

Incoherent Scatter Radar (ISR) Virtual Summer School 2021

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Oliver Stalder,
Tanmay Das,
and Ana Elias

THE “NON-STUDENTS” (of the Millstone Hill ISR)

- Observe DaY-Night Ionospheric vAriabiLity (DYNIAL)
- Recreating the 3 dim velocity vector and comparison with Madrigal database
- Are velocities following fieldlines and the neutral wind at low altitudes?

group-6



EXPERIMENT

Experiment Type A: Regional Vector

Vertical profiles [zenith],
regional measurements [45 deg elevation]

Off-zenith positions are on either side of magnetic
meridian (-12.5 az / -40.5 az)

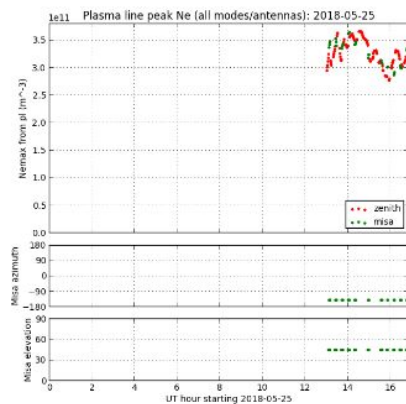
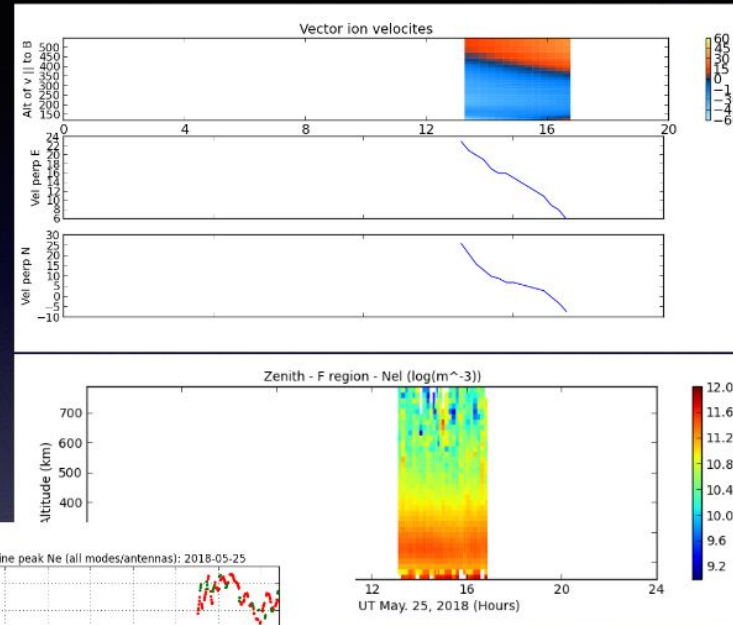
E, F region ionosphere

F2 peak high accuracy Langmuir mode
electron density available (daytime ionosphere)

Experiment cycle time = ~17 minutes



Zenith: 4 minutes
MISA fixed positions: 4 minutes
(Currently MISA motion is limited)



Millstone Hill ISRs

Latitude: 42.61°

Longitude: 288.51°

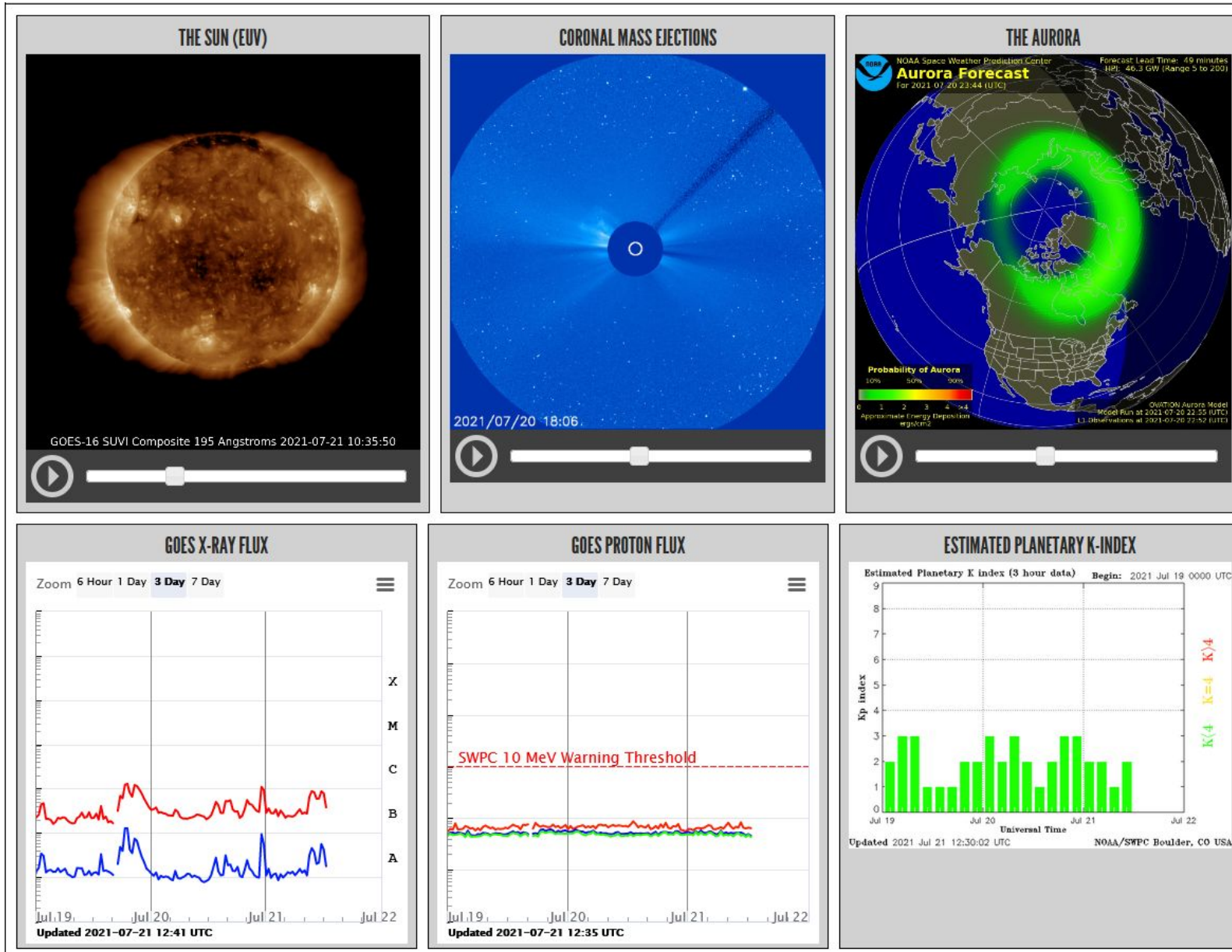
(54 degrees North Magnetic dip)

Radar Facilities:

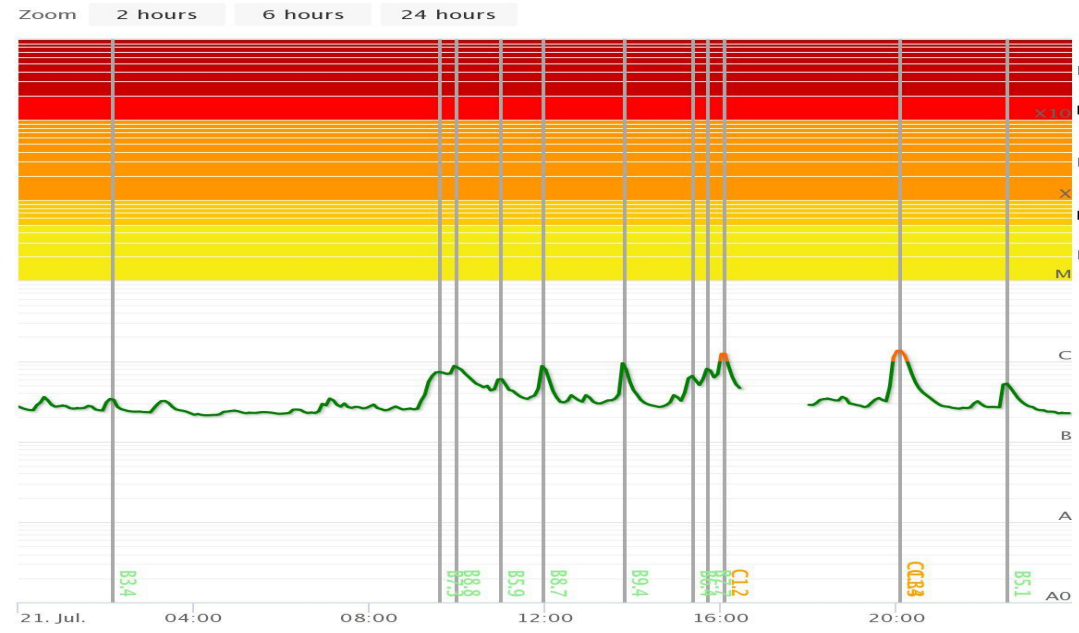
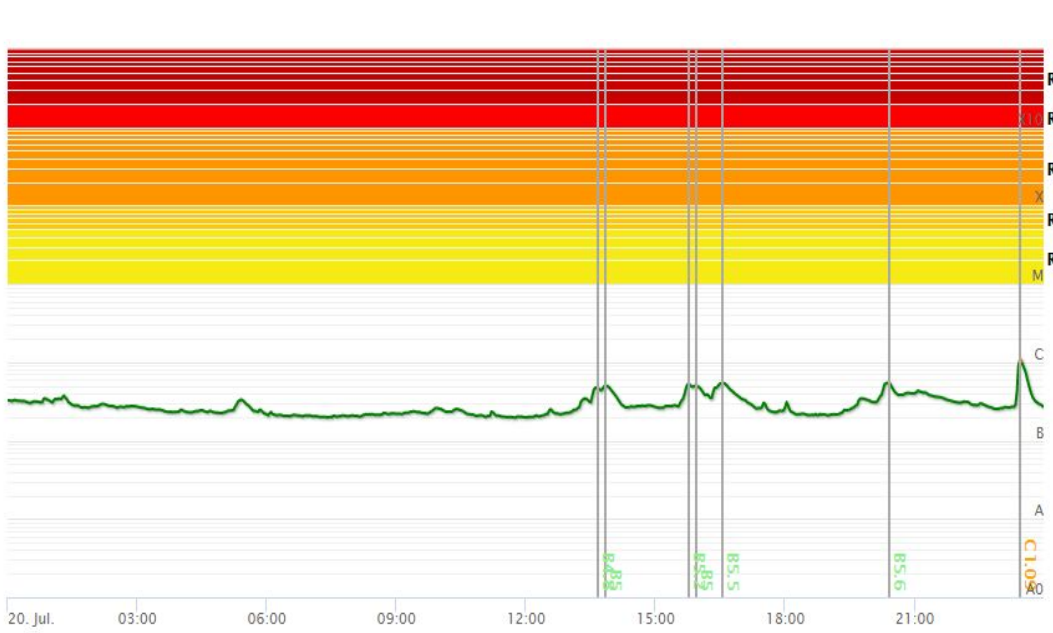
- 67 meter zenith antenna
- 46 meter fully steerable antenna

<https://www.haystack.mit.edu/about/haystack-telescope-s-and-facilities/millstone-hill-incoherent-scatter-radar/>

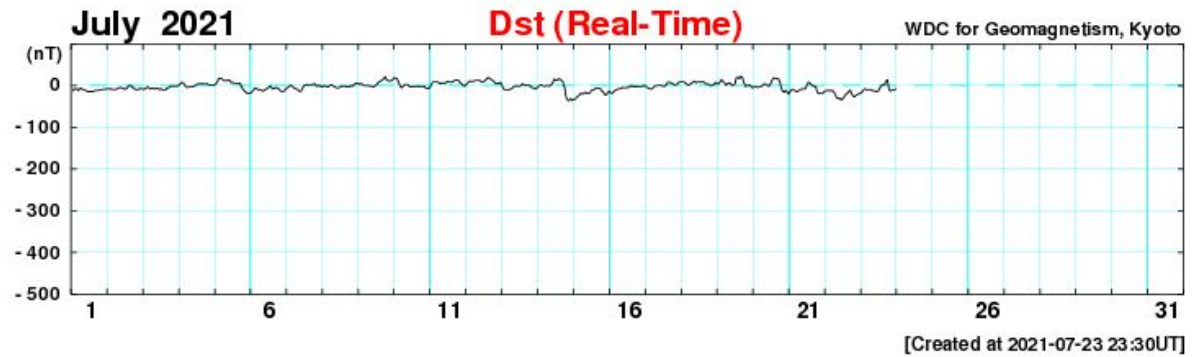
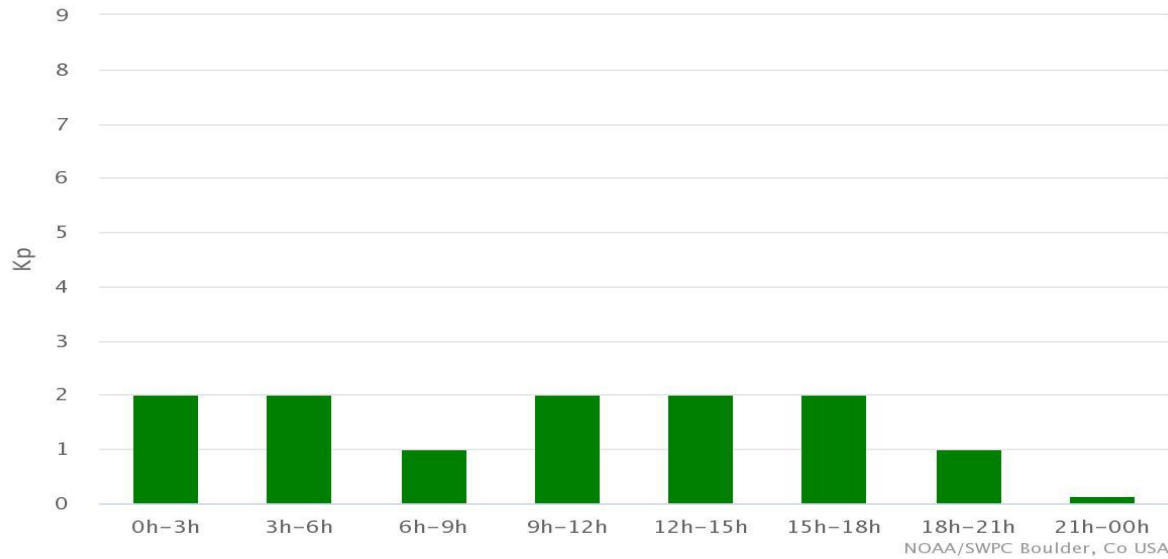
GENERAL SPACE WEATHER CONDITIONS



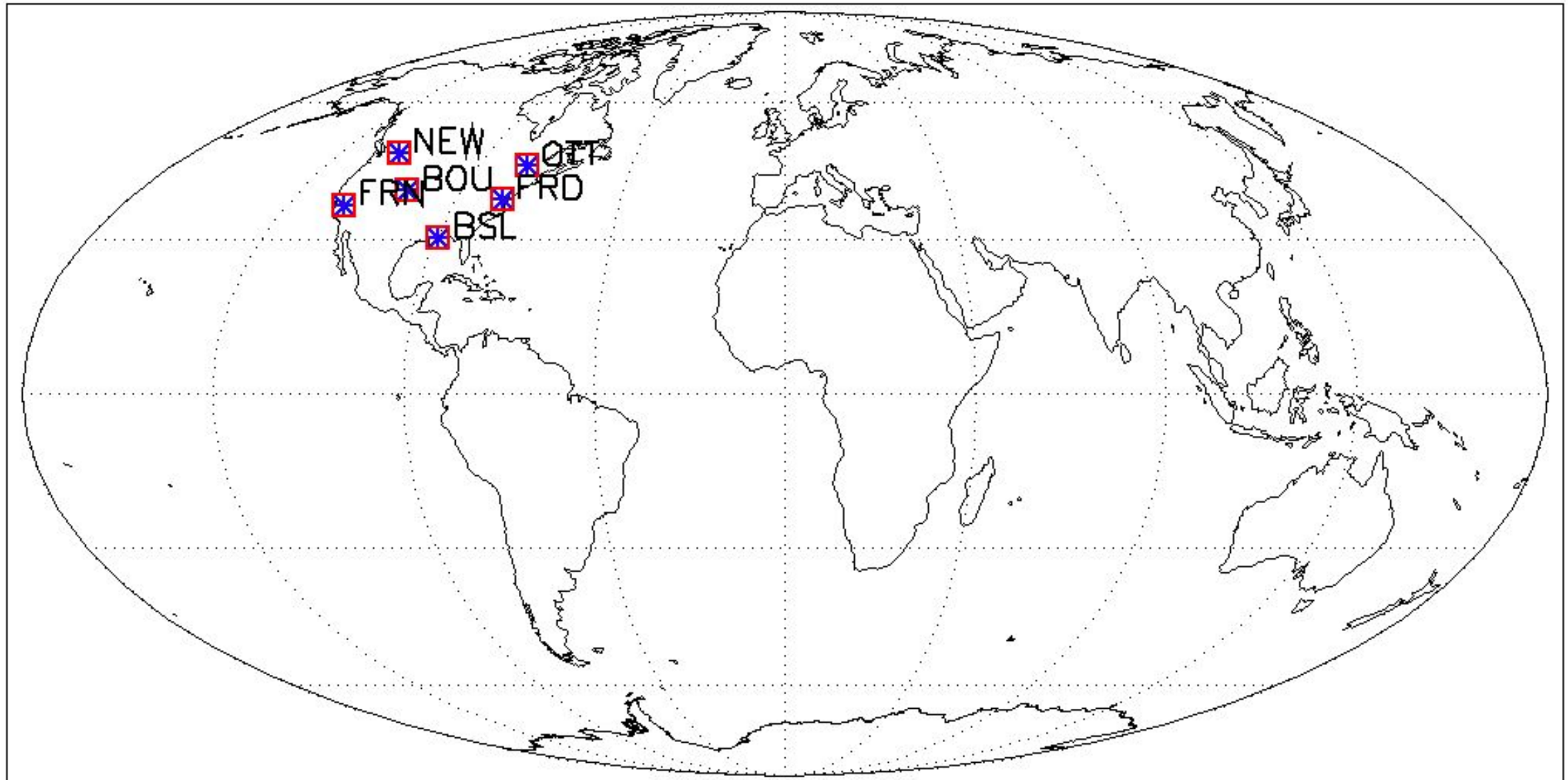
GOES X-ray satellite 1 minute solar X-rays average in the 1-8 Ångström passband



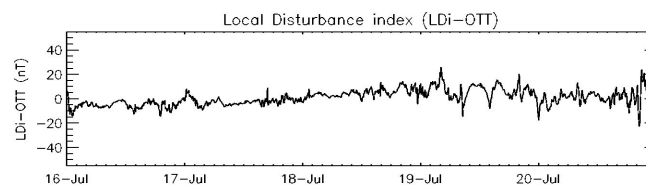
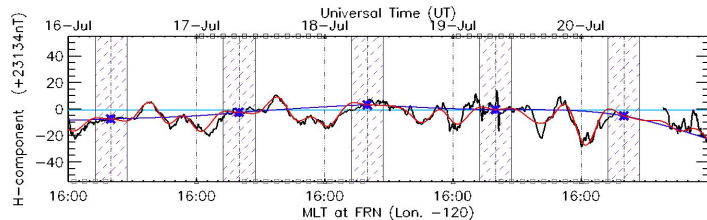
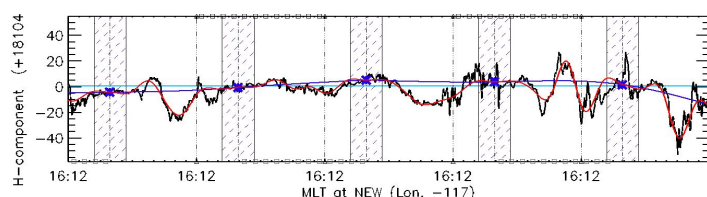
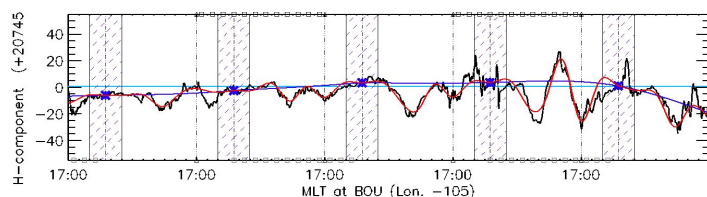
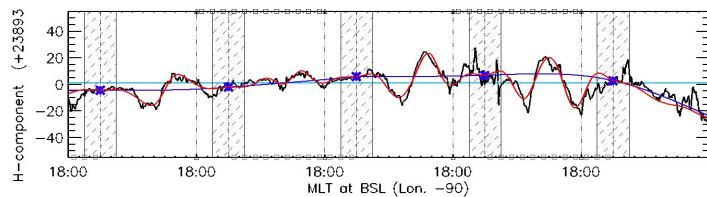
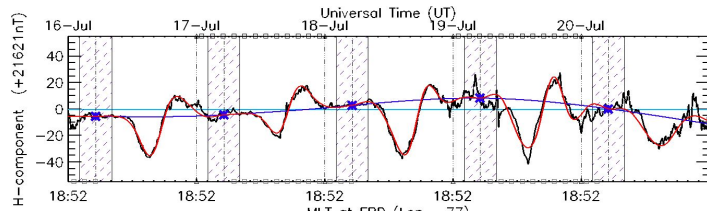
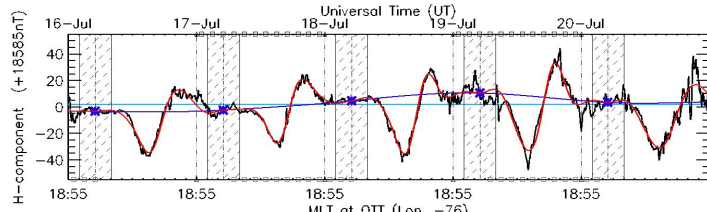
NOAA Kp-index



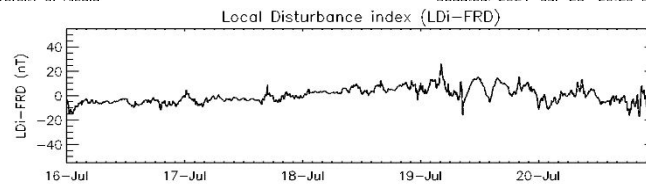
MAGNETOMETERS (InterMagnet Observatories)



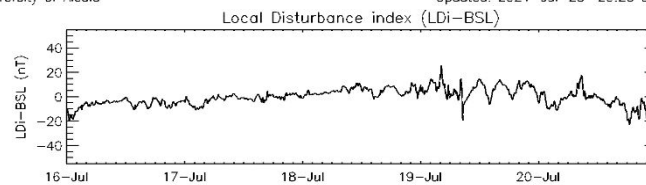
MAGNETOMETERS



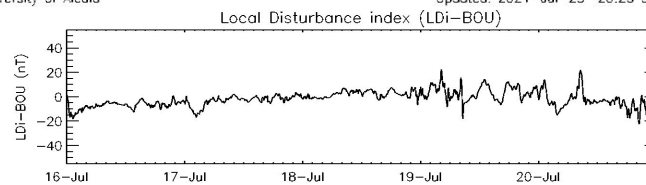
University of Alcala
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Updated: 2021-Jul-23 20:29 UT



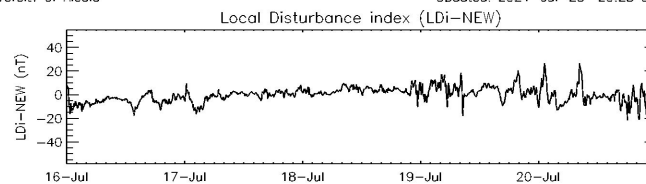
University of Alcala
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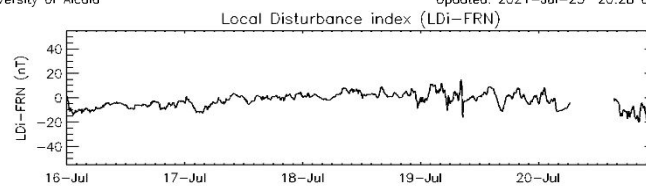
University of Alcala
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Updated: 2021-Jul-23 20:26 UT



University of Alcala
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Updated: 2021-Jul-23 20:25 UT



University of Alcala
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University of Alcala
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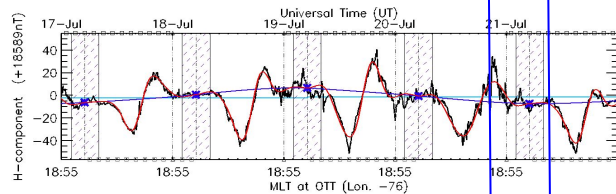
SOLAR RADIO FLUX

Date	Time	Julian day	Carrington rotation	Observed Flux	Adjusted Flux	URSI Flux
17/07/2021	20:00:00	2.459.413.322	2.246.470	77.4	80.0	72.0
17/07/2021	23:00:00	2.459.413.447	2.246.470	78.3	80.9	72.8
18/07/2021	17:00:00	2.459.414.197	2.246.500	79.5	82.1	73.9
18/07/2021	20:00:00	2.459.414.322	2.246.510	80.4	83.0	74.7
18/07/2021	23:00:00	2.459.414.447	2.246.510	80.2	82.8	74.5
19/07/2021	17:00:00	2.459.415.197	2.246.540	82.1	84.8	76.3
19/07/2021	20:00:00	2.459.415.322	2.246.540	82.6	85.3	76.7
19/07/2021	23:00:00	2.459.415.447	2.246.550	85.7	88.5	79.6
20/07/2021	17:00:00	2.459.416.197	2.246.580	88.4	91.3	82.2
20/07/2021	20:00:00	2.459.416.322	2.246.580	87.0	89.8	80.8
20/07/2021	23:00:00	2.459.416.447	2.246.580	86.2	89.0	80.1
21/07/2021	17:00:00	2.459.417.197	2.246.610	91.3	94.3	84.9
21/07/2021	20:00:00	2.459.417.322	2.246.620	93.5	96.5	86.8
21/07/2021	23:00:00	2.459.417.447	2.246.620	91.6	94.6	85.1

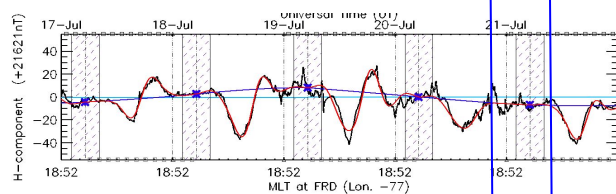
SOURCE: <https://spaceweather.gc.ca/forecast- prevision/solar-solaire/solarflux/sx-5-flux-en.php>

MAGNETOMETERS

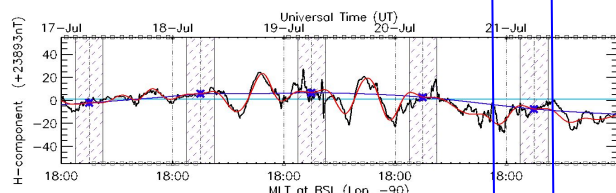
OTT



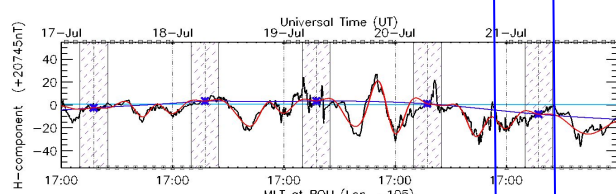
FRD



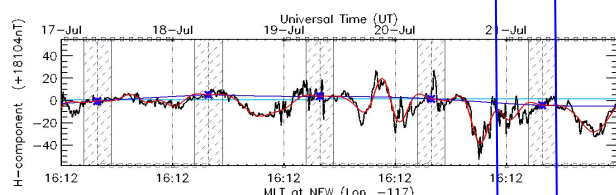
BSL



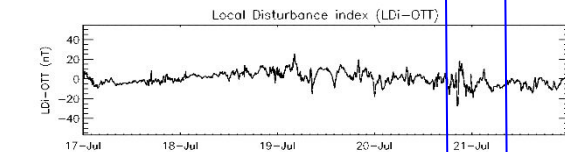
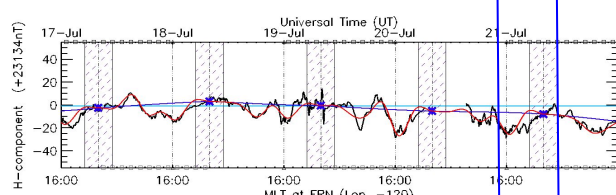
BOU



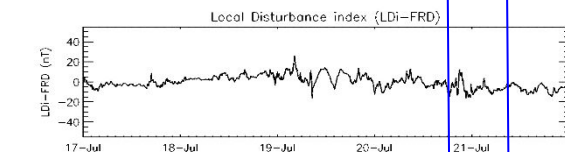
NEW



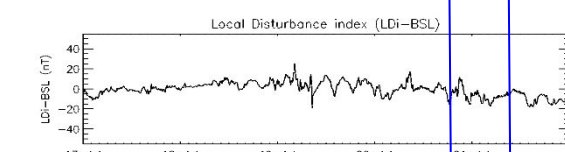
FRN



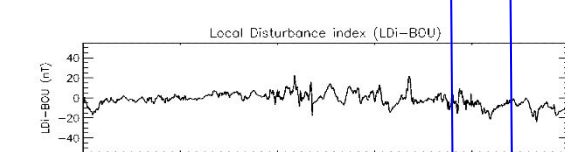
University of Alcalá
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 Updated: 2021-Jul-23 21:37 UT



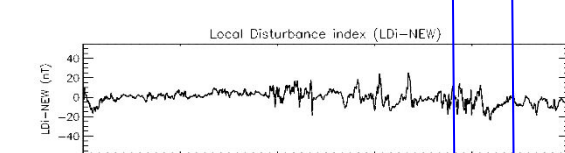
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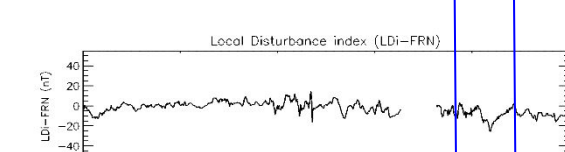
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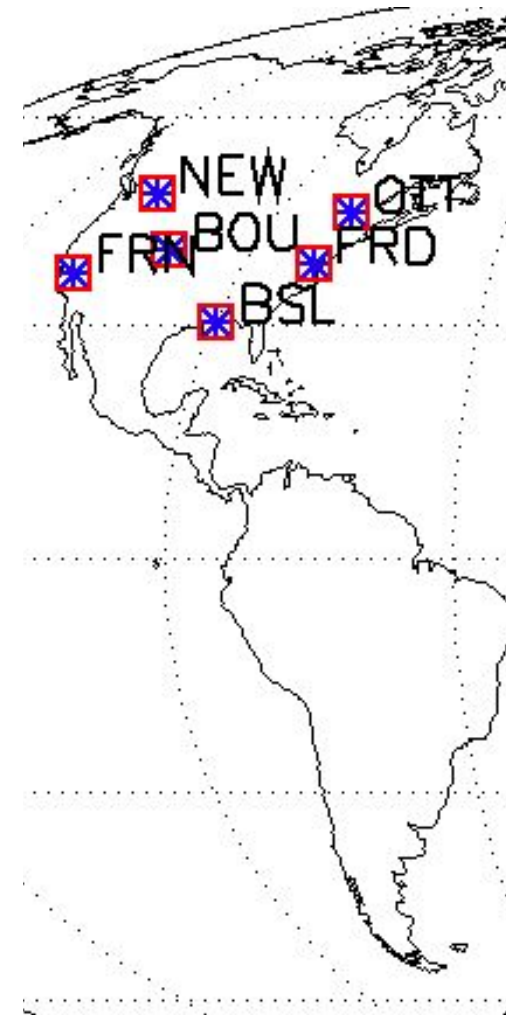
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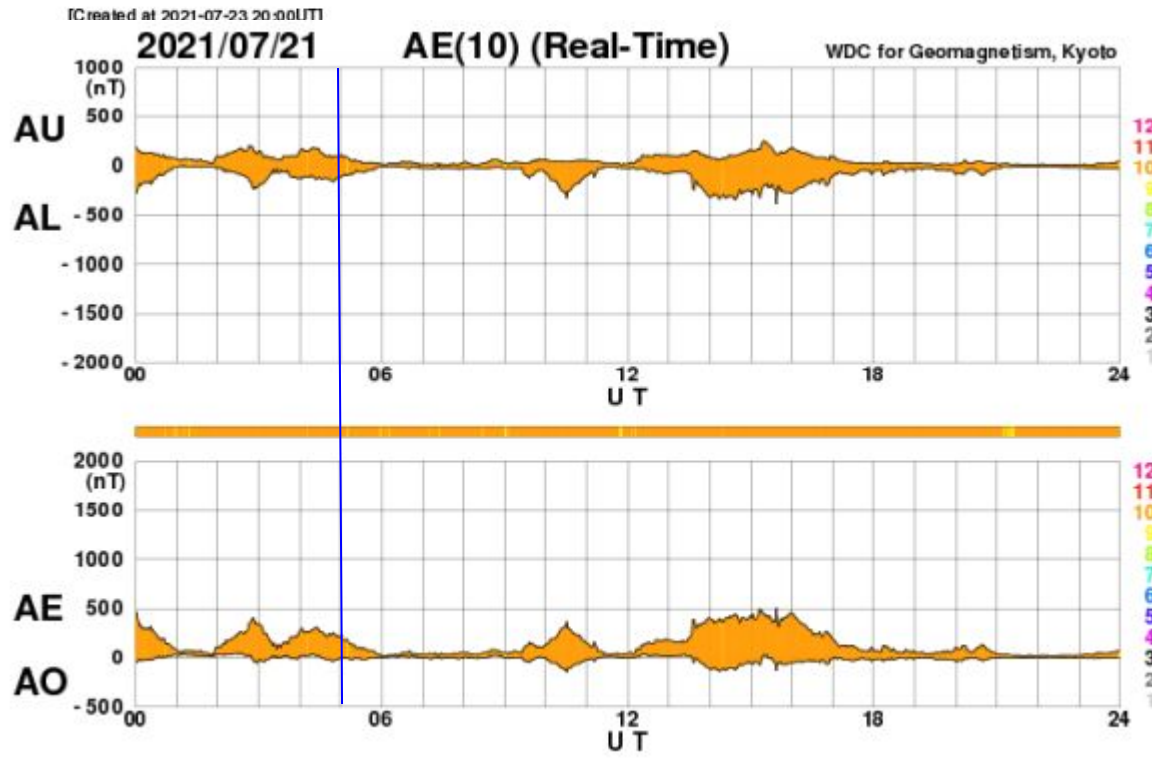
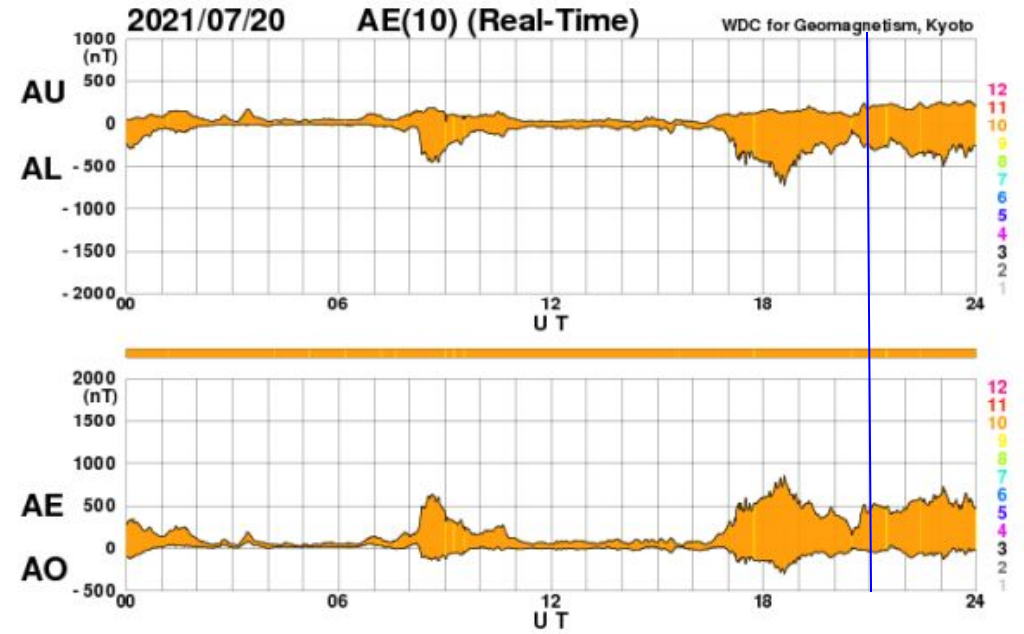
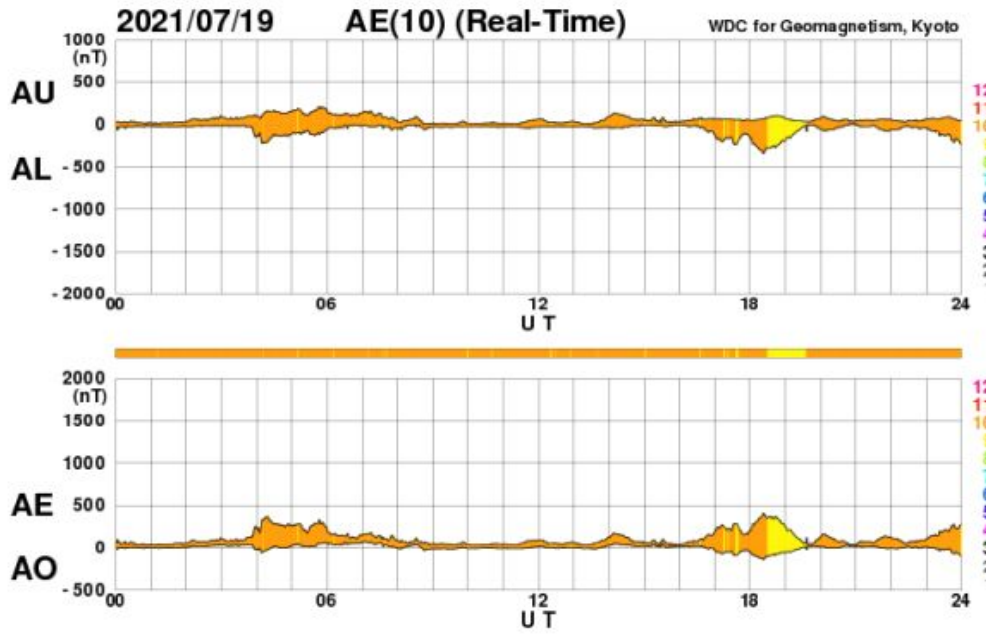


University of Alcalá
 Lost data: 2021-Jul-21 23:59 UT
 Updated: 2021-Jul-23 21:36 UT



University of Alcalá
 Lost data: 2021-Jul-21 23:59 UT
 Updated: 2021-Jul-23 21:36 UT

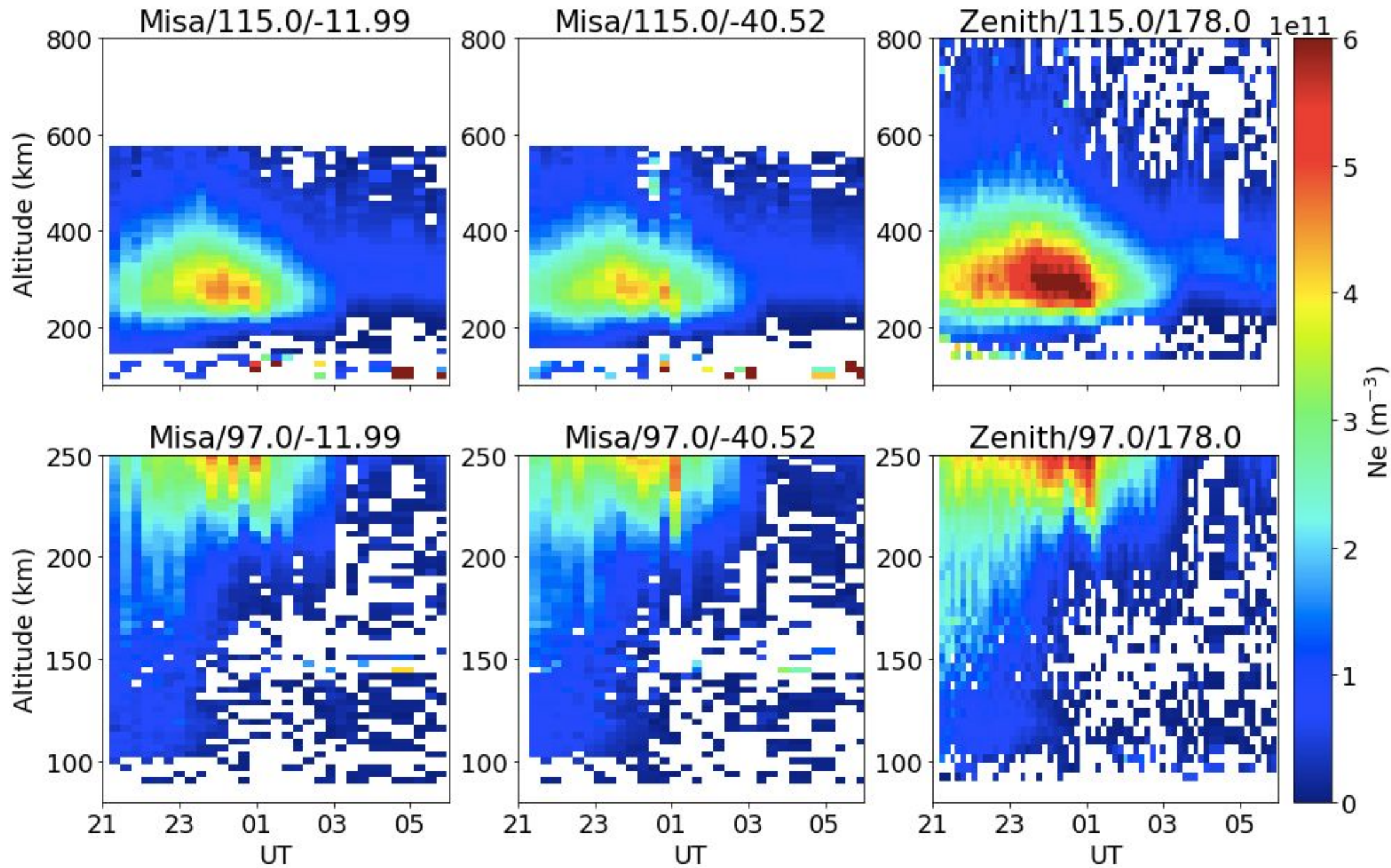


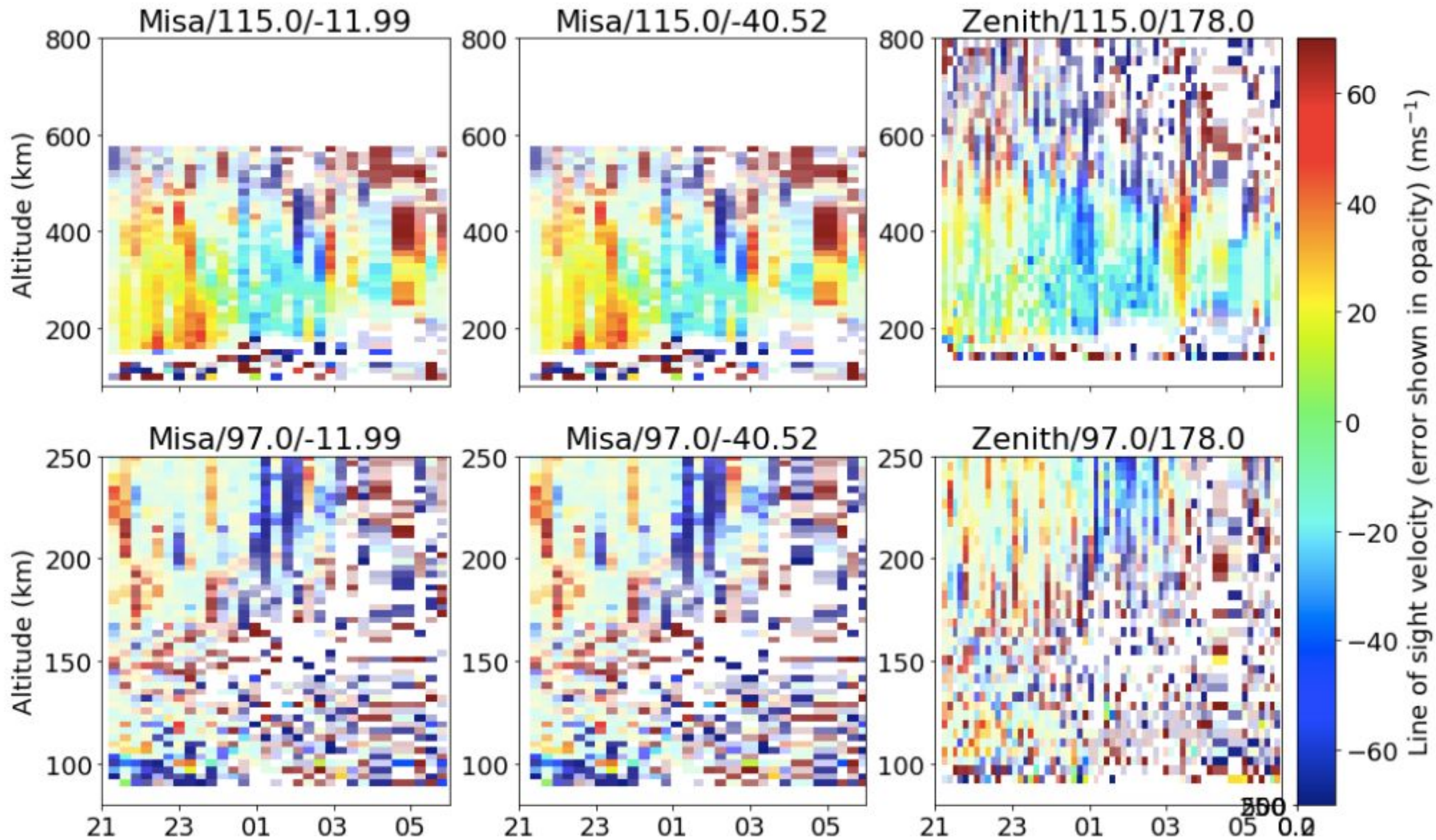


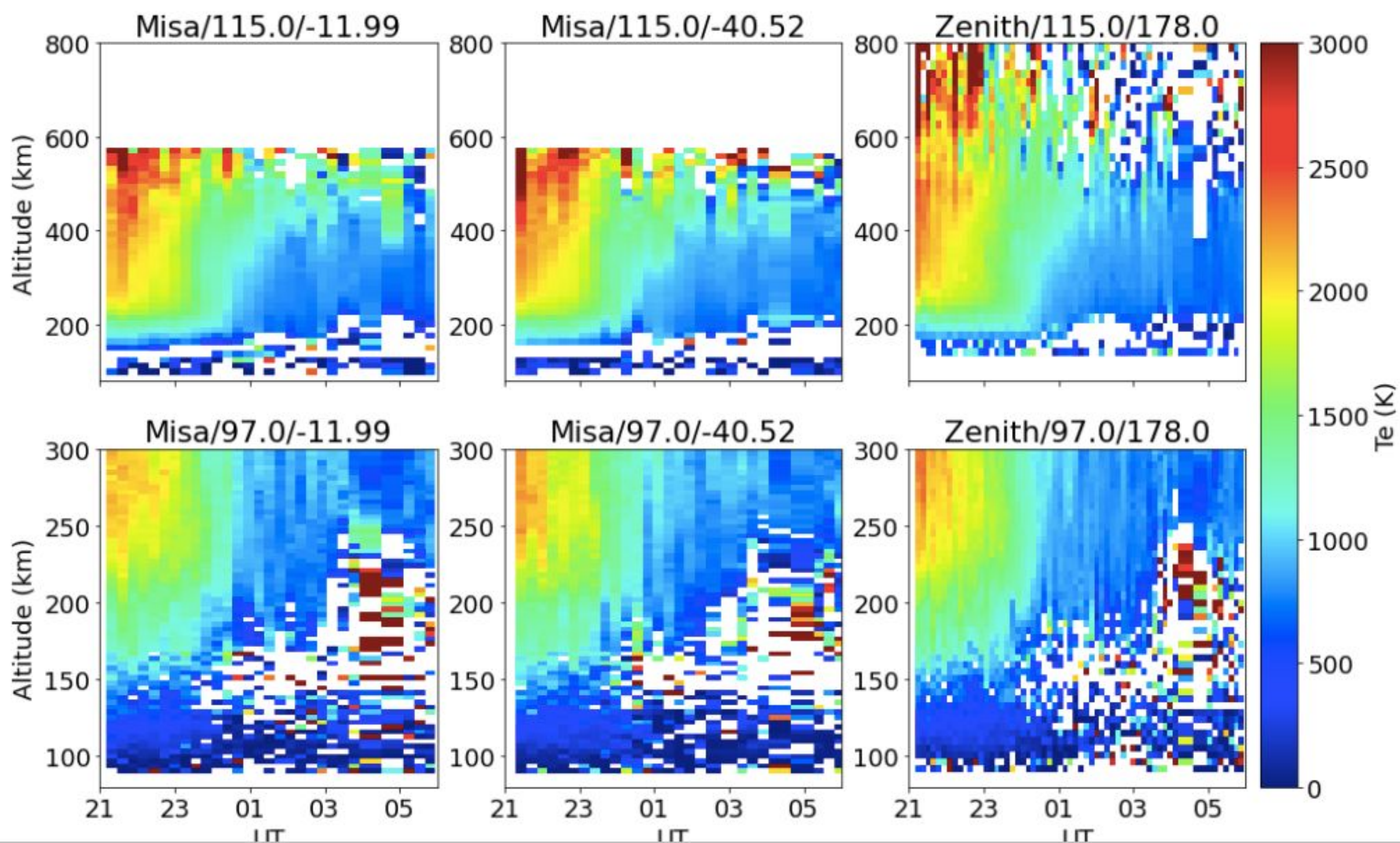
[Created at 2021-07-23 20:00UT]

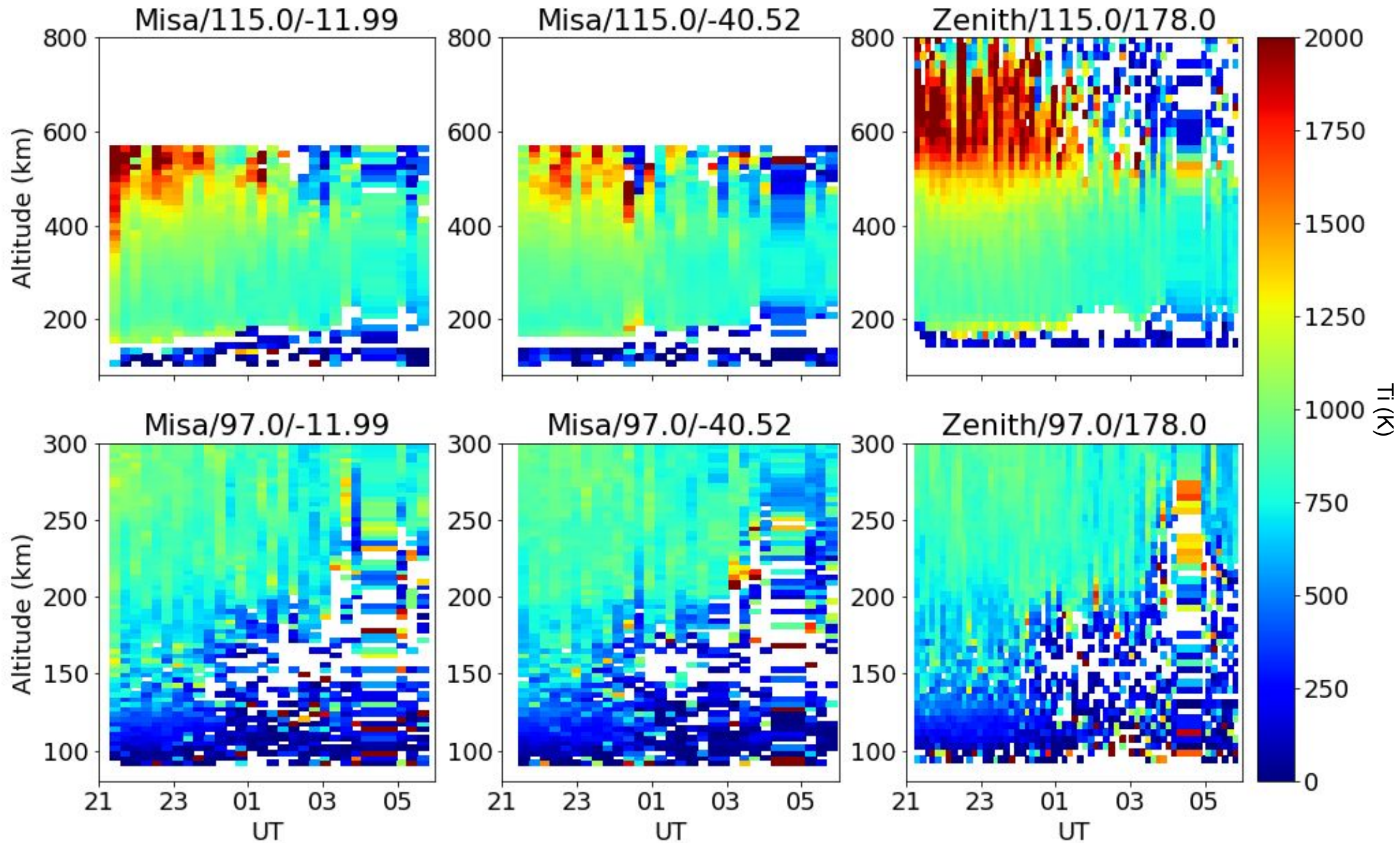
[Created at 2021-07-23 20:00UT]

OBSERVATIONS

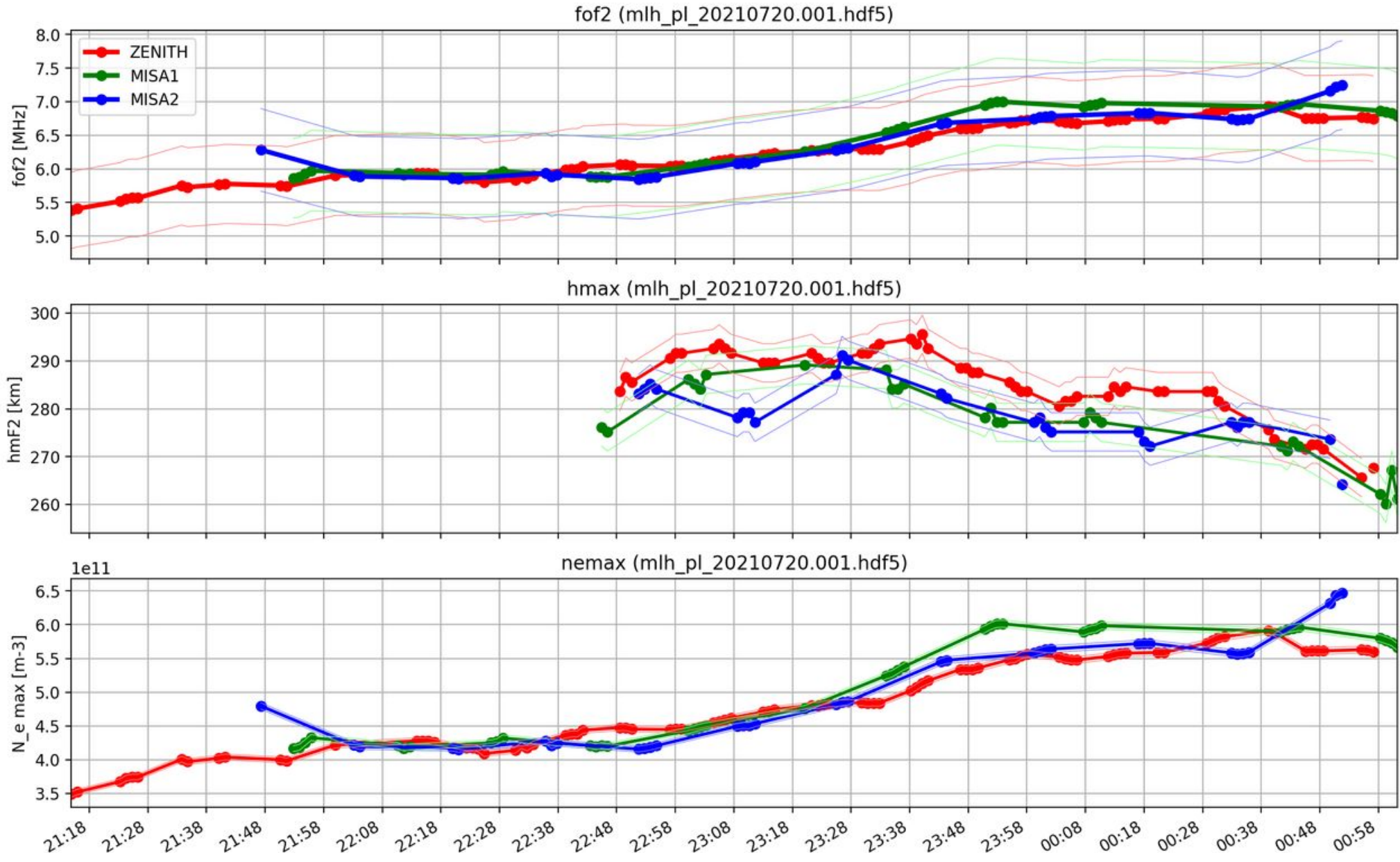




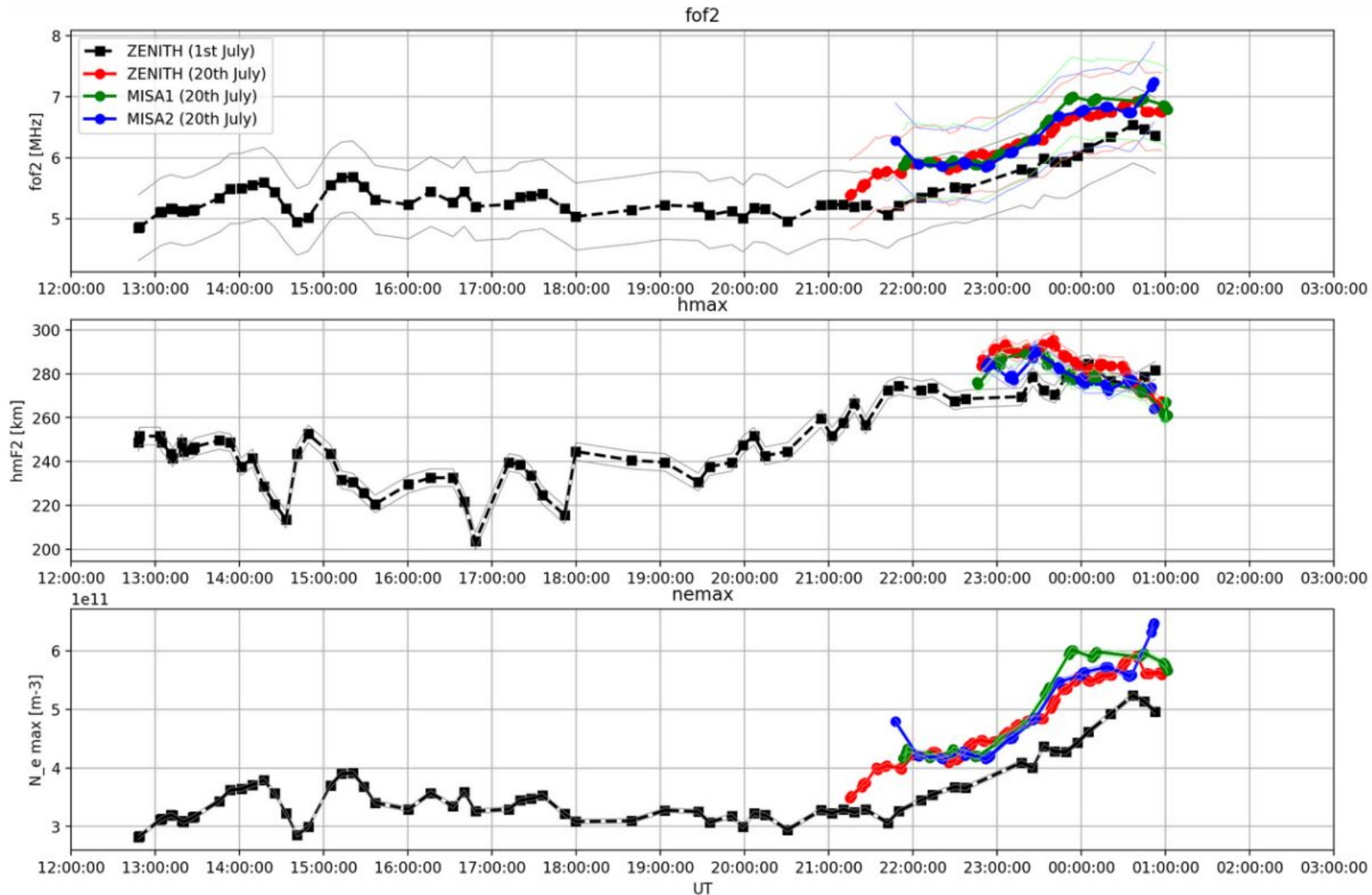




PLASMA LINE

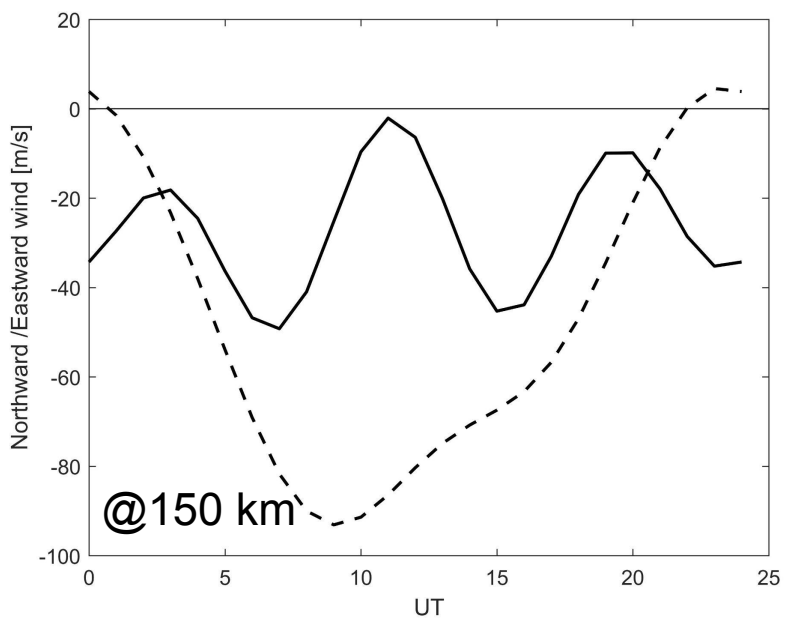
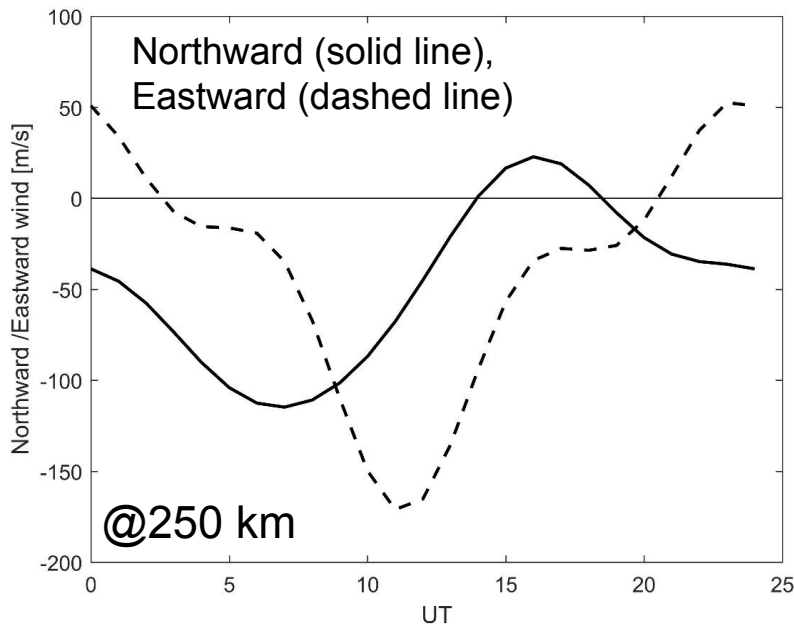


PLASMA LINE (Comparison of 1st and 20th July 2021)



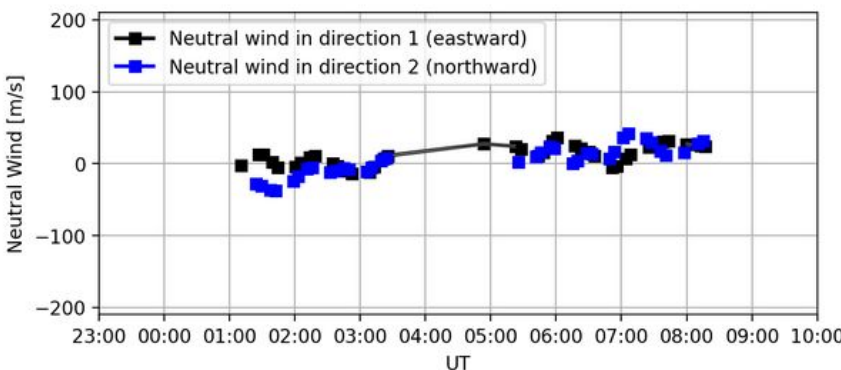
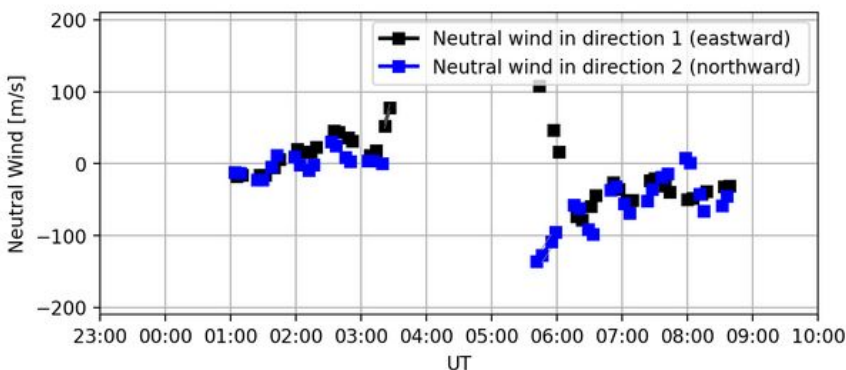
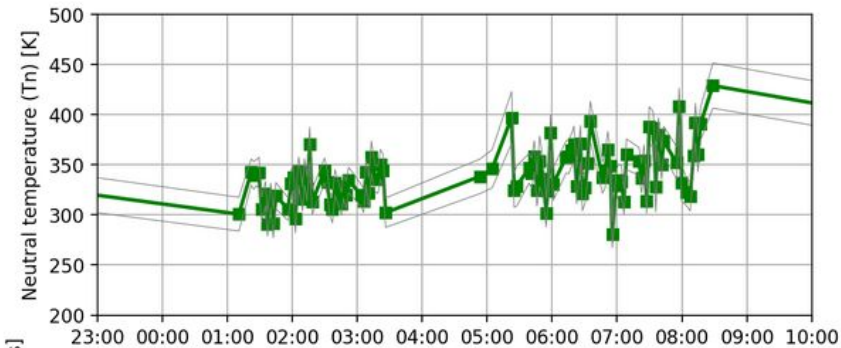
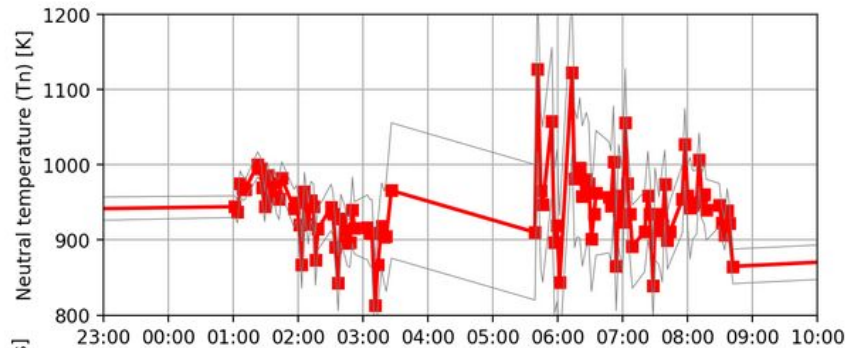
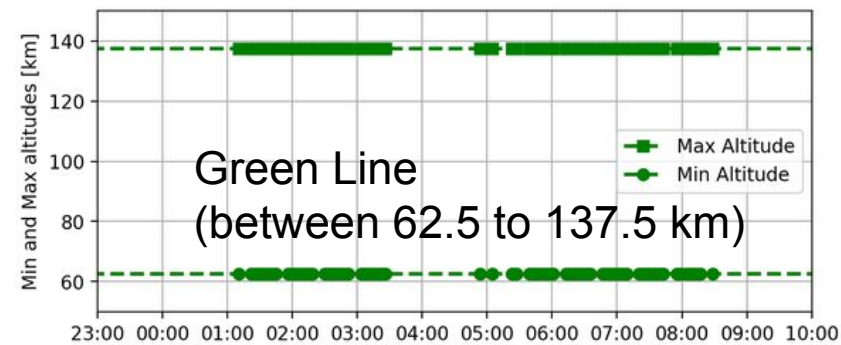
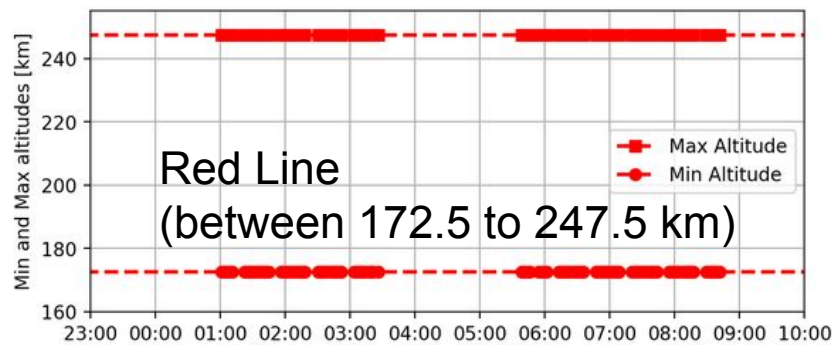
MODEL HWM14, at Millstone Hill (42.6°N, 288.5°E)

NEUTRAL WINDS



Fabry-Perot Interferometer (Neutral Winds and Temperatures)

Millstone Hill High-Res Fabry-Perot



Lowell
DIGISONDE

Station YYYY DAY DDD HHMMSS P1 FFS S AXN PPS IGA PS
Millstone Hill 2021 Jul21 202 010000 RSF 005 2 712 100 04+ 4C

foF2 6.600
foF1 N/A
foF1p N/A
foE N/A
foEp 0.65
fxI 7.38
foEs N/A
fmin 2.83

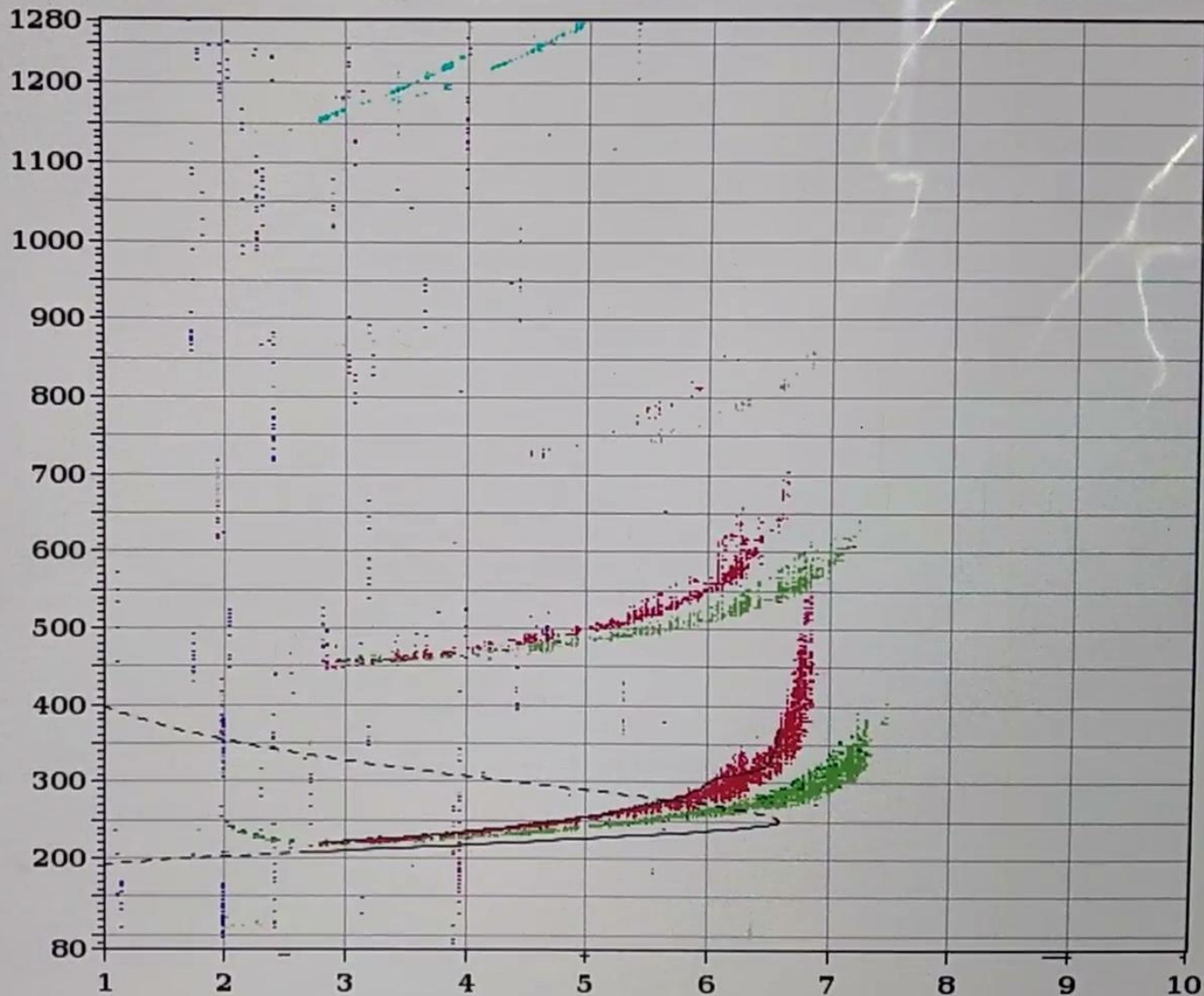
MUF(D) 22.90
M(D) 3.47
D N/A

h`F 217.5
h`F2 217.5
h`E N/A
h`Es N/A

hmF2 250.1
hmF1 N/A
hmE 110.0
yF2 38.0
yF1 N/A
yE 20.0
B0 37.4
B1 2.07

C-level 22

Auto:
Artist5
500200



IONOGRAMS

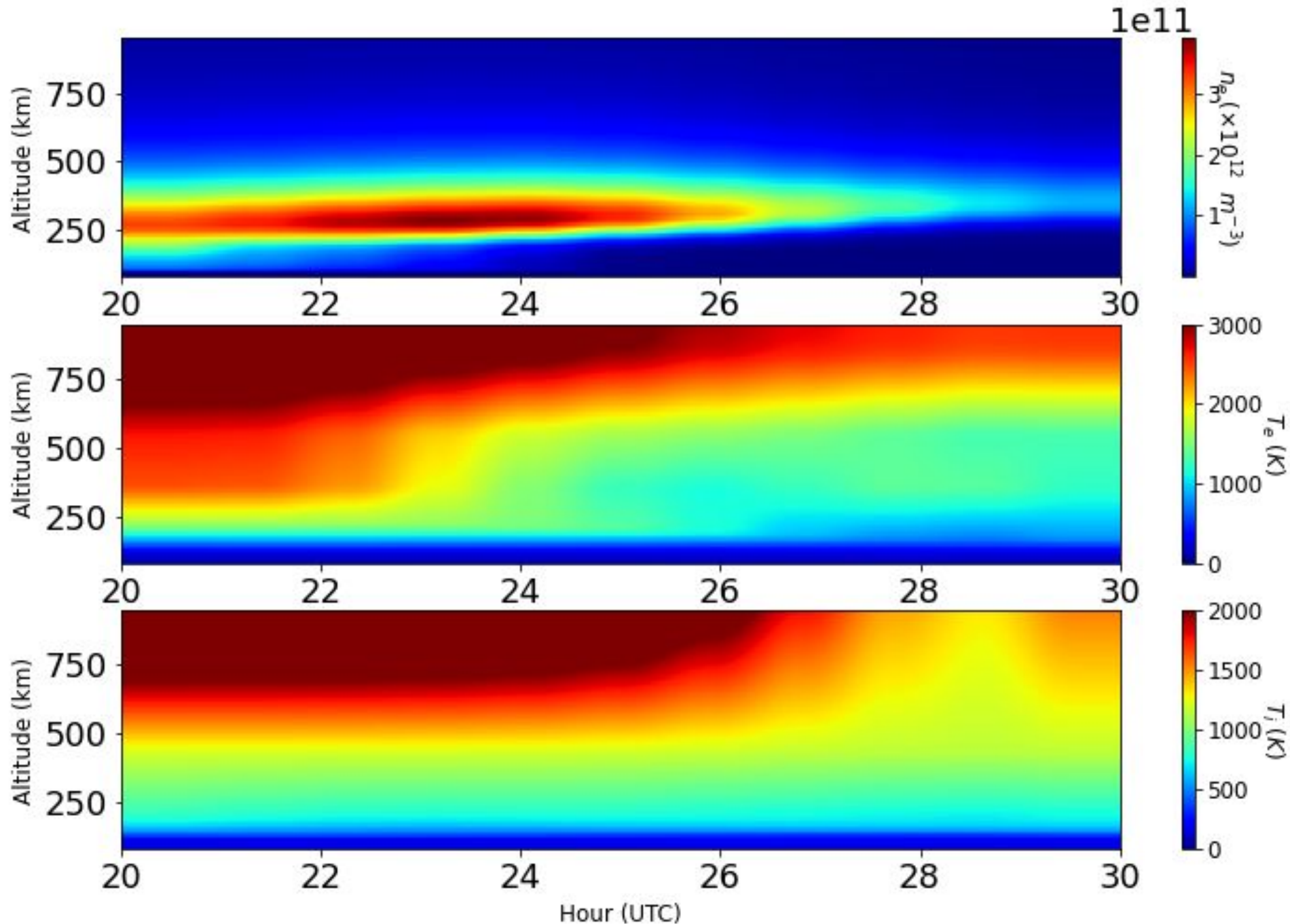
(from 20th 21:00 to 21st
7:00 July 2021)

MILLSTONE HILL IONOSONDE

MHJ45

**MODEL IRI2016
“NowCast”
(With Updated
Geo-Indices)**

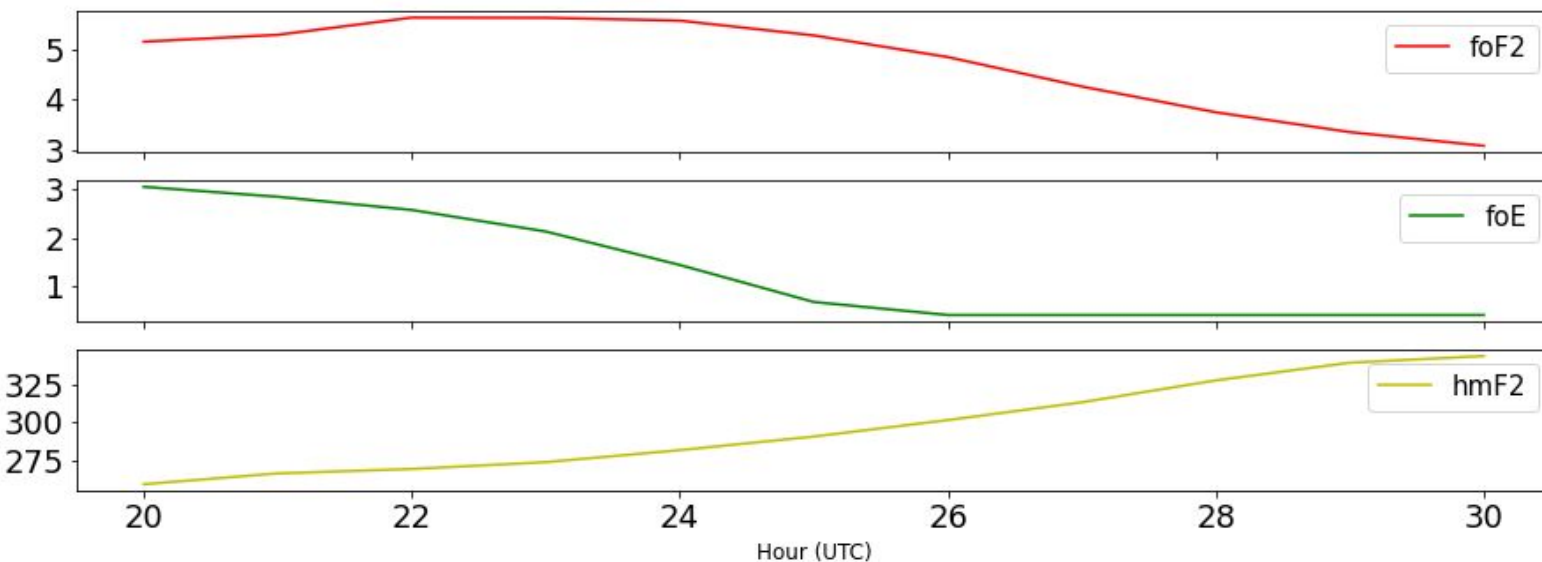
**@Millstone Hill
20th July 2021**



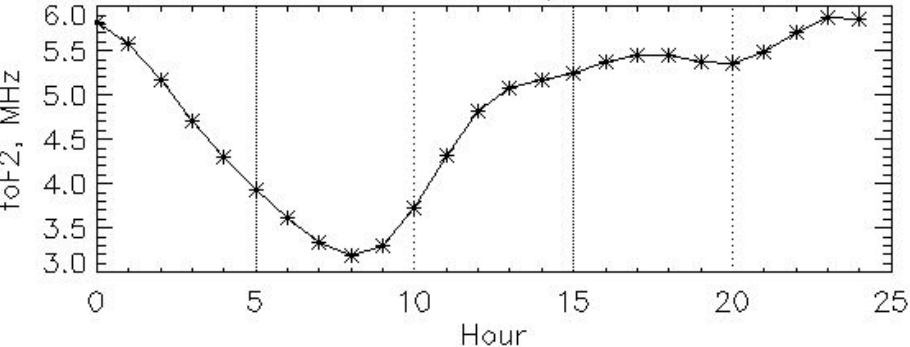
IRI MODEL

Location: Millston Hill - July 21st, 2021

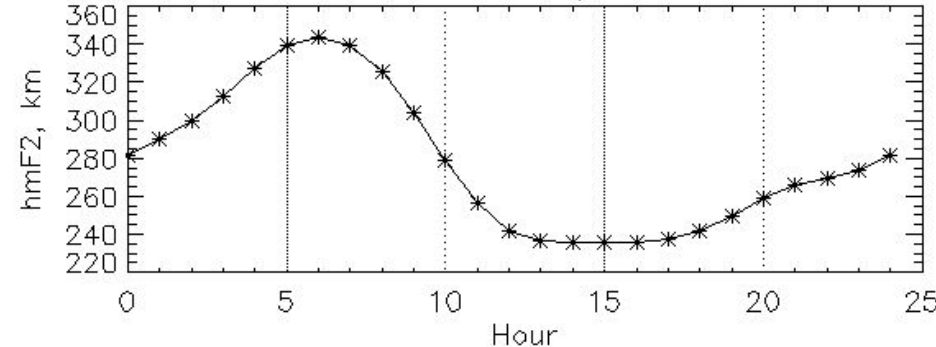
**IRI-2016 “NowCasting”
with updated Geo-Indexes**



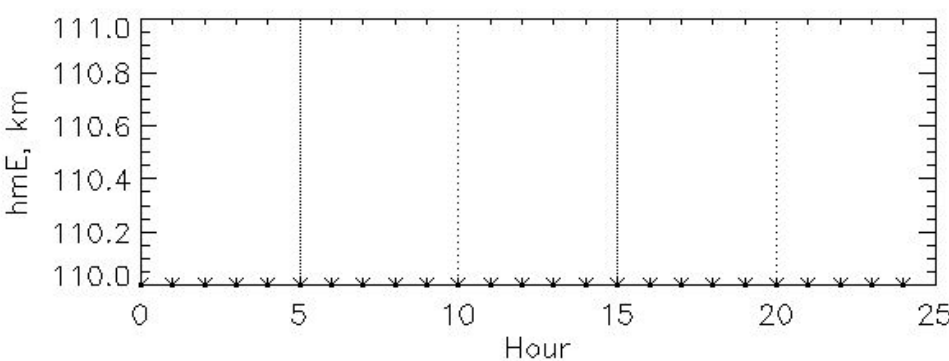
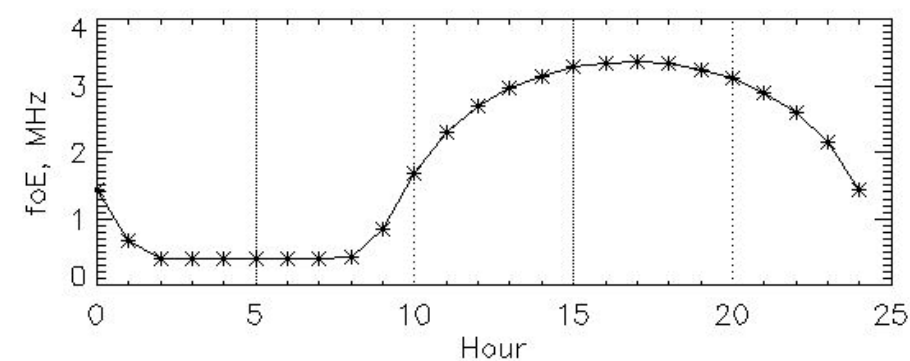
IRI-2016 model parameters

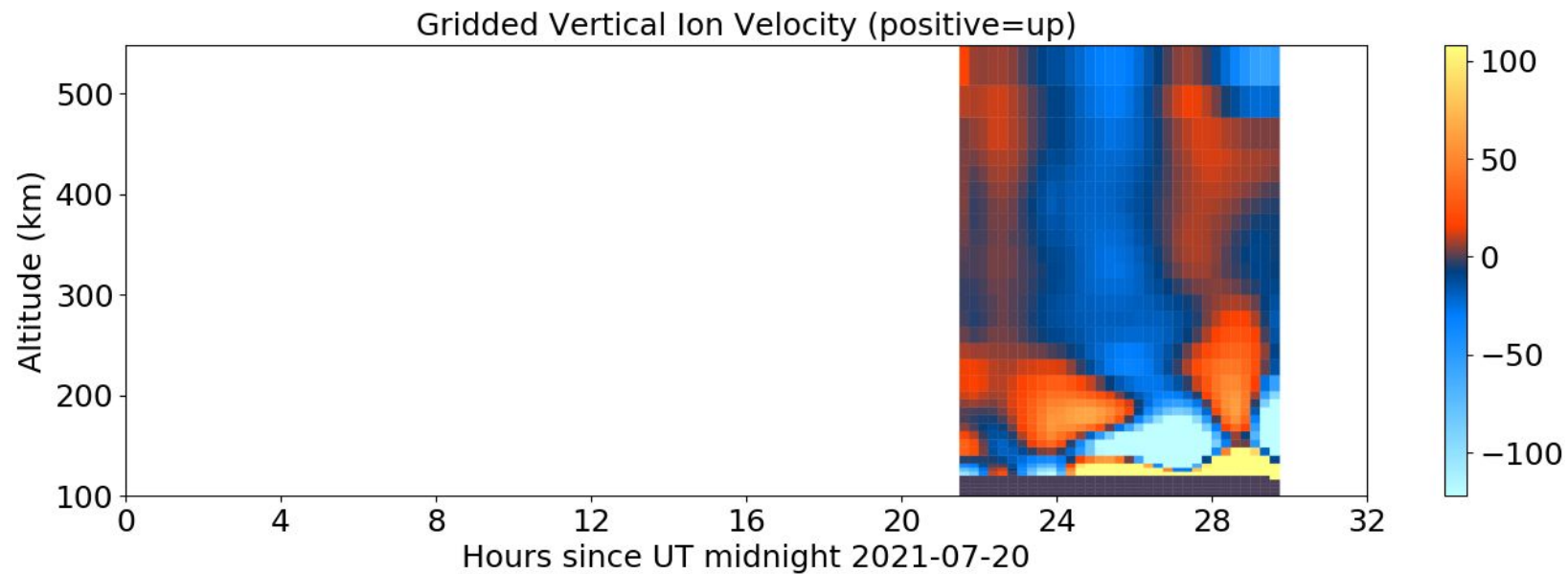


IRI-2016 model parameters



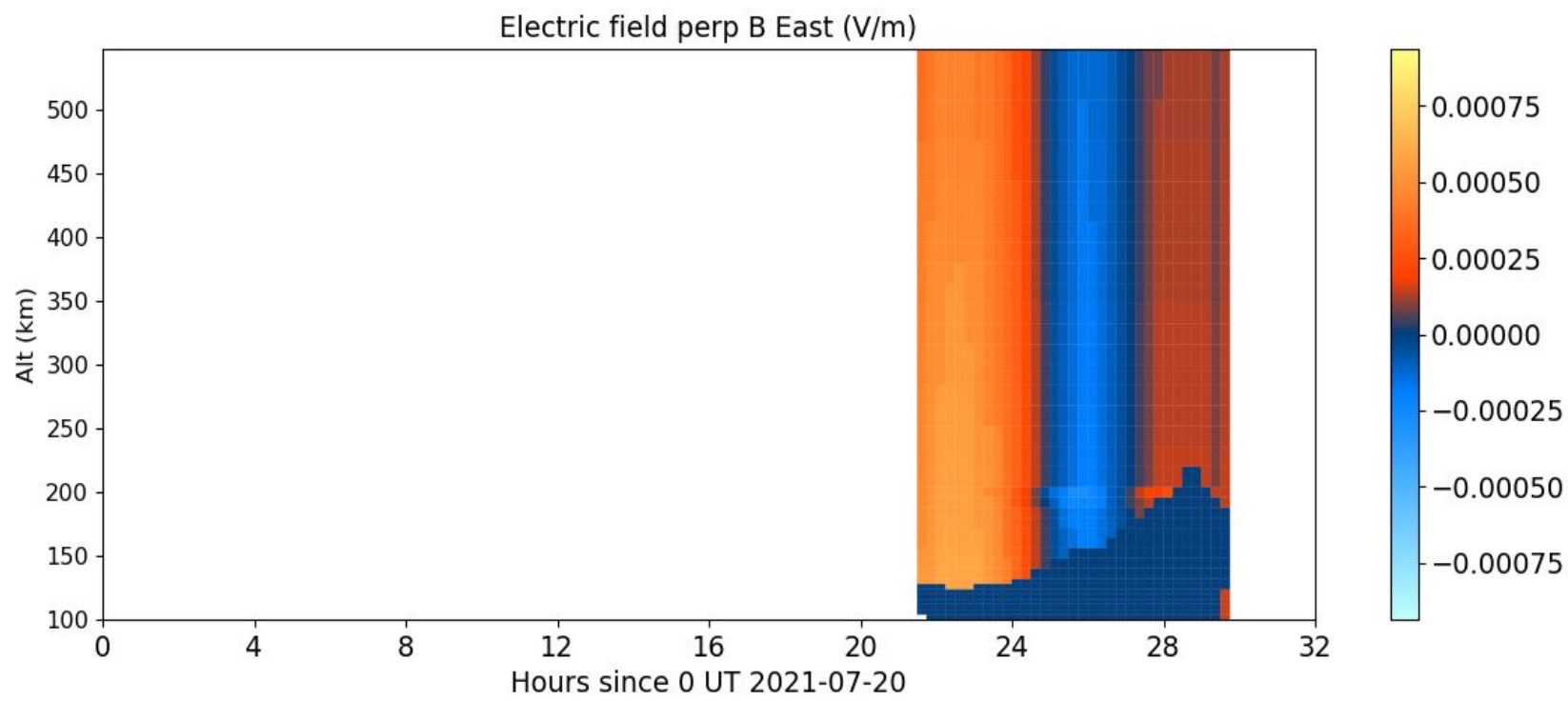
**IRI-2016 Standard
(Online)**





**Additional data
obtained from
Madrigal Database
(20th July 2021)**

http://millstonehill.haystack.mit.edu/showExperiment?experiment_list=10003816



DISCUSSION AND CONCLUSIONS

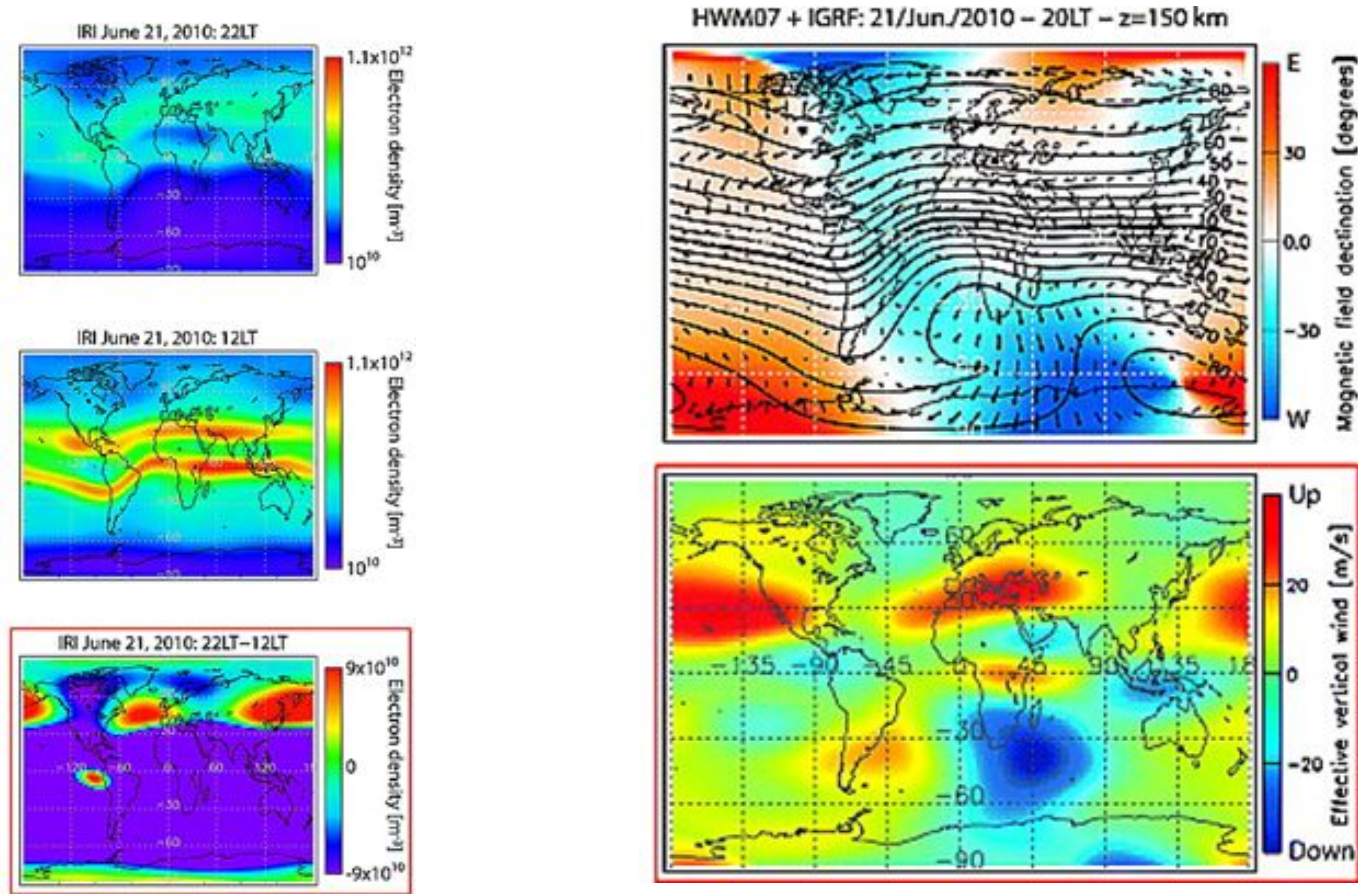
Observations Outline

1. Increase of electron density starting at ~00 UT
 - a. Seen in Ne at all antenna directions, mainly at Zenith
 - b. Seen in Plasma Line Ne (foF2)
 - c. Not seen in Ne height (hmF2). It begins to decrease.
2. Fast decrease of electron temperature starting at ~00 UT
3. Change of ion velocity from upward to downward at ~00 UT
4. Sudden upward change of ion velocity at ~03 UT to ~04 UT
5. Comparison with IRI Model
 - a. Much large Ne measured
 - b. No increase of Ne shown
 - c. Electron temperature and density decrease starting at ~23 UT
6. Fabry-Perot neutral velocities highly increase at ~03 UT
 - a. Seems that eastward increase while northward decreases (data gap)
 - b. Only seen at high altitudes (170 to 240 km)
 - c. May be related to the change of ion velocity at ~03 UT

de Larquier, S., Ruohoniemi, J. M., Baker, J. B. H., Ravindran Varrier, N., and Lester, M. (2011), First observations of the midlatitude evening anomaly using Super Dual Auroral Radar Network (SuperDARN) radars, *J. Geophys. Res.*, 116, A10321, doi:10.1029/2011JA016787.

“... evening electron densities higher than daytime densities during the summer.”

“... proposed mechanisms of the evening enhancement, namely, thermospheric horizontal winds and geomagnetic field configuration.”



First observations of the midlatitude evening anomaly using Super Dual Auroral Radar Network (SuperDARN) radars

Anomalous electron density events in the quiet summer ionosphere at solar minimum over Millstone Hill, Pavlov & Buonsanto, Ann. Geophysicae, 16, 460-469, 1998.
<https://angeo.copernicus.org/articles/16/460/1998/angeo-16-460-1998.pdf>

.... determination of a G condition using incoherent scatter radar data is sensitive both to the true concentration of O⁺ relative to the molecular ions, and to the ion composition model assumed in the data reduction process.

We do not observe this effect ...

**Antonio Guerrero,
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Tanmay Das,
and Ana Elias**

THANK YOU!

ISR SUMMER SCHOOL

July 19-23, 2021

Virtual School

