Signals for invisible matter from solar - terrestrial observations

Sergio Bertolucci

Presented by K. Zioutas

Work with: Konstantin Zioutas, Sebastian Hofmann, Marios Maroudas

- Analysis of ***OPEN ACCESSed*** **~40000** daily data **=> 1975 -**

[ ] **The Sun and its Planets as detectors for invisible matter** arXiv:1602.03666 **+**
https://indico.cern.ch/event/520074/

Established collaboration with:
V. Anastassopoulos, G. Cantatore, J. Dierle, H. Fischer, M. Karuza, Y. Semertzidis, A. Sonst, I. Tsagris …
Interested data provider: T. Hoeksema / WSO-Stanford

more?

Jeju / KOREA

21/6/2016

The question behind this work:

Are insisting anomalies/mysteries in the solar system the unnoticed manifestation of the dark Universe?

Solar Flares

Bursts of X-rays 1859-

".. one of the great solar mysteries" 2014

Seismic waves: **many open questions** 2016

Solar Corona problem

EUV excess 1939-

"one of the outstanding unsolved problems in astrophysics" 2015

Earth's Atmosphere

Annual anomaly 1937-

Total **E**lectron **C**ontent: TEC(December) > TEC(June) 2011

.....

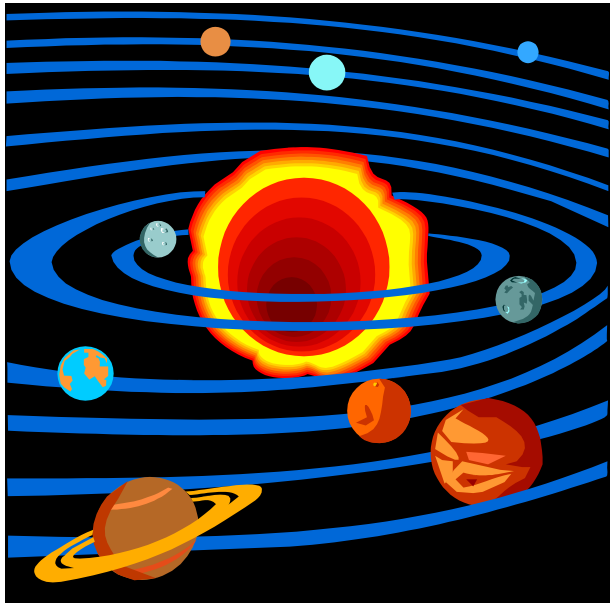
The driving idea behind this work:

- Planetary gravitational lensing possible for non-relativistic particles => in ideal case, flux enhancement up to **10^6.**
- Focused stream(s) of invisible matter interact with the solar / planetary Atmospheres

Search for (planetary) correlations

?

origin



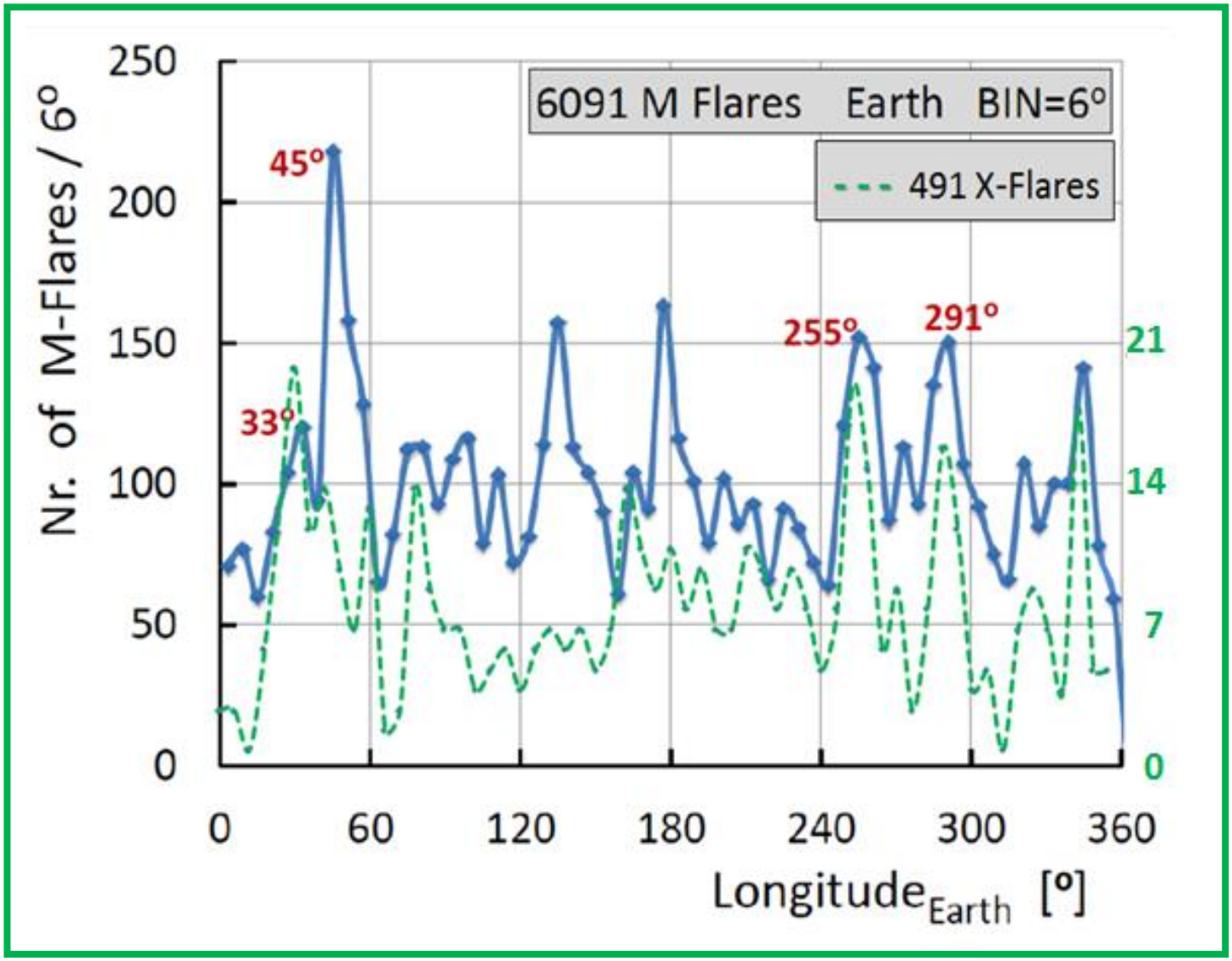
Solar Flares

1859 - ***"unpredictable mysteries"***

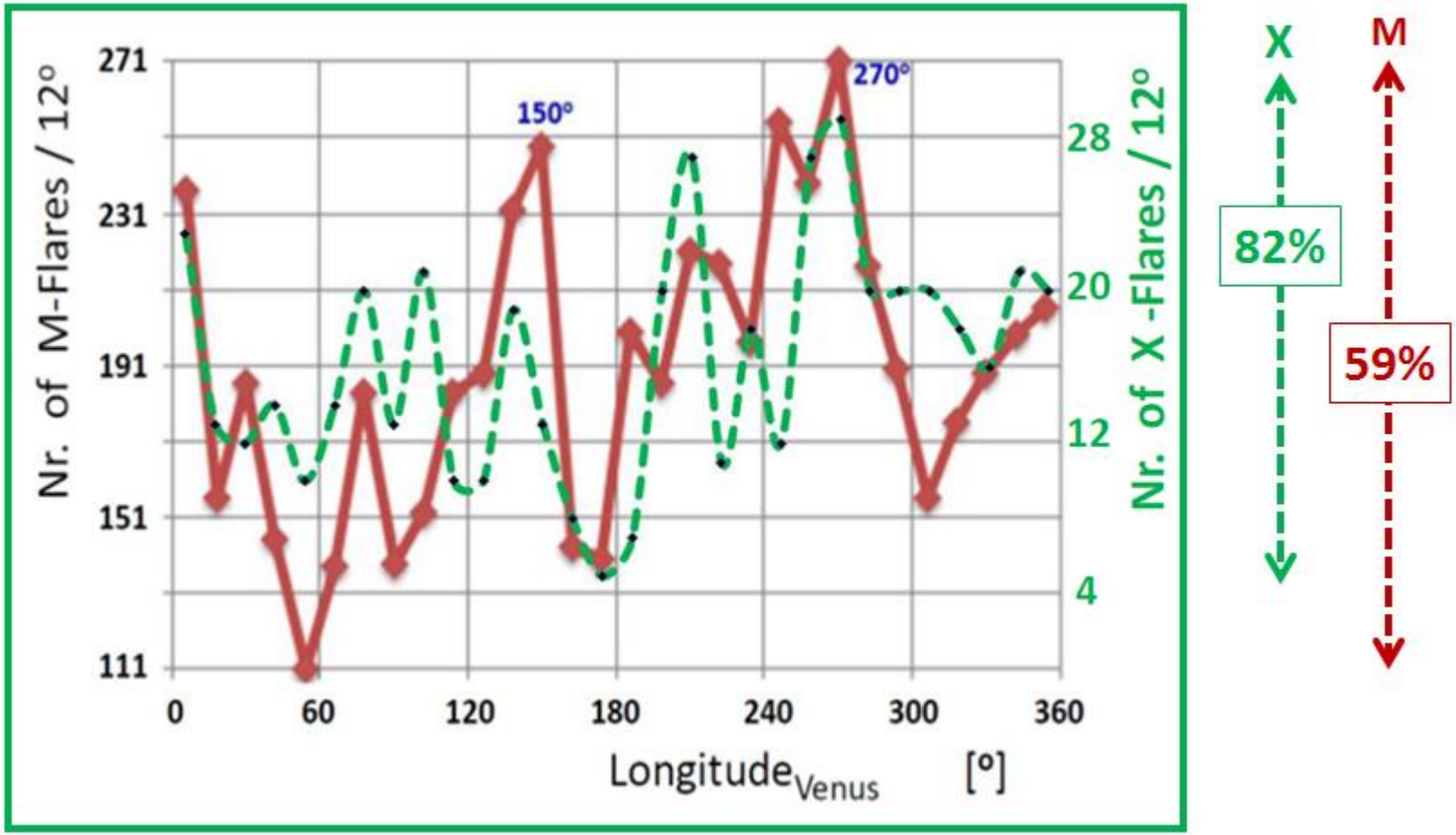
Related work so far:

FOURIER analysis of time series observations

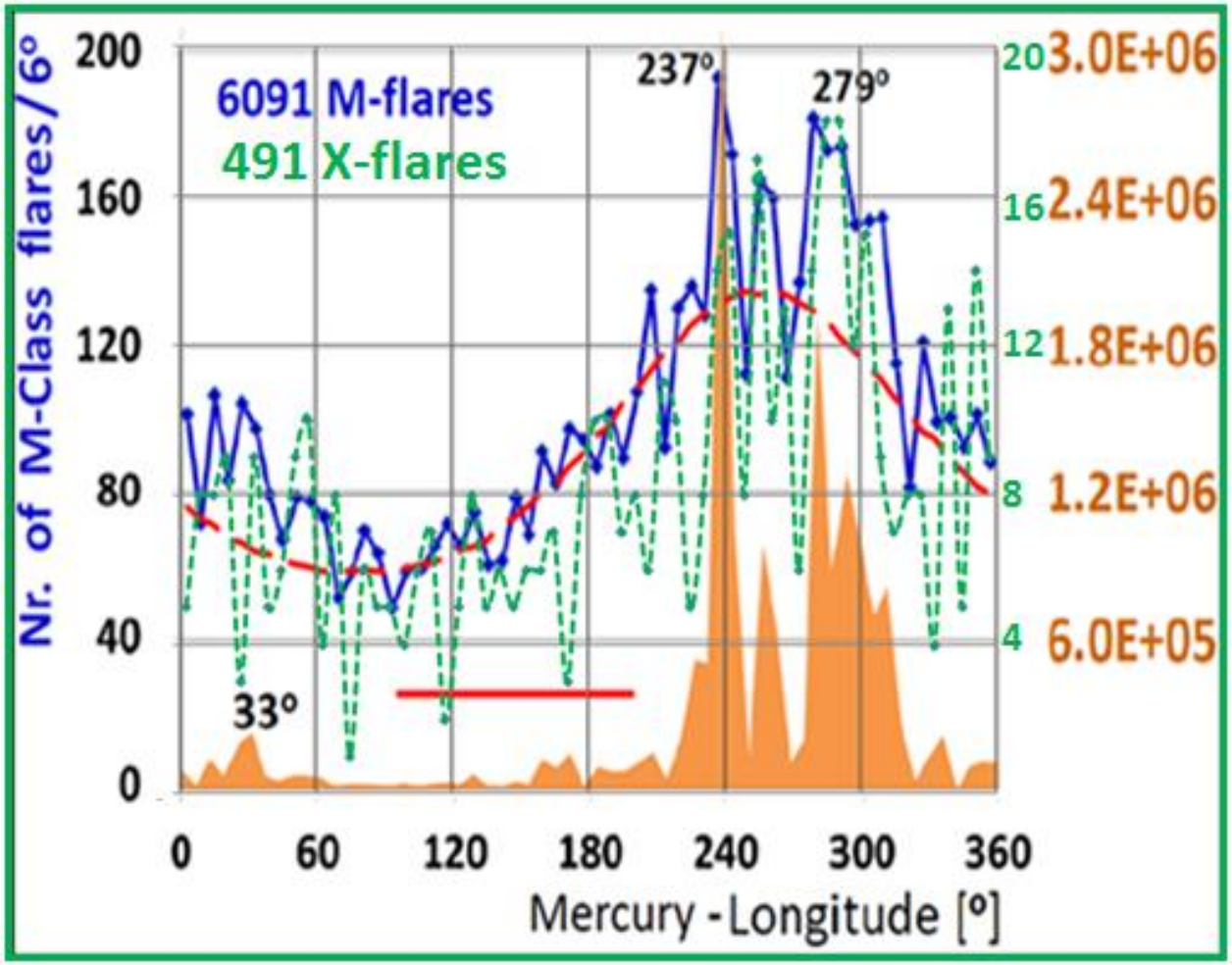
EARTH


6091 M Flares Earth BIN=6°
491 X-Flares
45°
33°
255°
291°
Nr. of M-Flares / 6°
250
200
150
100
50
0
21
14
7
0
0
60
120
180
240
300
360
Longitude$_{Earth}$ [°]

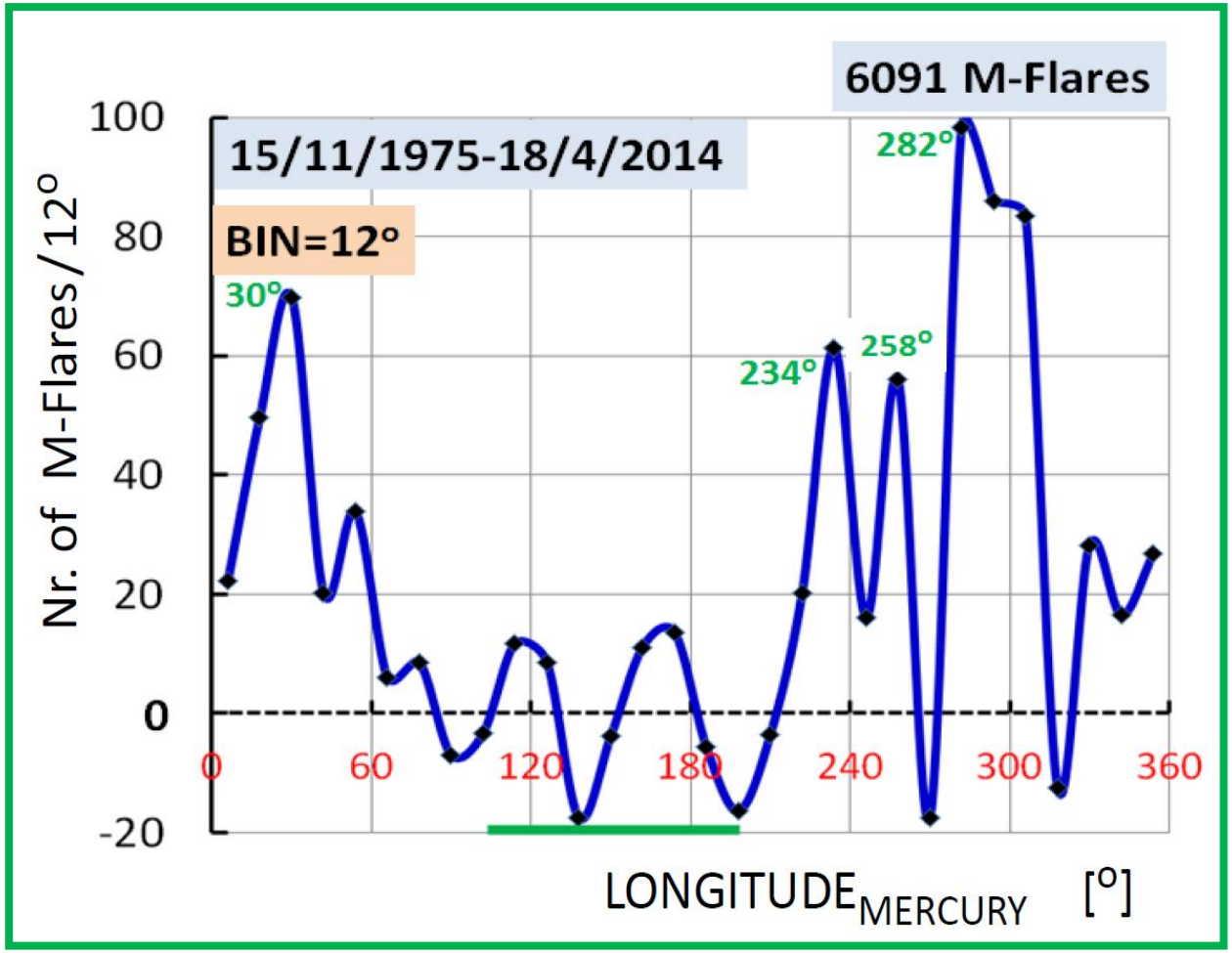
VENUS


Nr. of M-Flares / 12°
271
231
191
151
111
150°
270°
28
20
12
4
Nr. of X -Flares / 12°
0
60
120
180
240
300
360
Longitude$_{Venus}$ [°]
X
M
82%
59%

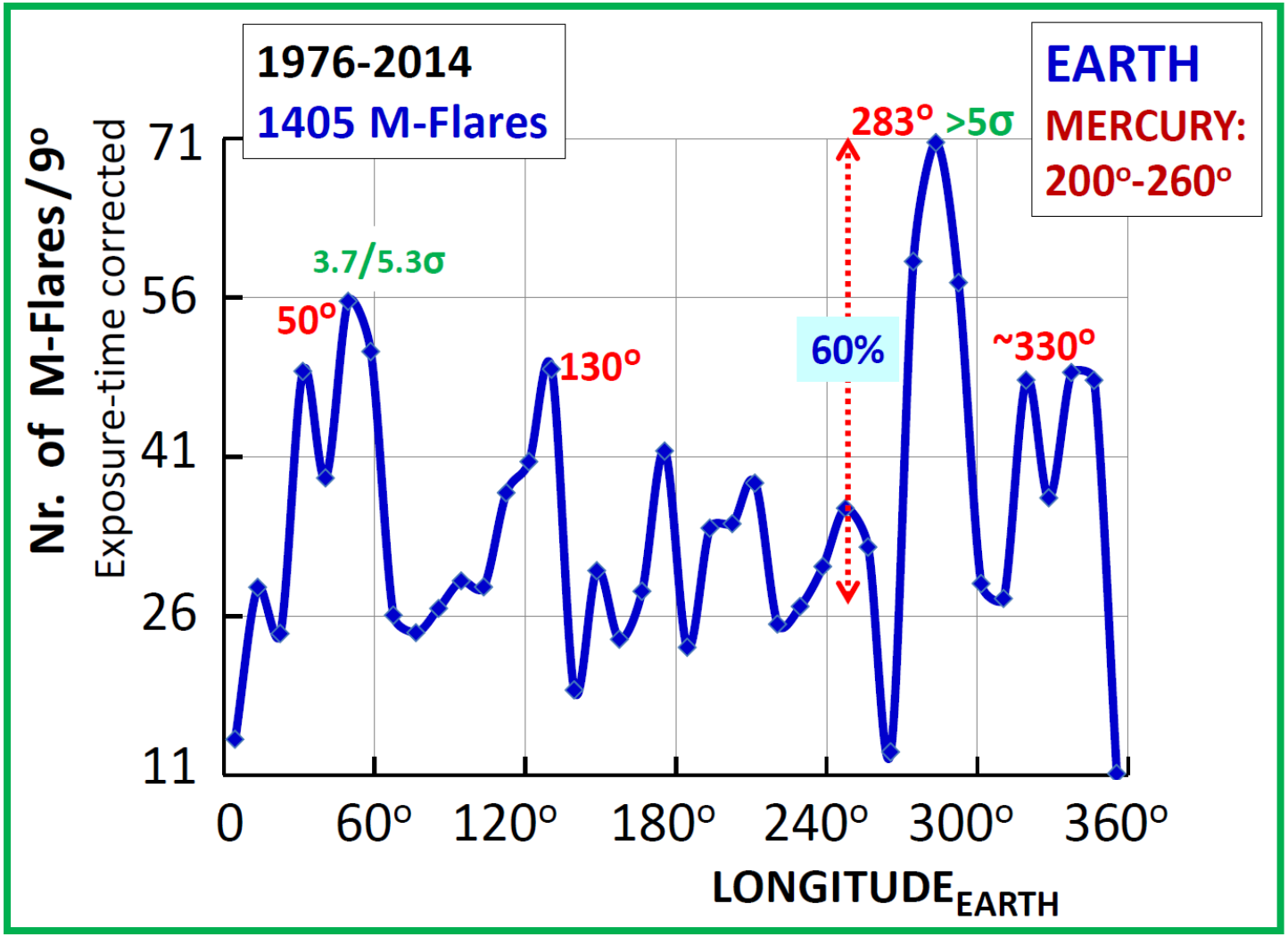
MERCURY


6091 M-flares
491 X-flares
237°
279°
33°
Nr. of M-Class flares/6°
200
160
120
80
40
0
20
16
12
8
4
3.0E+06
2.4E+06
1.8E+06
1.2E+06
6.0E+05
0
60
120
180
240
300
360
Mercury - Longitude [°]

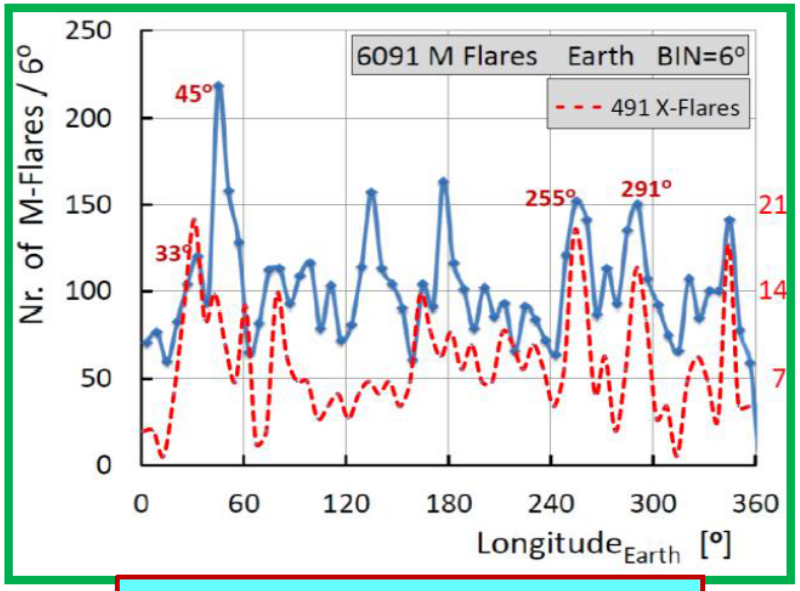
MERCURY


6091 M-Flares
15/11/1975-18/4/2014
BIN=12°
30°
234°
258°
282°
Nr. of M-Flares/12°
100
80
60
40
20
0
-20
0
60
120
180
240
300
360
LONGITUDE$_{MERCURY}$ [°]

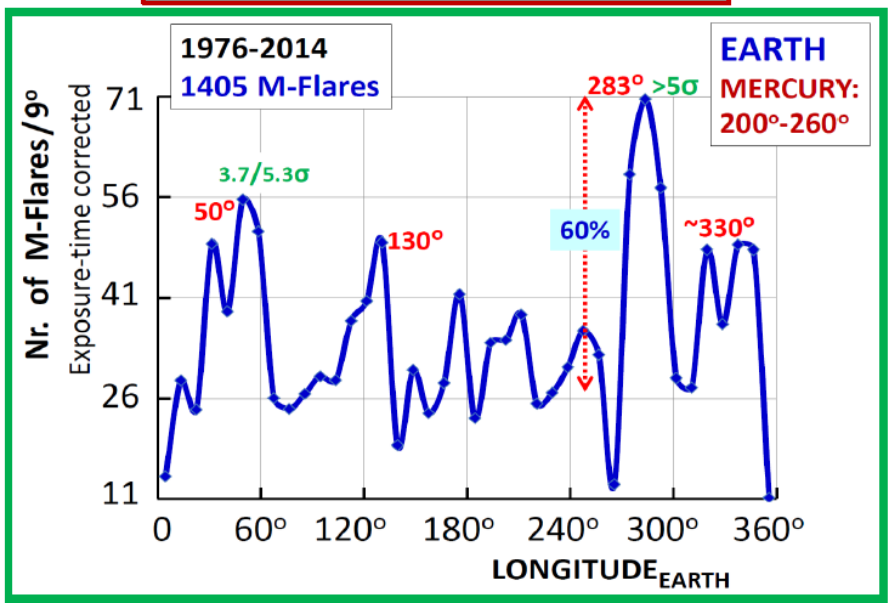
Combining planetary effects



EARTH
⊗
MERCURY



===> LONGITUDE$_{EARTH}$ ===>



ALL M-Flares

1405 M-Flares
Mercury:
200°-260°

EARTH

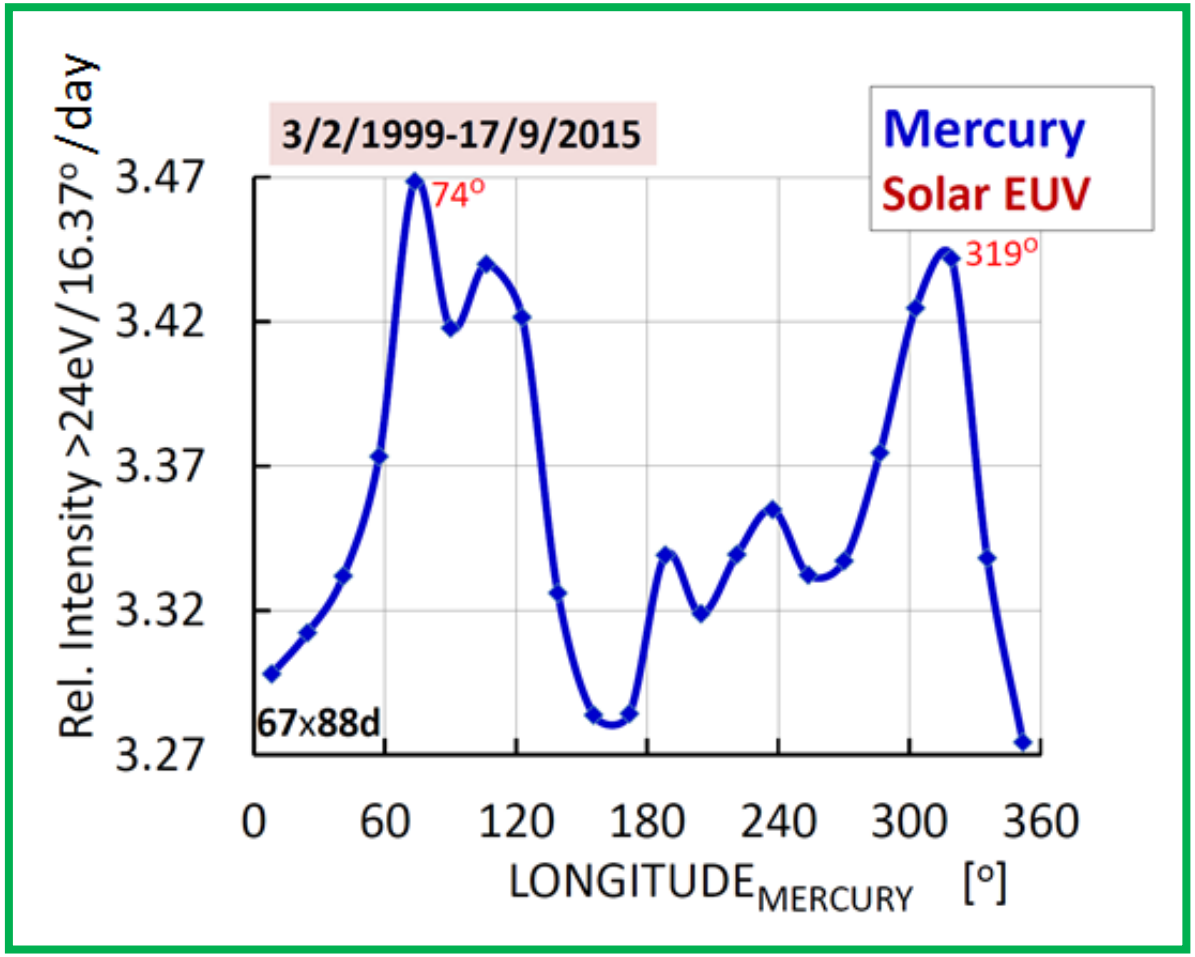
EARTH ⊗ MERCURY

Solar EUV >24eV

1939-

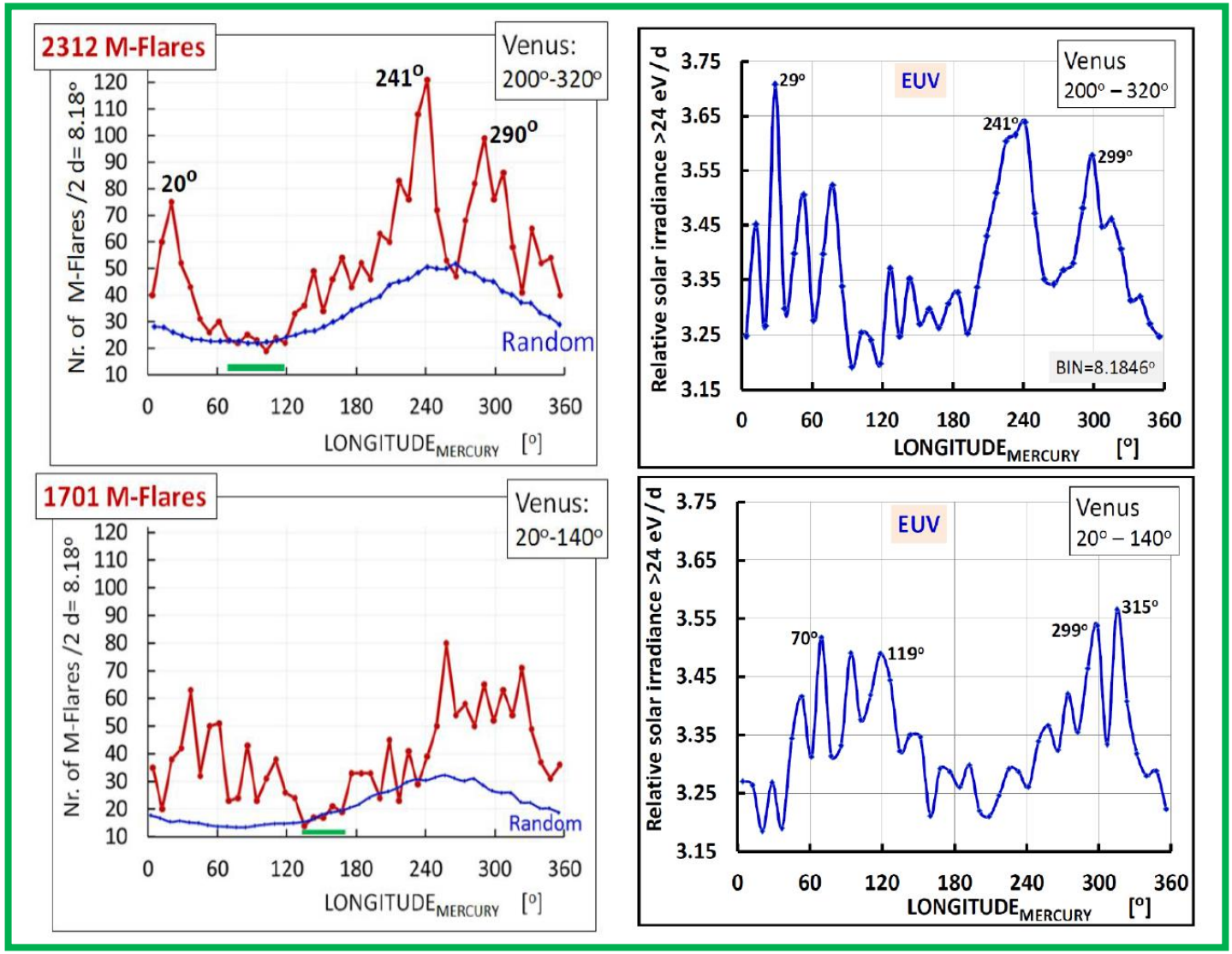
"» than expected for a 5800K bb"

MERCURY


3/2/1999-17/9/2015
Mercury
Solar EUV
74°
319°
67x88d
Rel. Intensity >24eV/16.37° /day
3.47
3.42
3.37
3.32
3.27
0
60
120
180
240
300
360
LONGITUDE$_{MERCURY}$ [°]

6%

FLARES and SOLAR EUV

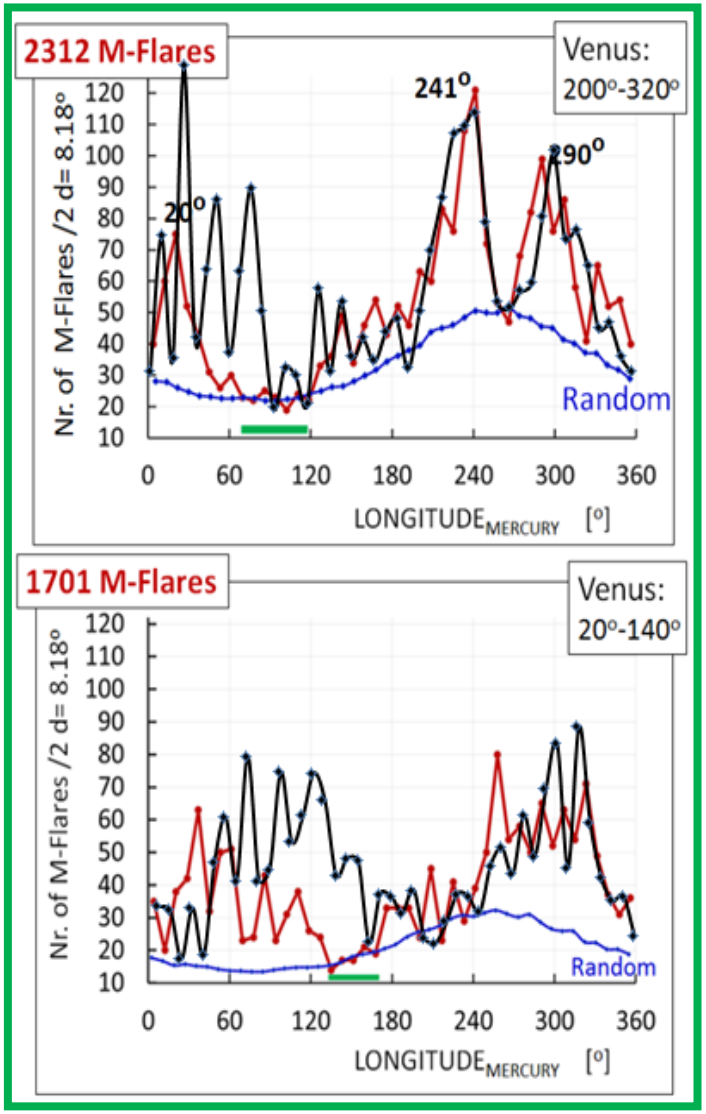


MERCURY

⊗

VENUS

FLARES/EUV

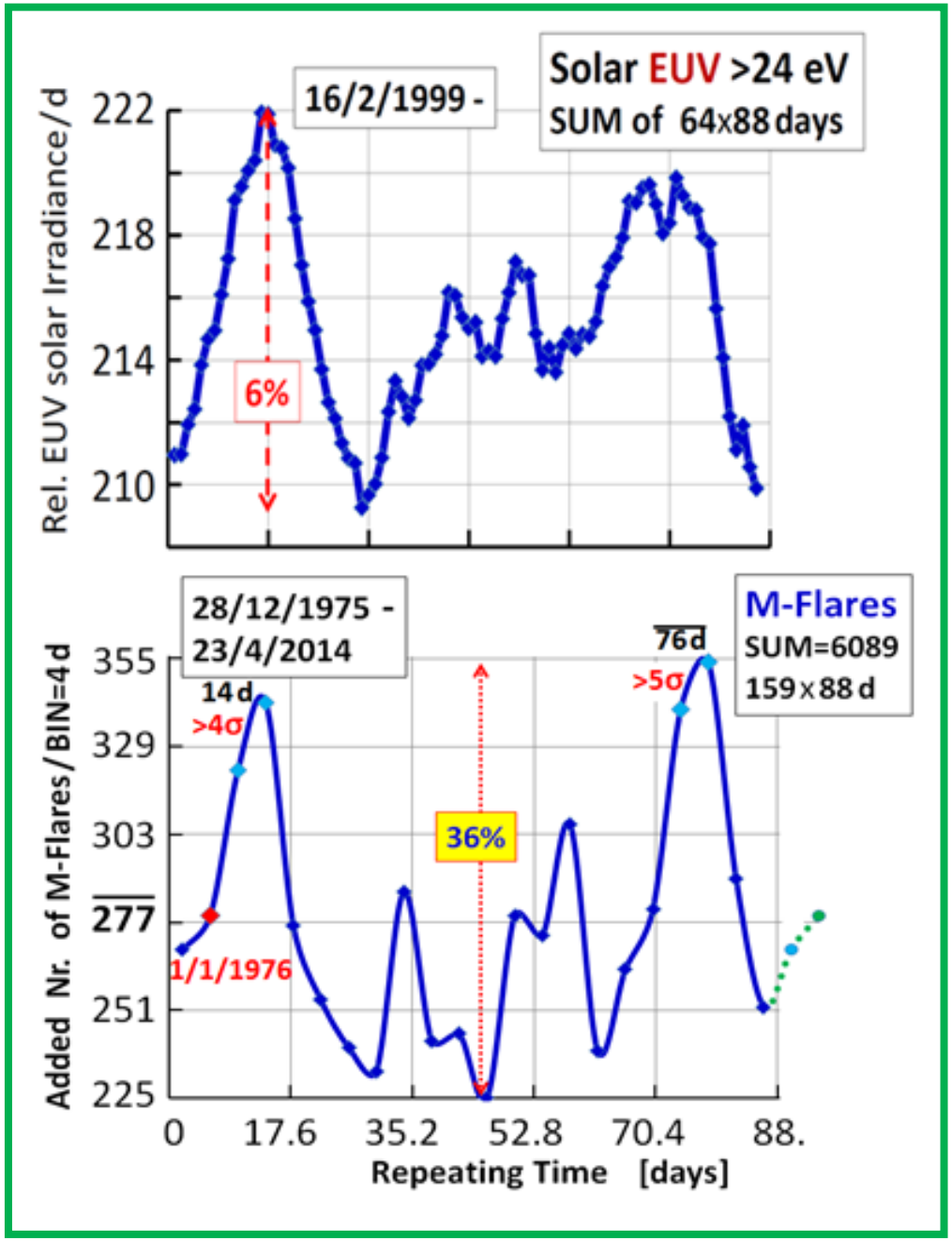


MERCURY
⊗
VENUS
FLARES/EUV

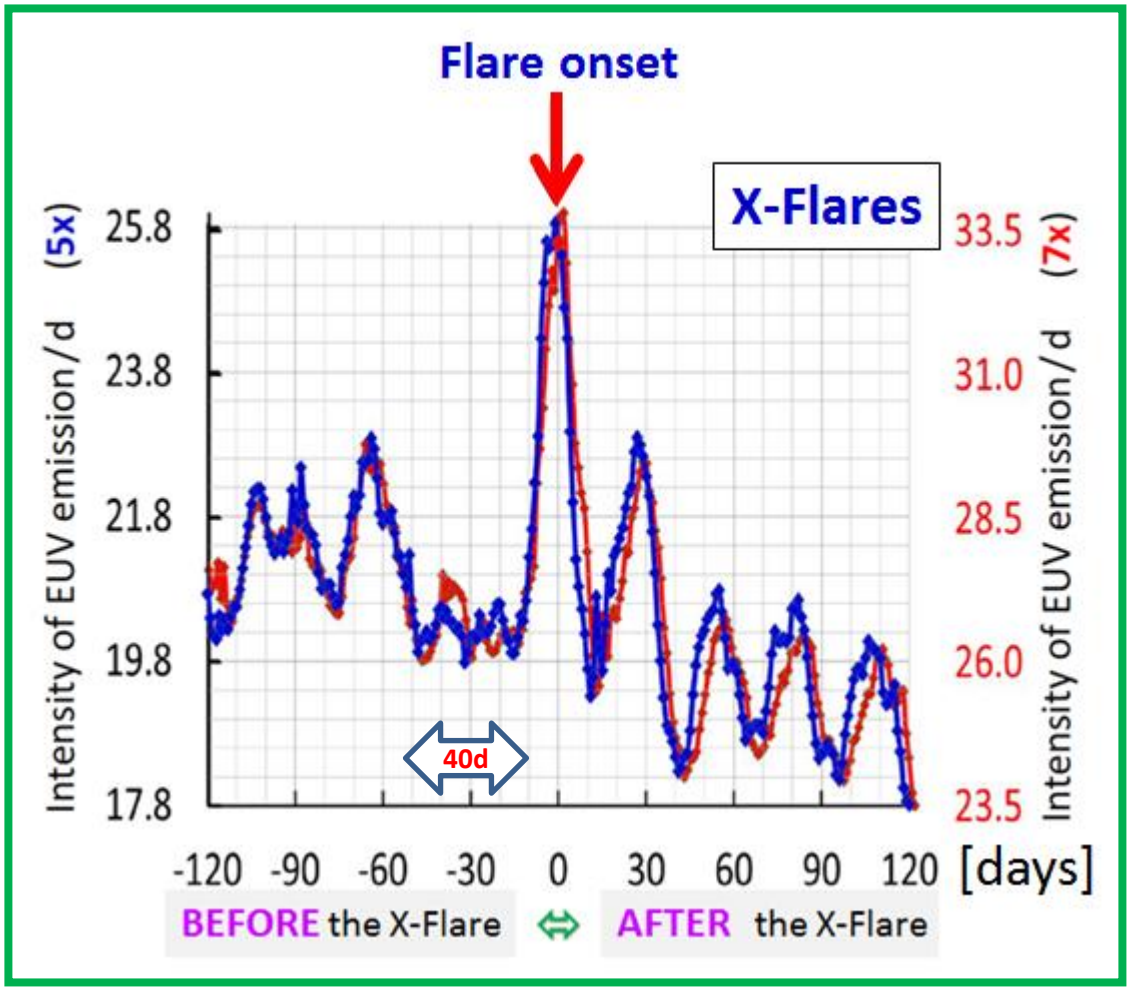
Solar flaring activity ⇔ EUV emission

=> corona

>>> (partly) common origin**?**


Solar EUV >24 eV
SUM of 64x88 days
16/2/1999 -
6%
Rel. EUV solar Irradiance/d
222
218
214
210
28/12/1975 -
23/4/2014
M-Flares
SUM=6089
159x88 d
14 d
>4σ
76d
>5σ
36%
1/1/1976
Added Nr. of M-Flares/BIN=4 d
355
329
303
277
251
225
0
17.6
35.2
52.8
70.4
88.
Repeating Time [days]

EUV
⊗
X-Flares



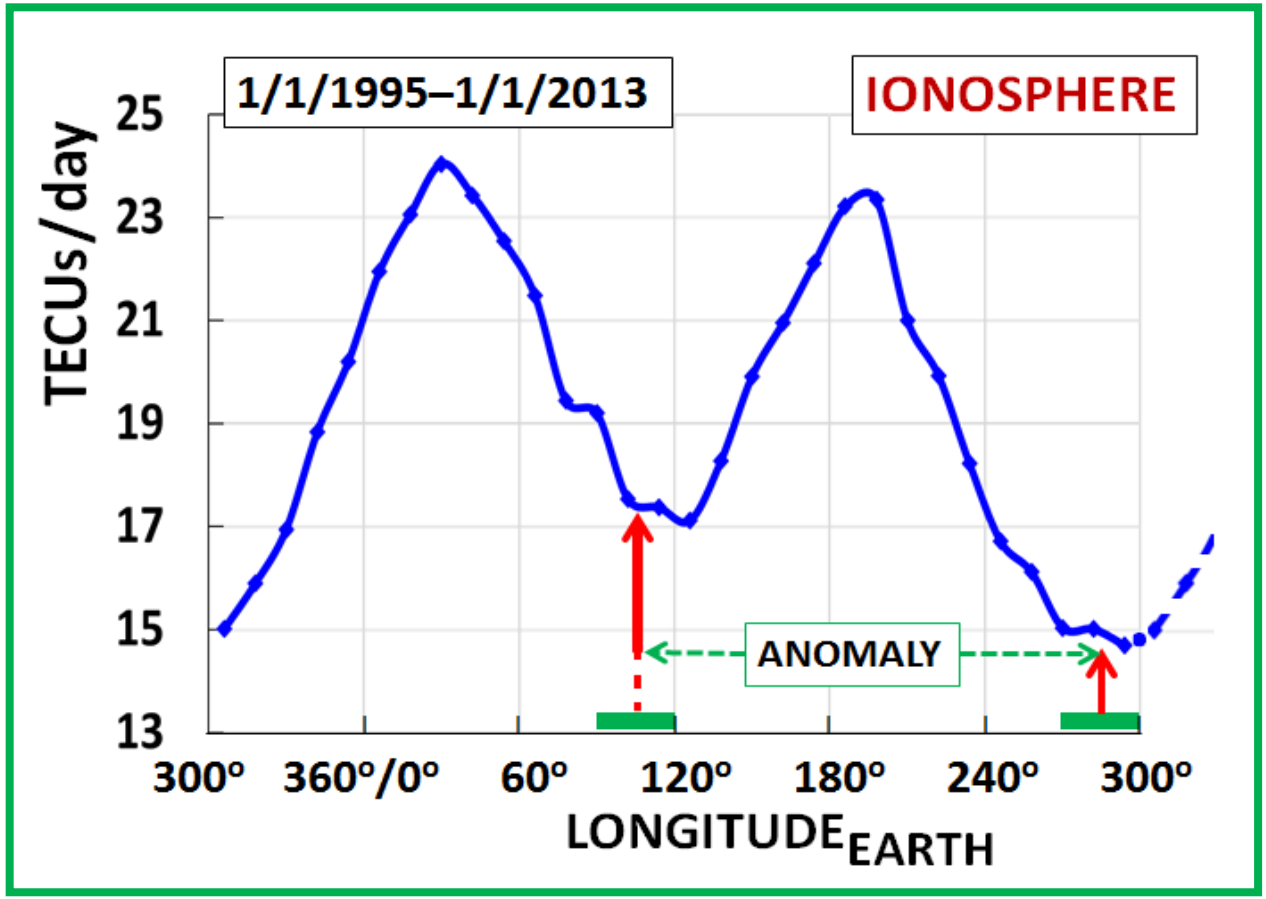
12%

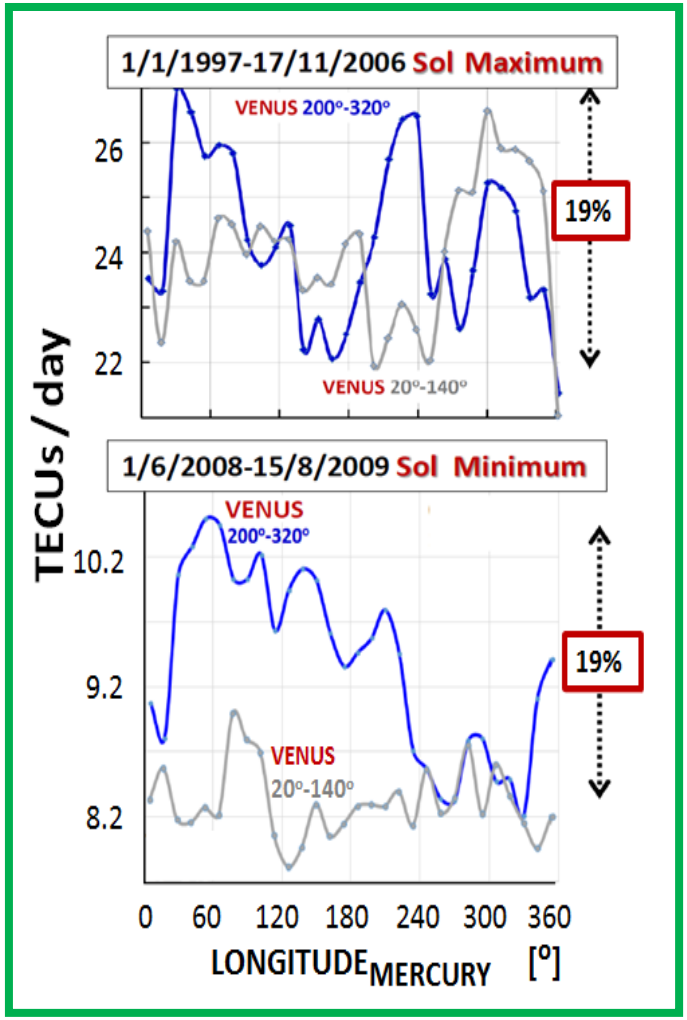
EARTH's IONOSPHERE

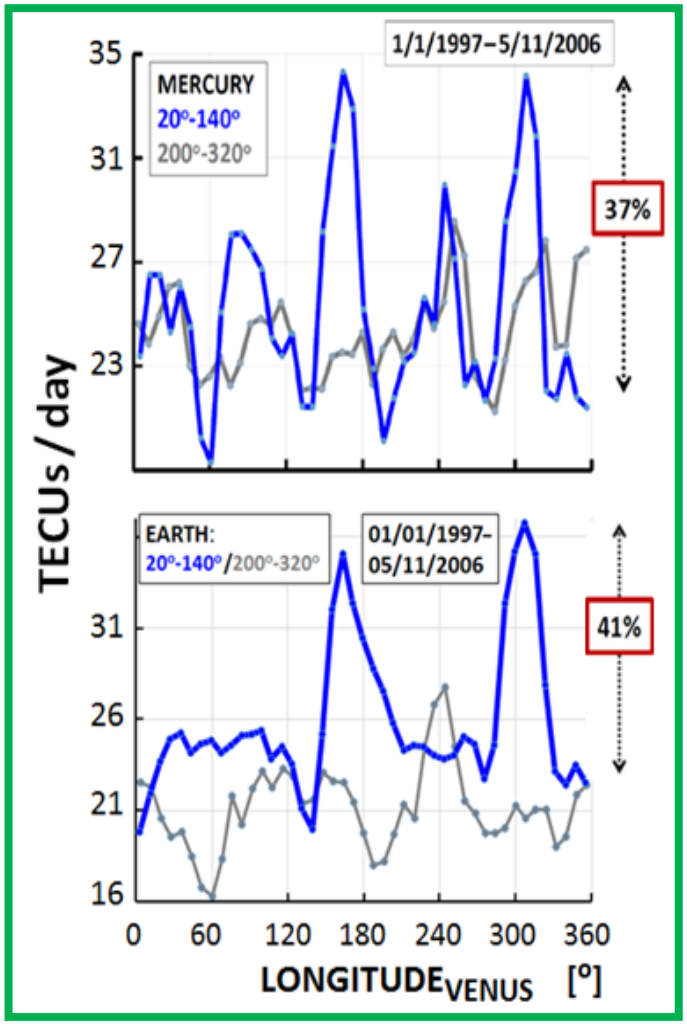
"Anomalies lasting for decades"

First observation in 1937/1938

EARTH

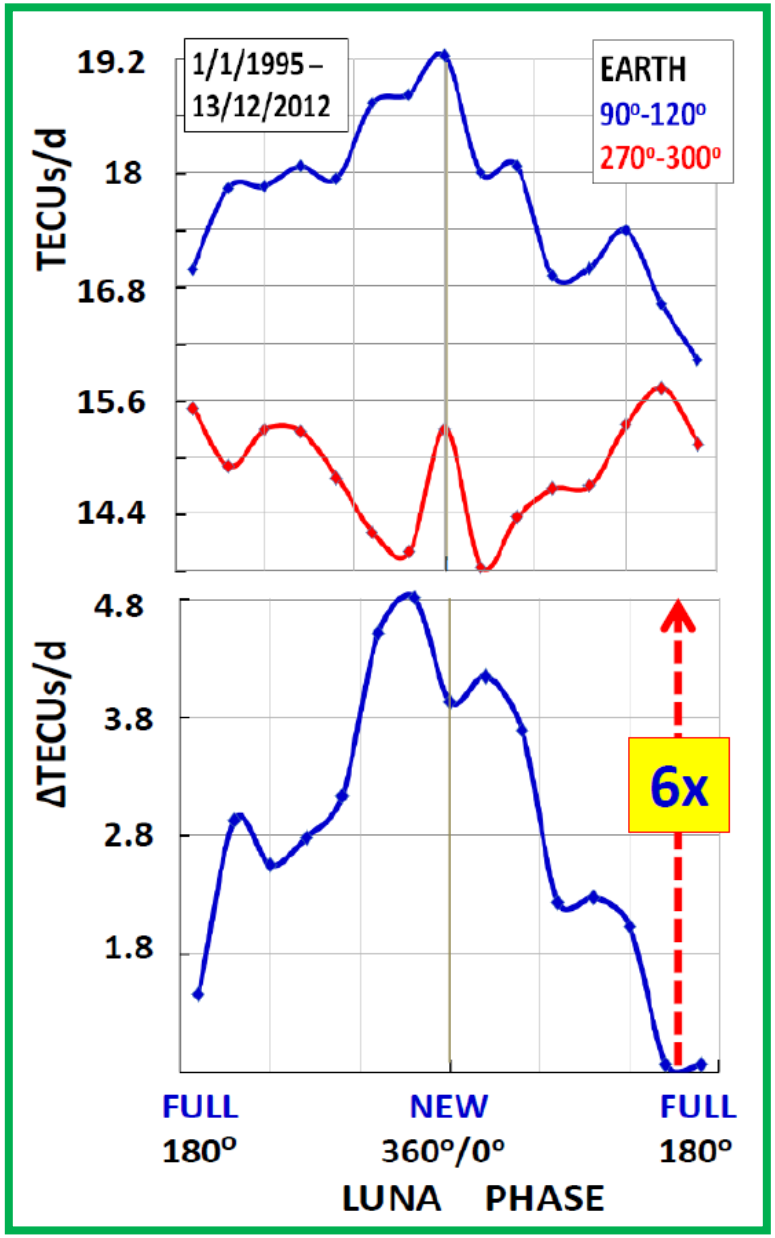

1/1/1995–1/1/2013
IONOSPHERE
TECUs/day
25
23
21
19
17
15
13
ANOMALY
300°
360°/0°
60°
120°
180°
240°
300°
LONGITUDE EARTH



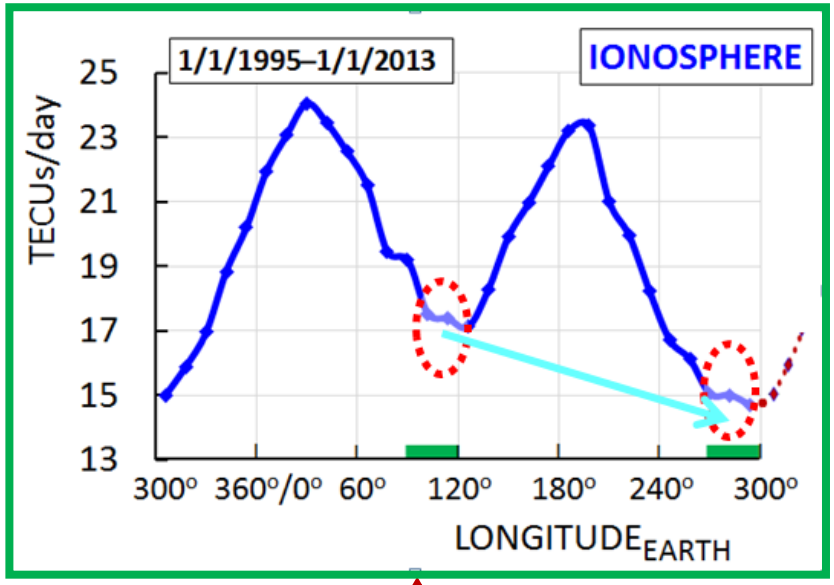


MERCURY
⊗
VENUS
⊗
EARTH

Max / Min



MOON ⊗ EARTH/ Ionosphere



Atmospheric anomaly!?

Bill Murray / ATLAS /UK suggested:
look at the sunspots!

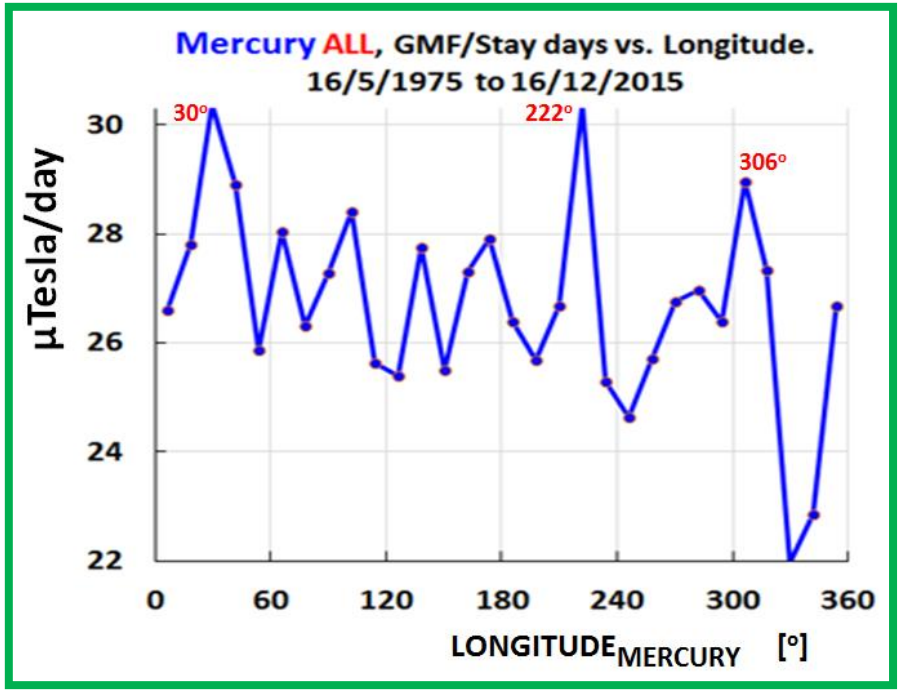
next

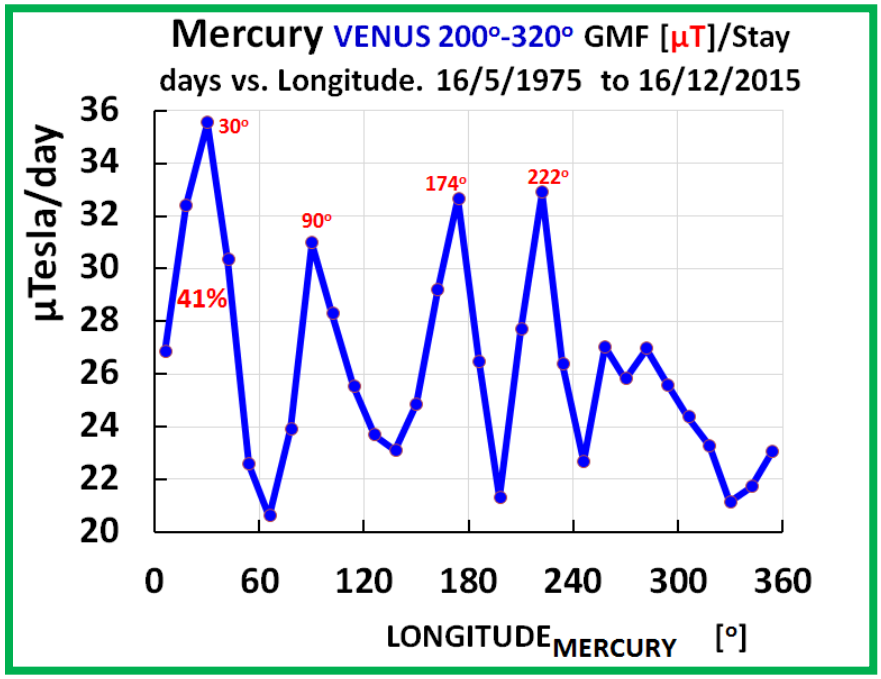
Alessandro Strumia / CERN :
search for dark planets?

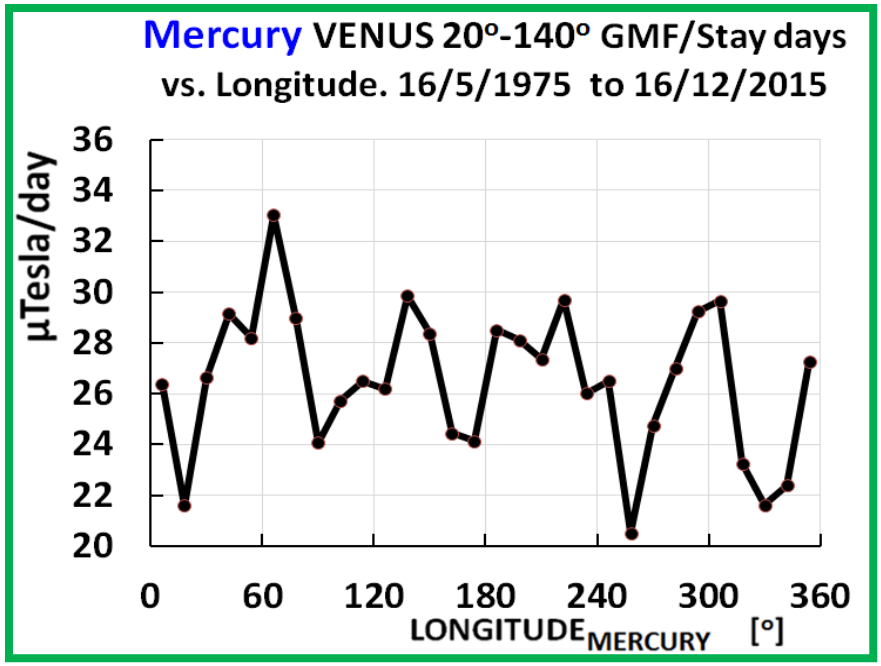
Sun's **1975-2015**

Global Magnetic Field

⊗ **Planets?** ⇨ **ORIGIN?**







PRELIMINARY

Thanks Todd Hoeksema for the GMF-data

Conclusions

- The analysis of the data supports our working hypothesis that a stream of invisible particles focused by the planets triggers the onset of solar phenomena (flares, EUV-emission, …).

- We observe a similar effect for the electron content of Earth's Ionosphere.

- We cannot at this point claim anything about the nature of these invisible particles, but we are strongly suggesting the re-analysis of Dark Matter experiments, especially DAMA, following our approach.

- We are planning more complete analyses, which will combine the simultaneous effect of all planets

THANK YOU!

Back-up slides

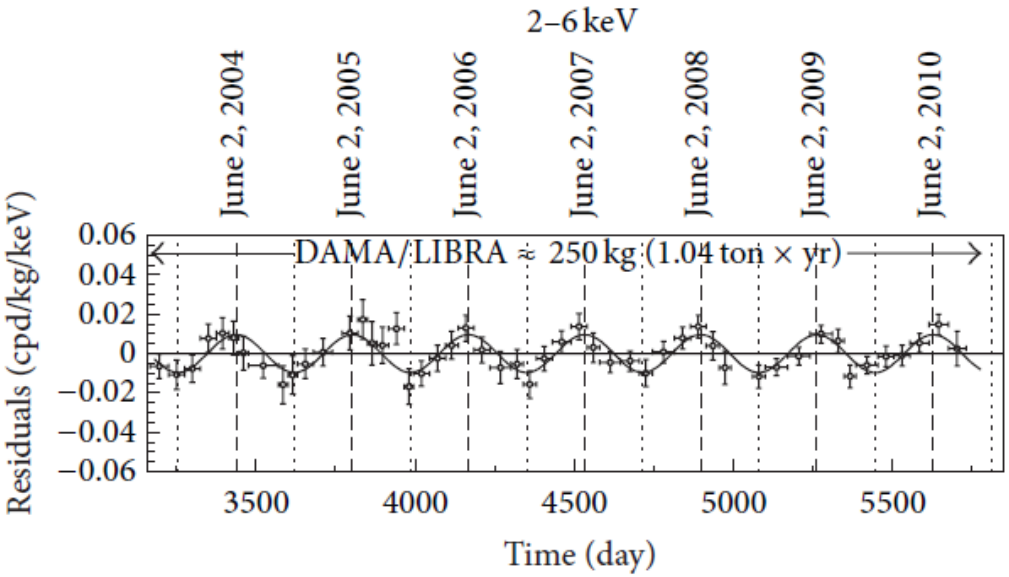


FIGURE 1: Experimental residual rate of the *single-hit* scintillation events measured by DAMA/LIBRA-phase1 in the (2–6) keV energy interval as a function of the time. The data points present the experimental errors as vertical bars and the associated time bin width as horizontal bars. The superimposed curves are the cosinusoidal functions behaviour $A \cos \omega(t - t_0)$ with a period $T = 2\pi/\omega = 1$ yr, a phase $t_0 = 152.5$ day (June 2nd) and modulation amplitudes, A, equal to the central values obtained by best fit on the data points of the entire DAMA/LIBRA-phase1. The dashed vertical lines correspond to the maximum expected for the DM signal (June 2nd), while the dotted vertical lines correspond to the minimum.

DAMA

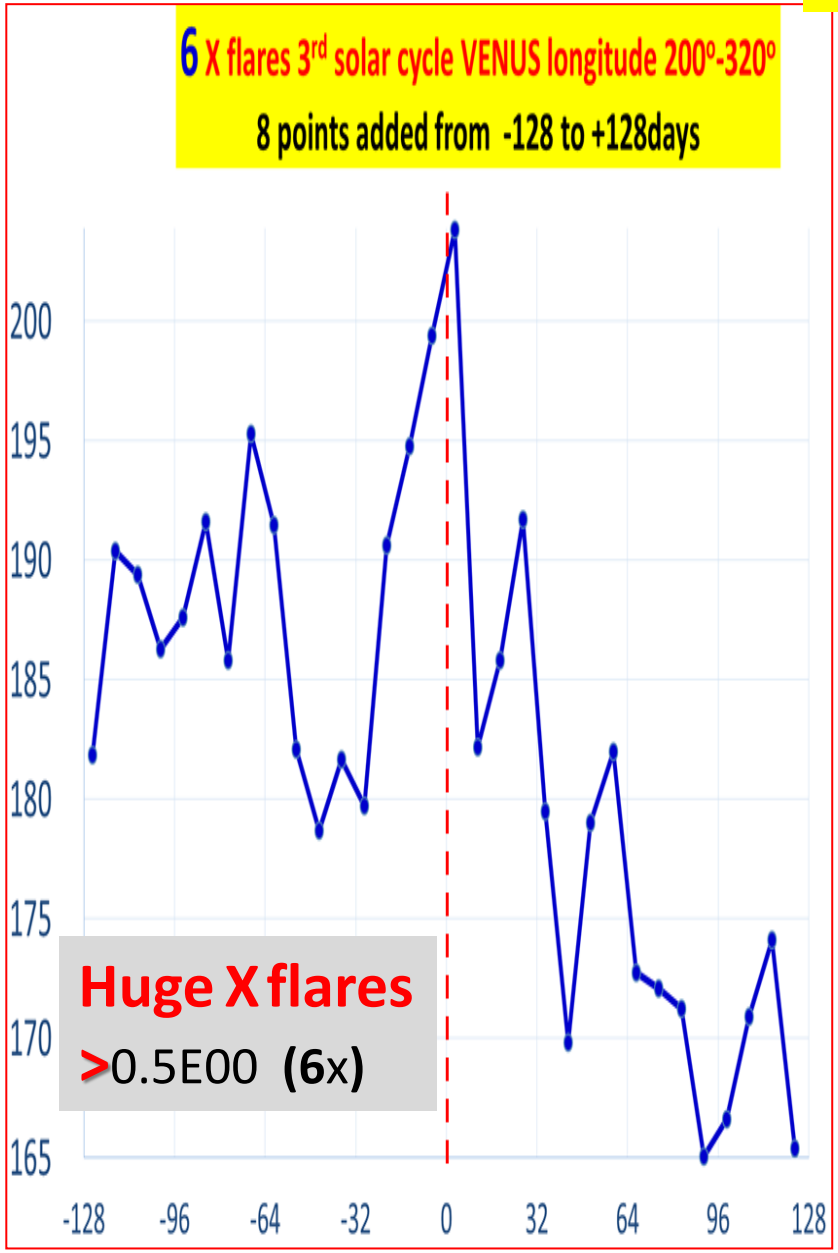
1996 -

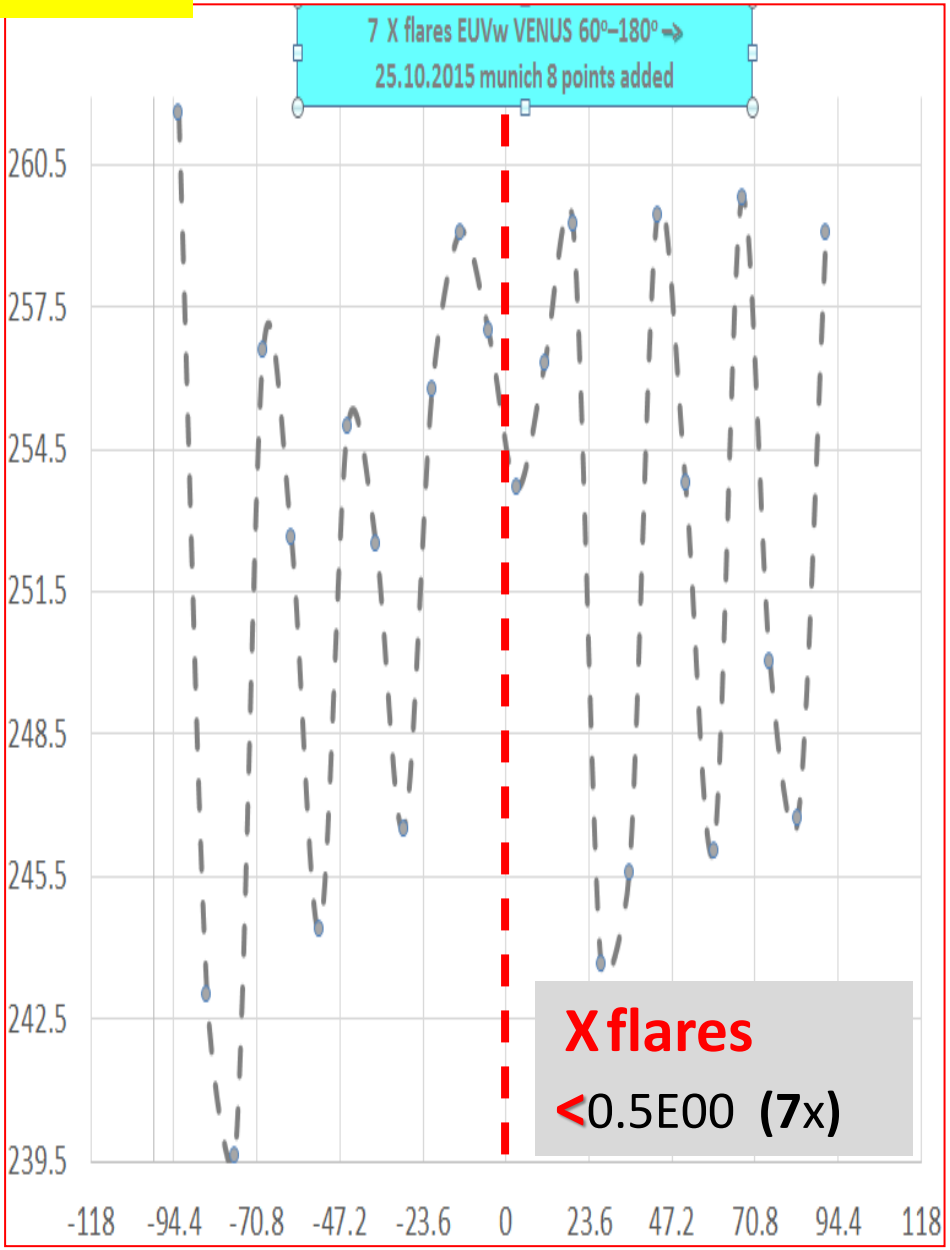
Modulation **9σ**

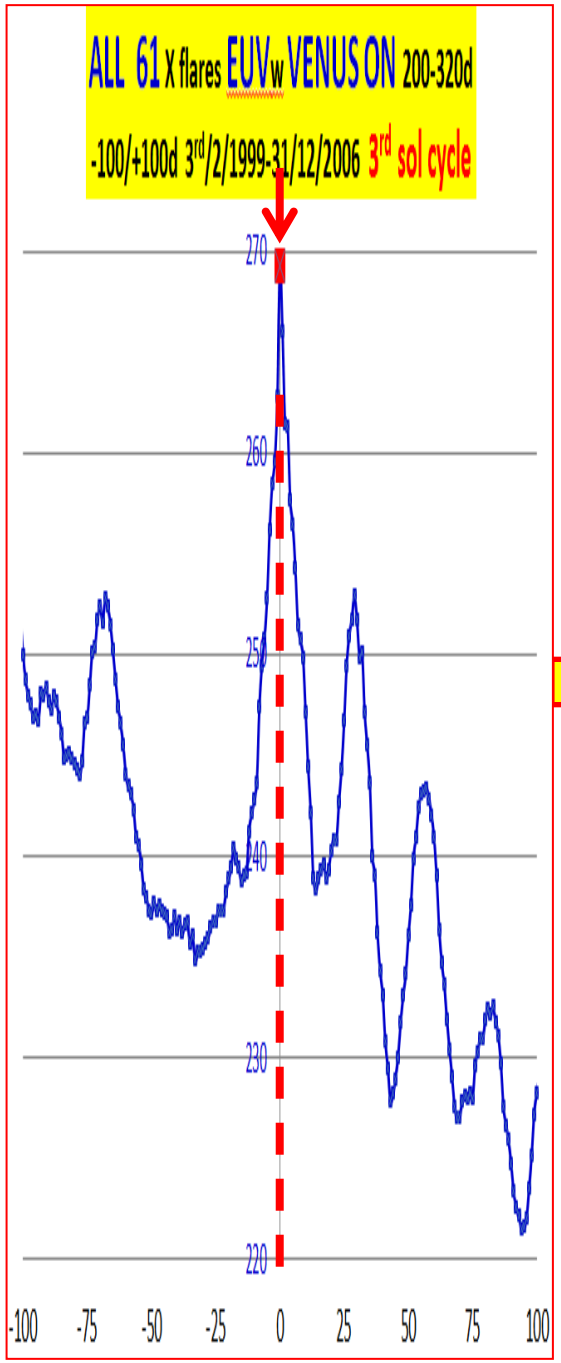
TBD: RE-ANALYSIS

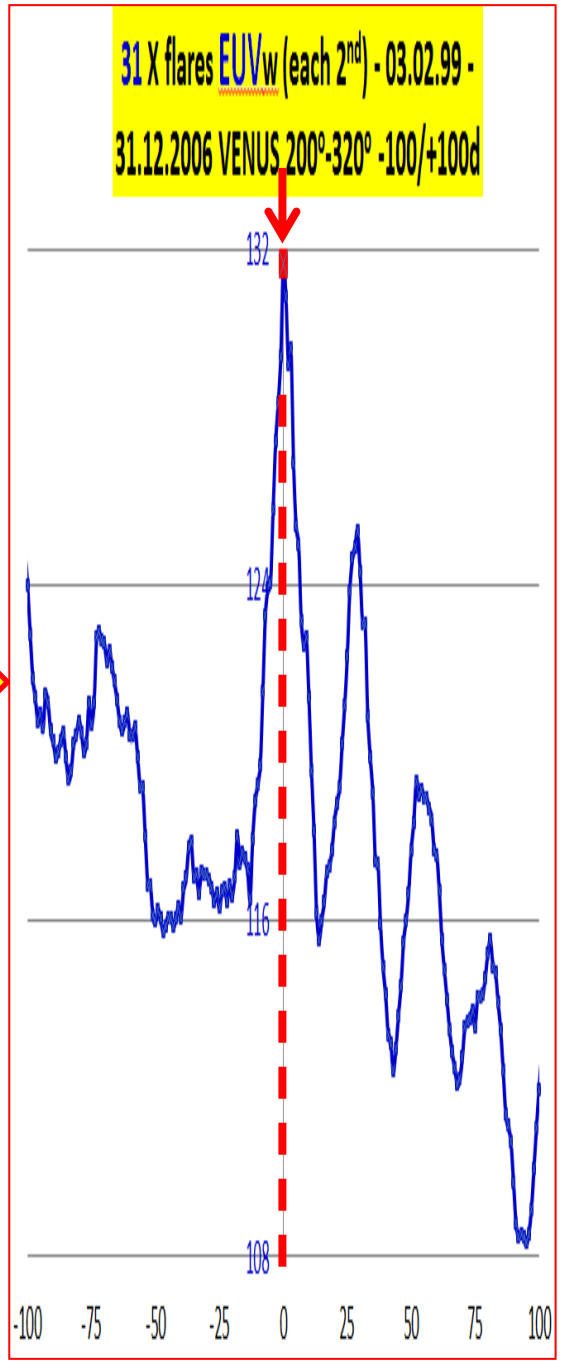
3rd sol cycle

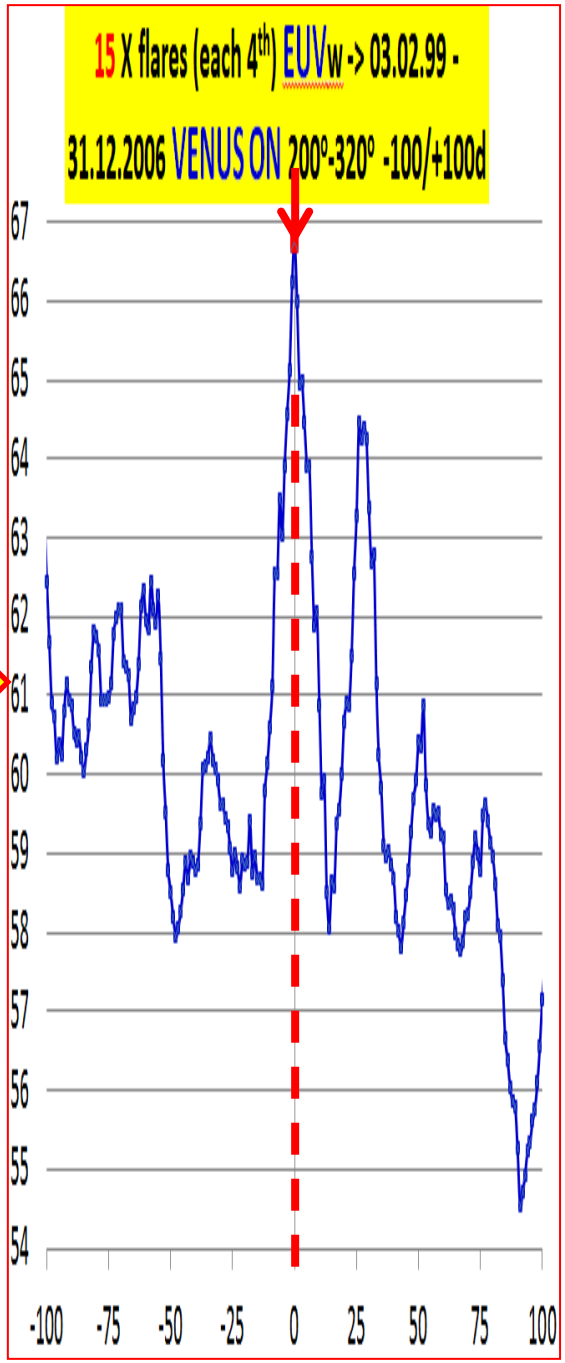
8 points added in both

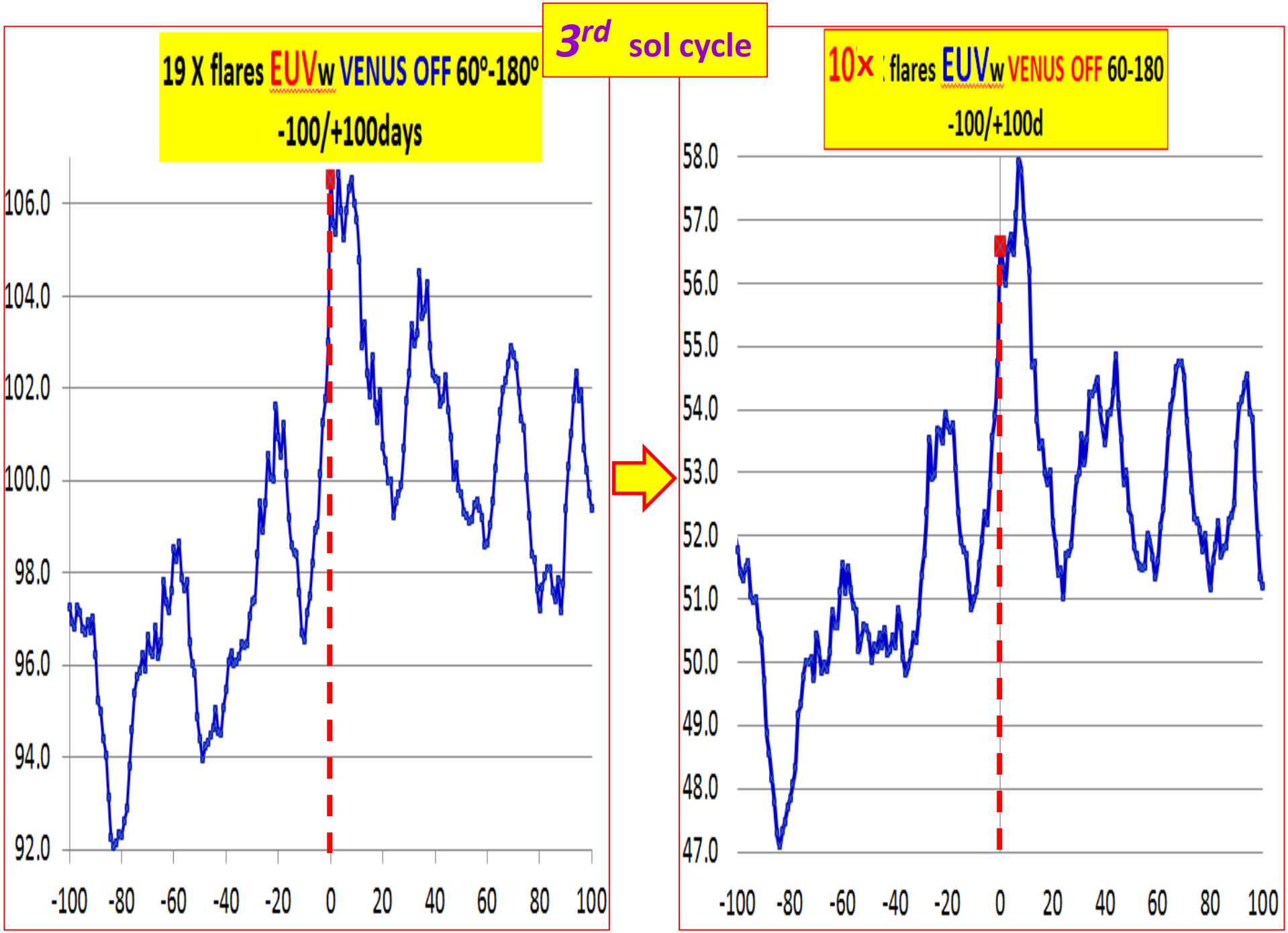





ALL 61 X flares EUVw VENUS ON 200-320d
-100/+100d 3rd/2/1999-31/12/2006 3rd sol cycle
270
260
250
240
230
220
-100
-75
-50
-25
0
25
50
75
100


31 X flares EUVw (each 2nd) - 03.02.99 -
31.12.2006 VENUS 200°-320° -100/+100d
132
124
116
108
-100
-75
-50
-25
0
25
50
75
100

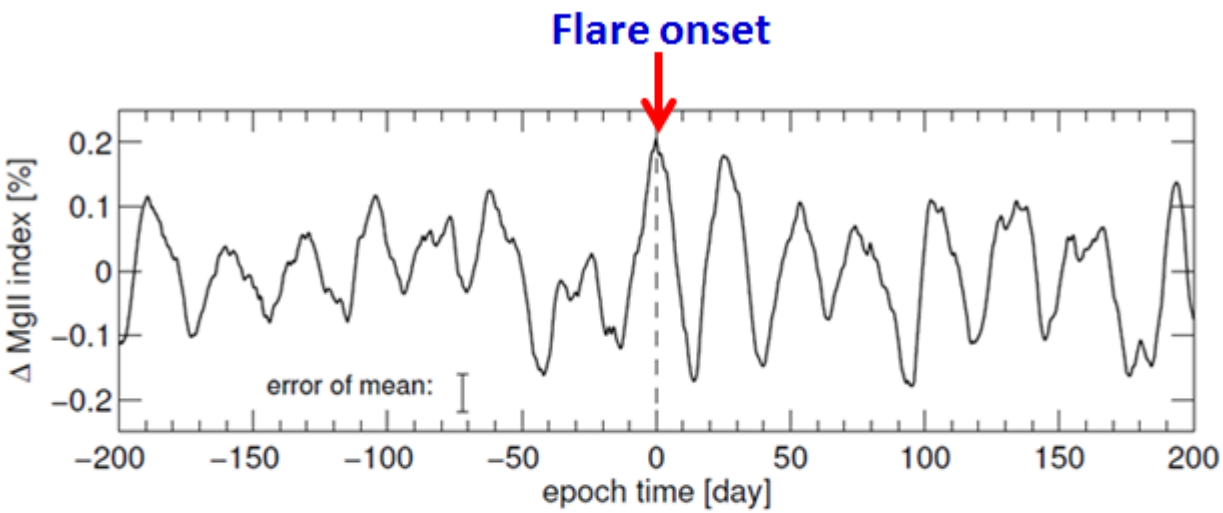

15 X flares (each 4th) EUVw -> 03.02.99 -
31.12.2006 VENUS ON 200°-320° -100/+100d
67
66
65
64
63
62
61
60
59
58
57
56
55
54
-100
-75
-50
-25
0
25
50
75
100


3rd sol cycle
19 X flares EUVw VENUS OFF 60°-180°
-100/+100days
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
-100 -80 -60 -40 -20 0 20 40 60 80 100
10x flares EUVw VENUS OFF 60-180
-100/+100d
58.0
57.0
56.0
55.0
54.0
53.0
52.0
51.0
50.0
49.0
48.0
47.0
-100 -80 -60 -40 -20 0 20 40 60 80 100

~Visible

⊗

130 X/M-Flares



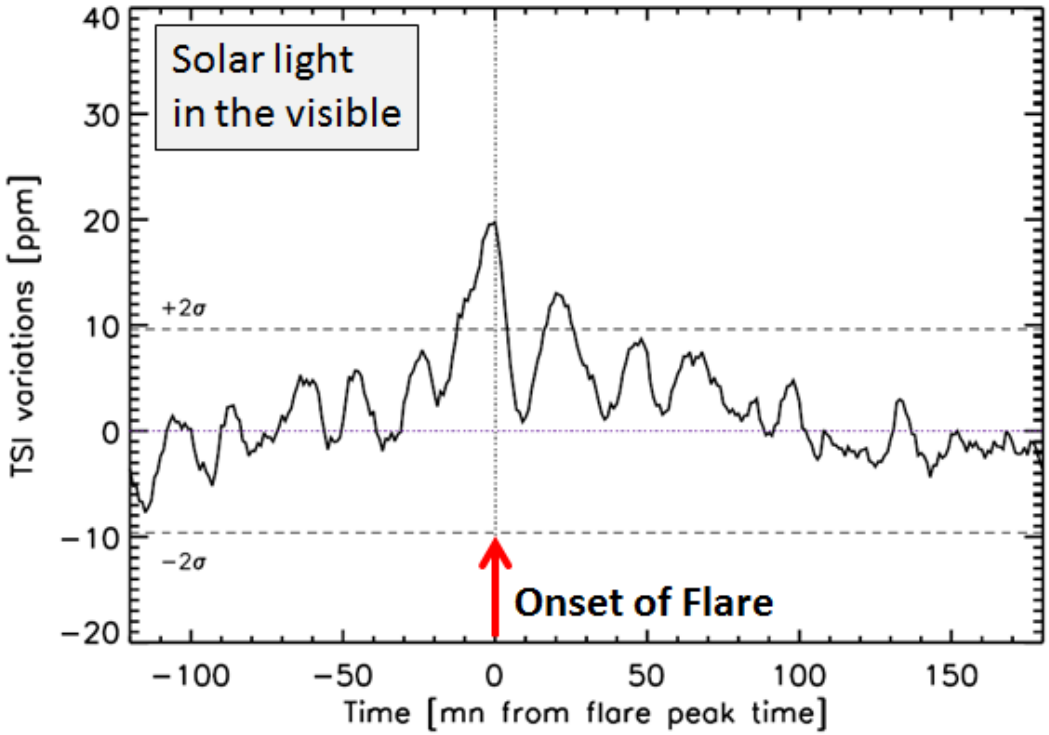
Variation of the Mg-II index which is a measure of the solar EUV/UV activity. ***Between 50 and 10 days before the event, the solar EUV/UV emission is a bit decreased.*** Then a brightening occurs with a maximum on Day 0, coincident with the X-ray burst but wider in time.

K. Hocke, N. Kämpfer, Sol. Phys. Res. Trends, Nova Science Publ., Chapter 9 (**2008**) 327
http://books.google.ch/books?id=royEo2yT9XMC&dq=Mg+II+index+27+days&source=gbs_navlinks_s

See also K. Hocke, J.G.R. 114 (**2008**) A01309, doi:10.1029/2008JA013679

Visible
⊗
130-Flares

The effect of flares on Total Solar Irradiance (TSI)



The excess time distribution of the TSI emission of 130 flares relative to the X-ray peak. 1 min resolution and smooth over 6 min. **X-rays come ~5 min later than the extra light emitted during flares.**

[M. Kretzschmar]

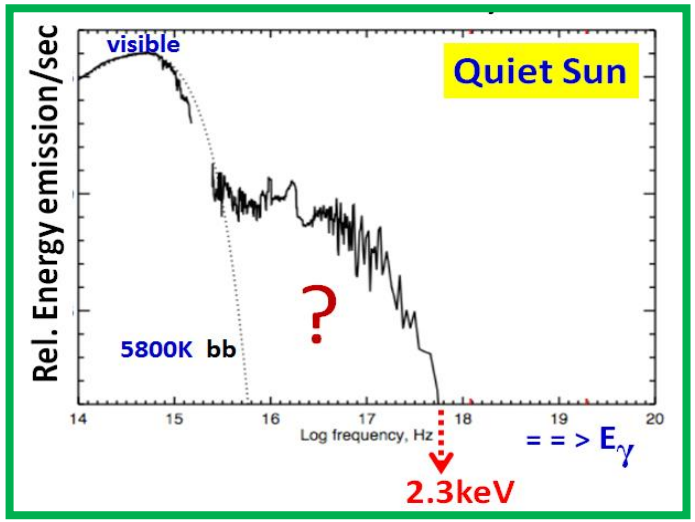
M. Kretzschmar, T. Dudok de Wit, W. Schmutz, S. Mekaoui, J.-F. Hochedez, S. Dewitte, **NATURE 6(2010)690**
http://www.nature.com/doifinder/10.1038/nphys1741

Solar Corona 1939- >>> observational mystery.

Sun's upper atmosphere much hotter than its surface => why?

- *" a major open issue in astrophysics"* **2015**
- *"one of the fundamental outstanding problems in solar physics"* **2015**
- ***"for 77 years…one of the outstanding unsolved problems in astrophysics"*** **2015**

[http://arxiv.org/abs/1502.07401 ; http://arxiv.org/abs/1508.05354; DOI: 10.1098/rsta.2014.0269]



*The striking **EUV excess** of the quiet Sun is the manifestation of the **solar corona problem**.*

H.S. Hudson

Zur Frage der Deutung der Linien im Spektrum der Sonnenkorona.

nachdem schließlich die Anzeichen dafür sich mehr und mehr verdichten, daß in den äußeren Zonen der Sonnenatmosphäre Bedingungen für die Anregung von Spektrallinien vorliegen, die weit über das hinausgehen, was bei thermischem Gleichgewicht zu erwarten wäre, scheint es nicht mehr völlig abwegig, die Frage zu diskutieren, ob die Koronalinien als verbotene Linien hochionisierter Atome zu deuten sind.

16. März 1939 W. Grotian

http://dx.doi.org/doi:10.1007/BF01488890

Solar Flares 1859-

- physical mechanisms/relationship *flare activity ⇔ sunspot activity*

  2 of the hottest + biggest problems in solar physics **2013**

  (Hathaway 2010; Hudson 2011); http://www.astron-soc.in/bulletin/13December/237412013-feng.pdf

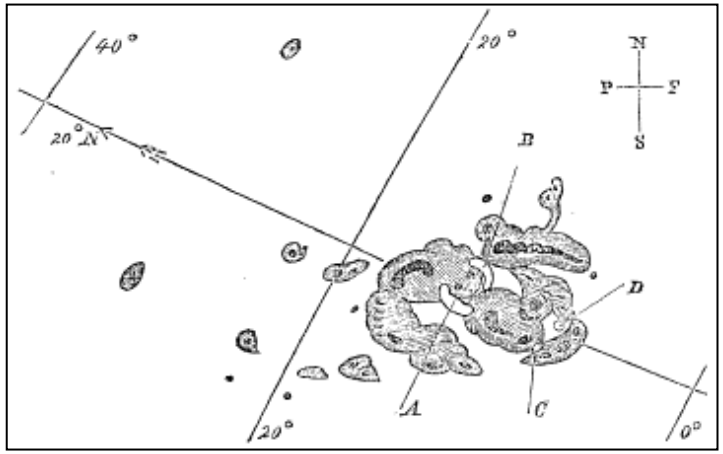
- *… solar flares + CMEs … one of* ***the great solar mysteries*** **2014**

  http://solarscience.msfc.nasa.gov/quests.shtml

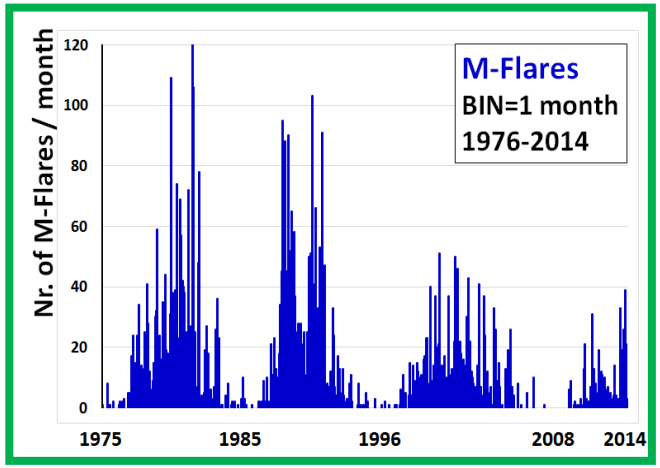
- *what powers a flare? what triggers it?*

  unpredictable for more fundamental reasons? C.J. Schrijver **2009**

The "*first flare*": 1st Sept 1859



R.C. Carrington, MNRAS 20 (**1859**) 13



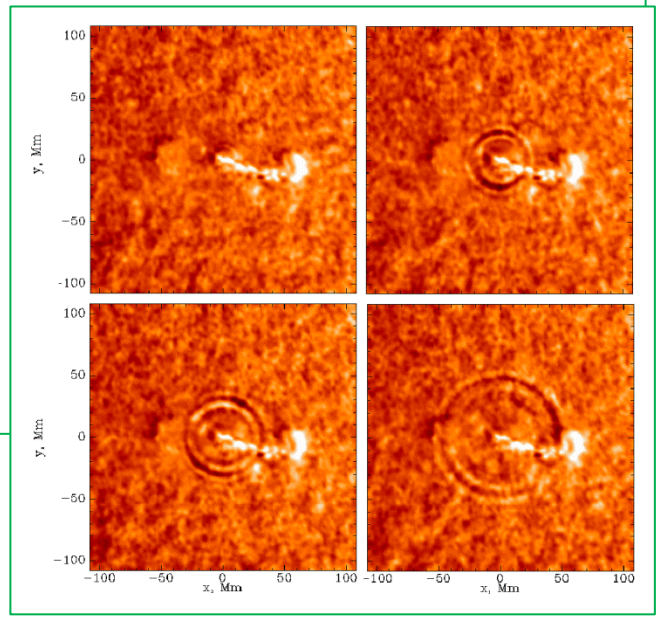
time

Solar quakes: 1998-

- *… are still **mysterious*** arXiv:**1402**.1249v1.
- *"Surprising: in some cases, the sunquake initiating impacts are observed in the early impulsive or even pre-heating phase.. and even without a significant hard X-ray signal"*

  Kosovichev; Sharykin; Zimovets **1/6/2014**
- *"… the energy transported downwards … is somehow invisible … the flux in something propagating downwards through the Sun's atmosphere must be detected"*. **arXiv:1508.07216v1** ApJ. (**2015**).
- *"like ripples spreading from a rock dropped into a pool of water"*

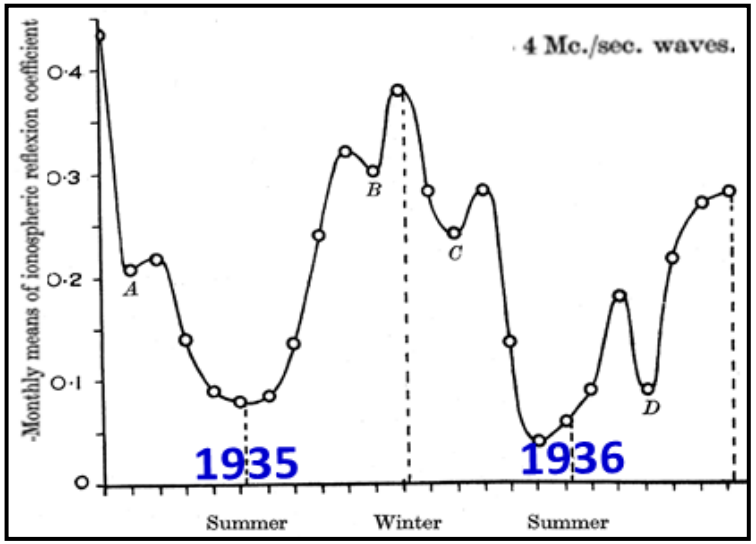
  http://sohowww.nascom.nasa.gov/bestofsoho/Helioseismology/mdi026.html
- **many open questions** … most notably the nature of the excitation mechanism(s) comes from a source area ~(3000km)^2 ➔ $10^{11\pm1}$ erg/cm^2 arXiv:1602.08245 **2016**



Earth's Atmosphere 1937

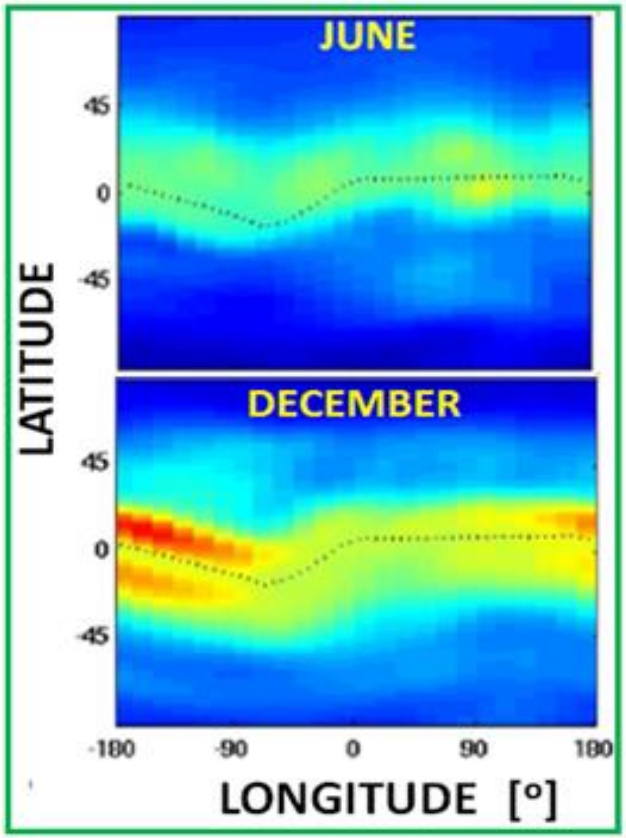
- *...peak electron density around December is greater than around June* ≠ expectation
  a long-standing unexplained annual anomaly
- **"the writers are inclined to the view that the cause is associated with the Earth or its motion..." 1938**
  doi:10.1029/TE043i001p00015
- .. there is a global **annual anomaly.**

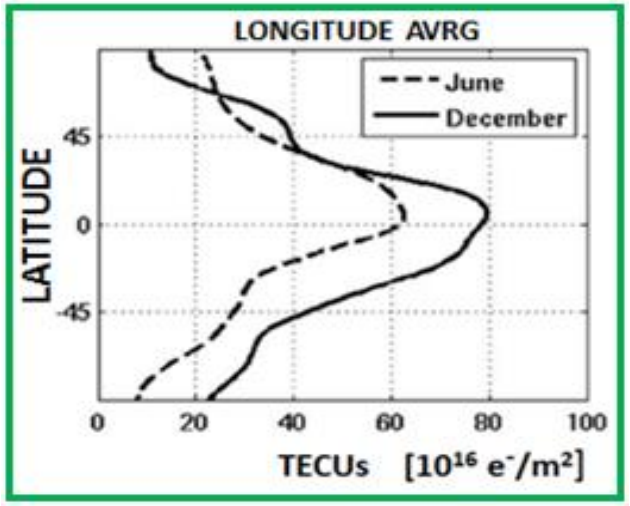
J. Lean *et al.*, J.G.R. 116 (**2011**) A10318, doi:10.1029/2011JA016567



Proc. Roy. Soc. London A162 (**1937**) 451

Total Electron Content	
Dec	**June**
2.87	2.12 [$10^{32}e^{-}s$]





J. Atm. Sol.-Terr. Phys. 67 (**2005**) 1377

Wolf, 1859: *solar dynamics is partially driven by* ***planetary tides****.*

a plausible physical mechanism has not been discovered yet…

the planetary tidal forces are too small to modulate solar activity..

although more complex mechanisms can not be excluded.

N. Scafetta, J. Atm. & Sol.-Terr. Phys. 81–82(**2012**)27

..tidal effects of planets on the solar surface are = $10^{-12} \cdot SUN_{Gravity}$

J. Javaraiah, Solar Physics 212(**2003**)23

Critical Analysis .. of the Planetary Tidal Influence on Solar Activity

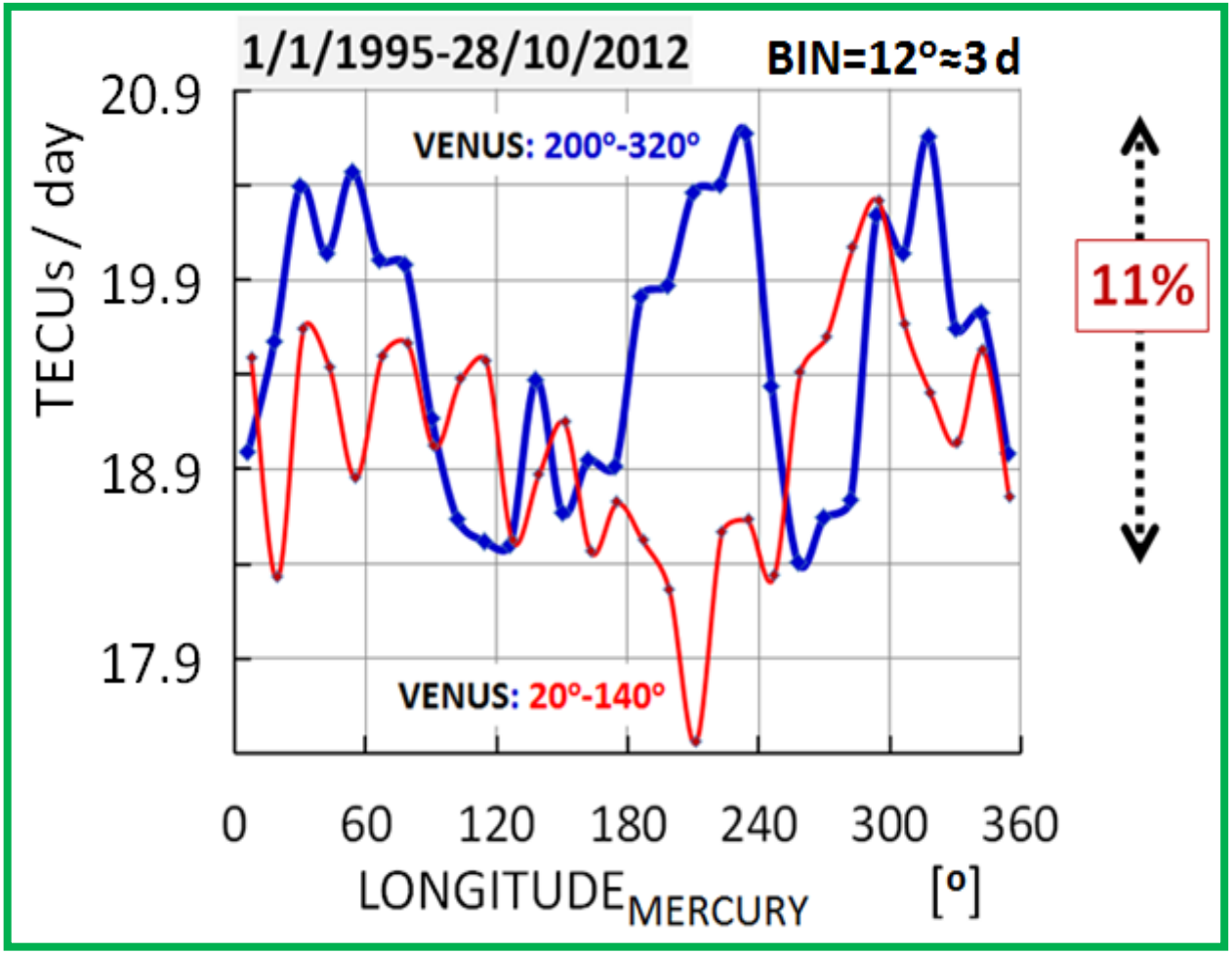
We found … ***artefacts*** caused by the calculation algorithm …

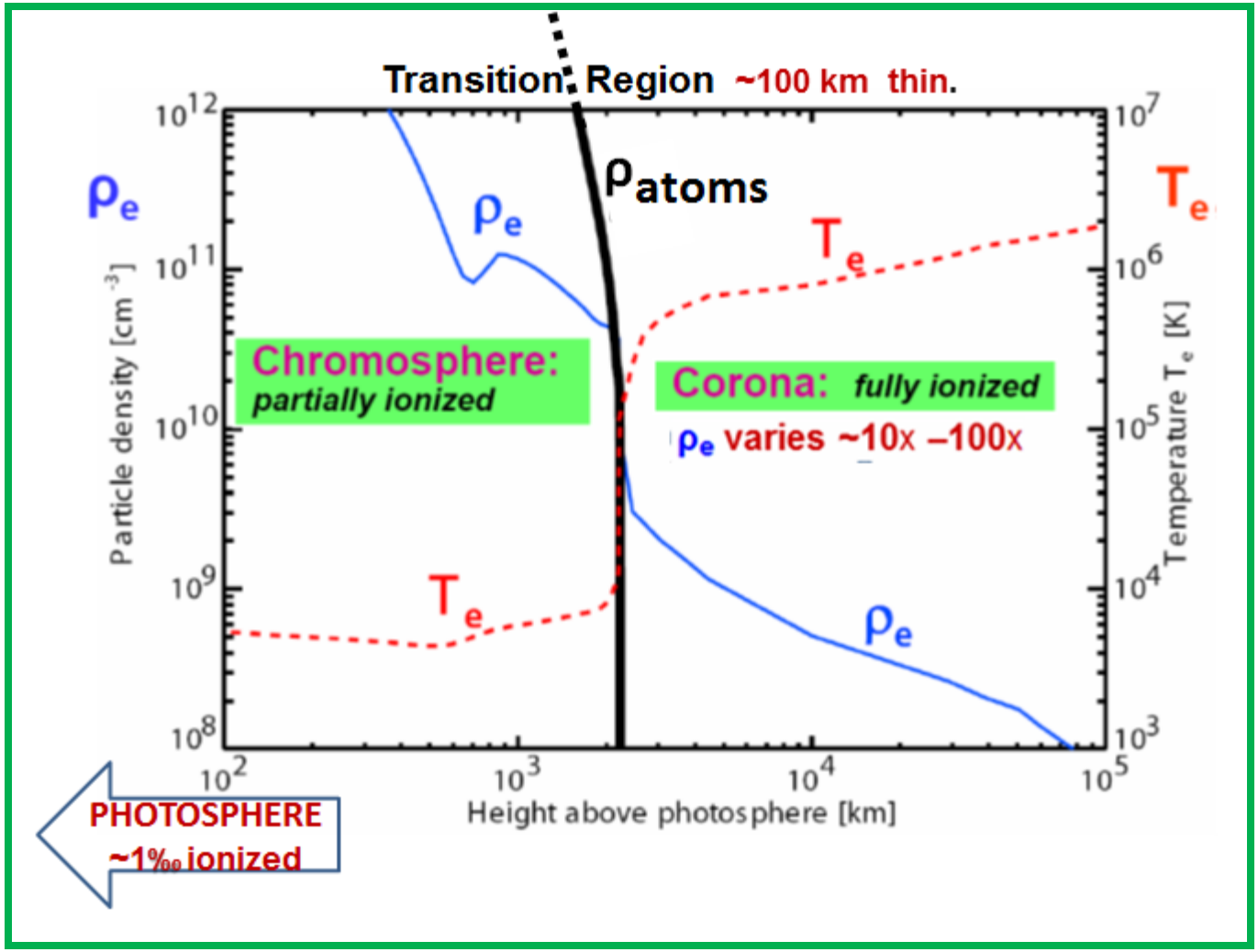
We conclude: the considered hypothesis [A.&A. 548(**2012**) A88]

is not based on a solid ground. S. Poluianov, I. Usoskin, Sol. Phys. 289(**2014**)2333

MERCURY
⊗
VENUS

ALL data




Transition Region ~100 km thin.
ρatoms
ρe
ρe
Te
Te
Chromosphere:
partially ionized
Corona: fully ionized
ρe varies ~10x –100x
Te
ρe
Particle density [cm⁻³]
Temperature Te [K]
Height above photosphere [km]
PHOTOSPHERE
~1‰ ionized