Determining Auroral Oval Boundaries Based on Global FUV Images and Aurora Model

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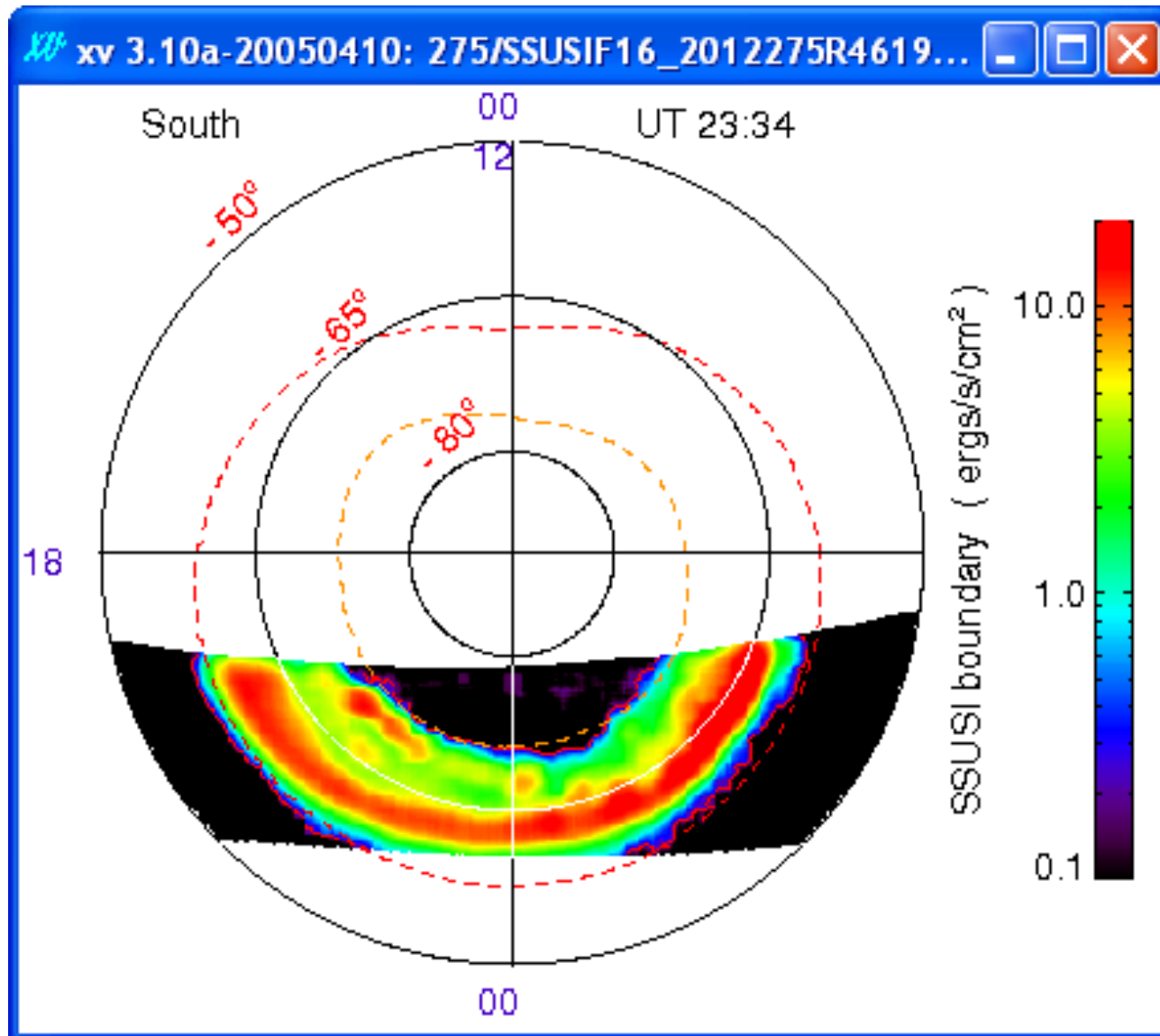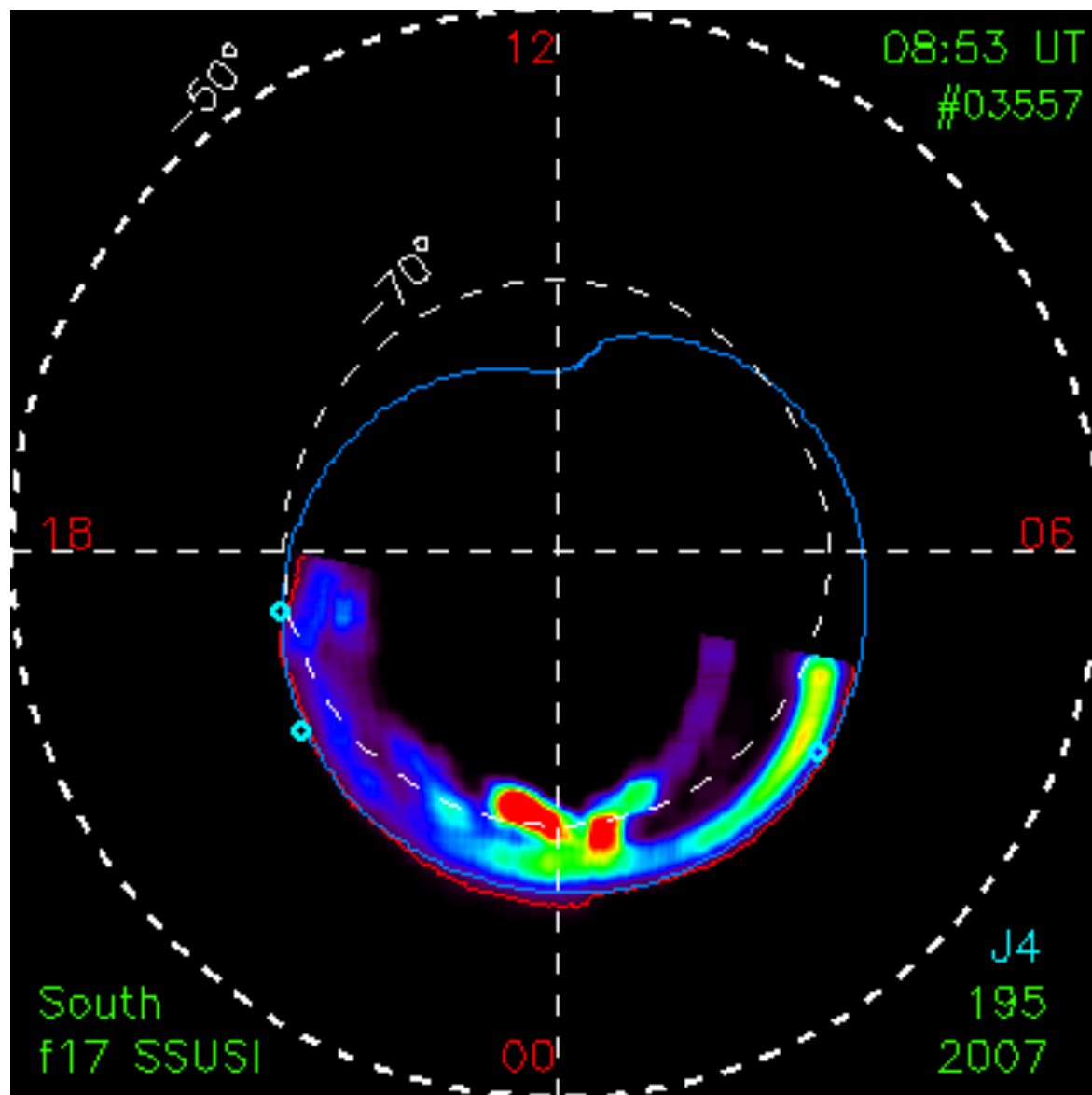
[1]Johns Hopkins University Applied Physics Laboratory

[2]NASA & George Mason University

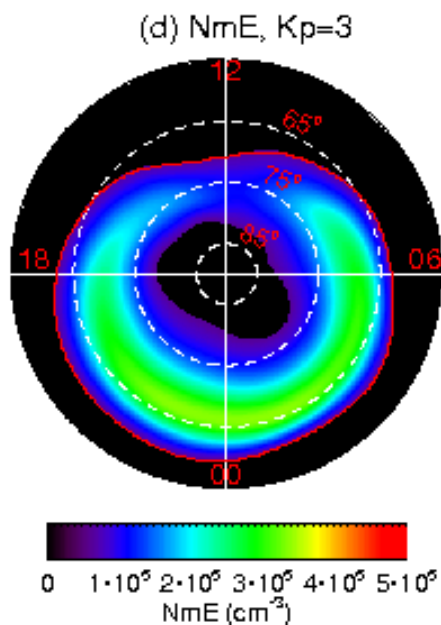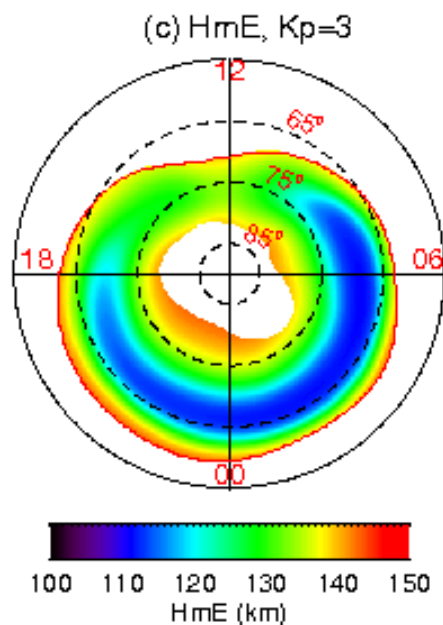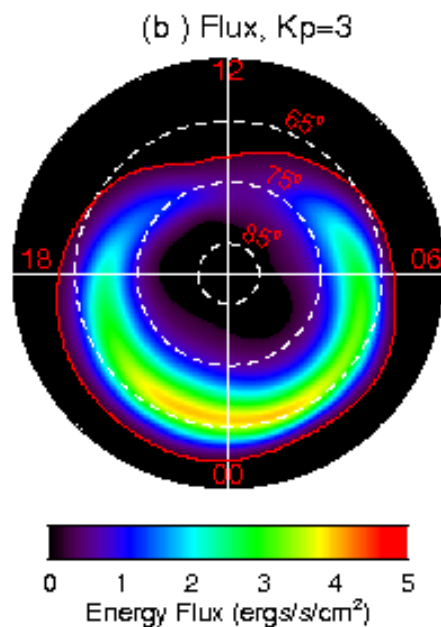# Definition and types of auroral boundaries

- Definition:
  - Boundaries at a fixed electron energy flux (0.2 ergs/s/cm2)
- Types:
  - Global (swath) equatorward boundaries
  - Global (swath) poleward boundaries

An example of boundaries

Validation

(a) Eo, Kp=3

(b) Flux, Kp=3

Mean Energy (keV)

Energy Flux (ergs/s/cm²)

(c) HmE, Kp=3

(d) NmE, Kp=3

HmE (km)

NmE (cm⁻³)
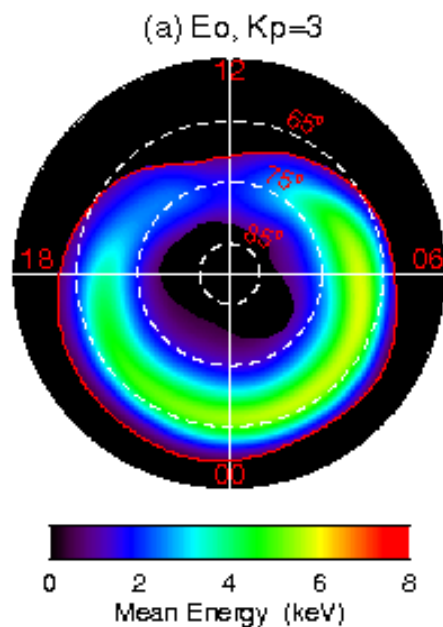
Outputs of GUVI
auroral model

How was the GUVI auroral model developed?

FUV spectra observed by TIMED/GUVI

(along pixel:12) 2008 DOY:099 Orbit:34298

Global FUV auroral images and products: TIMED/GUVI
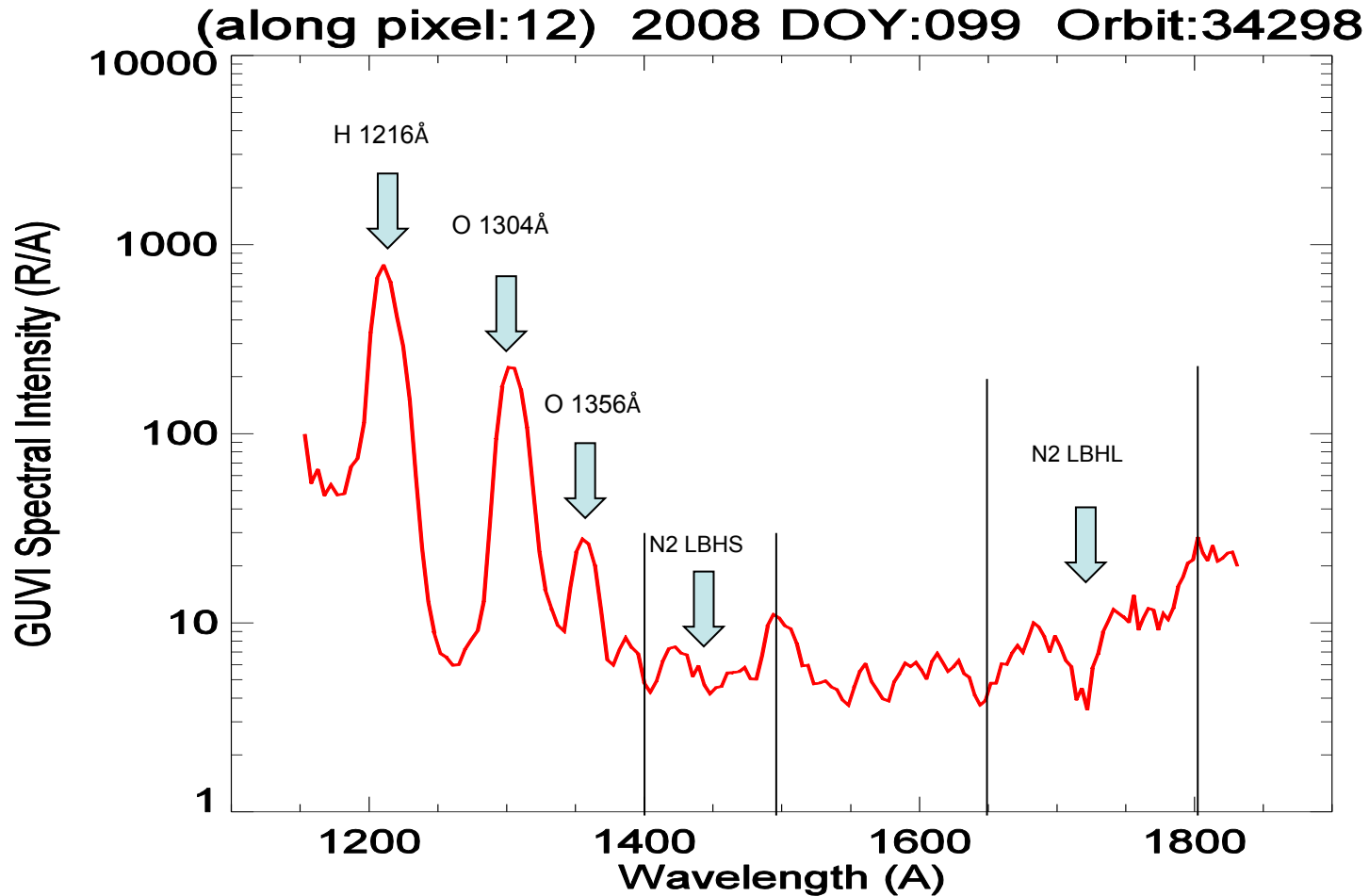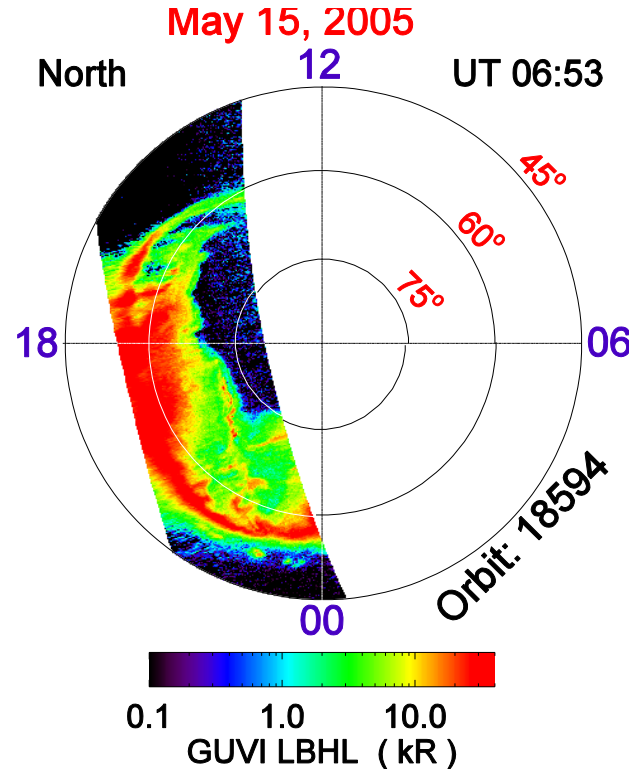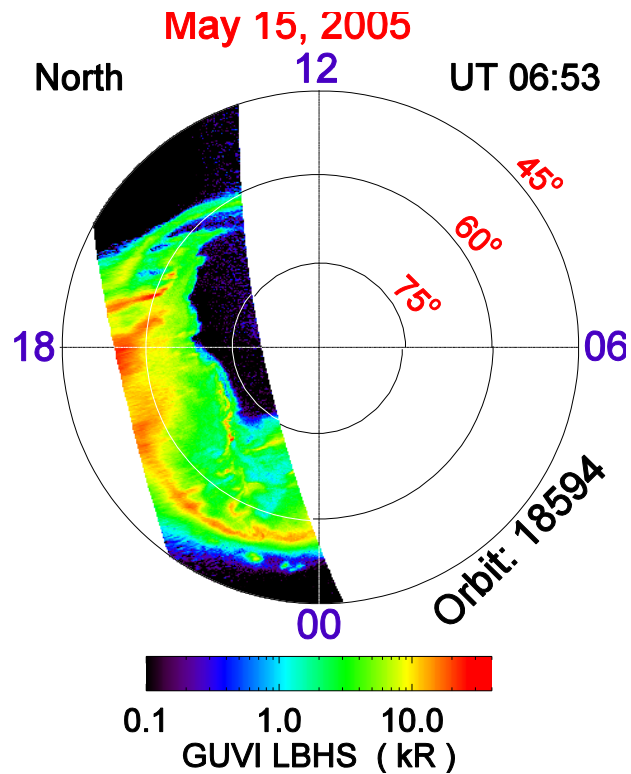

May 15, 2005
North
UT 06:53
12
45°
60°
75°
18
06
00
Orbit: 18594

0.1   1.0   10.0
GUVI LBHS (kR)

May 15, 2005
North
UT 06:53
12
45°
60°
75°
18
06
00
Orbit: 18594

0.1   1.0   10.0
GUVI LBHL (kR)

May 15, 2005

North UT 06:53

Orbit: 18594

GUVI Flux (ergs/s/cm^2)

0.1   1.0   10.0   100.0

May 15, 2005

North UT 06:53

Orbit: 18594

GUVI E0 (keV)

1   10
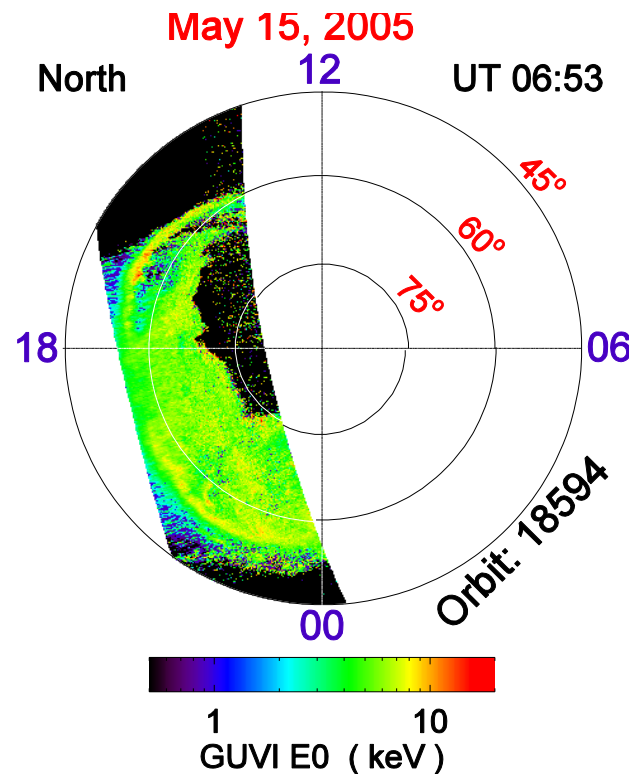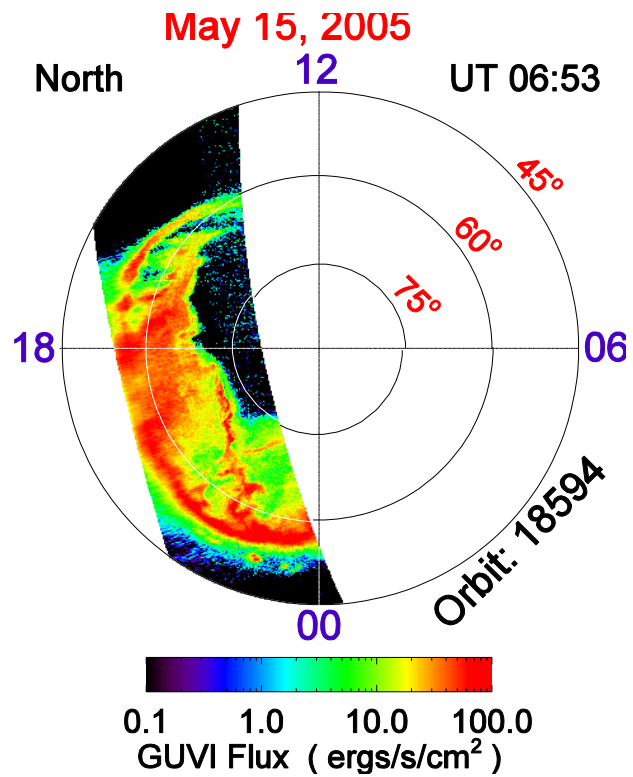
Auroral NmE and HmE too

FUV based auroral model (Kp dependent)

Flux (ergs/s/cm^2)

0.1   1.0   10.0

(a) Kp: 0.0 -1.5   (b) Kp: 1.5 -3.0   (c) Kp: 3.0 -4.5

50°   65°

(d) Kp: 4.5 -6.0   (e) Kp: 6.0 -8.0   (f) Kp: 8.0 -10.
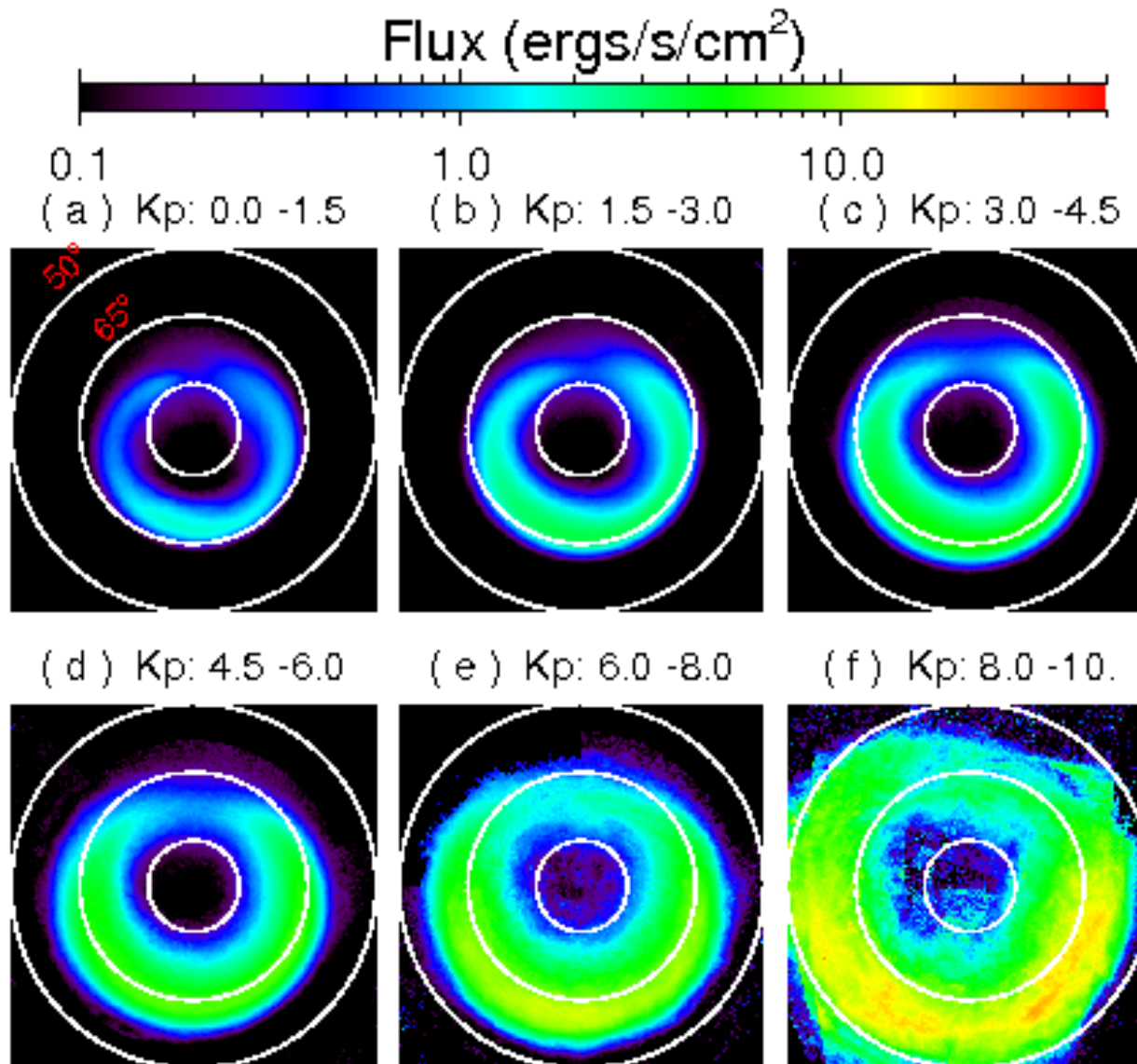
Kp dependence of electron mean energy

Mean Energy (keV)

0   2   4   6   8

(a) Kp: 0.0 -1.5   (b) Kp: 1.5 -3.0   (c) Kp: 3.0 -4.5

(d) Kp: 4.5 -6.0   (e) Kp: 6.0 -8.0   (f) Kp: 8.0 -10.
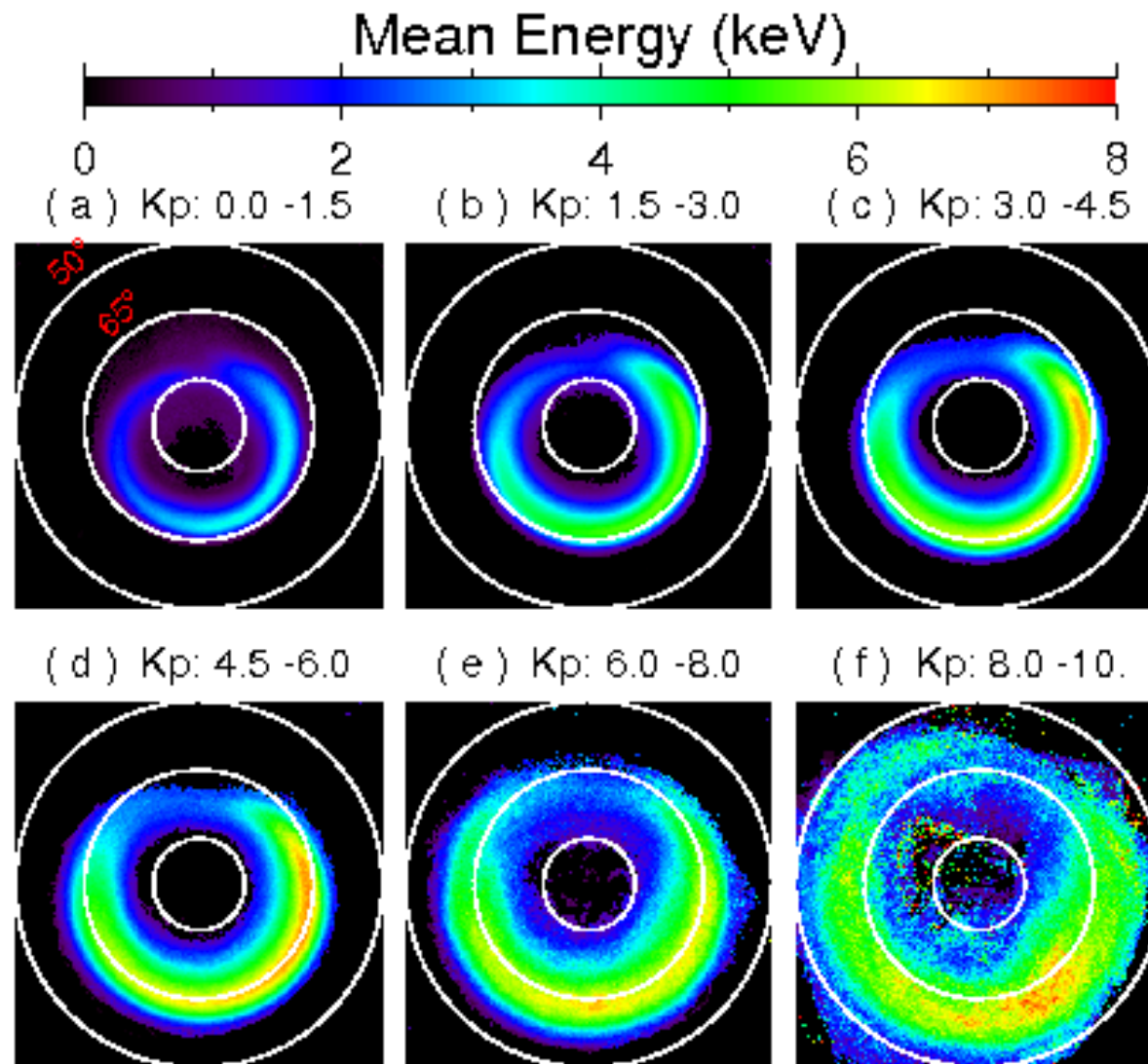
Epstein Function fits the data well.

Kp: 0.0 - 1.5   MLT: 01:00 - 01:30

$F = A* \exp[(X-B)/C] / \{ 1 + \exp[(x-B)/D] \}^2$

X = 90 - Mlat

A = 4.935

B = 23.76

C = 2.770

D = 1.390

Electron Flux (ergs/s/cm^2)

90. - Magnetic Latitude
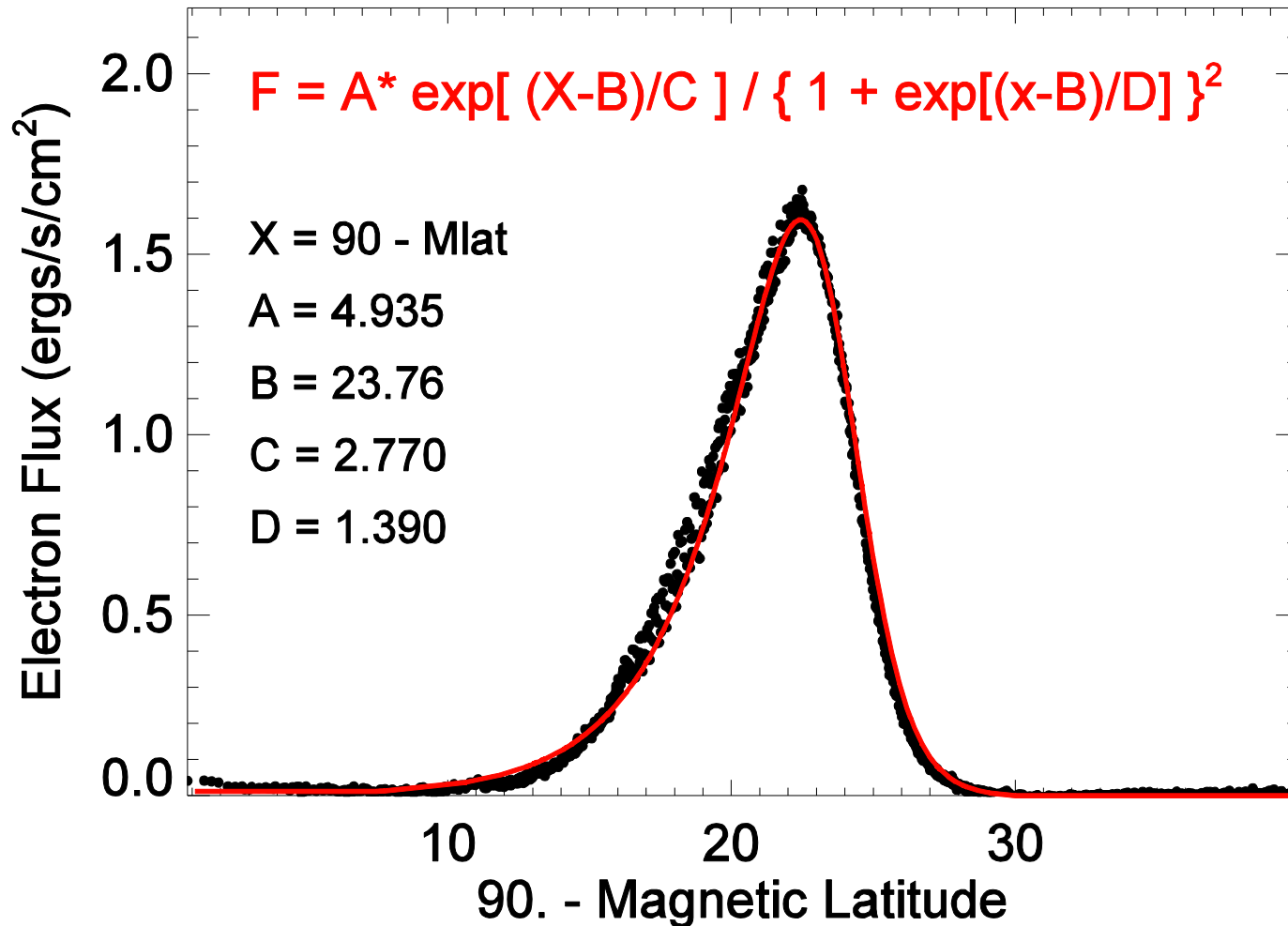
How do we know that the behavior of the model matches reality?
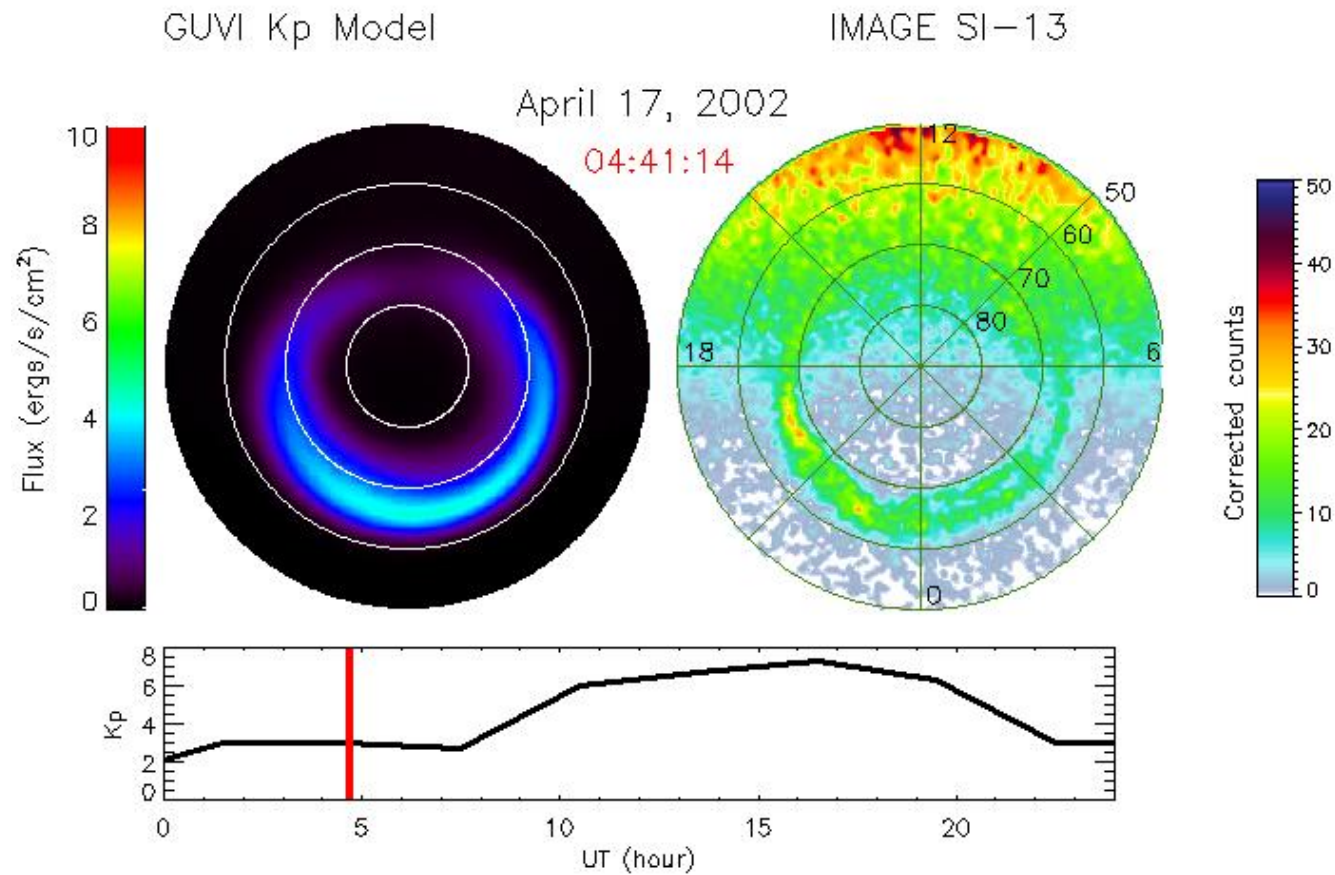
GUVI Kp Model

IMAGE SI-13

April 17, 2002

14:31:20

Flux (ergs/s/cm²)

Corrected counts

Kp

UT (hour)
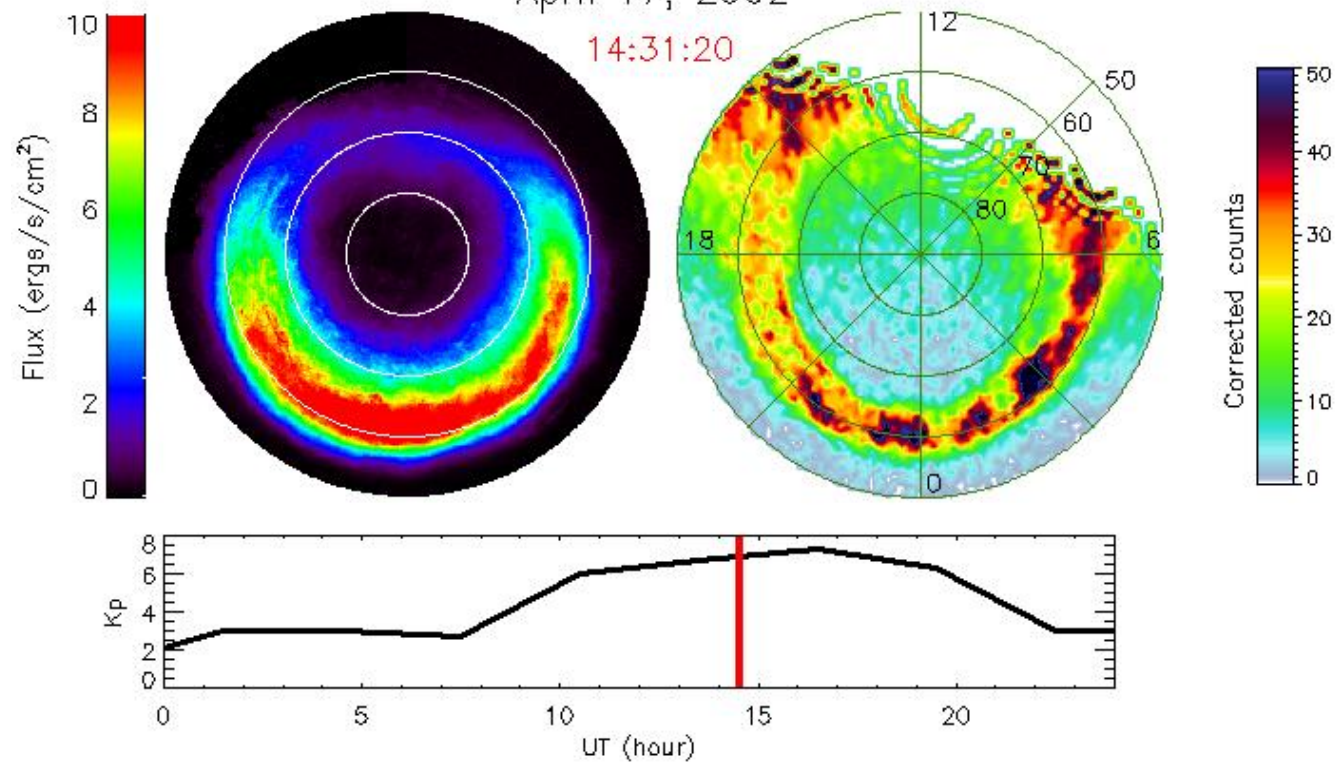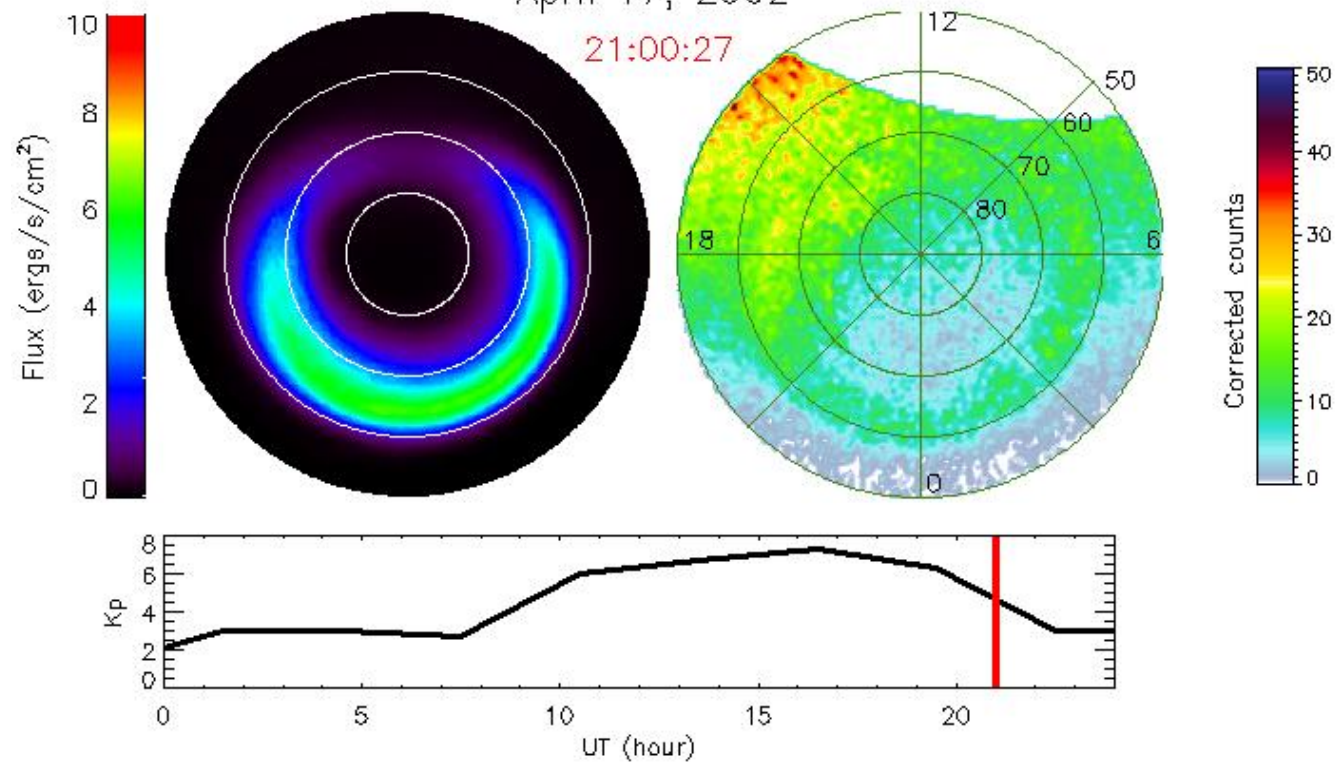
GUVI Kp Model

IMAGE SI-13

April 17, 2002

21:00:27

Flux (ergs/s/cm²)

Corrected counts

Kp

UT (hour)

Assimilating modeled and/or measured 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)

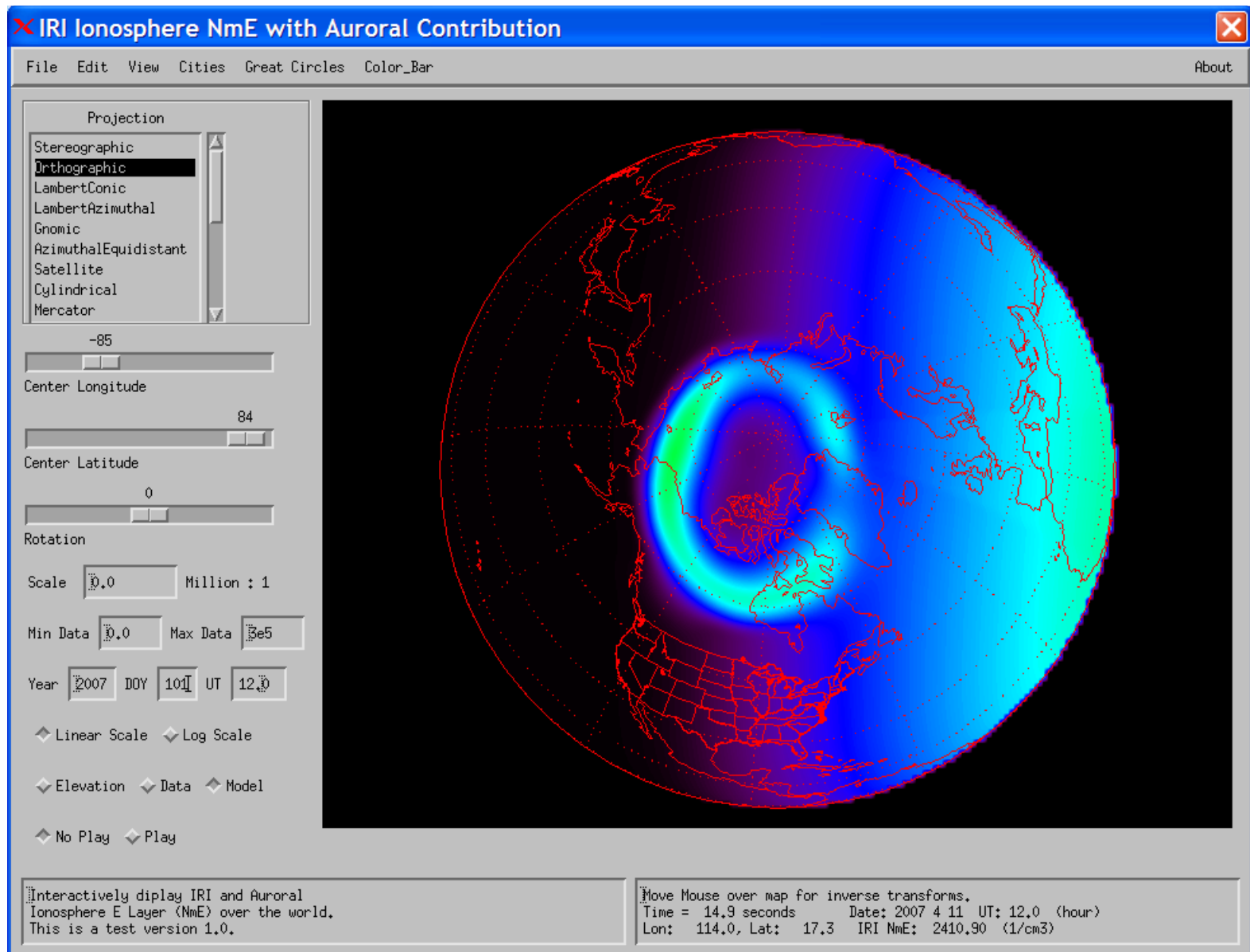$$\alpha N_e^2 = P_{euv} + P_e$$

Assumption

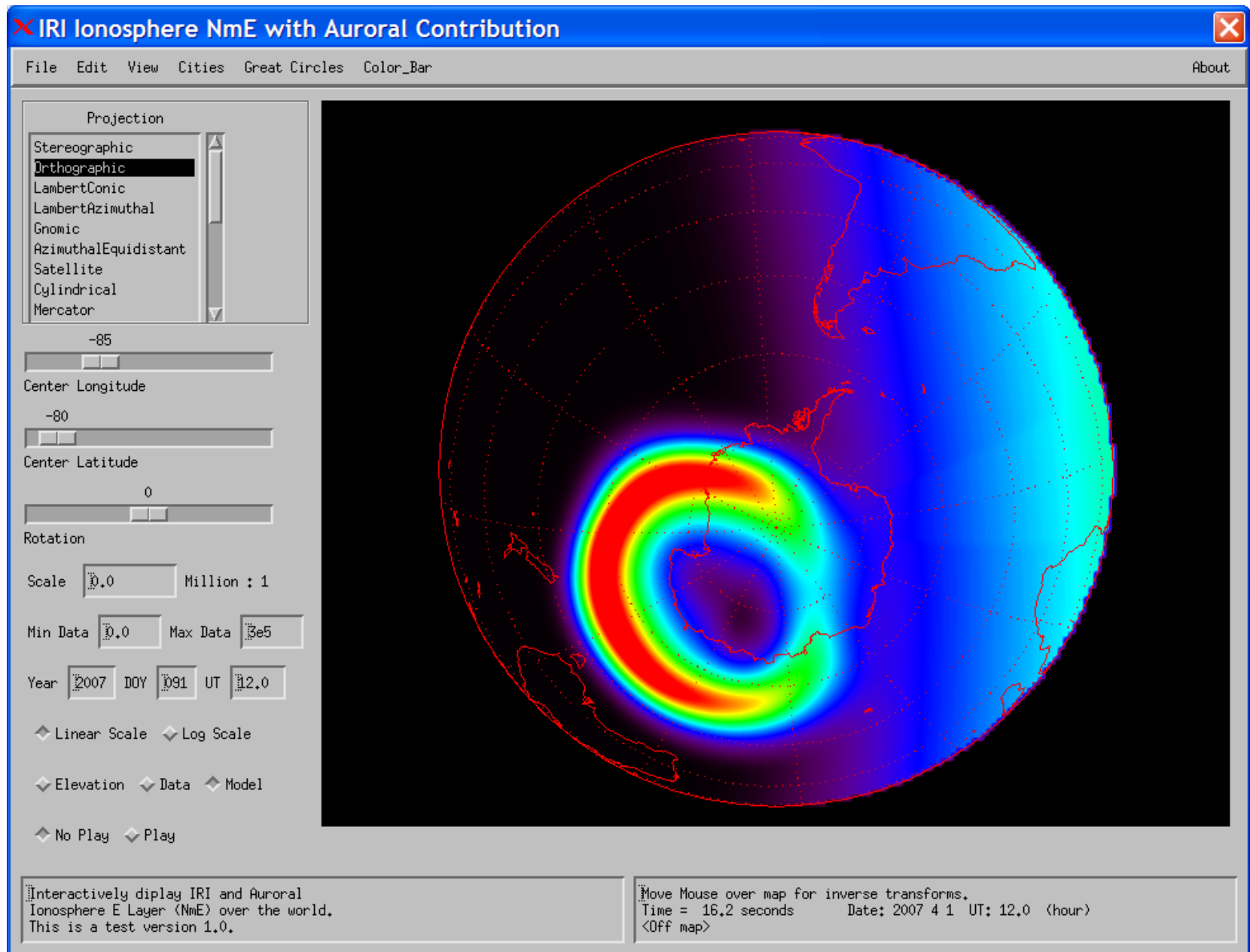$$\alpha (N_e^{euv})^2 = P_{euv} \qquad \alpha (N_e^e)^2 = P_e$$

Assimilation Equation

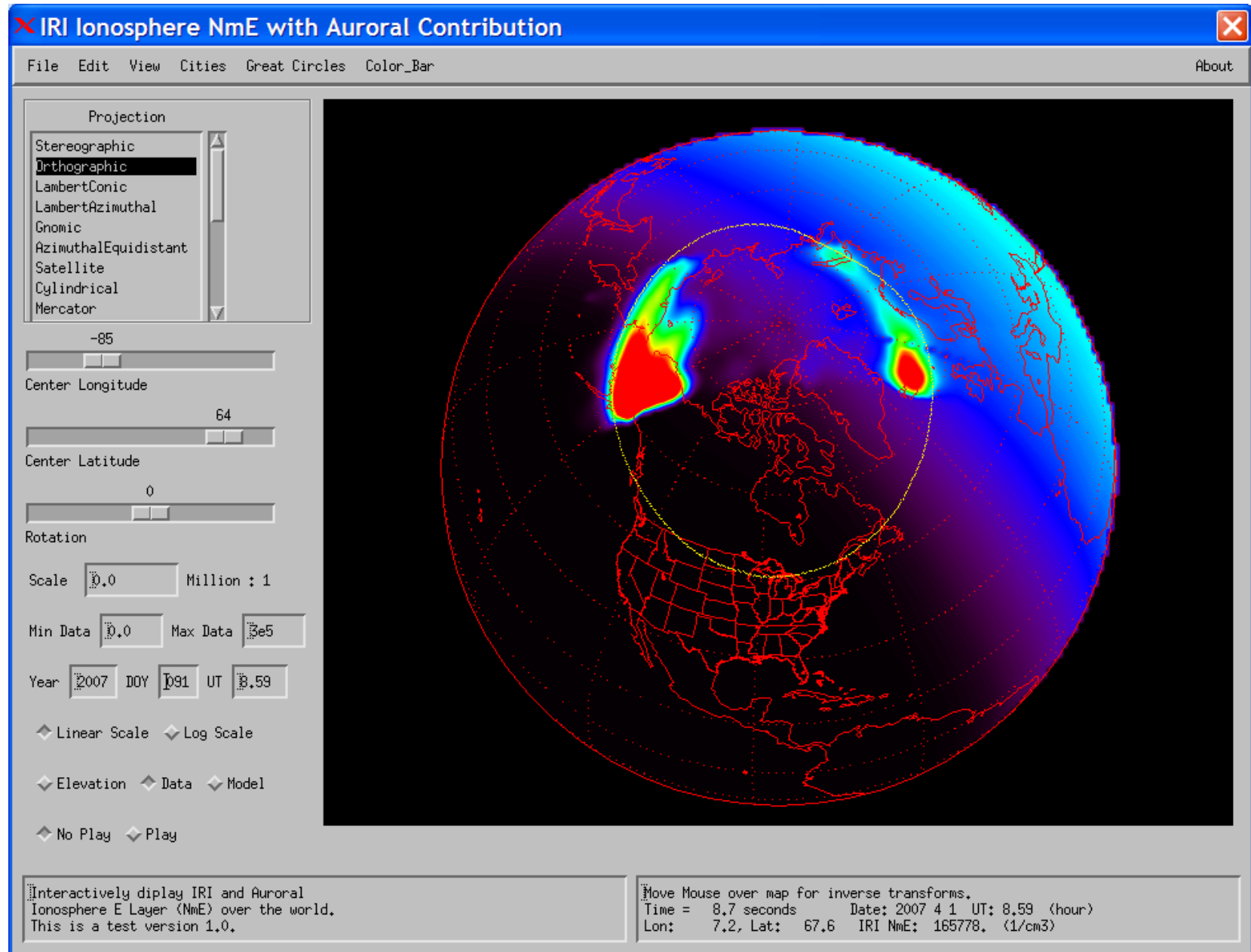$$N_e = \sqrt{(N_e^{euv})^2 + (N_e^e)^2}$$

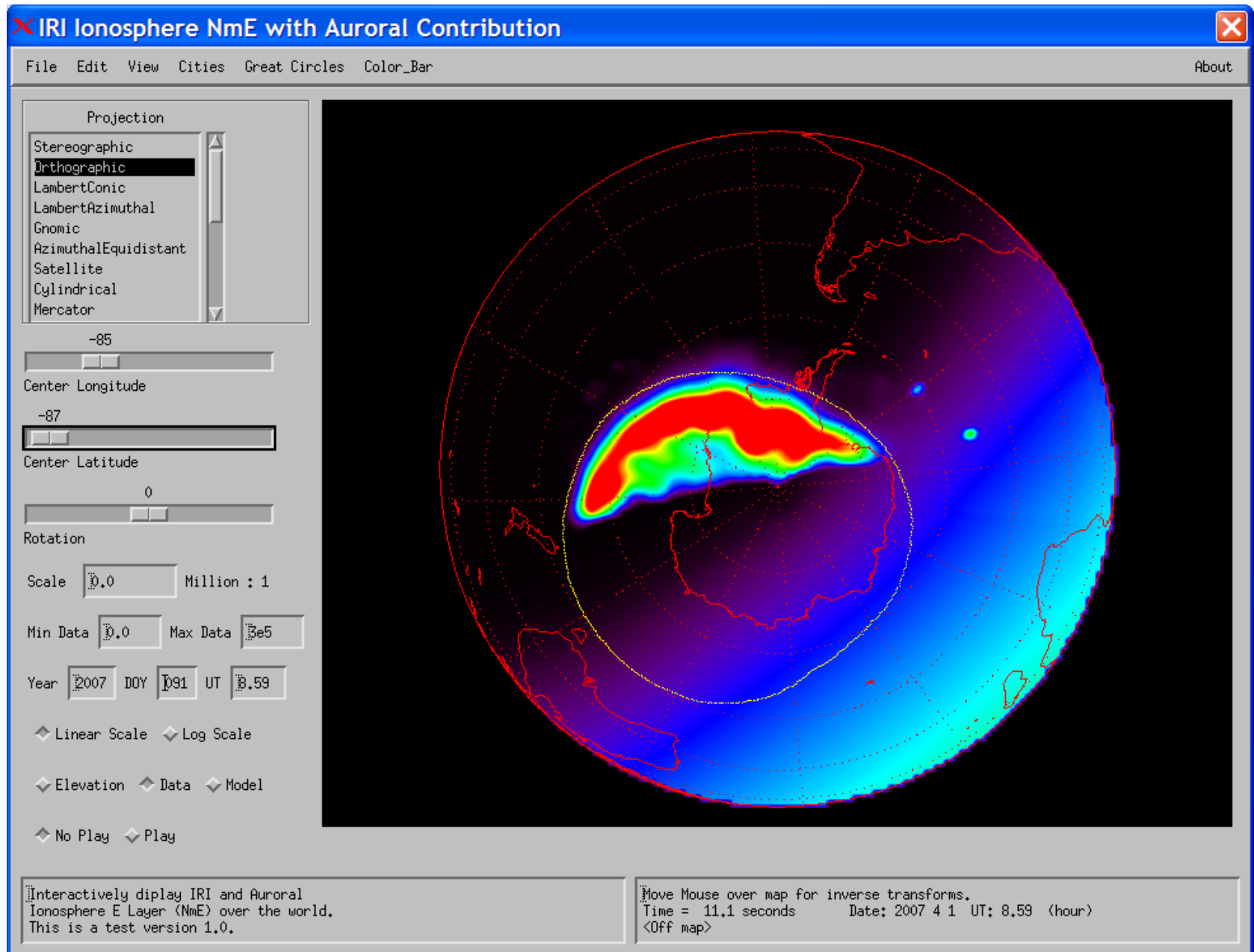# Assimilation of model NmE in IRI (Quiet time Kp =0.7)

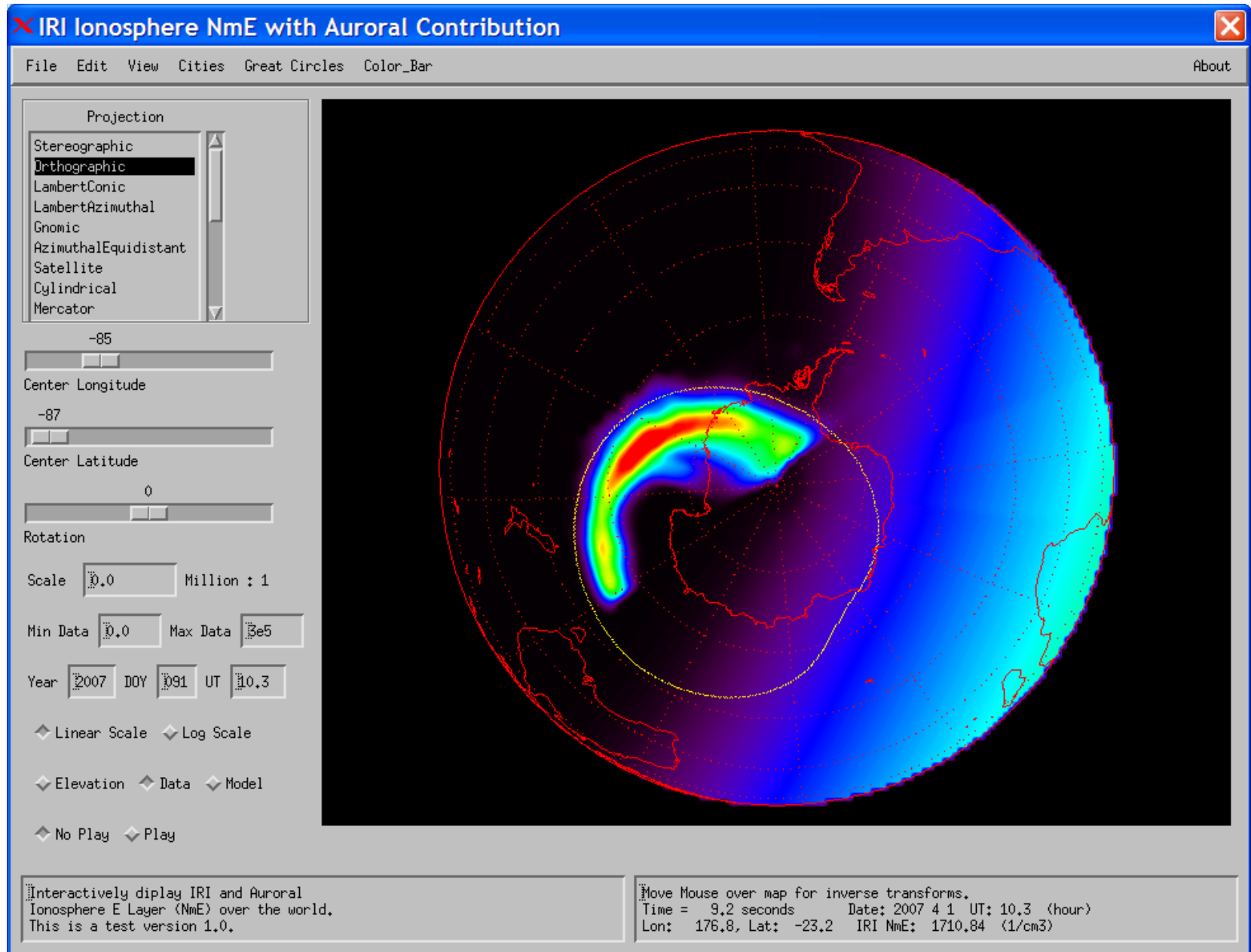# Assimilation of model NmE in IRI (Moderate Active time Kp =4.0)

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

SSUSI data in southern hemisphere

SSUSI data (next orbit, southern hemisphere)

Summary

- GUVI aurora (Kp dependent) model based equatorward boundary has been included in IRI 2012.

- Near real-time SSUSI boundaries are being added in IRI.

- A solar wind driven auroral model is nearly completed.

Thanks!