Group 4
2012 ISR Summer School

Arpita Barua[1], Siddhartha Choudhury[1]
Nathaniel A. Frissell[2], Vaibhav Kumar[3],
Mandana Sobhanzadeh[4]

[1]University of Saskatchewan
[2]Virginia Tech
[3]Stanford University
[4]University of Calgary

Mandatory Canadian Content

Outline

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I. Introduction
II. Case Study: 1 August 2012 0000 – 1100 UT
    I. Geospace and Geomagnetic Conditions
    II. Poker Flat ISR (PFISR) Observations
    III. Sondrestrøm ISR Observations
III. Summary and Conclusions

Introduction

- The auroral oval is region of particle precipitation typically located between ~60 – 70˚ magnetic latitude.
- Auroral oval exists even during quiet times.
- Dramatic nightside auroral brightening and enhanced precipitation occurs during substorms [*Akasofu*, 1964].
- Auroral observation provides a method of sensing magnetospheric dynamics and its impacts on the Earth.

- **Objective:** Characterize auroral structure and processes using ground-based instrumentation.

ACE SW/IMF

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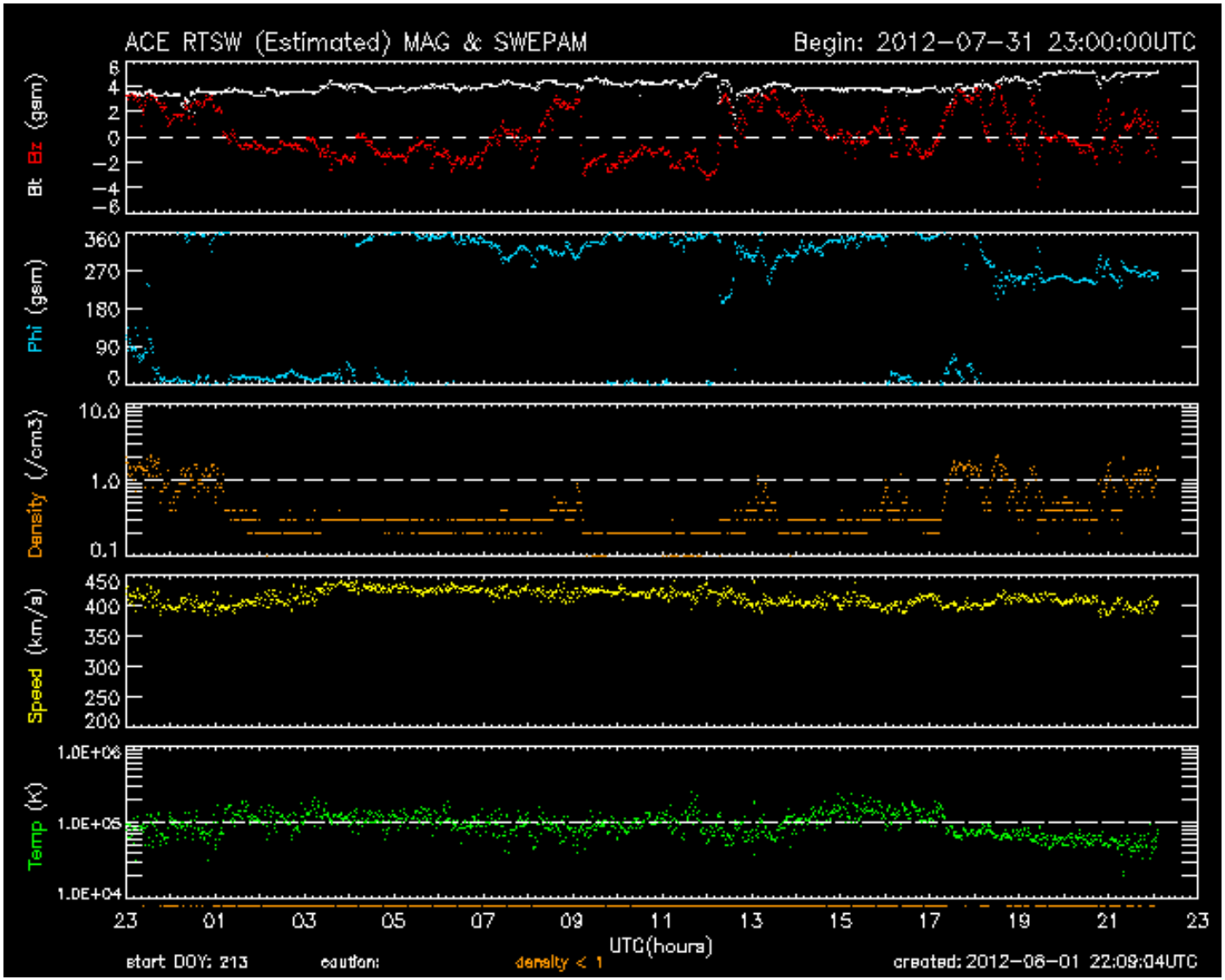

Bz

Phi

Density

Speed

Temp

Figure courtesy of E. Cousins (Group 3)

Geomagnetic Conditions

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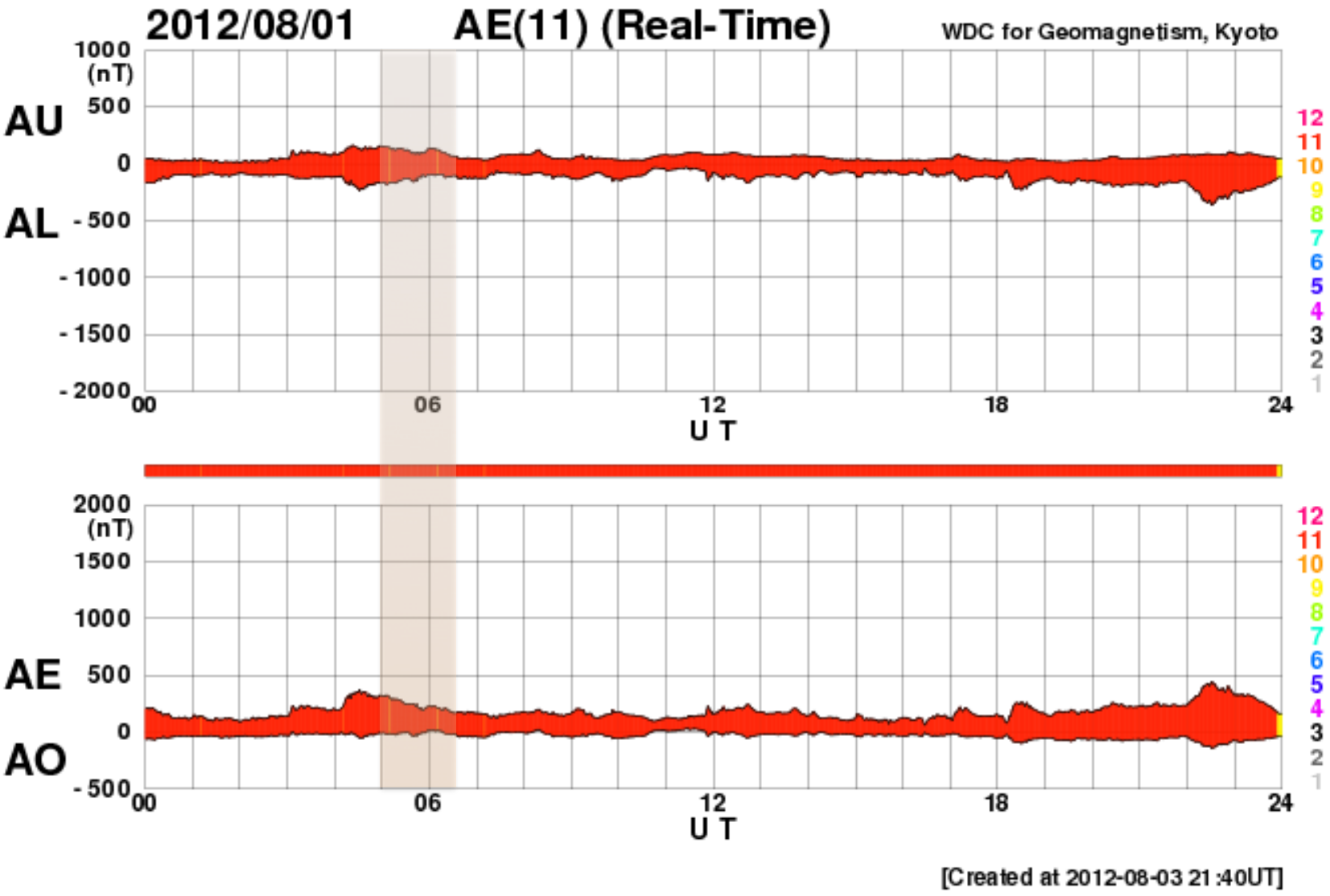
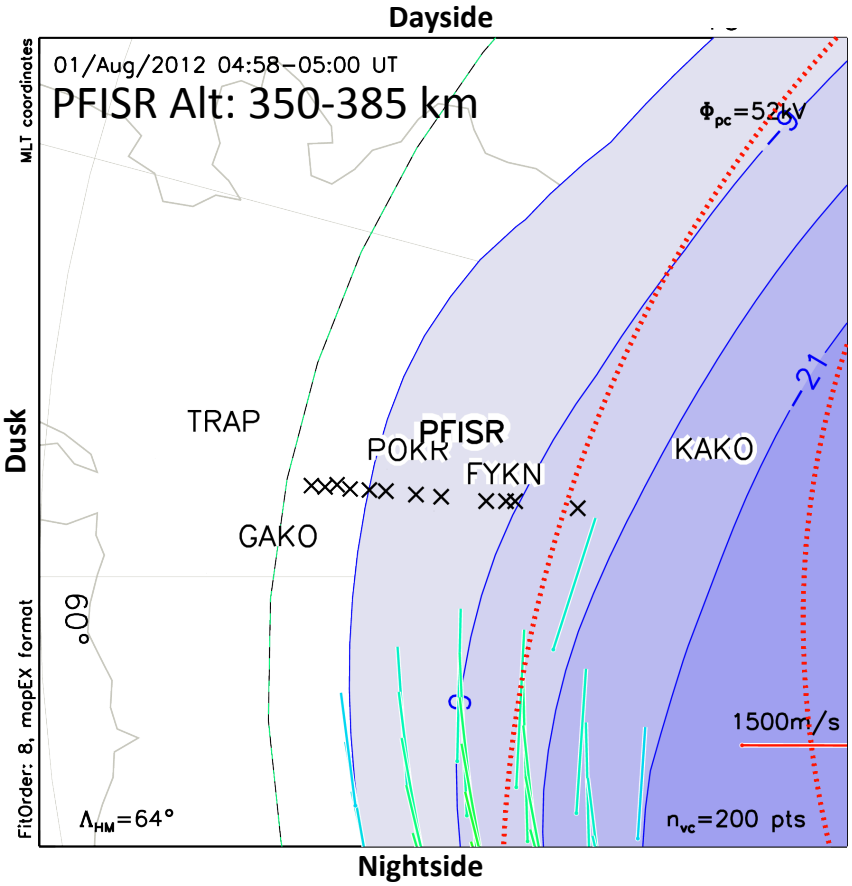
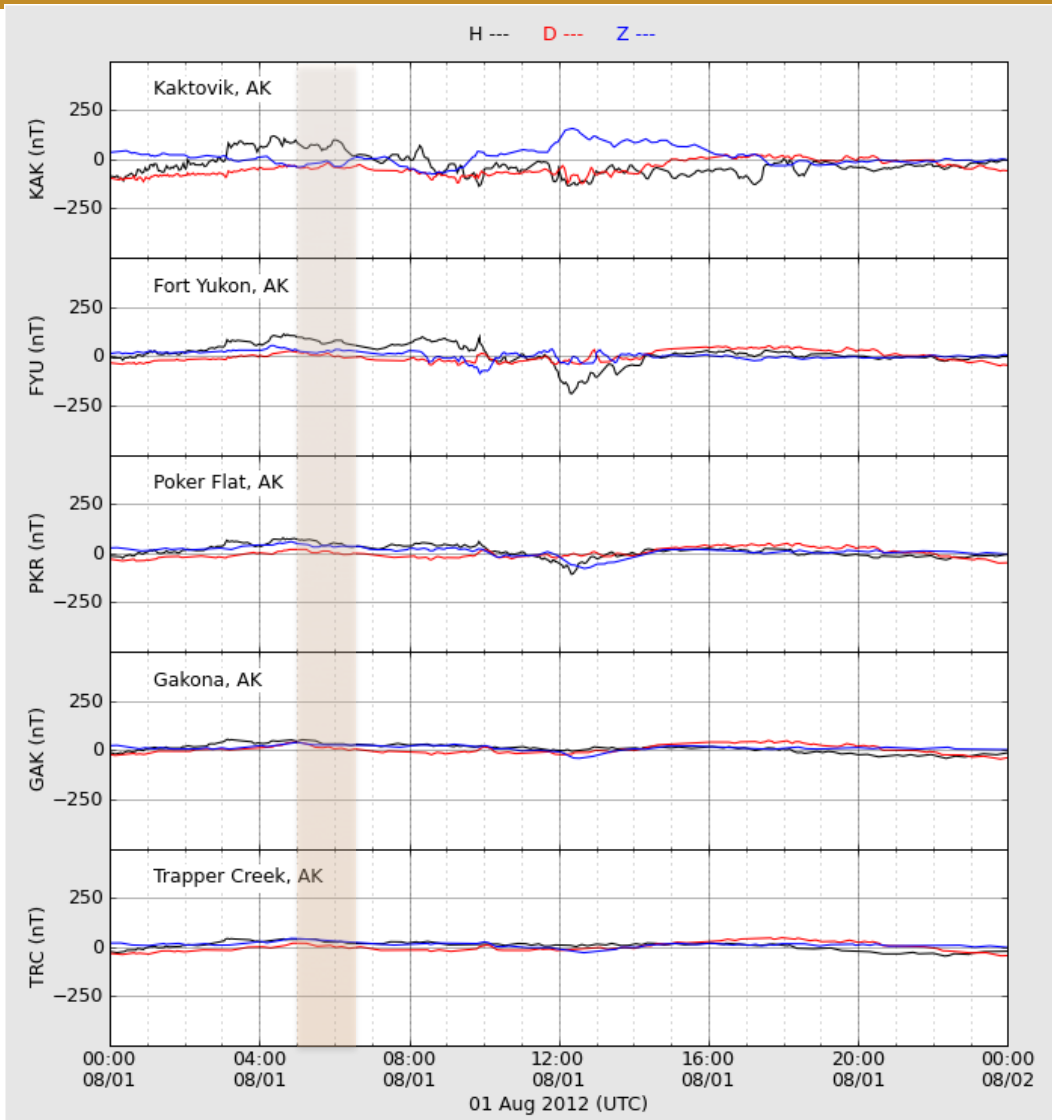


Ground Magnetometers





SuperDARN

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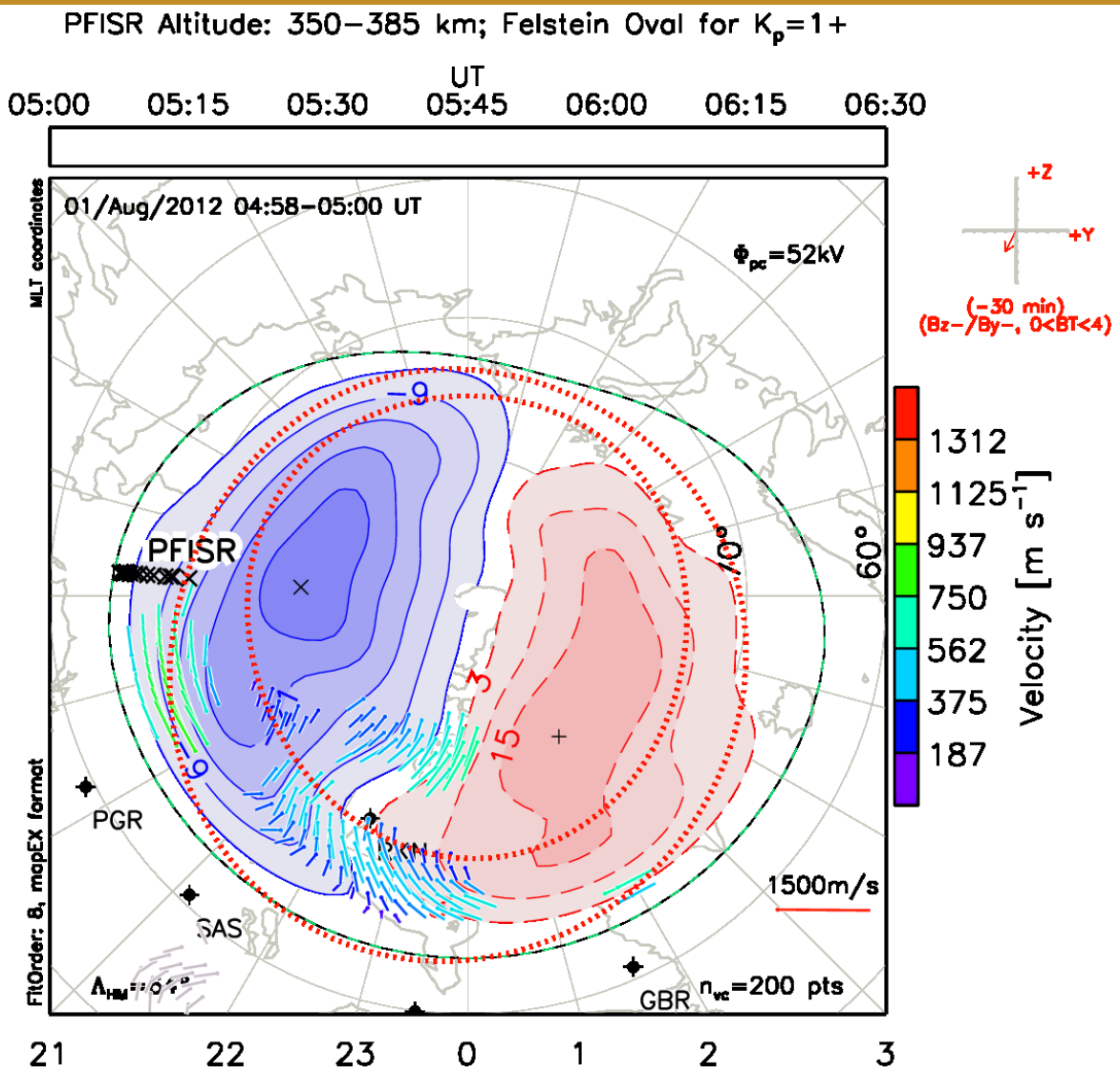

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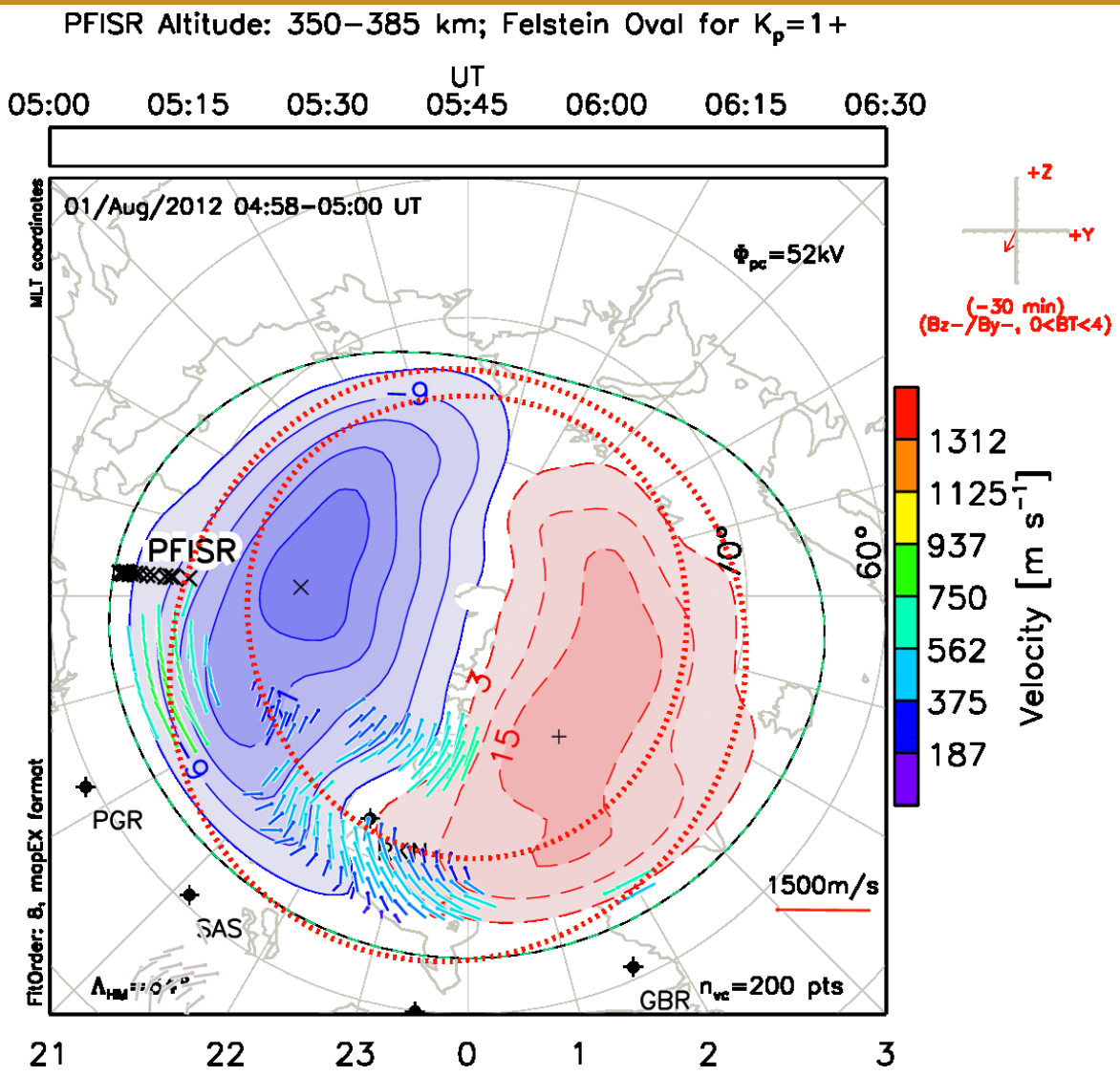

LP 1 min Ne

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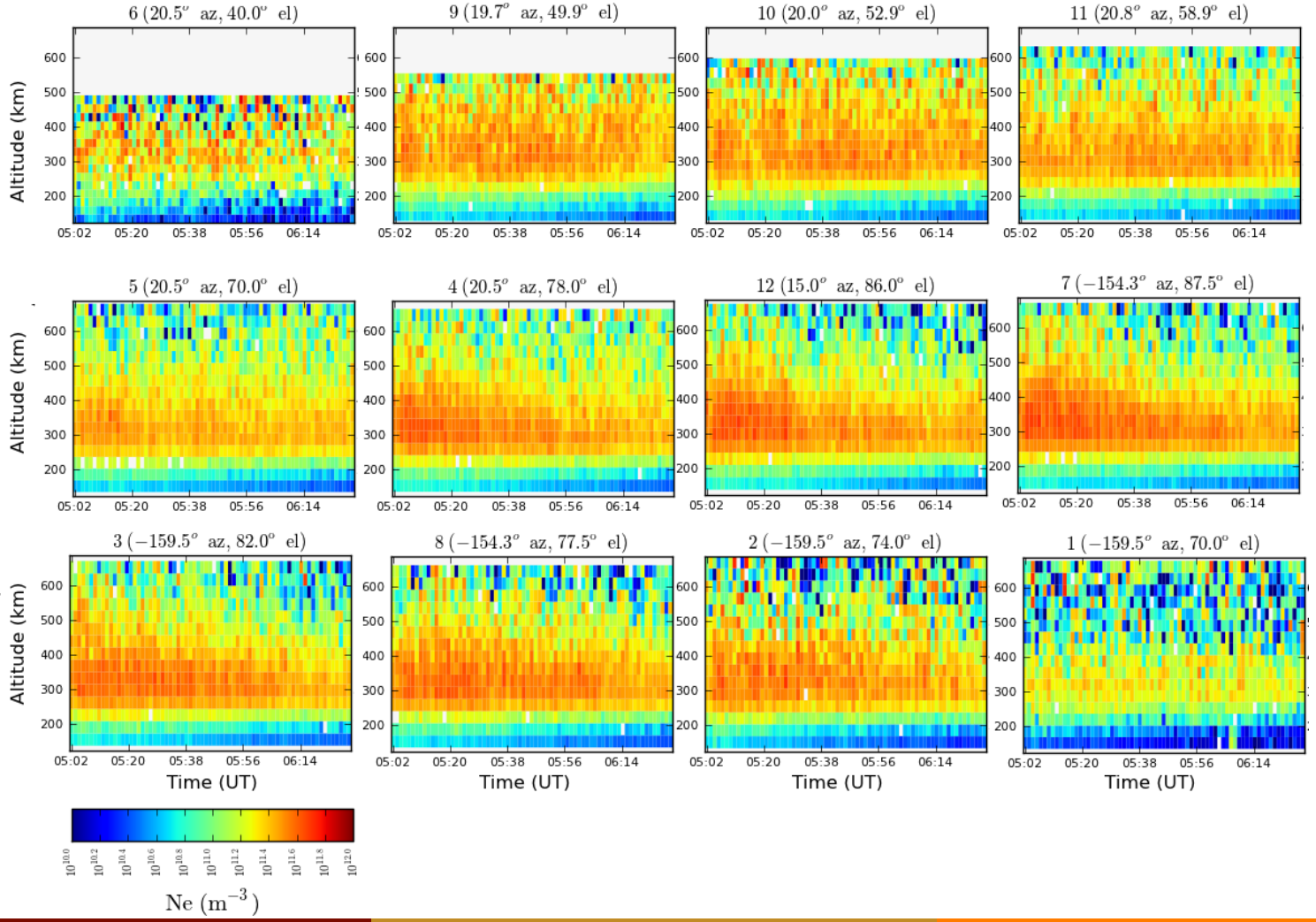
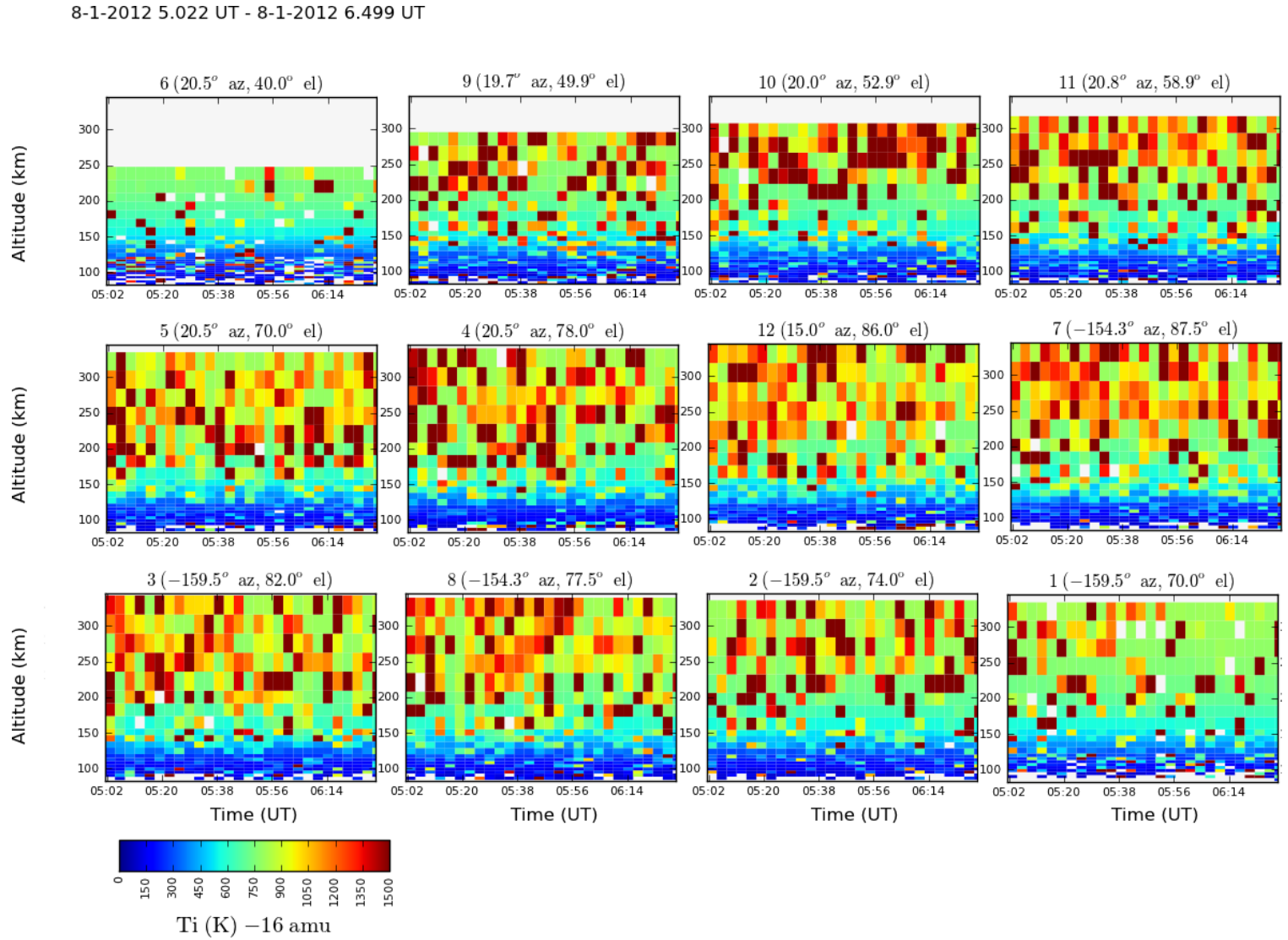
8-1-2012 5.022 UT - 8-1-2012 6.499 UT



AC 3 min Ti


8-1-2012 5.022 UT - 8-1-2012 6.499 UT
6 (20.5° az, 40.0° el)
9 (19.7° az, 49.9° el)
10 (20.0° az, 52.9° el)
11 (20.8° az, 58.9° el)
5 (20.5° az, 70.0° el)
4 (20.5° az, 78.0° el)
12 (15.0° az, 86.0° el)
7 (−154.3° az, 87.5° el)
3 (−159.5° az, 82.0° el)
8 (−154.3° az, 77.5° el)
2 (−159.5° az, 74.0° el)
1 (−159.5° az, 70.0° el)
Altitude (km)
Time (UT)
05:02
05:20
05:38
05:56
06:14
100
150
200
250
300
0
150
300
450
600
750
900
1050
1200
1350
1500
Ti (K) −16 amu

AC 3 min Ti

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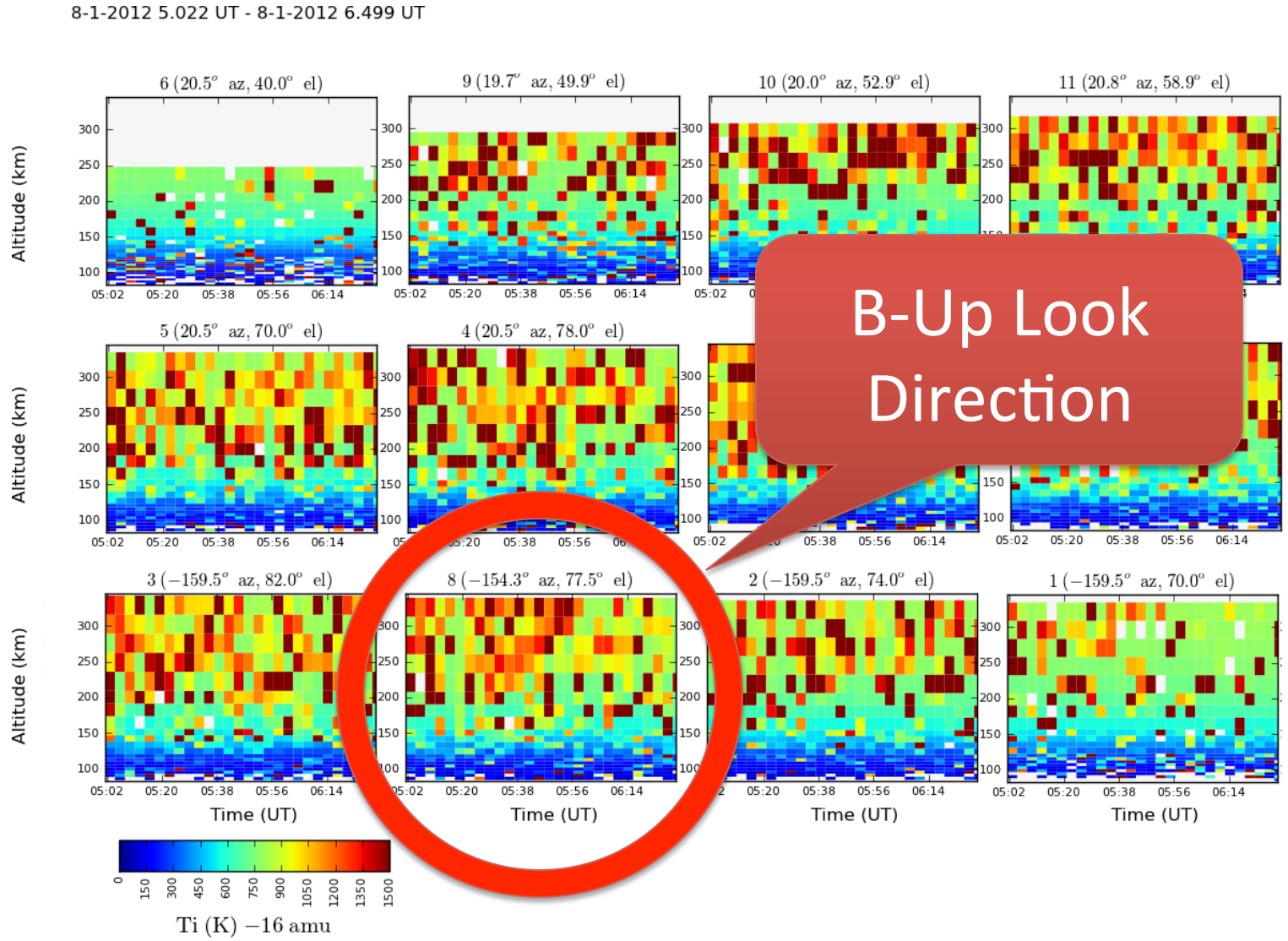

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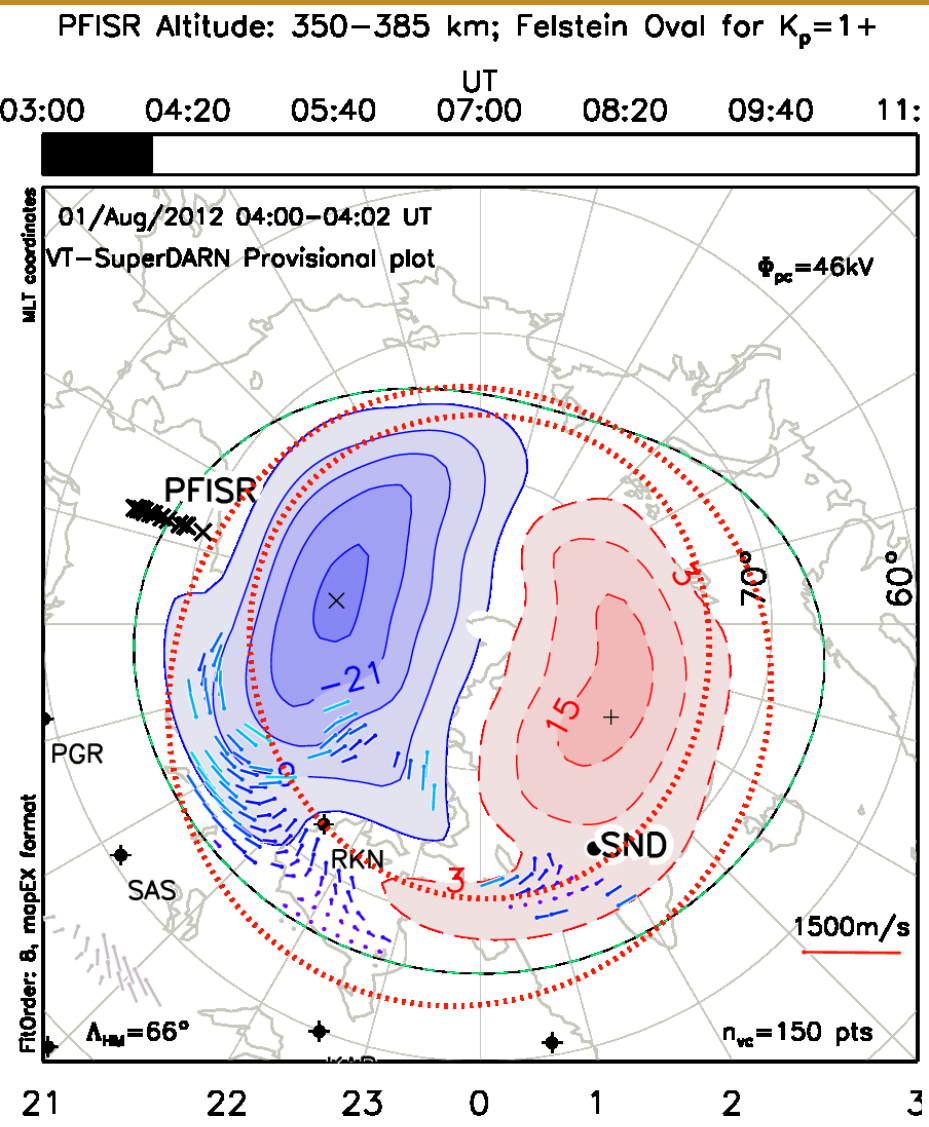
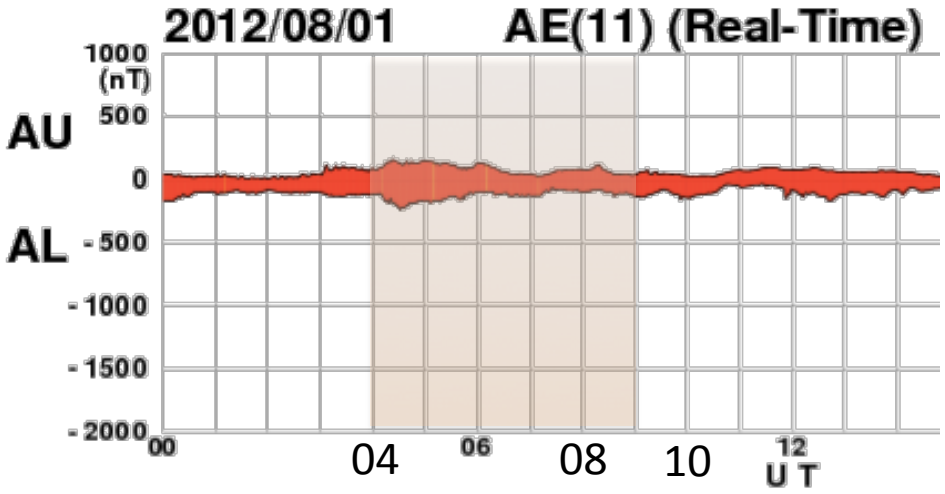

PFISR Altitude: 350–385 km; Felstein Oval for K_p=1+
UT
03:00
04:20
05:40
07:00
08:20
09:40
11:
01/Aug/2012 04:00–04:02 UT
VT–SuperDARN Provisional plot
Φ_{pc}=46kV
MLT coordinates
FitOrder: 8, mapEX format
PFISR
PGR
SAS
RKN
SND
-21
15
3
3
70°
60°
1500m/s
Λ_{HM}=66°
n_{vc}=150 pts
21
22
23
0
1
2
3


2012/08/01
AE(11) (Real-Time)
AU
AL
1000
(nT)
500
0
-500
-1000
-1500
-2000
00
04
06
08
10
12
UT

SuperDARN

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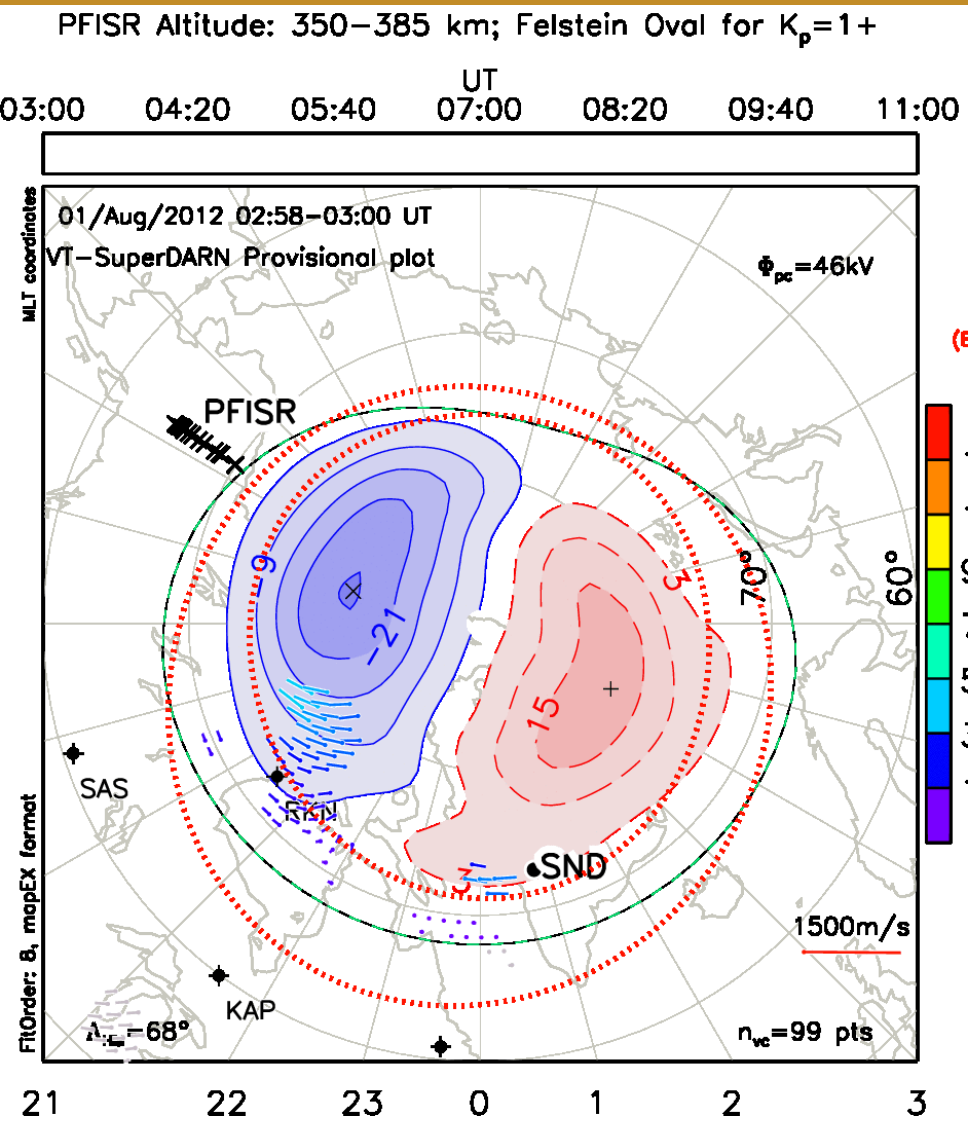
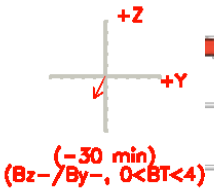
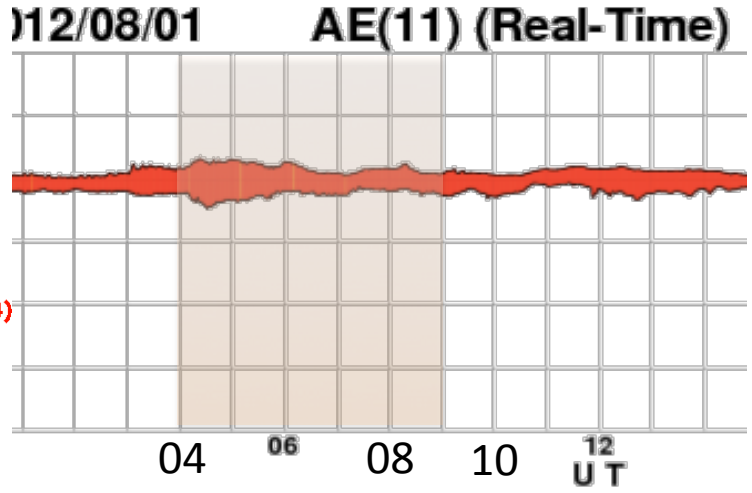
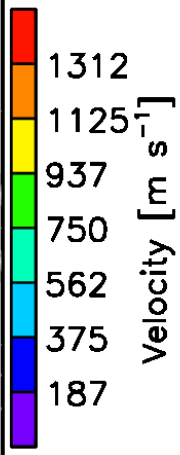
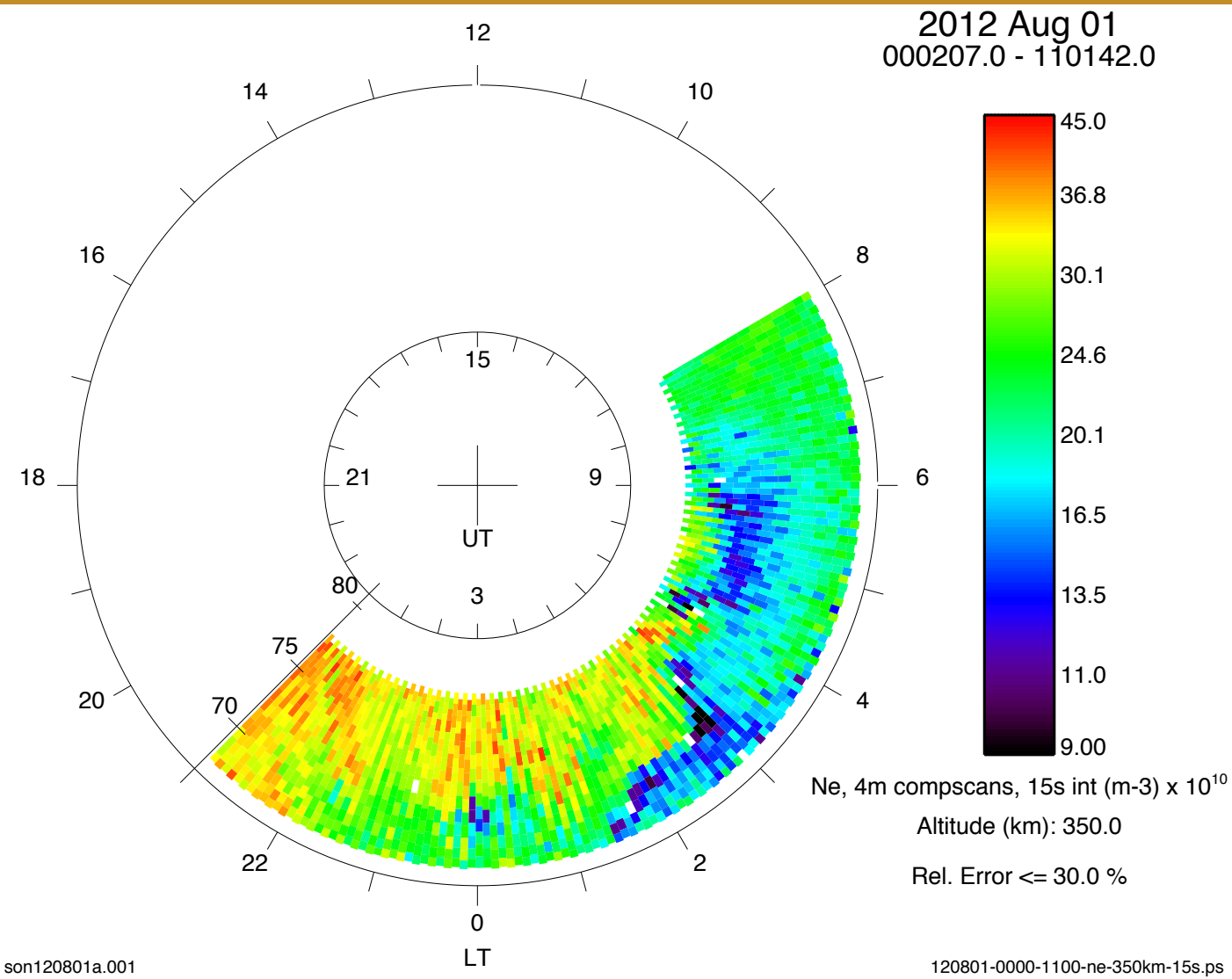




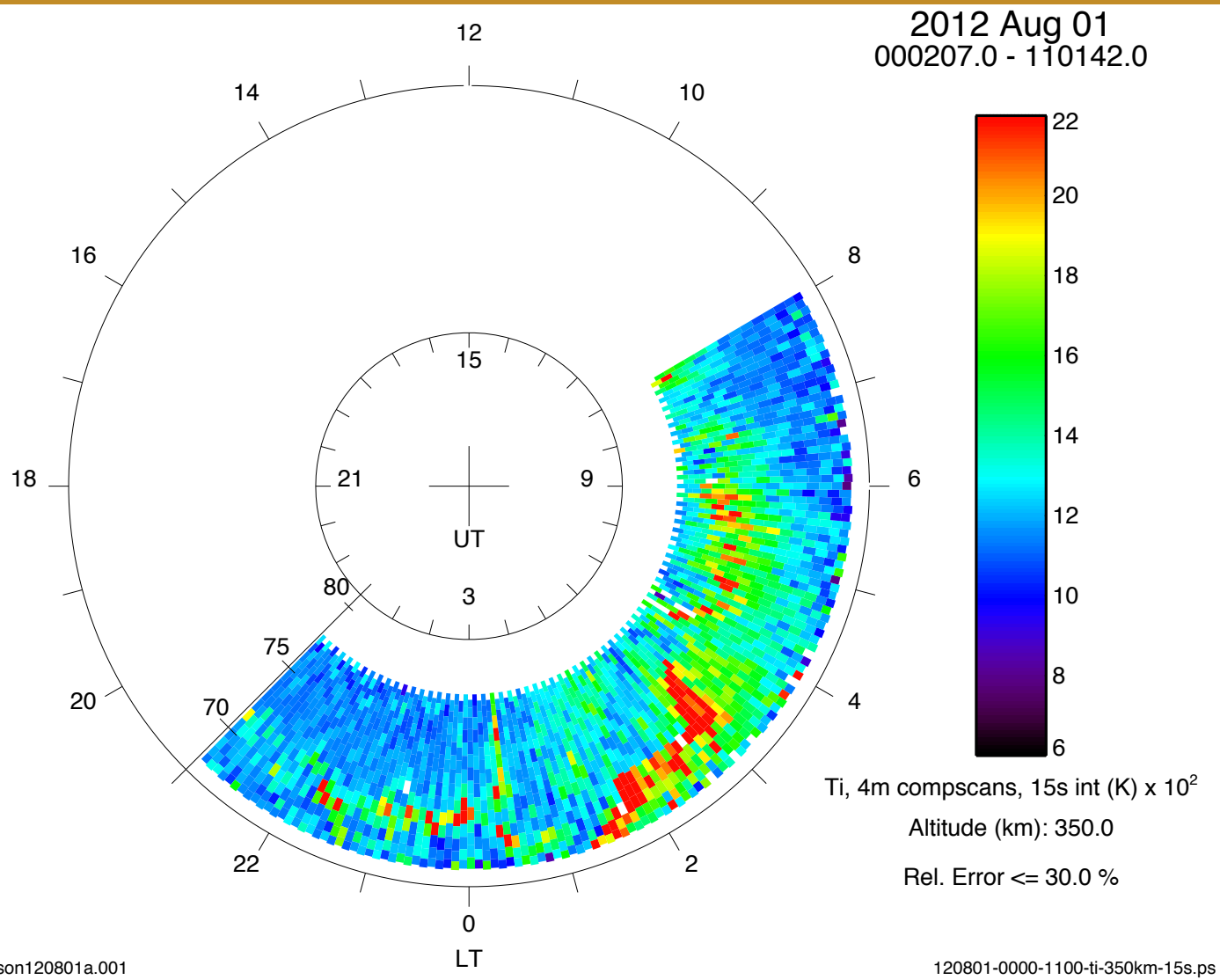




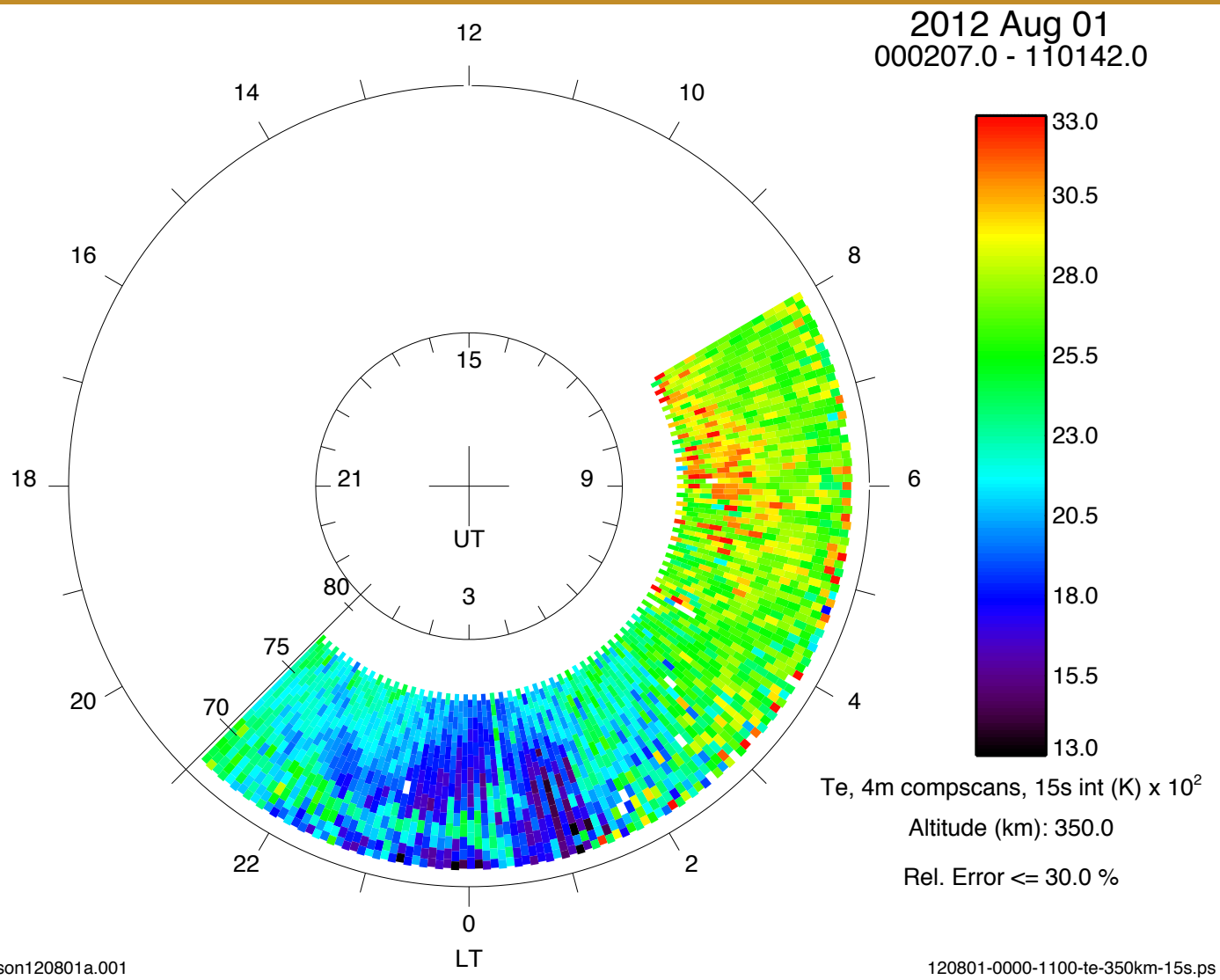
4m Compscans 15 s Ne



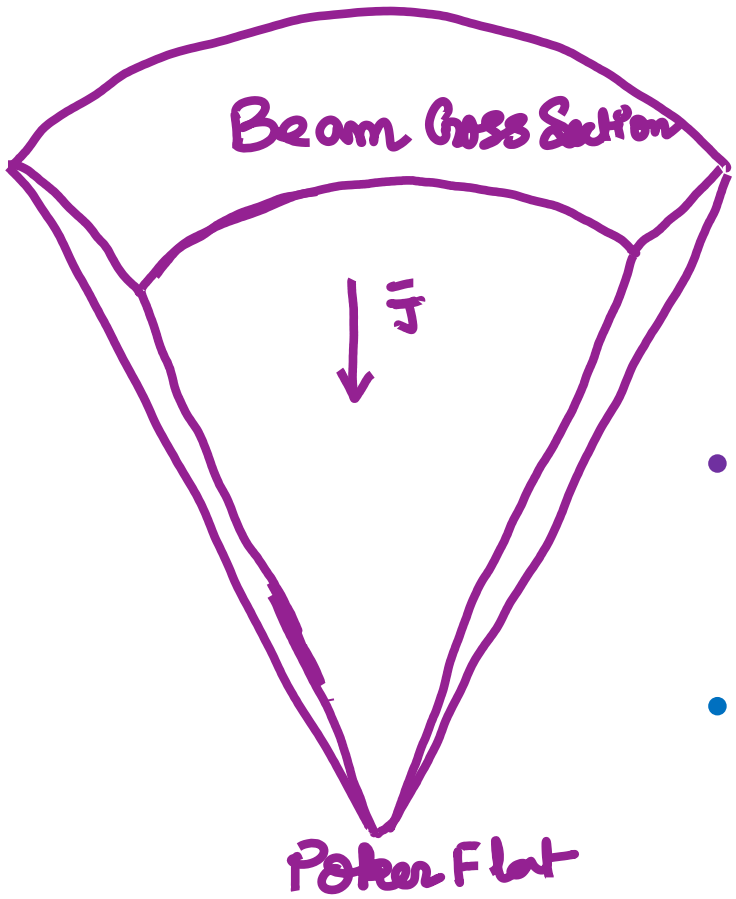
4m Compscans 15 s Ti



4m Compscans 15 s Te



ExB Velocities & Mag. Fields



$$ve = -\mathbf{E}/B\ \nu e/\Omega e + E\times\Omega e / B\,\Omega e$$

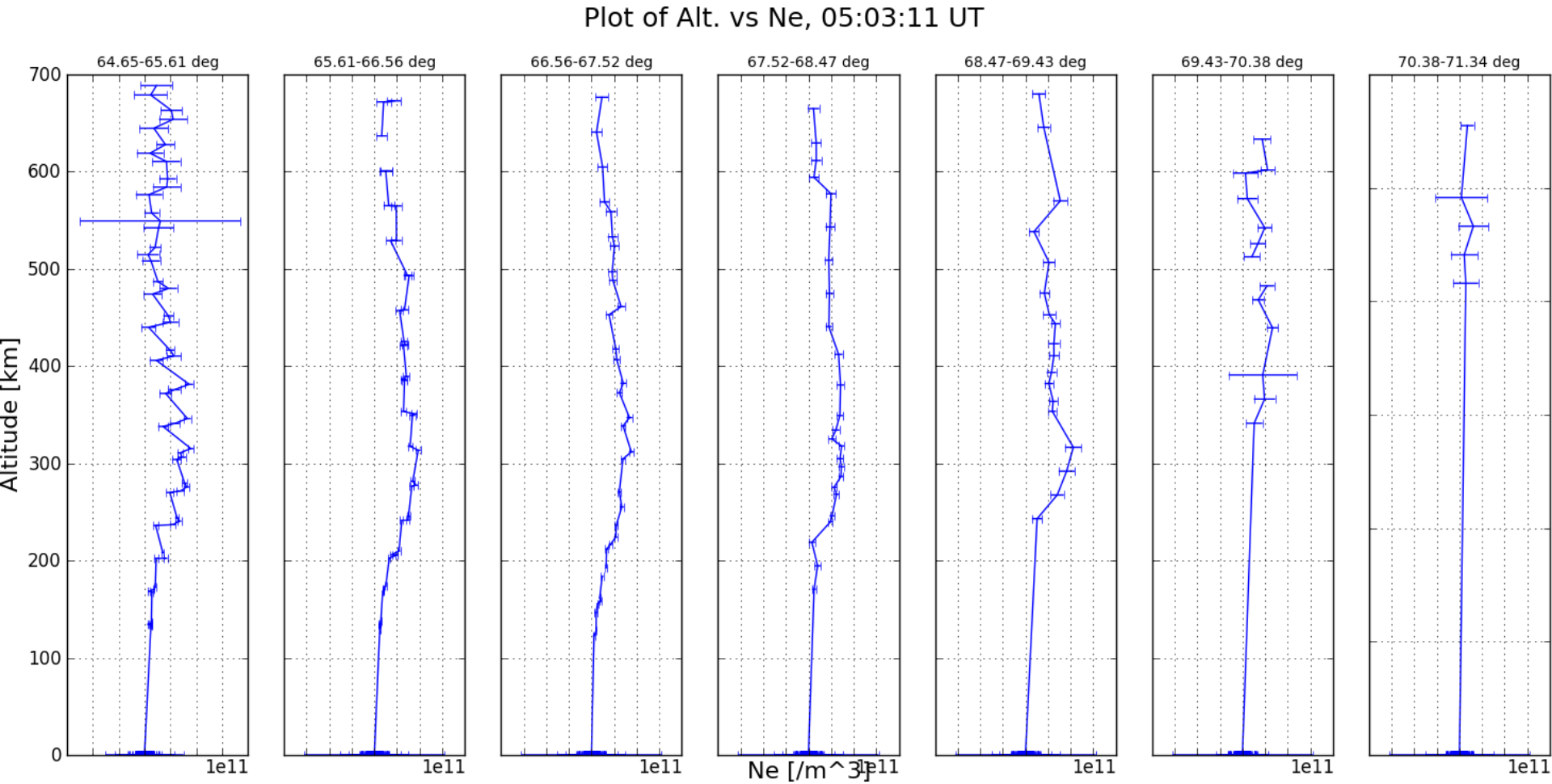
with $V_n=0$, $|\Omega_e|>0$

$$vi = -\mathbf{E}/B\ \nu i/\Omega i + E\times\Omega i / B\,\nu 2 i$$

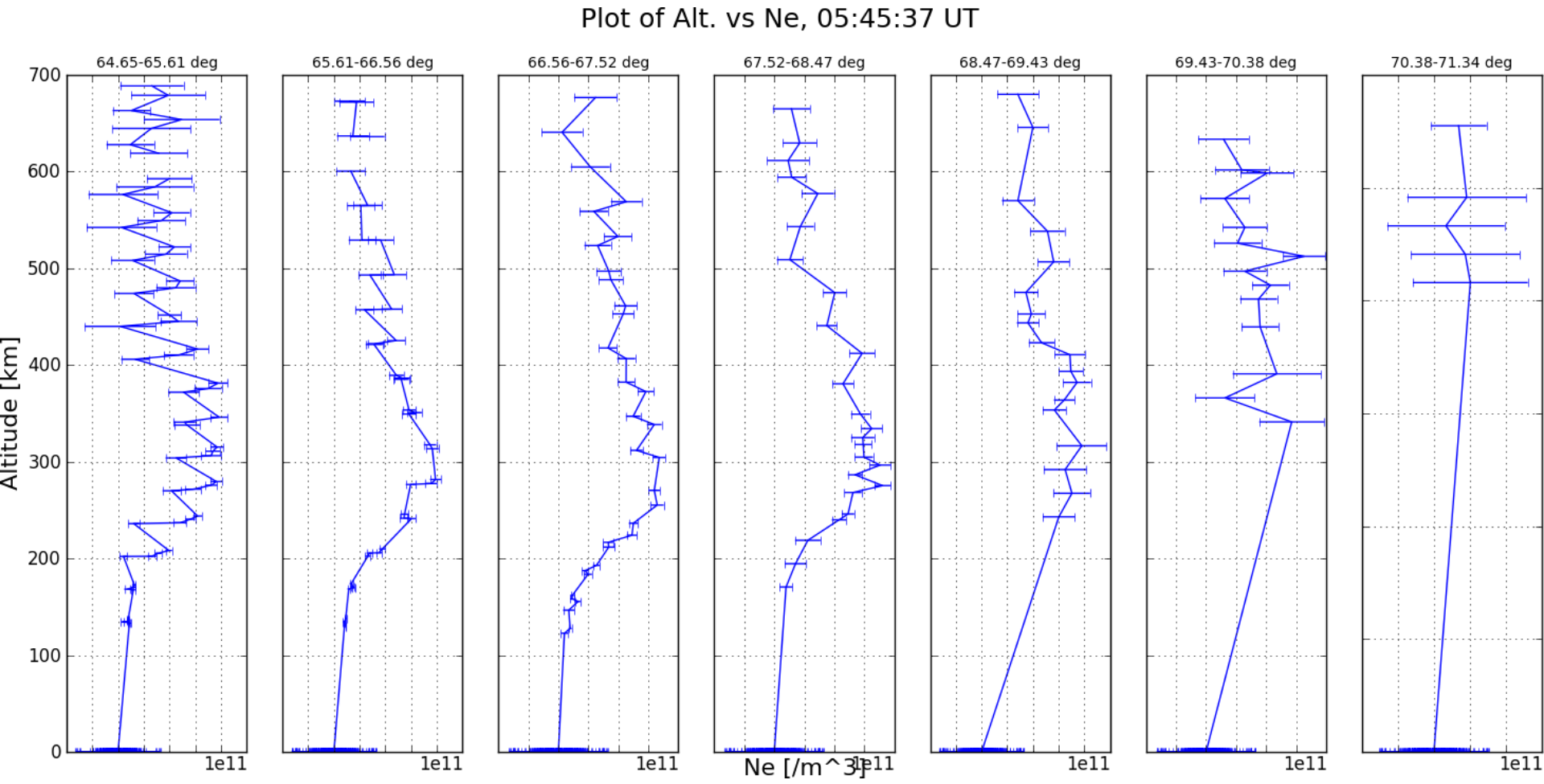
with $V_n=0$

- Rough estimate of velocity from SuperDARN 700m/s
- Magnetic Field Intensity values from various measurements

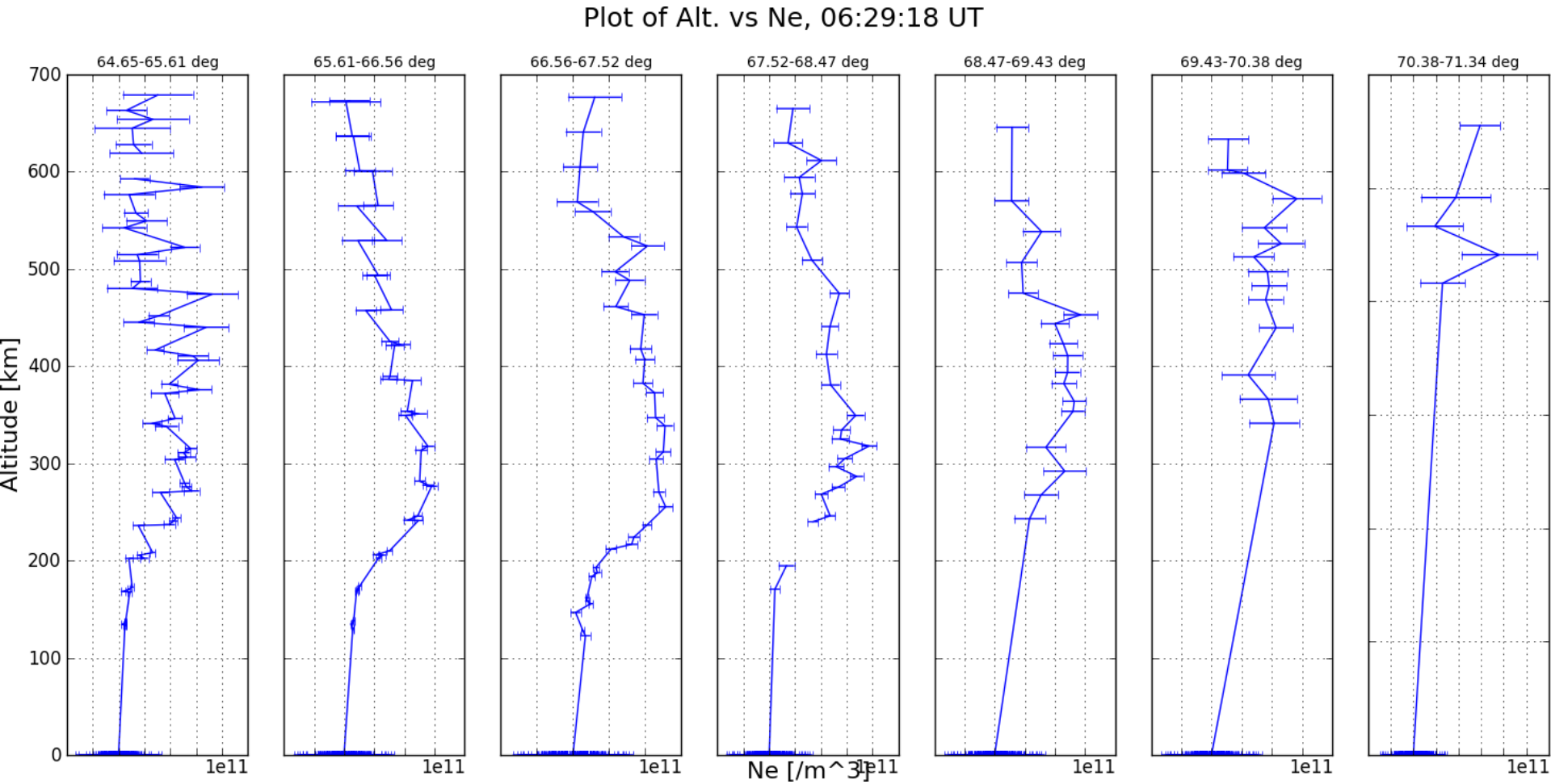
Latitudinal variation of Ne profiles



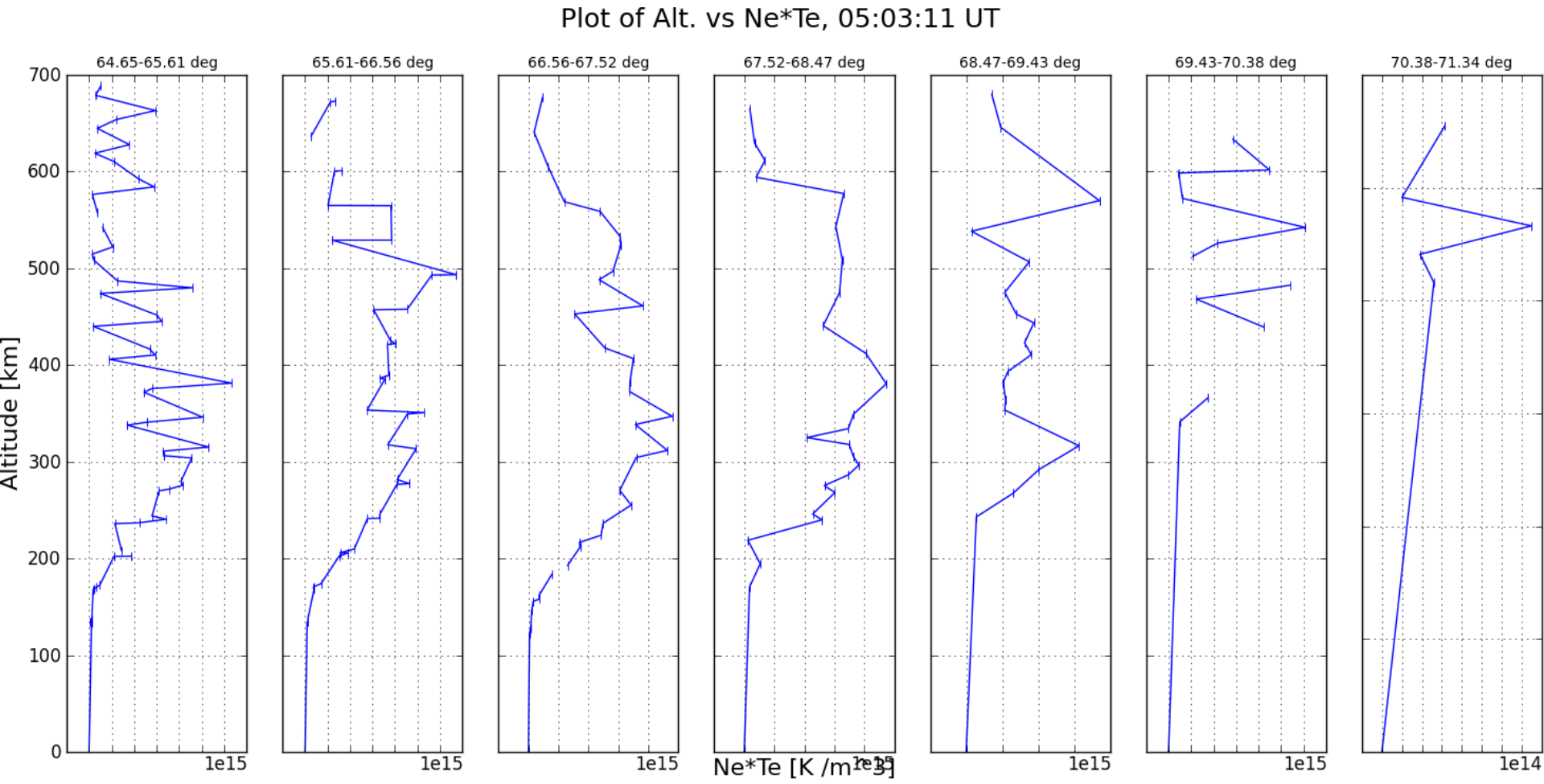
Latitudinal variation of Ne profiles



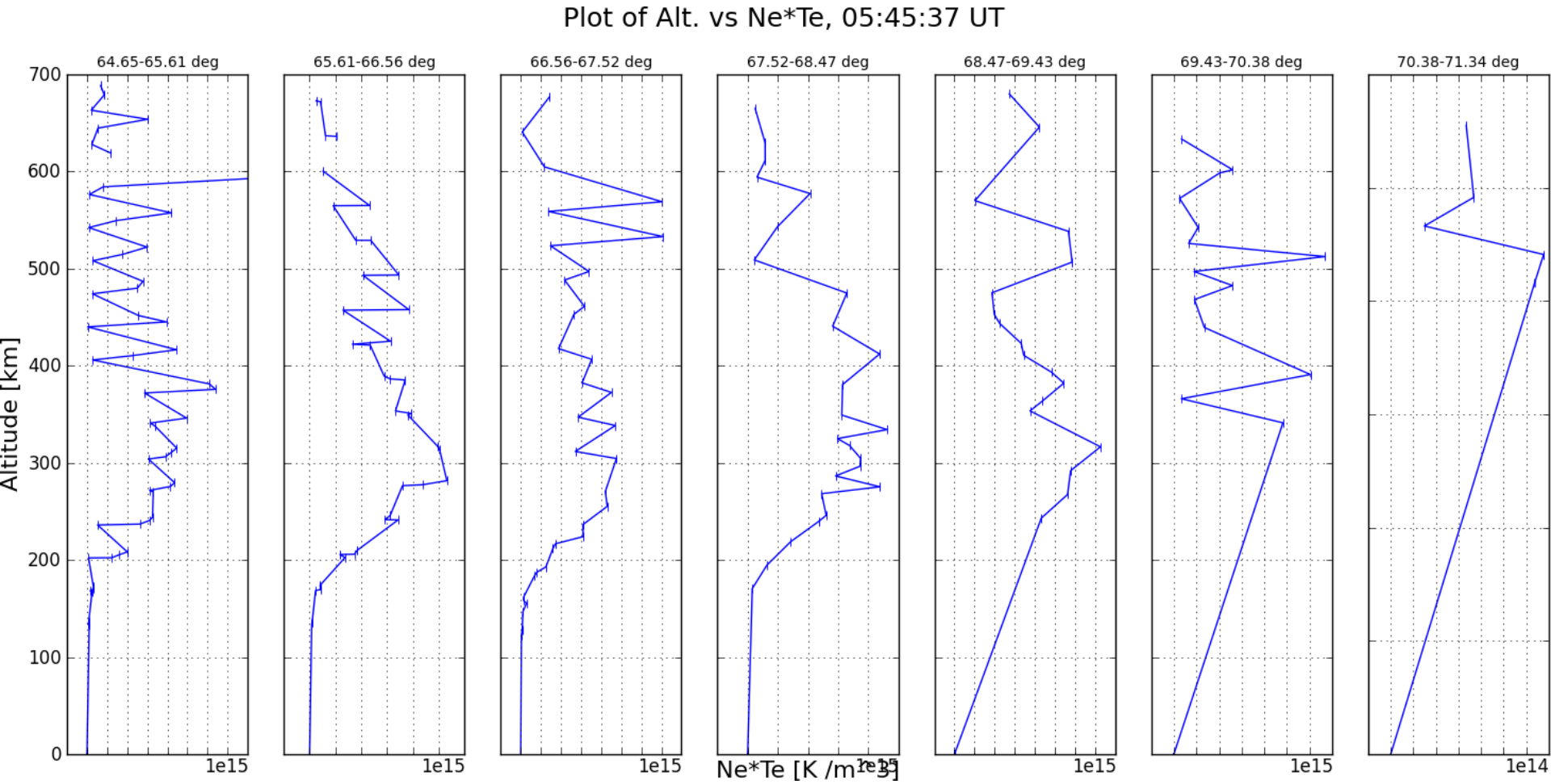
Latitudinal variation of Ne profiles



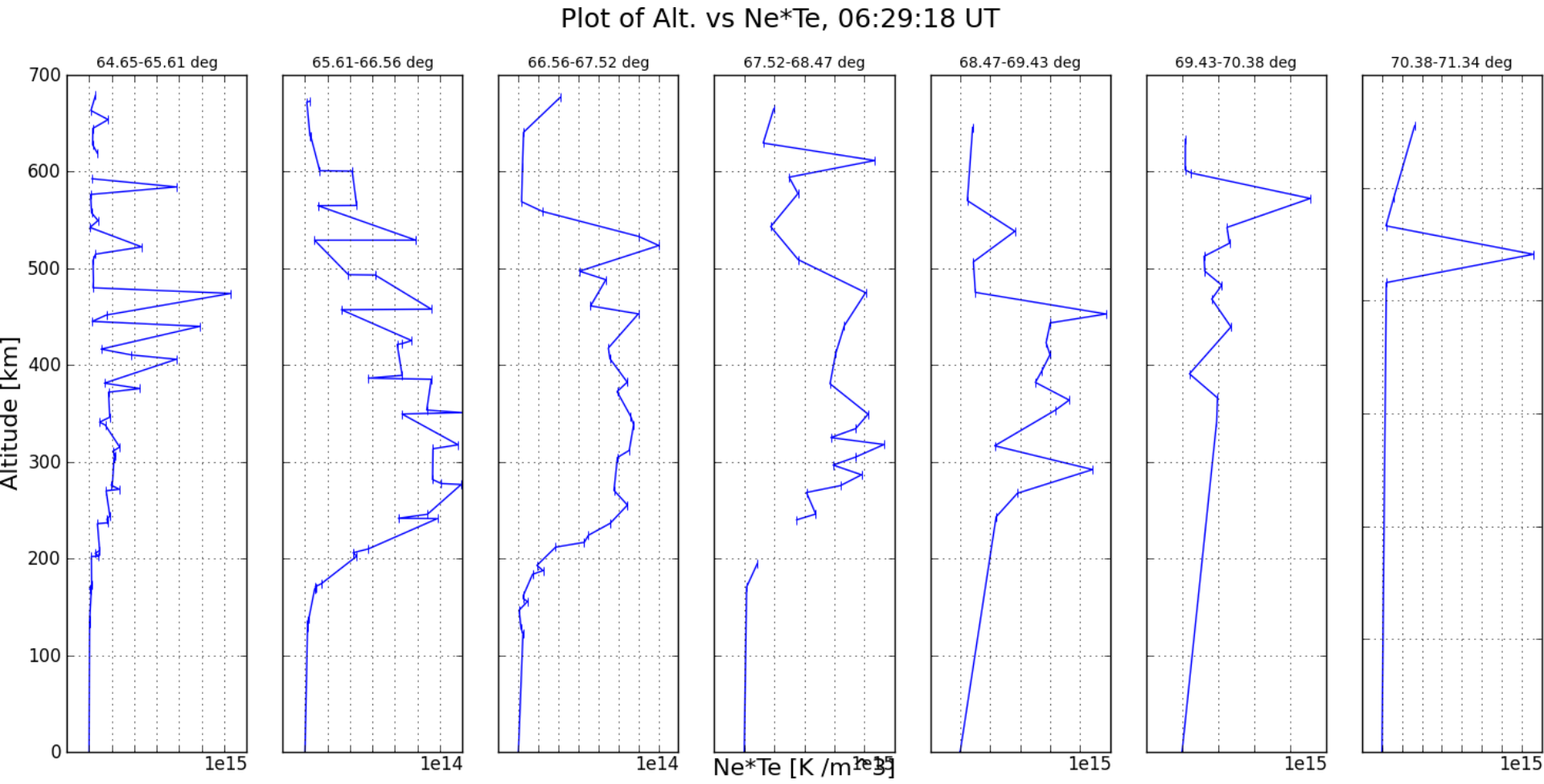
Latitudinal variation of Ne.Te



Latitudinal variation of Ne.Te



Latitudinal variation of Ne.Te



Summary and Conclusions

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- PFISR campaign conducted on 1AUG2012 0500-0630 UT to study latitudinal structure and dynamics of auroral oval.
- 12 beams located along magnetic meridian used with
  - Long Pulse and Alternating Code modulations
  - 1 and 3 min Integration Times

Summary and Conclusions

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- Observations during recovery phase of a small substorm.
  - SW/IMF and geophysical conditions relatively quiet.
  - GMAG shows only significant current system is north of PFISR FOV.
  - PFISR data shows smooth, quiet ionosphere.
- Observations were subauroral, consistent with Feldstein/Holzworth Oval for Kp = 1+.
- Slight T_i enhancement observed on **B**-up beam.

Summary and Conclusions

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- Observations also made with Sondrestrøm ISR.
- At 0400 UT substorm expansion occurs and radar FOV rotates into the auroral zone
- 0400-0900UT
  - Electron depletion
  - Electron and Ion temperature enhancement
- Observations were consistent with Feldstein Oval for Kp= 1+.

Summary and Conclusions

- All analysis was done with provisional data.
- Additional error analysis needs to be conducted.
- Sometimes important to look at the same data in different ways.

Acknowledgements

We would like to thank the PIs and funding agencies for providing data used in this study:

- Solar Wind and IMF data from ACE is provided by NASA and SWPC.
- AE and Kp index is from the World Data Center in Kyoto.
- Ground magnetometer data from University of Alaska Fairbanks.
- Poker Flat and Sondrestrøm ISR data funded by CEDAR and NSF provided by C. Heinselman and A. Stømme.
- SuperDARN data funded by NSF, CSA, and NSERC provided J.M. Ruohoniemi, K. McWilliams, and J.P. St. Maurice.

References

Akasofu, S. I. The development of the auroral substorm. *Planetary and Space Science*, 12(4):273–282, 1964.

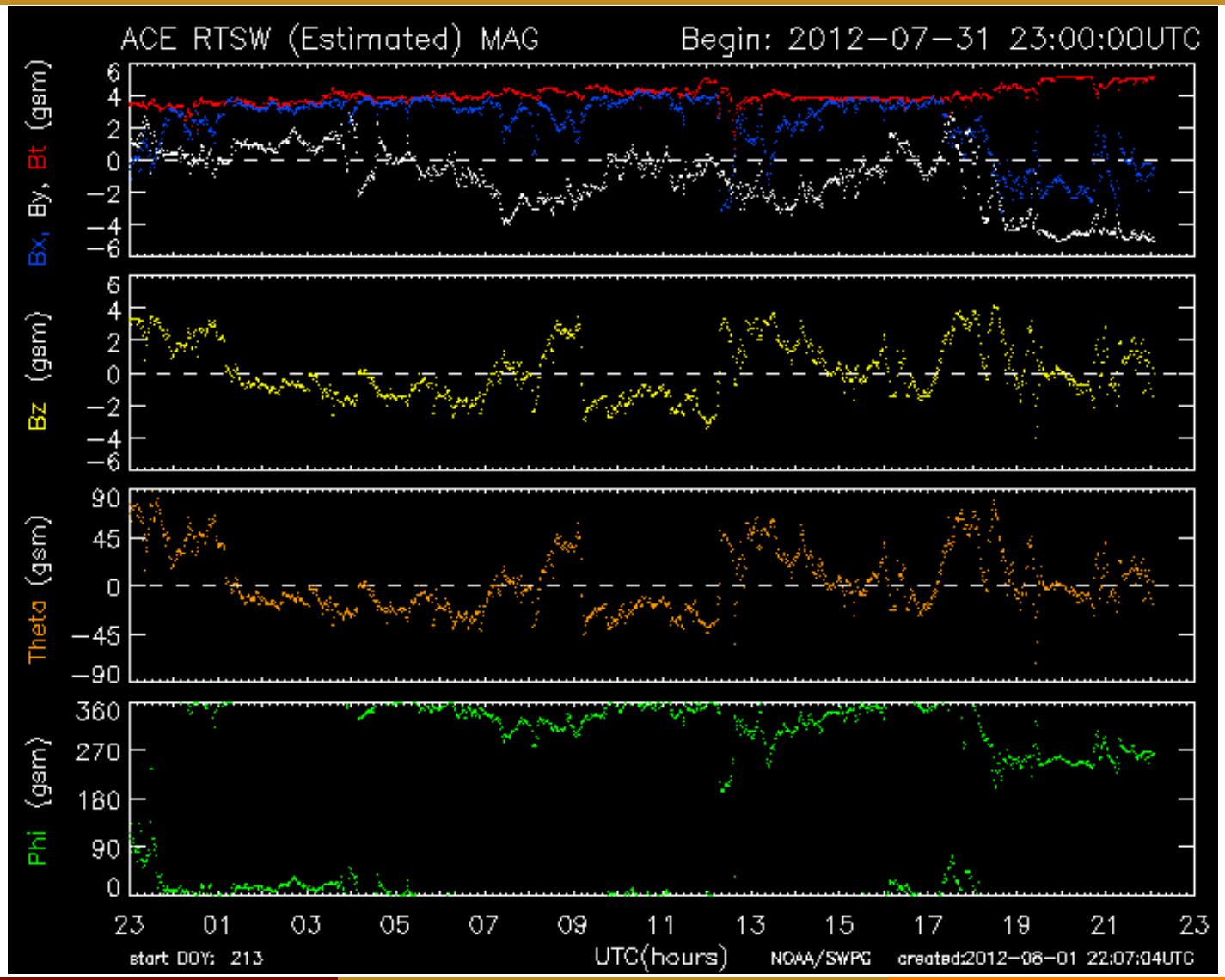
Holzworth, R. H. and C.-I. Meng (1975), Mathematical representation of the auroral oval, *Geophys. Res. Lett.*, 2 (9), 377–380, doi:10.1029/GL002i009p00377.

Thank you!

Student exercise/competition

Backup Slides

ACE SW


ACE RTSW (Estimated) MAG
Begin: 2012-07-31 23:00:00UTC
Bx, By, Bt (gsm)
Bz (gsm)
Theta (gsm)
Phi (gsm)
23 01 03 05 07 09 11 13 15 17 19 21 23
start DOY: 213
UTC(hours)
NOAA/SWPC
created:2012-08-01 22:07:04UTC

AC 3 min Ne

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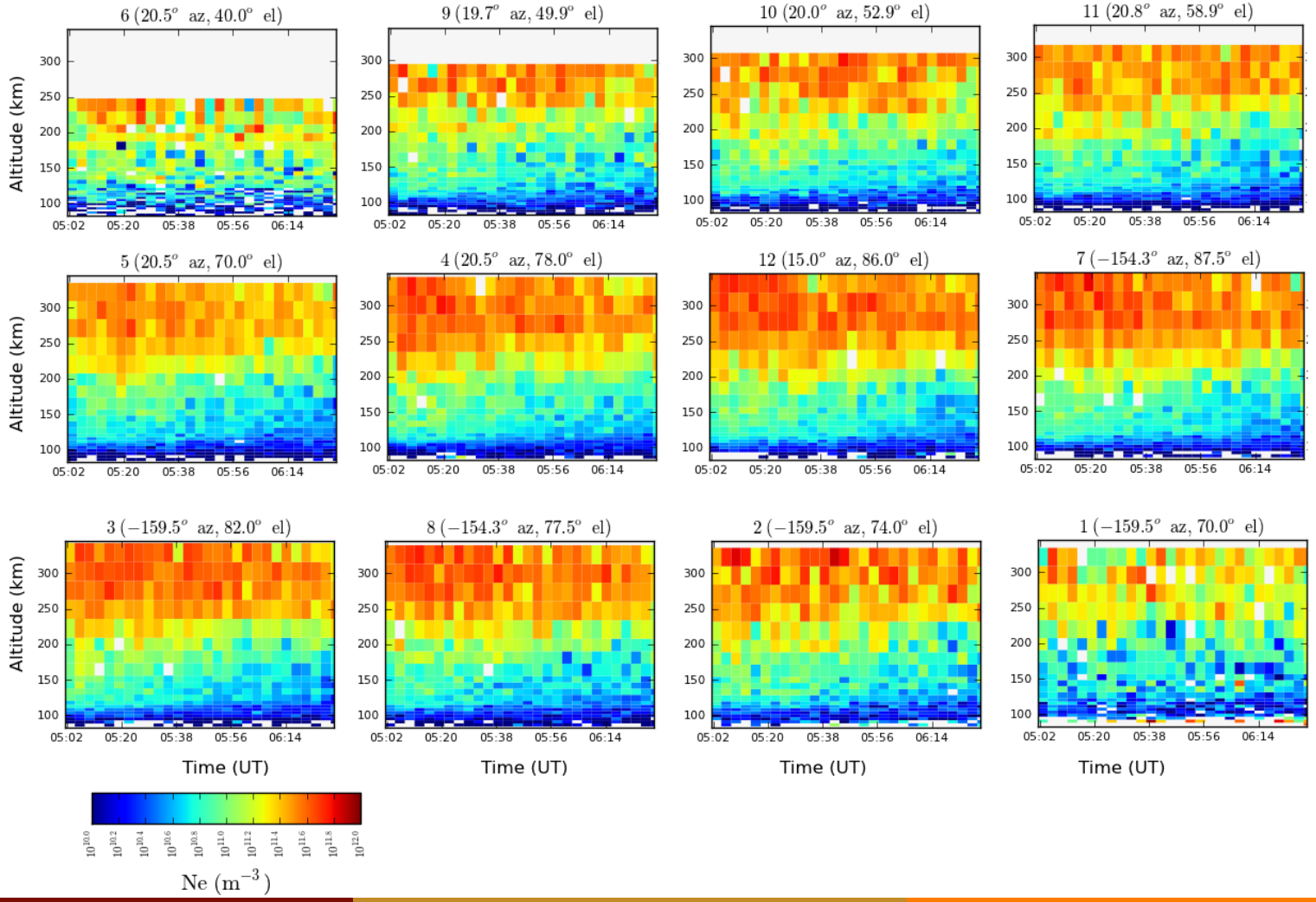
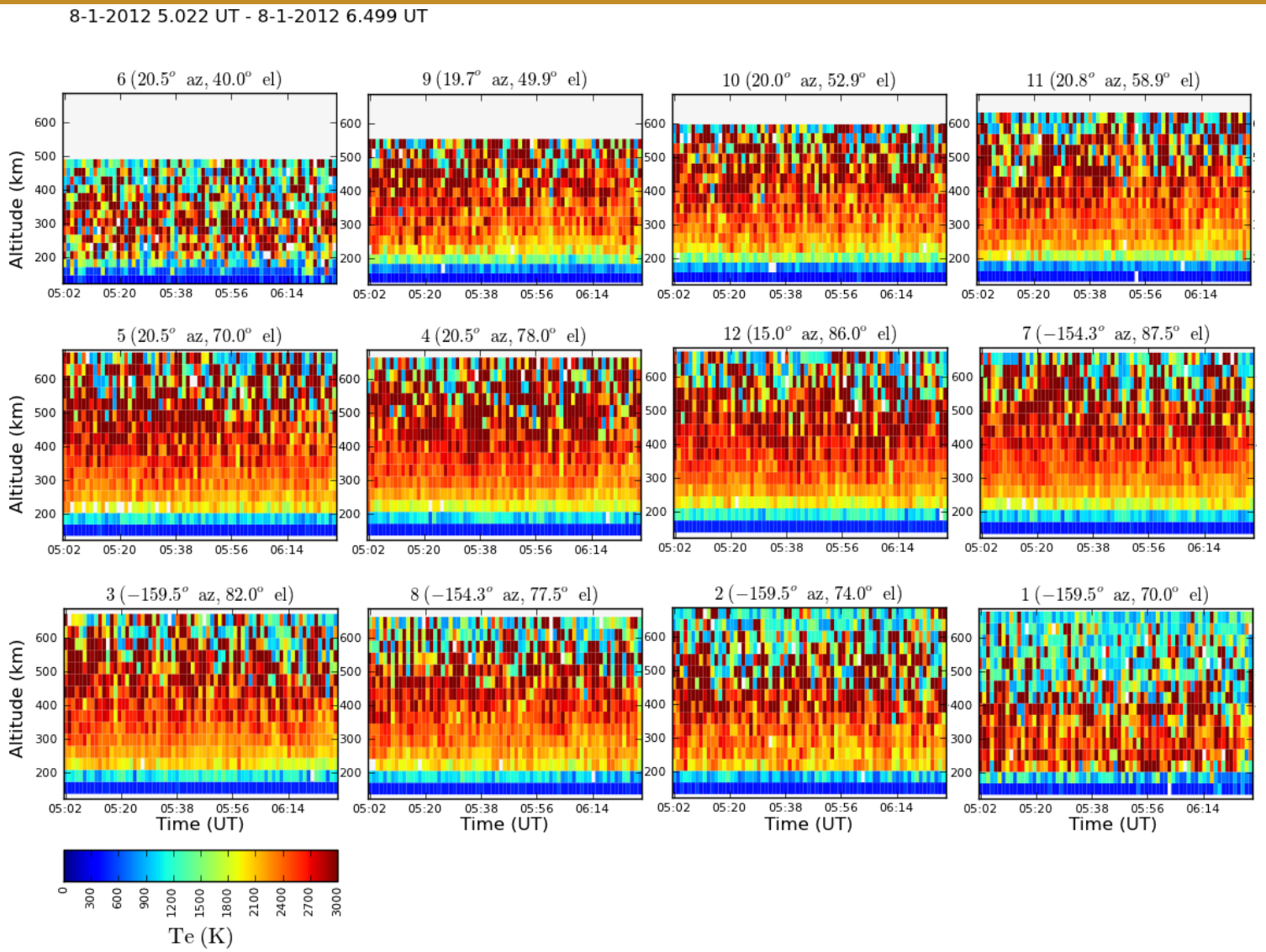
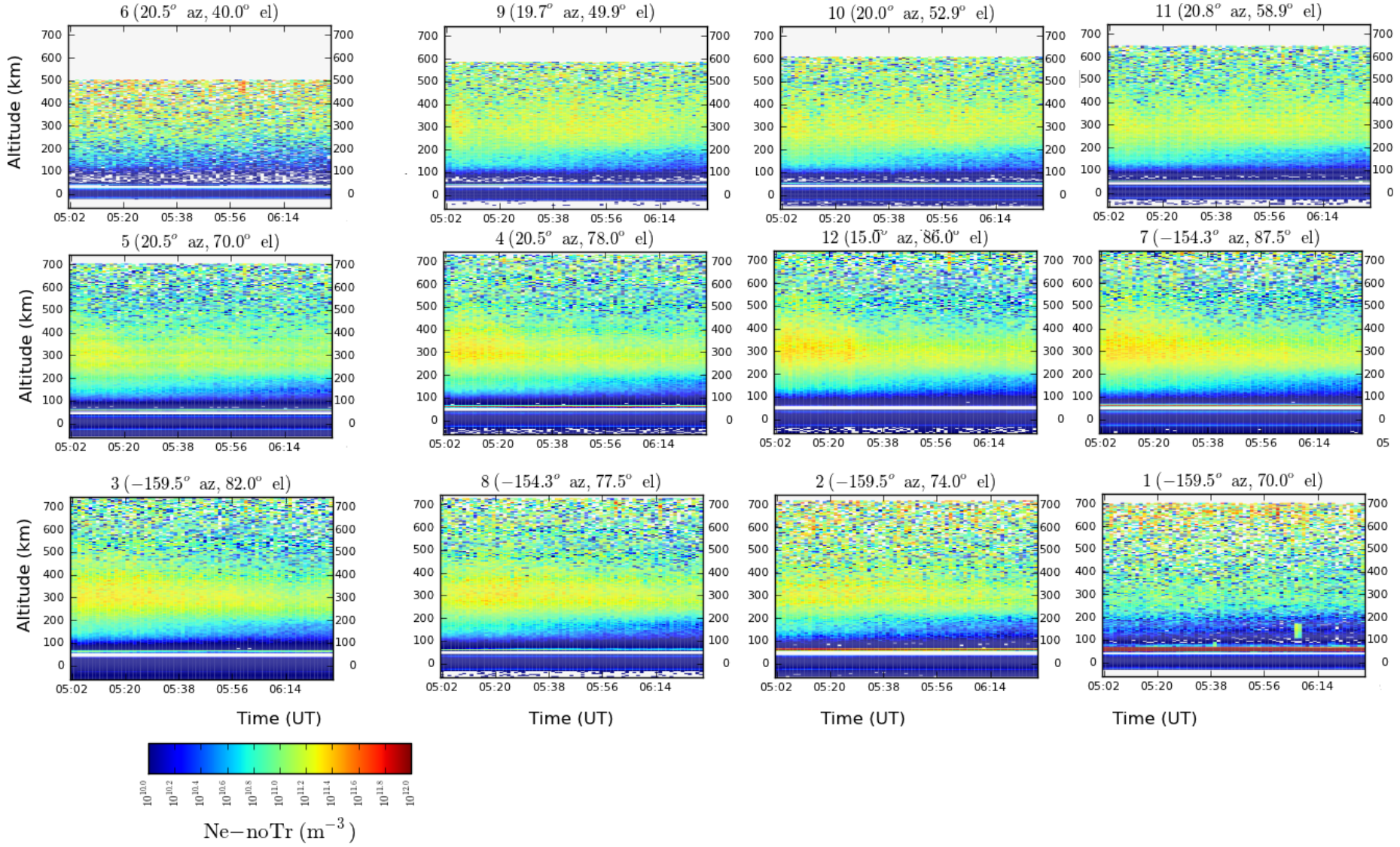
8-1-2012 5.022 UT - 8-1-2012 6.499 UT



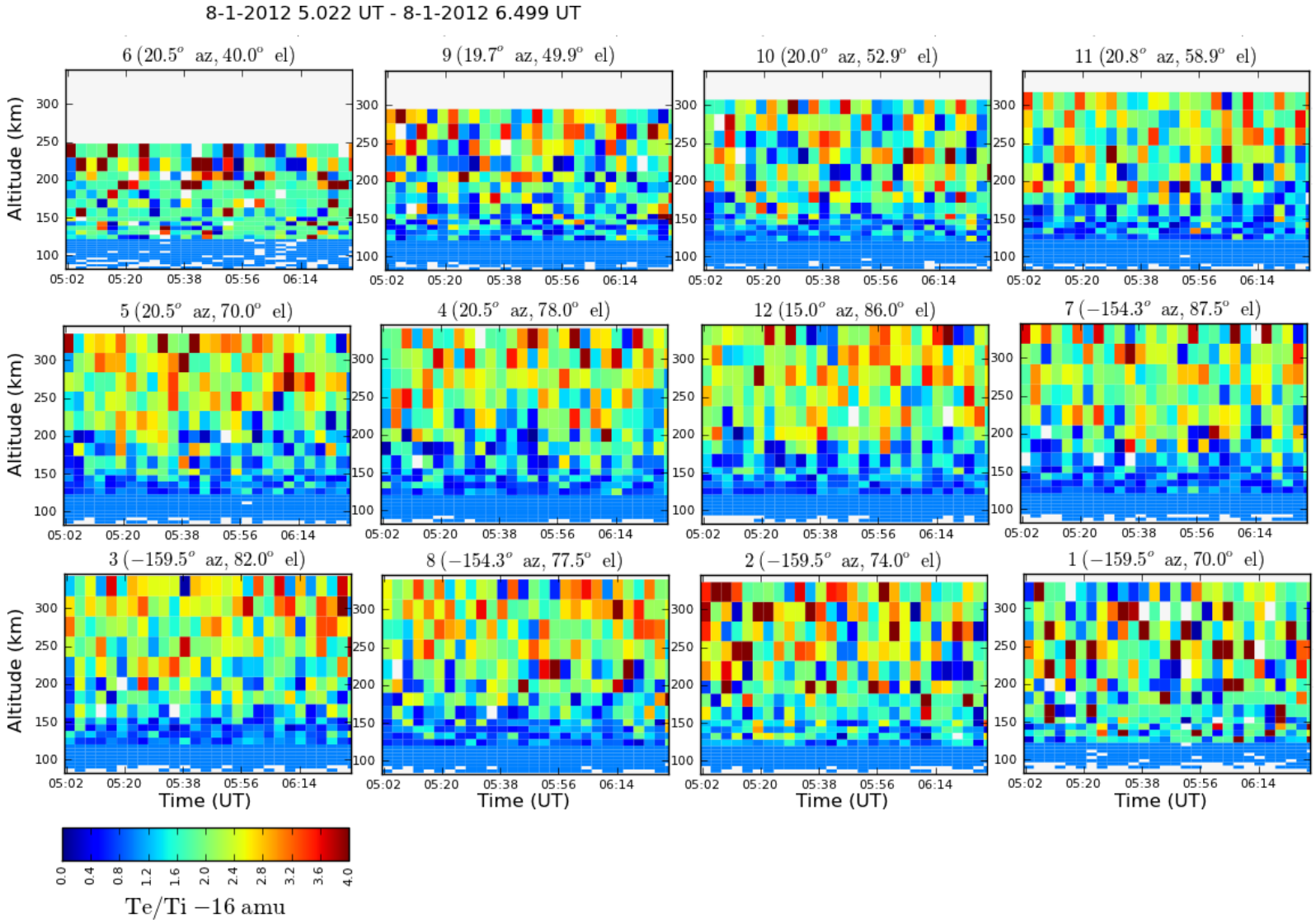
LP 1 min Te



LP 1 min Ne (Not Corrected)



AC 3 min Te/Ti


8-1-2012 5.022 UT - 8-1-2012 6.499 UT
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3 (−159.5° az, 82.0° el)
8 (−154.3° az, 77.5° el)
2 (−159.5° az, 74.0° el)
1 (−159.5° az, 70.0° el)
Altitude (km)
Time (UT)
Te/Ti −16 amu

AC 3 min LOS Velocity

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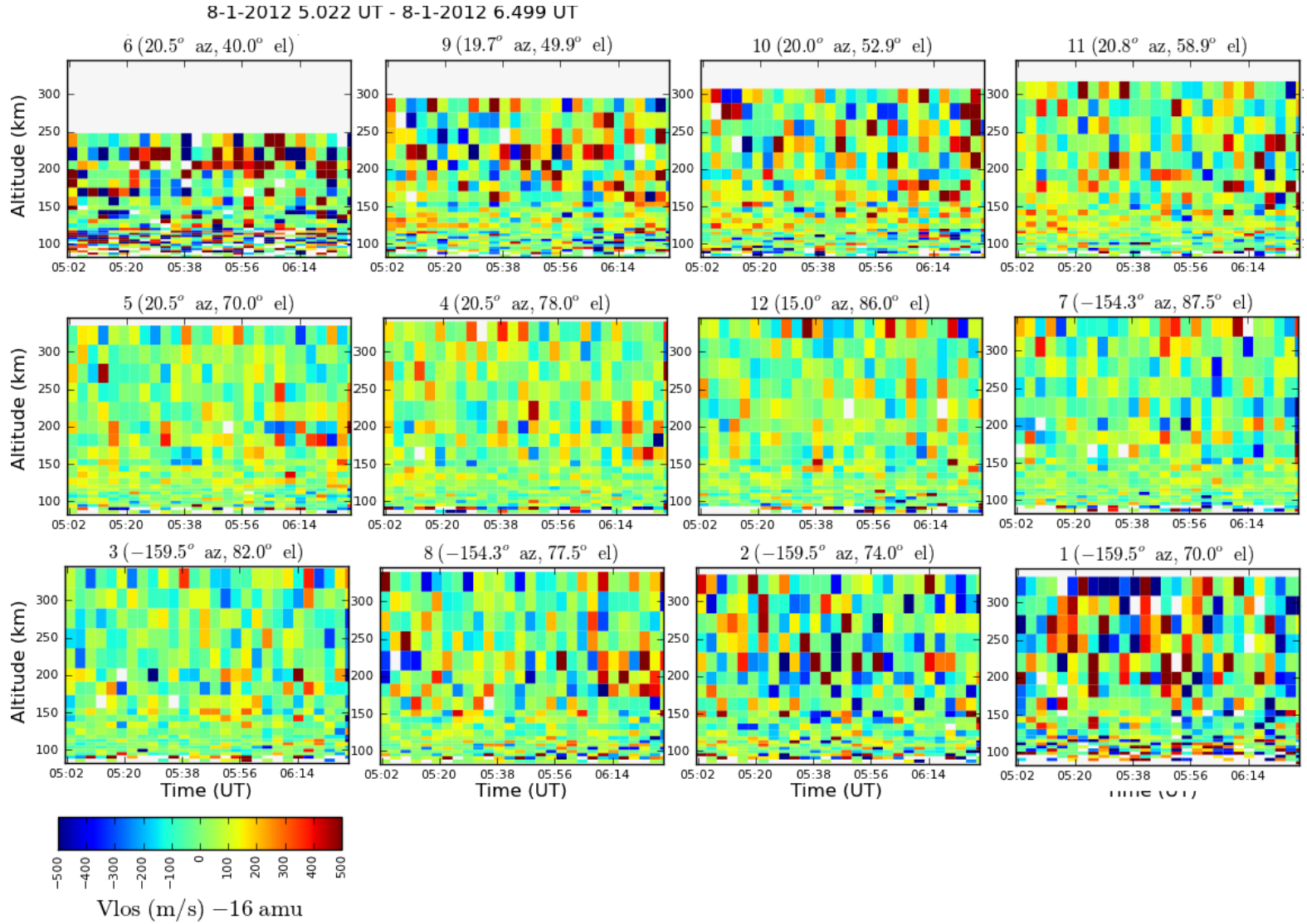
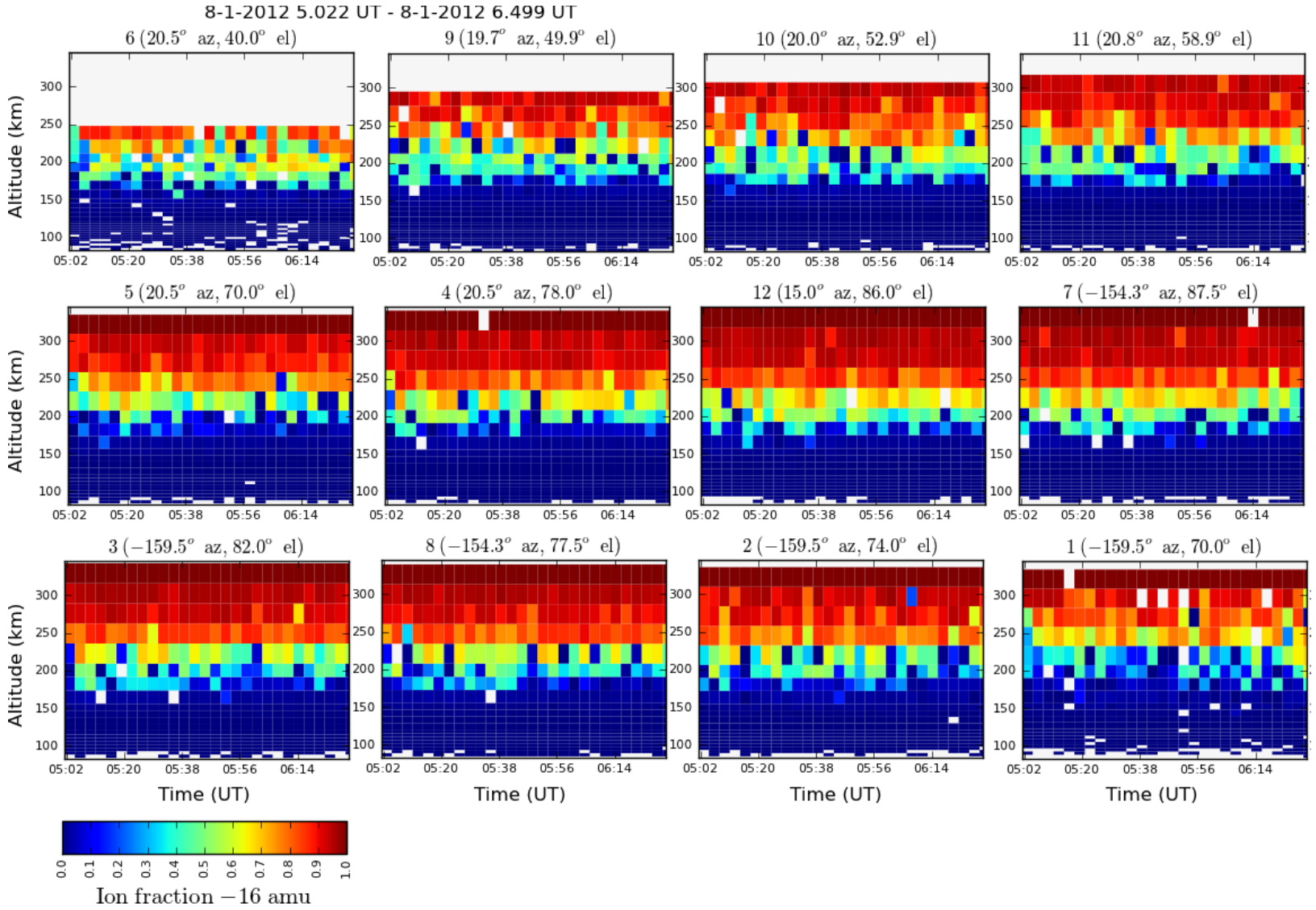


AC 3 min O+ Fraction



AC 3 min ν_{in}

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