DiSTAR Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
SCUOLA POLITECNICA E DELLE SCIENZE DI BASE

Impacts and risks of "realistic" global warming projections for the 21st century.

Nicola Scafetta

15 June 2024

How much will the Earth warm?

Nicola Scafetta. Impacts and risks of "realistic" global warming projections for the 21st century. Geoscience Frontiers 15(2), 101774, 2024. https://doi.org/10.1016/j.gsf.2023.101774

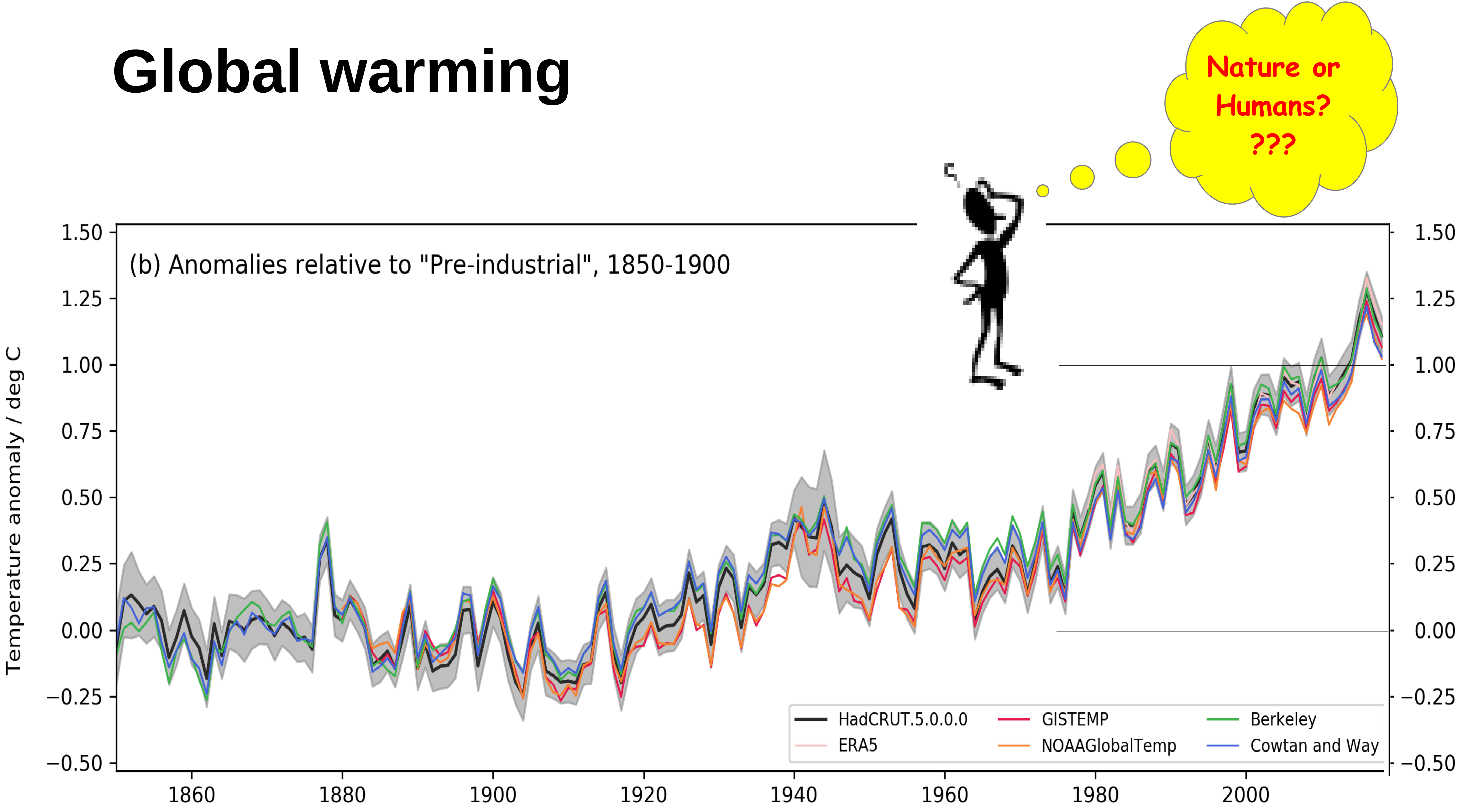
Nicola Scafetta. Empirical assessment of the role of the Sun in climate change using balanced multi-proxy solar records. Geoscience Frontiers, Volume 14, Issue 6, November 2023, 101650, 2023. https://doi.org/10.1016/j.gsf.2023.101650

Climate Alarmism

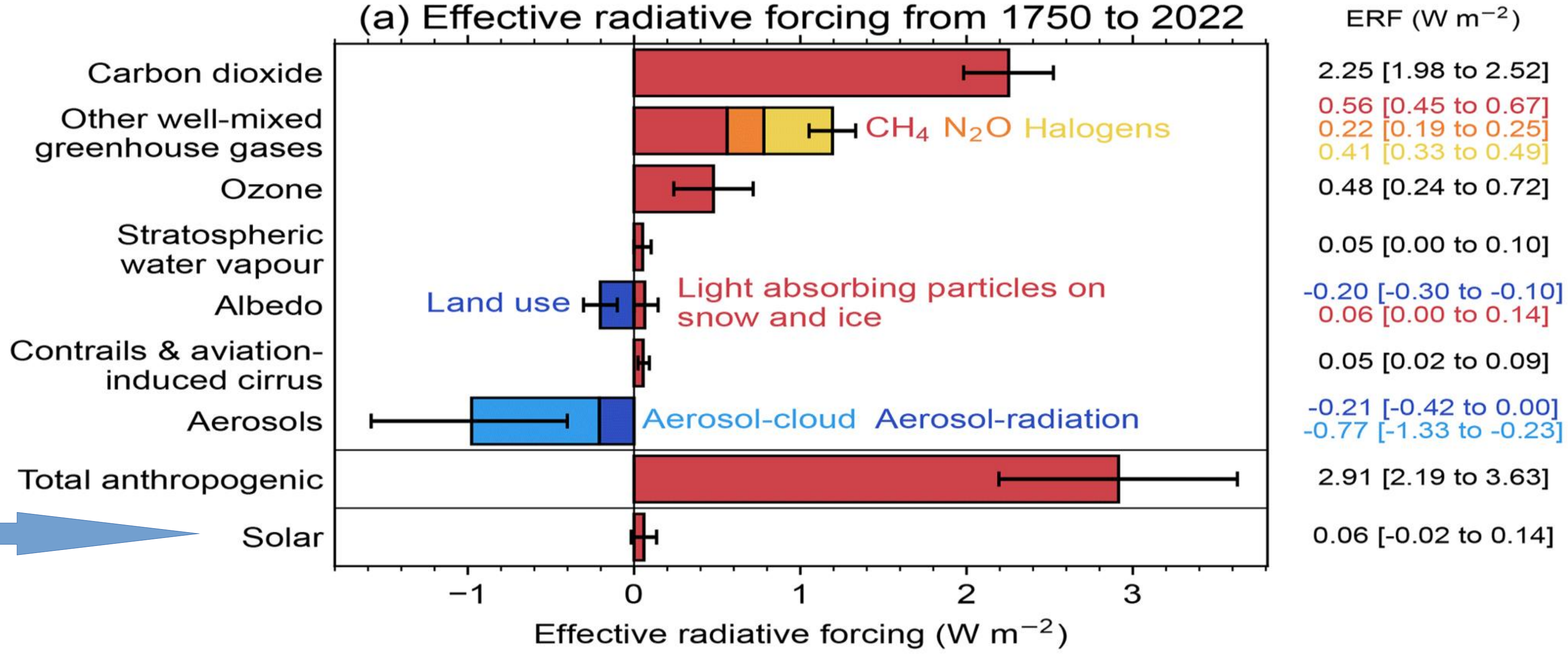





Global warming

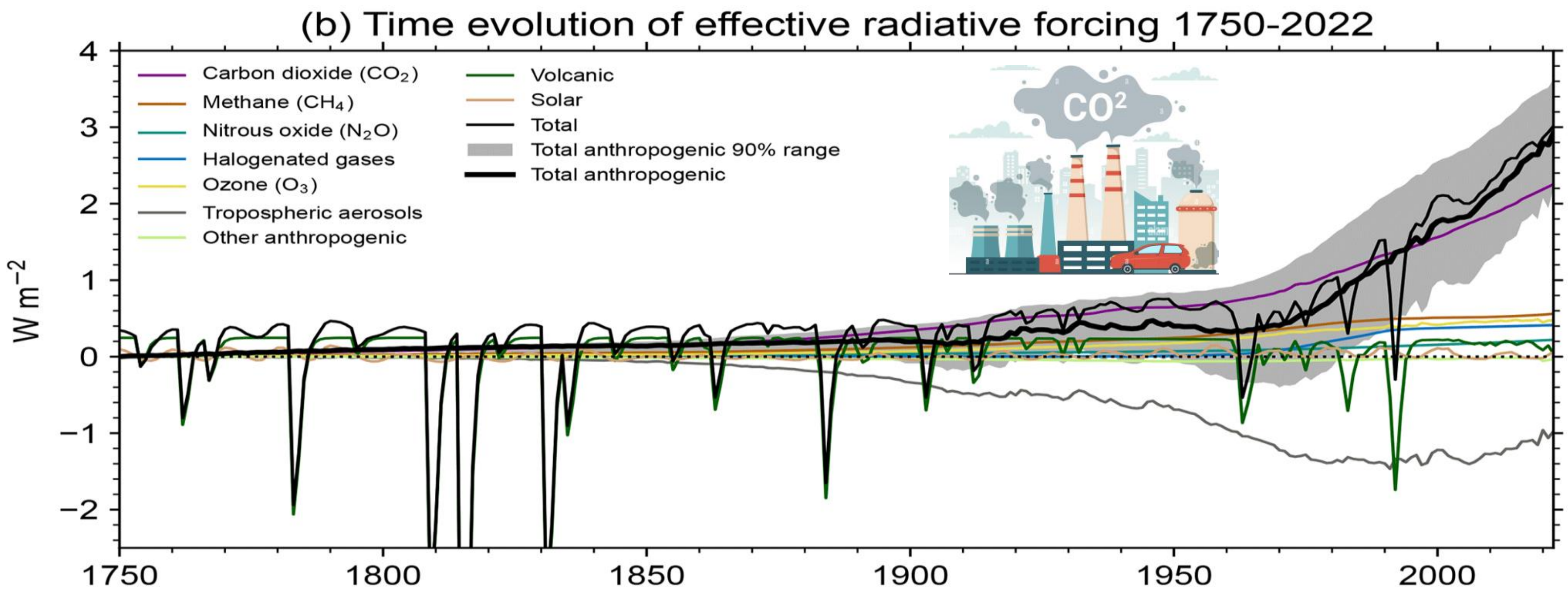


The solar contribution is negligible



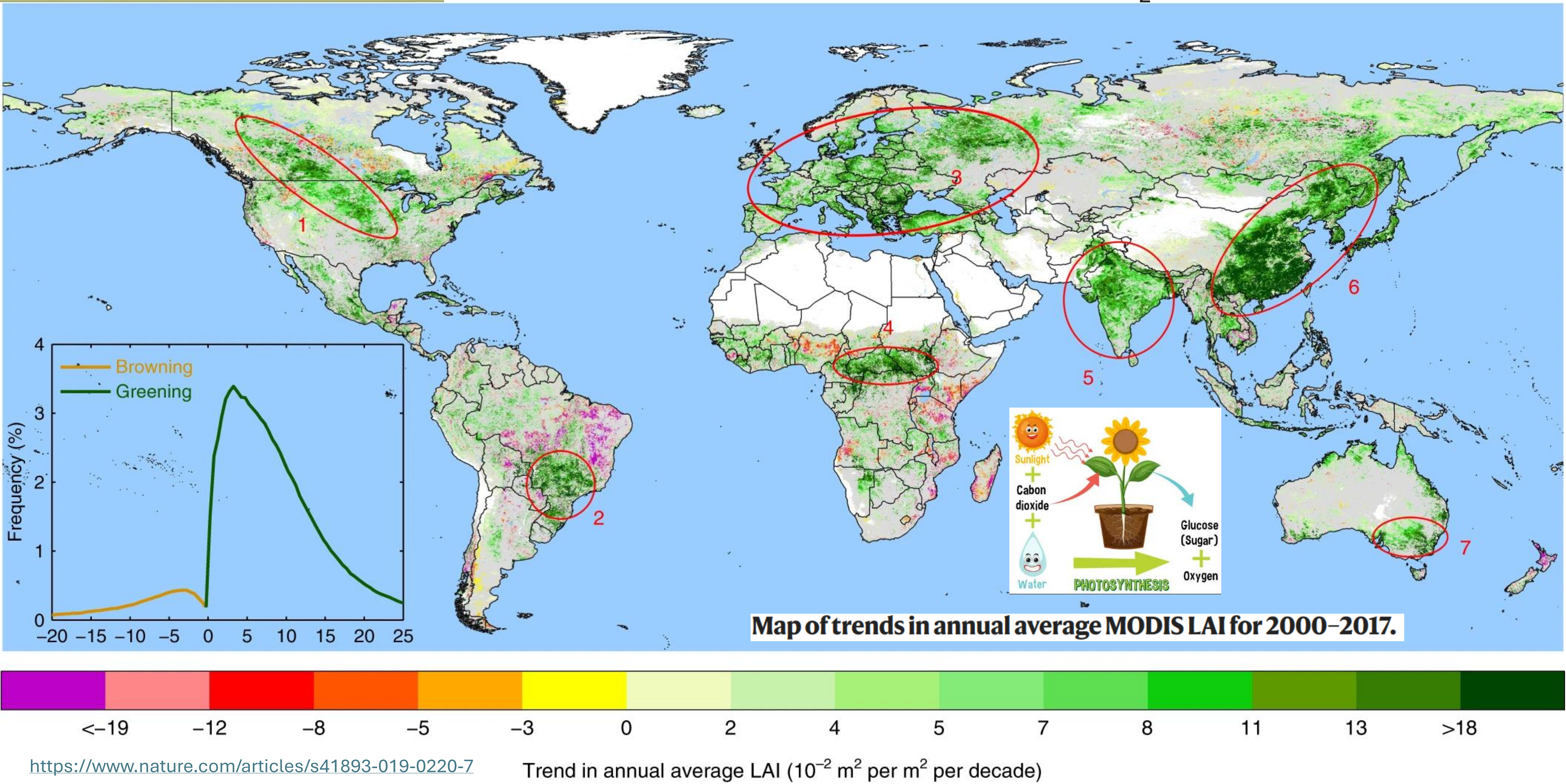
Nearly 100% of the forcing is man-made

(CO2 is pollution!)



CO_2 IS PLANT FOOD

Satellite data show increasing leaf area of vegetation mostly due to climate change and CO_2 fertilization effects.

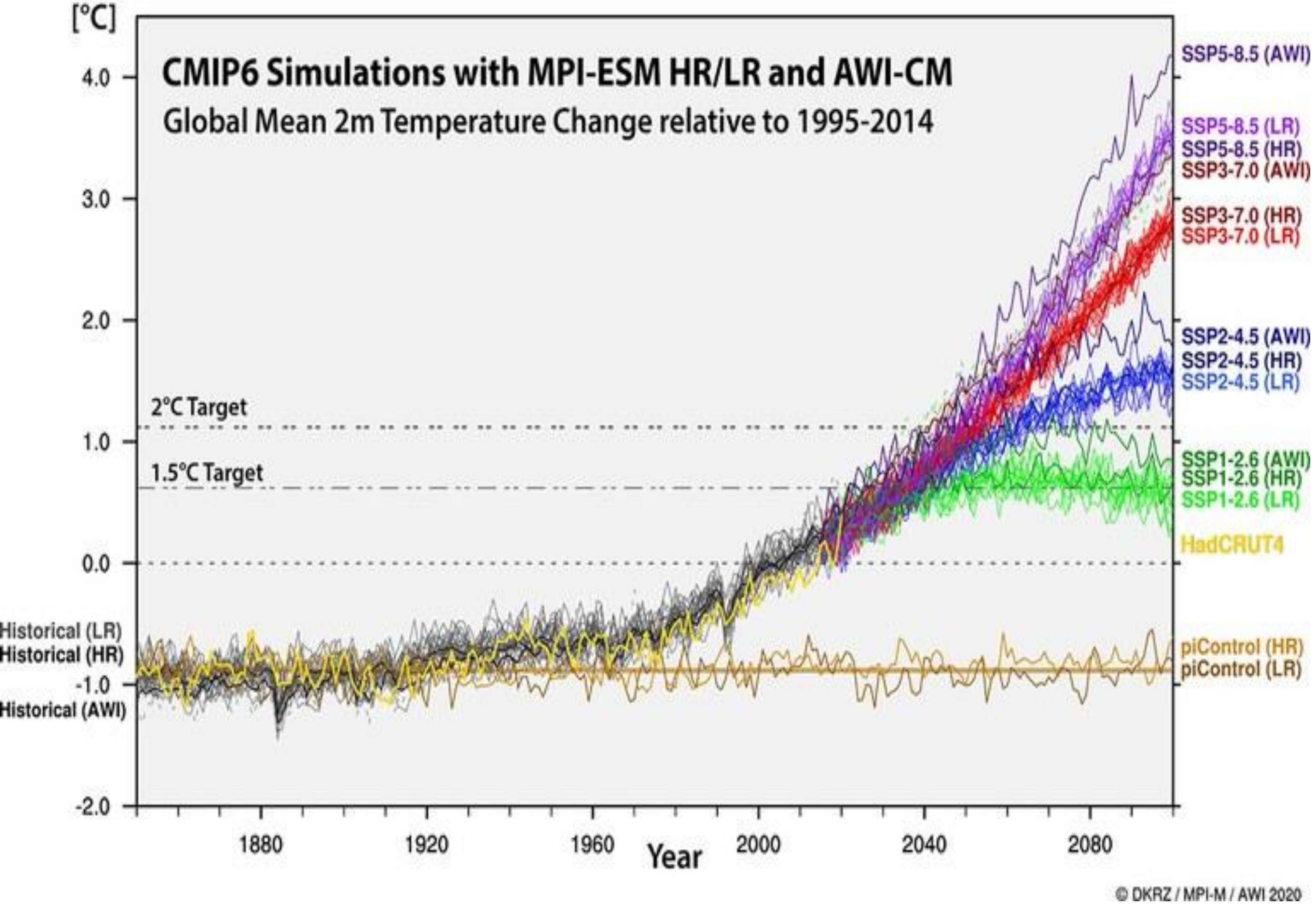


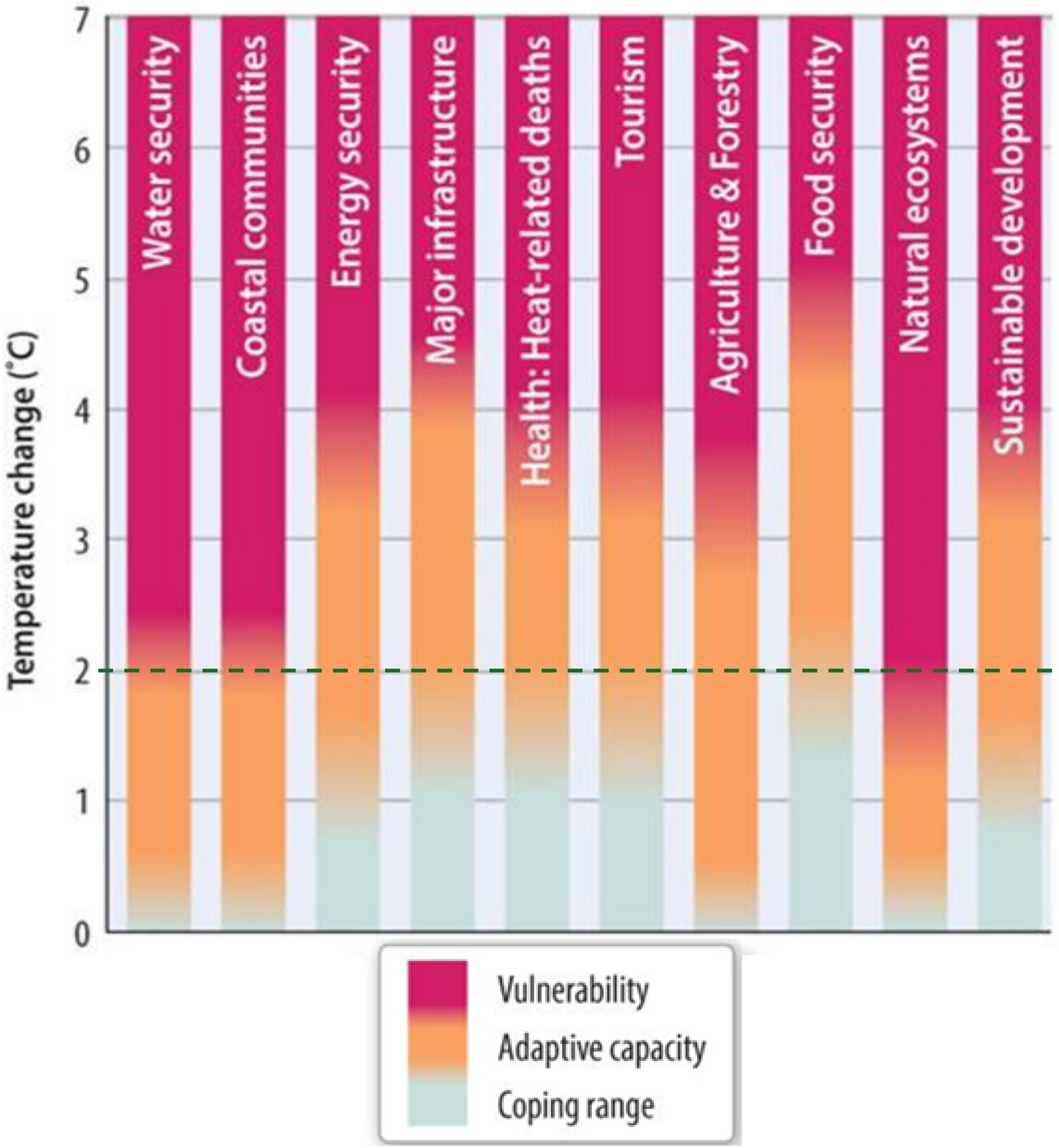
Map of trends in annual average MODIS LAI for 2000–2017.

https://www.nature.com/articles/s41893-019-0220-7

IPCC SR1.5 (2018)

Paris Agreement global warming goals 1.5 - 2.0 °C





"**We need to do more**"!

Only the **Net-Zero** emissions scenarios guarantees staying below 2 °C and

"**Saving the World**"!!!

Bureaucrats versus People

European Commission

Energy, Climate change, Environment

Climate Action

Home > EU Action > Climate strategies & targets > 2050 long-term strategy

2050 long-term strategy

The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions. This objective is at the heart of the European Green Deal, and in line with the EU's commitment to global climate action under the Paris Agreement.

The transition to a climate-neutral society is both an urgent challenge and an opportunity to build a better future for all.

All parts of society and economic sectors will play a role – from the power sector to industry, mobility, buildings, agriculture and forestry.

The EU can lead the way by investing into realistic technological solutions, empowering citizens and aligning action in key areas such as industrial policy, finance and research, while ensuring social fairness for a just transition.

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James Crisp, EUROPE EDITOR
19 January 2024 • 3:18pm

Von der Leyen's flagship petrol and diesel ban isn't even backed by her own party

European People's Party wants to scrap the plans due to the growing cost of living crisis

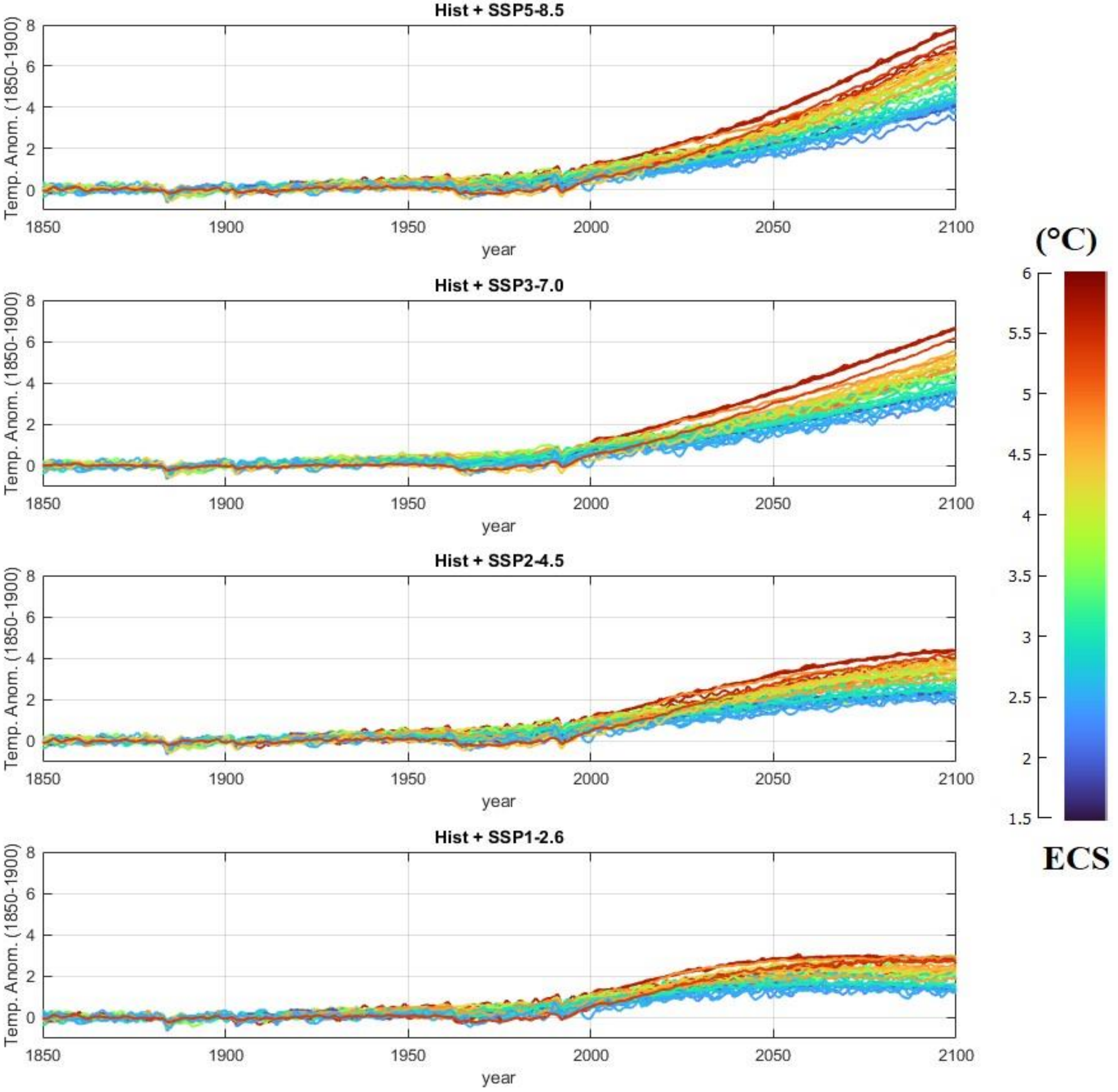
Conservative forces in the European Parliament are considering calling on the EU to drop its 2035 ban on petrol and diesel engines in an embarrassing blow to Ursula von der Leyen...

Is the alarmist narrative based on sand or rock?

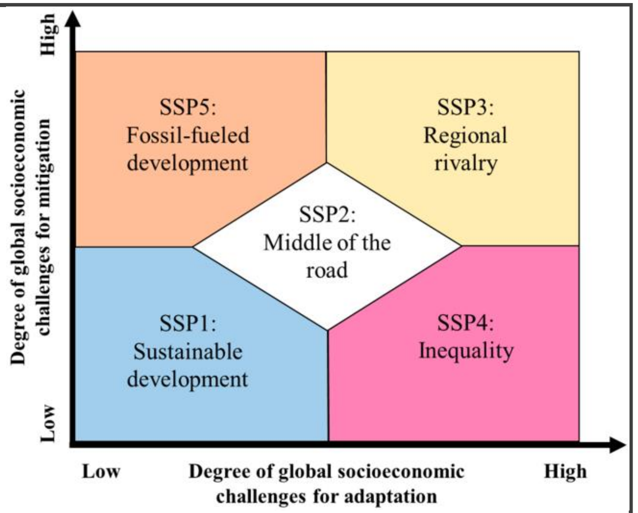
Critical Issues

- The projected warming for the 21st century strongly depends:

1. on the Shared Socioeconomic Pathways (SSP) chosen for the simulation;
2. on the equilibrium climate sensitivity (ECS) of the model;
3. on the reliability of the GCMs in properly reconstructing past climate changes



Critical Issue 1



Which Shared Socioeconomic Pathways (SSP) is realistic?

Only the SSP2-4.5 is realistic

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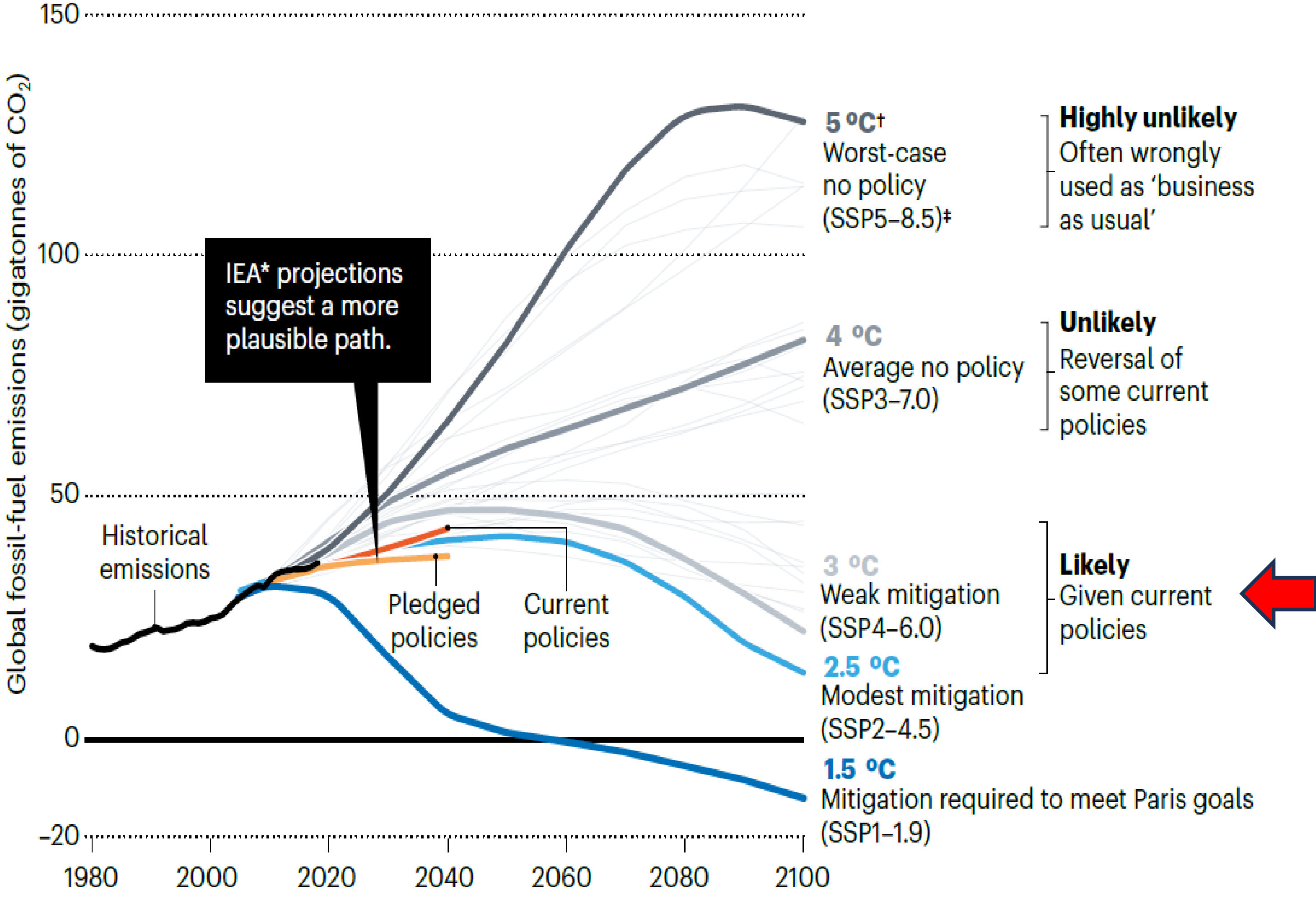
COMMENT | 29 January 2020

Emissions – the 'business as usual' story is misleading

Stop using the worst-case scenario for climate warming as the most likely outcome – more-realistic baselines make for better policy.

Zeke Hausfather & Glen P. Peters



Climatic Impact-driver Type	Climatic Impact-driver Category	Already Emerged in Historical Period	Emerging by 2050 at Least for RCP8.5/SSP5-8.5	Emerging Between 2050 and 2100 for at Least RC8.5/SSP5-8.5
Heat and Cold	Mean air temperature	1		
	Extreme heat	2	3	
	Cold spell	4	5	
	Frost			
Wet and Dry	Mean precipitation		6 7	
	River flood			
	Heavy precipitation and pluvial flood			8
	Landslide			
	Aridity			
	Hydrological drought			
	Agricultural and ecological drought			
	Fire weather			
Wind	Mean wind speed			
	Severe wind storm			
	Tropical cyclone			
	Sand and dust storm			
Snow and Ice	Snow, glacier and ice sheet		9	10
	Permafrost			
	Lake, river and sea ice	11		
	Heavy snowfall and ice storm			
	Hail			
	Snow avalanche			
Coastal	Relative sea level		12	
	Coastal flood			
	Coastal erosion			
Open Ocean	Mean ocean temperature			
	Marine heatwave			
	Ocean acidity			
	Ocean salinity	13		
	Dissolved oxygen	14		
Other	Air pollution weather			
	Atmospheric CO_2 at surface			
	Radiation at surface			

High confidence of decrease | Medium confidence of decrease | Low confidence in direction of change | Medium confidence of increase | High confidence of increase

Table 12.12 | Emergence of CIDs in different time periods. pp. 1856

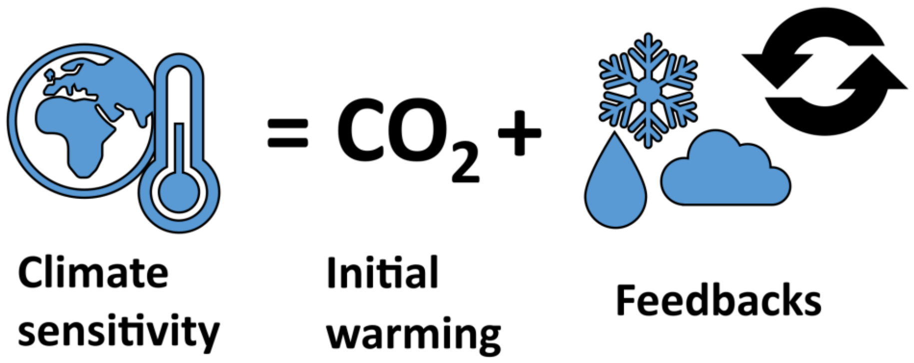
IPCC AR6 mostly highlights the SSP5-8.5 scenario.

Yet, IPCC AR6 also acknowledges:

"However, the likelihood of high-emissions scenarios such as RCP8.5 or SSP5-8.5 is considered low in light of recent developments in the energy sector (Hausfather and Peters, 2020a,b).

***Studies that consider possible future emissions trends in the absence of additional climate policies…. (are) approximately in line with the intermediate RCP4.5, RCP6.0 and SSP2-4.5 scenarios"* (pp. 238-239)**

Critical Issue 2

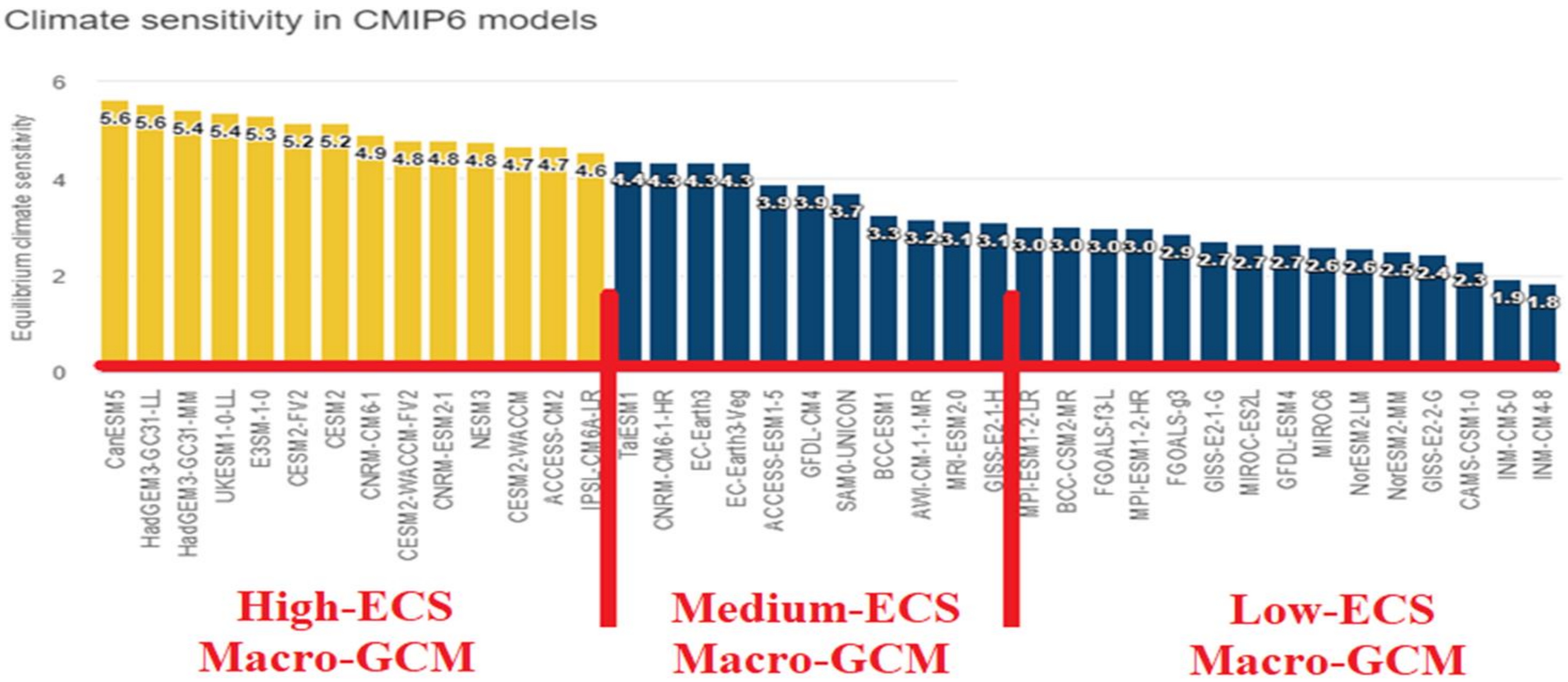


Which Models could be realistic?

(The “Equilibrium Climate Sensitivity” issue)

CMIP6 Global Climate Models (GCMs)
Equilibrium Climate Sensitivity (ECS) «huge» uncertainty

The ECS is an estimate of the global surface warming achieved at equilibrium after a doubling of atmospheric CO_2



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COMMENT | 04 May 2022

Climate simulations: recognize the ‘hot model’ problem

The sixth and latest IPCC assessment weights climate models according to how well they reproduce other evidence. Now the rest of the community should do the same.

Zeke Hausfather, Kate Marvel, Gavin A. Schmidt, John W. Nielsen-Gammon & Mark Zelinka

Addressing the "Hot Model" Problem

1) CMIP6 GCMs: ECS = **1.8–5.8** °C

2) Sherwood et al. (Rev. Geophysics 58, e2019RG000678, 2020):
ECS = **2.6–3.9** °C (66% confidence)
ECS = 2.3–4.7 °C (95% confidence)
IPCC AR6 (2021) accepts the evaluations of Sherwood et al. (2020)

3) Lewis (Climate Dynamics 60, 3139–3165, 2023):
ECS = **1.75–2.7** °C (66% confidence)
ECS = 1.55–3.2 °C (95% confidence)

4) Scafetta (GRL, Climate Dynamics, Climate, Geoscience Front. 2021-2023):
ECS <= 3 °C, with possibility of ECS = 1-2 °C

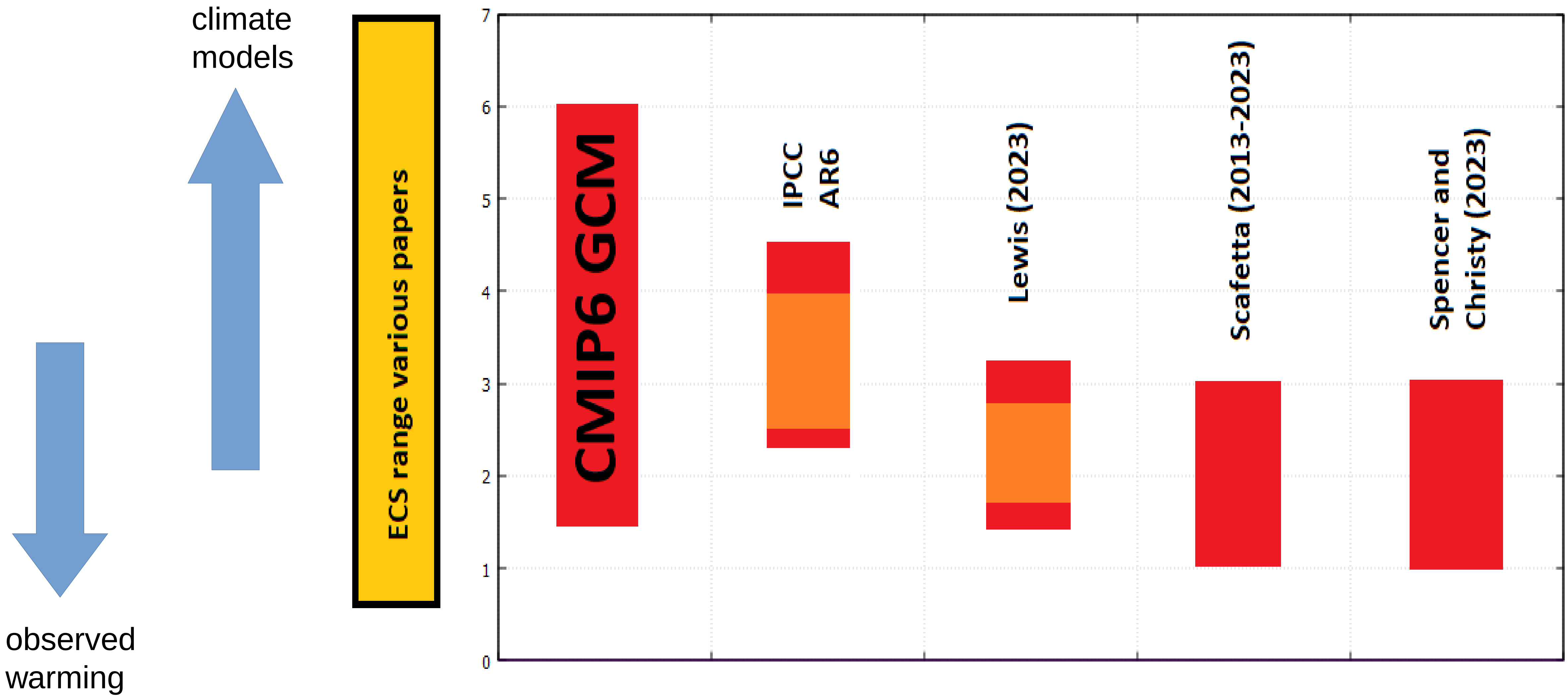
5) Spencer and Christy (Theoretical and Applied Climatology, 2023):
confirm Lewis and Scafetta's low ECS estimates.

Important new paper challenges IPCC's claims about climate sensitivity

Posted on September 20, 2022 by niclewis | 185 Comments

by Nic Lewis

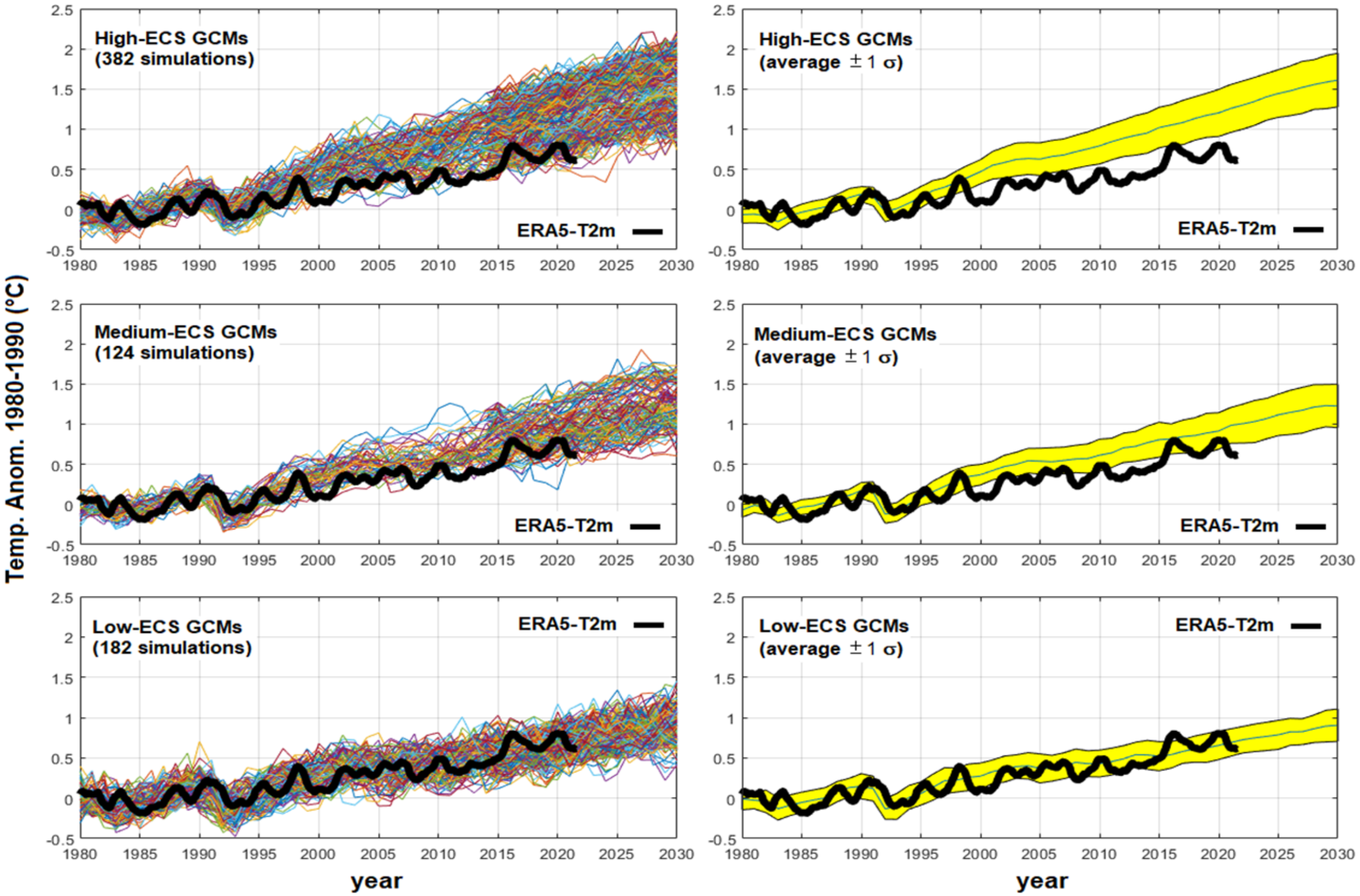
> Lewis' paper critiqued the methods used in the Sherwood et al. paper, finding significant errors, inconsistencies and other shortcomings. Lewis remedied these shortcomings and also revised key input data, almost entirely to reflect more recent evidence. The results of Lewis' analysis determined a *likely* range of 1.75 to 2.7°C for climate sensitivity. The central estimate from Lewis' analysis is 2.16 °C, which is well below the IPCC AR6 *likely* range. This large reduction relative to Sherwood et al. shows how sensitive climate sensitivity estimates are to input assumptions. Lewis' analysis implies that climate sensitivity is more likely to be below 2 °C than it is to be above 2.5 °C.

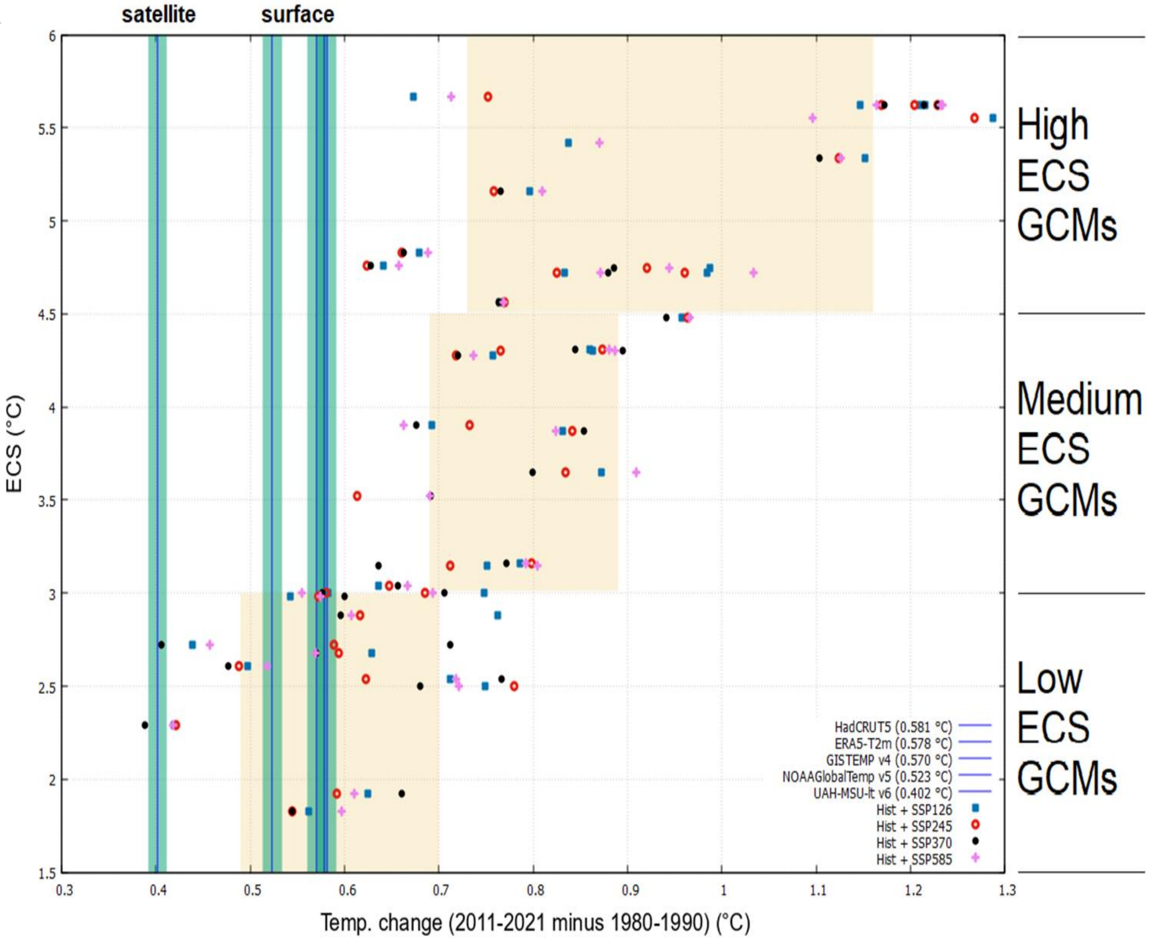


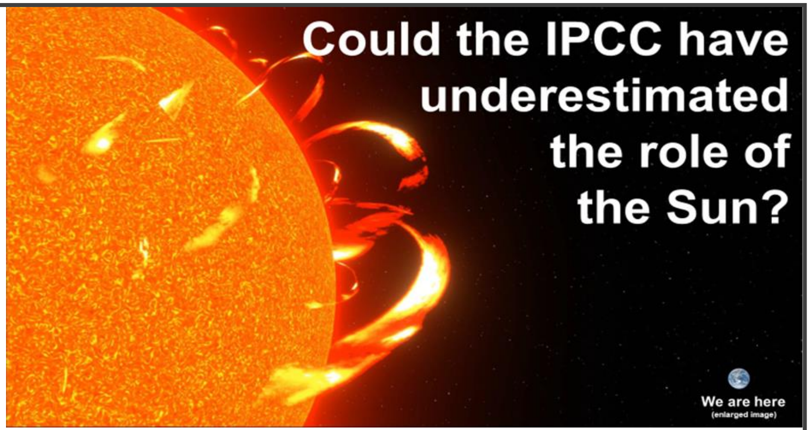
Rugenstein et al. (2023): "Early in the 2010s, a **substantial discrepancy** was noted **between estimates of climate sensitivity derived from climate models and estimates based on the observed warming record** and radiative balance ... **Estimates based on observed warming pointed to much lower values than those derived from models**".

CMIP6 GCMs versus Temperature Data from 1980 to 2022
Only the LOW-ECS GCMS might be realistic

- Scafetta, N. Geophys. Res. Lett. 2022, 49, e2022GL097716.
- Scafetta, N. Climate 2021, 9, 161.doi.10.3390/cli9110161
- Scafetta, N. Clim Dyn (2023). doi.10.1007/s00382-022-06493-w
- Scafetta, N. Atmosphere 2023, 14, 345. doi.10.3390/atmos14020345
- Scafetta, N. Geophys. Res. Lett. 2023, 50, e2023GL104960.







Critical Issue 3

Is there further evidence that the models may be physically incorrect?

(Warm biases and natural variability)

IPCC AR6
Figure 3.10
p. 443

The GCMS are not able to reproduce the warming of the troposphere

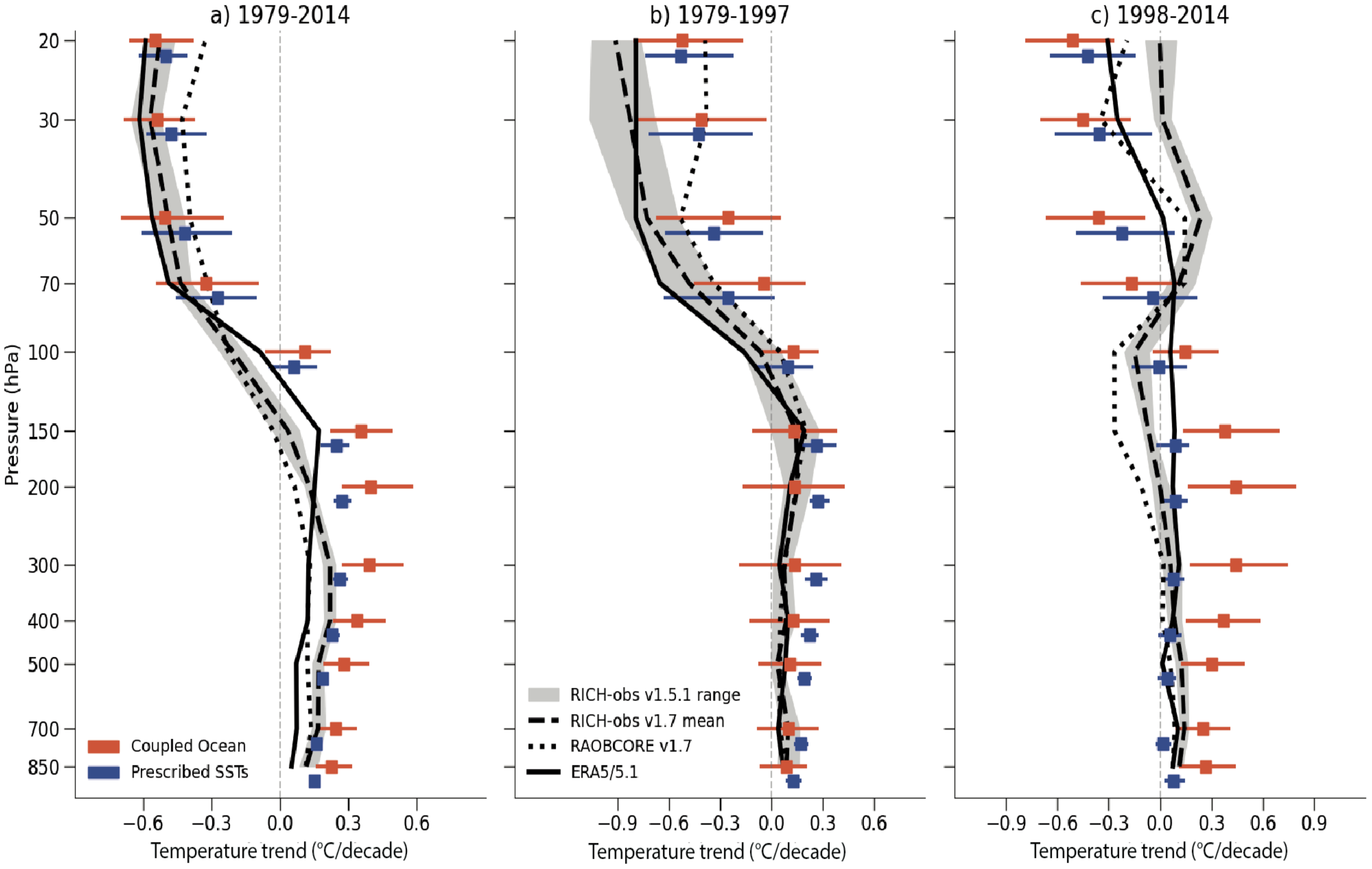
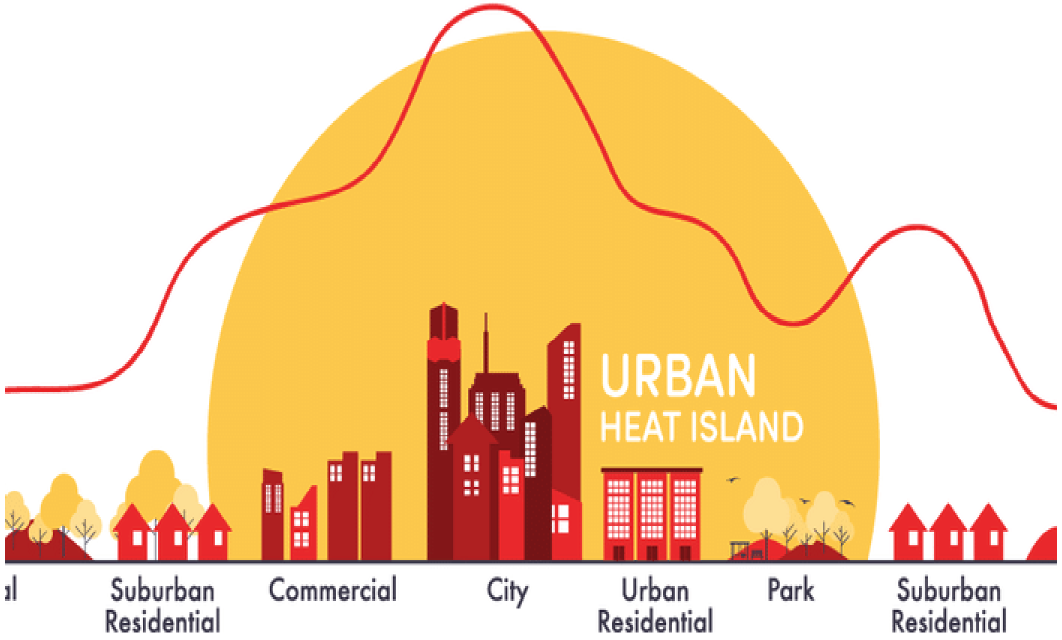
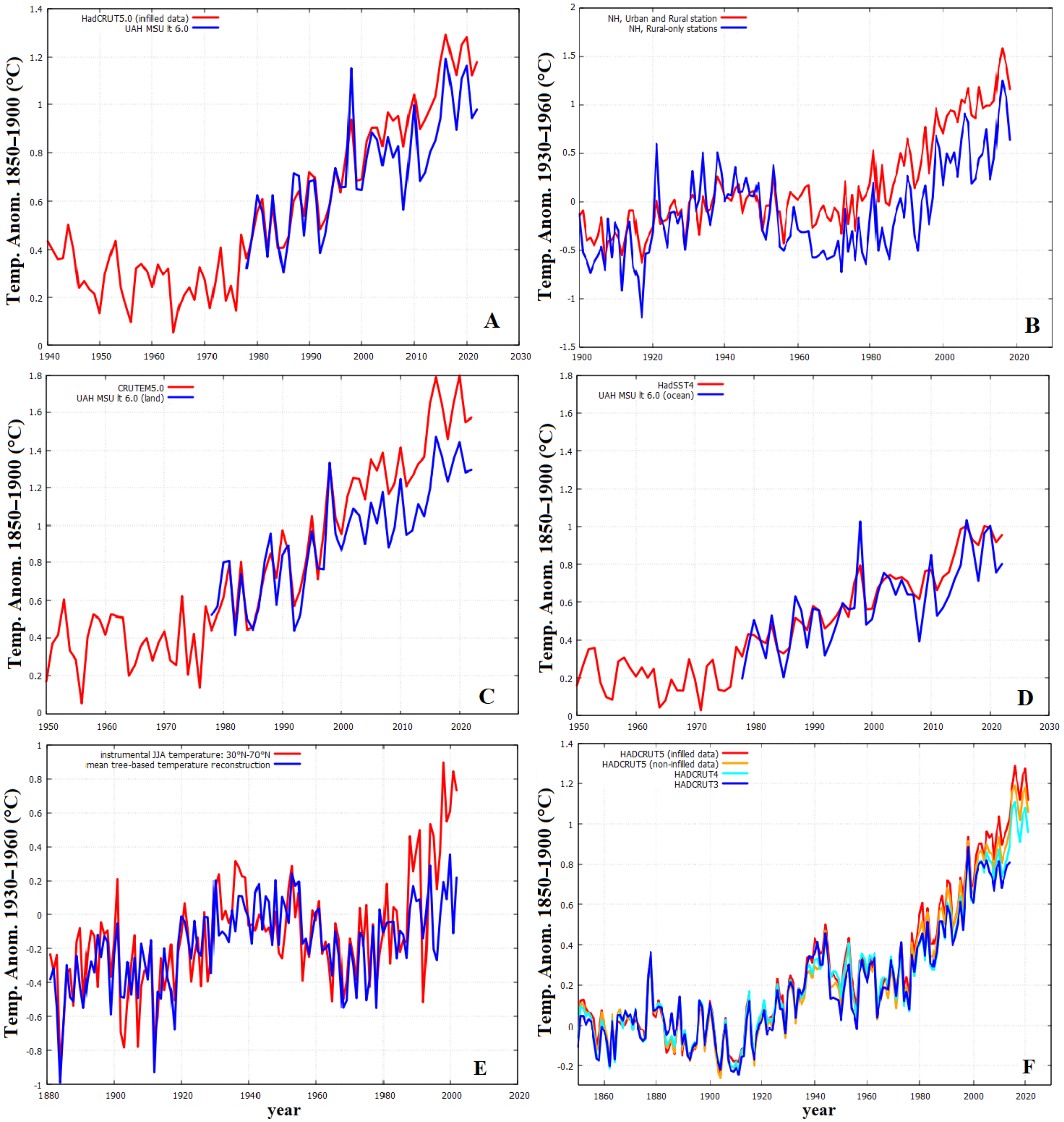


Figure 3.10 | Observed and simulated tropical mean temperature trends through the atmosphere. Vertical profiles of temperature trends in the tropics (20°S–20°N) for three periods: **(a)** 1979–2014, **(b)** 1979–1997 (ozone depletion era) and **(c)** 1998–2014 (ozone stabilization era). The black lines show trends in the Radiosonde Innovation Composite Homogenization (RICH) 1.7 (long dashed) and Radiosonde Observation Correction using Reanalysis (RAOBCORE) 1.7 (dashed) radiosonde datasets (Haimberger et al., 2012), and in the ERA5/5.1 reanalysis (solid). Grey envelopes are centred on the RICH 1.7 trends, but show the uncertainty based on 32 RICH-observations members of version 1.5.1 of the dataset, which used version 1.7.3 of the RICH software but with the parameters of version 1.5.1. ERA5 was used as reference for calculating the adjustments between 2010 and 2019, and ERA-Interim was used for the years before that. Red lines show trends in CMIP6 historical simulations from one realization of each of 60 models. Blue lines show trends in 46 CMIP6 models that used prescribed, rather than simulated, sea surface temperatures (SSTs). Figure is adapted from Mitchell et al. (2020), their Figure 1. Further details on data sources and processing are available in the chapter data table (Table 3.SM.1).



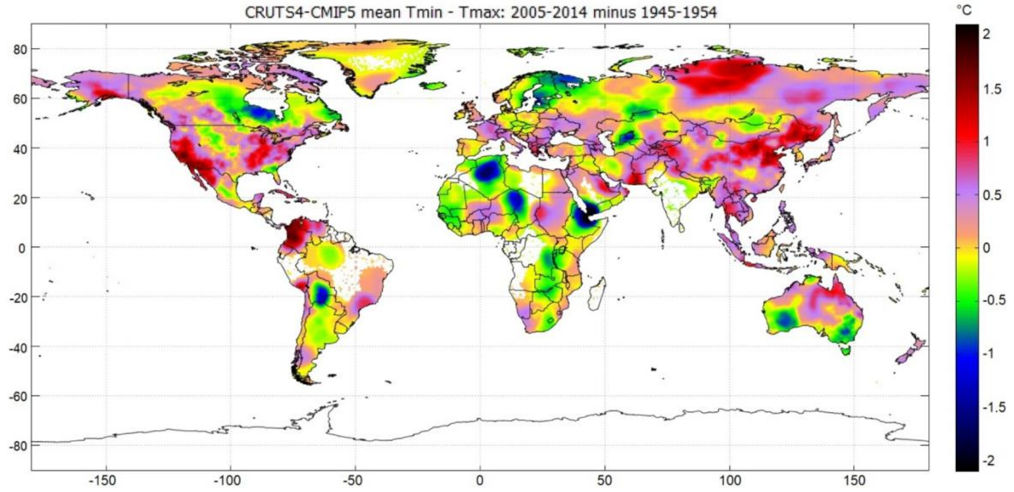
The surface temperature records are likely affected by urban heat

- Scafetta, N. Detection of non-climatic biases in land surface temperature records by comparing climatic data and their model simulations. Clim Dyn 56, 2959–2982 (2021).

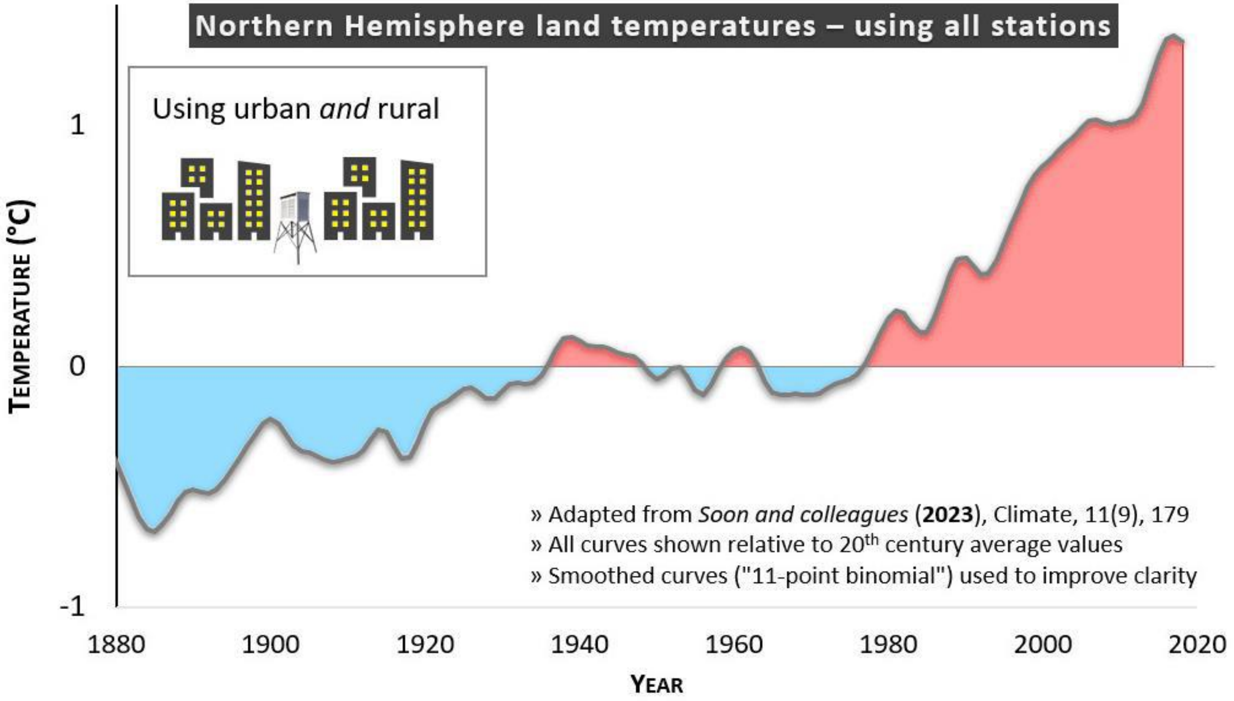


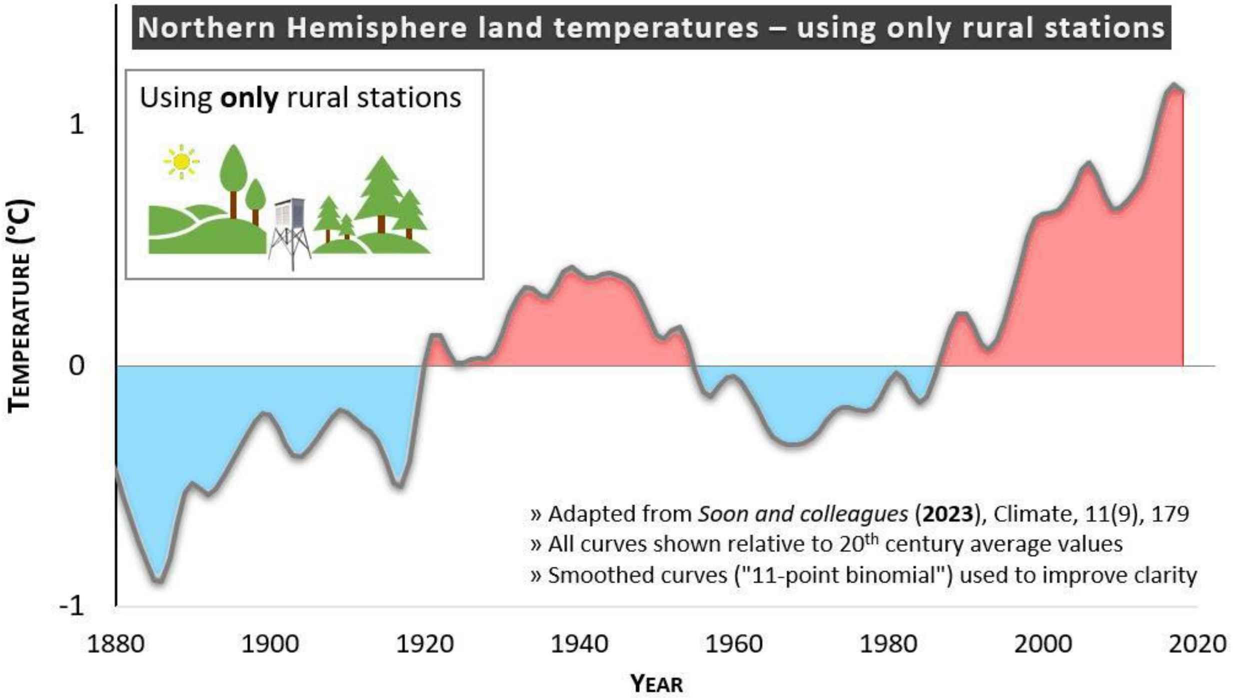
How does the rural-only temperature record compare to the urban & rural temperature record?

- Shows roughly same timings for warming/cooling/warming periods
- Except early warming to 1940s and cooling to 1970s is more pronounced
- Long-term warming (0.6°C per century) is much less than the “urban and rural” estimates (0.9°C per century)



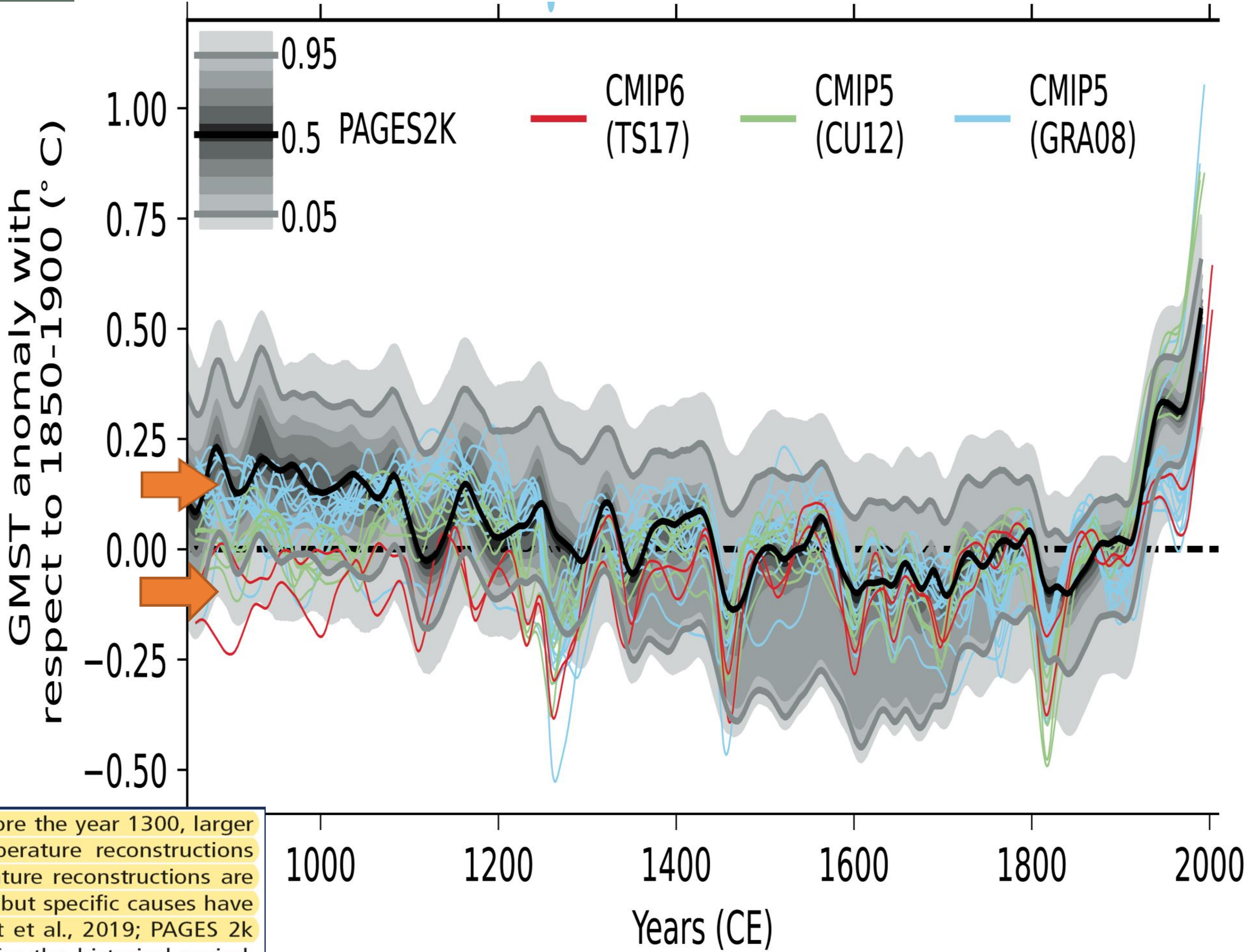
Scafetta Clim. Dyn.(2021); Soon et al. Climate (2023)





IPCC AR6 Figure 3.2, p. 432

The Medieval Warm Period is NOT reproduced



IPCC AR6, pp. 433

forcing datasets disagree (Figure 3.2c). Before the year 1300, larger disagreements between models and temperature reconstructions are expected because forcing and temperature reconstructions are increasingly uncertain further back in time, but specific causes have not been identified conclusively (Ljungqvist et al., 2019; PAGES 2k Consortium, 2019) (*medium confidence*). For the historical period,

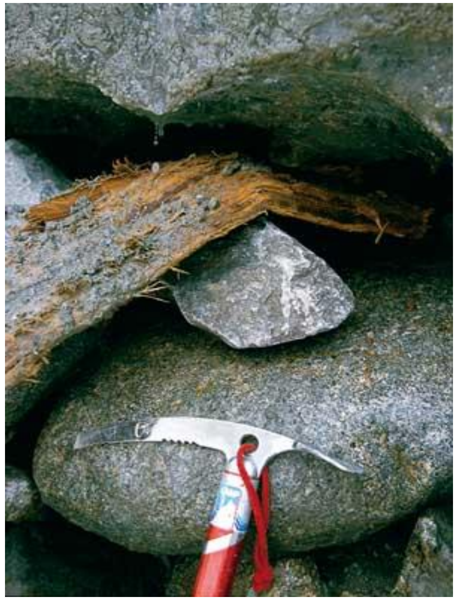
Trees under glaciers

Melting glaciers in Western Canada are revealing tree stumps up to 7,000 years old where the region's rivers of ice have retreated to a historic minimum, a geologist said today.

Glacier-buried forests from ~1000 years ago uncover a warm Medieval period

Figure 2. Students learn how scientists combine living and dead trees to create millennial-length records of temperature, such as the buried forests emerging here from the wasting margin of Mendenhall Glacier (Credit: Jesse Wiles).

Davi et al., 2019



Christian Schlüchter: "Alpen ohne Gletscher? Holz- und Torffunde als Klimaindikatoren", Die Alpen, 6/2004; The Alps with little ice: evidence for eight Holocene phases of reduced glacier extent in the Central Alps, The Holocene, 2001, 11/3: 255-265

The Susten pass (Switzerland) as it is today (above) and as it probably was in Roman times, 2000 years ago green and with several trees (below). (Die Alpen / Atelier Thomas Richner based on a draft from Christoph Schlüchter).

- Only solar activity has a millennial cycle.

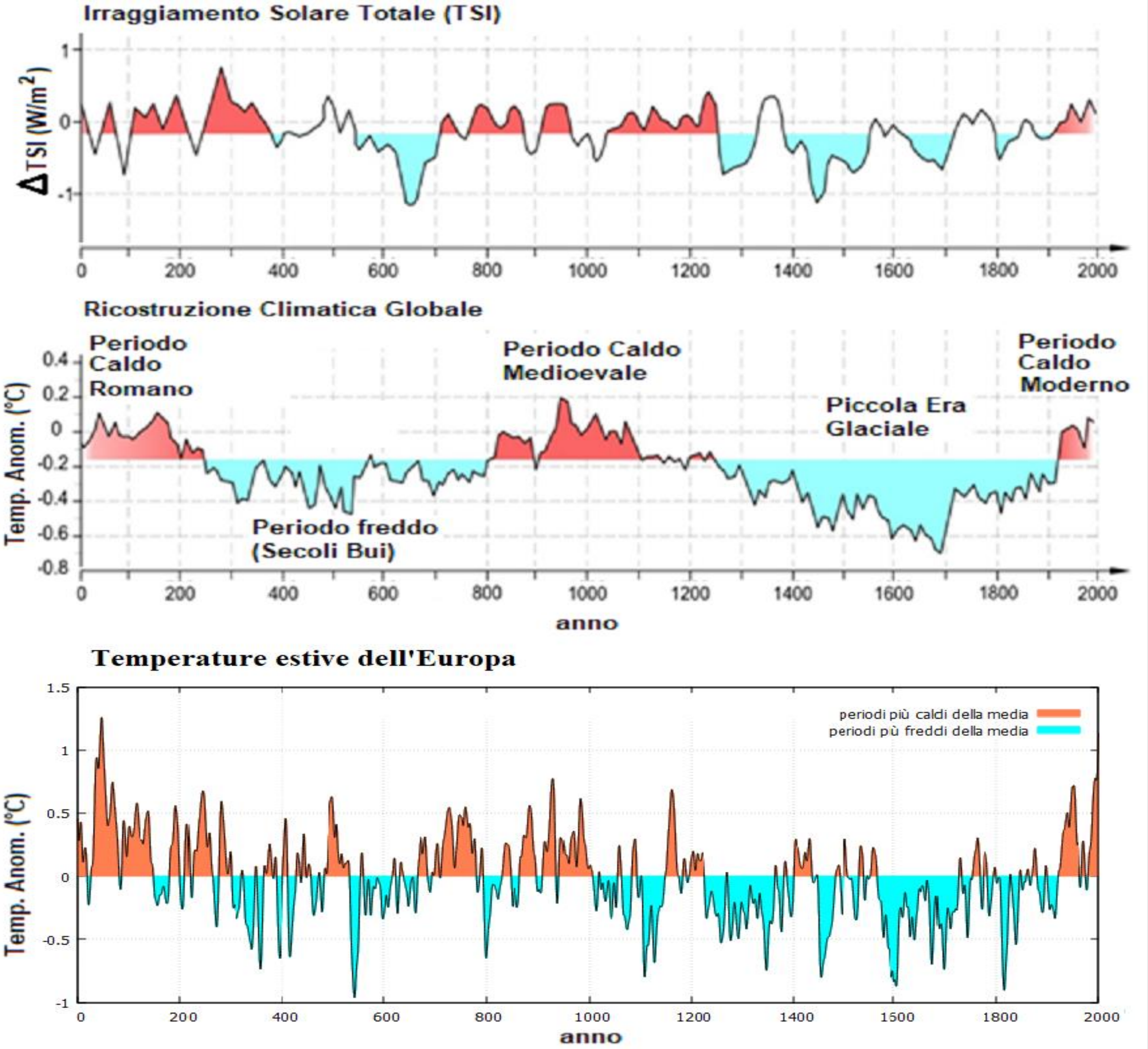
  (Steinhilber et al.,2012)

- Which correlates with the millennial cycle of temperatures

  (Ljungqvist, 2010)

  Summer European Temperature

  (Luterbacher et al., 2016)



Why do the GCMs fail in reproducing the Medieval Warm Period?

Wrong Total Solar Irradiance (TSI) forcing

Additional solar forcings not related to TSI

Scafetta, (2023). *Geoscience Frontiers* 14(6), 101650.

Connolly, …., Scafetta, et al. (2023). *Research in Astronomy and Astrophysics* 23, 105015.

Soon, …., Scafetta, et al. (2023). *Climate* 11, 179.

Scafetta, Bianchini, (2023). *Climate* 11(4), 77.

Scafetta, Bianchini, (2022). *Frontiers in Astronomy and Space Sciences*, 937930.

Connolly, …, Scafetta, et al. (2021). *Research in Astronomy and Astrophysics* 21, 131.

Scafetta, (2021). *Atmosphere*, 12, 147.

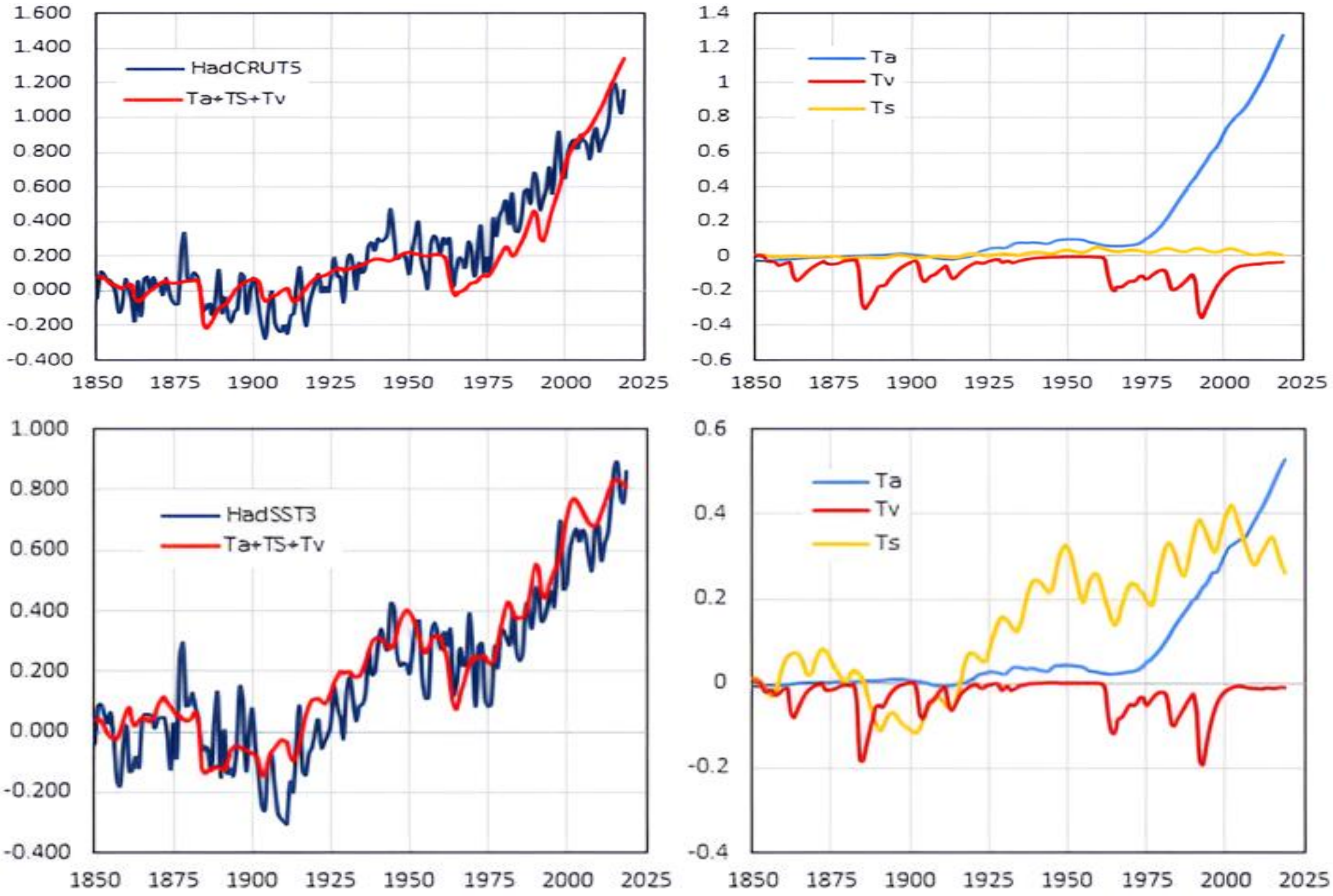
Scafetta, et al. (2019). *Remote Sensing*, 11(21), 2569.

CMIP6 based forcing vs. Global Temperature

ECS: 1.4 – 2.8 °C (66%)

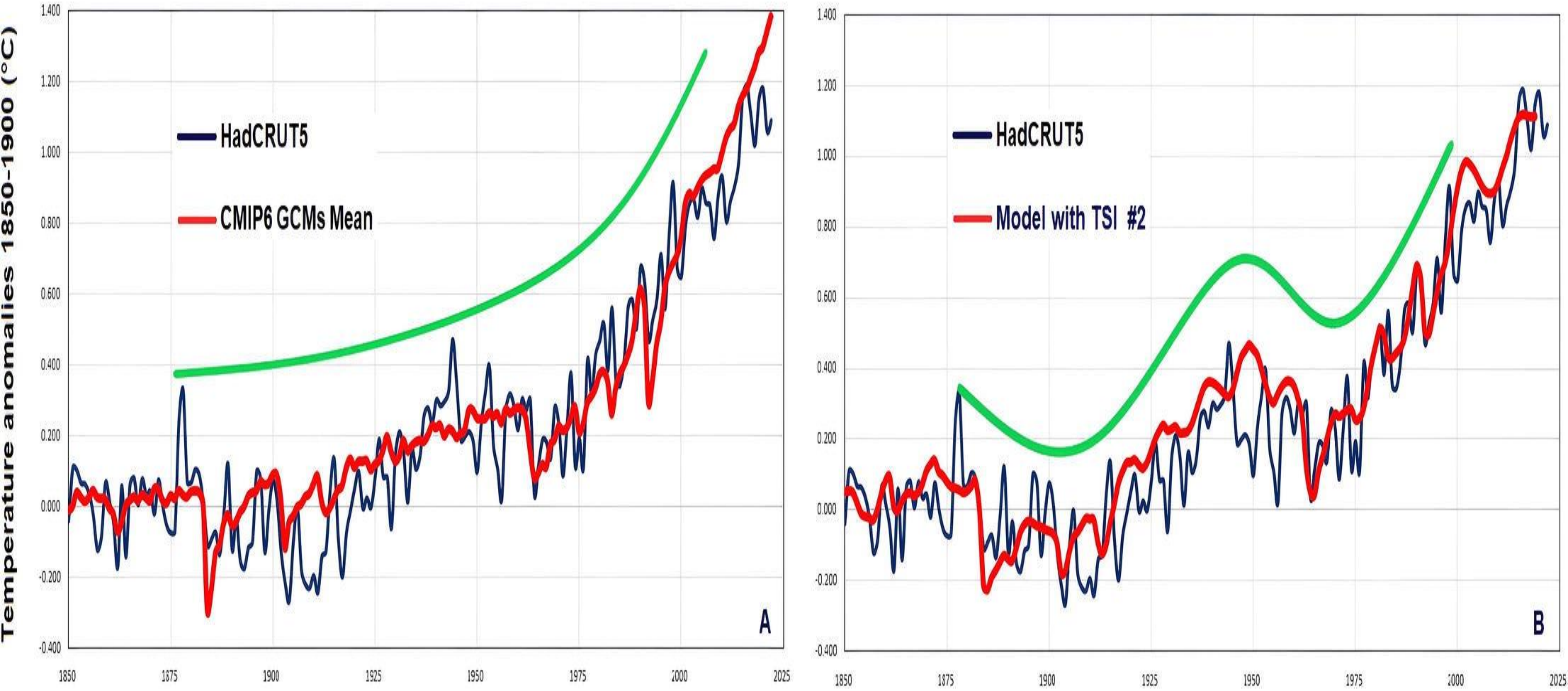
Alternative solar forcing vs. Ocean Temperature

ECS: 0.6 – 1.0 °C (66%)

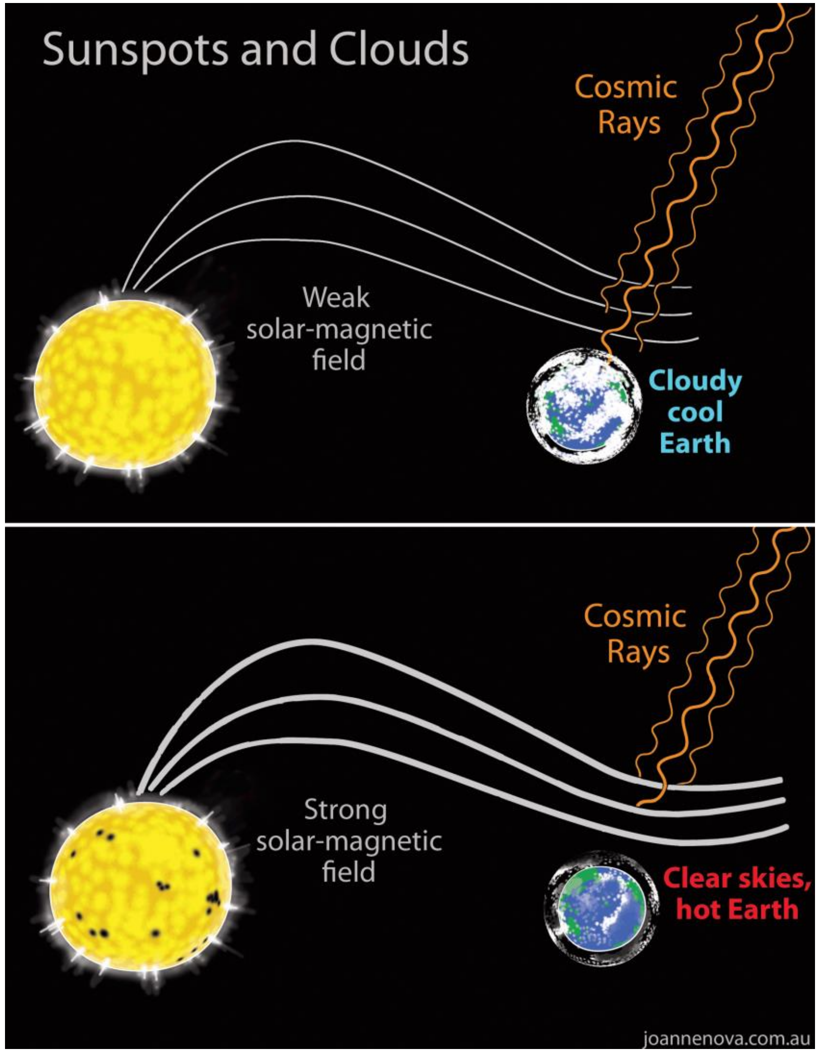


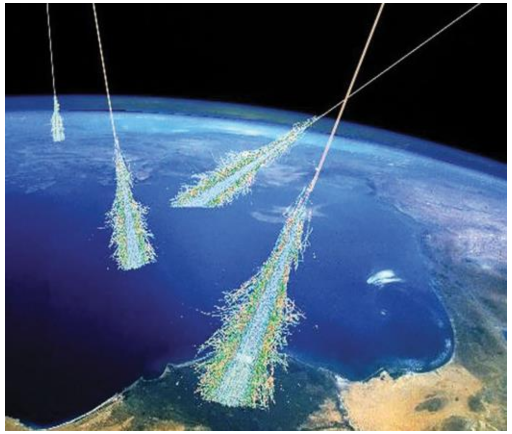
The 80% of solar influence on climate may not be caused solely by total solar irradiation forcing, but rather by other solar climate processes (e.g. cosmic rays).

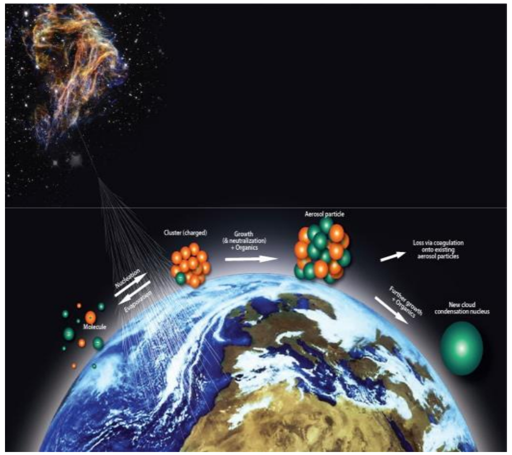
Scafetta, N.: Empirical assessment of the role of the Sun in climate change using balanced multi-proxy solar records. Geoscience Frontiers 14(6), 101650, 2023. Pagina Web: https://doi.org/10.1016/j.gsf.2023.101650

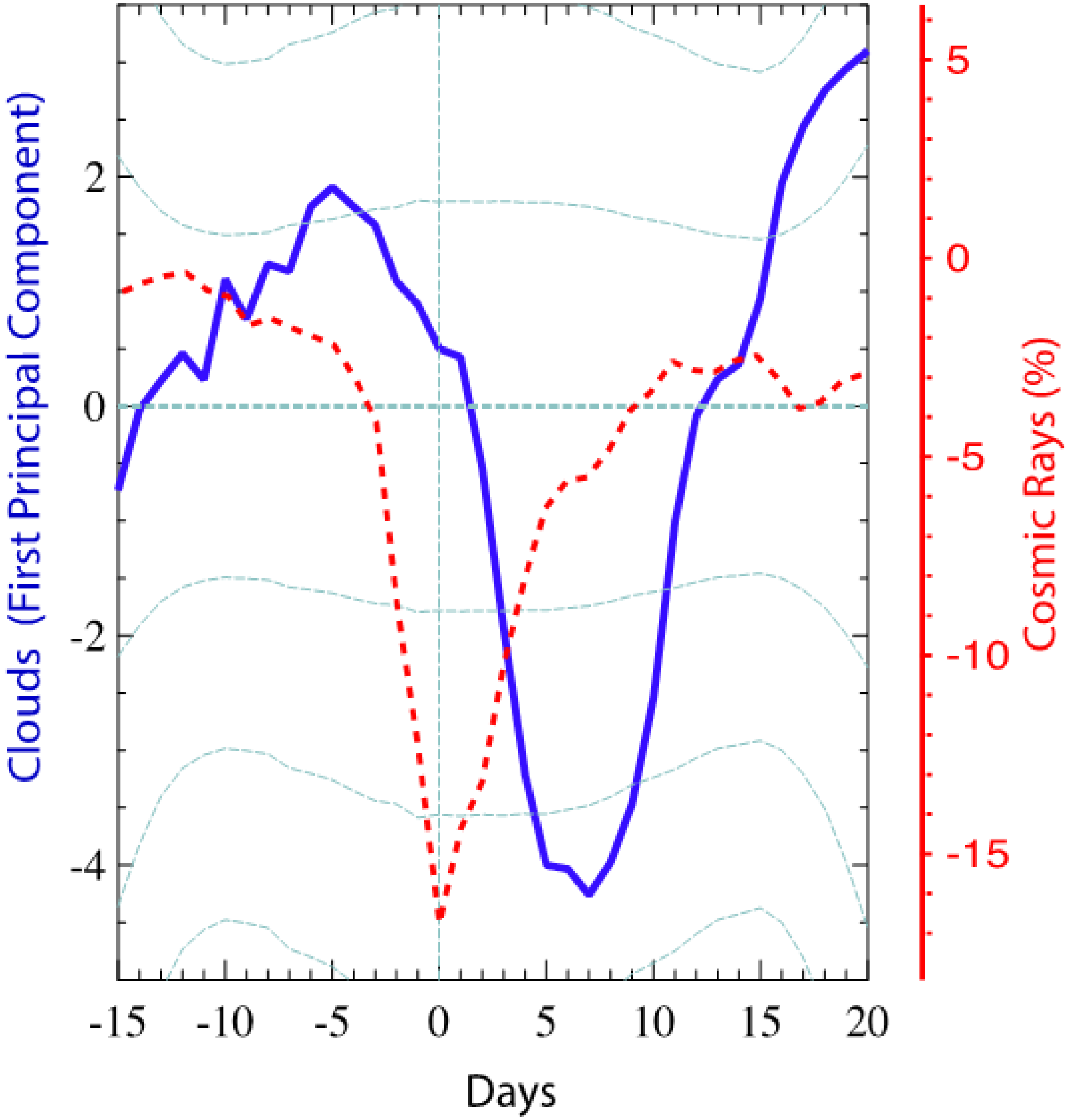


Forbush decreases: significant response is found in all studied aerosol and cloud data suggesting that cosmic ray ionization is important for cloud physics.









Svensmark, Enghoff, Shaviv, Svensmark, (2016). The response of clouds and aerosols to cosmic ray decreases. Journal of Geophysical Research: Space Physics 121 (9), 8152–8181.

“Realistic”
impacts and risks for the 21st century

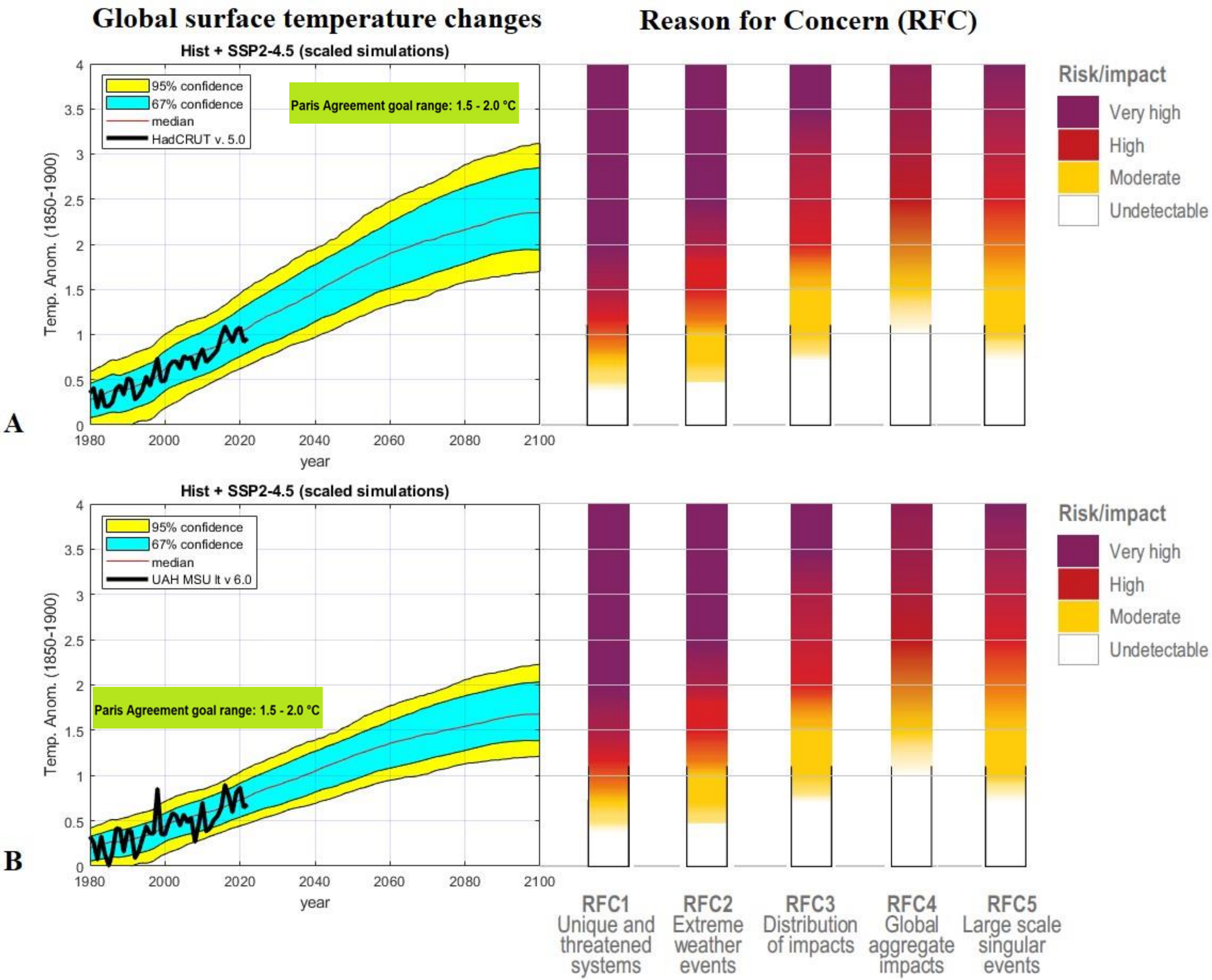
1) Low ECS Climate Models
2) Considering Urban Heat contaminations
3) Considering Natural/Solar variability

Impacts and risks of “realistic” global warming projections for the twenty-first century using the:

SSP2-4.5 scenario

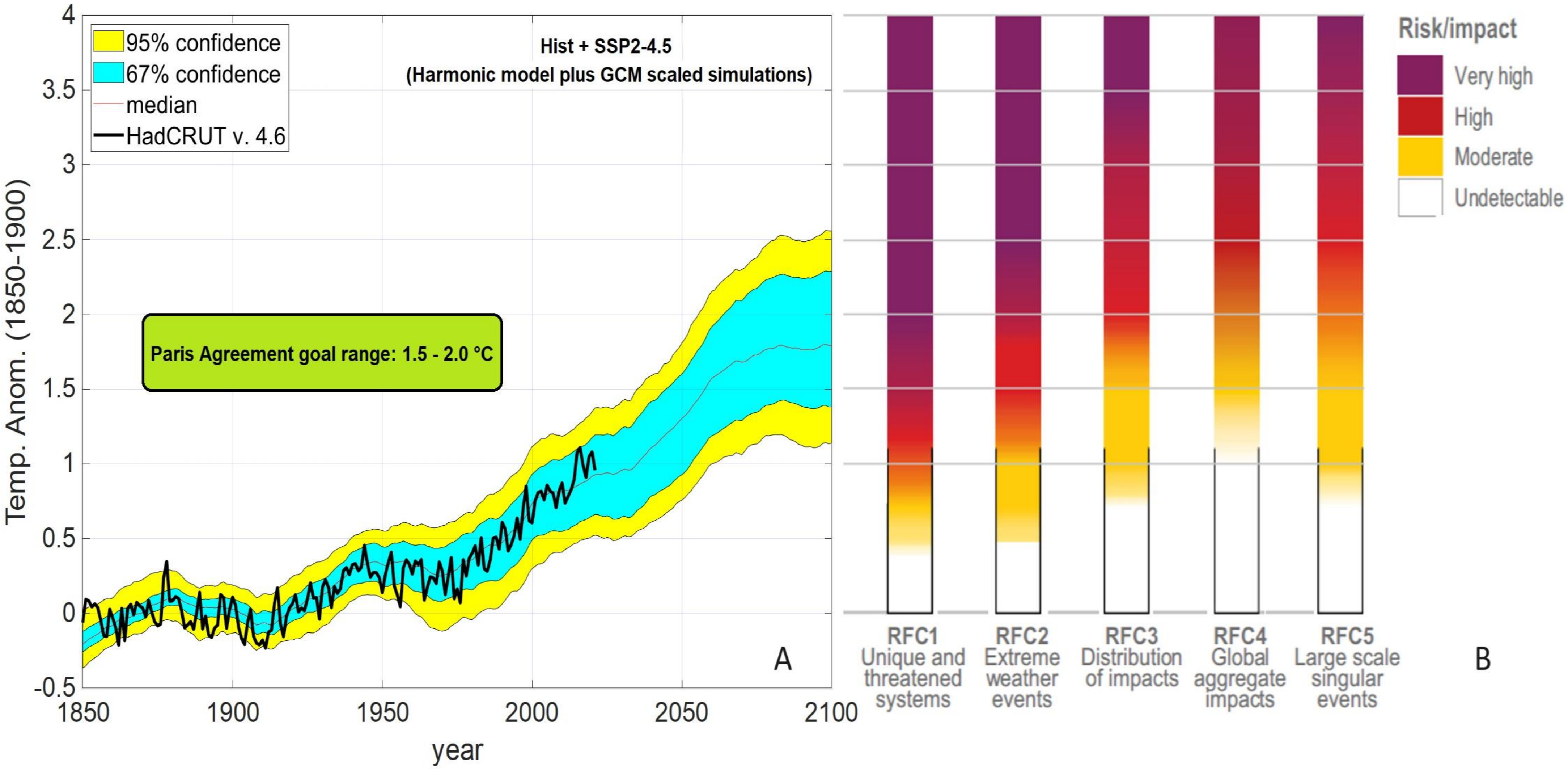
GCM optimization:

A) On the surface temperature records
B) On the lower troposphere temperature records

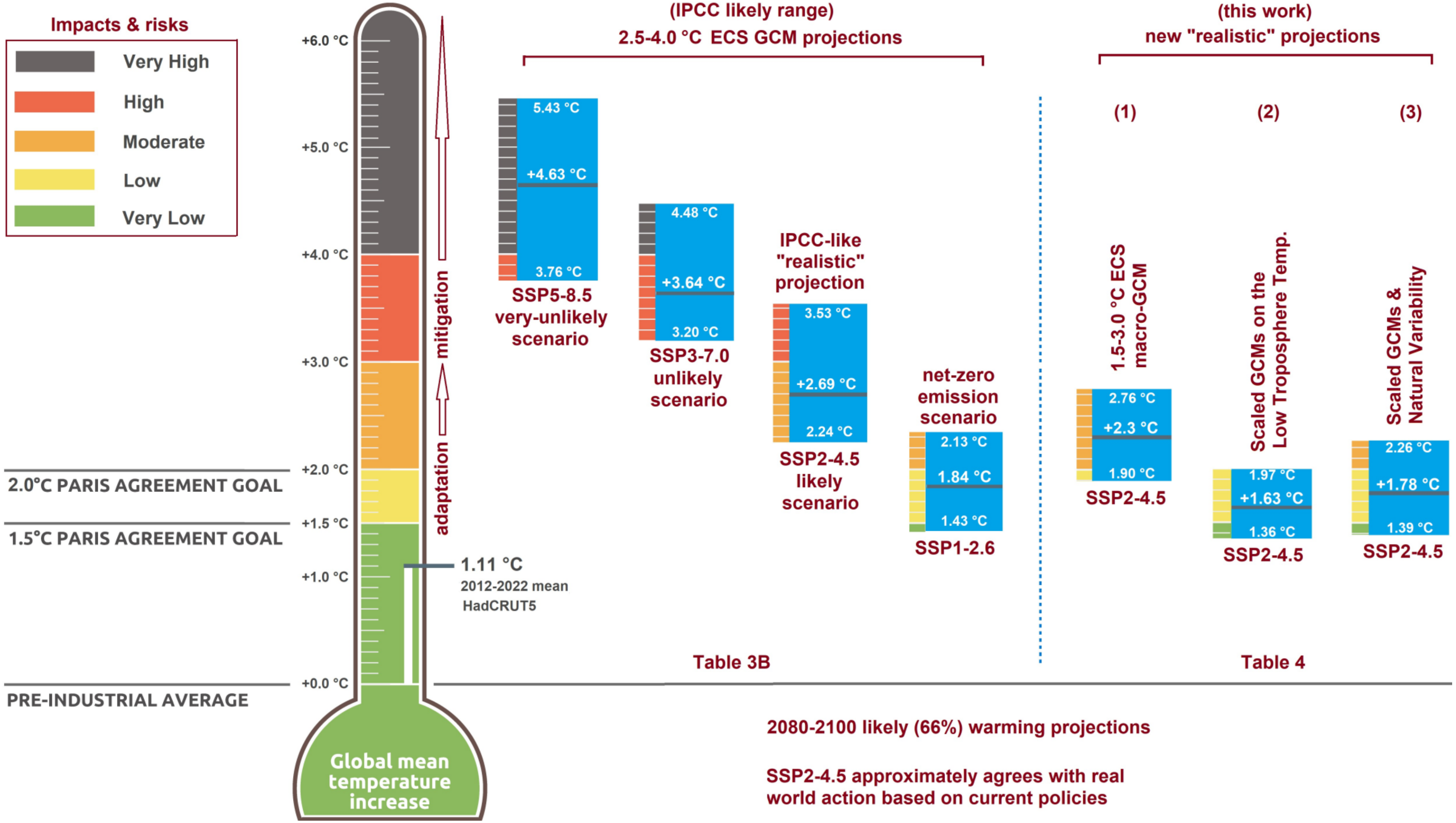


GCM optimization assuming natural variability non reproduced by the models

Scafetta, N., 2013. Discussion on climate oscillations: CMIP5 general circulation models versus a semi-empirical harmonic model based on astronomical cycles. Earth-Science Reviews 126, 321–357.

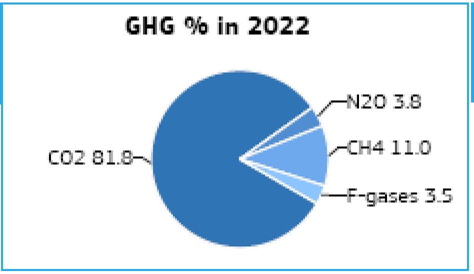


Conclusion:
Climate alarmism is not justified - **Net-zero is Unnecessary**

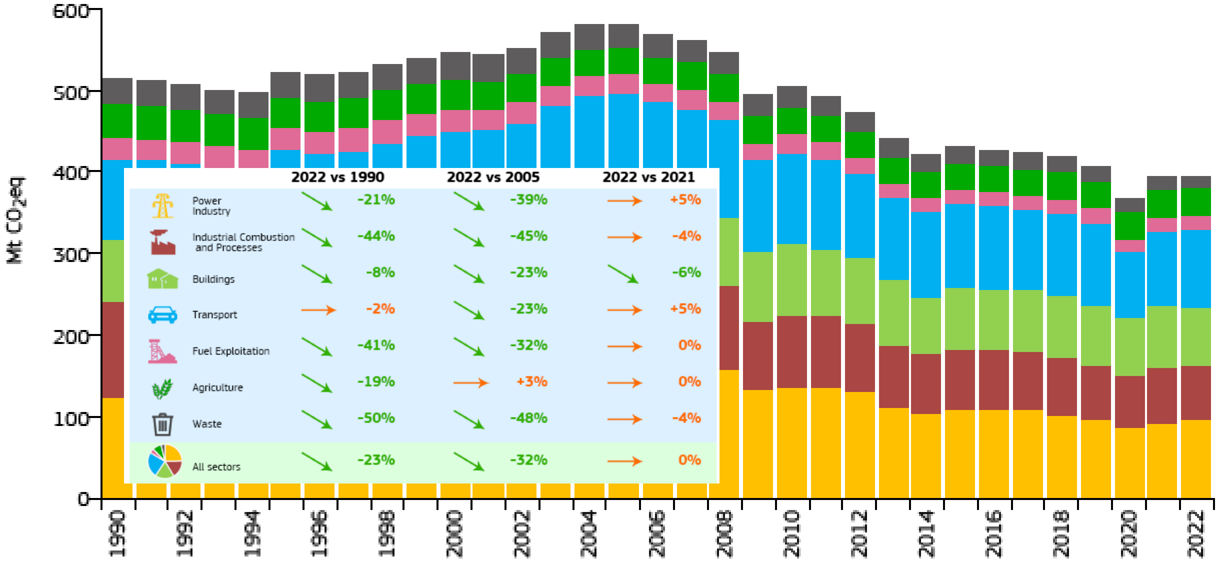


Economic Issues (hints)

Italy, San Marino and the Holy See

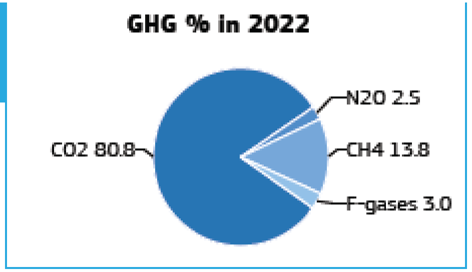


GHG emissions by sector

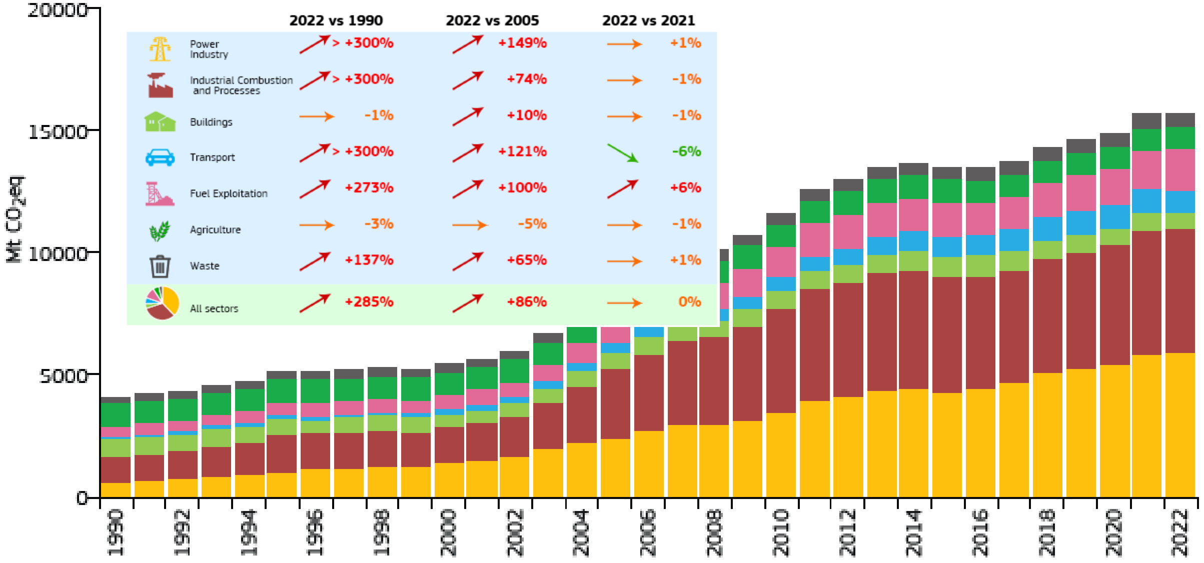


Year	GHG emissions Mt CO_2eq/yr	GHG emissions per capita t CO_2eq/cap/yr	GHG emissions per unit of GDP PPP t CO_2eq/kUSD/yr	Population
2022	394.748	6.698	0.153	58.937M
2015	430.297	7.231	0.176	59.504M
2005	580.427	9.870	0.226	58.809M
1990	513.738	8.993	0.248	57.127M

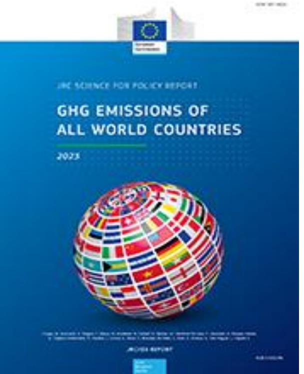
China



GHG emissions by sector

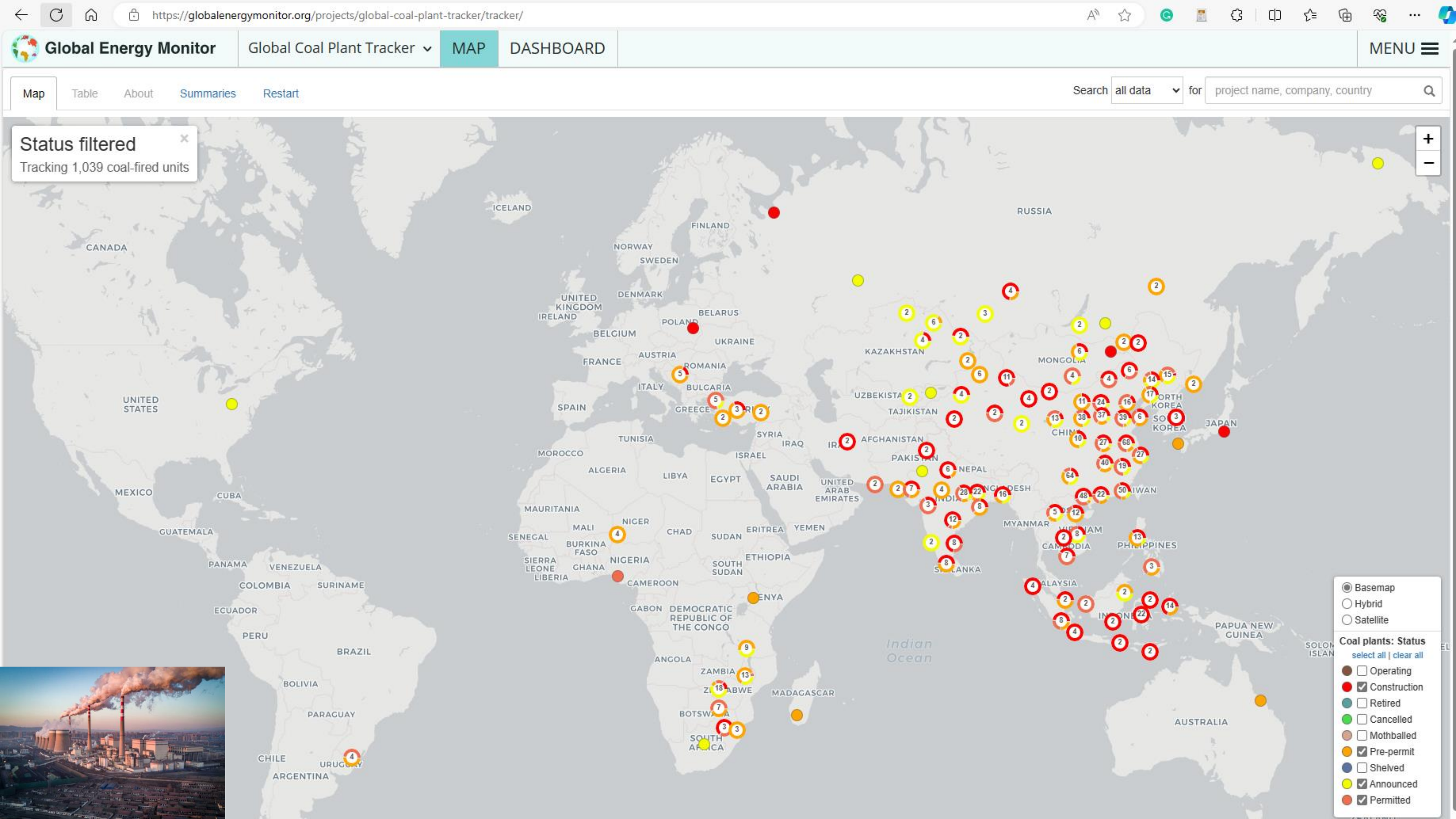


Year	GHG emissions Mt CO_2eq/yr	GHG emissions per capita t CO_2eq/cap/yr	GHG emissions per unit of GDP PPP t CO_2eq/kUSD/yr	Population
2022	15684.627	10.954	0.611	1.432G
2015	13479.880	9.649	0.775	1.397G
2005	8431.922	6.380	1.212	1.322G
1990	4073.563	3.474	2.520	1.172G

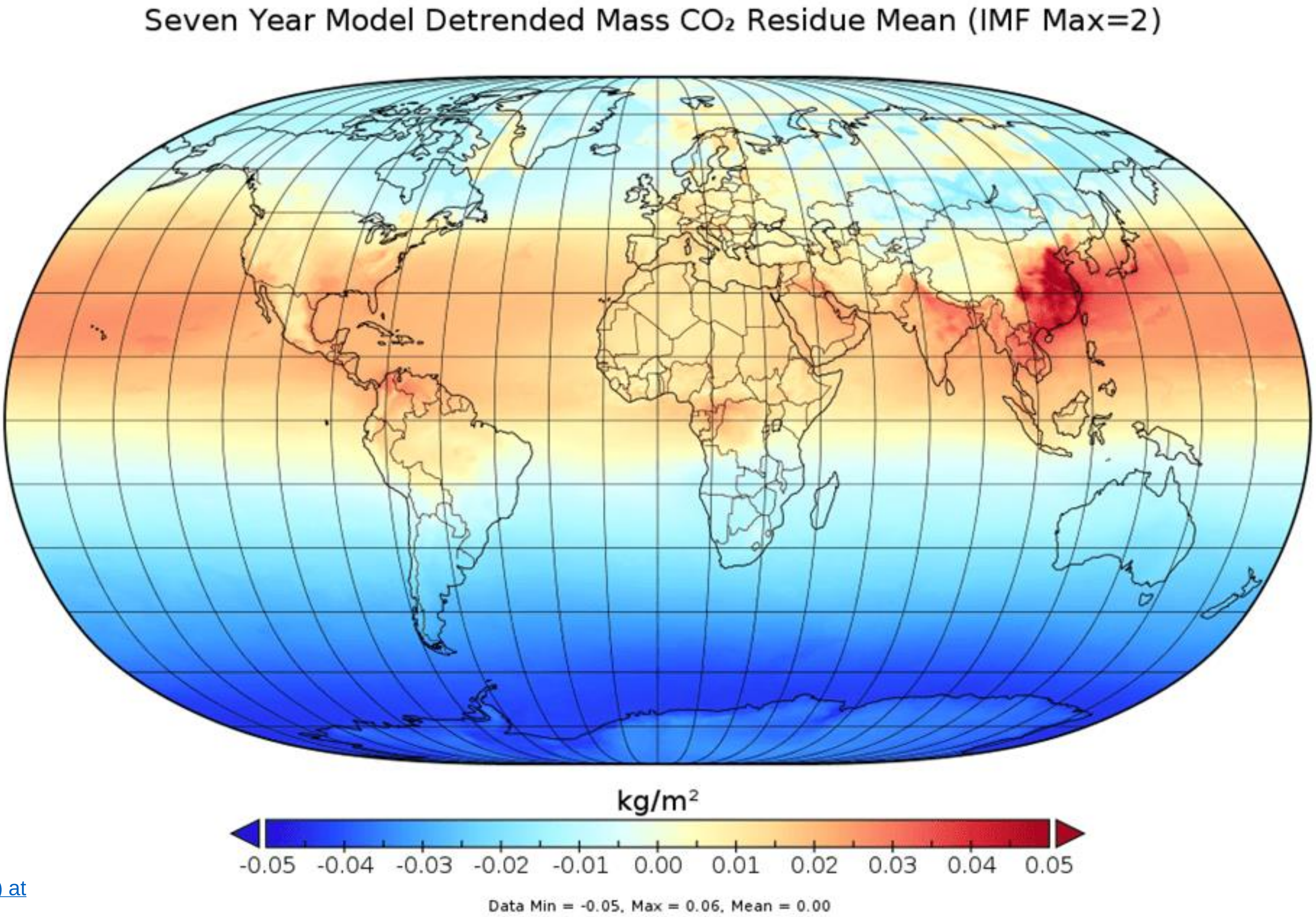


https://edgar.jrc.ec.eu
ropa.eu/report_2023

Country	1990	2000	2005	2015	2020	2021	2022	2022 %
unit	Mton CO_2eq	Mton CO_2eq	Mton CO_2eq	Mton CO_2eq	Mton CO_2eq	Mton CO_2eq	Mton CO_2eq	% World Tot
EU27	4915.14	4513.34	4597.10	3922.02	3427.44	3617.74	3587.80	6.67
China	4073.56	5425.51	8431.92	13479.88	14879.56	15632.89	15684.63	29.16
Italy, San Marino and the Holy See	513.74	545.78	580.43	430.30	367.41	392.96	394.75	0.73


https://globalenergymonitor.org/projects/global-coal-plant-tracker/tracker/
Global Energy Monitor
Global Coal Plant Tracker
MAP
DASHBOARD
MENU
Map
Table
About
Summaries
Restart
Search all data for project name, company, country
Status filtered
Tracking 1,039 coal-fired units
CANADA
UNITED STATES
MEXICO
CUBA
GUATEMALA
PANAMA
VENEZUELA
COLOMBIA
SURINAME
ECUADOR
PERU
BRAZIL
BOLIVIA
PARAGUAY
CHILE
ARGENTINA
ICELAND
NORWAY
SWEDEN
FINLAND
UNITED KINGDOM
IRELAND
DENMARK
BELGIUM
FRANCE
SPAIN
POLAND
BELARUS
UKRAINE
AUSTRIA
ITALY
ROMANIA
BULGARIA
GREECE
RUSSIA
KAZAKHSTAN
UZBEKISTAN
TAJIKISTAN
AFGHANISTAN
MONGOLIA
CHINA
NORTH KOREA
SOUTH KOREA
JAPAN
TAIWAN
NEPAL
INDIA
MYANMAR
CAMBODIA
PHILIPPINES
MALAYSIA
INDONESIA
PAPUA NEW GUINEA
AUSTRALIA
SRI LANKA
MOROCCO
ALGERIA
TUNISIA
LIBYA
EGYPT
ISRAEL
SYRIA
IRAQ
SAUDI ARABIA
UNITED ARAB EMIRATES
YEMEN
MAURITANIA
MALI
NIGER
CHAD
SUDAN
SENEGAL
BURKINA FASO
SIERRA LEONE
LIBERIA
GHANA
NIGERIA
CAMEROON
ERITREA
ETHIOPIA
SOUTH SUDAN
GABON
DEMOCRATIC REPUBLIC OF THE CONGO
KENYA
ANGOLA
ZAMBIA
MADAGASCAR
BOTSWANA
SOUTH AFRICA
Indian Ocean
Basemap
Hybrid
Satellite
Coal plants: Status
select all | clear all
Operating
Construction
Retired
Cancelled
Mothballed
Pre-permit
Shelved
Announced
Permitted

Mean of detrended CO2 concentration residue from 2015 to the end of 2019.



[OCO-2 GEOS Level 3 monthly, 0.5x0.625 assimilated CO2 V10r (OCO2_GEOS_L3CO2_MONTH) at GES DISC (nasa.gov)]

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COSTS AND BENEFITS OF THE PARIS CLIMATE TARGETS

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The temperature targets in the Paris Agreement cannot be met without very rapid reduction of greenhouse gas emissions and removal of carbon dioxide from the atmosphere. The latter requires large, perhaps prohibitively large subsidies. The central estimate of the costs of climate policy, unrealistically assuming least-cost implementation, is 3.8–5.6% of GDP in 2100. The central estimate of the benefits of climate policy, unrealistically assuming high no-policy emissions and constant vulnerability, is 2.8–3.2% of GDP. The uncertainty about the benefits is larger than the uncertainty about the costs. The Paris targets do not pass the cost-benefit test unless risk aversion is high and discount rate low.

Keywords: Climate policy; net-zero; cost-benefit analysis.

JEL Code: Q54

Benefits assuming worst-case-global warming based on SSP5-8.5

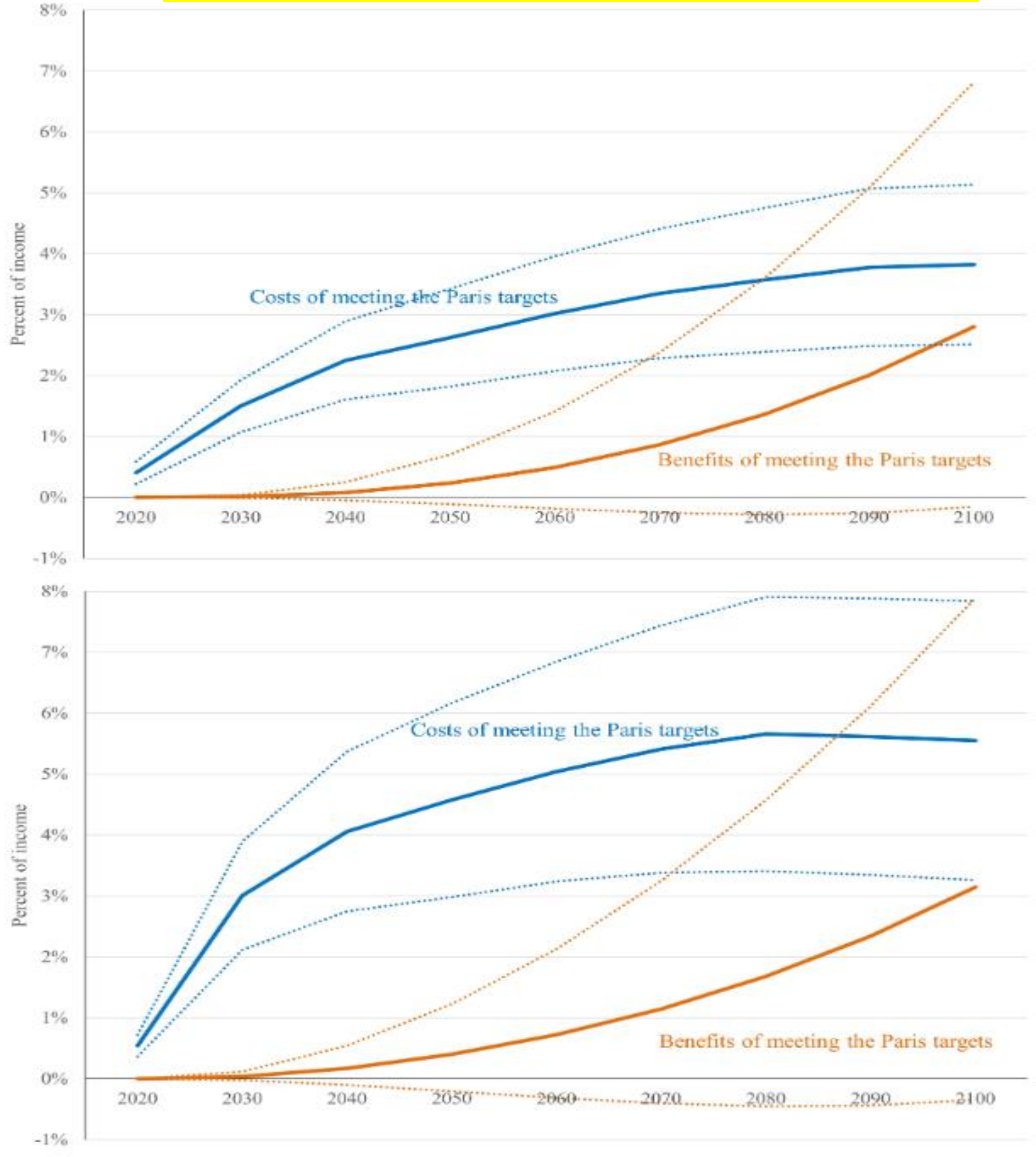

Figure 4. Costs and benefits of meeting the Paris targets of 2.0°C (top panel) and 1.5°C (bottom) global warming.

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Net zero climate remediations and potential terminal depletion of global critical metal resources: A synoptic geological perspective

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ABSTRACT

Over the past two decades, concerns about anthropogenic CO_2 emissions have led to computer-based climate models of the consequences, first on global warming and then on more general climate change. The more extremes of these models have been used to engender concerns about climate events that could be catastrophic for global populations even though natural climate change has always been incremental with only periodic large volcanic eruptions producing short-term catastrophic changes due to massive additions of aerosols to the atmosphere. Climate change accords have led to widespread acceptance of Net Zero by 2060 targets. However, indicative modelling of the nexus between clean energy and the critical metals required for low carbon solar and wind technologies and electric vehicles and their chargers indicates that many metals, particularly Co, Ni, Cu, Se, Ag, Cd, In, Te, and Pt, may be severely to terminally depleted by 2060, making further low carbon technology production impossible. Mineral exploration and currently unmined deposits with high risk factors are only likely to be able to replace these non-renewable metals at lower grades in more inaccessible or deeper mines, leading to even further increases in conventional energy for mining and metallurgy and consequent cost of the low carbon technology revolution. There is no current indication that recycling can replace the critical metal stocks. The heterogeneous global distribution of both mineral deposits containing the critical metals and production points could become a geopolitical issue if global security declines. These factors combined with the slow incremental, rather than catastrophic, changes related to climate change, suggest that a reset in Net Zero ambitions should be made to consider a more multicomponent plan for the future that involves a balanced portfolio of least polluting energy sources that do not cause serious depletion of affordable metal resources for the future.

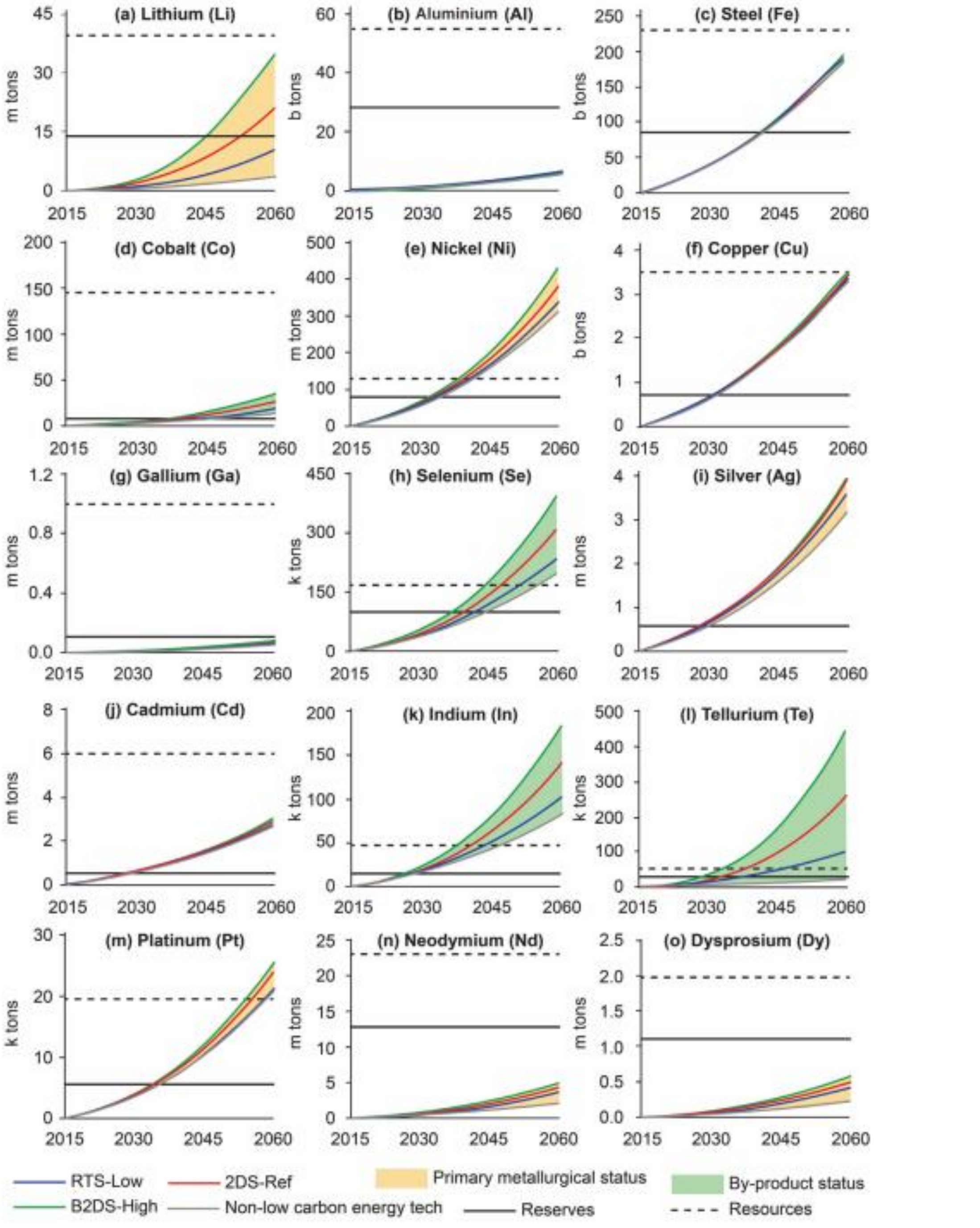


Fig. 4. Estimated cumulative demand for uses of all critical metals ordered in terms of increasing atomic number used in low carbon technologies from 2016 to 2060. Curves coloured orange to indicate primary metallurgical status of metal and green to indicate by-product status of metal. Adapted from Watari et al. (2018).

“Dora” The Italian electric car (1906)

Are electric cars the future?

Well, invented in the 19th century....

Electric cars remained popular until advances in internal-combustion engine (ICE) cars and mass production of cheaper gasoline- and diesel-powered vehicles, especially the Ford Model T, led to a decline.[32] ICE cars' much quicker refueling times and cheaper production-costs made them more popular. However, a decisive moment came with the introduction in 1912 of the electric starter motor[40] that replaced other, often laborious, methods of starting the ICE, such as hand-cranking.

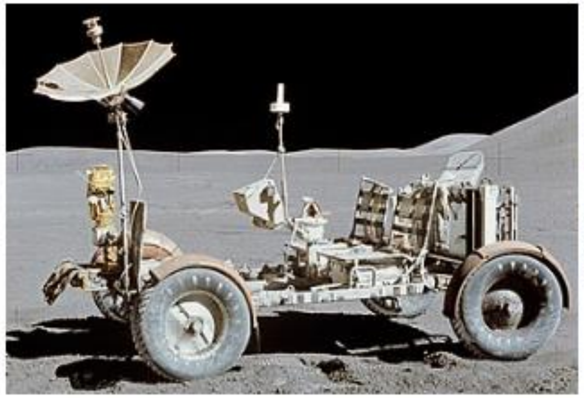
Gustave Trouvé's personal electric vehicle (1881), the world's first publicly presented full-scale electric car powered by an improved Siemens motor

World's first trolleybus by Werner von Siemens, Berlin 1882

The Flocken Elektrowagen (1888) was the first four-wheeled electric car in the world[41]

Early electric car built by Thomas Parker - photo from 1895[42]

"La Jamais Contente", 1899



NASA's Lunar Roving Vehicles were battery-driven

The General Motors EV1, one of the cars introduced due to a California Air Resources Board (CARB) mandate, had a range of 260 km (160 miles) with NiMH batteries in 1999.

https://en.wikipedia.org/wiki/Electric_car