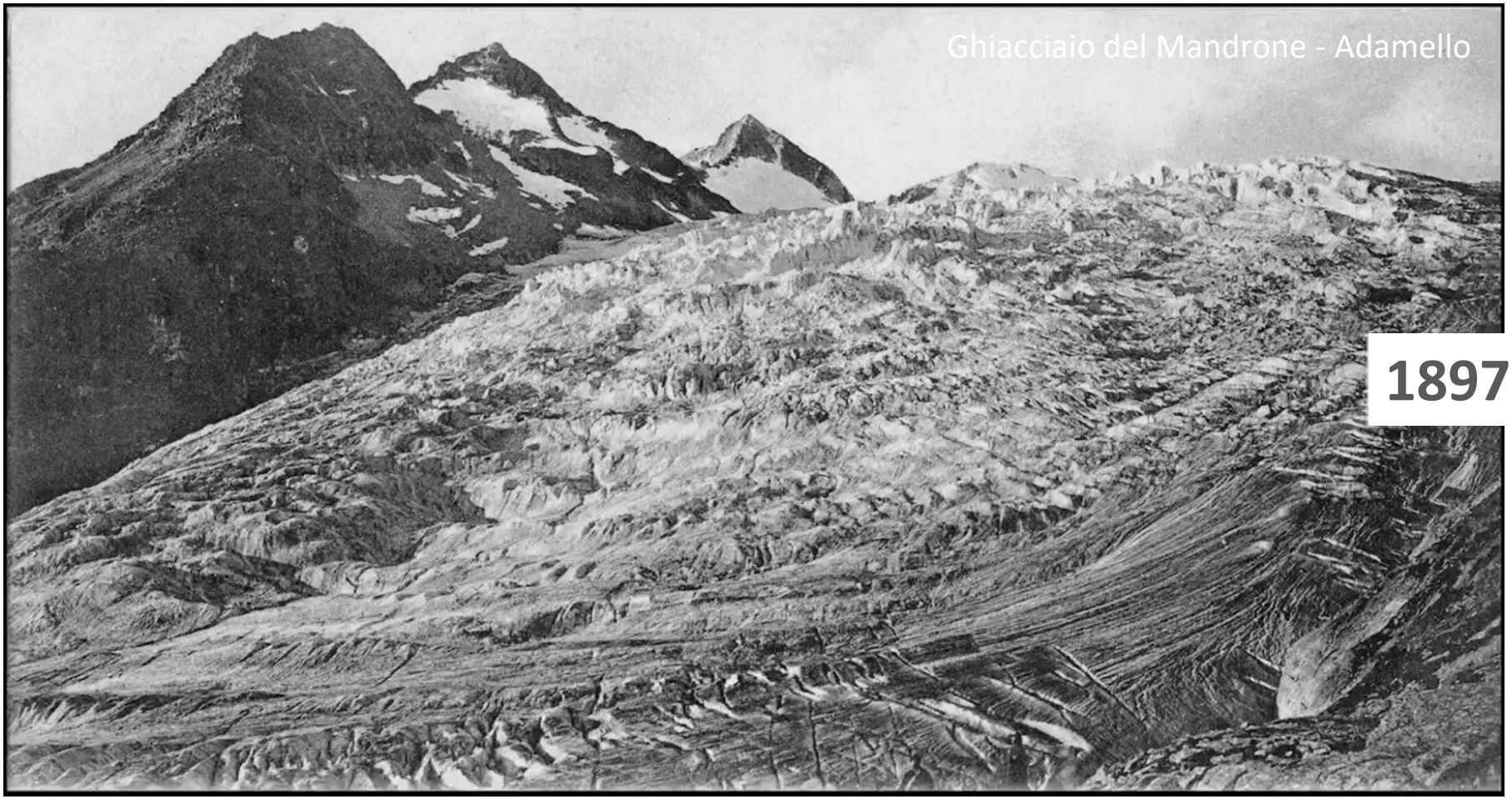


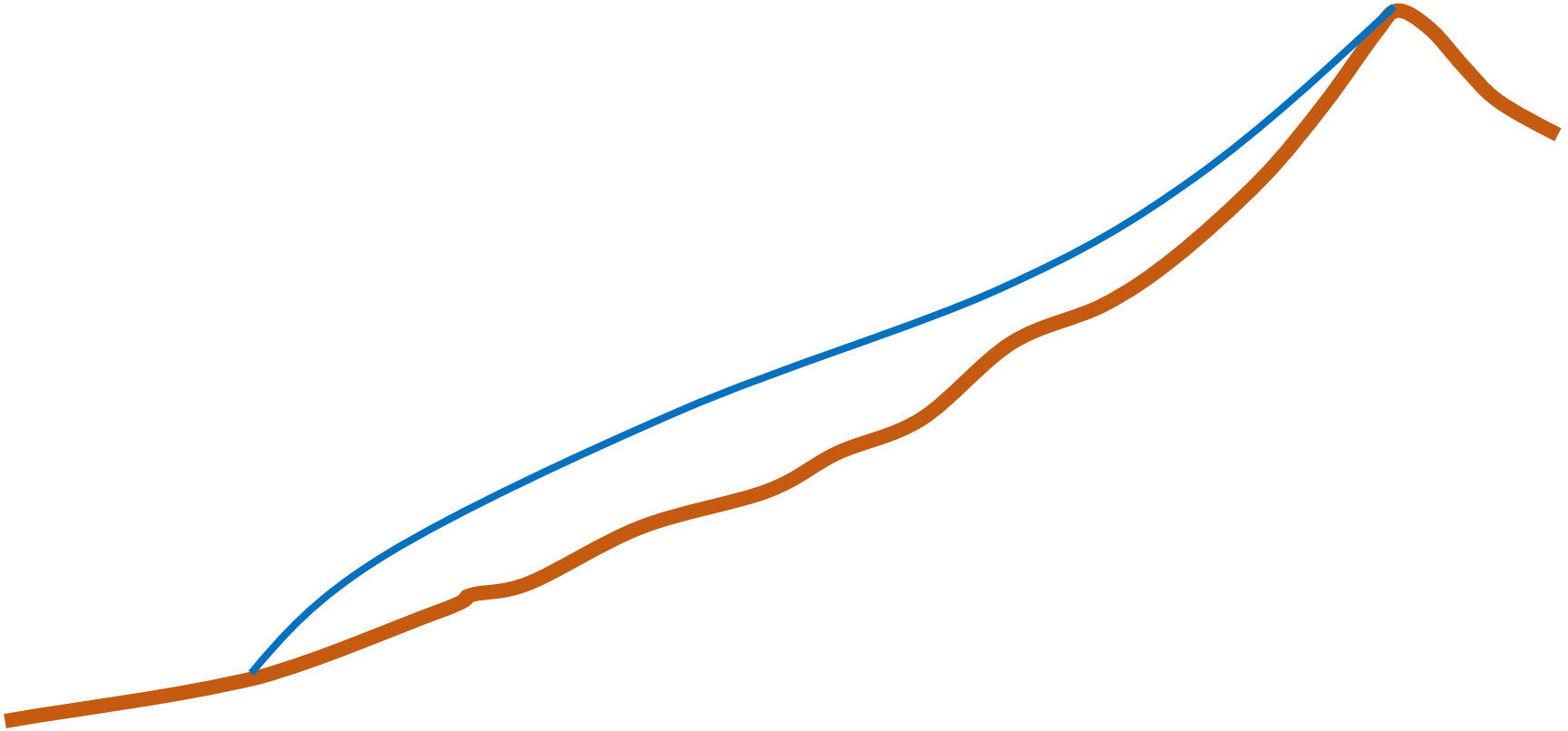
CNR
Consiglio Nazionale delle Ricerche

Dipartimento di Scienze del Sistema Terra e Tecnologie per l'Ambiente
ISMAR Trieste

Cambiamento climatico, evidenze globali e locali

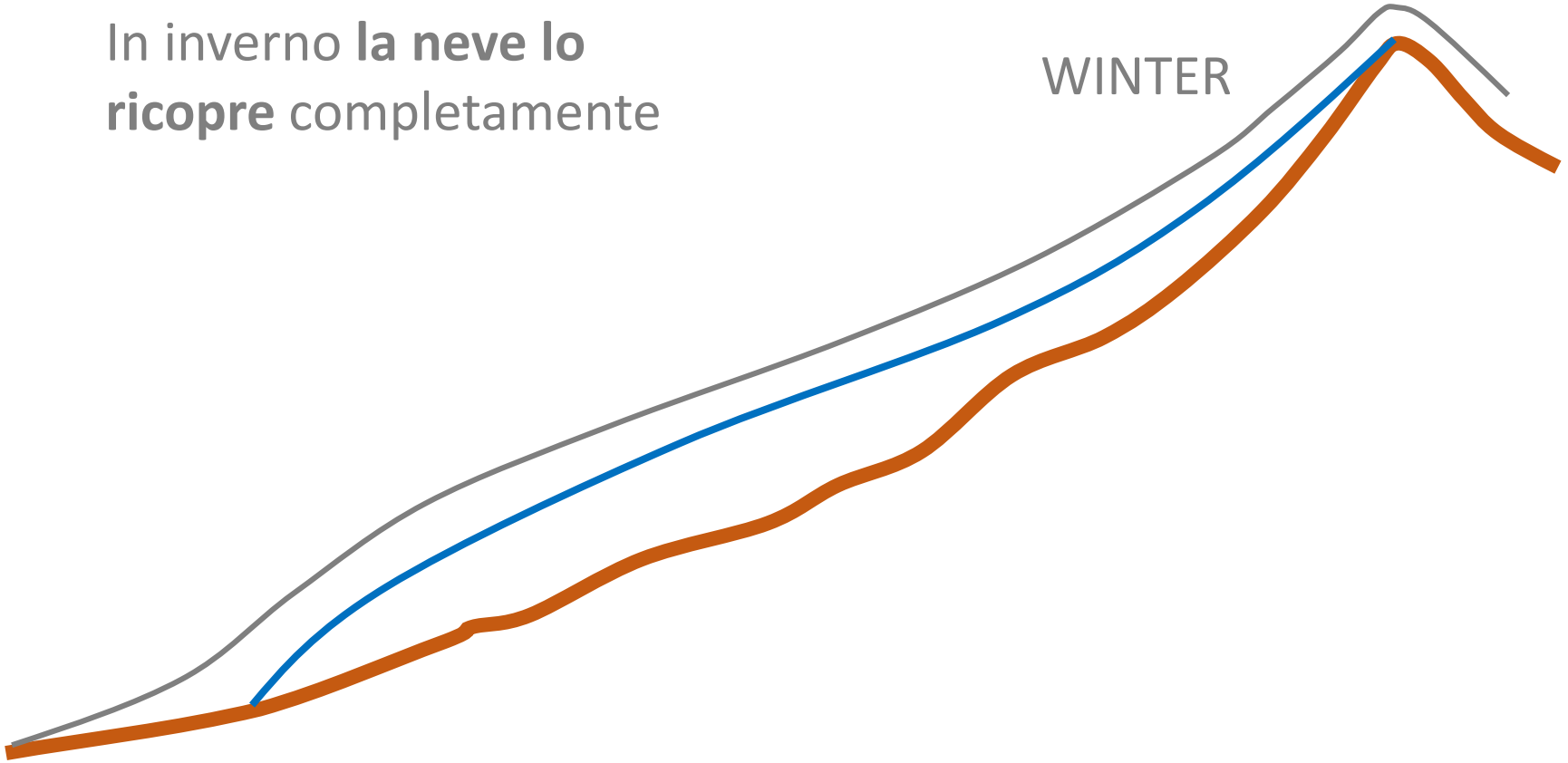
Renato R. Colucci

Che cos’è un ghiacciaio e quali sono le caratteristiche più importanti



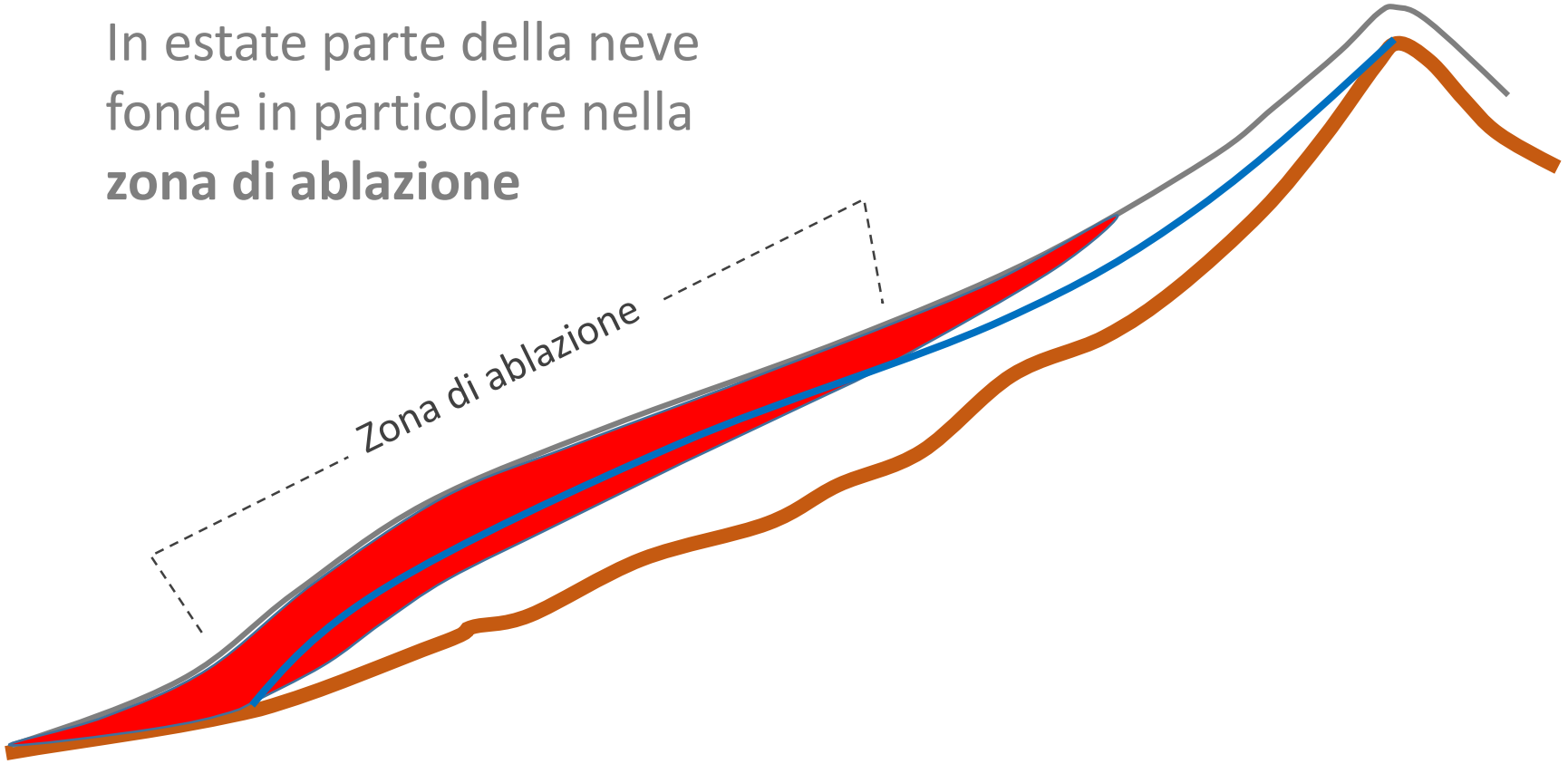
Che cos'è un ghiacciaio e quali sono le caratteristiche più importanti

In inverno **la neve lo ricopre** completamente



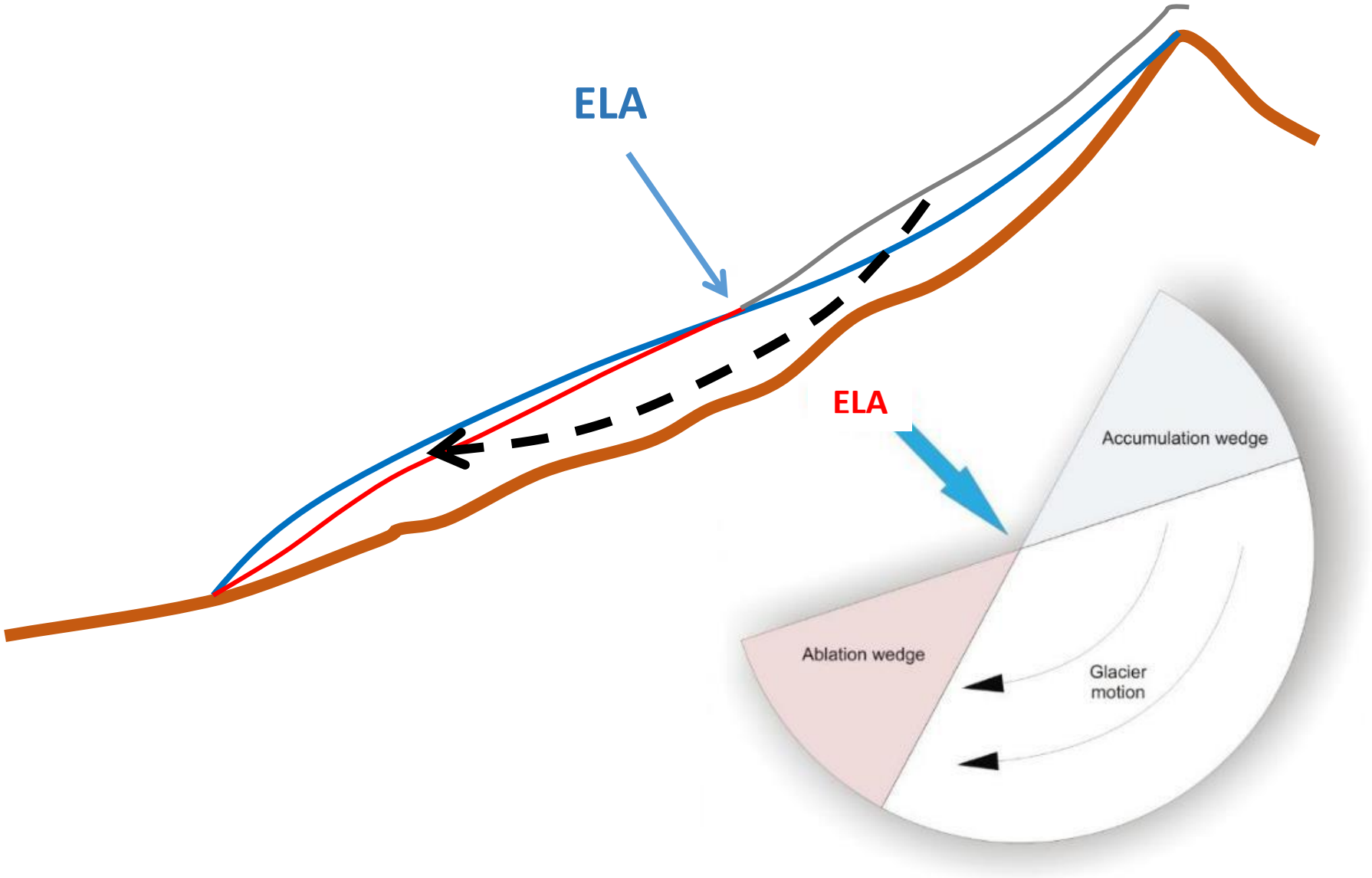
Che cos'è un ghiacciaio e quali sono le caratteristiche più importanti

In estate parte della neve fonde in particolare nella **zona di ablazione**



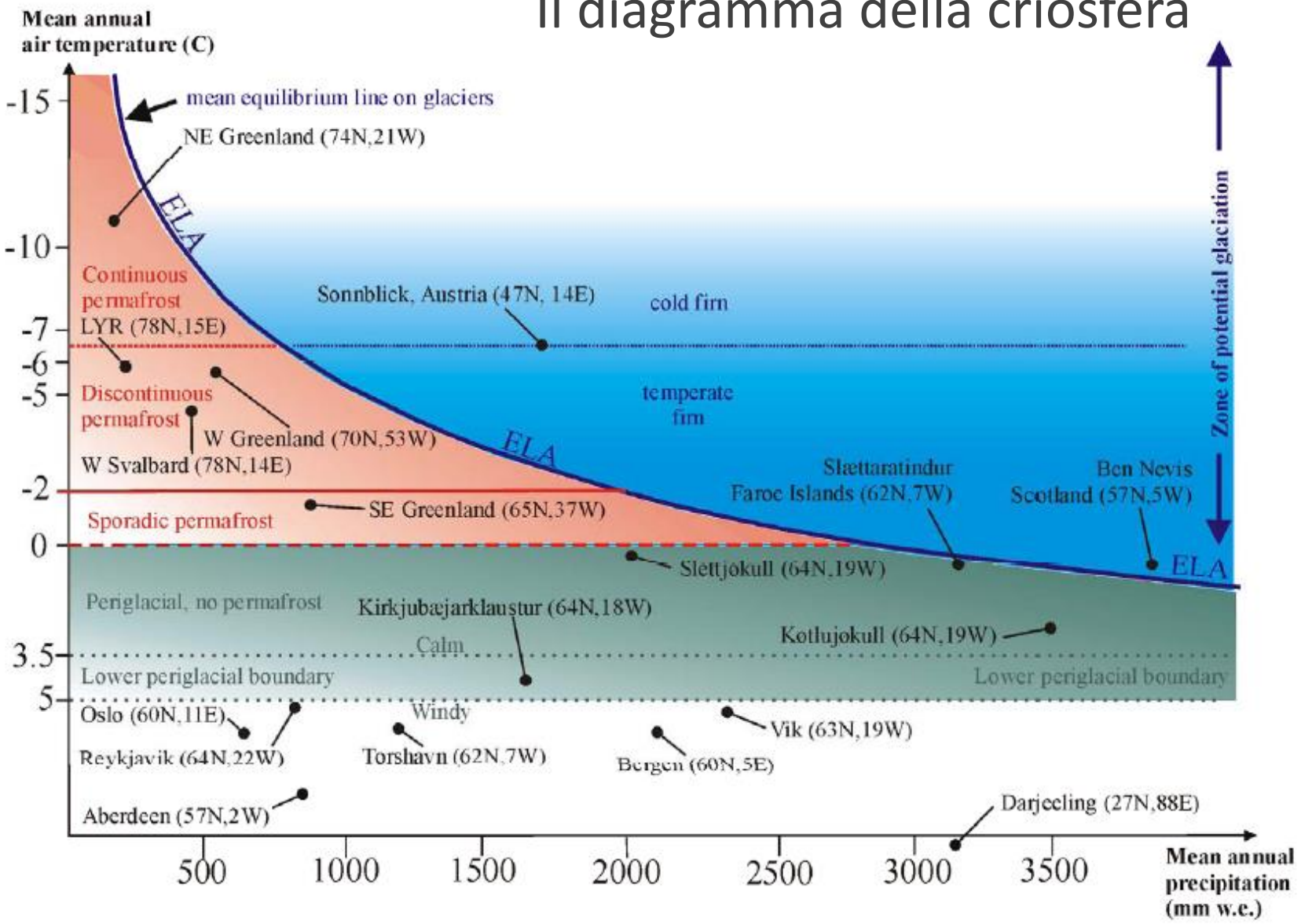
SUMMER

L’ Altitudine della Linea di Equilibrio – **ELA** (Equilibrium Line Altitude)

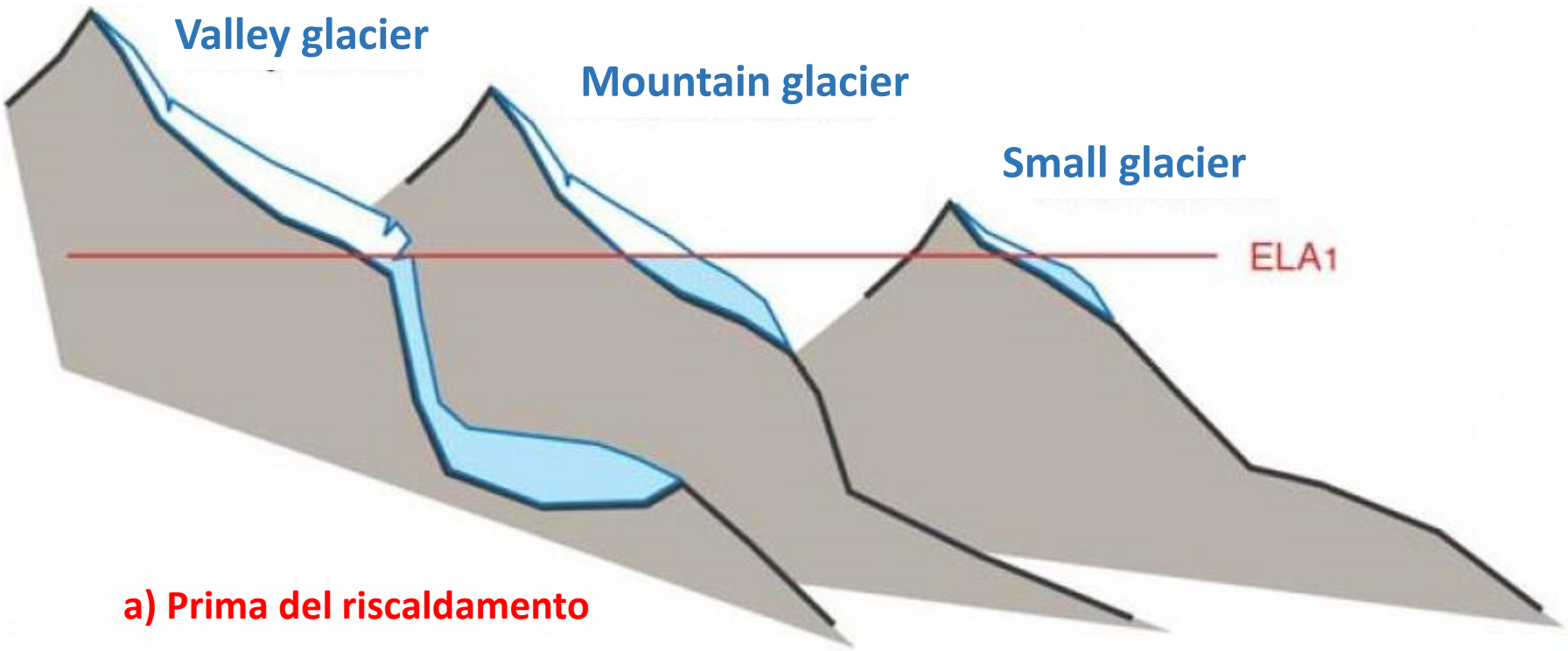


L’ Altitudine della Linea di Equilibrio **– ELA** (Equilibrium Line Altitude)

Il diagramma della criosfera

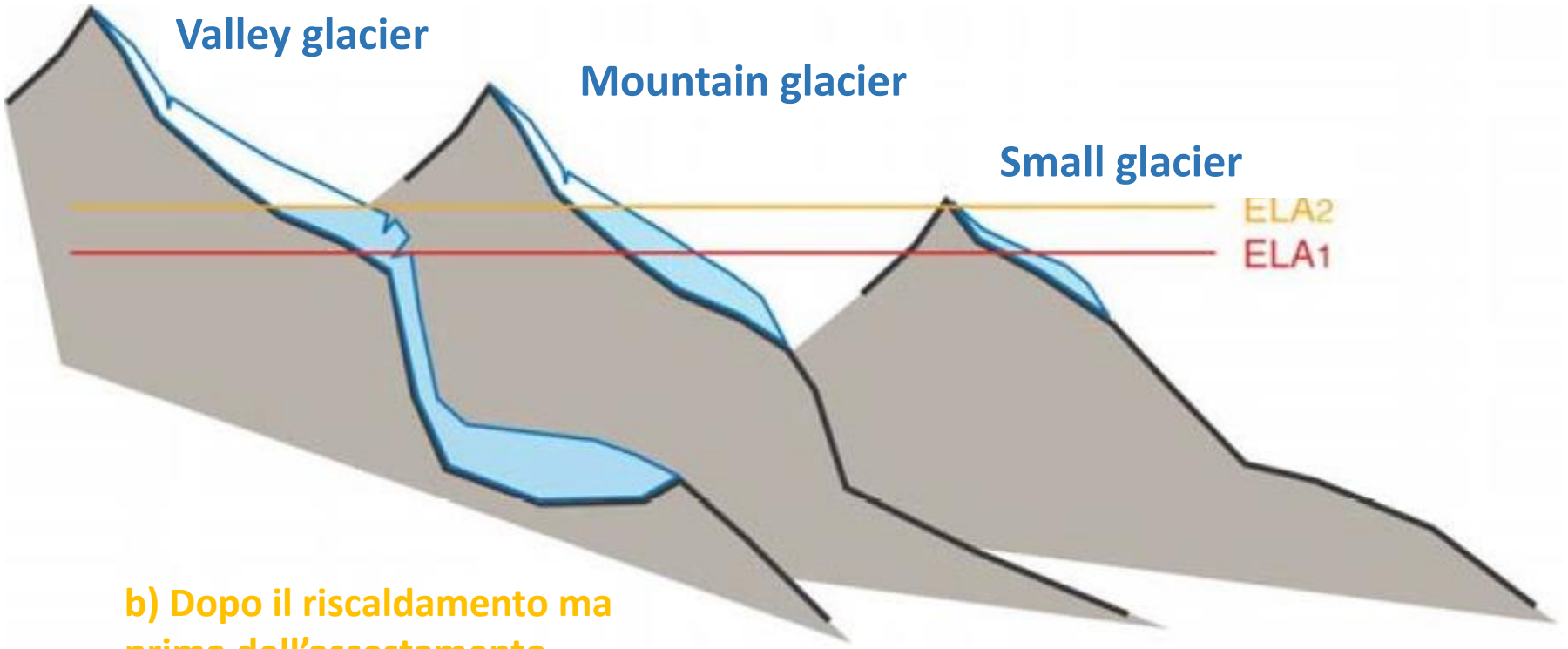


Altitudine della ELA



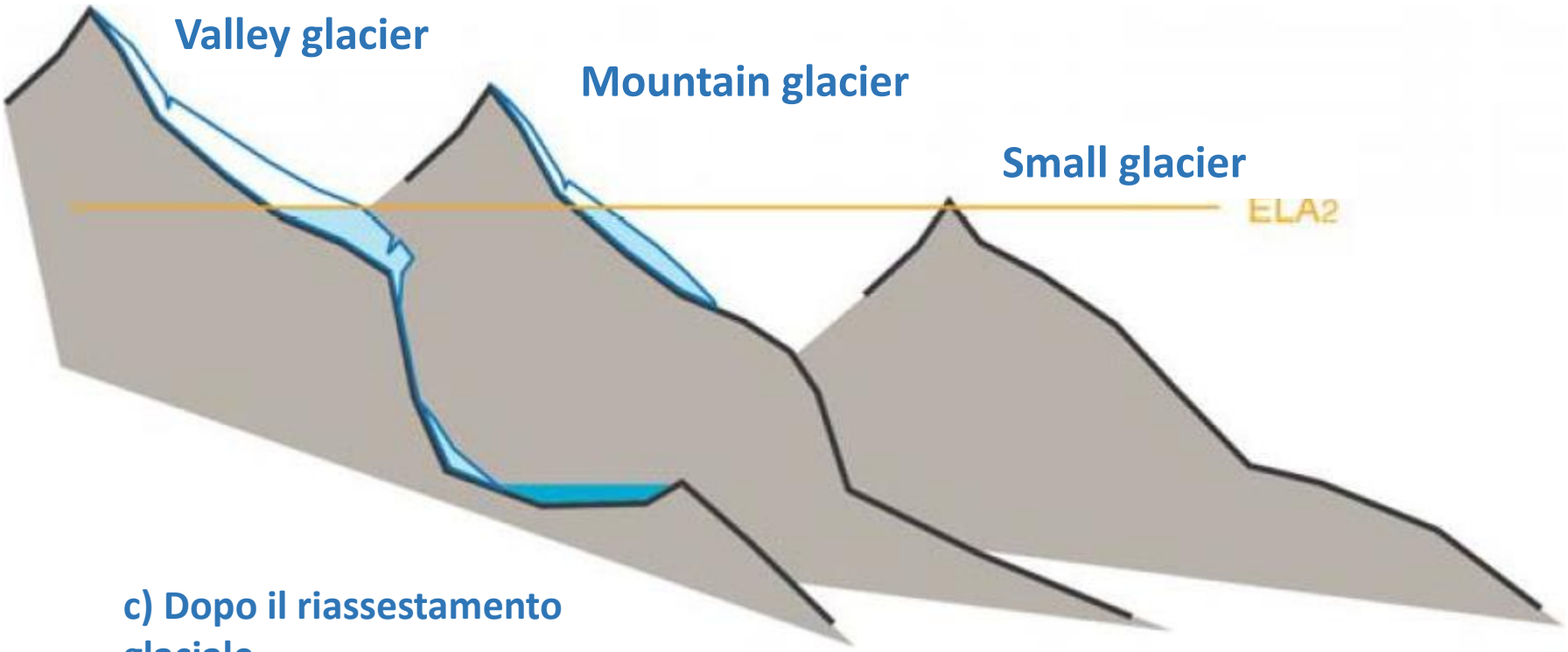
a) Prima del riscaldamento

Altitudine della ELA



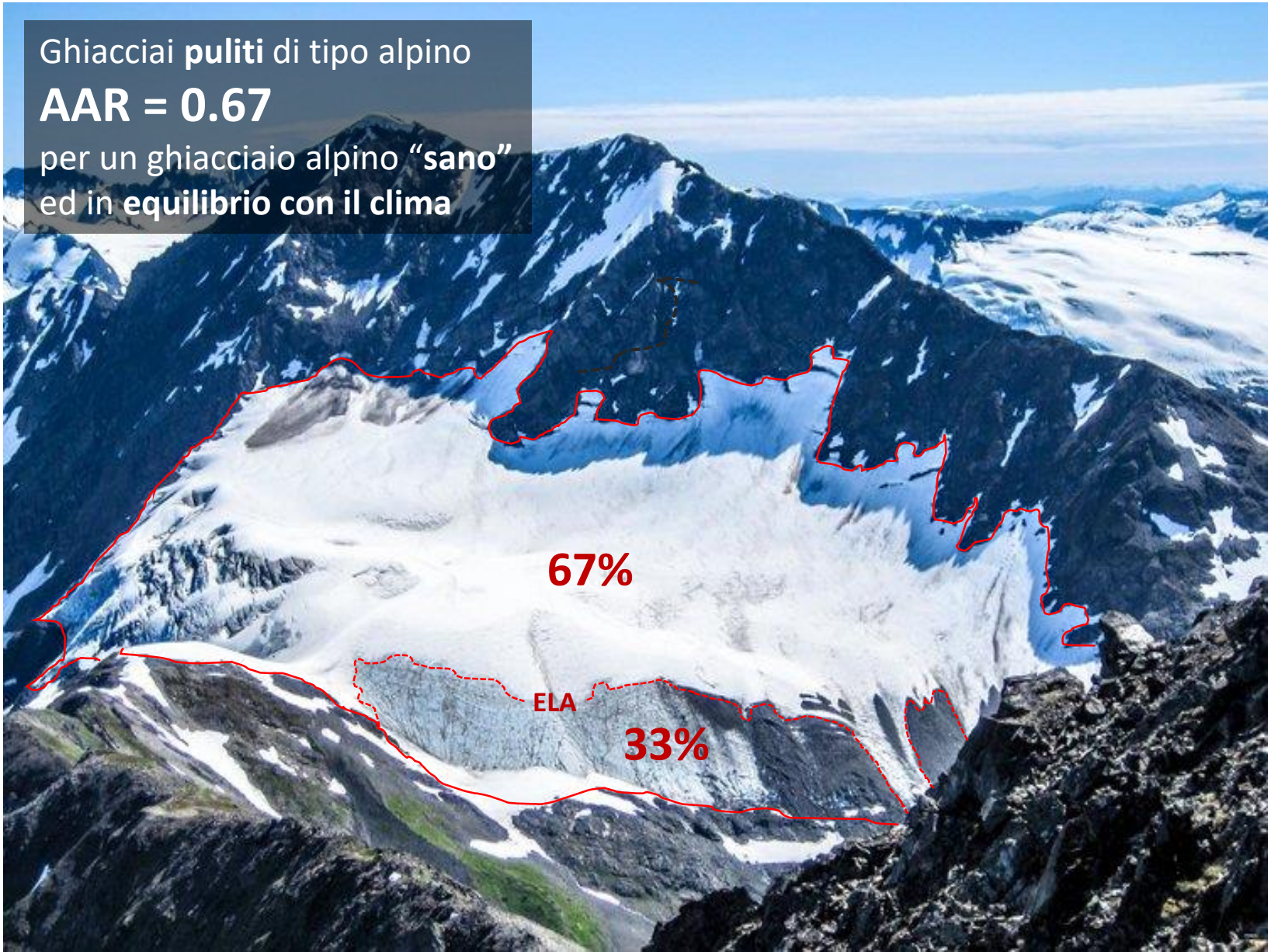
b) Dopo il riscaldamento ma prima dell'assestamento glaciale

Altitudine della ELA

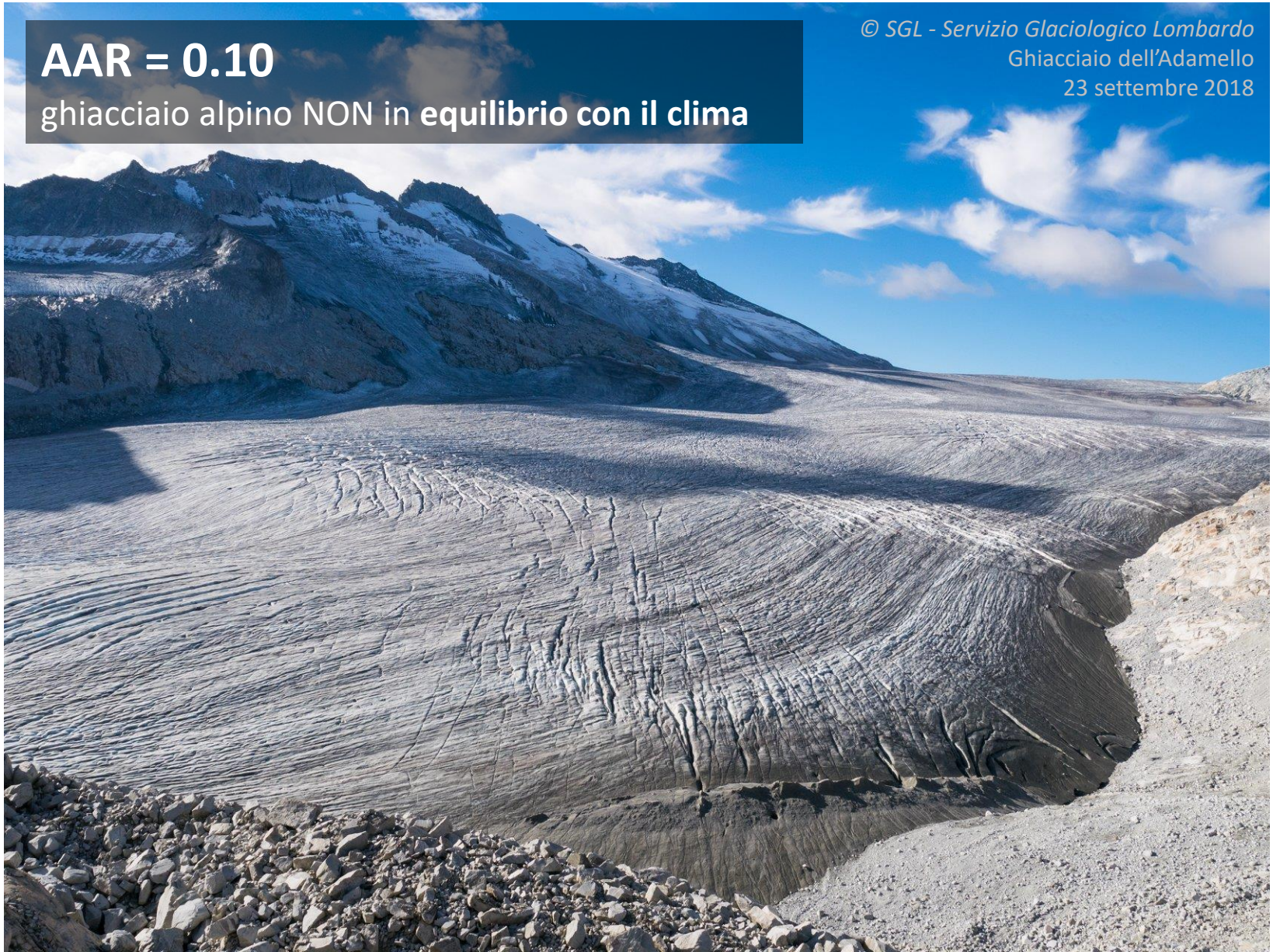


c) Dopo il riassestamento glaciale

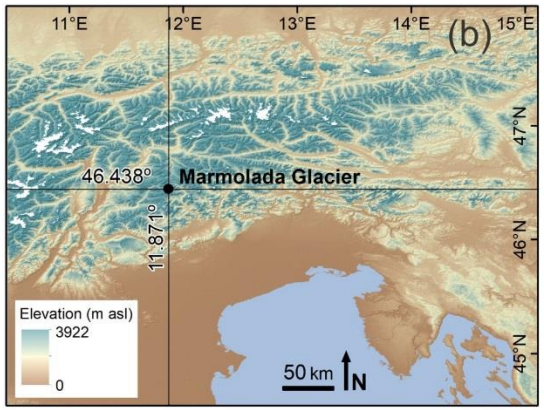
Rapporto tra Area di Accumulo e Area di Ablazione – **AAR** (Acc. Area Ratio)

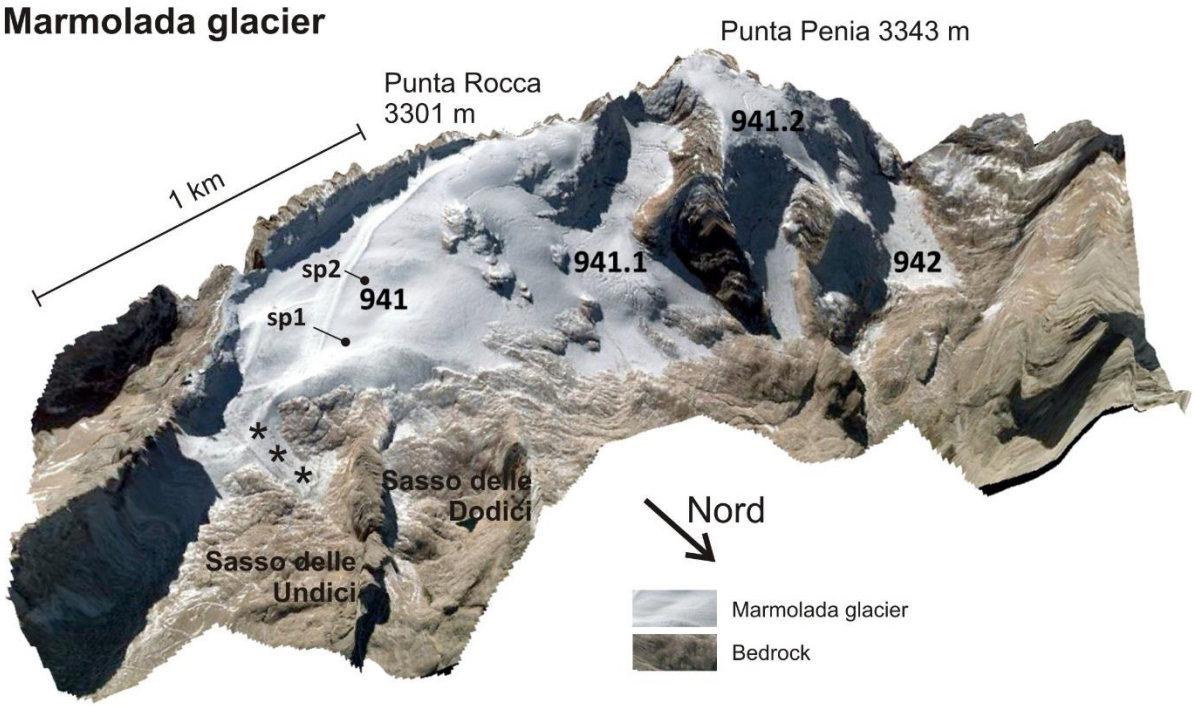


Rapporto tra Area di Accumulo e Area di Ablazione – **AAR** (Acc. Area Ratio)



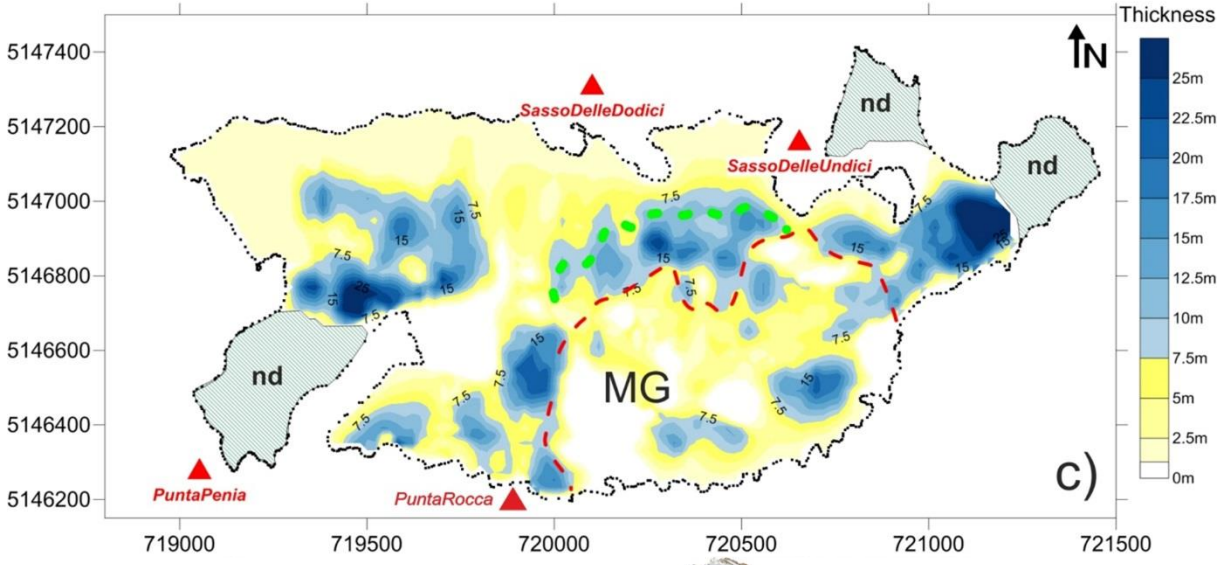
Il ghiacciaio della Marmolada… già un morto che cammina

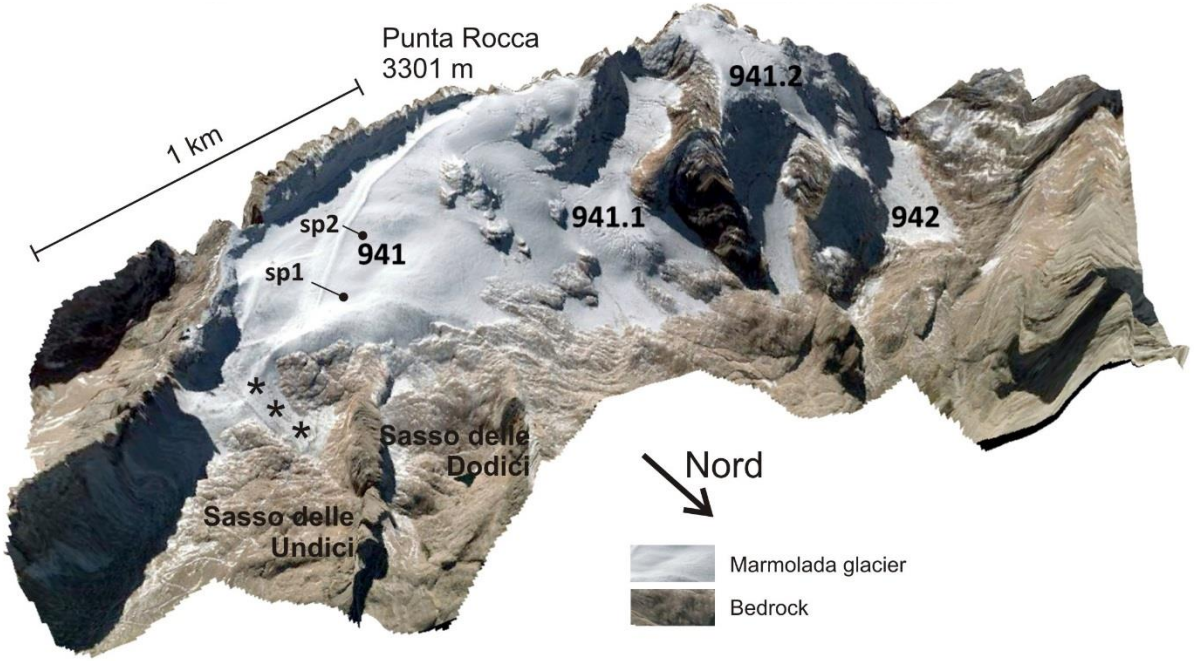




Santin et al., 2019

Il ghiacciaio della Marmolada… già un morto che cammina





2004 → 2014

- riduzione del 30% In volume
- Riduzione topografica media 5 m

Santin et al., 2019

Il ghiacciaio della Marmolada… già un morto che cammina

Il ghiacciaio della Marmolada

PARCO NATURALE PREALPI GIULIE

Unione Meteorologica del Friuli Venezia Giulia ONLUS

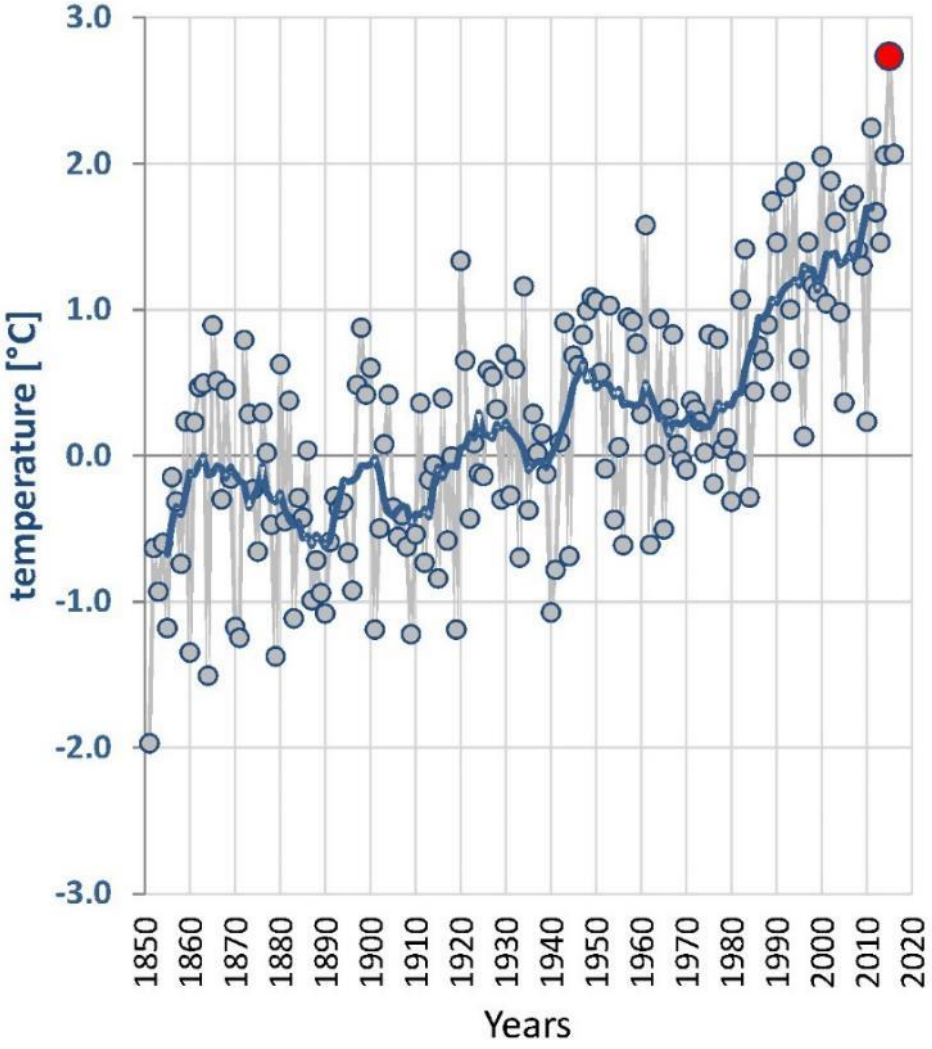
Climatologia (2200 m)

+1.6 °C in 100 anni
+1.3 °C ultimi 30 anni

"Attuale" (1981-2010)
MAAT **1.1°C** (σ = 0.6).
July 9.2°C, February -6.0°C

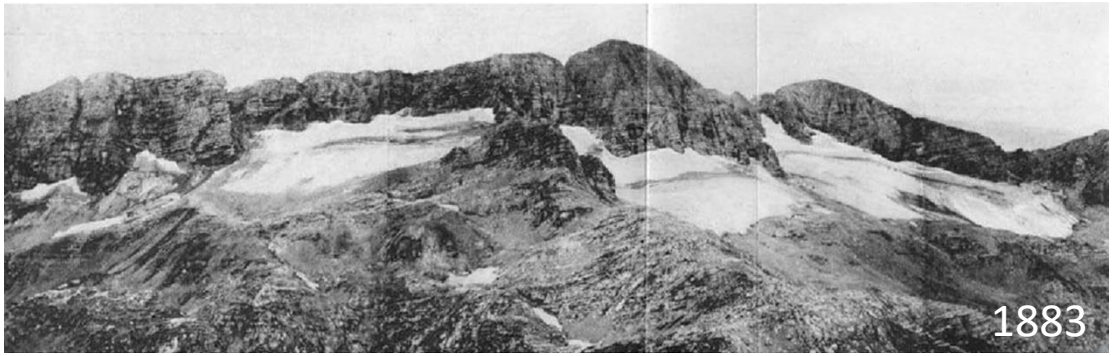
Alla fine della Little Ice Age
(1851-1880)
MAAT **-0.3°C** (σ = 0.8)

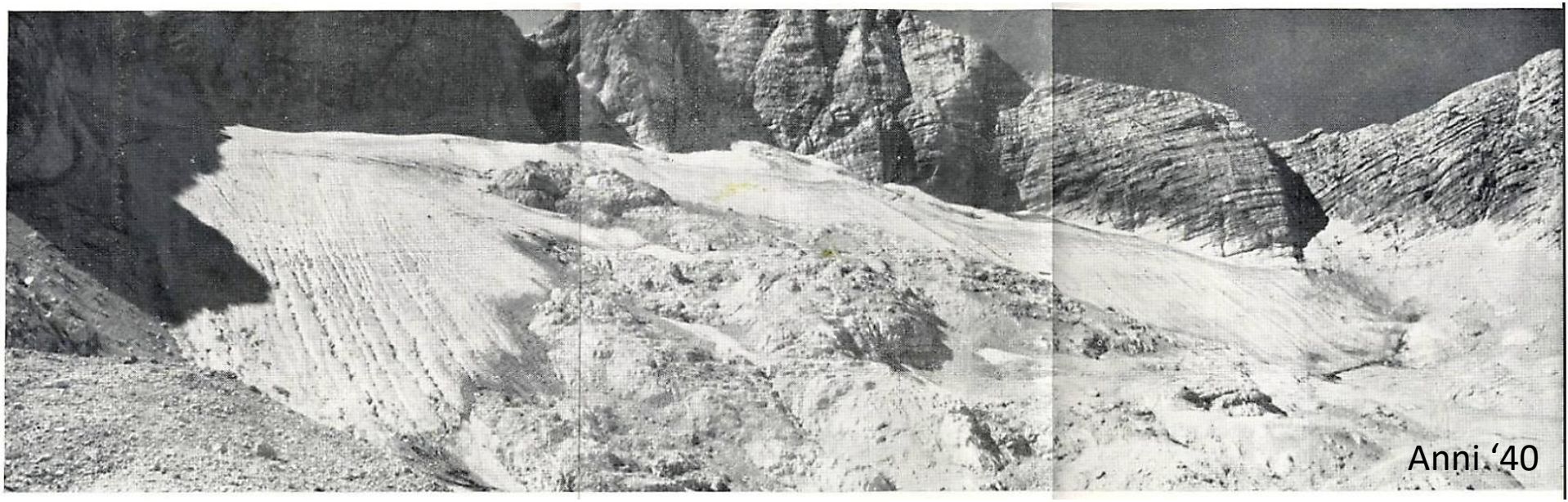
La Piccola Età Glaciale (LIA)
Ca. 1300-1850



Colucci & Guglielmin, (2015) Int. Journal Clim.

I ghiacciai del Canin in F.V.G.





Glacial evolution in the Julian Alps since the Little Ice Age

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[1]Department of Earth System Sciences and Environmental Technologies, ISMAR-CNR, Viale Romolo Gessi 2, 34123 Trieste, Italy; r.colucci@ts.ismar.cnr.it
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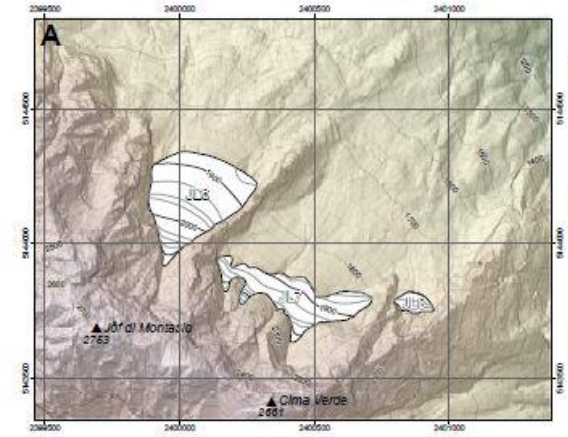
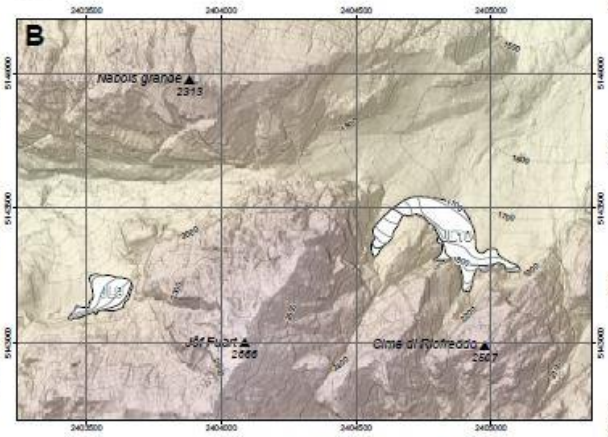
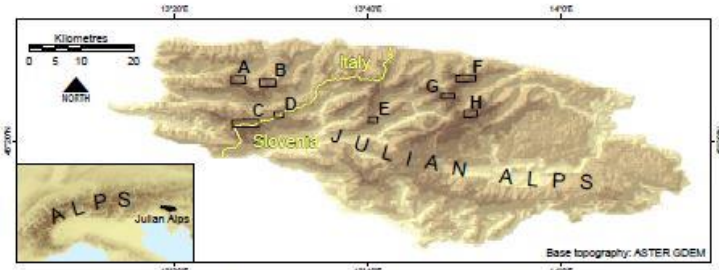
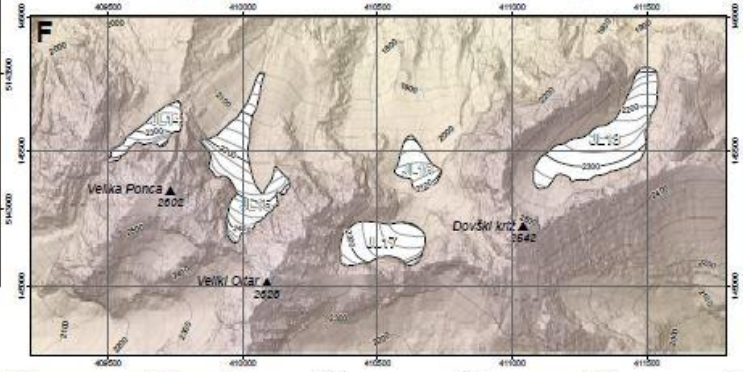






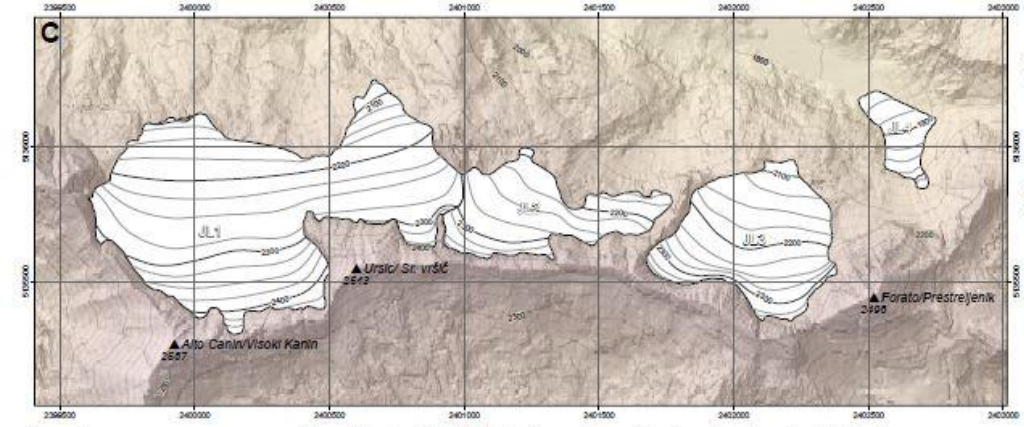


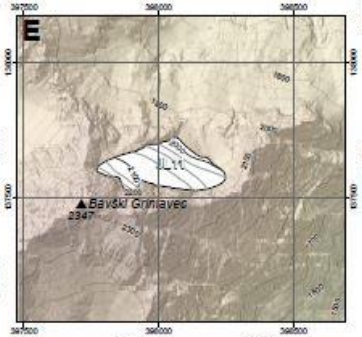
Metres
0 250 500 1.000 1.500

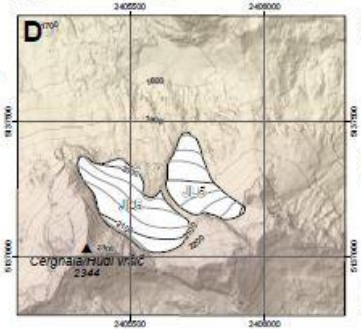
Scale 1:6.000

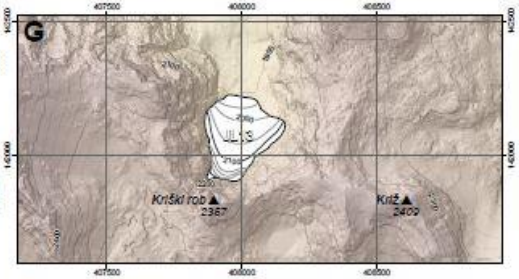
NORTH

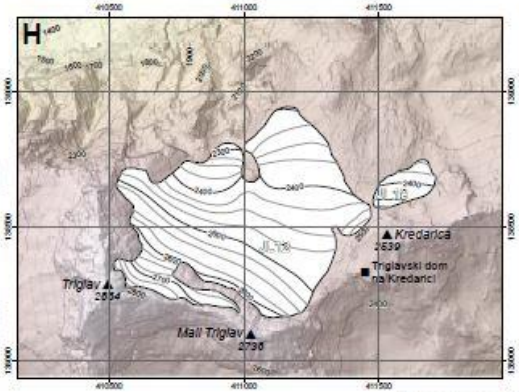
Coordinate system of maps A, B, C, D: Monte Mario Italy 2;
Projection: Transverse Mercator; Datum: Monte Mario
Coordinate system of maps E, F, G, H: D96 Slovenia;
Projection: Transverse Mercator; Datum: Slovenia Geodetic Datum 1996











Legend

Glacier extent in the Little Ice Age

Base topography of maps A, B, C, D: LiDAR data Italy 2006, Civil Defence of Friuli Venezia Giulia

Base topography of maps E, F, G, H: LiDAR data Slovenia 2014-2015, Geodetic Institute of Slovenia

Area of glaciers in the Little Ice Age and loss of glacier volume since the Little Ice Age

ID	Name	Area [km²]	Volume [km³ 10⁻³]	ID	Name	Area [km²]	Volume [km³ 10⁻³]
JL1	Canin	0.678	27.9	JL11	Bavški Grintavec	0.058	1.9
JL2	Ursic	0.180	2.7	JL12	Zeleni sneg - Triglav	0.442	13.8
JL3	Prestreljenik	0.259	4.9	JL13	Kmica	0.063	1.7
JL4	Prevala	0.051	0.5	JL14	Ponca North	0.022	0.4
JL5	Cergnala	0.125	2.0	JL15	Ponca East	0.068	1.2
JL6	Montasio West	0.100	2.9	JL16	Low Oltar	0.020	0.2
JL7	Montasio East	0.063	1.3	JL17	High Oltar	0.042	0.8
JL8	Montasio Minor	0.008	0.1	JL18	Dovški križ	0.083	1.9
JL9	Studence	0.020	0.3	JL19	Kredarica	0.025	0.4
JL10	Carnizza - Riofreddo	0.061	1.0				

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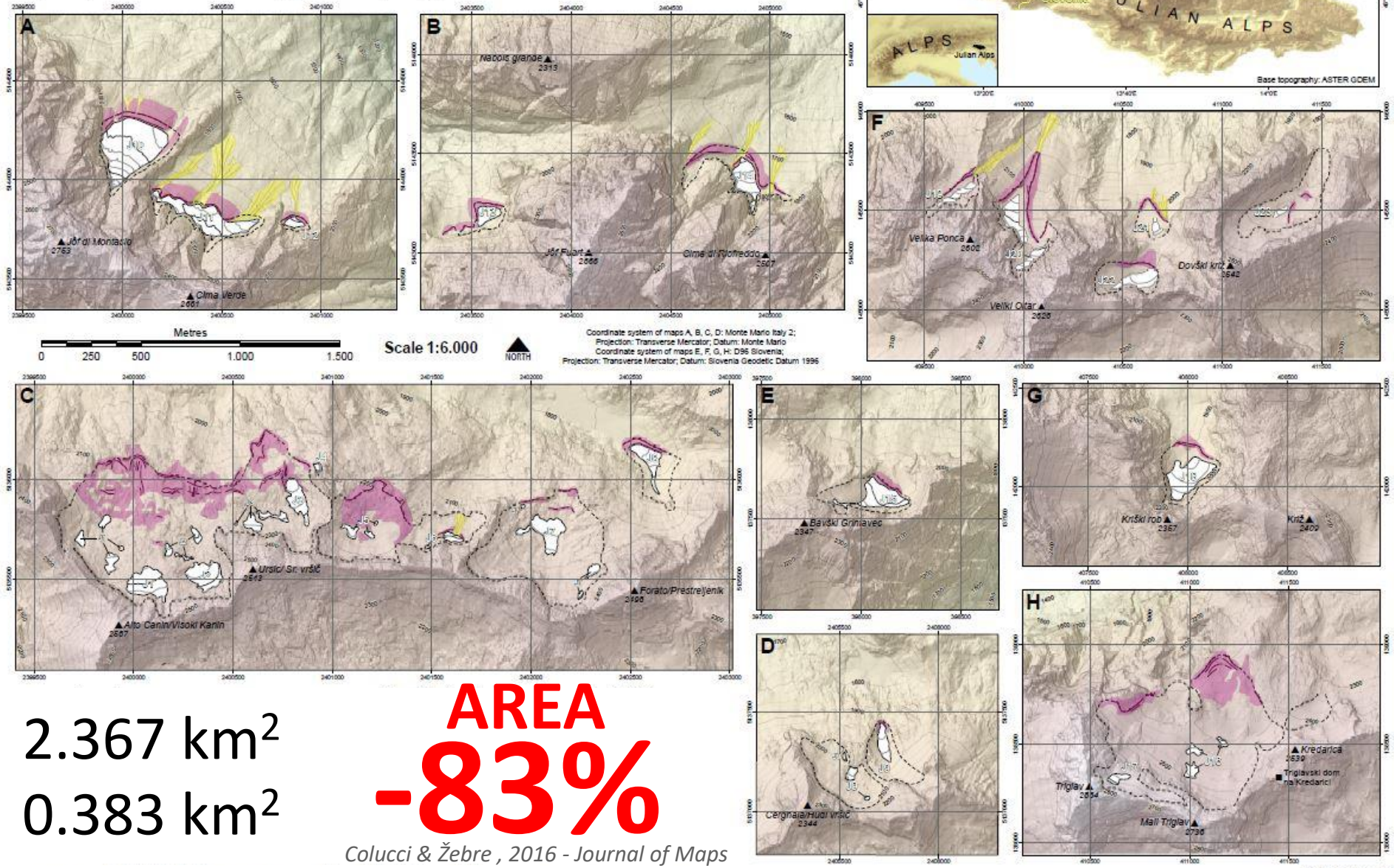

2.367 km²

0.383 km²

AREA

-83%

Colucci & Žebre , 2016 - Journal of Maps

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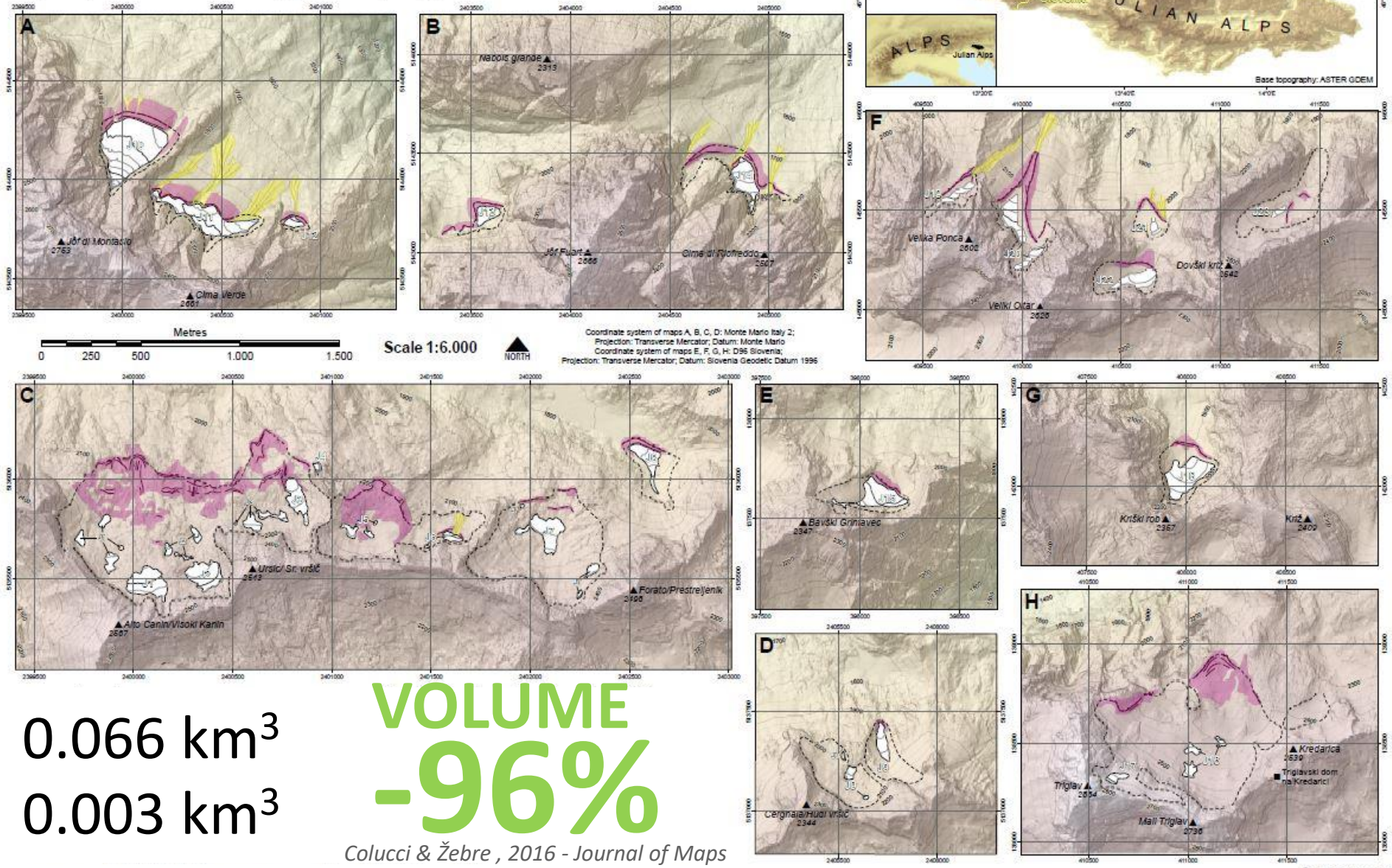


0.066 km^3

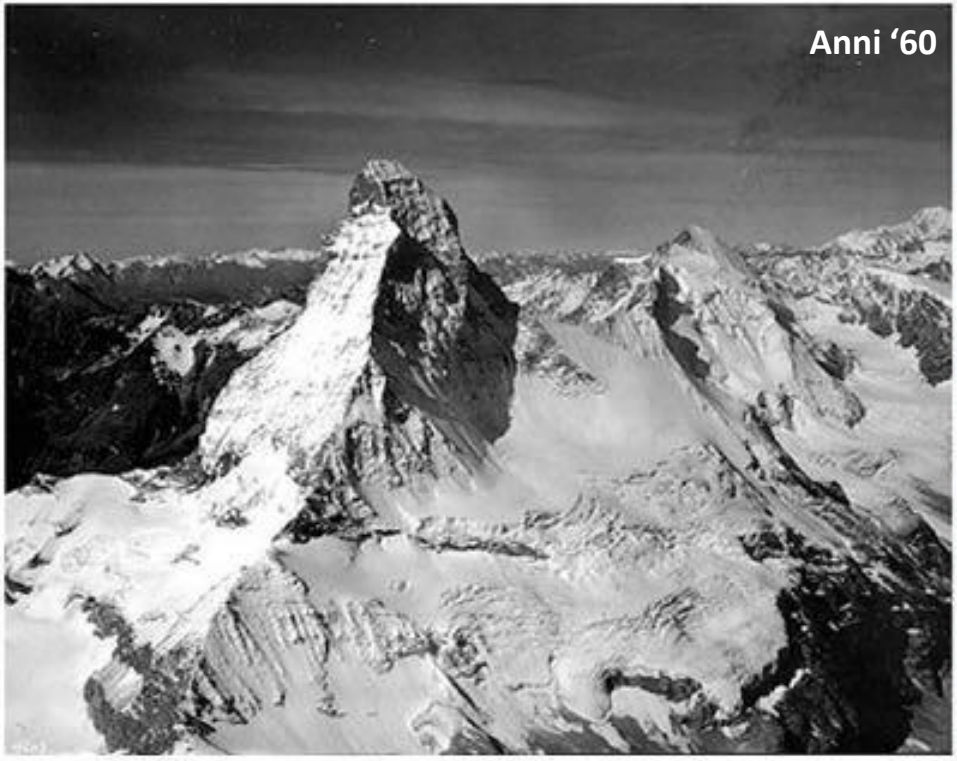
0.003 km^3

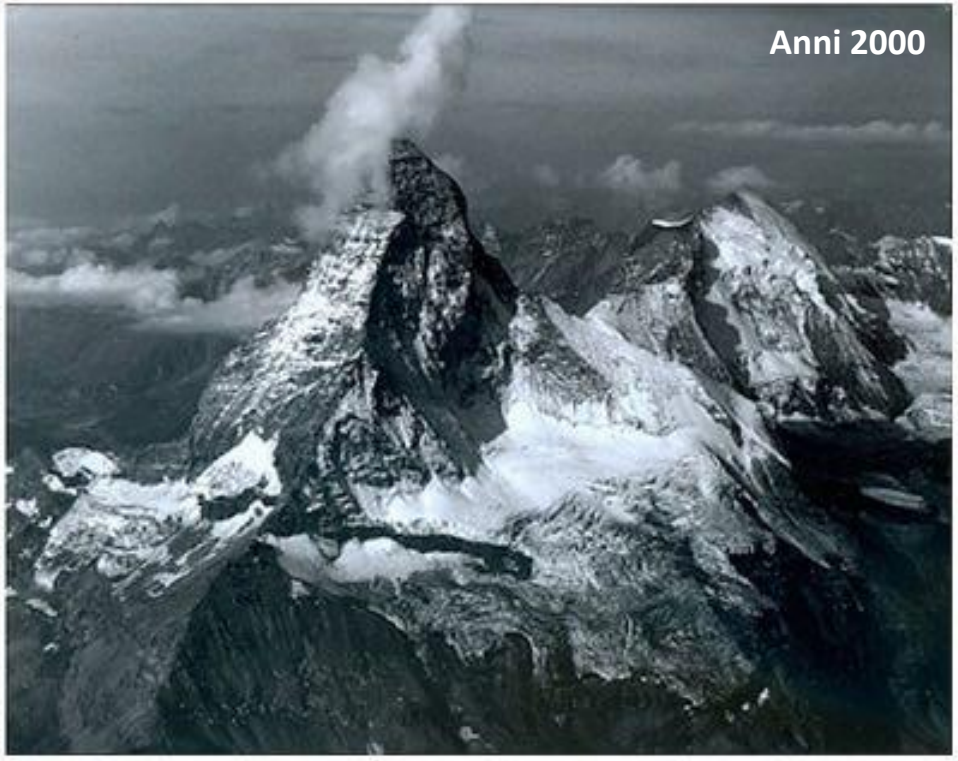
VOLUME

-96%

Colucci & Žebre , 2016 - Journal of Maps

Matterhorn-Cervino a fine agosto





Matterhorn-Cervino a fine agosto

Distribuzione potenziale del **Permaforst**

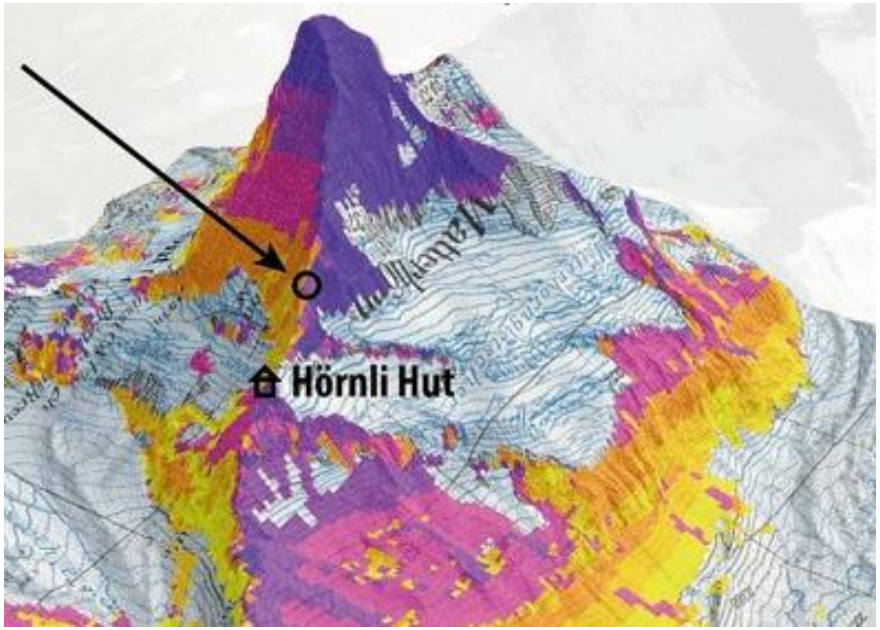
Permafrost

It is defined on the basis of **temperature**

that is **ground** (i.e. soil, sediments, bedrock, etc.) **that remains at or below 0°C** (i.e. the pressure melting point for pure ice) **for at least 2 consecutive years**

Moisture, in the form of water or ice, may or **may not be present** in permafrost

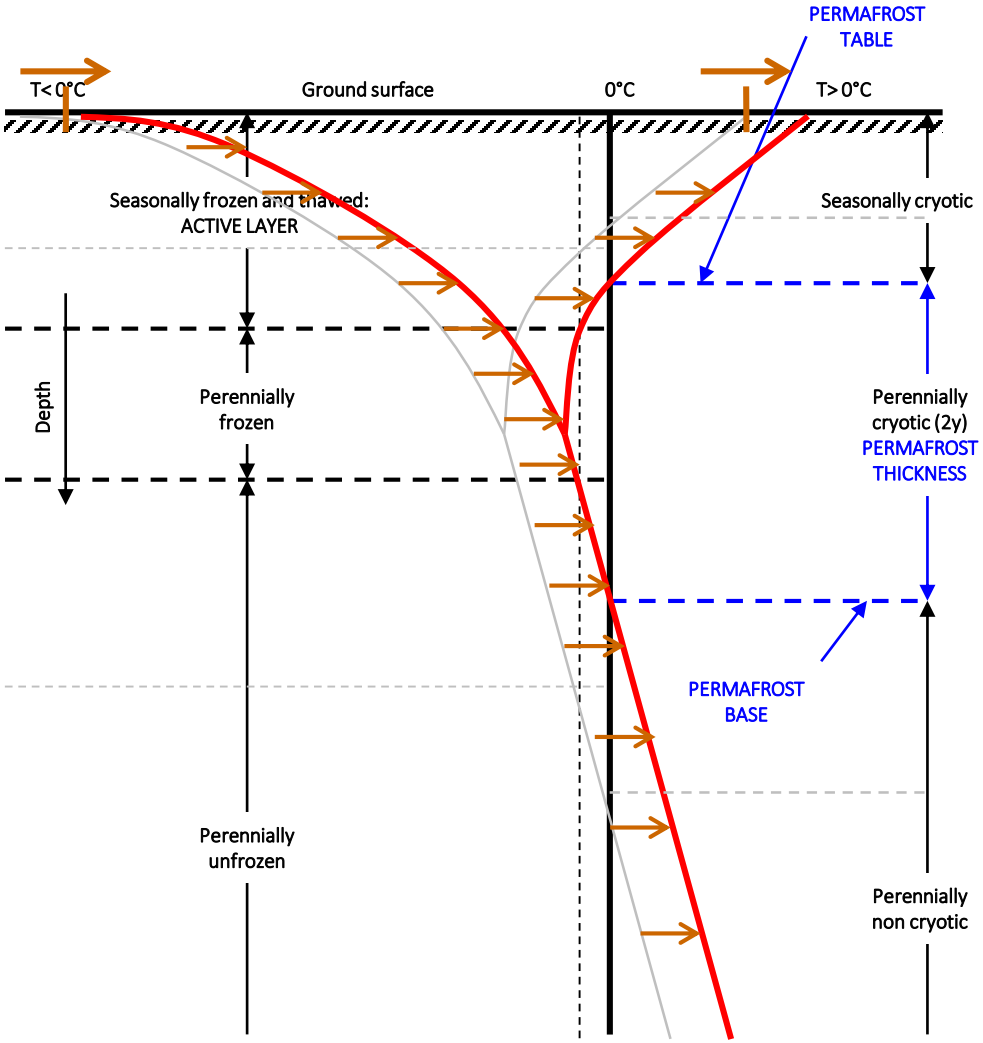
Permafrost may not necessarily be frozen since the freezing point of included water may be depressed several degrees below 0°C.



French (2007)

Permafrost

ground-thermal regime

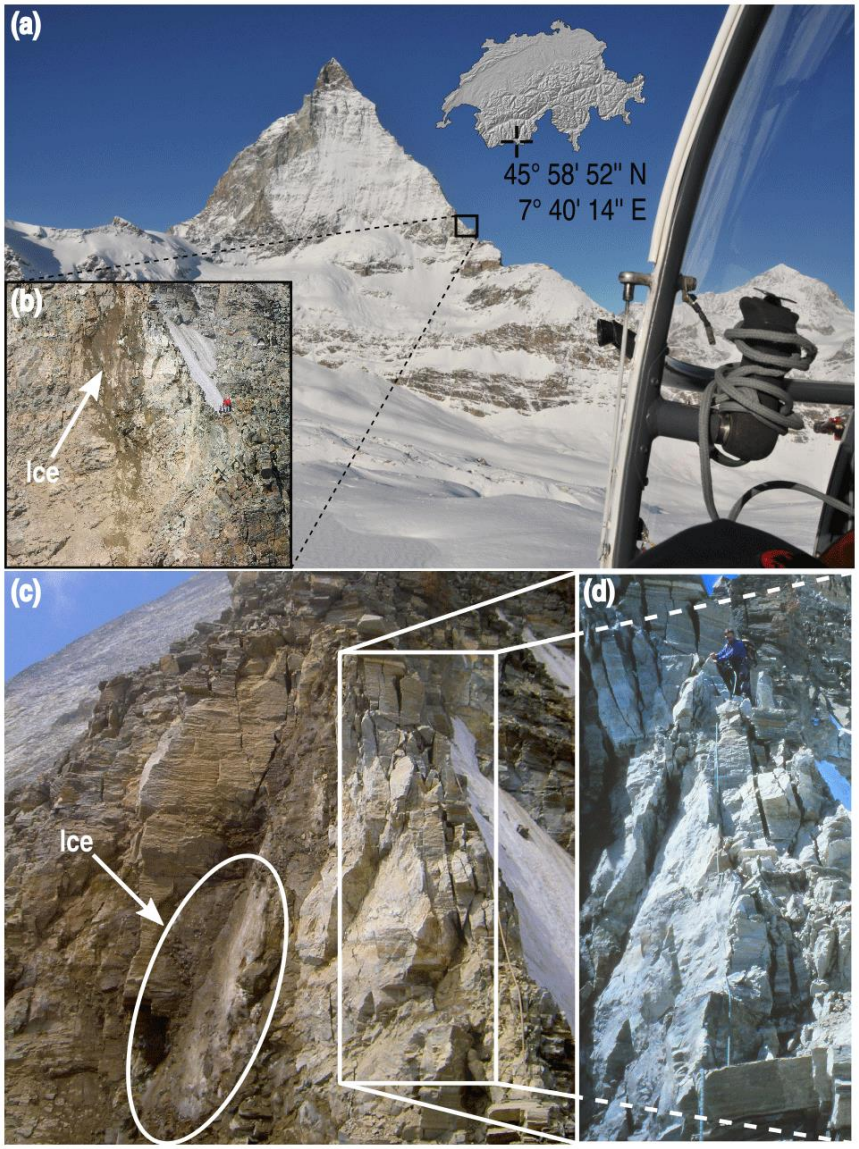


In un ambiente che si scalda

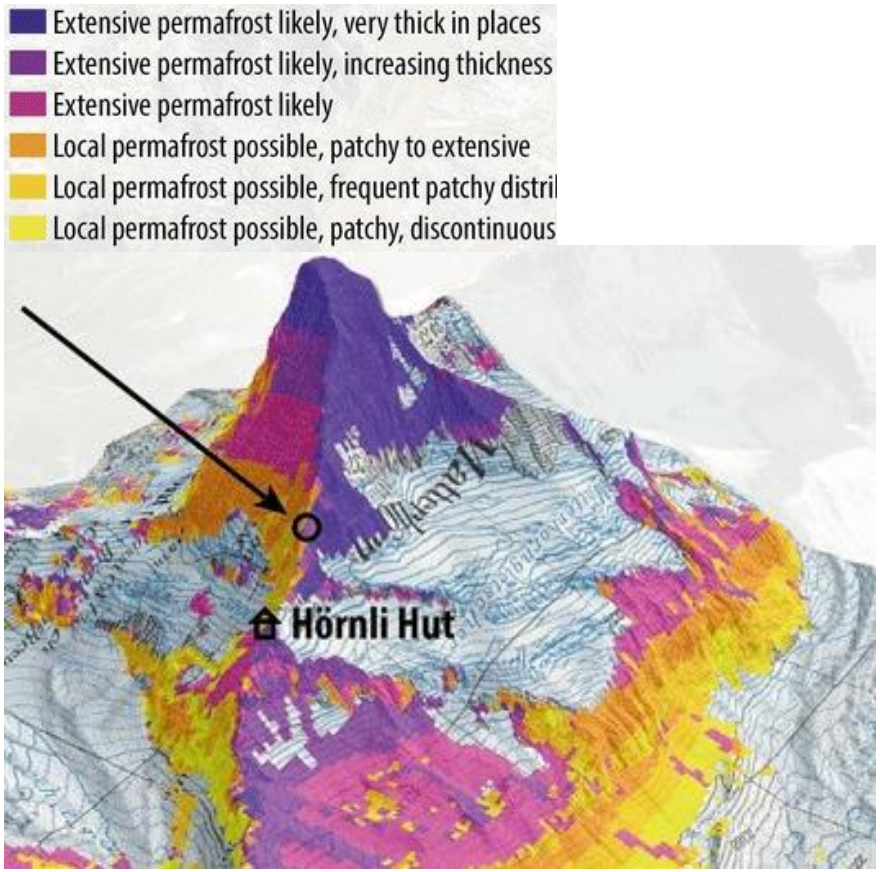
- Riscaldamento del permafrost
- Inspessimento dell'active layer
- Assottigliamento del permafrost
- Risalita della permafrost base

scongelamento del permafrost in roccia

scongelamento del permafrost in roccia

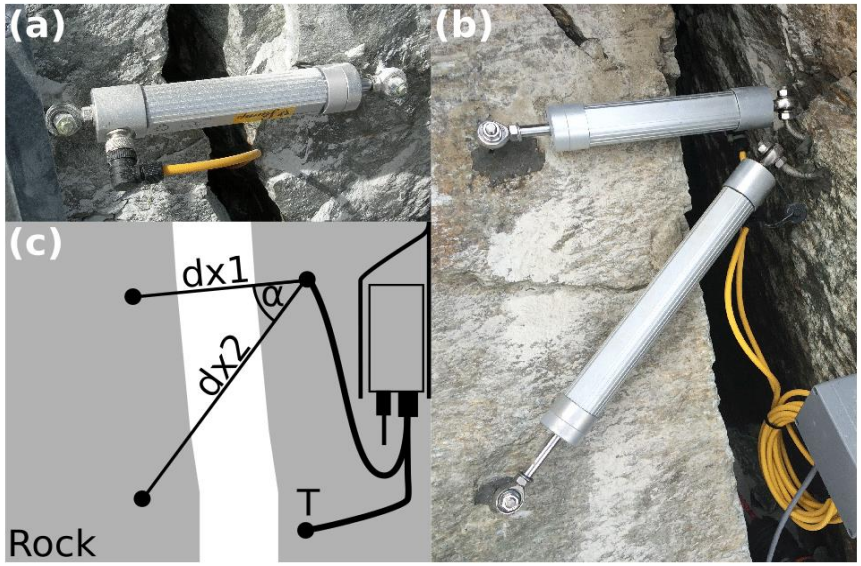


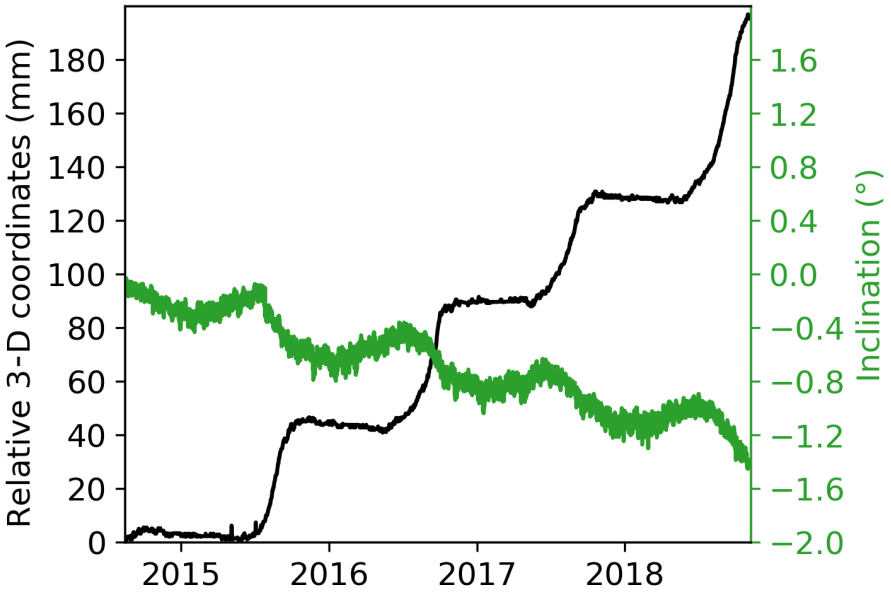
Distribuzione potenziale del **Permaforst**



Weber et al., 2019 (ETH)

scongelamento del permafrost in roccia





[Rock Fall Switzerland]
[Rock Fall Pizzo Cengalo (CH)]
[Rock Fall Swiss Alps]

Weber et al., 2019 (ETH)

TORINO

Caldo e temporali sulle Alpi: "chiusi per frana" il Cervino e il Monte Bianco

Il distacco di pietre per le temperature anomale mette in pericolo gli alpinisti: un gruppo bloccato lunedì alla capanna Carrel. I sindaci di Valtournenche e Saint Gervais vietano l'uso di una via e un rifugio fino a quando la situazione non tornerà normale.

di LEONARDO BIZZARO

Another study from last month, which appears in the journal Arctic, Antarctic, and Alpine Research, warned that mountaineering itself is imperiled by climate change. Researchers assessed the 100 mountaineering routes laid out in the influential guidebook The Mont Blanc Massif: The 100 Finest Routes, published in 1973. They found that of the 95 climbing itineraries they studied, 93 had been impacted by climate change, with 26 being greatly affected. Three climbing routes no longer exist. The signs of change are becoming more apparent as well; earlier this month during Europe's record-breaking heat wave, a new alpine lake formed at 10,000 feet on the Massif, which is normally permanently frozen.

Climate Change Has Made Climbing the Matterhorn More Dangerous

Melting permafrost is leading to more frequent rockfalls and landslides on the iconic peak and other areas of the Alps

(Zermatt photos via Wikimedia Commons under CC BY-SA 3.0)

Prosegue movimento ghiacciaio Planpincieux, ma è costante

Parte frontale si è mossa di 45 centimetri nelle ultime 24 ore

Redazione ANSA
AOSTA
18 ottobre 2019
17:52
NEWS

Il ghiacciaio di Planpincieux, sul versante italiano del massiccio del Monte Bianco, continua a muoversi, ma con velocità costante. Lo rivela il bollettino di oggi relativo al monitoraggio che viene effettuato dalla Regione Valle d'Aosta e dalla Fondazione Montagna Sicura utilizzando un sistema radar. Nelle ultime 24 ore lo scivolamento verso valle della massa è compreso tra i 45 centimetri della parte frontale e i 40 centimetri degli altri due settori più a monte, tra cui quello da 250 mila metri cubi. L'allerta per il pericolo della caduta del ghiacciaio nella sottostante Val Ferret è scattata martedì 24 settembre. Nello scenario peggiore, prefigurato dai modelli matematici elaborati dai tecnici, il ghiaccio potrebbe invadere un breve tratto della strada comunale che è stata chiusa al traffico, istituendo una viabilità alternativa.

Val Ferret Settembre 2018

Anche la criosfera sotterranea, "nascosta", sta scomparendo e con essa gli archivi di informazioni contenute nel ghiaccio

La ricerca scientifica in questo ambito è una LOTTA CONTRO IL TEMPO per cercare di salvare più informazioni possibili prima che vadano inseorabilmente perse… in acqua

Climate Change o Global Warming?

Cambiamento climatico o Riscaldamento Globale?

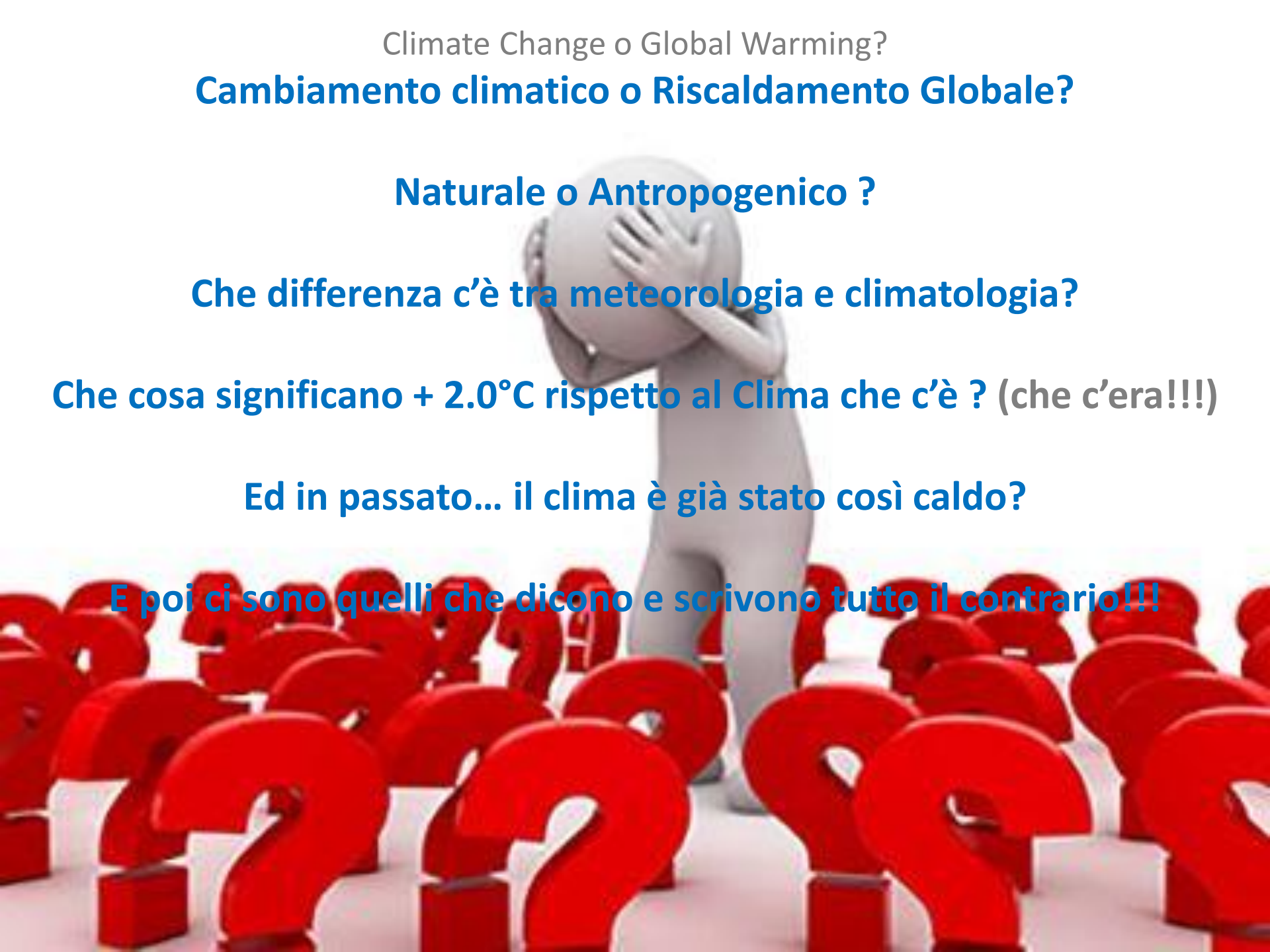
Naturale o Antropogenico ?

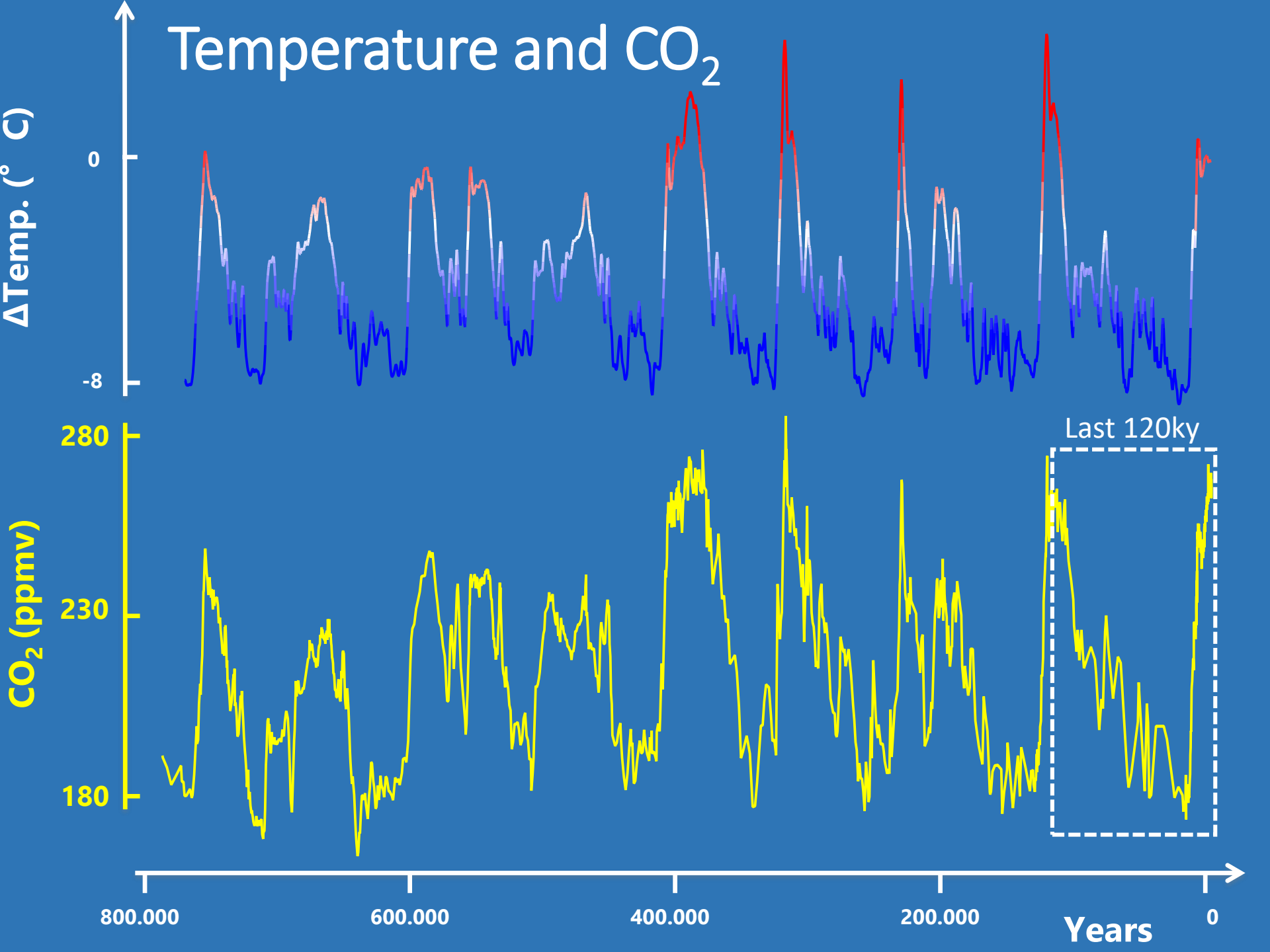
Che differenza c'è tra meteorologia e climatologia?

Che cosa significano + 2.0°C rispetto al Clima che c'è ? (che c'era!!!)

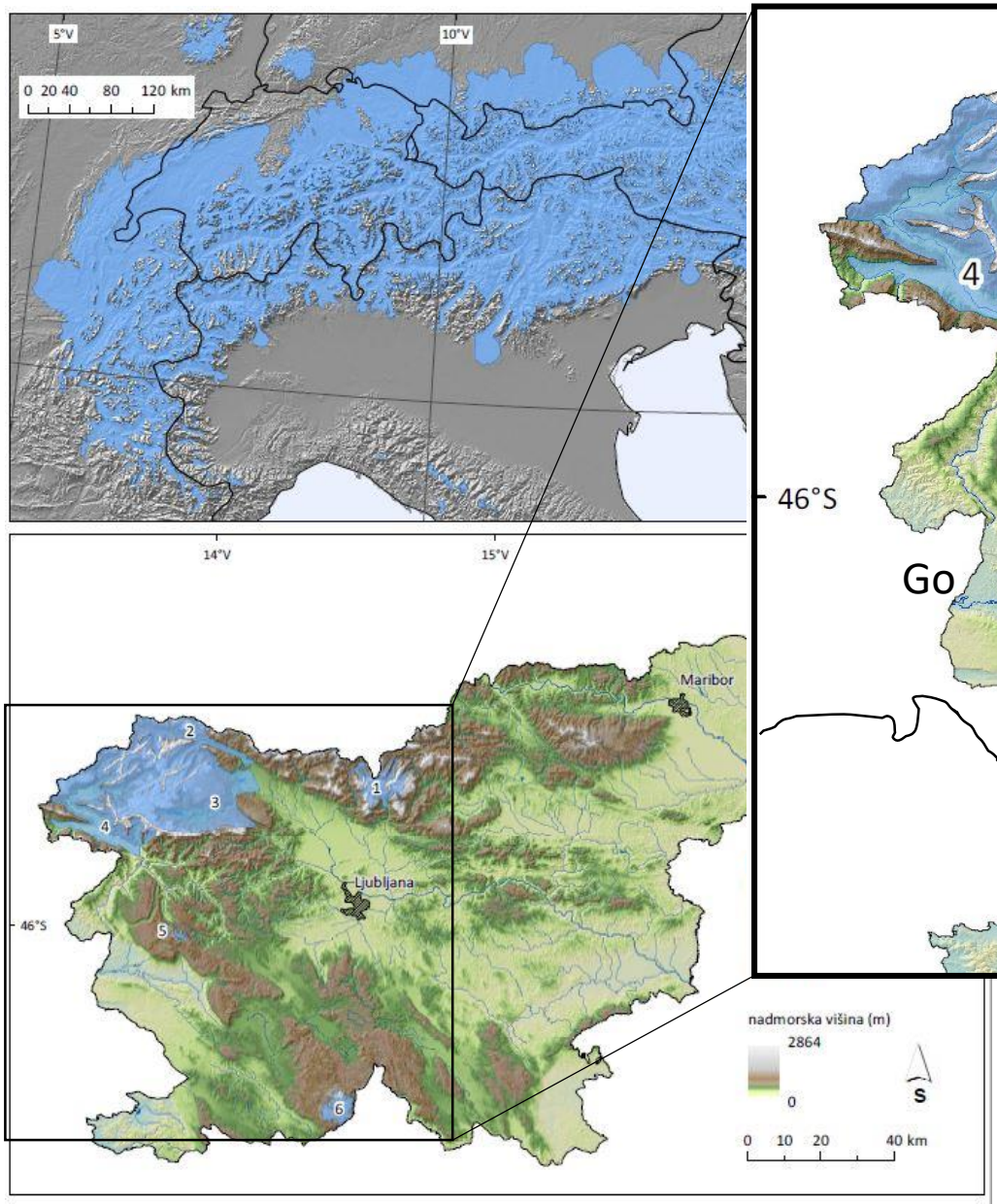
Ed in passato… il clima è già stato così caldo?

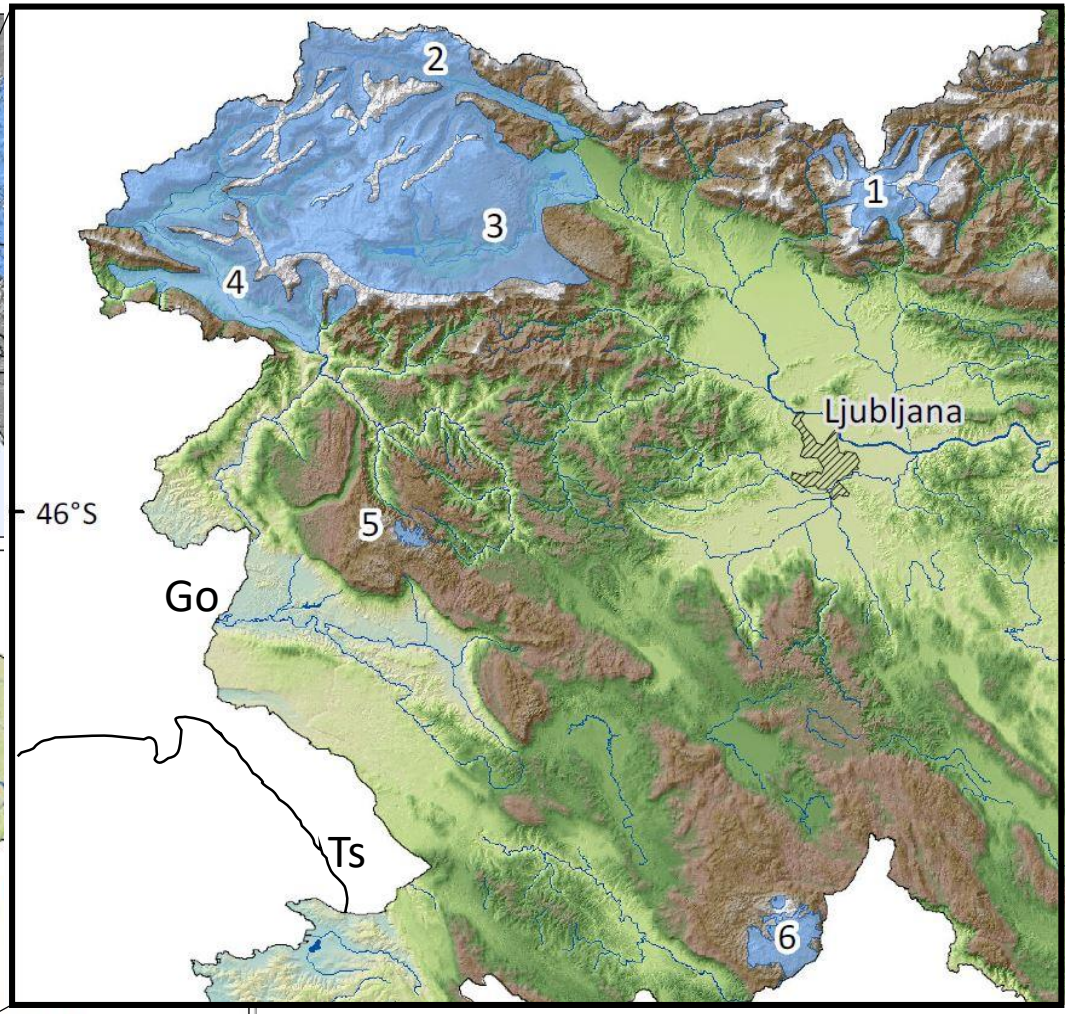
E poi ci sono quelli che dicono e scrivono tutto il contrario!!!




Temperature and CO_2
ΔTemp. (° C)
0
-8
CO_2 (ppmv)
280
230
180
Last 120ky
800.000
600.000
400.000
200.000
0
Years

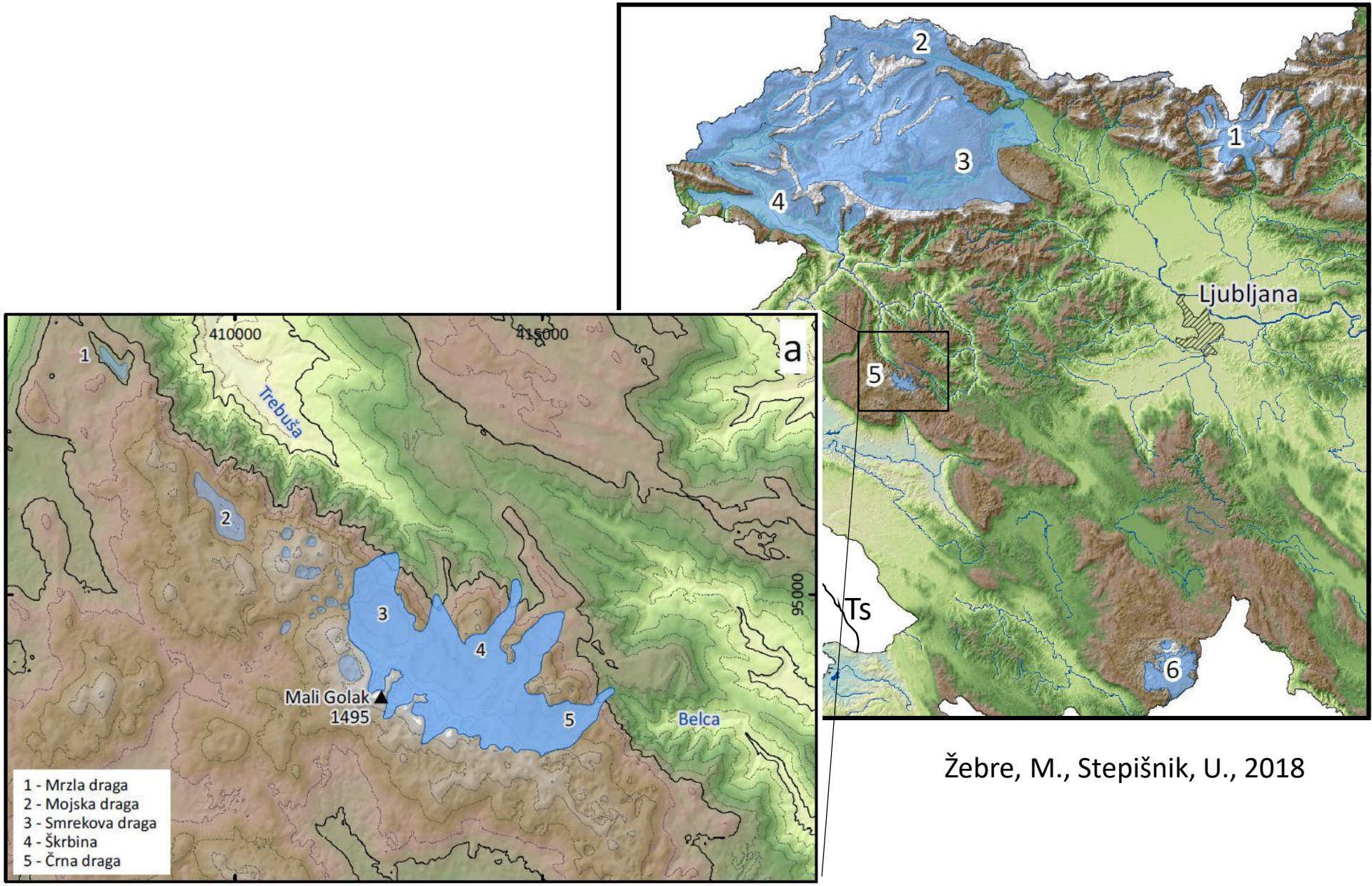
Che cosa significano pochi gradi di differenza a livello GLOBALE ?





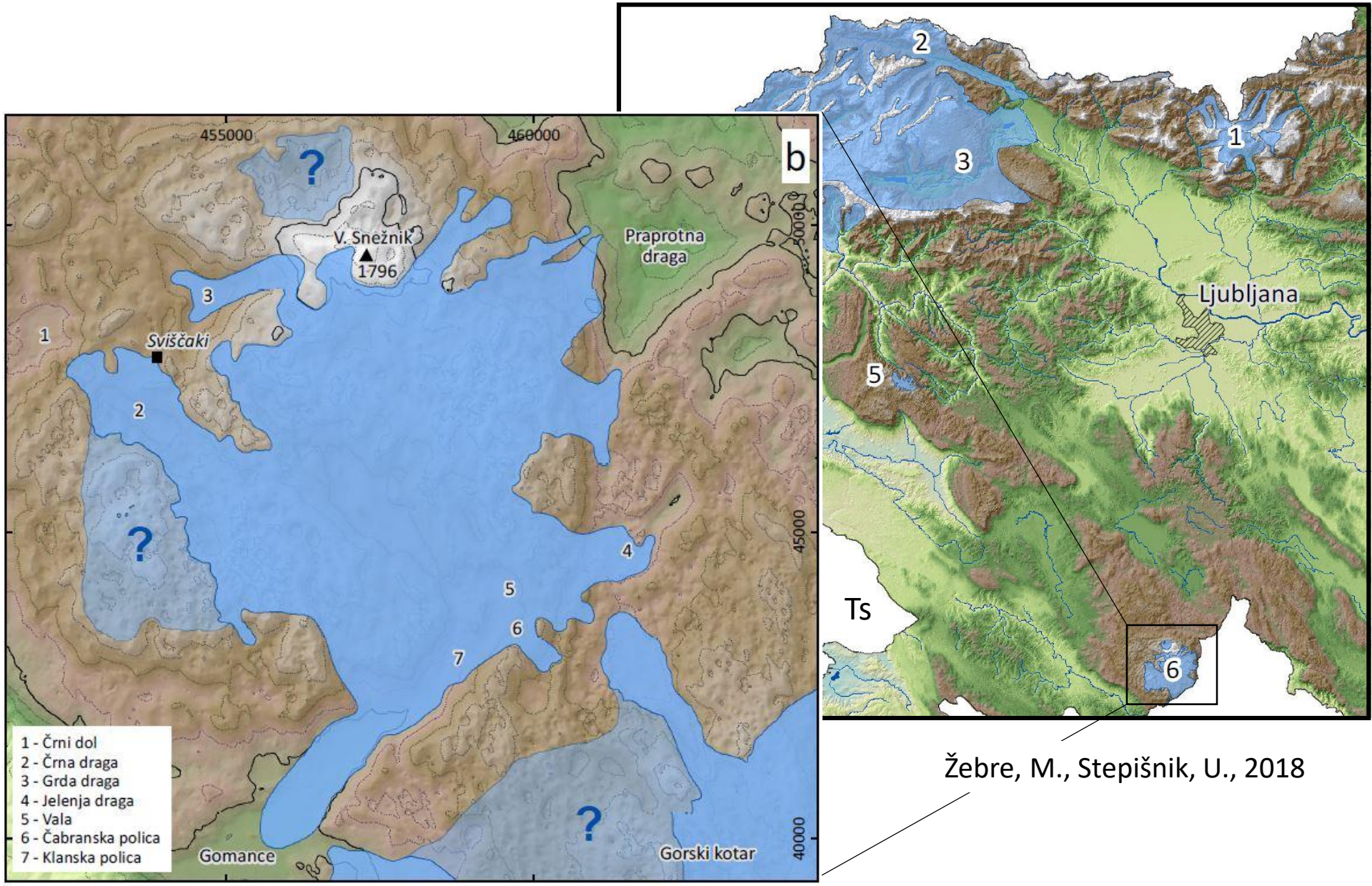
Žebre, M., Stepišnik, U., 2018

Che cosa significano pochi gradi di differenza a livello GLOBALE ?

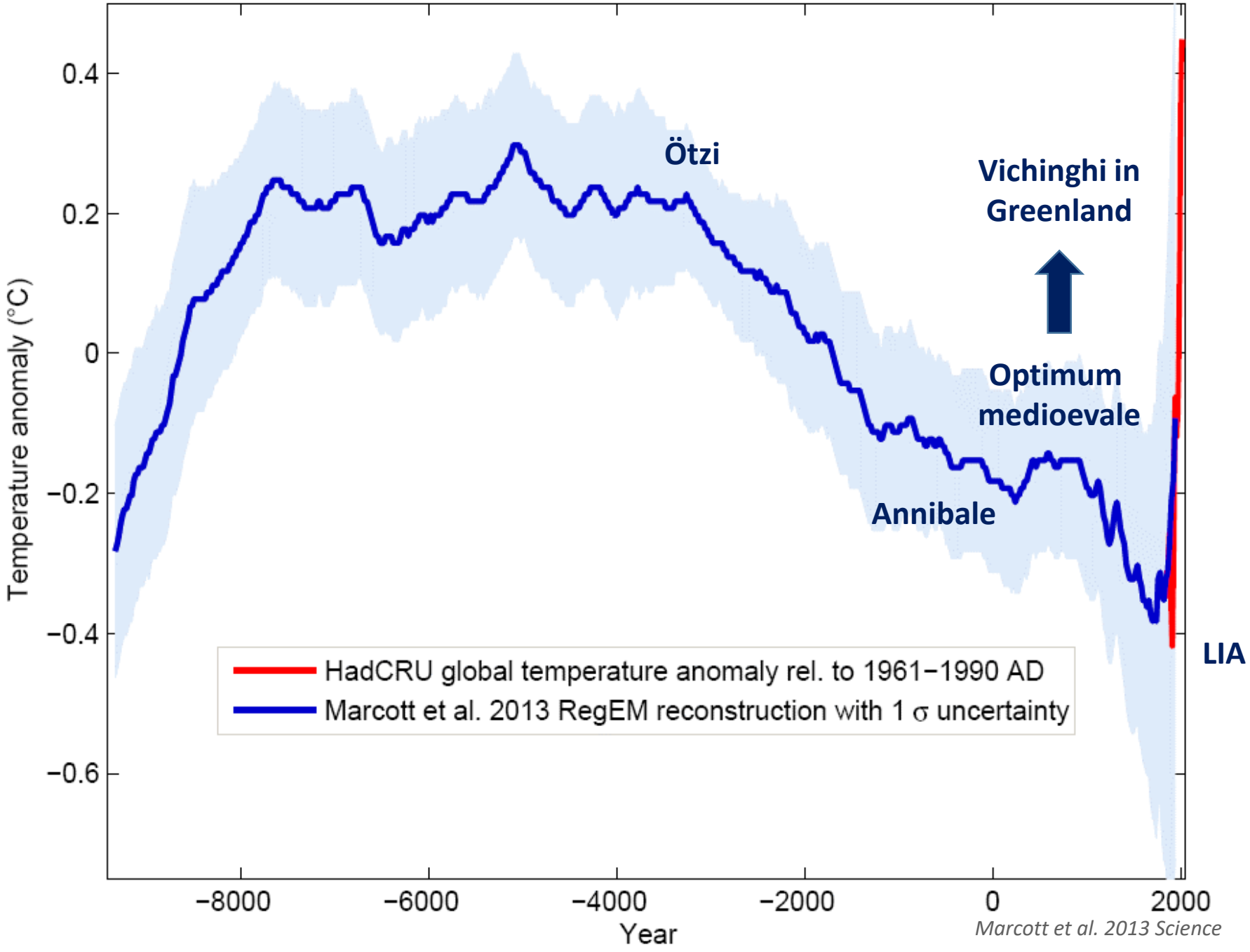


Žebre, M., Stepišnik, U., 2018

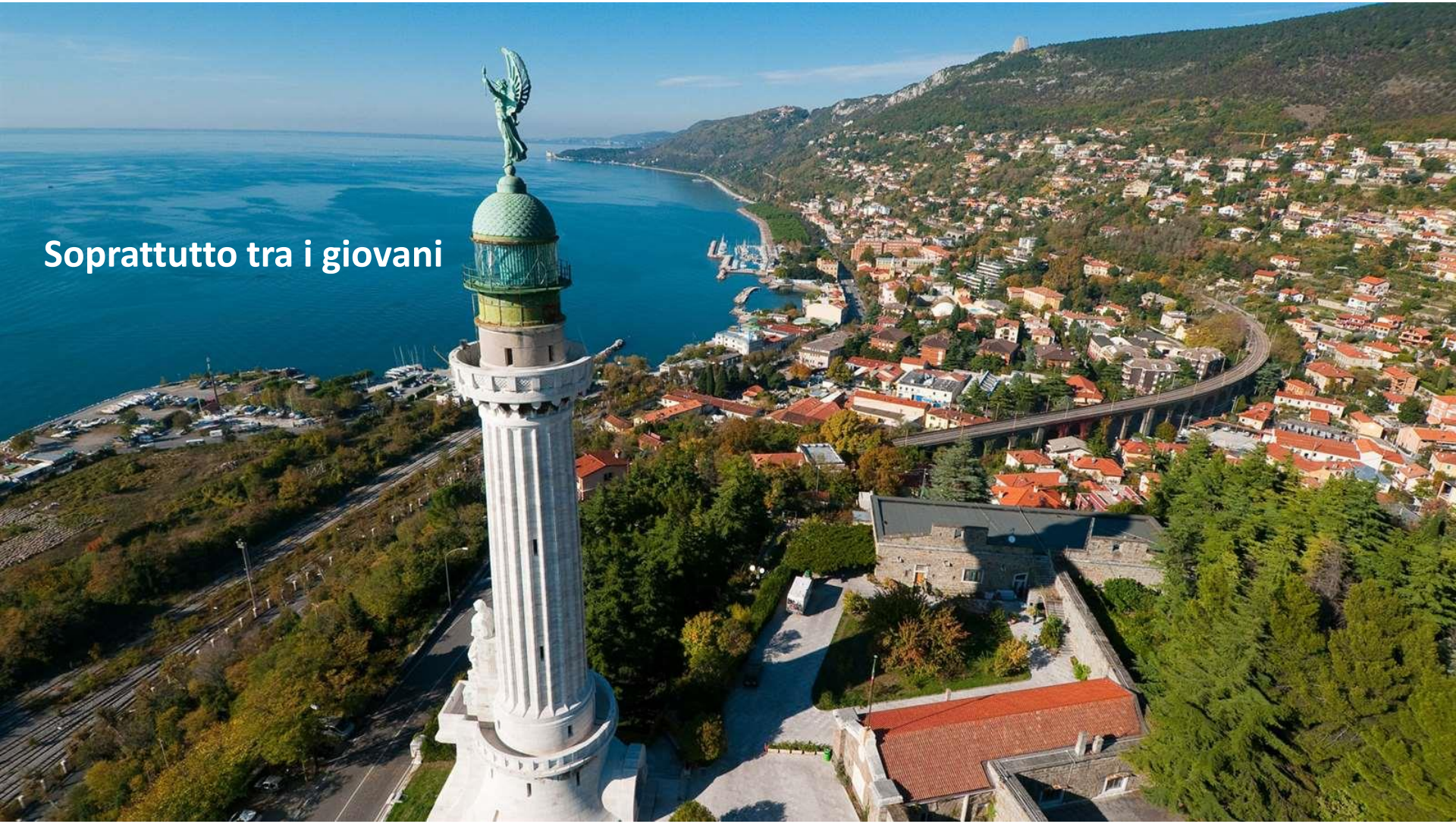
Che cosa significano pochi gradi di differenza a livello GLOBALE ?



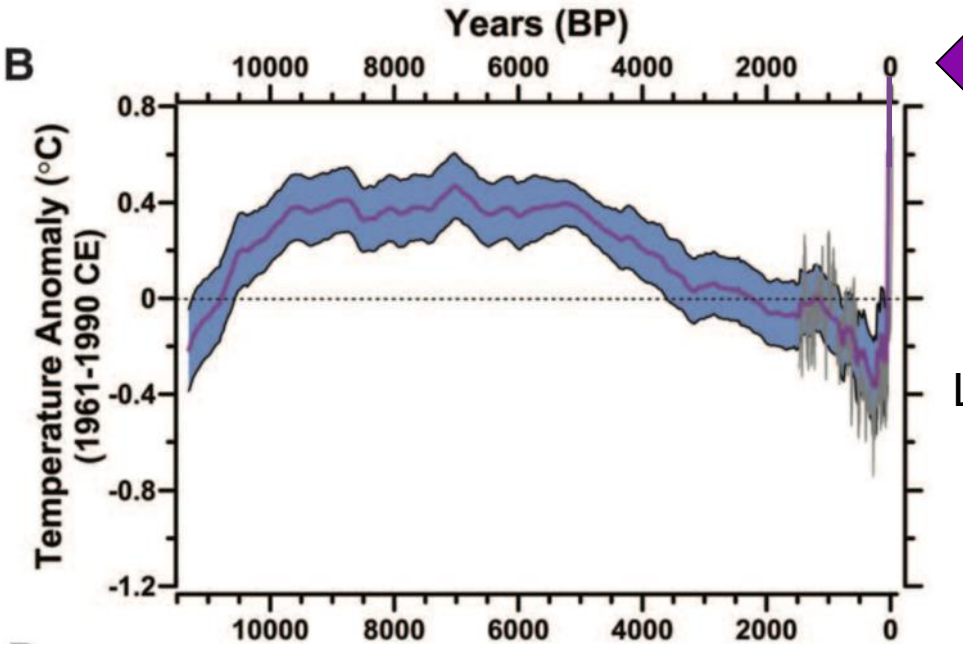
Žebre, M., Stepišnik, U., 2018


0.4
0.2
0
−0.2
−0.4
−0.6
Temperature anomaly (°C)
−8000
−6000
−4000
−2000
0
2000
Year
Ötzi
Vichinghi in Greenland
Optimum medioevale
Annibale
LIA
HadCRU global temperature anomaly rel. to 1961−1990 AD
Marcott et al. 2013 RegEM reconstruction with 1 σ uncertainty
Marcott et al. 2013 Science

Il cambiamento climatico nelle città… **un problema di Percezione**



Dove siamo?

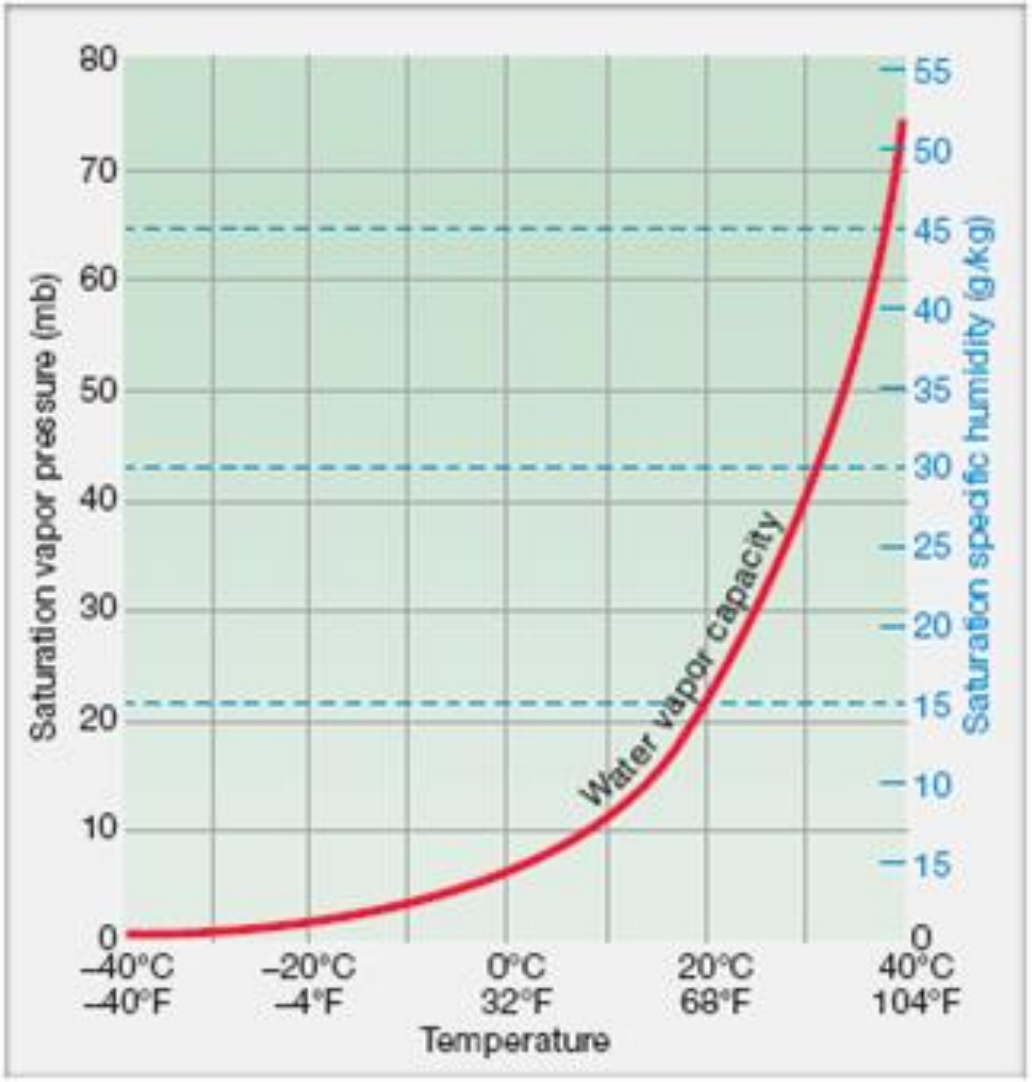


Oggi +1.0° C

LIA

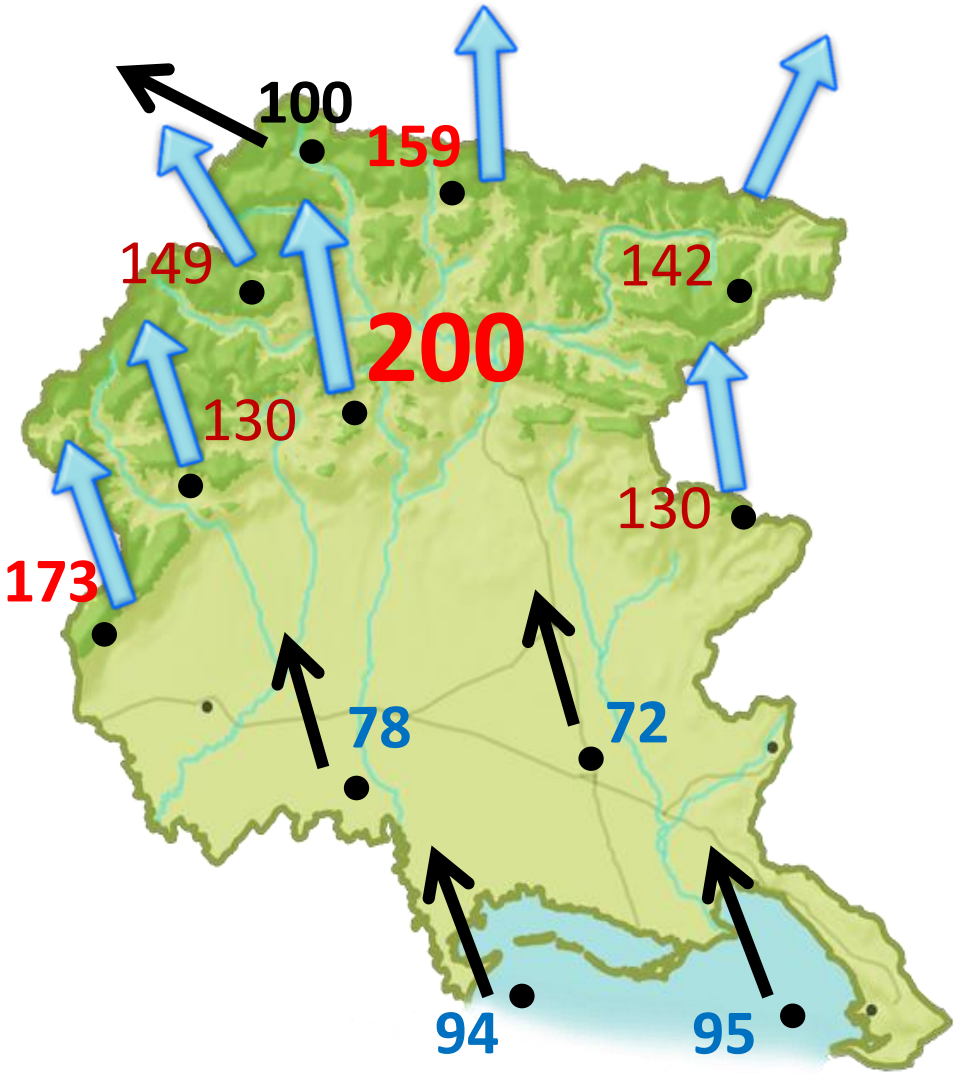
Marcott et al. 2013 Science

Un’atmosfera più calda è un’atmosfera più energetica



VAIA

VAIA



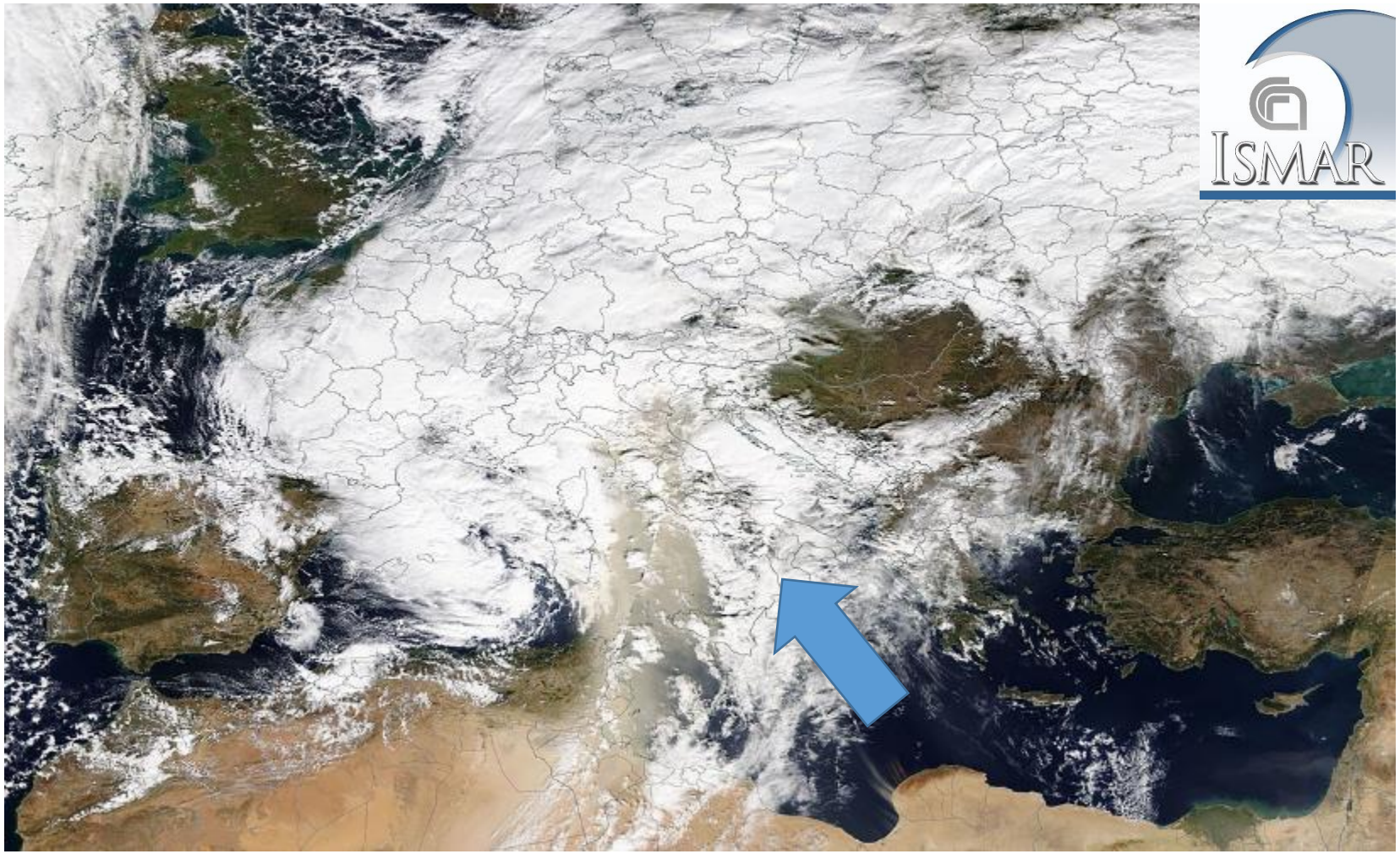
misure tra
1000 e 2000 m

200 km/h tra h 18 e 19 z sul monte Rest, dato più alto rilevato in regione

Marinelli 159 km/h
Casera Pieltinis 149 km/h

A cura di OSMER-ARPA

VAIA



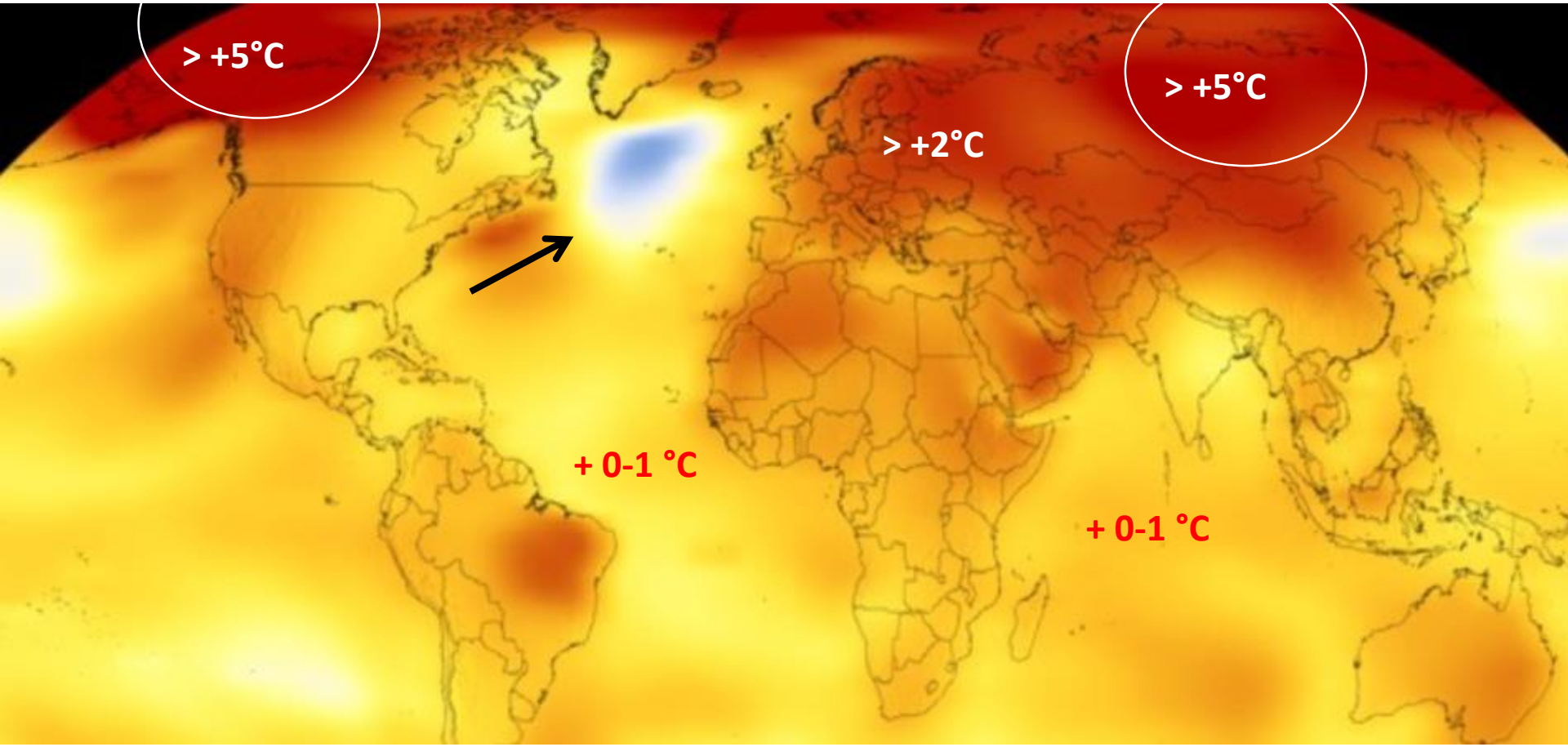
Masse d’aria sul Mediterraeno (29 ottobre 15:00 UTC)

A. Ricchi, D. Bonaldo, R.R. Colucci, S. Carniel
ISMAR CNR

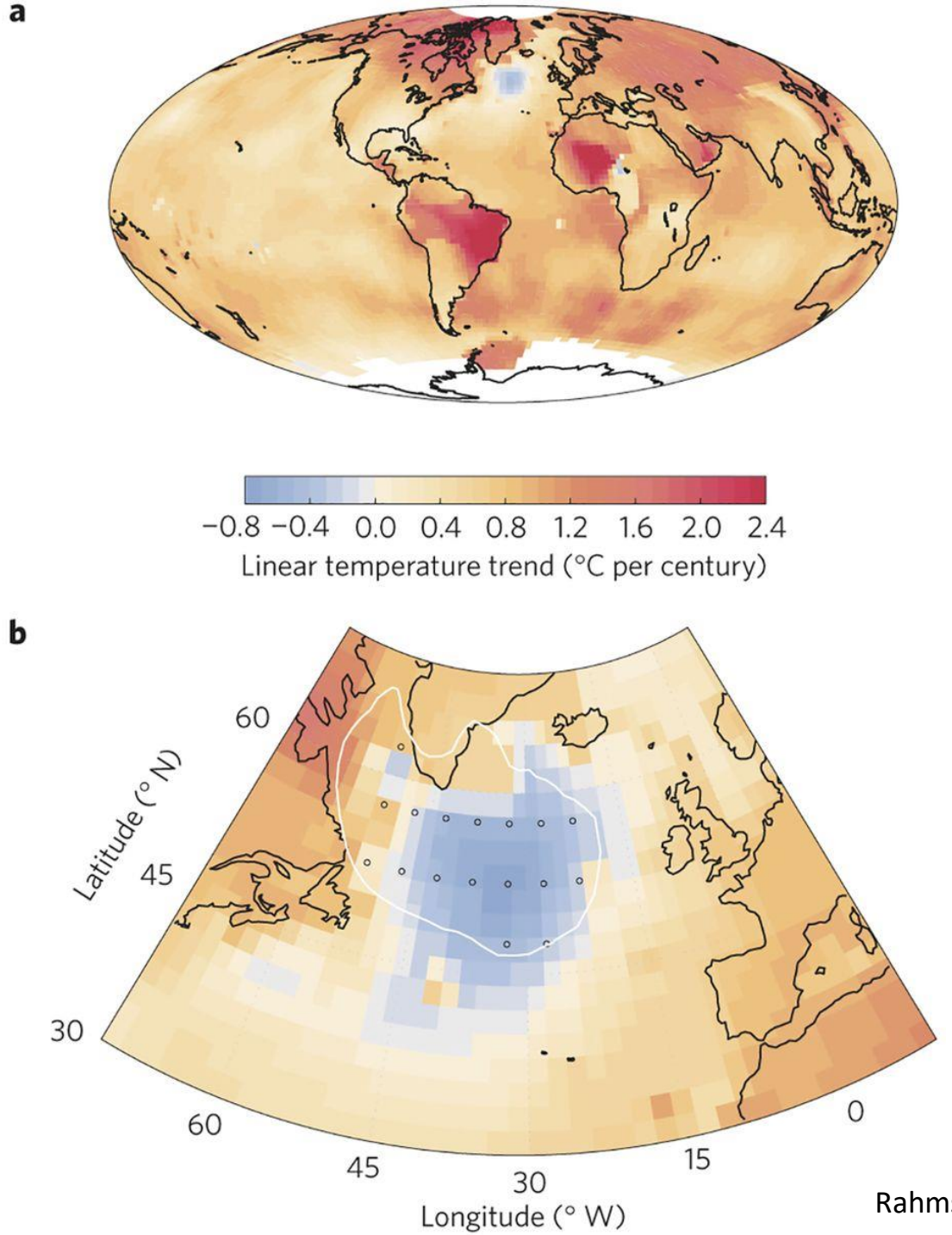
- la dinamica degli eventi 2018 e 1966 è simile
- le precipitazioni in 24 ore furono decisamente superiori nel 1966
- le precipitazioni in 2 giorni sono state simili all'evento del 1965,
  → ma NON nelle 24 ore
- La pausa tra le piogge del 28 e 29 è stata decisiva per il Tagliamento:
  questi due elementi sono importanti per la questione idraulica della piena del fiume
- Anche se non abbiamo dati strumentali per il confronto, è altamente probabile che il vento sia stato più forte quest'anno rispetto al 1966
- Il mare Mediterraneo più caldo, frutto di una estate che è risultata la seconda più calda da ALMENO 180 anni ed un periodo di 7 mesi (aprile-ottobre) il più caldo mai osservato ha influito sulla intensità del vento sulle Alpi

Questo è il segnale del Global Warming

2013-2018

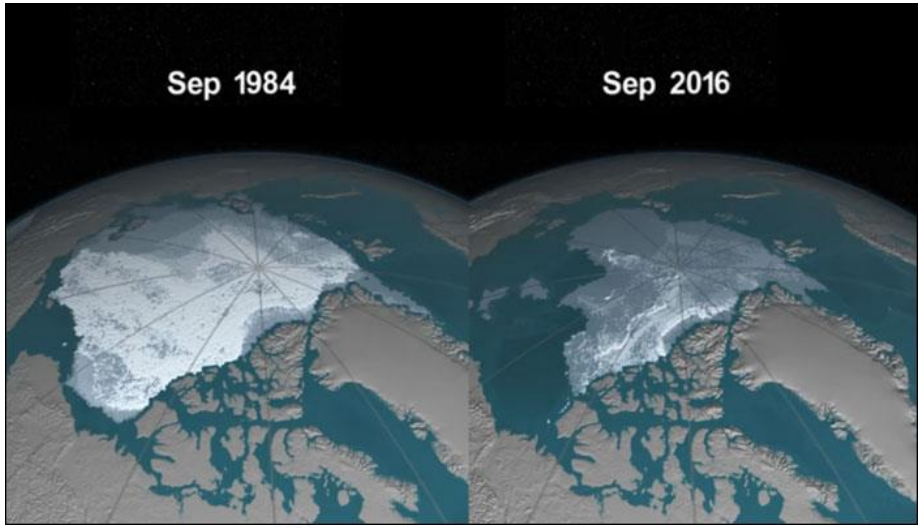


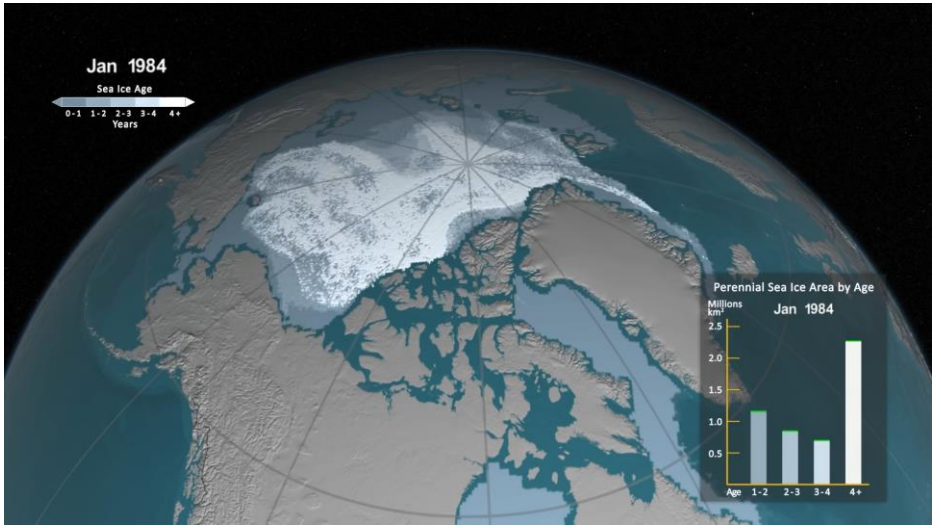
Anomalie globali di temperatura rispetto al trentennio 1981-2010

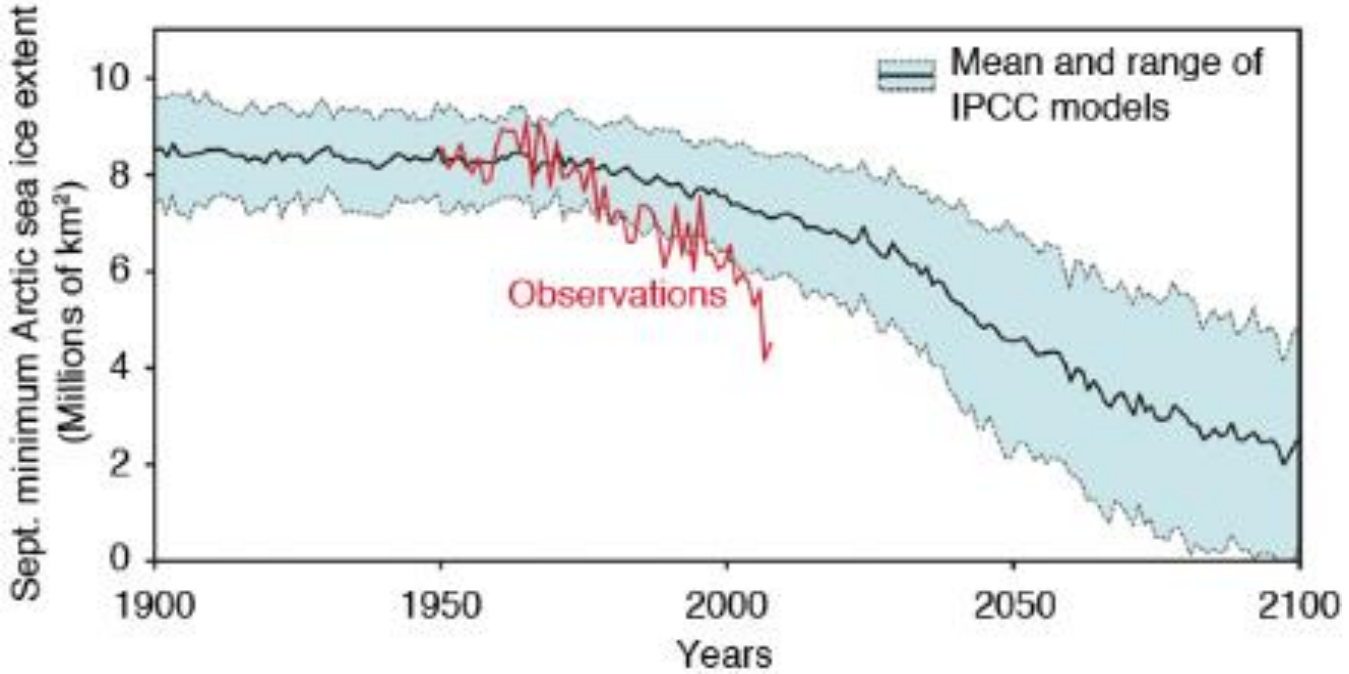


Rahmstorf et al., 2015 *Nature*

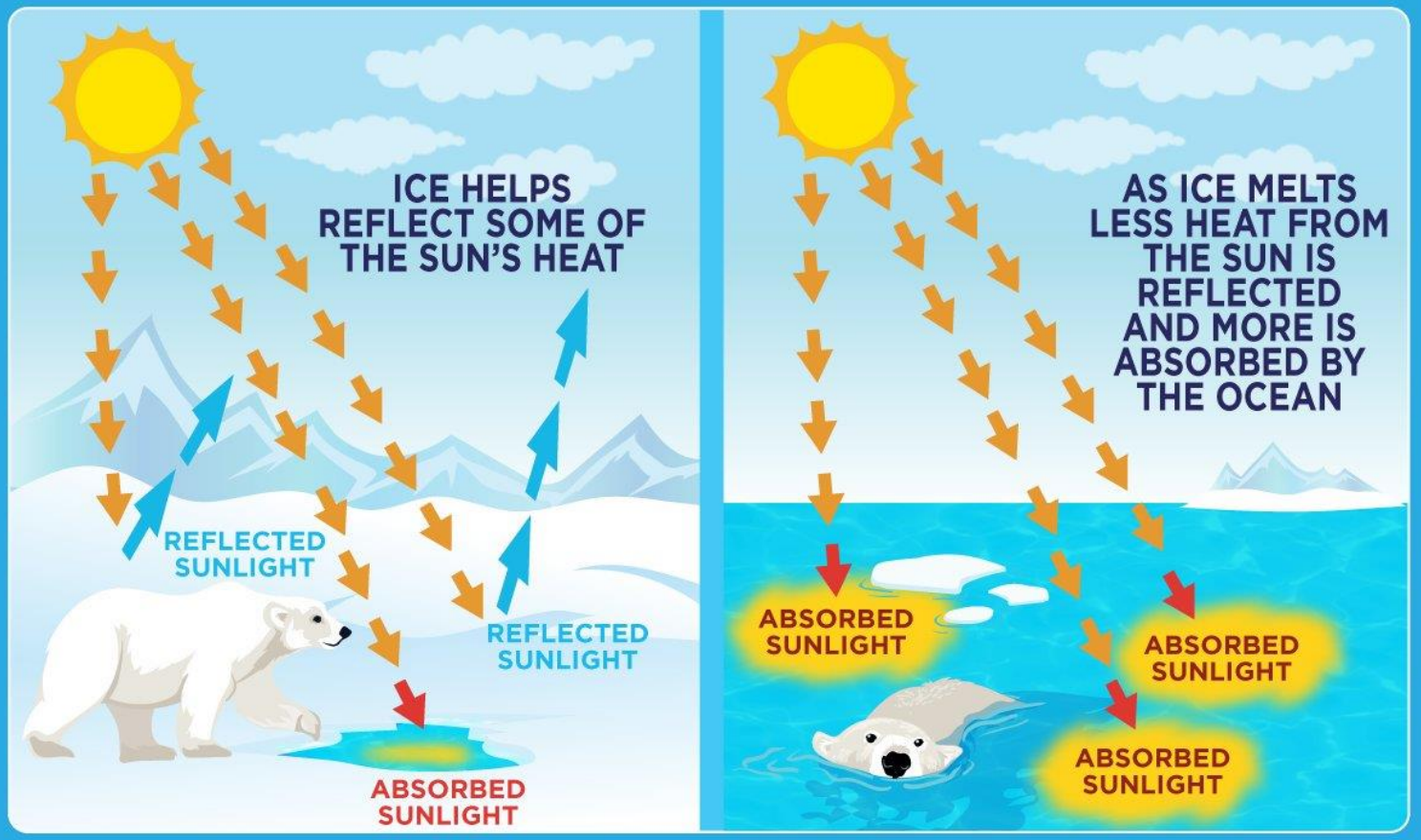
Arctic Amplification – **AA**





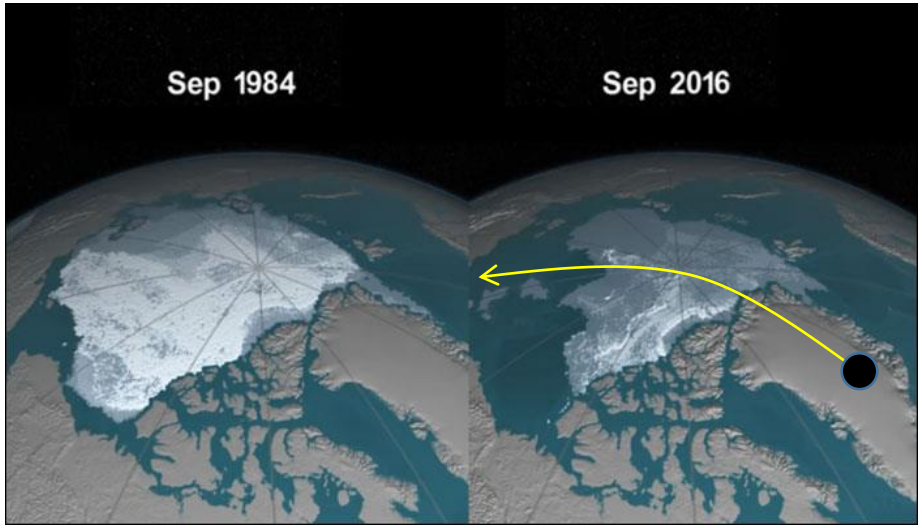


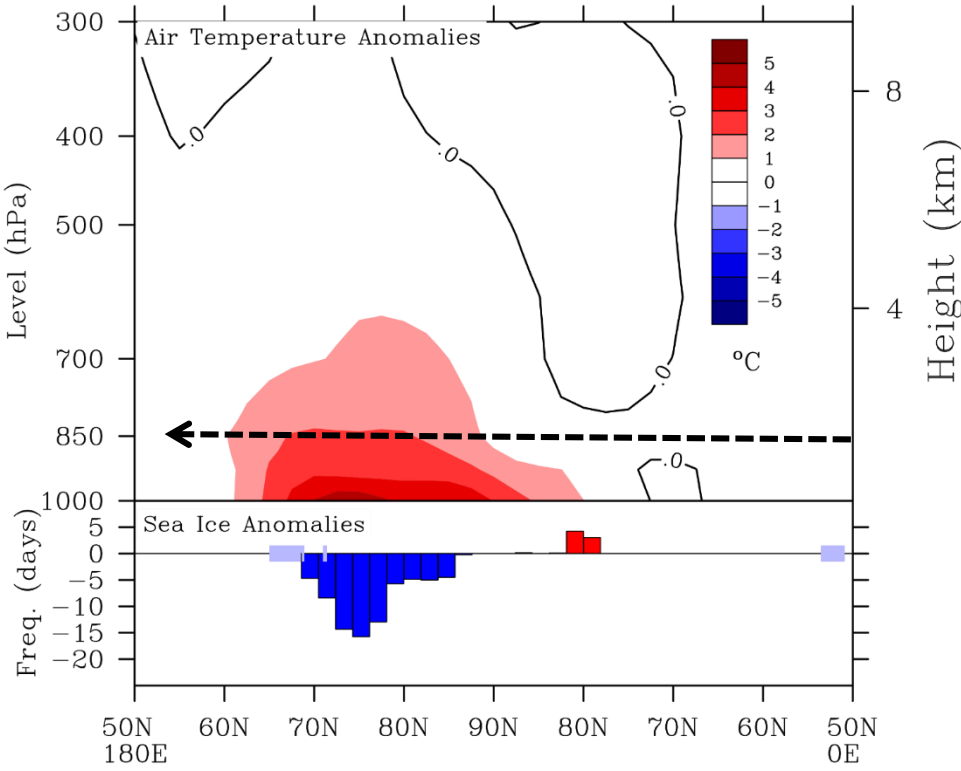
Arctic Amplification – **AA**



Less sea ice means more heat is absorbed into the ocean. Just as a heart circulates blood and regulates the body's temperature, the ocean controls the world's climate system by circulating heat, moisture, and nutrients around the planet. Disruptions in this system, such as extra heat, have global impacts and can lead to more frequent and extreme weather events around the world.

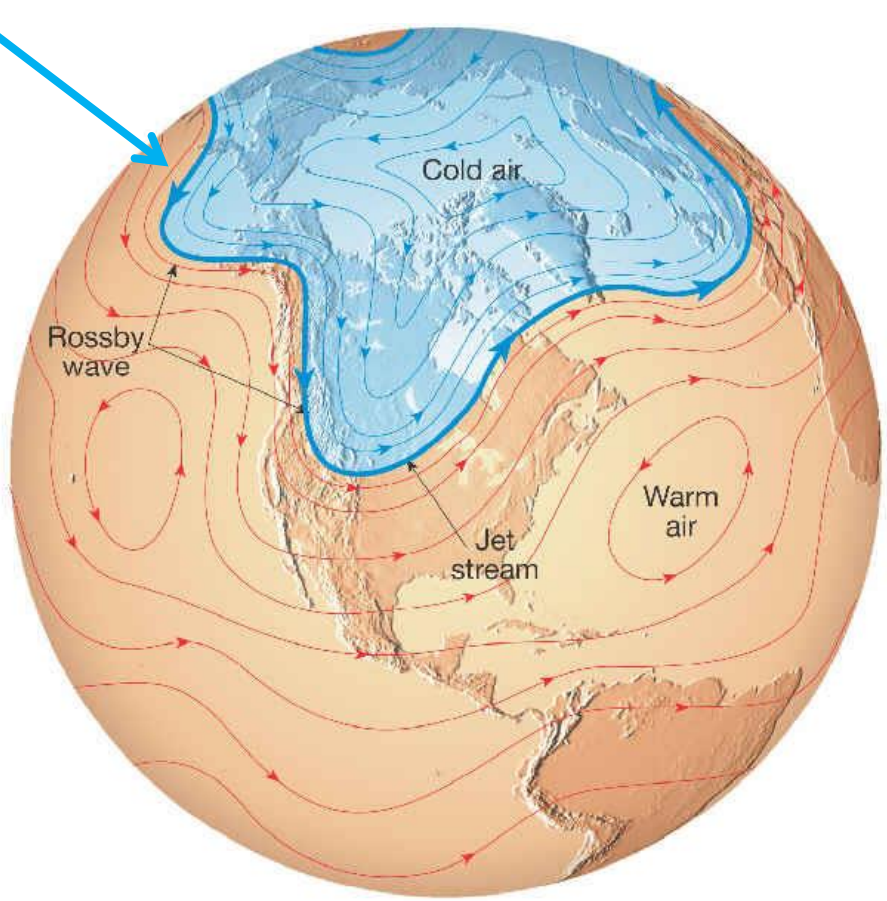
Arctic Amplification – **AA**





Riscaldamento molto più marcato su alcune zone artiche rispetto alle medie latitudini

L’Amplificazione Artica può portare a pattern meteorologici più persistenti alle medie latitudini attraverso 2 meccanismi che influiscono sulle ONDE DI ROSSBY



Quasi-Resonant Amplification

QRA

SCIENTIFIC REPORTS

Article | OPEN | Published: 27 March 2017

Influence of Anthropogenic Climate Change on Planetary Wave Resonance and Extreme Weather Events

Michael E. Mann, Stefan Rahmstorf, Kai Kornhuber, Byron A. Steinman, Sonya K. Miller & Dim Coumou

Scientific Reports **7**, Article number: 45242 (2017) | Download Citation

PNAS Proceedings of the National Academy of Sciences of the United States of America

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NEW RESEARCH IN Physical Sciences | Social Sciences

Role of quasiresonant planetary wave dynamics in recent boreal spring-to-autumn extreme events

Vladimir Petoukhov, Stefan Petri, Stefan Rahmstorf, Dim Coumou, Kai Kornhuber, and Hans Joachim Schellnhuber

PNAS June 21, 2016 113 (25) 6862-6867; published ahead of print June 6, 2016
https://doi.org/10.1073/pnas.1606300113

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RESEARCH ARTICLE | CLIMATOLOGY

Projected changes in persistent extreme summer weather events: The role of quasi-resonant amplification

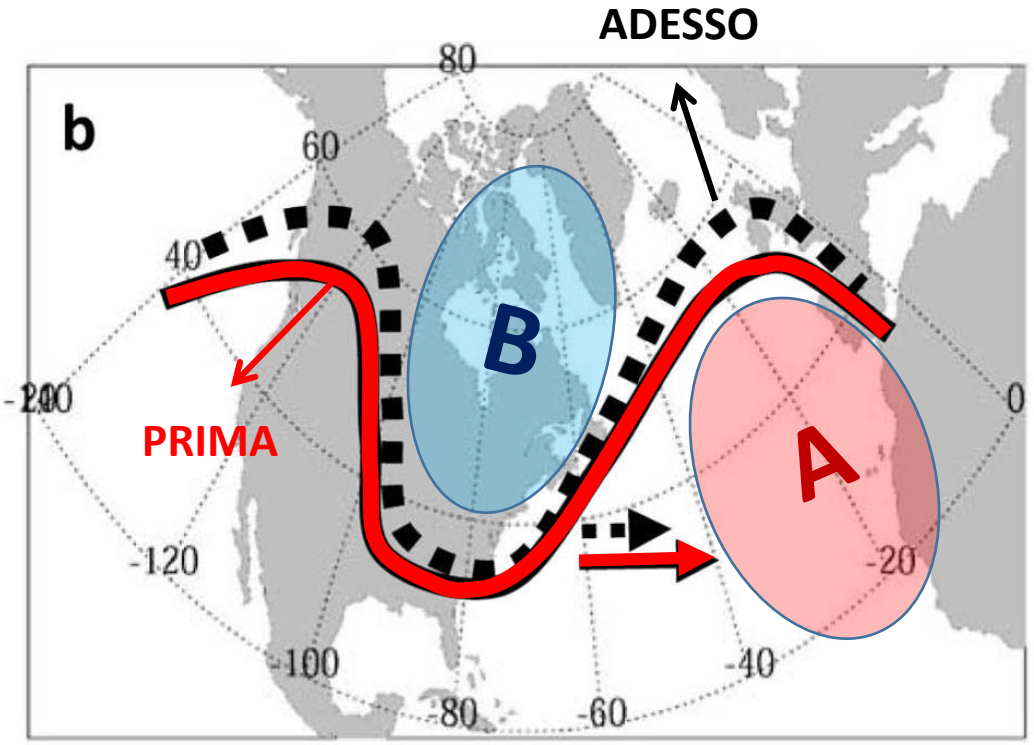
Michael E. Mann[1,*], Stefan Rahmstorf[2,3], Kai Kornhuber[2], Byron A. Steinman[4], Sonya K. Miller[1], Stefan Petri[2] and Dim Coum...
+ See all authors and affiliations

Science Advances 31 Oct 2018:
Vol. 4, no. 10, eaat3272
DOI: 10.1126/sciadv.aat3272

Quasi-Resonant Amplification – **QRA**

1) **Deformazione in latitudine** delle onde di Rossby

2) **rallentamento** delle onde di Rossby



Francis et al., 2012

Quasi-Resonant Amplification – **QRA**

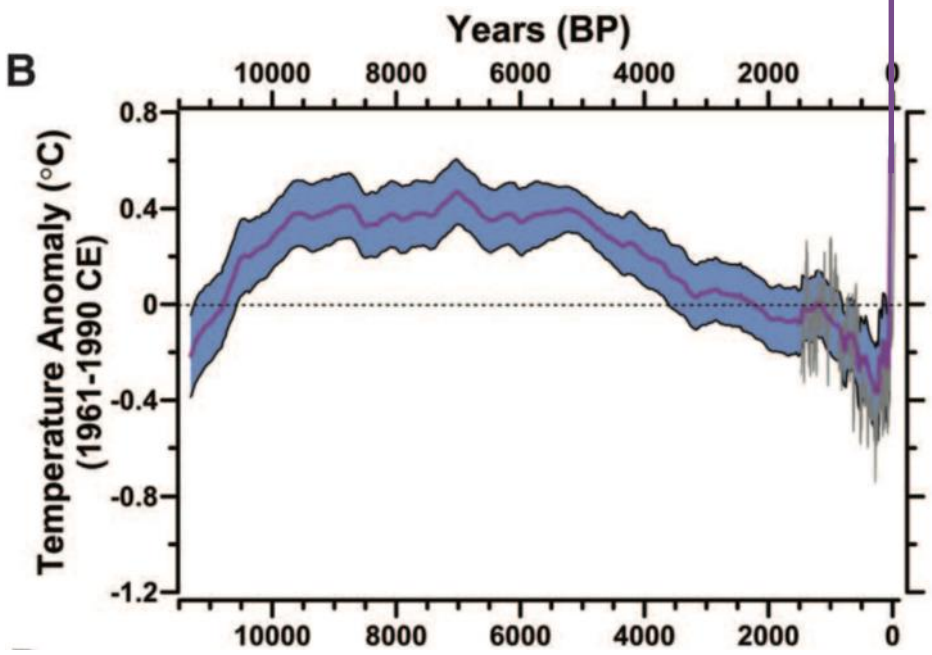
1) **Deformazione in latitudine** delle onde di Rossby

2) **rallentamento** delle onde di Rossby

Maggiore probabilità di eventi estremi ad **impronta calda**

→ **Precipitazioni intense**
→ **Ondate di calore estremo**
→ **Tempeste (vento) più forti**
→ **Periodi aridi**

Dove stiamo andando?



Paris Agreement

Oggi +1.0° C

LIA

IPCC, 2013: Climate Change 2013

Marcott et al. 2013 Science

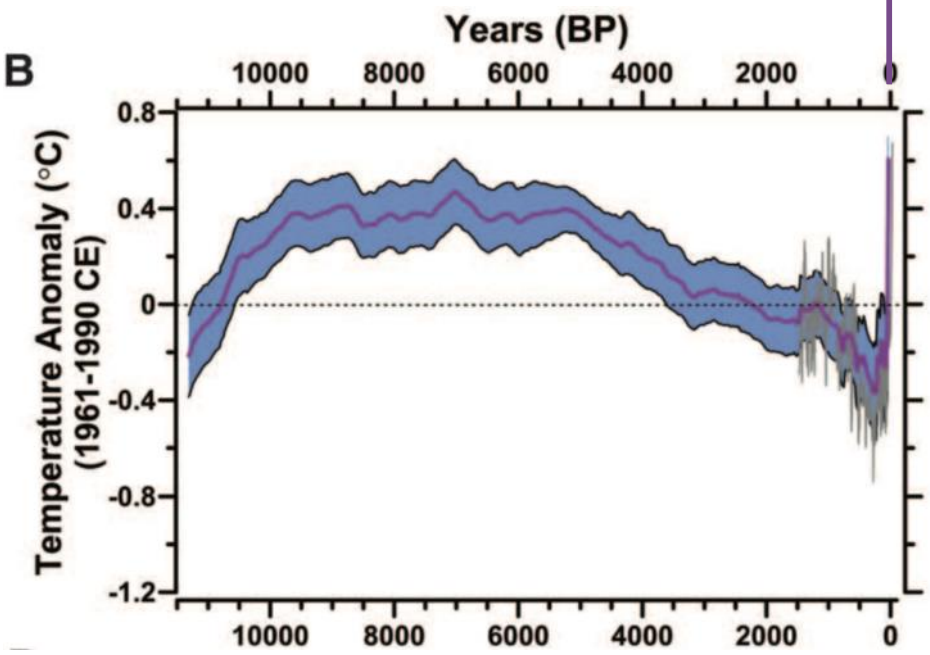
Dove stiamo andando?

RC8.5 (+4.0° C)
Business as usual?

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Paris Agreement

Oggi +1.0° C



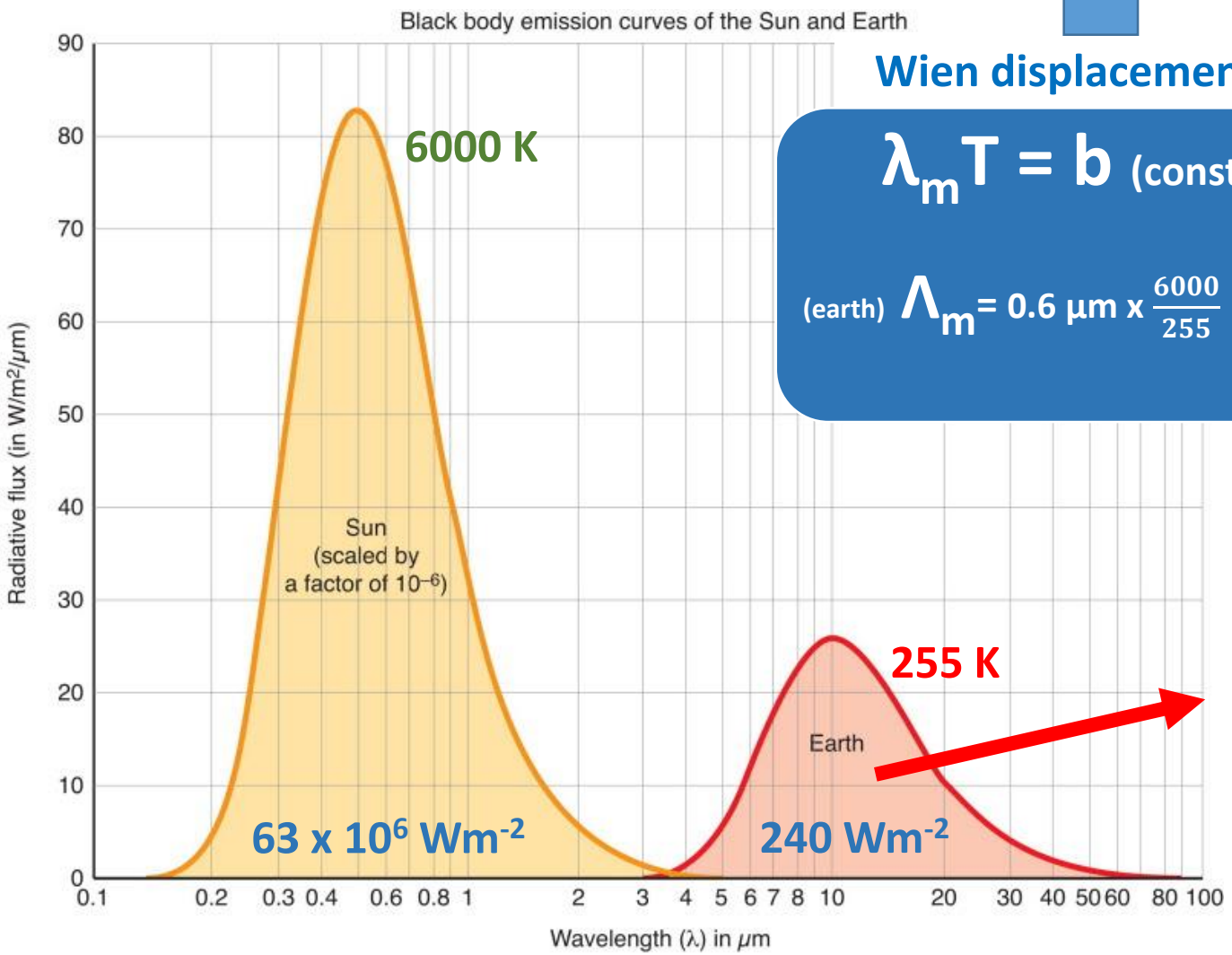
LIA

IPCC, 2013: Climate Change 2013
Marcott et al. 2013 Science

The Earth's energy budget

Heat balance at the top of the atmosphere

black body radiation curve for different temperatures peaks at a wavelength inversely proportional to the temperature



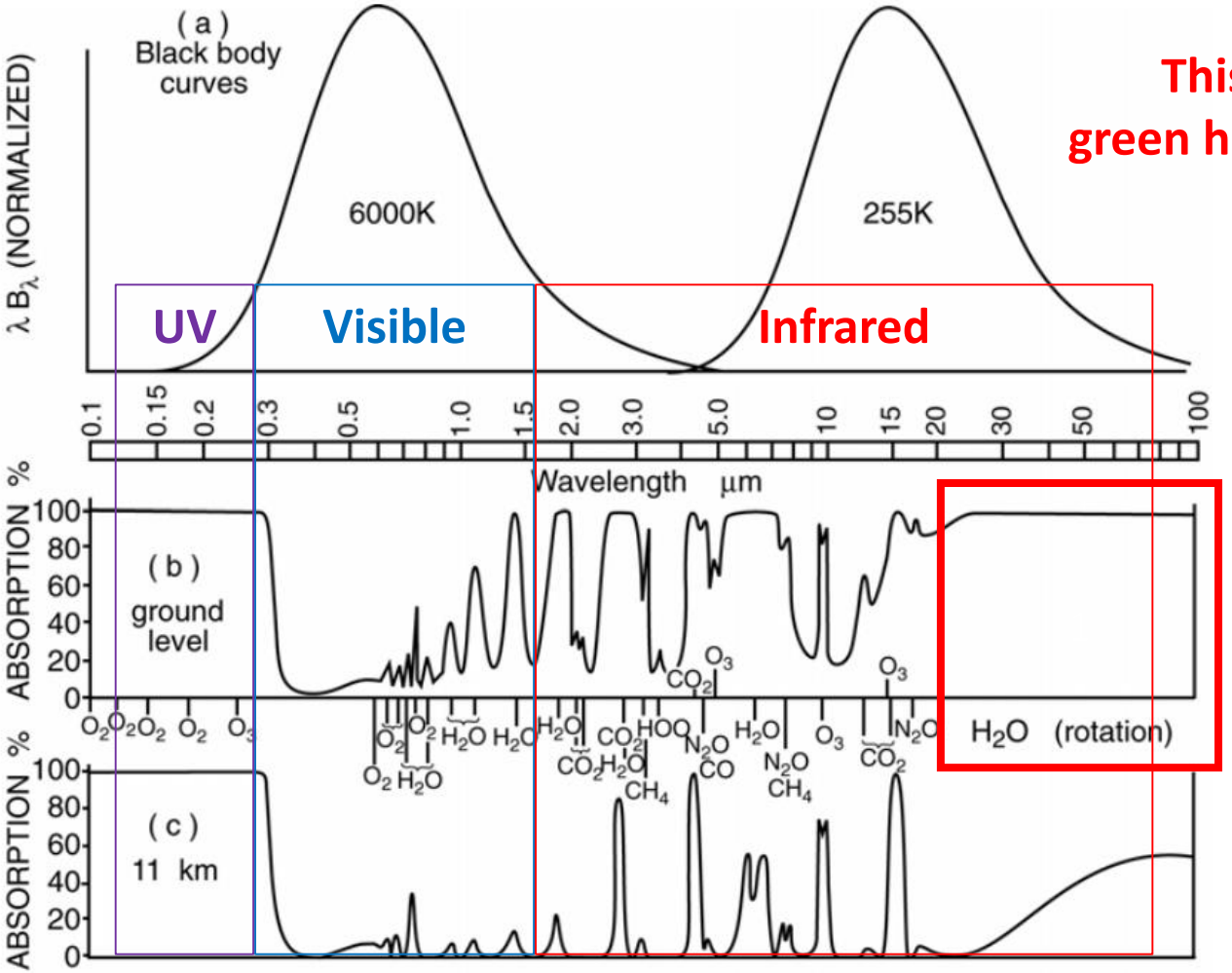
Wien displacement law

$$\lambda_m T = b \text{ (constant)}$$

(earth) $\Lambda_m = 0.6\ \mu m \times \frac{6000}{255} \cong 14\ \mu m$

The Earth's energy budget

Atmospheric absorption spectra - Normalized black body emission spectra



O_3

H_2O

CO_2

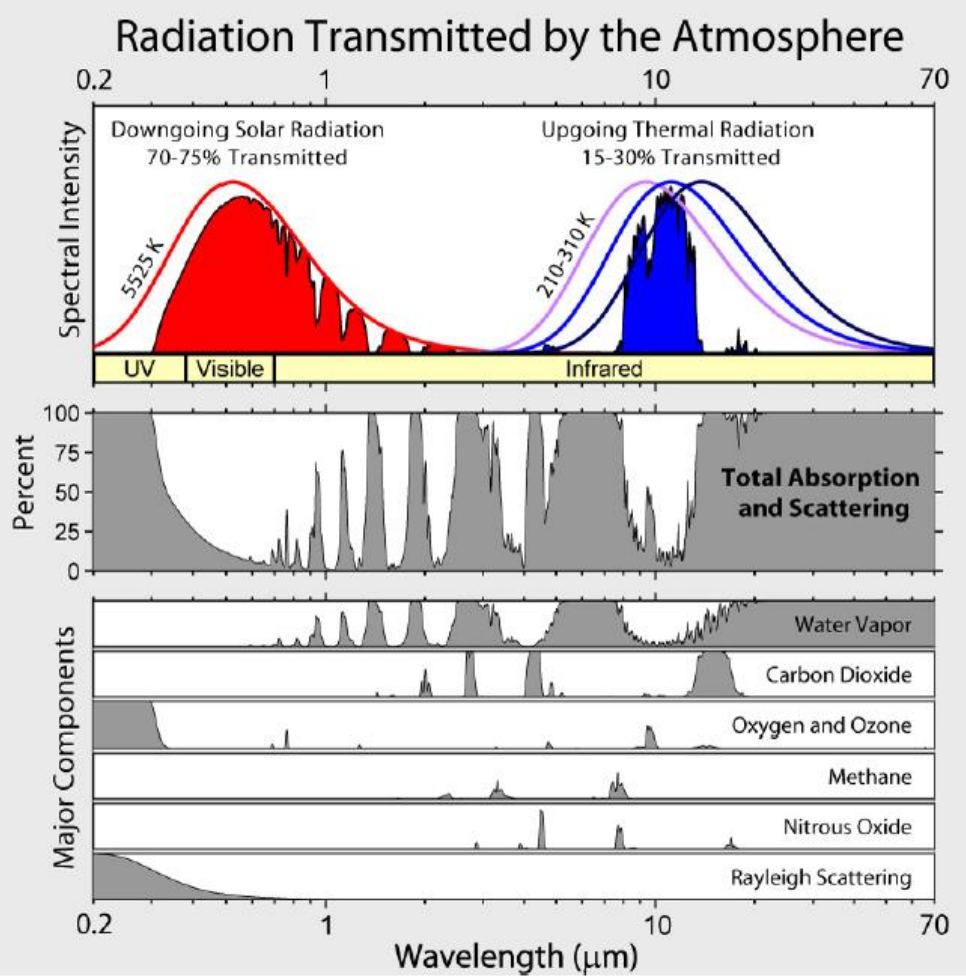
CH_4

This is the green house effect

(Good & Yung 1989)

The Earth's energy budget

Water vapour feedback



(Rohde 2007)

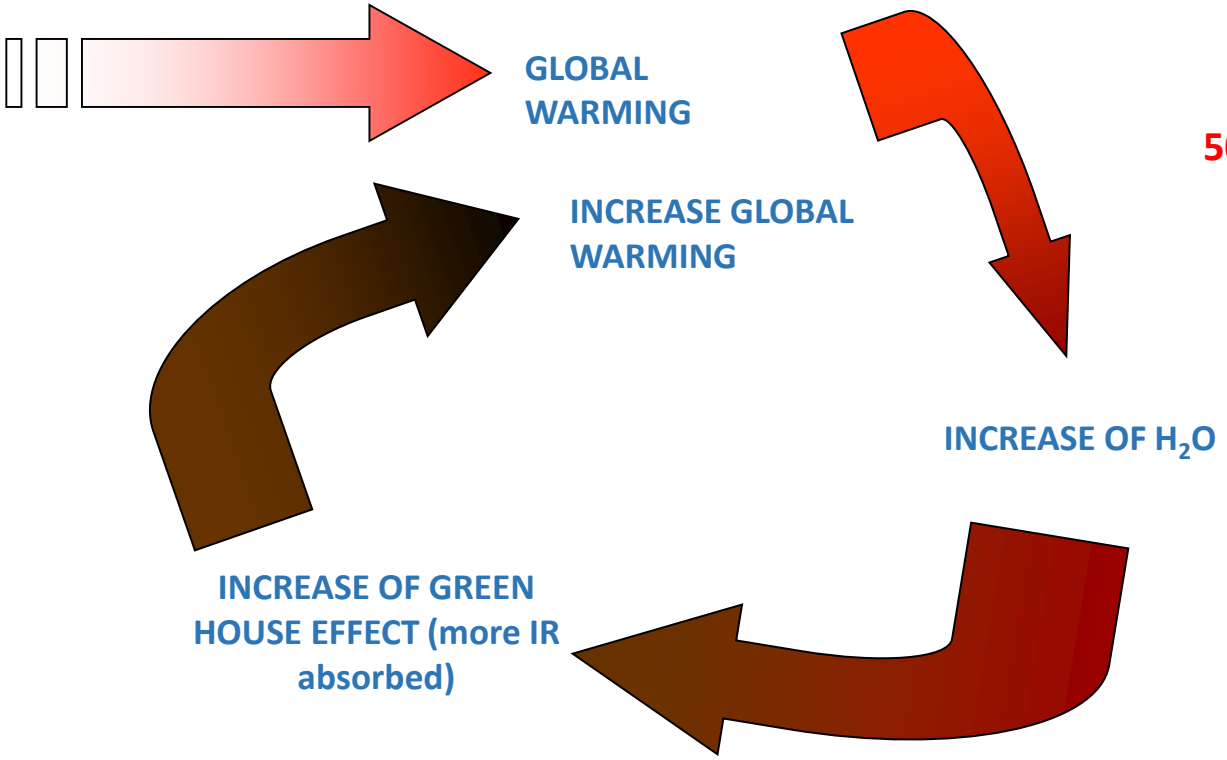
Gas removed	Wm^{-2}
H_2O	-56
CO_2	-23
H_2O and CO_2	-89

Effect of removal of individual greenhouse gases on longwave radiation

The Earth's energy budget

Water vapour feedback

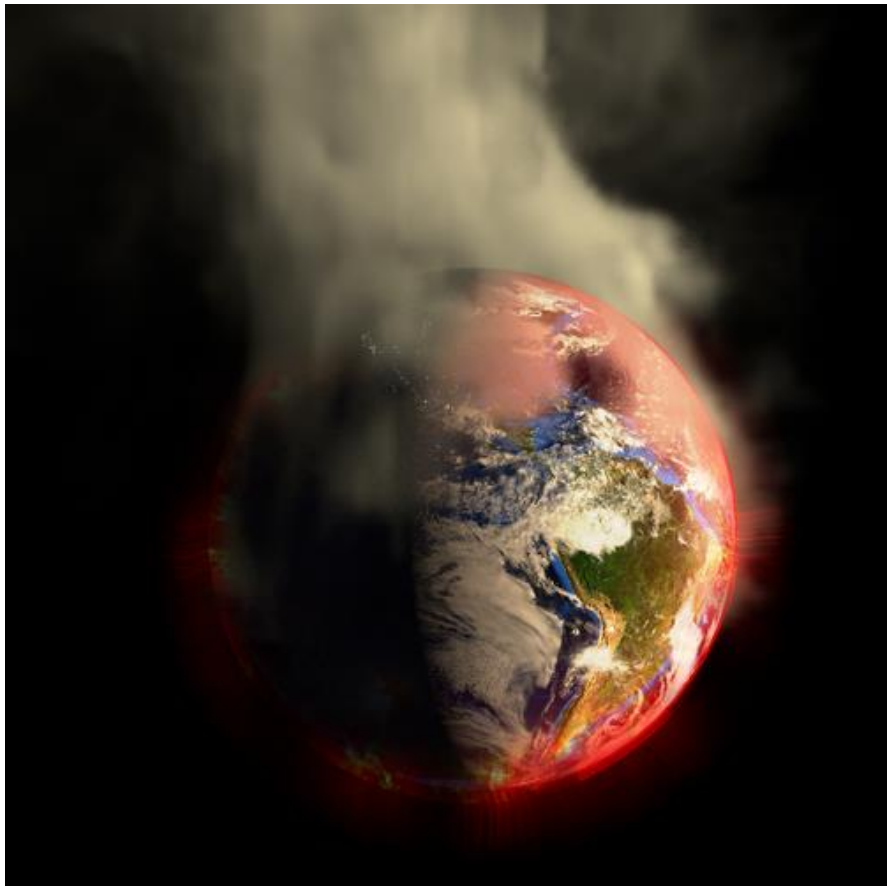
The **POSITIVE FEEDBACK** is so efficient to amplify the initial effect of 2 to 3 times



50-75% OF ANTROPOGENIC *Global Warming* IS ORIGINATED BY WATER VAPOUR

The Earth's energy budget

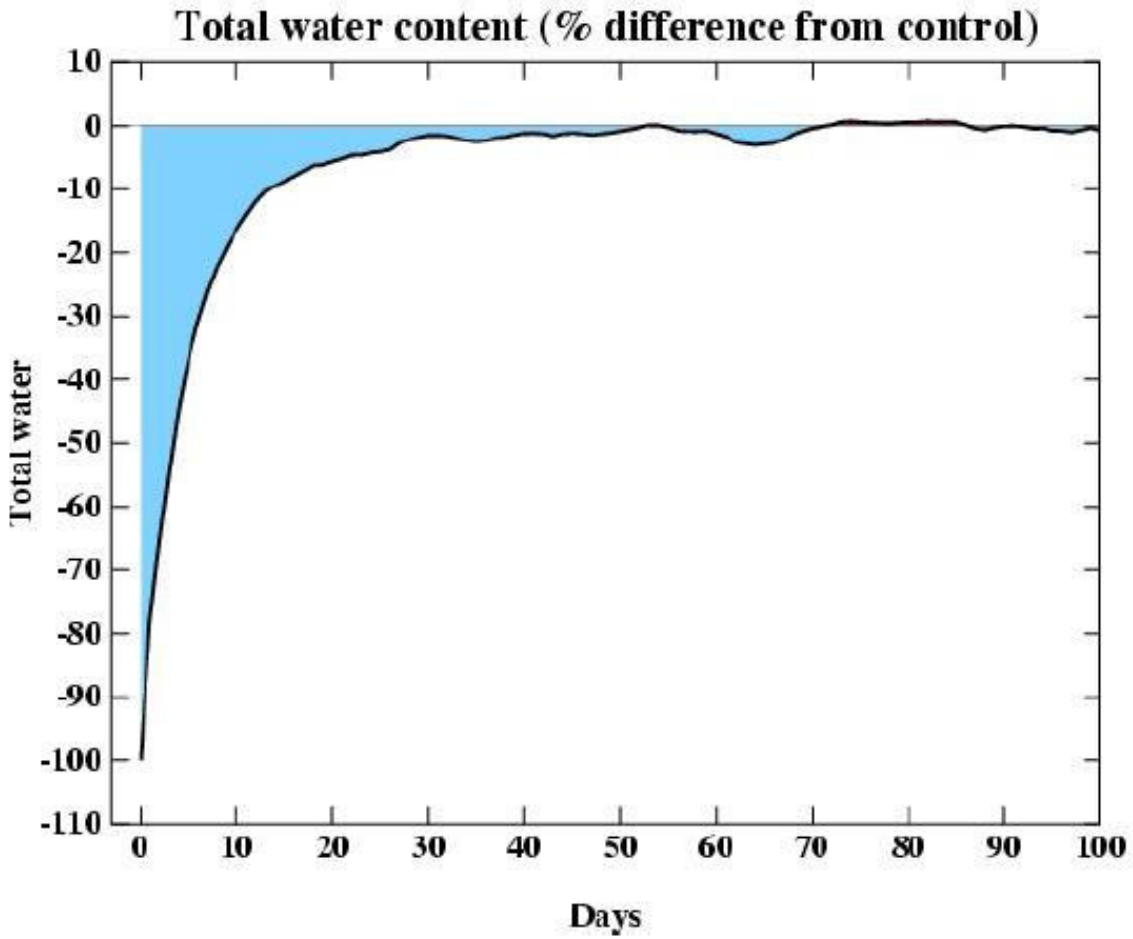
Water vapour feedback



Why always CO_2 plays the role of devil ?!

The Earth's energy budget

Water vapour feedback

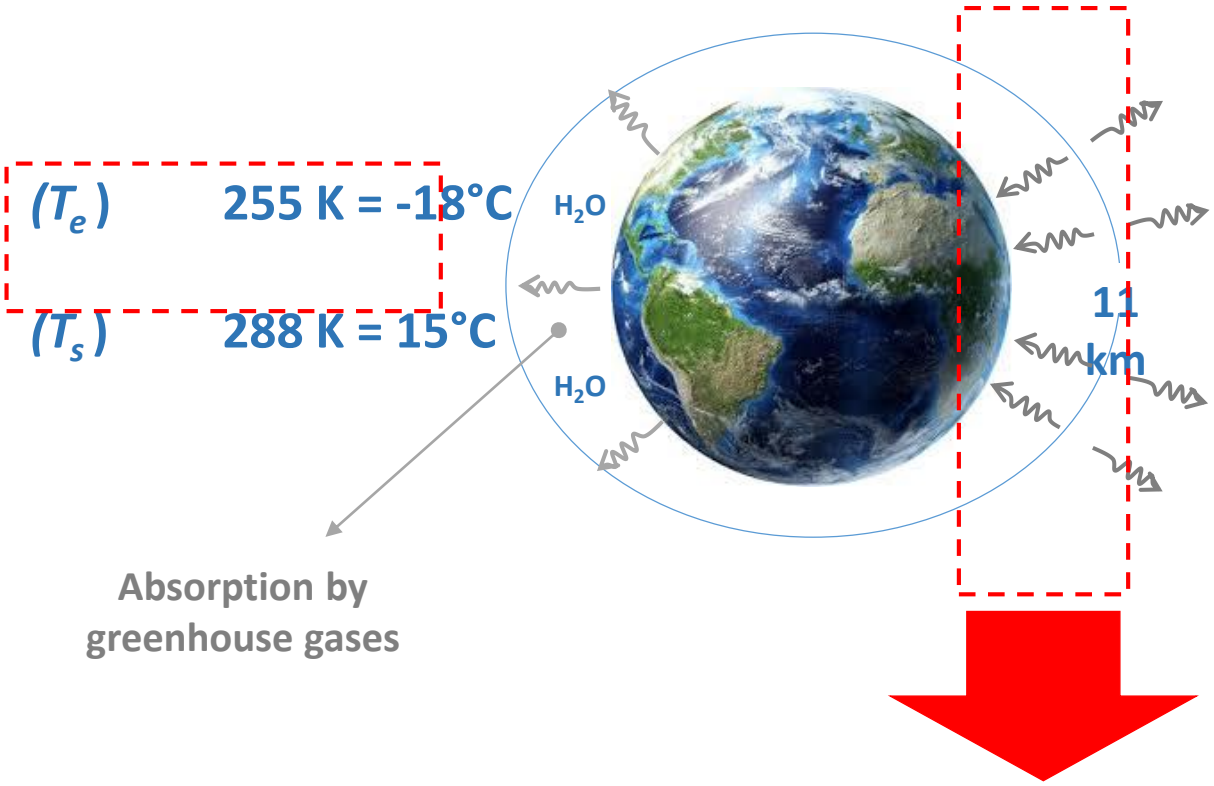


- Water vapour anomalies are short lived
- An equilibrium is approached very quickly

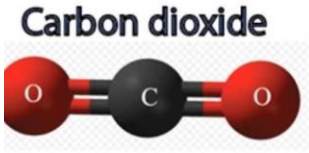
(Schmidt 2005)

The Earth's energy budget

Green house EFFECT

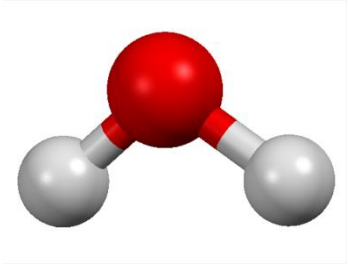


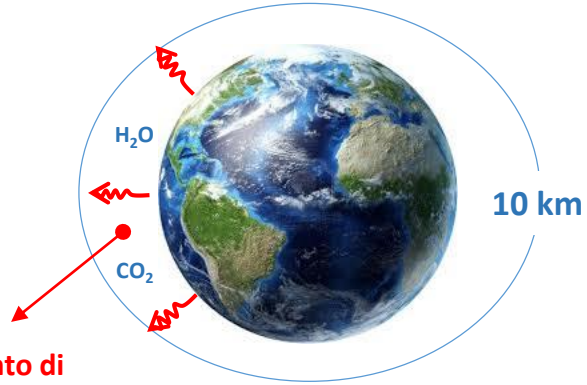
CO_2



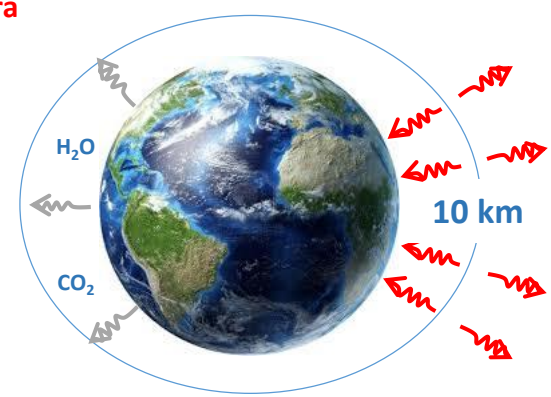
4 + 6(2) = 16

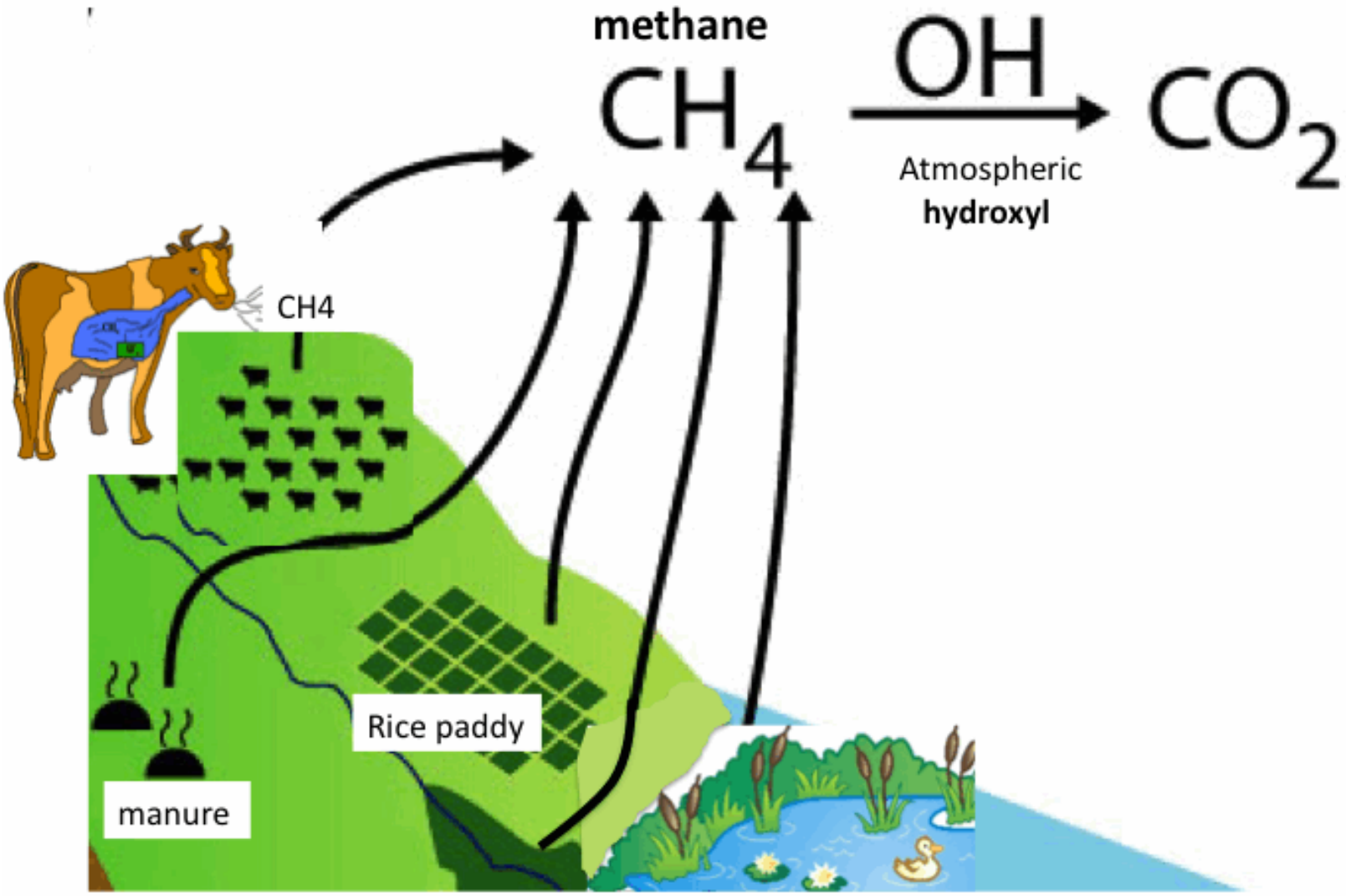
H_2O





Assorbimento di radiazione da parte dei gas serra




methane
CH_4
OH
CO_2
Atmospheric
hydroxyl
CH4
Rice paddy
manure

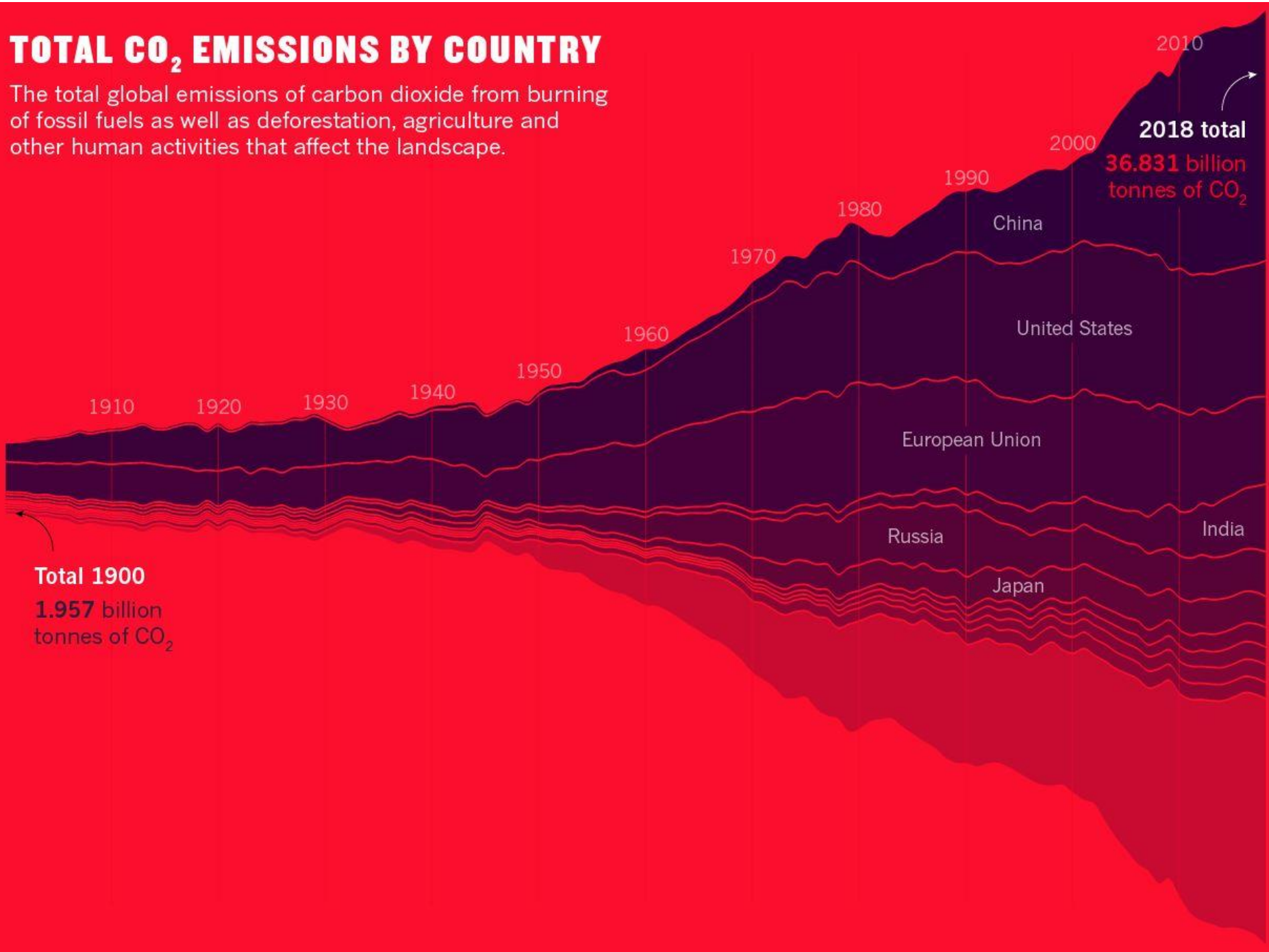
CO_2

CO_2

INCOLORE
INODORE
NON TOSSICA

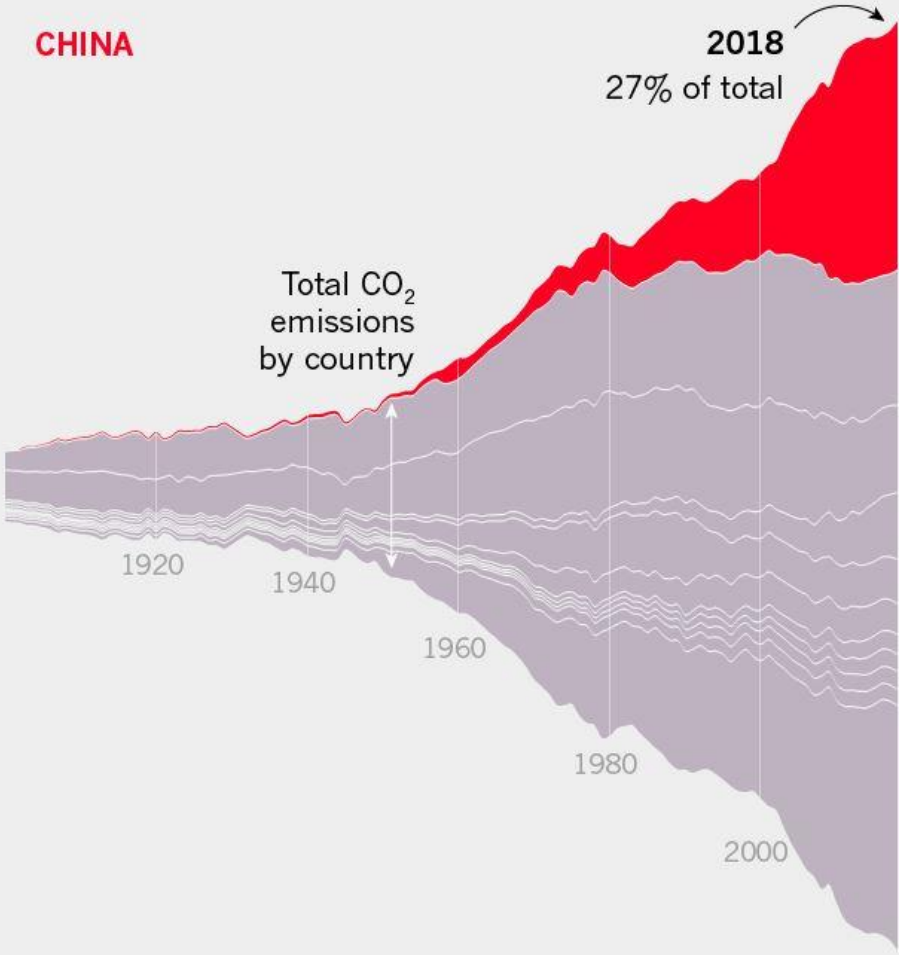
TOTAL CO_2 EMISSIONS BY COUNTRY

The total global emissions of carbon dioxide from burning of fossil fuels as well as deforestation, agriculture and other human activities that affect the landscape.



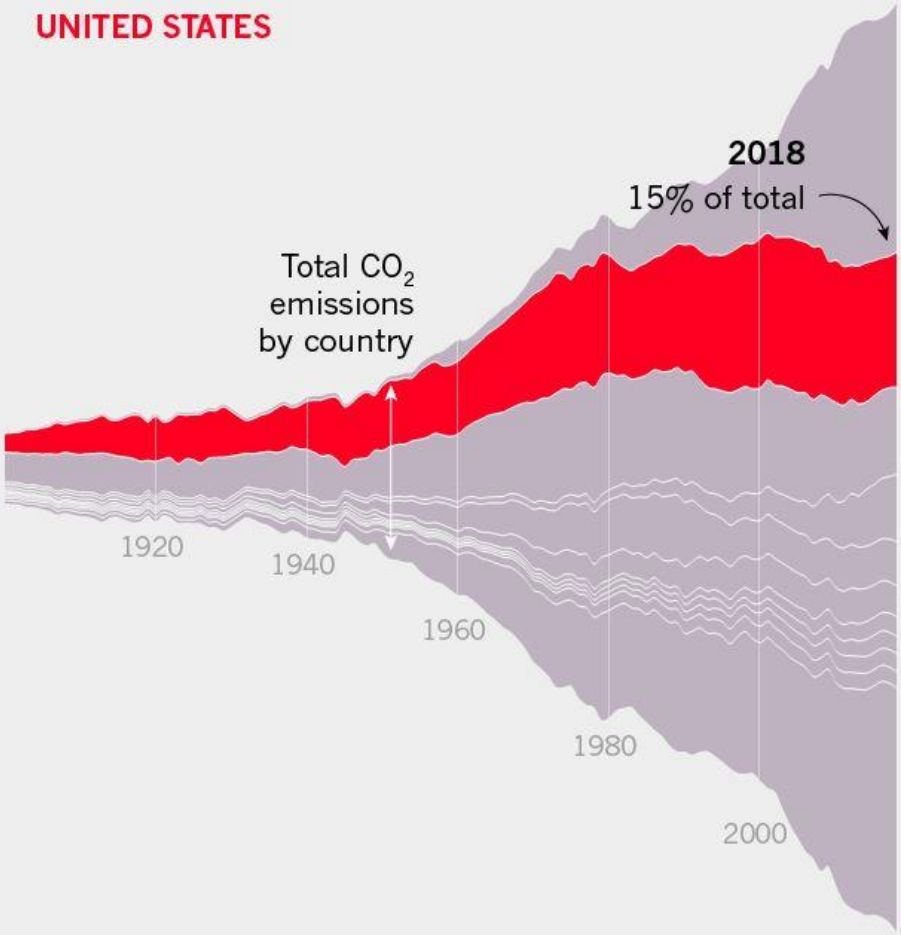
Source: Global Carbon Project

China: Where China goes, the world goes. The country is the largest source of CO_2 and its emissions are growing while other big emitters are turning the corner. CAT says China is on track to see its emissions peak by 2030 — in line with its Paris pledges — but that is not consistent with keeping global warming below 2 °C.



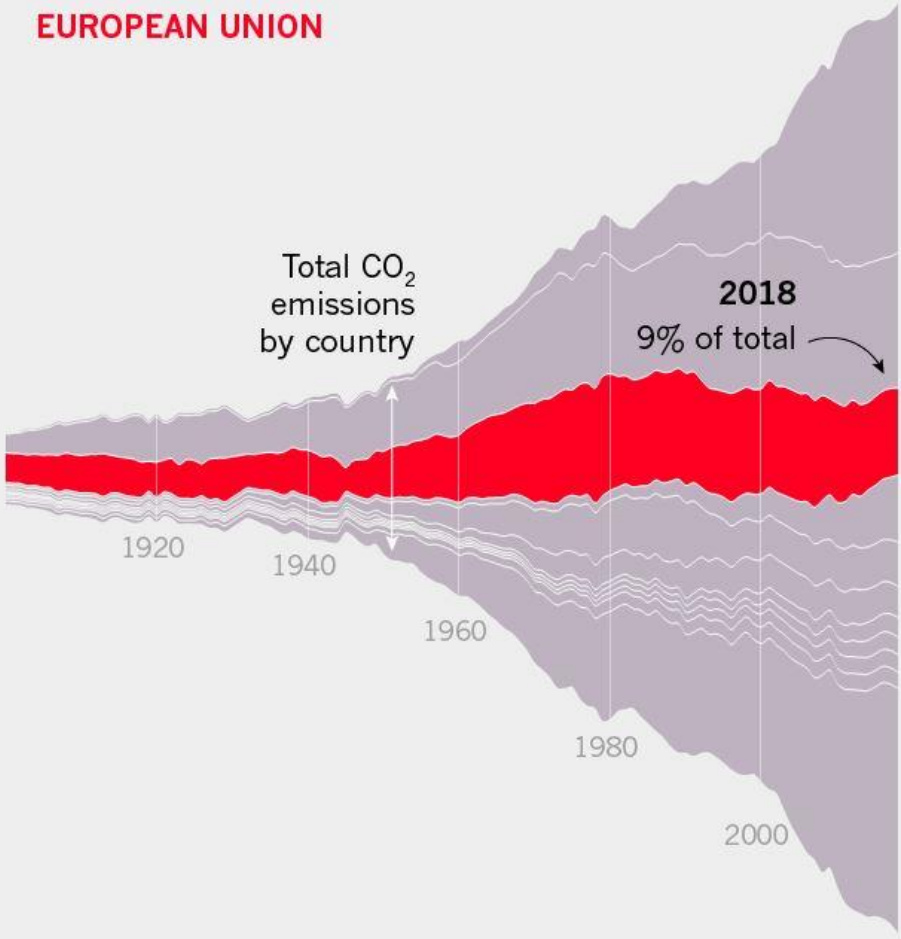
Source: Global Carbon Project

United States: US emissions surged in 2018, but they have been declining generally over the past decade because coal use has fallen, in favour of natural gas and renewables. However, President Donald Trump is rolling back provisions to curb greenhouse-gas pollution and wants to pull the country out of the Paris accord.



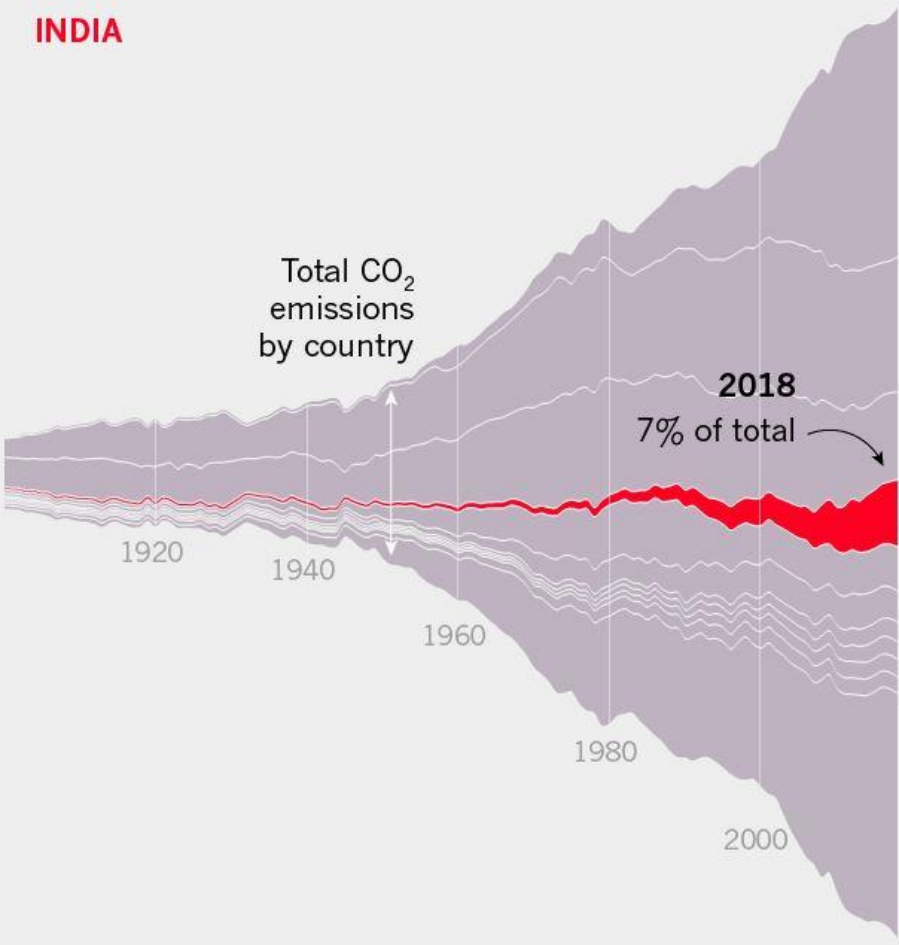
Source: Global Carbon Project

European Union: The 28 EU nations account for more than one-fifth of CO_2 emissions over time, but their collective annual emissions have dropped by more than 20% since 1990. Some estimates suggest the EU is on track to meet its Paris targets. Coal use is dropping but remains a major source of emissions.



Source: Global Carbon Project

INDIA

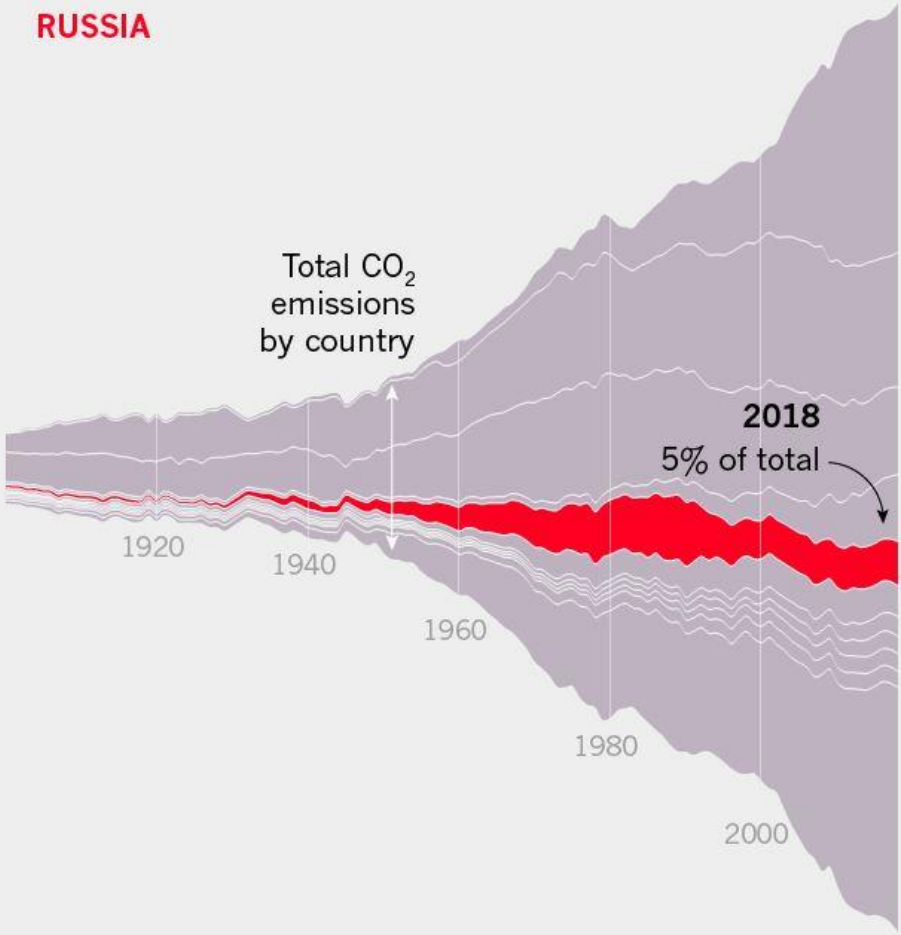


Source: Global Carbon Project

India: India has contributed much less to global warming than have other large countries, on a per capita basis. Although its energy use and coal consumption are growing rapidly, the country is also emerging as a leader in renewable energy.

Russia: The collapse of industry after the break-up of the Soviet Union caused CO_2 emissions to plunge, but they have been rising since. Russia has invested little in renewables such as solar and wind and the CAT gives Russia its lowest rating.

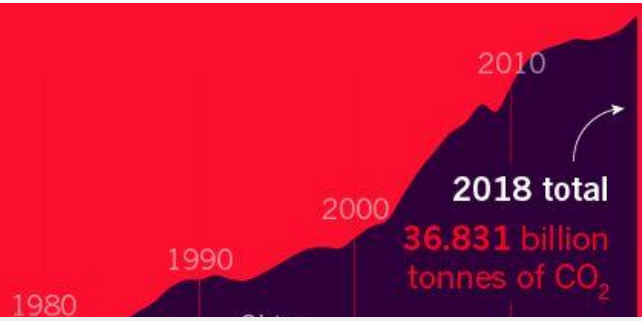
RUSSIA



Source: Global Carbon Project

TOTAL CO_2 EMISSIONS BY COUNTRY

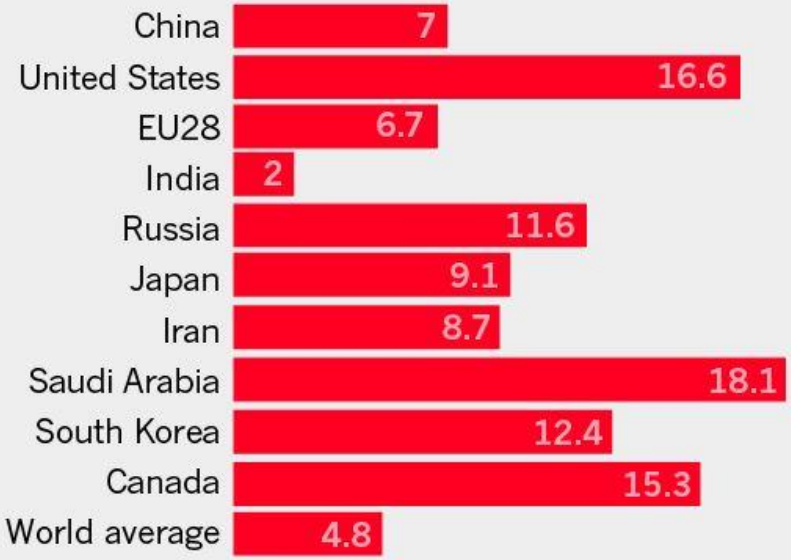
The total global emissions of carbon dioxide from burning of fossil fuels as well as deforestation, agriculture and other human activities that affect the landscape.



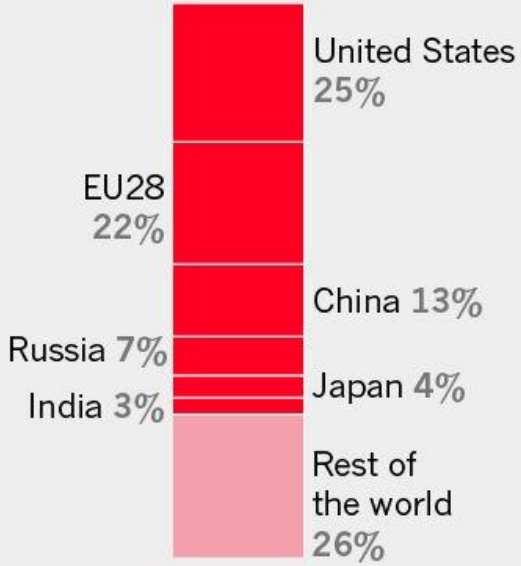
FAIRNESS

Current emissions are only one way of looking at the problem. Although China is now the largest producer of CO_2, it is responsible for just 13% of all emissions over time. Its per capita emissions are rising quickly, but the US leads in per capita and total emissions.

Per capita (tonnes CO_2)

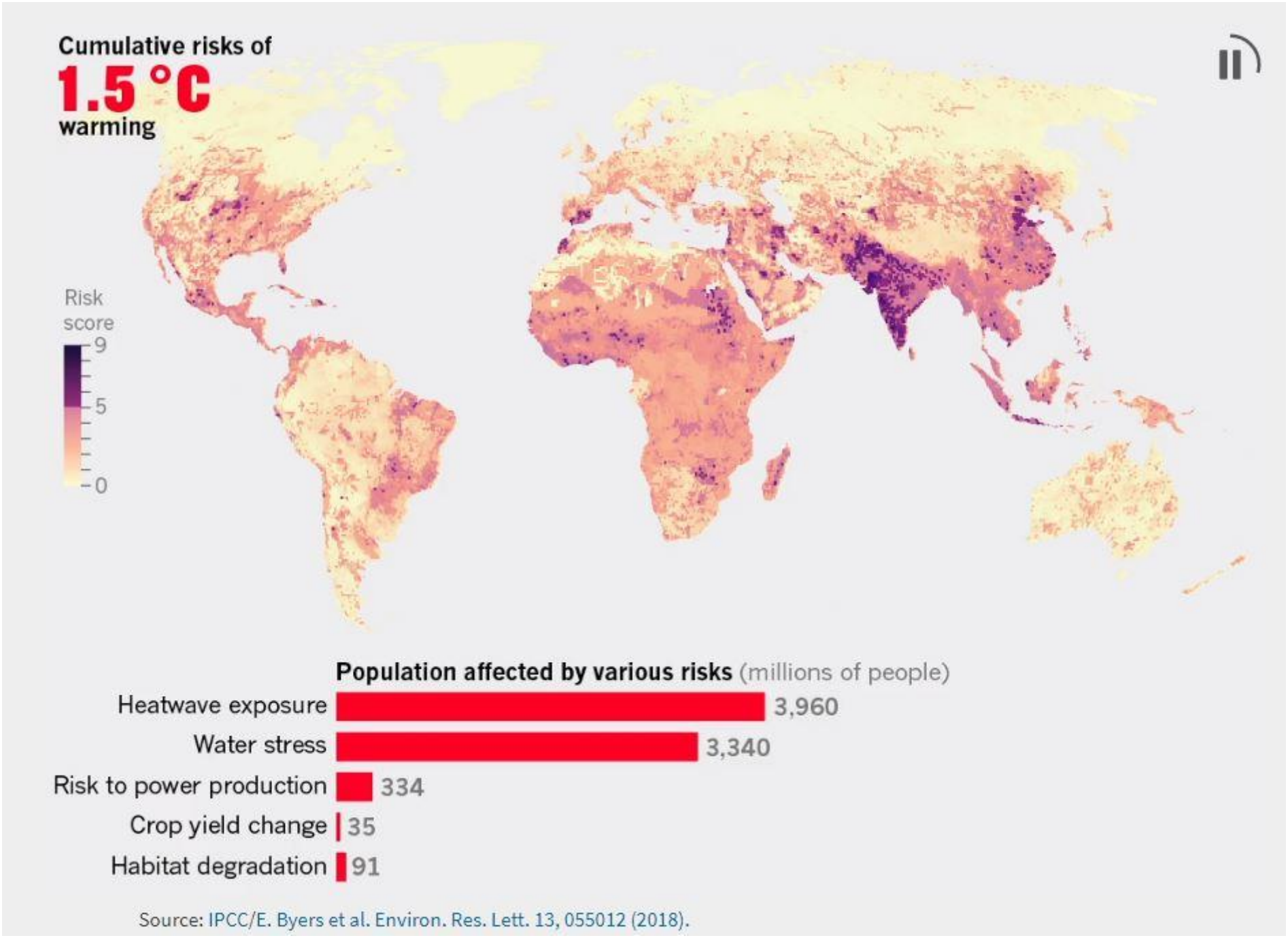


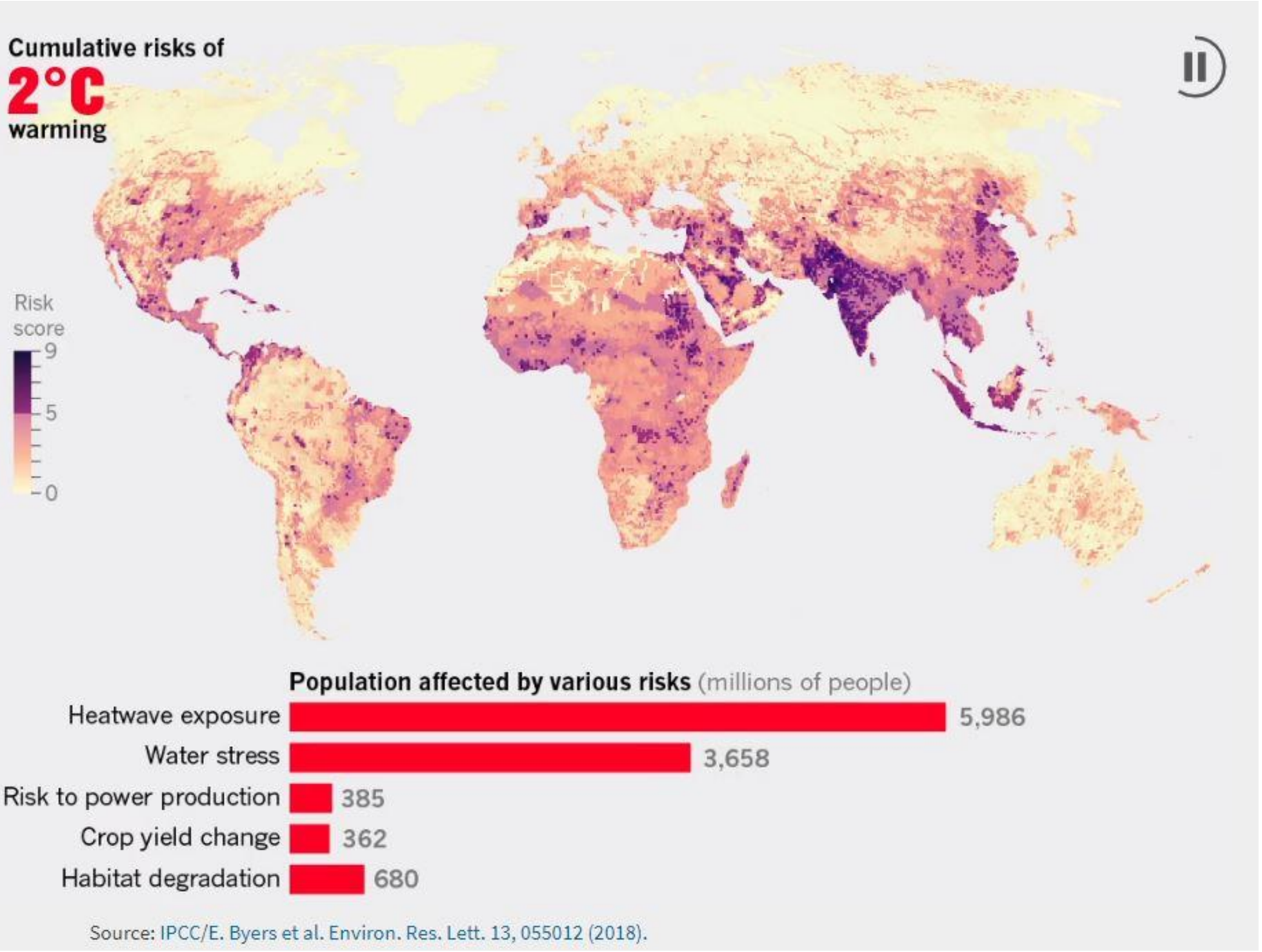
Cumulative emissions

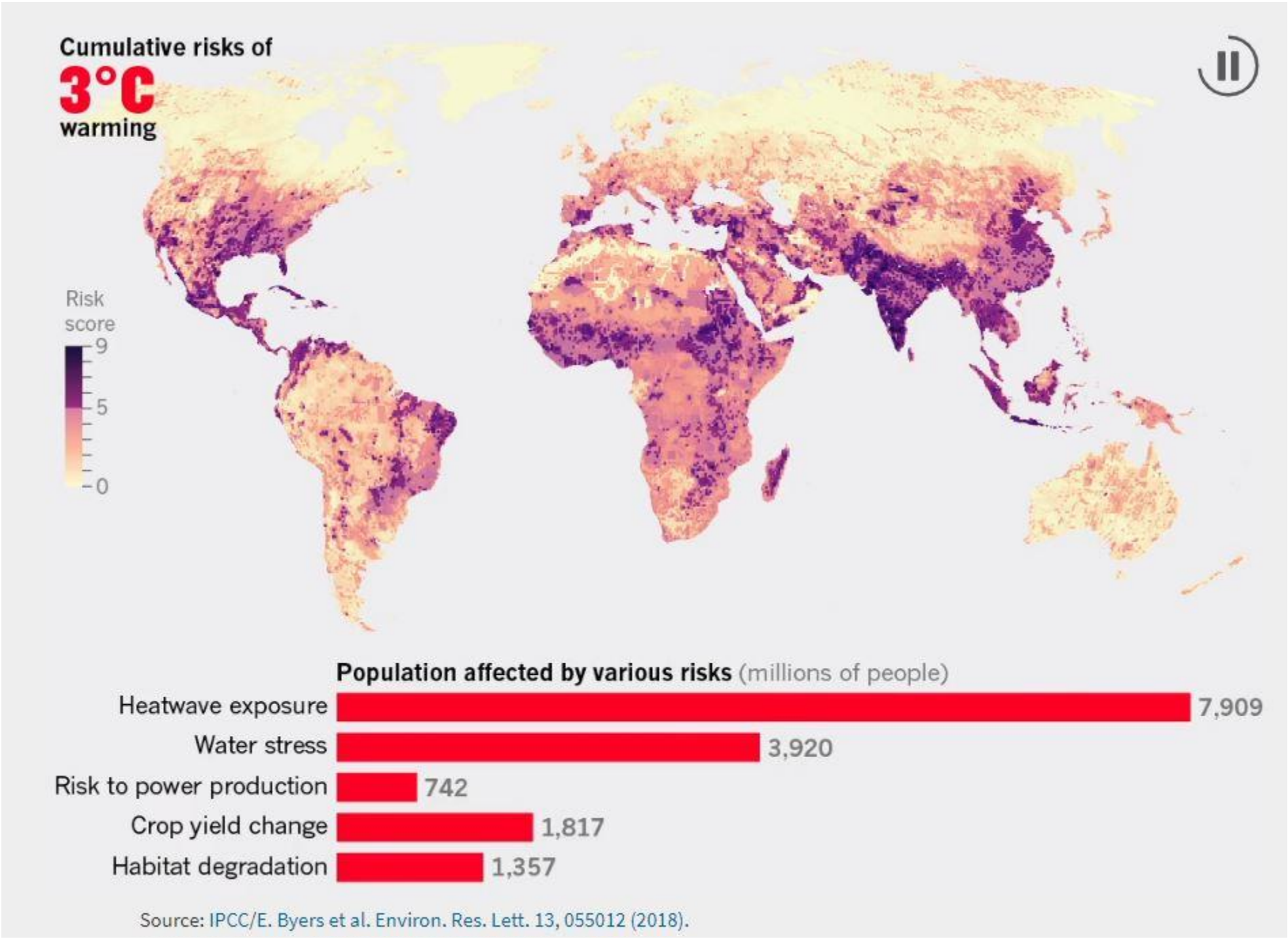


Source: Global Carbon Project

Source: Global Carbon Project


Cumulative risks of
1.5 °C
warming
Risk score
9
5
0
Population affected by various risks (millions of people)
Heatwave exposure
3,960
Water stress
3,340
Risk to power production
334
Crop yield change
35
Habitat degradation
91
Source: IPCC/E. Byers et al. Environ. Res. Lett. 13, 055012 (2018).


Cumulative risks of
2°C
warming
Risk score
9
5
0
Population affected by various risks (millions of people)
Heatwave exposure
5,986
Water stress
3,658
Risk to power production
385
Crop yield change
362
Habitat degradation
680
Source: IPCC/E. Byers et al. Environ. Res. Lett. 13, 055012 (2018).


Cumulative risks of
3°C
warming
Risk score
9
5
0
Population affected by various risks (millions of people)
Heatwave exposure
7,909
Water stress
3,920
Risk to power production
742
Crop yield change
1,817
Habitat degradation
1,357
Source: IPCC/E. Byers et al. Environ. Res. Lett. 13, 055012 (2018).

Svante Arrhenius

premio Nobel per la chimica nel 1903

THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

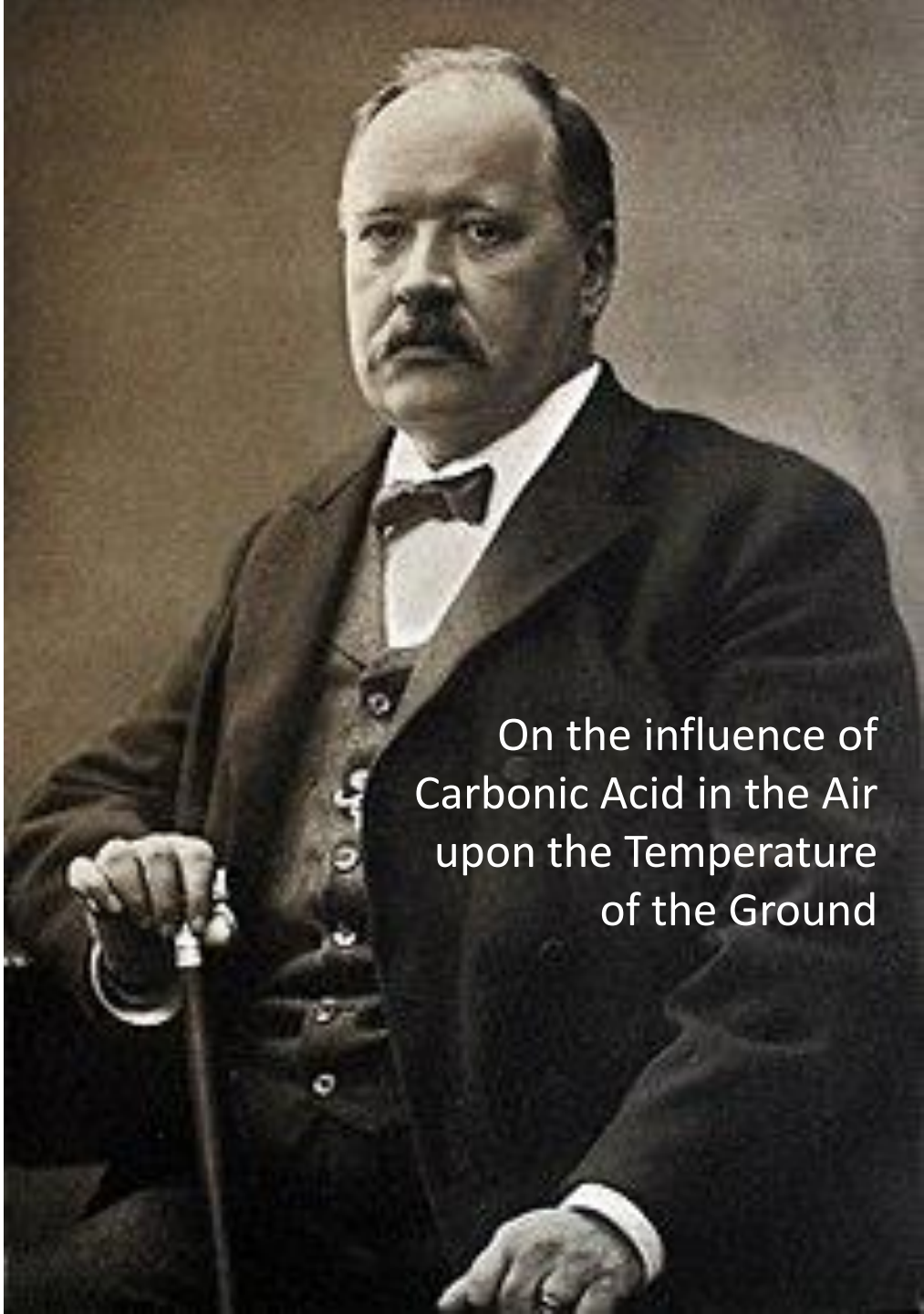
APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS *.

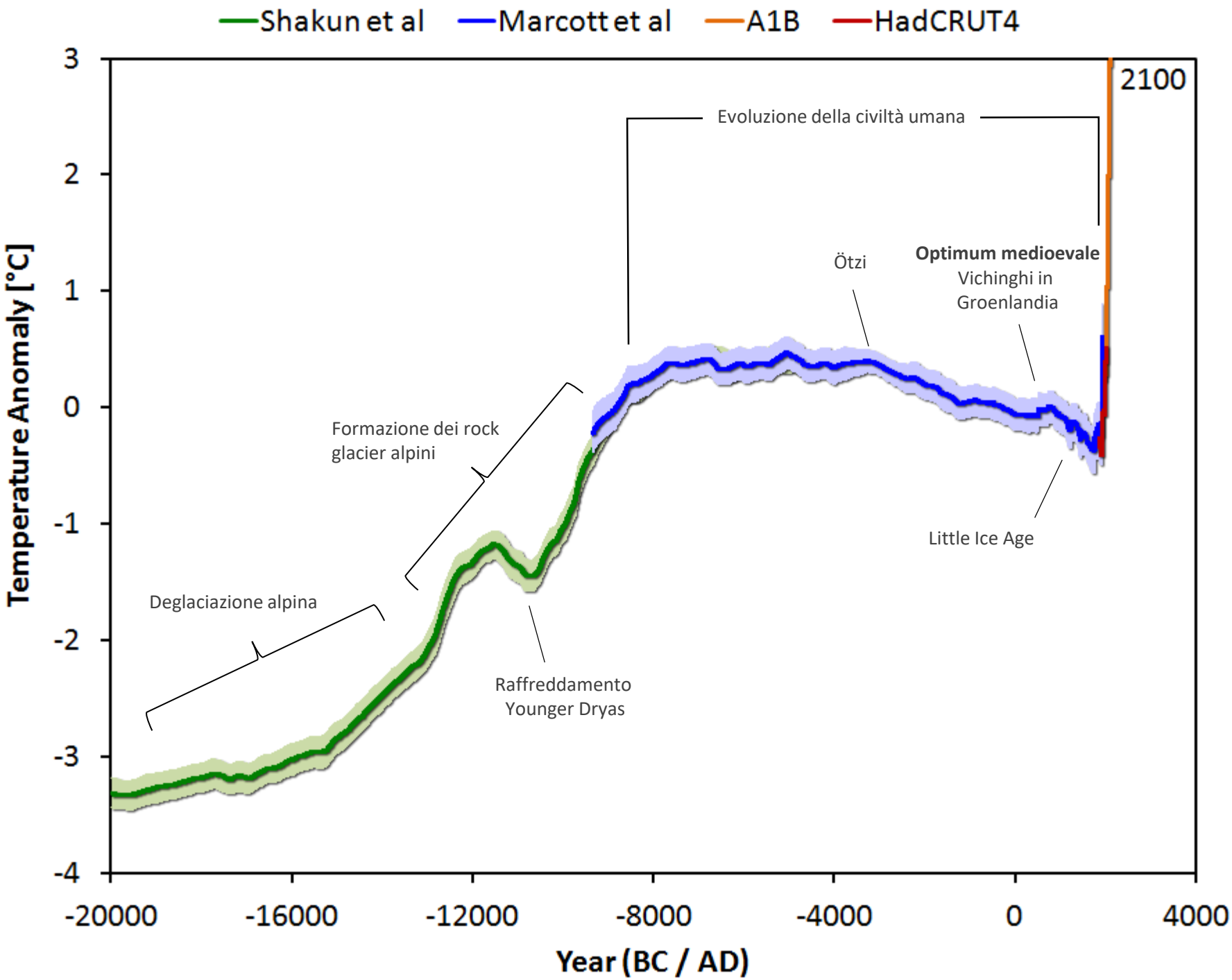
I. *Introduction : Observations of* Langley *on Atmospherical Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall † in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this: Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier‡ maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light rays of the sun but retains the dark rays from the ground. This idea was elaborated by Pouillet §; and Langley was by some of his researches led to the view, that "the temperature of the earth under direct sunshine, even though our atmosphere were present as now, would probably fall to −200° C., if that atmosphere did not possess the quality of selective

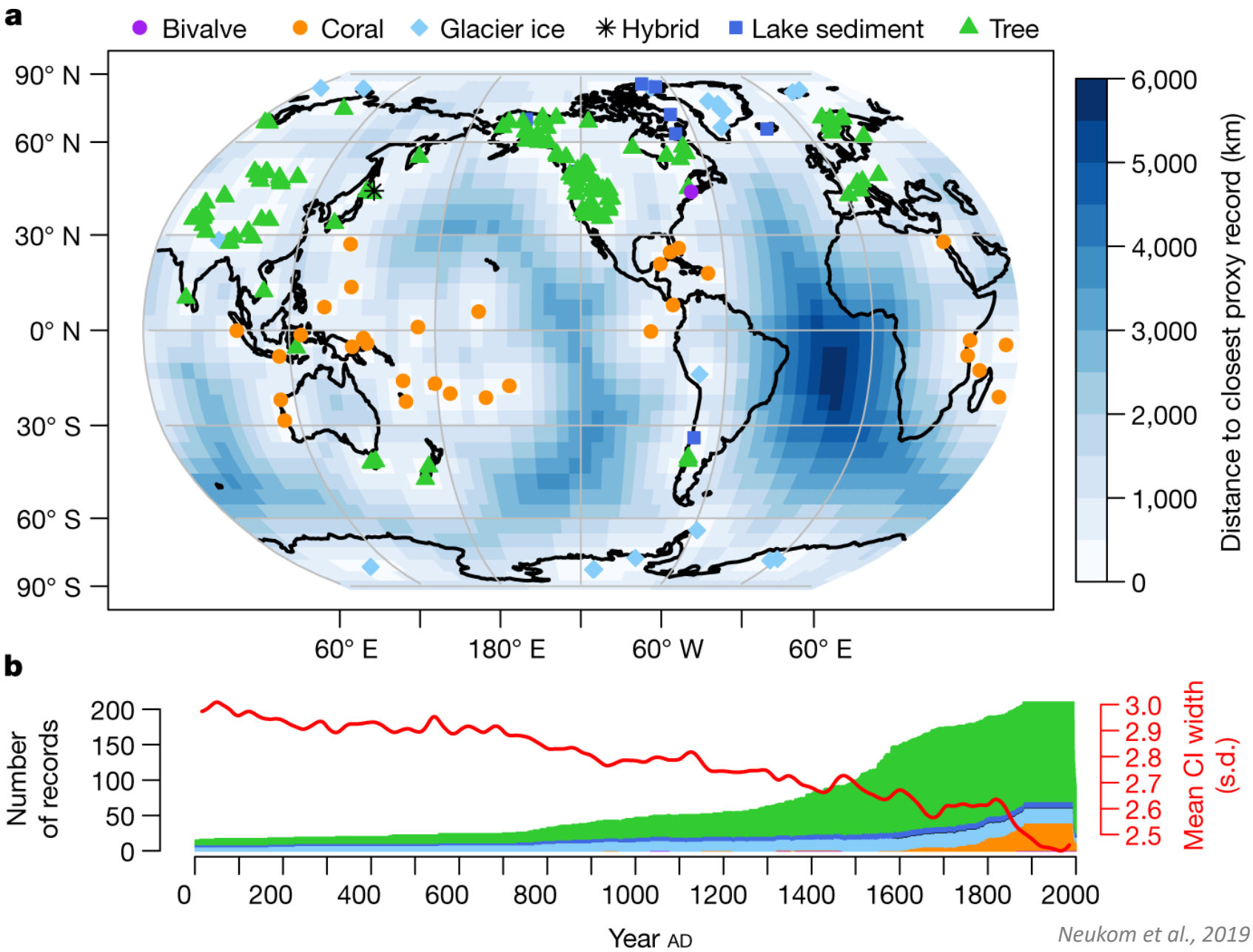
* Extract from a paper presented to the Royal Swedish Academy of Sciences, 11th December, 1895. Communicated by the Author.
† 'Heat a Mode of Motion,' 2nd ed. p. 405 (Lond., 1865).
‡ *Mém. de l'Ac. R. d. Sci. de l'Inst. de France*, t. vii. 1827.
§ *Comptes rendus*, t. vii. p. 41 (1838).



On the influence of Carbonic Acid in the Air upon the Temperature of the Ground

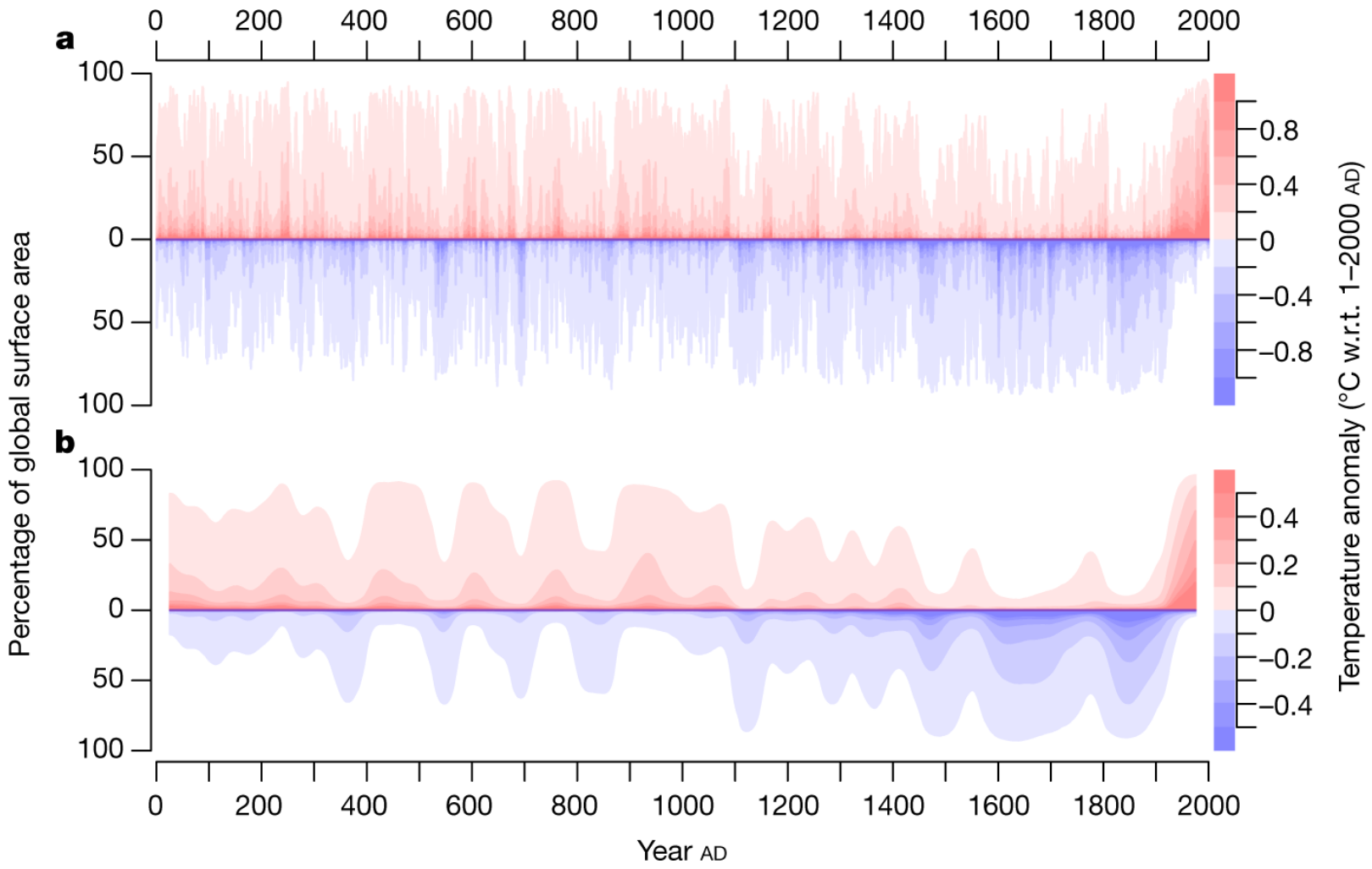

Shakun et al
Marcott et al
A1B
HadCRUT4
2100
Evoluzione della civiltà umana
Ötzi
Optimum medioevale
Vichinghi in
Groenlandia
Formazione dei rock
glacier alpini
Little Ice Age
Deglaciazione alpina
Raffreddamento
Younger Dryas
Temperature Anomaly [°C]
3
2
1
0
-1
-2
-3
-4
-20000
-16000
-12000
-8000
-4000
0
4000
Year (BC / AD)

No evidence for globally coherent warm and cold periods over the preindustrial Common Era



Neukom et al., 2019 Nature

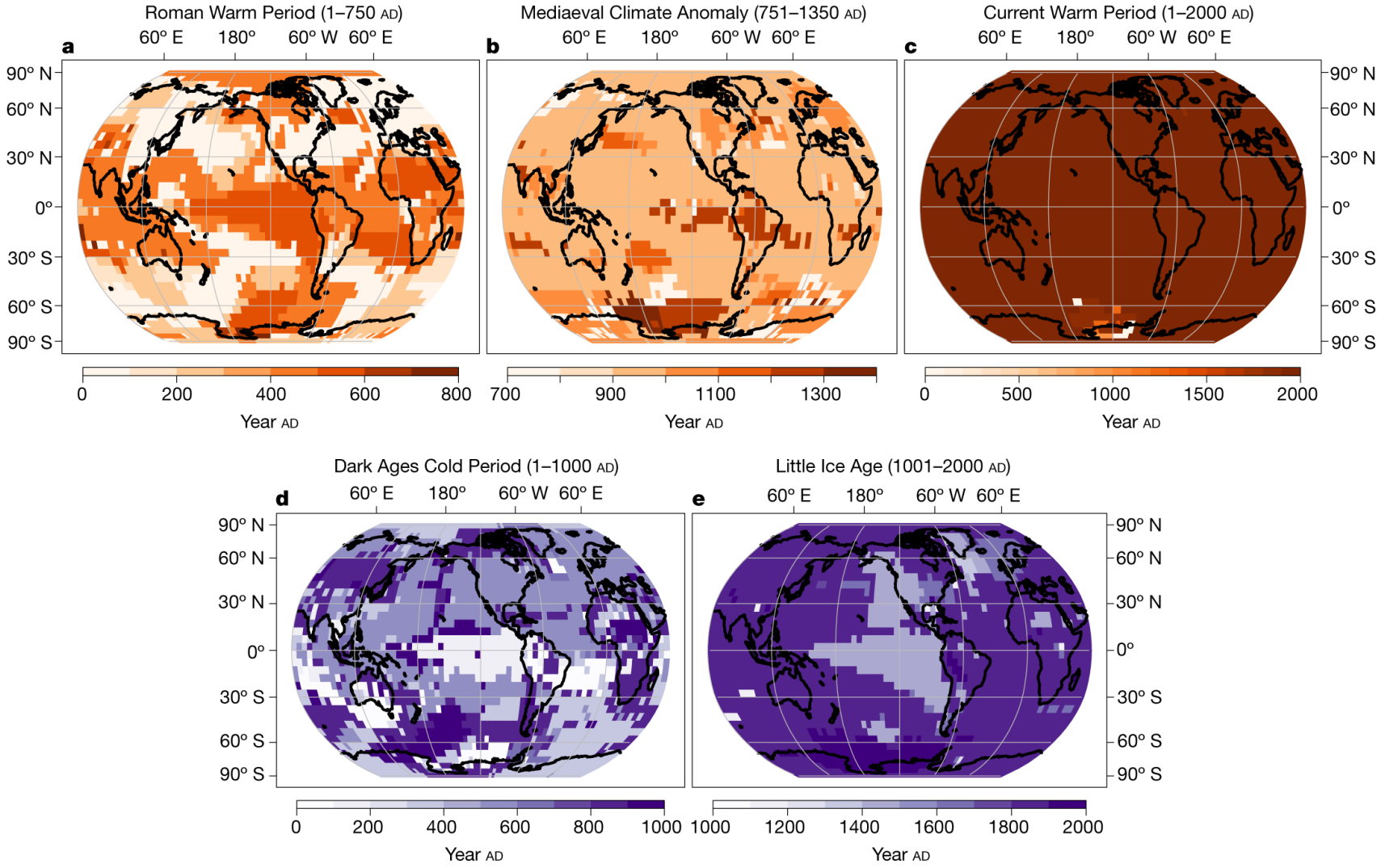
No evidence for globally coherent warm and cold periods over the preindustrial Common Era



percentages of global area with warm (red shading) and cold (blue shading) temperature anomalies with respect to a 1–2000 AD reference period. Shading intensity indicates the magnitude of warmth and cold. a, Annual unfiltered data. b, 51-year lowpass filtered data

Neukom et al., 2019 Nature

Timing of peak warm and cold periods.



Centuries with the highest ensemble probability of containing the warmest (a–c) and coldest (d, e) 51-year period within each putative climatic epoch (see Methods). The full time ranges over which the search was performed for each epoch are indicated in parentheses. The numbers on the y axis and upper x axis are degrees latitude and longitude.

Neukom et al., 2019 Nature

Conclusioni

Climate Change o Global Warming?

Cambiamento climatico o Riscaldamento Globale?

RISCALDAMENTO GLOBALE

Naturale o Antropogenico ?

ANTROPOGENICO

Che differenza c'è tra meteorologia e climatologia?

IL TEMPO

Che cosa significano + 2.0°C rispetto al Clima che c'è ? (che c'era!!!)

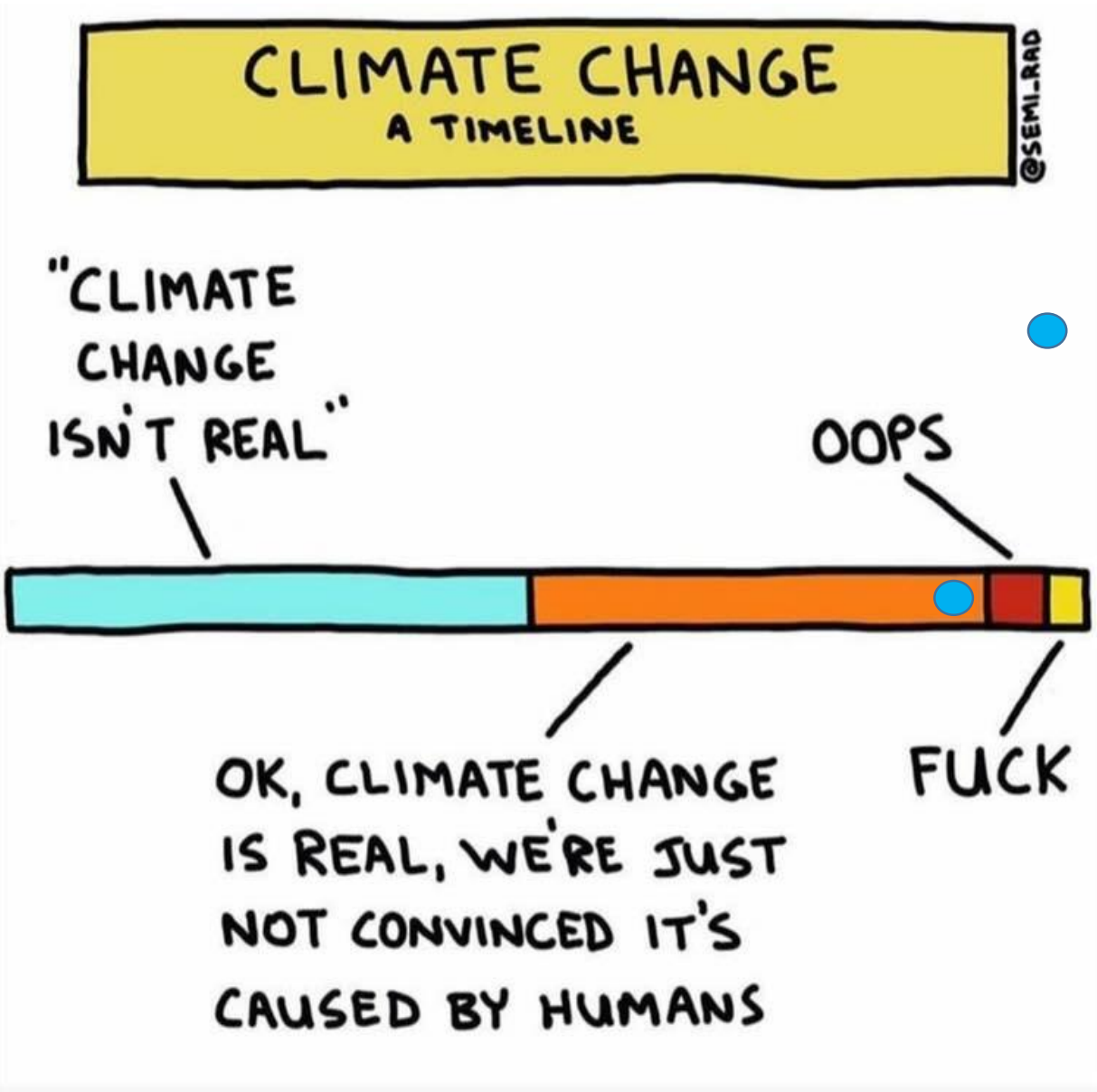
UN MONDO MOLTO DIVERSO DA QUELLO CHE CONOSCIAMO

Ed in passato… il clima è già stato così caldo?

NON VI SONO EVIDENZE NEL CORSO DELL'OLOCENE MA IN PARTICOLARE NEGLI ULTIMI 2000 ANNI

E poi ci sono quelli che dicono e scrivono tutto il contrario!!!

CE NE FOSSE UNO CHE SI OCCUPI DI CLIMATOLOGIA…


CLIMATE CHANGE
A TIMELINE
@SEMI_RAD
"CLIMATE CHANGE ISN'T REAL"
OOPS
You are here
OK, CLIMATE CHANGE IS REAL, WE'RE JUST NOT CONVINCED IT'S CAUSED BY HUMANS
FUCK