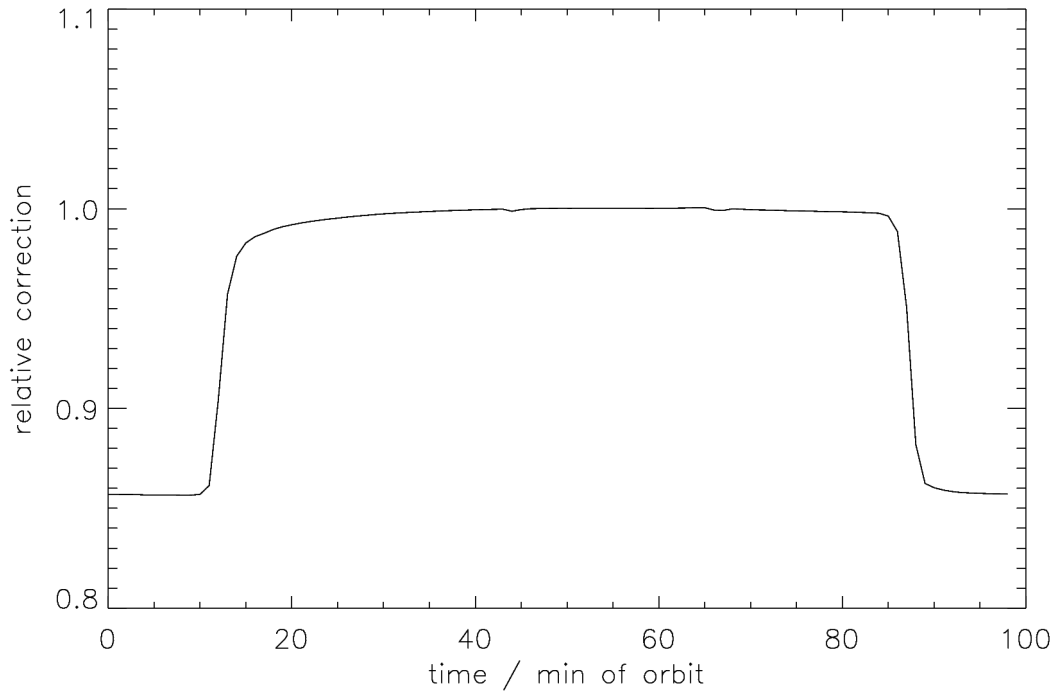
Correction of occultation patterns (Update)

IED 16 Mar 2021

There were previous attempts to resolve the problem of LYRA occultation patterns, see here:
http://solwww.oma.be/users/dammasch/IED_20141218_OccultationCorrection.pdf
The current attempt appears to work better.

In a first step, files with PROBA2 tangential altitude are used every day between 01 Oct and 28 Feb. Minutes in which the tangential altitude is not set to 1000 are considered problematic and excluded from the LYRA curves. Thus, these curves have relatively large gaps.

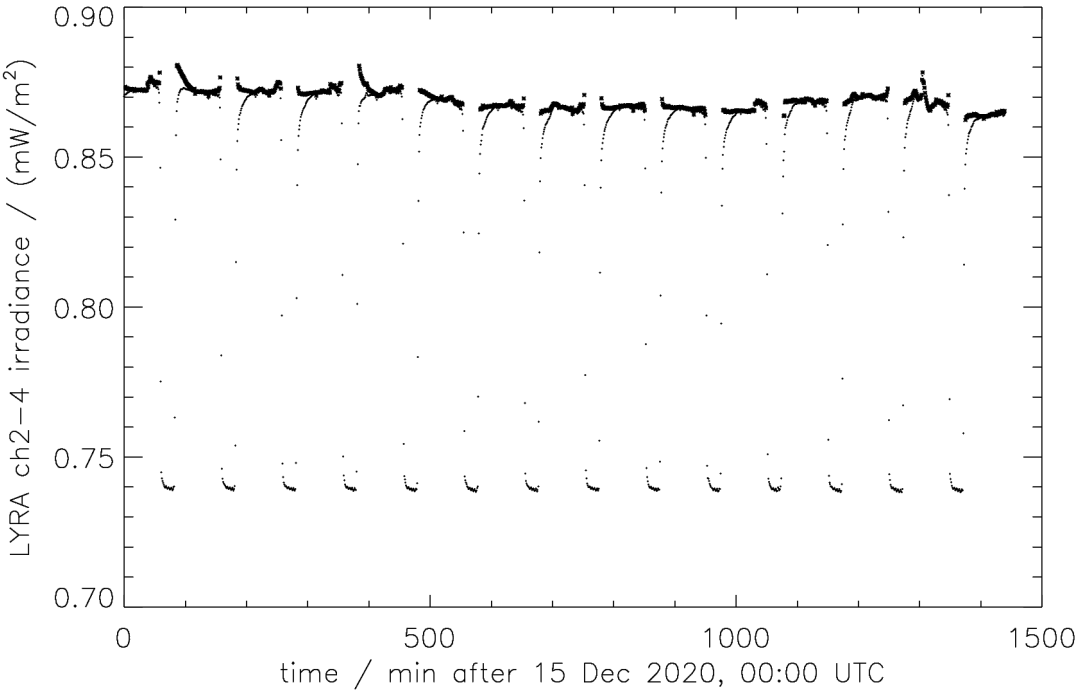
When the occultation season is over, a typical orbit profile is created for each day. Usually, there are ~14 orbits with ~100 minutes each. These orbits are averaged for a certain day, plus the three days before, plus the three days after. This could theoretically be up to 98 profiles. But profiles with flares, artifacts, or the well-known disturbances close to the polar circles are excluded as non-typical. (This is done manually.) So, e.g., for 15 Dec 2020, only 59 profiles could be used for averaging. The result looks like this:



The first minute of an orbit (min=0) is defined as the time when the tangential altitude starts to rise. The last minute of an orbit (min=99) usually is the time when the tangential altitude stops to fall. The middle of each orbit (min=44 to min=54) is set to 1.0 and the profile is normalized.

With the help of this typical profile, the real profiles of a day are corrected such that every minute is divided by the relative correction. Thus, the middle of the orbit remains practically unchanged, and the borders of the profile are lifted up. To avoid possible over-correction, minutes with a tangential altitude below 300 are excluded. This leads to gaps, but they are shorter than in the preliminary first step.

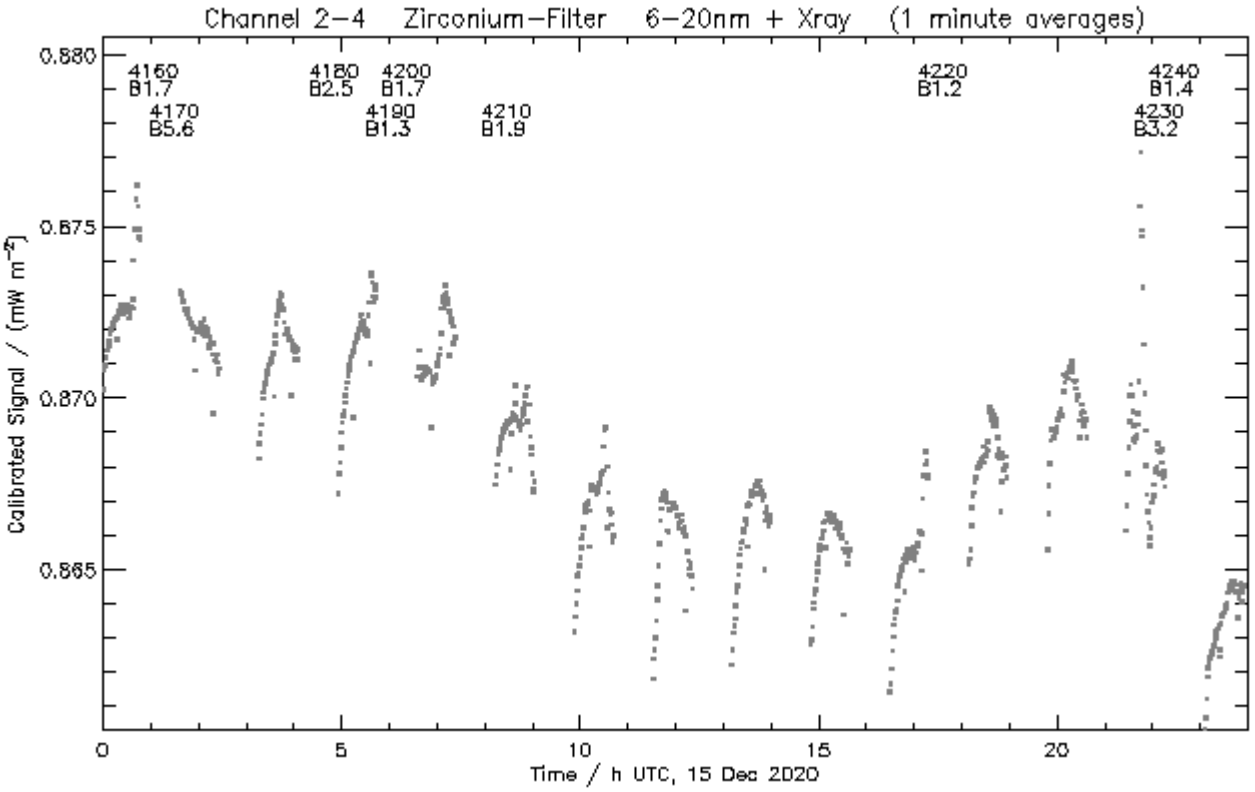
The resulting correction is shown in the following figure, again for 15 Dec 2020. The dots denote the original profile, i.e. with occultation; the small asterisks denote the corrected LYRA channel-4 curve of the day. This is done for all four LYRA channels, for all days of the occultation season.



Some interesting questions remain: Why is the LYRA profile influenced by the Earth's atmosphere even in minutes where the tangential altitude is defined as 1000, at times where the Sun is assumed to be above the horizon? Why are the profiles asymmetric, i.e., there is a difference between (fast) going into the dark and (slow) coming from the dark? It could be an influence of the Earth's atmosphere, but also the delayed reaction of the MSM detectors. (The PIN detector profile is more symmetric.) And how did the profiles change with time of mission?

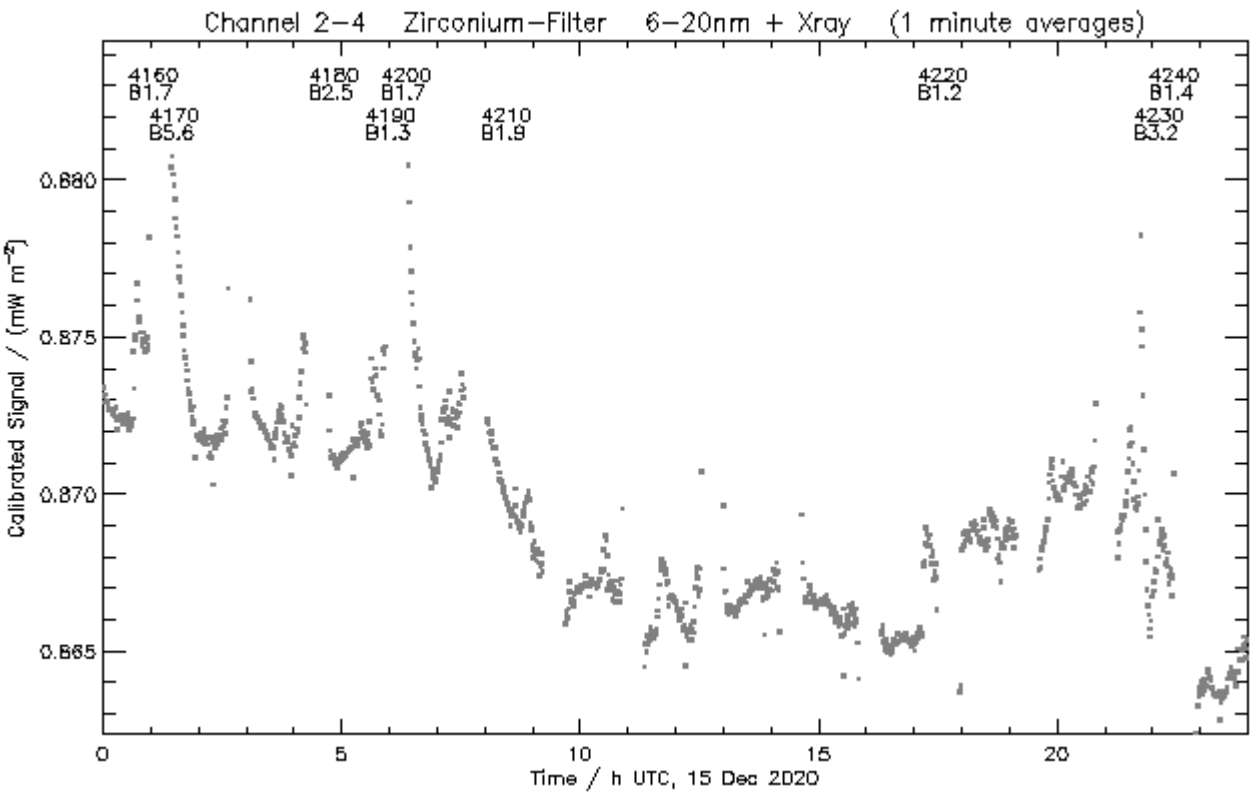
The following pages demonstrate the effect of the correction, again for 15 Dec 2020. “before” denotes the preliminary approach, just leaving a gap; “after” denotes the final correction. In detail:
- Flare List (before/after)
- example flare (before/after)
- GOES vs. LYRA Proxies (before/after)
- LYRA Level 4 (before/after/none*)
- LYRA Level4B (before/after/none*)

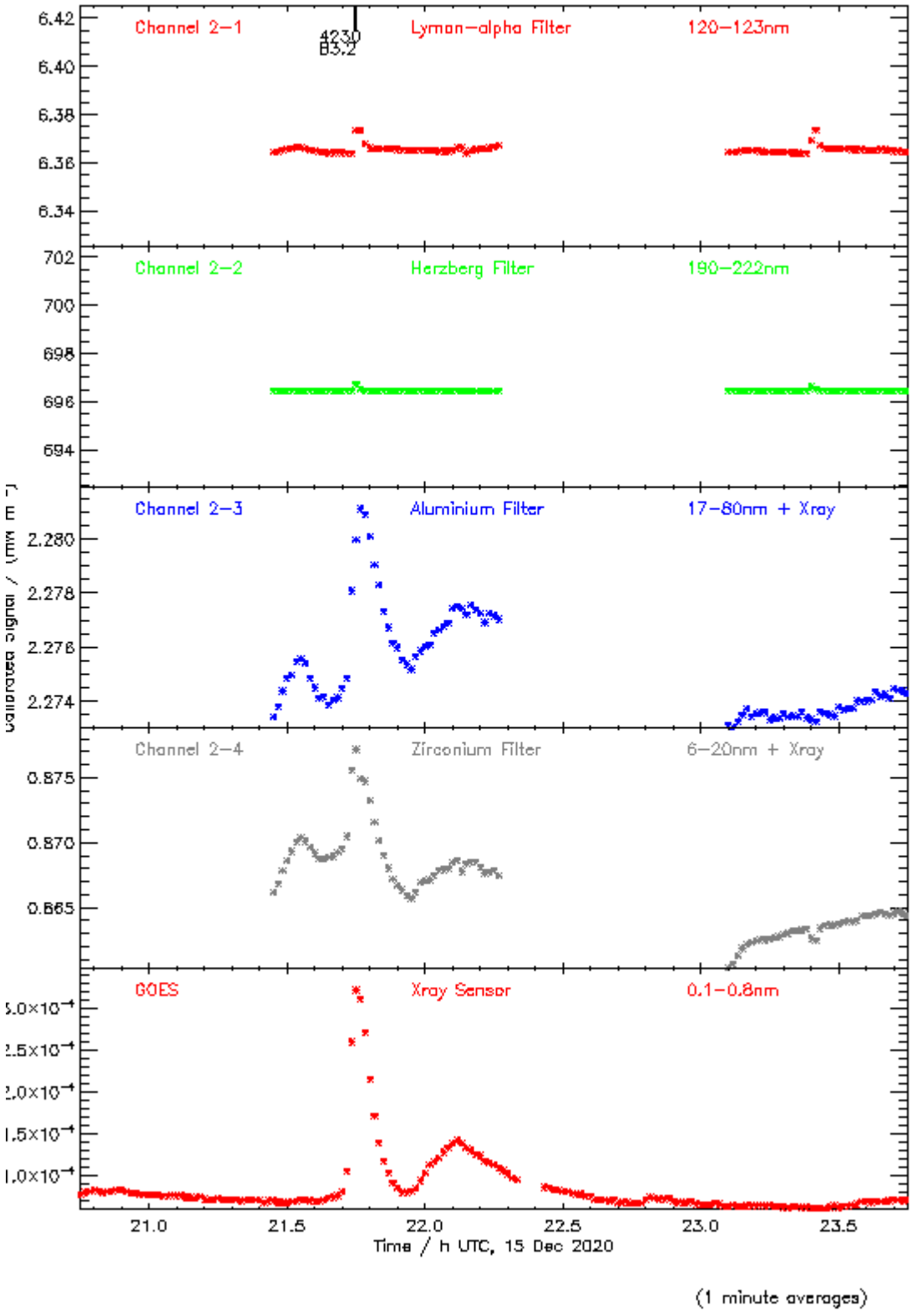
[* = the last two are the official images, created automatically, which are not corrected. It should be discussed whether they are to be replaced by the corrected images.]



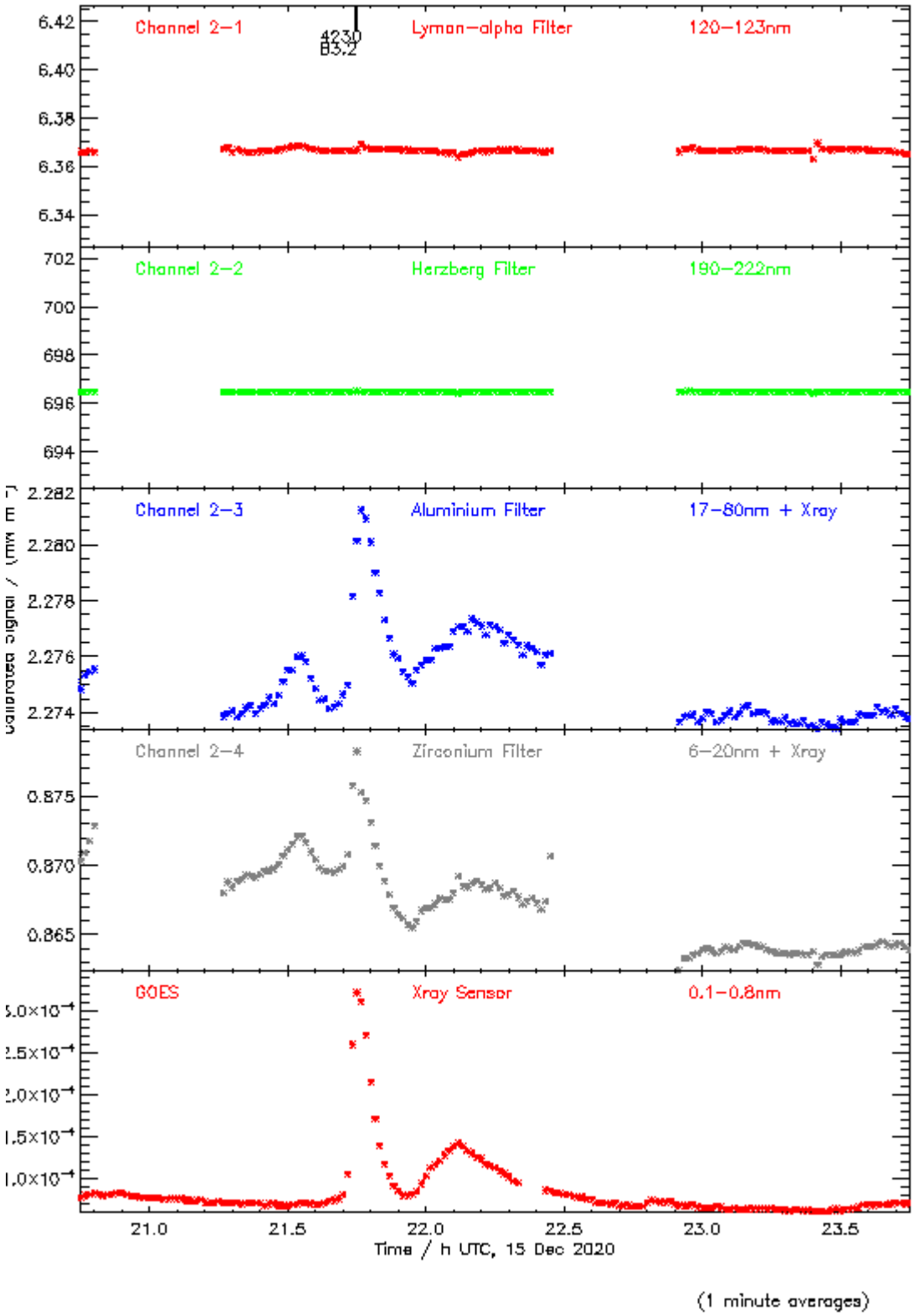
(before)

(after)

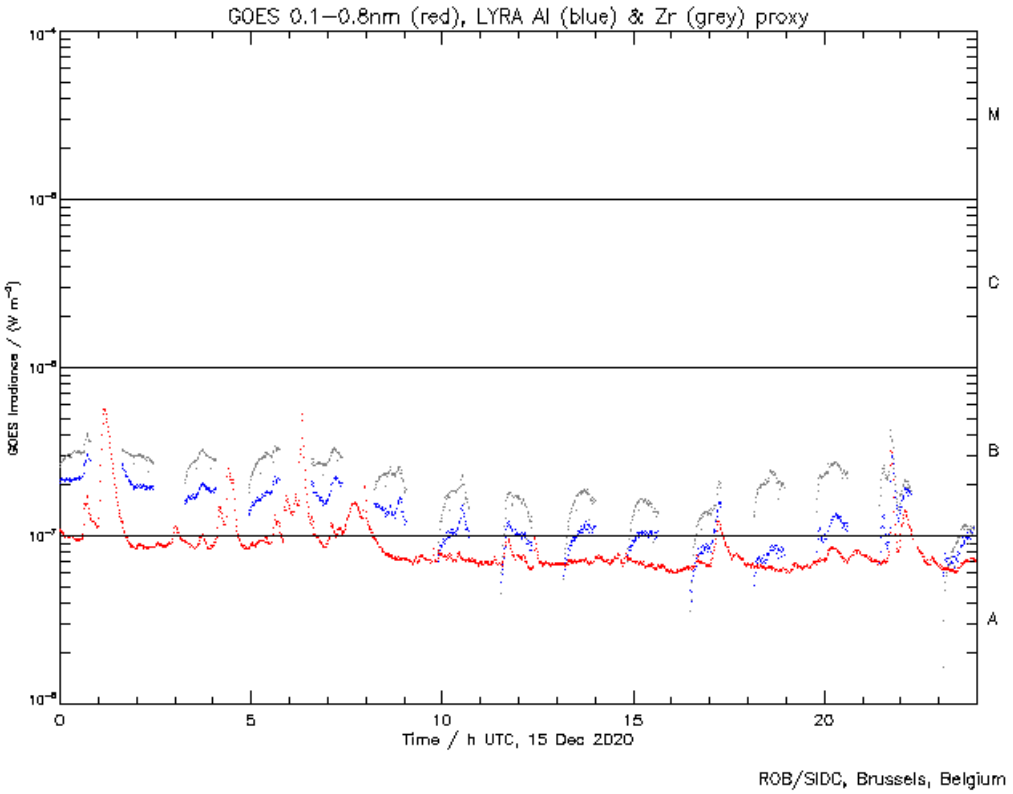



Channel 2-1
Lyman-alpha Filter
120-123nm
4230
03:2
Channel 2-2
Herzberg Filter
190-222nm
Channel 2-3
Aluminium Filter
17-80nm + Xray
Channel 2-4
Zirconium Filter
6-20nm + Xray
GOES
Xray Sensor
0.1-0.8nm
Calibrated signal / (mW m⁻²)
Time / h UTC, 15 Dec 2020
(1 minute averages)

(before)

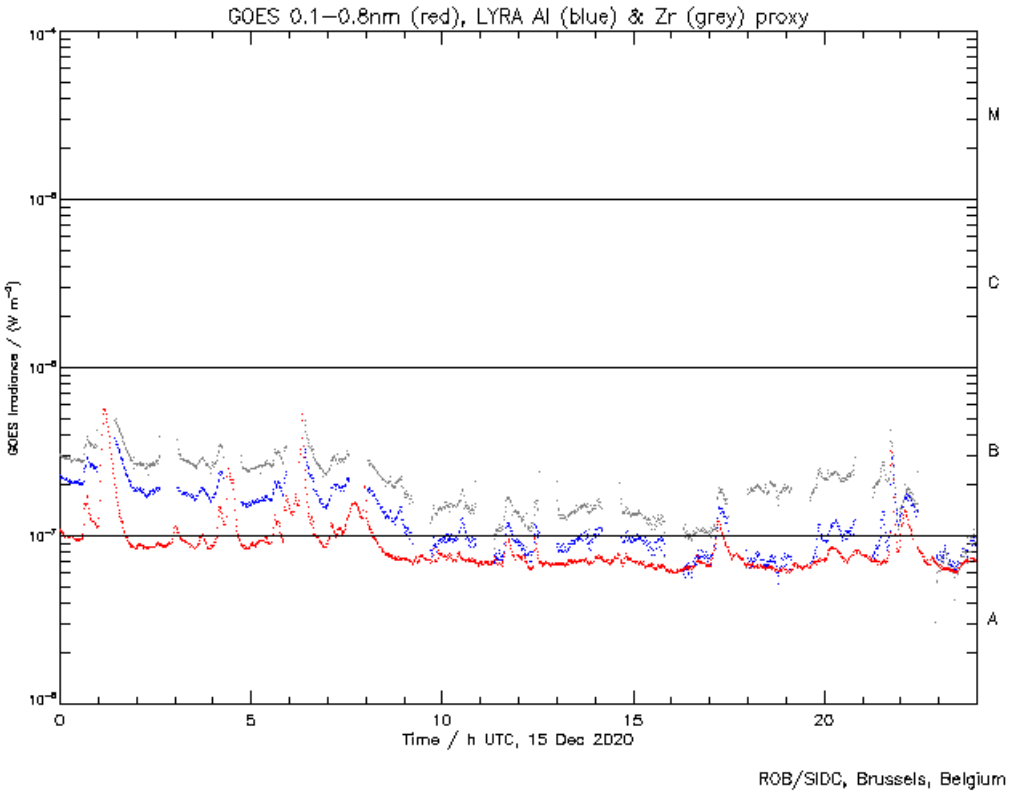

Channel 2–1
Lyman–alpha Filter
120–123nm
4230
B3.2
Channel 2–2
Herzberg Filter
190–222nm
Channel 2–3
Aluminium Filter
17–80nm + Xray
Channel 2–4
Zirconium Filter
6–20nm + Xray
GOES
Xray Sensor
0.1–0.8nm
Calibrated signal / (mW m⁻²)
Time / h UTC, 15 Dec 2020
(1 minute averages)

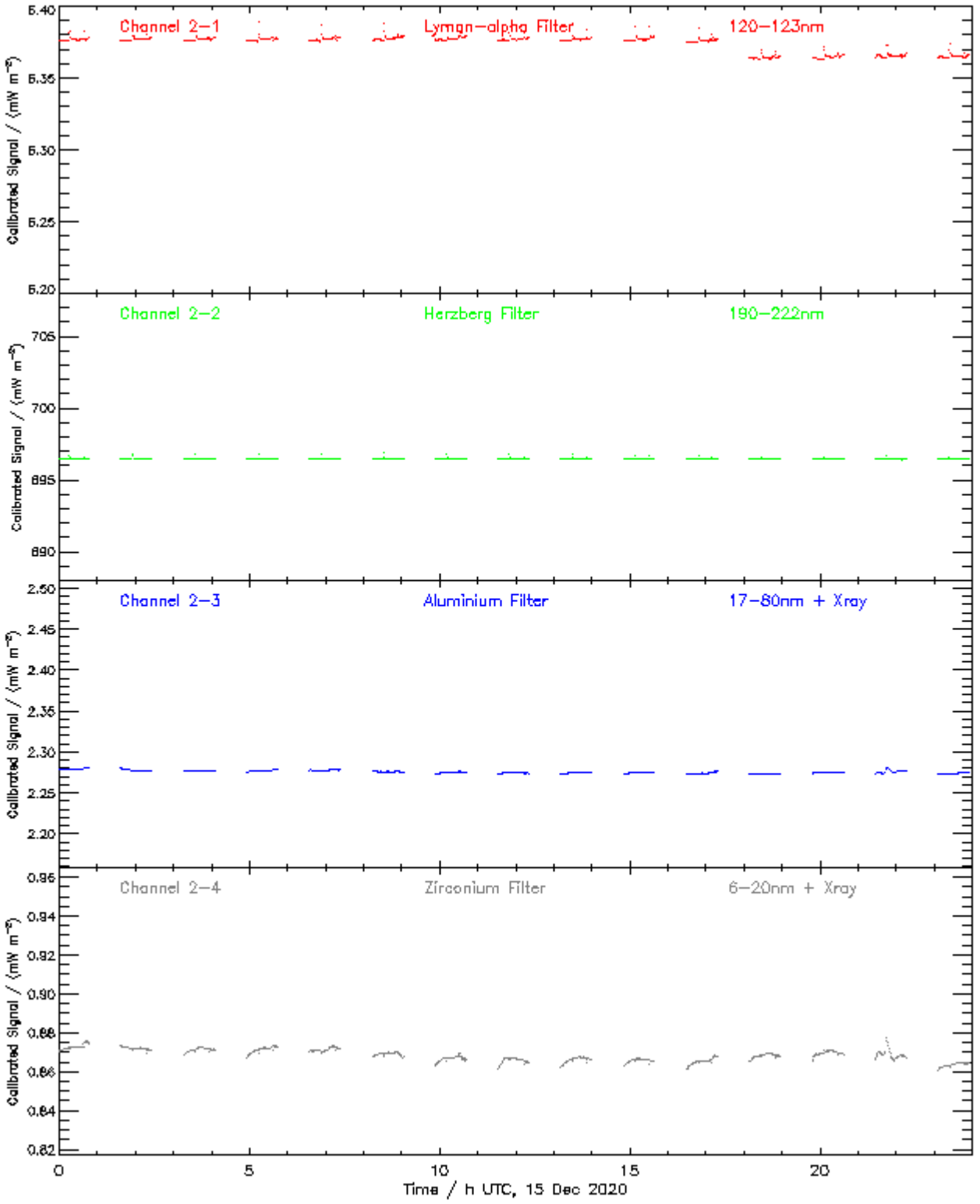
(after)



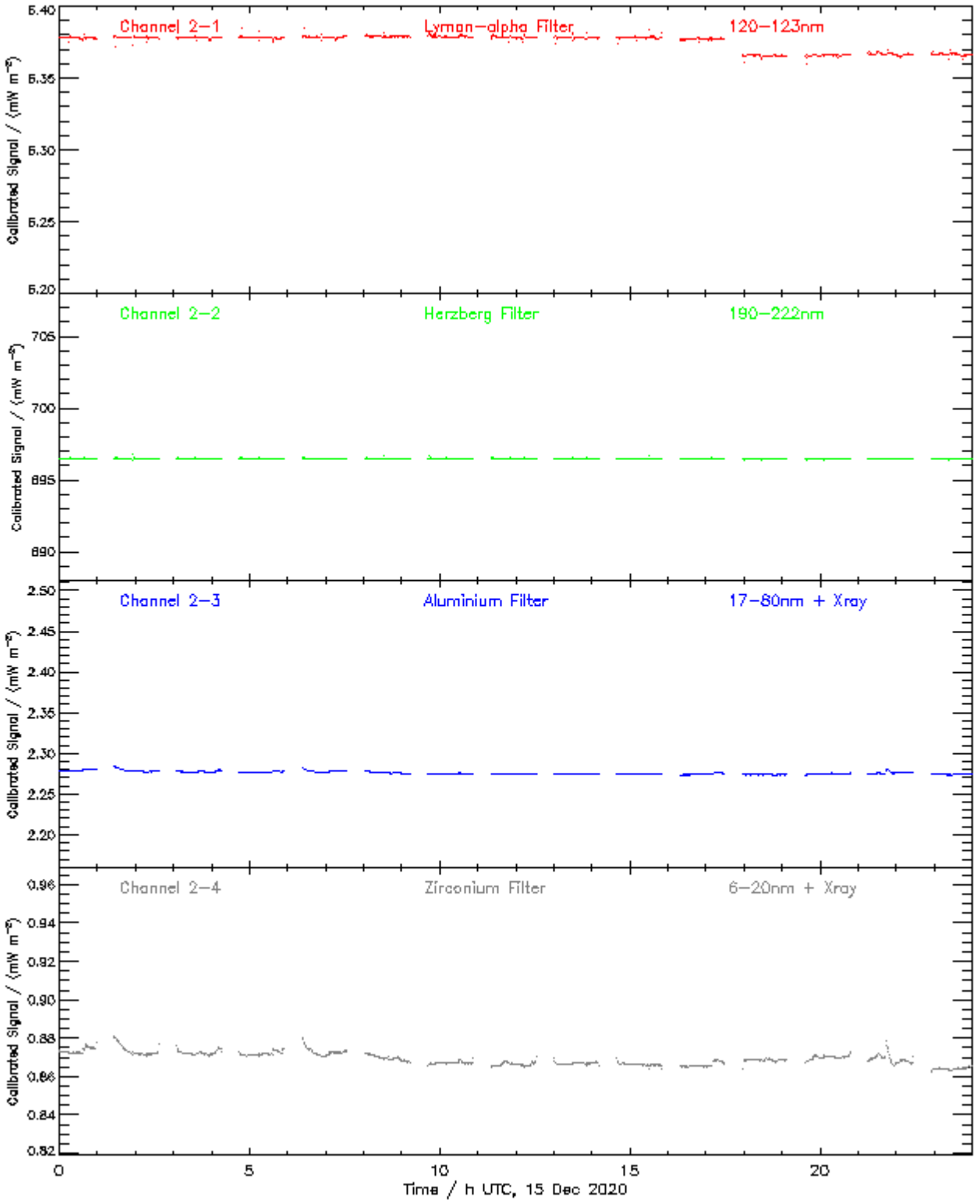
(before)

(after)

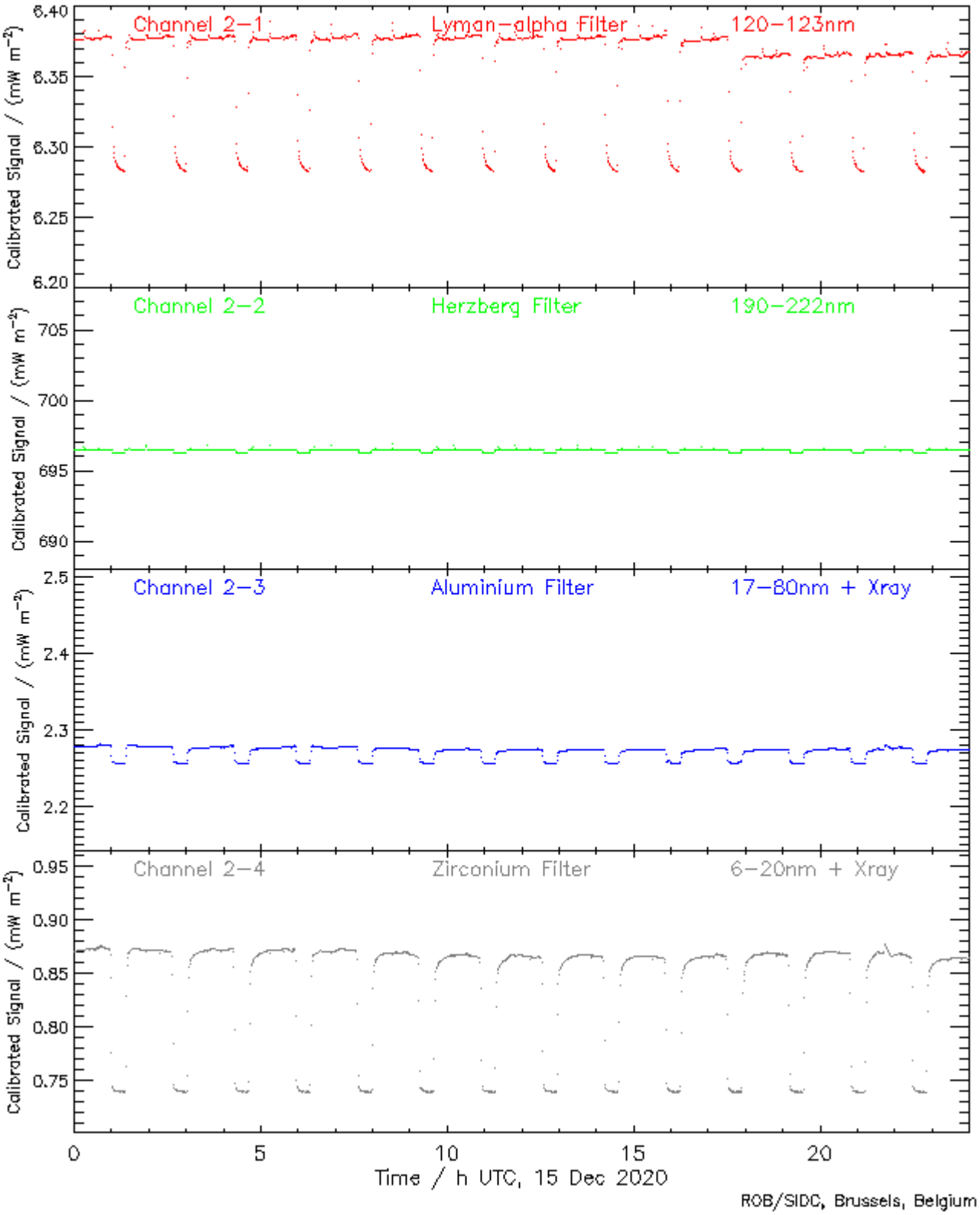



Channel 2–1
Lyman–alpha Filter
120–123nm
Channel 2–2
Herzberg Filter
190–222nm
Channel 2–3
Aluminium Filter
17–80nm + Xray
Channel 2–4
Zirconium Filter
6–20nm + Xray
Calibrated Signal / (mW m⁻²)
Time / h UTC, 15 Dec 2020
ROB/SIDC, Brussels, Belgium

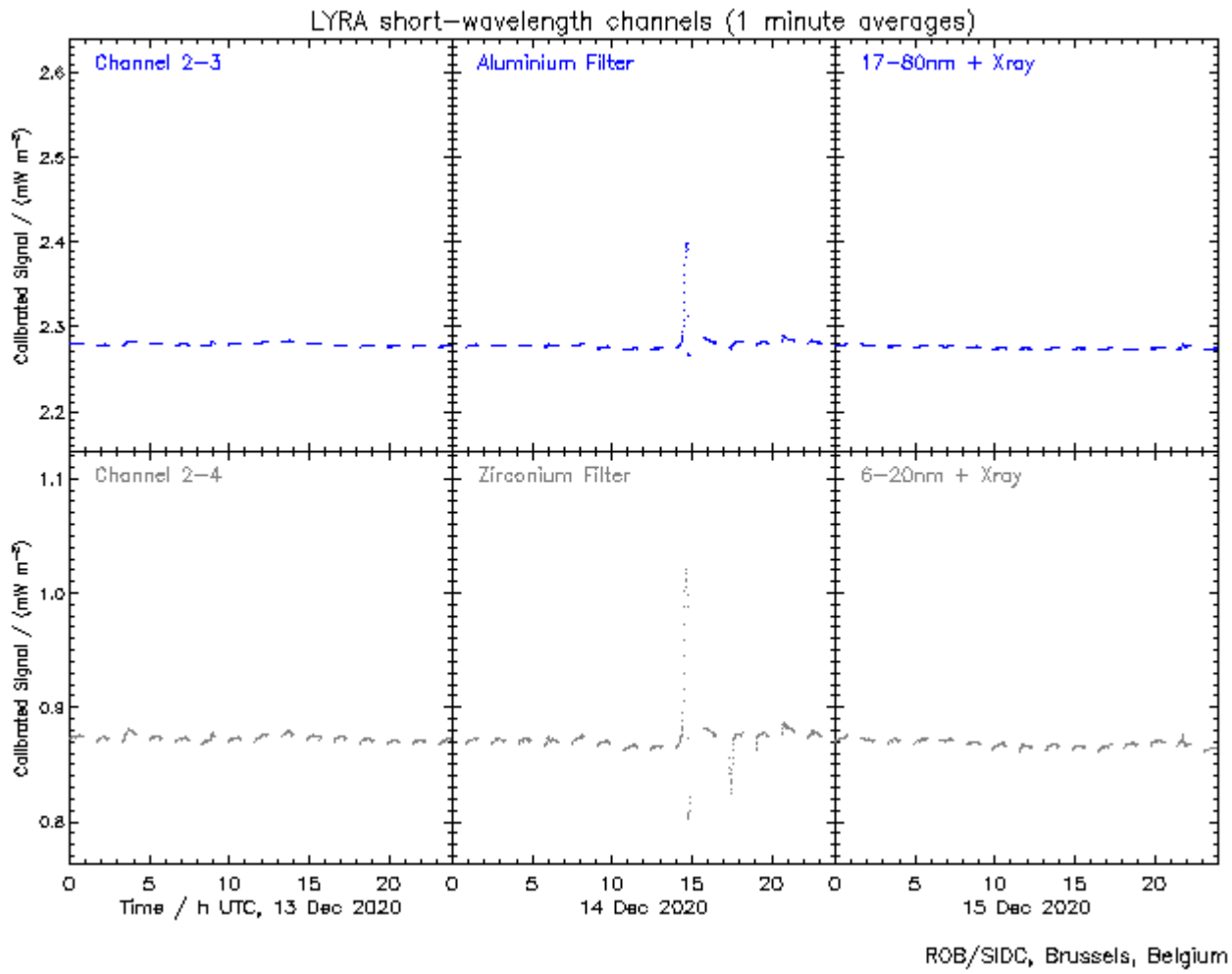
(before)


Channel 2–1
Lyman–alpha Filter
120–123nm
Channel 2–2
Herzberg Filter
190–222nm
Channel 2–3
Aluminium Filter
17–80nm + Xray
Channel 2–4
Zirconium Filter
6–20nm + Xray
Calibrated Signal / (mW m⁻²)
Time / h UTC, 15 Dec 2020
ROB/SIDC, Brussels, Belgium

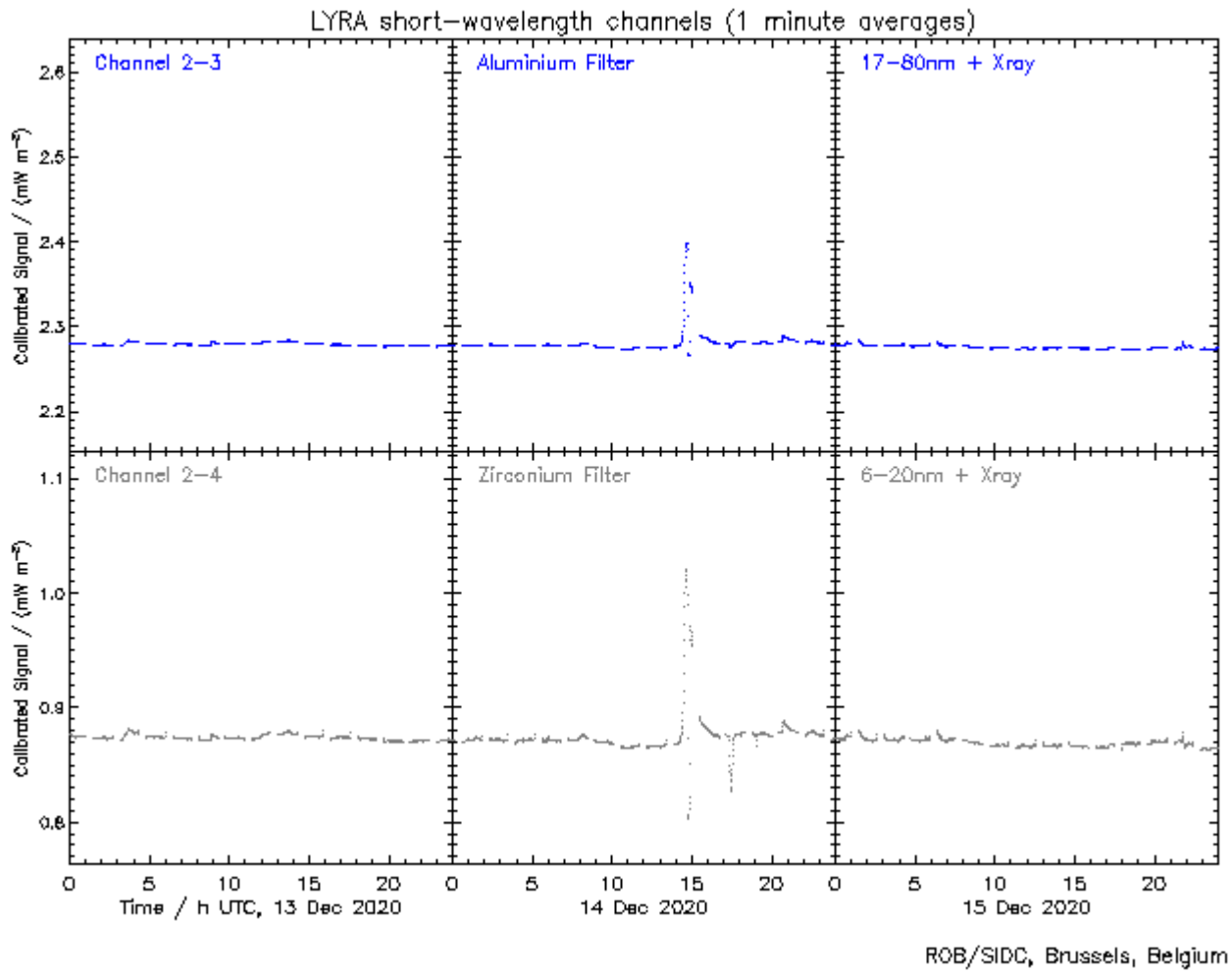
(after)


Channel 2-1
Lyman-alpha Filter
120-123nm
Channel 2-2
Herzberg Filter
190-222nm
Channel 2-3
Aluminium Filter
17-80nm + Xray
Channel 2-4
Zirconium Filter
6-20nm + Xray
Calibrated Signal / (mW m-2)
Time / h UTC, 15 Dec 2020
ROB/SIDC, Brussels, Belgium

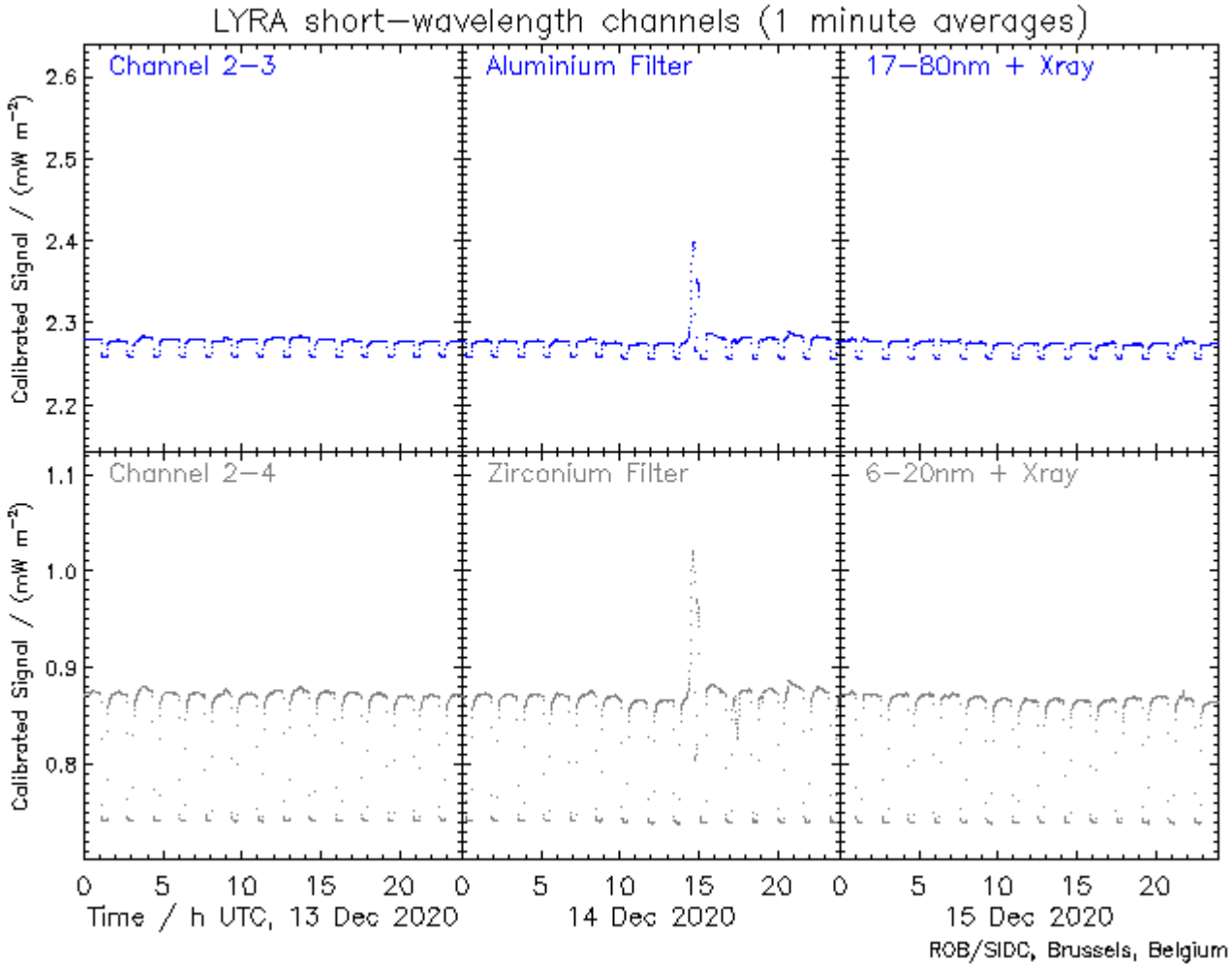
(none)


LYRA short-wavelength channels (1 minute averages)
Channel 2-3
Aluminium Filter
17-80nm + Xray
Channel 2-4
Zirconium Filter
6-20nm + Xray
Calibrated Signal / (mW m⁻²)
Time / h UTC, 13 Dec 2020
14 Dec 2020
15 Dec 2020
ROB/SIDC, Brussels, Belgium

(before)


LYRA short-wavelength channels (1 minute averages)
Channel 2-3
Aluminium Filter
17-80nm + Xray
Channel 2-4
Zirconium Filter
6-20nm + Xray
Calibrated Signal / (mW m⁻²)
Time / h UTC, 13 Dec 2020
14 Dec 2020
15 Dec 2020
ROB/SIDC, Brussels, Belgium

(after)


LYRA short−wavelength channels (1 minute averages)
Channel 2−3
Aluminium Filter
17−80nm + Xray
Channel 2−4
Zirconium Filter
6−20nm + Xray
Calibrated Signal / (mW m^{-2})
Time / h UTC, 13 Dec 2020
14 Dec 2020
15 Dec 2020
ROB/SIDC, Brussels, Belgium

(none)