Introduzione ai fondamenti fisici dei cambiamenti climatici

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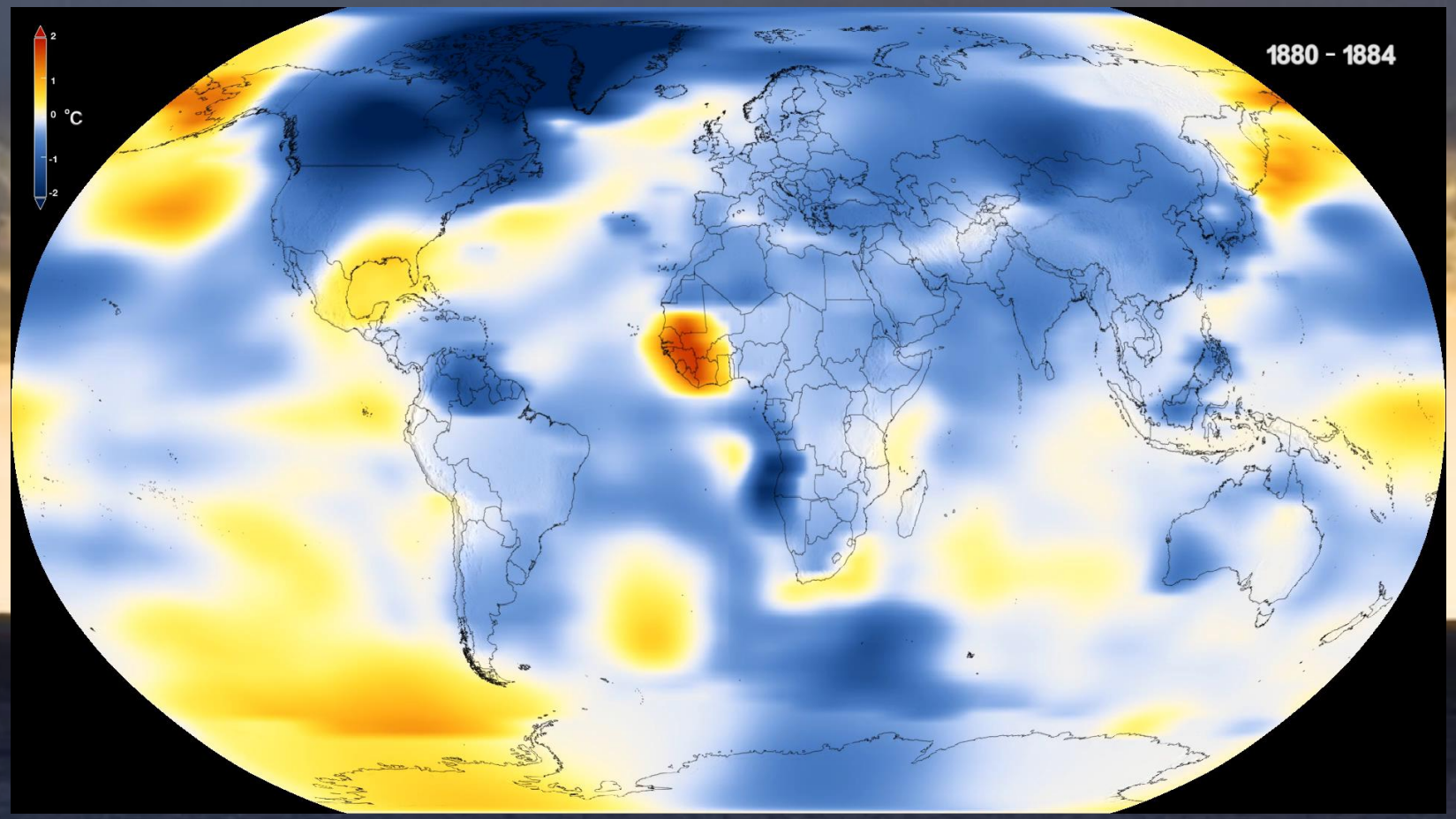
Evoluzione Temperatura terrestre dal 1880 ad oggi



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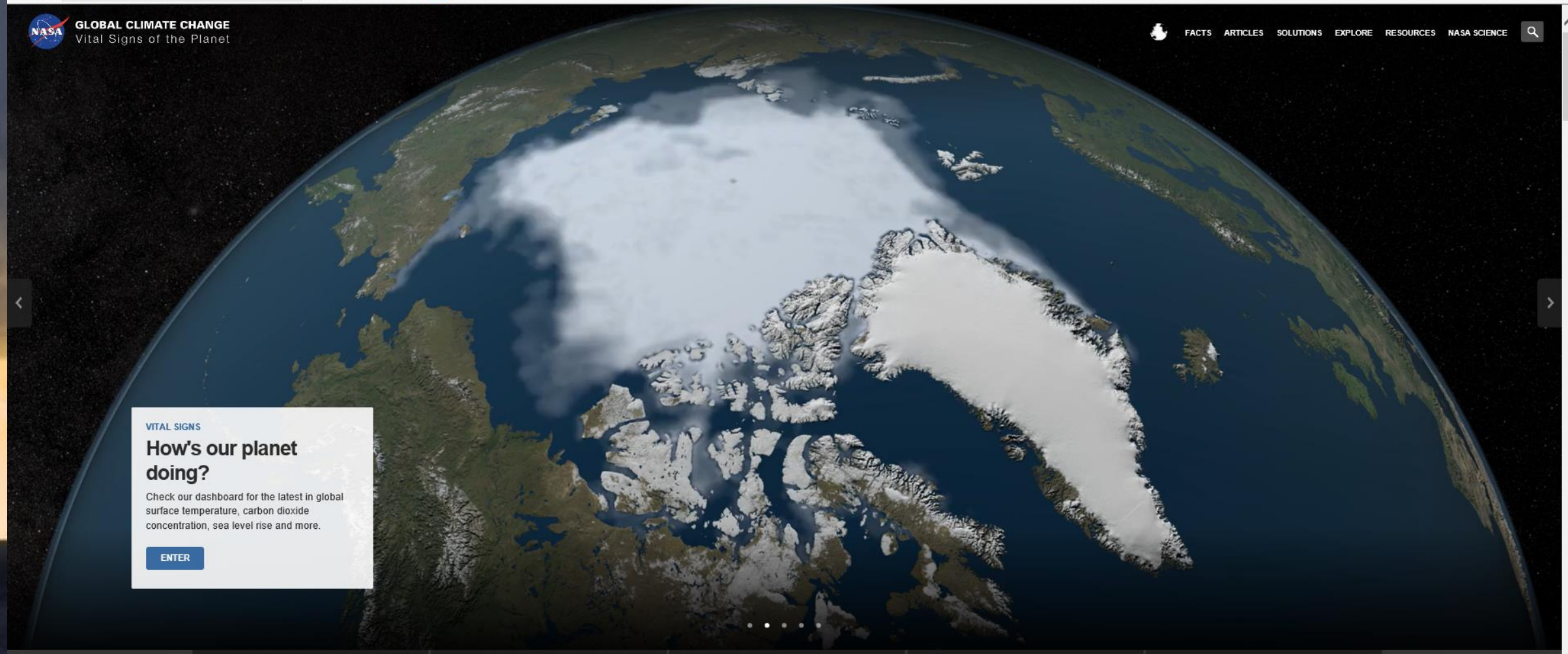
Trova: neglect Precedente Successivo Opzioni



CARBON DIOXIDE	GLOBAL TEMPERATURE	ARCTIC ICE MINIMUM	ICE SHEETS	SEA LEVEL
↑ 411 parts per million	↑ 1.9 °F since 1880	↓ 12.8 percent per decade	↓ 413 Gigatonnes per year	↑ 3.2 millimeters per year

75%

Scrivi qui per eseguire la ricerca

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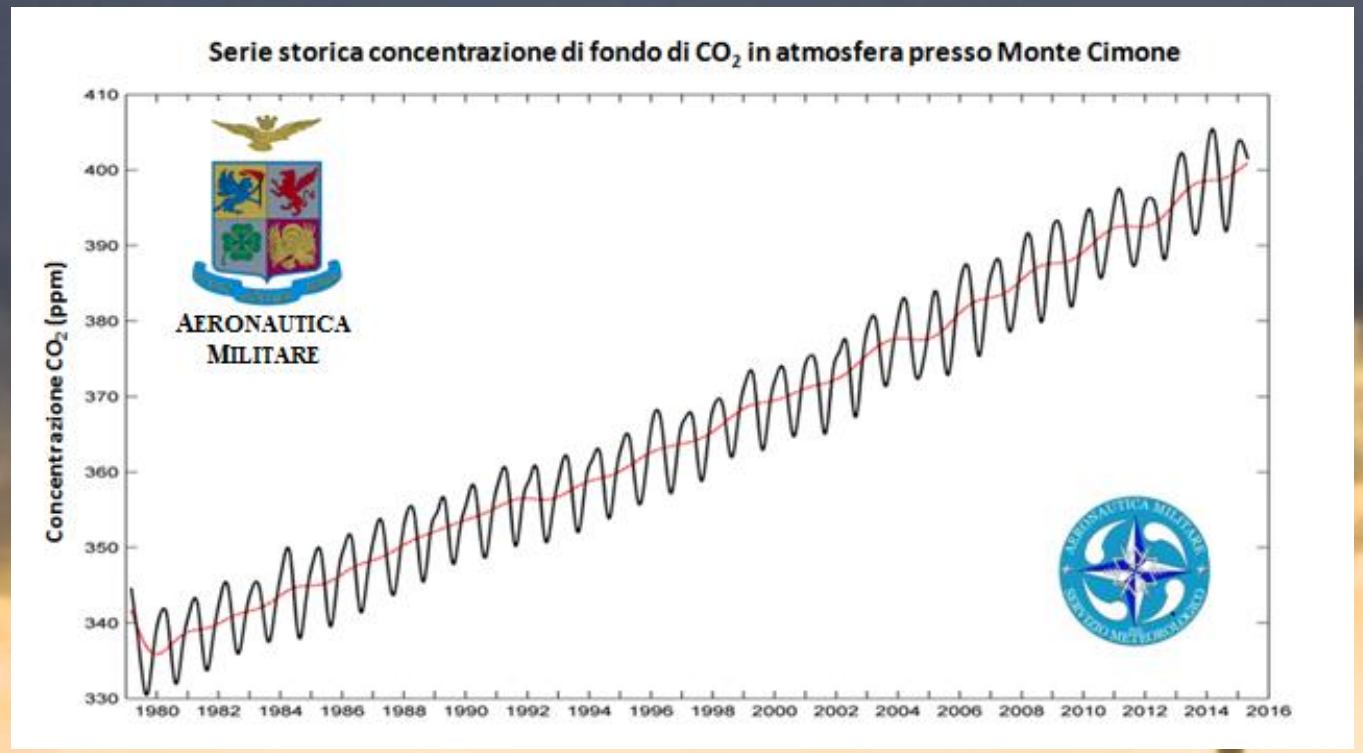
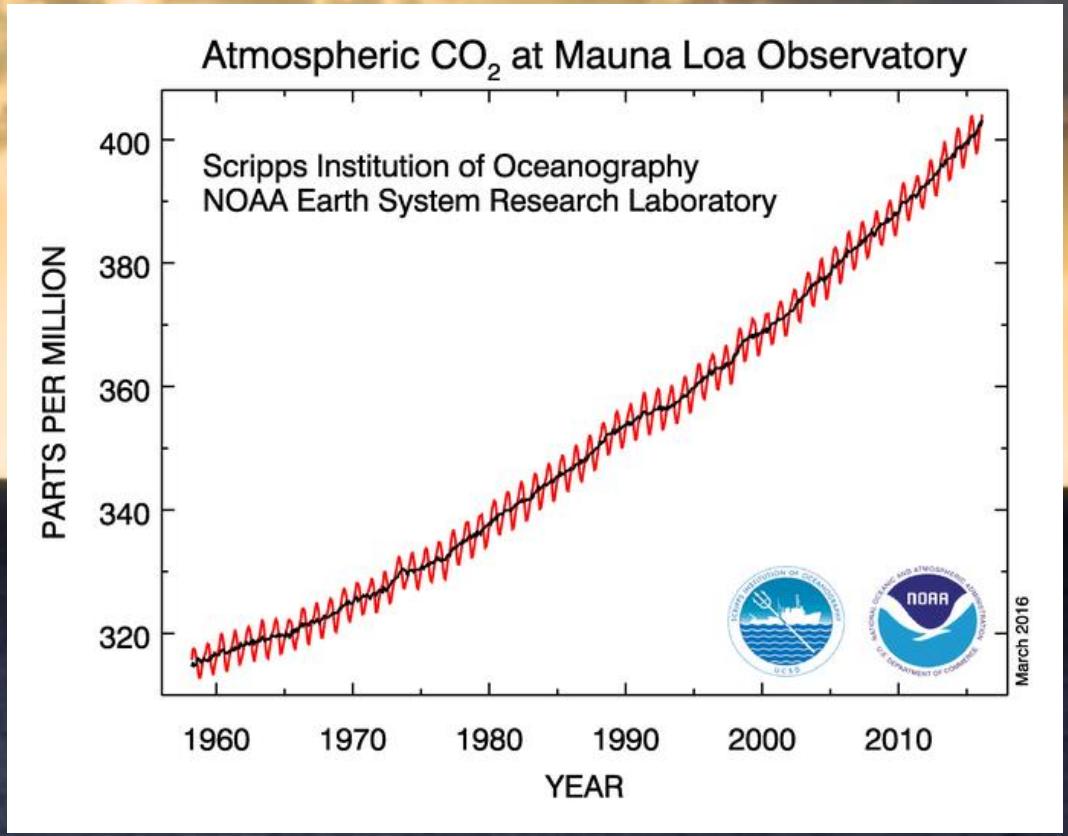
28/02/2019

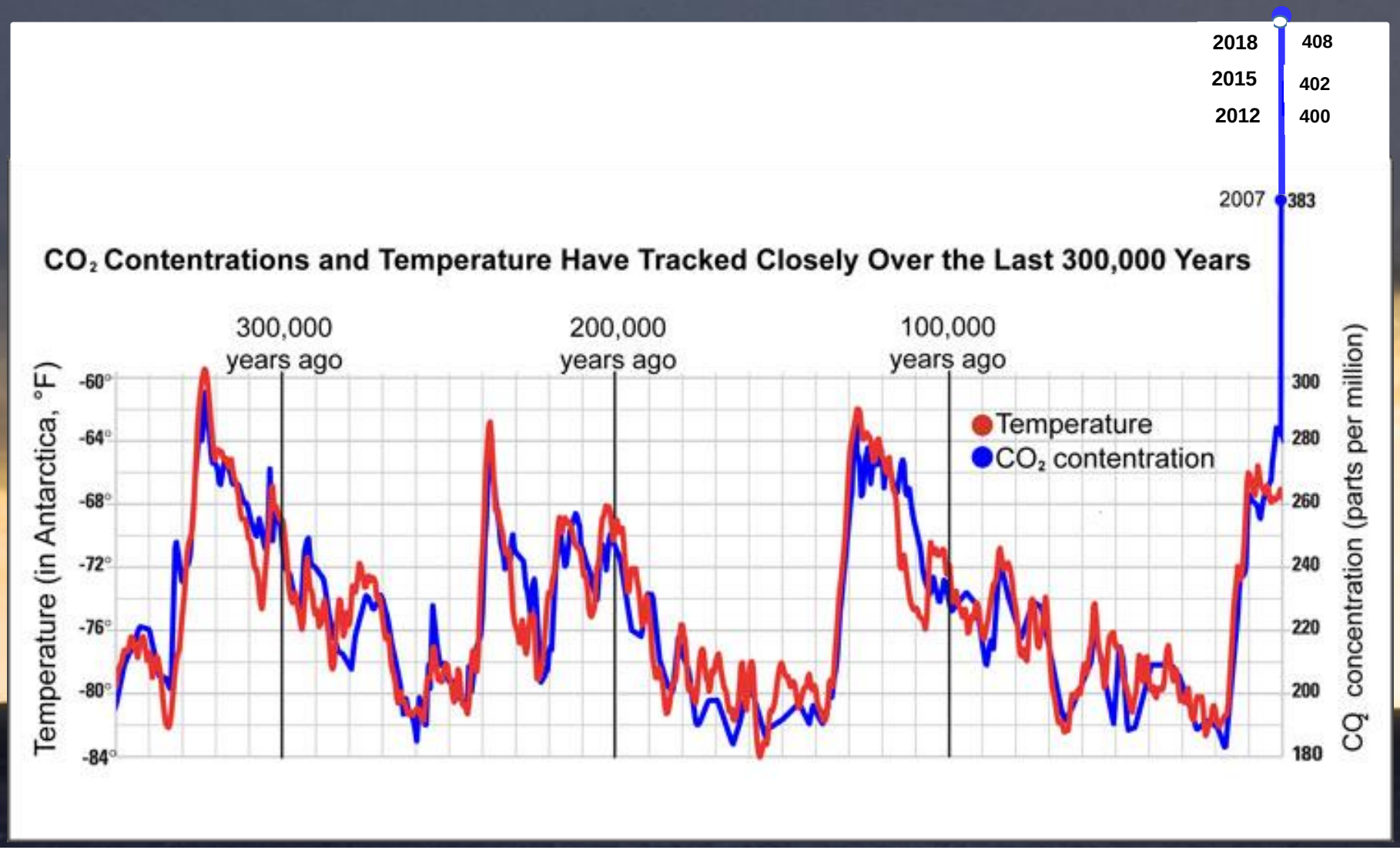
CO2 osservata

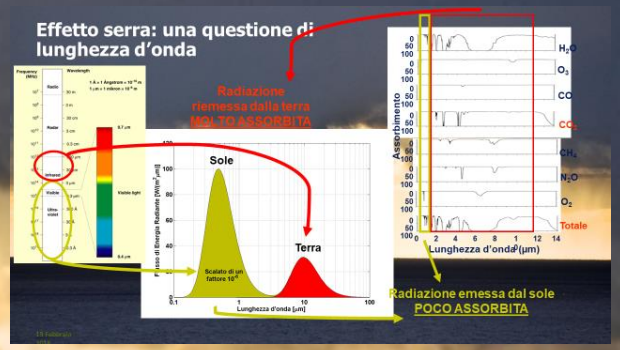


CO2 è gas 'ben mescolato'
e con 'vita media lunga'



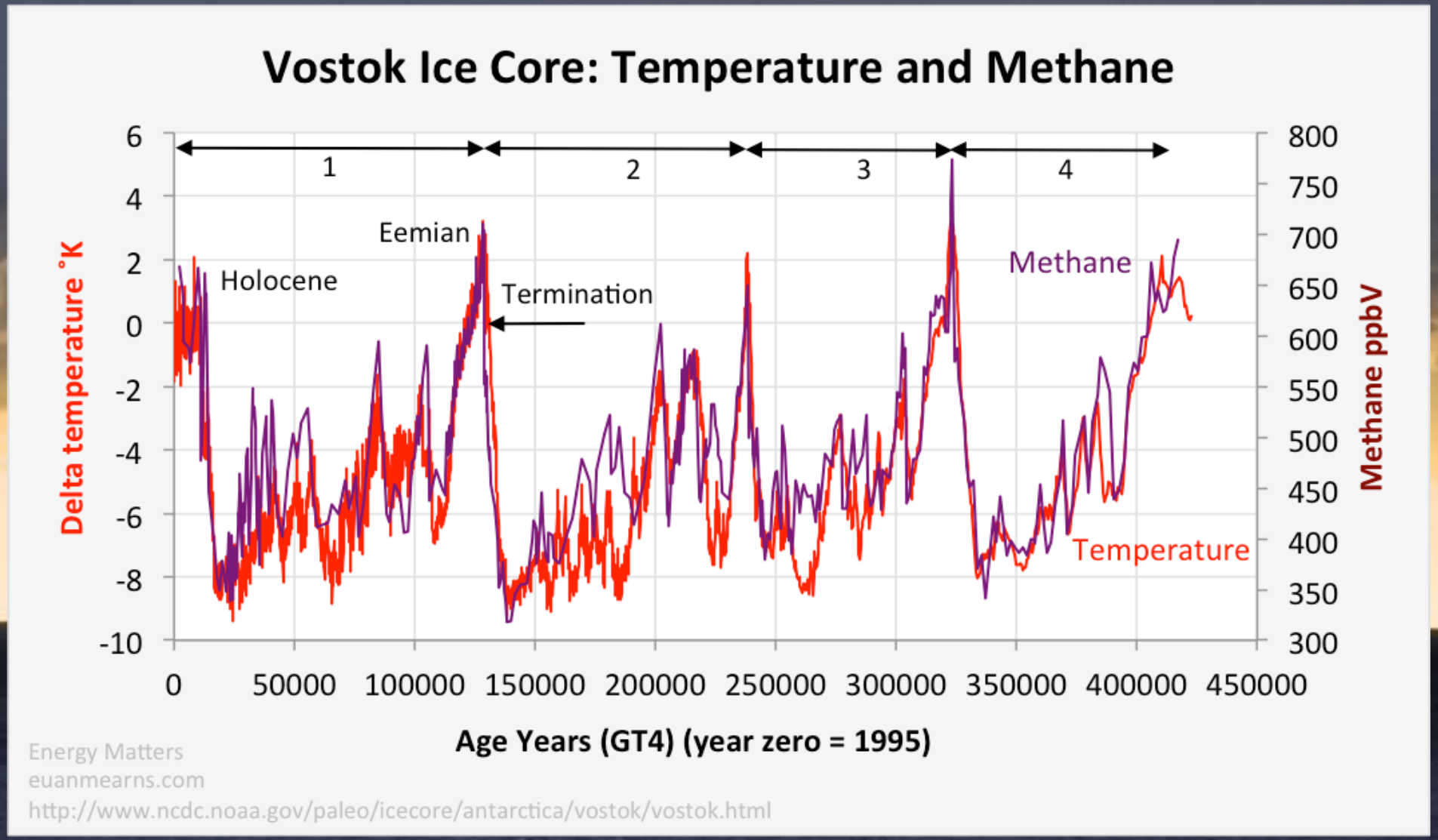
CO2 e cambiamenti climatici



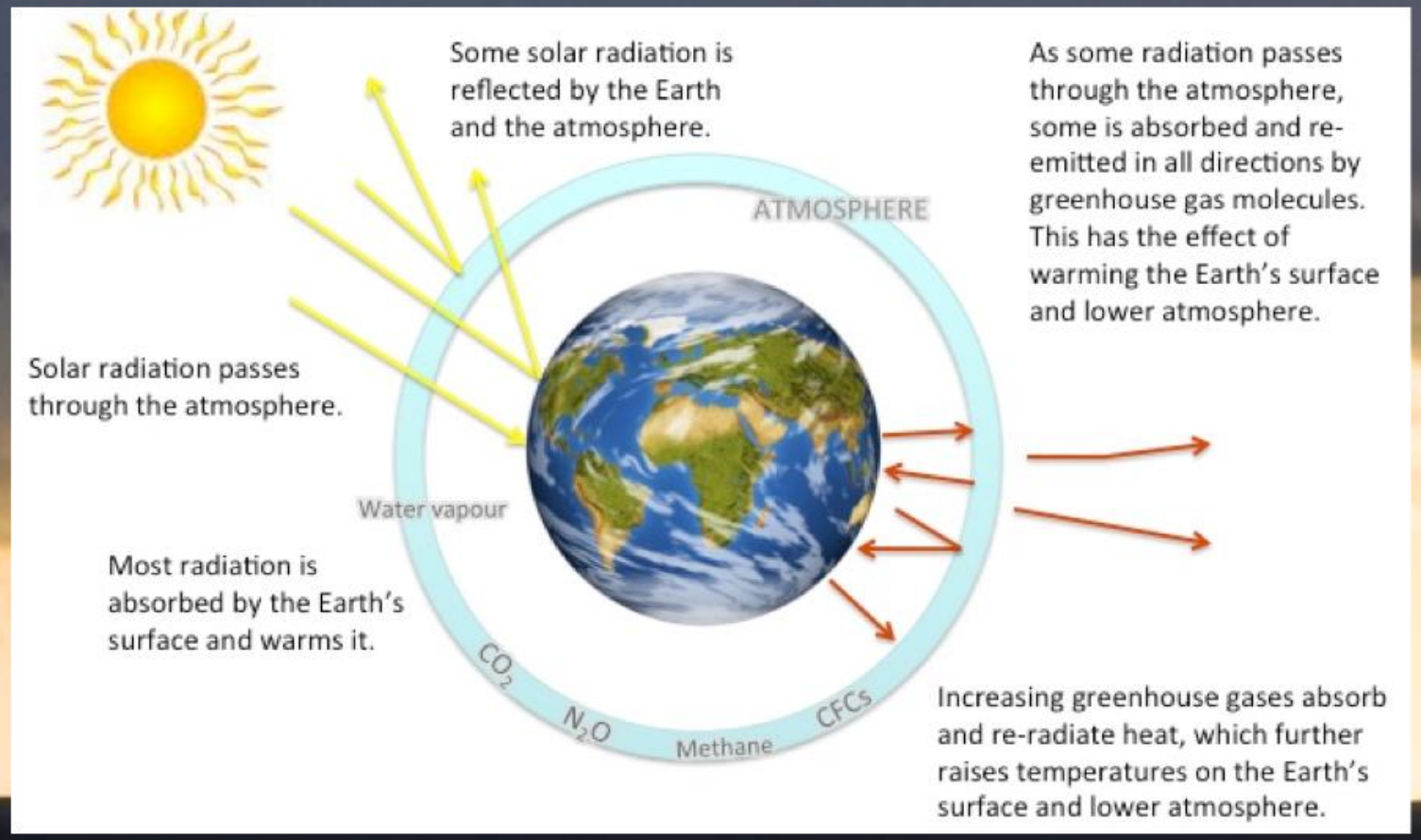


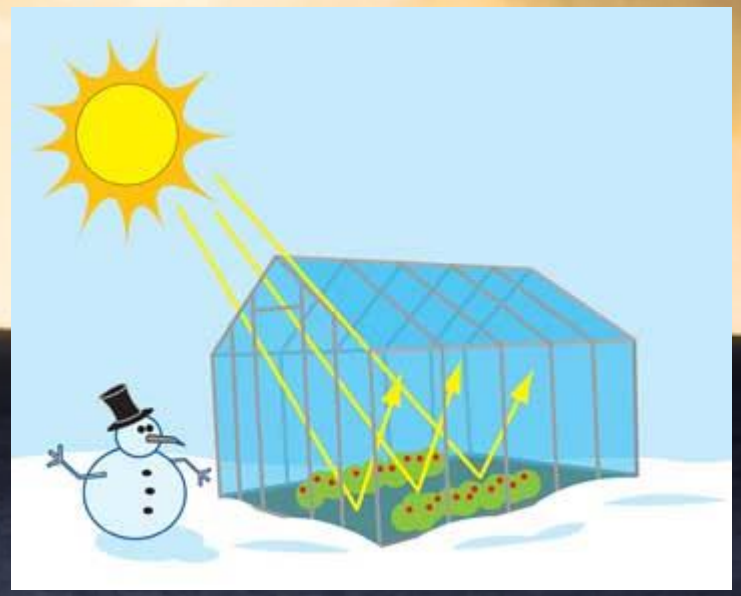
CO2 è un gas serra quindi ci si aspetta una forte correlazione tra le sue concentrazioni e la temperatura del pianeta.

CH4 e temperatura

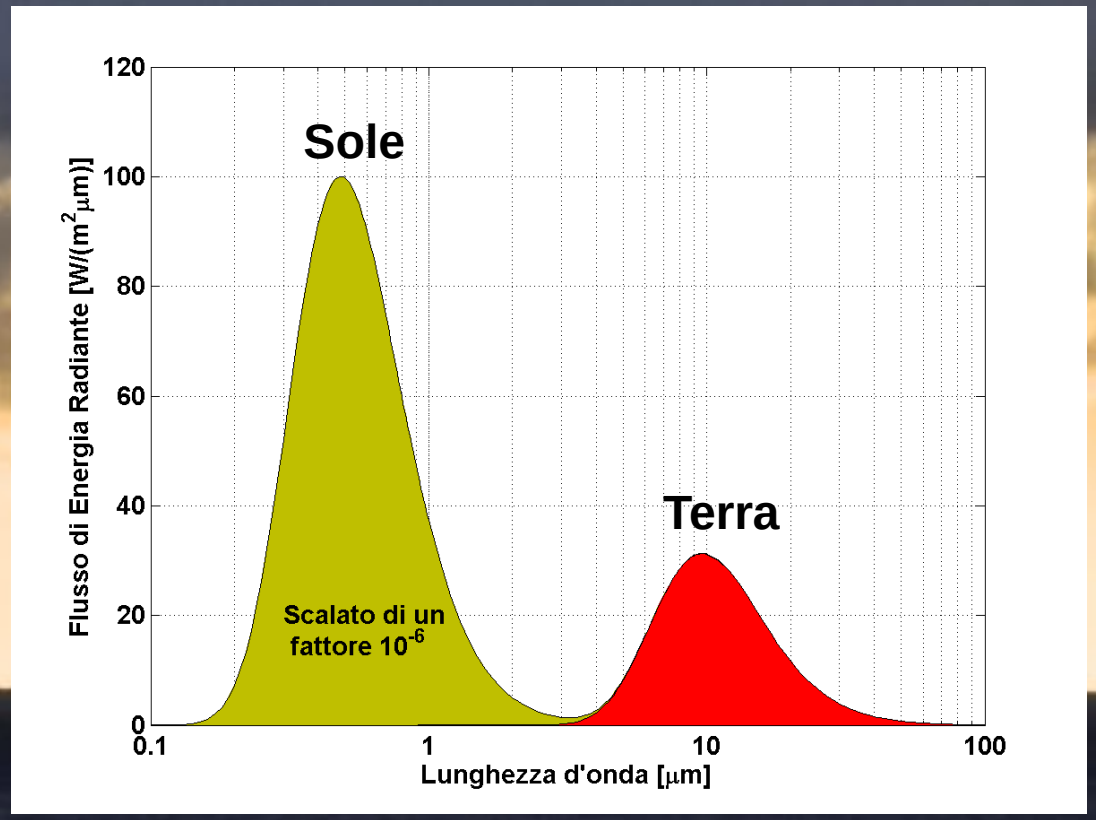


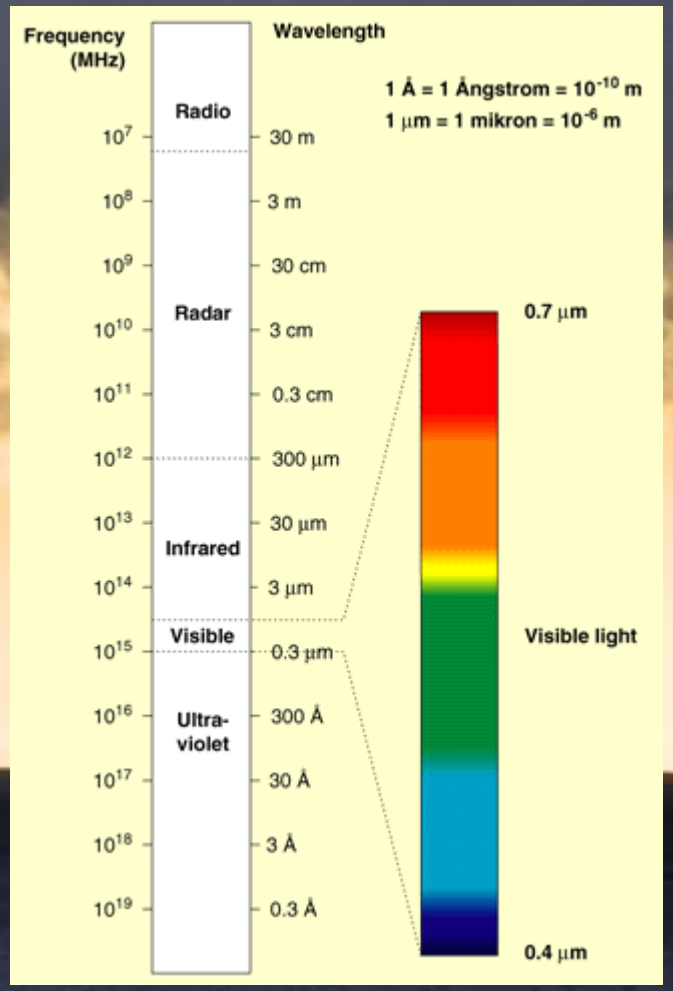
Atmosfera: ruolo dei suoi gas nel sistema climatico



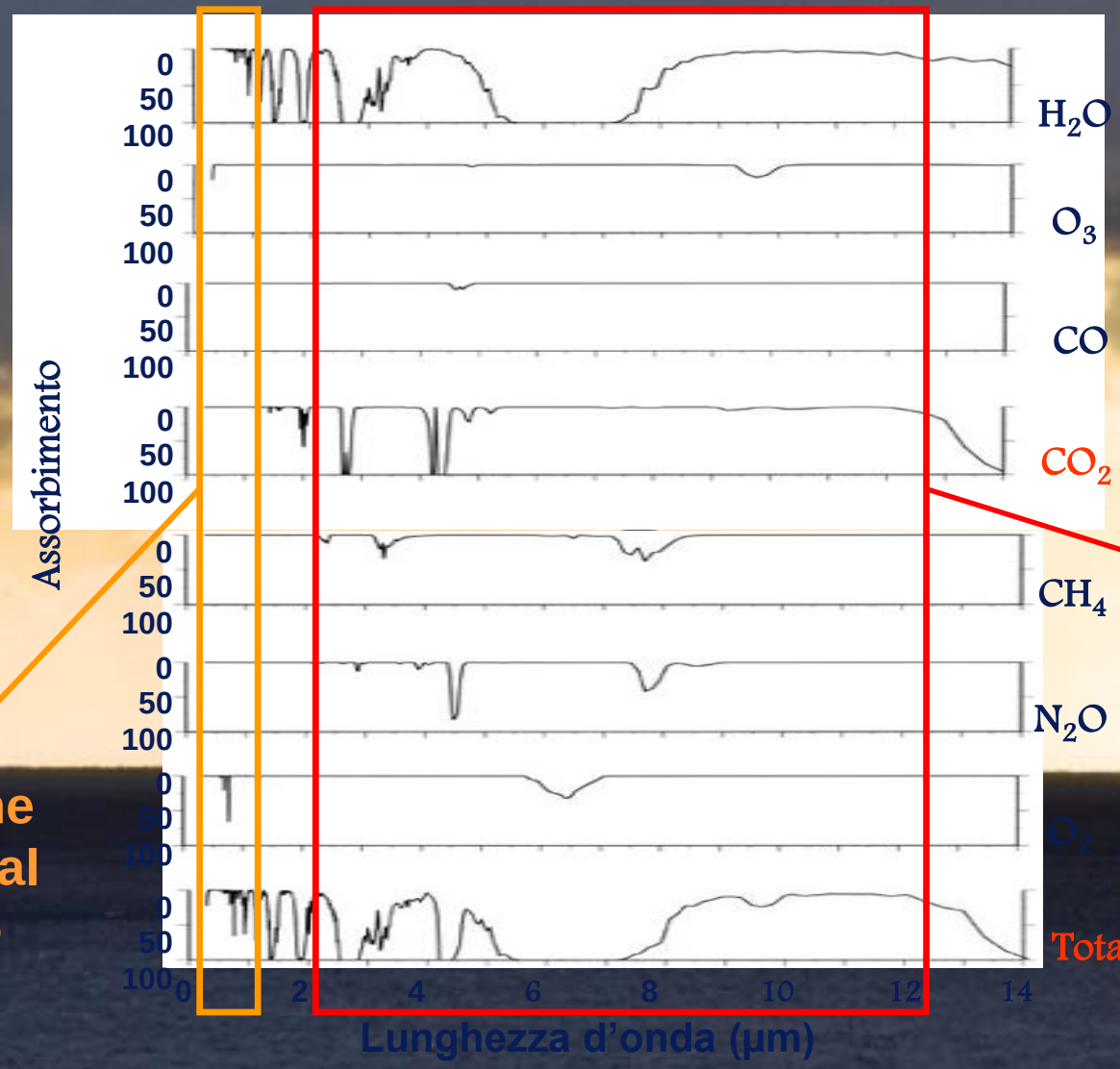


Effetto serra: flussi





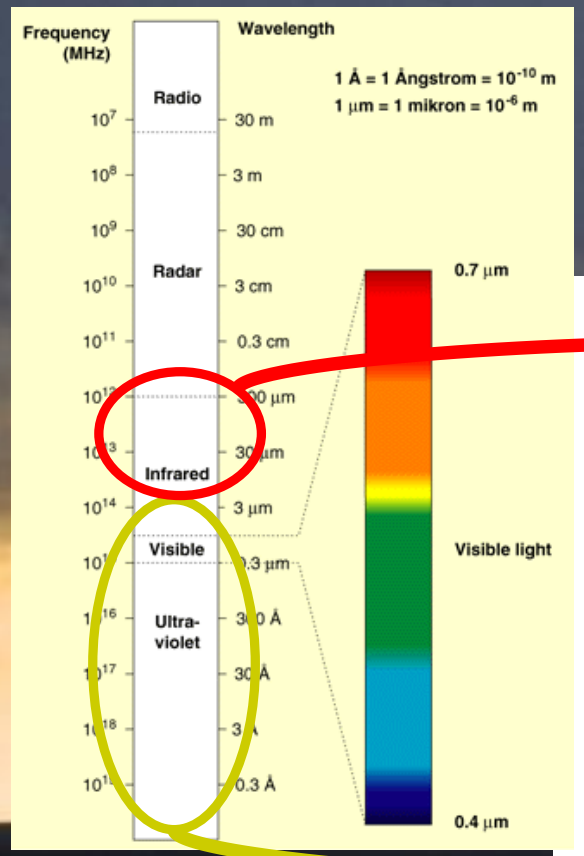
Effetto serra: assorbimento in atmosfera



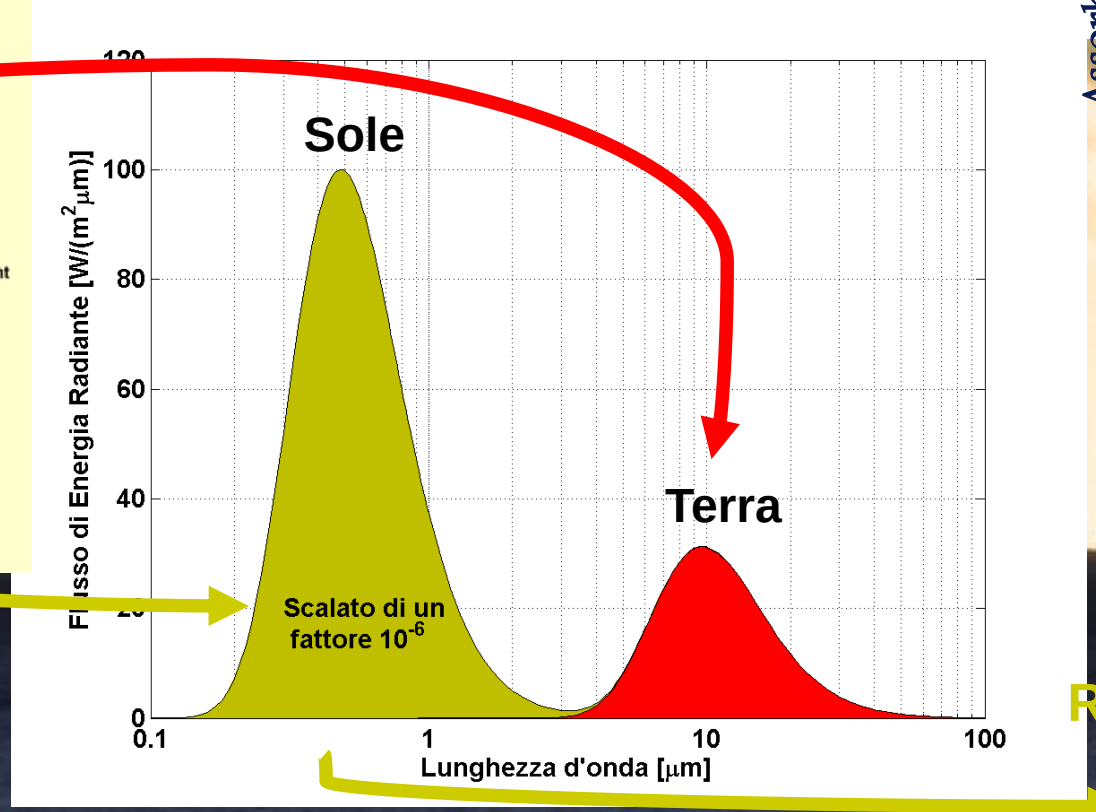
Radiazione emessa dal sole poco assorbita

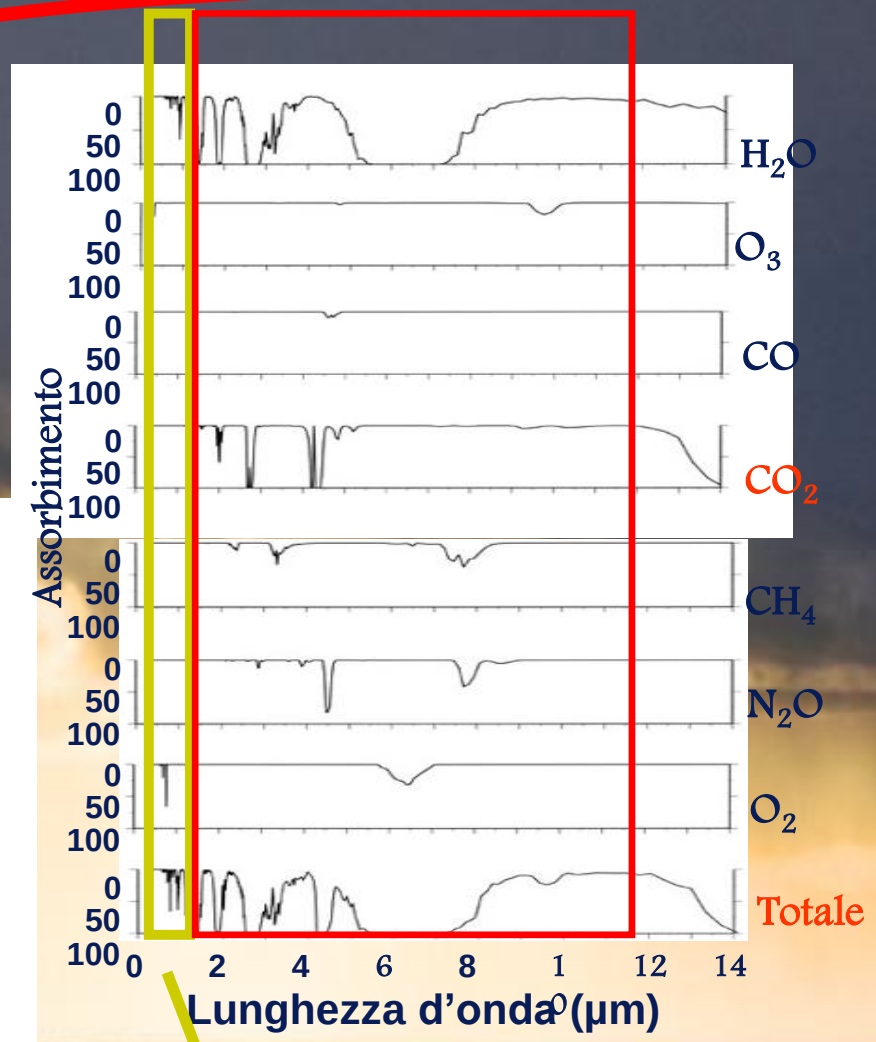
Radiazione riemessa dalla terra

Effetto serra: una questione di lunghezza d'onda



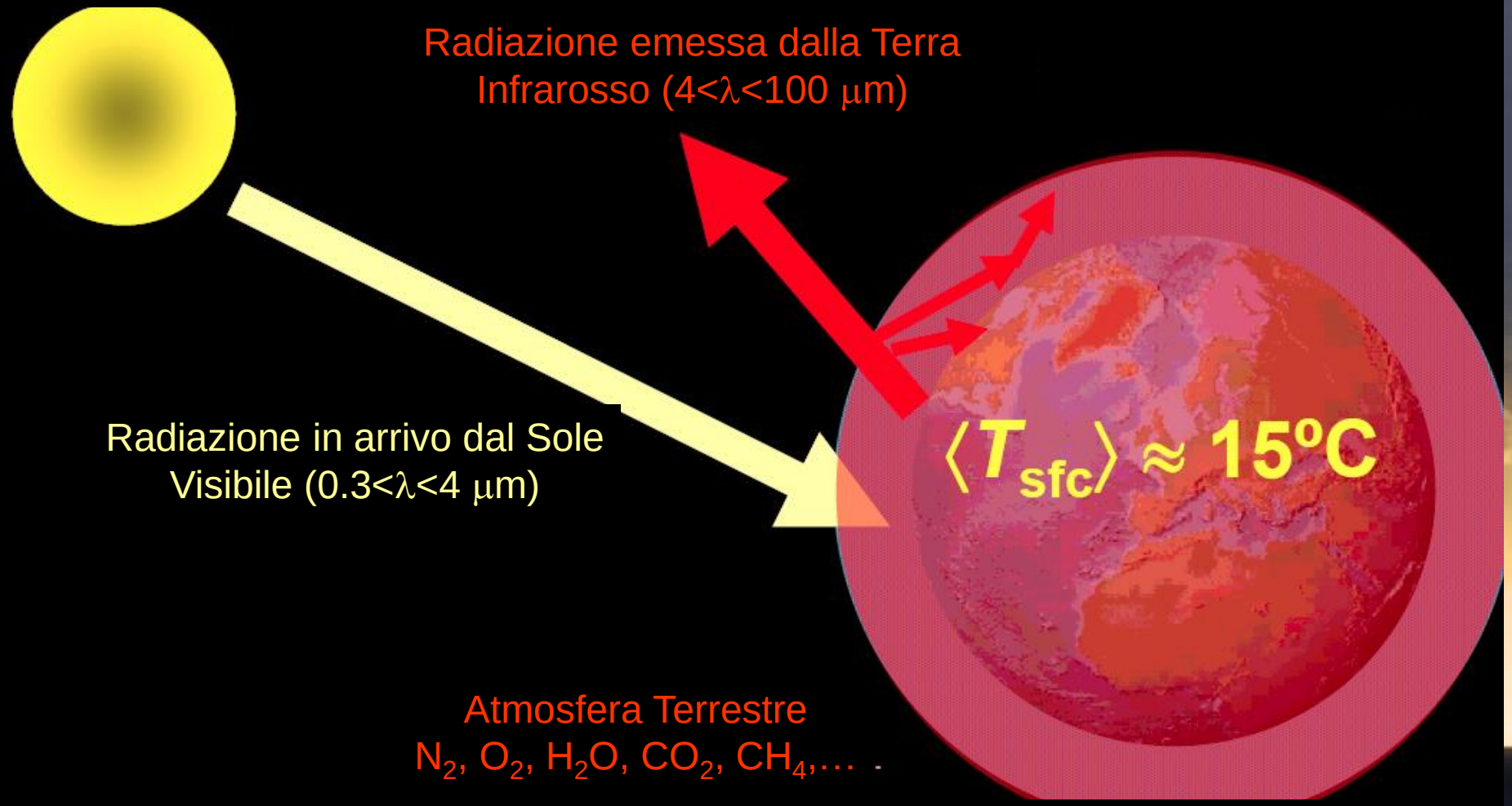
Radiazione riemessa dalla terra
MOLTO ASSORBITA





Radiazione emessa dal sole
POCO ASSORBITA

Effetto serra

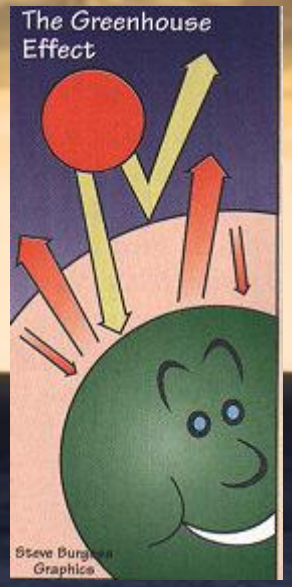


Più aumentano in atmosfera i gas con assorbimento nell'infrarosso (gas "serra")
Più energia entrante viene trattenuta
Più la temperatura del pianeta aumenta per equilibrare il bilancio energetico

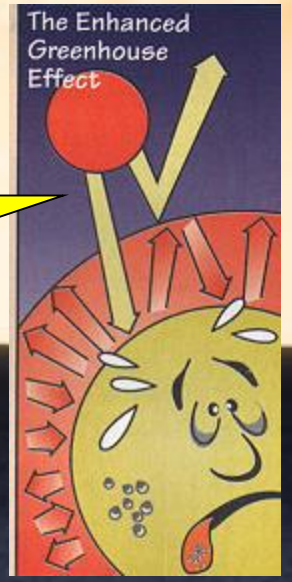
Effetto serra

Fenomeno naturale permette alla terra di avere una temperatura media vivibile (16°C)

Aumento dell'effetto serra è un problema!



Se non vi fosse l'atmosfera la temperatura media della terra sarebbe -18°C



Meteo vs clima

Meteo: si riferisce alle condizioni atmosferiche osservate localmente e in un periodo temporale breve (da qualche ore a qualche giorno). Le grandezze studiate sono: temperatura, radiazione solare, umidità, precipitazione ecc.

Clima: si riferisce alle condizioni atmosferiche su tempi scala lunghi (anni da circa 30 anni in su) su una scala spaziale regionale o globale. Le grandezze atmosferiche sono le stesse (temperatura, radiazione solare, umidità, precipitazione ecc.), ma **mediate** su scala regionale o globale e riferita a più anni.

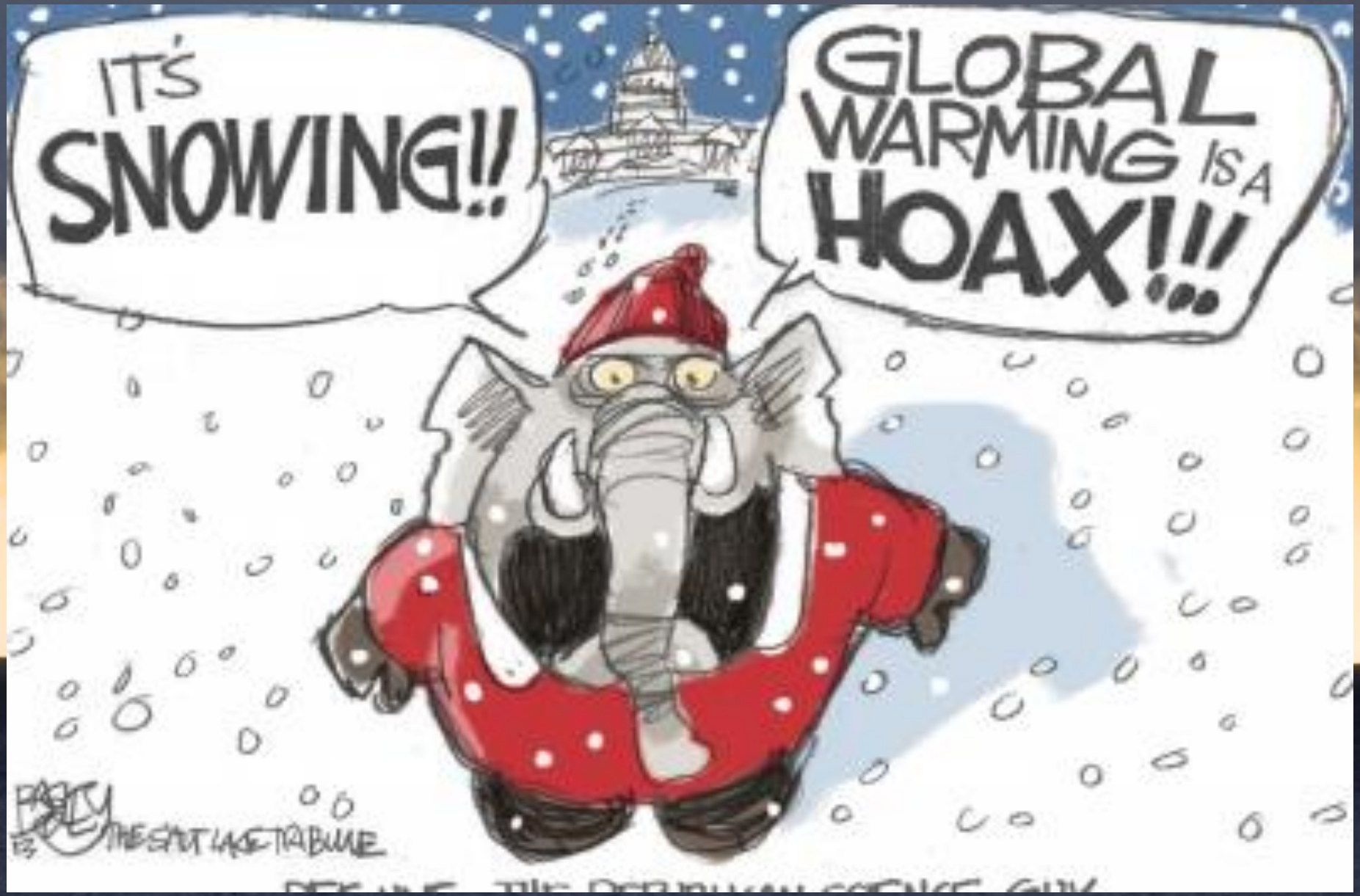
Temperatura, precipitazione, radiazione solare, umidità, ecc. dell'atmosfera

METEO

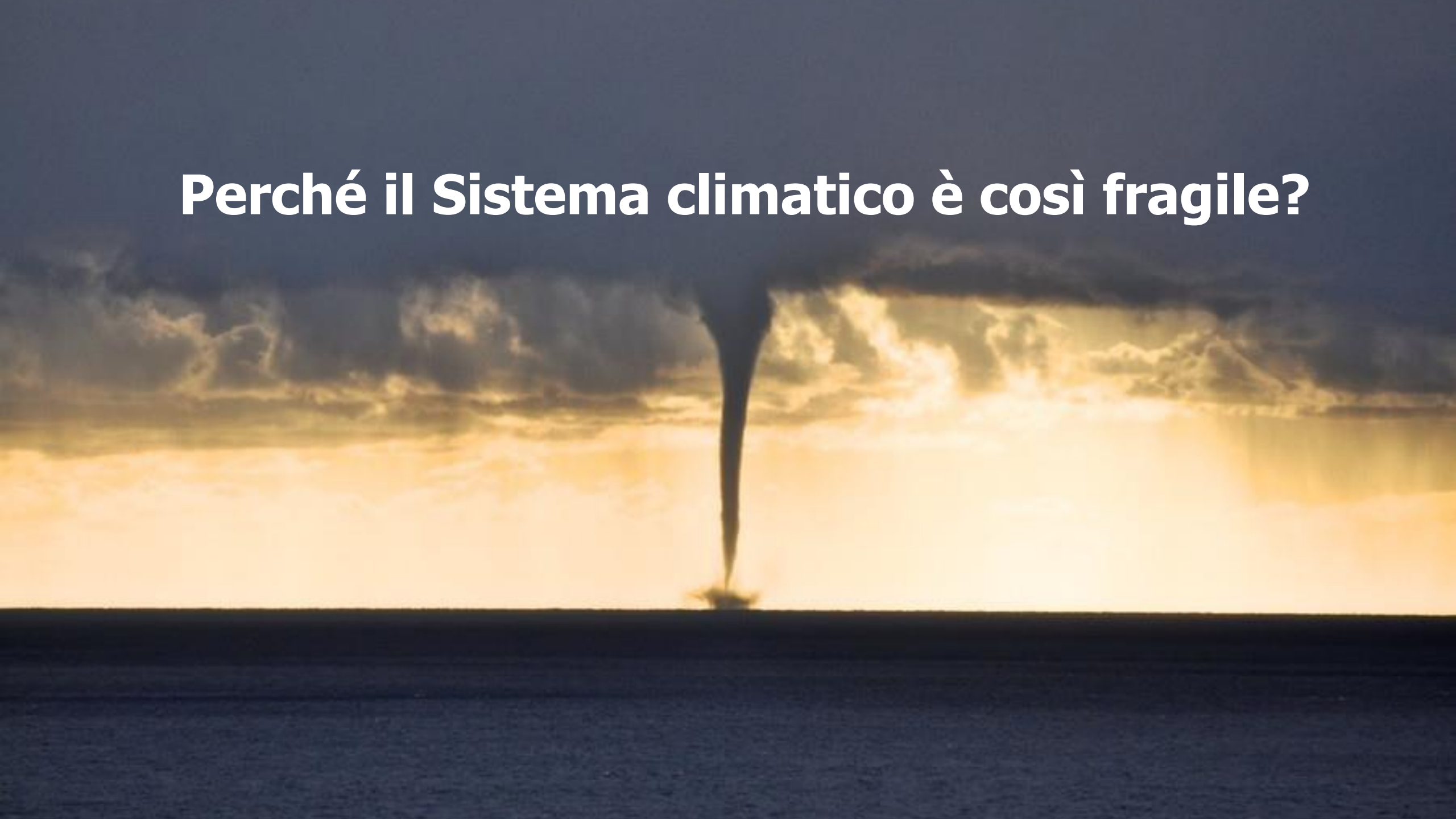
Su scala Locale e breve periodo

CLIMA

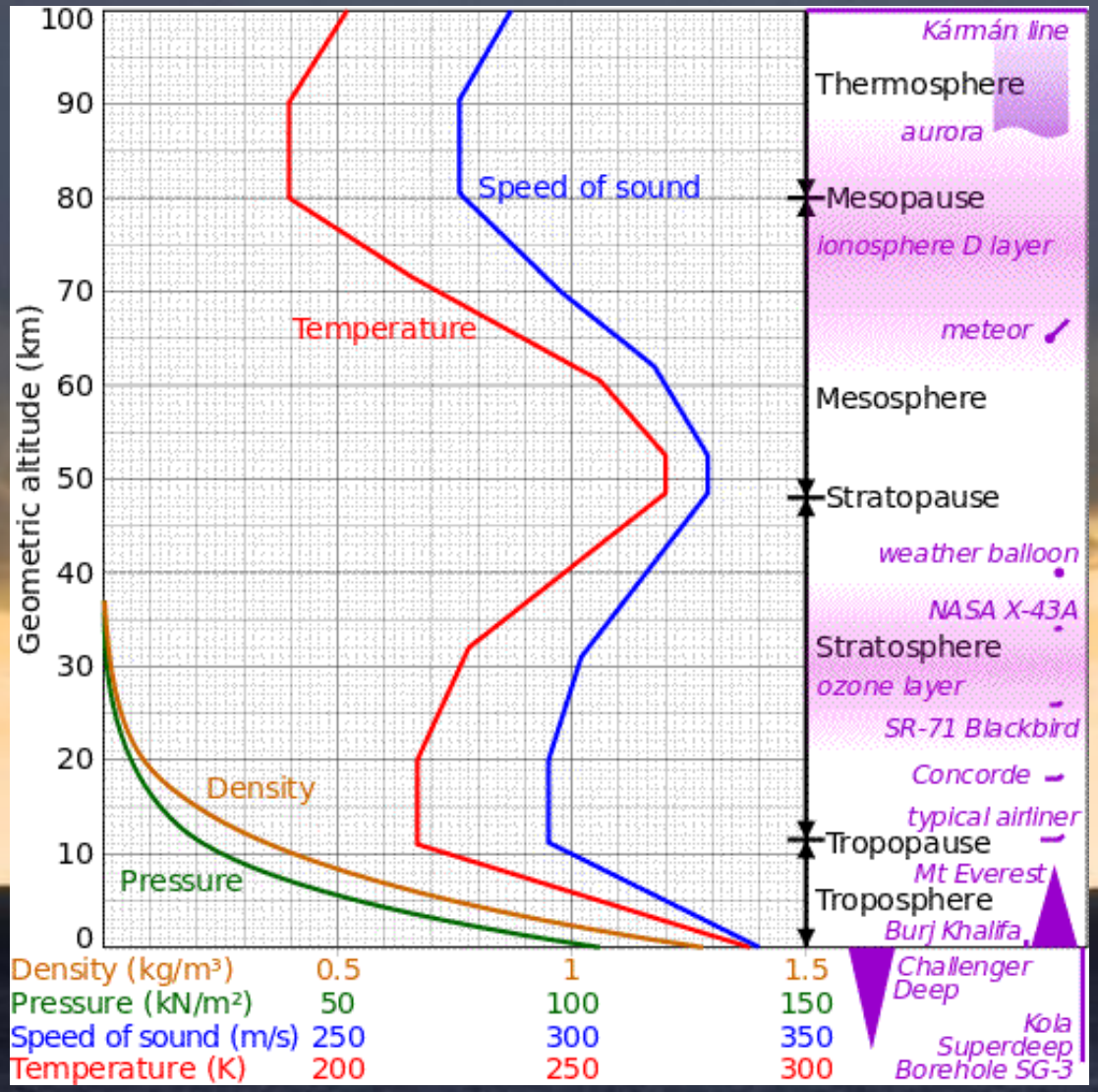
Su scala Globale e lungo periodo


IT'S SNOWING!!
GLOBAL WARMING IS A HOAX!!!
THE SALT LAKE TRIBUNE

Perché il Sistema climatico è così fragile?



Suddivisione dell'atmosfera e struttura



Variazione della temperatura con la quota:

$\Gamma = dT/dz = -6.5°C/km$

La pressione e la densità dell'aria decrescono quasi esponenzialmente con la quota

$$p \approx p_0 e^{-z/H}$$

dove H = altezza di scala = e-folding depth

H~7 km

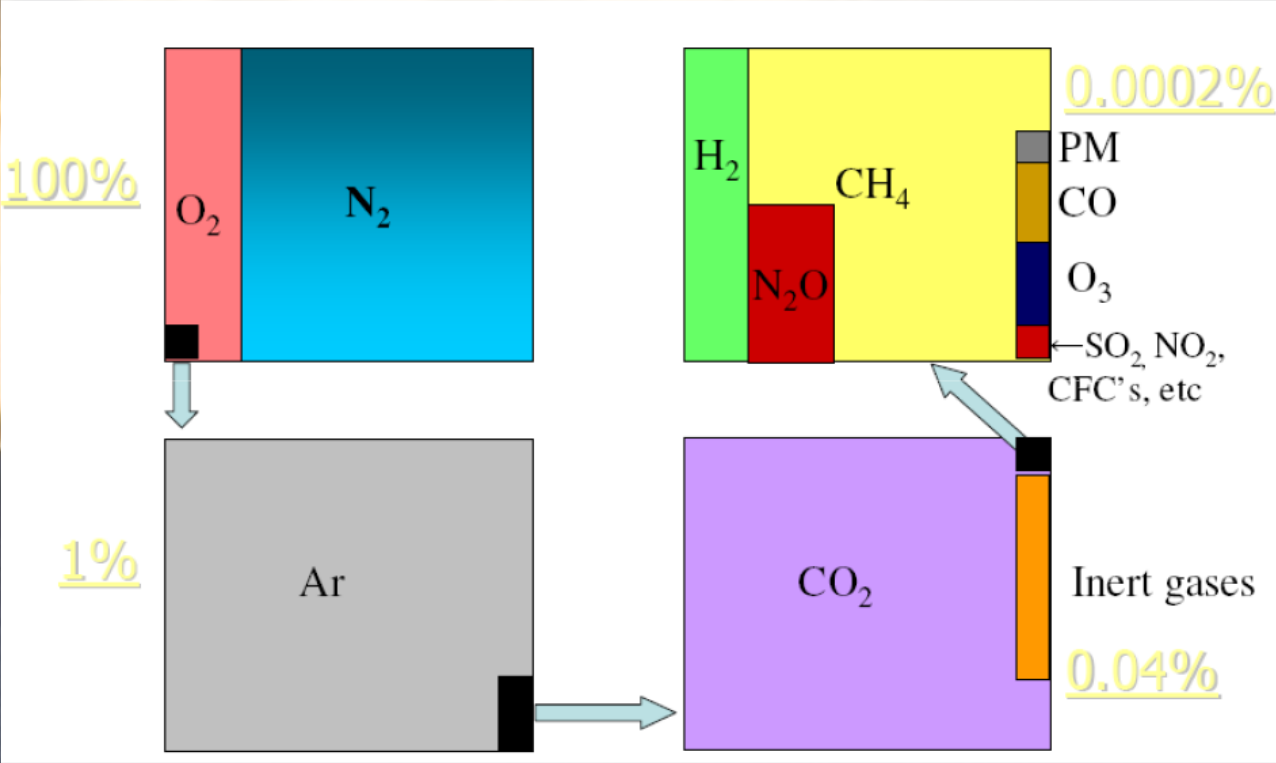
$$\ln \frac{p}{p_0} \approx -\frac{z}{H}$$

per stimare l'altezza dei livelli di pressione

Quota (o meglio altitudine) km s.l.m.	Densità (grossolanamente approssimata) densità kg/m³	Pressione millibar (ettoPascal)
0	1	1000
15,5	0,1	100
31,0	0,01	10
46,5	0,001	1
62,0	0,0001	0,1
77,5	0,00001	0,01
93,0	0,000001	0,001

Composizione chimica dell'atmosfera

Gas	Concentration by Volume	
Nitrogen (N_2)	780,840 ppmv	78.084%)
Oxygen (O_2)	209,460 ppmv	20.946%)
Argon (Ar)	9,340 ppmv	0.9340%)
Carbon dioxide (CO_2)	390 ppmv[77]	0.039%)
Neon (Ne)	18.18 ppmv	0.001818%)
Helium (He)	5.24 ppmv	0.000524%)
Methane (CH_4)	1.79 ppmv	0.000179%)
Krypton (Kr)	1.14 ppmv	0.000114%)
Hydrogen (H_2)	0.55 ppmv	0.000055%)
Nitrous oxide (N_2O)	0.3 ppmv	0.00003%)
Carbon monoxide (CO)	0.1 ppmv	0.00001%)
Xenon (Xe)	0.09 ppmv	9×10^{-6}%)
Ozone (O_3)	0.0 to 0.07 ppmv	0 to 7×10^{-6}%)
Nitrogen dioxide (NO_2)	0.02 ppmv	2×10^{-6}%
Iodine (I)	0.01 ppmv	1 × 10−6%
Ammonia (NH_3)	trace	



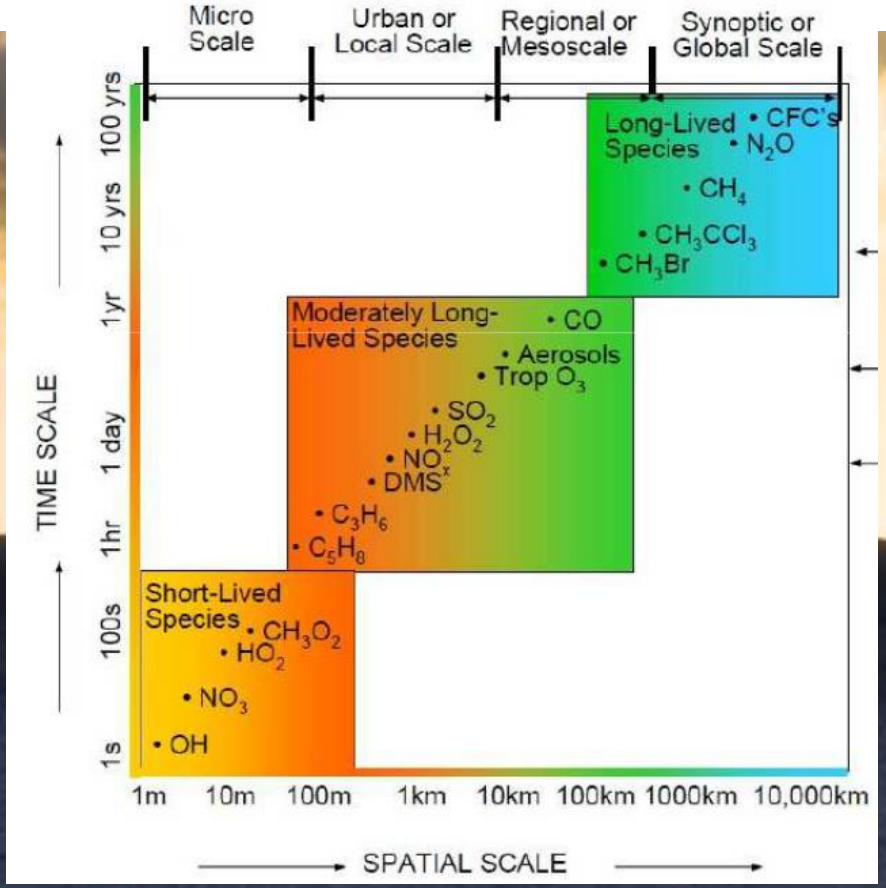
Tempo di residenza dei composti atmosferici

- Tempo di residenza $\tau = \frac{m}{F}$

m = massa totale del gas
F = afflusso/deflusso medio

τ

milioni di anni per i gas nobili
mesi/anni per i gas semi-permanenti (CO, CH_2)
giorni per i gas variabili (chimicamente attivi o legati al ciclo dell'acqua)



Tempo di Residenza in atmosfera della CO2

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Nature Reports Climate Change
Published online: 20 November 2008 | doi:10.1038/climate.2008.122

Carbon is forever

Carbon dioxide emissions and their associated warming could linger for millennia, according to some climate scientists. Mason Inman looks at why the fallout from burning fossil fuels could last far longer than expected.

After our fossil fuel blow-out, how long will the CO_2 hangover last? And what about the global fever that comes along with it? These sound like simple questions, but the answers are complex — and not well understood or appreciated outside a small group of climate scientists. Popular books on climate change — even those written by scientists — if they mention the lifetime of CO_2 at

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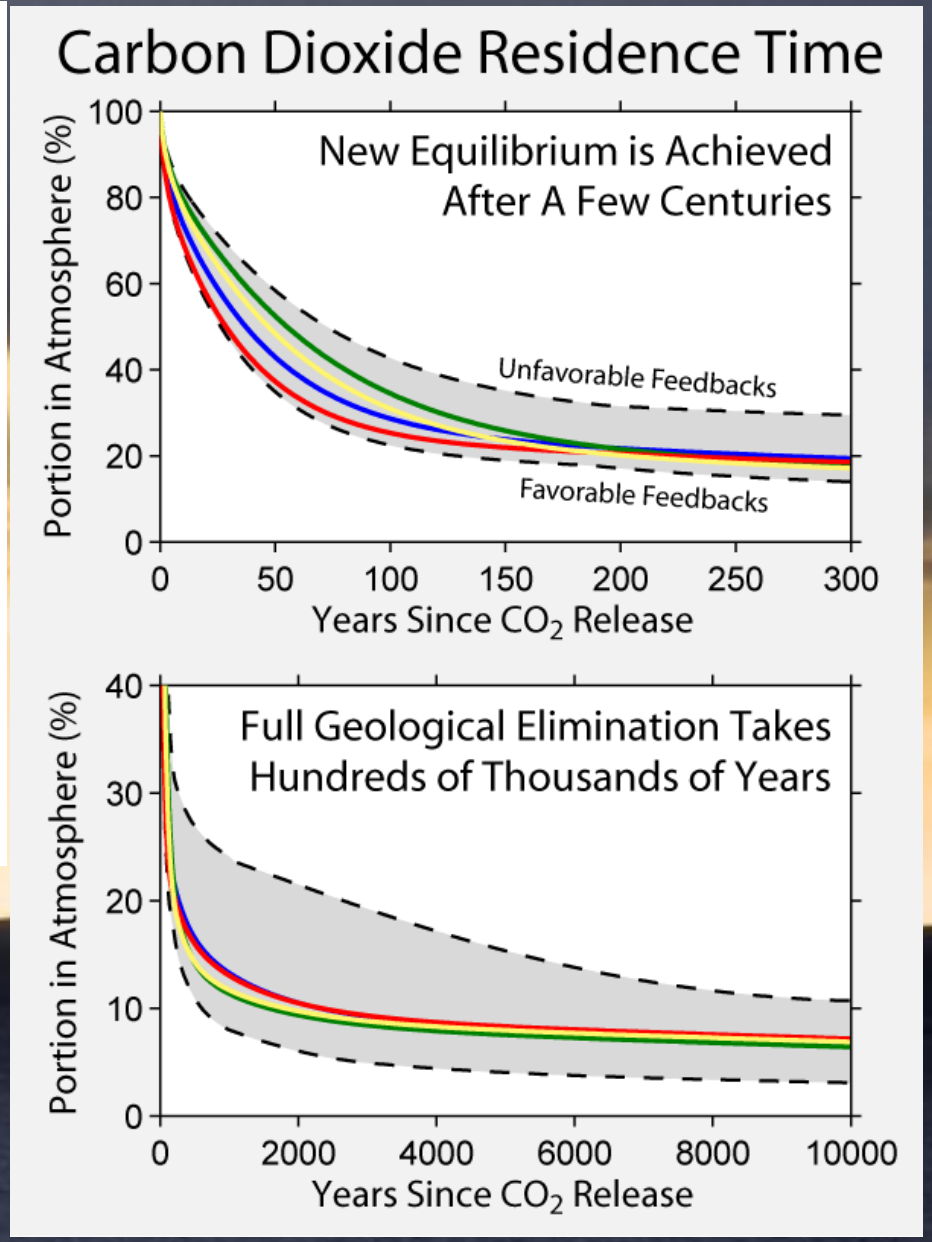
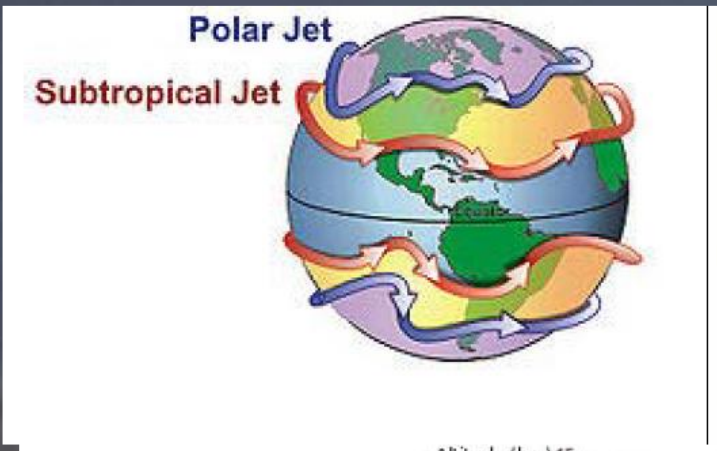
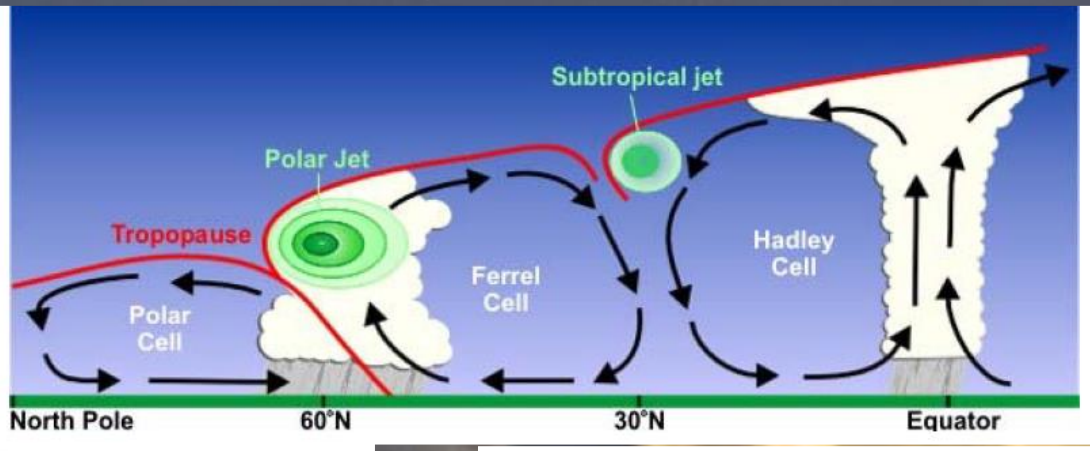
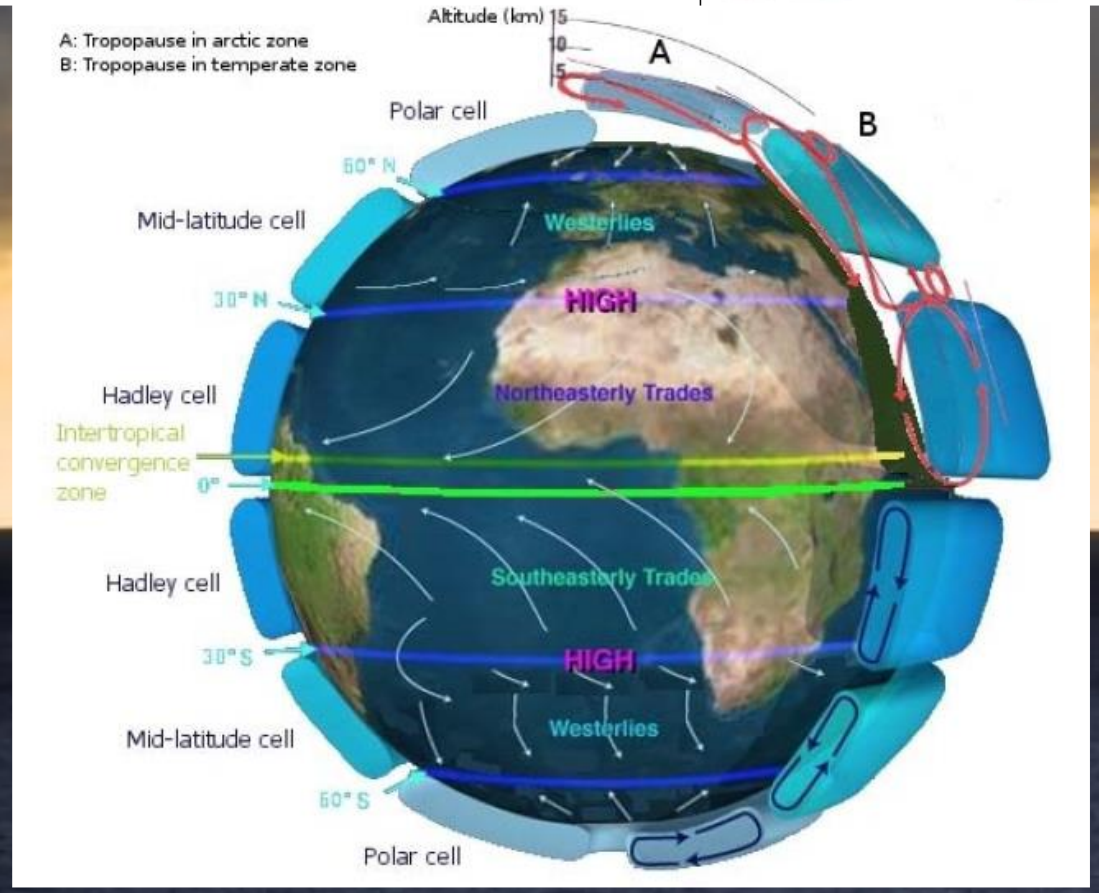
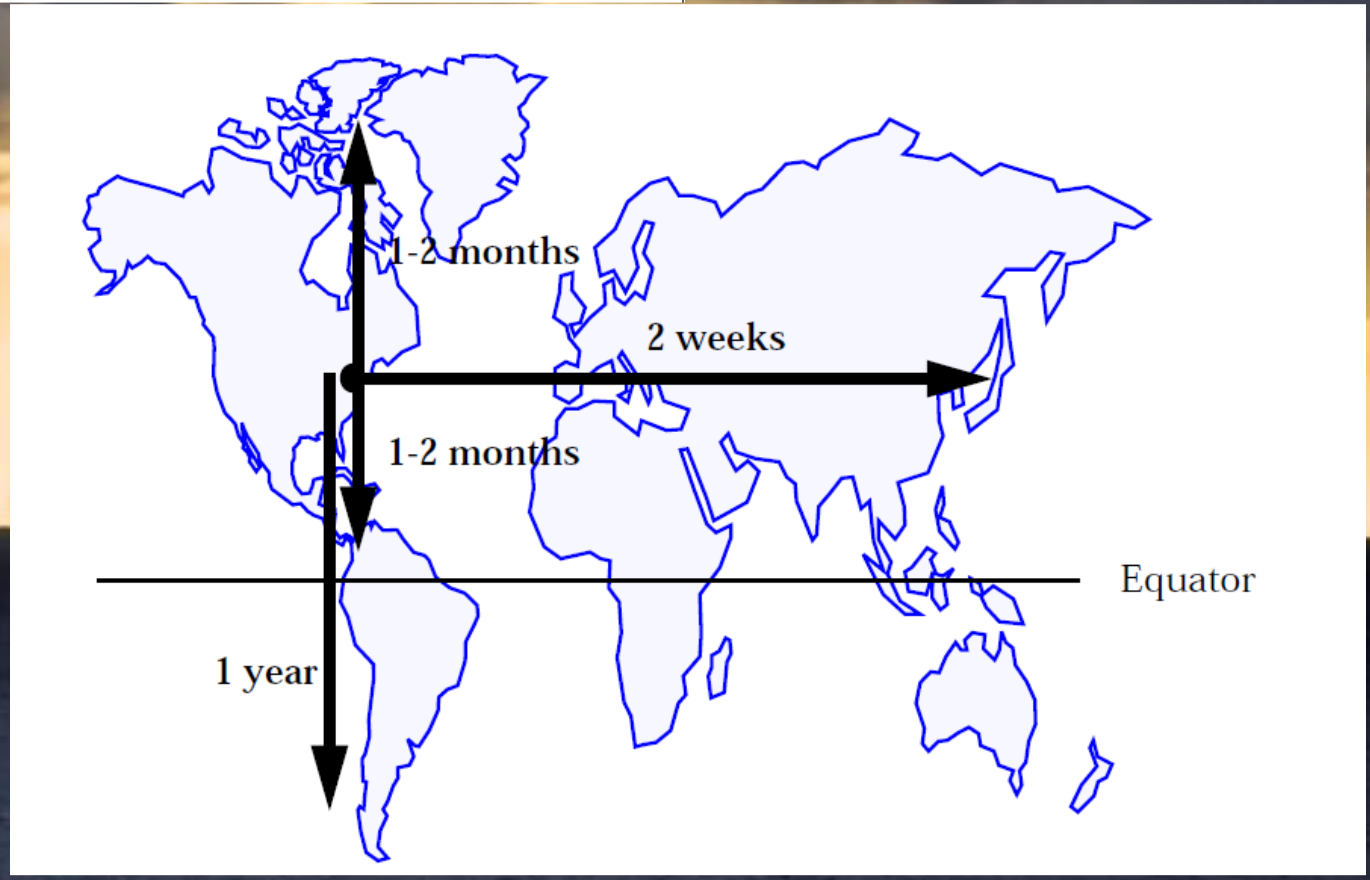


Circolazione globale e trasporto

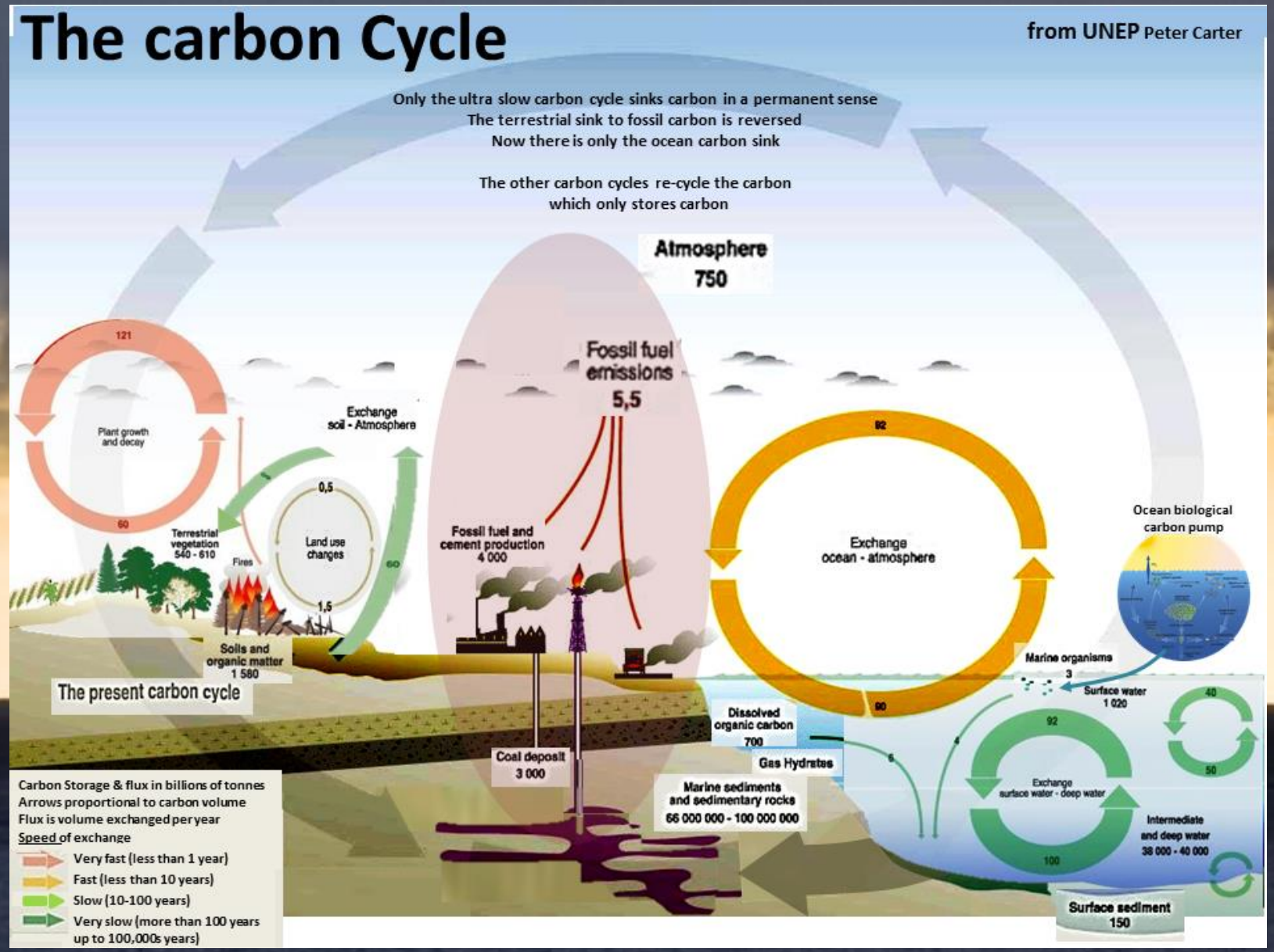








Il Ciclo del Carbonio



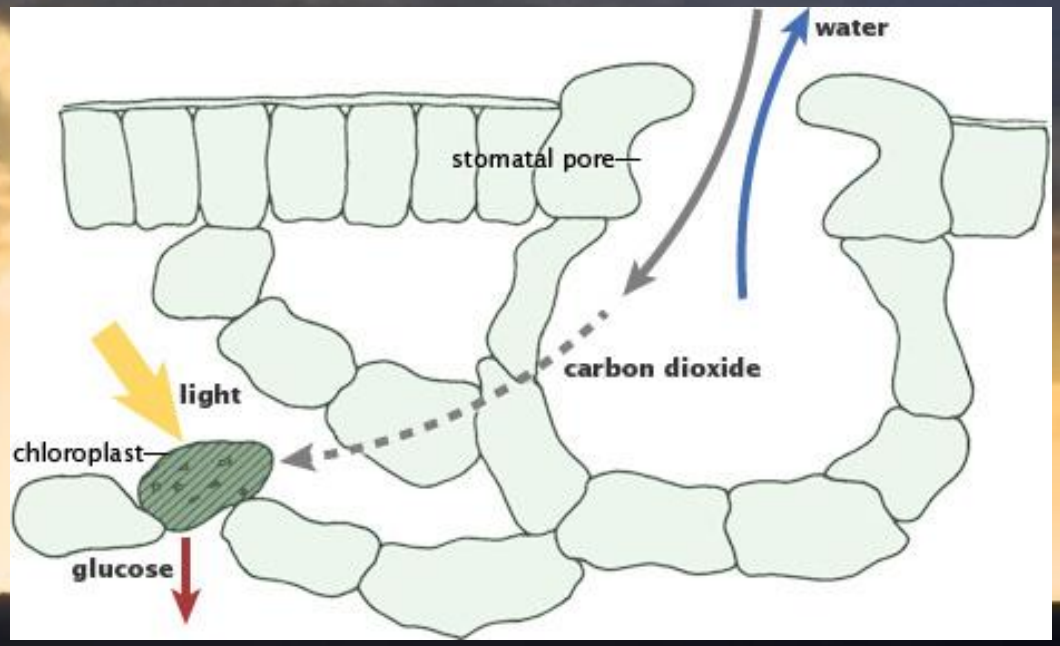
Il Ciclo del Carbonio: scale temporali corte

Fotosintesi: piante e fitoplancton:

$CO_2 + H_2O + h\nu = CH_2O + O_2$

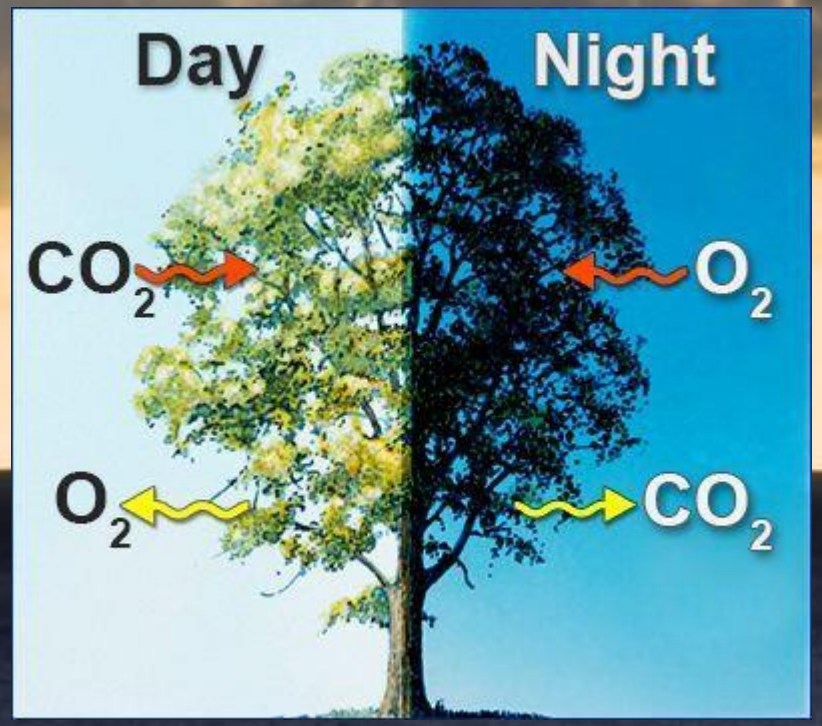
Riemissione di CO_2: metabolismo delle piante, mangiate, bruciate o decomposta da batteri quando muoiono:

$CH_2O + O_2 = CO_2 + H_2O$ + energia

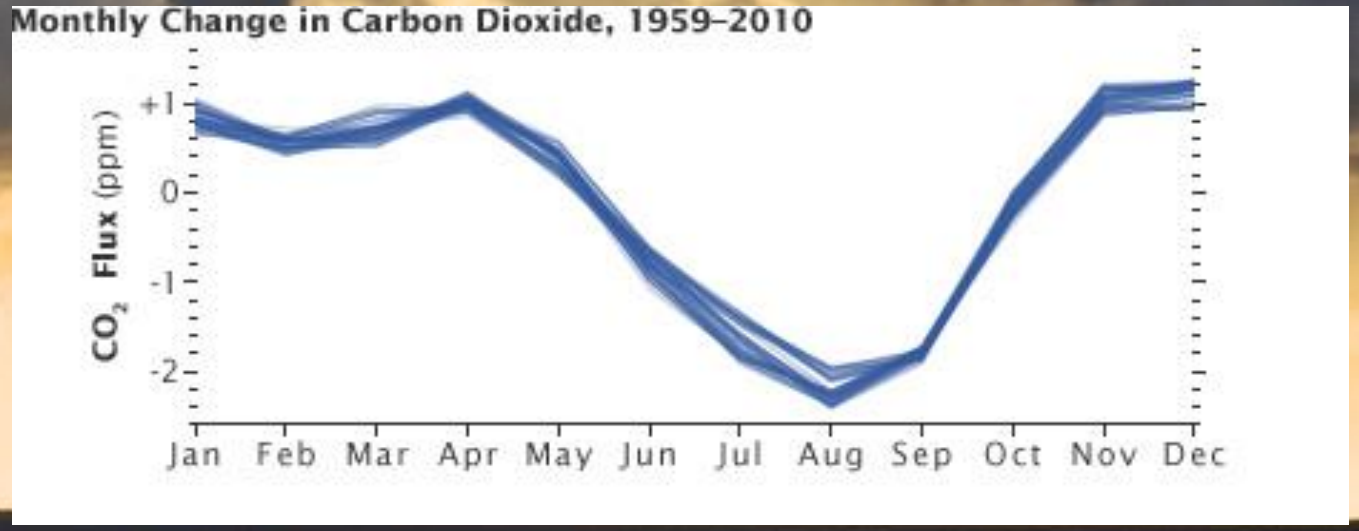


Il Ciclo del Carbonio: scale temporali corte

Ciclo diurno

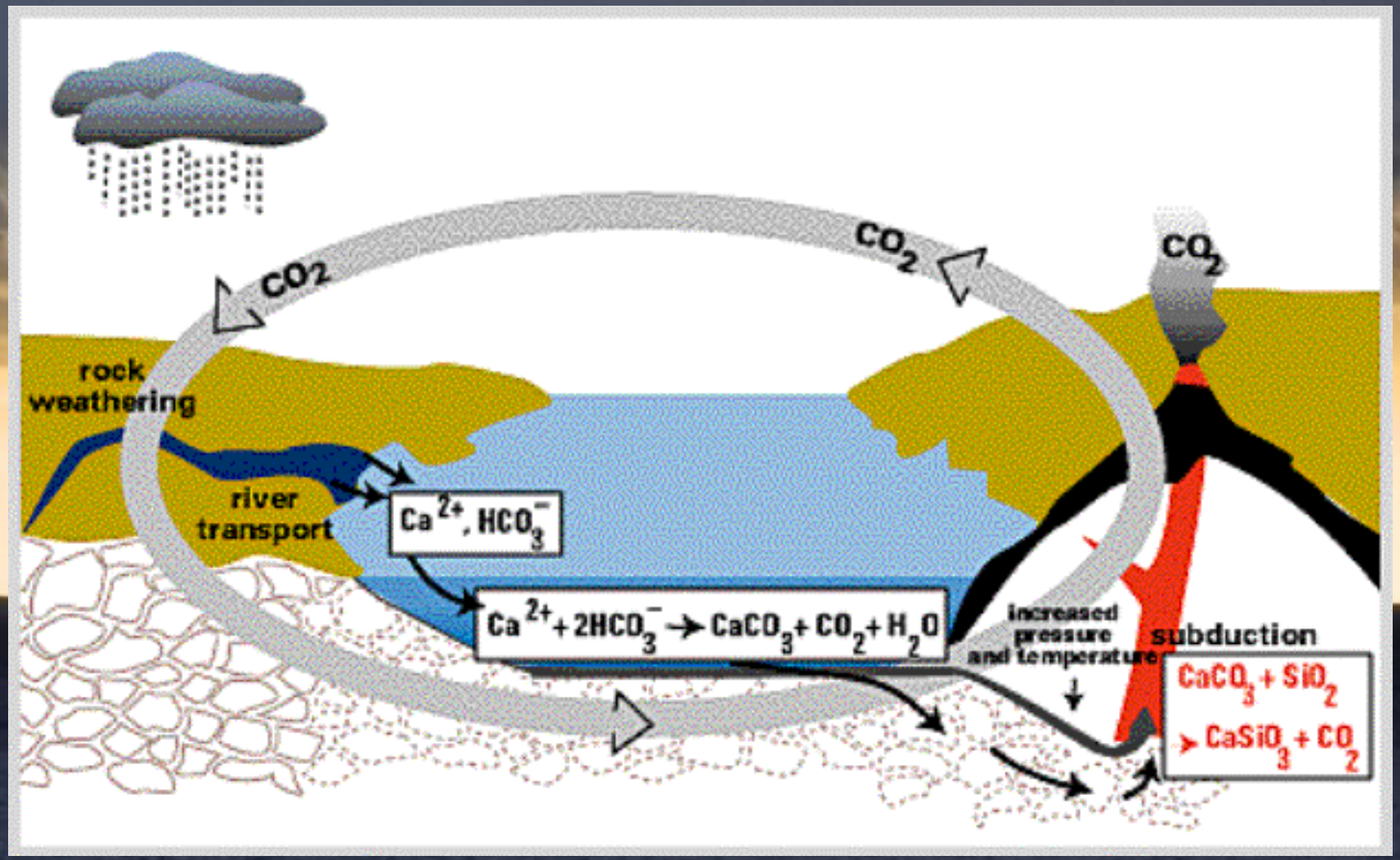


Ciclo stagionale



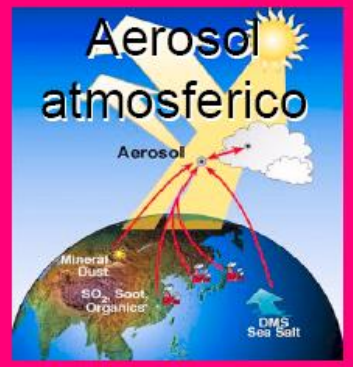
Il Ciclo del Carbonio: scale temporali lunghe

100-200 Milioni di anni



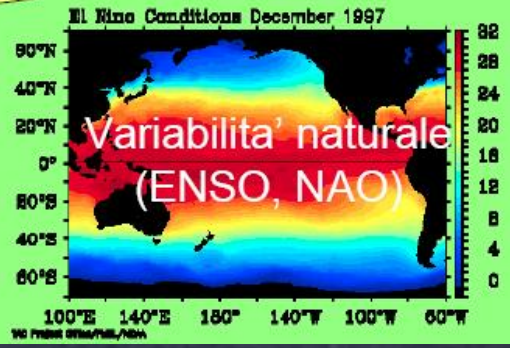
Cambiamento climatico: solo antropizzazione?

Fattori umani



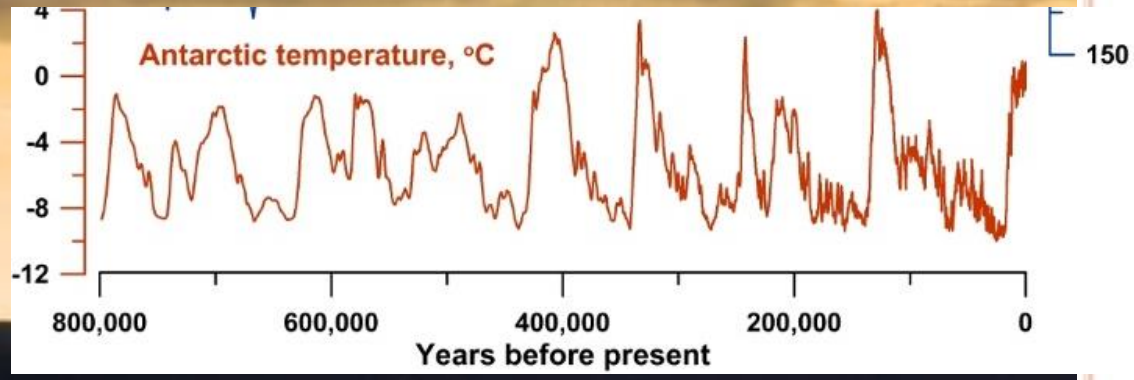
Il clima della terra puo' cambiare a causa di fattori umani o fattori naturali

Fattori naturali

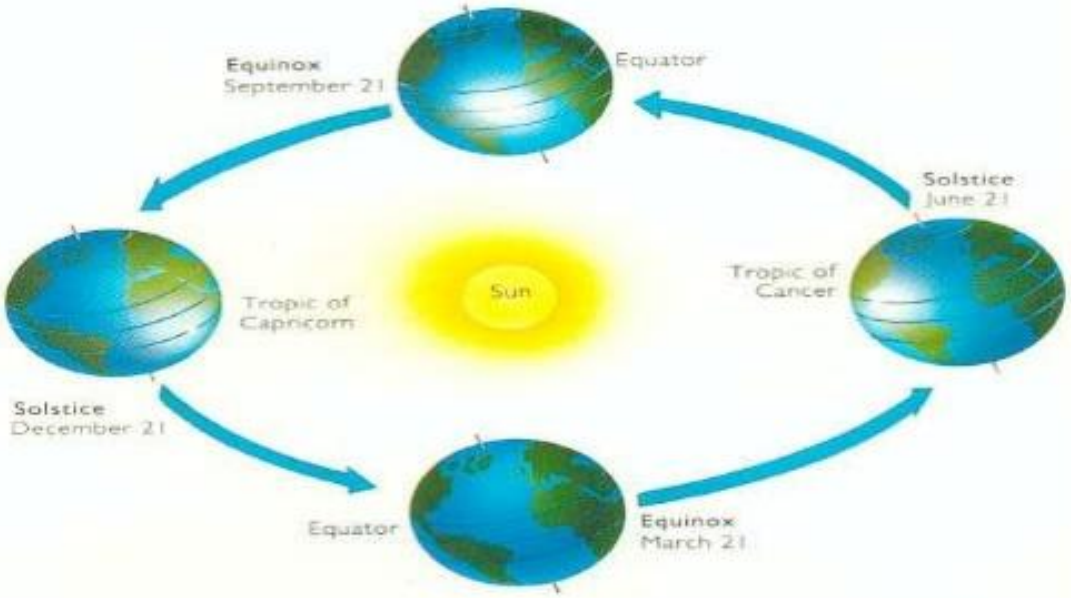


Perturbazioni naturali: orbita terrestre

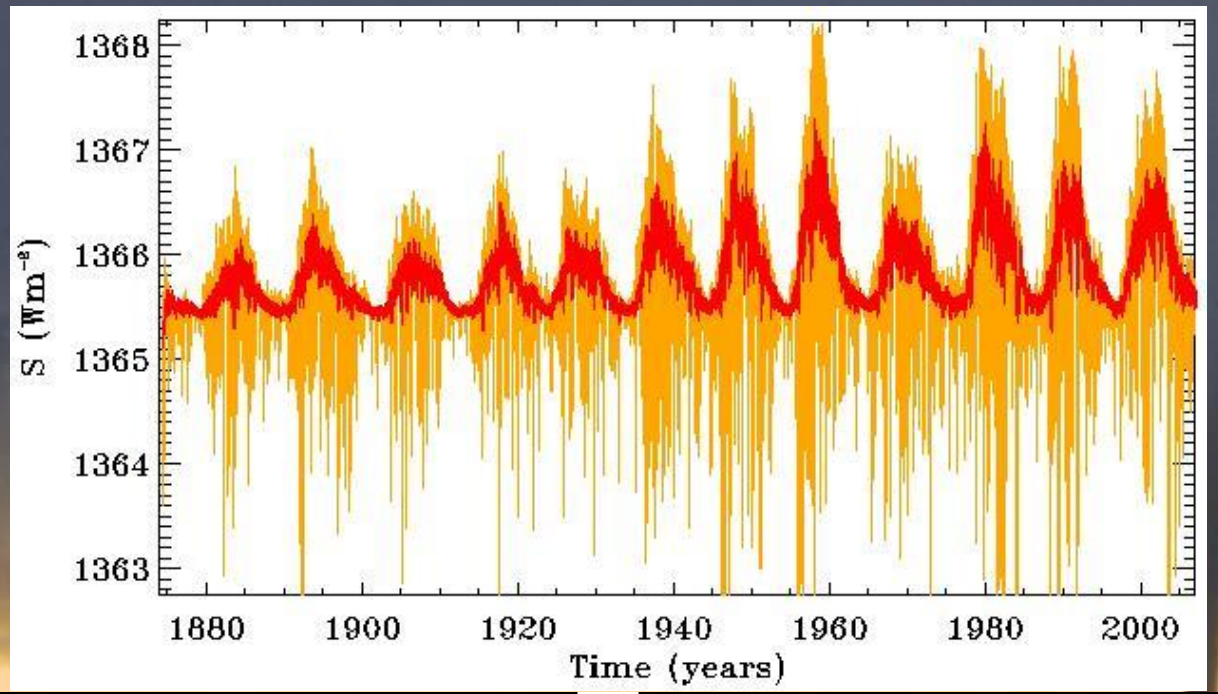
Scale temporali di milioni di anni



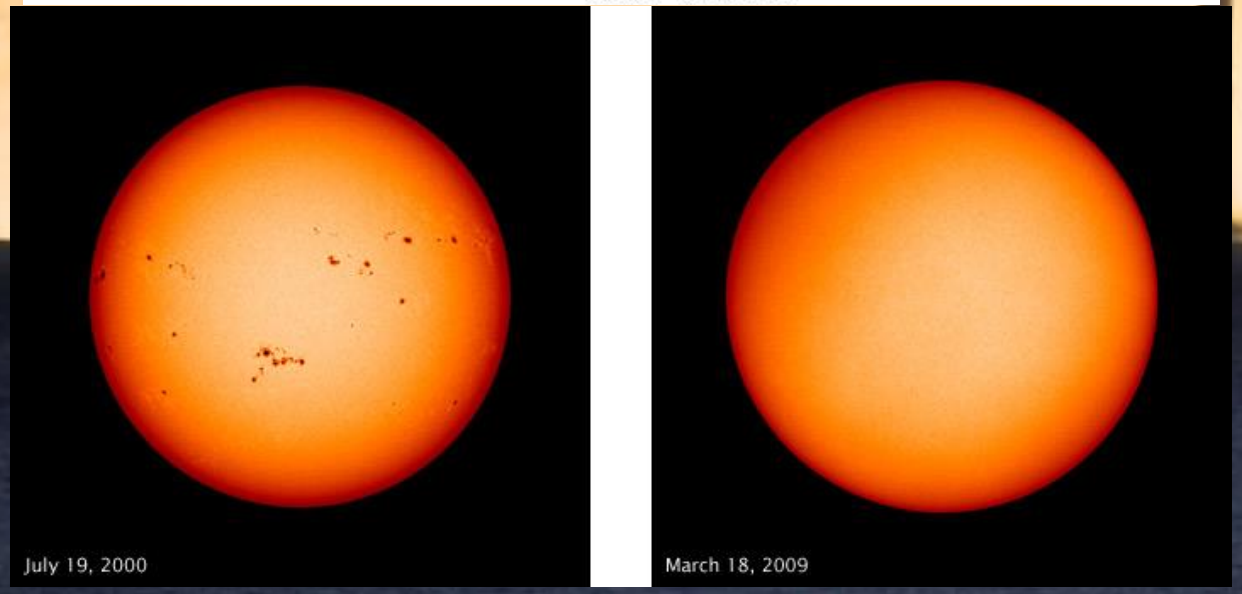
- Earth orbital changes-
  - More tilt = warmer summers & colder winters
  - Less tilt = cooler summers & milder winters

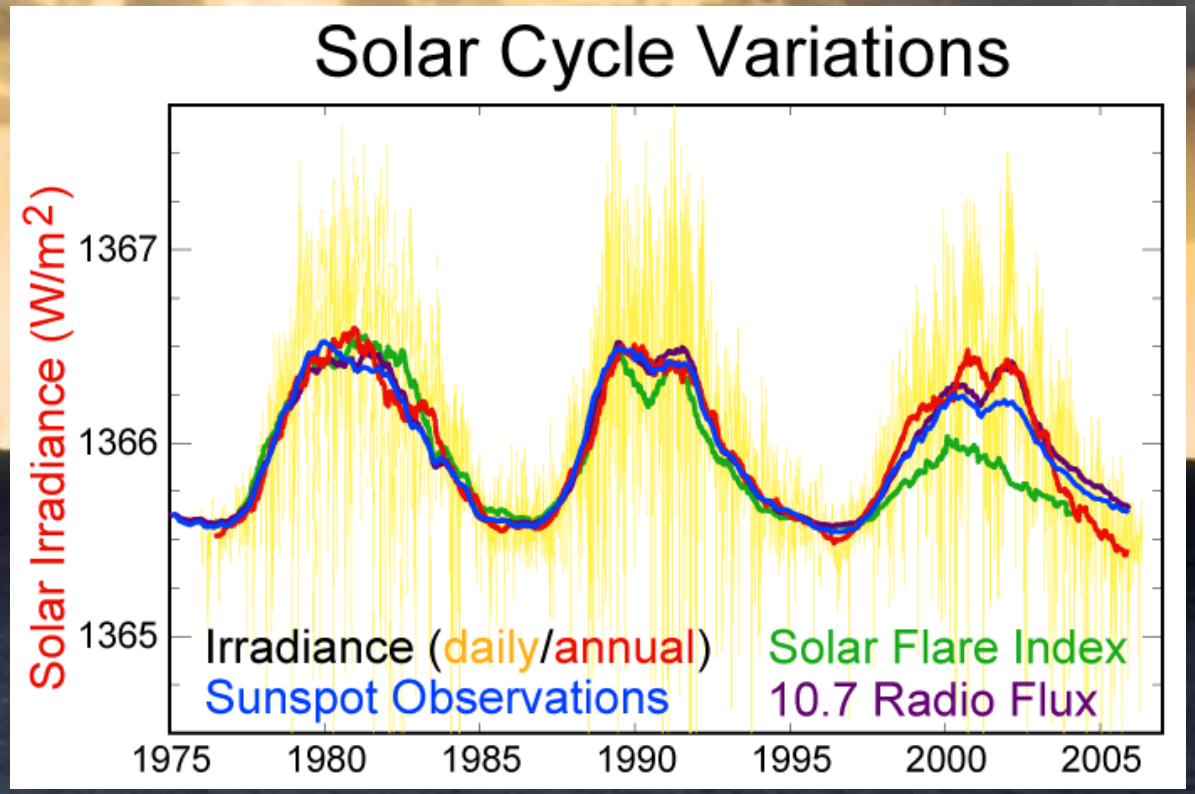


Cicli solari

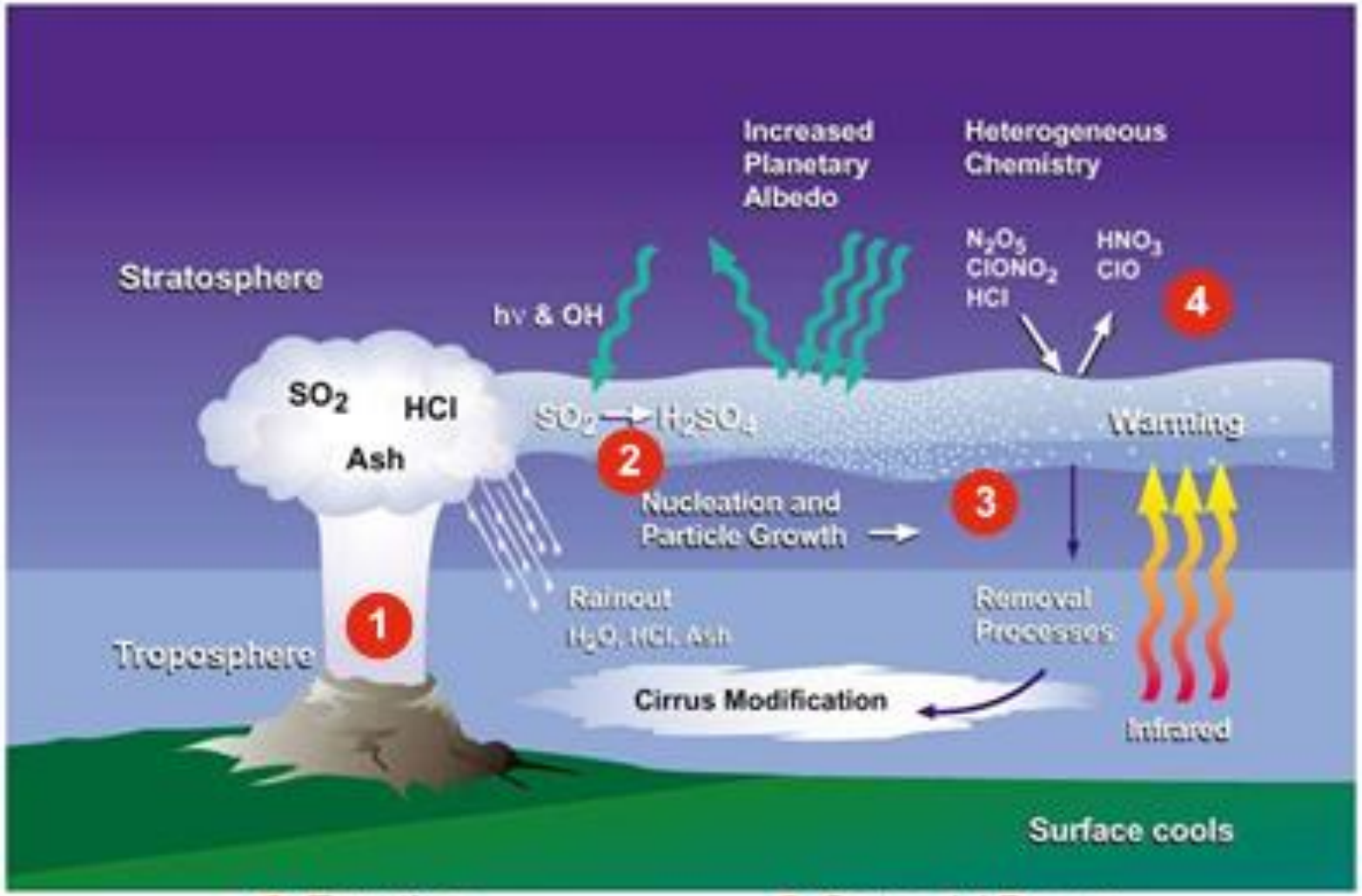


Con una periodicità di circa 11 anni il sole emette più energia del normale per via di tempeste elettromagnetiche conseguenze di eruzioni solari





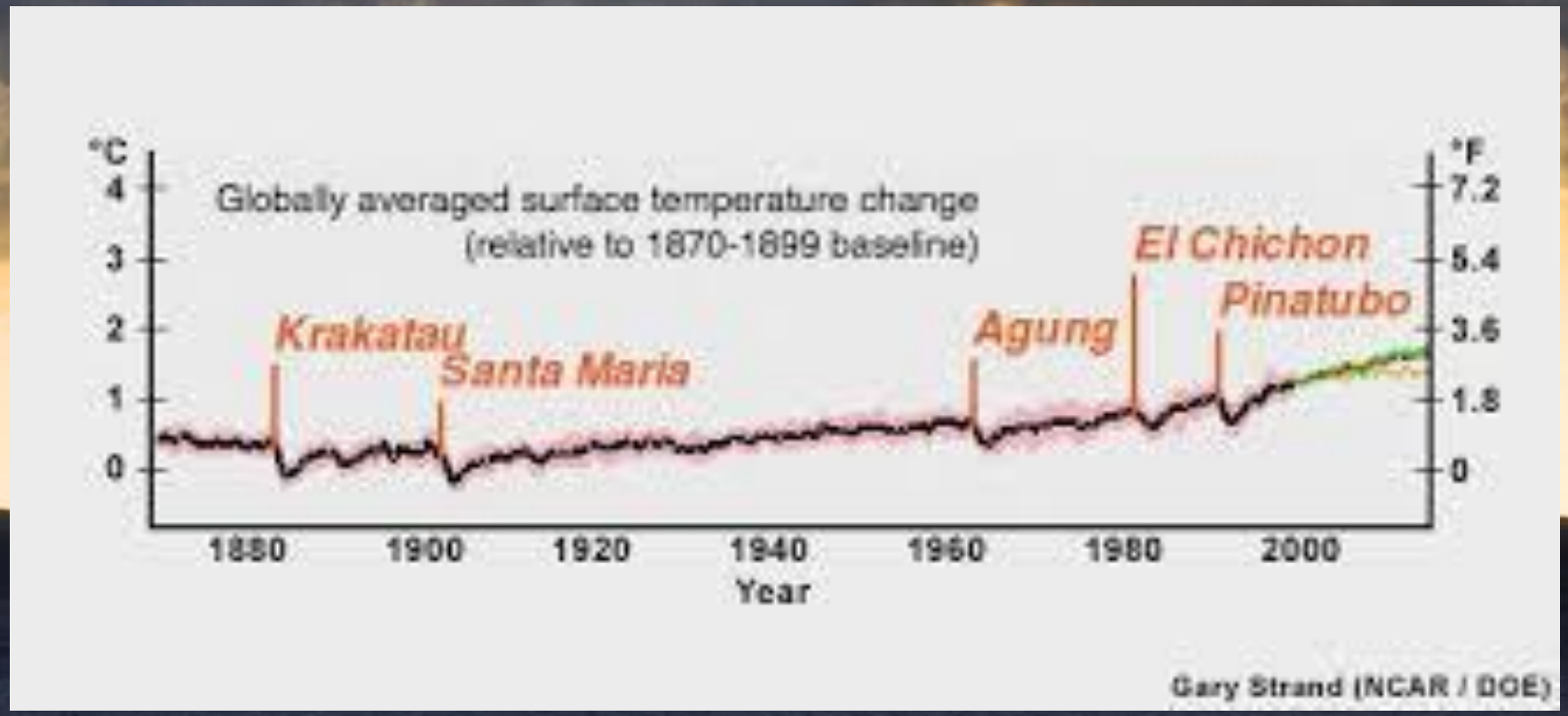
Perturbazioni naturali: eruzioni vulcaniche



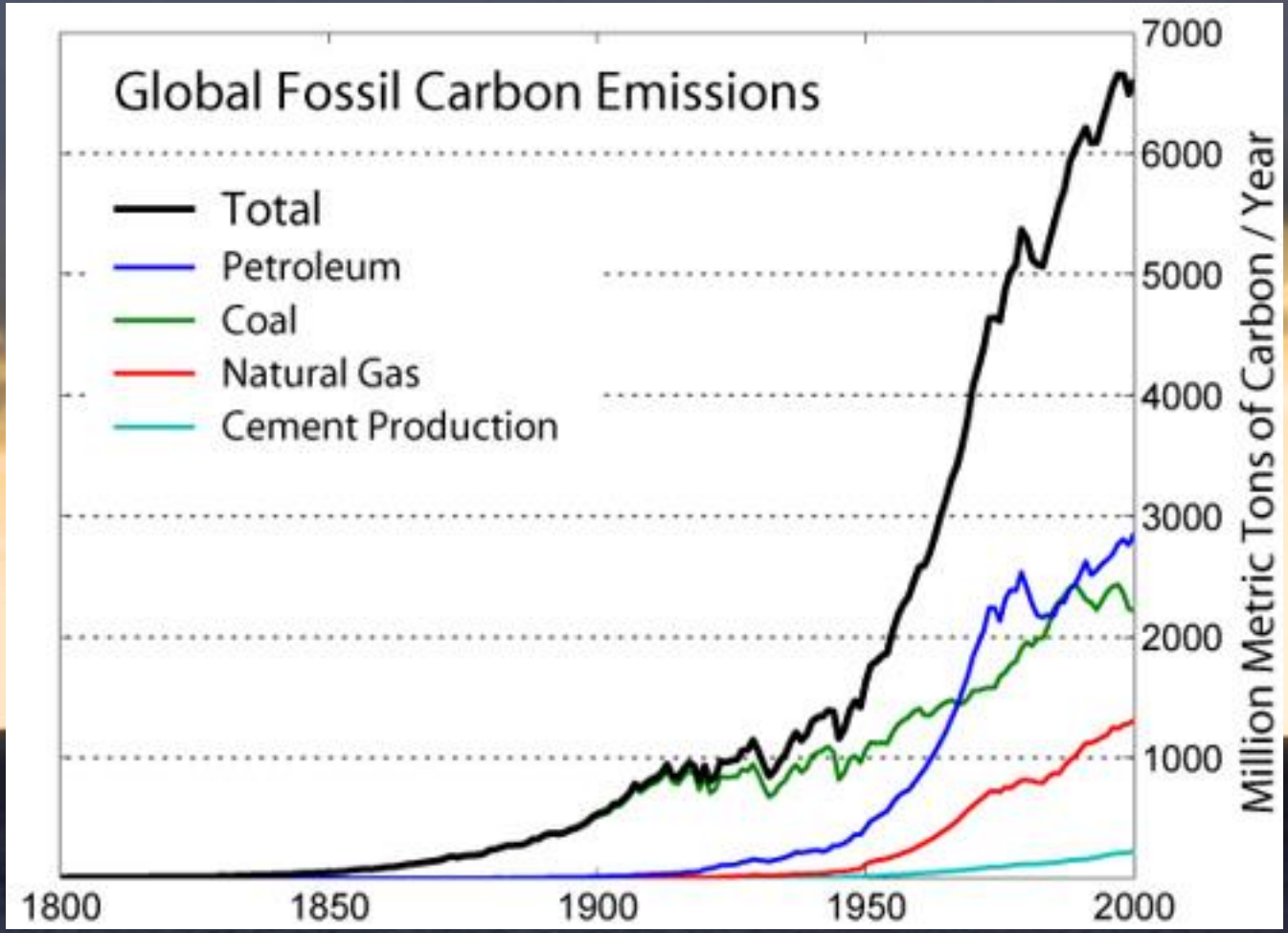
❶ Eruption
❷ Aerosol Formation
❸ Spread / Decay
❹ Climate Response

Perturbazioni naturali

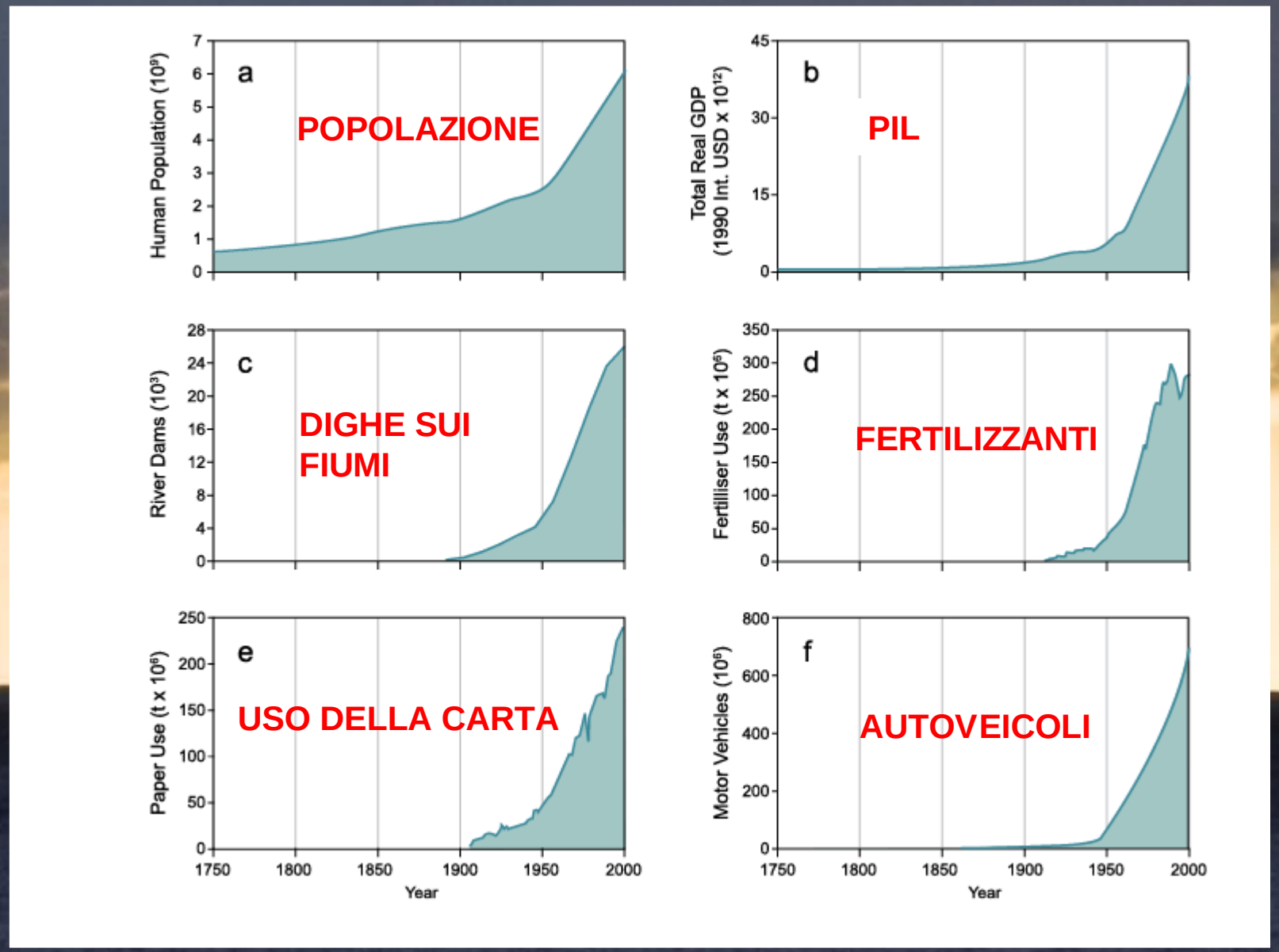
Effetti delle eruzioni vulcaniche sulla temperatura



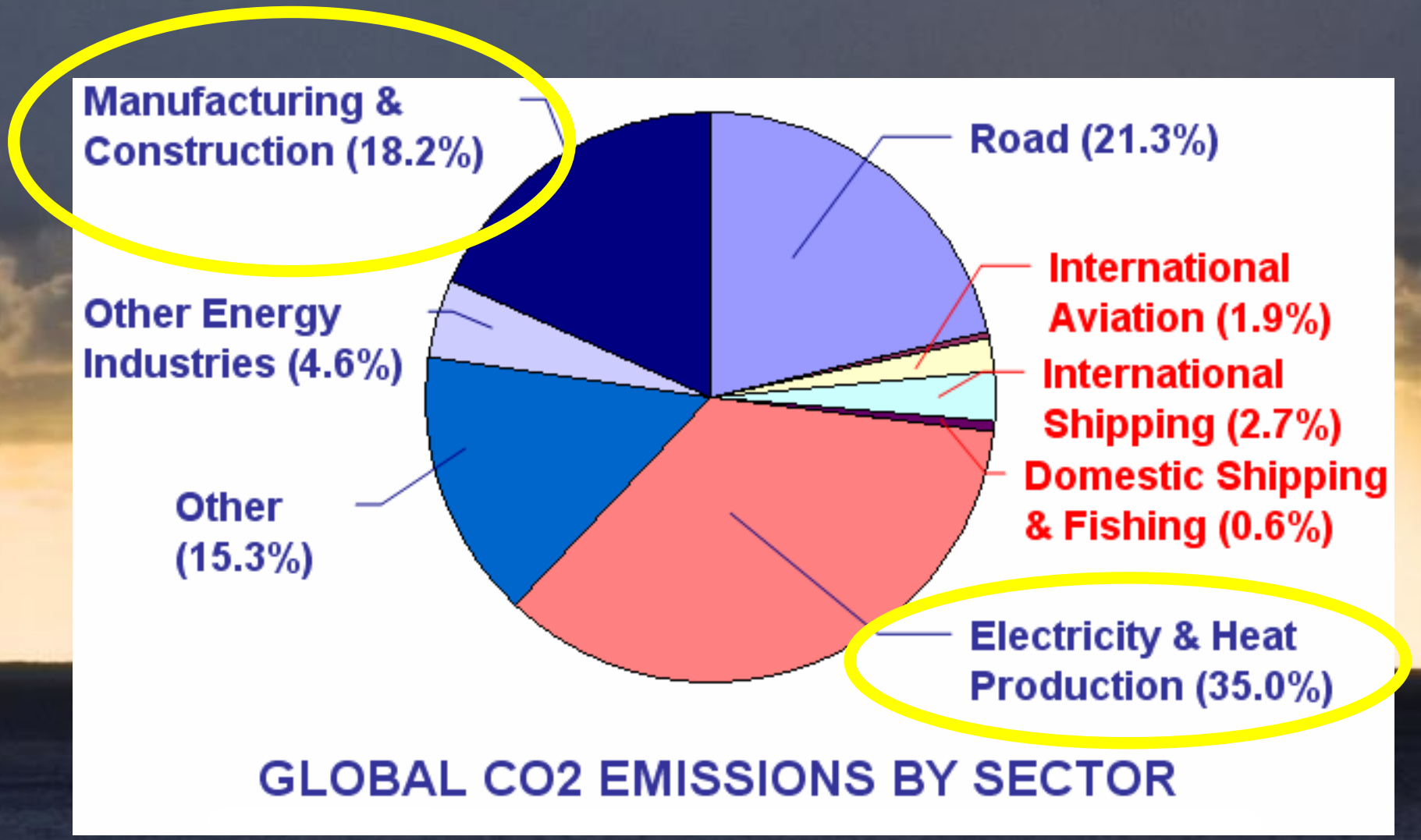
Emissioni CO_2



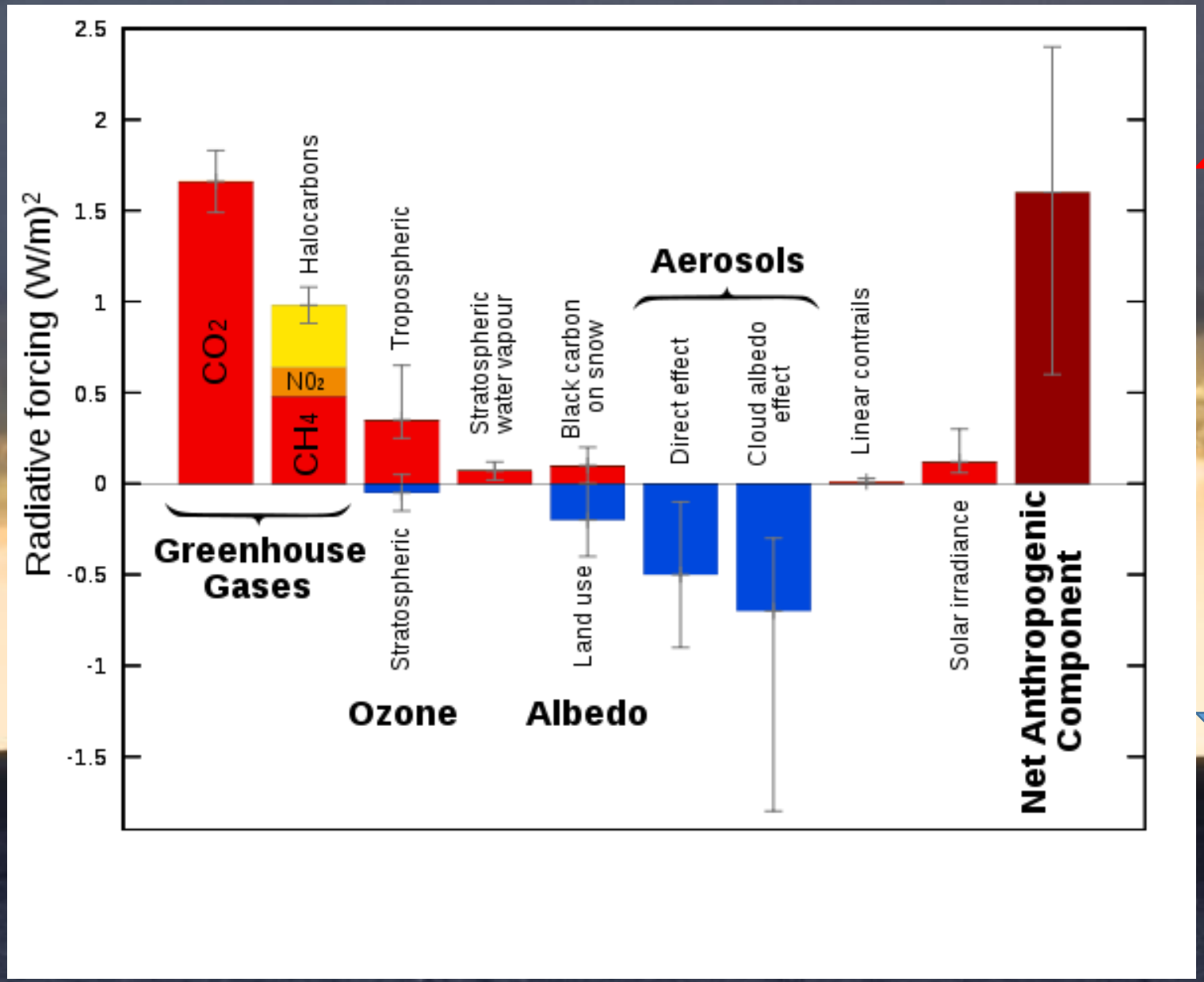
Le cause


a
POPOLAZIONE
Human Population (10⁹)
b
PIL
Total Real GDP (1990 Int. USD x 10¹²)
c
DIGHE SUI FIUMI
River Dams (10³)
d
FERTILIZZANTI
Fertilliser Use (t x 10⁶)
e
USO DELLA CARTA
Paper Use (t x 10⁶)
f
AUTOVEICOLI
Motor Vehicles (10⁶)
Year
Year

Emissioni per settori



Riassumendo



Riscaldamento

Raffreddamento

Aree urbane perché importanti?

City transformations in a 1.5 °C warmer world

Meeting the ambitions of the Paris Agreement will require rapid and massive decarbonization of cities, as well as adaptation. Capacity and requirement differs across cities, with challenges and opportunities for transformational action in both the Global North and South.

William Solecki, Cynthia Rosenzweig, Shobhakar Dhakal, Debra Roberts, Aliyu Salisu Barau, Seth Schultz and Diana Ürge-Vorsatz

Limiting warming to 1.5 °C requires cities to mitigate, whilst also preparing for the impacts of a warmer world. These conditions present different challenges and opportunities in cities of the Global North and Global South. A key challenge facing the international

community
motivation
to pursue e
increase to
levels — int
and sustain
the desired

NATURE CLIMATE CHANGE | VOL 8 | MARCH 2018 | 174–185 | www.nature.co

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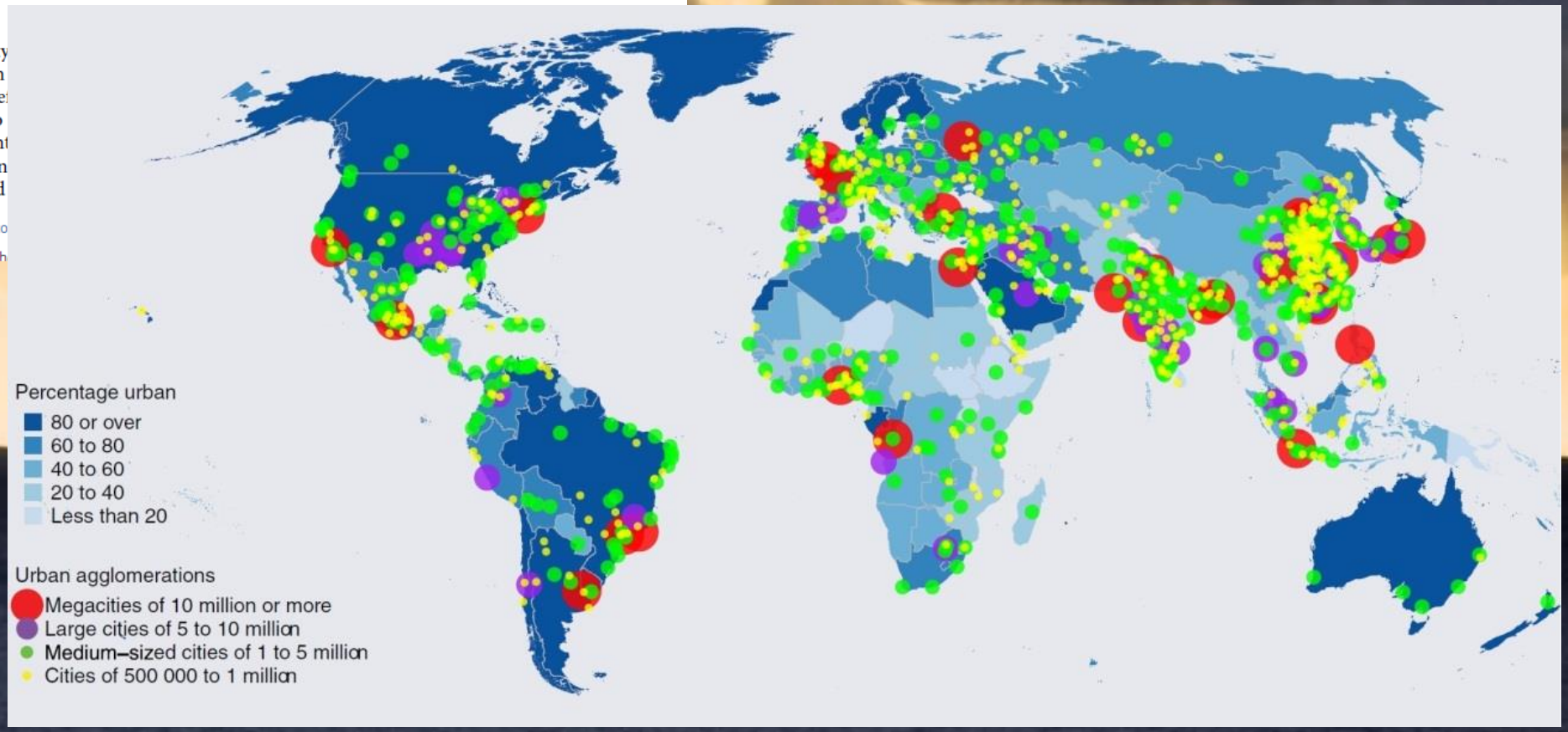
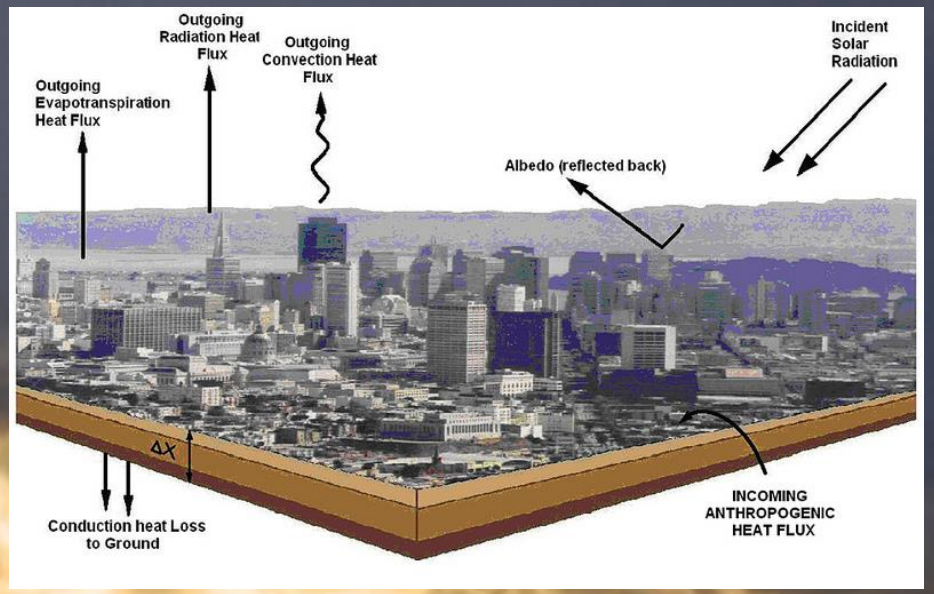
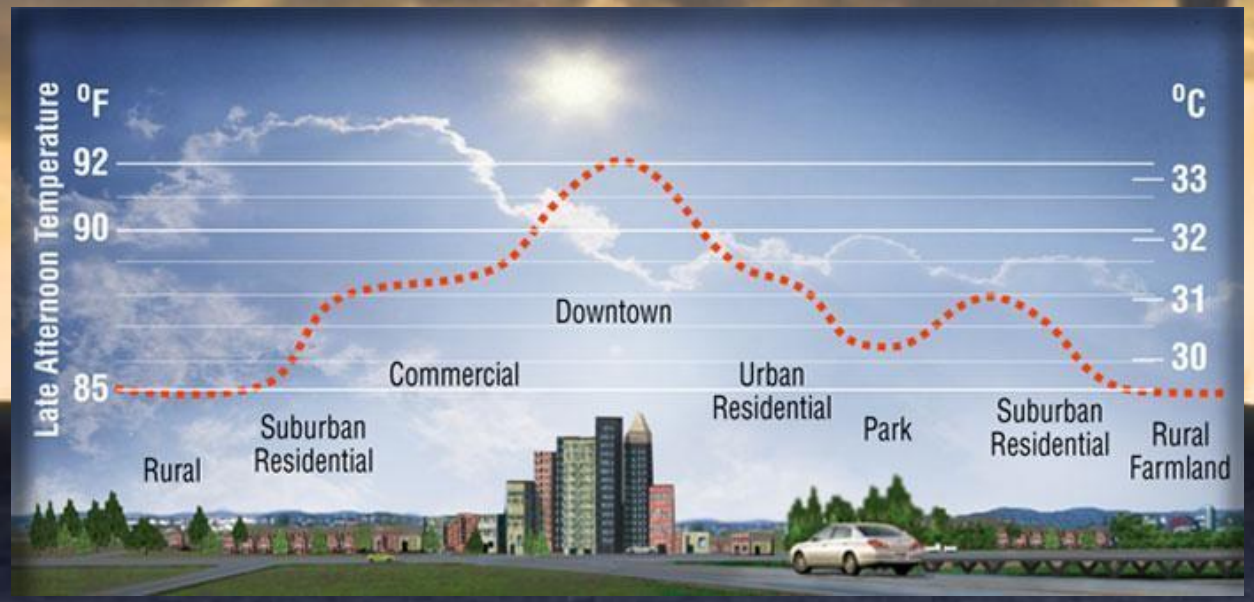
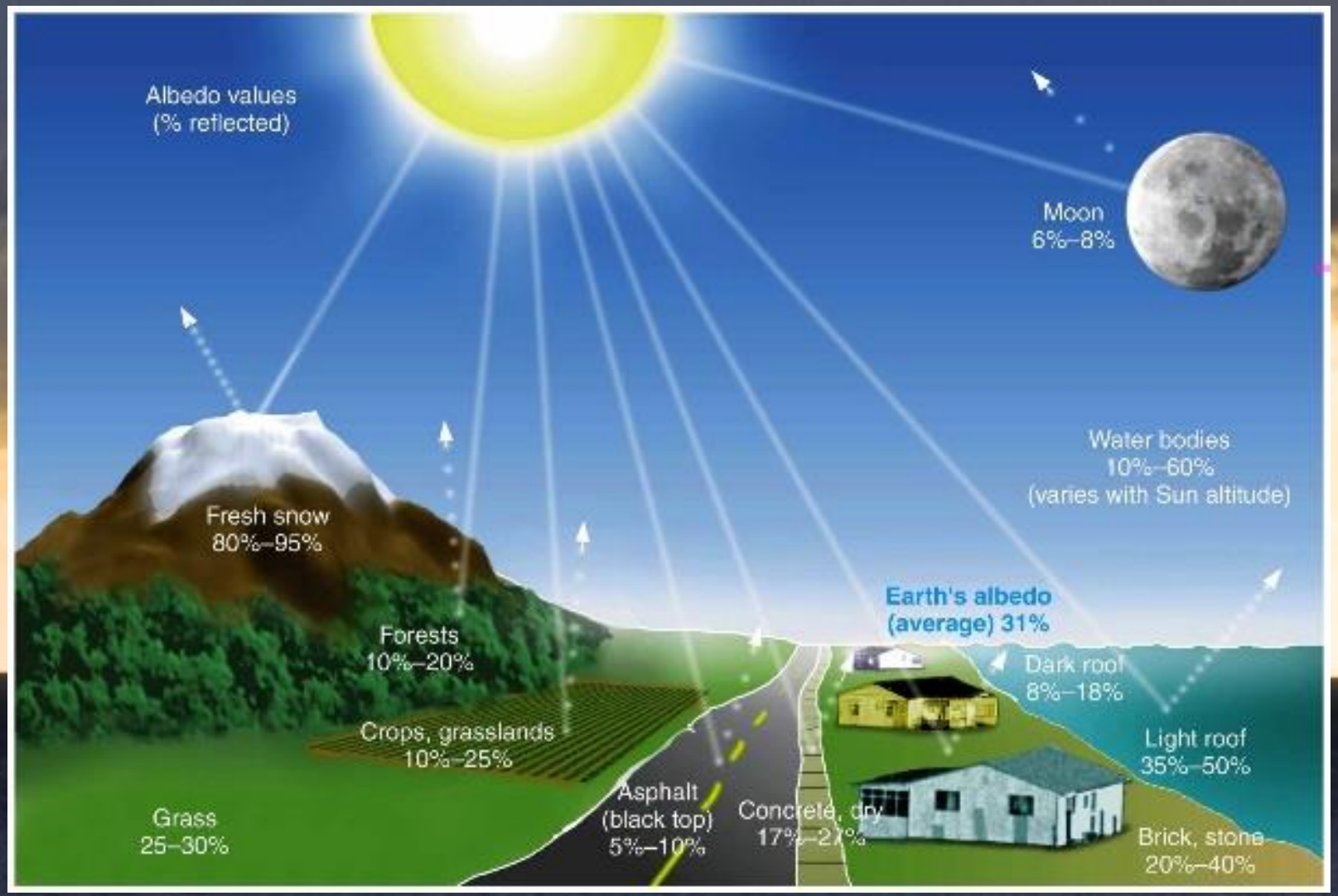


Aree urbane perché?



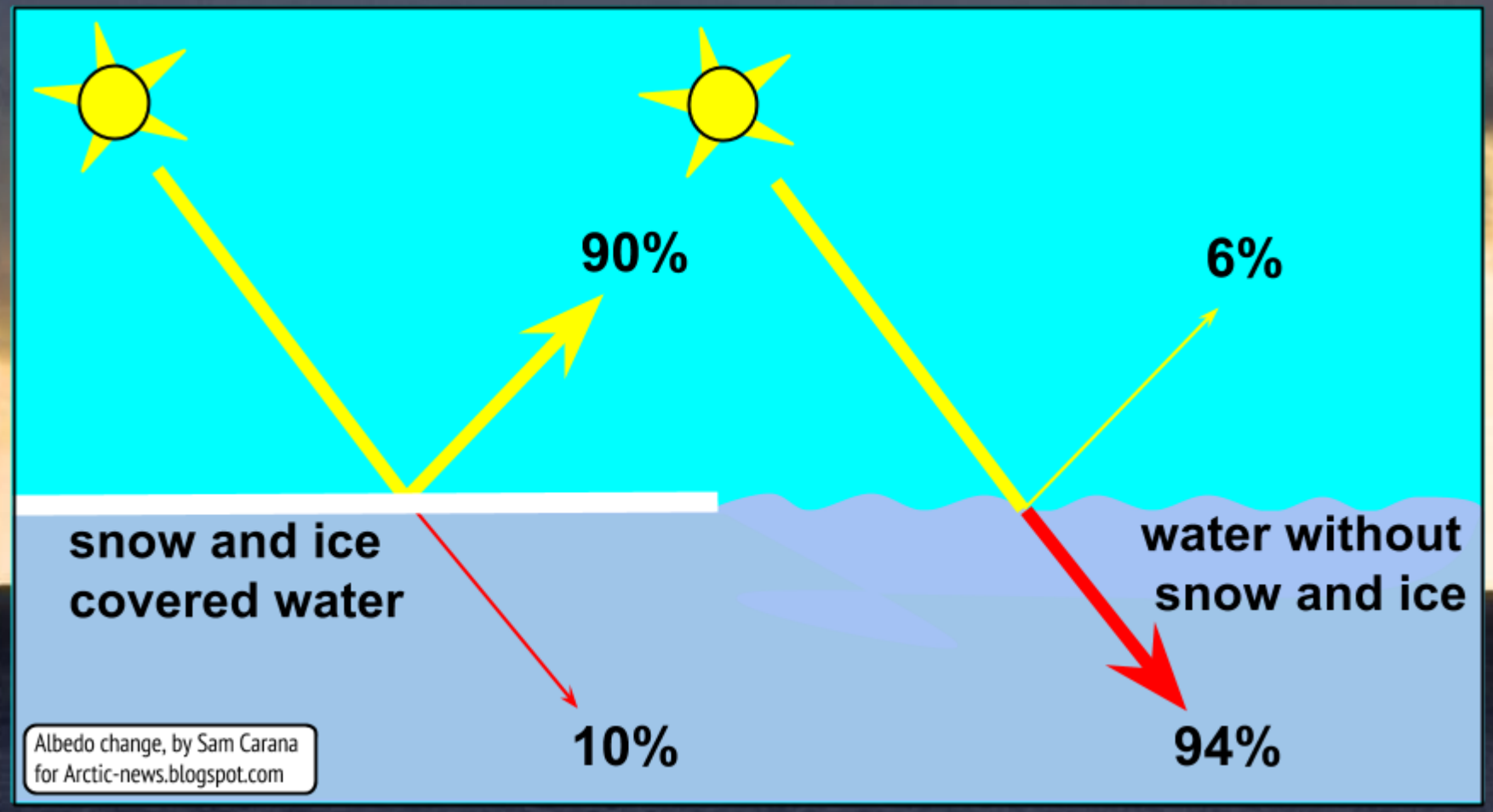


Terra: assorbimento e riemissione



Albedo: la frazione di radiazione che raggiunge la superficie terrestre riflessa. Dipende da come è fatta la superficie terrestre!

Terra: assorbimento e riemissione

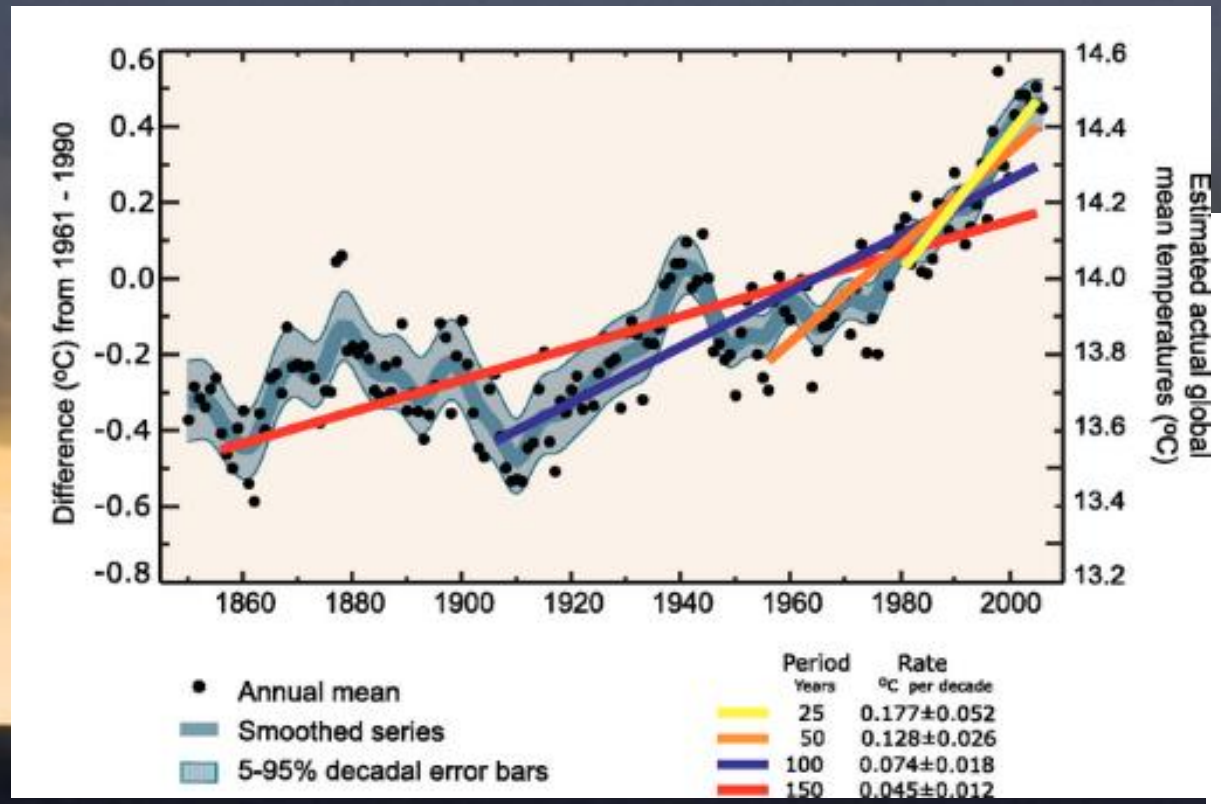


Un esempio su tutti la riduzione delle calotte di ghiaccio

Cosa si osserva in media nel mondo

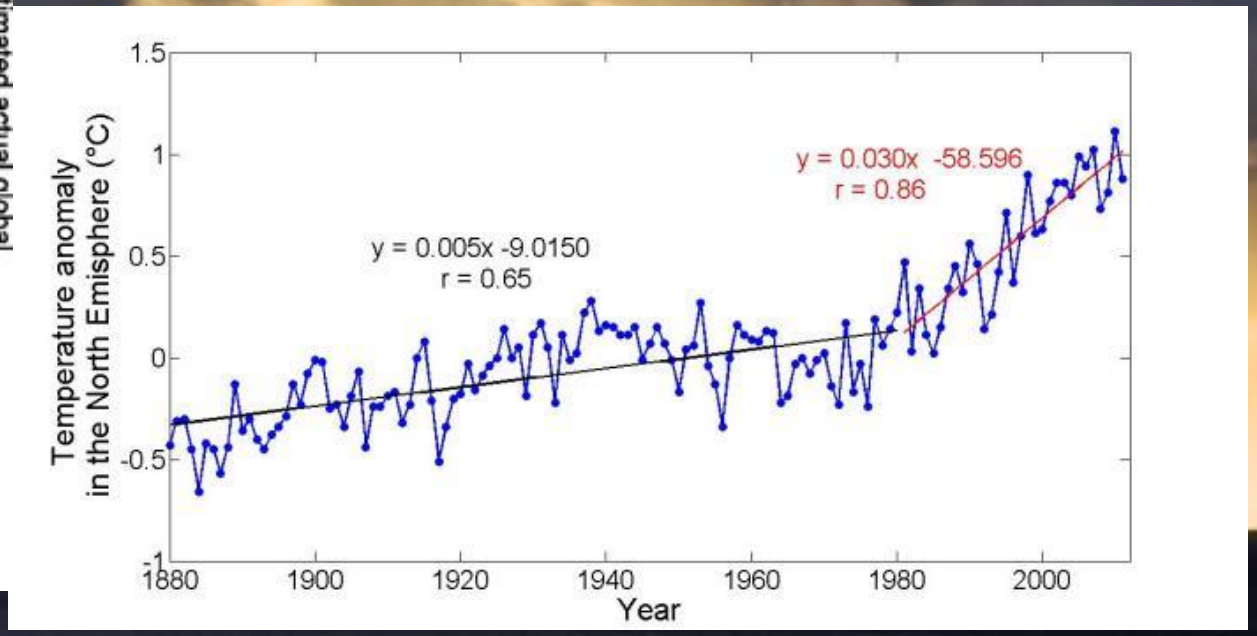
Anomalie Temperatura media

Su tutto il globo



0.02° C per anno a partire dal 1980
0.01°C per anno a partire dal 1950

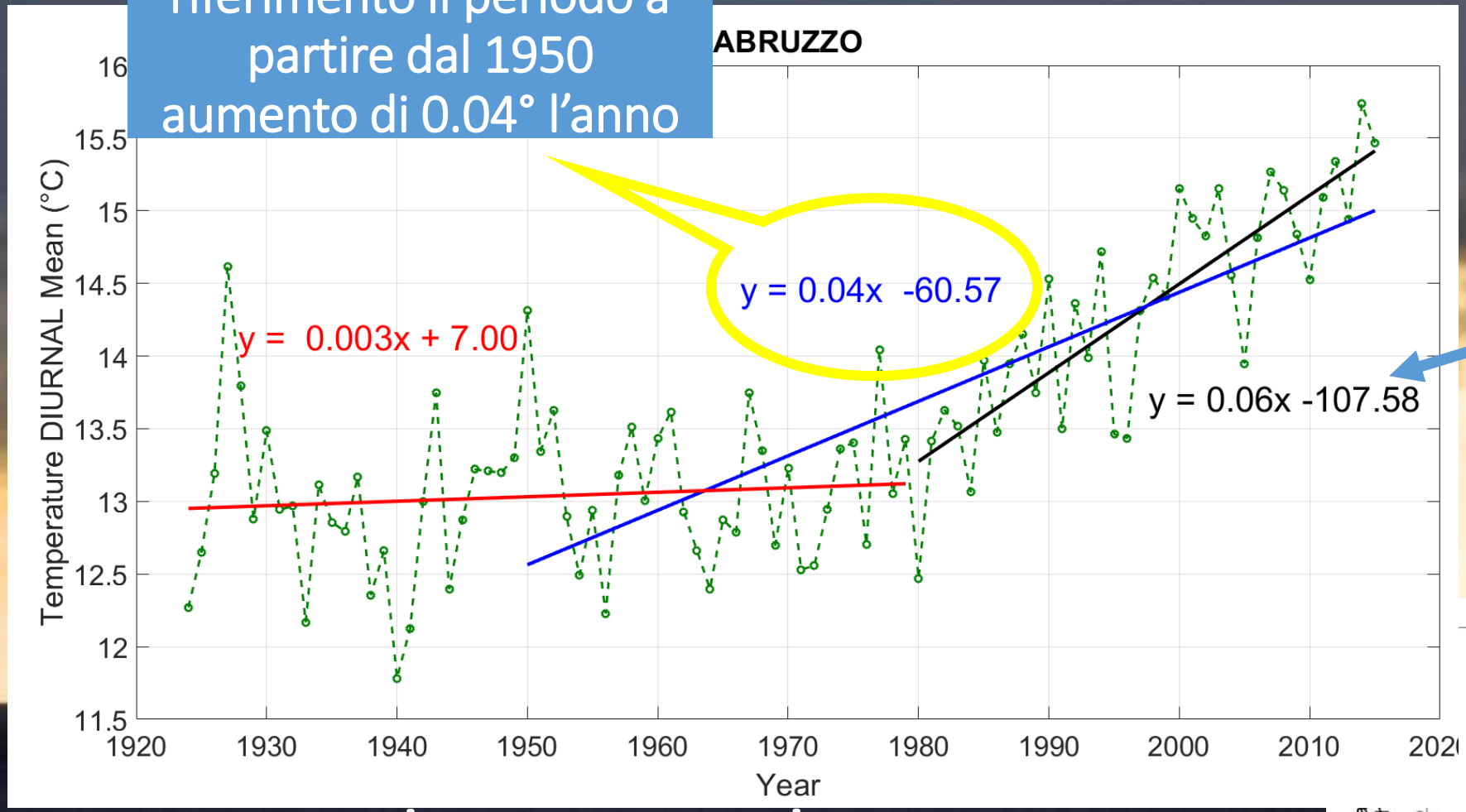
Emisfero Nord



0.03° C per anno a partire dal 1980

Temperature medie giornaliere osservate in Abruzzo

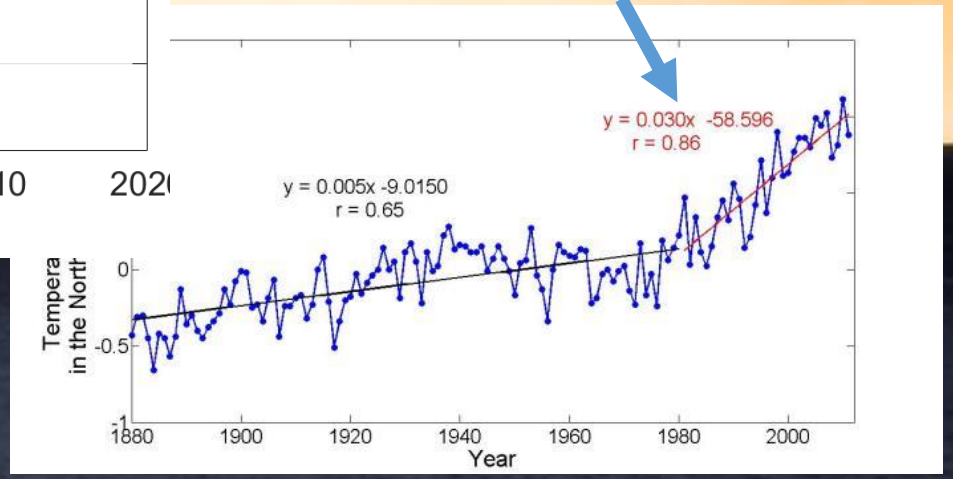
Prendendo come riferimento il periodo a partire dal 1950 aumento di 0.04° l'anno



In Abruzzo: Aumento della temperatura media diurna dal 1920 al 1980 di 0.003° l'anno

In Abruzzo: Aumento della temperatura media diurna a partire dal 1980 di 0.06° l'anno

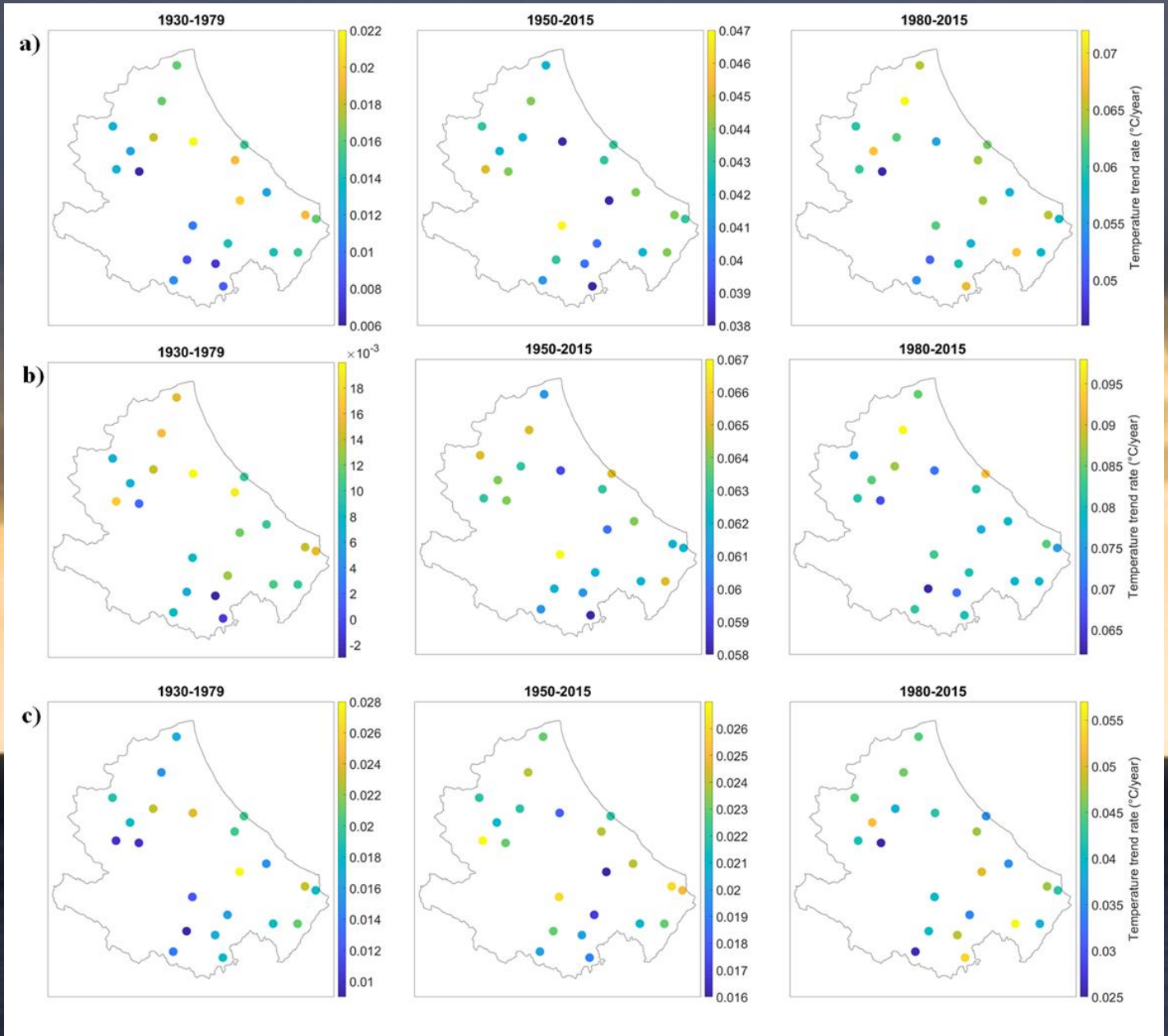
La media su tutto l'emisfero nord è la metà



Media su tutte le stazioni abruzzesi

	Altitudine (m. slm)	Tasso variazione Temperatura in °C/anno Periodo 1930-1979	Tasso variazione Temperatura in °C/anno Periodo 1950-2015	Tasso variazione Temperatura in °C/anno Periodo 1980-2015
TERAMO	218	0.016 ± 0.011	0.044 ± 0.008	0.072 ± 0.015
CHIETI	278	0.019 ± 0.012	0.043 ± 0.008	0.064 ± 0.017
PESCARA	2	0.015 ± 0.010	0.043 ± 0.006	0.063 ± 0.013
PESCOCOSTANZO	1461	0.007 ± 0.012	0.040 ± 0.009	0.059 ± 0.018
GUARDIAGRELE	551	0.020 ± 0.013	0.038 ± 0.009	0.064 ± 0.024
LANCIANO	298	0.012 ± 0.011	0.044 ± 0.008	0.057 ± 0.019
PESCASSEROLI	1164	0.011 ± 0.012	0.041 ± 0.008	0.054 ± 0.018
CASTEL DI SANGRO	800	0.009 ± 0.014	0.038 ± 0.010	0.067 ± 0.019
PALENA	781	0.014 ± 0.013	0.040 ± 0.008	0.057 ± 0.017
MONTAZZOLI	871	0.014 ± 0.015	0.042 ± 0.009	0.068 ± 0.019
SCERNI	125	0.019 ± 0.010	0.044 ± 0.007	0.065 ± 0.016
VASTO	196	0.016 ± 0.010	0.043 ± 0.007	0.058 ± 0.016
PALMOLI	624	0.015 ± 0.011	0.044 ± 0.008	0.058 ± 0.020
CAMPOTOSTO	1344	0.013 ± 0.011	0.043 ± 0.008	0.060 ± 0.019
ISOLA DEL GRAN SASSO	545	0.018 ± 0.011	0.042 ± 0.007	0.062 ± 0.017
NERETO	165	0.016 ± 0.011	0.042 ± 0.007	0.065 ± 0.018
PENNE	431	0.022 ± 0.013	0.038 ± 0.008	0.056 ± 0.018
LAQUILA	595	0.013 ± 0.011	0.045 ± 0.007	0.061 ± 0.015
ASSERGI	992	0.012 ± 0.011	0.042 ± 0.008	0.068 ± 0.019
SCANNO	1045	0.008 ± 0.012	0.043 ± 0.008	0.051 ± 0.015
SULMONA	372	0.010 ± 0.011	0.047 ± 0.007	0.062 ± 0.015
BARISCIANO	978	0.006 ± 0.010	0.044 ± 0.007	0.046 ± 0.015
MEDIA SU TUTTO L'ARBUZZO	**629**	**0.014 ± 0.010**	**0.042 ± 0.007**	**0.060 ± 0.015**

Trend variazione temperature

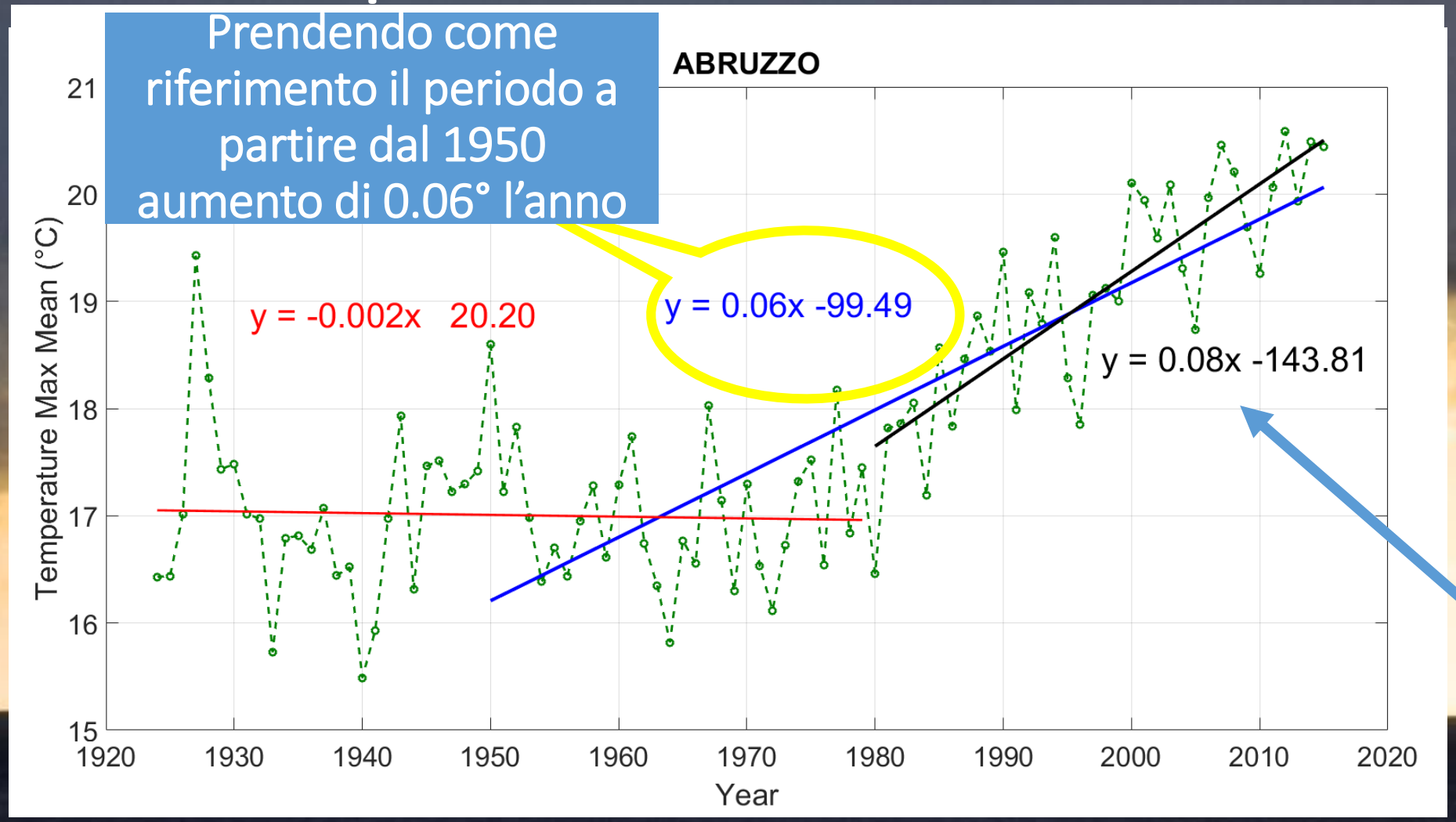


Temperatura Media giornaliera

Temperatura Massima

Temperatura Minima

Temperature massime osservate in Abruzzo



In Abruzzo: Aumento della temperatura massima diurna dal 1920 dal 1980 inesistente

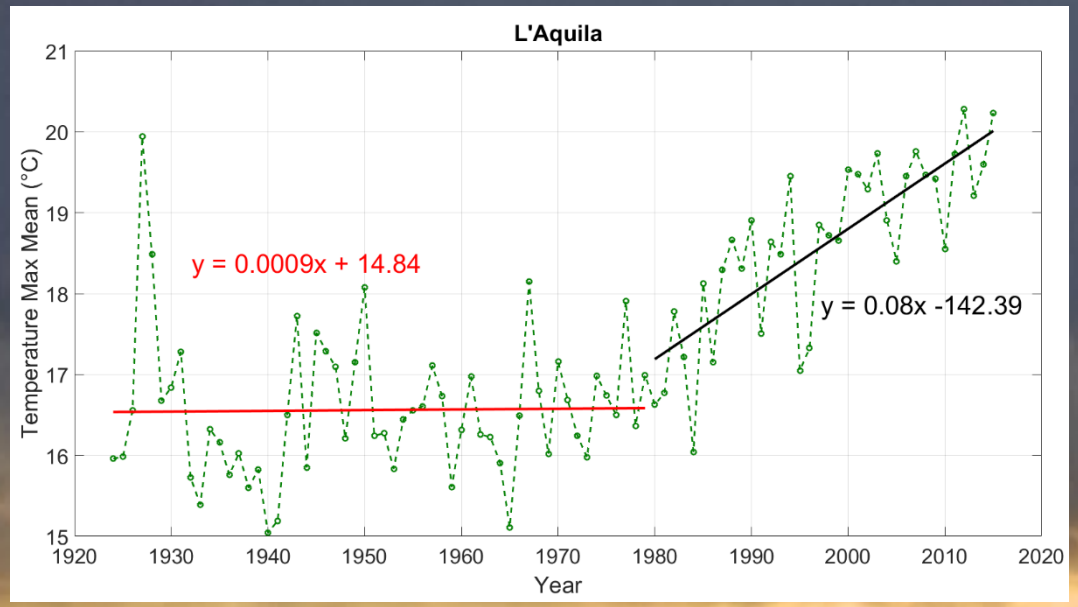
La temperatura media è di 0.04°

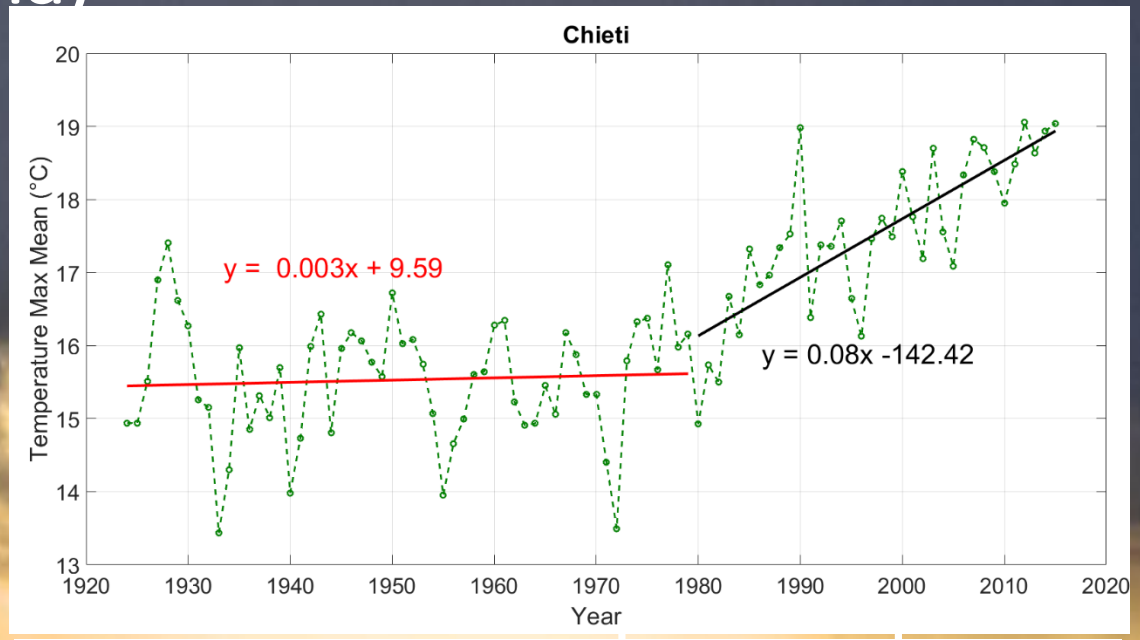
In Abruzzo: Aumento della temperatura massima diurna a partire dal 1980 di 0.08° l'anno

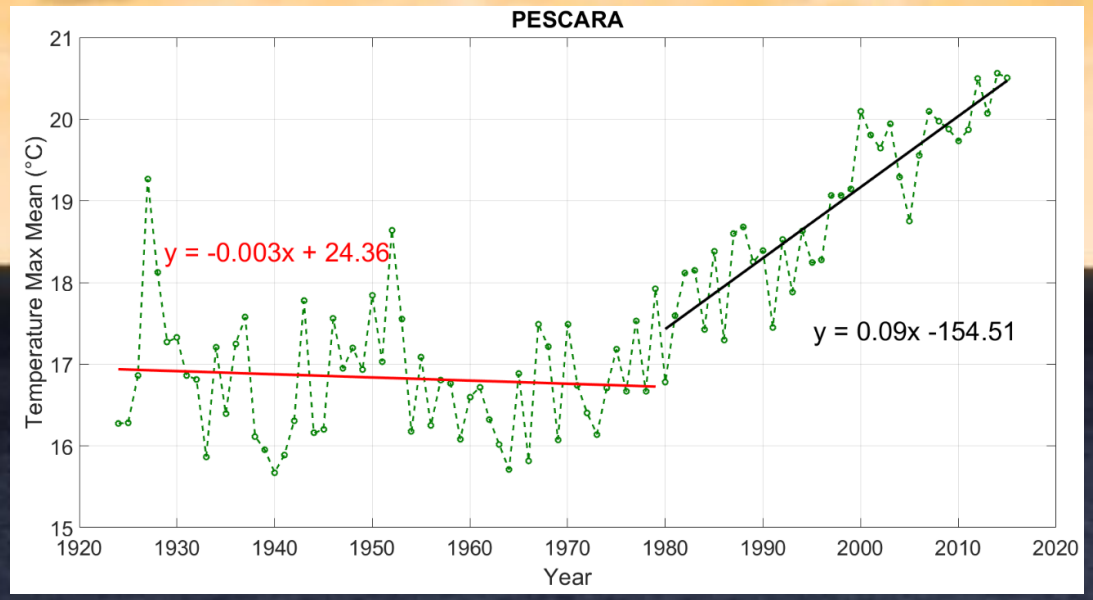
La temperatura media è di 0.06°

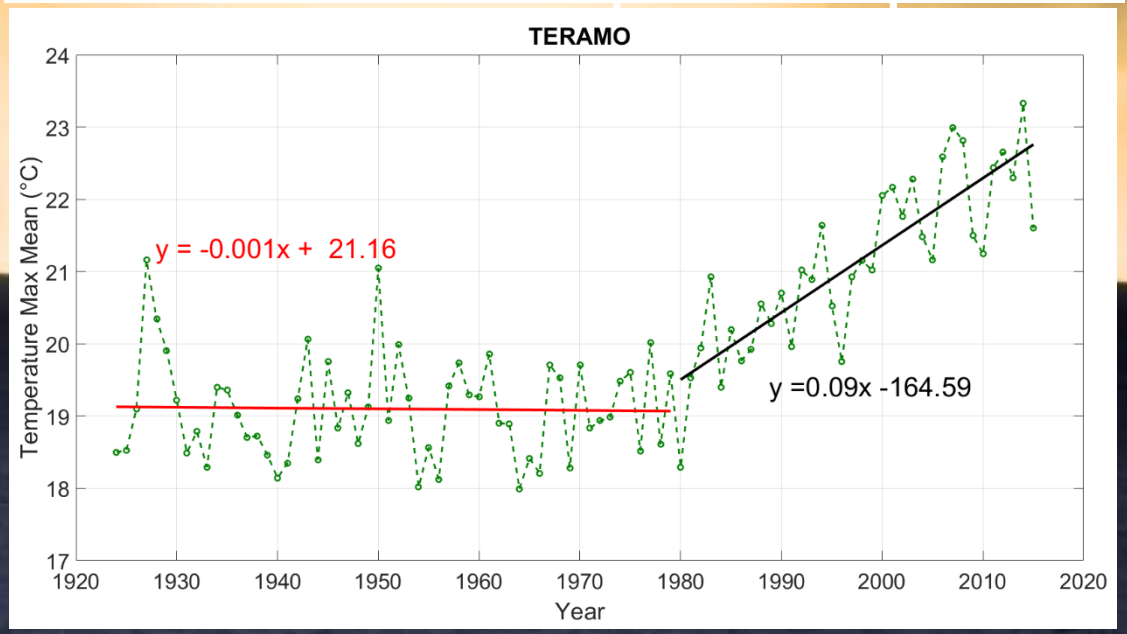
Media su tutte le stazioni abruzzesi

Serie Storica Temperature osservate nelle 4 province (Temp. massima)







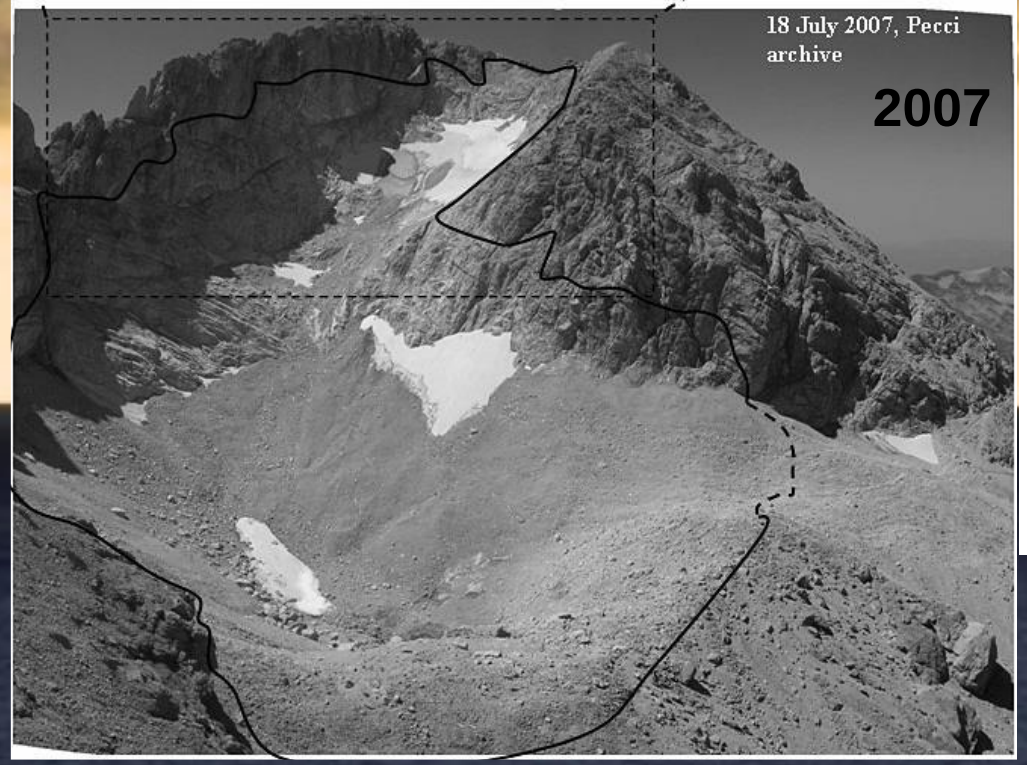


Esempi di conseguenze dei cambiamenti climatici

Effetti

GHIACCIAIO DEL CALDERONE

1912



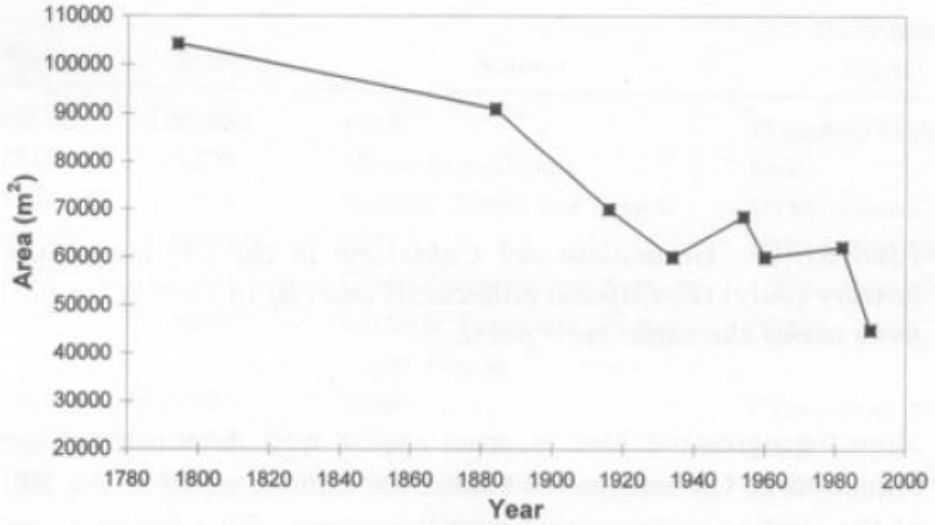
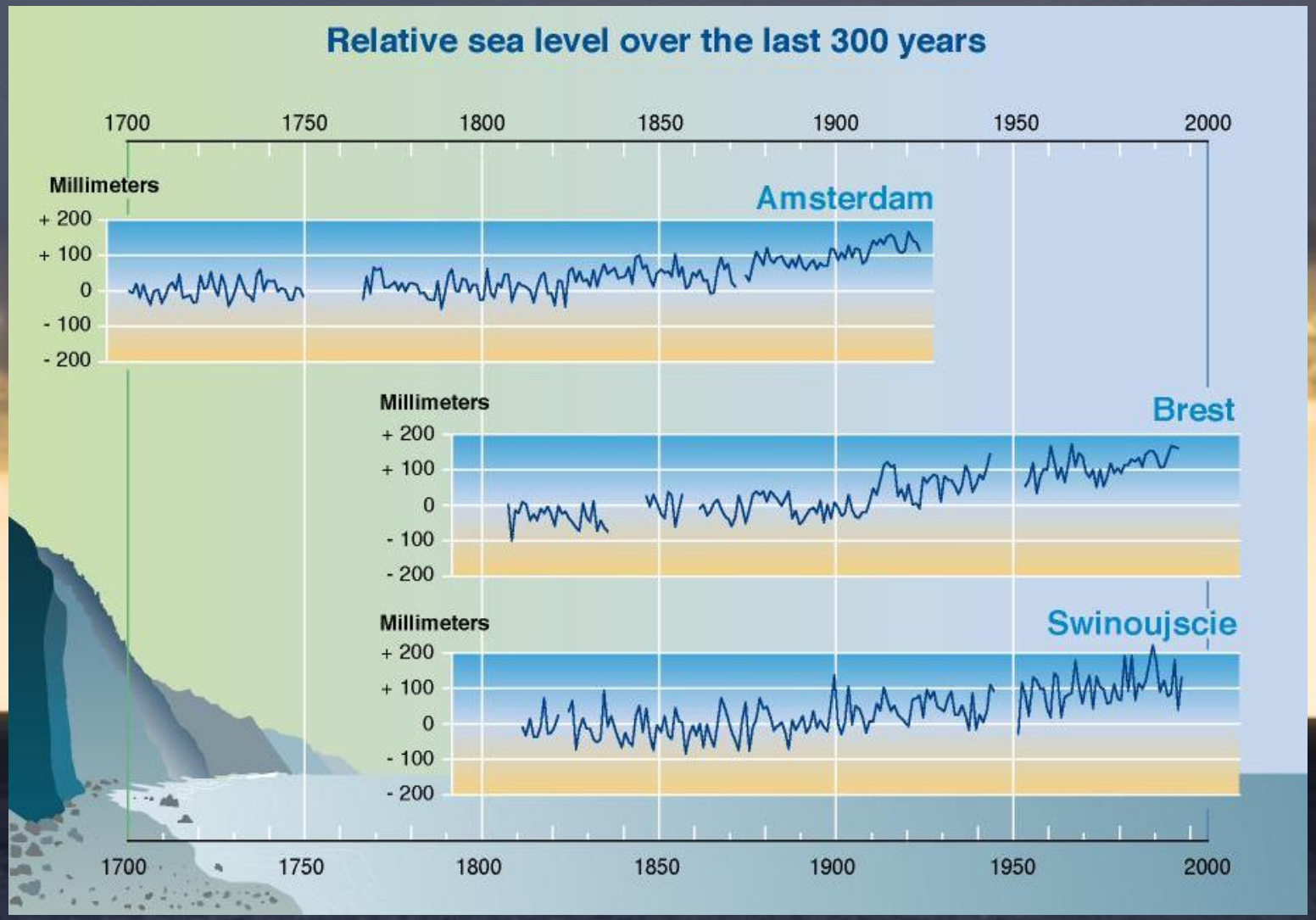


FIGURE 5. Variation in surface area of Ghiacciaio del Calderone since 1780.

200 / ARCTIC, ANTARCTIC, AND ALPINE RESEARCH

Conseguenze sul livello del mare

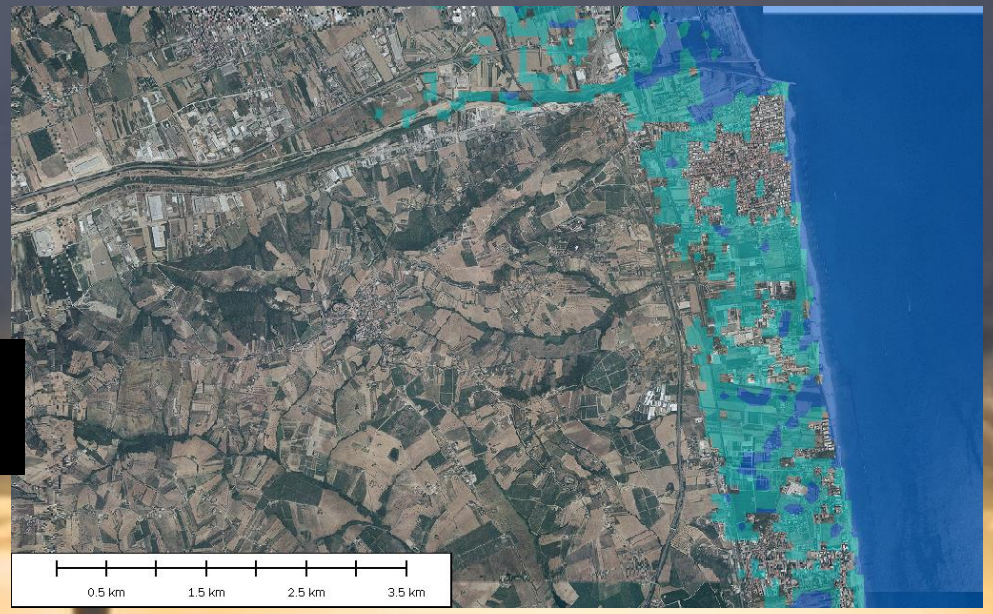


Rischio di inondazioni

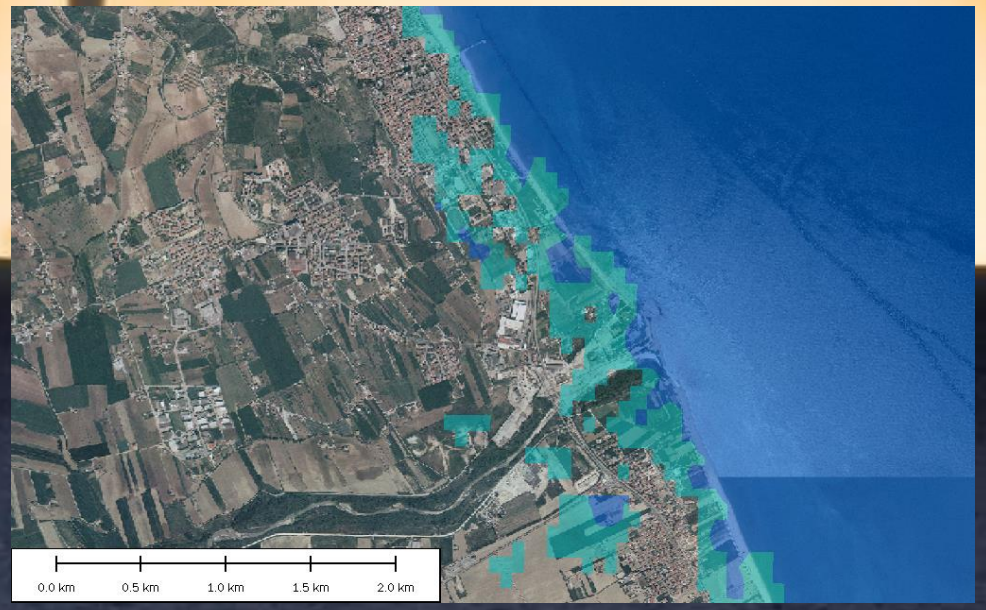
Il Bangladesh potrebbe perdere circa il 17% del proprio territorio con un innalzamento del mare di 1 metro

Simulazioni modellistiche!

Martinsicuro



Roseto



Biodiversità sul Gran Sasso

Praterie xerofitiche
a *Sesleria tenuifolia*

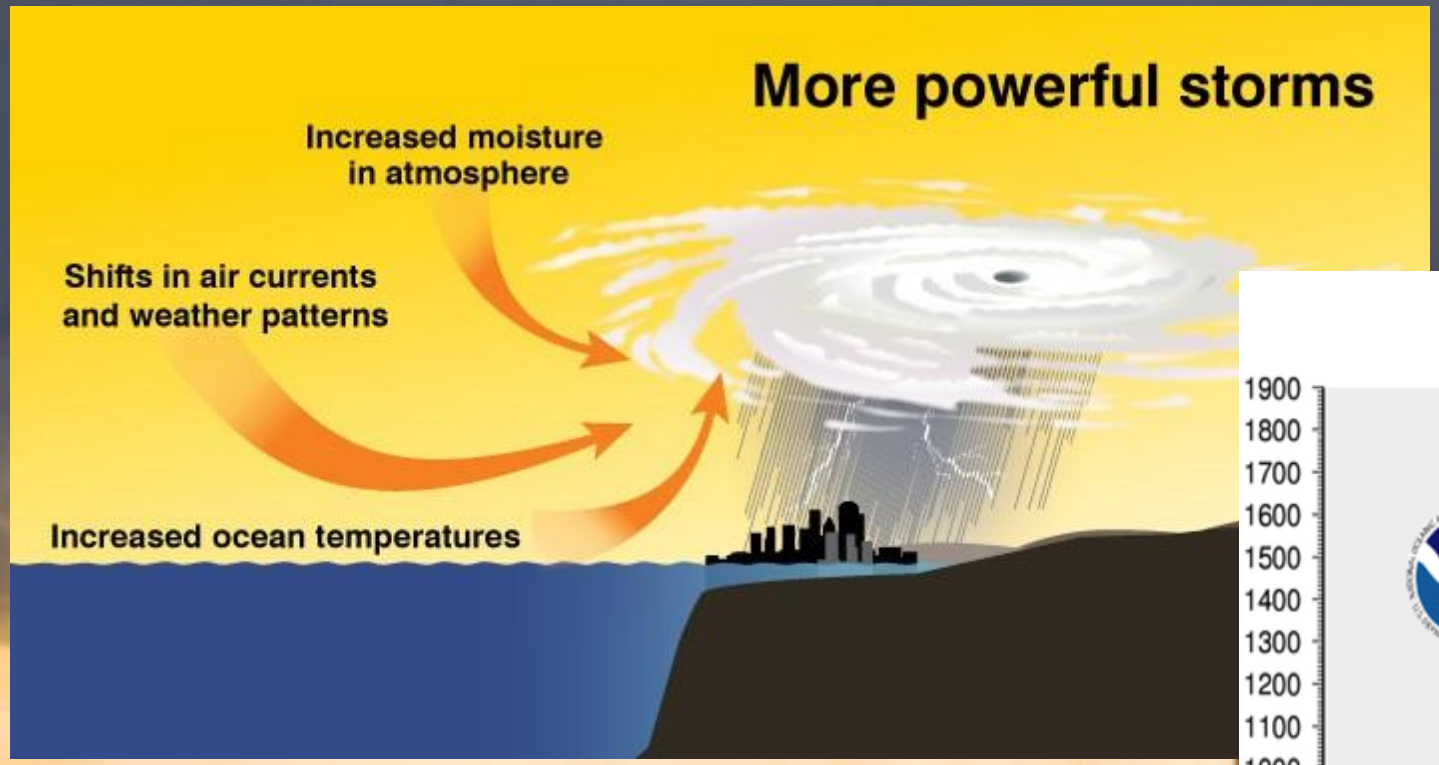
Praterie mesofile
a *Festuca macrathera*

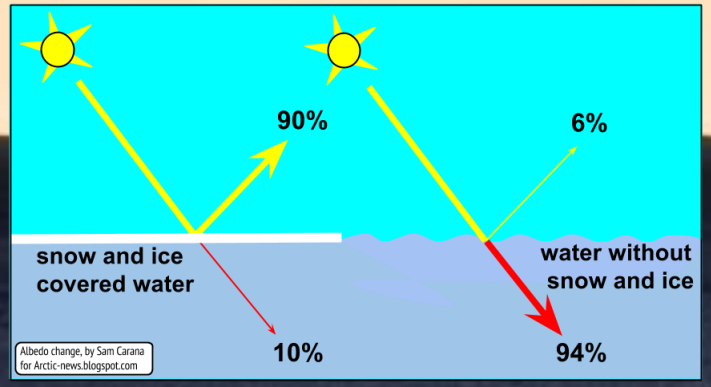
cambiamenti nella struttura e nella composizione delle comunità vegetali (30 anni di osservazioni)

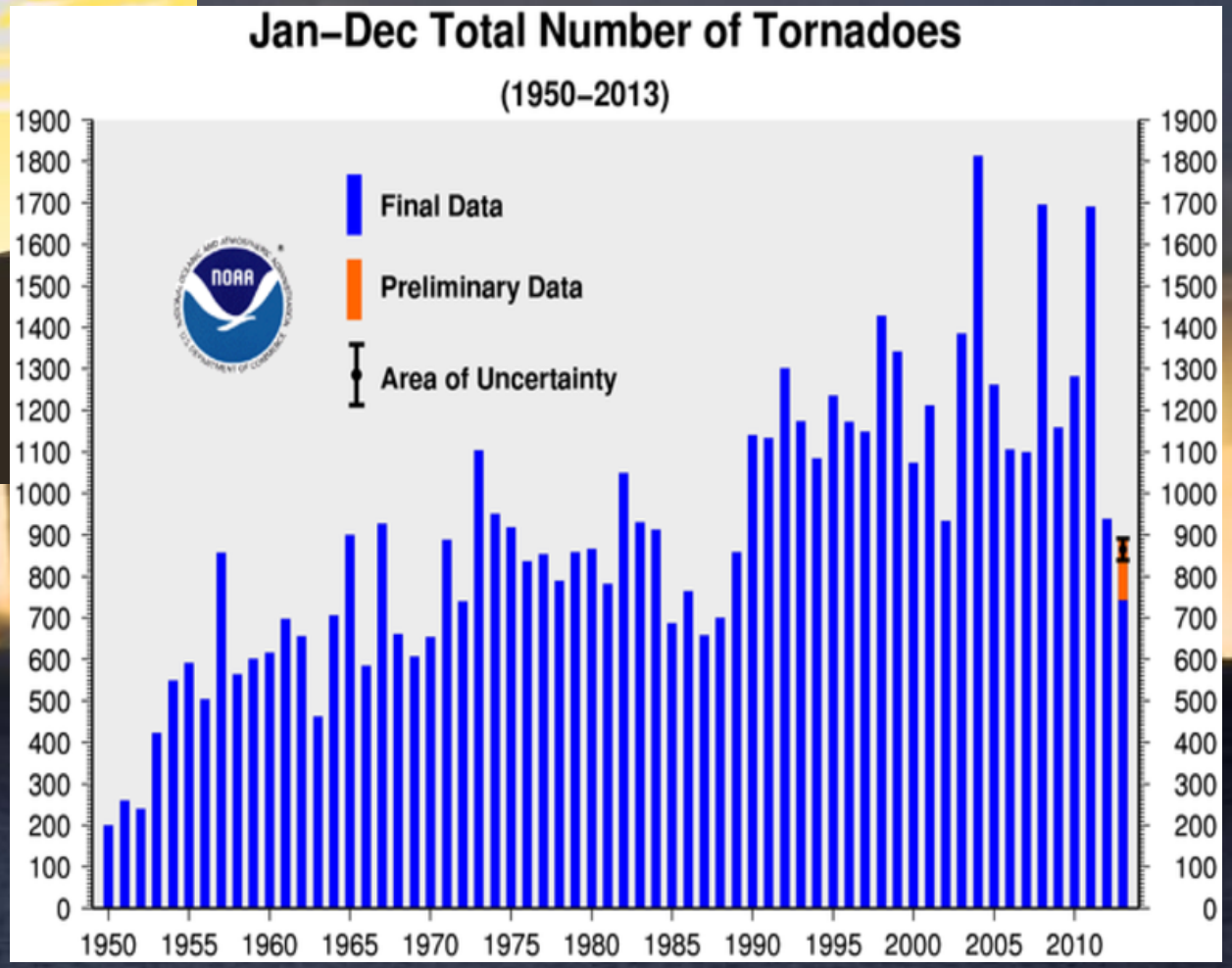
(Petriccione, 2012 – Aracne Ed., aggiornato)

Grazie Dott. Petriccione, Corpo Forestale-Carabinieri

Effetti cambiamenti climatici: eventi meteo estremi



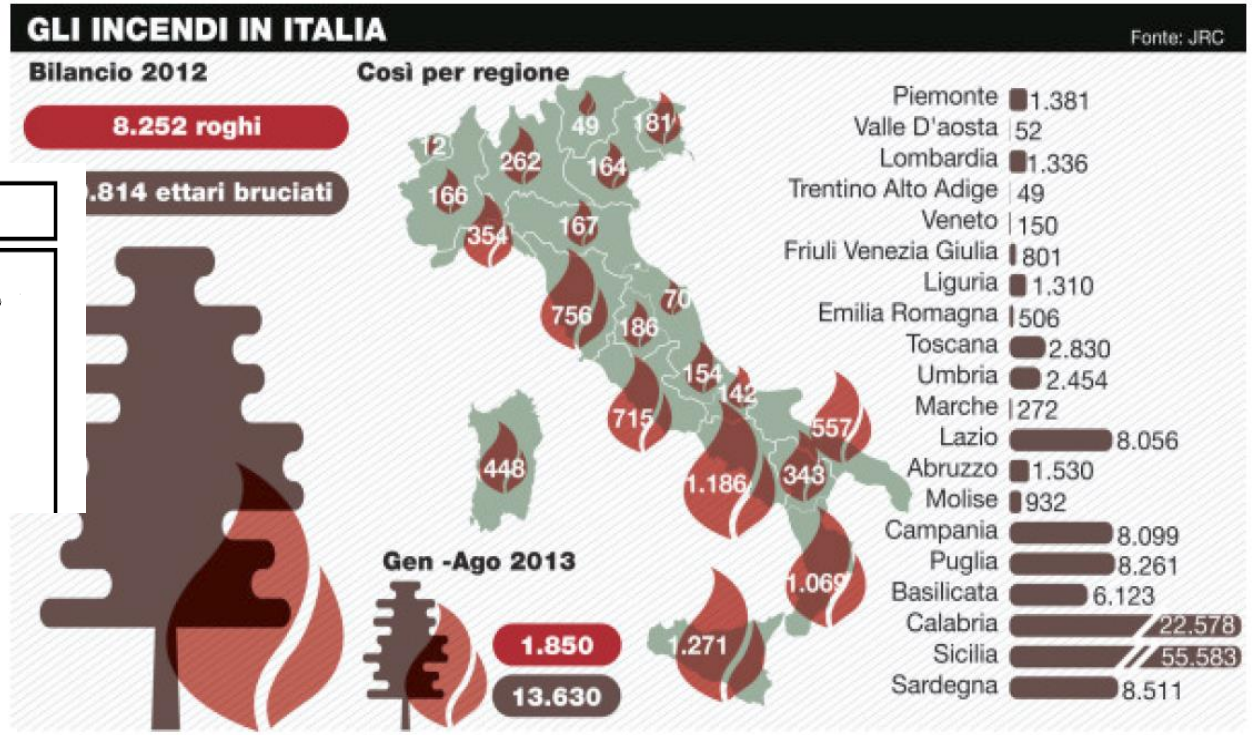




Incendi Abruzzo

del 04 Settembre 2015 | il Centro QUOTIDIANO DELL'ABRUZZO | estratto da pag. 7

Un'altra estate di fuoco che ci costa 15 milioni



il Centro 13.0°C prossimi 6 giorni

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Sei in: IL CENTRO > PESCARA > DUE MESI DI ROGHI, ECCO...

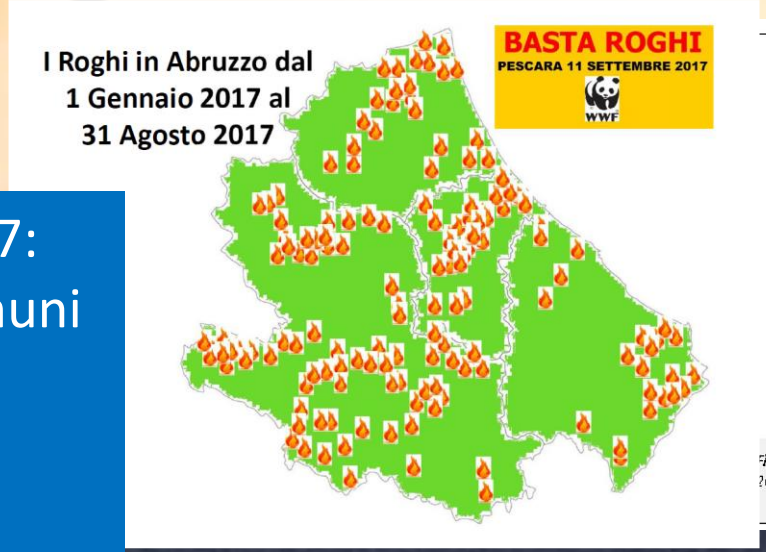
ABRUZZO IN FIAMME

Due mesi di roghi, ecco l'elenco inviato al premier Gentiloni

Dalle fiamme di Montesilvano ai disastri del Gran Sasso e del Morrone: 160 Comuni colpiti. Determinante questa relazione per ottenere 370 milioni di risarcimento danni

03 settembre 2017

Report incendi 2017: fiamme in 136 Comuni su 305, 210 i roghi. Bruciati oltre 6000 ettari



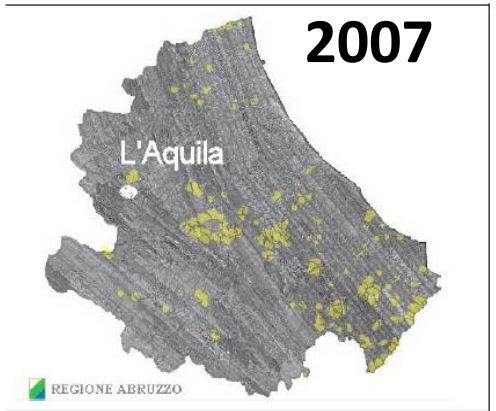


Figure 1. Map of the fires (yellow spots) reported during the summer 2007 in the Abruzzo region (Central Italy). The monitoring site was in L'Aquila (white spot).

Effetti sugli incendi di boschi e praterie

nature International weekly journal of science

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News & Comment > Column > World View > 2017 > October > Article

NATURE | COLUMN: WORLD VIEW

Prepare for larger, longer wildfires

Climate change makes land management more urgent than ever, says Kathie Dello.

13 October 2017

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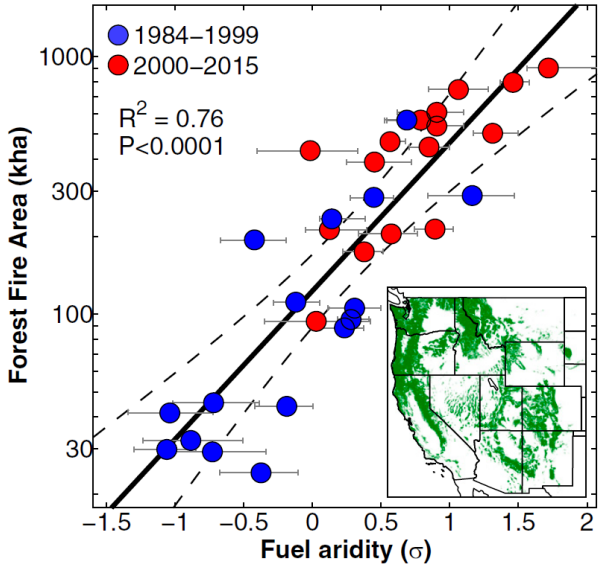
Bisogna prepararsi ad incendi sempre più vasti e di maggior durata

Negli Stati Uniti ogni anno dal 2003 ad oggi ci sono stati il 5000% in più di incendi rispetto al periodo 1972-1983, Inoltre in media I giorni con incendi sono passati da 23 a 116 (Westerling et al. Phil. Trans. R. Soc. 2016)



Impact of anthropogenic climate change on wildfire across western US forests

John T. Abatzoglou[a,1] and A. Park Williams[b]

[a]Department of Geography, University of Idaho, Moscow, ID 83844; and [b]Lamont–Doherty Earth Observatory, Columbia University, Palisades, NY 10964

Edited by Monica G. Turner, University of Wisconsin–Madison, Madison, WI, and approved July 28, 2016 (received for review May 5, 2016)

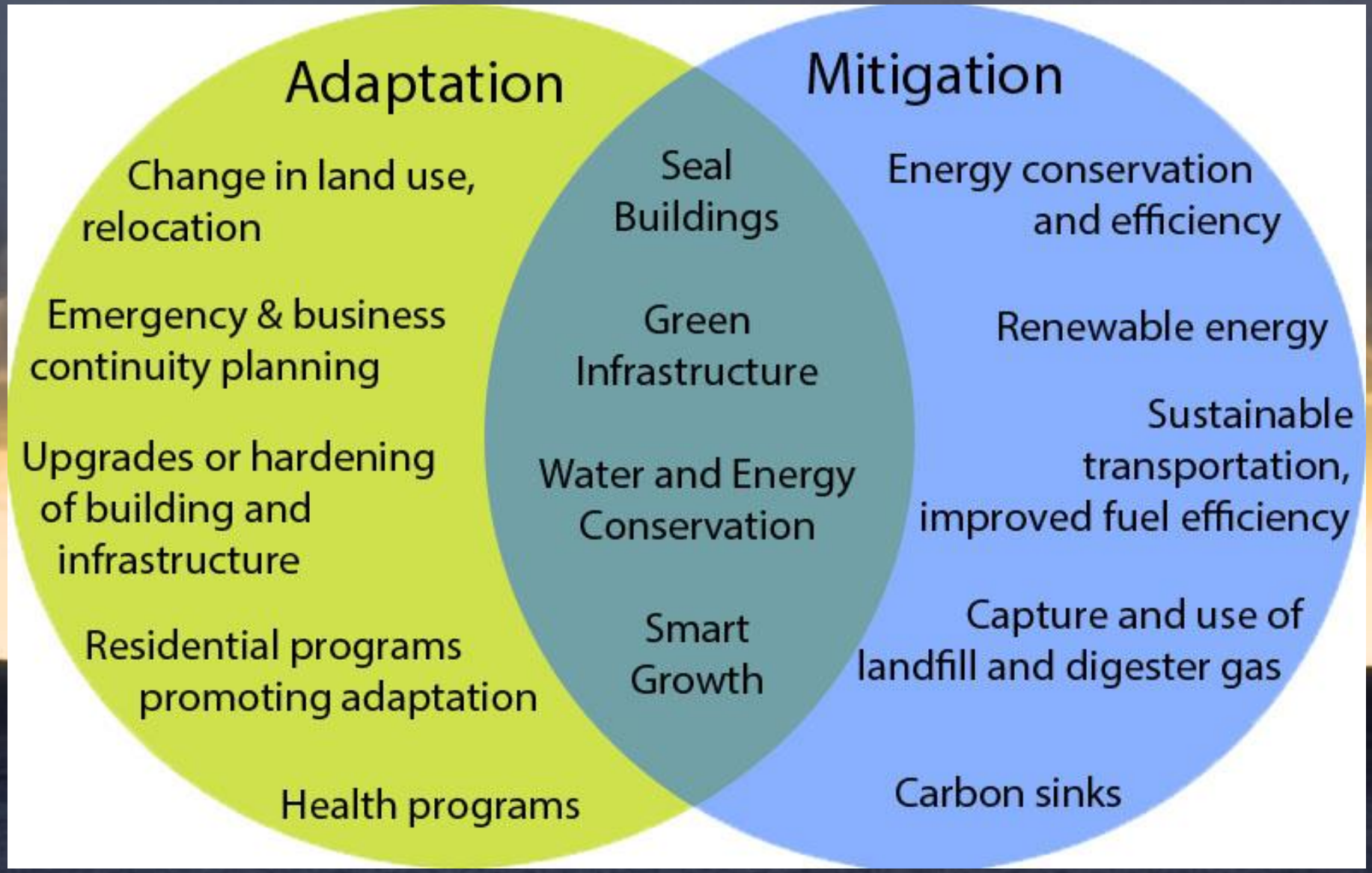
Increased forest fire activity across the western continental United States (US) in recent decades has likely been enabled by a number of factors, including the legacy of fire suppression and human settle-

considering eight fuel aridity metrics that have well-established direct interannual relationships with burned area in this region (1, 8, 24, 25). Four metrics were calculated from monthly data for

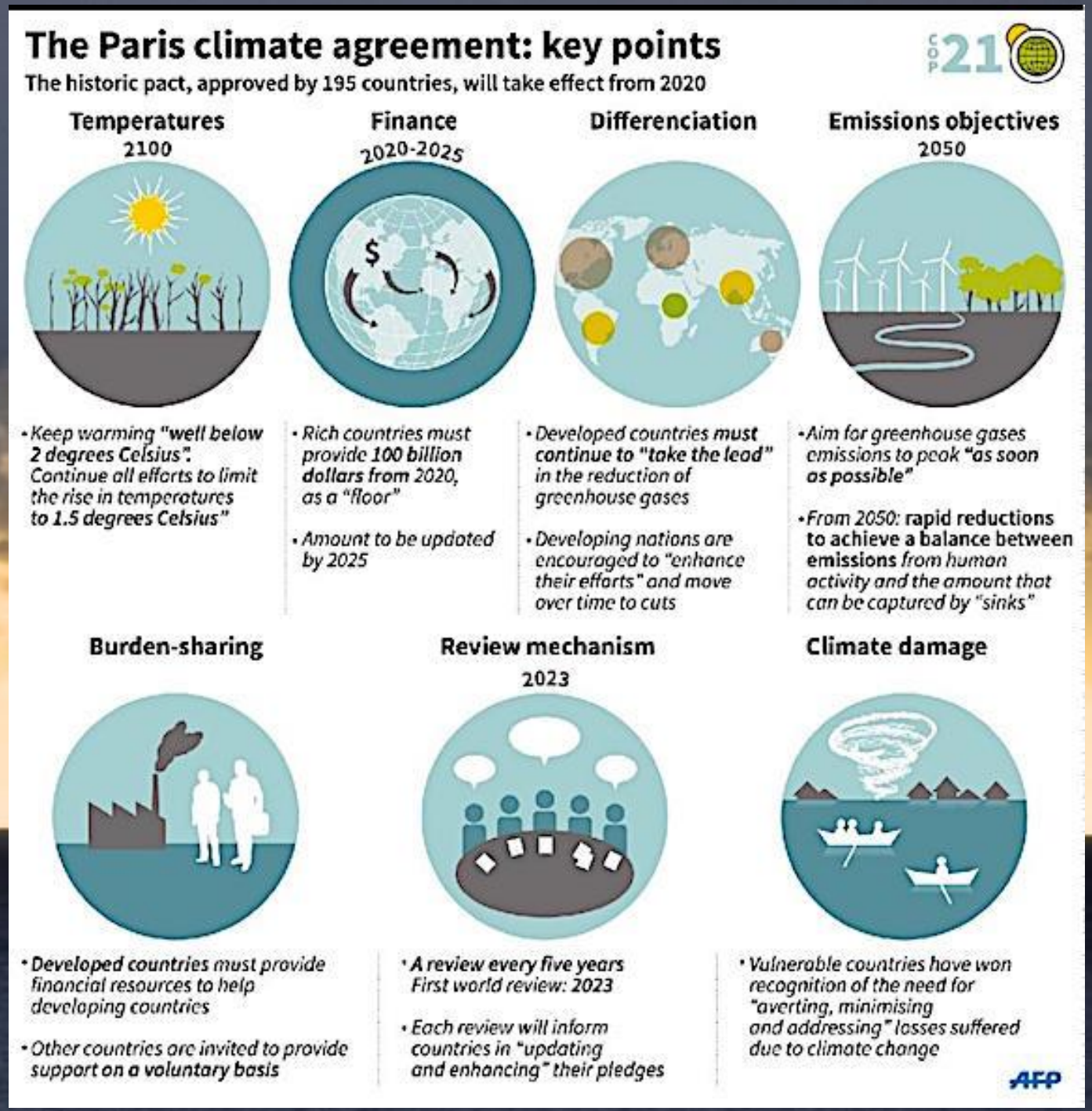
Aumento temperatura induce aumento dell'evaporazione: sistema più arido, alberi e praterie più secche incendi favoriti

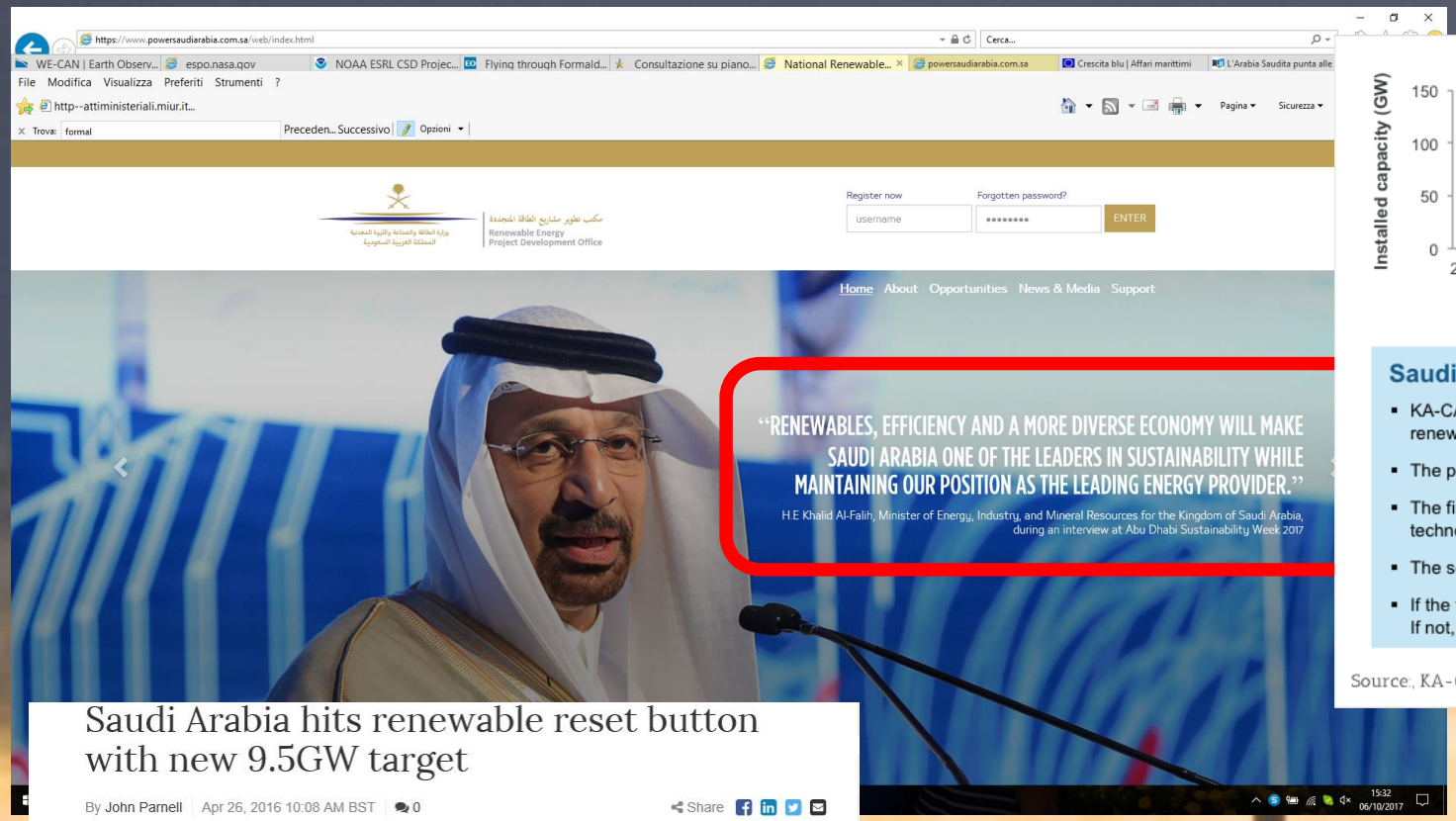
Considerazioni Finali

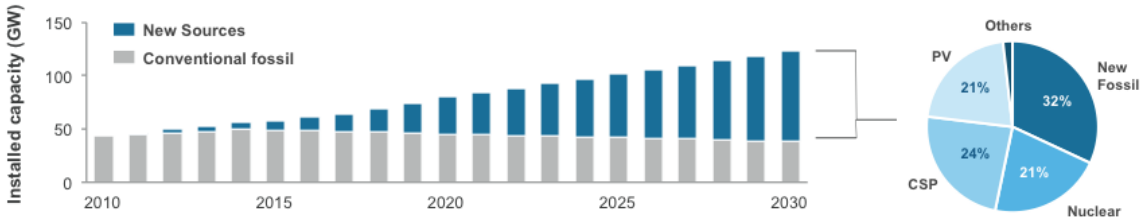
Che fare?


Adaptation
Mitigation
Change in land use, relocation
Emergency & business continuity planning
Upgrades or hardening of building and infrastructure
Residential programs promoting adaptation
Health programs
Seal Buildings
Green Infrastructure
Water and Energy Conservation
Smart Growth
Energy conservation and efficiency
Renewable energy
Sustainable transportation, improved fuel efficiency
Capture and use of landfill and digester gas
Carbon sinks

Che fare?


The Paris climate agreement: key points
The historic pact, approved by 195 countries, will take effect from 2020
COP21
Temperatures
2100
• Keep warming "well below 2 degrees Celsius". Continue all efforts to limit the rise in temperatures to 1.5 degrees Celsius"
Finance
2020-2025
$
• Rich countries must provide 100 billion dollars from 2020, as a "floor"
• Amount to be updated by 2025
Differenciation
• Developed countries must continue to "take the lead" in the reduction of greenhouse gases
• Developing nations are encouraged to "enhance their efforts" and move over time to cuts
Emissions objectives
2050
• Aim for greenhouse gases emissions to peak "as soon as possible"
• From 2050: rapid reductions to achieve a balance between emissions from human activity and the amount that can be captured by "sinks"
Burden-sharing
• Developed countries must provide financial resources to help developing countries
• Other countries are invited to provide support on a voluntary basis
Review mechanism
2023
• A review every five years First world review: 2023
• Each review will inform countries in "updating and enhancing" their pledges
Climate damage
• Vulnerable countries have won recognition of the need for "averting, minimising and addressing" losses suffered due to climate change
AFP





Saudi Arabia's KA-CARE Program

- KA-CARE's procurement program aims to be one of the largest sustained efforts of its kind in the world, resulting in 54 GW of renewable energy by 2030 (25GW of CSP, 15GW of PV and 13GW of wind and other renewable energies)
- The program will start with two competitive procurement rounds, followed by the institution of a feed-in-tariff
- The first round will launch in 2013, with a target of 1.100MW for PV, 900MW for CSP, 650MW for wind and 200MW for other technologies
- The second round will launch 12 months after the first
- If the first and second round projects are completed on time with acceptable attrition rates, a feed-in-tariff mechanism will be launched. If not, a third round might be considered

Source: KA-CARE, X&Y Partners analysis

Saudi Arabia hits renewable reset button with new 9.5GW target

By John Parnell | Apr 26, 2016 10:08 AM BST | 0

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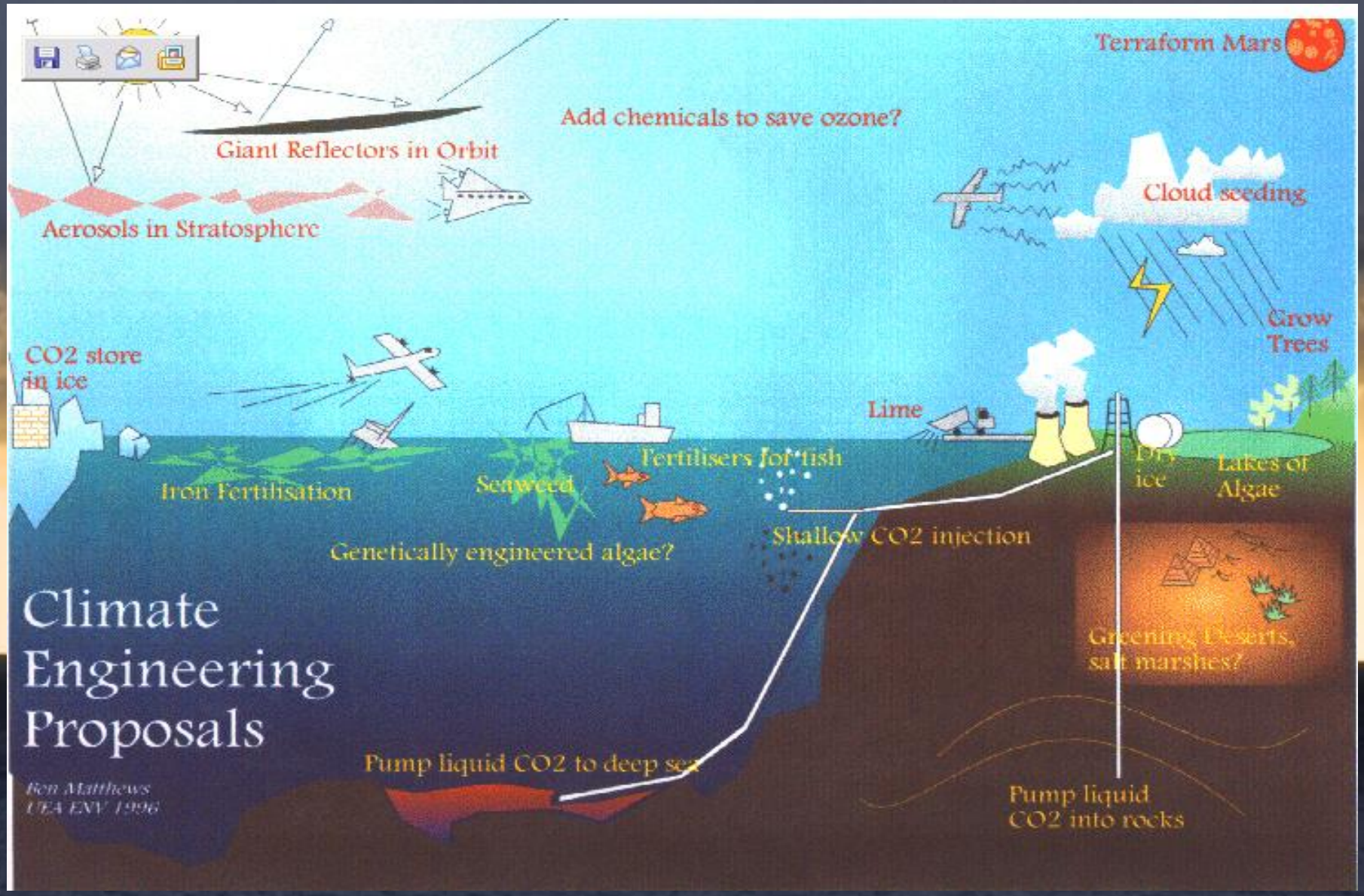
Saudis Kick Off $50 Billion Renewable Energy Plan to Cut Oil Use

By **Anthony Dipaola**

20 febbraio 2017 14:33 *Updated on* 20 febbraio 2017 23:00

- Energy ministry seeks bidder qualifications for next month
- Bids to be accepted by July for 700MW of wind, solar power

CHE FARE?


Terraform Mars
Add chemicals to save ozone?
Giant Reflectors in Orbit
Aerosols in Stratosphere
Cloud seeding
Grow Trees
CO2 store in ice
Lime
Fertilisers for fish
Iron Fertilisation
Seaweed
Dry ice
Lakes of Algae
Shallow CO2 injection
Genetically engineered algae?
Greening Deserts, salt marshes?
Climate Engineering Proposals
Pump liquid CO2 to deep sea
Ben Matthews
UEA ENV 1996
Pump liquid CO2 into rocks

CHE FARE?
Possiamo contribuire tutti

Scegliere attività ad più basse emissioni di inquinanti e gas serra

CO2 Footprint ***www.pe-international.com/***

CHE FARE?
Possiamo contribuire tutti

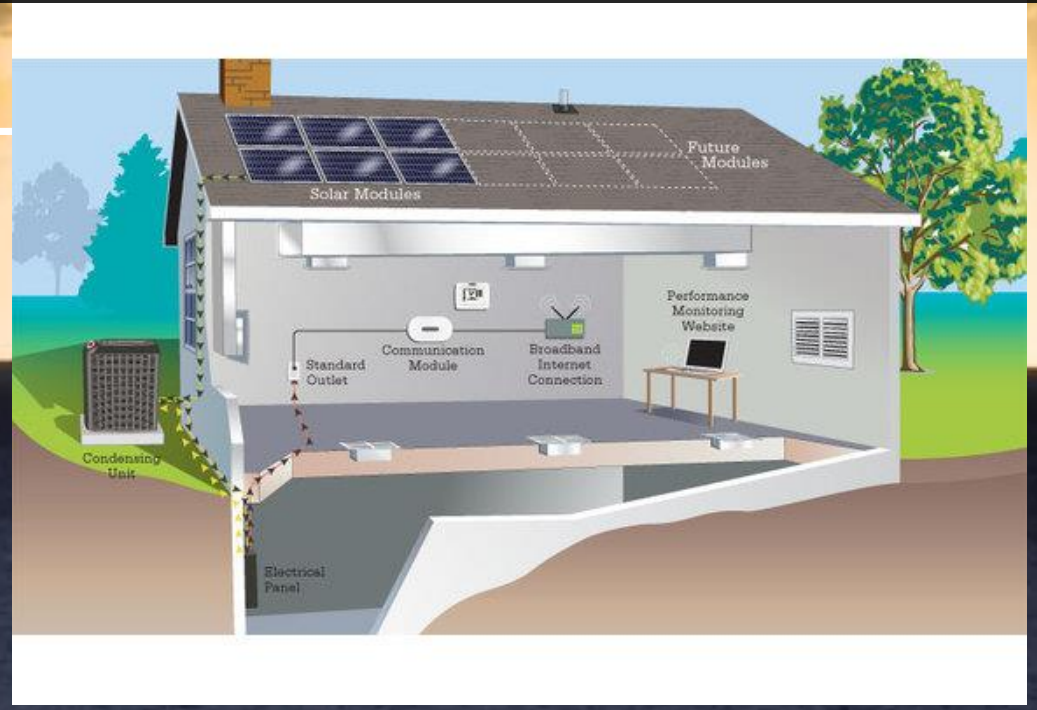
Rispetto del territorio

Evitare acquisto prodotti che portano alla deforestazione

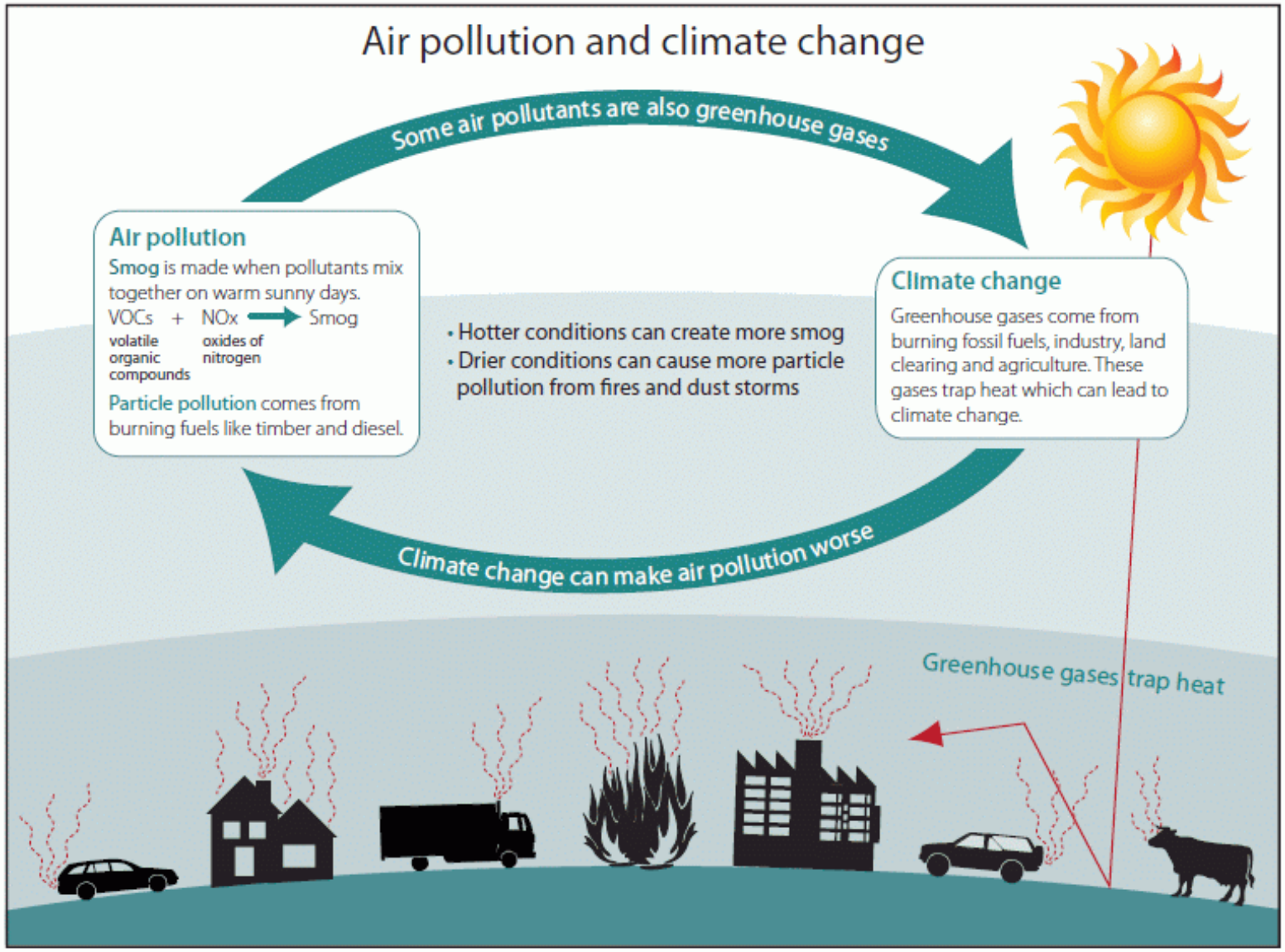
CHE FARE?
Cambiare stile di vita

Conclusioni: VOI potete veramente dare un grosso contributo

- **Segni di cambiamenti globali inequivocabili ed è essenziale sviluppare sorgenti energetiche alternative, cambiare stile di vita, costruire in maniera da ridurre emissioni di gas serra. <u>Effetti positivi sia sul clima che sulla qualità dell'aria!</u>**



Cambiamenti climatici e qualità dell'aria: due facce della stessa medaglia



Adapted from State of the Environment NSW 2000

flash mob

giovedì 28 febbraio 2019

dalle 17:45

Campus di Pescara: viale Pindaro, ingresso lato Economia

Campus di Chieti: via dei Vestini, scalinata Rettorato

Il nostro Ateneo, che aderisce alla **Rete delle Università per lo Sviluppo Sostenibile (RUS)**, partecipa a **"M'illumino di meno"**, iniziativa della trasmissione "Caterpillar"di Radio Rai2 per incoraggiare il risparmio energetico e i comportamenti virtuosi nell'ambito della sostenibilità ambientale.

In concomitanza con altri atenei italiani, promuoviamo la **"Caccia al kWh"**, un *flashmob* nel corso del quale studenti e personale spegneranno le luci rimaste accese e chiuderanno porte e finestre rimaste aperte dopo l'orario di apertura, all'interno dei locali delle sedi dell'Ateneo di Pescara e Chieti.
Un gesto simbolico per testimoniare un corretto uso dell'energia elettrica e termica per illuminazione e riscaldamento.

UdA
Università degli Studi "Gabriele d'Annunzio"
Chieti - Pescara