Observation of Atmospheric Composition Effects in an SPE with OSIRIS on Odin

ISAS, University of Saskatchewan
Saskatoon, SK
Canada
Calculated Ionization Rates from GOES data and GEANT4 model

- Monte Carlo model
- Considering the Earth magnetic field (that is very variable, particularly during SPE)
- Electrons are not considered (<10-30% effect, depends on the type of SPE)

Data courtesy M.-B. Kallenrode

Ozone Depletion during Solar Proton Storm October 2003

Anti-Correlation of Proton Flux and $O_3$ Change

- $O_3$ Change [%]
- 15-40 MeV
- GOES proton flux
- Meas. $>60^\circ$ magn. lat., 54.4 km
- Corresponding model, 54.4 km

Dates:
- 24 Oct.
- 1 Nov.
- 9 Nov.
- 17 Nov.
- 25 Nov.
Twilight and nighttime structures seen in OH and O\textsubscript{2} IR Atmospheric band emissions. Orbit 191F on April 29, 2002.
Mesospheric effects of Solar Storms
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Comparison of 61 km Altitude

- First Orbit During Storm
- Last Orbit During Storm
- First Baseline Orbit

Angle Along Satellite Track (degrees) vs. Volume Emission Rate
Figure 2. Single altitude VER cross sections that compare the results from three in-SPE orbits with the baseline orbit, 31/10/2003. The cross sectional slices are from 65 km and 55 km for panels a) and b) respectively.
Ozone Depletion during Solar Proton Storm October 2003

Observed interhemispheric differences due to the lower ambient HOₓ background!
(ACE-FTS H$_2$O + Model) vs (OSIRIS OH)

- ‘Validate’ OSIRIS OH
- Use ACE-FTS H$_2$O with Model
- Latitude within 2°
- Local Time within 30 minutes

![Graph showing OH density distribution and comparison of ACE-FTS H$_2$O and OSIRIS OH data.](GRL 2006)
Volume Emission Rate daily maps - 2002/01/02

(Ascending Node data)

- 77 km - V.E.R. distribution
- 80 km - V.E.R. distribution

- 77 km - Zonal Average
- 80 km - Zonal Average

- 77 km - Deviation from the mean (%)
- 80 km - Deviation from the mean (%)

---------PARTICLE EVENT---------

<table>
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<th>Start (Day/UT)</th>
<th>Maximum (Day/UT)</th>
<th>Proton Flux (pfu @ &gt;10 MeV)</th>
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<td>Sep 24/1215</td>
<td>Sep 25/2235</td>
<td>12900 ASTRONOMY MODE</td>
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<td>Nov 04/1705</td>
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2002

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2003

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<td>Date 2</td>
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Note: Proton fluxes are integral 5-minute averages for energies > 10 MeV, given in Particle Flux Units (pfu), measured by GOES spacecraft at Geosynchronous orbit: 1 pfu = 1 p/sq. cm-s-sr.
The observed orbit average OH Meinel band emission

**Observed Emission, Day 13 (May 13-14)**

![Graph showing observed emission over altitude and angle along satellite track.](image)
We have far more data than we can analyze in a reasonable time. The atmospheric change associated with auroral precipitation is now being detected through the nighttime [NO] profile. We can also see [NO] in the daytime and will shortly submit a paper on the day and night global [O] profile.