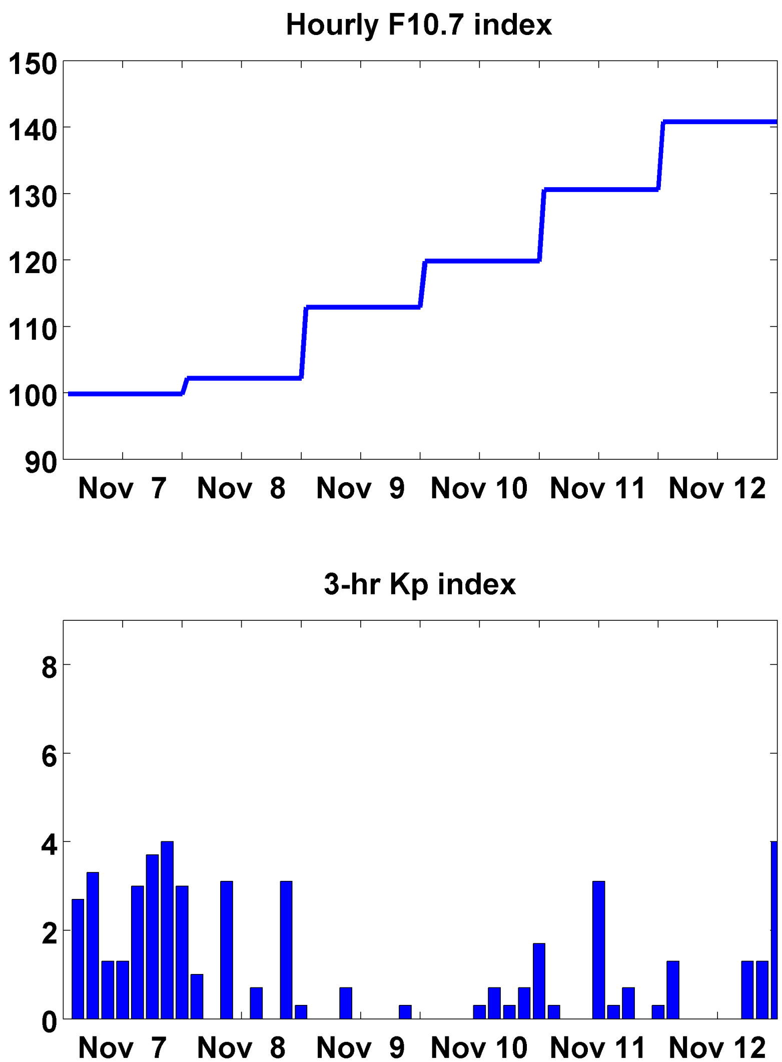
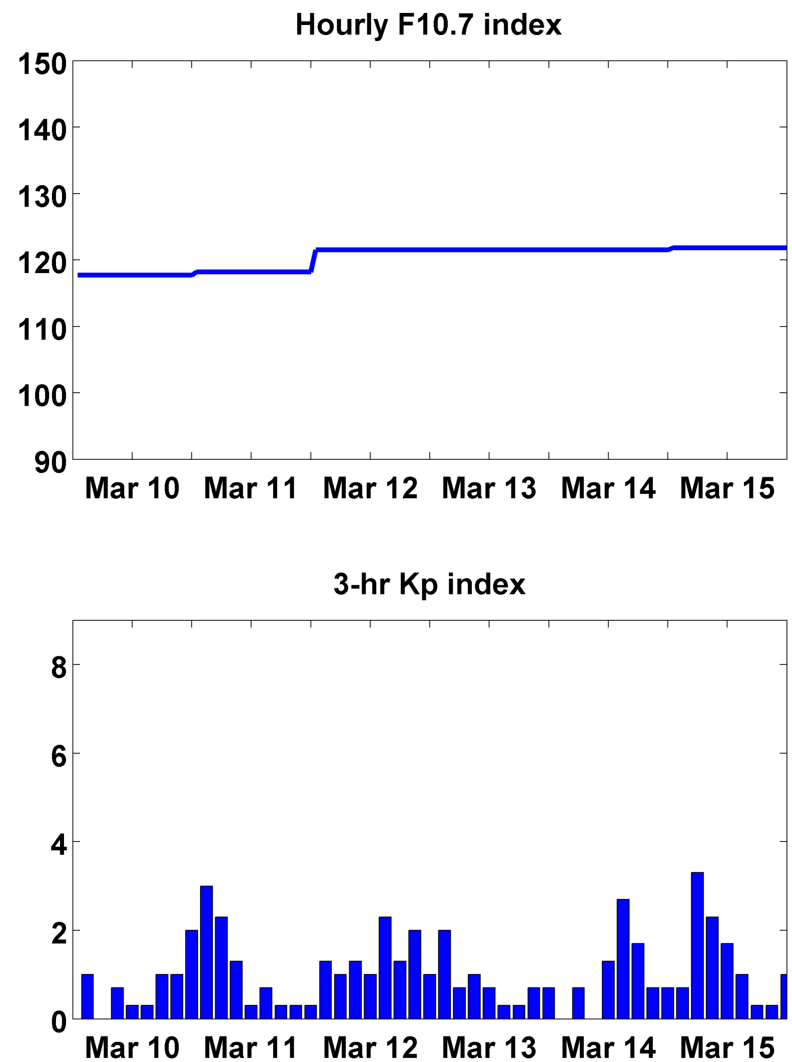
Model-data Comparisons for the Coupled Models

Models	Full Names	Participated Modelers
SAMI3	SAMI3 is Also a Model of the Ionosphere	Joe Huba Jonathan Krall (NRL)
TIEGCM	Thermosphere Ionosphere Electrodynamics General Circulation Model	Astrid Maute Art Richmond (NCAR)
GITM	Global Ionosphere-Thermosphere Model	Aaron Ridley Angeline Burrell (University of Michigan)
CTIPe	Coupled Thermosphere Ionosphere Plasmasphere Electrodynamics Model	Mariangel Fedrizzi Tim Fuller-Rowell Mihail Codrescu (CU/CIRES & NOAA SWPC)

Nov 7-12, 2012



Mar 10-15, 2013



Ionosphere Parameters

1. E×B vertical drift at 300 km in Jicamarca
2. NmF2 and HmF2 at three ionosonde locations
3. NmF2 and HmF2 at 75W (Latitude vs. LT)
4. TEC values at 4 different LT in 70W
5. E-region density (~100 km) at three ionosonde locations

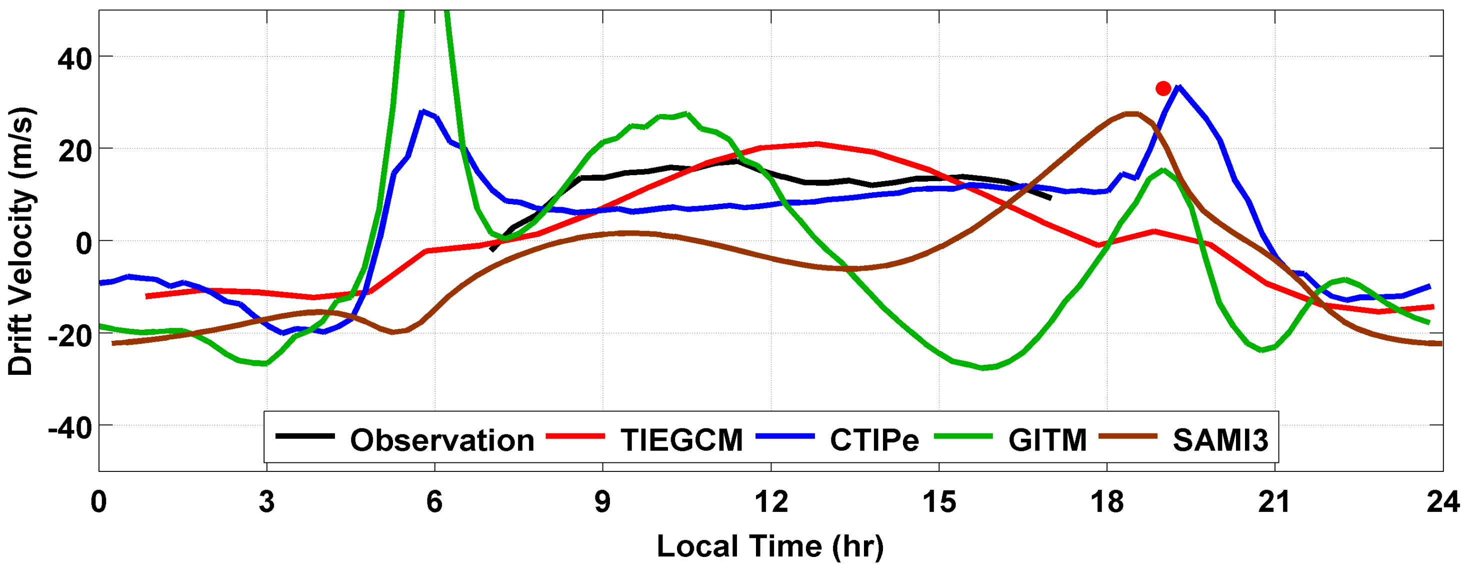
Thermospheric Parameters

6. O/N2 comparisons
7. Diurnal variations of zonal and meridional neutral winds at 150 km and 300 km in 70W

1. Equatorial vertical drift comparisons

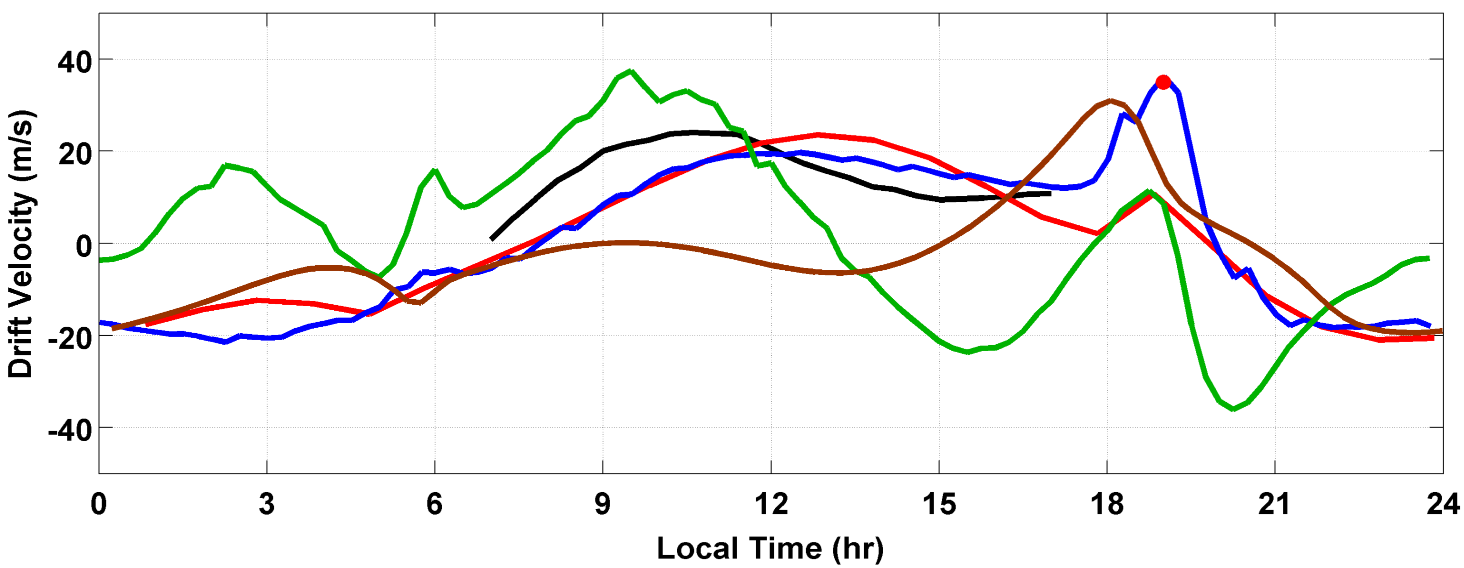
daytime observations: ΔH at Jicamarca longitude; PRE estimation: FIRST technique

2012-Nov Vertical Drift Average



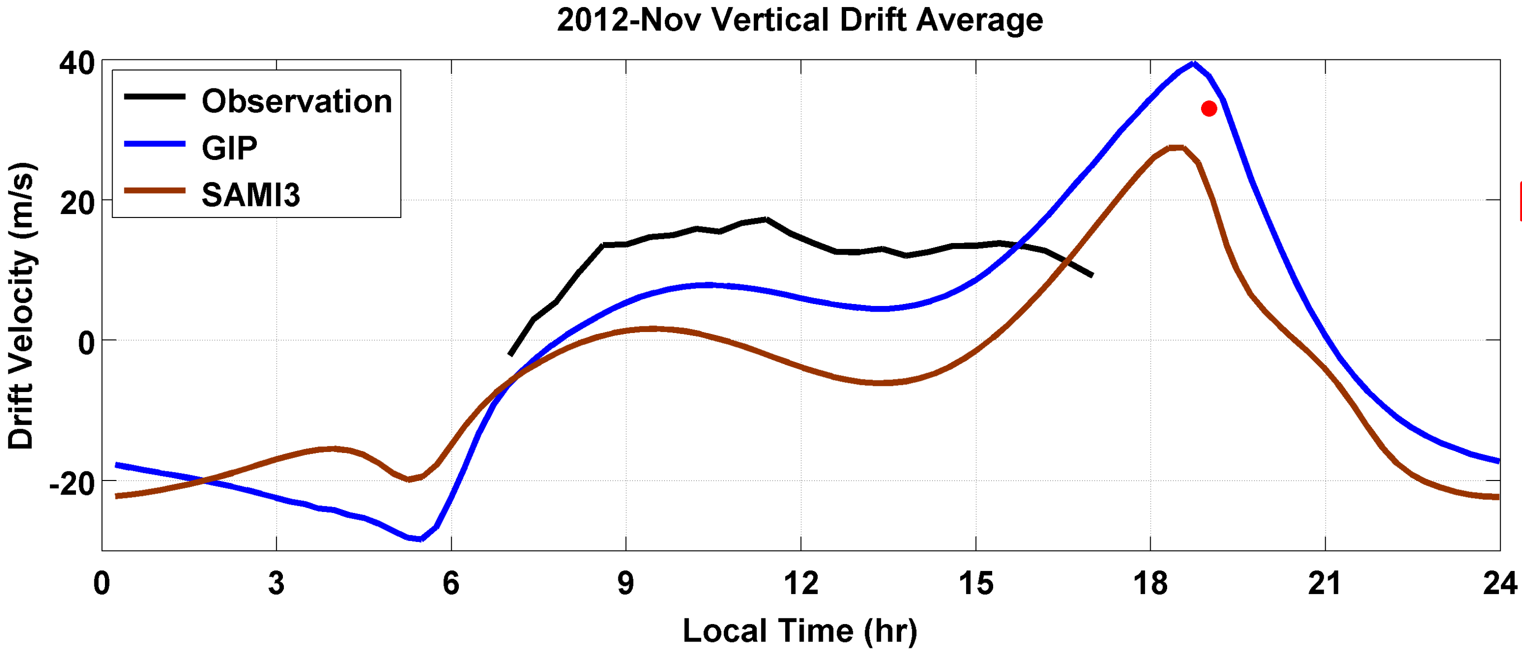
November

2013-Mar Vertical Drift Average

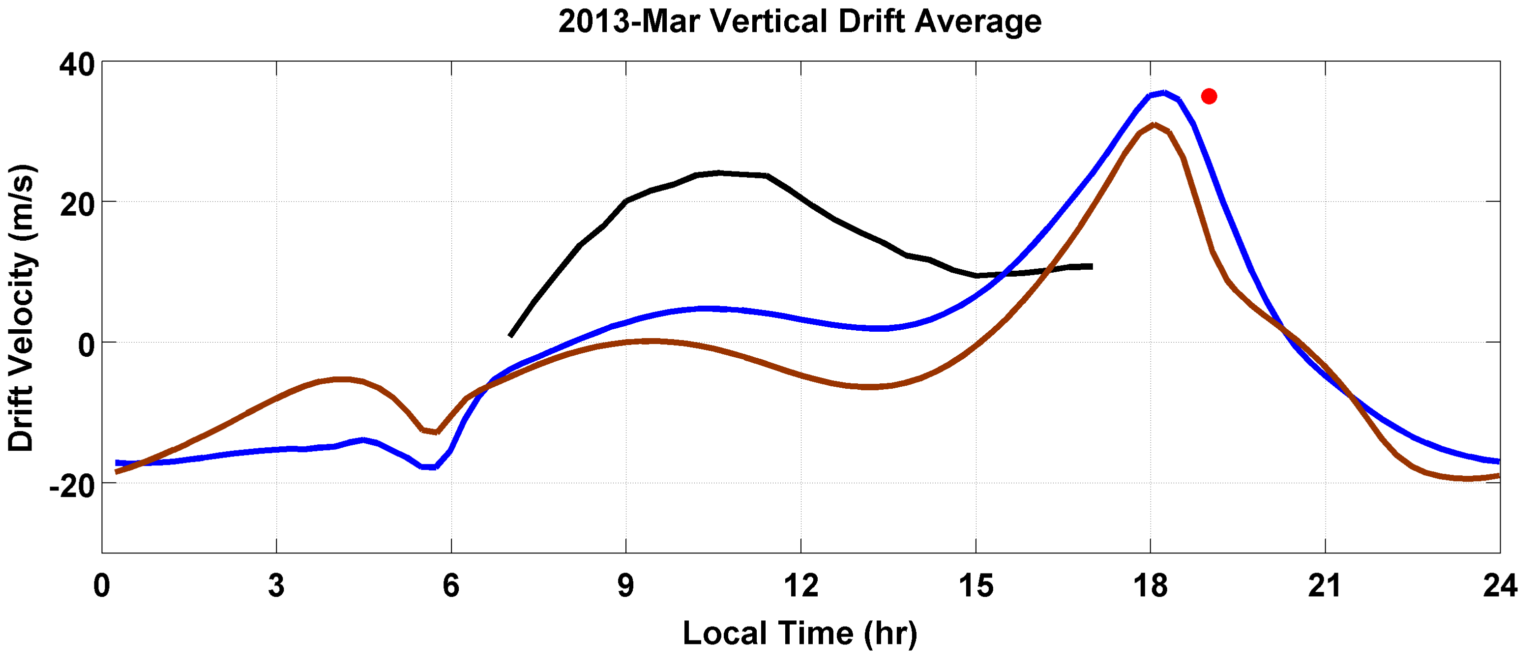


March

Both models use HWM93 and NRLMSIS-00



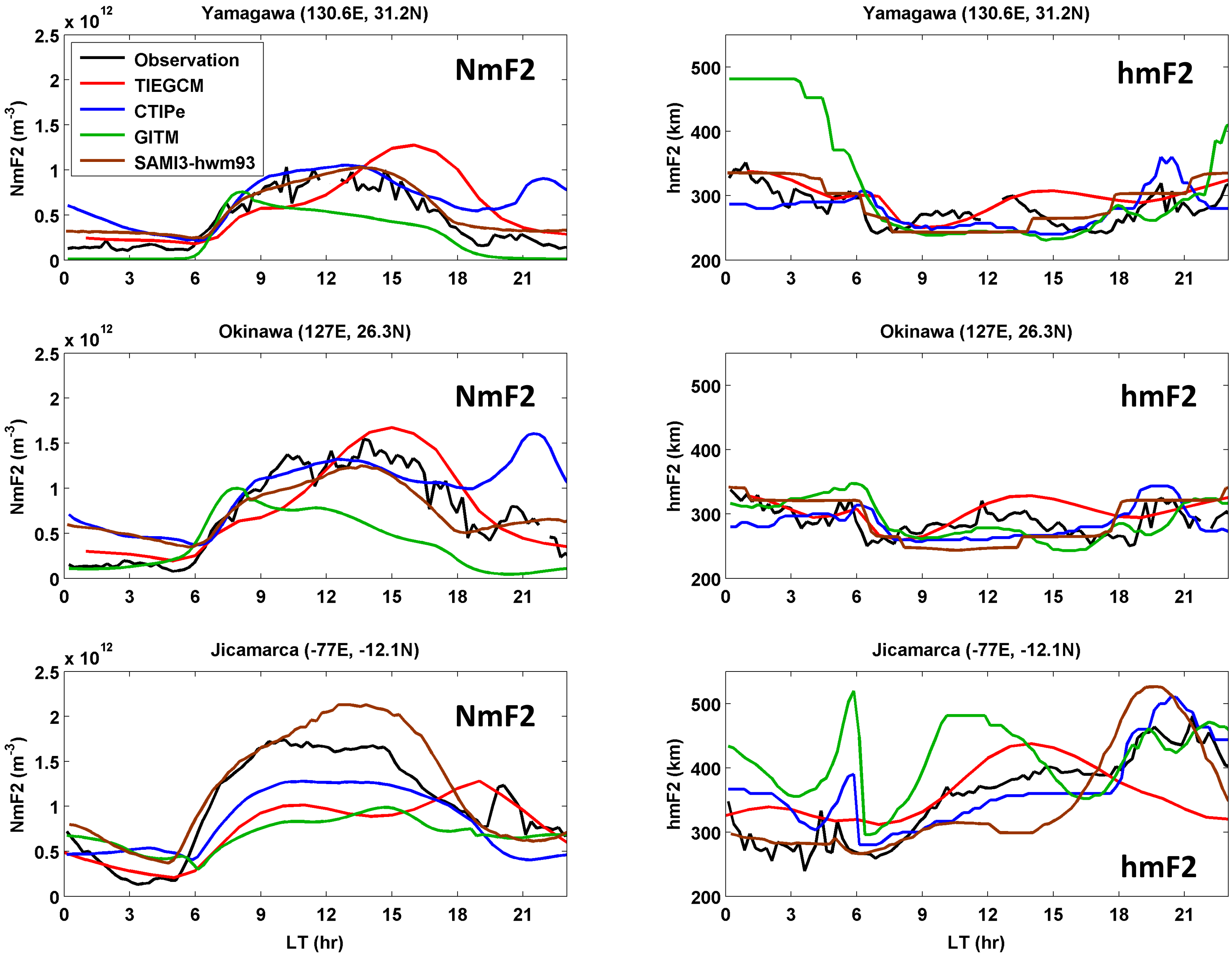
November



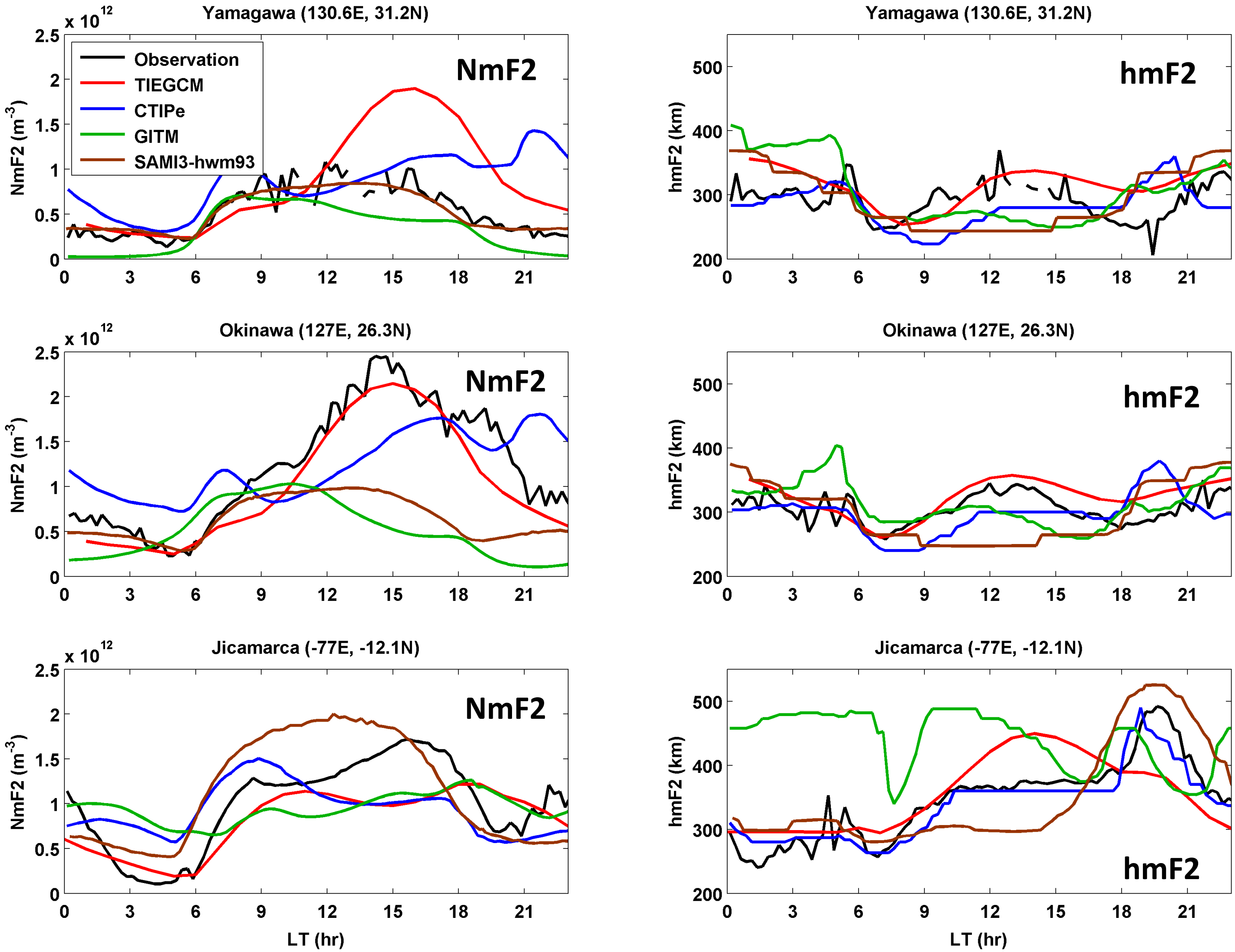
March

2. NmF2 and hmF2 at three different locations

November



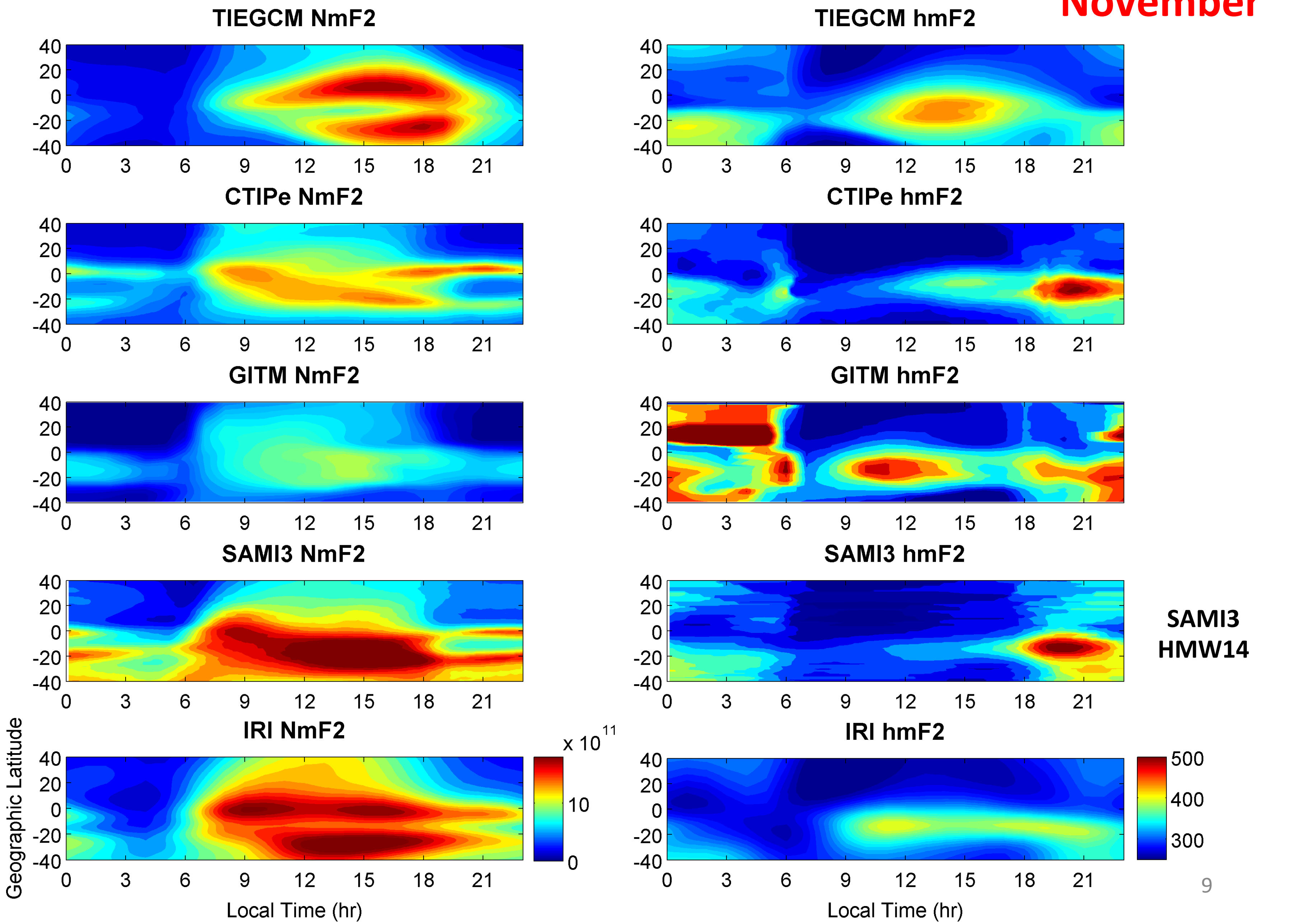
NmF2 and hmF2 at three different locations **March**



Large density differences in top two stations but not in model results

3. Diurnal variation of NmF2 and hmF2 at Jicamarca longitude

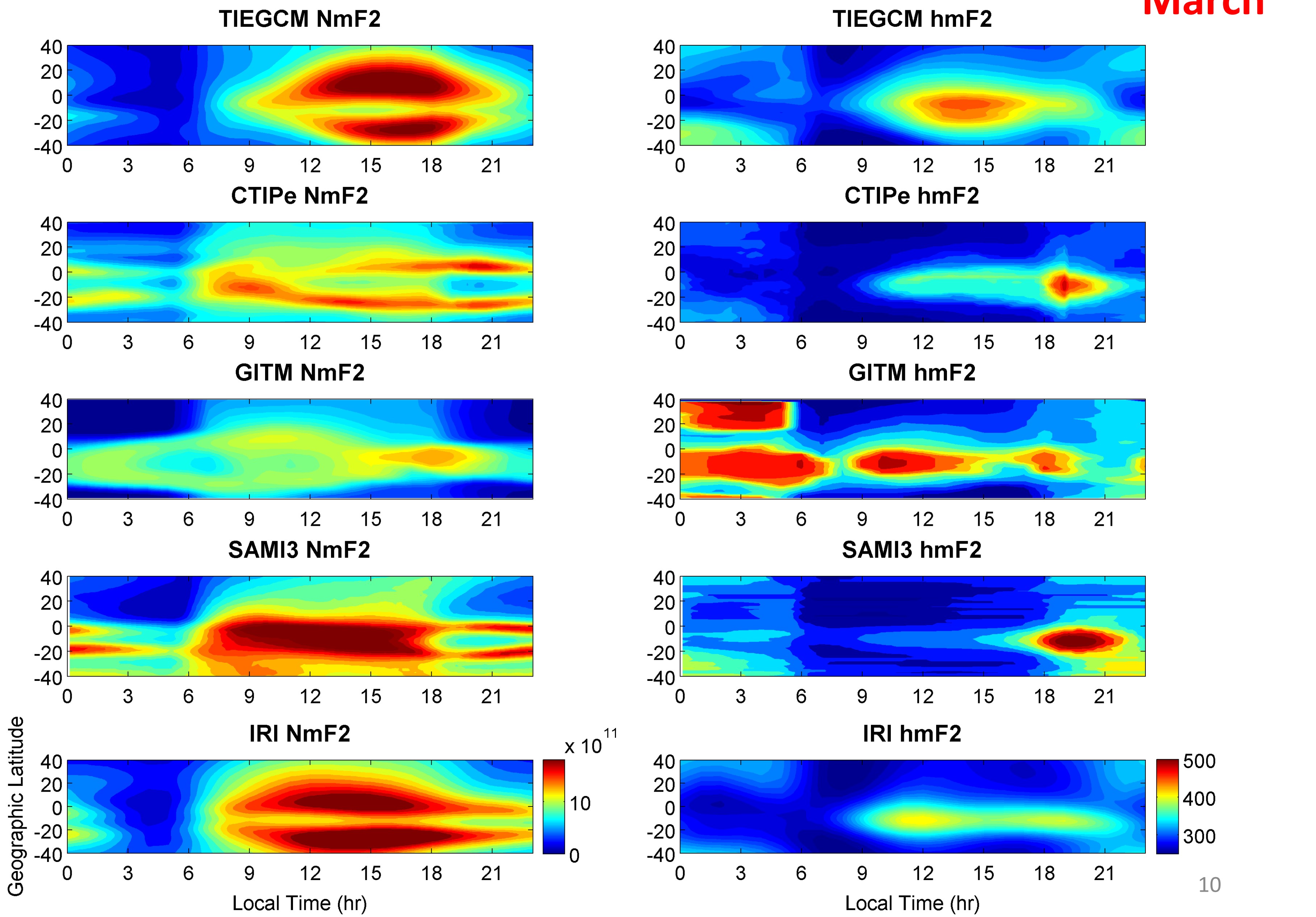
November



SAMI3 HMW14

Diurnal variation of NmF2 and hmF2 at Jicamarca longitude

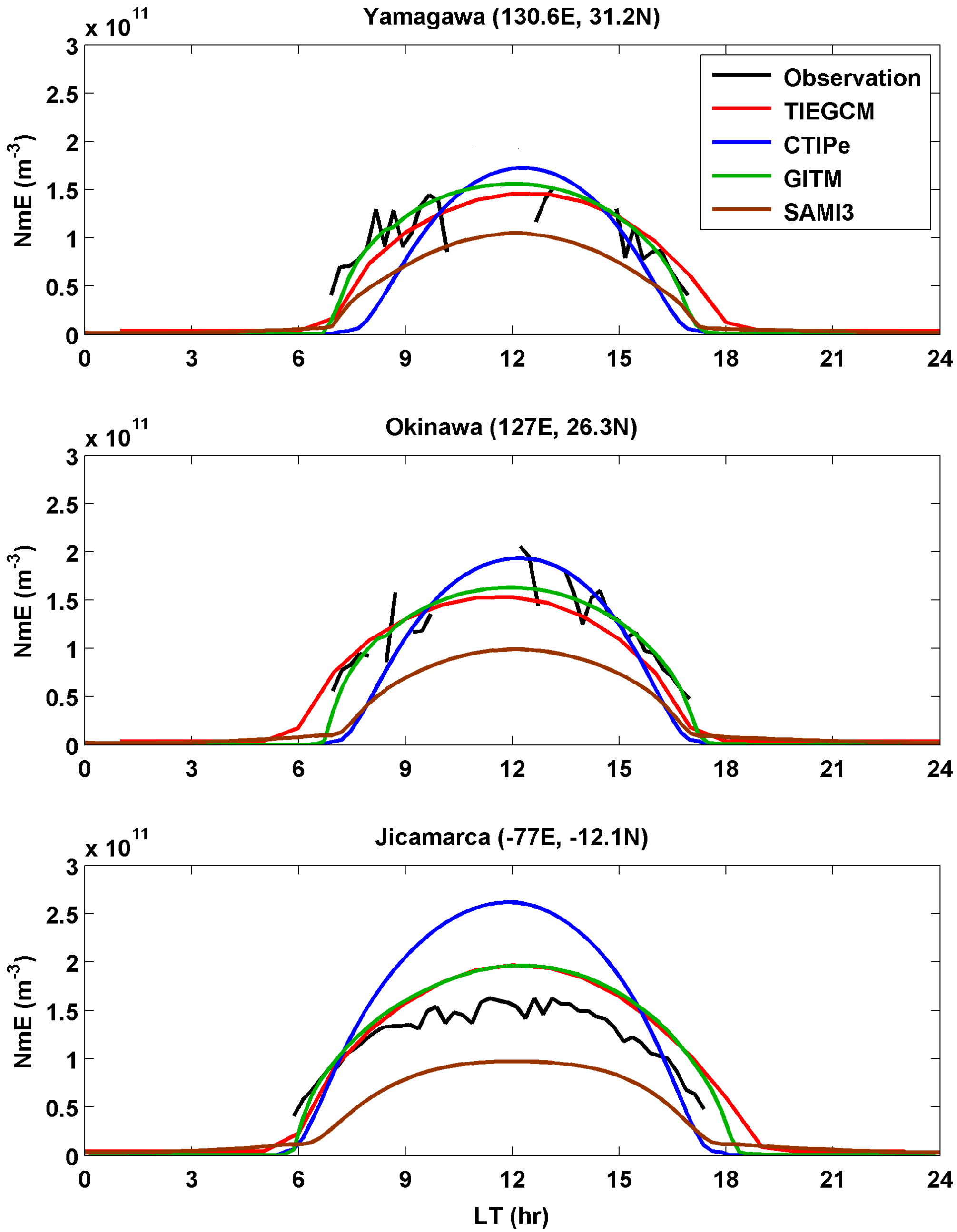
March



4. E-region density (~100km) at three ionosonde stations

November

TIEGCM shows earlier increase in Okinawa for both seasons



E-region density (~100km) at three ionosonde stations

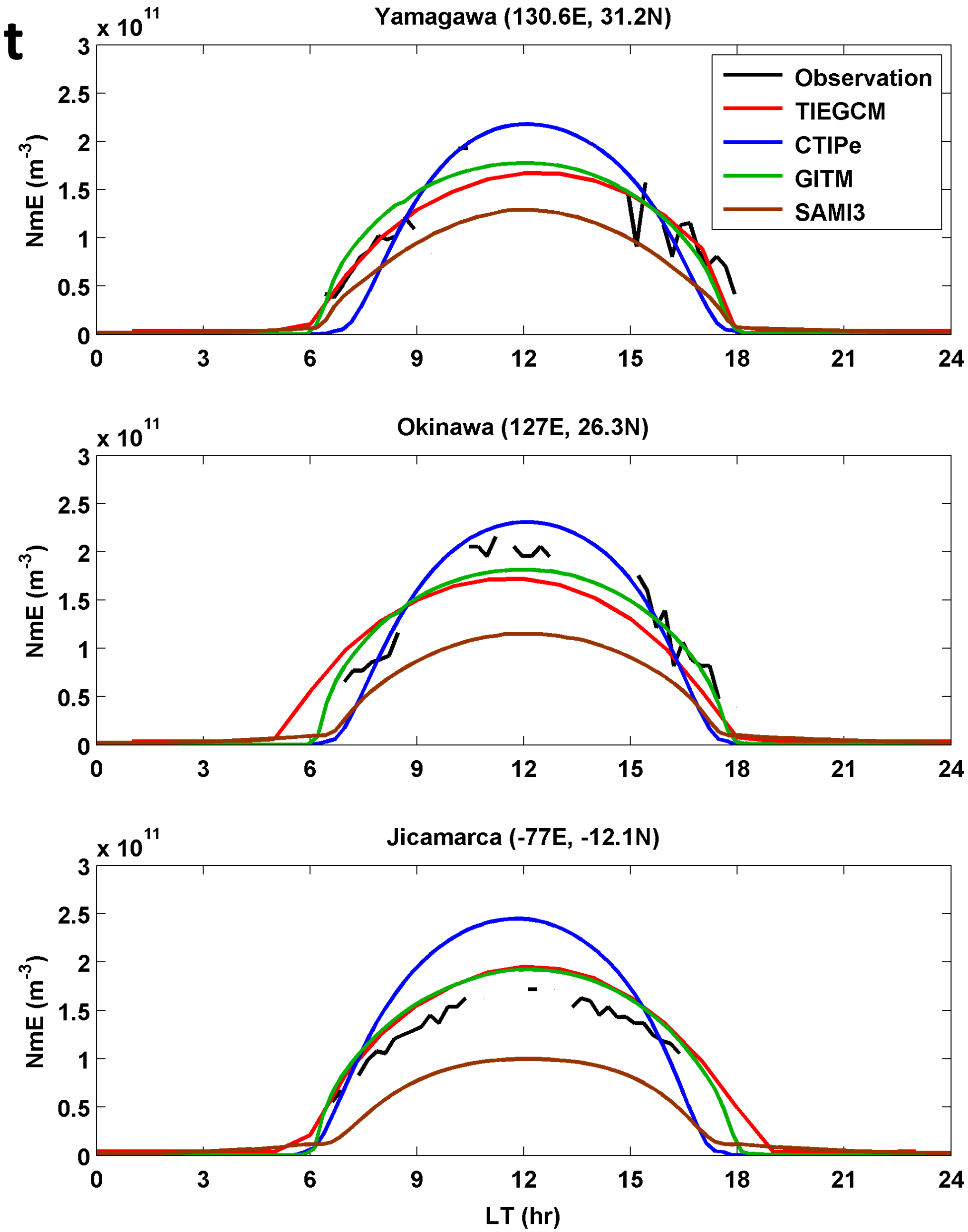
March

TIEGCM and SAMI3 have included nighttime ionization sources for E-region

TIEGCM (4×10^9 m^{-3}) fixed

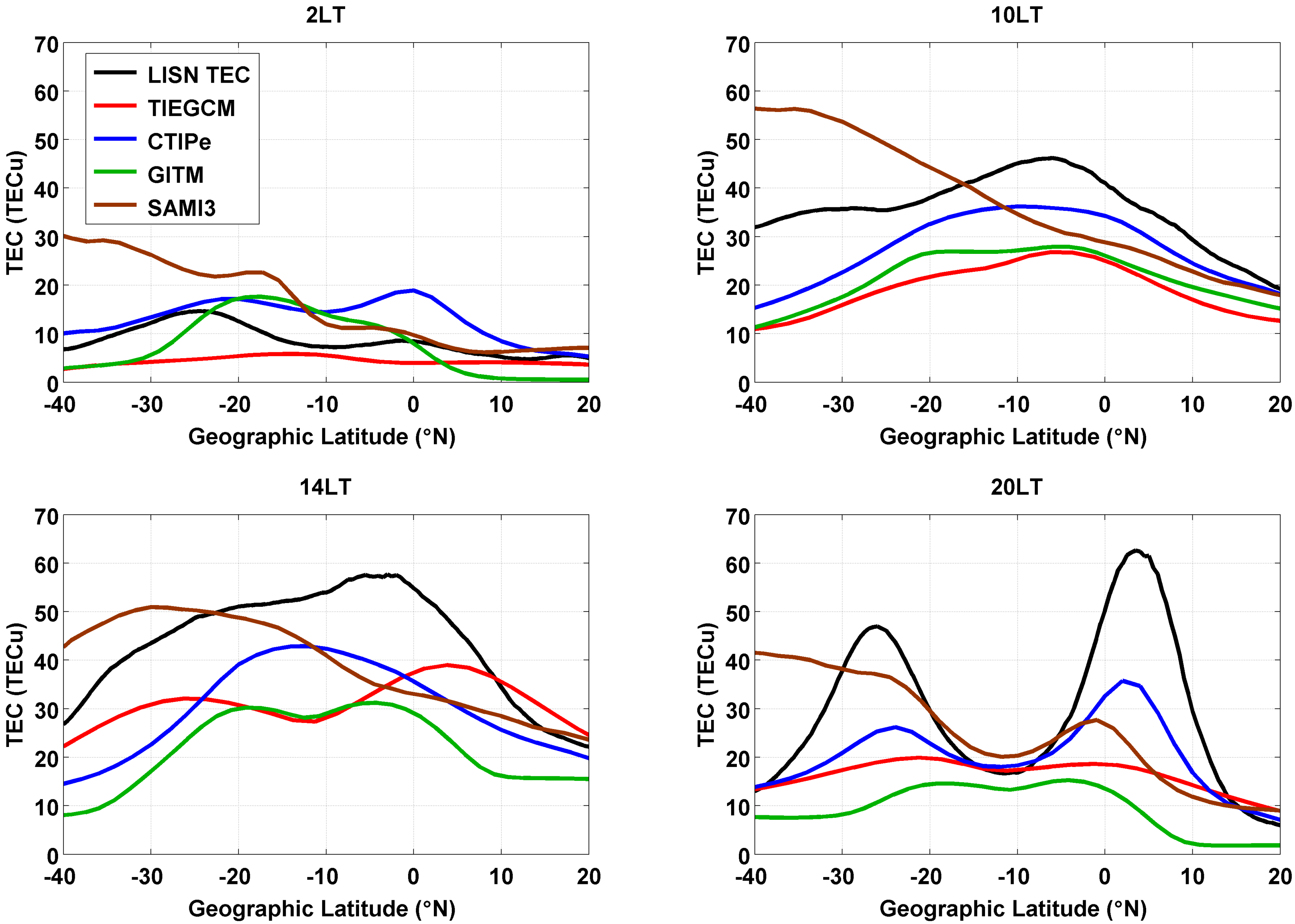
SAMI3 (~2×10^9 m^{-3})
Small fluctuation

CTIPe and GITM also seem to include something in the nighttime but with much weaker magnitude.



5. TEC Comparisons (70°W)

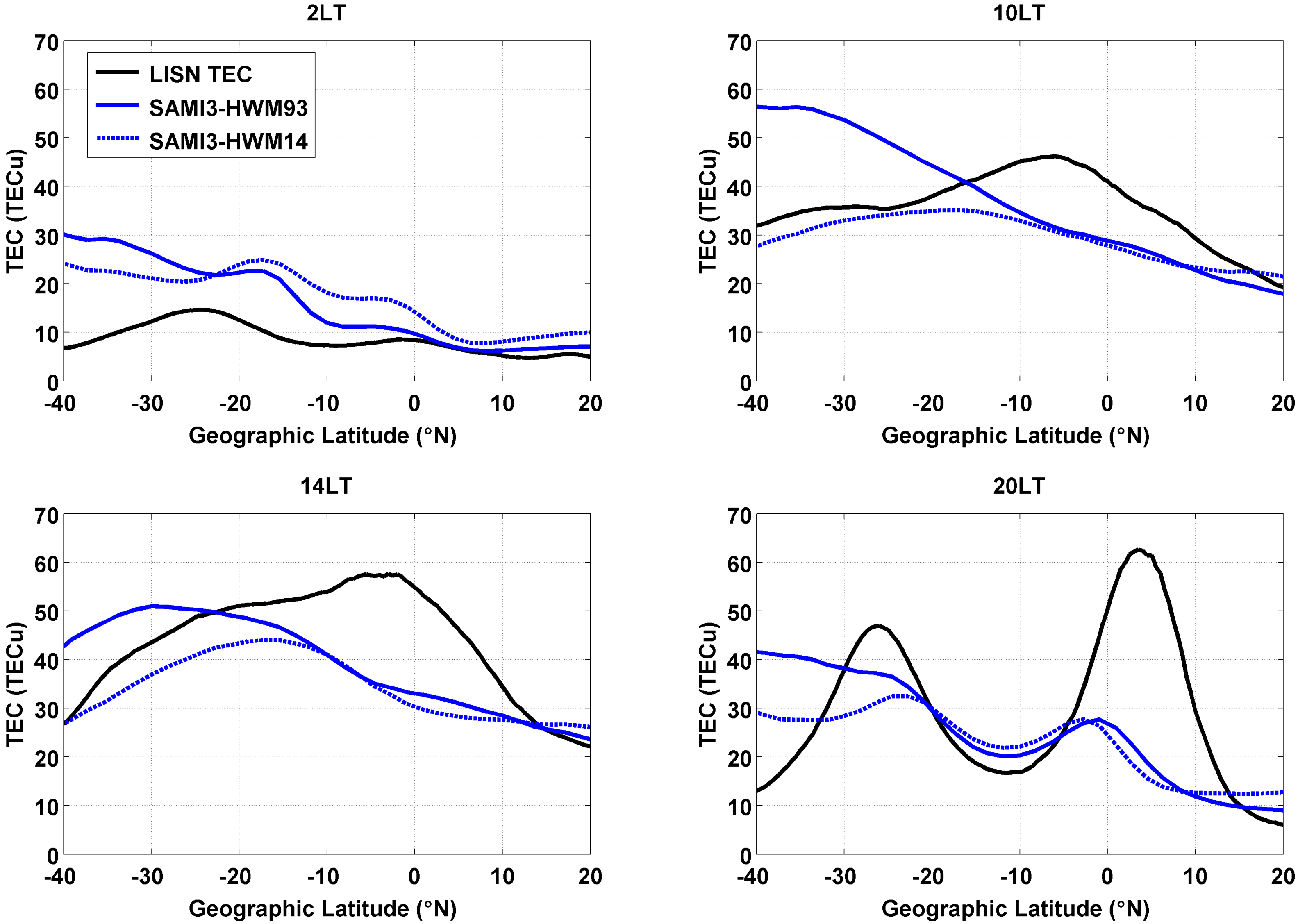
November



Height for the integration?

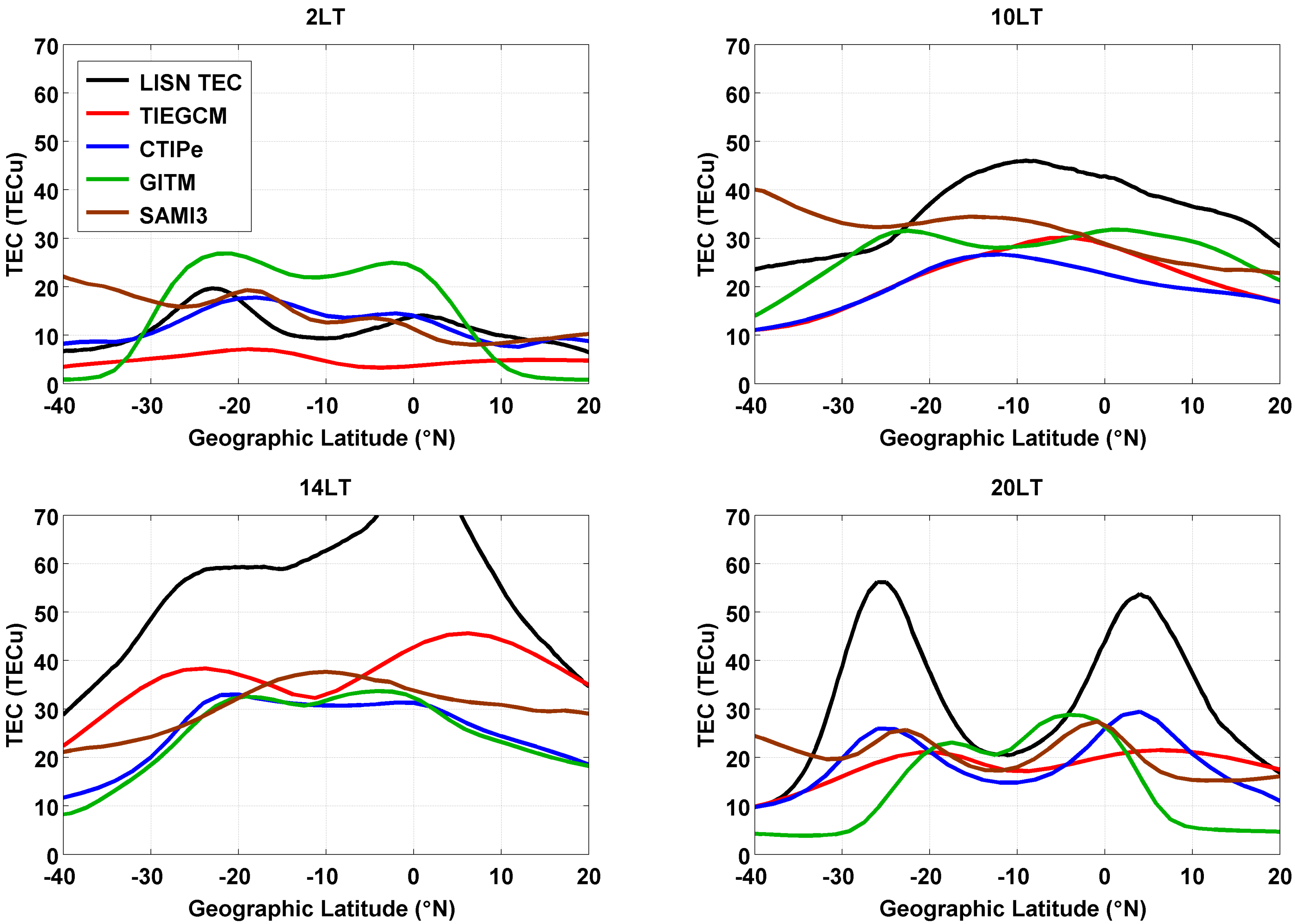
LISN data were provided by Cesar Valladares (BC)

November


2LT
10LT
14LT
20LT
LISN TEC
SAMI3-HWM93
SAMI3-HWM14
TEC (TECu)
Geographic Latitude (°N)
70
60
50
40
30
20
10
0
-40
-30
-20
-10
0
10
20

TEC Comparisons (70°W)

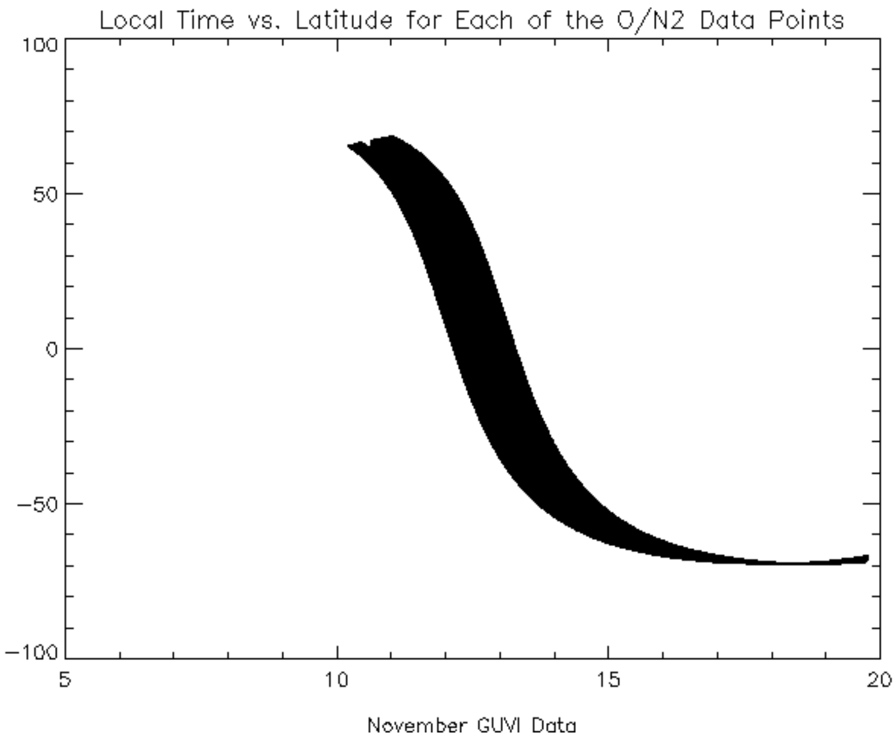
March



LISN data were provided by Cesar Valladares (BC)

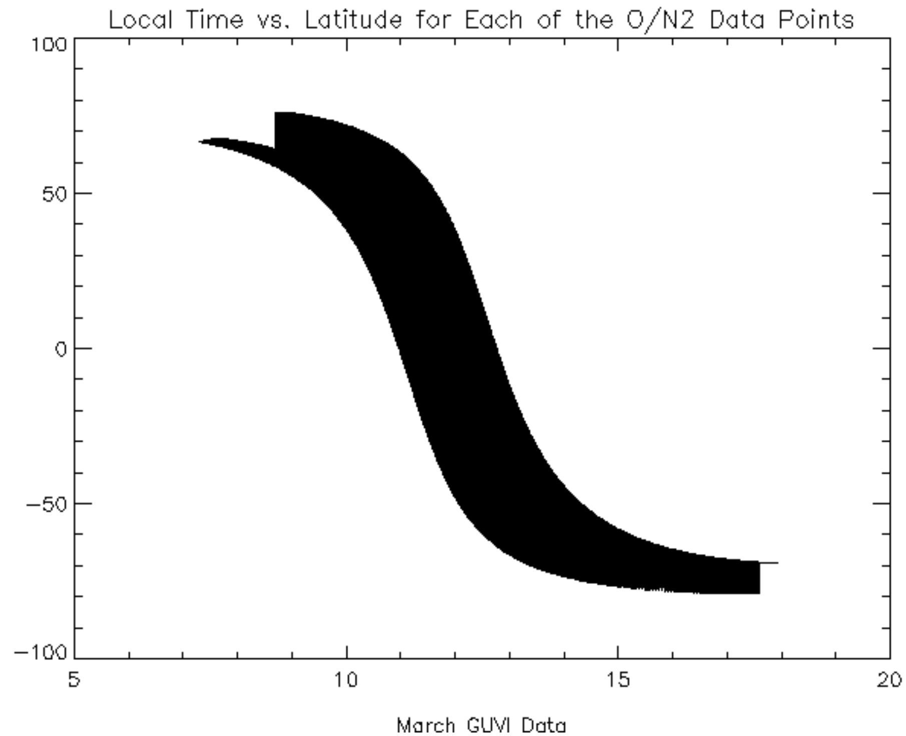
6. O/N2 Latitudinal Zonal Average from GUVI

November



11 - 14 LT

March

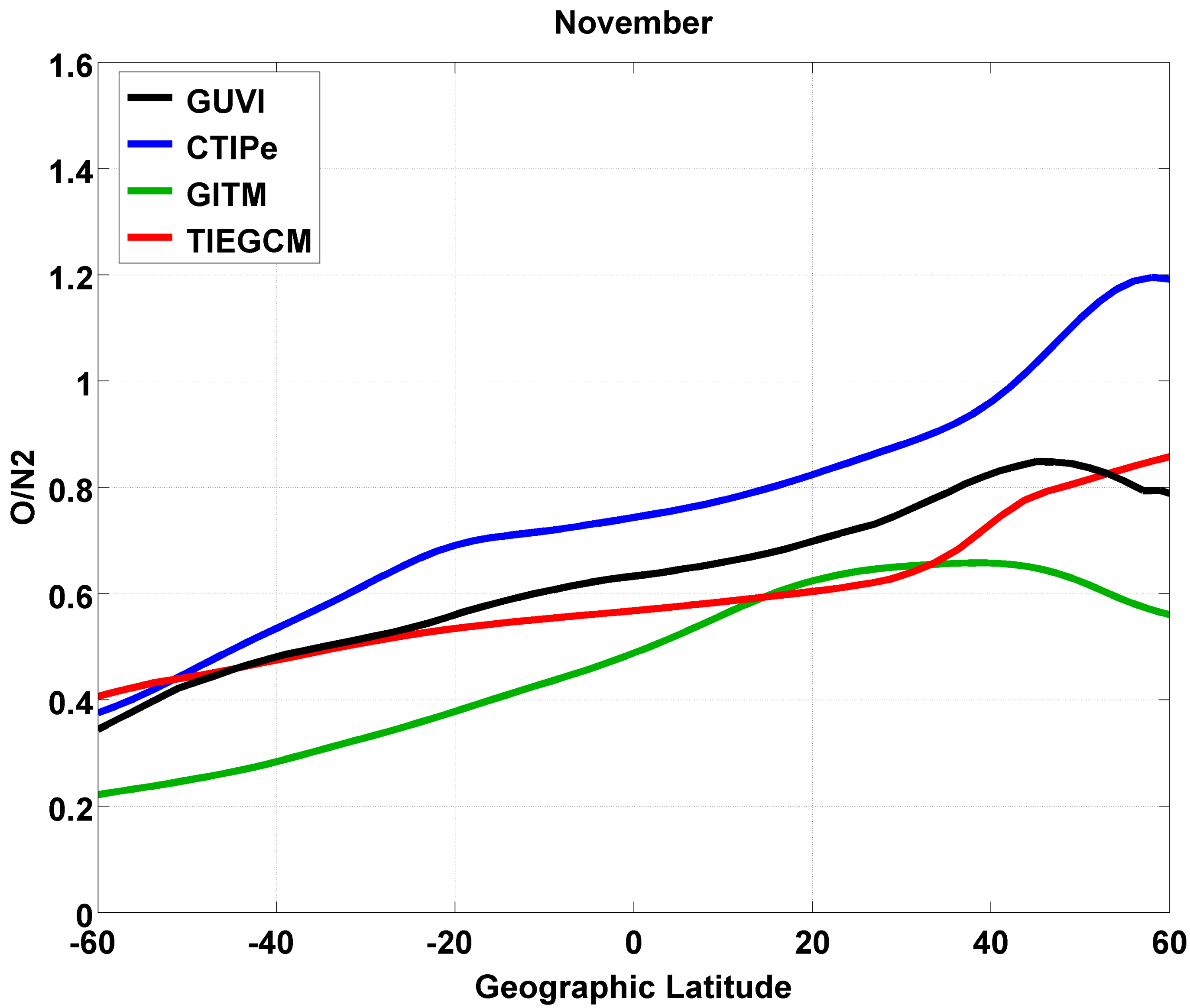


10 - 13 LT

GUVI observations were calculated by Jack Olsen (CU)

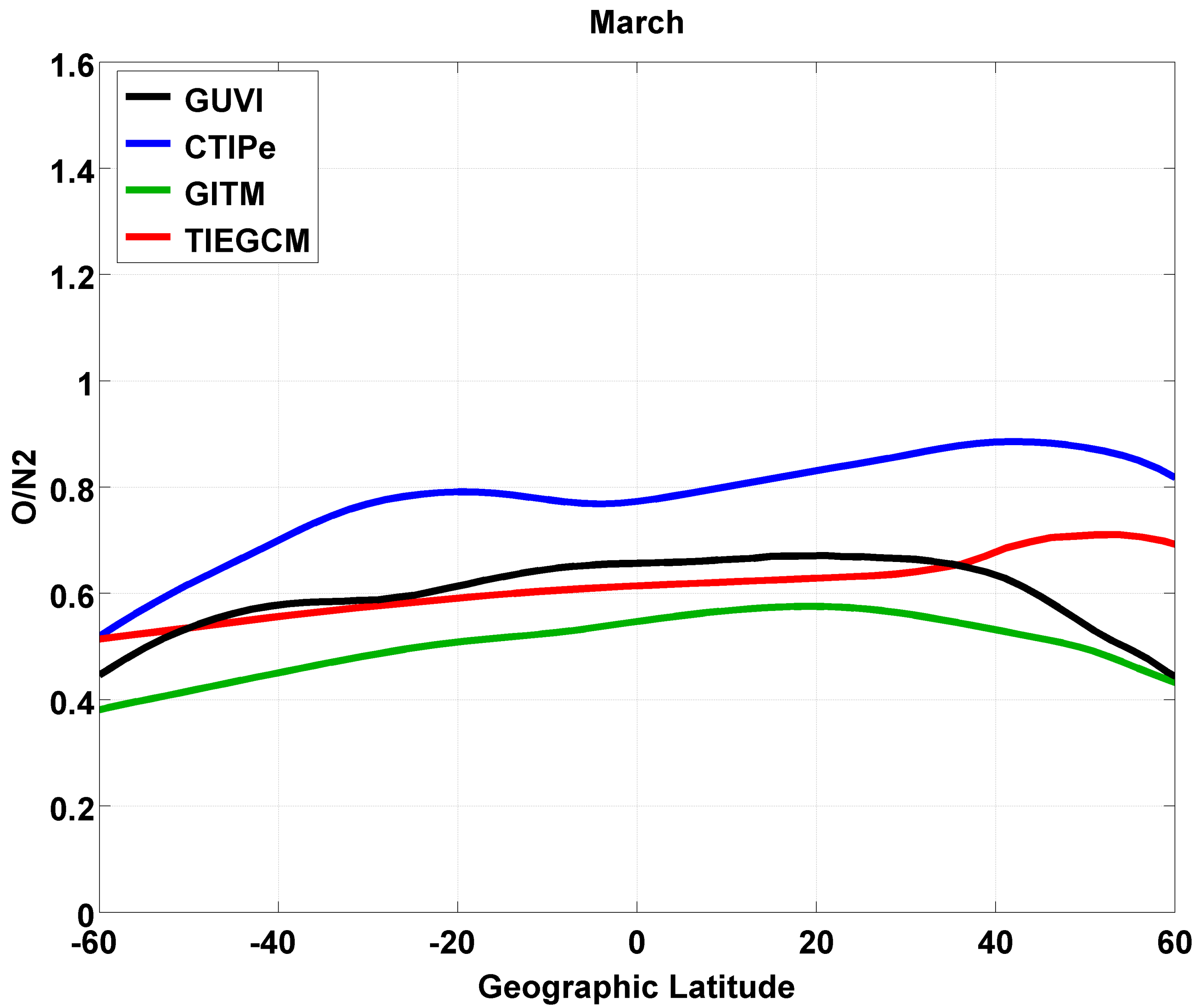
O/N_2 Comparisons

November



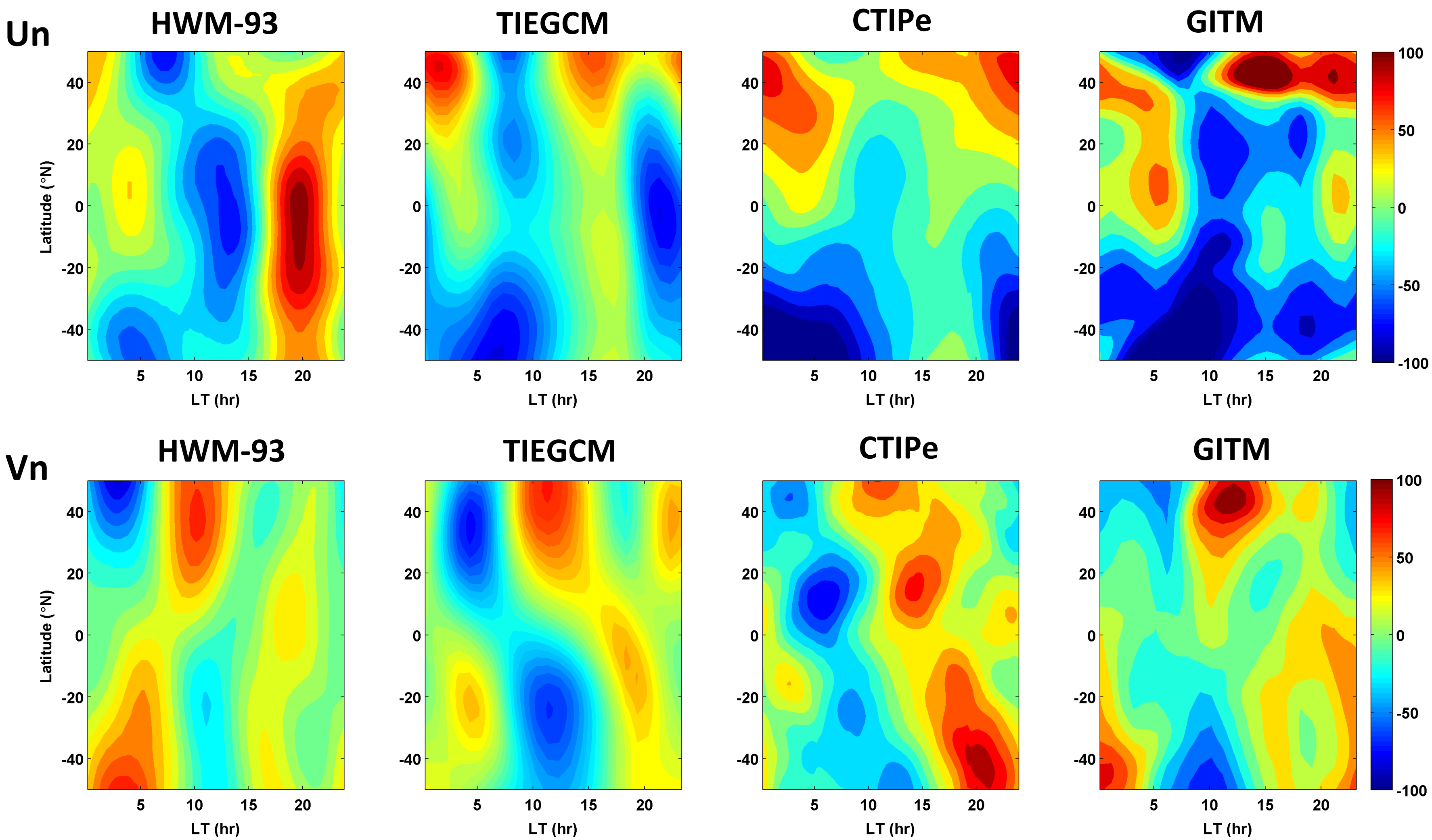
O/N_2 Comparisons

March



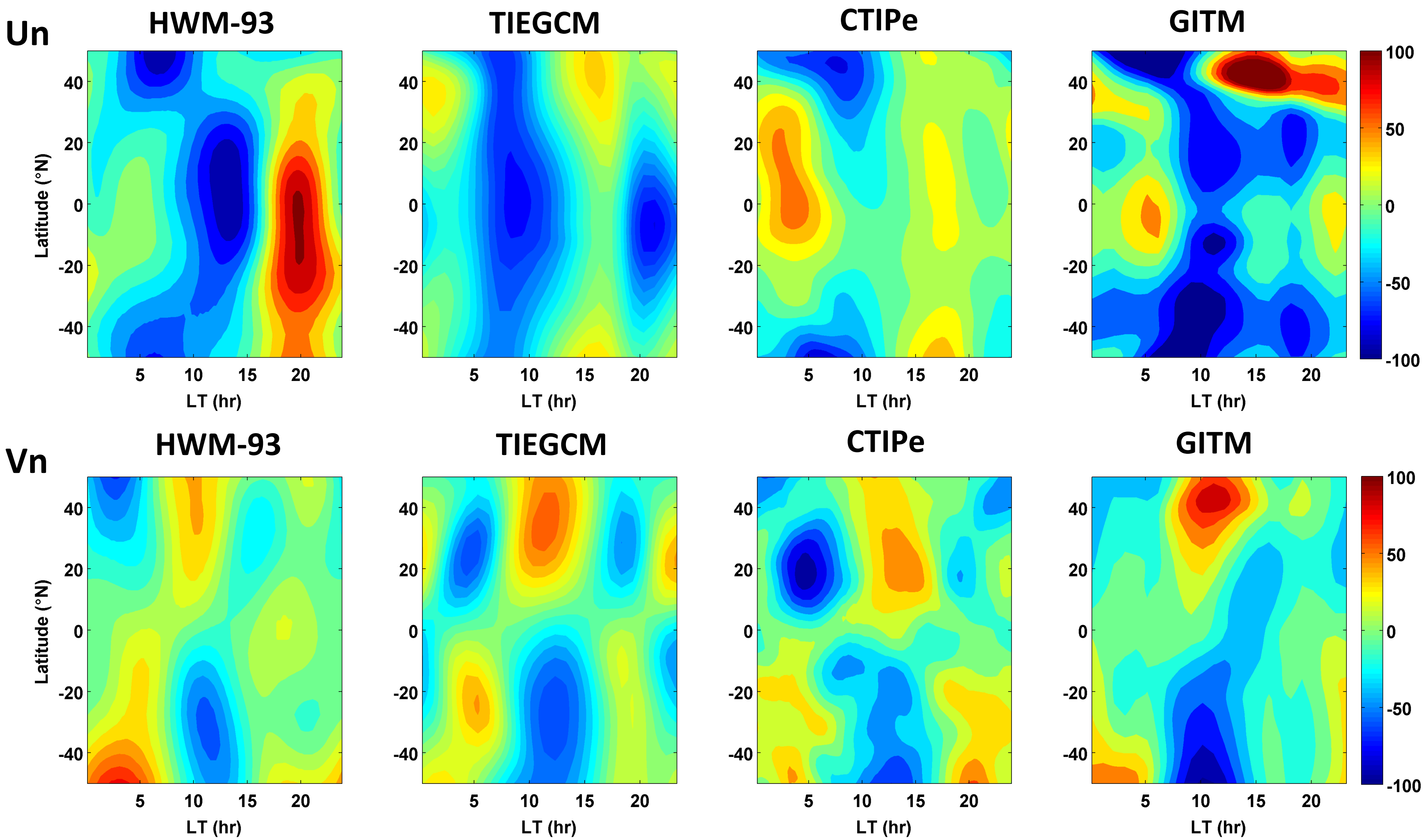
7. UN (Eastward positive) and VN (Northward positive) at 150 km in 70W

November



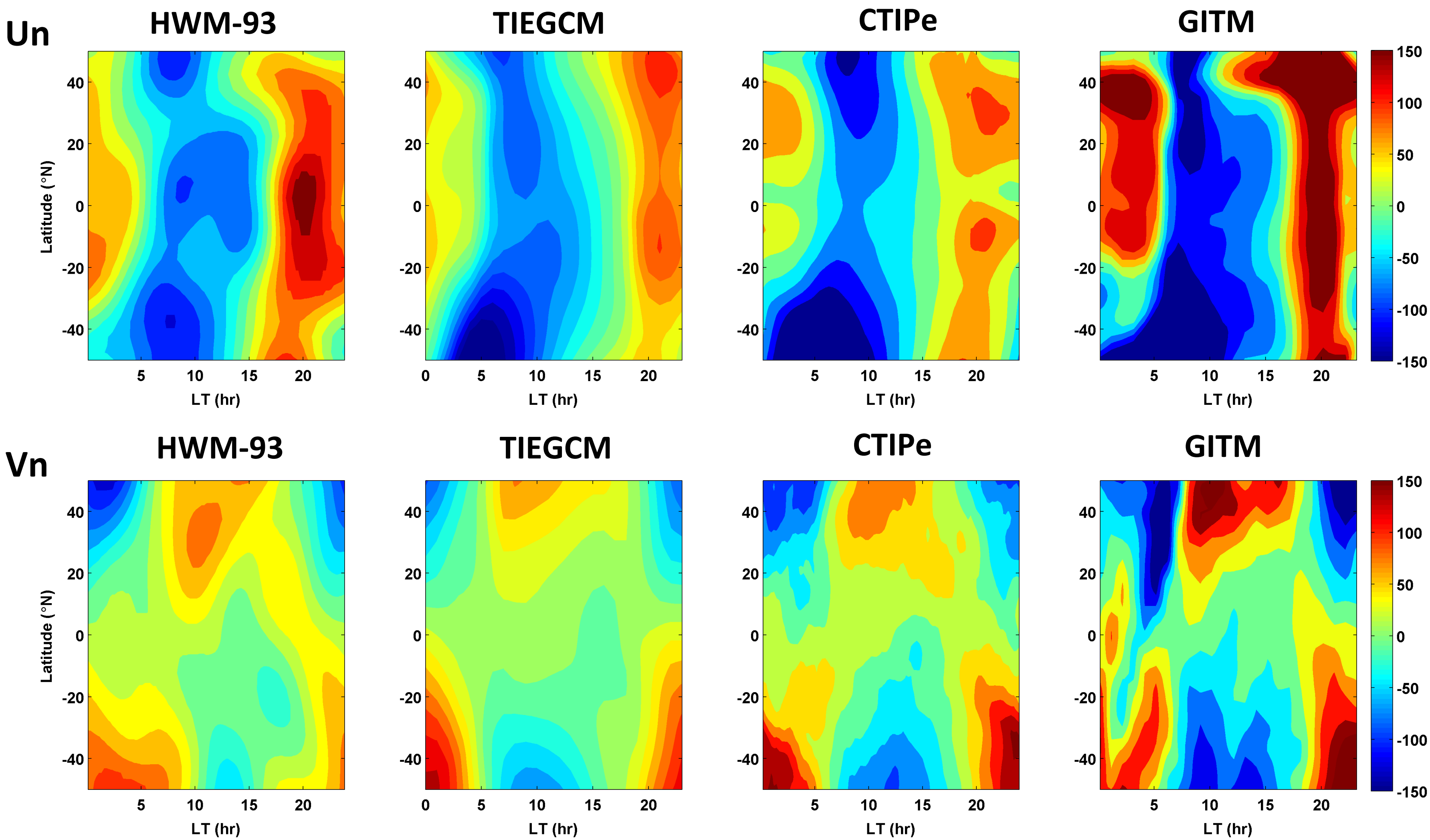
7. UN (Eastward positive) and VN (Northward positive) at 150 km in 70W

March



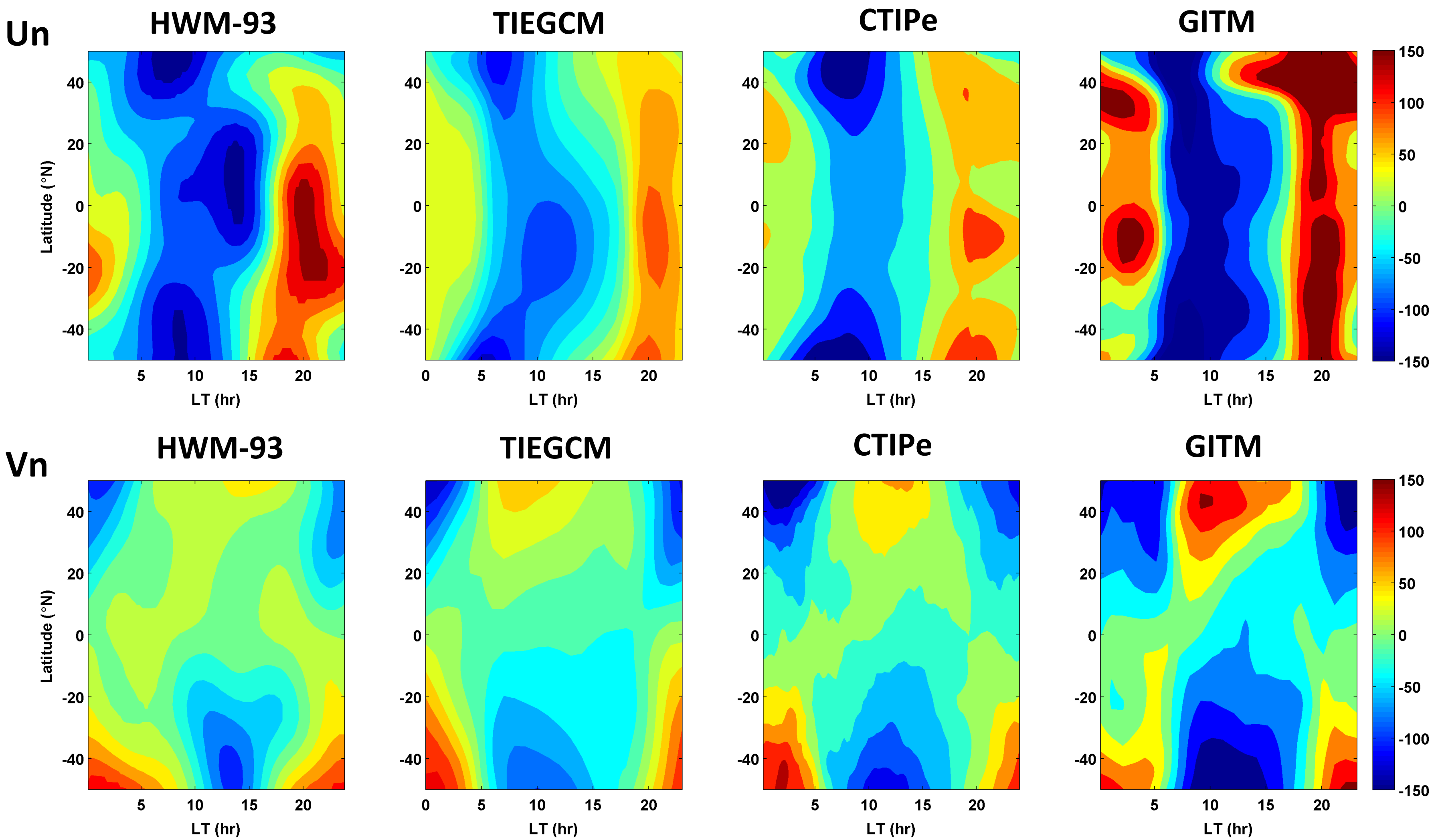
UN (Eastward positive) and VN (Northward positive) at 300 km in 70W

November



UN (Eastward positive) and VN (Northward positive) at 300 km in 70W

March

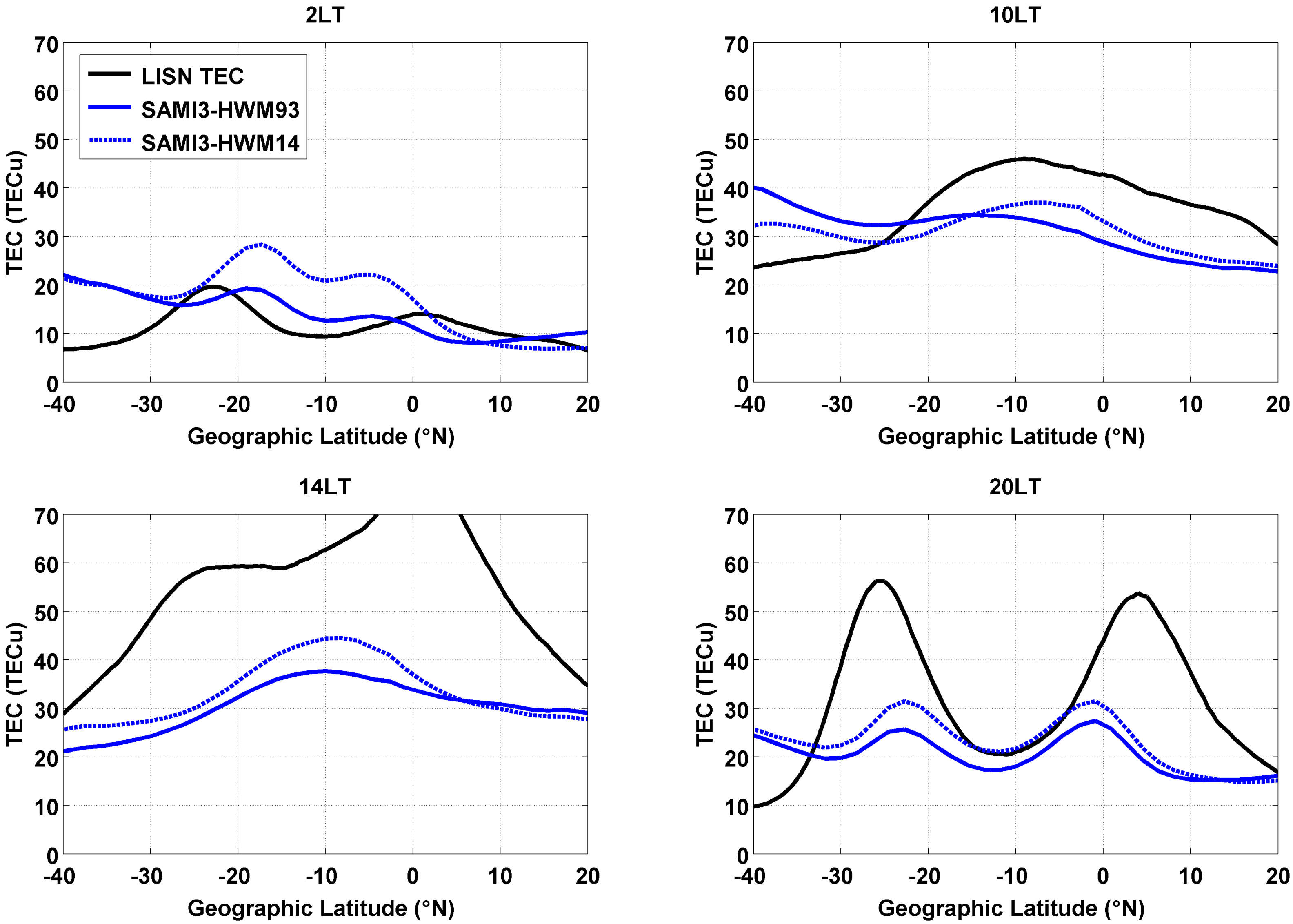


Summary

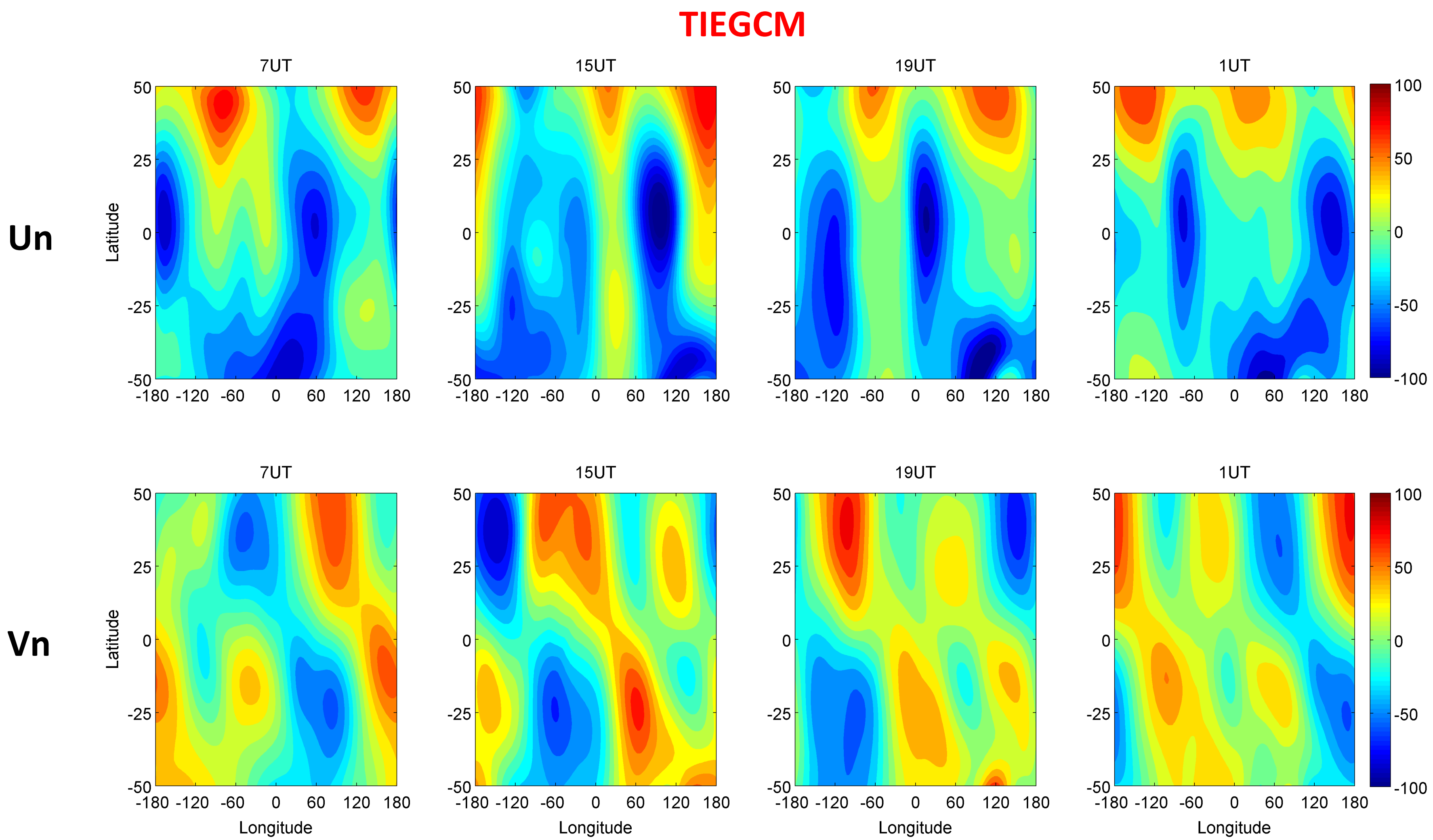
- It is difficult to compare model results with quiet-time observations from a single station. (long-term data or event studies may be ok)
- TEC is underestimated in these models. However, most of the coupled models have upper boundary at around 500 km, significant underestimations of TEC are expected.
- Tides at the lower boundary are certainly important in order to get reasonable values of equatorial vertical drift. Once the drift looks right, the ionosphere density distribution will look better.
- Daytime E-region density and daytime vertical drift are too low in SAMI3. Neutral winds seem too strong and O/N2 seems too low in GITM. NmF2 is too low while the hmF2 is too high in GITM.
- The F-region winds look reasonable in these models.
- All these models provide different magnitudes of PRE.
- Remember that all these results are under geomagnetic quiet conditions and moderate solar activity.

Other slides

March

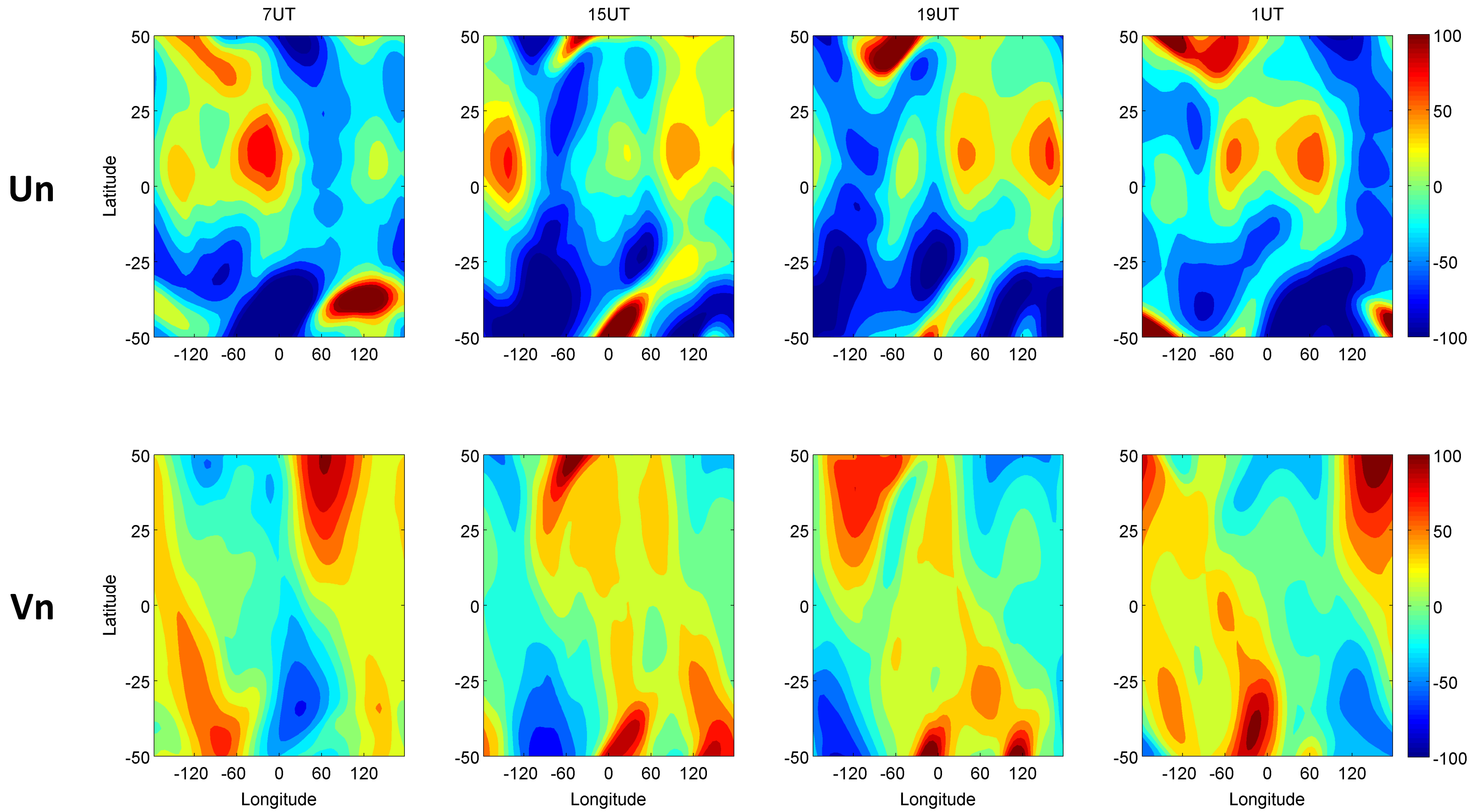

2LT
10LT
14LT
20LT
LISN TEC
SAMI3-HWM93
SAMI3-HWM14
TEC (TECu)
Geographic Latitude (°N)
70
60
50
40
30
20
10
0
-40
-30
-20
-10
0
10
20

Zonal and meridional Wind at around 150 km (or other altitudes) for 4 UTs in November. Maybe we should show time variation (24hr) of wind at a fixed longitude or zonal averaged wind at fixed LT.



Zonal and meridional Wind at around 150 km (or other altitudes) for 4 UTs in November. Maybe we should show time variation (24hr) of wind at a fixed longitude or zonal averaged wind at fixed LT.

GITM



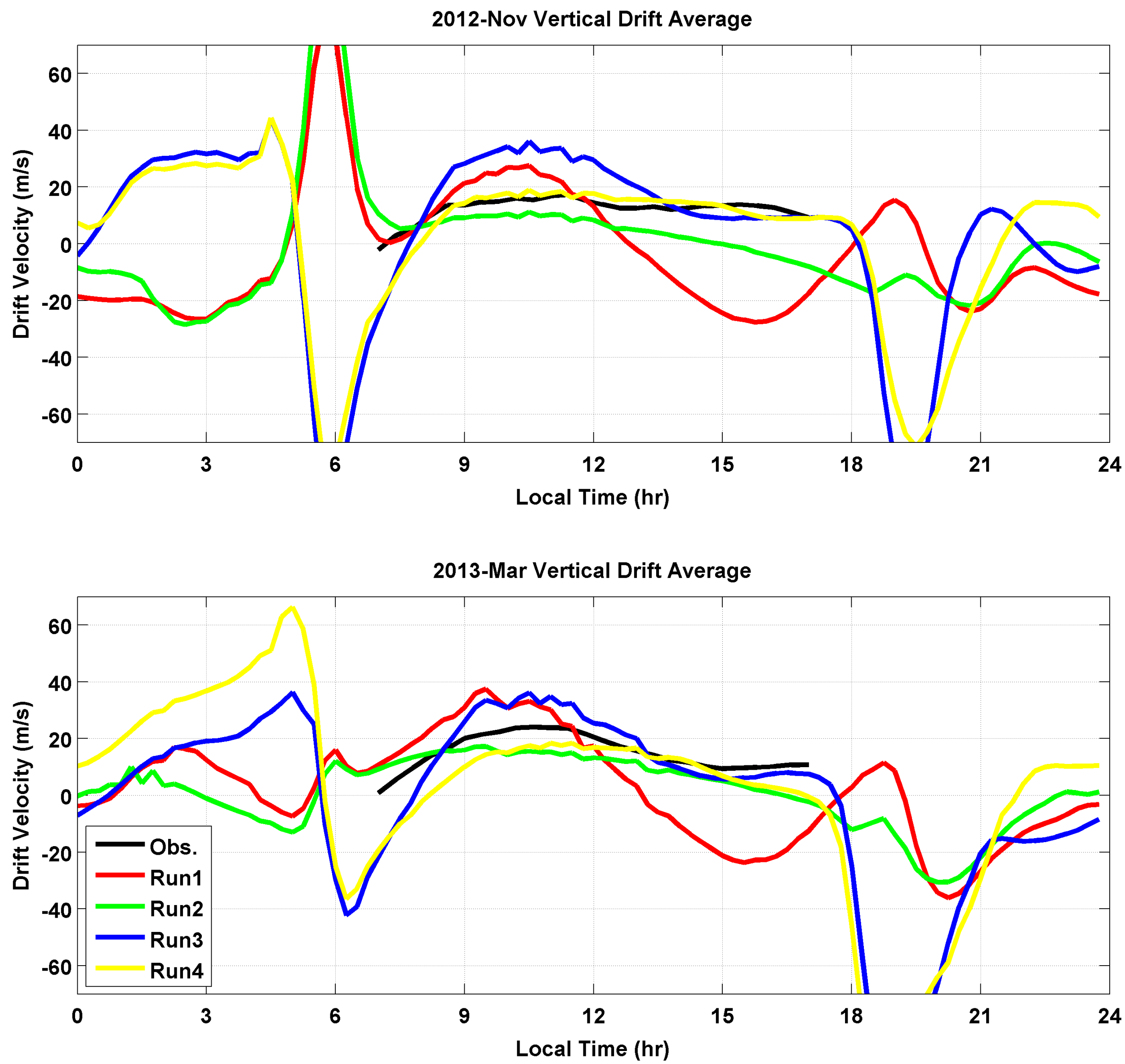
Few tests from GITM

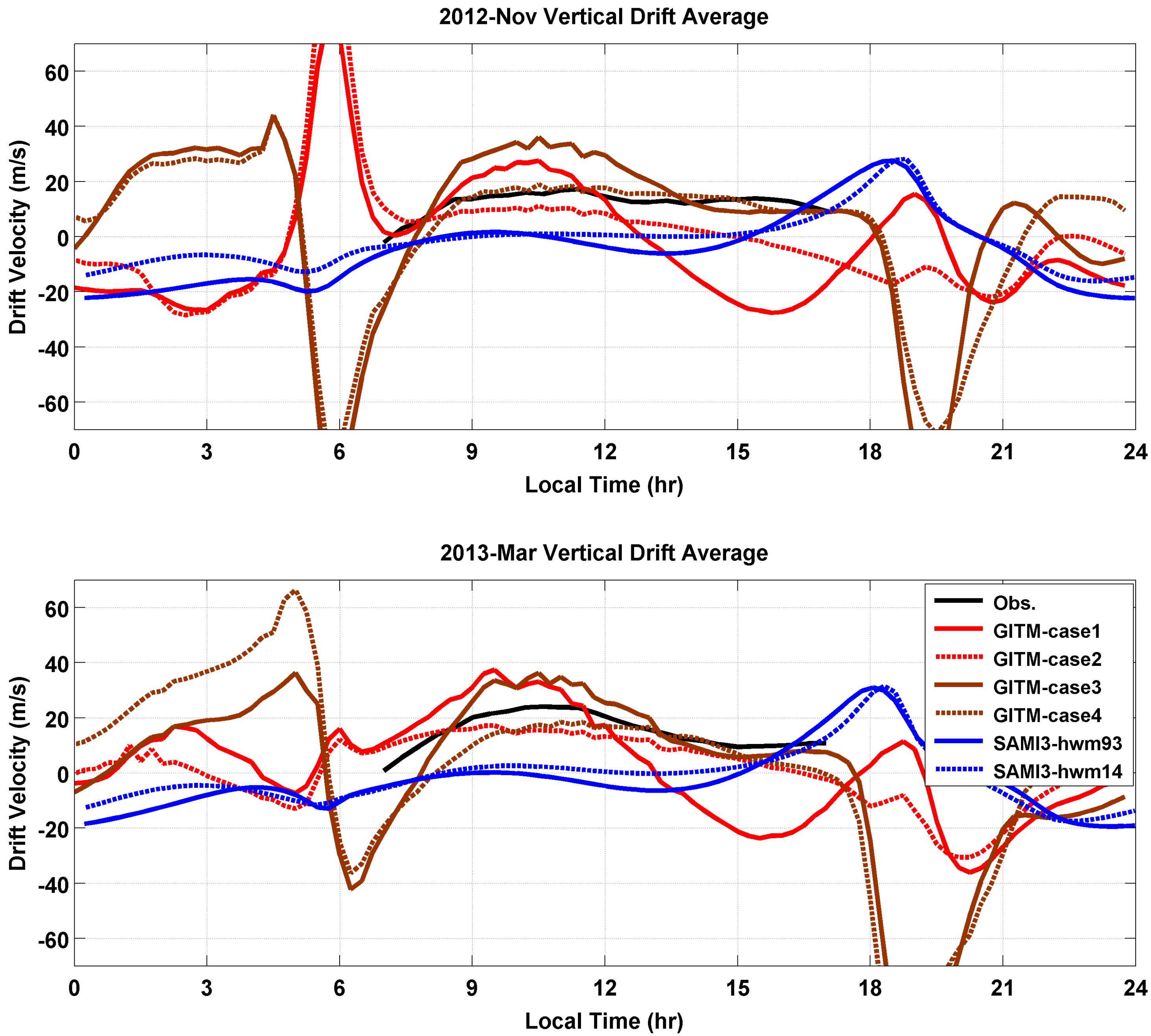
Run 1 is MSIS/HWM and NO Cowling conductivity.

Run 2 is GSWM and NO Cowling conductivity.

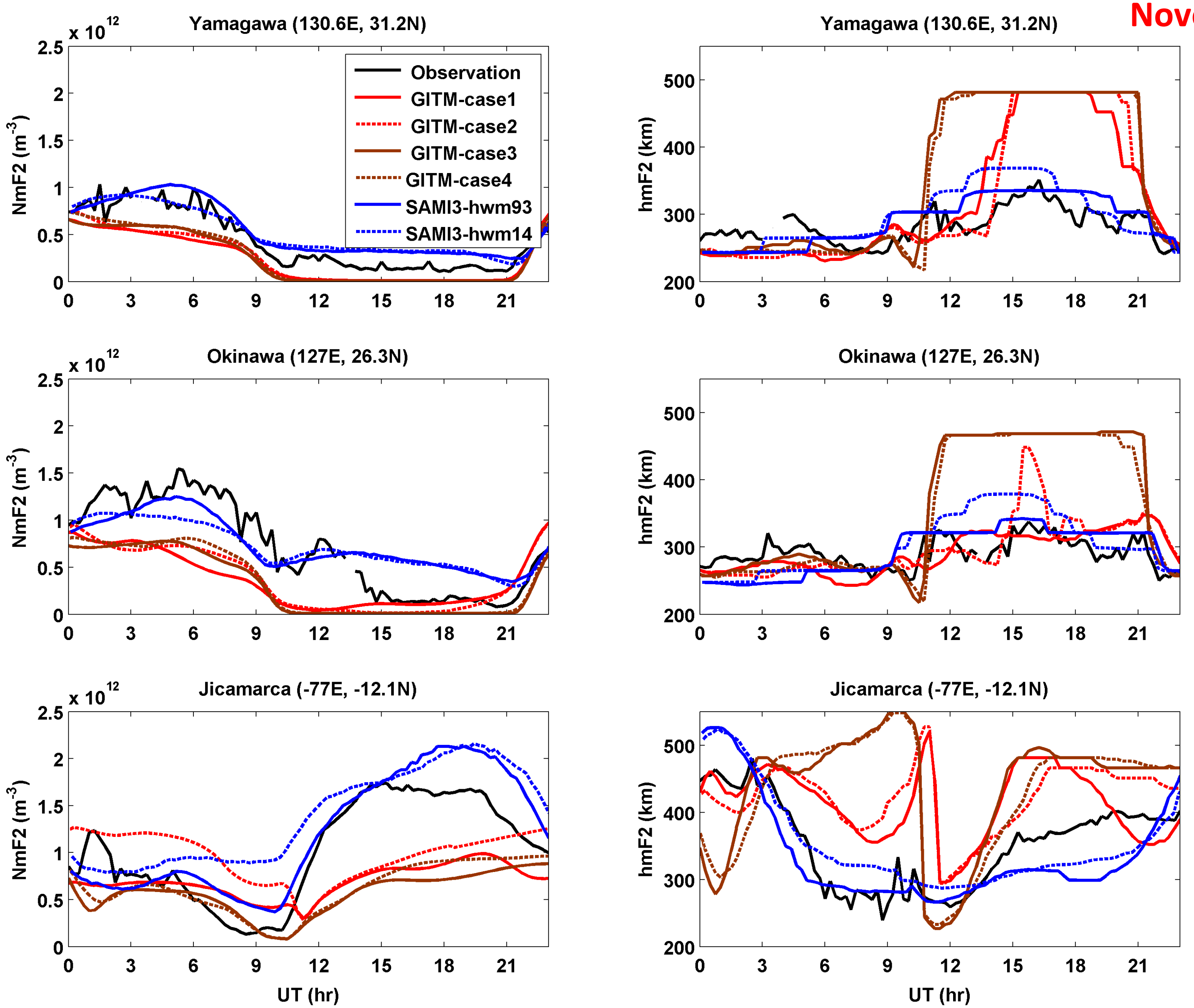
Run 3 is MSIS/HWM and Cowling conductivity.

Run 4 is GSWM and Cowling conductivity.

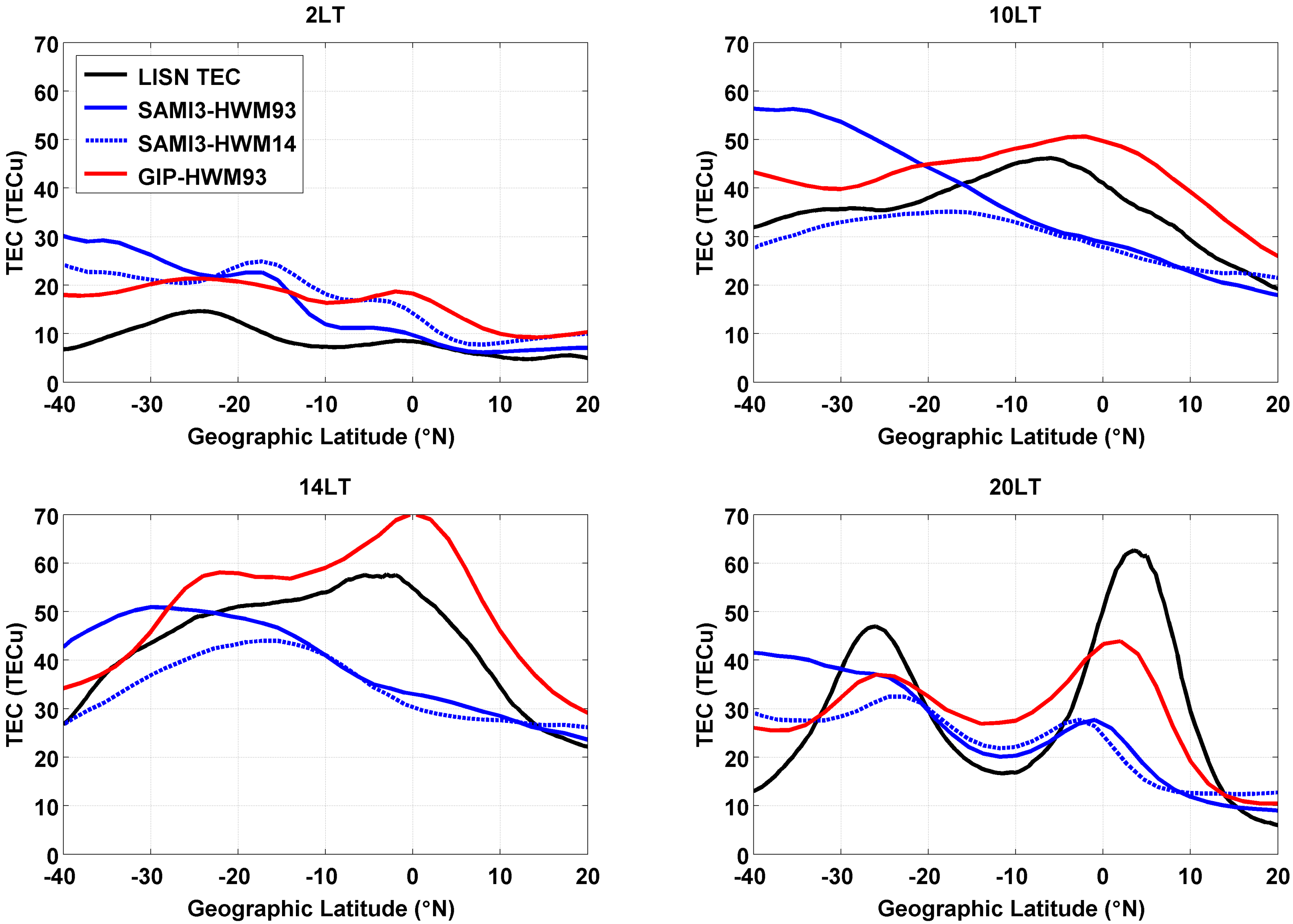



2012-Nov Vertical Drift Average
Drift Velocity (m/s)
60
40
20
0
-20
-40
-60
0
3
6
9
12
15
18
21
24
Local Time (hr)
2013-Mar Vertical Drift Average
Drift Velocity (m/s)
Local Time (hr)
Obs.
GITM-case1
GITM-case2
GITM-case3
GITM-case4
SAMI3-hwm93
SAMI3-hwm14

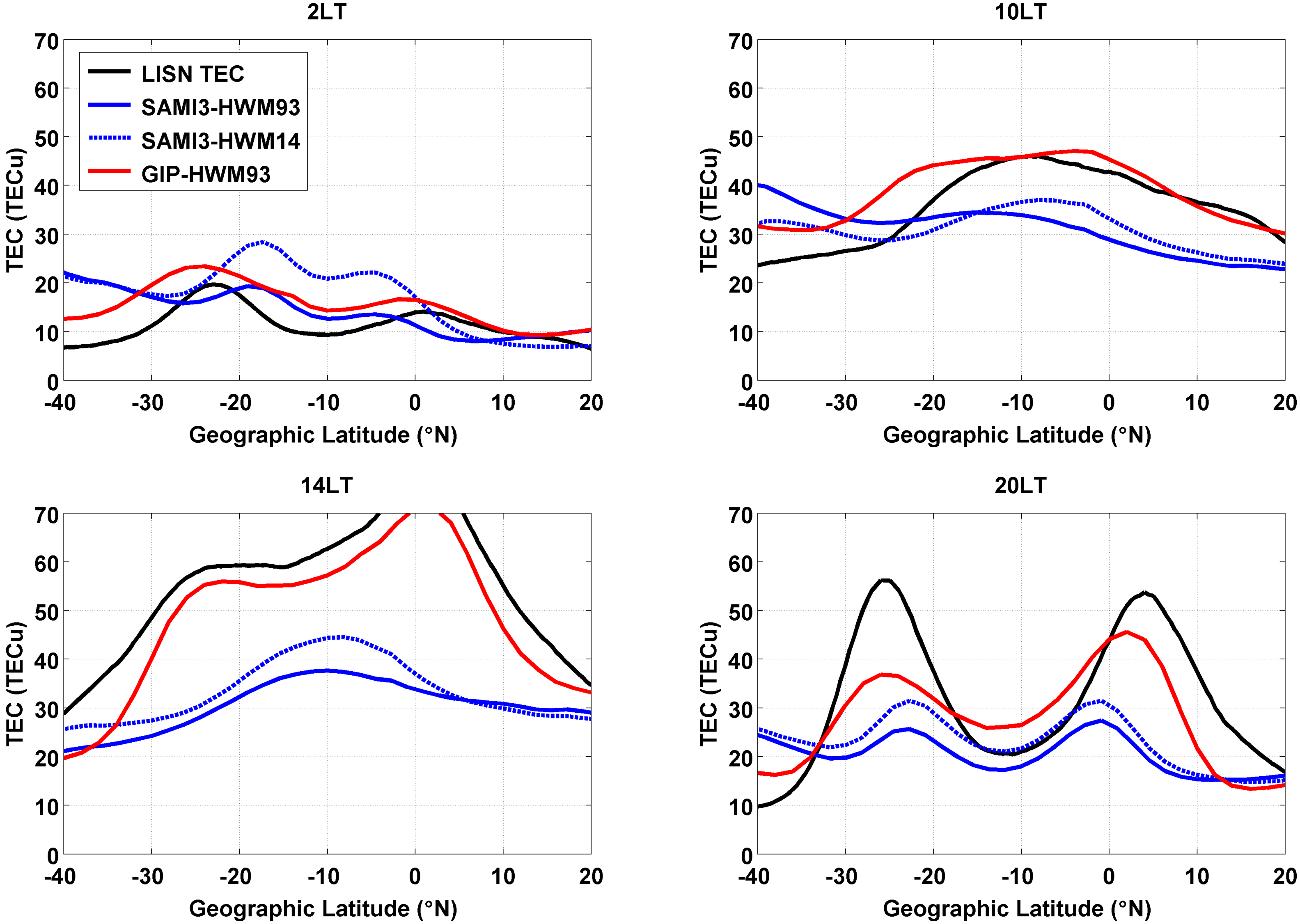
November


Yamagawa (130.6E, 31.2N)
x 10^12
NmF2 (m^-3)
Observation
GITM-case1
GITM-case2
GITM-case3
GITM-case4
SAMI3-hwm93
SAMI3-hwm14
Yamagawa (130.6E, 31.2N)
hmF2 (km)
Okinawa (127E, 26.3N)
NmF2 (m^-3)
Okinawa (127E, 26.3N)
hmF2 (km)
Jicamarca (-77E, -12.1N)
NmF2 (m^-3)
UT (hr)
Jicamarca (-77E, -12.1N)
hmF2 (km)
UT (hr)

November


2LT
10LT
14LT
20LT
LISN TEC
SAMI3-HWM93
SAMI3-HWM14
GIP-HWM93
TEC (TECu)
Geographic Latitude (°N)
70
60
50
40
30
20
10
0
-40
-30
-20
-10
0
10
20

March



2LT
10LT
14LT
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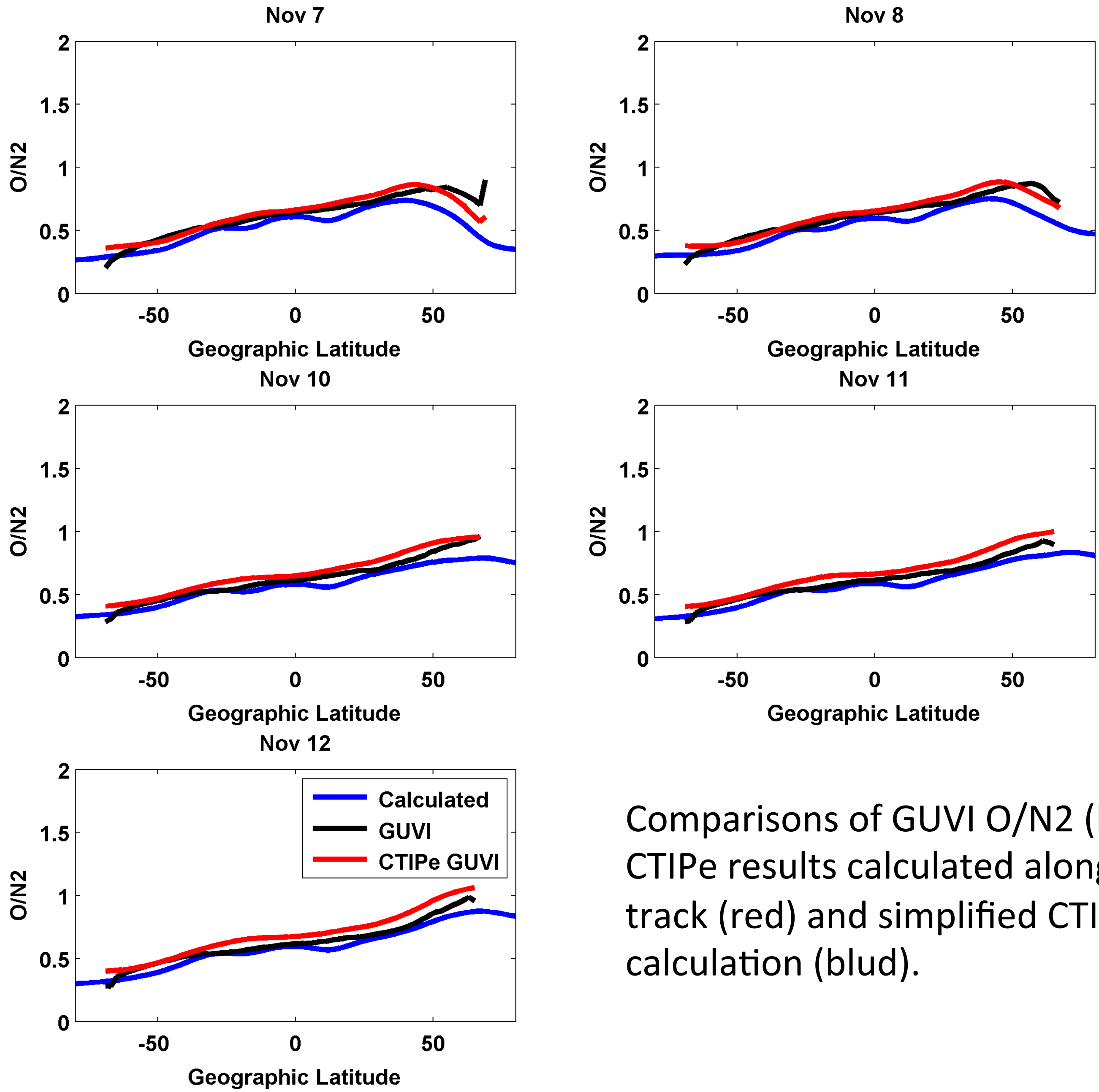
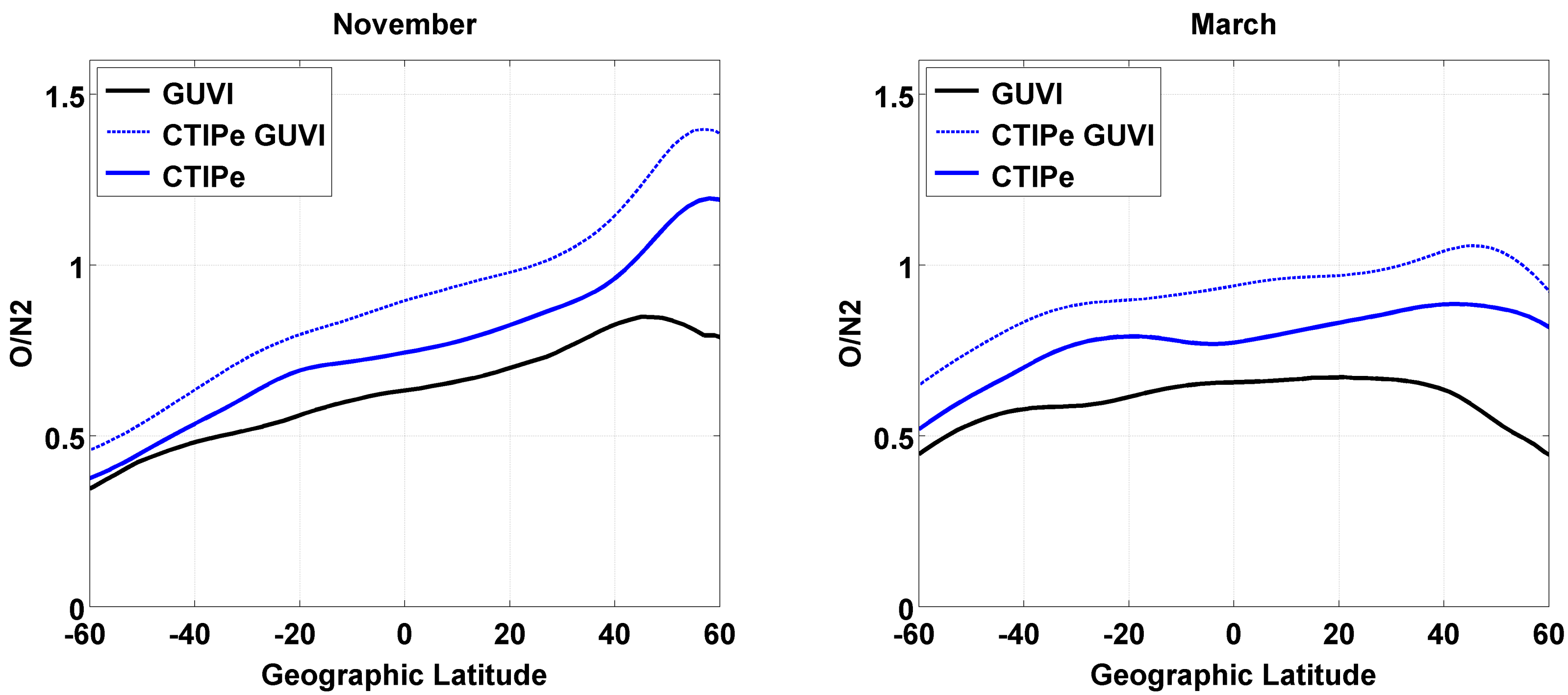
LISN TEC
SAMI3-HWM93
SAMI3-HWM14
GIP-HWM93
TEC (TECu)
Geographic Latitude (°N)
70
60
50
40
30
20
10
0
-40
-30
-20
-10
0
10
20



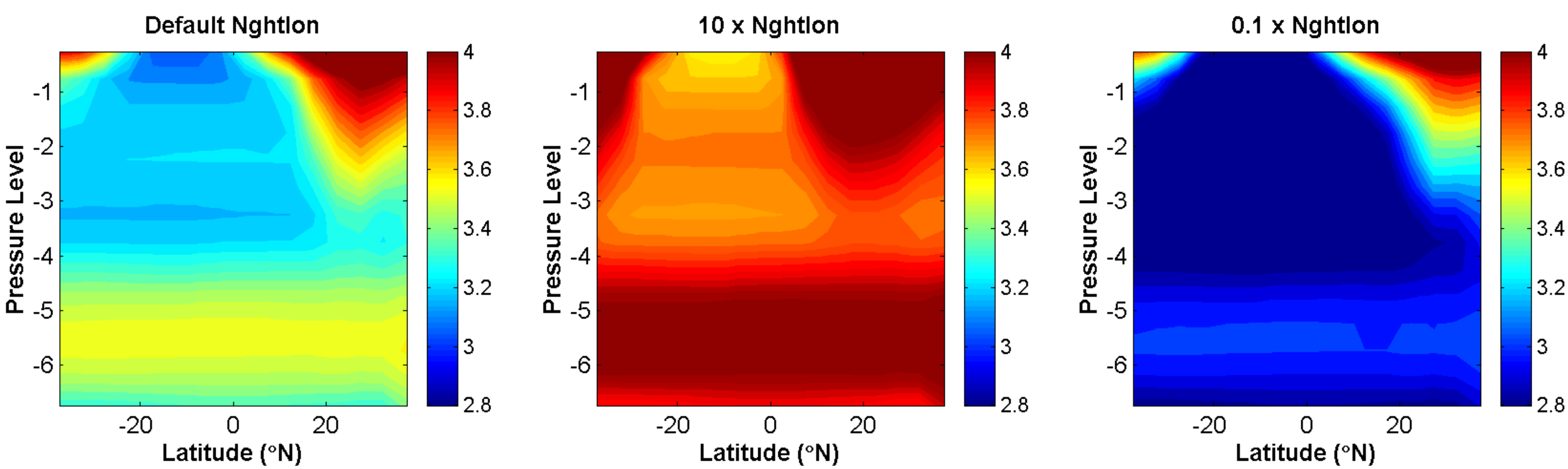
Comparisons of GUVI O/N2 (black), CTIPe results calculated along satellite track (red) and simplified CTIPe calculation (blud).


November
March
GUVI
CTIPe GUVI
CTIPe
O/N2
1.5
1
0.5
0
-60
-40
-20
0
20
40
60
Geographic Latitude

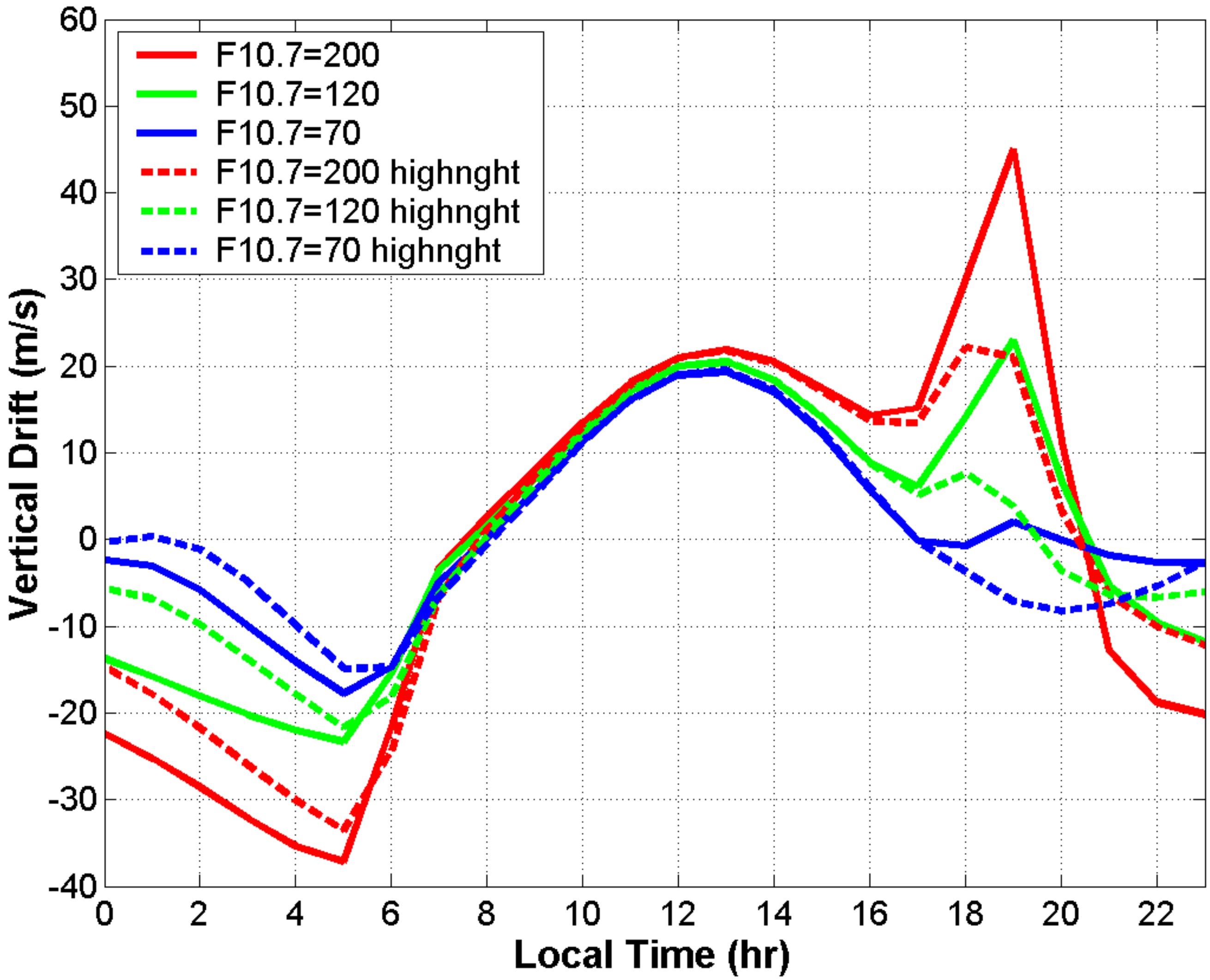
Q1. How does the nighttime ionization influence the PRE?

Main sources of nighttime ionization can be from the starlight or the solar radiation scattered through the geocoronal. The important photoionization sources for the maintenance of nighttime ionosphere are Lyman-α (1216Å, ionizes NO only), Lyman-β (1026Å, ionizes O_2 only), and He I (584Å), and He II (304Å). The nighttime ionization part of the model only includes the scattered solar radiation. The values are applied at all times and are constant with solar activity. How exactly the nighttime ionization should be parameterized and its relationship with the PRE are still fully understood.

Electron Density at Jicamarca Longitude

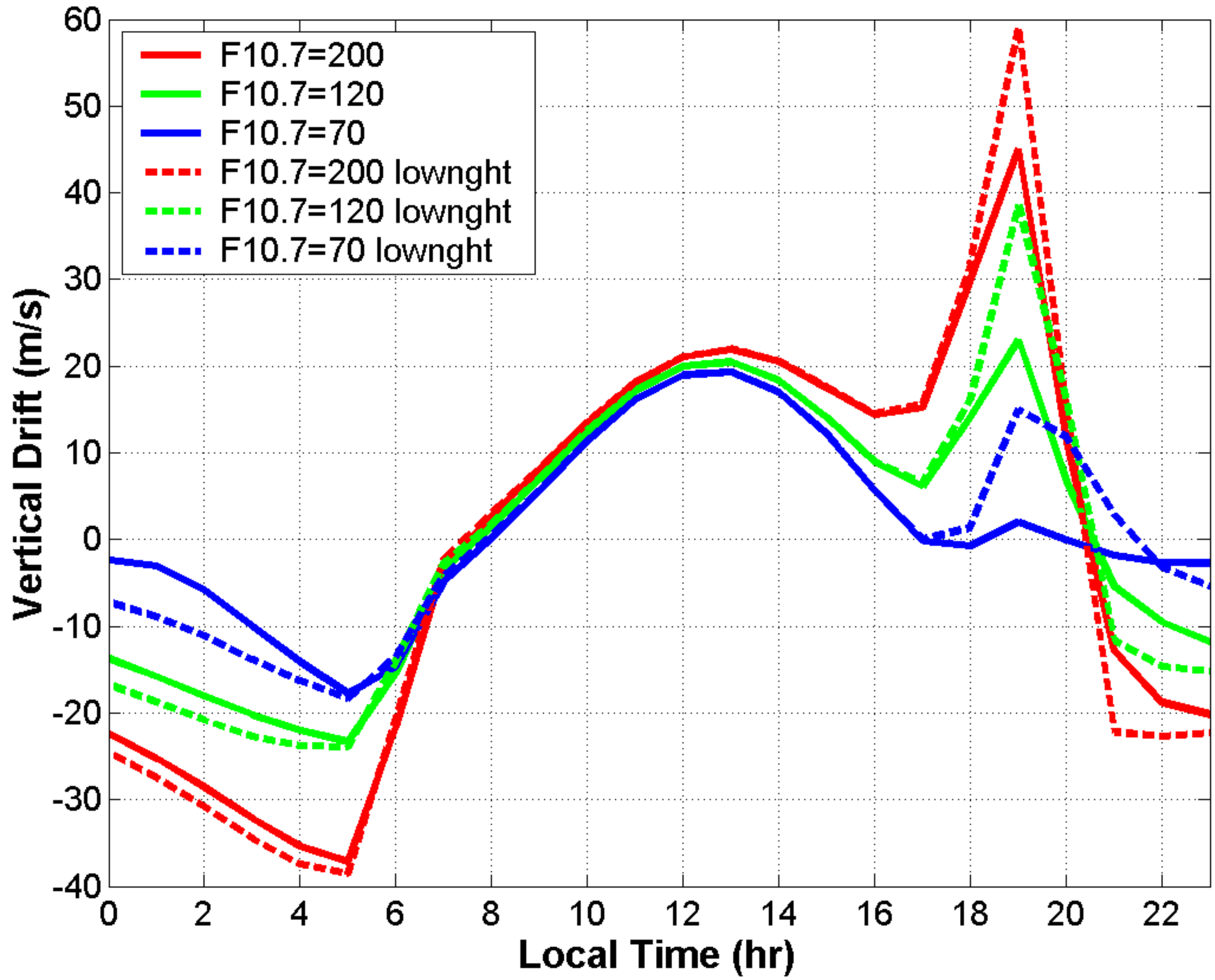


Increased Nighttime Ionization



With the increased nighttime ionization, the magnitudes of PREs decrease. For the low solar activity condition, the PRE completely disappears with the increased nighttime ionization.

Reduced Nighttime Ionization



With the reduced nighttime ionization, the magnitudes of PREs increase. With the decreased nighttime ionization, the PRE under low solar activity shows large increase.