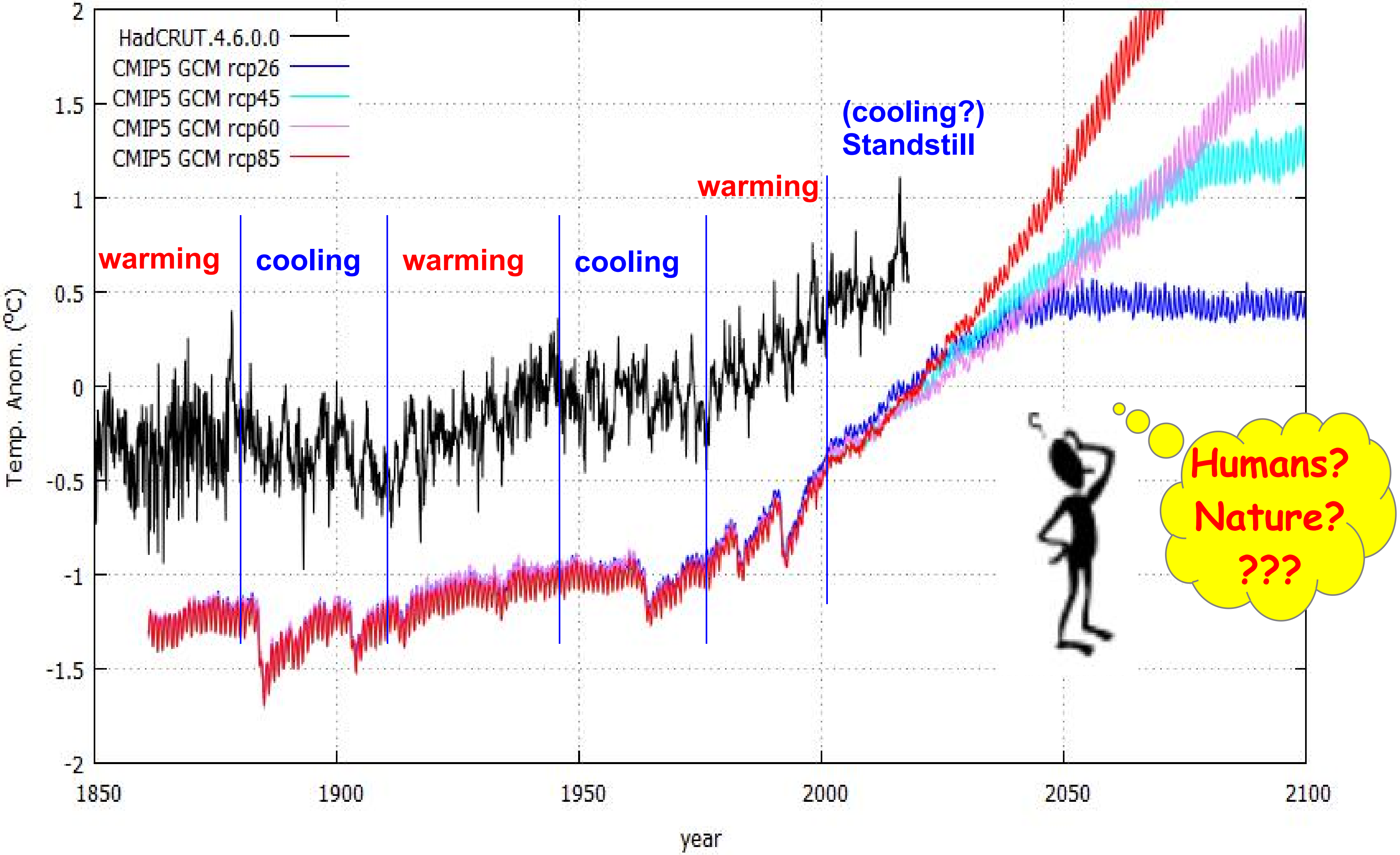
DiSTAR Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
SCUOLA POLITECNICA E DELLE SCIENZE DI BASE

Toward a better understanding of Natural Climate Variability

Prof. Nicola Scafetta

Munich, 24 November, 2018

Global Surface Temperature (CRU) versus the CMIP5 (IPCC AR5) GCMs

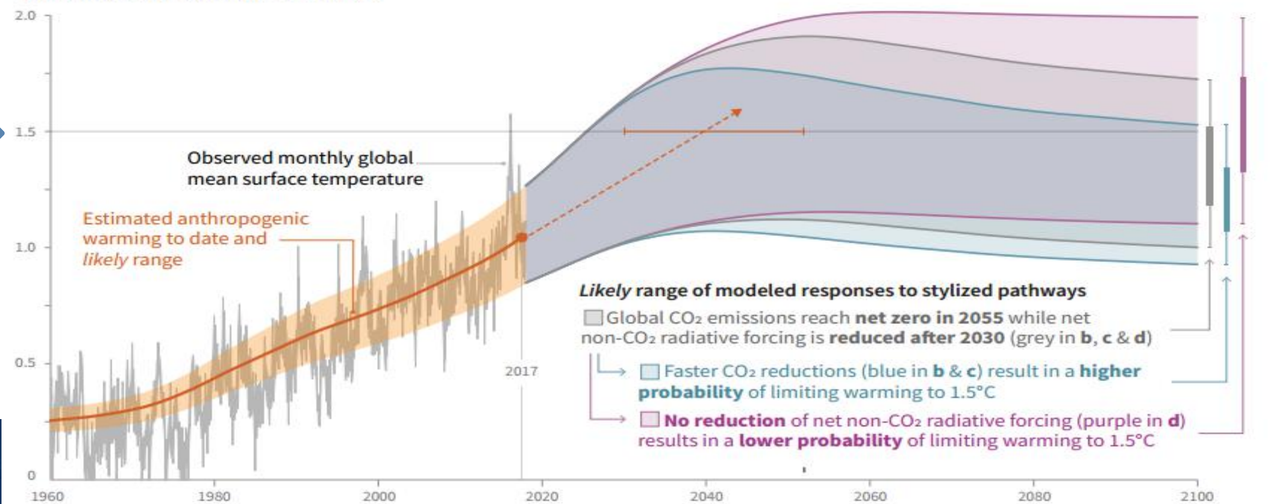


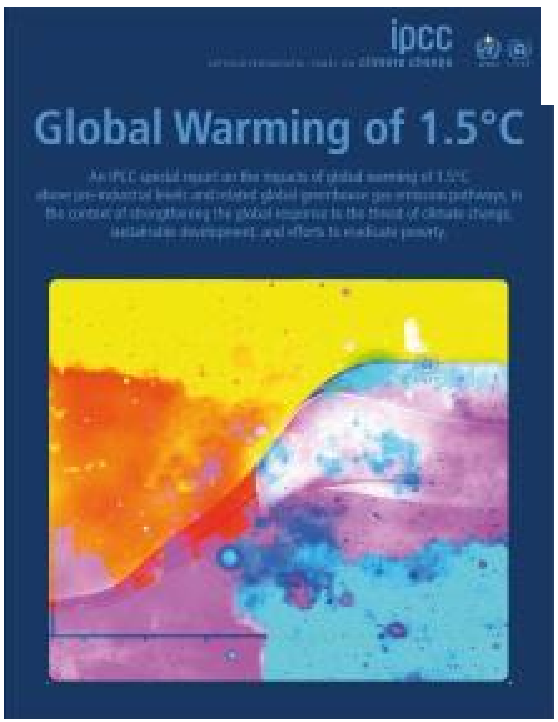
IPCC SR1.5

Keep the temperature below 1.5 °C

Cumulative emissions of CO_2 and future non-CO_2 radiative forcing determine the probability of limiting warming to 1.5°C

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

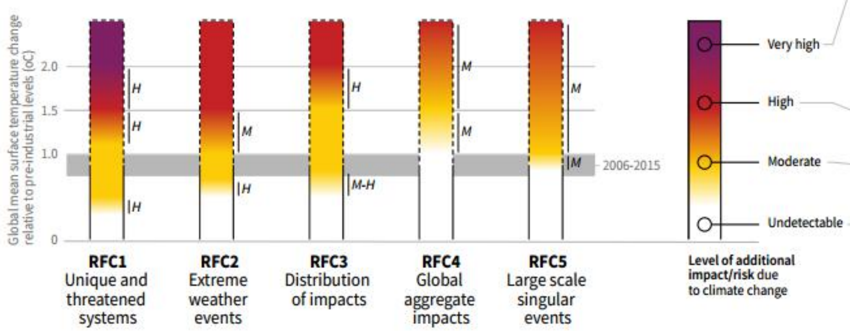




How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



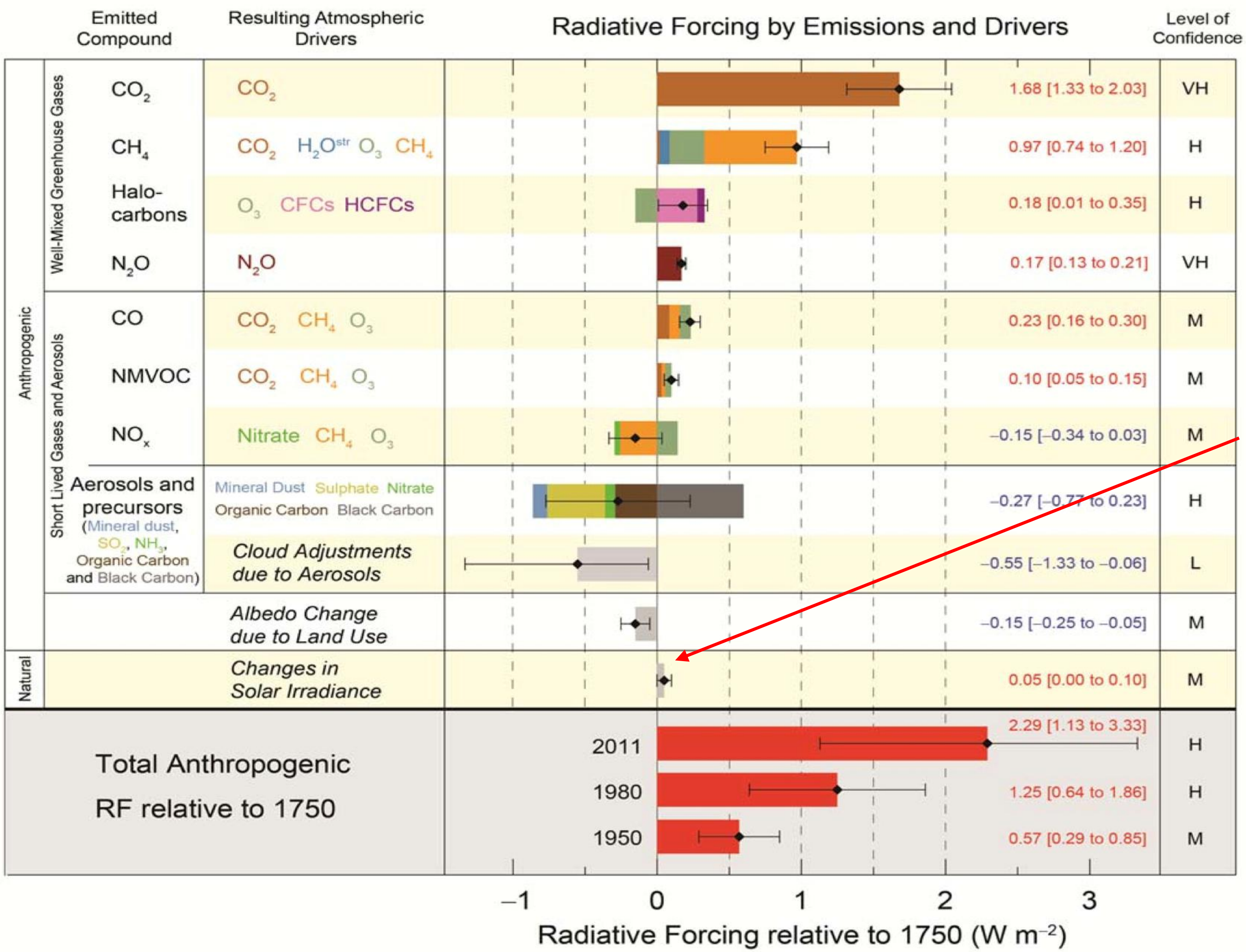
Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

Red indicates severe and widespread impacts/risks.

Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

White indicates that no impacts are detectable and attributable to climate change.

The IPCC Global Warming Theory



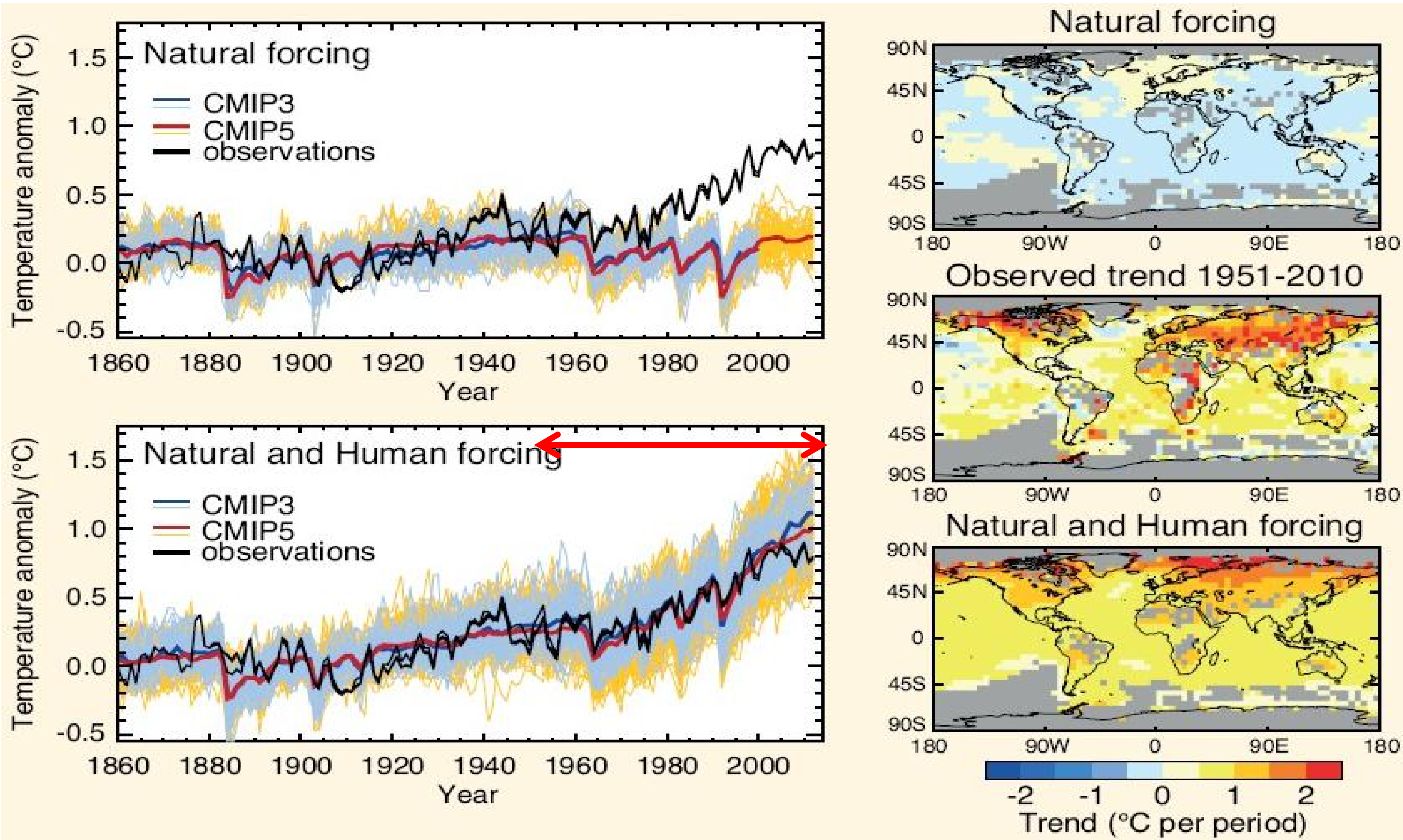
CMIP5 GCM Forcings:

IPCC AR5, 2013

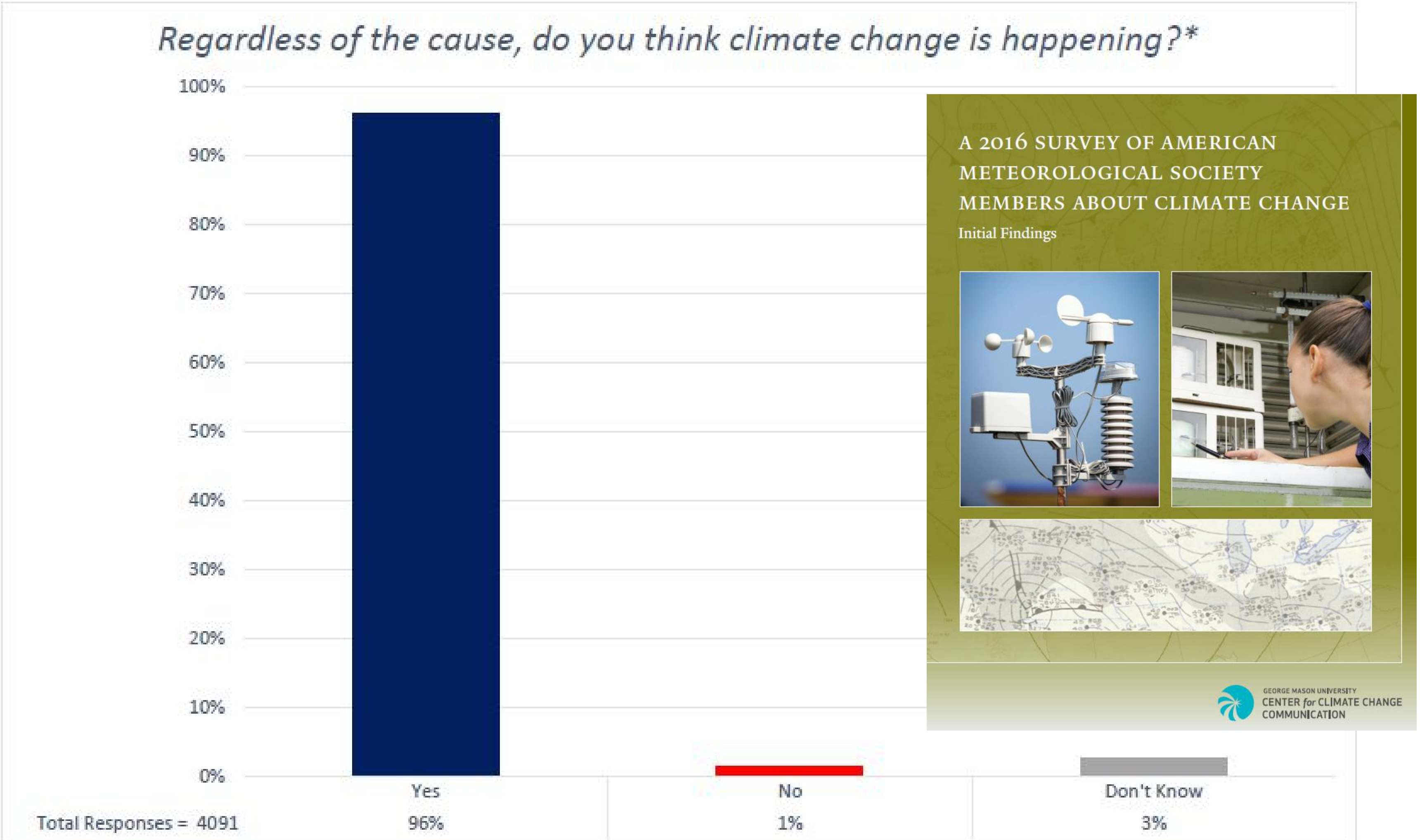
The Sun does not matter much!

The IPCC "Computer Model" Science

100% of the warming since 1951 is anthropogenic

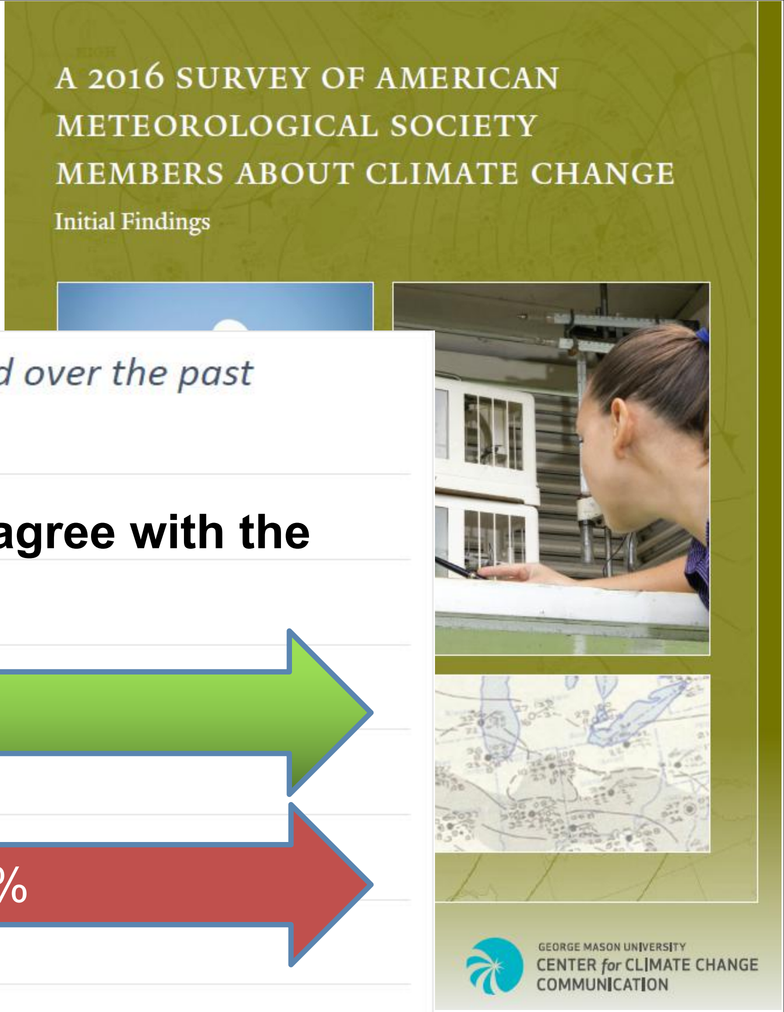


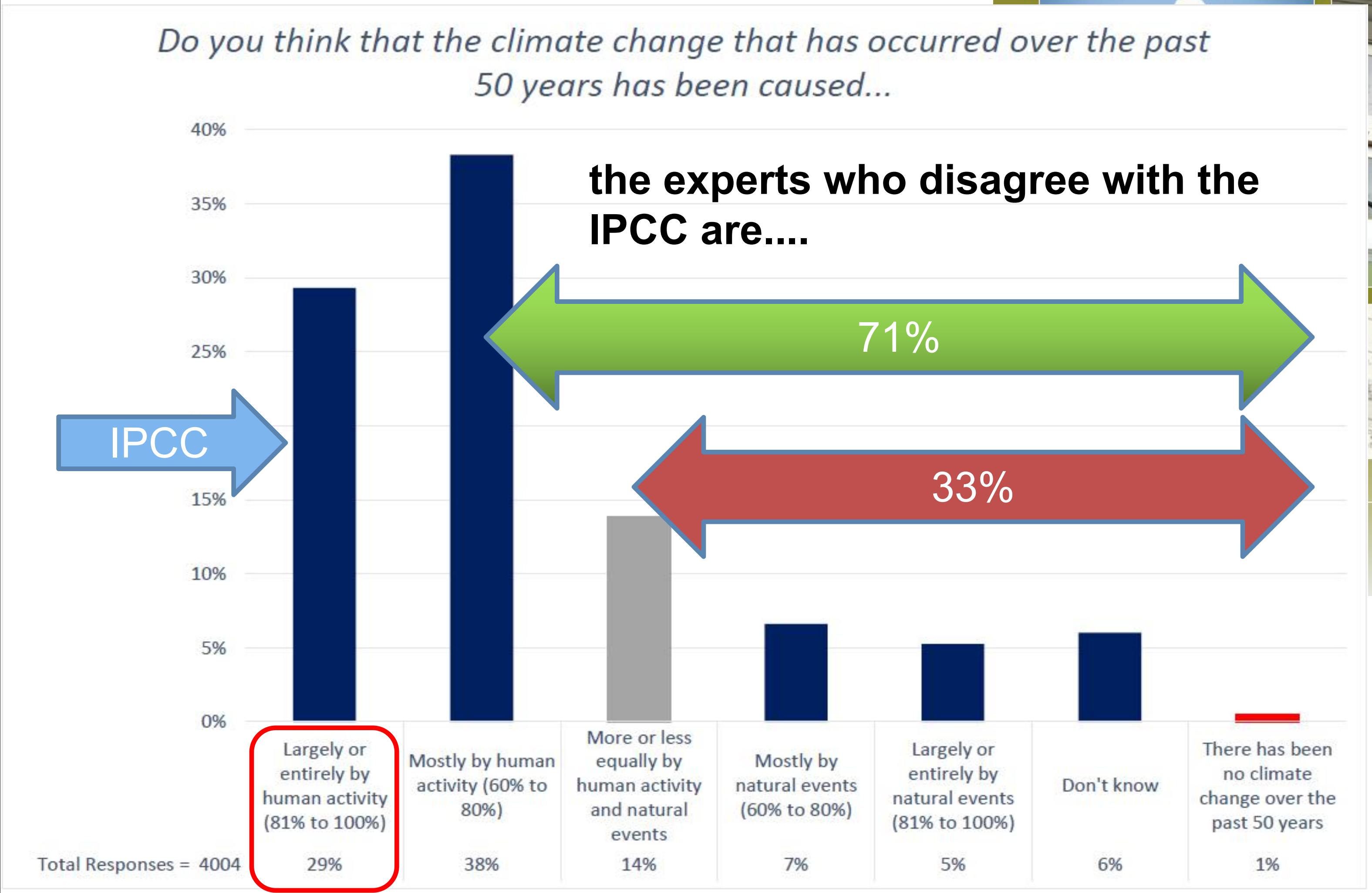
Do these GCMs results "prove" that the warming since 1951 has been really due to anthropogenic forcing?



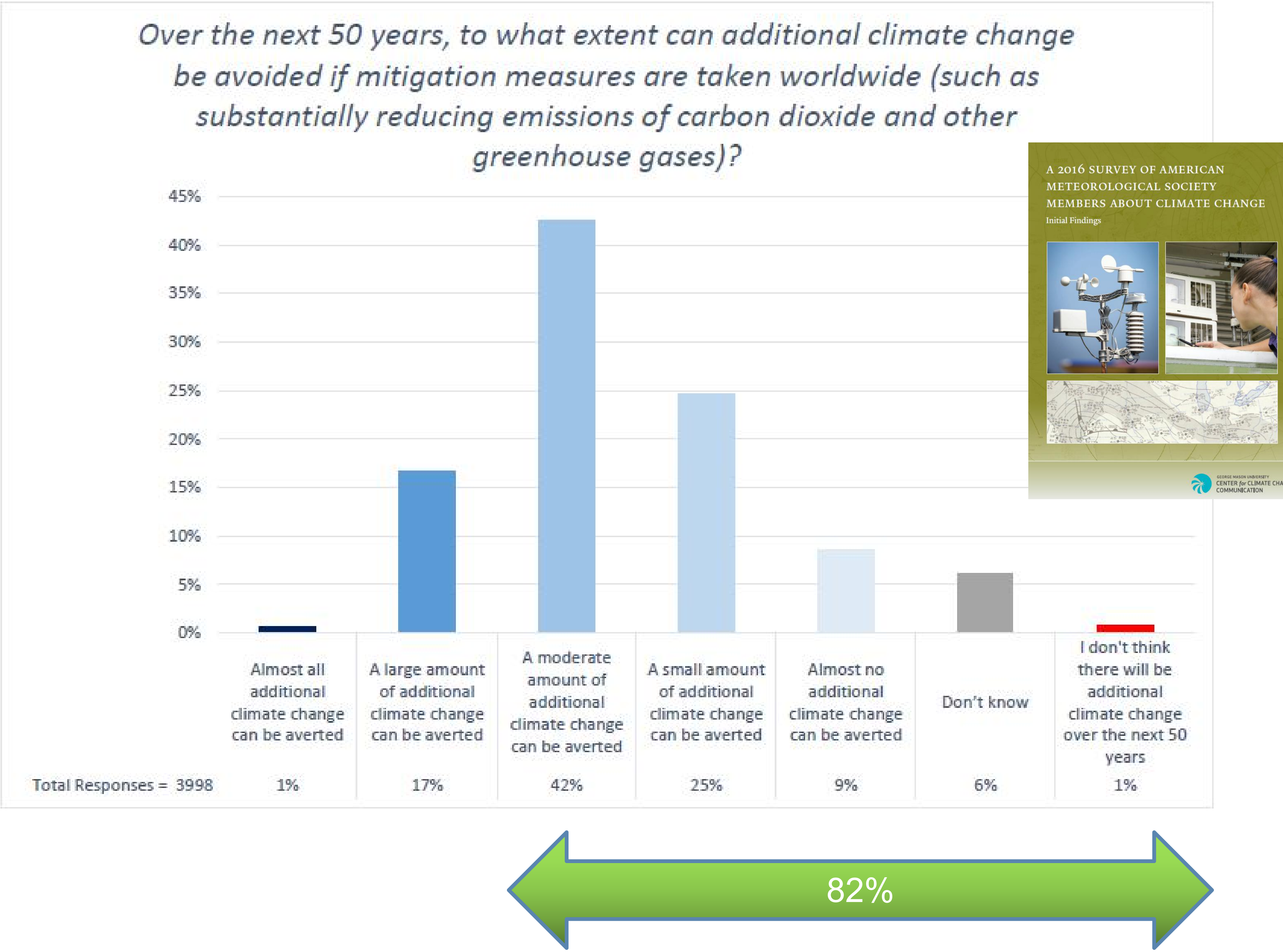
*Question was preceded by this statement: "Please read the following information: The American Meteorological Society (AMS) defines climate change as: "Any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or winds) sustained over several decades or longer. Climate change may be due to: natural external forcings, such as changes in solar emission or slow changes in the earth's orbital elements; natural internal processes of the climate system; or anthropogenic forcing."

96% thinks climate change is happening BUT the IPCC claims that humans caused 100% of the warming since 1951, while...





https://gmuchss.az1.qualtrics.com/CP/File.php?F=F_cRR9lW0HjZaiVV3

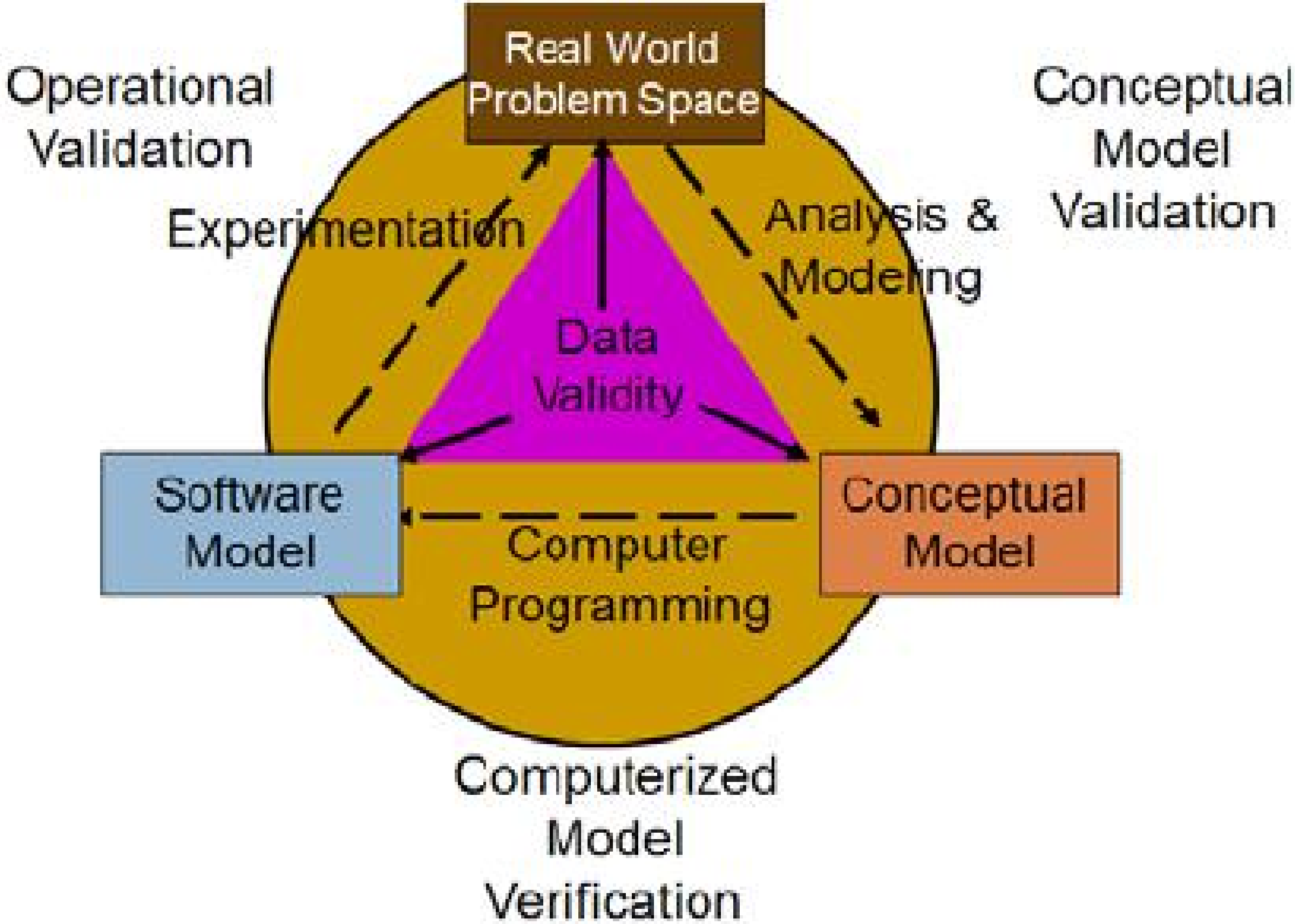

Over the next 50 years, to what extent can additional climate change be avoided if mitigation measures are taken worldwide (such as substantially reducing emissions of carbon dioxide and other greenhouse gases)?
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Almost all additional climate change can be averted
A large amount of additional climate change can be averted
A moderate amount of additional climate change can be averted
A small amount of additional climate change can be averted
Almost no additional climate change can be averted
Don't know
I don't think there will be additional climate change over the next 50 years
Total Responses = 3998
1%
17%
42%
25%
9%
6%
1%
A 2016 SURVEY OF AMERICAN METEOROLOGICAL SOCIETY MEMBERS ABOUT CLIMATE CHANGE
Initial Findings
CENTER for CLIMATE CHANGE COMMUNICATION
82%

Is the AGWT built on rocks or on sand?
(Are the AGWT models validated?)

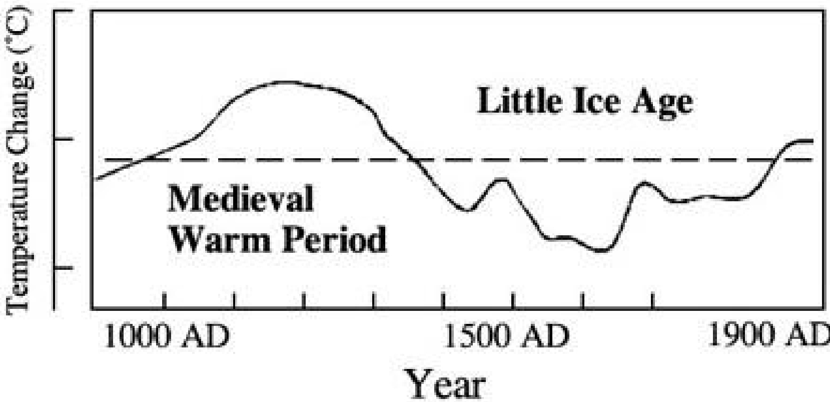
Wise And Foolish Builders

Matthew 7:26-27

Computer Simulation Models must be Verified and Validated

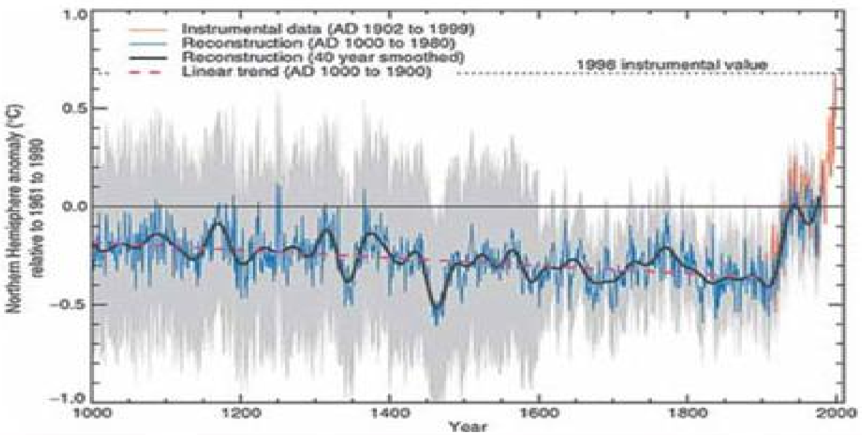


Are the IPCC climate models still validated?



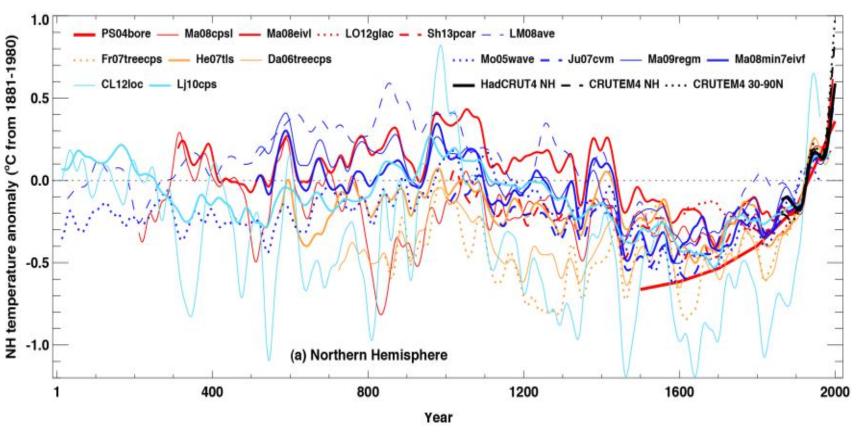
IPCC 1991

The natural variability is large; CO_2 records do not explain it; The sun is the main driver.



IPCC 2001

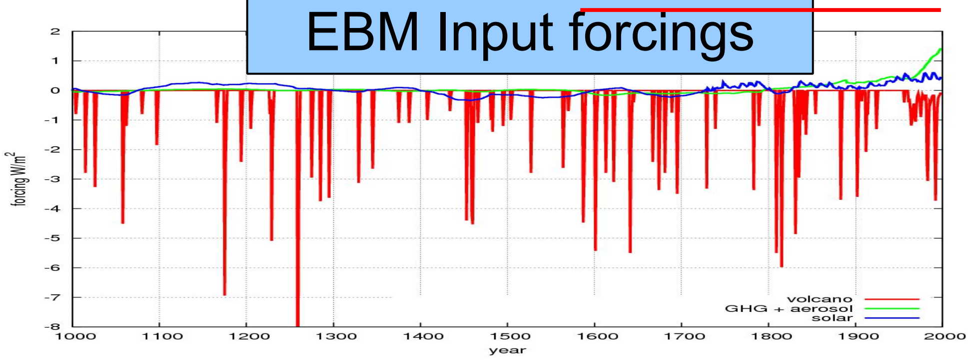
The natural variability is small (0.2 °C); Only CO_2 explains the warming since 1900; The IPCC climate models are claimed to have been validated & used for future climate scenarios.

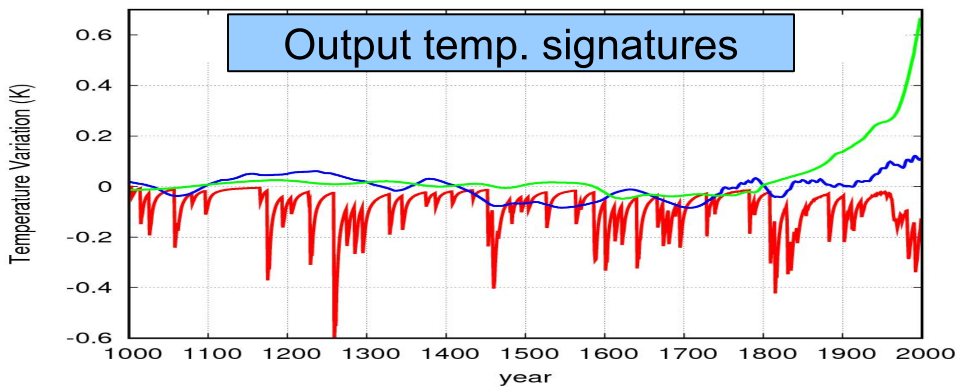


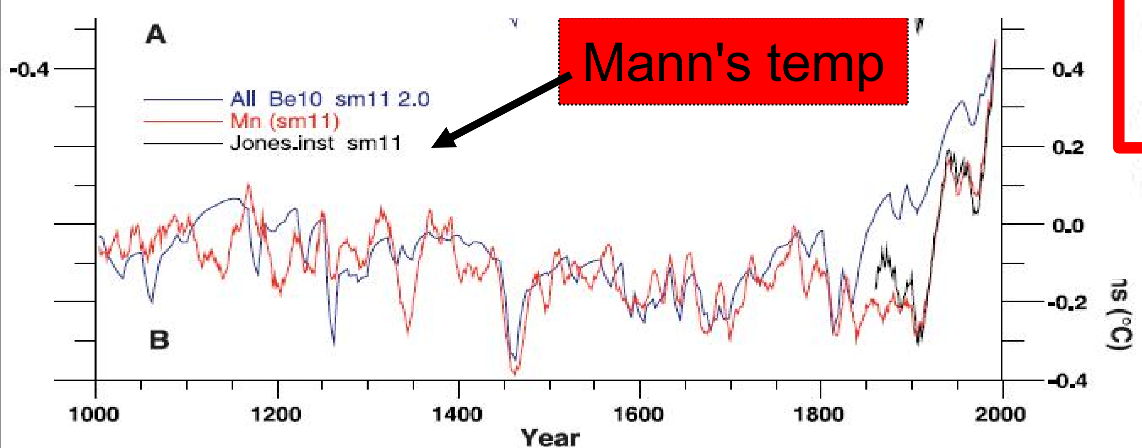
IPCC 2013

The natural variability is large (0.6-1.5 °C); The Sun, not the CO_2 records explains it.

In 2000 it was claimed that the AGWT models have been "validated"!





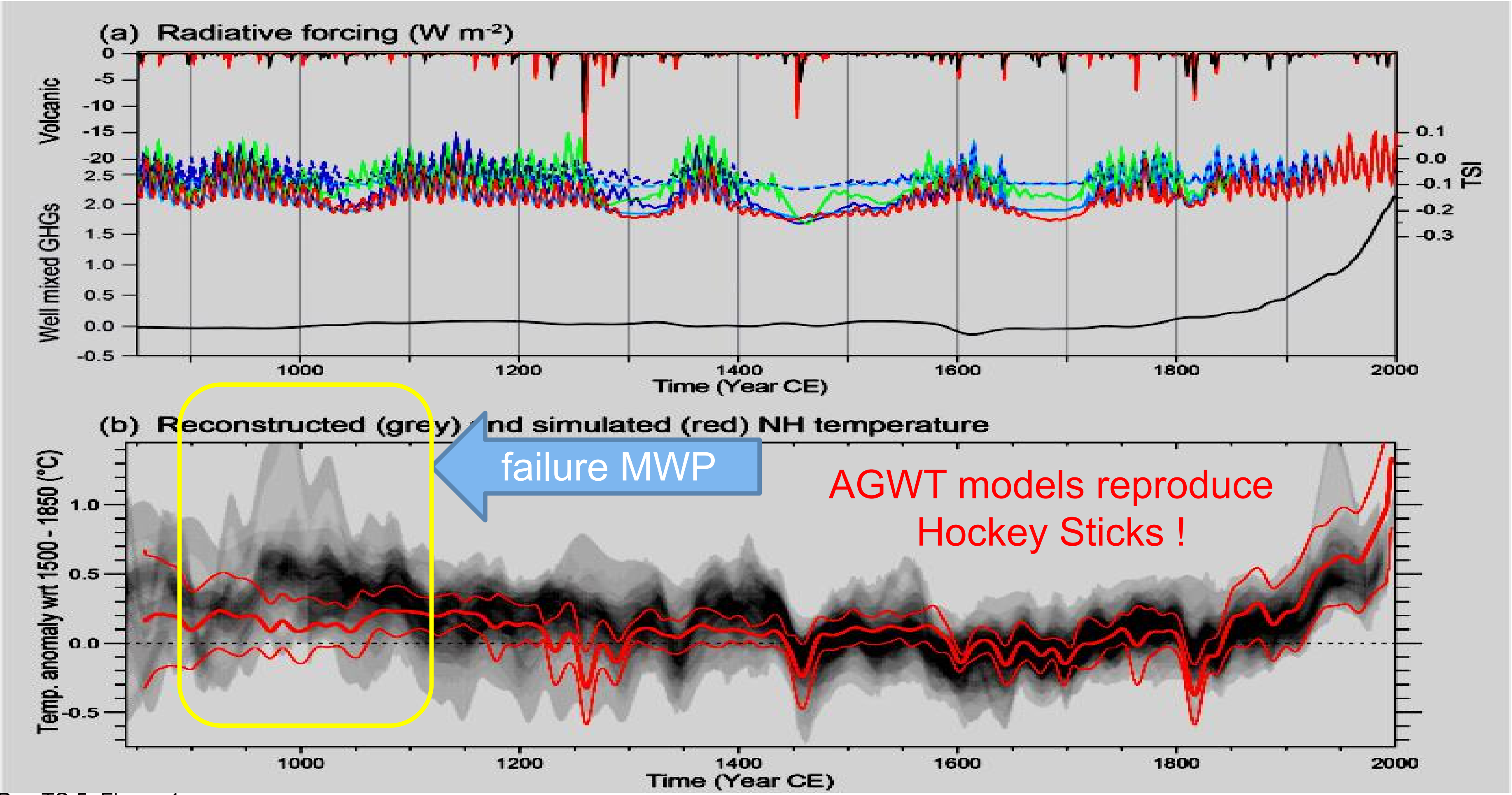


burning, and mineral dust. Although regional climate change is almost certainly influenced by these complex dynamic and thermodynamic feedbacks, the striking agreement seen in this study between simple model calculations and observations indicates that on the largest scale, temperature responds almost linearly to the estimated changes in radiative forcing. The very good agreement between models and data in the preanthropogenic interval also enhances confidence in the overall ability of climate models to simulate temperature variability on the largest scales.

Crowley,
Science 289, 270-277 (2000)

In the IPCC 2013
The last-millennium GCM simulations and reconstructions diverge

The models do not reproduce the Medieval Warm Period



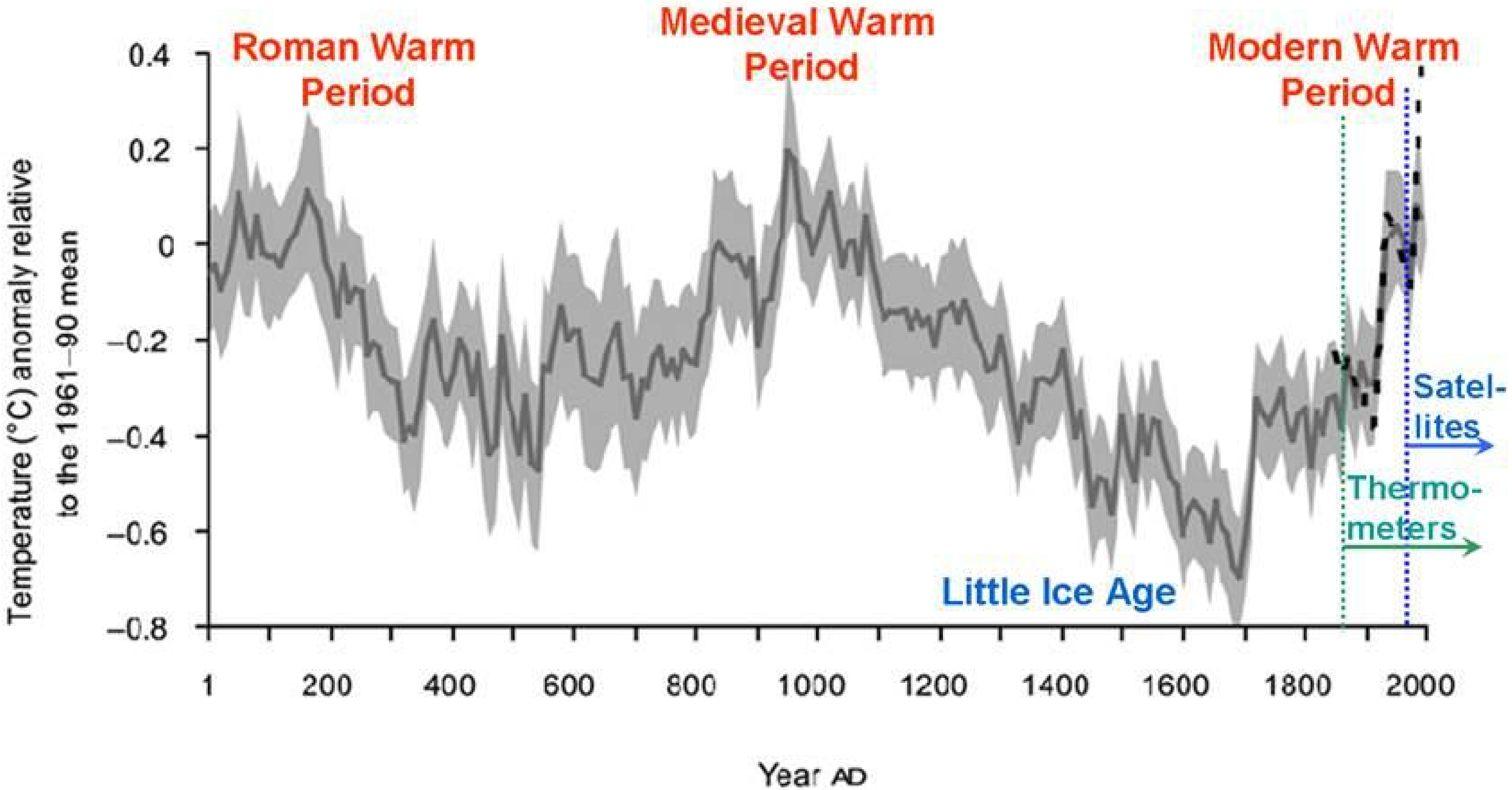
Box TS.5, Figure 1 -

(a) 850–2000 PMIP3/CMIP5 radiative forcing due to volcanic, solar and well-mixed green- house gases.

(b) 850–2000 PMIP3/CMIP5 simulated (red) and reconstructed (shading) Northern Hemisphere (NH) temperature changes.

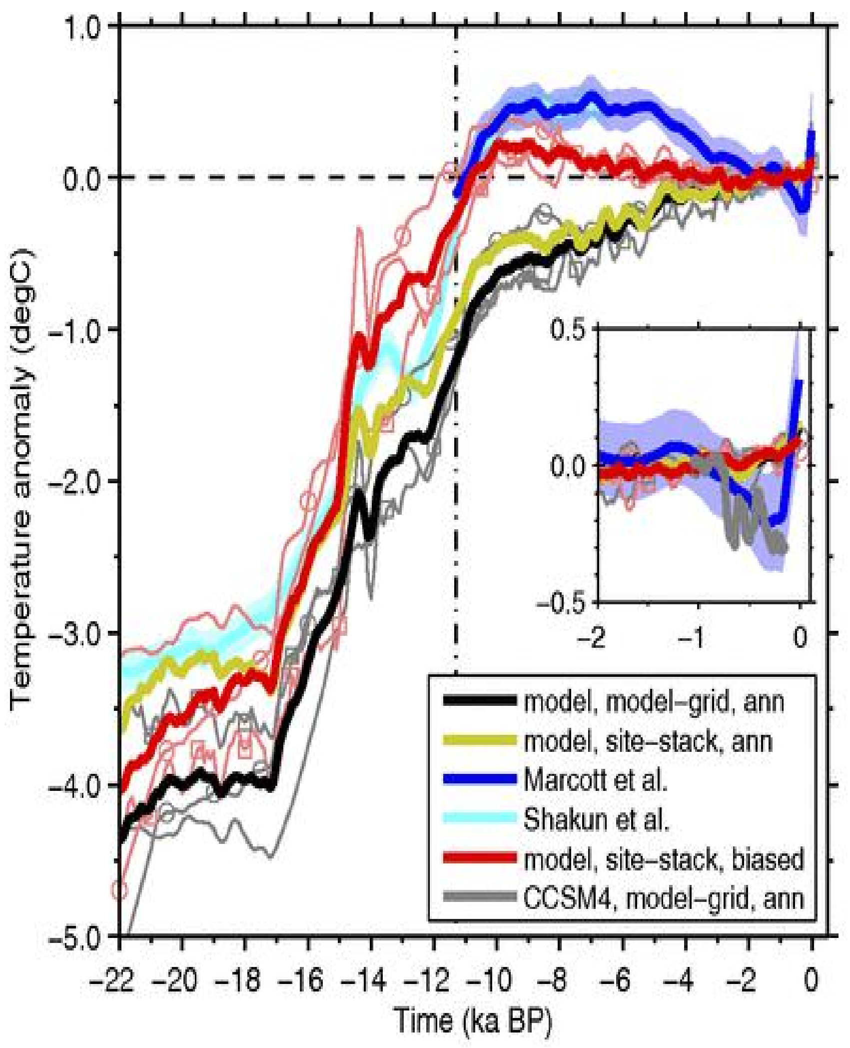
Nearly Every Century Experiences Global Warming or Cooling

Temperature Reconstruction* for N. Hemisphere, 1 - 2000 AD Shows Modern Warm Period Not Exceptional



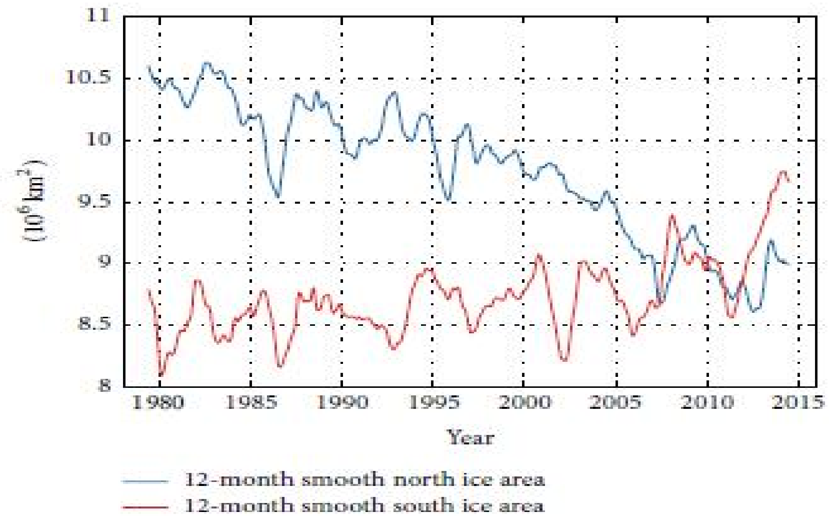
*Ljungqvist, F.C. 2010. A new reconstruction of temperature variability in the extra-tropical Northern Hemisphere during the last two millennia. Geografiska Annaler: Physical Geography, Vol. 92 A(3), pp. 339-351, September 2010. DOI: 10.1111/j.1468-0459.2010.00399.x

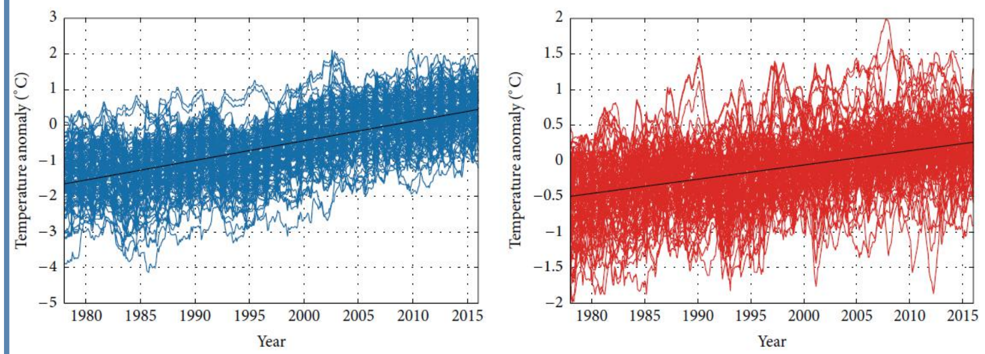
Other serious failures of the IPCC climate models



Comparison between Holocene temperature records (red and blue) and climate model predictions

Comparison between 12-month moving average of the Arctic and Antarctic sea-ice area index records against model prediction.





Liu, Z., Zhu, J., Rosenthal, Y., et al., PNAS, vol. 111 (2014), E3501–E3505.
Scafetta, N., Mazzarella, A.,Advances in Meteorology, 481834, 2015.
Douglass, D. H., Christy, J. R., Pearson, B. D., Singer S. F.: International Journal of Climatology, 28, 1693-1701, 2007.

Other serious failures of the IPCC climate models

A Test of the Tropical 200- to 300-hPa Warming Rate in Climate Models

Ross McKitrick[1] **and John Christy**[2]

[1]Department of Economics and Finance, University of Guelph, Guelph, Canada, [2]Earth System Science Center, University of Alabama in Huntsville, Huntsville, AL, USA

Abstract Overall climate sensitivity to CO_2 doubling in a general circulation model results from a complex system of parameterizations in combination with the underlying model structure. We refer to this as the model's *major hypothesis*, and we assume it to be testable. We explain four criteria that a valid test should meet: measurability, specificity, independence, and uniqueness. We argue that temperature change in the tropical 200- to 300-hPa layer meets these criteria. Comparing modeled to observed trends over the past 60 years using a persistence-robust variance estimator shows that all models warm more rapidly than observations and in the majority of individual cases the discrepancy is statistically significant. We argue that this provides informative evidence against the major hypothesis in most current climate models.

The CO_2 modeled hot spot

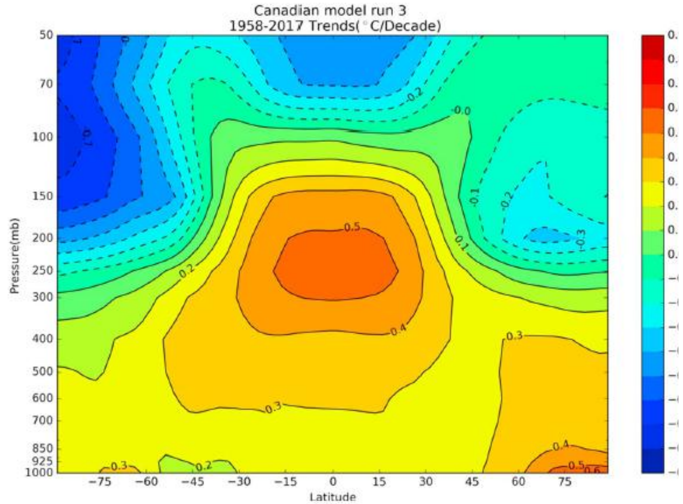


Figure 1. Warming pattern in Canadian model 1958–2017. Horizontal axis shows latitude, vertical axis show color shows warming trend magnitude.

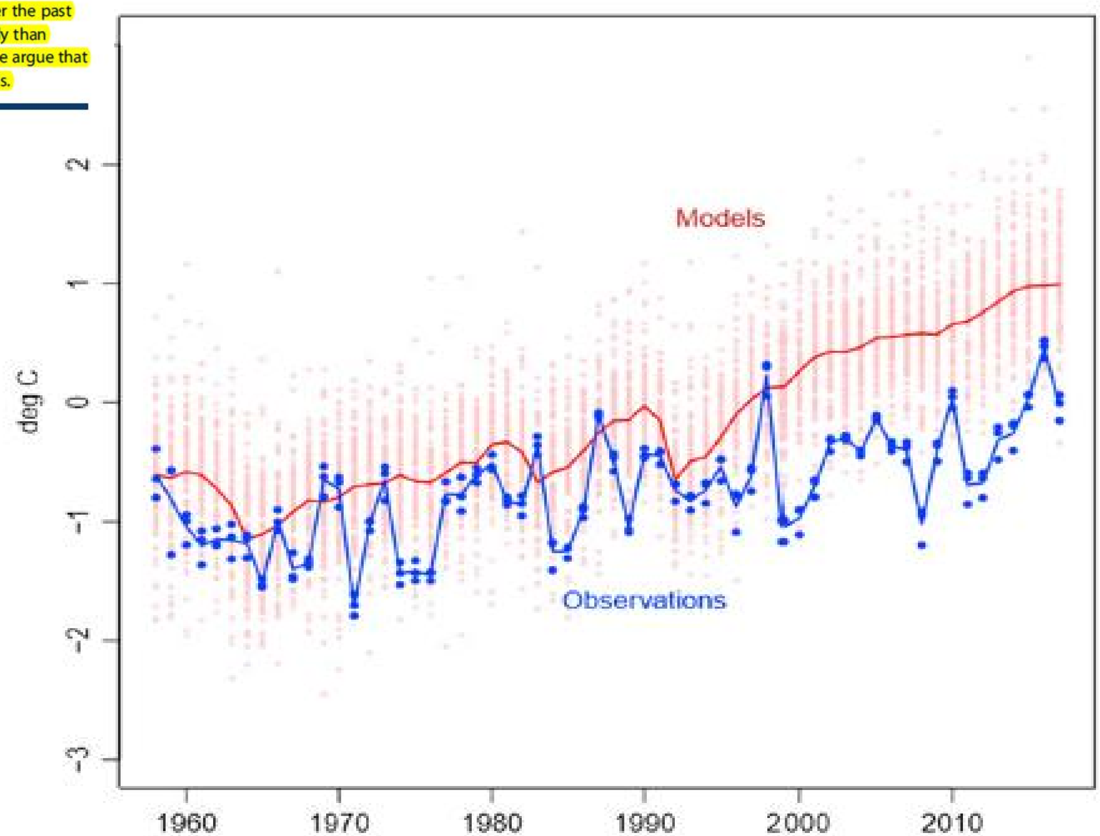
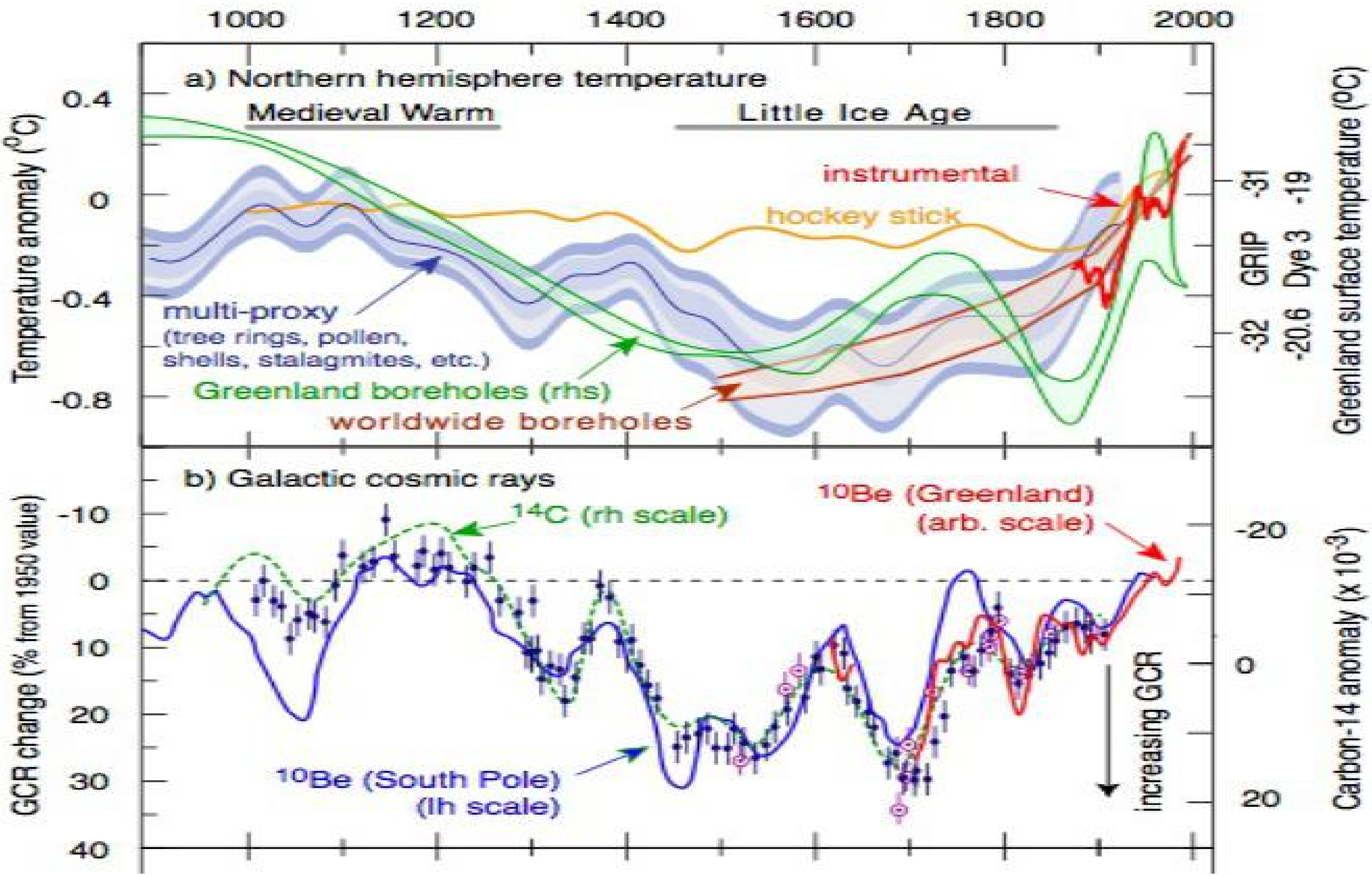


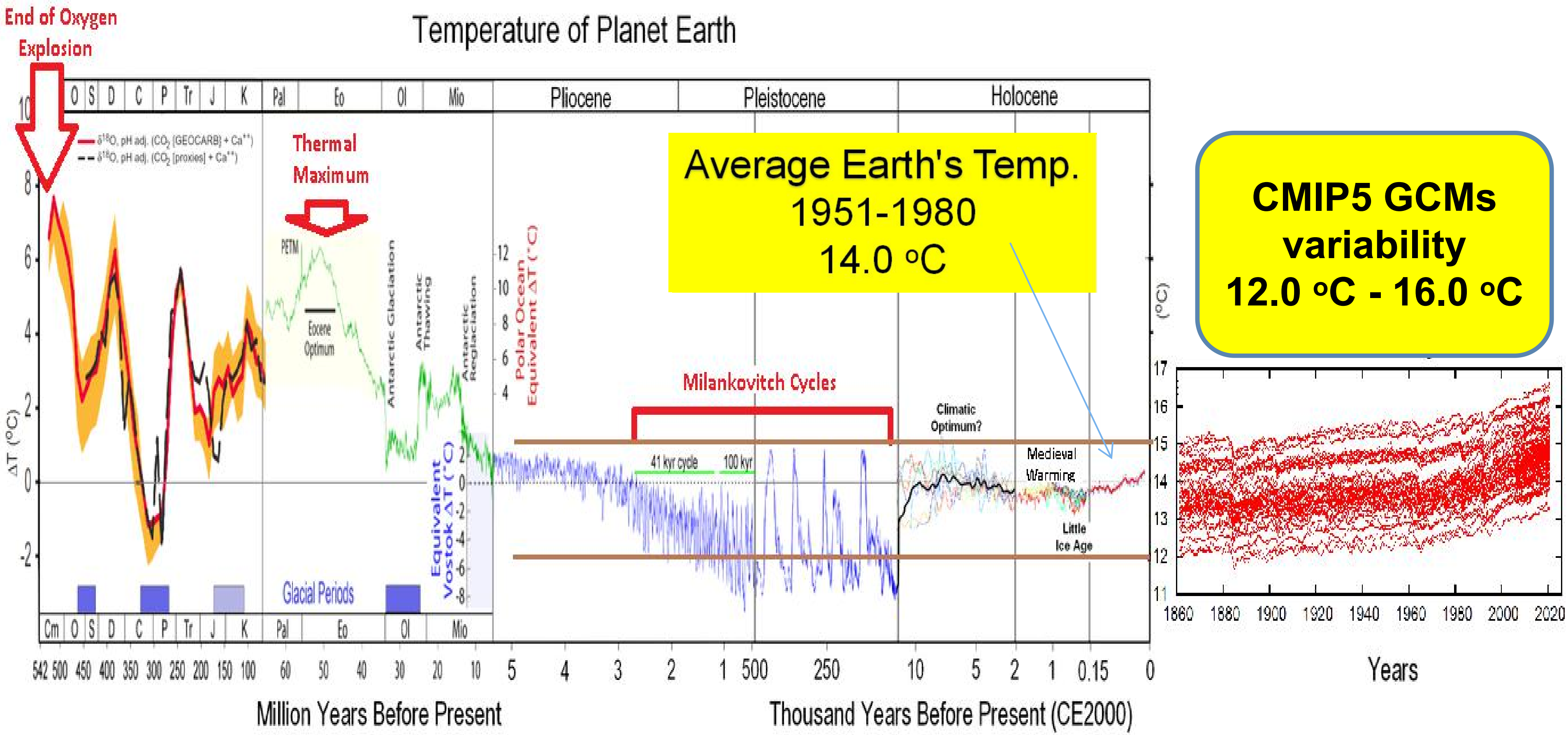
Figure 3. Model and observational data.

McKitrick, R., & Christy, J. (2018). A test of the tropical 200- to 300-hPa warming rate in climate models. Earth and Space Science, 5, 529–536.

The larger preindustrial climate variability is better reproduced by solar records

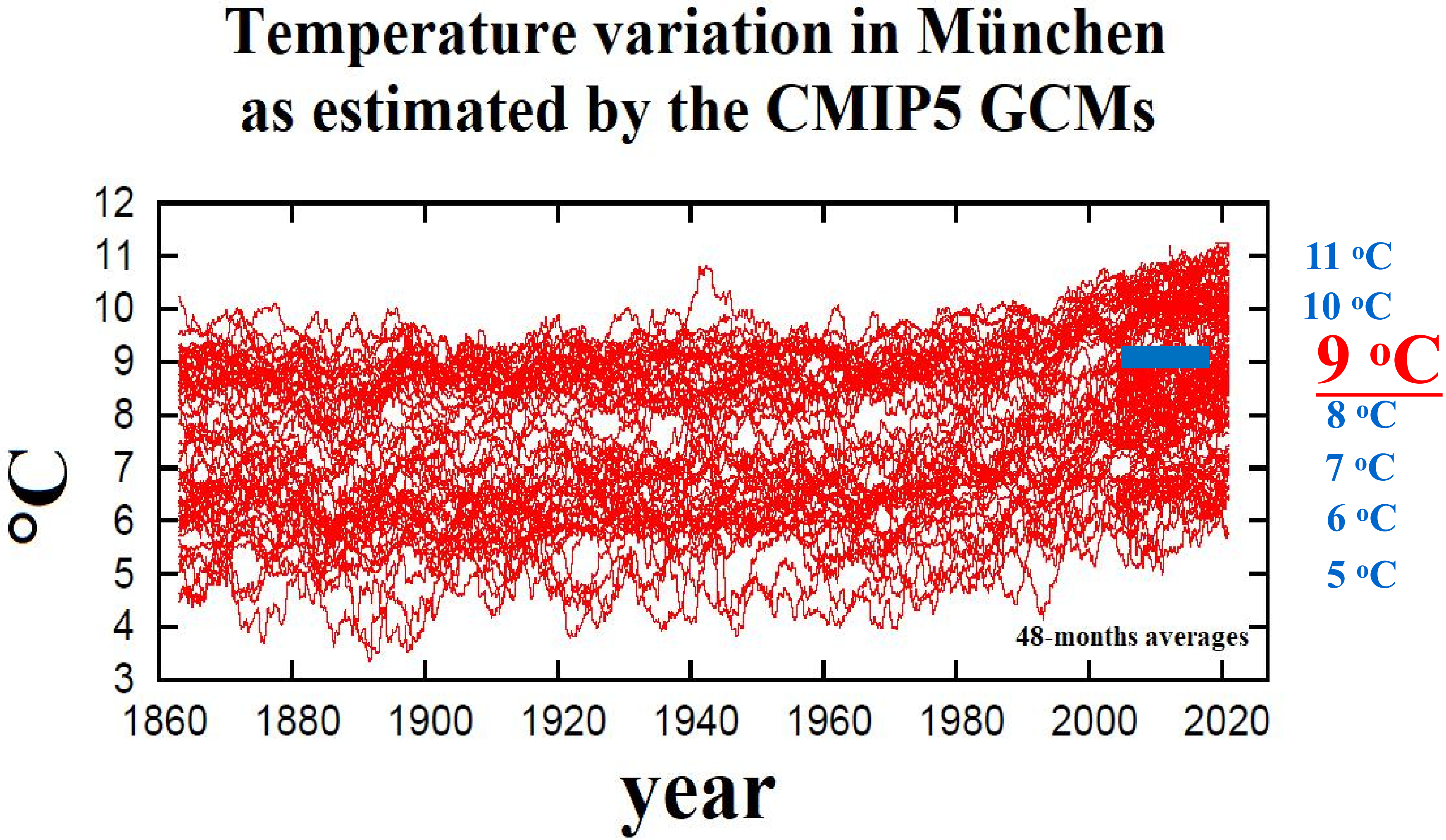


Variability of the Earth's Climate versus CMIP5 GCM simulations in the absolute T scale

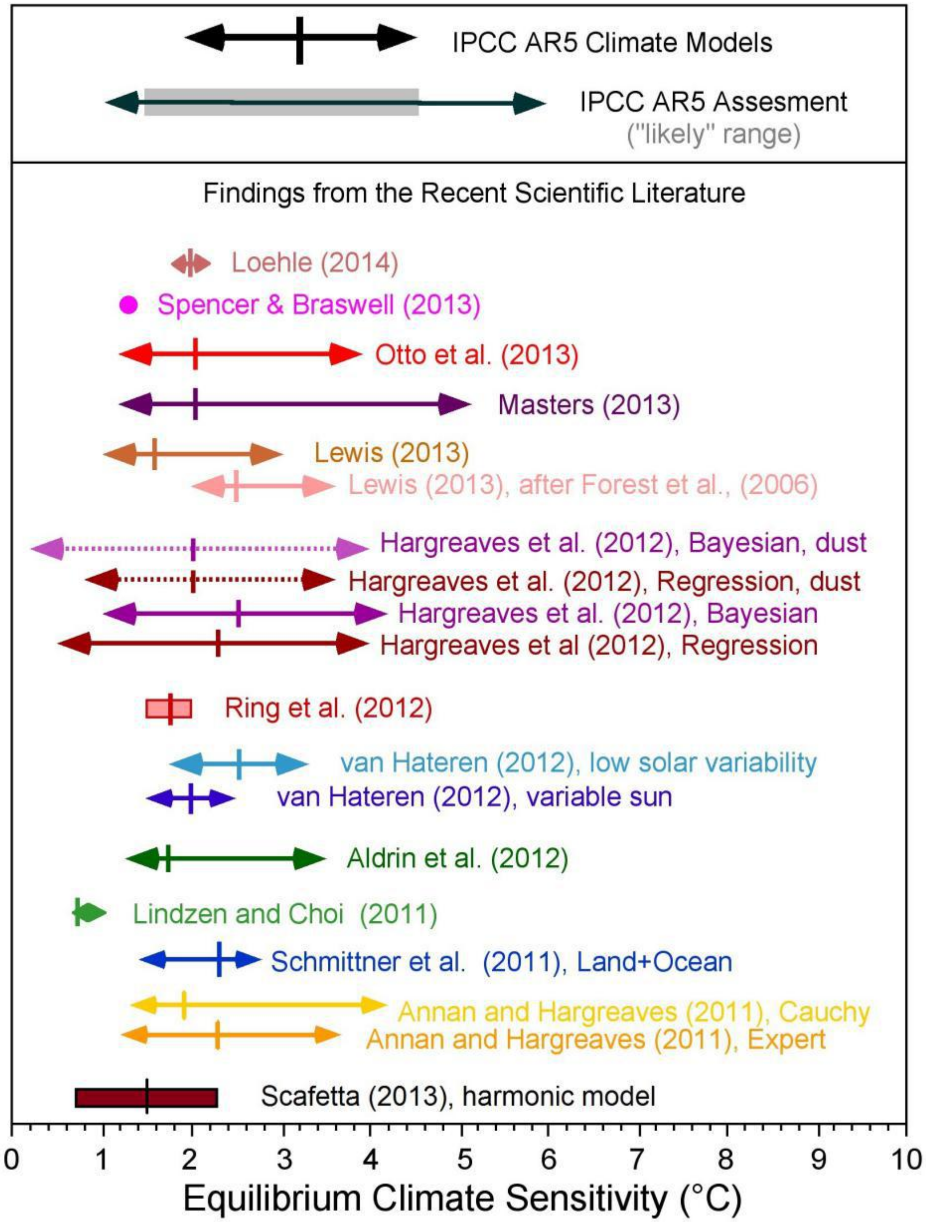


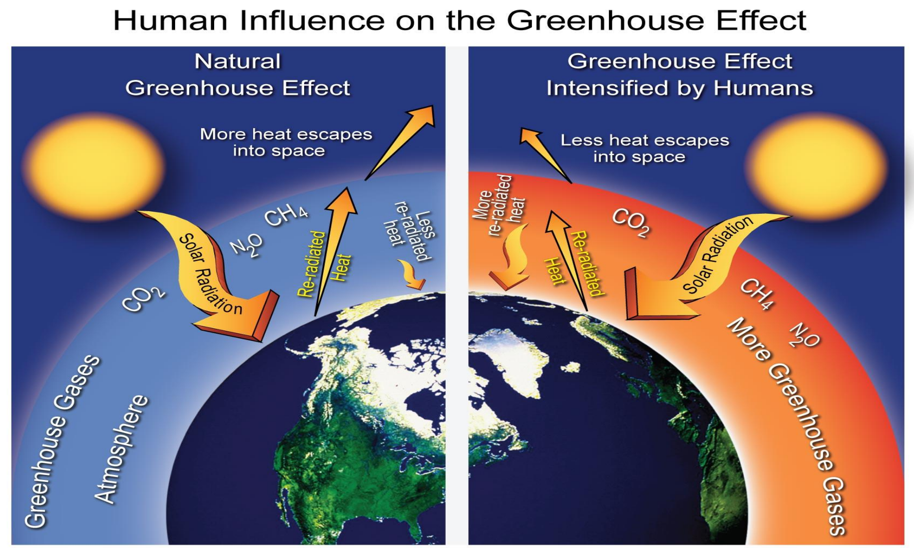
The CMIP5 GCMs, using the same 20th century forcings (!), predict all Earth's climates of the last 5,000,000 years (and more) !

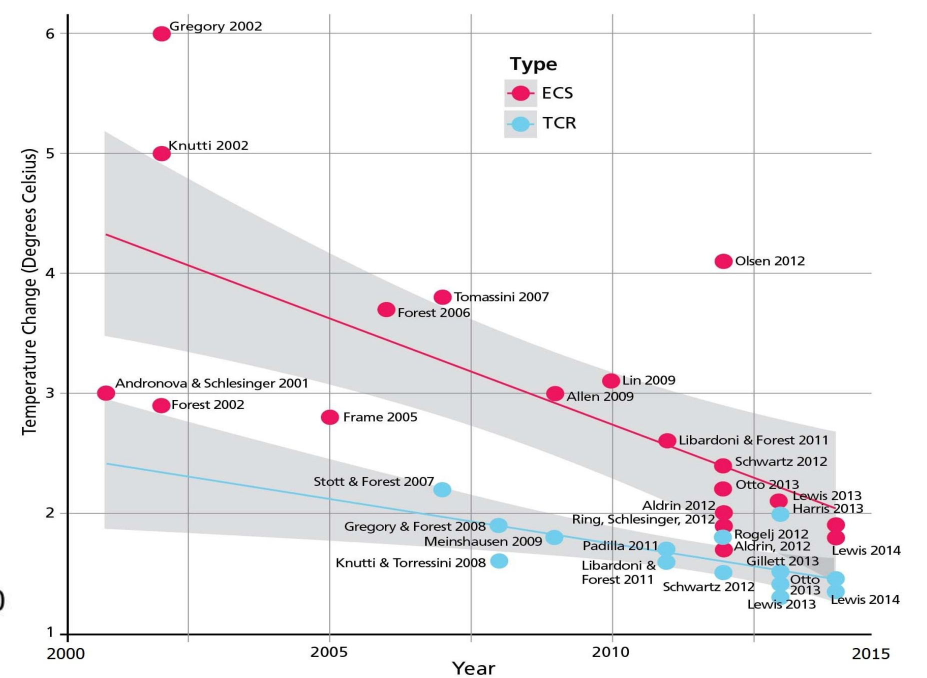
The mean annual temperature in München is about 9 ^oC, however....



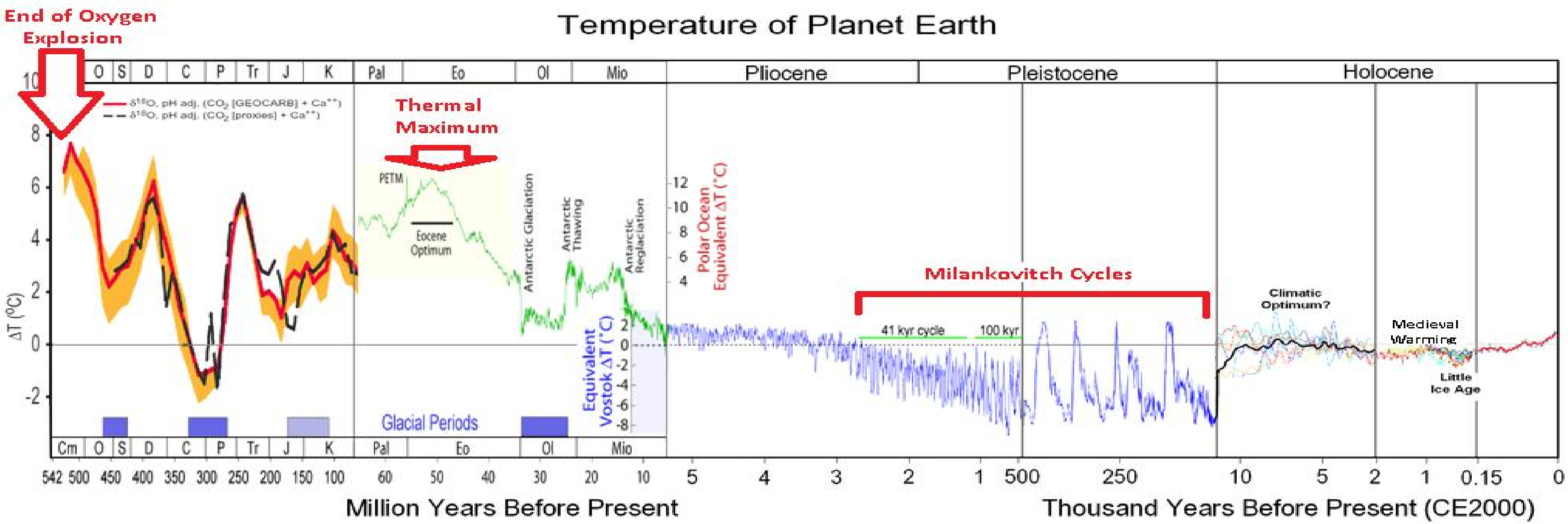
Comparison among estimates of the climate sensitivity to the radiative forcing induced by a doubling of atmospheric CO_2 concentration.

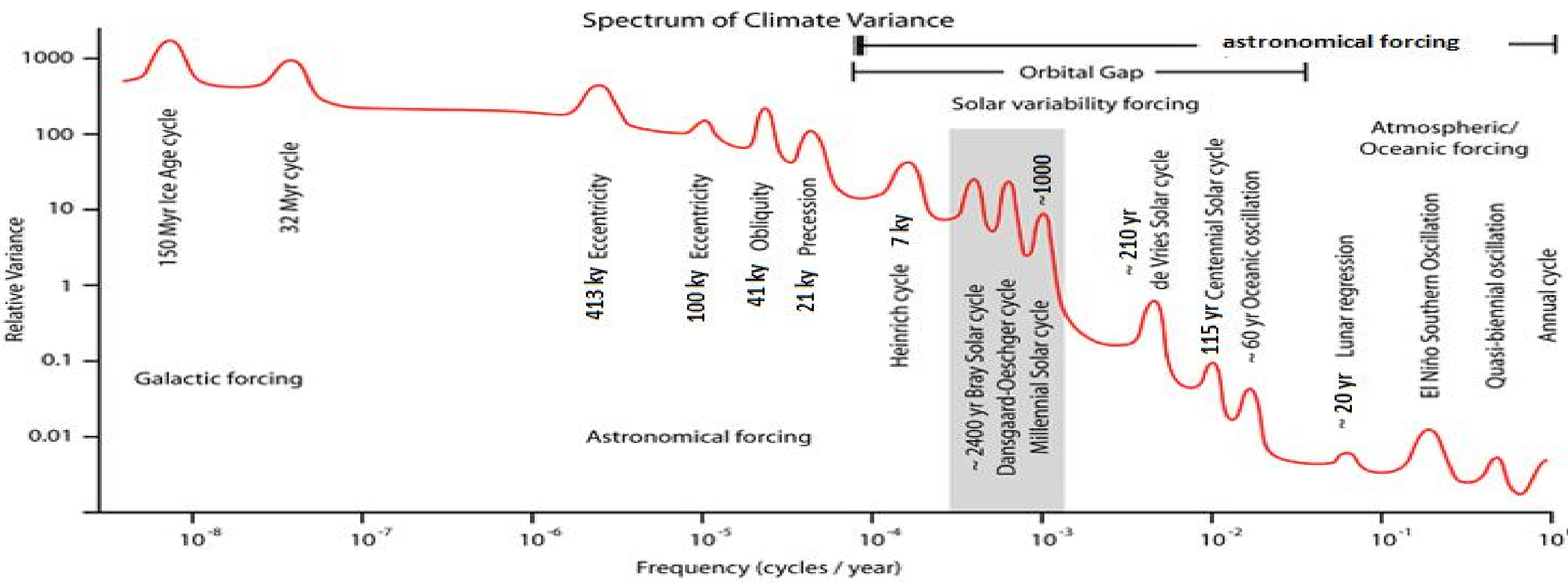




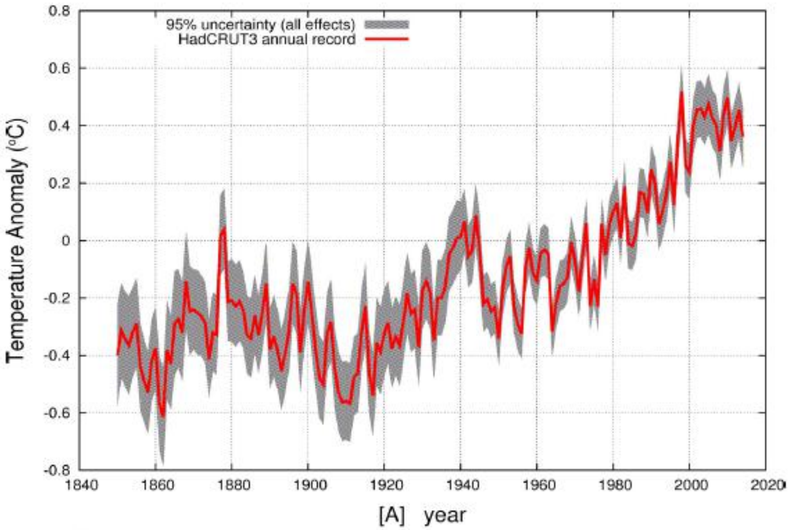


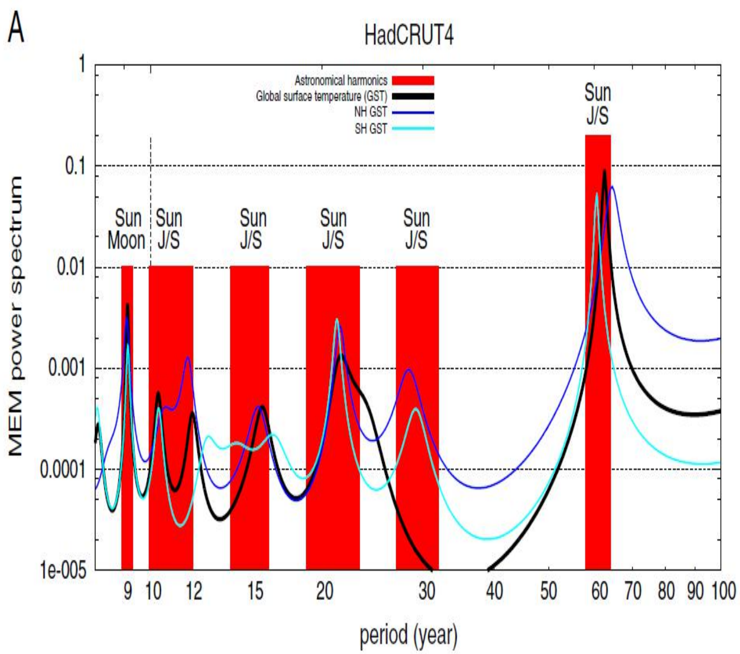
Natural Climate Oscillations



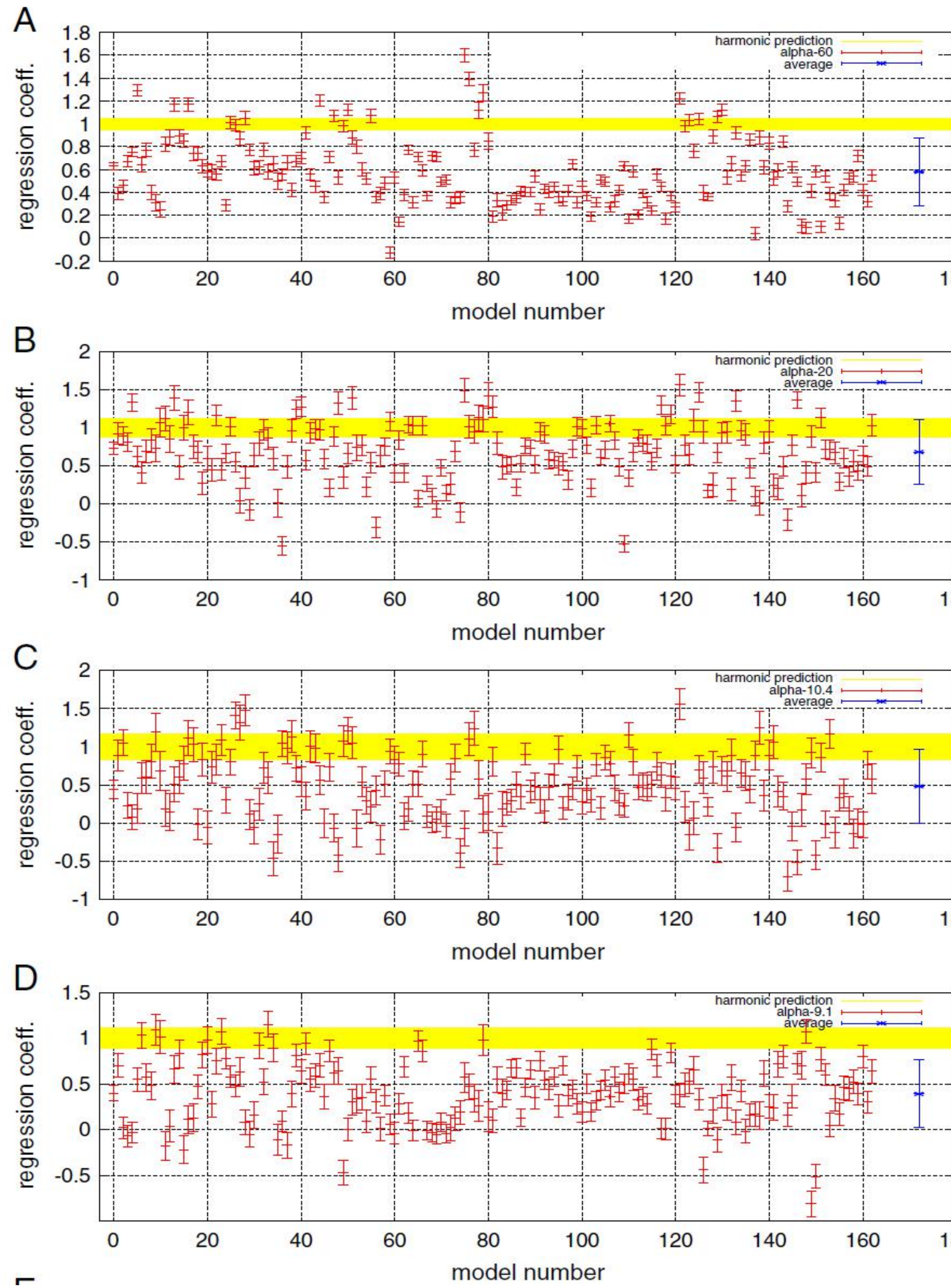


The IPCC climate models do not reproduce the natural oscillations at 9.1, 10-11, 20, 60 year periods



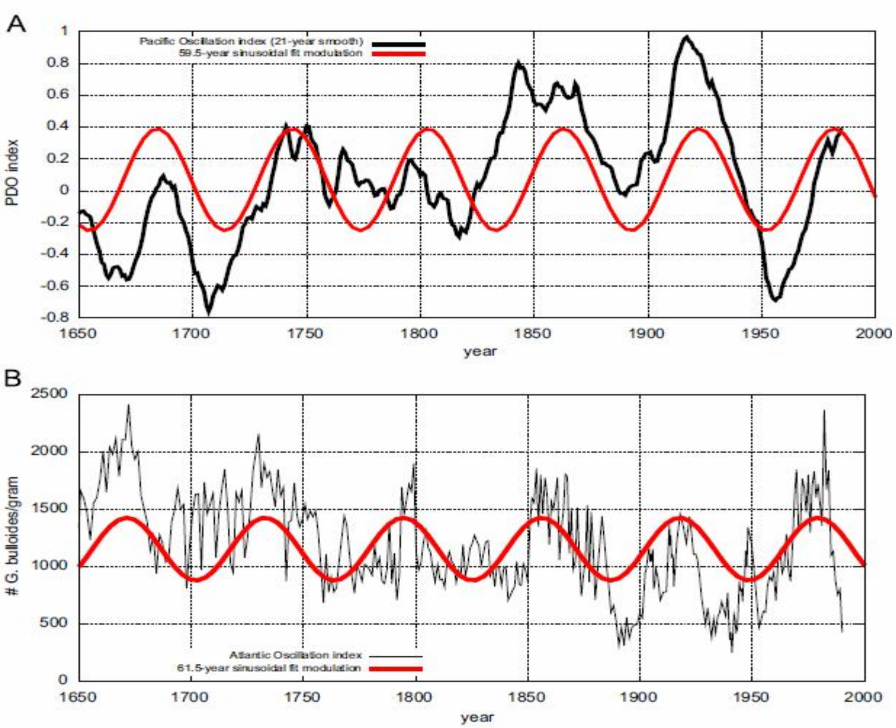


N. Scafetta / Earth-Science Reviews 126 (2013) 321–357



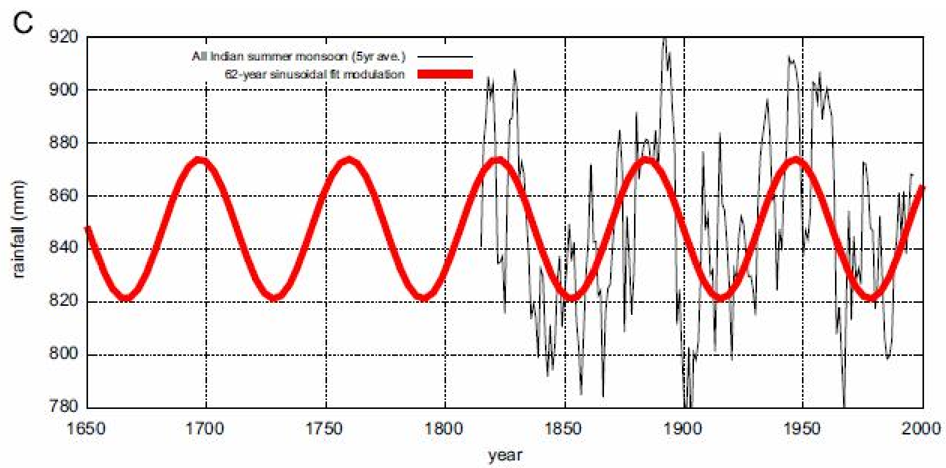
Natural Climate Oscillations: 60-year period

Pacific Decadal Oscillation

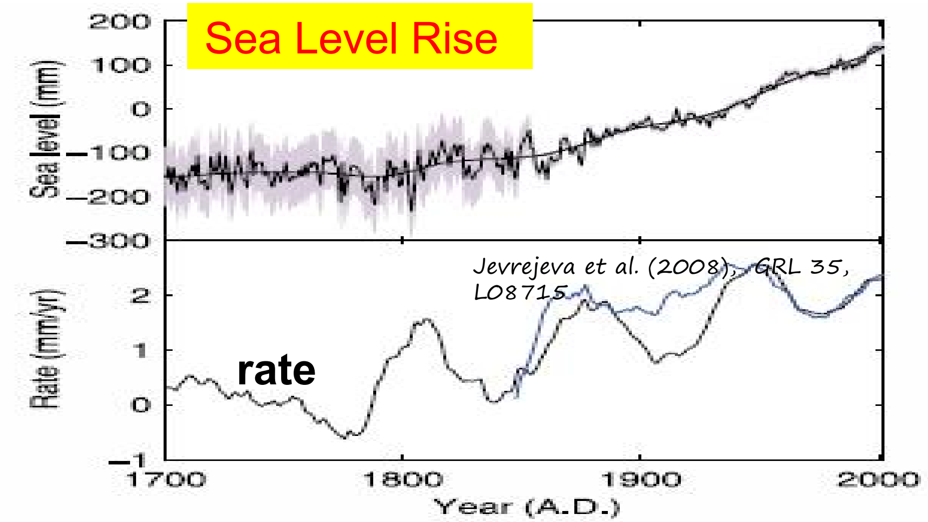


Atlantic Multidecadal Oscillation

Indian moonsoon

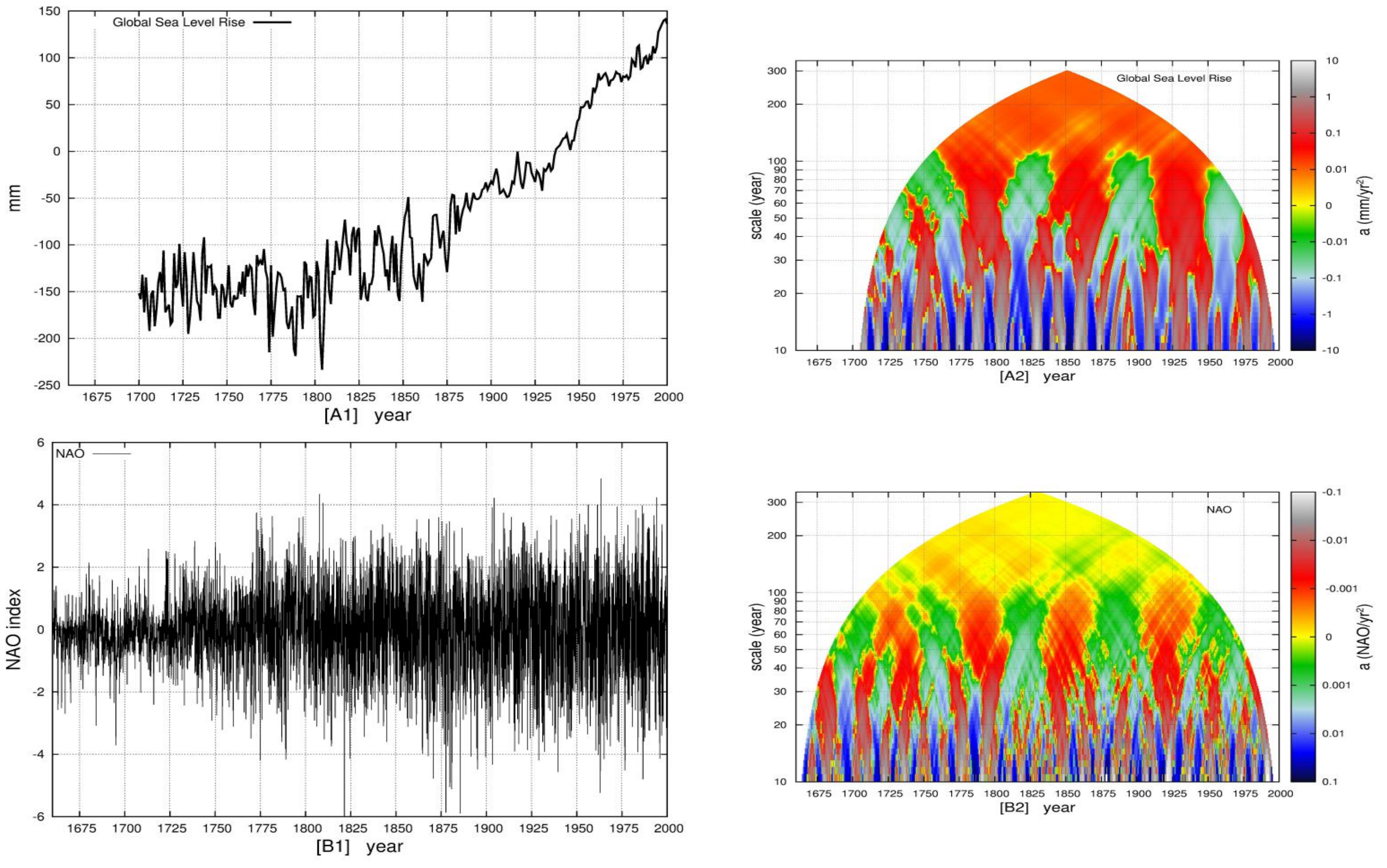


Sea Level Rise



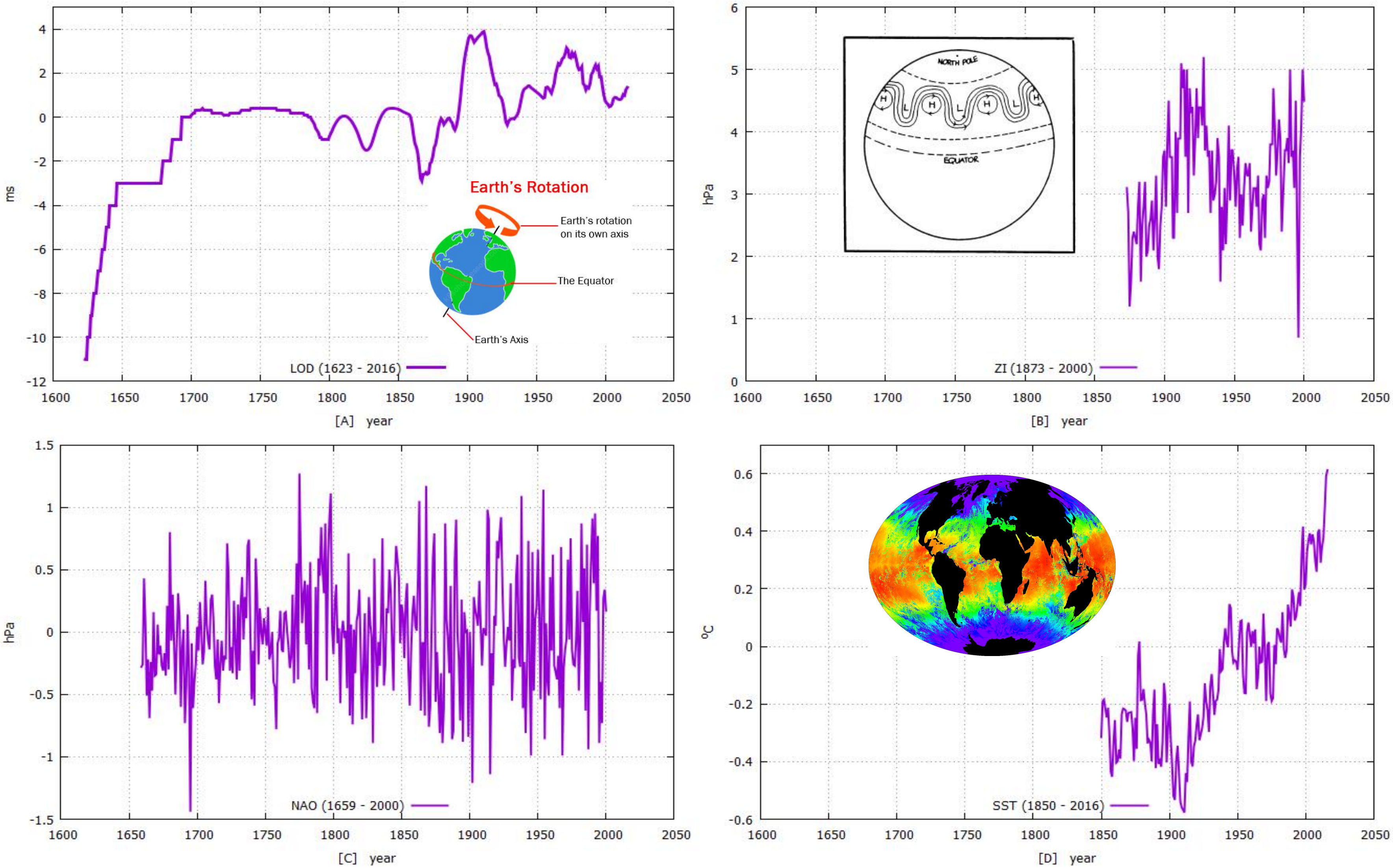
Scafetta N., 2012. A shared frequency set between the historical mid-latitude aurora records and the global surface temperature. Journal of Atmospheric and Solar-Terrestrial Physics 74, 145-163.

60-year oscillation in Global Sea Level and in NAO

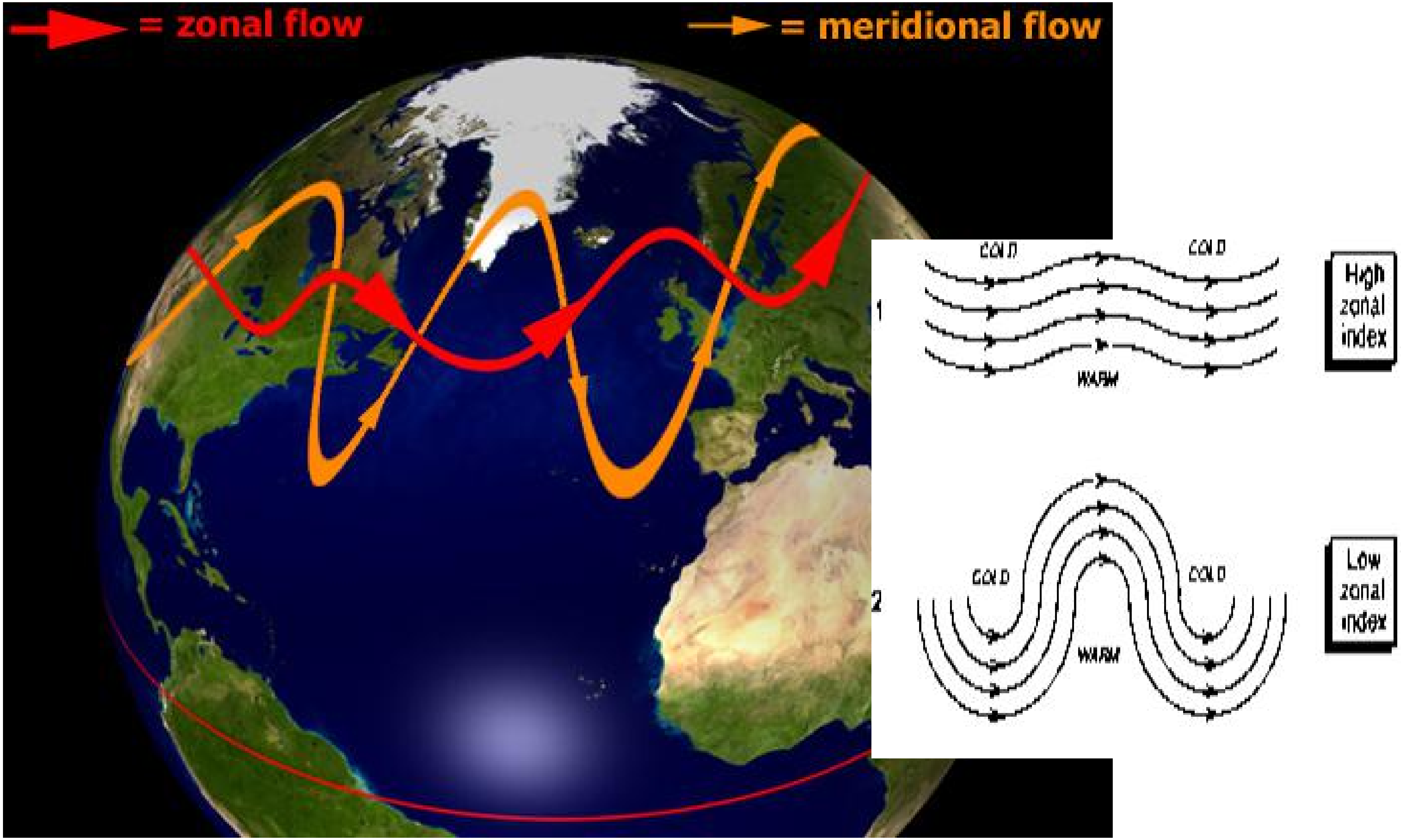


Are the Climatic Oscillations Internally or Astronomically induced?

(A) length of day - LOD (ms);
(B) Zonal index (between 35°N and 55°N) - ZI (hPa);
(C) Reconstruction of the North Atlantic Oscillation - NAO (hPa);
(D) Sea surface temperature - SST (°C).

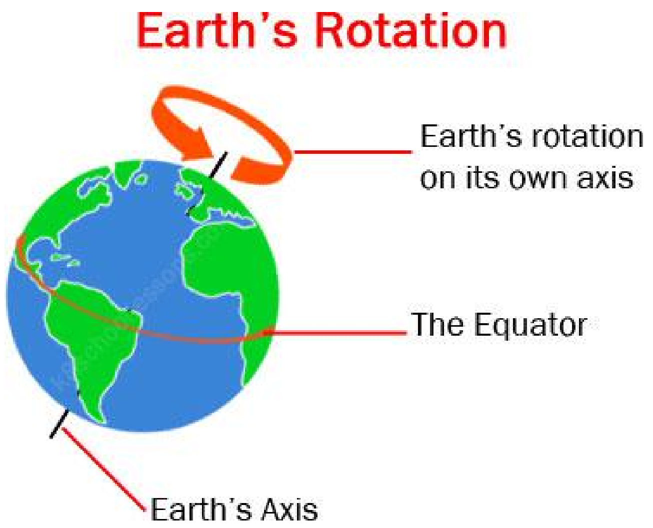


Mazzarella, A., Scafetta, N., 2018. Climate Dynamics, DOI: 10.1007/s00382-018-4122-6



If the westerly flow is strong, the zonal index (ZI) is high. In contrast, as the amplitude of the Rossby waves increases, the flow becomes less zonal and more meridional (i.e. it follows a north-south or longitudinal path). The ZI is then said to be low. For low ZI the net result is a significant latitudinal energy transfer which brings an increase of global surface temperature.

Integrated ZI : IZI(t)= IZI(t-1) +ZI(t)
Integrated NAO: INAO(t) =INAO(t-1) +NAO(t)



Interval Variability

$$ZI \sim NAO \propto LOD$$

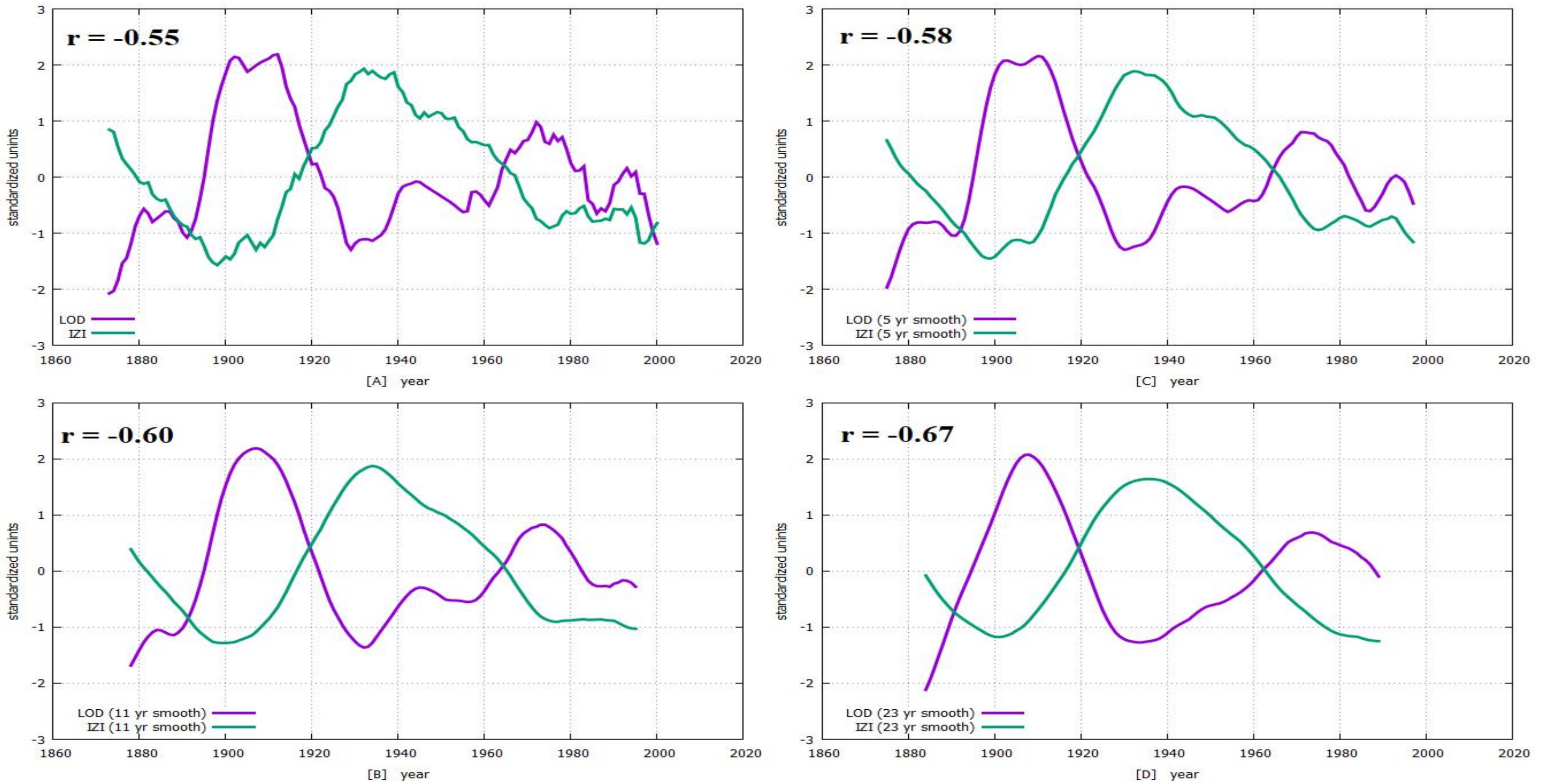
$$NAO \sim LOD$$

Astronomical forcing

$$IZI \sim INAO \propto -\Delta LD = -LOD$$

$$INAO \sim SST \sim -LOD$$

Time plot of standardized yearly values of LOD and IZI:
(A) Raw values;
(B) Smoothed according to a 5-yr running mean;
(C) Smoothed according to a 11-yr running mean;
(D) Smoothed according to a 23-yr running mean.

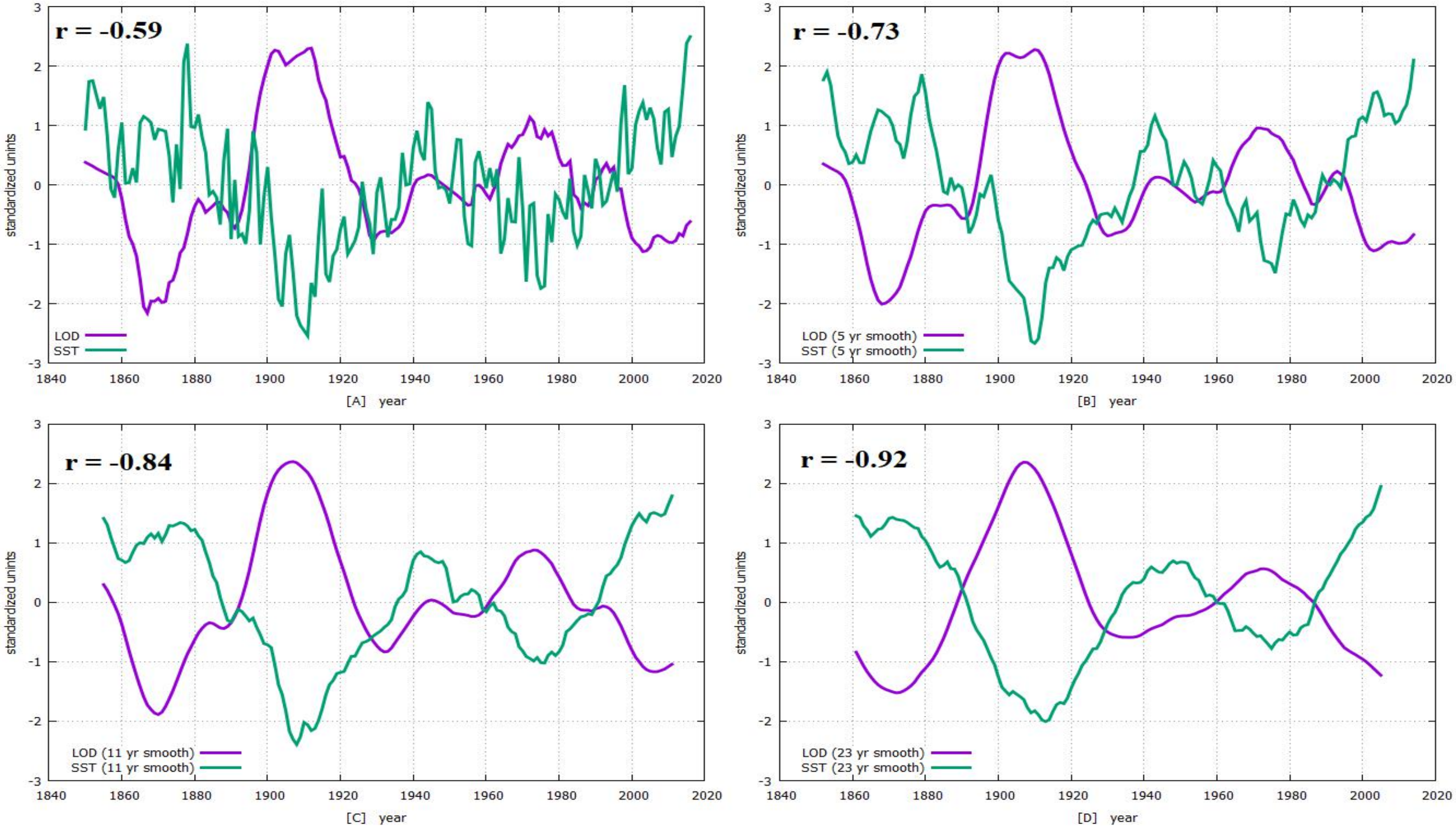


Astronomical forcing

$$IZI \sim INAO \sim \Delta U_g \propto -\Delta LD = -LOD$$

$$INAO \sim SST \sim -LOD$$

Time plot of standardized yearly values of LOD and SST: (A) Raw values; (B) Smoothed according to a 5-yr running mean; (C) Smoothed according to a 11-yr running mean; (D) Smoothed according to a 23-yr running mean.



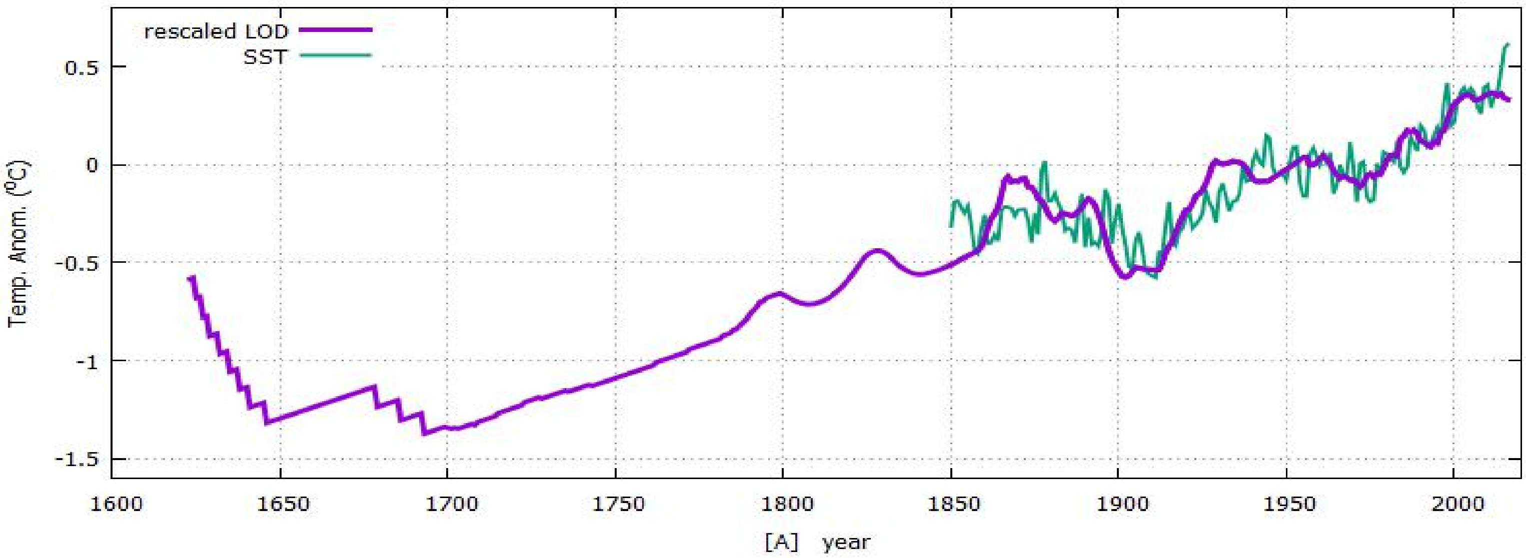
Astronomical forcing

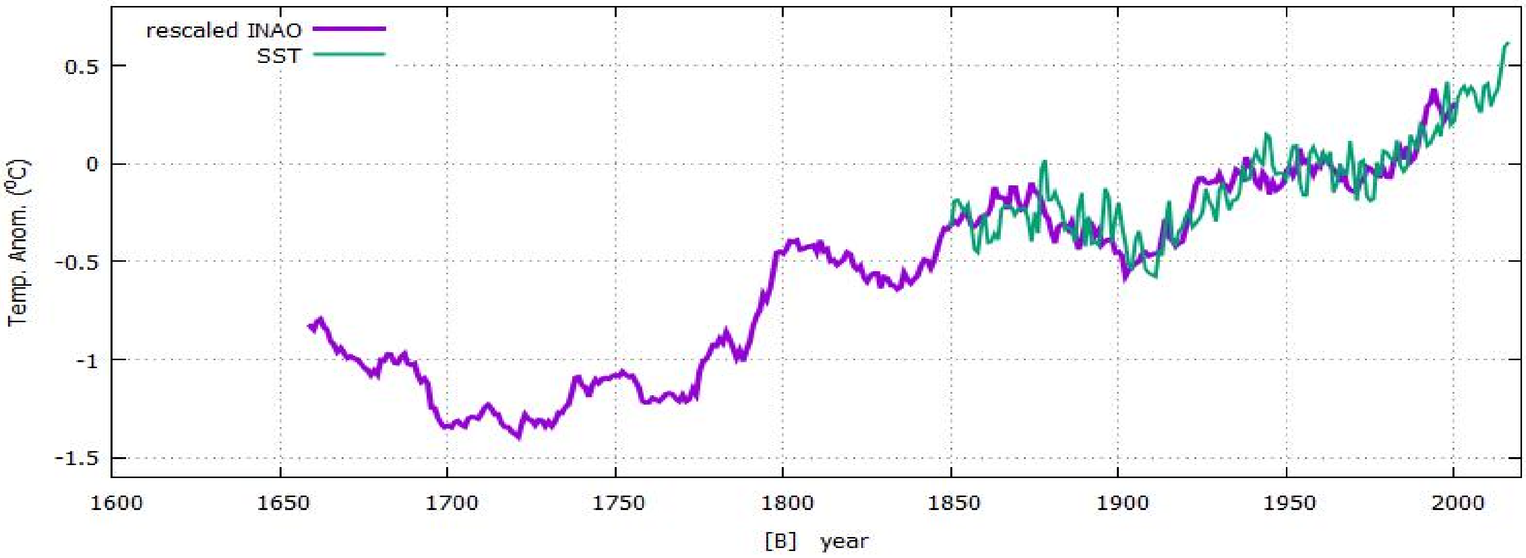
$$IZI \sim INAO \propto -\Delta LD = -LOD$$

$$INAO \sim SST \sim -LOD$$

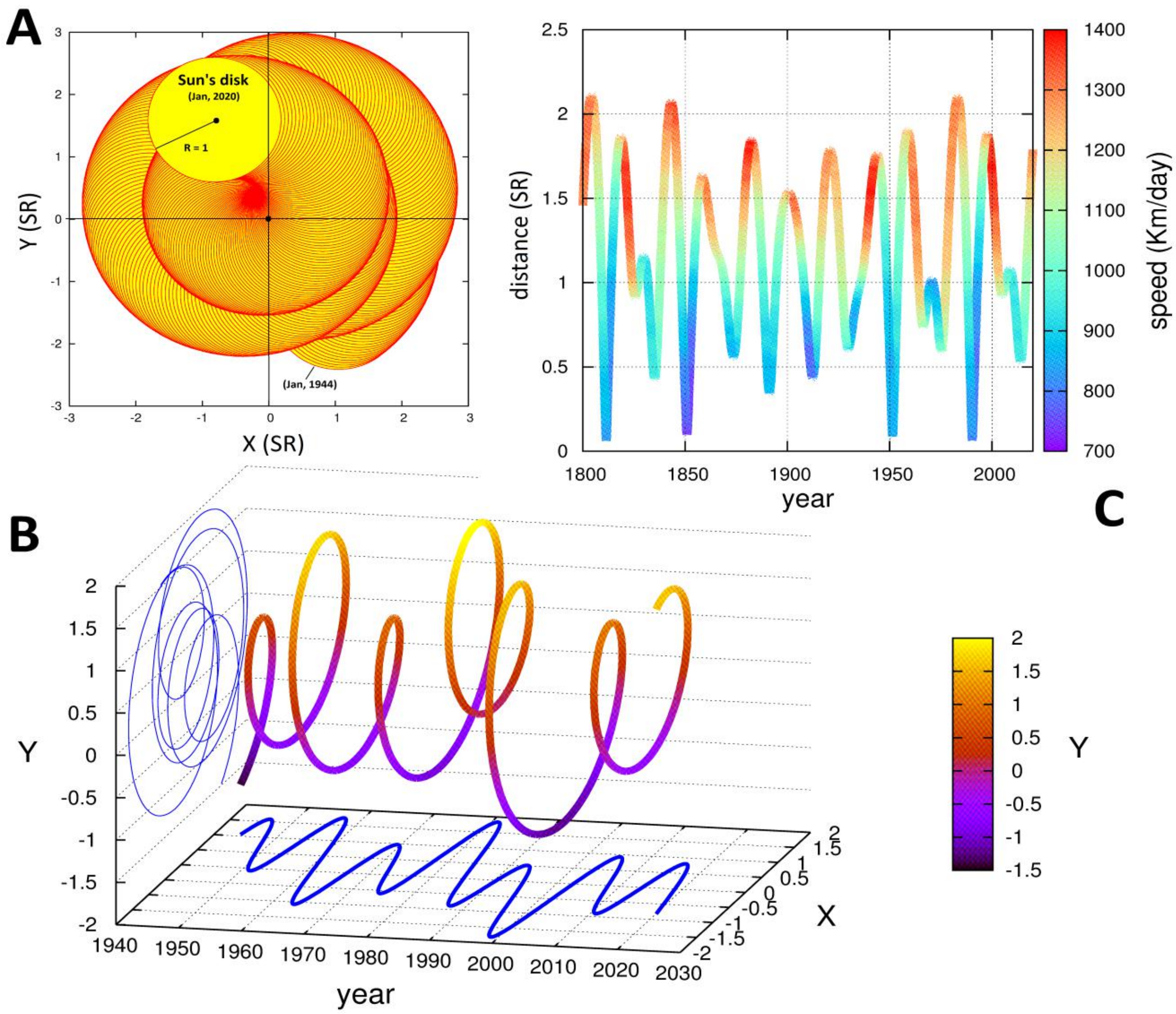
A large pre-industrial climatic variability is confirmed

(A) SST modelled using LOD
(B) SST modelled using INAO



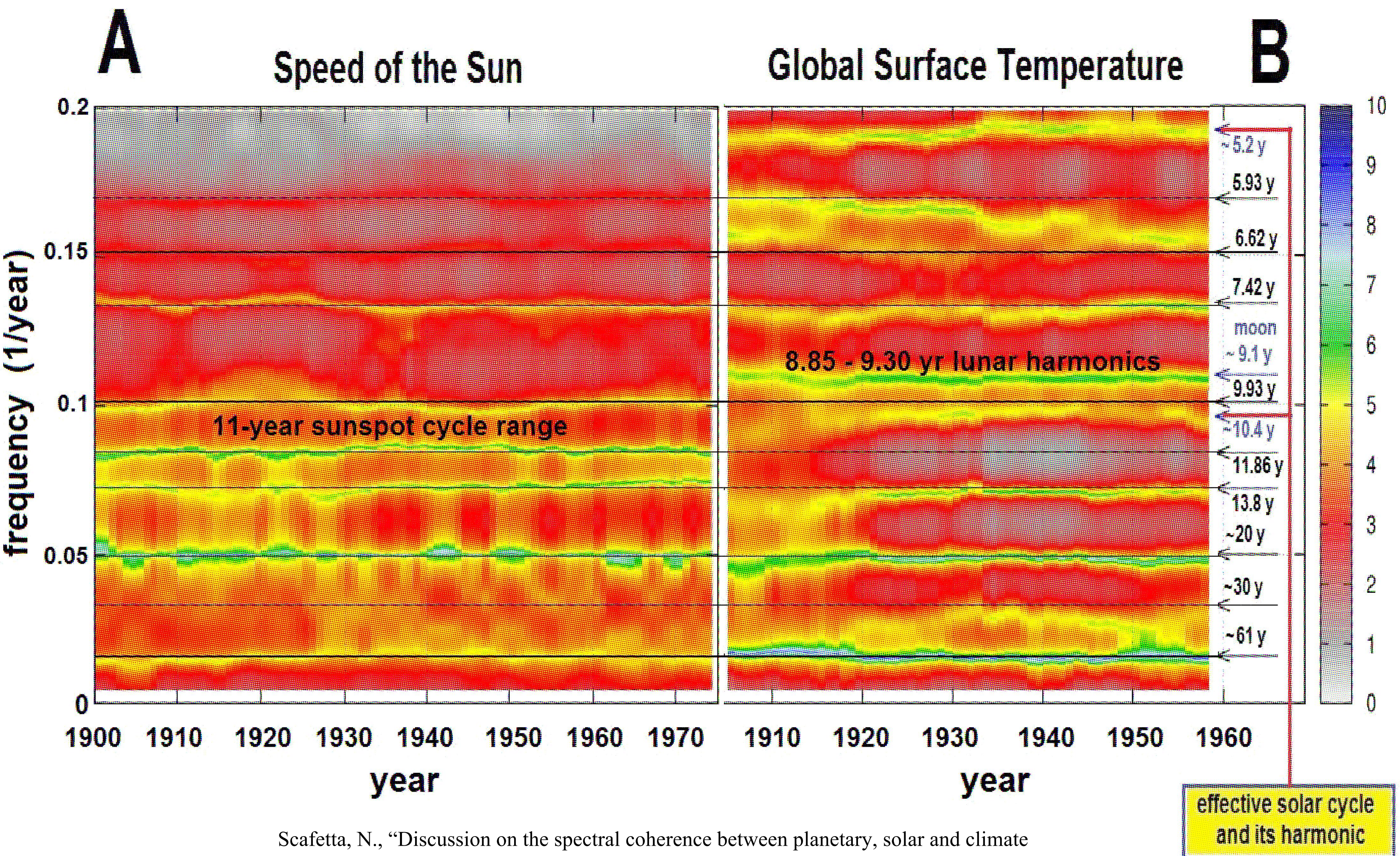


The Sun's Wobbling



Scafetta, N., 2014. The complex planetary synchronization structure of the solar system.Pattern Recognition in Physics 2, 1-19.

Evidence that the climate system is regulated by astronomical oscillations

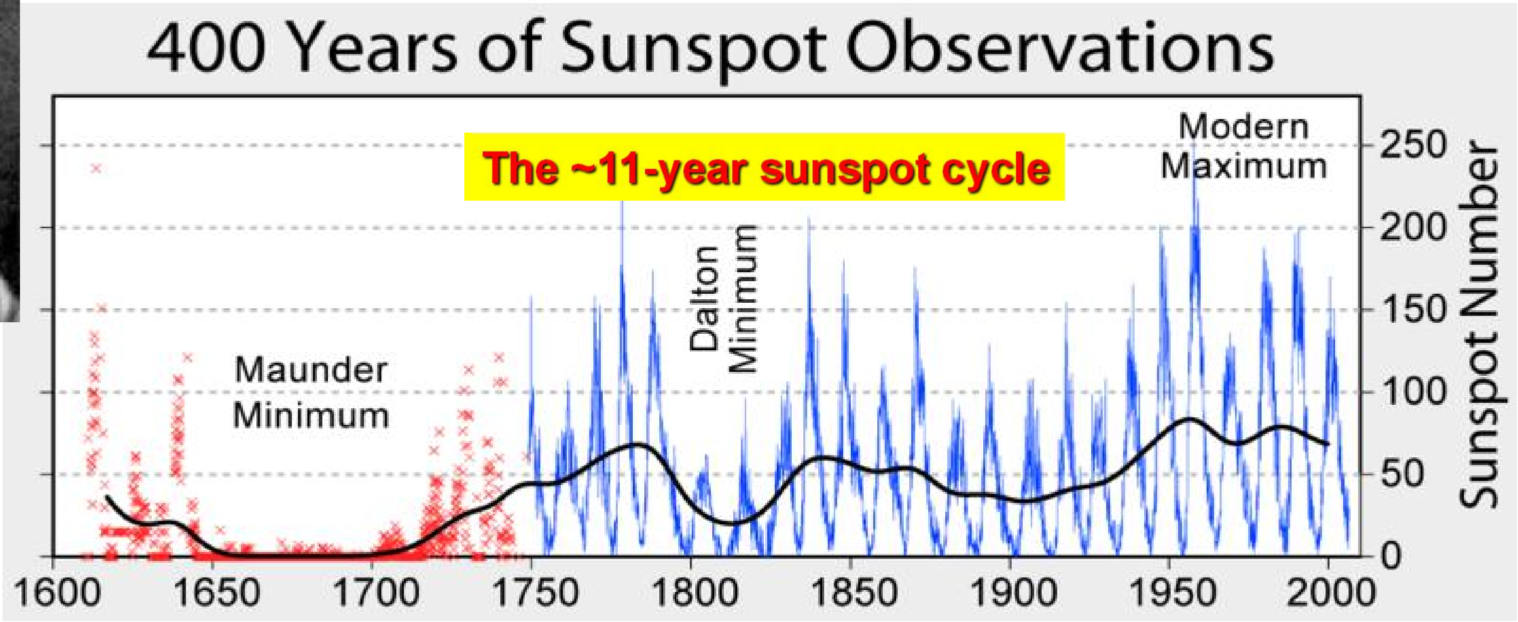


Scafetta, N., "Discussion on the spectral coherence between planetary, solar and climate oscillations: a reply to some critiques." *Astrophysics and Space Science*, vol. 354, pp. 275-299, 2014.

A Planetary theory of solar variations

Extract of a Letter from Prof. R. Wolf, of Zurich, to Mr. Carrington, dated Jan. 12, 1859.

(*Translation.*)



the same planets, the conclusion seems to be inevitable, that my conjecture that the variations of spot-frequency depend on the influences of *Venus, Earth, Jupiter, and Saturn,* will not prove to be wholly unfounded. The preponderating planet

The three main frequencies of the 11-year solar cycle

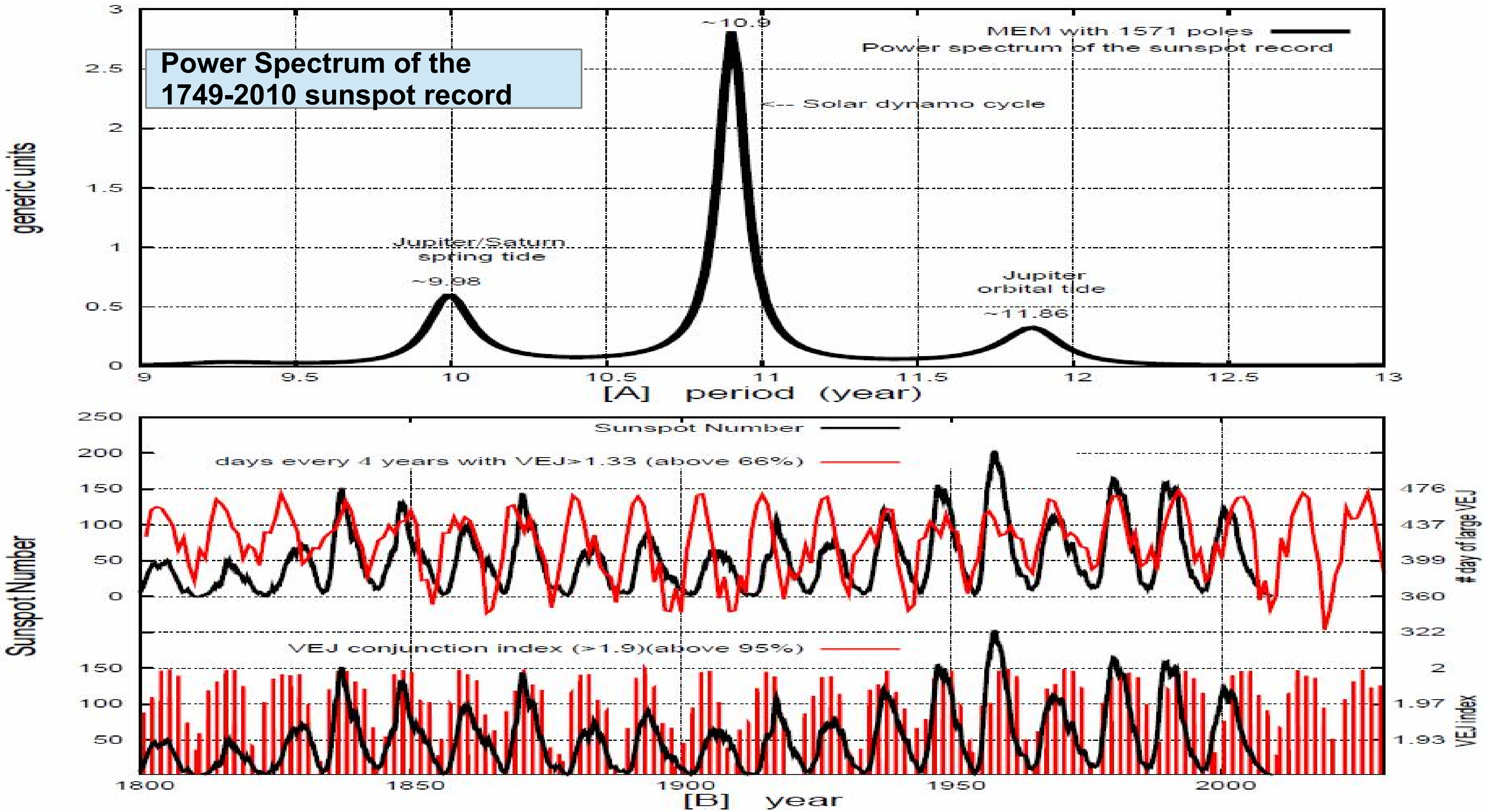


Figure 12: [A] Power spectrum of the sunspot record from 1749 to 2010 highlighting three peaks within the Schwabe frequency band (period 9-13 years) including the two major tides of Jupiter and Saturn. [B] Comparison between the sunspot record (black) and a particular tidal pattern configuration (red) made using Venus, Earth and Jupiter that reproduces on average the solar cycle length of 11.08 yr.

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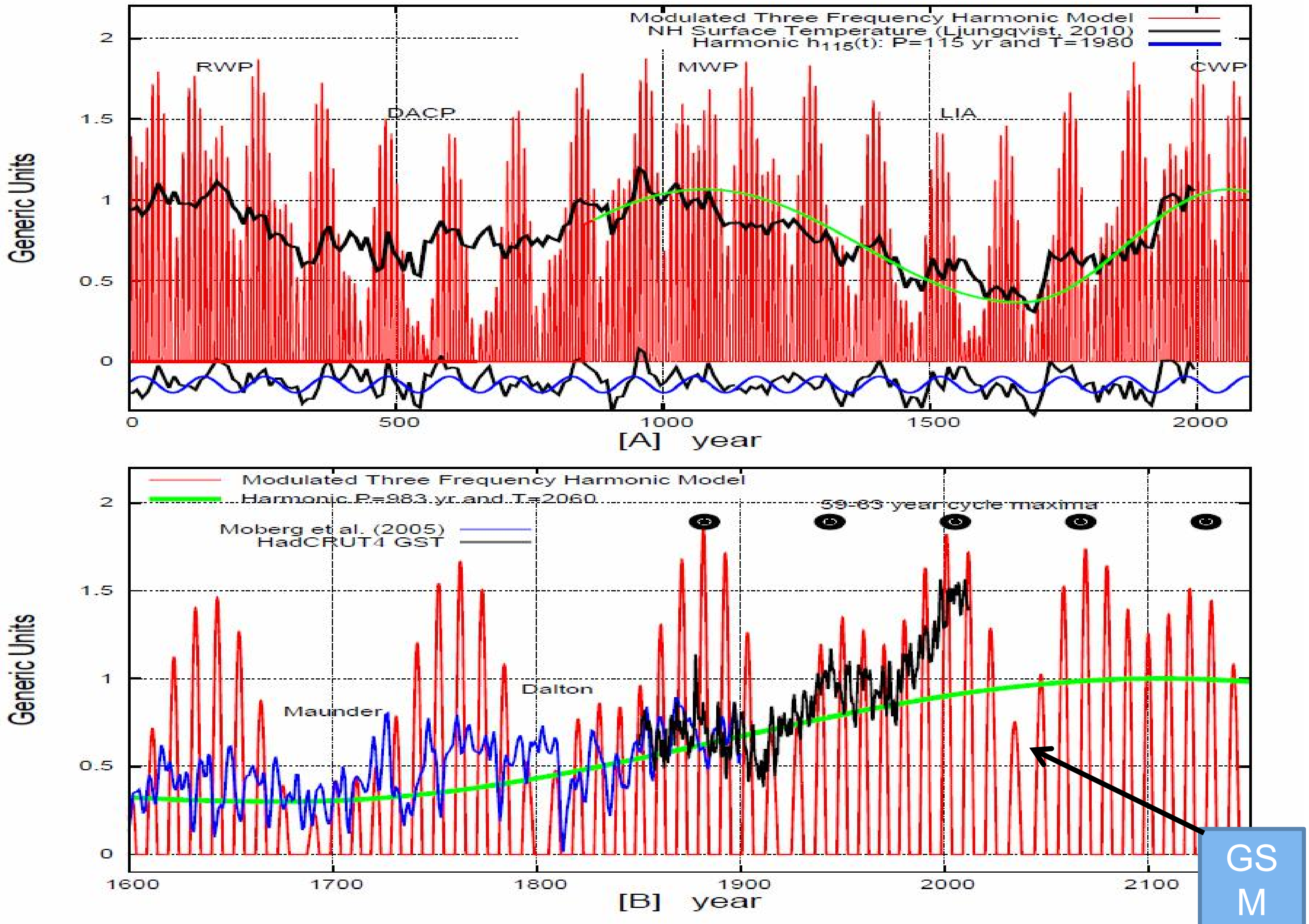
Three-frequency solar harmonic model vs. temperature reconstructions (~61 yr, ~115 yr, ~980 yr cycles)



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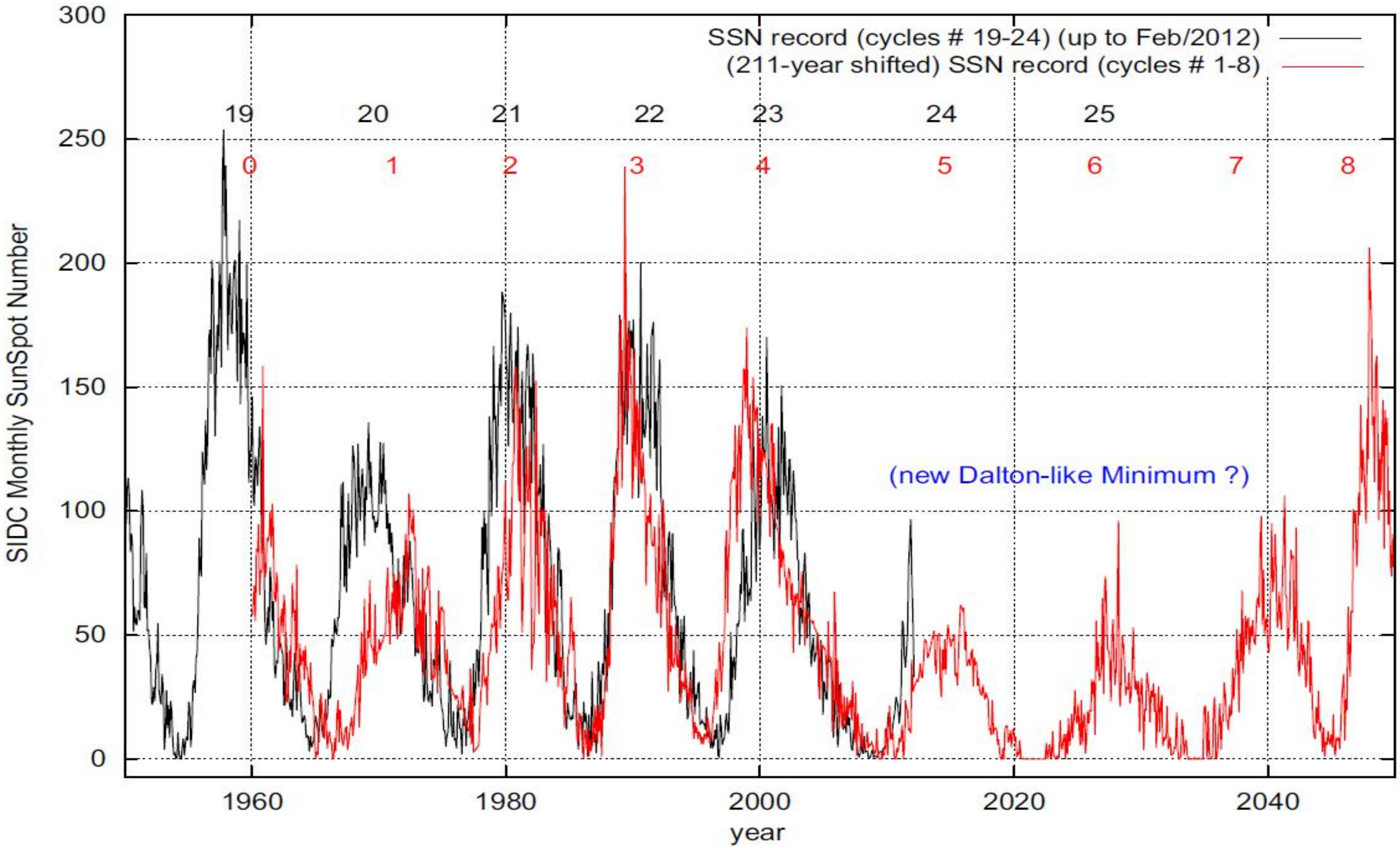
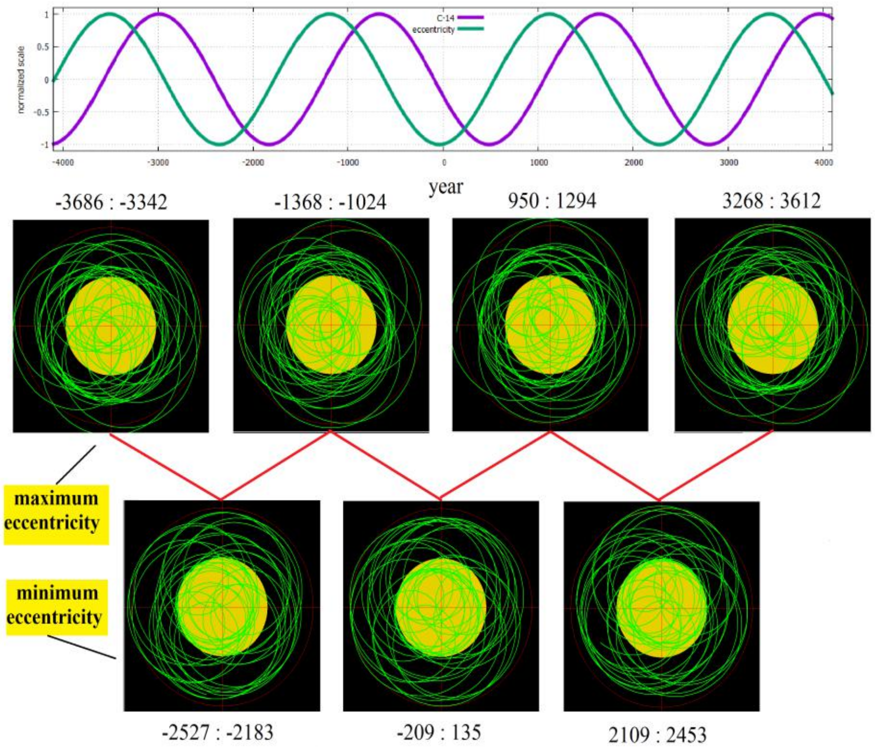
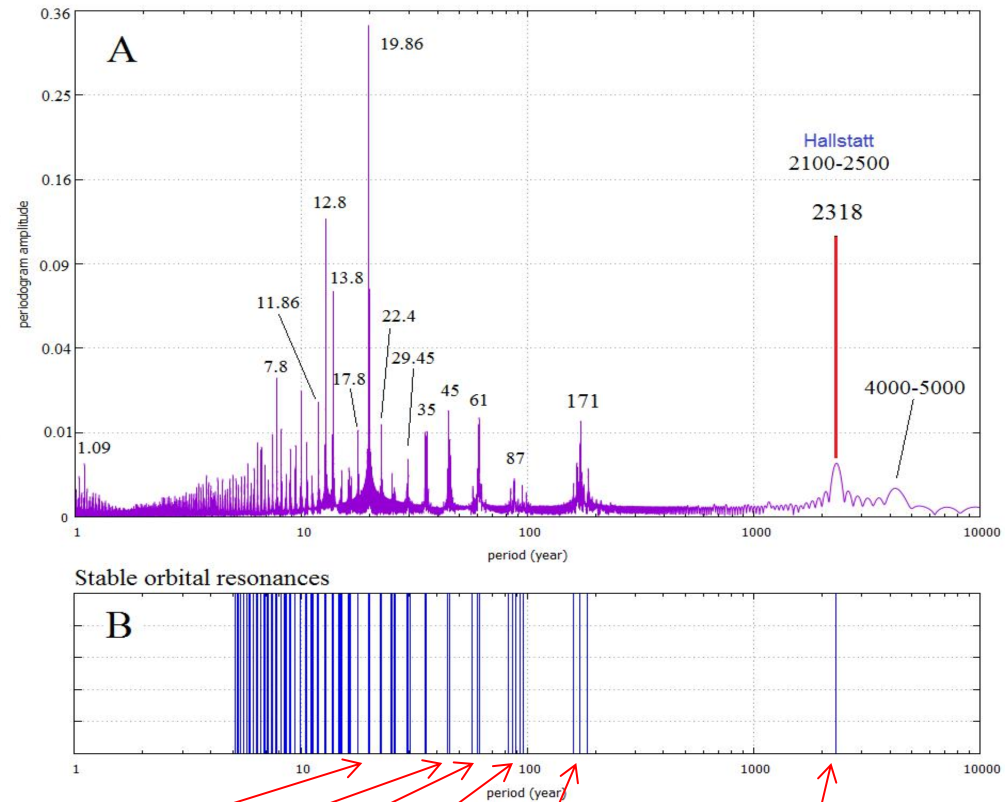
Versus a new grand solar minimum

N. Scafetta / Journal of Atmospheric and Solar-Terrestrial Physics 80 (2012) 296–311



The stable orbital resonances of the Jupiter-Saturn-Uranus-Neptune system





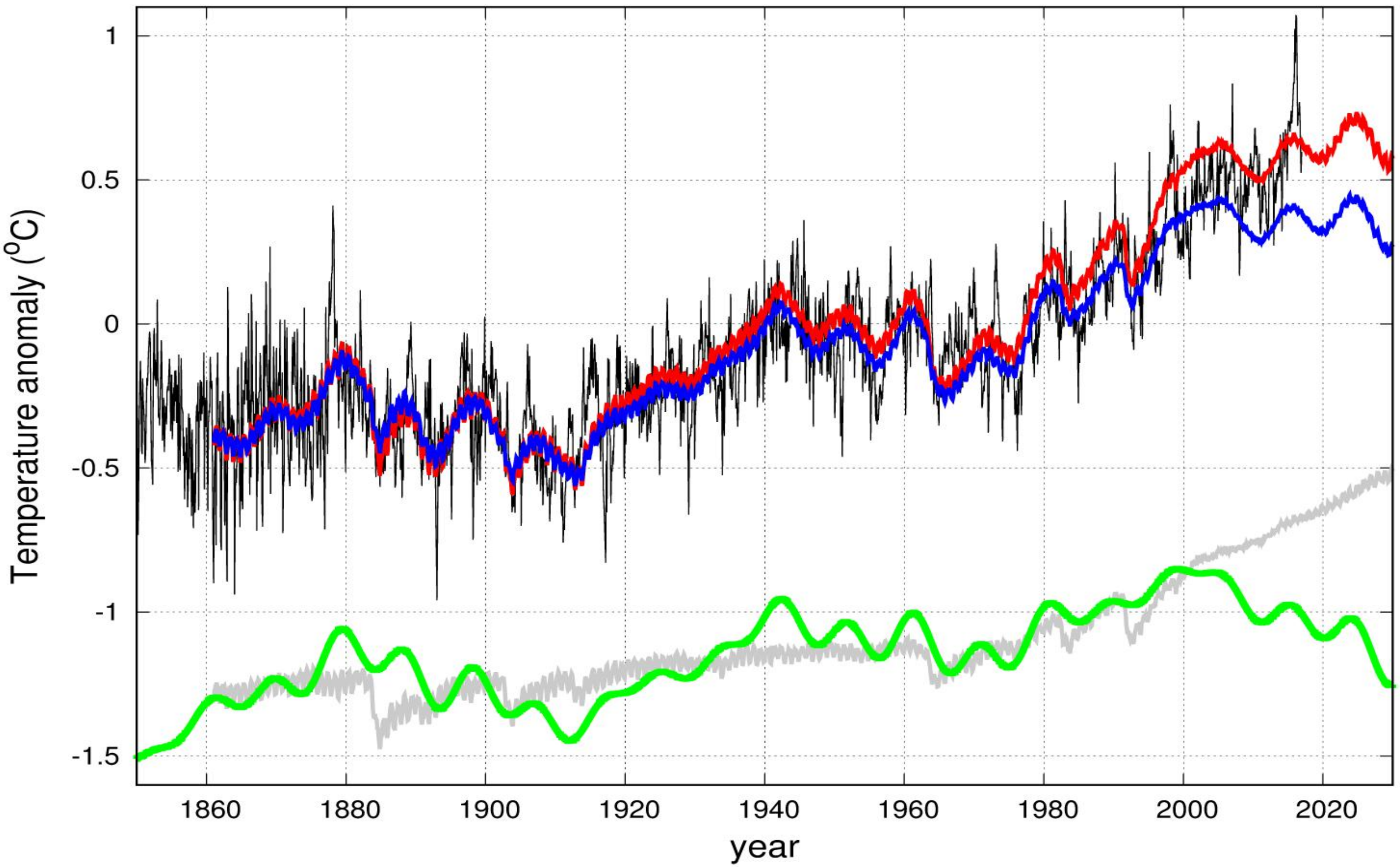
Stable resonances

20 yr | 44-45 yr | 57-61 yr | 82-96 yr | 159-171-185 yr | 2318 yr

Gleissberg | Jose | HallStatt

Harmonic Climate Model

$$H(t) = h_{983}(t) + h_{115}(t) + h_{60}(t) + h_{20}(t) + h_{10.4}(t) + h_{9.1}(t) + \beta * m(t) + const,$$



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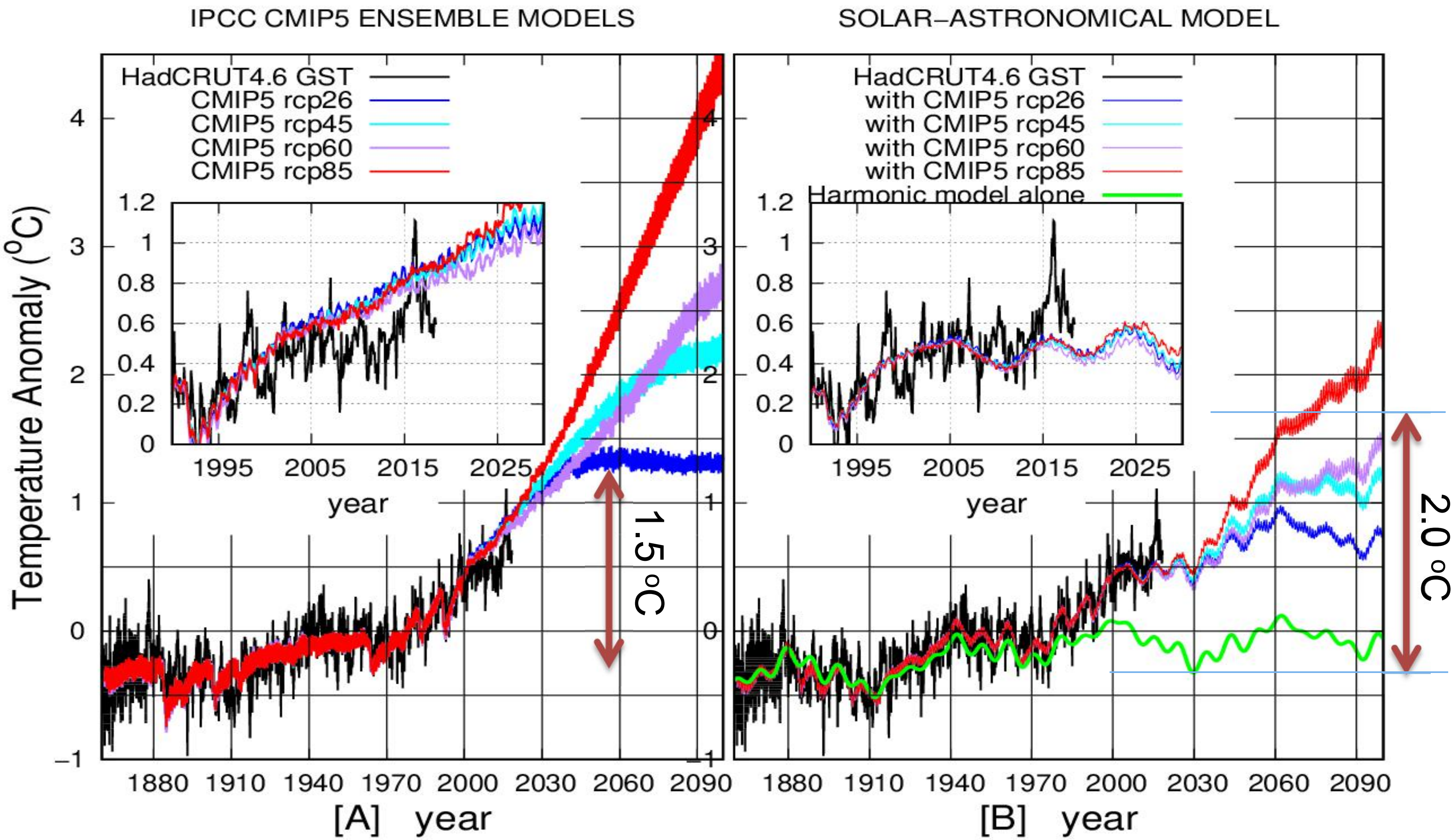
IPCC 2013 ALL CMIP5 Models

6-frequency + anthropogenic SOLAR-ASTRONOMICAL MODEL



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.

Scafetta's presentation at the Environmental Protection Energy (EPA, DC, USA) 02/26/2009

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https://www.epa.gov/environmental-economics/climate-change-and-its-causes-discussion-about-some-key-issues

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Climate Change and Its Causes: A Discussion about Some Key Issues

This is a presentation by Nicola Scafetta of Duke University about addressing climate change where several crucial physical ingredients are still severely uncertain. This presentation was given for a seminar titled Climate Change and Its Causes: A Discussion about Some Key Issues.

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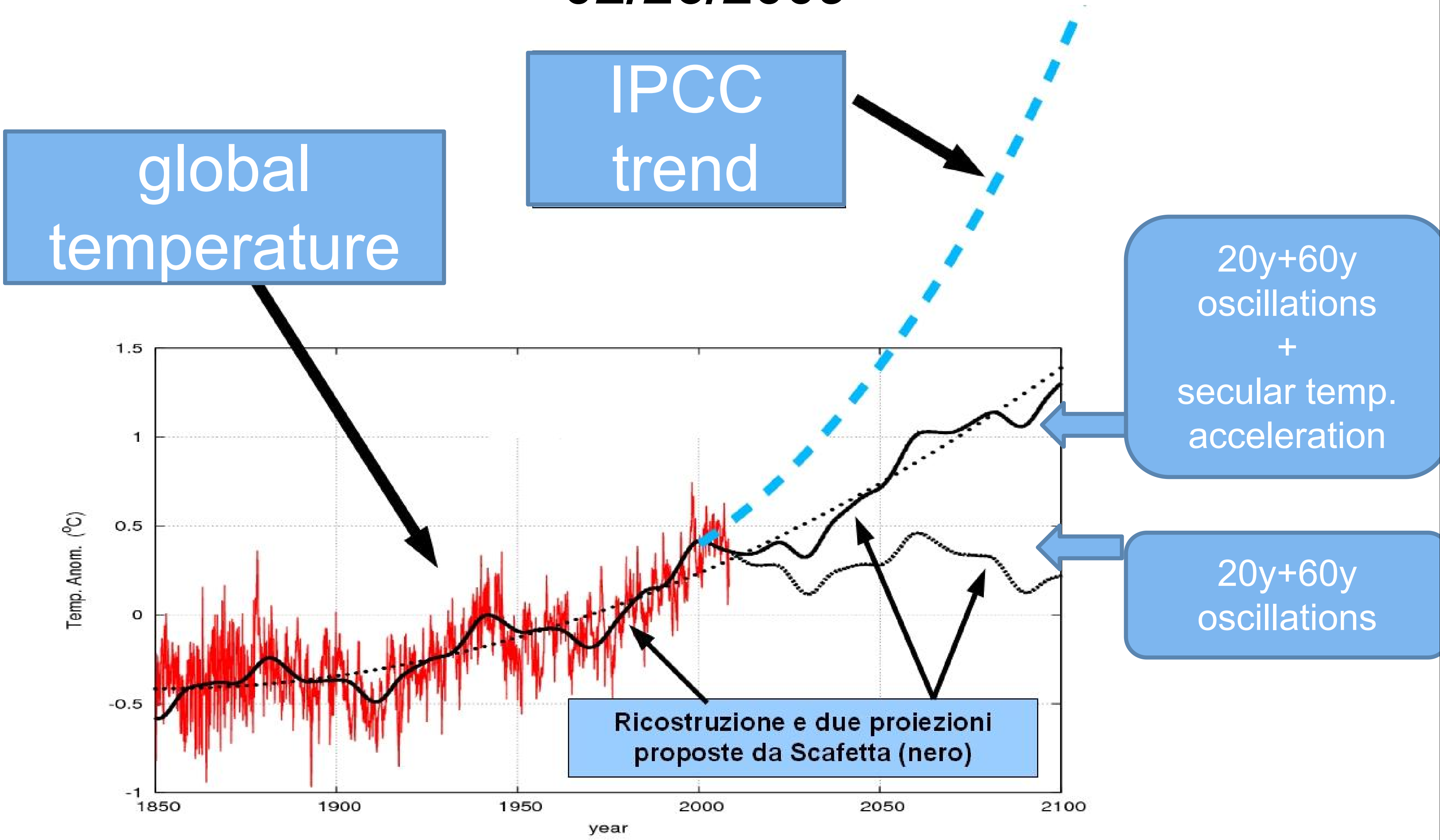
- Climate Change and Its Causes: A Discussion About Some Key Issues (PDF)
  (76 pp, 8 MB, 02/26/2009)

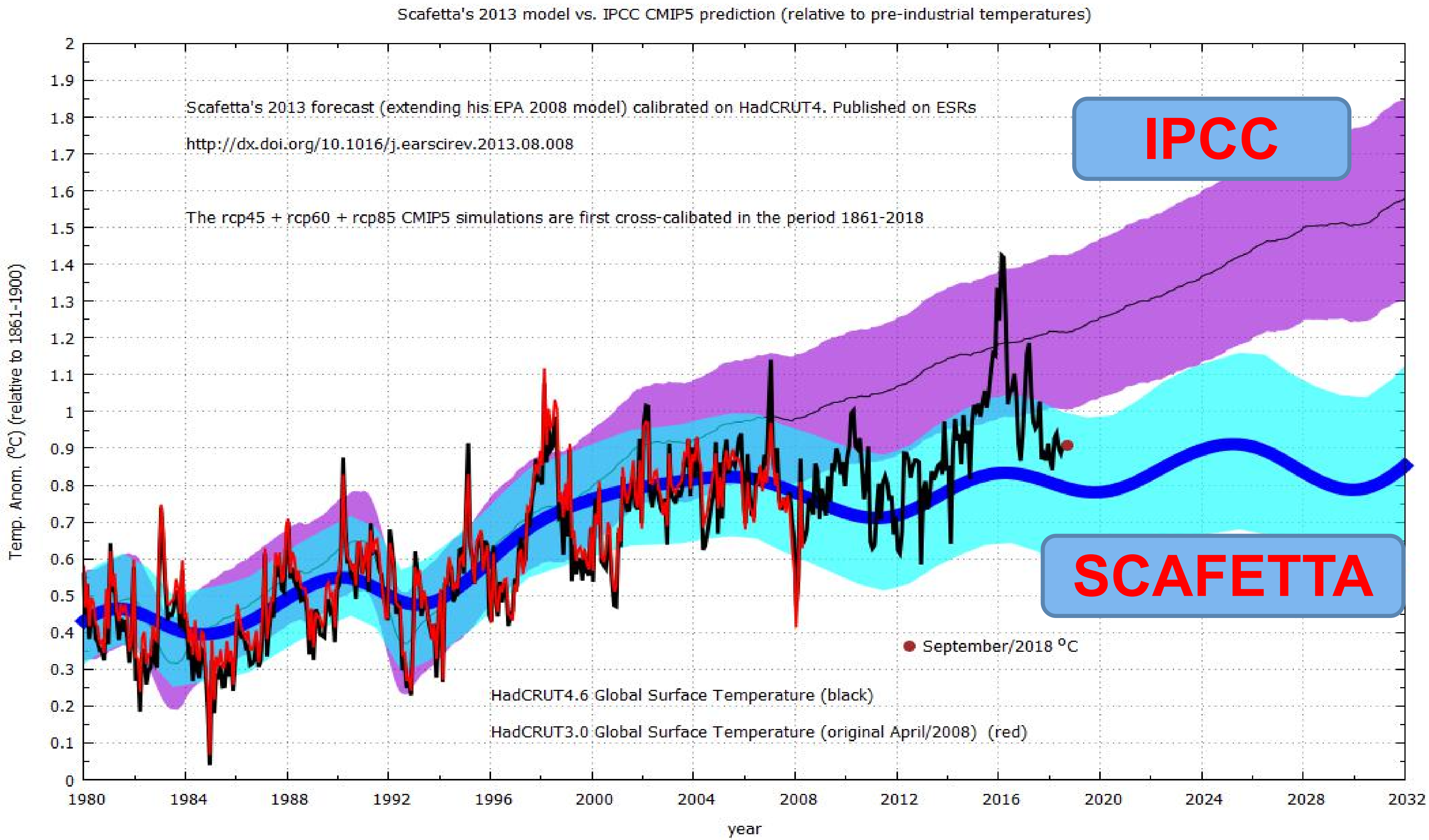
Contact Us to ask a question, provide feedback, or report a problem.

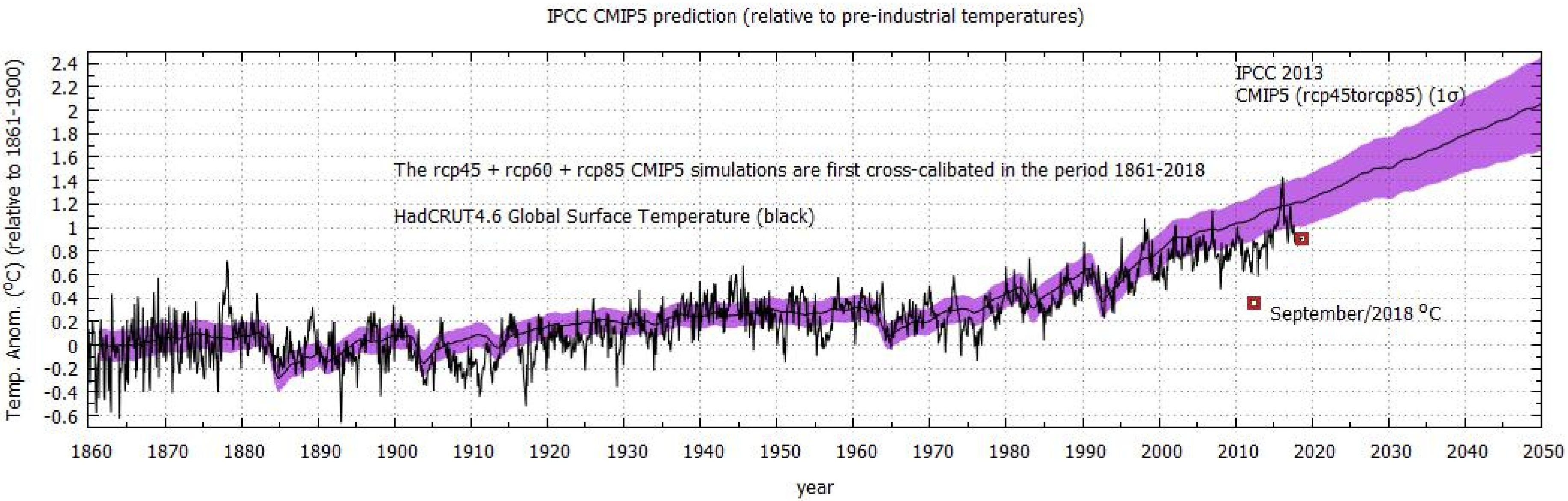
Scafetta's forecast shown at the Environmental Protection Energy (EPA, DC, USA) 02/26/2009

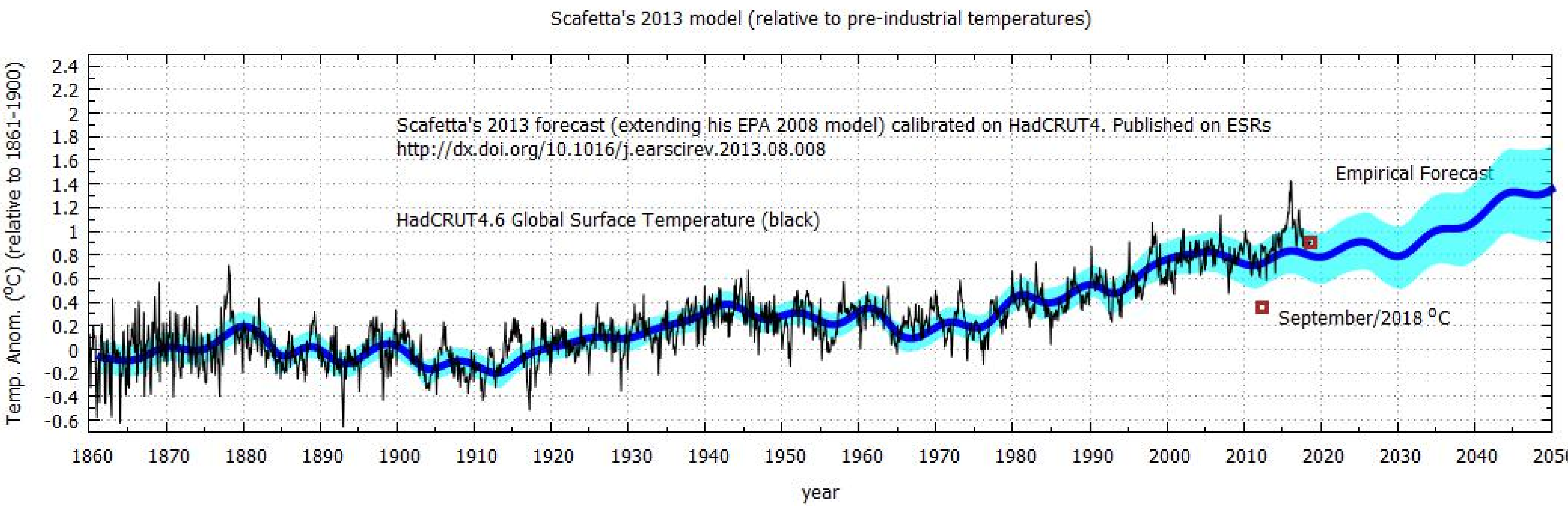


10-years later: How is Scafetta's forecast performing?

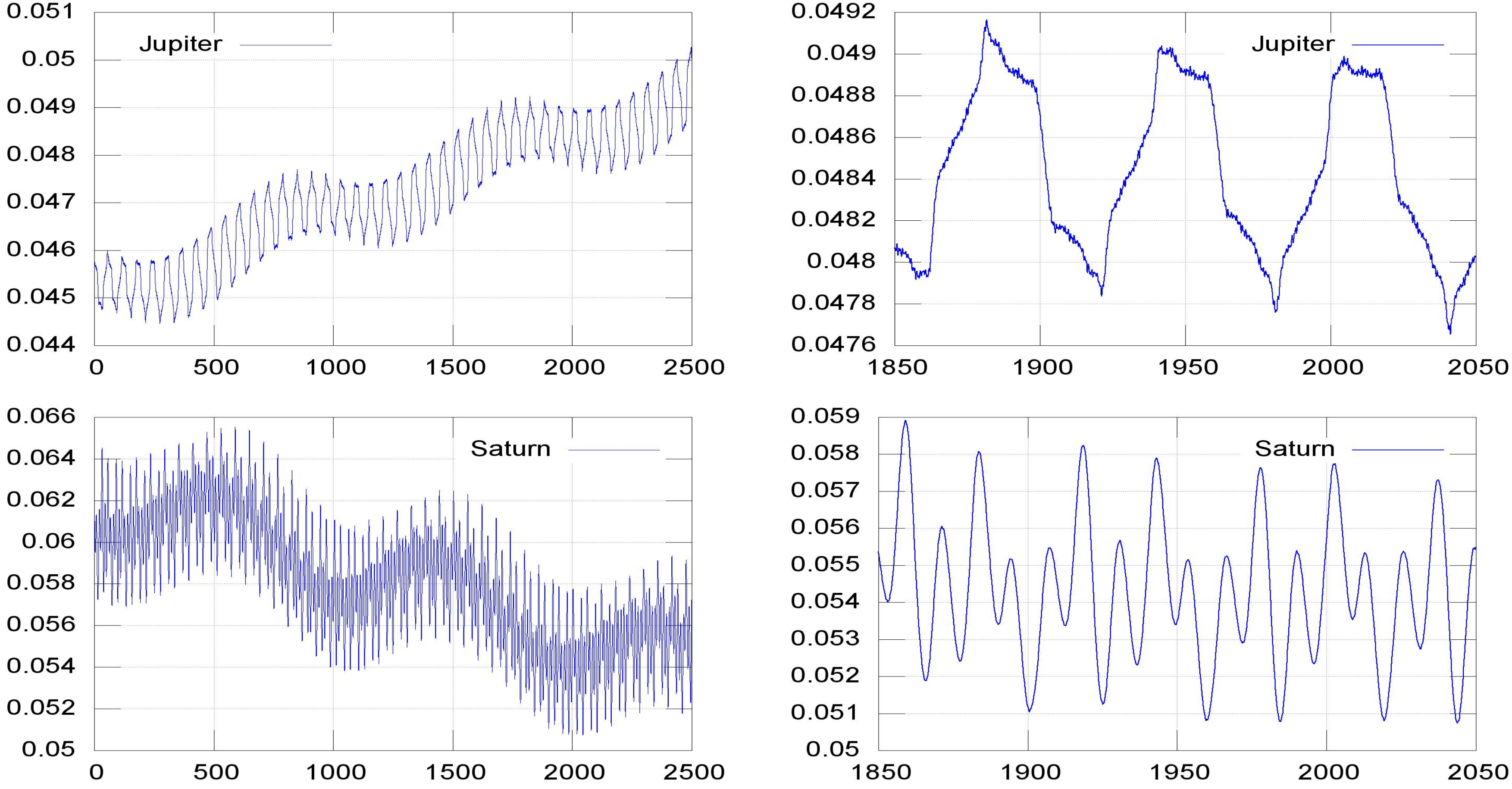
- Scafetta, N. 2013. Discussion on climate oscillations: CMIP5 general circulation models versus a semi-empirical harmonic model based on astronomical cycles. Earth-Science Reviews 126, 321-357.



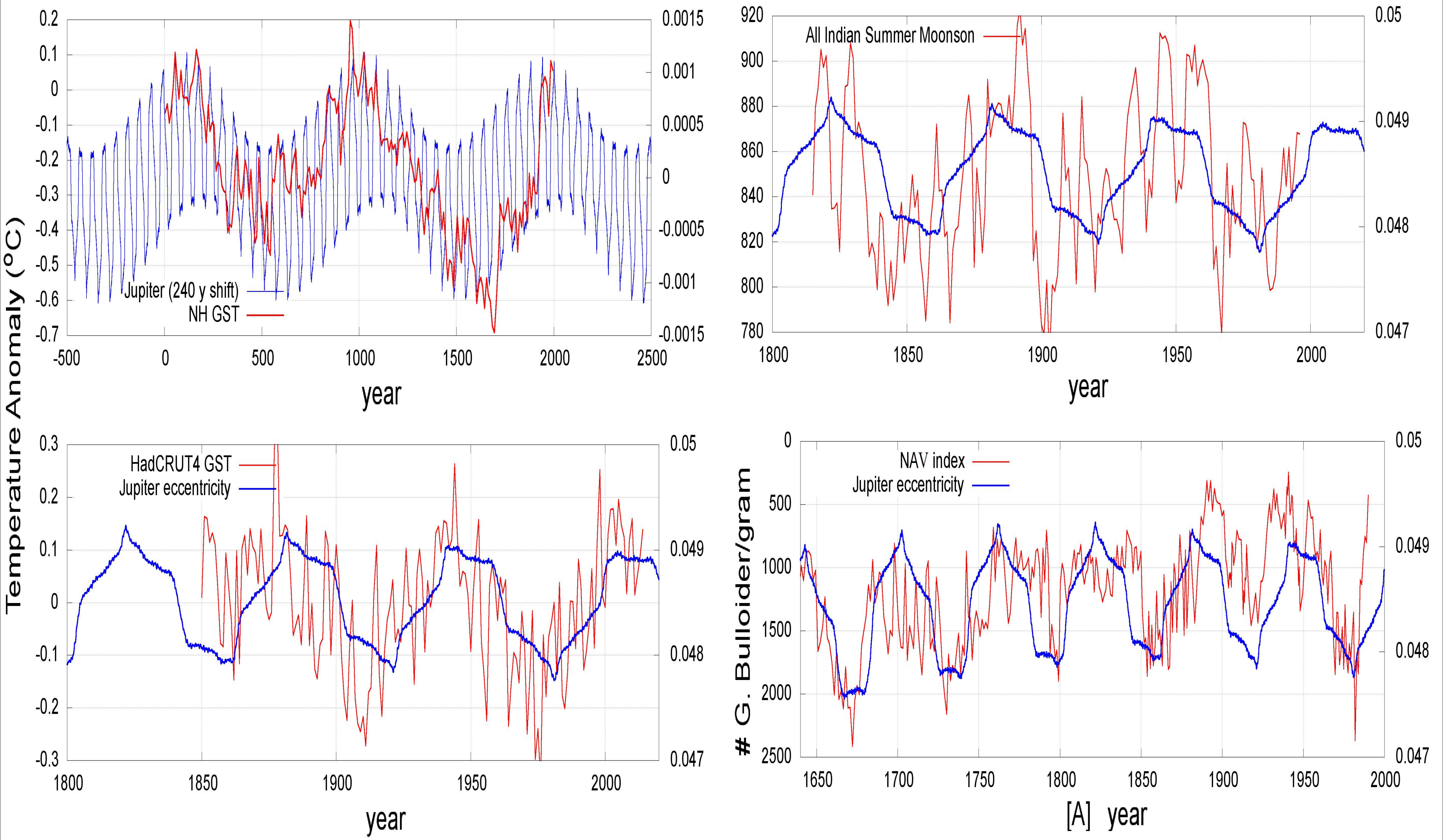

IPCC CMIP5 prediction (relative to pre-industrial temperatures)
IPCC 2013
CMIP5 (rcp45torcp85) (1σ)
The rcp45 + rcp60 + rcp85 CMIP5 simulations are first cross-calibated in the period 1861-2018
HadCRUT4.6 Global Surface Temperature (black)
September/2018 °C
Temp. Anom. (°C) (relative to 1861-1900)
year


Scafetta's 2013 model (relative to pre-industrial temperatures)
Scafetta's 2013 forecast (extending his EPA 2008 model) calibrated on HadCRUT4. Published on ESRs
http://dx.doi.org/10.1016/j.earscirev.2013.08.008
Empirical Forecast
HadCRUT4.6 Global Surface Temperature (black)
September/2018 °C
Temp. Anom. (°C) (relative to 1861-1900)
year

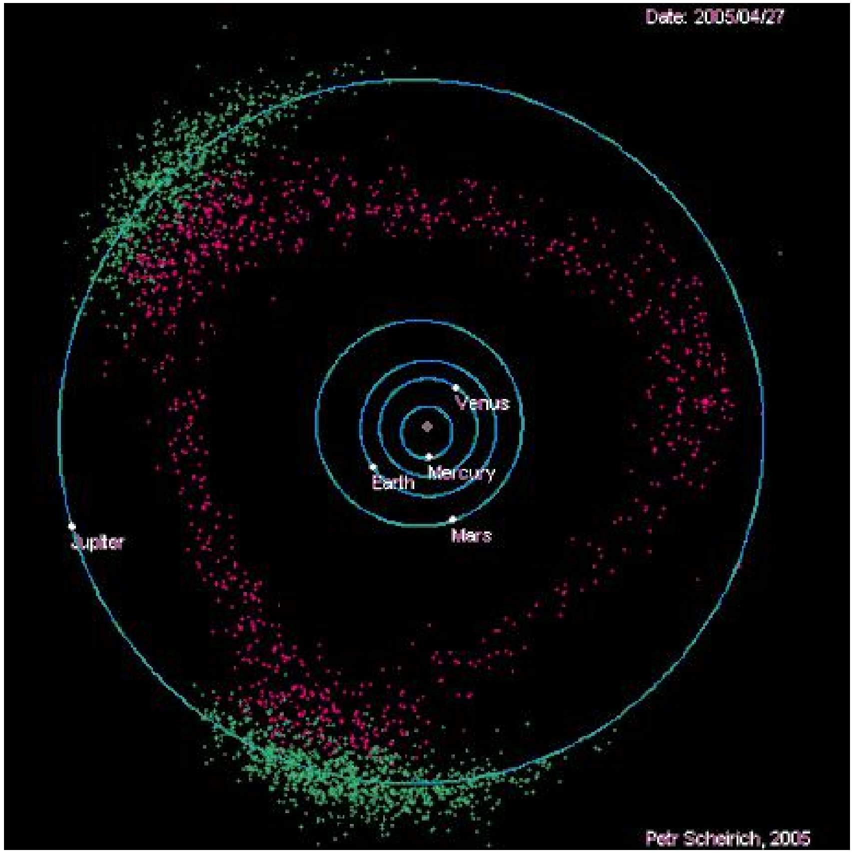
Eccentricity variation of Jupiter and Saturn



60 and 1000 years cycles



- A pulsing Heliosphere - An interplanetary dust-cloud forcing?



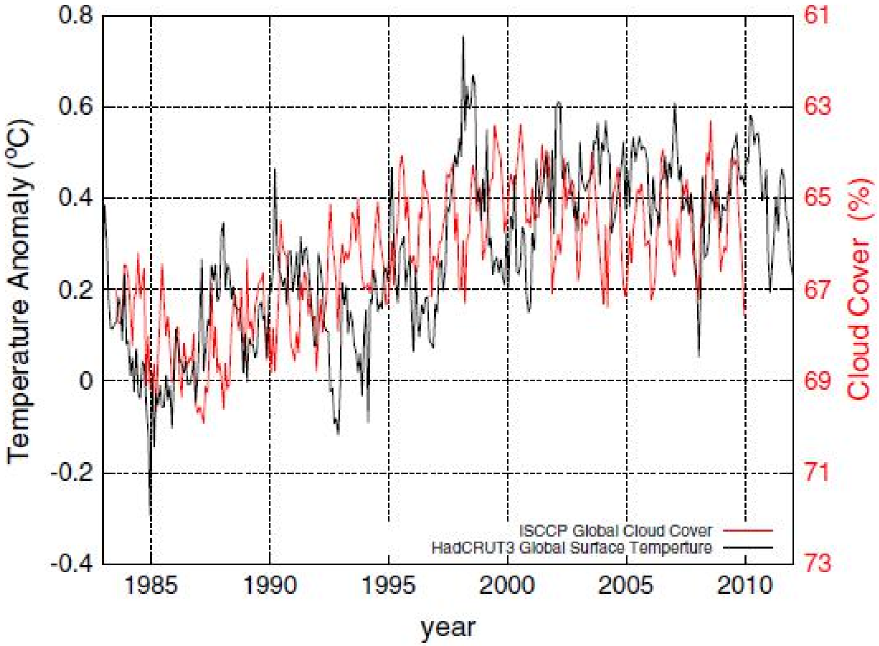
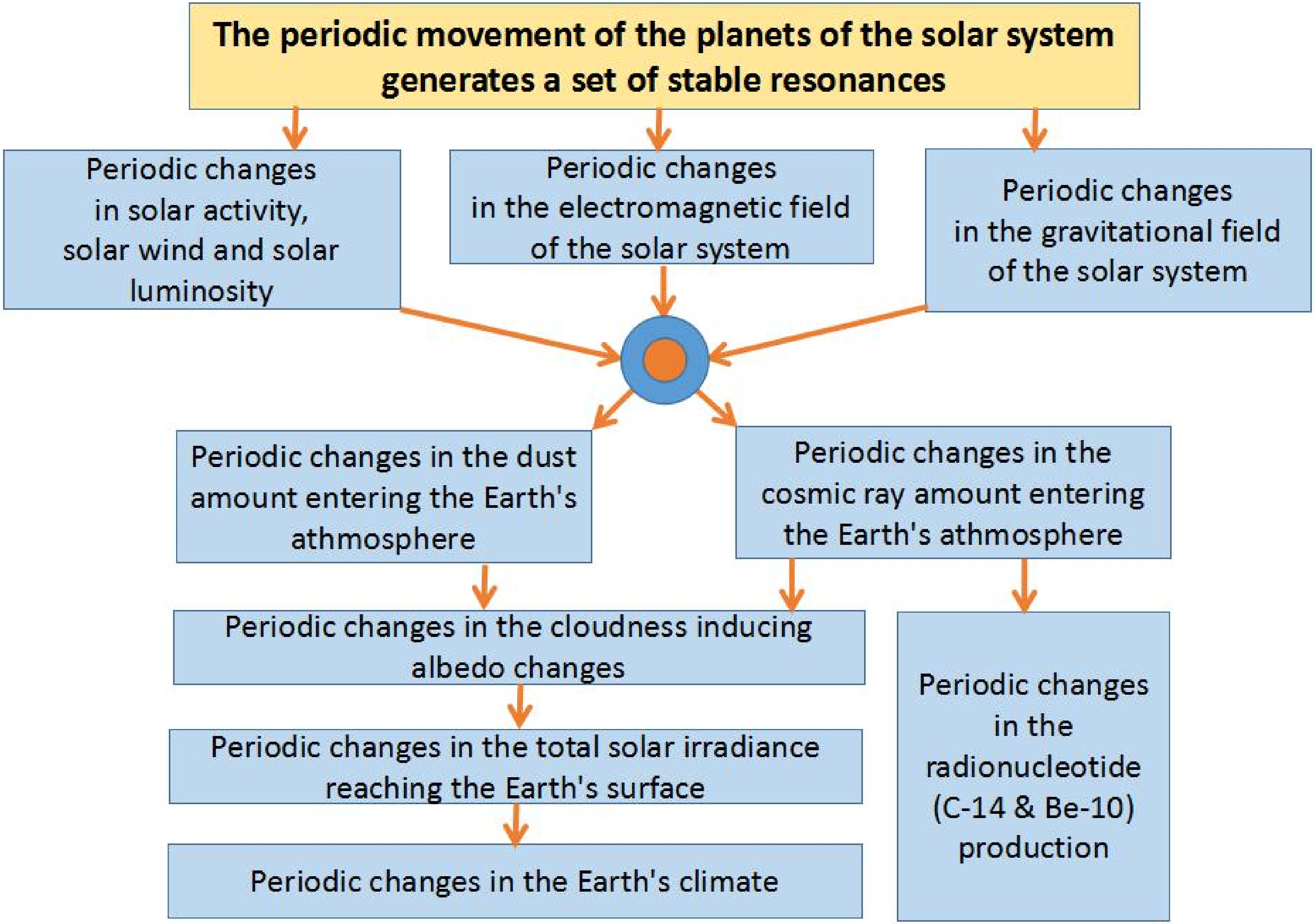


Fig. 19. Global surface temperature (black) against monthly variations in total global cloud cover since July 1983 (red). Correlation coefficient: $r_o = -0.52$, for 318 points $P(|r| \geq |r_o|) < 0.0005$. The cloud data are from the International Satellite Cloud Climatology Project (ISCCP). Cloud data from http://isccp.giss.nasa.gov/pub/data/D2BASICS/B8glbp.dat

Conclusions



Conclusions

- Climate models used to interpret the global climate change of the past and predict future climate warming fail by a large margin. They significantly overstimate the effect of GHGs and understimate solar-astronomical forcings, which are characterized by specific harmonics (e.g.: 9.1 yr, 10-12 yr, 20 yr, 60 yr, 100-150 yr,1000 yr).

- The evidences from corrected climate models suggest that in the 21th century the global climate will warm less than 2 ^{o}C suggesting that climate change adaptation policies could address most of the negative consequences of a climate change. Mitigation policies should be moderate.

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