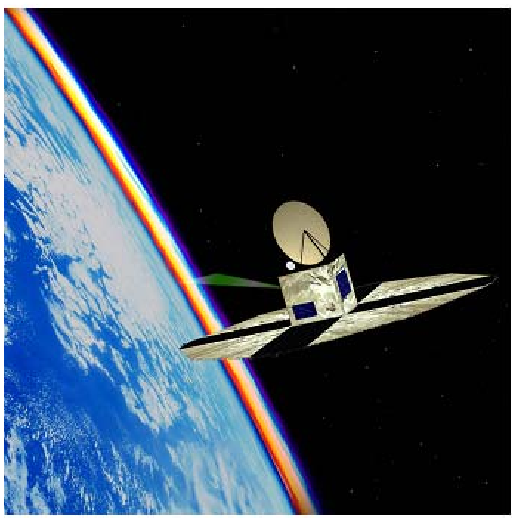
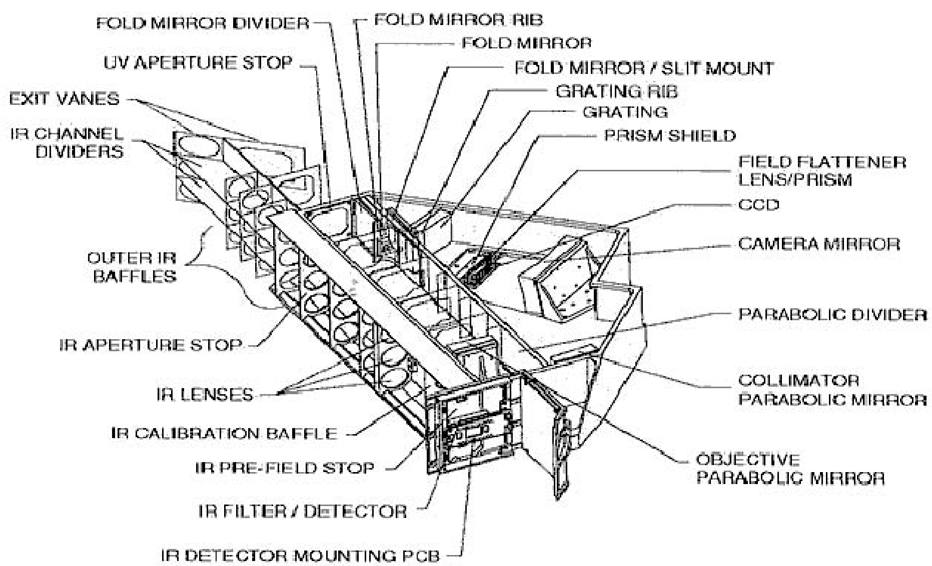
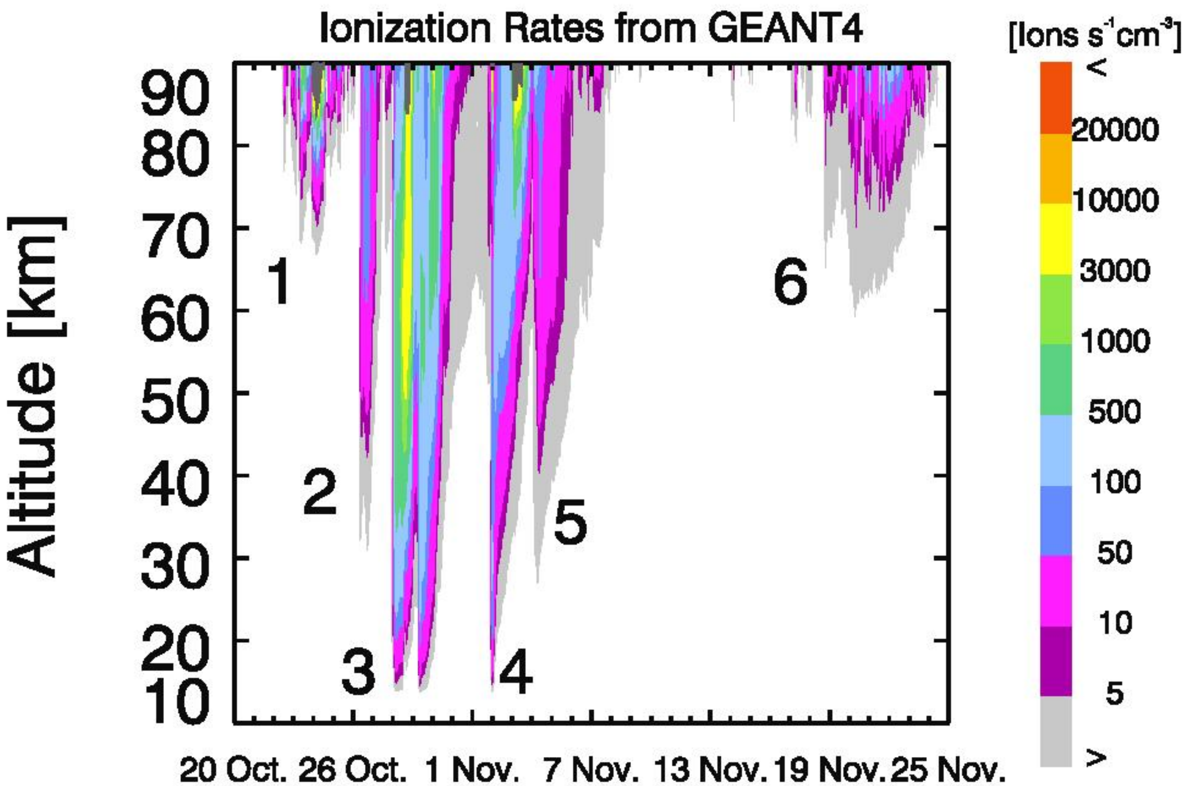
Observation of Atmospheric Composition Effects in an SPE with OSIRIS on Odin

E.J. Llewellyn, N.D. Lloyd, A.E. Bourassa,
D.A. Degenstein and R.L. Gattinger
ISAS, University of Saskatchewan
Saskatoon, SK
Canada





Calculated Ionization Rates from GOES data and GEANT4 model

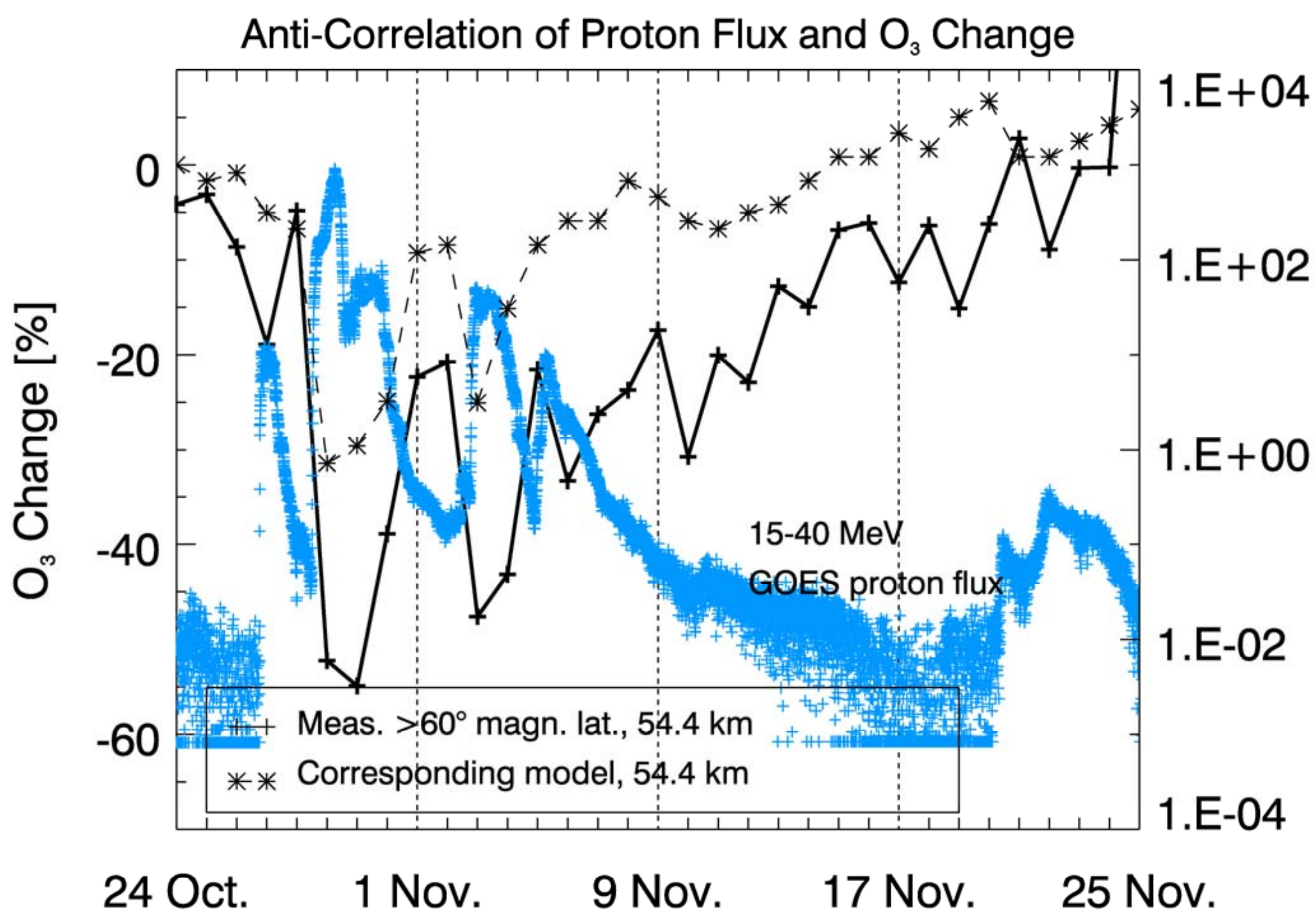


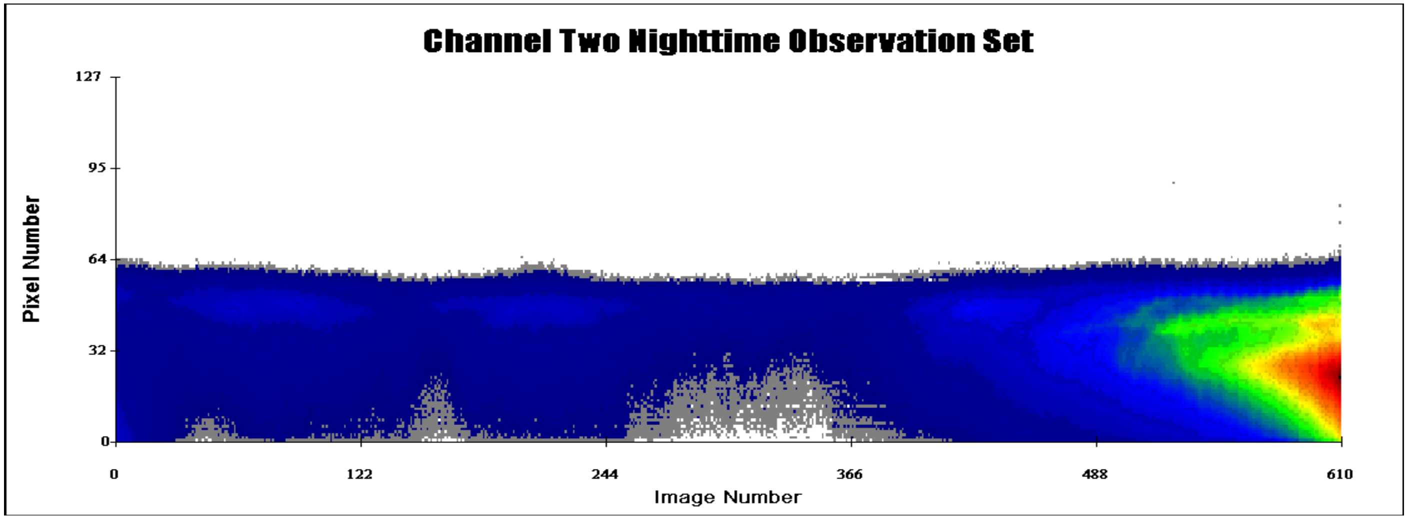
- Monte Carlo model
- Considering the Earth magnetic field (that is very variable, particularly during SPE)
- Electrons are not considered (<10-30% effect, depends on the type of SPE)

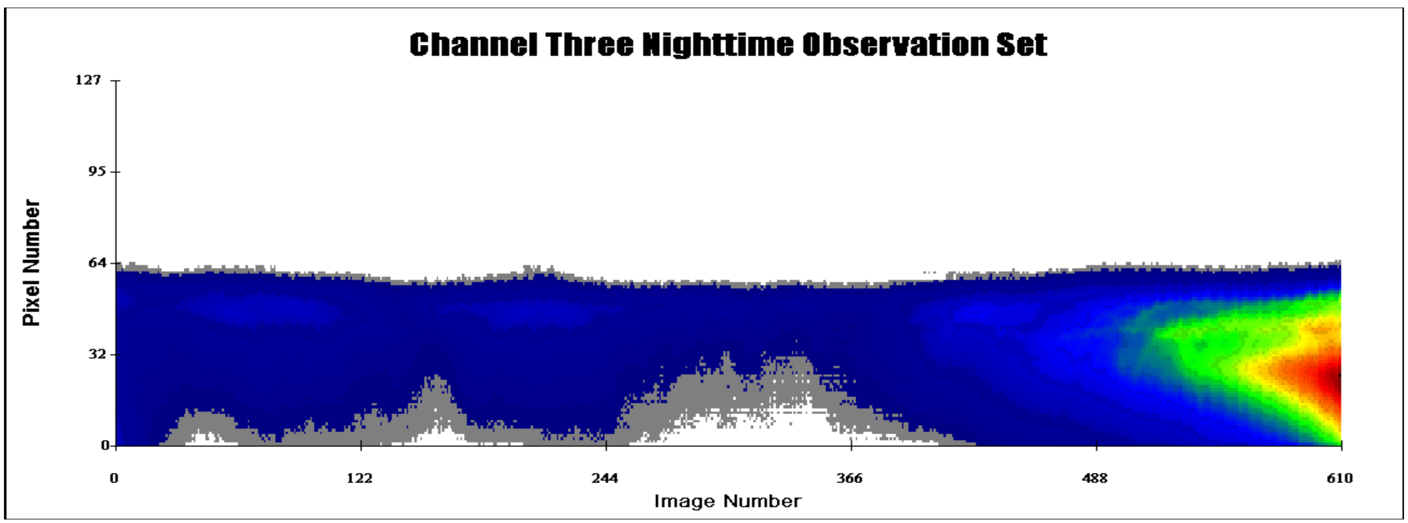
Data courtesy M.-B. Kallenrode

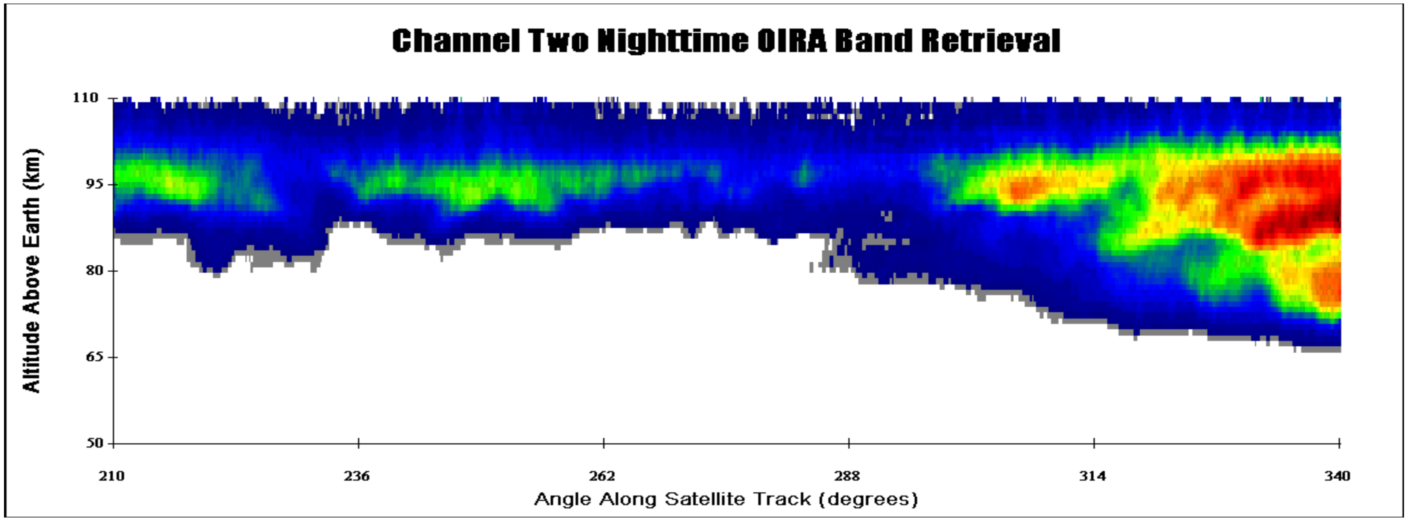
Agostinelli, S. et al.: GEANT4 – a simulation toolkit, Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Euqipment, 506(3), 250-303, 2003.

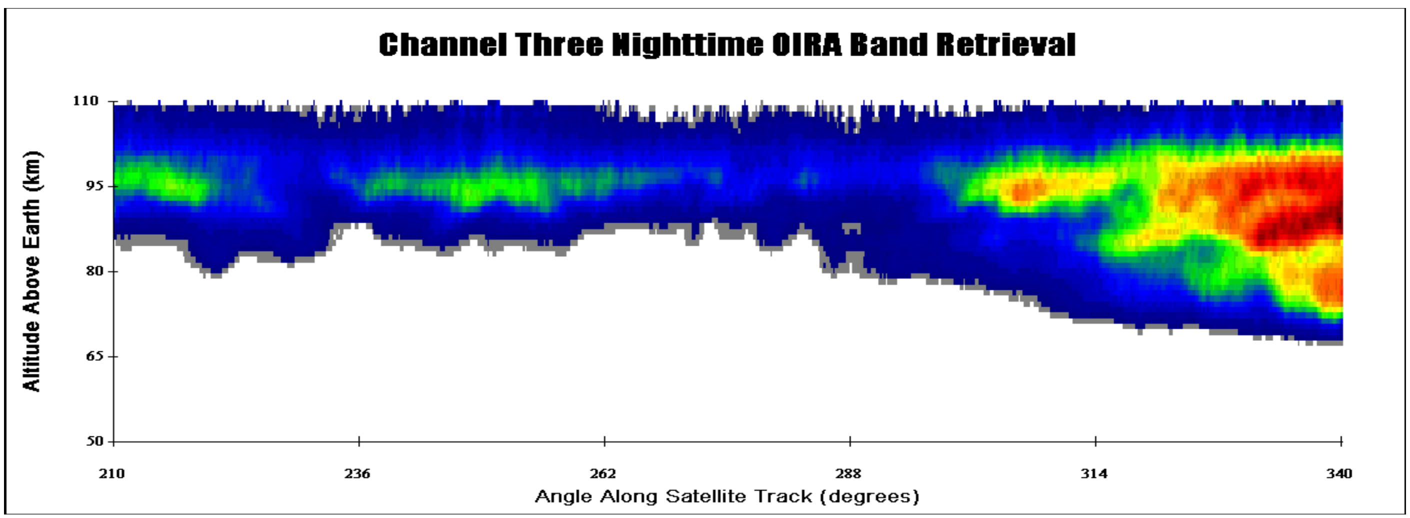
Ozone Depletion during Solar Proton Storm October 2003

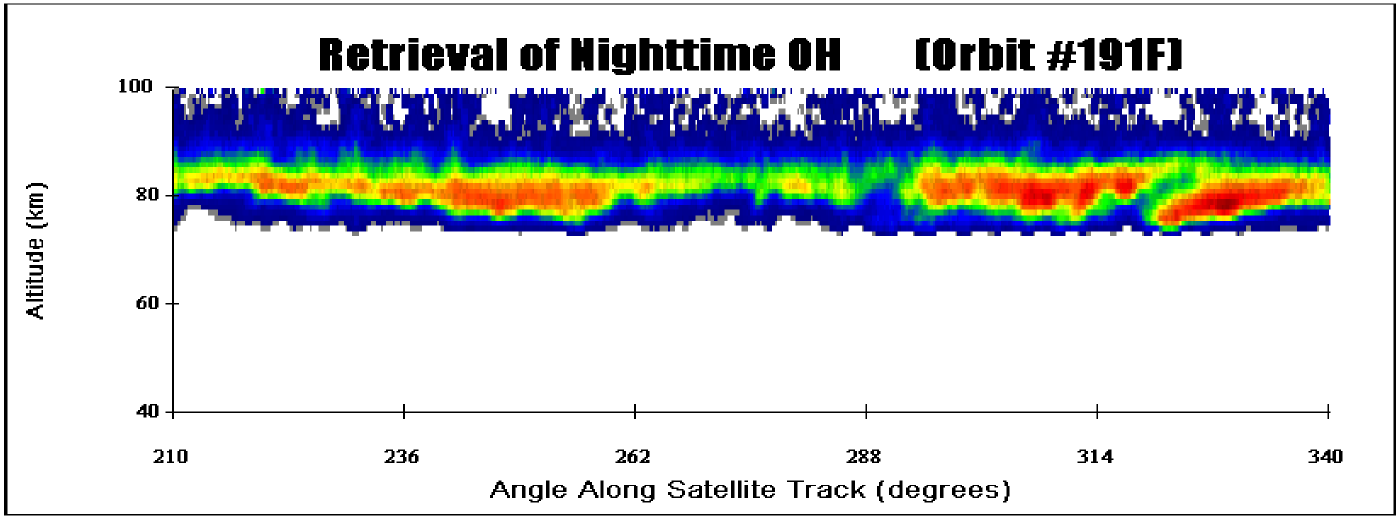


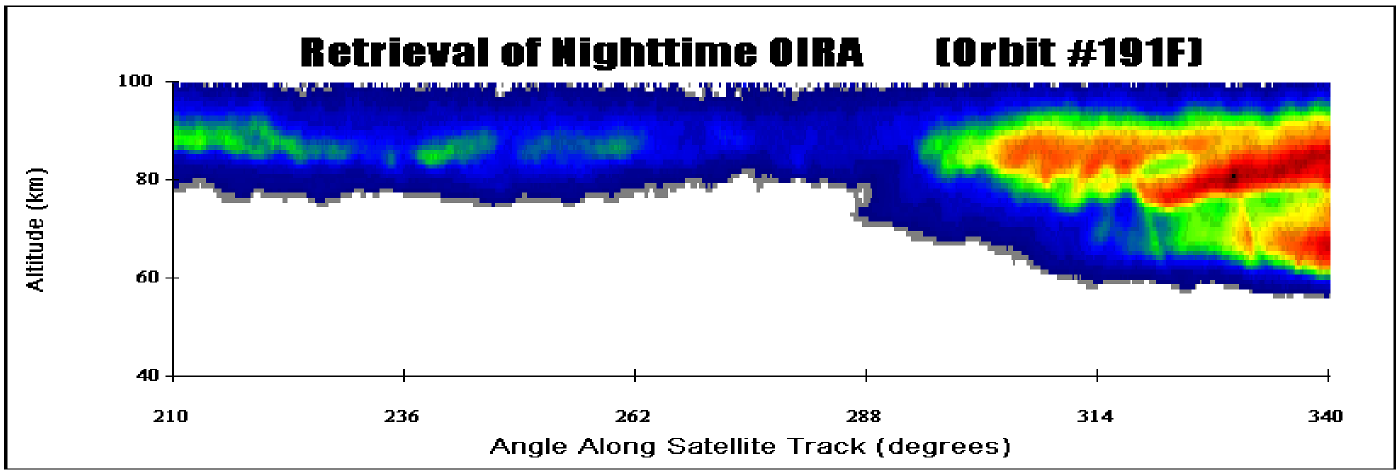

Channel Two Nighttime Observation Set
Pixel Number
127
95
64
32
0
0
122
244
366
488
610
Image Number


Channel Three Nighttime Observation Set
Pixel Number
127
95
64
32
0
0
122
244
366
488
610
Image Number


Channel Two Nighttime OIRA Band Retrieval
Altitude Above Earth (km)
110
95
80
65
50
210
236
262
288
314
340
Angle Along Satellite Track (degrees)

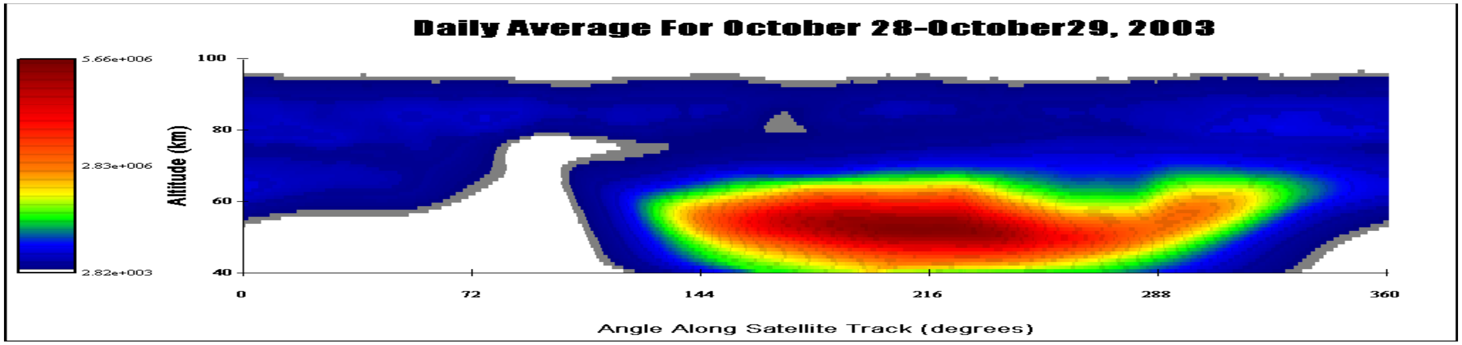

Channel Three Nighttime OIRA Band Retrieval
Altitude Above Earth (km)
110
95
80
65
50
210
236
262
288
314
340
Angle Along Satellite Track (degrees)

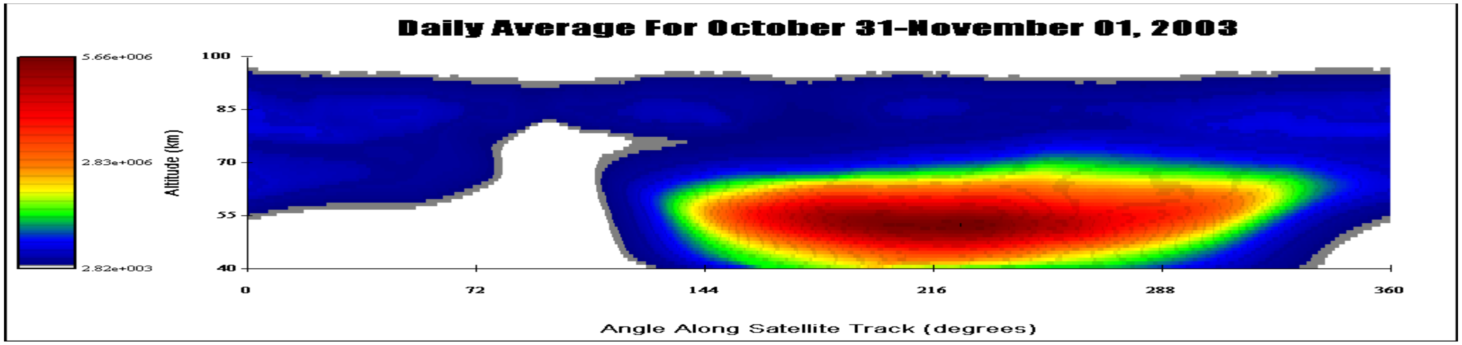




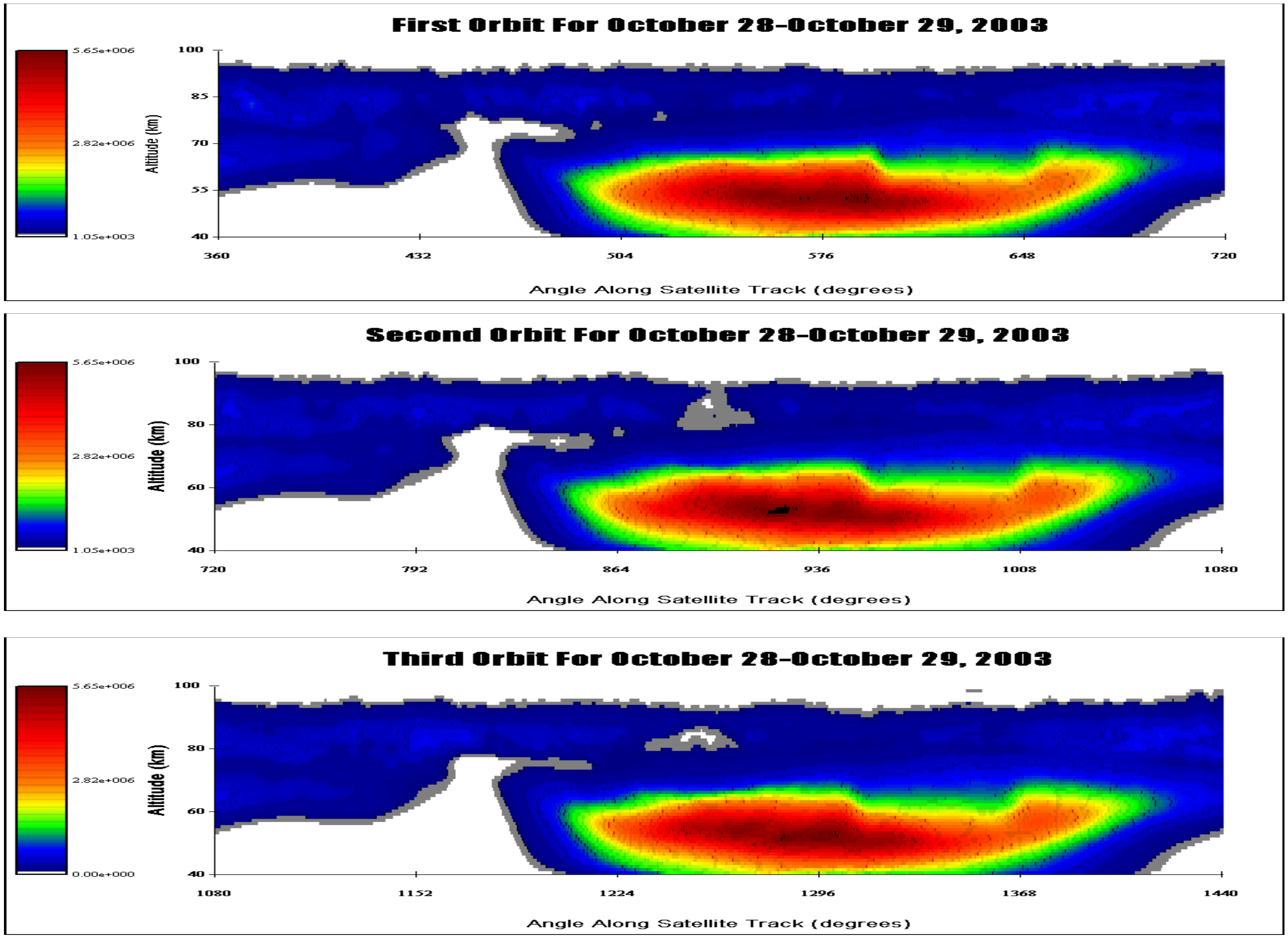
Twilight and nighttime structures seen in OH and O_2 IR Atmospheric band emissions. Orbit 191F on April 29, 2002.

Mesospheric effects of Solar Storms

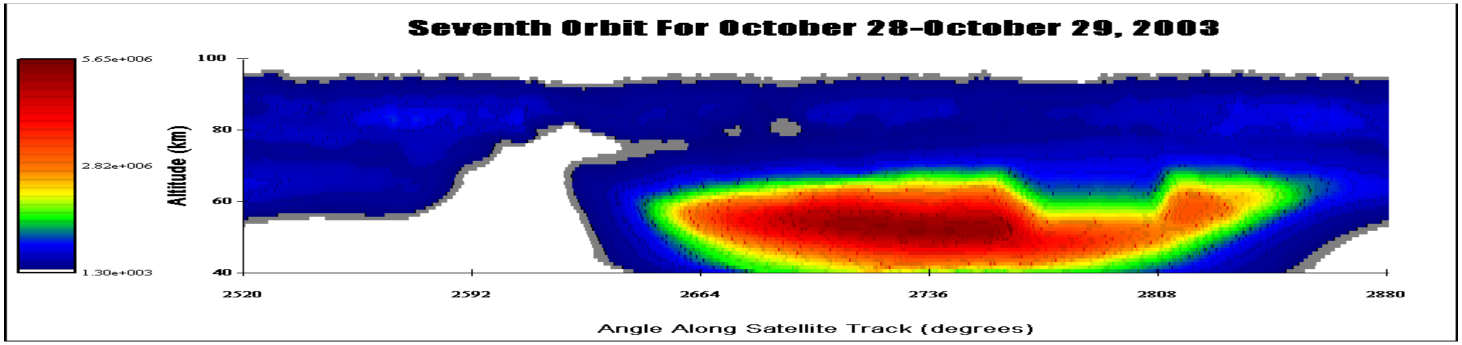


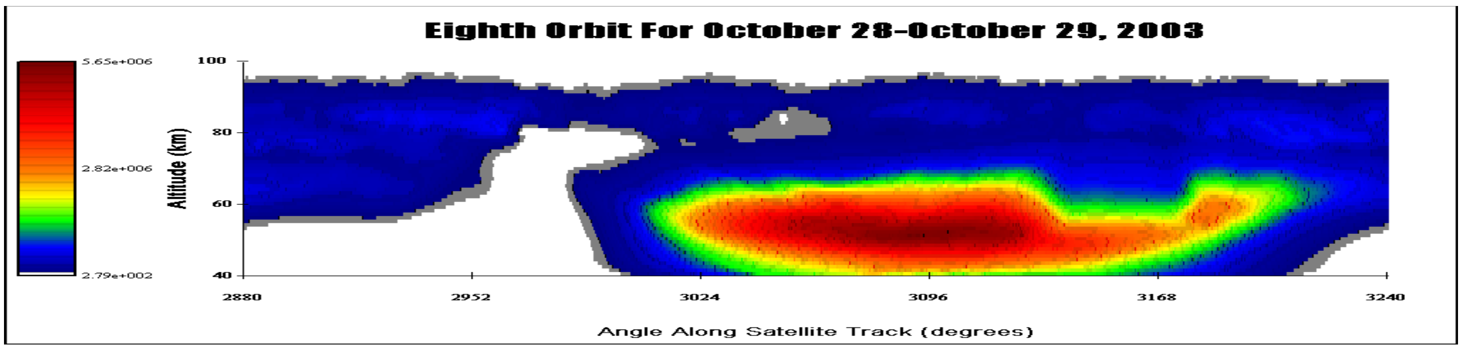


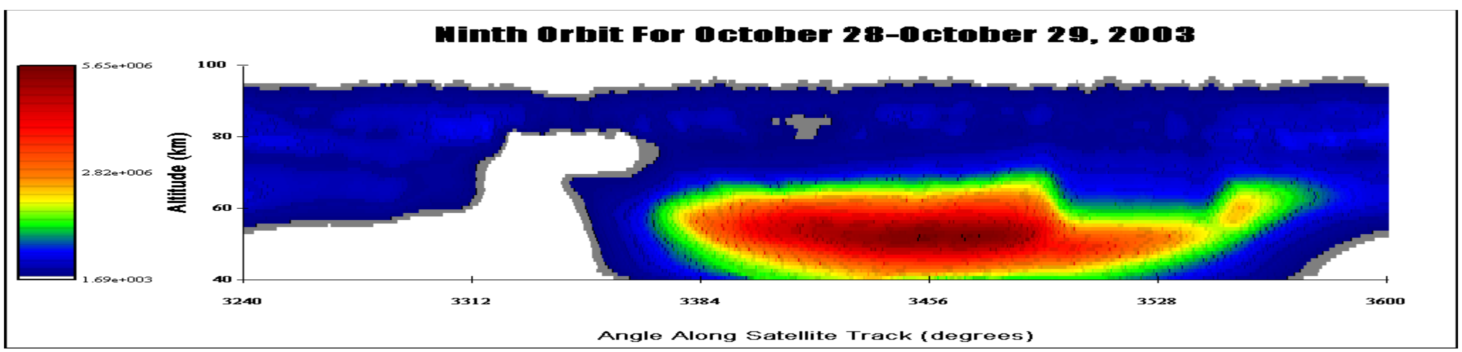
Mesospheric effects of Solar Storms



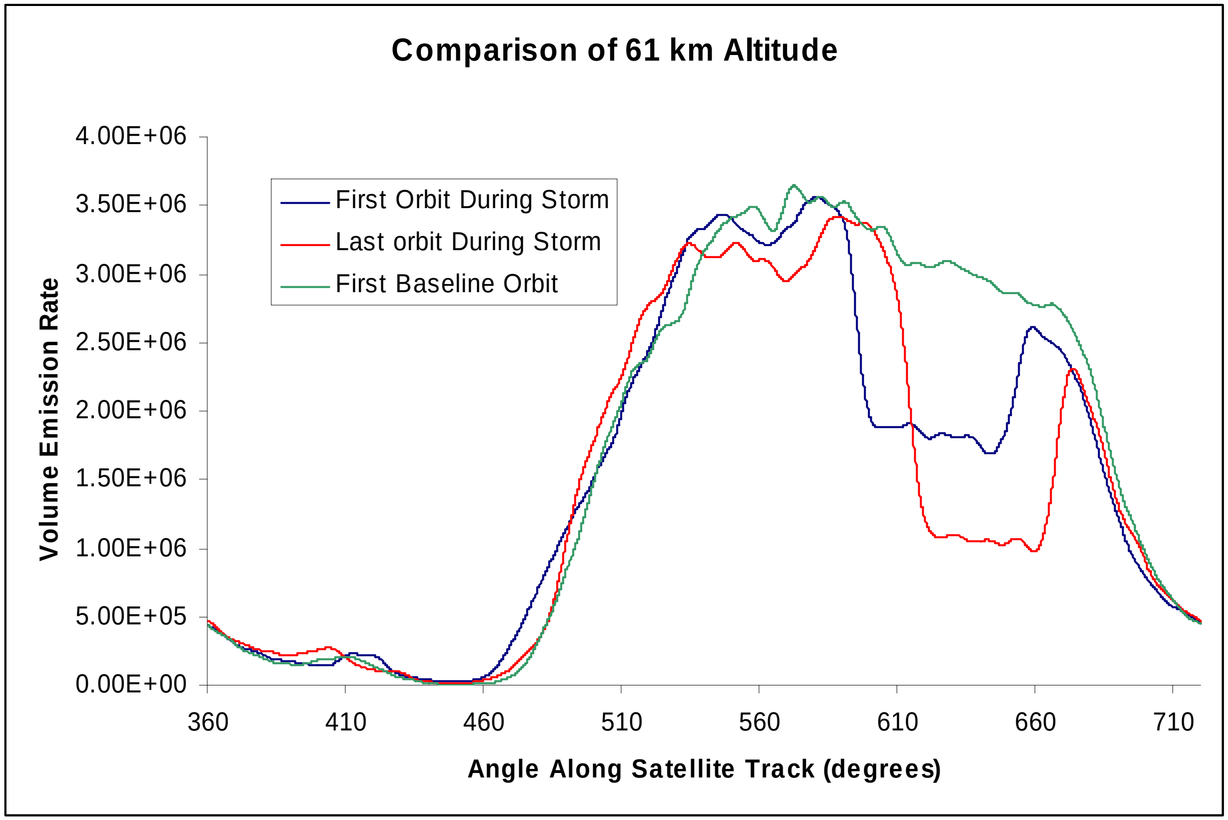
Mesospheric effects of Solar Storms







Mesospheric effects of Solar Storms



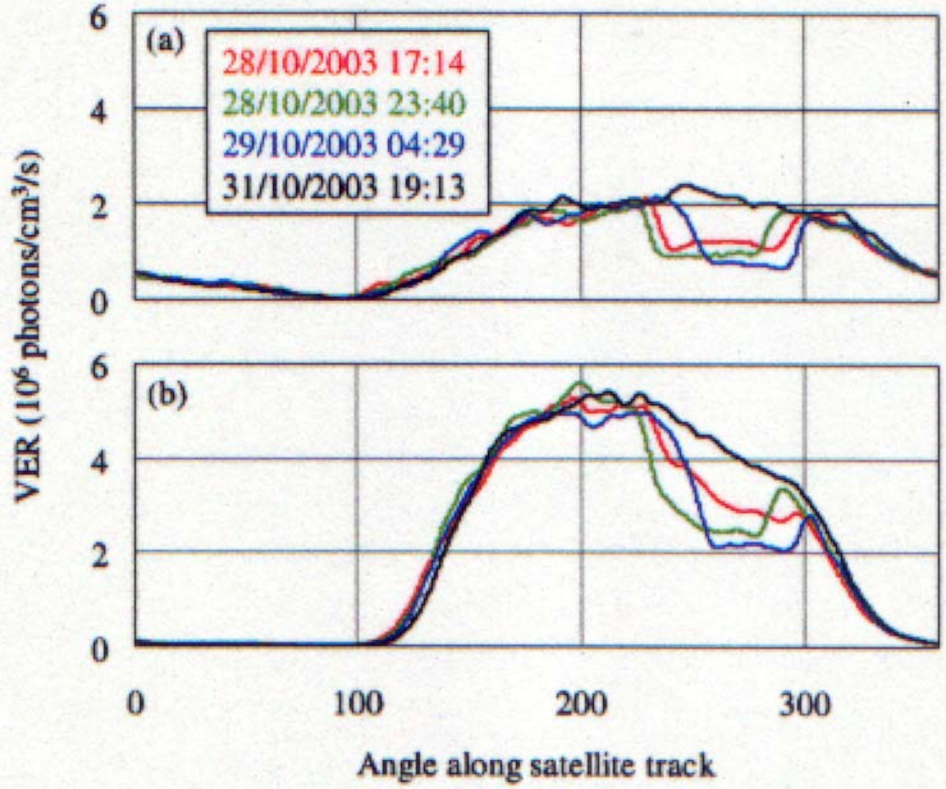
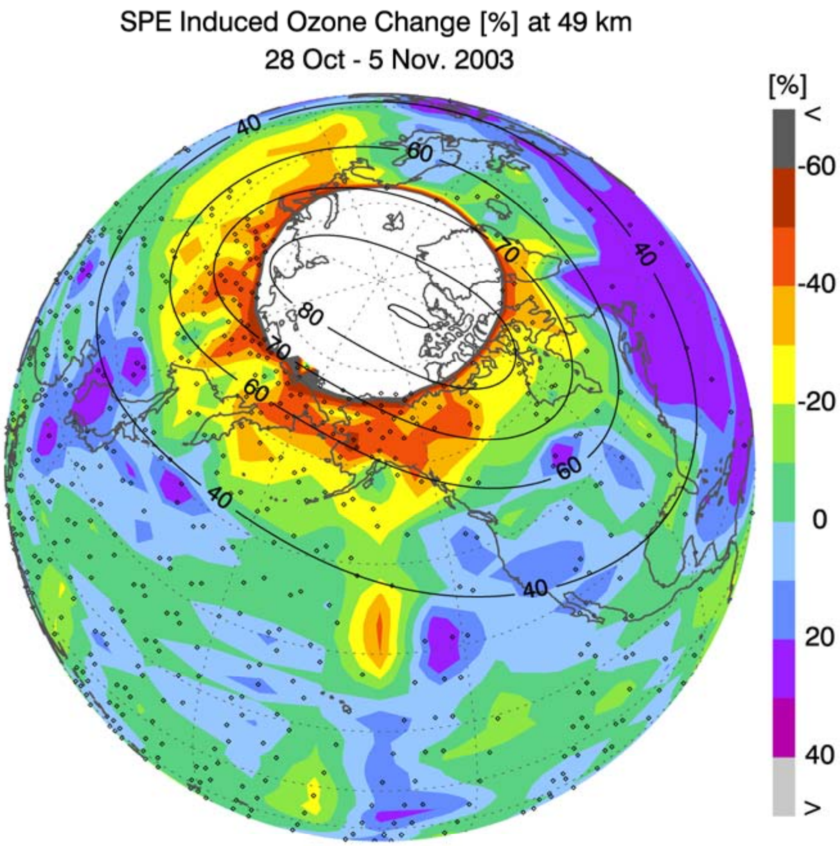
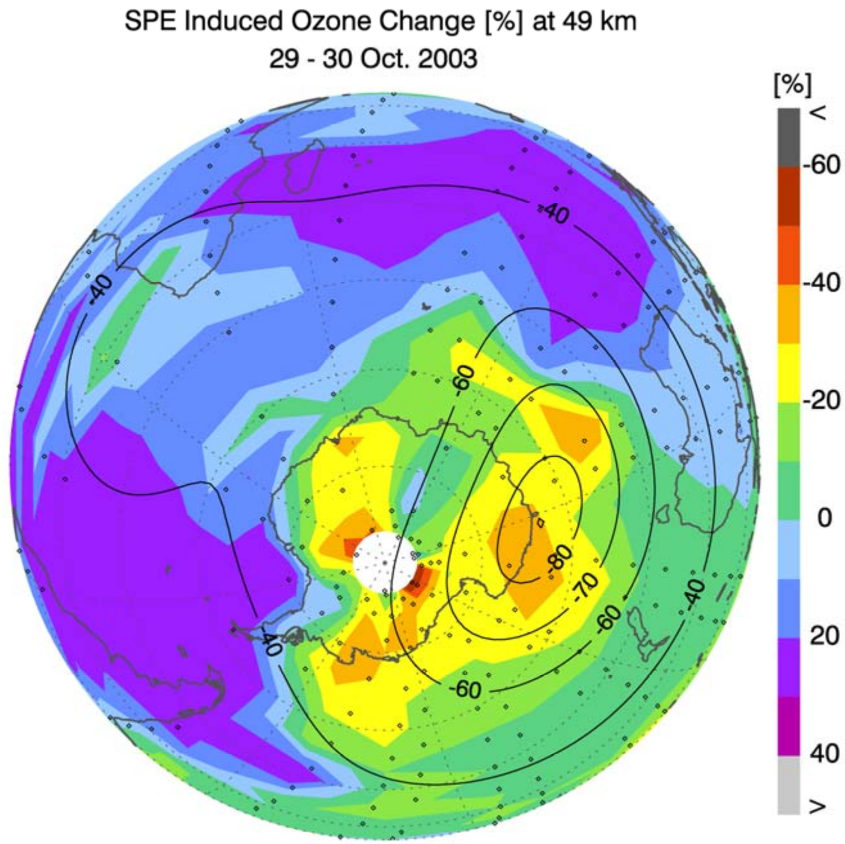


Figure 2. Single altitude VER cross sections that compare the results from three in-SPE orbits with the baseline orbit, 31/10/2003. The cross sectional slices are from 65 km and 55 km for panels a) and b) respectively.

f 4

Ozone Depletion during Solar Proton Storm October 2003

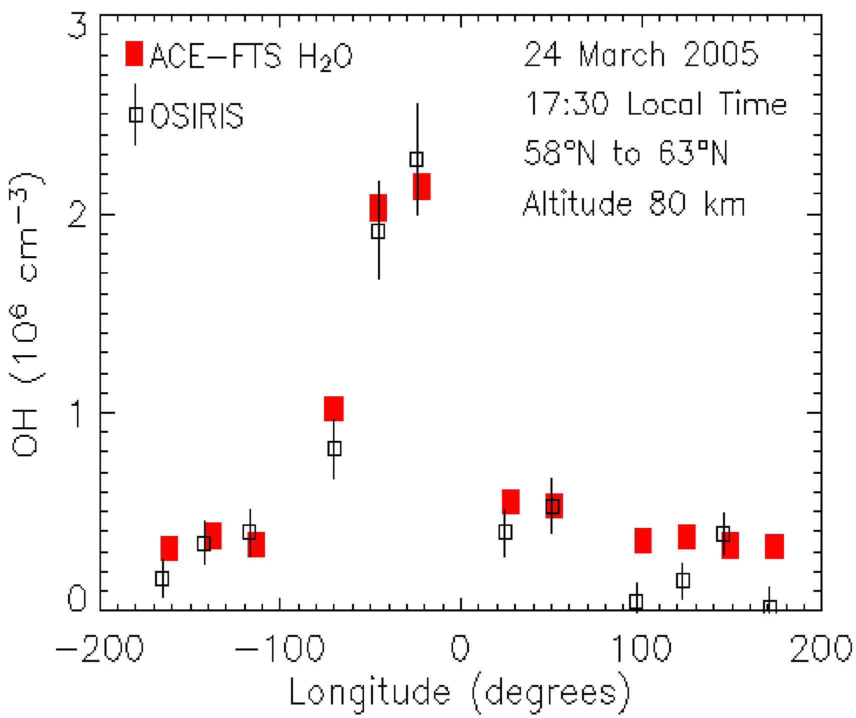


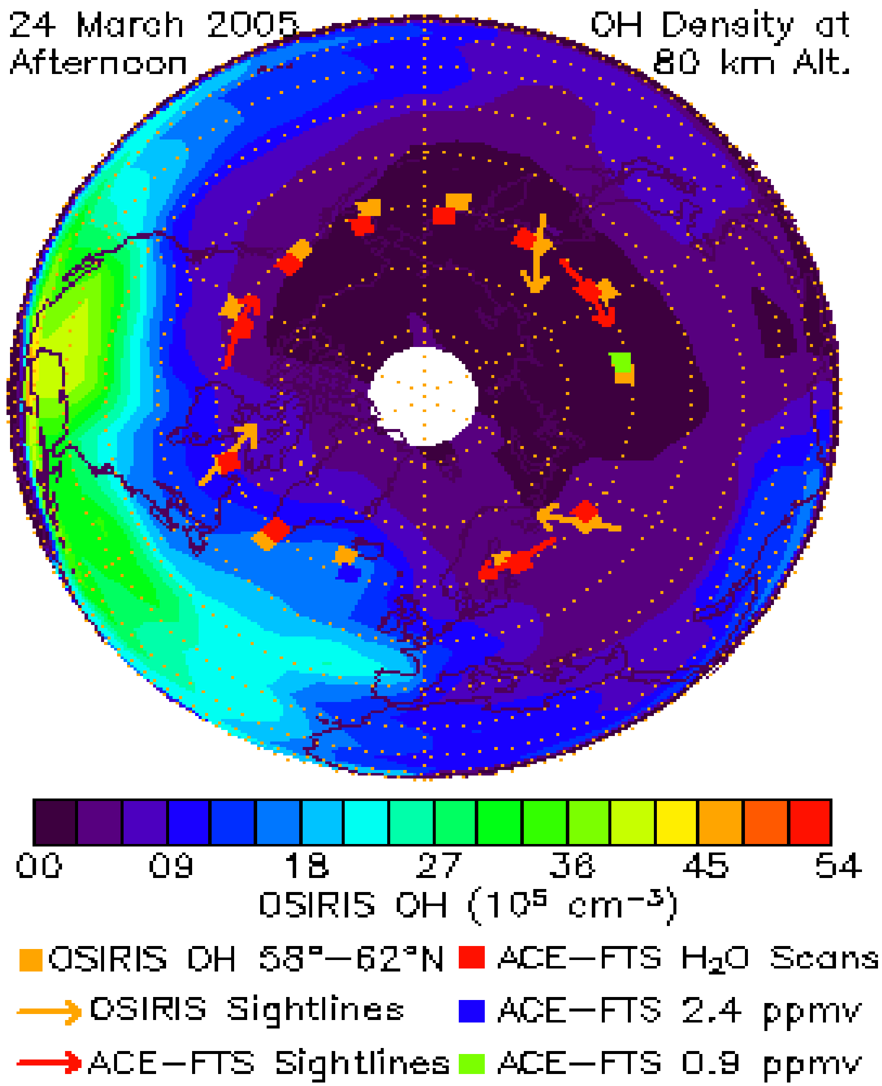


Observed interhemispheric differences due to the lower ambient HO_x background!

(ACE-FTS H_2O + Model) vs (OSIRIS OH)

- 'Validate' OSIRIS OH
- Use ACE-FTS H_2O with Model
- Latitude within 2°
- Local Time within 30 minutes

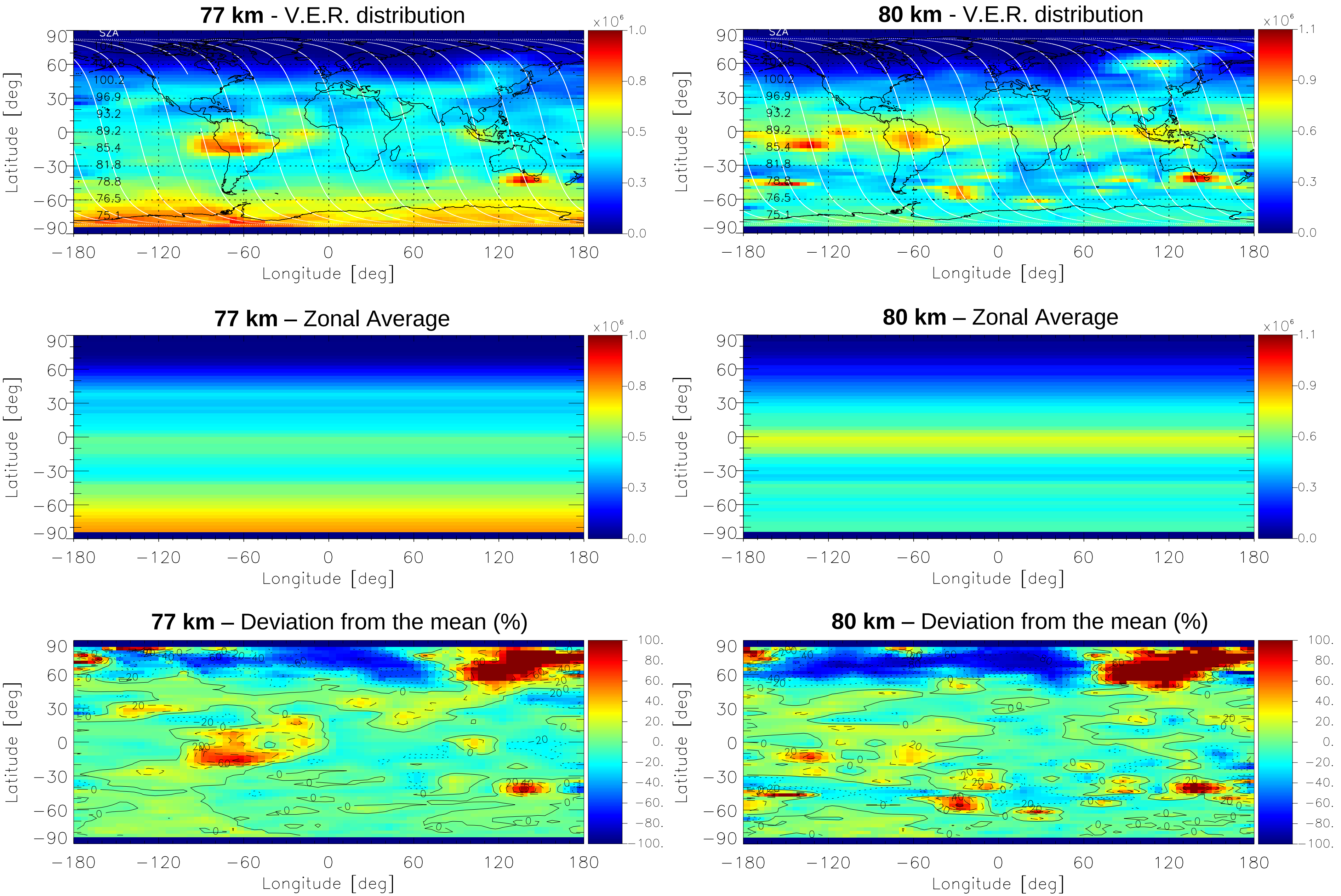




[GRL 2006]

Volume Emission Rate daily maps - 2002/01/02

(Ascending Node data)



U.S. Dept. of Commerce, NOAA, Space Environment Center(http://www.swpc.noaa.gov/ftpdir/indices/SPE.txt)Solar Proton Events Affecting the Earth Environment during Odin Mission and possibly seen with OSIRIS

February 20, 2001 - December 31, 2008

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

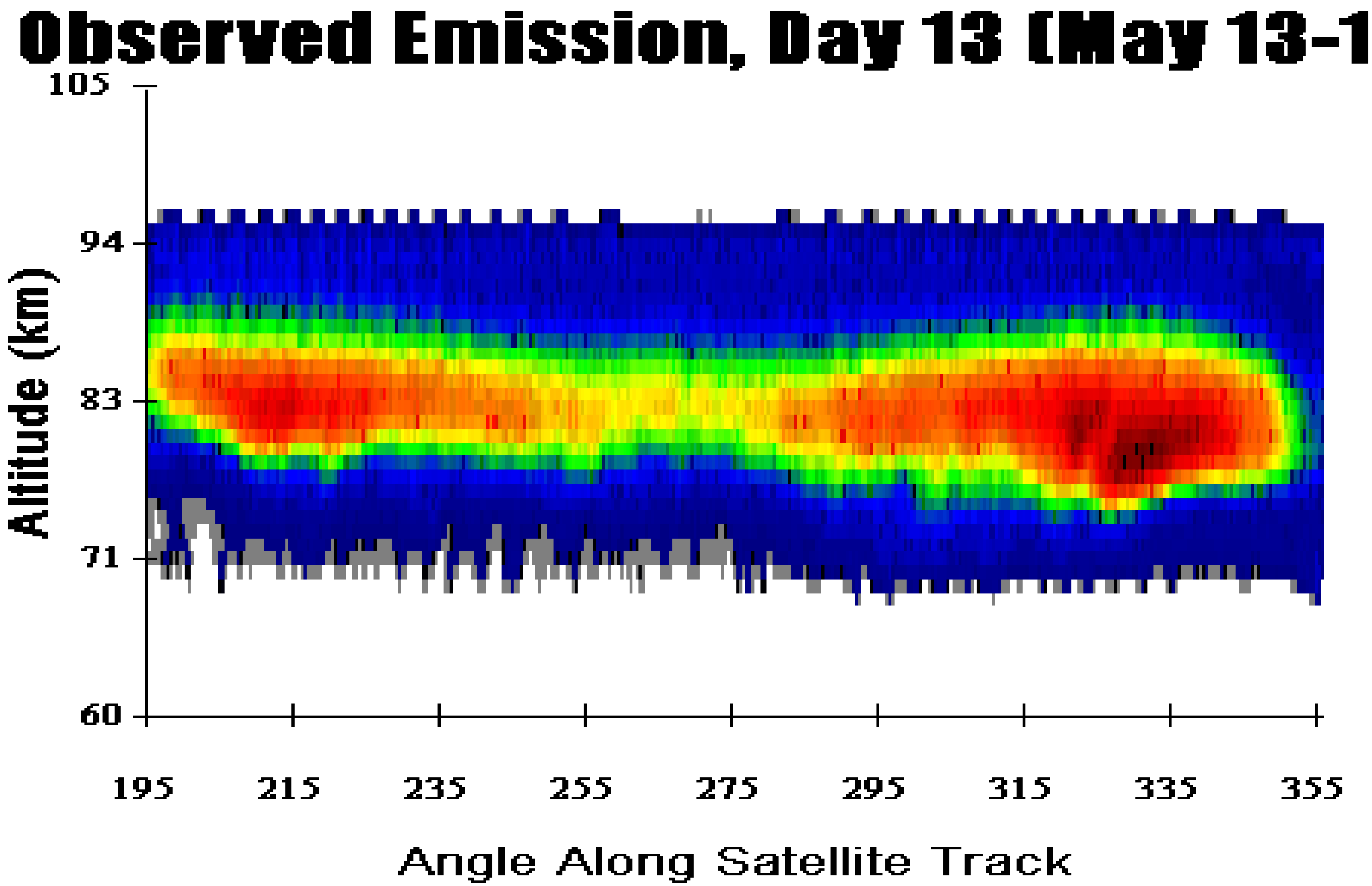
Start (Day/UT)	Maximum	Proton Flux (pfu @ >10 MeV)	
2001			
Odin Launch February 20, 2001/0948			
Apr 02/2340	Apr 03/0745	1110	NO DATA
Sep 24/1215	Sep 25/2235	12900	ASTRONOMY MODE
Oct 01/1145	Oct 02/0810	2360	
Nov 04/1705	Nov 06/0215	31700	
Nov 22/2320	Nov 24/0555	18900	
2002			
Apr 21/0225	Apr 21/2320	2520	
2003			
Oct 28/1215	Oct 29/0615	29500	

2004			
Jul 25/1855	Jul 26/2250	2086	ASTRONOMY MODE
2005			
Jan 16/0210	Jan 17/1750	5040	
May 14/0525	May 15/0240	3140	
Sep 08/0215	Sep 11/0425	1880	
2006			
Dec 06/1555	Dec 07/1930	1980	
2007			
none			
2008			
none			

==

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



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.

E.J. Llewellyn, **R.L. Gattinger,** N.D. Lloyd, A.E. Bourassa, D.A. Degenstein, P. Sheese and I.C. McDade