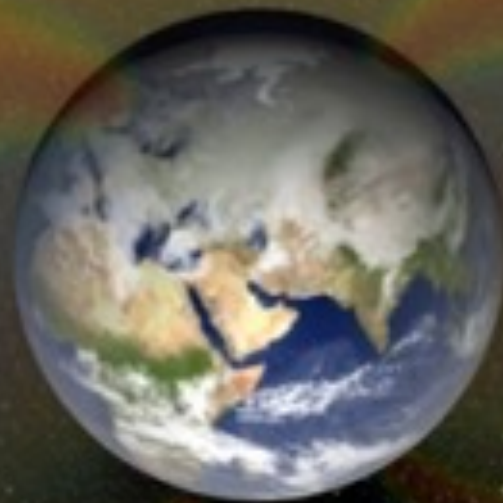


Arnaud Claret for the FSGS team - CEA Saclay



Space weather considerations for Svom

Xichang, June 2024

Context

Indicators

Procedure

What are we talking about?

1) Solar activity

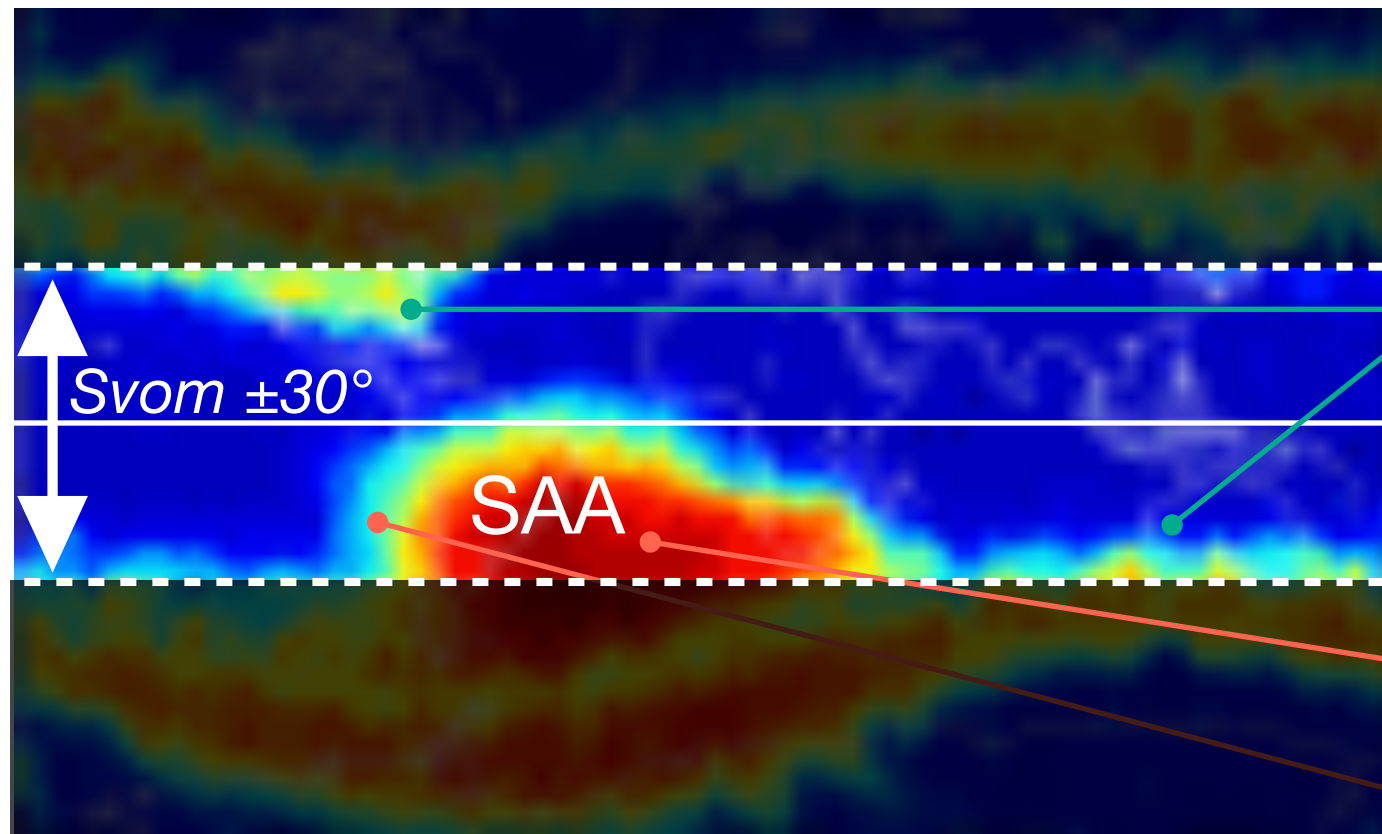
A diagram illustrating the Earth's magnetosphere and its interaction with solar activity. On the left, the Sun is shown as a bright, glowing orange and yellow sphere. A stream of solar wind, depicted as a turbulent, yellow and orange flow, moves from the Sun towards the Earth. The Earth is shown as a small globe in the center, with a satellite orbiting it. The magnetosphere is represented by a series of concentric, glowing blue and purple layers that surround the Earth. The magnetosphere is compressed on the side facing the Sun and extends into a long tail on the opposite side. The background is a dark blue space with stars.

Orbiting at 650km with an inclination of 30°, SVOM is rather well protected from solar events by the Earth magnetosphere

However, Svom is concerned by the content of the magnetosphere, which is affected by solar activity

What are we talking about?

2) Trapped particles in the magnetosphere (radiation belts)



Electrons (external belt)
Flux is variable around **central America and -30° latitude** (in stormy conditions)
—> **can affect the trigger**

Protons & Electrons (internal belt)
Flux is high but ~stable in the SAA core
—> trigger is OFF
Flux is variable **near the frontier of SAA**
—> **can affect the trigger**

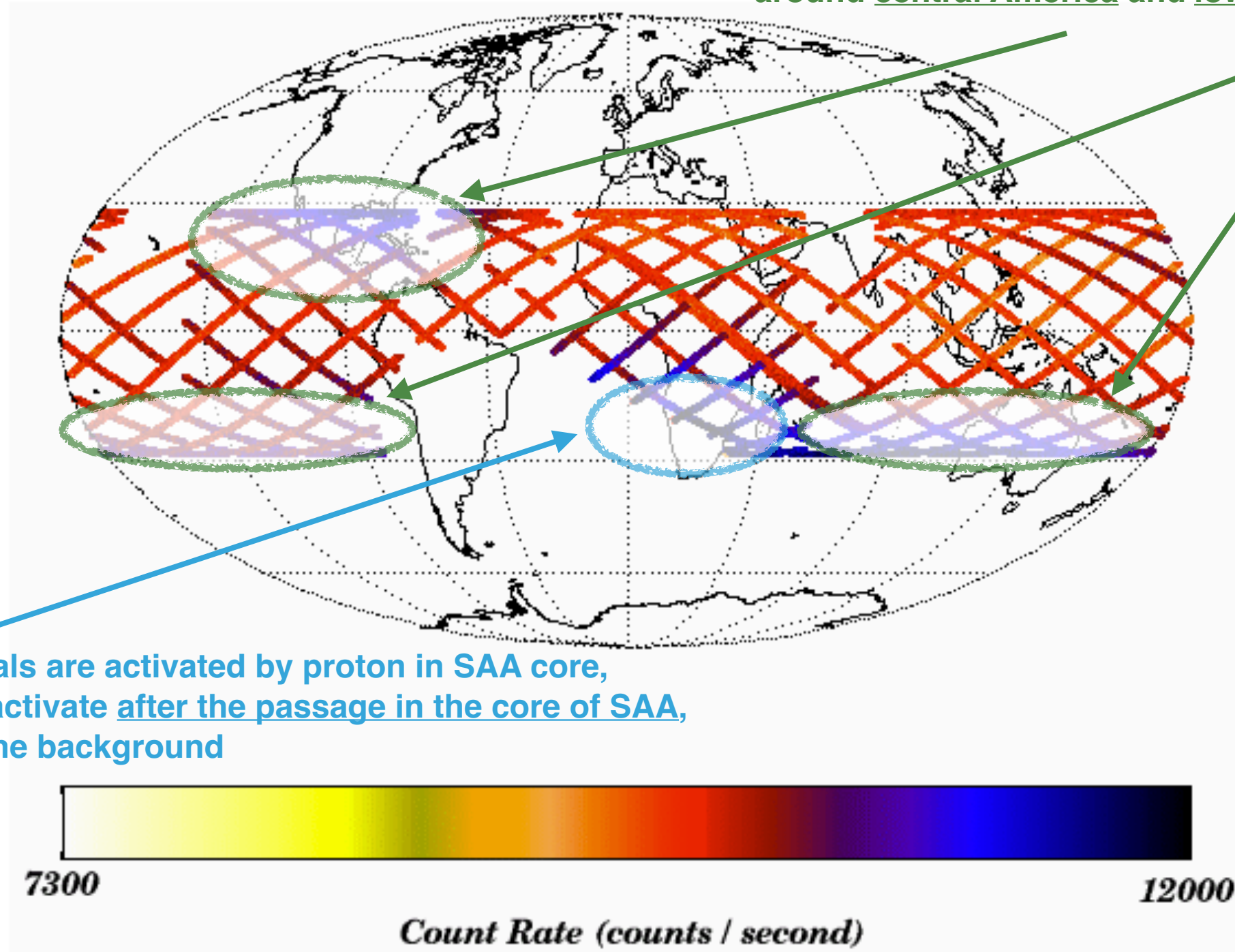
Particle flux encountered at Low Earth Orbit

Additionally, the SAA itself moves westward 0.3-0.7°/yr
—> SAA contours shall be regularly updated

Count rate along the orbit

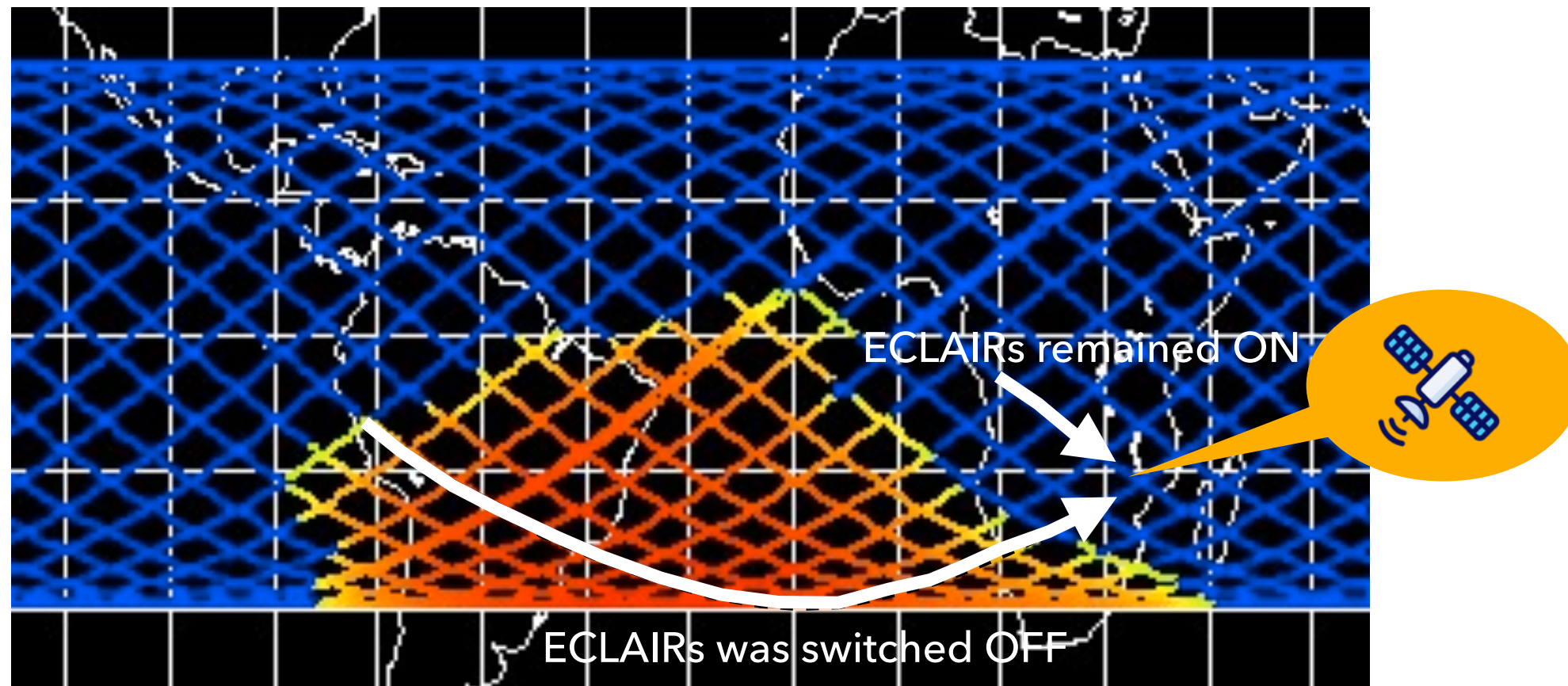
Swift in-flight

Background can increase due to electrons around central America and low-latitude zones



When to expect activation?

Not position but trajectory dependant

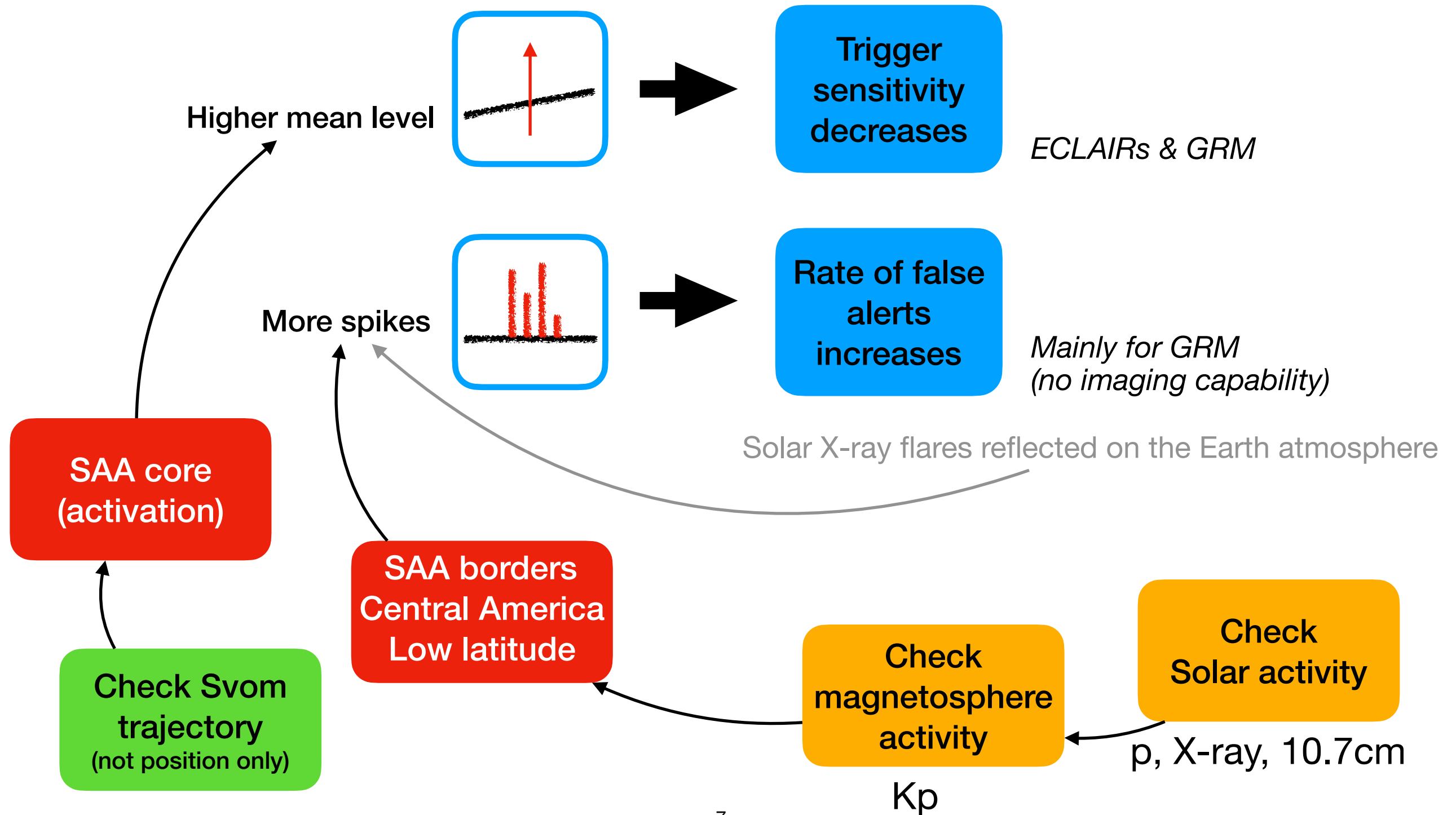


- Activation occurs after passing through the SAA core
—> does not depend on the position, but on the past trajectory
- How to know that ECLAIRs has passed through the core of the SAA?
—> the power supply has been cut off a while before

More details about activation effects will be evaluated during the commissioning and then documented for the BA users

How the trigger is affected?

Effects on instrumental background



Context
Indicators
Procedure

Background monitoring

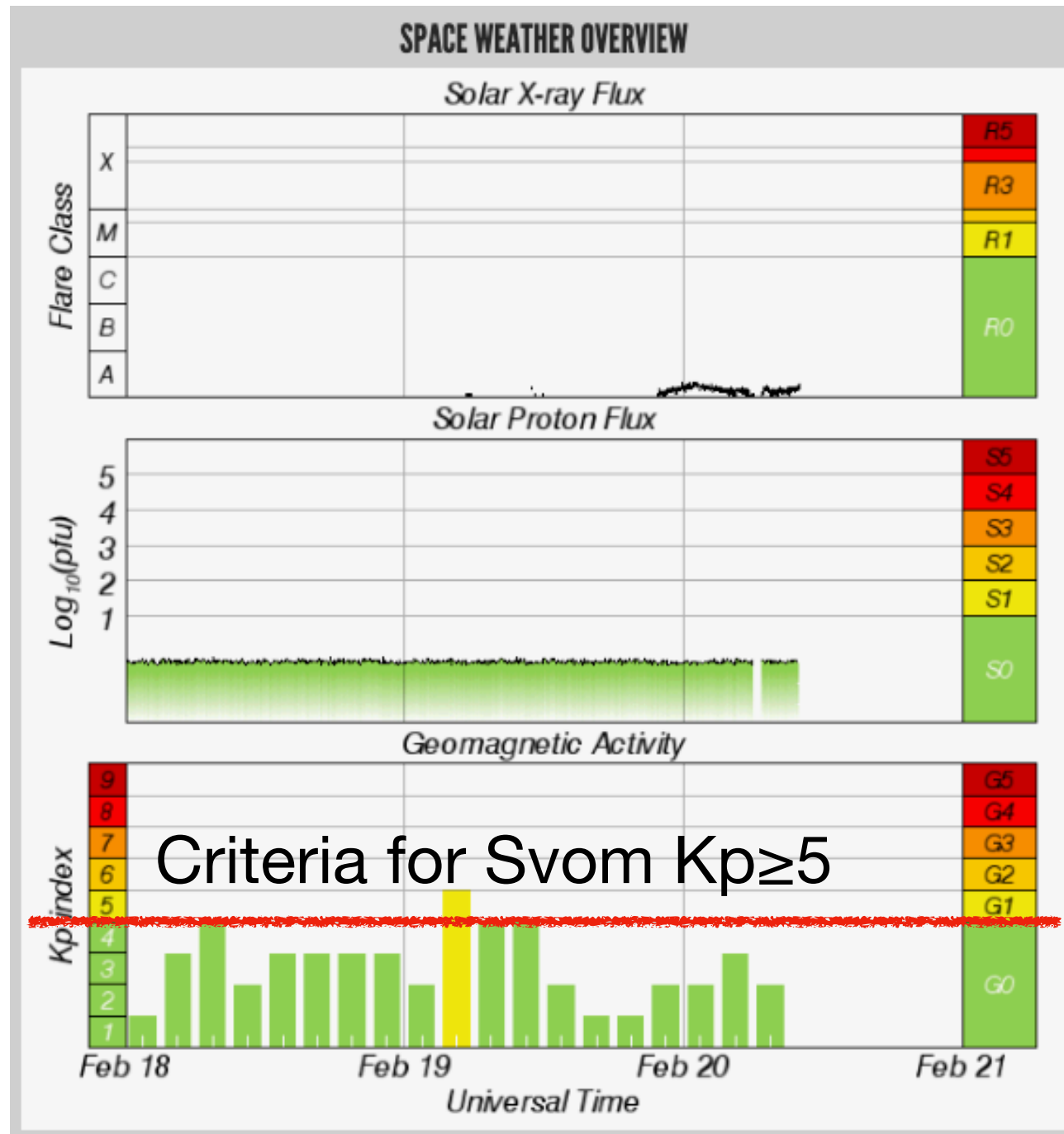
VHF recurrent packets



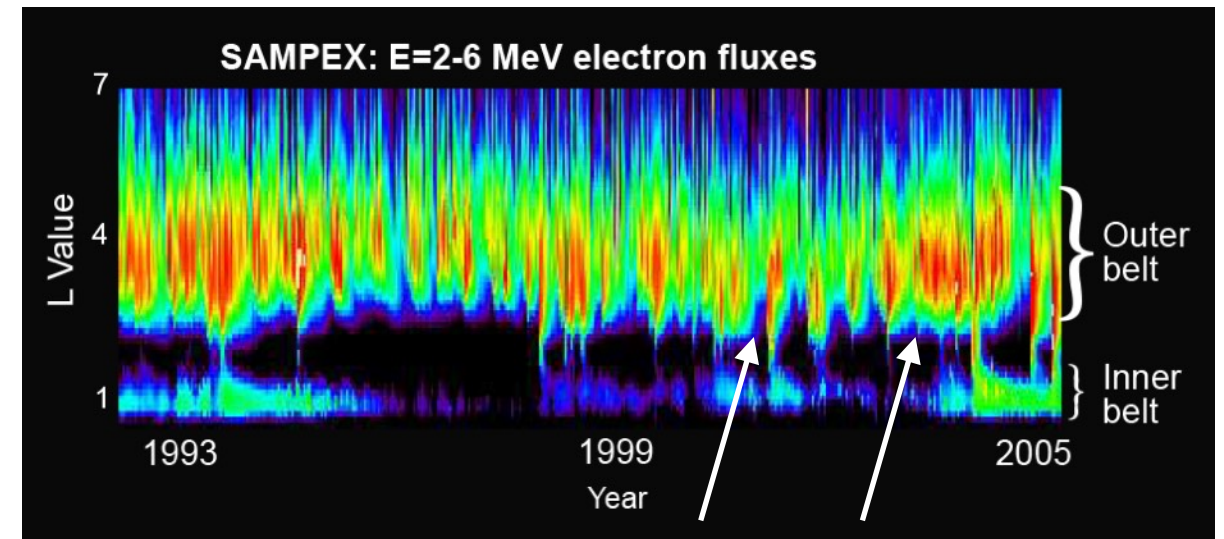
- Use **iFSC-tools** to visualise continuous count rates of **ECLAIRs**, **GRM** and **GPM** (particle monitor)
 - Background in several energy bands, every 30 sec
 - As well as “Saturated” and “Multiple” events of ECLAIRs soon available
 - The ‘extended SAA’ due to solar activity can last several days —> to be monitored by BA
- Also possible to use **ETC-UI**
 - Not enough simulated data yet available for training until now (in particular recurrent data in between two GRB candidates) but real data will come soon :-)
 - Displays more information than required at BA level —> could be worth developing a special page dedicated to BA users easier to use

See hands-on
this afternoon

Solar and magnetosphere activity



Not so easy to predict the effects

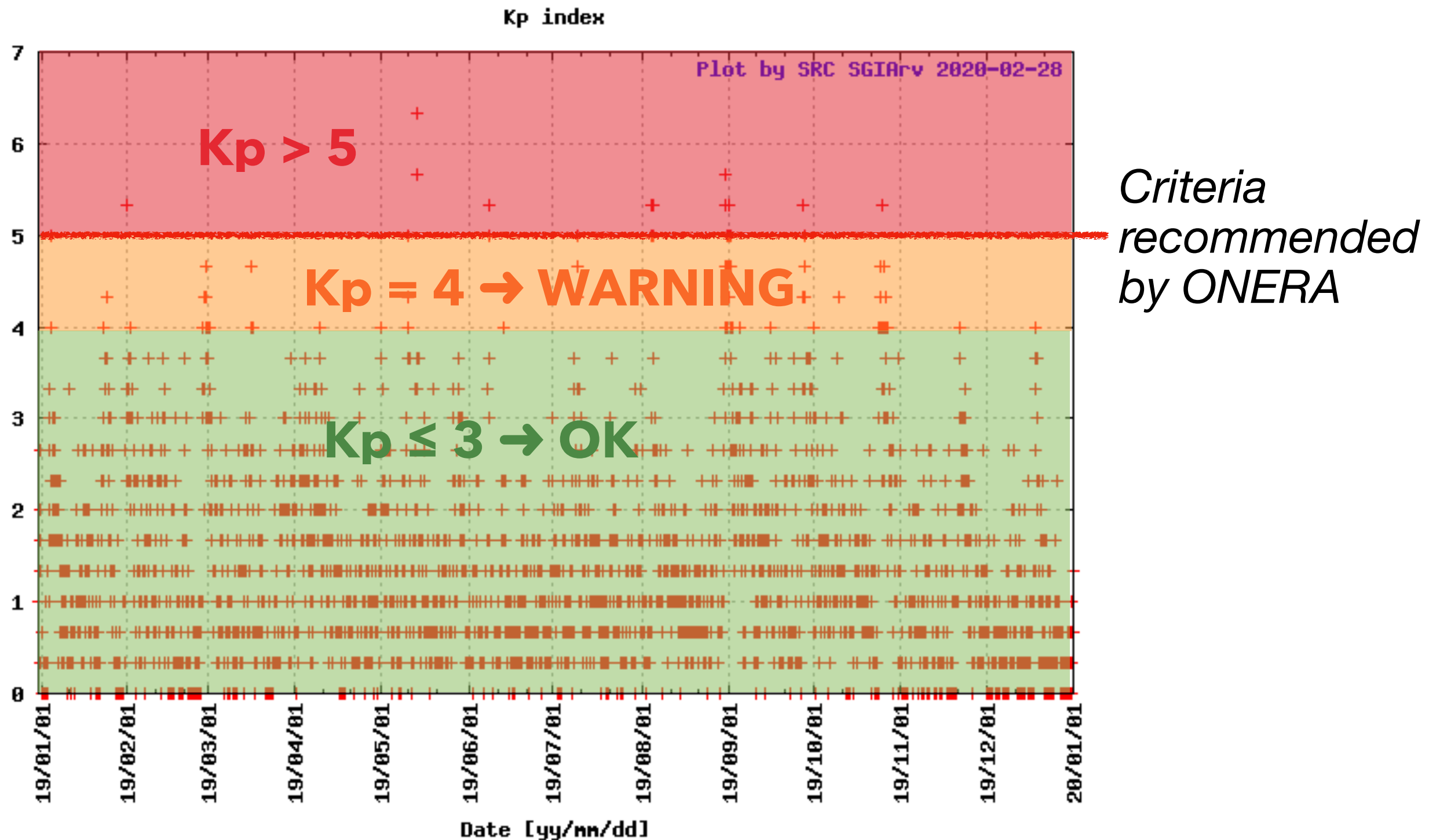


- It can happen that
 - A major solar event injects particles in the external belts with no particle precipitation in the inner belt
—> no effect for Svom
 - And on the contrary, a minor geomagnetic storm can precipitate electrons stored in the inner belt
—> background increase for Svom

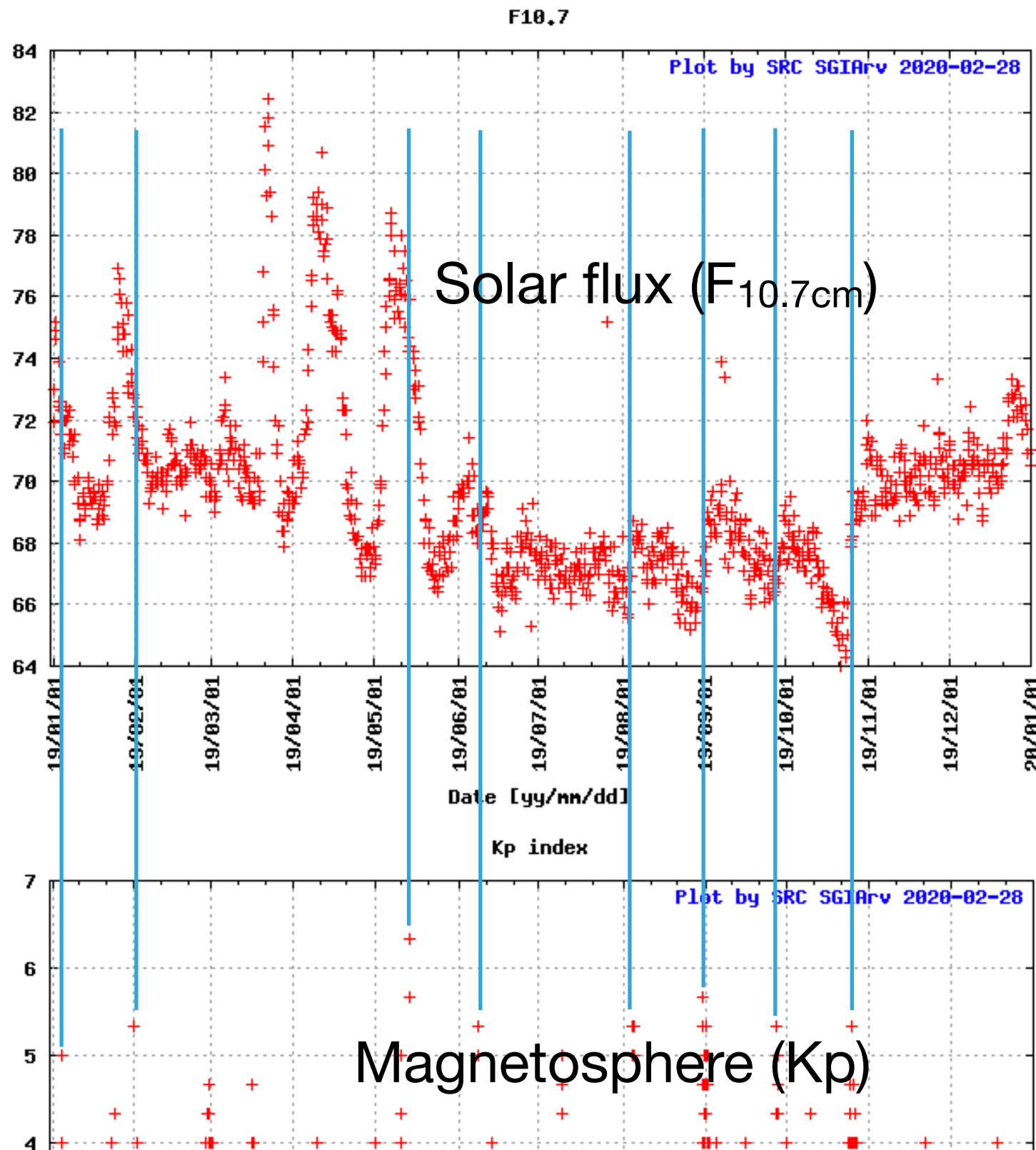
<https://www.swpc.noaa.gov/products/planetary-k-index>
<https://www.swpc.noaa.gov/products/goes-proton-flux>
<https://www.swpc.noaa.gov/products/goes-x-ray-flux>

Statistics on Kp

“p” means planetary = measurements averaged around the Earth



Solar-Earth link (Kp versus F_{10.7cm})



Not so easy to understand unambiguously what is the situation at a given time $T0_{GRB}$ but these indexes are useful:

- *to get a raw idea of what's happening in magnetosphere*
- *can help to 'Feel' if the confidence level attributed to the trigger has to be degraded or not*

Context
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Procedure

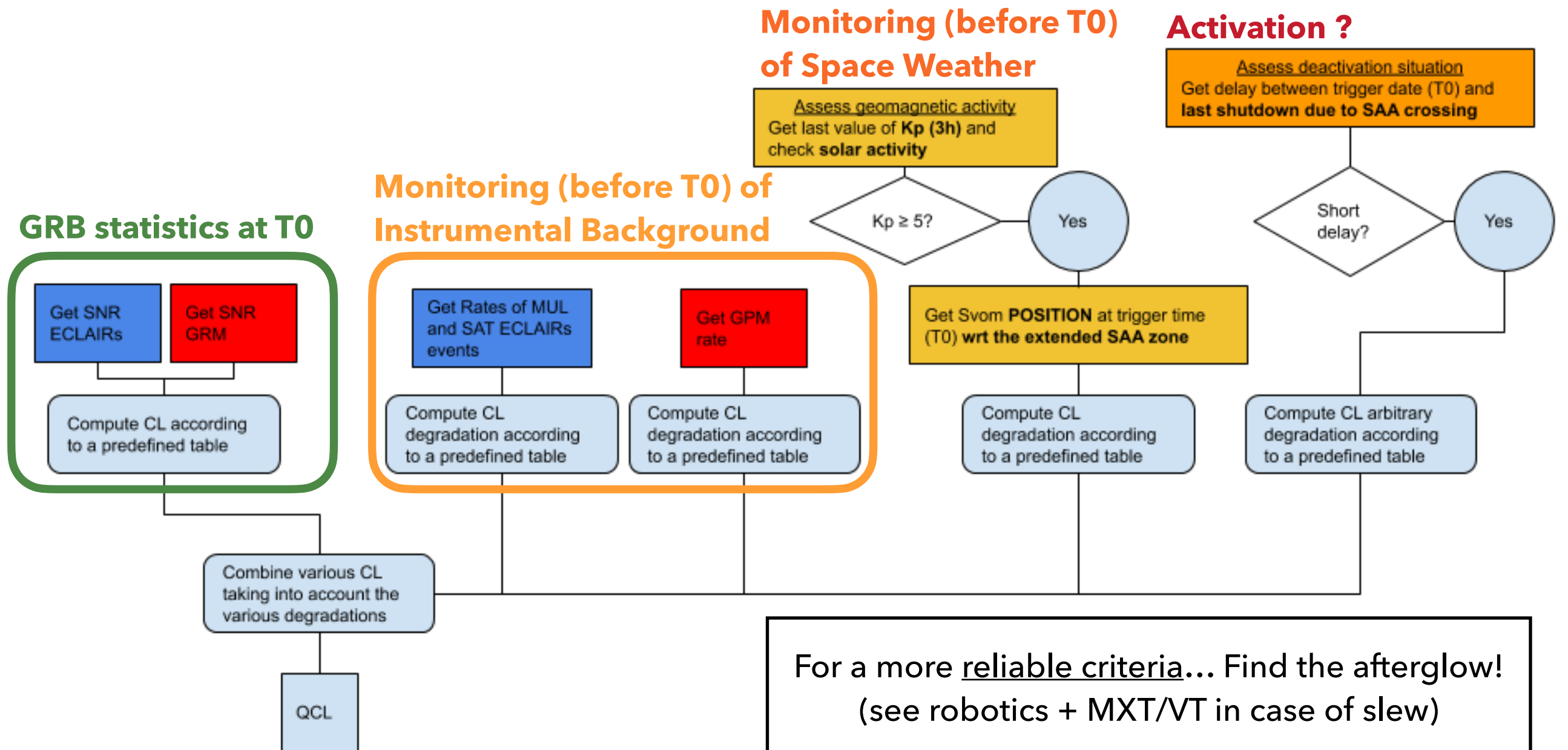
Monitor key parameters in iFSC-tools



- The BA shall monitor the **background continuously** (ie. not only when a GRB occurs ut regularly) in order to assess general trends and identify suspicious changes
 - Count rates of **ECLAIRs**, **GRM** & **GPM** (particle monitor)
 - Of course this work does not take priority over the work on a GRB
- The BA shall monitor the **space weather less frequently**
 - **Magnetosphere index** Kp is published every 3h (~2 orbits)
 - **Solar activity indexes** (p, X, F10.7cm)
 - Generic email (eg. svomba@cea.fr) could subscribe to ESA alerts

Procedure

Towards an automated procedure



Automatic Quick Confidence Level

Procedure

Take home messages

- Since GRBs and solar events are independent phenomenon, keep in mind that a **real GRB can occur even if the space weather conditions are very bad**
 - Observed effects at low altitudes (600km) are not necessarily proportional to the intensity of solar events
- Due to less shielding around GRM and lack of imaging capabilities, the trigger validation process is **more difficult for GRM-only triggers**
- **Don't focus only on the SAA core**
 - Look also around Central America and eastwards South Africa
 - Spacecraft activation (only after SAA core)
- Space weather can also affects the ionosphere and thus the **quality of data reception by VHF antennas**
- **BA documentation** will be finalised soon taking into account commissioning data



Svom and Catch on the way to space weather conditions

Thank you!

Background monitoring

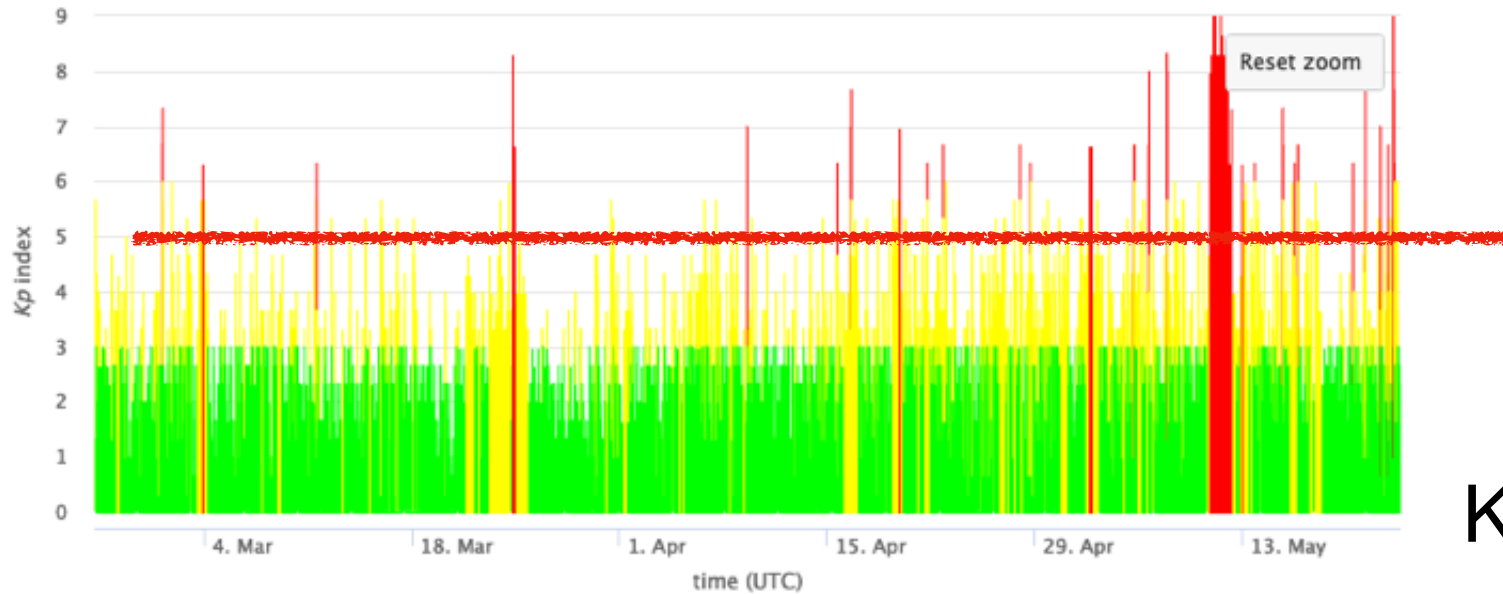
Additional information from ECLAIRs

Ambient particle flux	ECLAIRs MUL rate	ECLAIRs SAT rate
nominal particle flux	7 %	6 %
x2	10 %	7 %
x3	13 %	9 %
x5	19 %	10 %
x10	34 %	19 %

To be validated during commissioning

Based on A.Sauvageon assessment

Recent strong solar event (May 2024)



Criteria for Svom
 $Kp \geq 5$

Kp reached 9 on May 10th



Aurora visible from Paris

