Marios Maroudas

Work with: Sergio Bertolucci, Konstantin Zioutas, Sebastian Hofmann

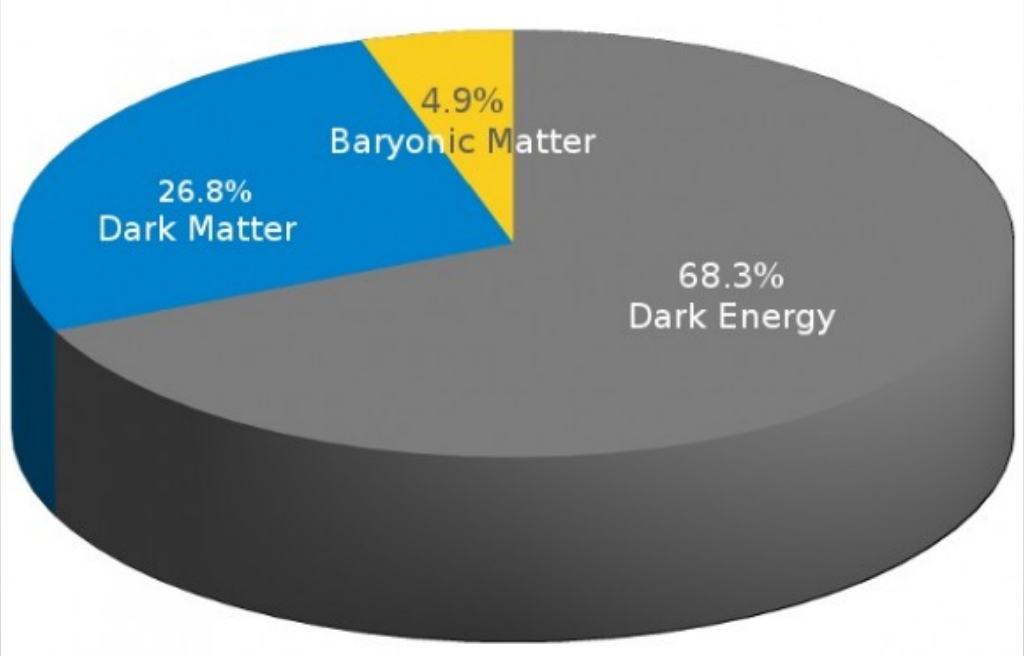
Signals for invisible matter from solar – terrestrial observations

[ ] 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.

ICNFP, Kolymbari, Crete
11/07/2016

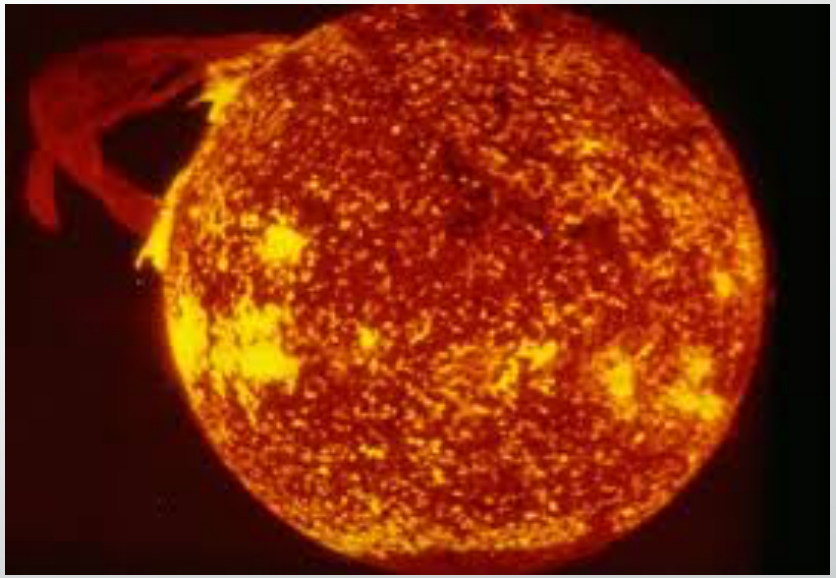
??Are insisting anomalies/mysteries in the solar system the unnoticed manifestation of the dark Universe??



Solar Flares (1859 - Now)

".. One of the great solar mysteries" (2014)

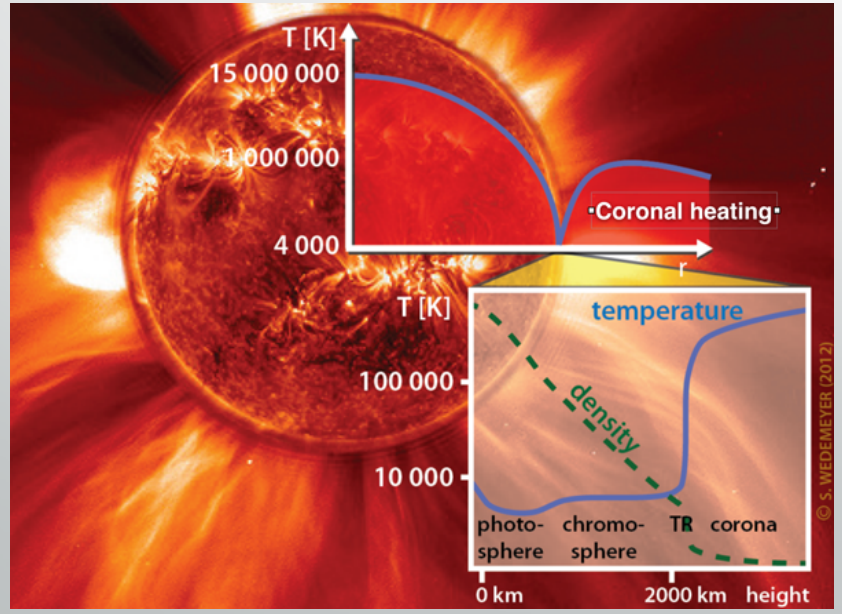
- Bursts of X-rays
- Unknown physical mechanism
- **Seismic Waves**: many open questions (2016)

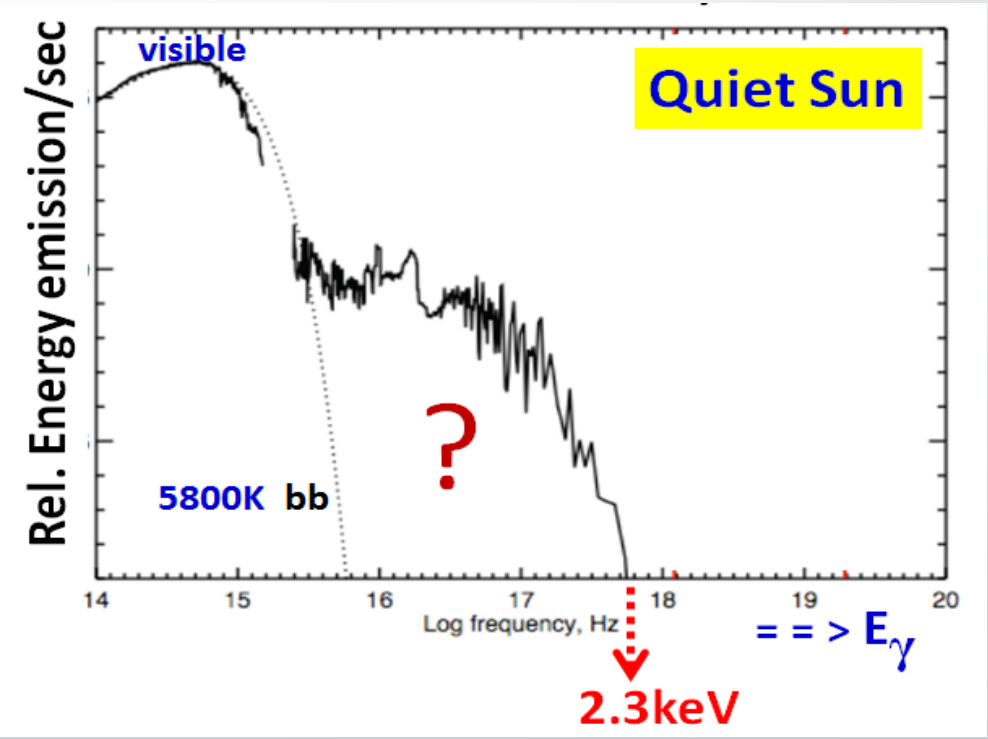


Solar Corona problem (1939 - Now)

"One of the outstanding unsolved problems in astrophysics" (2015)

- EUV excess
- Sun's upper atmosphere much hotter than its surface => Why?





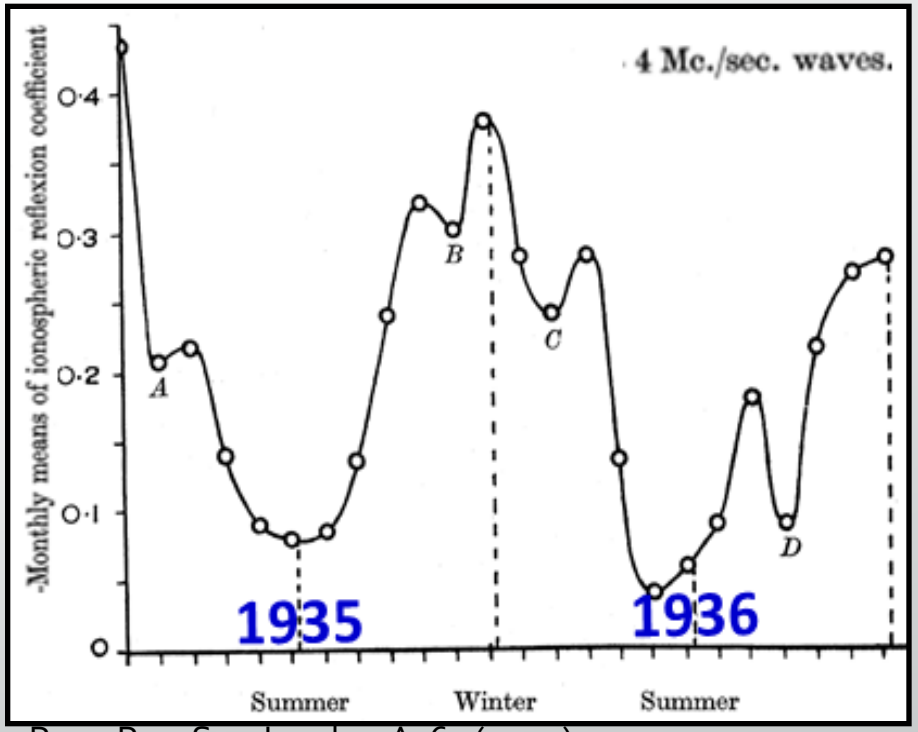
Earth's Atmosphere (1937 - Now)

"a long standing unexplained annual anomaly" (2011)

- Annual anomaly
- **T**otal **E**lectron **C**ontent:

$TEC_{DECEMBER} > TEC_{JUNE}$

$2.87 > 2.12 \; [10^{32} e^{-} s]$



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

Driving Idea

- 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

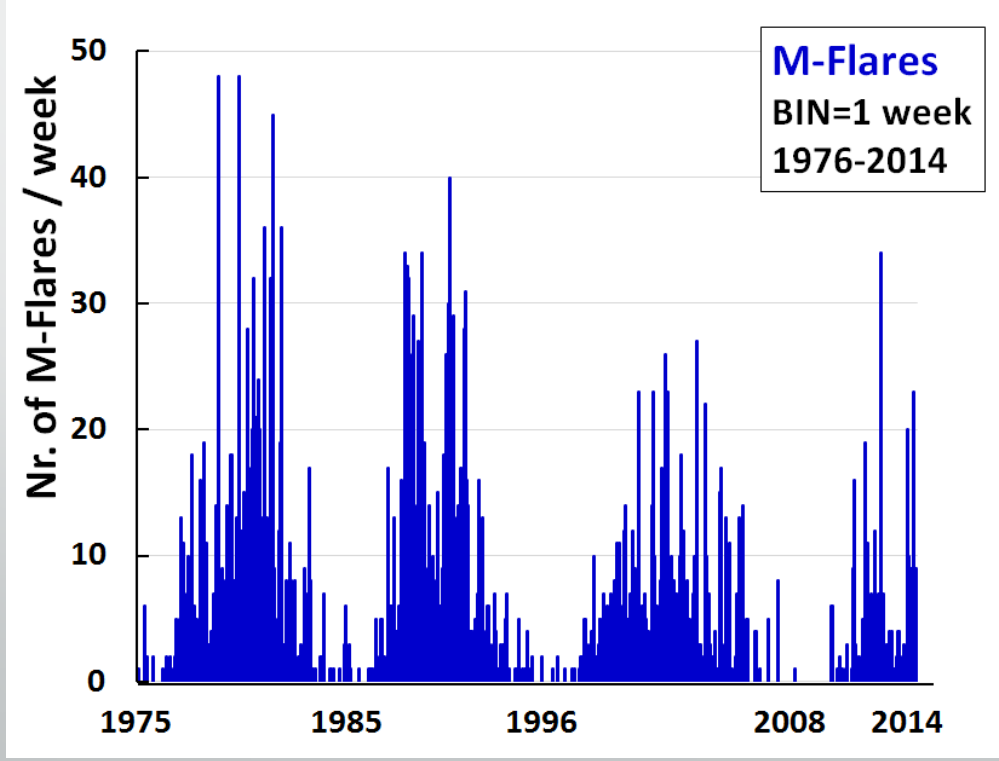
?

Origin

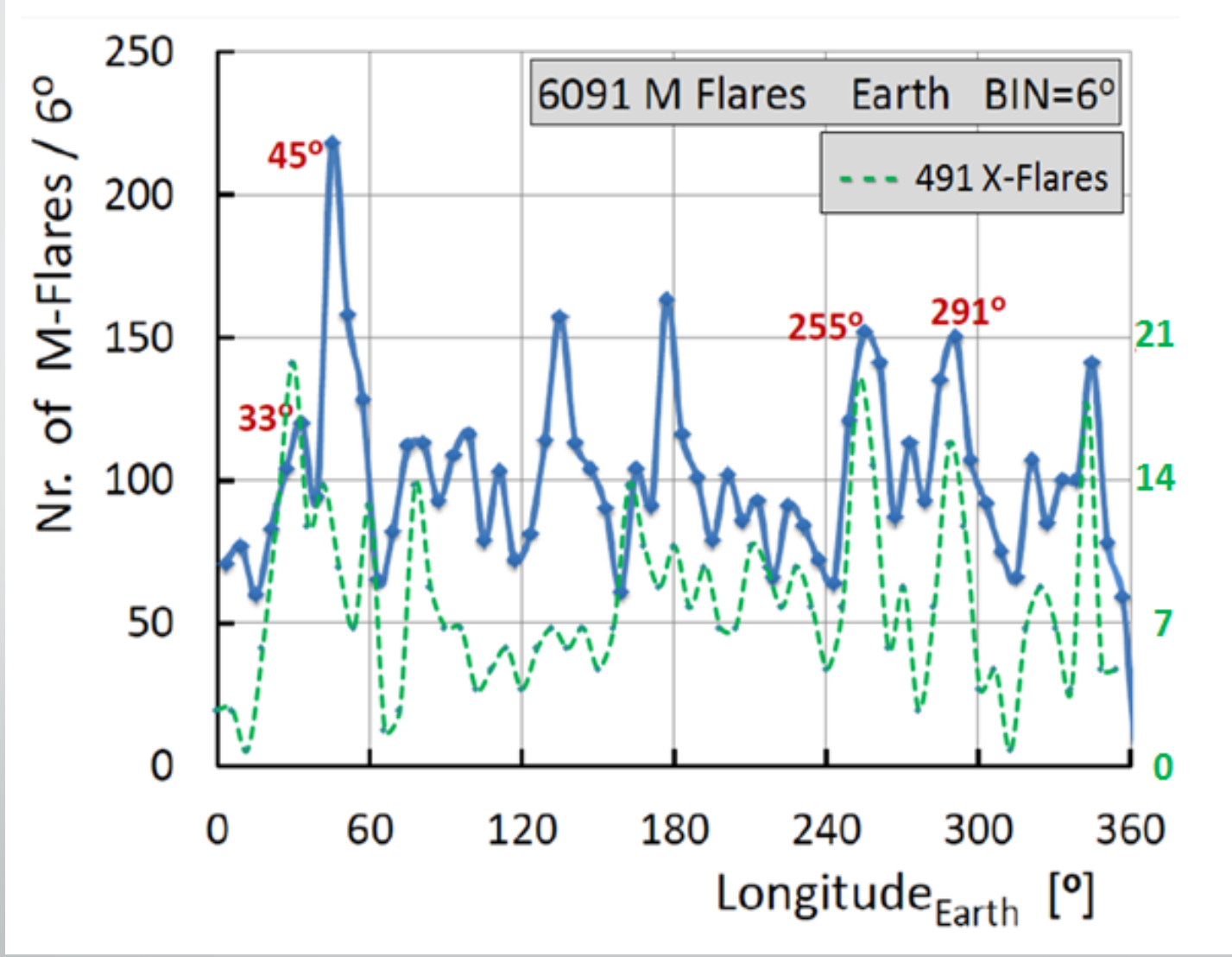
Solar Flares

Related work so far:

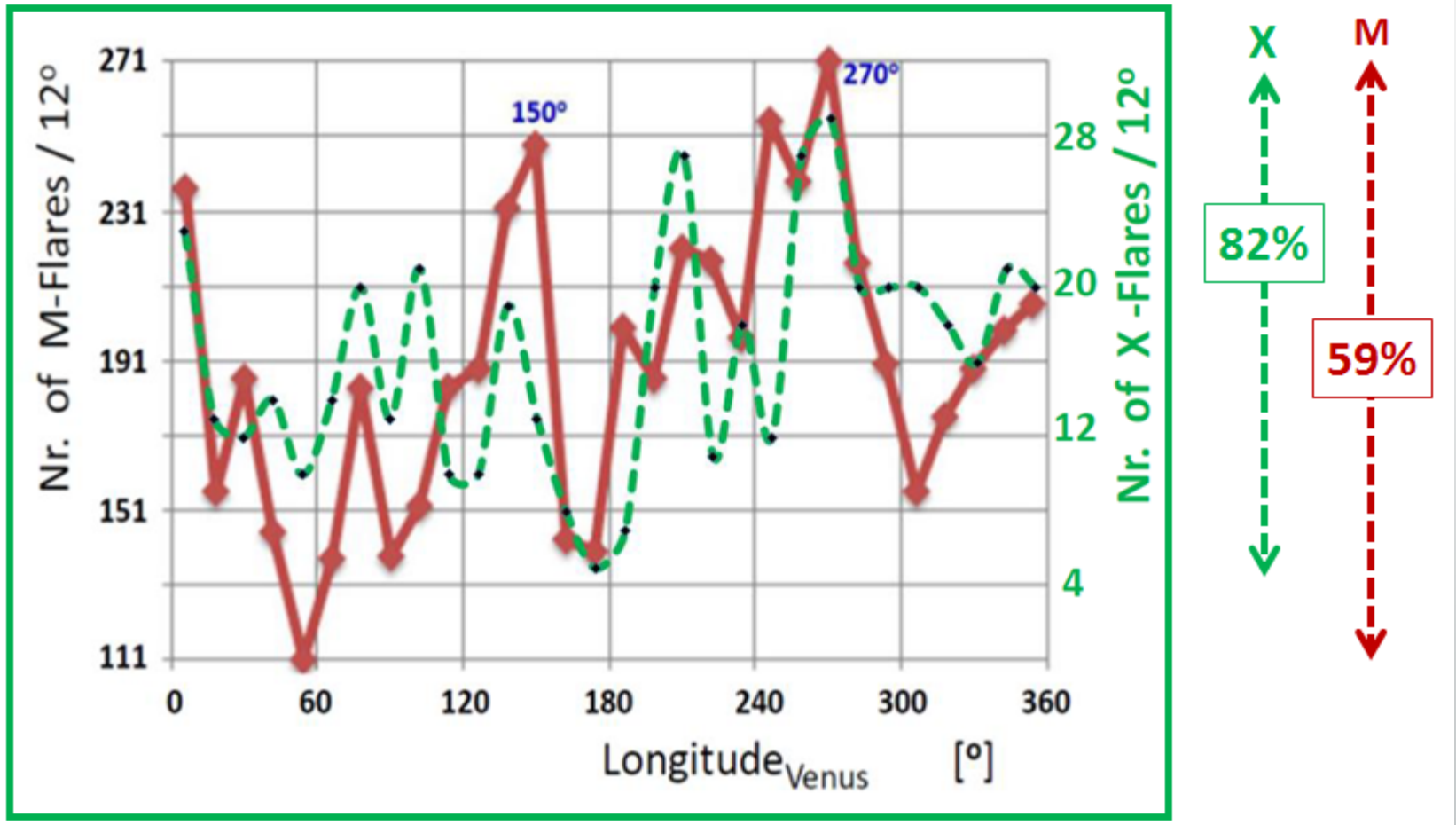
Fourier analysis of time series observations



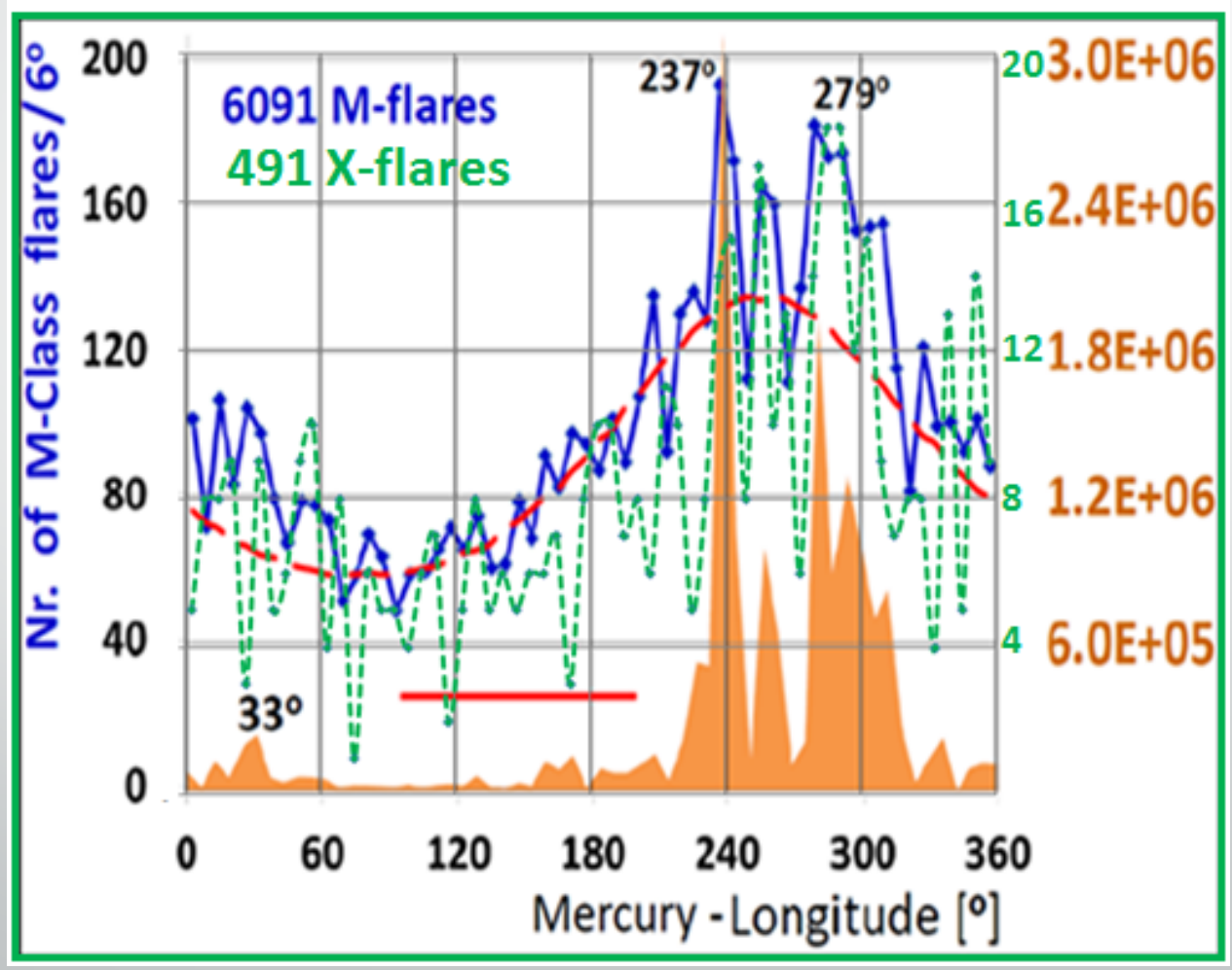
Solar Flares - EARTH



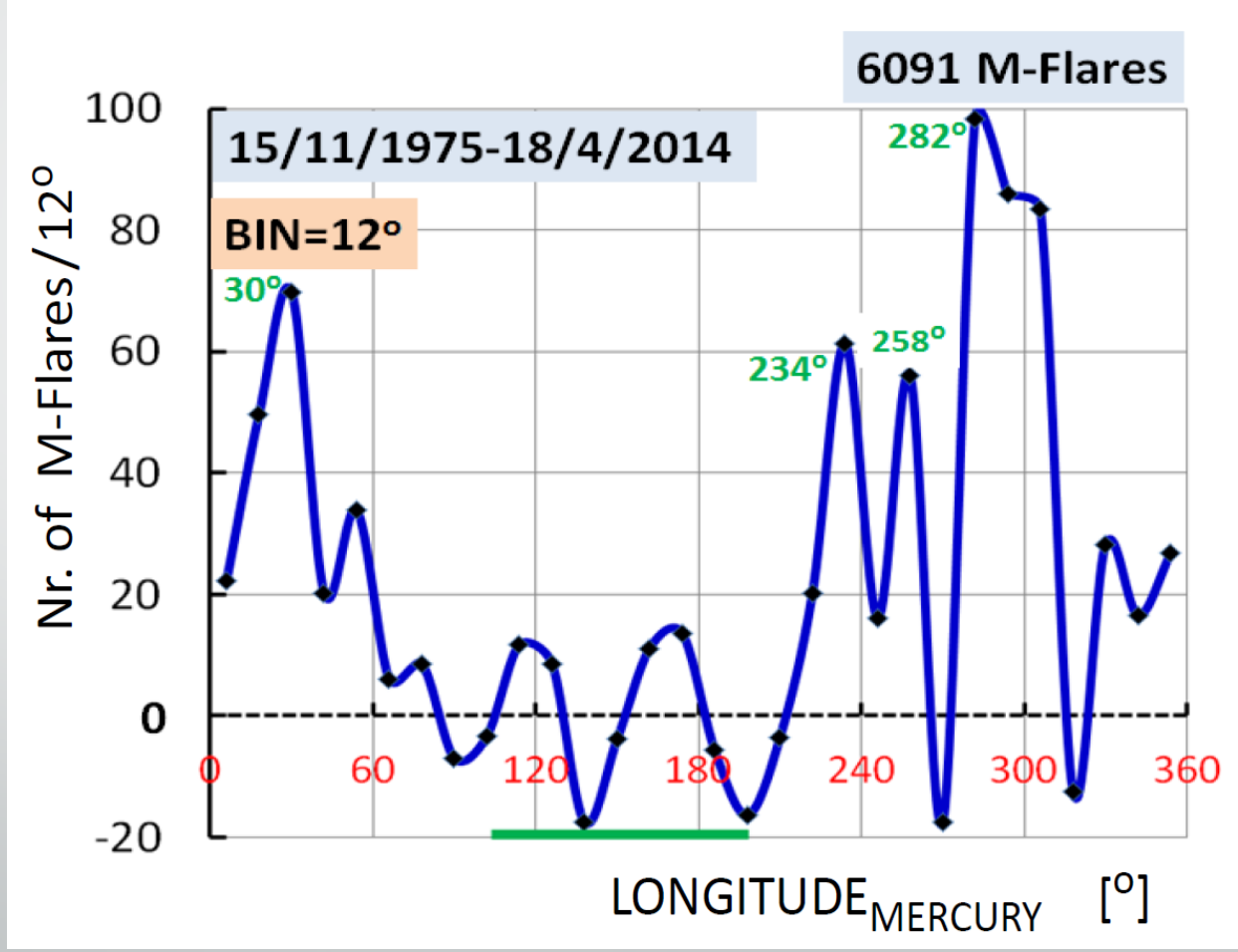
Solar Flares - VENUS



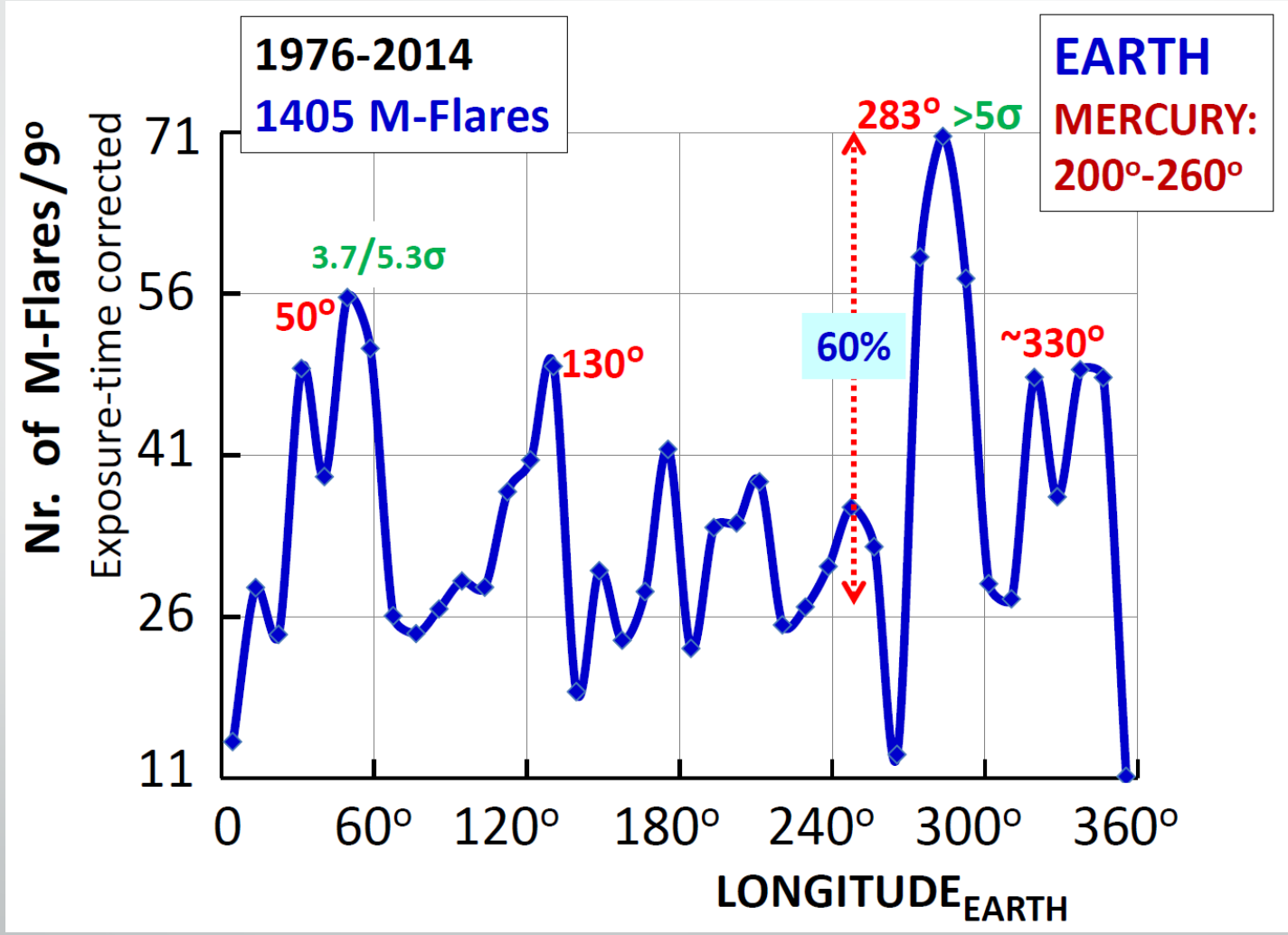
Solar Flares - MERCURY



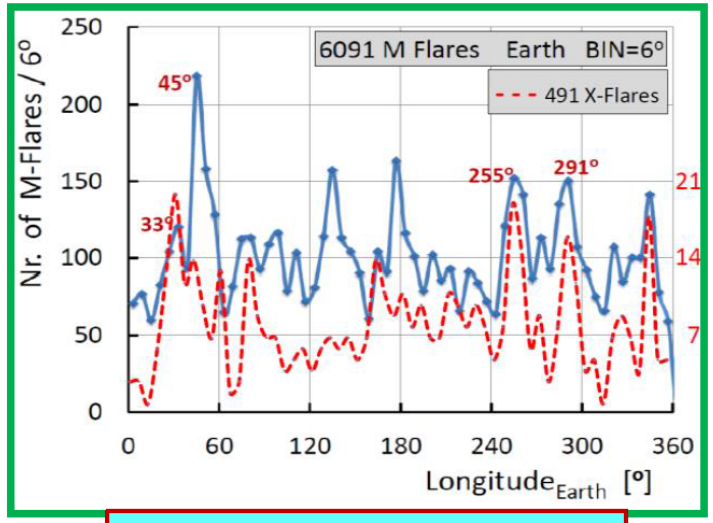
Solar Flares - MERCURY



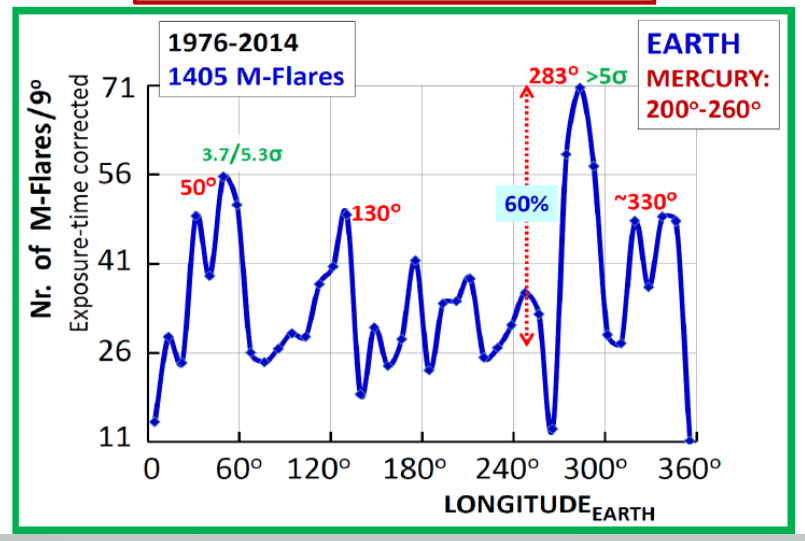
Solar Flares - EARTH ⊗ MERCURY



Solar Flares - EARTH ⊗ MERCURY



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

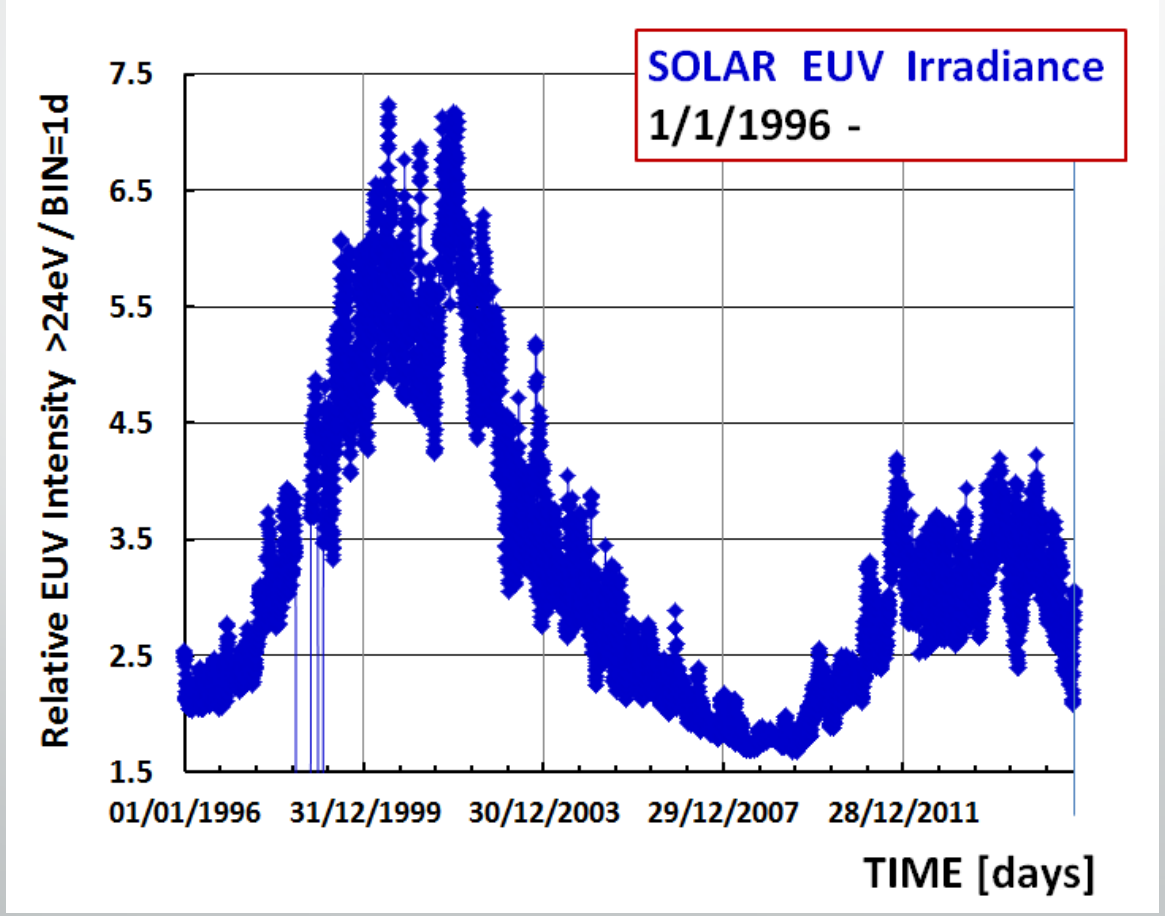


ALL M-Flares

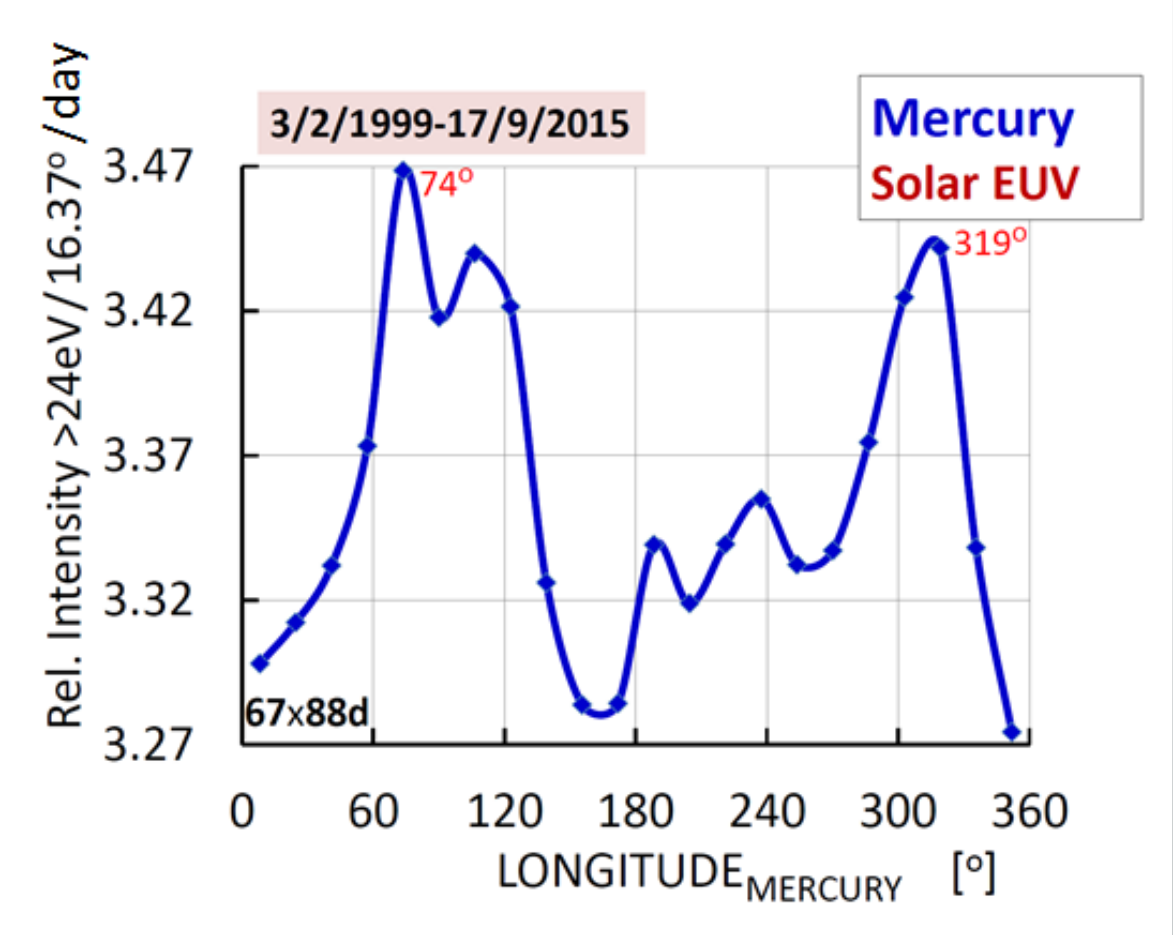
1405 M-Flares
Mercury:
200°-260°

Solar EUV > 24eV

Unexpected for a 5800K bb

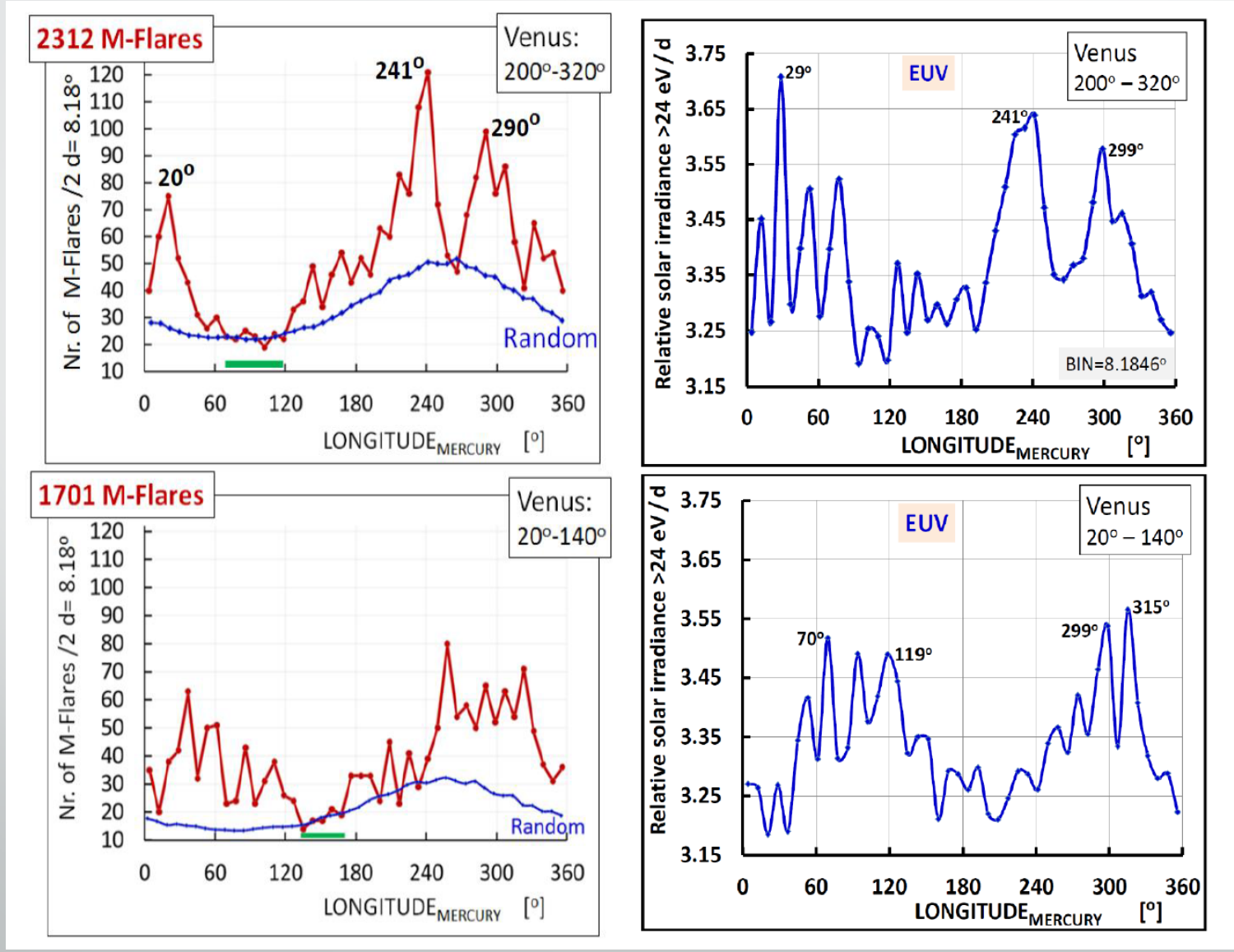


Solar EUV - MERCURY

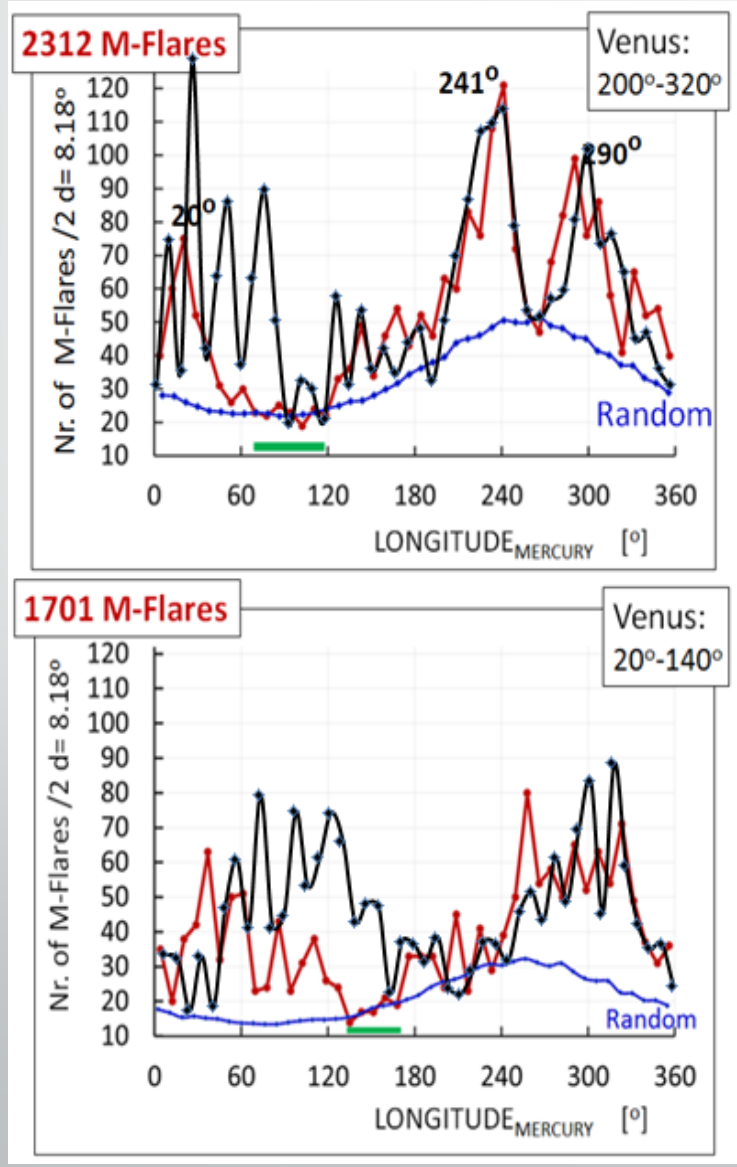


6%

M-Flares + EUV - MERCURY ⊗ VENUS



M-Flares + EUV - MERCURY ⊗ VENUS



Solar flaring activity ⇔ EUV emission

=> corona

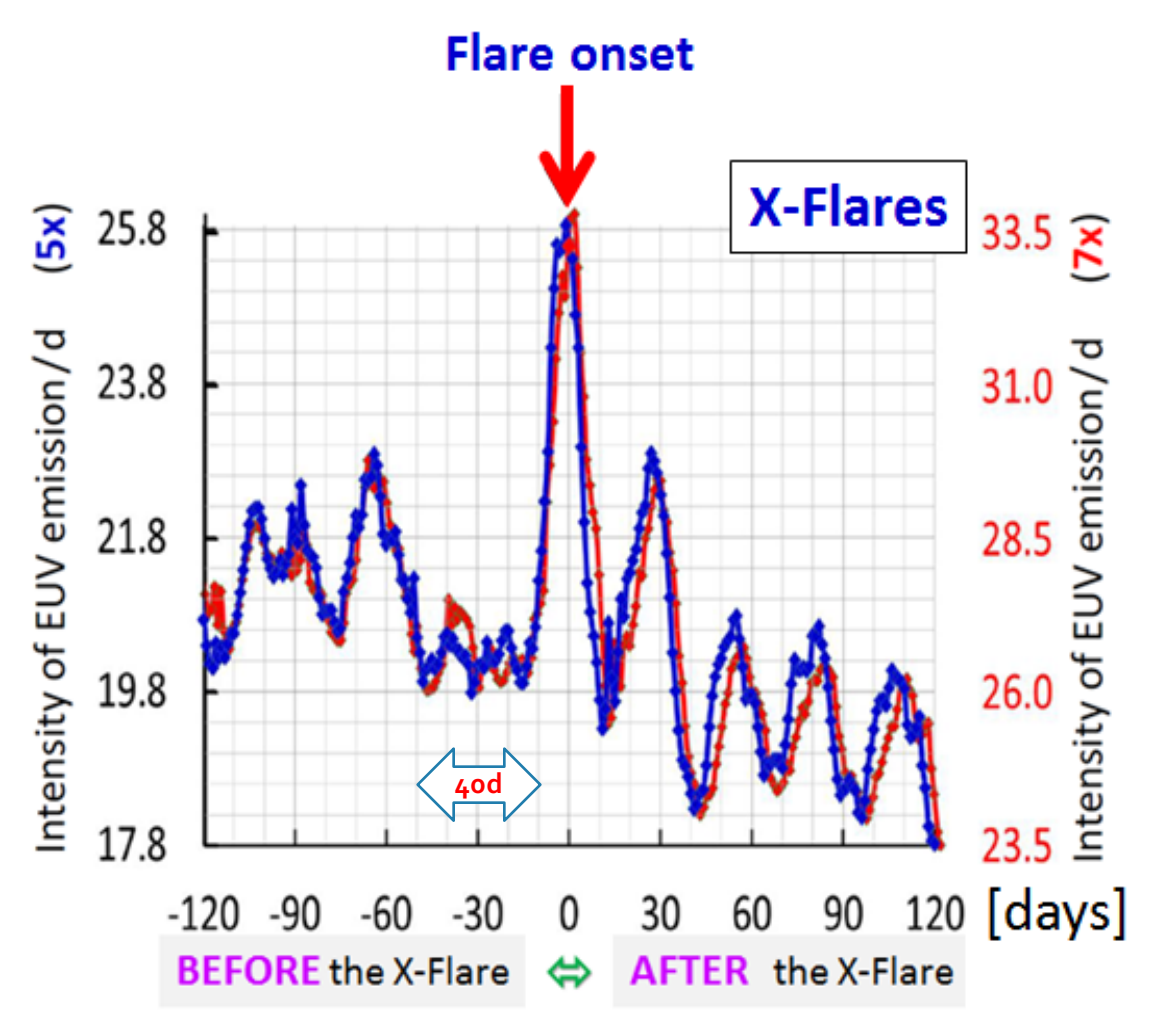
>>> (partly) common origin**?**

X-Flares + EUV

02/04/2001
28/12/2001

01/11/2003
20/01/2005

08/09/2005

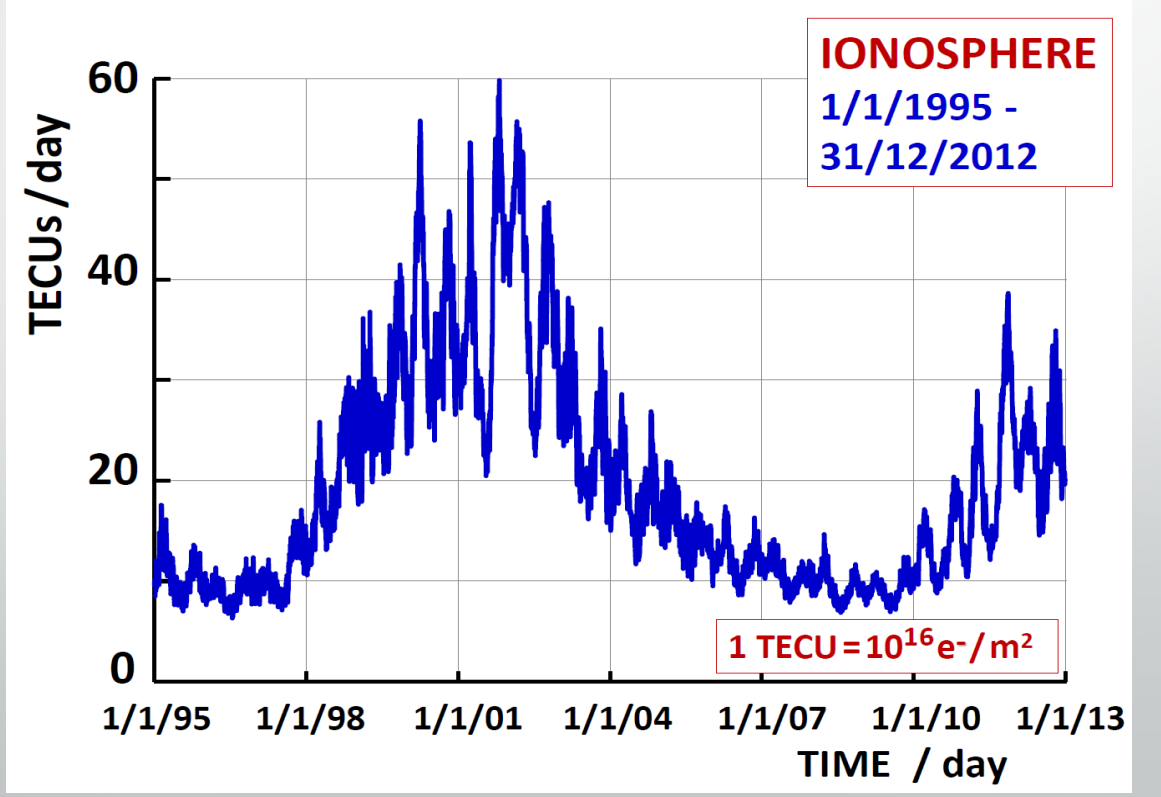


12%

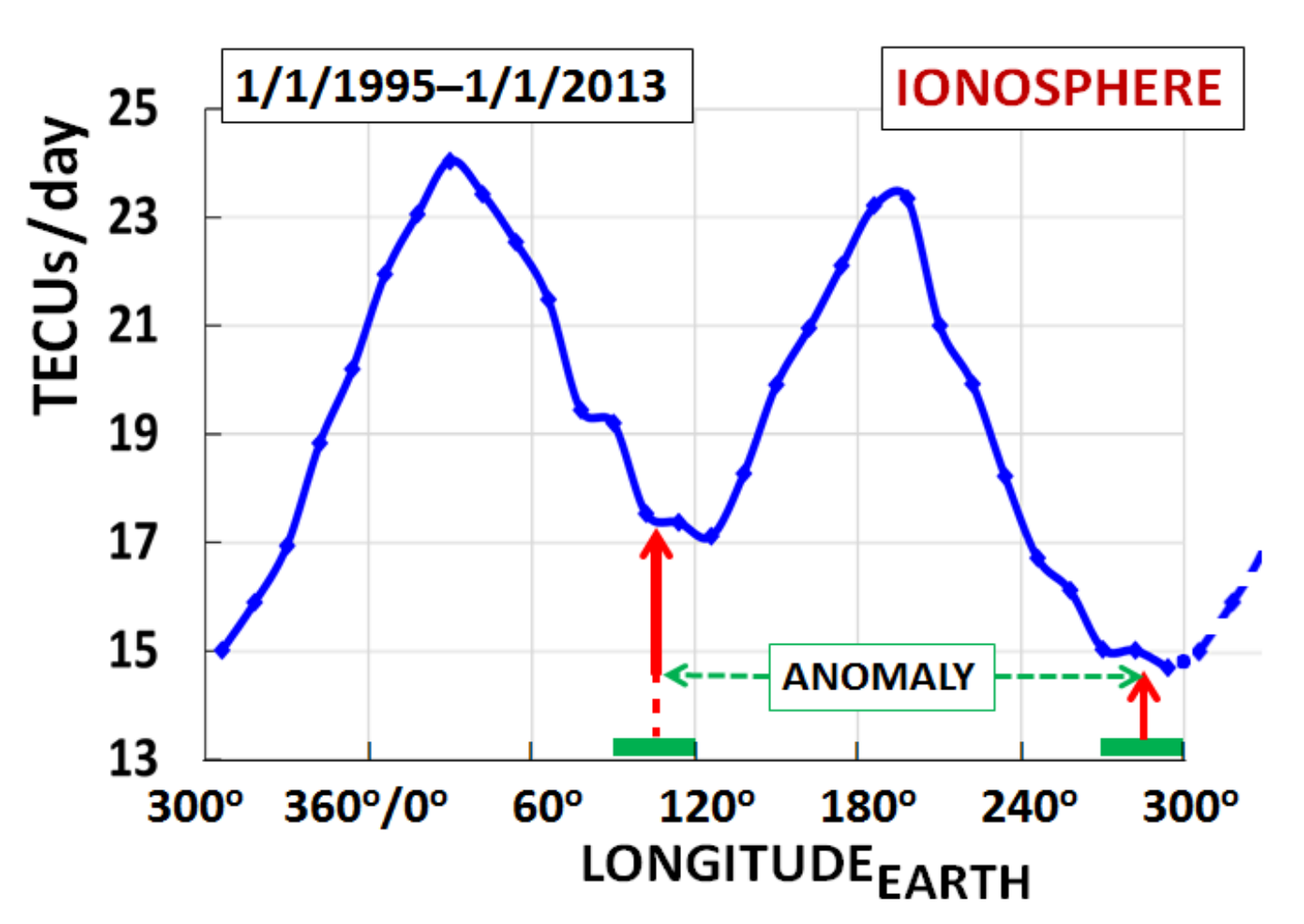
02/04/2001
28/12/2001
28/10/2003
04/11/2003
20/01/2005
07/09/2005
09/09/2005

Earth's Ionosphere

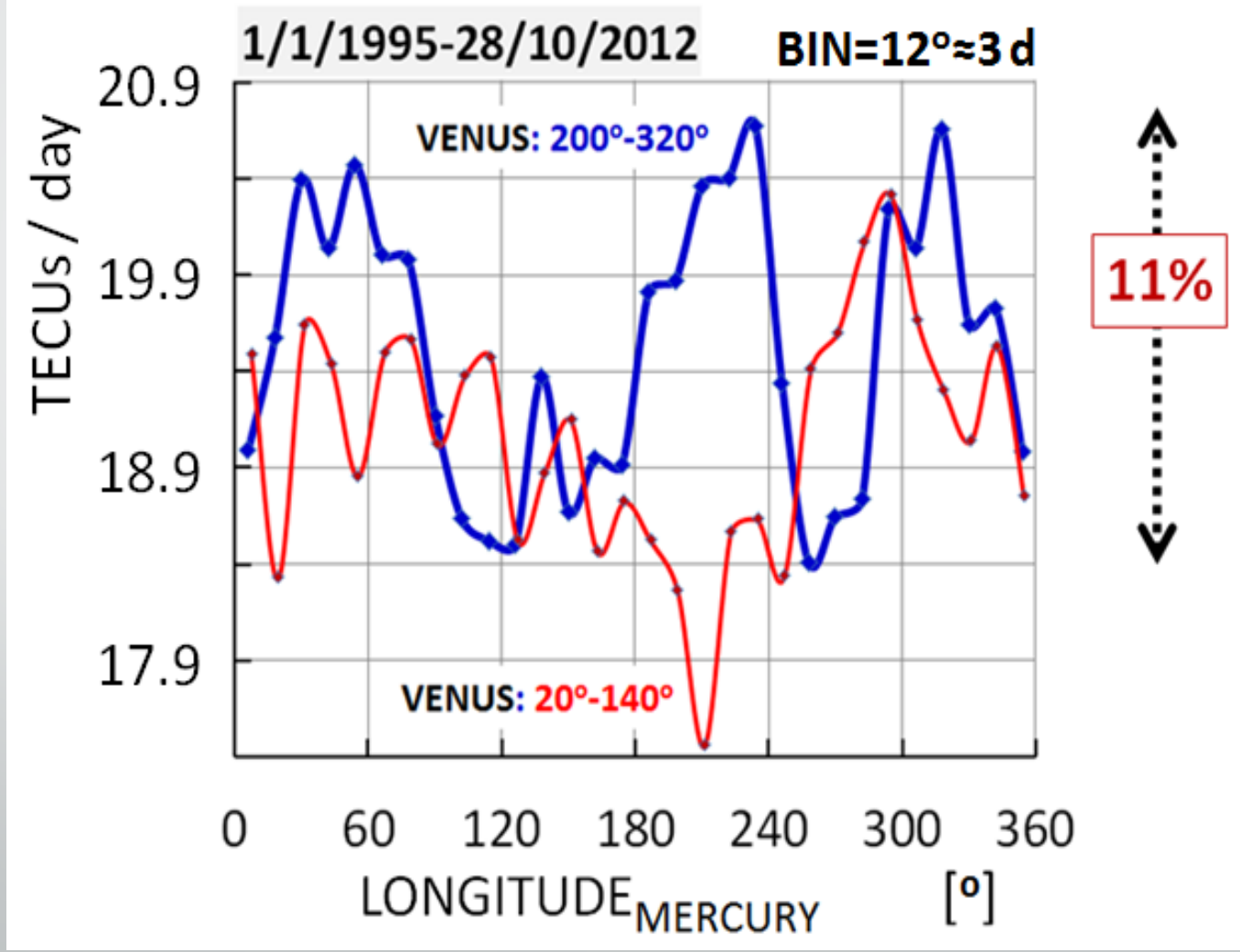
Anomalies lasting for some decades:
First observations 1937/1938



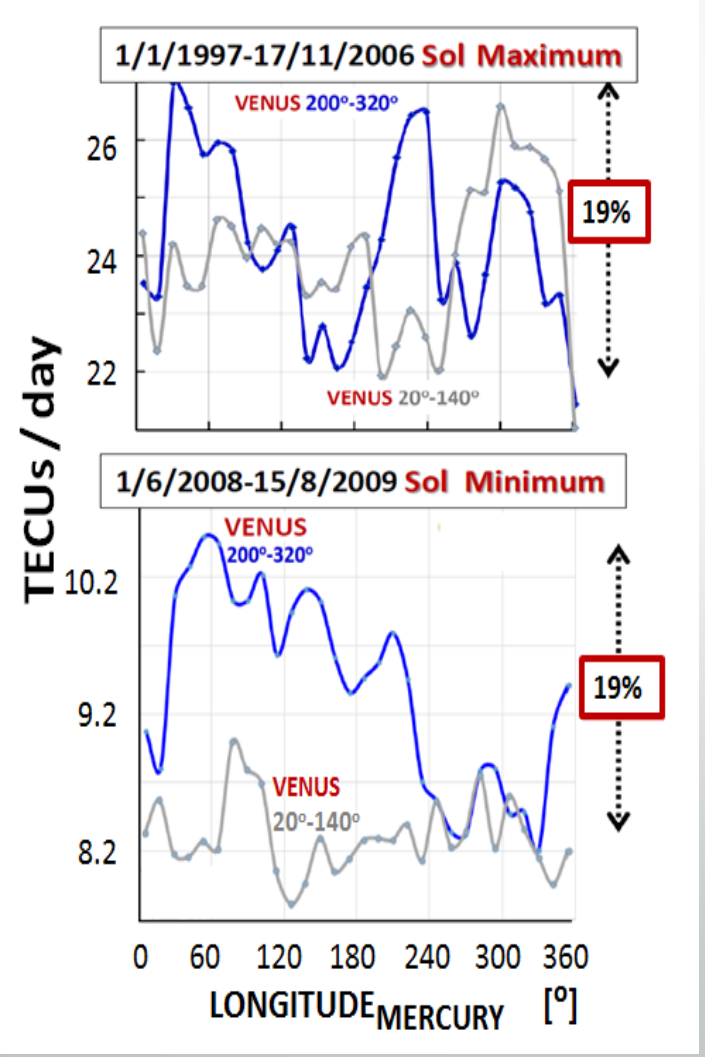
Earth's Ionosphere - EARTH

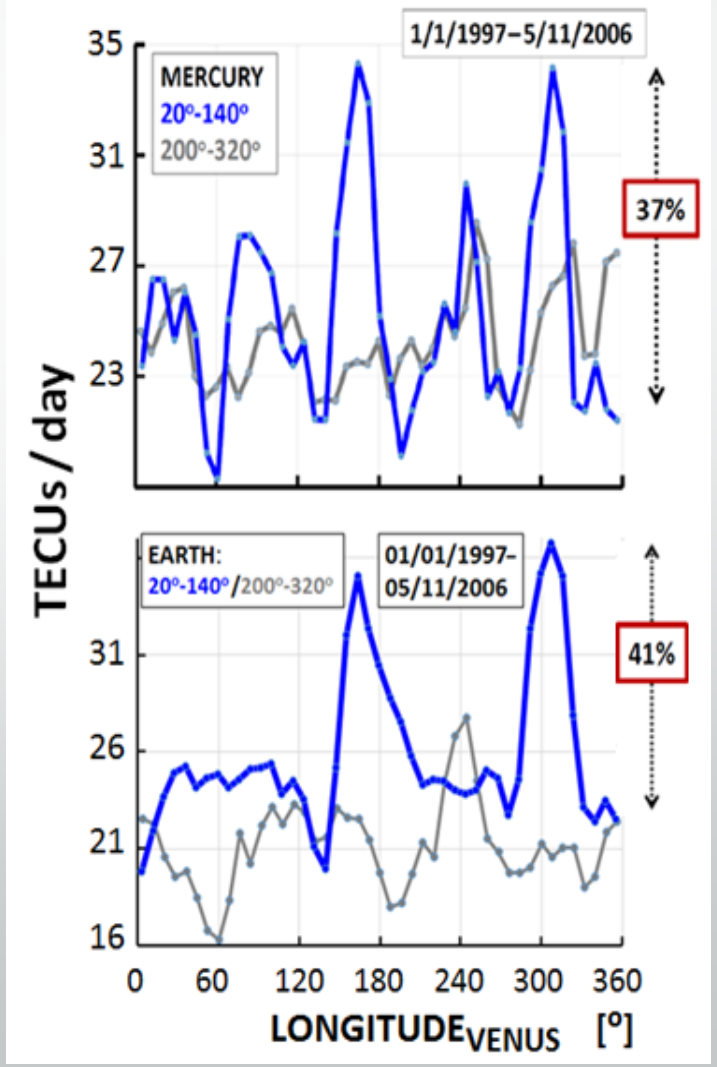


Earth's Ionosphere - MERCURY ⊗ VENUS

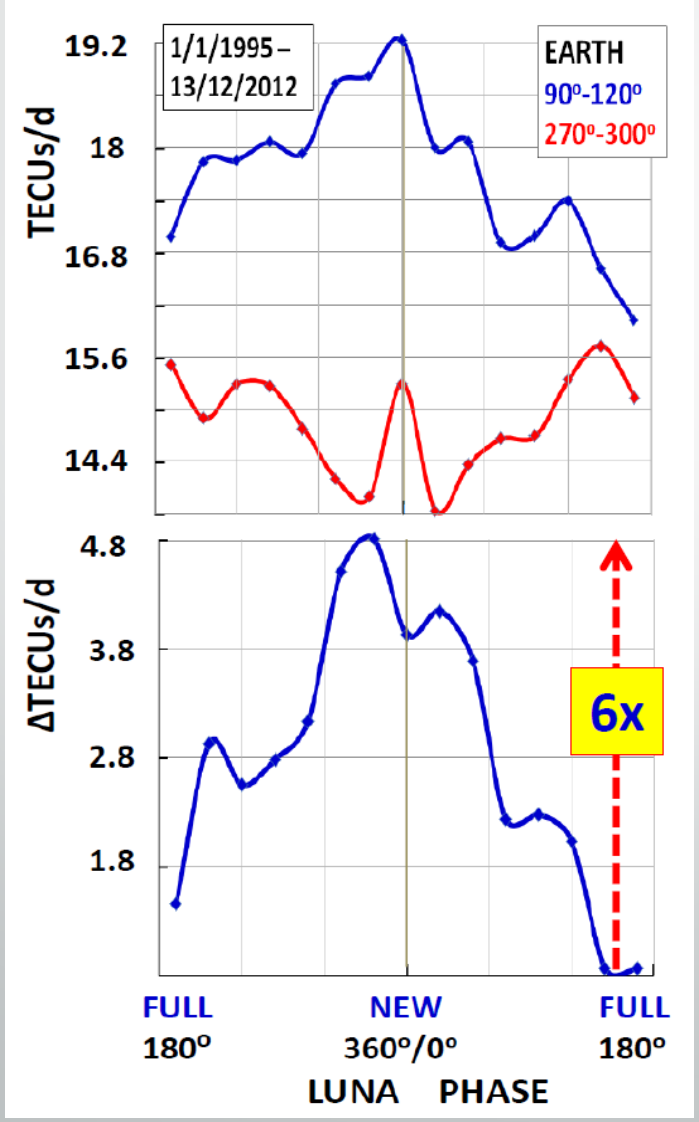


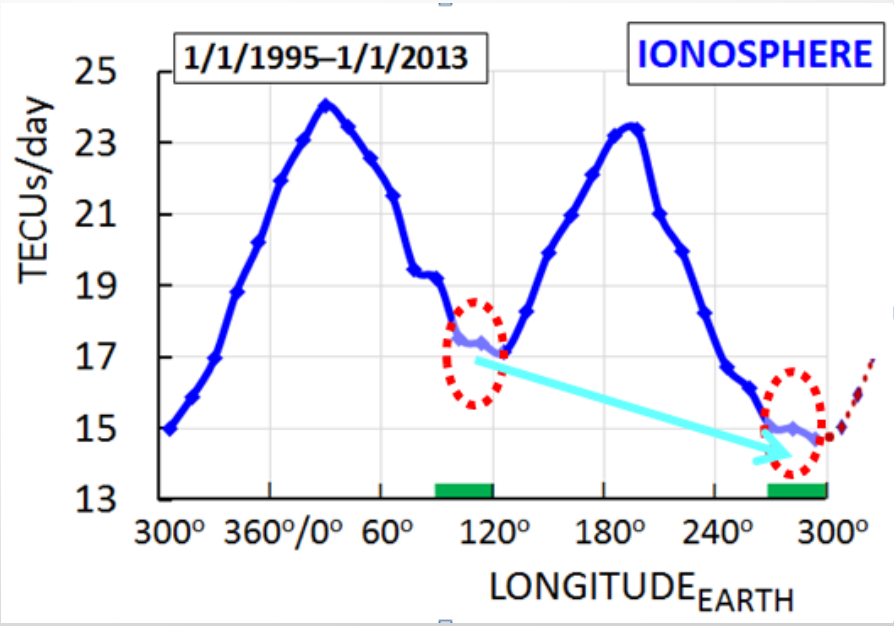
Earth's Ionosphere - MERCURY ⊗ VENUS ⊗ EARTH (Max / Min)



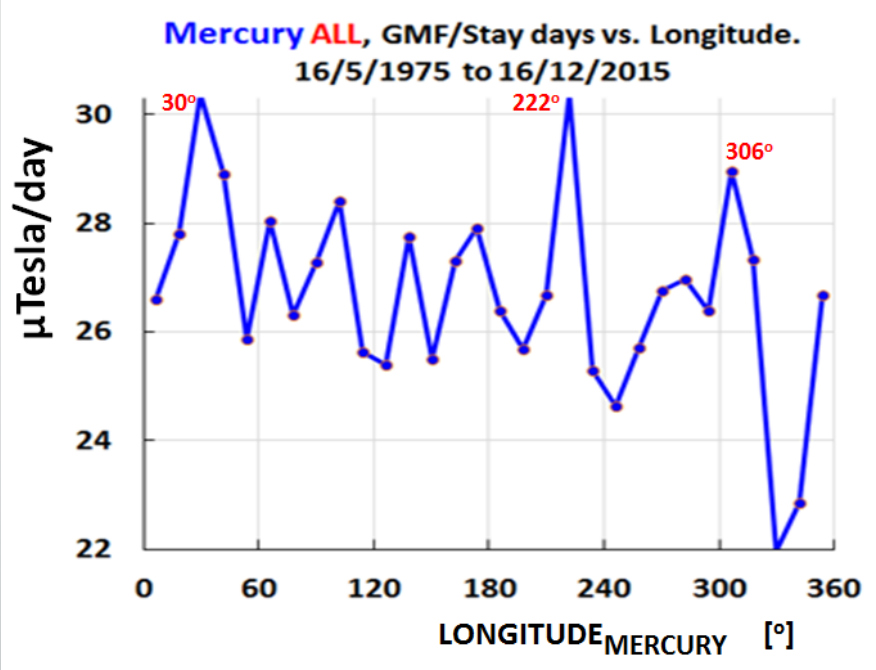


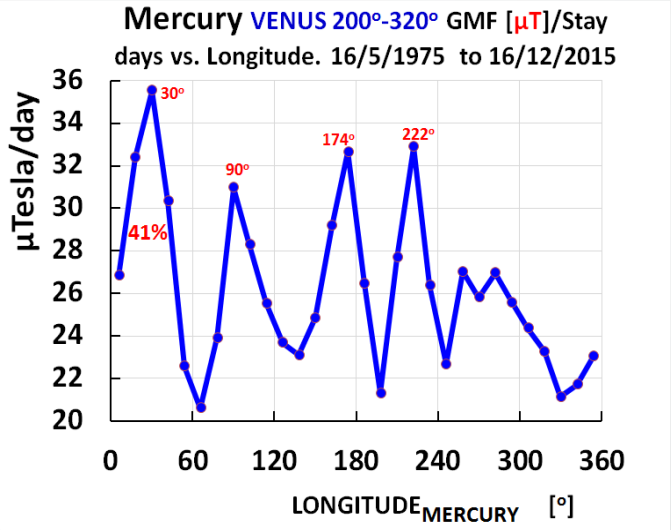
Earth's Ionosphere - MOON ⊗ EARTH

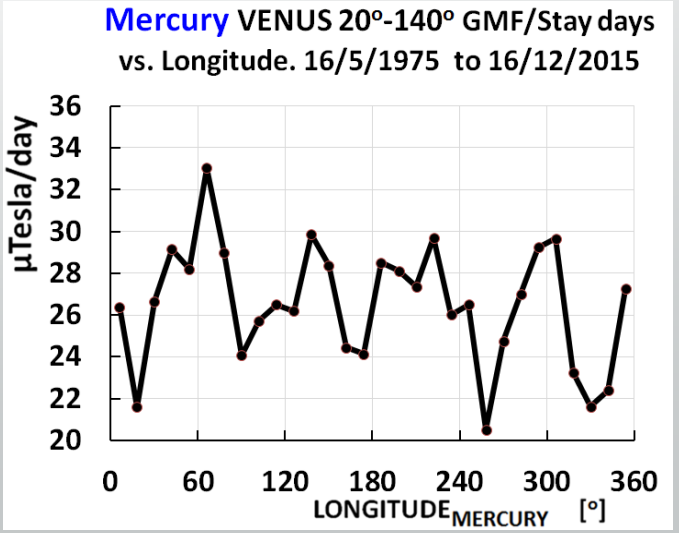




!!Sun's Global Magnetic Field (1975 - 2015)!!







PRELIMINARY

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 and 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!!!

EXTRA SLIDES

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]

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

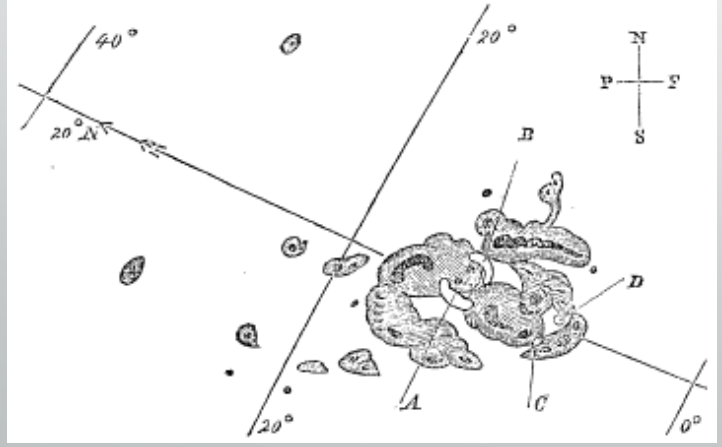
- *… solar flares + CMEs … one of* ***the great solar mysteries*** **2014**

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

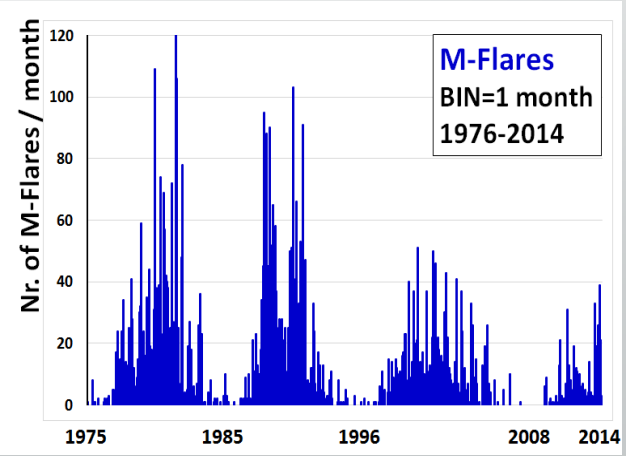
- *what powers a flare? what triggers it?*

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

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



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



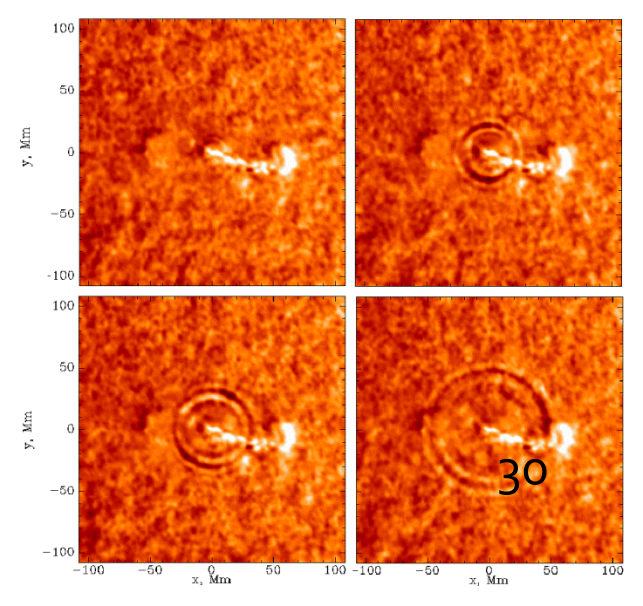
time

Solar quakes: 1998-

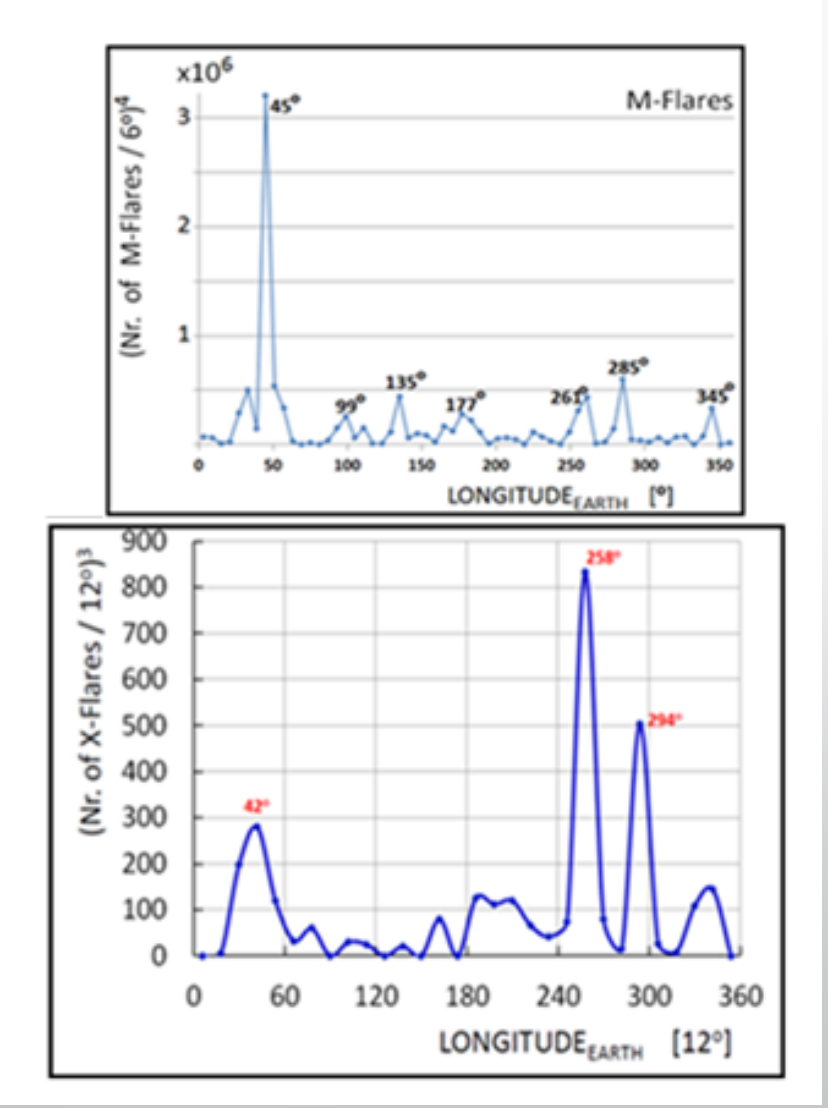
- *… are still **mysterious*** arXiv:**1402**.1249v1.
- *"Surprising: in some cases, the sunquake initiating impacts are observed in the early impulsive or even pre-heating phase.. and even without a significant hard X-ray signal"*

  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"*

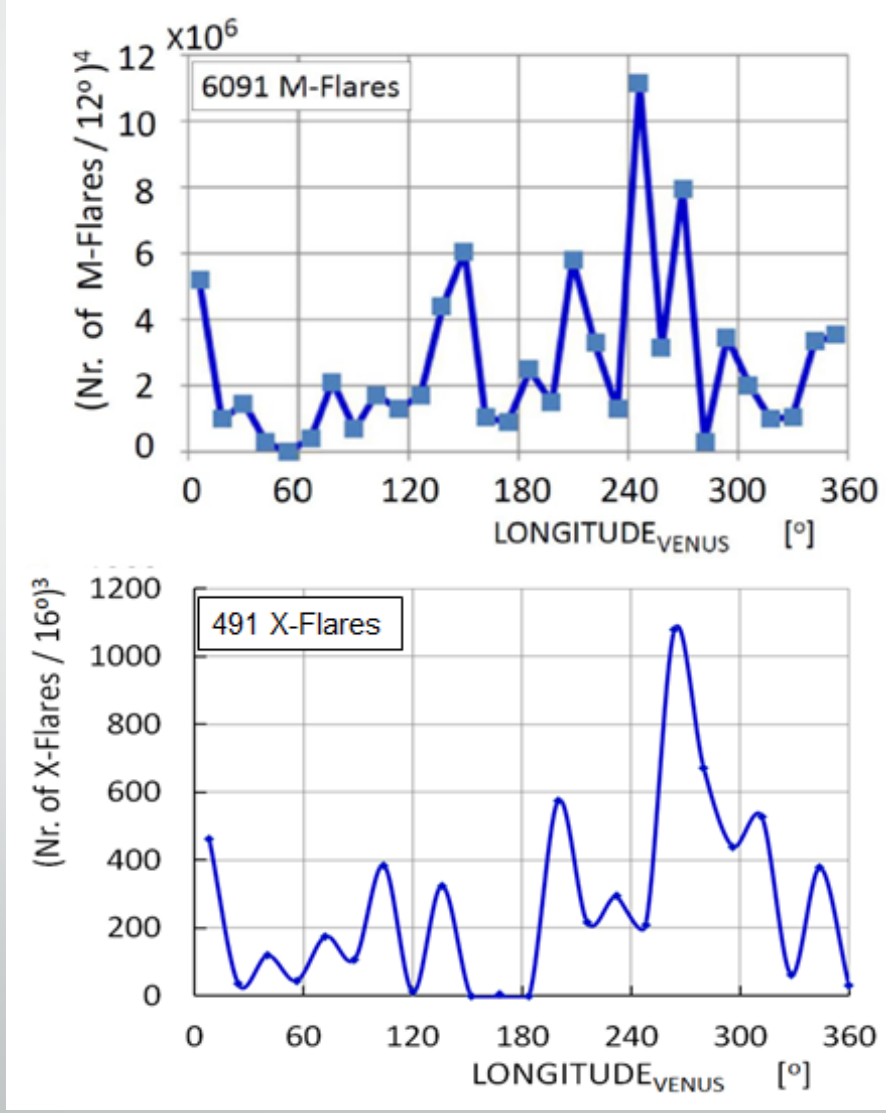
  http://sohowww.nascom.nasa.gov/bestofsoho/Helioseismology/mdio26.html
- **many open questions** … most notably the nature of the excitation mechanism(s) comes from a source area ~(3000km)^2 ➔ $10^{11\pm1}$ erg/cm^2 arXiv:1602.08245 **2016**



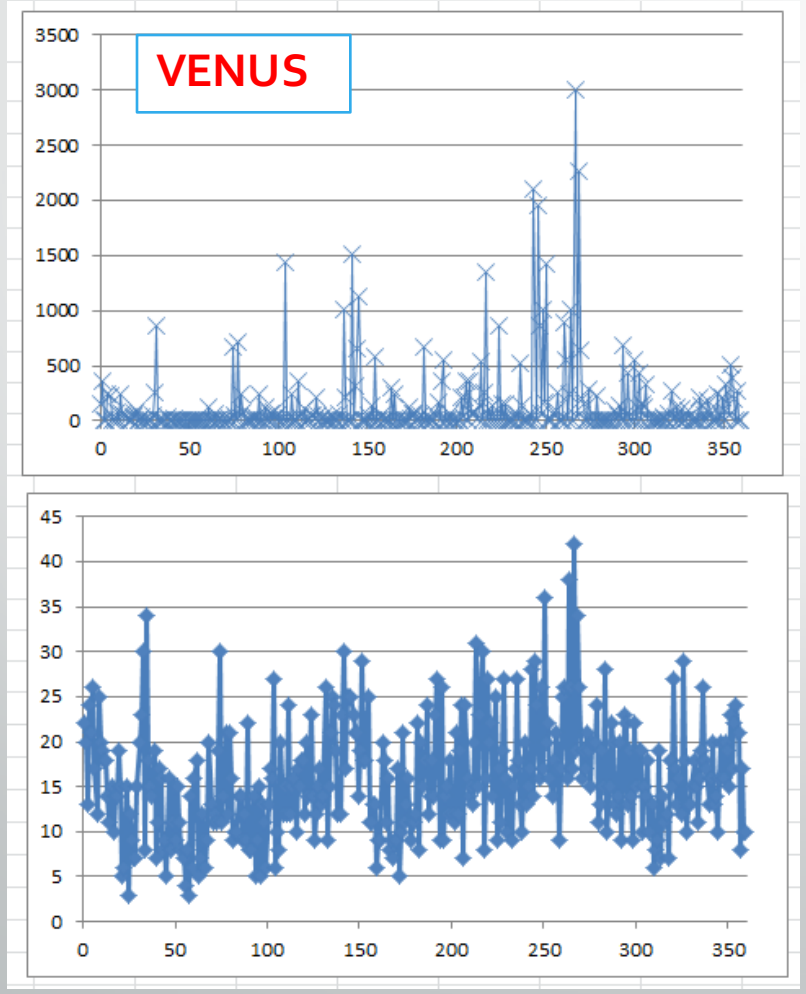
Solar Flares - EARTH

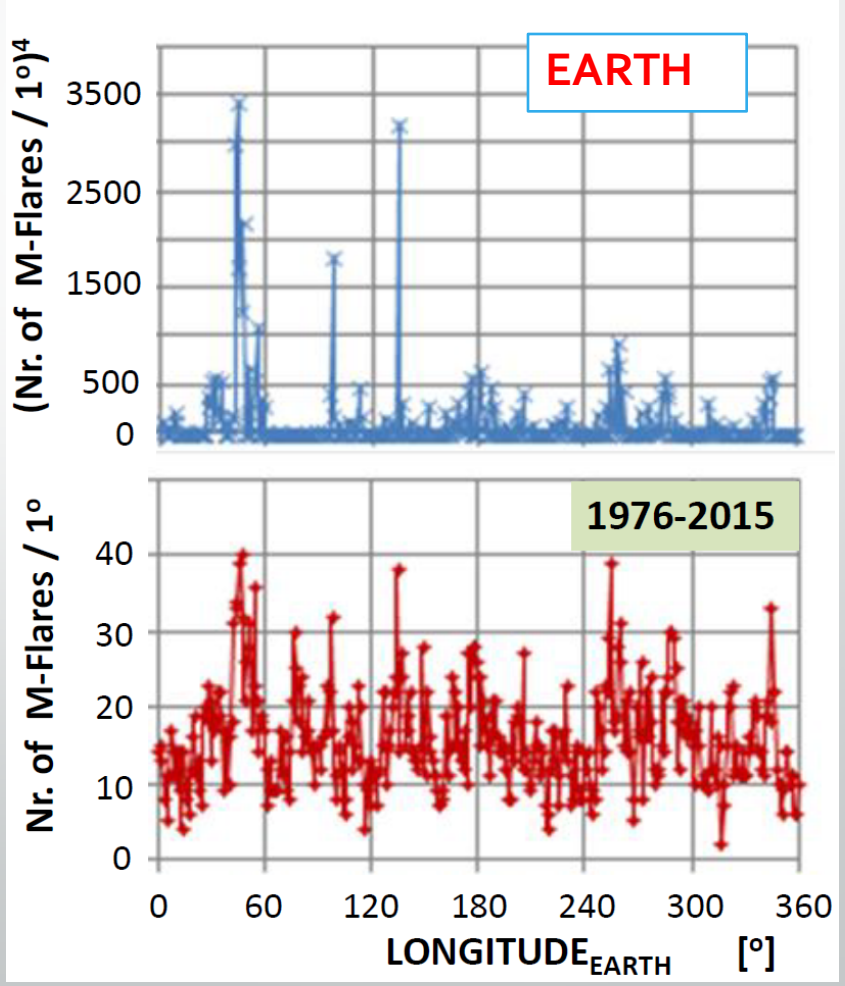


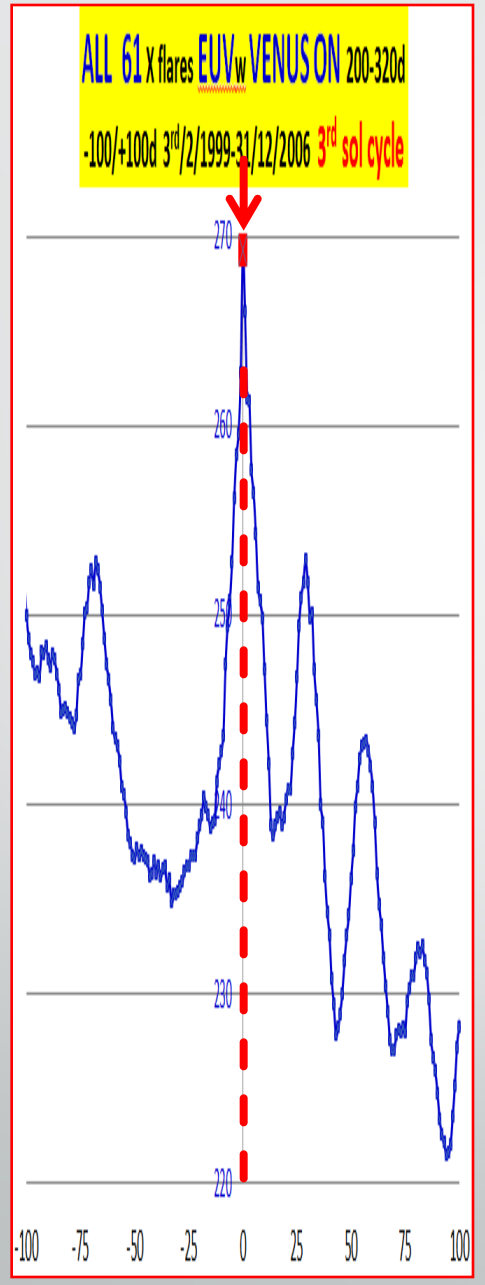
Solar Flares - VENUS

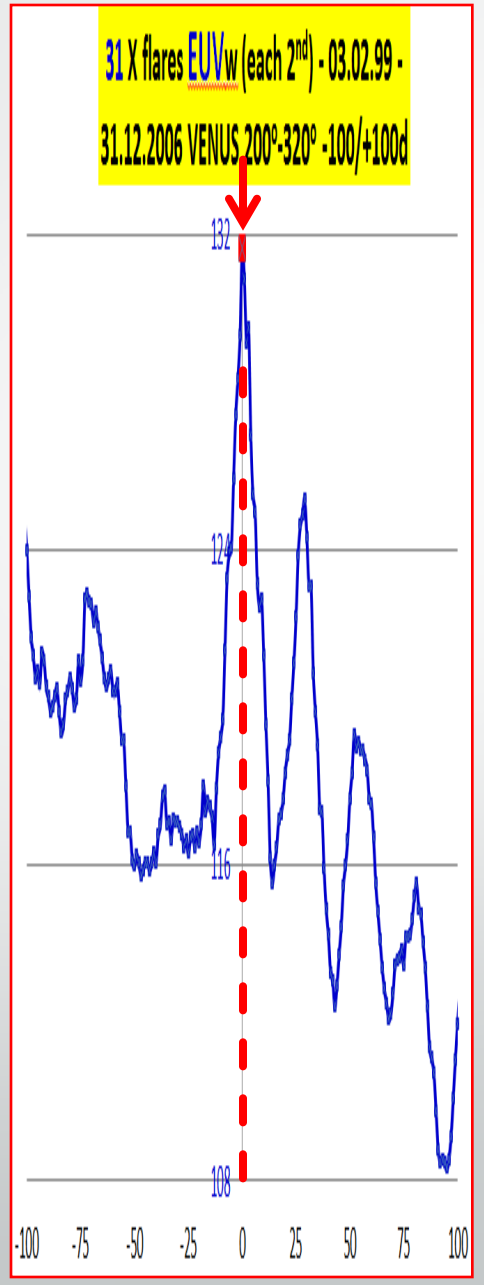


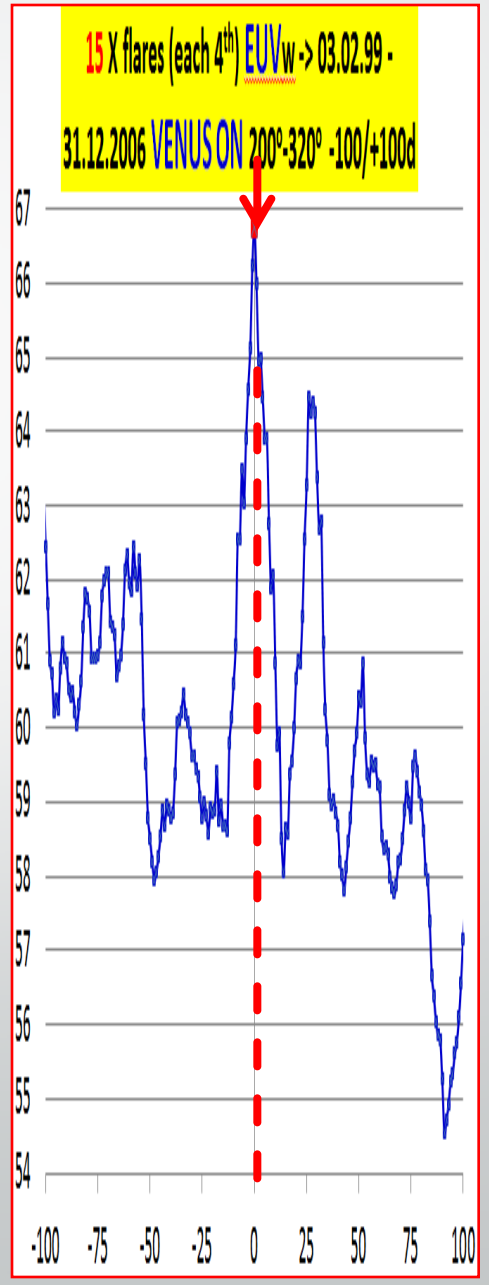
Solar Flares – VENUS, EARTH

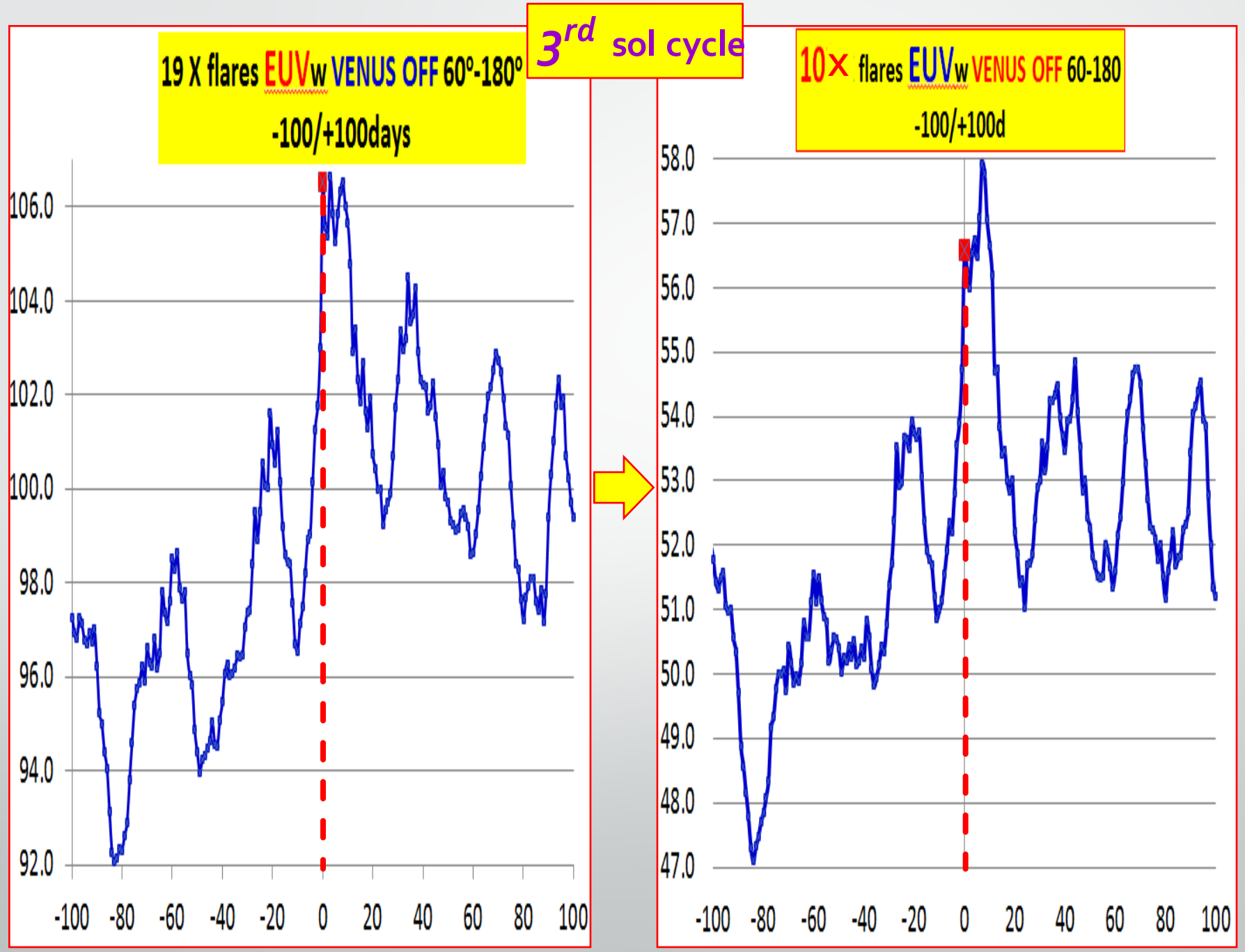




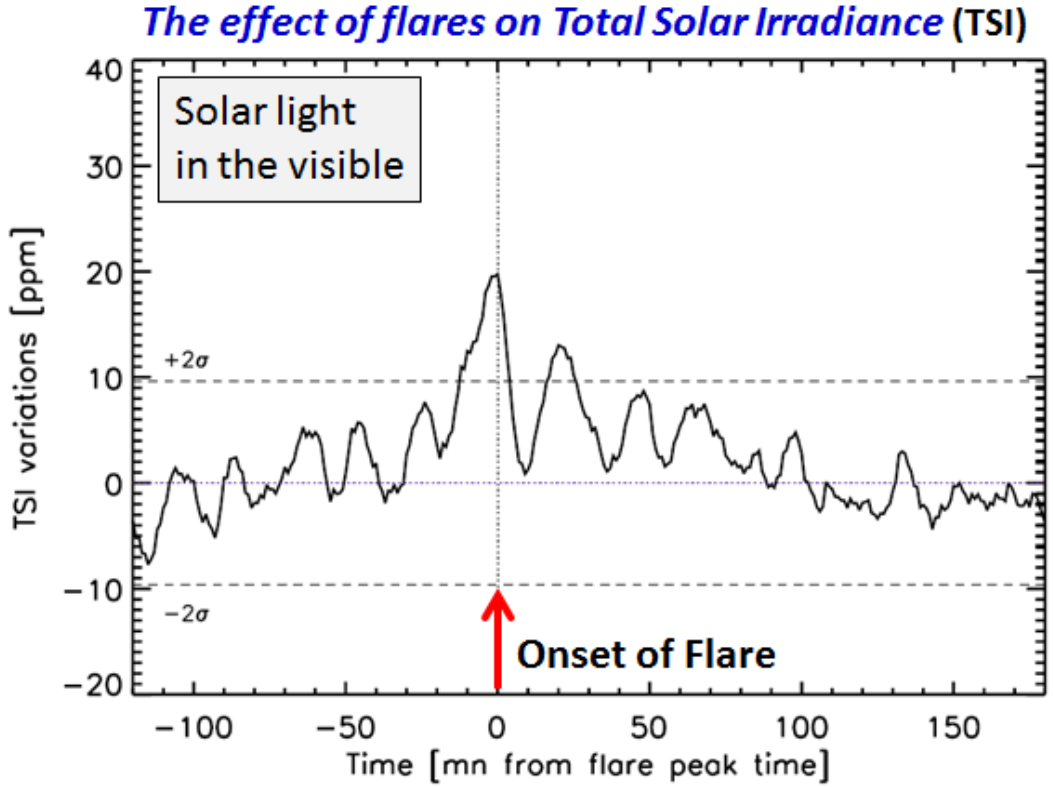

ALL 61 X flares EUVw VENUS ON 200-320d
-100/+100d 3rd/2/1999-31/12/2006 3rd sol cycle
270
260
250
240
230
220
-100 -75 -50 -25 0 25 50 75 100


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
10× 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

130-Flares + Visible

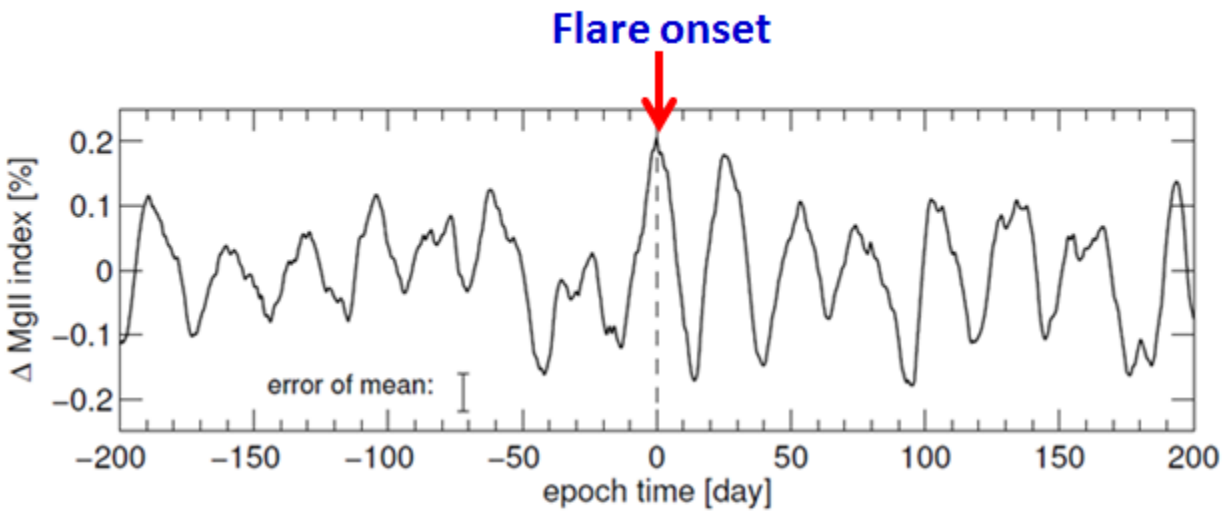


The excess time distribution of the TSI emission of 130 flares relative to the X-ray peak. 1 min resolution and smooth over 6 min. **X-rays come ~5 min later than the extra light emitted during flares.**

[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

130-Flares + ~Visible

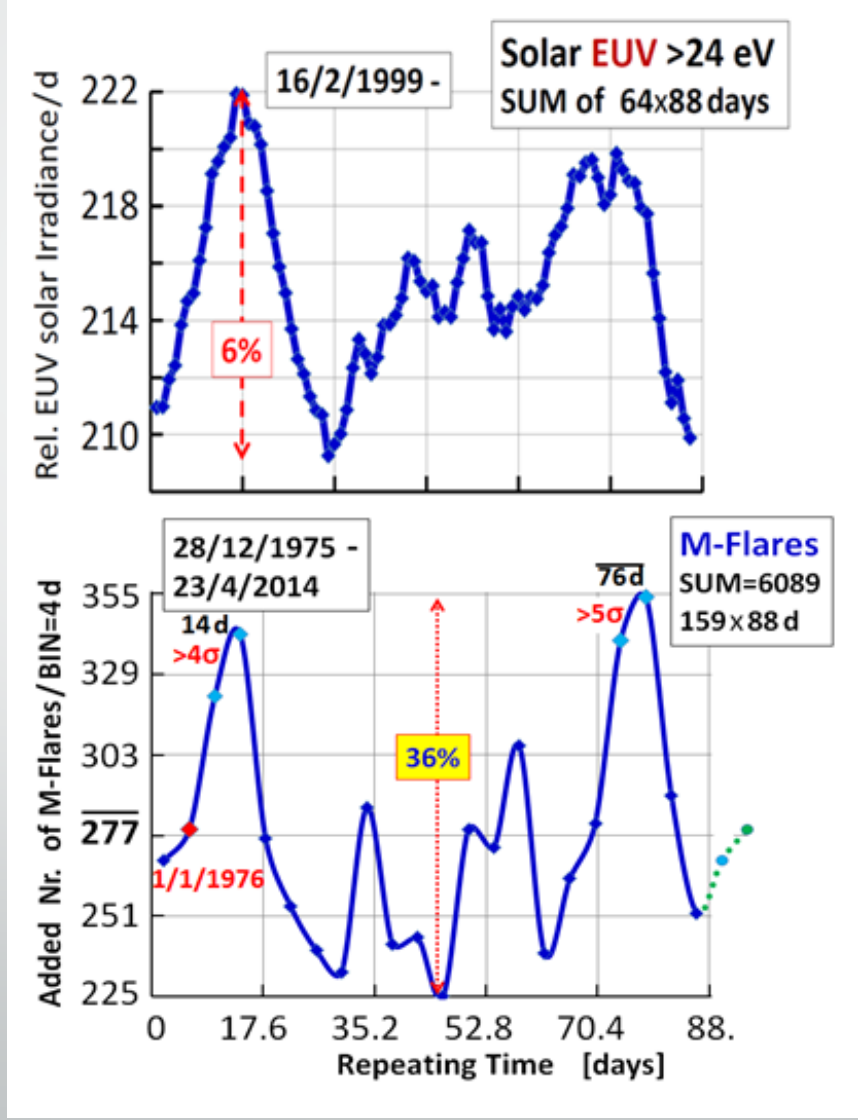


Variation of the Mg-II index which is a measure of the solar EUV/UV activity. ***Between 50 and 10 days before the event, the solar EUV/UV emission is a bit decreased.*** Then a brightening occurs with a maximum on Day 0, coincident with the X-ray burst but wider in time.

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

Solar EUV


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

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]

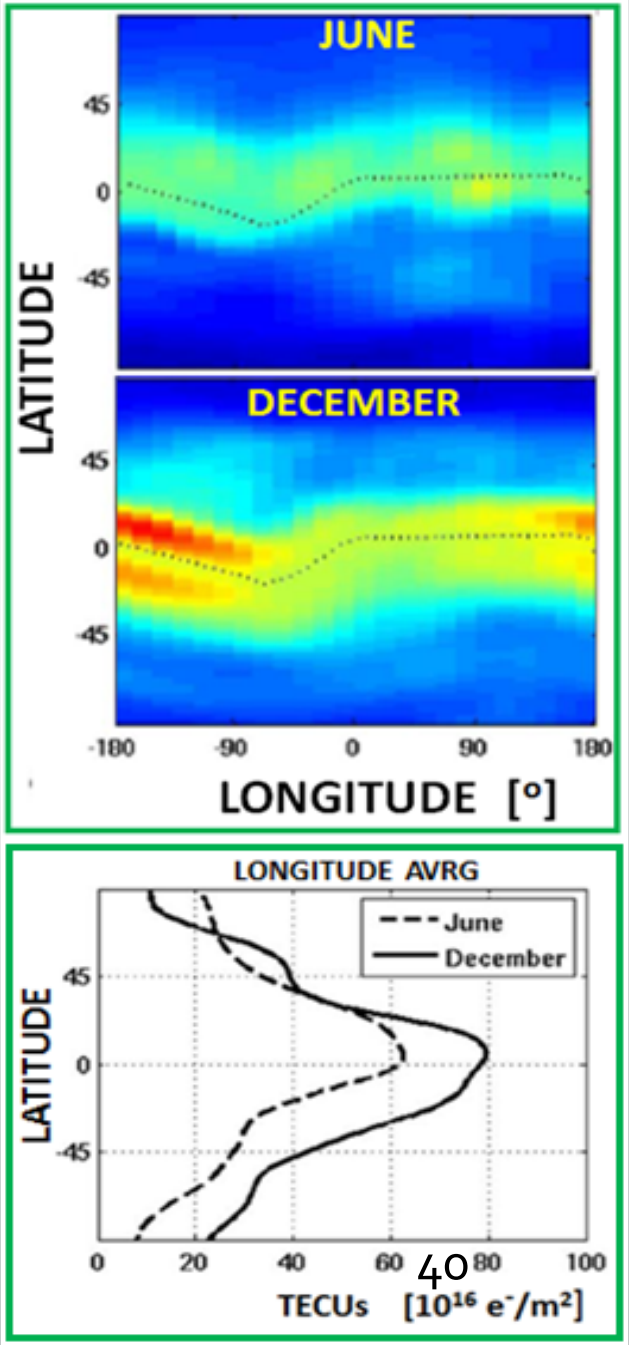
is not based on a solid ground*.* S. Poluianov, I. Usoskin, Sol. Phys. 289(**2014**)2333

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**

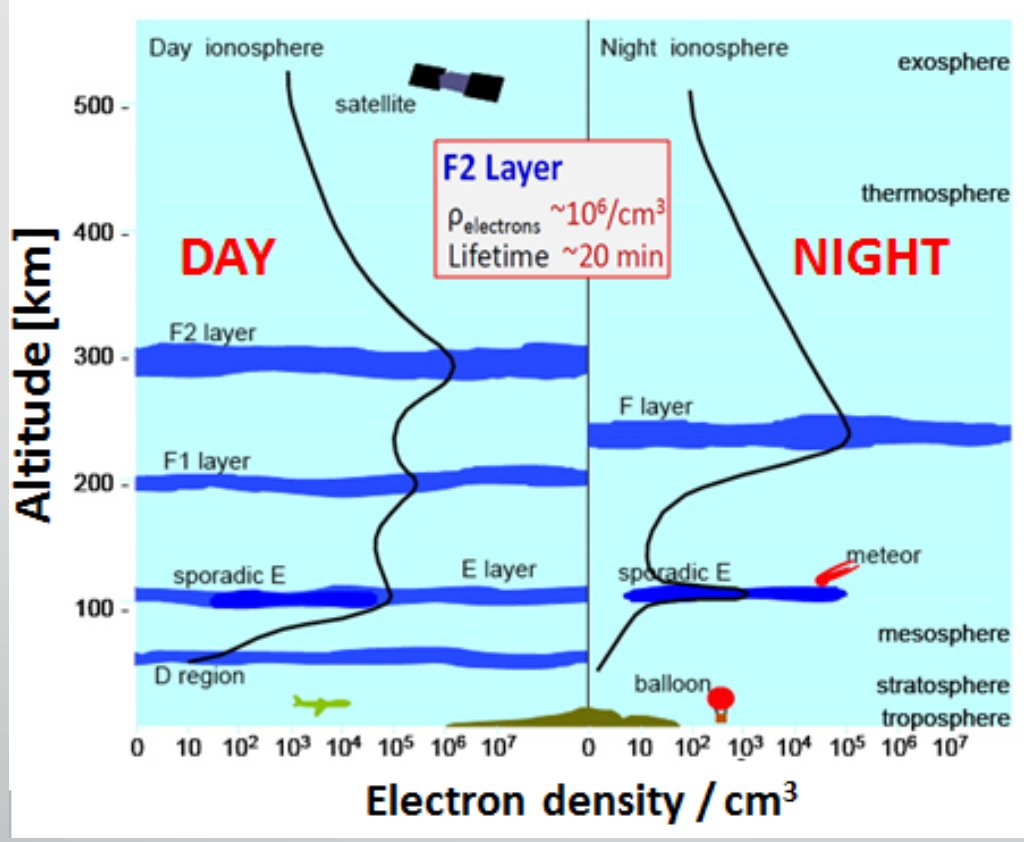
  doi:10.1029/TE043i001p00015
- .. there is a global **annual anomaly.**

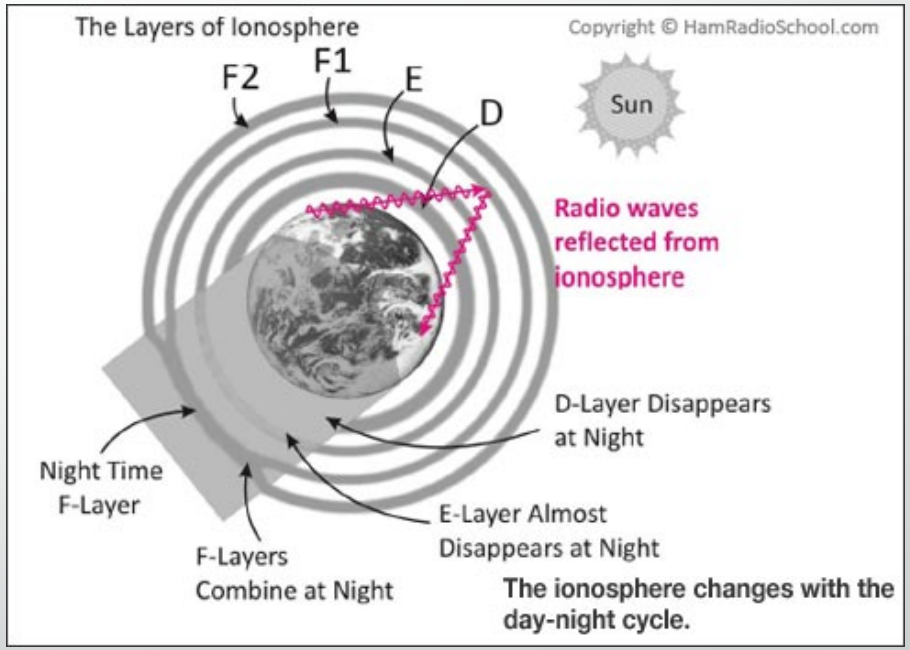
  J. Lean *et al.*, J.G.R. 116 (**2011**) A10318, doi:10.1029/2011JA016567



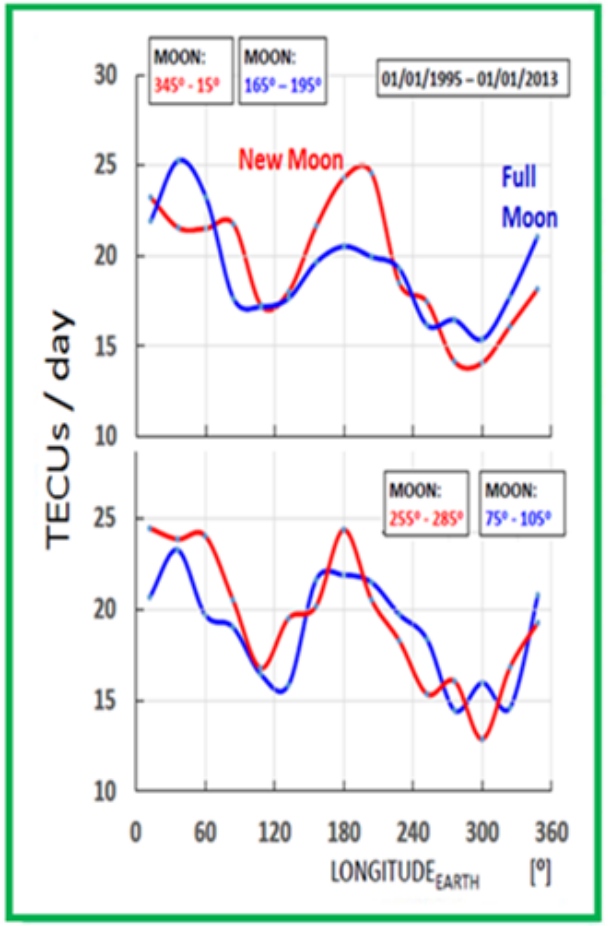
J. Atm. Sol.-Terr. Phys. 67 (**2005**) 1377

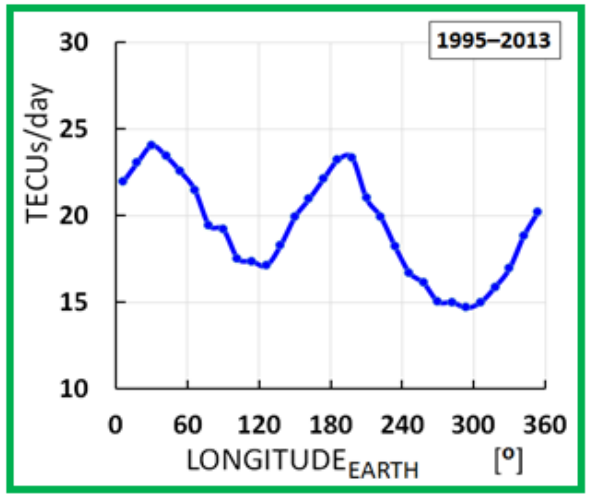
Earth's Ionosphere





Earth's Ionosphere - EARTH ⊗ MOON





DAMA

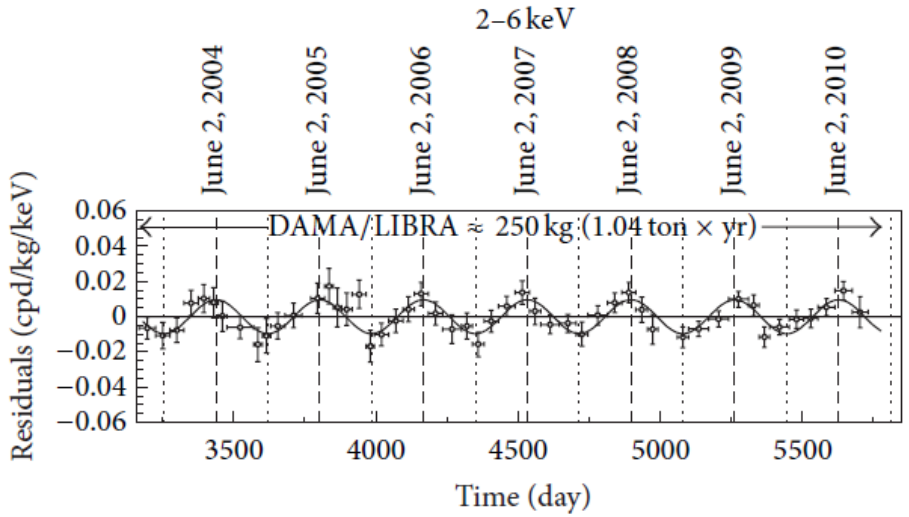


FIGURE 1: Experimental residual rate of the *single-hit* scintillation events measured by DAMA/LIBRA-phase1 in the (2–6) keV energy interval as a function of the time. The data points present the experimental errors as vertical bars and the associated time bin width as horizontal bars. The superimposed 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