GUVI Observations of Dramatic Temperature and Composition Changes During the November 20-21 2003 Superstorm

Robert R Meier
E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375; 202-767-2773
(meier@uap2.nrl.navy.mil)
DJ Strickland, G. Crowley, AB Christensen, LJ Paxton, D Morrison

TIMED Science Team Meeting 15 March 2004
Limb Data Yield:

- \( \text{N}_2, \text{O}, \& \text{O}_2 \) vs altitude
- Temperature vs altitude
- Inferred solar EUV
- Altitude-dependent response to geomagnetic and solar forcing

GUVI observes:

- 32 tangent altitudes
- 520 – 110 km
- 14 horizontal pixels
GUVI Converts Spectra into Five “Colors”

**GUVI Color Tables**

- HI Lyman $\alpha$
  - 119.3 – 123.7
- OI 130.4 nm
  - 128.4 – 131.8
- OI 135.6 nm
  - 134.2 – 137.7
- $N_2$ LBH short
  - 141.0 – 152.8
- $N_2$ LBH long
  - 167.1 – 181.2

**Photoelectron-excited Dayglow**

![Graph showing spectral radiance with regions for H, O, O, N$_2$, N$_2$]
Limb Data Are Inverted for SZA < 60° (β < 40°)
Limb Image Constructed from Multiple Limb Scans, Rev 1471 on Feb 17, 2002

- Appleton Anomaly
- Aurora
- Dayglow
- Stars
- SAA
Limb Image Constructed from Multiple Limb Scans, Rev 10566 on Nov 20, 2003

- **Aurora**
- **Dayglow**
- **Stars**
Data Products from Limb Retrievals

GUVI to NRLMSIS ratio near 200 km:

\[
\frac{X_{\text{GUVI}}}{X_{\text{MSIS}}}
\]

Nov 6 – Dec 16, 2003

Inversions limited to: SZA < 60° |Latitude| < 60°

Nov 20 Storm
Nov. 2003 Super Storm (11/20/03- Day 324)

- Note: Time goes from right to left
- Low O/N₂ air reaches equator during storm
- High temperature tracks the low O/N₂
- Temperatures measured one orbit after disk orbit
Nov. 2003 Super Storm (11/21/03 - Day 325)

- **Note:** Time goes from right to left
- Low O/N₂ air at equator moves back up in North
- Storm perturbed air returns to "normal" after ~ 13 UT
- High temperature tracks the low O/N₂

\[ K_p: 2 \quad 3 \quad 3 \quad 3 \quad 4 \quad 6 \quad 6 \quad 7 \]
Comparison of GUVI O/N$_2$ with TIME-GCM

Initial Results for Day 324 (11/20/2003)

GUVI O/N$_2$
Day 324 (11/20) 2003

\[ K_p: 7 \quad 9 \quad 8 \quad 7 \quad 6 \quad 3 \quad 1 \]

ASPN TIME-GCM Model
TIME-GCM FIXED LOCAL TIME Col O/N$_2$
SLT = 13:00 ZP = 2:00 DOY = 324
Comparison of GUVI $T_{exo}$ with TIME-GCM
Initial Results for Day 324 (11/20/2003)

**GUVI $T_{exo}$**

**ASPEN TIME-GCM Model**

$K_p$: 7 9 8 7 7 6 3 1
Altitude Profiles of Composition and Temperature from Limb data: 2003324
Altitude Profiles of Composition and Temperature from Limb data: 2003325

Rev 10572

O/N₂

N₂ Density

Temperature

T_exo

North

South
Altitude Profiles of Composition and Temperature from Limb data: 2003325
Summary

- Huge changes in atmospheric composition and temperature during the Nov. 20-21, 2003 storm
- Low O/N₂ invariably accompanied by high temperature
- Initial model results qualitatively explain the disturbances
  - Model O/N₂ and temperature changes consistent with observations
  - Model recovers too rapidly