Polar Cap Patches? Auroral Streamers? & Substorms with EISCAT

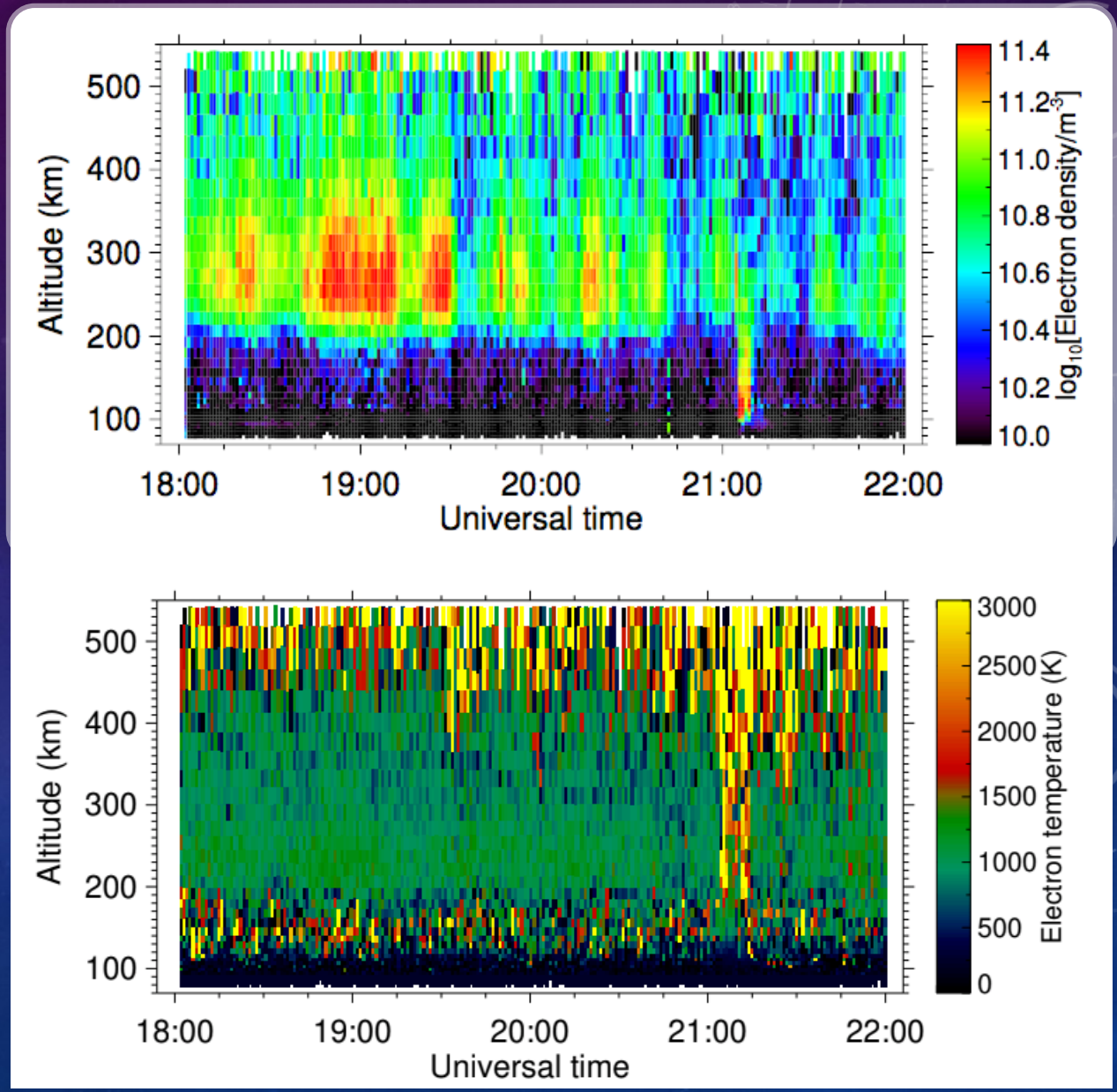
Sara Gasparini, Fasil Tesema, Chirag Rathod, Marcus Pedersen, Junyi Wang, Emma Mirizio, (Jia Jia)

OUTLINE

- Scientific Objective and Polar Cap Patches
- Instruments and data sources
- Features and structures observed
- Conclusion

SCIENTIFIC OBJECTIVE- POLAR CAP PATCHES

- Islands of high density plasma with spatial scales of 100 – 1000 km (Weber et al. 1984)
- Double the electron density of surrounding regions
- Usually observable from September to March (easier to detect during winter)
- Between 12 and 24 MLT
- Approximately 82° MLAT
- Found in F region between 200 and 450 km
- Driven by southward IMF-B_Z

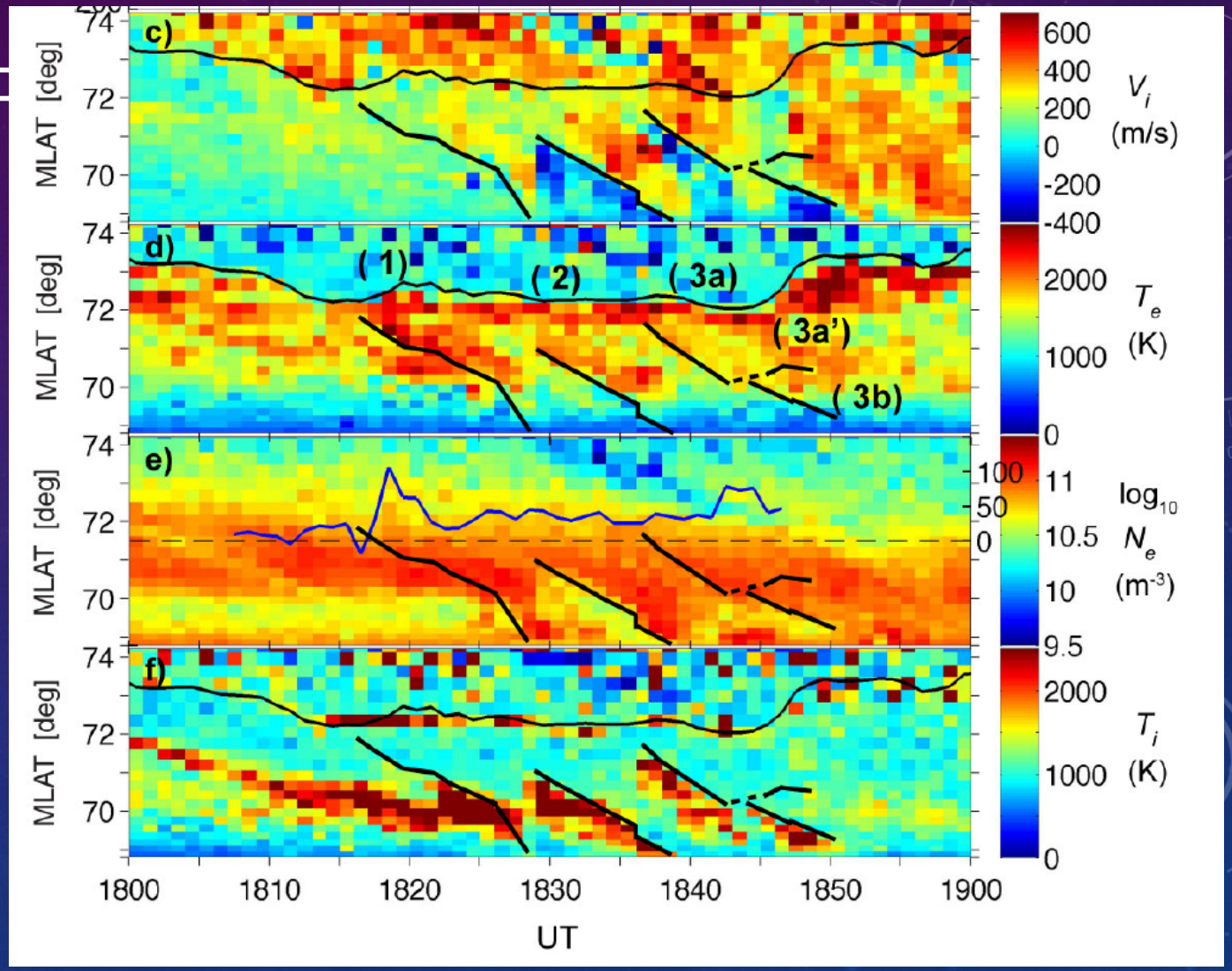


Jen et al. 2018

Figure: Gasparini's Master's Thesis 2019

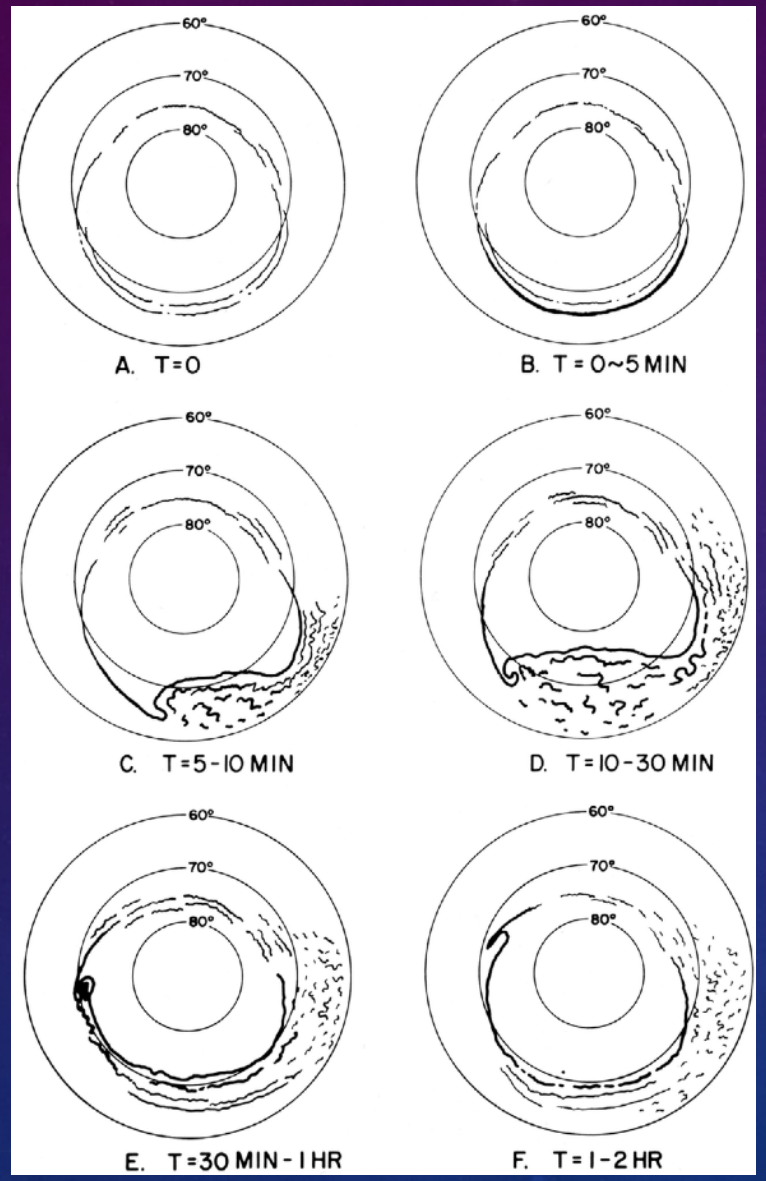
AURORAL STREAMER

- Auroral layer aligned north-south
- Transient stream created in auroral oval and headed southward
- Must be confirmed with optical data



Pitkänen et al. 2011

SUBSTORMS

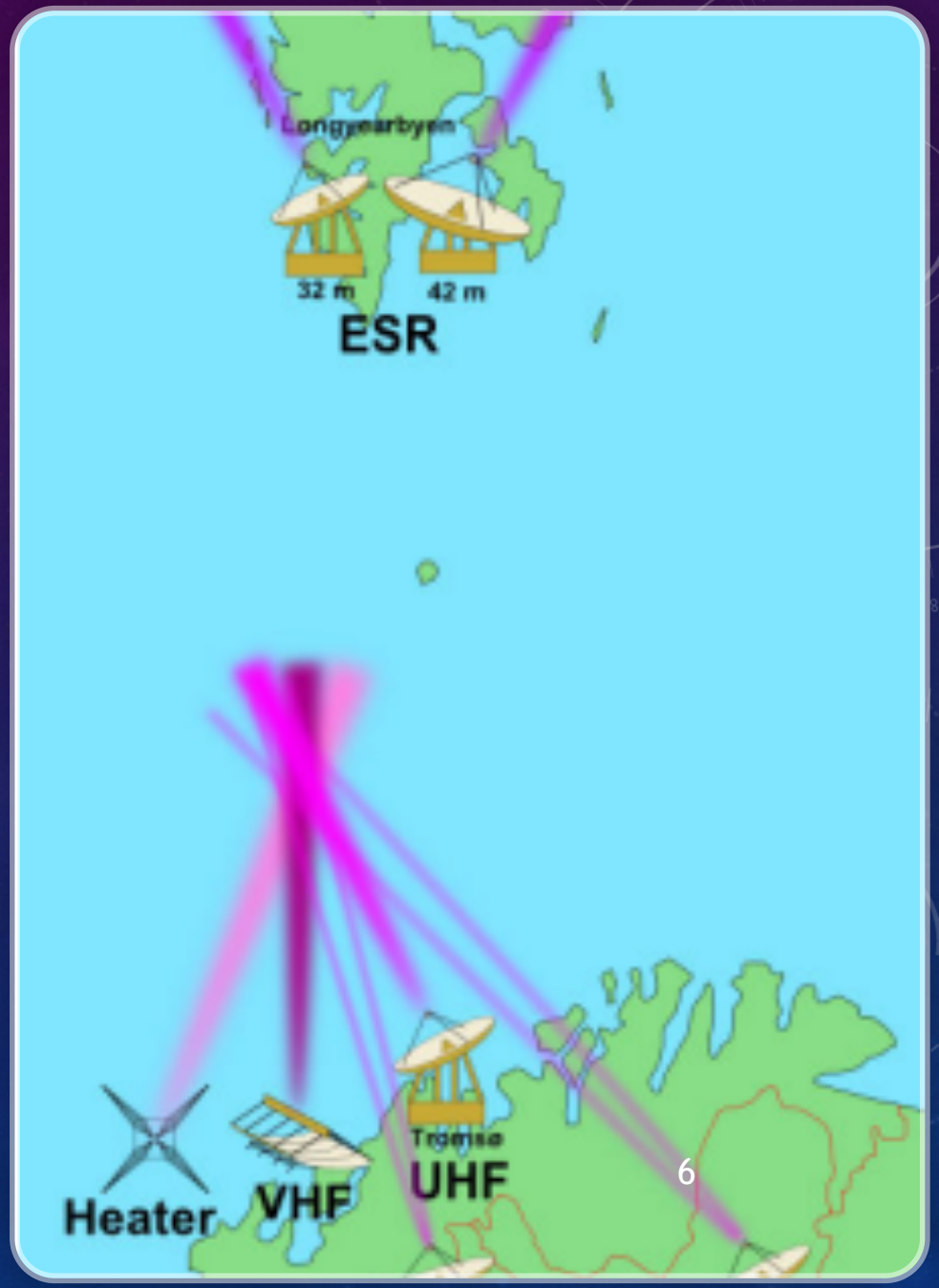


Akasofu 1964

- Disturbance in the magnetospheric tail causes particles to precipitate into the ionosphere
- Disturbance is driven by a change in the IMF, mainly southward IMF-B_z in the dayside
- Signatures include expanding the auroral oval, enhanced electron temperatures and enhanced electron densities

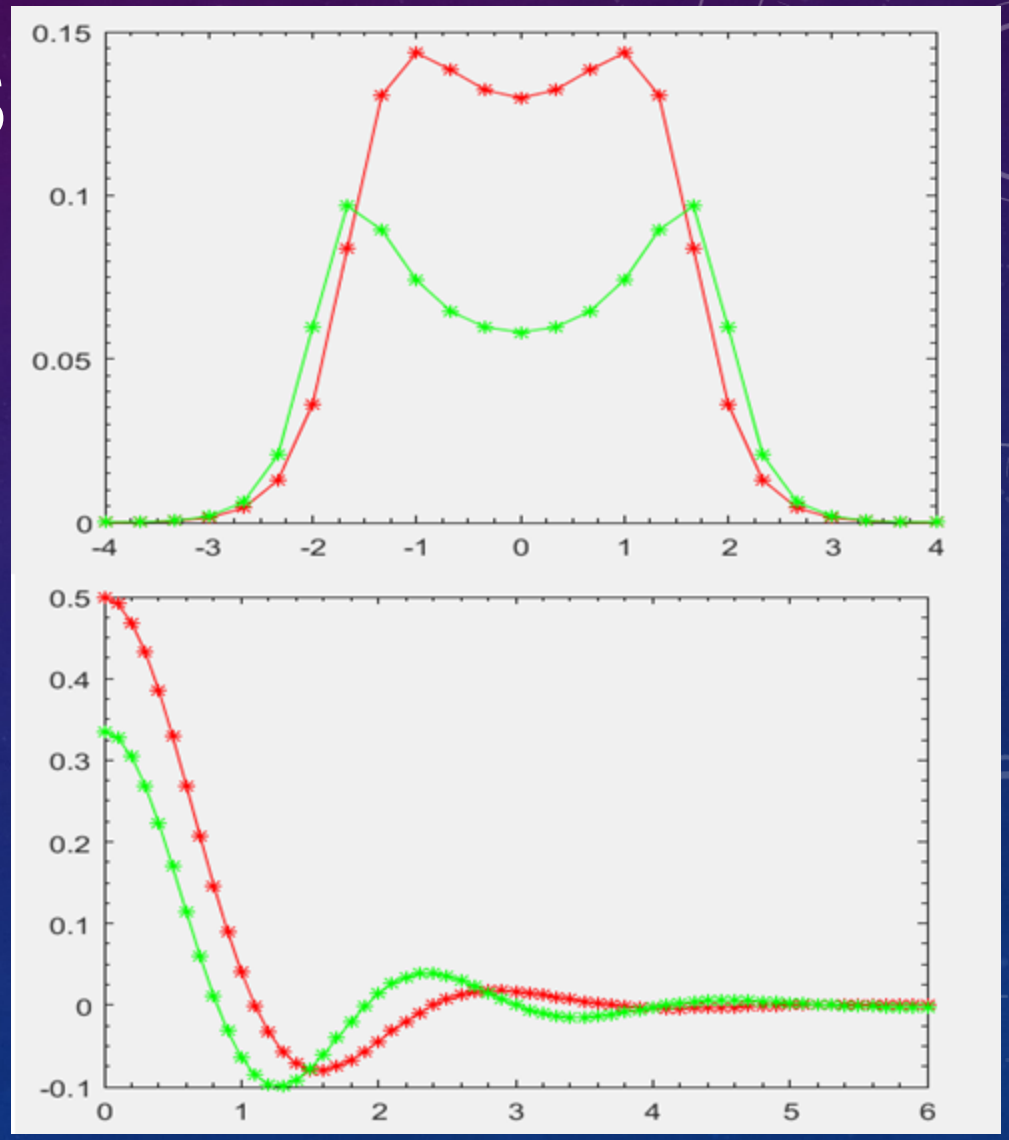
INSTRUMENTS AND DATA SOURCES

- ESR (32m meridional scanning and 42m magnetic North) operating ip3, folke mode (500 MHz)
- Tromsø-VHF (224 MHz)
- DMSP-SUSSI data
- Magnetometers, ACE-solar wind data
- Analyzed RISR data initially for evolution of polar cap patches, but none appeared



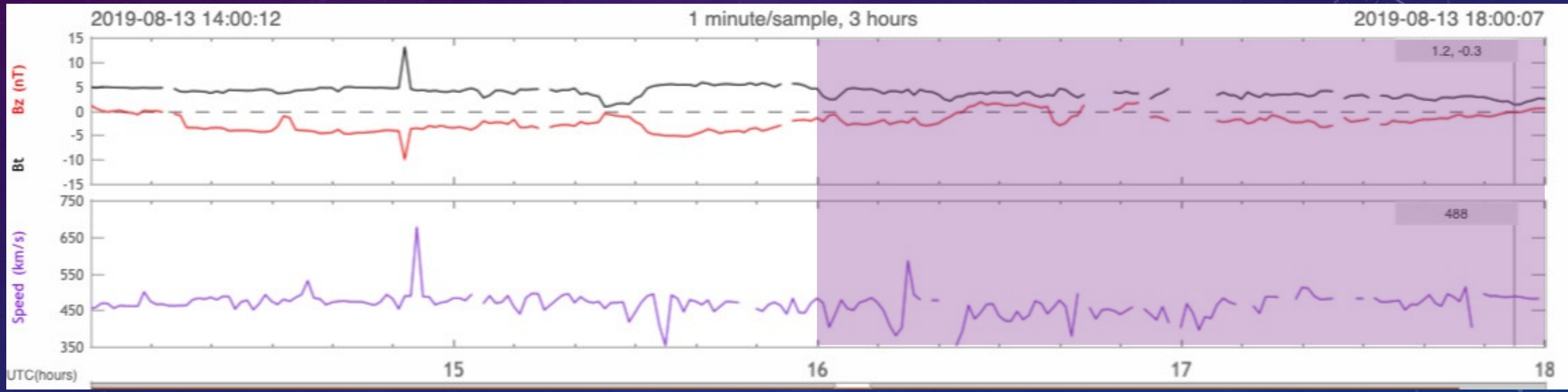
ANALYSIS AND LIMITATIONS

- Madrigal database
- GUISDAP used for EISCAT radar analysis
  - 32m uses 6.4 second (smallest) integration to find small scale structures
- The figure shows the theory spectrum and the corresponding autocorrelation function with different Ti/Te. The data fitting between the measurement ACF and the spectrum was finished by Levenberg-Marquart(LM) in GUISDAP.

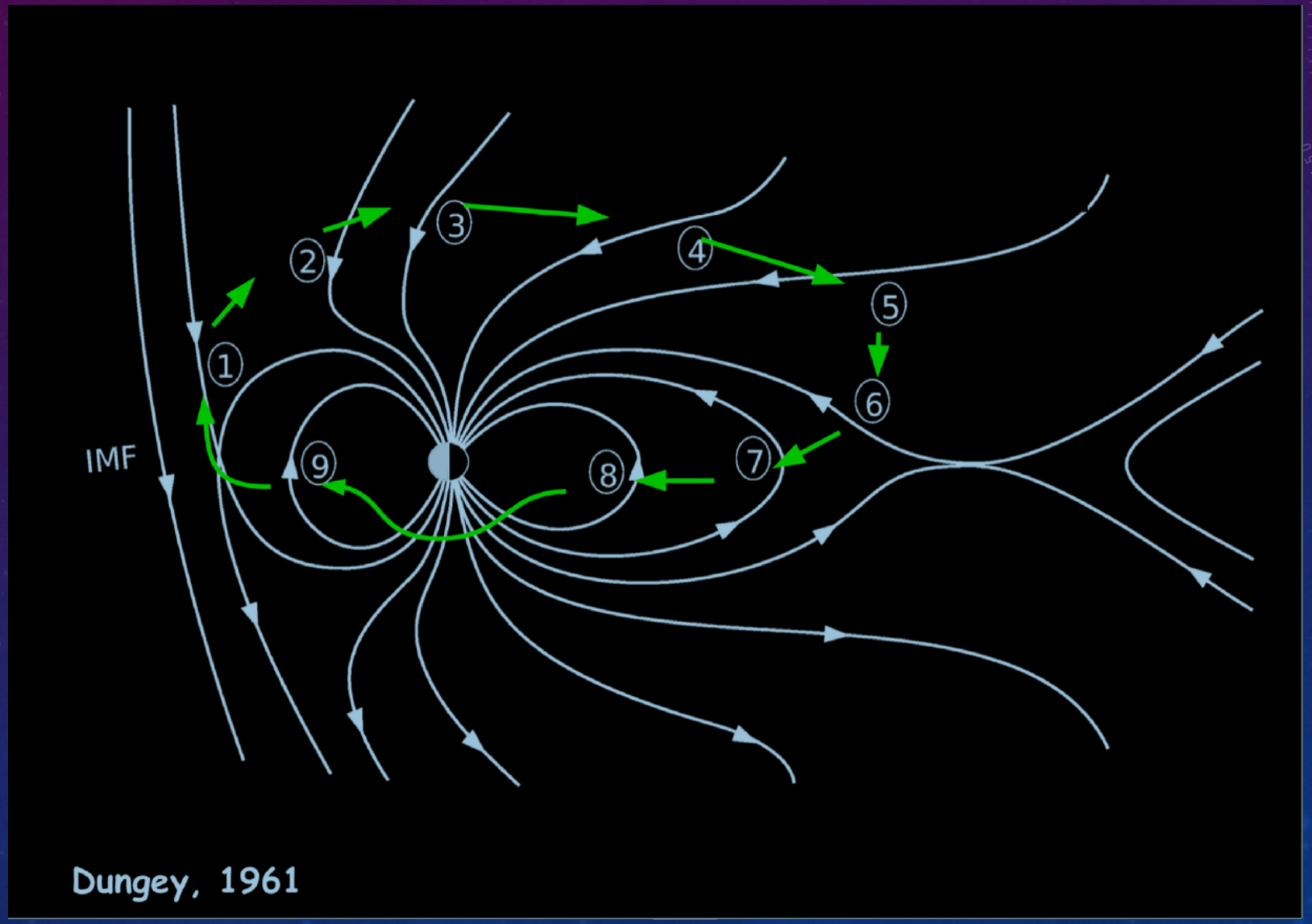


SOLAR WIND CONDITIONS

- ACE solar wind data (steady Vsw)
- Persistent southward IMF before observation

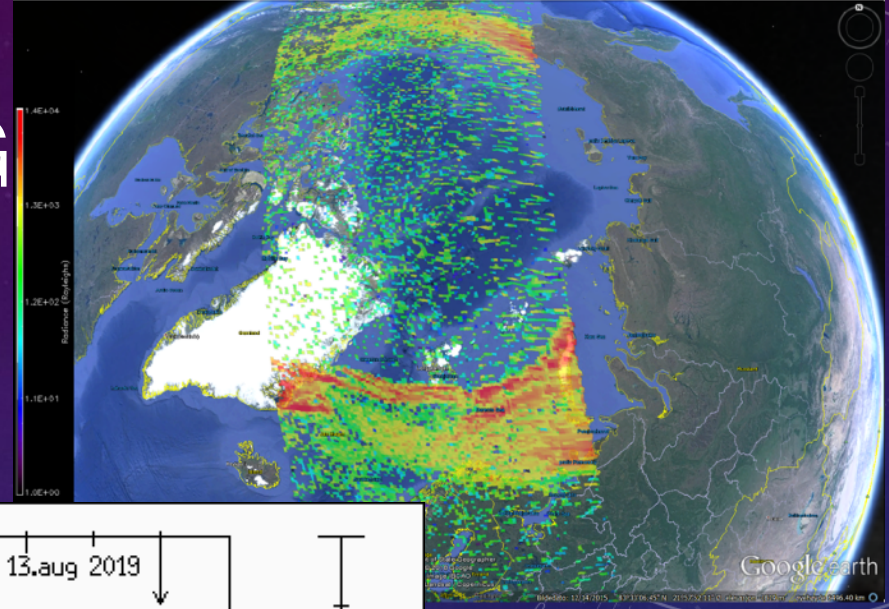


DUNGEY CYCLE

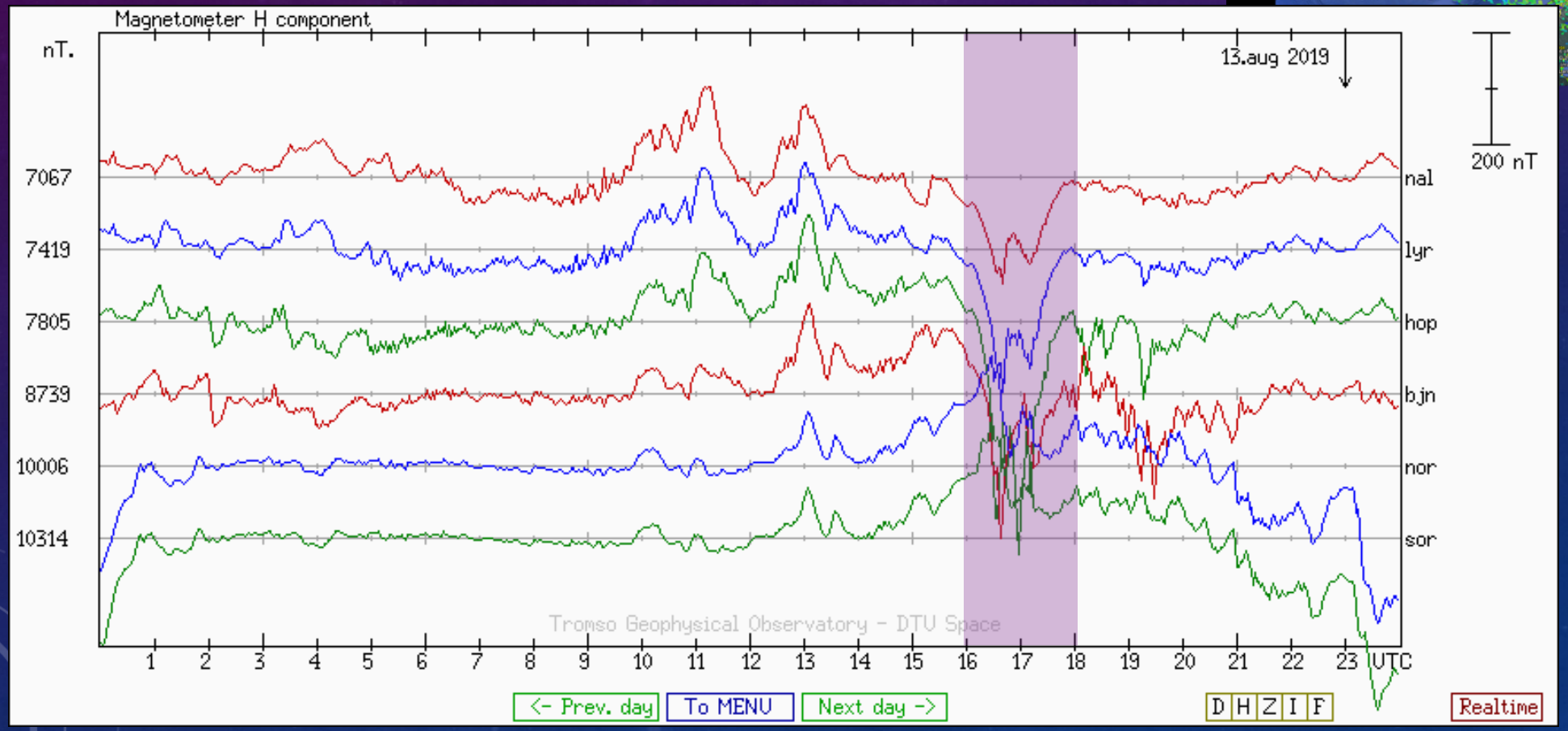


MAGNETOMETER AND SPECTROG

- Signatures of geomagnetic disturbances (below)
- Location of auroral oval (right)

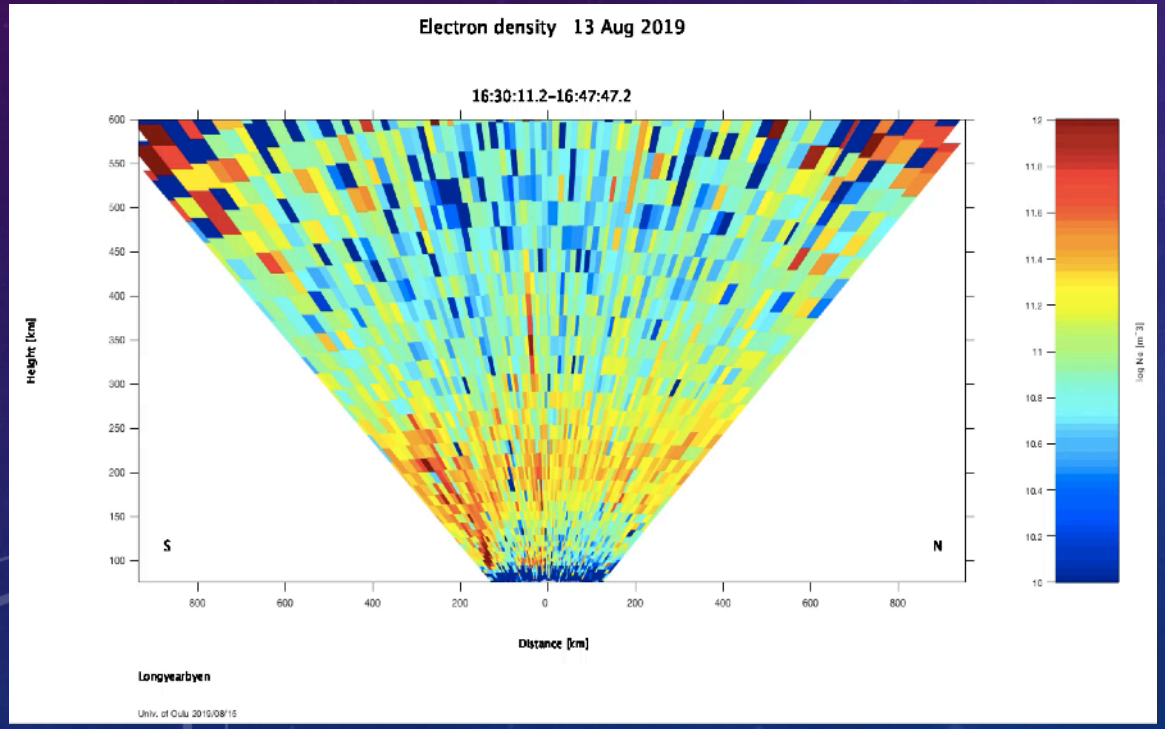


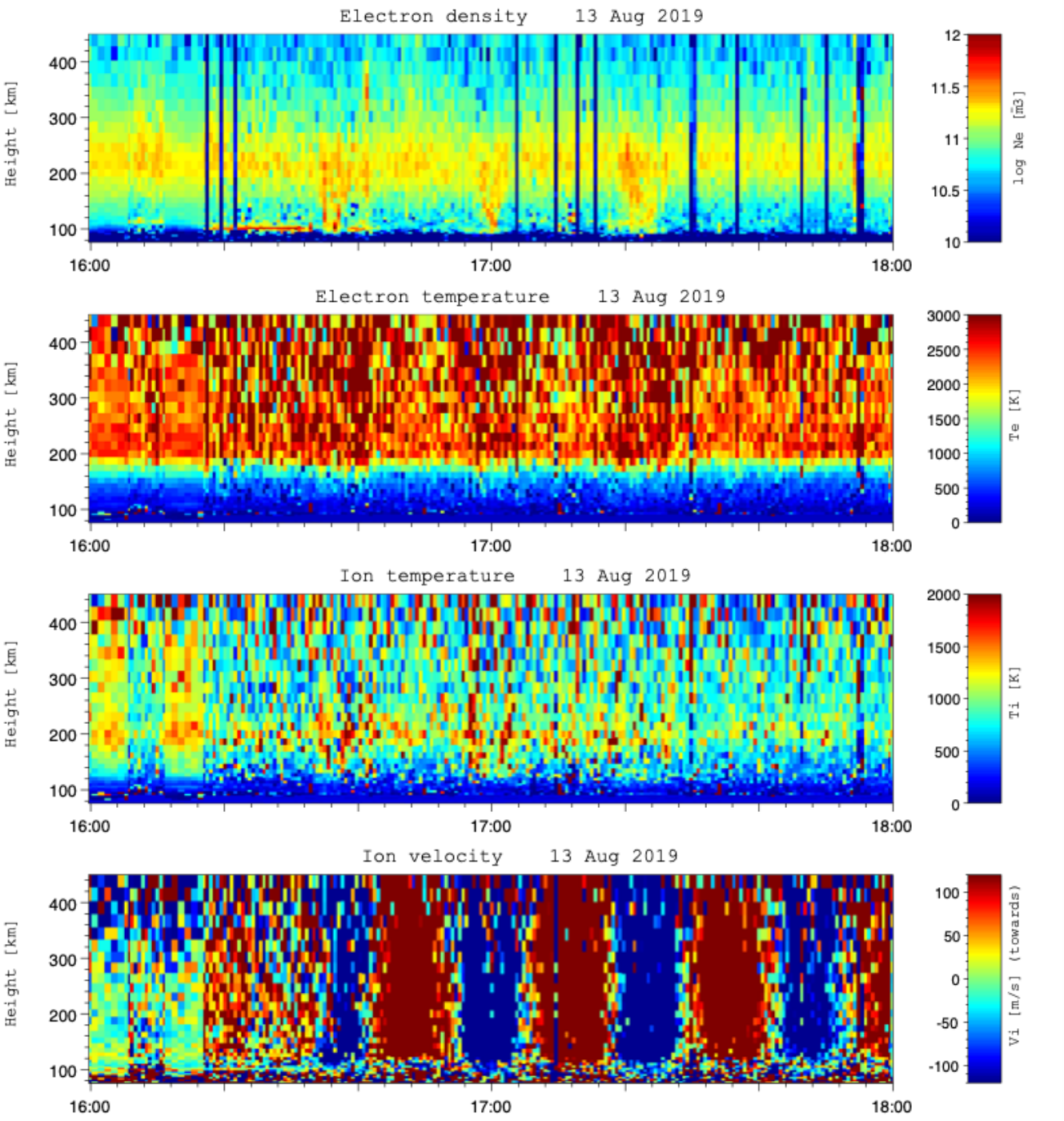
SUSSI Data
13/8/19
17 UT



ESR 32 M MERIDIONAL SCANS

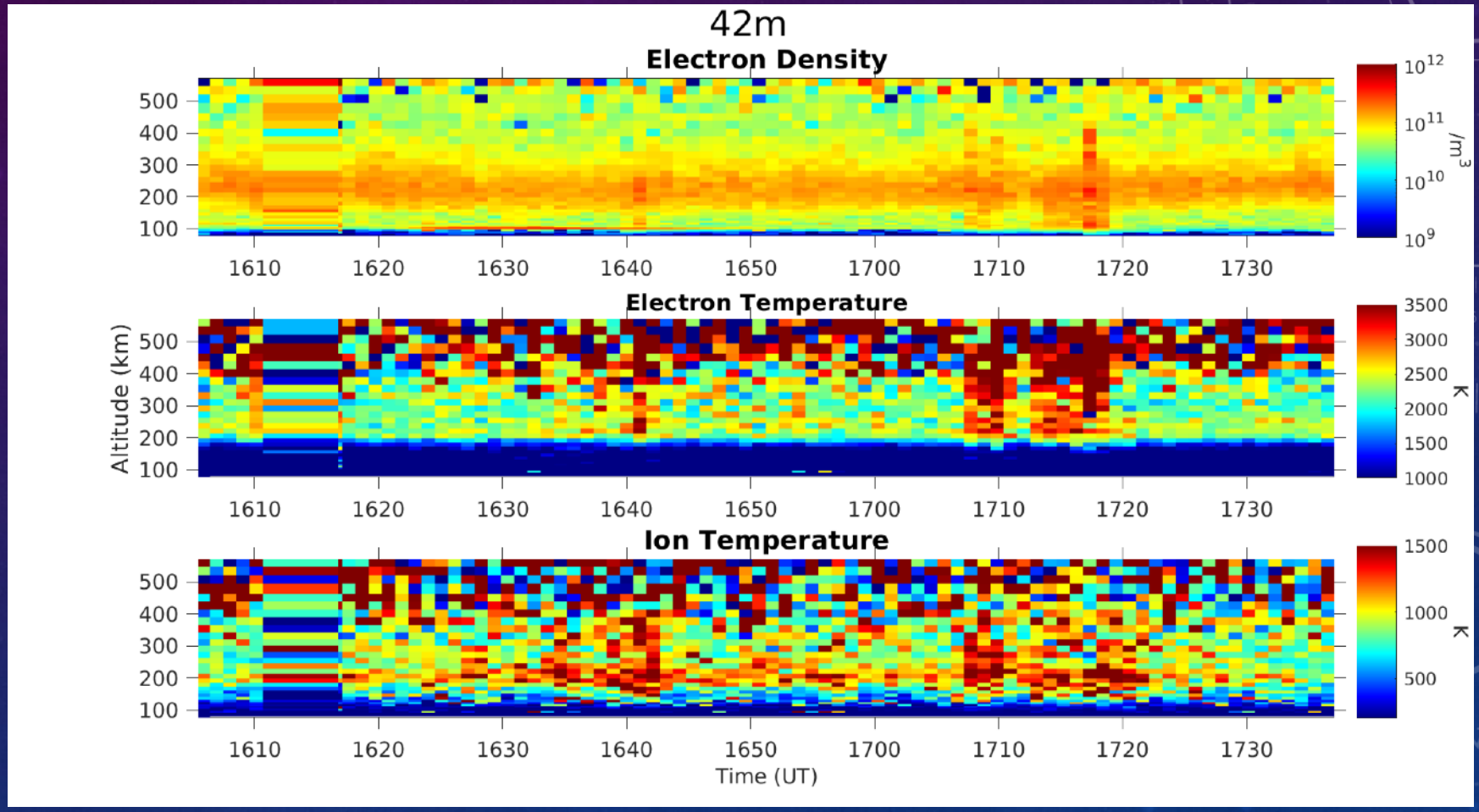
- See auroral oval when pointing southward, possible precipitation





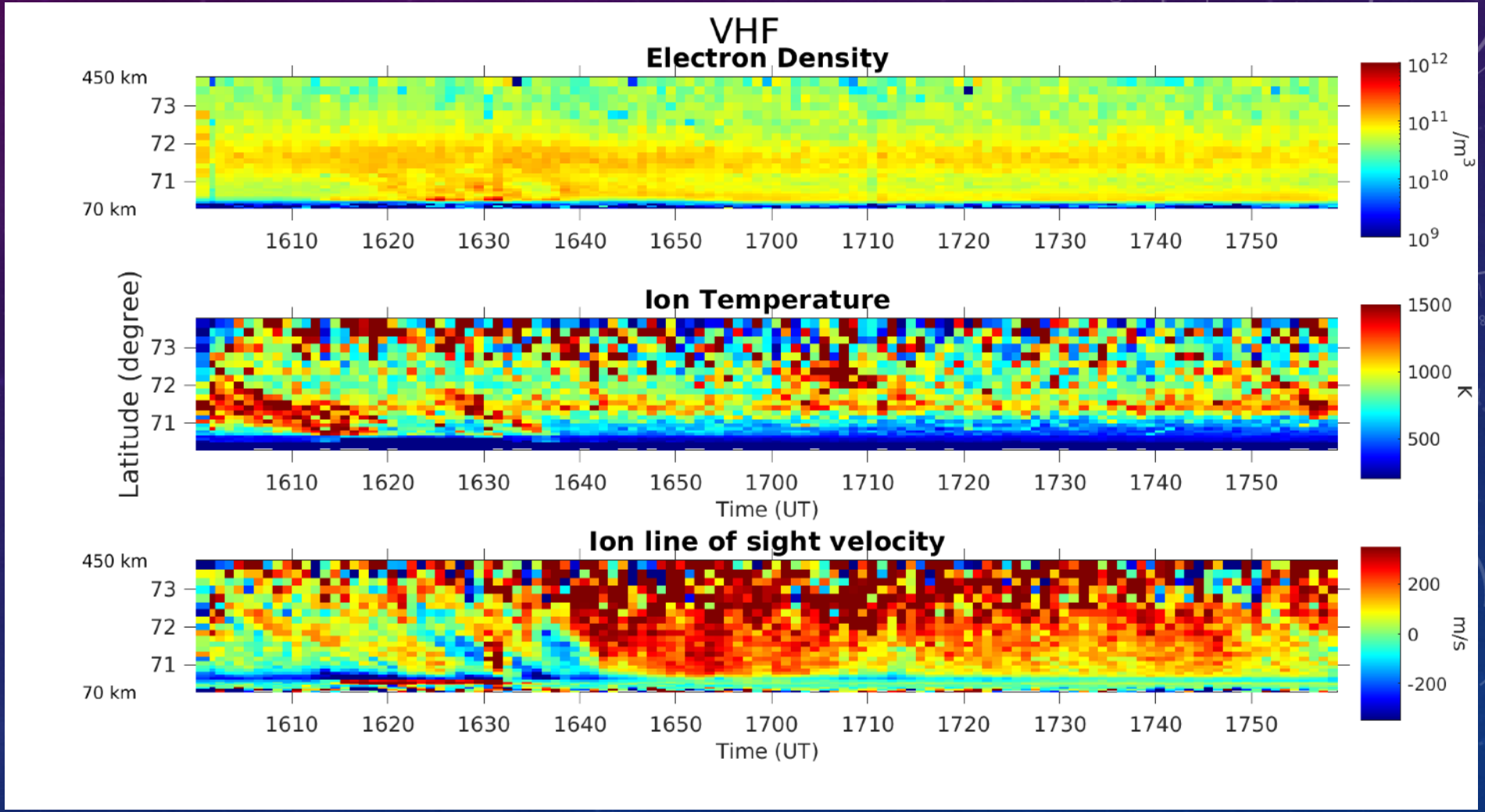
ELECTRON PRECIPITATION FROM ESR 42 M

- Field aligned measurements
- Precipitation consistent with magnetic signatures



STRUCTURES FOUND IN TROMSØ VHF

- Southward moving precipitating electrons
- Increase in Ne corresponding to increased Ti



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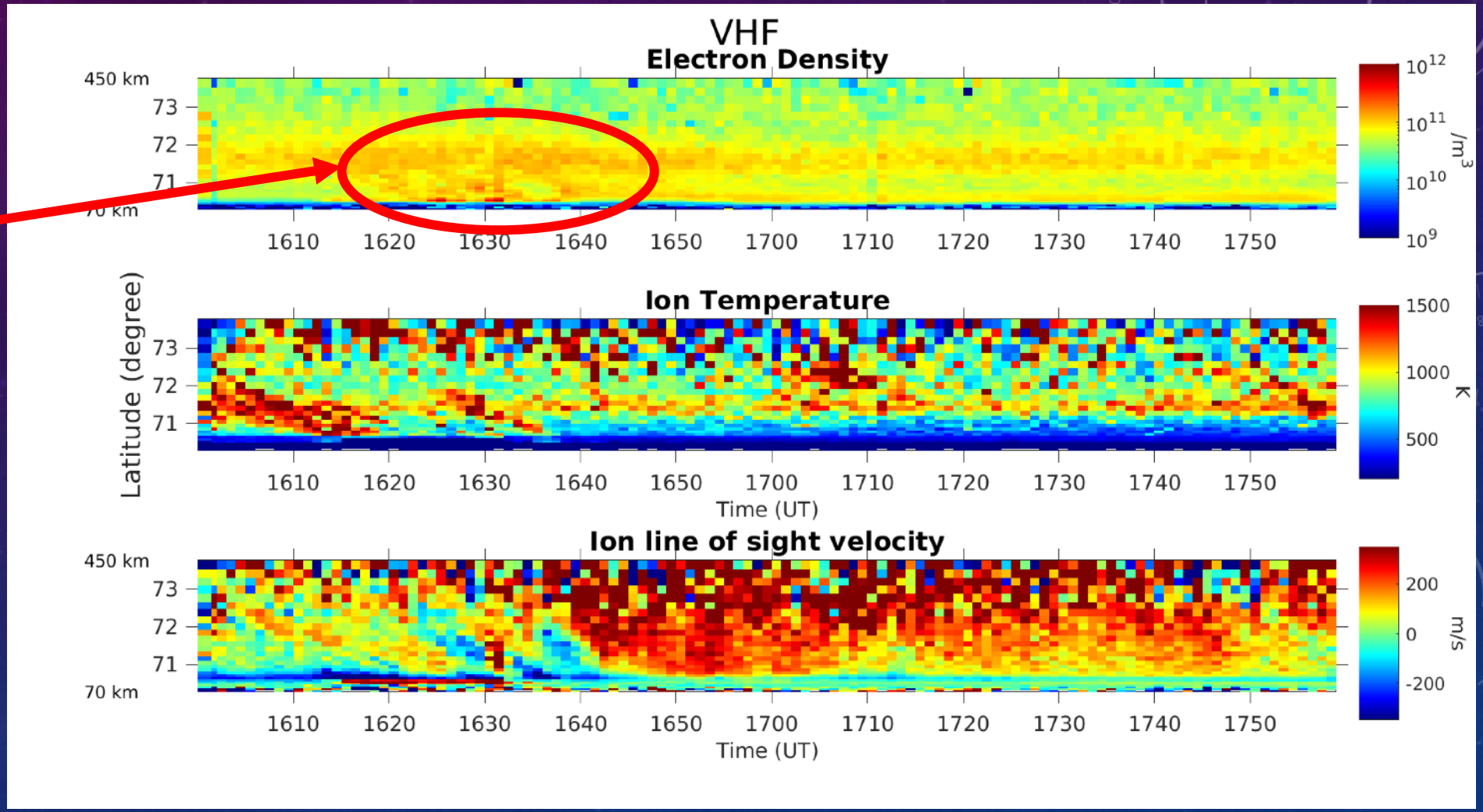
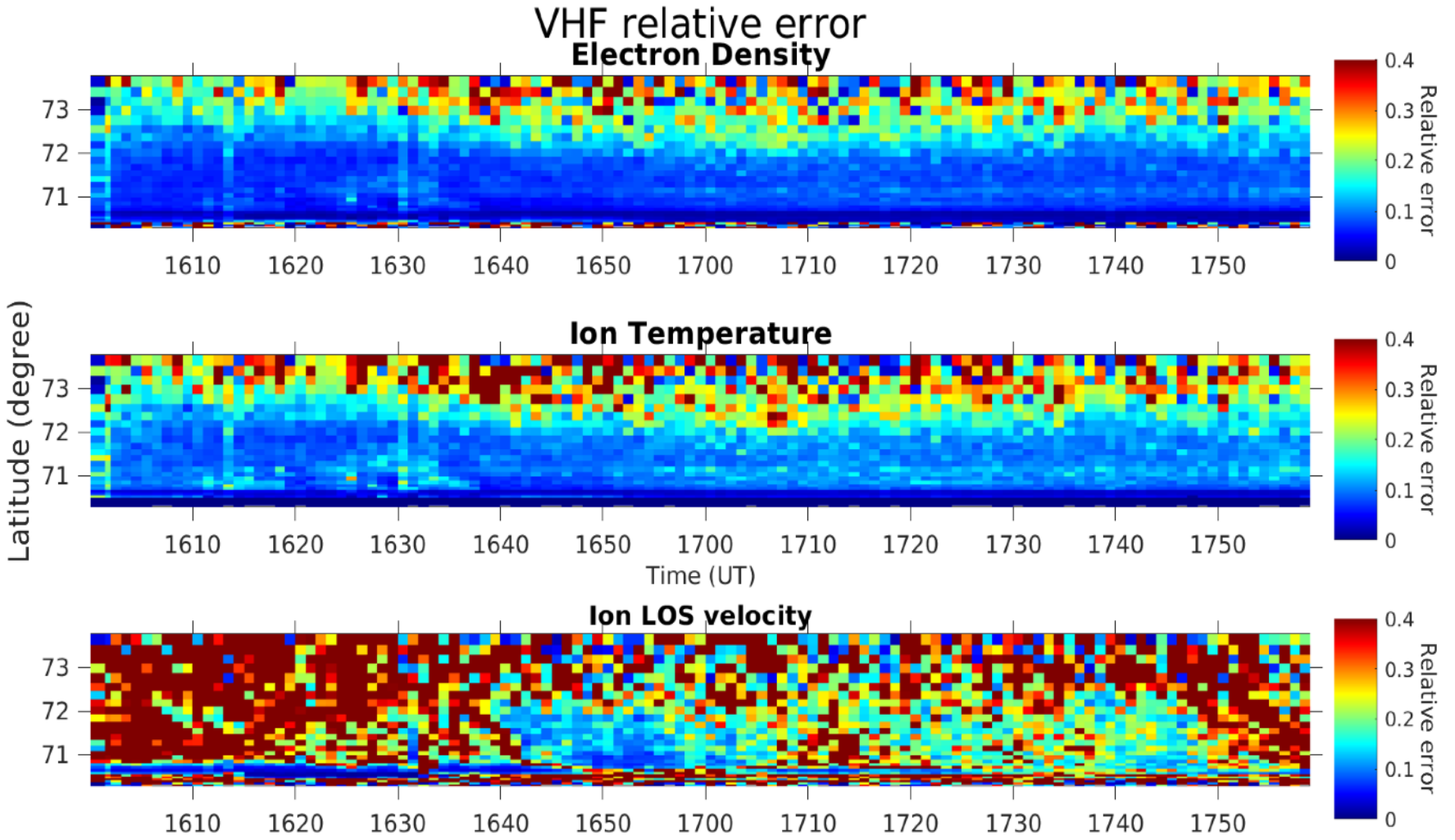
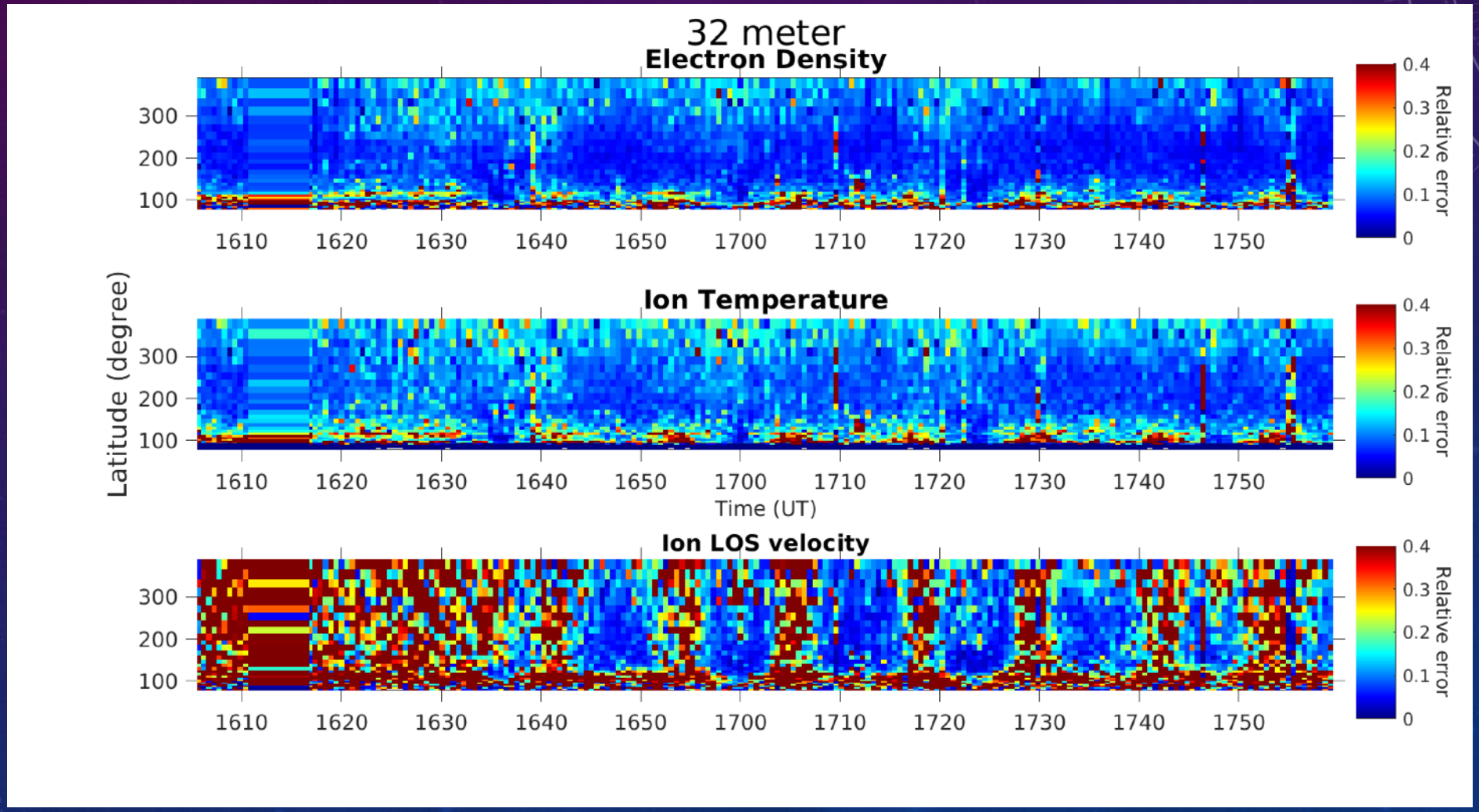


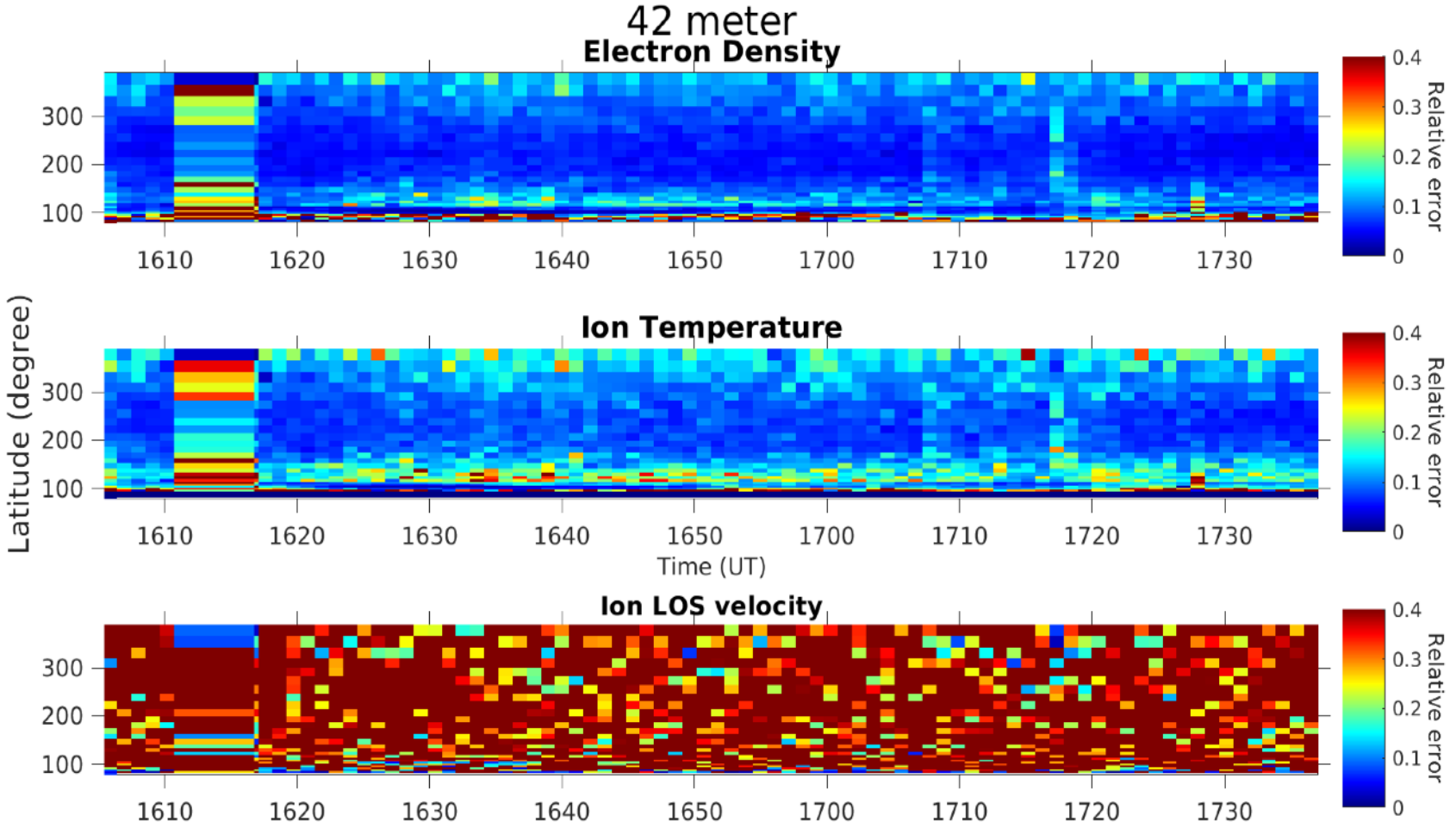
TROMSØ VHF RELATIVE ERROR



32 METER ESR RELATIVE ERROR



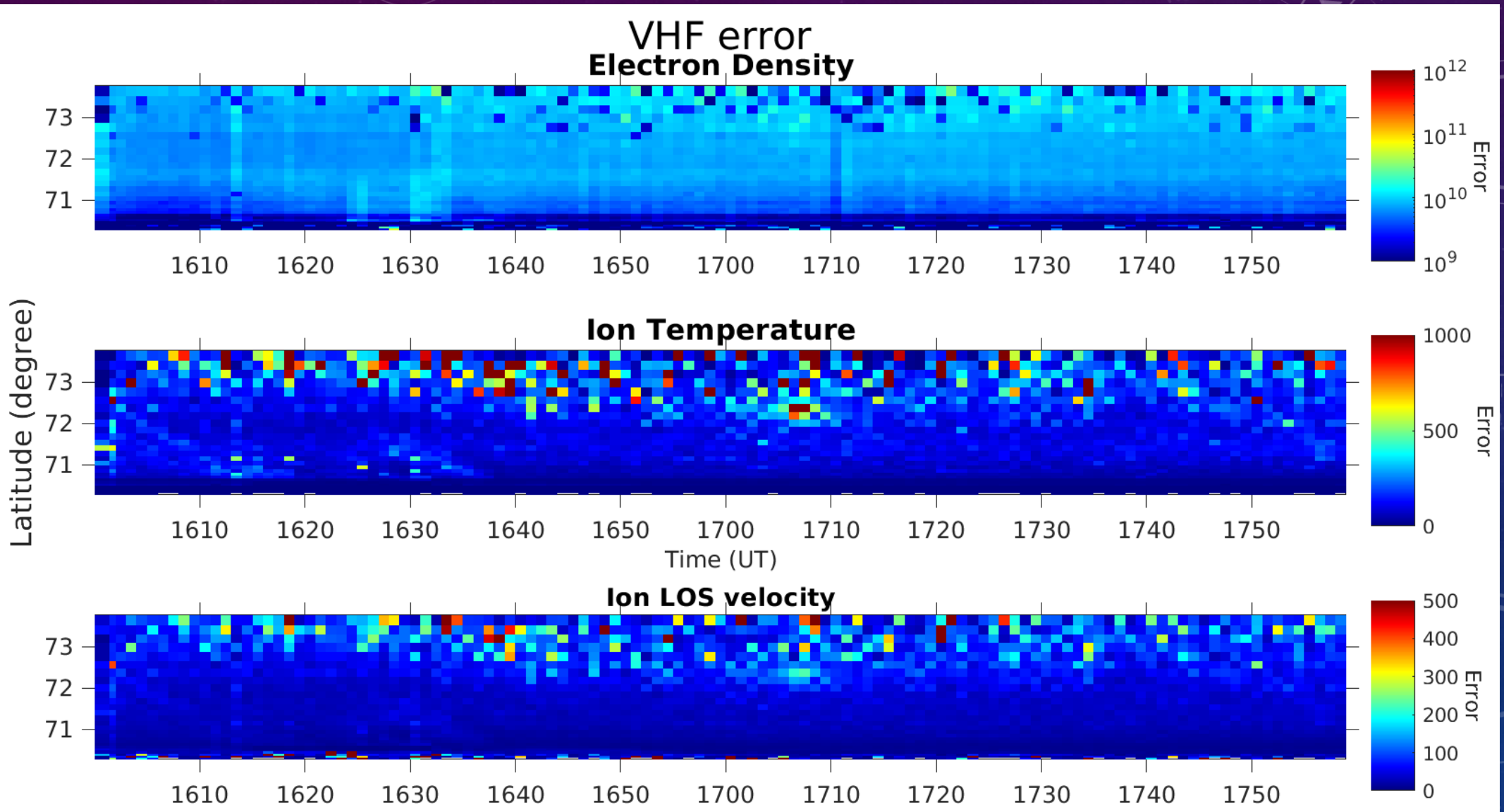
42 METER ESR RELATIVE ERROR

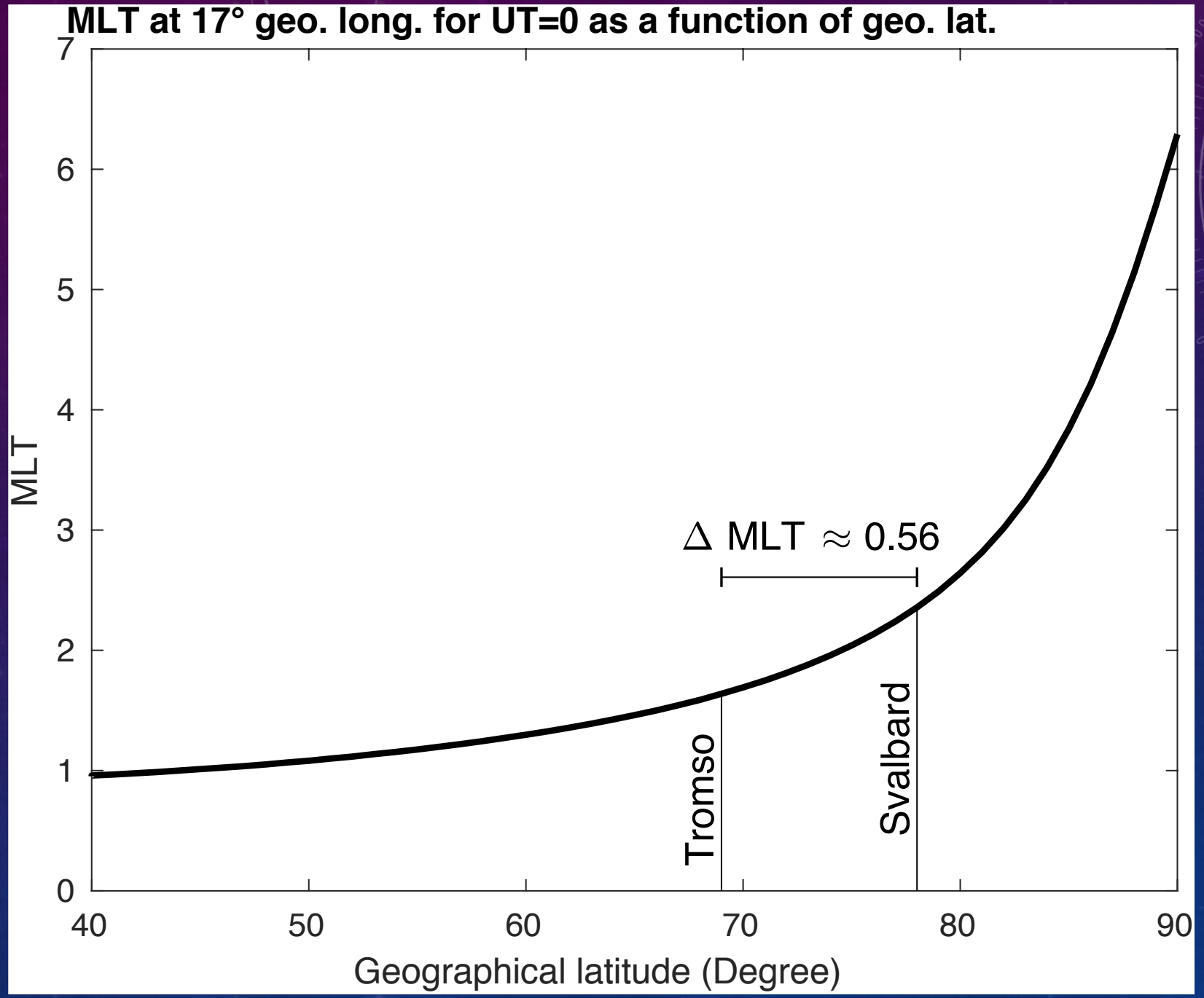


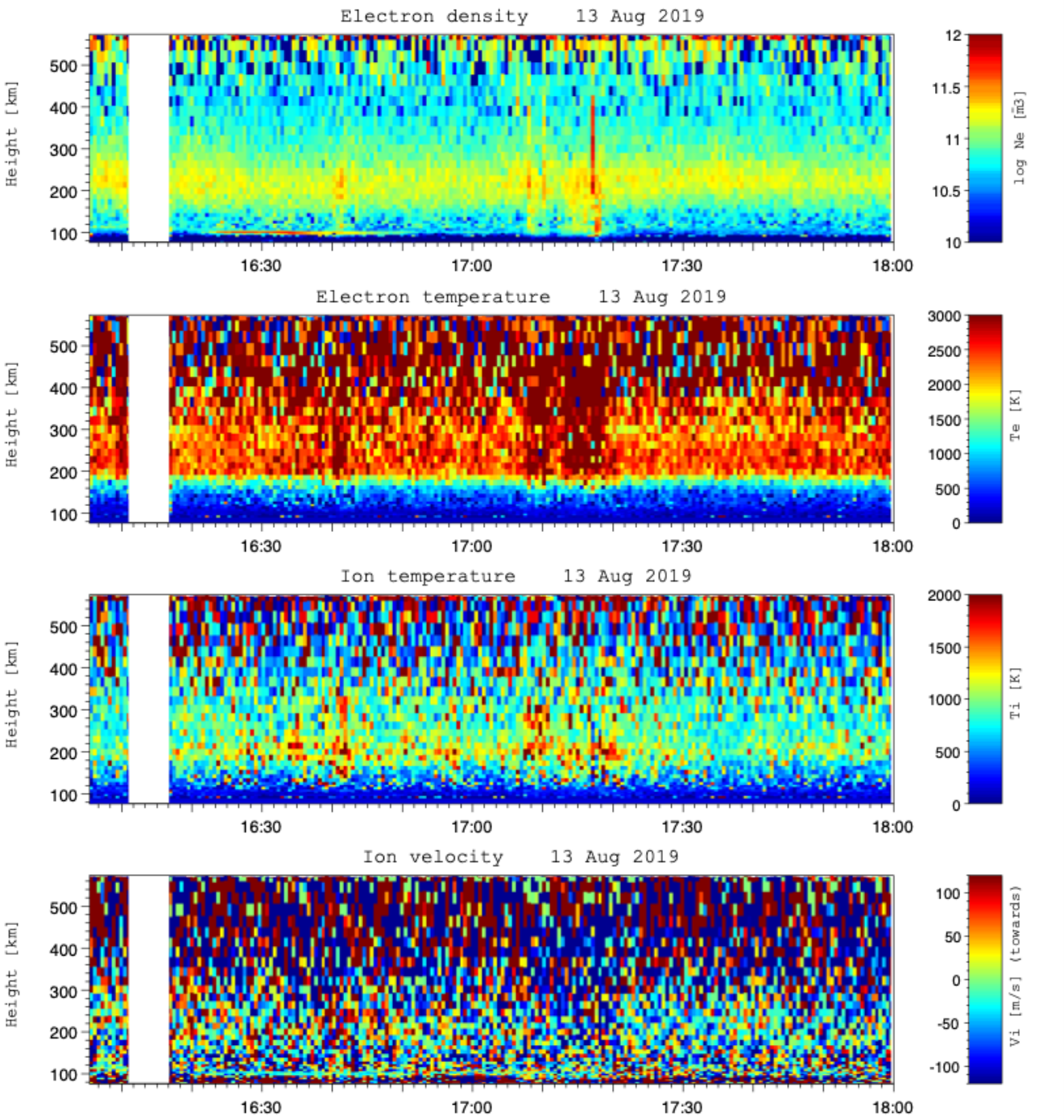
CONCLUSIONS

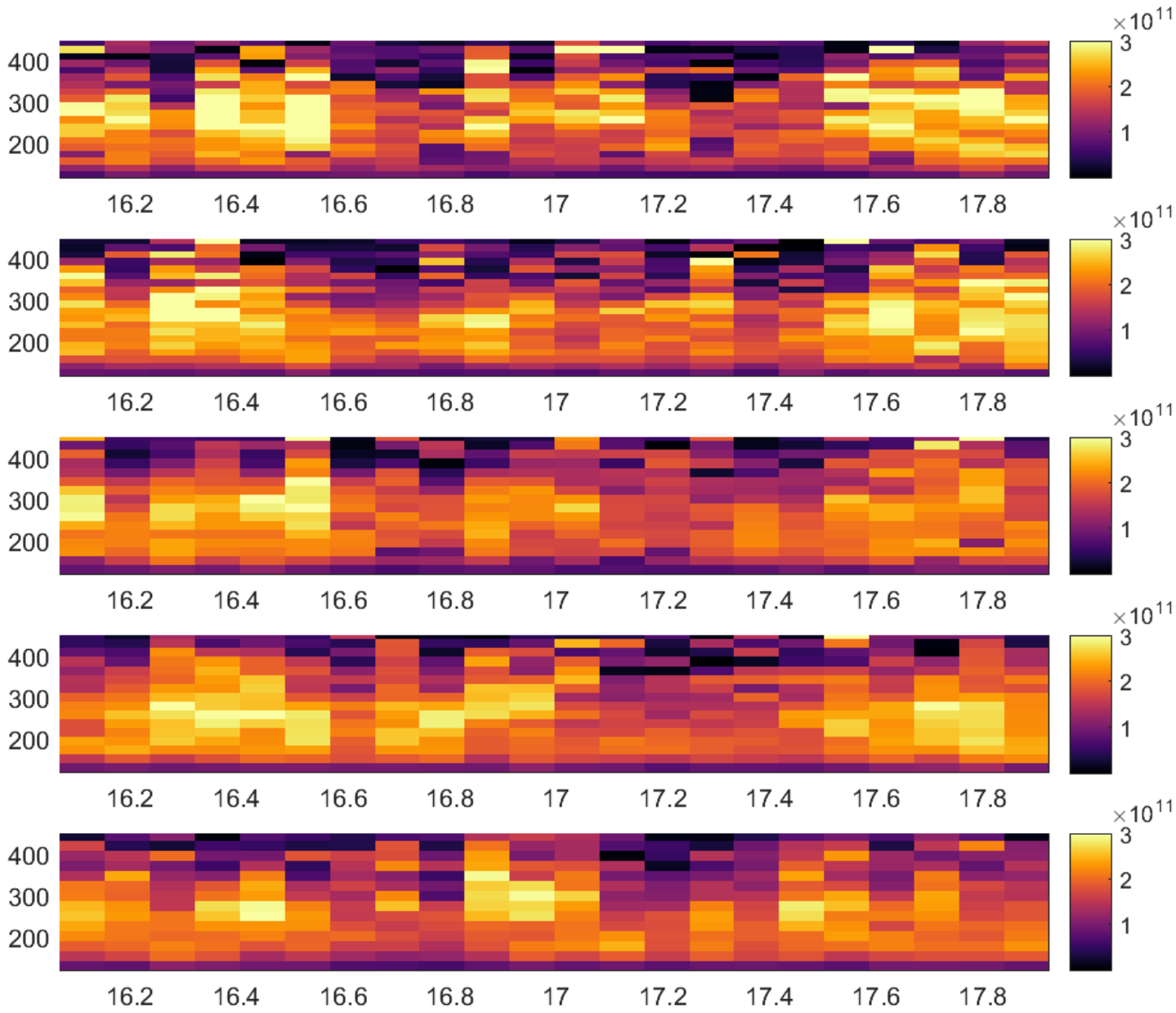
- Likely no polar cap patches detected (previous studies showed that the patches are most often observed during winter, because of the easier detection due to better ionospheric background conditions)
- Short duration electron precipitation (substorm)
- Drift of plasma in southward direction (possibly auroral streamers, need optical data to confirm)

QUESTIONS?


VHF error
Electron Density
Ion Temperature
Ion LOS velocity
Latitude (degree)
Time (UT)
Error
73
72
71
1610
1620
1630
1640
1650
1700
1710
1720
1730
1740
1750
10^{12}
10^{11}
10^{10}
10^{9}
1000
500
0
400
300
200
100


MLT at 17° geo. long. for UT=0 as a function of geo. lat.
MLT
Geographical latitude (Degree)
Δ MLT ≈ 0.56
Tromso
Svalbard
0
1
2
3
4
5
6
7
40
50
60
70
80
90


Electron density 13 Aug 2019
Height [km]
500
400
300
200
100
16:30
17:00
17:30
18:00
12
11.5
11
10.5
10
log Ne [m3]
Electron temperature 13 Aug 2019
Height [km]
500
400
300
200
100
16:30
17:00
17:30
18:00
3000
2500
2000
1500
1000
500
0
Te [K]
Ion temperature 13 Aug 2019
Height [km]
500
400
300
200
100
16:30
17:00
17:30
18:00
2000
1500
1000
500
0
Ti [K]
Ion velocity 13 Aug 2019
Height [km]
500
400
300
200
100
16:30
17:00
17:30
18:00
100
50
0
-50
-100
Vi [m/s] (towards)


400
300
200
16.2
16.4
16.6
16.8
17
17.2
17.4
17.6
17.8
×10^11
3
2
1