Auroral Boundary From FUV Imagers for Validation of Auroral Products at the CCMC

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April 14, 2016

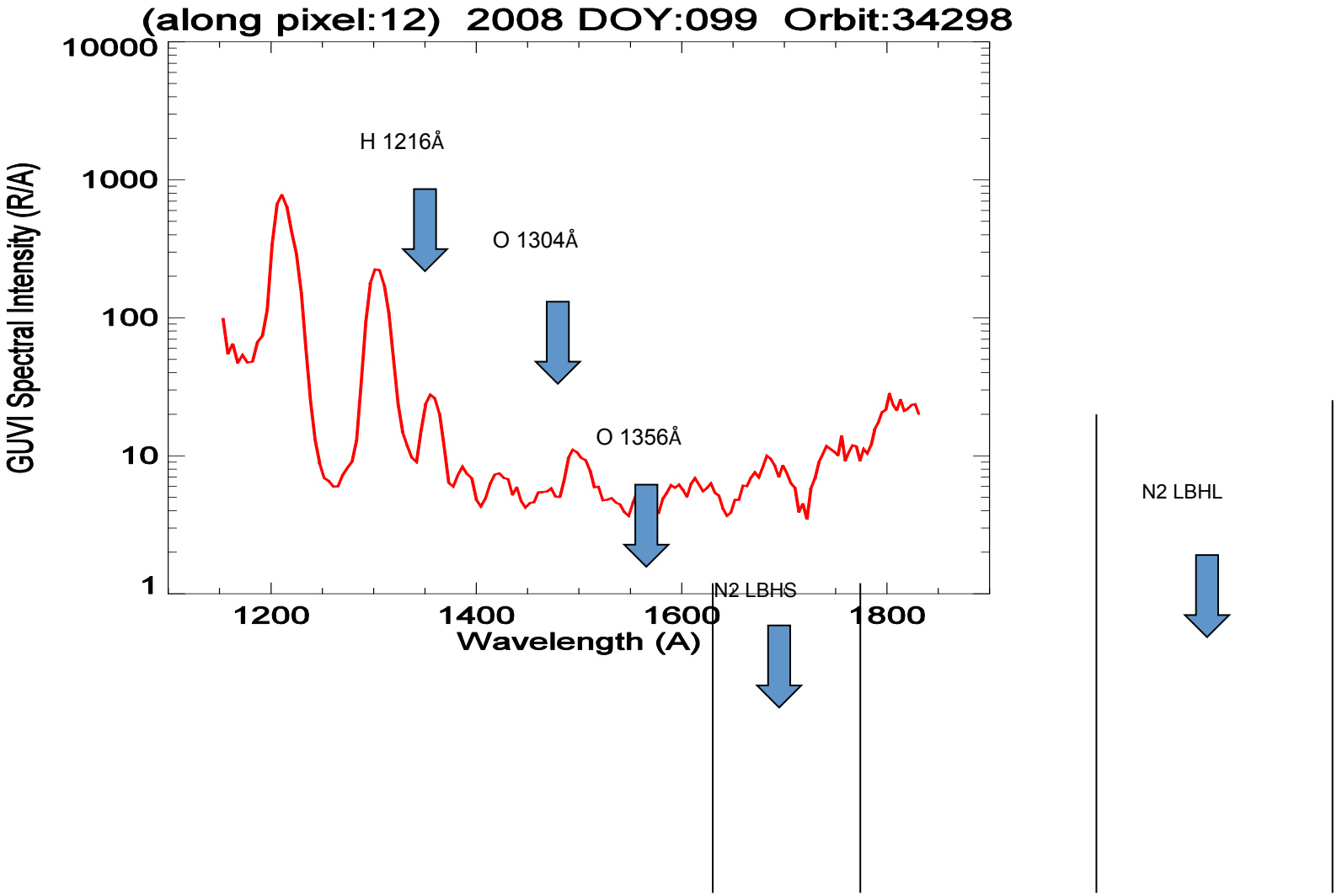
Outline

- Aurora observations in FUV
- TIMED/GUVI and DMSP/SSUSI
- Auroral products
  - E0,Q, NmE, HmE, boundary, HP, proton aurora
- Application to IRI and CCMC validation
- Near real time Observations

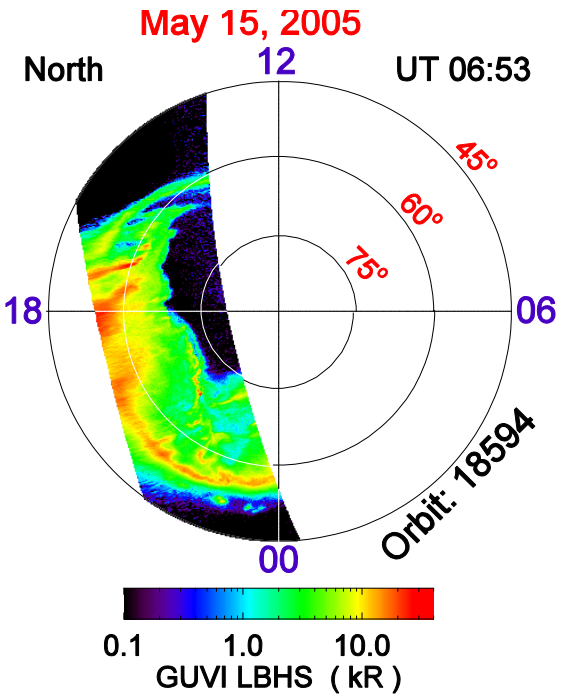
FUV Observations

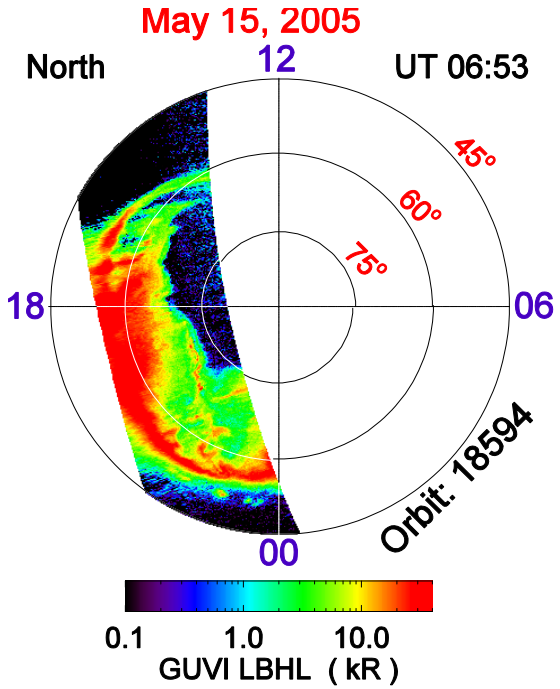
- Polar/UVI, IMAGE/FUV, TIMED/GUVI, and DMSP/SSUSI (4)
  - UVI & FUV: filter based
  - GUVI & SSUSI: spectrograph based
- The newest F19 DMSP/SSUSI was launched on April 3, 2014
- GUVI and SSUSI (PI: Larry Paxton of JHU/APL) provide
  - auroral images with high spatial resolution
  - reliable auroral products (E0, Q, HP, boundary)
  - Both northern and southern hemispheres
  - simultaneous measurements at different wavelengths

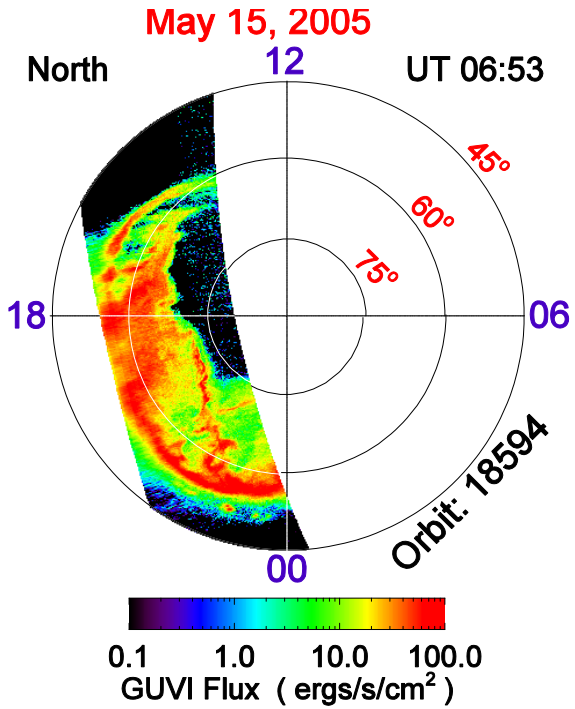
FUV Spectra and five “colors”

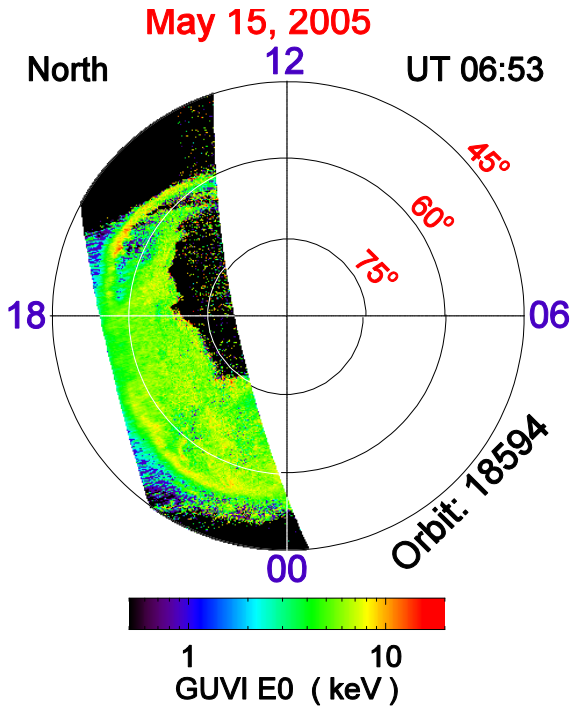


FUV auroral images: TIMED/GUVI

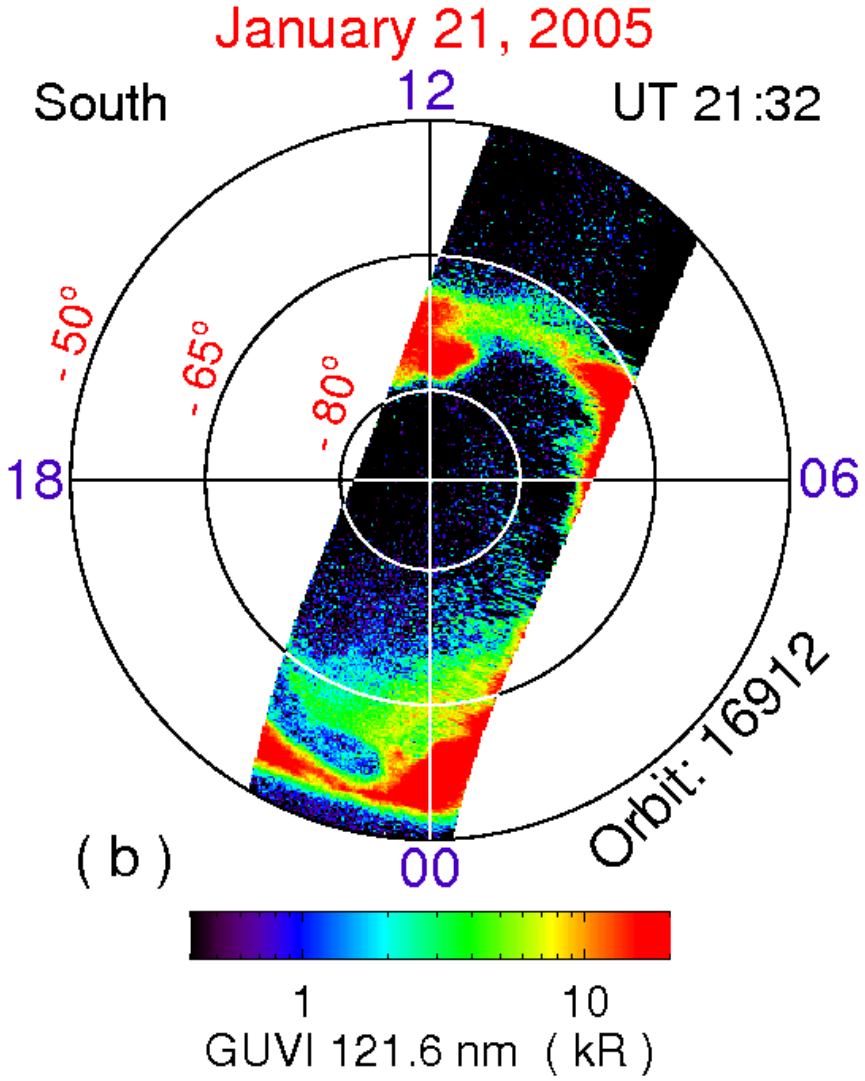




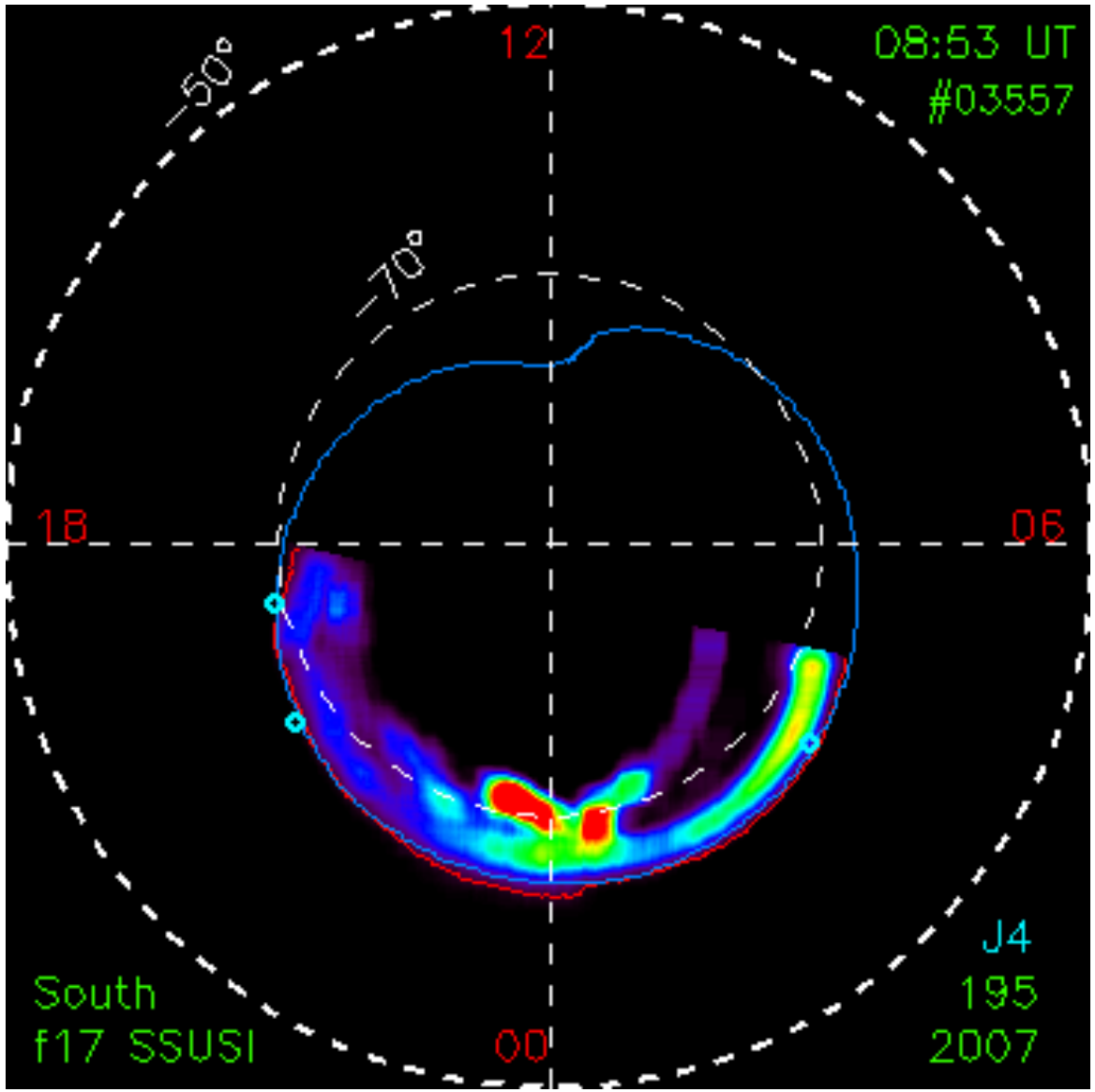

May 15, 2005
North
12
UT 06:53
45°
60°
75°
18
06
00
Orbit: 18594
0.1
1.0
10.0
100.0
GUVI Flux (ergs/s/cm2)


May 15, 2005
North
12
UT 06:53
45°
60°
75°
18
06
00
Orbit: 18594
1
10
GUVI E0 (keV)

Proton Aurora



Equatorward auroral boundary



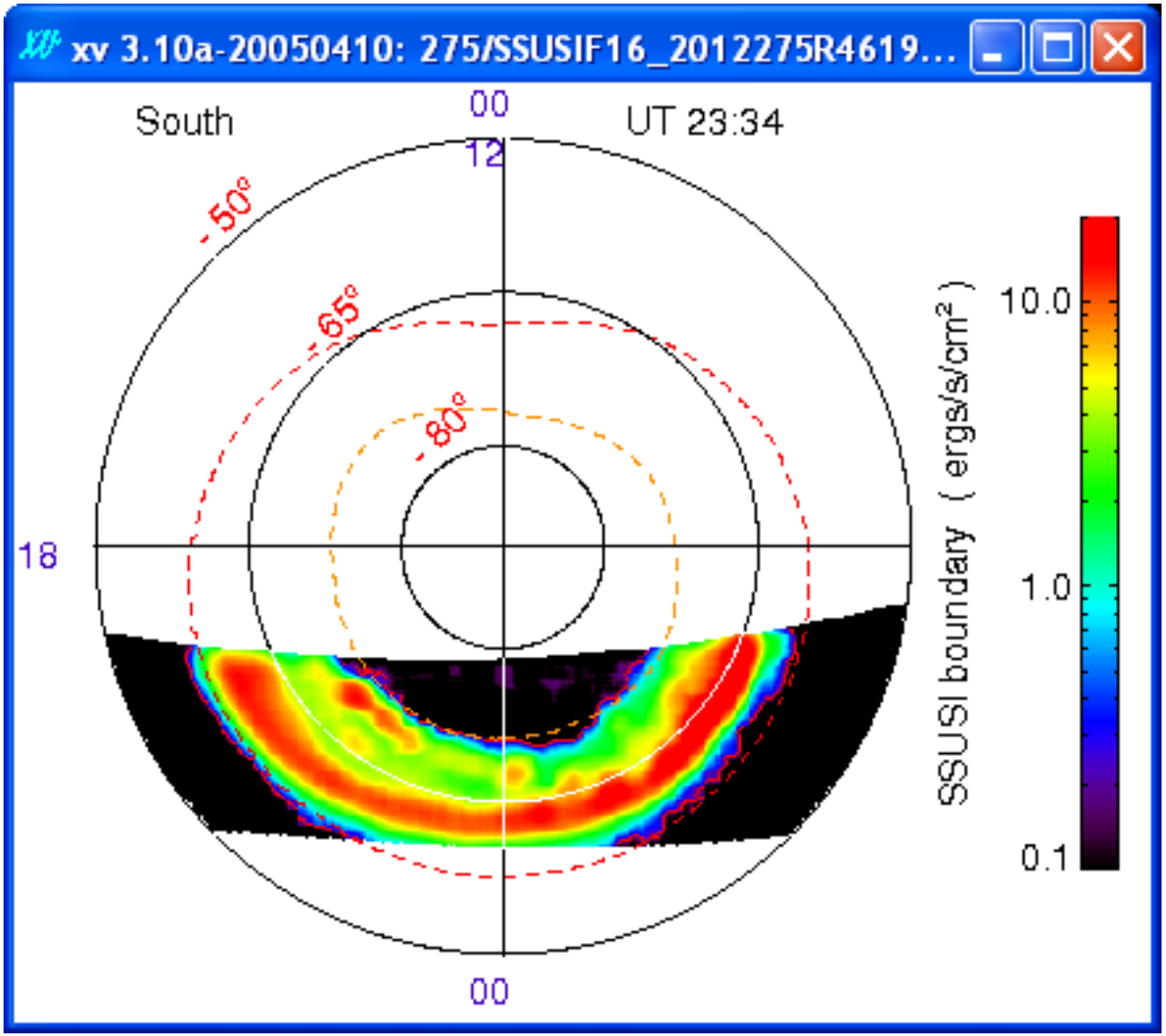
The TIMED/GUVI based auroral model [Zhang and Paxton, 2008] can be driven by Kp or boundary

Poleward boundary: polar cap size and total open B flux

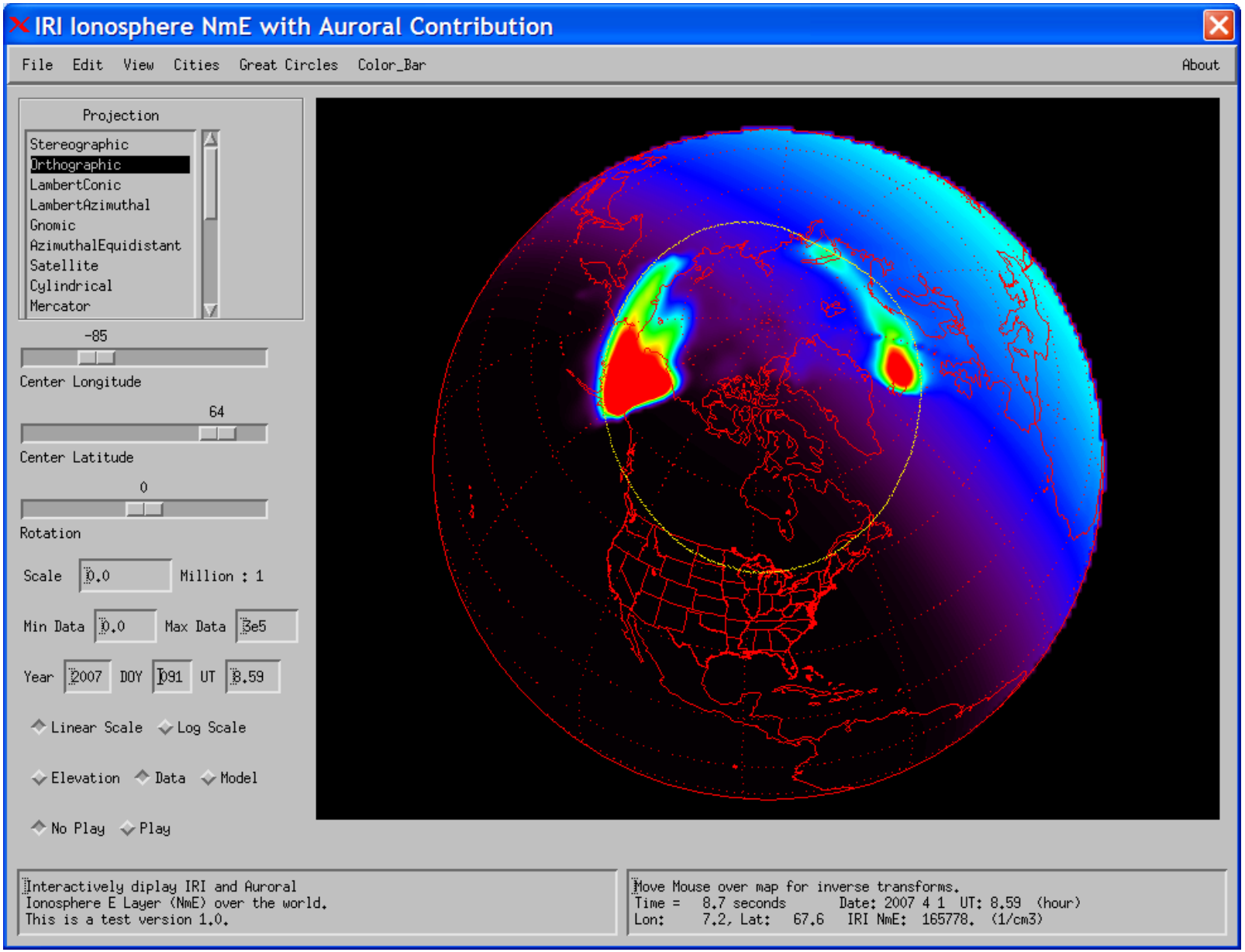
Equatorward boundary: magnetotail stretch

Both of the boundaries are useful for CCMC model validation

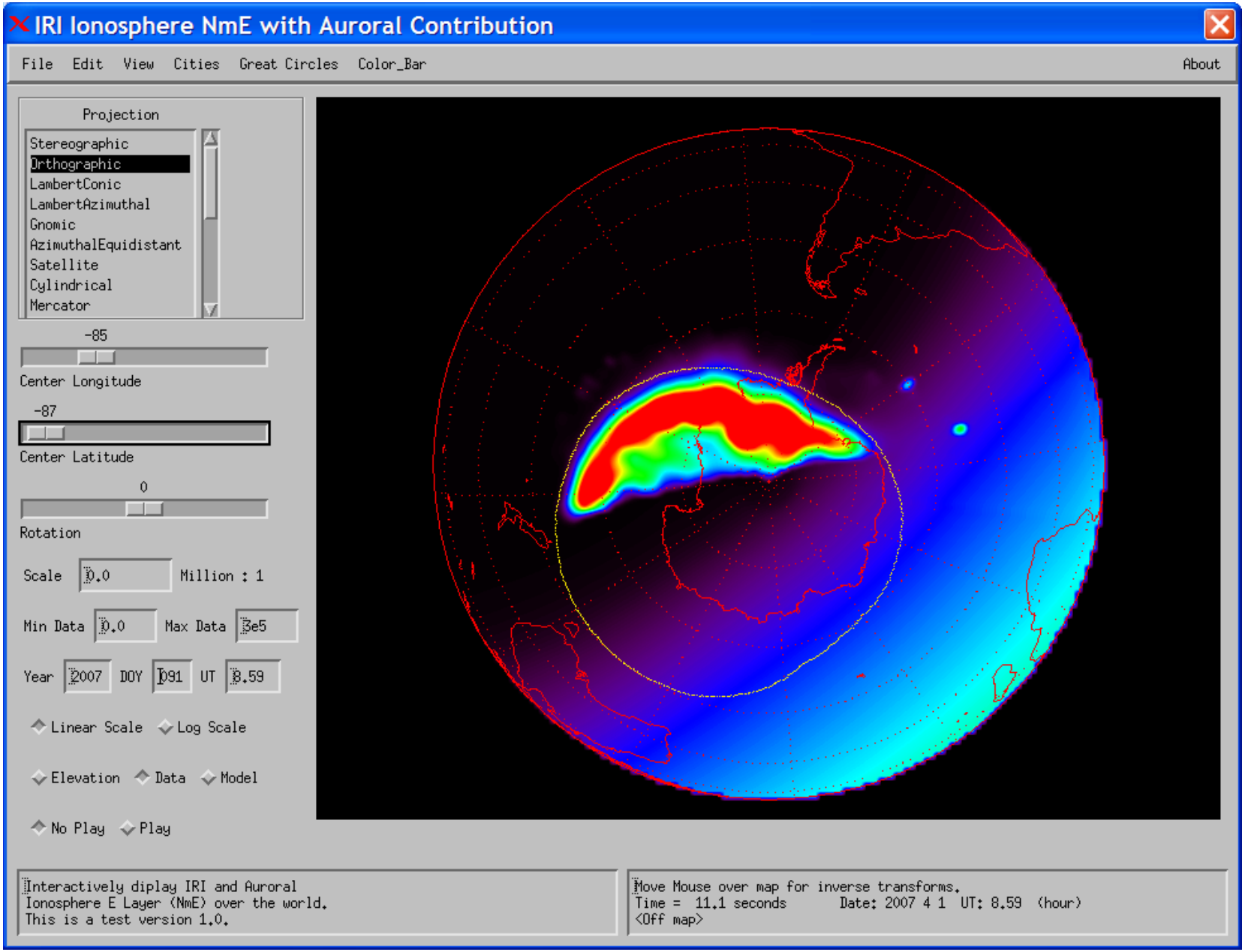
Poleward boundary



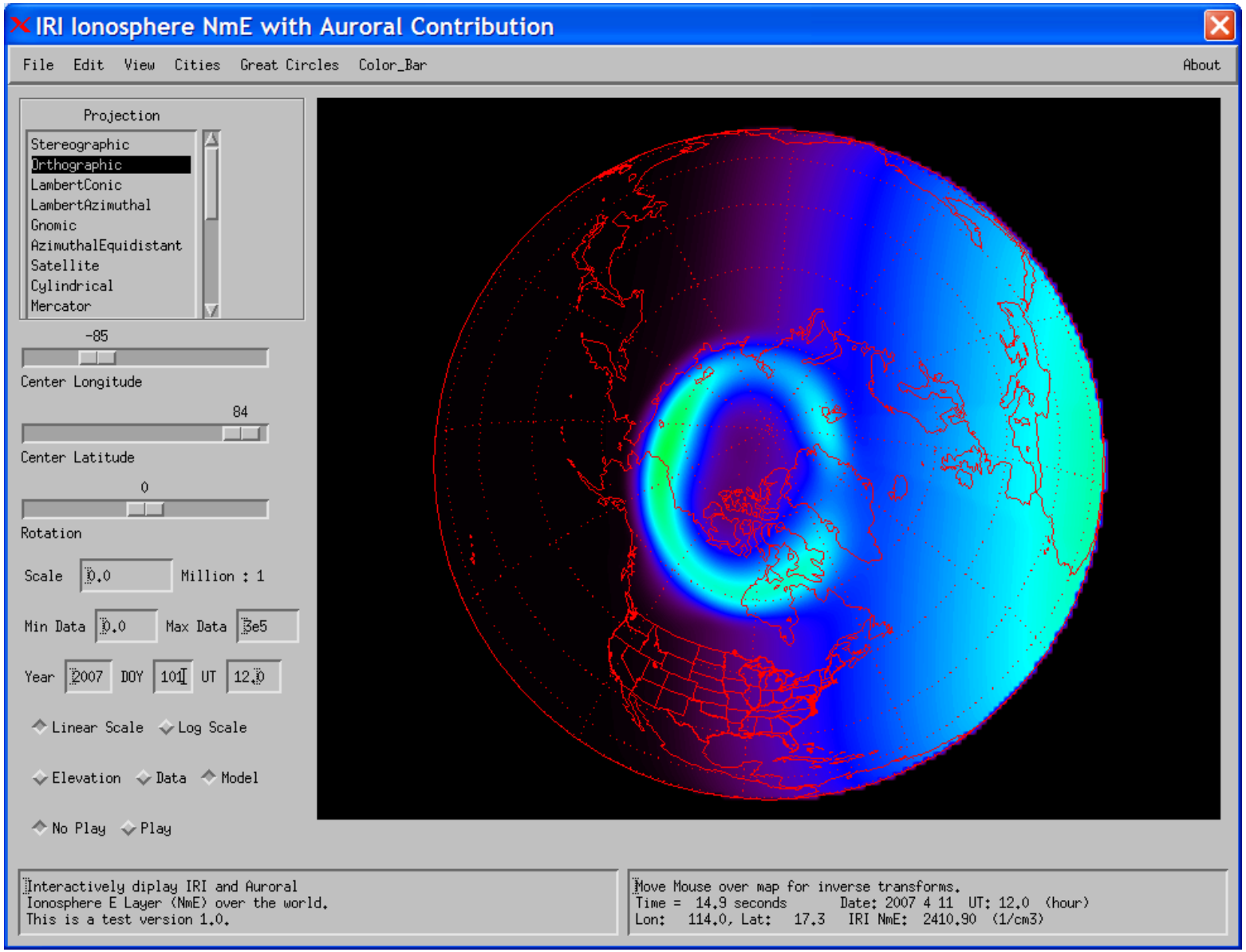
Assimilation of measured SSUSI NmE and boundary in IRI (Kp =4.3, April 1, 2007, 8:59UT)



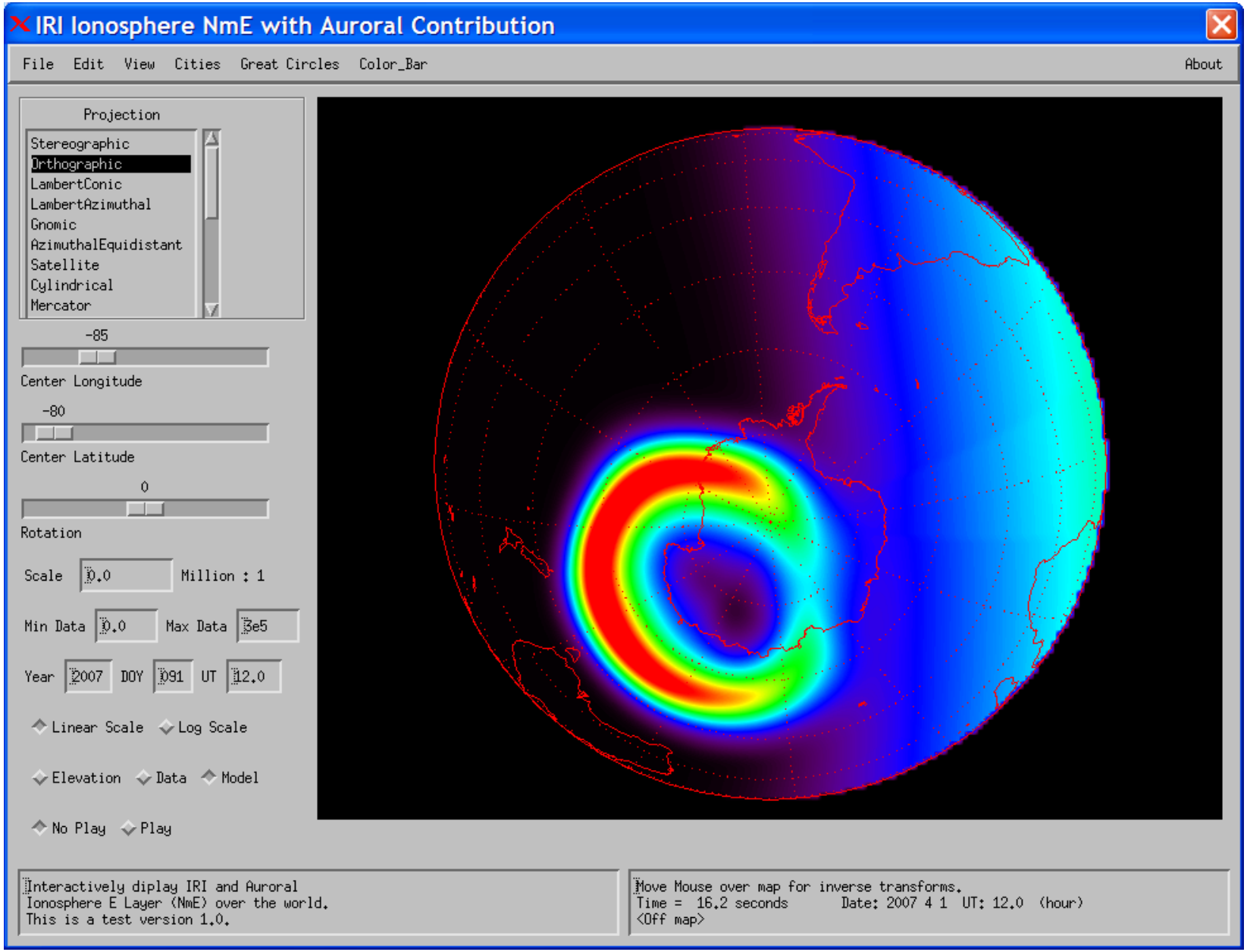
SSUSI data in southern hemisphere



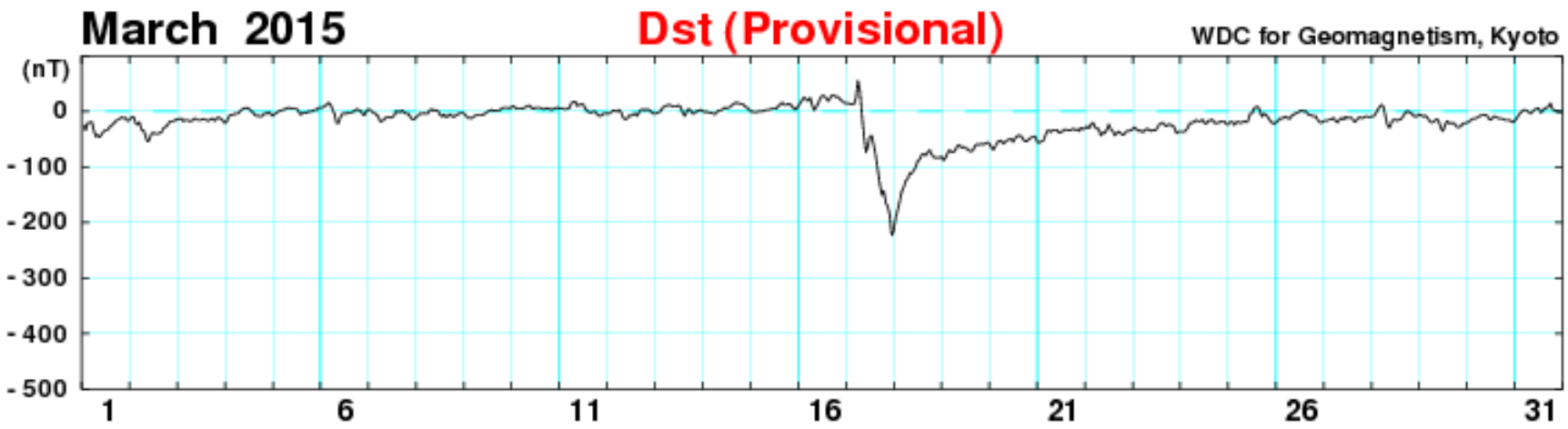
Assimilation of model NmE in IRI (Quiet time Kp =0.7)

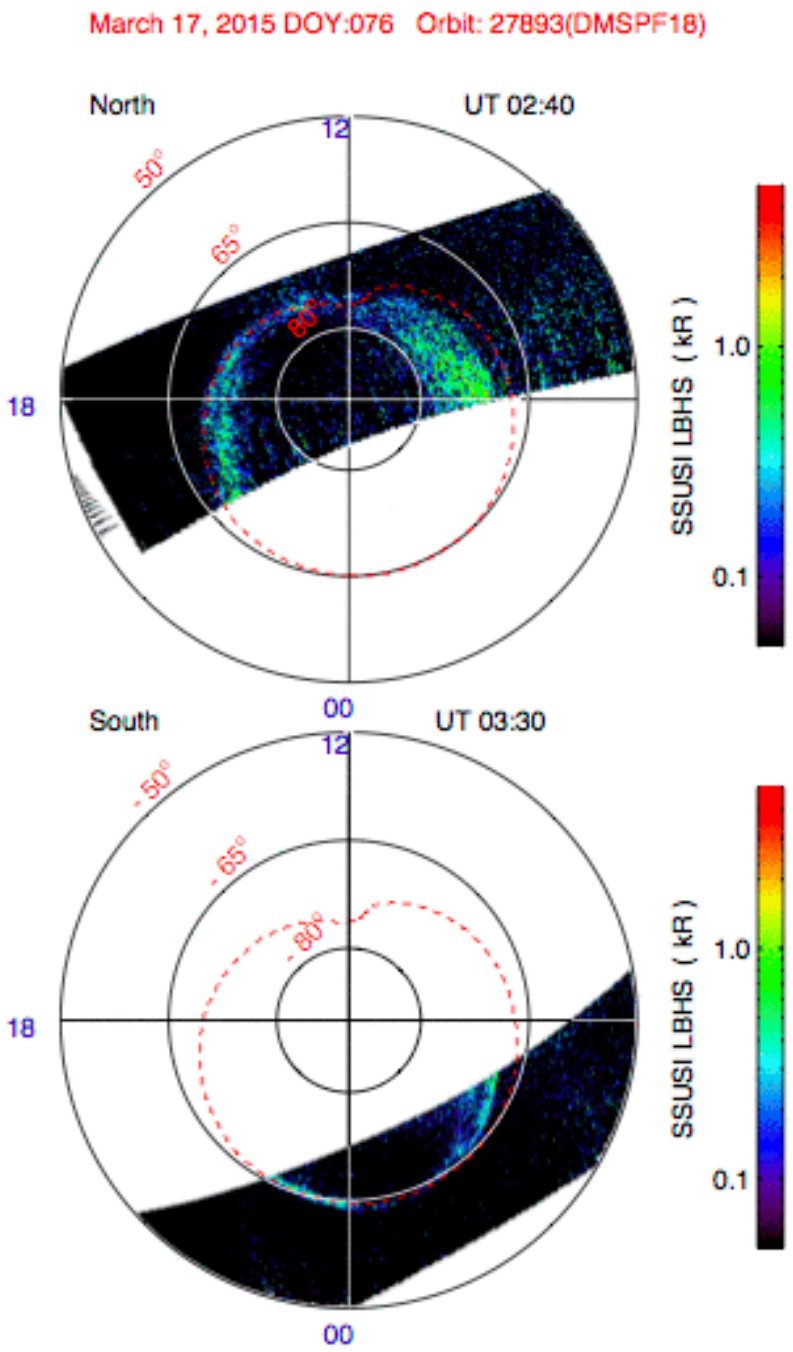


Assimilation of model NmE in IRI (Moderate Active time Kp =4.0)



The March 17, 2015 St Patrick Storm





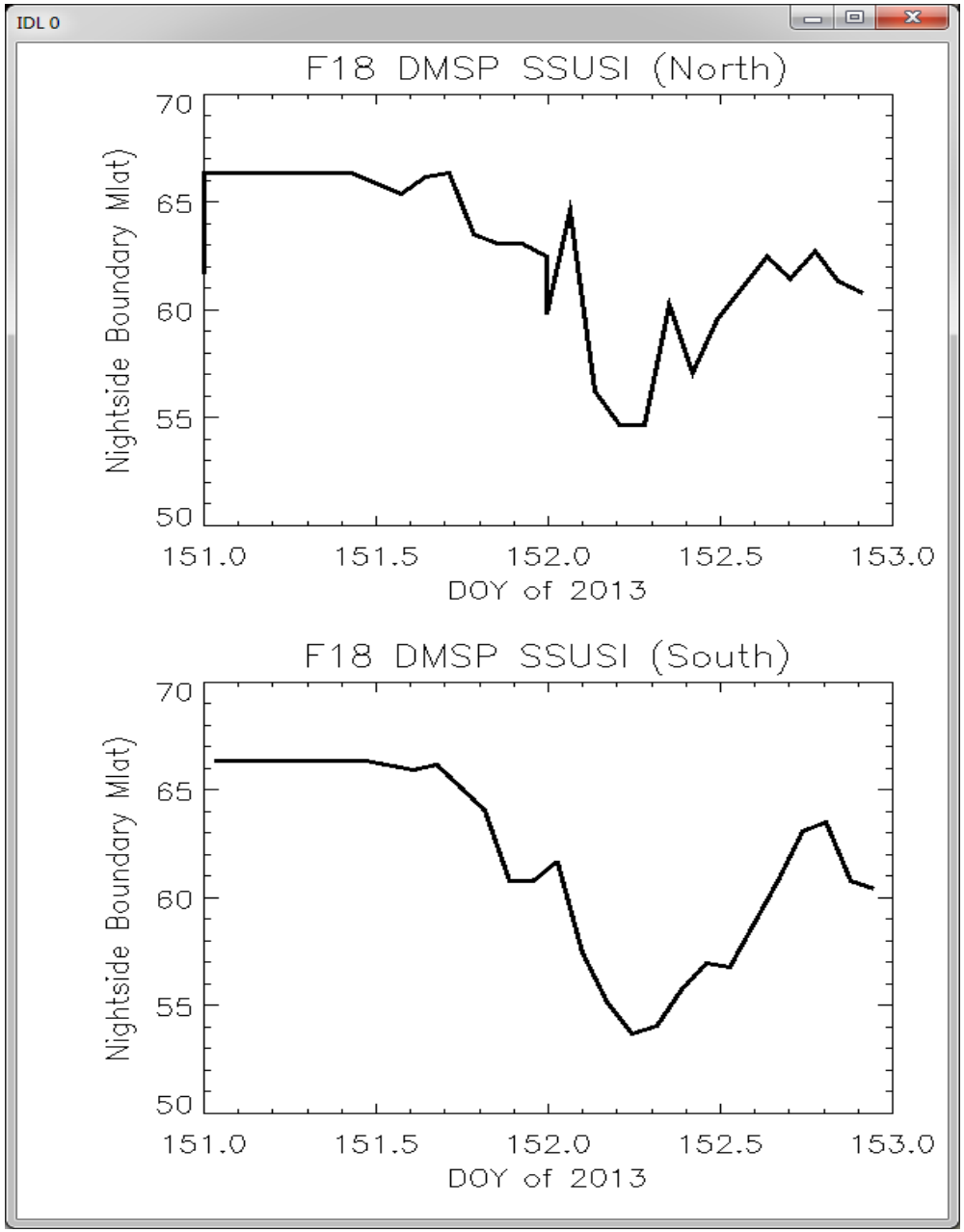
F18 DMSP SSUSI auroral images with global boundaries

Storm-time auroral features:

(1) Variations with different time and spatial scales

(2) Proton auroral equatorward boundary are at lower latitudes than that of electron aurora in the dusk sector.

(3) Auroral structures affect the Joule heating estimation



Nightside boundary variations during a storm

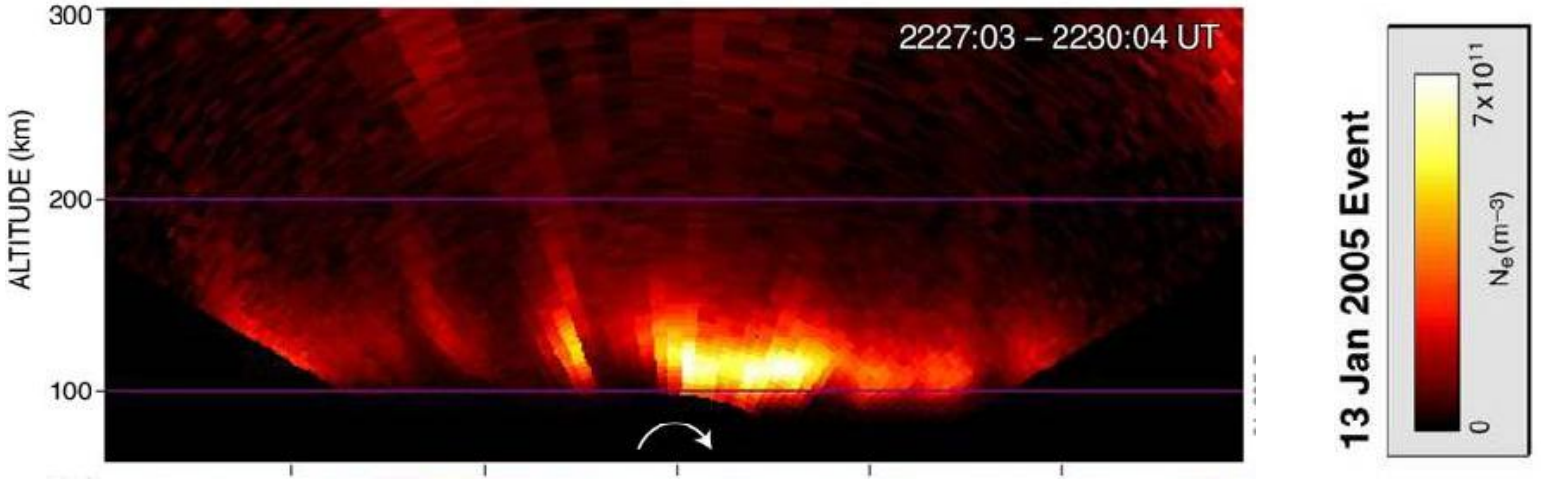
SSUSI Auroral Data

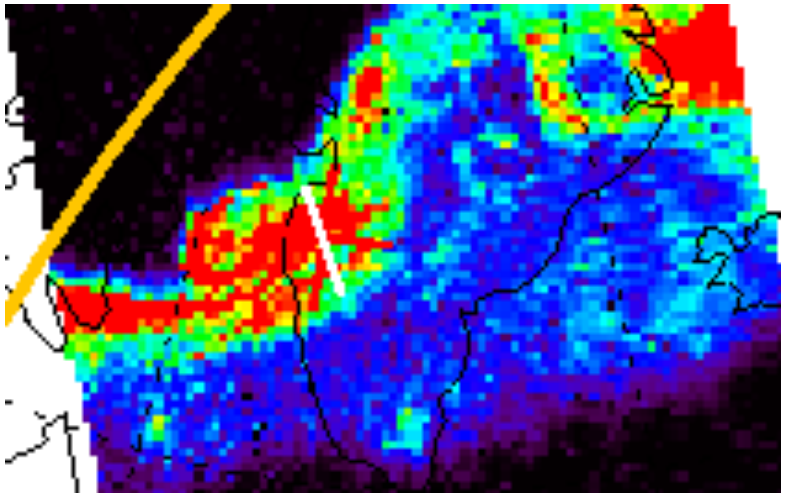
- Auroral data
  - E0, Q, HmE, NmE, HP, equatorward/poleward boundaries, field line mapping, auroral arc identification, proton aurora
- Near real-time (2-3 hour delay)
- How to get the data?
  - ssusi.jhuapl.edu (APL website)
  - NASA SPDF
- If Questions
  - Larry.paxton@jhuapl.edu (PI of GUVI and SSUSI)
    yongliang.zhang@jhuapl.edu

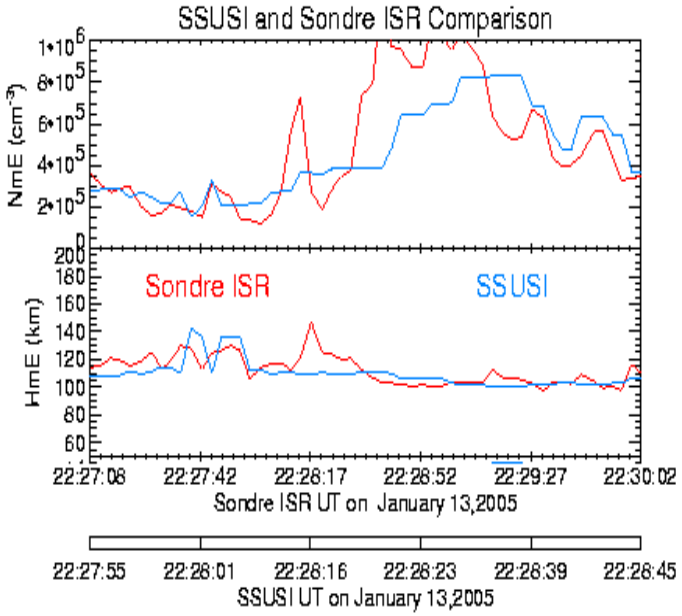
Thanks

Validation of FUV based HmE and NmE using radar data

Sondrestrom Incoherent Scattering Radar (ISR), Jan 13, 2005







Assimilating Auroral NmE in IRI

Plasma continuity equation

$$\frac{\partial N_e}{\partial t} + \nabla \bullet (N_e \vec{V}_e) = P_{euv} + P_e - \alpha N_e^2$$

In ionosphere E-region (local equilibrium)

$$\alpha N_e^2 = P_{euv} + P_e$$

Assumption

$$\alpha (N_e^{euv})^2 = P_{euv} \qquad \alpha (N_e^{e})^2 = P_e$$

Assimilation Equation

$$N_e = \sqrt{(N_e^{euv})^2 + (N_e^{e})^2}$$