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

Yongliang Zhang\textsuperscript{1}, Larry J. Paxton\textsuperscript{1}, and Dieter Bilitza\textsuperscript{2}

\textsuperscript{1}Johns Hopkins University Applied Physics Laboratory
\textsuperscript{2}NASA & George Mason University

December 2, 2012, CEDAR-GEM Mini Workshop
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
Outputs of GUVI auroral model
How was the GUVI auroral model developed?

FUV spectra observed by TIMED/GUVI

![Graph showing FUV spectra observed by TIMED/GUVI](image-url)
Global FUV auroral images and products: TIMED/GUVI
Auroral NmE and HmE too
FUV based auroral model (Kp dependent)
Kp dependence of electron mean energy
Epstein Function fits the data well.

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

- \( X = 90 - \text{Mlat} \)
- \( A = 4.935 \)
- \( B = 23.76 \)
- \( C = 2.770 \)
- \( D = 1.390 \)
How do we know that the behavior of the model matches reality?
Assimilating modeled and/or measured NmE in IRI

Plasma continuity equation

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

In ionosphere E-region (local equilibrium)

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

Assumption

\[
\alpha (N_{euv}^e)^2 = P_{euv} \quad \alpha (N_e^e)^2 = P_e
\]

Assimilation Equation

\[
N_e = \sqrt{(N_{euv}^e)^2 + (N_e^e)^2}
\]
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!