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Solar magnetic field, solar radiation and their impact on terrestrial temperature

https://solargsm.com/solar-activity/

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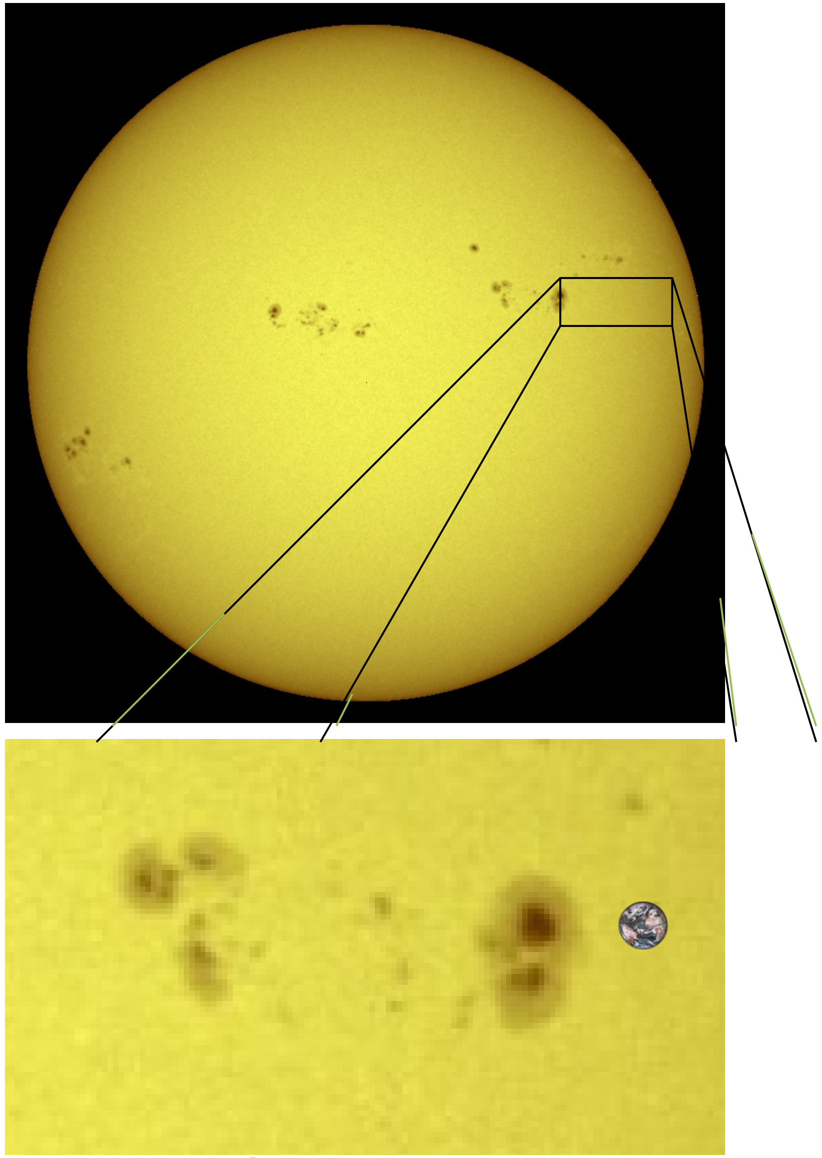
https://solargsm.com/publications/

With thanks to Drs. S. Shepherd (UK), E. Popova (Russia) and S. Zharkov (UK)

Solar activity



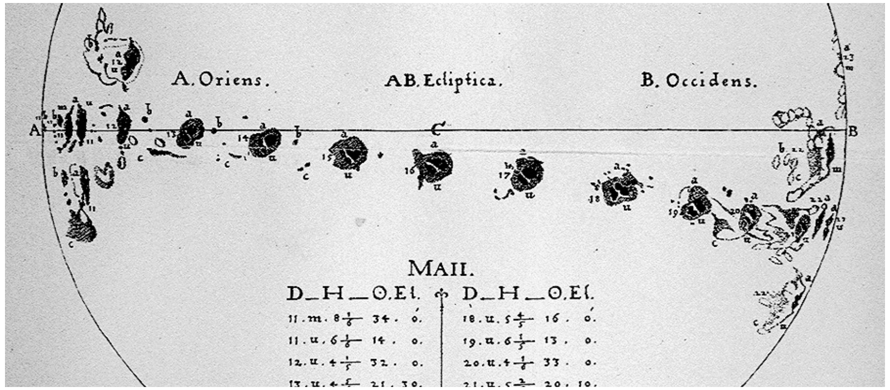
Sunspots

Sunspots are dark (and cooler) regions on the surface of the Sun. They have a darker inner region (the Umbra) surrounded by a lighter ring (the Penumbra).

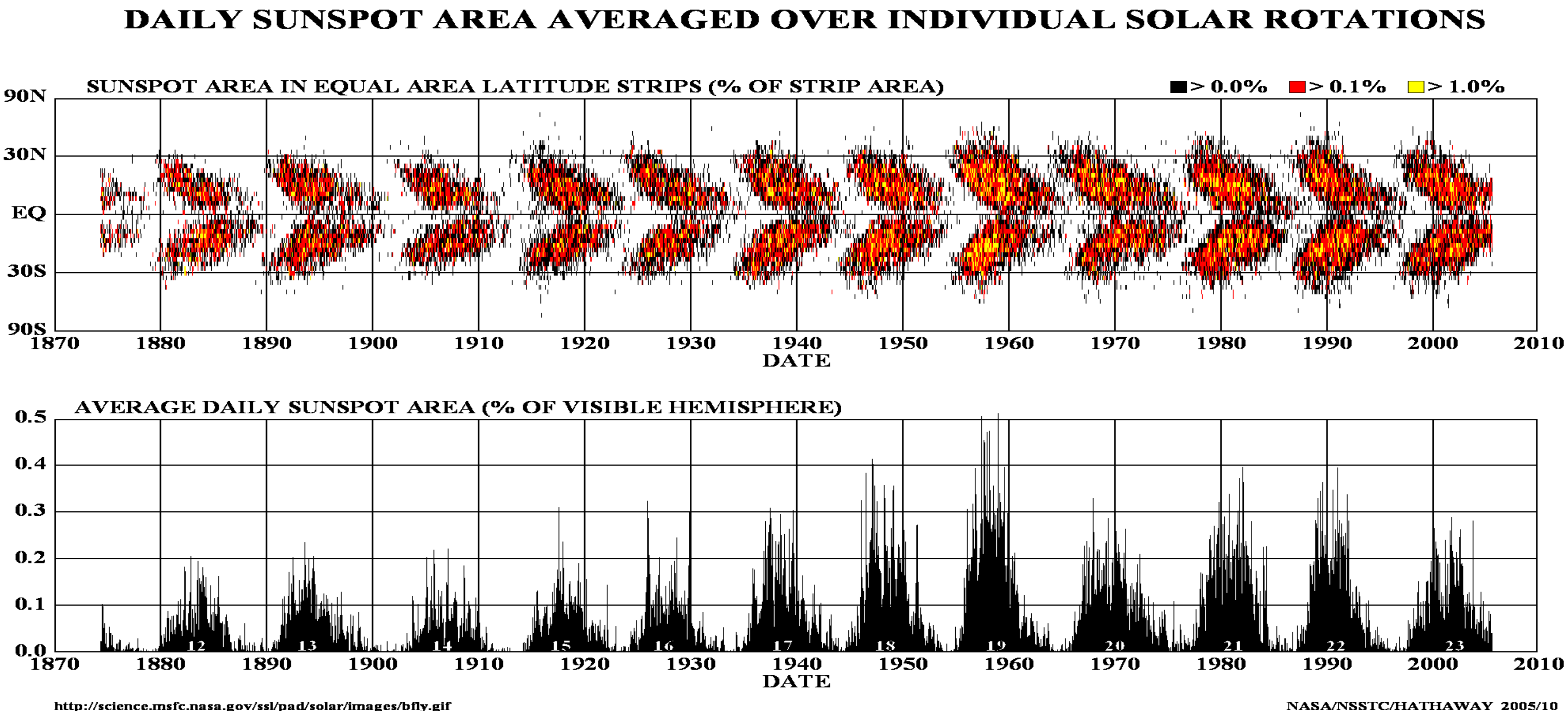
Sunspots usually appear in groups that form over hours or days and last for days or weeks.

These early sunspot observations indicated that the Sun rotates once in about 27 days.

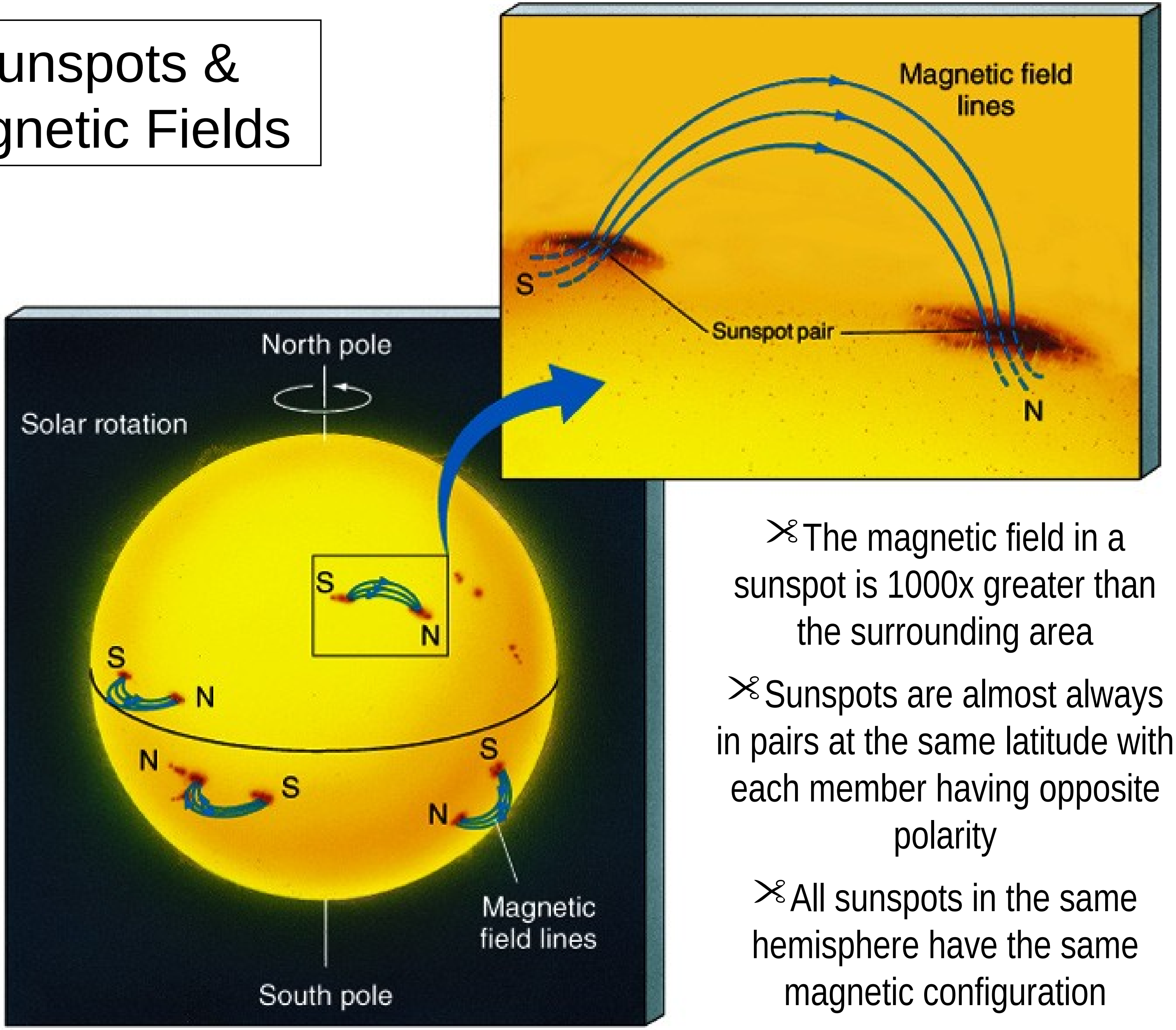
Solar activity index – average sunspot numbers



Current solar activity index

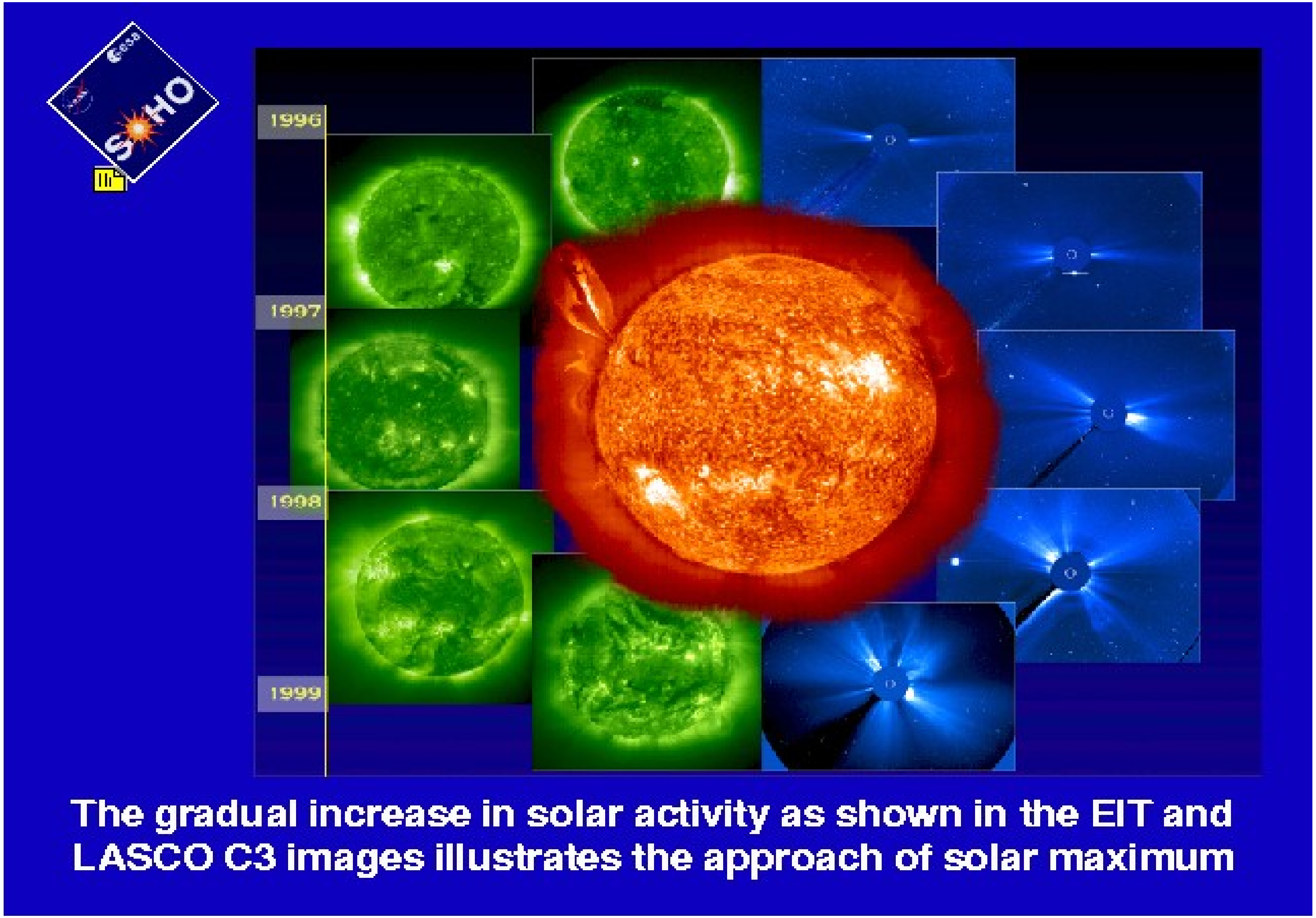


Sunspots & Magnetic Fields

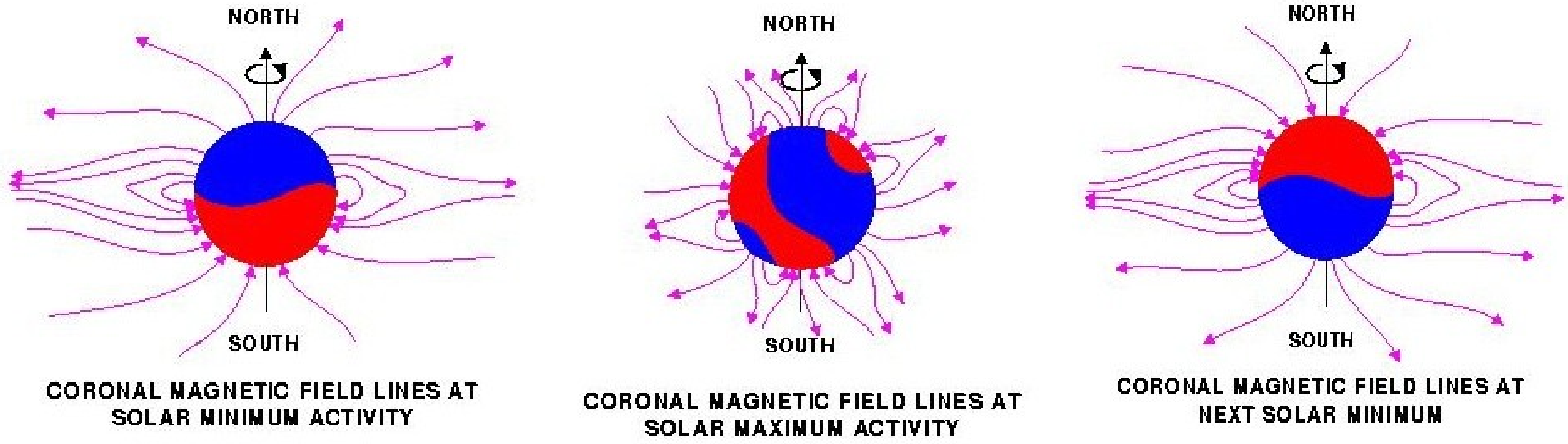


- The magnetic field in a sunspot is 1000x greater than the surrounding area
- Sunspots are almost always in pairs at the same latitude with each member having opposite polarity
- All sunspots in the same hemisphere have the same magnetic configuration

What is the active Sun?

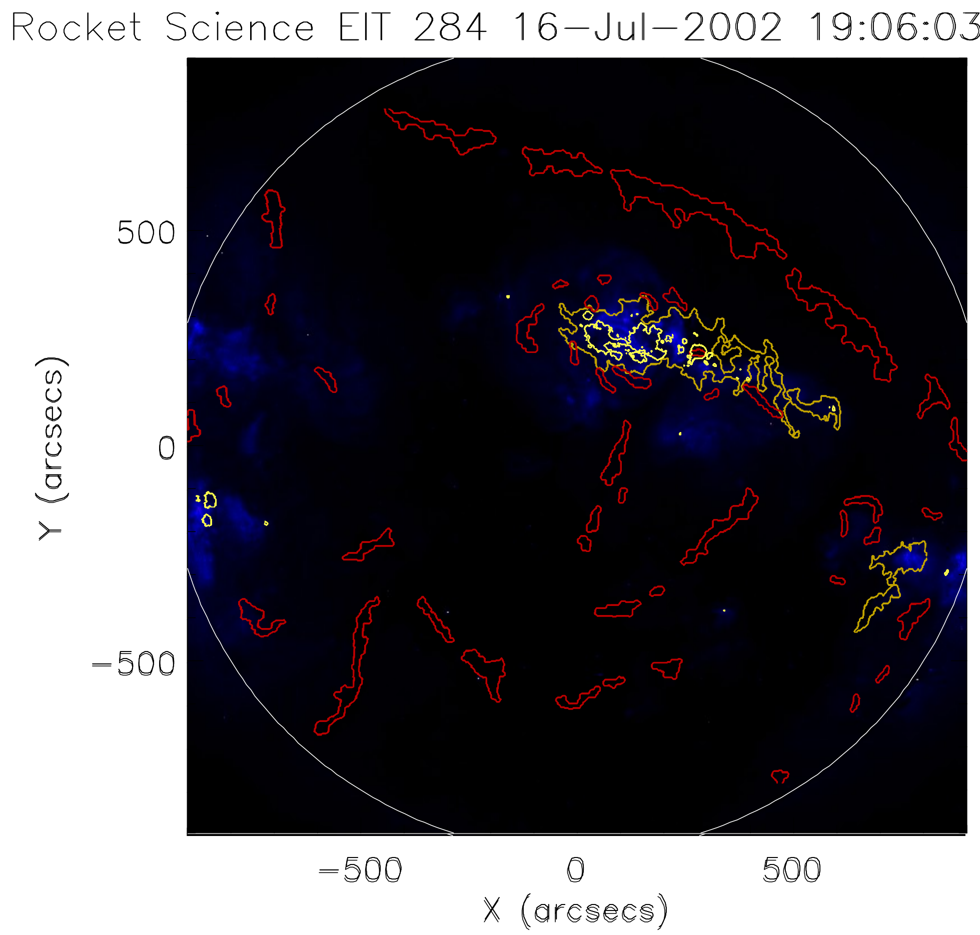


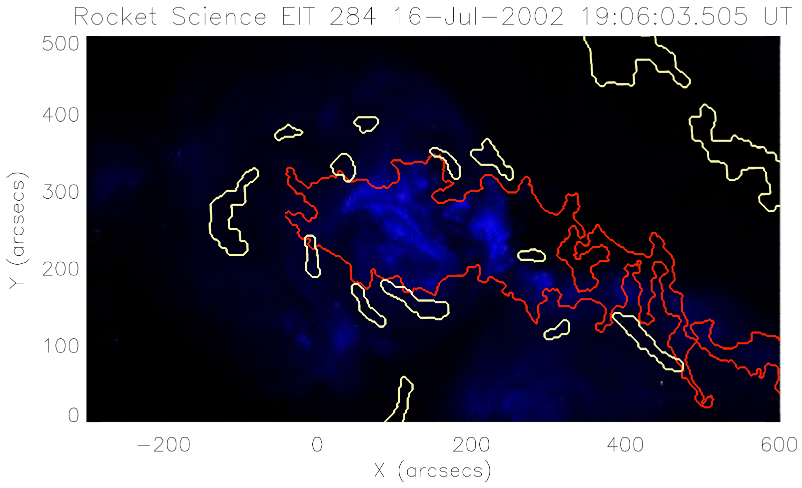
Solar magnetic field reversal



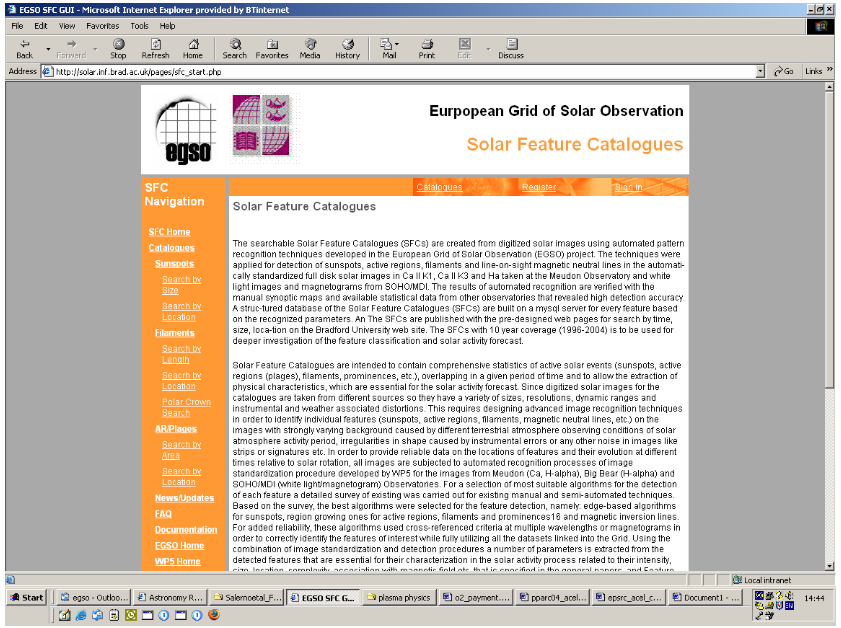
- Strong toroidal magnetic fields (TMF) forming Active Regions (ARs)
- are created in a shear layer beneath the base of the Solar Convection zone (SCZ).

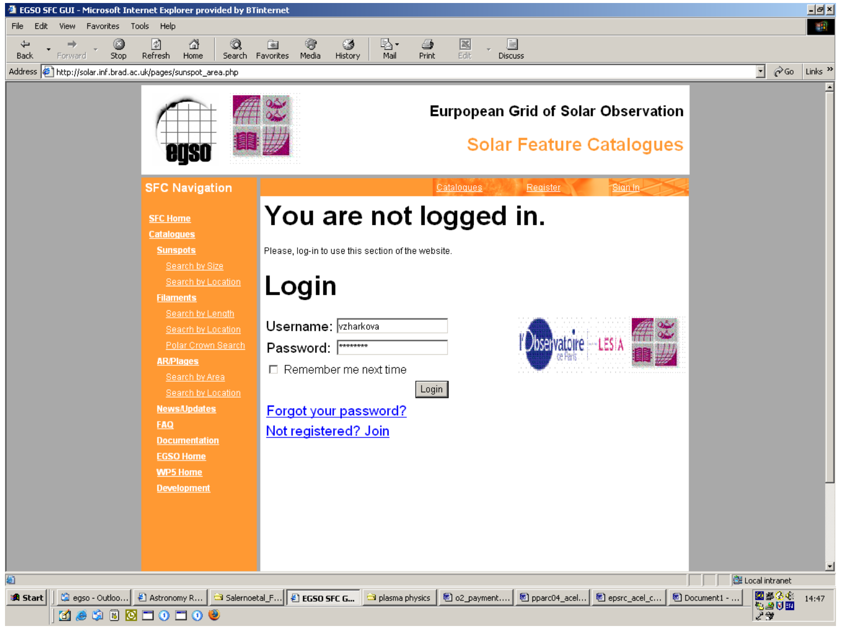
Automated feature extraction

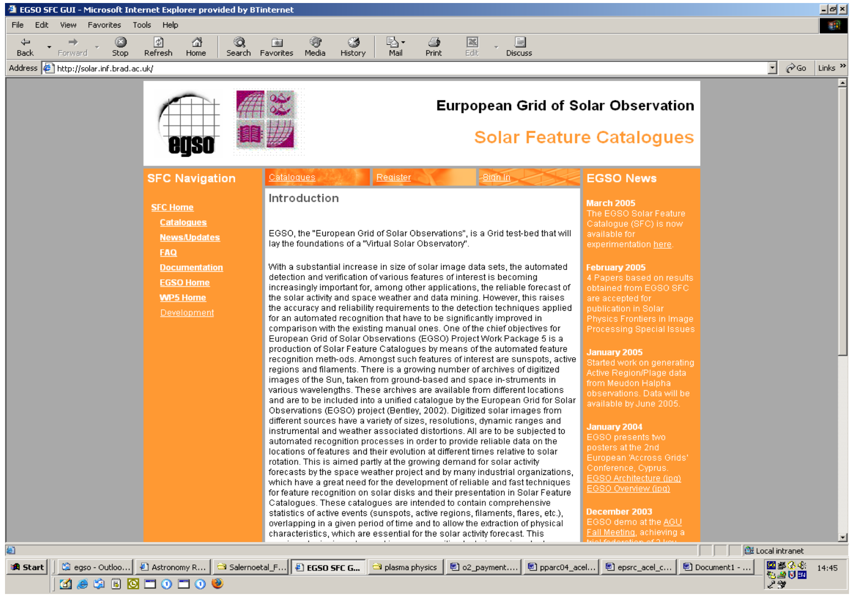


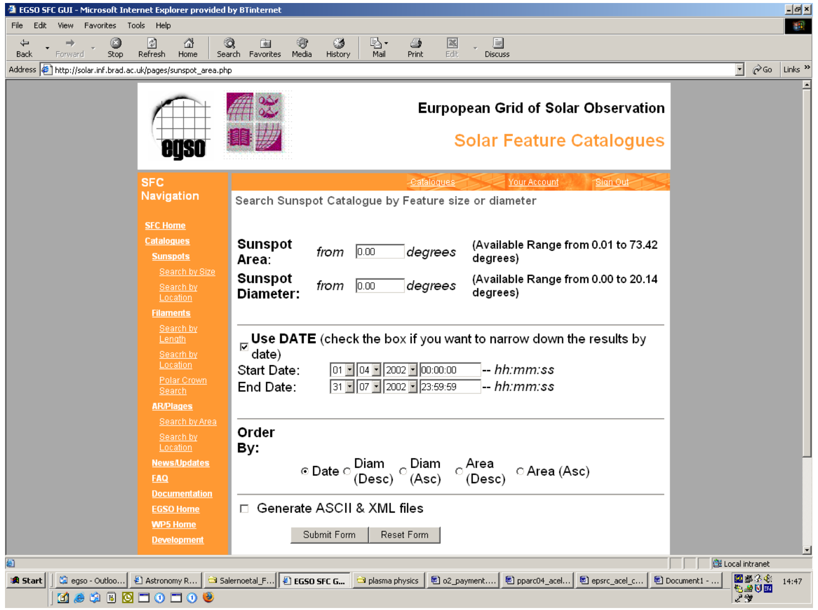


SFCs created in EGSO project 2002-2005







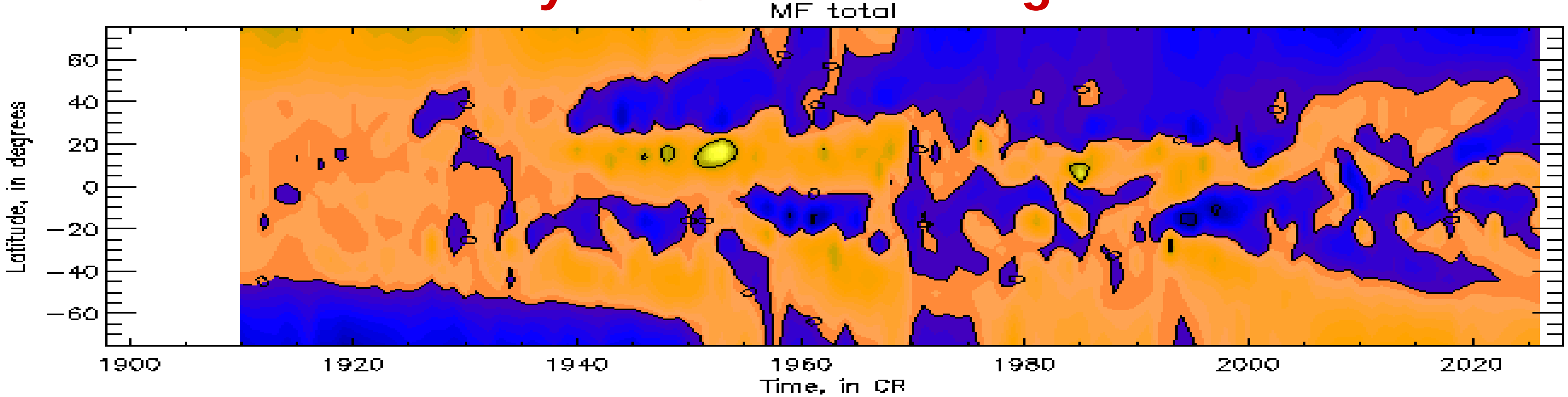


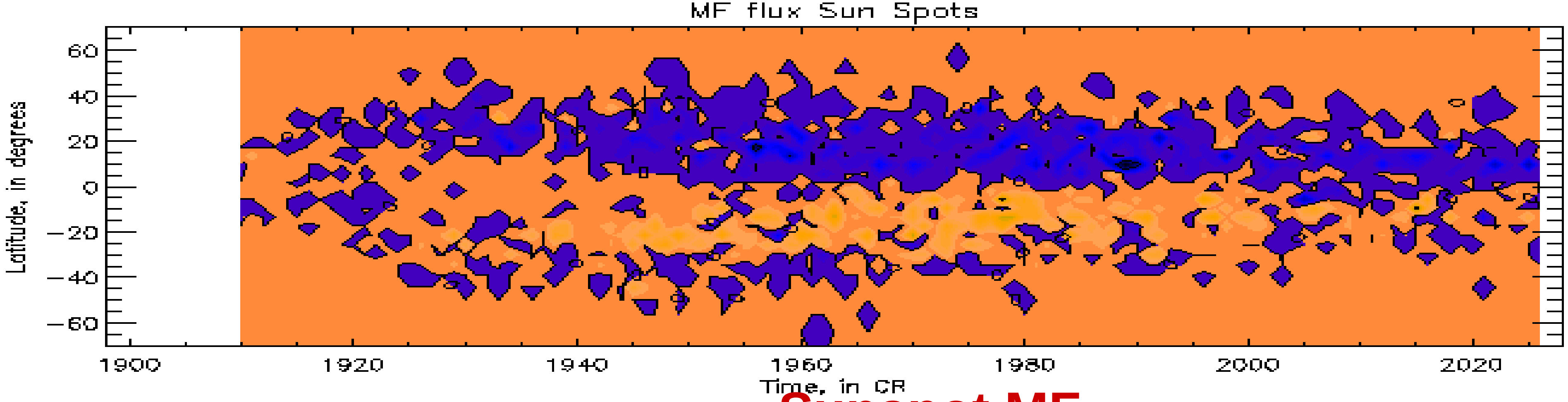
New proxy for solar activity index

SBMF (top) and sunspot MF (bottom)

(Zharkov et al, 2008, Stix 1976)

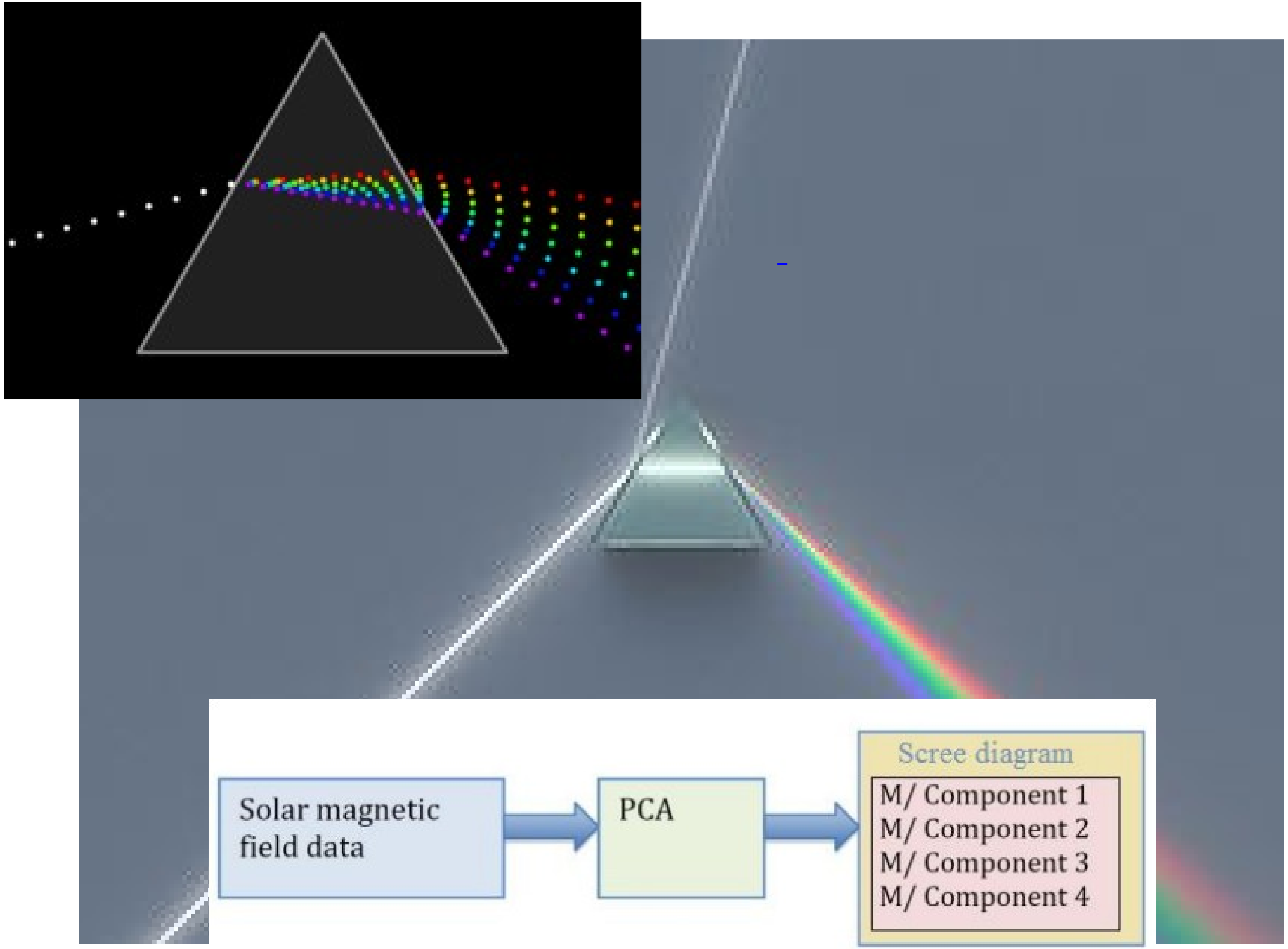
Cycle 23 -Solar Background MF





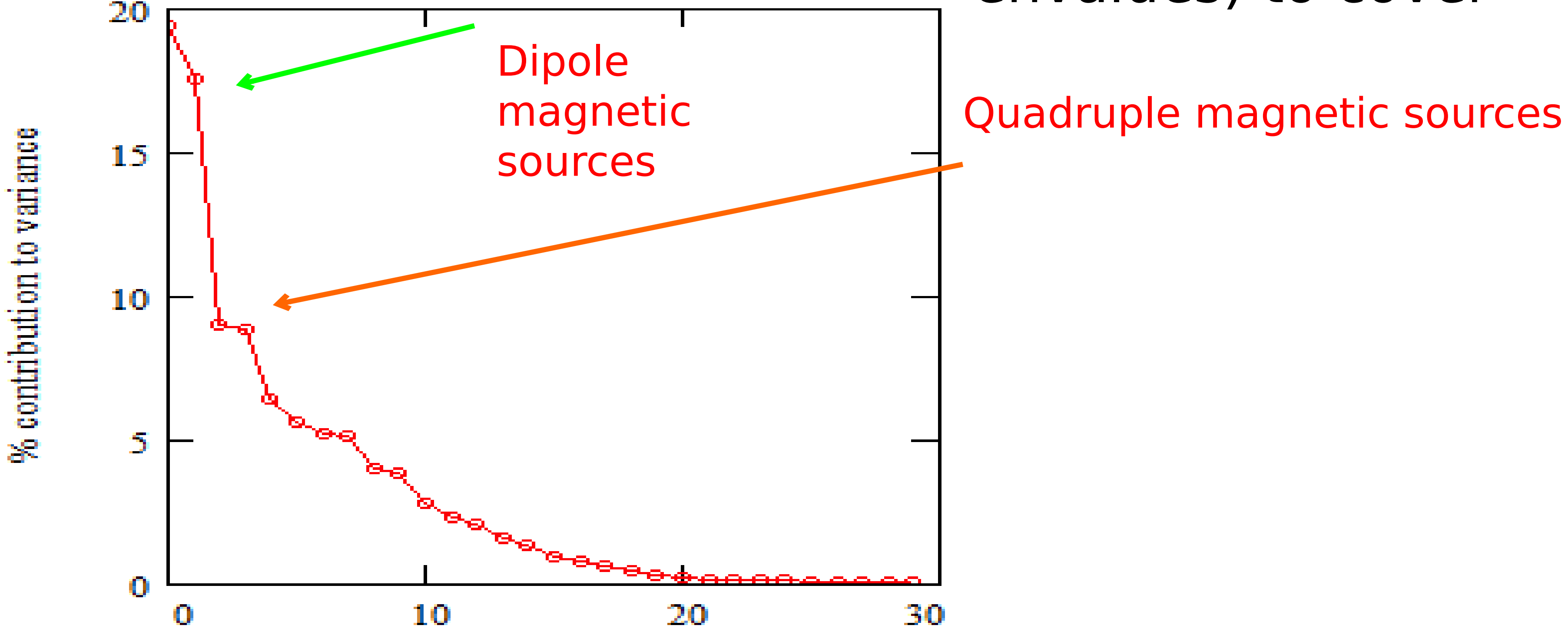
Sunspot MF

White light refraction into waves of different colors, or wavelengths

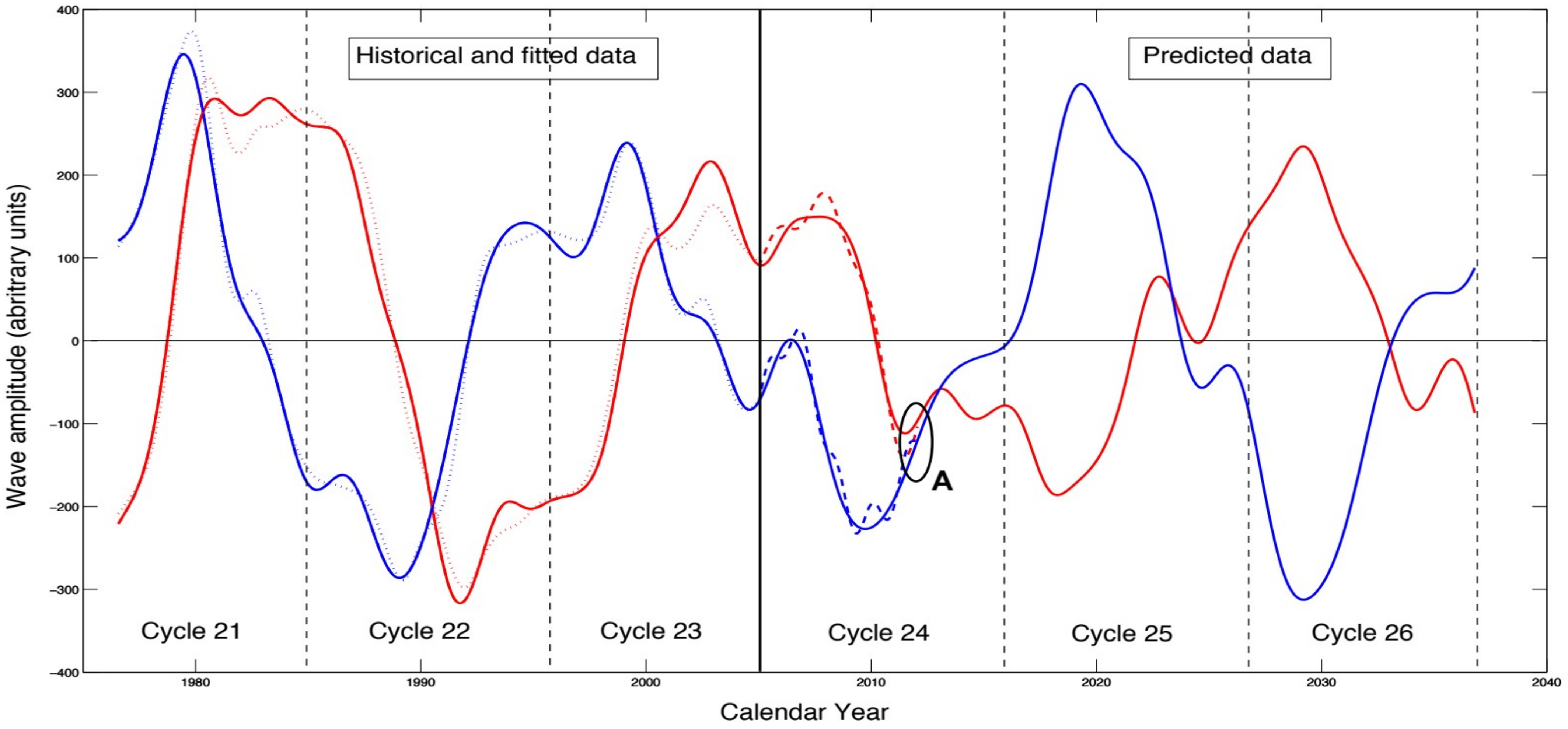


SBMF results: Scree plot (->prizm) Eigenvalues vs variances (Zharkova et al, 2012)

- 2 main eigenvalues covering 40% of variance – (67% of SDV) - 3 pairs (6 eigenvalues) to cover



Eigen vectors come in pairs, here are PCs



(Shepherd et al, 2014, Zharkova et al, 2015)

Mathematical laws from PCs: Symbolic regression -Hamiltonian approach (Schmidt and Lipton, 2009, Science)

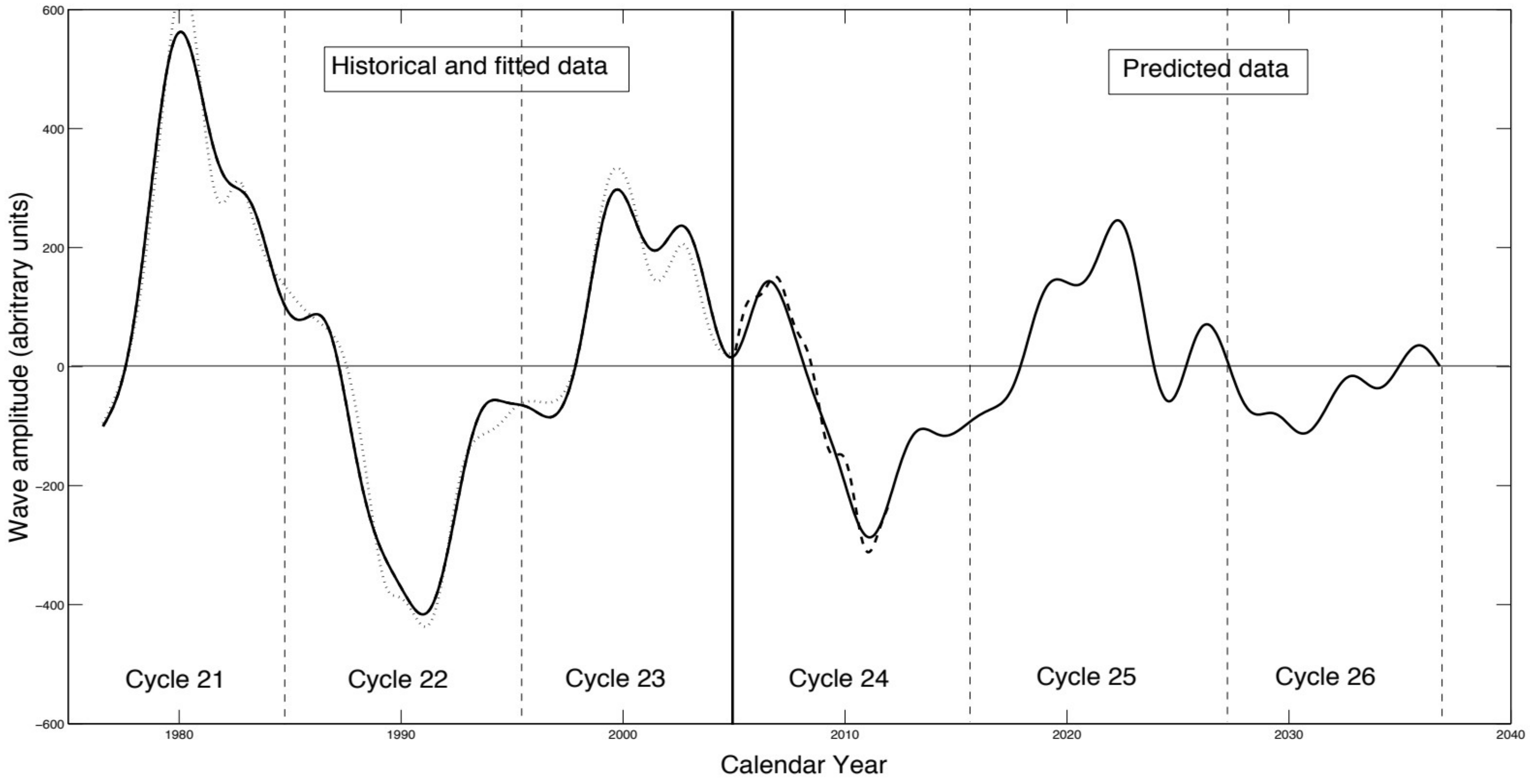
- Mathematical law for the first principal component:

$$F_1(t) = \Sigma_{k=1,..,5} A_k \cos(\omega_{k,1}t + \phi_{k,1})\cos(B_{k,1} \cos(\omega_{k,1}t + \phi_{k,1})$$

- Mathematical law for the second principal component:

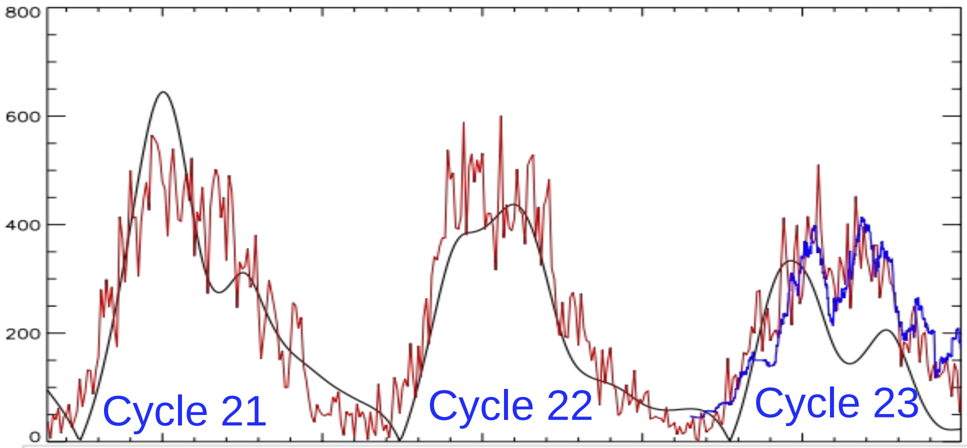
$$F_2(t) = \Sigma_{k=1,..,5} A_k \cos(\omega_{k,2}t + \phi_{k,2})\cos(B_{k,2} \cos(\omega_{k,2}t + \phi_{k,2})$$

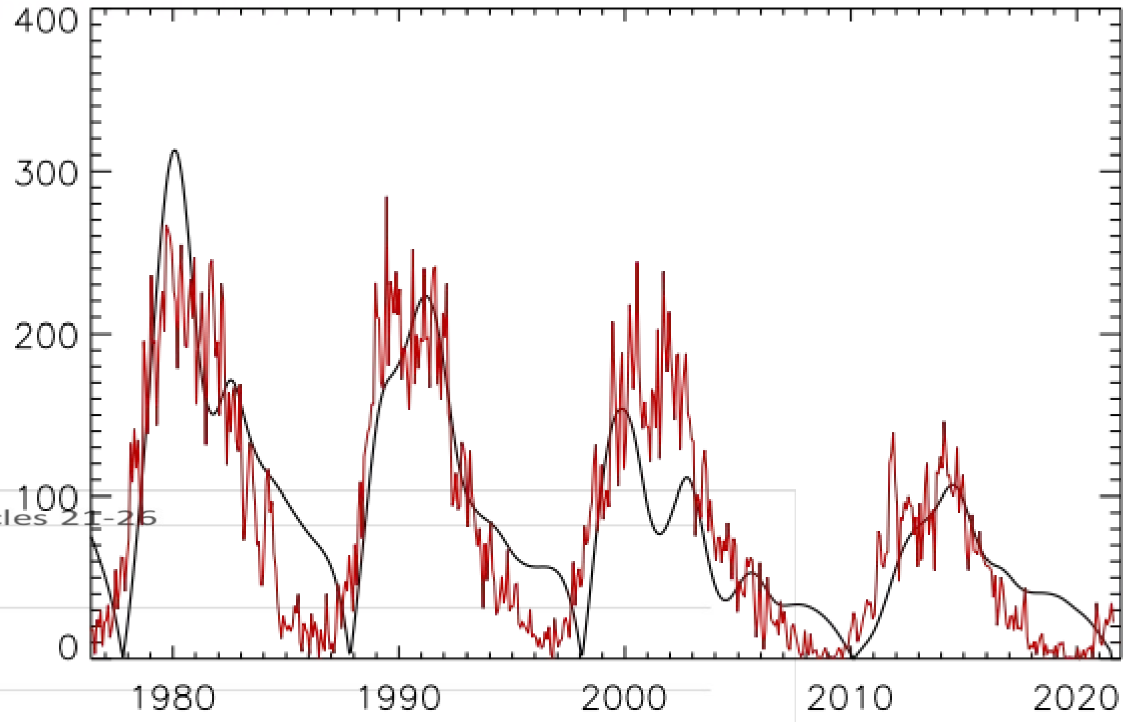
Summary curve of 2 PCs

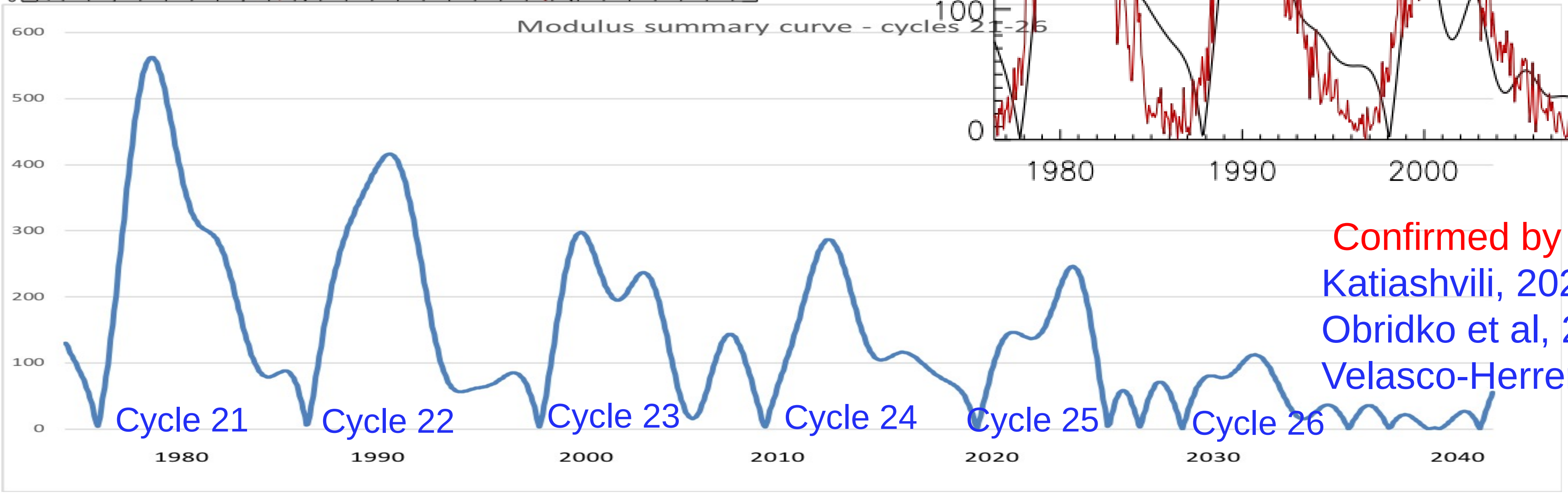


Modulus summary curve

Zharkova et al, 2015, SciRep; 2020, Temp., Zharkova et al, 2022, MNRAS



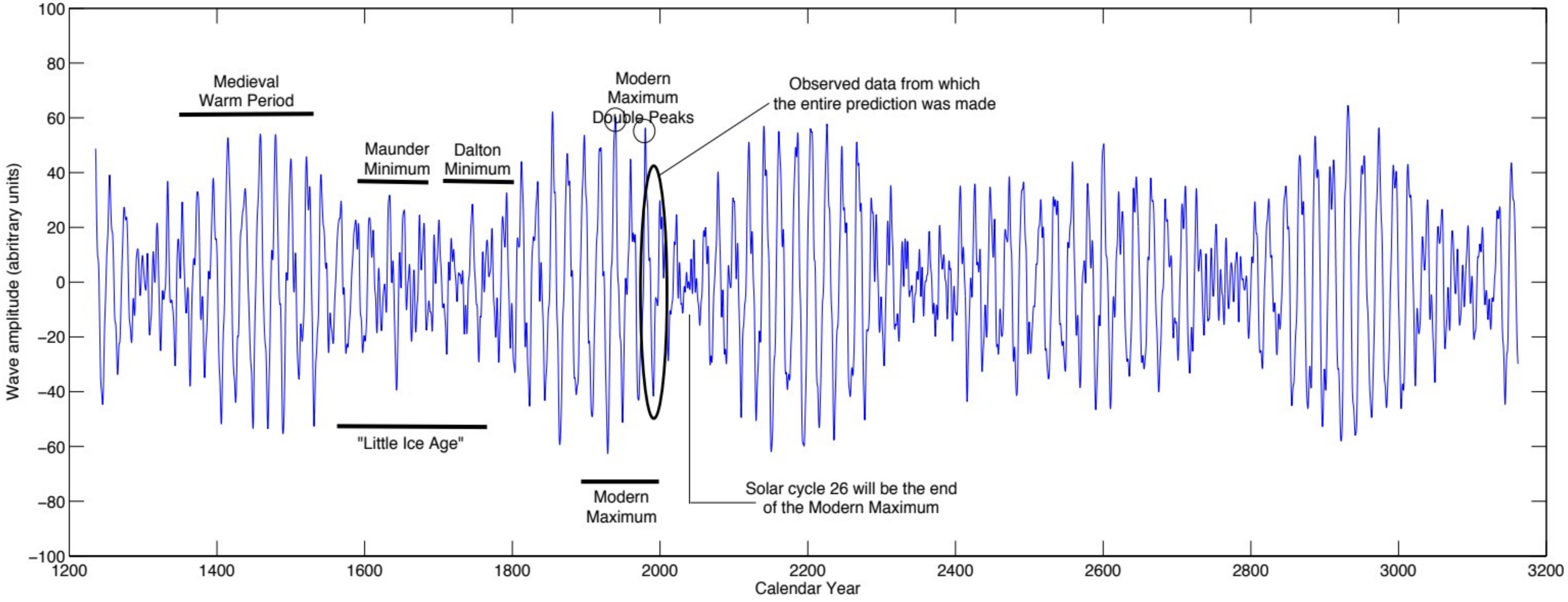




Confirmed by
Katiashvili, 2020, ApJ;
Obridko et al, 2021, MNRAS
Velasco-Herrera et al, 2021

Predicted solar activity (Zharkova et al, 2015, SR https://www.nature.com/articles/srep15689)

Observational result, dynamo model was not yet considered



Discovery of grand solar cycles :350-400 years
In addition to 11 year cycles

https://solargsm.com/solar-activity/ - my webpage

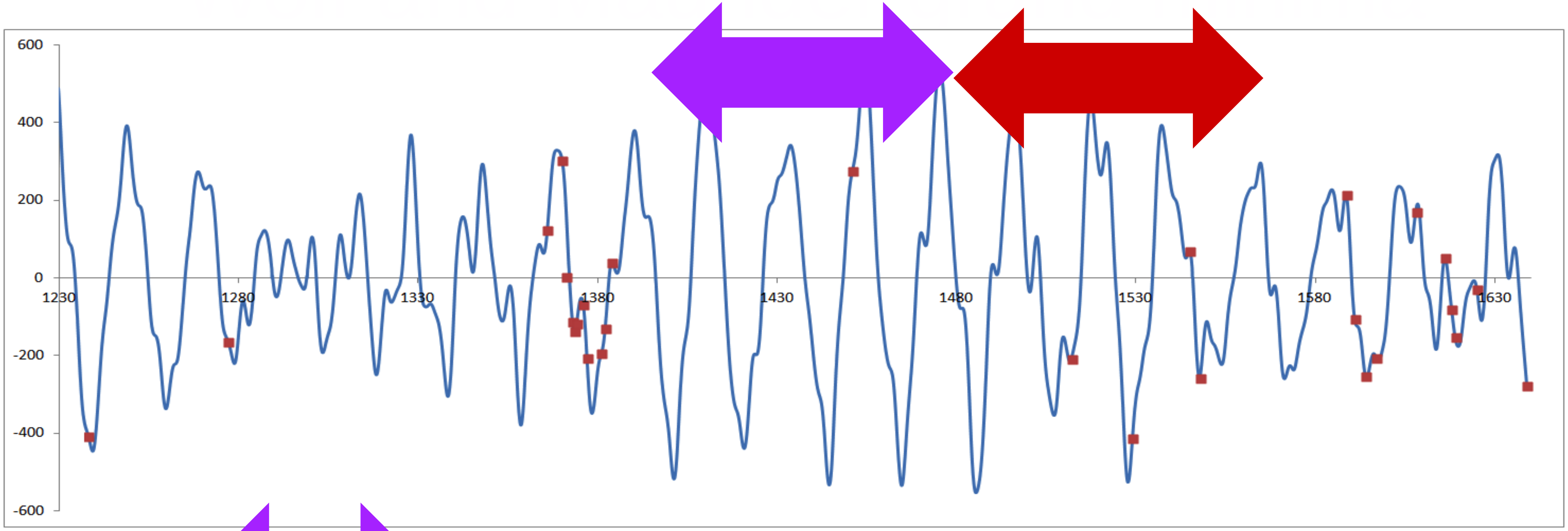
This result was reported at

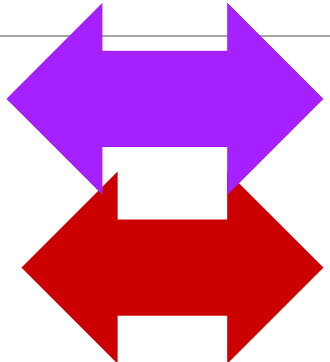
- the National Astronomy Meeting in Llandudno and covered by the RAS press-release https://nam2015.org/index.php/press-releases/64-irregular-heartbeat-of-the-sun-driven-by-double-dynamo

- media https://www.sciencedaily.com/releases/2015/07/150709092955.htm and https://www.chroniclelive.co.uk/business/business-news/mini-ice-age-could-freeze-11607587

- U-tube talks https://www.youtube.com/results?search_query=double+dynamo+and+grand+solar+minimum

Verification of summary curve with large s/s for grand cycle prior MM (Zharkova etal, 2017, 2018)





Severe diseases in China, no observers

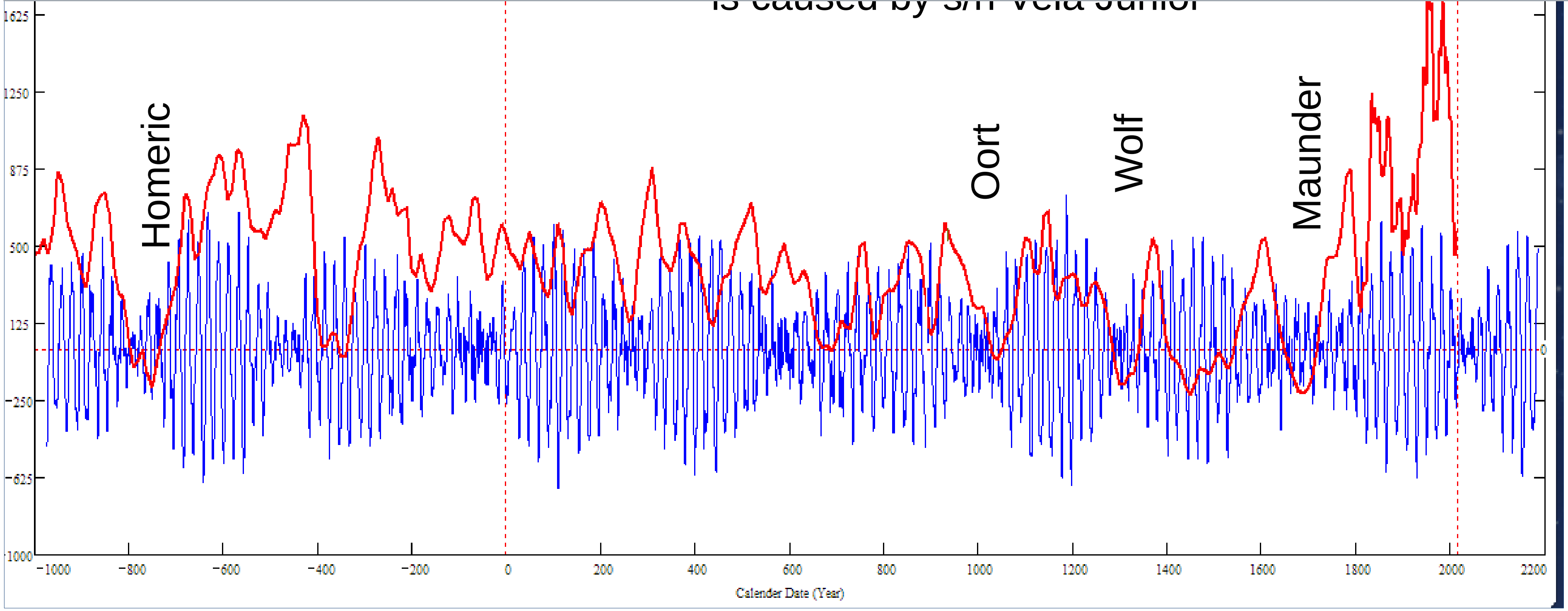
New dynasty in China, Great Wall project

Do

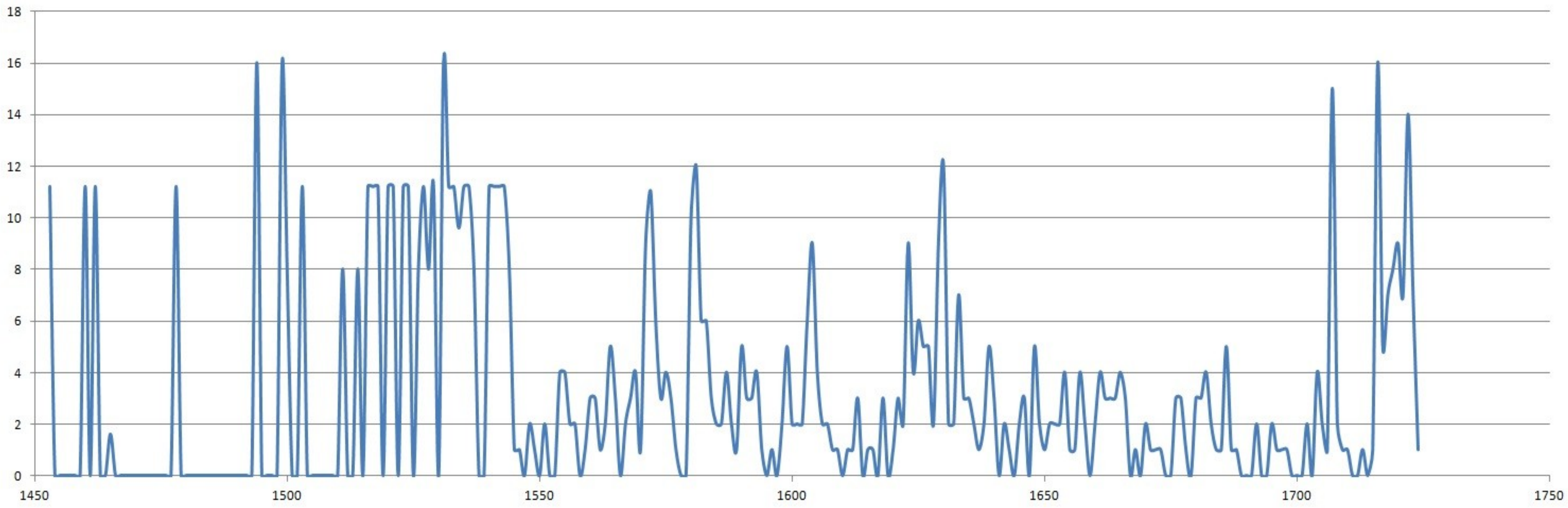
ver

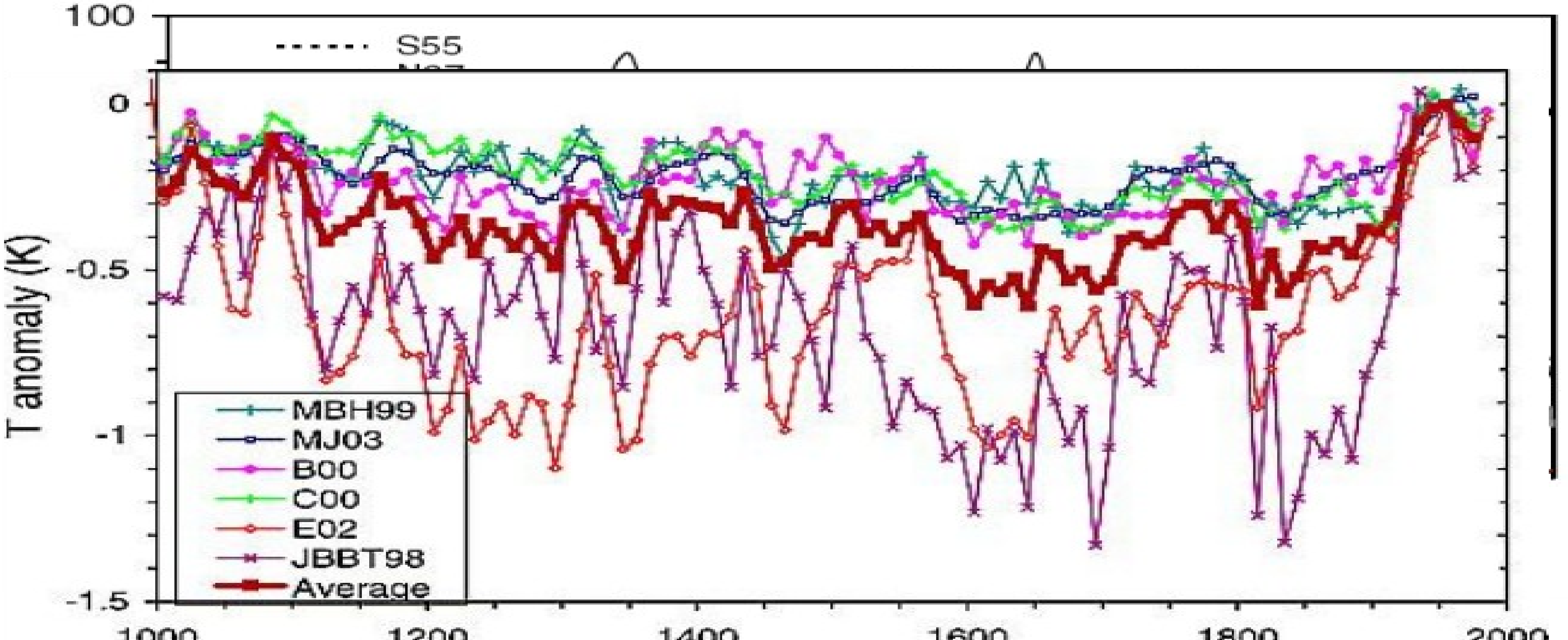
Homeric minimum[13]	750 BCE	550 BCE
Oort minimum	1040 CE	1080 CE
Medieval maximum	1100	1250
Wolf minimum	1280	1350
Spörer Minimum	1450	1550
Maunder Minimum	1645	1715
Dalton Minimum	1790	1820

is caused by s/n Vela Junior

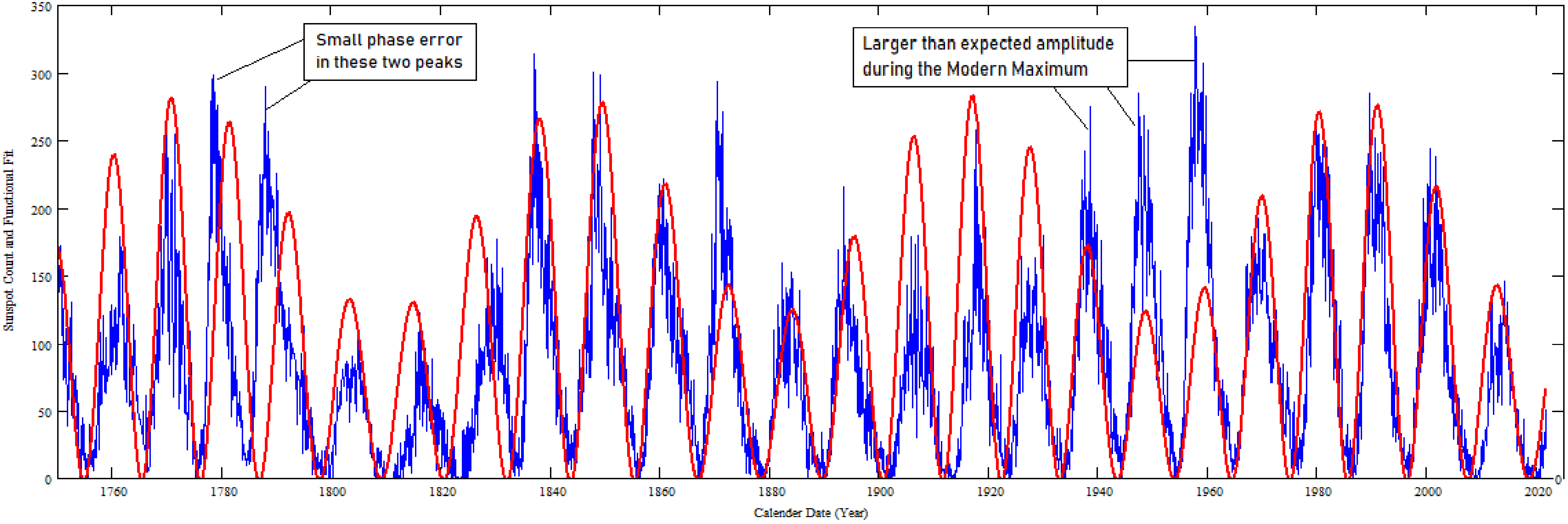


Periods – grand cycle: 350-400 years and super-grand cycle :2000-2100 years

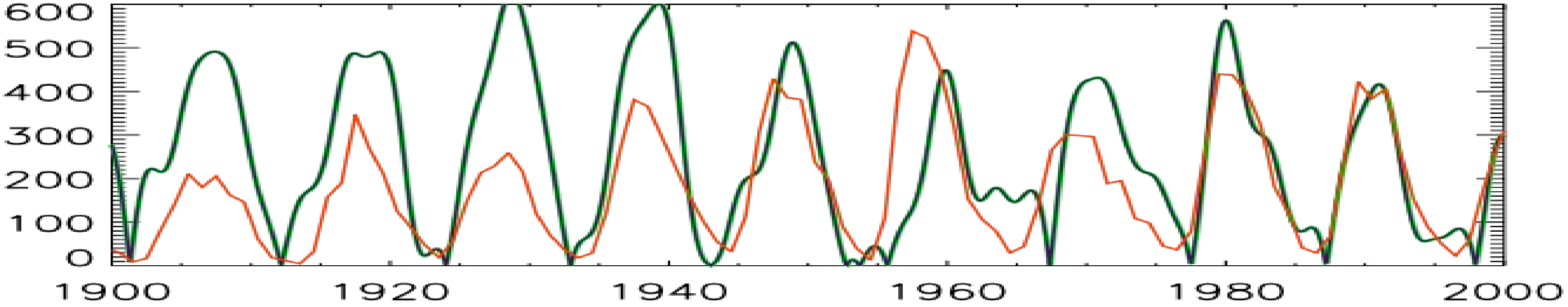

18
16
14
12
10
8
6
4
2
0
1450
1500
1550
1600
1650
1700
1750


100
S55
T anomaly (K)
0
-0.5
-1
-1.5
MBH99
MJ03
B00
C00
E02
JBBT98
Average

Verification of summary curve with sunspot index Zharkova et al, 2022b



Zharkova et al, 2022b



Summary:
new proxy of solar activity

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- **New proxy of SA -Principal components of SBMF**
- **PCs are paired – double dynamo waves**
- **The strongest 2 PCs cover more than 40% of variance or 67% of SD**
- **Prediction of the solar activity on a millennium scale shows grand solar cycle with a period of 350-400 years**
- **Next grand solar minimum is underway in 2020-2053**
- **Prediction for 3000-10000 years backwards fits the main grand minima and warming periods**

https://solargsm.com/solar-activity/

2 layer dynamo model explaining some PCA features

Zharkova et al, 2015, Popova et al, 2013

We included the meridional flows in each layer:

$$\frac{\partial B}{\partial t} + \frac{\partial (VB)}{\partial \theta} = \beta \Delta B, \qquad \frac{\partial A}{\partial t} + V\frac{\partial A}{\partial \theta} = \alpha B + \beta \Delta A, \tag{2.3}$$

$$\frac{\partial b}{\partial t} + \frac{\partial (vb)}{\partial \theta} = D\cos\theta \frac{\partial a}{\partial \theta} + \Delta b, \qquad \frac{\partial a}{\partial t} + v\frac{\partial a}{\partial \theta} = \Delta a\,, \tag{2.4}$$

here $V(\theta), v(\theta)$ are the meridional flows in the respective layers.

Following Parker we prescribe $r = 0$ for the radial boundary between two layers and use boundary conditions:

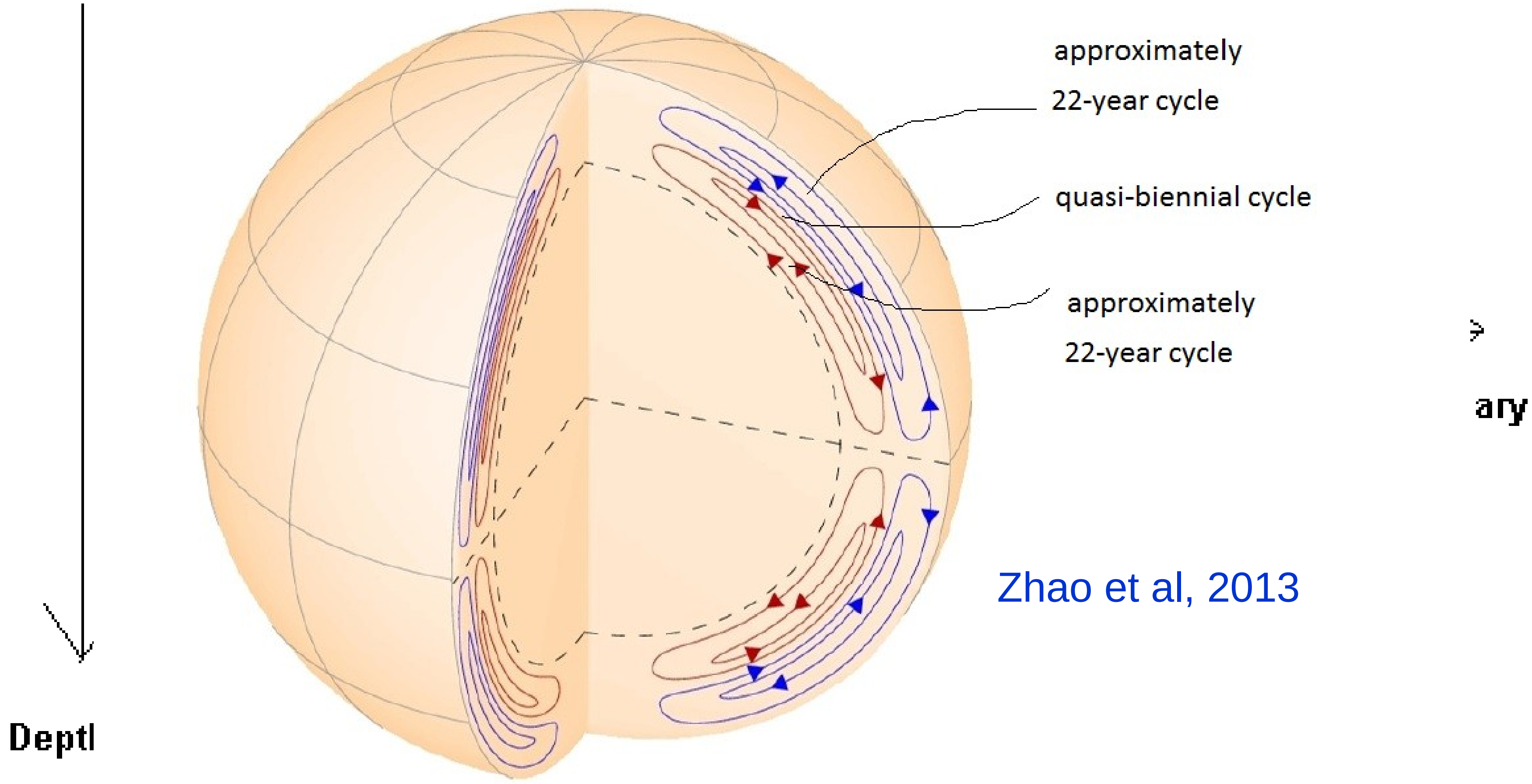
$$b = B, \qquad a = A, \qquad \frac{\partial b}{\partial r} = \beta\frac{\partial B}{\partial r}, \qquad \frac{\partial a}{\partial r} = \frac{\partial A}{\partial r}. \tag{2.5}$$

In view of the symmetry conditions $\alpha(-\theta) = -\alpha(\theta), V(-\theta) = -V(\theta)$ the above system of equations can be considered in only one (e.g., the northern) hemisphere using anti-symmetry (dipolar symmetry) or symmetry (quadrupolar symmetry) conditions at the equator.

We obtained Hamilton-Jacobi equation for eqs. (2.3) and (2.4) by a method similar to the method described in Popova et al. (2010).

Two-Layer Medium observed with

HMI/SDO heliosesimic observations



Zhao et al, 2013

Undamped Equation: Solution to Initial Value Problem (1 of 2)

- Thus our solution is

$$y(t) = \frac{F_0}{m(\omega_0^2 - \omega^2)}\left(\cos\omega t - \cos\omega_0 t\right)$$

- To simplify the solution even further, let $A = (\omega_0 + \omega)/2$ and $B = (\omega_0 - \omega)/2$. Then $A + B = \omega_0 t$ and $A - B = \omega t$. Using the trigonometric identity

$$\cos(A \pm B) = \cos A\cos B \mp \sin A\sin B,$$

it follows that

$$\cos\omega t = \cos A\cos B + \sin A\sin B$$

$$\cos\omega_0 t = \cos A\cos B - \sin A\sin B$$

and hence

$$\cos\omega t - \cos\omega_0 t = 2\sin A\sin B$$

Undamped Equation: Beats (2 of 2)

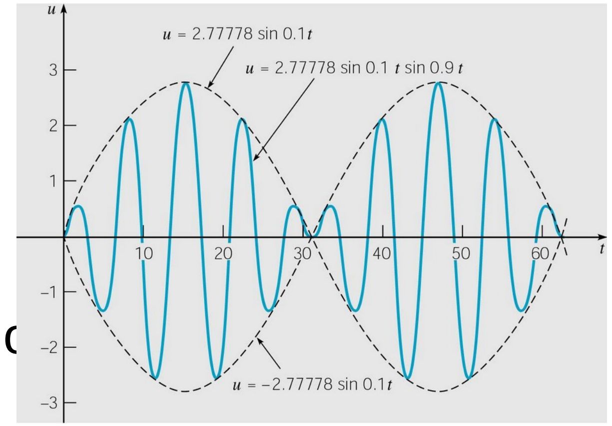
- Using the results of the previous slide, it follows that oscillations are described by the formula:

$$y(t) = \left[\frac{2F_0}{m(\omega_0^2 - \omega^2)} \sin\frac{(\omega_0 - \omega)t}{2}\right] \sin\frac{(\omega_0 + \omega)t}{2}$$

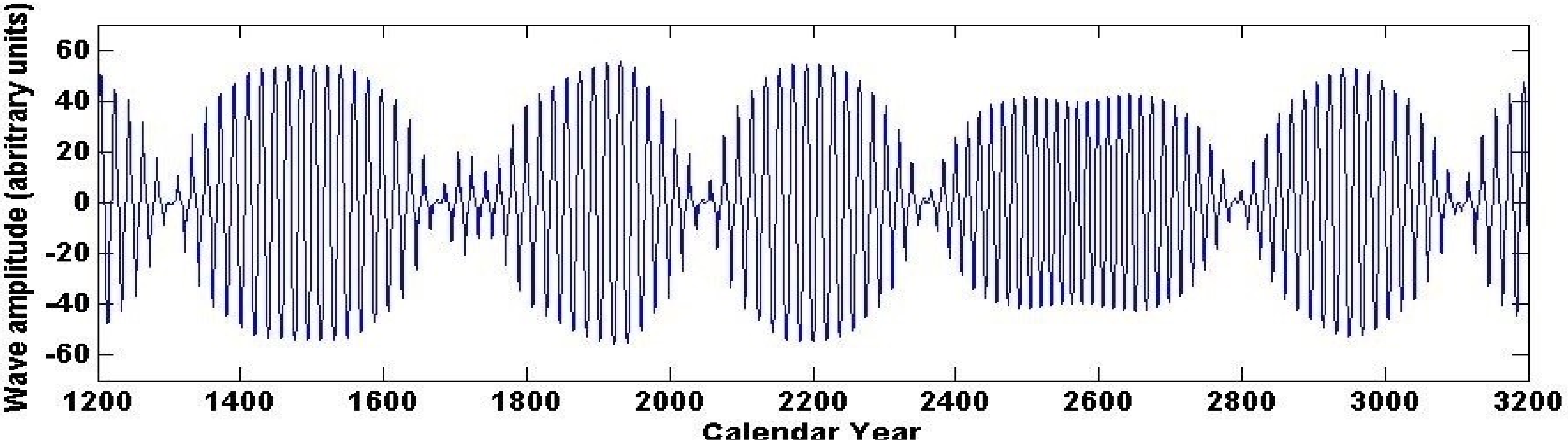
- When $|\omega_0 - \omega| \approx 0$, $\omega_0 + \omega$ is much larger than $\omega_0 - \omega$, and $\sin[(\omega_0 + \omega)t/2]$ oscillates more rapidly than $\sin[(\omega_0 - \omega)t/2]$ (amplitude of faster oscillation).
- Thus motion is a rapid oscillation with frequency $(\omega_0 + \omega)/2$, but with slowly varying sinusoidal amplitude given by formula:

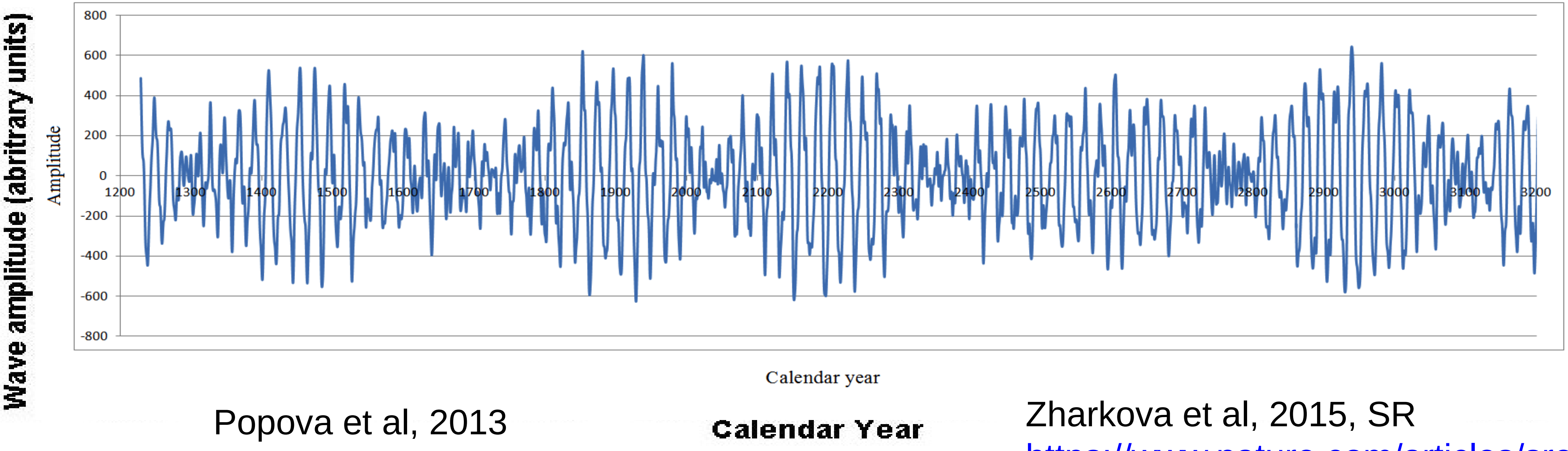
$$\frac{2F_0}{m\left|\omega_0^2 - \omega^2\right|}\left|\sin\frac{(\omega_0 - \omega)t}{2}\right|$$

- This phenomena is called a **beat**.
- Beats occur with two tuning forks of nearly equal frequency (beats used for tuning piano c



Dynamo model (top) and summary curve (bottom

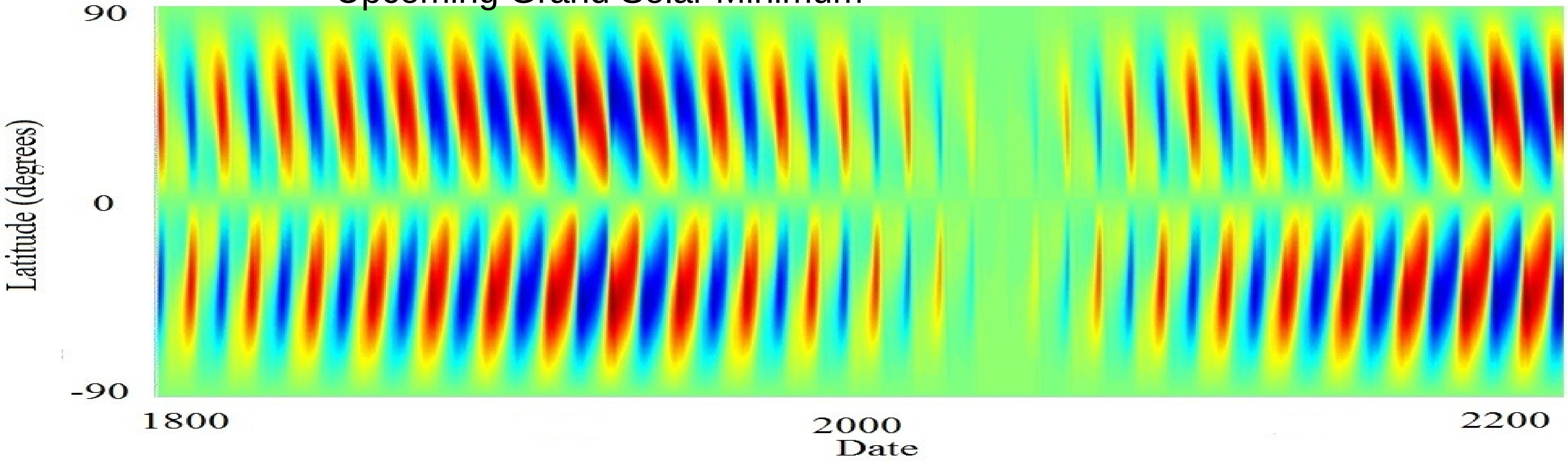




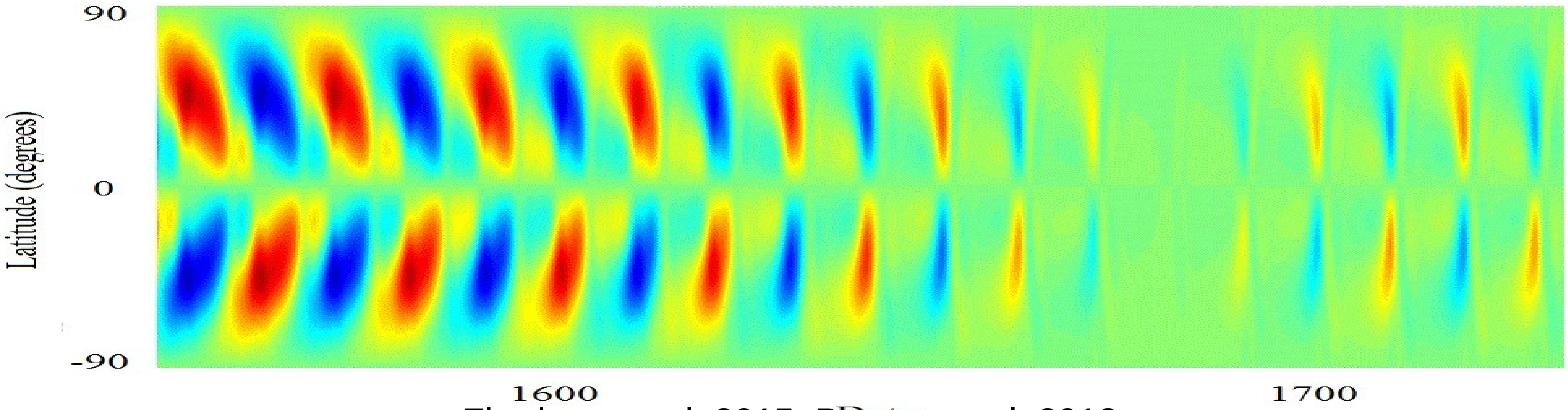
Popova et al, 2013

Zharkova et al, 2015, SR
https://www.nature.com/articles/srep15689

Upcoming Grand Solar Minimum



Maunder Grand Solar Minimum



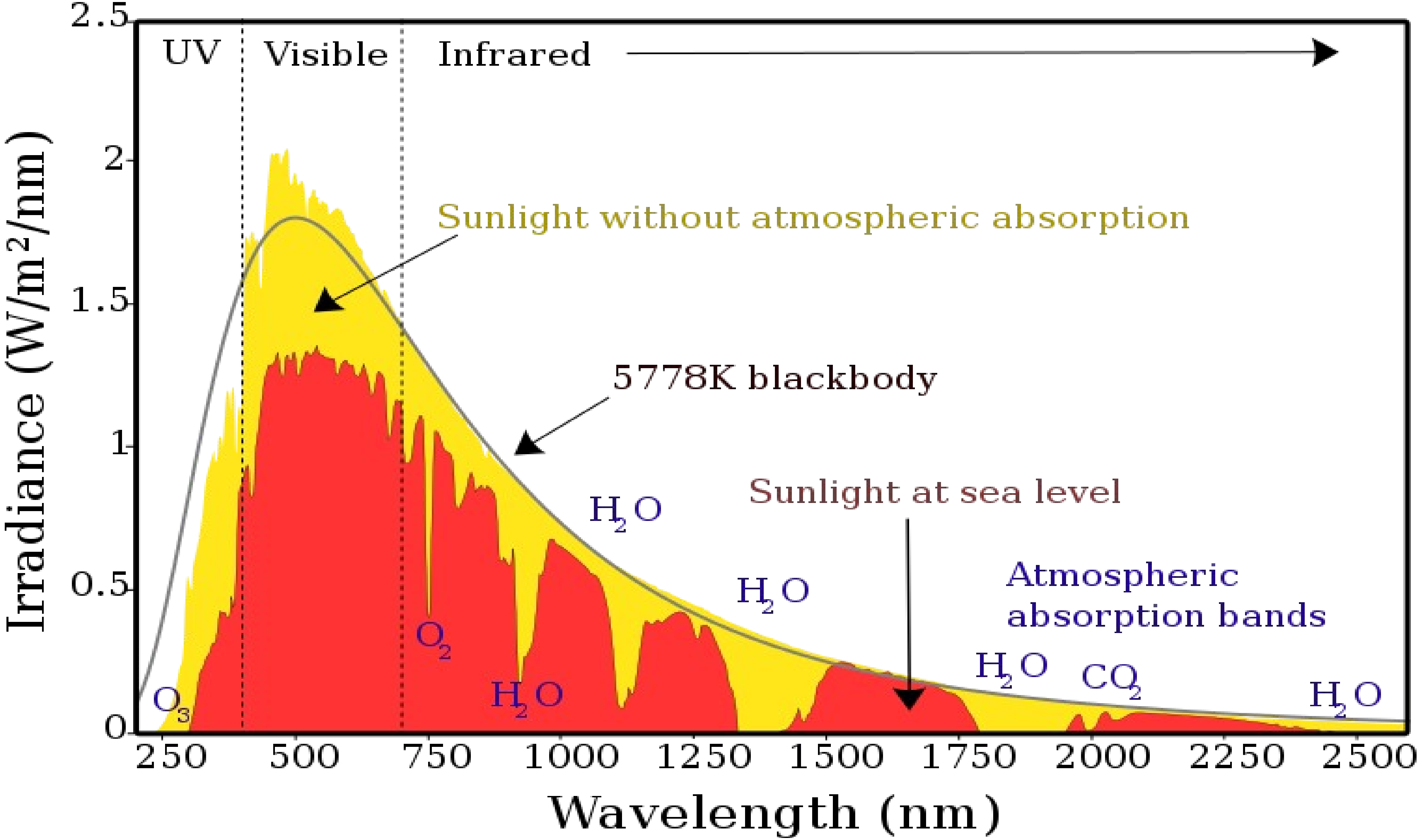
Zharkova et al, 2015, Popova et al, 2018

Solar activity, Total Irradiance and Climate

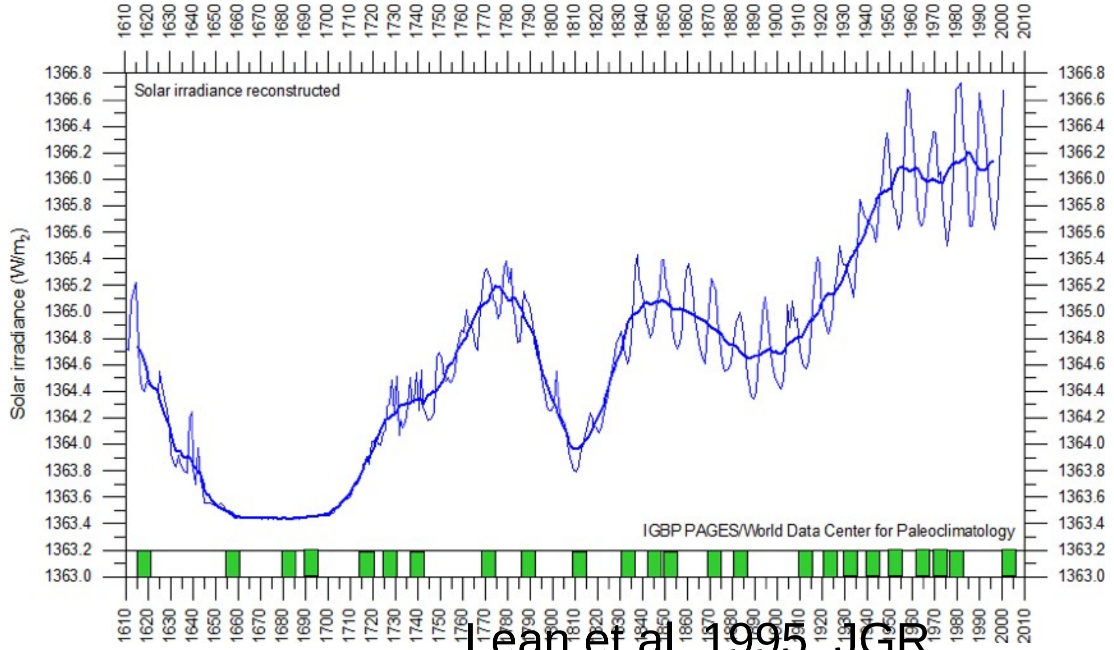
The 0.1% change in the Total Solar Irradiance seen over the last three solar cycles only produces a 0.1° C temperature change in climate models. However, the Sun seems to have a bigger impact.

Two other mechanisms (besides direct forcing by the Total Solar Irradiance variations) are under study: 1) solar ultraviolet and extreme ultraviolet variability and 2) Cosmic Ray modulation on cloud cover.

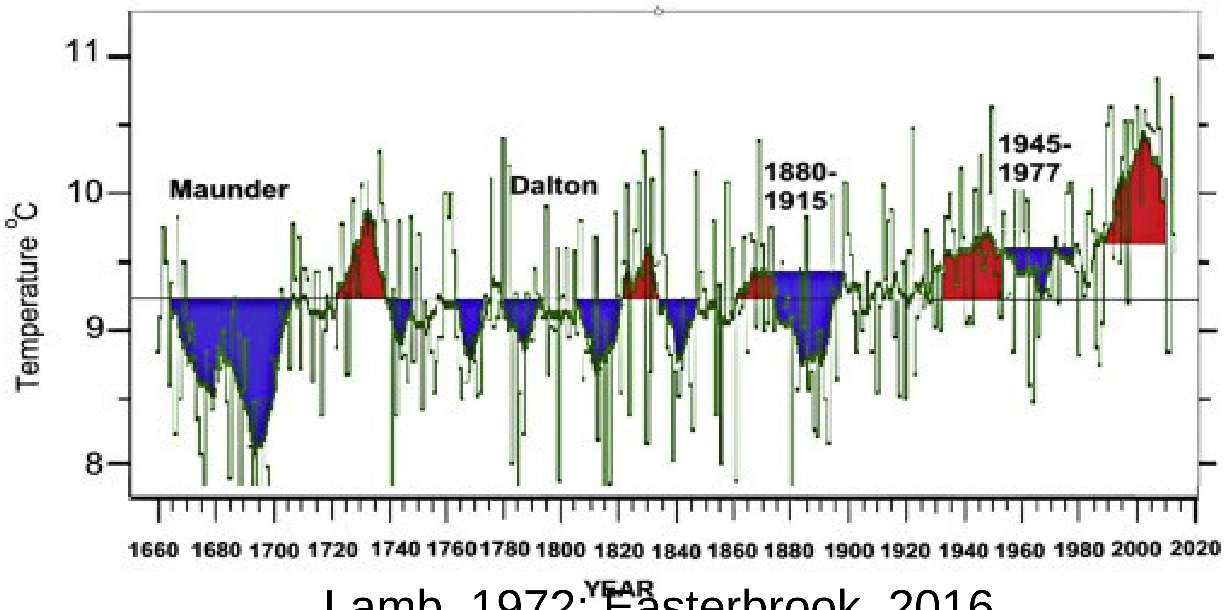
Spectrum of Solar Radiation (Earth)



Solar irradiance and terrestrial temperature during MM



Lean et al, 1995, JGR



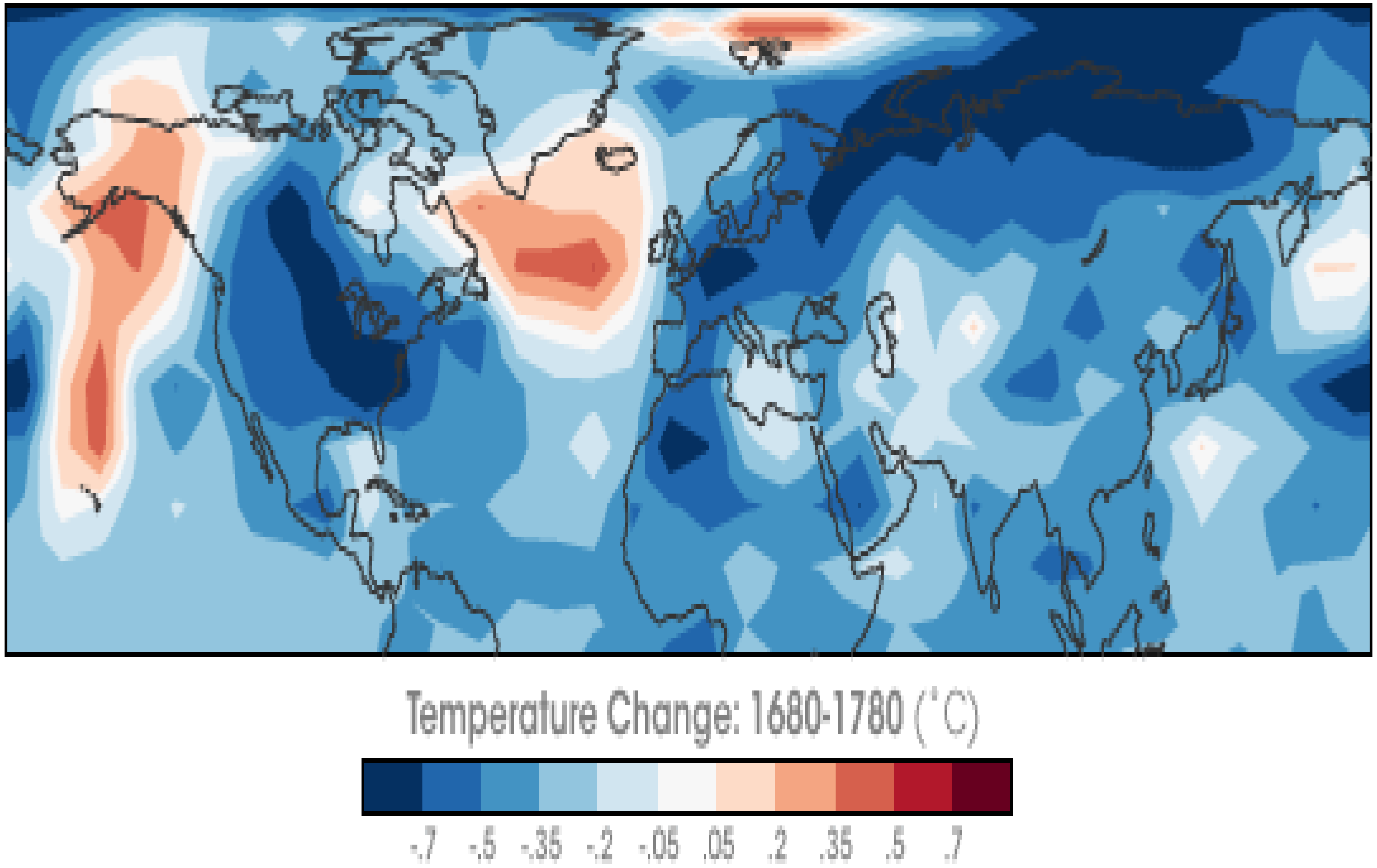
Lamb, 1972; Easterbrook, 2016

Authors	S, Maunder minimum, W/m^2	S 1990-2000, W/m^2	△S from MM, %
Lean et. Al., 1995	1363	1366	0.22
Steinhilber et al, 2012	1364	1366	0.22
Shirley et al., 1990	---	1370	0.51
Wolff and Hickey, 1987	---	1371	0.51
Lee et al., 1995	---	1372	0.51

After the TSI data were re-normalized the old data are hardly usable

Temperature restoration during/after MM

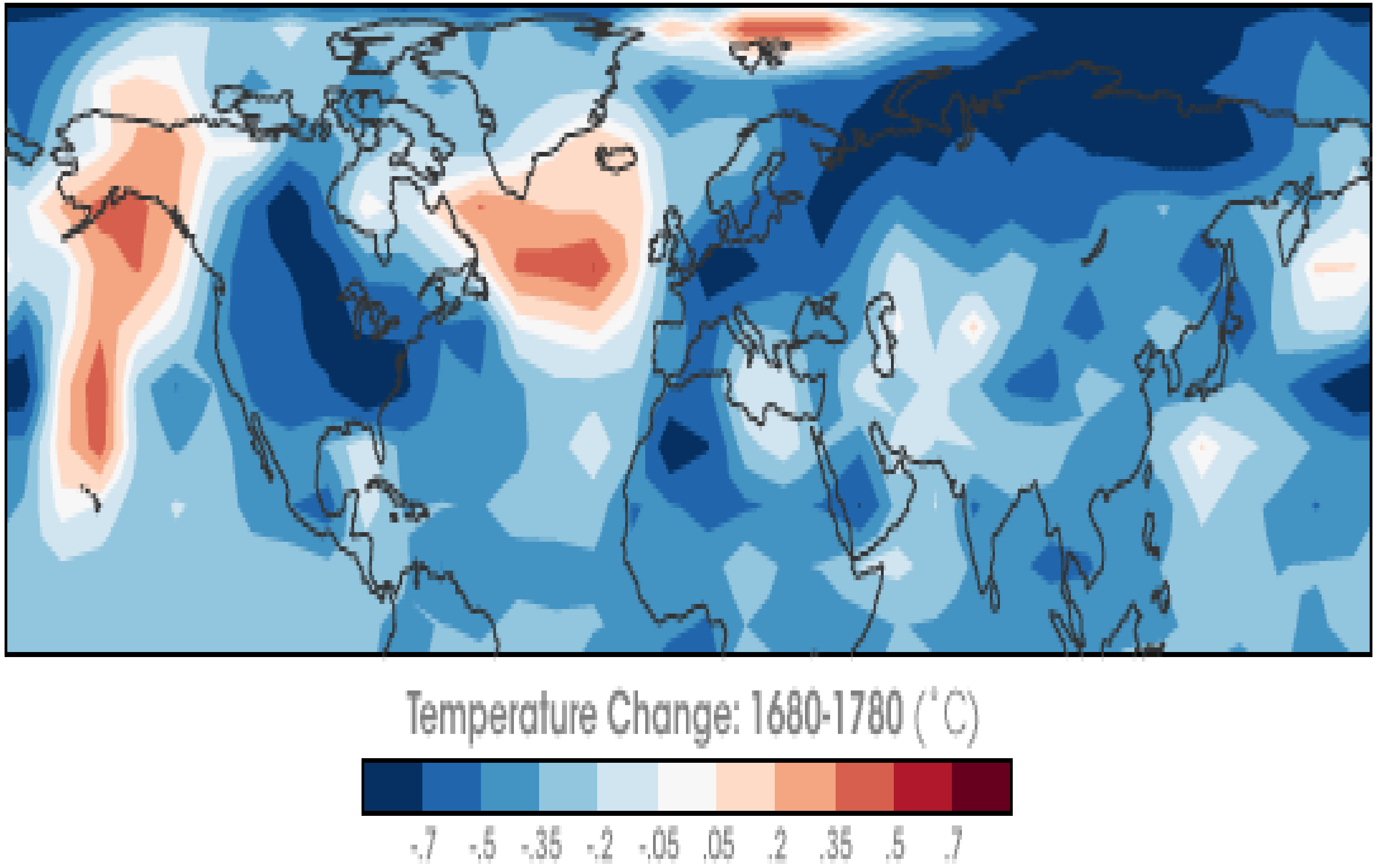
(Shindell et al., 2001, Science)



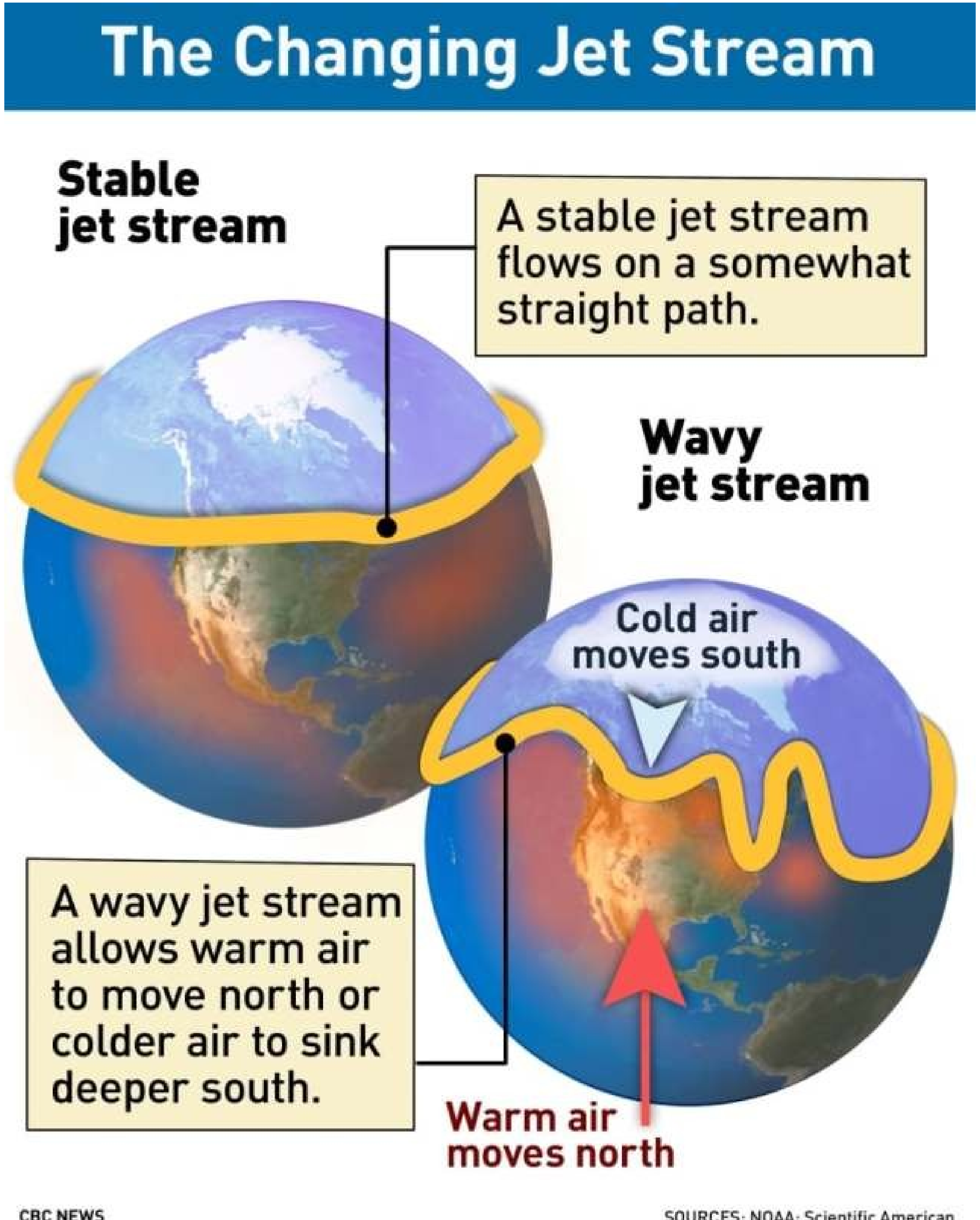
- The surface temperature of the Earth was reduced all over the Globe
- Europe and North America went into a deep freeze
- Alpine glaciers extended over valley farmland
- Sea ice crept south from the Arctic
- Dunab and Thames rivers & canals in the Netherlands froze regularly

Temperature restoration during MM

(Shindell et al., 2001, Science)

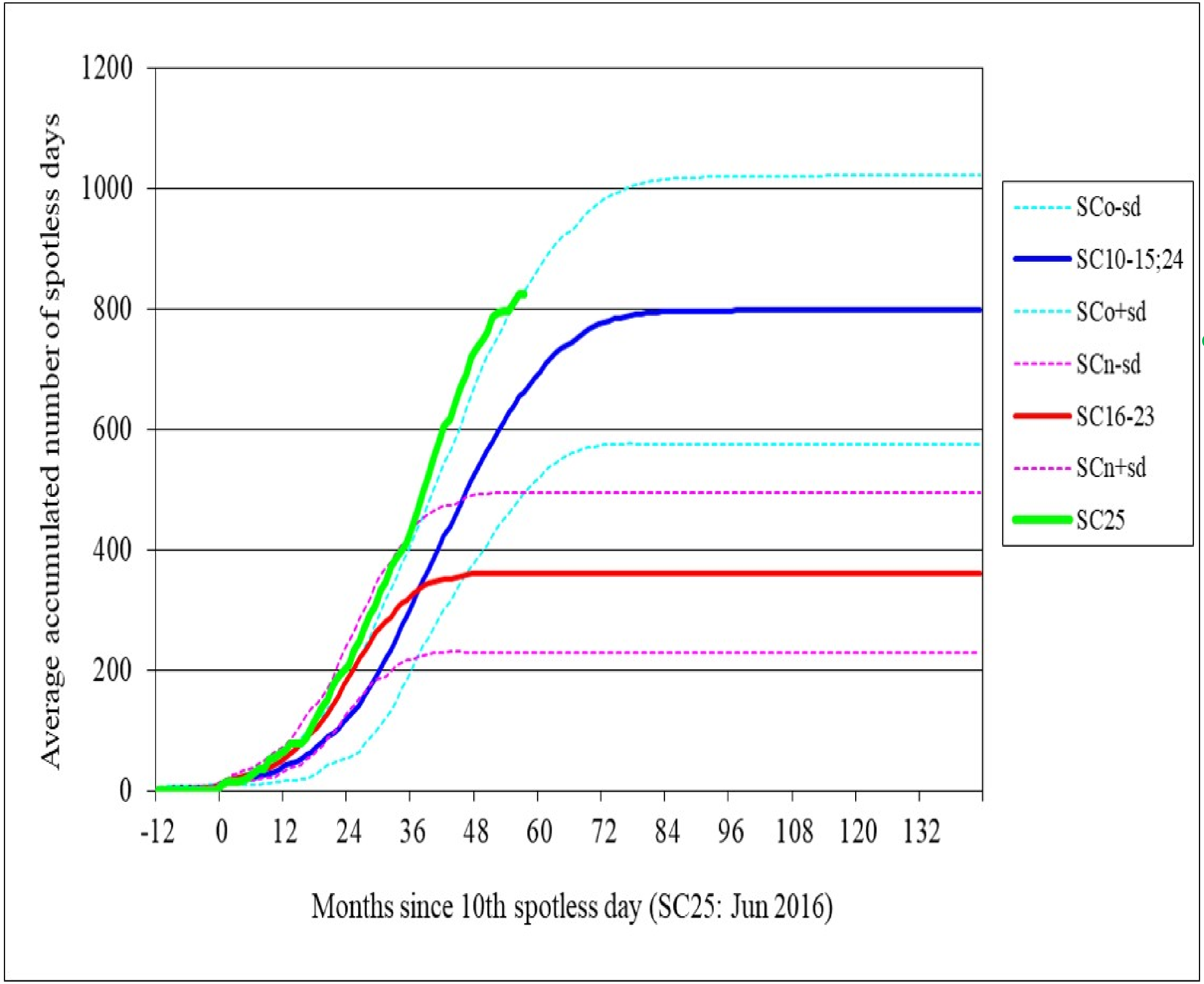


- the drop in the temperature was related to dropped abundances of ozone created by solar ultra-violate light in the stratosphere, the layer of the atmosphere located between 10 and 50 kilometers from the Earth’s surface



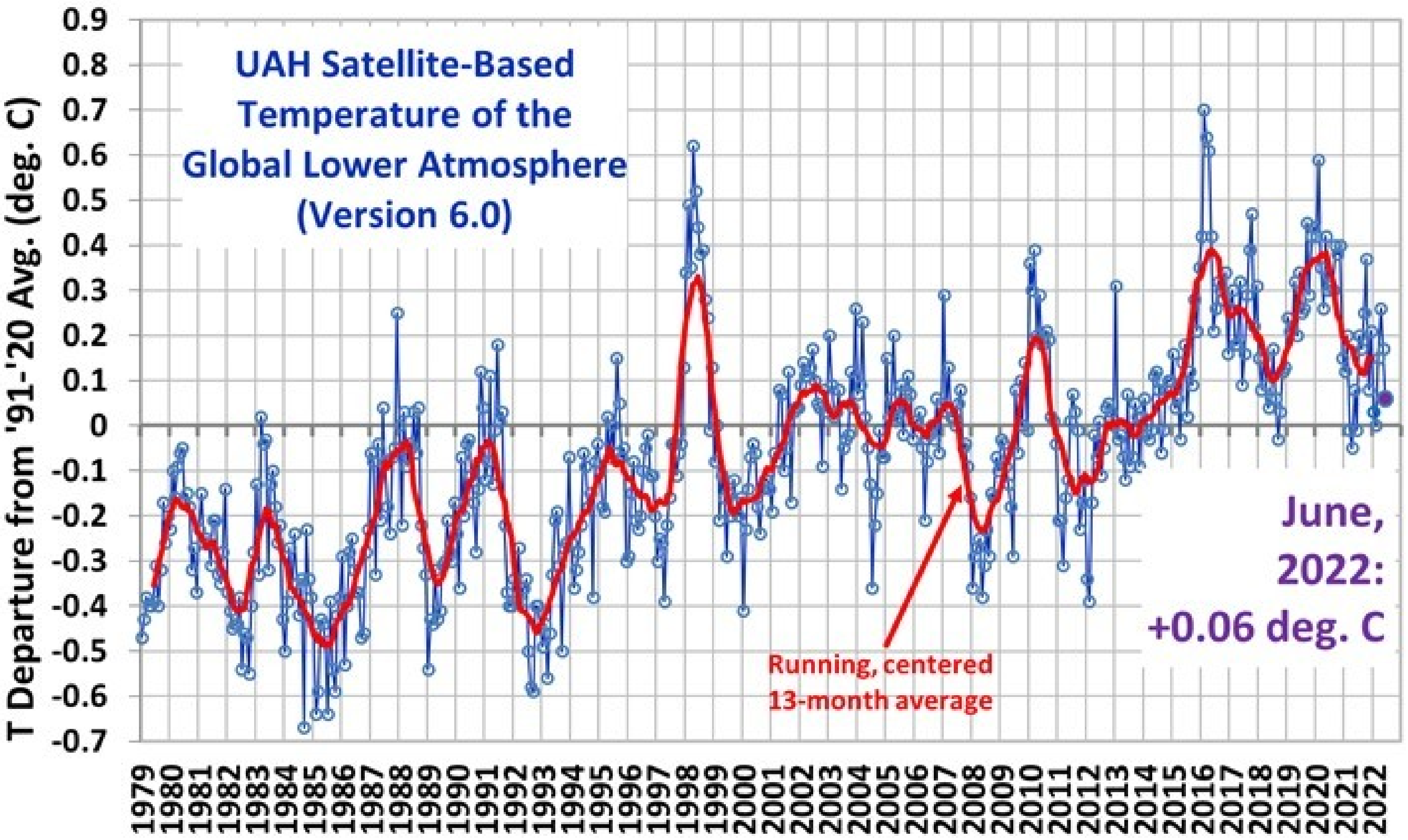
- Less ozone affected planetary atmosphere waves
- They, in turn, caused the giant wiggles in the jet stream as shown in picture on the left
- It kicked the North Atlantic Oscillation (NAO)—the balance between a permanent low-pressure system near Greenland and a permanent high-pressure system to its south—into a negative phase
- that led to Europe to remain unusually cold during the MM

Shindell et al., 2001



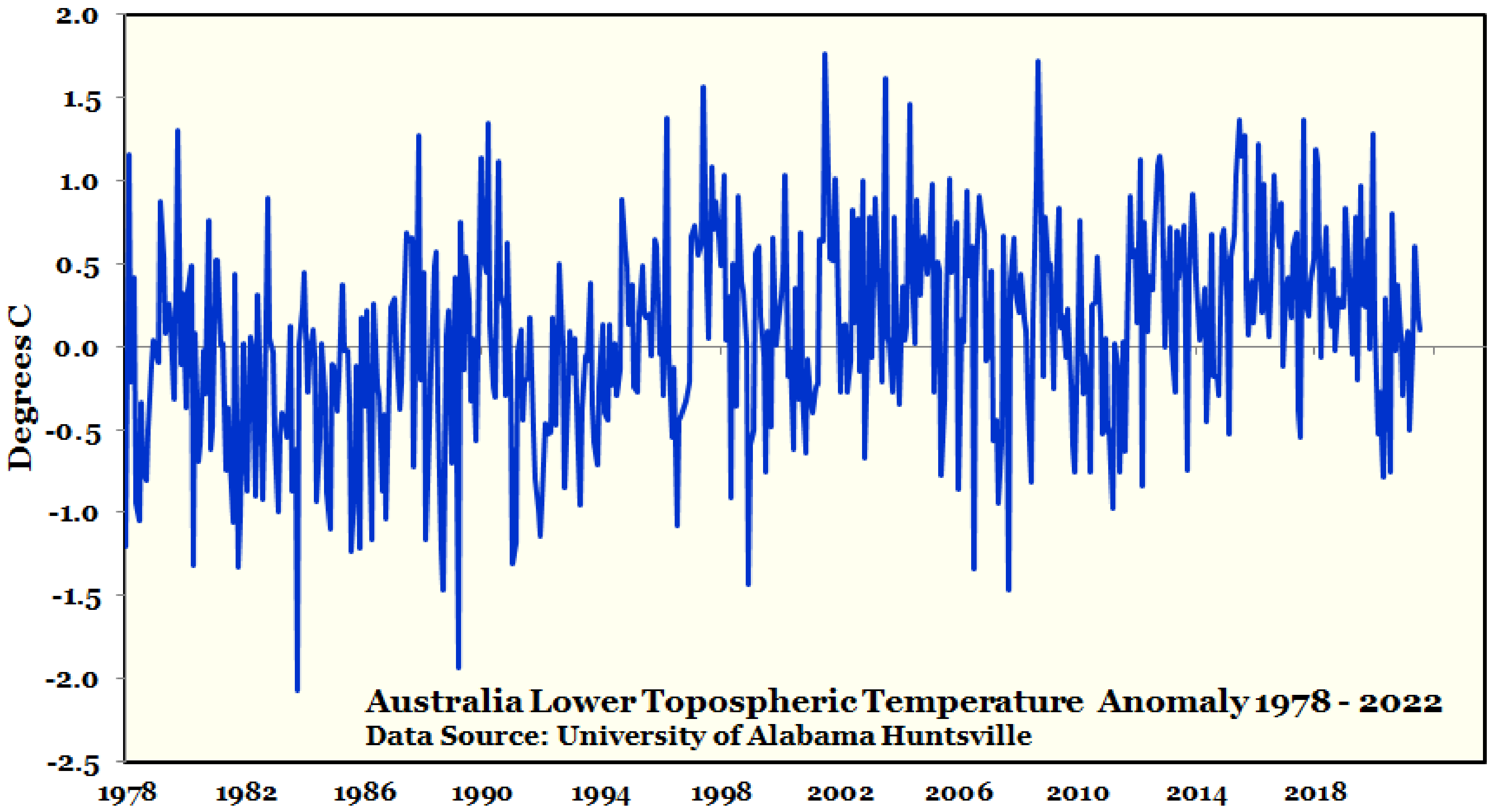
- Cycle 25 (green line) shows a steeper growth of the number of spotless days than any other cycles including the ones during Dalton min (cycles 15 and 24) (blue line)

Has the world warmed?



The atmosphere hasn’t warmed – in downtrend from 2016.

Australia is much the same.



Nothing has happened really – sideways for the last 25

Modern Grand Solar Minimum 2020-2053

Snow in Carpathian mountains

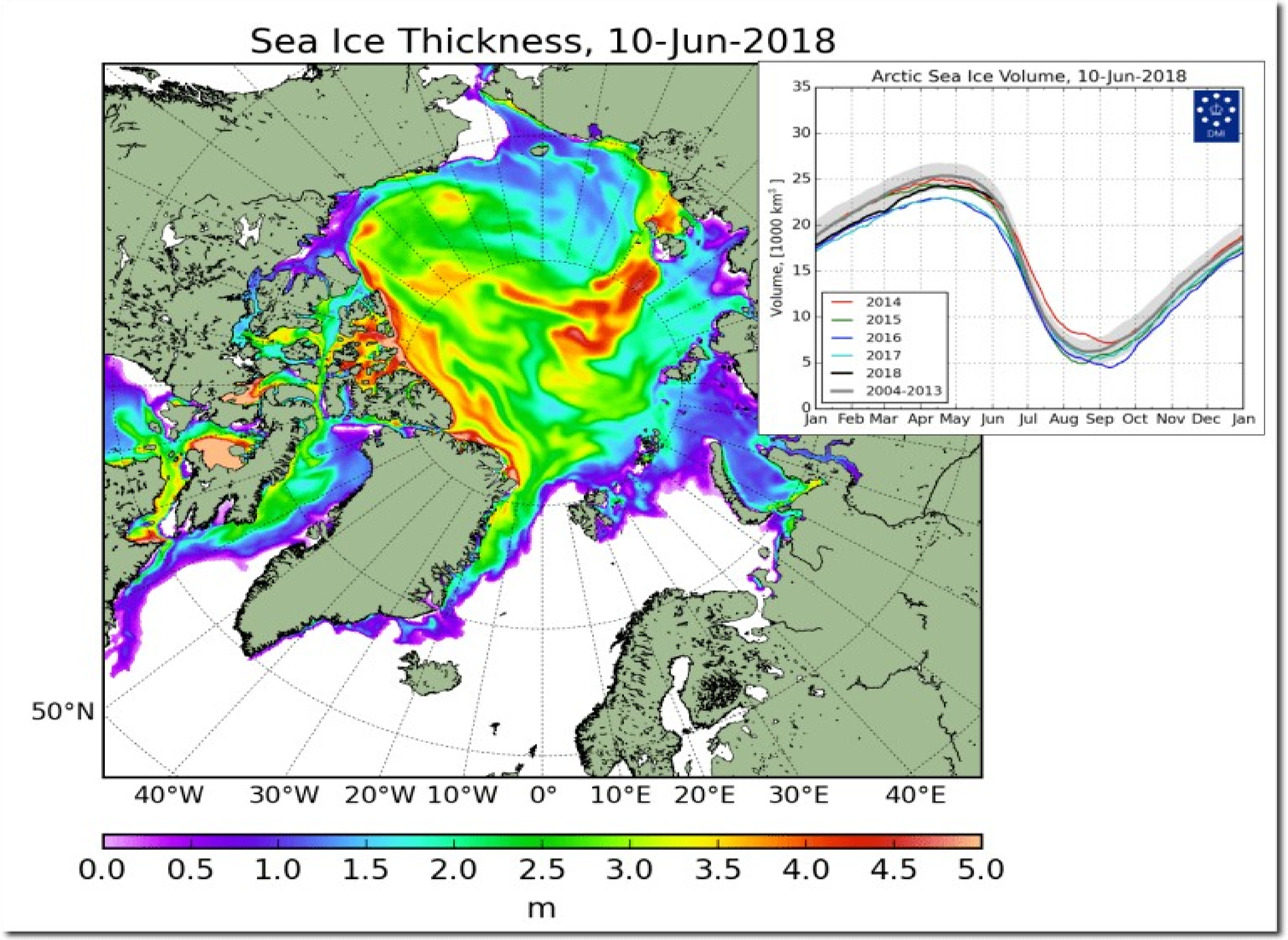
7, 14 July'19 July –Ukraine, 12 July 2019, 2021-2021 – many examples

- Contrary to the prediction of JAMES HANSEN, 1989: "NEW YORK CITY'S WEST SIDE HIGHWAY WILL BE UNDERWATER BY 2009"
- January 2020 snow and frost -2C was recorded in Amman, Arabia, first in 150 years
- Early snow in Canada in September' 20, May 21
- Summer snow in south of Australia 2021

Snow in Africa’s desert 8 December 2020

https://twitter.com/GerryAMcG/status/1336420778582138886

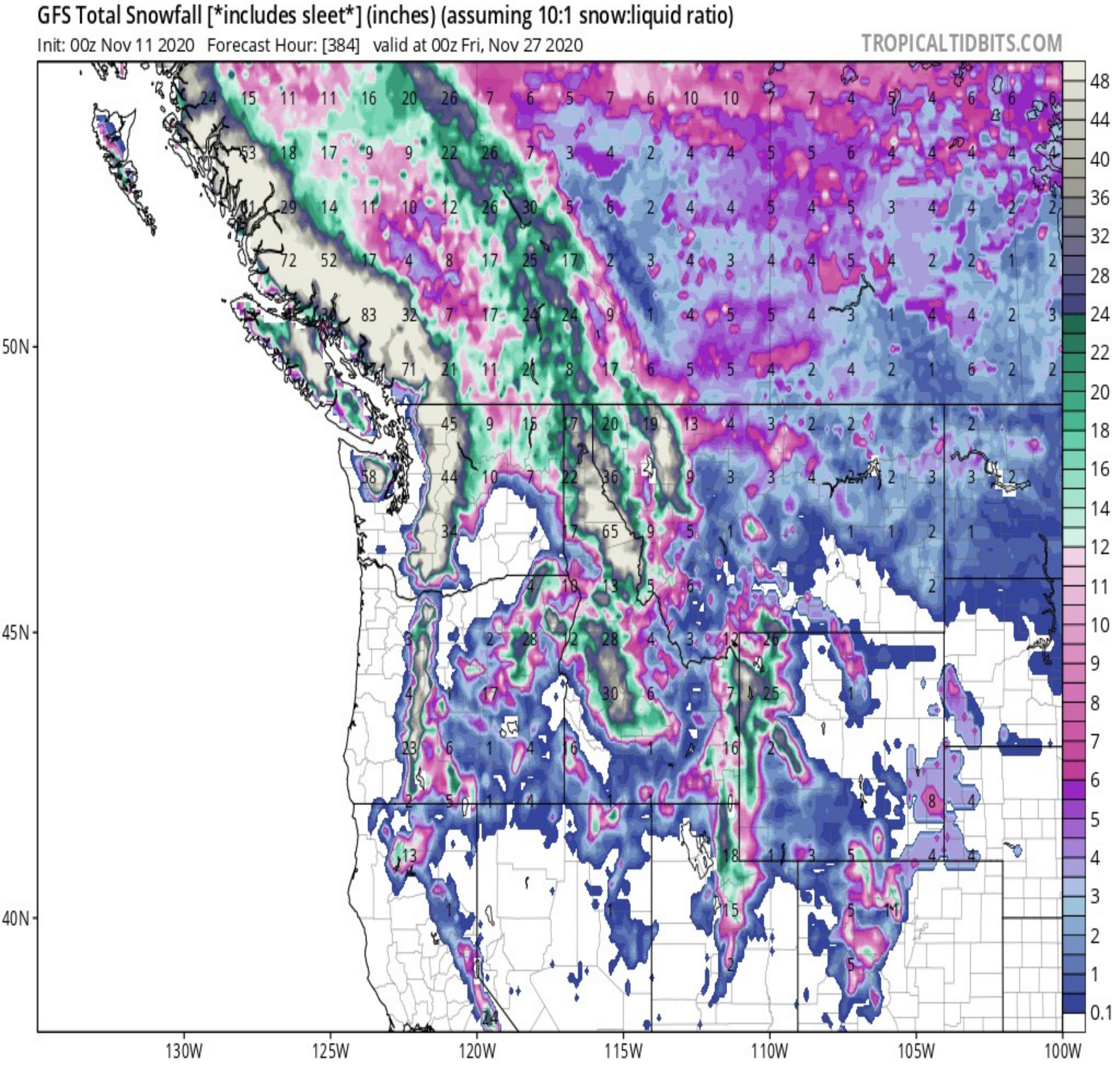
Modern GSM: Sea ice thickness increase in 2018-2020



- Contrary to prediction of JAMES HANSEN, 1989: “NEW YORK CITY’S WEST SIDE HIGHWAY WILL BE UNDERWATER BY 2009”

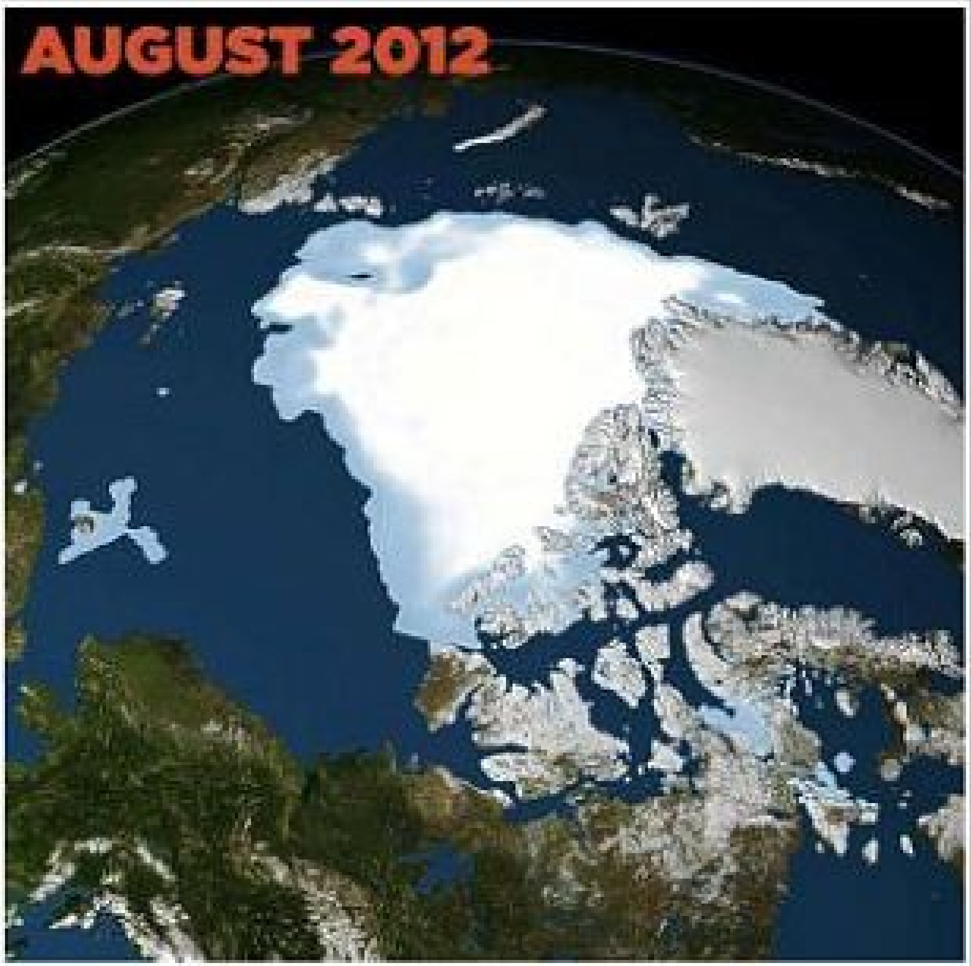
- Arctic sea ice thickness grown significantly in 2018 and continues to grow

Modern GSM is progressing –November 2020- June 2022



- UNPRECEDENTED WINTER STORM HITS BRITISH COLUMBIA
- Both NOAA and NASA appear to agree, *if you read between the lines*, with NOAA saying we're entering a [‘full-blown’ Grand Solar Minimum]() in the late-2020s
- NASA seeing this upcoming solar cycle *(25)* as “[the weakest of the past 200 years]()”, with the agency correlating previous solar shutdowns to prolonged periods of global cooling [here]().

HOW ICE SHEET GREW 533,000 SQUARE MILES IN A YEAR



CONTRACTION: This Nasa satellite image shows the ice at the smallest extent on record, with much of the Arctic Ocean uncovered

RECOVERY: Contrary to predictions that the ice would have vanished by this summer, it has actually increased by 29 per cent from last year

Volcanic activity correlates with SA cycles of southern polarity (Vasilieva and Zharkova, 2022, ApJ in press)

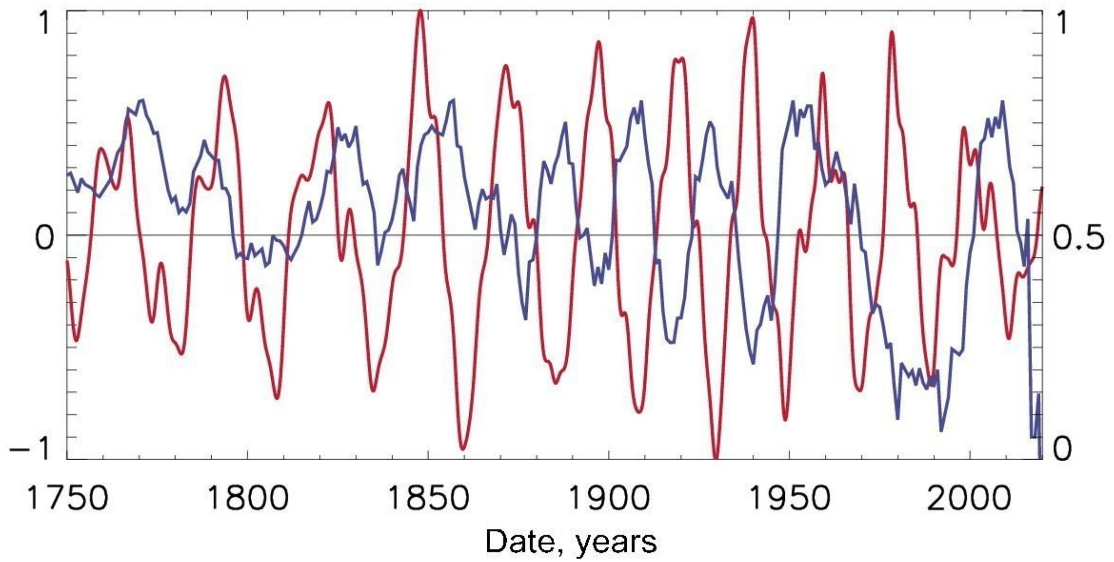
Top plot

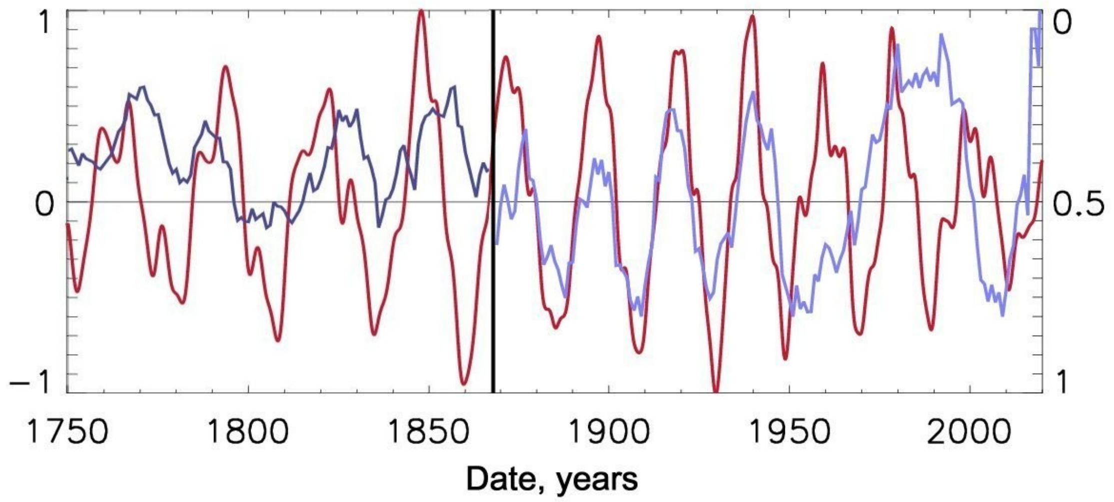
Blue – frequencies of volcanic eruptions
Red - the summary curve of solar background magnetic field. Positive magnitudes – northern polarity, negative - southern polarity.

Bottom plot

Volcanic eruption frequencies highly (0.84) correlate with the summary curve with southern polarity with a period of 22 years (1860-1950).

Next maximum of volcanic eruptions will occur in cycle 26 (2031-2042).



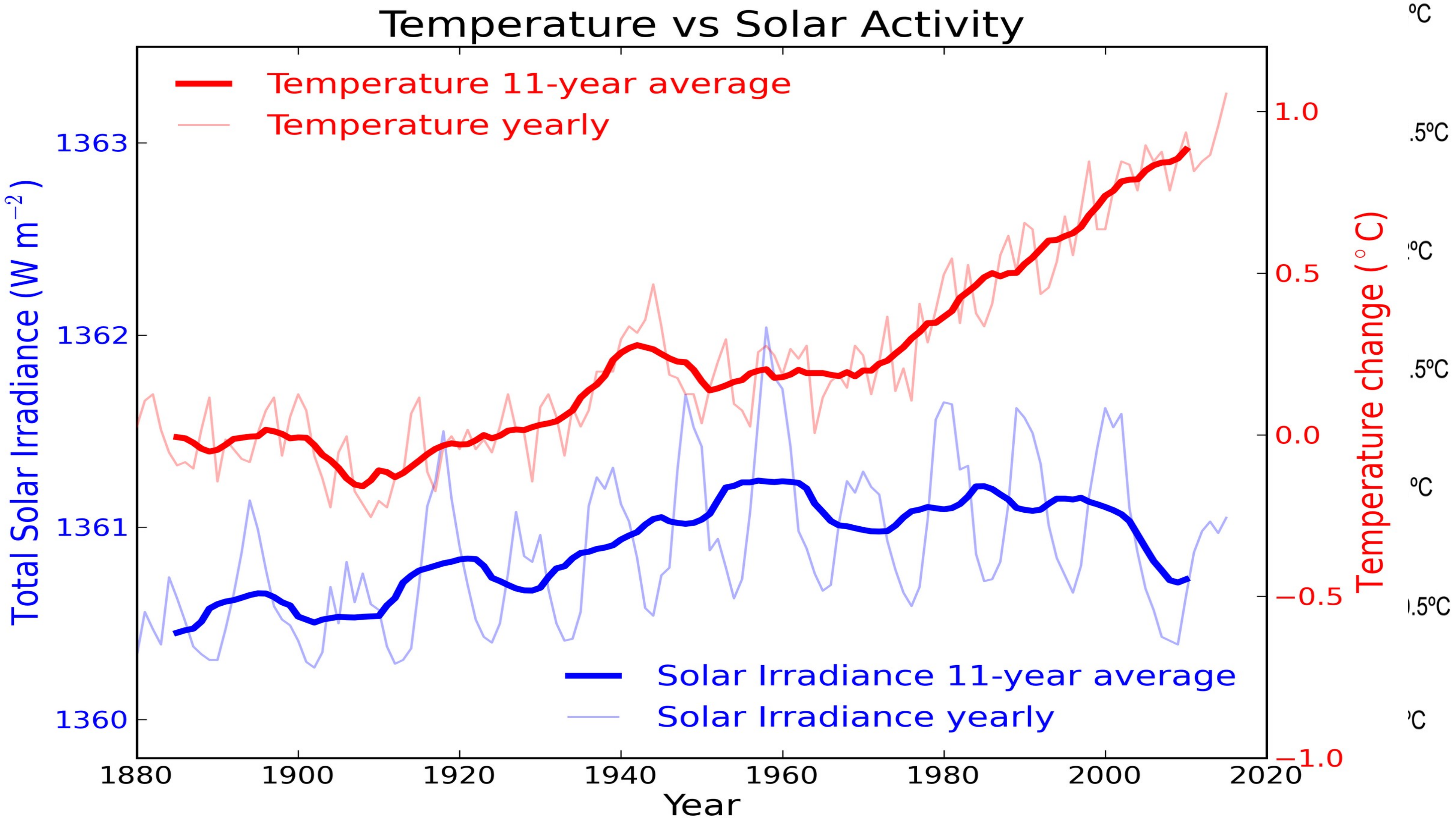


Modern Grand Solar Minimum

https://solargsm.com/solar-activity/

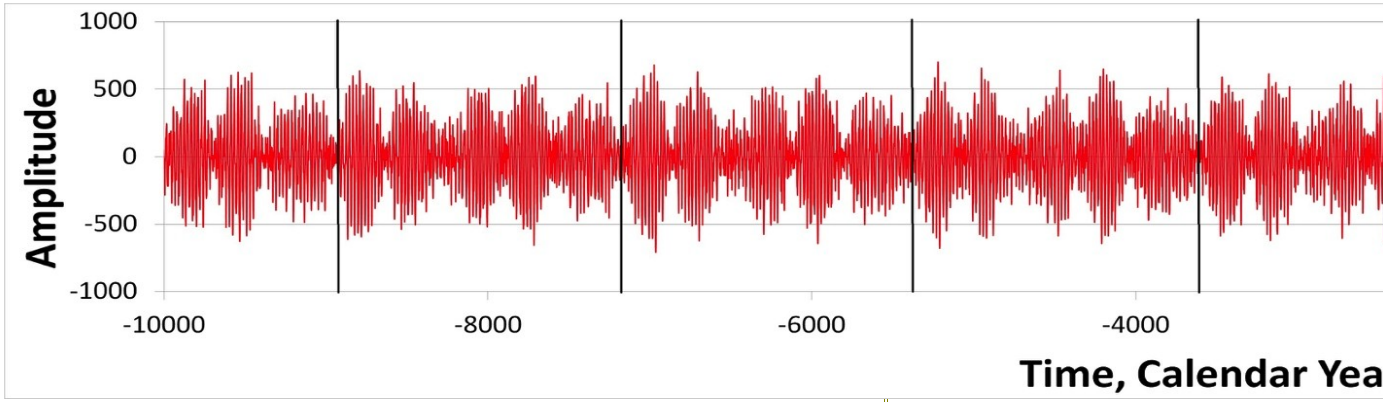
- To occur in 2020 – 2053
- This is a unique event in solar-terrestrial connection will reveal the pros and cons of solar dynamo models
- Decrease of solar magnetic field big impact ozone reduction, high cloud formation, jet direction changes, cosmic rays inclease
- Increase of volcanic and earthquake activities
- Effects on the terrestrial temperature via TSI, jets and volcanic activity
- Shortage of vegetation periods can lead to possible food shortages in 2028-2042
- Need inter-government efforts to avoid disasters

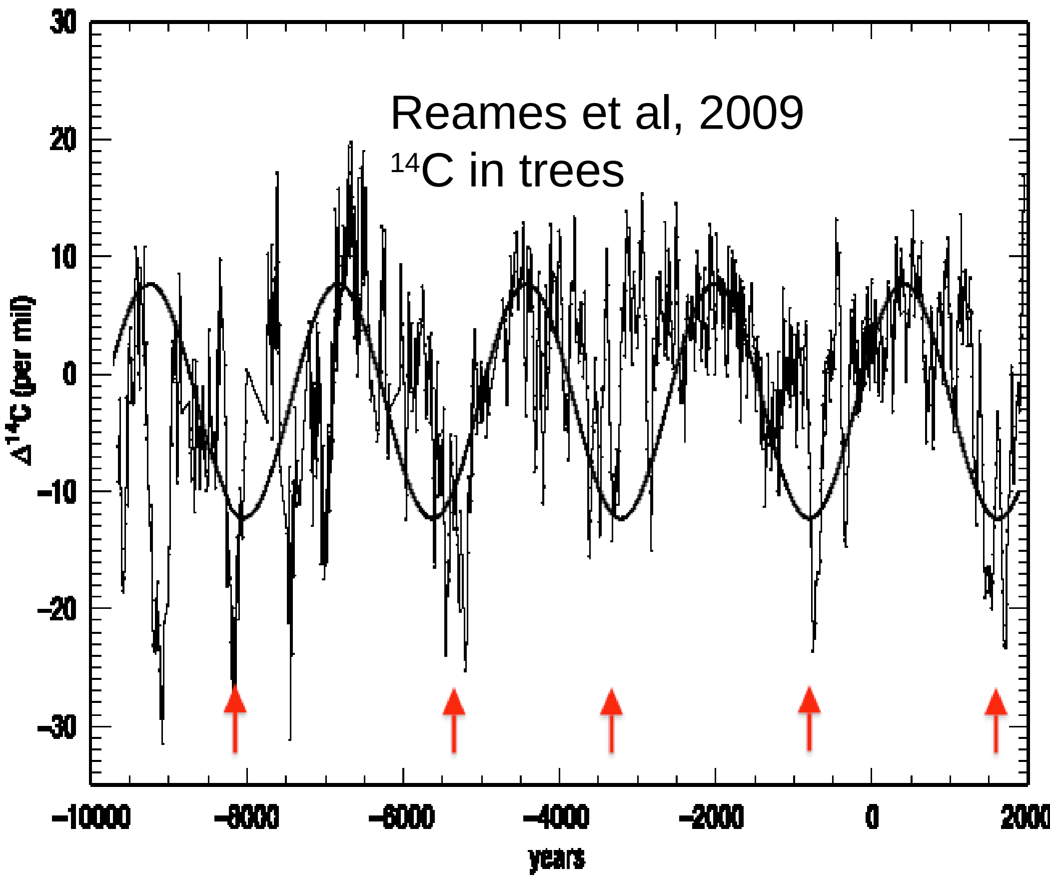
Terrestrial temperature recovery recovery after mini ice age during

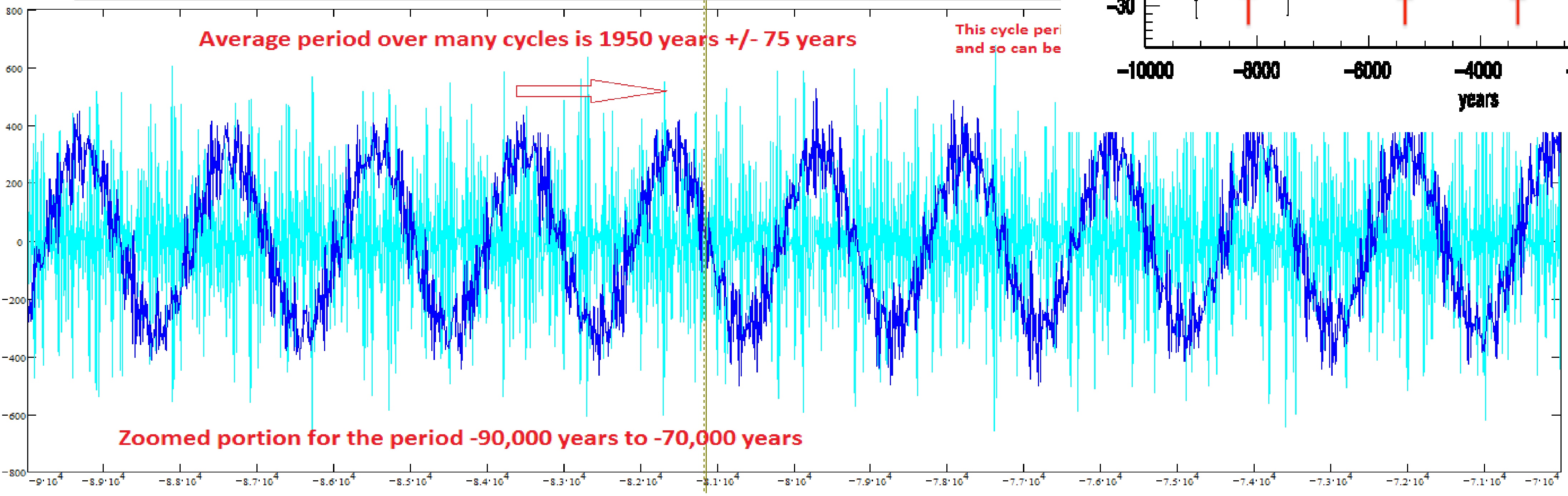


Solar magnetic field (top)
baseline oscillations (bottom)

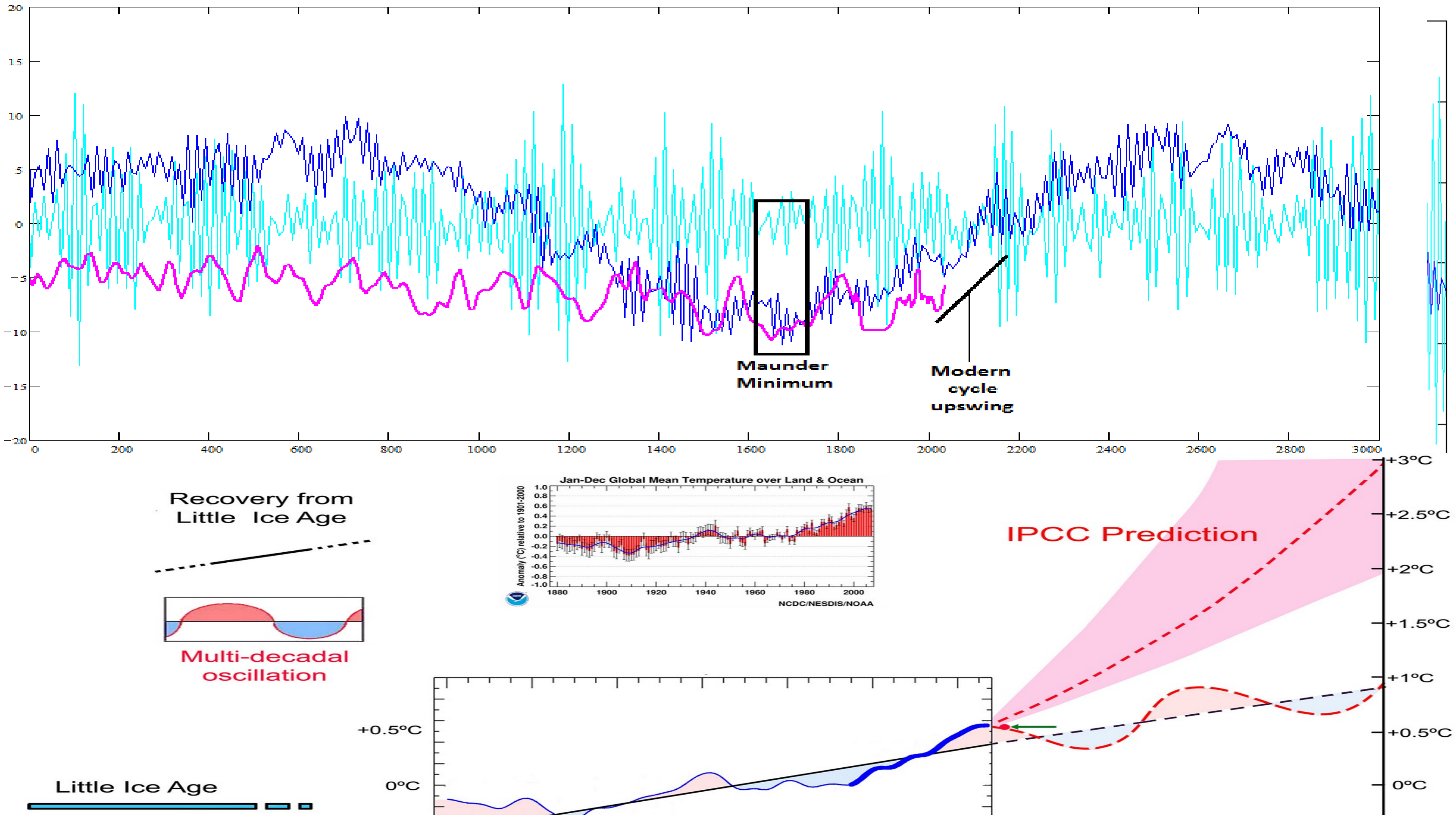
Zharkova et., 2019, 2021







2000-2100 year oscillations (Zharkova et al, 2019, 2020)
of the MF baseline coincides with that of the solar irradiance (Vierra et al, 2011)

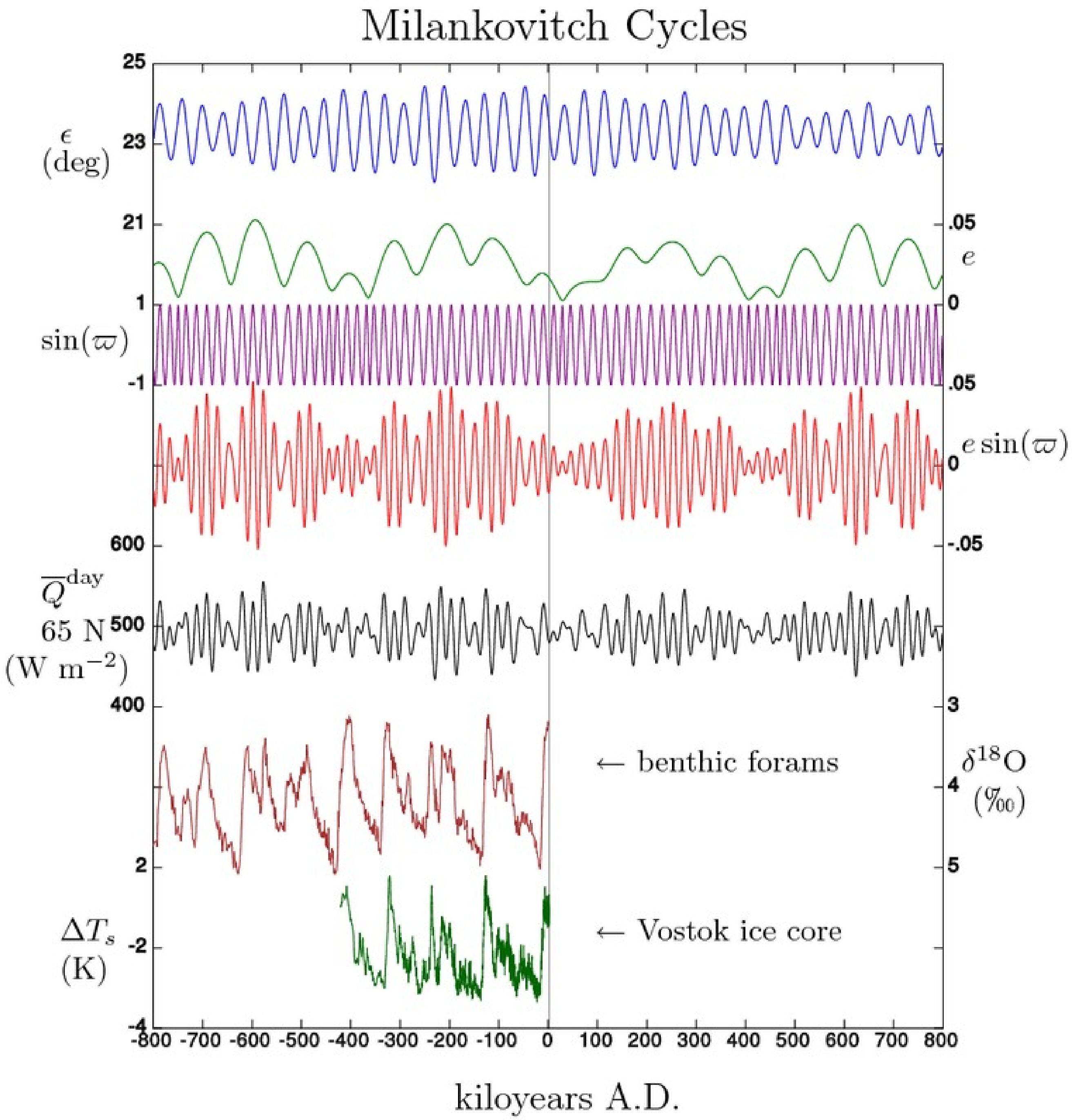


(Akasofu, 2010)

Zharkova et al, 2019, 2020

What are the reasons of solar irradiance oscillations?

- Sun, Earth and other planets



Obliquity (axial tilt) (ε) (22°.1-24°.5)
current 23.5 - T~41 000 years

Eccentricity (e). Change on semi-minor axis
T~100-400K years effects of Jupiter and Saturn

Longitude of perihelion (sin(ϖ)).

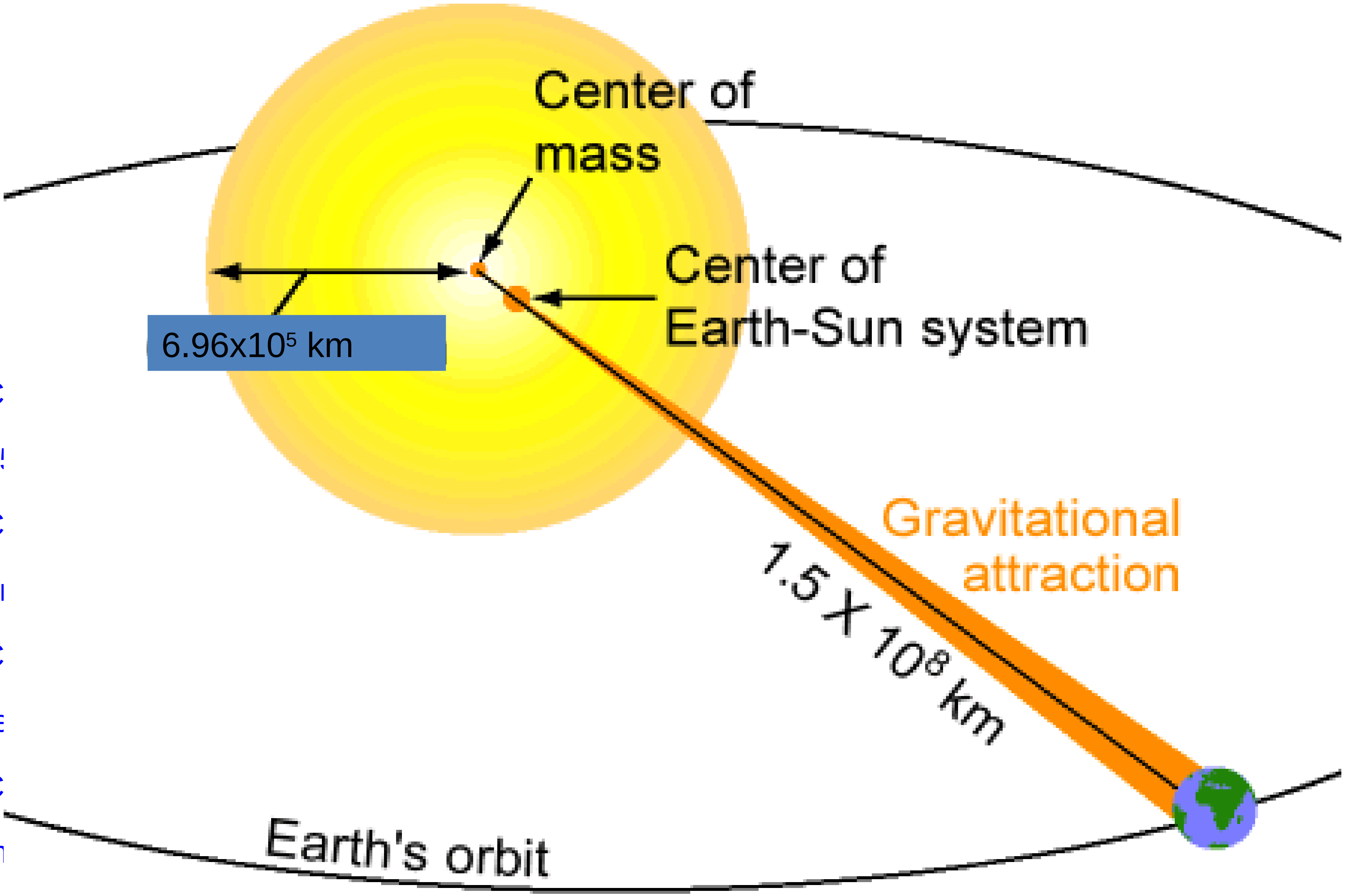
Precession index (e sin(ϖ)) –

- Axial - Earth's axis of rotation relative to fixed stars – T~ 25,771.5 y
- **Apsidal -** orbit ellipse relative to fixed stars – T~113 000 y
- Orbital inclination – T~ 70 000 y

Earth's movements:

1.1 Orbital shape (eccentricity)
1.1.1 Effect on temperature
1.1.2 Effect on lengths of seasons
1.2 Axial tilt (obliquity)
1.3 Axial precession
1.4 Apsidal precession
1.5 Orbital inclination (

Solar Inertial Motion



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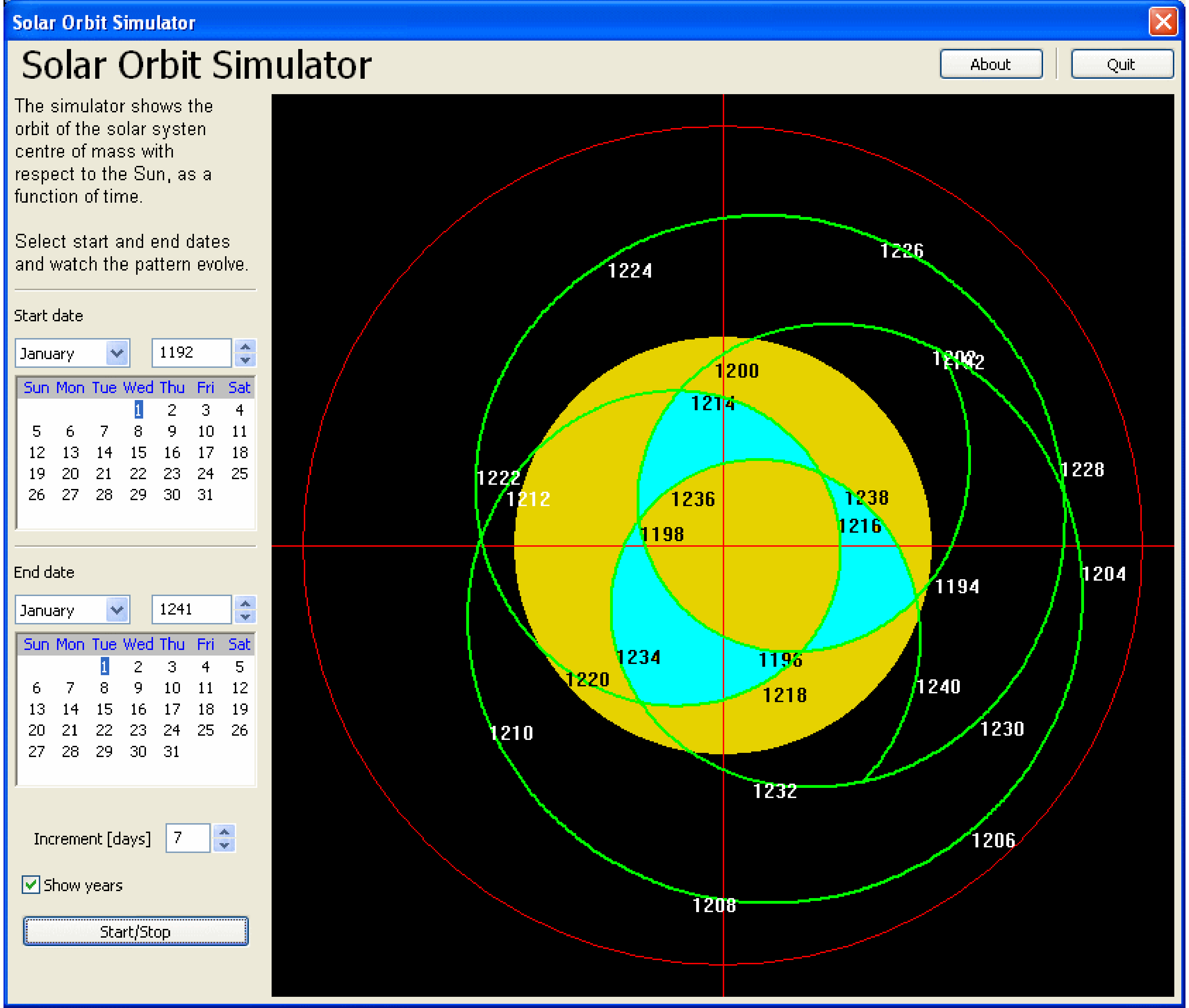
Solar Orbit Simulator
Solar Orbit Simulator
About
Quit
The simulator shows the orbit of the solar system centre of mass with respect to the Sun, as a function of time.
Select start and end dates and watch the pattern evolve.
Start date
January
1192
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31
End date
January
1241
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4 5
6 7 8 9 10 11 12
13 14 15 16 17 18 19
20 21 22 23 24 25 26
27 28 29 30 31
Increment [days]
7
Show years
Start/Stop
1224
1226
1200
1214
1222
1212
1236
1238
1216
1198
1228
1194
1204
1234
1196
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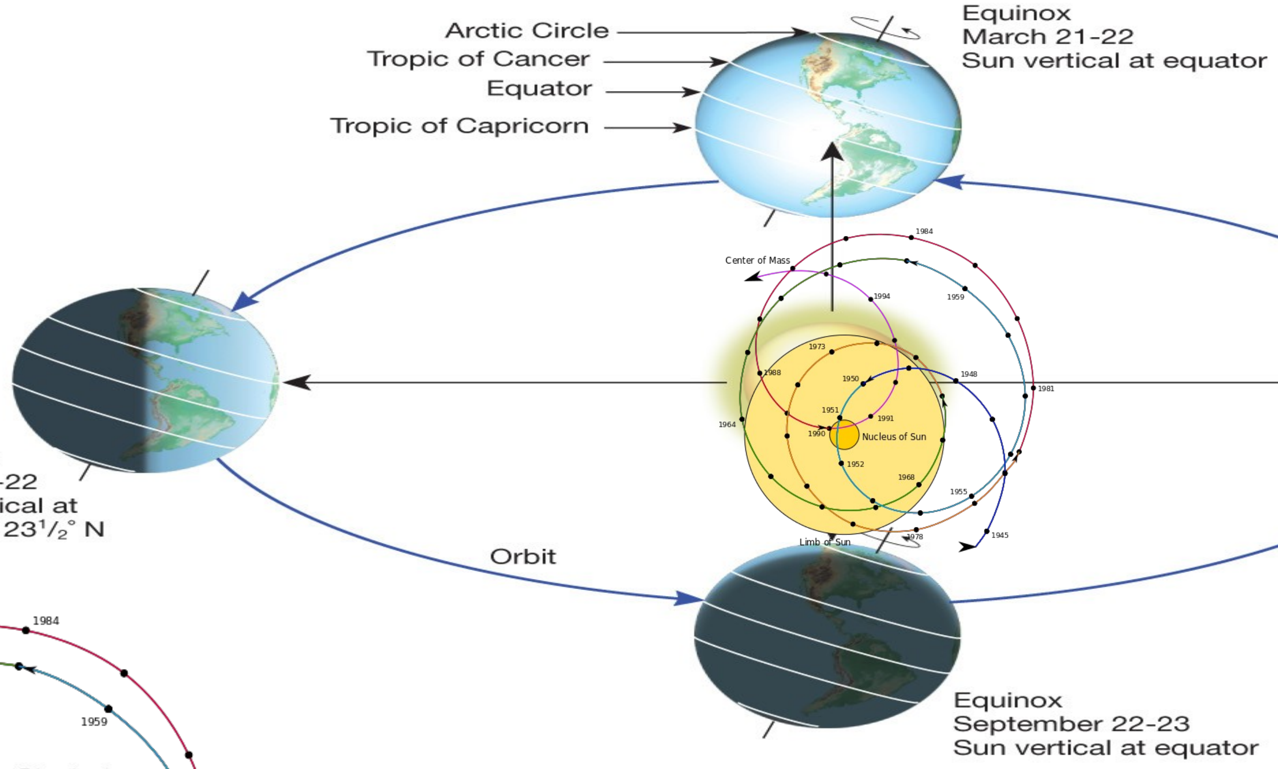
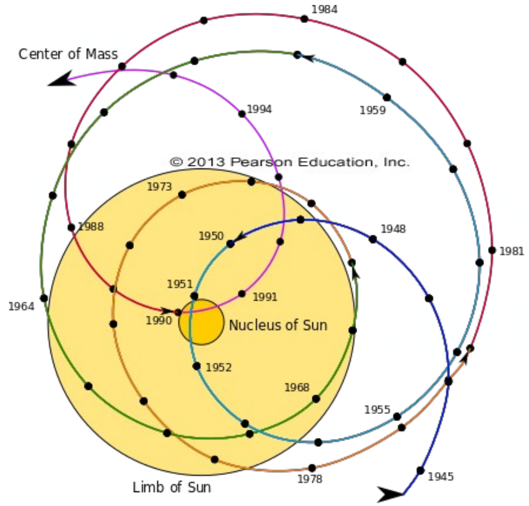
1230
1232
1206
1208

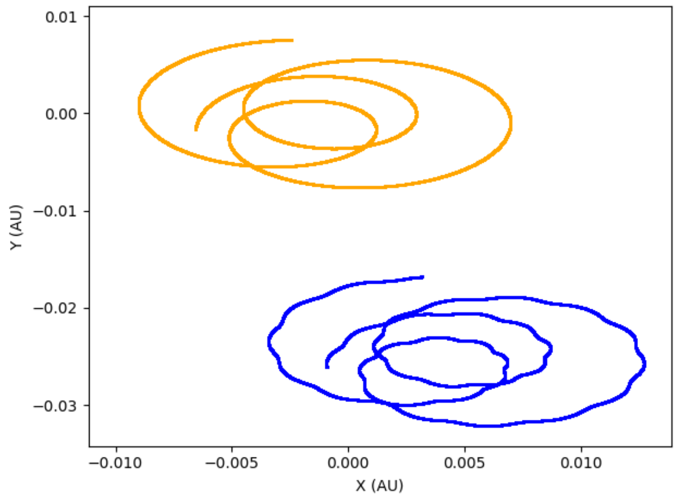


Objection from AGW people

https://youtu.be/vDgUmTq4a2Q



The Sun moves inside a circular area which has a diameter of 0.02 AU (= 4.3 solar radii = 3.106 km). The Sun moves with a velocity between 9 and 16 m/s.

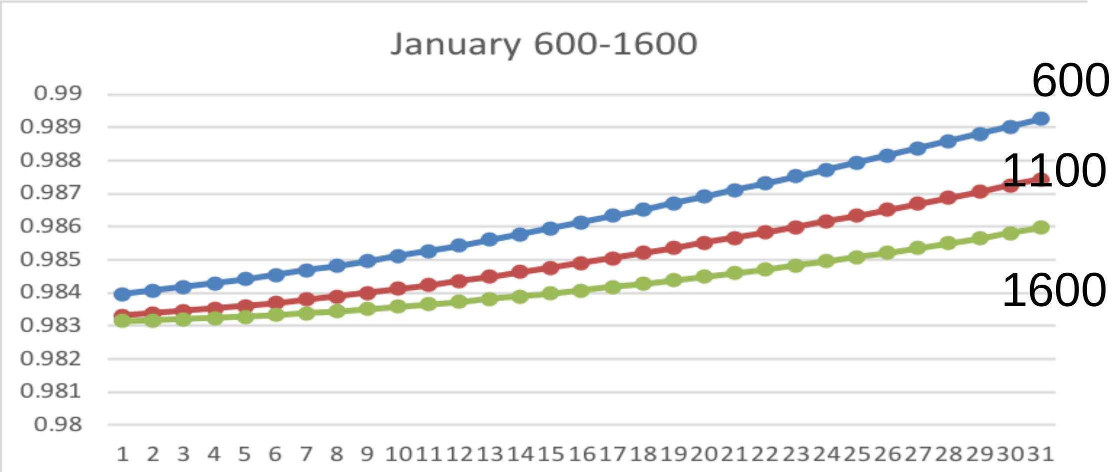


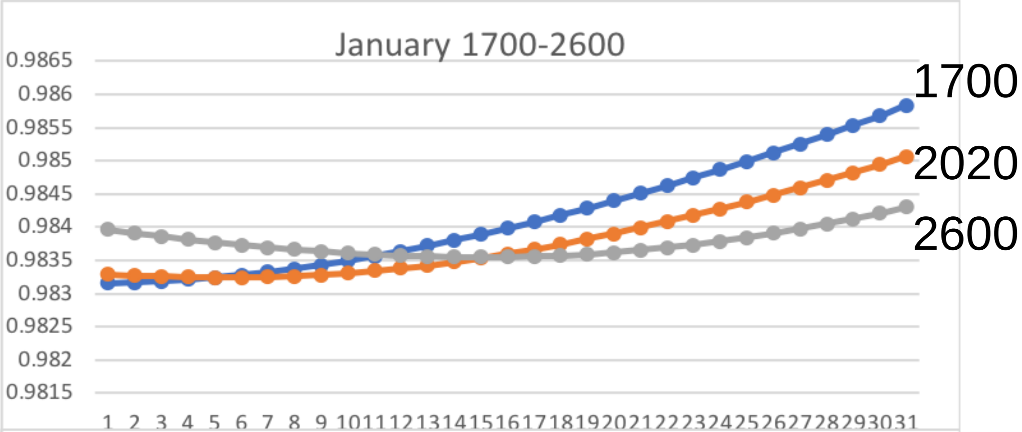
S. Perminov, E.D. Kuznetsov, 2018

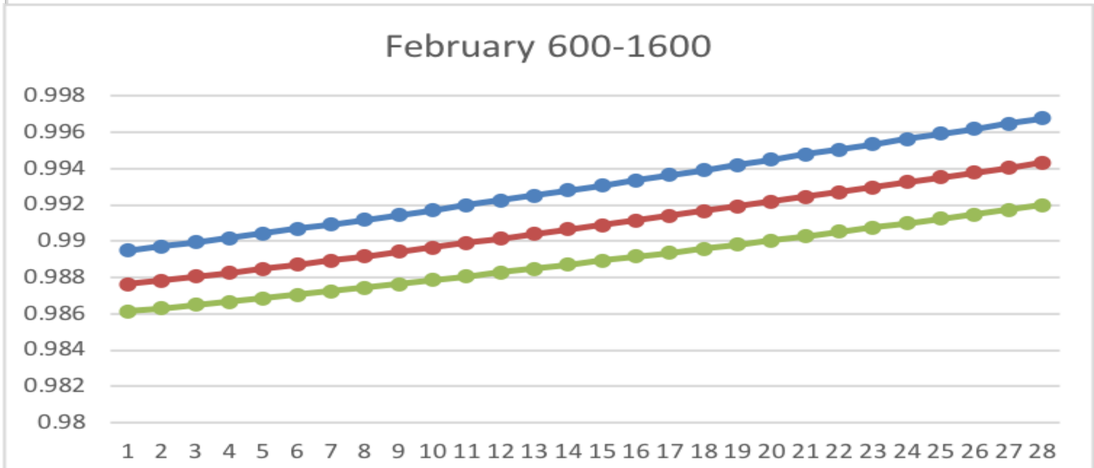
SIM imposed by planets Jupiter, Saturn, Neptune and Uranus

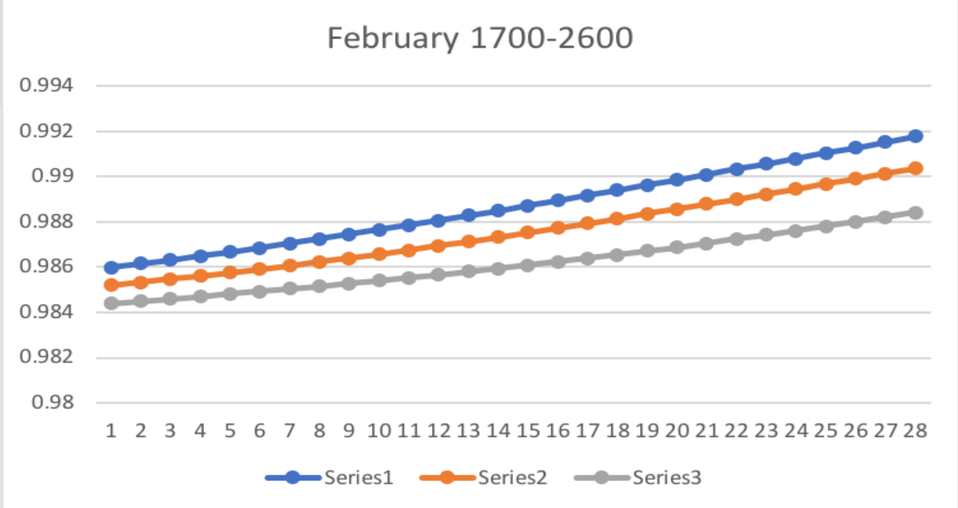
Charvatova, 1988,
Palus et al, 2007

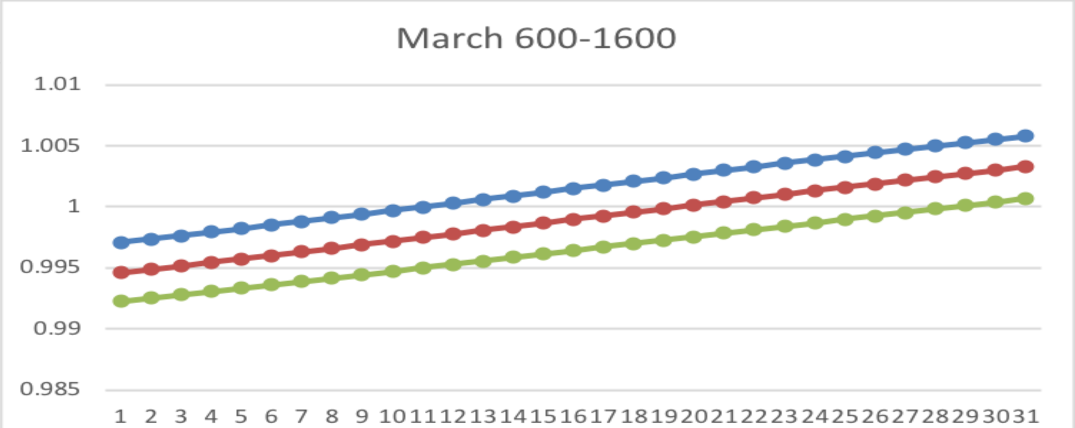
Rice et al, PP comments #72, 96

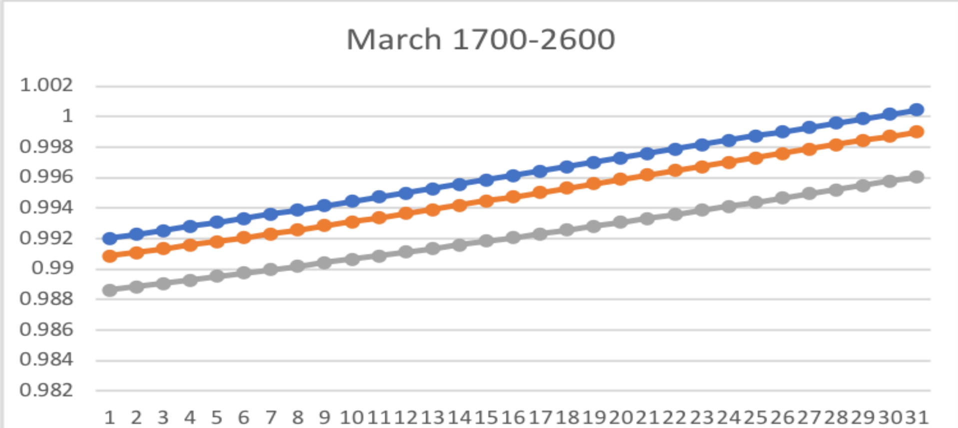




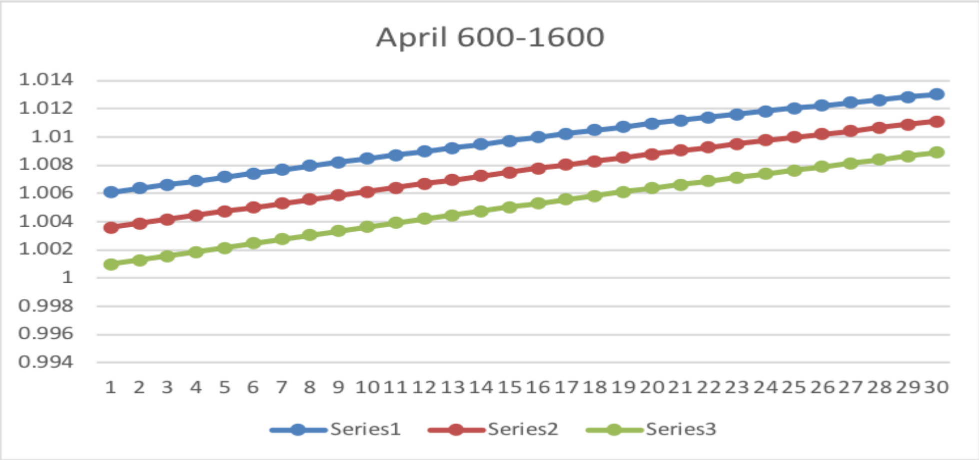


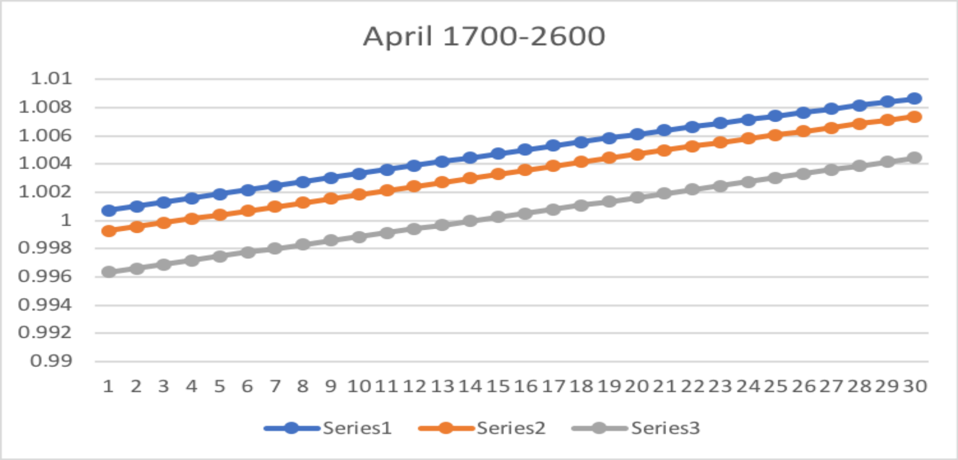


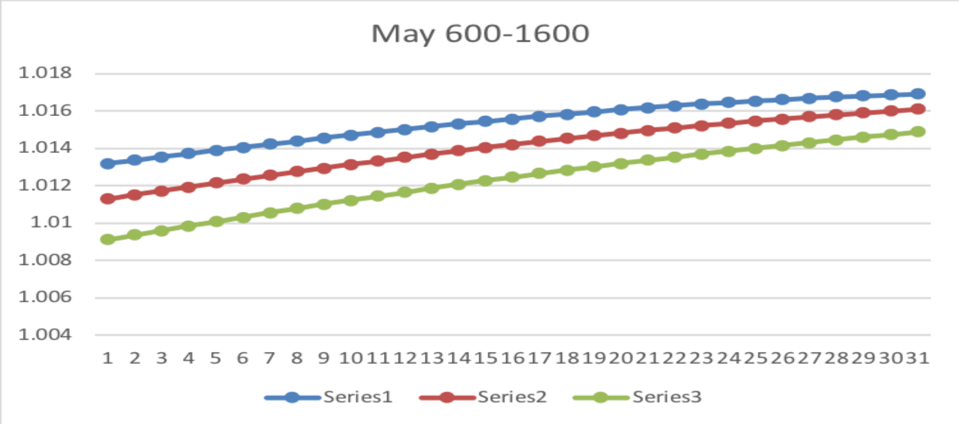


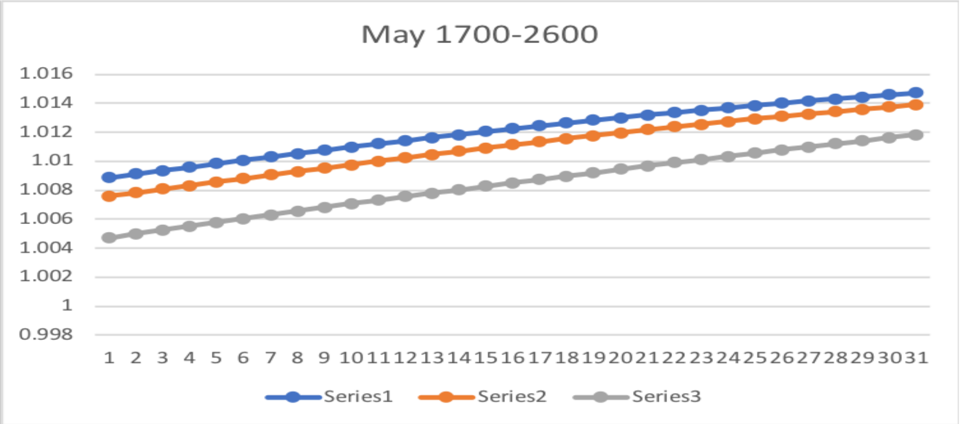


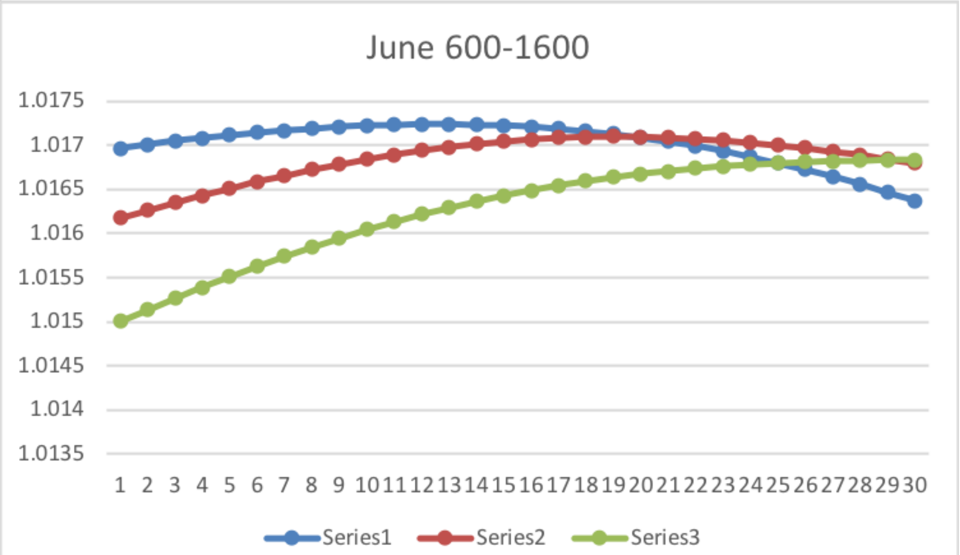
https://www.intechopen.com/online-first/millennial-oscillations-of-solar-irradiance-and-magnetic-field-in-600-2600


April 600-1600
1.014
1.012
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Series1
Series2
Series3


April 1700-2600
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Series1
Series2
Series3


May 600-1600
1.018
1.016
1.014
1.012
1.01
1.008
1.006
1.004
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
Series2
Series3


May 1700-2600
1.016
1.014
1.012
1.01
1.008
1.006
1.004
1.002
1
0.998
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
Series2
Series3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1.017
1.0165
1.016
1.0155
1.015
1.0145
1.014
1.0135
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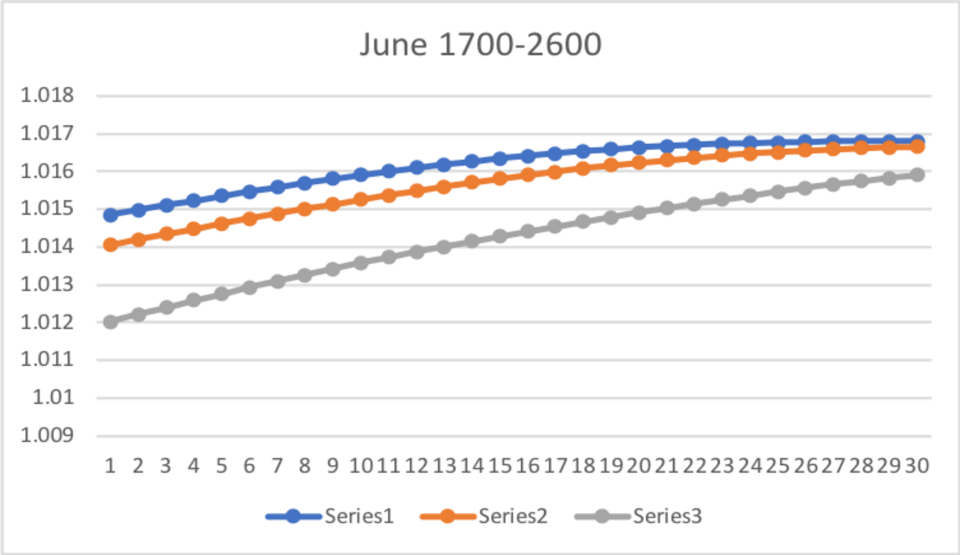
Series1
Series2
Series3


June 1700-2600
1.018
1.017
1.016
1.015
1.014
1.013
1.012
1.011
1.01
1.009
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Series1
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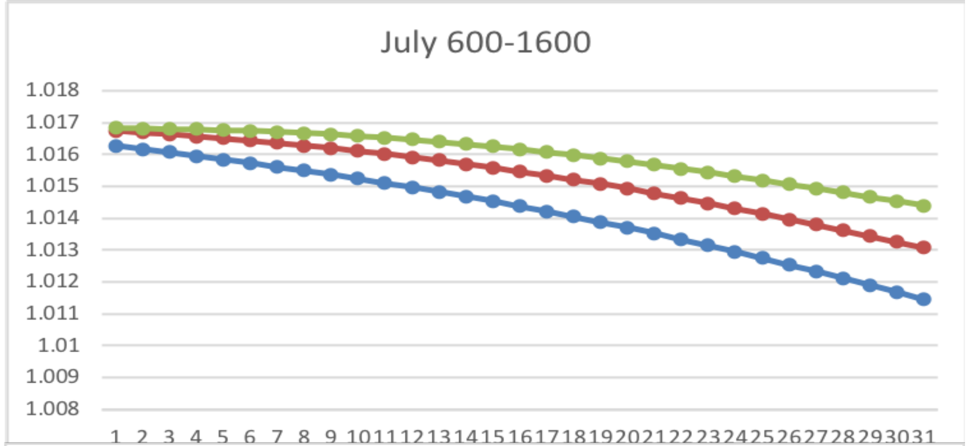
Series3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1.018
1.017
1.016
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1.014
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1.012
1.011
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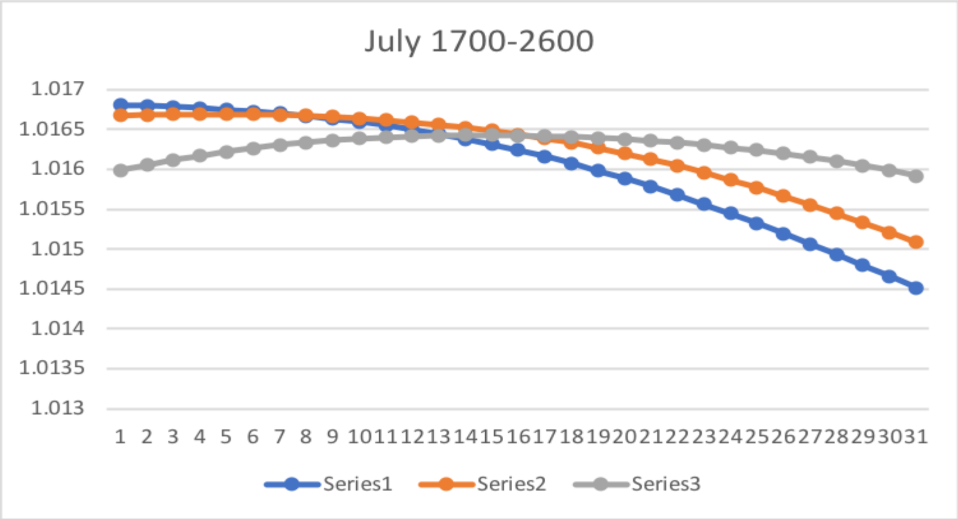
1.009
1.008
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


July 1700-2600
1.017
1.0165
1.016
1.0155
1.015
1.0145
1.014
1.0135
1.013
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
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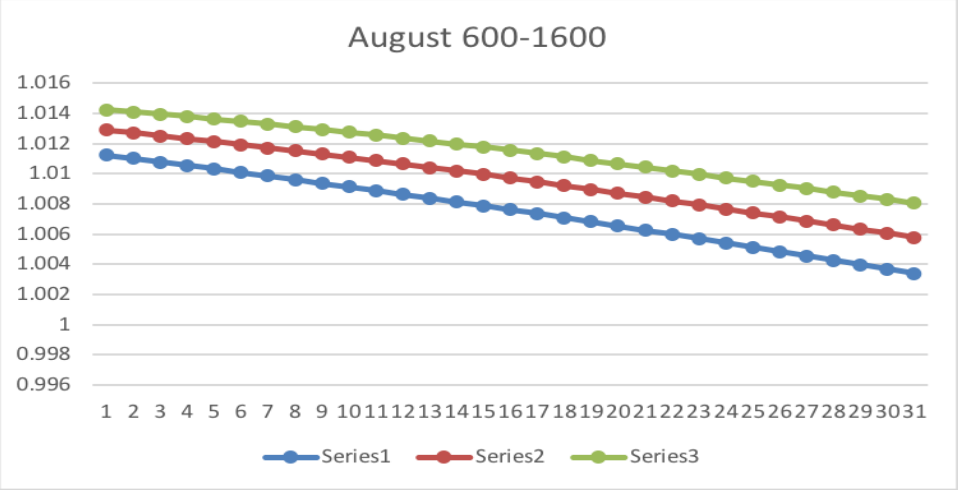
Series3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1.016
1.014
1.012
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
Series2
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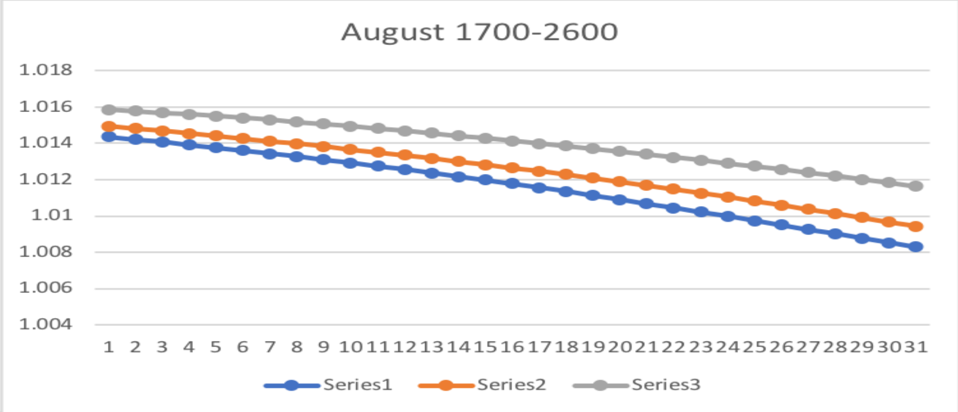
August 1700-2600
1.018
1.016
1.014
1.012
1.01
1.008
1.006
1.004
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
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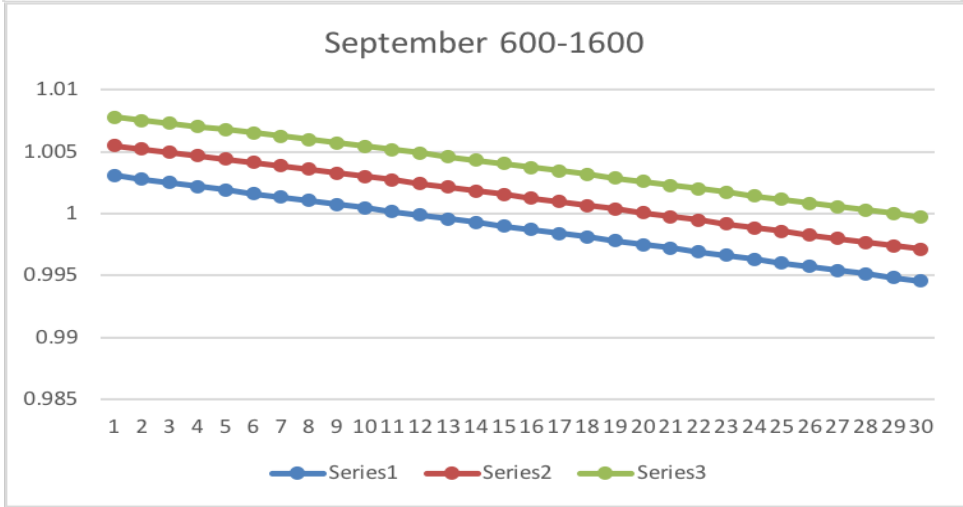
September 600-1600
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1.005
1
0.995
0.99
0.985
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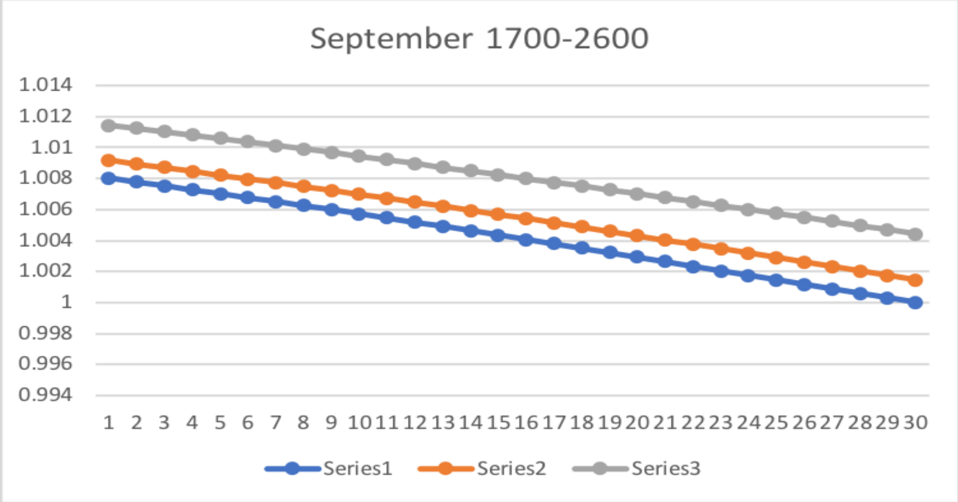
Series1
Series2
Series3


September 1700-2600
1.014
1.012
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Series1
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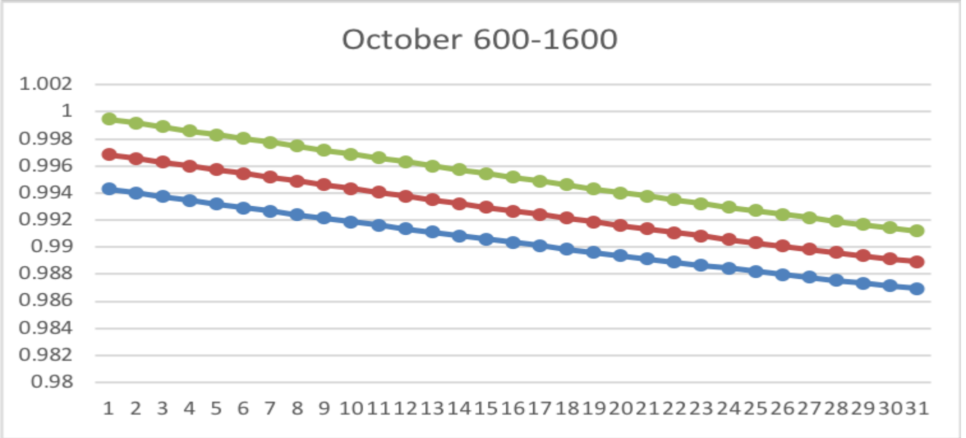
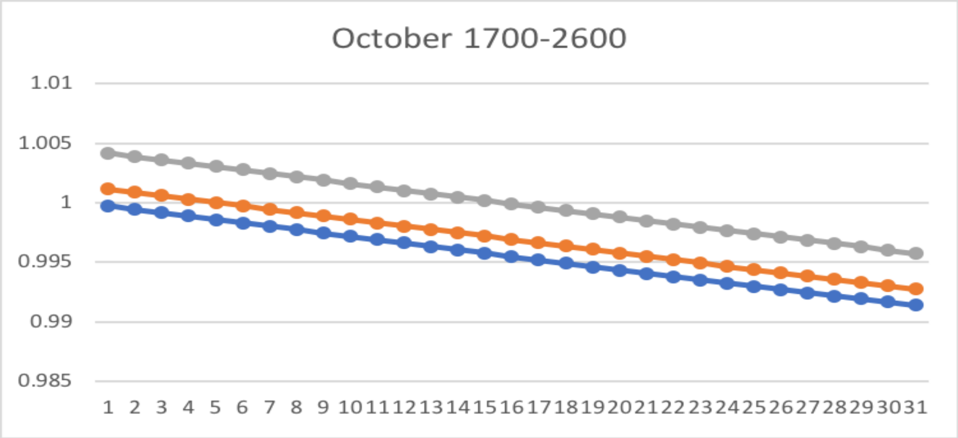
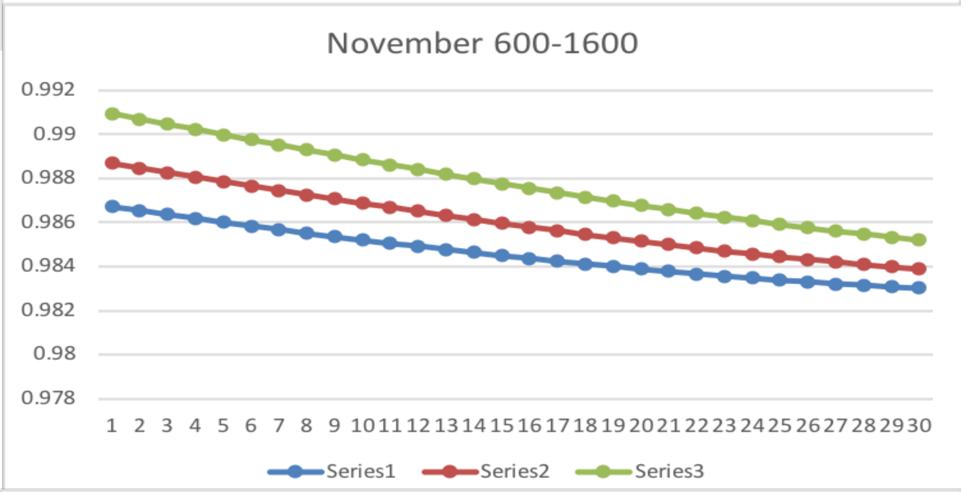
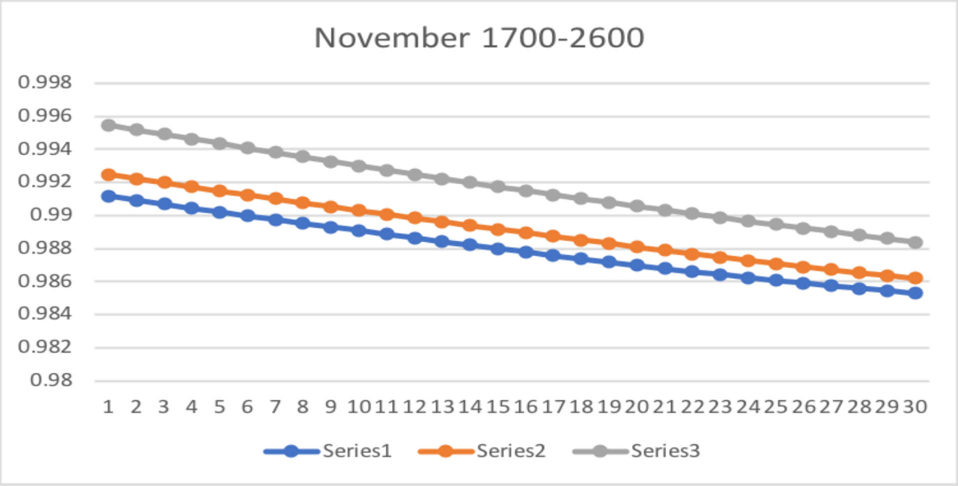

October 600-1600
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
0.986
0.984
0.982
0.98
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


October 1700-2600
1.01
1.005
1
0.995
0.99
0.985
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


November 600-1600
0.992
0.99
0.988
0.986
0.984
0.982
0.98
0.978
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Series1
Series2
Series3


November 1700-2600
0.998
0.996
0.994
0.992
0.99
0.988
0.986
0.984
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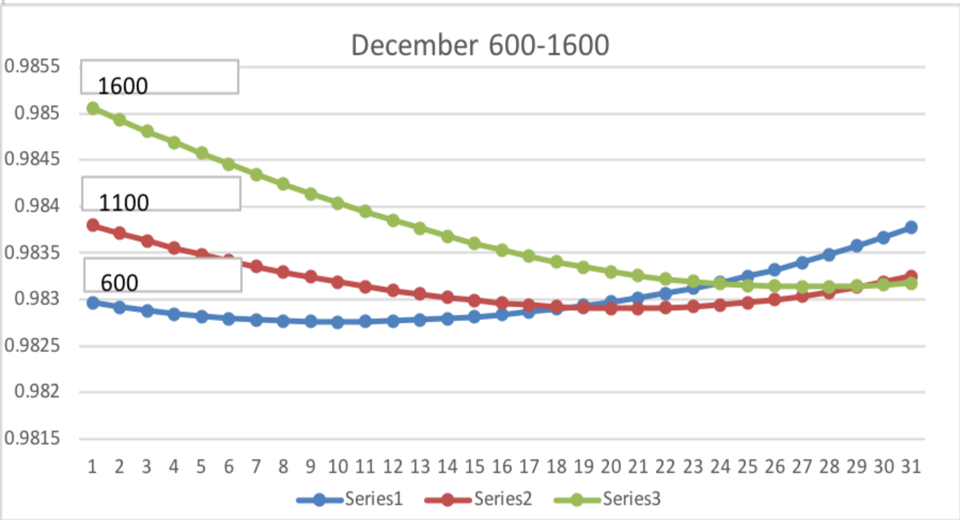
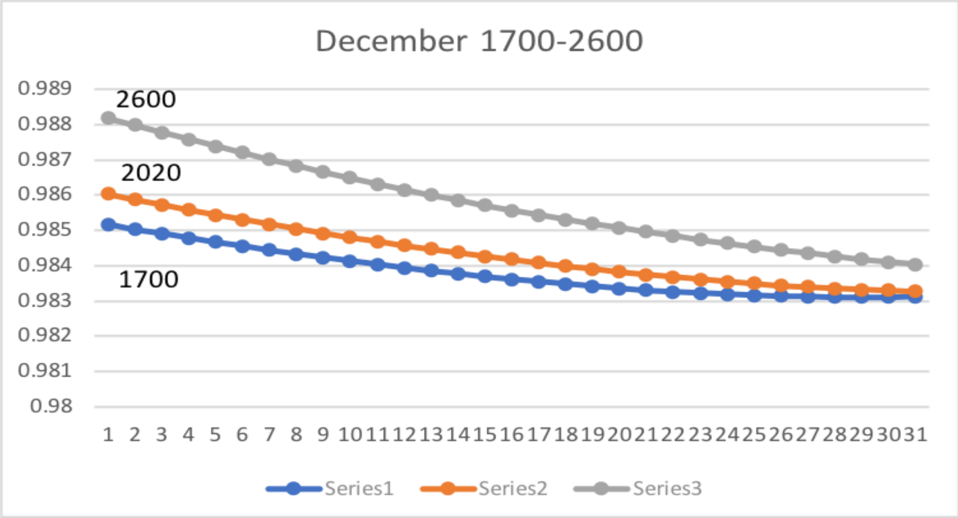
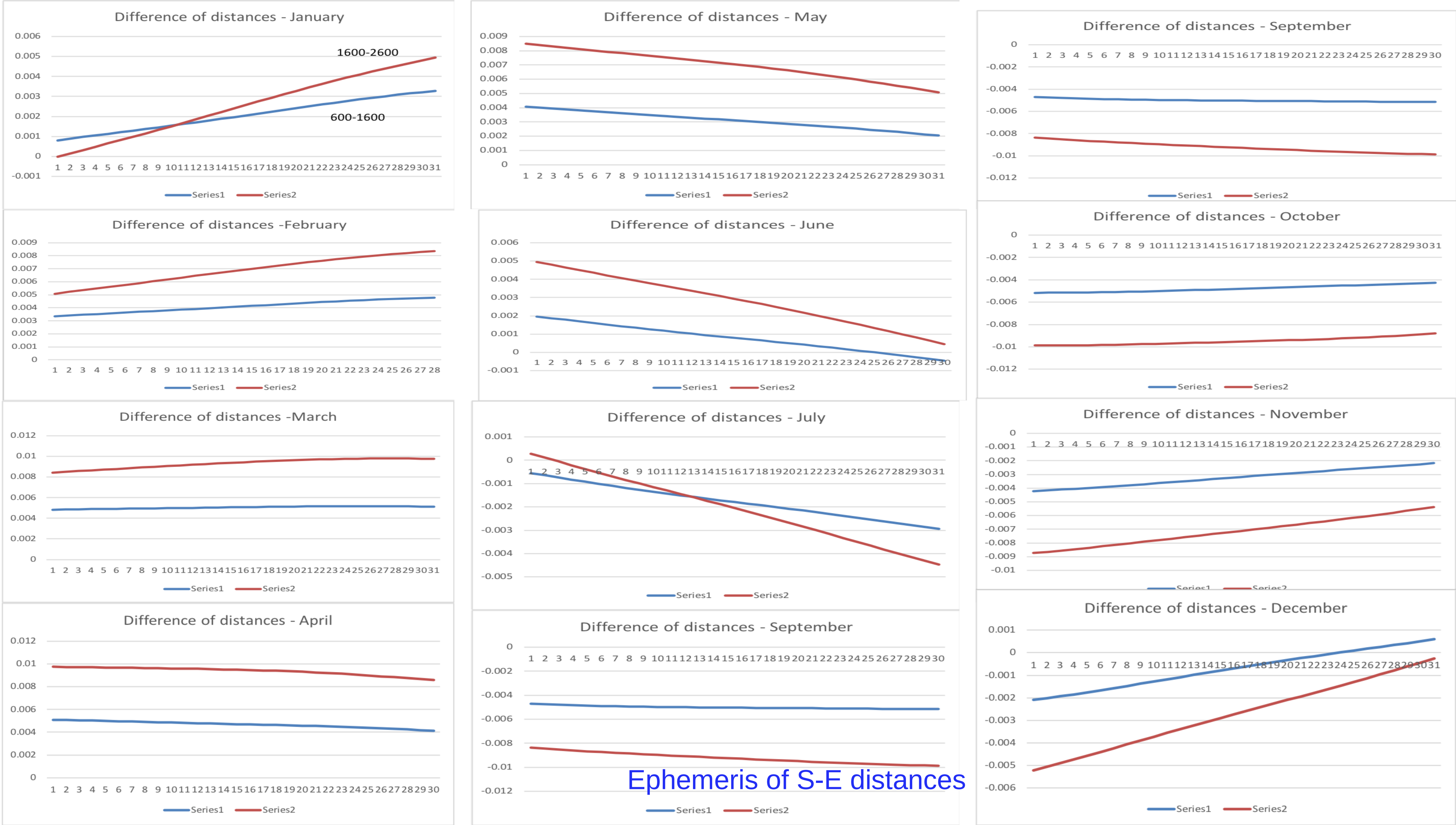
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Series1
Series2
Series3


December 600-1600
1600
1100
600
0.9855
0.985
0.9845
0.984
0.9835
0.983
0.9825
0.982
0.9815
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
Series2
Series3


December 1700-2600
2600
2020
1700
0.989
0.988
0.987
0.986
0.985
0.984
0.983
0.982
0.981
0.98
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Series1
Series2
Series3

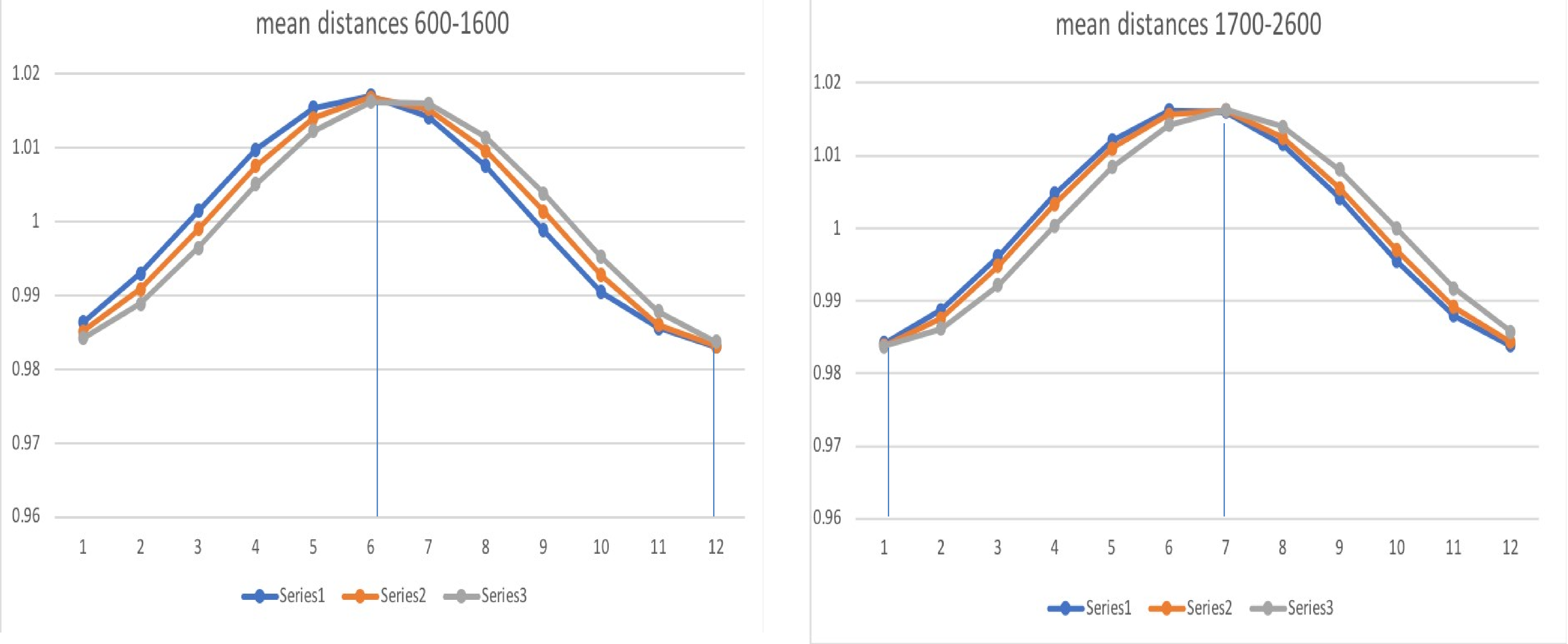


Ephemeris of S-E distances

Annual variations of mean S-E distances (ephemeris)

in M1 (600-1600) and M2 (1700-2600)

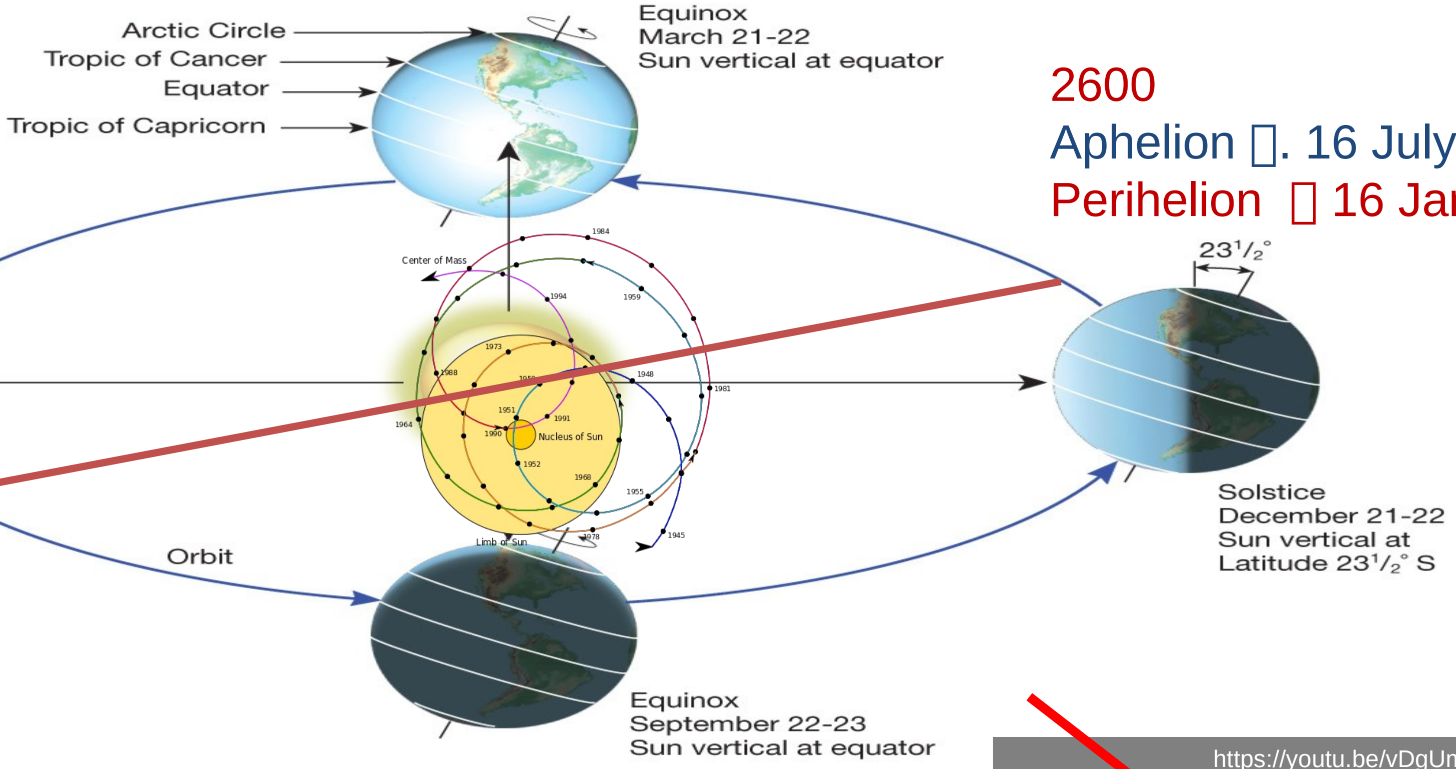
(Zharkova, 2020 https://arxiv.org/pdf/2008.00439.pdf)



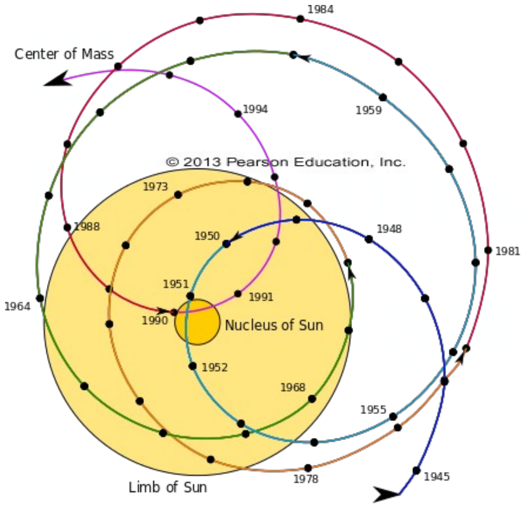
M1 – aphelion is in June, shifting to mid-July in M2

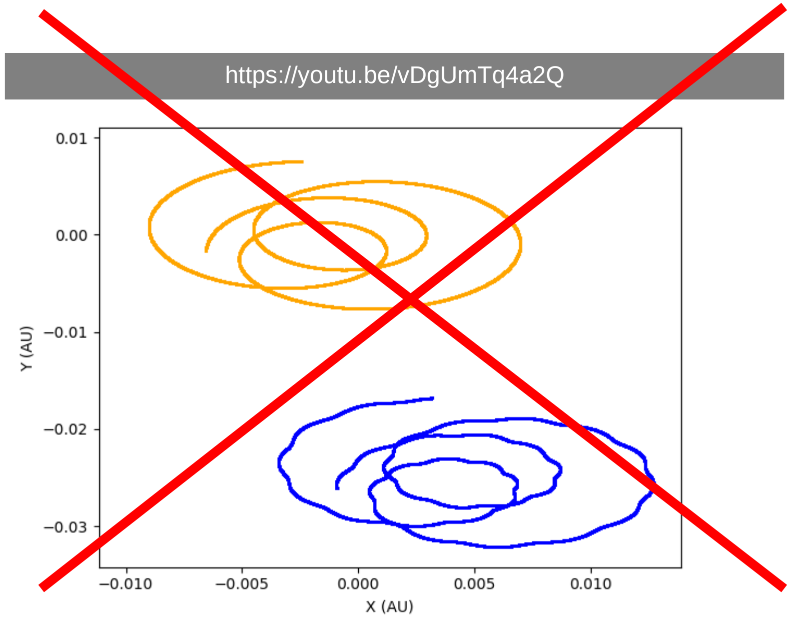
a - Sun - in the ellipse focus

b - Sun shifted by SIM to spring equinox



2600
Aphelion □. 16 July
Perihelion □ 16 January



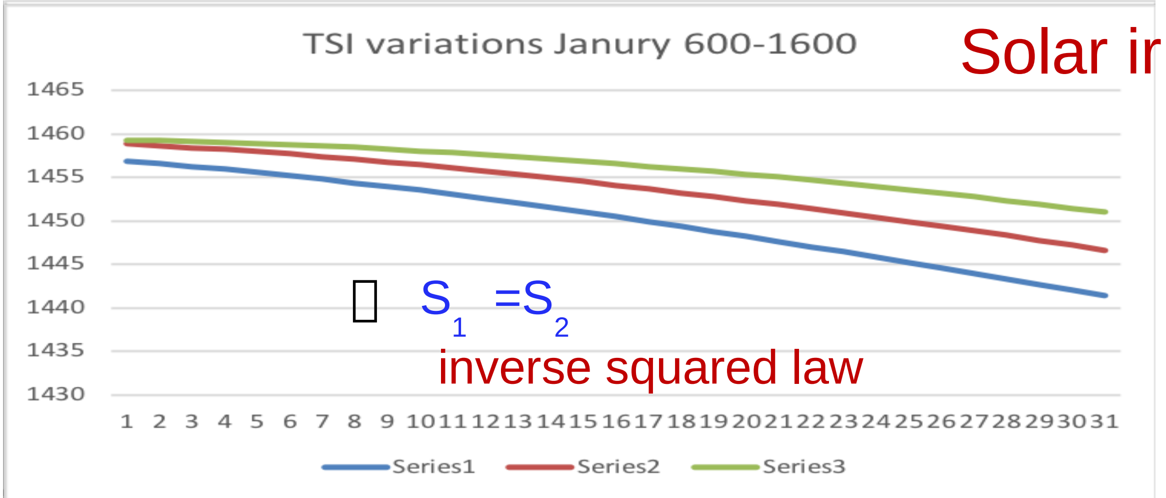


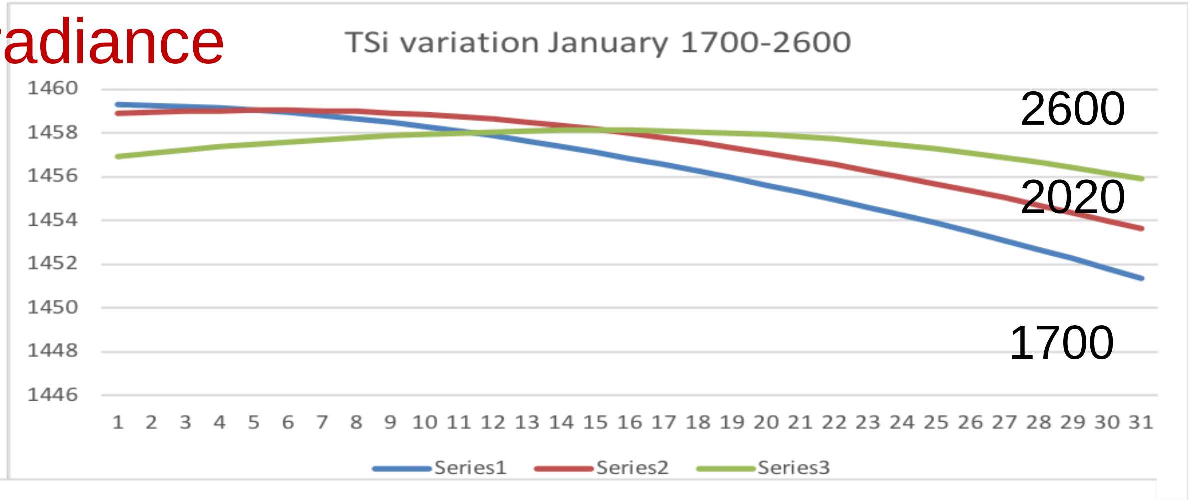
S. Perminov, E.D. Kuznetsov, 2018
SIM imposed by planets Jupiter, Saturn, Neptune and Uranus

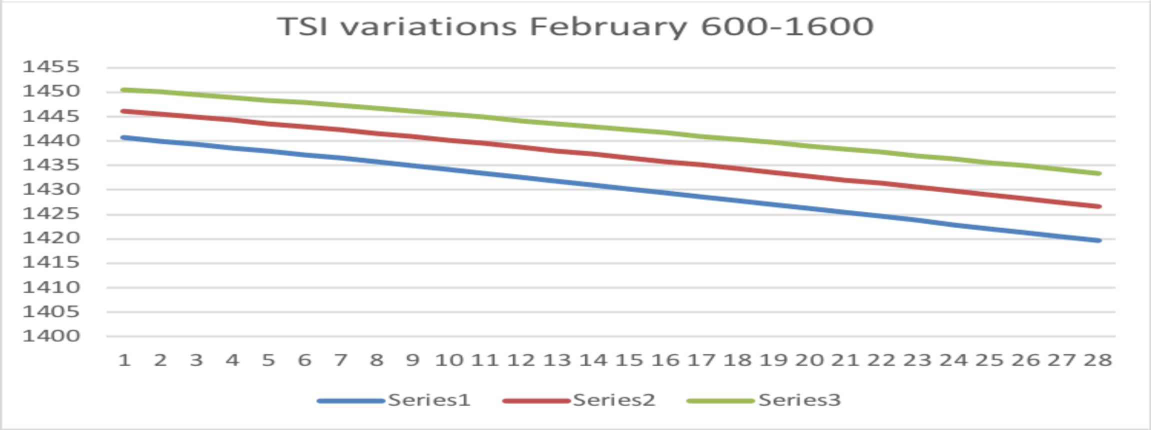
Charvatova, 1988,
Palus et al, 2007

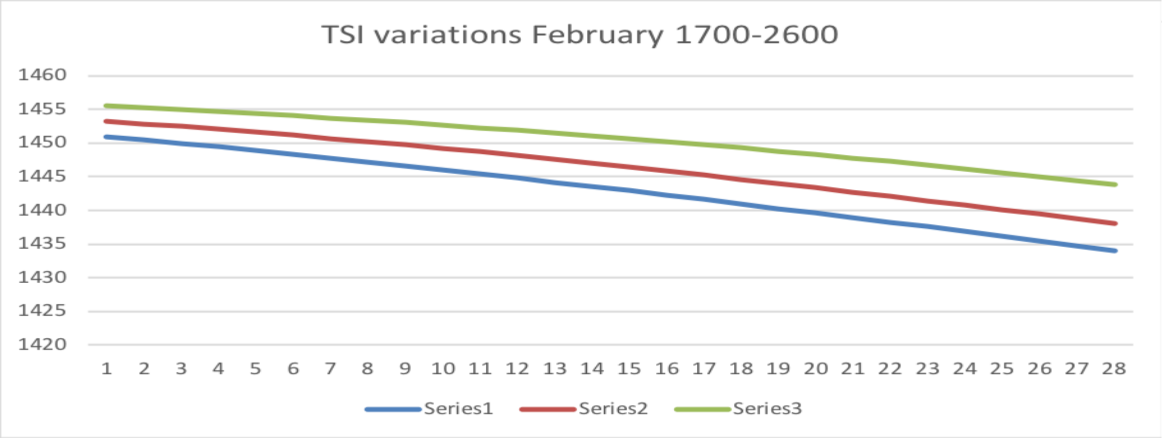
Rice et al, PP comments #72, 96

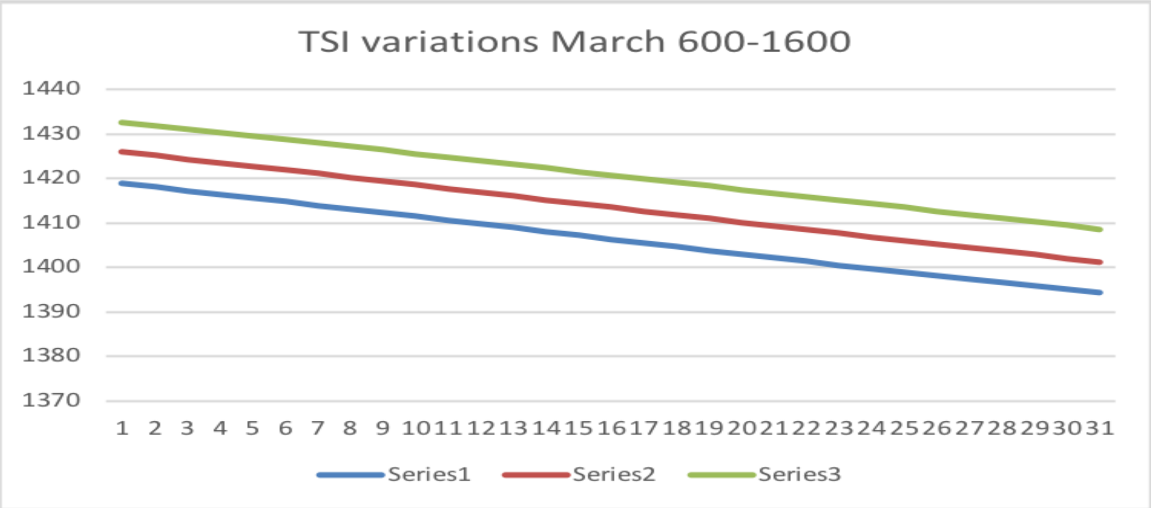
Solar irradiance

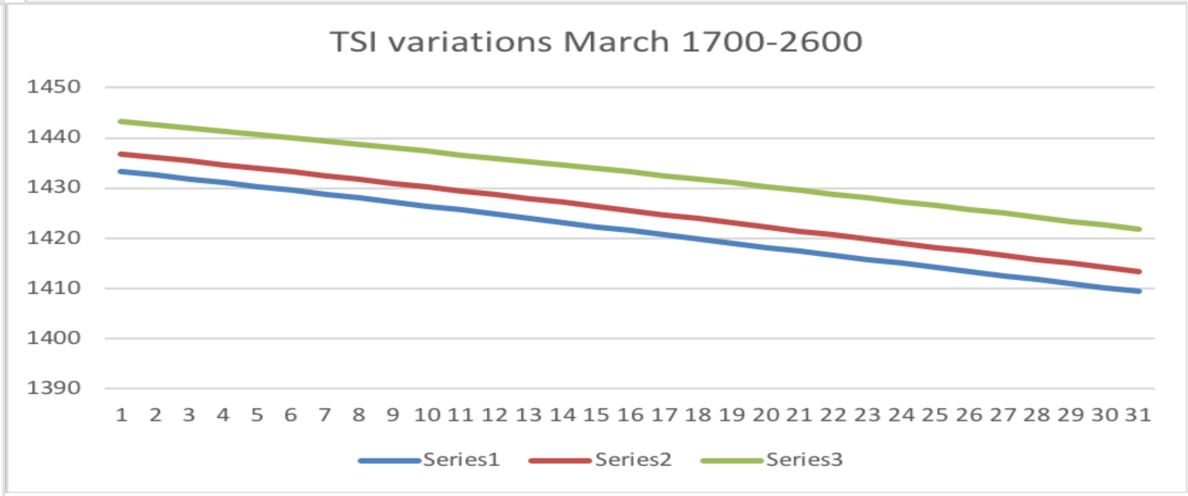


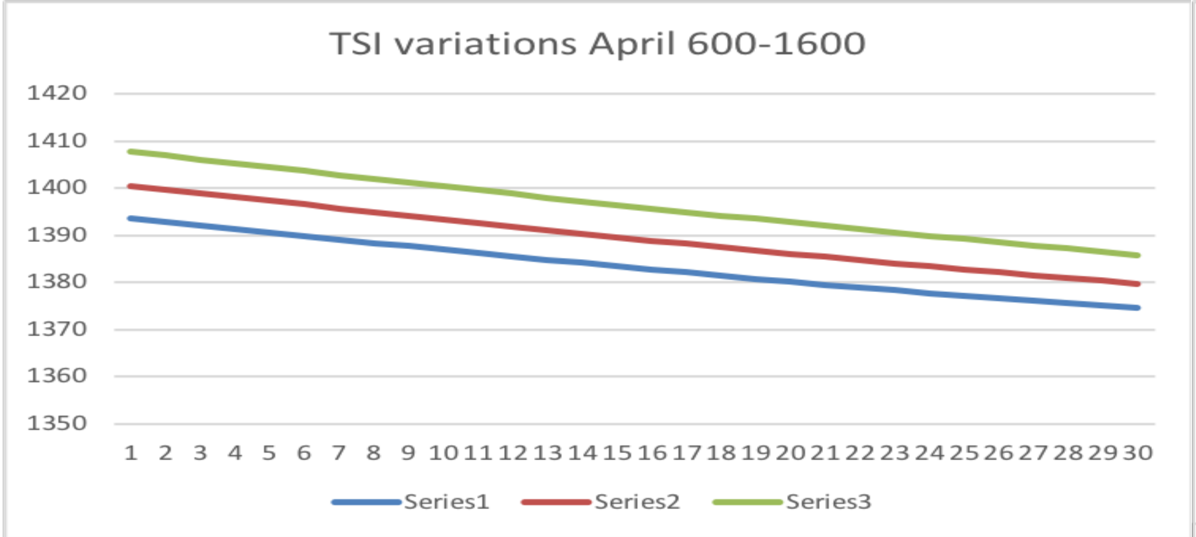











TSI variations April 600-1600
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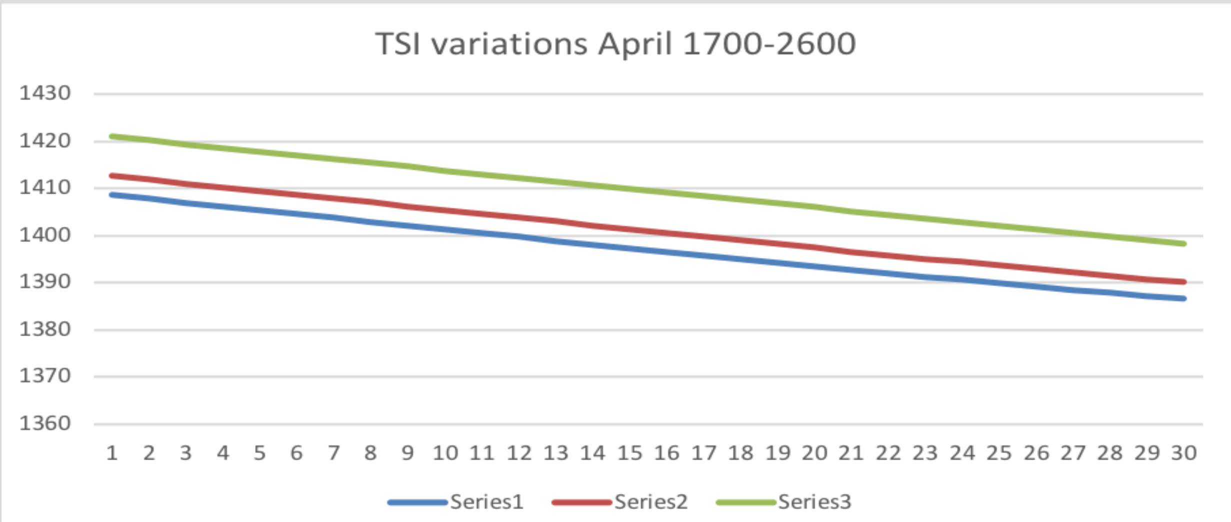
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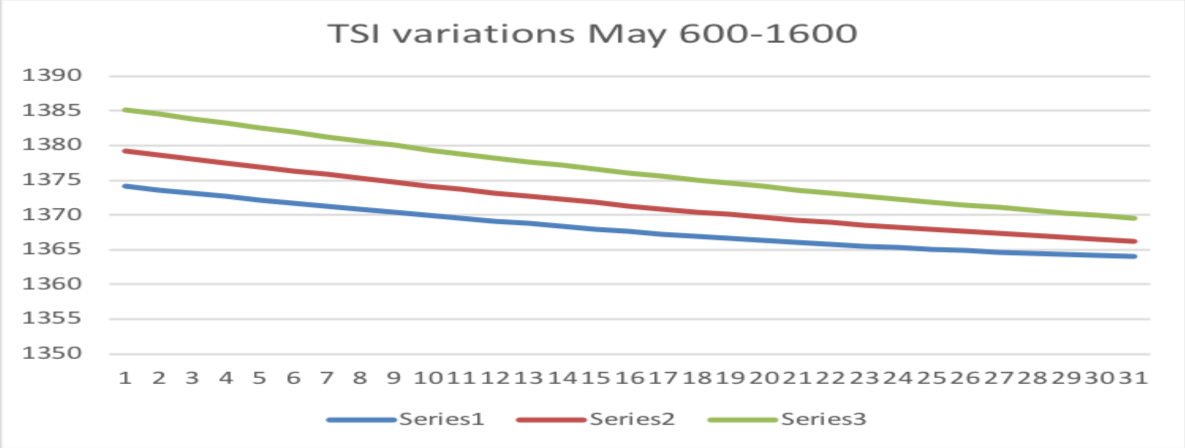
TSI variations May 600-1600
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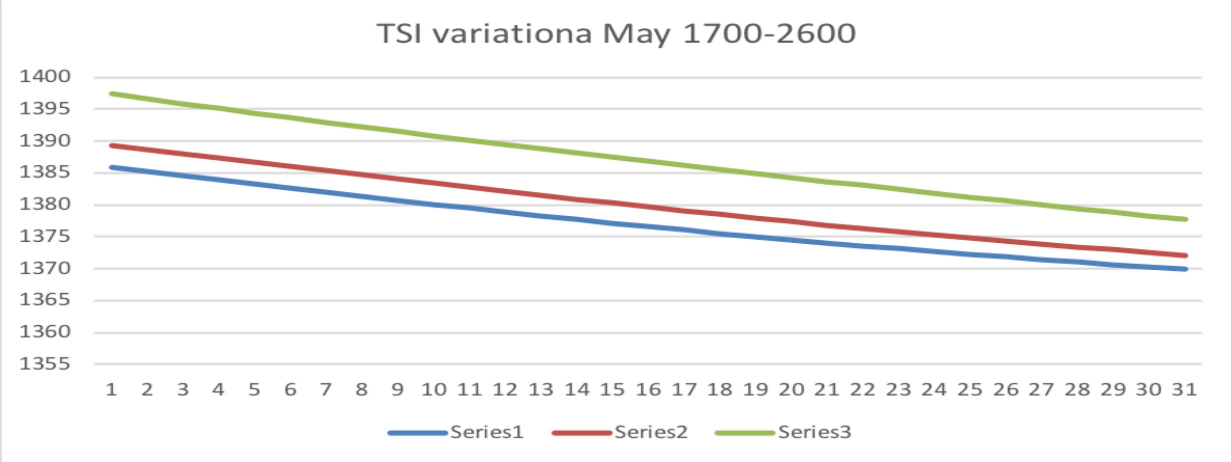
TSI variationa May 1700-2600
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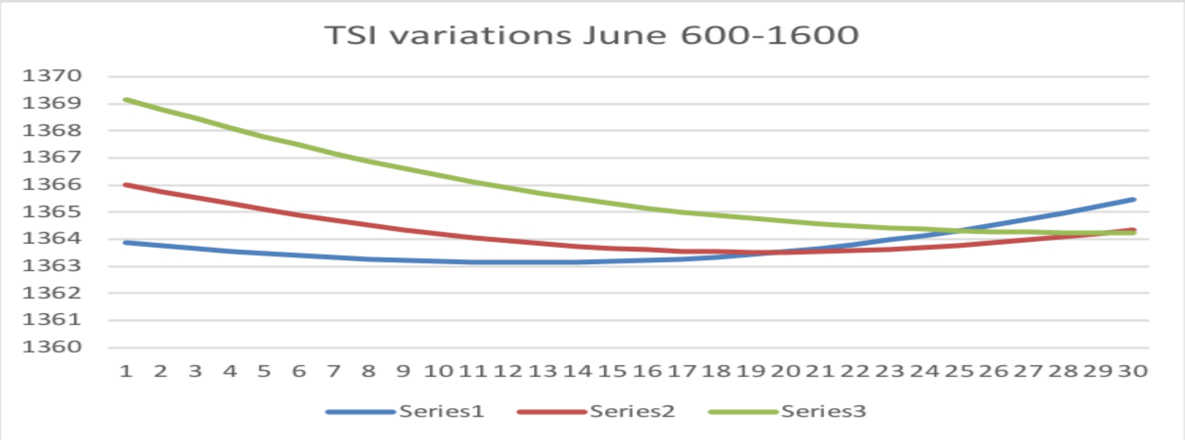
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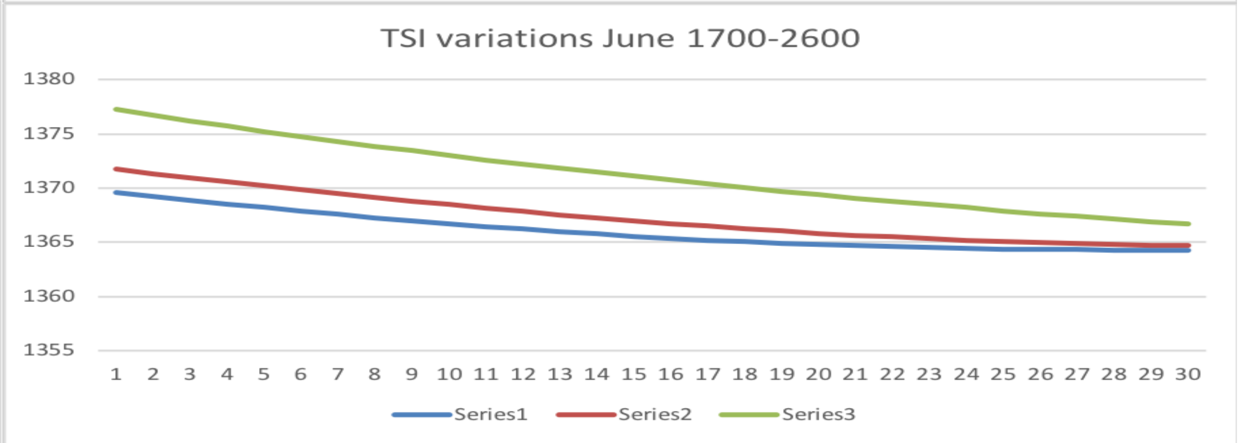
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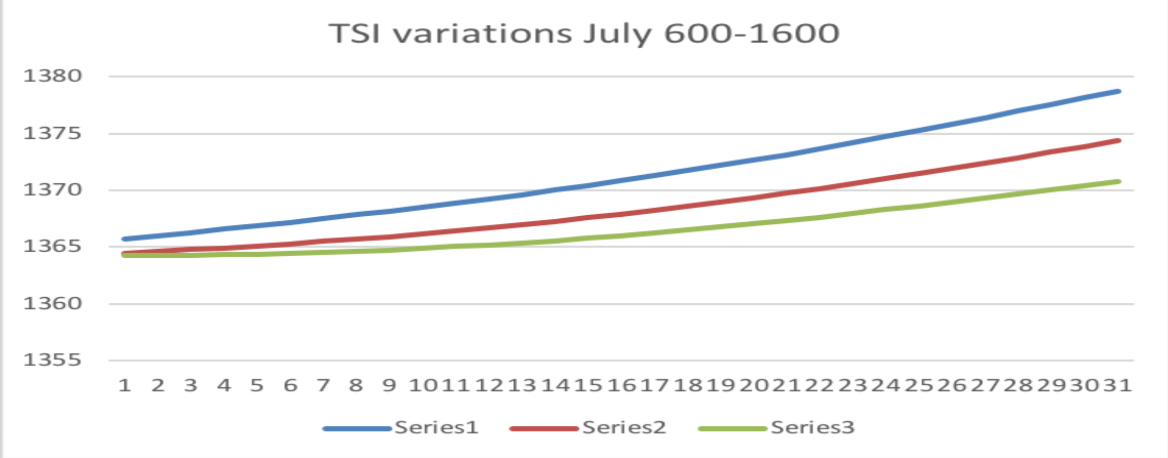
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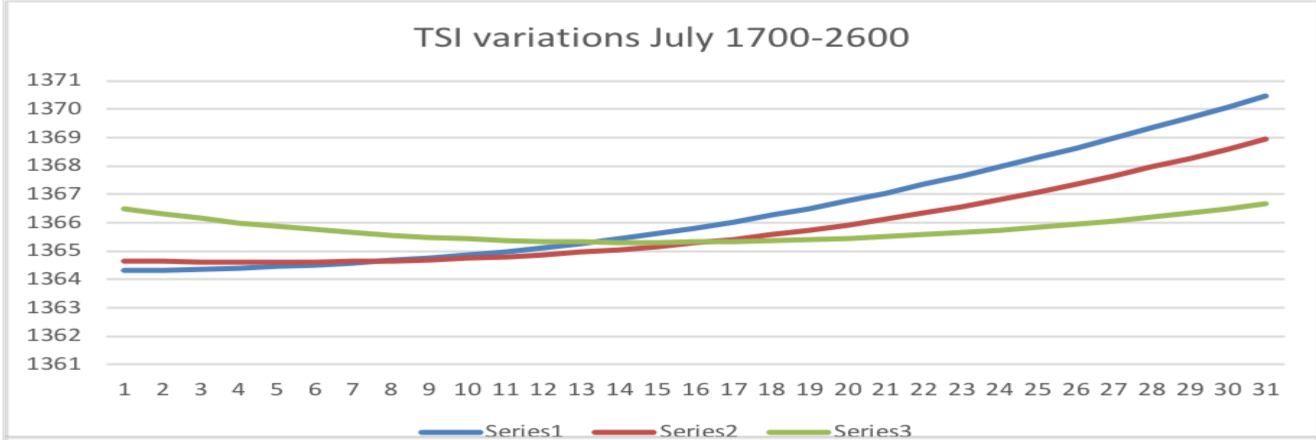
TSI variations July 1700-2600
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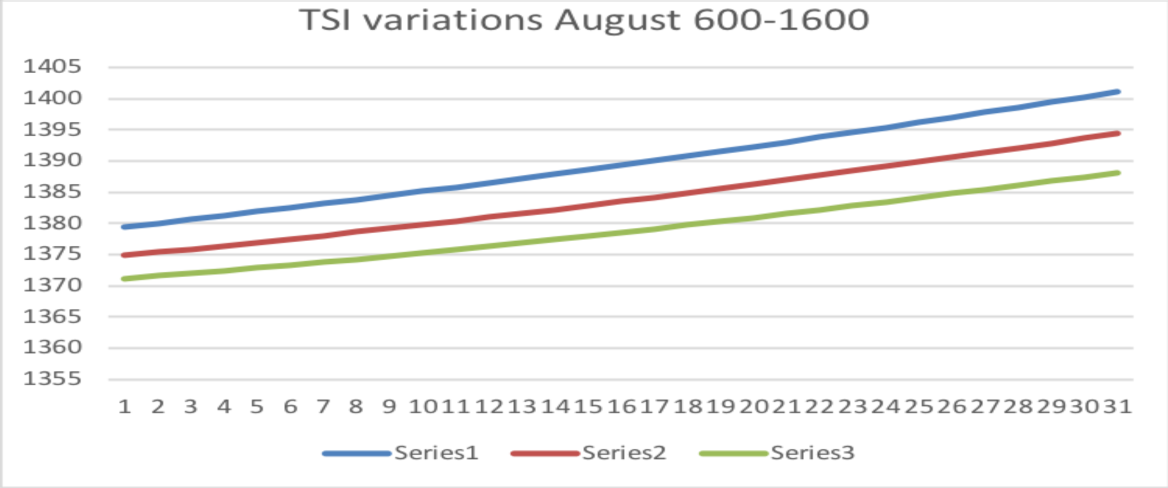
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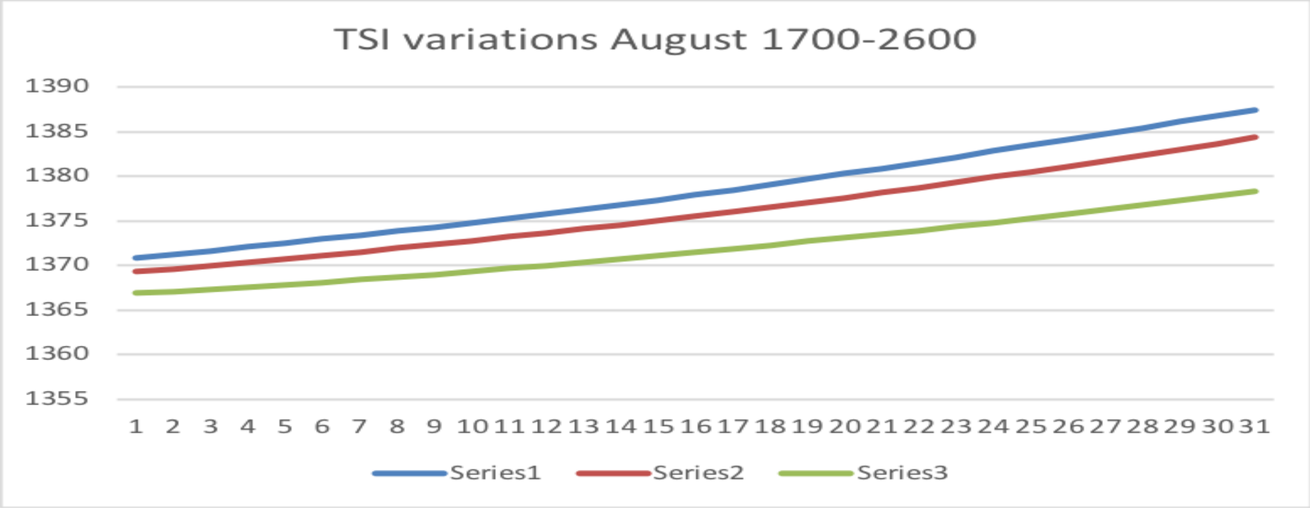
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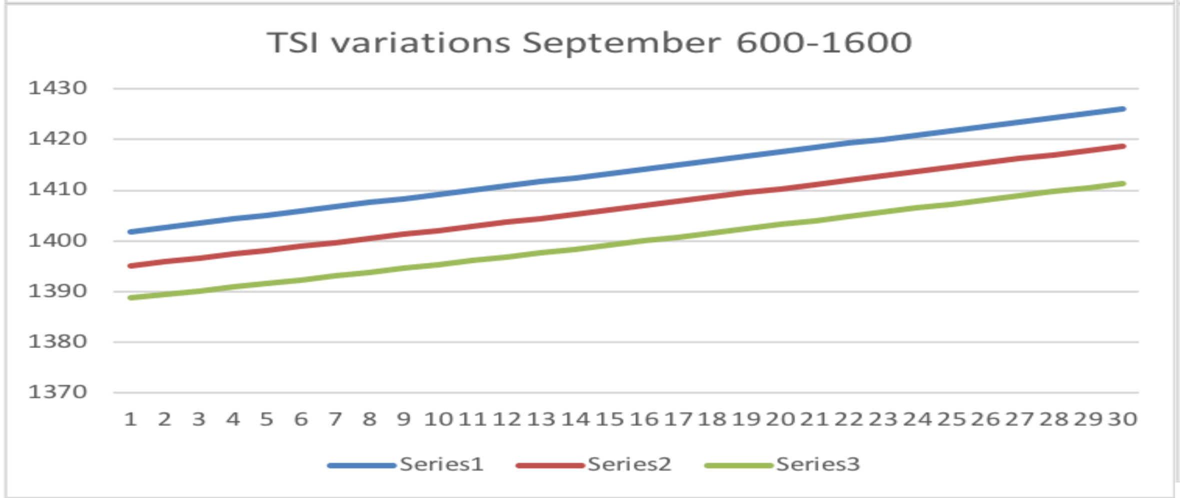
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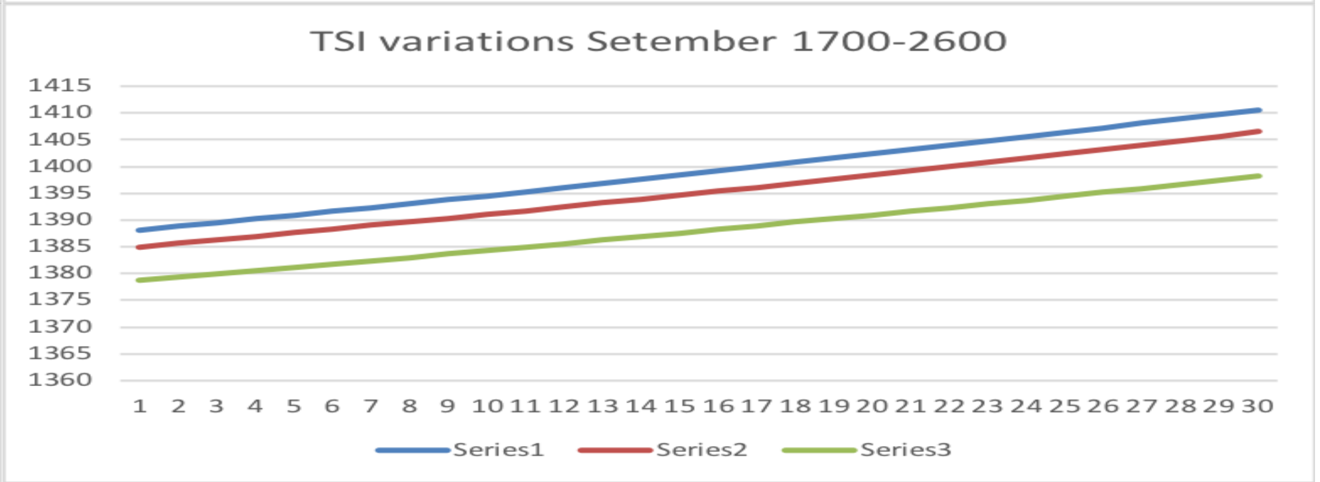
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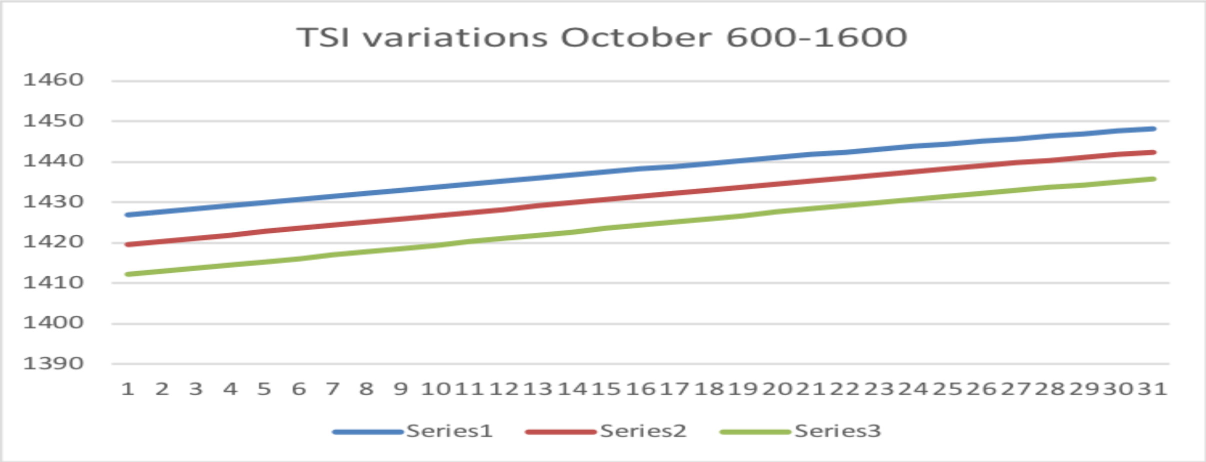
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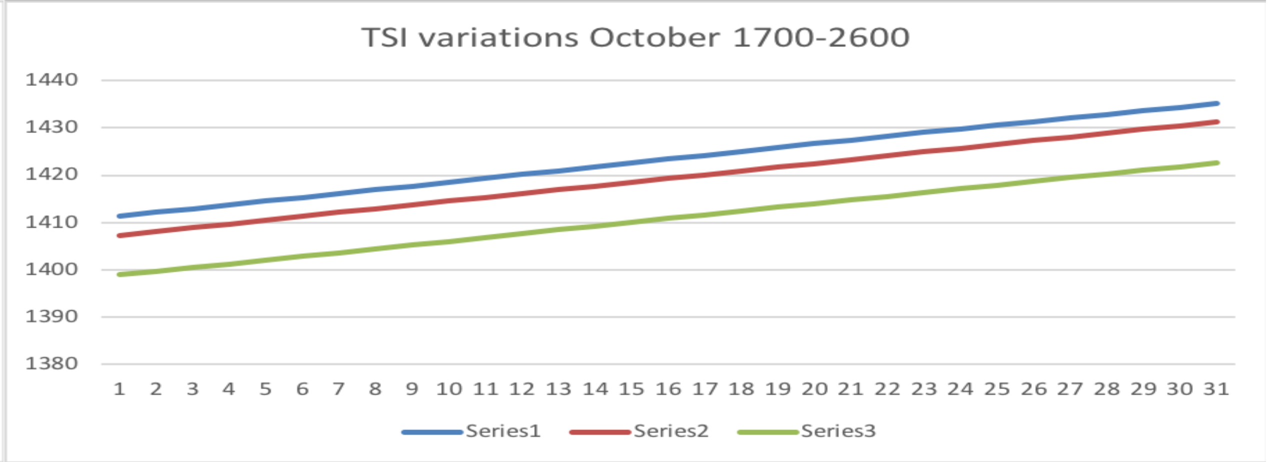
TSI variations October 1700-2600
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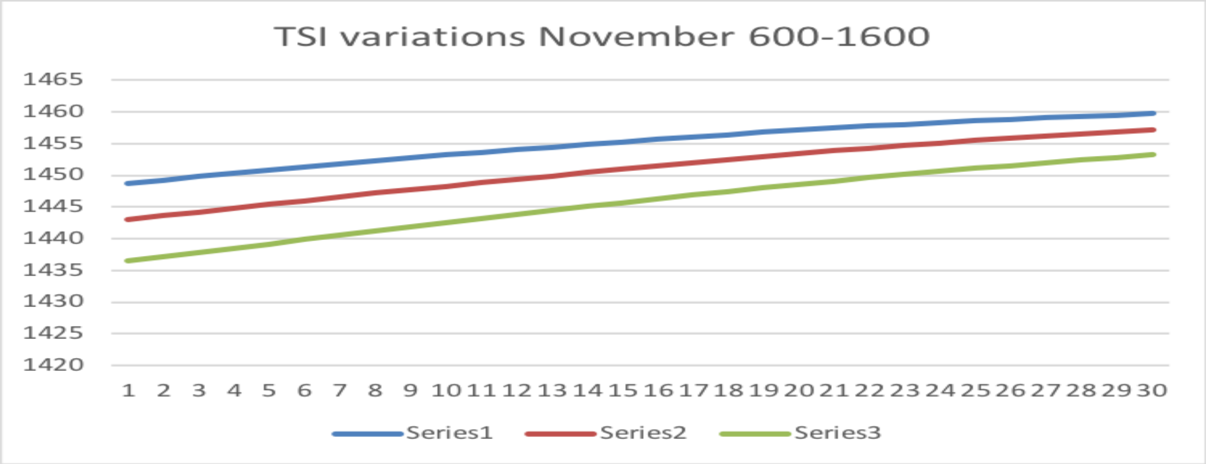
TSI variations November 600-1600
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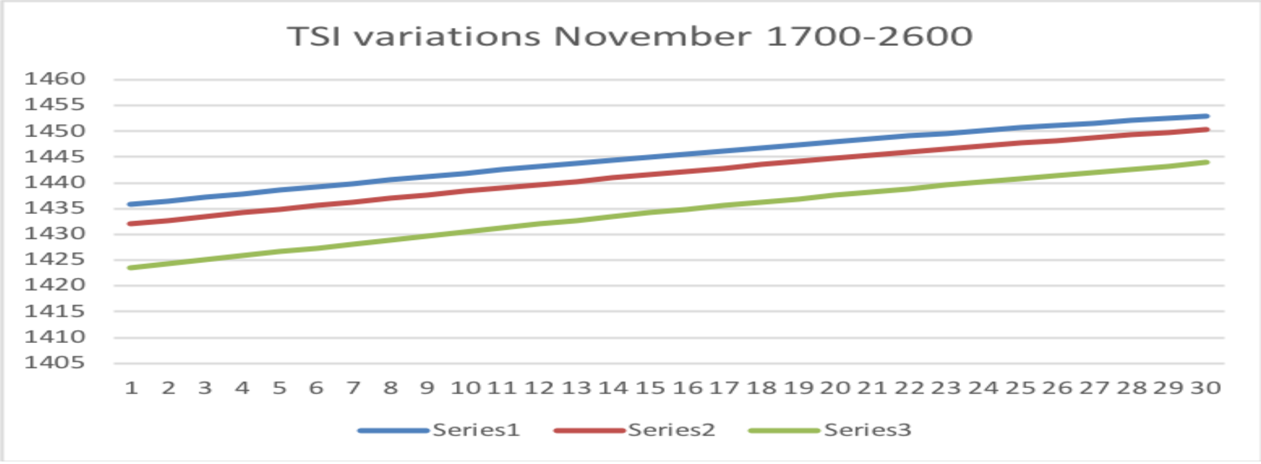
TSI variations November 1700-2600
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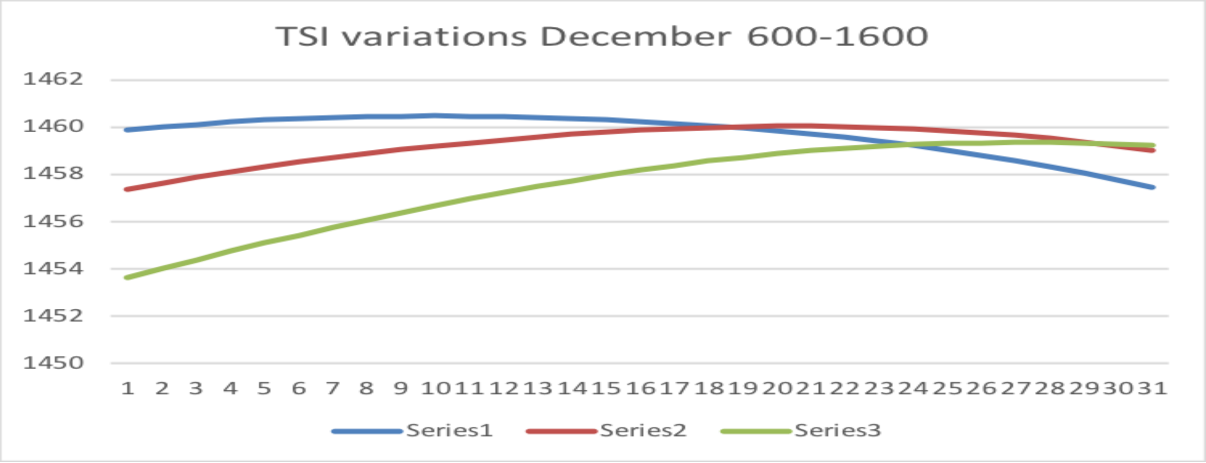
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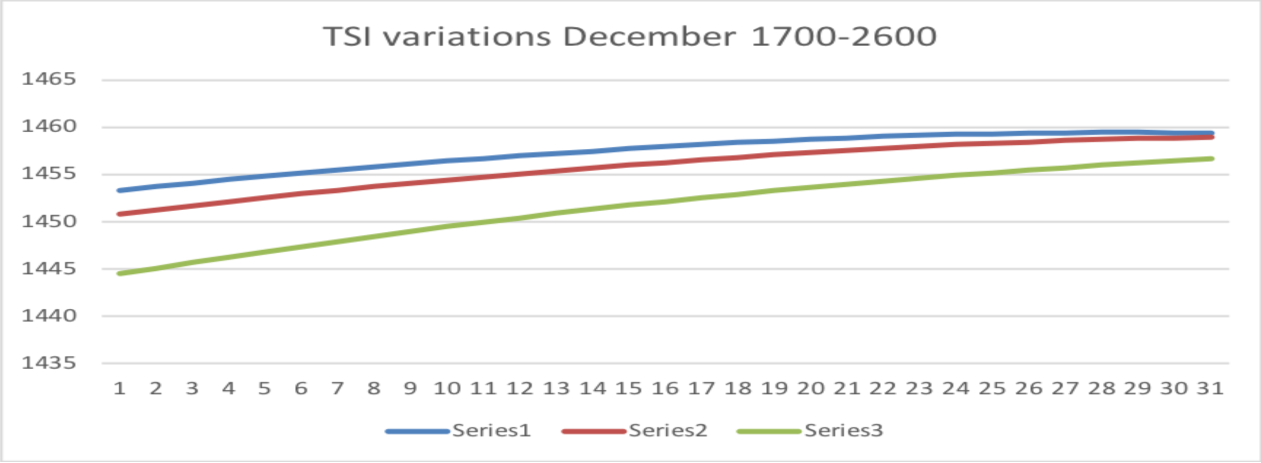
TSI variations December 1700-2600
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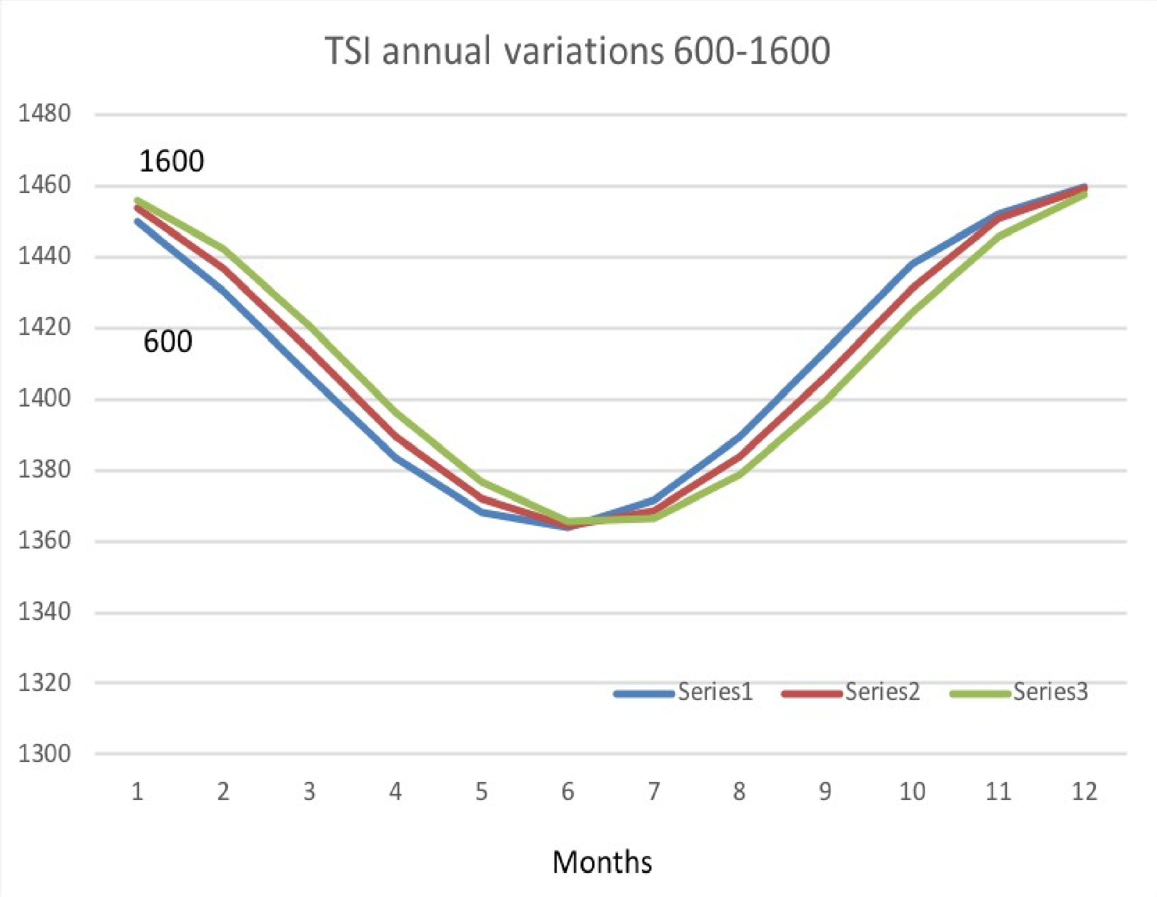
Series1
Series2
Series3

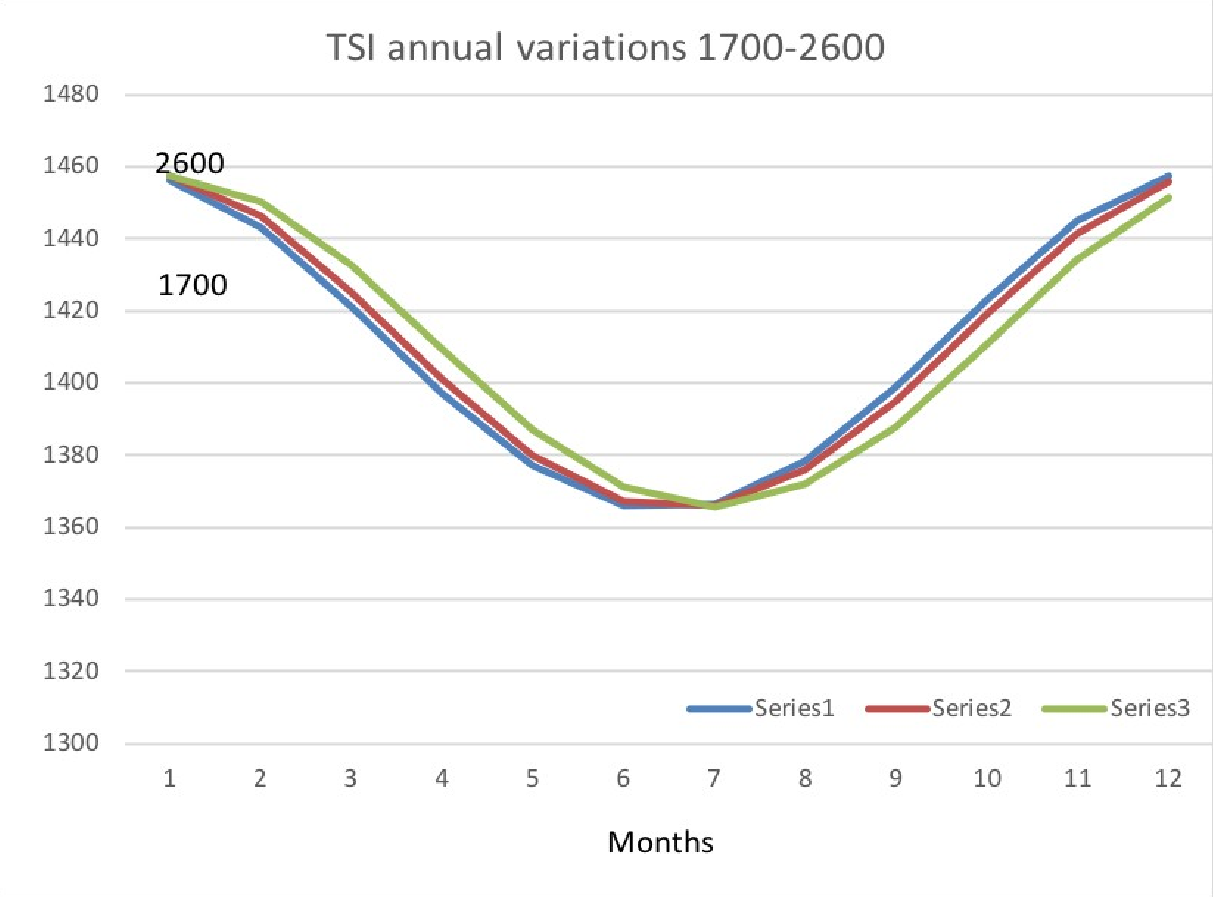
Annual TSI variations

in M1 (600-1600) and M2 (1700-2600)

Zharkova, 2021

https://www.intechopen.com/online-first/millennial-oscillations-of-solar-irradiance-and-magnetic-field-in-600-2600)



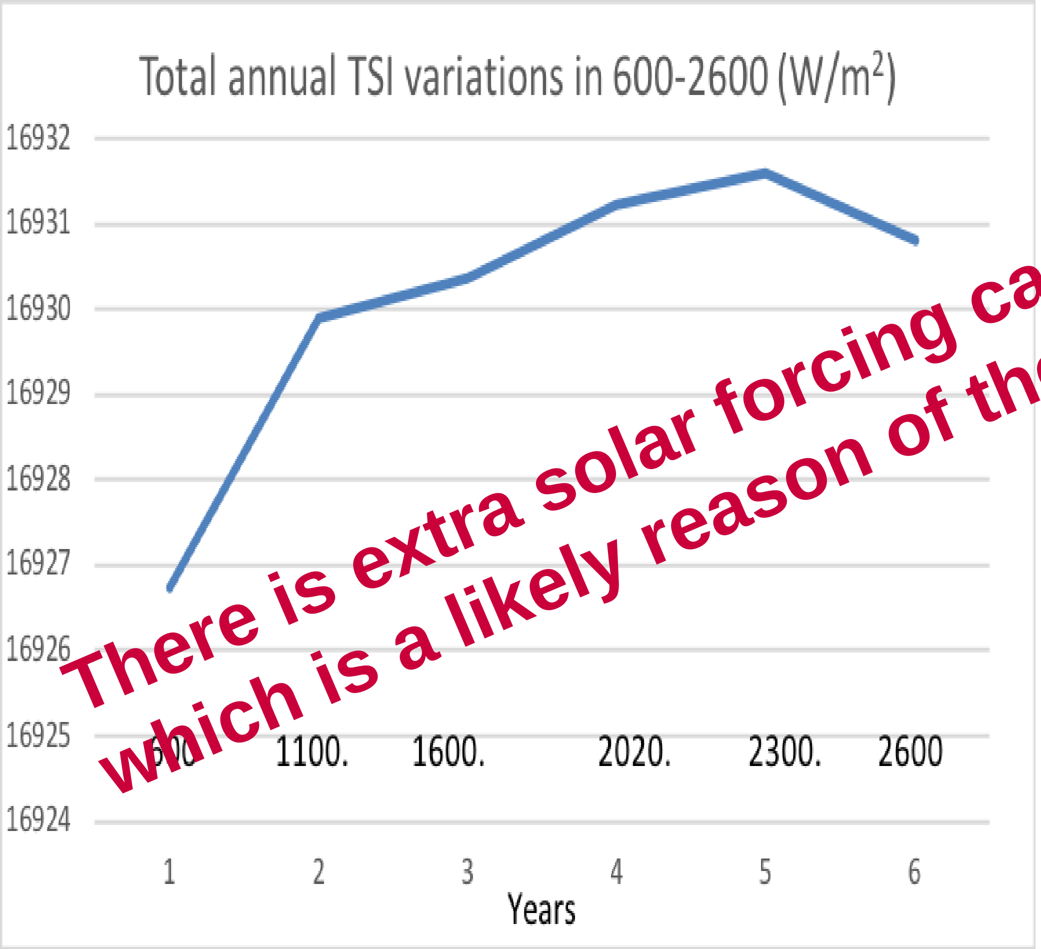


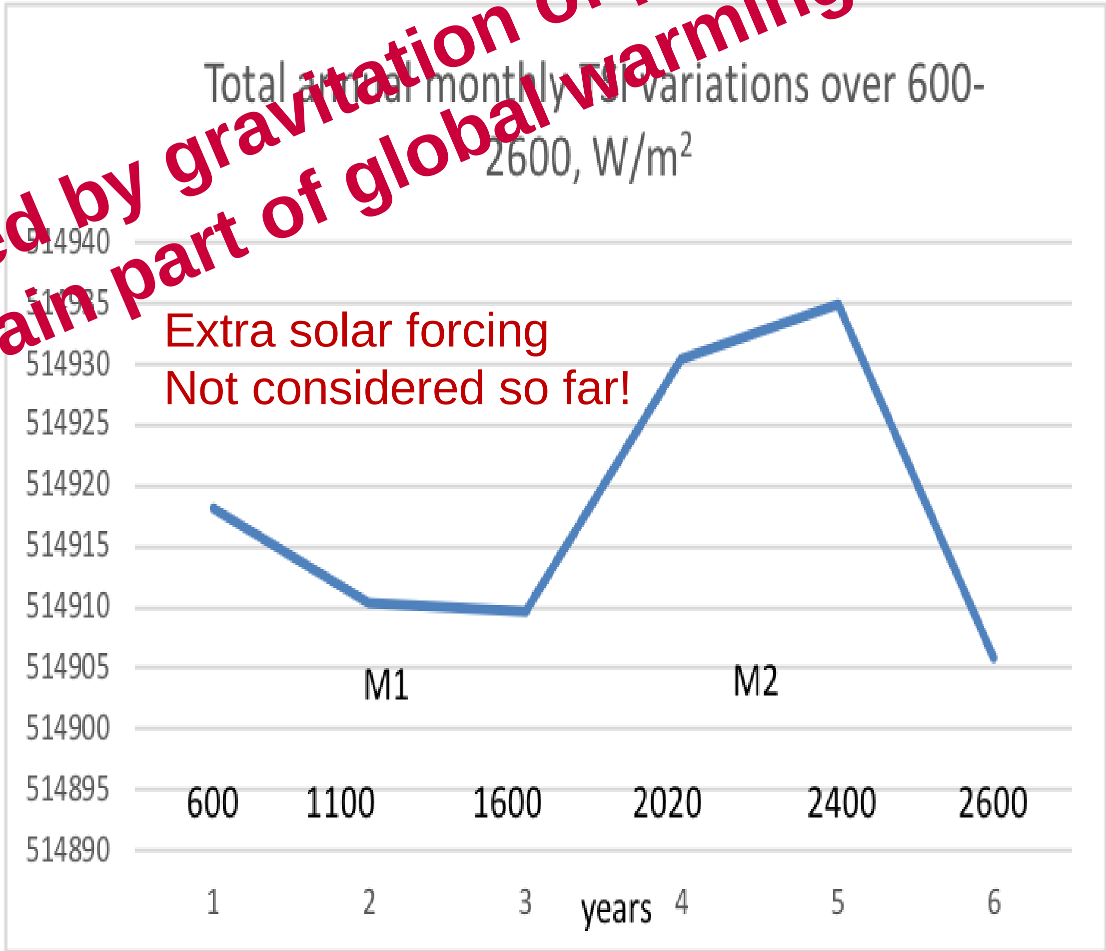
M1: TSI significantly increases in February – June, and decreases in June-December. M2: the aphelion shifts to mid-July TSI decrease in July – January is not fully compensated!

Variations of the total annual TSI
in M1 (600-1600) and M2 (1600-2600)
averaged for each month (left) and daily (right)

https://arxiv.org/pdf/2008.00439.pdf
Zharkova et al, 2019, Zharkova, 2020

There is extra solar forcing caused by gravitation of planets,
which is a likely reason of the main part of global warming





Global Warming Over Last Century (Hardy, 2017)

- **Total Temperature Balance if extra 5 W/m^2 radiation is added:**
  - **Solar warming over last century**:

    for solar anomaly *°TSI = 2.6‰* $°T_{Sun}$ = *°TSI x* S_S = ***0.44°C*** → ***60%***

  - **CO_2 warming over last century**:

    100 ppm CO_2 at *ECS = 0.70°C* $°T_{CO2}$ = ***0.30°C*** → ***40%***

➢ **Full agreement with observed temperature increase: *0.74°C***

➢ **Full agreement with observed cloud cover changes**

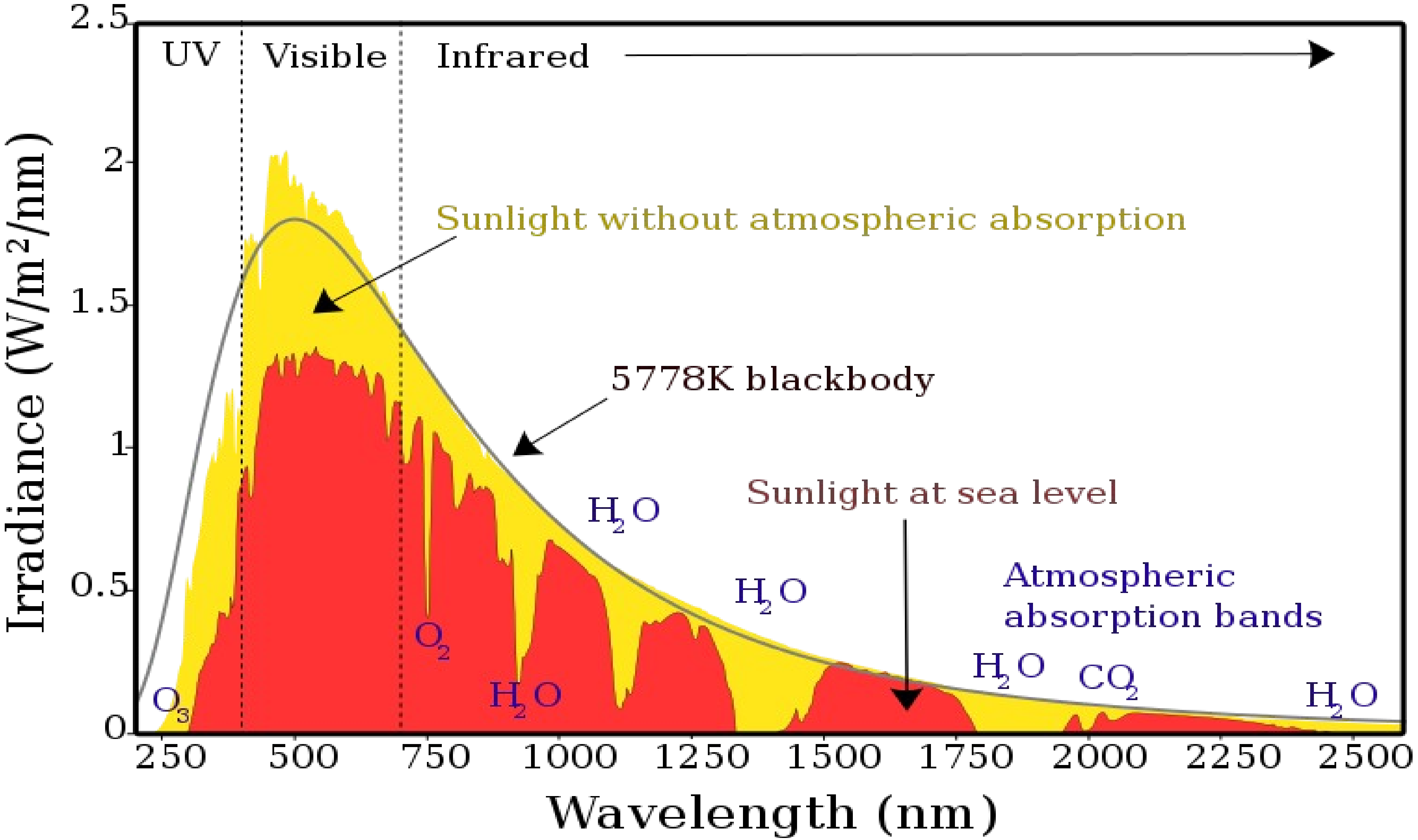
We have extra 20-25 W/m^2 radiation every year!
Hence, the hating comes from this radiation!

How IPCC models can account for extra-heating from CO_2

Radiative Transfer:

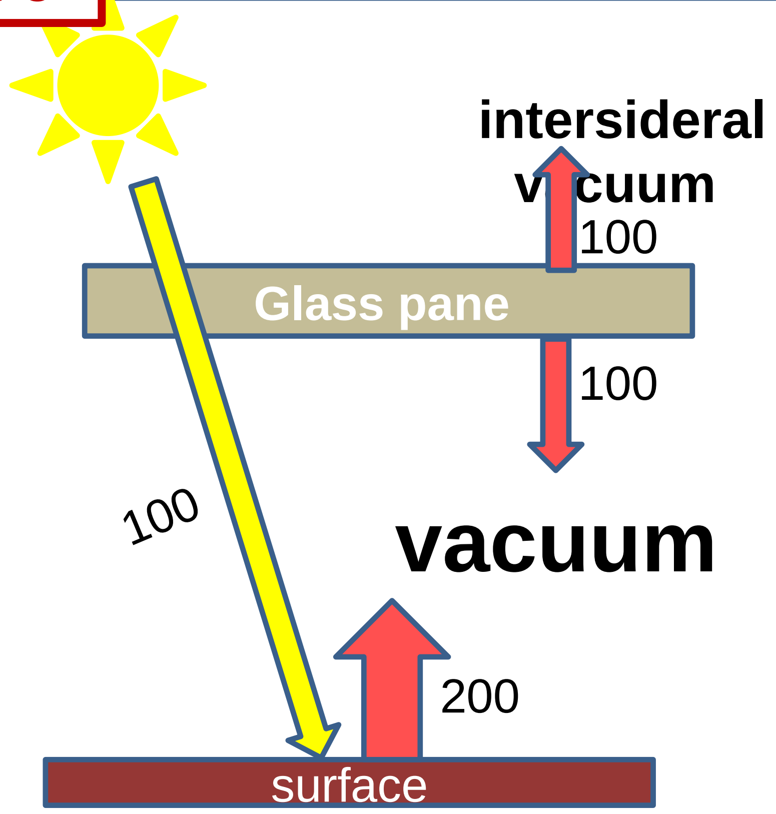
What IPCC missed
when interpreting the emission of CO_2?

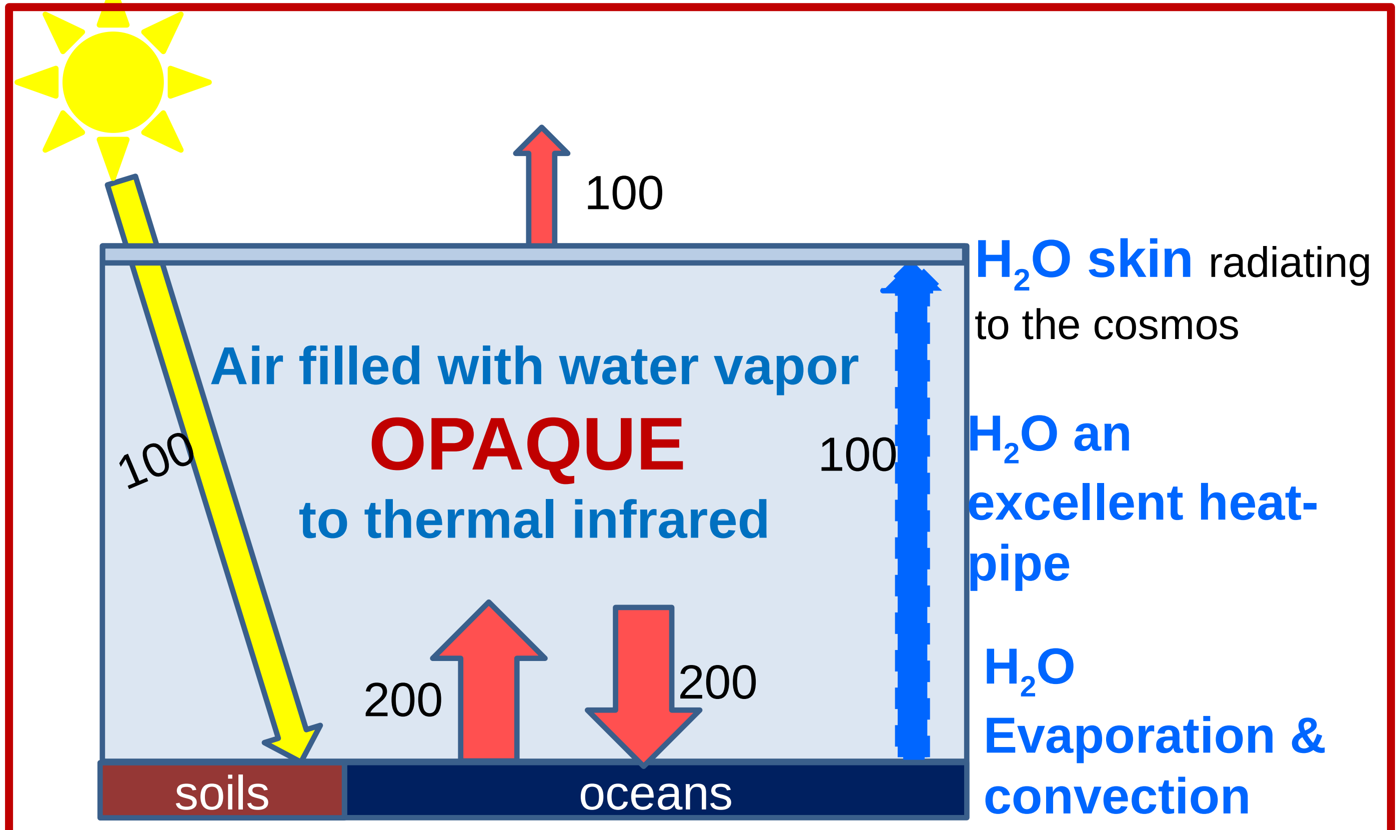
Spectrum of Solar Radiation (Earth)



Fact 9

Imaginary Greenhouse effect and real Earth: conceptual frameworks





A glass pane in vacuum, the wall of a thermos bottle, a good insulator, is <u>by no way</u> a model for a turbulent and water-vapor laden air, which is an <u>excellent heat-pipe,</u> carrying latent and sensible heat!

No heat transfer by thermal infrared from the surface as 200 - 200 = 0

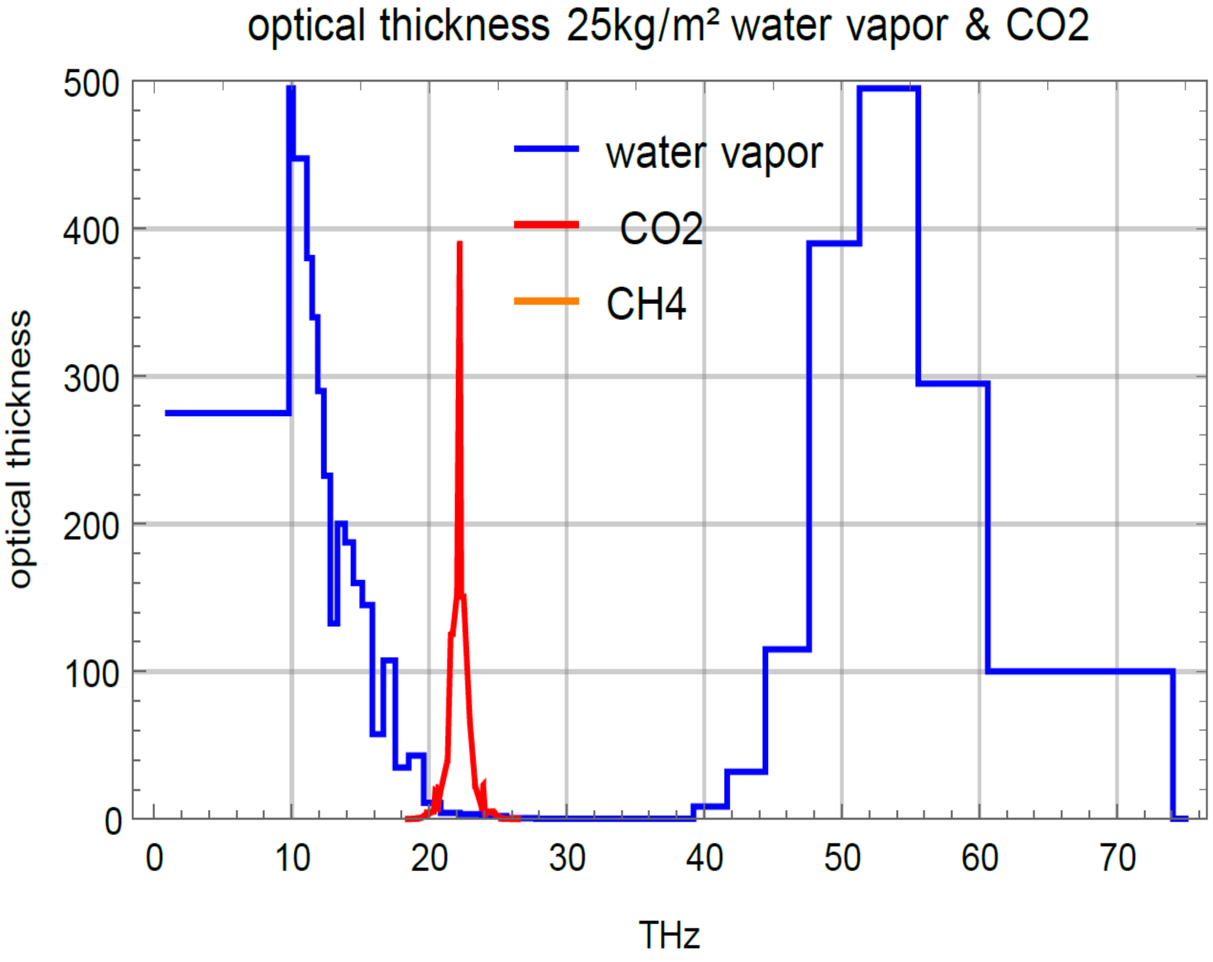
No radiative carriage of heat through the air made opaque by the water vapor

(T surface) / (T radiating pellicle) = ((P surface)/ (P pellicle))^{0,19}

Note : the flows 100 or 200 are not W/m² but simple numbers to help the understanding of what happens

The <u>optical thickness τ</u> of the atmosphere is <u>the</u> parameter to use to compute the diffuse radiation in an absorbing and radiating medium like the atmosphere

(Chandrasekhar 1948, K. Ya. Kondratiev 1969)



- $f_{down}(\nu, z) =$

$$\pi \int_0^{\tau(\nu,z)} B(\nu, T(t'))\, 2\, E_2(\tau(\nu, z) - t')\, dt'$$

$f_{up}(\nu, z) =$

$$= \pi \int_{\tau(\nu,z)}^{\tau max} B(\nu, T(t'))\, 2\, E_2(t' - \tau(\nu, z))\, dt'$$

- $f_{surface}(\nu, z) = \pi B(\nu, T_{surface})\, 2\, E_3(t_{max} - \tau(\nu, z))$
- B Planck's function, E_2 and E_3 exponential integral functions

80% of the thermal radiation from a body is produced in its skin or "pellicle" of optical thickness τ = 1,07

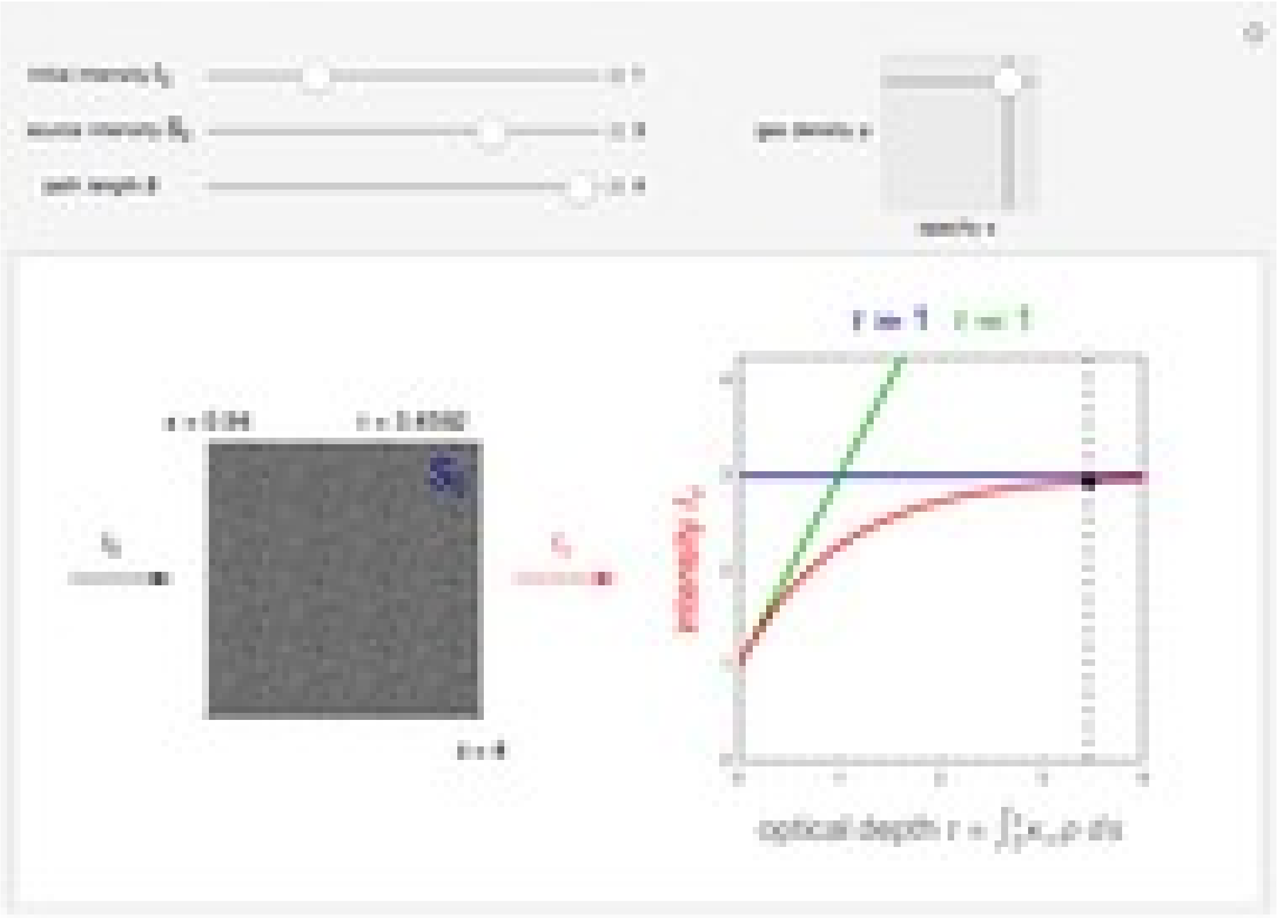
Interpretation of the equation of radiative transfer

- **The formal solution of the radiative transfer equation yields the observed intensity of the radiation:**

$$I_\nu = I_\nu(0)\, e^{-\tau_\nu} + \int_0^{\tau_\nu} S_\nu e^{-\tau_\nu}\, d\tau_\nu$$

- **The frequency […]n and absorption co[…]tion of emission and/or absorption features.**

Radiative transfer in action



https://demonstrations.wolfram.com/ComputationOfRadiativeTransfer/

- intensity of emission from the gray area on the left.
- for tau<1 emission (green curve) the emitted intensity is proportional to the density of excited molecules (CO2)
- for tau>1 it becomes saturated (red curve).
- IPCC assumes that all CO2 emitting as green curve while its tau>>1, so it is emitting as the red curve (saturated).

Optical depth

The overall optical depth of a batch of gas is an important number. If tells us right away if the cloud falls into one of two useful regimes:

<u>optically thin: << 1</u>

- **Chances are small that a photon will interact with particle**
- **Can effectively see right through the cloud**
- **In the optically thin regime, the amount of extinction (absorption plus scattering) is linearly related to the amount of material: double the amount of gas, double the extinction**

  ** if we can measure the amount of light absorbed (or emitted) by the gas, we can calculate exactly how much gas there is**

Optical depth

I = I(0) exp(- τ) → I/I(0)=
Exp(-10)=5e-5
Exp(-1)=0.37
Exp(-0.1)=0.9
Exp(-0.0001)=0.99

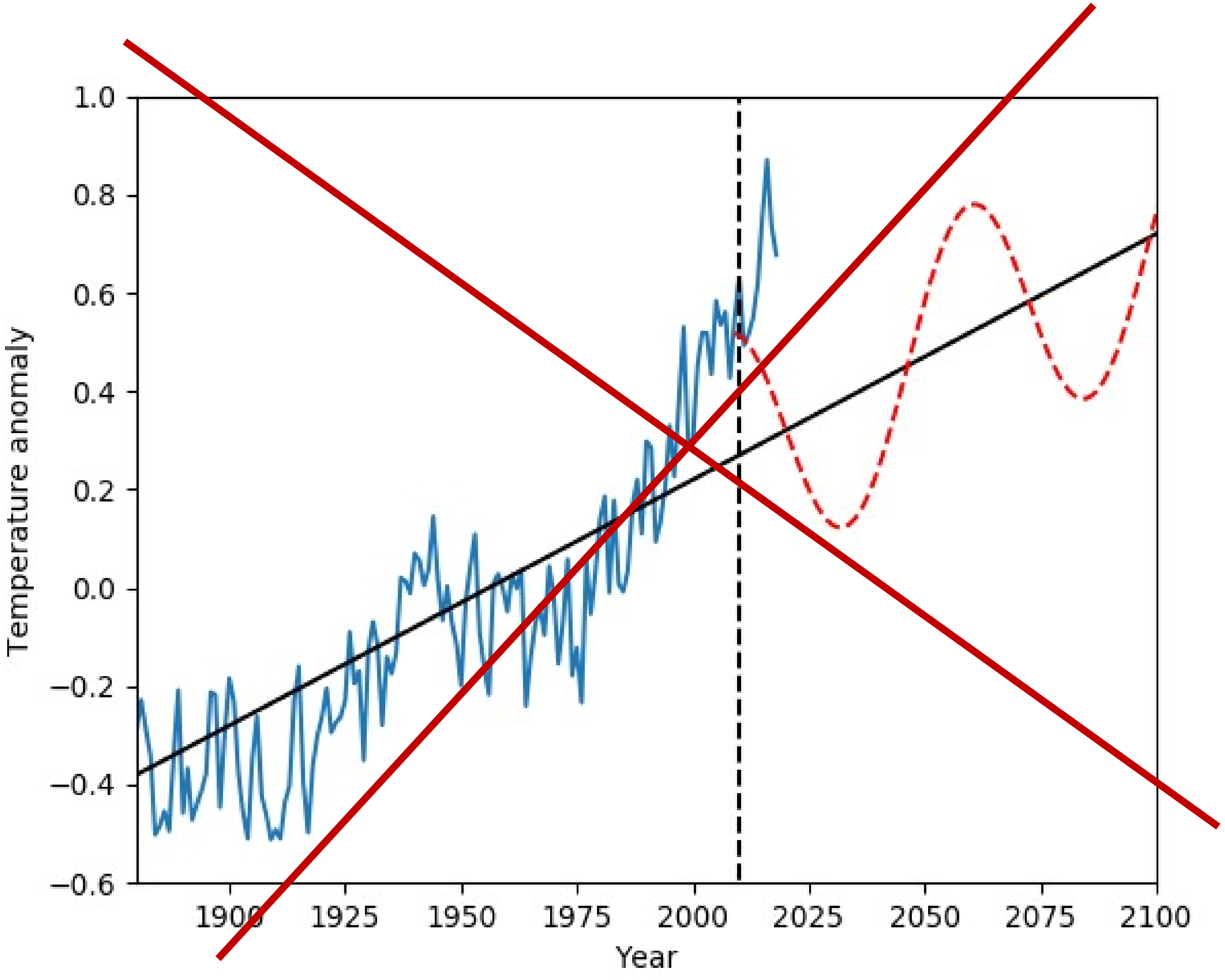
Optically thick: τ >> 1

- Certain that a photon will interact many times with particles before it finally escapes from the cloud
- Any photon entering the cloud will have its direction changed many times by collisions -- which means that its "output" direction has nothing to do with its "input" direction. → *Cloud is opaque*
- You can't see through an optically thick medium; you can only see light emitted by the very outermost layers. → *i.e., can't 'see' interior of a star – only see the 'surface' or the photosphere*
- One convenient feature of optically thick materials: the spectrum of the light they emit is a blackbody spectrum, or very close to it → *layers deep within a star (can assume LTE)*

Increase of SI with a decrease of S-E distance would lead to the increase of T by 1.2C by 2010, and by further 2.5-3.0 C in 2500.

SIM solar forcing and green house (GH) effects

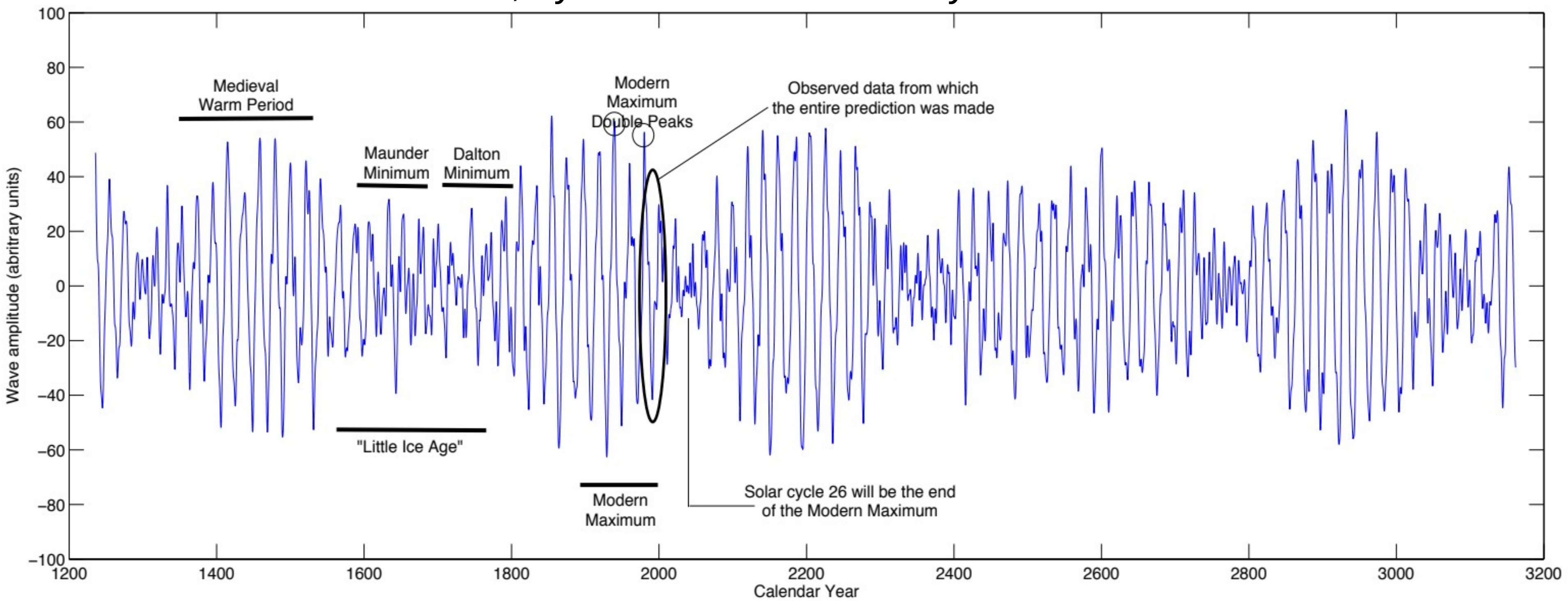
- The terrestrial temperature increase induced by change of the S-E distance can only account for the **baseline temperature variations (straight line)** here and in Akasofu's curve (2010).
- K.Rice Pubpeer comment #38 (shown in the figure on the right) that whole T is defined by **the blue curve. The T increase above the baseline is** interpreted by the **current terrestrial models Including GH gases**
- **Harde et al., 2017 (IJAS, id 9251034)** modelled radiative transfer of CO_2 with extra solar forcing of the similar magnitudes found from SIM T increase: 60% solar and 40% by CO_2



K.Rice Pubpeer comment #38

Predicted solar activity (Zharkova et al, 2015, SR https://www.nature.com/articles/srep15689)

Observational result, dynamo model was not yet considered

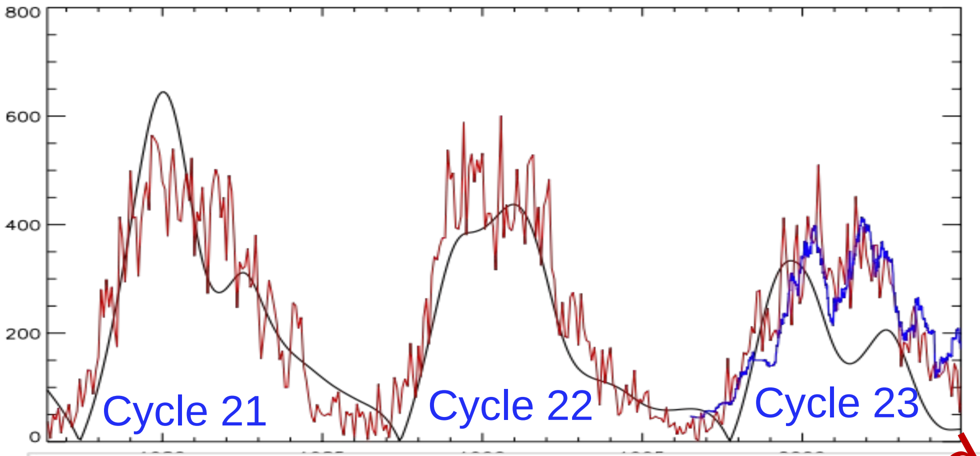


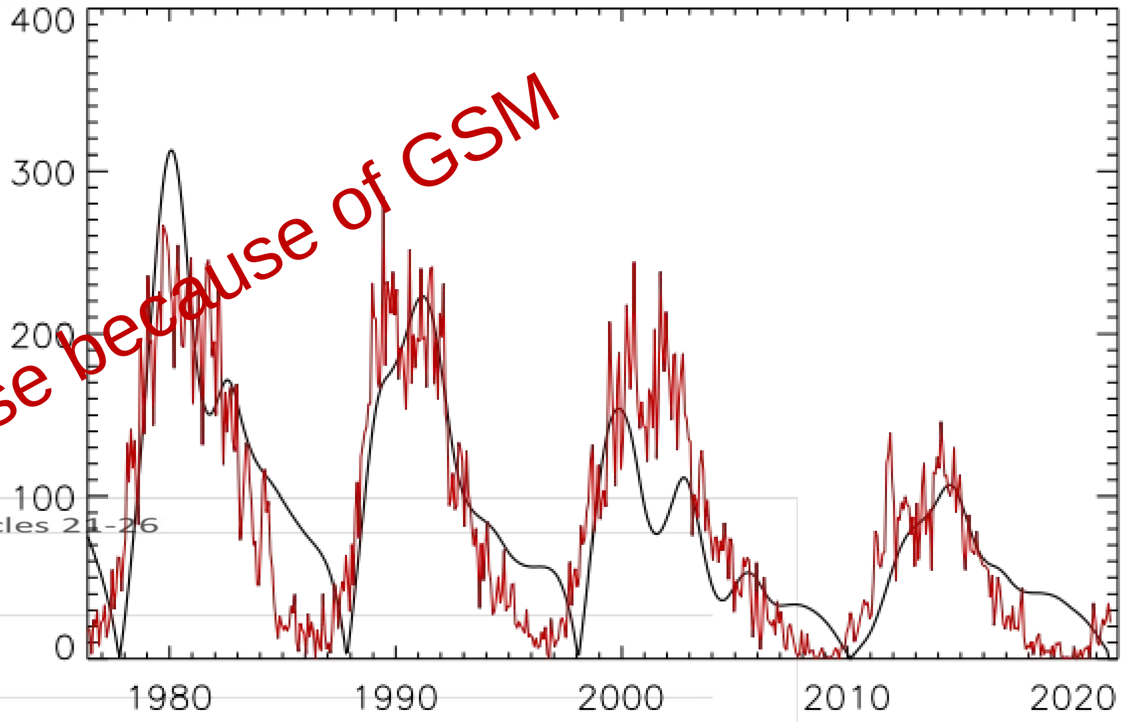
The Sun entered the grand solar minimum in 2020 until 2053

https://solargsm.com/solar-activity/ - my webpage

Modulus summary curve

Zharkova et al, 2015, SciRep; 2020, Temp., Zharkova et al, 2022, MNRAS



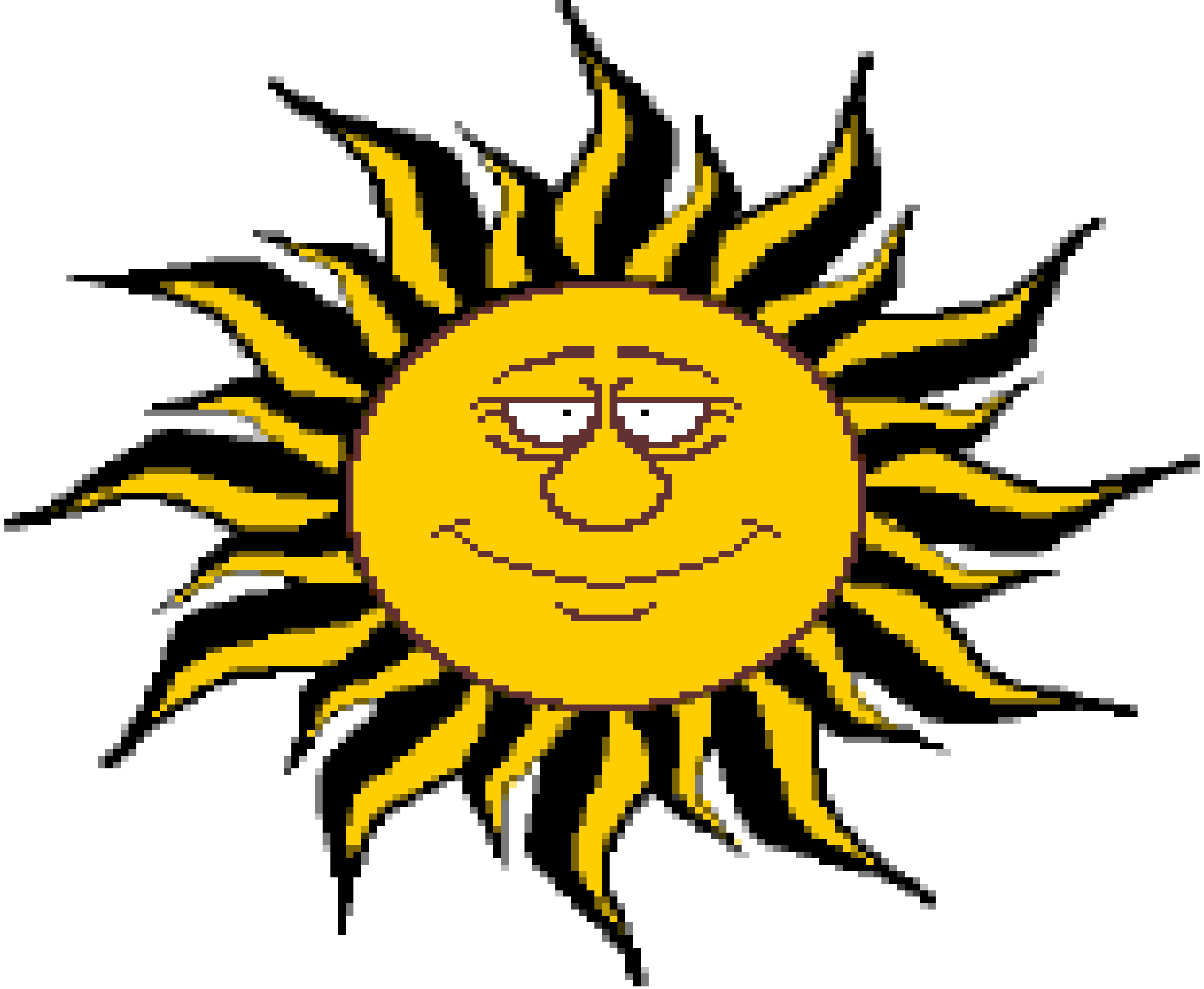


Terrestrial temperature will decrease because of GSM

Confirmed by
Katiashvili, 2020, ApJ;
Obridko et al, 2021, MNRAS
Velasco-Herrera et al, 2021

Conclusions

- **PCs of solar magnetic field are paired – double dynamo waves**
- **Prediction of the solar activity on a millennium scale shows grand cycle variations with period of 350-400 years**
- **Global cooling: the modern GSM to occur in 2020 – 2053 Different narratives for governments!**
- **What about global warming? It occurs independently to any solar activity!**
- **Analysis of summary curve for 100,000 years detects weak variations of the magnetic field baseline with a period of ~2100-2200 years – Hallstatt's cycle**
- **These MF variations are closely linked to the solar inertial motion about a barycentre of the solar system**
- Owing to SIM SI would increase from 1600 to 2500 by further 20-25 W/m^2 per year (10-12 W/m^2 per hemisphere)
- Increase of SI with a decrease of S-E distance would lead to the increase of T by 1.2C by 2010, and by further 2.5-3.0 C in 2500.
- Is there AGW effect? If Sun SIM covers this heating than not much left to think so!



Thanks for your attention!