A Study of the Particle Precipitation and its Associated Plasma Phenomena in the Bottomside Ionosphere (SPECTACLE)

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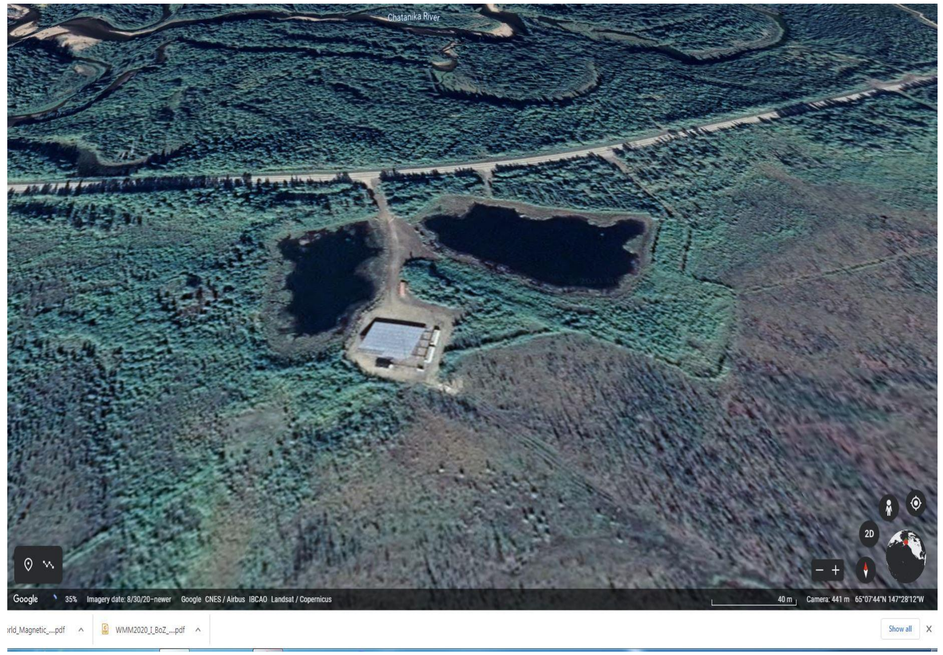
Outline

- Poker Flat ISR and Data Products
- Our experiment Setup
- Experiment on 21 July 2021 (MSWinds27)
- A case study of particle precipitation during a geomagnetic storm
- A case study of noctilucent clouds seen in the PFISR and AIM data

Poker Flat ISR and Data Product



The Poker Flat Incoherent Scatter Radar (PFISR) is located at Alaska, US (65.13°N GLat, 147°W GLon.).

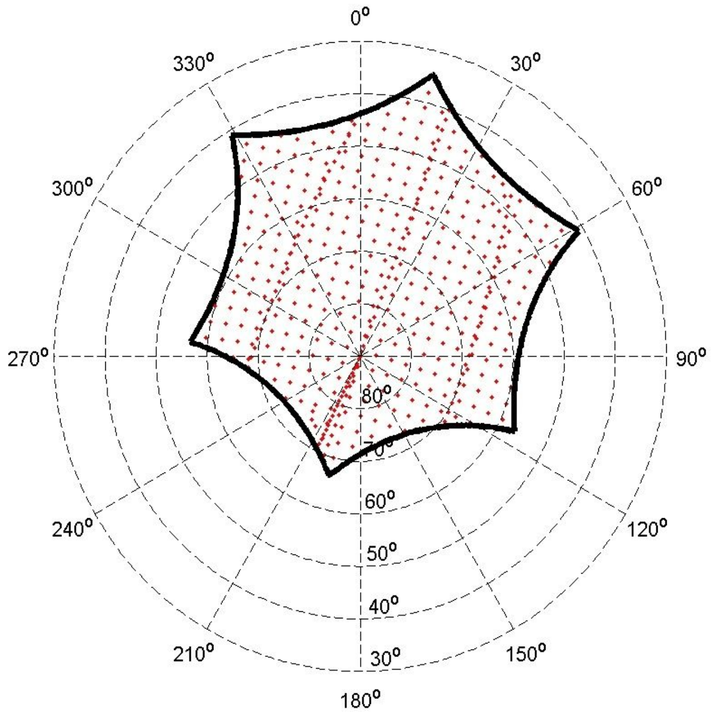
The measured parameters are:

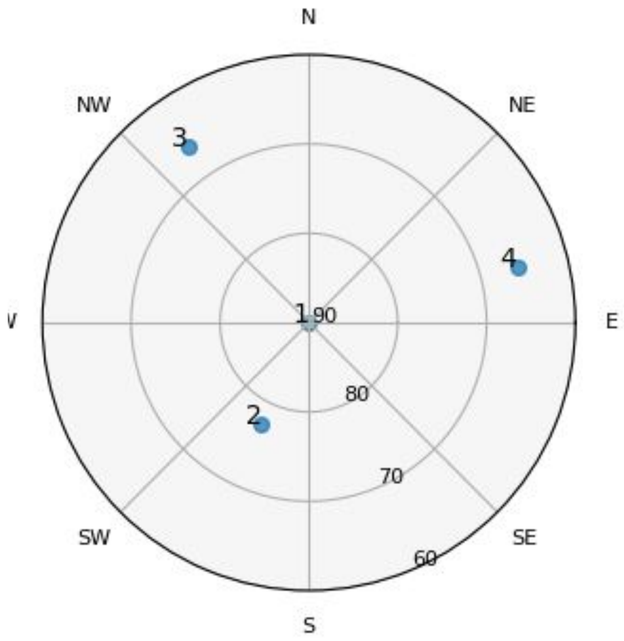
- Electron density
- Ion temperature
- Electron Temperature
- LOS Velocity
- O+ Ion Fraction, etc

Our Experimental Setup

D-region E region and F-region local measurements:

MSWinds27



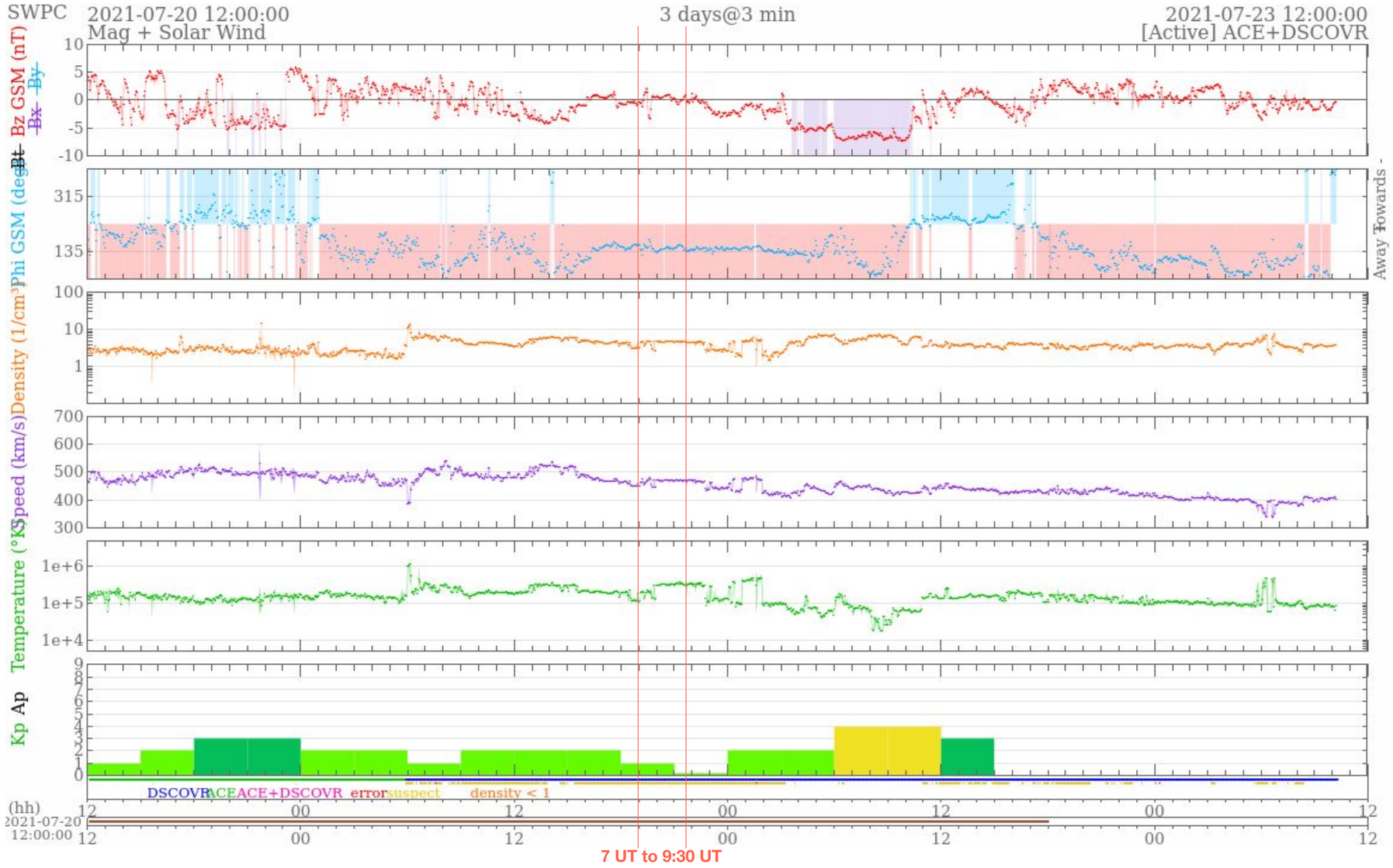


BEAM # 1, 2, 3 and 4.

Pulse Scheme:

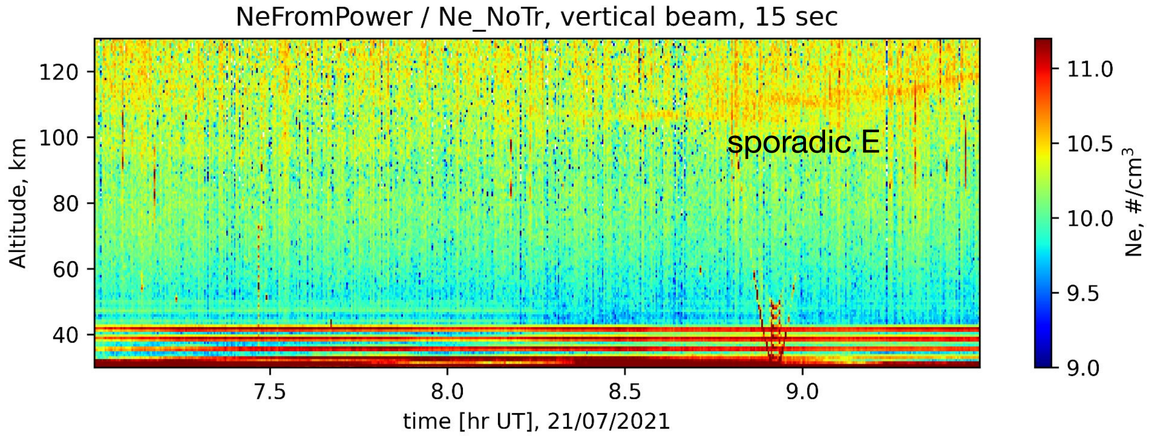
1. Barker Code: 30-150 km (Resolution ~ .8 km)
2. Alternating Code: 90-350 km (Resolution ~ 1.5 km)
3. Long pulse:100-700 km (Resolution ~ 5 km)

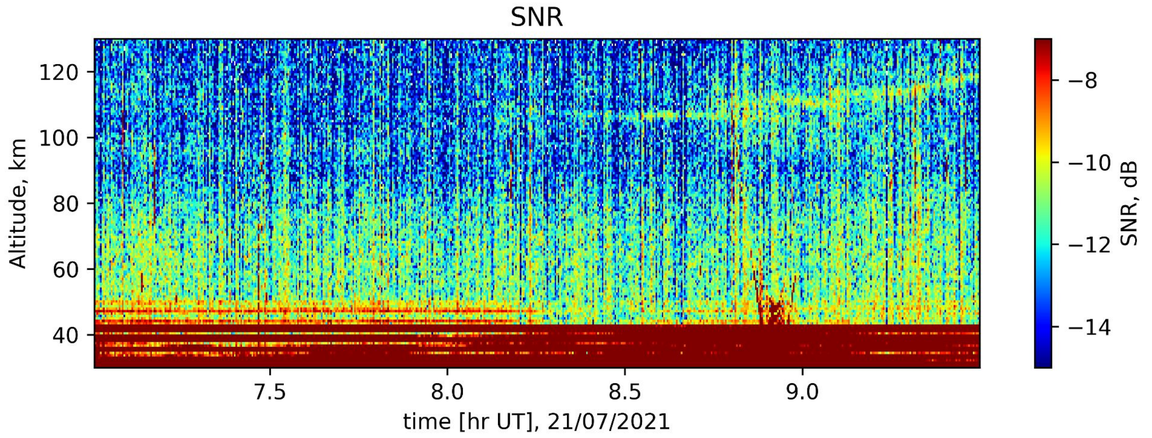
Solar wind and geomagnetic conditions

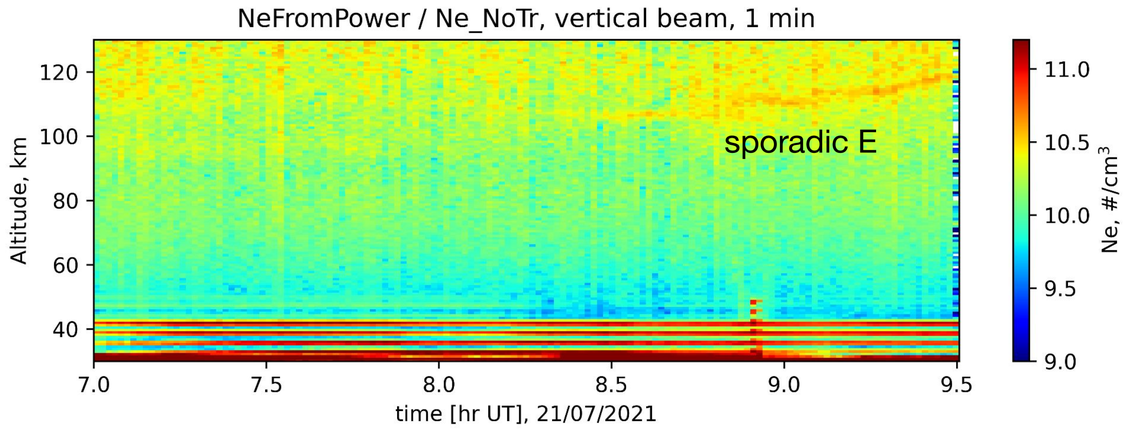


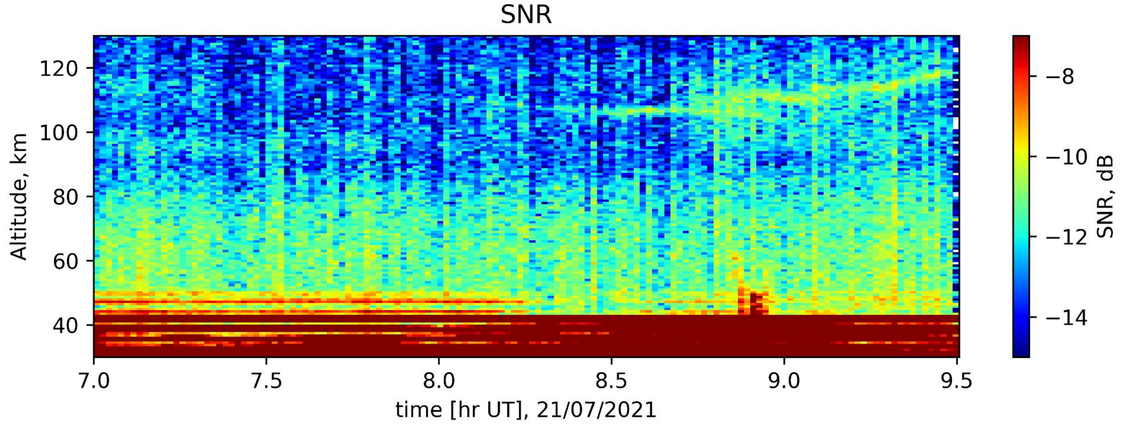
7 UT to 9:30 UT

Barker code density observations



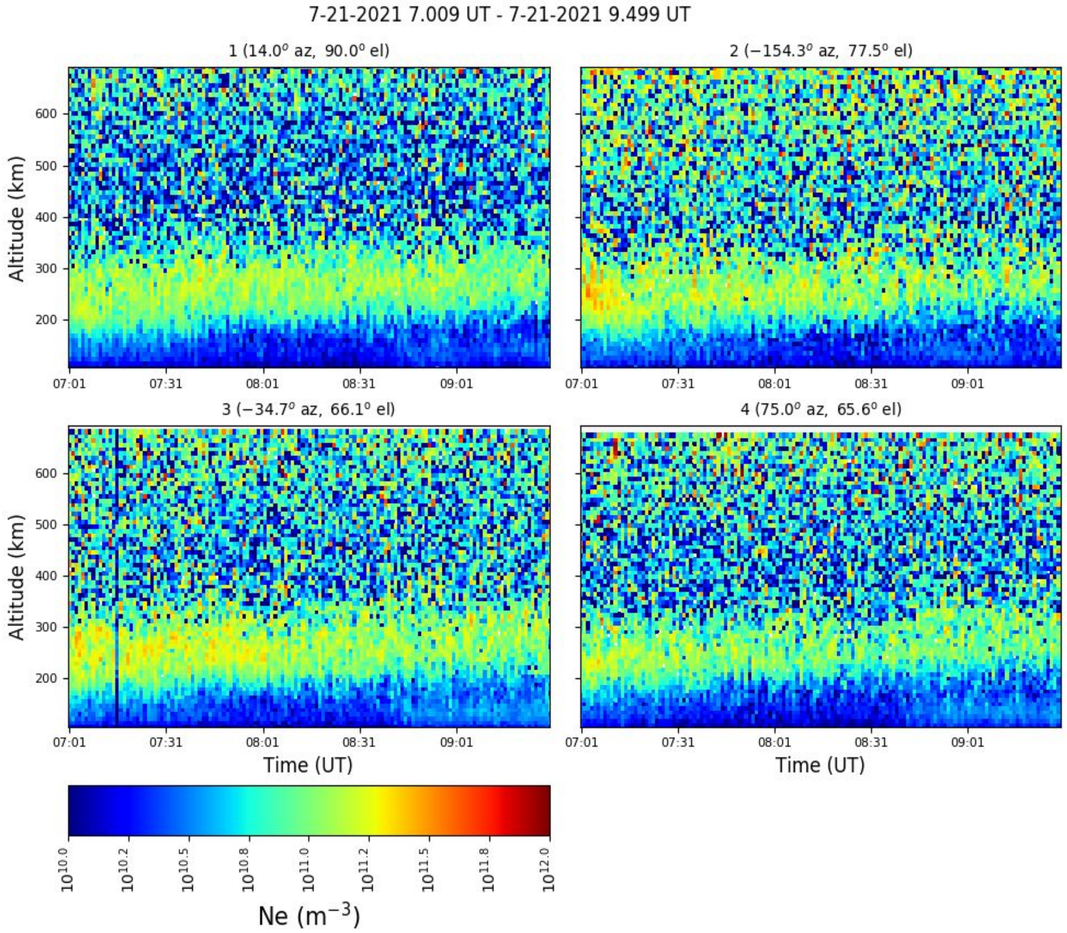




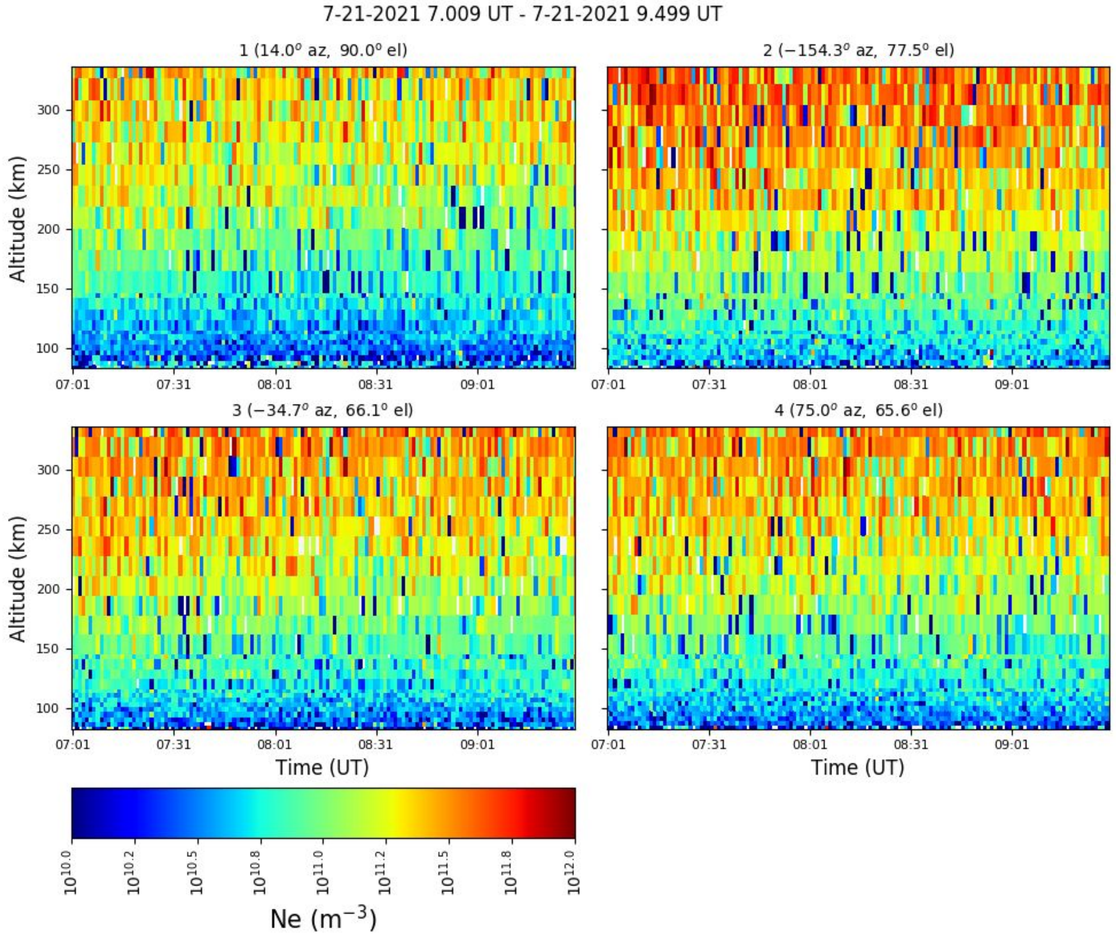


LP and AC

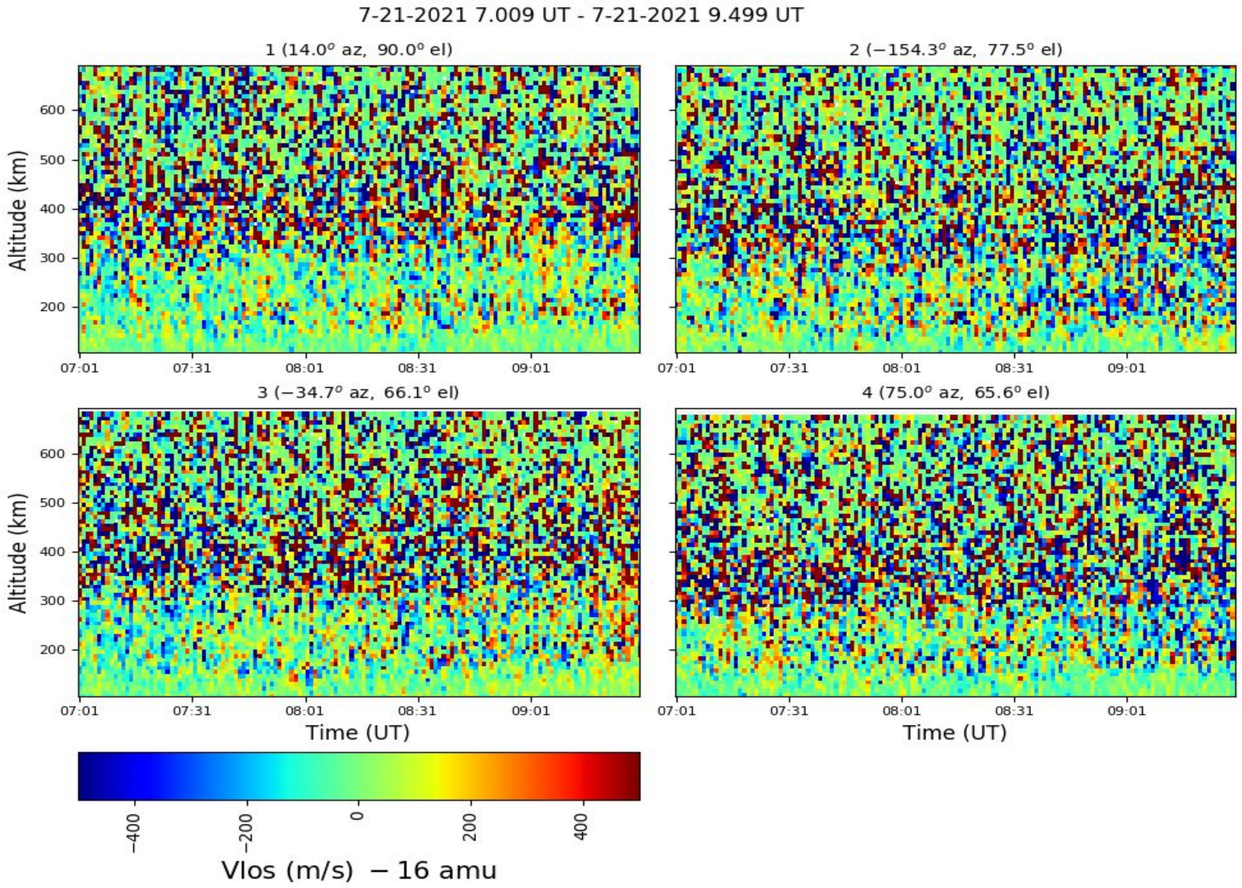
LP 1 min



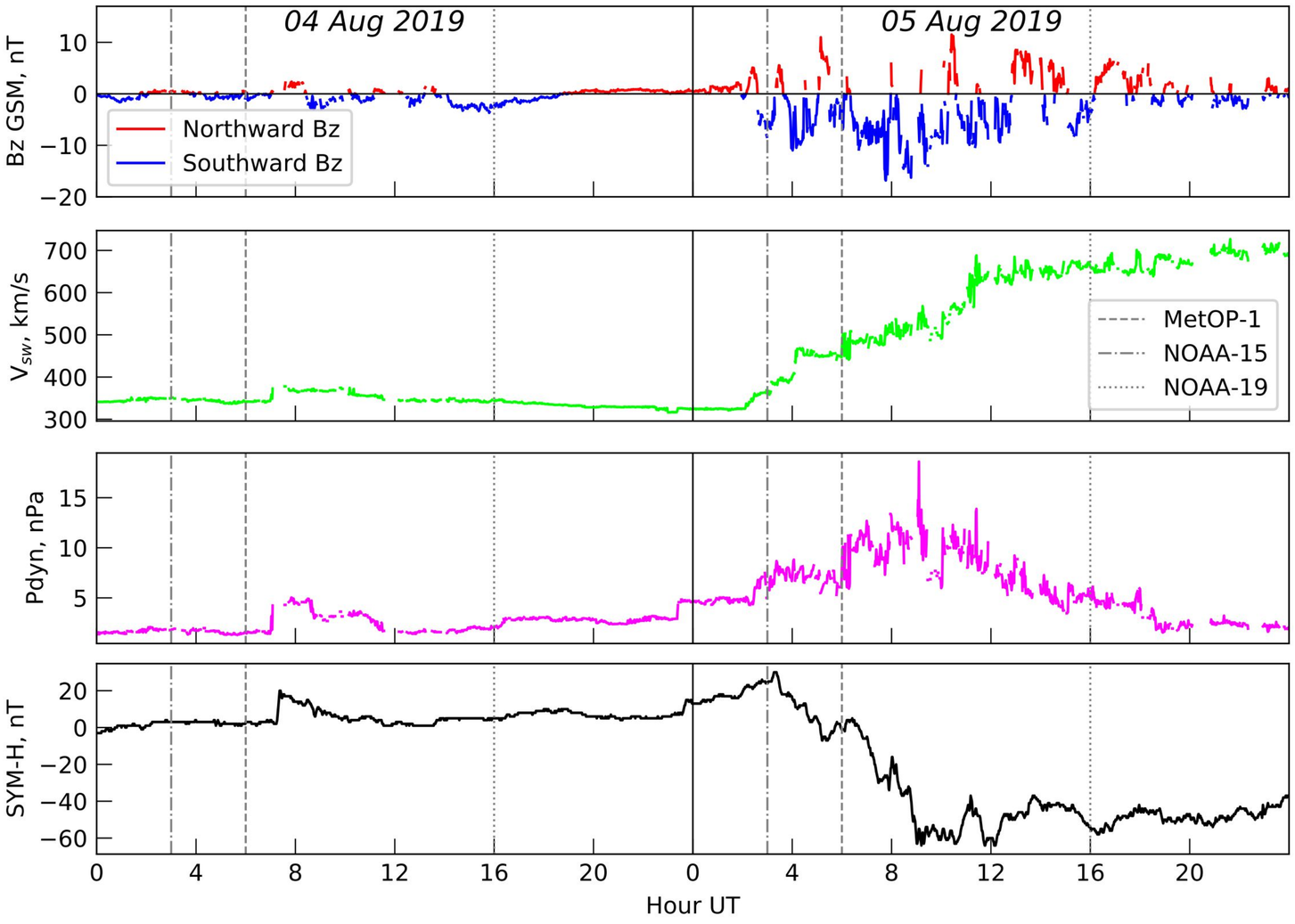
AC 1 min



Our velocity observation

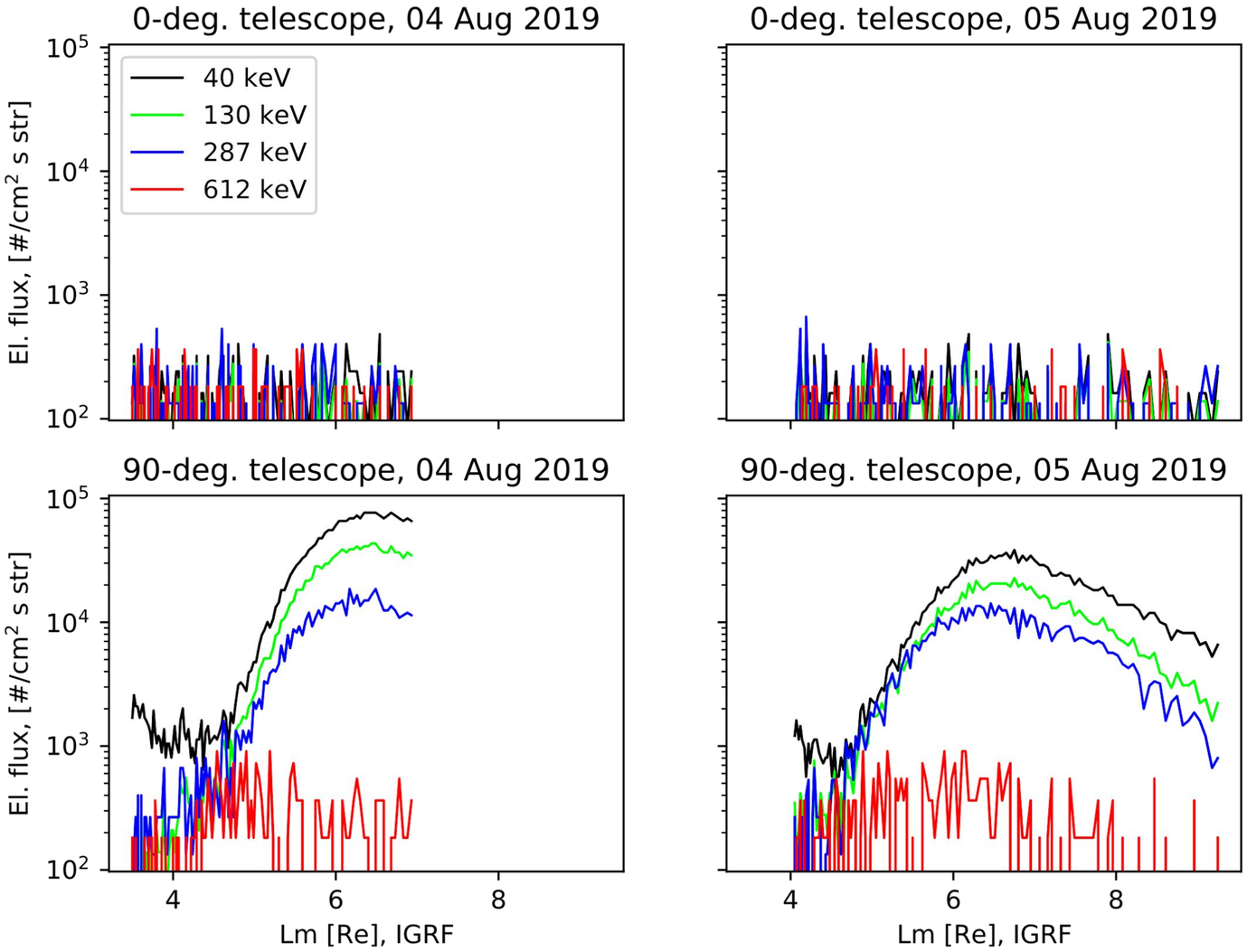


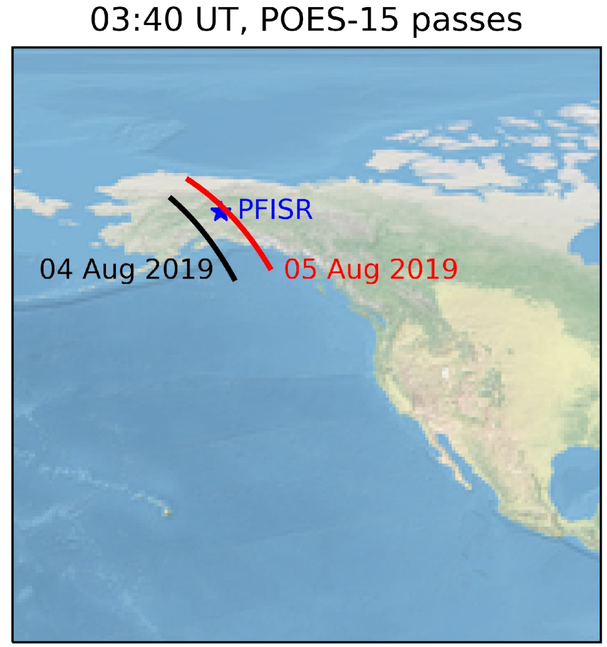
05 Aug 2019 storm - a case study



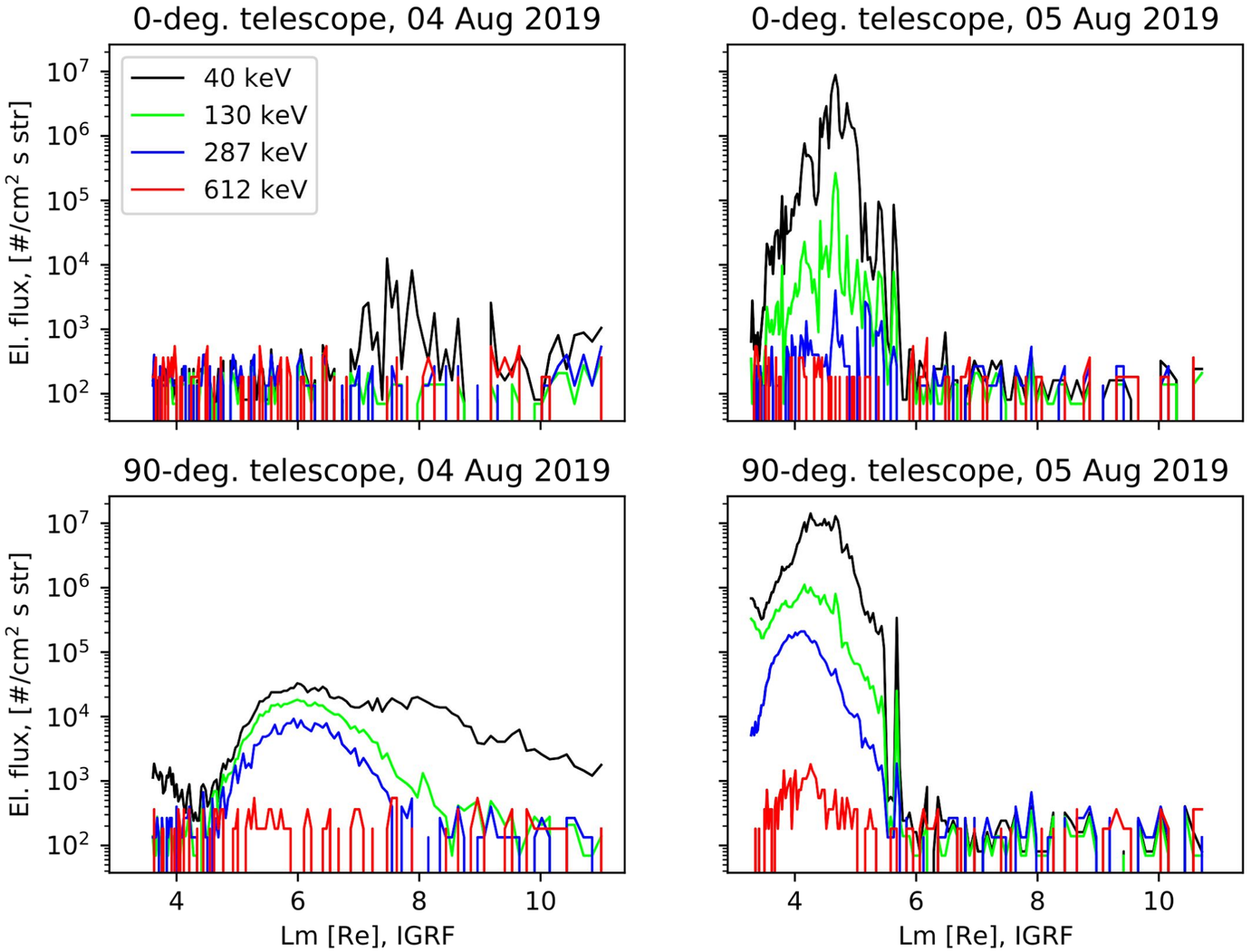
[SuperMAG]

Conjunctions with POES-15 during quiet conditions





Conjunctions with POES-19 during disturbed conditions



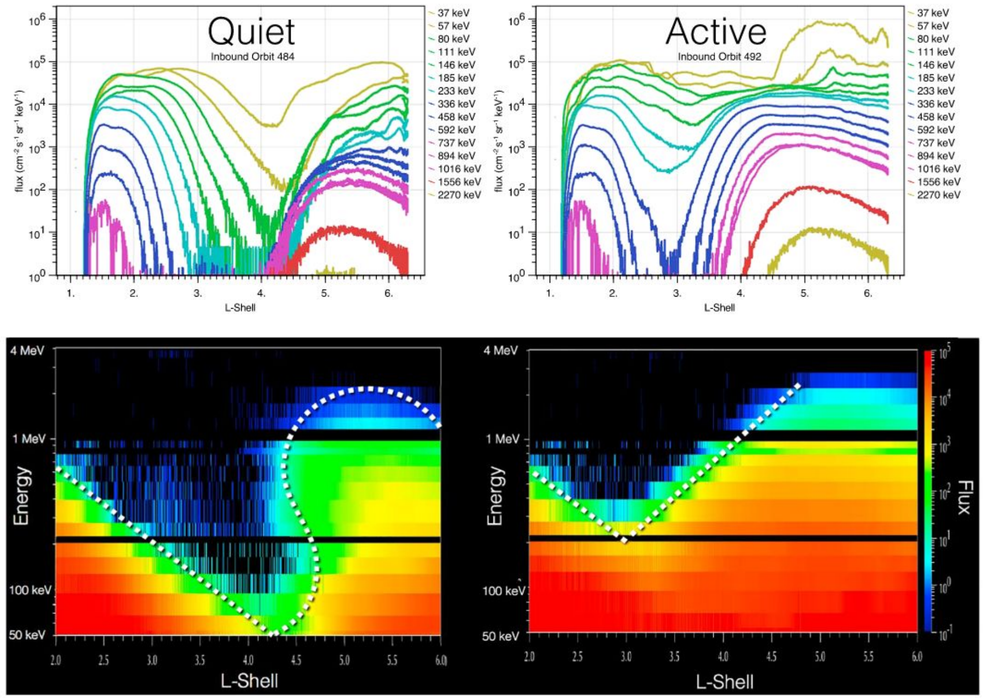
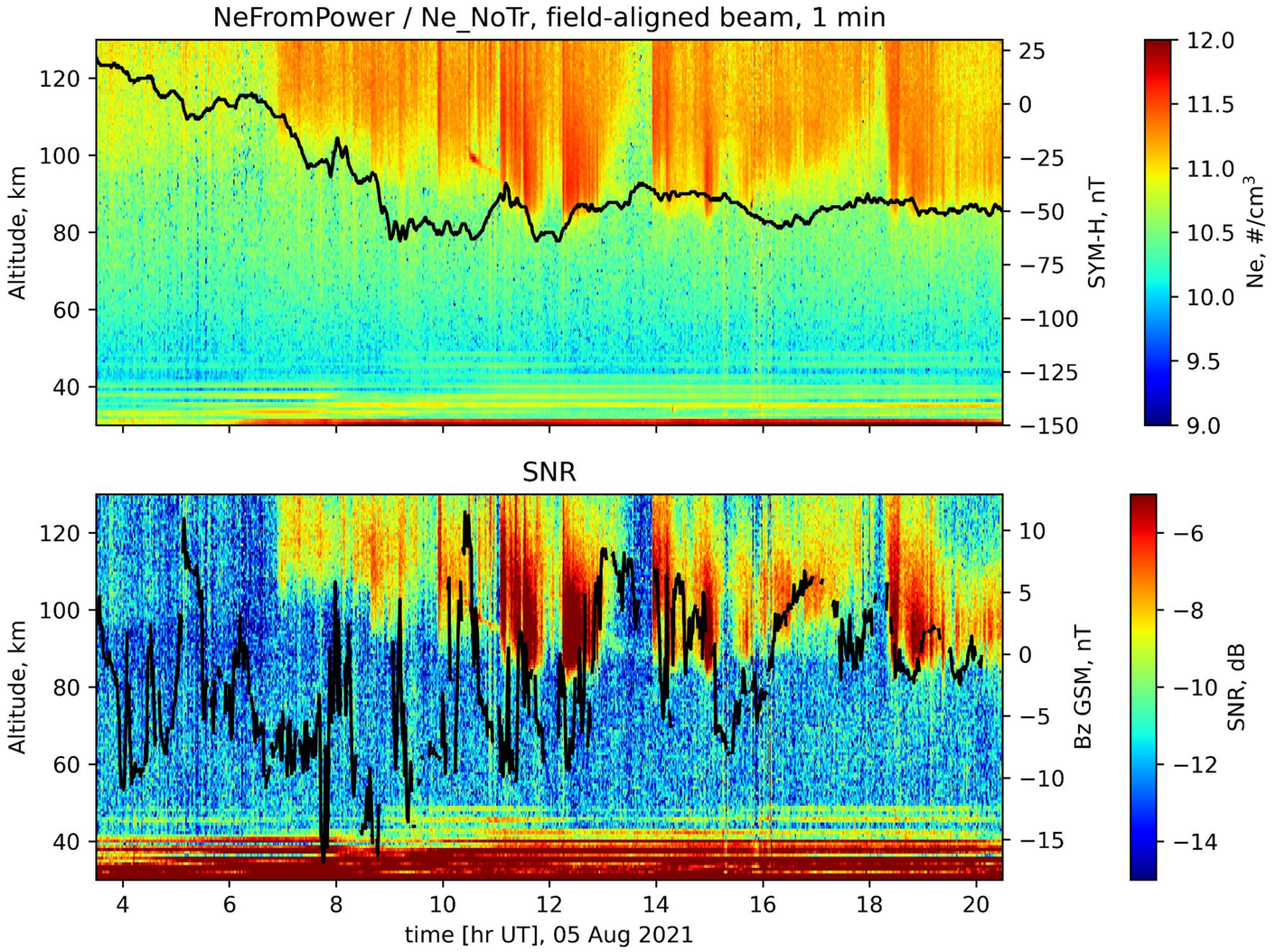


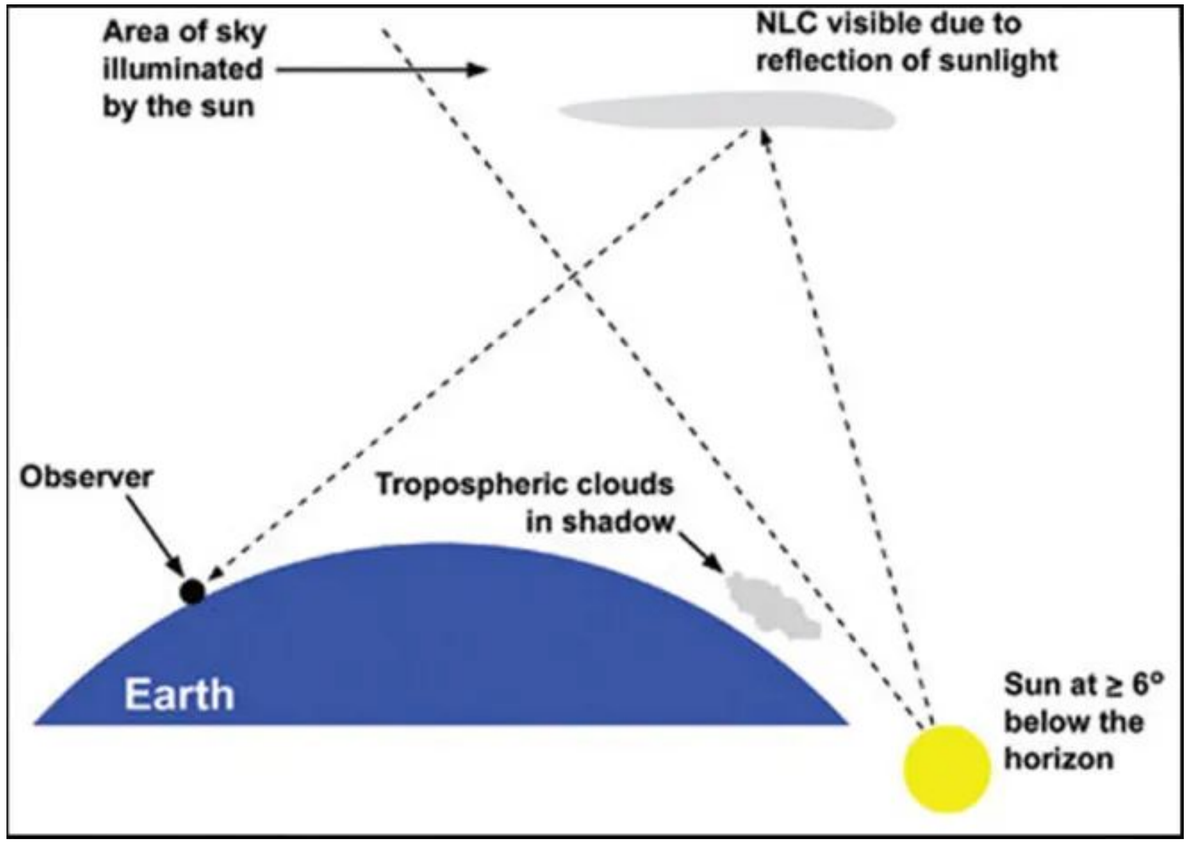
Figure 12. Radiation belt electron flux during quiet and active conditions. (top) Electron flux as a function of *L* shell for various energies during quiet (left) and active conditions (right). (bottom) 2-D electron flux as a function of *L* shell and energy during quiet (left) and active conditions (right). The outer belt exhibit an "S"-shaped structure with energy-dependent inner boundary during quiet conditions, whereas during active times electron fluxes are enhanced in the slot region indicating a "V"-shaped structure. This figure is adapted from Reeves et al. (2016).

How does this relate to PFISR data?

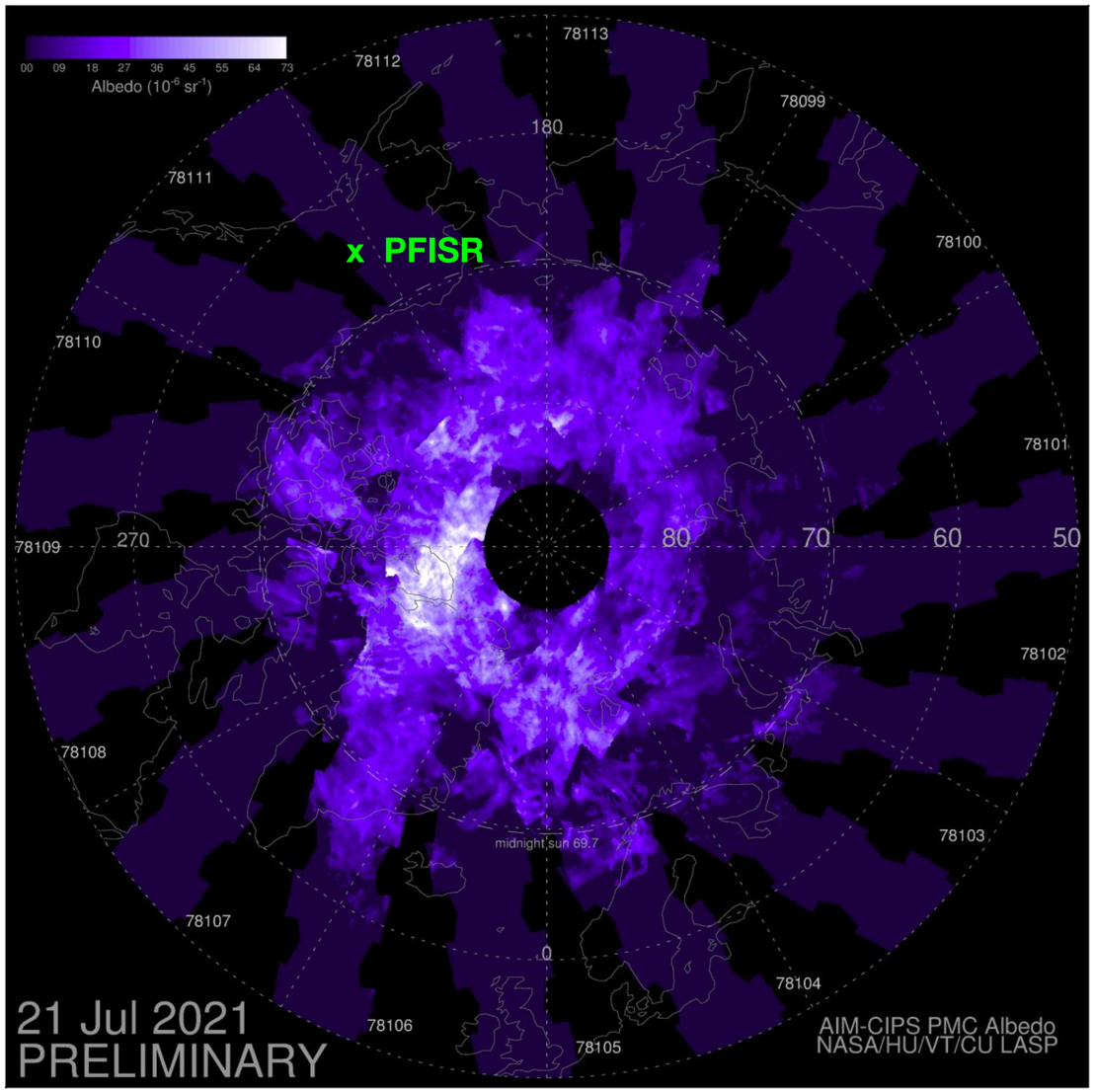
- PFISR was operating in the SMWinds26 mode during 03-21 hours UT on 05 August 2019
- During 03-06 hr UT, one could observe some precipitation, while with increasing storm activity the electron density became much more intense
- Furthermore, higher values of electron density were observed at lower altitudes
- This indicates precipitation of higher-energy particles

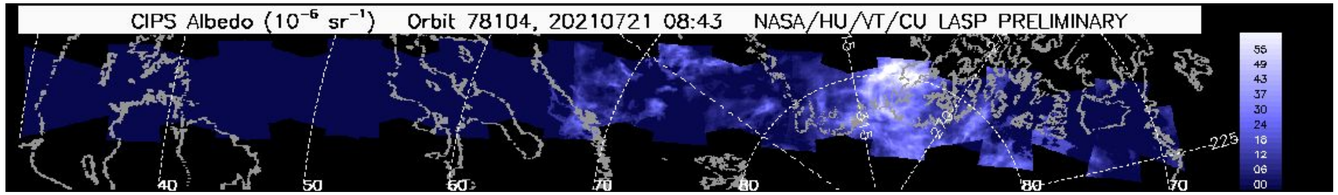


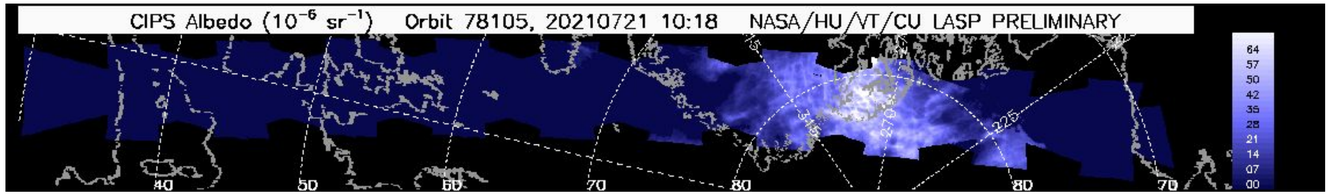
Noctilucent clouds



Noctilucent clouds

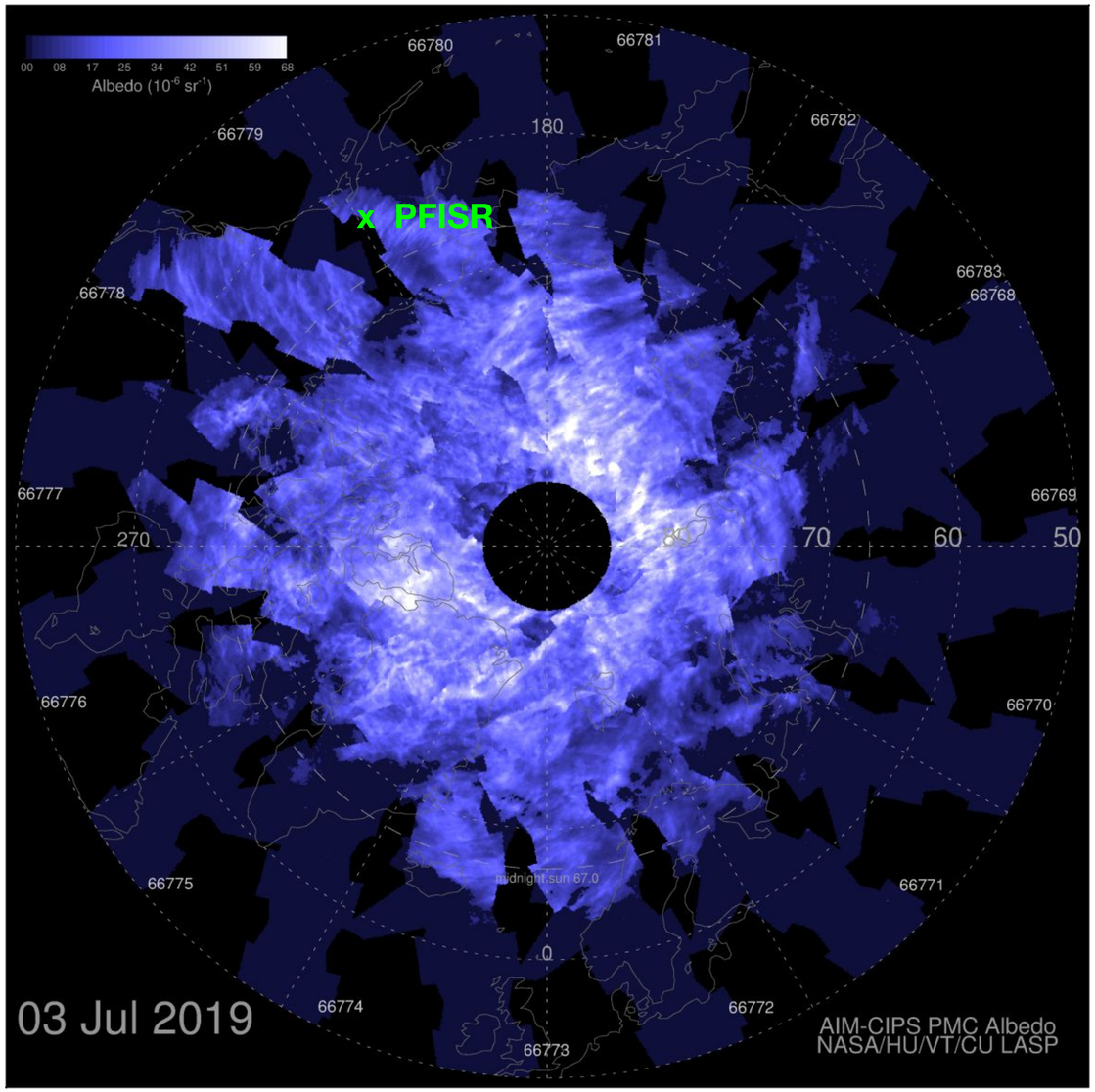




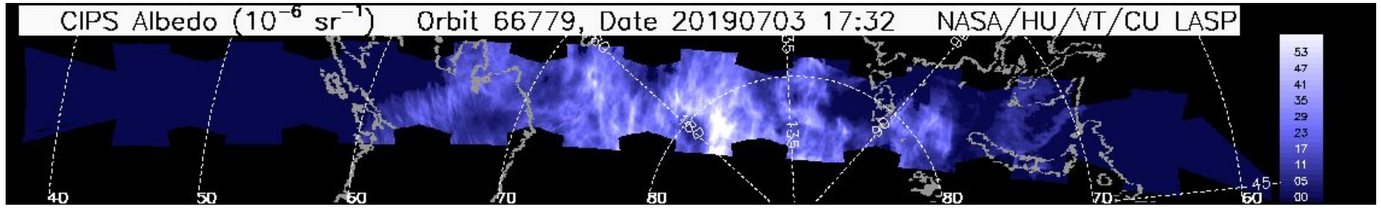


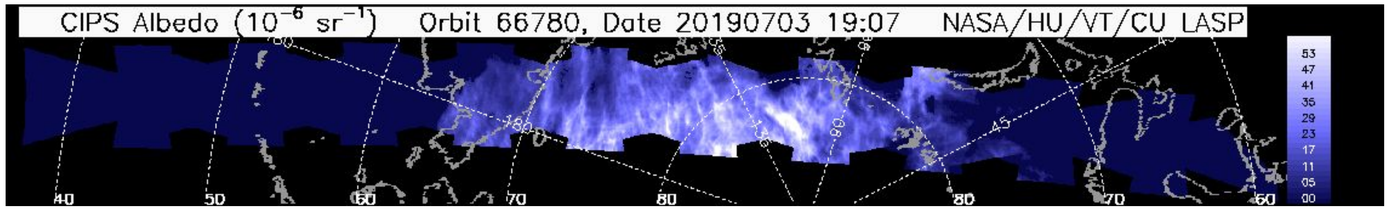
At 09:12, there was a conjunction with AIM. However, at the time no noctilucent clouds could be observed around PFISR location.

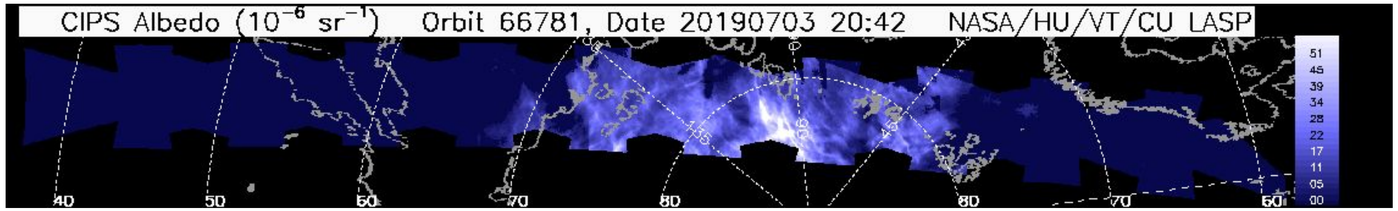
Noctilucent clouds

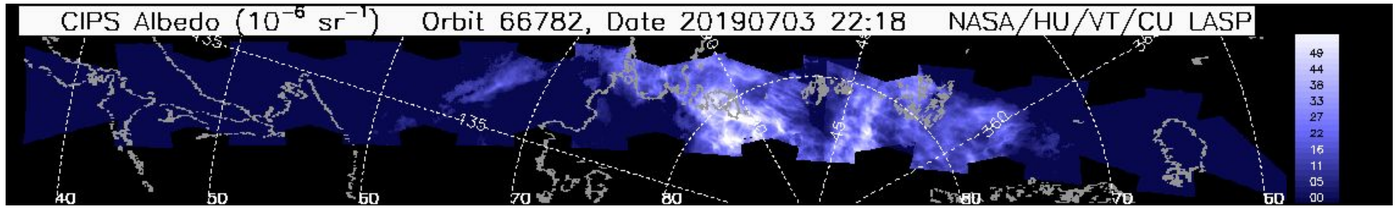


The AIM satellite flew over the PFISR location during 4 consecutive passes



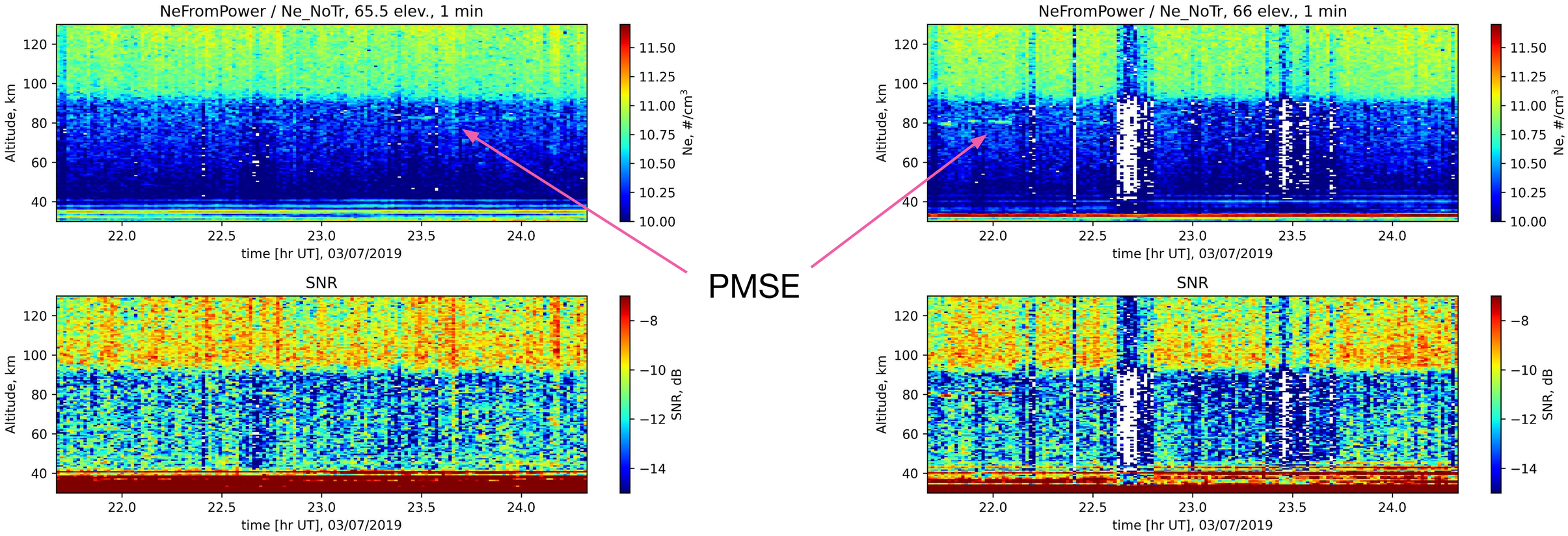






At the same time, PFISR was operating in the SMWinds26 mode

PFISR density observations

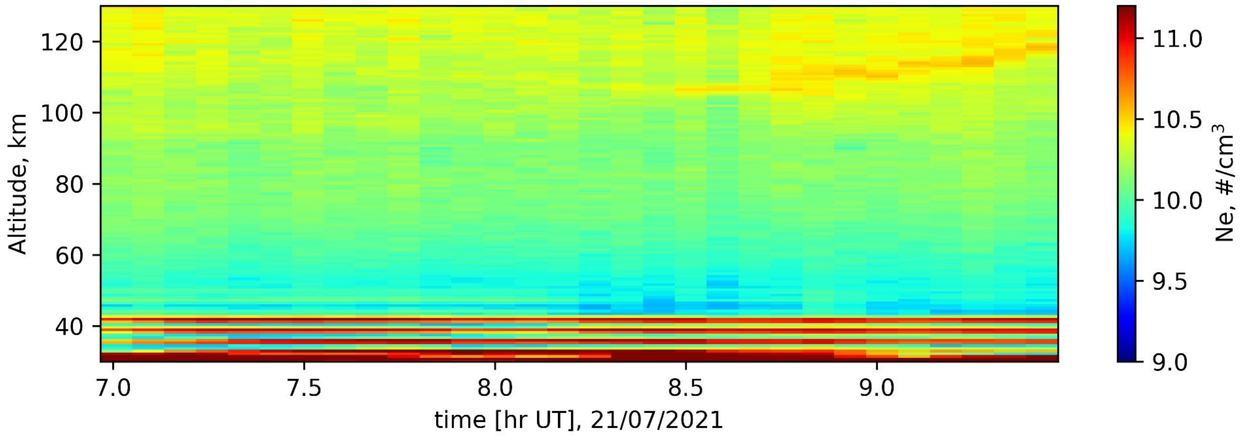


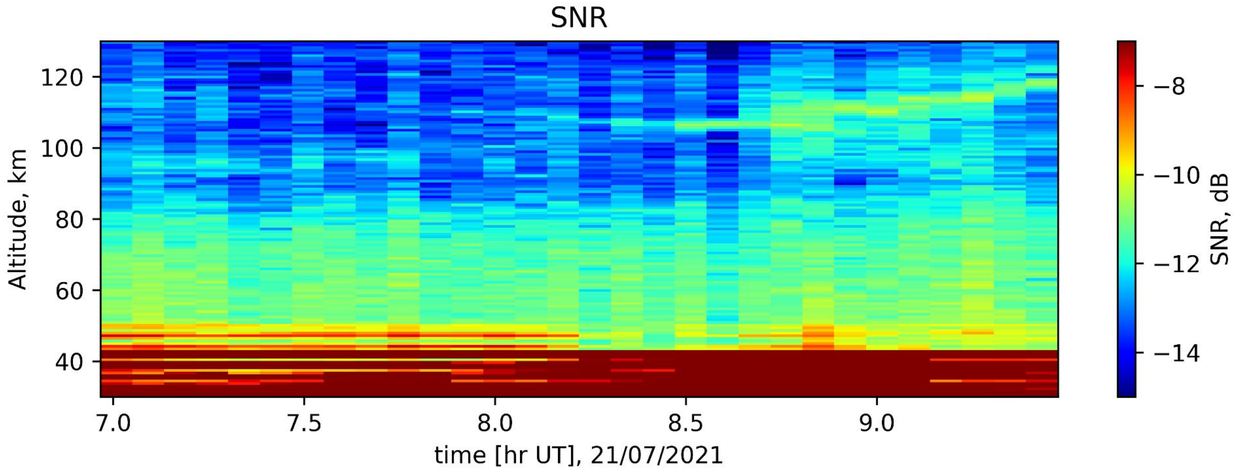
The observed signatures at ~80 km altitude throughout the event are due to PMSEs. Combined with the fact that the AIM spacecraft observed the noctilucent clouds around the same region and at the same time, we can conclude that the noctilucent clouds are the cause.

Conclusions

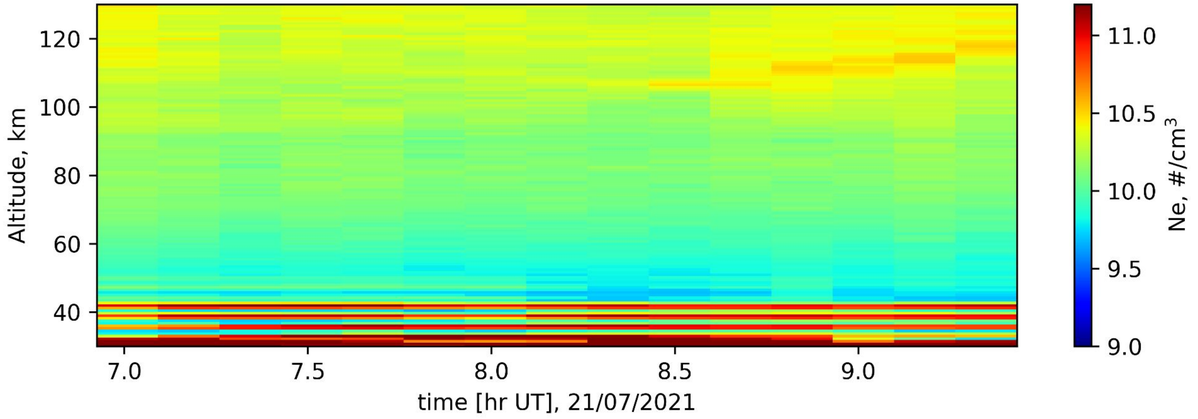
- The aim of this study was to use incoherent radar data in D- and E- layers of the ionosphere in order to observe precipitation
- Throughout the event (07:00-09:30 UT, 21 July 2021), levels of precipitation were relatively low, due to very quiet magnetospheric conditions
- Sporadic E-layer was observed at altitudes ~100-120 km
- We compare the event in question with another event corresponding to a strong storm (5 August 2019), with Dst<-60 nT.
- By comparing the PFISR observations to the POES overhead passes, we see increased precipitation of electron with energies up to 300 keV
- We further demonstrate an event of PFISR conjunction with the AIM satellite observing the noctilucent clouds. Their signatures could be seen in PFISR data at around 80 km altitude
- The ISR data can be used in combination with a variety of satellite missions to better understand processes in the magnetosphere-ionosphere-neutral atmosphere system

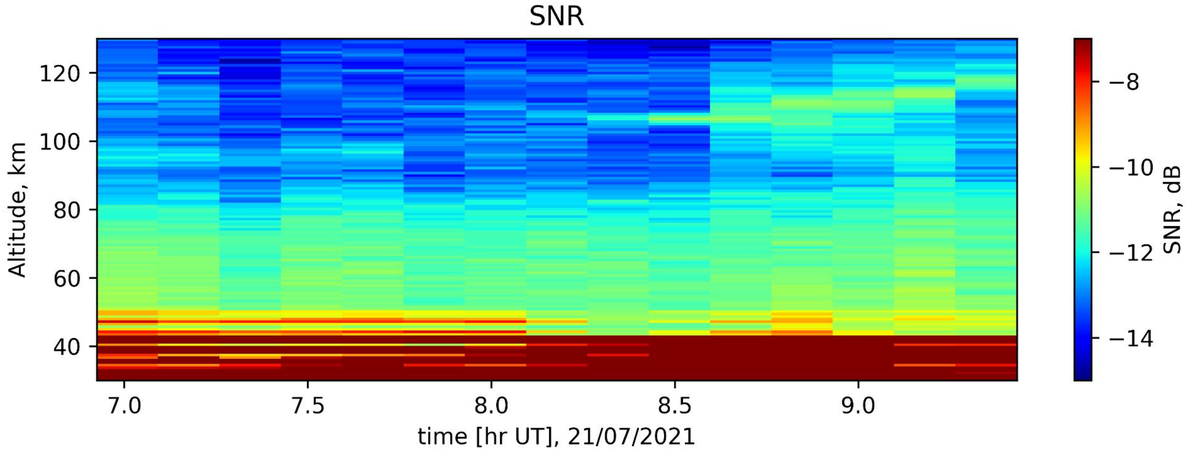
5 minutes





10 minutes





Conjunction with METOP-C for our event