deviation from the average as recorded from June to August 2003. In some areas the difference exceeds 4°C. Climatological base period is 1988-2003.

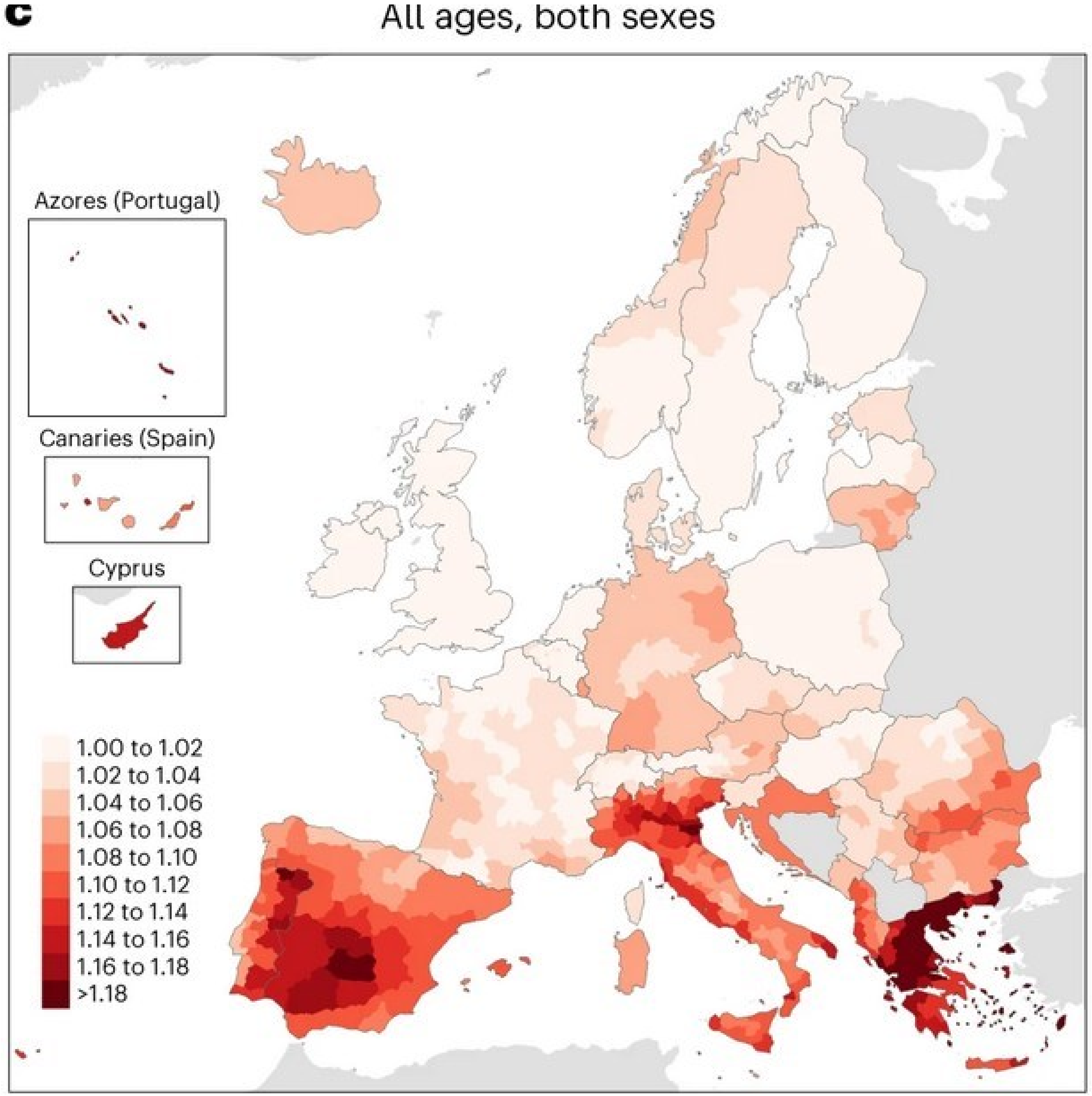
Giustizia climatica

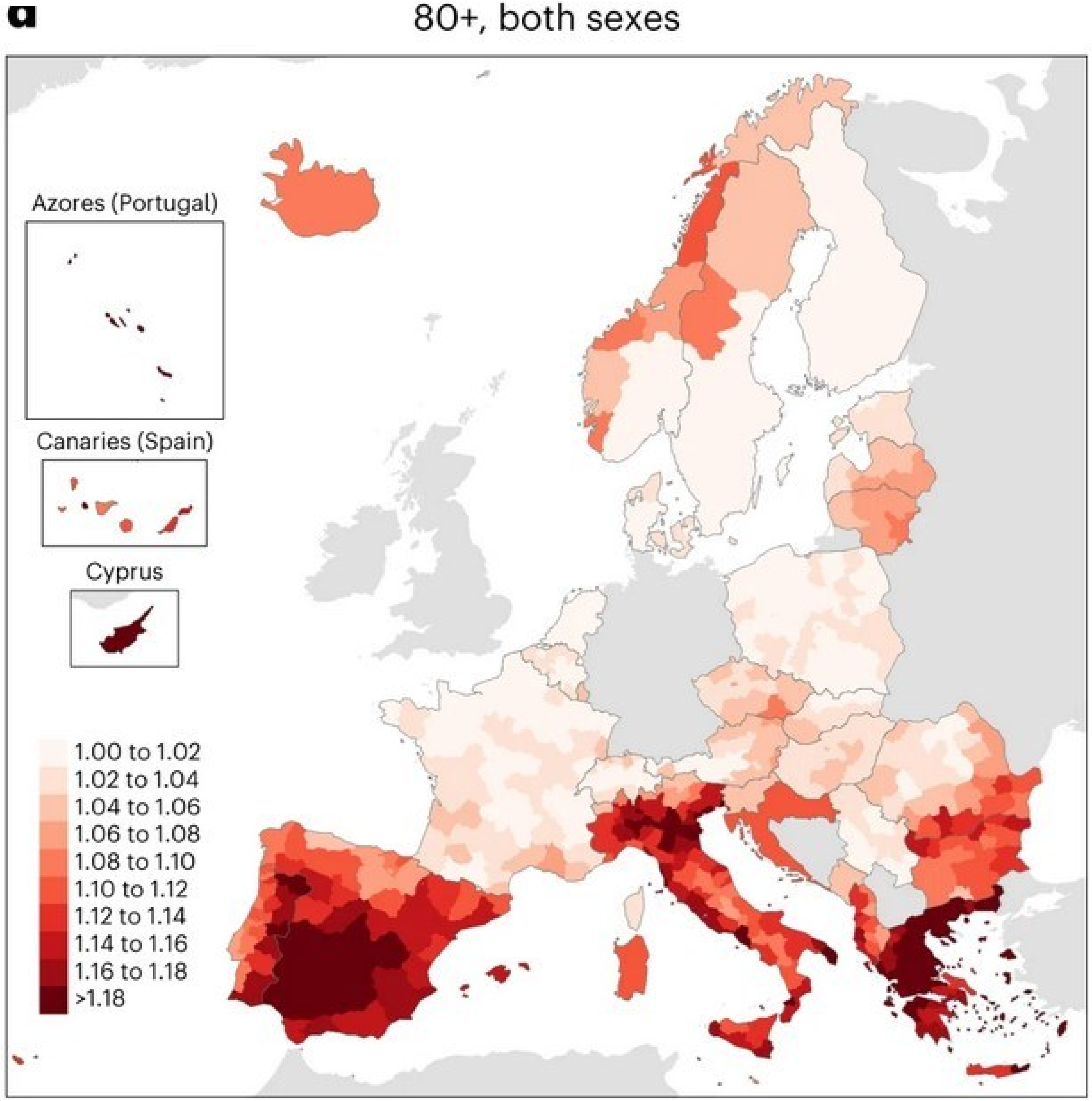
https://www.unisdr.org/files/1145_ewheatwave.en.pdf

Article | Open Access | Published: 10 July 2023

Heat-related mortality in Europe during the summer of 2022

nature medicine





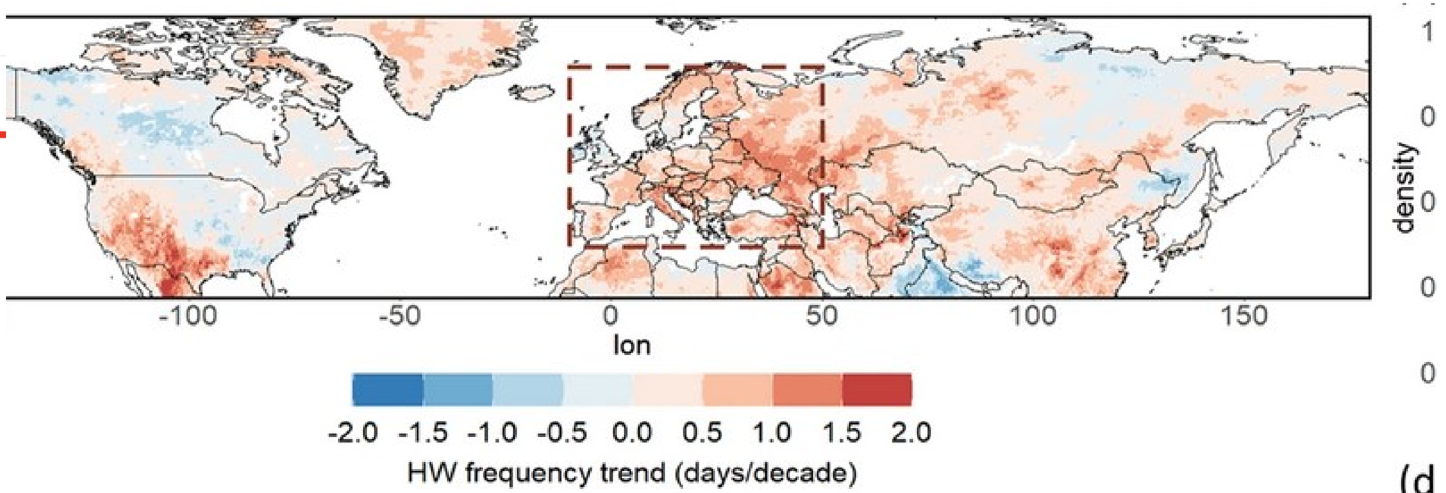
Università degli Studi di Padova

ICEA

GIScience

Climate Justice Centre of Excellence

Europa come *heatwave* hotspot



nature communications

Explore content | About the journal | Publish with us

nature > nature communications > articles > article

Article | Open Access | Published: 04 July 2022

Accelerated western European heatwave trends linked to more-persistent double jets over Eurasia

Efi Rousi, Kai Kornhuber, Goratz Beobide-Arsuaga, Fei Luo & Dim Coumou

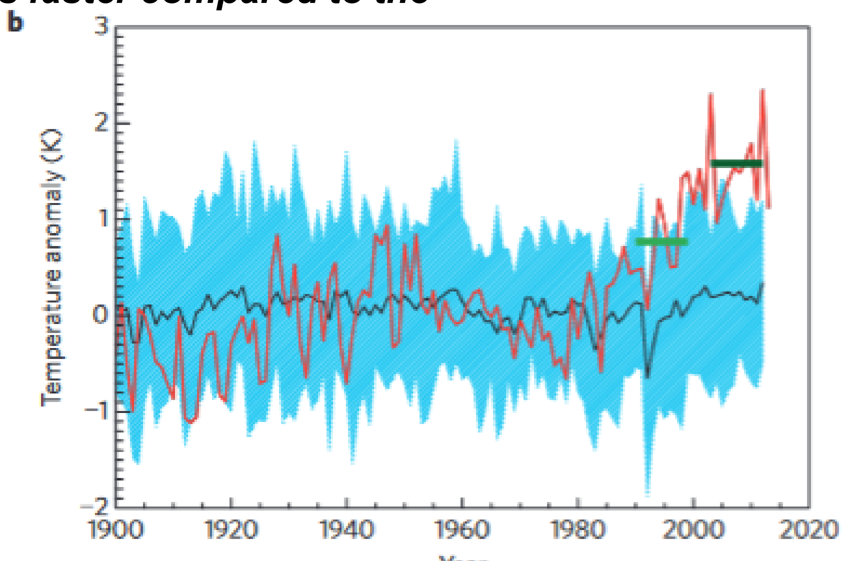
*“Here we identify Europe as a heatwave hotspot, exhibiting upward trends **that are three-to-four times faster compared to the rest of the northern midlatitudes** over the past 42 years” (Rouse et al. 2022)*

nature climate change | LETTERS

PUBLISHED ONLINE: 8 DECEMBER 2014 | DOI: 10.1038/NCLIMATE2468

Dramatically increasing chance of extremely hot summers since the 2003 European heatwave

Nikolaos Christidis*, Gareth S. Jones and Peter A. Stott



Using a previously employed temperature threshold to define extremely hot summers, we find that events that **would occur twice a century in the early 2000s are now expected to occur twice a decade**

https://www.nature.com/articles/s41467-022-31432-y

Climate extremes

WMO update: 50:50 chance of global temperature temporarily reaching 1.5°C threshold in next five years

- The chance of at least one year between 2022 and 2026 exceeding the warmest year on record (2016) is 93%
- The chance of the five-year mean for 2022-2026 being higher than the last five years (2017-2021) is also 93%

“Extreme events are the new norm” (Petteri Taalas, WMO)

Extreme weather events are the “daily face” of climate emergency (WMO, 2022)

Heatwaves kill

Heat stress, when the body cannot cool itself, is the leading cause of weather-relat
Region. Temperature extremes can also exacerbate chronic conditions, including c
and cerebrovascular diseases, and diabetes-related conditions.

Based on country data submitted so far, it is estimated that at least 15 000 people
heat in 2022. Among those, nearly 4000 deaths in Spain, more than 1000 in Portug
United Kingdom, and around 4500 deaths in Germany were reported by health au
months of summer.

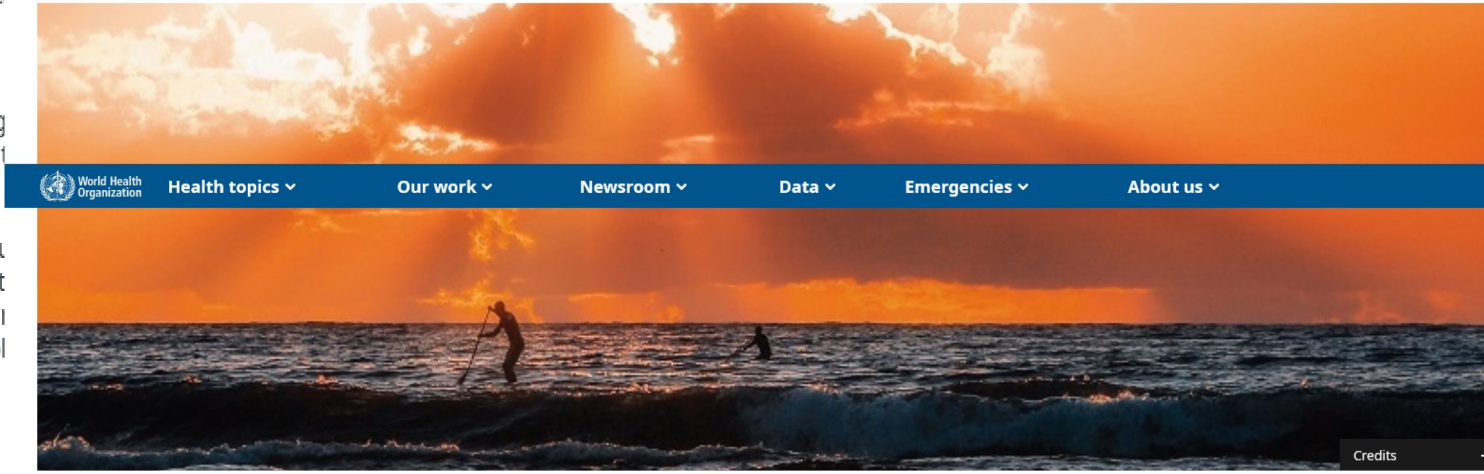
This estimate is expected to increase as more countries report on excess deaths du
France's National Institute of Statistics and Economic Studies (INSEE) reported that
people died between 1 June and 22 August 2022 compared with the same period i
the COVID-19 pandemic. INSEE suggested that these figures were "likely to be expl
occurred in mid-July, after an initial heatwave episode as early as mid-June".

CLIMATE

'Silent killers': Preparing for heatwaves could save thousands of lives every year, warns Red Cross

World Health Organization | Europe

Home / News / Statement – Climate change is already killing us, but strong action now can prevent more deaths



Français | Русский | Deutsch

Statement – Climate change is already killing us, but strong action now can prevent more deaths

Statement by WHO Regional Director for Europe Dr Hans Henri P. Kluge

7 November 2022 |Statement |Reading time: 4 min (1042 words)

Related

https://www.who.int/europe/news/item/07-11-2022-statement---climate-change-is-already-killing-us--but-strong-action-now-can-prevent-more-deaths

Scott Duncan
7.263 Tweet

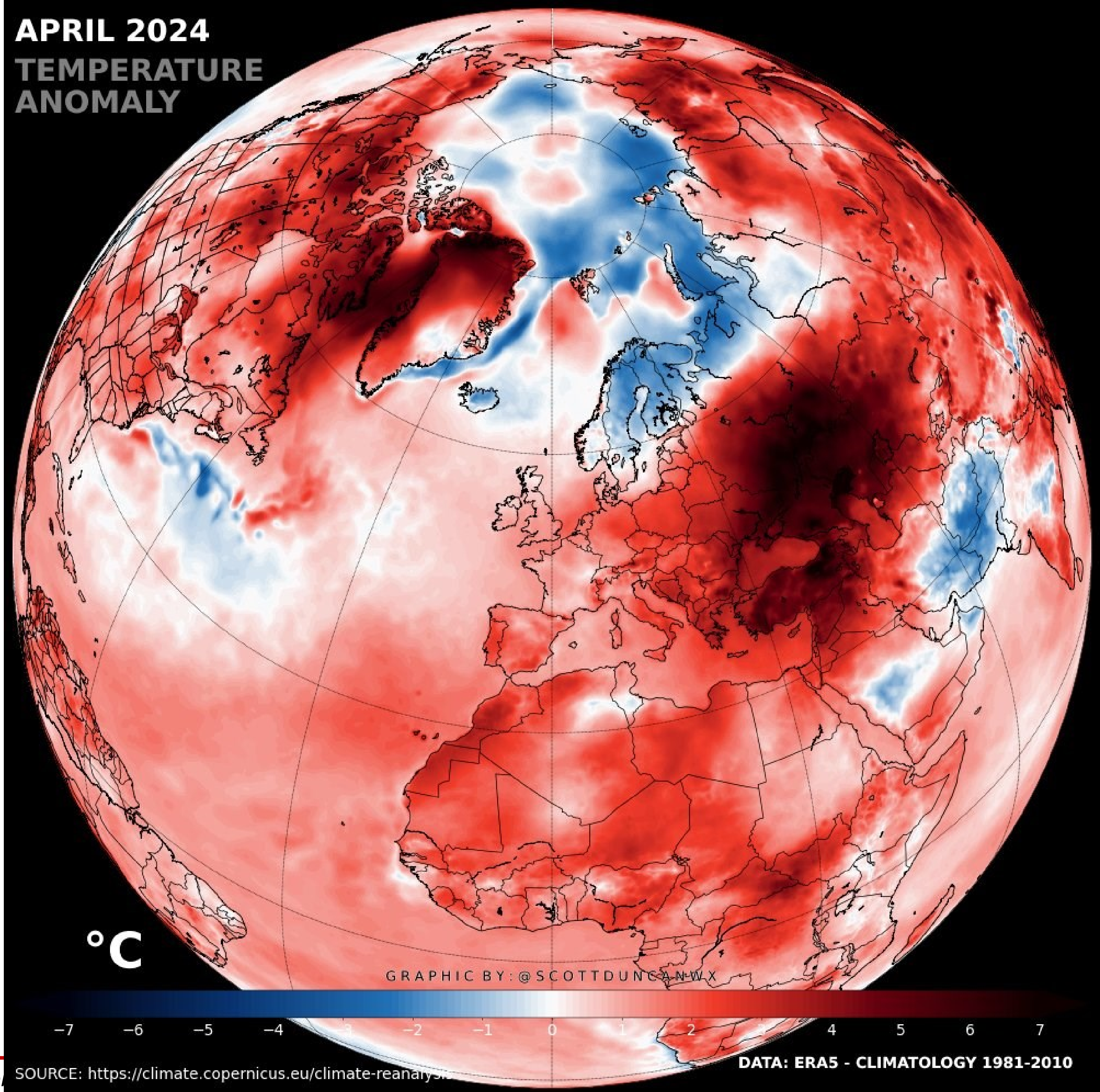
Segui

Scott Duncan
@ScottDuncanWX

Scottish meteorologist based in London | opinions are my own

London scottduncanwx.com Data di nascita: 24 settembre
Iscrizione: febbraio 2015

986 following **108.879** follower



Climate: Extreme temperatures for countries across the world

Pakistan's also seen a heatwave, with temperatures of more than 50C, causing fires to break out in some areas. A recent Met Office study found climate change is making record-breaking heatwaves in northwest India and Pakistan 100 times more likely.

WORLD

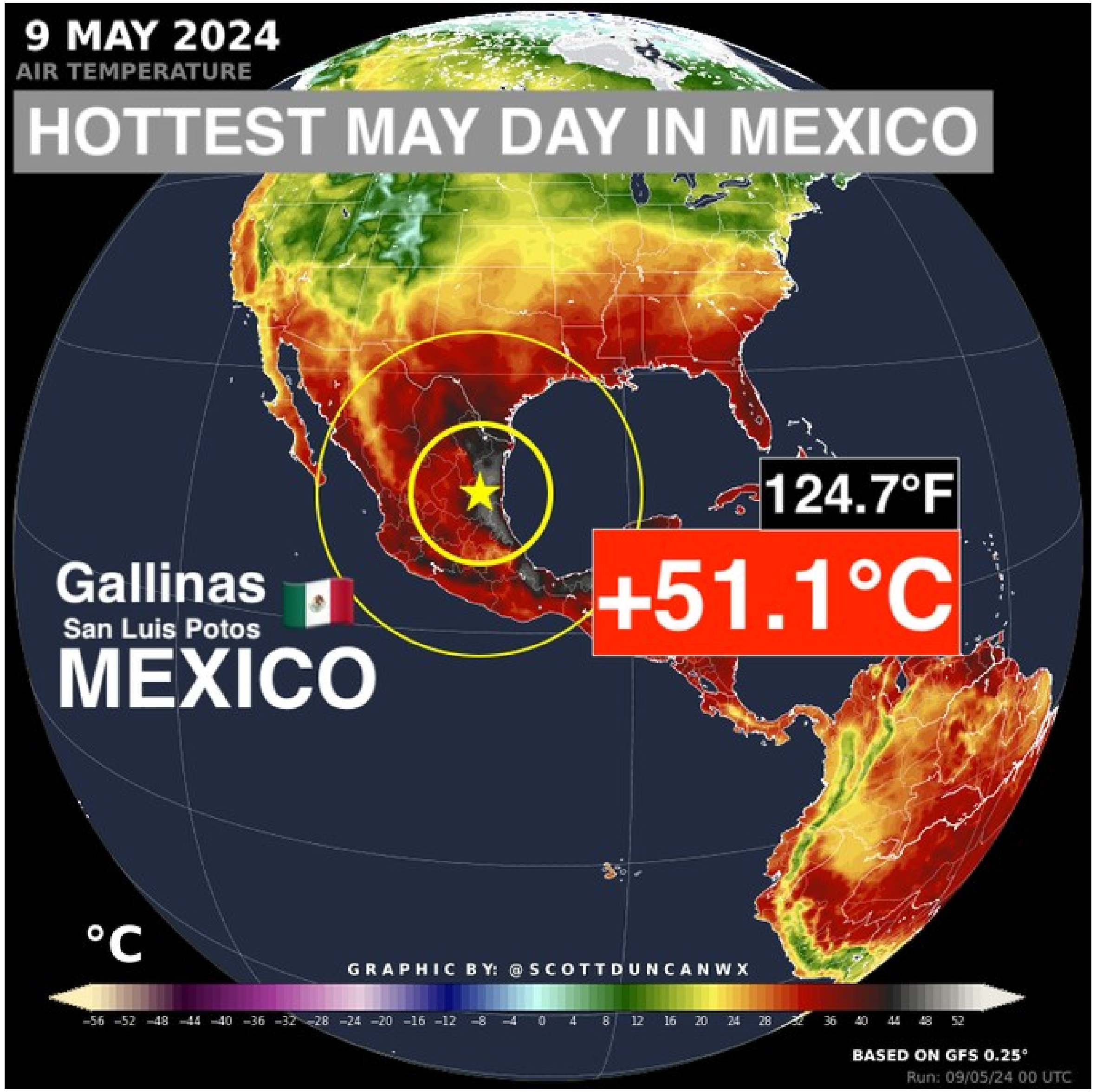
At least 50 deaths blamed on India heat wave in just a week as record temperatures scorch the country

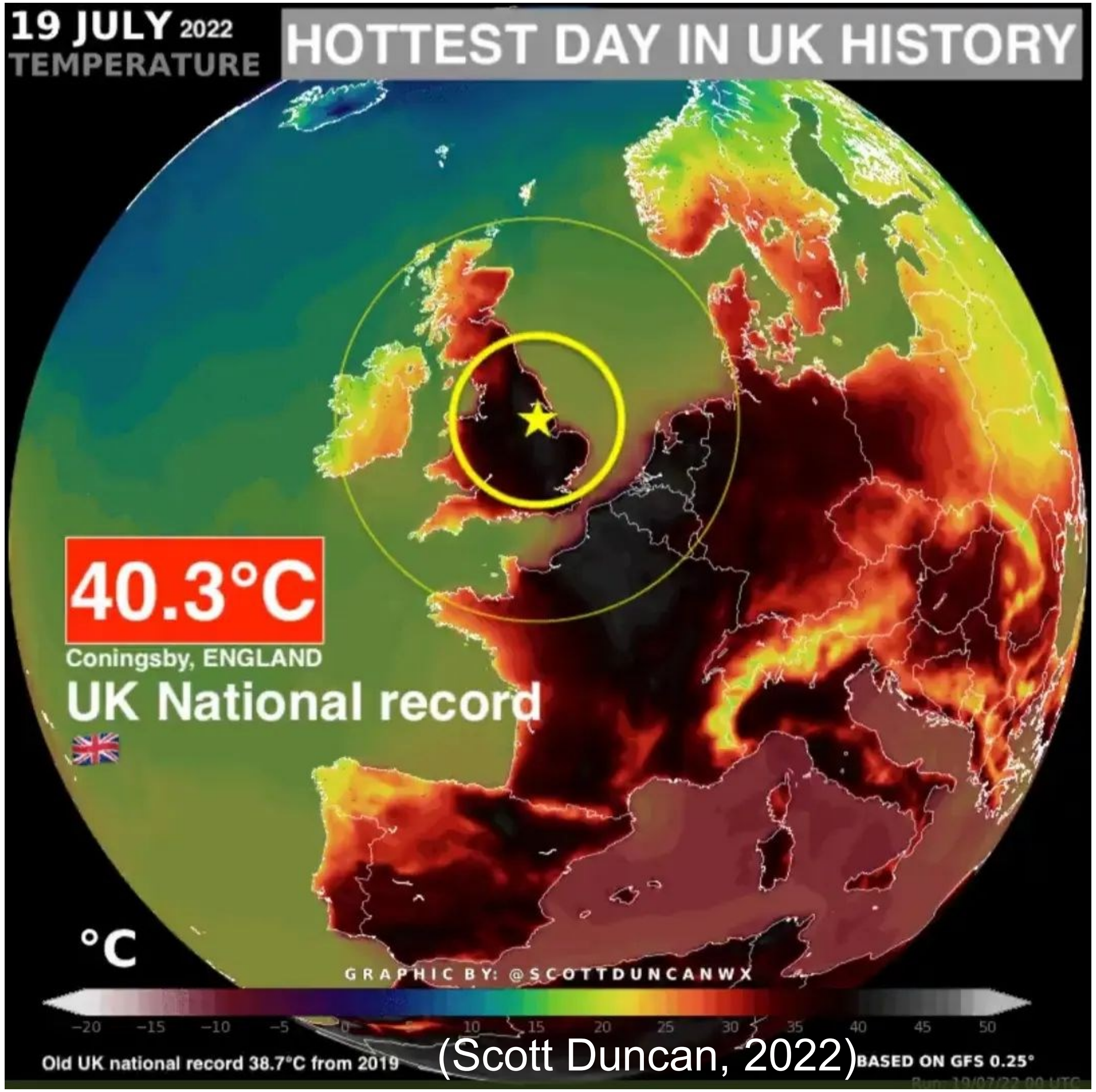
CBS NEWS

Pakistan temperatures cross 52 C in heatwave

By Akhtar Soomro and Ariba Shahid

May 28, 2024 4:18 PM GMT+2 · Updated 8 days ago





(Scott Duncan, 2022)

Heat waves impacts on energy supply

CNN BUSINESS | Markets | Tech | Media | Success | More

Europe braces for a potential gas crisis as historic heatwave boosts demand

By Anna Cooban, CNN Business

Updated 1501 GMT (2301 HKT) July 18, 2022

BBC | Sign in | Home | News | Sport | Reel | Worklife | Travel

NEWS

Home | War in Ukraine | Coronavirus | Climate | Video | World | UK | Business | Tech | Science | Stories

England | Regions | Sheffield & South Yorkshire

UK heatwave: Thousands suffer power cuts after equipment overheats

1 hour ago · Comments

UK heatwaves

Northern Powergrid is responsible for providing power to 3.9m households in the North East, Yorkshire and northern Lincolnshire

Heat waves impacts on the people

Spain's heat wave death toll climbs to 84

A heat wave in Spain has sparked forest fires and caused at least 84 deaths in its first week, according to figures published by the country's health ministry. CNN's Al Goodman reports. Source: CNN

“400 000 deaths worldwide in 2019 were linked to extreme heat events”


THE LANCET

THE LANCET
Planetary Health

ARTICLES | VOLUME 5, ISSUE 7, E415-E425, JULY 2021

Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study

Prof Qi Zhao, PhD • Prof Yuming Guo, PhD • Tingting Ye, MSc • Prof Antonio Gasparrini, PhD • Prof Shilu Tong, PhD • Ala Overcenco, PhD • et al. Show all authors

Open Access • Published: July, 2021 • DOI: https://doi.org/10.1016/S2542-5196(21)00081-4 • Check for updates

https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00081-4/fulltext

- Climate change in Italy is linked to increases in temperature, **changes in rainfall patterns and increased frequency and duration of extreme weather events**.
- The climate scenarios analyzed in this report show **a generalized +5°C increase** in average temperature **in 2100 compared** to the beginning of the century (worst case scenario, RCP8.5).
- The precipitation regime shows significant differences throughout the region.
- **All the scenarios considered show an increase in the number of hot and dry days during the year.**

https://www.cmcc.it/wp-content/uploads/2020/09/en_EXECUTIVE_SUMMARY_CMCC_climate_RISK_in_ITALY.pdf

3 - Analysis of the expected risk for Italy: key sectors

Risk Analysis

Climate Change in Italy

Executive Summary

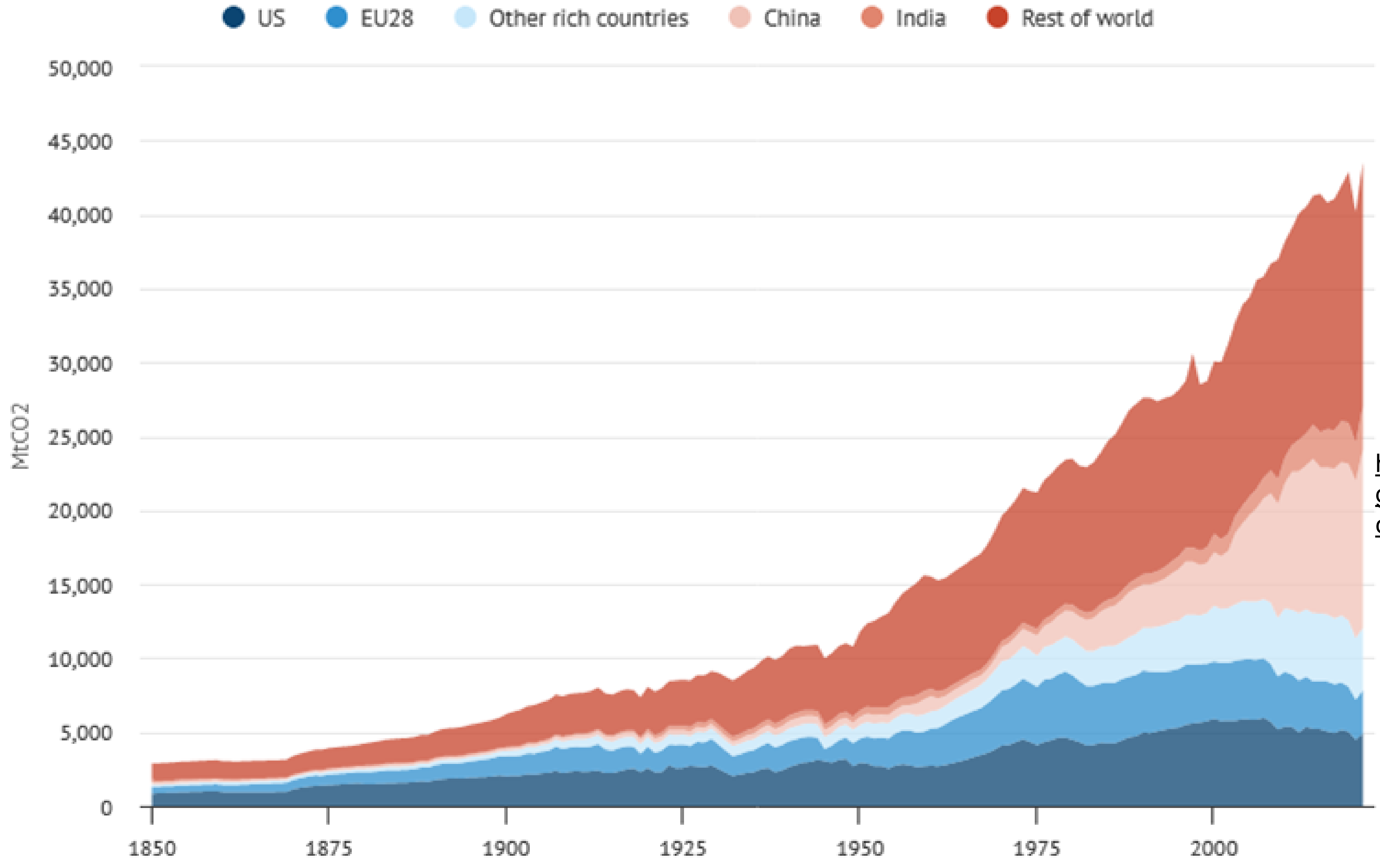
- **Urban environment**
  Urbanized areas will suffer strong negative impacts from climate change, especially in reference to extreme climate phenomena (heat waves and intense precipitation events).
  The most fragile segments of the population (children, the elderly and people with disabilities) will be the primary victims of the most negative effects.
  Intense heat represents a health risk for the population.
  Urban centers experience temperatures 5-10°C higher than their surrounding rural areas.
  In 2019, there were 29 more days of intense heat than in the period 1961-1990. Climate projections predict an increase in these phenomena, which are exacerbated in urban area

https://www.cmcc.it/wp-content/uploads/2020/09/en_EXECUTIVE_SUMMARY_CMCC_climate_RISK_in_ITALY.pdf

climate justice

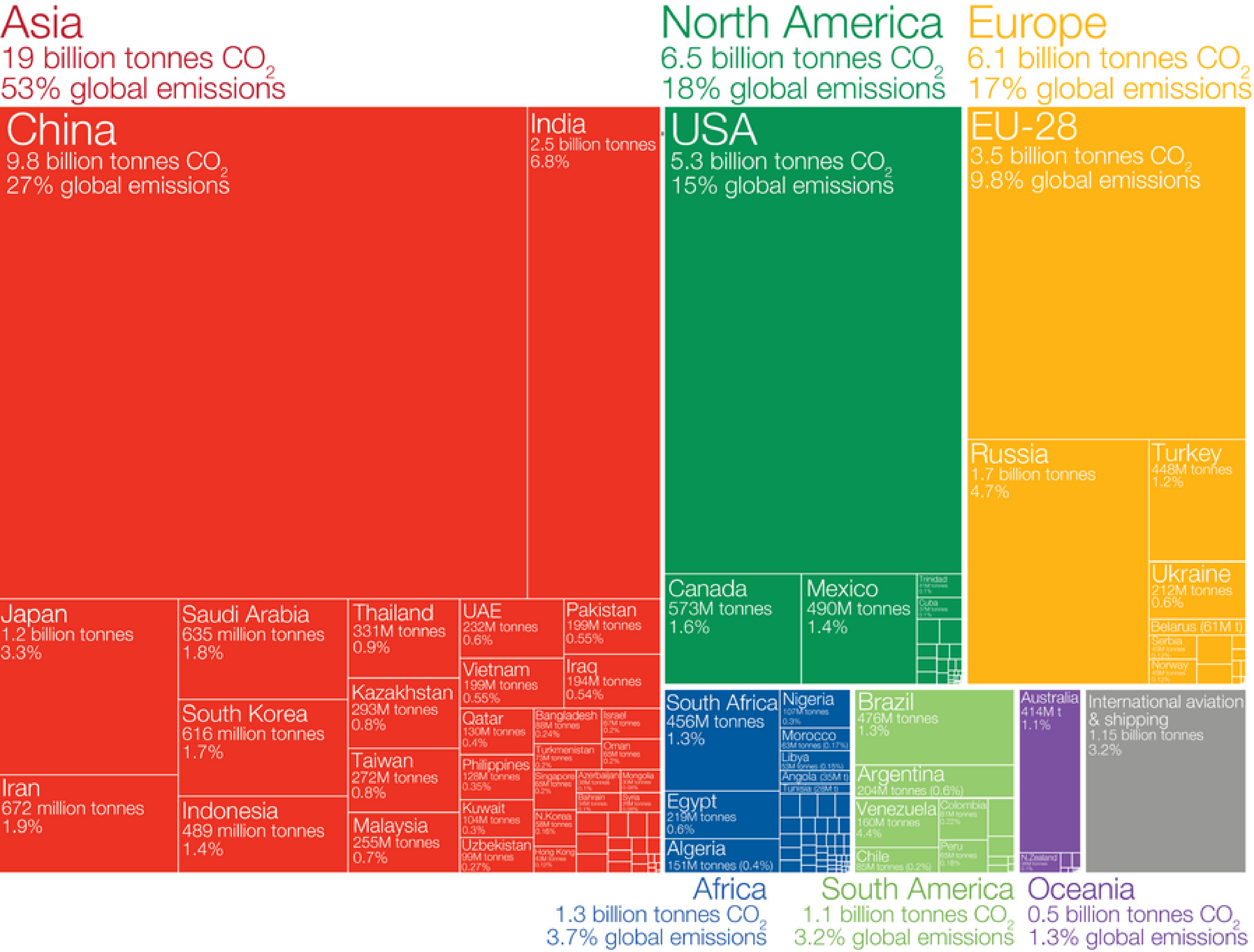
Rich nations have produced a disproportionate volume of emissions

Countries that are home to just 14% of the global population are responsible for nearly half of historical emissions



https://www.carbonbrief.org/in-depth-qa-what-is-climate-justice/

(**Figure TS.2,** AR5, WGIII, SPM, 2015)



Climate Justice
Centre of Excellence

Global CO_2 emissions (Gt)

2017 36.2 Gt CO_2

Who emits the most?

https://ourworldindata.org/co2-emissions#annual-co2-emissions

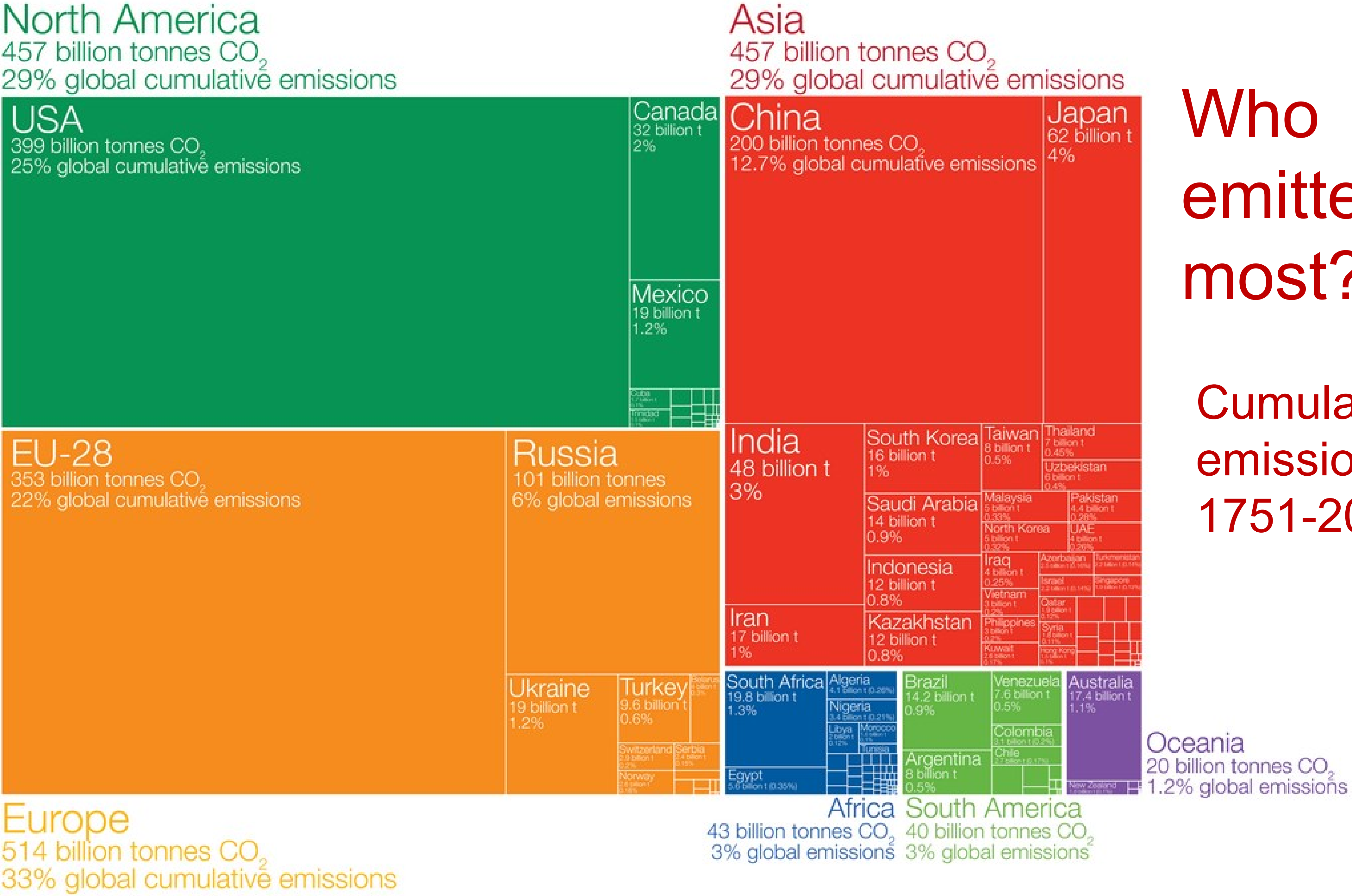
(GCP 2017)

Prof. Salvatore Pappalardo

te Justice
of Excellence

Who emitted the most?

Cumulative CO_2 emissions 1751-2017

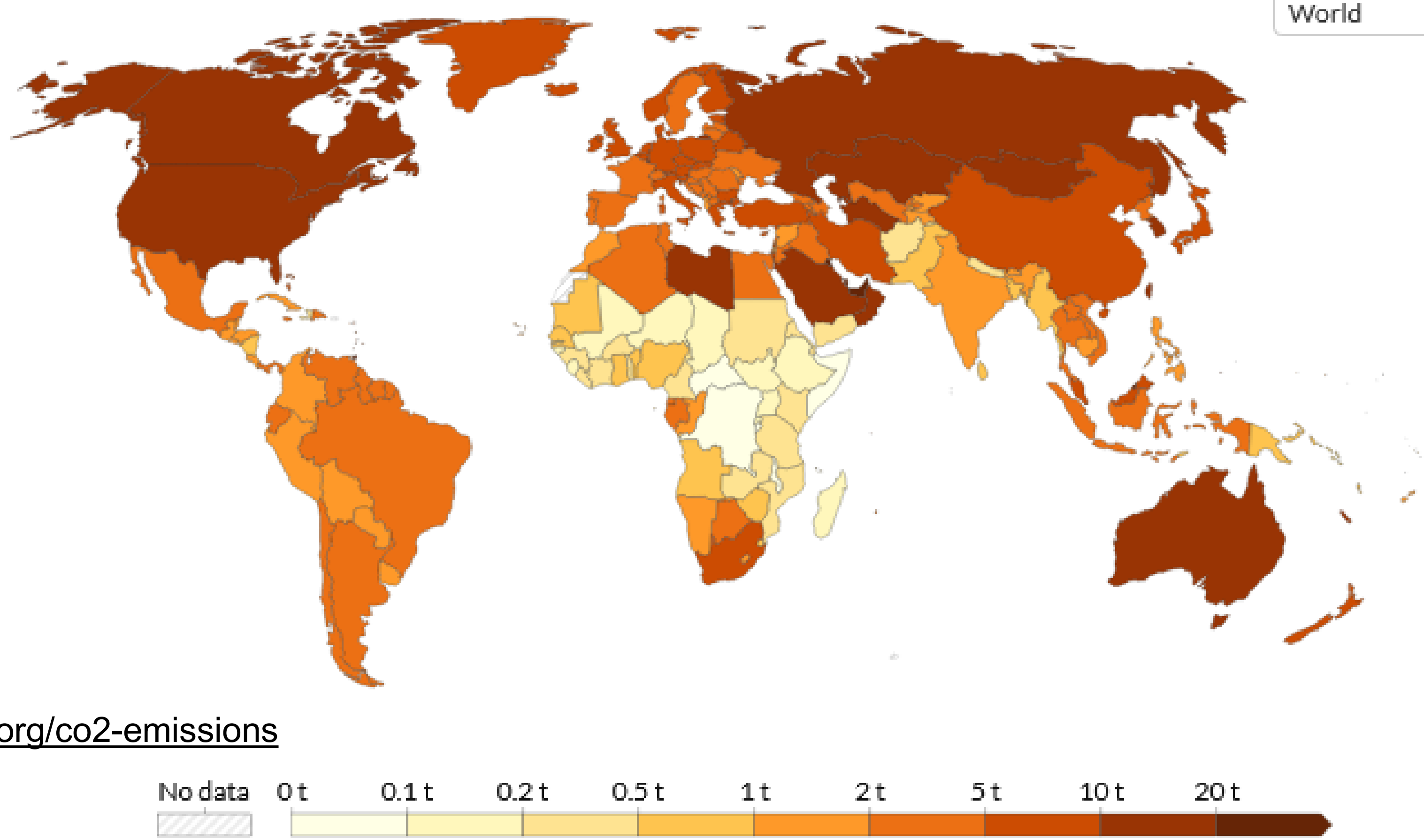


Per capita CO_2 emissions, 2021

Carbon dioxide (CO_2) emissions from fossil fuels and industry. Land use change is not included.

Our World in Data

World



https://ourworldindata.org/co2-emissions

Source: Our World in Data based on the Global Carbon Project (2023)

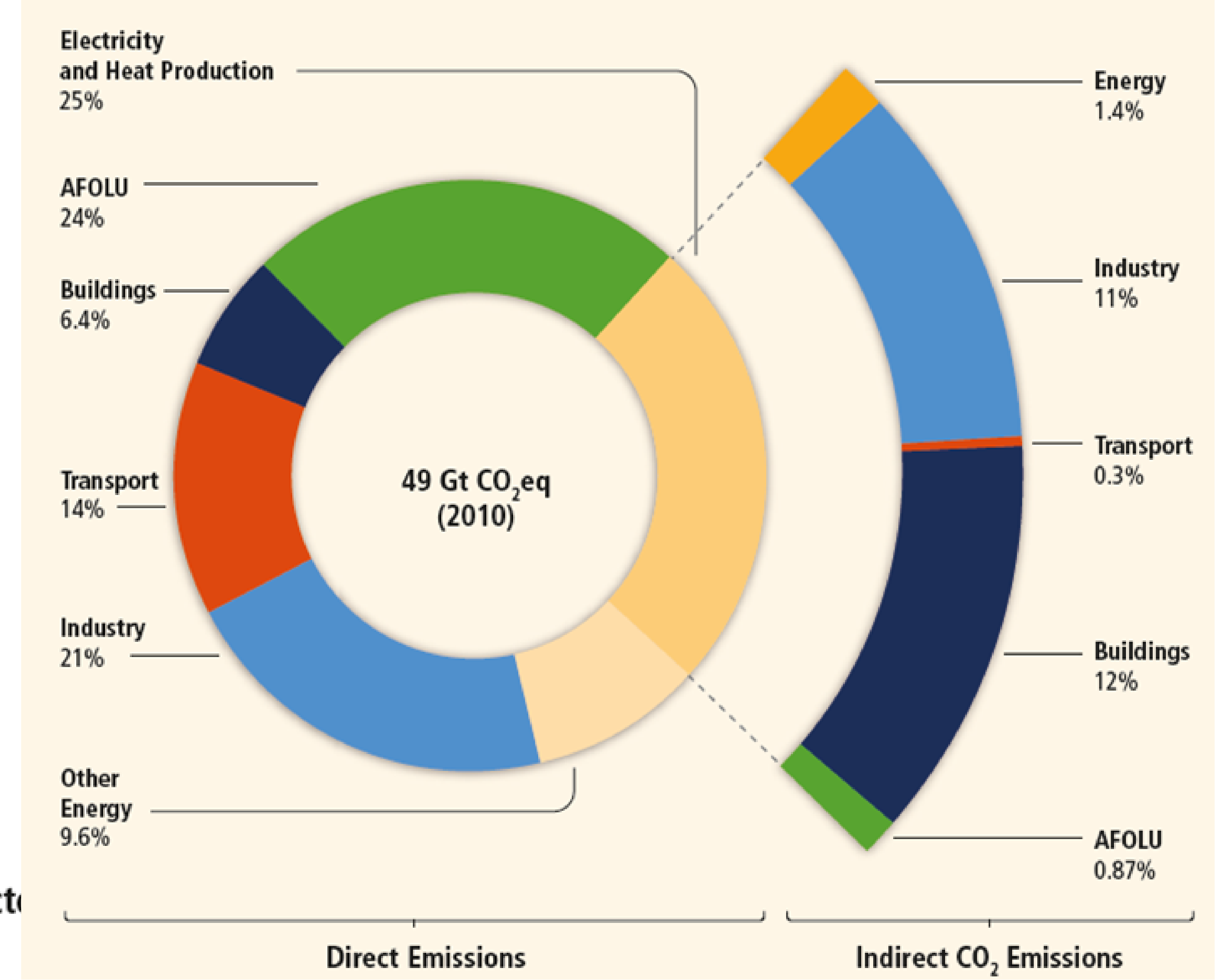
1750 2021

CHART | MAP | TABLE | SOURCES | DOWNLOAD

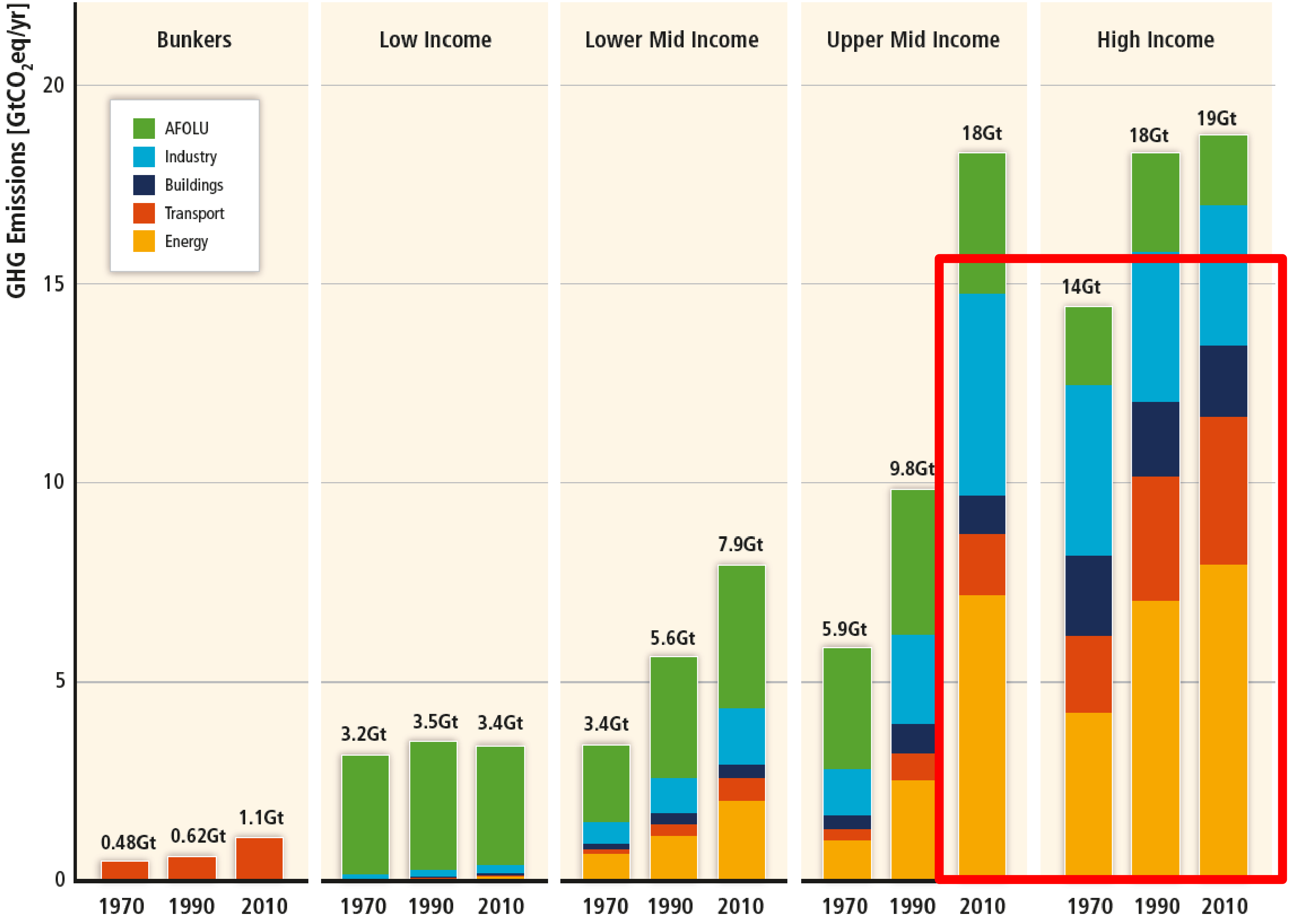
Related: CO_2 data: sources, methods a

Feedba

Greenhouse Gas Emissions by Economic Sect

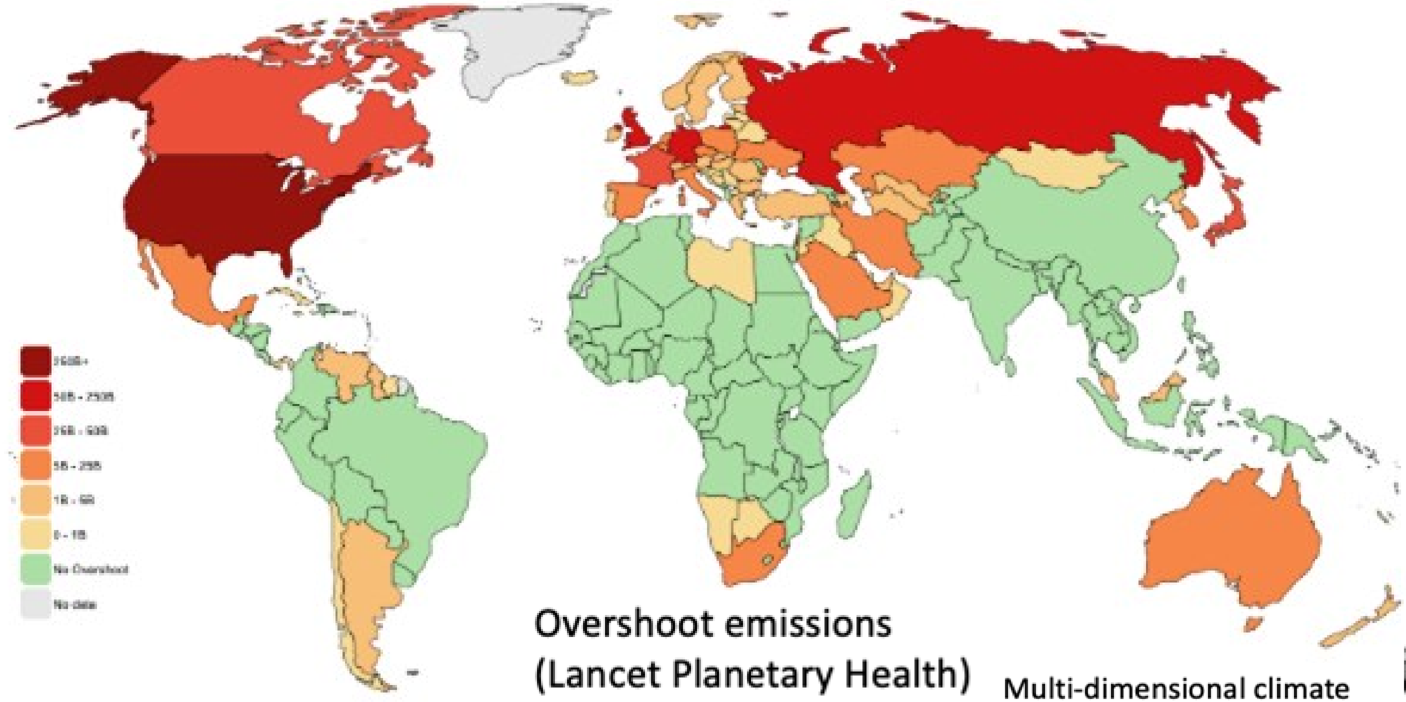


(**Figure TS.3,** AR5, WGIII, SPM, TS, 2015)



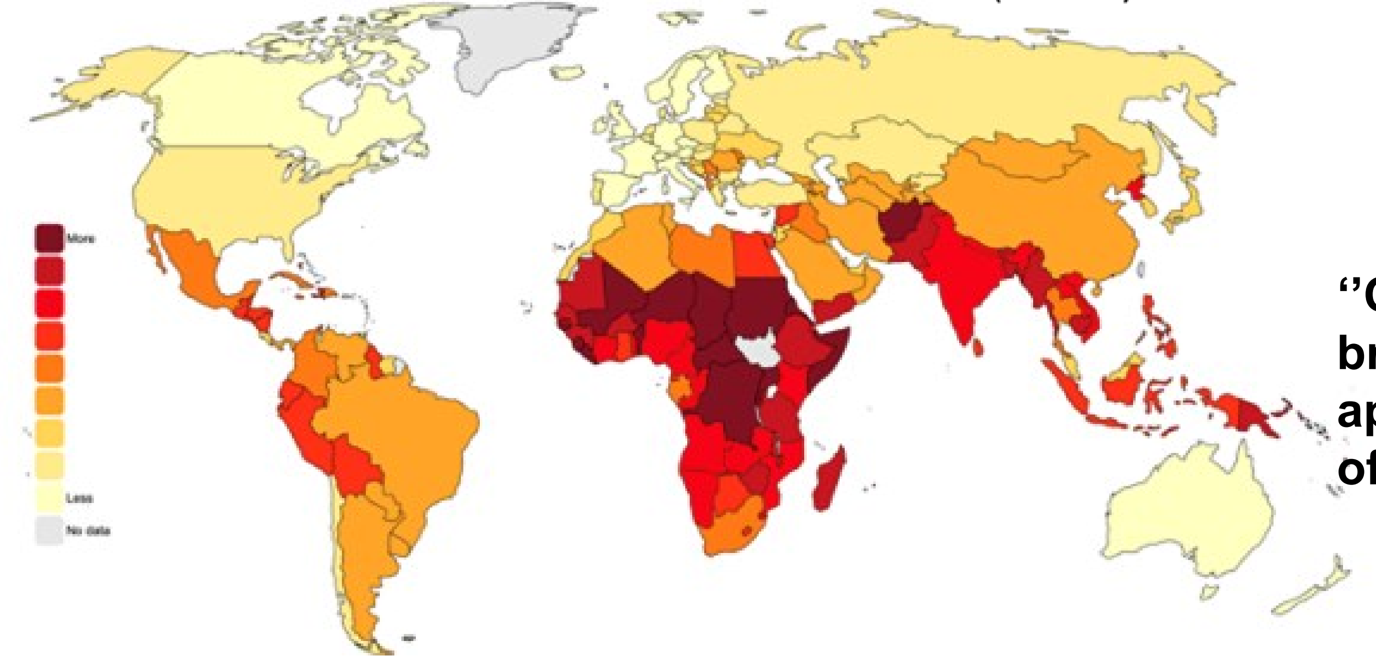
Total anthropogenic GHG emissions in 1970, 1990 and 2010 by five major economic sectors and country income groups

(**Figure TS.3,** AR5, WGIII, SPM, 2015)



Overshoot emissions
(Lancet Planetary Health)

Multi-dimensional climate
vulnerability
(ND-GAIN)



- USA 40%
- EU-28 29%
- G8 85%
- Paesi Annex1 (UNFCC) 90%
- Global North 92%
- Global South sotto soglia (tranne Cina)

Jason Hickel
@jasonhickel

The top map shows which nations are most responsible for excess emissions. The bottom map shows which nations are most impacted by it. If we are not attentive to the colonial dimensions of climate breakdown, we are missing the point.

Traduci il Tweet

''Quantifying national responsibility for climate breakdown: an equality-based attribution approach for carbon dioxide emissions in excess of the planetary boundary''

(Hickel 2020, Lancet Planetary Health)

https://gain.nd.edu/our-work/country-index/download-data/

What is ‘climate justice’?

What is 'climate justice'?

The impacts of climate change will not be borne equally or fairly, between rich and poor, women and men, and older and younger generations. (UN Portal)

Climate Justice recognizes the **disproportionate impacts of climate change on low-income communities and communities of color around the world, the people and places least responsible for the problem**. It connects the climate crisis to the social, racial and environmental issues in which it is deeply entangled. It recognizes the disproportionate impacts of climate change on low-income and BIPOC communities around the world, the people and places least responsible for the problem. (UC, Center for Climate Justice)

Climate justice means that countries that became wealthy through unrestricted carbon emissions have the greatest responsibility to not only stop warming the planet, but also to help other countries adapt to climate change and develop economically with nonpolluting technologies (MIT, Climate Portal)

Climate justice is a set of rights and obligations, which corporations, individuals and governments have towards those vulnerable people who will be in a way significantly disproportionately affected by climate change (Rosa, 2021)

What is ‘climate justice’?

https://centerclimatejustice.universityofcalifornia.edu/what-is-climate-justice/

https://yaleclimateconnections.org/2020/07/what-is-climate-justice/

https://climate.mit.edu/explainers/climate-justice

https://www.iucn.org/news/world-commission-environmental-law/202103/climate-equity-or-climate-justice-more-a-question-terminology

Climate justice

- Responsabilità storica dei cambiamenti climatici dei paesi più ricchi e degli attori più potenti
- I cambiamenti climatici impattano in maniera disproporzionata sugli attori più poveri e più vulnerabili
- Contrasto tra i paesi più industrializzati e i PVS
- Ineguale distribuzione degli impatti tra diversi ‘attori deboli’ (popolazioni indigene, etnie non occidentali, donne) in diverse aree geografiche e territori
- Giustizia ‘intergenerazionale’ tra le generazioni più vecchie che hanno beneficiato dei combustibili fossili e che lasciano a quelle più giovani il compito di affrontare e gestire le conseguenze

Climate justice

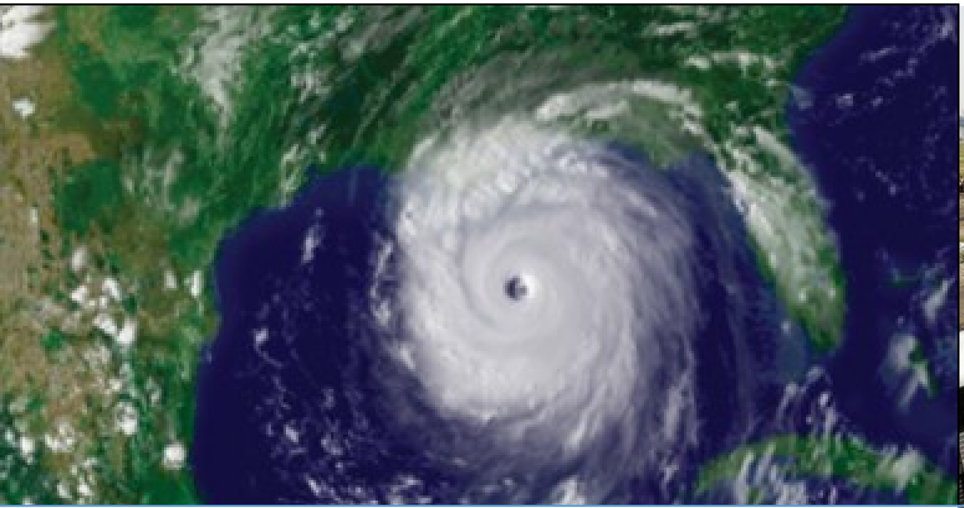
Climate change →

- Impatti sociali
- Impatti economici
- Impatti sulla salute pubblica

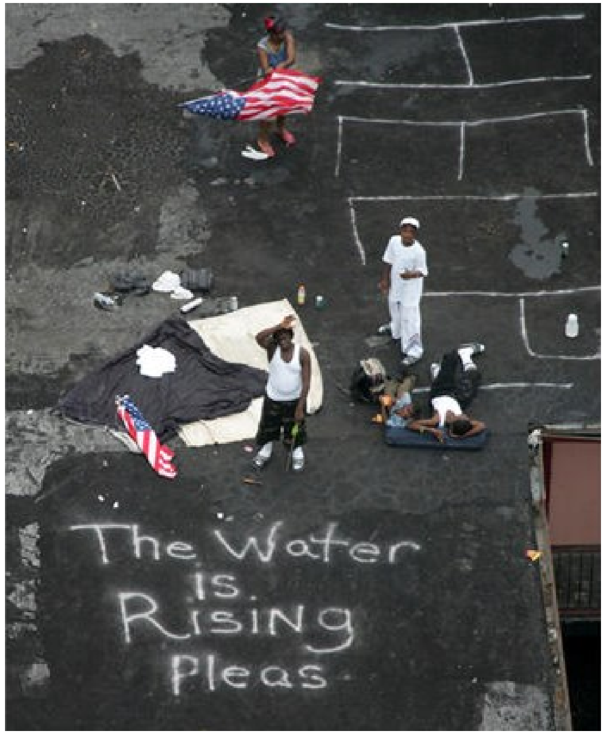
- Coinvolgimento della **sfera sociale e dei diritti** circa gli effetti del *climate change*
- Riconoscimento che diversi attori (stakeholders, gruppi sociali) sono colpiti in maniera diversa dagli effetti del *climate change*
- Gli impatti del *climate change* possono esacerbare le condizioni sociali di ineguaglianza

“The impacts of climate change will not be borne equally or fairly, between rich and poor, women and men, and older and younger generations” (UN, 2019)

“Climate change is happening now and to all of us. No country or community is immune and, as is always the case, the poor and vulnerable are the first to suffer and the worst hit.”
(António Guterres, UN Secretary-General)



Hurricane Katrina
(New Orleans, August 2005)



Condizioni preesistenti di ingiustizia sociale:

- povertà
- segregazione razziale
- divario educativo e culturale

Heat waves impacts on the people

Sweltering streets: Hundreds of homeless die in extreme heat

By ANITA SNOW June 24, 2022

AP NEWS

Spain's heat wave death toll climbs to 84

A heat wave in Spain has sparked forest fires and caused at least 84 deaths in its first week, according to figures published by the country's health ministry. CNN's Al Goodman reports. Source: CNN

THE LANCET

THE LANCET
Planetary Health

ARTICLES | VOLUME 5, ISSUE 7, E415-E425, JULY 2021

Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study

Prof Qi Zhao, PhD • Prof Yuming Guo, PhD • Tingting Ye, MSc • Prof Antonio Gasparrini, PhD • Prof Shilu Tong, PhD • Ala Overcenco, PhD • et al. Show all authors

Open Access • Published: July, 2021 • DOI: https://doi.org/10.1016/S2542-5196(21)00081-4 • Check for updates

“400 000 deaths worldwide in 2019 were linked to extreme heat events”

https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00081-4/fulltext

Achieving a climate justice pathway to 1.5 °C

Key concepts:

- Climate risks to human rights
- Risks from climate action
- Risks from impacts versus action
- Just pathway to 1.5°C

Mary Robinson and Tara Shine 2015

PERSPECTIVE
https://doi.org/10.1038/s41558-018-0189-7
nature climate change

Achieving a climate justice pathway to 1.5 °C

Mary Robinson and Tara Shine *

It is vital for climate justice to pursue a pathway to zero carbon emissions by 2050 to limit global temperature rise to 1.5 °C above pre-industrial levels and to minimize the adverse impacts of climate change on people and their human rights. But can such a pathway be achieved without undermining human rights and restricting the right to development? This Perspective discusses the risks of action and inaction to identify a fair and just transition. It compares the risks posed to human rights from climate impacts with the risks posed by climate action and suggests that rights-informed climate action can maximize benefits for people and the planet.

Climate justice is a concept that views climate change and efforts to combat it as having ethical implications and considers how these relate to wider justice concerns[1]. Climate justice links human rights and development to achieve a human-centred approach, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts equitably and fairly[2]. It is informed by science and responds to science. As a result, climate justice strives to achieve the 1.5 °C temperature goal and avoid dangerous climate change. This approach is underpinned by a desire to respect and protect the human rights of all people, particularly those living in vulnerable situations, in the face of climate impacts and through climate actions.

Climate change is well established as an issue of ethics and justice[3–11]; in terms of climate impacts (including asymmetrical

Paris Agreement includes a commitment to respect human rights and gender equality in all climate action. This is a less explored and less well understood area of climate justice: how human rights can inform climate action — particularly the aggressive climate action needed to pursue a 1.5 °C pathway.

This Perspective investigates whether it is possible to make the rapid transition to low-carbon, climate-resilient development without undermining human rights, including the right to development. First the impacts of climate change on human rights are assessed, followed by an appraisal of the risks to human rights from climate action and international regulations on GHG emissions. Both sets of risks are then compared, and the implications for climate action consistent with a 1.5 °C pathway are discussed to identify the critical factors for a fair and just transition.

UNIVERSITÀ DEGLI STUDI DI PADOVA | ICEA | GIScience | Climate Justice Centre of Excellence

PennIUR — Penn Institute for Urban Research | Kleinman Center for Energy Policy | Perry World House

PENN: CURRENT RESEARCH ON SUSTAINABLE URBAN DEVELOPMENT

Climate Justice and the Right to the City

https://penniur.upenn.edu/uploads/media/Cohen.pdf

nature communications

Explore content | About the journal | Publish with us

nature > nature communications > articles > article

Article | Open Access | Published: 30 September 2022

US cities increasingly integrate justice into climate planning and create policy tools for climate justice

Claudia V. Diezmartínez & Anne G. Short Gianotti

Nature Communications **13**, Article number: 5763 (2022) | Cite this article

https://www.nature.com/articles/s41467-022-33392-9

ELSEVIER

Environmental Science & Policy

Volume 136, October 2022, Pages 609-619

Connecting climate justice and adaptation planning: An adaptation justice index

Sirkku Juhola, Milja Heikkinen, Taru Pietilä, Fanny Groundstroem, Janina Käyhkö

Show more

+ Add to Mendeley | Share | Cite

Climate change | Urban

Urban climate justice: connecting social justice and decarbonisation

iied International Institute for Environment and Development

To achieve sustainable urbanisation, cities must build inclusive systems that reduce inequality while enabling pathways to net zero.

UNIVERSITÀ DEGLI STUDI DI PADOVA

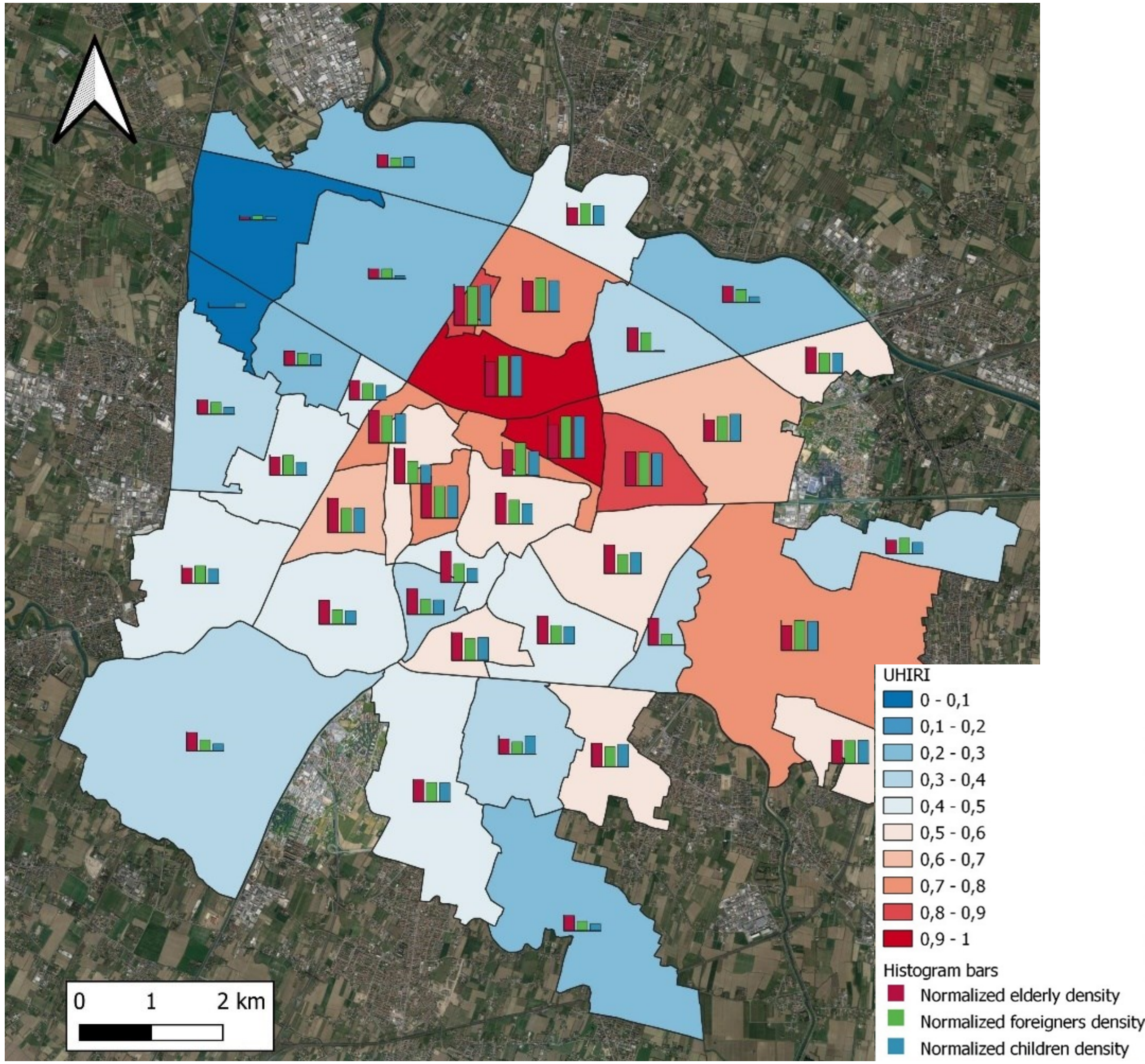
ICEA

GIScience

Climate Justice Centre of Excellence

Climate Justice – Integrated heat-related Risk Analysis for vulnerable social groups

1. Heat-related Child Risk analysis (HCRI Index)
2. Heat-related Elderly Risk Index analysis (HERI)
3. Heat-related Alone Elderly Risk Index (HAERI)
4. Heat-related Foreigners Risk Index (HFRI)
5. Heat-related Low-Income Risk Index (HLIRI)
6. UHI Risk Index (UHIRI)



(Pappalardo SE, Zanetti C, Todeschi, 2023, *in review*)

"Extreme heat costs lives. Climate change is wreaking havoc on subsistence farmers and is driving a steady stream of people from rural areas into informal settlements in cities"

Yvonne Aki-Sawyerr, Mayor of Freetown, Sierra Leone

Università degli Studi di Padova

ICEA

GIScience

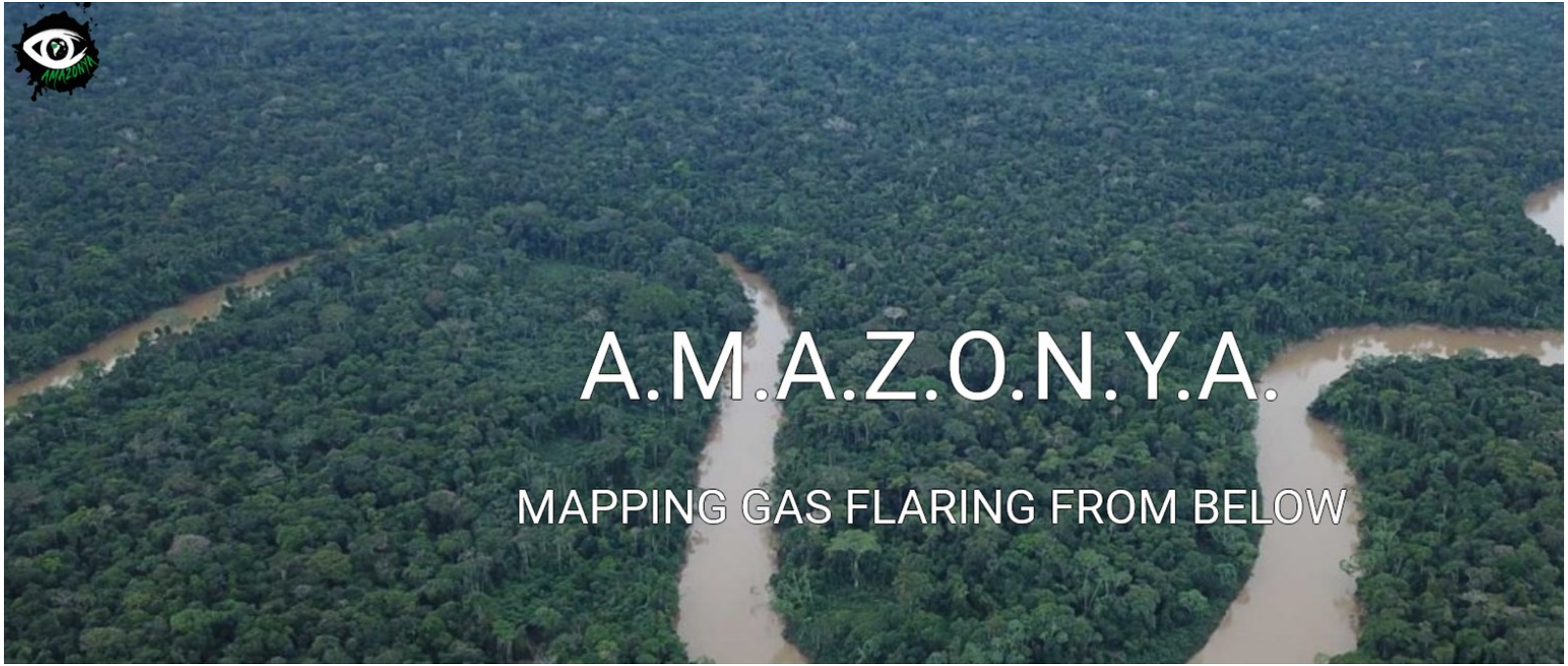
Climate Justice
Centre of Excellence

Cambiamenti climatici e adattamenti negli ecosistemi e società

- Seminari ed eventi GIScience
- Iniziative ed incontri ESTATE GIS
- Festival Drones4Good
- Science4All Unipd

www.mastergiscience.it
https://em-stede.eu/
https://www.gishub.it/

https://www.facebook.com/MasterGIScience
https://www.facebook.com/EMSTeDe



https://www.climate-justice.earth/amazonya/index.html

https://www.youtube.com/watch?v=YkknFGyr3AY
https://www.youtube.com/watch?v=BNMfipCOtOk&t=7s
https://www.youtube.com/watch?v=xv4Q7twwR80&t=11s
https://www.youtube.com/watch?v=0E7eh3plCc4&t=20s
https://www.youtube.com/watch?v=xv4Q7twwR80