

SPETTRALE project

investigating the Spikes in Swarm electron temperature data

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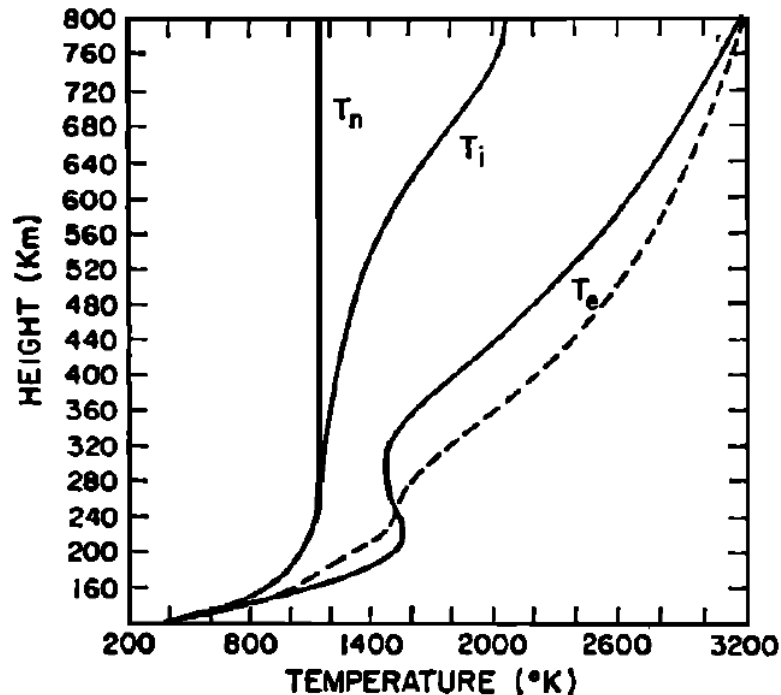
Living Planet Symposium 2022

Why to monitor electron Temperature ?

Electron Temperature (T_e) is an important parameter to understand processes and characteristics of the ionosphere.

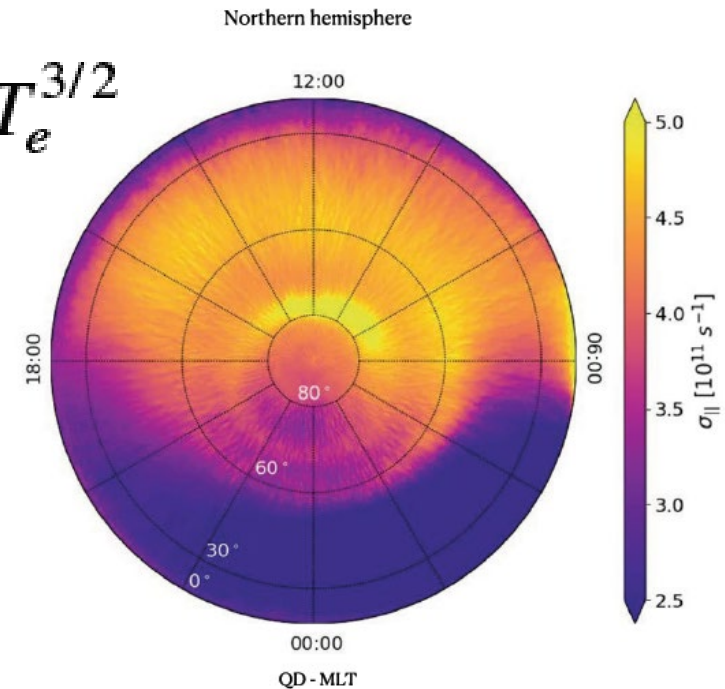
Lack of thermal equilibrium $T_e \neq T_i \neq T_n$ in F region; T_e is the more variable and sensitive to ultraviolet radiation, electric fields, collisions with neutrals. T_e influences properties of the upper ionosphere, e.g. Electrical conductivity

T_n , T_i , T_e from Millstone Hill radars [Schunk & Nagy 1978]



Electrical conductivity from Swarm data [Giannattasio et al. 2020]

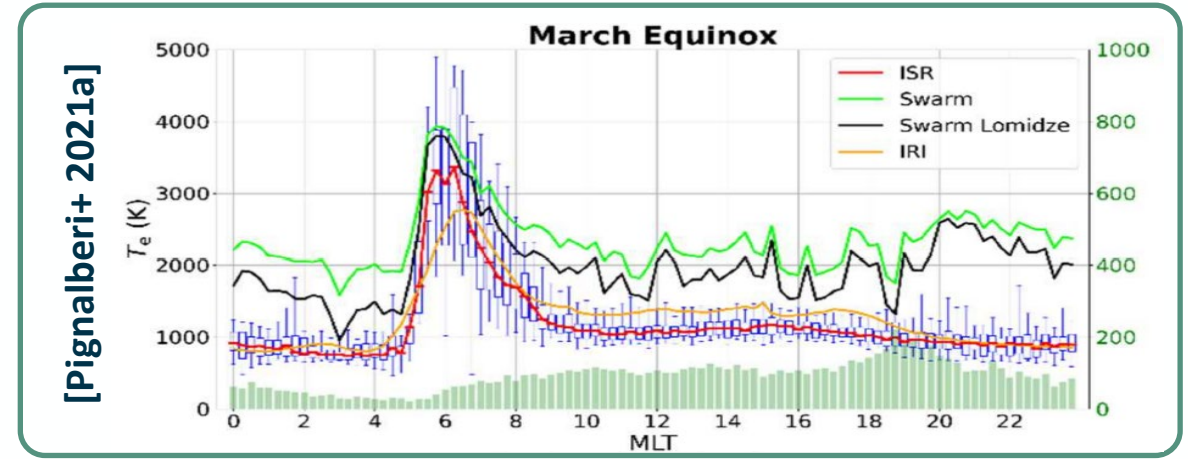
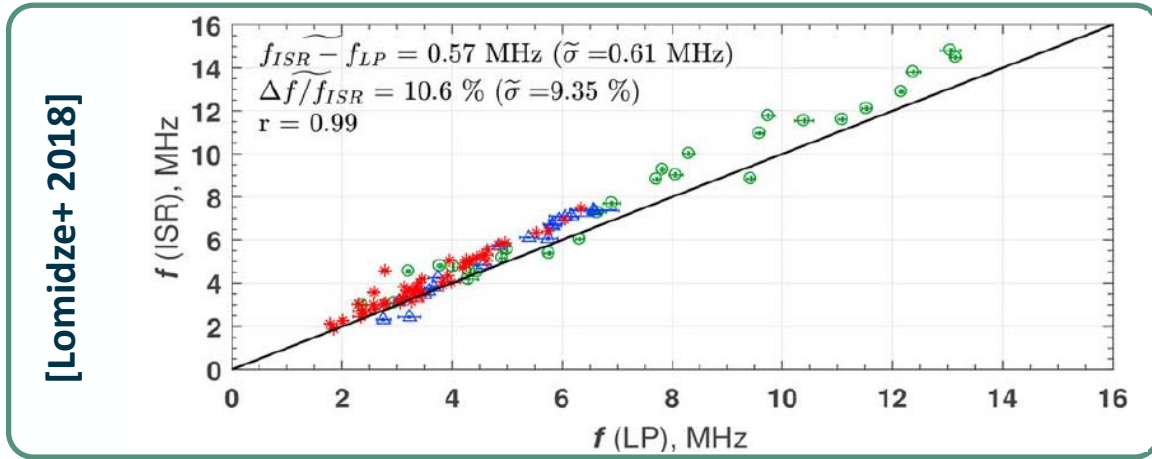
$$\sigma_{\parallel} \propto T_e^{3/2}$$



Te agreement with other dataset, and Te spikes

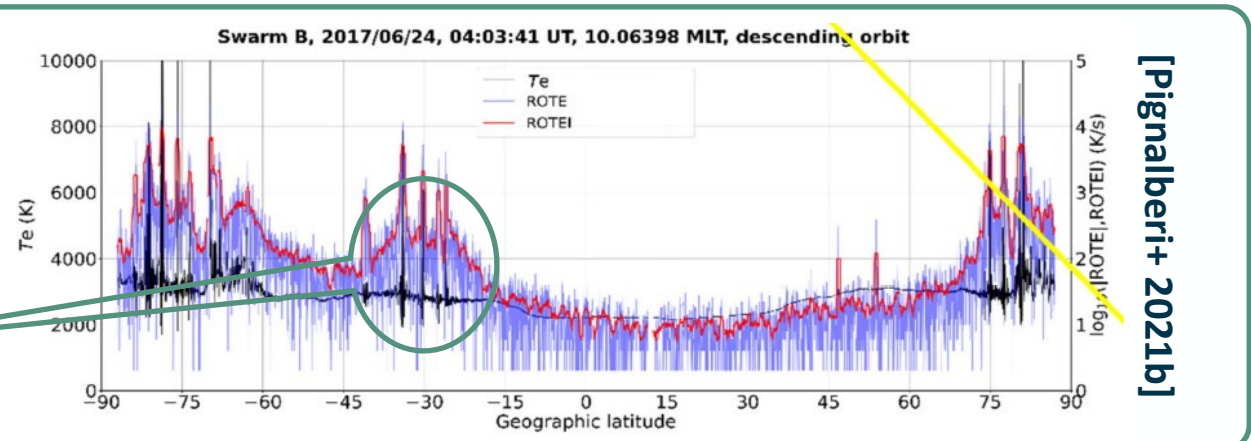
Average values of Swarm Te are in good agreement with ground-based ISR and models for:

- ISR overflights, 80s average $T_{e, \text{Swarm}}$, removing outliers ($T_{e, \text{Swarm}} - T_{e, \text{ISR}} < 3\sigma$ median difference) [Lomidze+ 2018]
- Climatology over various LT, reasonable good agreement also with IRI model [Pignalberi+ 2021].



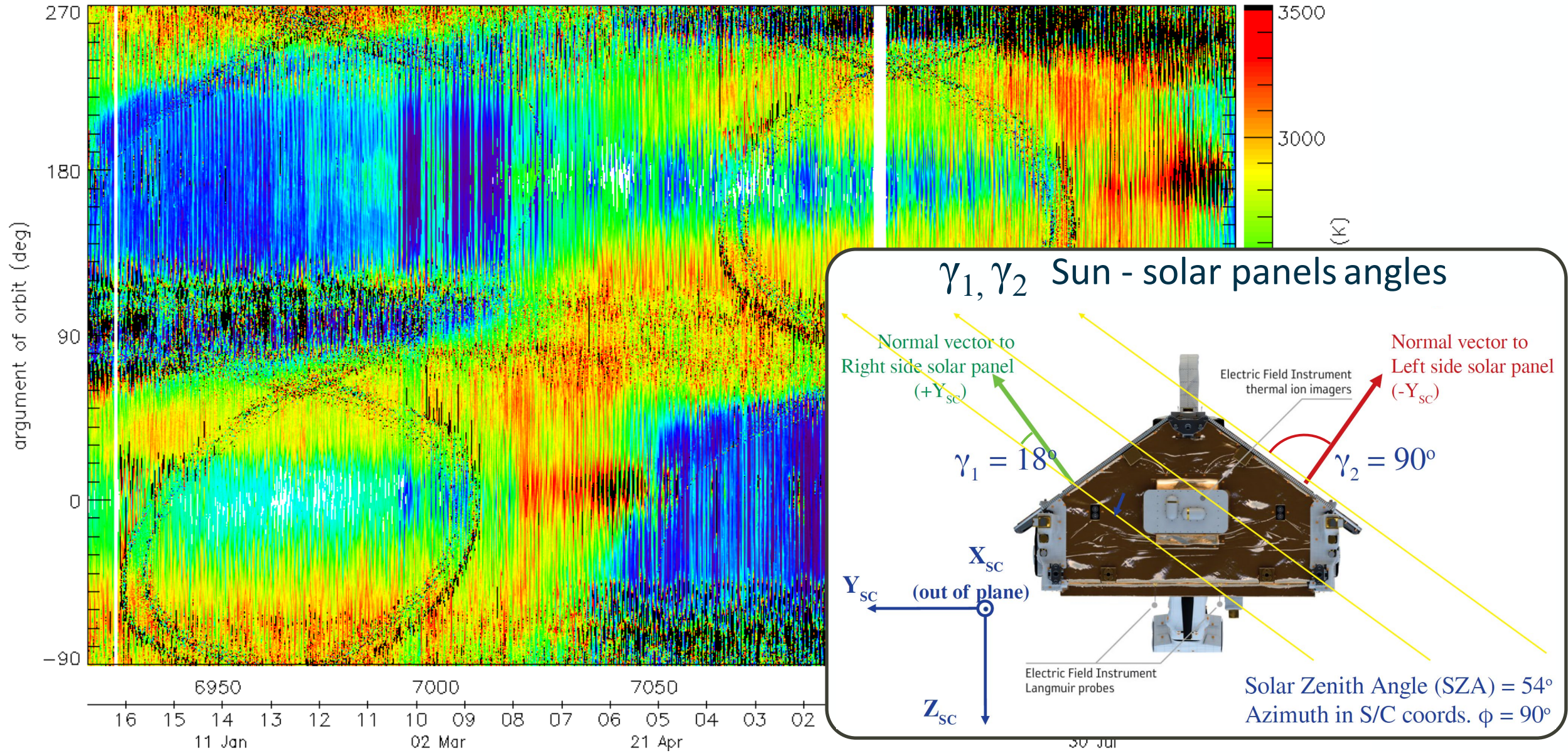
However, when looking at 2Hz data, Swarm Te is sometime affected by Spikes not predicted by the models.

This presentation will focus on **Te Spikes**

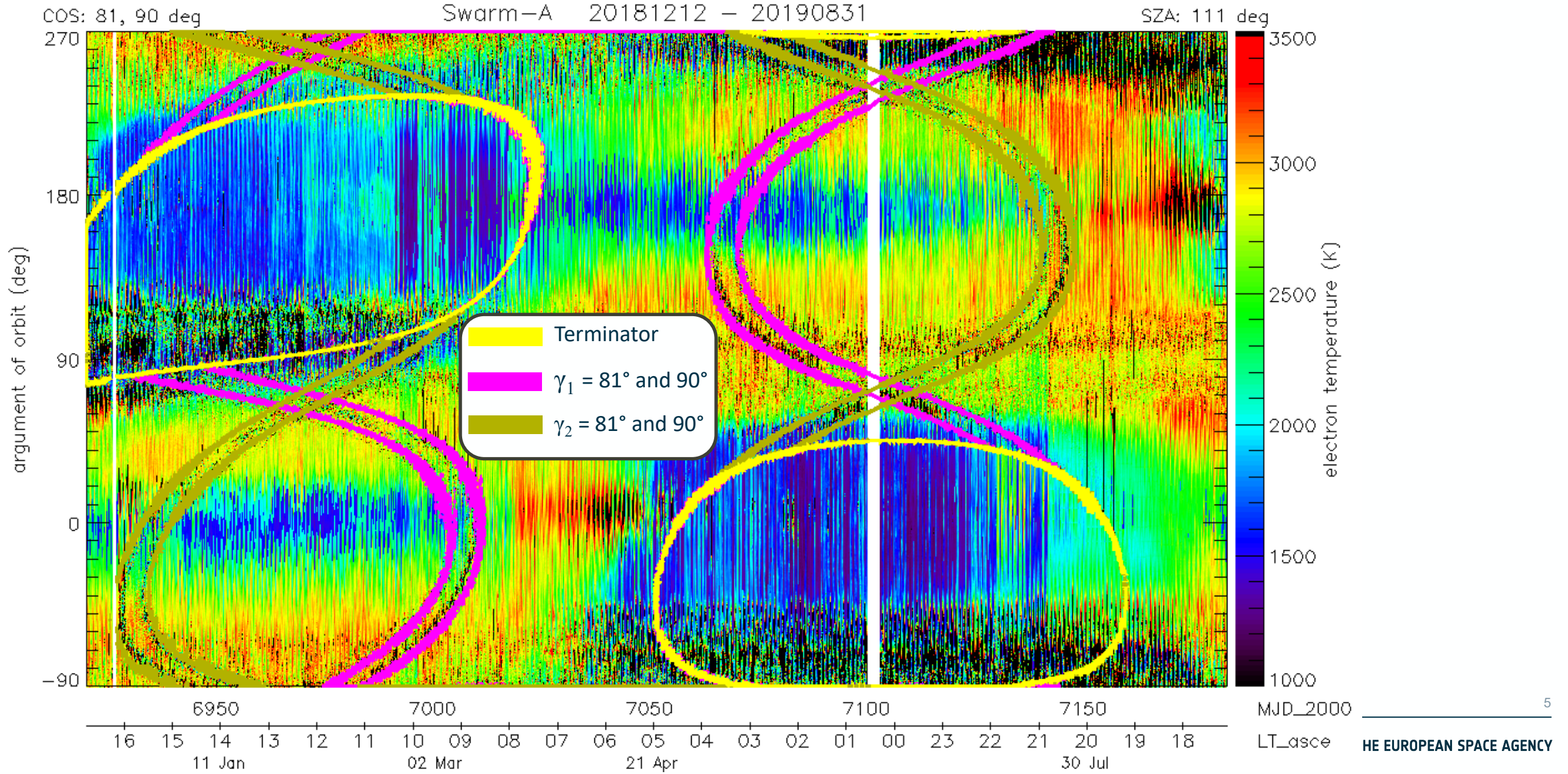


Overall distribution of Te spikes along the orbits

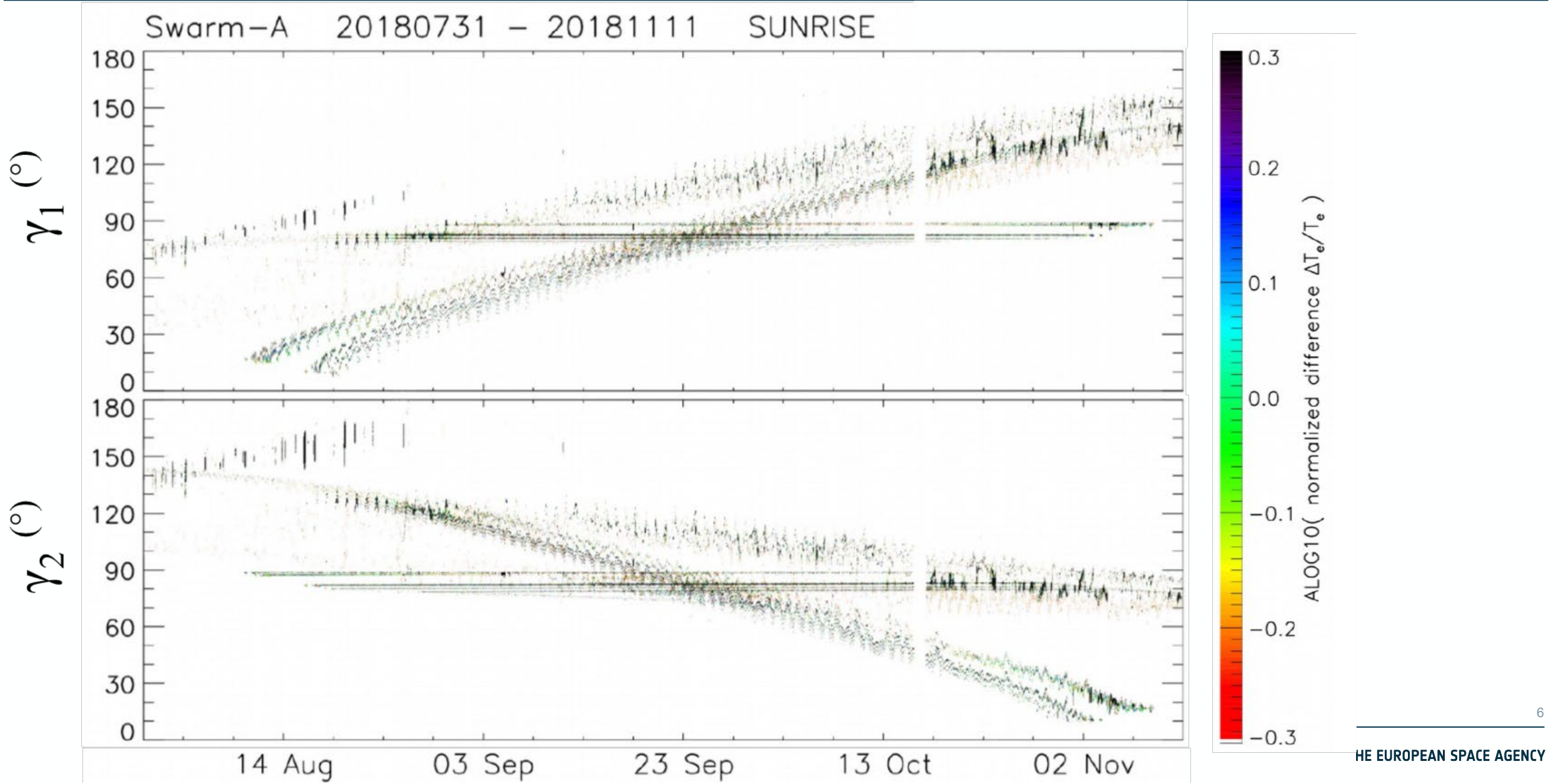
Swarm-A 20181212 - 20190831



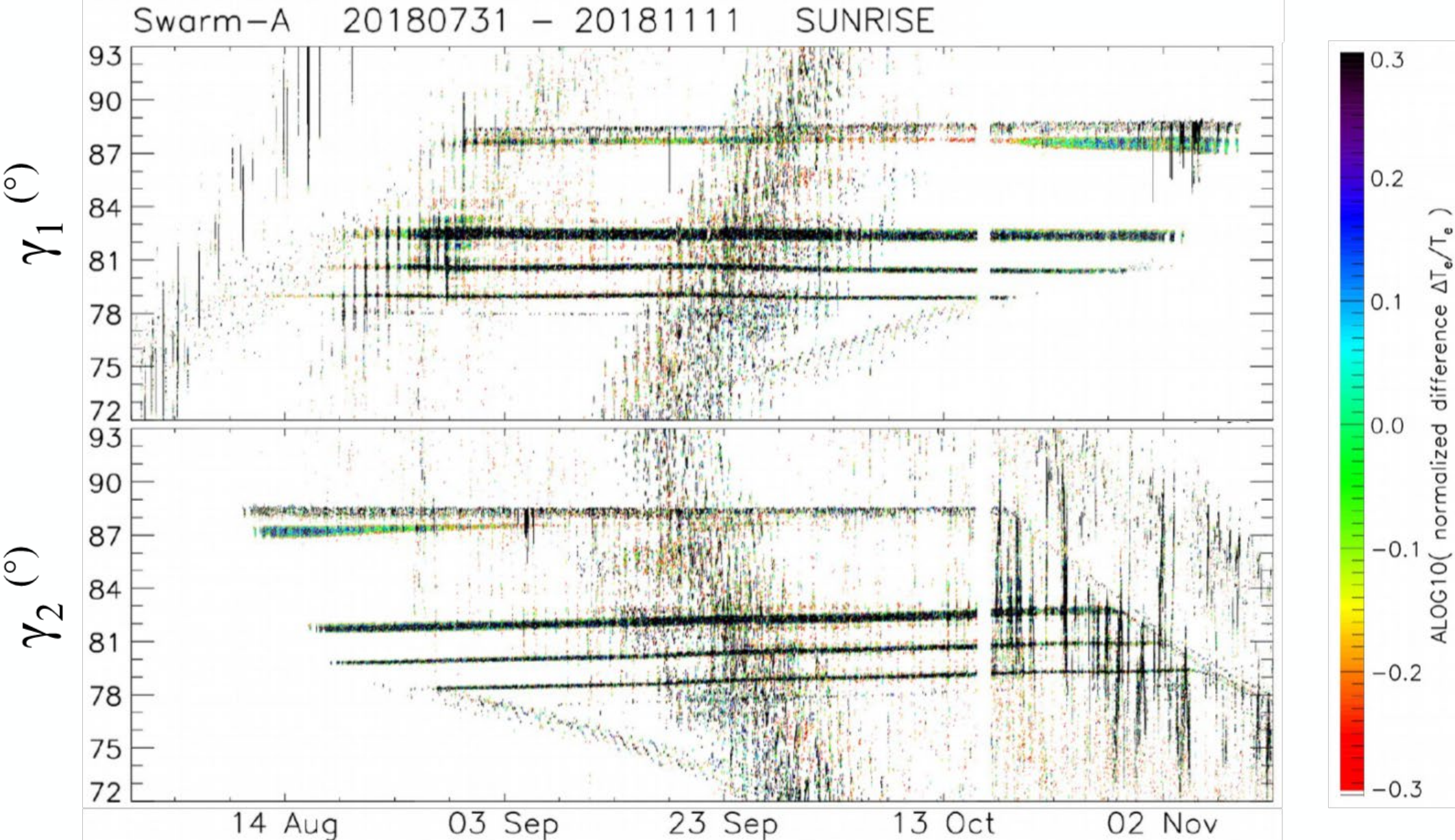
Overall distribution of Te spikes along the orbits



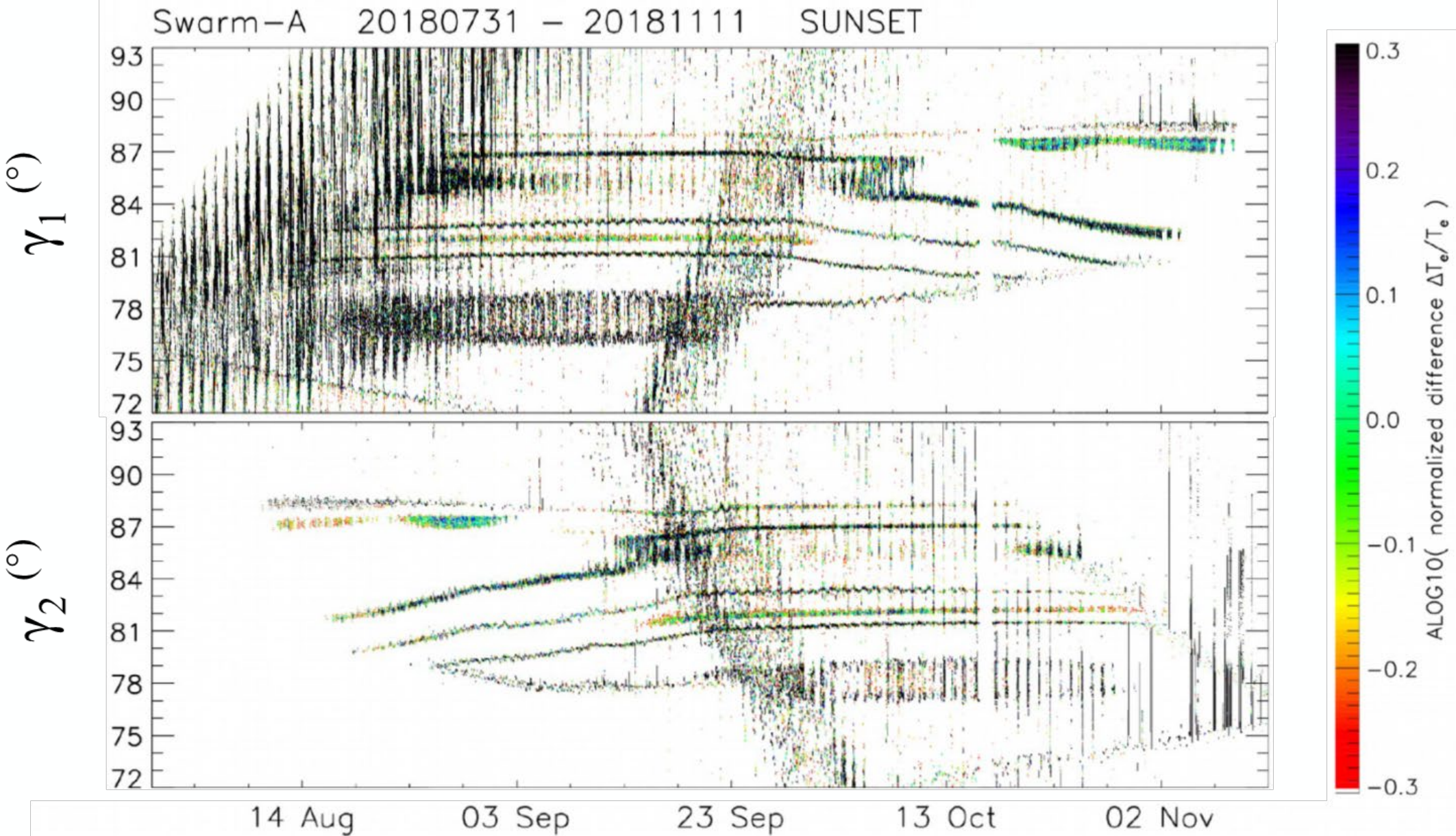
Te spikes dependence of solar panels illumination



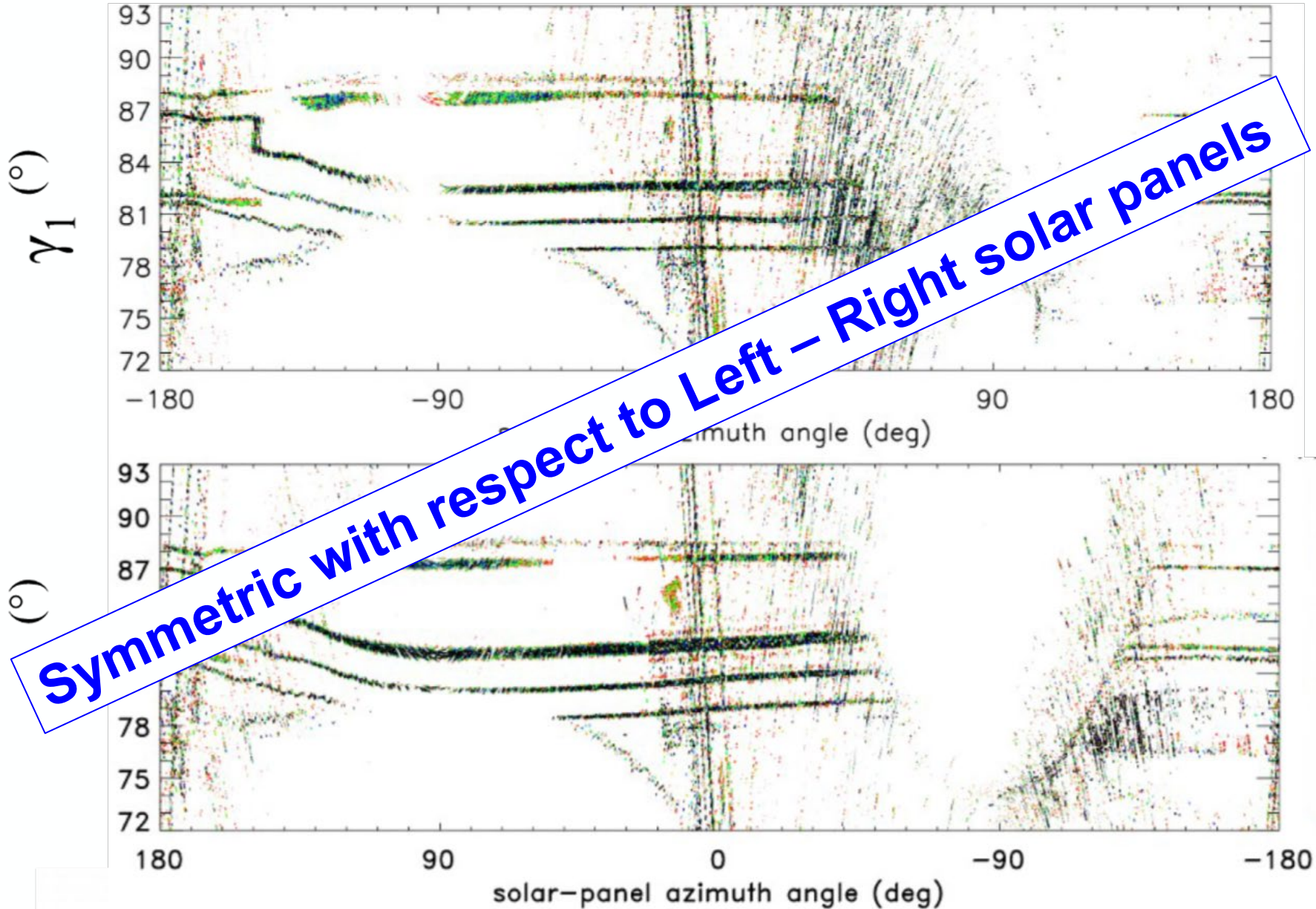
Te spikes dependence of solar panels illumination



Te spikes dependence of solar panels illumination

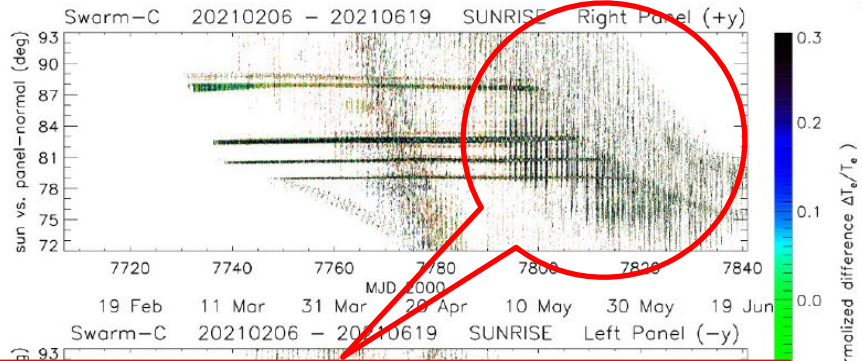


Left and right solar panels ?

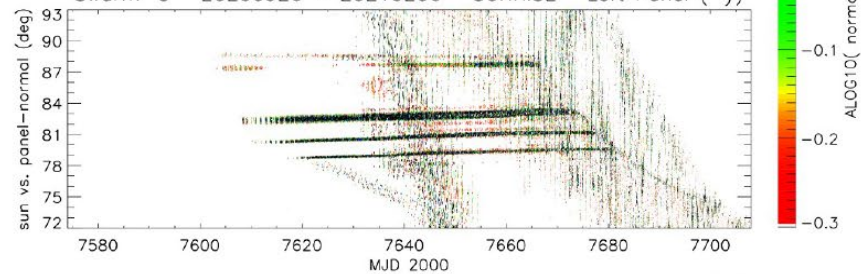
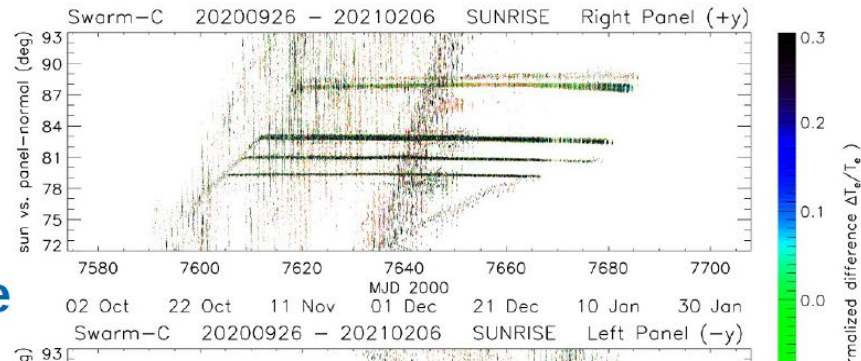


Inverted

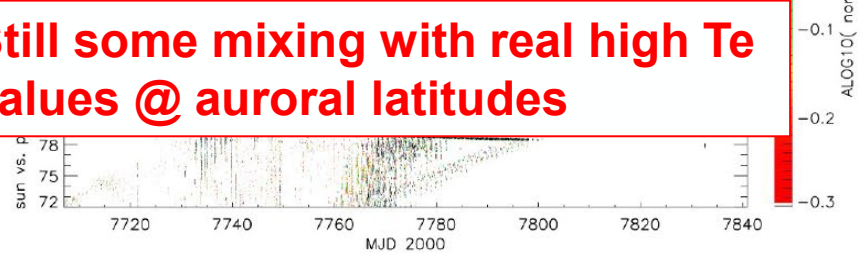
Behaviour for three S/C, from launch till present ?



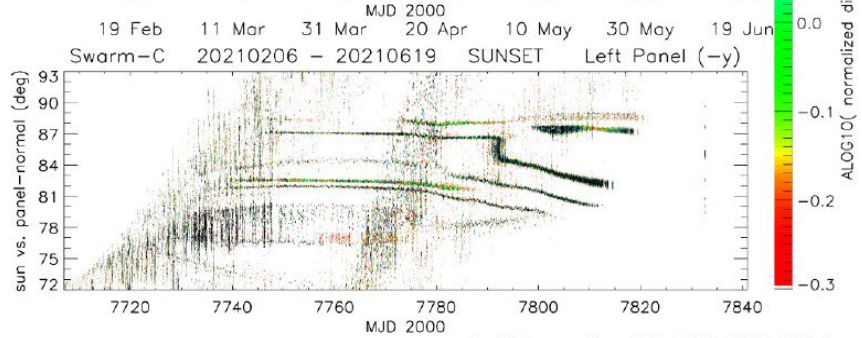
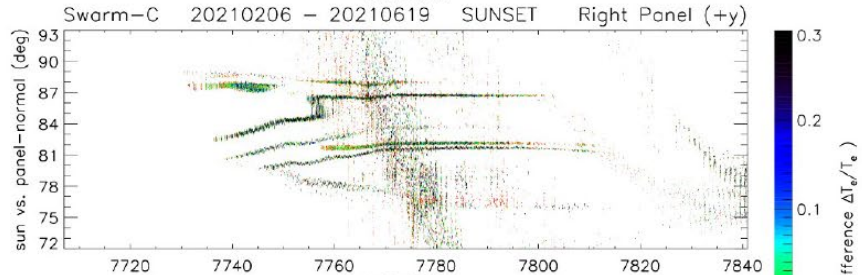
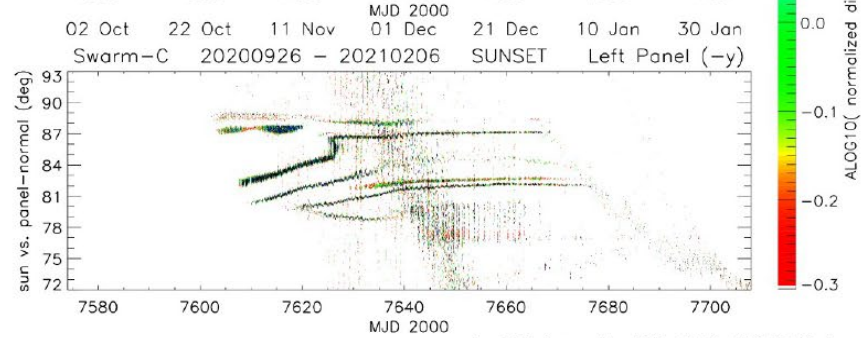
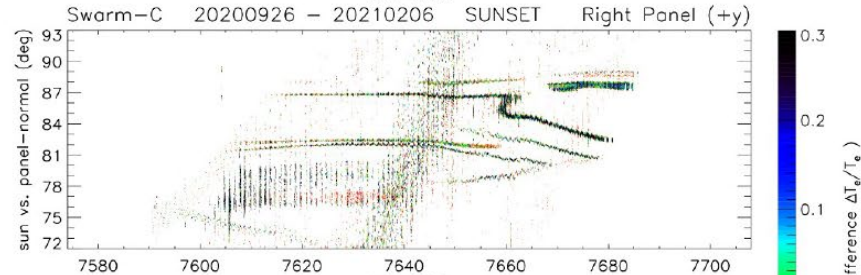
Sunrise



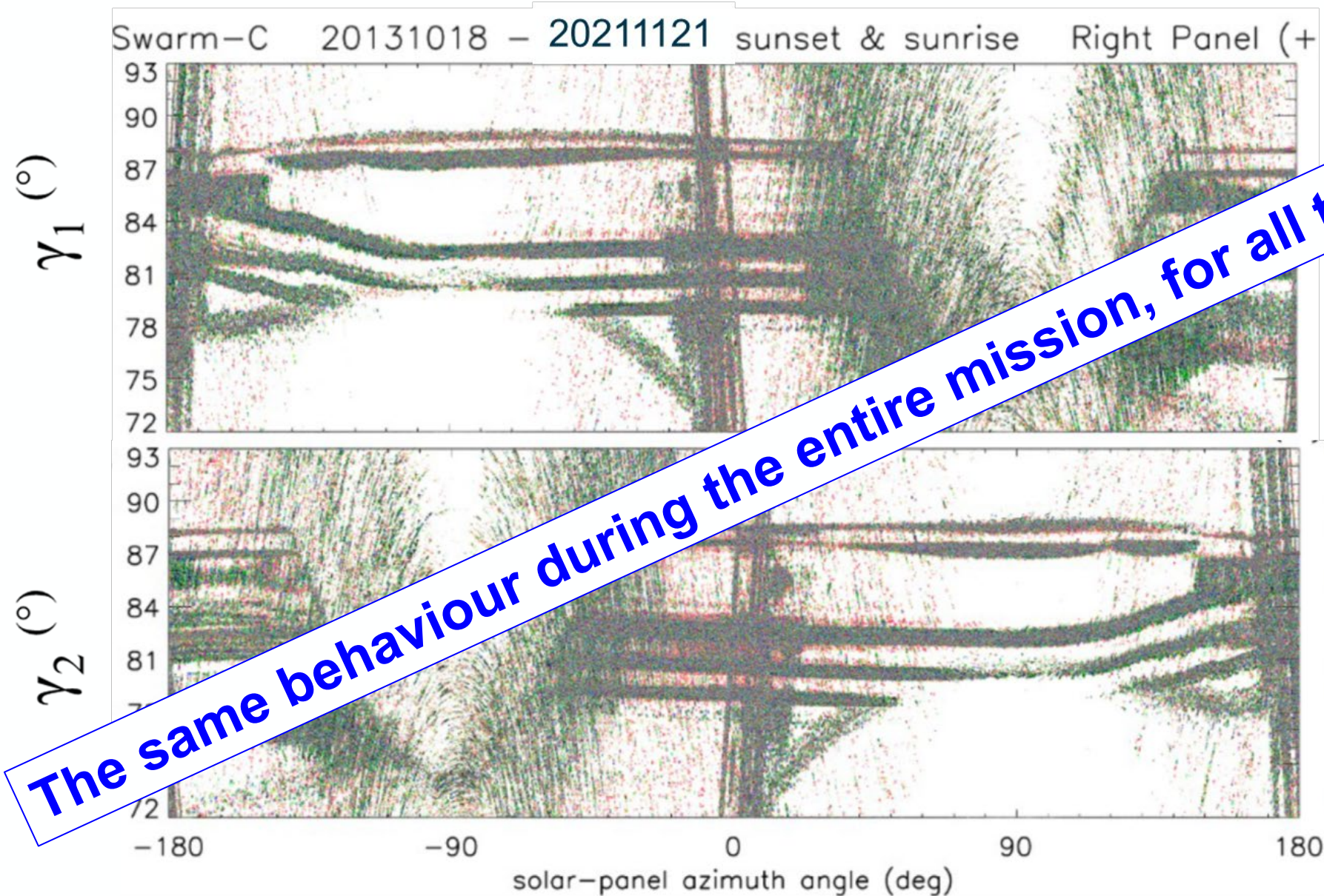
Still some mixing with real high T_e values @ auroral latitudes



Sunset



Behaviour for three S/C, from launch till present ?

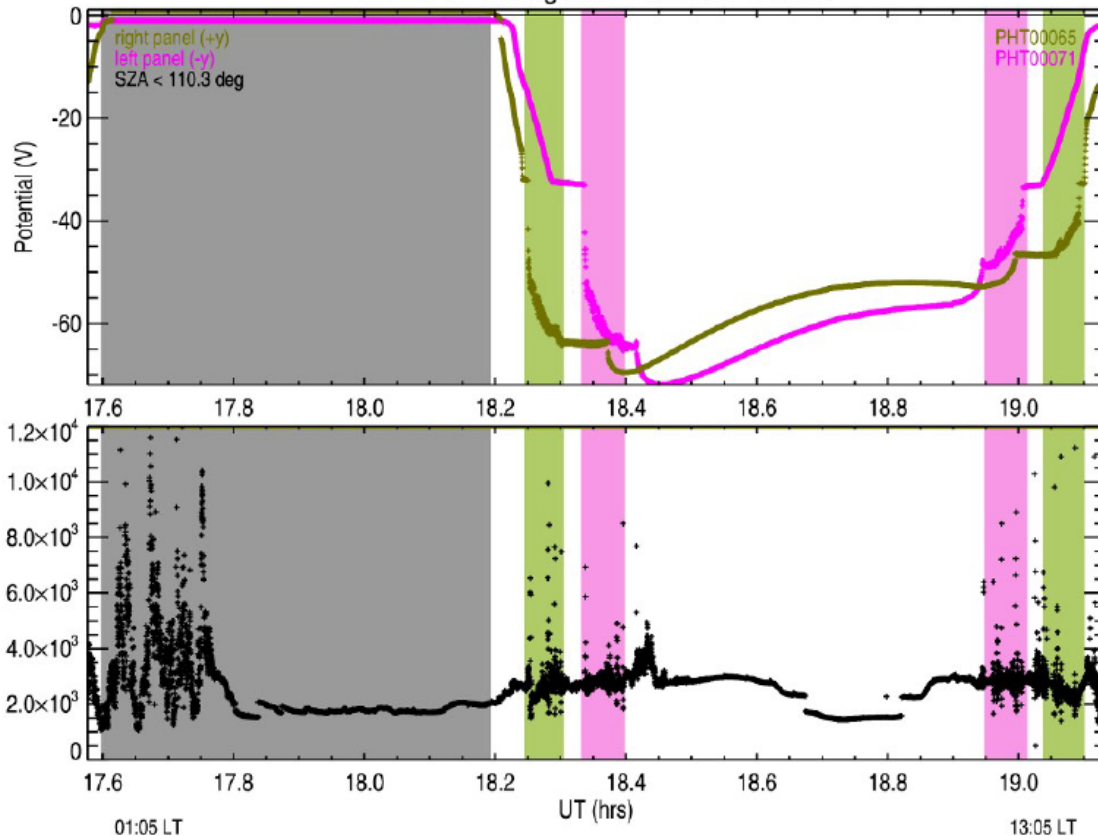


The same behaviour during the entire mission, for all the three s/c

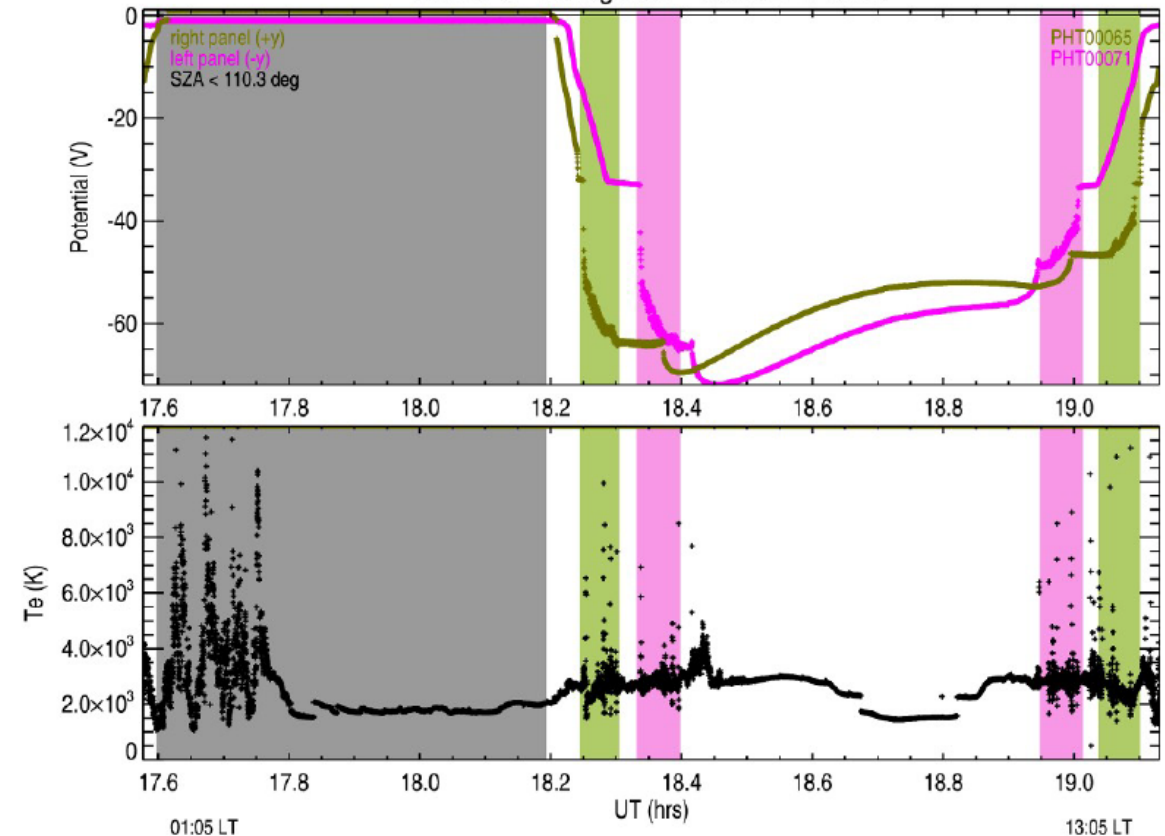
Correlation with currents / power from solar panels ?

- A possible explanation regards some interference in the on-board electronics, in currents / power from solar panels with Langmuir probes
- A dedicated analysis of Power Control and Distribution Units (PCDU) packets of House Keeping data.
- A 3-months dedicated campaign performed since July 2021 producing high-time resolution HK PCDU data with sampling rate increased from 4 seconds to 1 second.

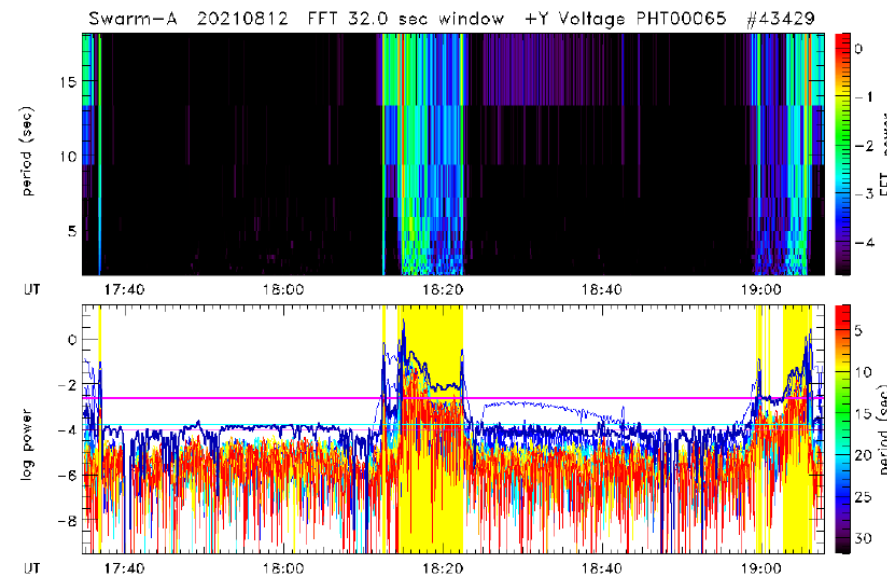
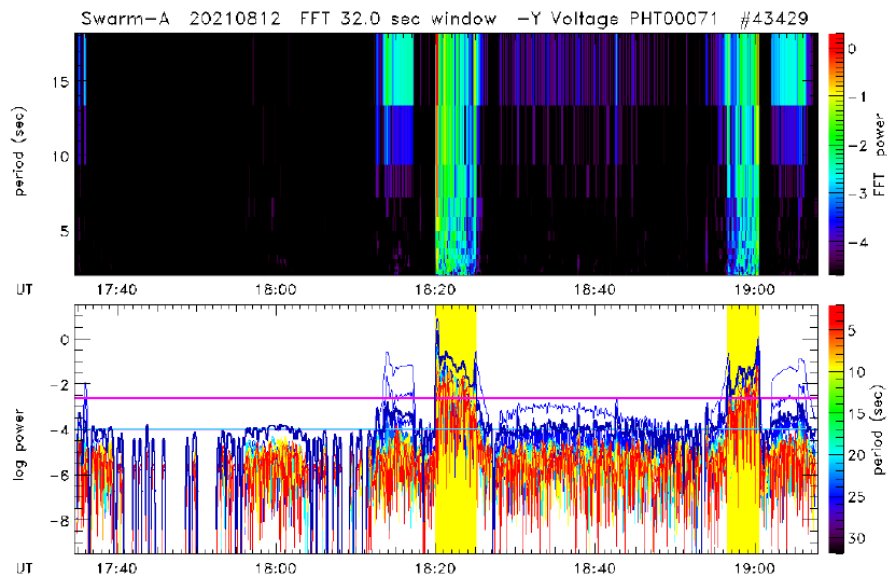
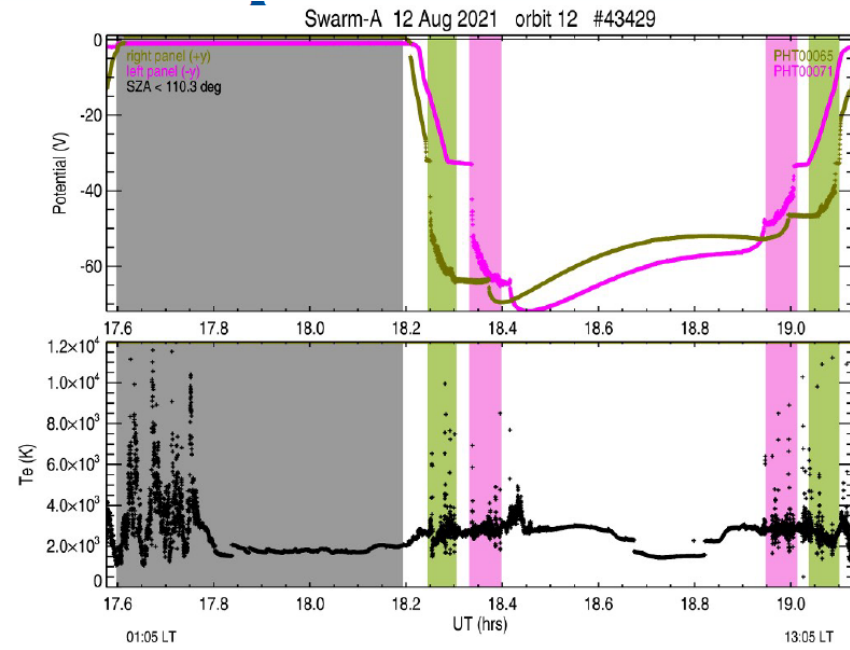
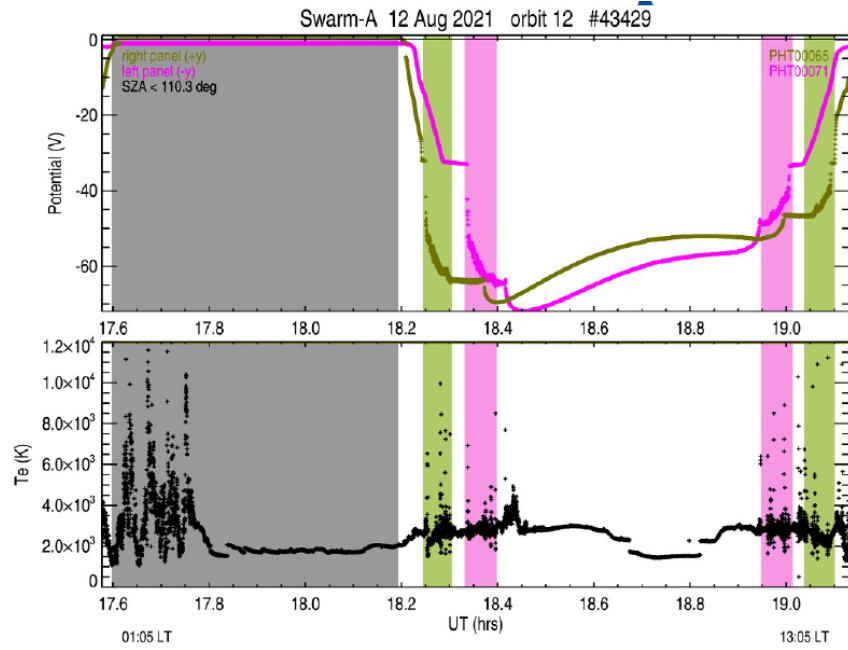
Swarm-A 12 Aug 2021 orbit 12 #43429



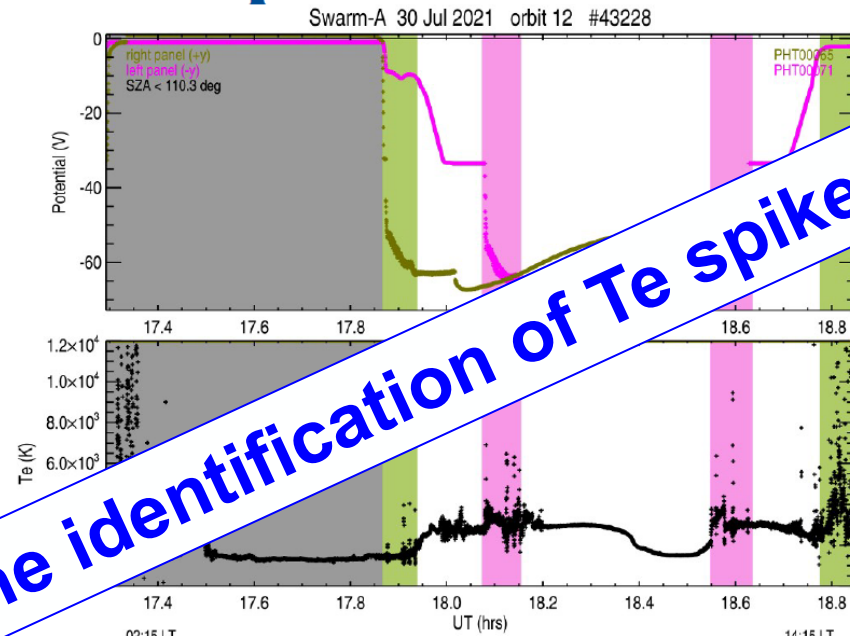
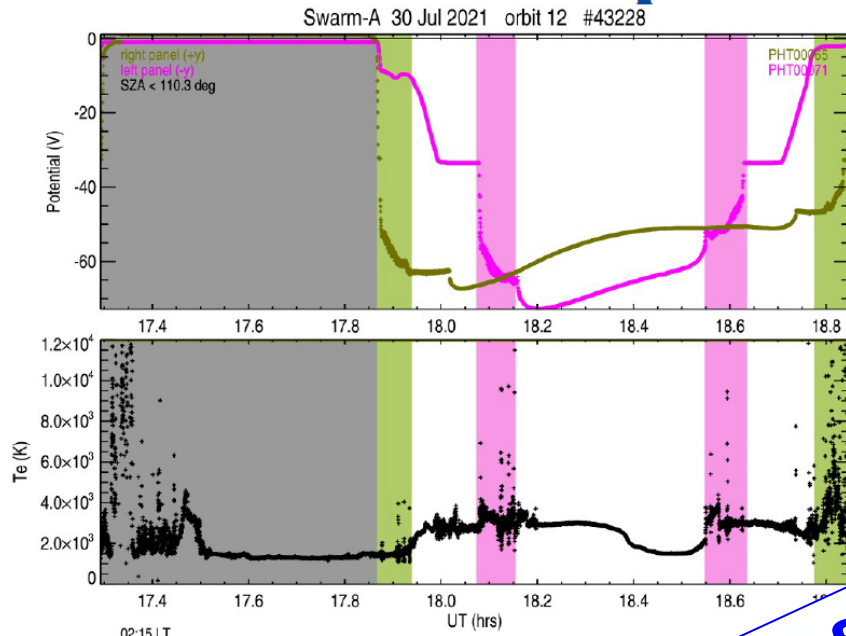
Swarm-A 12 Aug 2021 orbit 12 #43429



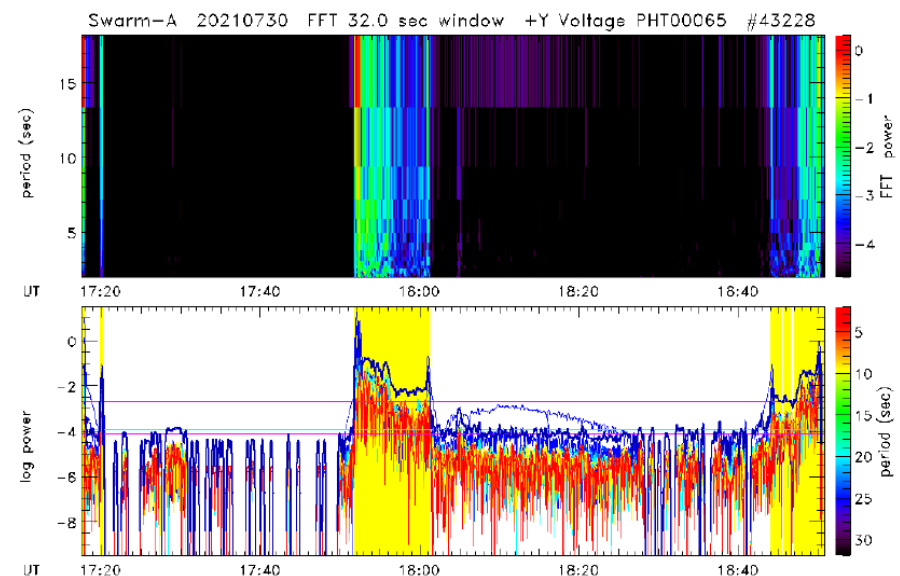
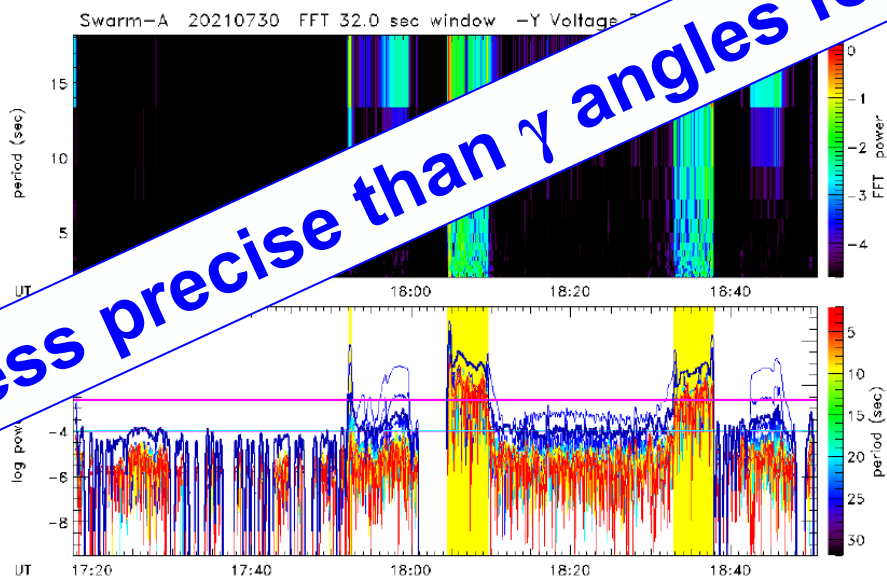
Correlation with currents / power from solar panels ?



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Less precise than γ angles for the identification of Te spikes



- Te spikes are a regular feature in LP data, related to specific solar orientation with respect to Swarm solar panels.
- Same behaviour for all the three spacecraft, during the entire mission, symmetric for the two solar panels: 5 – 7 lines in the γ range $\sim 77^\circ - 89^\circ$, with different response during sunrise and sunset intervals
- The HK analysis confirmed correlation of Te spikes with currents / voltages from solar panels, but didn't improved the identification of spikes with respect to γ angles.
- The physical scenario for Te spikes generation remains unexplained sofar. Some interaction on-board the spacecraft ? External interaction with plasma surrounding the solar panels?
- The team is now working on the implementation of new quality flag to identify the Te spikes