MAPPING THE AURORAL OVAL...

In an hour and a half

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- Contents Page (Currently Viewing…not long until the presentation is over)
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- The Experiment (To be viewed after the Introduction)
- POES (To be viewed…you get the idea…)
- Feldstein Models
- Best Estimate of Latitudes
- Results
- Conclusions and Summary

Introduction - The Auroral Oval

What is the Auroral Oval?

The auroral **oval** is an oval.

In this oval (Auroral Oval) there is **aurora**.

Its not really an oval, but an oval with an oval of no aurora in the middle of the oval.

We aim to plot this auroral oval for our planet (Earth).

Picture of Earth

The Experiment

The aurora are **aligned** primarily along the oval (i.e roughly along lines of magnetic **longitude**).

Lund et al. (1967) found that the **average** F-layer and topside electron densities within the region of latitudes containing aurora were two to five times greater than those outside the region. It was suggested that secondary electrons produced by the aurora primaries produced the **increase** in ionospheric electron density.

If we could detect this increase in electron density we could locate the auroral oval.

The Experiment

Our Experiment comprised radar data from the **Sondrestrom** radar (Greenland) and **EISCAT** radars (Tromso, Kiruna, Sodankyla).

We were able to check the most up to date data online (eventually) to determine if it was possible to physically detect the auroral oval location on that day using the two radars. We concluded that it would be possible for both radars to detect these latitudes.

We could then compare our data to see if the **increased** electron density at certain latitudes matched the latitudes found online.

The data was taken between 4:00-5:30 UT

Sondrestrom

Elevation: 33 degrees
Azimuth: 14 degree steps, 2 minutes at each location

EISCAT

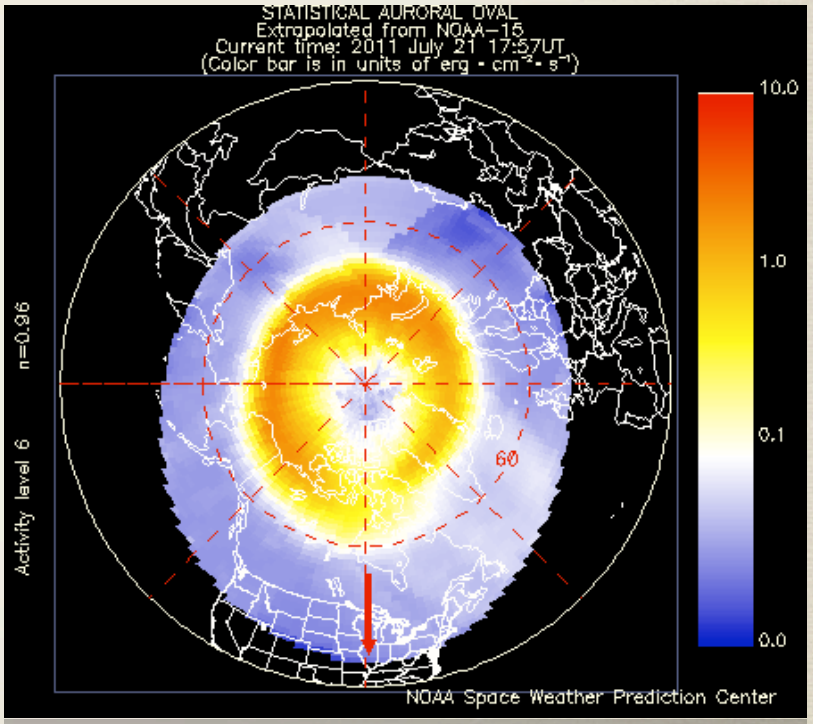
CP3 program - Magnetic Meridian elevation scan taking 24 minutes.

POES

Polar - orbiting **O**perational **E**nvironmental **S**atellite

Continually monitors the power **flux** carried by the protons and electrons that produce aurora in the atmosphere.

The Space Weather Prediction Center (SWPC) developed a technique that uses the power flux observations obtained during a single pass of the satellite over a polar region (which takes about 25 minutes) to estimate the total power deposited in an entire polar region by these auroral particles.



Feldstein Models

In 1969 Feldstein developed two separate **empirical** models to determine the latitude of the auroral oval

Model 1: Predicts the **poleward** latitude as a function of **angle** between the north magnetic pole and the Earth-Sun line.

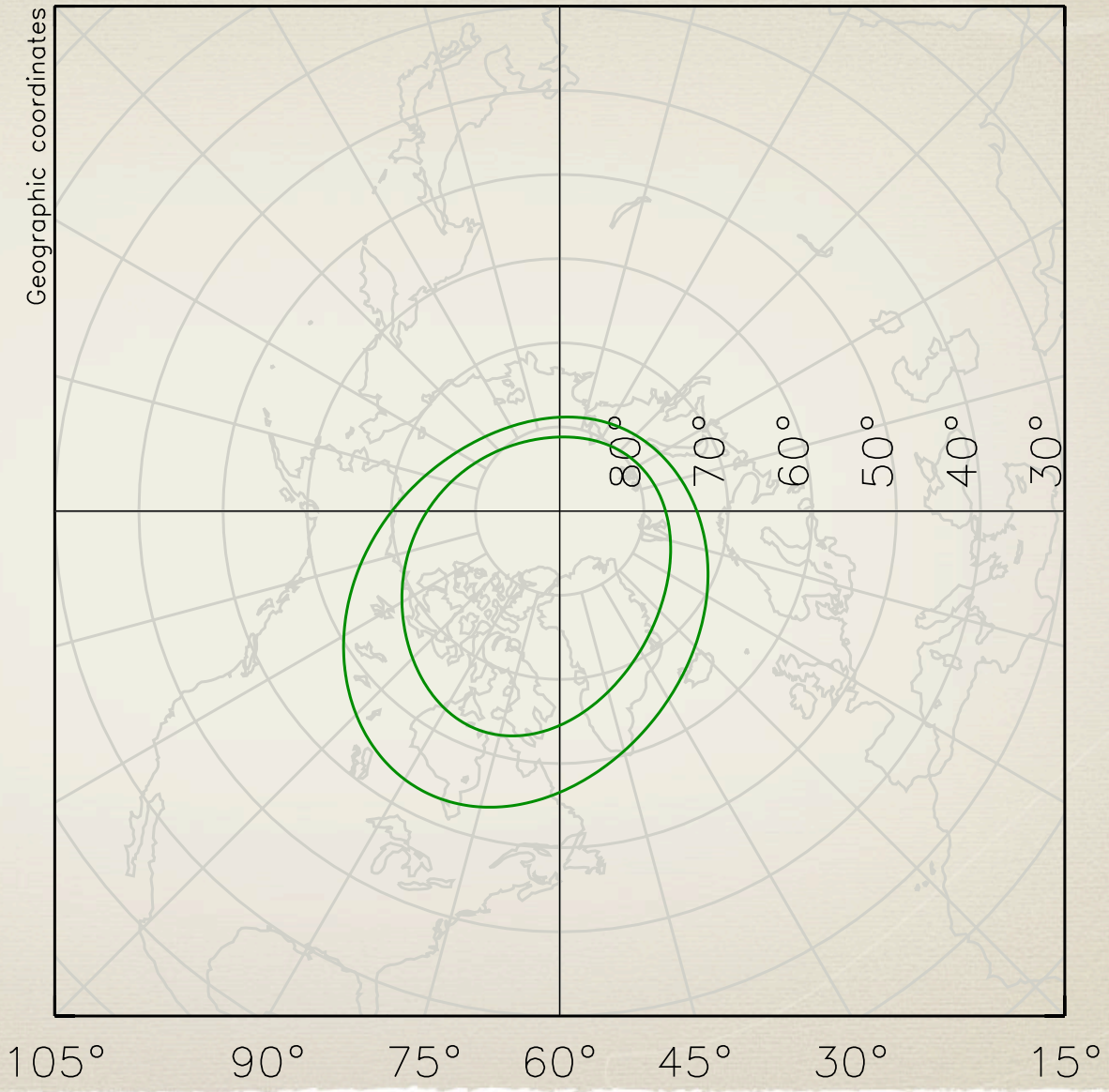
This gives latitude ~63 degrees. Assumptions are that it is geomagnetically quiet and on the night side.

Feldstein Models

Model 2:
Predicts the entire oval as a function of **Kp** index.

Consists of sums of cos(time+ coefficients).

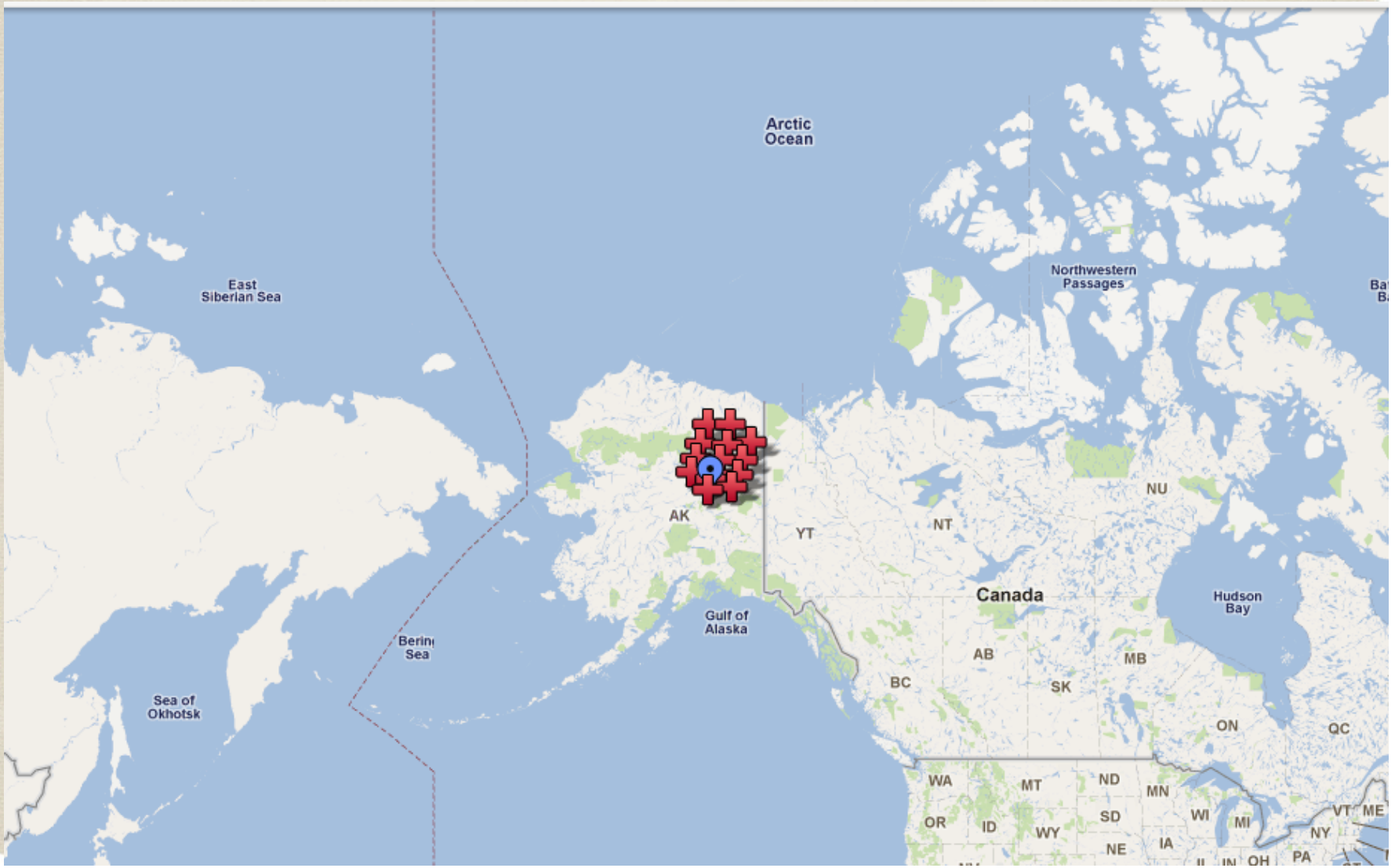
Coefficients depend on Kp



Summary of the models (Latitudes)

	Latitude
POES Poleward	75
POES Equatorward	64
Feldstein Model 1 Poleward	63
Feldstein Model 2 Poleward	69
Feldstein Model 2 Equatorward	58

PFISR Location



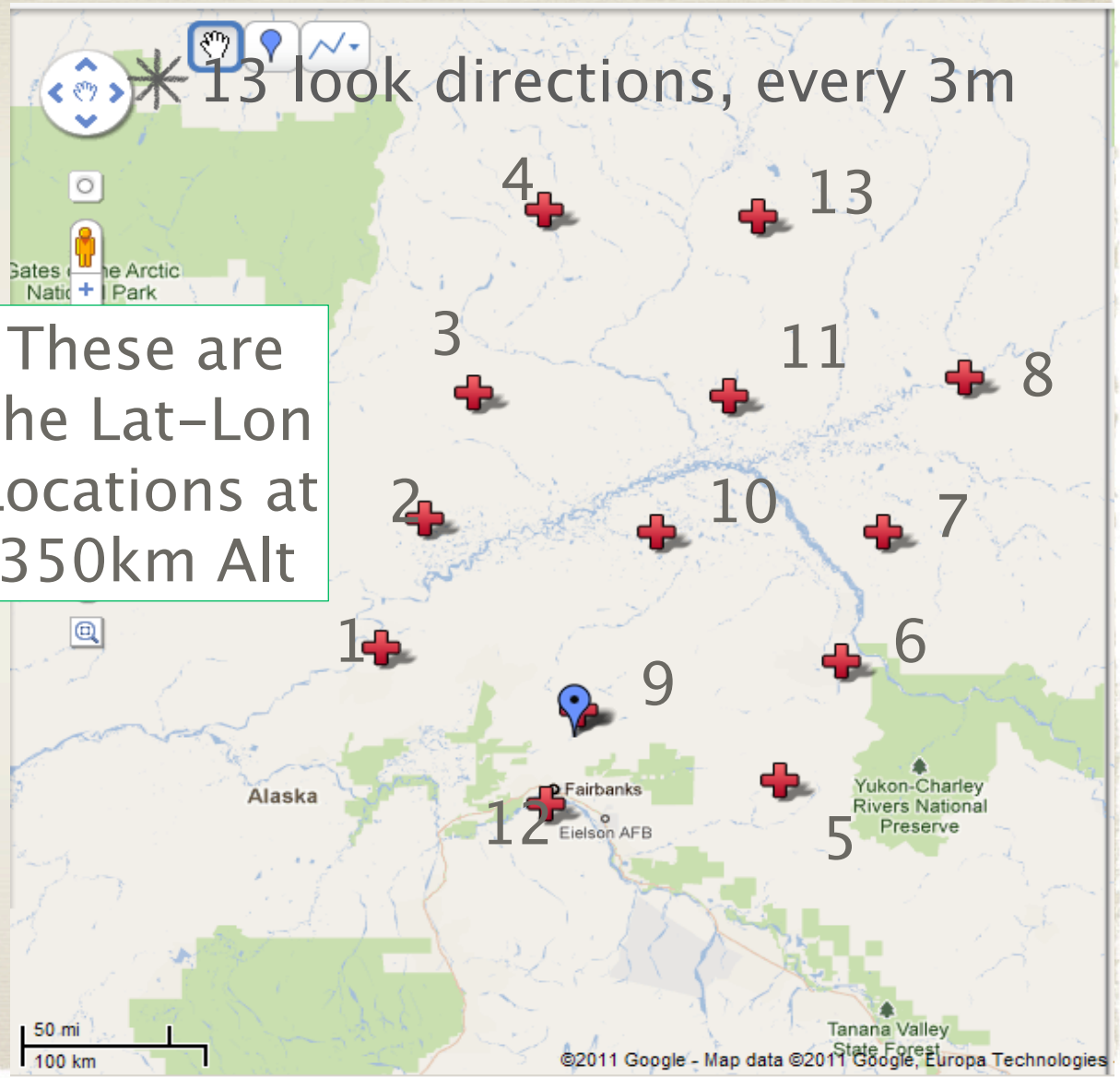
PFISR

Get directions My places

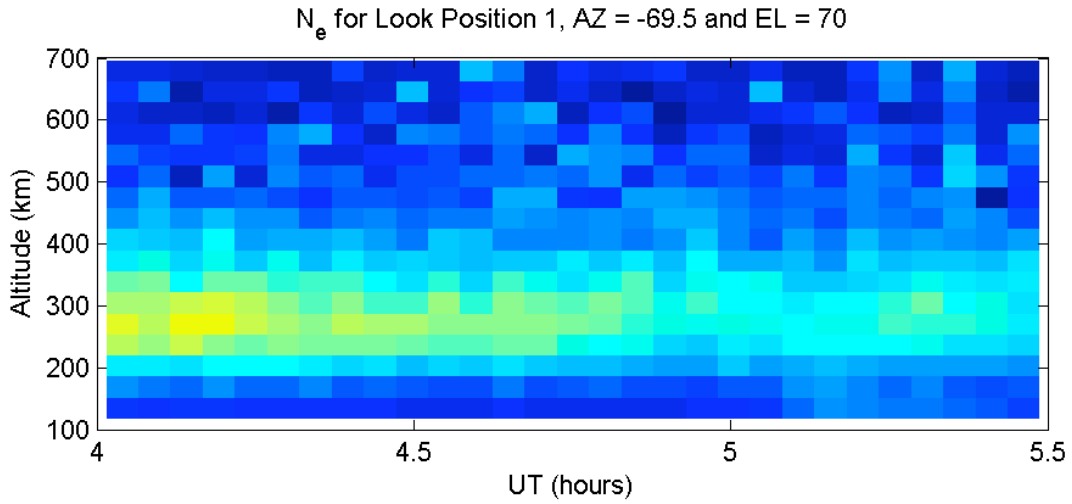
Public - Shared with everyone. Th
published in search results and us
Unlisted - Shared only with selec
have this map's URL.

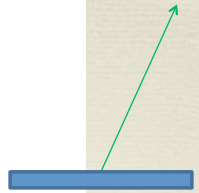
Poker Flat Research Range

- Look 1: 65.5, -149.8
  El ~ 70
- Look 2: 66.17, -149.3
  El ~ 66
- Look 3: 66.83, -148.7
  El ~ 59
- Look 4: 67.75, -147.85
  El ~ 48
- Look 5: 64.75, -145.0
  El ~ 70
- Look 6: 65.4, -144.25
  El ~ 66
- Look 7: 66.1, -143.75
  El ~ 59
- Look 8: 66.9, -142.75
  El ~ 48
- Look 9: 65.12, -147.4
  STRAIGHT UP: EL = 90
- Look 10: 66.1, -146.5
  El ~ 70
- Look 11: 66.75, -145.75
  El ~ 58
- Look 12: 64.5, -148.1
  El ~ 77.5
- Look 13: 67.75, -145.25
  El ~ 50

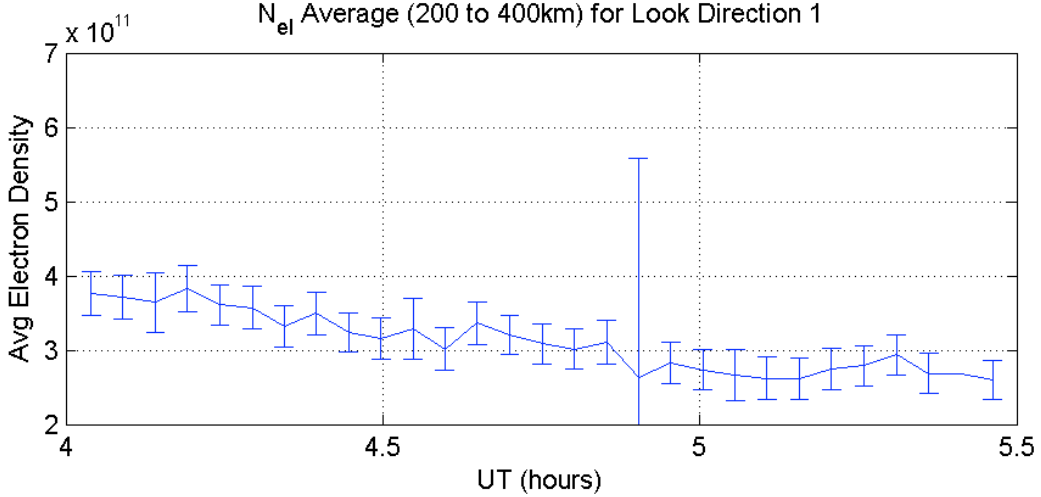


PFISR


N_e for Look Position 1, AZ = -69.5 and EL = 70
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0



EL ~ 70


N_{el} Average (200 to 400km) for Look Direction 1
x 10^{11}
Avg Electron Density
7
6
5
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3
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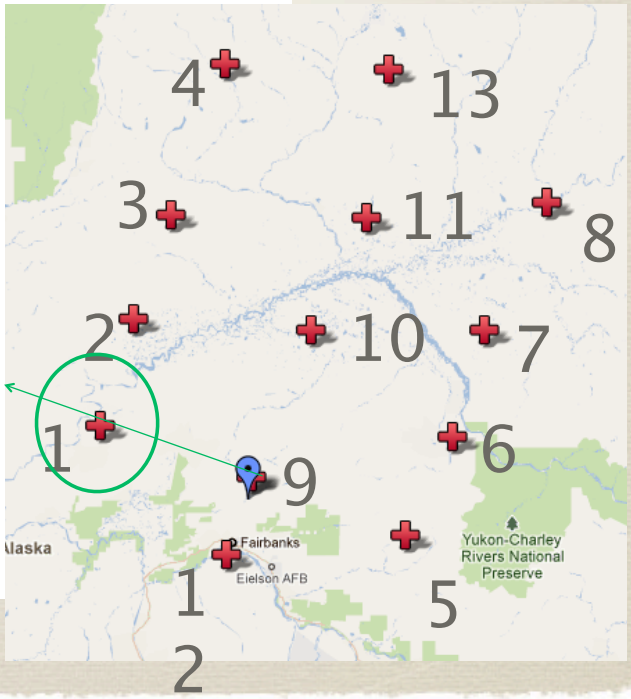
4
4.5
5
5.5
UT (hours)


4
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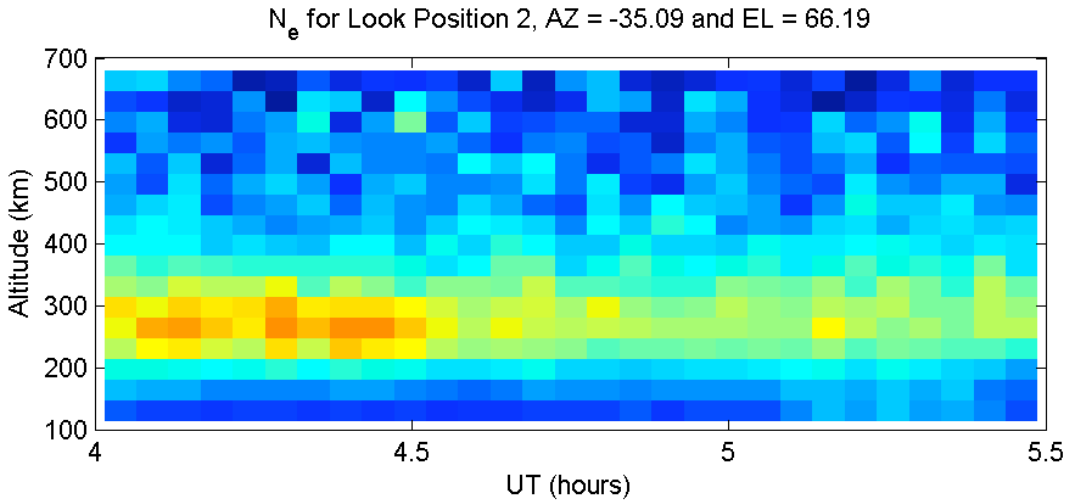
Fairbanks
Eielson AFB
Yukon-Charley Rivers National Preserve
1
2
5

PFISR


N_e for Look Position 2, AZ = -35.09 and EL = 66.19
Altitude (km)
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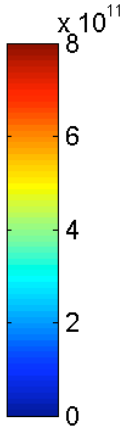
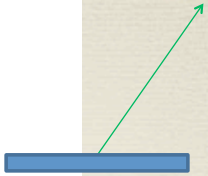
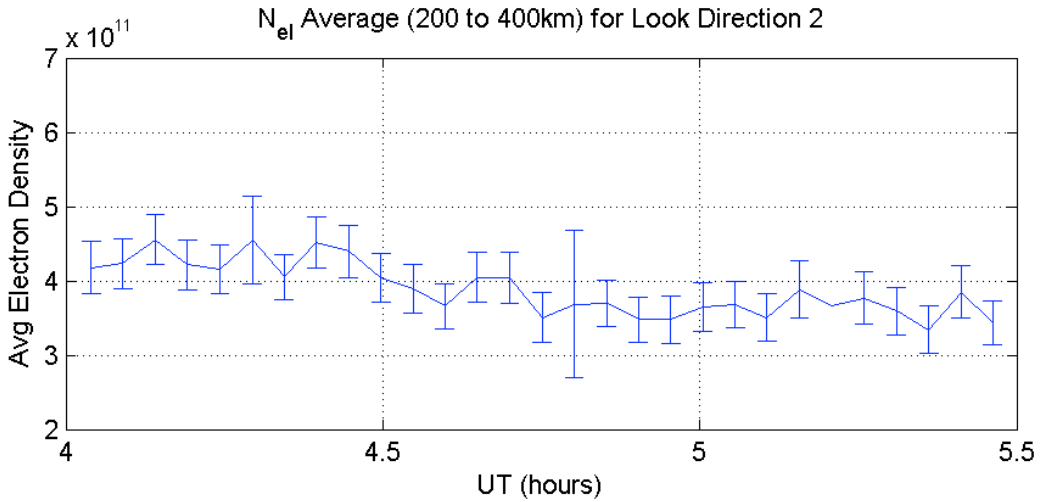
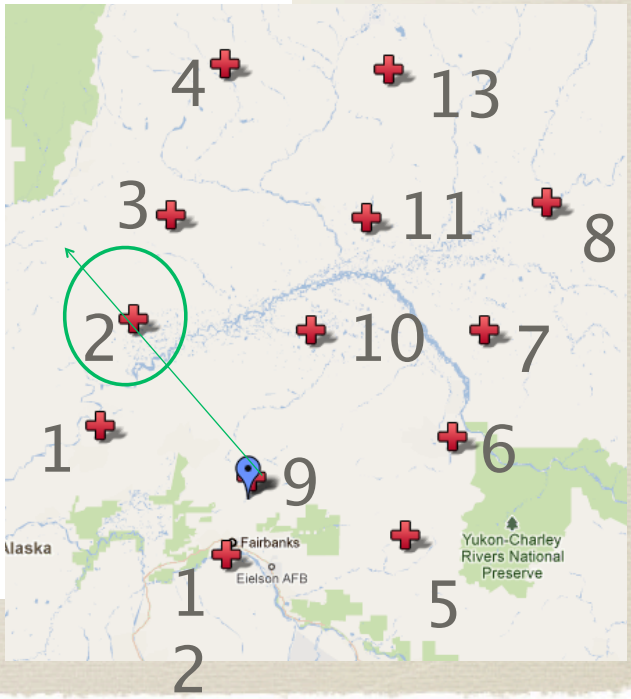
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)


x 10^{11}
8
6
4
2
0



EL ~ 66


N_{el} Average (200 to 400km) for Look Direction 2
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)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Fairbanks
Eielson AFB
Yukon-Charley Rivers National Preserve
1
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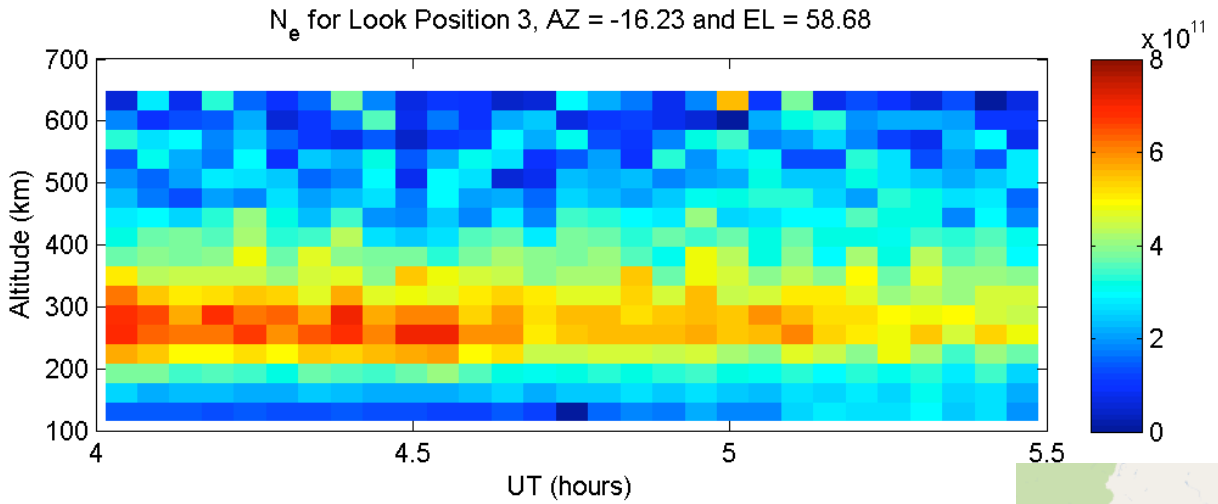
PFISR


N_e for Look Position 3, AZ = -16.23 and EL = 58.68
Altitude (km)
700
600
500
400
300
200
100
4
4.5
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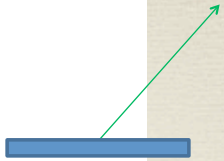
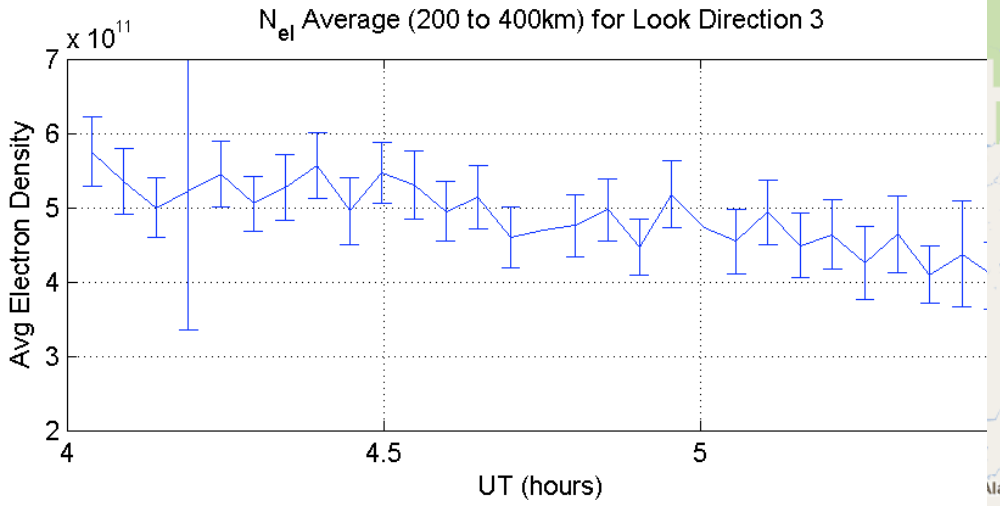
5.5
UT (hours)
x 10^{11}
8
6
4
2
0


EL ~
59


N_{el} Average (200 to 400km) for Look Direction 3
x 10^{11}
Avg Electron Density
7
6
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4
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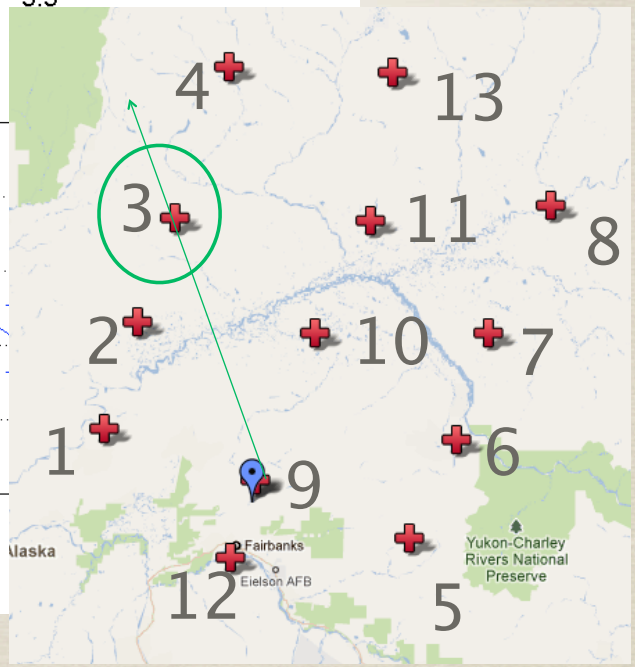
4
4.5
5
UT (hours)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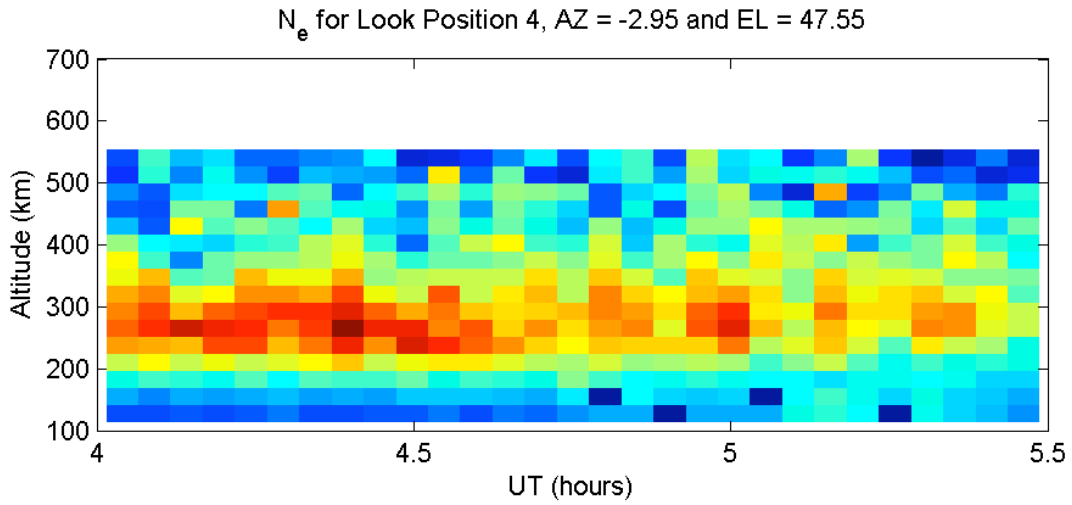
Fairbanks
Eielson AFB
Yukon-Charley
Rivers National
Preserve
12
5

PFISR


N_e for Look Position 4, AZ = -2.95 and EL = 47.55
Altitude (km)
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600
500
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300
200
100
4
4.5
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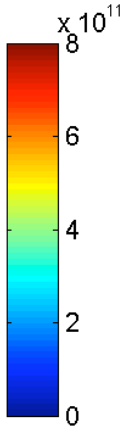
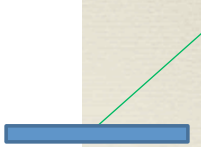
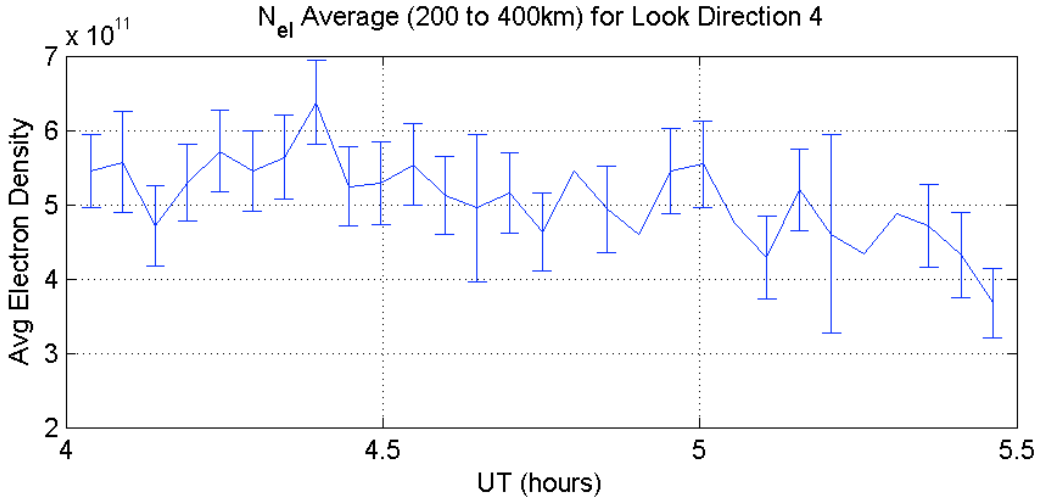
5.5
UT (hours)


x 10^{11}
8
6
4
2
0


EL ~
48


N_{el} Average (200 to 400km) for Look Direction 4
x 10^{11}
Avg Electron Density
7
6
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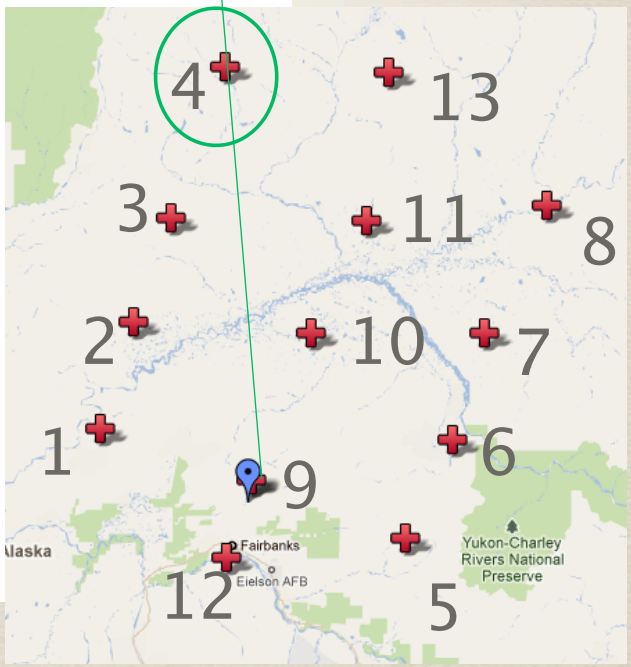
4
3
2
4
4.5
5
5.5
UT (hours)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Eielson AFB
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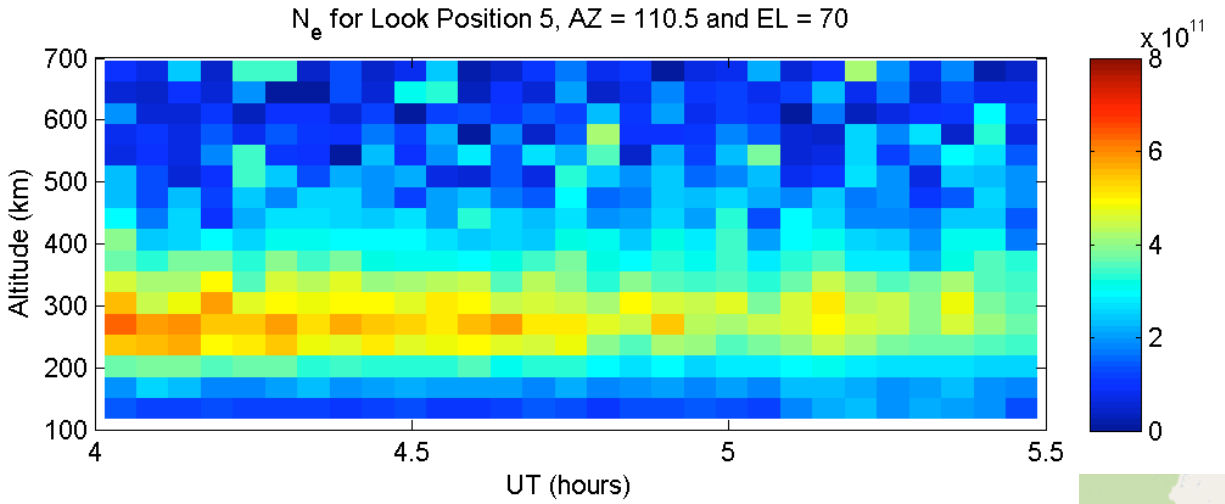
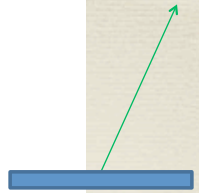
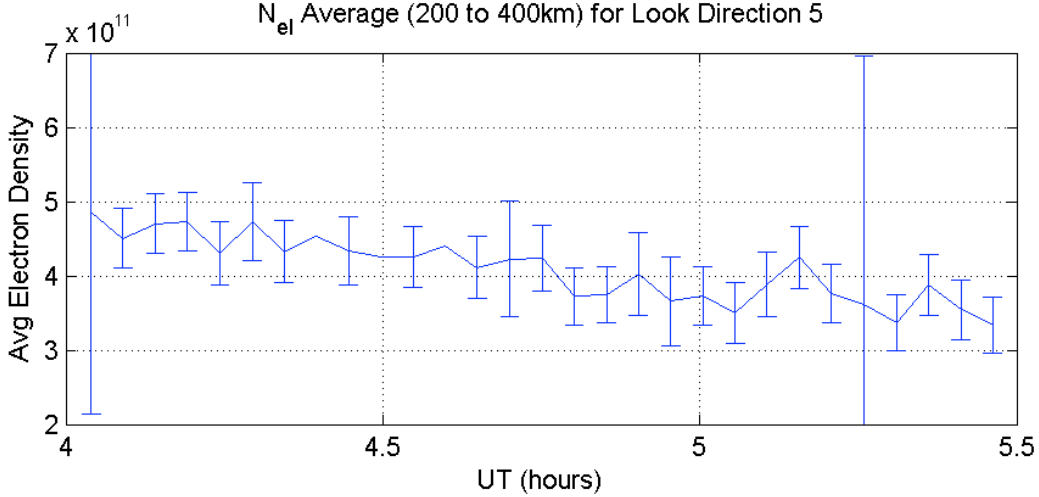
Yukon-Charley
Rivers National
Preserve

PFISR


N_e for Look Position 5, AZ = 110.5 and EL = 70
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0



EL ~ 70


N_{el} Average (200 to 400km) for Look Direction 5
x 10^{11}
Avg Electron Density
7
6
5
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2
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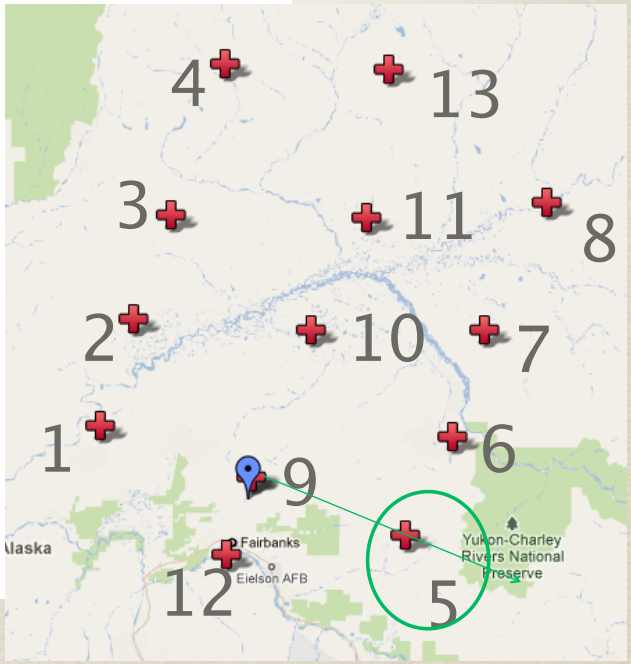
4.5
5
5.5
UT (hours)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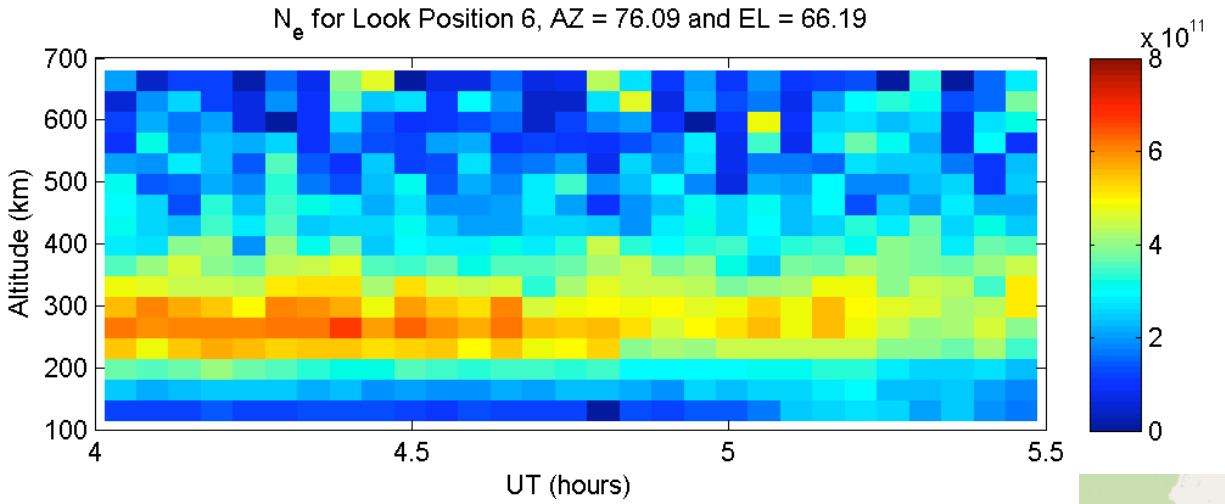
Fairbanks
Eielson AFB
Yukon-Charley Rivers National Preserve

PFISR


N_e for Look Position 6, AZ = 76.09 and EL = 66.19
Altitude (km)
700
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5.5
UT (hours)
x 10^{11}
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6
4
2
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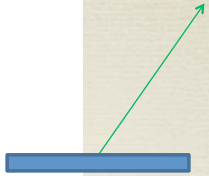
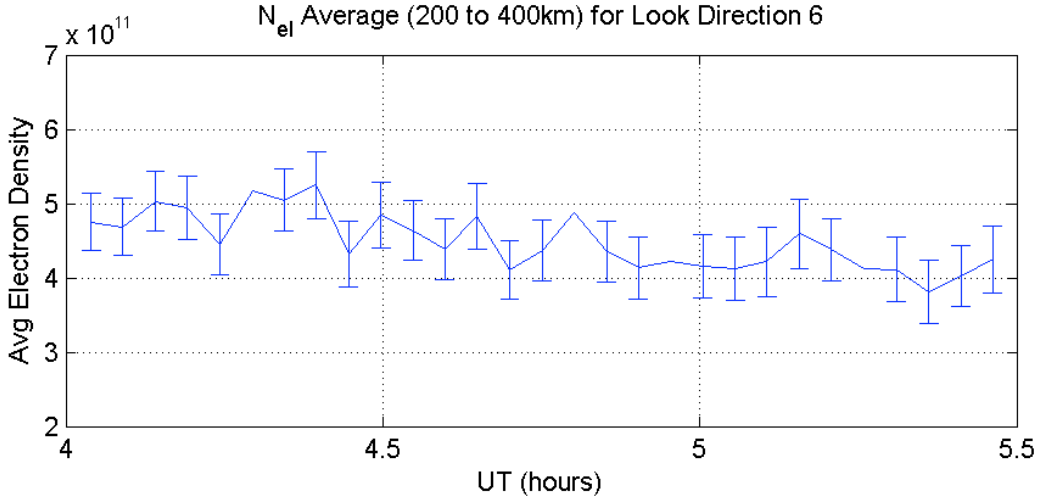
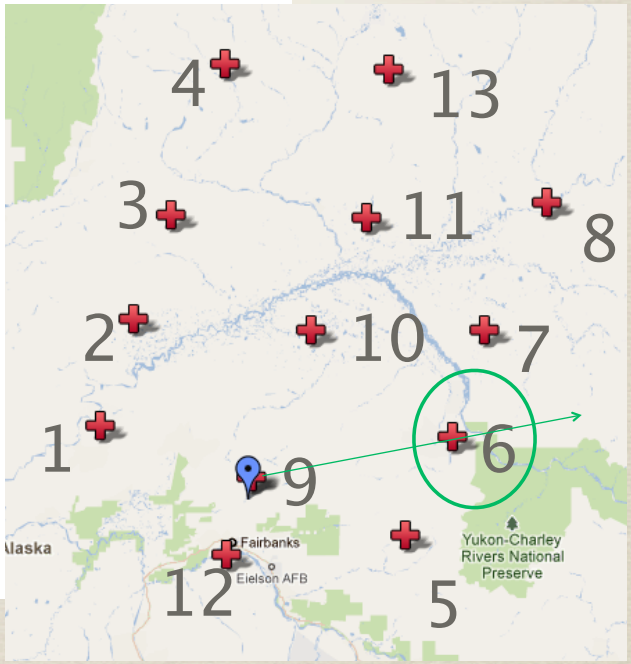

EL ~
66


N_{el} Average (200 to 400km) for Look Direction 6
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)


4
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Fairbanks
Eielson AFB
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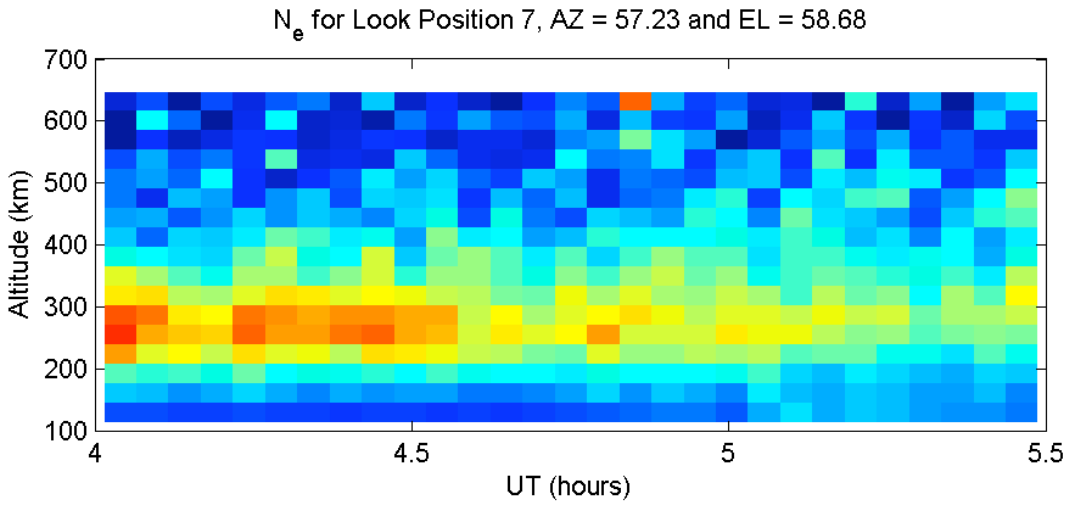
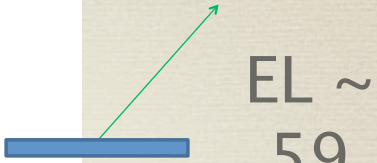
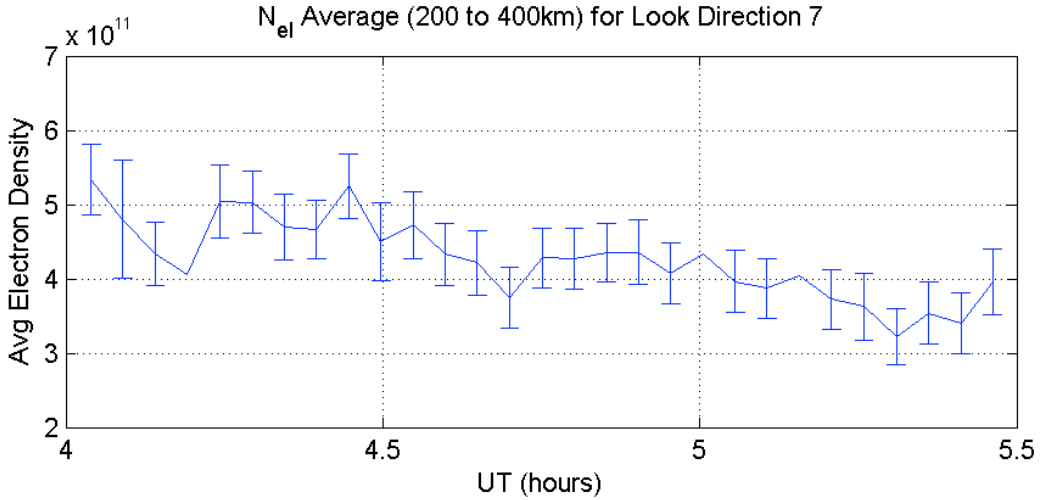
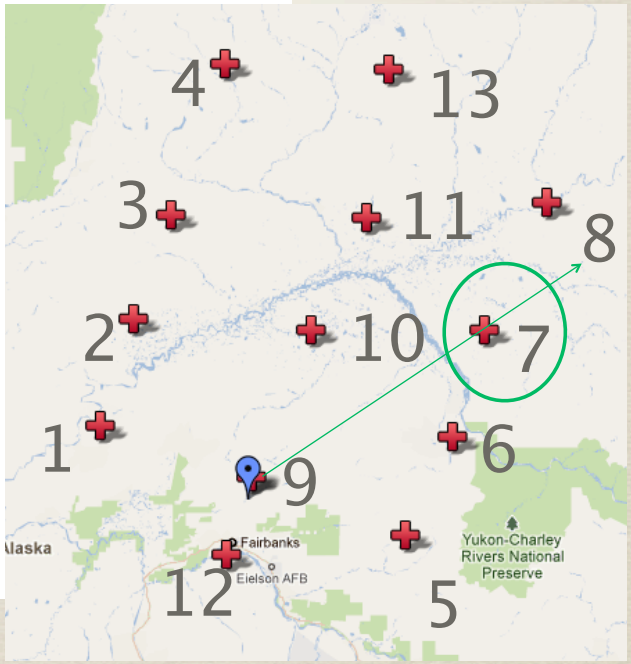
5
Yukon-Charley
Rivers National
Preserve

PFISR


N_e for Look Position 7, AZ = 57.23 and EL = 58.68
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0


EL ~
59


N_{el} Average (200 to 400km) for Look Direction 7
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)


4
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Fairbanks
Eielson AFB
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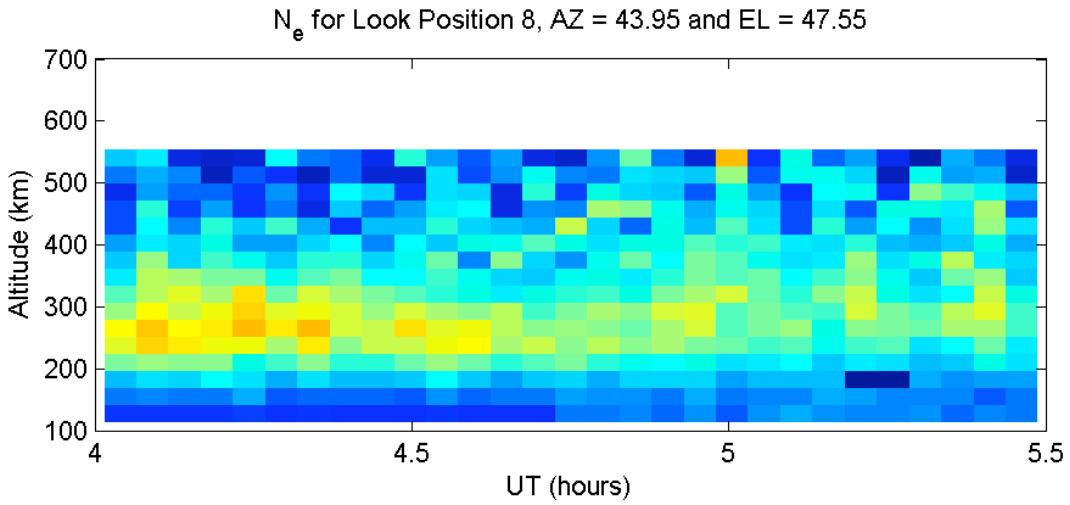
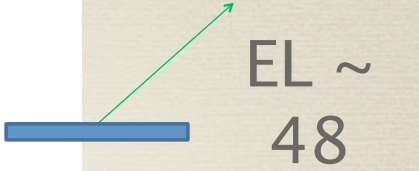
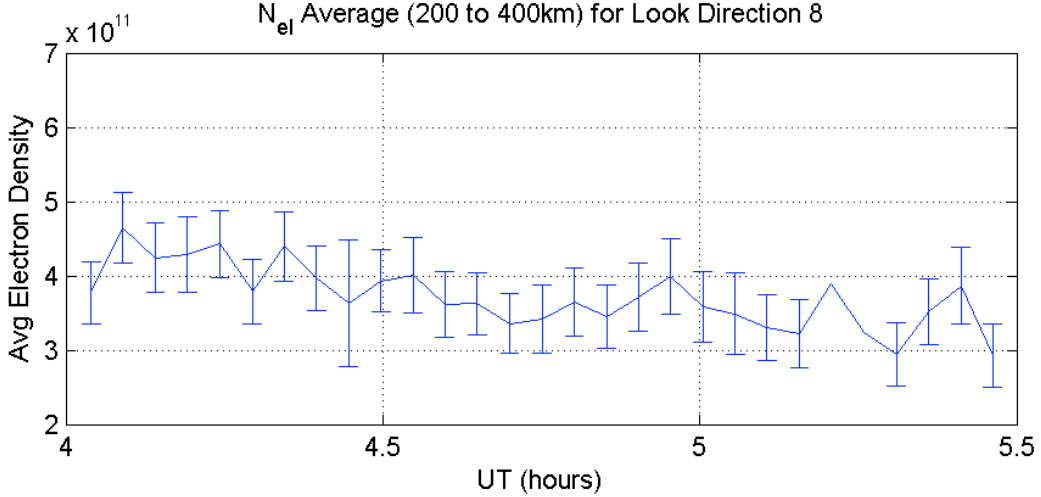
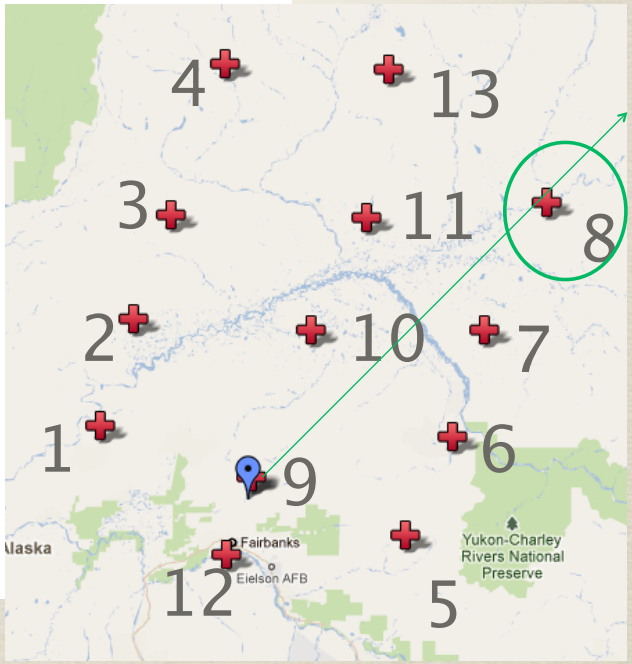
Yukon-Charley
Rivers National
Preserve

PFISR


N_e for Look Position 8, AZ = 43.95 and EL = 47.55
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0


EL ~
48


N_{el} Average (200 to 400km) for Look Direction 8
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)


4
13
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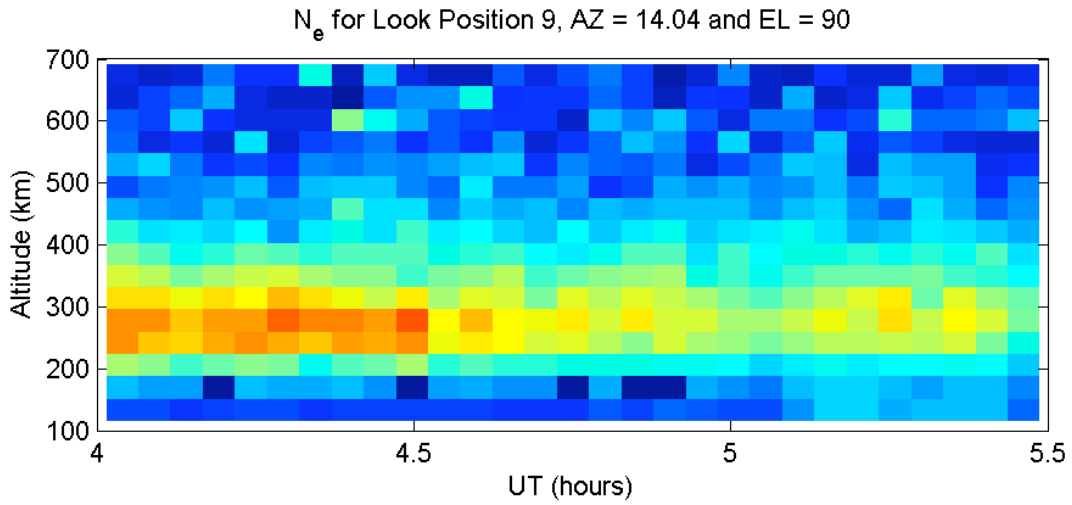
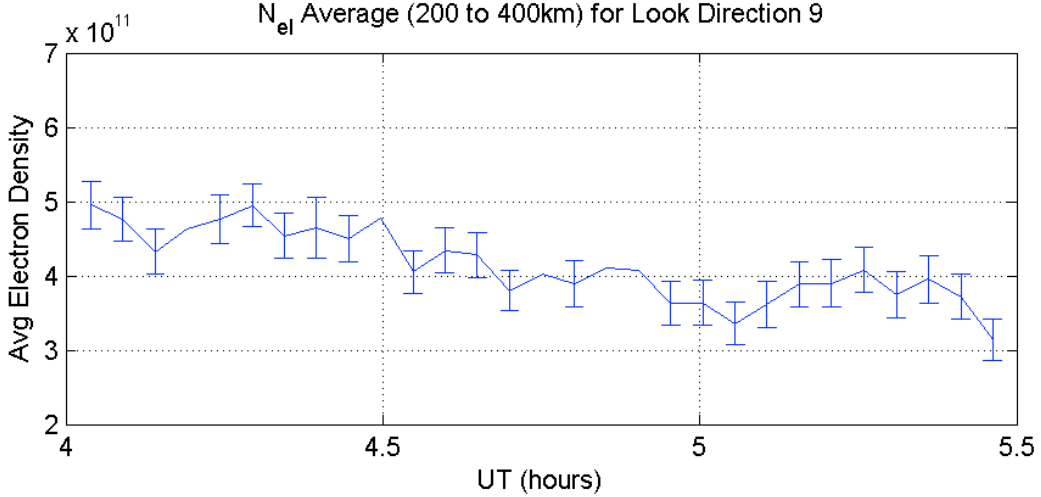
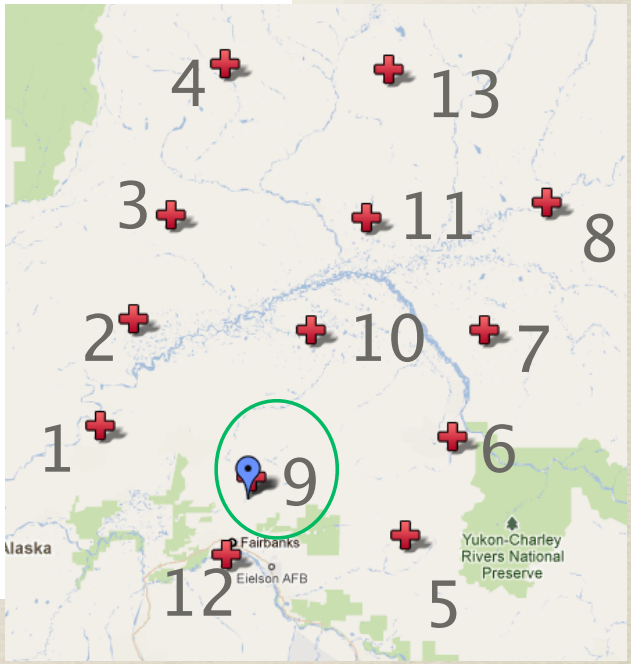
9
12
5
Fairbanks
Eielson AFB
Yukon-Charley
Rivers National
Preserve

PFISR

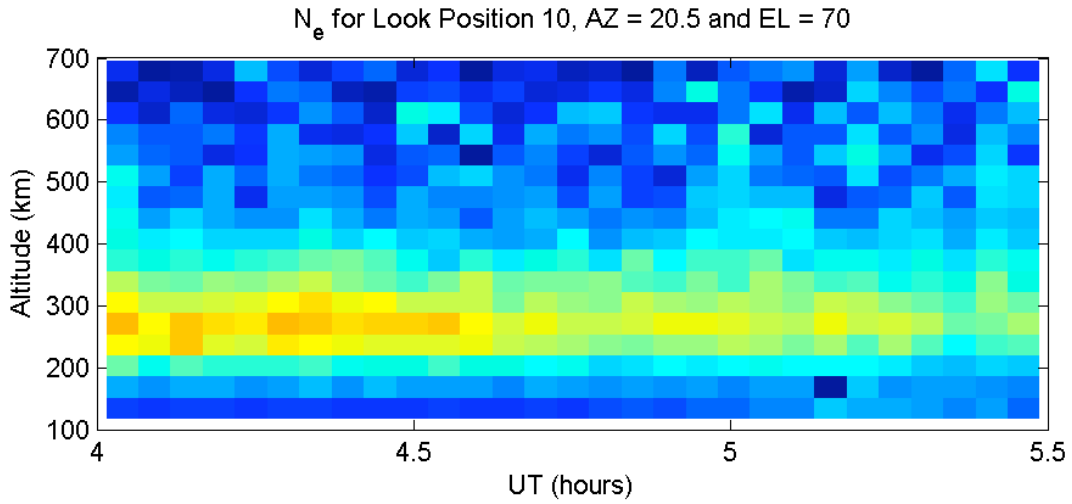

N_e for Look Position 9, AZ = 14.04 and EL = 90
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0

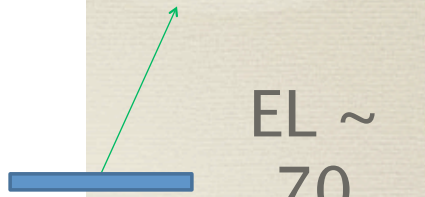
EL up

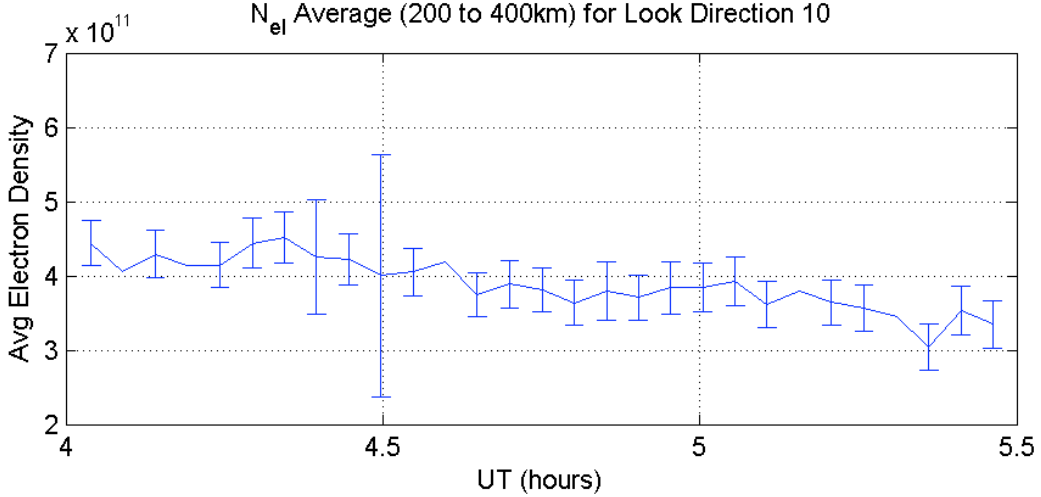

N_{el} Average (200 to 400km) for Look Direction 9
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)

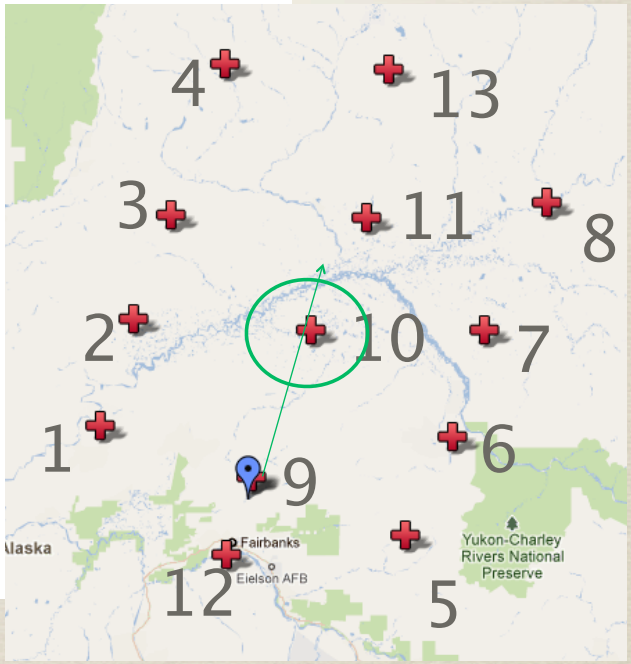

4
13
3
11
8
2
10
7
1
9
6
12
5
Fairbanks
Eielson AFB
Yukon-Charley Rivers National Preserve

PFISR

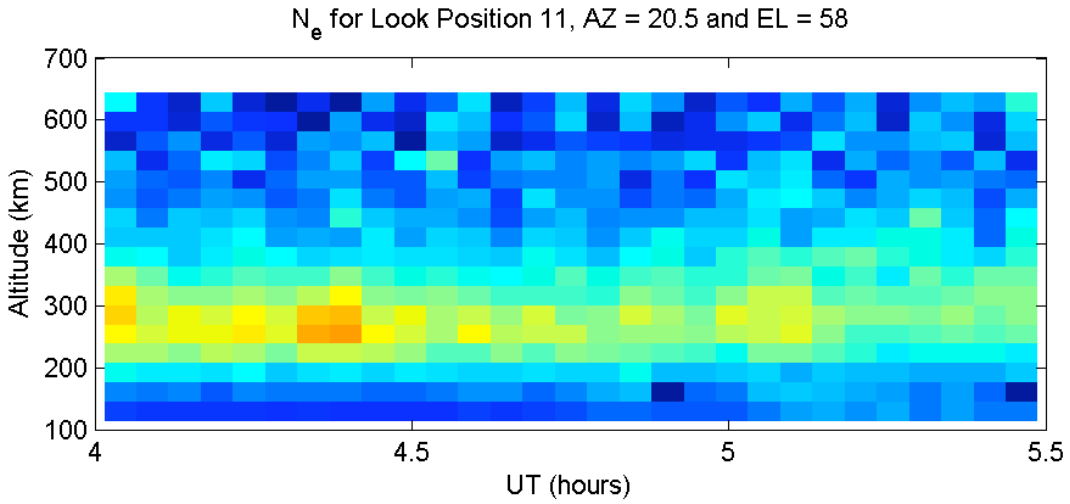

N_e for Look Position 10, AZ = 20.5 and EL = 70
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0

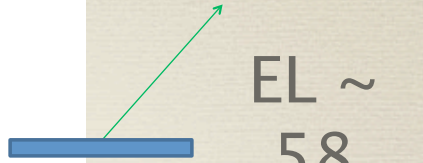

EL ~ 70

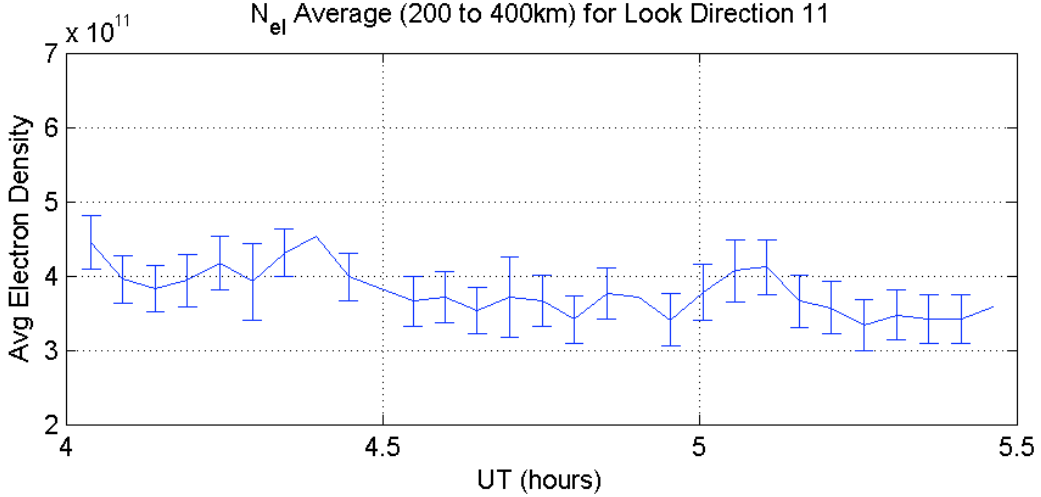

N_{el} Average (200 to 400km) for Look Direction 10
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)

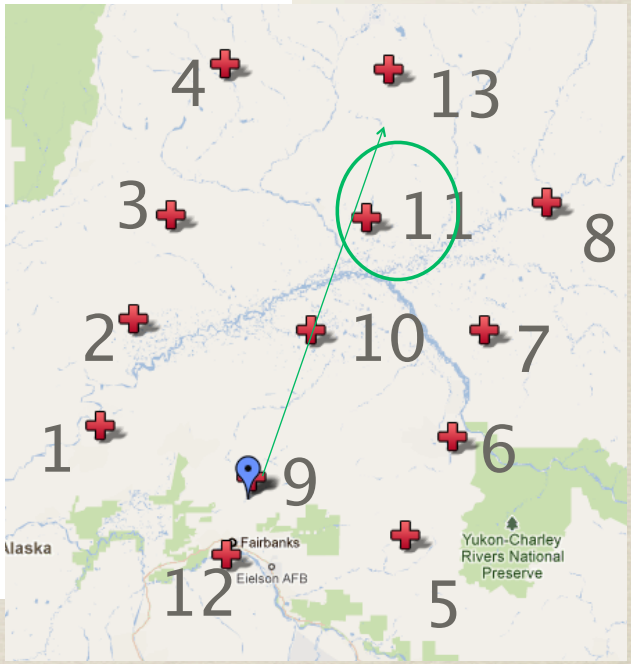

4
13
3
11
8
2
10
7
1
6
9
Fairbanks
Eielson AFB
12
5
Yukon-Charley Rivers National Preserve

PFISR

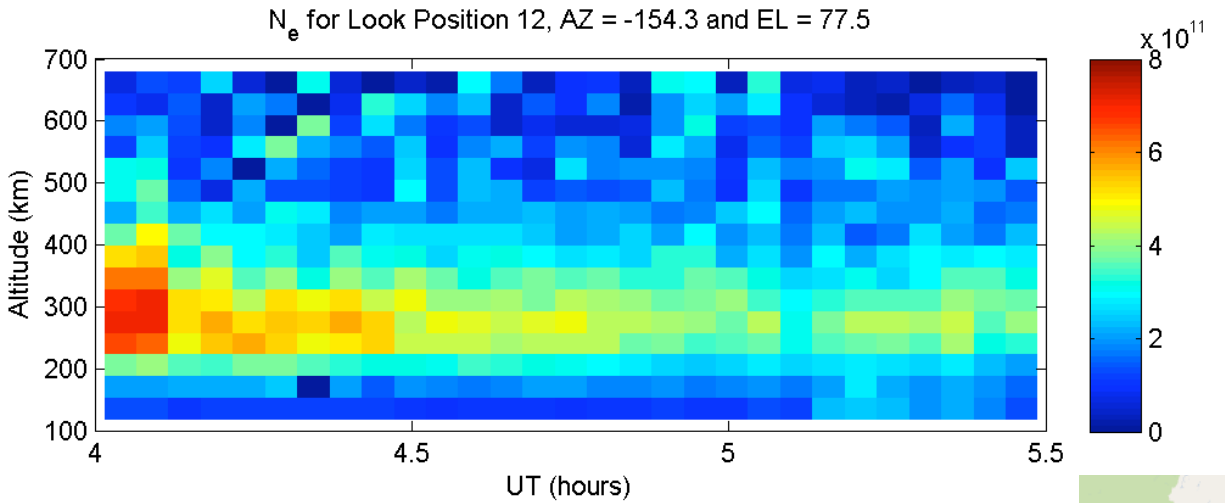

N_e for Look Position 11, AZ = 20.5 and EL = 58
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0

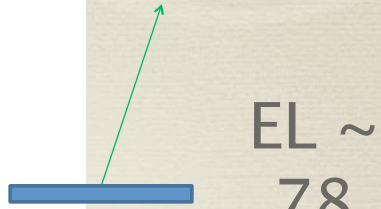

EL ~
58

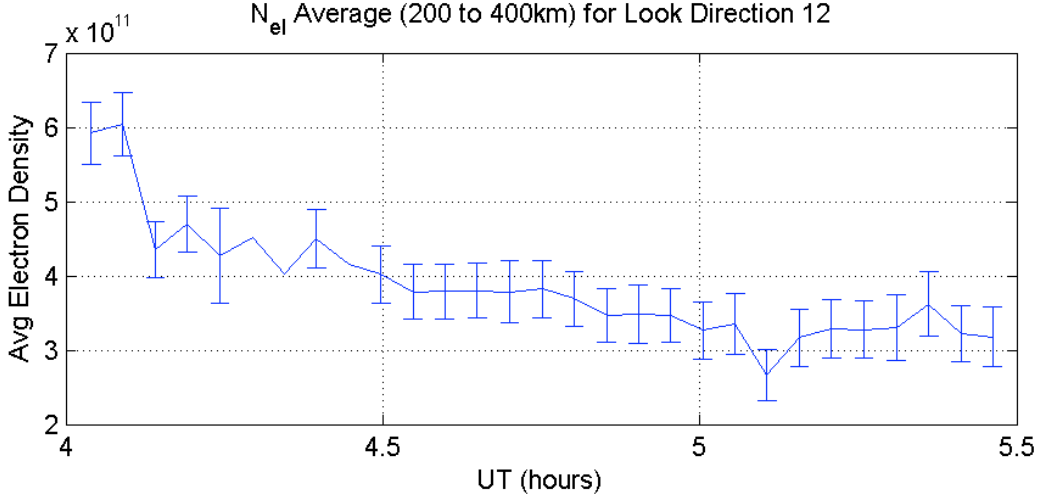

N_{el} Average (200 to 400km) for Look Direction 11
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)

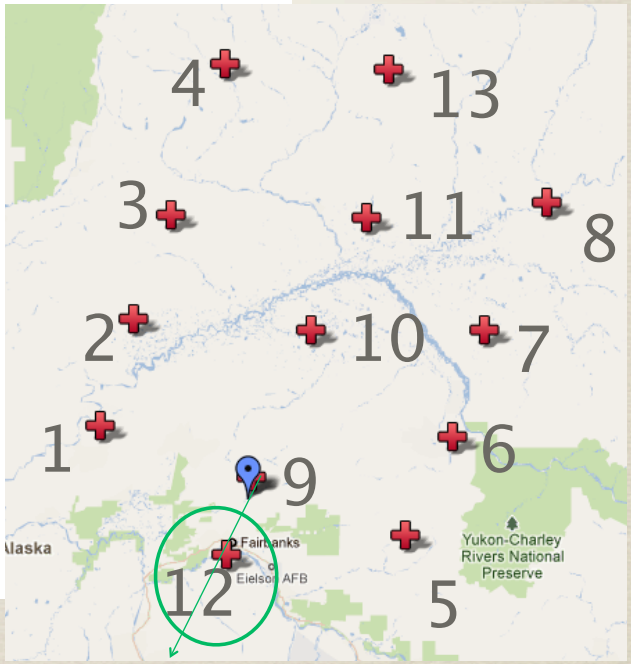

4
13
3
11
8
2
10
7
1
6
9
Fairbanks
Eielson AFB
12
5
Yukon-Charley
Rivers National
Preserve

PFISR

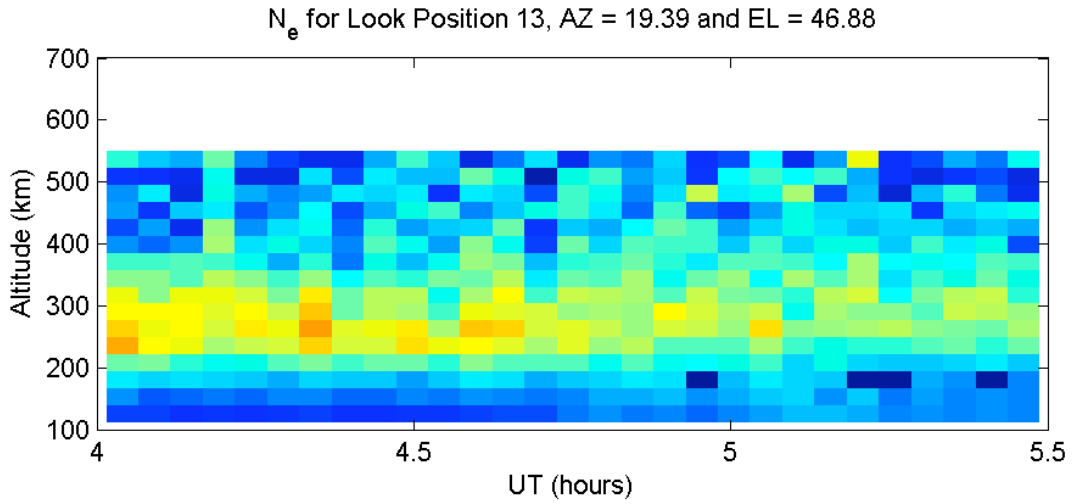

N_e for Look Position 12, AZ = -154.3 and EL = 77.5
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0

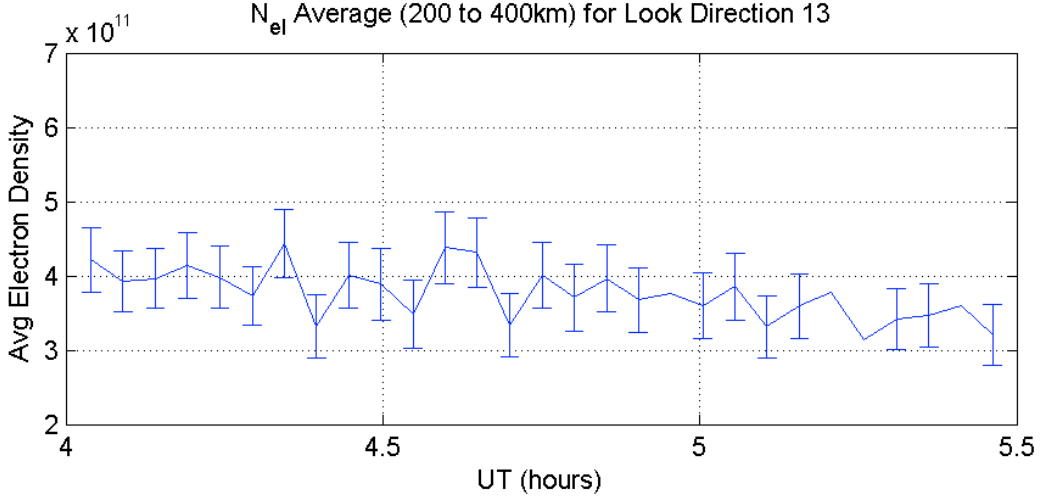

EL ~
78

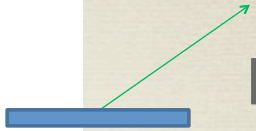

N_{el} Average (200 to 400km) for Look Direction 12
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)

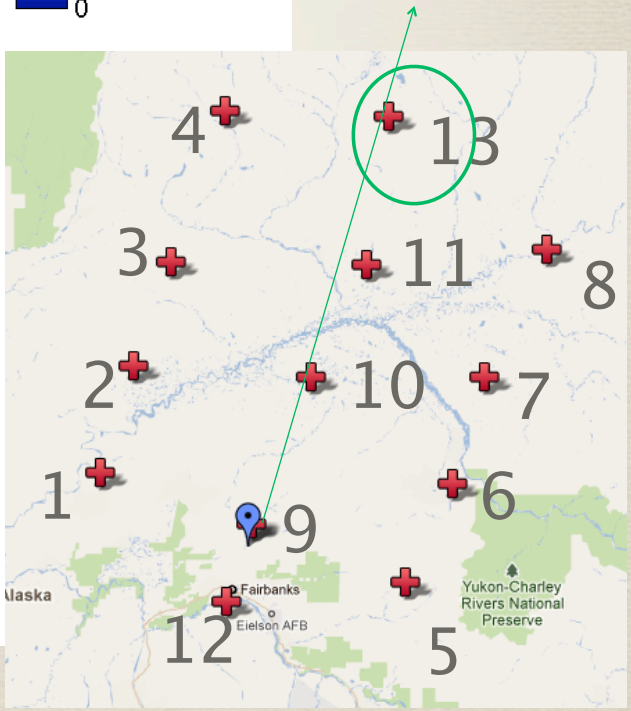

4
13
3
11
8
2
10
7
1
6
9
12
5
Yukon-Charley
Rivers National
Preserve

PFISR

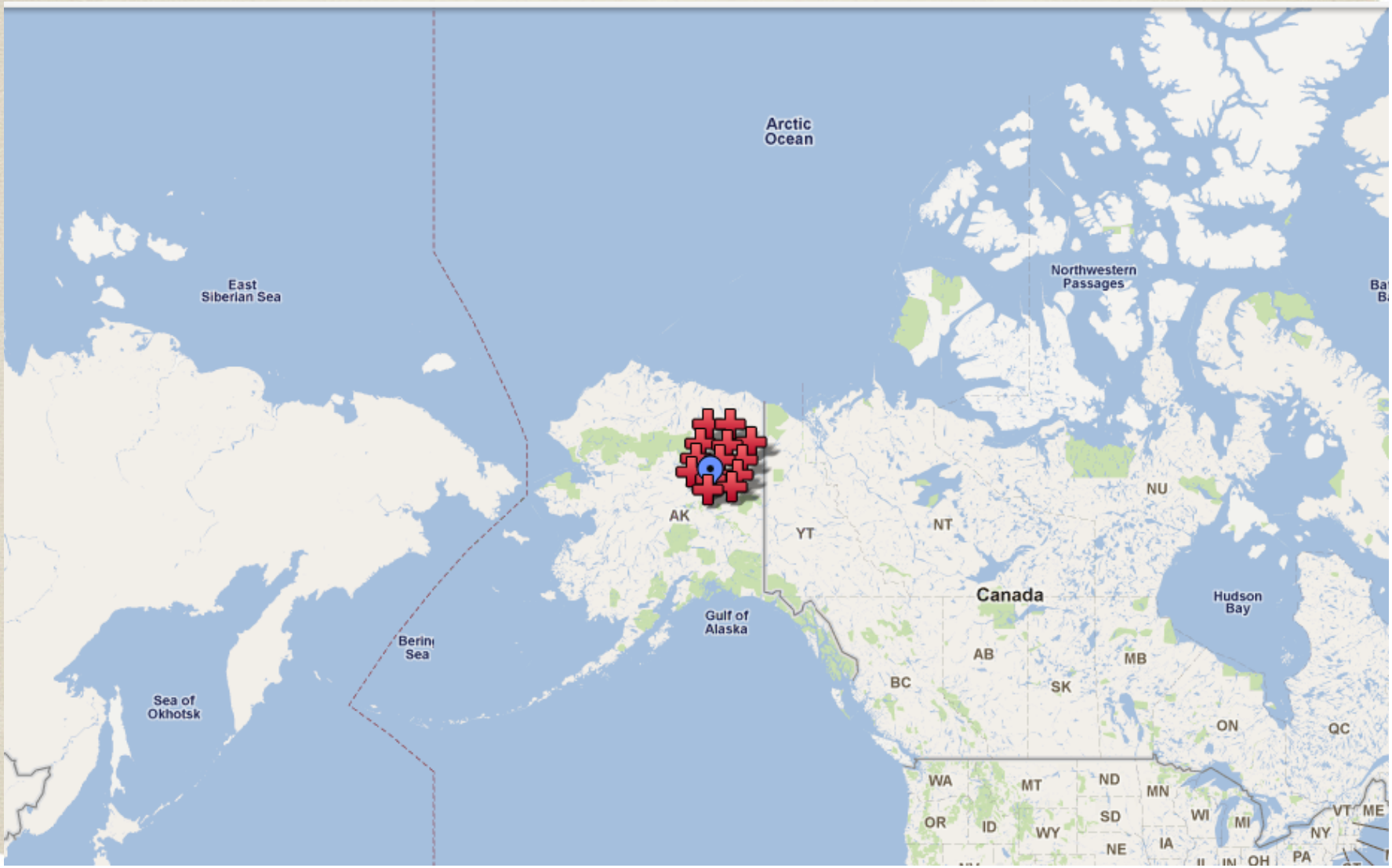

N_e for Look Position 13, AZ = 19.39 and EL = 46.88
Altitude (km)
700
600
500
400
300
200
100
4
4.5
5
5.5
UT (hours)
x 10^{11}
8
6
4
2
0


N_{el} Average (200 to 400km) for Look Direction 13
x 10^{11}
Avg Electron Density
7
6
5
4
3
2
4
4.5
5
5.5
UT (hours)

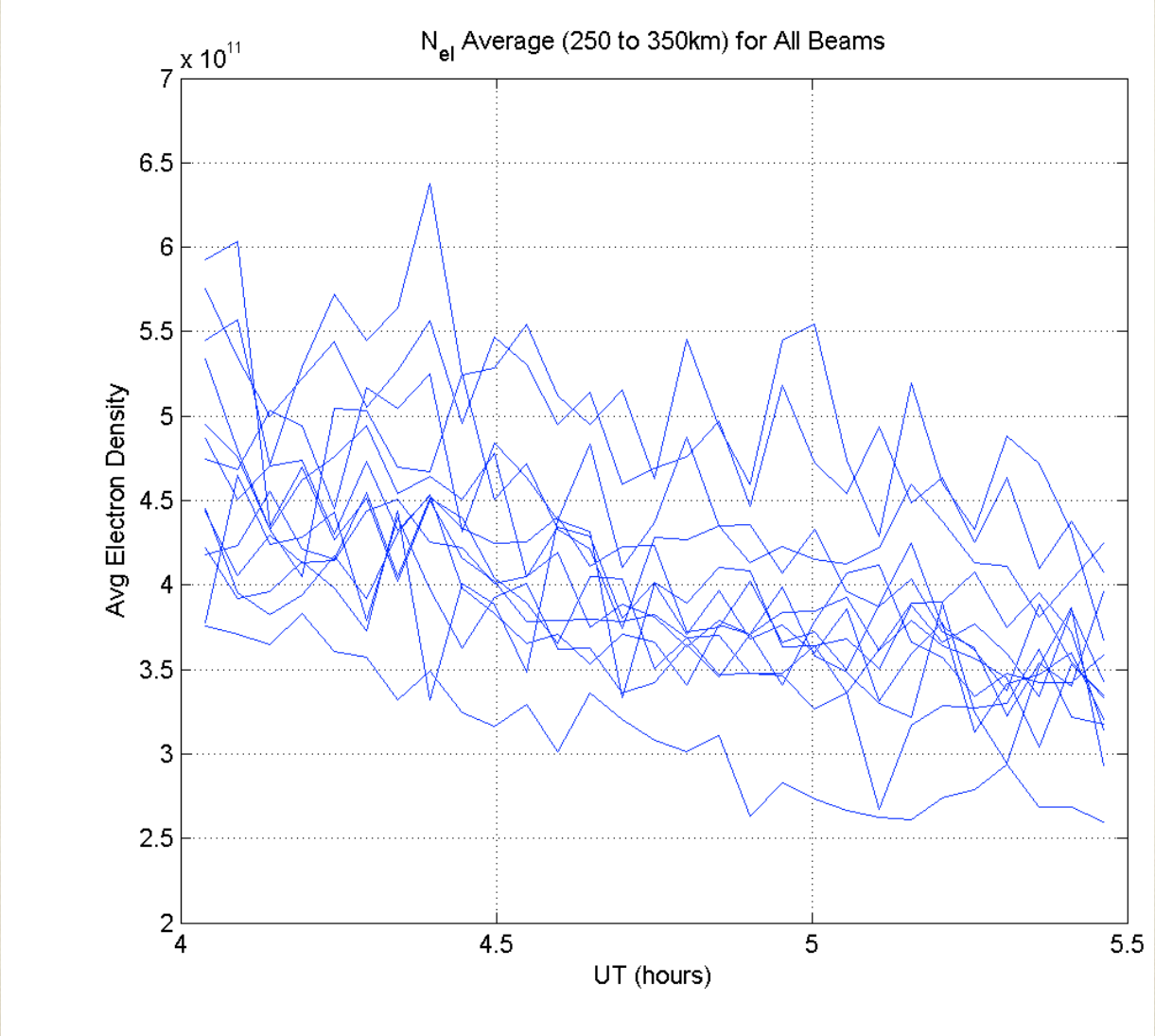

EL ~ 47


4
13
3
11
8
2
10
7
1
6
9
12
5
Fairbanks
Eielson AFB
Yukon-Charley Rivers National Preserve

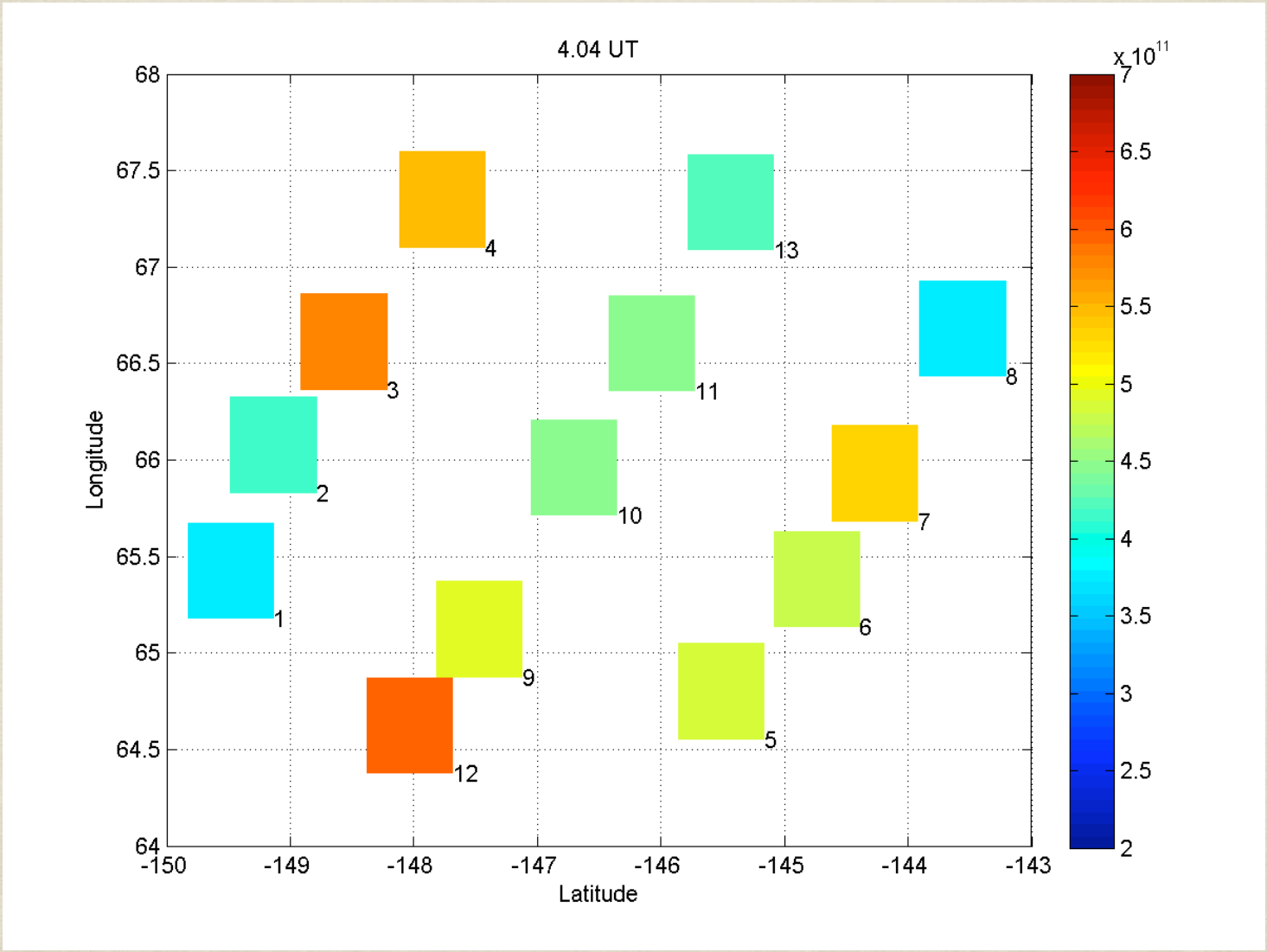
PFISR from Afar



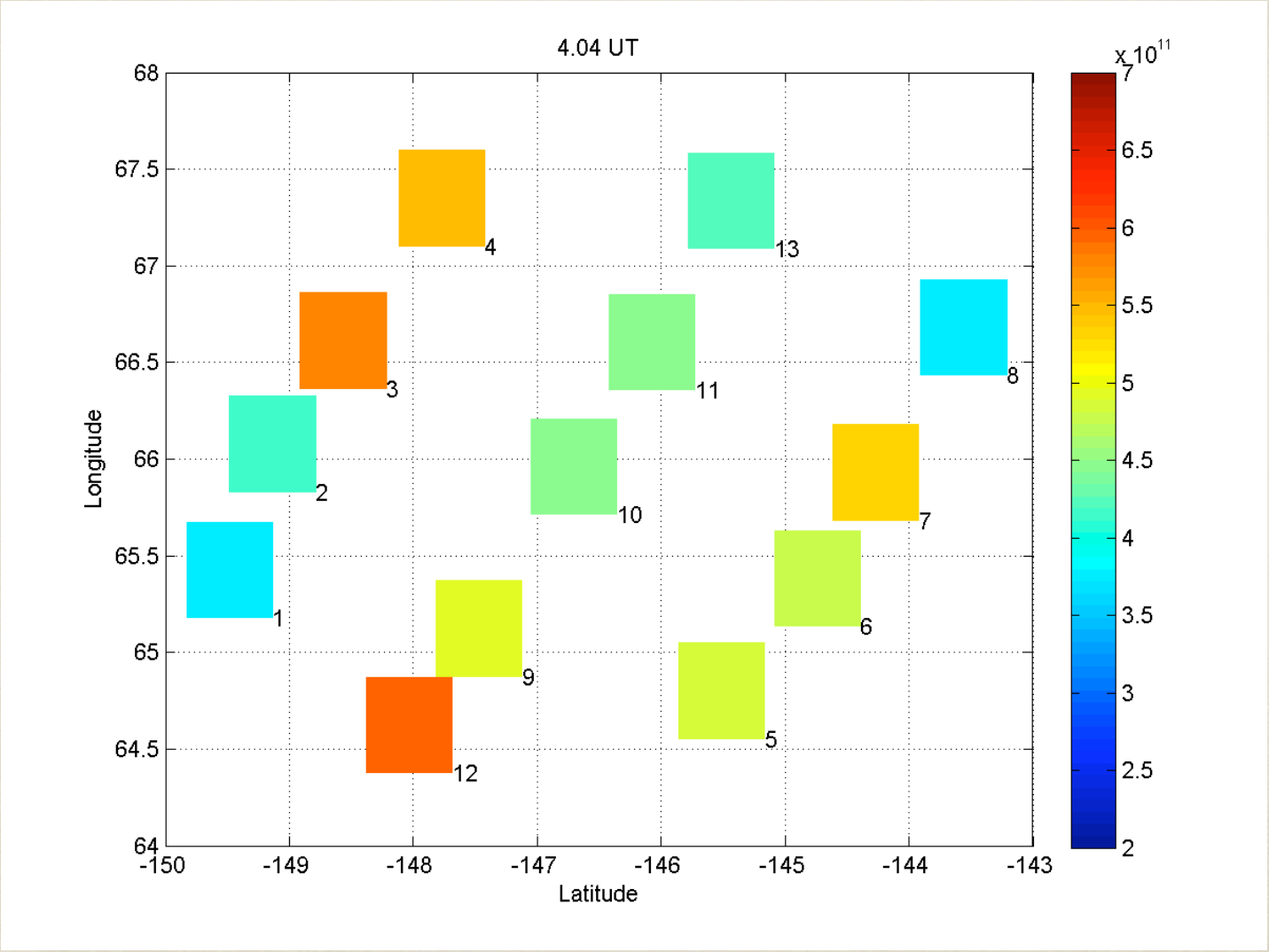
Comparing the Beams



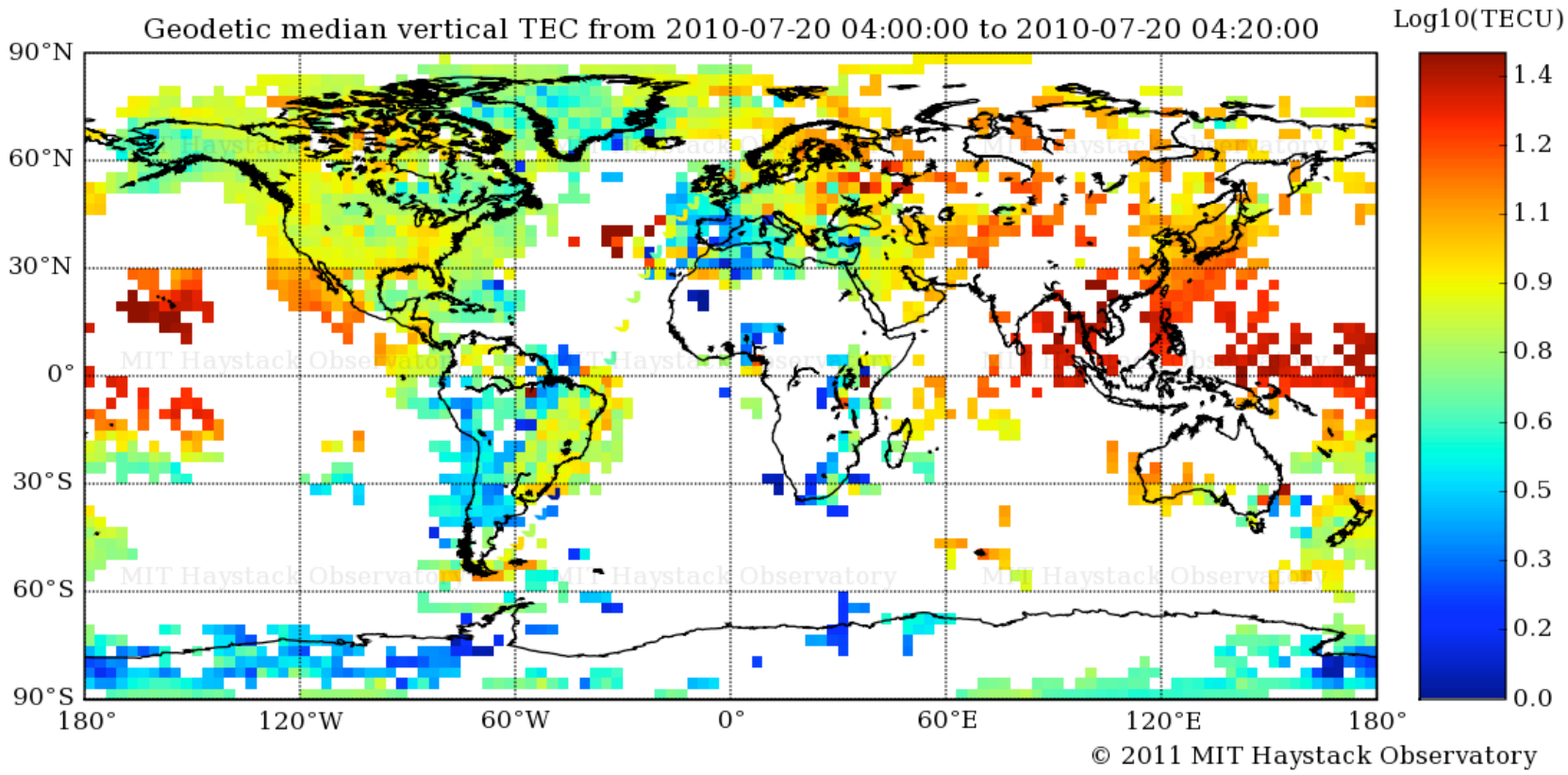
PFISR @ 300km Alt, avg n_{el} in F



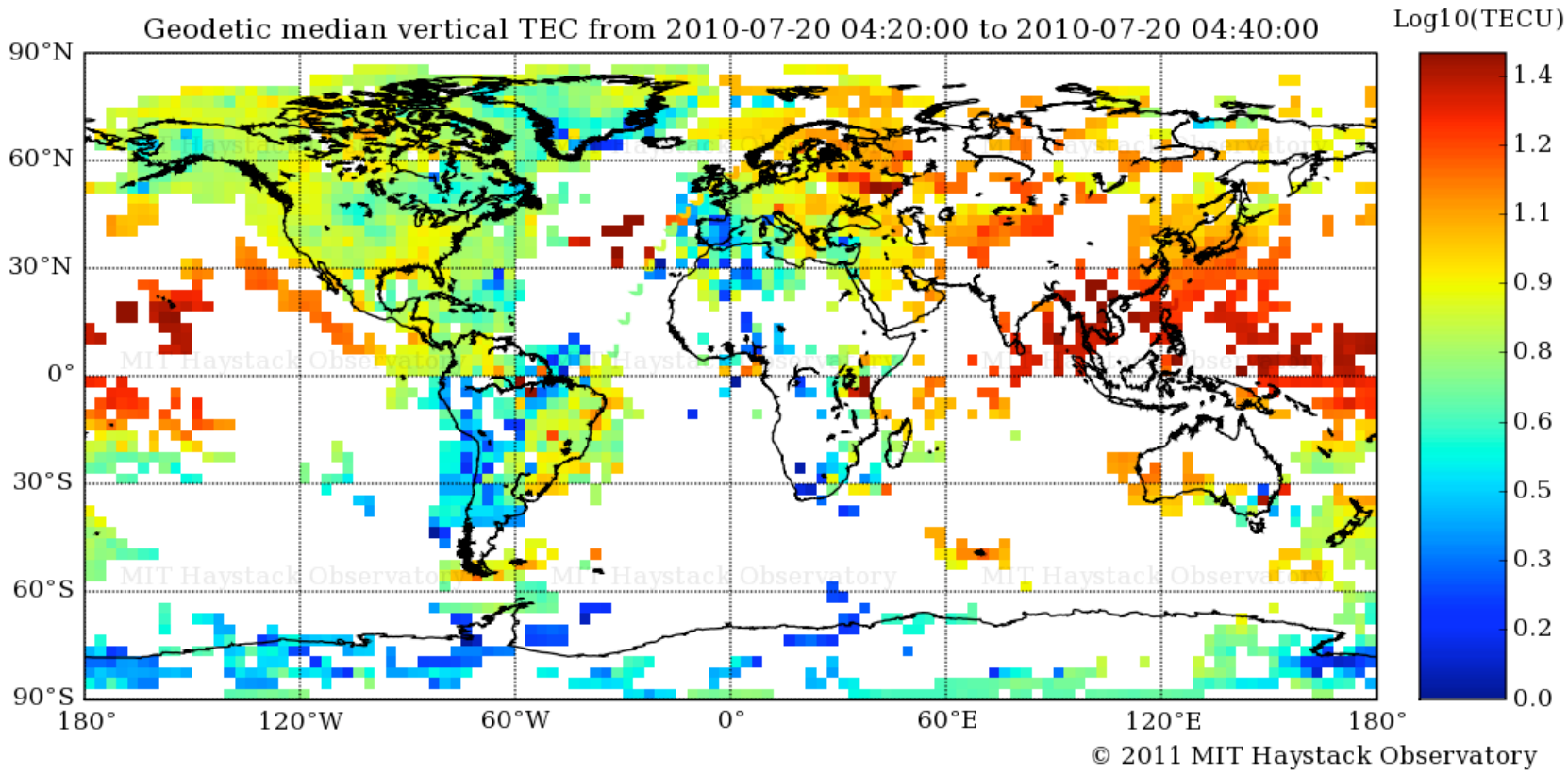
PFISR @ 300km Alt, avg n_{el} in F



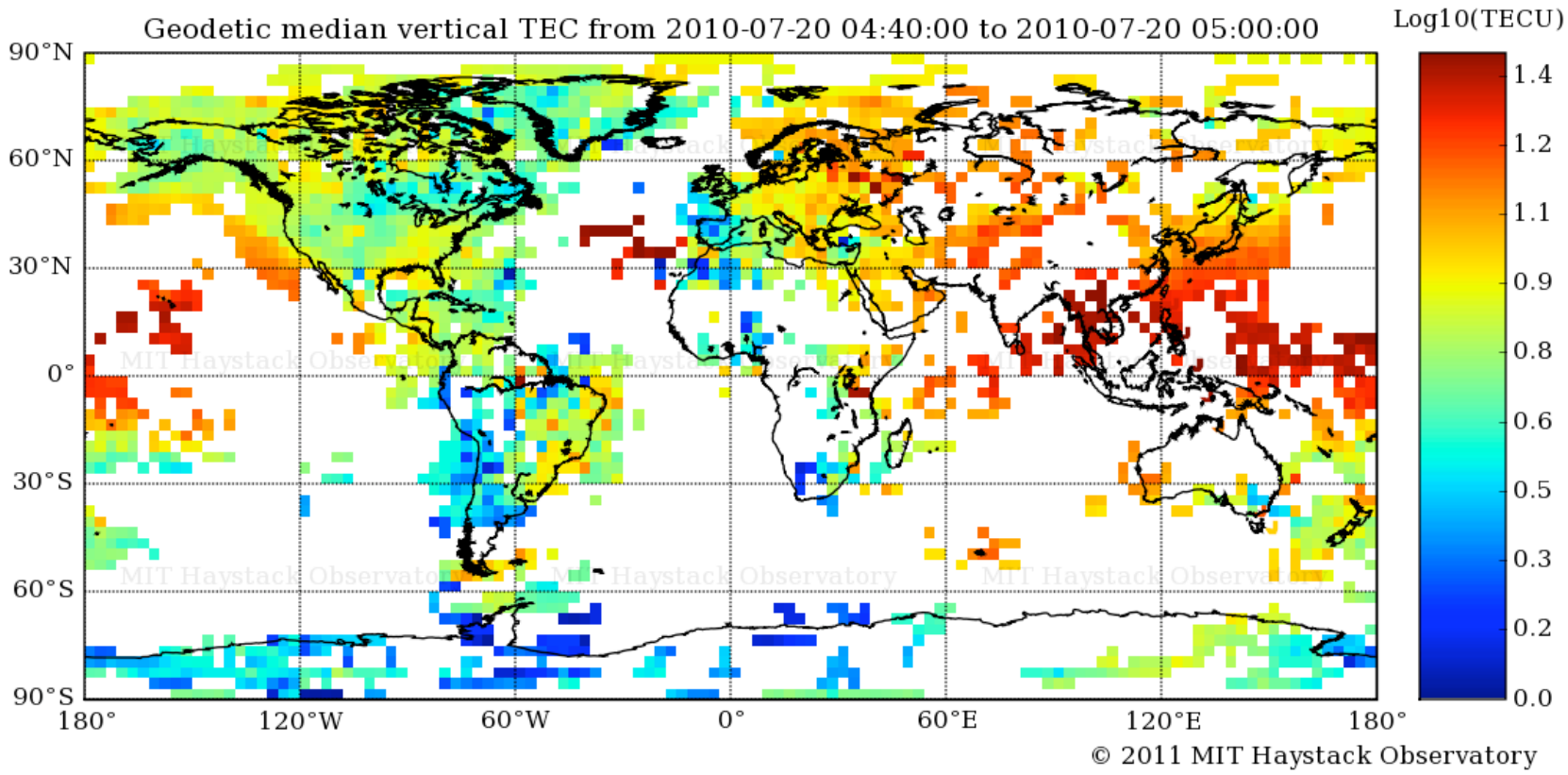
07/16/2010 – 1 year



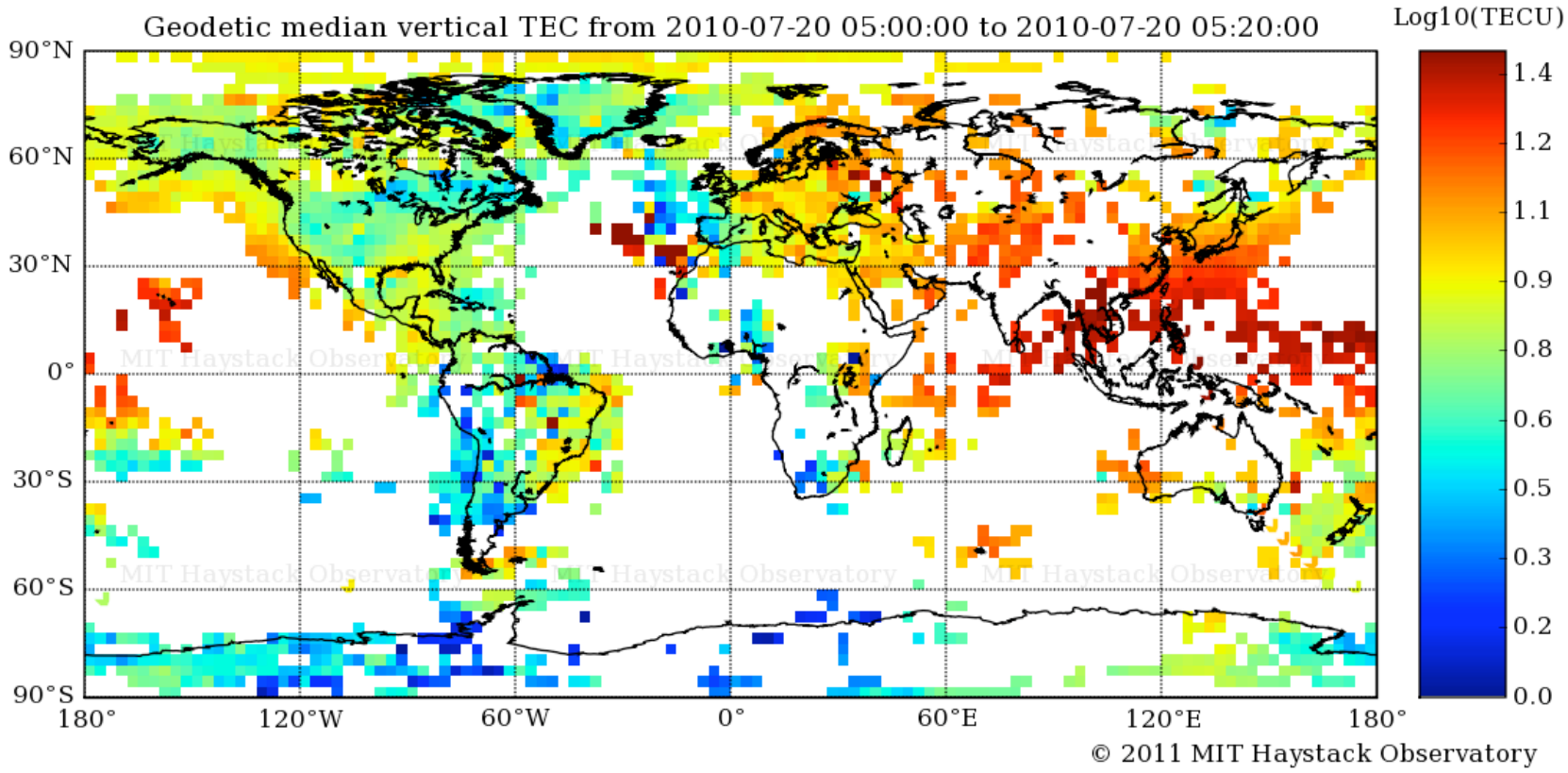
07/16/2010 – 1 year



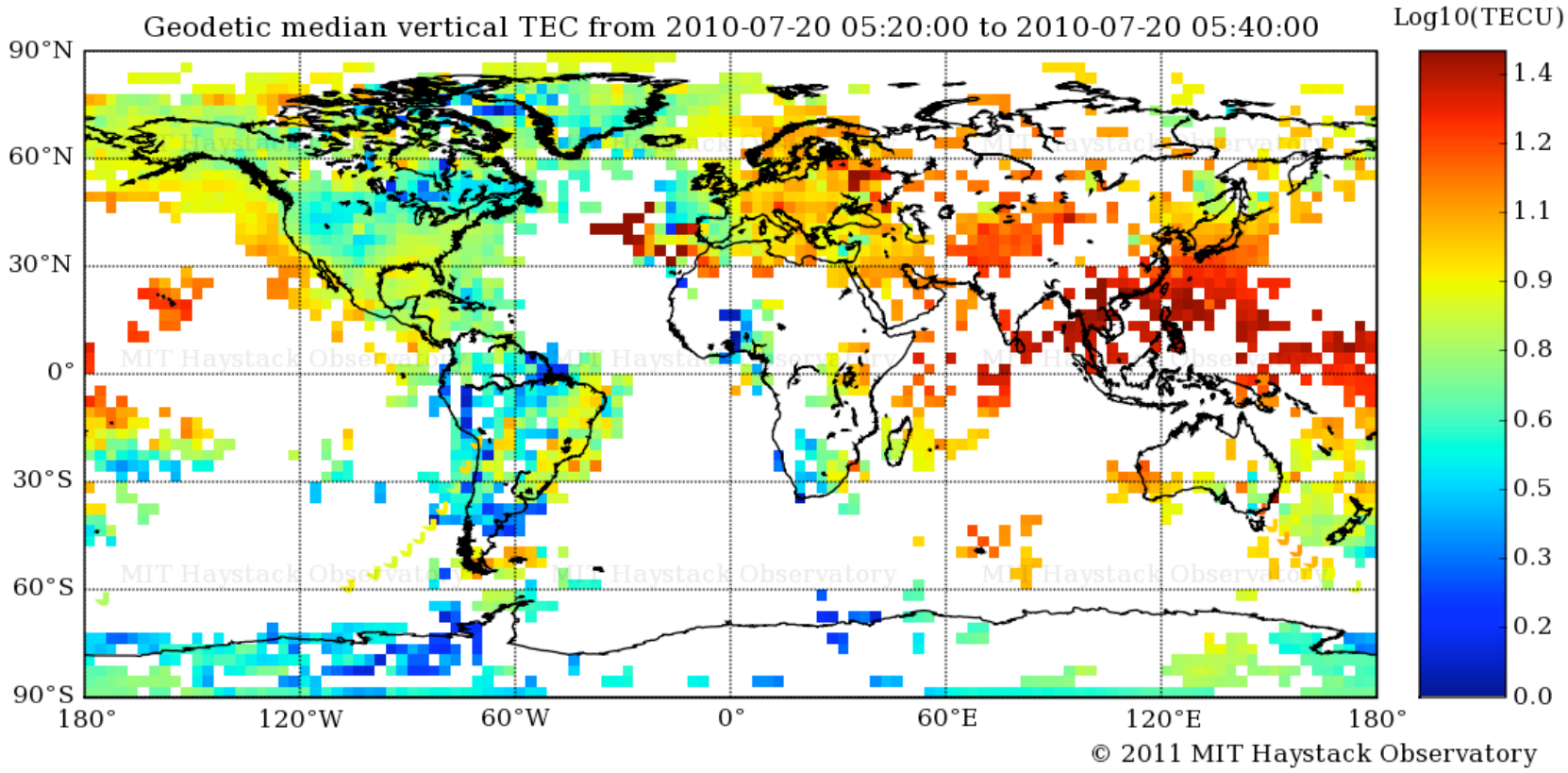
07/16/2010 – 1 year



07/16/2010 – 1 year

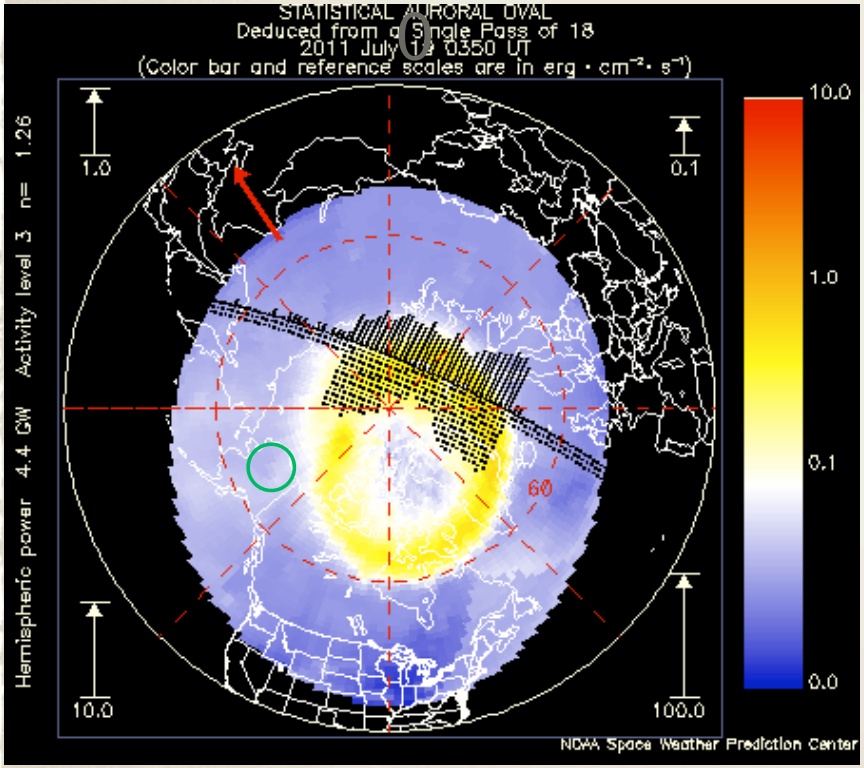


07/16/2010 – 1 year

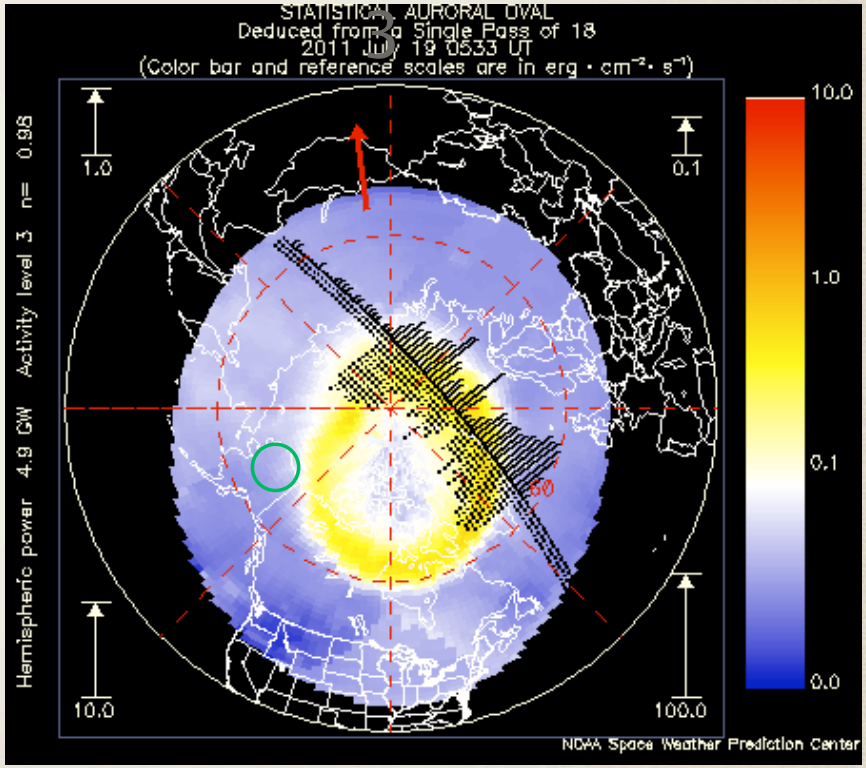


Auroral Oval?

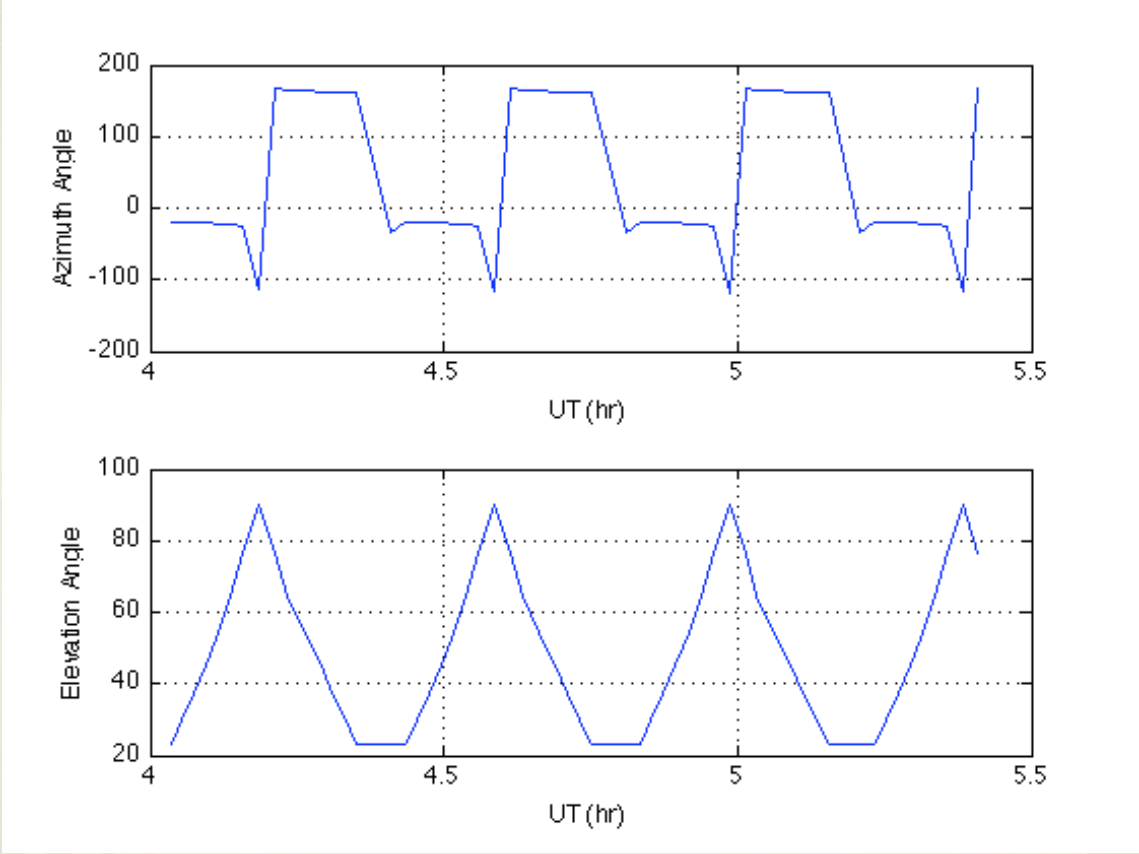
3:5



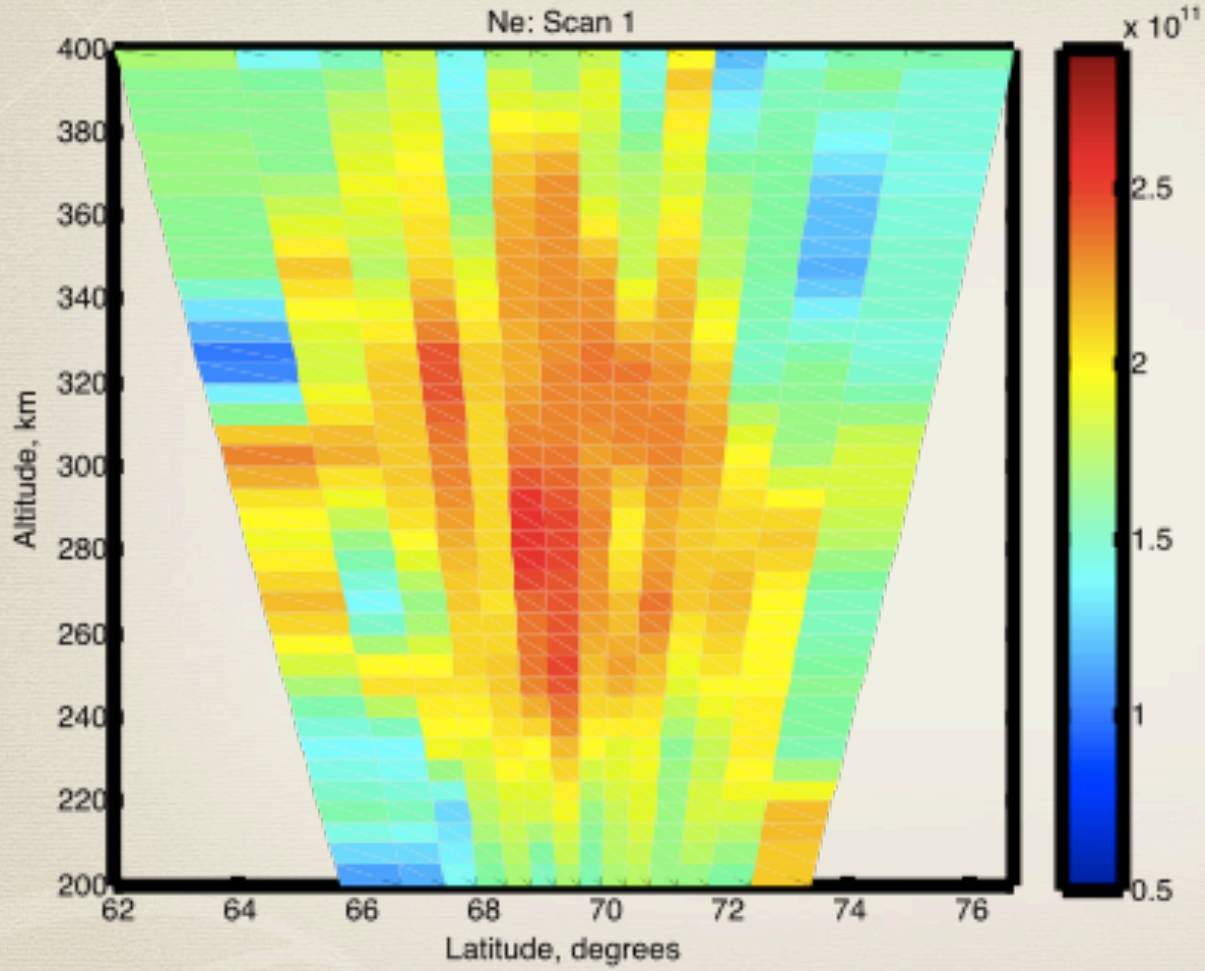
5:3



EISCAT

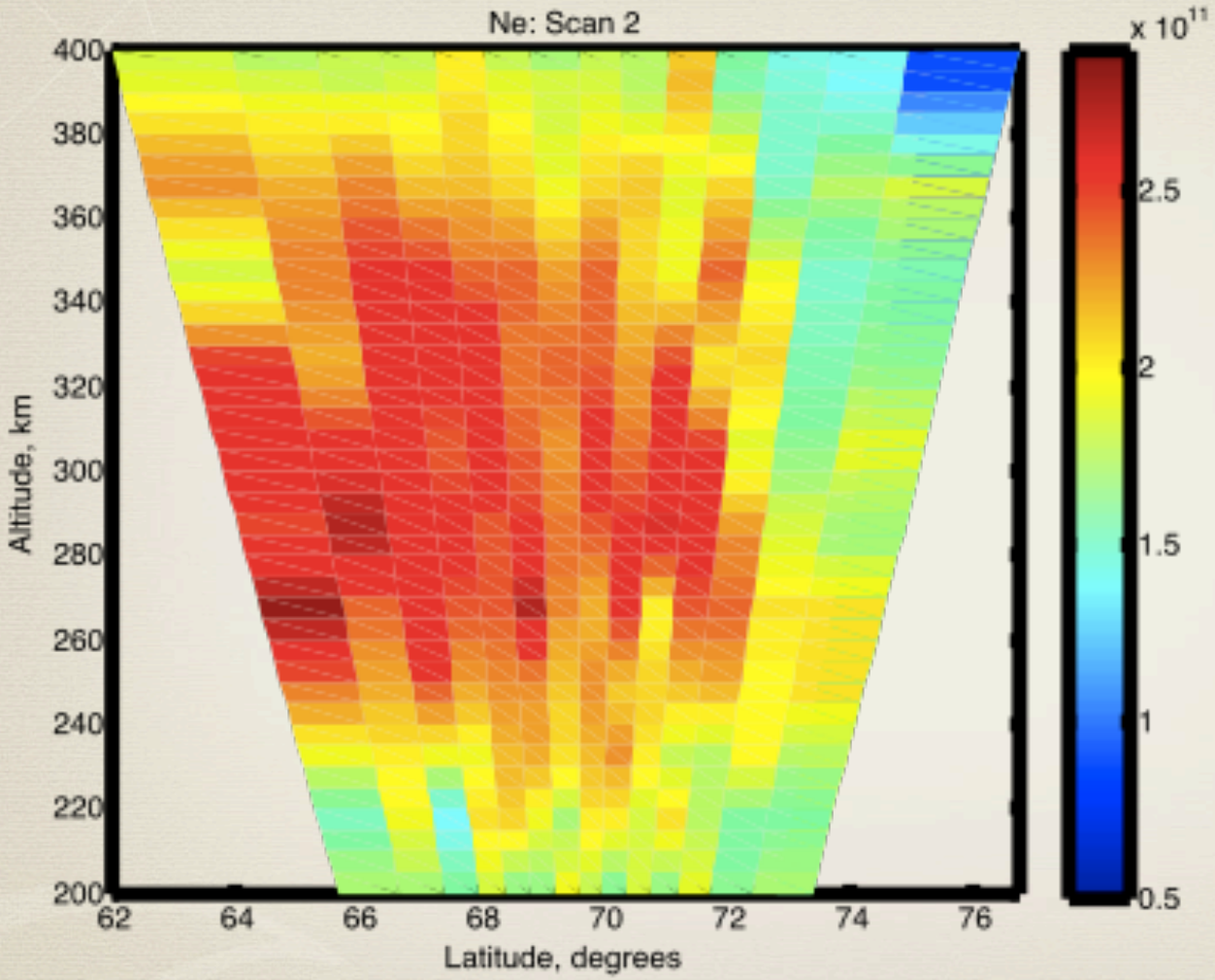

200
100
0
-100
-200
Azimuth Angle
4
4.5
5
5.5
UT (hr)
100
80
60
40
20
Elevation Angle
4
4.5
5
5.5
UT (hr)

EISCAT



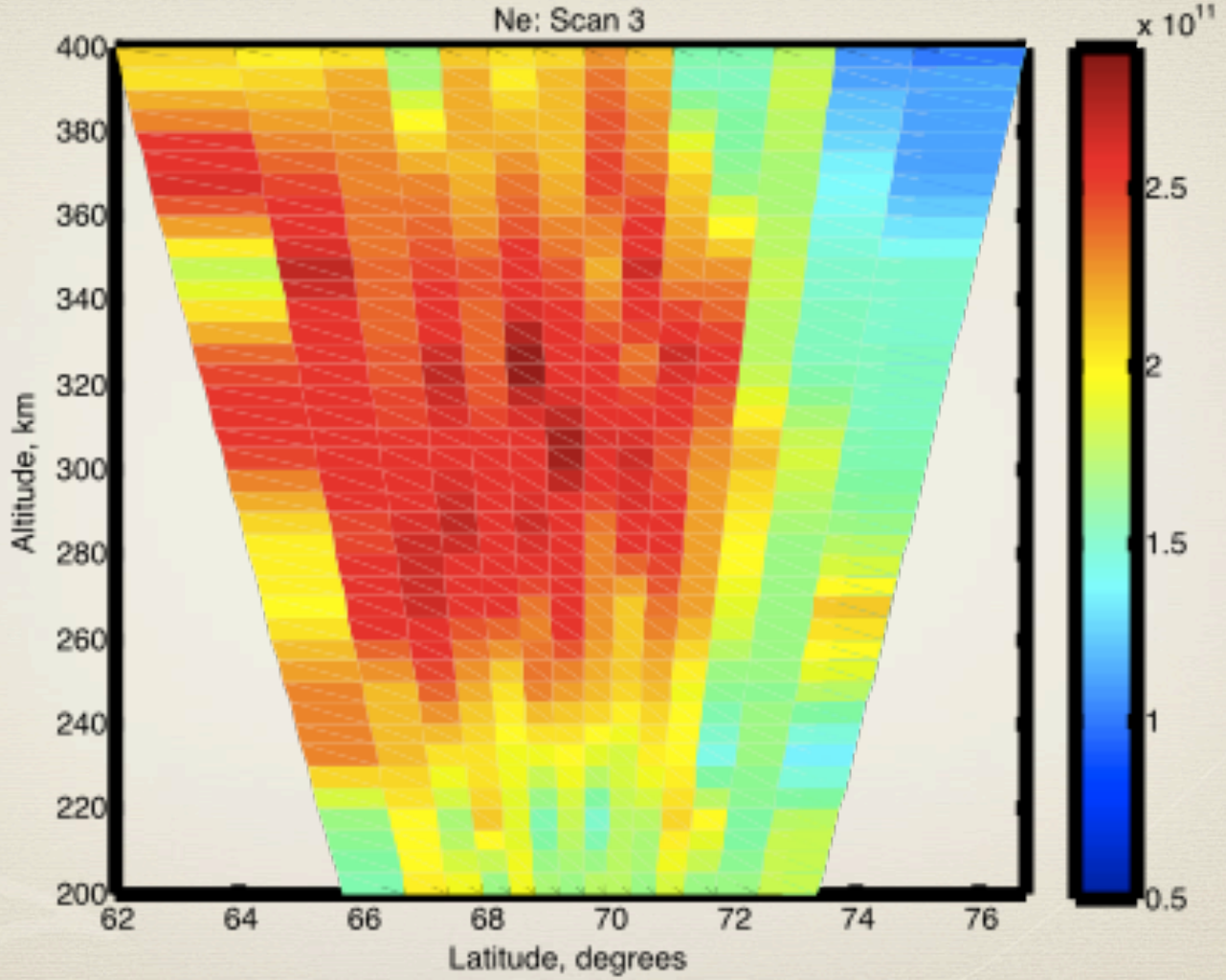
Enhanced Ne observed throughout F-region

EISCAT

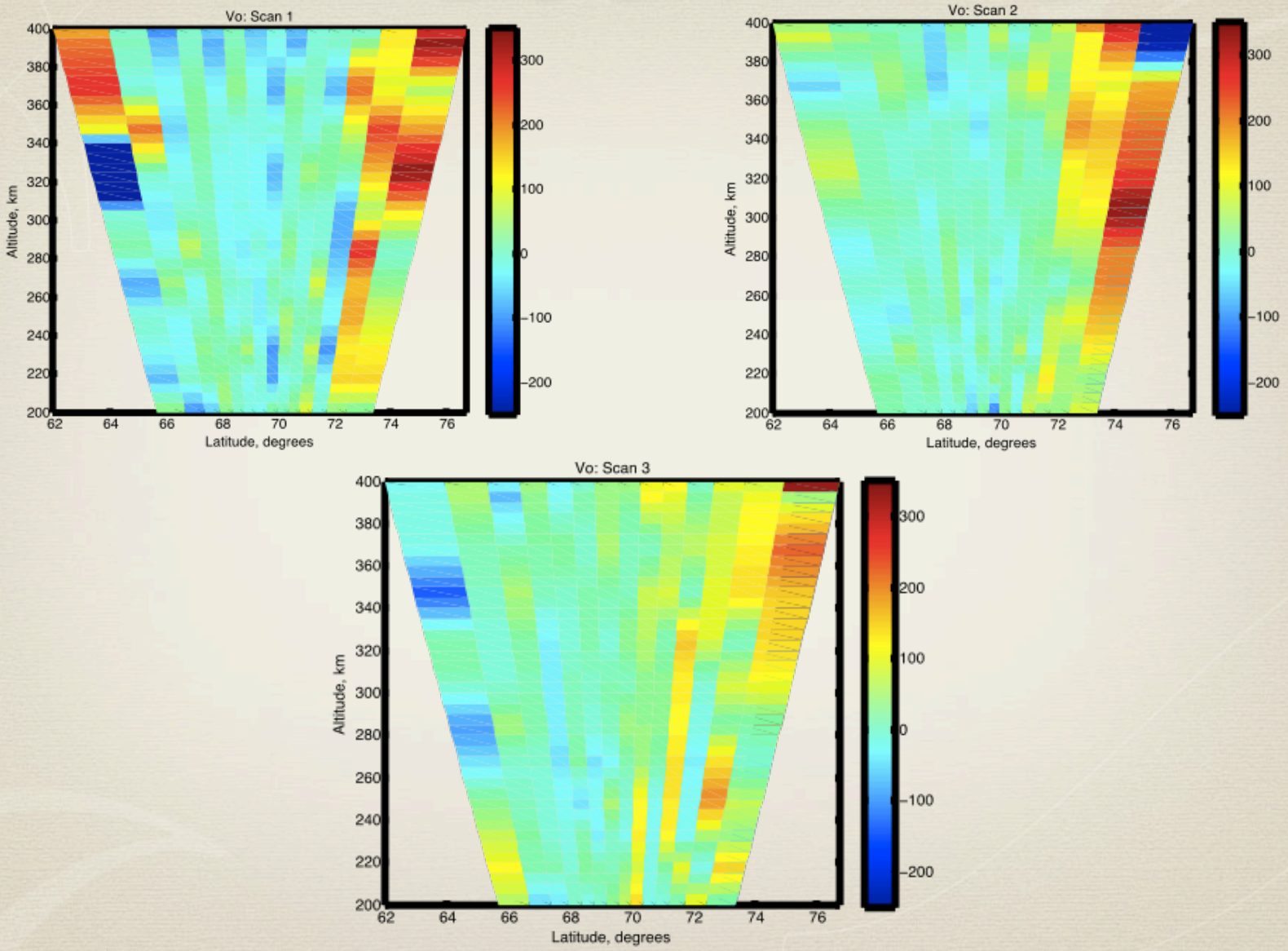


Enhanced Ne region migrates southward

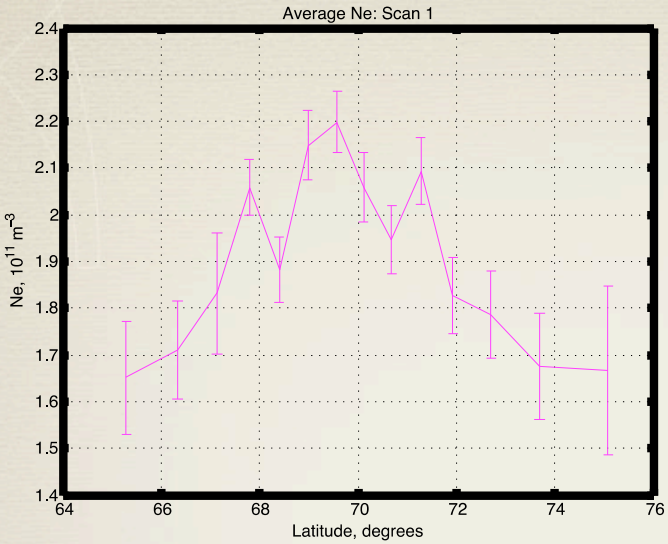
EISCAT

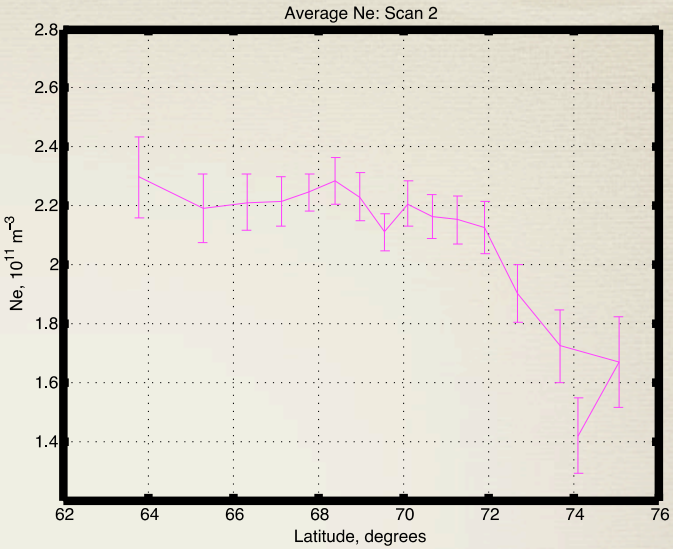

Ne: Scan 3
x 10^11
Altitude, km
400
380
360
340
320
300
280
260
240
220
200
62
64
66
68
70
72
74
76
Latitude, degrees
2.5
2
1.5
1
0.5

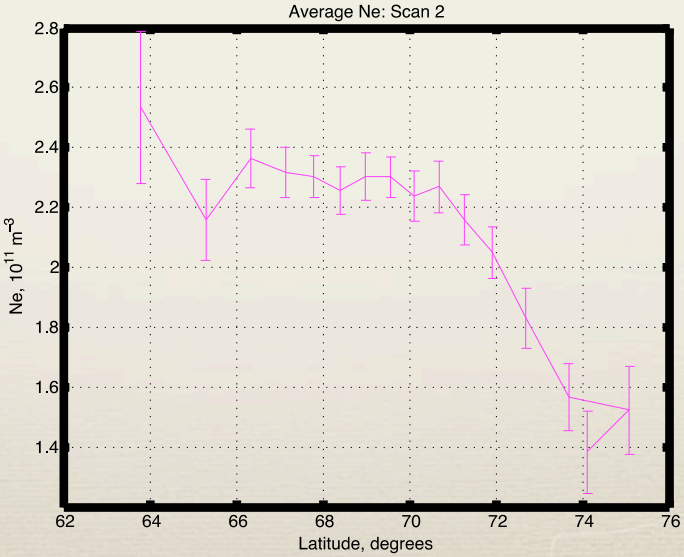
EISCAT


Vo: Scan 1
Vo: Scan 2
Vo: Scan 3
Altitude, km
Latitude, degrees
400
380
360
340
320
300
280
260
240
220
200
62
64
66
68
70
72
74
76
300
200
100
0
−100
−200

EISCAT

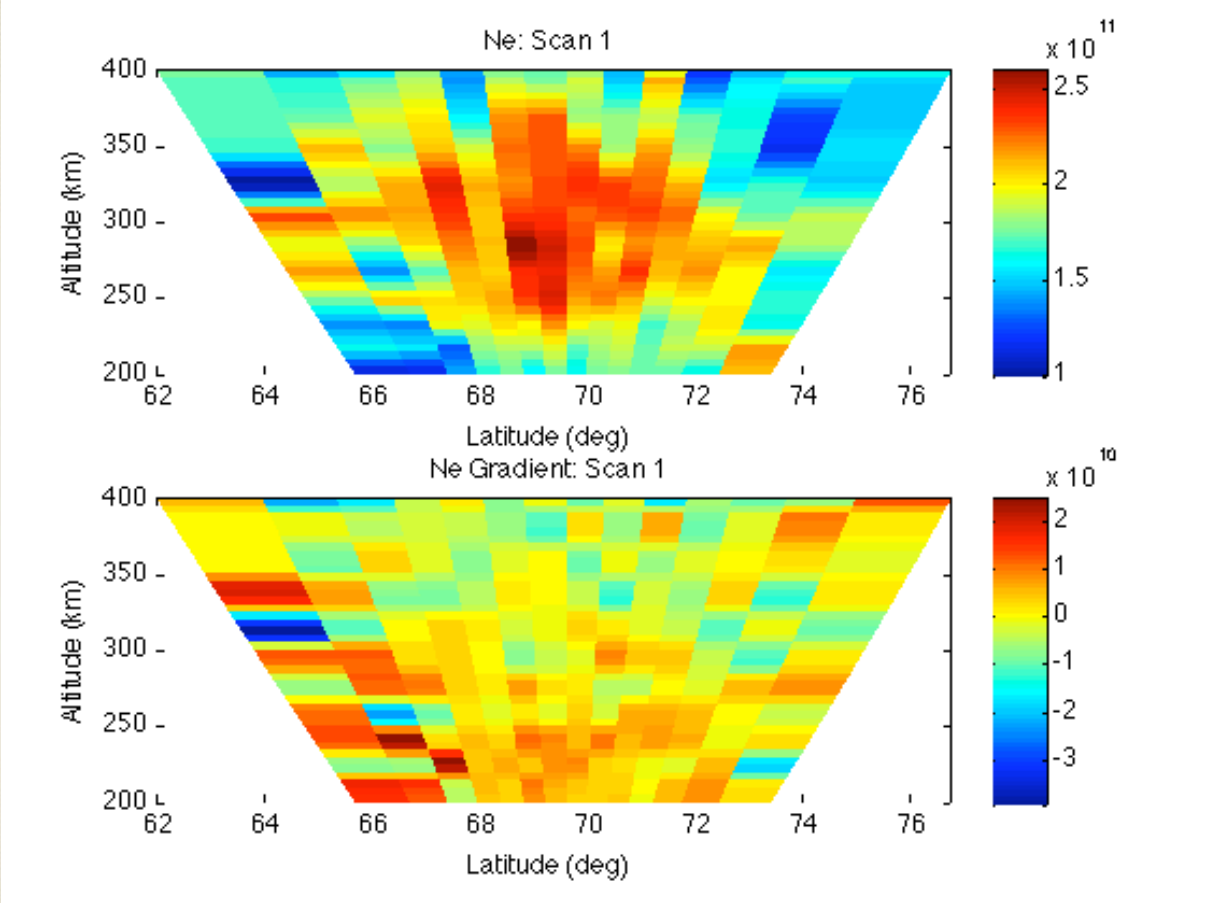




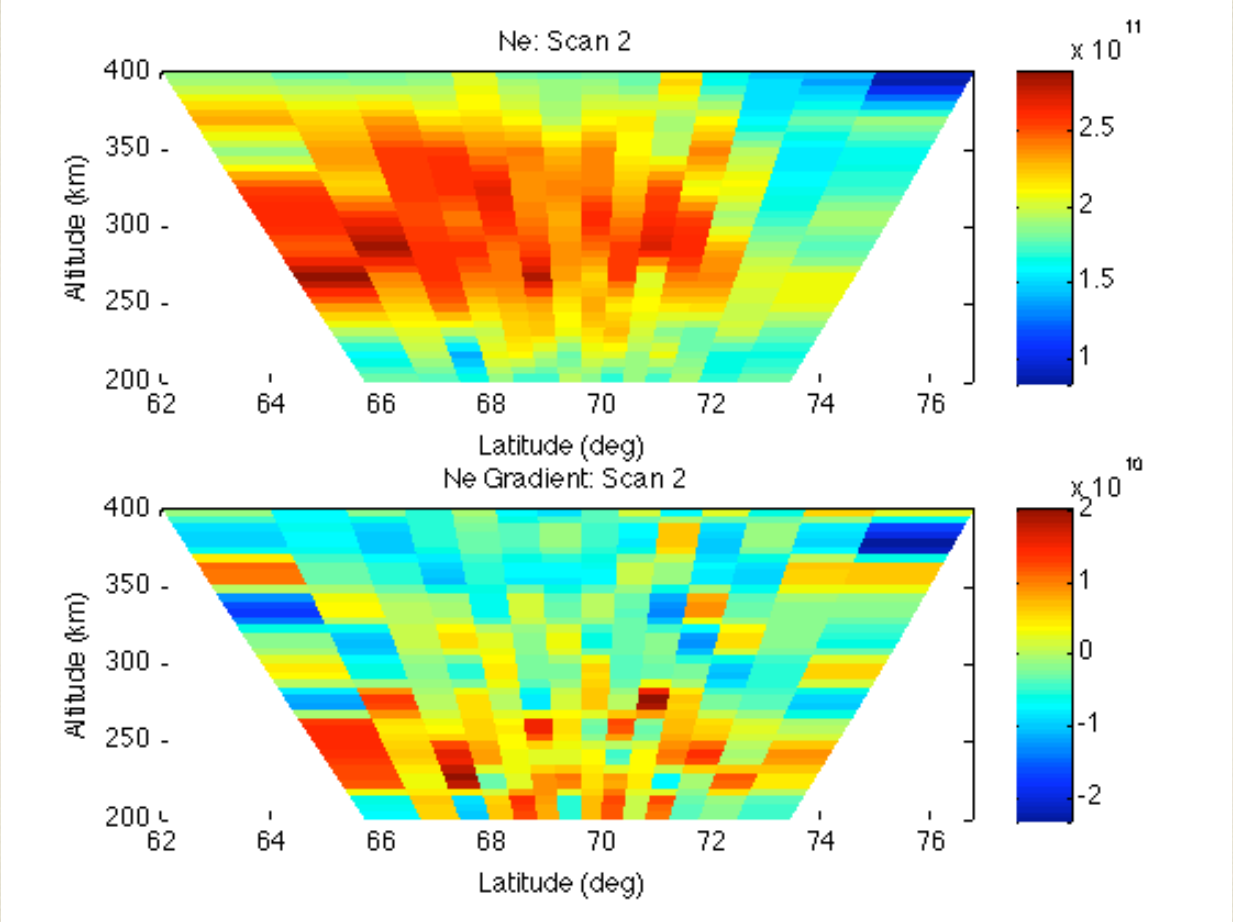


Enhanced Ne region migrates southward

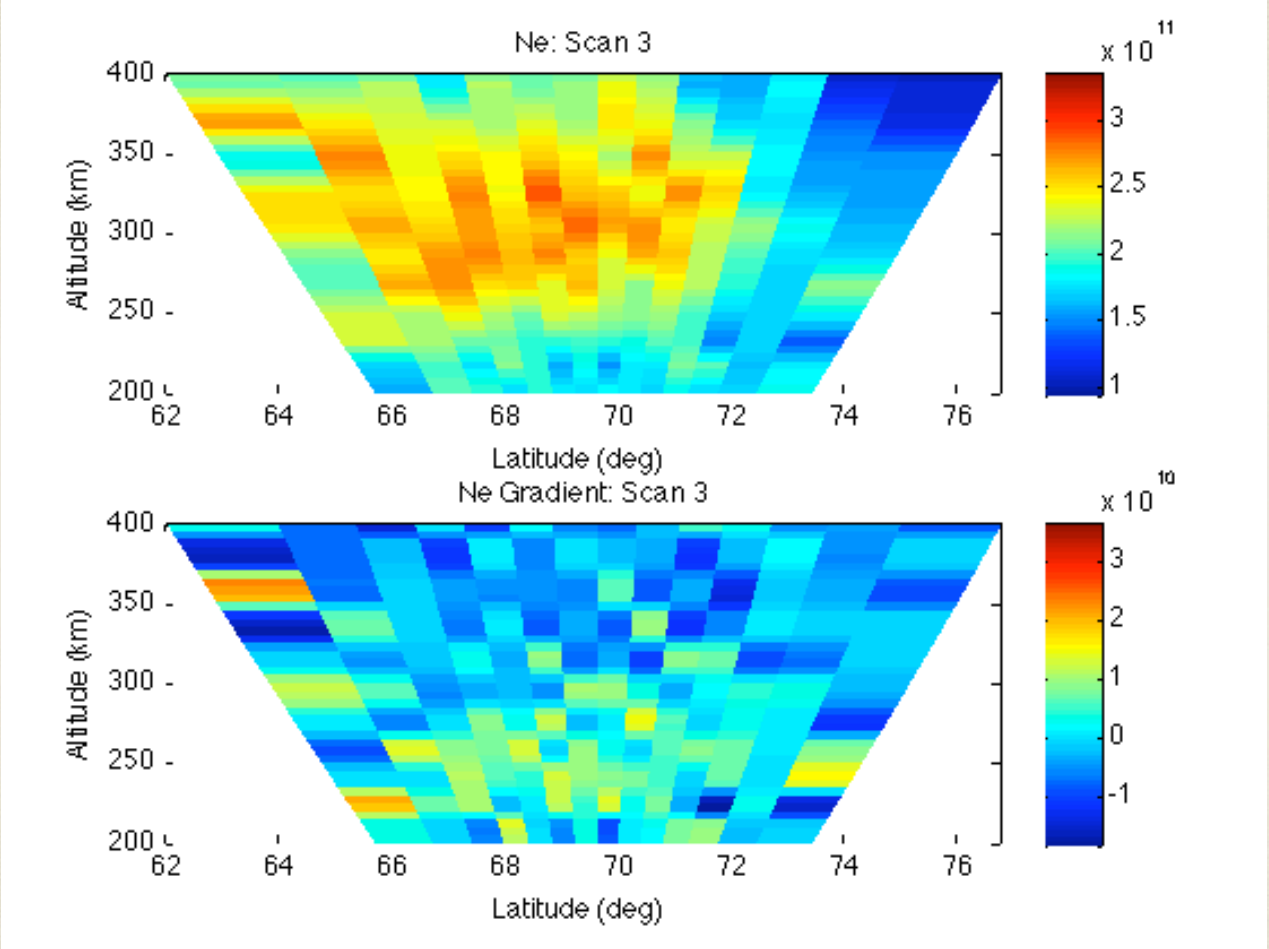
EISCAT


Ne: Scan 1
x 10^11
2.5
2
1.5
1
Altitude (km)
400
350
300
250
200
62
64
66
68
70
72
74
76
Latitude (deg)
Ne Gradient: Scan 1
x 10^10
2
1
0
-1
-2
-3
Altitude (km)
Latitude (deg)

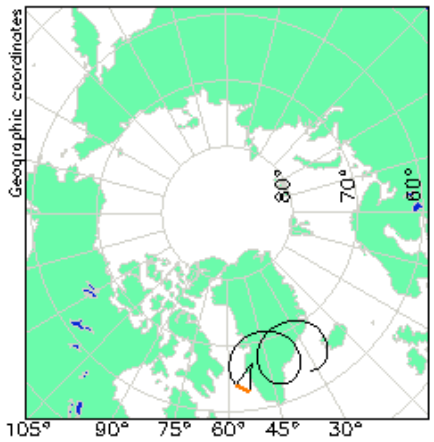
EISCAT

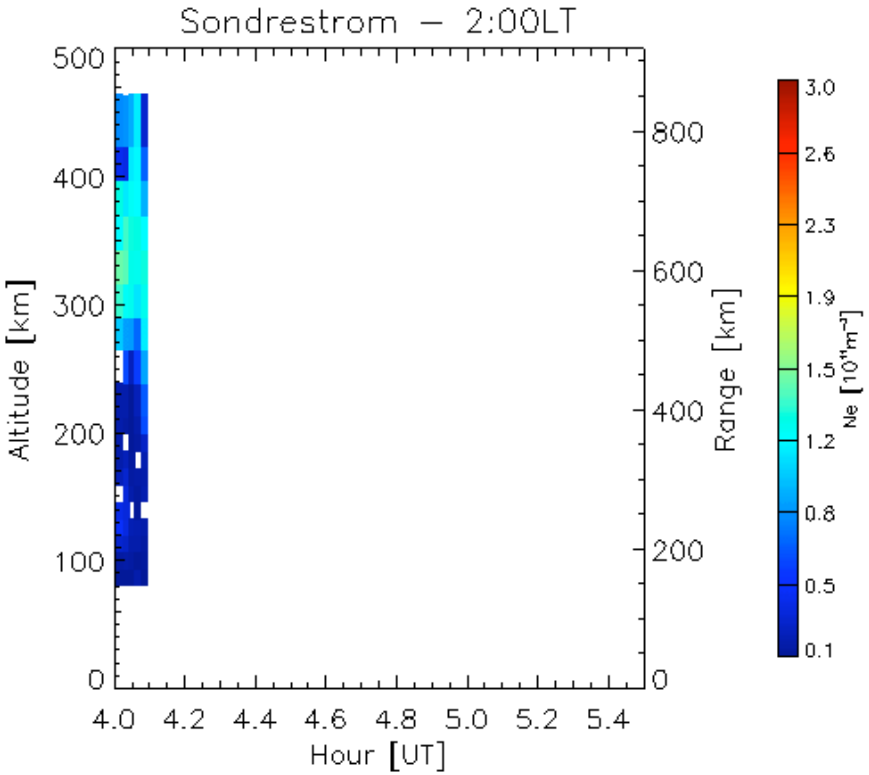

Ne: Scan 2
x 10^11
2.5
2
1.5
1
Altitude (km)
400
350
300
250
200
62
64
66
68
70
72
74
76
Latitude (deg)
Ne Gradient: Scan 2
x 10^10
2
1
0
-1
-2
Altitude (km)
Latitude (deg)

EISCAT

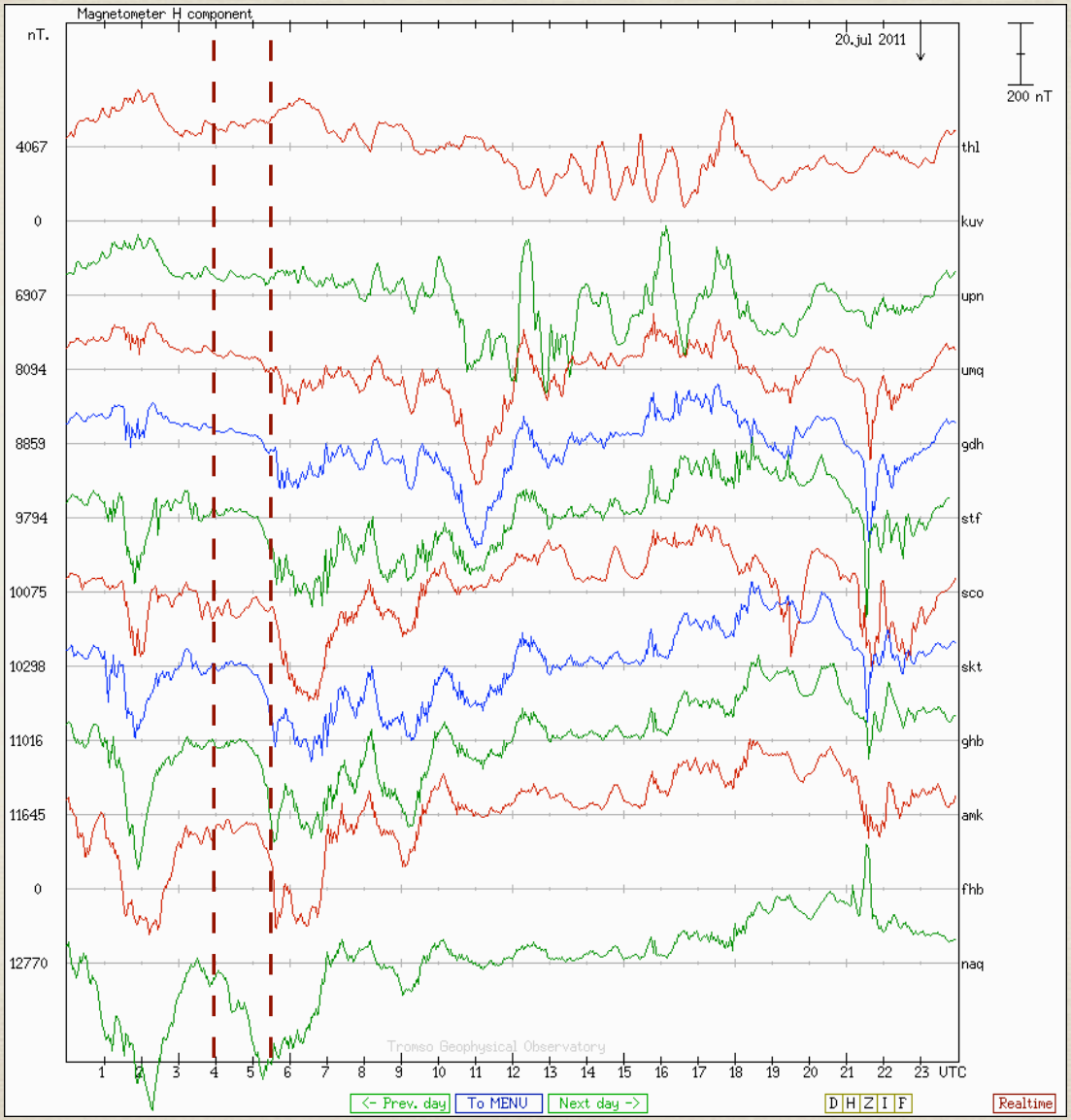

Ne: Scan 3
x 10^11
400
350
300
250
200
Altitude (km)
62
64
66
68
70
72
74
76
Latitude (deg)
3
2.5
2
1.5
1
Ne Gradient: Scan 3
x 10^10
3
2
1
0
-1
Altitude (km)
Latitude (deg)

Sondrestrom azimuth scans

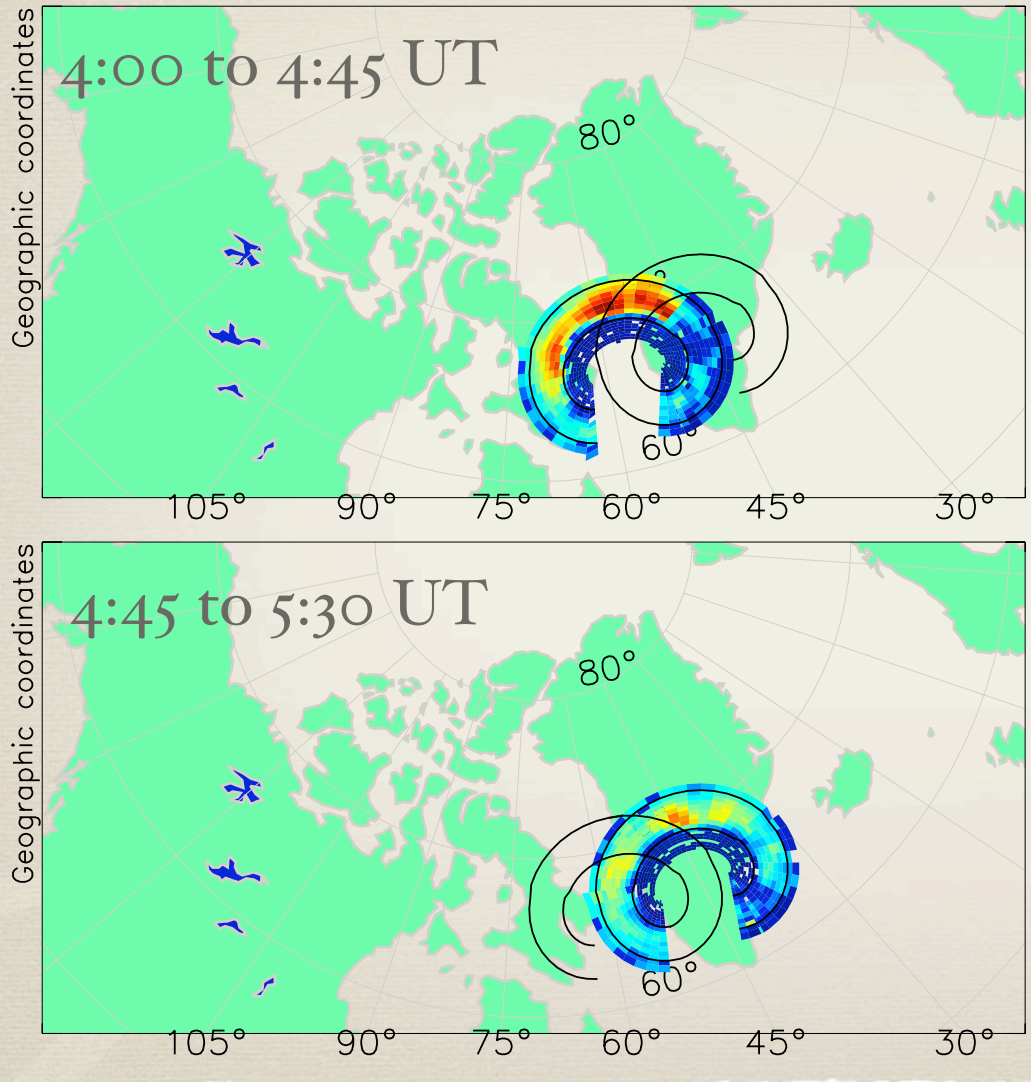




Greenland magnetometer data

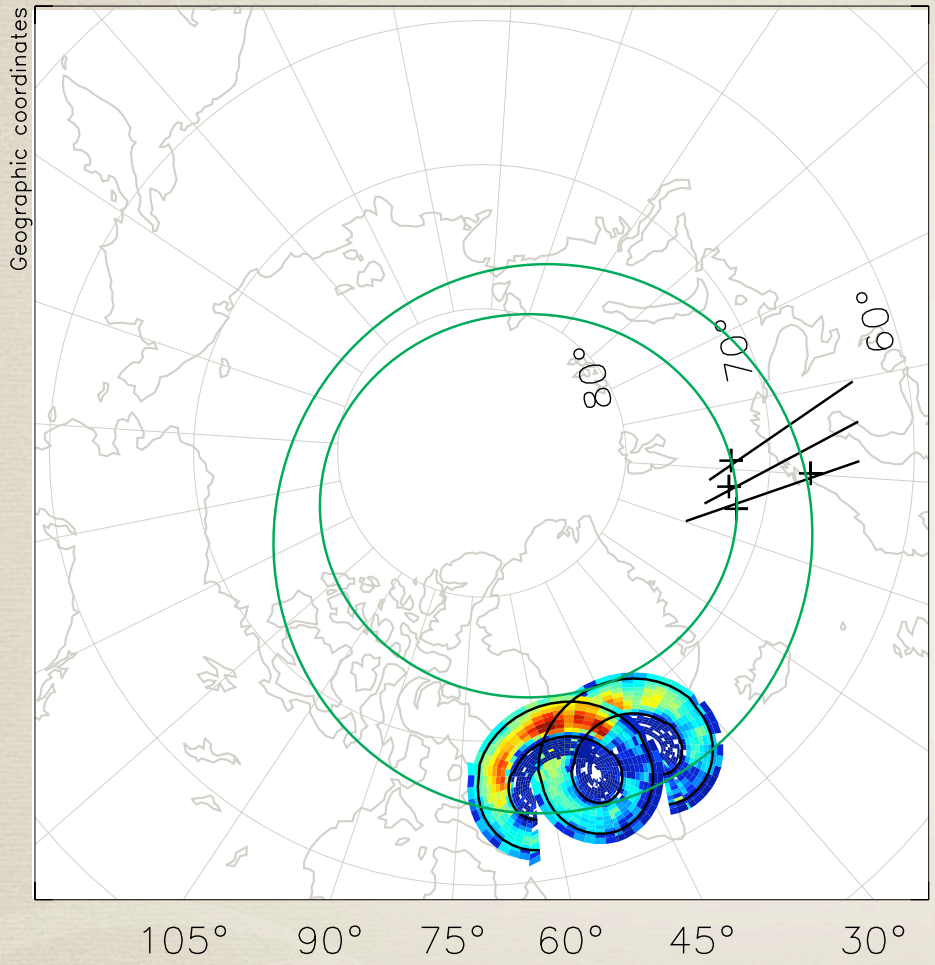


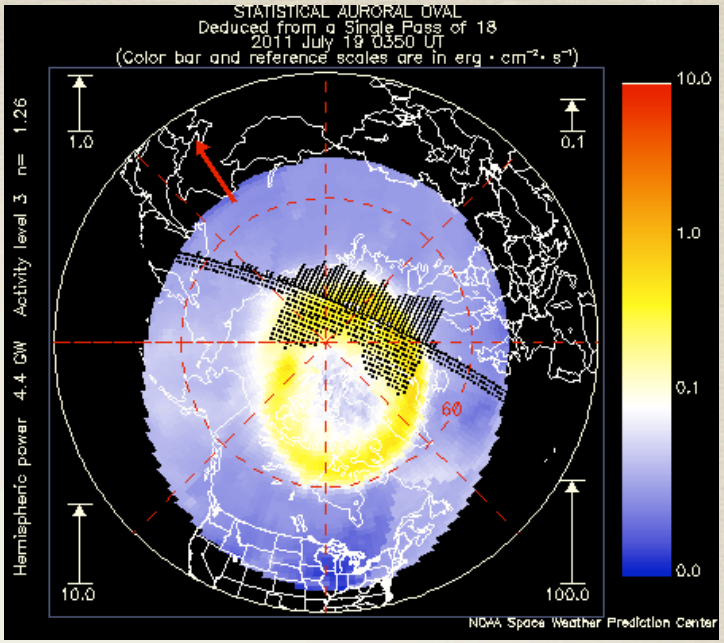
Sondredtrom azimuth scans

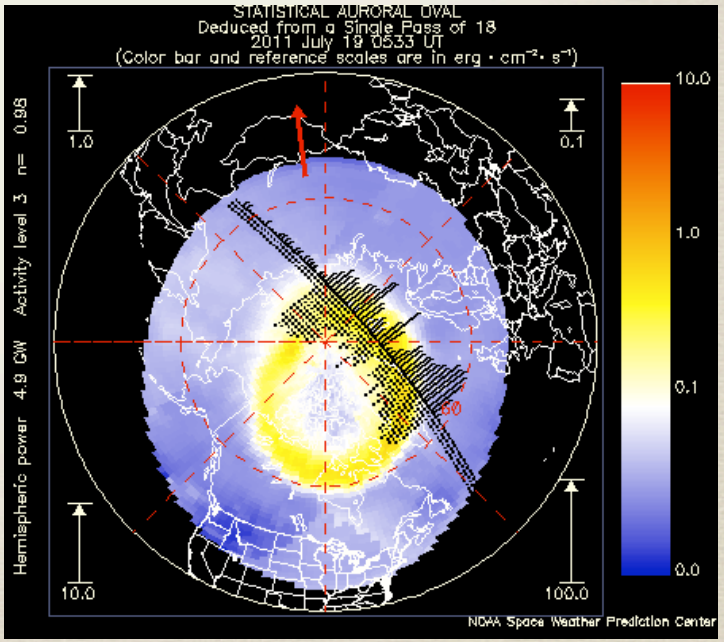


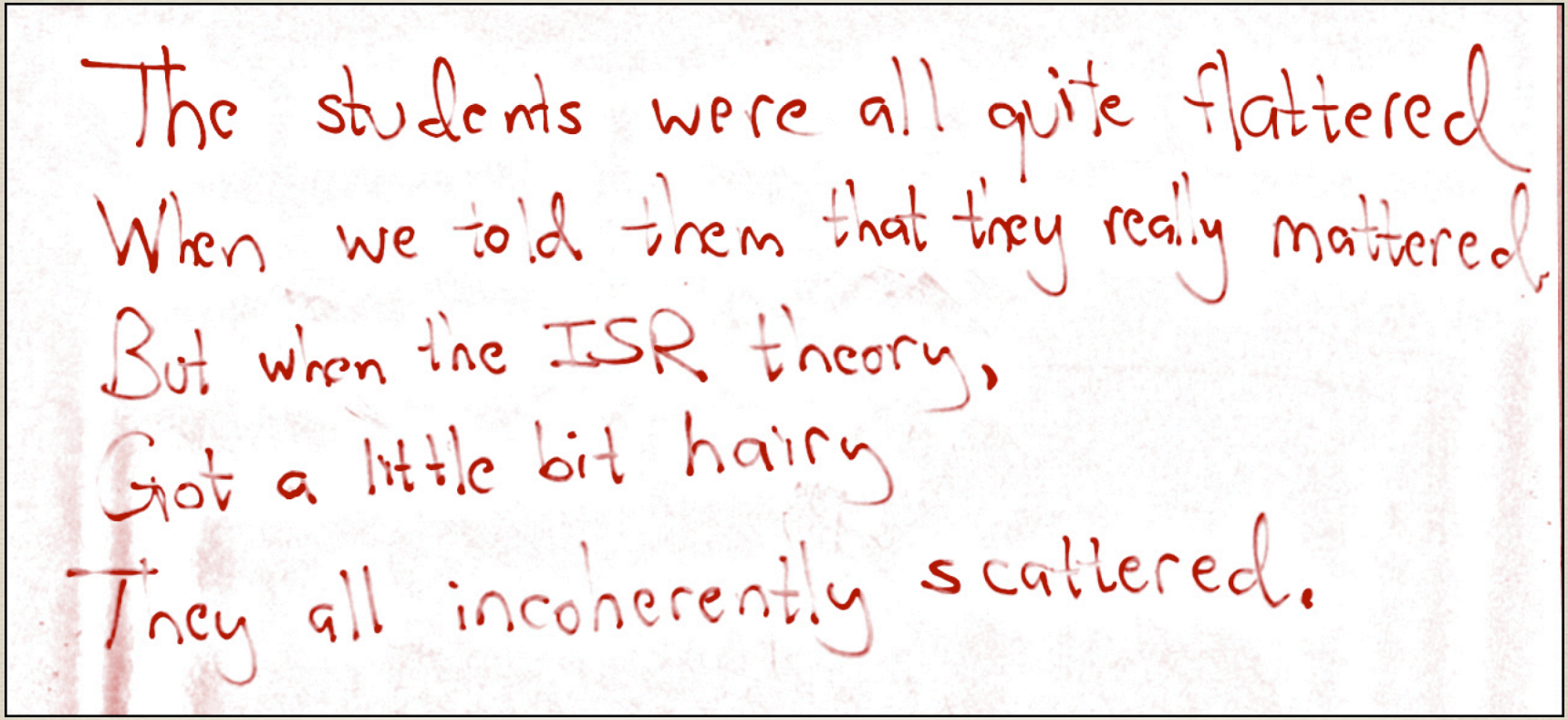
Azimuth - range plots of electron density. Two lines mark the approximate altitude limits of the F region the colour scale is meant to provide gradient information.

Auroral Oval fitting









Found on the dry board of Konference room A – Wednesday, July 20th, Kangerlussuaq