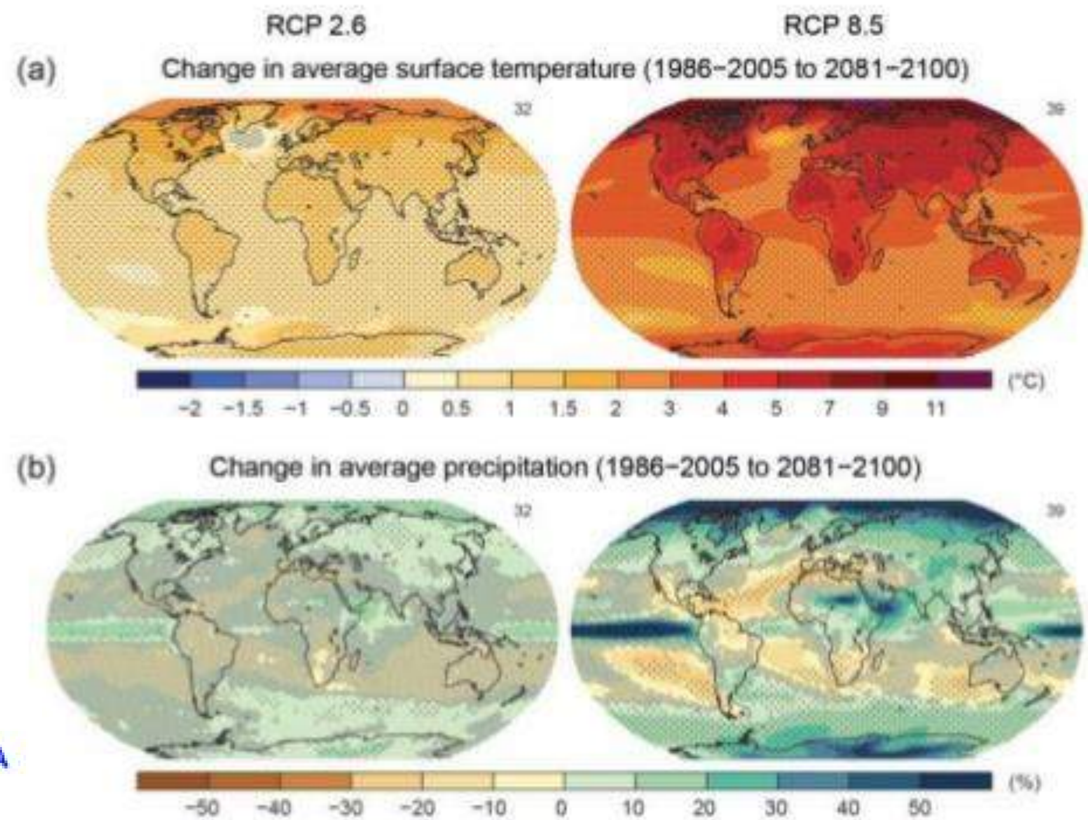
Gli scenari climatici del futuro

Luca Mercalli – Società Meteorologica Italiana
www.nimbus.it

Figure SPM.8a,b
Maps of CMIP5 multi-model mean results



SOCIETÀ METEOROLOGICA ITALIANA ONLUS
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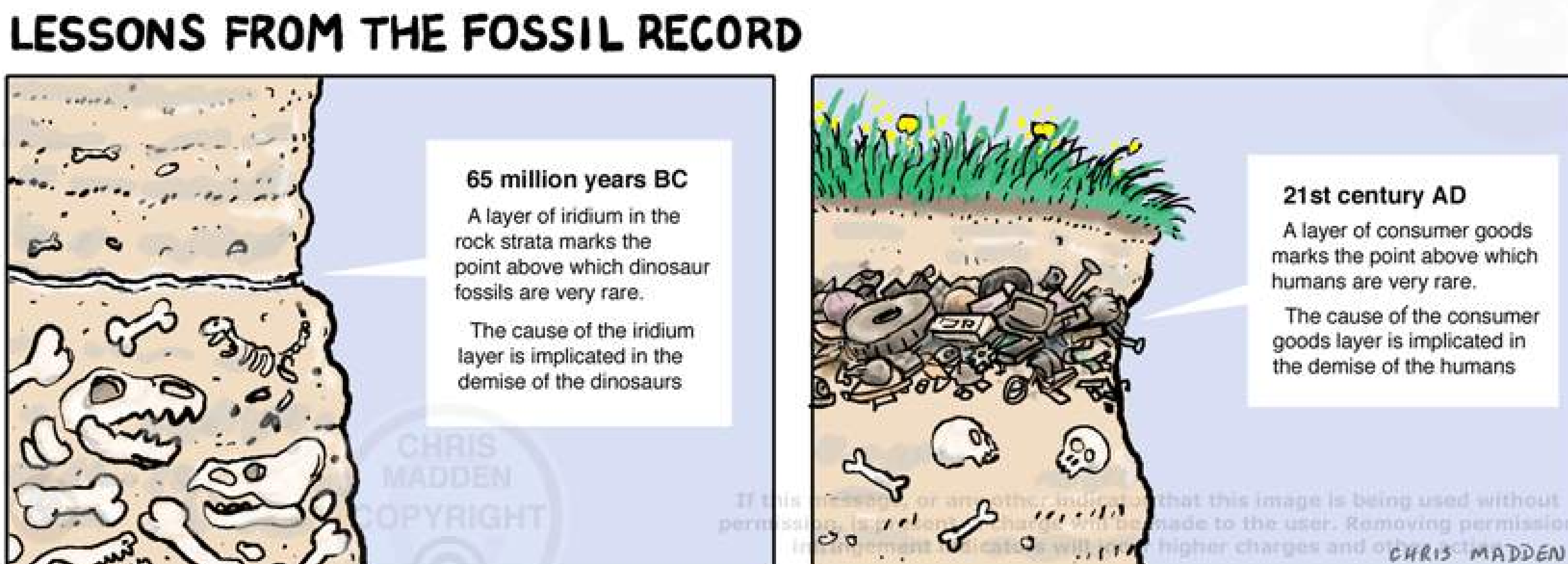
IPCC AR5 Working Group I
Climate Change 2013: The Physical Science Basis

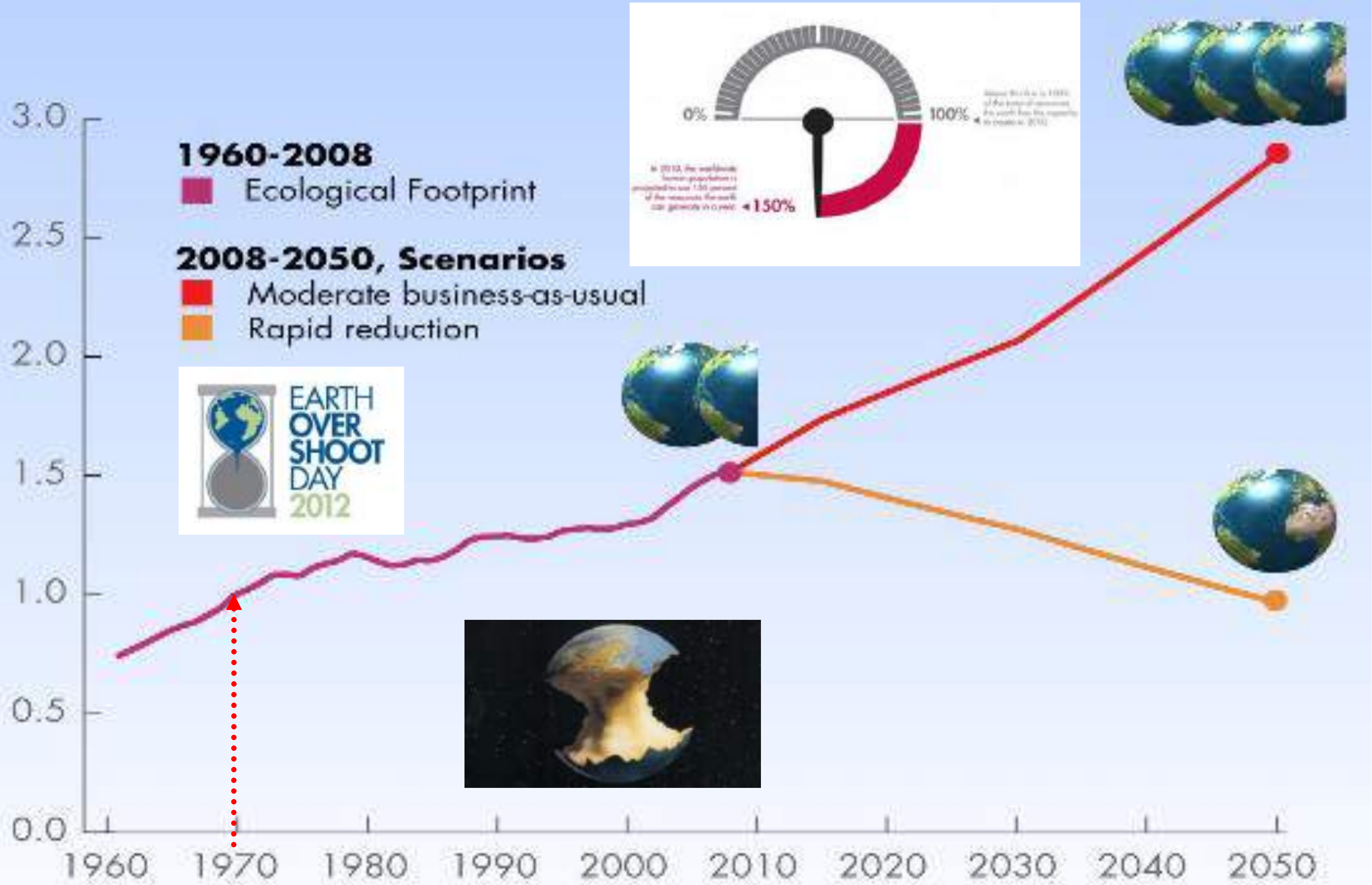
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

ANTHROPOCENE

approx. 1945 A.D. - present

A new geologic era with no precise start date. Marked by significant human impact on climate and ecosystems. Coined by Paul Crutzen. Rise of agriculture. Deforestation. Cement. Combustion of fossil fuels. Coal, oil and gas roused from the earth. Extraction and emission. Operation Crossroads vaporizes 70 acres of Bikini Atoll. Deep geologic repositories. Pacific Trash Vortex, a swirling gyre of marine litter and plastic. 6.7 billion humans + growing. Palo Verde Nuclear Power Plant. Hull-Rust-Mahoning open pit mine. Three Gorges Dam. Fresh Kills Landfill. Las Vegas. Dubai.





y-axis: number of planet earths, x-axis: years

Rockstrom et al., 2009

nature Vol 461|24 September 2009

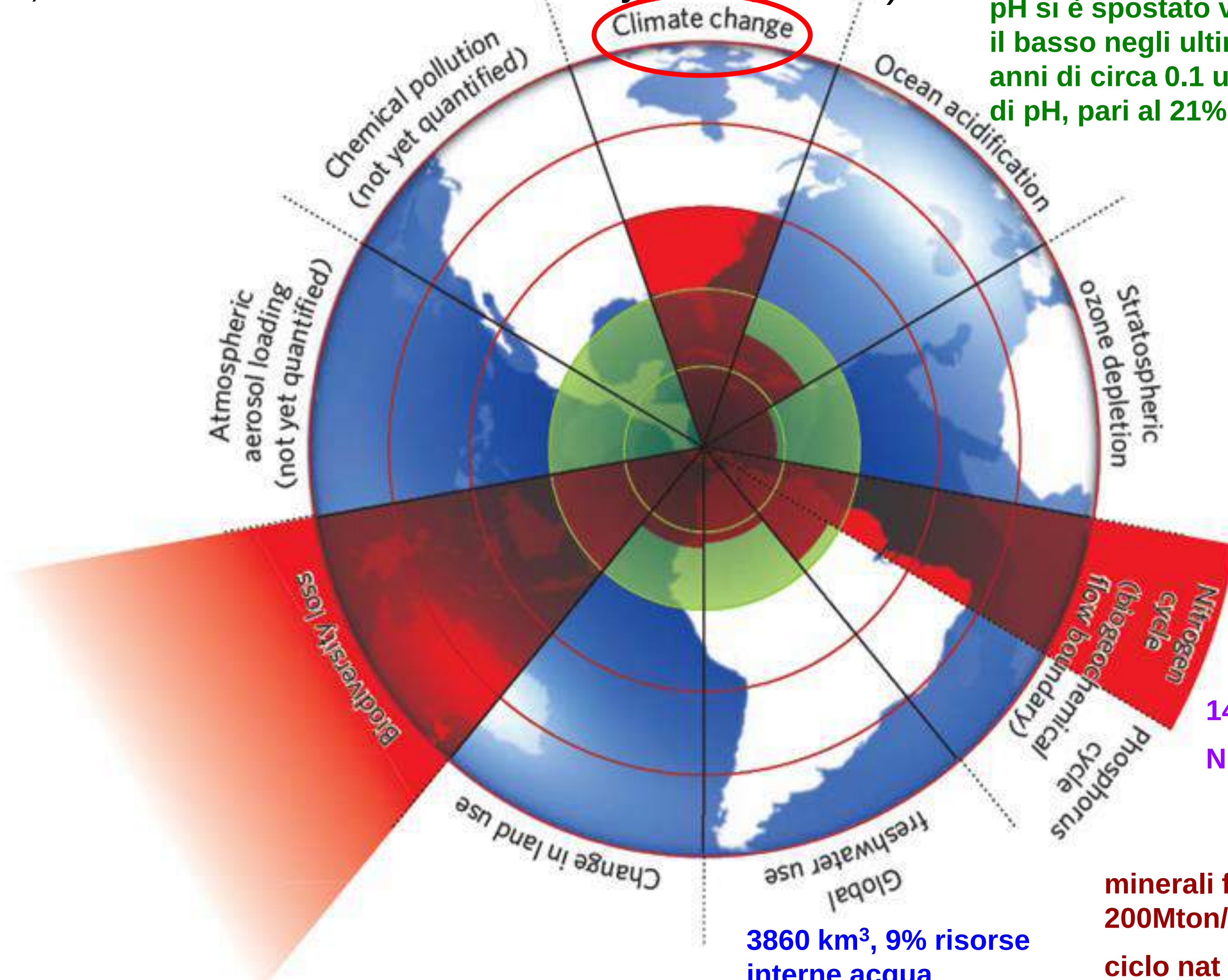
FEATURE

A safe operating space for humanity

Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change, argue **Johan Rockström** and colleagues.

9.4GtonC/yr, 15% (34 $GtCO_2$)

pH si è spostato verso il basso negli ultimi 250 anni di circa 0.1 unità di pH, pari al 21%



140Mton N, 100%

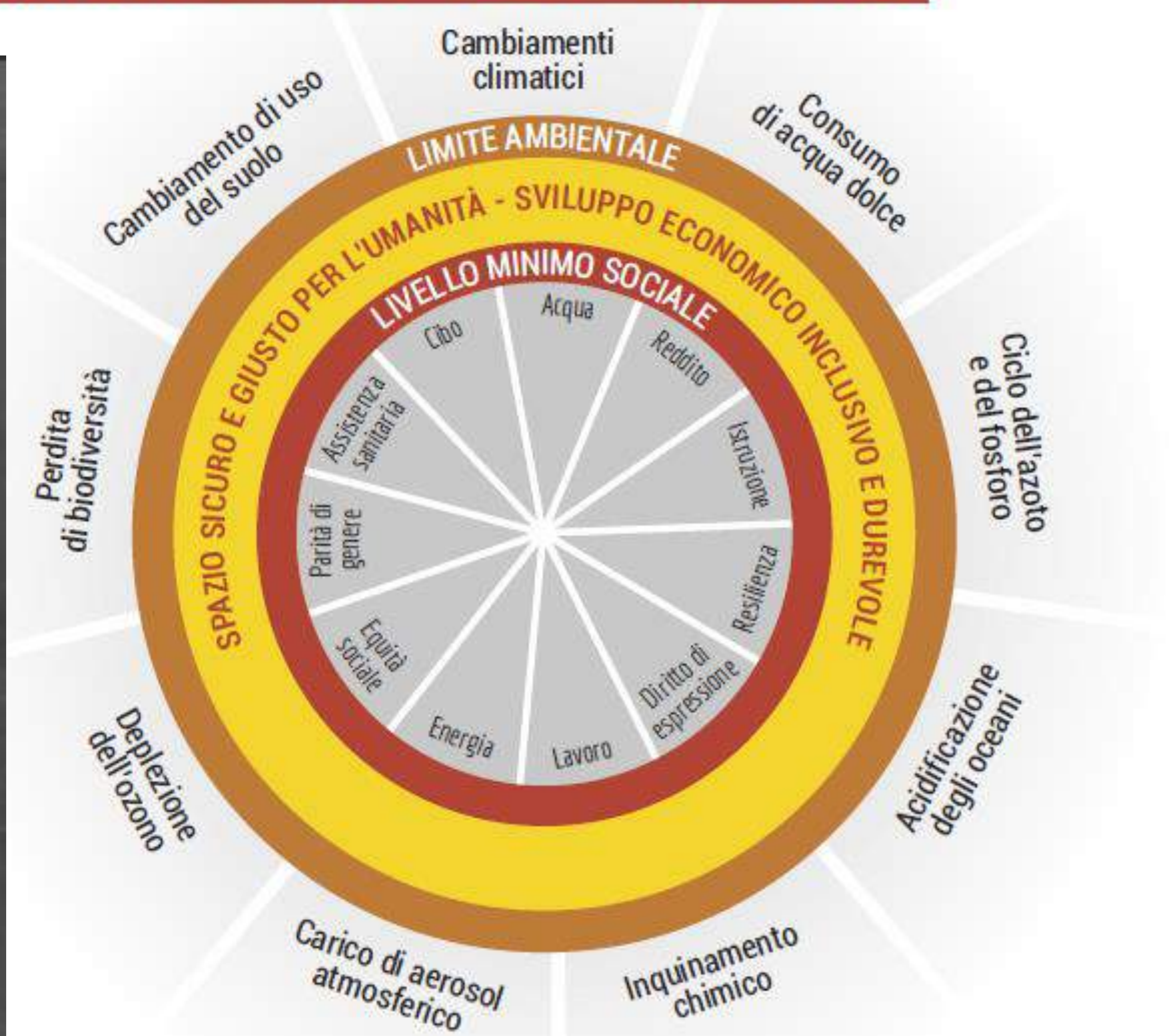
minerali fosfatici 200Mton/anno; 1/7 ciclo nat

3860 km^3, 9% risorse interne acqua (AQUASTAT)

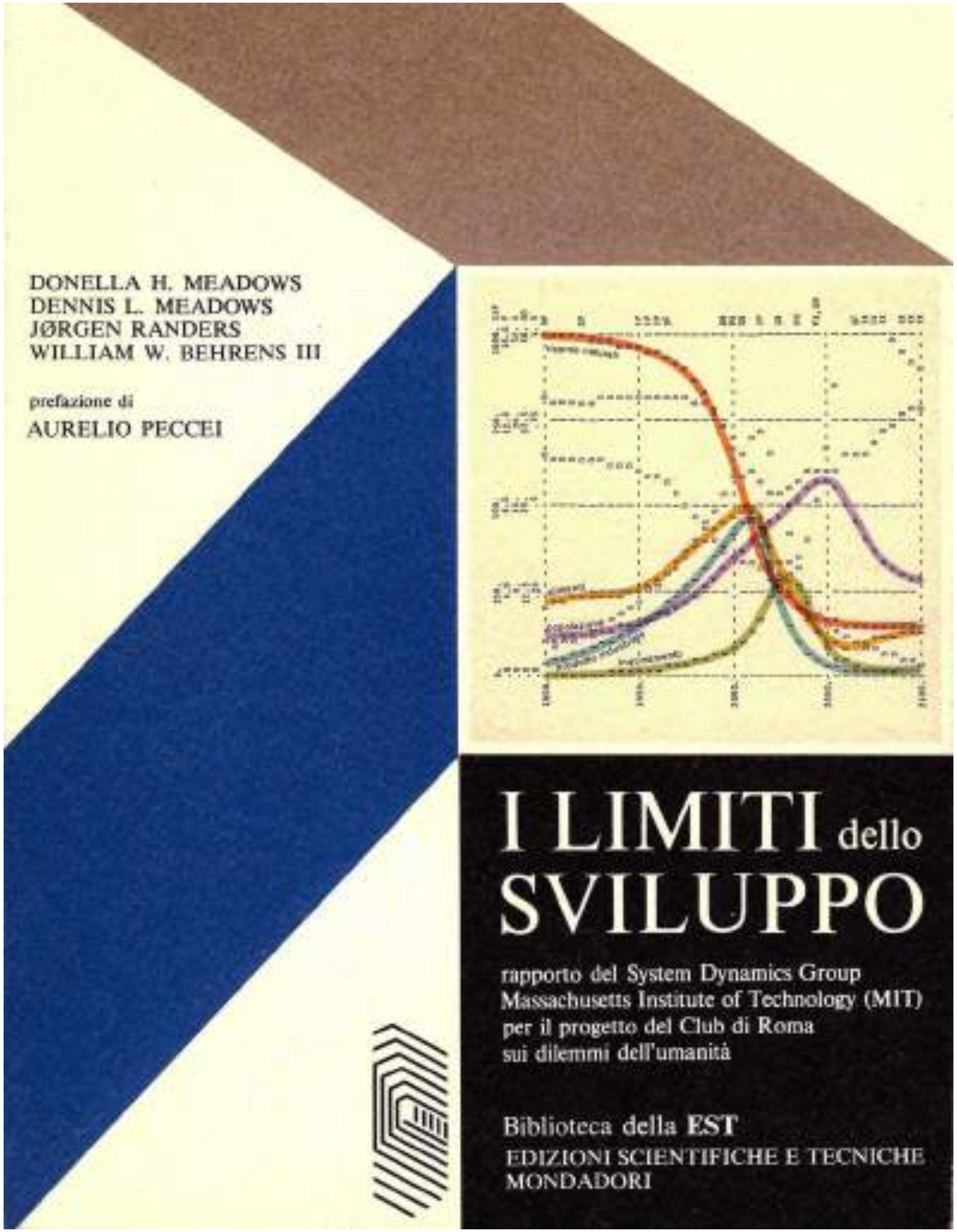
Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

LA "CIAMBELLA"
DEI LIMITI SOCIALI E PLANETARI

FONTE: A SAFE AND JUST SPACE FOR HUMANITY - OXFAM DISCUSSION PAPERS.



Aurelio Peccei
Torino 1908- Roma 1984



http://scientistswarning.forestry.oregonstate.edu/

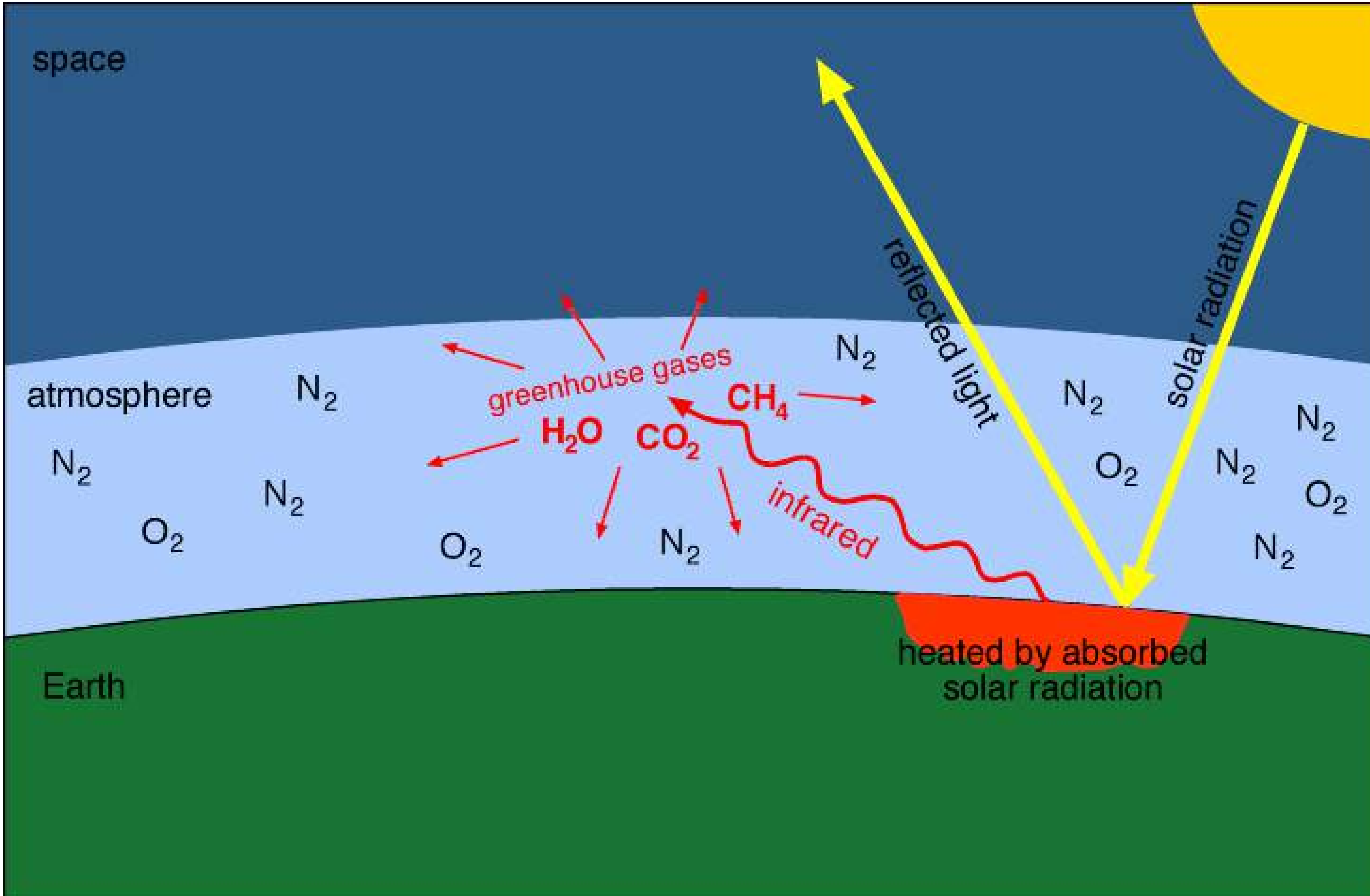
Oregon State University

World Scientists' Warning to Humanity: A Second Notice

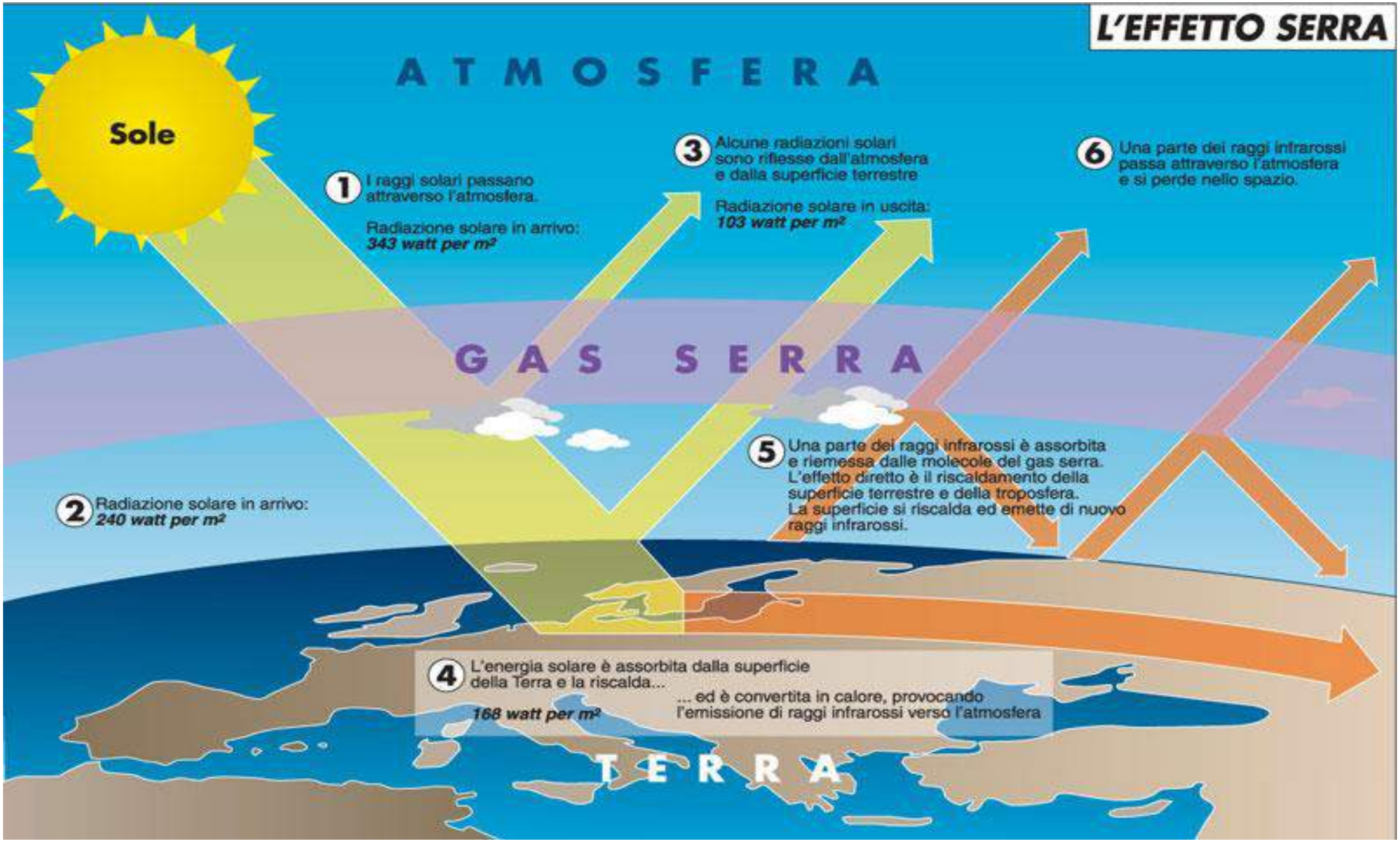
WILLIAM J. RIPPLE, CHRISTOPHER WOLF, THOMAS M. NEWSOME, MAURO GALETTI, MOHAMMED ALAMGIR, EILEEN CRIST, MAHMOUD I. MAHMOUD, WILLIAM F. LAURANCE, and 15,364 scientist signatories from 184 countries

Twenty-five years ago, the Union of Concerned Scientists and more than 1700 independent scientists, including the majority of living Nobel laureates in the sciences, penned the 1992 "World Scientists' Warning to Humanity" (see supplemental file S1). These concerned professionals called on humankind to curtail environmental destruction and cautioned that "a great change in our stewardship of the Earth and the life on it is required, if vast human misery is to be avoided." In their manifesto, they showed that

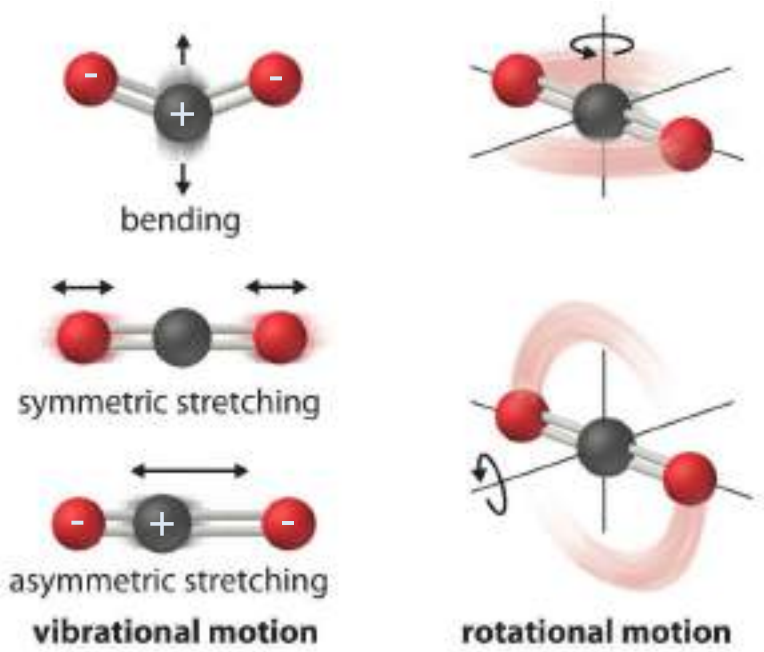
Effetto serra naturale e antropogenico



Terra senza effetto serra -18 °C
Con effetto serra naturale +15 °C

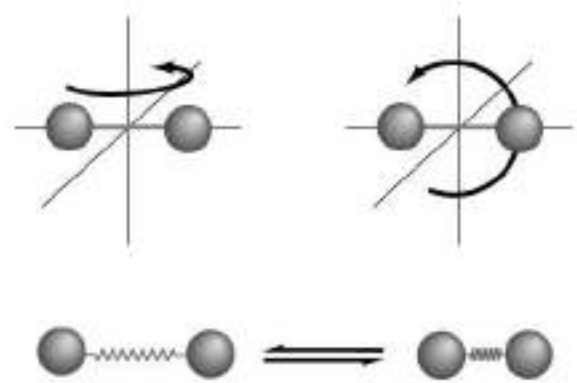


The reason why: how air molecules interact with electromagnetic radiation



Some of the many modes of motion of a CO_2 molecule

Some of these modes create asymmetrically-charged "dipoles" which interact with electromagnetic radiation, particularly in the infra-red part of the spectrum.

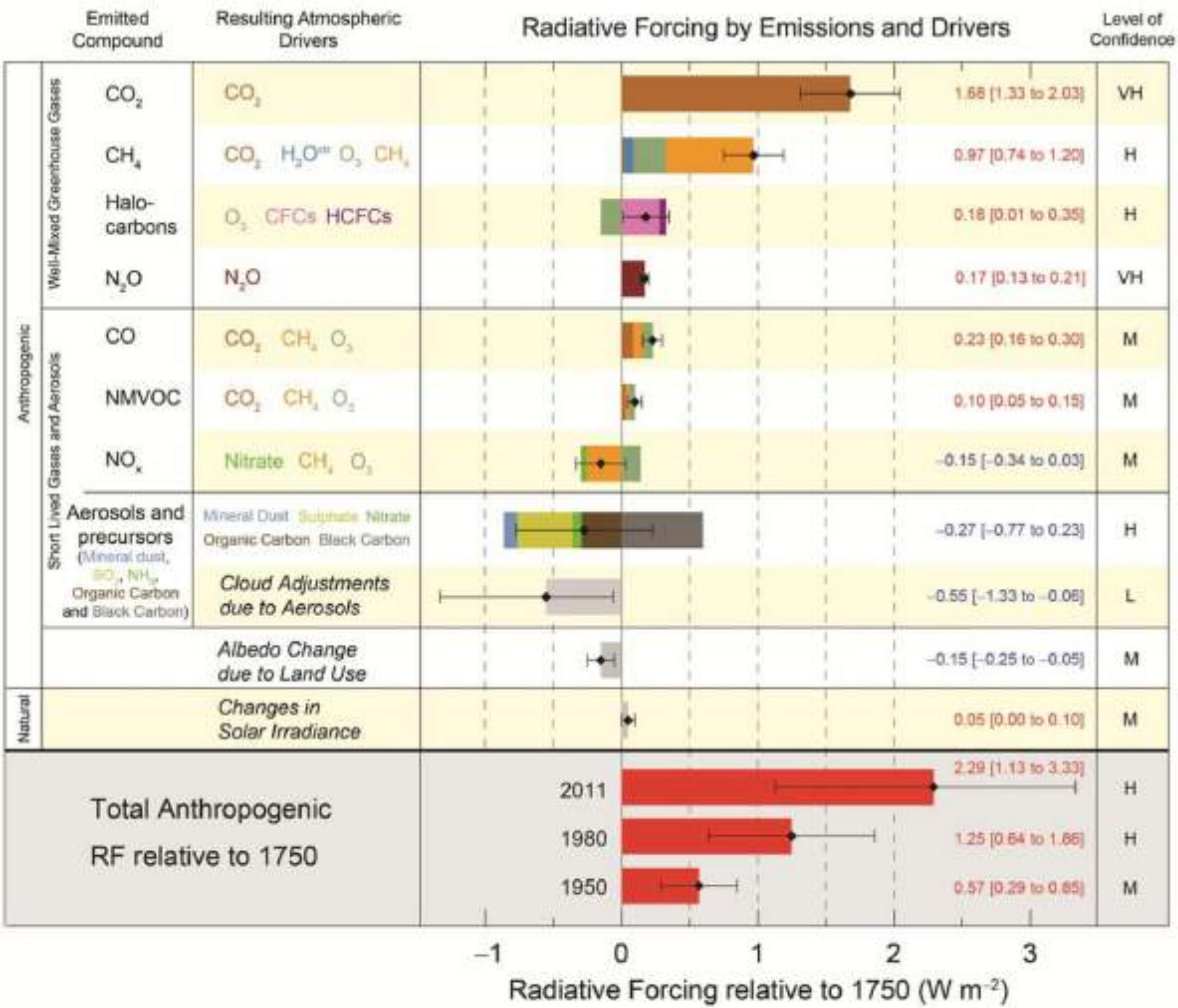


The fewer modes of motion of an O_2 or N_2 molecule

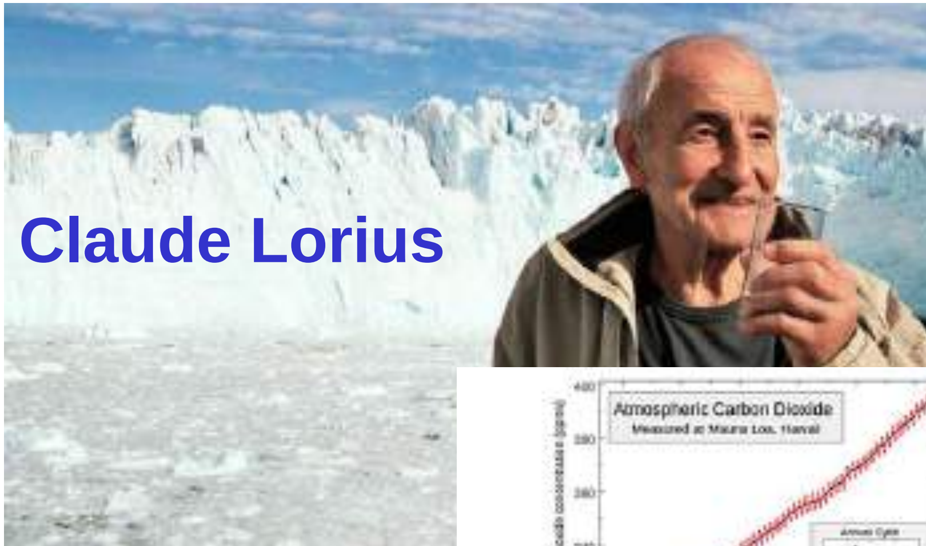
Ipcc Ar5

Forzanti radiativi dei diversi gas serra

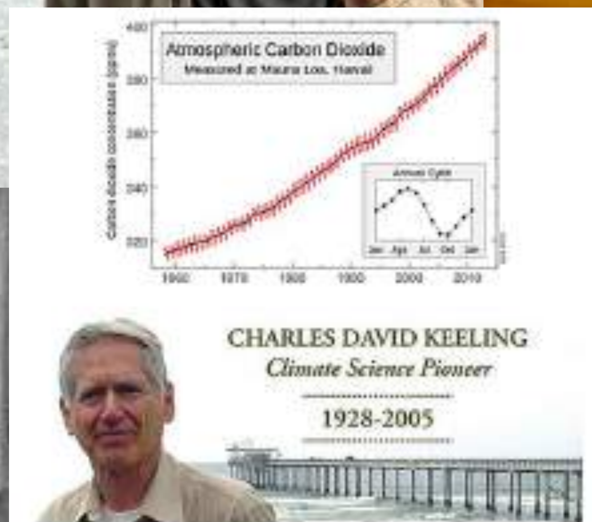
Totale forzante +2,3 W/m2



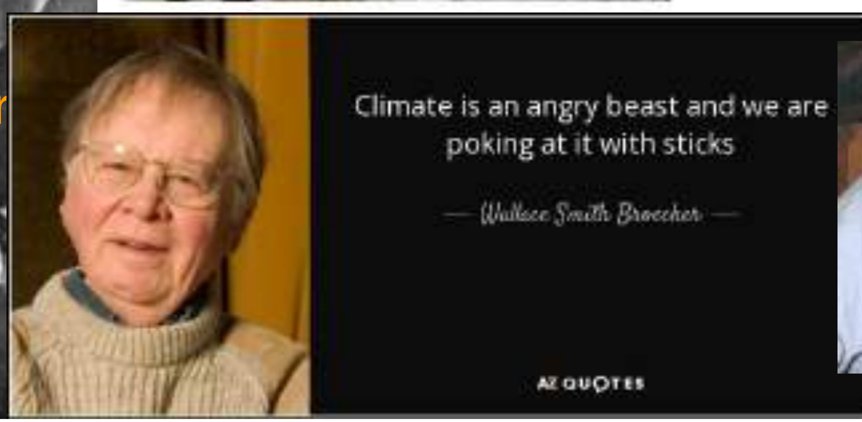
Sulle spalle dei giganti...

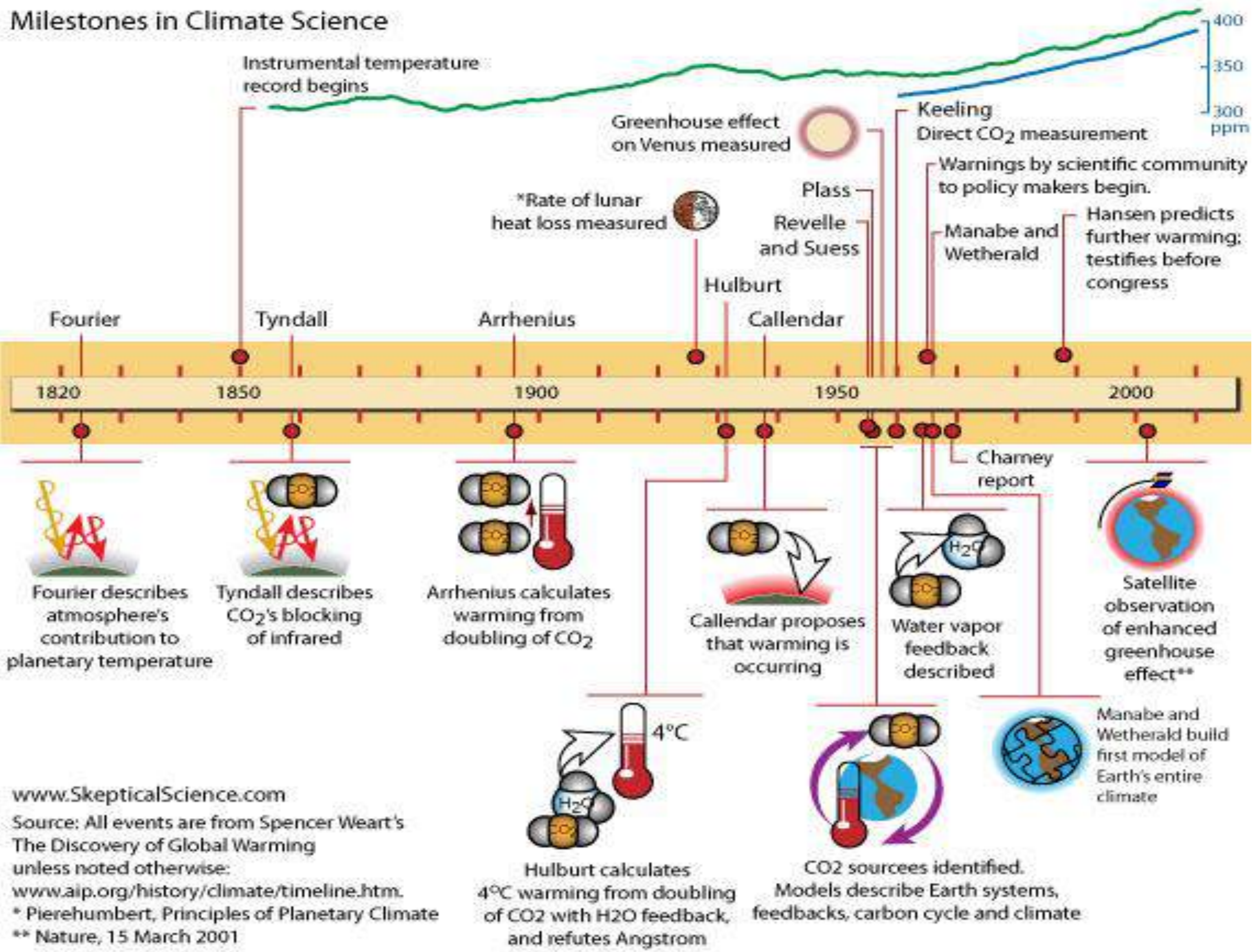


Claude Lorius



Svante Arrher




Milestones in Climate Science
Instrumental temperature record begins
Greenhouse effect on Venus measured
Keeling
Direct CO_2 measurement
400
350
300 ppm
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 CO_2's blocking of infrared
Arrhenius calculates warming from doubling of CO_2
Callendar proposes that warming is occurring
Water vapor feedback described
Satellite observation of enhanced greenhouse effect**
4°C
Manabe and Wetherald build first model of Earth's entire climate
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
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

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 *.

Svante August Arrhenius
(Nobel prize, Chemistry, 1903)

Developed the hothouse theory for CO_2 in 1896, and in 1905 predicted that raising CO_2 content of the atmosphere would cause an increase in mean global temperature similar in magnitude to modern predictions

Endeavour Vol. xxx No. x
ScienceDirect

CO_2, the greenhouse effect and global warming: from the pioneering work of Arrhenius and Callendar to today's Earth System Models

Thomas R. Anderson[a,*], Ed Hawkins[b] and Philip D. Jones[c,d]

[a]National Oceanography Centre, European Way, Southampton SO14 3ZH, UK
[b]NCAS-Climate, Department of Meteorology, University of Reading, Reading RG6 6BB, UK
[c]Climatic Research Unit, University of East Anglia, School of Environmental Sciences, Norwich NR4 7TJ, UK
[d]Center of Excellence for Climate Change Research/Dept of Meteorology, King Abdulaziz University, Jeddah, Saudi Arabia

Climate warming during the course of the twenty-first century is projected to be between 1.0 and 3.7 °C depending on future greenhouse gas emissions, based on the ensemble-mean results of state-of-the-art Earth System Models (ESMs). Just how reliable are these projections, given the complexity of the climate system? The early history of climate research provides insight into the understanding and science needed to answer this question. We examine the mathematical quantifications of planetary energy budget developed by Svante Arrhenius (1859–1927) and Guy Stewart Callendar (1898–1964) and construct an empirical approximation of the latter, which we show to be successful at retrospectively predicting global warming over the course of the twentieth century. This approximation is then used to calculate warming in response to increasing atmospheric greenhouse gases during the twenty-first century, projecting a temperature increase at the lower bound of results generated by an ensemble of ESMs (as presented in the latest assessment by the Intergovernmental Panel on Climate Change). This result can be interpreted as follows. The climate system is conceptually complex but has at its heart the physical laws of radiative transfer. This basic, or "core" physics is relatively straightforward to compute mathematically, as exemplified by Callendar's calculations, leading to quantitatively robust projections of baseline warming. The ESMs include not only the physical core but also climate feedbacks that introduce uncertainty into the projections in terms of magnitude, but not sign: positive (amplification of warming). As such, the projections of end-of-century global warming by ESMs are fundamentally trustworthy: quantitatively robust baseline warming based on the well-understood physics of radiative transfer, with extra warming due to climate feedbacks. These projections thus provide a compelling case that global climate will continue to undergo significant warming in response to ongoing emissions of CO_2 and other greenhouse gases to the atmosphere.

Introduction

Climate change is a major risk facing mankind. At the United Nations Climate Change Conference held in Paris at the end of last year, 196 countries agreed on a plan to reduce emissions of CO_2 and other greenhouse gases, aiming to limit global temperature increase to well below 2 °C (relative to pre-industrial climate, meaning a future warming of less than 1.4 °C because temperature had already increased by 0.6 °C by the end of the twentieth century). The link between CO_2 and climate warming has caught the attention of scientists and politicians, as well as the general public, via the well-known "greenhouse effect" (Figure 1). Solar radiation passes largely unhindered through the atmosphere, heating the Earth's surface. In turn, energy is re-emitted as infrared, much of which is absorbed by CO_2 and water vapour in the atmosphere, which thus acts as a blanket surrounding the Earth. Without this natural greenhouse effect, the average surface temperature would plummet to about −21 °C,[1] rather less pleasant than the 14 °C experienced today.

The concentration of CO_2 in the atmosphere is increasing year on year as we burn fossil fuels, which enhances the natural greenhouse effect and warms the planet. To what extent, then, must CO_2 emissions be kept under control in order to restrict global temperature rise to within 2 °C? The projections of complex Earth System Models (ESMs) provide quantitative answers to this question. Run on supercomputers, these models integrate the many processes taking place in the atmosphere, on land and in the ocean. According to the Intergovernmental Panel on Climate Change (IPCC), the latest results of these models indicate

*Corresponding author. Anderson, T.R.

Keywords: Greenhouse effect; Global warming; Earth System Models; Arrhenius; Callendar.

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.

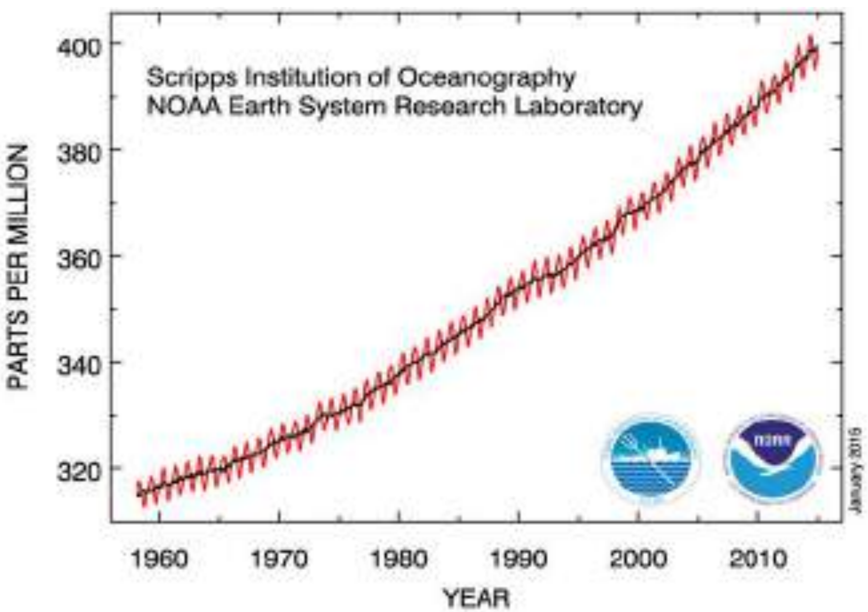
The temperature observations at 200 meteorological stations are used to show that world temperatures have actually increased at an average rate of 0·005°C. per year during the past half century.

Roger Revelle, 1957

- Explained how ocean buffer chemistry limits the amount of CO_2 taken up by the oceans, even in equilibrium.
- Hence CO_2 emissions have a permanent impact on climate: we can't rely on the oceans to dilute them away.

Charles David Keeling's first observations, 1958-60

- Unequivocal evidence that CO_2 concentrations are rising steadily



1.2 Brief history: Syukuro Manabe (1931-)

First predictions of global warming based on comprehensive global climate models

Smagorinsky, J., S. Manabe, J. L. Holloway, Jr., 1965: Numerical results from a nine-level general circulation model of the atmosphere. Monthly Weather Review, 93(12), 727-768.

Manabe, S., and R. T. Wetherald, 1975: The effects of doubling CO2 concentration on the climate of a general circulation model. Journal of the Atmospheric Sciences, 32(1), 3-15.

Manabe, S., K. Bryan, and M. J. Spelman, 1975: A global ocean-atmosphere climate model. Part I. The atmospheric circulation. Journal of Physical Oceanography, 5(1), 3-29.

Carbon Dioxide and Climate: A Scientific Assessment

Report to the National Academy of Sciences
Jule G. Charney and co-authors
1979

When it is assumed that the CO2 content of the atmosphere is doubled and statistical thermal equilibrium is achieved, the more realistic of the modeling efforts predict a global surface warming of between 2°C and 3.5 °C, with greater increases at high latitudes.

- Oceans “could delay the estimated warming for several decades”
- “We may not be given a warning until the CO_2 loading is such that an appreciable climate change is inevitable.”

1981

SCIENCE MAGAZINE

28 August 1981, Volume 213, Number 4511

SCIENCE

Climate Impact of Increasing Atmospheric Carbon Dioxide

J. Hansen, D. Johnson, A. Lacis, S. Lebedeff
P. Lee, D. Rind, G. Russell

Atmospheric CO_2 increased from 280 to 300 parts per million in 1880 to 335 to 340 ppm in 1980 (1, 2), mainly due to burning of fossil fuels. Deforestation and changes in biosphere growth may also

The major difficulty in accepting this theory has been the absence of observed warming coincident with the historic CO_2 increase. In fact, the temperature in the Northern Hemisphere decreased by

Summary. The global temperature rose by 0.2°C between the middle 1960's and 1980, yielding a warming of 0.4°C in the past century. This temperature increase is consistent with the calculated greenhouse effect due to measured increases of atmospheric carbon dioxide. Variations of volcanic aerosols and possibly solar luminosity appear to be primary causes of observed fluctuations about the mean trend of increasing temperature. It is shown that the anthropogenic carbon dioxide warming should emerge from the noise level of natural climate variability by the end of the century, and there is a high probability of warming in the 1980's. Potential effects on climate in the 21st century include the creation of drought-prone regions in North America and central Asia as part of a shifting of climatic zones, erosion of the West Antarctic ice sheet with a consequent worldwide rise in sea level, and opening of the fabled Northwest Passage.

have contributed, but their net effect is probably limited in magnitude (2, 3). The CO_2 abundance is expected to reach 600 ppm in the next century, even if growth of fossil fuel use is slow (4).

Carbon dioxide absorbs in the atmospheric "window" ...

about 0.5°C between 1940 and 1970 (9), a time of rapid CO_2 buildup. In addition, recent claims that climate models overestimate the impact of radiative perturbations by an order of ...

Greenhouse Effect

The effective radiating temperature of the earth, T_e, is determined by the need for infrared emission from the planet to balance absorbed solar radiation:

$$\pi R^2(1 - A)S_0 = 4\pi R^2\sigma T_e^4 \quad (1)$$

or

$$T_e = [S_0(1 - A)/4\sigma]^{1/4} \quad (2)$$

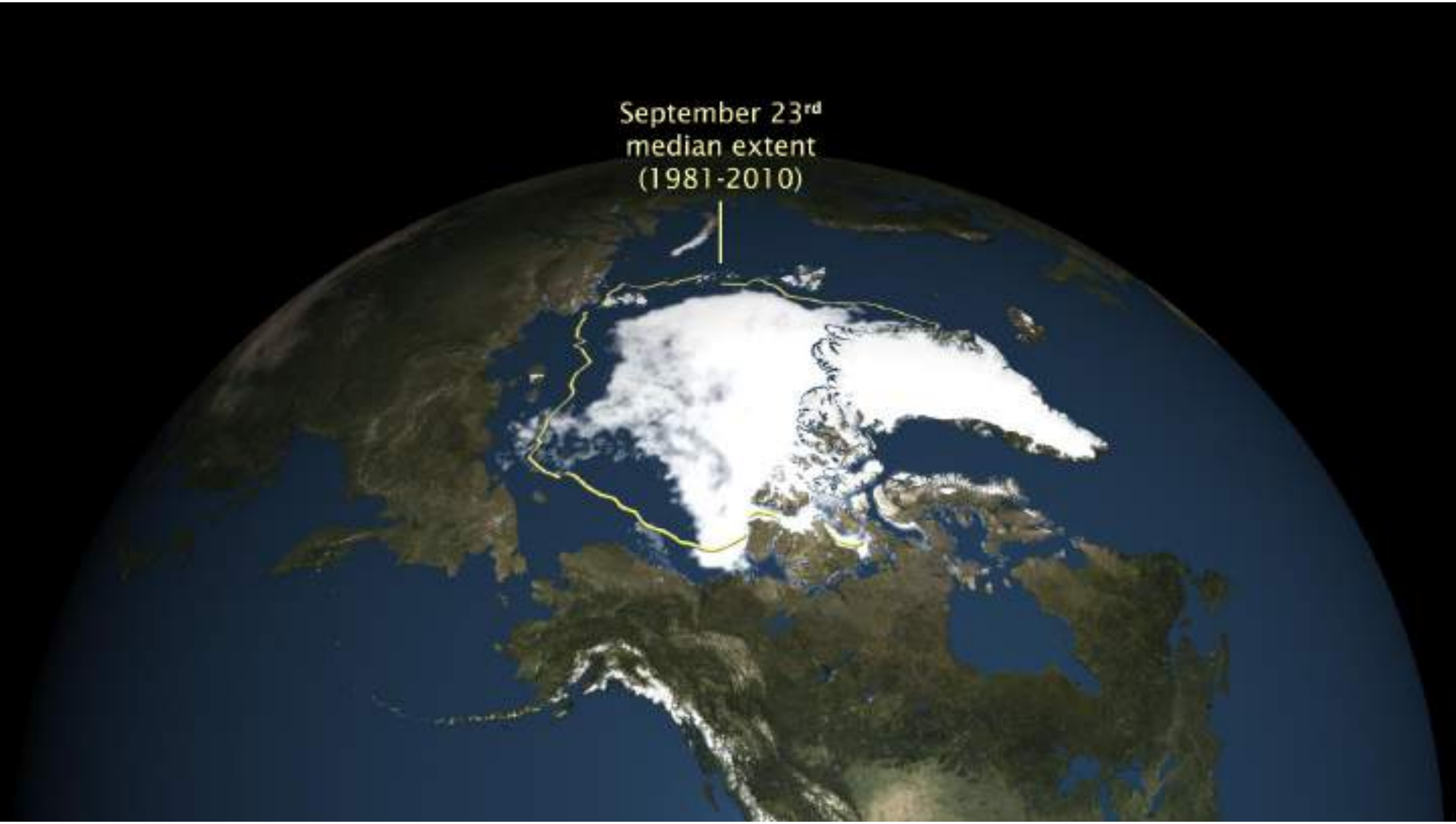
where R is the radius of the earth, A the albedo of the earth, S_0 the flux of solar radiation, and σ the Stefan-Boltzmann constant. For $A \approx 0.3$ and $S_0 = 1367$ watts per square meter, this yields $T_e \approx 255$ K.

The mean surface temperature is $T_s \approx 288$ K. The excess, $T_s - T_e$, is the greenhouse effect of gases and clouds, which cause the mean radiating level to be above the surface. An estimate of the greenhouse warming is

$$T_s - T_e = \Gamma H \quad (3)$$

where H is the flux-weighted mean altitude of the emission to space and Γ is the mean temperature gradient (lapse rate) between the surface and H. The earth's troposphere is sufficiently opaque in the infrared that the purely radiative vertical temperature gradient is convectively unstable, giving rise to atmospheric motions that contribute to vertical transport of heat and result in $\Gamma \sim 5°$ to 6°C per kilometer. The mean lapse rate is less than the dry adiabatic value because of latent heat release by condensation as moist air rises and cools and because the atmospheric motions that transport heat vertically include large-scale ...

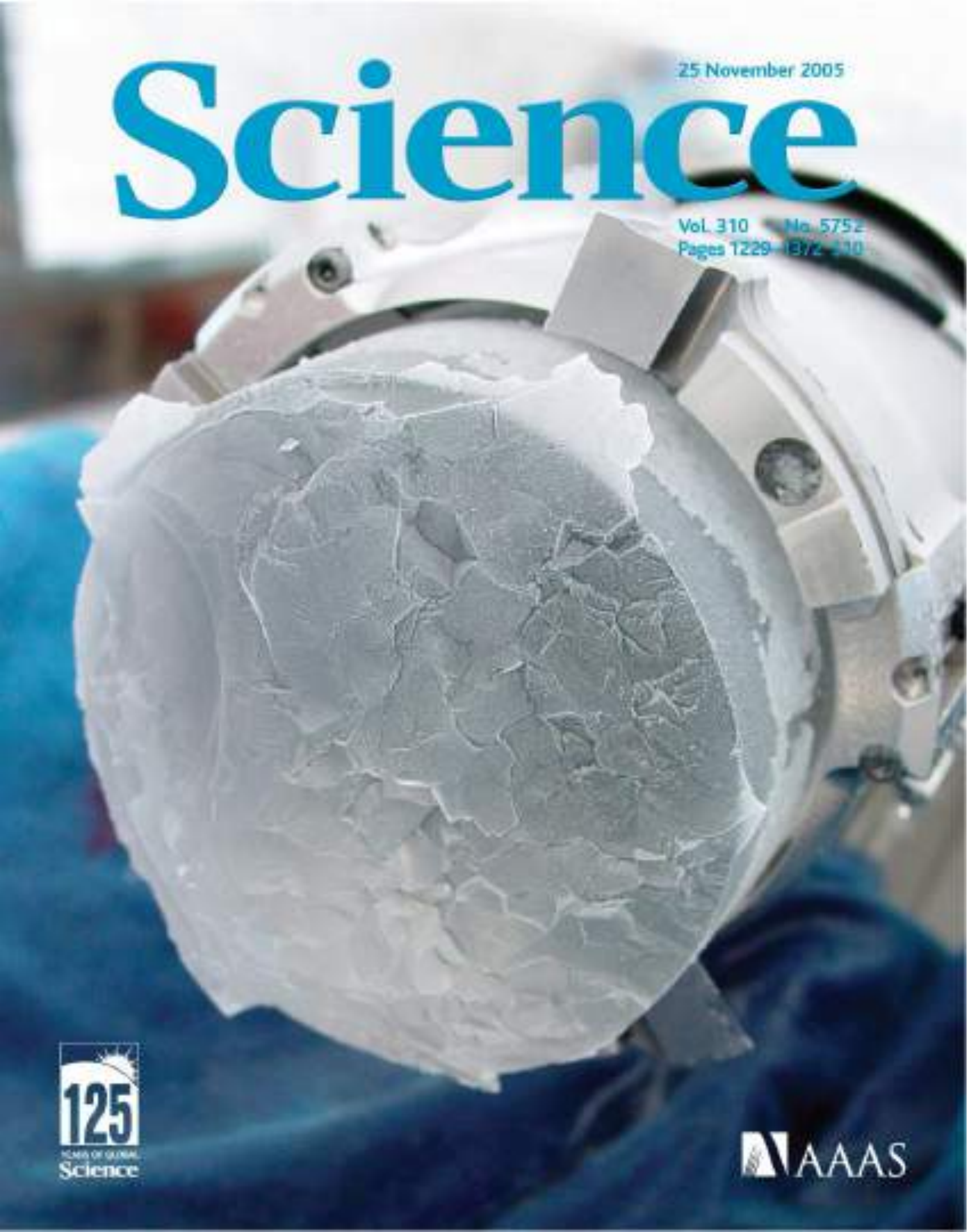
Banchisa artica autunno 2018: sesto caso di minima estensione dal 1978



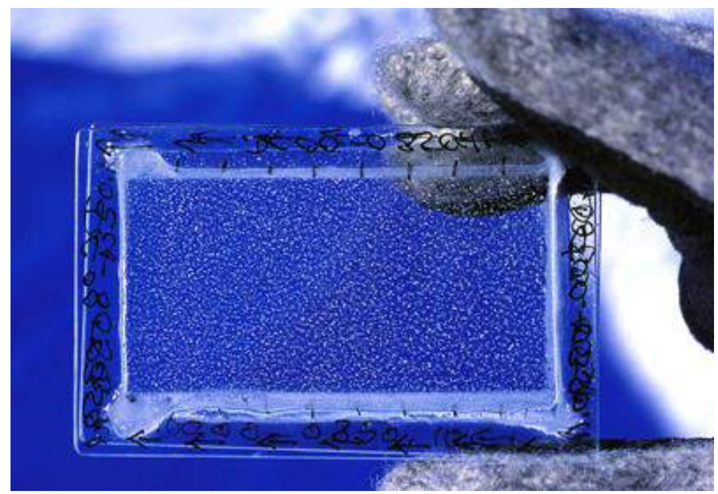
Progetto EPICA - EPICA

(European Project for Ice Coring in Antarctica)

Stazione italo-francese Concordia, a Dome C - Antartide

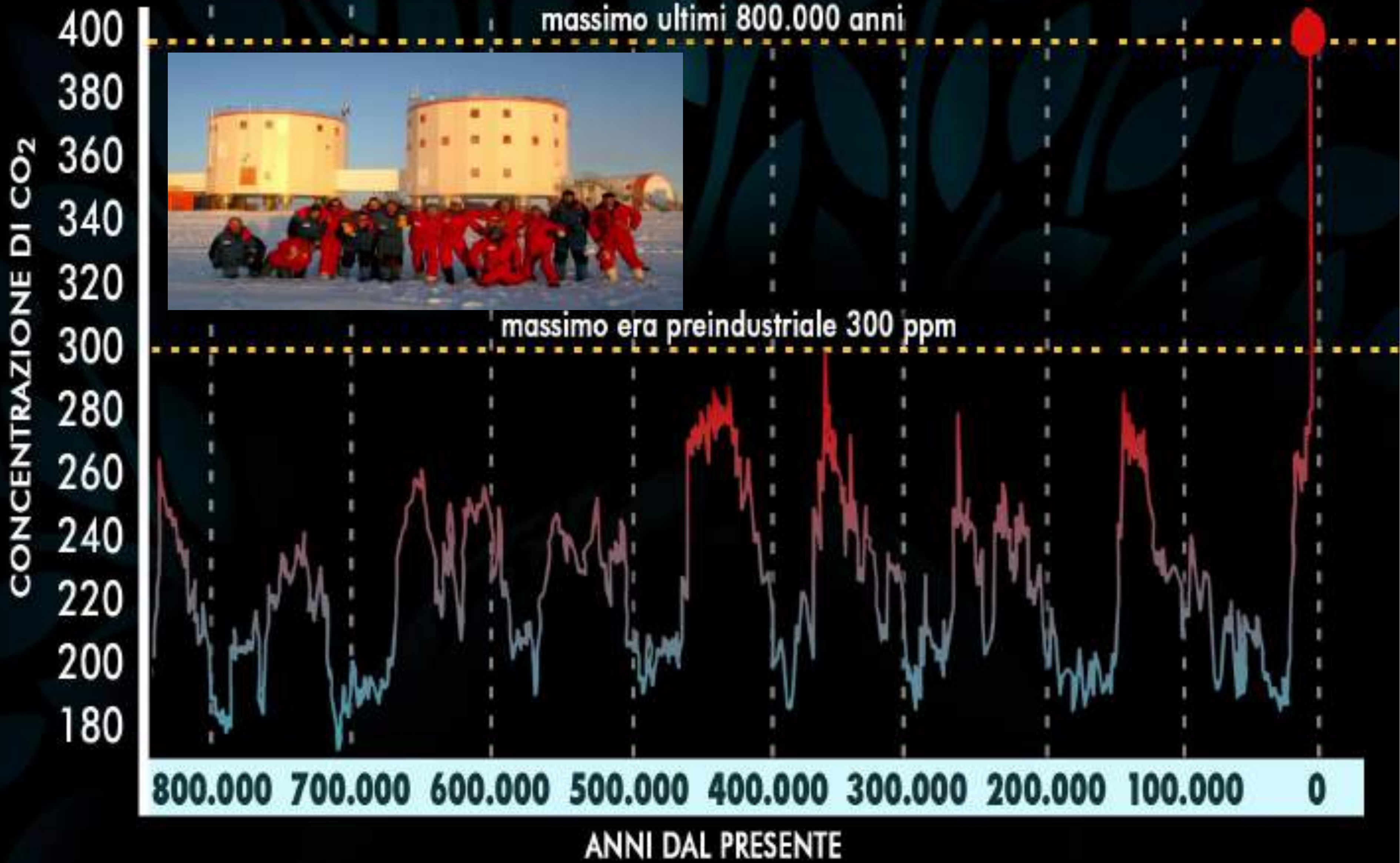


L'analyse des bulles d'air emprisonnées dans la glace permet de retracer l'histoire du dioxide de carbone et du méthane

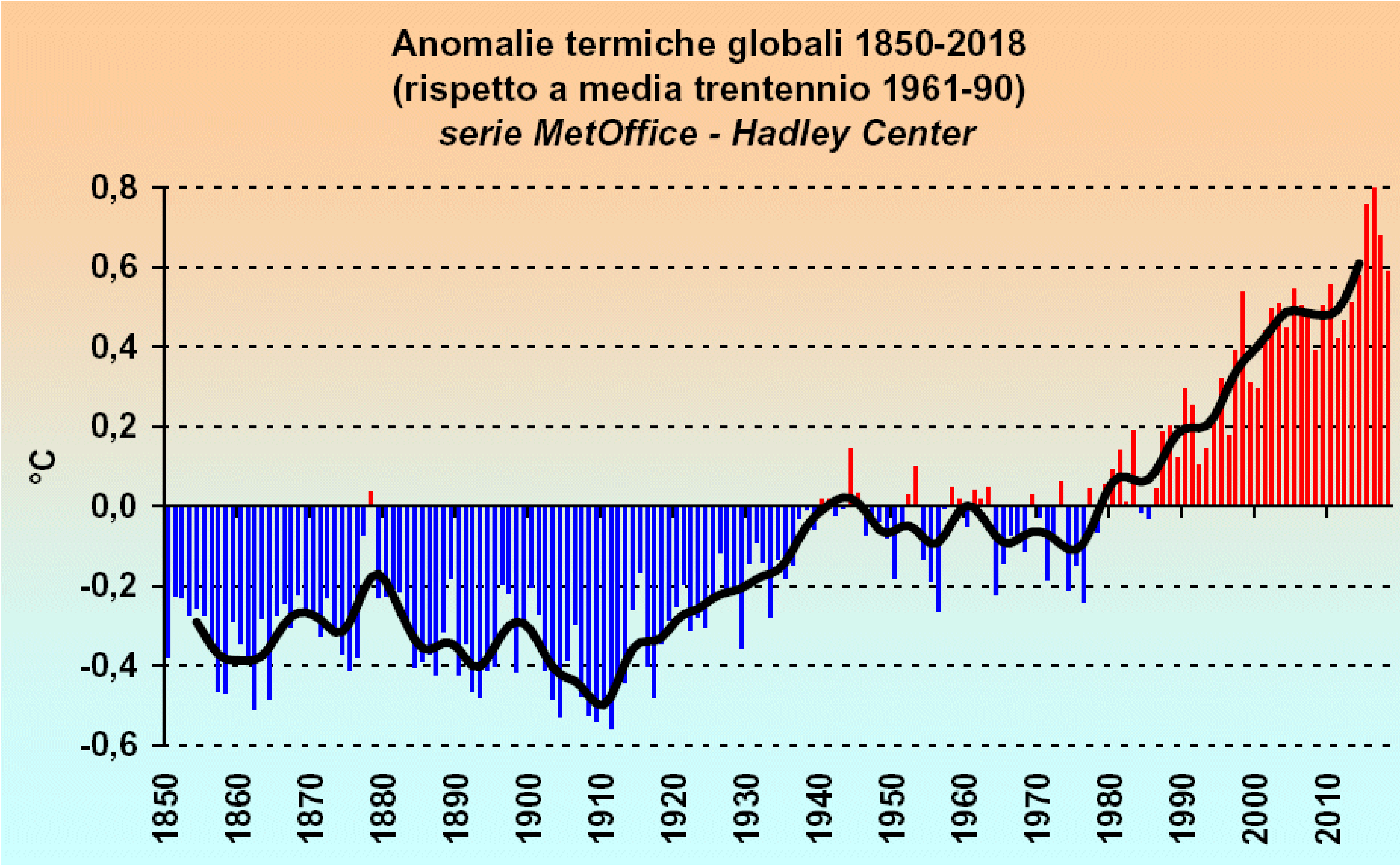


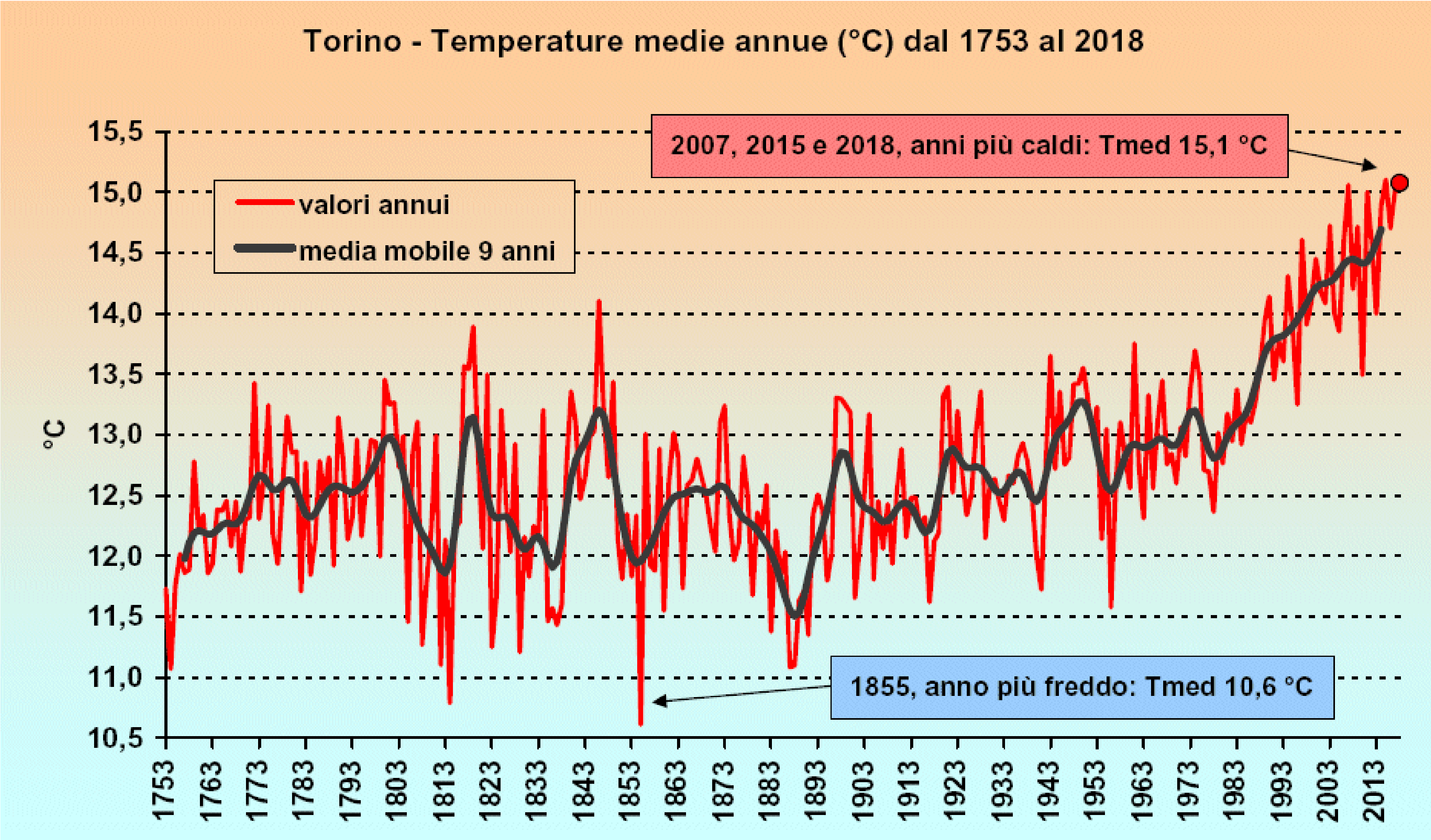
fonte: progetto EPICA

LIVELLO CO_2 NEL TEMPO

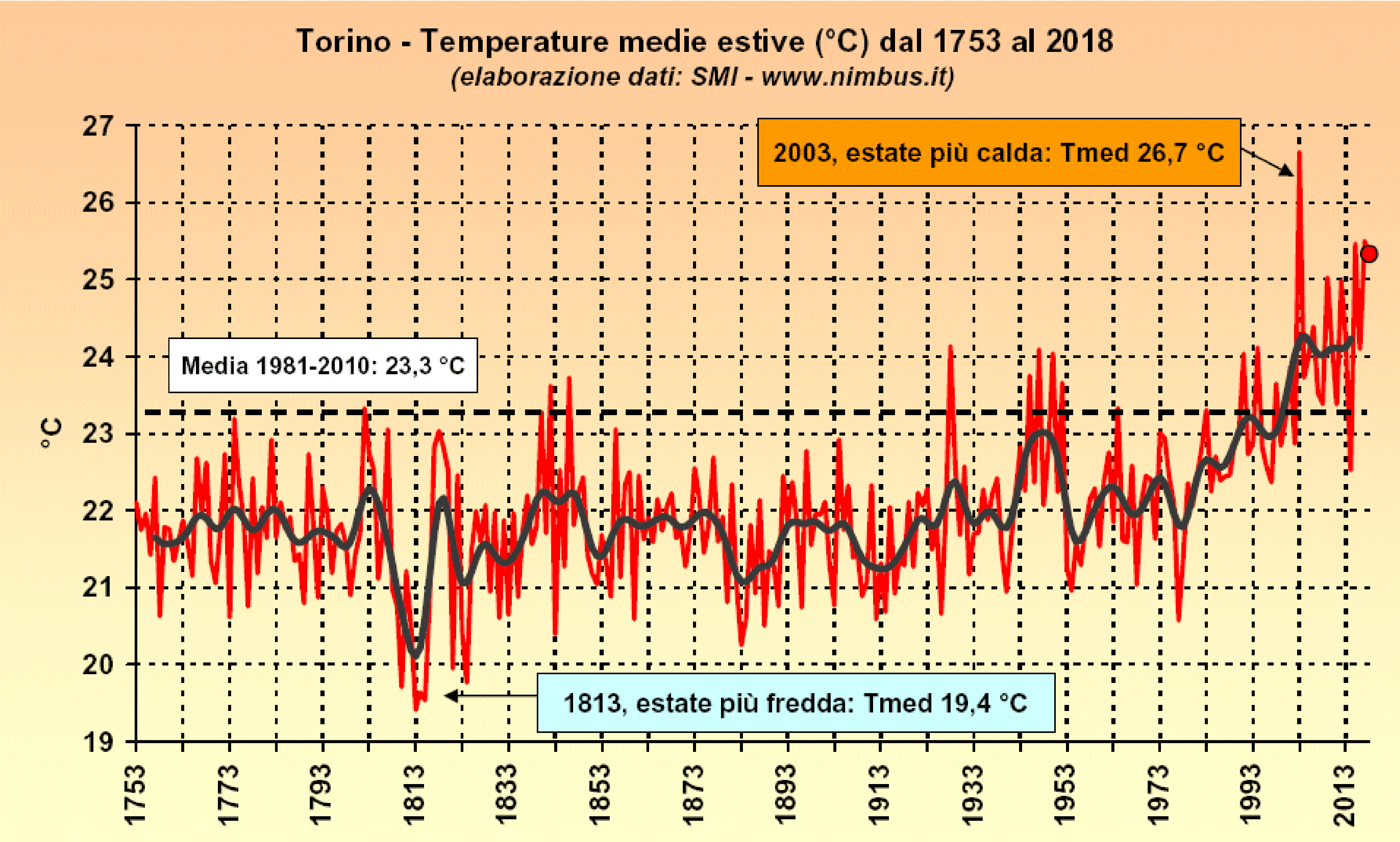


Temperatura media globale: +1°C in più nell'ultimo secolo

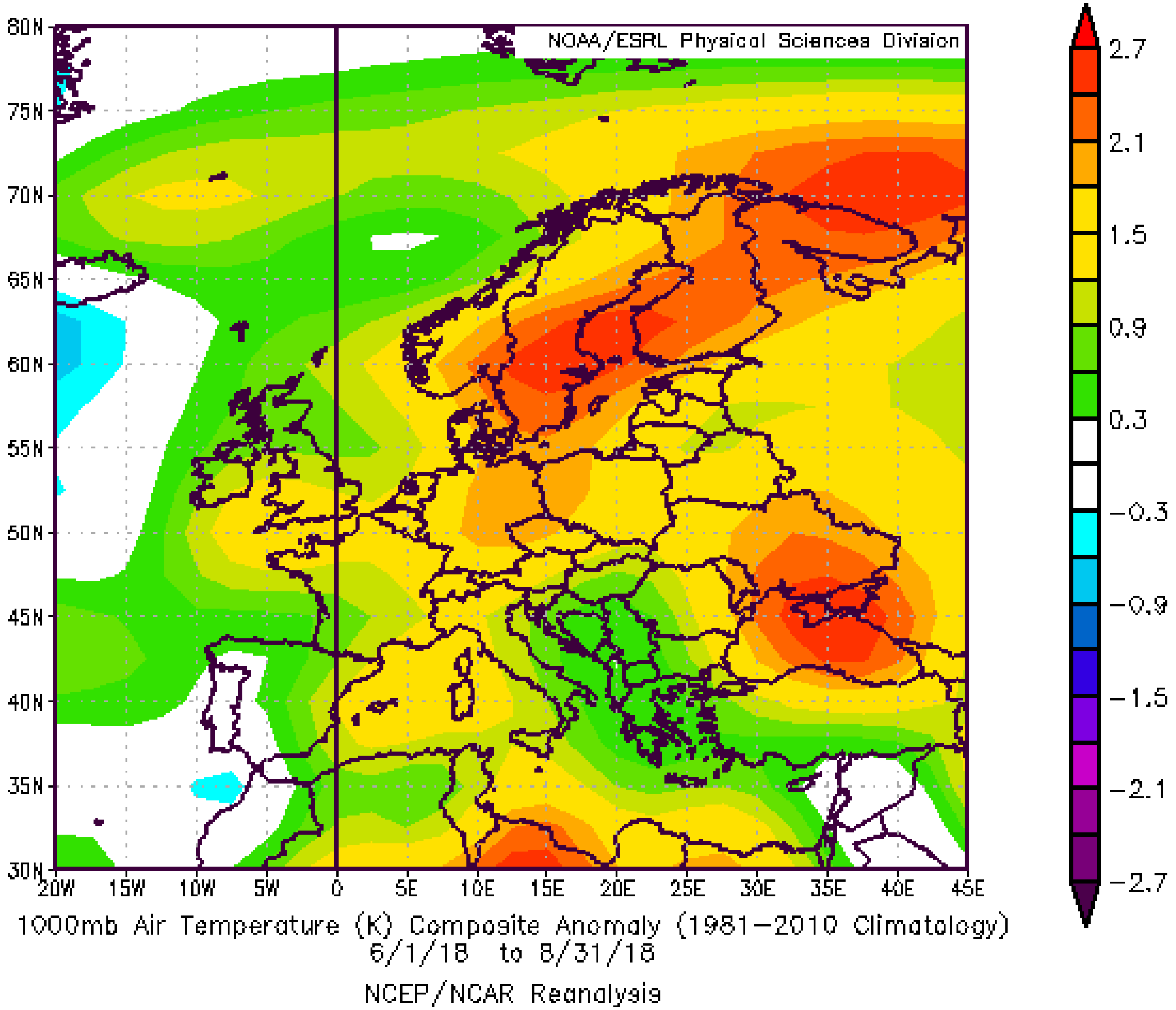




2018: anno più caldo dal 1753 insieme a 2007 e 2015 (1,2 °C sopra media). Tutti i 10 anni più caldi sono successivi al 1996.



9 su 10 delle estati più calde sono successive al 2002



Estate 2018: caldo eccezionale su Scandinavia e Mar Nero



1897
(f. Druetti)

2005
(f. L. Mercalli)

2015
(f. S. Jobard)

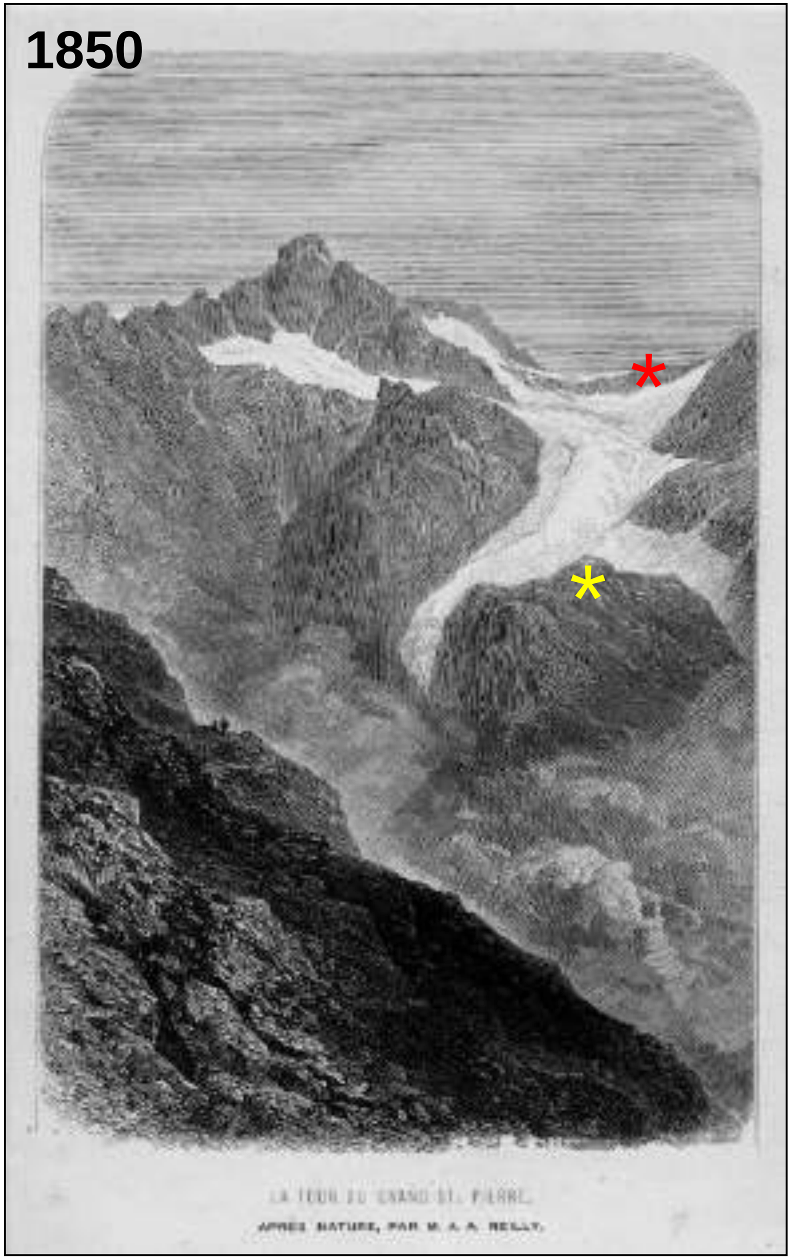
Ghiacciaio Pré de Bar (Monte Bianco):

ritiro della fronte di oltre 800 m dal 1897 al 2015

I ghiacciai alpini si sono ridotti di oltre il 50% in un secolo

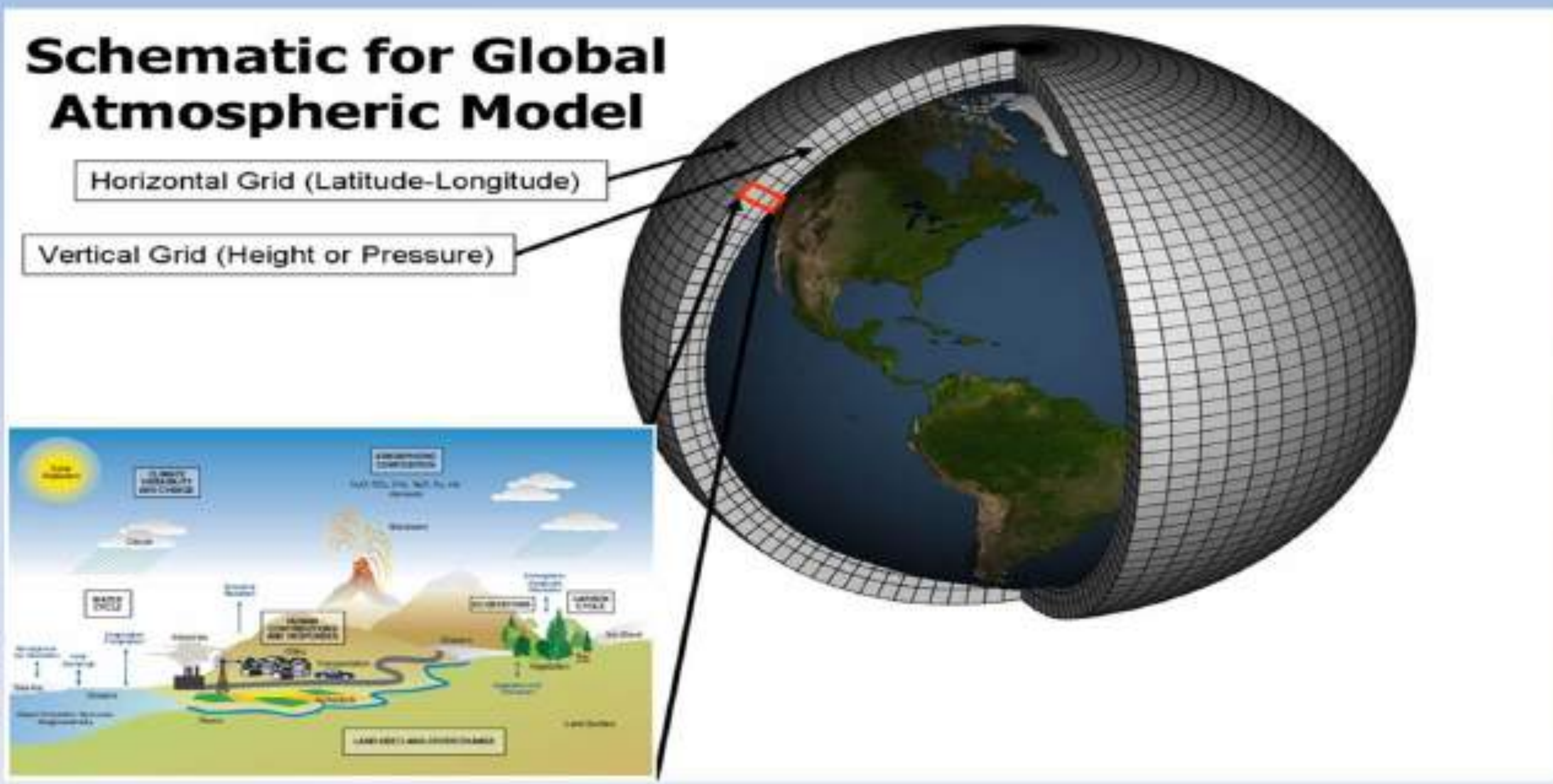
Ghiacciaio
Meridionale del
Sabbione
(Ossola)
dalla diga.

Regresso frontale
circa 1200 m.

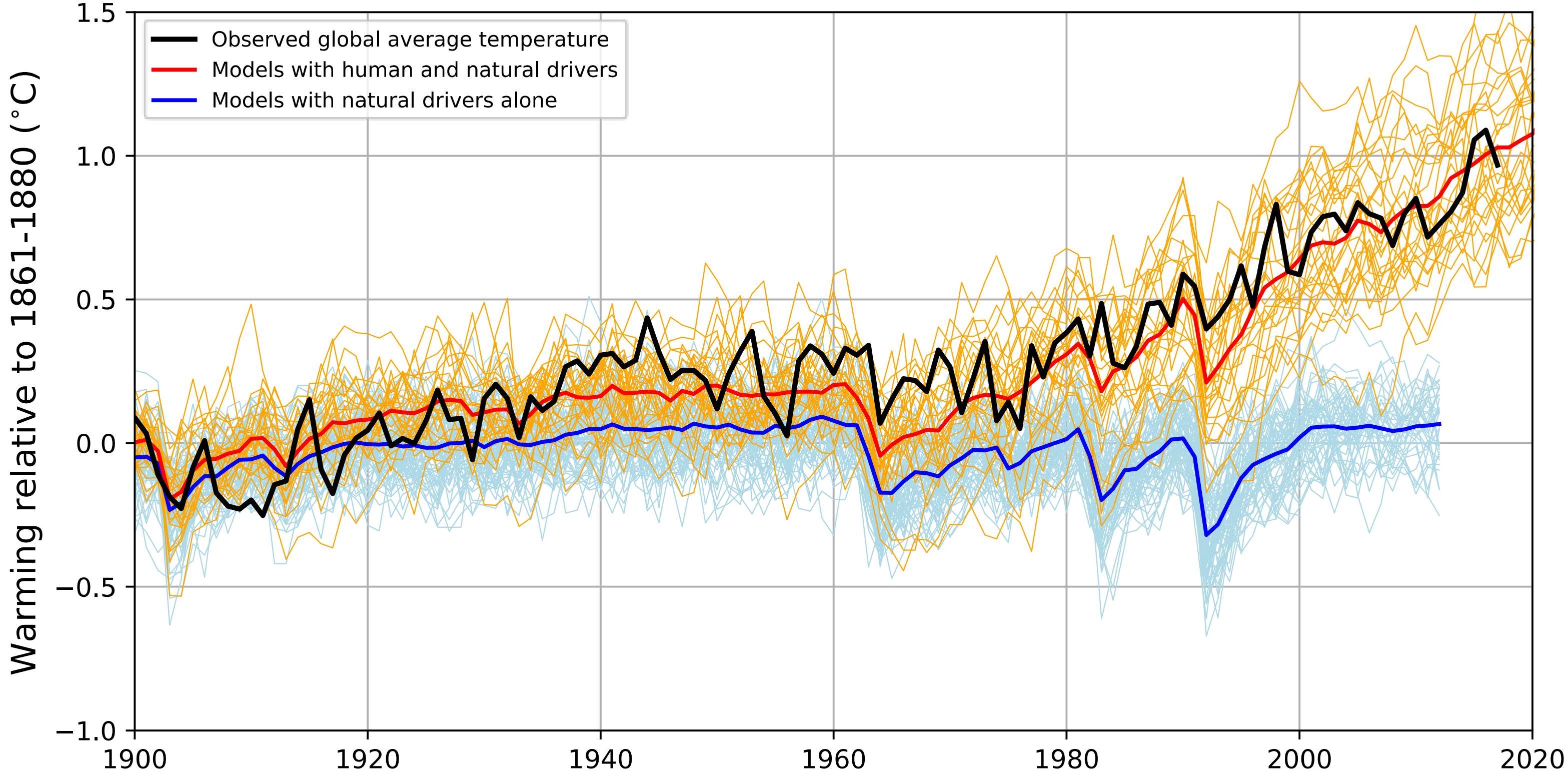


Ghiacciaio di Teleccio (Gran Paradiso)

Global Climate Models



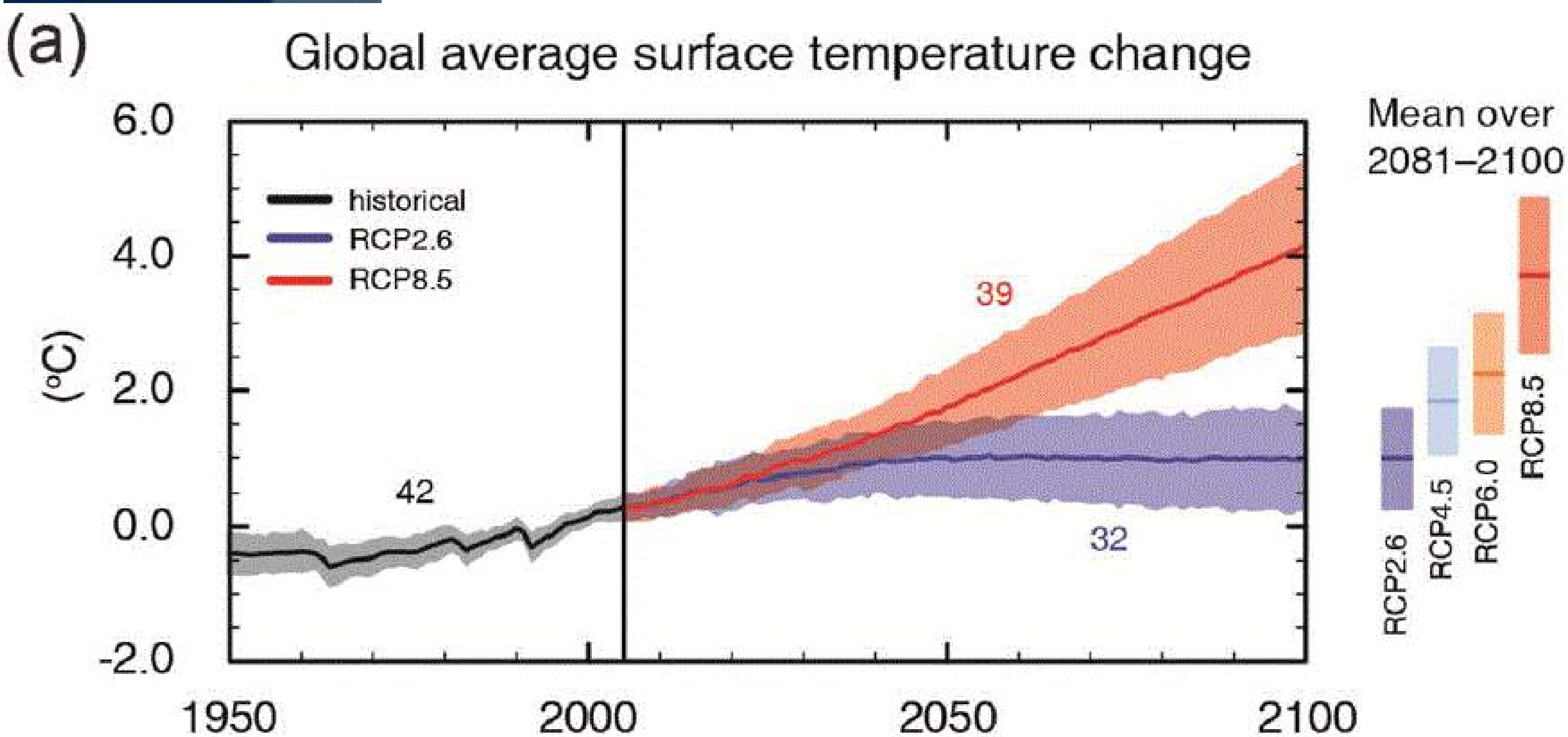
Climate models reproduce observed warming only when human influences are included



Richardson et al, 2017

Scenari 5° rapporto IPCC (2013):

+2°C al 2100 se si applica Accordo Parigi (linea azzurra), oppure fino a **+5°C** in più con business-as-usual (linea rossa)



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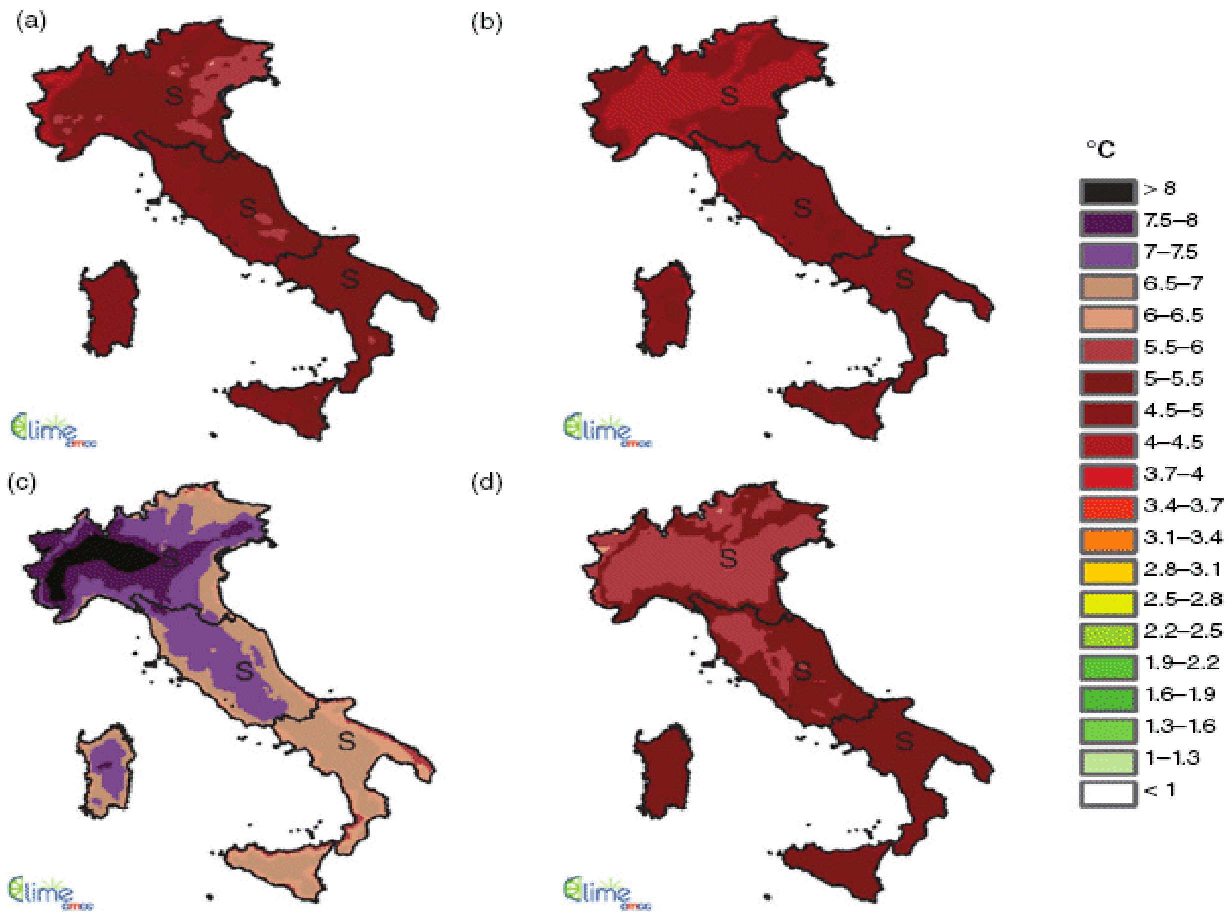
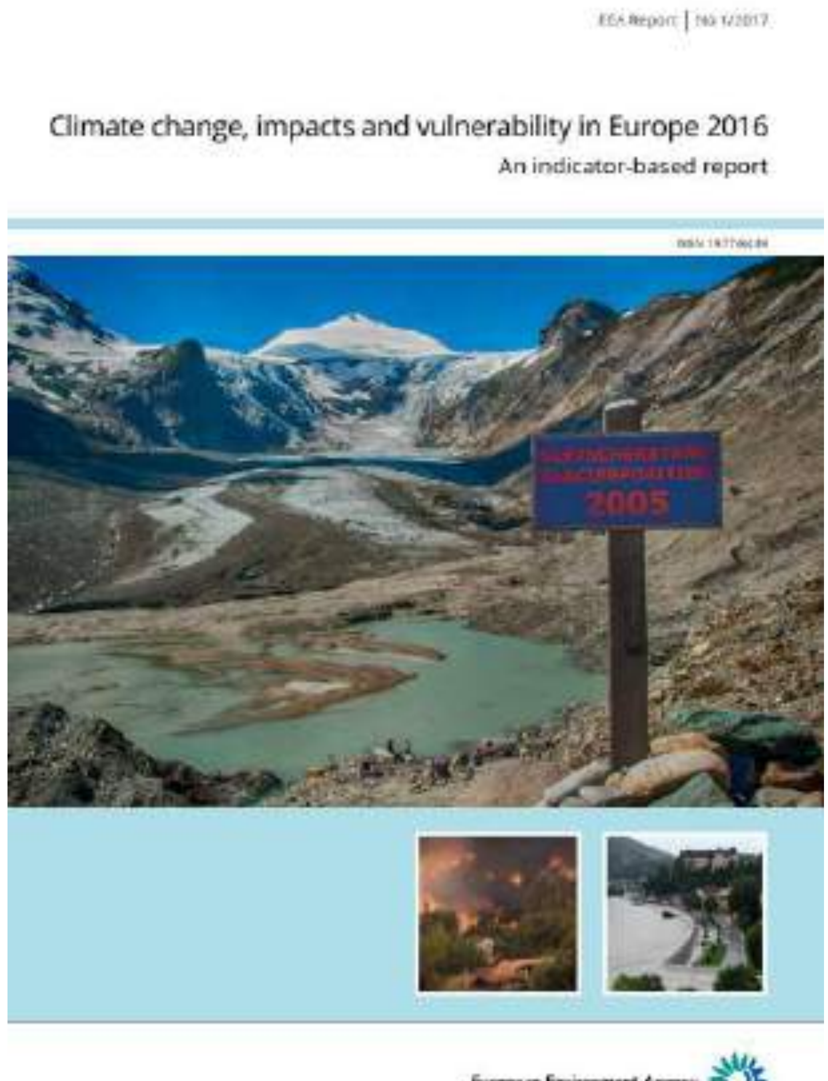


Figure 9. Temperature climate projections, RCP8.5: seasonal differences (°C), between the average value over 2071–2100 and 1971–2000 for (a) DJF, (b) MAM, (c) JJA and (d) SON (S, significant; NS, not significant).

E se non facessimo nulla? NW Italiano + 8 ° C in estate nel 2100! Torino come Karachi…

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

https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016



Map ES.1 Key observed and projected climate change and impacts for the main biogeographical regions in Europe

Arctic region
- Temperature rise much larger than global average
- Decrease in Arctic sea ice coverage
- Decrease in Greenland ice sheet
- Decrease in permafrost areas
- Increasing risk of biodiversity loss
- Some new opportunities for the exploitation of natural resources and for sea transportation
- Risks to the livelihoods of indigenous peoples

Atlantic region
- Increase in heavy precipitation events
- Increase in river flow
- Increasing risk of river and coastal flooding
- Increasing damage risk from winter storms
- Decrease in energy demand for heating
- Increase in multiple climatic hazards

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

Coastal zones and regional seas
- Sea level rise
- Increase in sea surface temperatures
- Increase in ocean acidity
- Northward migration of marine species
- Risks and some opportunities for fisheries
- Changes in phytoplankton communities
- Increasing number of marine dead zones
- Increasing risk of water-borne diseases

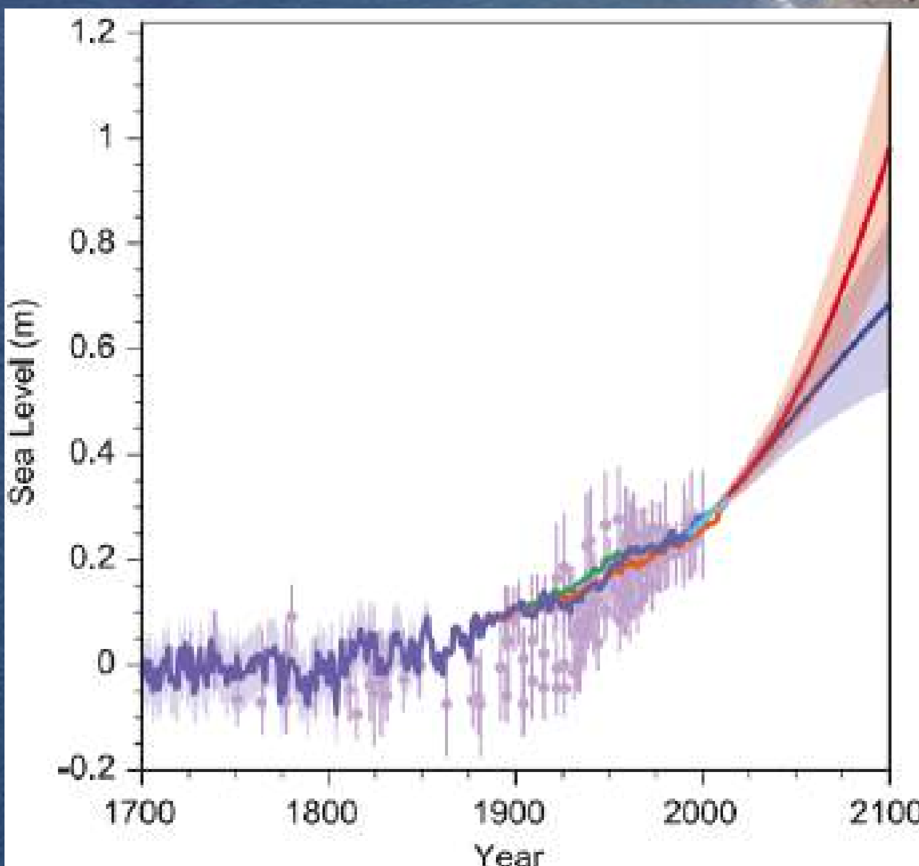
Boreal region
- Increase in heavy precipitation events
- Decrease in snow, lake and river ice cover
- Increase in precipitation and river flows
- Increasing potential for forest growth and increasing risk of forest pests
- Increasing damage risk from winter storms
- Increase in crop yields
- Decrease in energy demand for heating
- Increase in hydropower potential
- Increase in summer tourism

Continental region
- Increase in heat extremes
- Decrease in summer precipitation
- Increasing risk of river floods
- Increasing risk of forest fires
- Decrease in economic value of forests
- Increase in energy demand for cooling

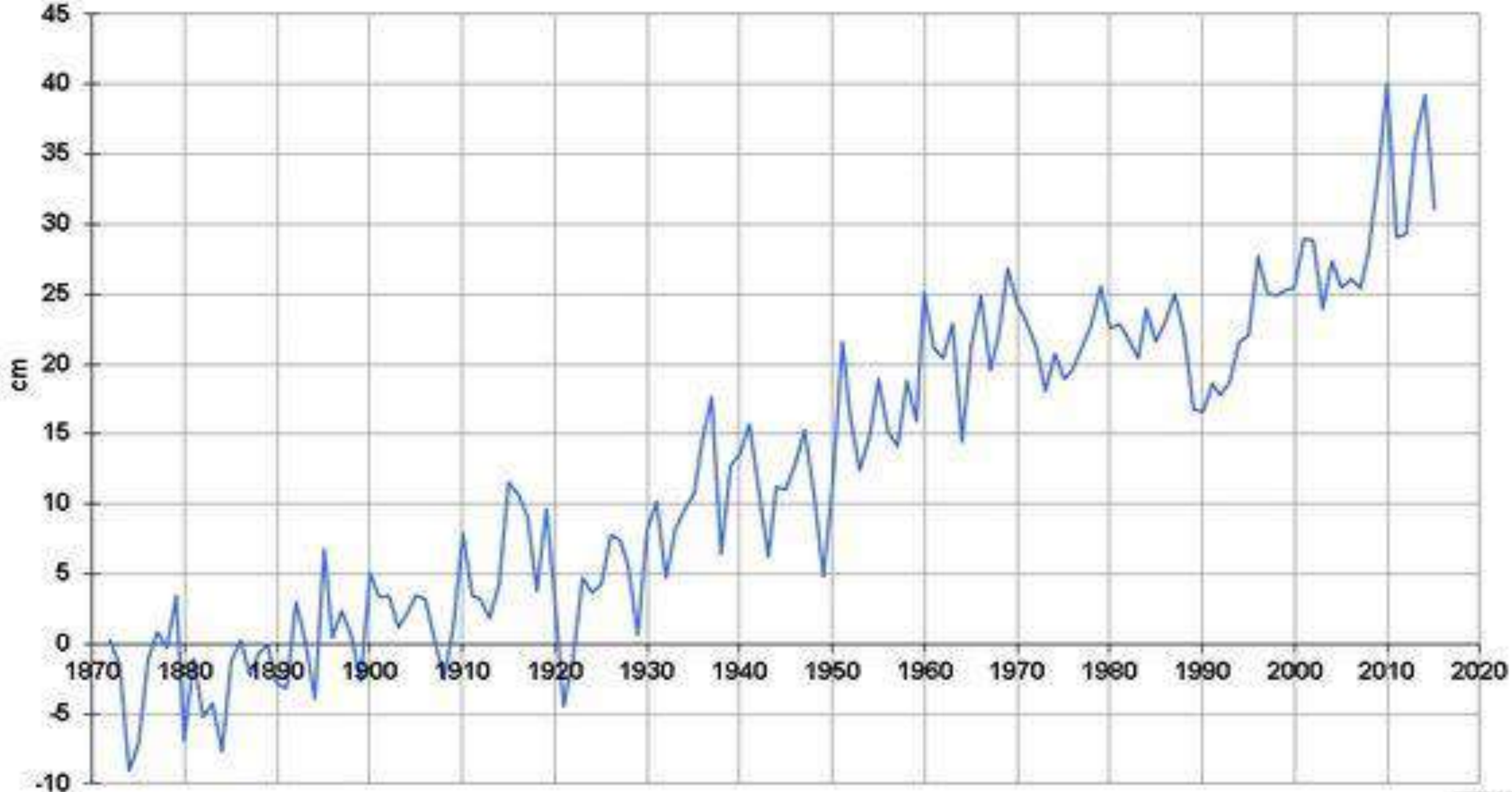
Mediterranean region
- Large increase in heat extremes
- Decrease in precipitation and river flow
- Increasing risk of droughts
- Increasing risk of biodiversity loss
- Increasing risk of forest fires
- Increased competition between different water users
- Increasing water demand for agriculture
- Decrease 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


Aumento livello marino:
a rischio laguna veneta e delta del Po

Le zone costiere risentiranno dell’aumento del livello marino, e dovranno essere adeguatamente protette (es: Venezia, delta del Po)



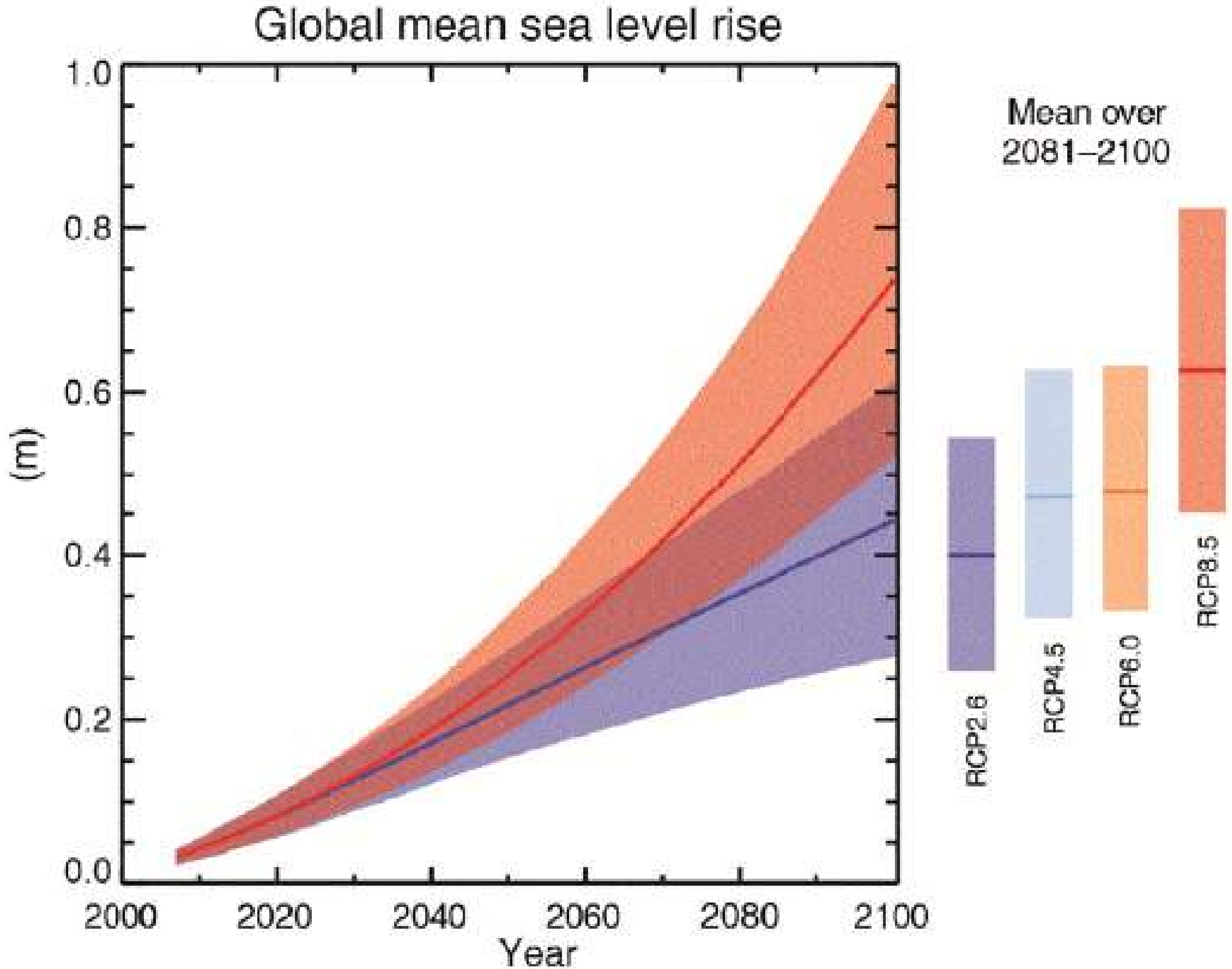
Venezia: livello mare +30 cm in un secolo



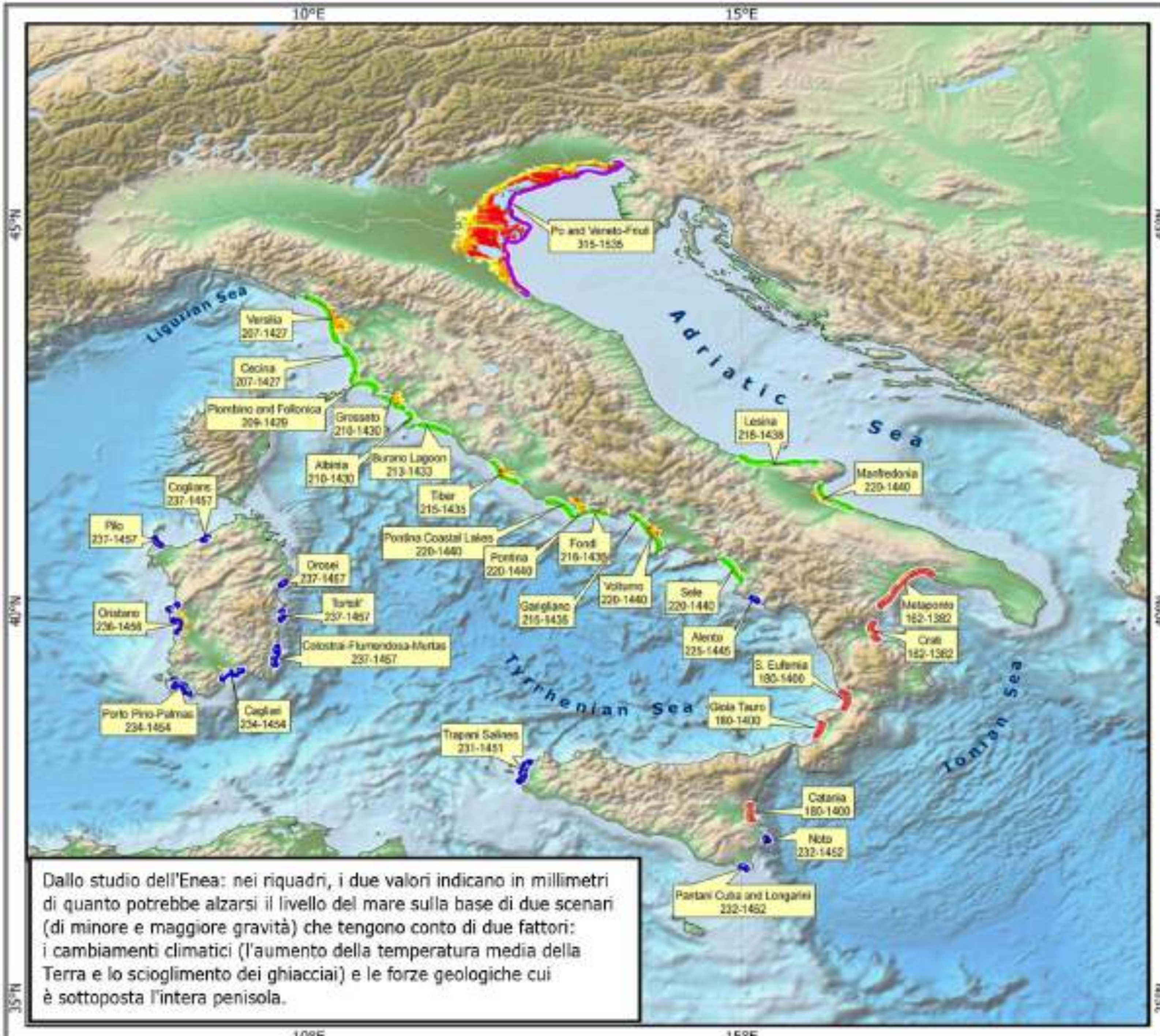
Istituzione
Centro Previsioni
e
Segnalazioni Maree

CITTÀ DI VENEZIA

SLR Sea Level Rise, attuale +3,4 mm/yr, +2°C = +50 cm al 2100, +5°C=+100 cm

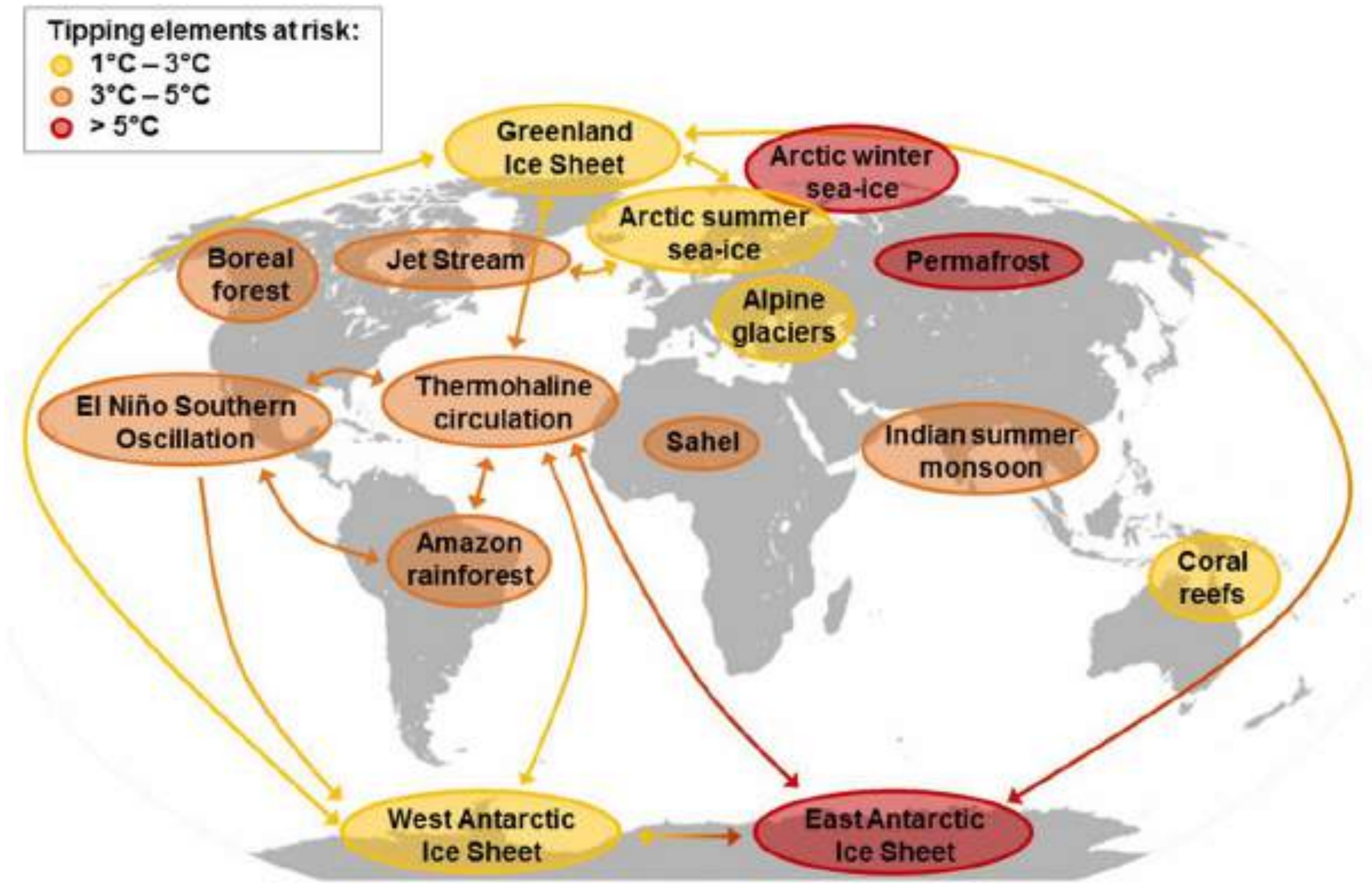


Ipcc
AR5



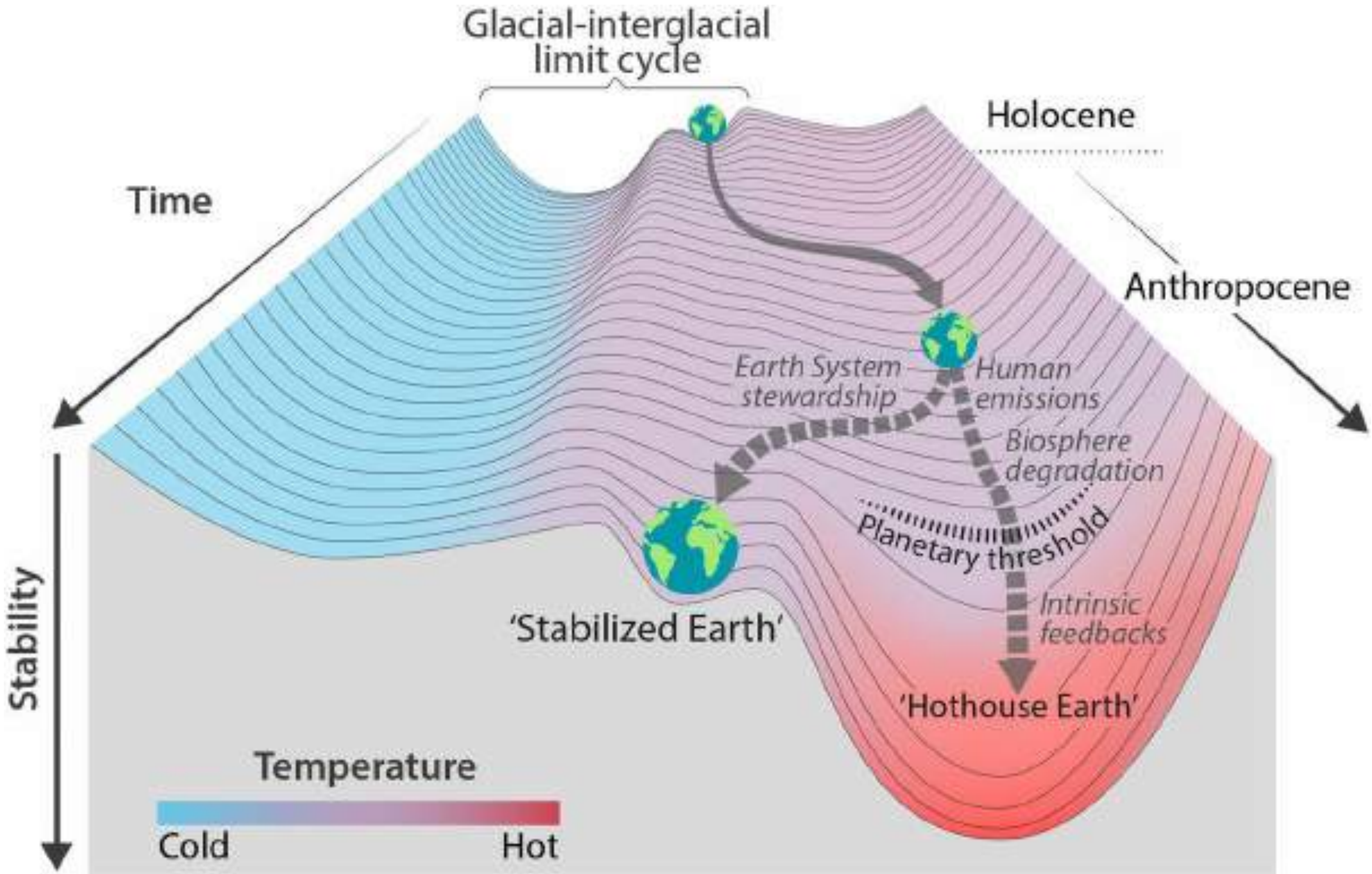
Dallo studio dell'Enea: nei riquadri, i due valori indicano in millimetri di quanto potrebbe alzarsi il livello del mare sulla base di due scenari (di minore e maggiore gravità) che tengono conto di due fattori: i cambiamenti climatici (l'aumento della temperatura media della Terra e lo scioglimento dei ghiacciai) e le forze geologiche cui è sottoposta l'intera penisola.

ential tipping cascades.



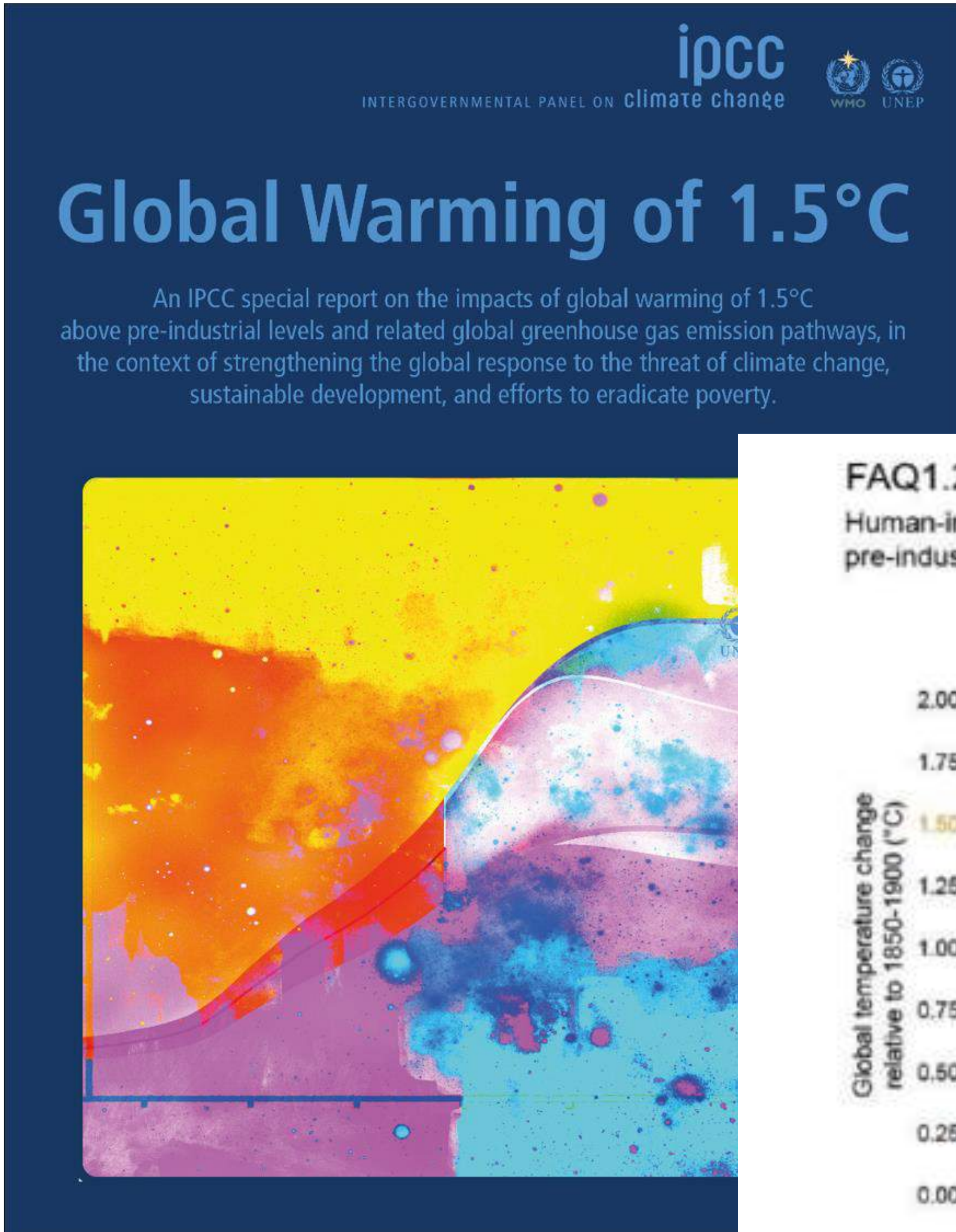
Will Steffen et al. PNAS doi:10.1073/pnas.1810141115

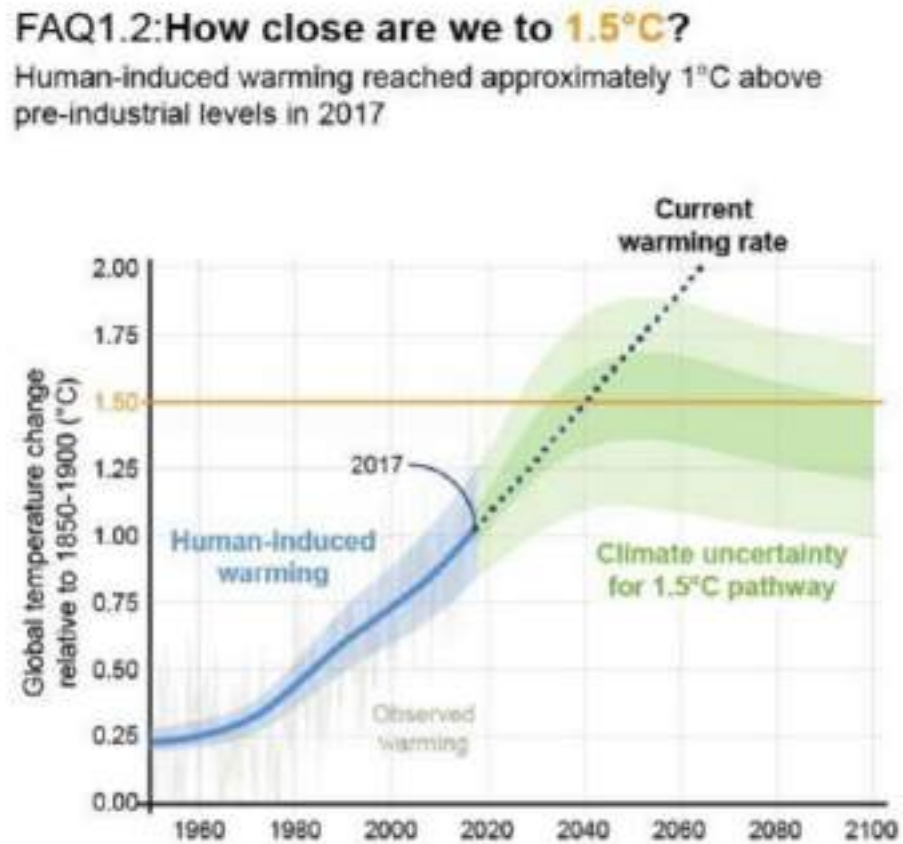
us, out of the glacial–interglacial limit cycle to its present position in the hotter Anthropocene.



Will Steffen et al. PNAS doi:10.1073/pnas.1810141115

PNAS

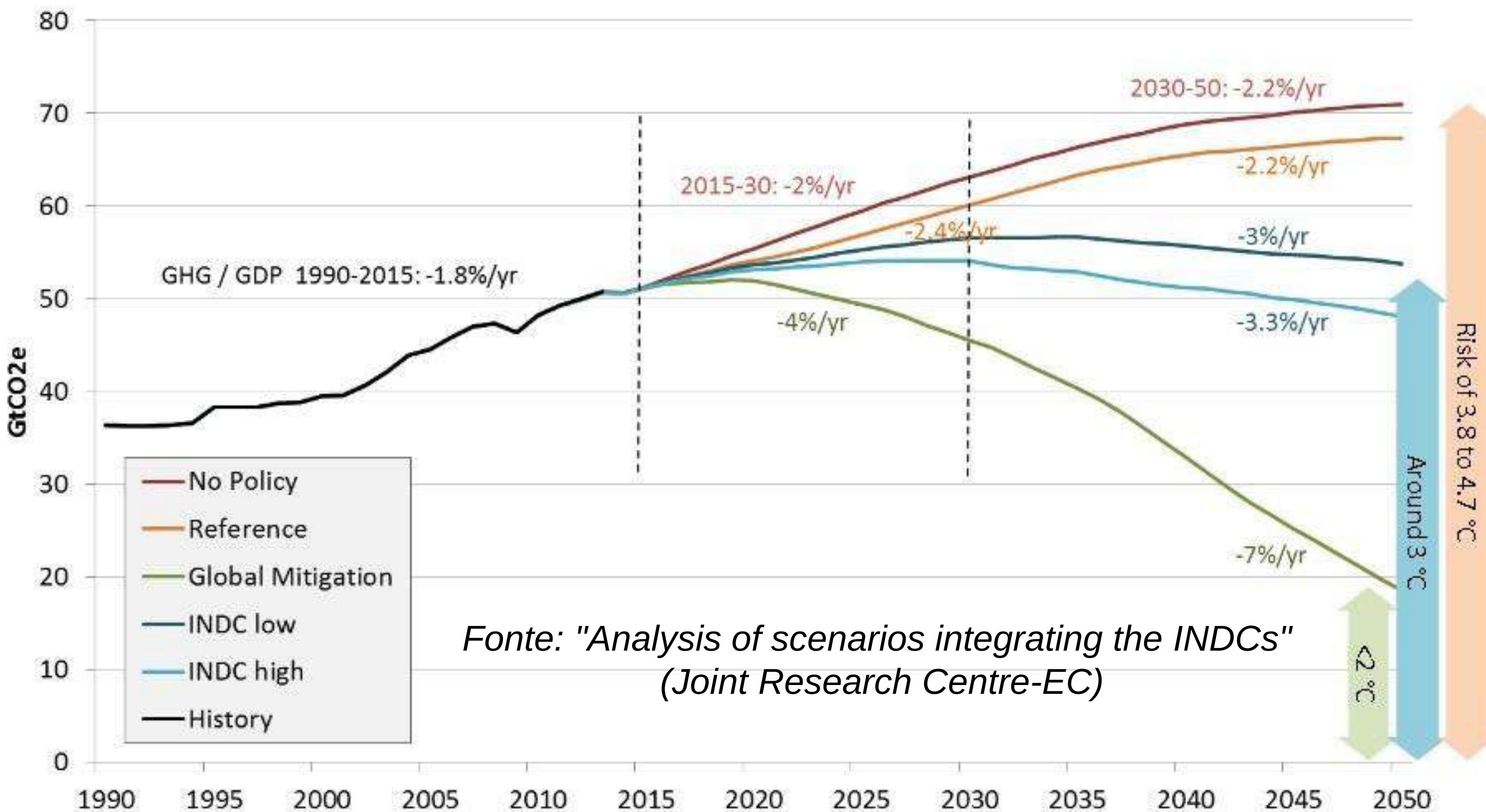




FAQ1.2. Figure 1: Human-induced warming reached approximately 1°C above pre-industrial levels in 2017. At the present rate, global temperatures would reach 1.5°C around 2040.

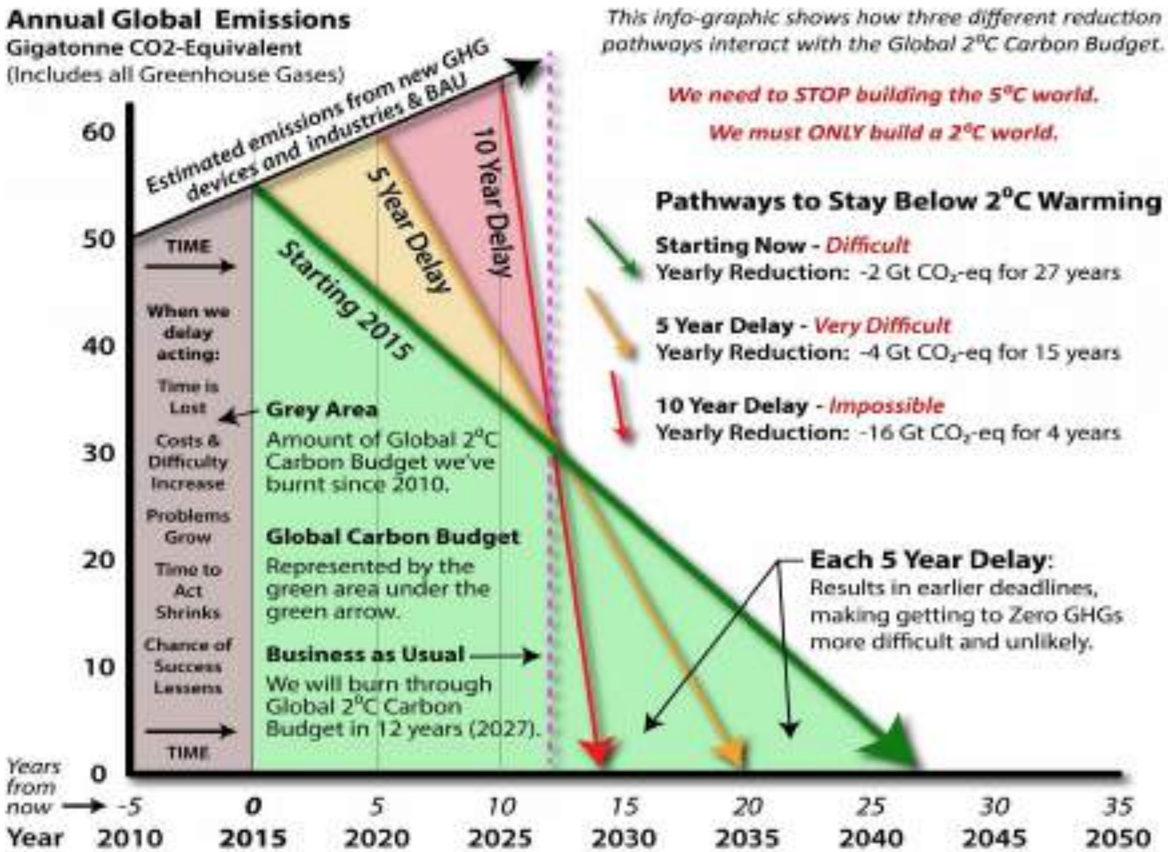
Testi e illustrazioni ispirati da:
IPCC Special Report on Global Warming of 1.5°C

Promesse ambiziose di riduzione CO_2, ma non bastano: se applicate, circa +3 °C nel 2100 !



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

DON'T DELAY CLIMATE ACTION



What's the big deal?

If we don't address climate change, the average global temperature might rise 4°C to 5°C by 2100.
In Canada, scientists say we've been experiencing temperature increases 1.5 - 2 times the global average.
So for the year 2100, add 8°C or 10°C to your local temperatures.

Will your town be habitable in 2100? Where will Canadians be able to live? Where will you live?

Where will we put all those climate refugees from the USA?

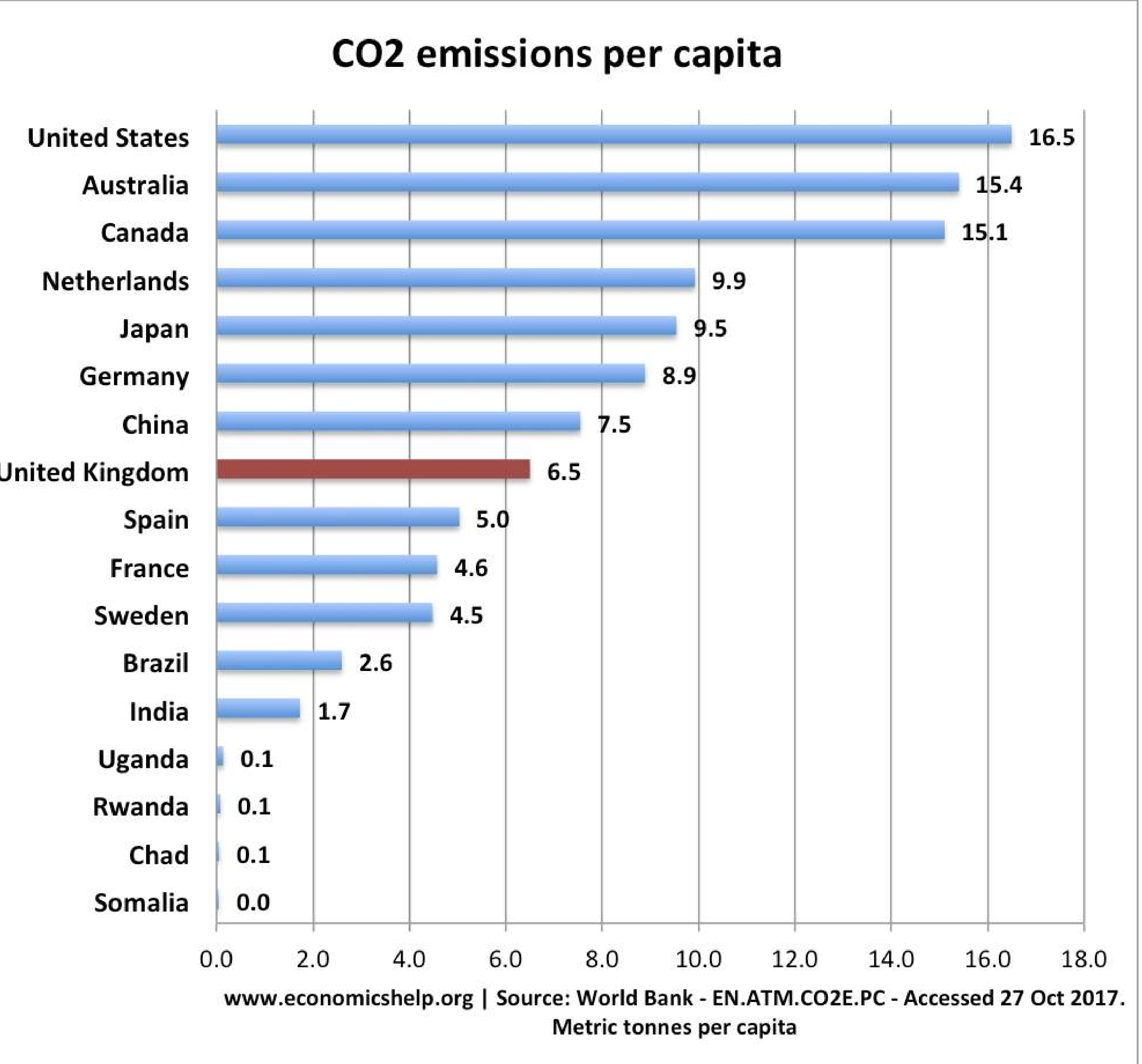
Global 2°C Carbon Budget:

The amount of CO_2 (and other GHGs) that can be added to the atmosphere and still remain below 2°C average warming.

Global 2°C Carbon Budget as of 2011: 1,000 Gt CO_2-equivalent[1]
GHGs emitted in 2010: 49 +/- 4.5 Gt CO_2-equivalent[1]
GHG emissions increase: 2000 - 2010: 2.2%/year[1]

[1] *IPCC Climate Change 2014 Synthesis Report Summary for Policymakers, pages 5 & 10*

Info-graphic by: Craig Henschel at EnergyandClimatePlan.org 2015-12-07 This is terrifying. I hope I've made errors. If you find some, let me know. Thanks.



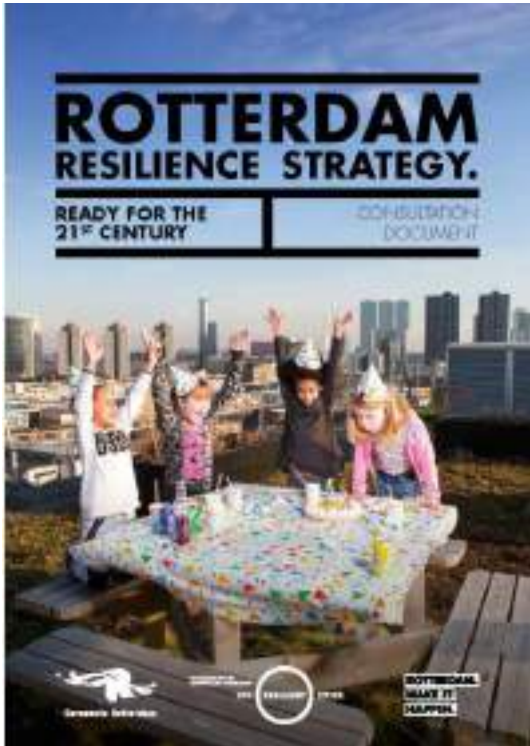
2014

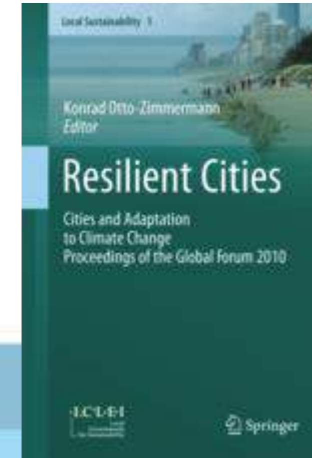
Italy 5.3

EU 6,4

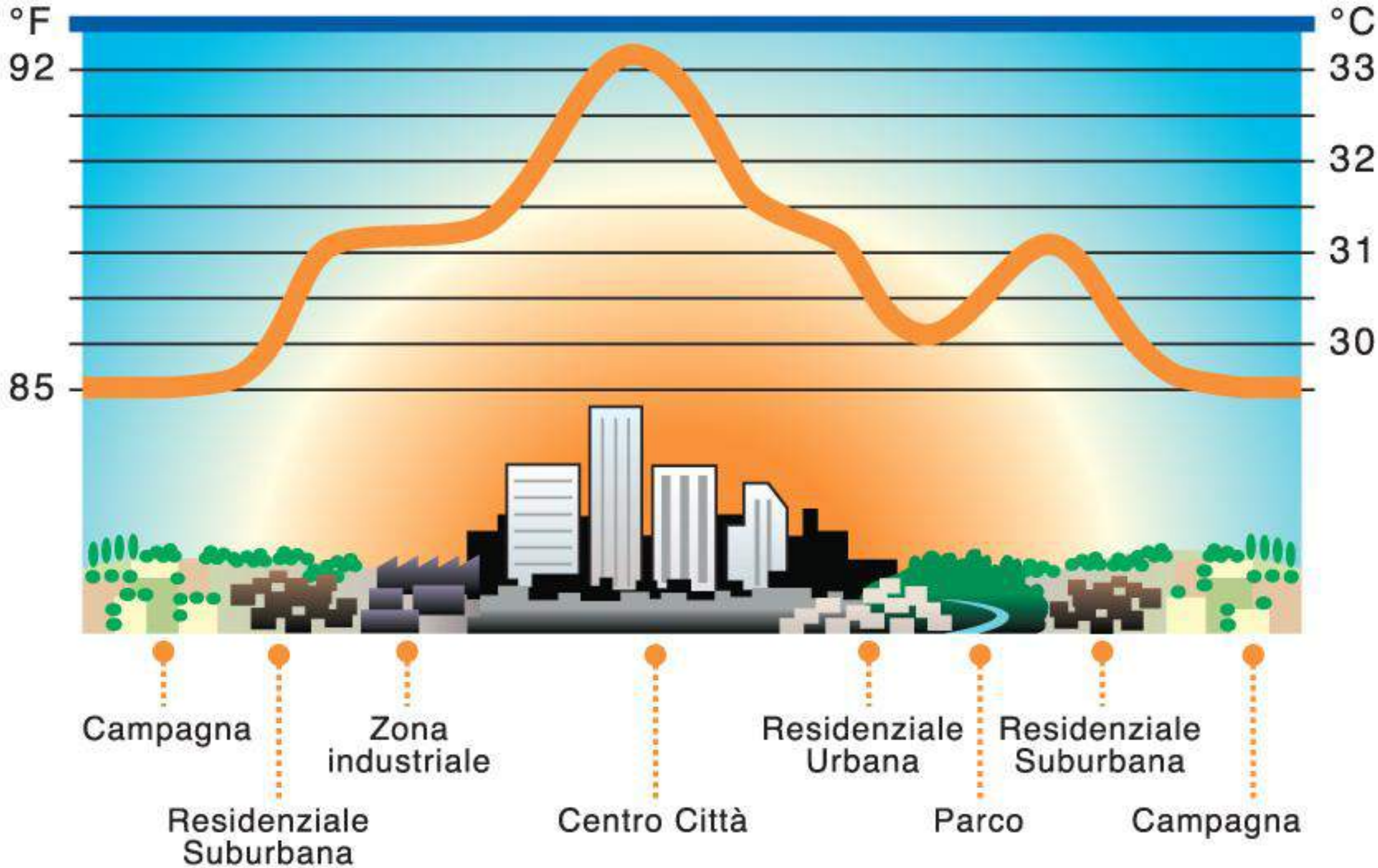
Global mean 5,0

Città resilienti e sostenibili





Isola di calore urbana



Adattamento = resilienza a eventi estremi, ondate di caldo e nubifragi/alluvioni

Mitigazione = riqualificazione per efficienza energetica e mi

Più energie rinnovabili ed efficienza energ


Produrre meno rifiuti!
514 kg/pc anno
Riciclare!
Fare il compost!


www.midwayfilm.com

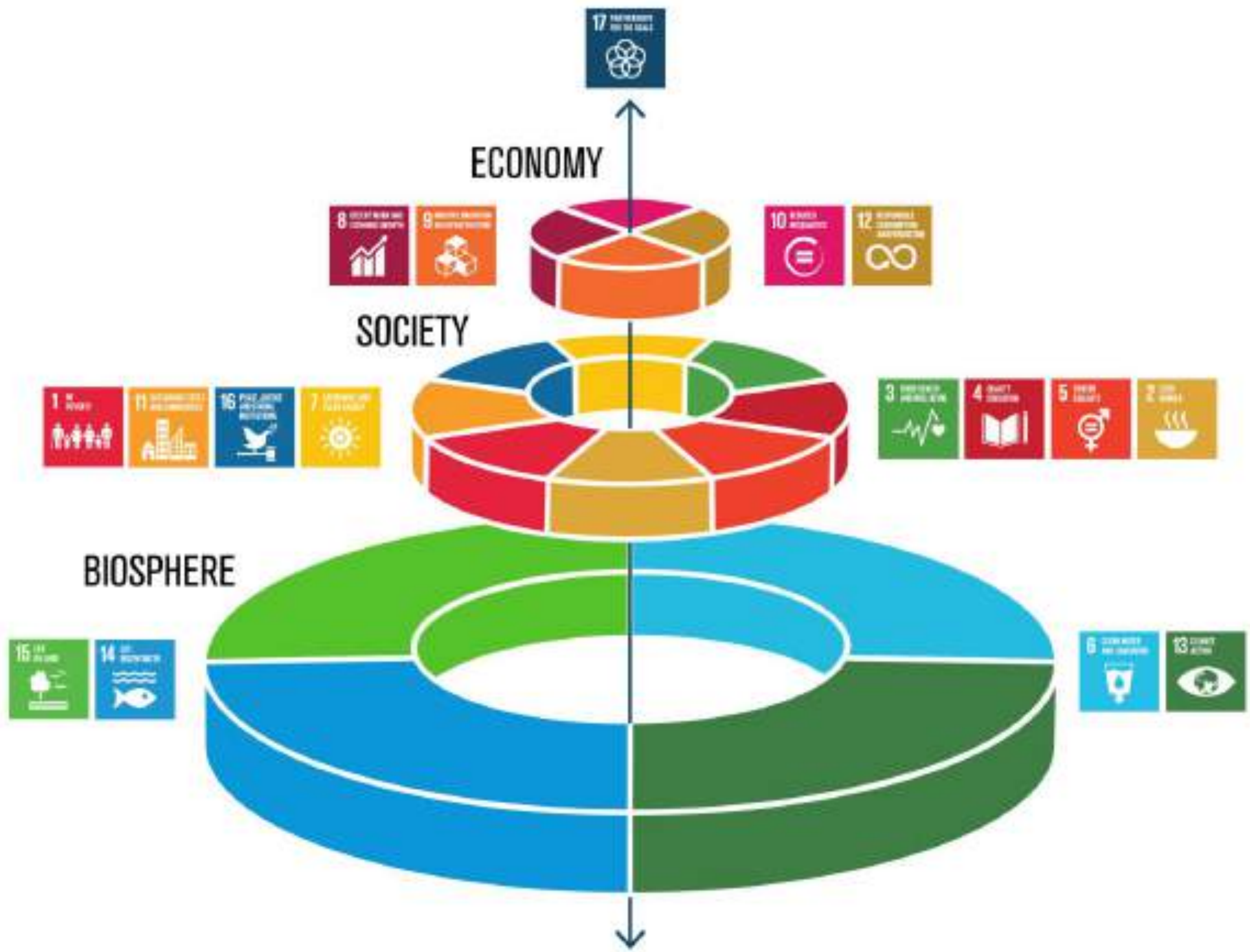

Passaggio a mobilità elettrica

Meno viaggi aerei, meno trasporti in genere, più telelavoro

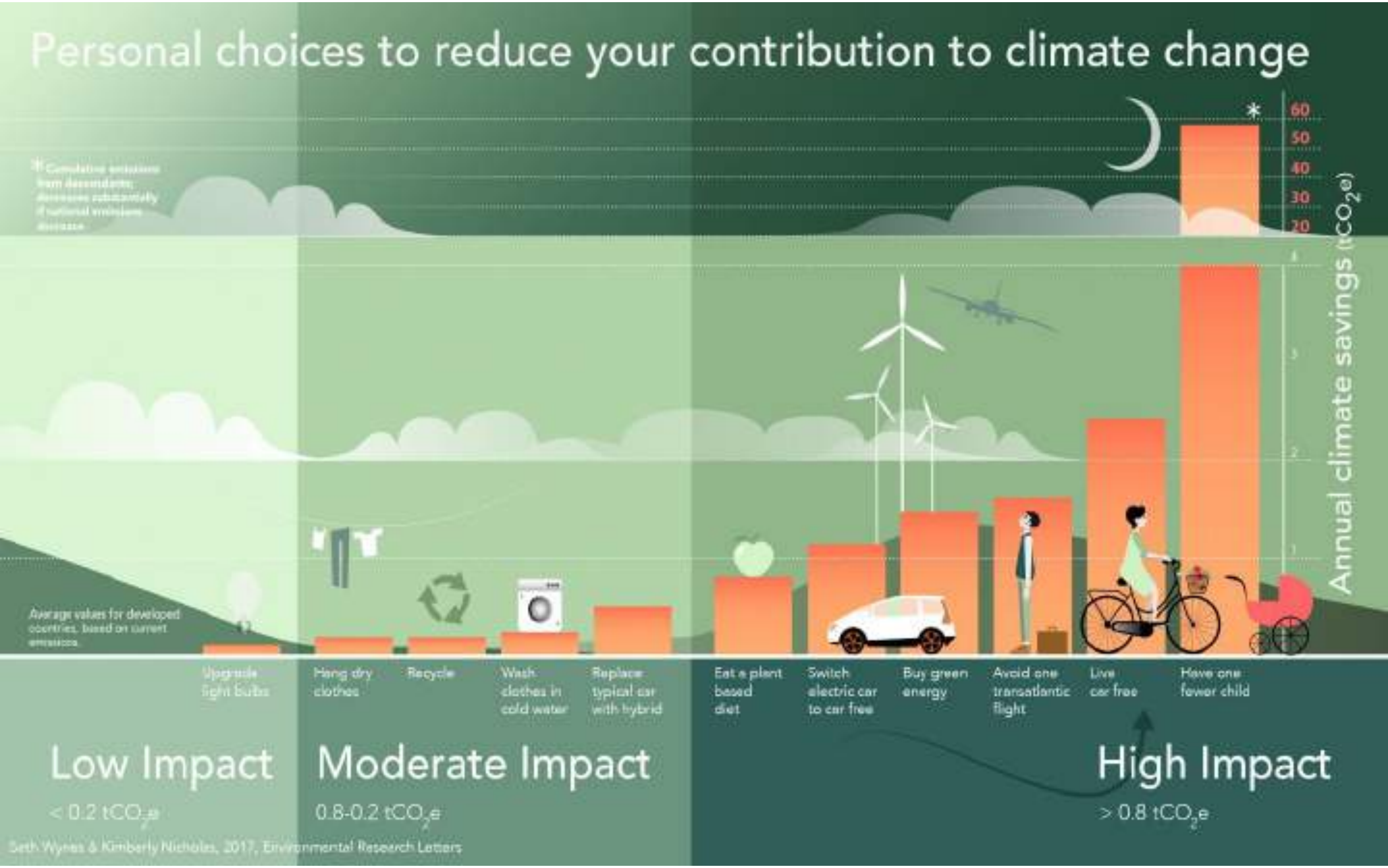
Al lavoro! Gli obiettivi UN dell’Agenda 2030

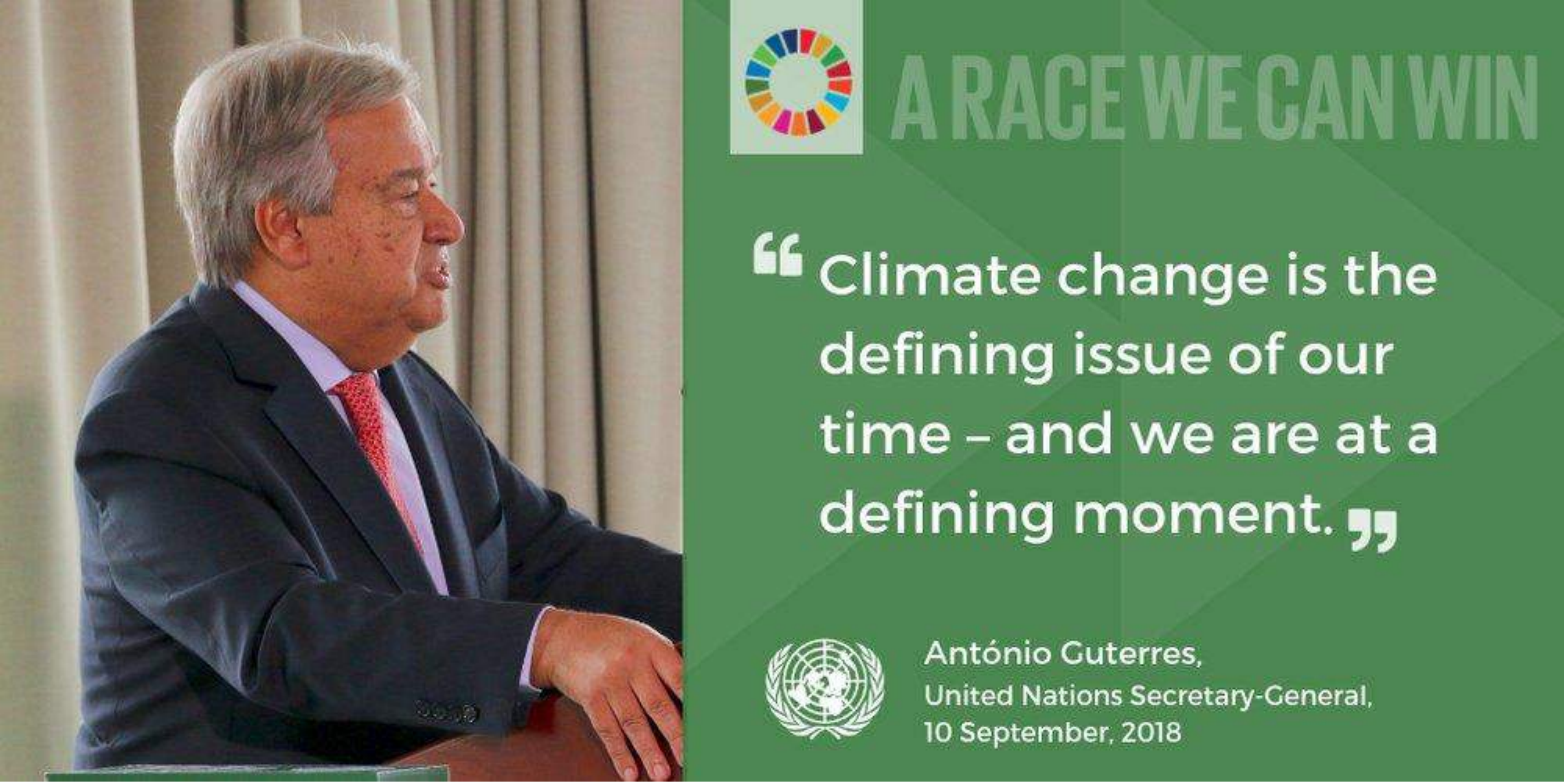
SUSTAINABLE DEVELOPMENT
SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

“The wedding cake” - organizzazione gerarchica dei Sustainable Development Goals (SDGs) - Da Johan Rockström and Pavav Sukhdev - Stockholm Resilience Centre



Per ottenere risultati servono riduzioni delle emissioni ad alto potenziale (high-impact), i piccoli gesti per l’ambiente non bastano più!

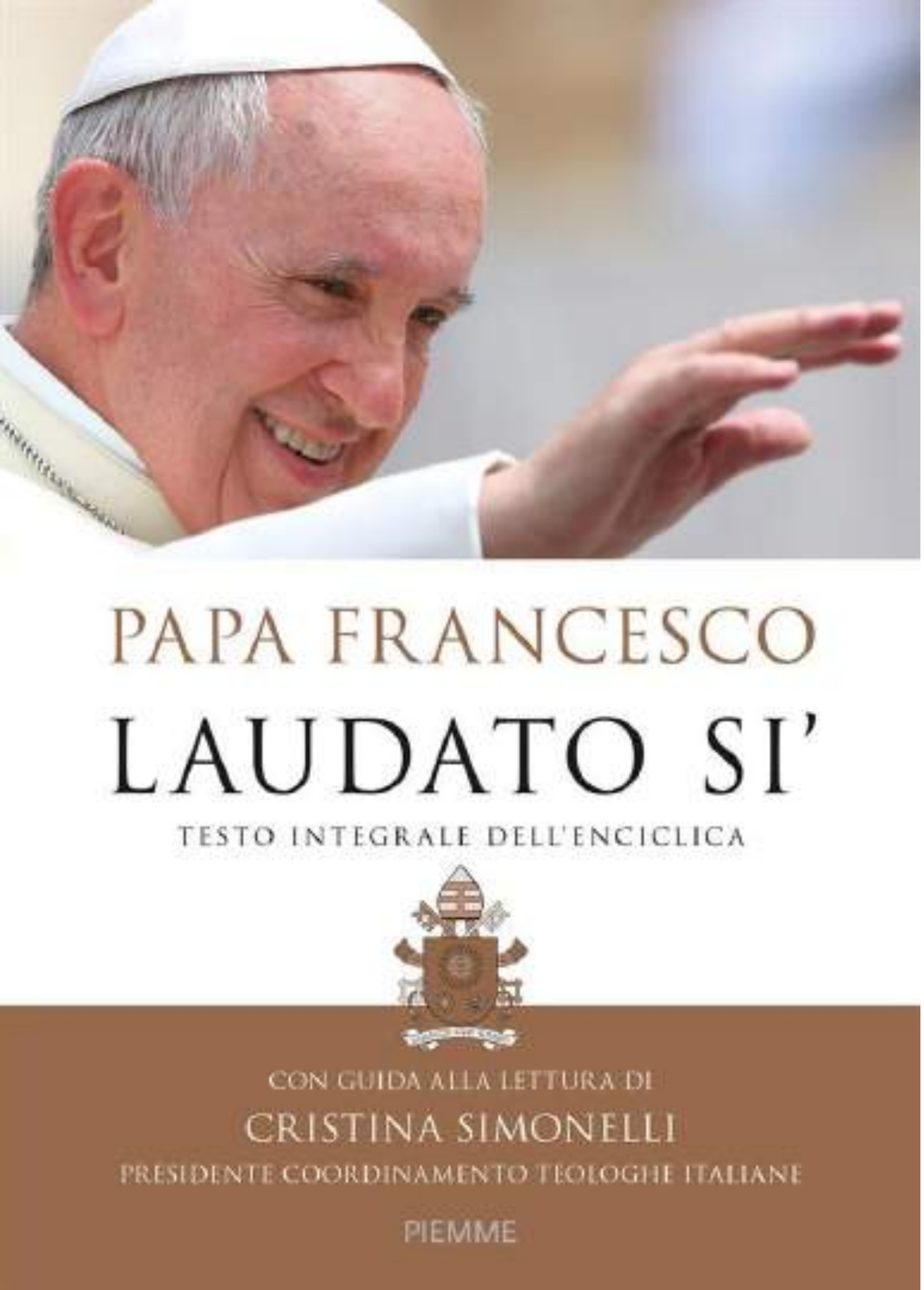




“Climate change is moving faster than we are.”

“If we do not change course by 2020, we risk missing the point where we can avoid runaway climate change, with disastrous consequences for people and all the natural systems that sustain us.”


A RACE WE CAN WIN
"The transition to a cleaner, greener future needs to speed up. We stand at a truly "use it or lose it" moment."
António Guterres,
United Nations Secretary-General,
10 September, 2018



Maggio 2015, storica enciclica di Papa Francesco "**Laudato si'**": la Chiesa sposa ufficialmente la lotta ai cambiamenti climatici e al degrado ambientale:

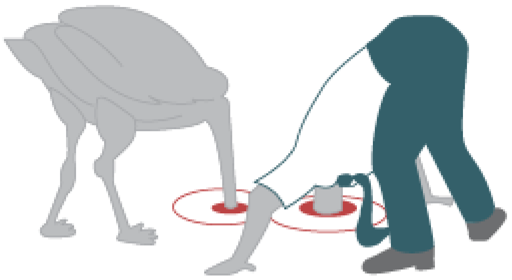
sì al necessario, no al superfluo

Il tempo è il fattore critico di successo.
Dobbiamo accelerare la transizione!

Ostrich Effect

We tend to ignore or avoid negative and risky information and situations. We 'bury our heads in the sand'.

This is particularly common when it comes to money. It's the last week of the month. Rather than carefully budgeting what's left, we choose not to look at our bank balance.



gravity
BEHAVIOURAL CHANGE AGENCY

The only question is how to communicate the gravity of our situation to the non-scientific public. In the words of Kaisa Kosonen, an observer at the negotiations, “Scientists might want to write in capital letters, ‘ACT NOW, IDIOTS,’ but they need to say that with facts and numbers.”


LUCA
MERCALLI
NON C'È PIÚ TEMPO
COME REAGIRE AGLI ALLARMI AMBIENTALI

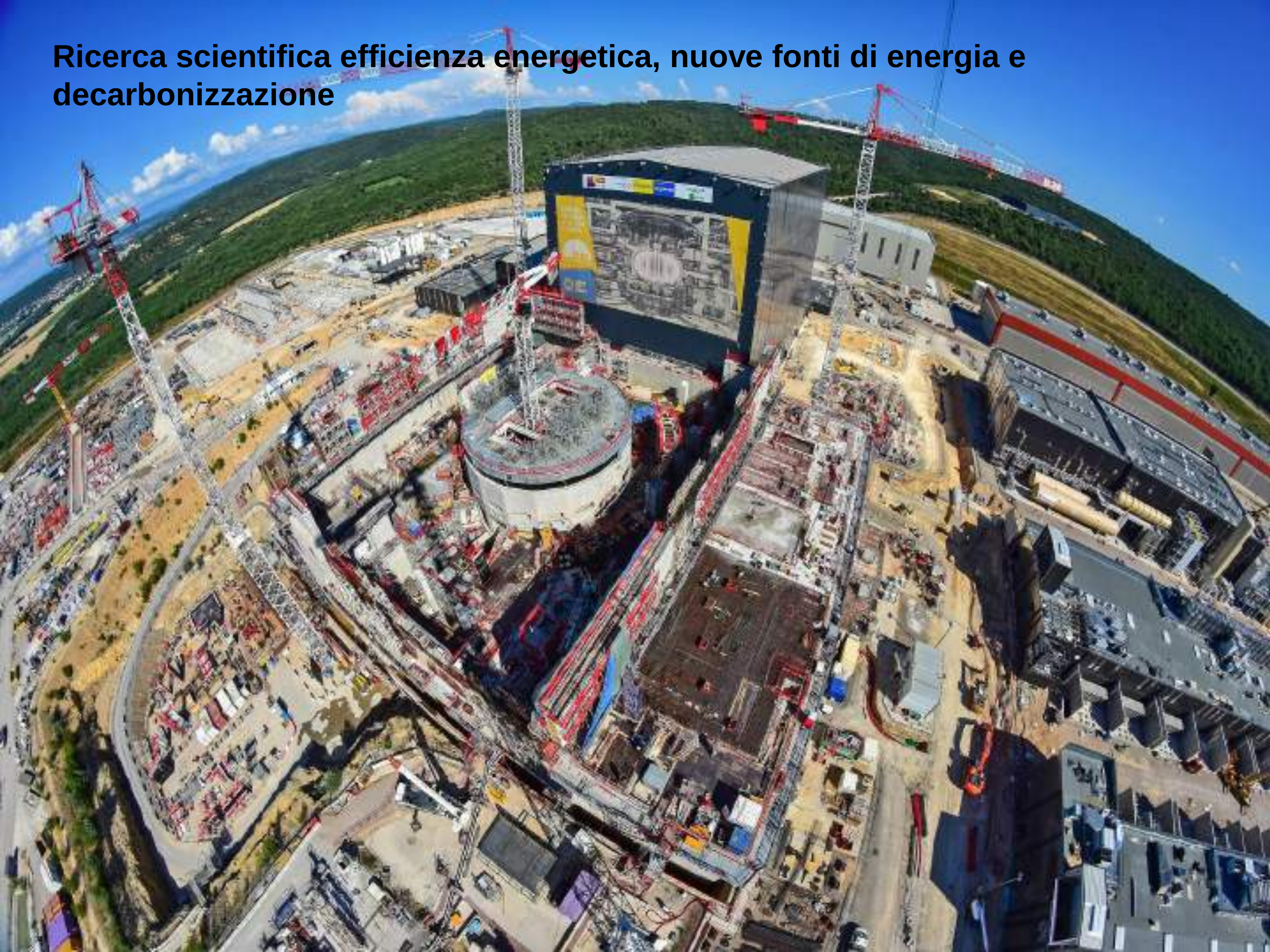

UN PIANO PER SALVARCI
PREPARIAMOCI
A VIVERE IN UN MONDO CON MENO RISORSE,
MENO ENERGIA, MENO ABBONDANZA...
E FORSE PIÙ FELICITÀ
Luca Mercalli
chiarelettere

Nuove professioni della sostenibilità ambientale

Ricerca scientifica sistema Terra

- climatologia
- meteorologia
- glaciologia
- geofisica e geochimica
- ecofisica
- oceanografia
- biologia (protezione ambiente e biodiversità)
- geologia ambientale
- ingegneria ambientale
- idrologia
- remote sensing (satelliti)
- geoidrologia, eventi meteo estremi, frane, valanghe, alluvioni
-

Ricerca scientifica efficienza energetica, nuove fonti di energia e decarbonizzazione

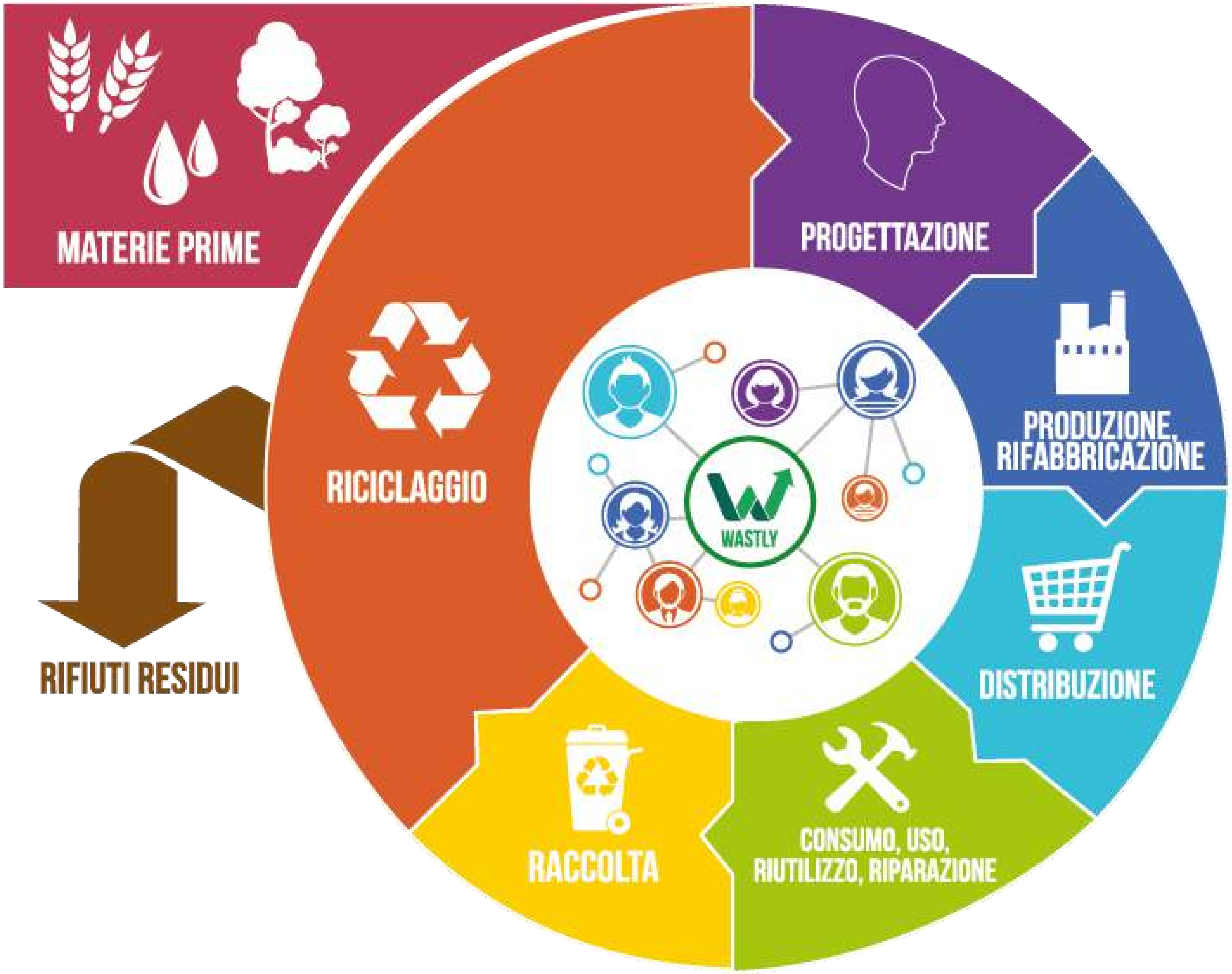


Sviluppo efficienza energetica e nuove fonti energia a basse emissioni (pannelli solari, turbine eoliche, reattore a fusione ITER, biogas, isolamento termico, domotica, mobilità elettrica…)

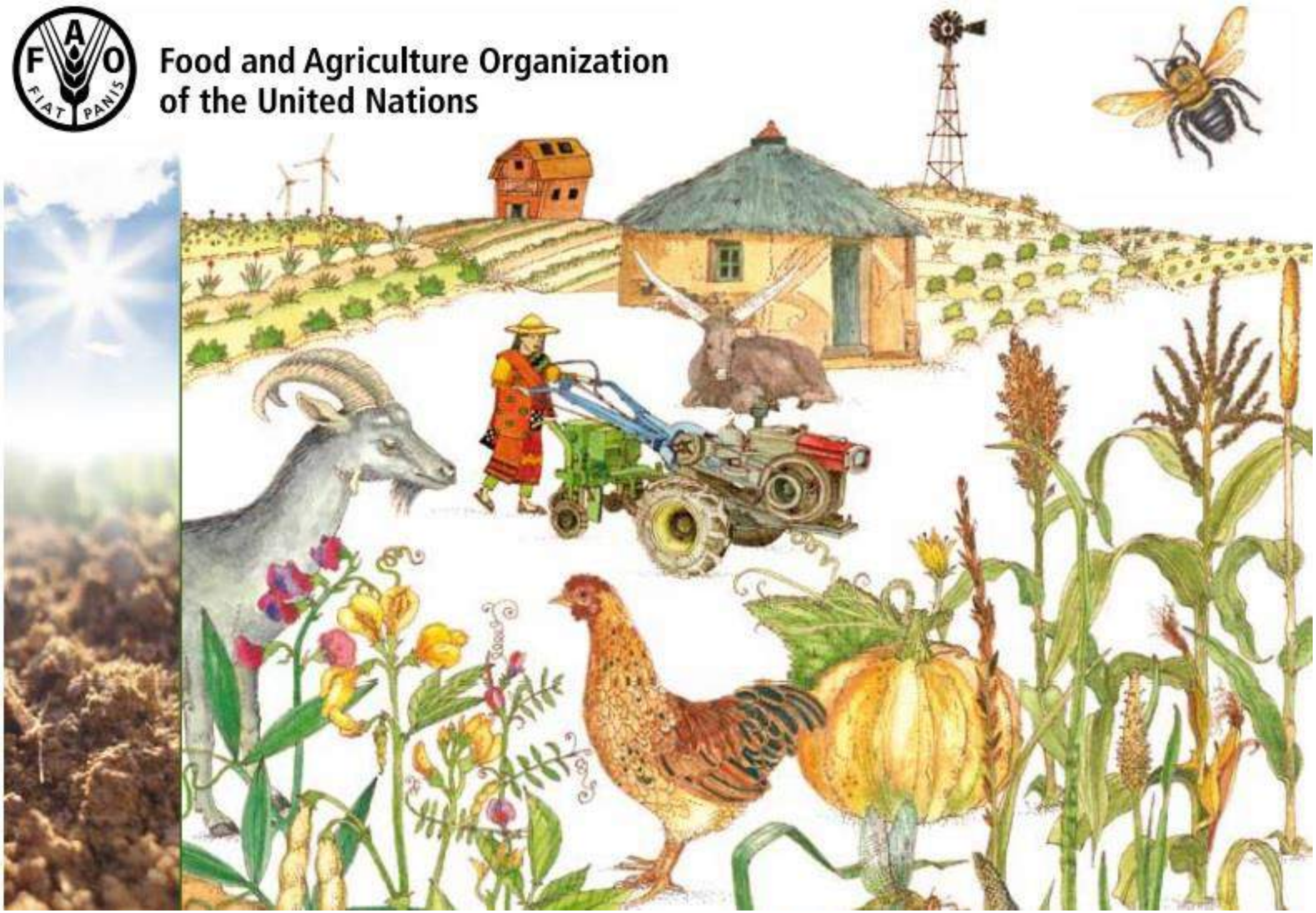
- Fisica tecnica
- Fisica teorica
- Ingegneria elettrica
- Ingegneria elettronica
- Ingegneria civile / Architettura sostenibile
- Ingegneria meccanica (auto elettriche)
- Informatica applicata alla modellistica energetica e ambientale
- Biotecnologie (specie vegetali resistenti a siccità, alghe per produzione di biocombustibili…)
- Architettura sostenibile, bioarchitettura, bioedilizia
- Urbanistica / città resilienti e sostenibili / protezione civile
- Ingegneria idraulica, gestione reti idriche
- ...

Professioni applicate alla sostenibilità ambientale / risparmio energetico

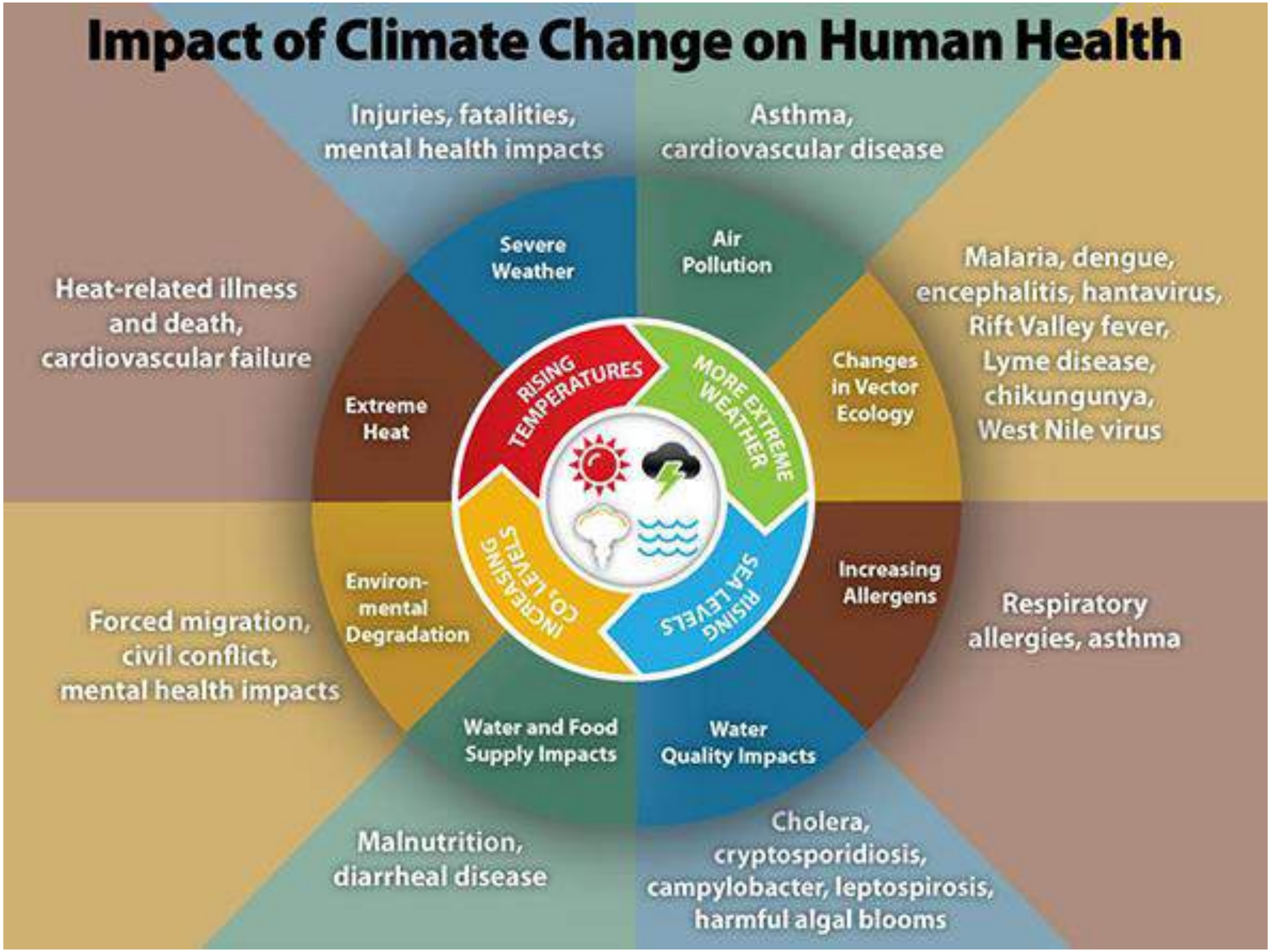
Economia circolare e gestione rifiuti



Agroecologia e agricoltura / filiera agroalimentare sostenibile



Cambiamenti climatici e medicina / sanità / prevenzione malattie da caldo e da insetti vettori di virus tropicali



Scienze umane
- Diritto dell’ambiente, accordi internazionali
- Sociologia dell’ambiente
- Psicologia sociale
- Economia ambientale / bioeconomia
- Storia dell’ambiente
- Geografia economica in relazione alla sostenibilità globale
- Comunicazione e giornalismo ambientale

Anche la moda e l'arte possono essere sostenibili!

Qualsiasi disciplina tecnica, scientifica, economica, sociale o artistica può essere declinata verso la sostenibilità ambientale