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C/NOFS Thermospheric Research and Reentry EXperiment (T-RREX)

Ionospheric Effects Symposium
12-14 May 2015

L. C. Gentile, C. G. Fesen
Air Force Research Laboratory Space Vehicles Directorate
R.A. Heelis
University of Texas at Dallas
R. F. Pfaff
NASA Goddard Space Flight Center

C/NOFS T-RREX

- As of 16 April 2015, C/NOFS has completed 7 years on orbit!
- Spacecraft systems are nominal; all payloads are working well;
- Apogee/perigee are now: ~495 km/353 km.
- Storm-time energy inputs on 17 Mar 2015 produced a global increase of ~250°K in thermosphere and ionosphere temperature; neutral density at fixed altitudes increased by a factor of 2.
- Initial observations below the peak of the F-layer show a consistent pattern; when plasma density is depleted in the bottomside, the ion motion (drift) is westward.

C/NOFS Status

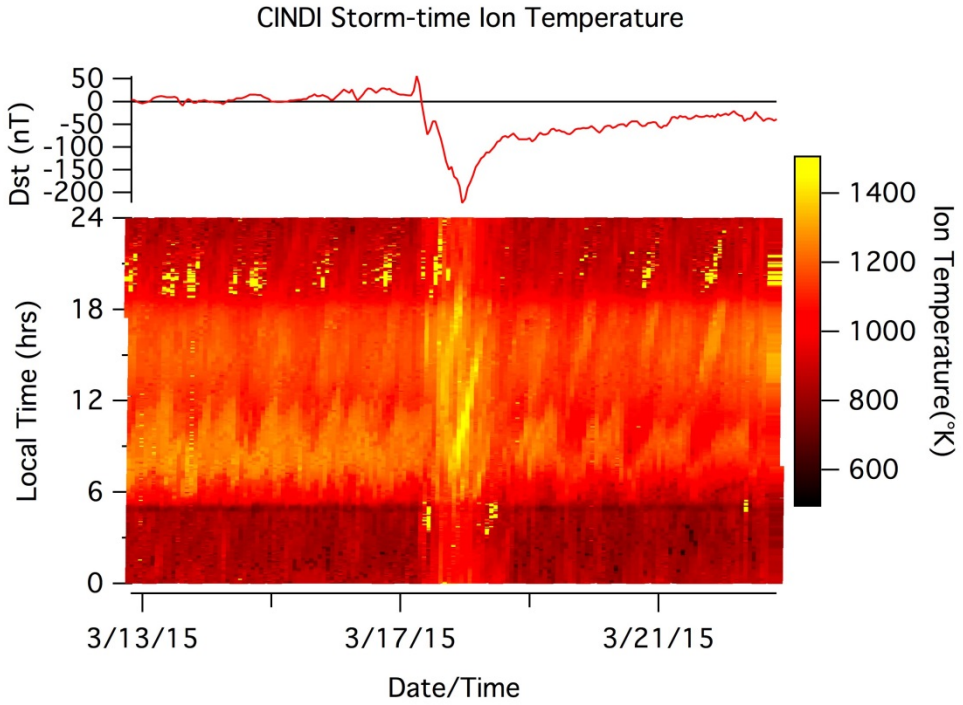
Instrument	Partner	Provides	Status
NWM Neutral Wind Meter	NASA Small Explorer CINDI grant to U. Texas at Dallas	Neutral winds, neutral pressure	**Cross-track ON**
IVM Ion Velocity Meter		Ion velocities, temperatures, composition	**ON**
CORISS C/NOFS Occultation Receiver for Ionospheric Sensing and Specification	The Aerospace Corporation	Line-of-sight TEC, PNT	**ON**
VEFI Vector Electric Field Instrument	NASA	Ion velocities, electric and magnetic fields	**ON**
CERTO Coherent Electromagnetic Radio Tomography	NRL	TEC, electron density profiles, scintillation phase and amplitude	**OFF**
PLP Planar Langmuir Probe	AFRL/RVB	Ion and electron densities and fluctuations	**Cycling in sun/eclipse**

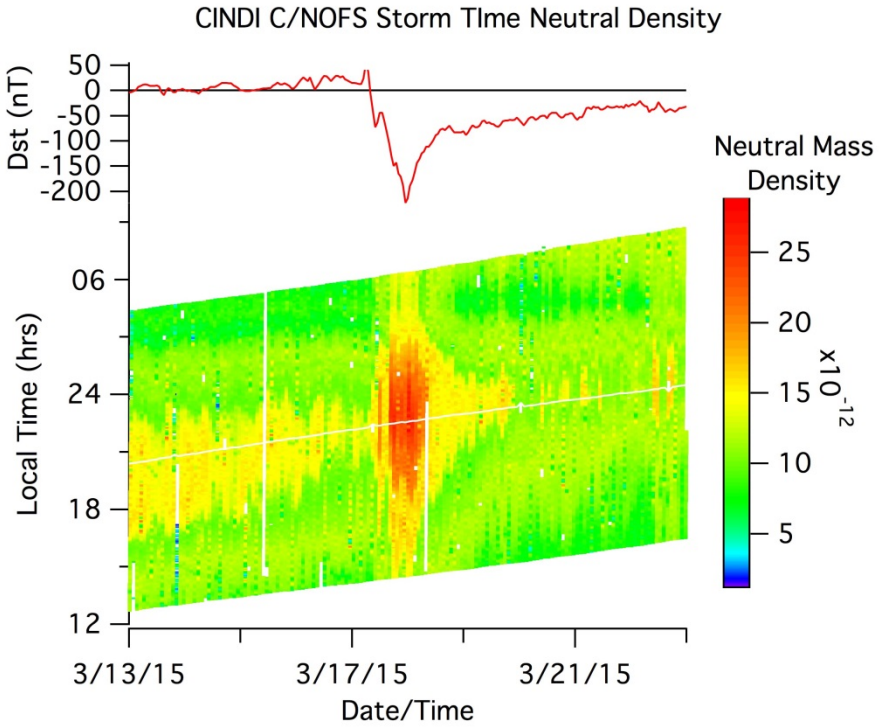
- Spacecraft systems are nominal.
- All payload instruments are working well.
- CERTO beacon is off; PLP is cycling in eclipse to conserve power while beta angle is marginal.
- As of 16 April 2015, C/NOFS has completed 7 years on orbit!

CINDI: Coupled Ion-Neutral Dynamics Investigation

New Results: Coupled Ion Neutral Dynamics Investigation (CINDI) Observations

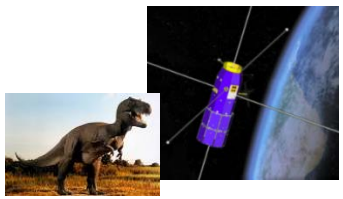
Response of Equatorial Ionosphere and Thermosphere to 17 March 2015 Storm





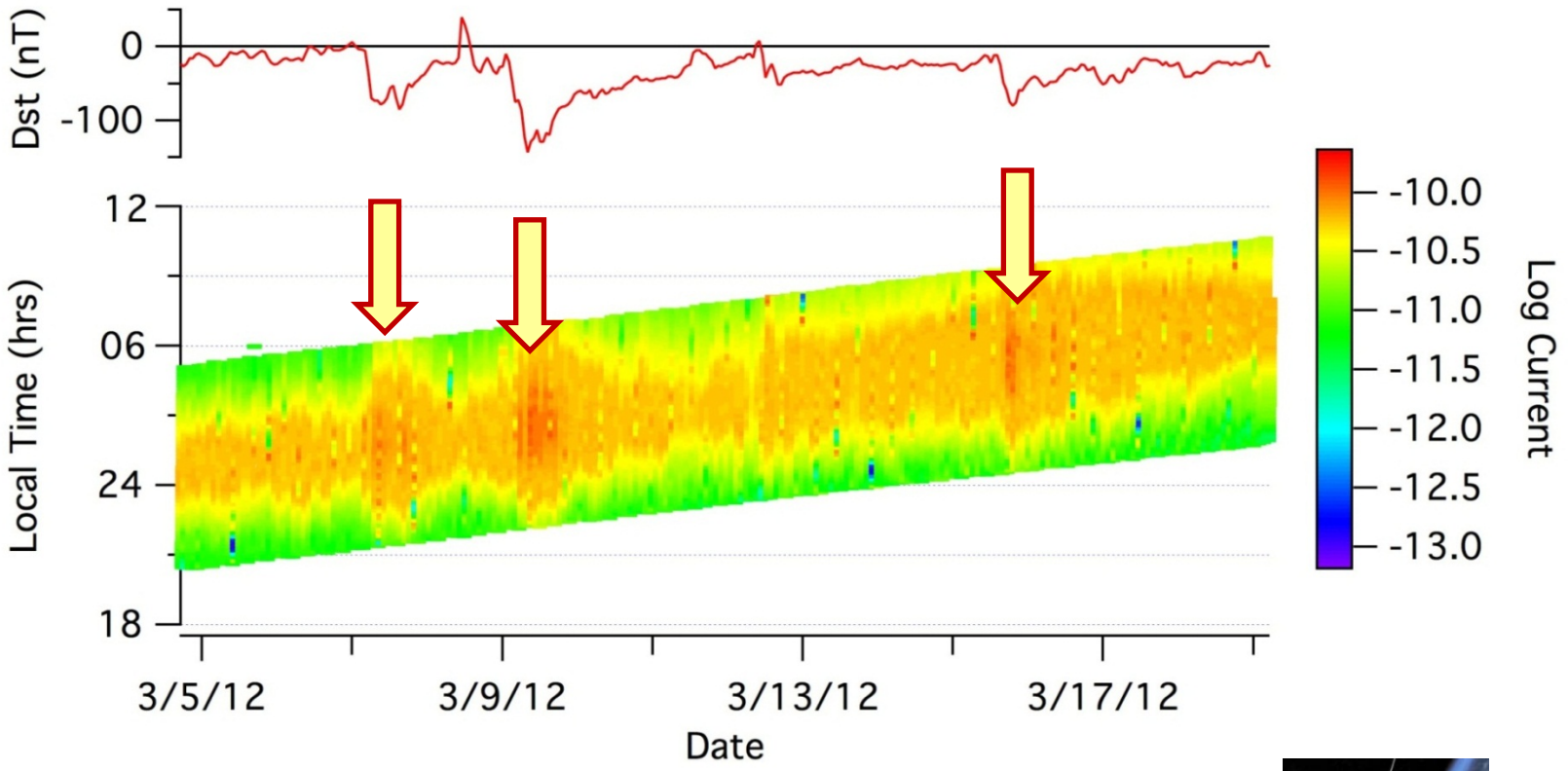
Storm-time energy inputs produce global increase of ~250°K in thermosphere and ionosphere temperature.

Global storm-time increase in temperature produces expansion of the thermosphere; neutral density at fixed altitudes increased by a factor of 2.



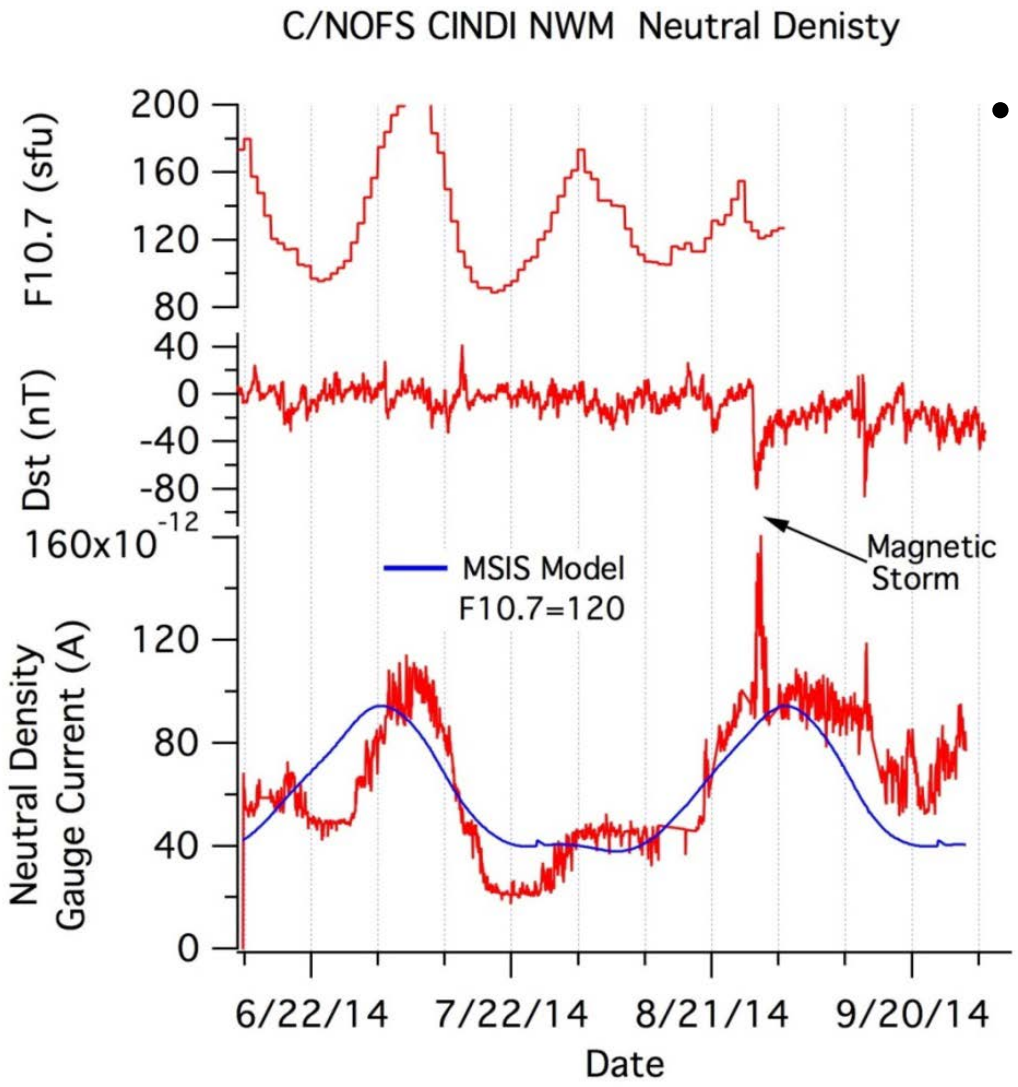
C/NOFS CINDI Neutral Density Variations with Local Time vs Dst

Density data are highly structured and clearly respond to geomagnetic activity. Effects persist for a day or more, well into the recovery phase of the storm.



Reentry predictions may be off 20°– 40° in latitude if low-altitude neutral density variations are not incorporated into predictive models.

C/NOFS CINDI Neutral Density vs MSIS Model



Solar Activity (F10.7) Index

- Data reflect typical variability due to 27-day solar rotation and geomagnetic storms

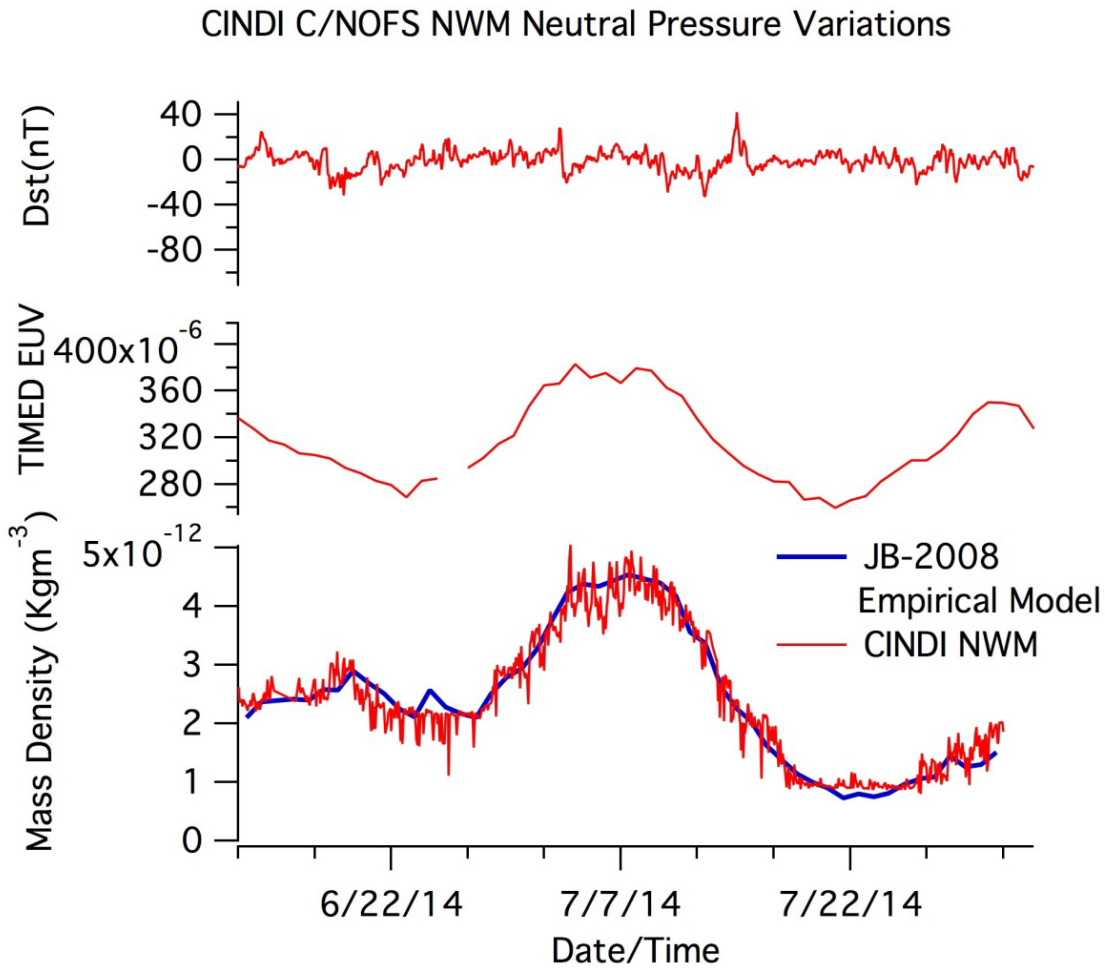
Magnetic Activity (Dst) Index

- Typically varies between +/- 50 nT
- May fall below -400 nT in major storms
- Lowest Dst since launch: ~ -225 nT, so effects of major storms remain TBD

Neutral Density Variations

- Red: C/NOFS NWM observations
  - Clear response to solar activity
  - Large/impulsive responses to geomagnetic activity
- Blue: standard neutral wind model predictions

C/NOFS CINDI Neutral Density vs JB2008 Orbital Drag Model



Magnetic Activity (Dst) Index

- Typical quiet time variations between +/- 40 nT

Solar EUV from TIMED

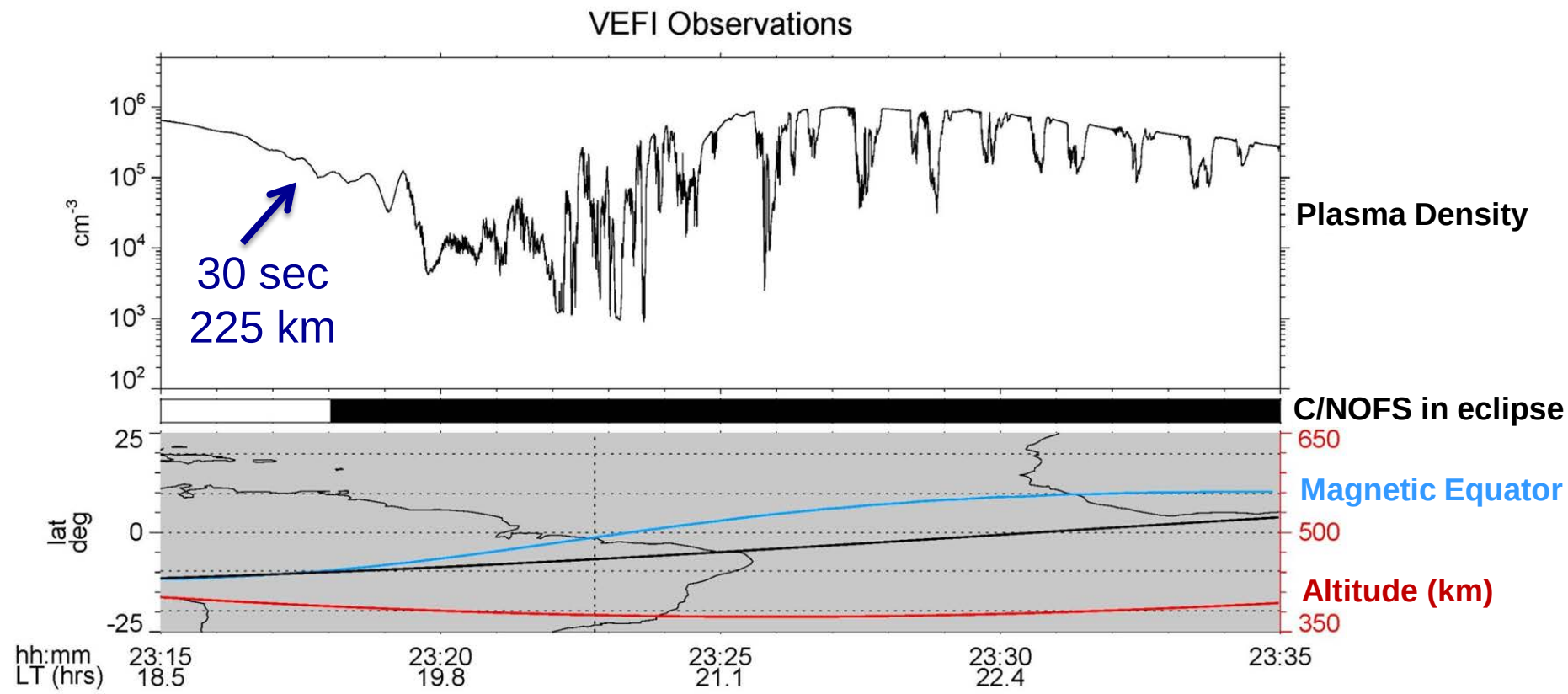
- Typical daily variations

Neutral Density: Quiet Time

- Red: C/NOFS observations
- Blue: Jacchia-Bowman 2008 AFSPC operational orbital drag model

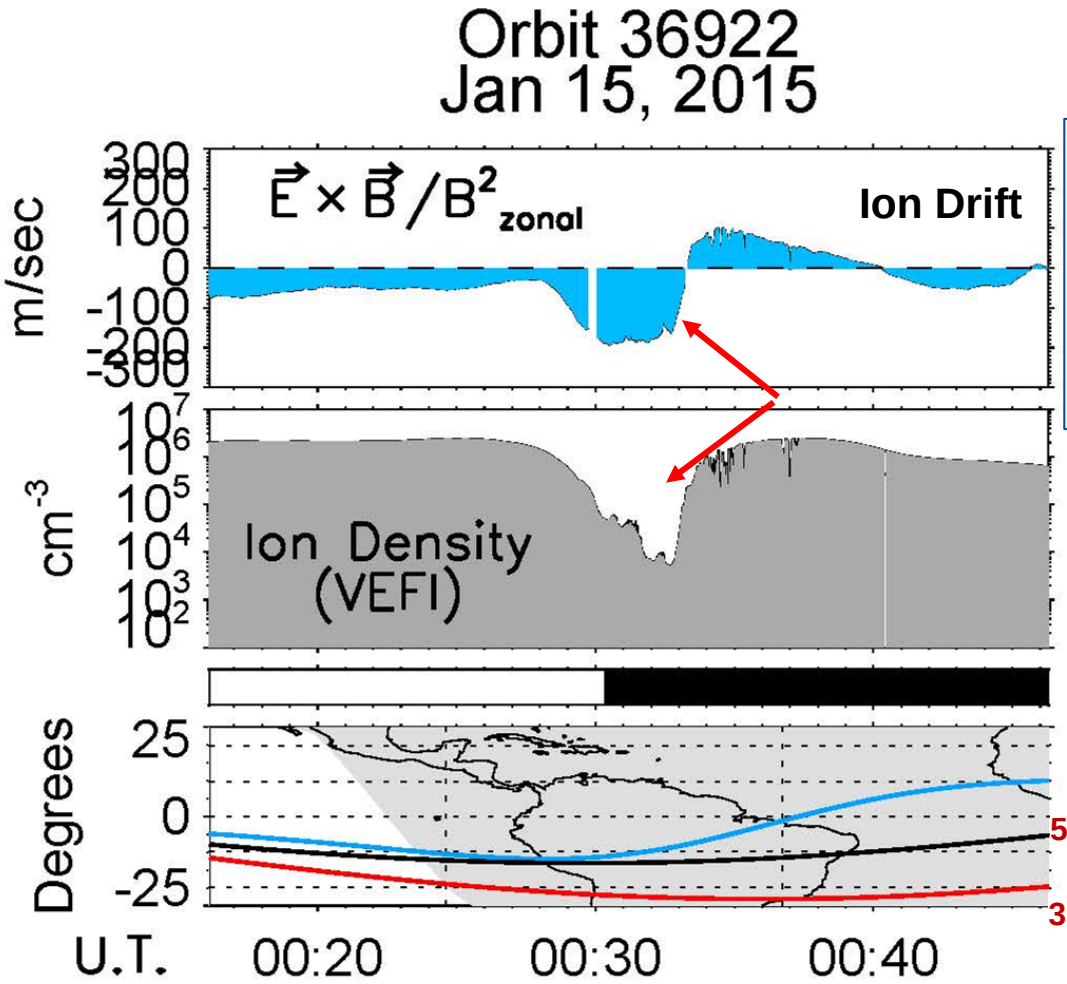
Note: this is just one example for a very quiet time interval. There is much more analysis to be done under varying solar conditions.

C/NOFS Vector Electric Field Instrument (VEFI) Observations of Bottomside Structures



VEFI observations below the peak of the F-layer show bottomside wave structures and plasma density irregularities.

VEFI Shows Relationship Between Bottomside Density and Plasma Drift Motion



Initial analysis shows a consistent pattern in the bottomside observations; when plasma density is depleted in the bottomside, the ion motion (drift) is westward.

Plasma Density

C/NOFS in eclipse

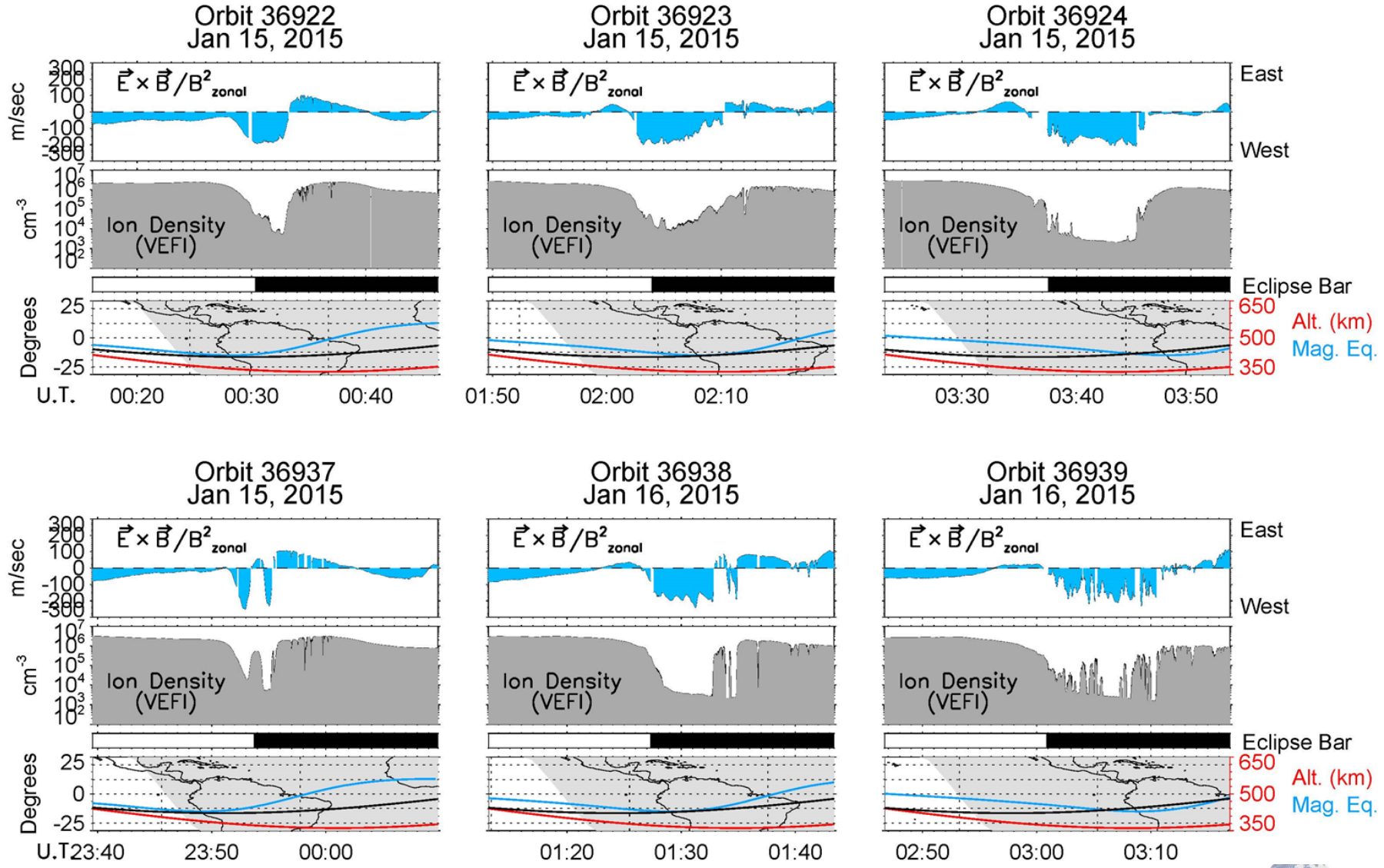
Magnetic Equator

500

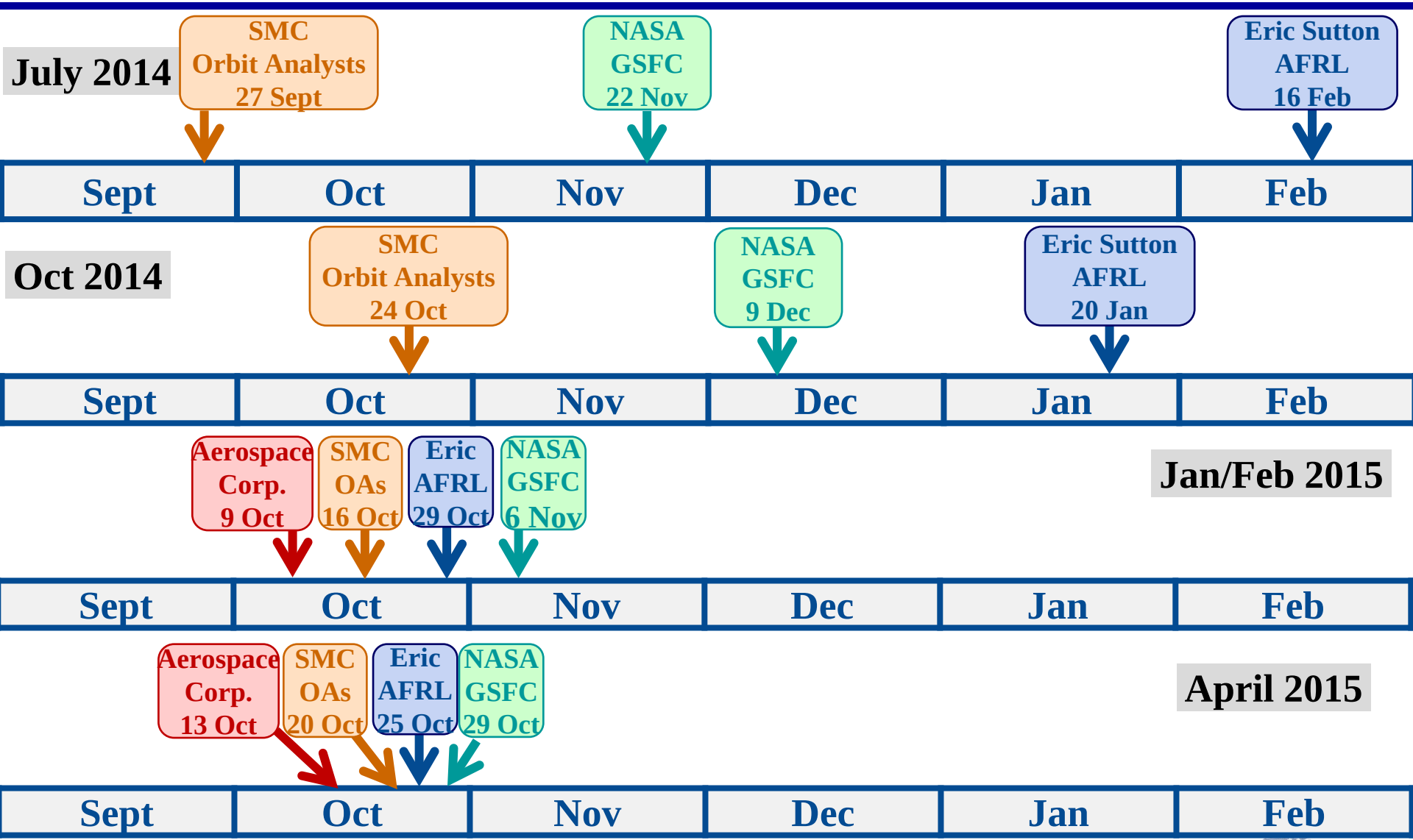
Altitude (km)

350

VEFI Shows Relationship Between Bottomside Density and Plasma Drift Motion



Reentry Prediction Mean Estimates Are Converging



C/NOFS T-RREX Summary

- C/NOFS is poised to gather significant new low-altitude observations in the low-latitude ionosphere.
- These data will advance our understanding of ionospheric coupling above and below the F peak and fill gaps in ionospheric models, providing a far more realistic picture of the low-latitude, low-altitude ionosphere.
- Initial results are quite promising, but there is still much work to be done in understanding the mechanisms that couple the topside and bottomside of the ionosphere.
- We have never had this opportunity before, and we may not have it again in the foreseeable future.
- We invite and encourage any collaborations that will leverage the results from this unique data set.