




# *Space Weather During the Two Recent Solar Activity Minima*

Szymon Gburek

Space Research Centre Polish Academy of Sciences
Solar Physics Division
51-622 Wrocław, Kopernika 11 str.
Poland

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# OUTLINE

- Description of data and instruments used
- Selection of temporal intervals for space weather events studies
- Analysis of selected space weather parameters and events
- Conclusions

**DATA**

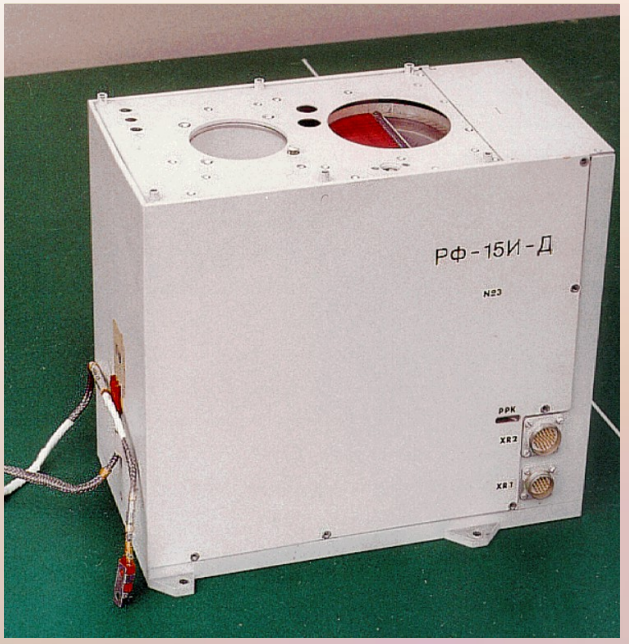
- GOES X-ray flux in 1- 8 angstrom range
- GOES flare lists
- AR data from NASA reports
- Kp index
- SEP list
- CACTUS summary plot

**INSTRUMENTS**

- RF15-I
- SphinX
- GOES

**PURPOSE**

Comparison of  space weather conditions during solar activity minima between Cycles 22/23 and 23/24.




**RF15-I** - soft and hard X-ray photometer-imager

Mission duration: August 1995 - October 2000

Satellite: *INTERBALL-Tail*

Three soft X-ray channels: 2-3-5-8 keV

Five hard X-ray channels: 10-15-30-60-120-240 keV.

Time resolution: 0.125 - 2 s


**SphinX** soft X-ray spectrometer

Mission duration: February – November 2009

Satellite: *CORONAS-Photon*

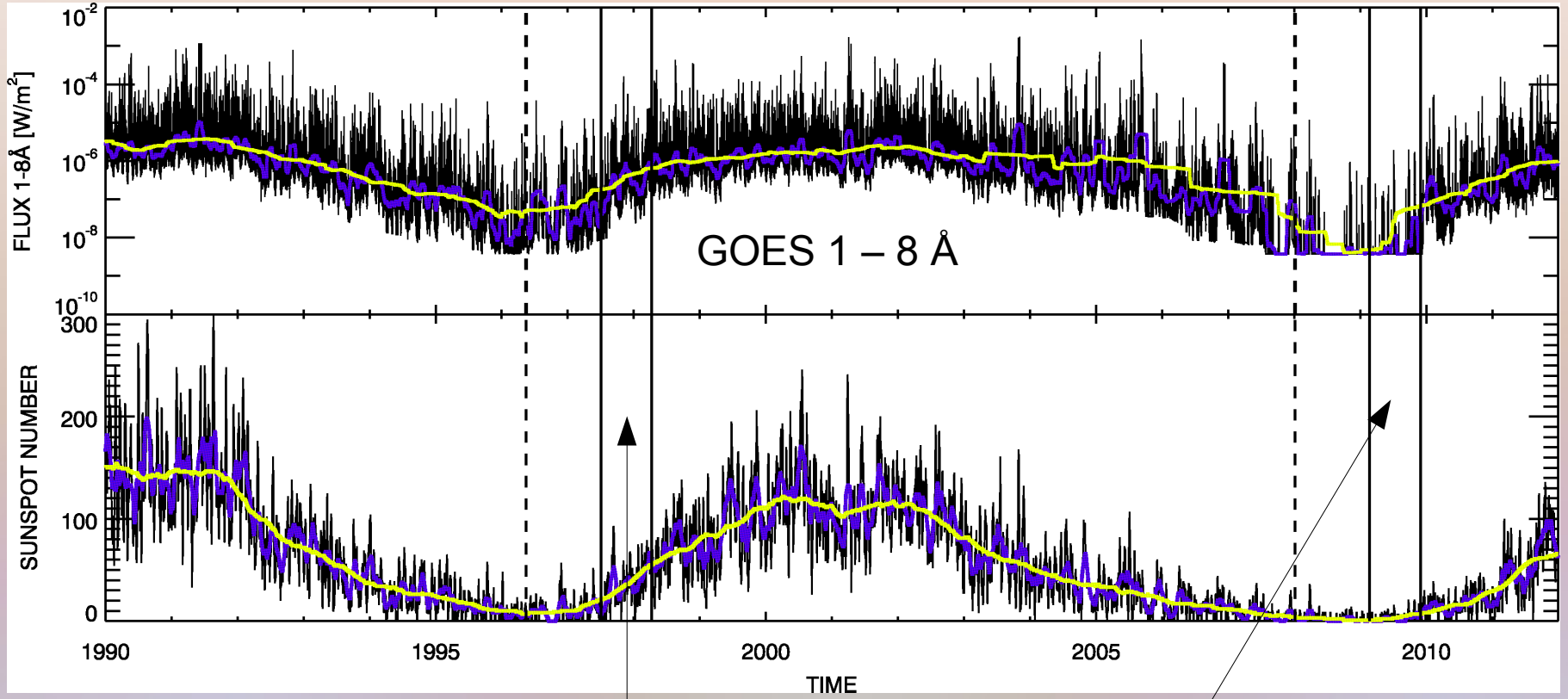
Energy range 1 – 15 keV.

Time resolution: 6 μs in photon counting mode
1 – 8 s in spectral mode

# Temporal intrervals compared

May 1996 - start of Cycle 23th

January 2008 Start of Cycle 24th

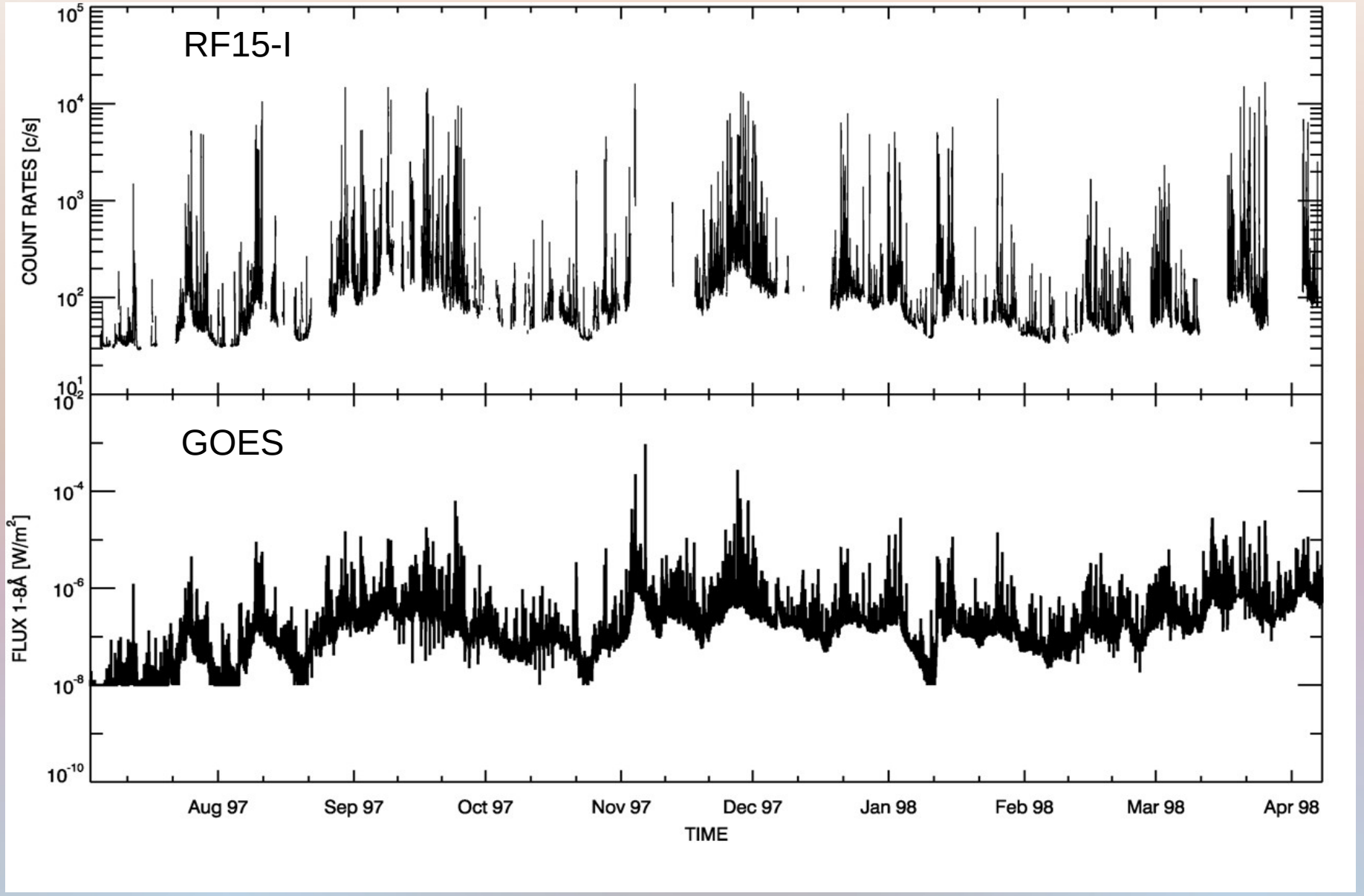



Period 1 02 July 1997 to 10 April 1998

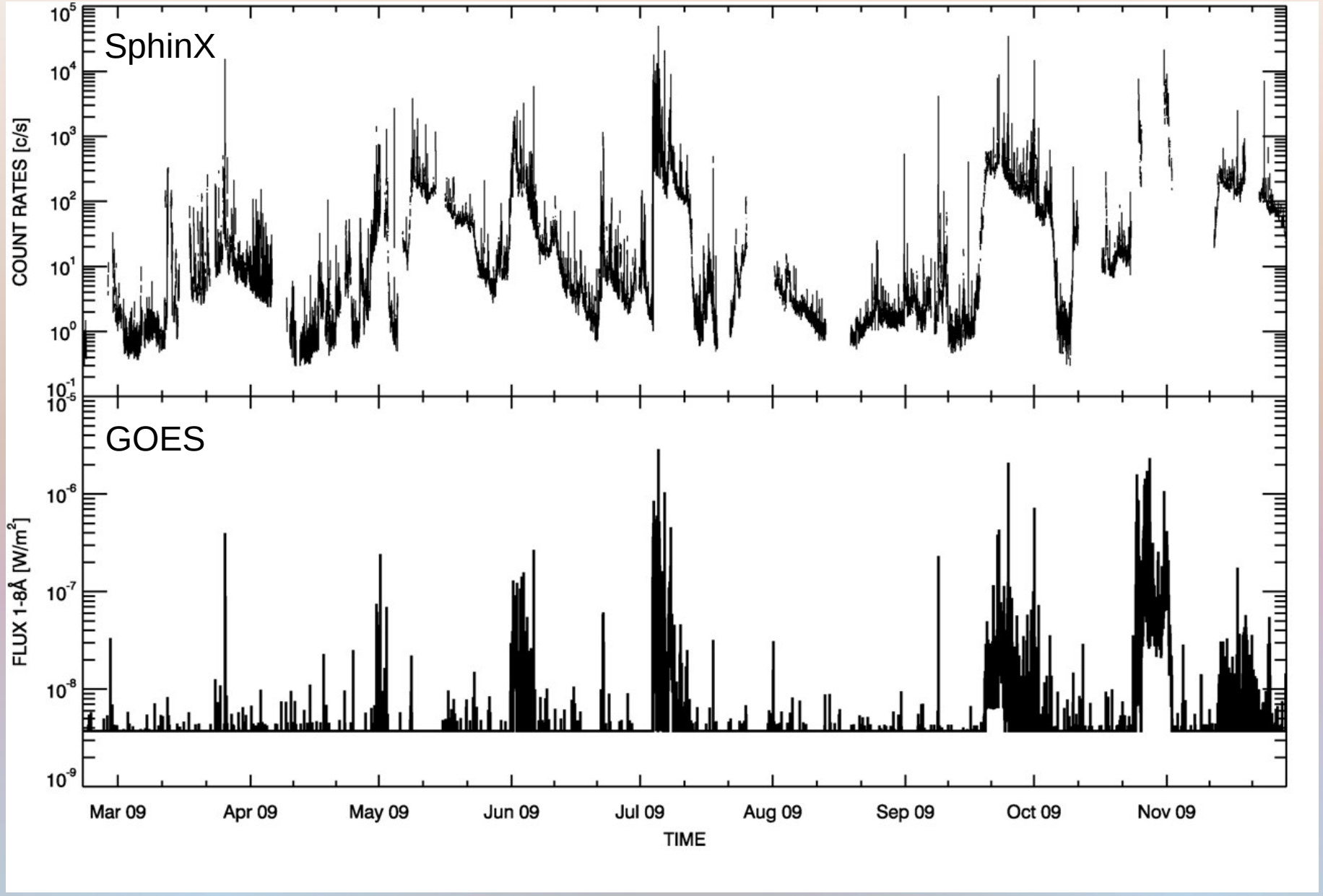
Period 2 20 February 2009 until 29 November 2009

Monthly and yearly averages are overplotted in violet and yellow respectively.

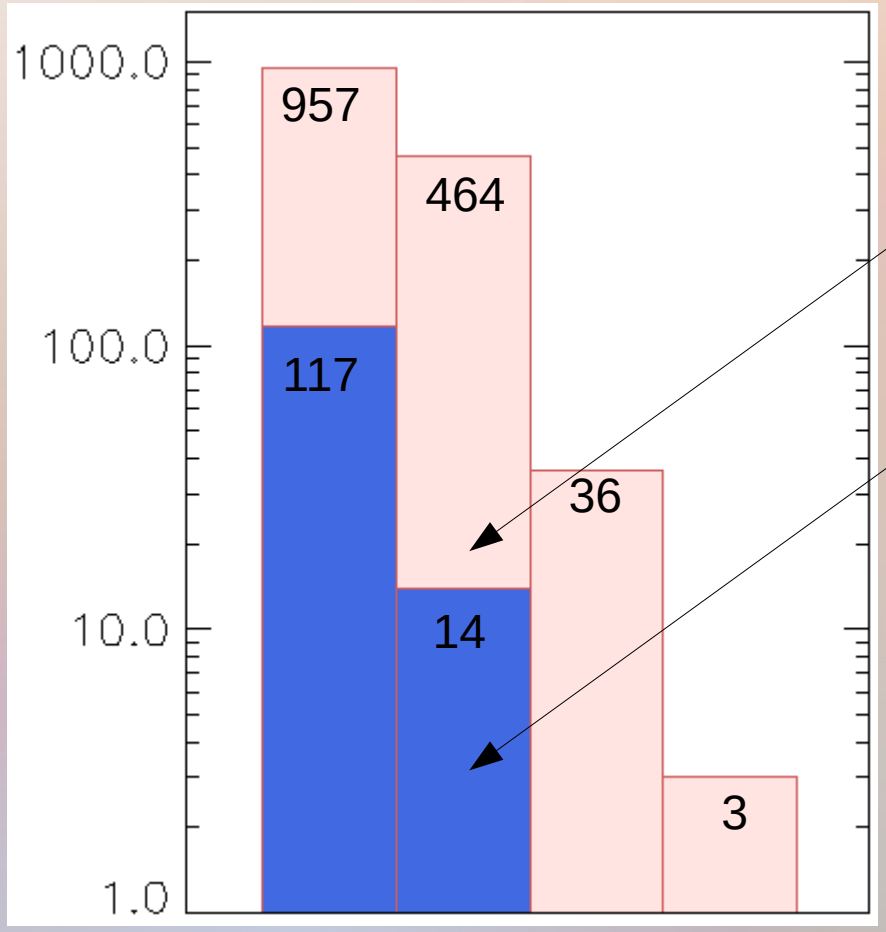
# Flaring Activity in Period 1: 02 July 1997 to 10 April 1998



# Flaring Activity in Period 2 2009-02-20, 2009-11-29



# FLARING ACTIVITY - comparison




Period 1
1997-07-02 1998-04-10

Period 2
2009-02-20 2009-11-29

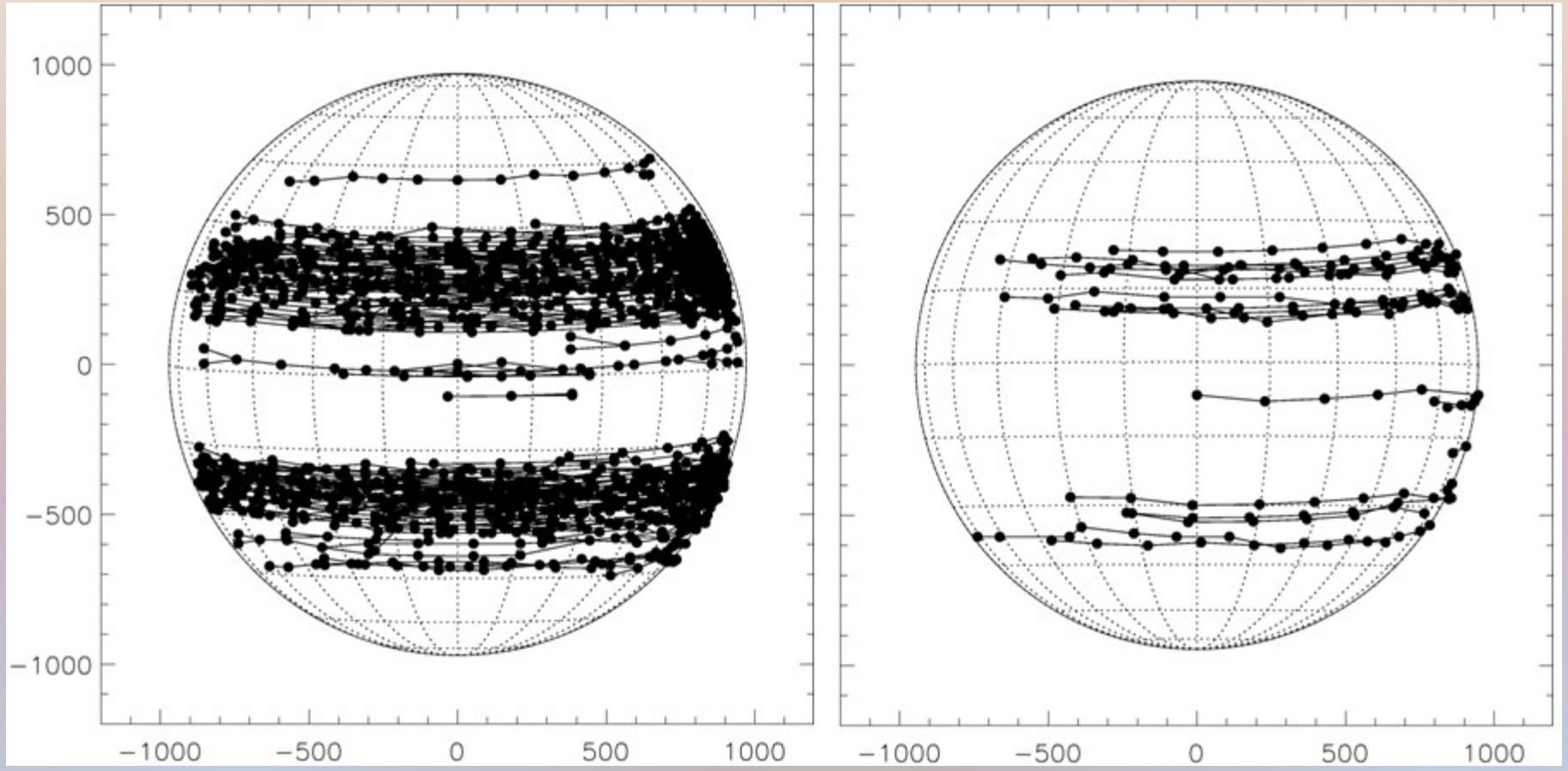
GOES flare classification

| Classification | Peak Flux Range at 100-800 picometre |
|---|---|
| | (Watts/square metre) |
| A | $< 10^{-7}$ |
| B | $10^{-7}$ - $10^{-6}$ |
| C | $10^{-6}$ - $10^{-5}$ |
| M | $10^{-5}$ - $10^{-4}$ |
| X | $10^{-4}$ - $10^{-3}$ |

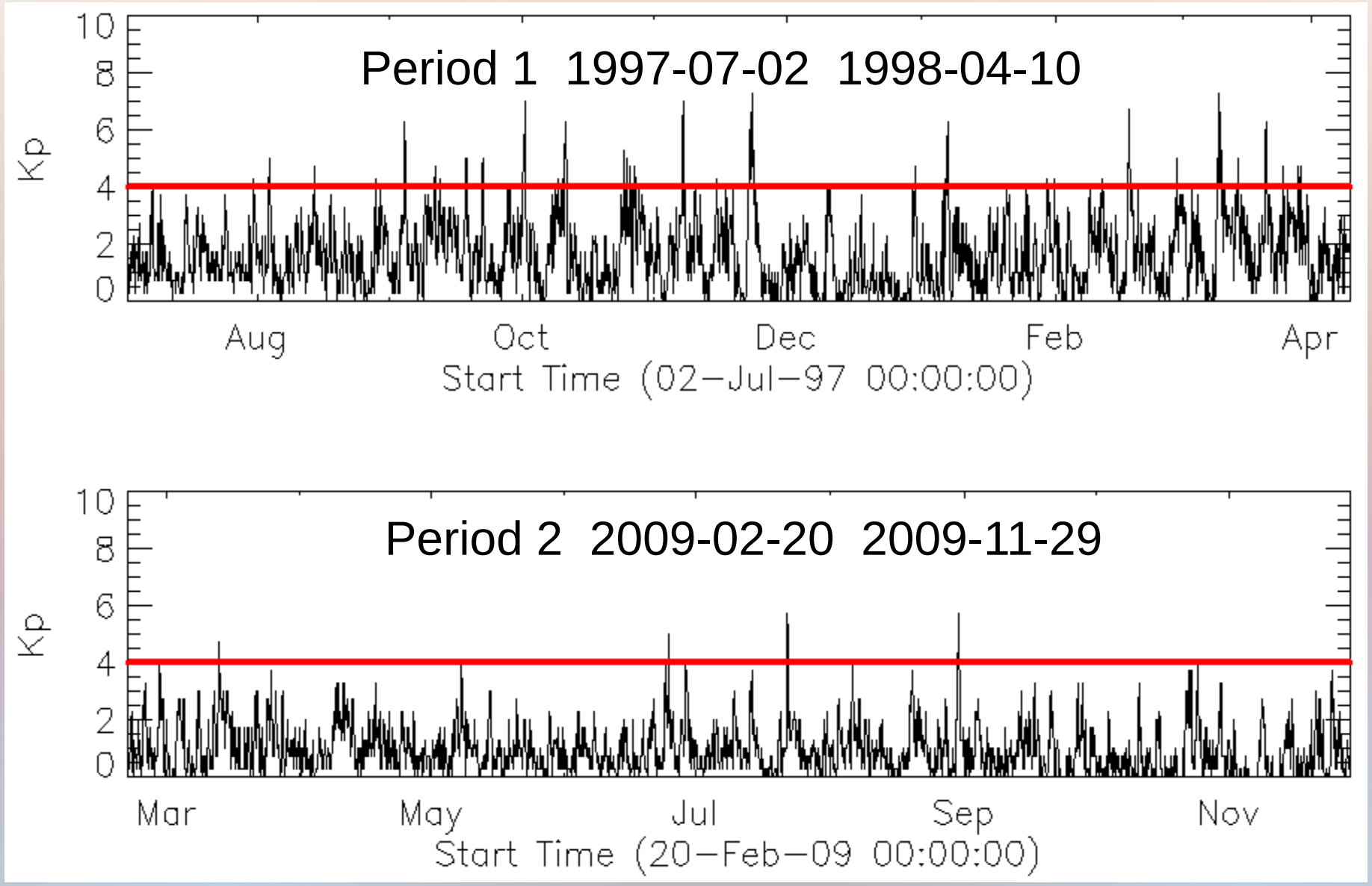
# AR PRODUCTIVITY

Period 1
1997-07-02  1998-04-10

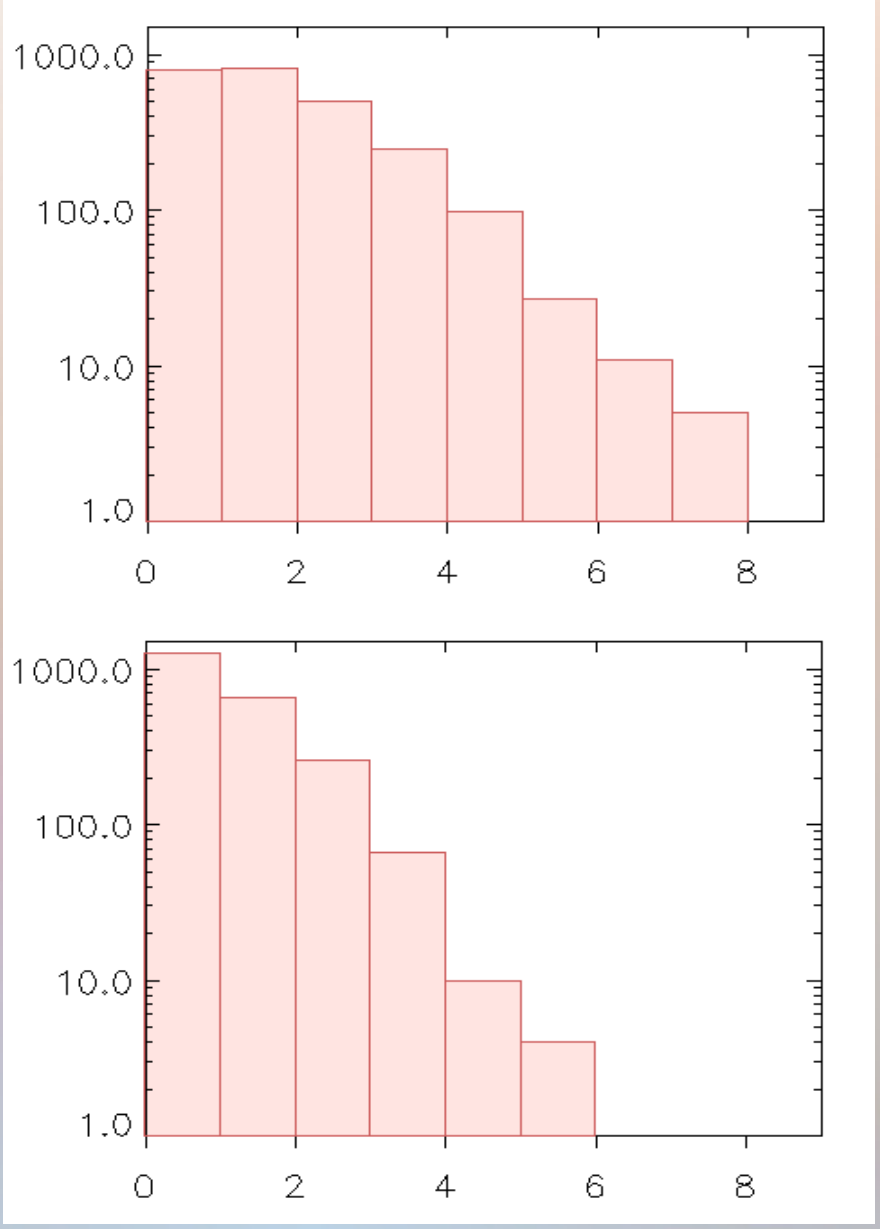
Period 2
2009-02-20  2009-11-29



# Magnetospheric disturbances – Kp index



# Kp index – comparison (three hour intervals)




Period 1  1997-06-02 until 1998-04-10

Quiet intervals Kp = 0 - **175**

Max Kp - **7.3**

Intervals with Kp above 4  -  **141**

Period 2  2009-02-20T until 2009-11-29

Quiet intervals Kp = 0 - **337**

Max Kp - **5.7**

Intervals with Kp above 4 -  **14**

**Solar Proton Events Affecting the Earth Environment**
**NOAA SPACE ENVIRONMENT SERVICES CENTER**
http://www.swpc.noaa.gov/ftpdir/indices/SPE.txt

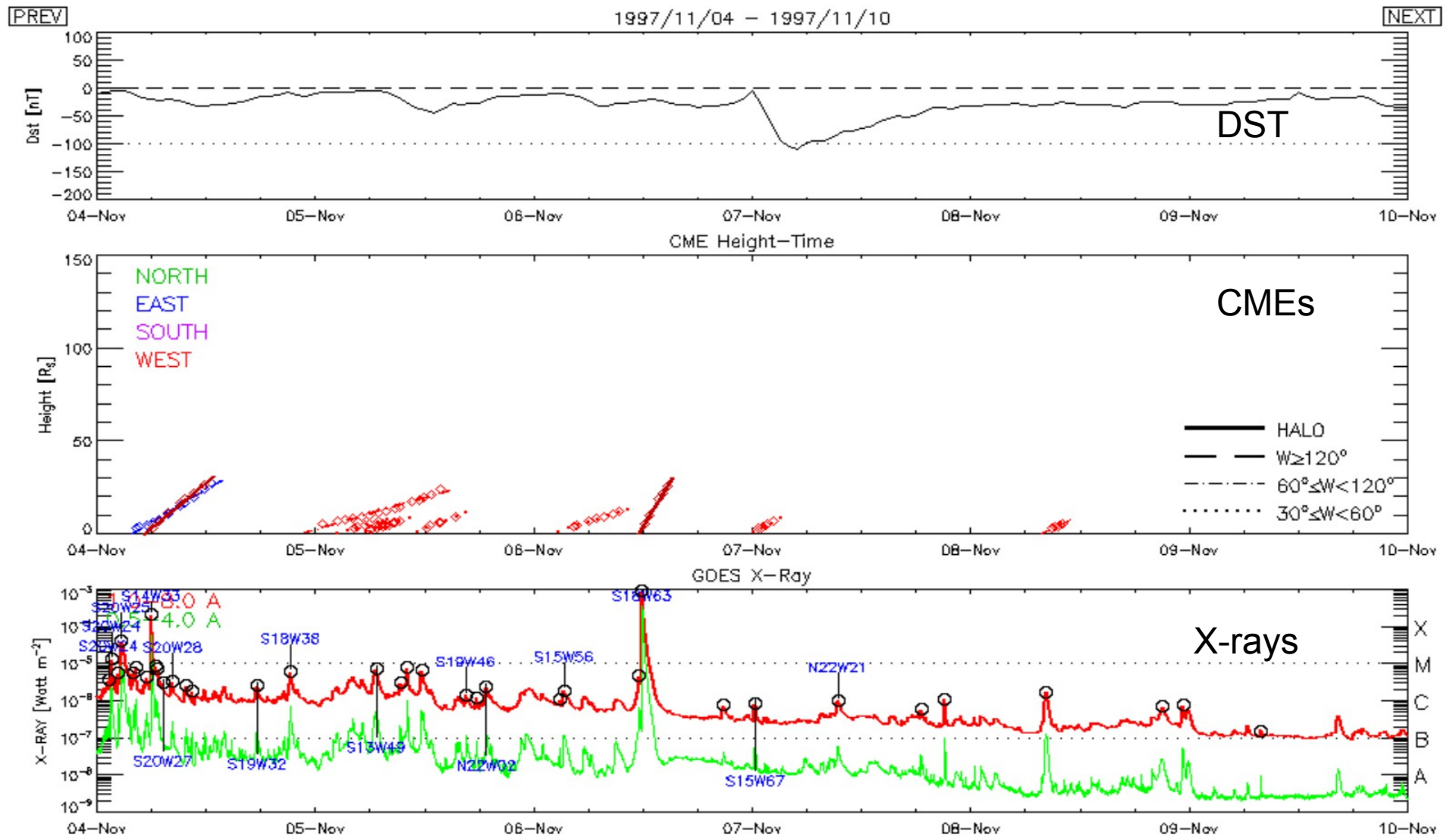
Period 1 1997-06-02  1998-04-10

| PARTICLE EVENT | | | ASSOCIATED | FLARE AND ACTIVE REGION | | | |
|---|---|---|---|---|---|---|---|
| Start (Day/UT) | Maximum (pfu @ >10 MeV) | Proton Flux | CME (Loc./ Day UT) | Flare Max. | Importance (Xray/Opt.) | Location | Region# (SWO) |
| **1997 Nov 04/0830** | Nov 04/1120 | 72 | W/04 0610 | Nov 04/0558 | X2/2B | S14W33 | 8100 |
| **1997 Nov 06/1305** | Nov 07/0255 | 490 | W/06 >1300 | Nov 06/1155 | X9/2B | S18W63 | 8100 |

Period 2 2009-02-20  2009-11-29

**None**

# 7 November 1997 solar storm




http://cdaw.gsfc.nasa.gov/CME_list/daily_plots/dsthtx/1997_11/dsthtx_19971104.html

# CME generation rates

period 1

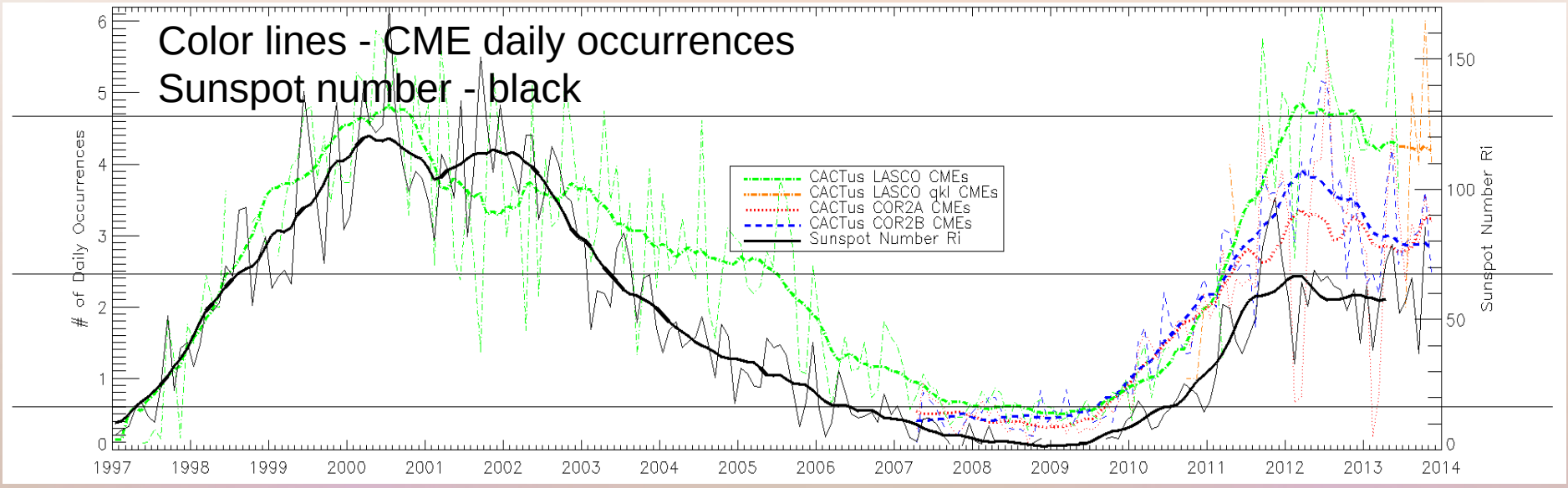
avg CME rate per day – about 2

period 2

avg CME rate per day – about 2

Needs to be confirmed

# CMEs as seen by CACTUS





http://sidc.oma.be/cactus/catalog/LASCO/2_5_0/dataoverview/CME_and_SSN_rate.pngc

**This talk uses data from the CACTus CME catalog, generated and maintained by the SIDC at the Royal Observatory of Belgium.**

## CONCLUSIONS

- The Sun atmosphere displayed different activity pattern during analyzed periods.
- The recent minimum 23/24 turned out to be unusual quiet in comparison to previous one.
- Number of observed flares decreased by a factor of about ten.
- Number of ARs on visible on disk also decreased about tenfold.
- CMEs do not follow the general decreasing trends and their generation rate stays the same for both periods – about 2 CMEs daily.
- In the second period there were no SEP events while in the first one two are reported.
- The Earth magnetosphere was generally much more quiet during the second period.

# Thank you