Claudio Cassardo

Department of Physics

Università degli Studi di Torino

claudio.cassardo@unito.it

claudiocassardo.wordpress.com

www.agi.it/blog-italia/autore/claudio_cassardo/

www.climalteranti.it

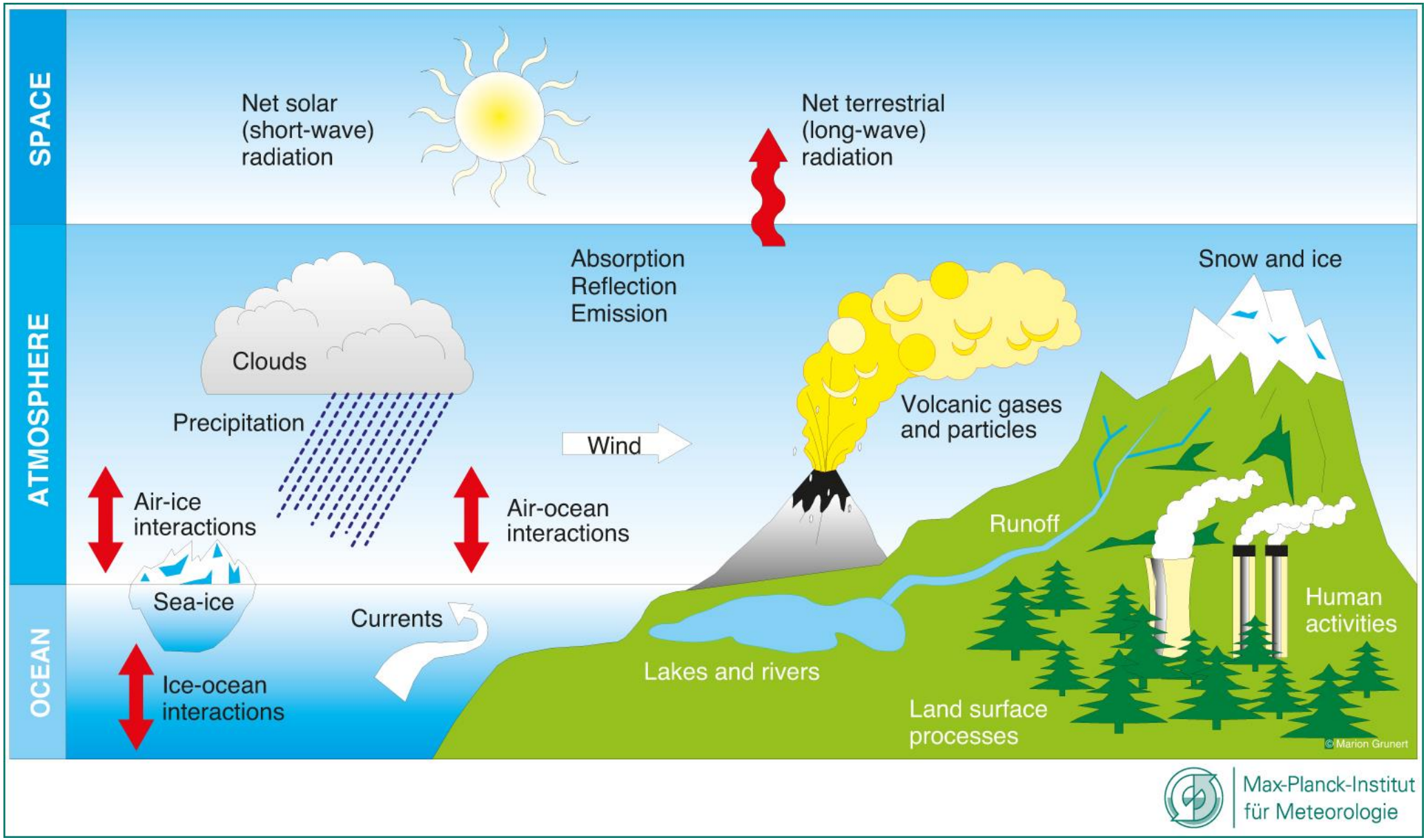
Photo by Francesco Ungaro

Mountain Weather and Climate in a Warmer World – Part I: climate change bases

The topics I'd like to talk to you about

- Introduction to climate
  - Climate system, climate & meteorology, greenhouse effect, climatic factors
- Climate change
  - Present and Recent Past Data: temperature and precipitation
  - Global Phenomena but Locally More Intense Causes
- Causes of climate change
- Modelling climate change
  - Models Projections in the Future
- What to do to contrast climate change?
  - Adaptation and mitigation
  - Collective level: international cooperation and individual level agreements

The climate system



Climate and meteorology

«Weather is what you get, climate is what you expect»

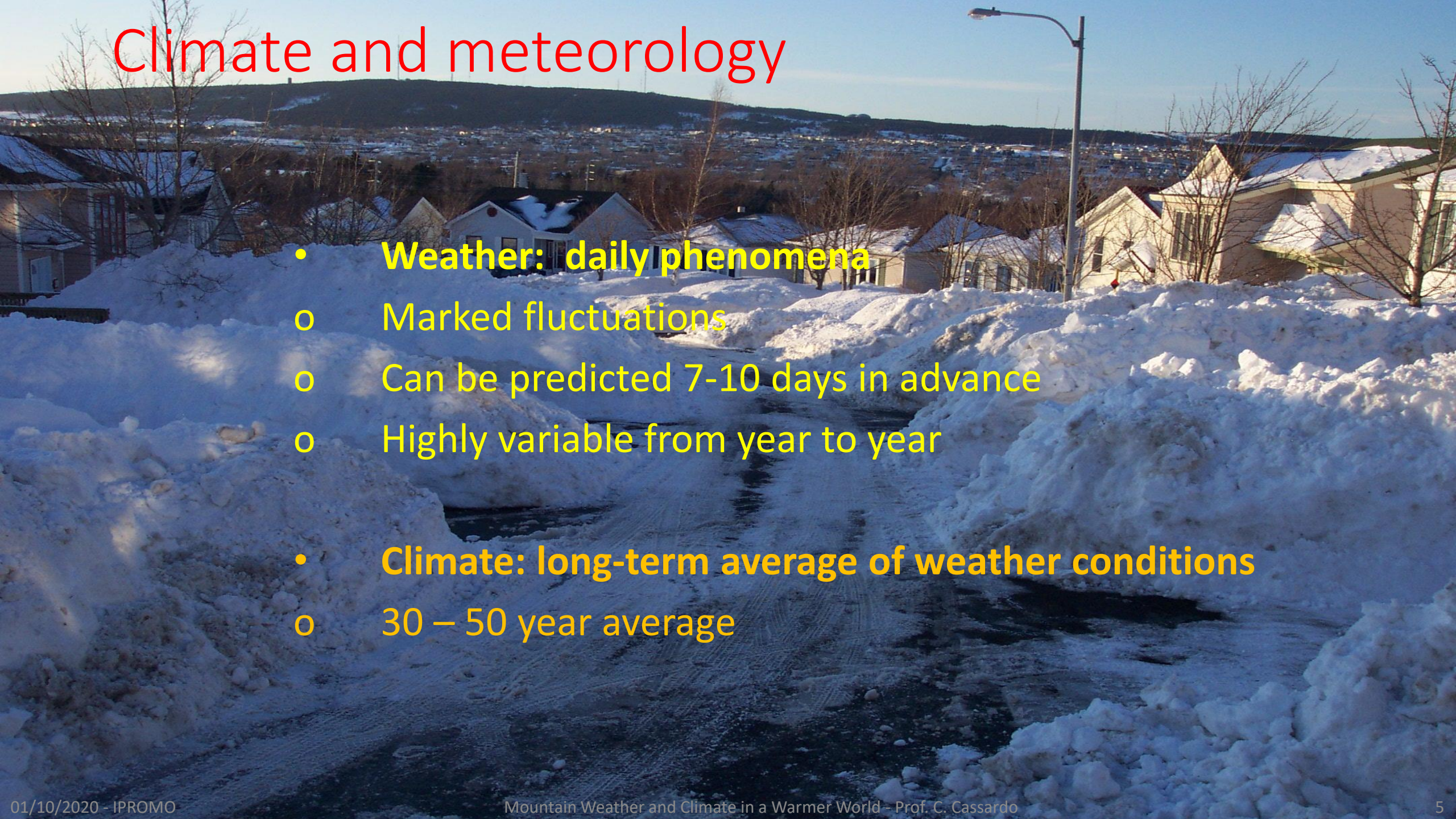
WEATHER

It is defined by instantaneous conditions (or averaged over short periods, from minutes to weeks) of the atmospheric variables as temperature, pressure, humidity, cloudiness, precipitation, wind, etc., in a given place

CLIMATE

Statistical analysis, in terms of average values and variability, of the average meteorological conditions of a given region, and based on data available for a sufficiently long period of time (at least 30 years, WMO – World Meteorological Organization)

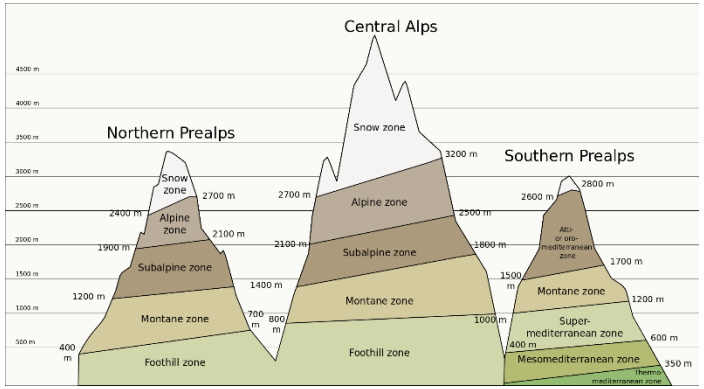
Climate and meteorology



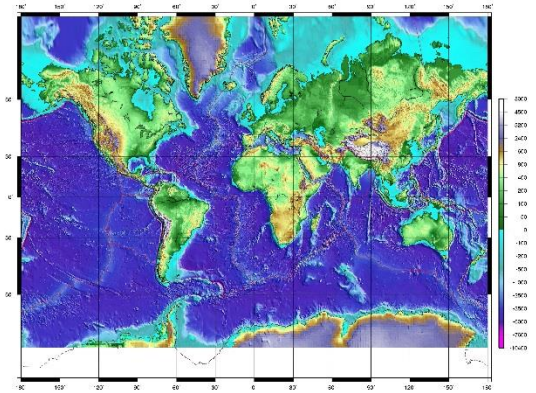
- **Weather: daily phenomena**
  - Marked fluctuations
  - Can be predicted 7-10 days in advance
  - Highly variable from year to year

- **Climate: long-term average of weather conditions**
  - 30 – 50 year average

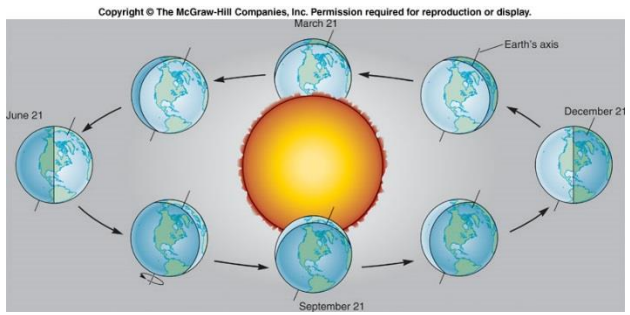
Climatic Factors



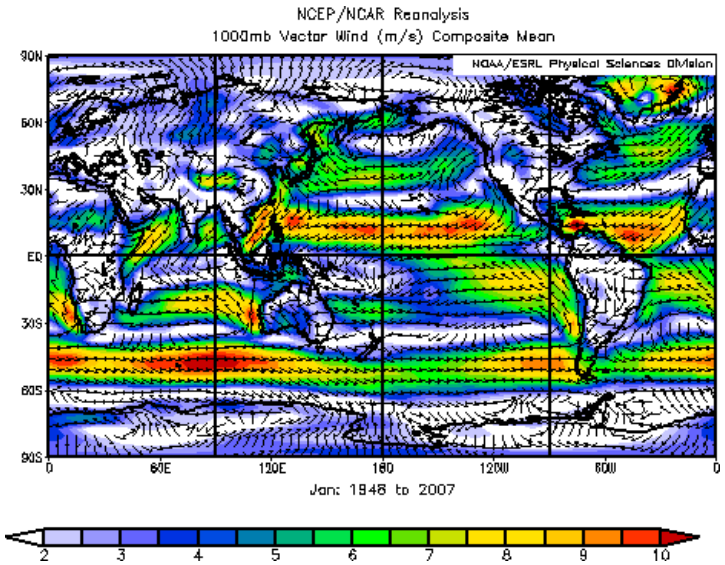
Elevation



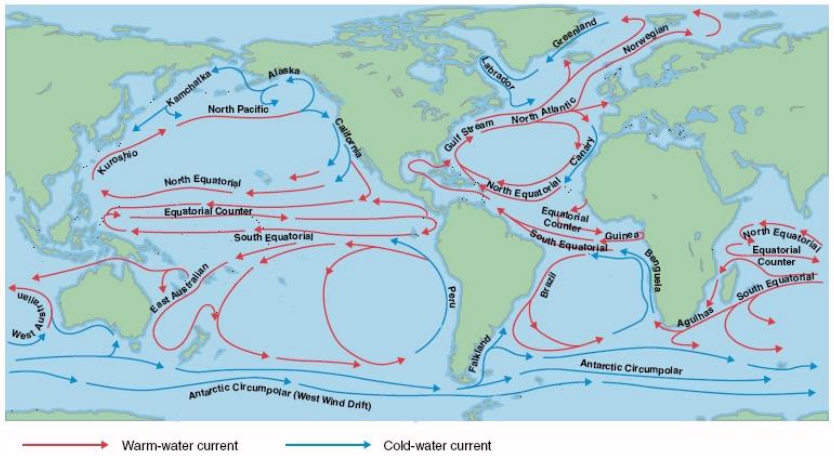
Topography



Latitude and seasons

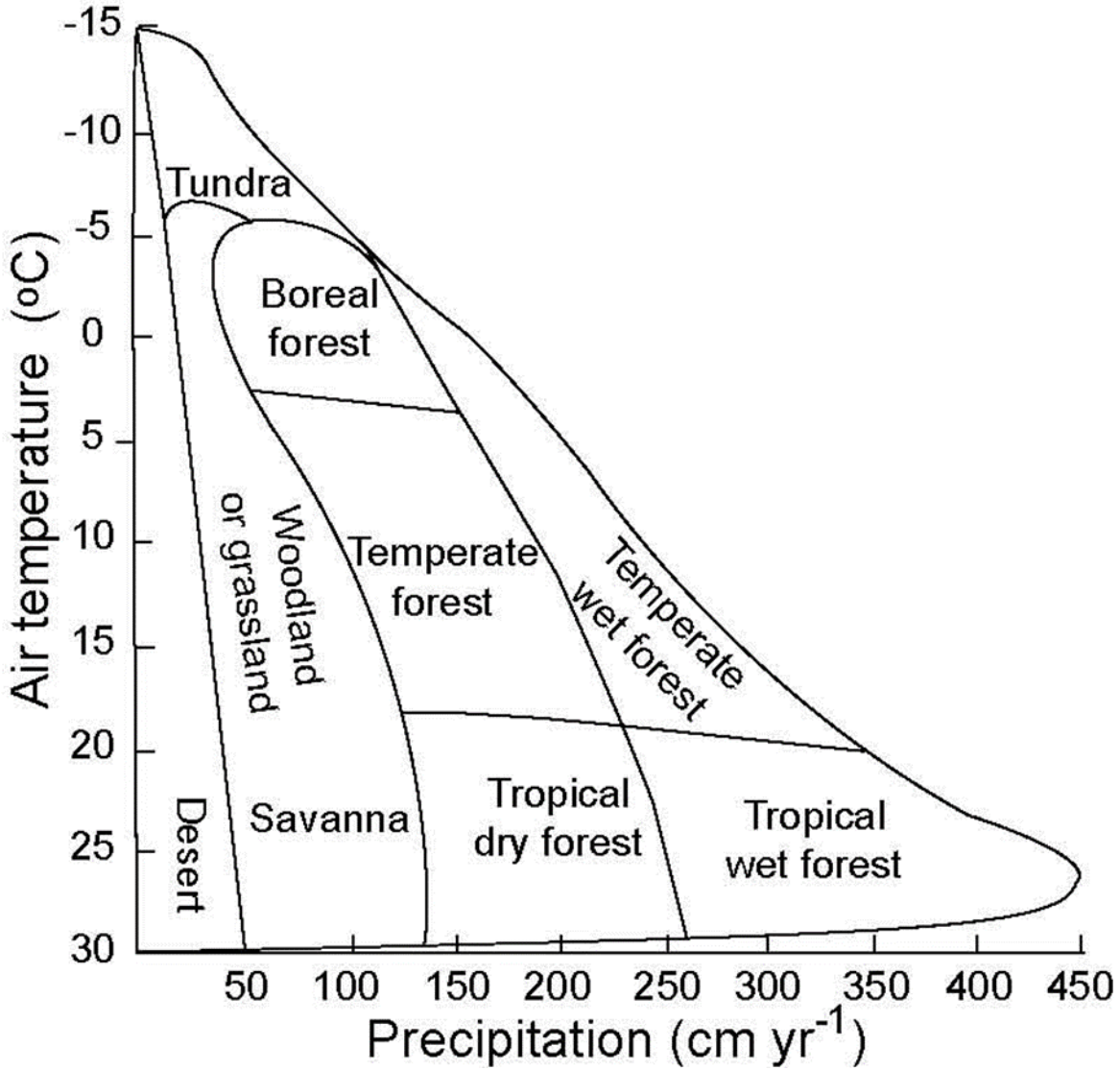


Winds

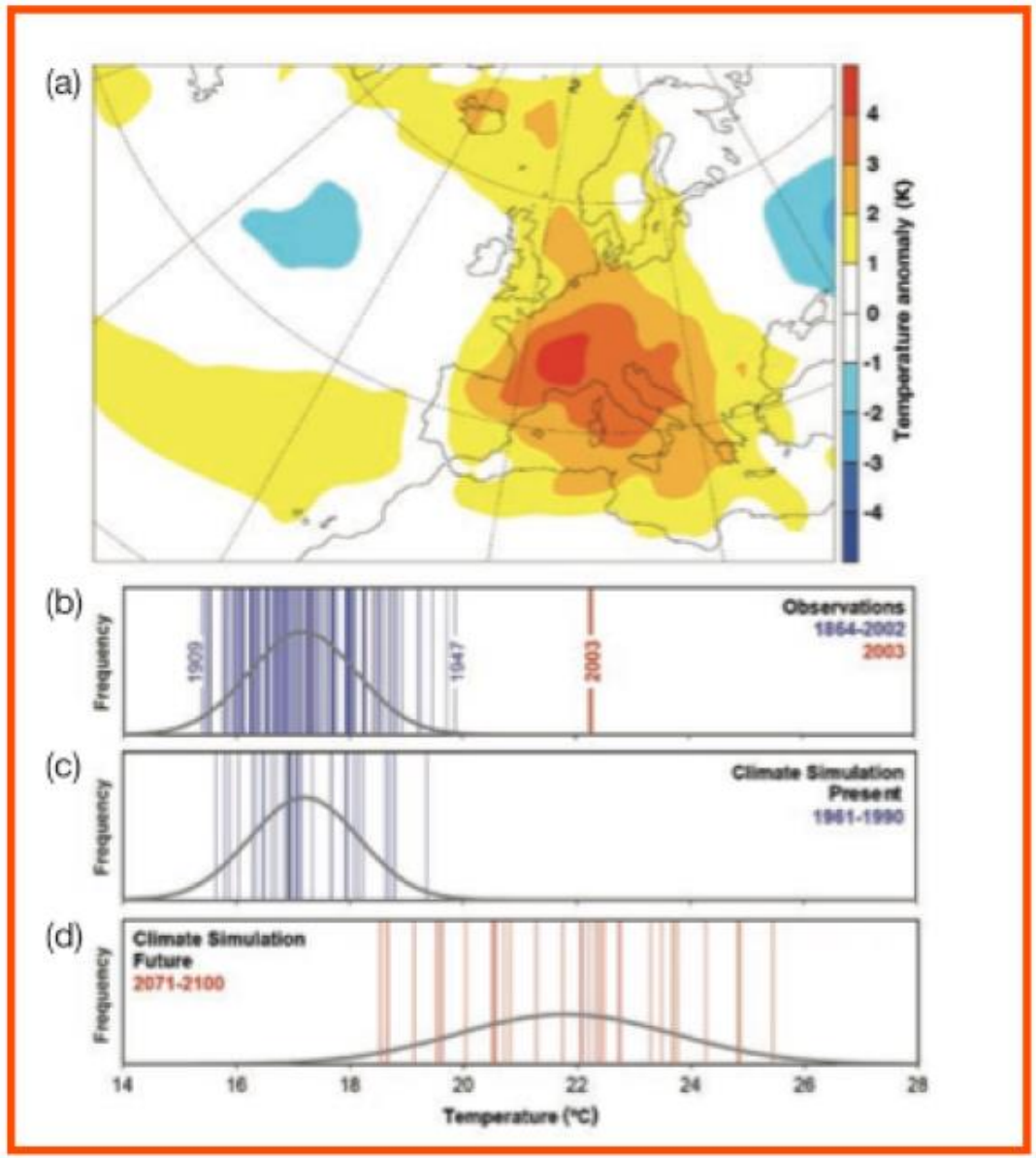


Ocean currents

Example: influence of climatic factors on vegetation distribution



The statistical nature of climate



Heat wave, summer 2003 in Swiss

a. June-July-August temperature anomaly compared to the 1961-1990 average

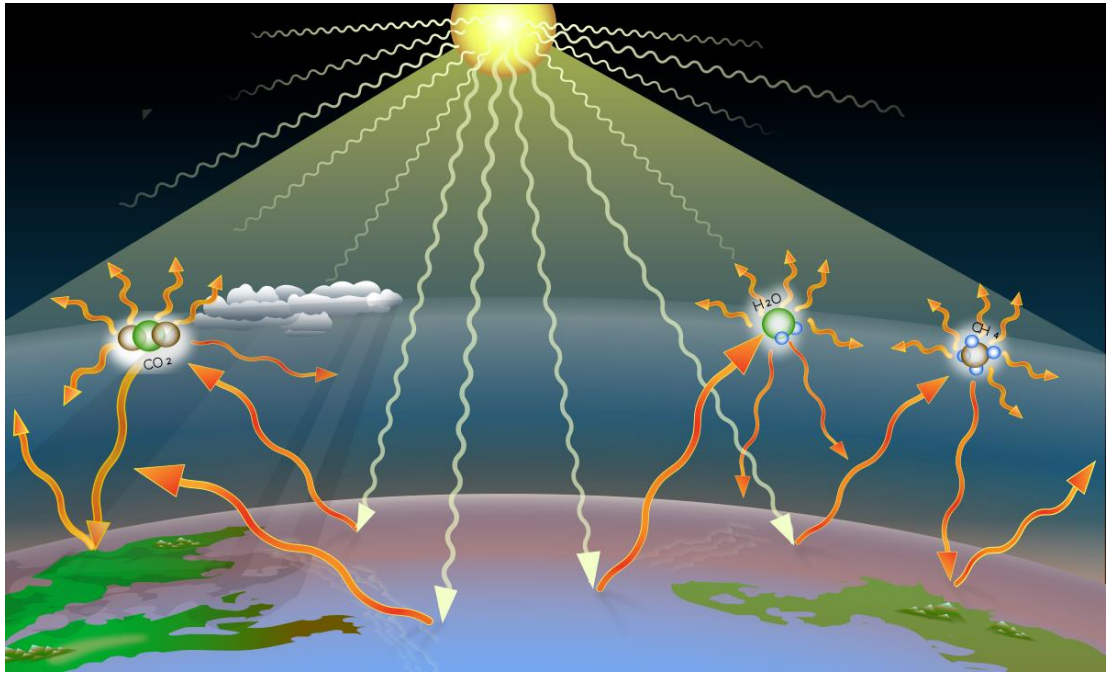
b. Average summer temperatures measured in Switzerland during the period 1864-2003

c. Simulated temperatures using a regional climate model of climate in the period 1961-1990

d. Temperatures simulated with the same model in the period 2071-2100 for a possible future scenario

The greenhouse effect

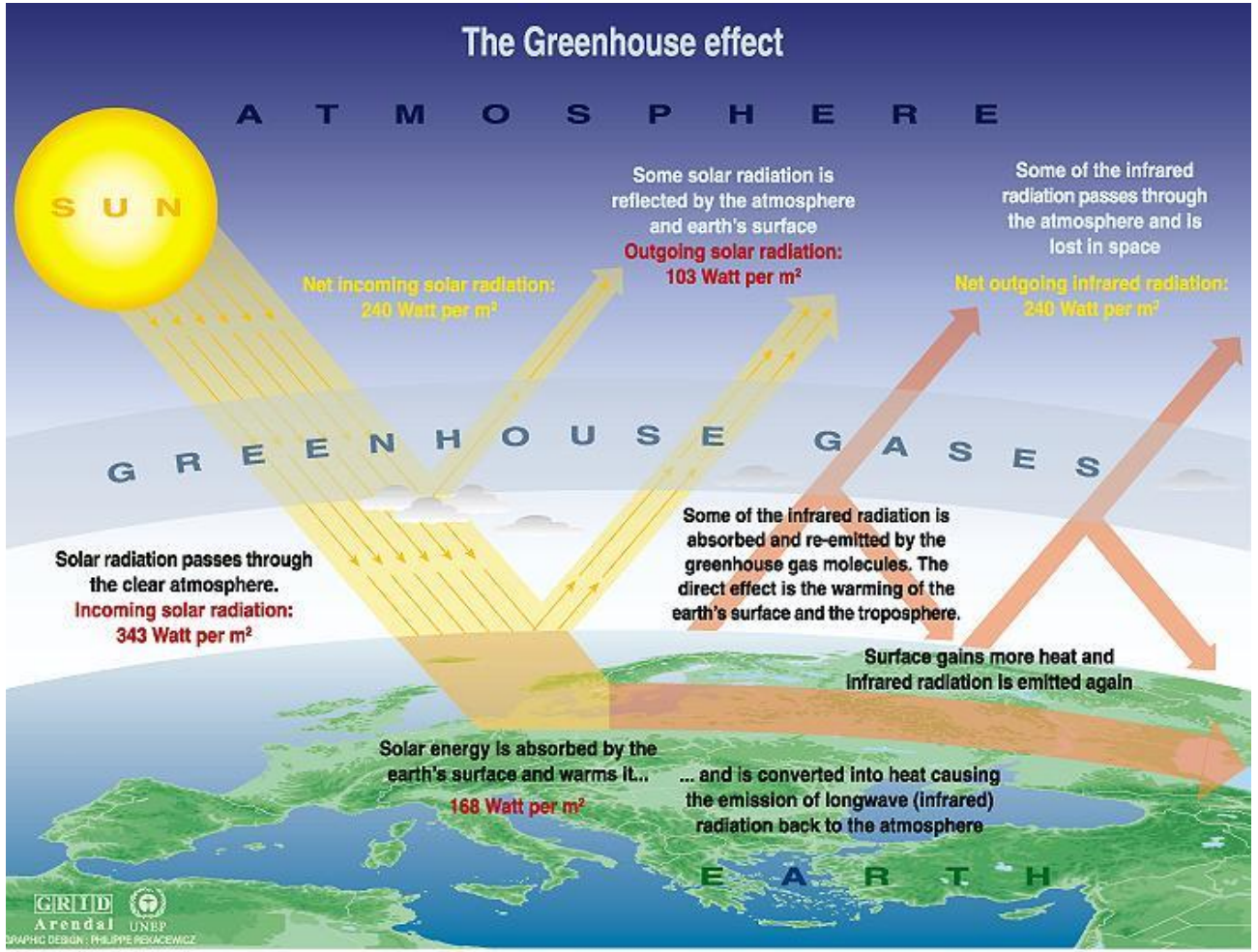
- The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat.
- This process makes Earth much warmer than it would be without an atmosphere.
- It is called greenhouse effect because there are similarities with what happens in a greenhouse!
  - In the daytime, sunlight shines into the greenhouse and warms the plants and air inside.
  - At nighttime, it's colder outside, but the greenhouse stays pretty warm inside. That's because the glass walls of the greenhouse trap the Sun's heat.
- The greenhouse effect is one of the things that makes Earth a comfortable place to live.



Earth without greenhouse effect: -18 °C

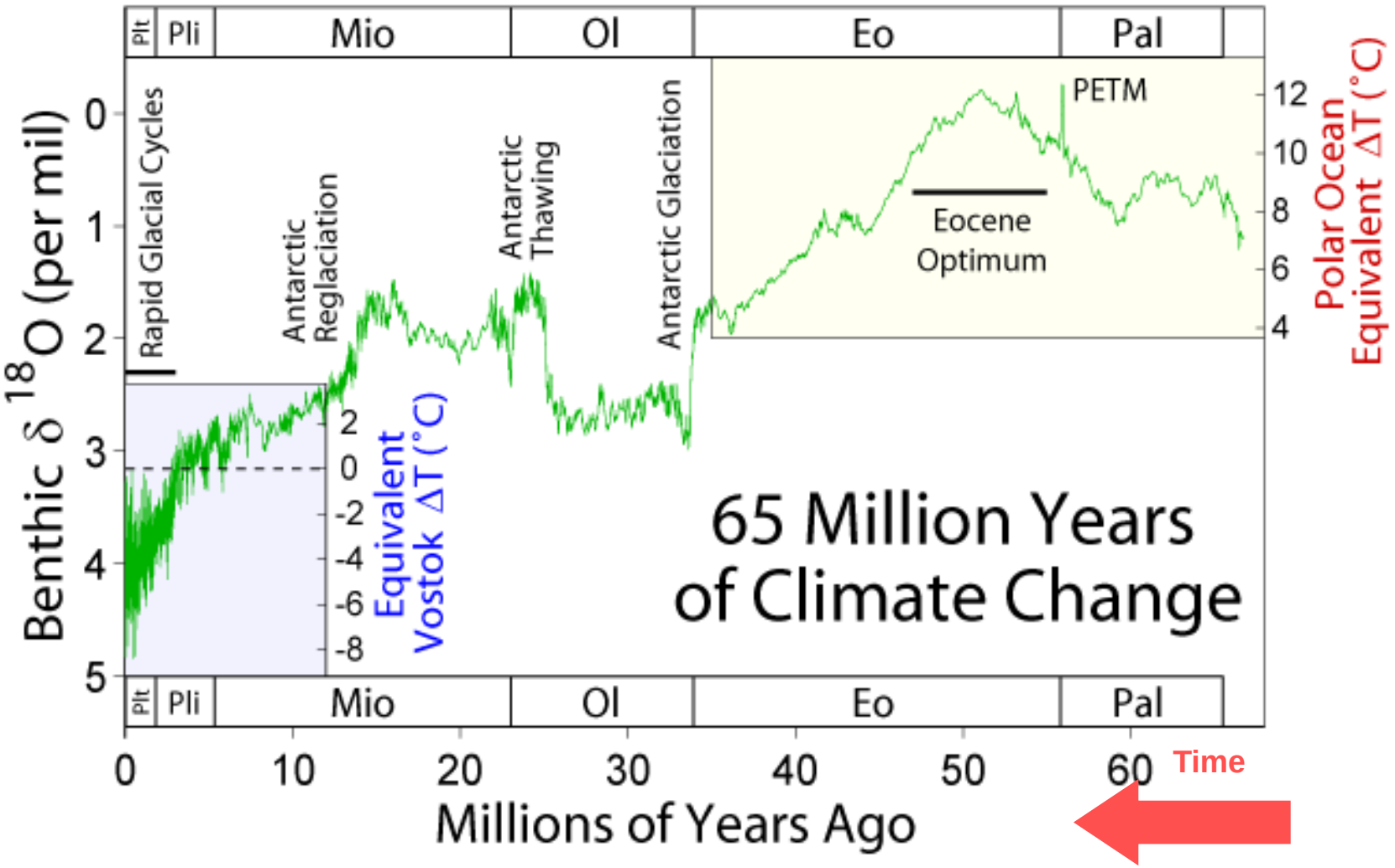
With natural greenhouse effect: +14 °C

With natural+anthropic greenhouse effect: +15 °C

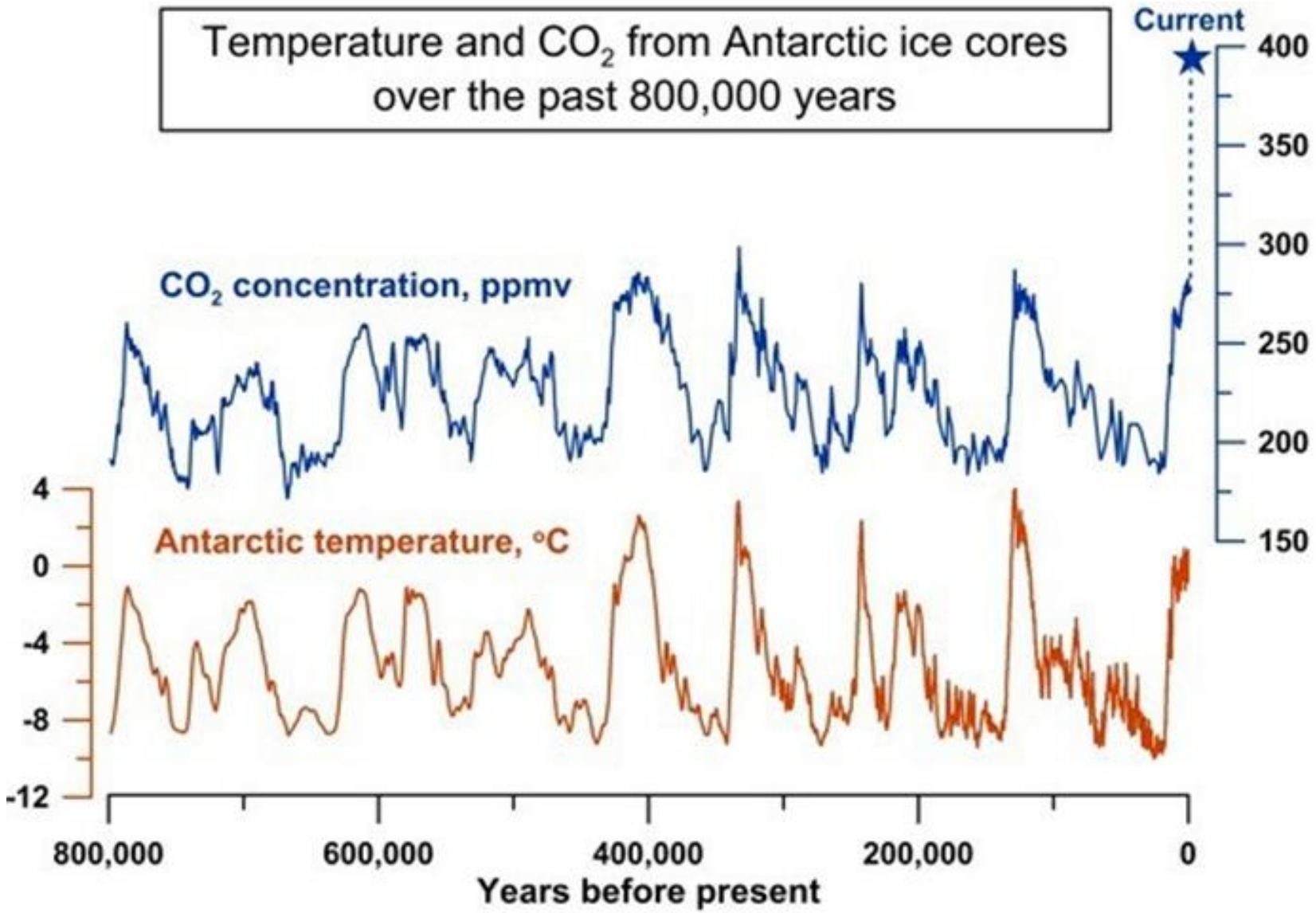


Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

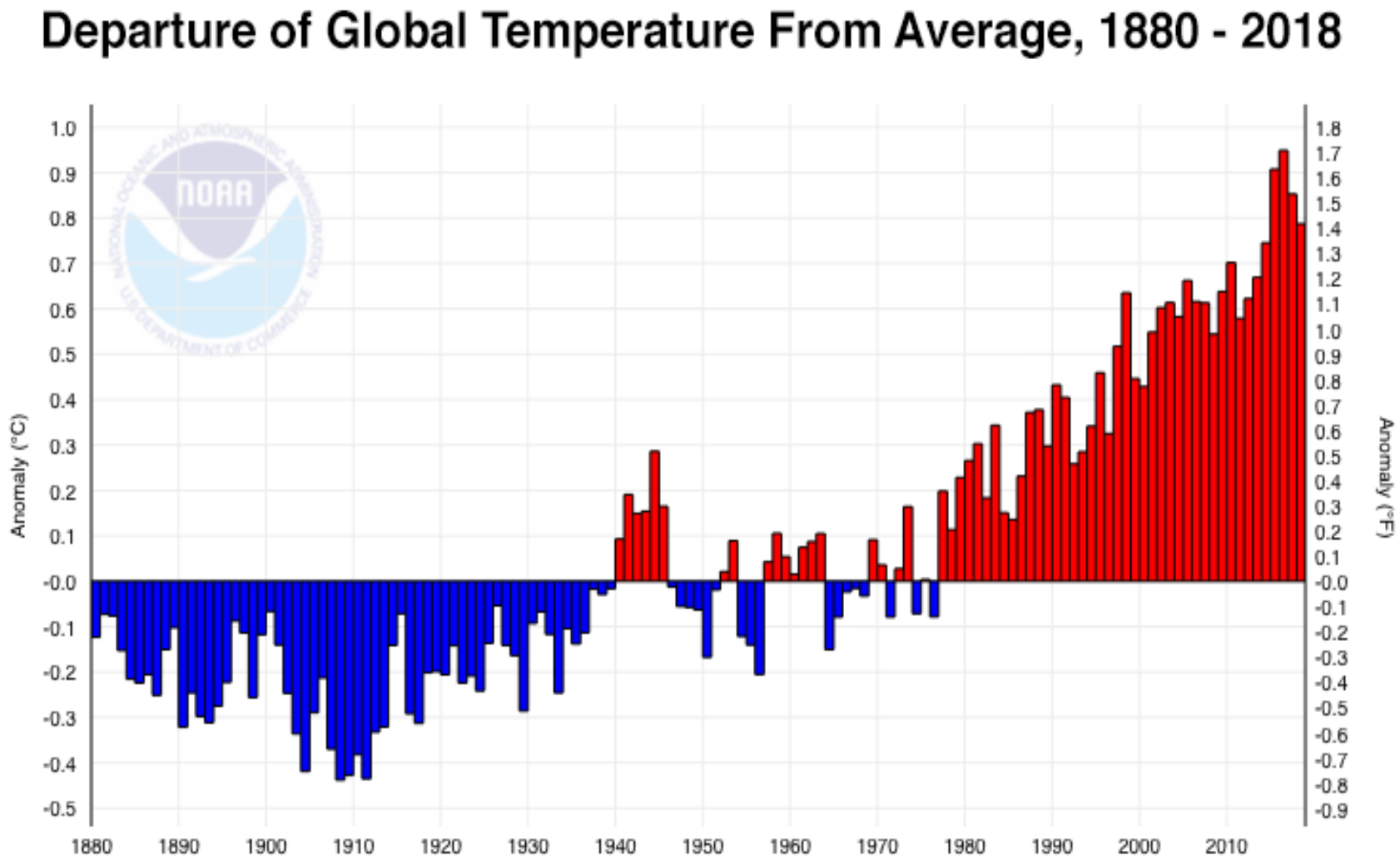
Example of climatology



Example of climatology

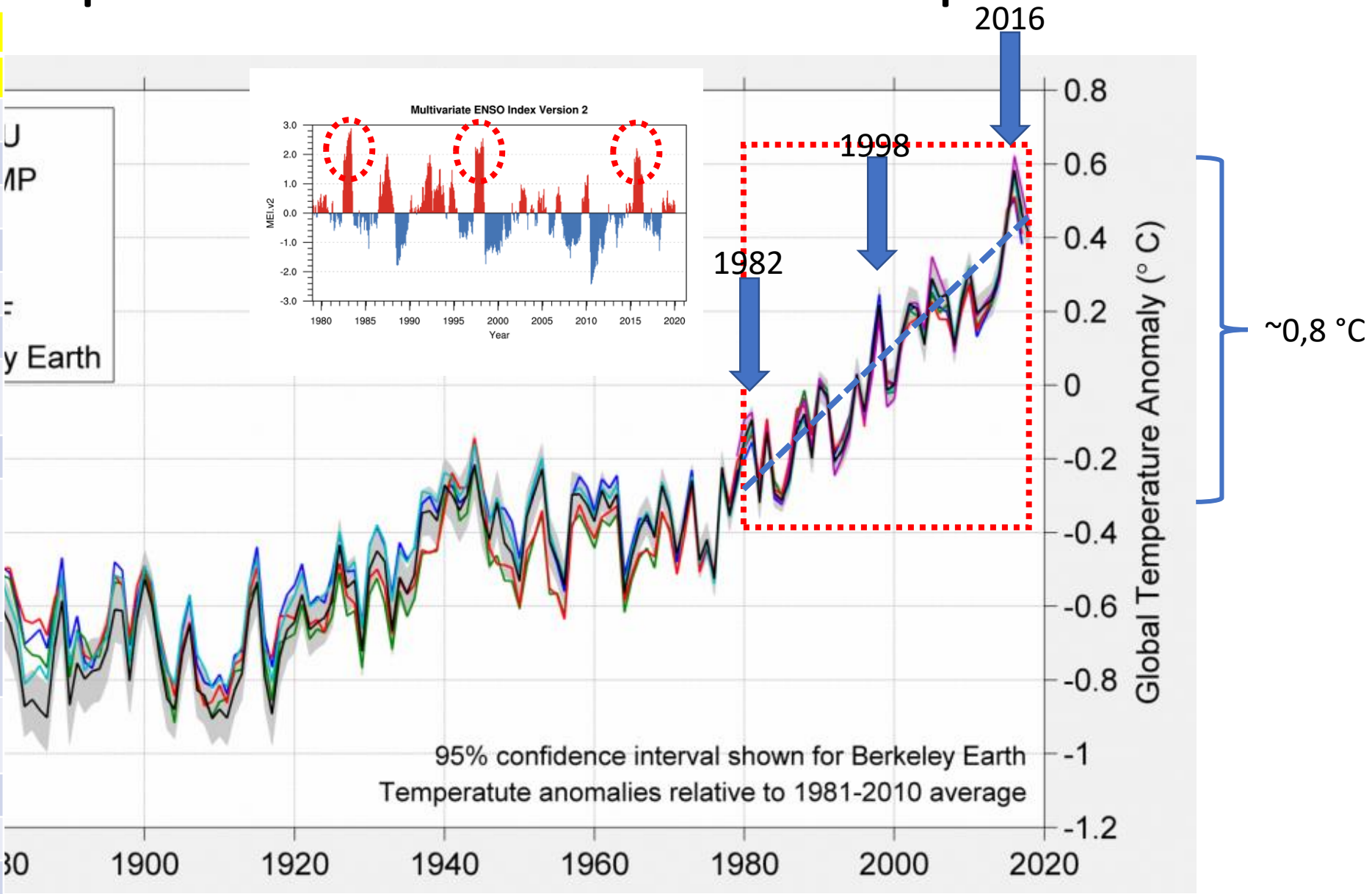


Example of climatology



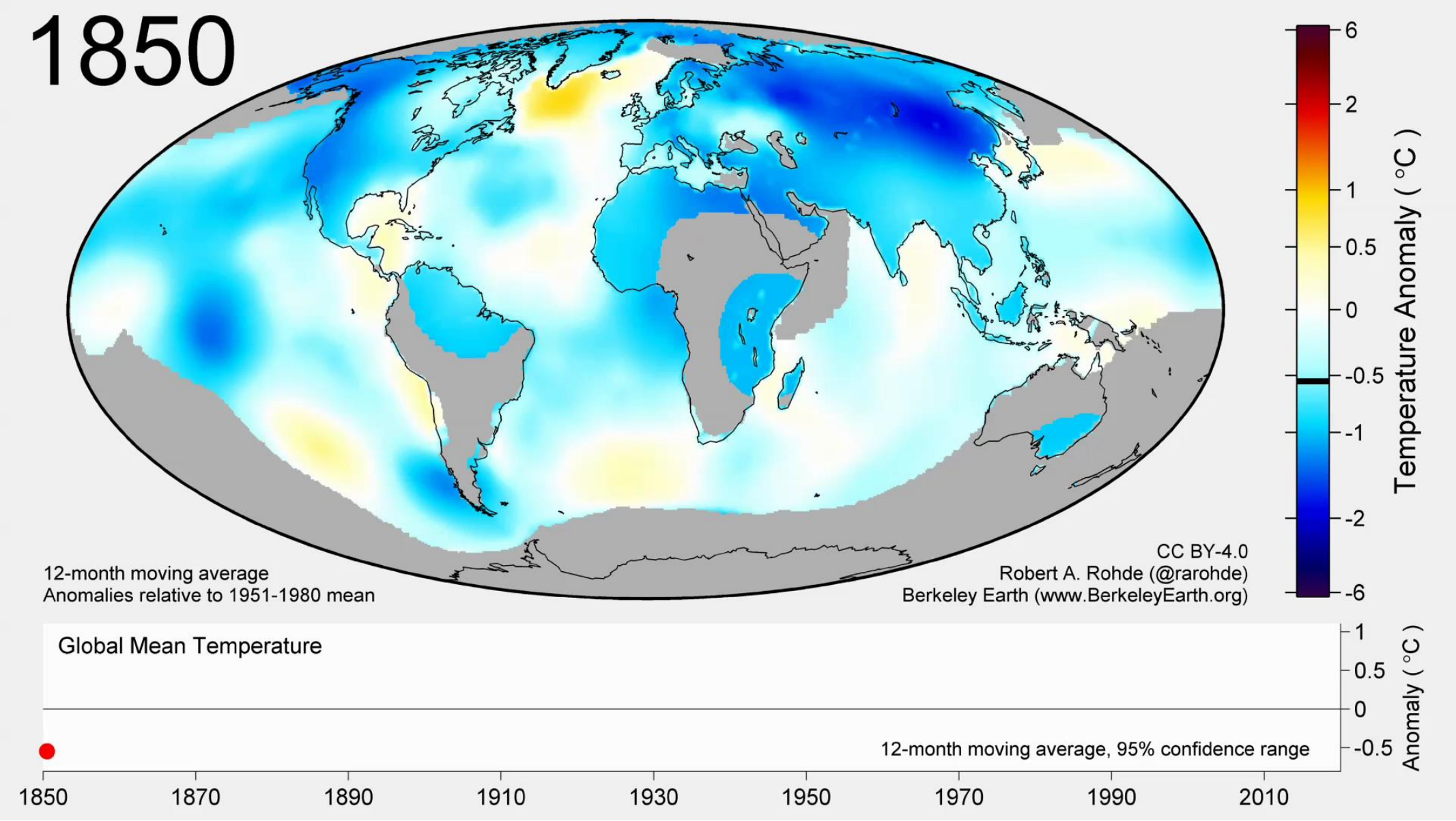
Global temperature rise from 1850 to the present

#	Year	Anomaly (1901-2000)
1	2016	0.99
2	2019	0.95
3	2015	0.93
4	2017	0.91
5	2018	0.83
6	2014	0.74
7	2010	0.72
8	2005 2013	0.67
10	1998	0.65
11	2003 2006 2009 2012	0.64
15	2002 2007	0.62
17	2004 2011	0.58
19	2001	0.57
20	2008	0.54
NOAA data		

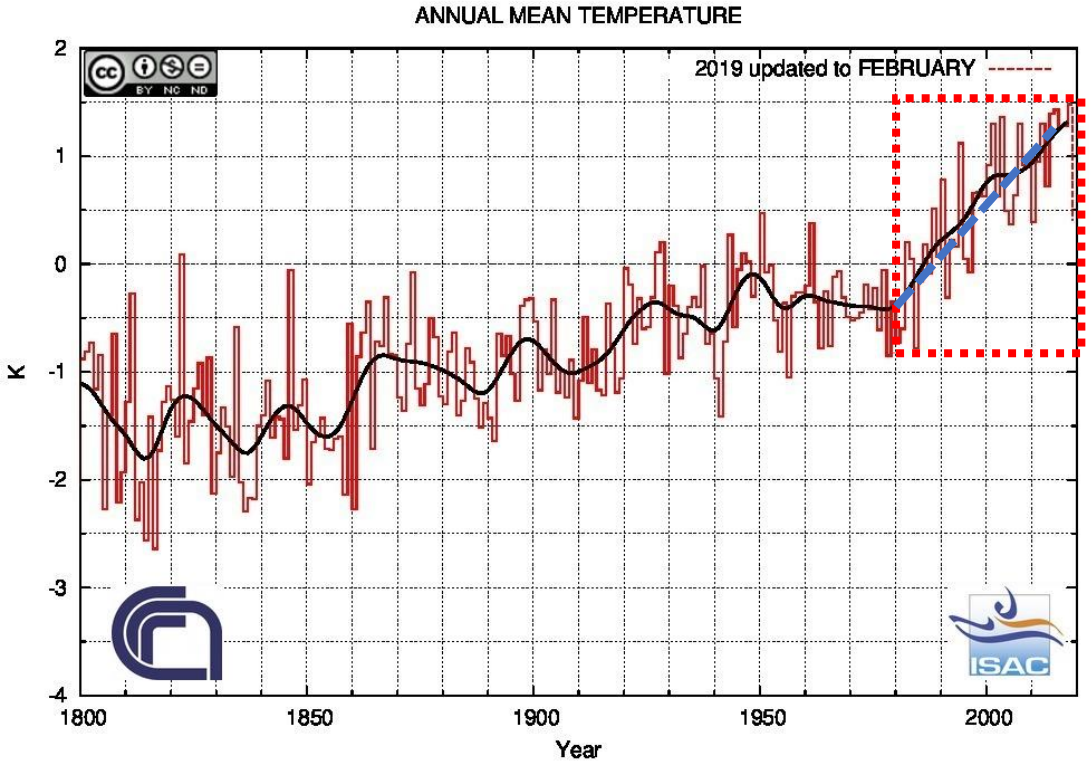


Temperature time series, from 1850 to the present

The different regions of the earth have not all warmed up in the same way



Temperatures in Italy



~1,7 °C

- Strong increase since the 1980s,
- The double of the global anomaly

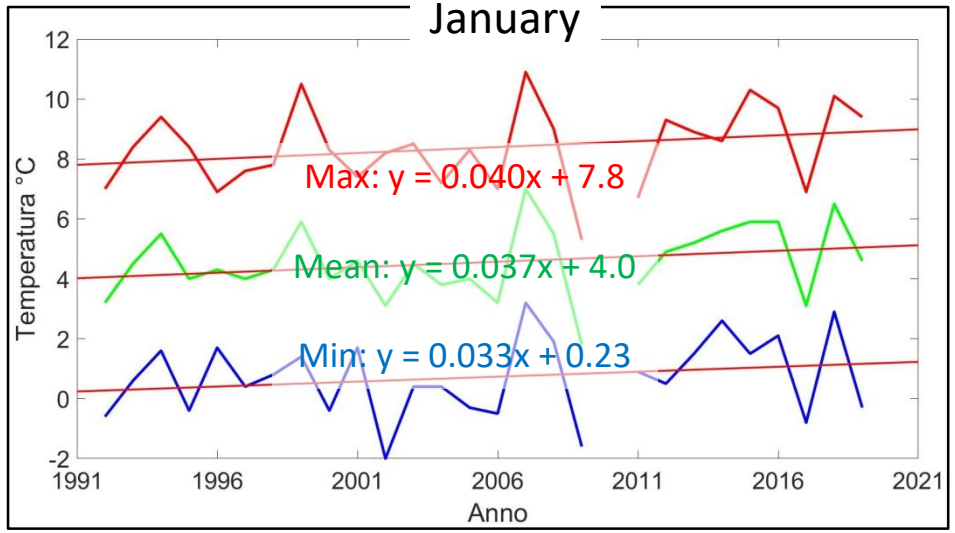
Source: http://www.isac.cnr.it/climstor/climate_news.html

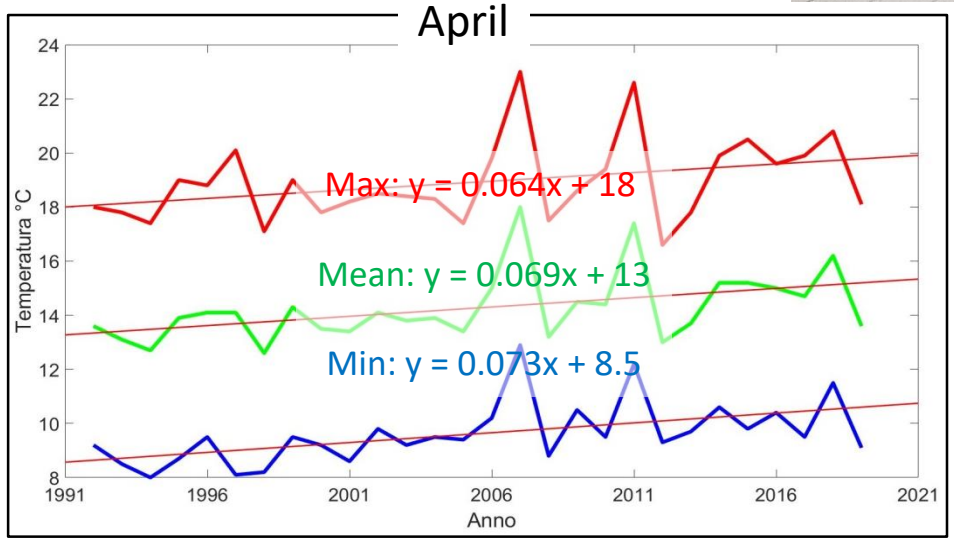
- Aumento più sensibile nel periodo estivo e autunnale al centro-sud e isole
- Dal 1951 netto aumento delle ondate di calore, alcune molto forti (Agosto 1999, Agosto 2003, Giugno 2007, Luglio 2017)
- È diminuito il numero (ma si verificano ancora) delle ondate di freddo intenso: inverni 1985 e 1986, febbraio 2012, febbraio/marzo 2018

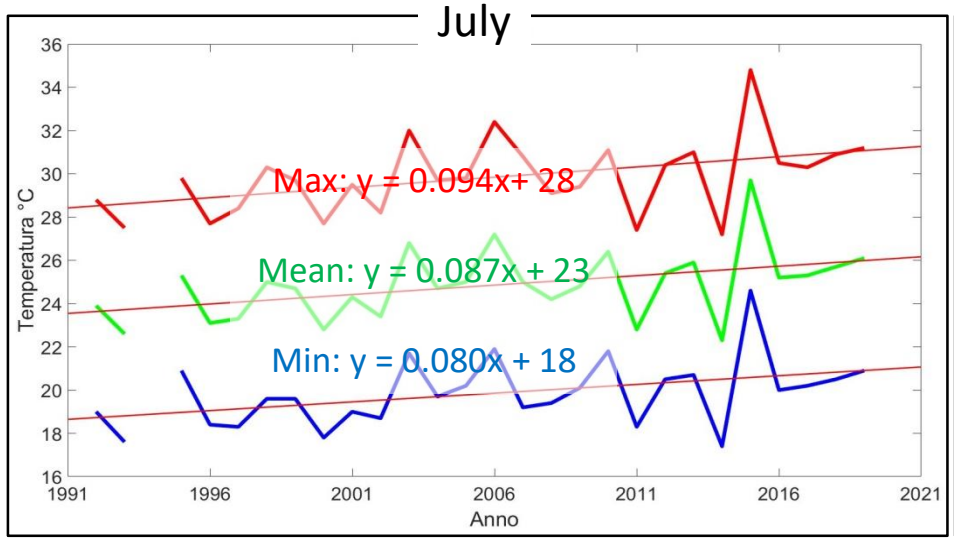
Temperatures in Turin

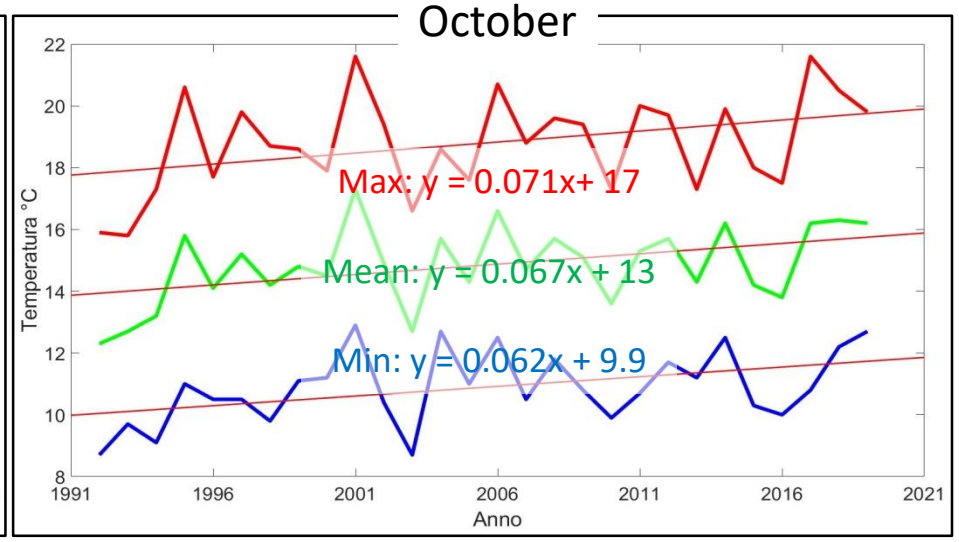
the station of the institute of physics

Analysis of 28.3 years of data acquired on the roof of the Institute of Physics, Turin University









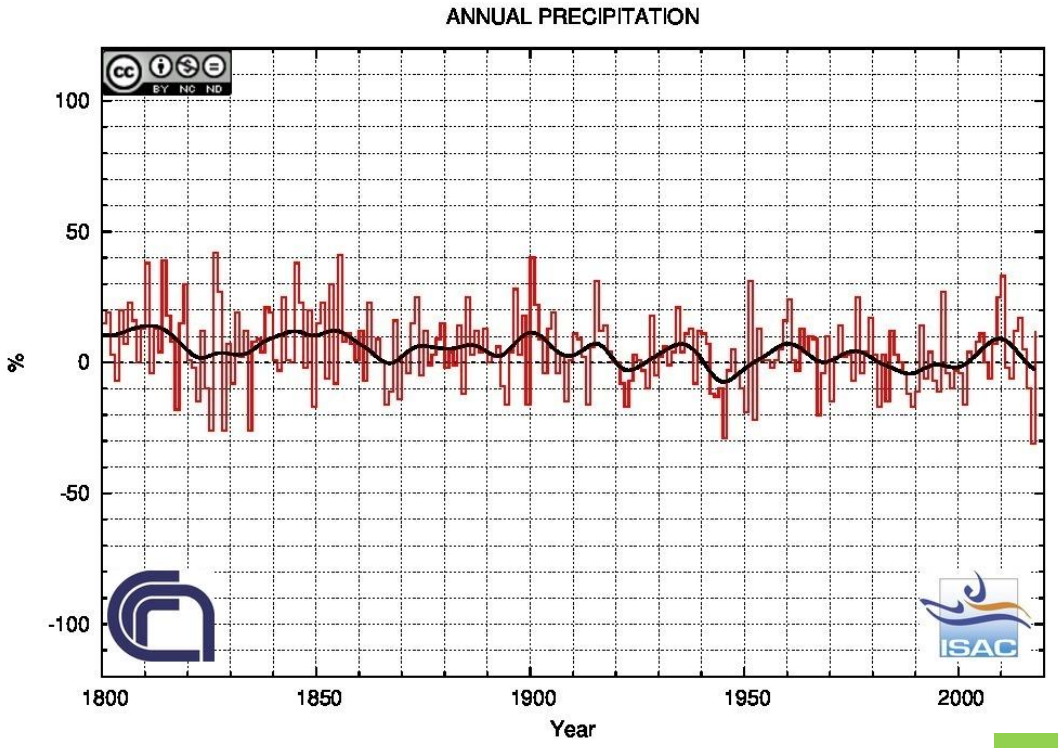
On 30 years:

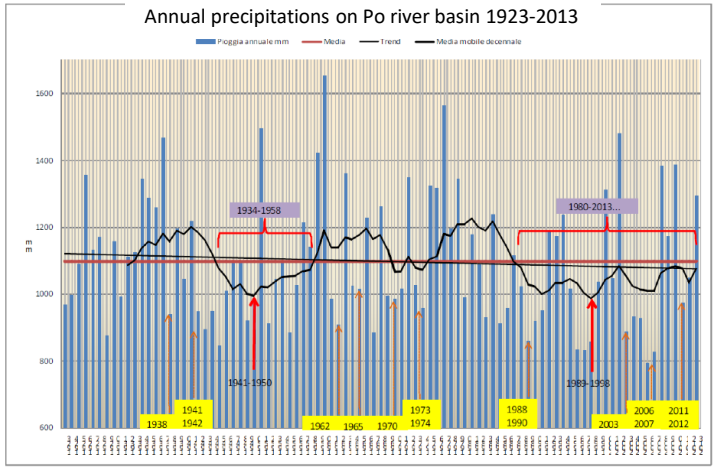
Jun: +1,1 °C
Aug: +2,1 °C
Jul: +2,6 °C
Oct: +2,0 °C

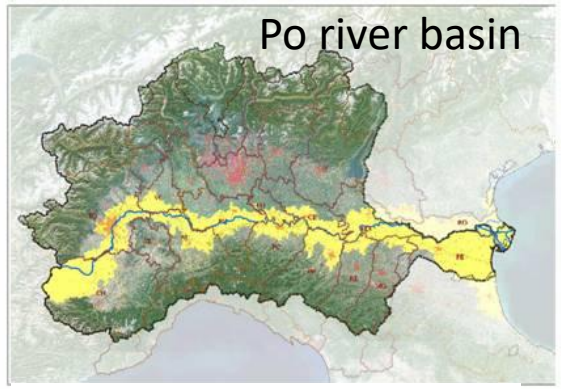
Year: 1,3 °C

Source: Stefano Ziero, «Verification of the thermal series of quasi 30-years of the Department of Physics, batchelor thesis in physics, Univ. of Torino, 2020

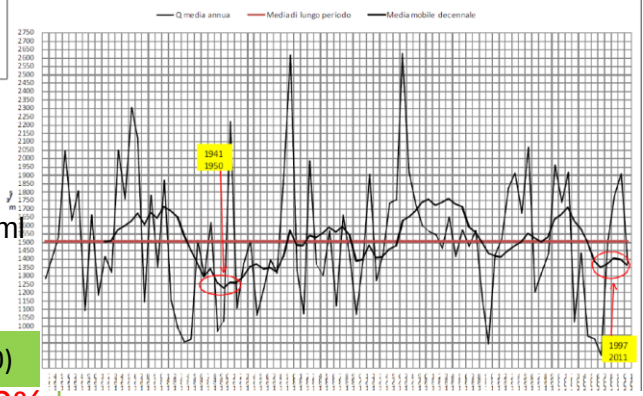
Rainfall in Italy







Annual mean flow at the mouth of Po river basin (1923-2011)



Source: http://www.isac.cnr.it/climstor/climate_news.html

- It rains slightly less in the year and in all seasons
- No variation is statistically significant
- But it has effects on river flows

Parameter	Value (1923-2000)	Value (2001-2010)	
Mean flow	1522	1398	-9%
Semipermanent flow	1210	1078	-12%
Full limit flow	1840	1675	-10%
Lean limit range	874	794	-10%
365-days flow	493	313	-6%
Minumum flow	275	168	-6%

WHAT IS THE CAUSE?

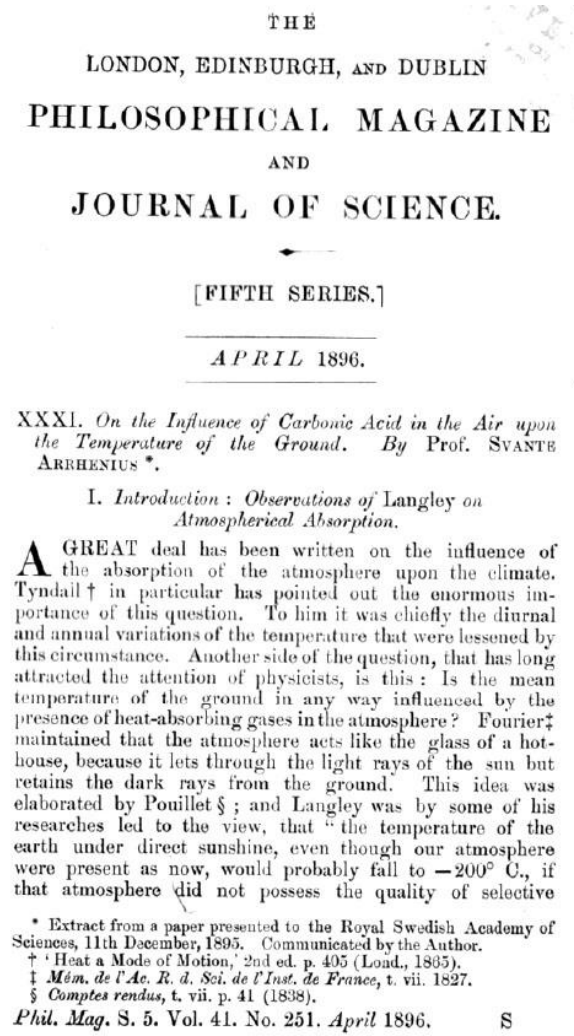
Human activities are the dominant cause of the warming observed since the second half of the 20th century.

(Fifth Evaluation Report of IPCC – IPCC AR5)

And we've known that for over a century...

- In 1895 Arrhenius presented to the Stockholm Physical Society a document entitled "On the influence of carbonic acid in the air on soil temperature", where an energy balance model was described that considered **the radiative effects of carbon dioxide (carbonic acid) and water vapour on the Surface Temperature of the Earth**
- In the article Arrhenius argued that **changes in carbon dioxide could have greatly affected the Earth's thermal balance**
- His calculations estimated that the temperature of the Arctic regions could increase by about **8-9 °C** if the concentration of carbonic acid had increased by **2.5-3 times**,
- He also estimated that, with concentrations of **55-62% of current ones**, temperatures could have **decreased by 4-5 °C** in the mid-latitudes (glaciations)
- In 1900 there were 300 ppm of CO_2

Svante August Arrhenius
(1859 –1927)
Swedish chemist and physicist
Nobel Prize in Chemistry in 1903



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

[FIFTH SERIES.]

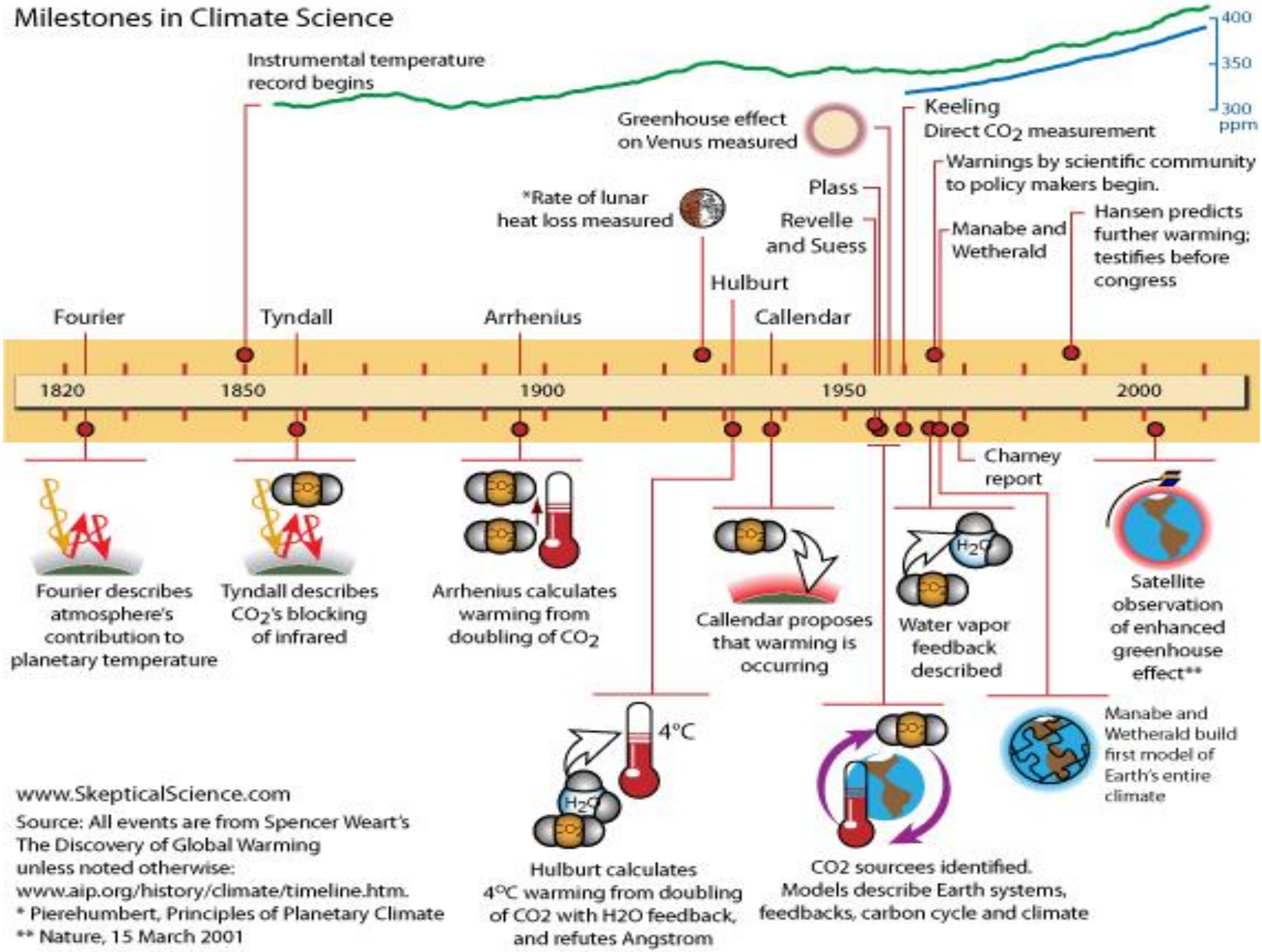
APRIL 1896.

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).


Milestones in Climate Science
Instrumental temperature record begins
400
350
300
ppm
Greenhouse effect on Venus measured
Keeling
Direct CO2 measurement
Warnings by scientific community to policy makers begin.
*Rate of lunar heat loss measured
Plass
Revelle and Suess
Manabe and Wetherald
Hansen predicts further warming; testifies before congress
Hulburt
Fourier
Tyndall
Arrhenius
Callendar
1820
1850
1900
1950
2000
Charney report
Fourier describes atmosphere's contribution to planetary temperature
Tyndall describes CO2's blocking of infrared
Arrhenius calculates warming from doubling of CO2
Callendar proposes that warming is occurring
H2O
Water vapor feedback described
Satellite observation of enhanced greenhouse effect**
4°C
H2O
Manabe and Wetherald build first model of Earth's entire climate
www.SkepticalScience.com
Source: All events are from Spencer Weart's The Discovery of Global Warming unless noted otherwise: www.aip.org/history/climate/timeline.htm.
* Pierehumbert, Principles of Planetary Climate
** Nature, 15 March 2001
Hulburt calculates 4°C warming from doubling of CO2 with H2O feedback, and refutes Angstrom
CO2 sourcees identified. Models describe Earth systems, feedbacks, carbon cycle and climate

Callendar, 1938

551.510.4 : 551.521.3 : 551.524.34

THE ARTIFICIAL PRODUCTION OF CARBON DIOXIDE AND ITS INFLUENCE ON TEMPERATURE

By G. S. CALLENDAR

(Steam technologist to the British Electrical and Allied Industries Research Association.)

(Communicated by Dr. G. M. B. DOBSON, F.R.S.)

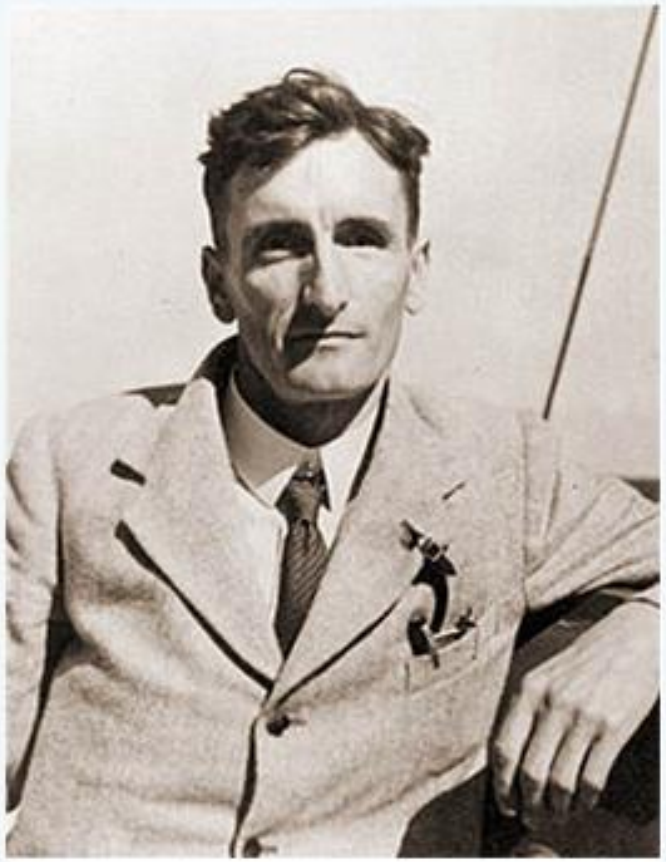
[Manuscript received May 19, 1937—read February 16, 1938.]

SUMMARY

By fuel combustion man has added about 150,000 million tons of carbon dioxide to the air during the past half century. The author estimates from the best available data that approximately three quarters of this has remained in the atmosphere.

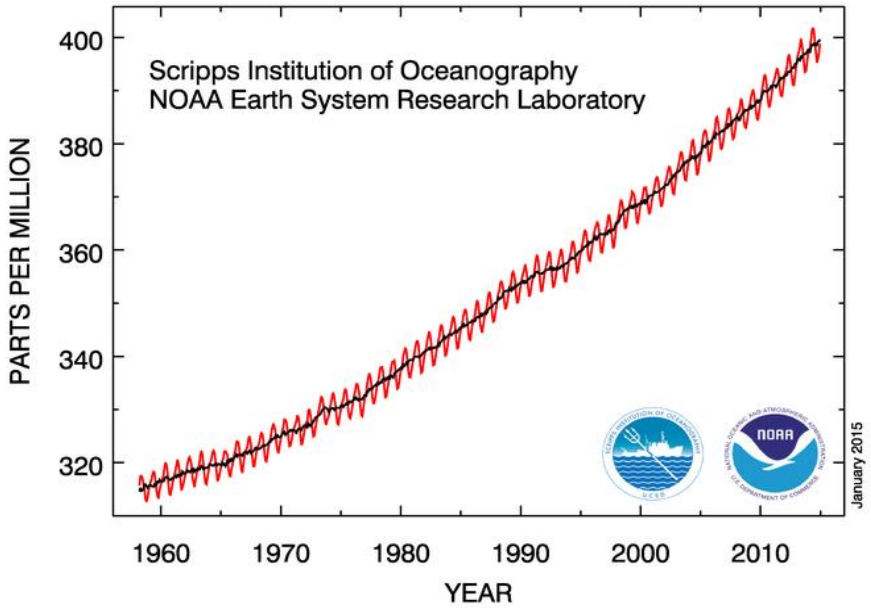
The radiation absorption coefficients of carbon dioxide and water vapour are used to show the effect of carbon dioxide on " sky radiation." From this the increase in mean temperature, due to the artificial production of carbon dioxide, is estimated to be at the rate of 0·003°C. per year at the present time.

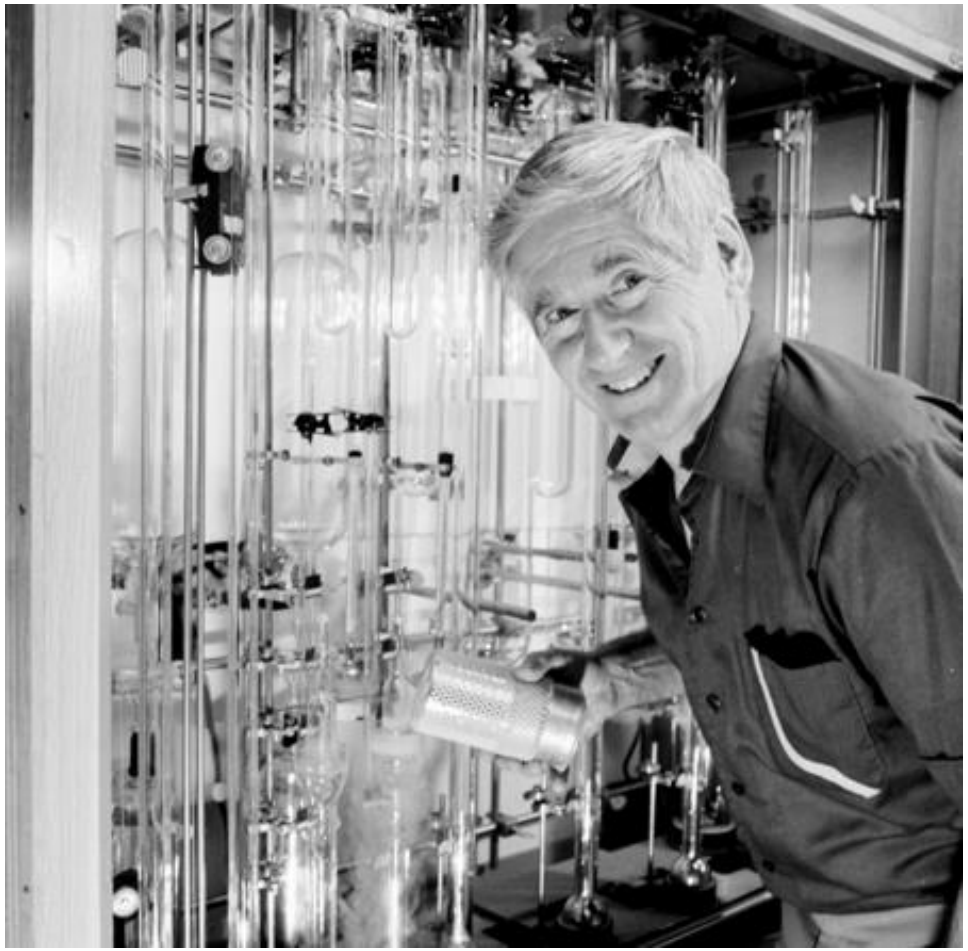
The temperature observations at 200 meteorological stations are used to show that world temperatures have actually increased at an average rate of 0·005°C. per year during the past half century.



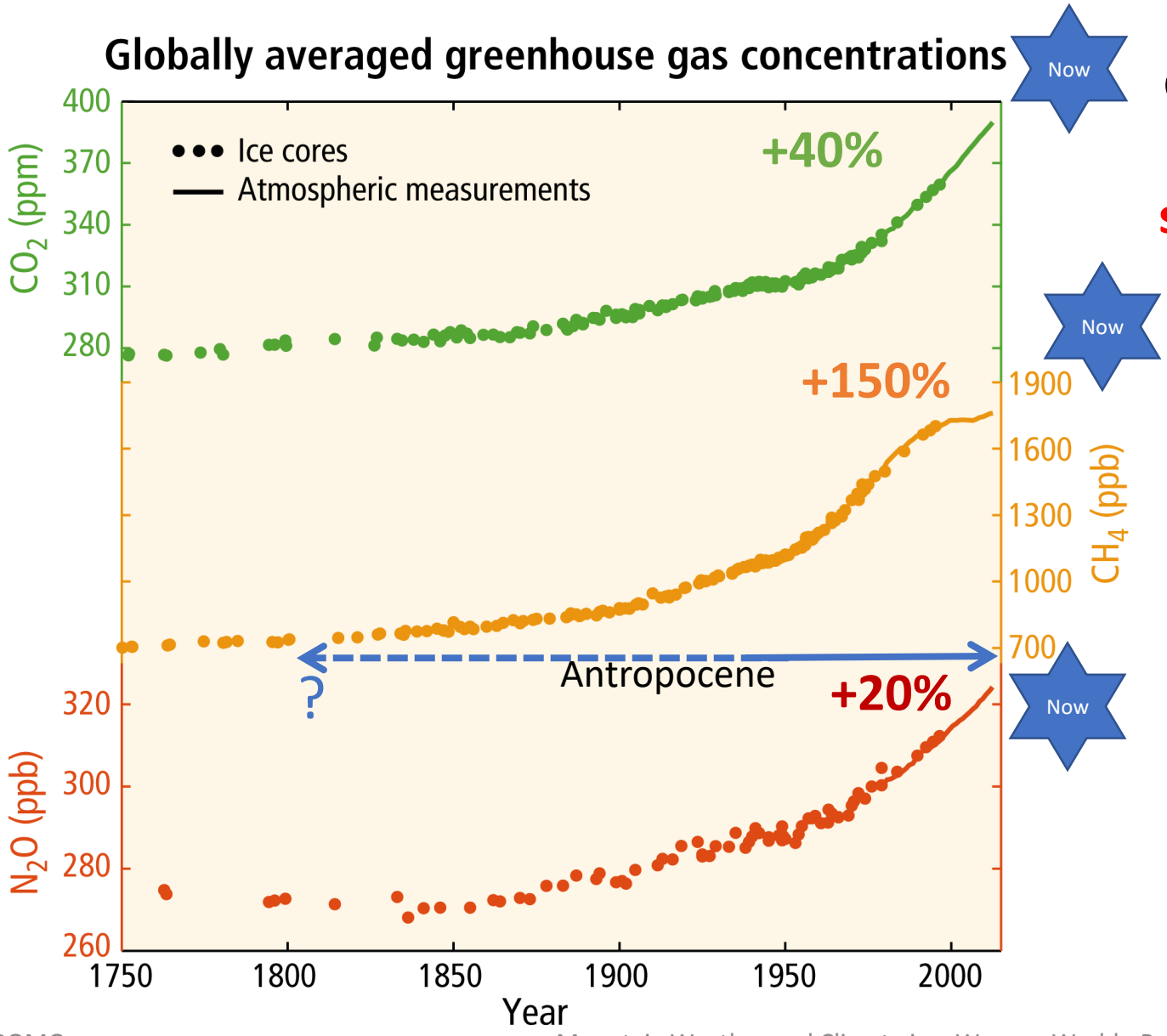
Charles David Keeling's first observations, 1958-60

- Unequivocal evidence that CO_2 concentrations are rising steadily

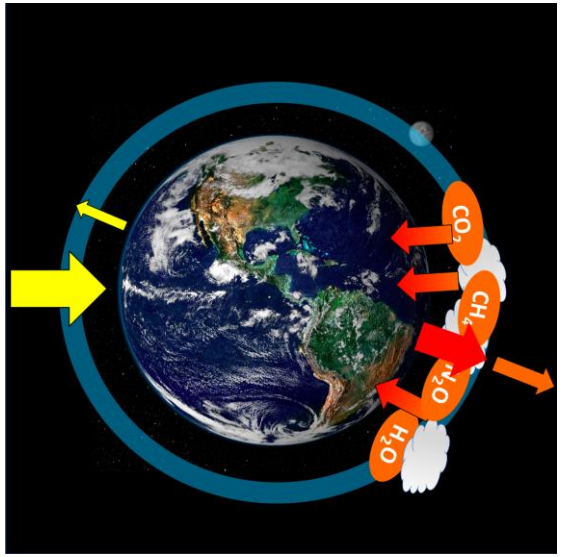




Epochal increases in greenhouse gases



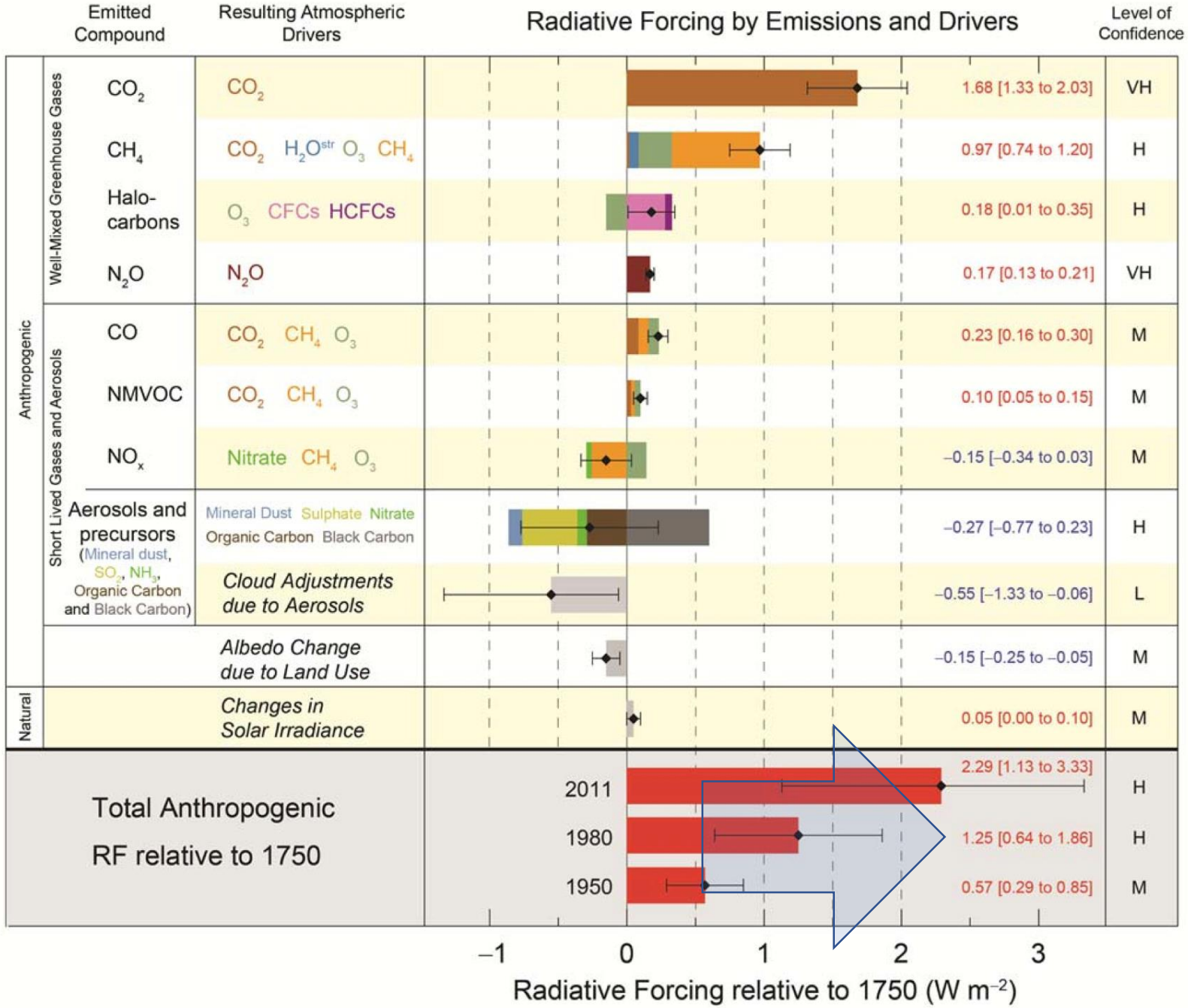
Greenhouse gas emissions have increased since 1750, with a strong acceleration over the last 40 years, leading to an unprecedented increase in temperature.

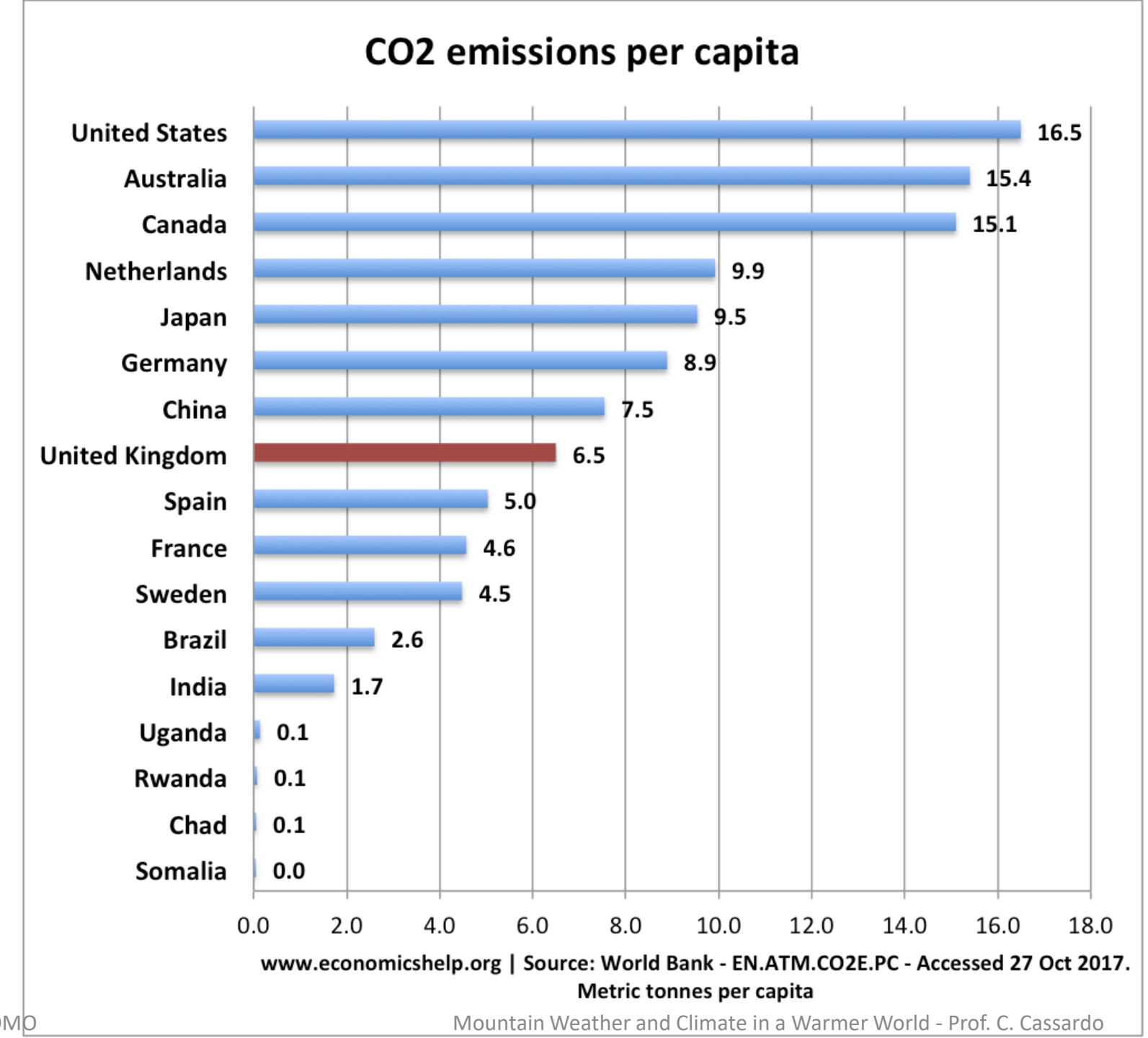


Who is the responsible?

Ipcc AR5

Radiative forcing of the different greenhouse gases
Total forcing: 2.3 W/m^2





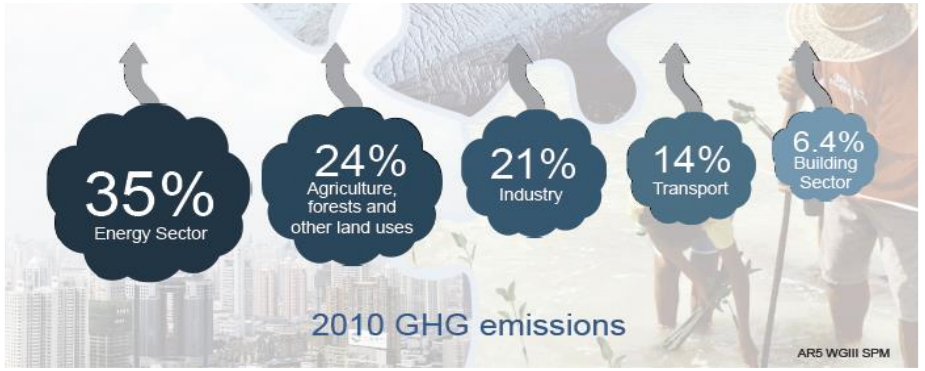
2014

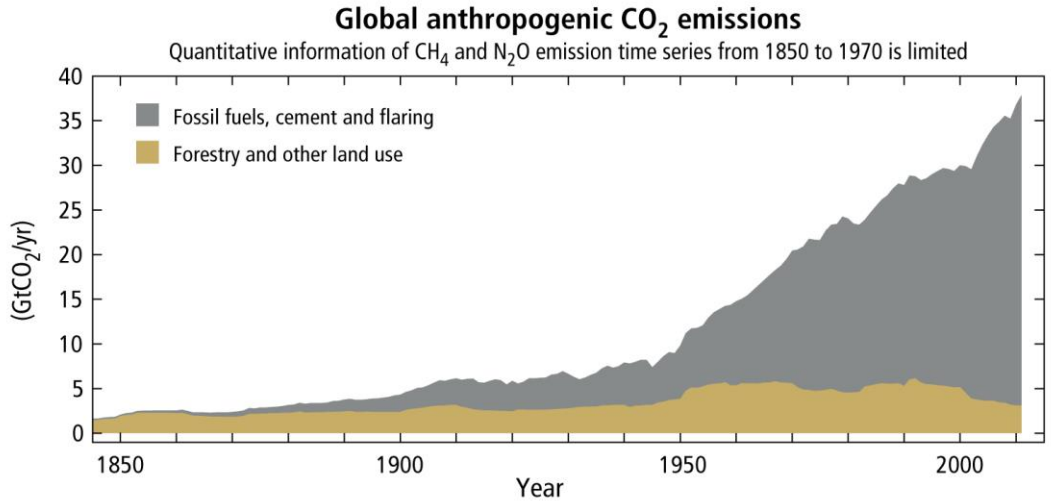
Italy 5.3

EU 6,4

Global mean 5,0

Where does anthropic CO_2 come from, and where does it go?

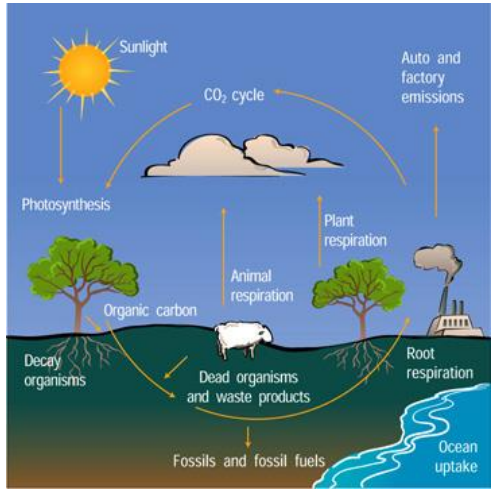




1. **Energy production**
2. **Agriculture**
3. **Industry**
4. **Transportations**
5. **Constructions**

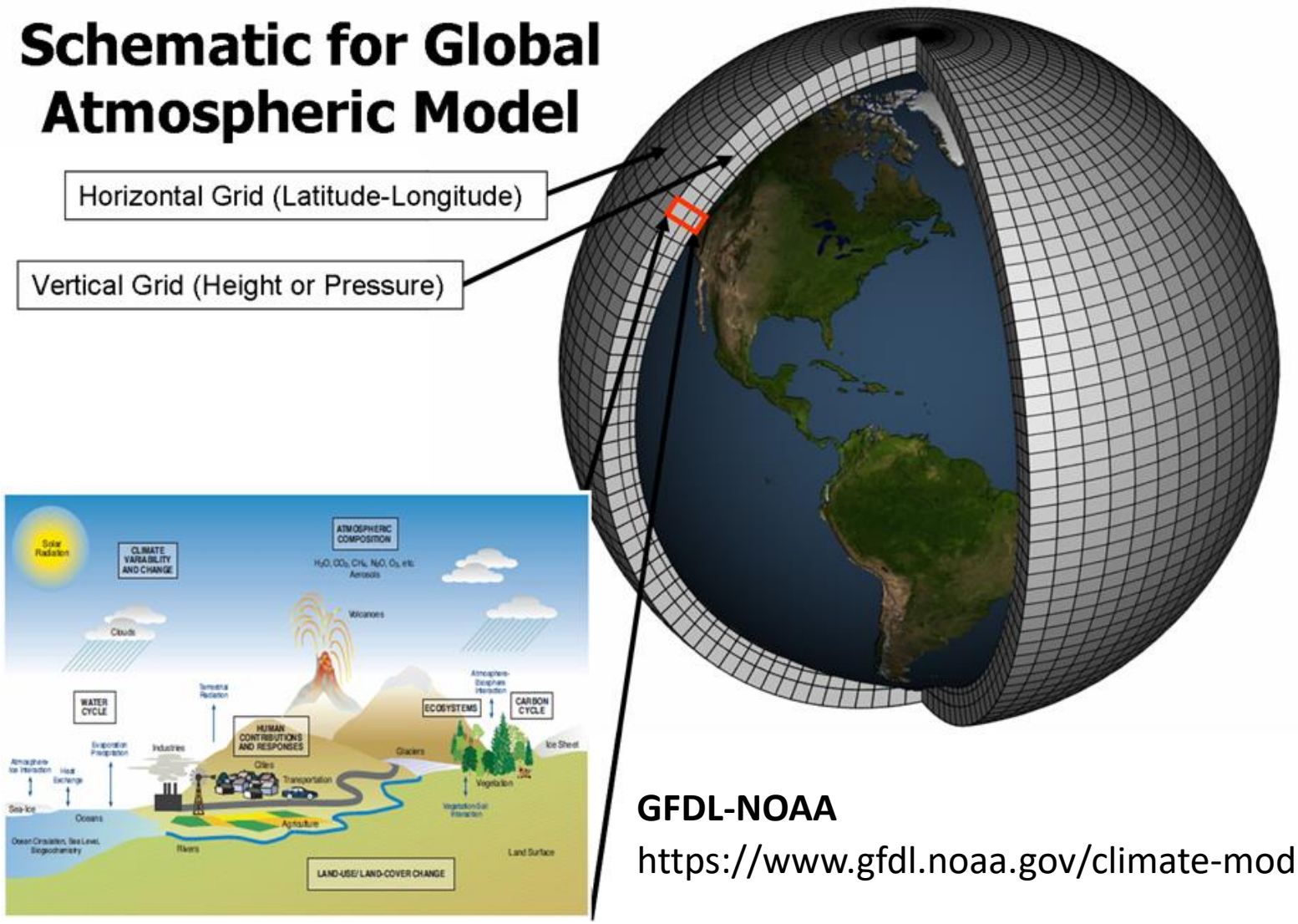
Where does anthropic CO_2 come from, and where does it go?

With this rate of growth in emissions, oceans and vegetation are not able to effectively remove CO_2 from the atmosphere, as in past centuries and millennia



Climatic models

tools to understand the climate and predict its future evolution

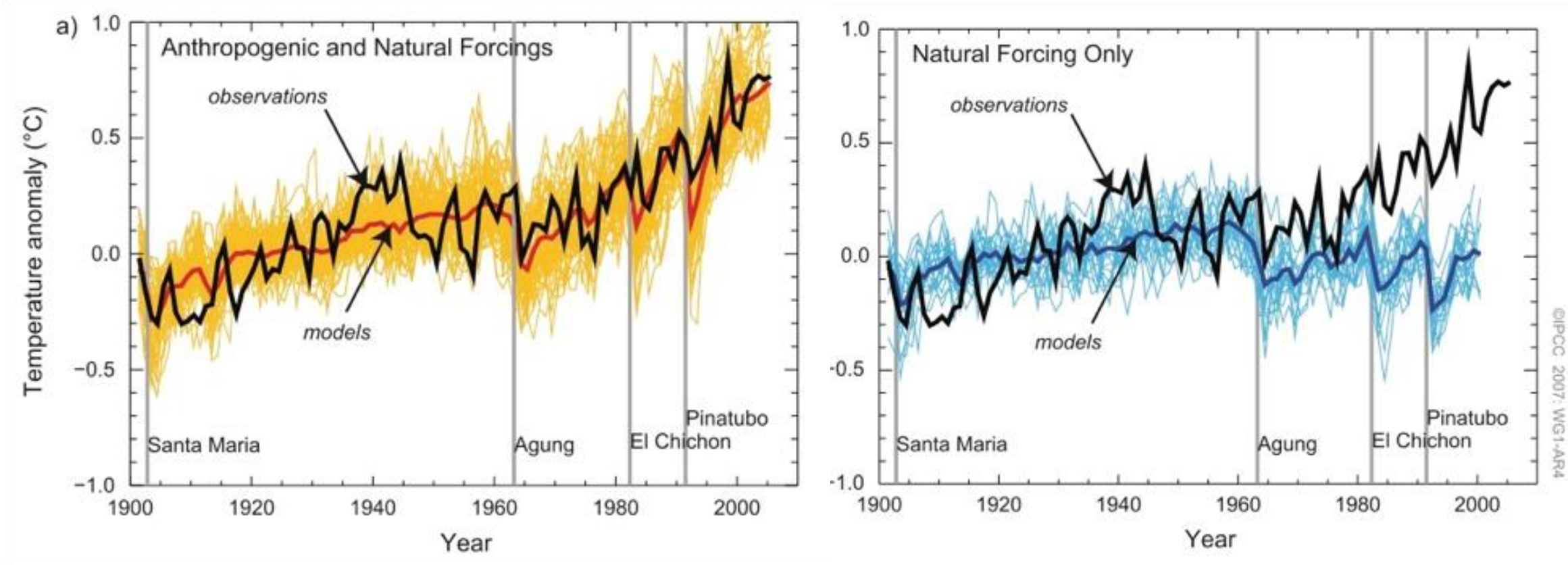


GFDL-NOAA

https://www.gfdl.noaa.gov/climate-modeling/

- **DIAGNOSTIC tools: useful for doing attribution "exercises" (understand the cause of a change that has been considered as statistically significant)**
- **PROGNOSTIC tools: to make future climate projections) based on natural climate variability and assuming changes in forcing**

Models show anthropogenic contribution to warming

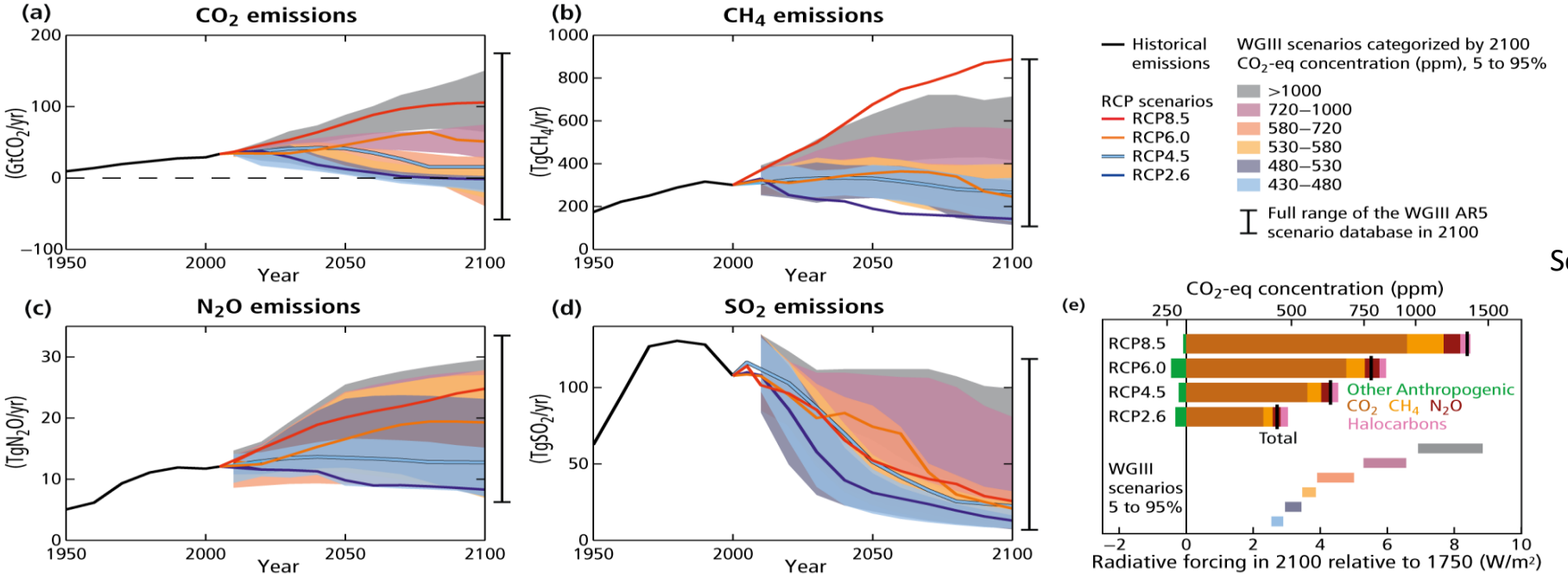


(IPCC, 2007)

Not one, but many models.

Future projections and emission scenarios

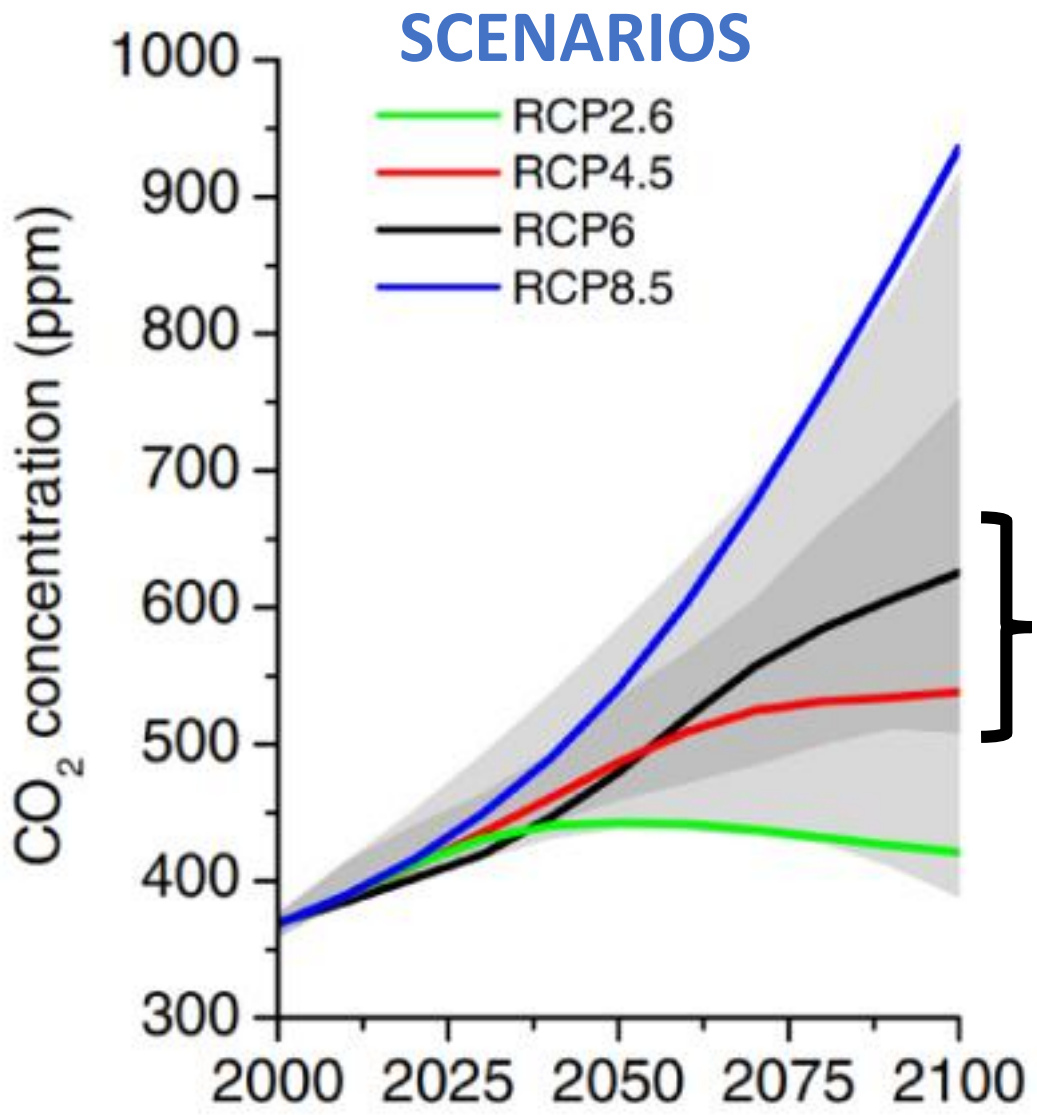
The future climate projections performed with the models are based on a set of possible "scenarios" that the society can undertake in terms of future greenhouse gas emissions, population growth, etc... called Representative Concentration Pathways (RCP)



Source: IPCC Fifth Assessment Report

- In the RCP2.6 scenario, CO_2 emissions begin to decline around 2025 and will be zeroed out between 2060 and 2070!

What do we expect? Future climate projections

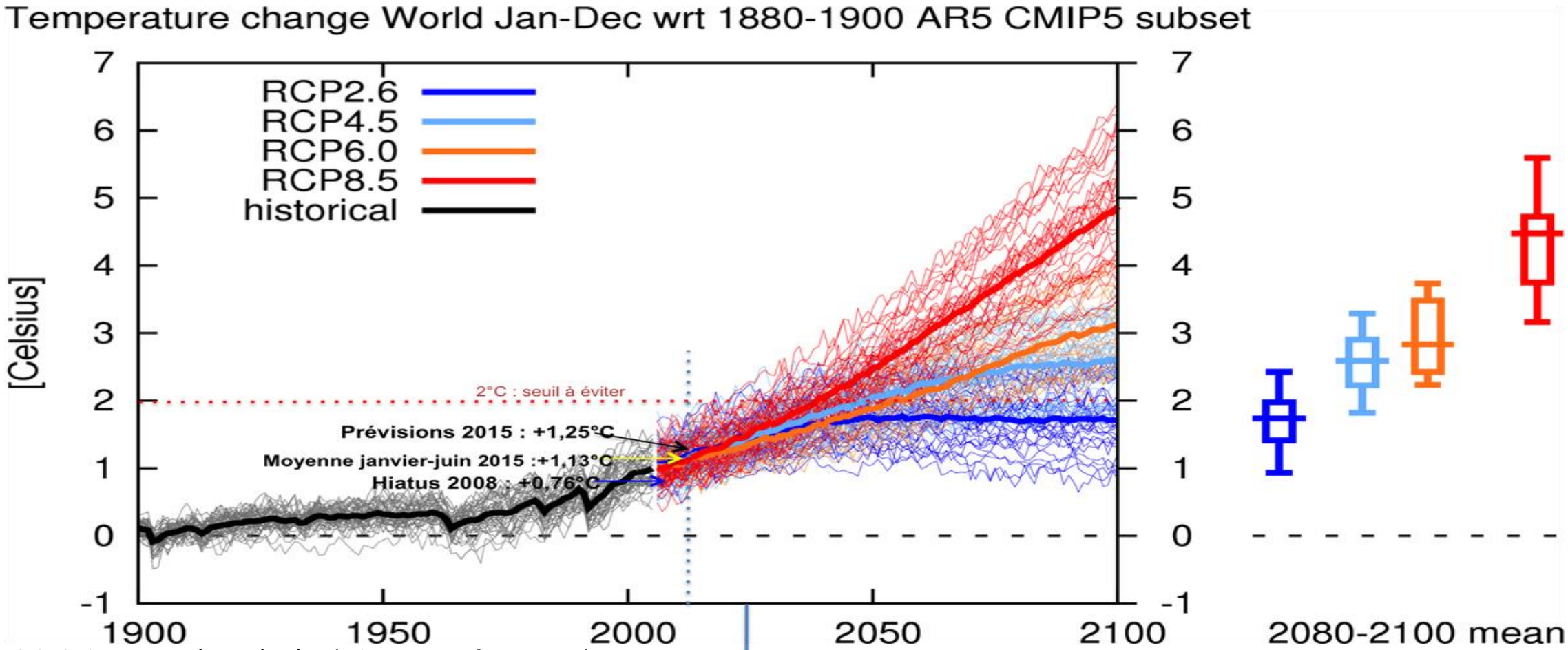


Business as Usual (BaU)

Stabilization

Mitigation

What do we expect? Future climate projections

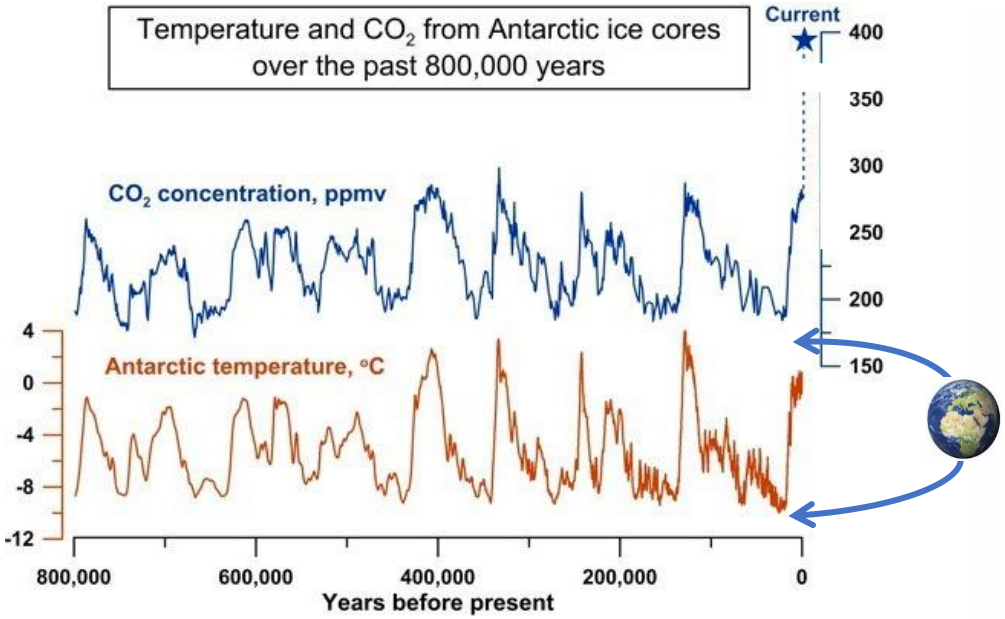


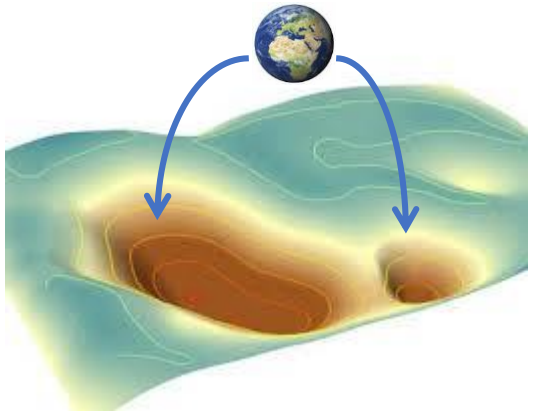
Source: global-climat.com/2015/09/20 (adaptation of IPCC-AR5)

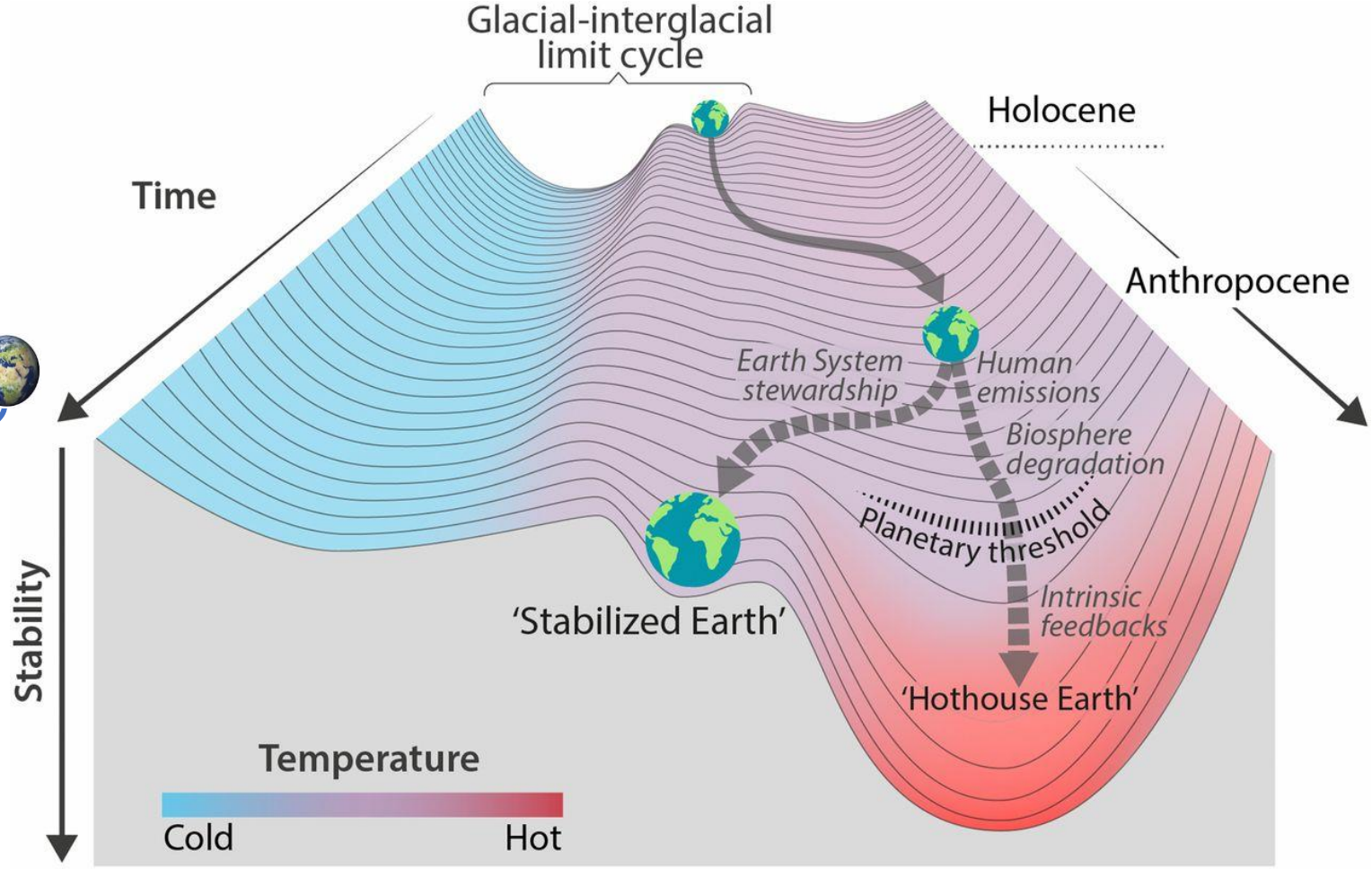
- Increase in the global average temperature at the end of the century between 1.5 and 5 °C depending on the emission scenarios

New equilibrium points?

Stability landscape showing the pathway of the Earth System out of the Holocene and thus, out of the glacial–interglacial limit cycle to its present position in the hotter Anthropocene.





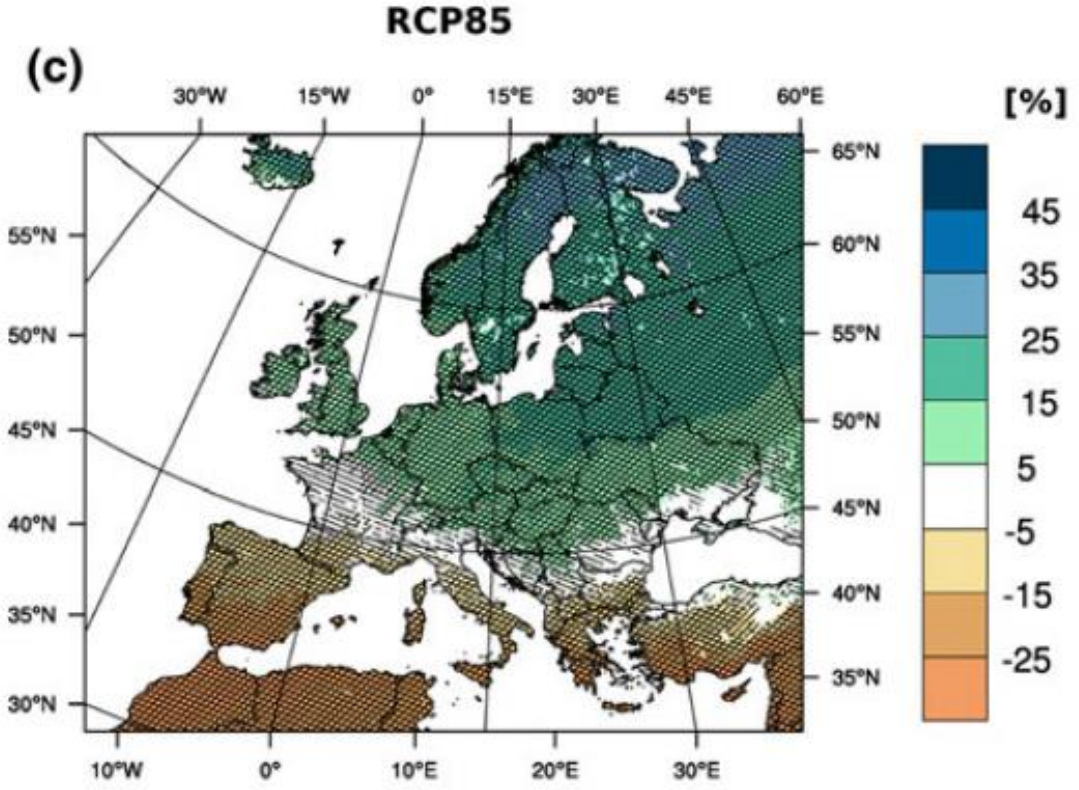


Will Steffen et al. PNAS doi:10.1073/pnas.1810141115
Trajectories of the Earth System in the Anthropocene

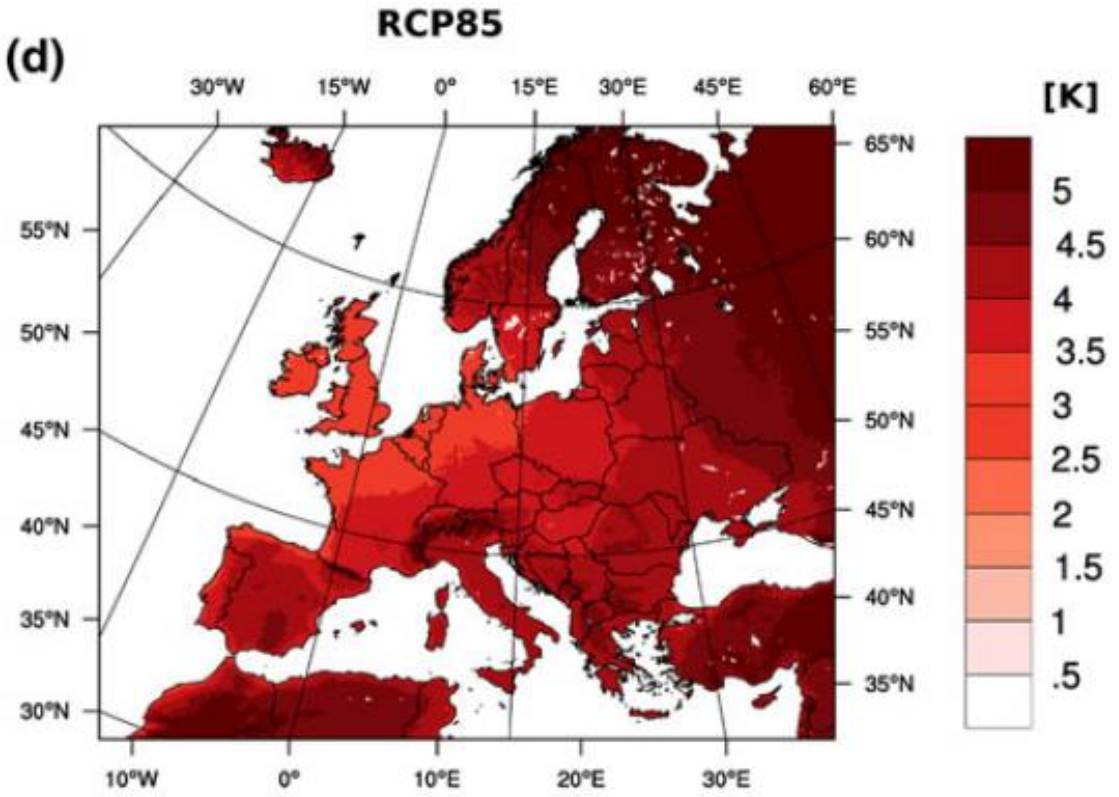
PNAS

Precipitations and temperatures in Europe

(2071-2100 vs 1971-2000)

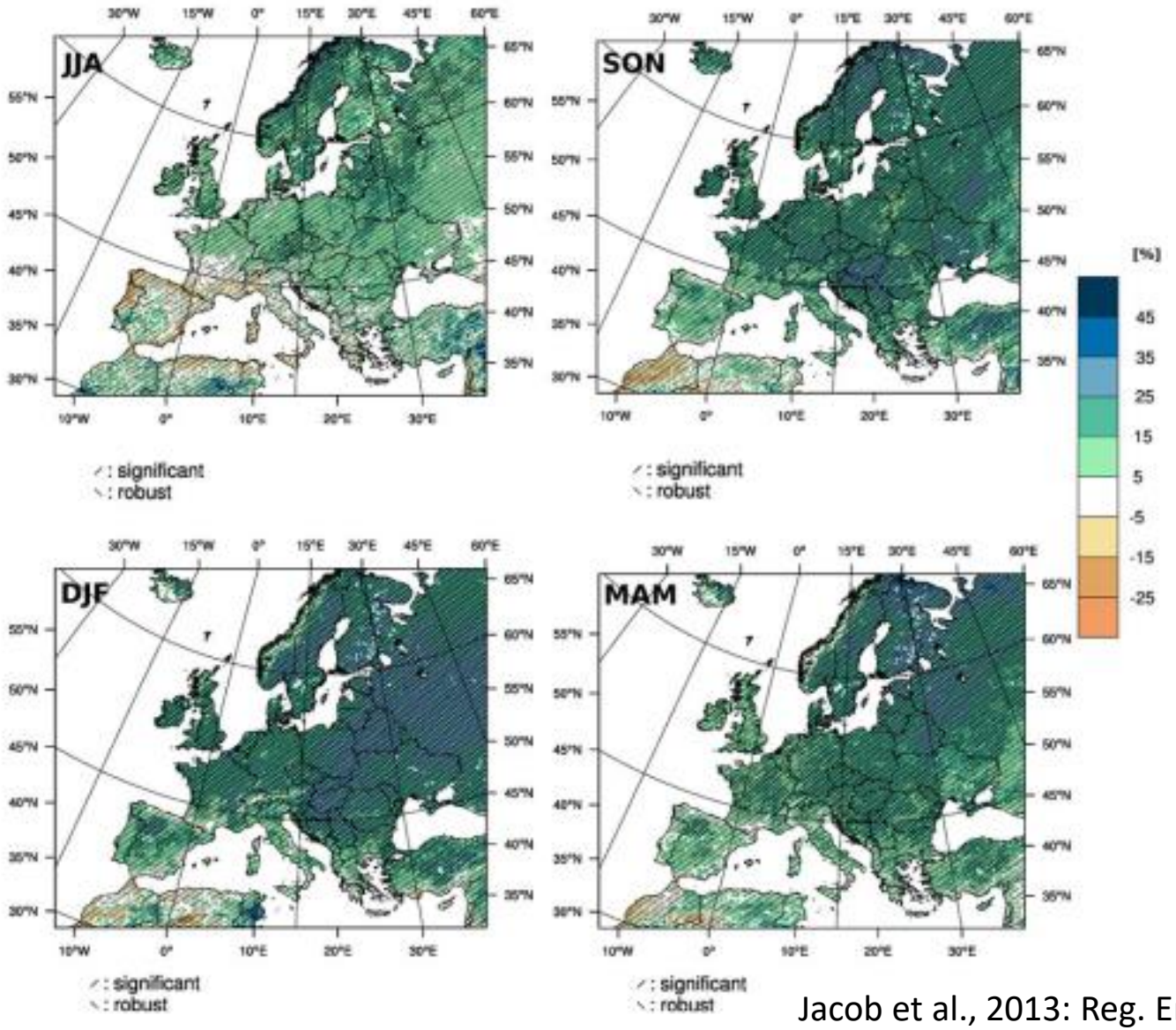


Jacob et al., 2013: Reg. Environ. Change



Seasonal heavy precipitation in Europe

(2071-2100 vs 1971-2000)

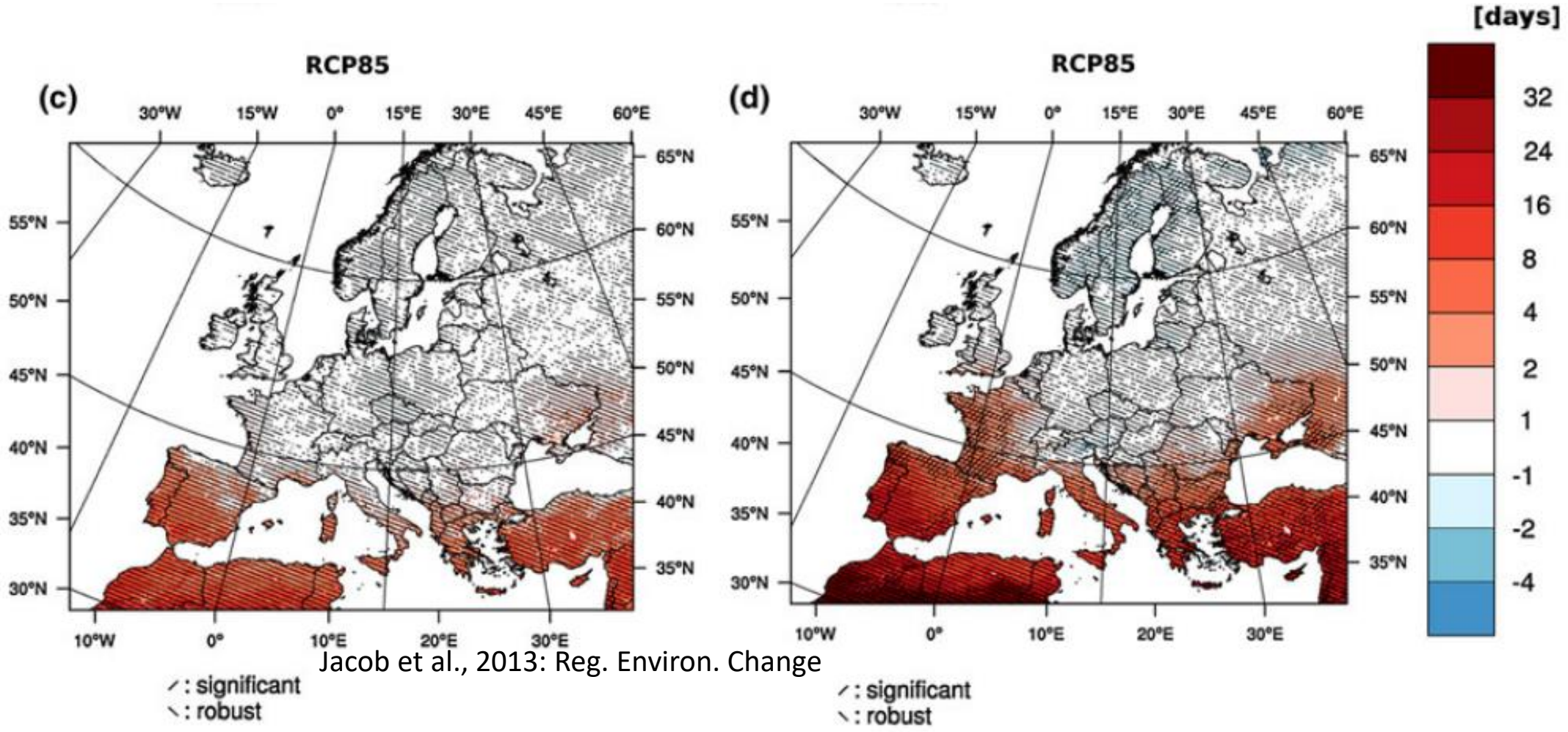


On average, the western Mediterranean basin shows decreasing trends in heavy rainfall, more pronounced in the summer season

Jacob et al., 2013: Reg. Environ. Change

Length of drought periods

(2021-2050) (2071-2100)



Jacob et al., 2013: Reg. Environ. Change

Claudio Cassardo

Department of Physics

Università degli Studi di Torino

claudio.cassardo@unito.it

claudiocassardo.wordpress.com

www.agi.it/blog-italia/autore/claudio_cassardo/

www.climalteranti.it

Photo by Francesco Ungaro

Mountain Weather and Climate in a Warmer World – Part III: climate change effects

The topics I'd like to talk to you about

- A remind: future climate changes
- Overview of Some Effects
  - The Mountains of Climate Sentinels
  - The Problem of Air Pollution
  - The Water Budget Resources in Agriculture
- Part IV – What to Do?
  - Adaptation and mitigation
  - Collective level: international cooperation and individual level agreements

Expected effects of climate change in the Mediterranean

Mediterranean region
Large increase in heat extremes
Decrease in precipitation and river flow
Increasing risk of droughts
Increasing risk of biodiversity loss
Increasing risk of forest fires
Increased competition between different water users
Increasing water demand for agriculture
Decrease in crop yields
Increasing risks for livestock production
Increase in mortality from heat waves
Expansion of habitats for southern disease vectors
Decreasing potential for energy production
Increase in energy demand for cooling
Decrease in summer tourism and potential increase in other seasons
Increase in multiple climatic hazards
Most economic sectors negatively affected
High vulnerability to spillover effects of climate change from outside Europe

Expected effects of climate change in the mountains

Mountain regions

Temperature rise larger than European average

Decrease in glacier extent and volume

Upward shift of plant and animal species

High risk of species extinctions

Increasing risk of forest pests

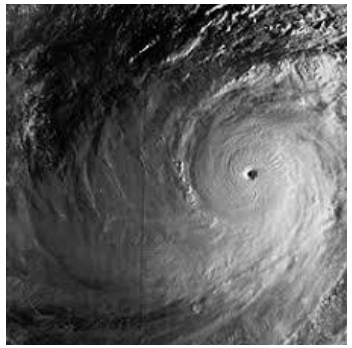
Increasing risk from rock falls and landslides

Changes in hydropower potential

Decrease in ski tourism

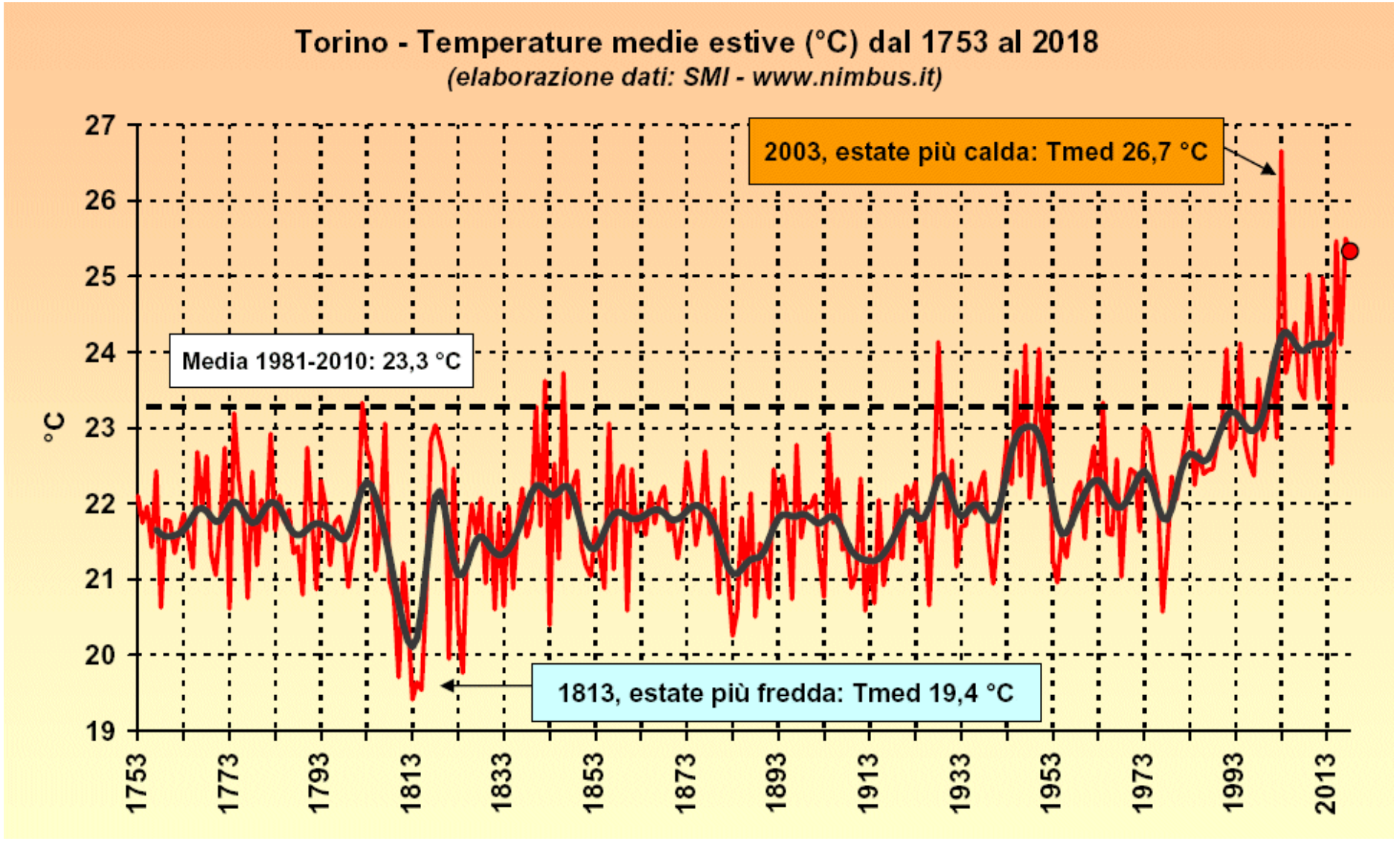
Increase of climate extremes

- VERY debated topic
- Extreme events are rare
- The statistical set is LIMITED
- Interannual variability, especially for events involving precipitation, is high
- As far as temperatures (heat waves, cold waves) trends are more obvious and significant
- As far as precipitation (floods, droughts, rains and very intense phenomena), it is difficult to see statistically significant trends
- An exception is given by snowfalls, almost everywhere decreasing



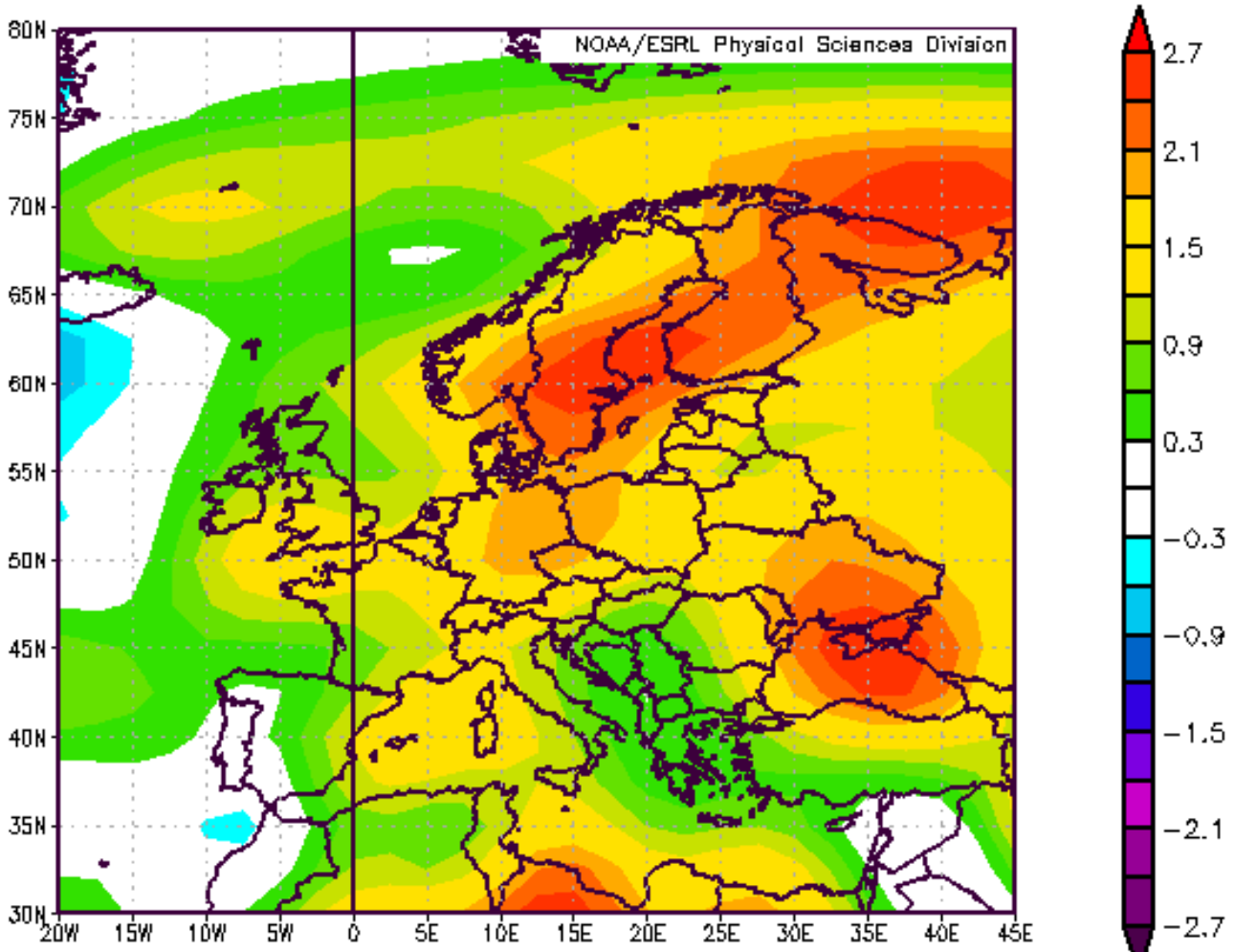
Big events on large basins (well predictable)

Localized flash floods (sometimes less predictable)



Torino: 9 on 10 hottest summers are subsequent to 2002

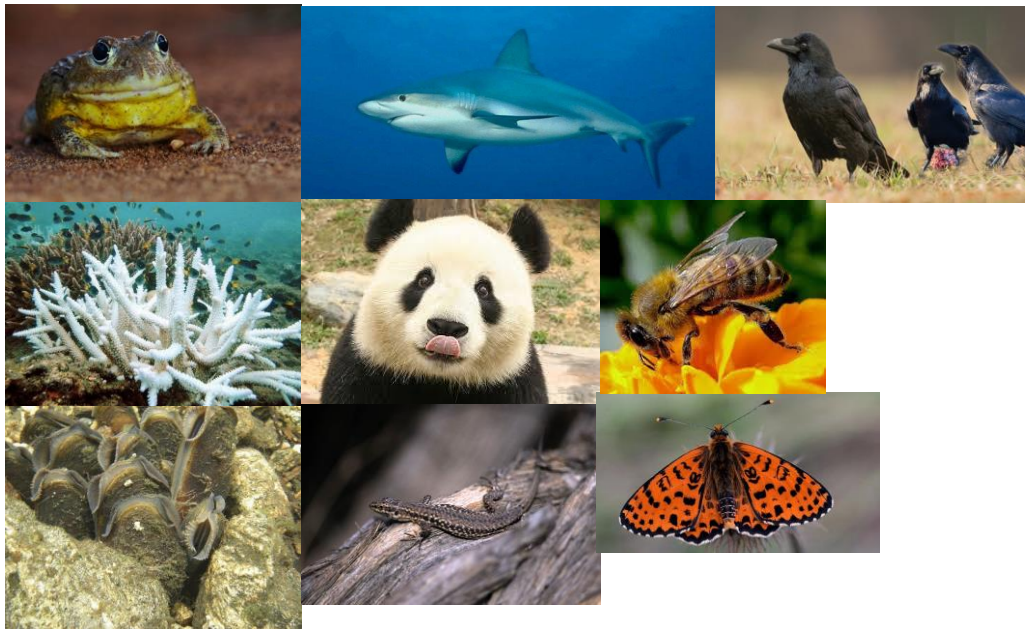
2018 summer: exceptionally hot on Scandinavia and Black Sea



Biodiversity is decreasing

The sixth mass extinction has already arrived?

We lose between 11,000 and 58,000 species every year mainly concentrated in tropical regions.



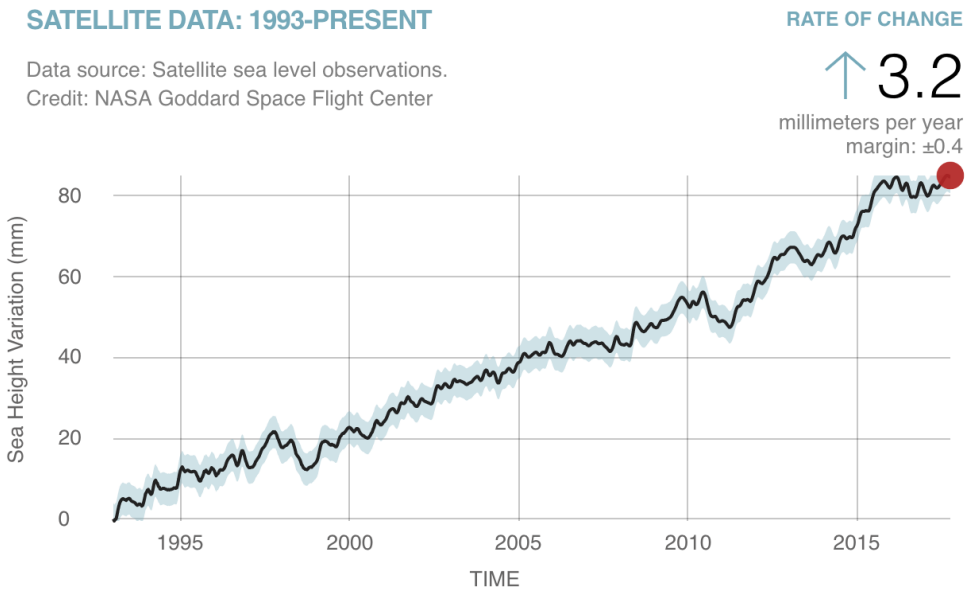
The five great mass extinctions

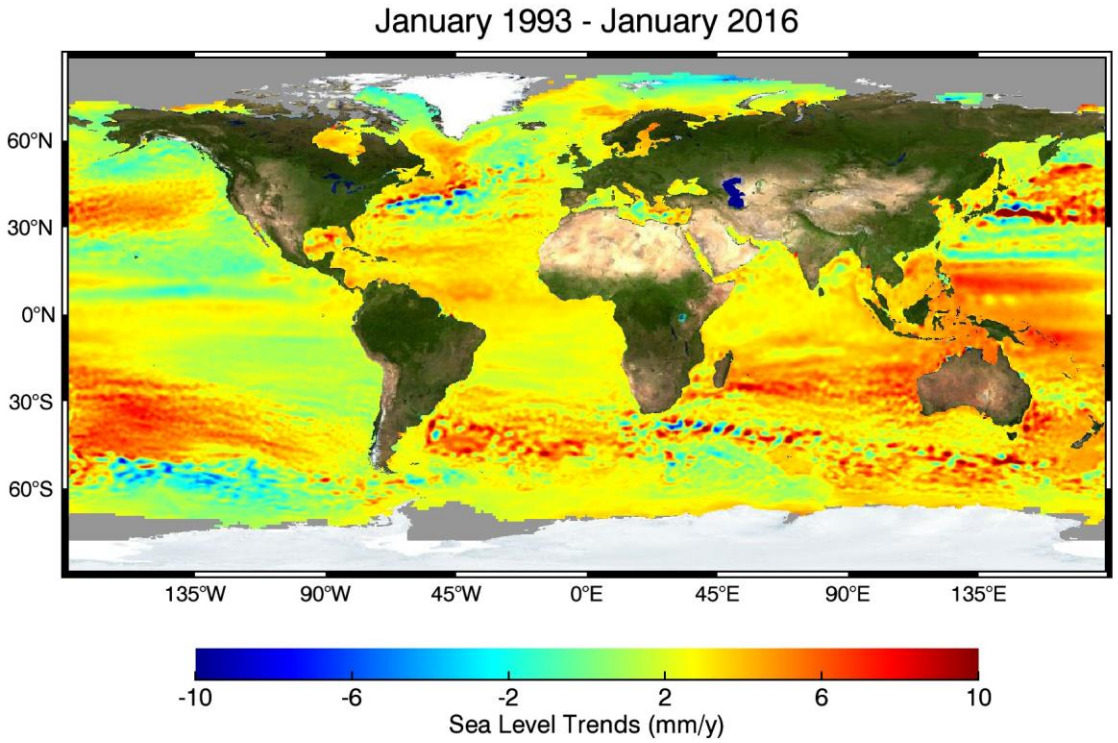
1) Ordovician-Silurian (450 Ma)
2) Devonian sup. (377 Ma)
3) Permian-Triassic (-50%)
4) Triassic-Jurassic (203 Ma) (-76%)
5) Cretaceous-Paleocene (66 Ma) (-76%)

6) Anthropocene?

Many species are disappearing at a dizzying rate.
Some scientists believe that we can talk about a **sixth mass extinction** and that this extinction, due to its rapid impact and mortality, has nothing to envy to the other previous five mass extinctions.

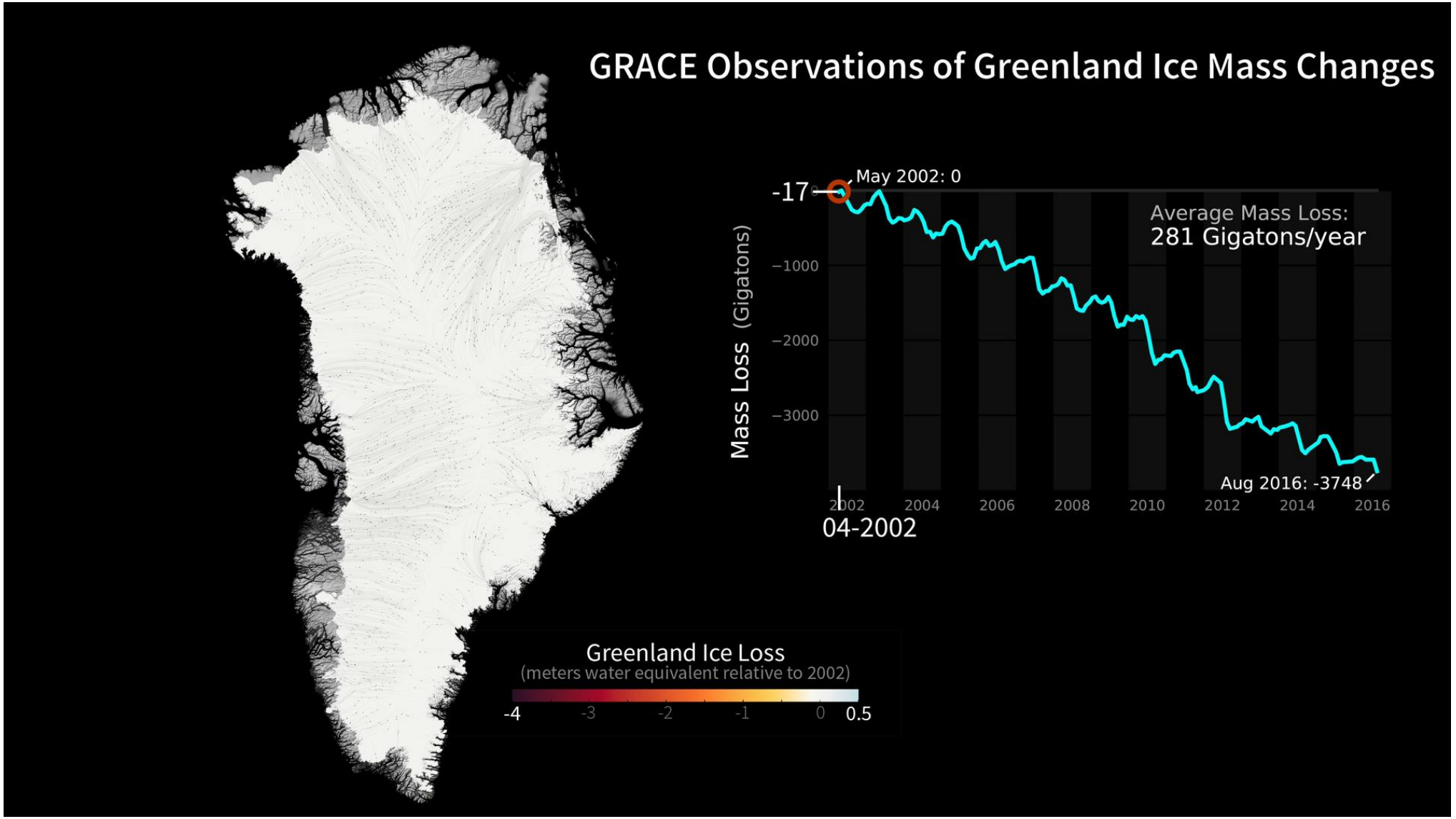
Sea level rise



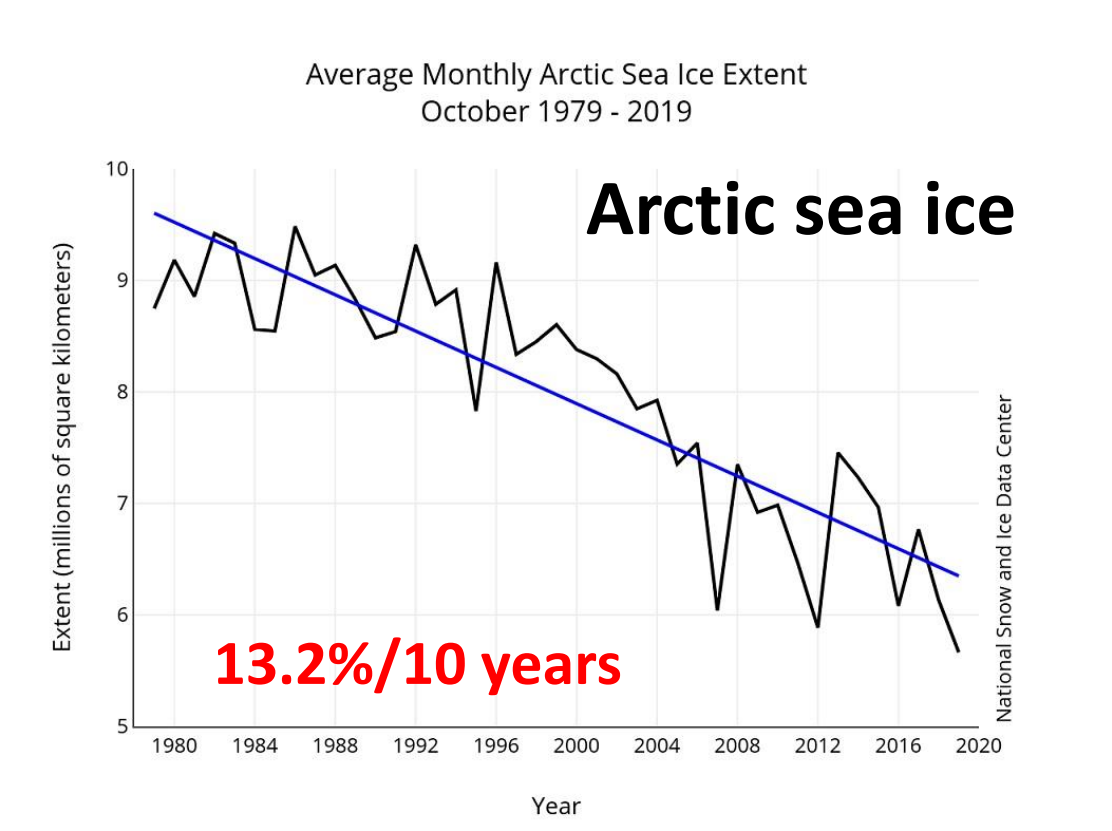


- **Warm water thermal expansion**
- **Freshwater supply from continental ice melting**

Land ice melting



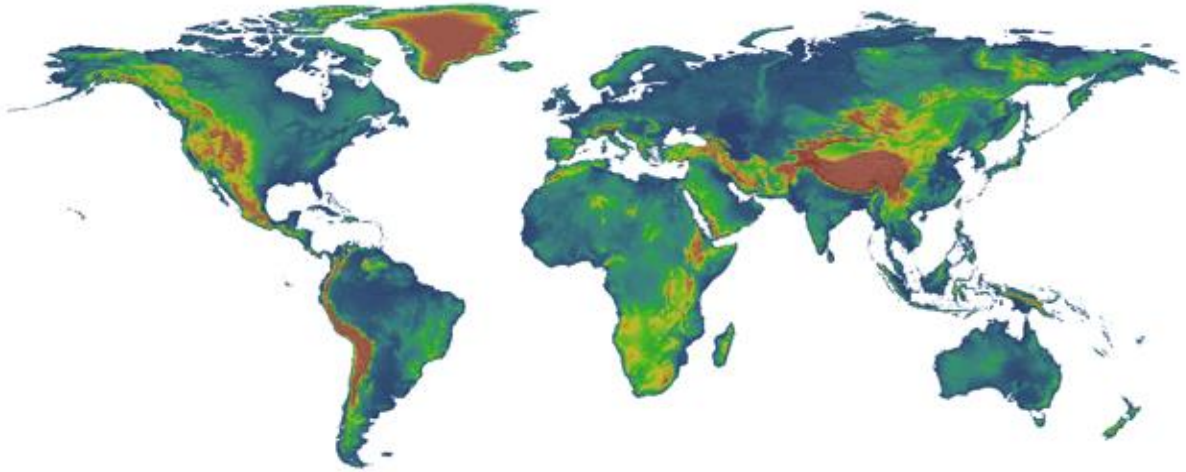
Sea ice melting



- Ice extent decreases
- Ice shrinks

It is not only the newest ice that decreases, but also the "old" ice

The mountains "sentinels of the changing climate"



Cold regions are the most sensitive

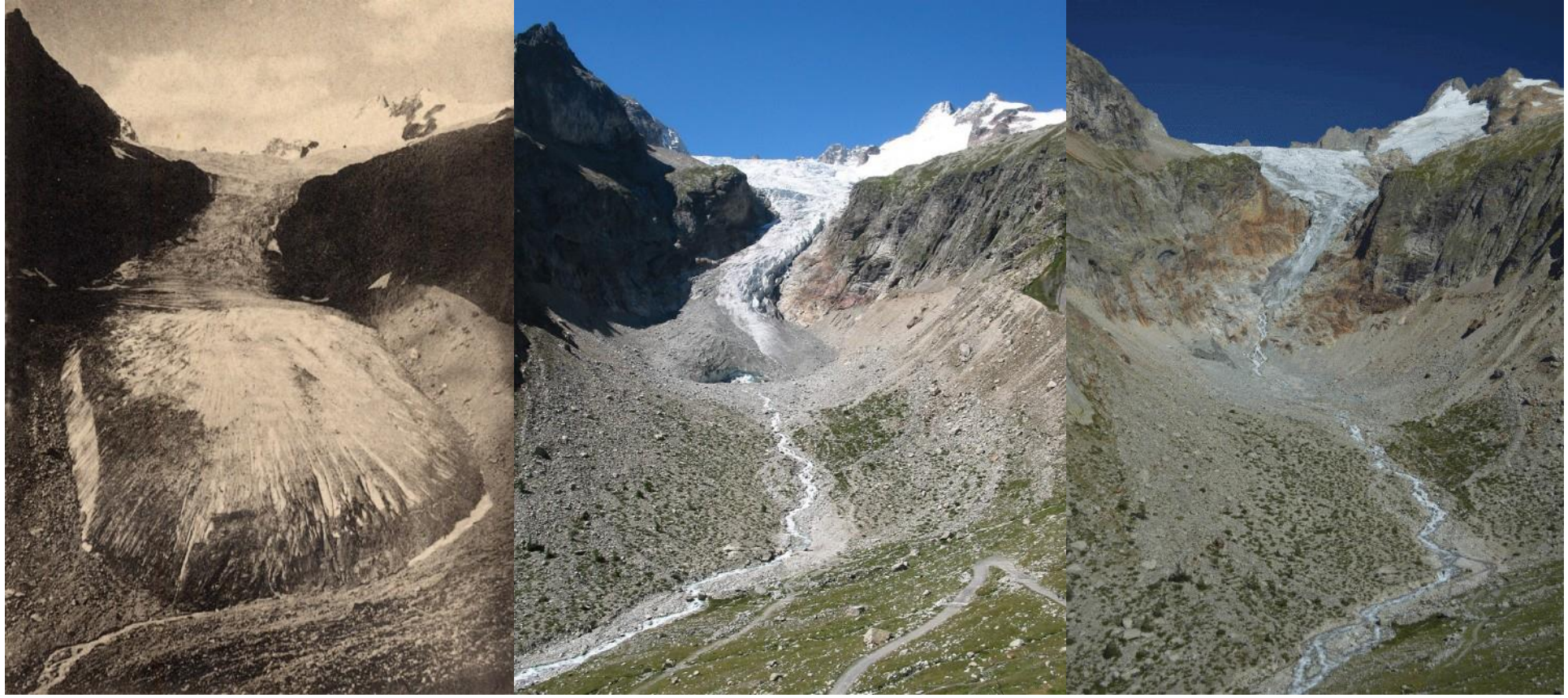
Amplified response to the increase of temperature

In the mountains the temperature increased at a rate about twice with respect to the global average

Mountains are
IMPORTANT
as VULNERABLE

They are natural indicators of the health of the planet

1. glacier's retreat
2. permafrost degradation
3. decrease in the duration, extent and thickness of snow on the ground
4. biodiversity in decline
5. changes in ecosystems (shifts and displacements of flora and fauna)



1897
(ph. Druetti)

2005
(ph. L. Mercalli)

2015
(ph. S. Jobard)

Glacier Pré de Bar (Mont Blanc): frontal retreat of more than 800 m from 1897 to 2015

Alpine glaciers have shrunk by more than 50% in a century

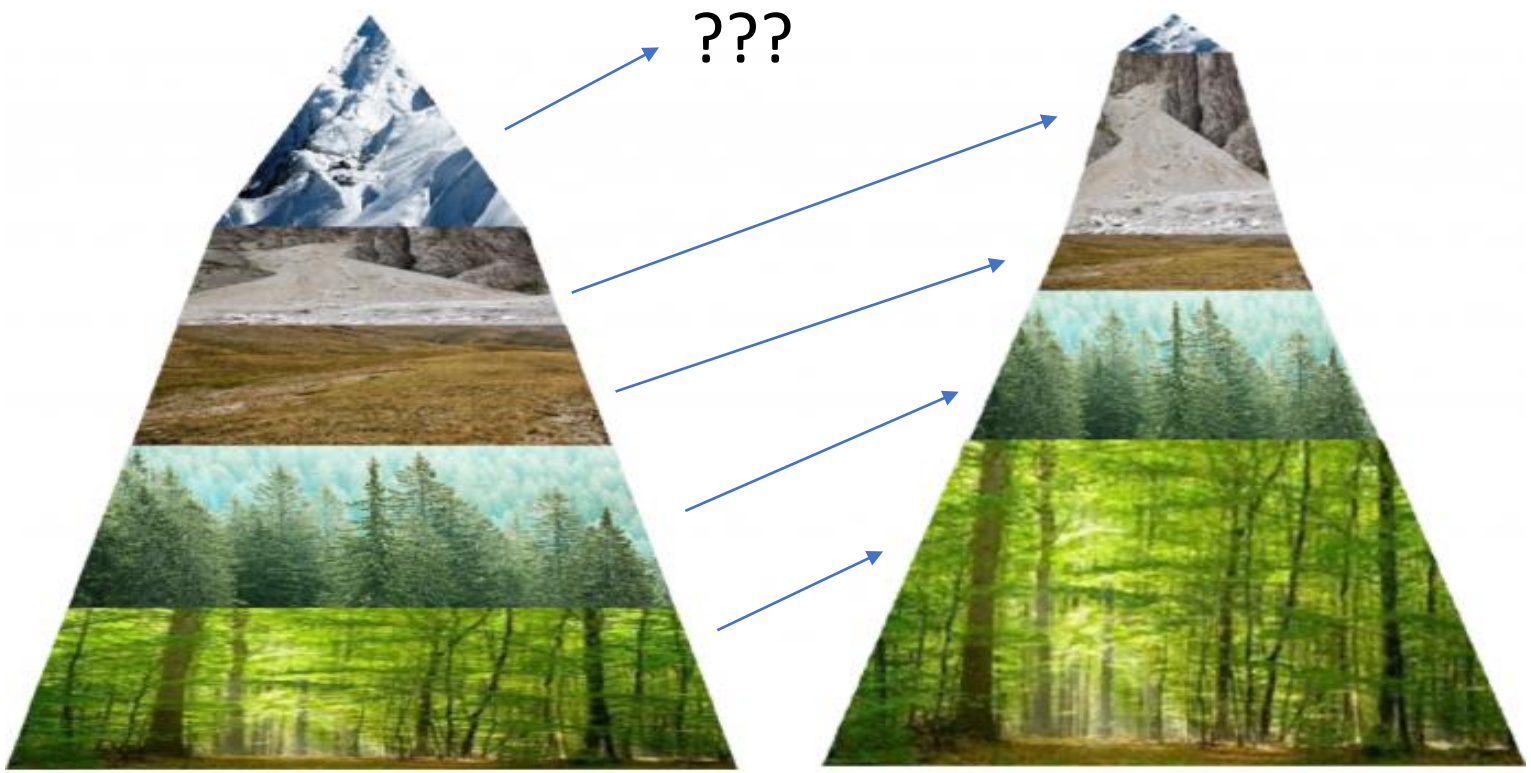
Climate thermometer mountains

Valle Orco: Carro glacier (photo: C. Cassardo)

Since about 1850, the Alpine glaciers have already lost 50% of their surface area and 2-3% of their volume.

The snow fusion is anticipated, with the risk that it is already disappeared when there is an increased need of water (during the summer season, hot and dry)

ALPINE Biodiversity declining



The problem of habitat reduction

The presence and extent of vegetation is mainly determined by the climate.

Climate change is helping to raise the range, but reducing their extent (the area is reduced)

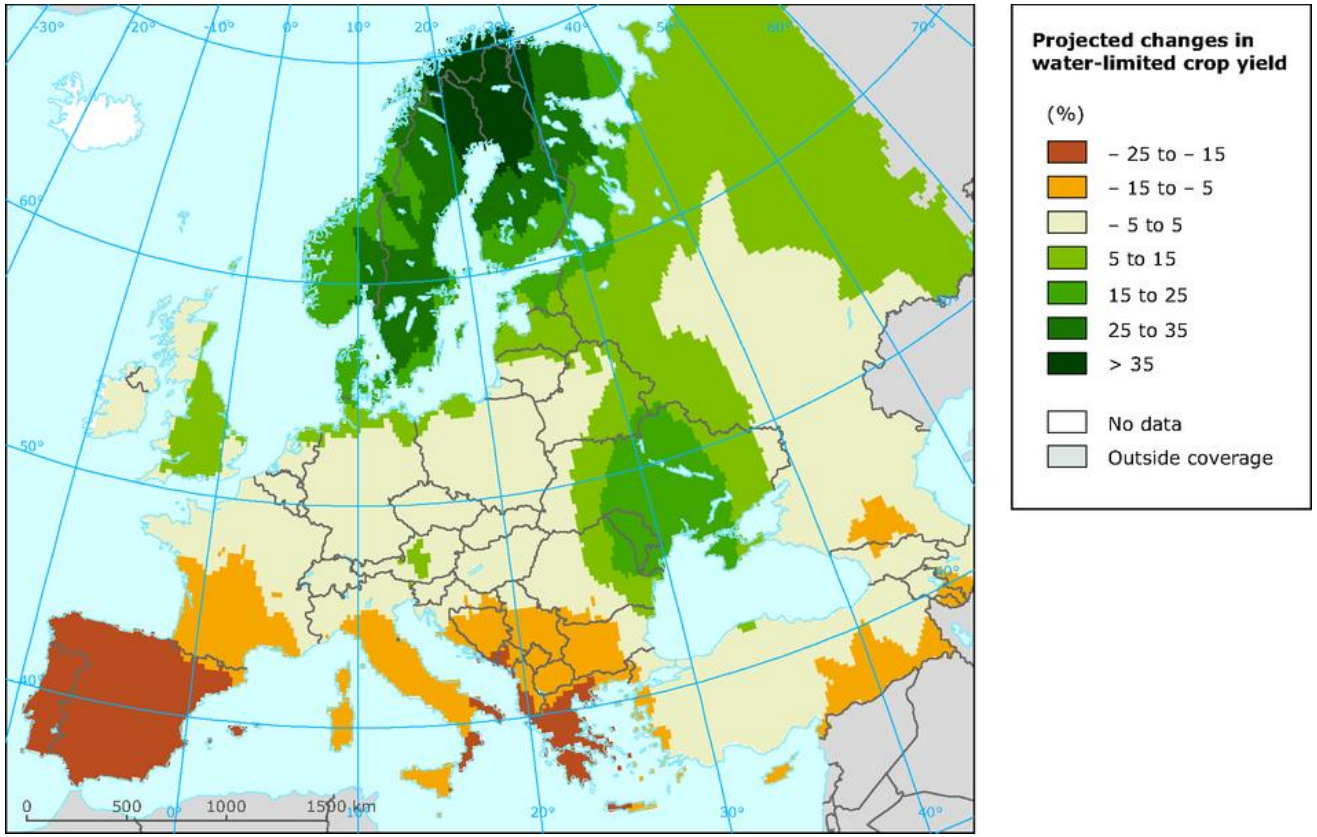
Also, suitable substrates are missing and the soil is crumbly.

On the other hand… there are invasive species

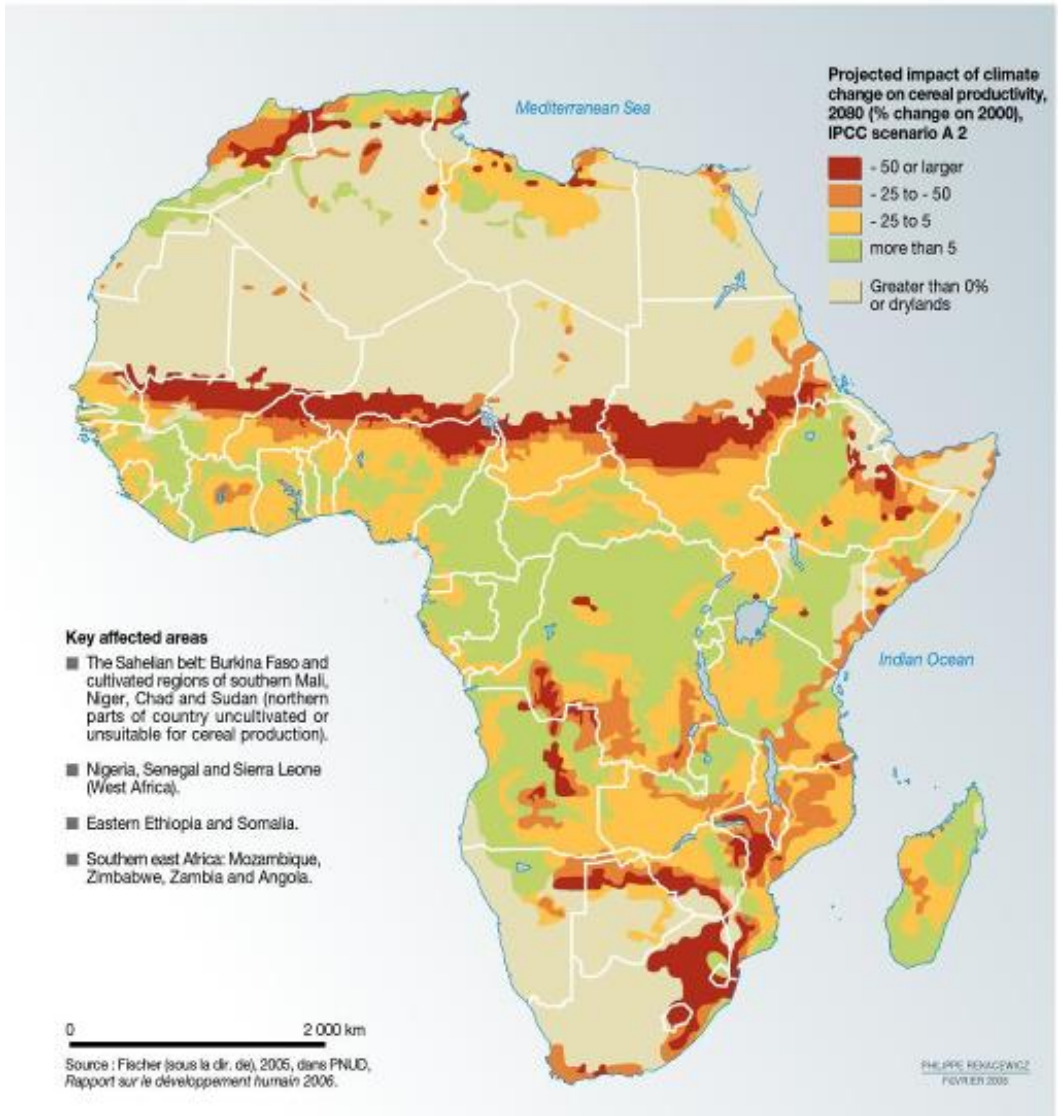

Ambrosia artemisifolia


Balsamina ghiandolosa

Impacts on future agricultural productivity: Africa and Europe

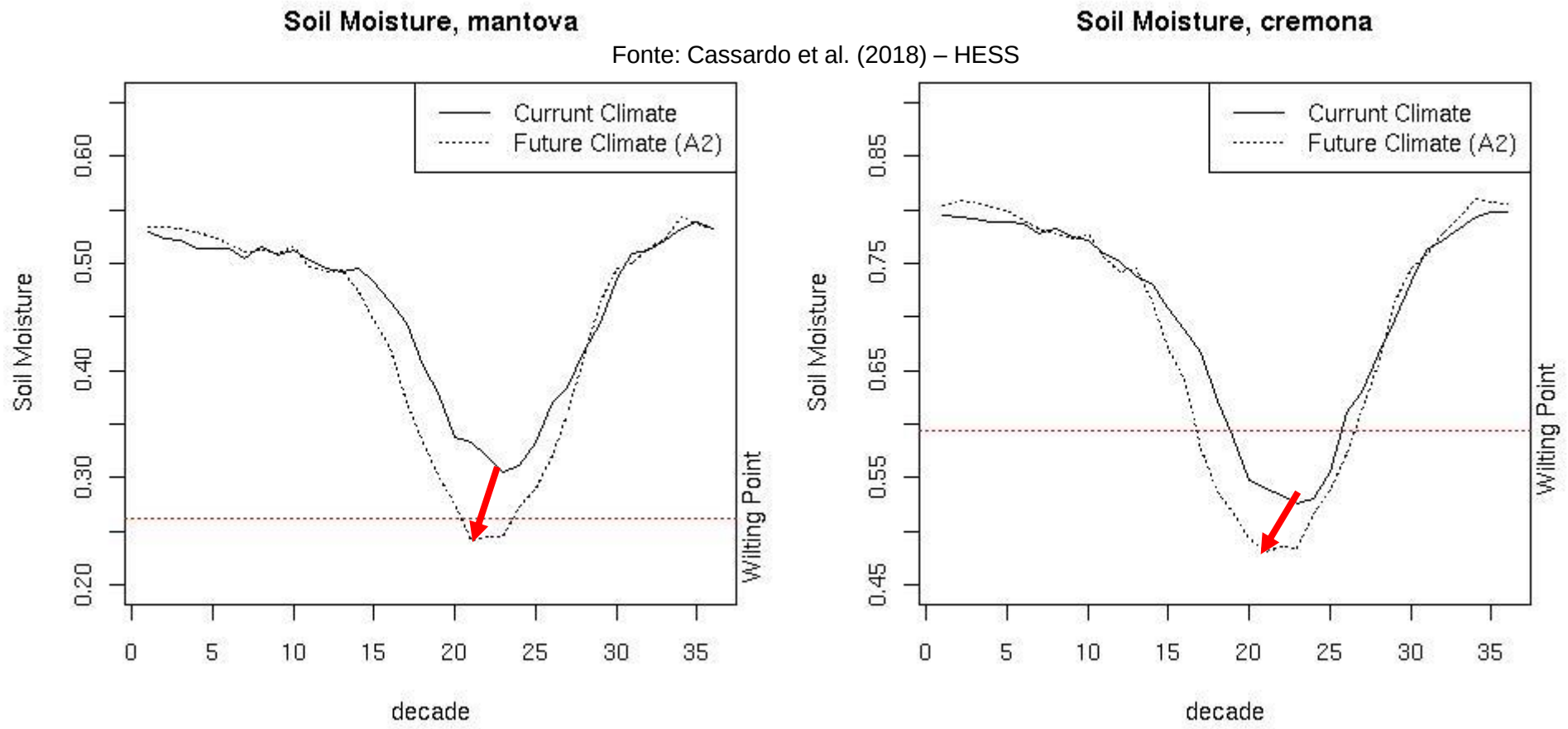


Cereal productivity in Sub-Saharan Africa under a scenario of the IPCC that shows CO_2 atmospheric concentrations a level at 520-640 ppm by 2050



Impacts on future agricultural productivity: soil moisture

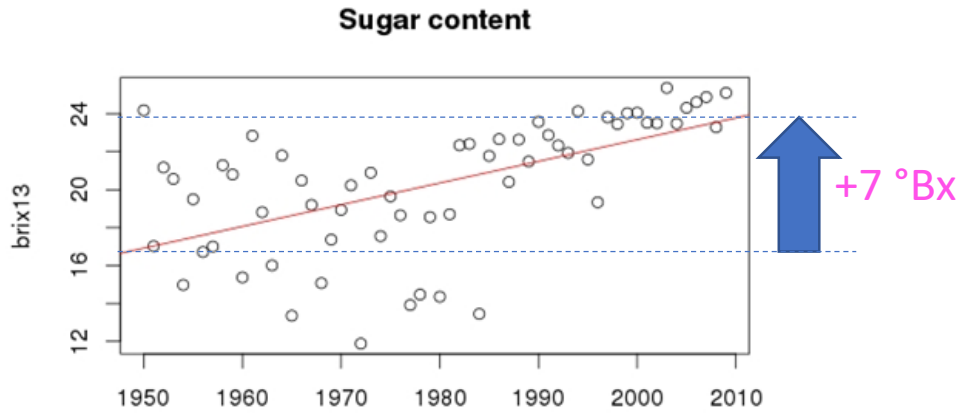
Po valley – simulation based on a run with RegCM3 (Hirlam) run

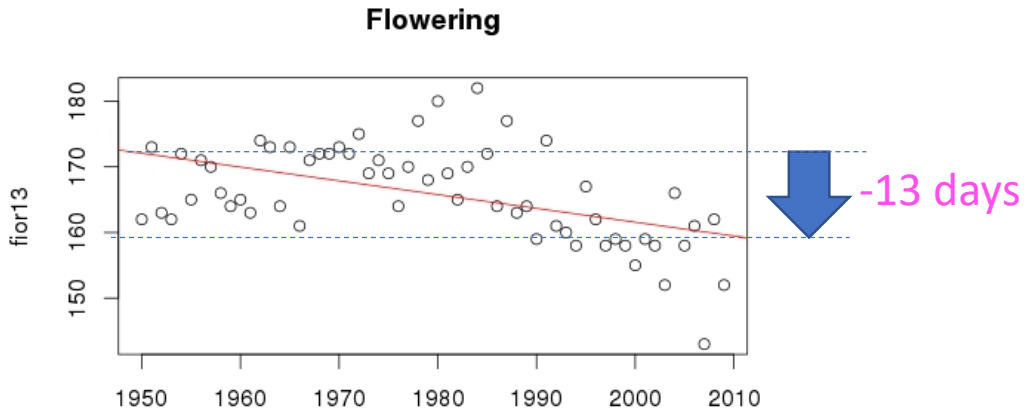


Fonte: Cassardo et al. (2018) – HESS

- Slightly wetter soils in cold and much driest seasons in warmer ones (greater variability)
- **WE WOULD NEED TO RETHINK AGRICULTURAL PRACTICES?**

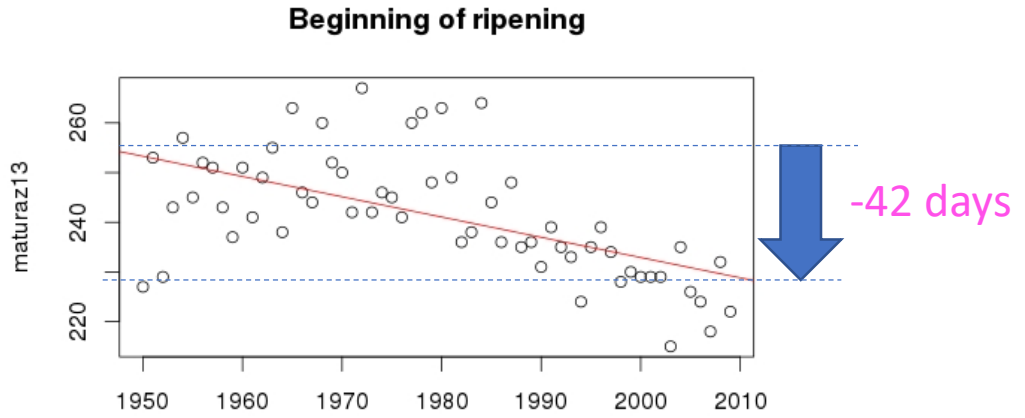
Changes already in place on crops the case of the vineyards in Piedmont





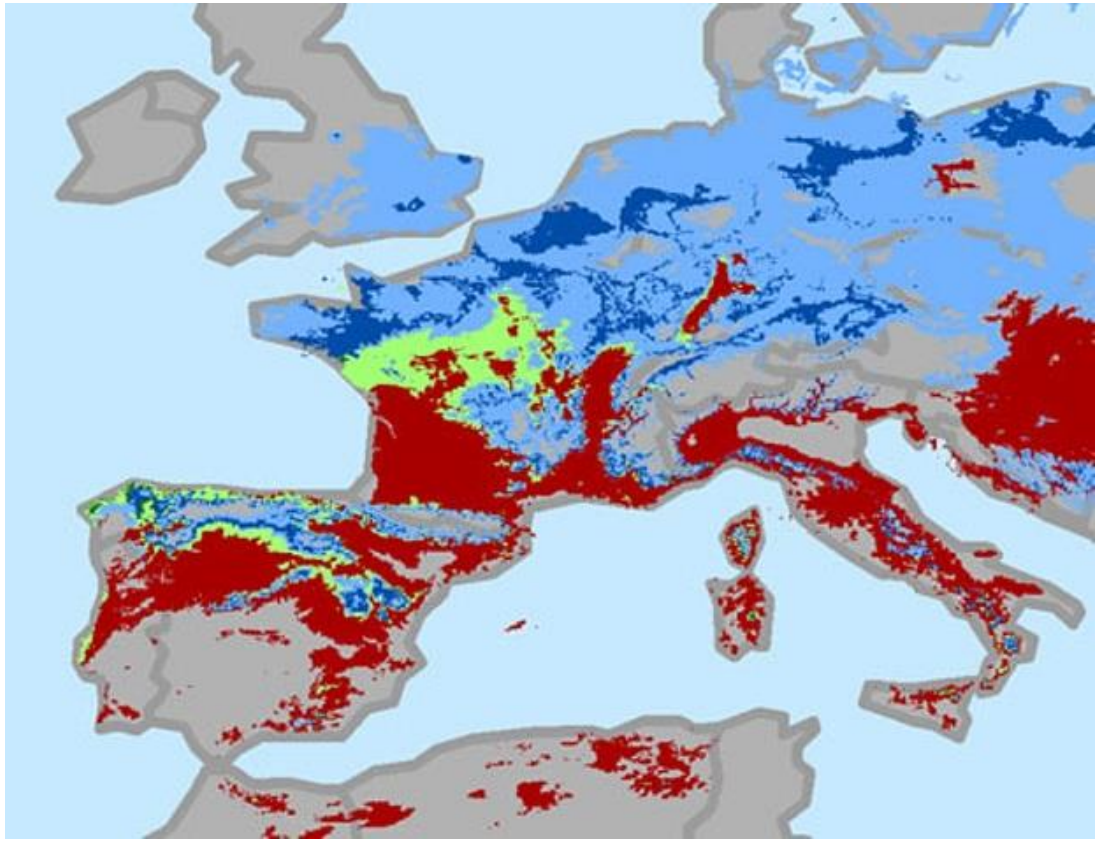
Vineyards in Piedmont

- Vine flowering and grape ripening **2-3 weeks in advance in the last thirty years**
- Sugar berry content strongly rising (7 °Bx correspond to 1-2° of alcohol)



Source: Andreoli et al. (2019), Agronomy

Shocking news: the end of the wine?



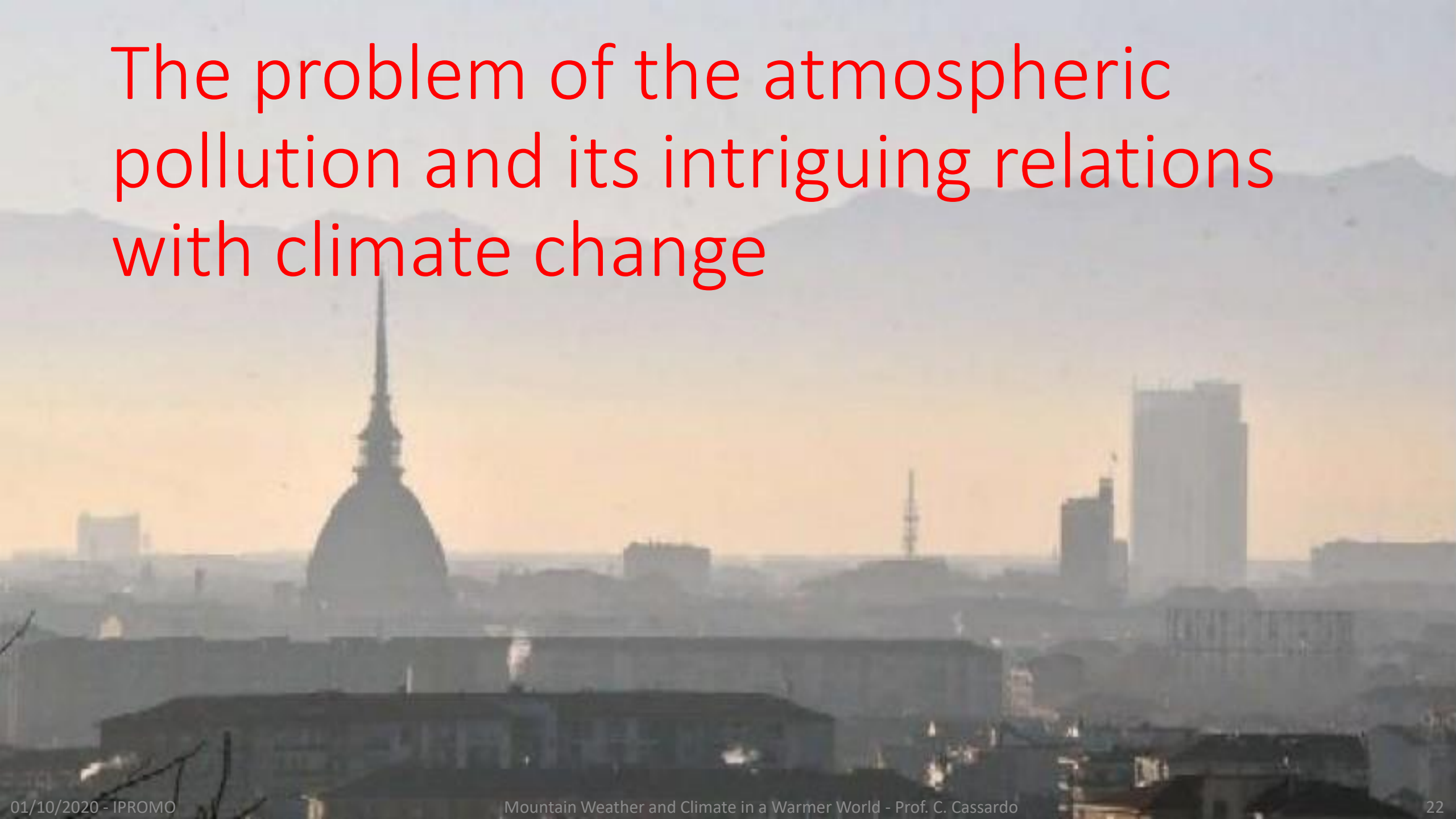
It is produced NOW but NOT IN THE FUTURE
It is produced NOW and IN THE FUTURE
It is NOT produced NOW but IT WILL BE PRODUCED

Fonte: Hannah et al., 2013, PNAS

- Could climate change move wine-producing areas very far from traditional wine areas?
- In Piedmont, no more wine? Substituted by olive trees?

- Barolo wine will be produced in Swiss? Or in England? And the terroir?

The problem of the atmospheric pollution and its intriguing relations with climate change



What data tell us

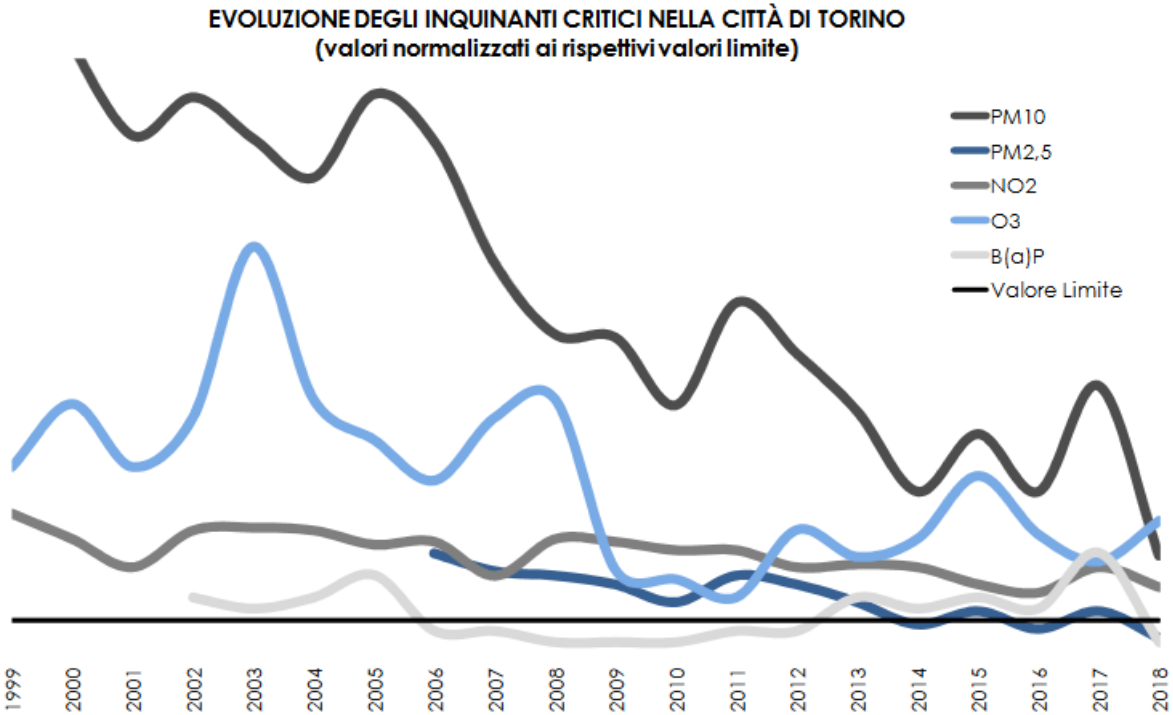
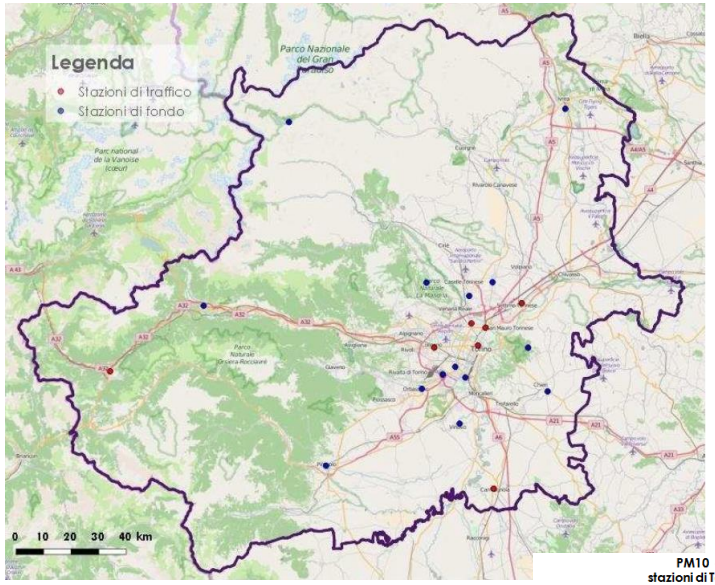
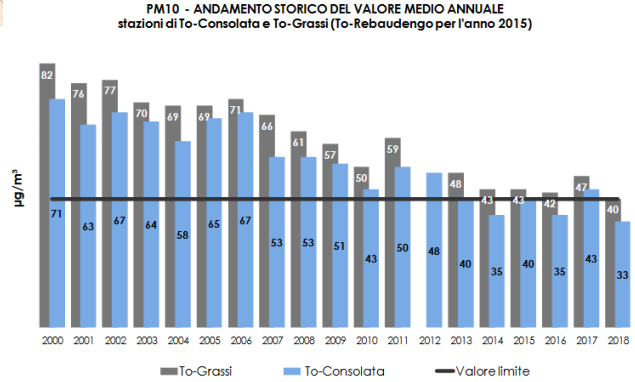
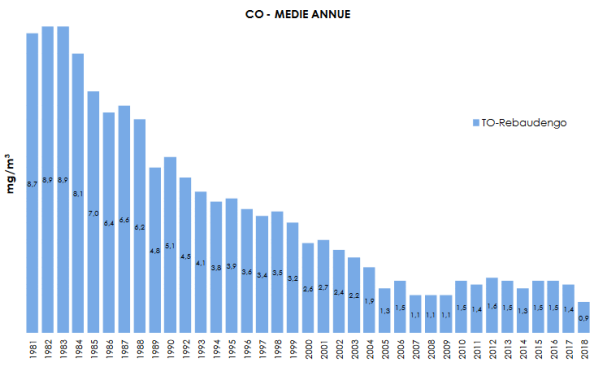


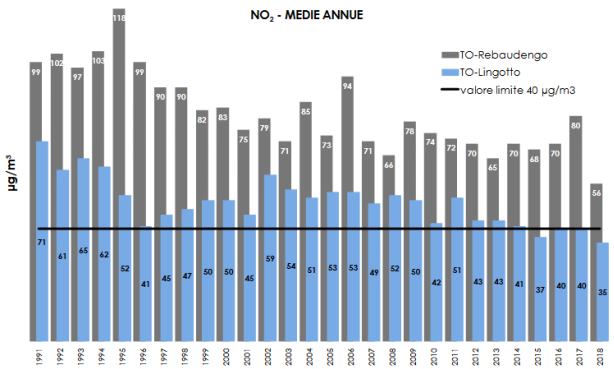
FIGURA 1: evoluzione degli inquinanti nella città di Torino.

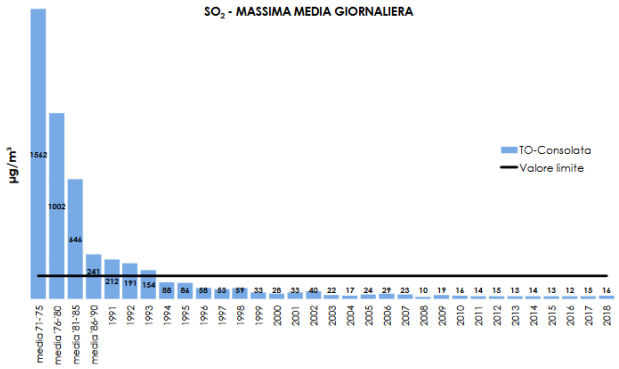


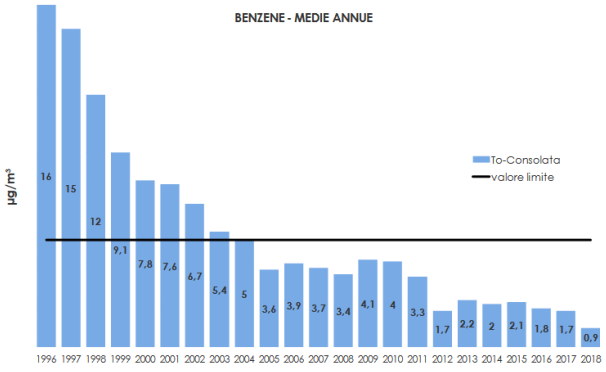
Fonte: Rapporto 2018 sulla qualità dell'aria - Città metropolitana di Torino e Arpa Piemonte



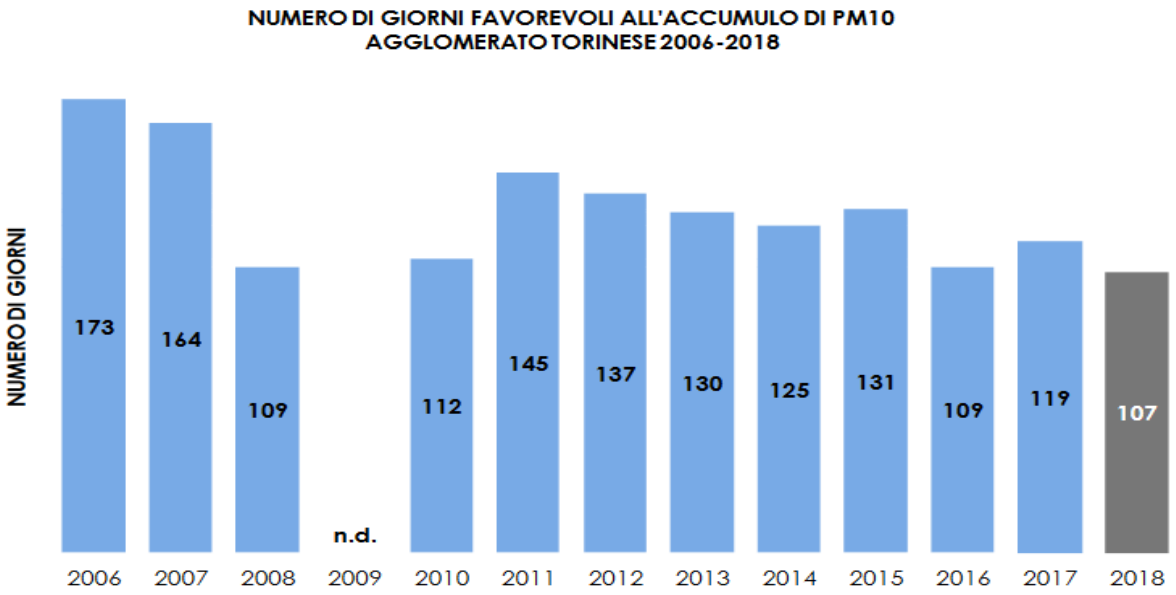


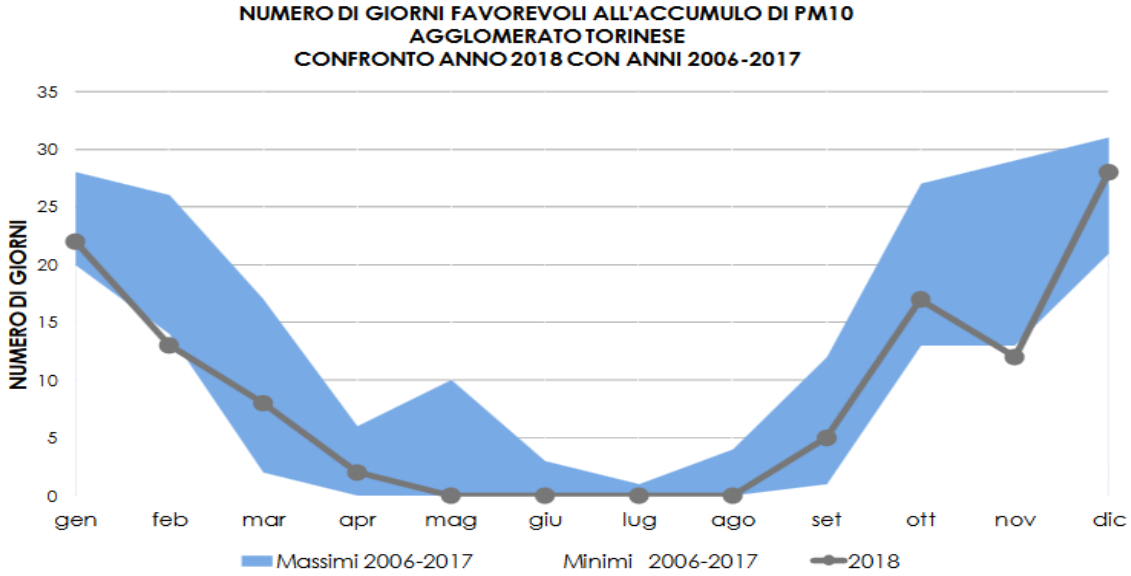


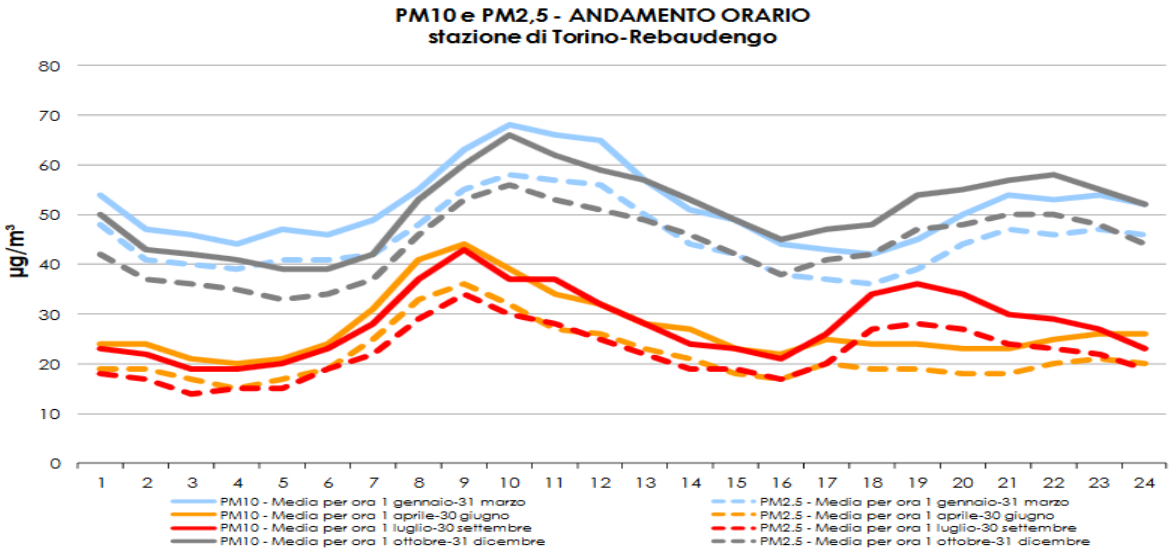




When pollution is higher?



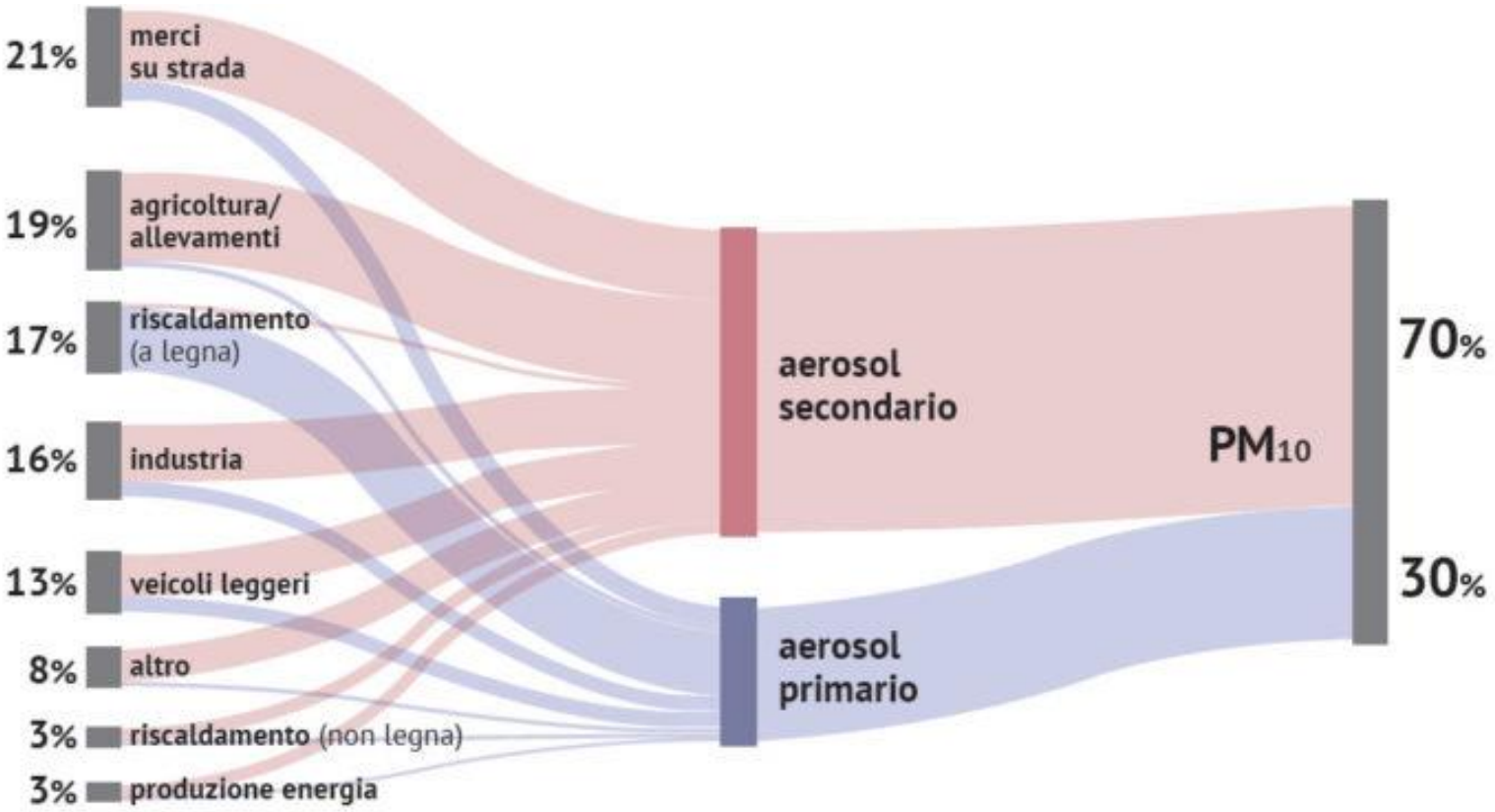




n.	Città	Centralina	Superamenti da gennaio 2018	data aggiornamento
1	Torino	Rebaudengo	87	31/12/2018
2	Frosinone	Frosinone scalo	83	31/12/2018
3	Lodi	Viale Vignati	78	31/12/2018
4	Milano	Marche	74	31/12/2018
5	Venezia	V. Tagliamento	63	31/12/2018
6	Padova	Arcella	60	31/12/2018
7	Alessandria	D'Annunzio	59	31/12/2018
8	Asti	Baussano	57	31/12/2018
9	Reggio Emilia	Timavo	56	31/12/2018
10	Cremona	via Fatebenefratelli	56	31/12/2018
11	Pavia	Piazza Minerva	53	31/12/2018
12	Treviso	S.Agnese	53	31/12/2018
13	Modena	Giardini	51	31/12/2018
14	Monza	via Machiavelli	51	31/12/2018
15	Rovigo	Centro	49	31/12/2018
16	Terni	Le Grazie	49	31/12/2018
17	Vicenza	Quartiere Italia	48	31/12/2018
18	Brescia	Villaggio Sereno	47	31/12/2018
19	Avellino	AV42	46	31/12/2018
20	Parma	Montebello	45	31/12/2018

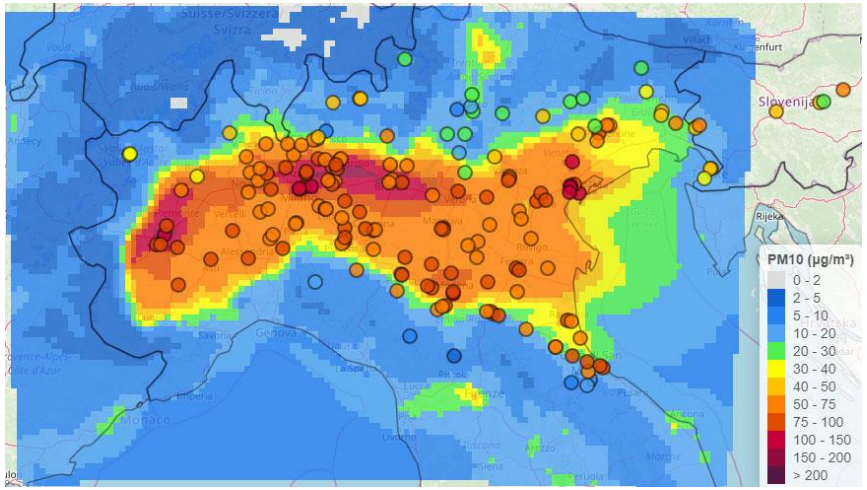
Fonte: Rapporto 2018 sulla qualità dell'aria - Città metropolitana di Torino e Arpa Piemonte

What is the cause?

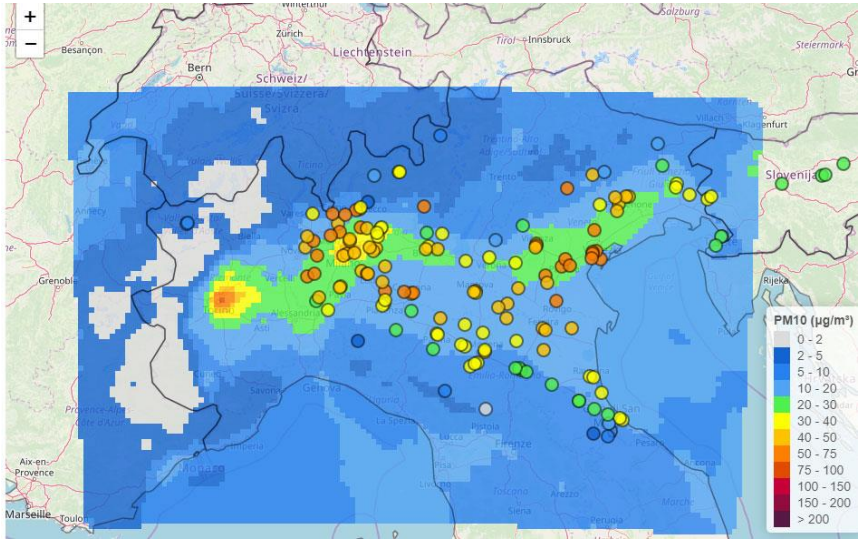


Emissioni di “PM10 equivalente in Emilia-Romagna. La larghezza della banda è proporzionale al “PM10 equivalente” Dati Arpa ER

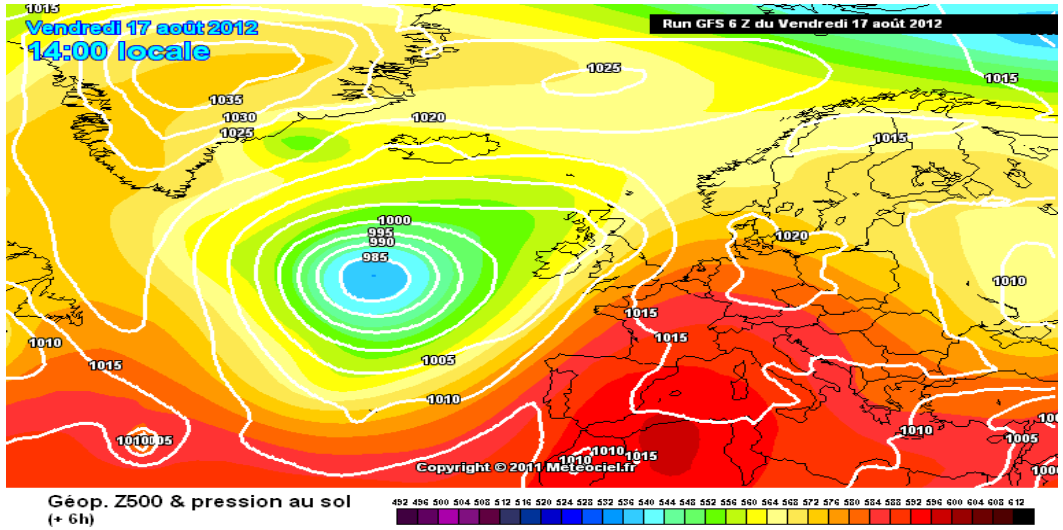
Fonte: Arpa ER



La concentrazione di PM10 nel Bacino Padano il 14 (sopra) e 18 (sotto) gennaio 2020.

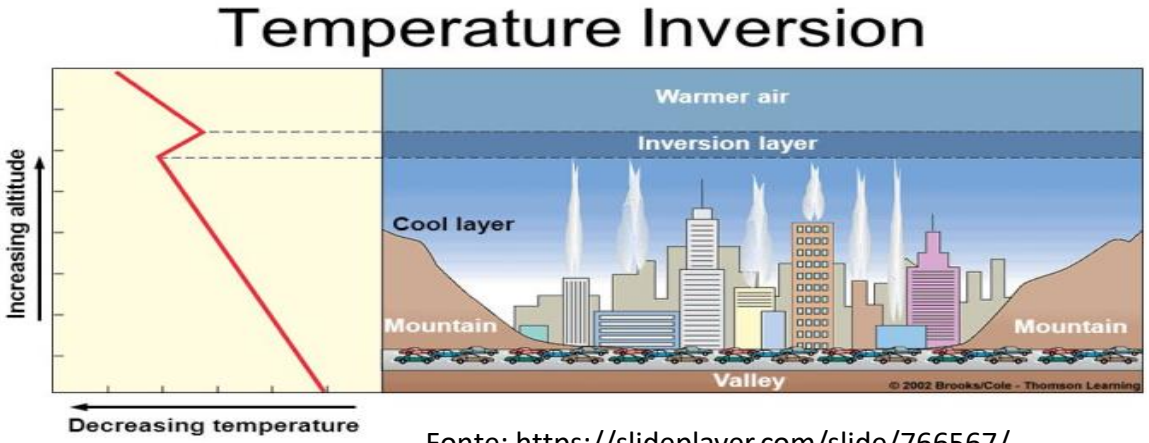


Anticyclones and pollution



Fonte: retemeteoamatori.it

- Increase of average pressure on the Western Mediterranean
- Increase in frequency and intensity of anticyclonic ridges

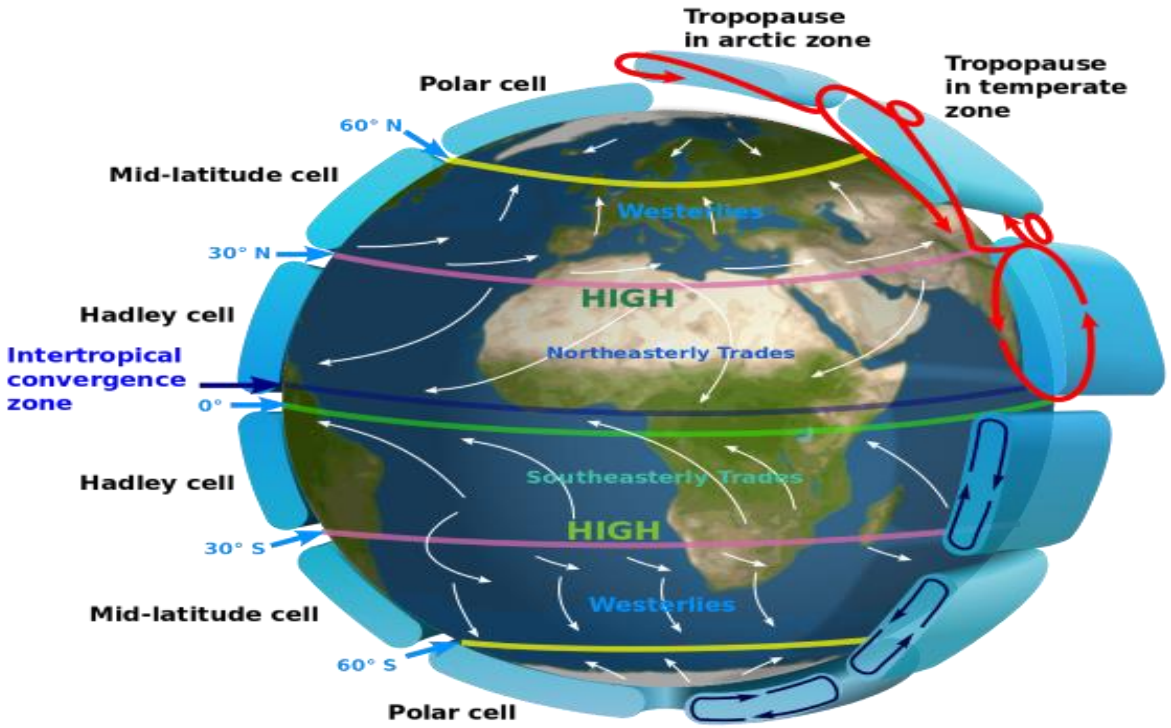


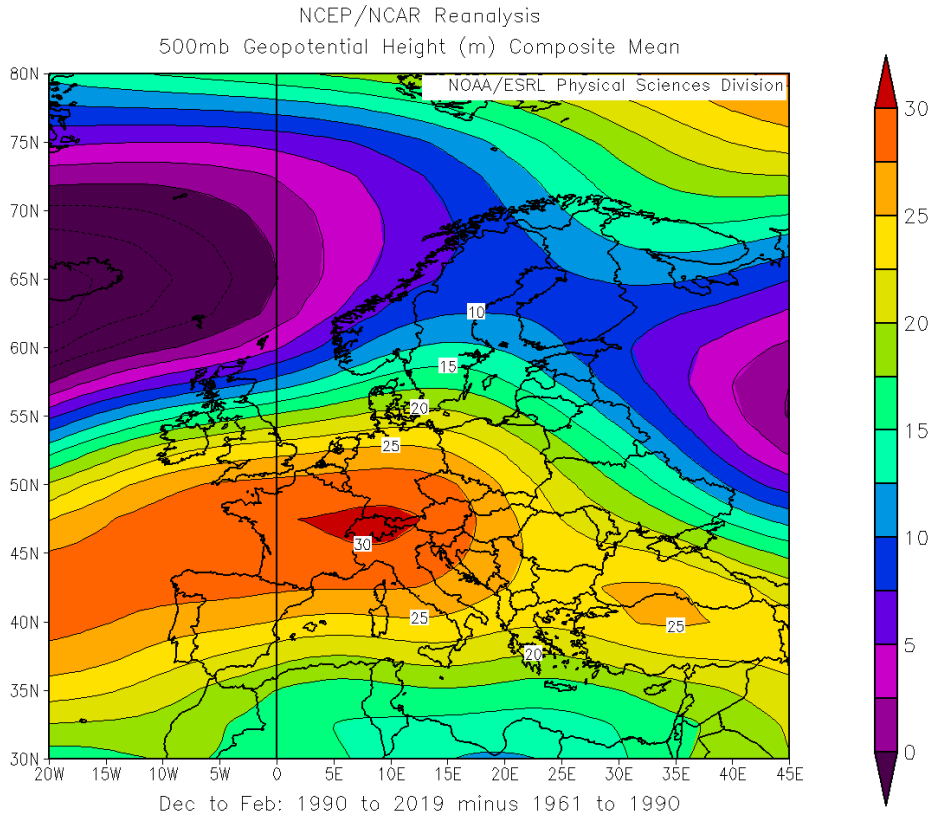
Fonte: https://slideplayer.com/slide/766567/

Fonte: Repubblica Torino 5/12/2018

Traps pollutants near surface. Mountains prevent wind in area and shadow sun to keep lower air cool.

The link climate - pollution





Inverni 1990-2019 meno 1961-1990

- **Mediterranean basin suffers more than other areas from the effects of climate change**
- It is geographically located in a transition zone between two climatic zones, temperate and subtropical, with very different climatic characteristics
- Climate change is shifting this border northwards, thus increasing the frequency and intensity of the drought conditions typical of the subtropical area

WHAT TO DO?

From big *international agreements* to small *daily actions* to tackle the problem of global warming

COP21 and Paris Agreement

OBJECTIVE 2°C

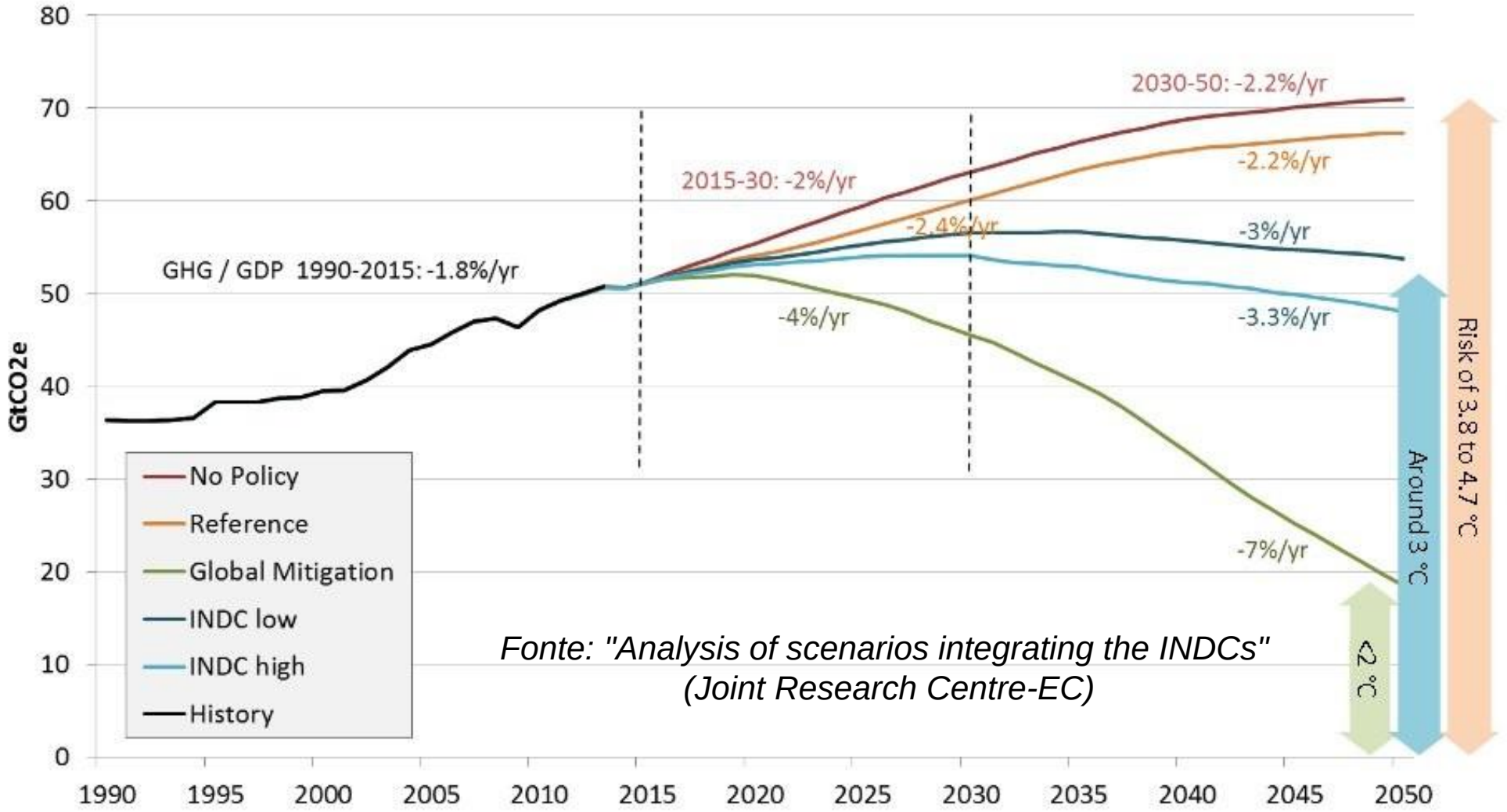
Reducing greenhouse gas emissions *"to keep the increase in the global average temperature below 2 °C above pre-industrial levels, trying to limit this increase to 1.5 °C,* acknowledging that *this would significantly reduce the risks and impacts of climate change".*

CO_2 in atmosphere fixed at no more than 450 ppm in 2100

PRESCRIPTION

- **Reduce global anthropogenic emissions by 40%-70% compared to 2010 by 2050**
- **Zero emissions in 2100**
- **Do not exceed 2900 Gt of CO_2 emissions accumulated since the beginning of the industrial era**

Paris agreement: ambitious proposal to reduce CO_2 emissions, but insufficient: if applied, T will rise about +3 °C (at least) in 2100 !



Fonte: "Analysis of scenarios integrating the INDCs" (Joint Research Centre-EC)

What if we do not do nothing?

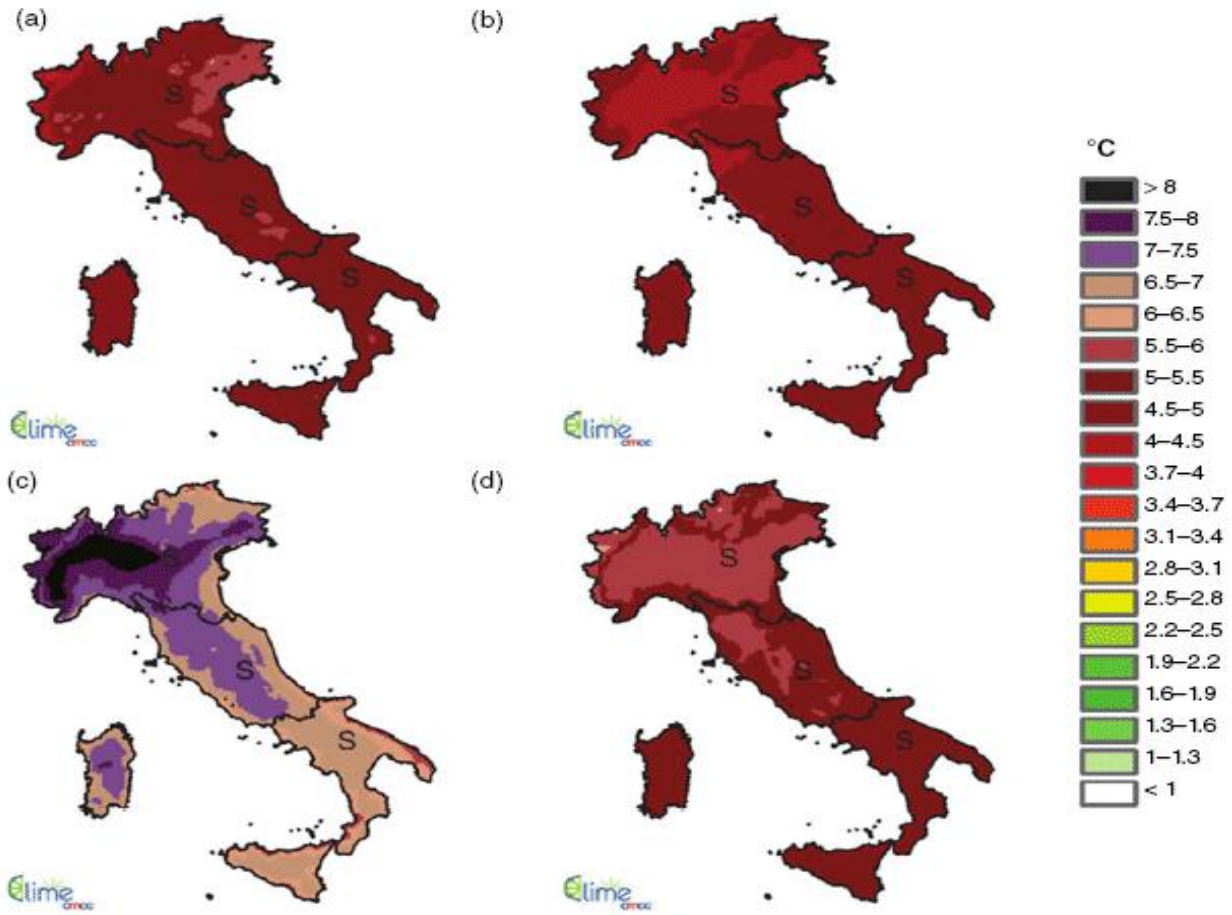
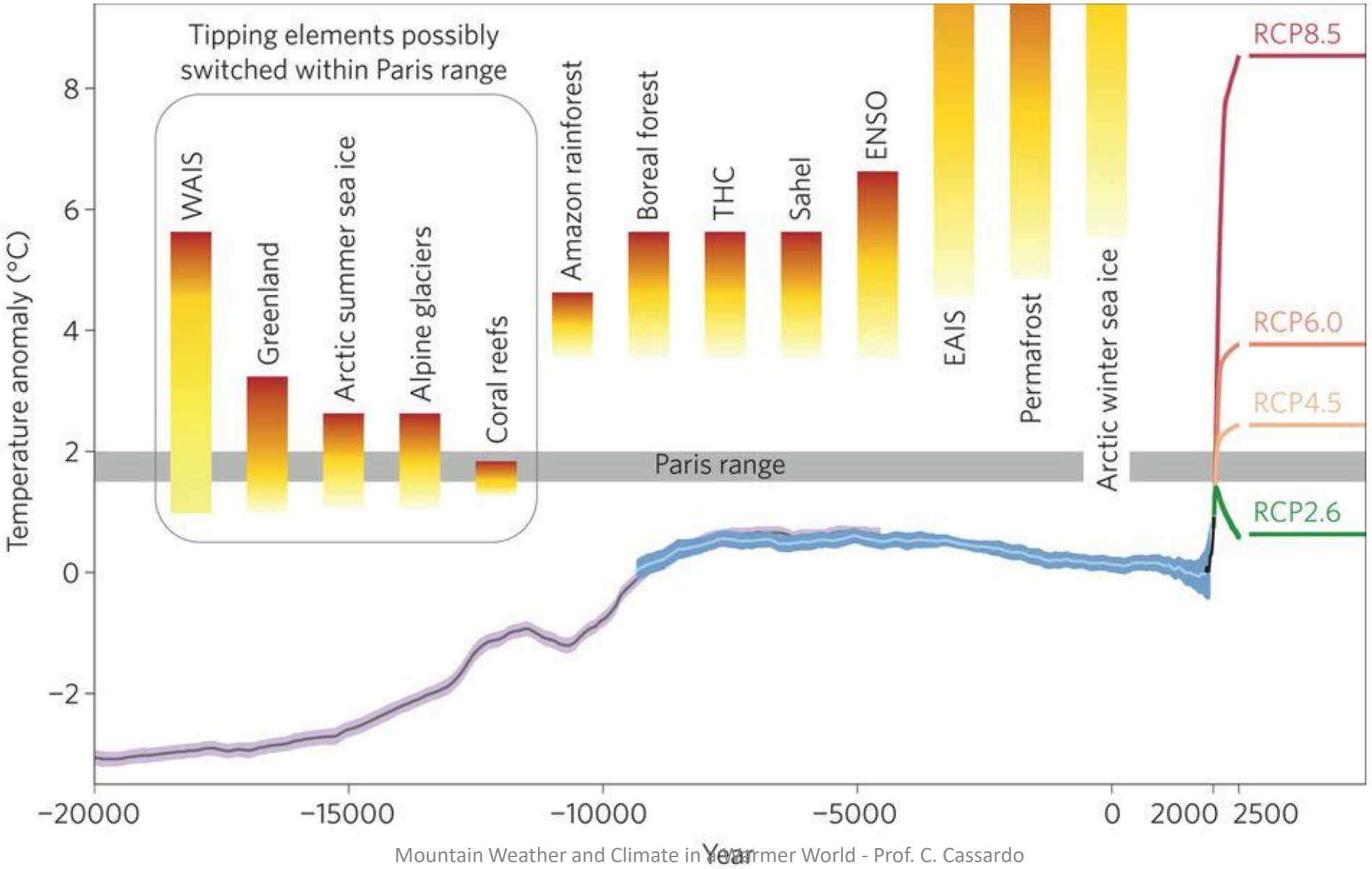


Figure 9. Temperature climate projections, RCP8.5: seasonal differences (°C), between the average value over 2071–2100 and 1971–2000 for (a) DJF, (b) MAM, (c) JJA and (d) SON (S, significant; NS, not significant).

Source:
Bucchignani et al. (2015) *High-resolution climate simulations with COSMO-CLM over Italy*, Int. J. Climatol.

Italian North-West (Torino) in summer like Karachi now: + 8 ° C

Risk of overcoming tipping points



Addressing causes to reduce and/or eliminate future effects

MITIGATION

- Reducing emissions of greenhouse gases and atmospheric aerosols
  - Increase energy efficiency
  - Increase no- and low-carbon energy use
  - Increase carbon sinks
- **Change our lifestyles → virtuous management of our energy consumption, choices for mobility, recycling and waste management, eating habitudes.**

Living with the already underway and expected effects

ADAPTATION

- Use efficiently the scarce water resources
- Adjust building regulations to cope with future weather conditions and extreme weather
- Build flood defences and raise artificial levees
- Develop drought-resistant crops, select species and forest practices less sensitive to violent rainfall and fires
- Draw up territorial plans and corridors to facilitate the migration of species

The uniqueness of COP21 and the Paris Agreement

The Paris Agreement is the first UN document in which it I written that we will have to set to zero the CARBON emissions in the second half of this century.

But it's not yet operational!!!

Severn Suzuki

Greta Thumberg

Rio Summit
COP 1 Berlin
COP 2 Geneva
COP 3 Kyoto Accord
COP 4 Buenos Aires
COP 5 Bonn
COP 6 The Hague
COP 7 Marrakech
COP 8 New Dehli
COP 9 Milan
COP 10 Buenos Aires
COP 11 Montreal
COP 12 Nairobi
COP 13 Bali
COP 14 Poznan
COP 15 Copenhagen Accord
COP 16 Cancun
COP 17 Durban
COP 18 Doha
COP 19 Warsaw
COP 20 Lima
COP 21 Paris Agreement
COP 22 Marrakech
COP 23 Bonn
COP 24 Katowice
COP 25 Chile-Madrid

50 ppm

450 ppm
440
430
420
410
400
390
380
370
360
350 ppm
340
330
320

United Nations Framework Convention on Climate Change, UNFCCC

OLD STABLE CLIMATE

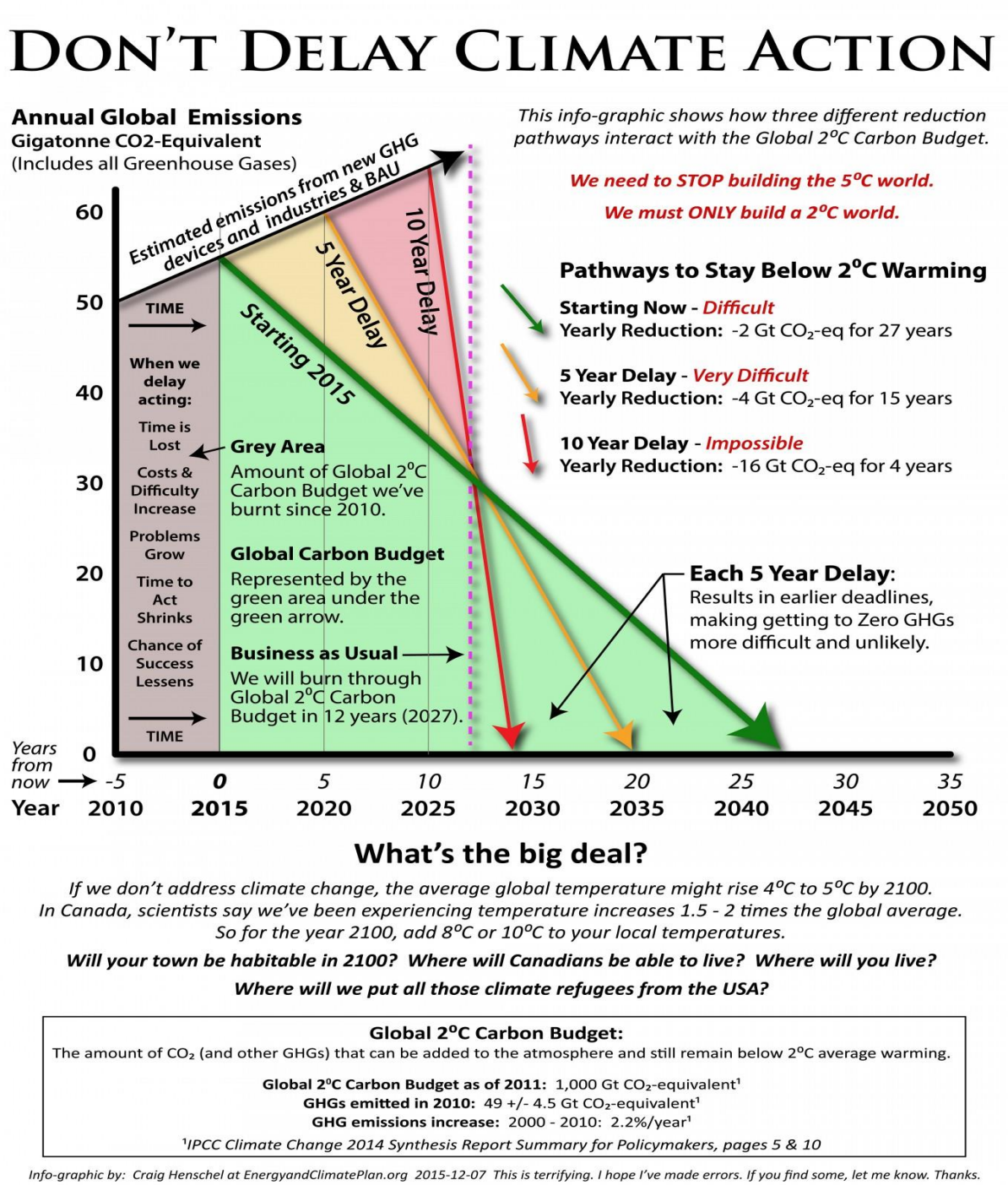
NEW EXTREME CLIMATE

1960 1970 1980 1990 2000 2010 2020 2030

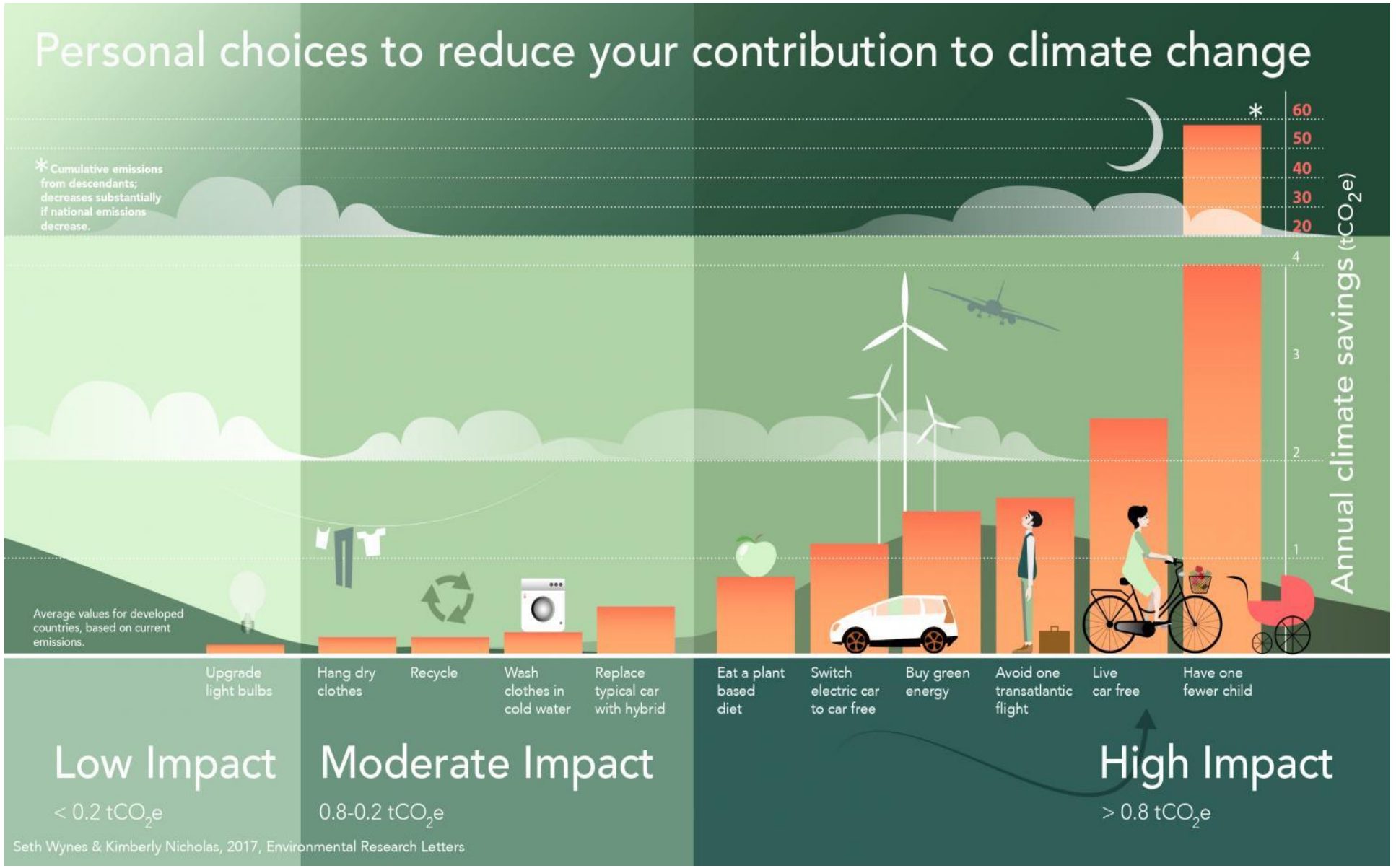
But... you have to act SOON

- There's little time
- Otherwise... rien ne va plus!

- Actually there are 414 ppm of CO_2
- Increment rate: 2.9 ppm/year
- (450-414)/2.9 ~ 12 years
- After... we need to decrease the CO_2 concentration... (how?)



To get results you need **high-impact emission reductions**
Small actions **are no longer enough**!



Communicate the severity of the climate emergency

- We need to raise the awareness in the public