Estimating GOES flare peaks from LYRA data

IED 22 Sep 2011

During certain time intervals, GOES obviously suffers from short occultations, as LYRA does in other months. In September, there are usually no GOES data approx 05:30-06:30. An interesting question arises: Can the GOES flare size be estimated from the LYRA flare size, although LYRA contains data from different band passes?

As an example, 62 flares were collected from the first two weeks of September 2011. Using the LYRA Flare List, the LYRA flare size was estimated (by eye), subtracting the offset level – i.e. before the flare starts - from the peak level. This takes into account the fact that LYRA flares start on a significant level of EUV-dominated irradiance (on the order of 2.0 or 1.0 mW m^{-2} for channel 3 and 4, resp), while the GOES offset level is almost negligible - though not quite, as it eventually appears.

The flare sizes (peaks) are compared on a logarithmic scale, see figure next page. Their logarithms are fitted with a straight line, assuming that the relationships follow a power law, like,

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GOES = a * LYRA^b
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The fit results in an exponent b=0.94 for the relationship GOES vs. LYRA channel 3 and channel 4, and an exponent b=1.0 for the relationship LYRA channel 4 vs. channel 3. Maybe the first exponent is slightly underestimated, because actually one should also remove the GOES offset level before the flare starts. But this appears not to be the philosophy behind the well-known GOES notation, since the absolute flare peak – not the net contribution - is used to denote the flare class.

The other parameter is fitted a=0.015 and a=0.018 for GOES vs. LYRA channel 3 and channel 4, resp, and a=0.8 for channel 4 vs. channel 3; the latter result is in good agreement with earlier findings (see "Separate Contributions" report from 18 Aug 2011).

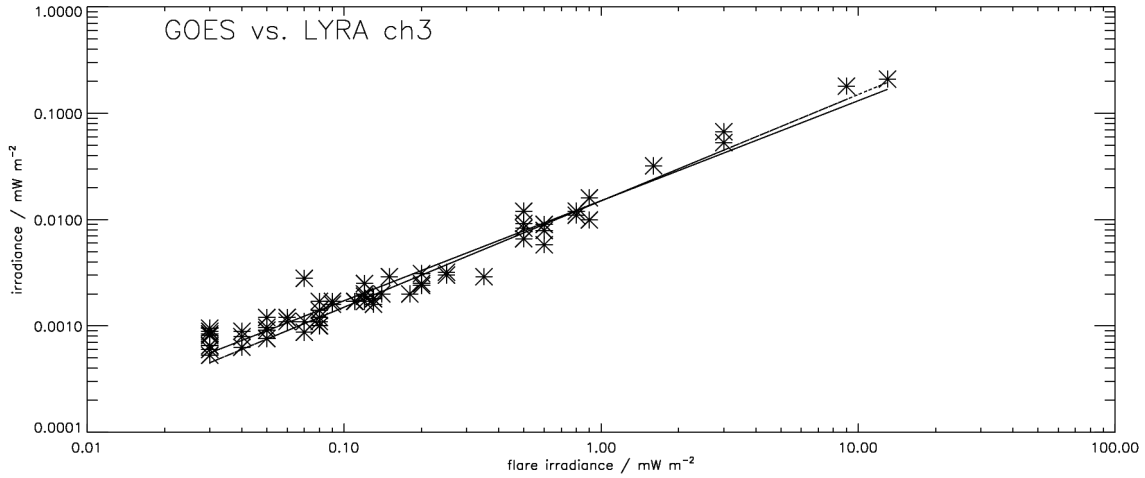
Having derived a simple relationship (see figure caption next page), the question is if the missing GOES flares can be estimated in a convincing way. Four examples are selected:

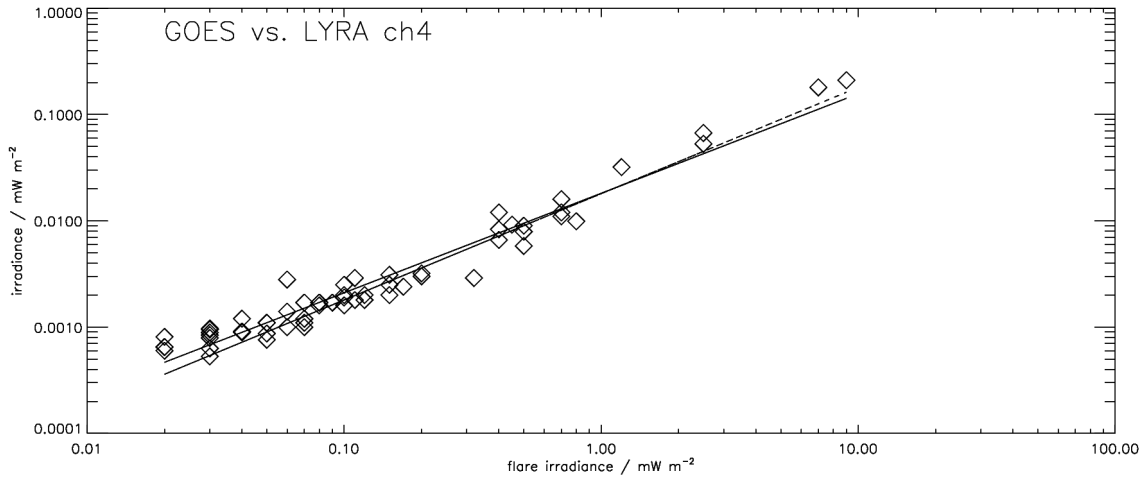
03 Sep 2011
http://solwww.oma.be/users/dammasch/flares/flare20110903.html
http://www.swpc.noaa.gov/ftpdir/warehouse/2011/2011_plots/xray/20110903_xray.gif
GOES misses the flare. LYRA would estimate it as around C2.0, peaking around 06:00.

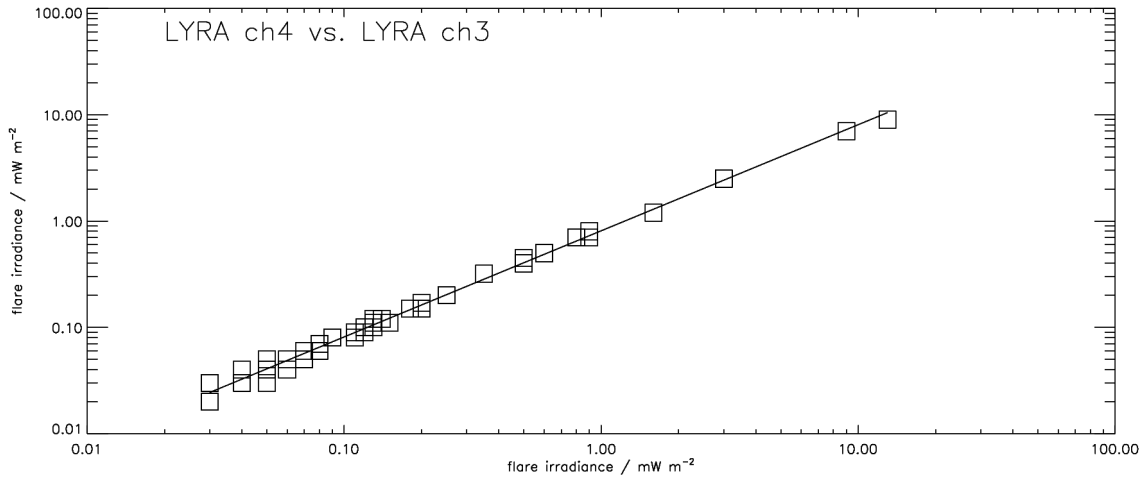
04 Sep 2011
http://solwww.oma.be/users/dammasch/flares/flare20110904_7570.png
http://www.swpc.noaa.gov/ftpdir/warehouse/2011/2011_plots/xray/20110904_xray.gif
GOES wrongly claims a C4.0 flare at 06:18. LYRA would estimate it as around C9.0, peaking around 05:55.

06 Sep 2011
http://solwww.oma.be/users/dammasch/flares/flare20110906.html
http://www.swpc.noaa.gov/ftpdir/warehouse/2011/2011_plots/xray/20110906_xray.gif
GOES misses the flare. LYRA would estimate it as around C9.0, peaking around 06:15, in good agreement with remaining GOES data.

09 Sep 2011
http://solwww.oma.be/users/dammasch/flares/flare20110909_8830.png
http://www.swpc.noaa.gov/ftpdir/warehouse/2011/2011_plots/xray/20110909_xray.gif
GOES claims an M2.7 flare at 06:11, which is surprising, because it does not really observe it. Nevertheless the size (M2.7-M3.0) and the time are confirmed by the LYRA estimate.







"flare" irradiance means that for the LYRA flare sizes, the irradiance level before the flare is subtracted. The GOES flare size is taken as it is, covering B, C, M, and X flares.

The dotted lines in the upper two images denote the simplified flare size relationships,

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GOES = 0.015 * LYRA ch3      GOES = 0.018 * LYRA ch4
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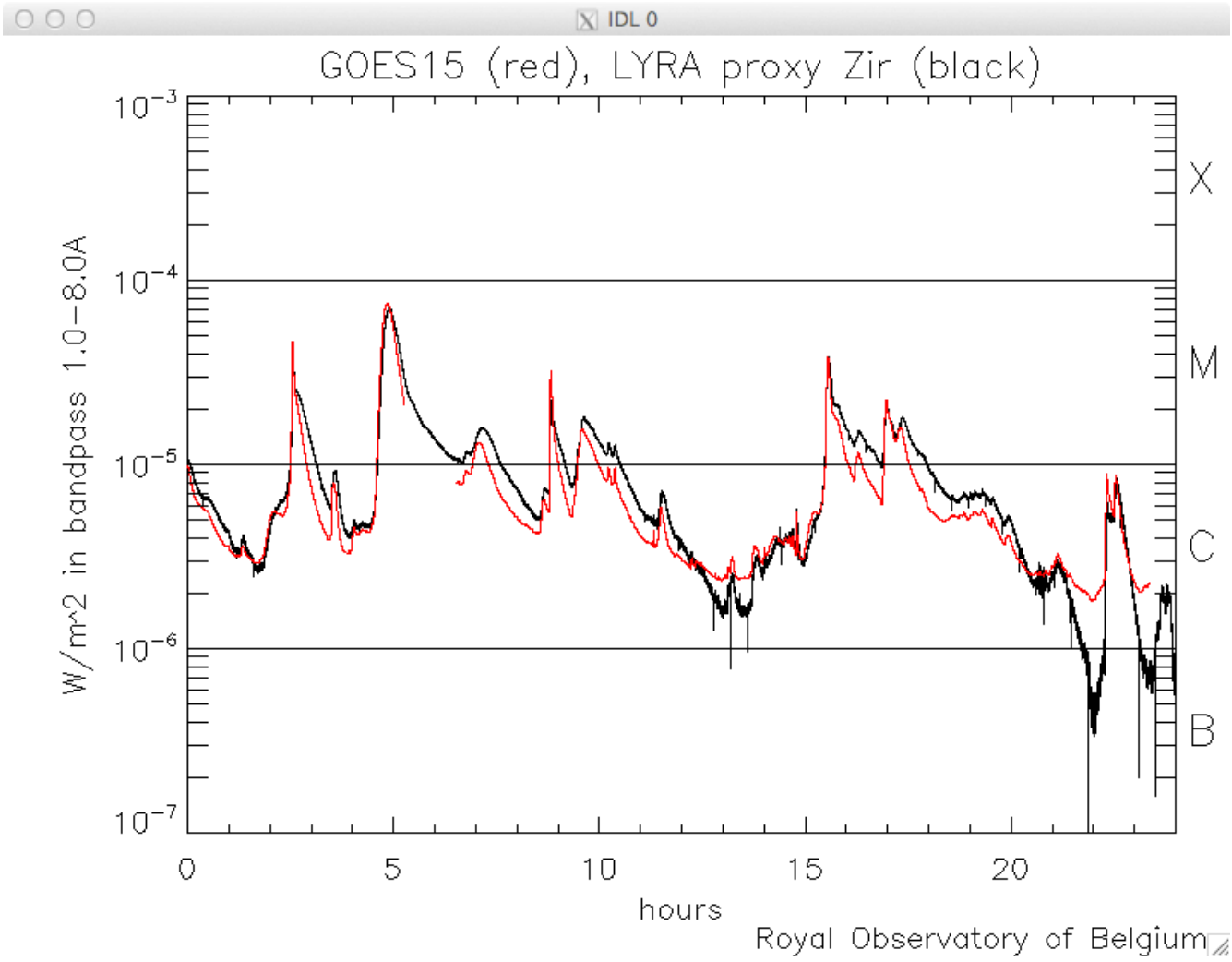
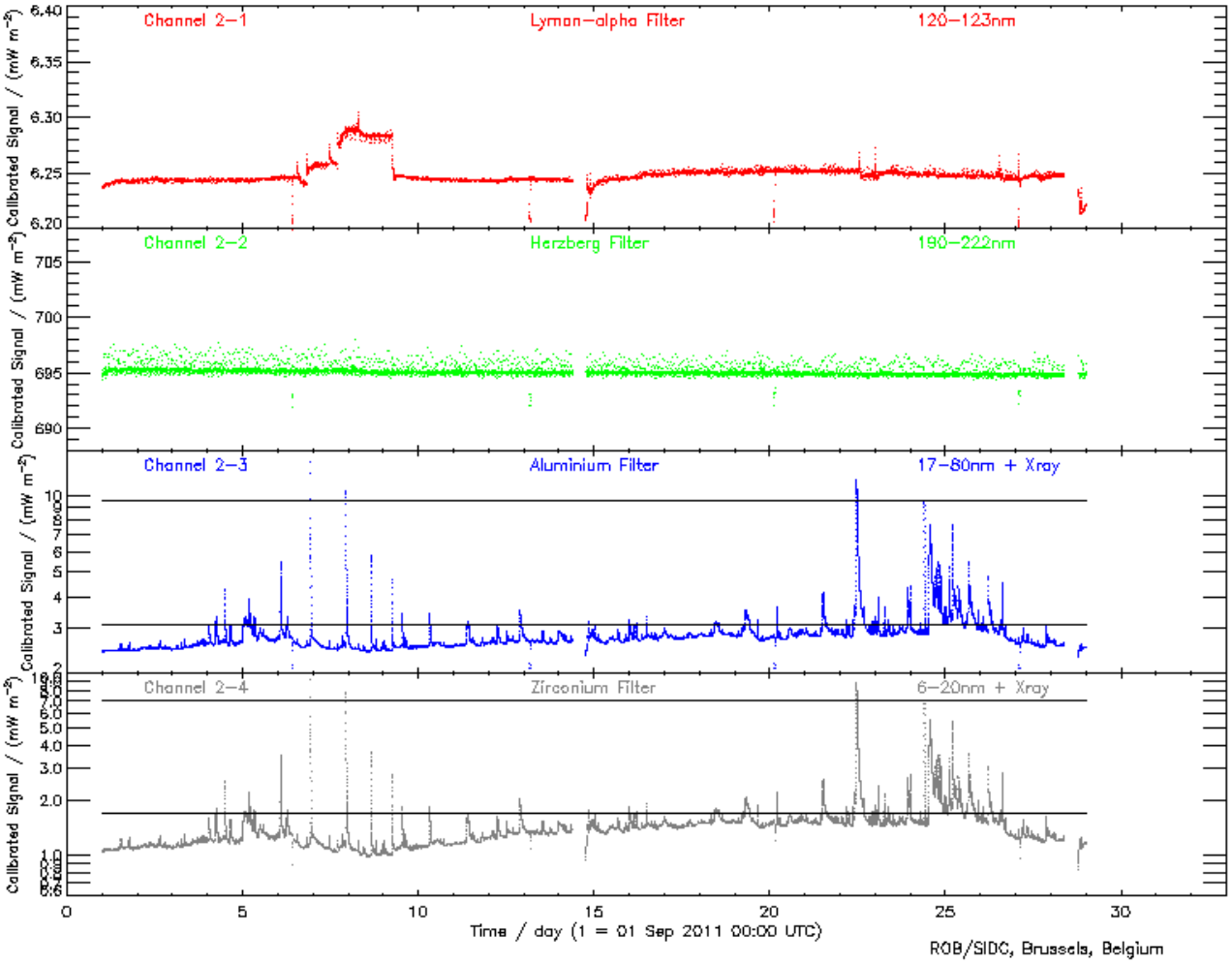
whereas the straight lines are the exact log-log first-order polynomial fits.

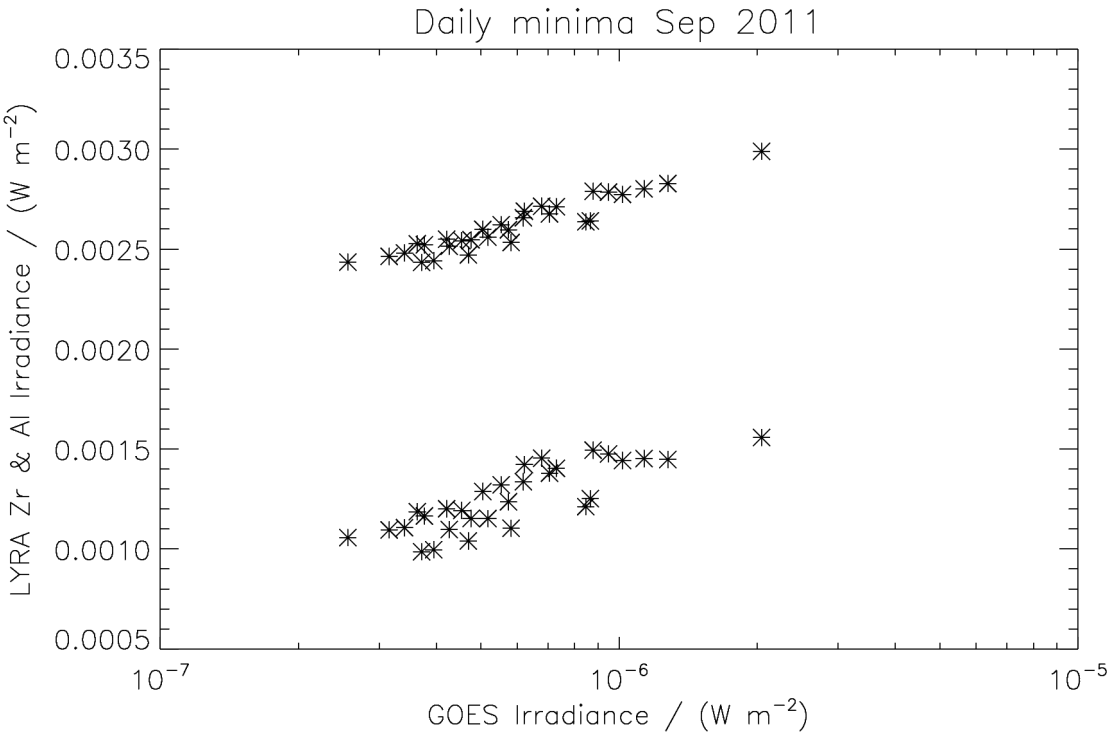

IDL 0
GOES15 (red), LYRA proxy Zir (black)
W/m^2 in bandpass 1.0–8.0A
10^-3
10^-4
10^-5
10^-6
10^-7
X
M
C
B
0
5
10
15
20
hours
Royal Observatory of Belgium

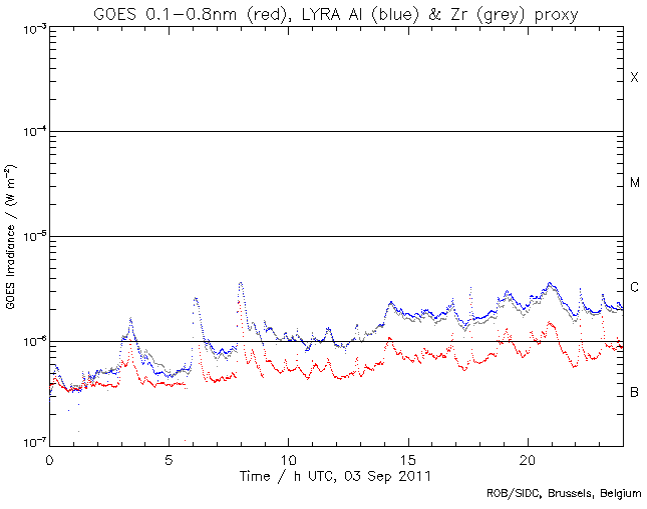


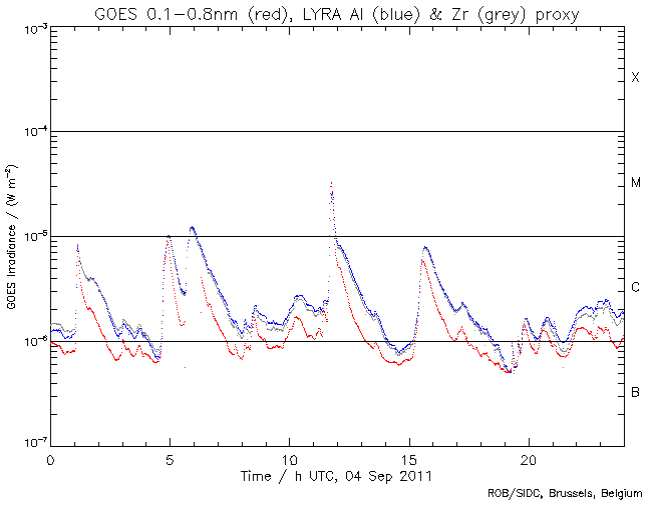
General solution ??

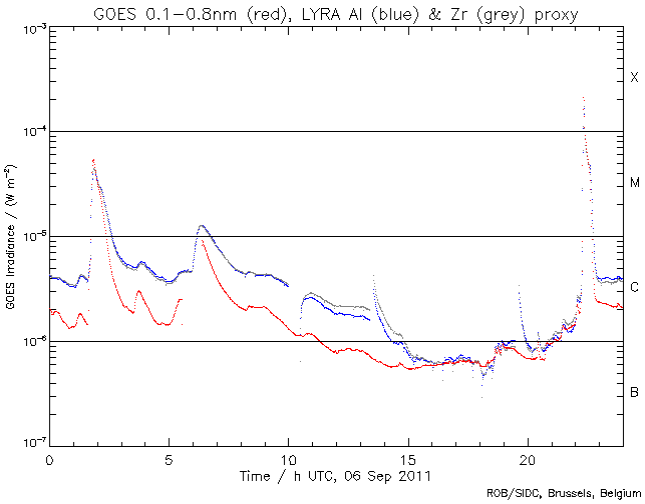
ad-hoc solution:
find common daily minimum: min(GOES), min(LYRA ch3), min(LYRA ch4)
plot LYRA proxy = 0.015*(LYRA ch3 – min(LYRA ch3))+min(GOES)
and LYRA proxy = 0.018*(LYRA ch4 – min(LYRA ch4))+min(GOES)

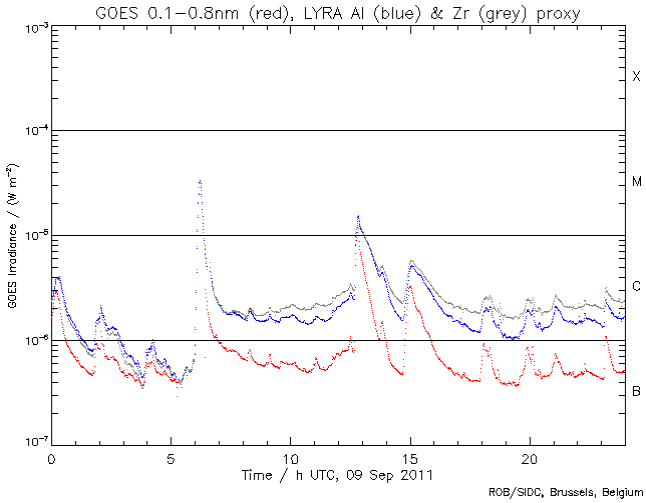
Example September 2011, here:
http://solwww.oma.be/users/dammasch/GoesVsLyra.html

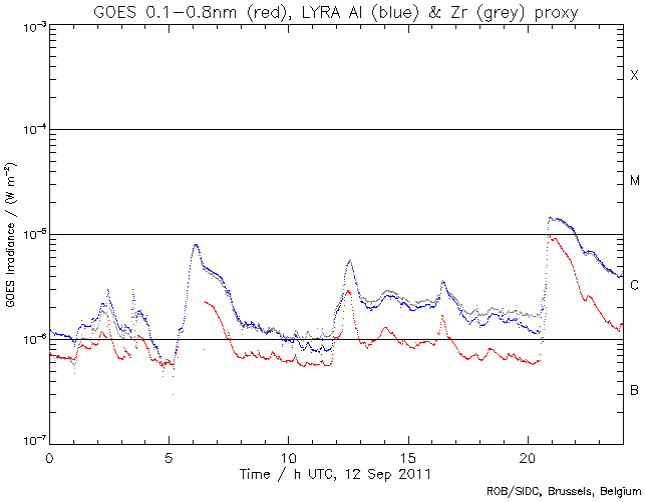

Daily minima Sep 2011
LYRA Zr & Al Irradiance / (W m^{-2})
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
10^{-7}
10^{-6}
10^{-5}
GOES Irradiance / (W m^{-2})

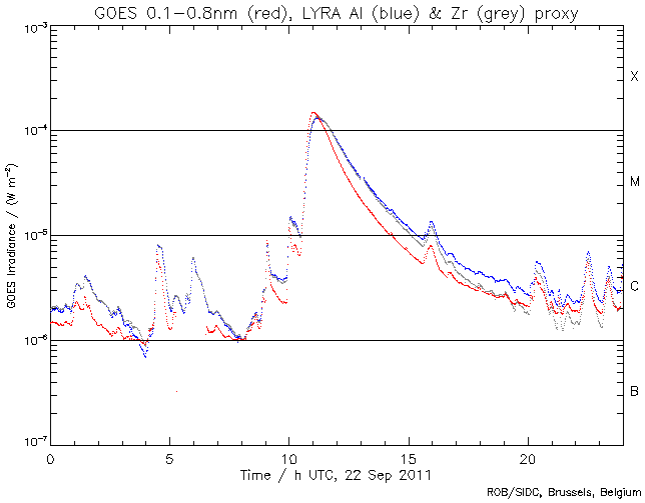

GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m^{-2})
X
M
C
B
0
5
10
15
20
Time / h UTC, 03 Sep 2011
ROB/SIDC, Brussels, Belgium

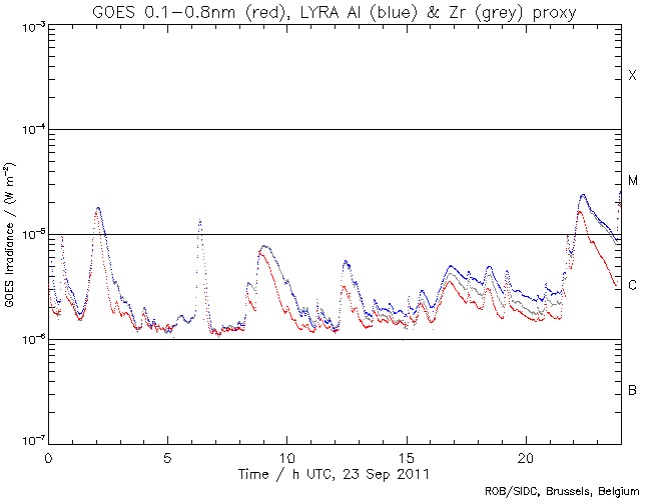

GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m^{-2})
X
M
C
B
0
5
10
15
20
Time / h UTC, 04 Sep 2011
ROB/SIDC, Brussels, Belgium

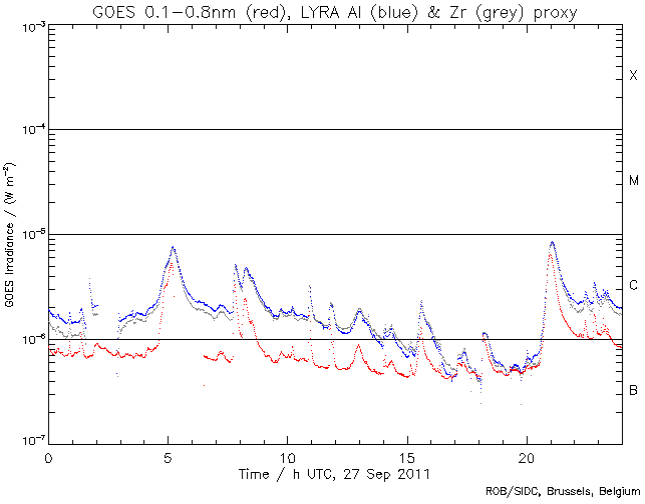

GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m⁻²)
X
M
C
B
Time / h UTC, 06 Sep 2011
ROB/SIDC, Brussels, Belgium


GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m⁻²)
X
M
C
B
Time / h UTC, 09 Sep 2011
ROB/SIDC, Brussels, Belgium


GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m⁻²)
X
M
C
B
Time / h UTC, 12 Sep 2011
ROB/SIDC, Brussels, Belgium


GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m⁻²)
X
M
C
B
Time / h UTC, 22 Sep 2011
ROB/SIDC, Brussels, Belgium


GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m⁻²)
X
M
C
B
Time / h UTC, 23 Sep 2011
ROB/SIDC, Brussels, Belgium


GOES 0.1–0.8nm (red), LYRA Al (blue) & Zr (grey) proxy
GOES Irradiance / (W m⁻²)
X
M
C
B
Time / h UTC, 27 Sep 2011
ROB/SIDC, Brussels, Belgium