Scientific challenges of the "detection and attribution of global warming"

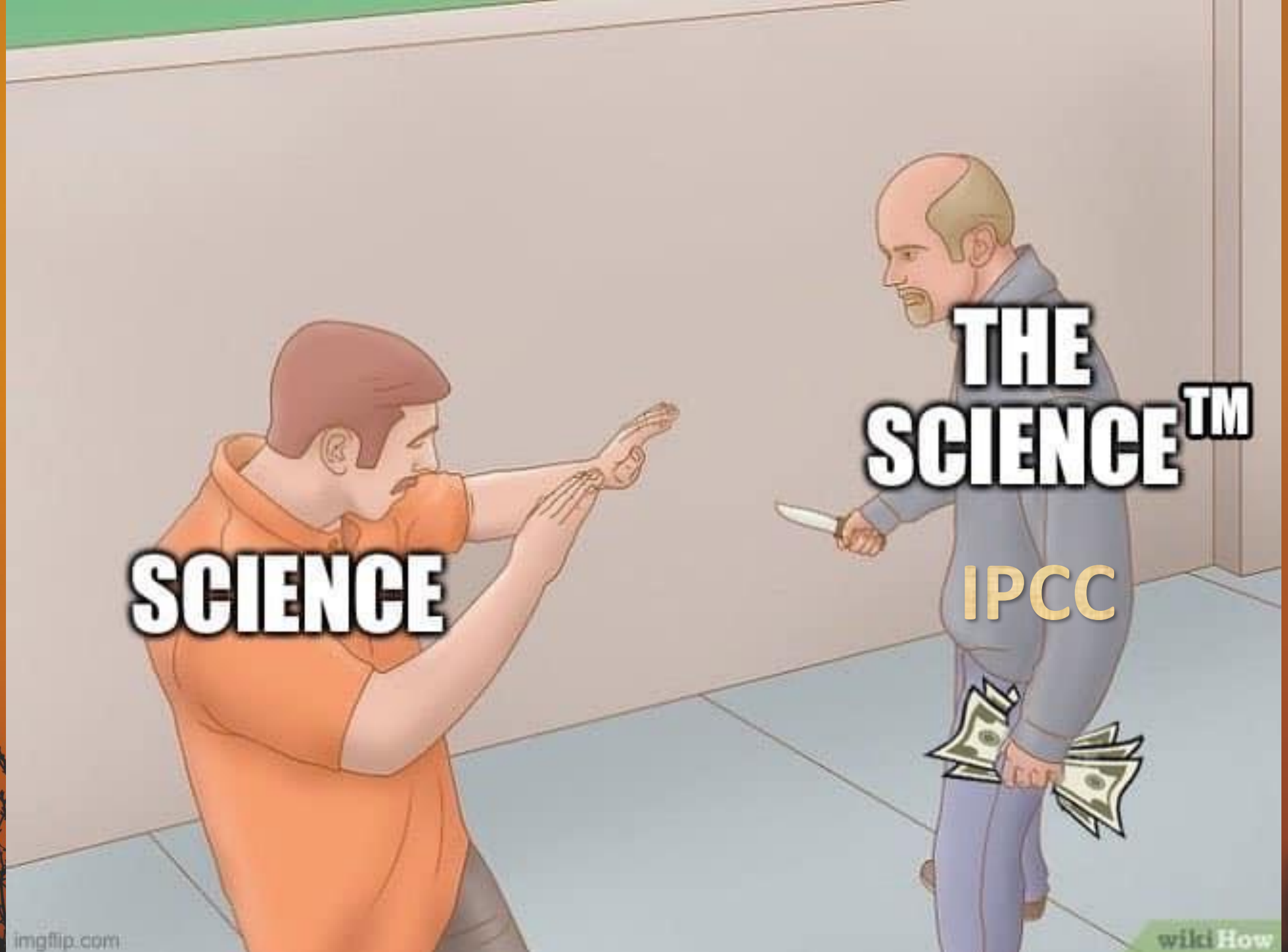
by Dr. Michael Connolly, Dr. Ronan Connolly and Dr. Willie Soon

Center for Environmental Research and Earth Sciences

(www.ceres-science.com)

June 18, 2024

CLINTEL Climate Conference, Roelofarendsveen, The Netherlands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The Sun-Climate Puzzle?

Art works by Charles Rotter (March 10, 2024)

Outline of this presentation

1. The **UN panel's** approach to "**the detection and attribution of global warming**"
2. Problems in the UN's "**detection**" approach:
   - Underestimating the extent of the urban heat island problem
   - Problems with current "temperature homogenization" approach
3. Our **rural-only** Northern Hemisphere land temperature record
4. Other non-urbanized temperature series (**oceans**, **tree-rings**, **glaciers**)
5. Problems with the UN's "**attribution**" approach:
   - UN's "radiative forcings" underestimate the role of natural climate change
6. Trying to better answer how solar activity has changed since 1850
   - Different aspects of solar activity
   - Changes in solar activity during satellite era
   - Using solar proxies to reconstruct solar activity in the past
7. 27 different estimates of solar activity changes since 1850
8. Our **latest** detection and attribution results
9. How well can we measure Earth's Energy Budget?
10. Conclusions

The UN Intergovernmental Panel on Climate Change (IPCC)

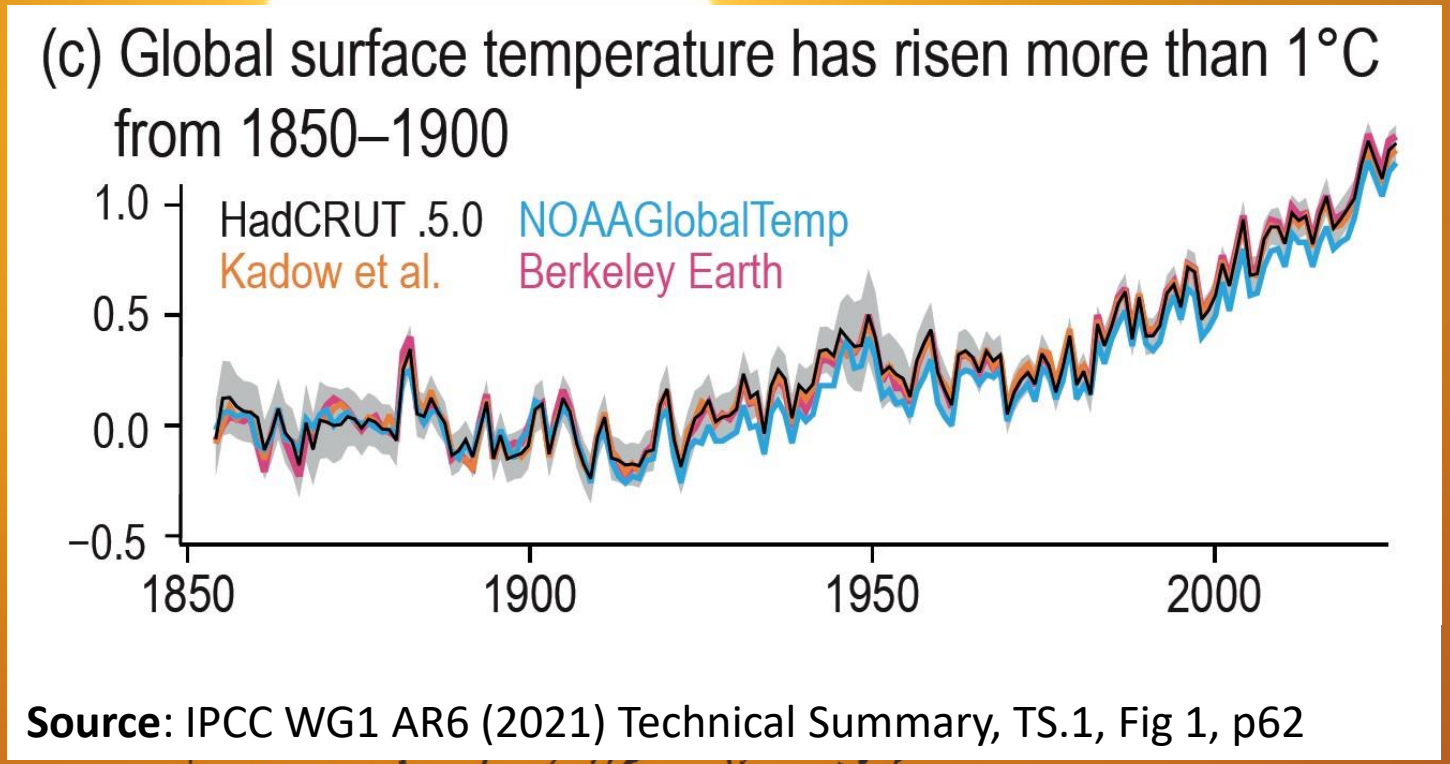
- "Created in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the objective of the IPCC is to provide governments at all levels **with scientific information that they can use to develop climate policies**." - https://www.ipcc.ch/about/

- They have so far published 6 Assessment Reports (AR for short):
  - AR1 (1990); AR2 (1995); AR3 (2001); AR4 (2007); AR5 (2013); AR6 (2021)

- **Most iconic statement**: *The observed global warming since **at least** 1950s is mostly human-caused and also unprecedented*.

- How did they reach this conclusion? And is it scientifically justified?

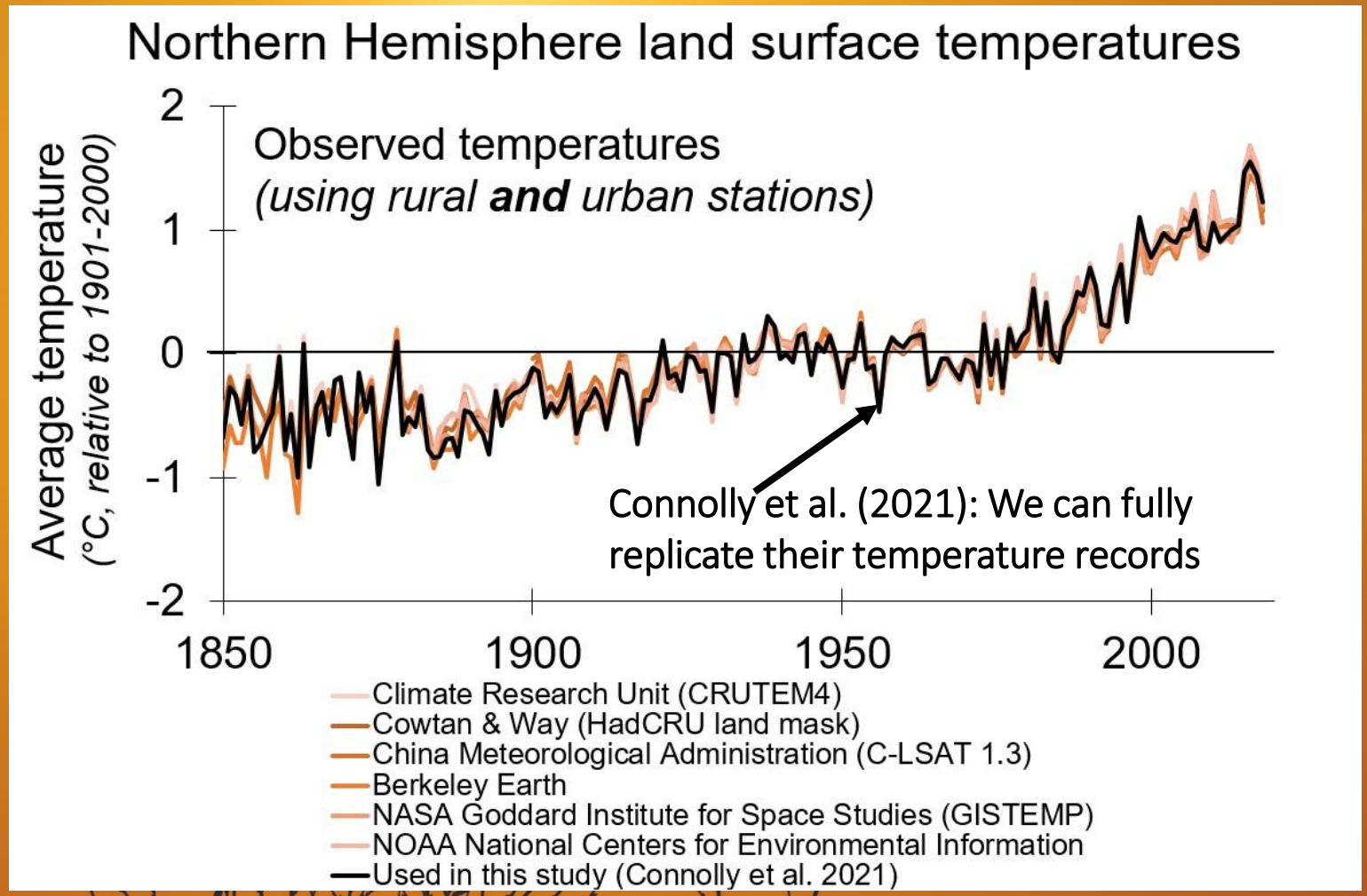
The IPCC's approach: Detection



Source: IPCC WG1 AR6 (2021) Technical Summary, TS.1, Fig 1, p62

IPCC's "Detection" of global warming

- IPCC compiled several "**global surface temperature anomaly**" time series (1850-2020)
- All of them show an almost continuous "global warming" of 1°C since the 19th century



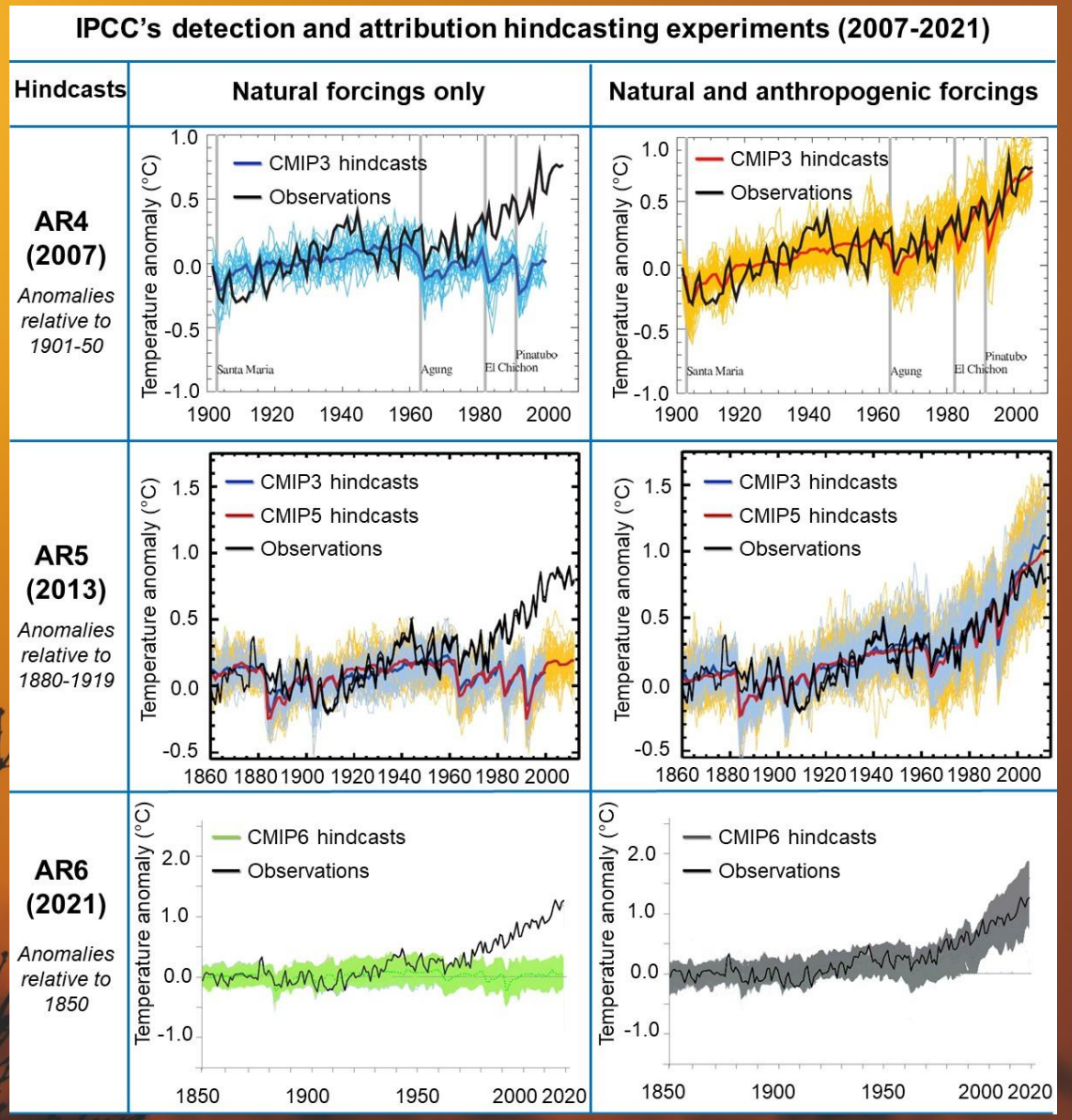
- Nonetheless, by averaging together all the available records for each year, you can generate graphs like the above!
- The warming shown by these time series is called “global warming”

"No recent literature has emerged to alter the AR5 finding that it is unlikely that any uncorrected effects from urbanization […], or from changes in land use or land cover […], have raised global Land Surface Air Temperature (LSAT) trends by more than 10%, although larger signals have been identified in some specific regions, especially rapidly urbanizing areas such as eastern China."

—AR6 (2021), Chapter 2, pp. 43–44

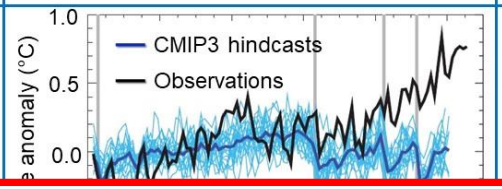
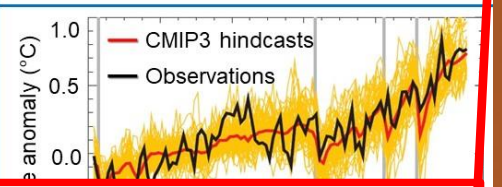
The IPCC's approach: Attribution

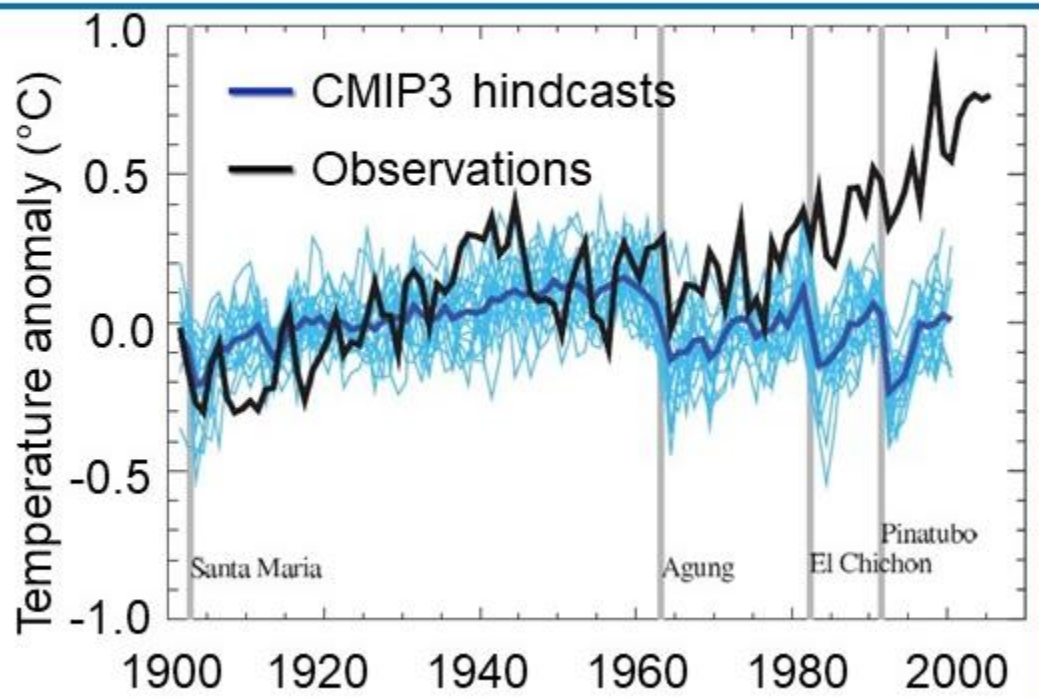
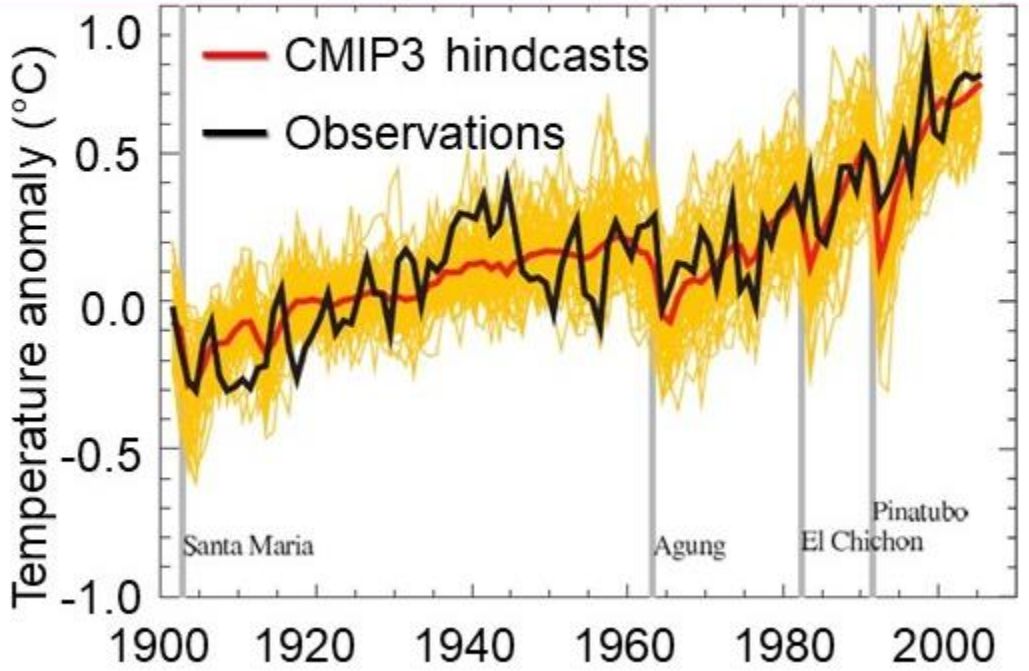
- The IPCC's "attribution" statements are based on comparing the "observed" temperature record to computer model "**hindcasts**".
- A computer model "hindcast" is the opposite of a "forecast" – what the model says **should** have happened in the past.
- When the hindcasts use only natural factors (sun & volcanoes), they can't explain the warming after 1950. But, when they add in anthropogenic ("human-caused") factors, they can.
- Their conclusion: "it's mostly human-caused"!



The IPCC's approach: Attribution

IPCC's detection and attribution hindcasting experiments (2007-2021)

Hindcasts	Natural forcings only	Natural and anthropogenic forcings
AR4 (2007)		

Hindcasts	Natural forcings only	Natural and anthropogenic forcings
AR4 (2007) *Anomalies relative to 1901-50*		

The IPCC's approach: Attribution

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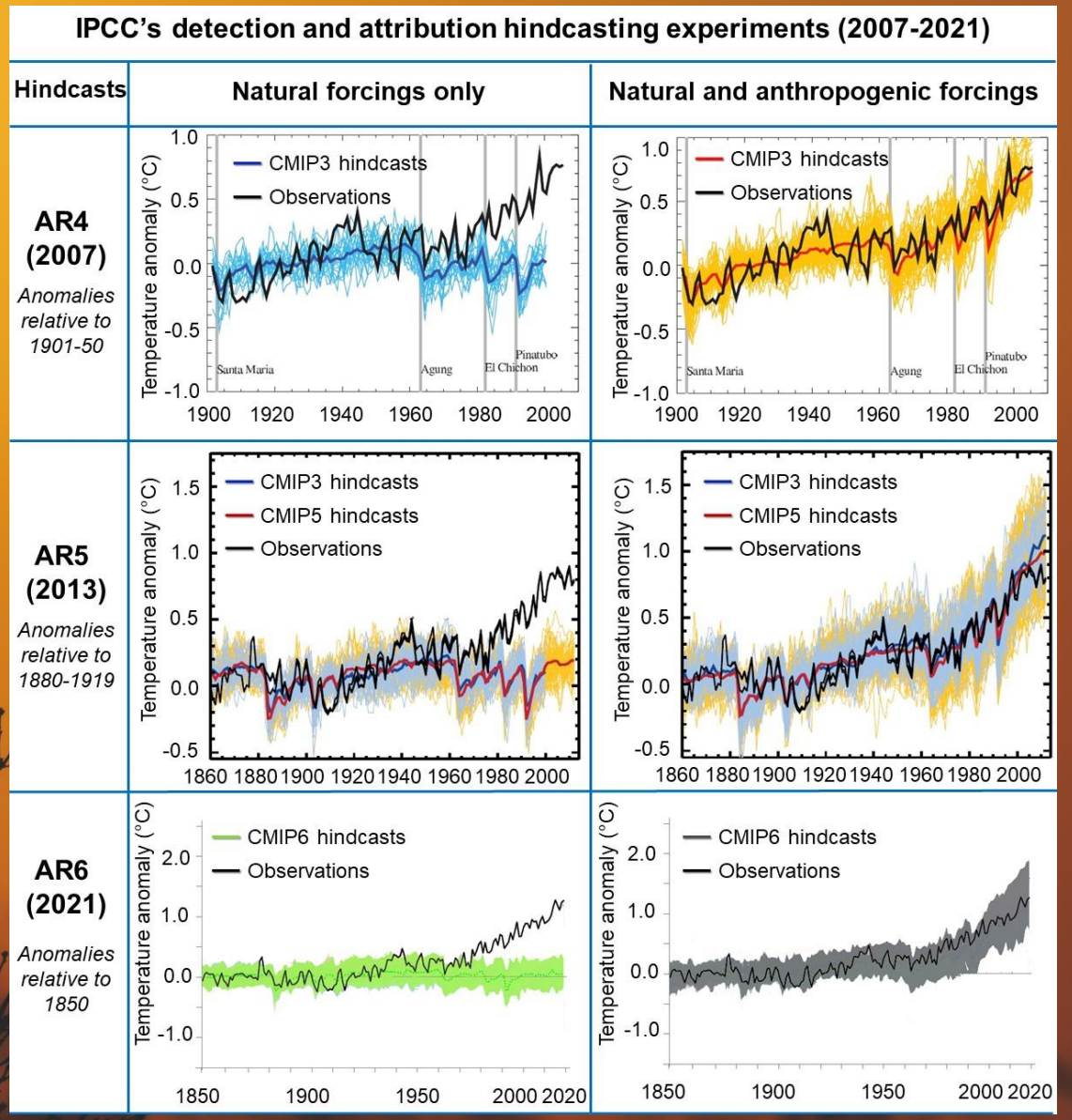
- Their conclusion: "it's mostly human-caused"!



What is involved in the sausage making of a climate model?

Willis Eschenbach (May 13, 2024):

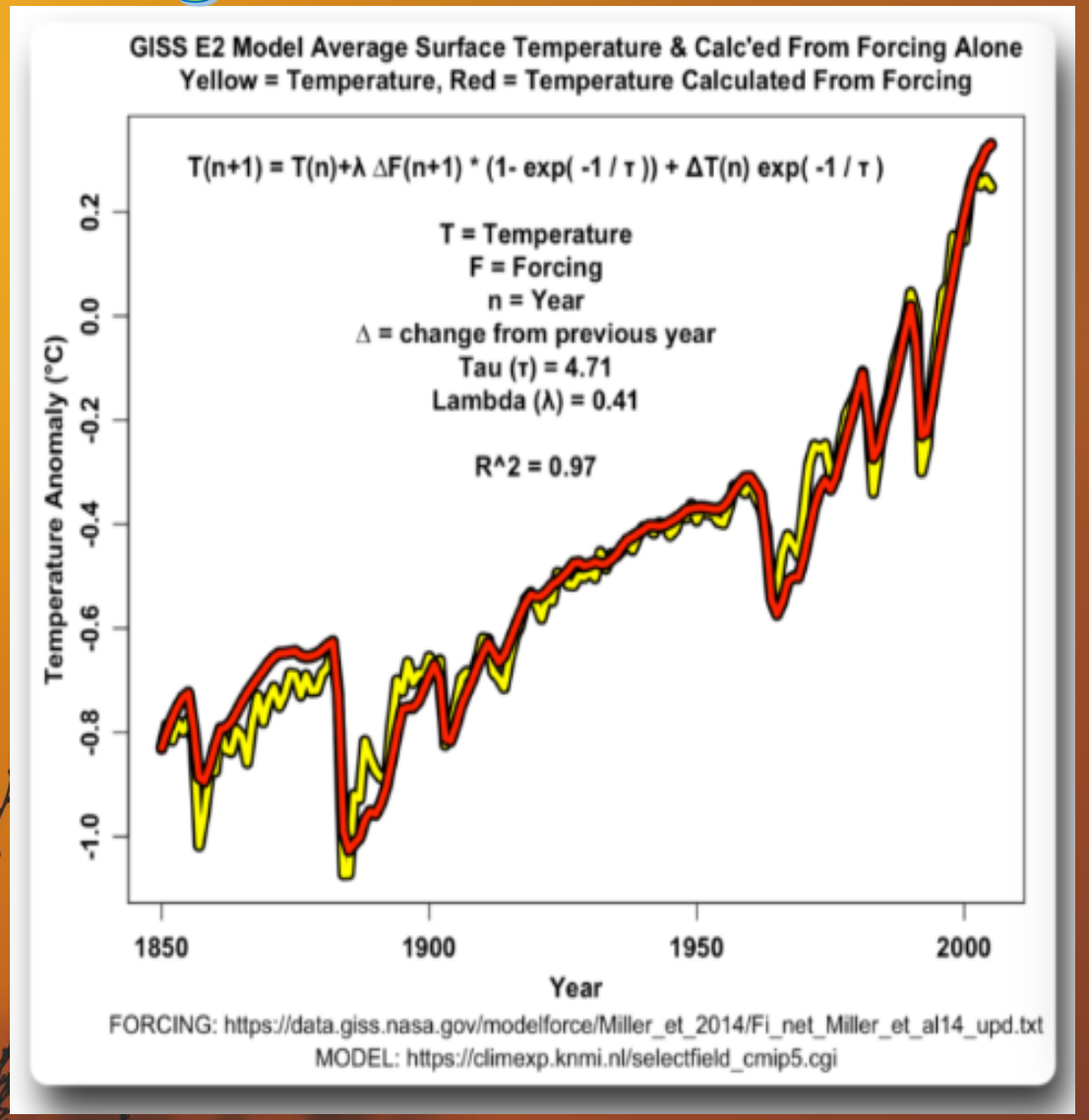
"I wanted to see if the CMIP5 modeled temperatures slavishly follow the forcings. Thirteen years ago (2011), I showed that the temperature output of the CCSM3 climate model could be very closely emulated by a simple one-line formula, viz:

$$T(n+1) = T(n) + \lambda\, \Delta F(n+1) * (1- \exp(-1 / \tau)) + \Delta T(n) * \exp(-1 / \tau)$$

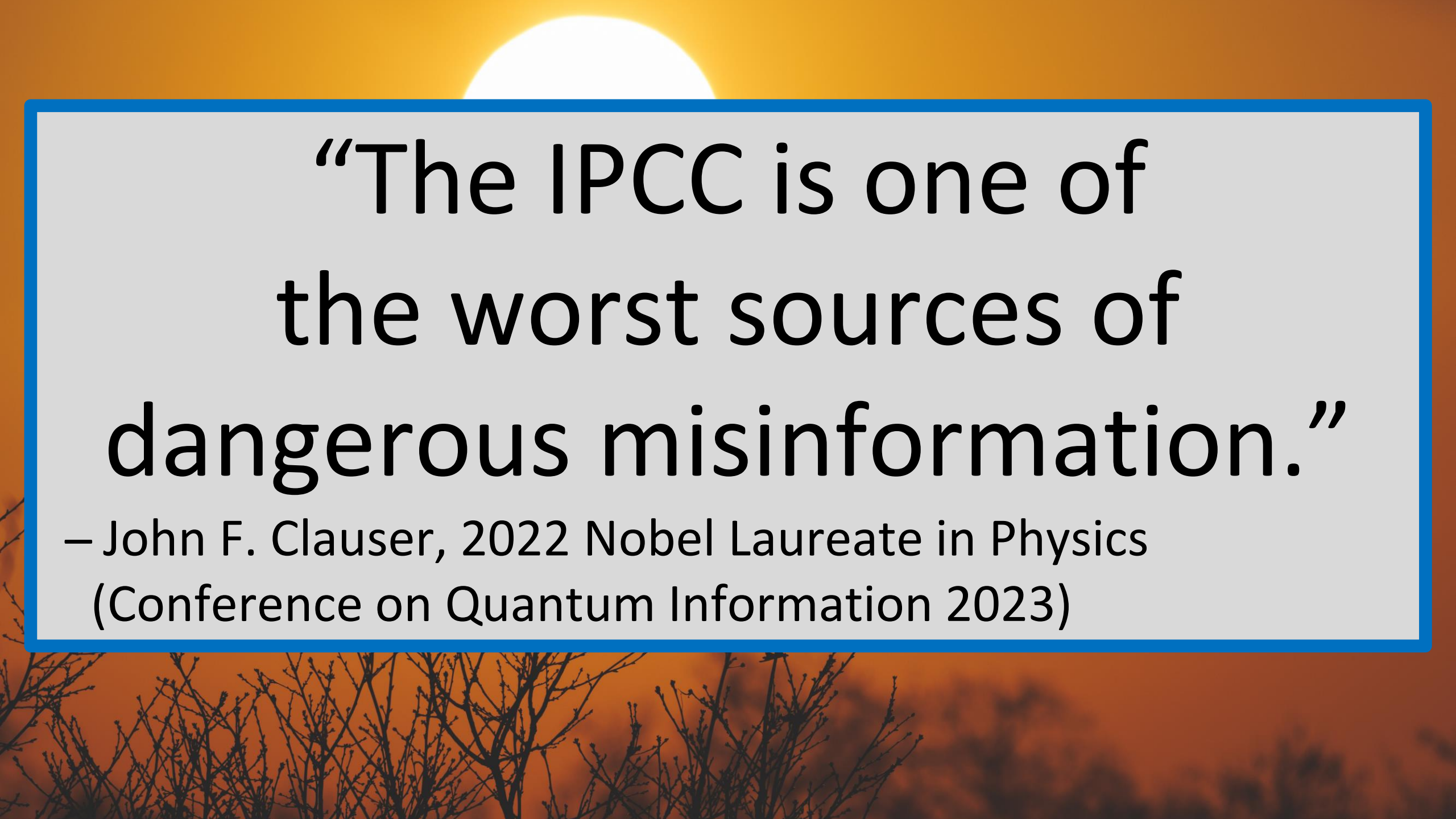
So I used that formula, to see how well I could emulate the temperature output using nothing but the forcing applied to the model. Here's the result: Shown to the right.

***In any case, to recap the bidding:** The GISS-E2 climate model has 440,000+ lines of code. It has over two million gridcells representing the world, and it takes a whole day to do just one model run on a parallel-processing computer with 88 processors.*

And after all that, it merely spits out a lagged and resized version of the input forcing."



Source: Willis Eschenbach, May 13, 2024: https://wattsupwiththat.com/2024/05/13/modeling-the-mysteries/


“The IPCC is one of the worst sources of dangerous misinformation.”
– John F. Clauser, 2022 Nobel Laureate in Physics (Conference on Quantum Information 2023)

Is the IPCC's analysis scientifically justified?

We have published a number of papers since AR5 highlighting at least two major problems with their "detection and attribution" modelling experiments:

1. The land component of their global temperature record ("observations") is contaminated by "**urbanization bias**" due to the "**urban heat island**" (**UHI** for short) effect.

2. Their estimates for the changes in solar activity ("**Total Solar Irradiance**" or **TSI** for short) are **only a small subset** of those used by the scientific community. And, this subset coincidentally only comprises "**low variability**" reconstructions that imply a negligible solar contribution.

Our relevant papers on the challenges of the detection and attribution of global warming

1. **S2015**: Soon, Connolly & Connolly (**2015**). *Earth-Science Reviews*, 150, 409-452. https://doi.org/10.1016/j.earscirev.2015.08.010.
2. **C2017**: Connolly, Connolly & Soon (**2017**). *Hydrological Sciences Journal*, 62, 1317-1340. https://doi.org/10.1080/02626667.2017.1324974.
3. **S2018**: Soon and 7 co-authors (**2018**). *Earth-Science Reviews*, 185, 80-101. https://doi.org/10.1016/j.earscirev.2018.05.013.
4. **S2019**: Soon and 7 co-authors (**2019**). *Earth-Science Reviews*, 189, 102950. https://doi.org/10.1016/j.earscirev.2019.102950.
5. **C2020**: Connolly and 3 co-authors (**2020**). *Energies*, 13, 1365. https://doi.org/10.3390/en13061365.
6. **C2021**: Connolly and 22 co-authors (**2021**). *Research in Astronomy and Astrophysics*, 21, 131. https://doi.org/10.1088/1674-4527/21/6/131.
7. **O'N2022**: O'Neill and 16 co-authors (**2022**). *Atmosphere*, 13(2), 285. https://doi.org/10.3390/atmos13020285.
8. **K2023**: Katata, Connolly & O'Neill (**2023**). *Journal of Applied Meteorology and Climatology*. 62(8), 1095-1114. https://doi.org/10.1175/JAMC-D-22-0122.1.
9. **C2023**: Connolly and 19 co-authors (**2023**). *Research in Astronomy and Astrophysics*. https://doi.org/10.1088/1674-4527/acf18e.
10. **S2023**: Soon and 36 co-authors (**2023**). *Climate*, 11(9), 179; https://doi.org/10.3390/cli11090179.

Connolly et al. (2021): IPCC AR6 said our paper was 11 weeks too late for them

RAA 2021 Vol. **21** No. **6**, 131(68pp) doi: 10.1088/1674-4527/21/6/131
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http://www.raa-journal.org *http://iopscience.iop.org/raa*

Research in Astronomy and Astrophysics

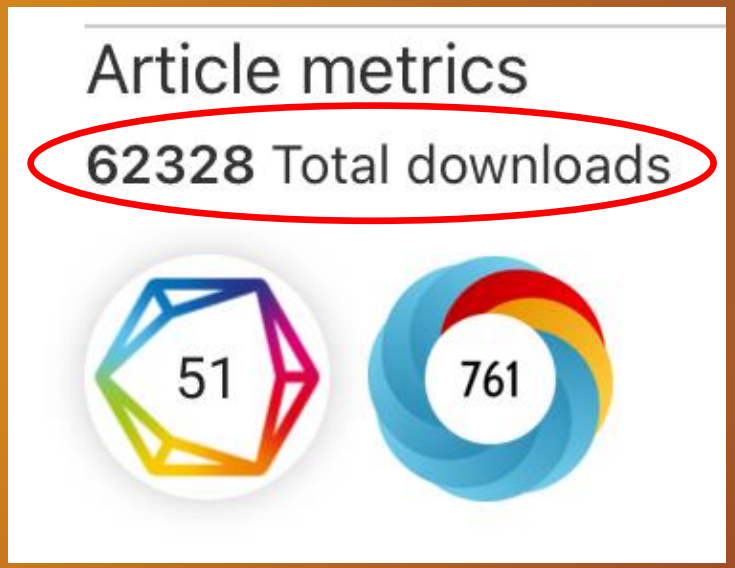
INVITED REVIEWS

How much has the Sun influenced Northern Hemisphere temperature trends? An ongoing debate.

Ronan Connolly[1,2], Willie Soon[1], Michael Connolly[2], Sallie Baliunas[3], Johan Berglund[4], C. John Butler[5], Rodolfo Gustavo Cionco[6,7], Ana G. Elias[8,9], Valery M. Fedorov[10], Hermann Harde[11], Gregory W. Henry[12], Douglas V. Hoyt[13], Ole Humlum[14], David R. Legates[15], Sebastian Lüning[16], Nicola Scafetta[17], Jan-Erik Solheim[18], László Szarka[19], Harry van Loon[20], Víctor M. Velasco Herrera[21], Richard C. Willson[22], Hong Yan (鄢杆畯)[23] and Weijia Zhang[24,25]

1 Center for Environmental Research and Earth Science (CERES), Salem, MA 01970, USA; *ronan@ceres-science.com*
2 Independent scientists, Dublin, Ireland
3 Retired, formerly Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA
4 Independent researcher, Malmö, Sweden
5 Retired, formerly Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland, UK
6 Comisión de Investigaciones Científicas de la Provincia de Buenos Aires, Argentina
7 Grupo de Estudios Ambientales, Universidad Tecnológica Nacional, Coløn 332, San Nicolás (2900), Buenos Aires, Argentina
8 Laboratorio de Física de la Atmósfera, Facultad de Ciencias Exactas y Tecnología, Universidad Nacional de Tucumán, Av. Independencia 1800, 4000 Tucumán, Argentina
9 Instituto de Física del Noroeste Argentino (Consejo Nacional de Investigaciones Cientficas y Técnicas - Universidad Nacional de Tucumán), 4000 Tucumán, Argentina
10 Faculty of Geography, Lomonosov, Moscow State University, Leninskie Gory St. 1, Moscow 119991, Russia
11 Helmut-Schmidt-University, Hamburg, Germany
12 Center of Excellence in Information Systems, Tennessee State University, Nashville, TN 37209 USA
13 Independent scientist, Berkeley Springs, WV, USA
14 Emeritus Professor in Physical Geography, Department of Geosciences, University of Oslo, Norway
15 College of Earth, Ocean, and the Environment, University of Delaware, Newark DE 19716-2541, USA
16 Institute for Hydrography, Geoecology and Climate Sciences, Hauptstraβe 47, 6315 Ägeri, Switzerland
17 Department of Earth Sciences, Environment and Georesources, University of Naples Federico II, Complesso Universitario di Monte S. Angelo, via Cinthia, 21, 80126 Naples, Italy
18 Retired, formerly Department of Physics and Technology, UiT The Arctic University of Norway, 9037 Tromsø, Norway
19 ELKH Institute of Earth Physics and Space Science, 9400 Sopron, Csatkai utca 6-8, Hungary
20 Retired, formerly National Center for Atmospheric Research, Boulder, Colorado, USA
21 Instituto de Geofisica, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, 04510, México D.F., México
22 Active Cavity Radiometer Irradiance Monitor (ACRIM), Coronado, CA 92118, USA
23 State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710061, China
24 Department of Mathematics and Physics, Shaoxing University, Shaoxing, China
25 Department of AOP Physics, University of Oxford, Oxford, UK

Received 2020 December 7; accepted 2021 April 14



23 co-authors
from
14 countries
and
530 references

A comparison of citations/references cited by IPCC reports and Connolly et al. (2021)

Assessment report	Published	Solar activity as a climate driver	Urbanization bias problem	Both topics
IPCC AR6	pre-AR5	17	7	24
	post-AR5	51	21	72
	total	68	28	96
Connolly et al. (2021)	pre-AR5	261	15	276
	post-AR5	135	17	151
	total	396	32	428
Common citations	pre-AR5	7	1	8
	post-AR5	13	1	14
	total	20	2	22

Table 1. Total numbers of citations considered by both assessment reports specifically with respect to (i) the potential role of solar activity as a driver of recent climate change and (ii) the magnitude of the urbanization bias problem. Note that one reference was cited for both topics by Connolly et al. (2021) but is only counted once for the "Both topics" column.

The IPCC's over 22 years: Dazzle them with the number of pages

IPCC Report	Total Pages
FAR	168
SAR	572
TAR	881
AR4	996
AR5	1535
AR6	2391
Total	**6543**

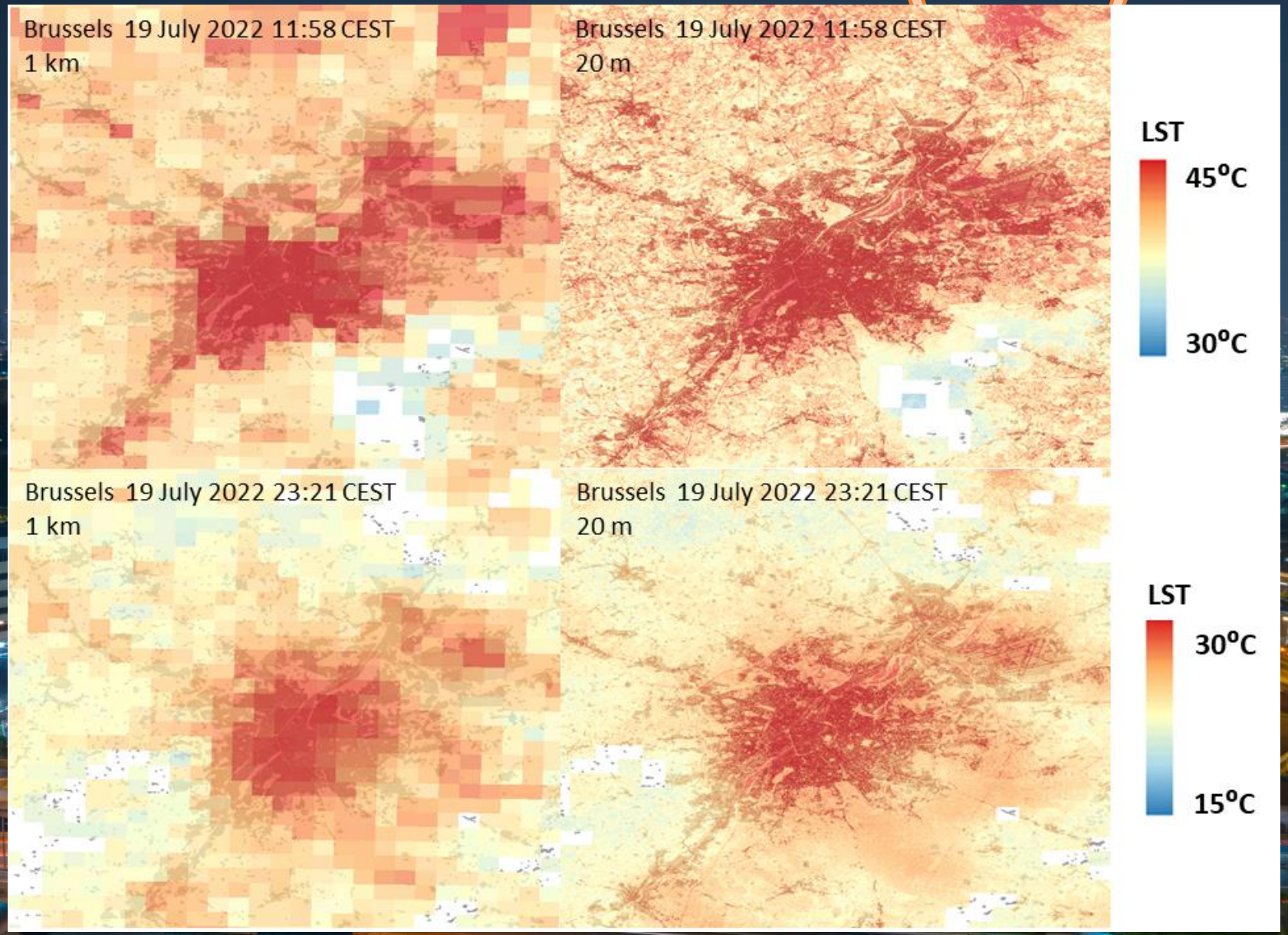
If you can't dazzle them with brilliance, **bury them with large number of pages!**

The IPCC's detection process

- The IPCC's global temperature estimates from 1850-present comprise two components:
  1. Land Surface Temperatures (LST) based on weather station thermometer records
  2. Sea Surface Temperatures (SST) based on ship-based samplings of ocean temperatures and more recently (since 1980s), thermometers on buoys

- The IPCC's claims that the recent warming is "unprecedented" in thousands of years are based on combining these instrumental temperature measurements with "temperature proxies", e.g., tree-ring widths, ice cores, lake sediments, glacier changes.

The Urban Heat Island (UHI): Brussel



https://terrascope.be/en/cases/urban-heat-island-mapping-combined-sentinel-2-and-sentinel-3-observations

Local and Regional Urban Heat Island (UHI) about 2 to 15°C

Tom Nelson reposted

Ryan Maue
@RyanMaue

Subscribe

Urban heat island enhancement of local temperatures can range from 3°C to 12°C depending upon geography and arid/tropical climate zones.

Seems the urban heat island effect is about an order of magnitude larger than greenhouse gas warming.

Why isn't this an existential threat?

10:34 PM · May 20, 2024 · **13.9K** Views

https://twitter.com/RyanMaue/status/1792745782577369445

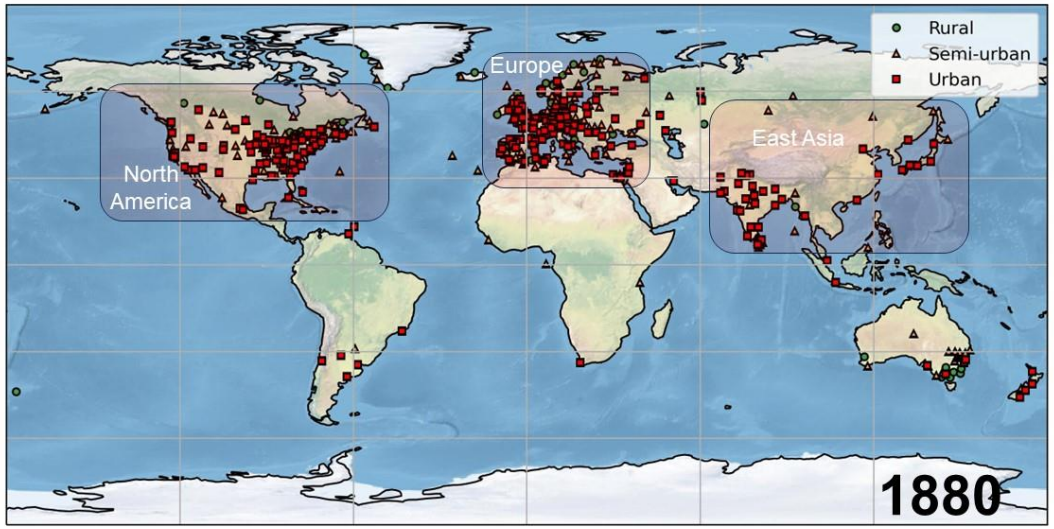
Urban climate change

- The urban heat island (UHI) has been known since 1800s
- Cities are getting bigger and UHIs are also getting bigger
- Urban areas still only make up 3-4% of the land and less than 2% of planet
- But, more than 75% of weather stations are in areas that are now urbanized
- Since 2011, more than half of the world's population live in urban areas. This means **for most people** the biggest local climate change they experience is urban warming

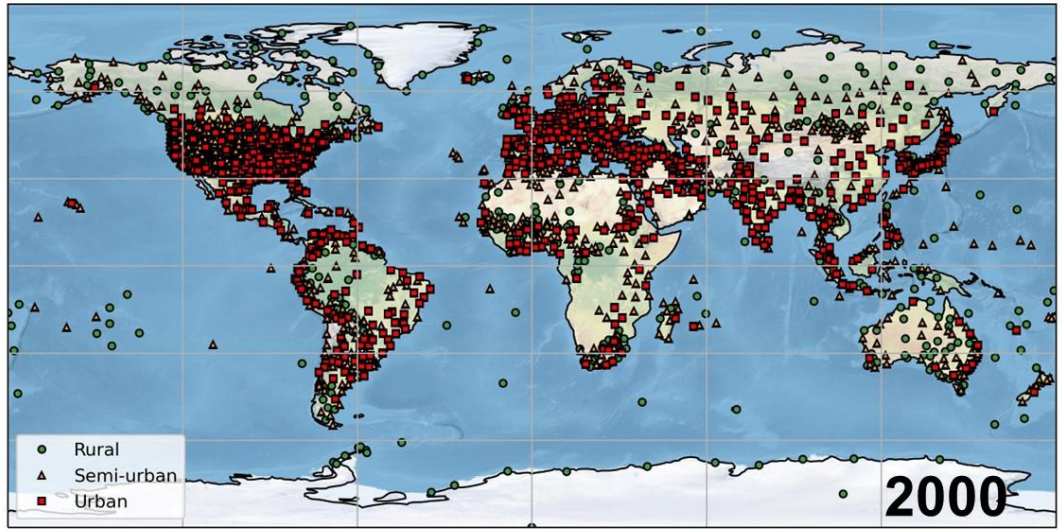
Not enough rural data globally

- For late 19th century, most of the weather stations are in North America and Europe with some East Asian stations (mostly urbanized) – **not** "global", but "**Northern Hemisphere**"
- More than 75% of the weather stations have become urbanized
- For the longest and most complete station records that reach back to the early 20th century or earlier, it's more like 80-90% of the stations

Distribution of rural, semi-urban and urban stations available in **1880**
Global Historical Climatology Network (GHCN), version 3



Distribution of rural, semi-urban and urban stations available in **2000**
Global Historical Climatology Network (GHCN), version 3



Automatic Climate Station, Clonmacnoise (Ireland)
Visited: 2nd Aug 2021

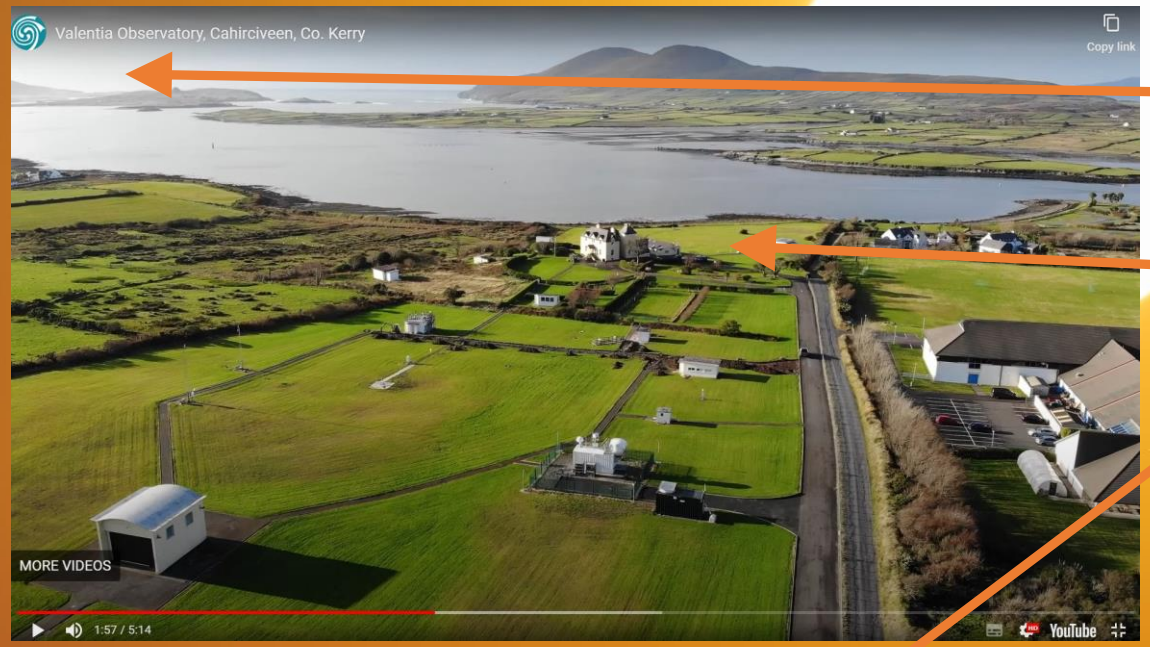
Automatic Weather Station (*GHCN v3, RA*)
Valentia Observatory (Ireland)
Visited: 14th Jan 2015

(*GHCN v3, SA*)
Tromsø (Norway)
Visited: 24th Mar 2022

Rural stations also have problems

- Even with rural stations, there can be non-climatic biases in the records, e.g.
  - Changes in instrumentation and observation practice over the years
  - Changes in local “microclimate” (nearby buildings, concrete, trees)
  - Station moves – often weather stations are moved after a few decades

A rare long, rural record: Valentia Observatory, Ireland



1867-1892: Located on Valentia Island

1892-2001: Located near ocean

2001-present: Current location.
Automatic weather station since 2012

Station history metadata (key changes)

- 1892. Station move. Valentia Island to the mainland
- 1937. Change in government. Republic of Ireland formed. But staff and observations remained the same.
- 2001. Station move 350 m inland (~20 m higher)
- 2012. Instrumentation change. Manual weather station to automatic

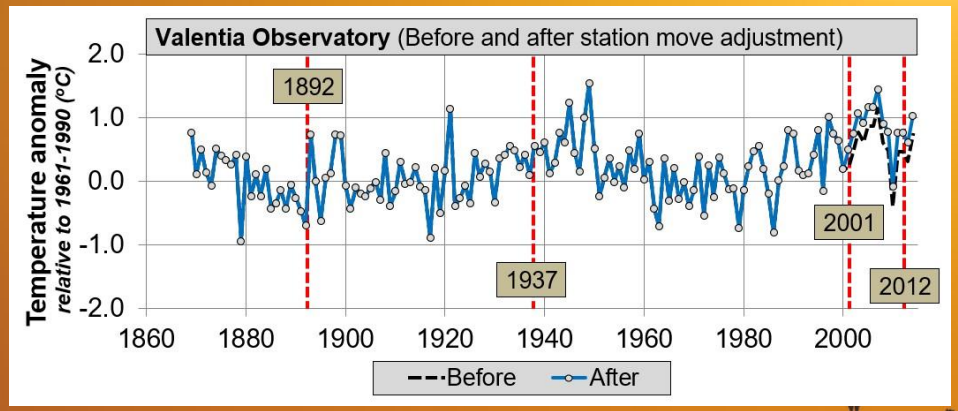
Correcting the raw Valentia Observatory record

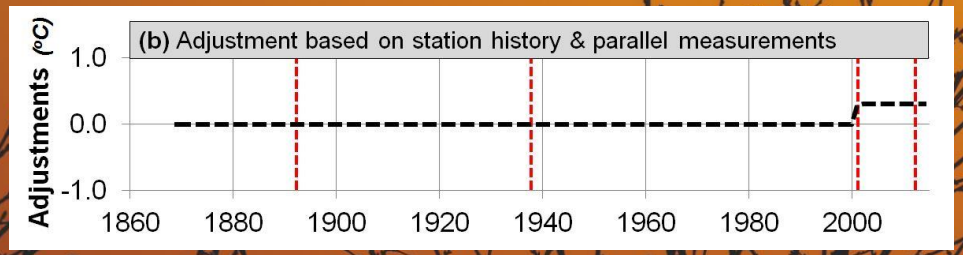
Earth-Science Reviews 150 (2015) 409–452

Re-evaluating the role of solar variability on Northern Hemisphere temperature trends since the 19th century

Willie Soon [a,*], Ronan Connolly [b], Michael Connolly [b]

[a] Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA
[b] Independent research scientists, Dublin, Ireland



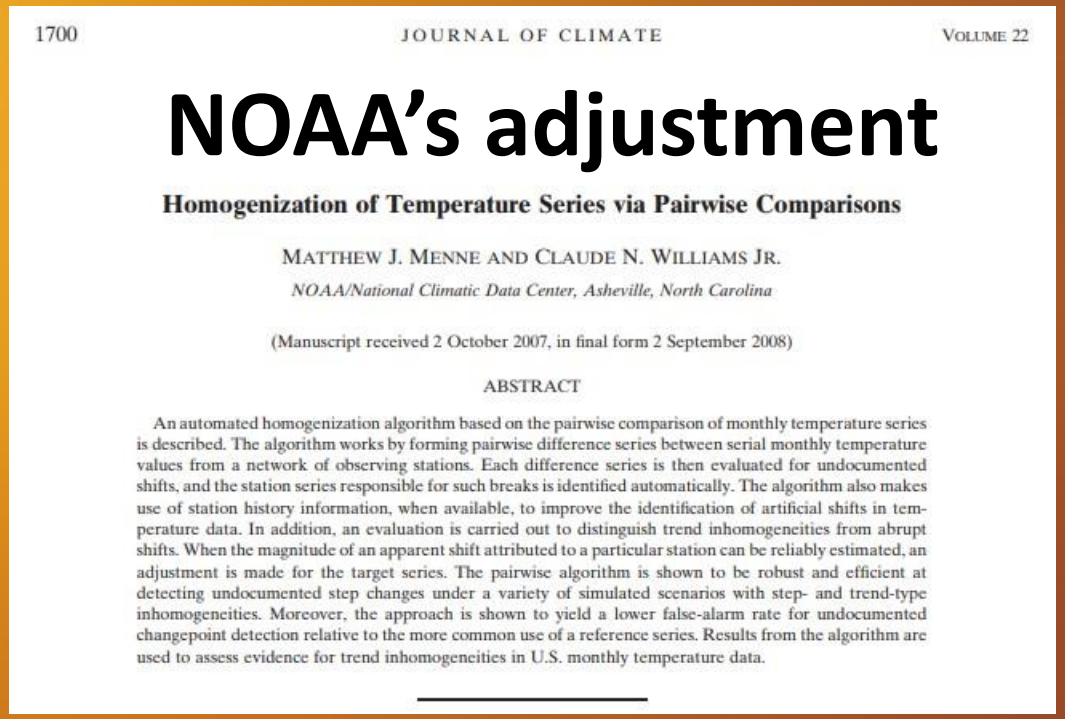


Soon et al. 2015: Corrections for non-climatic biases

- **1892**. Station move. Valentia Island to the mainland. Possible bias, but unclear what magnitude or sign. **No adjustments applied**.
- **1937**. Change in government. Republic of Ireland formed. But staff and observations remained the same. **No adjustments necessary**
- **2001**. Station move. 350 m. Parallel measurements reveal the new location was 0.3 °C colder. **+0.3 °C adjustment applied**.
- **2012**. Instrumentation change. Parallel measurements show bias was less than 0.1 °C. **No adjustments necessary**

NOAA's "temperature homogenization" approach

- Other groups **don't** take our approach of combining known station history metadata & information to develop empirical corrections.
- Instead, they mostly rely on automated computer programs that use statistical algorithms to try and identify and remove "non-climatic biases".
- NOAA's Menne & Williams (2009) "PHA" is one of main ones
- Compares each station record to neighboring stations & applies adjustments – usually run without using station history metadata



NOAA's adjustment

Homogenization of Temperature Series via Pairwise Comparisons

MATTHEW J. MENNE AND CLAUDE N. WILLIAMS JR.

NOAA/National Climatic Data Center, Asheville, North Carolina

(Manuscript received 2 October 2007, in final form 2 September 2008)

ABSTRACT

An automated homogenization algorithm based on the pairwise comparison of monthly temperature series is described. The algorithm works by forming pairwise difference series between serial monthly temperature values from a network of observing stations. Each difference series is then evaluated for undocumented shifts, and the station series responsible for such breaks is identified automatically. The algorithm also makes use of station history information, when available, to improve the identification of artificial shifts in temperature data. In addition, an evaluation is carried out to distinguish trend inhomogeneities from abrupt shifts. When the magnitude of an apparent shift attributed to a particular station can be reliably estimated, an adjustment is made for the target series. The pairwise algorithm is shown to be robust and efficient at detecting undocumented step changes under a variety of simulated scenarios with step- and trend-type inhomogeneities. Moreover, the approach is shown to yield a lower false-alarm rate for undocumented changepoint detection relative to the more common use of a reference series. Results from the algorithm are used to assess evidence for trend inhomogeneities in U.S. monthly temperature data.

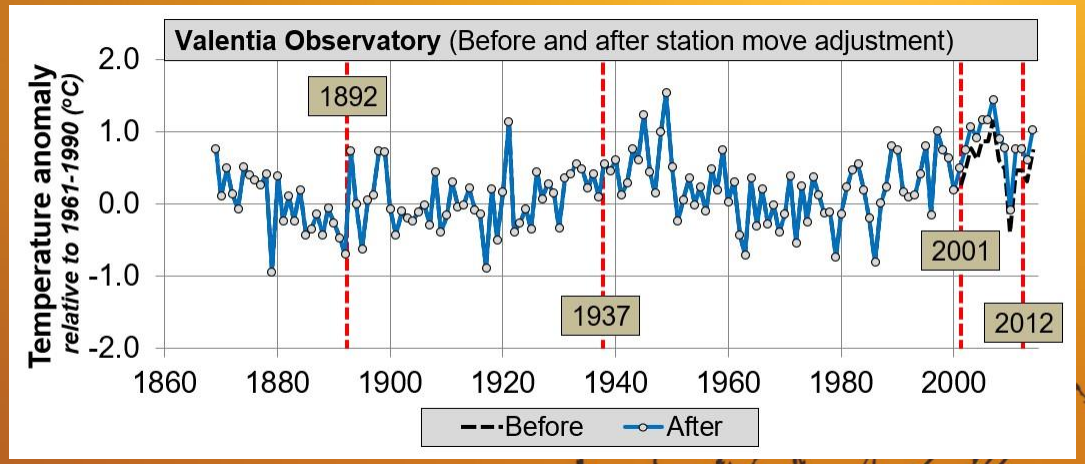
How well does statistical homogenization work?

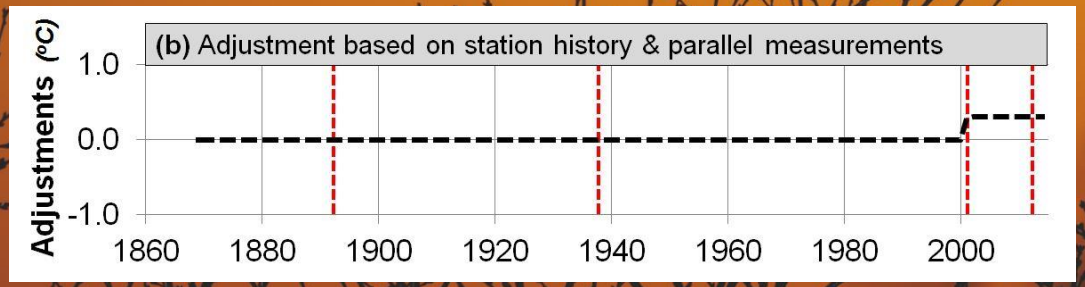
Soon et al. 2015:

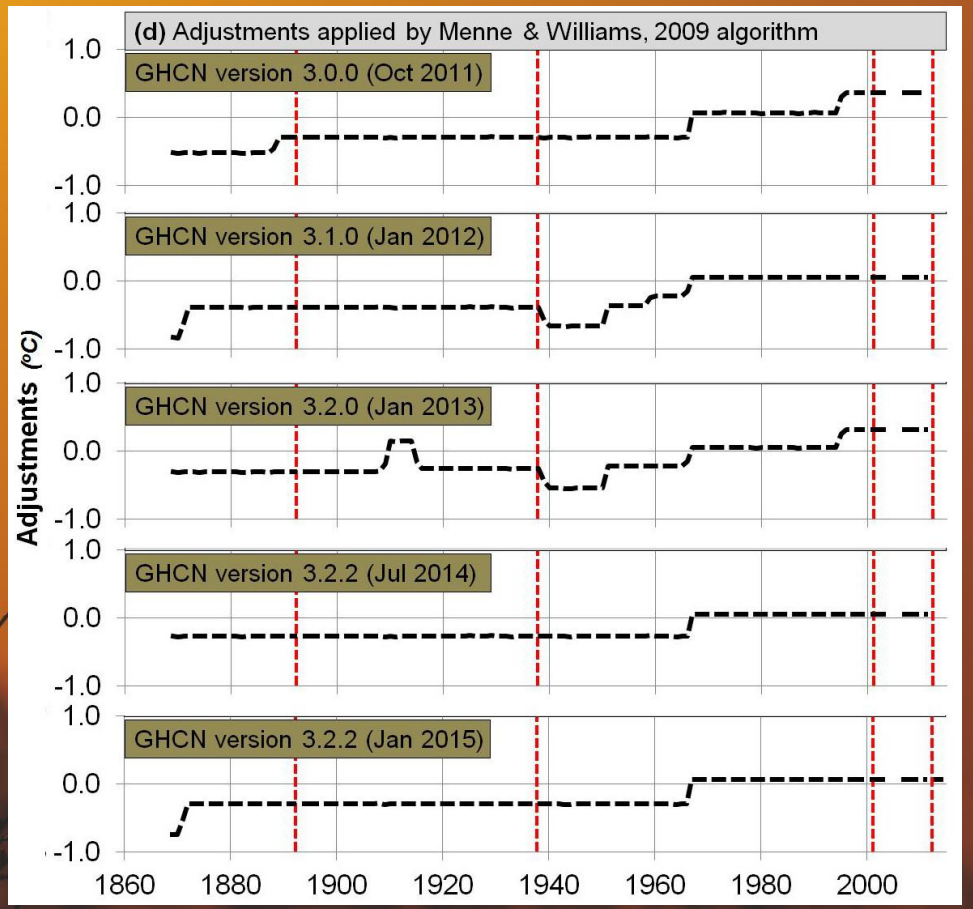
Our empirically-based corrections for non-climatic biases using station histories

NOAA's statistical homogenization adjustments

- Every time they run the program, NOAA changes their mind!
- None of their adjustments matched with reality!







Nearly 4000 versions of NOAA's statistical homogenization adjustments: Peter O'Neill

Table 2. Numbers of distinct GHCN datasets downloaded from NOAA's website for each year. Version 4 was originally introduced as a "beta" version in October 2015 until the official version was released in October 2018. Version 3 was discontinued in August 2019. For this study, we consider all distinct datasets up to July/August 2021 (some stations were analyzed up to July and others up to August). This comprises 1877 for version 3 (covering the period 2011–2019) and 1812 for version 4 (covering the period 2015–2021).

O'Neill et al. (2022)

Year	GHCN Version 3	GHCN Version 4	Version 4 ("Beta")
2011	6	-	-
2012	39	-	-
2013	34	-	-
2014	283	-	-
2015	316	71	(71)
2016	342	303	(303)
2017	346	322	(322)
2018	315	314	(256)
2019	196	287	-
2020	-	310	-
2021	-	205	-
Total distinct datasets	1877	1812	(952)

atmosphere

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Article

Evaluation of the Homogenization Adjustments Applied to European Temperature Records in the Global Historical Climatology Network Dataset

Peter O'Neill [1], Ronan Connolly [2,3,*], Michael Connolly [3], Willie Soon [2,4], Barbara Chimani [5], Marcel Crok [6], Rob de Vos [7], Hermann Harde [8], Peter Kajaba [9], Peter Nojarov [10], Rajmund Przybylak [11,12], Dubravka Rasol [13], Oleg Skrynyk [14,15], Olesya Skrynyk [14,16], Petr Štěpánek [17,18], Agnieszka Wypych [19,20] and Pavel Zahradníček [17,18]

Article Views 15666

Citations 13

1 School of Mechanical and Materials Engineering, University College Dublin, Belfield, D04 Dublin, Ireland; peter.oneill@ucd.ie
2 Center for Environmental Research and Earth Science (CERES), Salem, MA 01970, USA; willie@ceres-science.com
3 Independent Researcher, D01 Dublin, Ireland; michael@ceres-science.com
4 Institute of Earth Physics and Space Science (ELKH EPSS), H-9400 Sopron, Hungary
5 Zentralanstalt für Meteorologie and Geodynamik (ZAMG), Hohe Warte 38, 1190 Wien, Austria; barbara.chimani@zamg.ac.at
6 CLINTEL Foundation, Zekeringstraat 41, 1014 BV Amsterdam, The Netherlands; marcel.crok@clintel.org
7 Independent Researcher, 5751 HM Deurne, The Netherlands; rob@klimaatgek.nl
8 Electrical Engineering, Helmut-Schmidt-University, Holstenhofweg 85, 22043 Hamburg, Germany; harde@hsu-hh.de
9 Slovak Hydrometeorological Institute, 833 15 Bratislava, Slovakia; peter.kajaba@shmu.sk
10 National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Akad. G. Bonchev Str., Bl. 3, Room 327, 1113 Sofia, Bulgaria; pnojarov@abv.bg
11 Department of Meteorology and Climatology, Faculty of Earth Sciences and Spatial Management, Nicolaus Copernicus University, 87-100 Toruń, Poland; rp11@umk.pl
12 Centre for Climate Change Research, Nicolaus Copernicus University, 87-100 Toruń, Poland
13 Meteorological and Hydrological Service of Croatia, 10 000 Zagreb, Croatia; dubravka.rasol@cirus.dhz.hr
14 Ukrainian Hydrometeorological Institute, 03028 Kyiv, Ukraine; skrynyk@uhmi.org.ua (O.S.); skrynyk@nubip.edu.ua (O.S.)
15 Center for Climate Change C3, Universitat Rovira i Virgili, 43480 Tarragona, Spain
16 Department of Agronomy, National University of Life and Environmental Sciences of Ukraine, 03041 Kyiv, Ukraine
17 Global Change Research Institute, Czech Academy of Sciences, 603 00 Brno, Czech Republic; stepanek.p@czechglobe.cz (P.Š.); zahradnicek.p@czechglobe.cz (P.Z.)
18 Czech Hydrometeorological Institute, Brno Regional Office, 616 67 Brno, Czech Republic
19 Department of Climatology, Jagiellonian University, 7 Gronostajowa St., 30-387 Kraków, Poland; agnieszka.wypych@uj.edu.pl
20 Institute of Meteorology and Water Management—National Research Institute, 61 Podleśna St., 01-673 Warszawa, Poland
* Correspondence: ronan@ceres-science.com

check for updates

Citation: O'Neill, P.; Connolly, R.; Connolly, M.; Soon, W.; Chimani, B.; Crok, M.; de Vos, R.; Harde, H.; Kajaba, P.; Nojarov, P.; et al. Evaluation of the Homogenization Adjustments Applied to European Temperature Records in the Global Historical Climatology Network Dataset. *Atmosphere* **2022**, *13*, 285. https://doi.org/10.3390/atmos13020285

Academic Editor: Amal Chandran

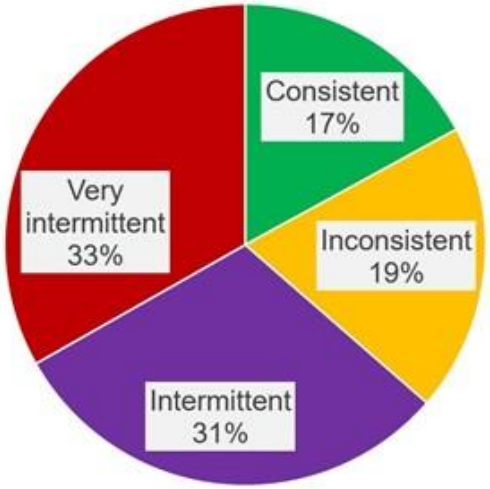
Received: 13 January 2022
Accepted: 6 February 2022
Published: 8 February 2022

Publisher's Note: MDPI stays neutral

European Thermometer Project at CERES-science.com

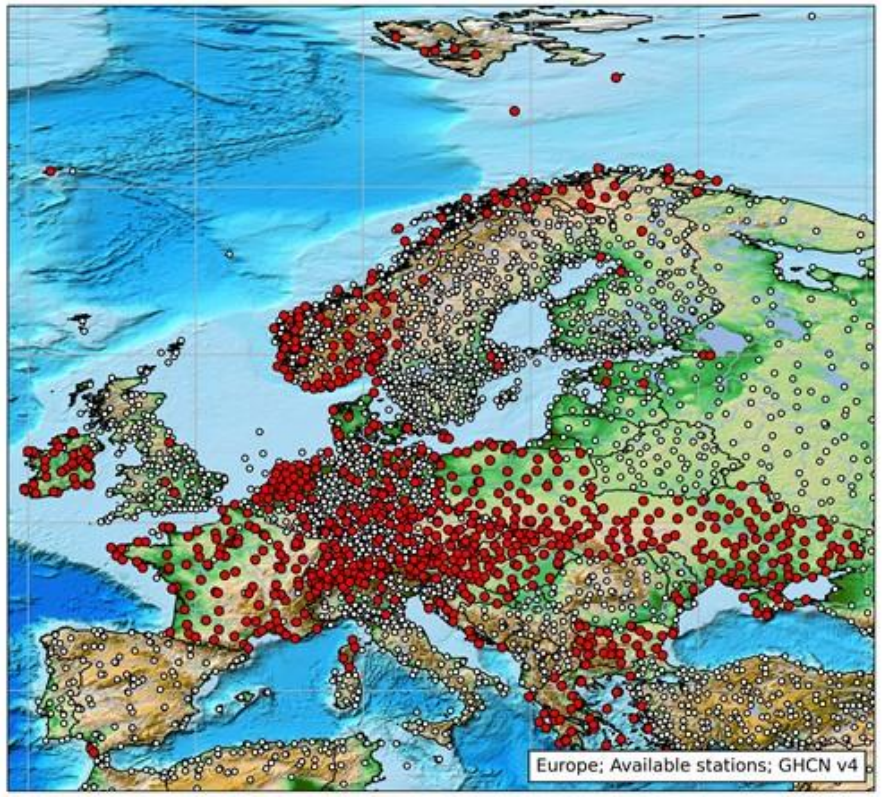
Summary of the new study on NOAA's temperature adjustments

Consistency of NOAA's adjustments for each station

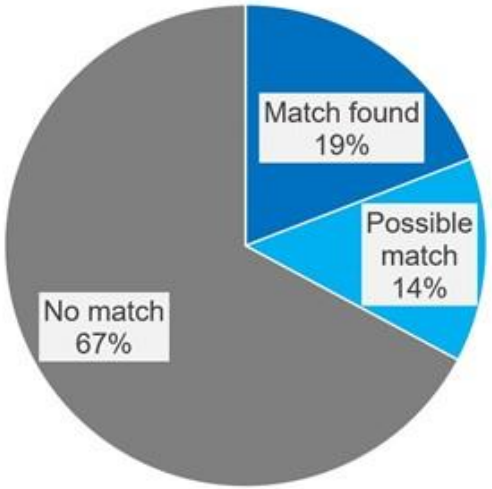


Only 17% of NOAA's adjustments are applied consistently

Details on the histories of more than 800 weather stations from 24 European countries were collected to check if the adjustments corresponded to documented changes associated with the weather station. The locations of these stations are indicated below in red.



How often do NOAA's adjustments match to known documented station events?



Less than 20% of NOAA's adjustments were clearly associated with a documented change to the weather station observations

A second problem: "Urban blending"

Evidence of Urban Blending in Homogenized Temperature Records in Japan and in the United States: Implications for the Reliability of Global Land Surface Air Temperature Data

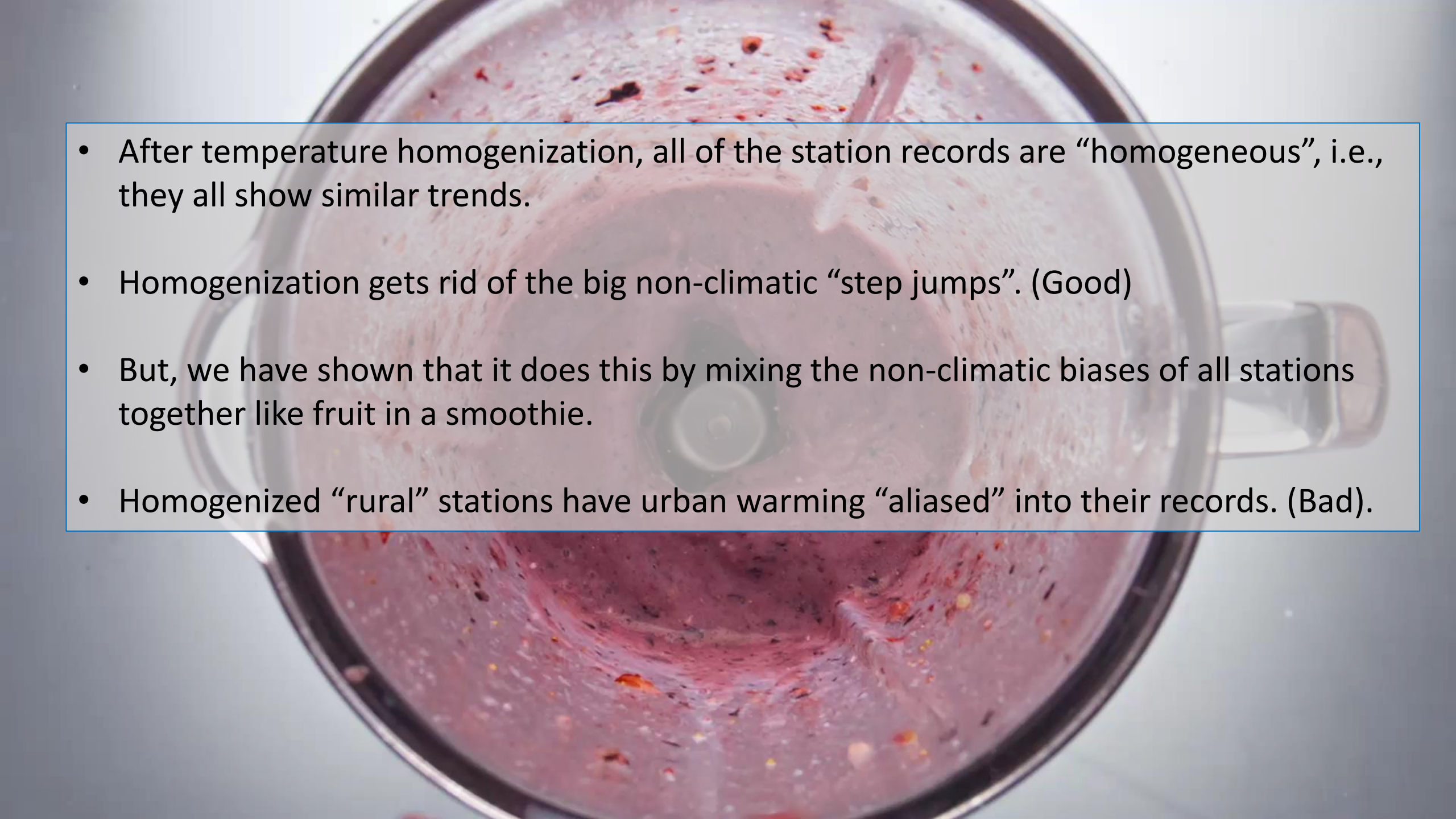
GENKI KATATA,[a,b] RONAN CONNOLLY,[c] AND PETER O'NEILL[d]

[a] *Ibaraki University, Ibaraki, Japan*
[b] *The Canon Institute for Global Studies, Tokyo, Japan*
[c] *Center for Environmental Research and Earth Science, Salem, Massachusetts*
[d] *School of Mechanical and Materials Engineering, University College Dublin, Dublin, Ireland*

(Manuscript received 30 July 2022, in final form 4 June 2023, accepted 3 July 2023)

- When the standard temperature homogenization algorithms are calculating the size of a non-climatic bias, they use the differences between the temperature records of the neighbors before and after the non-climatic change

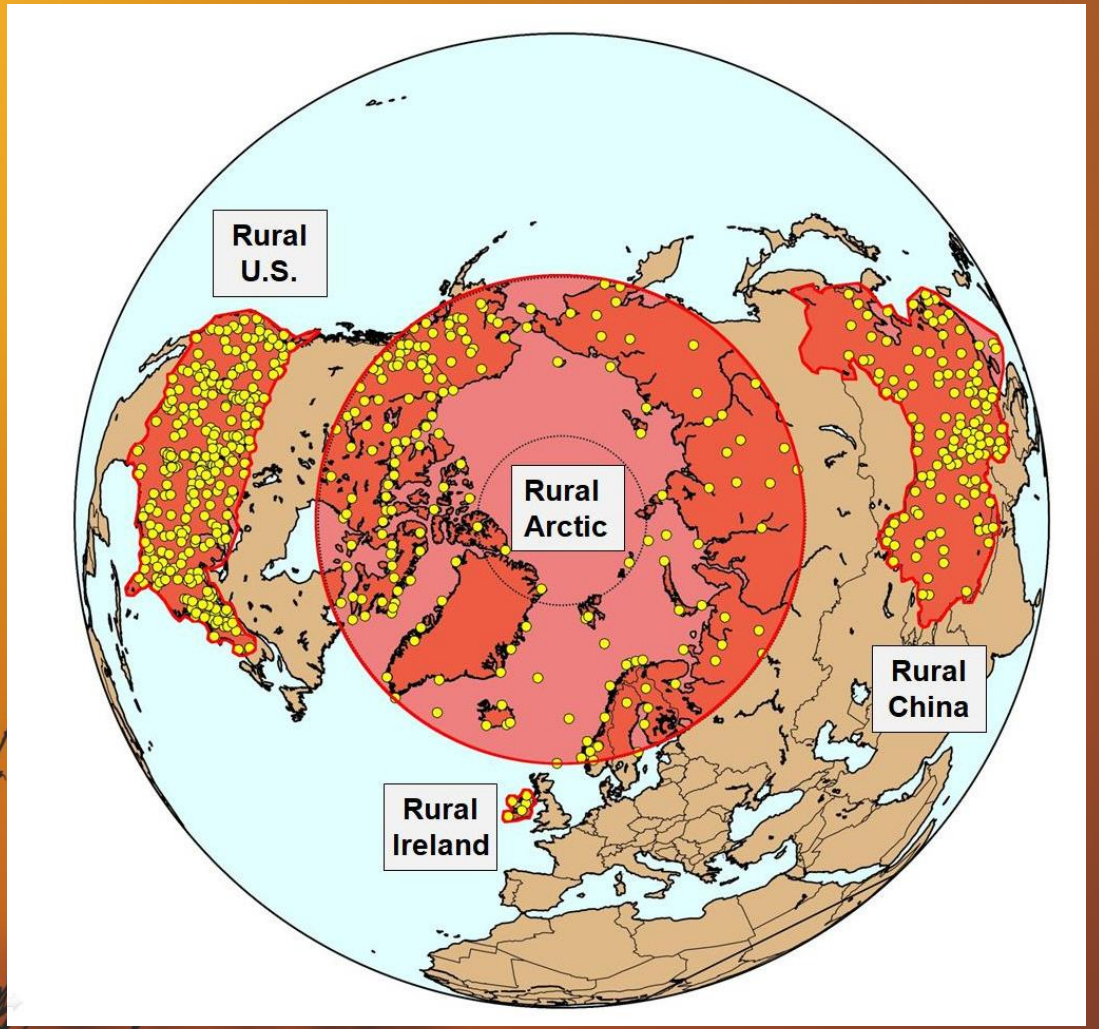
- But, if the neighbors are affected by urbanization bias, then the "homogenization adjustment" will add urban warming to rural station records!



- After temperature homogenization, all of the station records are “homogeneous”, i.e., they all show similar trends.
- Homogenization gets rid of the big non-climatic “step jumps”. (Good)
- But, we have shown that it does this by mixing the non-climatic biases of all stations together like fruit in a smoothie.
- Homogenized “rural” stations have urban warming “aliased” into their records. (Bad).

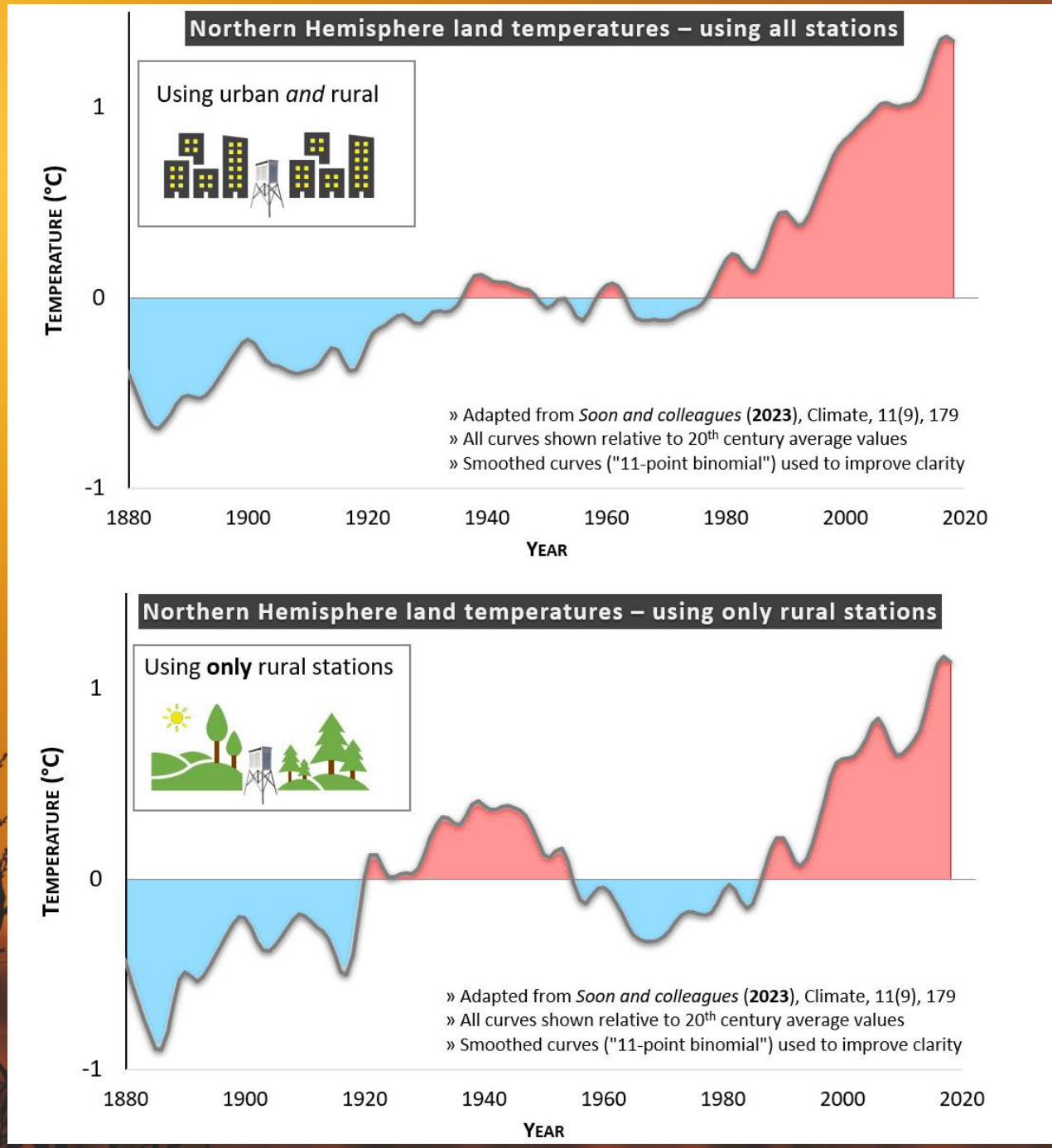
Our current rural-only Northern Hemisphere record

- In the meantime, in S2015 and C2021, we developed a rural-only temperature record using version 3 of NOAA's GHCN temperature dataset (1850-2018)
- Only uses 10-15% of the available temperature records, and confined to four geographical regions (all in N. Hemisphere)
- However, these regions account for more than 90% of the rural records that cover long enough to reach back to 19th century
- All four regions are geographically isolated from each other and cover tropics to poles



How does our rural record compare to IPCC's?

- Our rural-only record is "noisier" because only uses 10-15% of the data of the standard "urban & rural" records
- 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)



Are there other climate change indicators?

- The weather station-based land component actually is the best data – **direct** temperature measurements taken daily from the **same physical location** (between station moves) for centuries or longer. [Direct ✓ + Fixed spot ✓ + long records ✓]

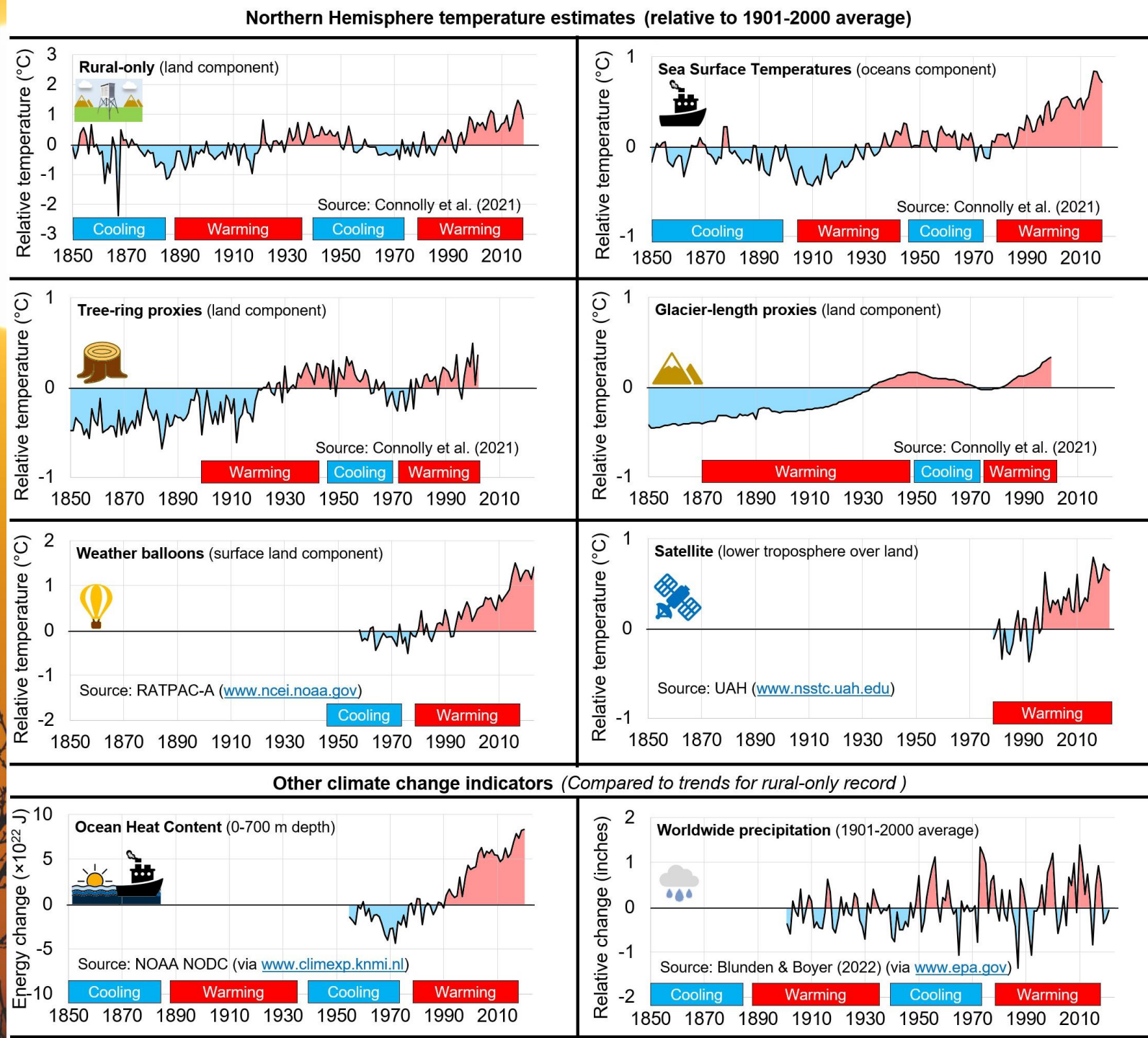
- Sea surface temperature (SST) and marine air temperature (MAT) measurements are direct measurements, but different locations and measurement methods (until fixed buoys began deployment in 1980s-1990s)
  [Direct ✓ + long records ✓, but inconsistent measurements ✗]

- Temperature proxies (tree-ring widths, lake sediments, etc.) are **indirect** estimates of temperatures that are also affected by other factors.
  [Fixed spot ✓ + long records ✓, but indirect ✗]

- Other climate records typically **only began** in the 1950s (e.g., weather balloons), the 1970s (e.g., satellite temperature records) or 2000s (ice sheet monitoring)

How does it compare?

- Nonetheless, our rural-only Northern Hemisphere temperature estimates match surprisingly well to the other non-urbanized climate records
- All capture warming to 1940s, then cooling to 1970s then warming (if long enough)
- One exception: worldwide precipitation – no clear trend



Look what IPCC (1990) First Assessment Report said about the 1920-1940 warmth?

Natural climate variations have occurred since the end of the last glaciation. **The Little Ice Age in particular involved global climate changes of comparable magnitude to the warming of the last century. It is possible that some of the warming since the nineteenth century may reflect the cessation of Little Ice Age conditions. The rather rapid changes in global temperature seen around 1920-1940 are very likely to have had a mainly natural origin.** Thus, a better understanding of past variations is essential if we are to estimate reliably the extent to which the warming over the last century, and future warming, is the result of an increase of greenhouse gases. (p. 233)

Look what happened when you consider the ocean heat content

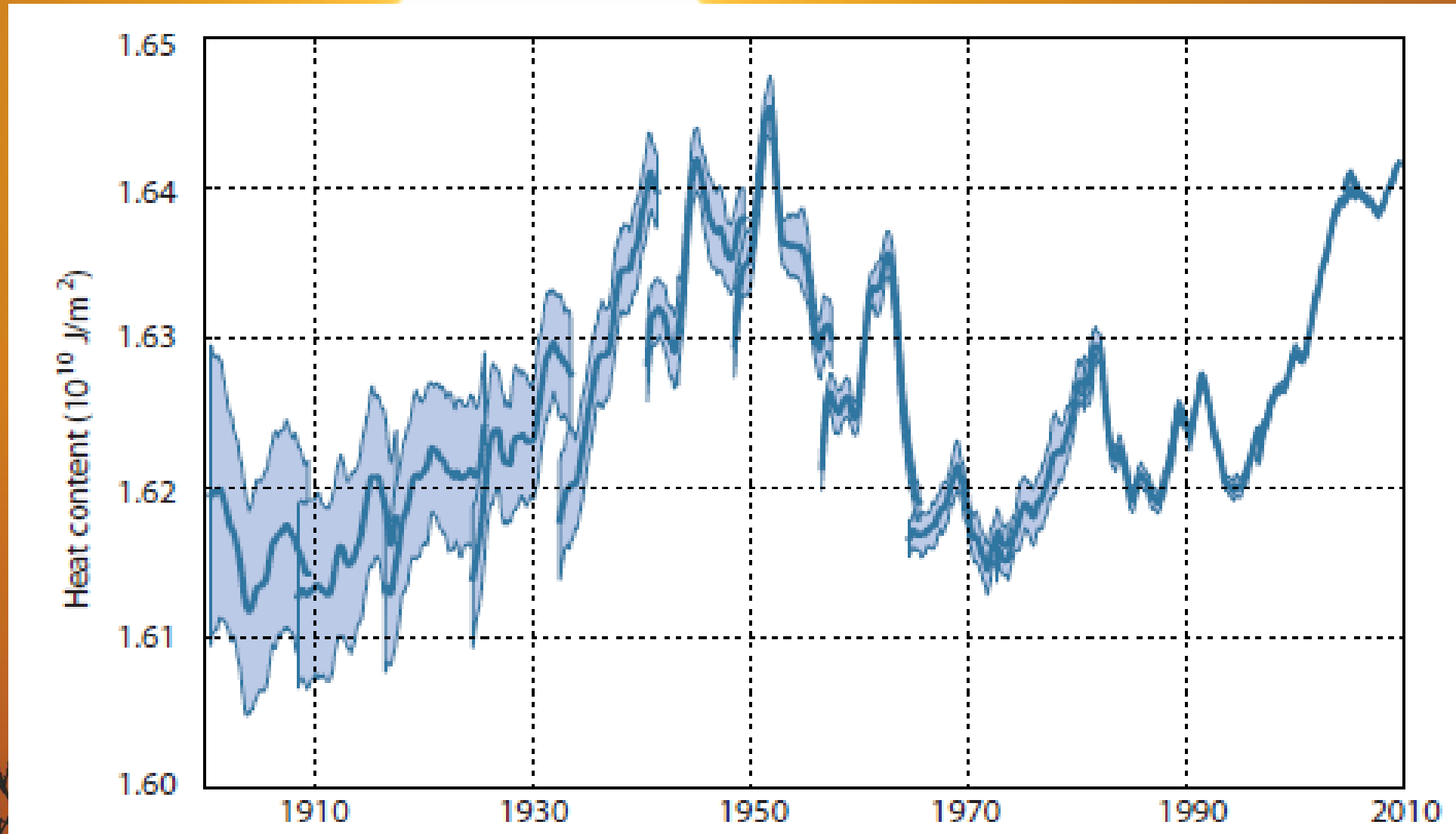
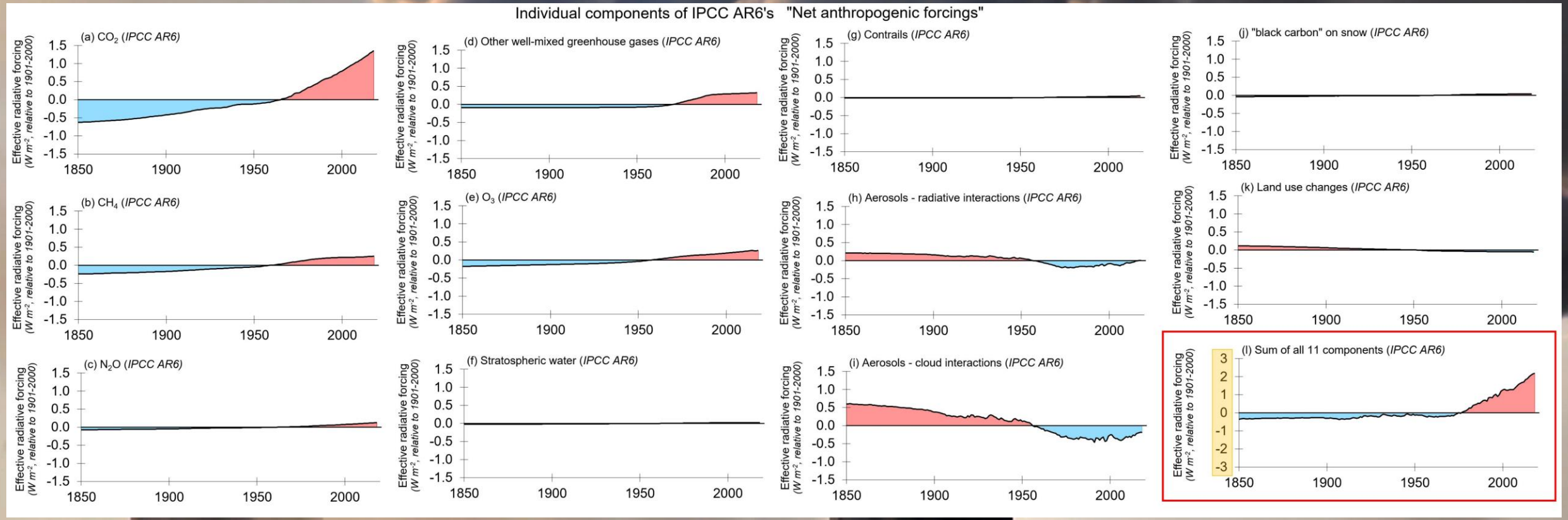


Figure 6: Global average ocean heat content for the upper 300 m.
From the ECMWF CERA-20C reanalysis ensemble, and redrawn from Laloyaux *et al.* Figure 10.

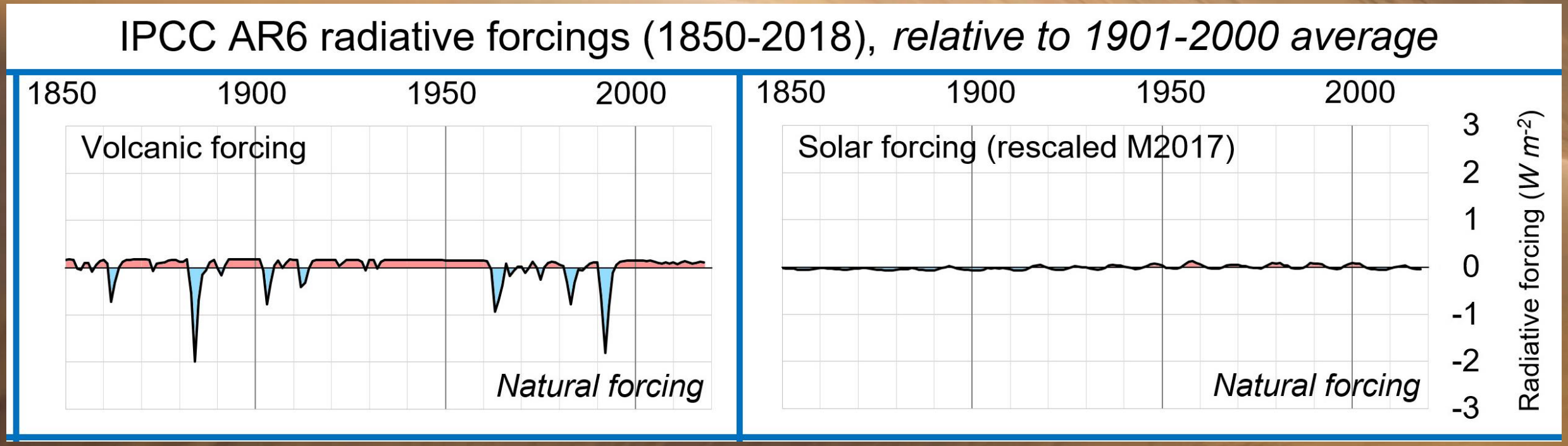
The IPCC's attribution process

- The computer model hindcasts used by the IPCC for their attribution involve plugging two types of climatic drivers:
  - natural factors and human-caused ("anthropogenic") factors
- IPCC describe drivers in terms of "radiative forcings" in Watts per m^2
- The hindcasts only consider two natural climatic drivers ("solar" and "volcanic")
- But, they consider 11 human-caused climatic drivers (mostly greenhouse gases and aerosol particles)

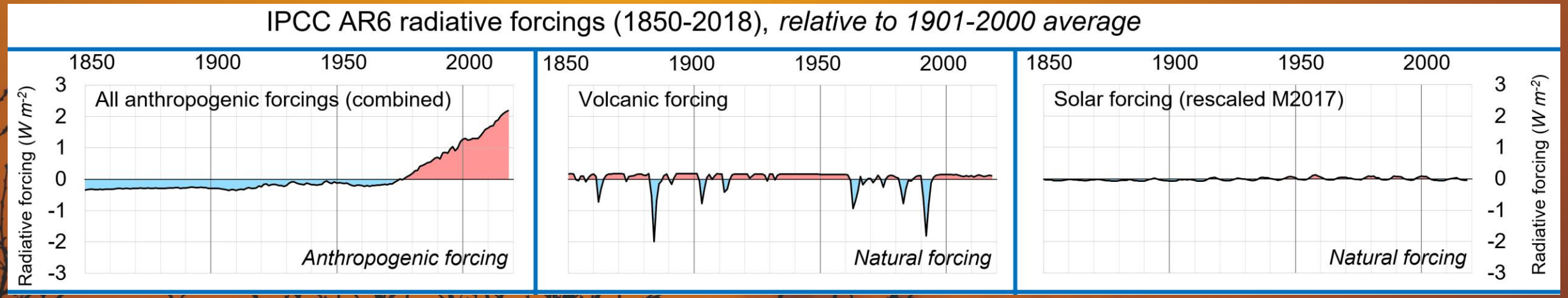
The IPCC thinks human-activities are the 11 smoking guns



They are not so interested in finding natural climate drivers



These are <u>all</u> the "natural and anthropogenic" forcings used for the IPCC AR6 hindcasts




UN
IPCC
C'mon. Boil.
imgflip.com


Let me introduce you to Mister BOB:
Bright Orange Ball

The weather-climate system is strictly powered by solar energy

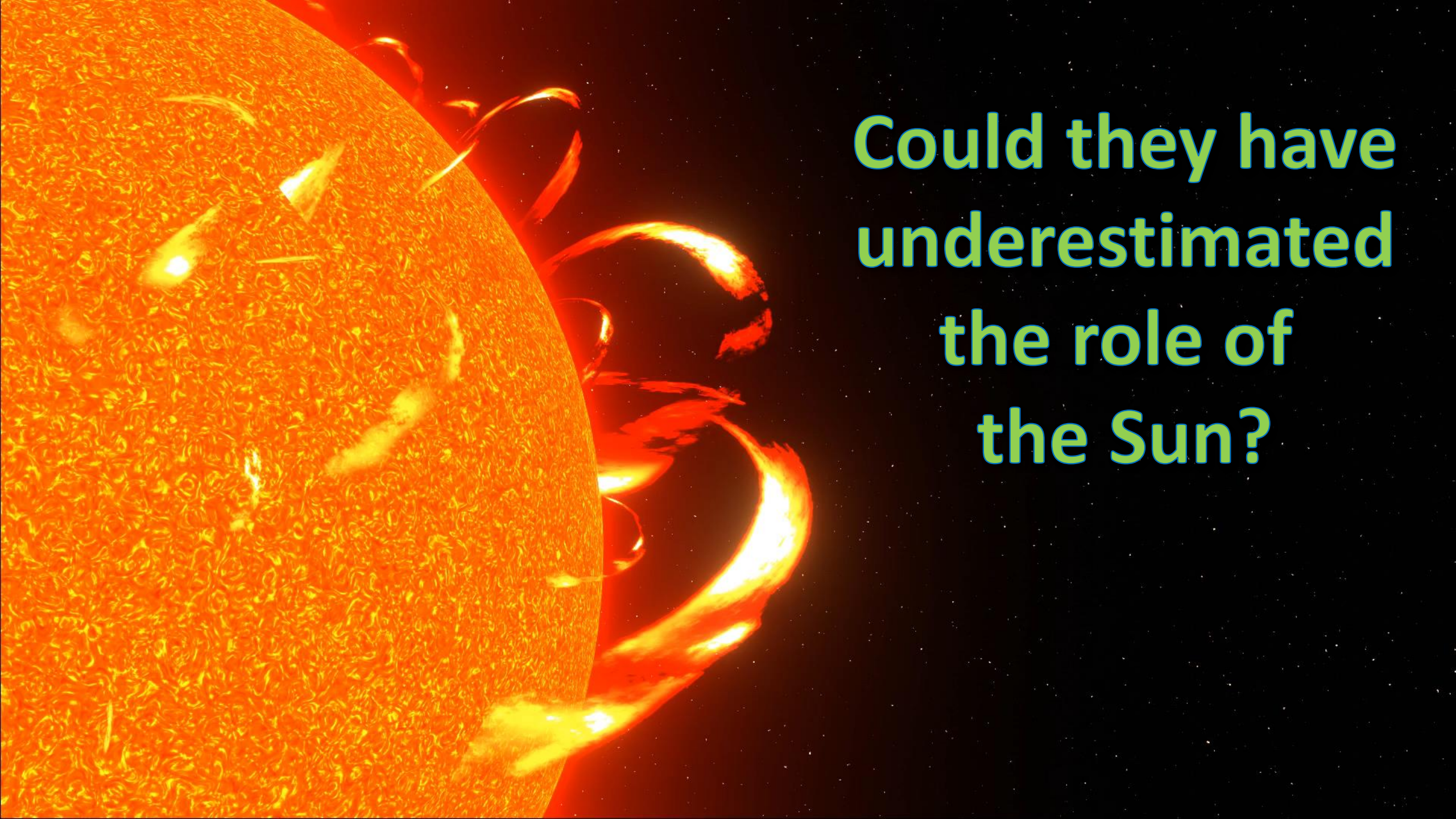
Power: 4×10^{26} W (Earth is 2 billion times weaker) 2×10^{17} W

radiogenic heat = 2 to 5 x 10^{13} W

(world's most powerful laser: 5-10 x 10^{15} W; 100 petawatts pulse coming*)

Adapted from Jurg Beer 2007's presentation

*Ruxin Li, Shanghai Superintense Ultrafast Laser Facility (January 24, 2018 Science Magazine News)

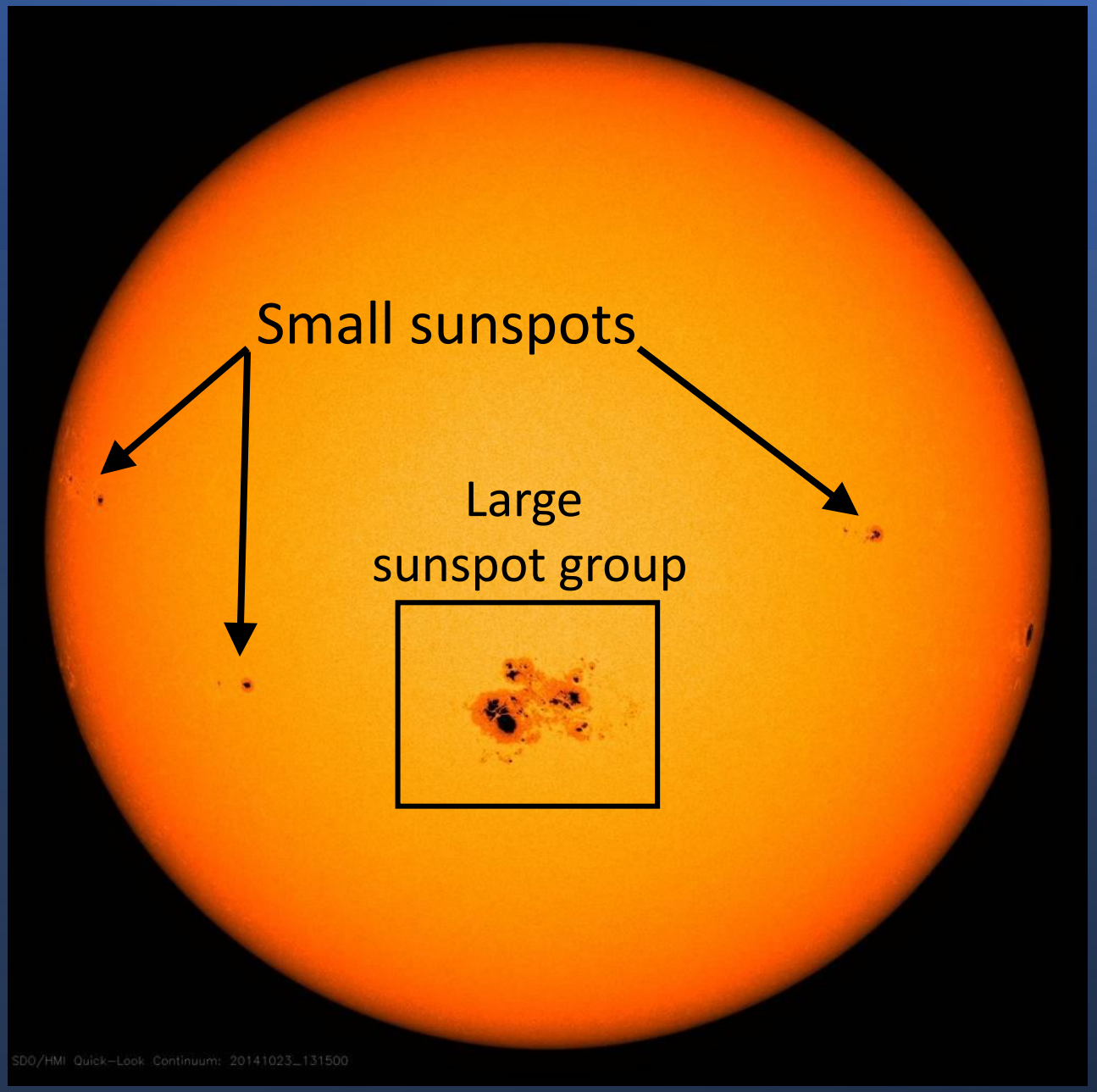

Could they have
underestimated
the role of
the Sun?

Oldest noticed feature on the Sun: “Sunspots”

Source: NASA GSFC

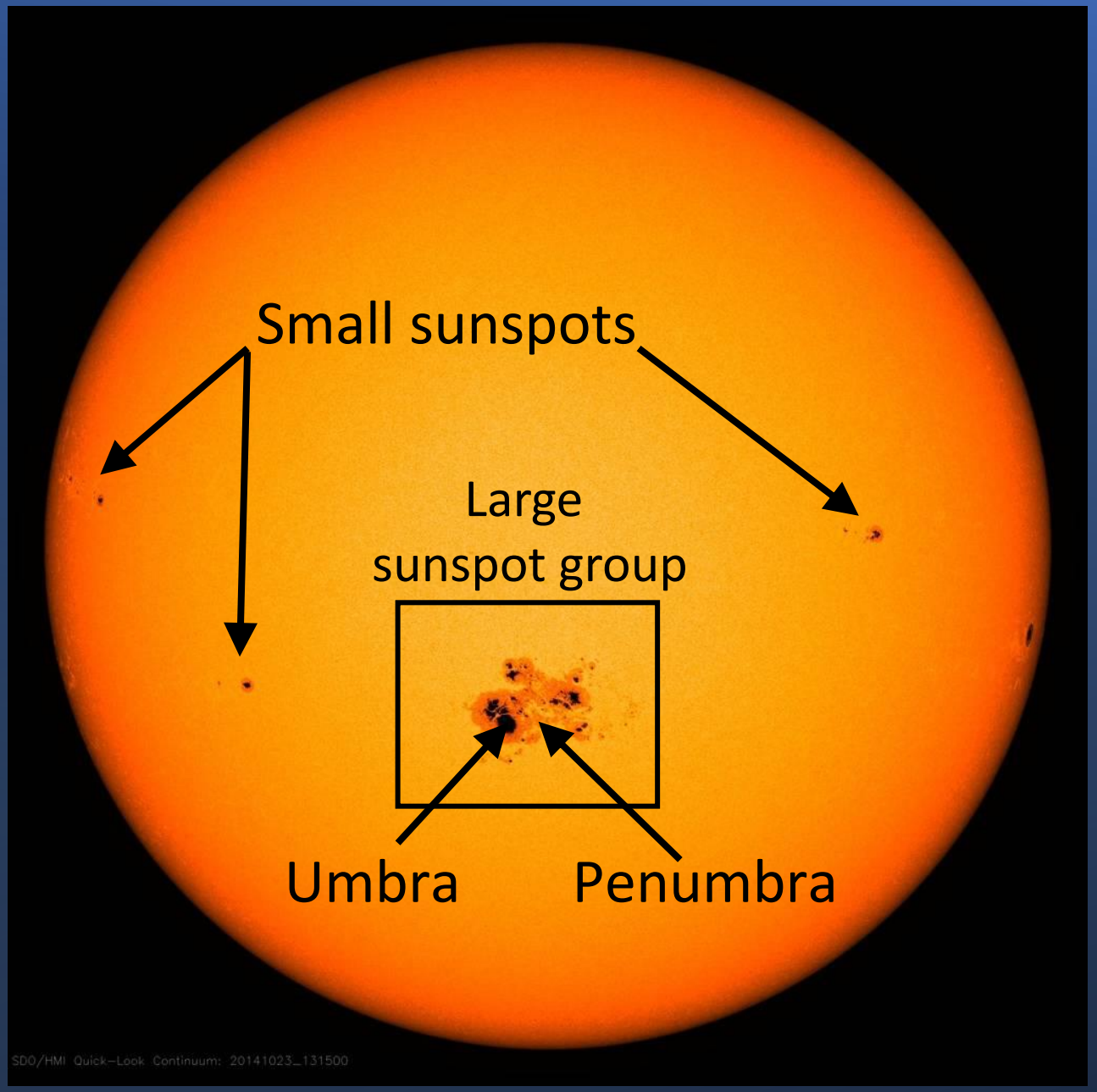
“Cosmic Cycles: The Sun” (https://svs.gsfc.nasa.gov/14313)

Some “sunspots”



Source: NASA

Some “sunspots”

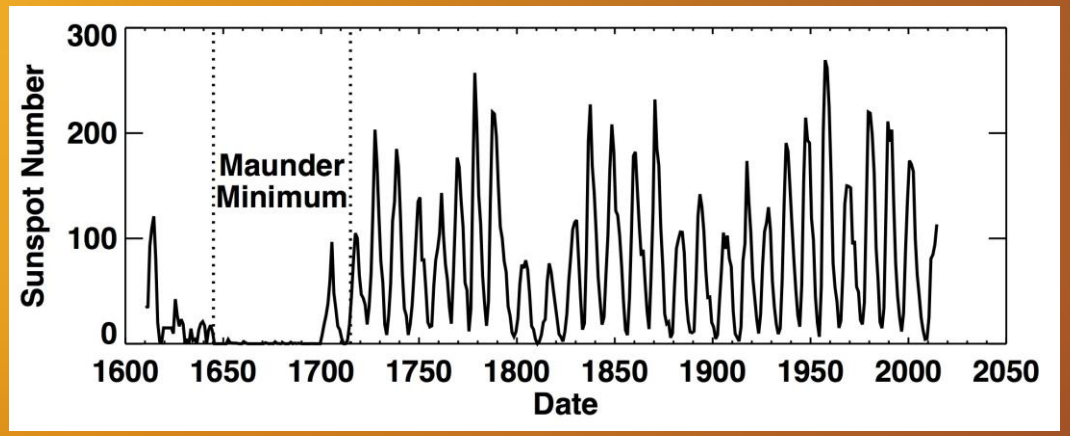


Source: NASA

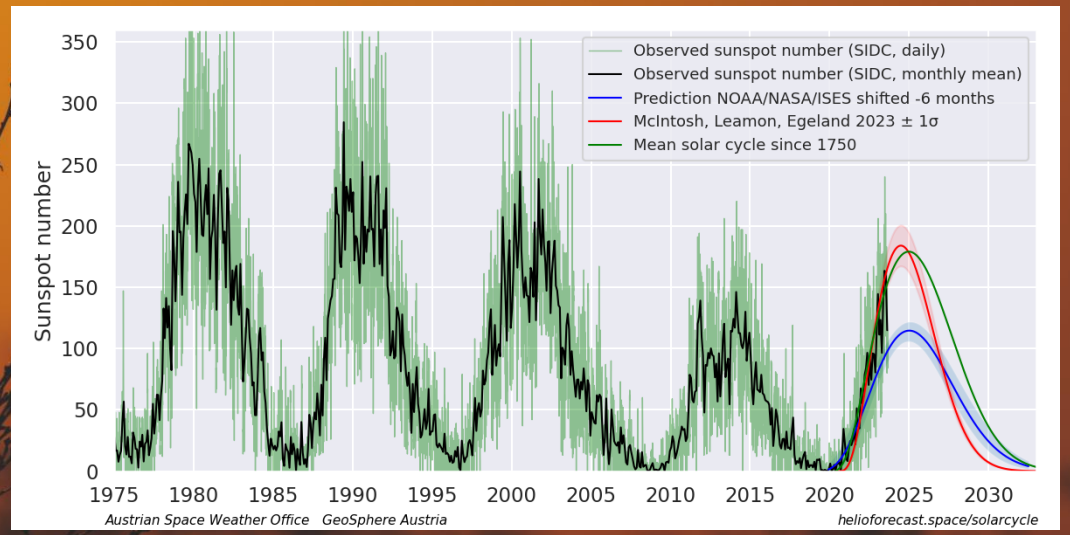
Sunspots have been recorded since Galileo

- Galileo noticed dark spots on the Sun with his early telescope in 1610 – called “sunspots”
- Number of sunspots increases to a maximum and then decreases to zero over a **roughly** 11 year cycle (“Sunspot cycle” or “solar cycle”)
- Sunspots disappeared from 1645-1715 (“Maunder Minimum”), but then reappeared
- Sunspot numbers (SSN) are clearly a measure of solar activity – but not a direct measurement of TSI – just a “solar proxy”
- There are other solar proxies, e.g., Ca(II)+H/K emission lines, penumbra/umbra ratios, etc.

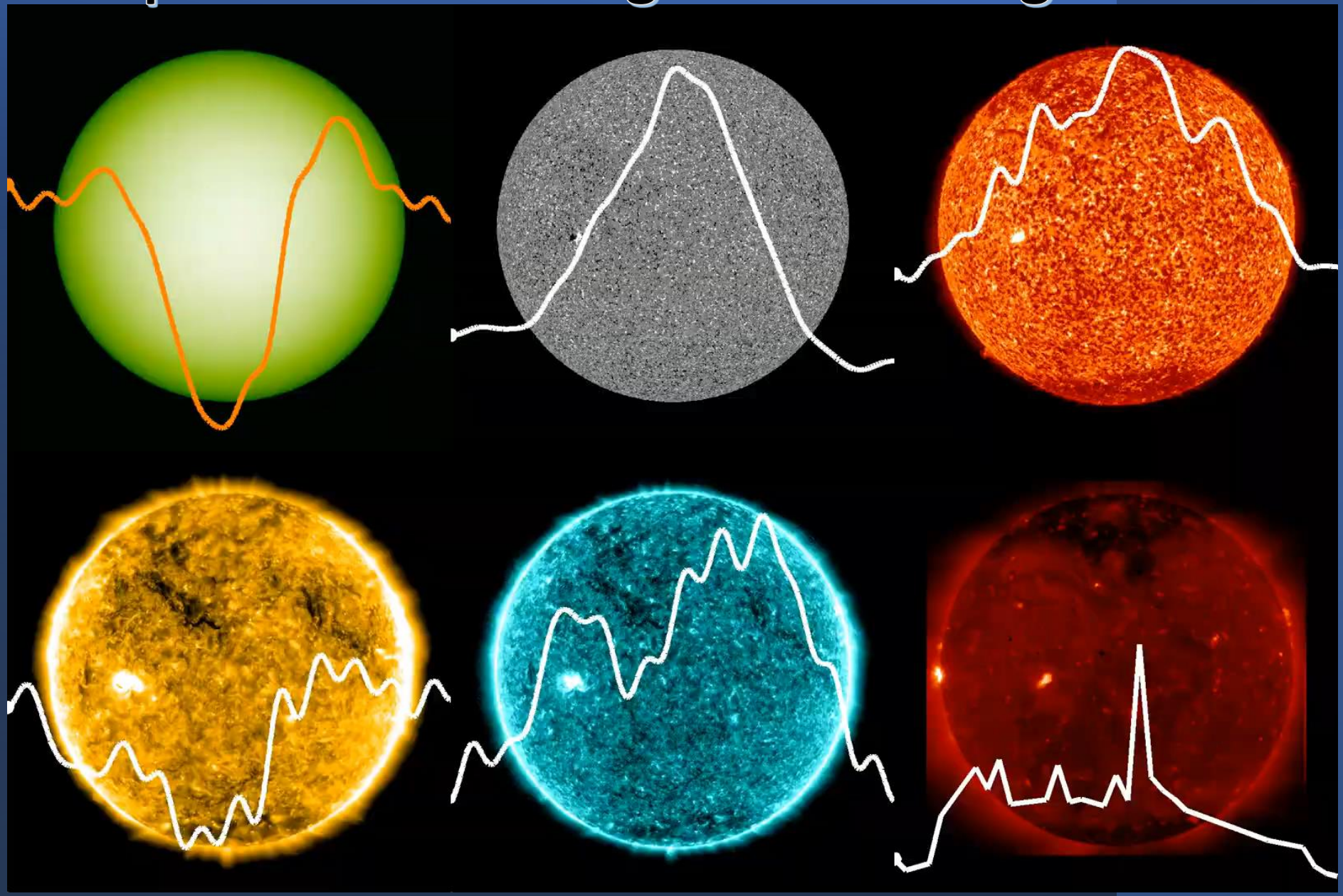
Yearly sunspots (Galileo to present)



Daily sunspots (1975 to the future!)



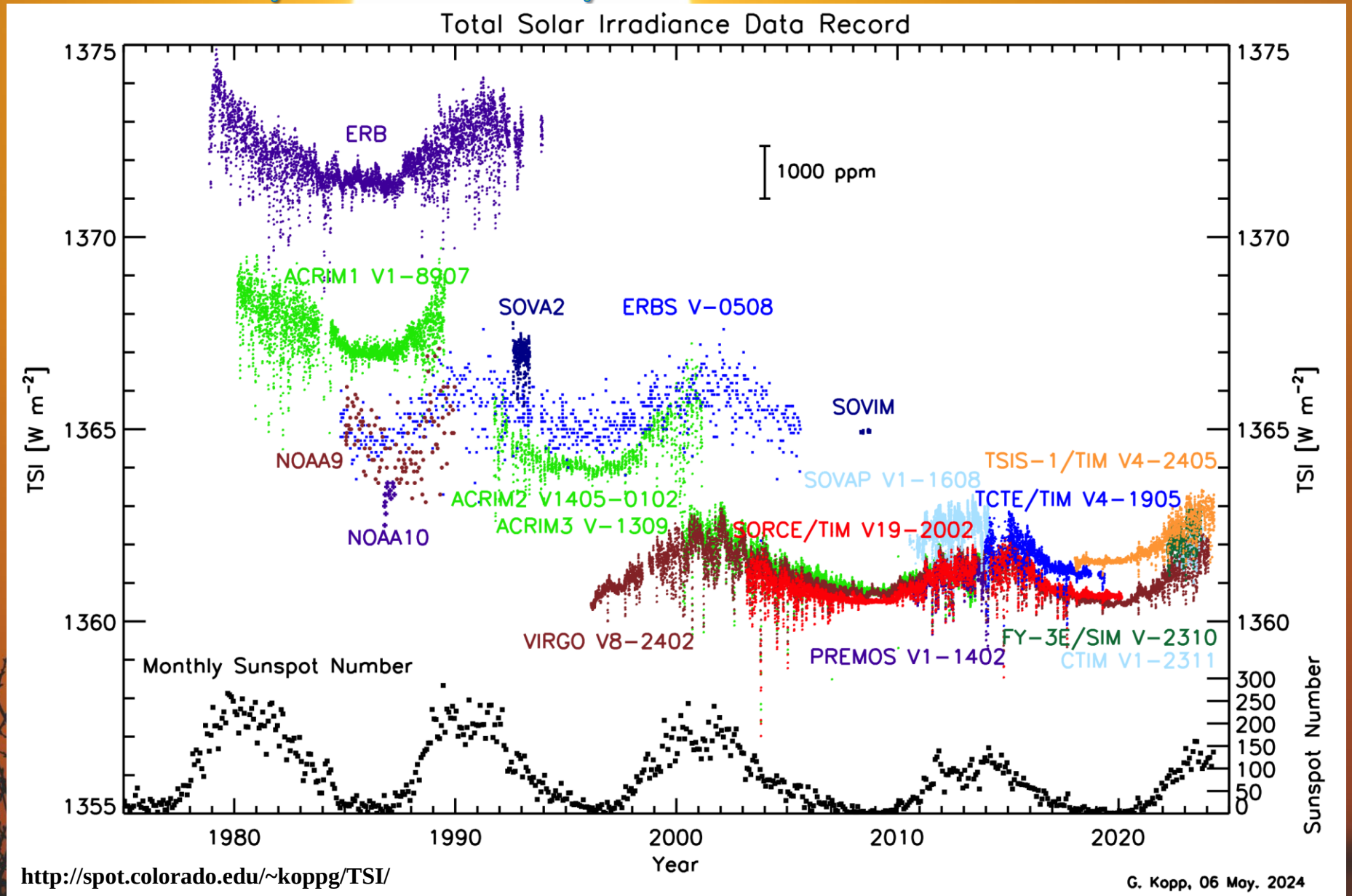
Different aspects of solar magnetism during solar rotation



Source: NASA

https://www.nasa.gov/feature/goddard/2020/a-new-look-at-sunspots-is-helping-nasa-scientists-understand-major-flares-and-life-around/

Thirteen instruments with 13 TSI values: How do you correctly normalize them all?

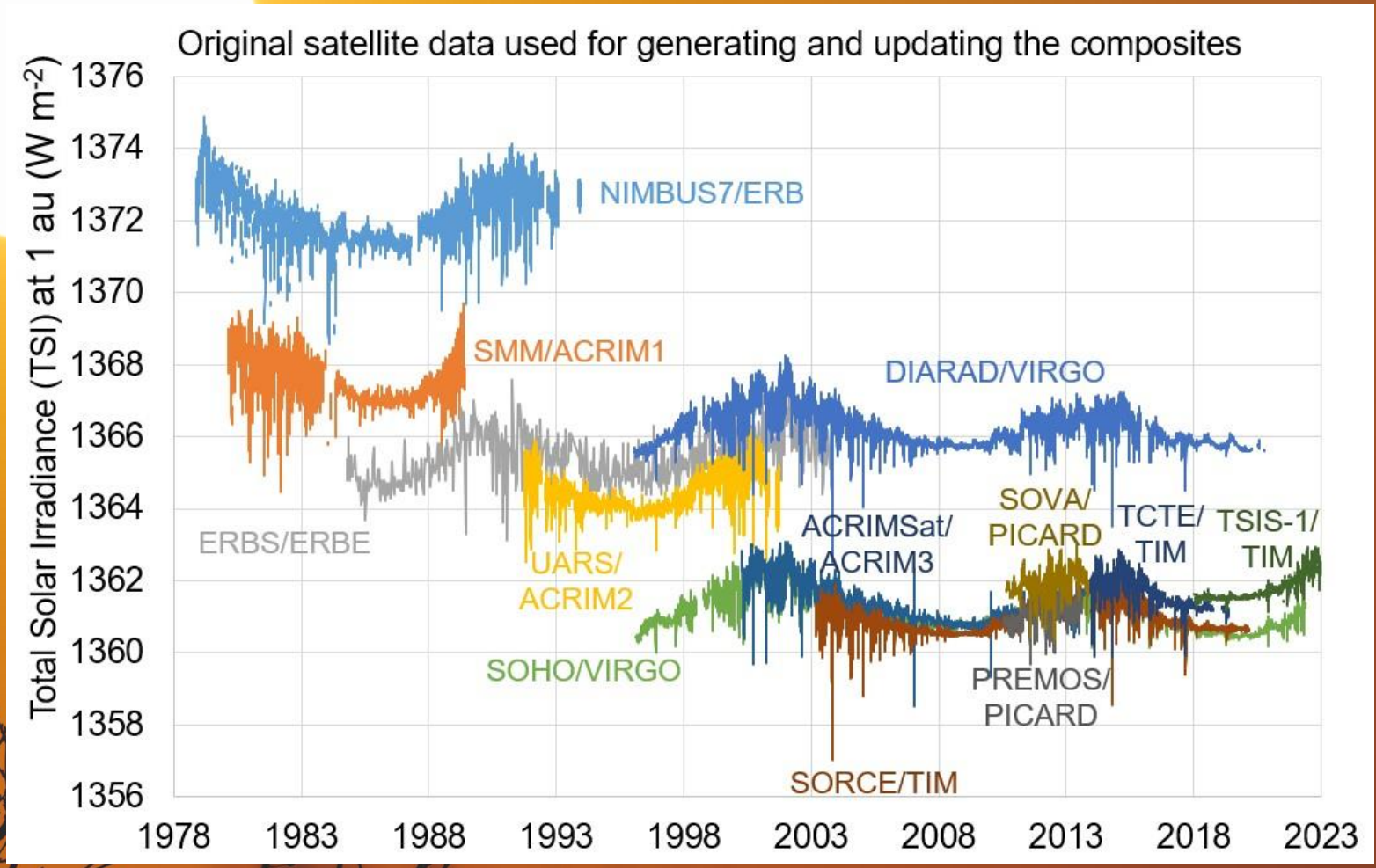


http://spot.colorado.edu/~koppg/TSI/

G. Kopp, 06 May. 2024

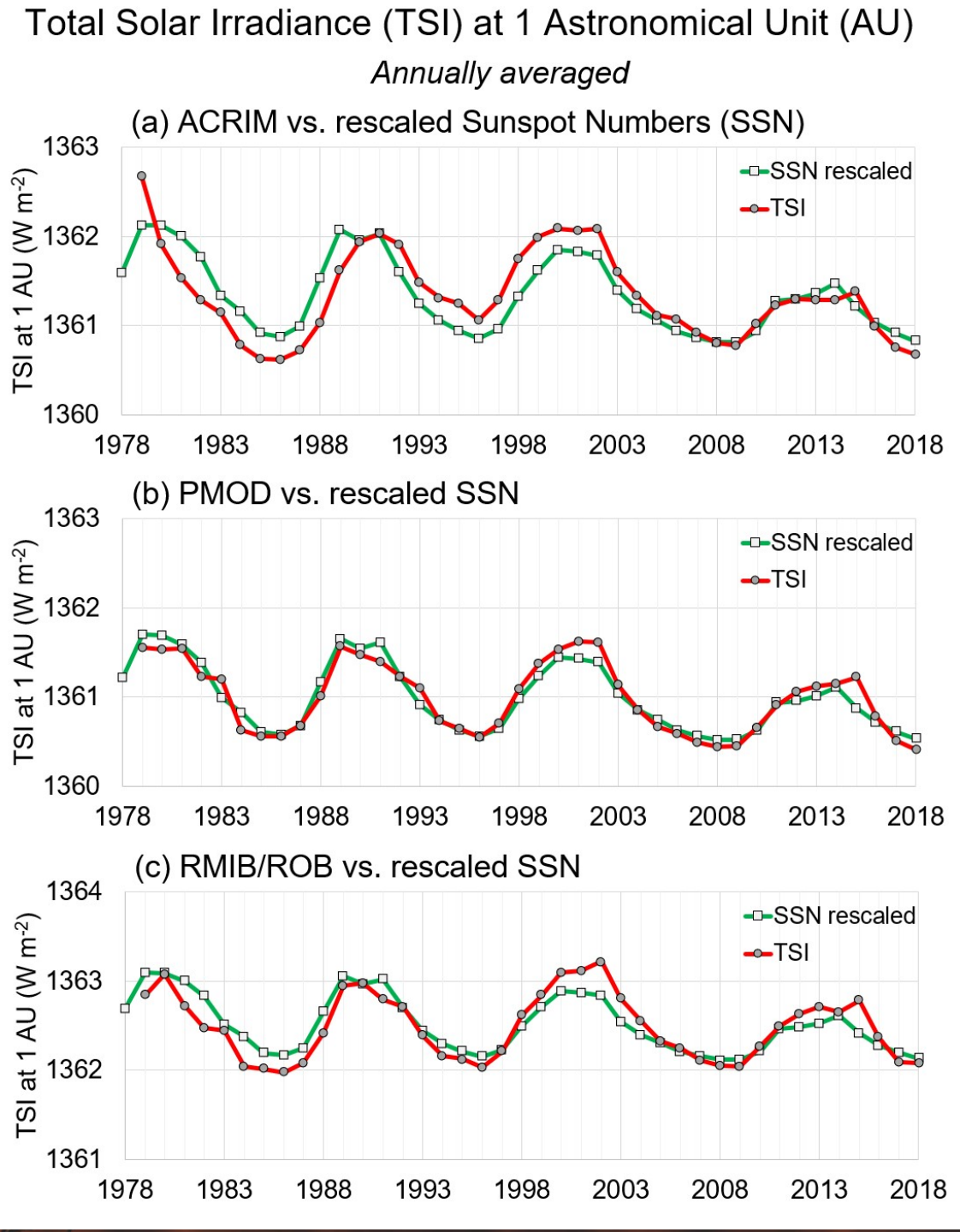
The satellite era TSI problem!

- Direct measurements of Total Solar Irradiance (TSI) above the Earth's atmosphere **only** began in 1978
- Each satellite only lasts 10-15 years. And implies a different average TSI!
- All capture the up/down roughly 11 year sunspot cycle.
- But, each shows different trends between cycles.

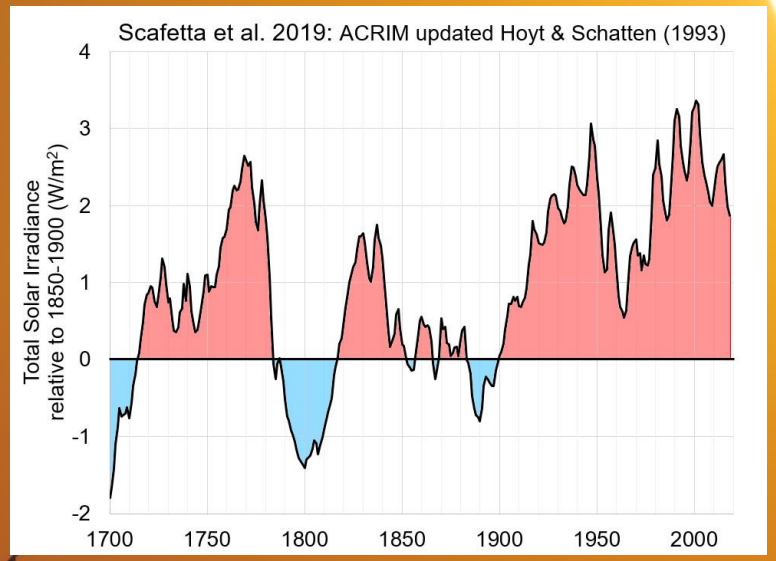


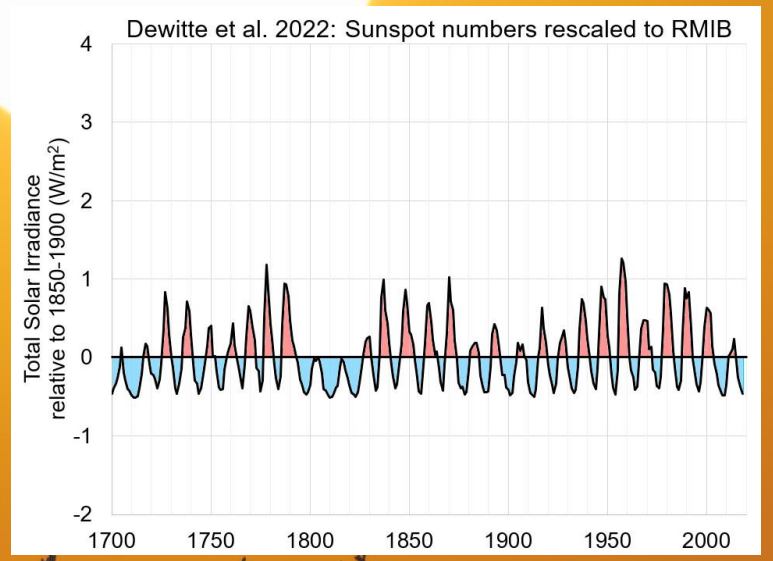
Using satellite TSI composites to calibrate solar proxies

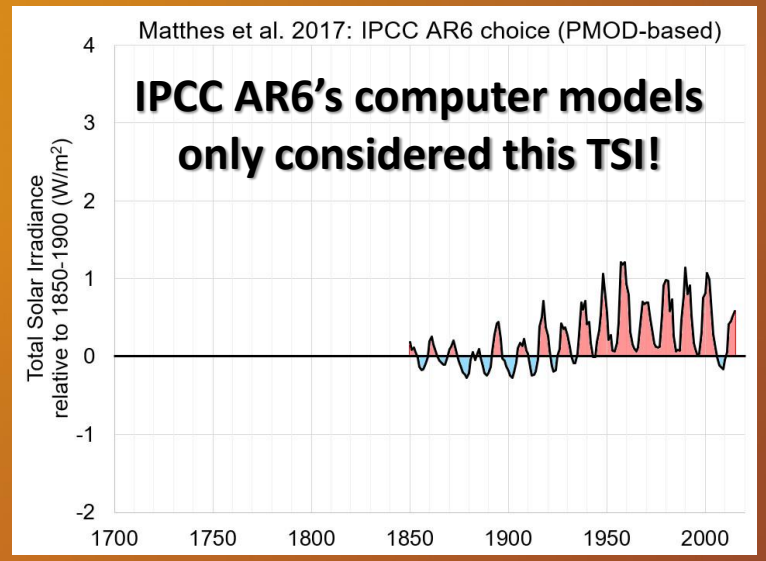
- By scaling a solar proxy to match TSI in the satellite era, you can extend the rescaled proxy TSI values for the entire solar proxy record
- But, the solar proxies do not capture all of the observed TSI variability during the satellite era – so they might be missing important trends for the pre-satellite era too
- PMOD matches almost exactly to SSN. PMOD-scaled reconstructions are simple! Just SSN and maybe 1 or 2 more proxies
- ACRIM suggests multiple different solar proxies needed – SSN is important but not enough!



Using satellite TSI composites to calibrate solar proxies: Three examples of very different TSI estimates





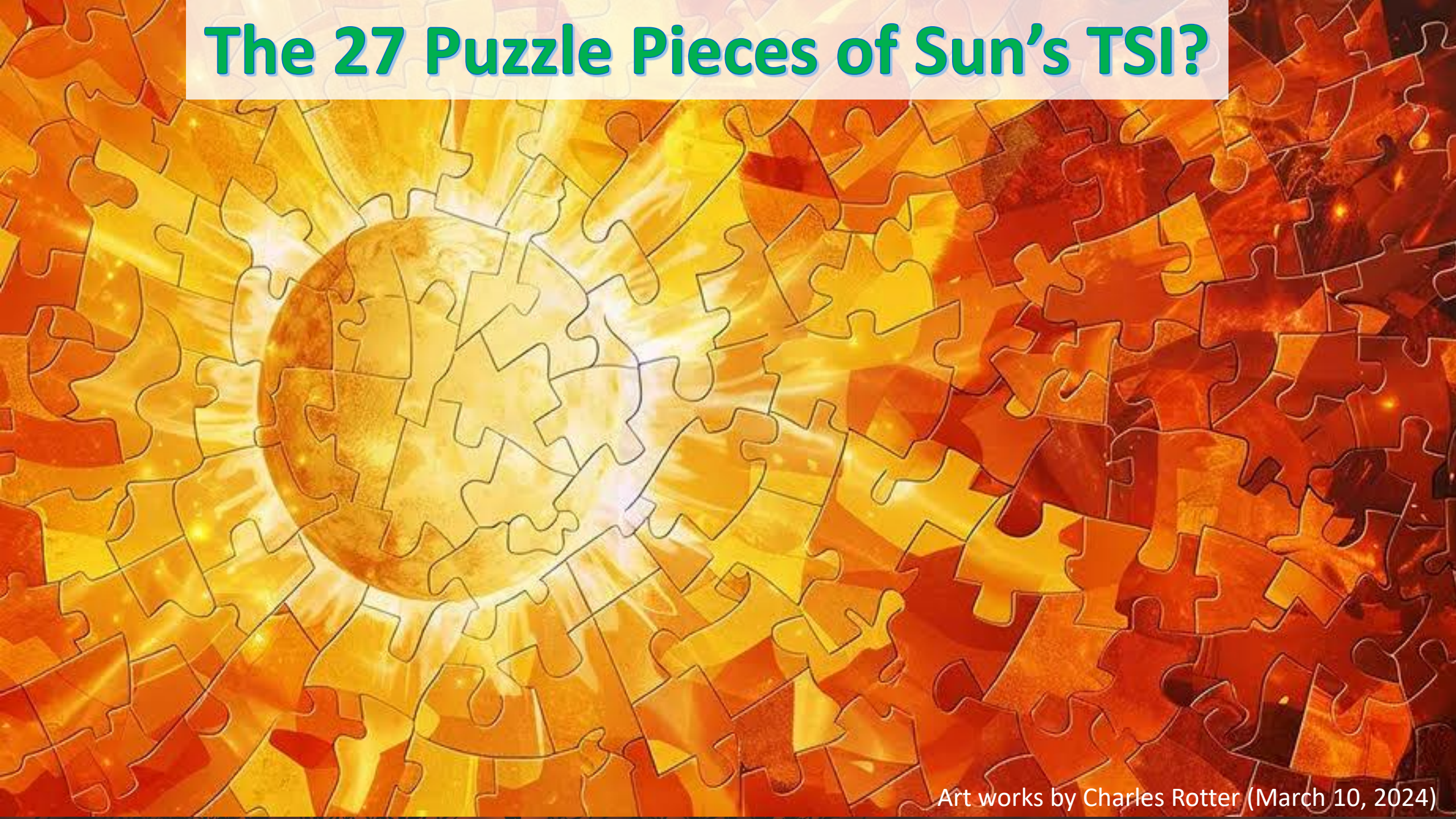


ACRIM-calibrated
5 solar proxies used

RMIB-calibrated
1 solar proxy used (SSN)

PMOD-calibrated
2-3 solar proxies used

The 27 Puzzle Pieces of Sun's TSI?

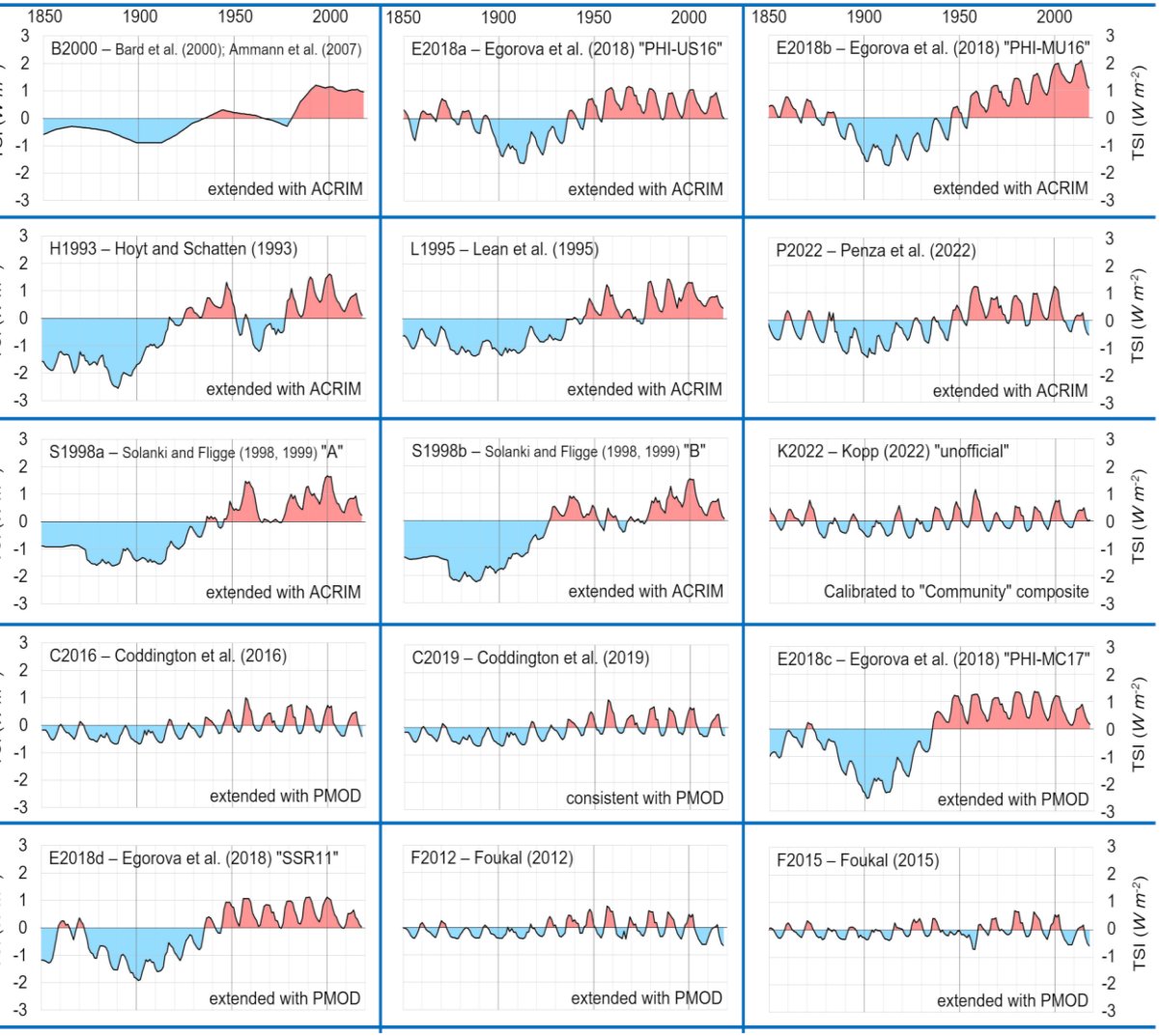


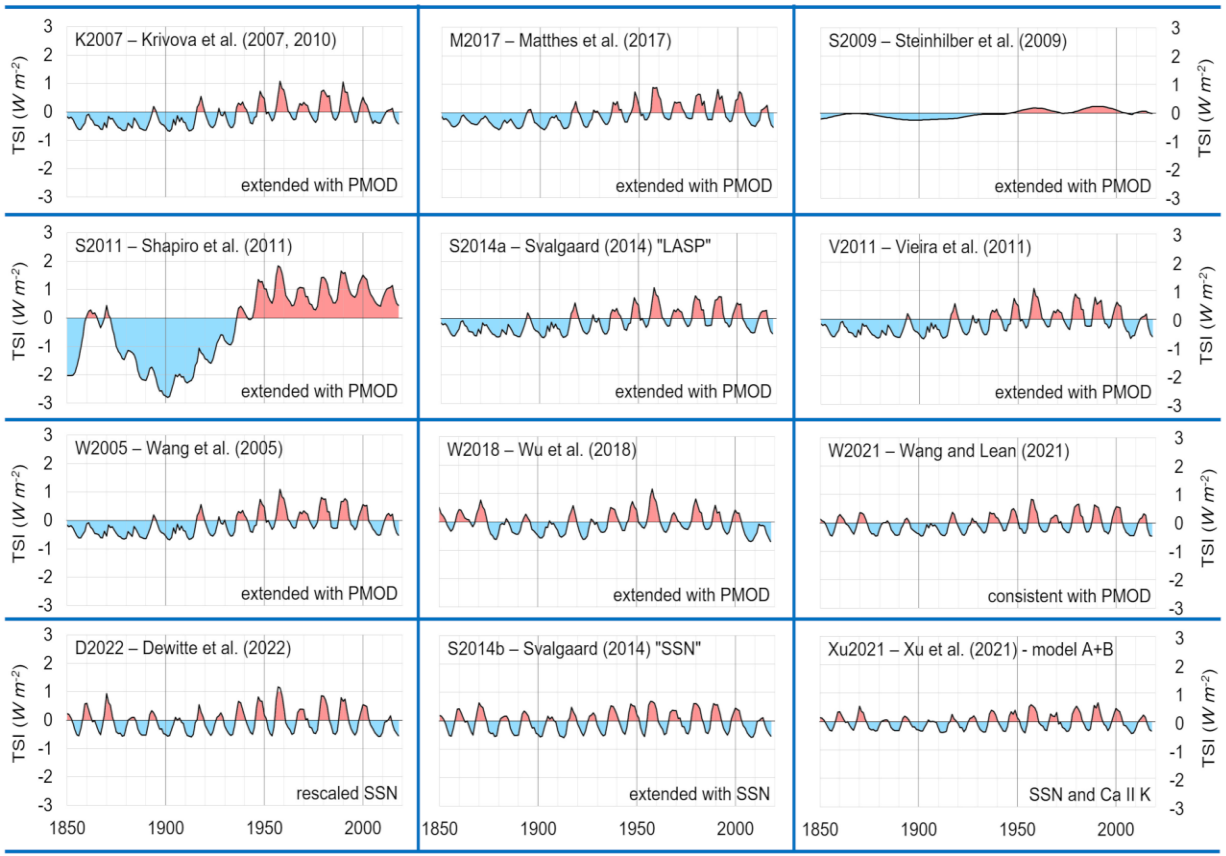
Art works by Charles Rotter (March 10, 2024)

Which of the 27 estimates is correct?

- We compiled 27 different TSI estimates and updated them all to cover period 1850-2018
- 8 ACRIM, 15 PMOD, 1 “Community” composite and 3 “SSN-based” estimates

TSI reconstructions (1850-2018), *relative to 1901-2000 average*





Connolly, Soon, Connolly et al. (2023) Research in Astronomy and Astrophysics, vol. 23, article # 105015

Which of the 27 estimates is correct?

- We compiled 27 different TSI estimates and updated them all to cover period 1850-2018
- 8 ACRIM, 15 PMOD, 1 “Community” composite and 3 “SSN-based” estimates
- IPCC AR4 in 2007 considered 6-10 TSI records: Chapter 2 and Supplementary Materials for Chapter 9

2

Changes in Atmospheric Constituents and in Radiative Forcing

Coordinating Lead Authors:
Piers Forster (UK), Venkatachalam Ramaswamy (USA)

Lead Authors:
Paulo Artaxo (Brazil), Terje Berntsen (Norway), Richard Betts (UK), David W. Fahey (USA), James Haywood (UK), Judith Lean (USA), David C. Lowe (New Zealand), Gunnar Myhre (Norway), John Nganga (Kenya), Ronald Prinn (USA, New Zealand), Graciela Raga (Mexico, Argentina), Michael Schulz (France, Germany), Robert Van Dorland (Netherlands)

9

Supplementary Materials

Understanding and Attributing Climate Change

Coordinating Lead Authors:
Gabriele C. Hegerl (USA, Germany), Francis W. Zwiers (Canada)

Lead Authors:
Pascale Braconnot (France), Nathan P. Gillett (UK), Yong Luo (China), Jose A. Marengo Orsini (Brazil, Peru), Neville Nicholls (Australia), Joyce E. Penner (USA), Peter A. Stott (UK)

Table 2.10. *Comparison of the estimates of the increase in RF from the 17th-century Maunder Minimum (MM) to contemporary solar minima, documenting new understanding since the TAR.*

Reference	Assumptions and Technique	RF Increase from the Maunder Minimum to Contemporary Minima ($W m^{-2}$)[a]	Comment on Current Understanding
Schatten and Orosz (1990)	Extrapolation of the 11-year irradiance cycle to the MM, using the sunspot record.	~ 0	Irradiance levels at cycle minima remain approximately constant.
Lean et al. (1992)	No spots, plage or network in Ca images assumed during MM.	0.26	Maximum irradiance increase from a non-magnetic sun, due to changes in known bright features on contemporary solar disk.
Lean et al. (1992)	No spots, plage or network and reduced basal emission in cell centres in Ca images to match reduced brightness in non-cycling stars, assumed to be MM analogues.	0.45	New assessment of stellar data (Hall and Lockwood, 2004) does not support original stellar brightness distribution, or the use of the brightness reduction in the Baliunas and Jastrow (1990) ‘non-cycling’ stars as MM analogues.
Hoyt and Schatten (1993)[b]	Convective restructuring implied by changes in sunspot umbra/penumbra ratios from MM to present: amplitude of increase from MM to present based on brightness of non-cycling stars, from Lean et al. (1992).	0.65	As above
Lean et al. (1995)	Reduced brightness of non-cycling stars, relative to those with active cycles, assumed typical of MM.	0.45	As above
Solanki and Fligge (1999)[b]	Combinations of above.	0.68	As above
Lean (2000)	Reduced brightness of non-cycling stars (revised solar-stellar calibration) assumed typical of MM.	0.38	As above
Foster (2004) Model	Non-magnetic sun estimates by removing bright features from MDI images assumed for MM.	0.28	Similar approach to removal of spots, plage and network by Lean et al. (1992).
Y. Wang et al. (2005)[b]	Flux transport simulations of total magnetic flux evolution from MM to present.	0.1	Solar model suggests that modest accumulation of magnetic flux from one solar cycle to the next produces a modest increase in irradiance levels at solar cycle minima.
Dziembowski et al. (2001)	Helioseismic observations of solar interior oscillations suggest that the historical Sun could not have been any dimmer than current activity minima.	~ 0	

SOL = solar irradiance
L95: Lean et al. (1995).
L95 (C00): temporally varying solar constant based on Lean et al. (1995) (Crowley, 2000).
L00: Lean (2000).
L02: Lean et al. (2002).
HS: Hoyt and Schatten (1993).
SK: Solanki and Krivova (2003).

Which of the 27 estimates is correct?

- We compiled 27 different TSI estimates and updated them all to cover period 1850-2018
- 8 ACRIM, 15 PMOD, 1 “Community” composite and 3 “SSN-based” estimates
- IPCC AR4 in 2007 considered 6-10 TSI records: Chapter 2 and Supplementary Materials for Chapter 9

2

Changes in Atmospheric Constituents and in Radiative Forcing

Coordinating Lead Authors:
Piers Forster (UK), Venkatachalam Ramaswamy (USA)

Lead Authors:
Paulo Artaxo (Brazil), Terje Berntsen (Norway), Richard Betts (UK), David W. Fahey (USA), James Haywood (UK), Judith Lean (USA), David C. Lowe (New Zealand), Gunnar Myhre (Norway), John Nganga (Kenya), Ronald Prinn (USA, New Zealand), Graciela Raga (Mexico, Argentina), Michael Schulz (France, Germany), Robert Van Dorland (Netherlands)

9

Supplementary Materials

Understanding and Attributing Climate Change

Coordinating Lead Authors:
Gabriele C. Hegerl (USA, Germany), Francis W. Zwiers (Canada)

Lead Authors:
Pascale Braconnot (France), Nathan P. Gillett (UK), Yong Luo (China), Jose A. Marengo Orsini (Brazil, Peru), Neville Nicholls (Australia), Joyce E. Penner (USA), Peter A. Stott (UK)

Table 2.10. *Comparison of the estimates of the increase in RF from the 17th-century Maunder Minimum (MM) to contemporary solar minima, documenting new understanding since the TAR.*

Reference	Assumptions and Technique	RF Increase from the Maunder Minimum to Contemporary Minima (W m^{-2})[a]	Comment on Current Understanding
Schatten and Orosz (1990)	Extrapolation of the 11-year irradiance cycle to the MM, using the sunspot record.	~ 0	Irradiance levels at cycle minima remain approximately constant.
Lean et al. (1992)	No spots, plage or network in Ca images assumed during MM.	0.26	Maximum irradiance increase from a non-magnetic sun, due to changes in known bright features on contemporary solar disk.
Lean et al. (1992)	No spots, plage or network and reduced basal emission in cell centres in Ca images to match reduced brightness in non-cycling stars, assumed to be MM analogues.	0.45	New assessment of stellar data (Hall and Lockwood, 2004) does not support original stellar brightness distribution, or the use of the brightness reduction in the Baliunas and Jastrow (1990) ‘non-cycling’ stars as MM analogues.
Hoyt and Schatten (1993)[b]	Convective restructuring implied by changes in sunspot umbra/penumbra ratios from MM to present: amplitude of increase from MM to present based on brightness of non-cycling stars, from Lean et al. (1992).	0.65	As above
Lean et al. (1995)	Reduced brightness of non-cycling stars, relative to those with active cycles, assumed typical of MM.	0.45	As above
Solanki and Fligge (1999)[b]	Combinations of above.	0.68	As above
Lean (2000)	Reduced brightness of non-cycling stars (revised solar-stellar calibration) assumed typical of MM.	0.38	As above
Foster (2004) Model	Non-magnetic sun estimates by removing bright features from MDI images assumed for MM.	0.28	Similar approach to removal of spots, plage and network by Lean et al. (1992).
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SOL = solar irradiance
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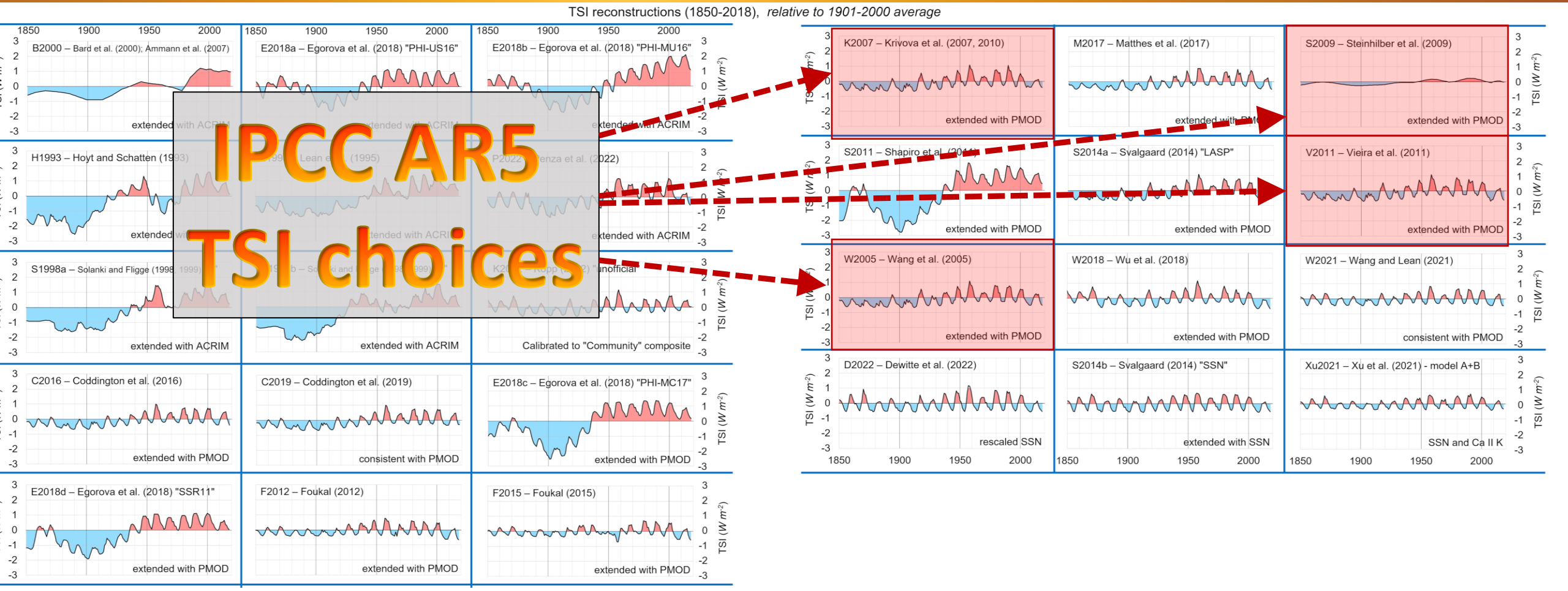
L00: Lean (2000).
L02: Lean et al. (2002).
HS: Hoyt and Schatten (1993).
SK: Solanki and Krivova (2003).

Note that HS93 was one of the main TSI reconstructions considered in IPCC AR4 (2007)

Which of the 27 estimates is correct?

- We compiled 27 different TSI estimates and updated them all to cover period 1850-2018
- 8 ACRIM, 15 PMOD, 1 “Community” composite and 3 “SSN-based” estimates
- IPCC AR5 considered 4 of these: K2007, S2009, V2011 and W2005
- IPCC AR6 only considered 1 of them: M2017 (the average of C2016 and K2007)



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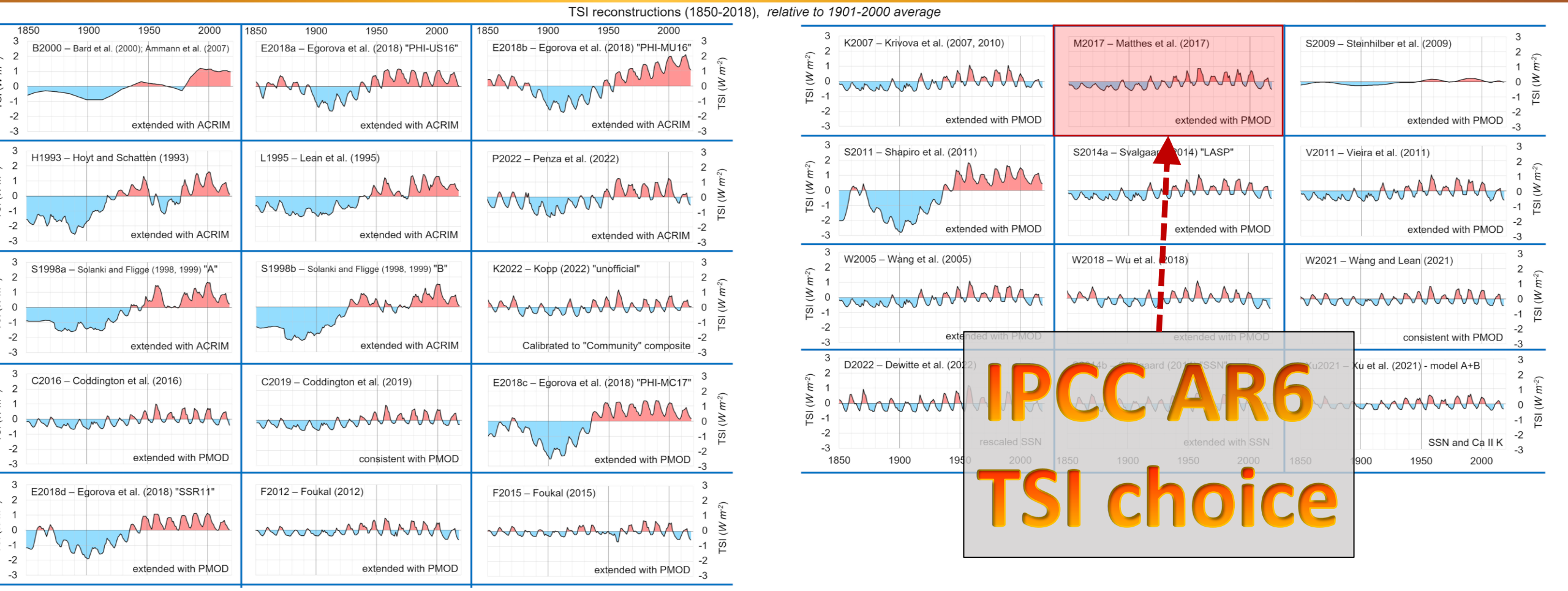

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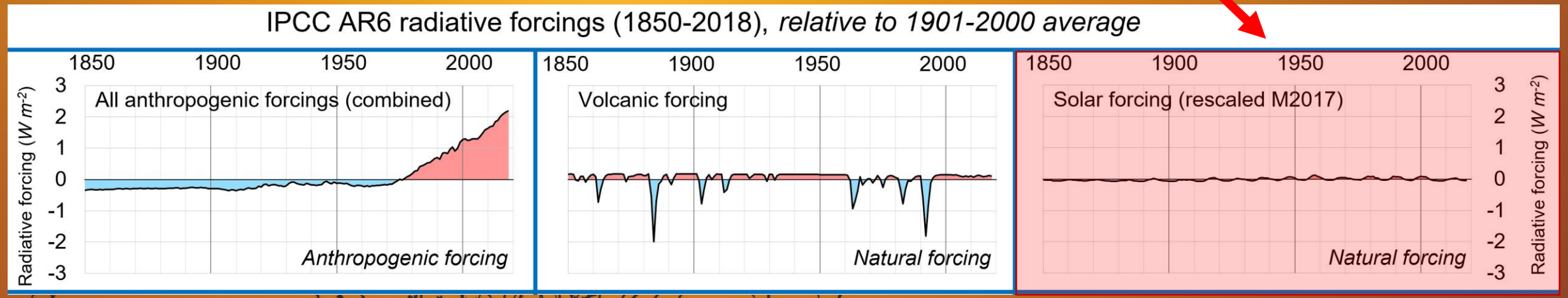
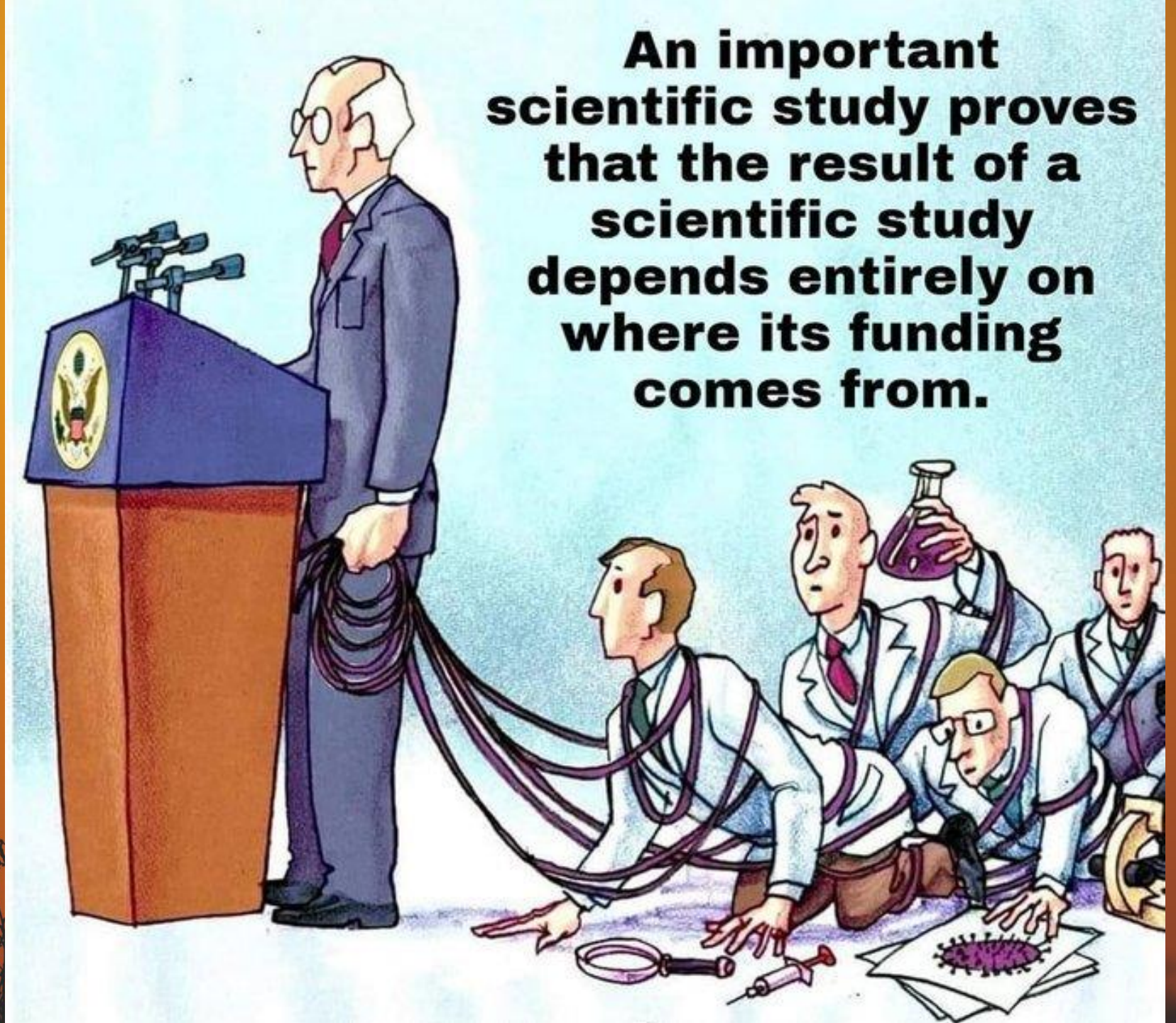
8 ACRIM-calibrated Available now

Can you honestly say IPCC AR6 (2023)'s single choice of TSI is correct?

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The Detection and Attribution of Northern Hemisphere Land Surface Warming (1850–2018) in Terms of Human and Natural Factors: Challenges of Inadequate Data

by Willie Soon [1,2], Ronan Connolly [1,3,*], Michael Connolly [1,3], Syun-Ichi Akasofu [4], Sallie Baliunas [5,†], Johan Berglund [6], Antonio Bianchini [7,8], William M. Briggs [9], C. J. Butler [10,†], Rodolfo Gustavo Cionco [11,12], Marcel Crok [13], Ana G. Elias [14], Valery M. Fedorov [15], François Gervais [16], Hermann Harde [17], Gregory W. Henry [18], Douglas V. Hoyt [19], Ole Humlum [20], David R. Legates [21,22,†], Anthony R. Lupo [23], Shigenori Maruyama [24,†], Patrick Moore [25], Maxim Ogurtsov [26,27], Coilín ÓhAiseadha [28], Marcos J. Oliveira [29], Seok-Soon Park [30], Shican Qiu [31], Gerré Quinn [32], Nicola Scafetta [33], Jan-Erik Solheim [34,†], Jim Steele [35,†], László Szarka [2], Hiroshi L. Tanaka [36,†], Mitchell K. Taylor [37], Fritz Vahrenholt [38], Víctor M. Velasco Herrera [39] and Weijia Zhang [40] — Hide full author list

1 Center for Environmental Research and Earth Sciences (CERES), Salem, MA 01970, USA
2 Institute of Earth Physics and Space Science (EPSS), H-9400 Sopron, Hungary
3 Independent Researcher, D08 Dublin, Ireland
4 International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK 99775, USA
5 Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA
6 Independent Researcher, 211 10 Malmö, Sweden
7 Osservatorio Astronomico di Padova, INAF, Vicolo Osservatorio 5, 35122 Padova, Italy
8 Department of Physics and Astronomy, University of Padua, Via Francesco Marzolo, 8, 35131 Padova, Italy
9 Independent Researcher, Charlevoix, MI 49720, USA
10 Armagh Observatory, College Hill, Armagh BT61 9DG, UK
+ Show full affiliation list
* Author to whom correspondence should be addressed.
† Retired.

Climate **2023**, *11*(9), 179; https://doi.org/10.3390/cli11090179

Submission received: 19 July 2023 / Revised: 21 August 2023 / Accepted: 22 August 2023 / Published: 28 August 2023

Research in Astronomy and Astrophysics, 23:105015 (20pp), 2023 October https://doi.org/10.1088/1674-4527/acf18e
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October 2023

Challenges in the Detection and Attribution of Northern Hemisphere Surface Temperature Trends Since 1850

Ronan Connolly[1,2], Willie Soon[1,3], Michael Connolly[1,2], Sallie Baliunas[4], Johan Berglund[5], C. J. Butler[6], Rodolfo Gustavo Cionco[7,8], Ana G. Elias[9,10], Valery M. Fedorov[11], Hermann Harde[12], Gregory W. Henry[13], Douglas V. Hoyt[14], Ole Humlum[15], David R. Legates[16], Nicola Scafetta[17], Jan-Erik Solheim[18], László Szarka[3], Víctor M. Velasco Herrera[19], Hong Yan[20], and Weijia Zhang[21]

[1] Center for Environmental Research and Earth Science (CERES), Salem, MA 01970, USA; ronan@ceres-science.com
[2] Independent scientists, Dublin, Ireland
[3] Institute of Earth Physics and Space Science (EPSS), Sopron, Hungary
[4] Retired, formerly Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA
[5] Independent researcher, Malmö, Sweden
[6] Retired, formerly Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland, UK
[7] Comisión de Investigaciones Científicas de la Provincia de Buenos Aires, Argentina
[8] Grupo de Estudios Ambientales, Universidad Tecnológica Nacional, Colón 332, San Nicolás (2900), Buenos Aires, Argentina
[9] Laboratorio de Ionosfera, Atmosfera Neutra y Magnetosfera (LIANM), Facultad de Ciencias Exactas y Tecnología, Universidad Nacional de Tucumán, Av. Independencia 1800, 4000 Tucumán, Argentina
[10] Instituto de Física del Noroeste Argentino (Consejo Nacional de Investigaciones Científicas y Técnicas—Universidad Nacional de Tucumán), 4000 Tucumán, Argentina
[11] Faculty of Geography, Lomonosov Moscow State University, Leninskie Gory St. 1, Moscow 119991, Russia
[12] Helmut-Schmidt-University, Hamburg, Germany
[13] Center of Excellence in Information Systems, Tennessee State University, Nashville, TN 37209 USA
[14] Independent scientist, Berkeley Springs, WV, USA
[15] Emeritus Professor in Physical Geography, Department of Geosciences, University of Oslo, Norway
[16] Professor Emeritus, College of Earth, Ocean, and the Environment, University of Delaware, Newark DE 19716-2541, USA
[17] Department of Earth Sciences, Environment and Georesources, University of Naples Federico II, Complesso Universitario di Monte S. Angelo, via Cinthia, 21, I-80126 Naples, Italy
[18] Retired, formerly Department of Physics and Technology, UiT The Arctic University of Norway, 9037 Tromsø, Norway
[19] Instituto de Geofisica, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, 04510, México D.F., México
[20] State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710061, China
[21] Department of Mathematics and Physics, Shaoxing University, Shaoxing 312000, China
Received 2023 July 26; revised 2023 August 9; accepted 2023 August 15; published 2023 September 27

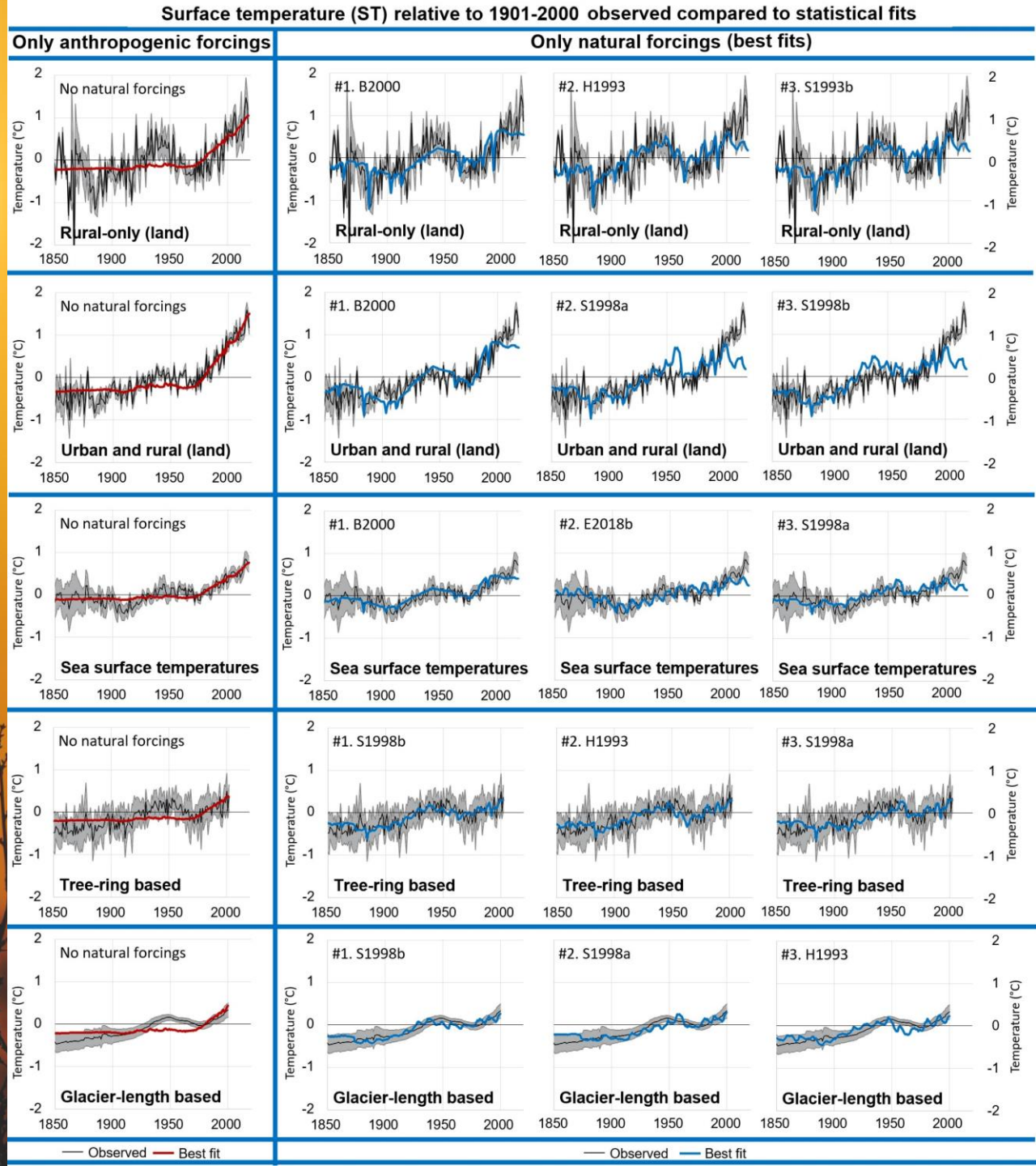
Abstract

Since 2007, the Intergovernmental Panel on Climate Change (IPCC) has heavily relied on the comparison between global climate model hindcasts and global surface temperature (ST) estimates for concluding that post-1950s global warming is mostly human-caused. In Connolly et al., we cautioned that this approach to the detection and attribution of climate change was highly dependent on the choice of Total Solar Irradiance (TSI) and ST data sets. We compiled 16 TSI and five ST data sets and found by altering the choice of TSI or ST, one could (prematurely) conclude anything from the warming being "mostly human-caused" to "mostly natural." Richardson and Benestad suggested our analysis was "erroneous" and "flawed" because we did not use a multilinear regression. They argued that applying a multilinear regression to one of the five ST series re-affirmed the IPCC's attribution statement. They also objected that many of the published TSI data sets were out-of-date. However, here we show that when applying multilinear regression analysis to an expanded and updated data set of 27 TSI series, the original conclusions of Connolly et al. are confirmed for all five ST data sets. Therefore, it is still unclear whether the observed warming is mostly human-caused, mostly natural or some combination of both.

Key words: Sun: activity – (Sun:) solar-terrestrial relations – Earth

C2023: Five temperature estimates and 27 TSI series

- If we look at the fits themselves, we find that the best-fitting ACRIM-calibrated TSI records capture the warming and cooling periods surprisingly well
- In contrast, the “only anthropogenic factors” can only really capture the recent warming since the 1970s
- We don’t know which of the 27 TSI is most accurate – but neither does the IPCC!!!



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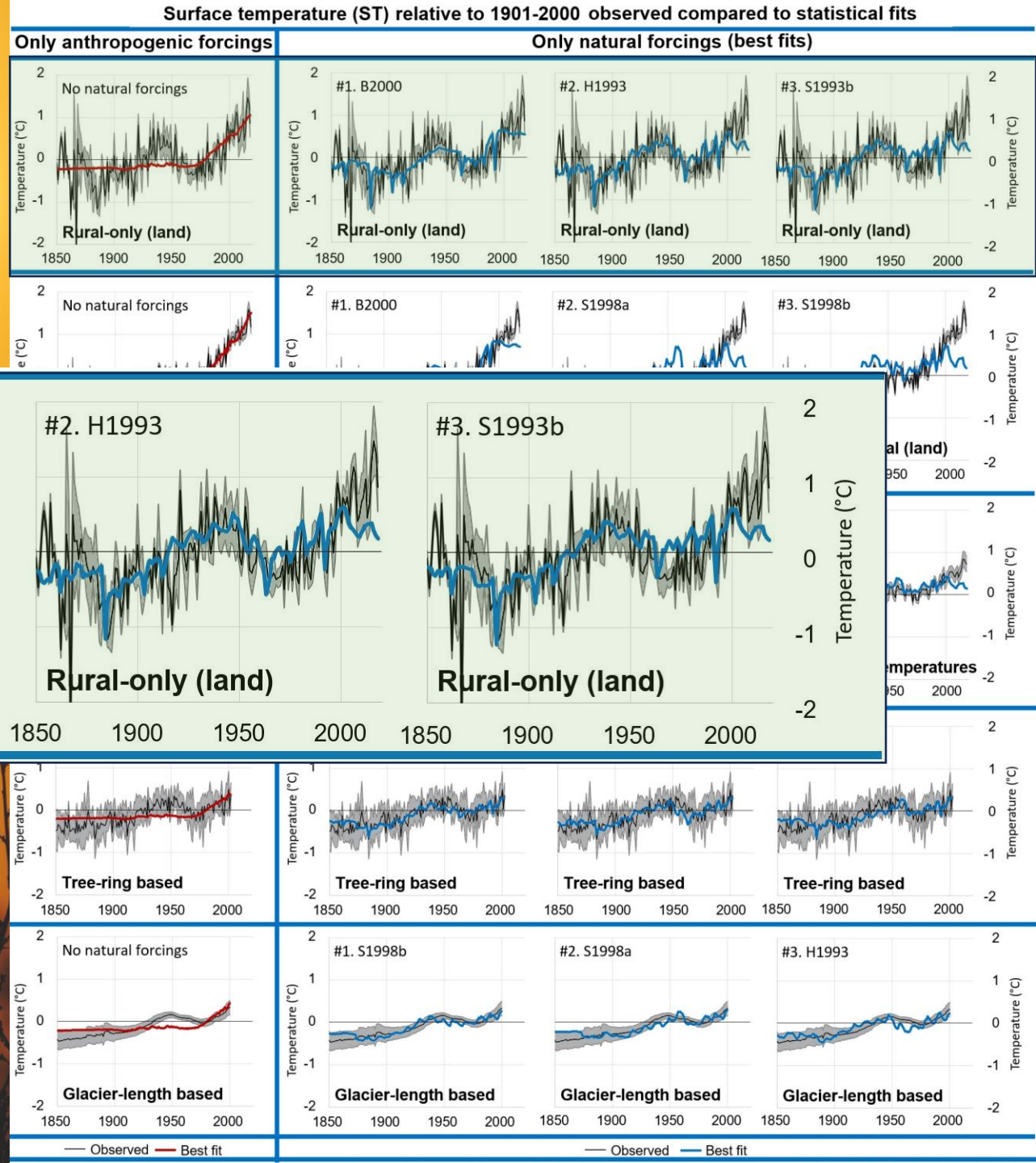

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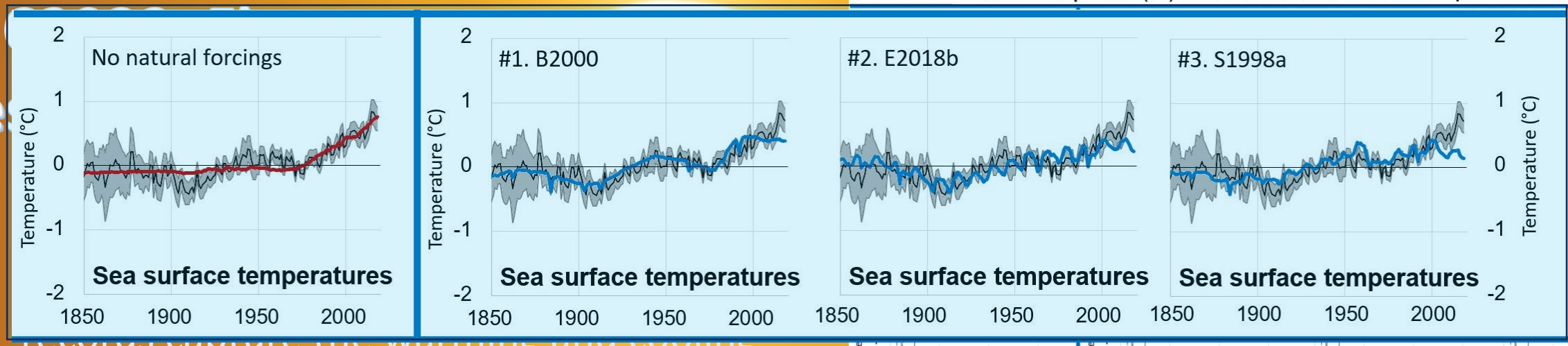

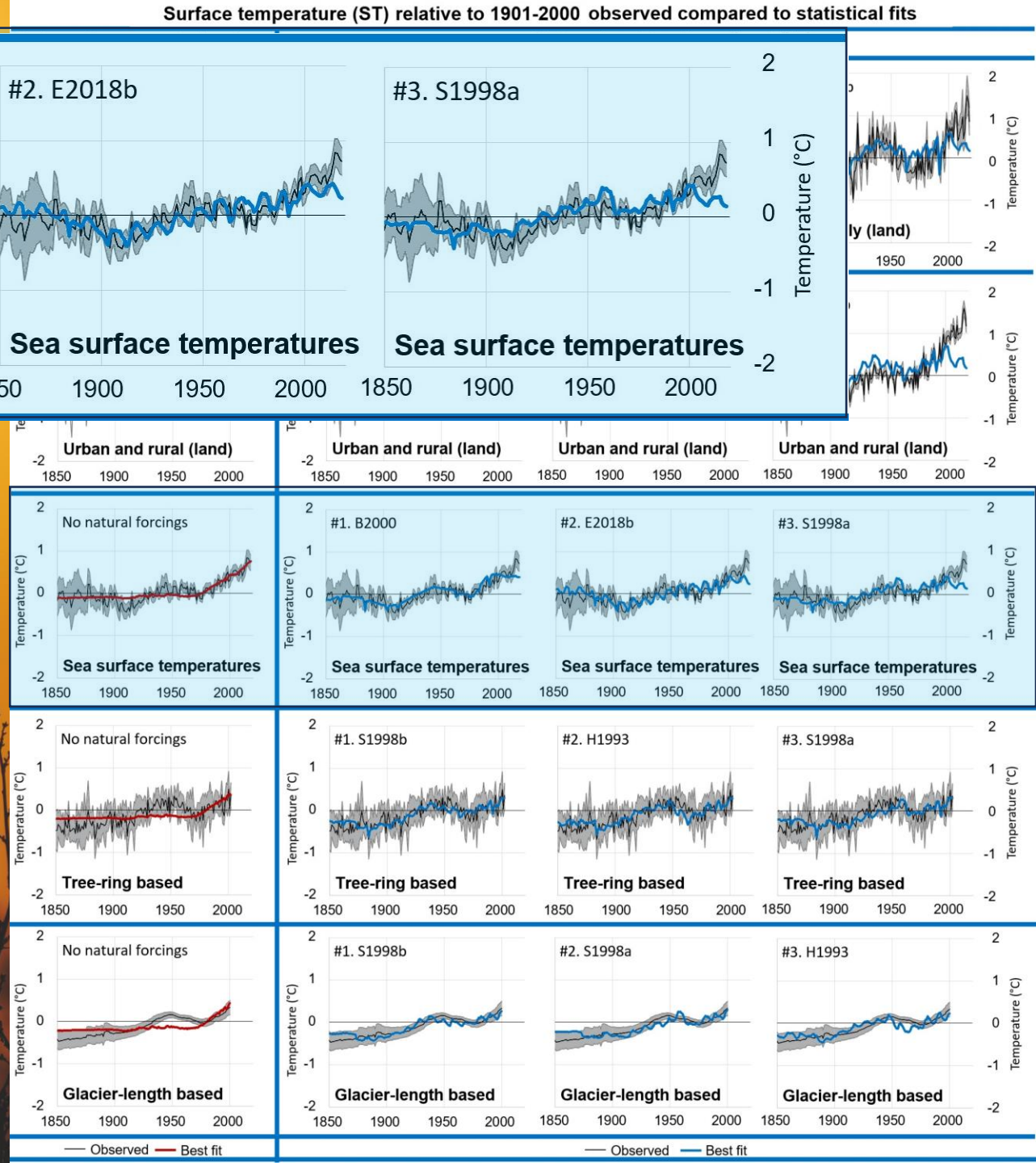

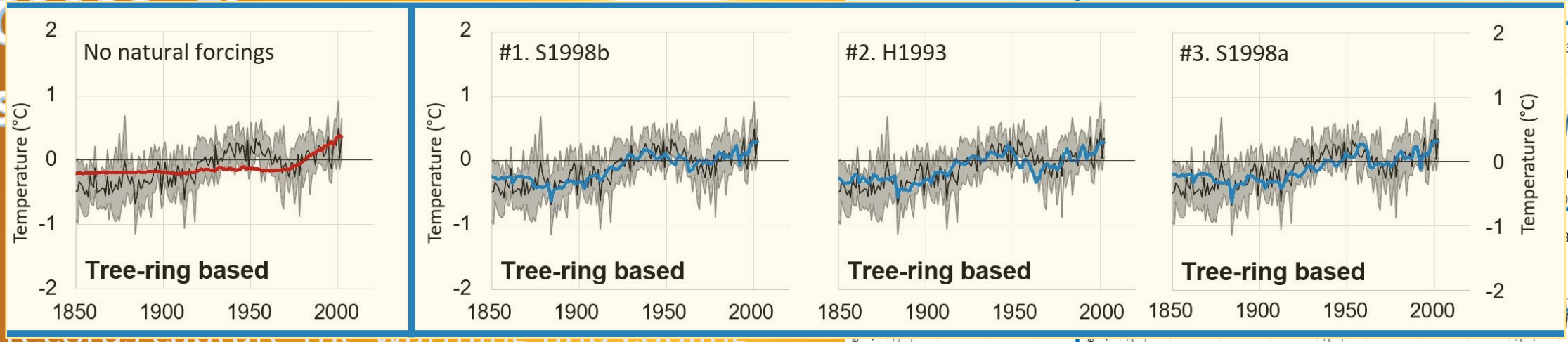

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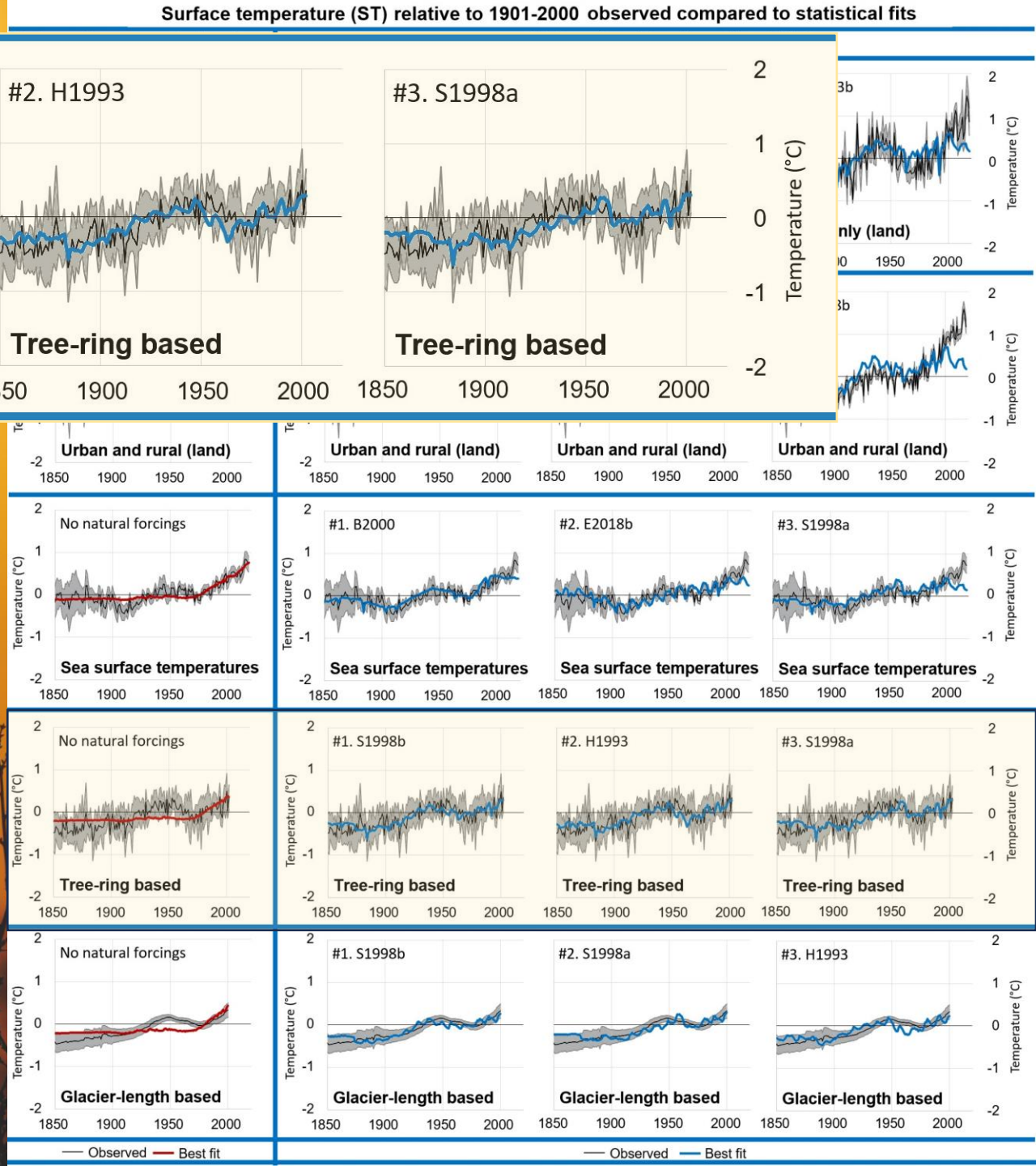

Conclusions

- The IPCC insist that urbanization bias is less than 10% of the warming and therefore doesn't need to be accounted for – They are wrong on impacts of UHI!
- The IPCC insist that they have already resolved the best solar activity ("TSI") records, for their latest 6th Assessment Report (2021), they only considered one estimate. But, we have found 27. They are wrong on TSI too!
- When we consider the non-urbanized temperature data, we can explain almost all the observed warming **and** cooling periods since 1850 in terms of changes in the Sun: whether looking at rural temperatures, ocean temperatures or temperature proxies (tree-rings and glaciers).
- The scientific community **is not yet able** to establish if the global warming since 1850 is: a) "mostly natural", b) "both natural and human-caused" or c) "mostly human-caused".
- The measurements of the Earth's Energy Budget, on a global-scale, are highly uncertain and mostly unresolved because the total global energy budget is not accounted for up to **6.5 W/m²** at the TOA and up to **17 W/m²** at the surface.

"The central mystery of climate science"

"The people who are supposed to be the experts and who claim to understand the science are precisely the people who are blind to the evidence...I hope that a few of them will make the effort to examine the evidence in detail and see how it contradicts the prevailing dogma, but I know that the majority will remain blind. That to me is the central mystery of climate science. It is not a scientific mystery but a human mystery. How does it happen that the whole generation of scientific experts is blind to obvious facts?" **– Freeman Dyson, foreword in a GWPF report on "Carbon Dioxide: The Good News" by Indur Goklany (2015)**

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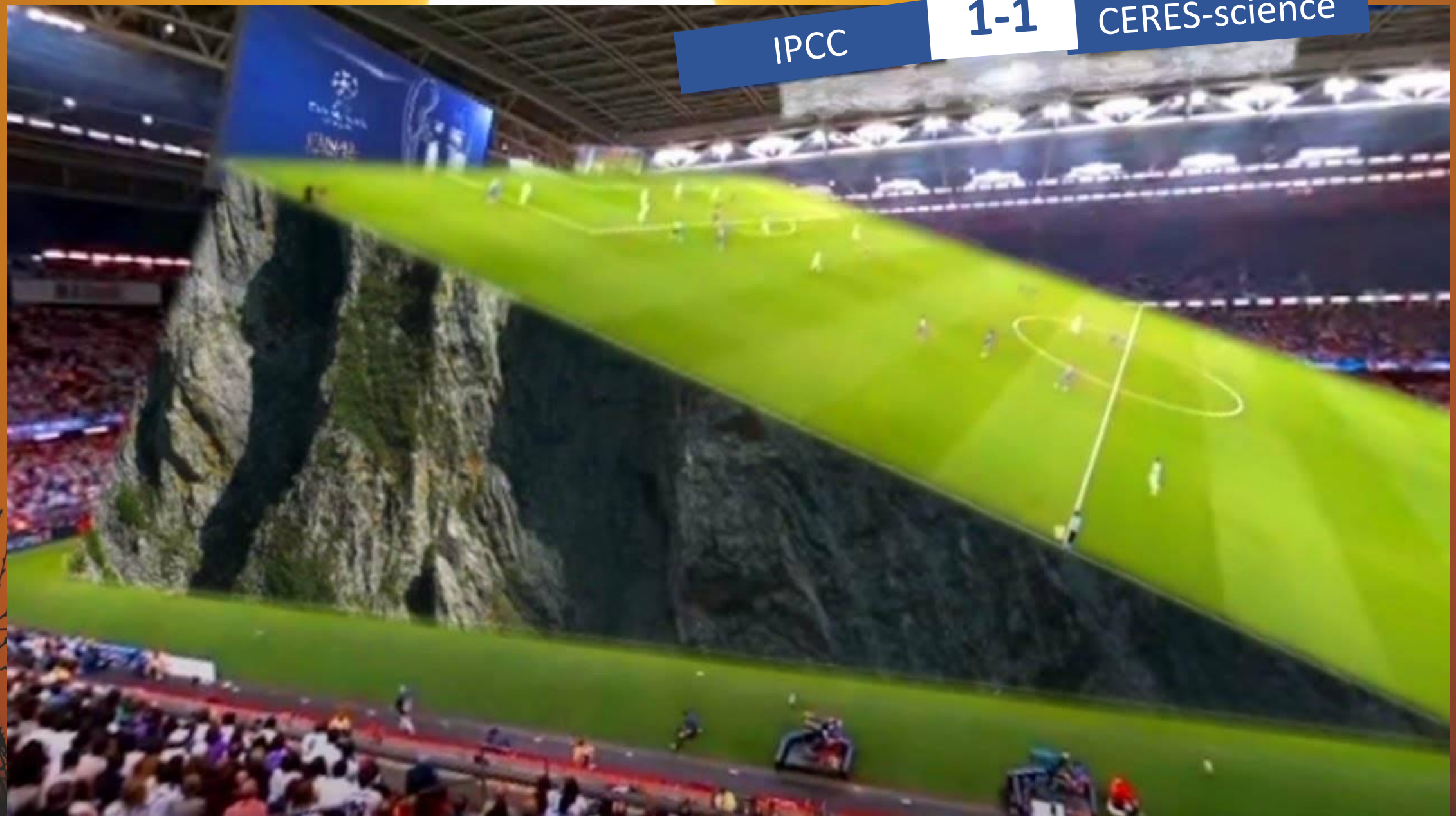

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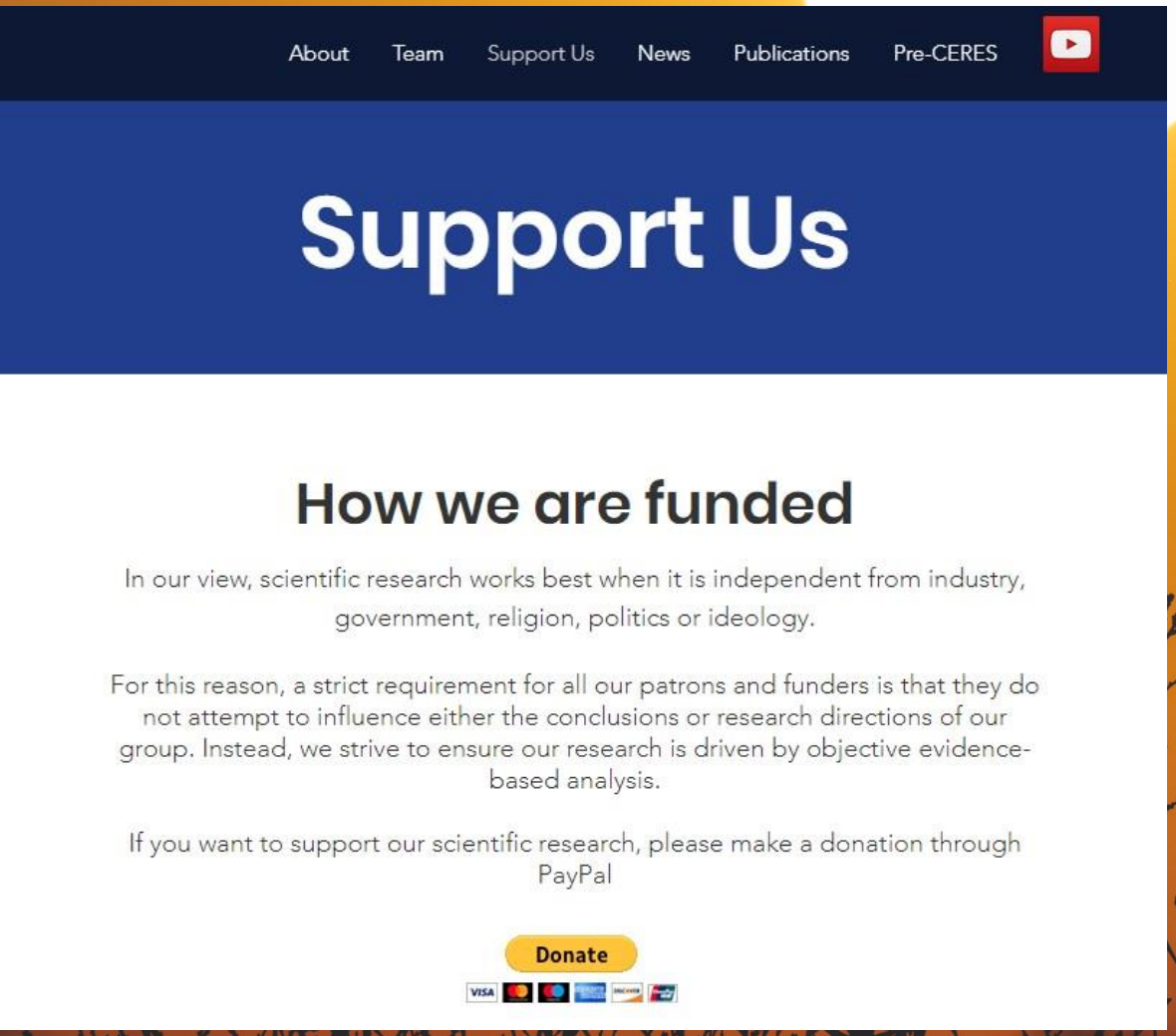

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