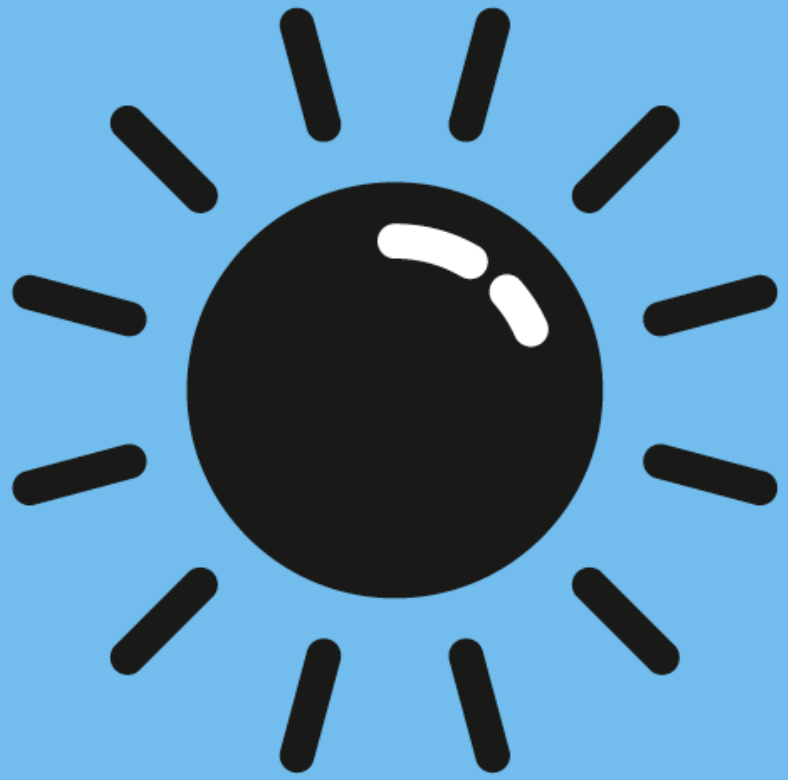
Federico Grazzini - Sergio Rossi

Fa un po’ caldo

Breve storia del riscaldamento globale
e dei suoi protagonisti

I Webinar(i) del giovedì CETEMPS – 19 novembre 2020

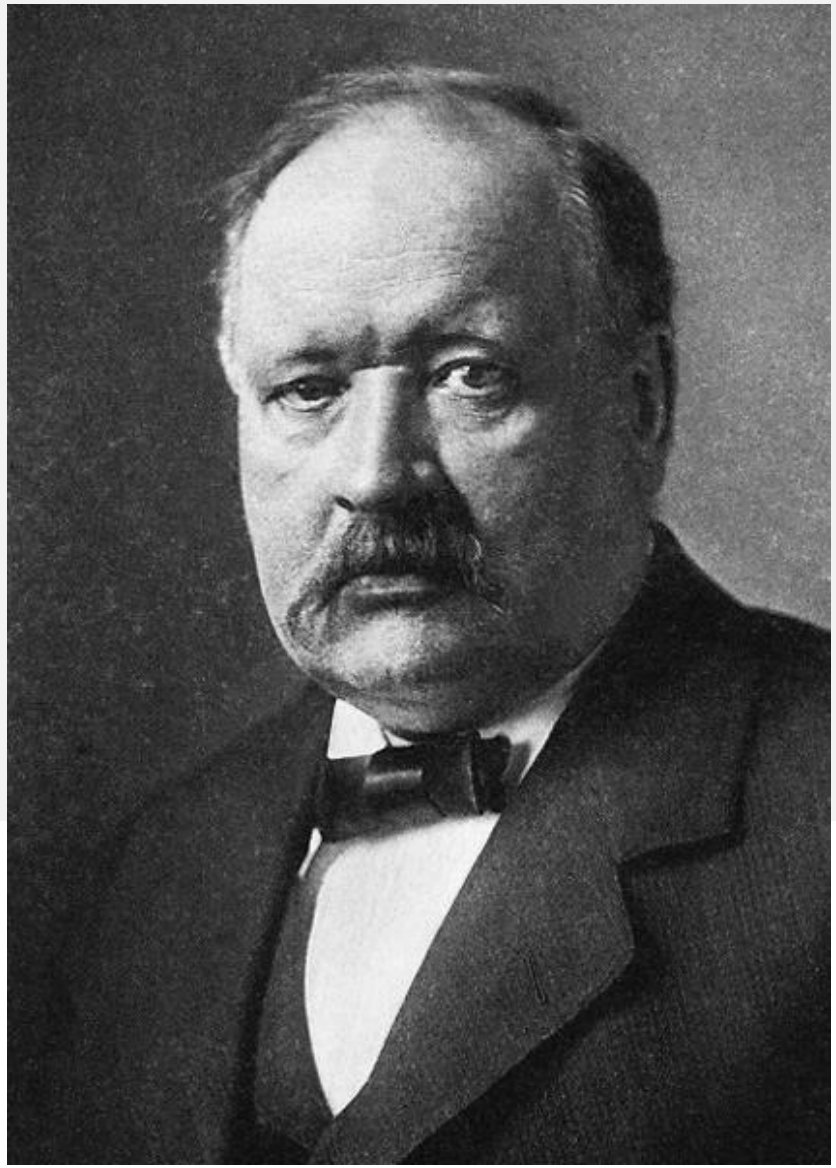


1896-1965:
LA TEMPERATURA
SI ALZA

Parte 1

Chi ha scoperto il riscaldamento globale:

- Fourier
- Foote
- Arrhenius
- Callendar
- Revelle
- Keeling



Svante Arrhenius, ppm 285, 1896

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).

MÉMOIRE

SUR

LES TEMPÉRATURES DU GLOBE TERRESTRE ET DES ESPACES PLANÉTAIRES.

PAR M. FOURIER.

La question des températures terrestres, l'une des plus importantes et des plus difficiles de toute la philosophie naturelle, se compose d'éléments assez divers qui doivent être considérés sous un point de vue général. J'ai pensé qu'il serait utile de réunir dans un seul écrit les conséquences principales de cette théorie; les détails analytiques que l'on omet ici se trouvent pour la plupart dans les ouvrages que j'ai déja publiés. J'ai désiré surtout présenter aux physiciens, dans un tableau peu étendu, l'ensemble des phénomènes et les rapports mathématiques qu'ils ont entre eux.

La chaleur du globe terrestre dérive de trois sources qu'il est d'abord nécessaire de distinguer.

1° La terre est échauffée par les rayons solaires, dont l'inégale distribution produit la diversité des climats.

2° Elle participe à la température commune des espaces planétaires, étant exposée à l'irradiation des astres innombrables qui environnent de toutes parts le système solaire.

1824. 72

Jean-Baptiste Jospeph Fourier, 14 °C e non – 17 °C, 1827

Eunice Foote, il ruolo della CO_2, 1856

382 *On the Heat in the Sun's Rays.*

ART. XXXI.—*Circumstances affecting the Heat of the Sun's Rays;* by EUNICE FOOTE.

(Read before the American Association, August 23d, 1856.)

MY investigations have had for their object to determine the different circumstances that affect the thermal action of the rays of light that proceed from the sun.

Several results have been obtained.

First. The action increases with the density of the air, and is diminished as it becomes more rarified.

The experiments were made with an air-pump and two cylindrical receivers of the same size, about four inches in diameter and thirty in length. In each were placed two thermometers, and the air was exhausted from one and condensed in the other. After both had acquired the same temperature they were placed in the sun, side by side, and while the action of the sun's rays rose to 110° in the condensed tube, it attained only 88° in the other. I had no means at hand of measuring the degree of condensation or rarefaction.

The observations taken once in two or three minutes, were as follows:

Exhausted Tube		Condensed Tube.	
In shade.	In sun.	In shade.	In sun.
75	80	75	80
76	82	78	95
80	82	80	100
83	86	82	105
84	88	85	110

This circumstance must affect the power of the sun's rays in different places, and contribute to produce their feeble action on the summits of lofty mountains.

Secondly. The action of the sun's rays was found to be greater in moist than in dry air.

In one of the receivers the air was saturated with moisture—in the other it was dried by the use of chlorid of calcium.

Both were placed in the sun as before and the result was as follows:

Dry Air.		Damp Air.	
In shade.	In sun.	In shade.	In sun.
75	75	75	75
78	88	78	90
82	102	82	106
82	104	82	110
82	106	82	114
88	108	92	120

Marcou's Geological Map of the United States. 383

The high temperature of moist air has frequently been observed. Who has not experienced the burning heat of the sun that precedes a summer's shower? The isothermal lines will, I think, be found to be much affected by the different degrees of moisture in different places.

Thirdly. The highest effect of the sun's rays I have found to be in carbonic acid gas.

One of the receivers was filled with it, the other with common air, and the result was as follows:

In Common Air.		In Carbonic Acid Gas.	
In shade.	In sun.	In shade.	In sun.
80	90	80	90
81	94	84	100
80	99	84	110
81	100	85	120

The receiver containing the gas became itself much heated—very sensibly more so than the other—and on being removed, it was many times as long in cooling.

An atmosphere of that gas would give to our earth a high temperature; and if as some suppose, at one period of its history the air had mixed with it a larger proportion than at present, an increased temperature from its own action as well as from increased weight must have necessarily resulted.

On comparing the sun's heat in different gases, I found it to be in hydrogen gas, 104°; in common air, 106°; in oxygen gas, 108°; and in carbonic acid gas, 125°.

Guy S. Callendar, ppm 310 con aumento di temperatura 0,3 °C, 1938

Roger Revelle, ”effetto Revelle”, 1956

Charles Keeling, Osservatorio di Mauna Loa, 1957

L’effetto dell’accumulo dei gas serra era già noto dall’inizio del 1900

e negli anni sessanta se ne ha piena conferma

David Keeling @SCRIPPS Institute

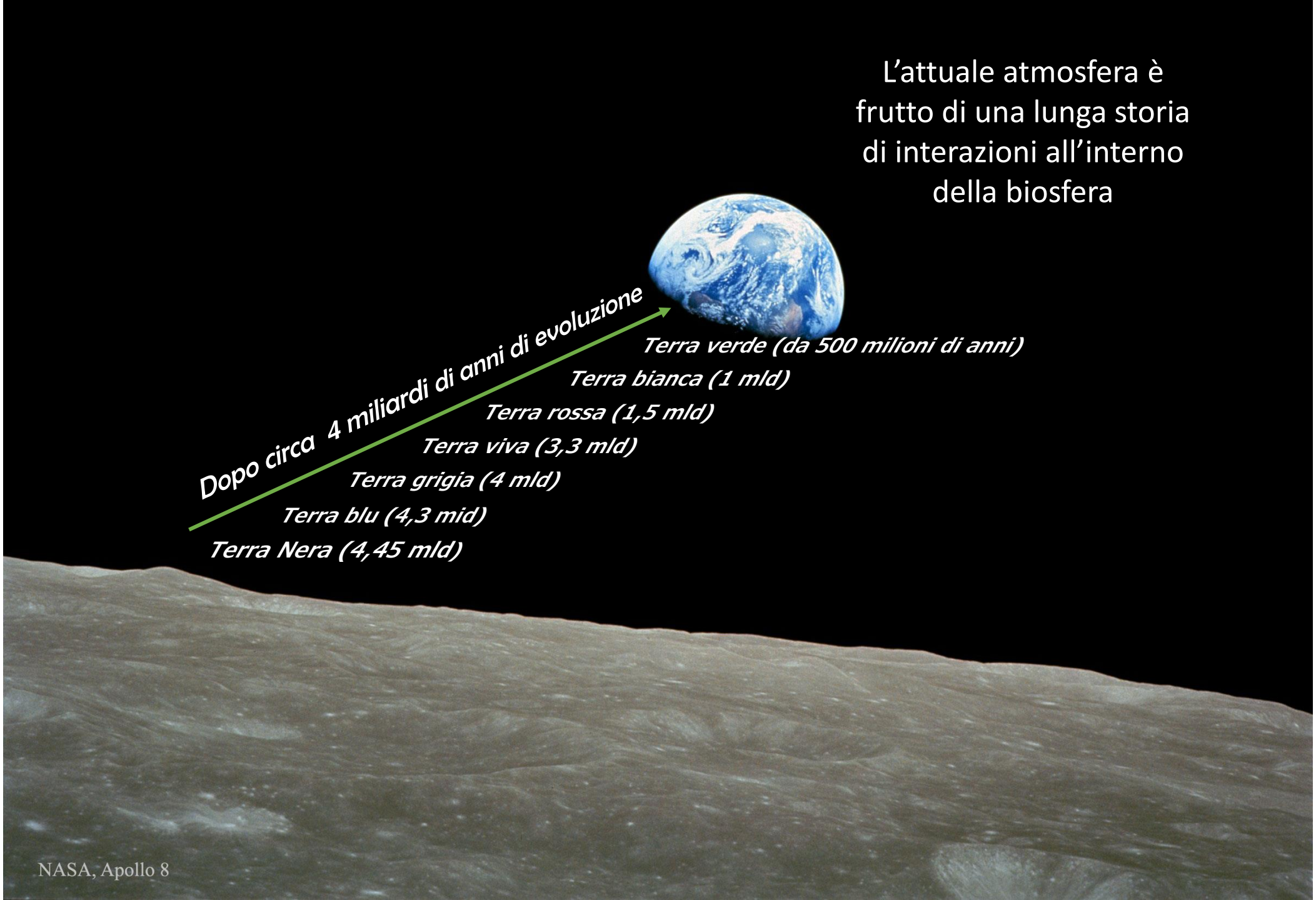
BREVE STORIA DELL'ATMOSFERA E DELLA CO_2

Parte 2

L'atmosfera in cui viviamo:

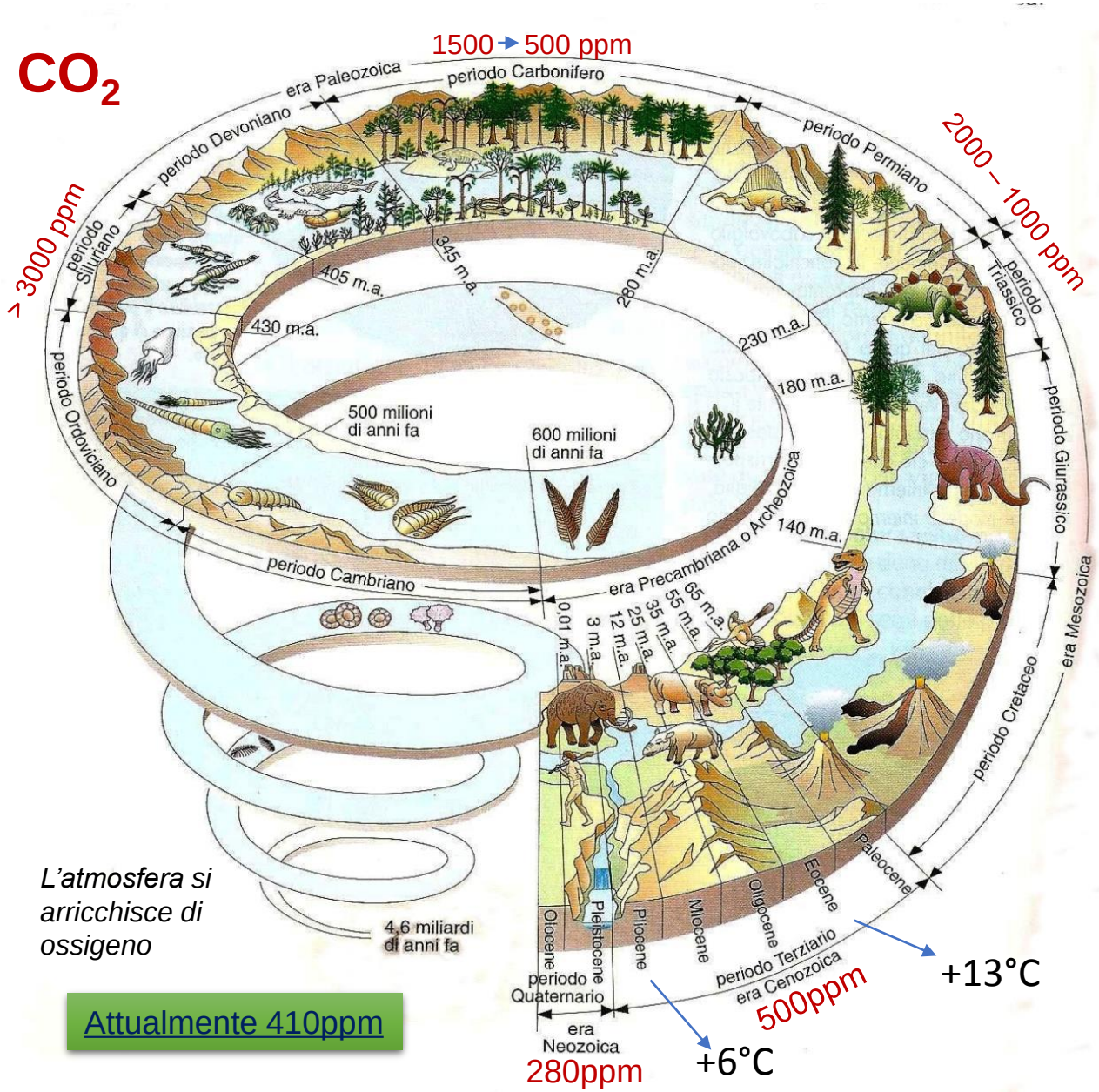
- La composizione e l'evoluzione
- Il ruolo dei gas serra
- Il ruolo del Sole
- L'aumento della CO_2
- Gli effetti del riscaldamento globale

L’attuale atmosfera è frutto di una lunga storia di interazioni all’interno della biosfera



NASA, Apollo 8

Evoluzione della vita e dell'atmosfera



Con l'uso massiccio di combustibili fossili stiamo ripristinando un'atmosfera primordiale ricca di CO_2. Assorbita, prima dai cianobatteri e poi dalle immense foreste del Carbonifero, si stima che 2/3 del carbonio depositato nel sottosuolo sia già stato bruciato e reimmesso nell'atmosfera.

L’attuale pellicola atmosferica

Composizione per unità di volume (aria secca)

* GWP: Global warming potential

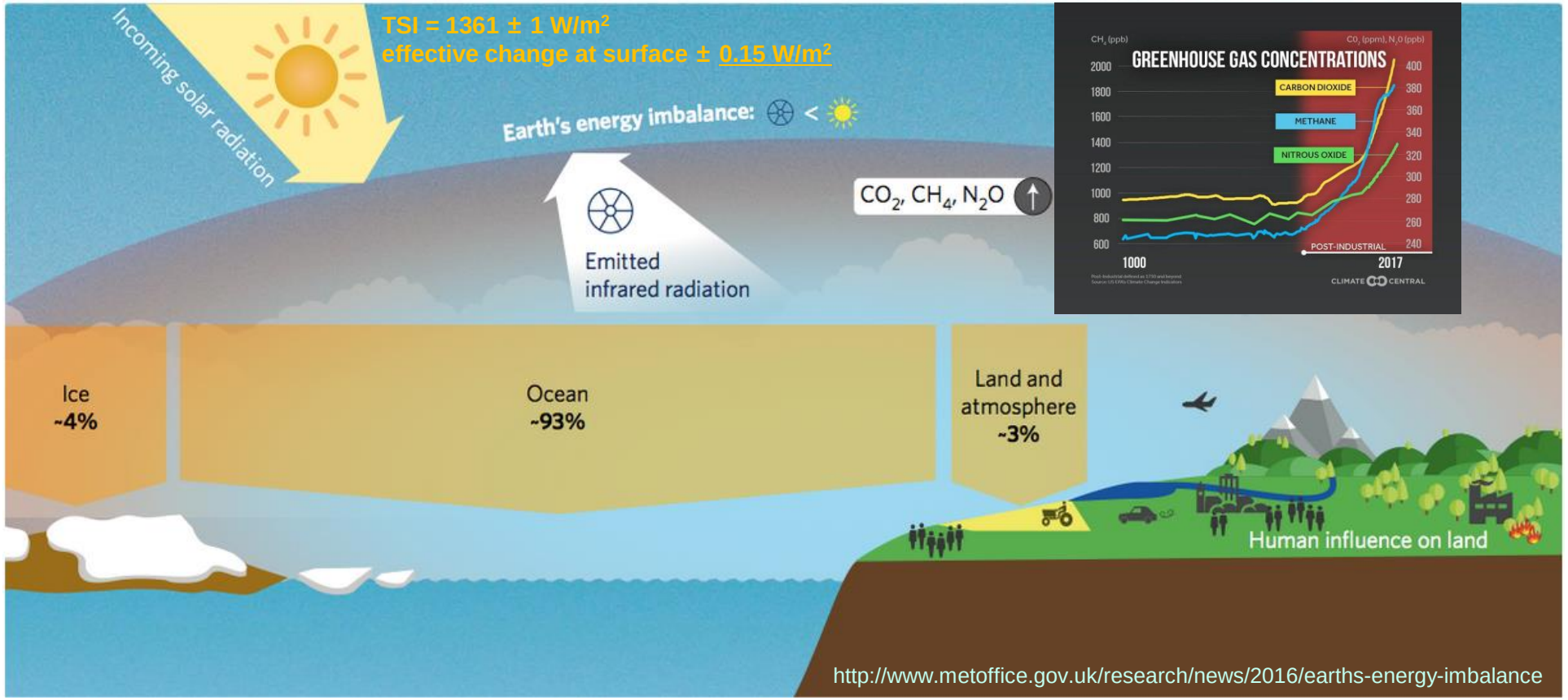
Azoto (N_2): 78 %	Anidride Carbonica (CO_2): 0.0410% (410ppm)	1 GWP*
Ossigeno (O_2): 21 %	Metano (CH_4): 0.0002% (2ppm)	20-100 GWP
Argon (Ar) : 0.9%	Protossido d’azoto (N_2O): 328ppb	265 GWP

Il ruolo dei gas serra (GHG)

Il clima è il risultato di fattori astronomici, geologici, fisico-chimici, antropici.

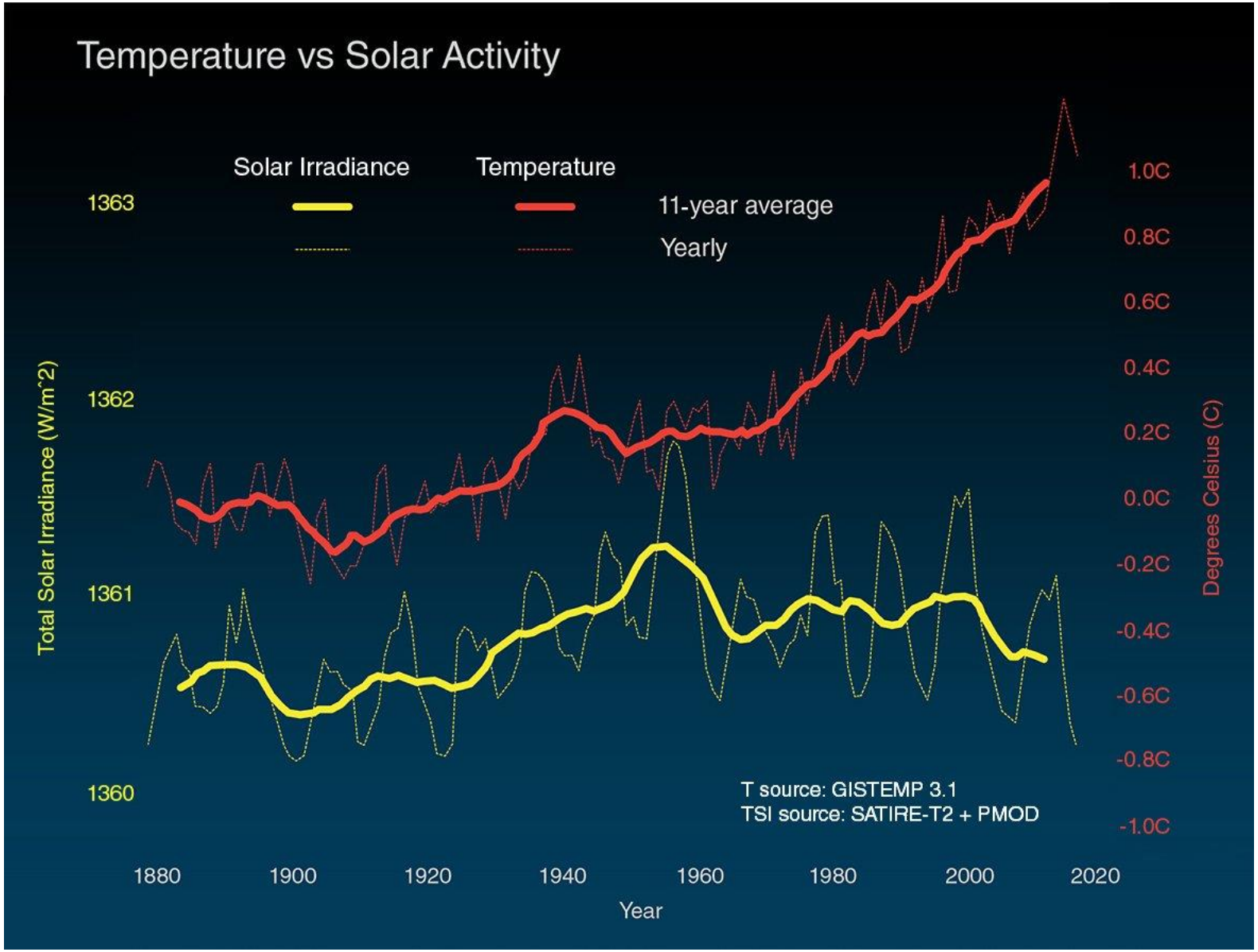
Il suo equilibrio dipende dal bilancio della radiazione in entrata e in uscita.

Uno squilibrio di pochi decimi di W/m^2 è sufficiente a modificarne le caratteristiche.



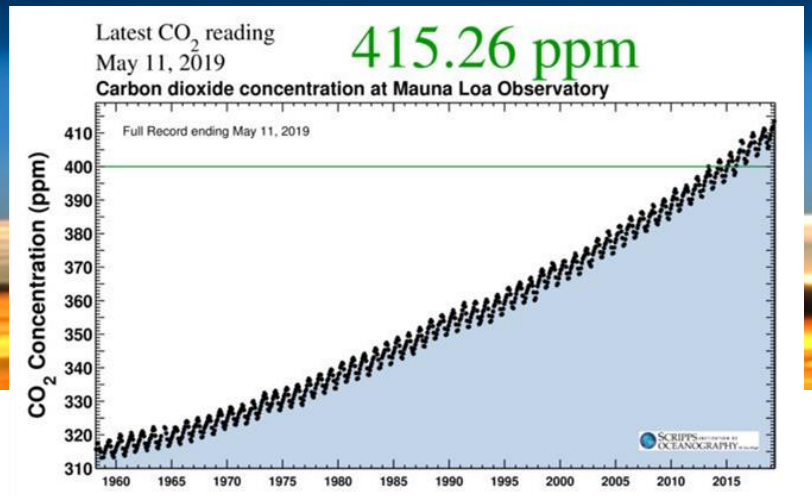
Lo squilibrio dovuto all'accumulo di gas serra è di circa +2.3 W/m^2,
dieci volte superiore a qualsiasi altro effetto naturale.

L’attività solare è in lieve calo mentre la temperatura aumenta



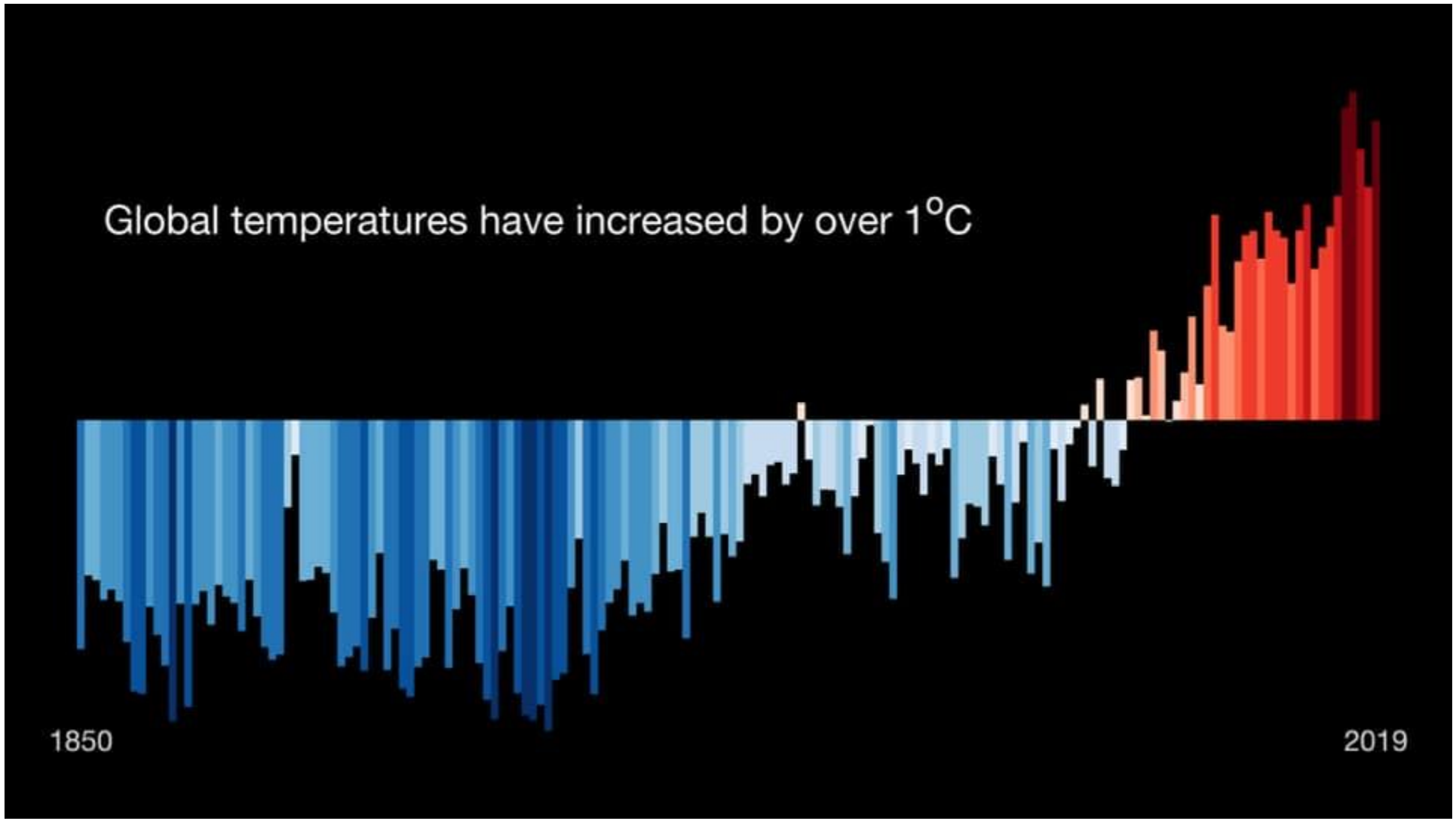
CO_2 evolution

(Credit: Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO2 record.)

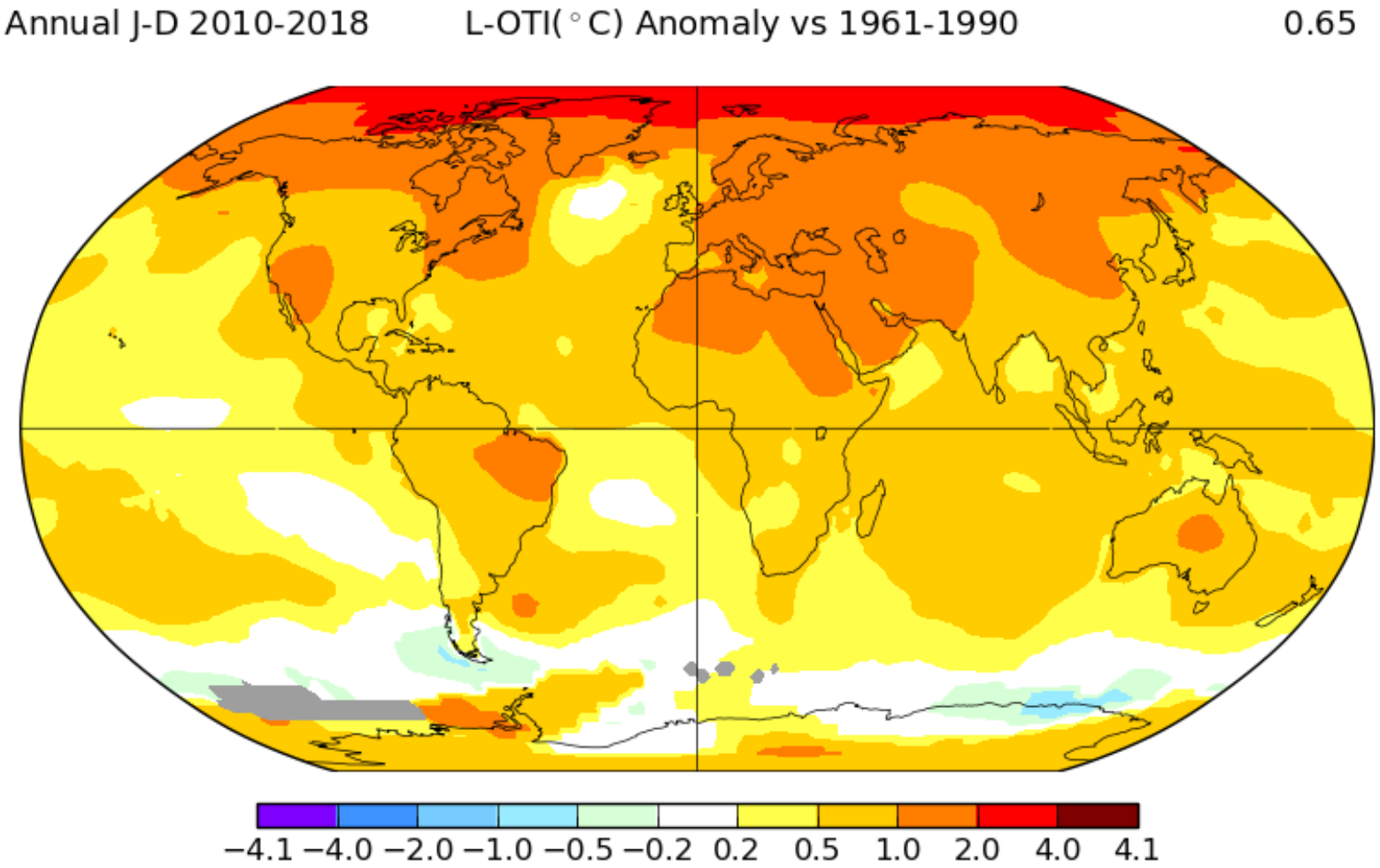


Combustion of fossil (64%) plus deforestation (34%) are the main sources of CO_2 increase.

First day ever above 415ppm

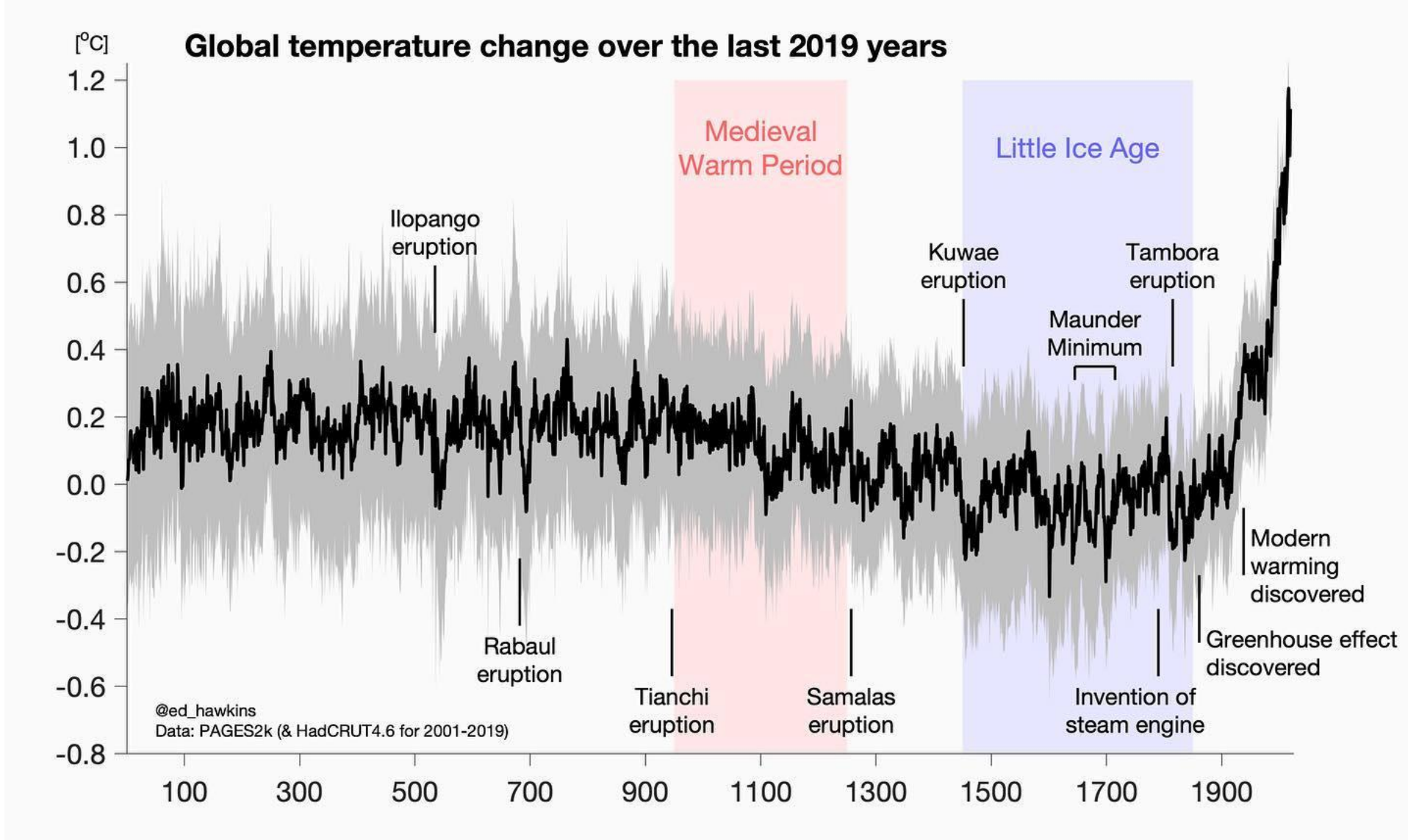

Global temperatures have increased by over 1°C
1850
2019

Il riscaldamento non è omogeneo nelle diverse fasce climatiche

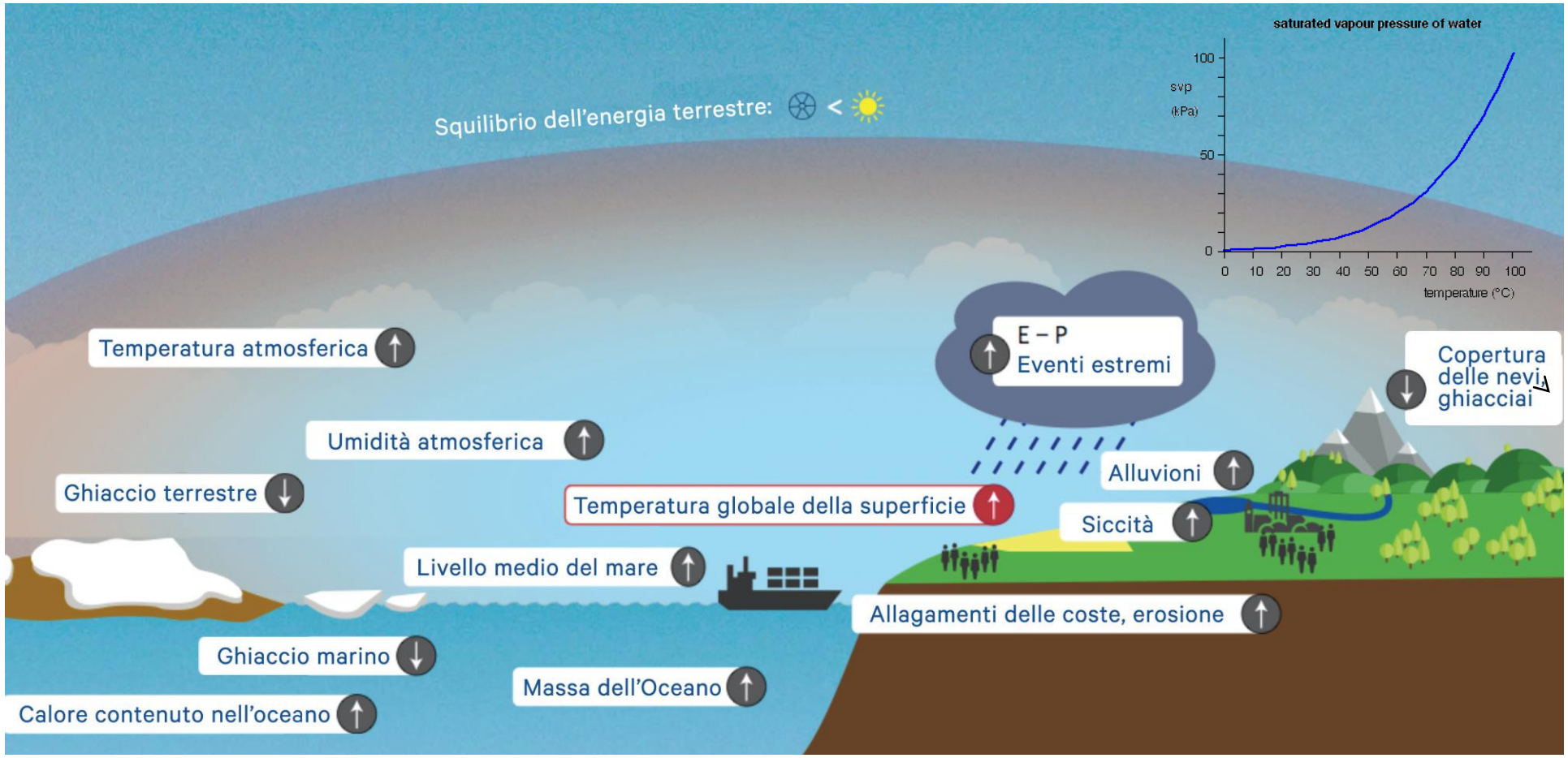


L'Artico si sta scaldando più velocemente di qualsiasi altro luogo.
Il riscaldamento è minore nell'emisfero sud. Il Mediterraneo è un hot-spot

http://data.giss.nasa.gov/gistemp/


Global temperature change over the last 2019 years
[°C]
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
100
300
500
700
900
1100
1300
1500
1700
1900
Medieval Warm Period
Little Ice Age
Ilopango eruption
Rabaul eruption
Tianchi eruption
Samalas eruption
Kuwae eruption
Maunder Minimum
Tambora eruption
Invention of steam engine
Greenhouse effect discovered
Modern warming discovered
@ed_hawkins
Data: PAGES2k (& HadCRUT4.6 for 2001-2019)

Altri effetti del riscaldamento globale



http://www.metoffice.gov.uk/research/news/2016/earths-energy-imbalance

Impacts quantification:

https://interactive.carbonbrief.org/impacts-climate-change-one-point-five-degrees-two-degrees/?utm_source=web&utm_campaign=Redirect


The Economist
Iran's dangerous game
Lessons from a Wall Street titan
Why rent controls are wrong-headed
Goddess of the Taiwan Strait
SEPTEMBER 21ST-27TH 2019
The climate issue
1850
1900
1950
2000

1970-2020: L'ATMOSFERA SI SCALDA, E ANCHE LA POLITICA

Parte 3

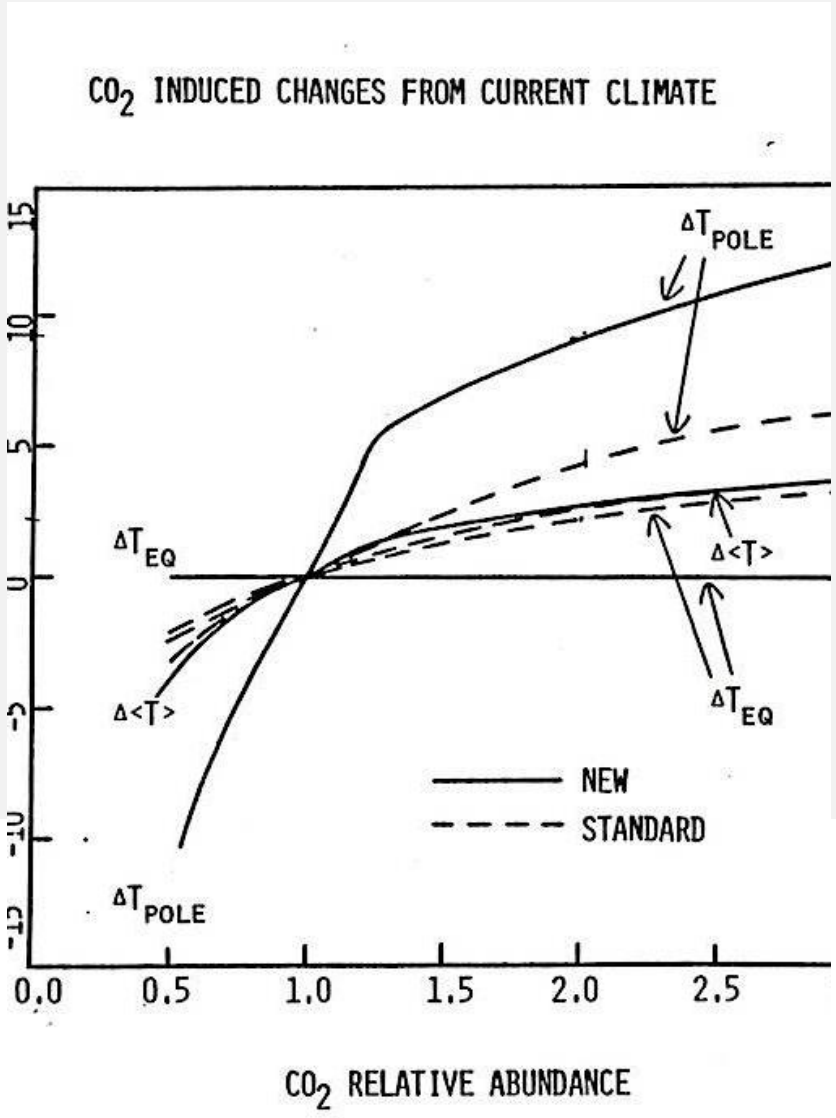
Gli ostacoli alla lotta al riscaldamento globale:

- "So they knew": il caso Exxon, 2019
- Fine del nucleare per il dottor Stranamore, 1957
- Il "caso Ippolito", 1963-1965
- I limiti dello sviluppo, 1973
- Il rapporto Charney, 1979
- Greta, i Fridays for Future, la Green Economy e la transizione desiderabile

«So they knew.»

Alexandra Ocasio Cortez (AOC) vs Martin Hoffert:

il caso Exxon, 2019



EXXON RESEARCH AND ENGINEERING COMPANY

P.O. BOX 101, FLORHAM PARK, NEW JERSEY 07932

M. B. GLASER
Manager
Environmental Affairs Programs

Cable: ENGREXXON, N.Y.

November 12, 1982

CO_2 "Greenhouse" Effect

82EAP 266

TO: See Distribution List Attached

Attached for your information and guidance is briefing material on the CO_2 "Greenhouse" Effect which is receiving increased attention in both the scientific and popular press as an emerging environmental issue. A brief summary is provided along with a more detailed technical review prepared by CPPD.

The material has been given wide circulation to Exxon management and is intended to familiarize Exxon personnel with the subject. It may be used as a basis for discussing the issue with outsiders as may be appropriate. However, it should be restricted to Exxon personnel and not distributed externally.

Very truly yours,

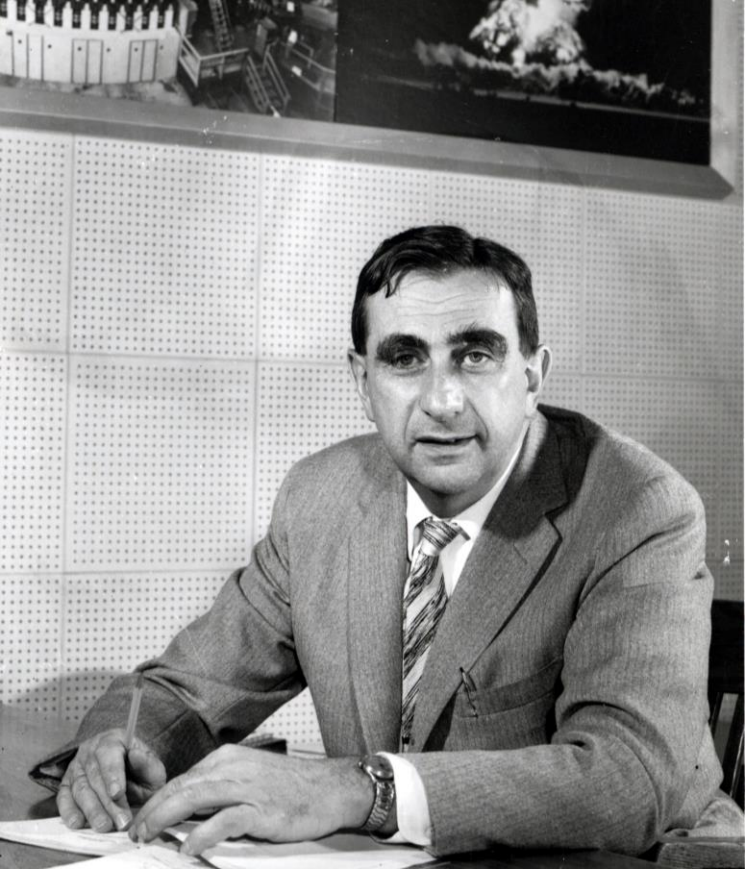
M. B. GLASER

MBG:rva

Attachments

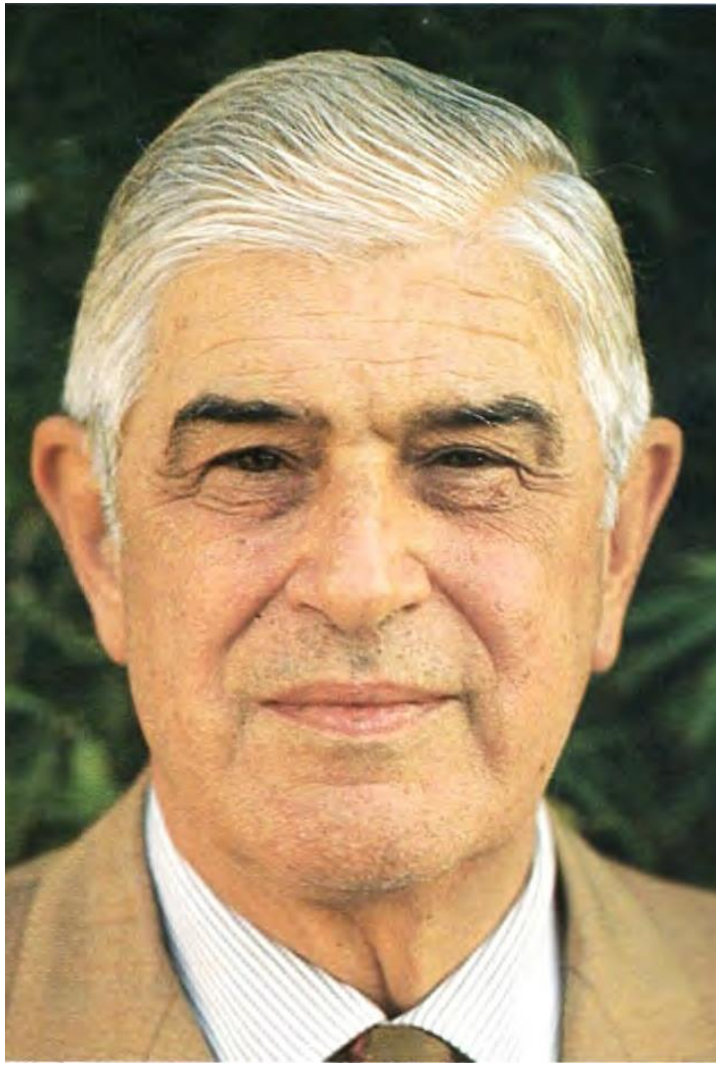
H. N. WEINBERG
NOV 15 1982

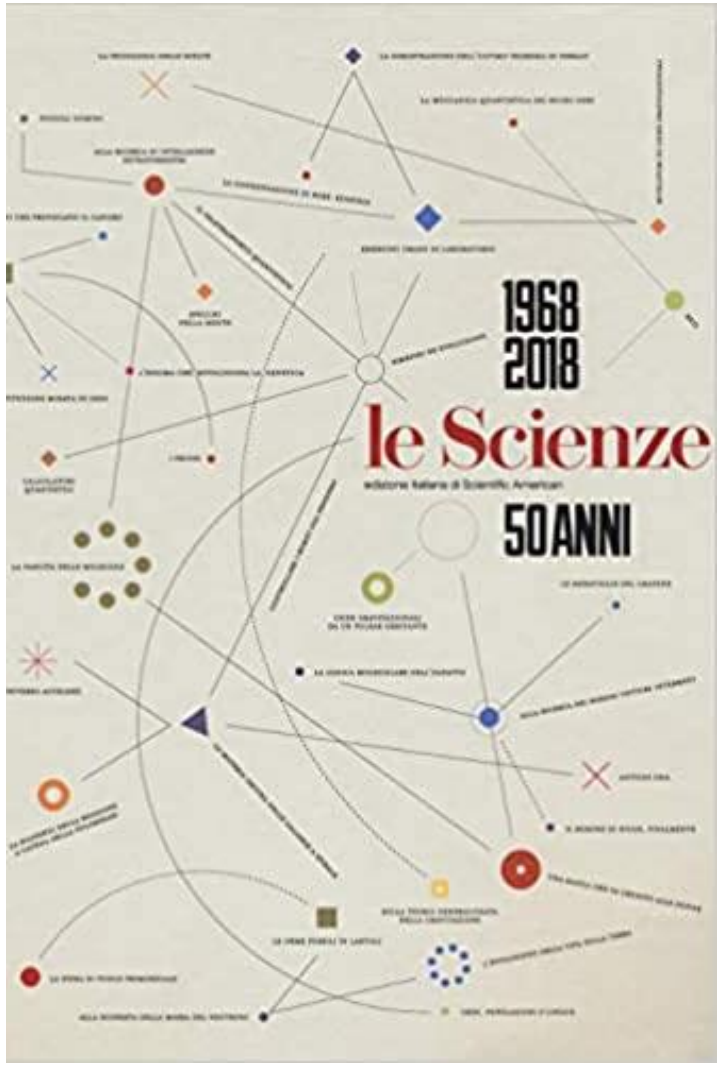
«…and not distribuited externally»



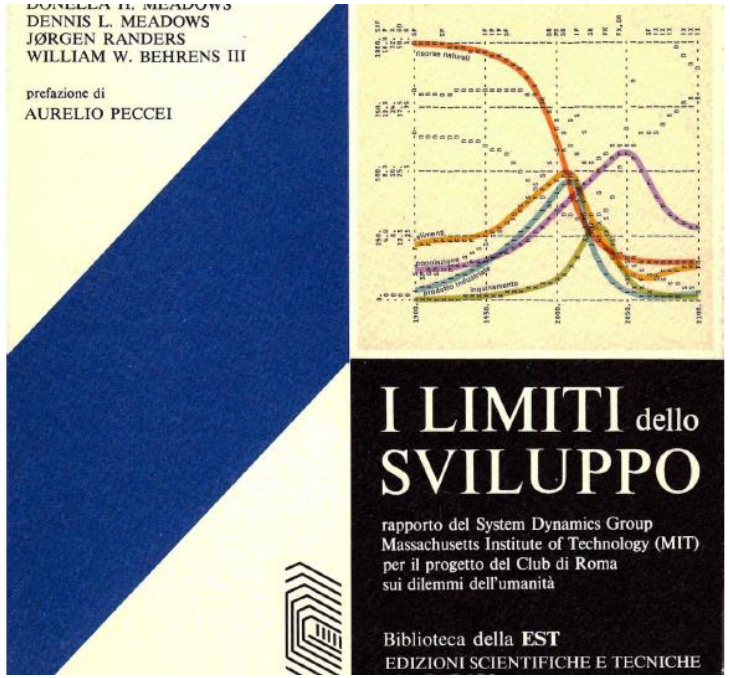
Fine del nucleare per il dottor Stranamore, 1957

Edward Teller e la fine della ricerca nucleare nel ricordo di Freeman Dyson



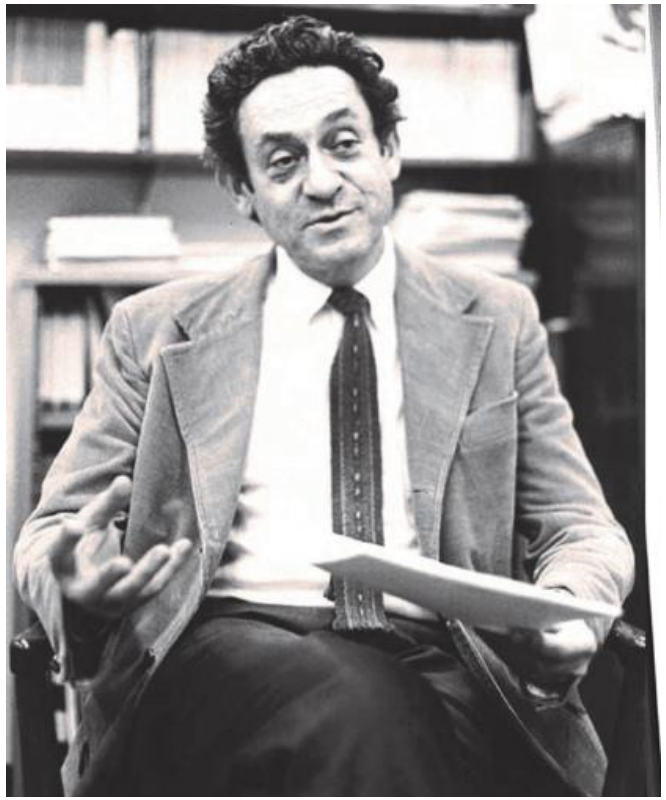


Il “caso Ippolito”, 1963-1965



Però non dobbiamo illuderci. Senza una forte ventata di opinione pubblica mondiale, alimentata a sua volta dai segmenti più creativi della società — i giovani e l'intellighenzia' artistica, intellettuale, scientifica, manageriale — la classe politica continuerà in ogni paese a restare in ritardo sui tempi, prigioniera del corto termine e d'interessi settoriali o locali, e le istituzioni politiche, già attualmente sclerotiche, inadeguate e ciononpertanto tendenti a perpetuarsi, finiranno per soccombere. Ciò renderà inevitabile il momento rivoluzionario come unica soluzione per la trasformazione della società umana, affinché essa riprenda un assetto di equilibrio interno ed esterno atto ad assicurarne la sopravvivenza in base alle nuove realtà che gli uomini stessi hanno creato nel loro mondo.

I limiti dello sviluppo, 1973



Carbon Dioxide and Climate:
A Scientific Assessment

Report of an Ad Hoc Study Group on Carbon Dioxide and Climate
Woods Hole, Massachusetts
July 23–27, 1979
to the
Climate Research Board
Assembly of Mathematical and Physical Sciences
National Research Council

For more than a century, we have been aware that changes in the composition of the atmosphere could affect its ability to trap the sun's energy for our benefit. We now have incontrovertible evidence that the atmosphere is indeed changing and that we ourselves contribute to that change. Atmospheric concentrations of carbon dioxide are steadily increasing, and these changes are linked with man's use of fossil fuels and exploitation of the land. Since carbon dioxide plays a significant role in the heat budget of the atmosphere, it is reasonable to suppose that continued increases would affect climate.

These concerns have prompted a number of investigations of the implications of increasing carbon dioxide. Their consensus has been that increasing carbon dioxide will lead to a warmer earth with a different distribution of climatic regimes. In view of the implications of this issue for national and international policy planning, the Office of Science and Technology Policy requested the National Academy of Sciences to undertake an independent critical assessment of the scientific basis of these studies and the degree of certainty that could be attached to their results.

Il rapporto Charney, 1976

Greta, i Fridays for future, la Green economy
e la transizione desiderabile

“… una decisa rifondazione culturale e sociale di ciò che si desidera in una società, o in una comunità si consideri desiderabile.”

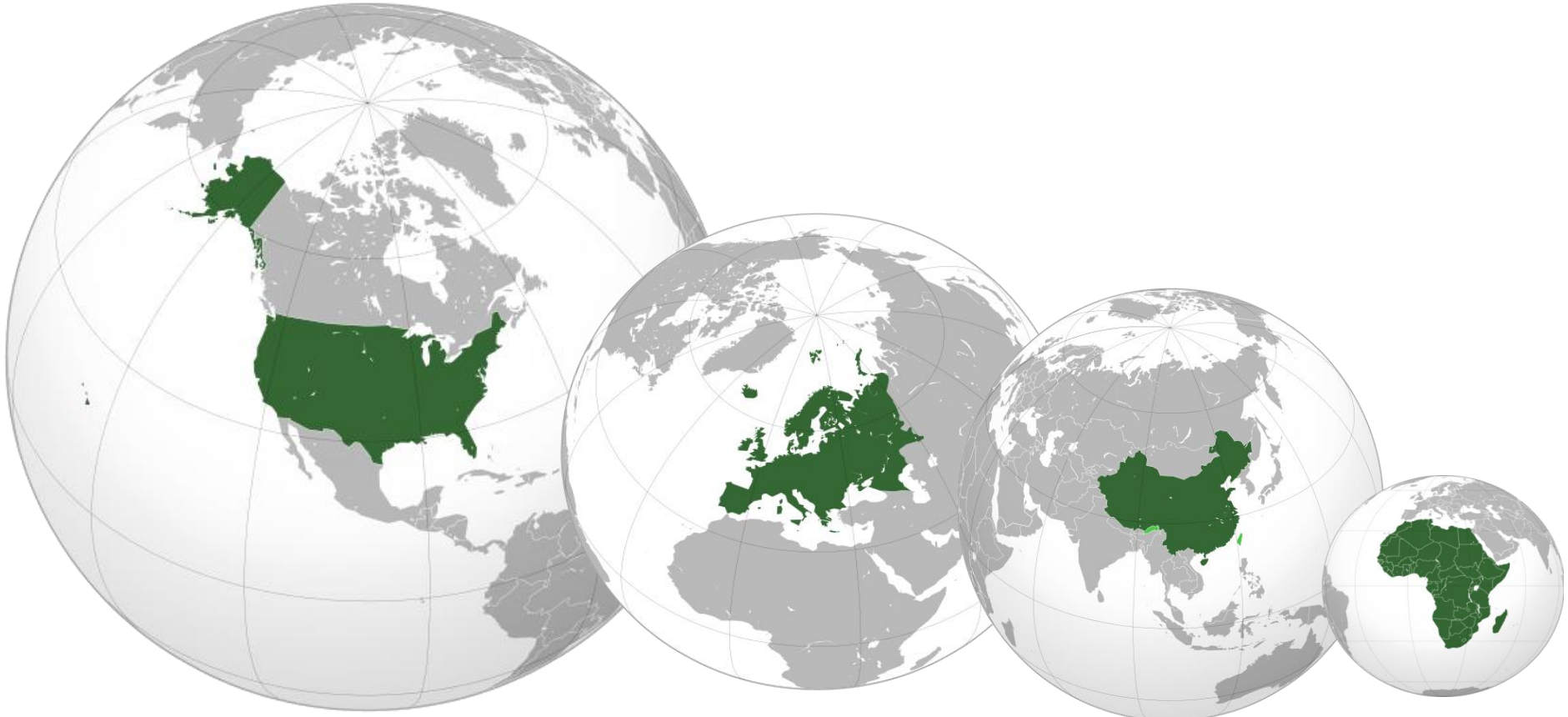
Alexander Langer, 1994

Parte 4

Dati e previsioni:

- Emissioni
- I consumi aumentano
- Azioni individuali
- Azioni politiche
- Scenari per il 2021
- Scenari locali

Emissioni procapite di alcune nazioni



USA=17

322 milioni di persone

UE=7.5

739 milioni di persone

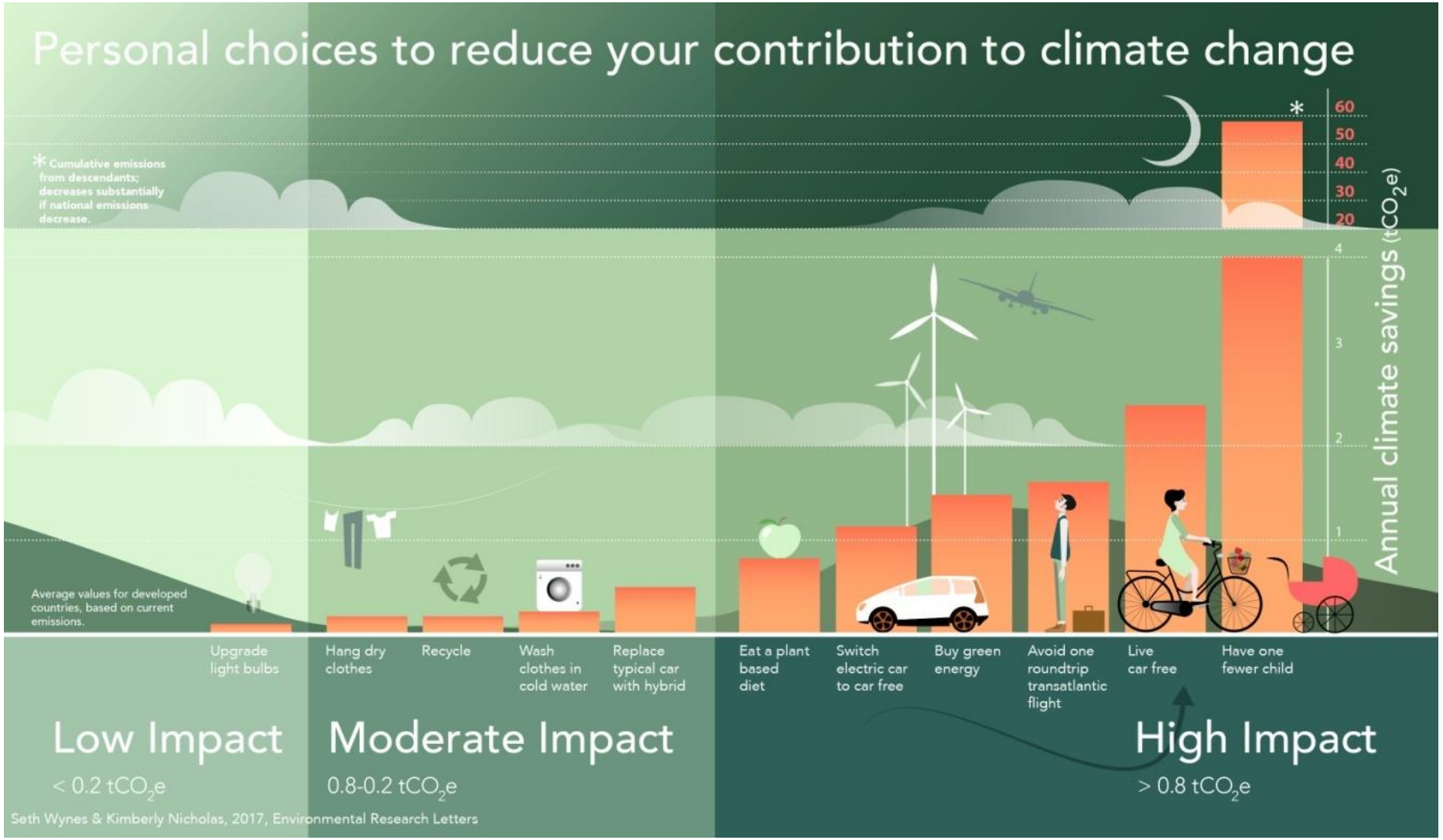
Cina=7.5

1.4 miliardi di persone

Africa=1

1.8 miliardi di persone

Cosa possiamo fare ? – Azione individuale



Cosa possiamo fare ? – Azione politica

"Preventing dangerous climate change is a key priority for the European Union. Europe is working to cut its greenhouse gas emissions while encouraging other nations to do likewise."

perché…«ci preoccupiamo degli effetti ma continuiamo ad adorare le cause».

Nuovo aggiornamento IPCC in preparazione per il 2021

"equilibrium climate sensitivity" riscaldamento dovuto al raddoppio di CO_2

Senza maggiori provvedimenti il raddoppio avverrà nel 2060 (560ppm)

Nel 5° rapporto IPCC, pubblicato nel 2013, si stimava che questo raddoppio avrebbe prodotto un aumento della temperatura media mondiale compreso fra 1.5 e 4.5°C

Bastano 2°C di riscaldamento per annientare il 99% delle barriere coralline. Un intero componente della biosfera terrestre verrebbe a mancare con gravi conseguenze per il 25% della vita marina e per l'uomo.

Gli ultimi scenari modellistici, che verranno usati per redigere il 6° report IPCC del 2021, indicano un sensibile rialzo della precedente stima: probabilmente la forchetta sarà compresa fra 2.8 e 5.8°C di riscaldamento per il raddoppio di CO_2.
Almeno 8 di questi modelli (tutti afferenti a rinomati centri di ricercar) indicano una *climate sensitivity* intorno a 5°C.

The terrible truth of climate change, by Joëlle Gergis (IPCC lead author), The Monthly

Scenari locali