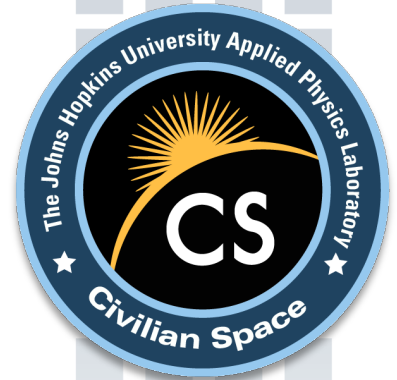


UV Hyperspectral Observations of Space Weather in the Near-Earth Environment – an Expanding Capability

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APL

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Outline

- Space Weather and SSUSI
- New Products and Tools
 - 3D ionosphere and Radio
 - Auroral Products
 - Spacecraft Environment Awareness
- Data Availability
- Conclusions



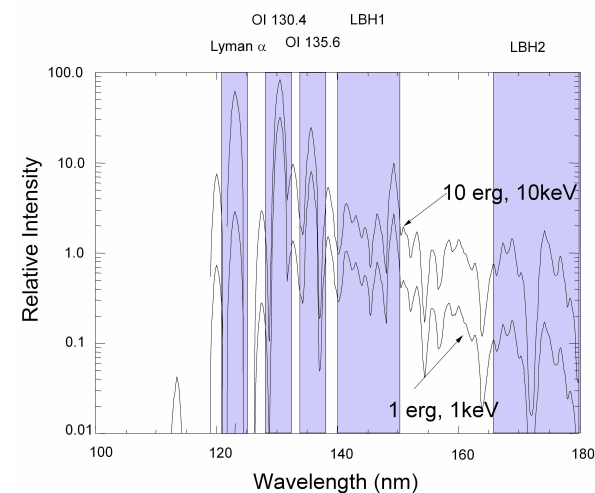
Space Weather – what does it mean?

- Space Weather is usually discussed in media stories of Space Weather in terms of Extreme Events
- However, less dramatic space weather conditions are still important for planning operations – communication, radar signals, flight plans, GPS errors, polar transportation, satellite safety
- SSUSI sees extreme SWx, but makes important measurements concerning daily operations – also important for understanding ionosphere/atmosphere coupling.

Event Type	Terrestrial Weather	Space Weather
Rare Catastrophic Events	Hurricane Katrina Moore Tornado	Carrington Event 1859 Halloween Storm 2003
Daily Conditions affecting Operations	Rain, Snow, cloud cover, temperature, winds	Ionosphere electron density and height, auroral extent, proton precipitation, auroral patch events, atmospheric heating, radiation intensity

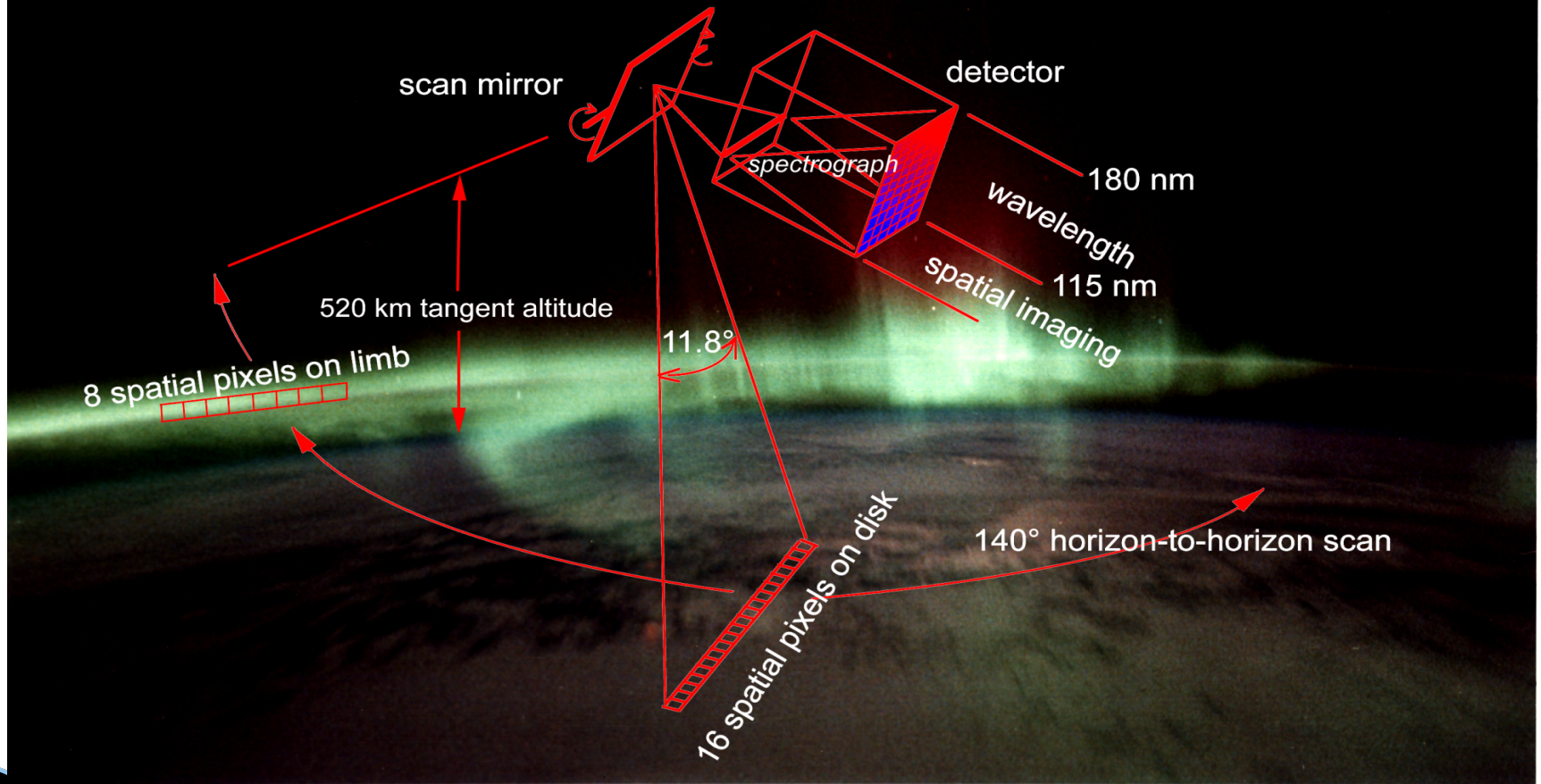
SSUSI – what is it?

- SSUSI is the (Special Sensor) Ultraviolet Spectrographic Imager on DMSP spacecraft
- SSUSI images the ionosphere and polar caps in 5 UV “colors” that correspond to N_2 , O, and H emissions
- First SSUSI (on F16) launched in 2003.
- Now 3 SSUSIs on orbit, 4th set for launch 4/3/14



The SSUSI Scan Pattern Observes both the Limb and Disk of the Earth

Special Sensor Ultraviolet Spectrographic Imager **SSUSI**



SSUSI Capabilities

- Similar to TIMED/GUVI (sister) instrument
 - GUVI products have always been publicly available.
- After nearly a decade of experience on orbit, and with the advancement of scientific knowledge, new capabilities have been added – **we have new products** that were not produced for GUVI.

SSUSI Products - A Rich Diversity of Products That is Expanding

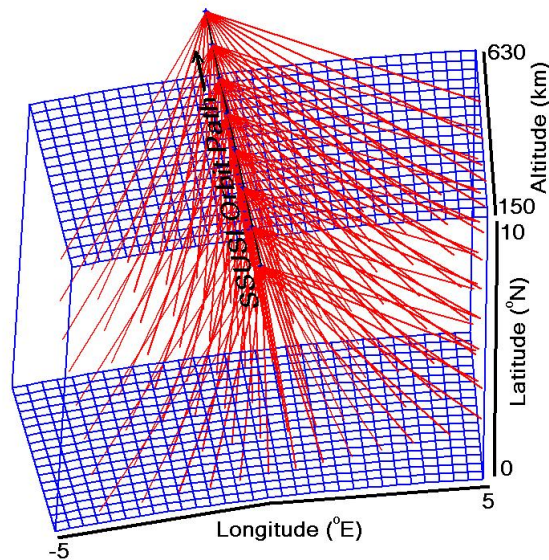
Category	Original GUVI/ SSUSI Products	Additional New SSUSI Products
Ionospheric Electron Density	2D F2 region electron density profile information, TEC, coarse gridded GAIM Radiances	3D electron density data, ionospheric bubble id, bubble properties (density difference, location, size), MN corrected radiances for GAIM, daylight contamination flags
Polar Zone products	Auroral imagery, Energy Flux, Mean Electron Energy, Auroral Equatorward Boundary, E region electron density profile properties	Global poleward auroral boundaries, Hemispheric Power, magnetic field line mapping, proton correction, proton precipitation region maps, discrete arc ID
Dayside products	Solar EUV flux, neutral densities, O.N2 maps	dayside topside electron densities
Space Environment	MeV particle noise flag	SSUSI South Atlantic Anomaly model, SAA sensor correction algorithm

This list does not include new APL prototyped products!



I. SSUSI 3D Ionosphere – A new product

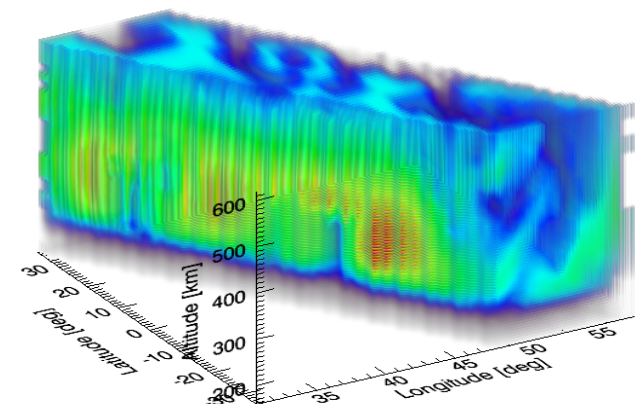
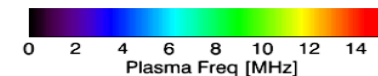
- Originally only 2D electron maximum density information
- However, distinct overlapping scans allow 3D tomography
- Now SSUSI provides 3D ionospheric electron density reconstructions as a new operational product - Many uses



SSUSI observes the Earth disk along
~600,000 lines of sight per orbit

Tomographic
reconstruction

SSUSI Reconstructed
3-D Electron Density

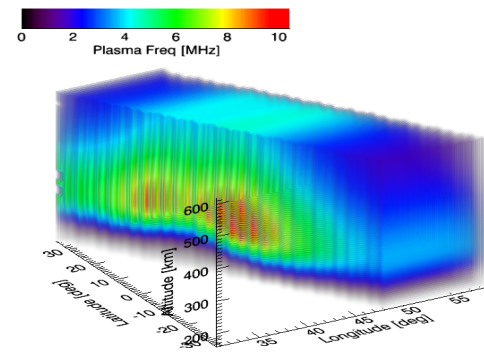


SSUSI data is higher resolution than typical global model resolution

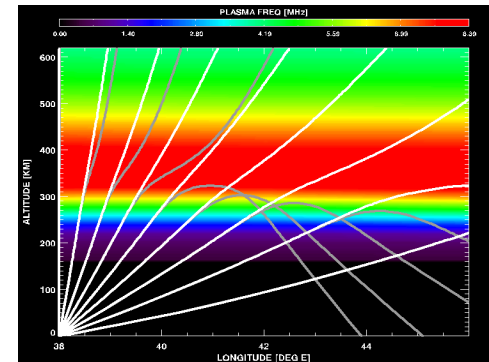
- SSUSI images are (tomographically) converted into “3D” ionospheric cubes that show the location of irregularities and bubbles in the ionosphere

What the user expects
based on global models
(here IRI)

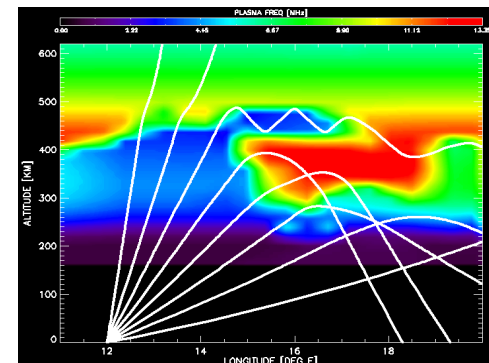
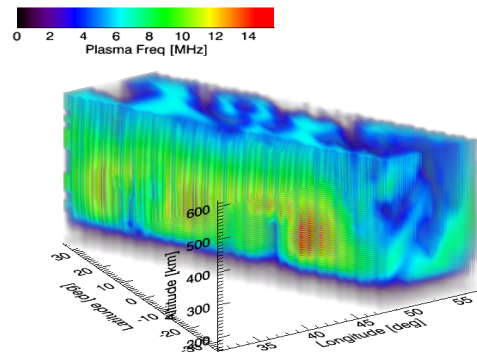
Electron Densities



Radio Signal Paths

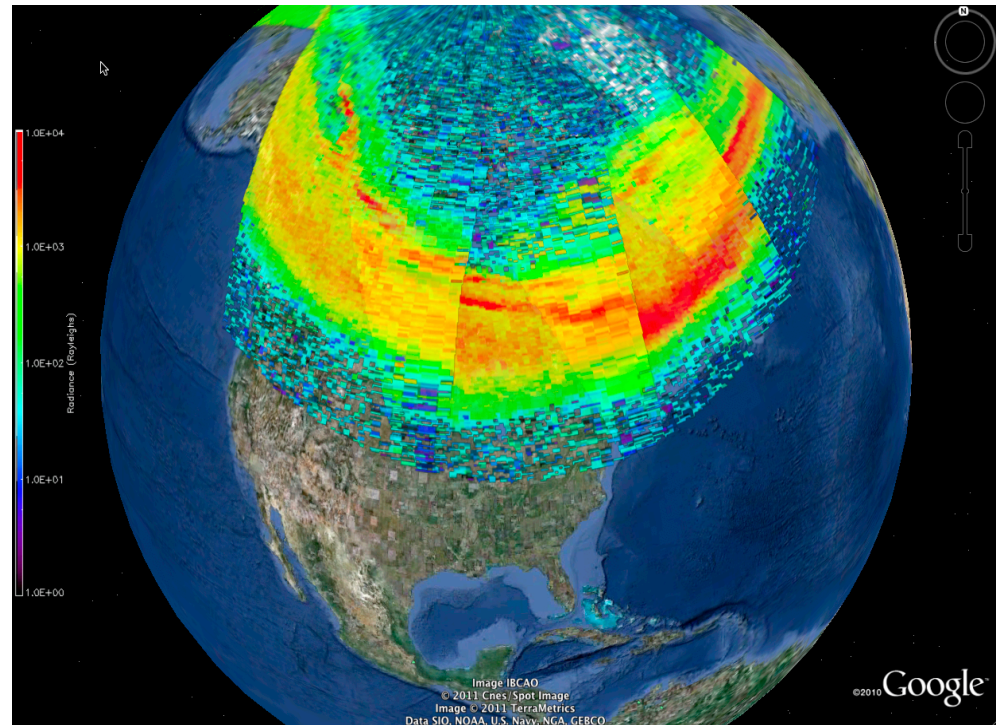


What the user will
Experience based on SSUSI
data reconstructions



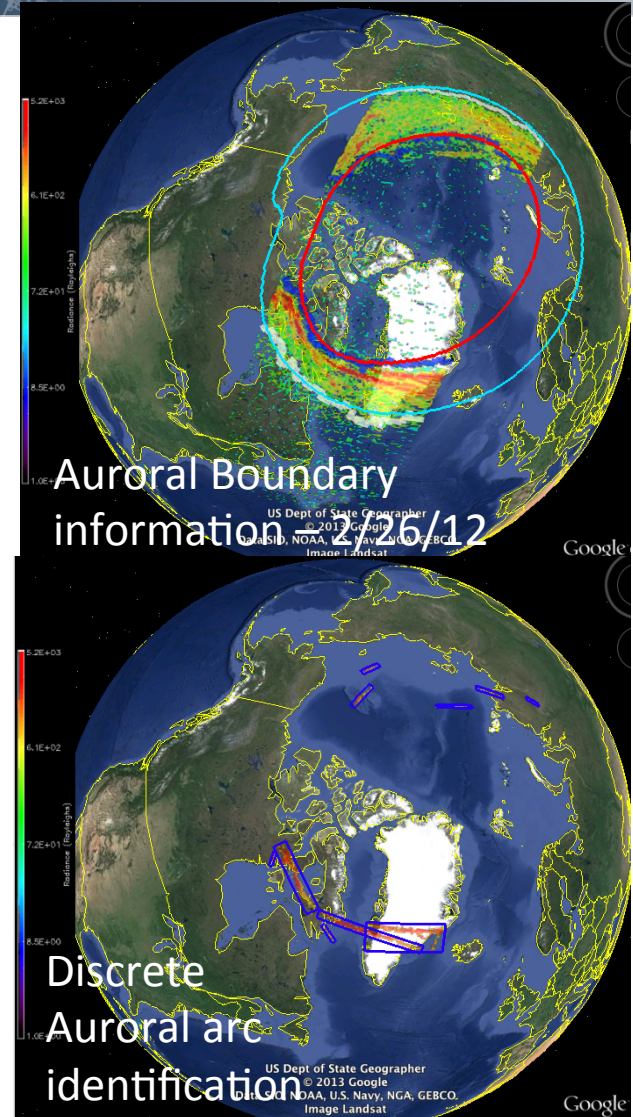
II. SSUSI Auroral Region Specification

- Auroral Zone New Products
- Auroral poleward (as well as equatorward boundaries)
- Hemispheric power
- Proton precipitation regions



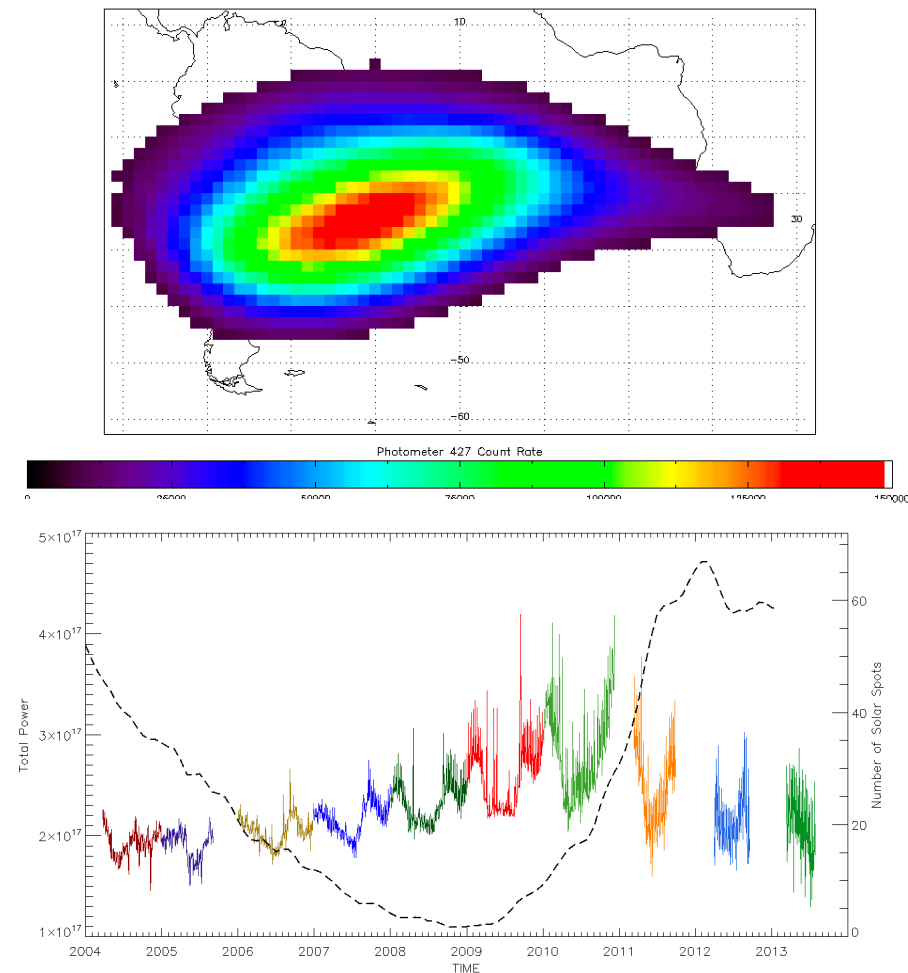
Auroral Data and Derived Products

- SSUSI now provides poleward boundaries, both global and detailed local specifications (as well as equatorward boundaries)
- Discrete auroral arcs are identified and specified
- These are part of the auroral data products (that also contain Q, E_0 , NmE, HmE, hemispheric power, proton precipitation regions, magnetic field line traces)



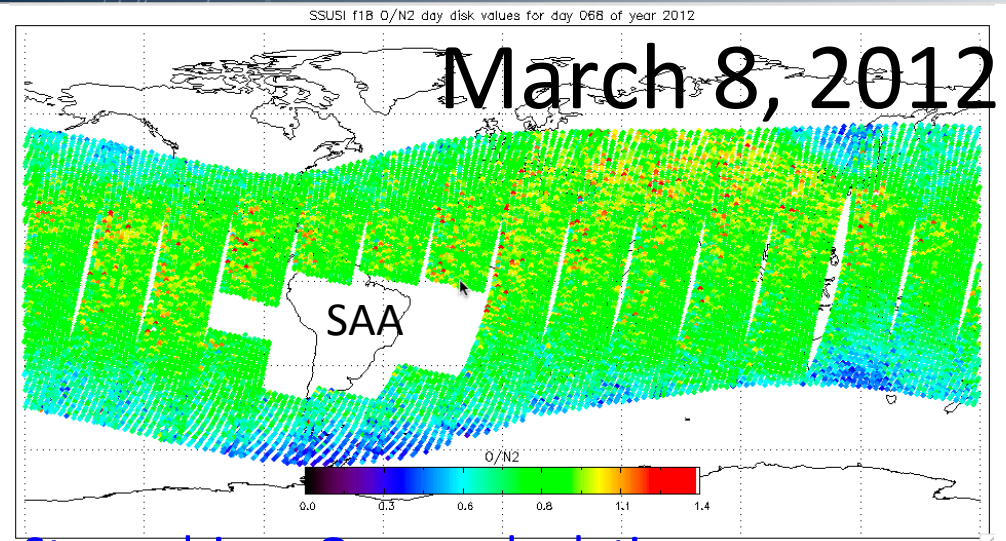
III. SSUSI Monitoring of particle radiation

- Charged particle hits on SSUSI generate detector noise that can be identified and isolated.
- Detailed study of the particle noise South Atlantic Anomaly shows we can monitor high energy charged particle fluxes.

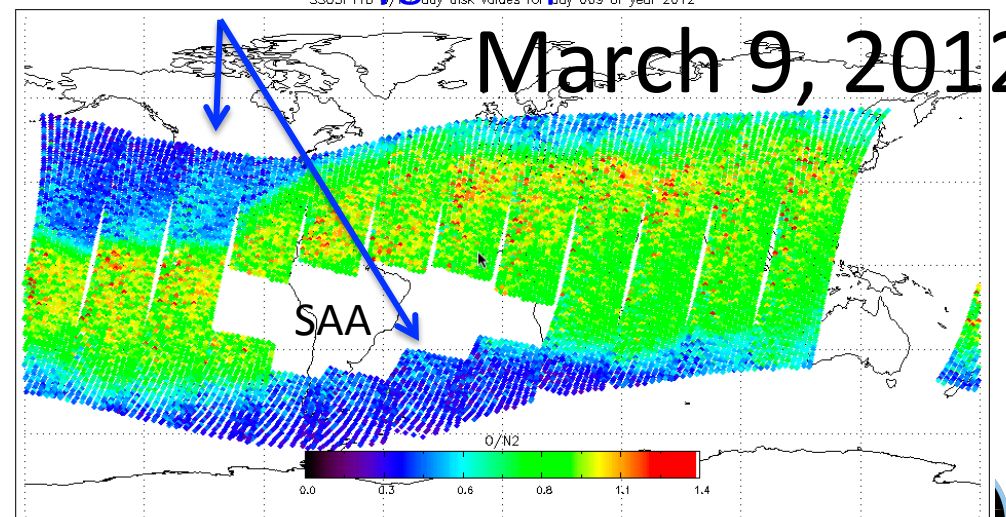


Many Possible Scientific Uses

- SSUSI provides a wealth of observational data that can be used to understand upper atmosphere dynamics and couplings to other “spheres” (incl. terrestrial weather)
- E.g.. Storm time heating of the upper atmosphere as seen in the SSUSI O/N₂ ratio (at right).



Storm driven Oxygen depletions

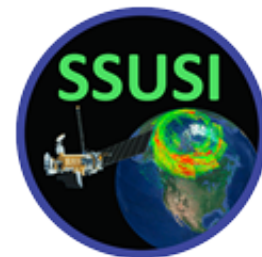


Data Availability - NEW!

- Data is now available publicly
- NASA: Space Physics Data Facility
 - <http://spdf.gsfc.nasa.gov>
- Virtual ITM Observatory – <http://vitmo.jhuapl.edu>
- SSUSI home page – <http://ssusi.jhuapl.edu>
- Important source of new observations for ionospheric/atmospheric dynamics

Space Physics Data Facility

Virtual ITM Observatory



Conclusions

- SSUSI provides many products that can aid users that need to know conditions for communication, radar, and GPS in especially in the auroral zone and also the state of local spacecraft charging.
 - Large list of standard heritage space weather products (auroral imagery, equatorward auroral boundary, etc.)
 - **New products** developed (e.g., 3D ionosphere, ionospheric bubble characterization, auroral global boundaries, SAA relative intensity maps)
- **New! Data Products now available on-line**
- Concept for follow-on instrument SSUSI-Lite
 - Smaller, lighter, lower power (more adaptable to other s/c platforms) to continue monitoring and create new Space weather products