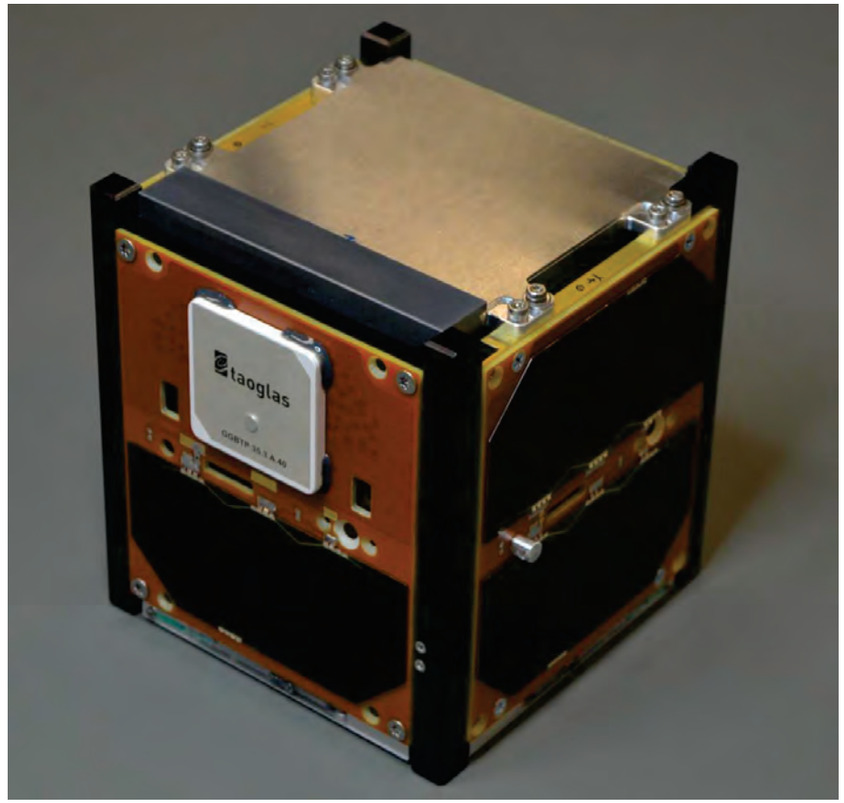
Space weather effects at LEO as experienced by GRBAlpha

Marianna Dafčíková, Bezovec 2023

GRBAlpha

- CZ–SK–HU–JPN collaboration
- 1U CubeSat
- Launched 22.3.2021 to polar LEO
- Technological mission
- CsI(Tl) scintillator (50-900 keV)
- 54 detections (35 GRBs)



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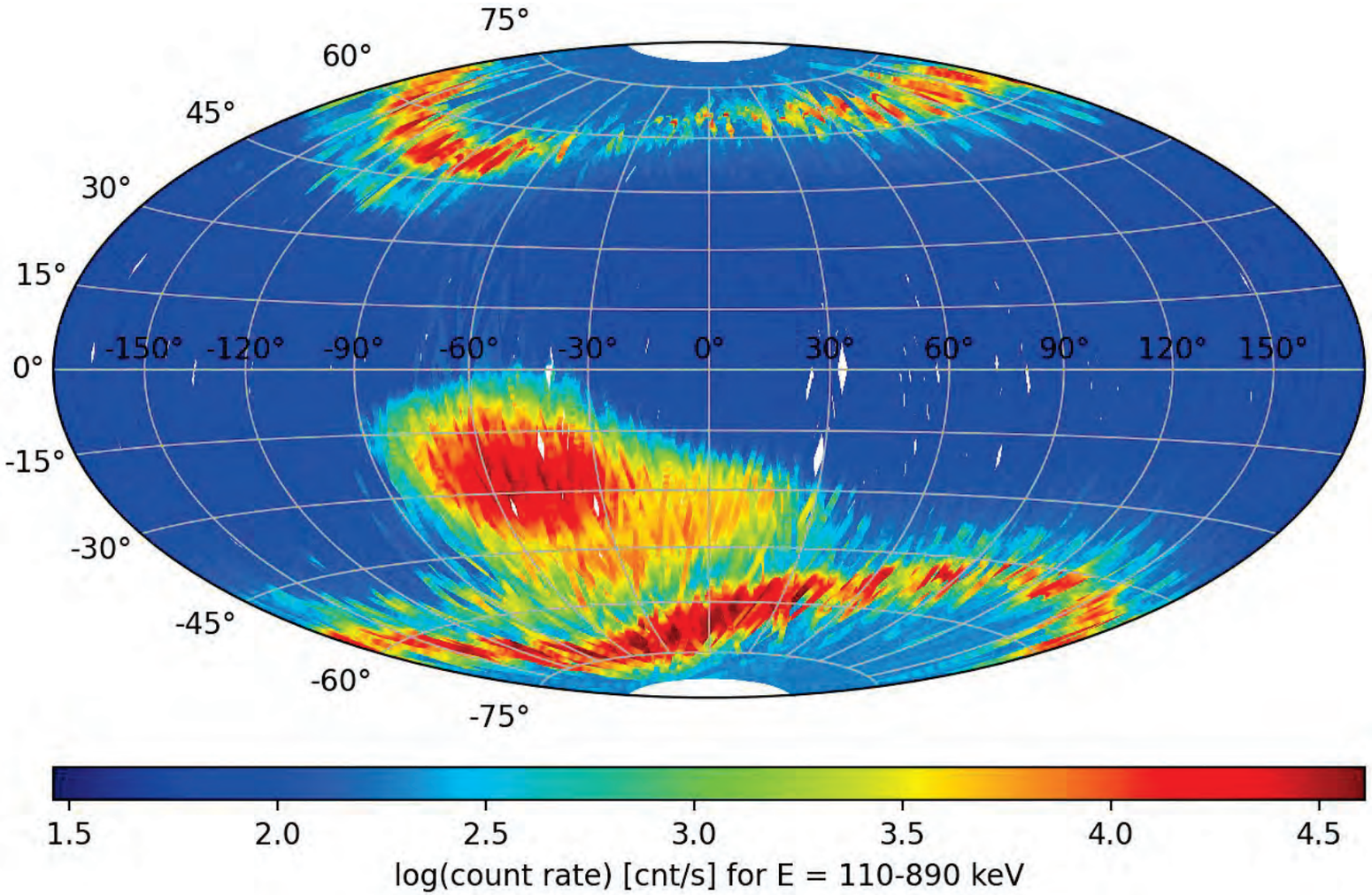
Motivation



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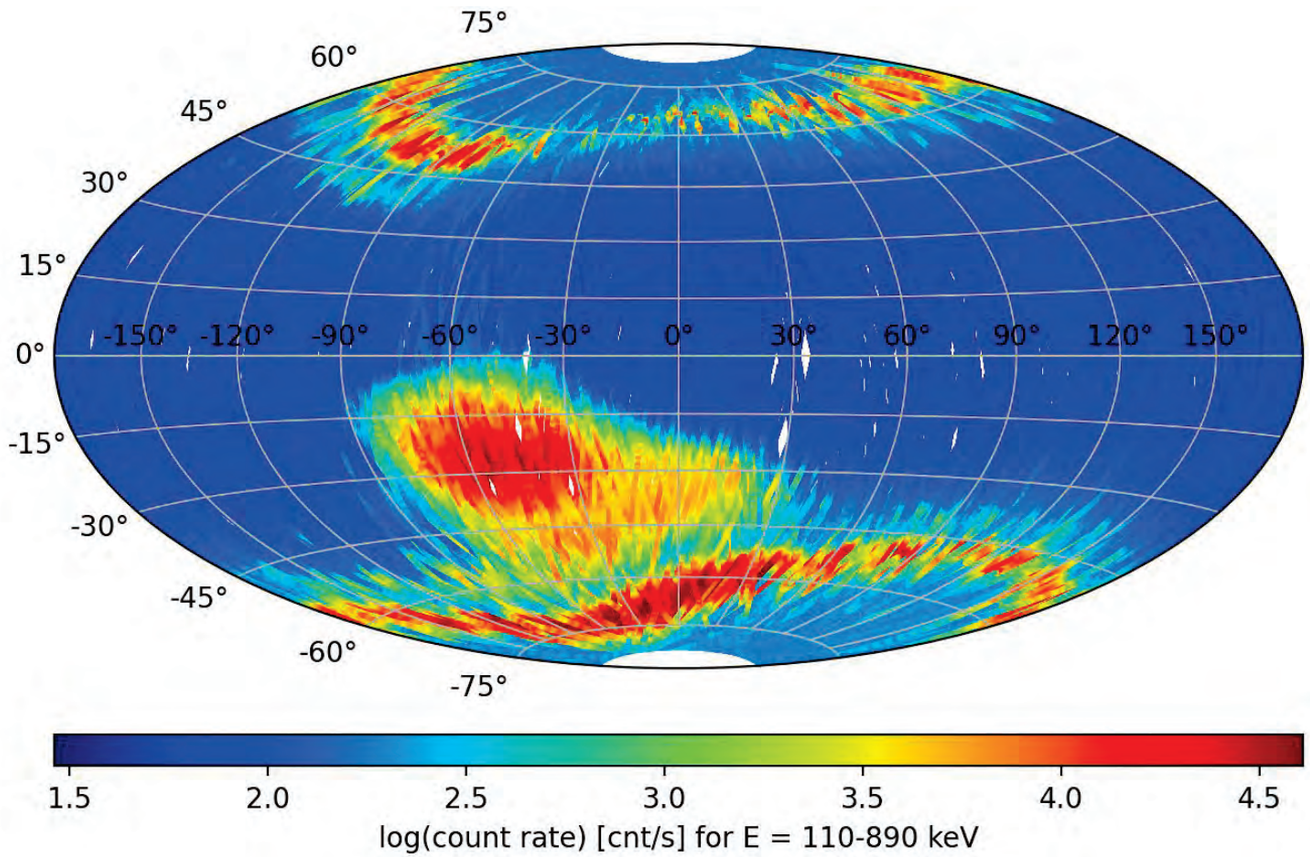
Motivation

1. Upcoming era of CubeSats at LEO:
   energetic protons and electrons harmful
   for satellites
2. Maximizing duty cycle
3. Curiosity

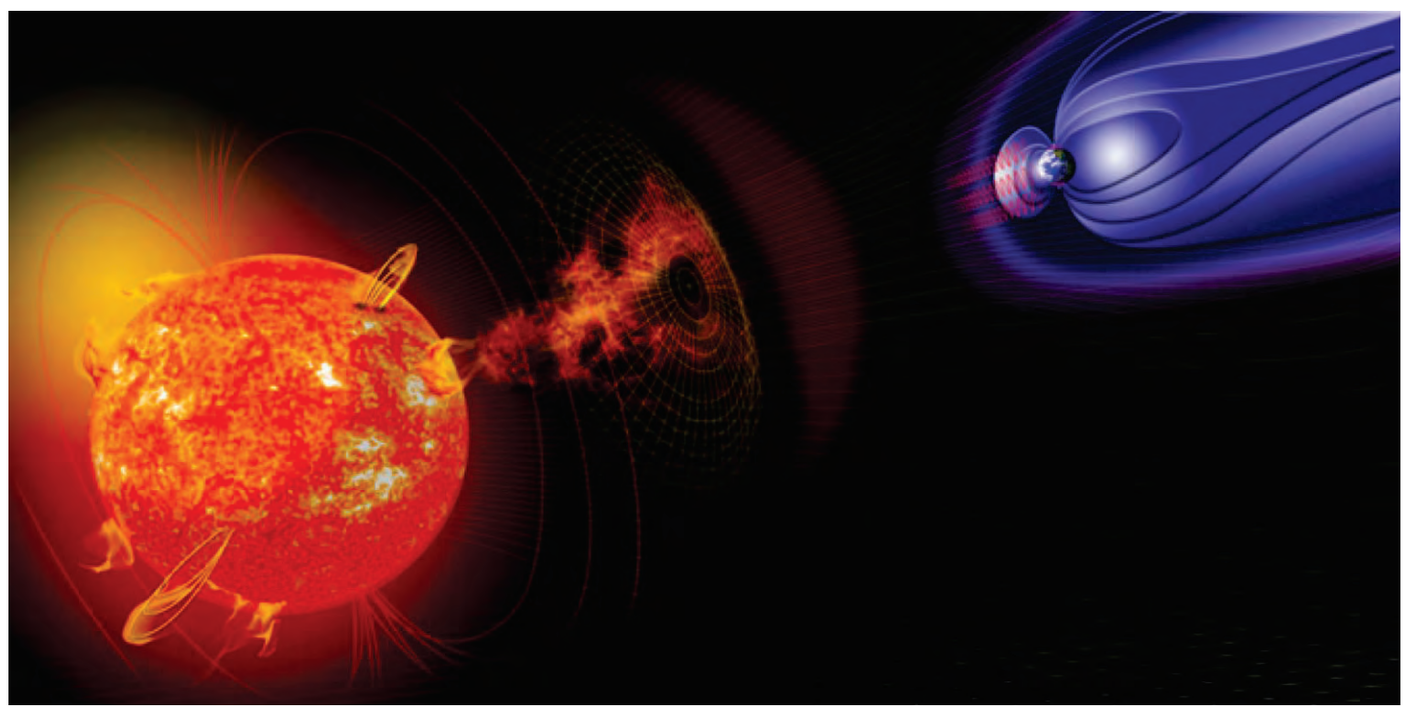
Radiation belts are shaped
by the interplanetary
conditions controlled
by the Sun



Space weather events at LEO

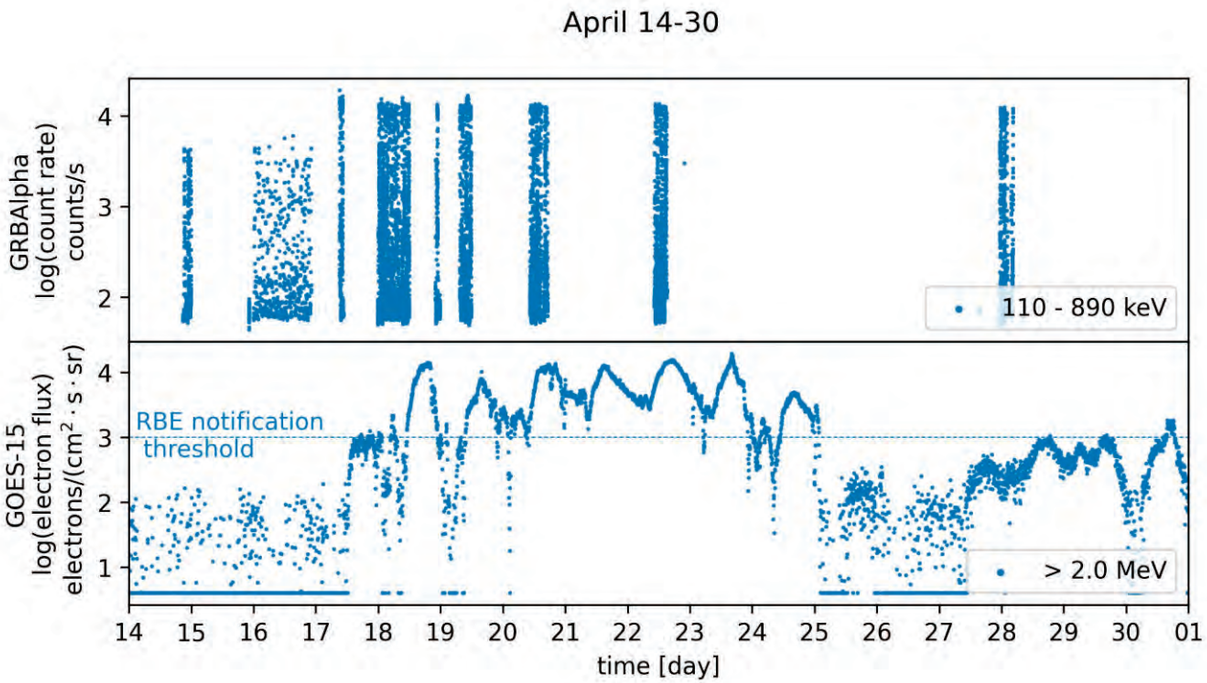
– Driven by solar eruptions (SF, CME) and fast solar wind (HSS)

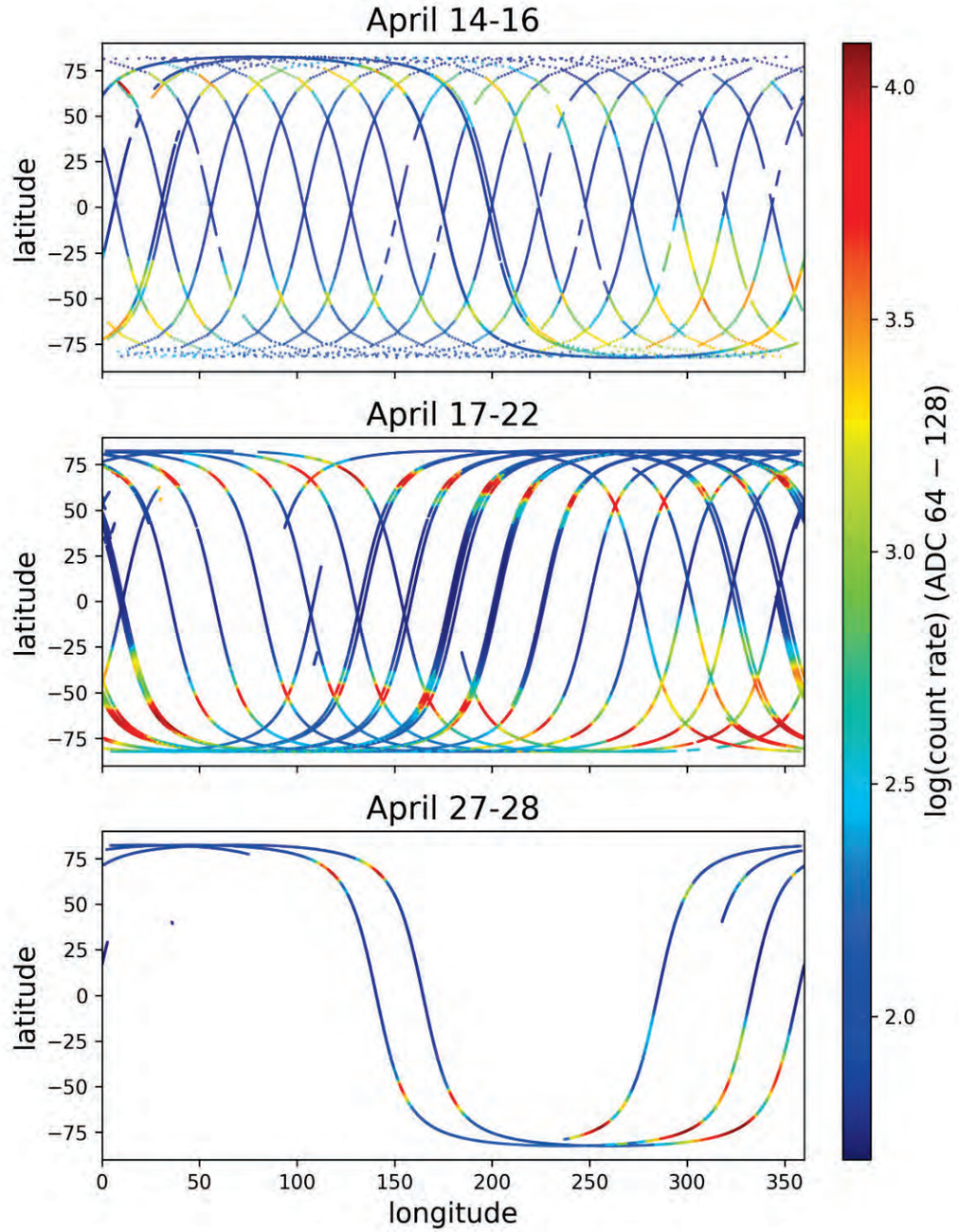
1. Radiation belt enhancements
2. Solar energetic particle (SEP) events
3. Geomagnetic storms



Radiation belt enhancement

April 2021

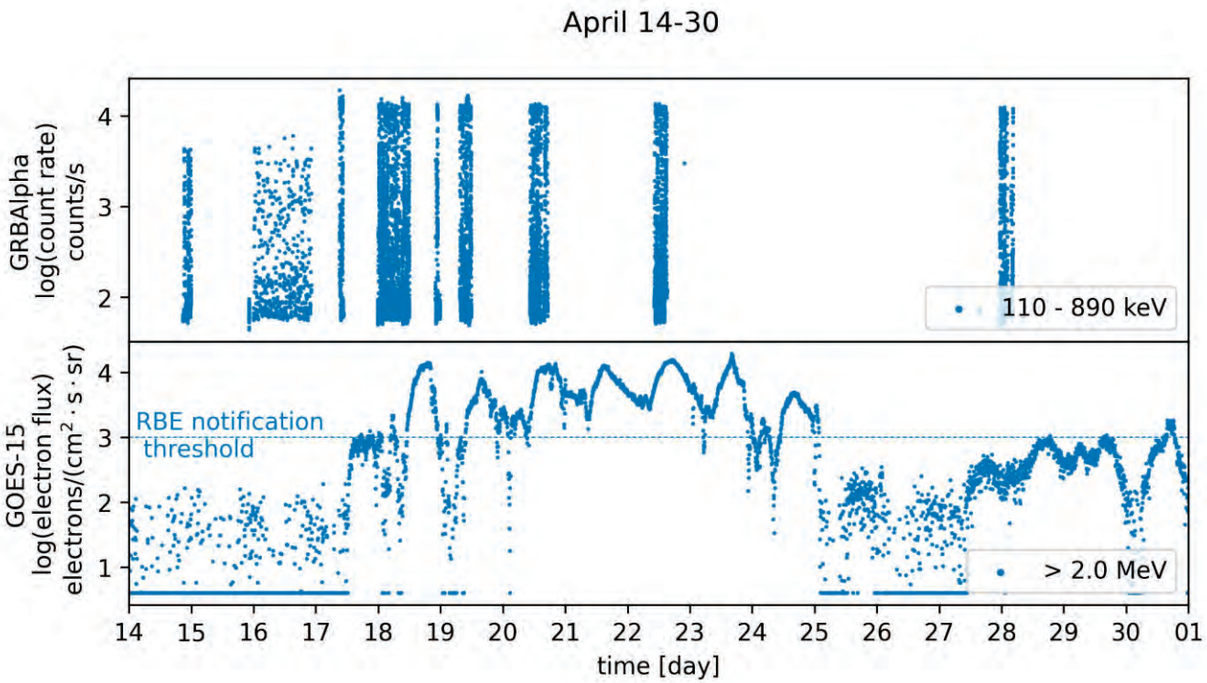


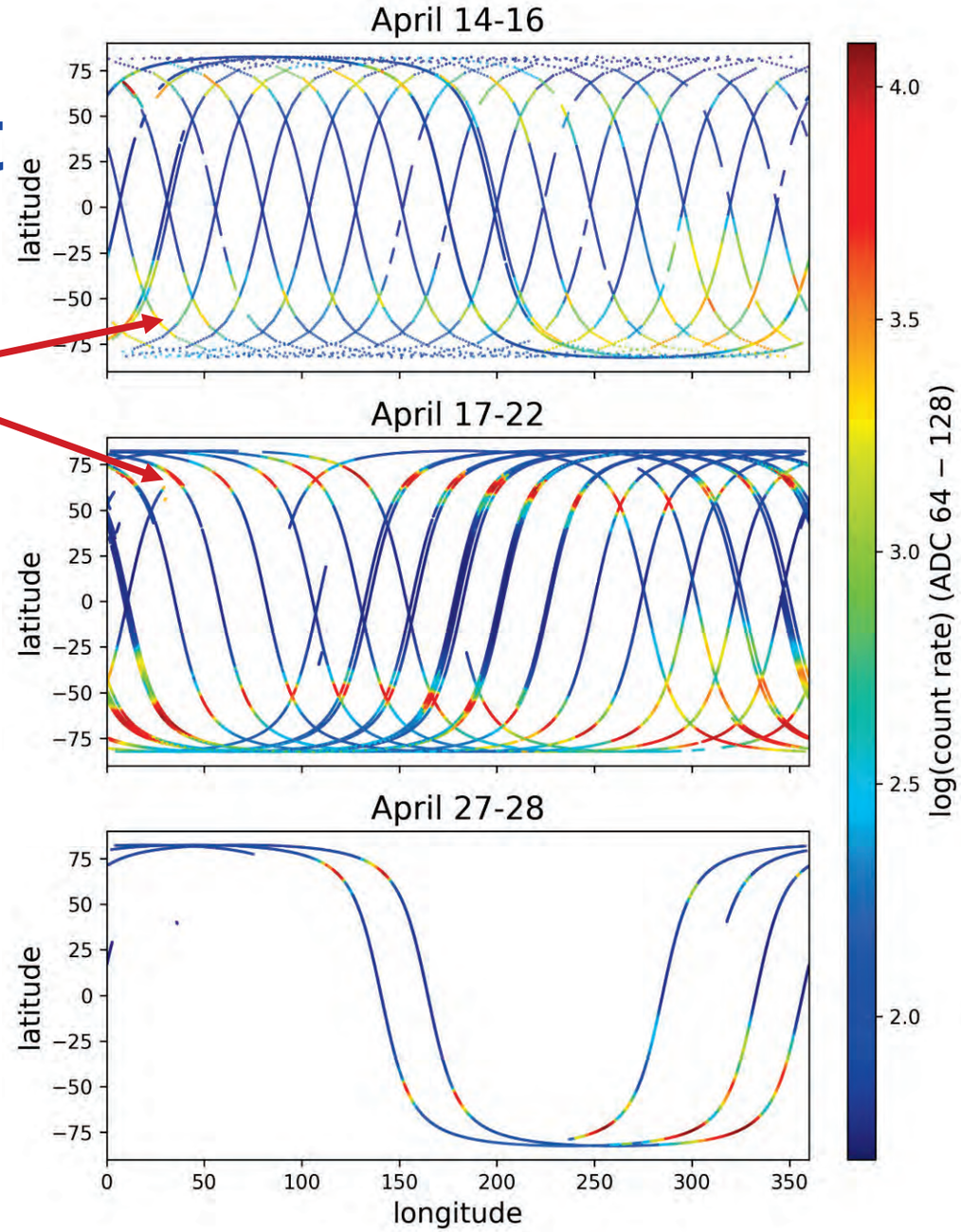


Radiation belt enhancement

April 2021

Increased electron
population in the outer belt





Geomagnetic storm 1: April 2023

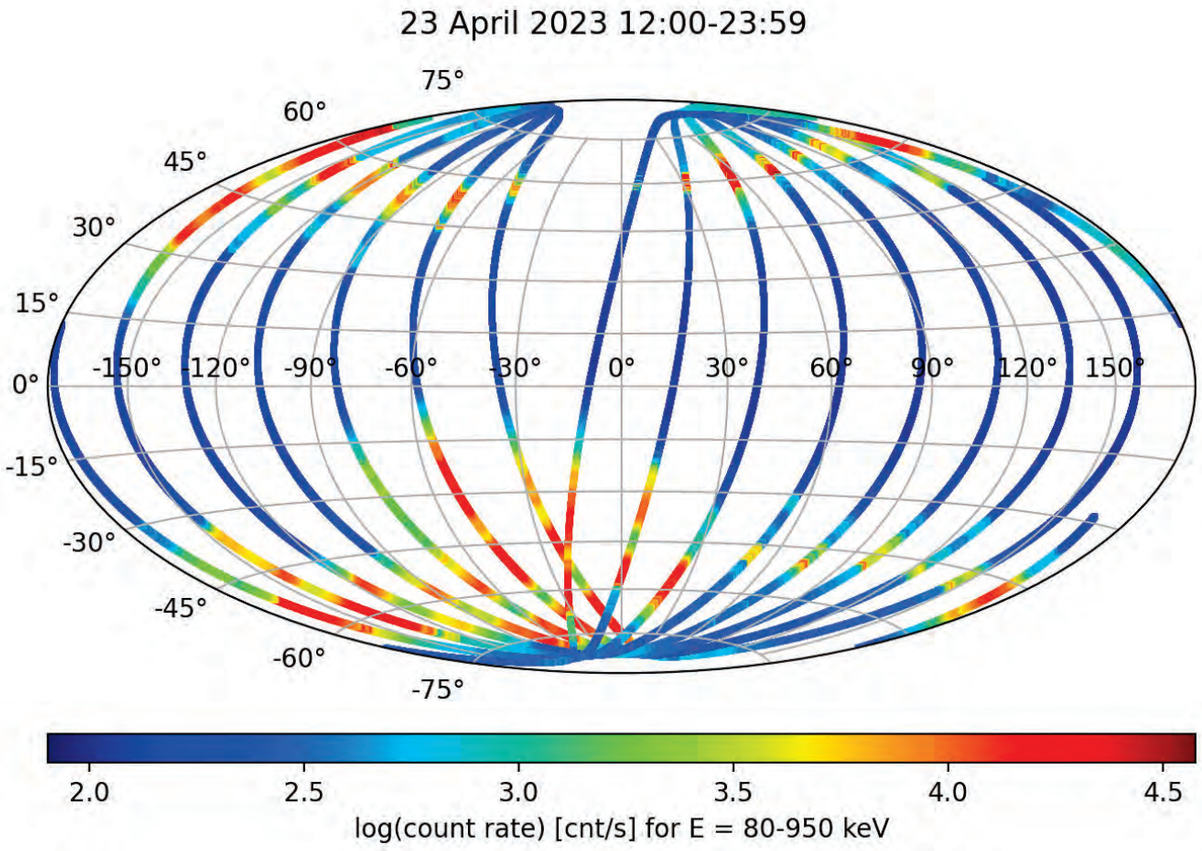


Photo: Jan Drahokoupil
23.04. 2023, Lodenice, Czech republic

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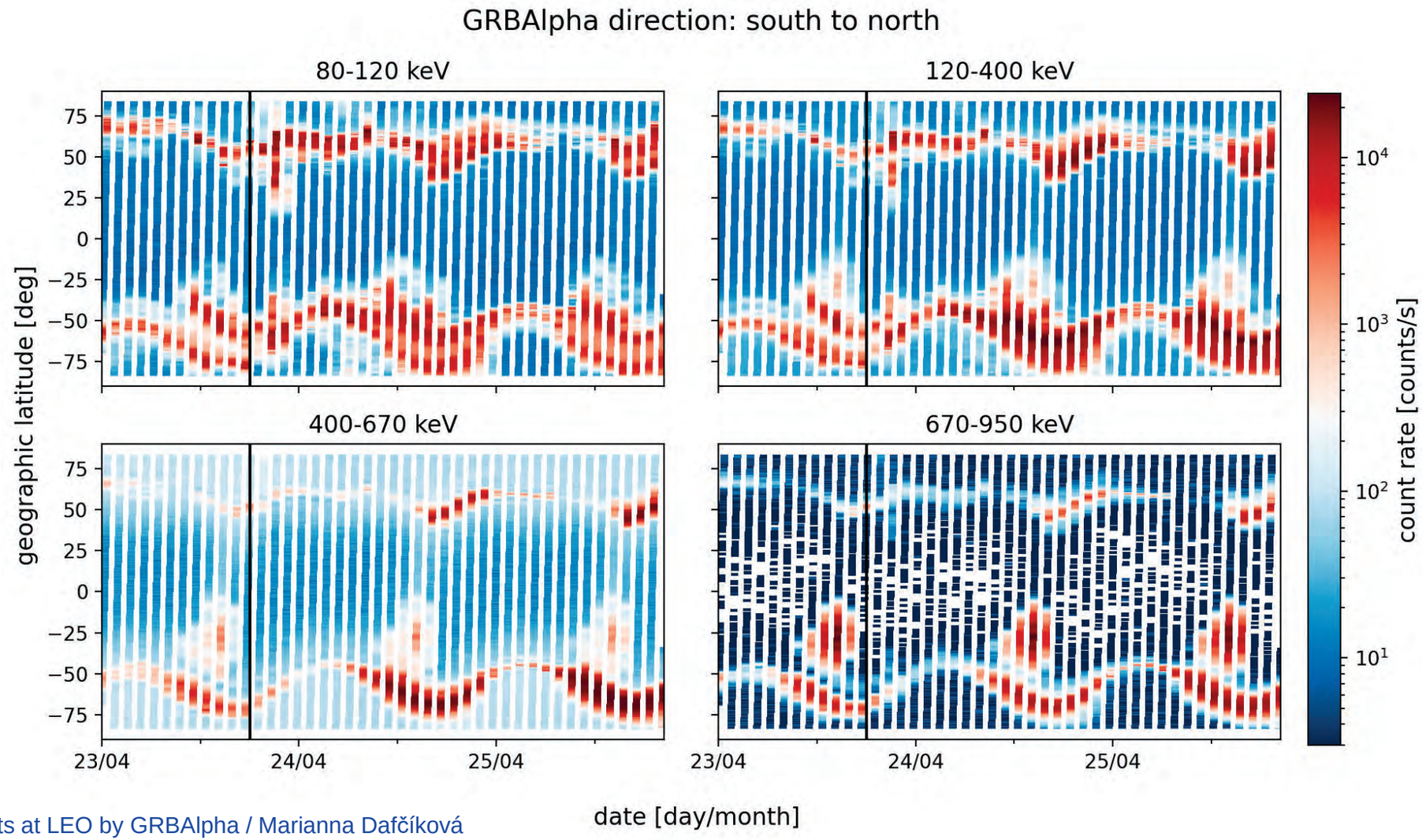
Geomagnetic storm 1: April 2023



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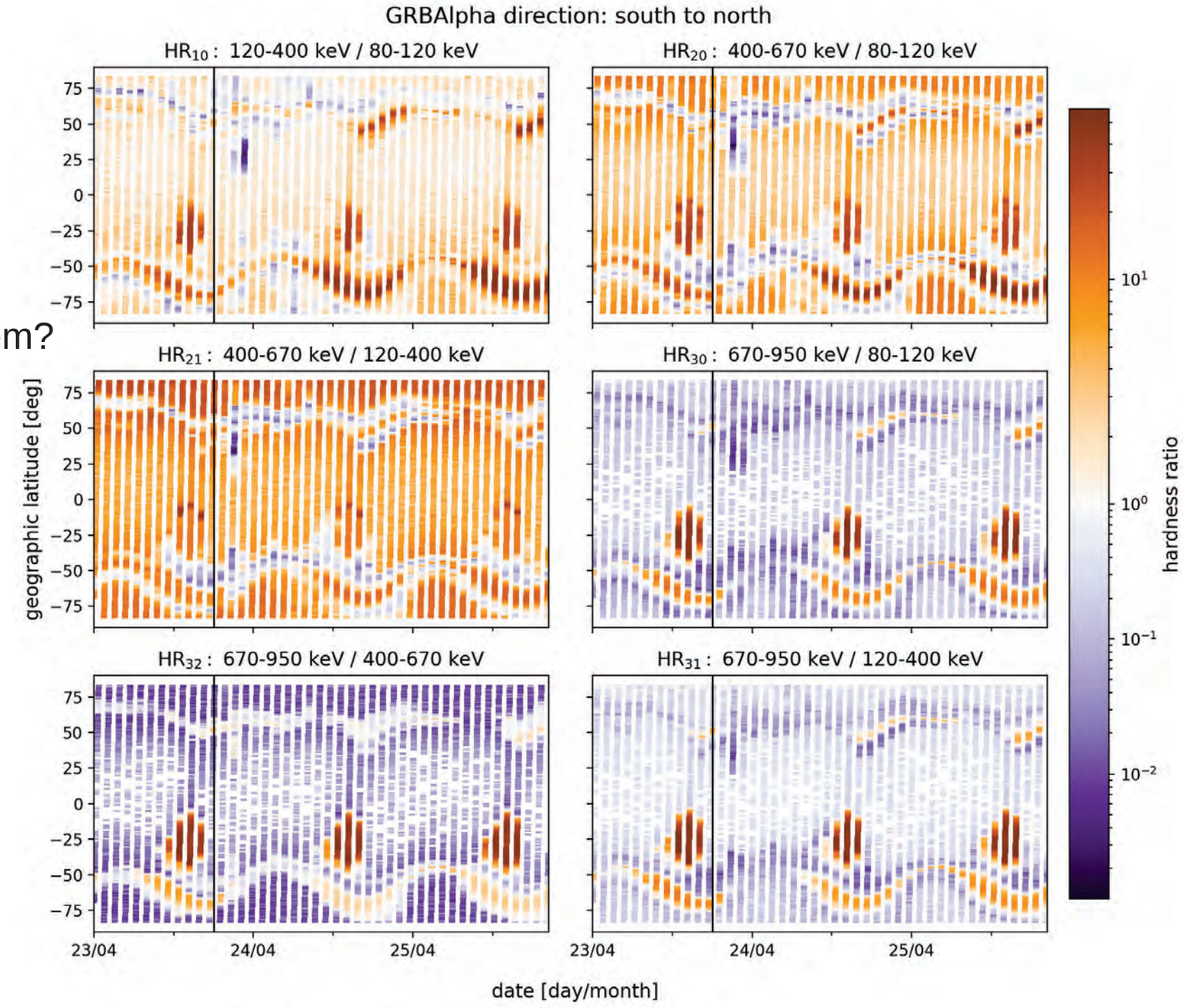
Inner belt: protons + electrons

Outer belt: electrons

=> can we distinguish between them?

Not corrected for pile-up effect!



Geomagnetic storm 2: March 2022

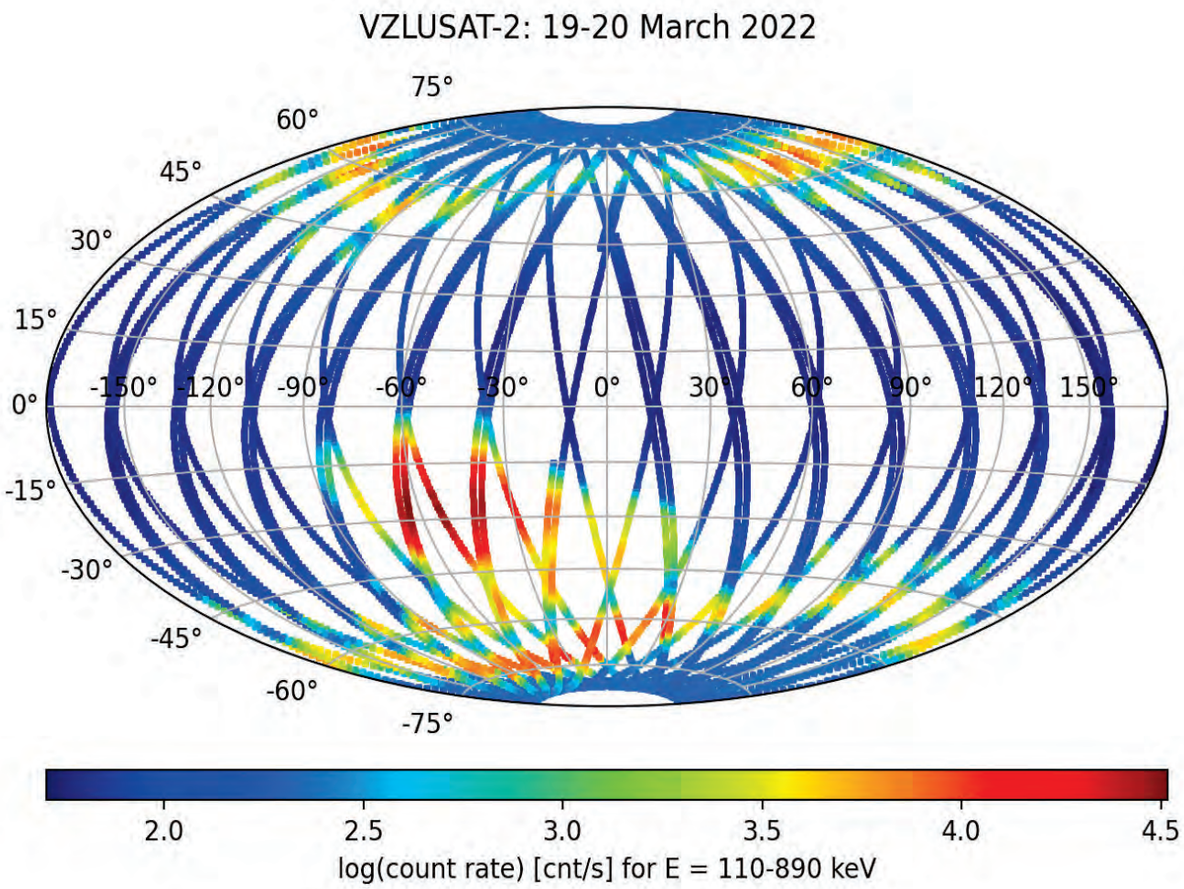


Photo: Petr Horálek,
14.03 2022, Ústupky, Czech republic

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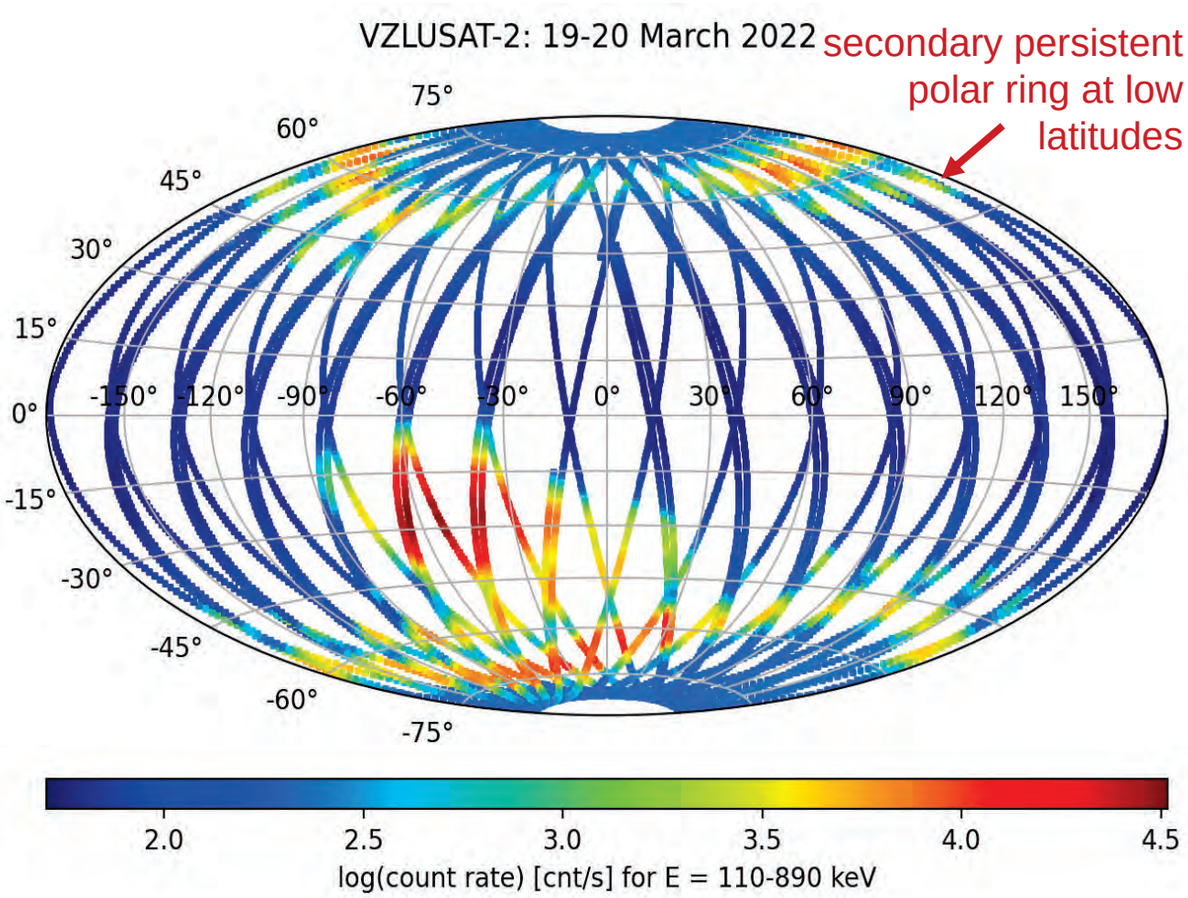
Geomagnetic storm 2: March 2022



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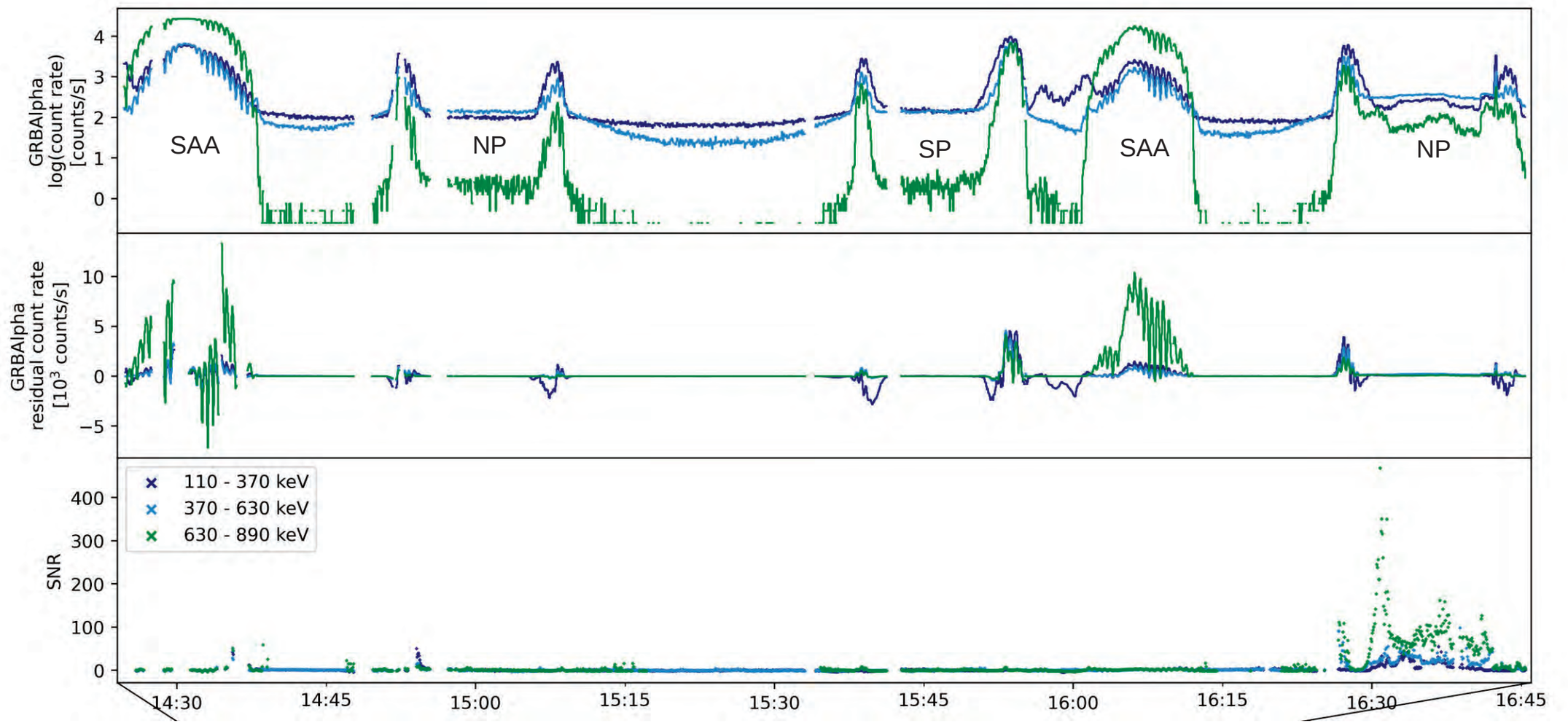
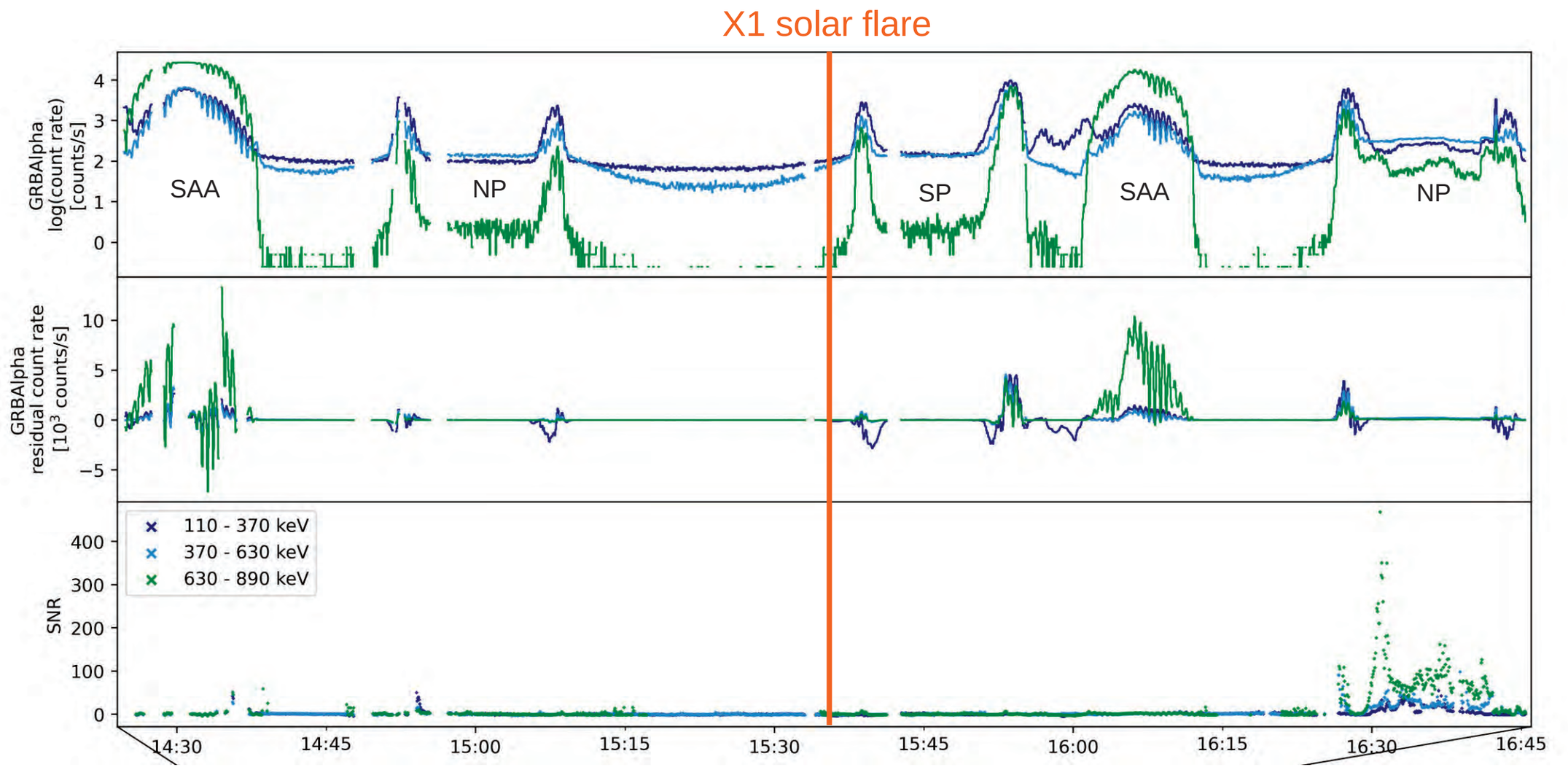
SEP event on 28 Oct. 2021

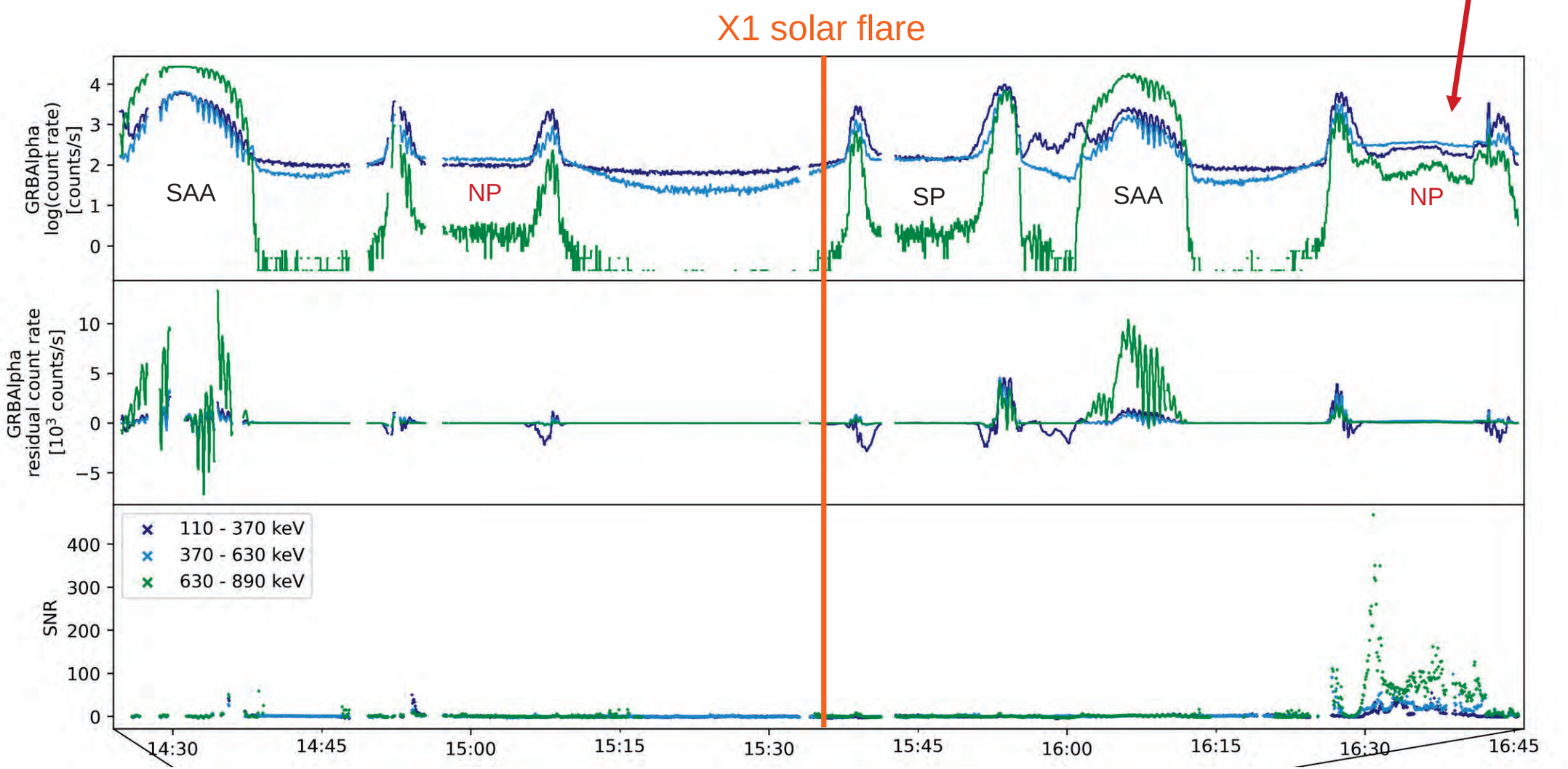


SEP event on 28 Oct. 2021

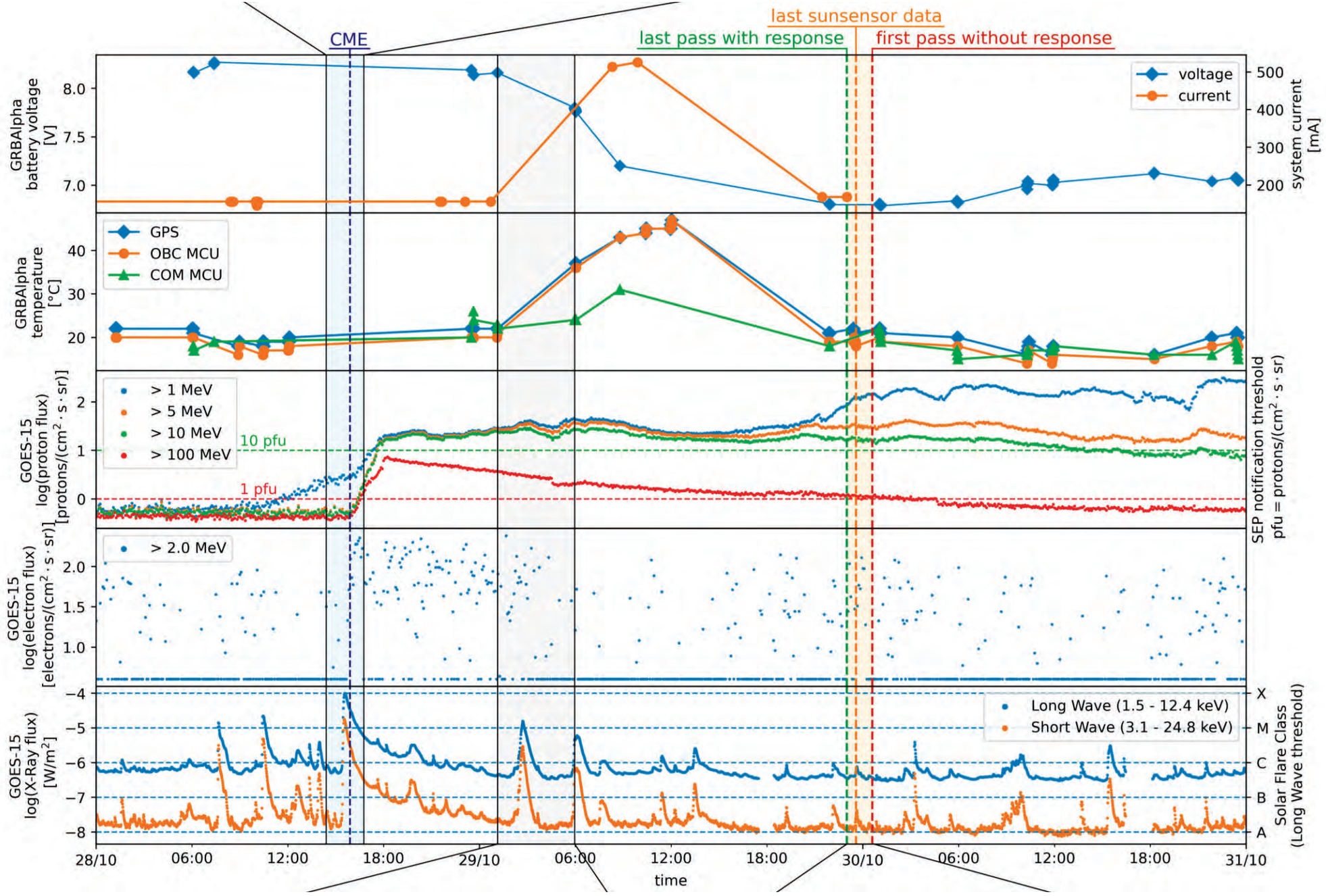


SEP event on 28 Oct. 2021

Penetration of energetic protons into low altitudes



VHF radio loss



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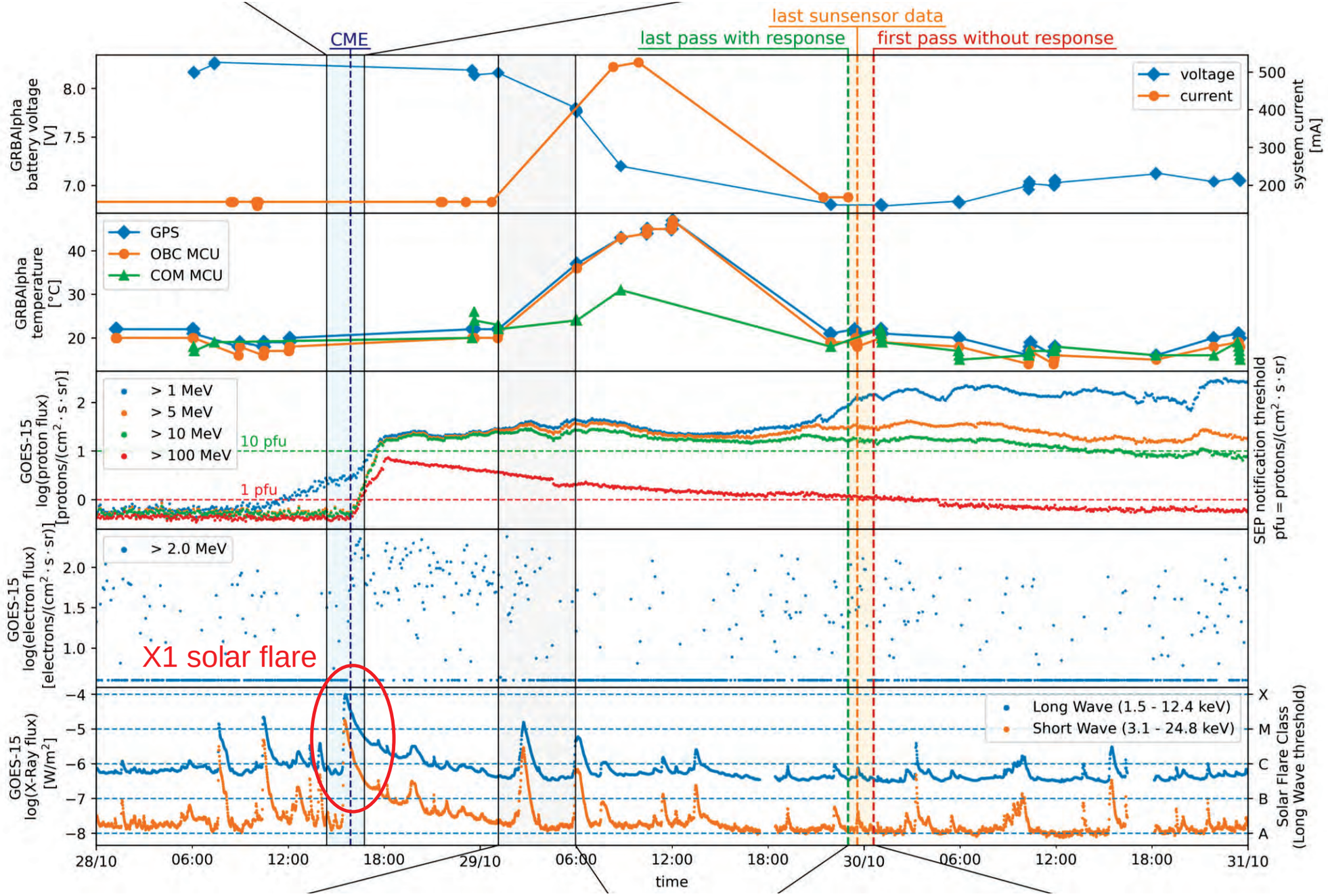
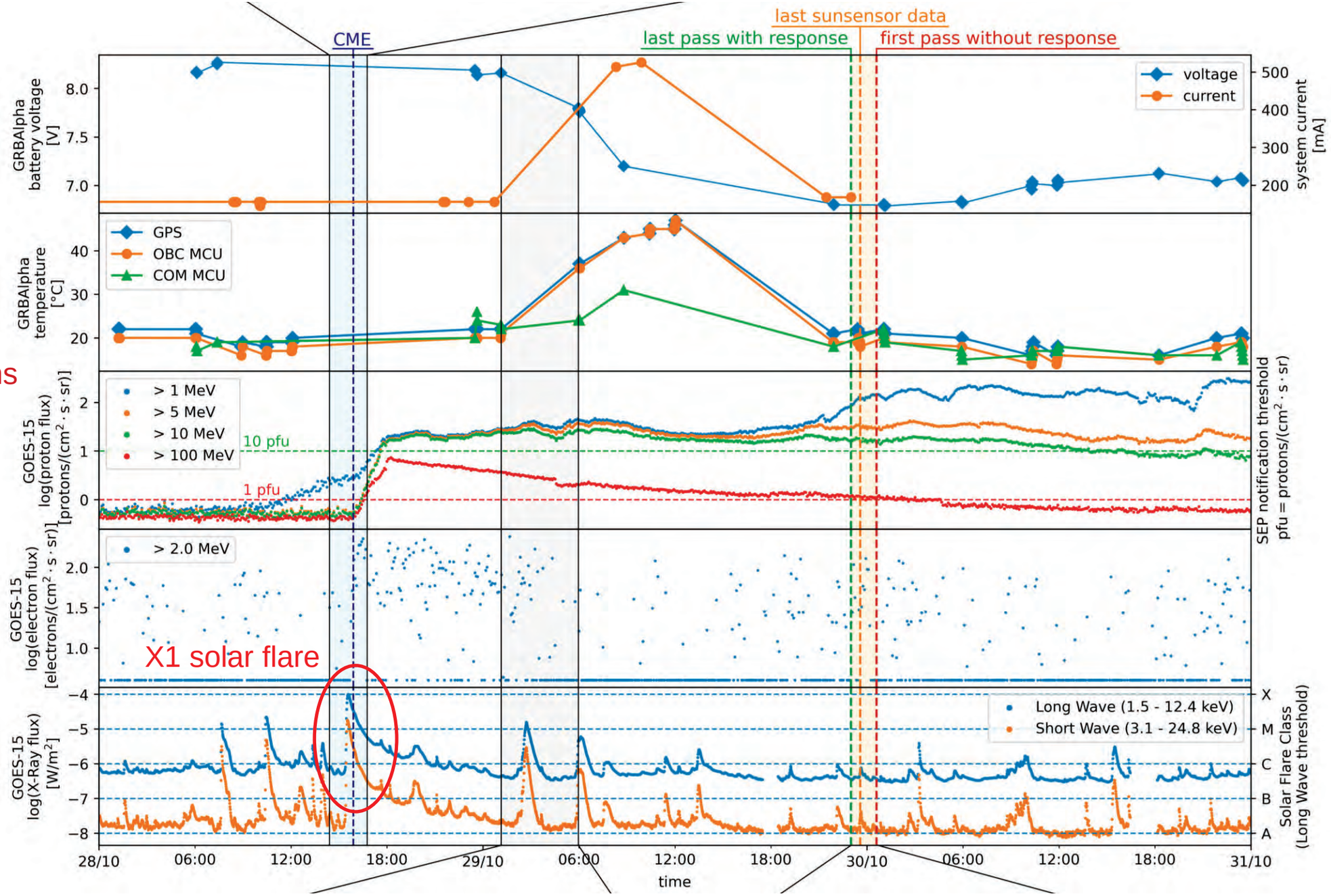


VHF radio loss

caused by solar energetic protons in polar regions



Take-away messages

- LEO environment is very dynamic; different space weather events affect it differently
- We should use CubeSat data to learn as much as possible in order to maximize their potential
- Two radios ☺

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Thank you!

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