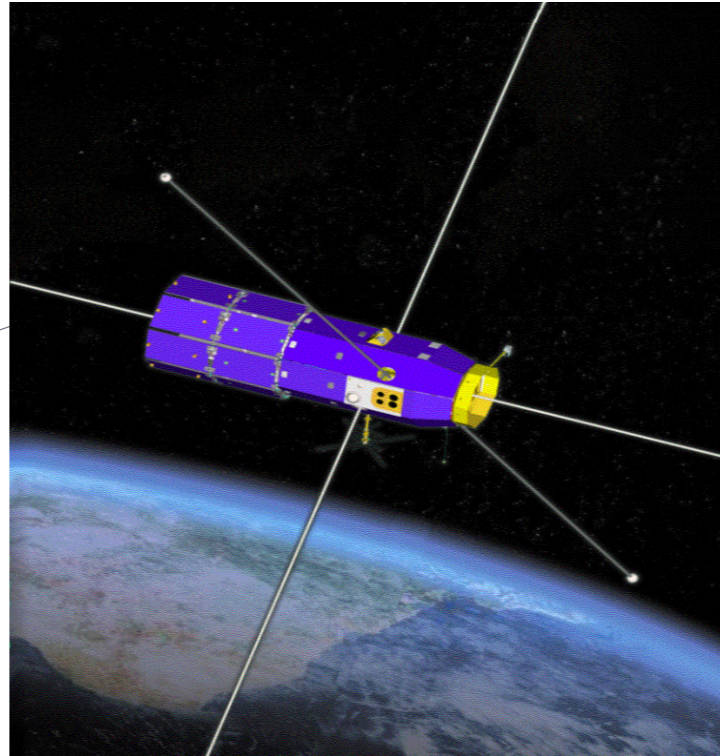
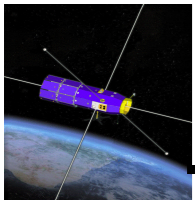


Performance of the IRI-2007 and SAMI2 models during Extreme Solar Minimum



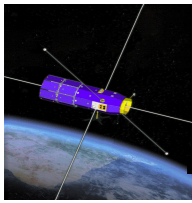
J. Klenzing
NASA / GSFC

D. Bilitza, AG Burrell, RA Heelis, J Huba, F Simoes



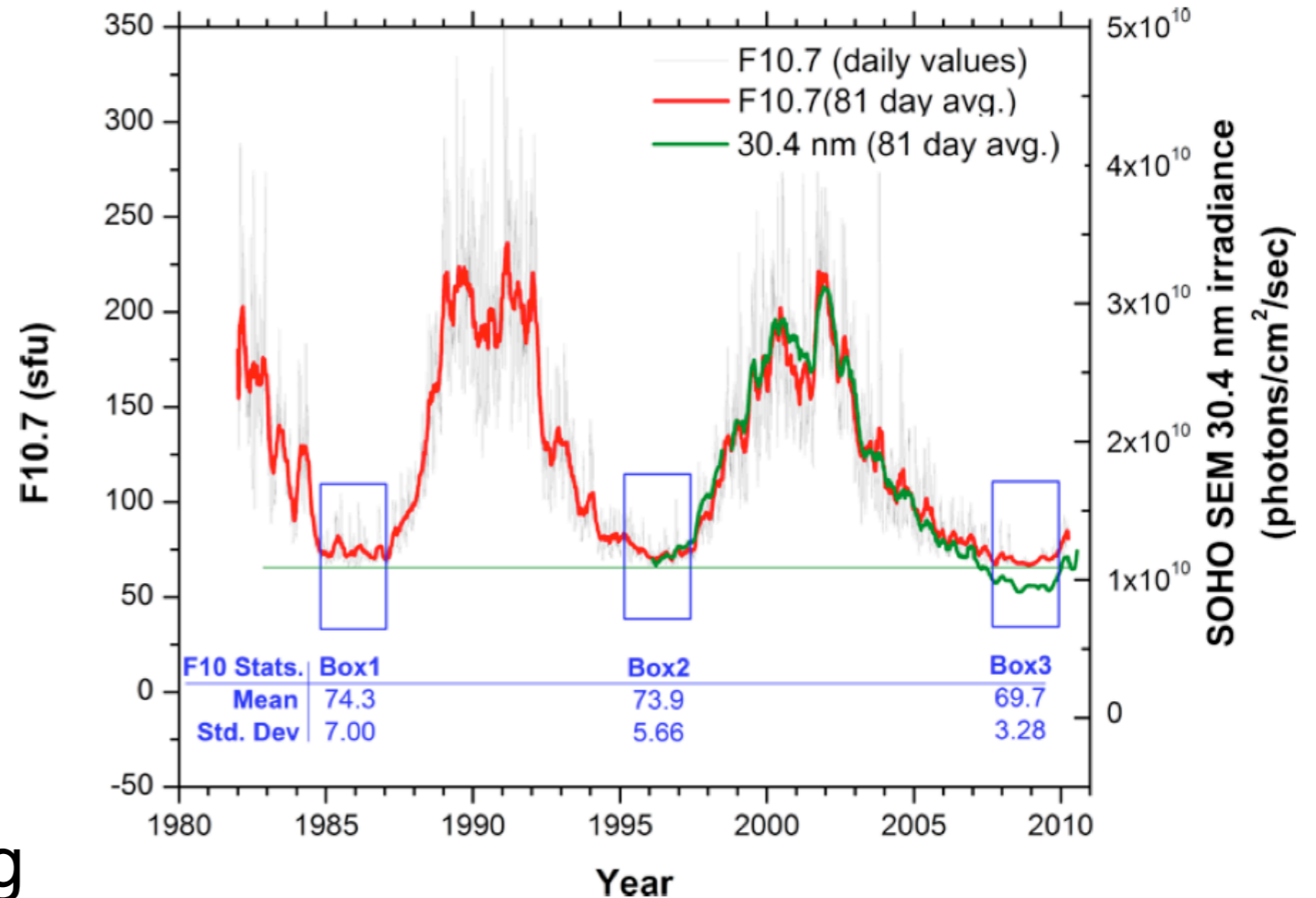
Outline

- ▶ Why is Extreme Solar Minimum important?
- ▶ How can we use C/NOFS data to constrain models?
- ▶ How well do IRI-2007 and SAMI2 predict topside ion densities during ESM?
- ▶ What happens when we change the empirical models driving SAMI2?

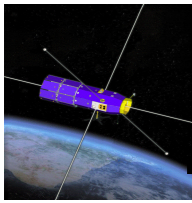


Extreme Solar Minimum

- ▶ Reduced EUV as measured by SOHO [Araujo-Pradere et al, 2011].
- ▶ Record low thermospheric density calculated from satellite drag [Emmert et al, 2010].
- ▶ Weak to non-existent pre-reversal enhancements during solar min [Pfaff et al, 2010].
- ▶ Increased detection of Equatorial Spread F [Candido et al, 2011] and Mid-latitude Spread F [Bhaneja et al, in preparation].

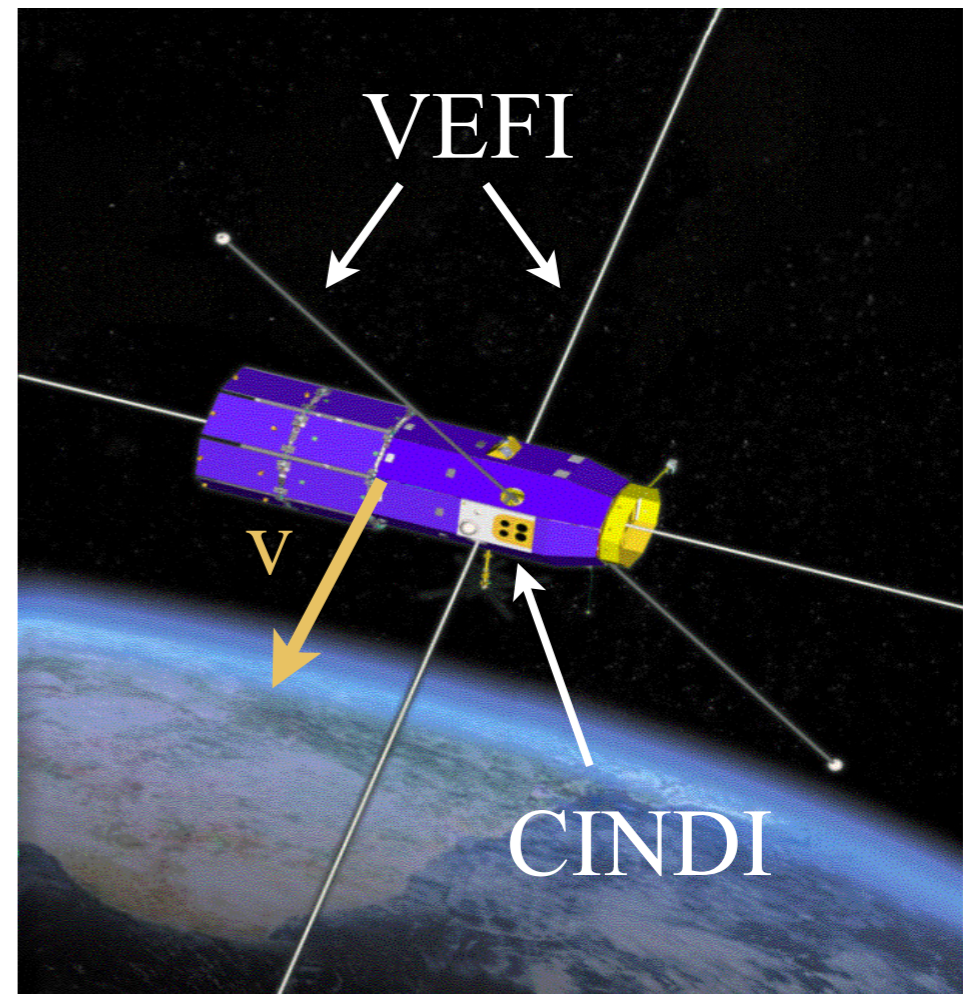


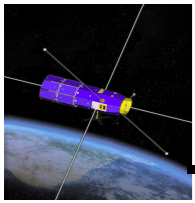
[Araujo-Pradere et al, 2011]



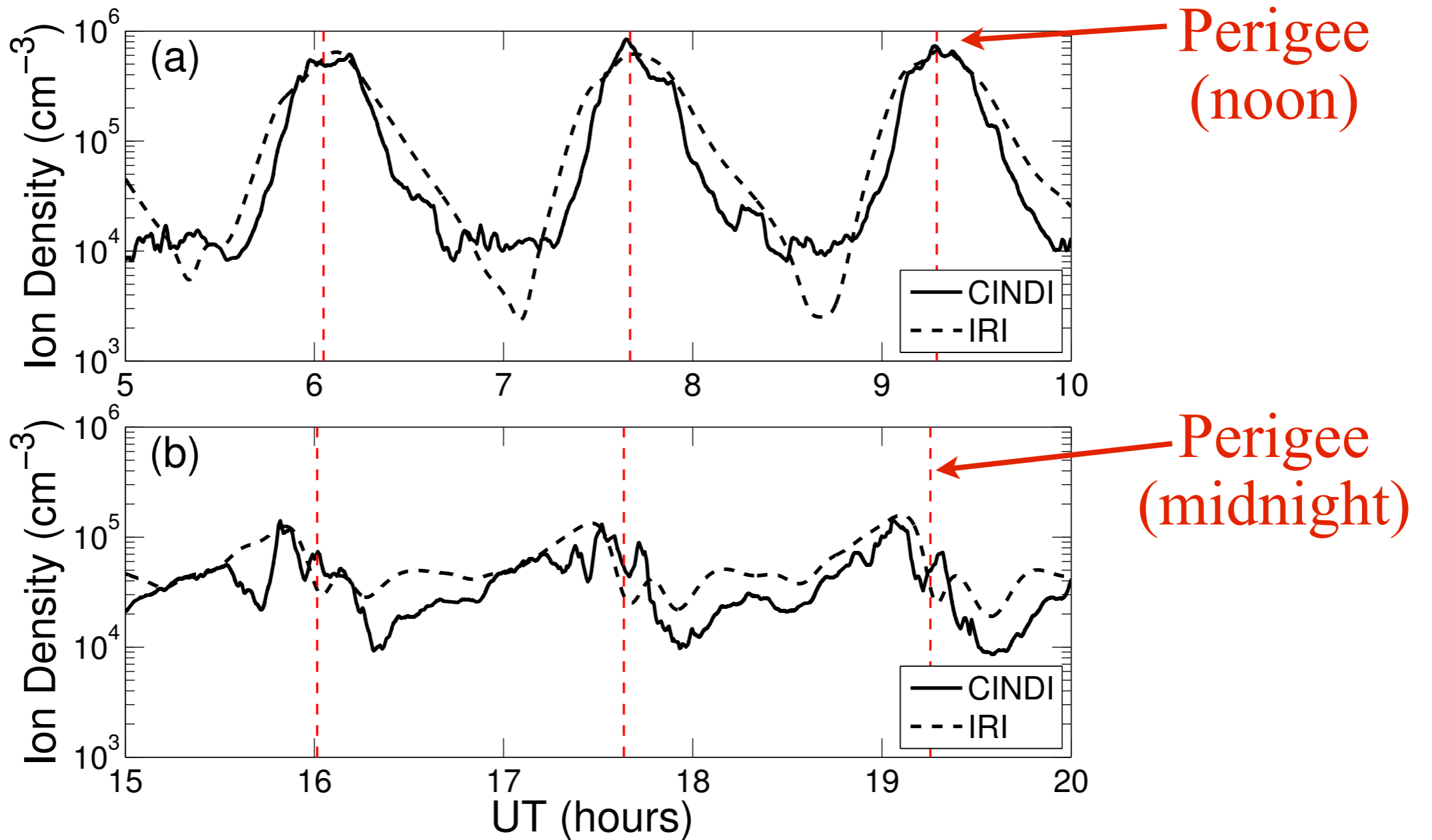
The C/NOFs Satellite

- ▶ Communication/Navigation Outage Forecast System
 - ▶ Launched in April 2008
 - ▶ 13° inclination orbit, 400-850 km
- ▶ CINDI (Coupled Ion Neutral Dynamics Investigation)
 - ▶ Ion Density, Composition
- ▶ VEFI (Vector Electric Field Instrument)
 - ▶ DC Electric fields (ExB drifts)

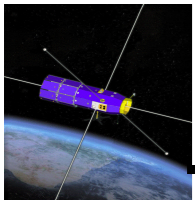




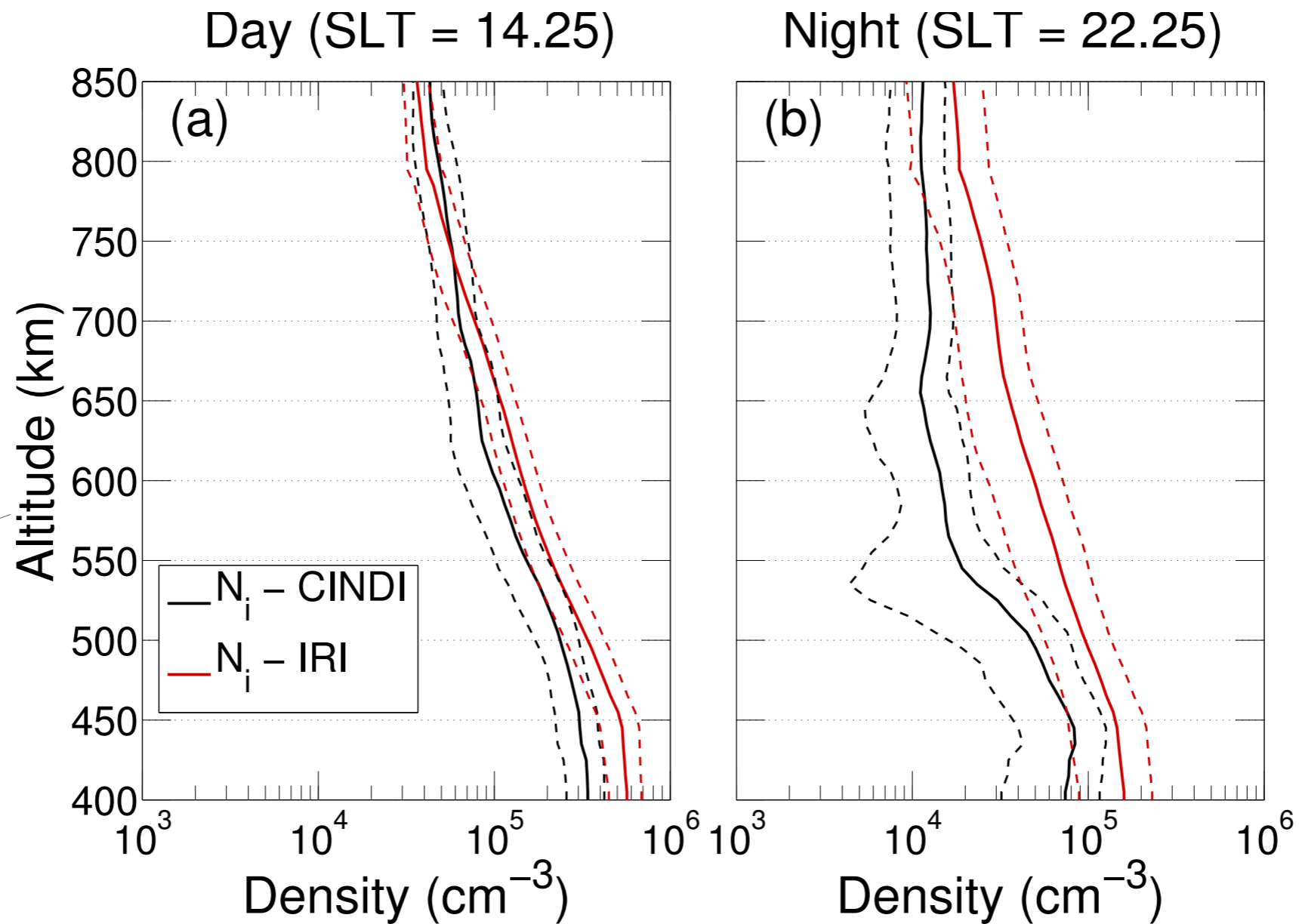
Sample CINDI Data



Precession of perigee through local time is ~ 65 days.



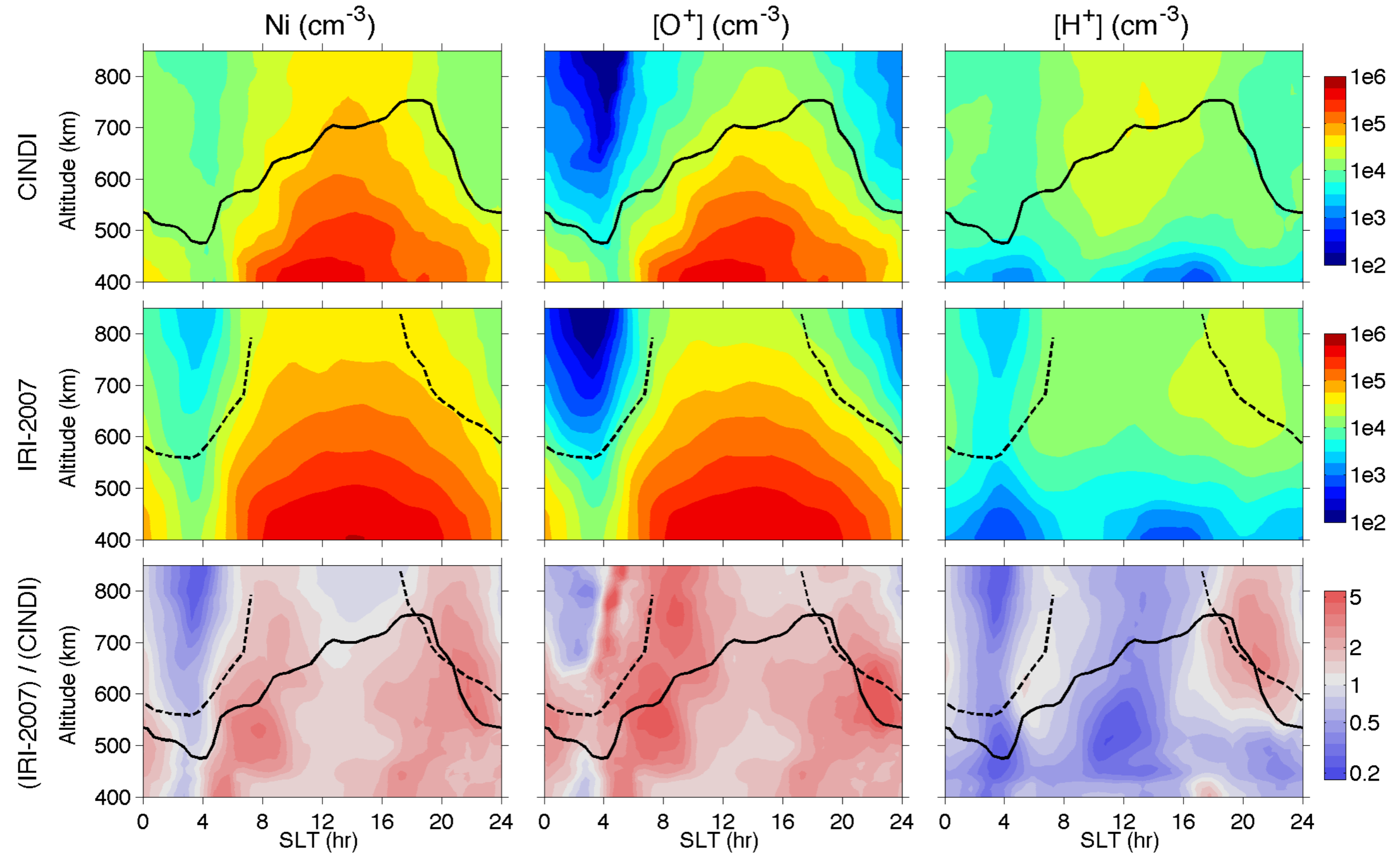
Reconstructed Profiles



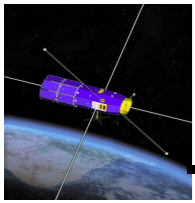
91 days of consecutive data for low K_p ,
consistently low solar activity

December Solstice 2008

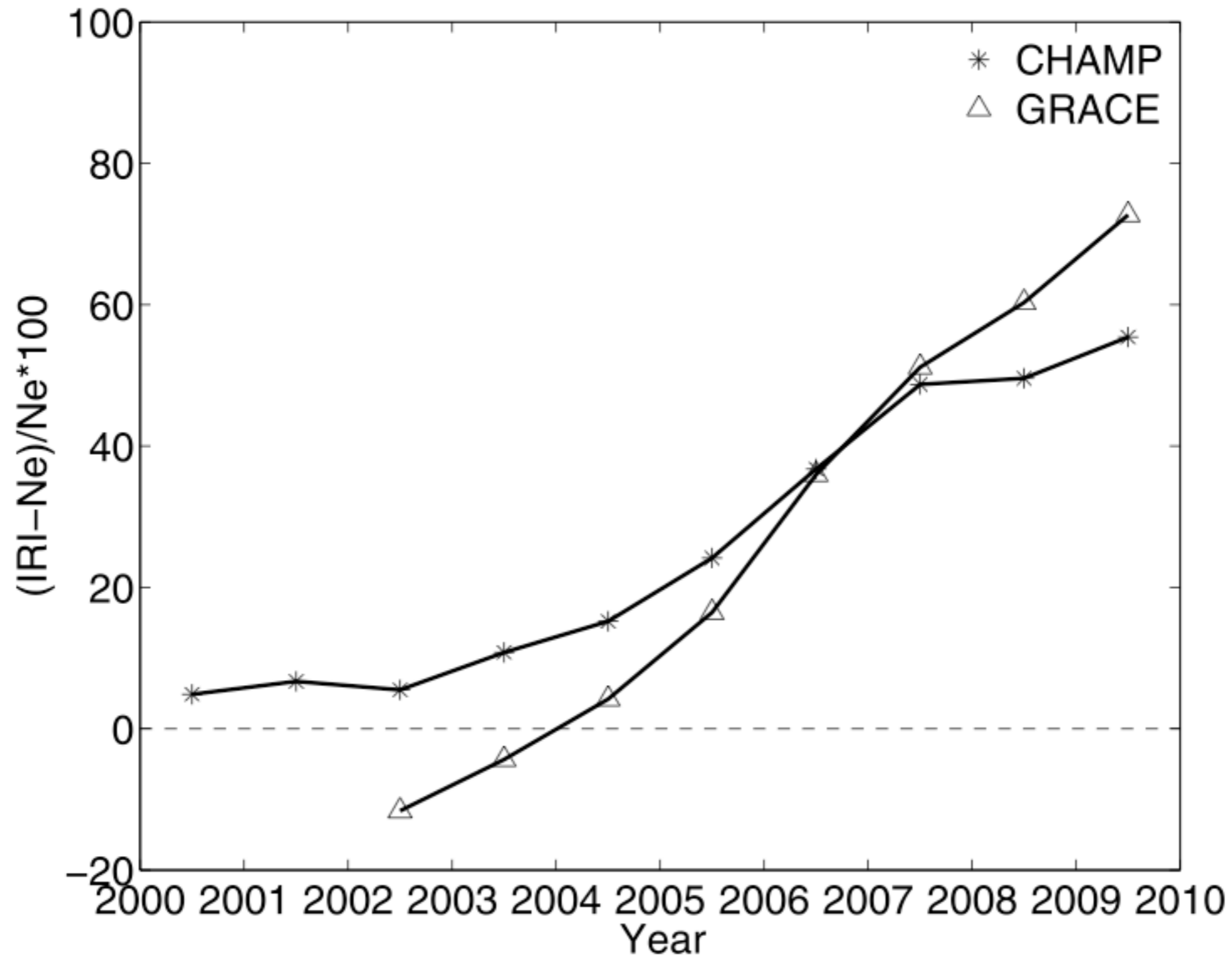
Dip Equator, All Longitudes



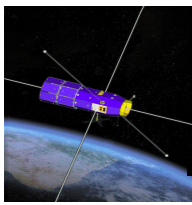
[Klenzing et al, 2011]



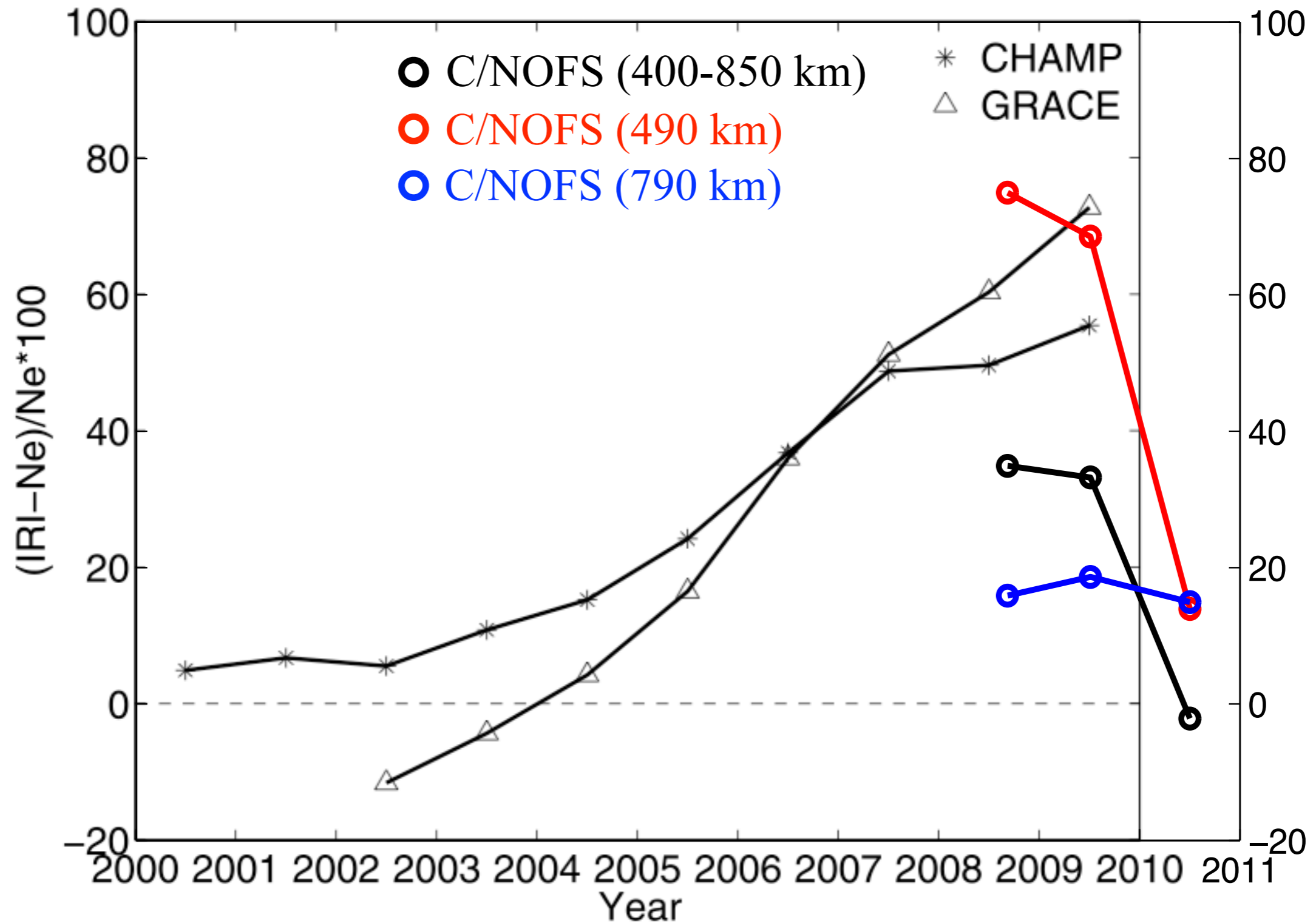
Performance of IRI-2007



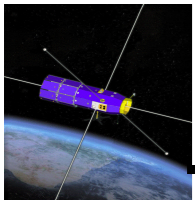
[Lühr and Xiong, 2010]



Performance of IRI-2007

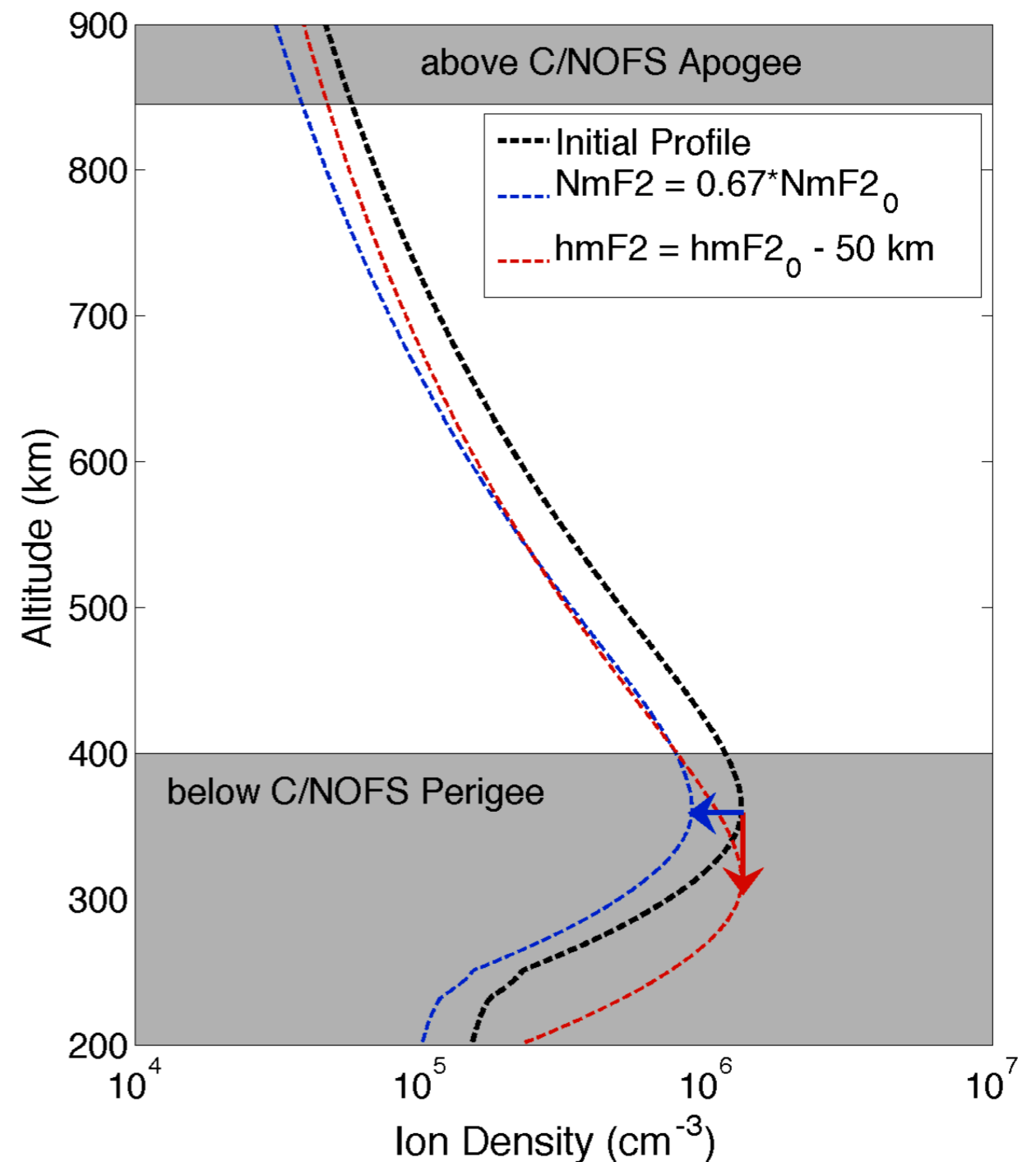


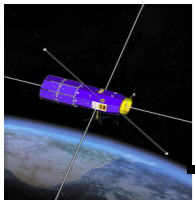
[Lühr and Xiong, 2010]



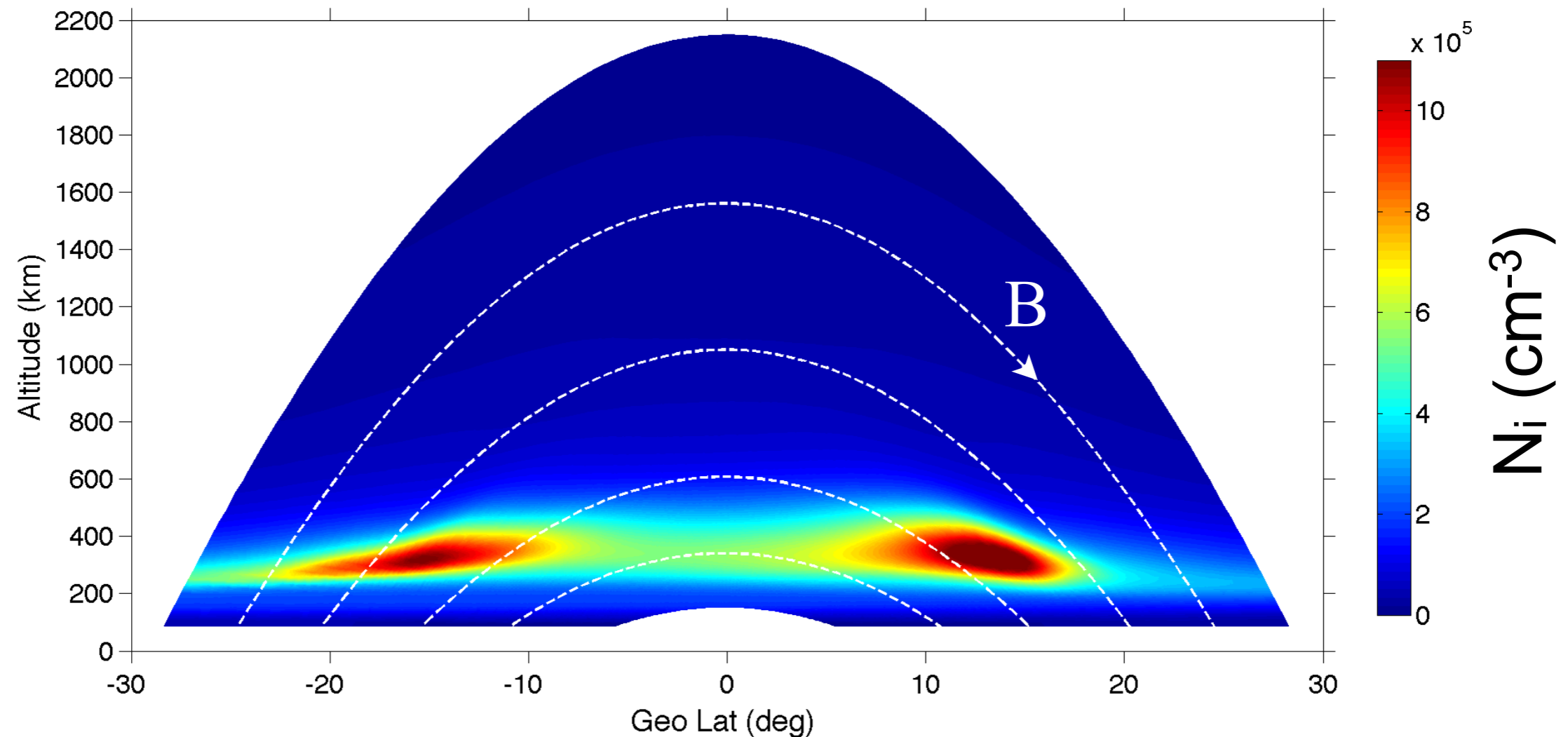
What changed?

- ▶ The C/NOFS orbit limits our comparisons with IRI.
- ▶ NmF2 predictions during 2008-2009 show similar performance to previous years when compared to ionosondes [Bilitza].
- ▶ Likely to be a change in the height of the F-peak.

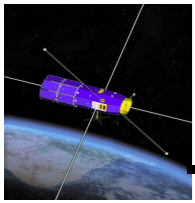




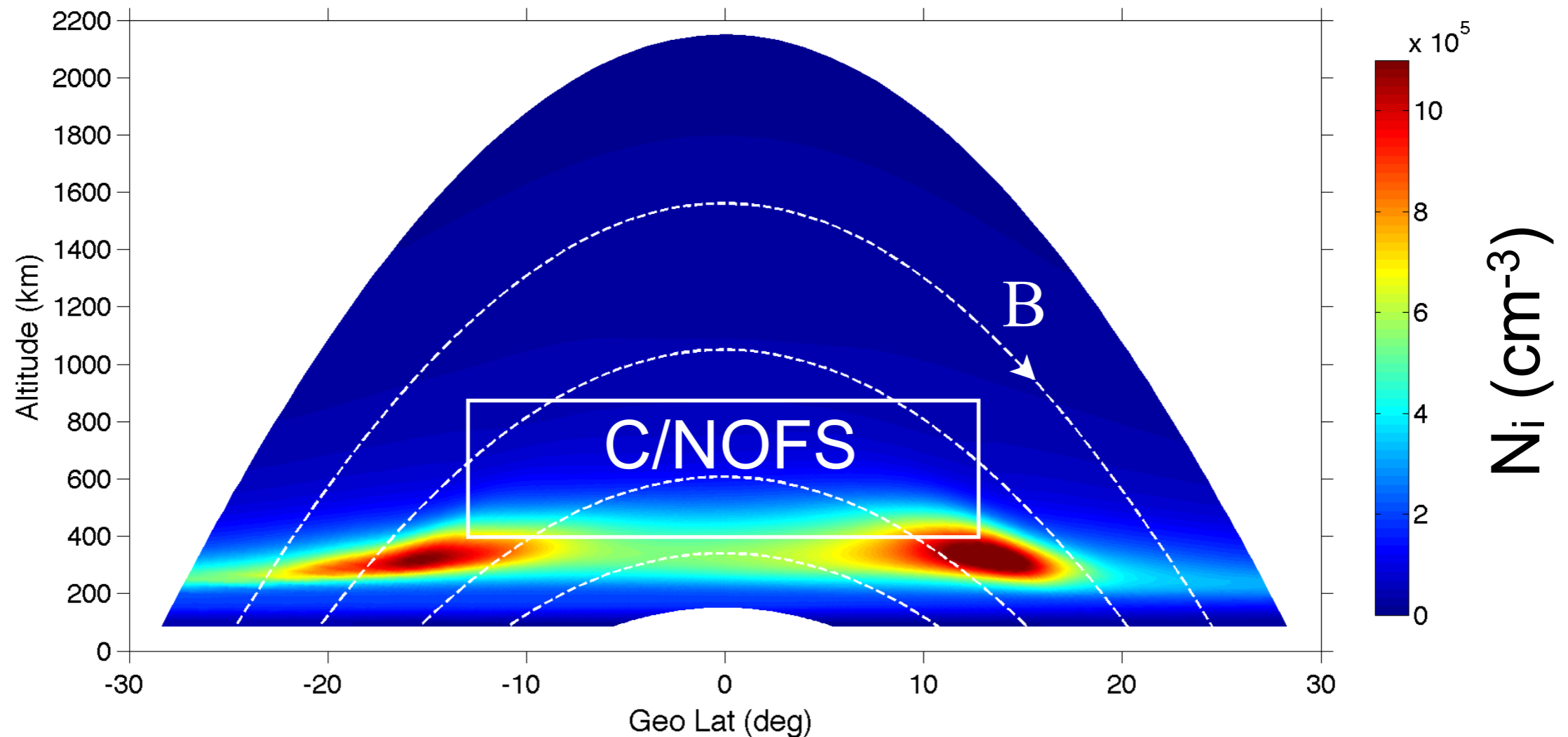
SAMI2 is Another Model of the Ionosphere



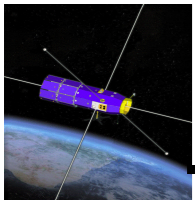
- ▶ Uses continuity and momentum equations to simulate seven species of ions along magnetic field lines.



SAMI2 is Another Model of the Ionosphere



- ▶ Uses continuity and momentum equations to simulate seven species of ions along magnetic field lines.

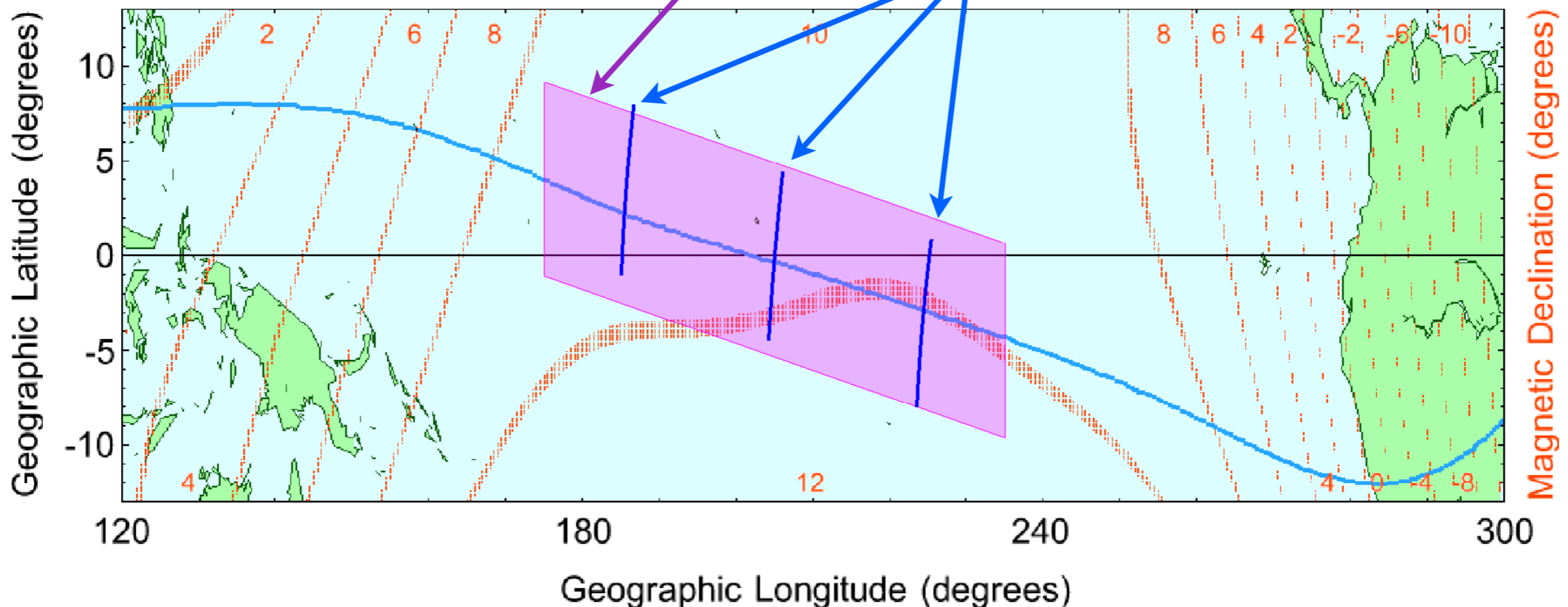


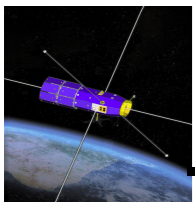
SAMI2 Comparisons

- 91 days centered about the December Solstice 2008
- $<5^\circ$ of the dip equator
- between 175° and 235° E

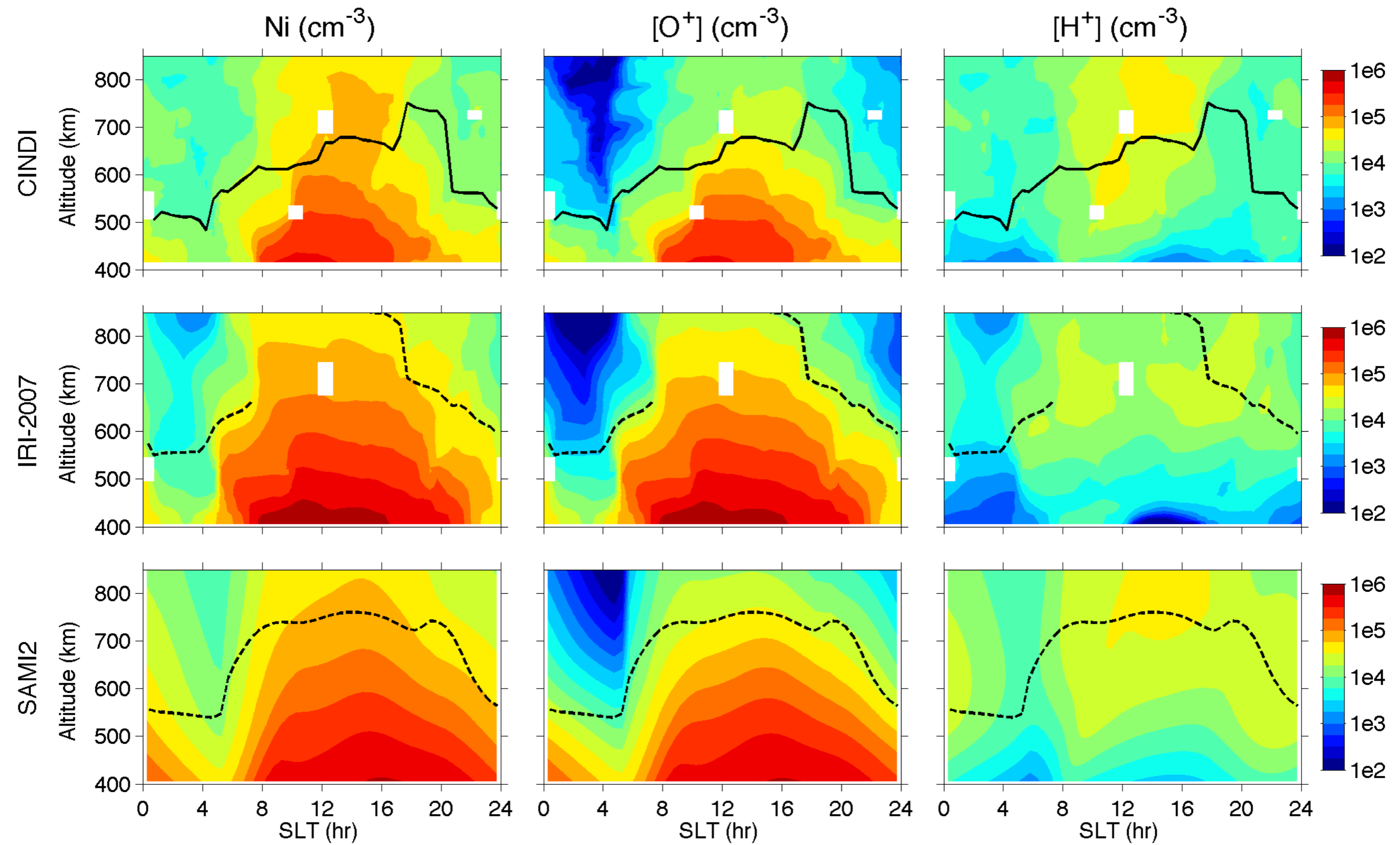
CINDI Data
(91 days, many orbits)

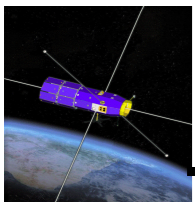
SAMI2 Runs
(3 longitudes, 9 days each)



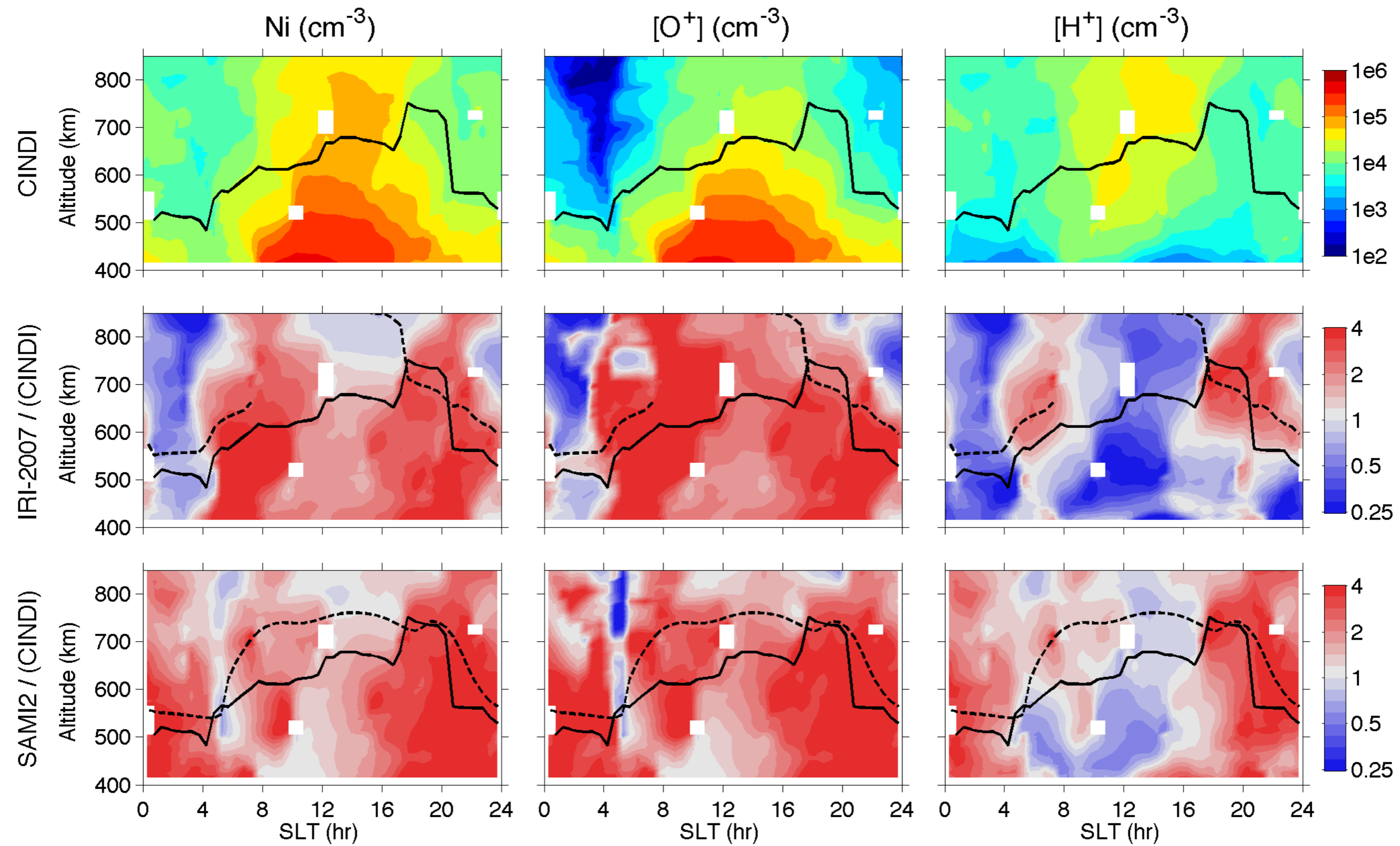


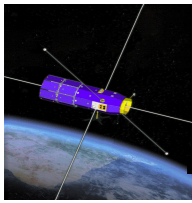
Performance





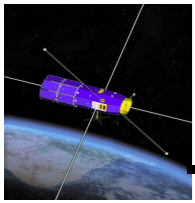
Performance





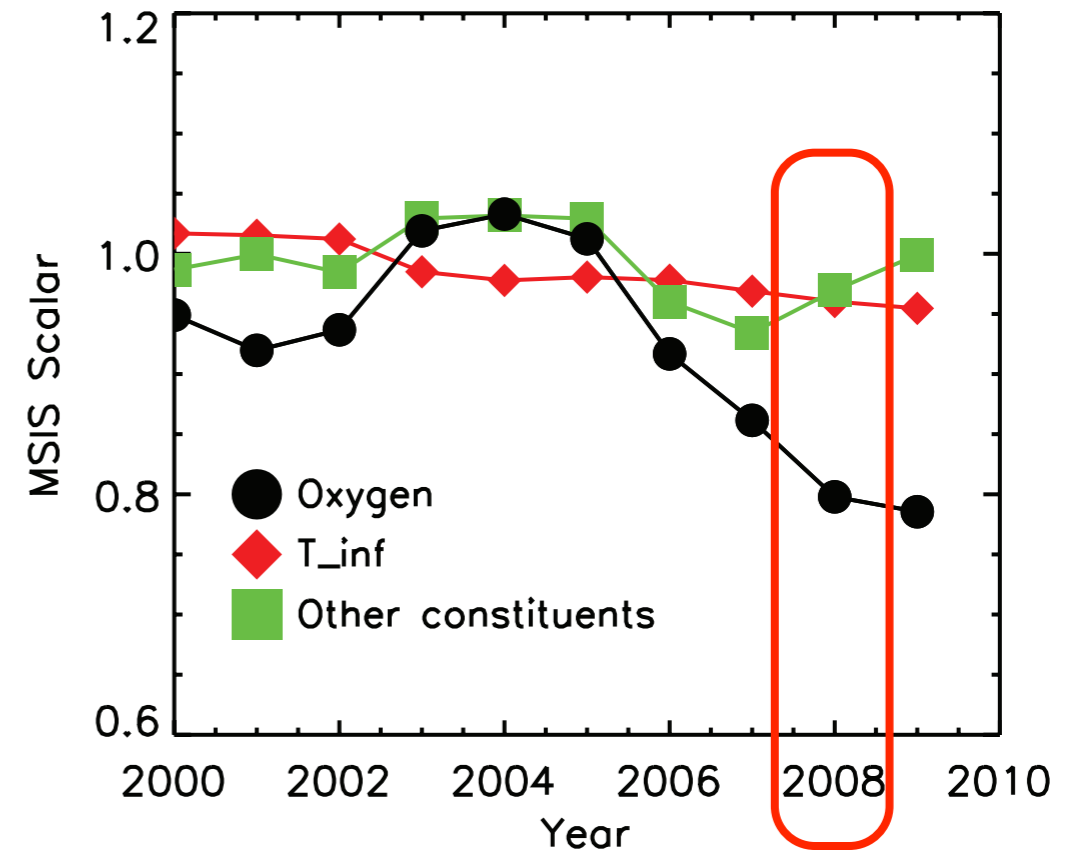
F10.7-driven Components

Model	Provides	Strategy
MSIS	N_n and T_n profiles	Use MSIS scalars based on satellite drag calculations [Emmert and Siefring, private communication]
EUVAC	Ionization Rates	Reduce EUV by 15% [based on reported EUV proxies from Solomon et al, 2010]
Fejer-Scherliess	$E \times B$ drifts	Use VEFI drift climatology
HWM07	Neutral Winds	Unchanged in this iteration

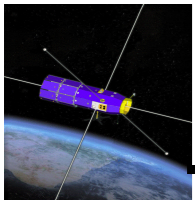


MSIS Scalars

- ▶ MSIS is known to overestimate neutral density during the recent minimum [e.g., Emmert et al, 2010].
- ▶ Preliminary results for MSIS scalars based on satellite drag studies.

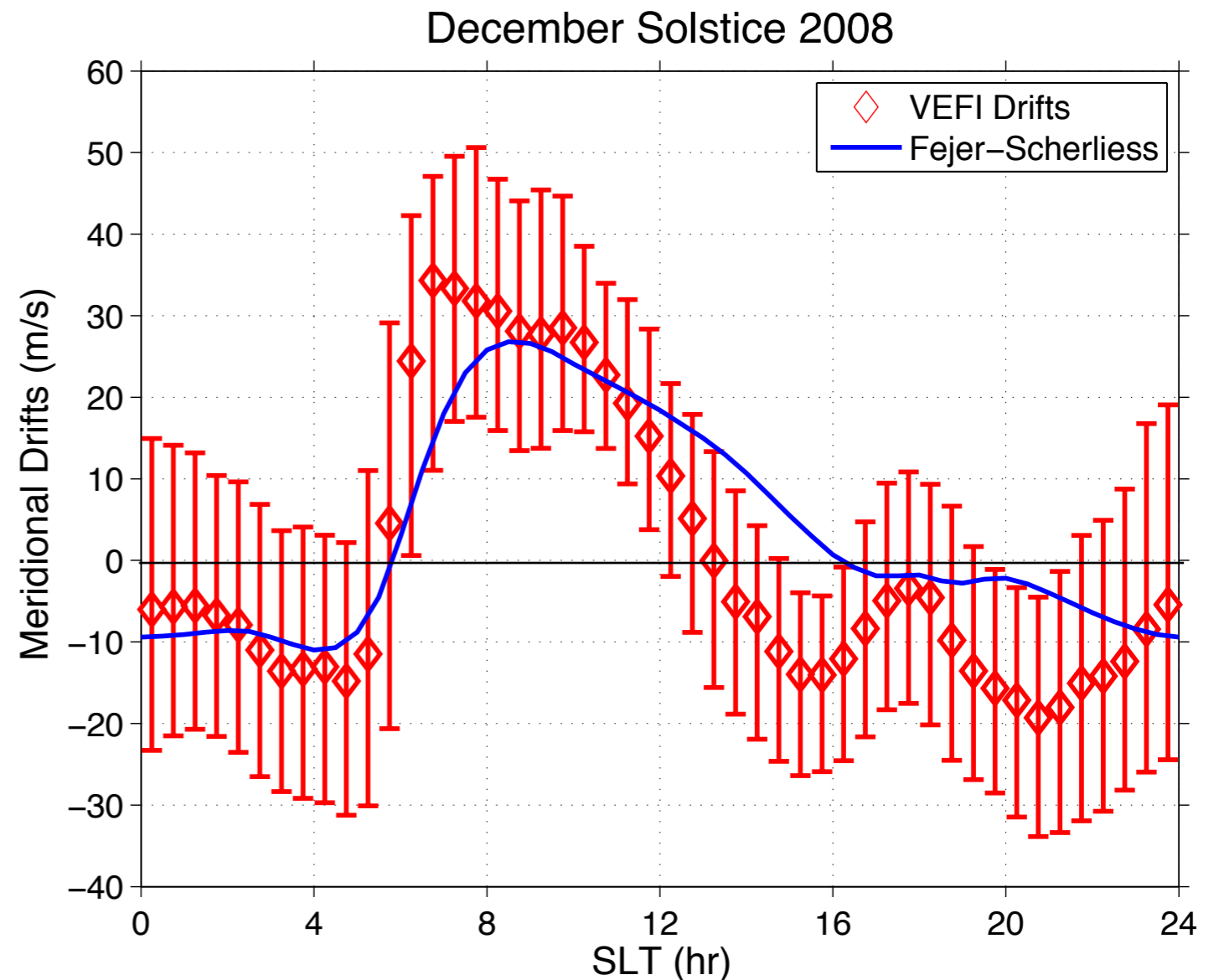


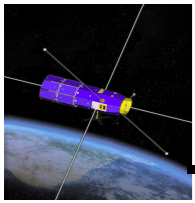
[Emmert and Siefiring,
private communication]



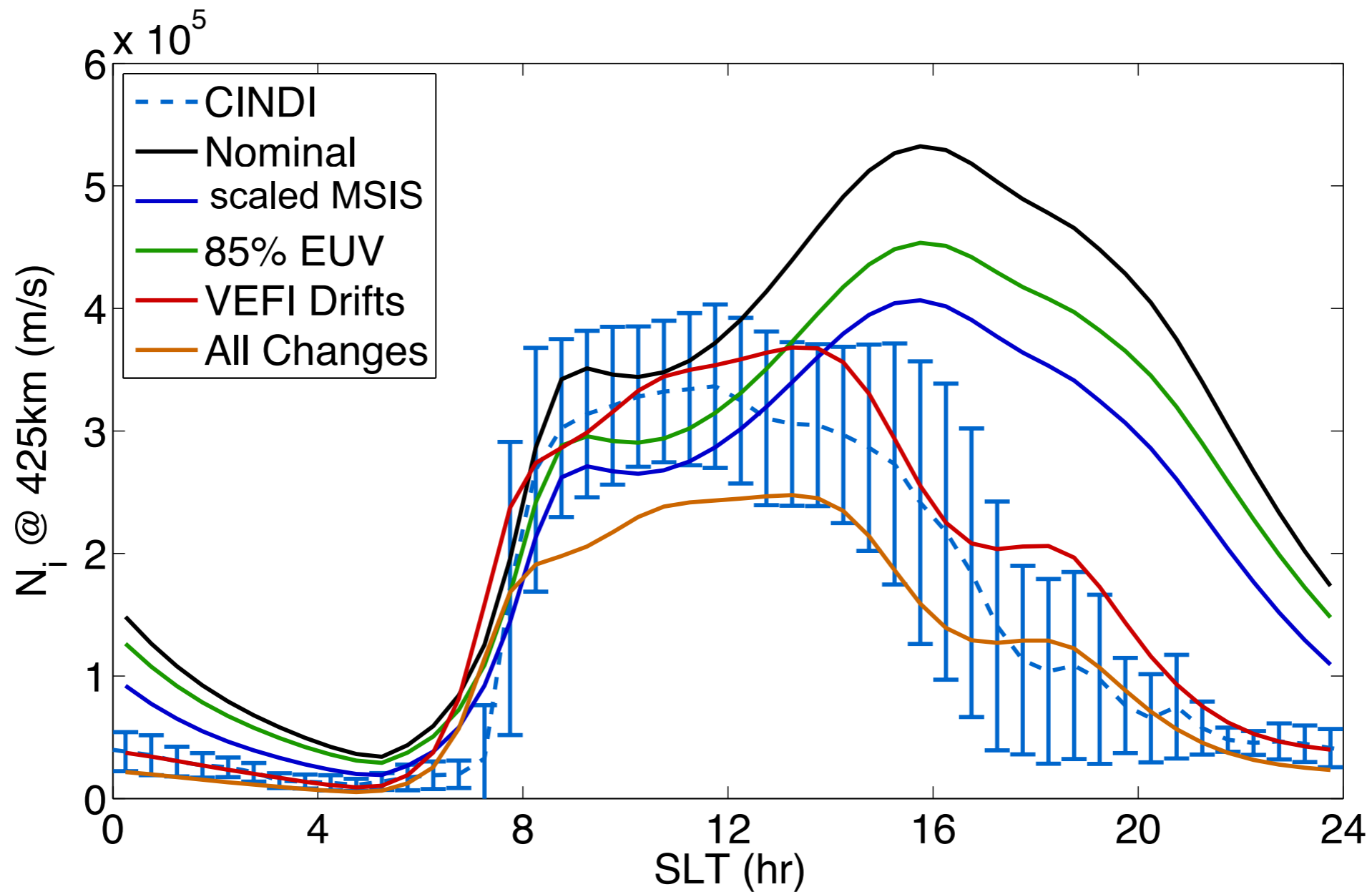
ExB Drifts

- VEFI drifts are averaged in the longitude sector for the SAMI2 runs.
- Only quiet time are used, and spread-F effects are removed in the averages.
- Drifts are downward in the early afternoon!
- For use in SAMI2, drifts are fit to an 8th order Fourier series.

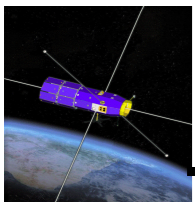




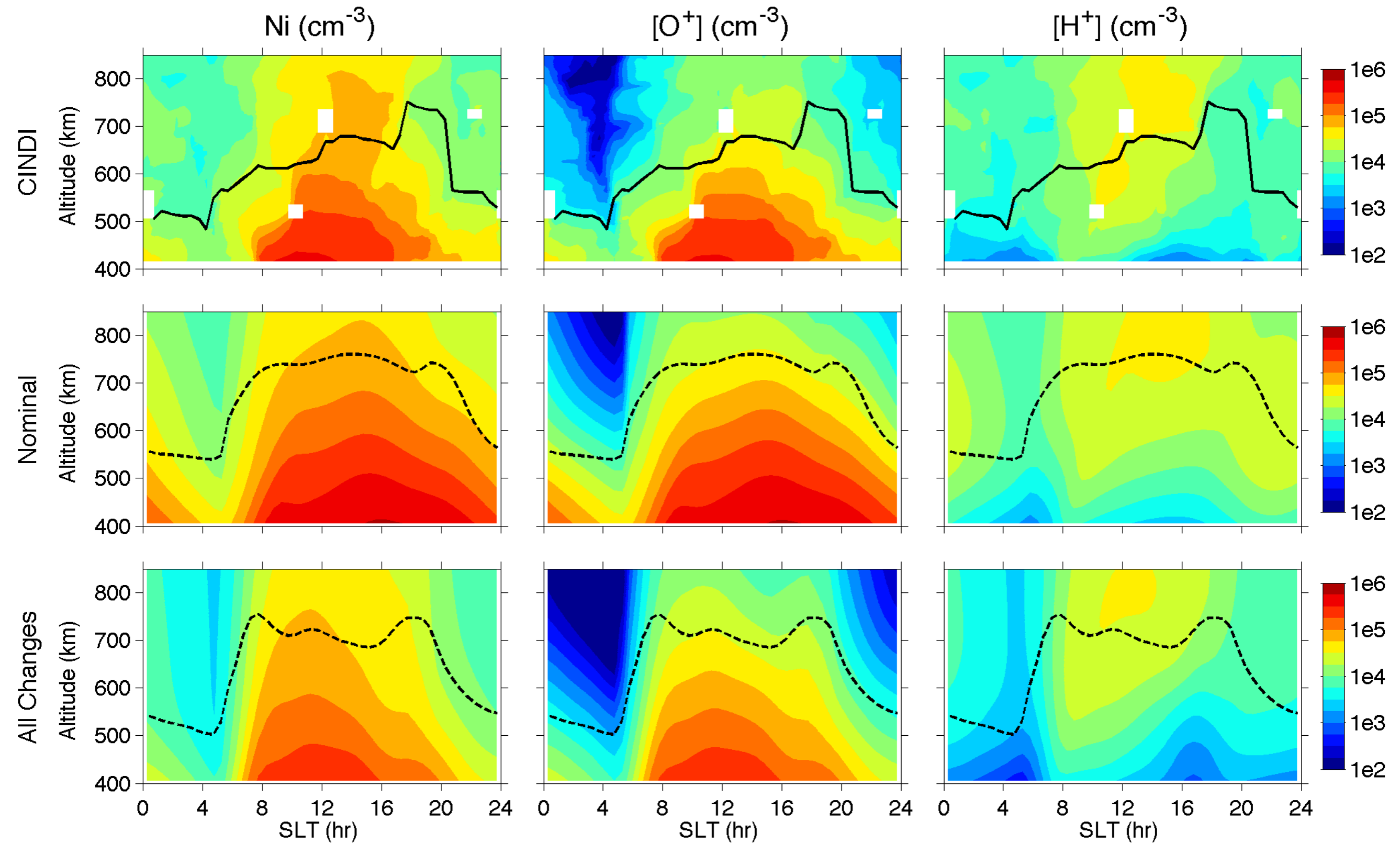
Results at 425 km

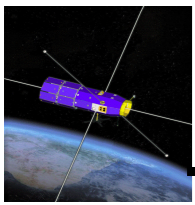


Afternoon / Nighttime greatly improved with VEFI drifts!

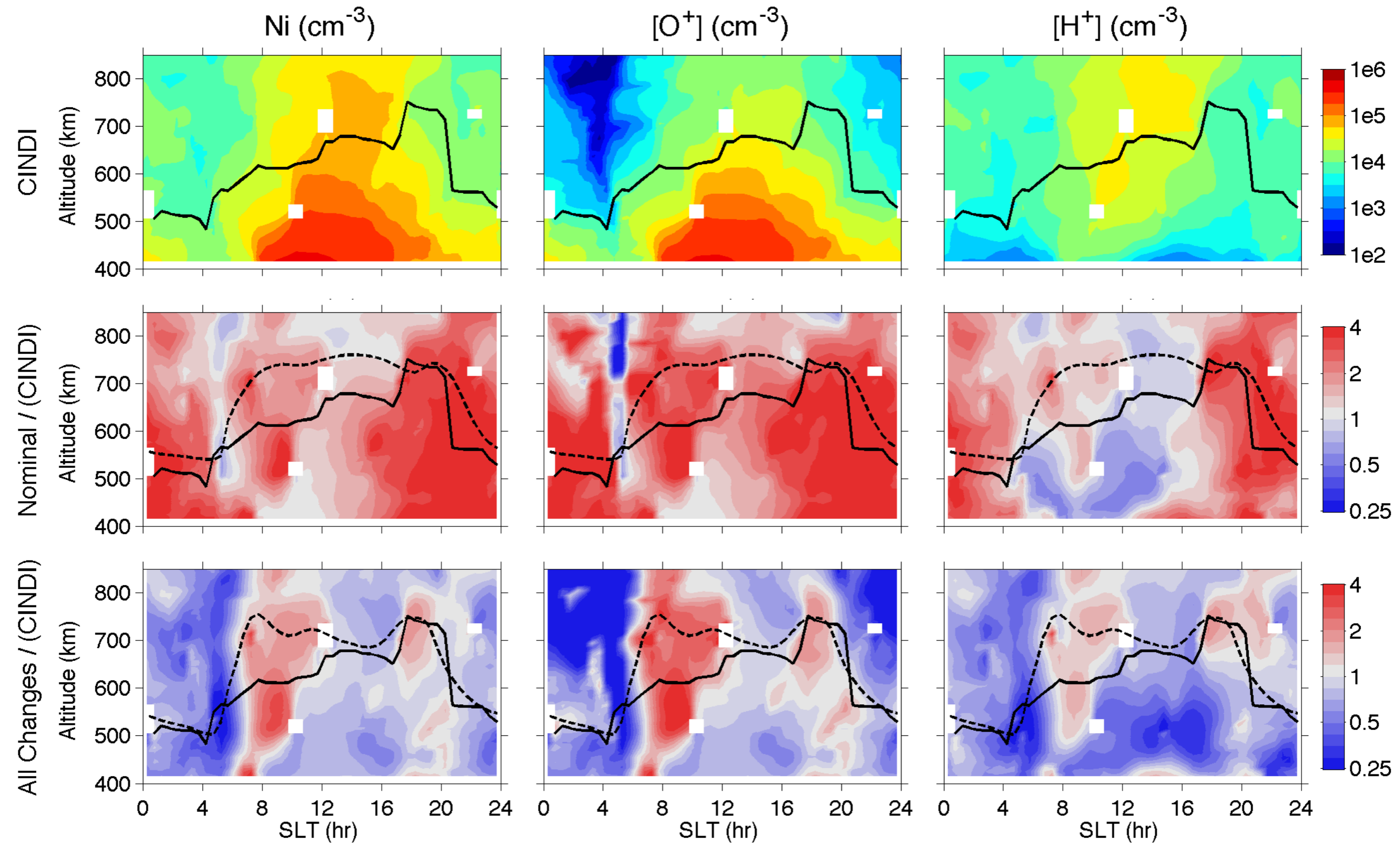


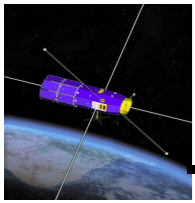
General SAMI2 Results





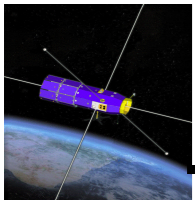
General SAMI2 Results





Future Questions

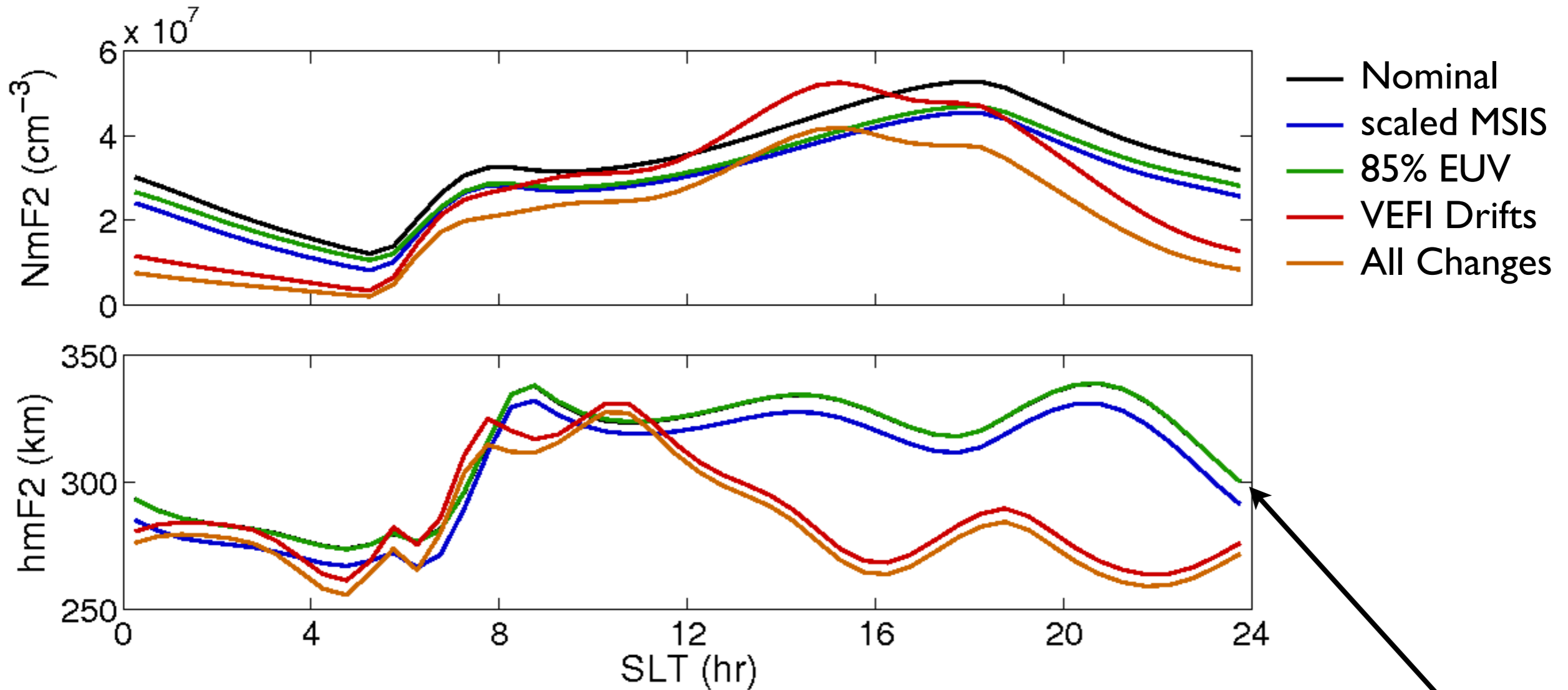
- ▶ Changes in neutral composition may be more complicated.
- ▶ Variability of meridional drifts in SAMI2.
- ▶ Effects of neutral winds.
- ▶ Accurate modeling of non-migrating tides.
- ▶ Thermal effects.



Summary

- ▶ Both the IRI-2007 and SAMI2 models tend to overestimate topside density in the afternoon / evening sectors during the recent solar min.
- ▶ Using the VEFI drifts in SAMI2 produces better density estimates in the afternoon and evening.
- ▶ Full sensitivity study of SAMI2 is in progress.

Bonus Slides

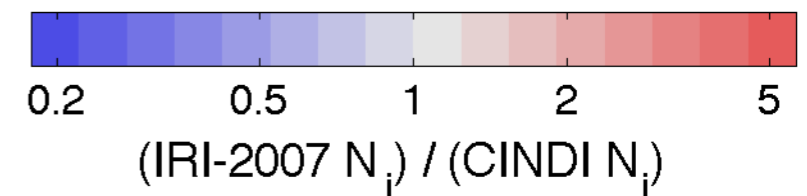
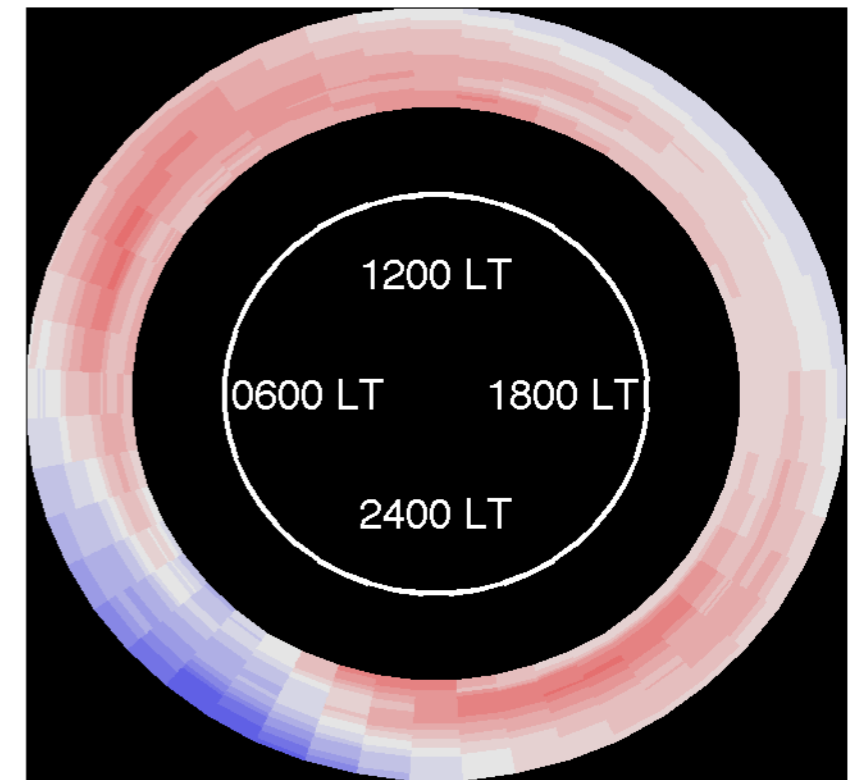
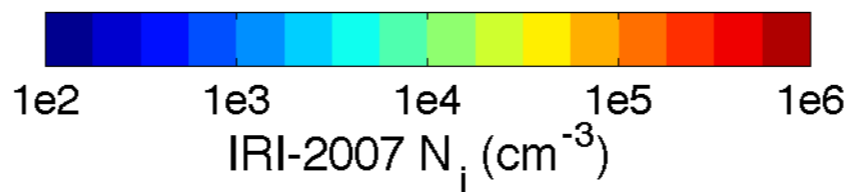
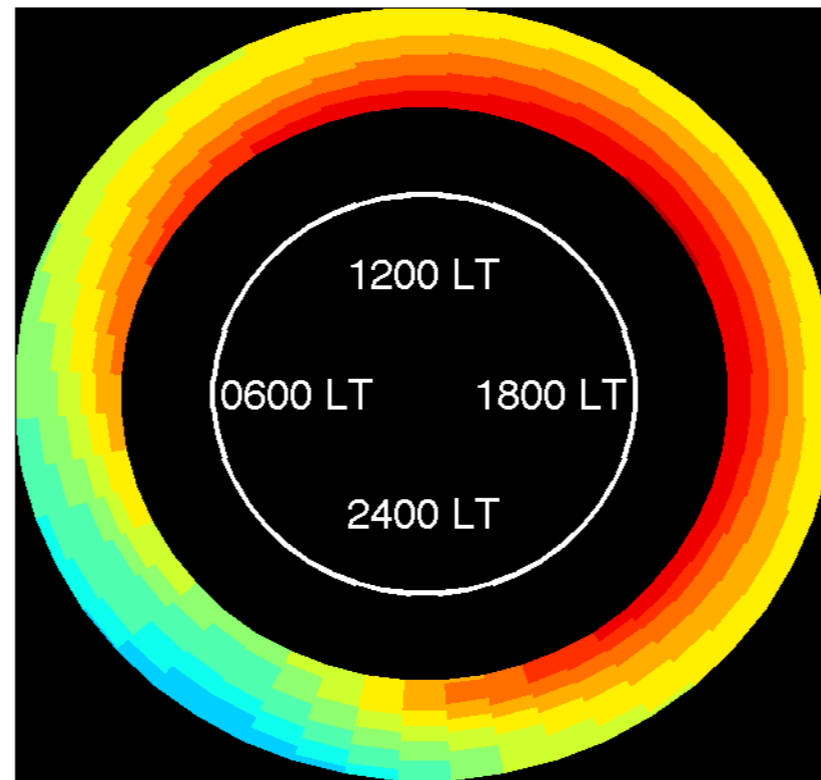
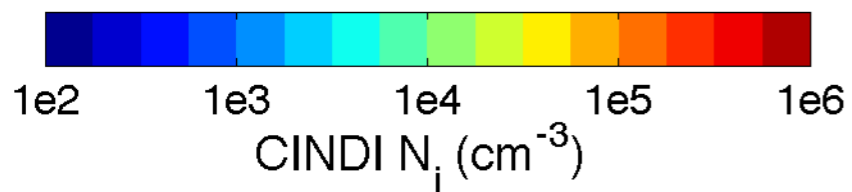
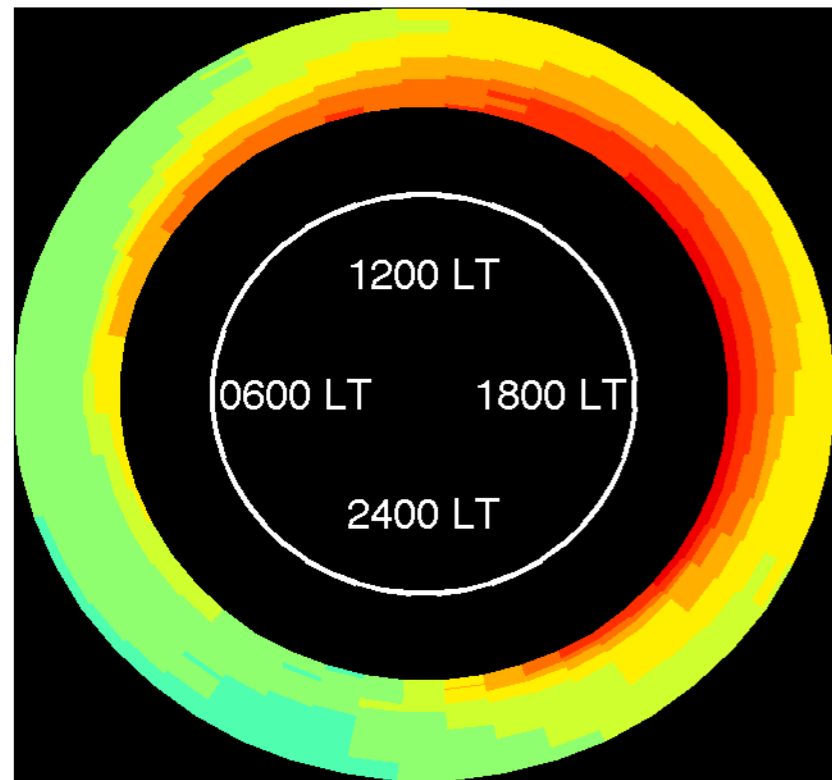


Note there is no change in hmF2 for a reduction in EUVAC!

December Solstice 2008

All Longitudes, Mag Dip Equator

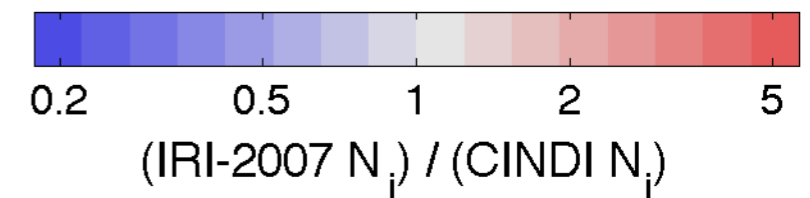
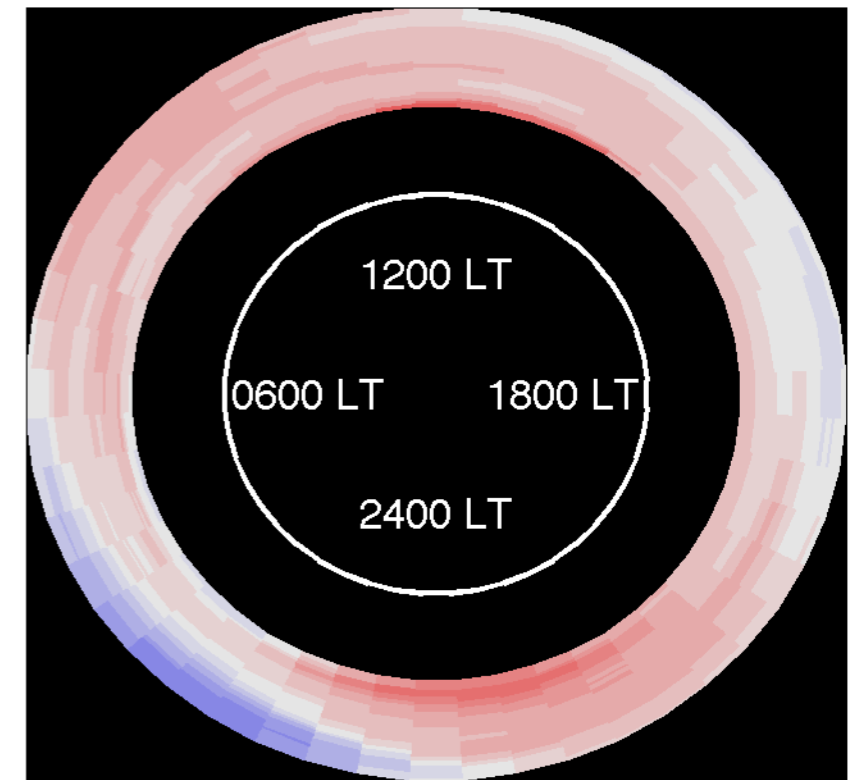
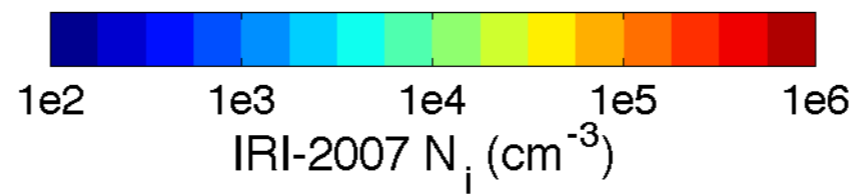
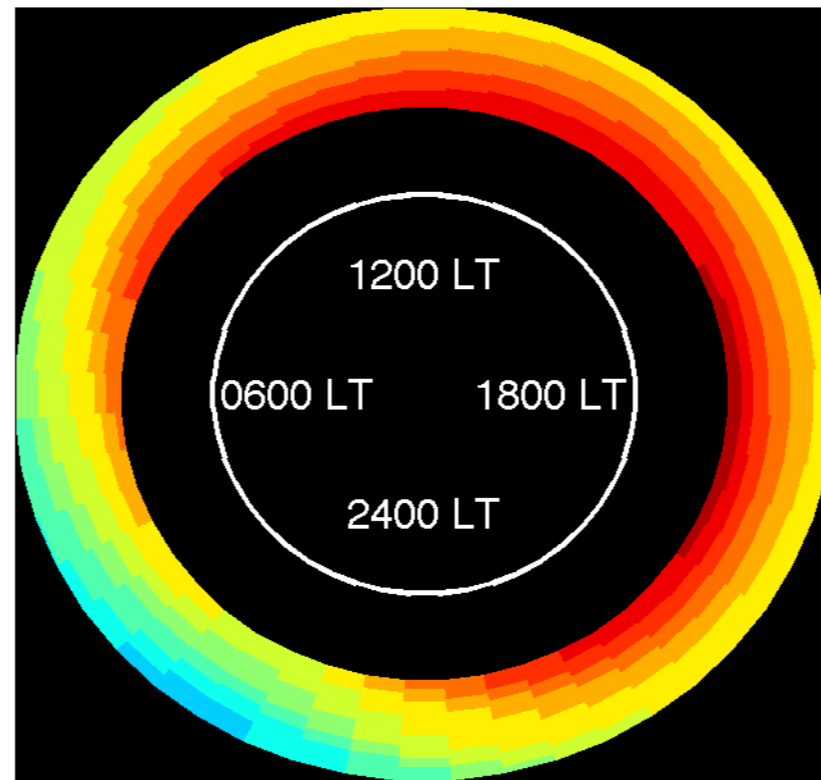
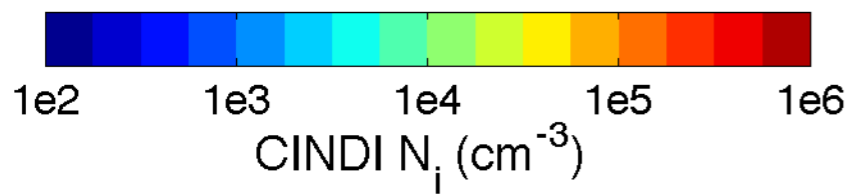
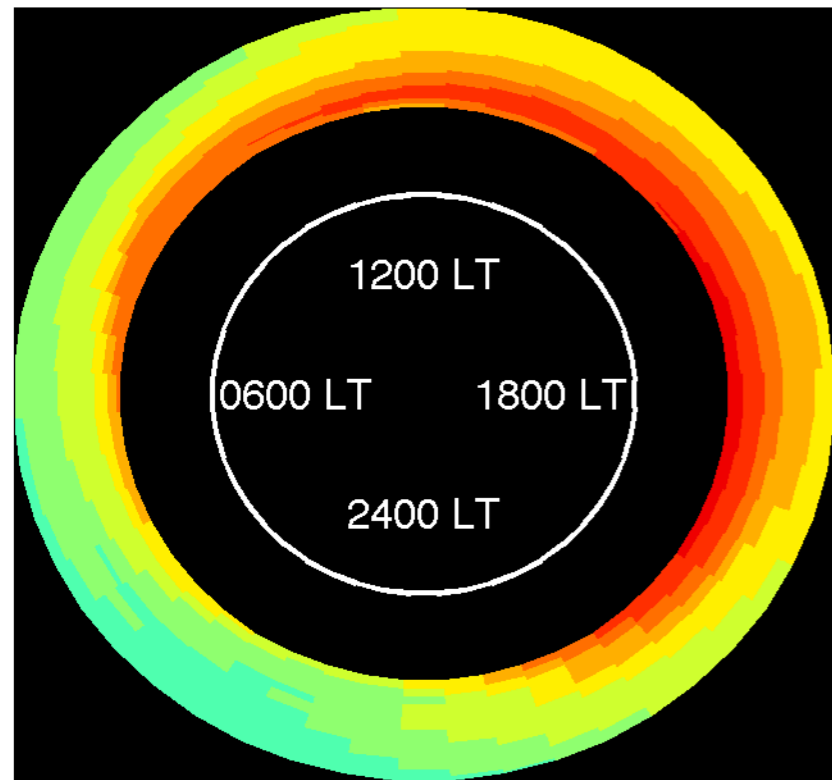
Dec Sol 2008



December Solstice 2009

All Longitudes, Mag Dip Equator

Dec Sol 2009



December Solstice 2010

All Longitudes, Mag Dip Equator

Dec Sol 2010

