JPSS Data and Applications in Support of Forecasting and Environmental Assessments

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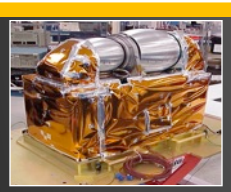
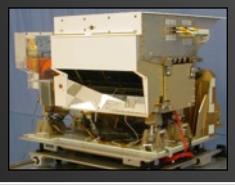
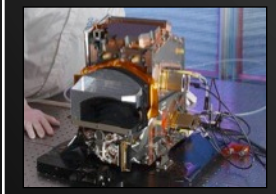
Overview

JPSS starting with Suomi-NPP is providing operational continuity and improved capability in providing critical datasets needed for both weather forecasting and environmental assessments

Critical attributes required:

- Information of the vertical structure of the atmosphere (temperature, water vapor, ozone)
- High spatial resolution imagery and global coverage
- Radiometric and spectral performance

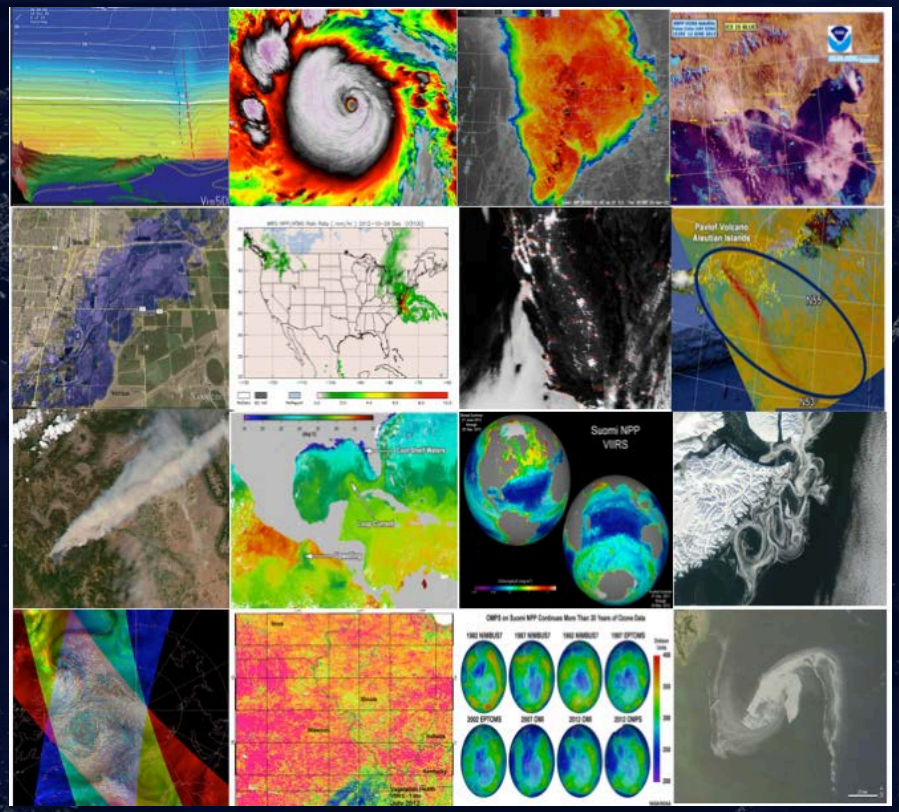
JPSS-1 Instruments (same as S-NPP)

	JPSS Instrument	Measurement
	**ATMS** - Advanced Technology Microwave Sounder	ATMS and CrIS together provide high vertical resolution **temperature** and **water vapor information needed to maintain and improve forecast skill** out to 5 to 7 days in advance for extreme weather events, including hurricanes and severe weather outbreaks
	**CrIS** - Cross-track Infrared Sounder	
	VIIRS – Visible Infrared Imaging Radiometer Suite	VIIRS provides many **critical imagery products** including snow/ice cover, clouds, fog, aerosols, fire, smoke plumes, vegetation health, phytoplankton abundance/chlorophyll
	**OMPS** - Ozone Mapping and Profiler Suite	Ozone spectrometers for **monitoring ozone** hole and recovery of stratospheric ozone and for UV index forecasts
	CERES - Clouds and the Earth's Radiant Energy System	Scanning radiometer which supports studies of Earth Radiation Budget

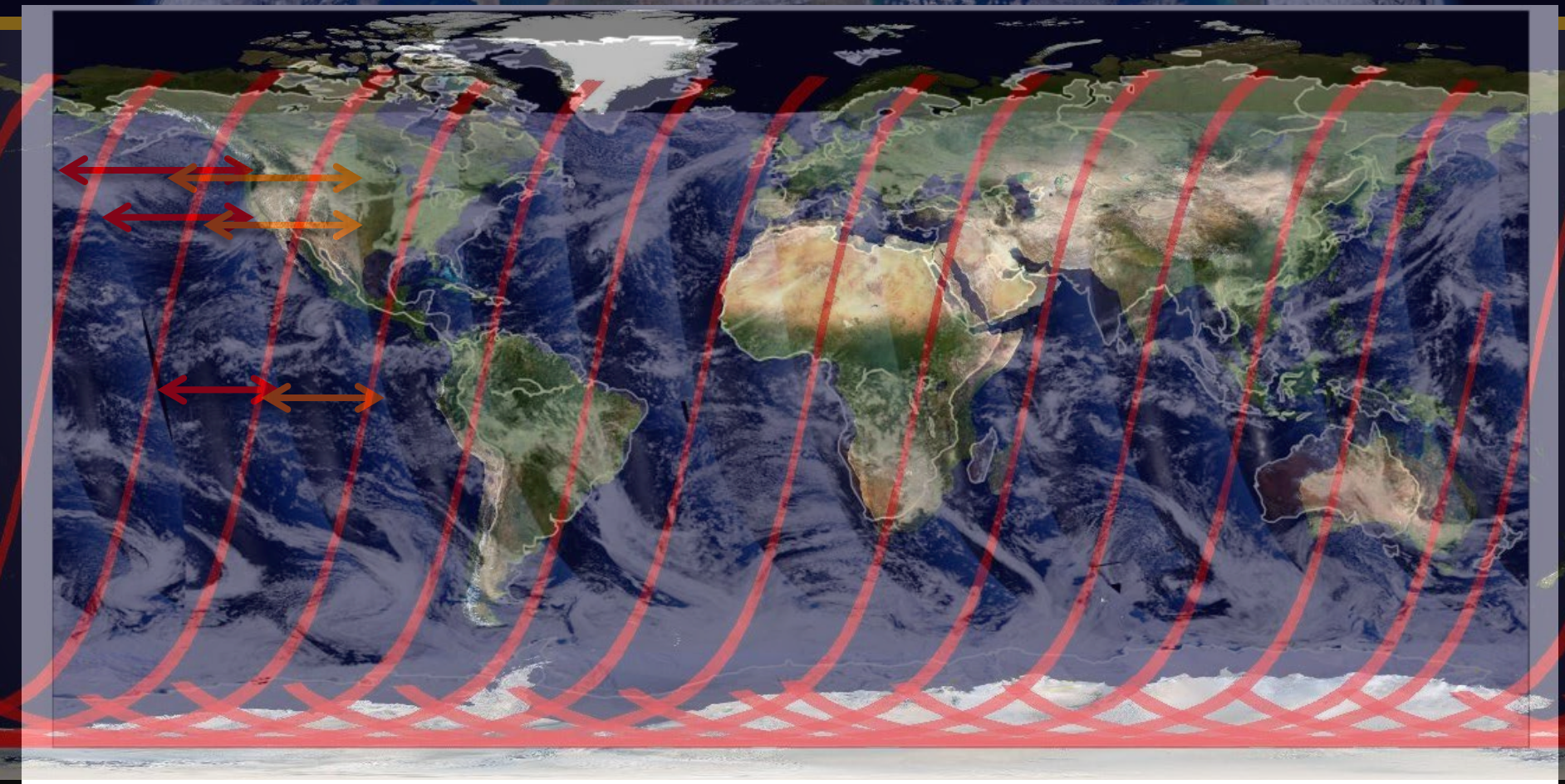
JPSS Environmental Assessments

Enhanced data products include:

- Atmospheric temperature/moisture profiles
- Hurricane intensity and position
- Thunderstorms, tornado potential
- Alaska “nowcasting” (e.g. ice detection)
- Significant precipitation and floods
- Dense fog
- Volcanic ash
- Fire and smoke
- Sea surface temperature, ocean color
- Sea ice extent and snow cover /depth
- Polar satellite derived winds (speed/direction/height)
- Vegetation greenness indices and health
- Ozone
- Oil spills



VIIRS – the work horse for environmental assessments



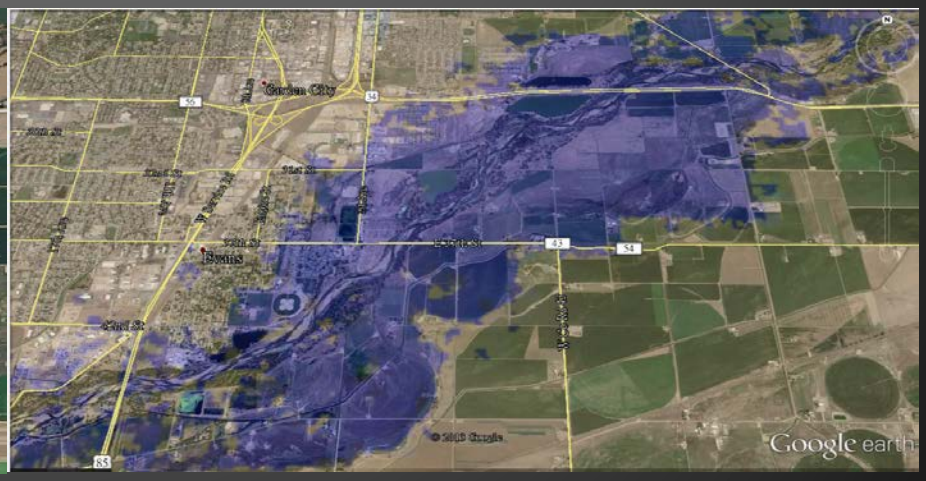
VIIRS RGB (True Color), 20111122

R : M05 (0.672 μm); G : M04 (0.555 μm); B : M02 (0.445 μm)

Creation date: 2011-11-26 07:19:26 Z

VIIRS Flood map vs Landsat 30 m September 17, 2013

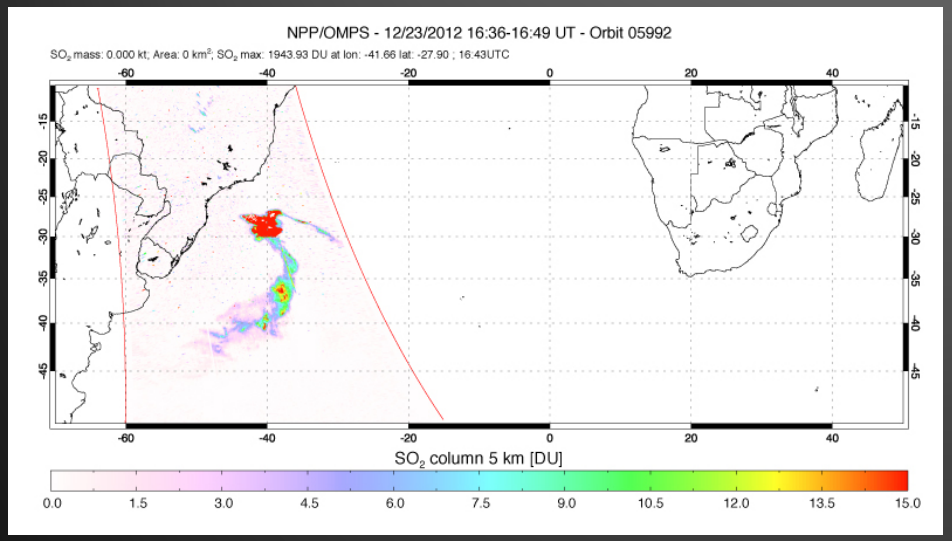
LANDSAT-8 30 m



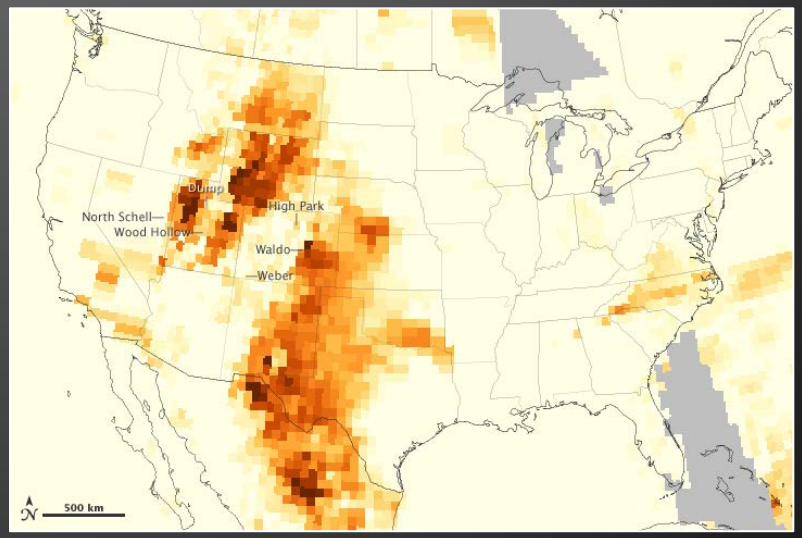
VIIRS using 30 m DEM

OMPS Aerosol and SO_2 Index

Copahue Eruption Dec. 13, 2012

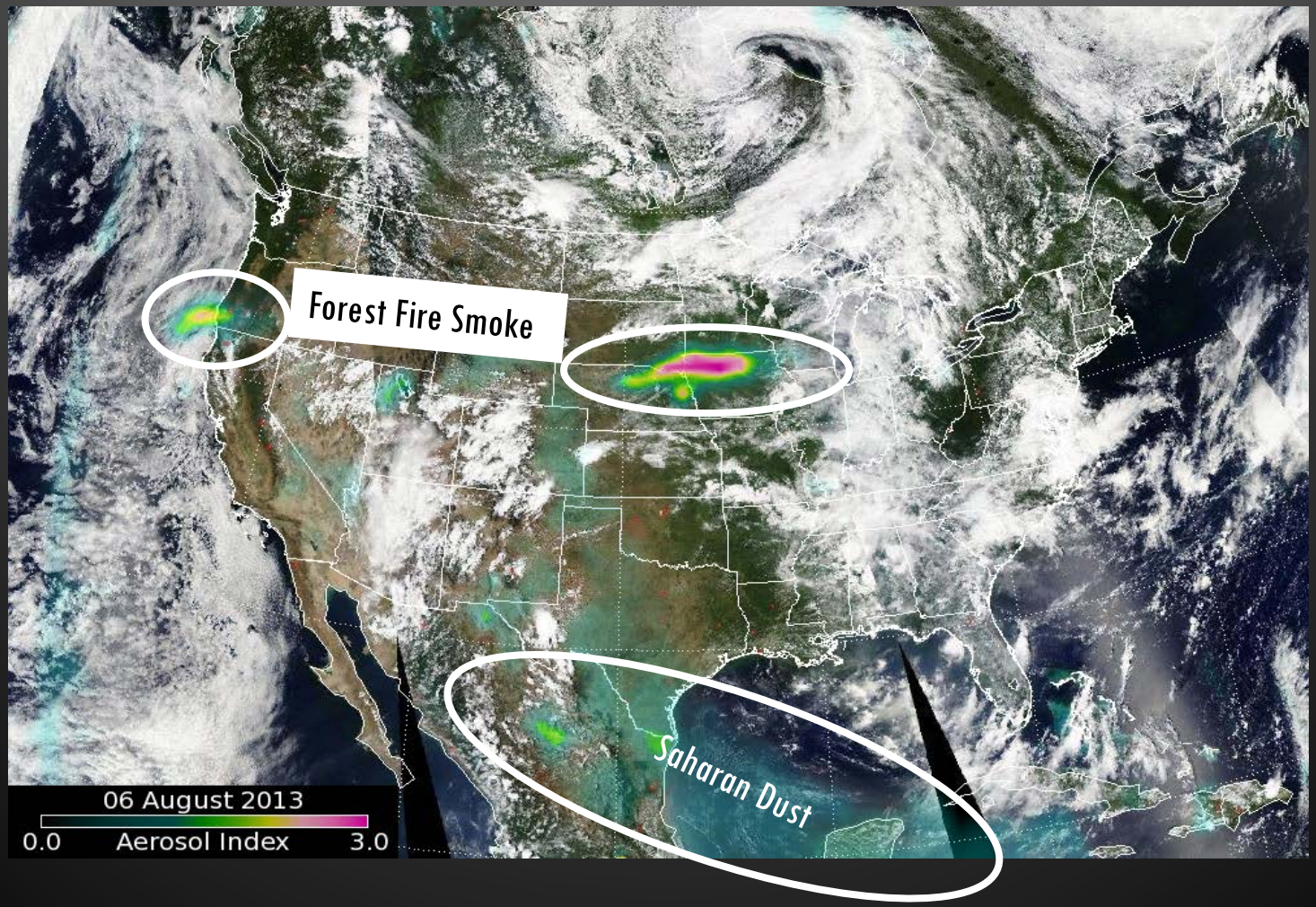


June 23, 2012



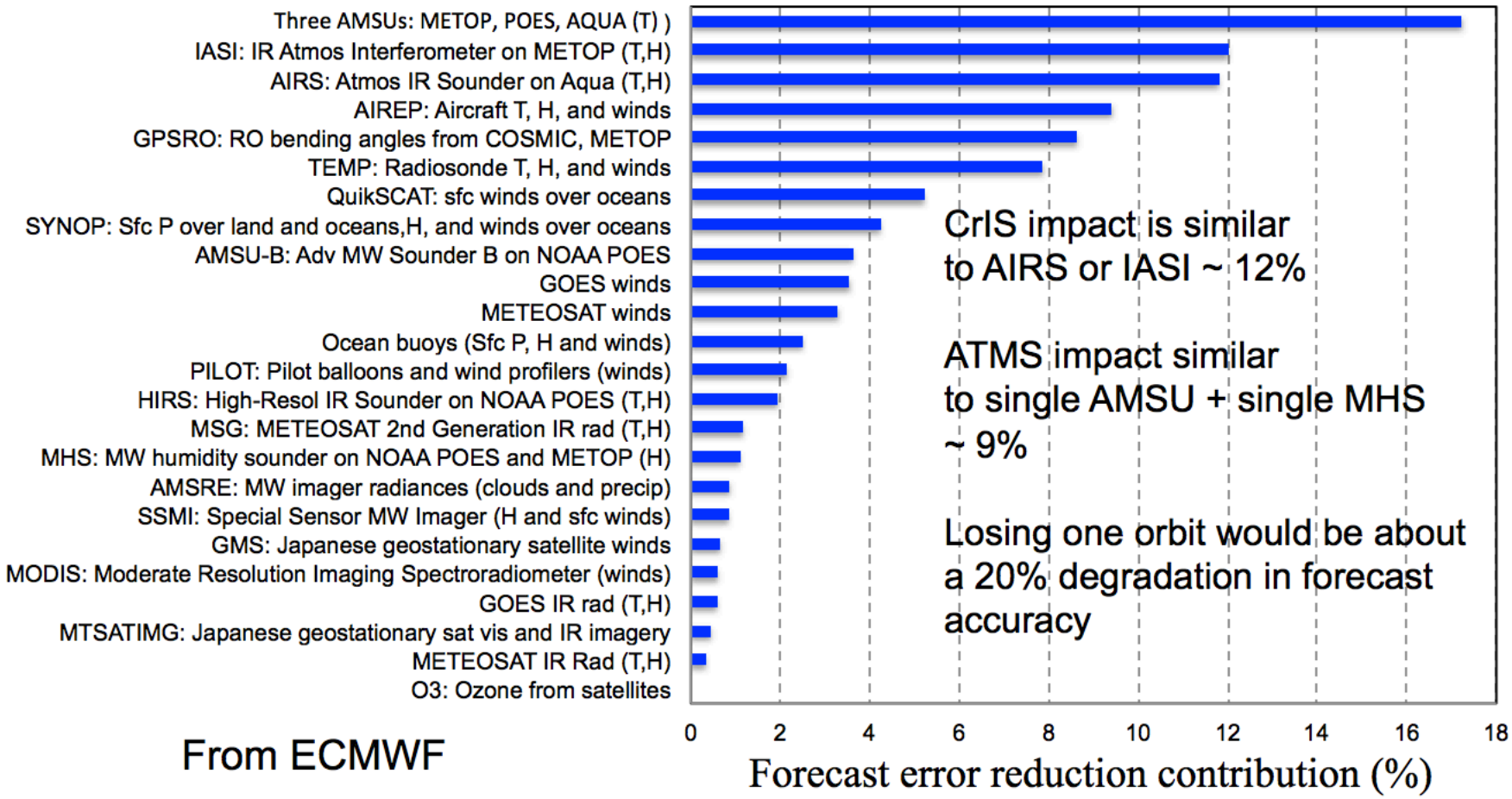
(NASA Science Team)

OMPS Aerosol Product
6 Aug 2013



CrIS and ATMS provides continuity of essential atmospheric sounding information for weather forecasting

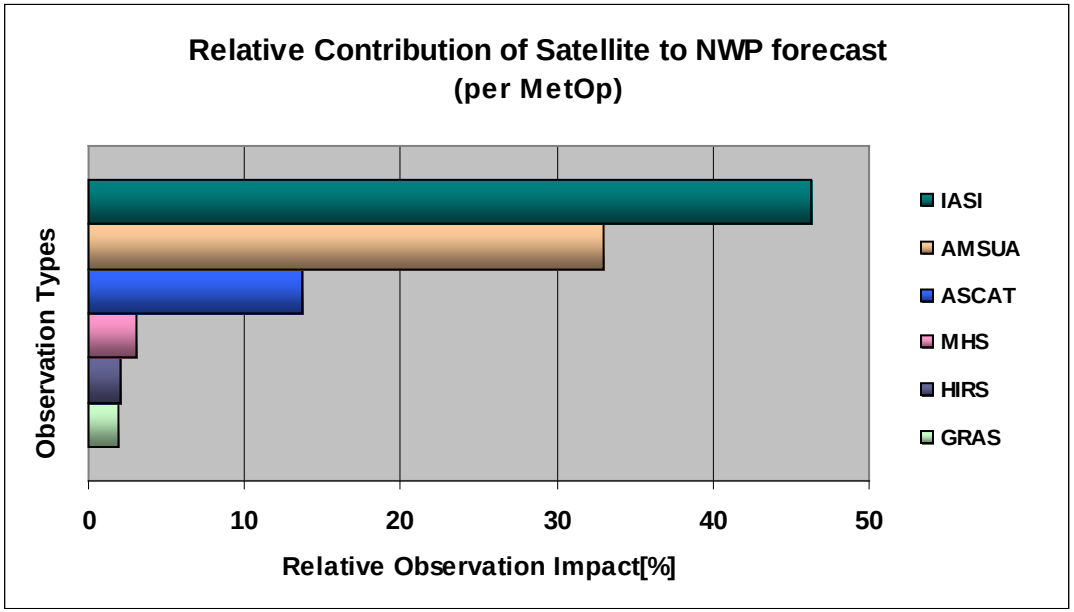
Hyperspectral Infrared Sounders (.e.g. CrIS) and Advanced Microwave Sounders (e.g. ATMS) are the top two contributors for reducing forecast errors



From ECMWF

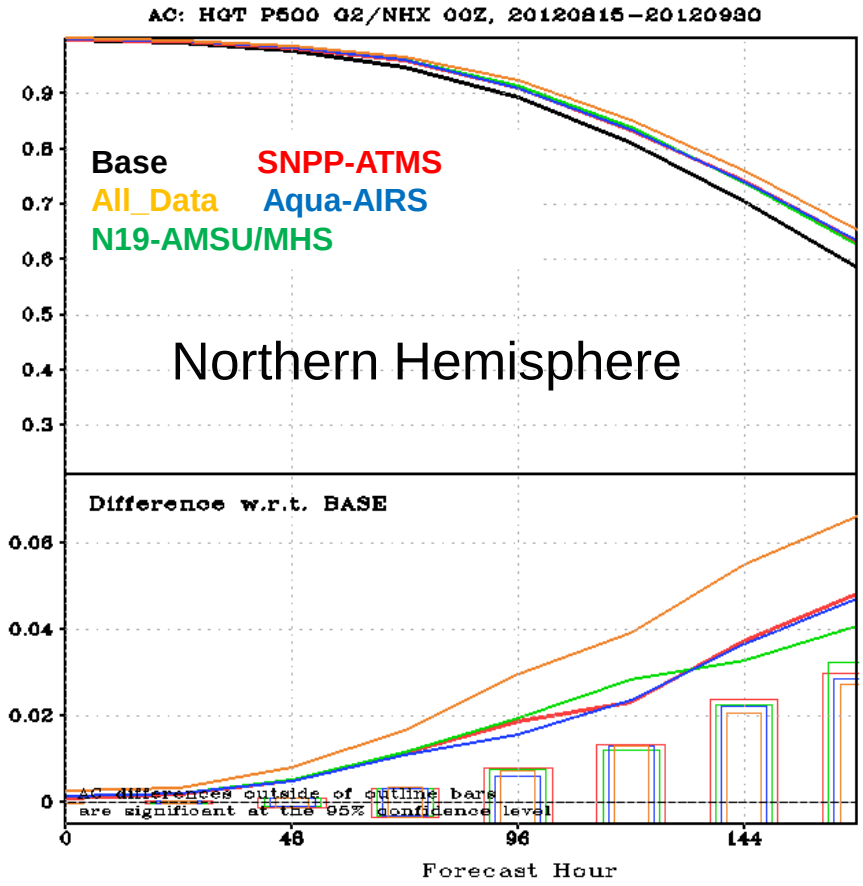
Observation impact per EUMETSAT METOP sensor

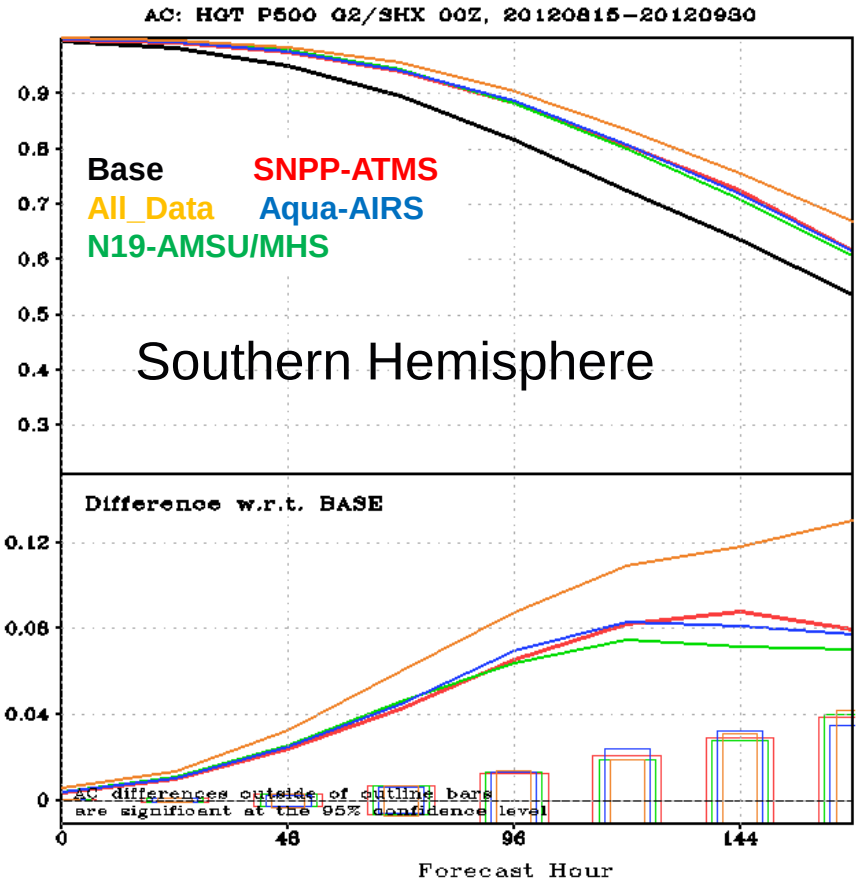
AMSU-A:	Metop-A
MHS:	Metop-A
HIRS:	Metop-A
IASI:	Metop-A
ASCAT:	Metop-A
GRAS:	Metop-A



© Crown copyright 2007

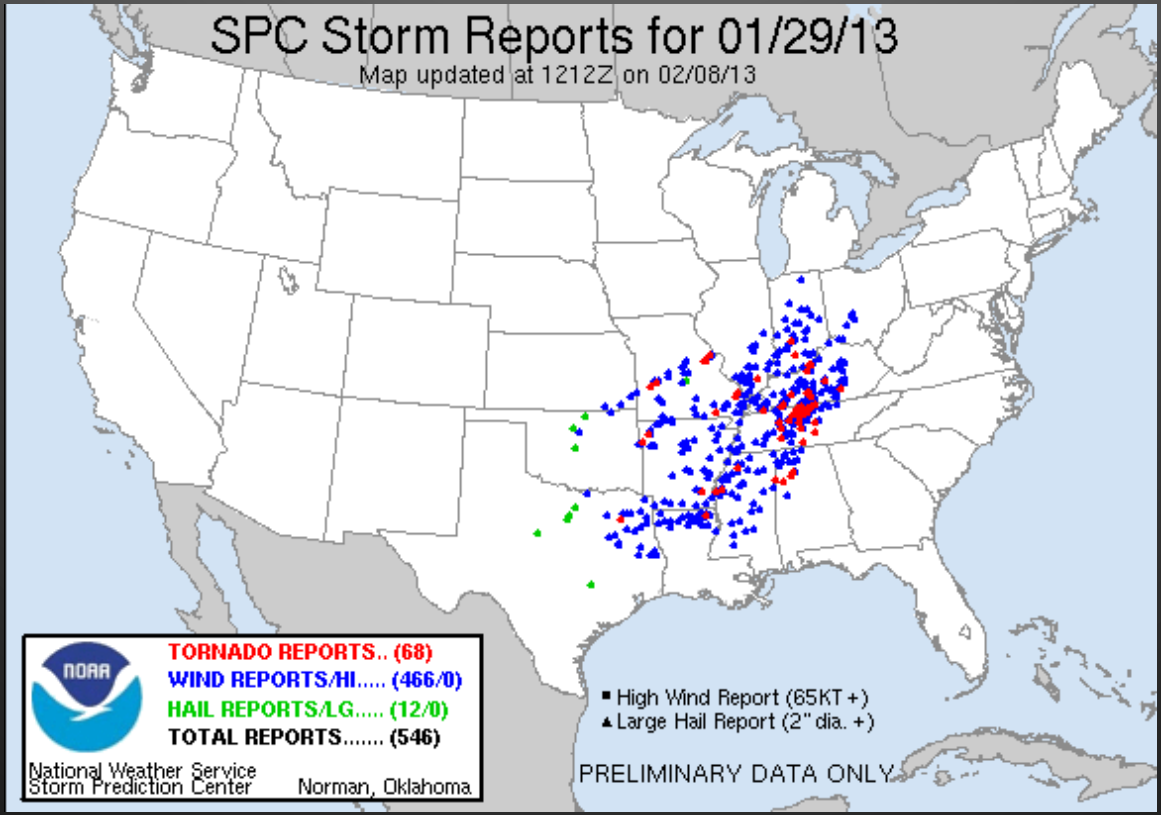
Single Sensor Impacts
500 hPa AC scores for
00Z 20120815-20120930 (Jim Jung)





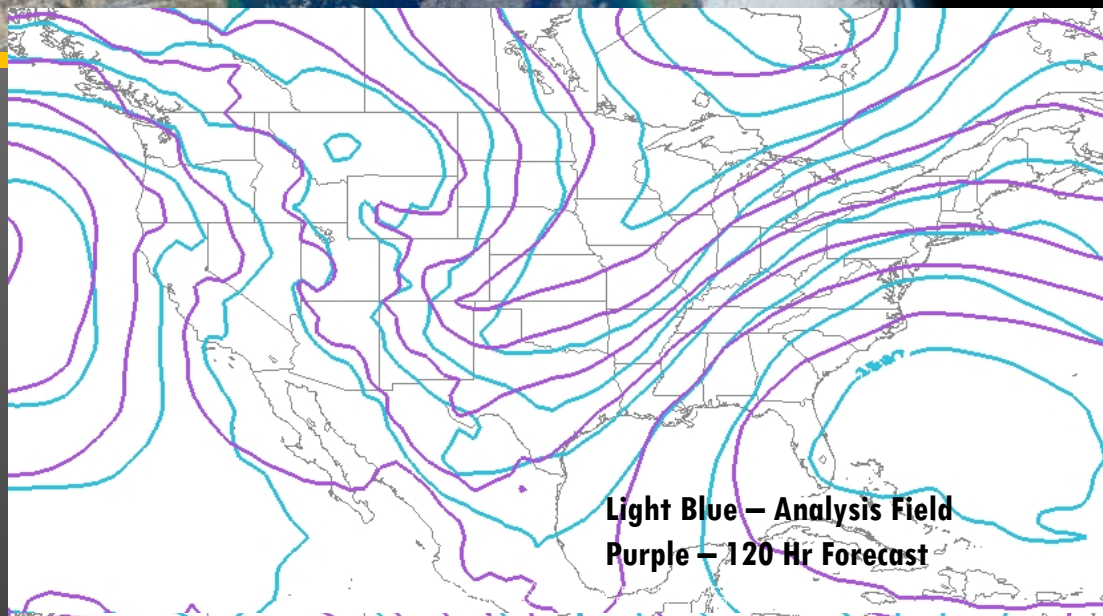
01/29/2013

(from Wayne Mackenzie, STC)

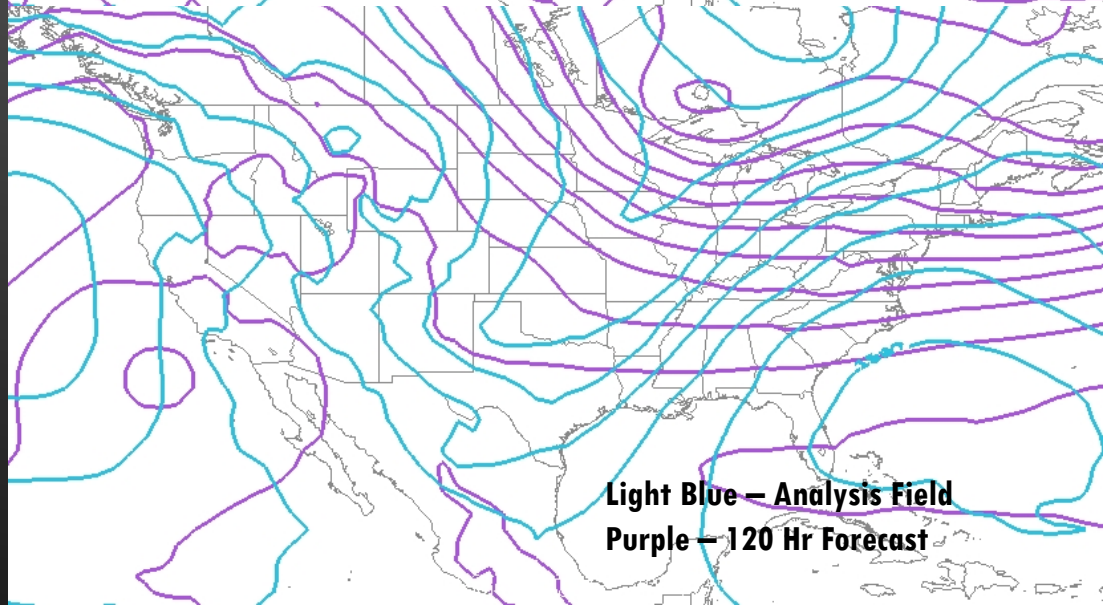


Analysis Field vs 120 Hr GFS Forecast 850 hPa
29 January 2013

120 Hour Forecast with
ALL Satellite Data



120 Hour Forecast with
NO Satellite Data



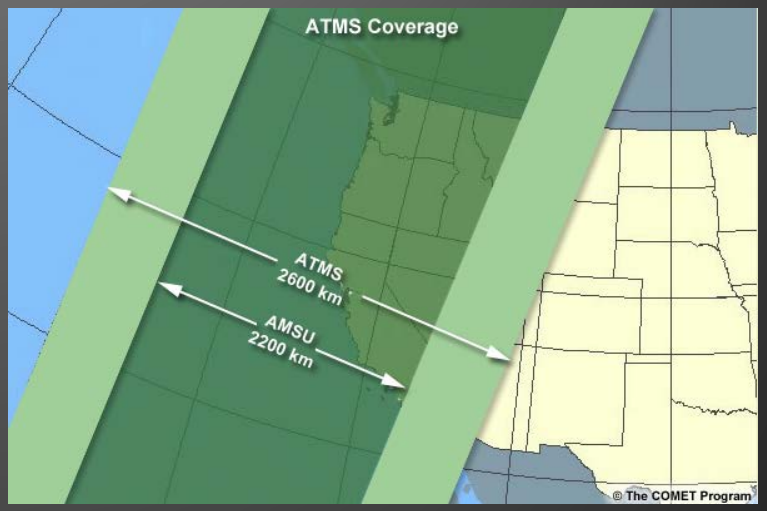
ATMS - Advanced Technology Microwave Sounder

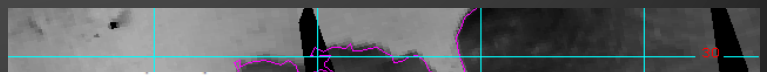
Advanced Features

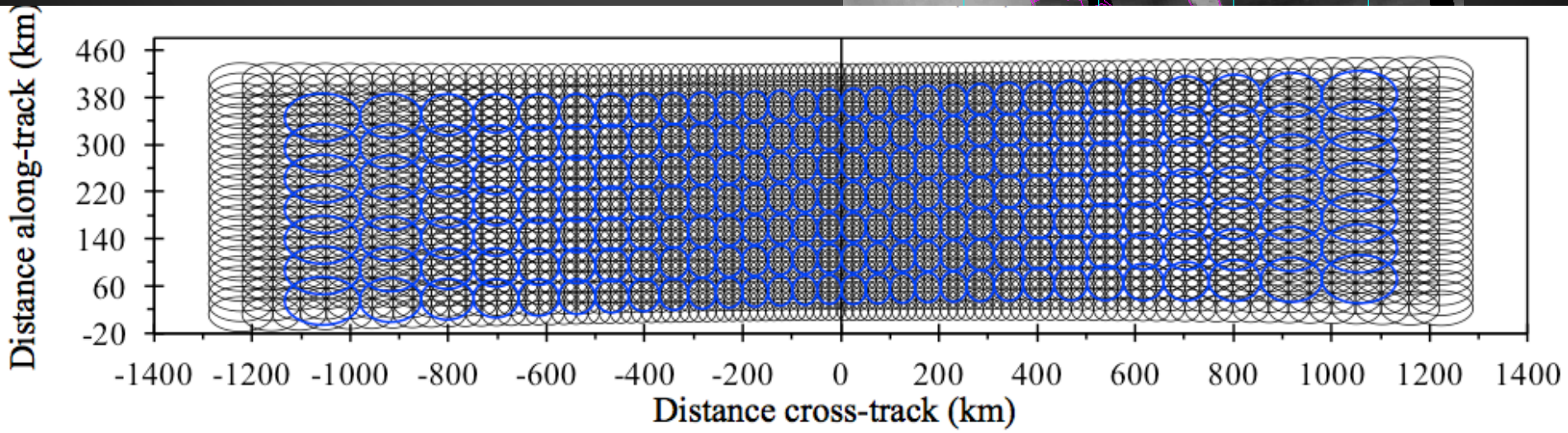
Three instruments (AMSU-A1, AMSU-A2 and MHS) in one instrument – less power and weight

Better spatial resolution (~48 to 32 km) for key temperature sounding channels

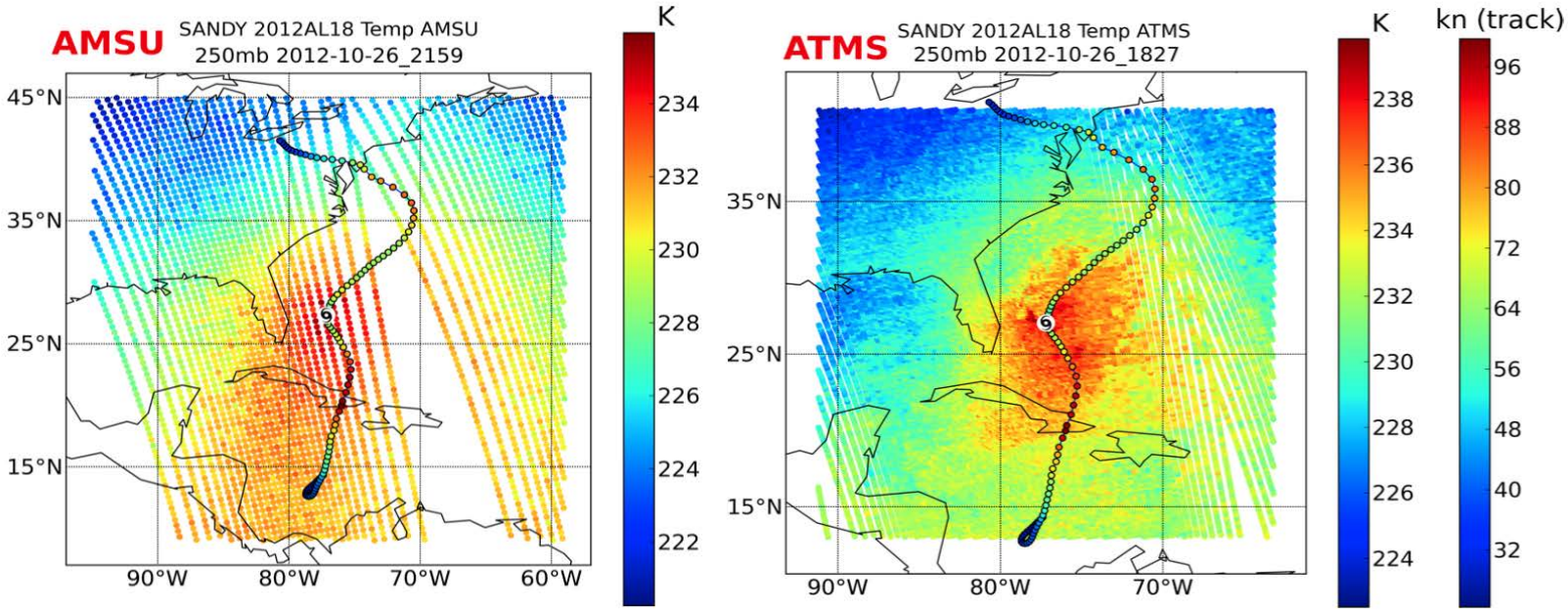
Oversampled footprints for improved warm core







Resolution: ATMS vs AMSU



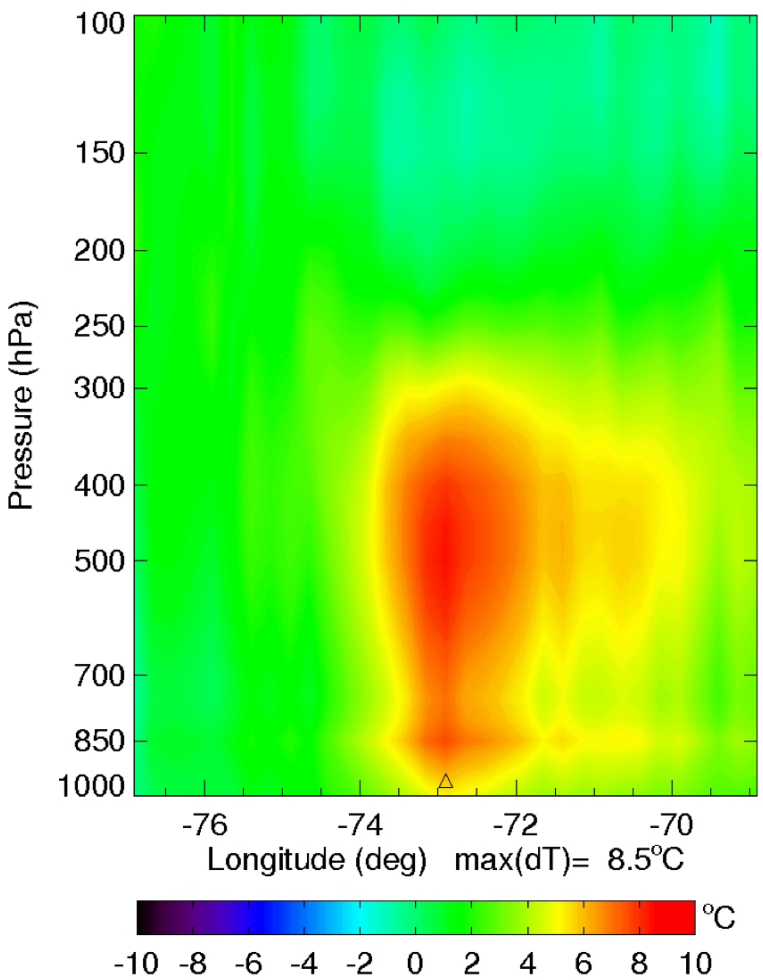
ATMS:

- higher resolution
- wider swath
- much smaller gaps between passes

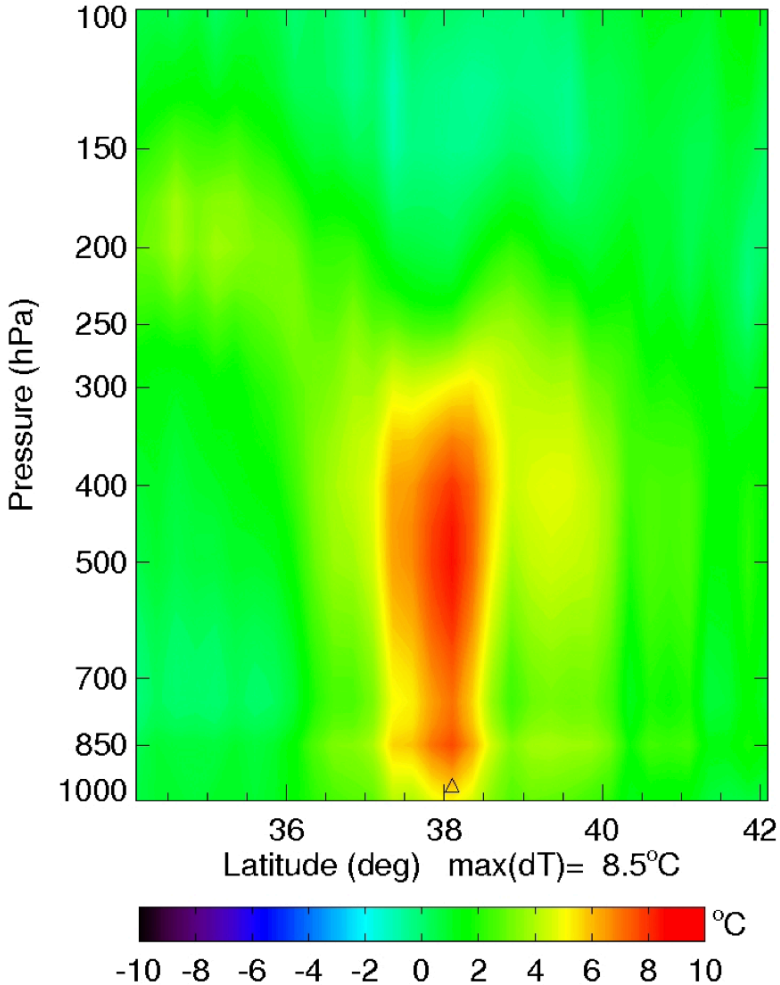
- Broader ATMS coverage gives increased coverage benefit for 2-orbit system (currently provided by legacy instruments)
- Increased horizontal resolution potentially beneficial for high gradient phenomena (such as hurricanes)

Hurricane Sandy Warm Core Anomaly Ascending 1730 UTC, 29 October 2012

At 1800 UTC Oct 29 Max Wind: 90 MPH, Min Pressure: 940 hPa



Cross section along Latitude 38.1 N

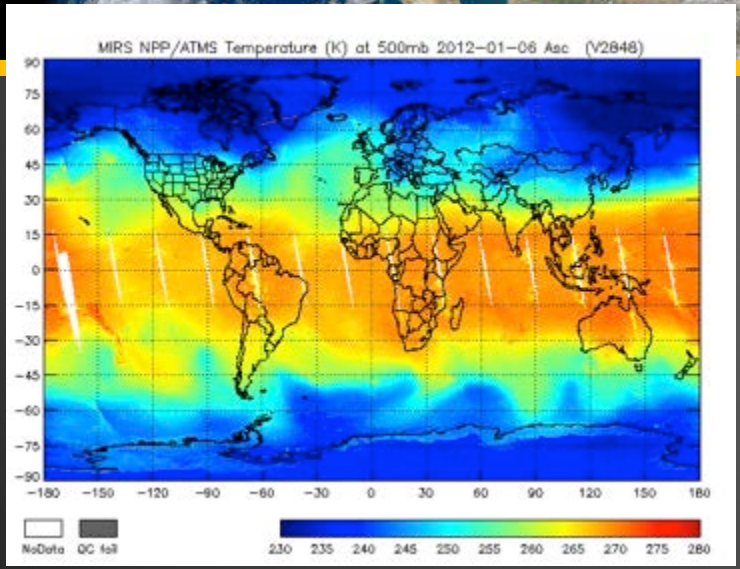


Cross section along Longitude 72.9 W

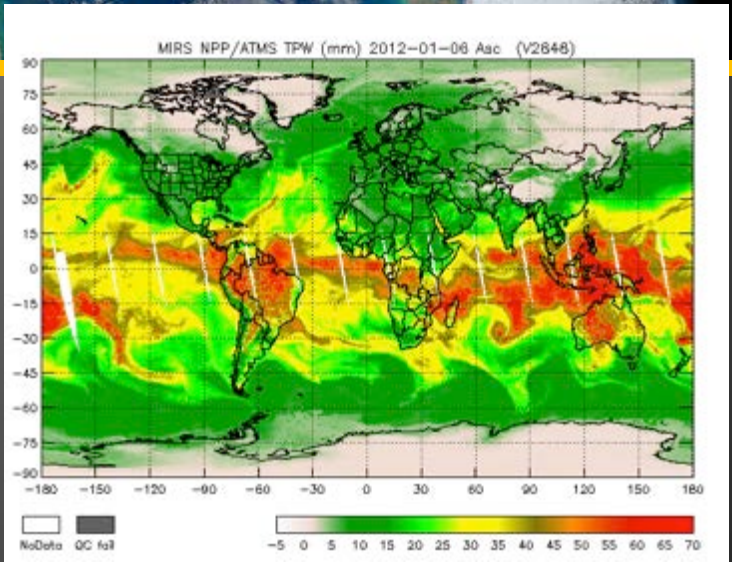
Zhu and Weng, 2013, GRL

NOAA ATMS MIRS Products

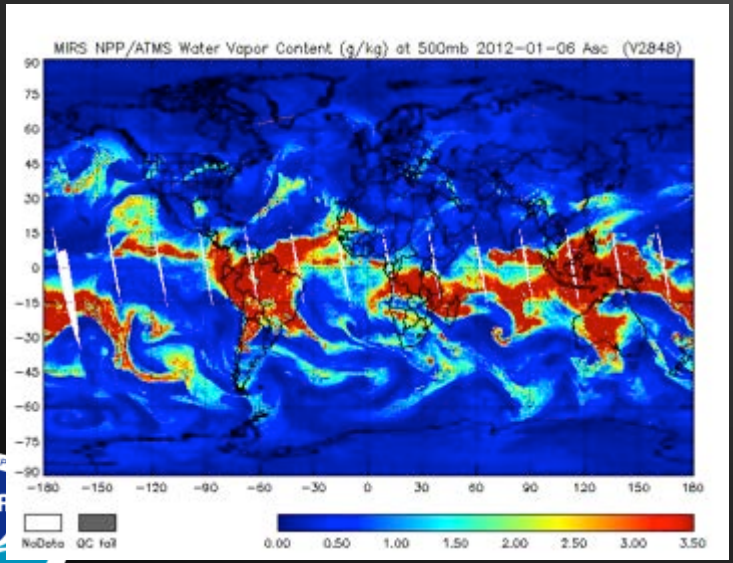
T



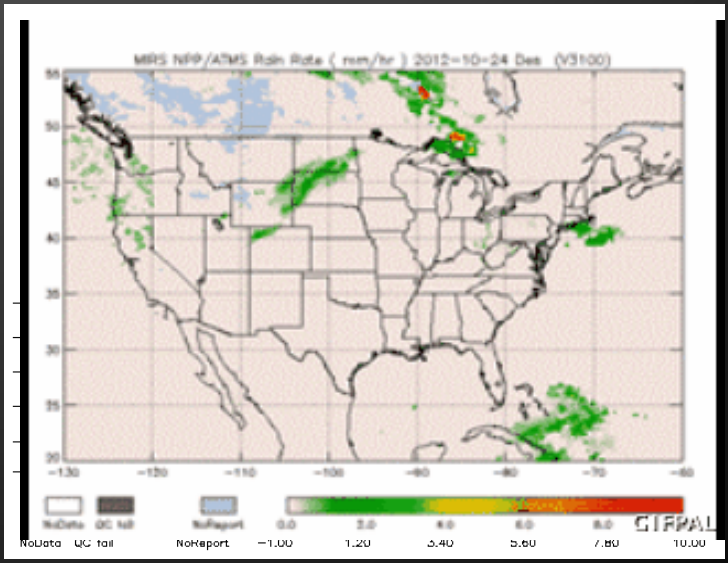
TPW



WV

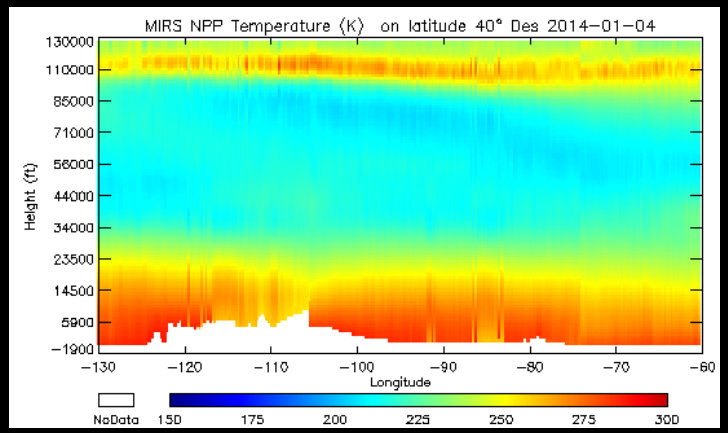


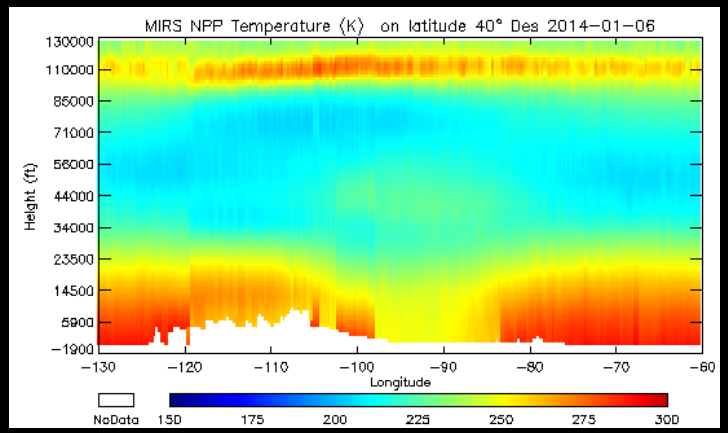
RR

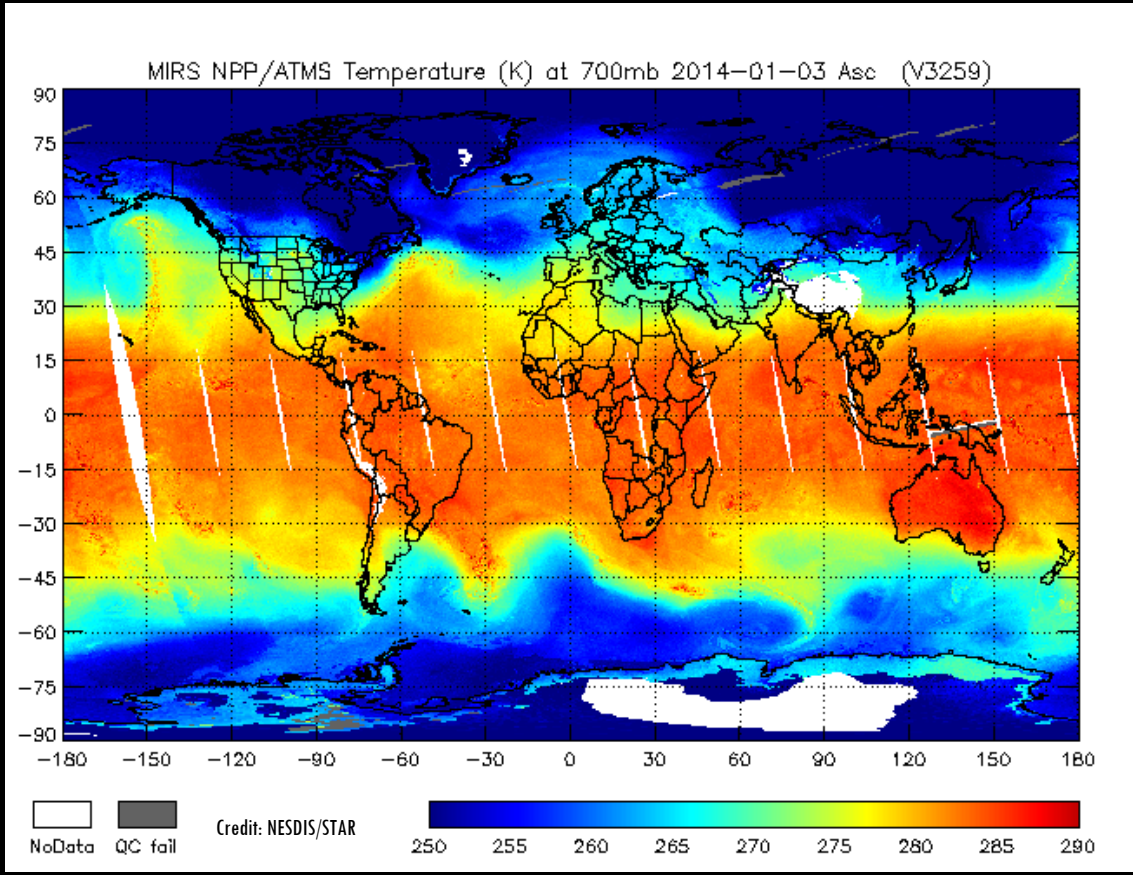


Courtesy of Sid Boukabara (STAR)

Polar Vortex







ATMS penetration of clouds reveals the transport of the Polar Vortex that impacted the US with large swath of record cold temperatures. The peak for DC area was 1/7/14. Above left are vertical cross-sections of temperature comparing January 4 with January 6, showing normal air temperature at ~ 23000 feet (-45 to -10 F, Winter) reached the surface on 1/6/14.

CrIS – Cross-track InfraRed Sounder

Advanced Features

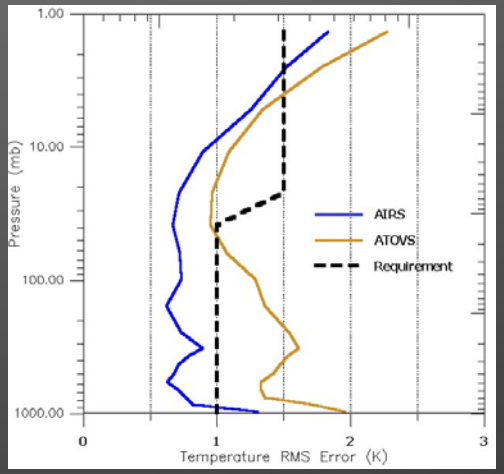
Lower power, volume and mass when compared to AIRS and IASI, and excellent signal to noise

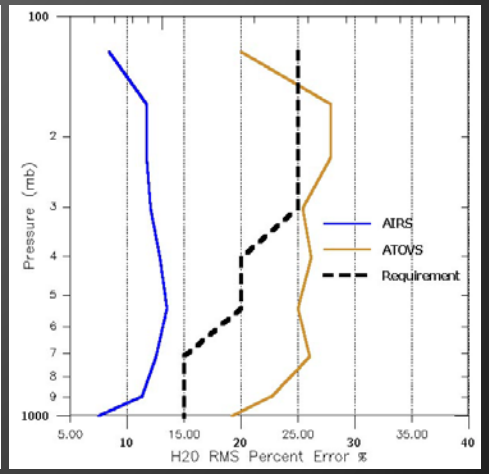
Significantly improved vertical resolution of temperature and water vapor when compared to POES HIRS and AMSU (1 – 2 km instead of - 6 km)

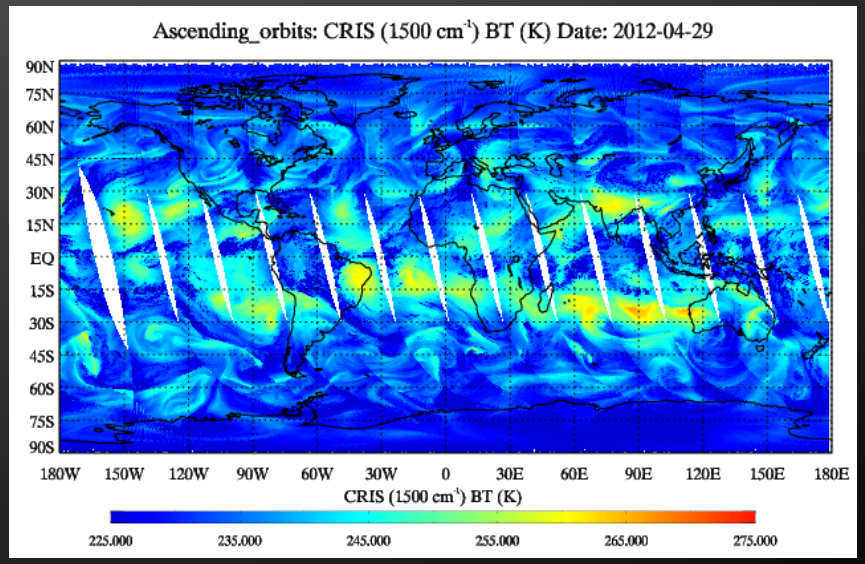
Combined with ATMS for cloud clearing – provides precision of about 1 Celsius for temperature and 15% for water vapor at vertical resolutions of 1-2 km

Also provides information on trace gases – O3, CO2, CO, CH4 - monitor continental transport of greenhouse gases

Provides accurate cloud properties (at 14 km resolution near nadir)

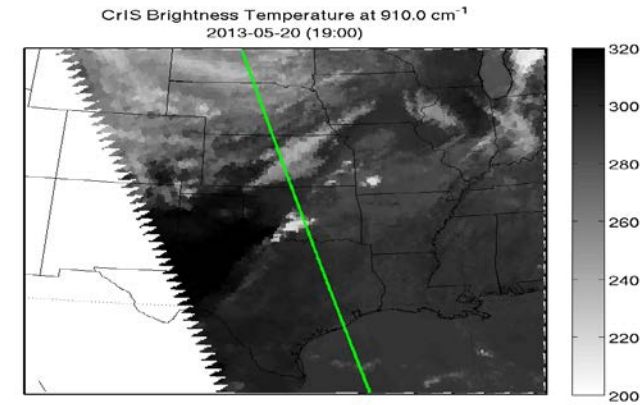


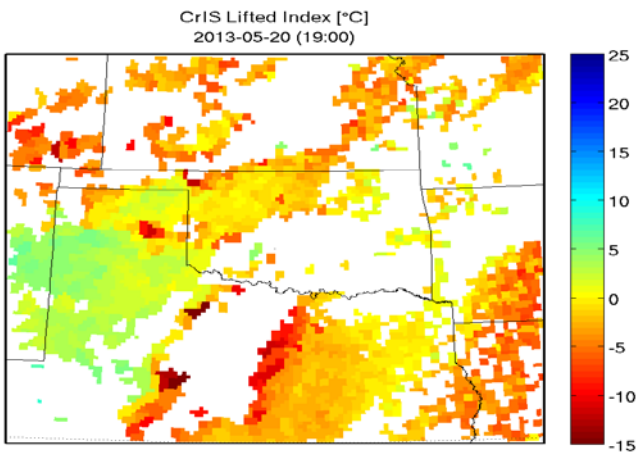


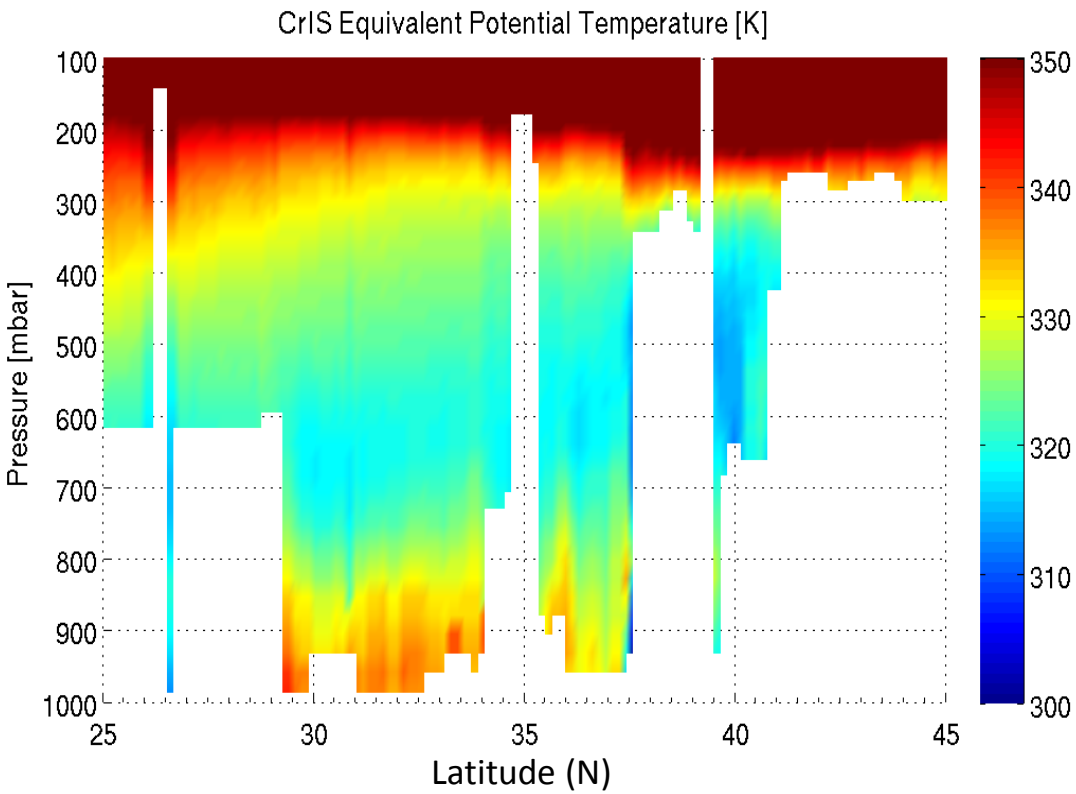


Moore OK Tornado (May 20, 2013)

(Bill Smith, Elisabeth Weisz)



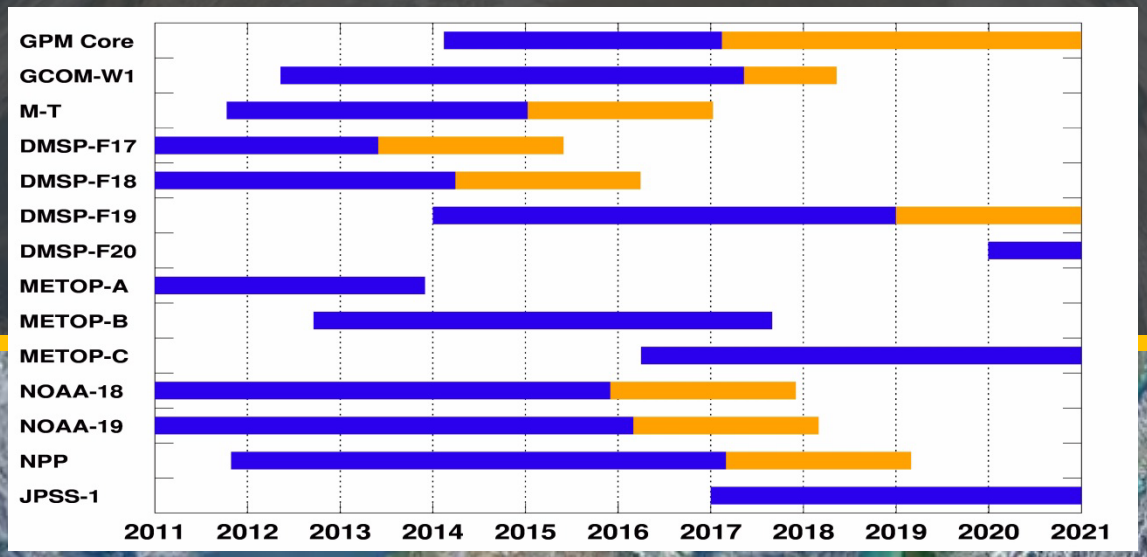


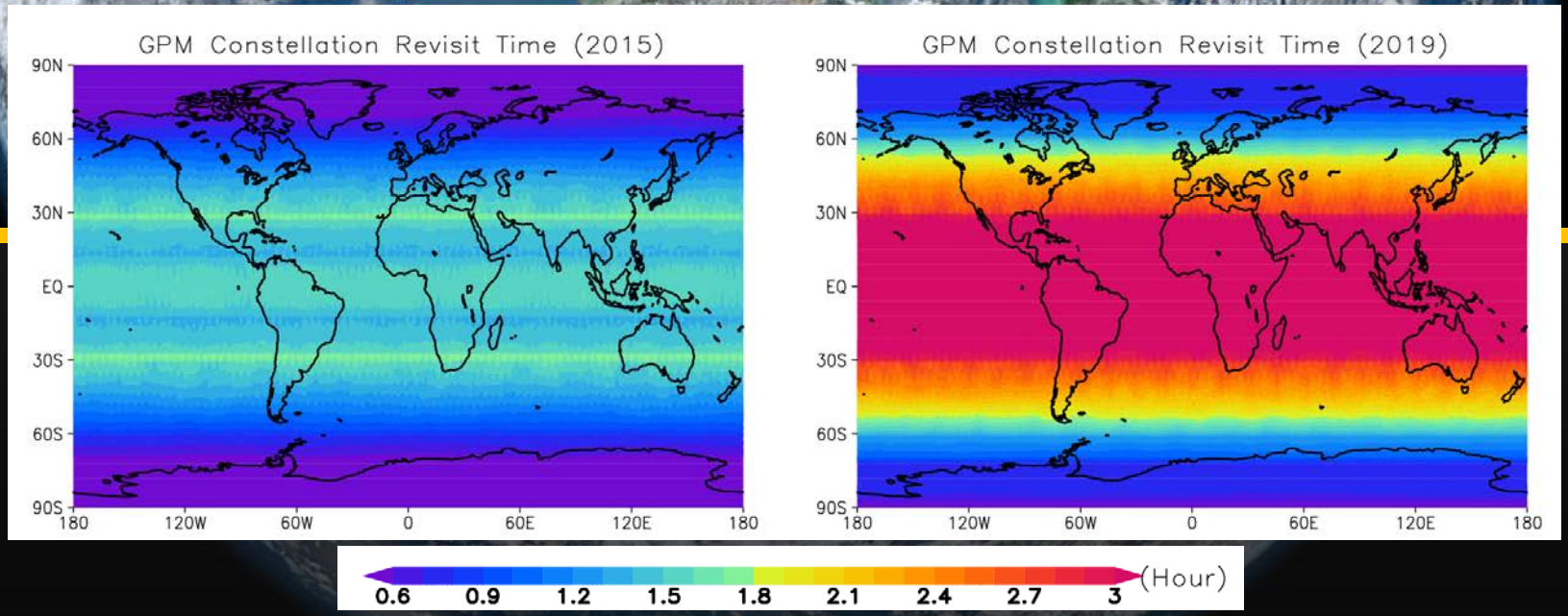


CrIS provides relatively high vertical resolution (1-2km) temperature and water vapor profiles with approximately 15 km spatial resolution. The CrIS observed tropospheric vertical lapse rate of Equivalent Potential Temperature and large negative values of Lifted Index revealed very strong instability across the Texas and Oklahoma region where strong convective storms developed, one of which spawned an EF-5 tornado within an hour after the SNPP overpass, leaving 25 dead in Moore OK.

Multiple Polar Orbiters significantly improves revisit times: GPM Example

But need direct readout add improved latency



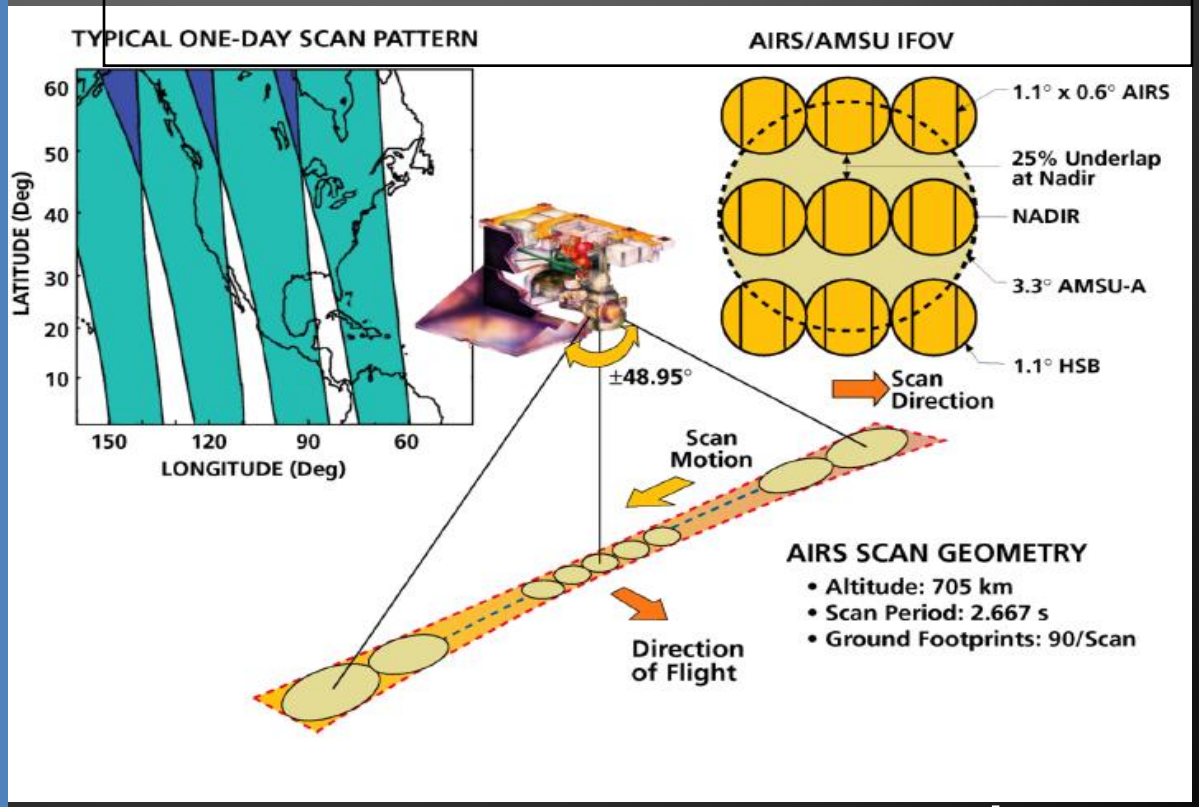


Sounding Strategy in Cloudy Scenes

- Sounding is performed on 50 km a field of regard (FOR)
- FOR is currently defined by the size of the microwave sounder footprint
- IASI/AMSU has 4 IR FOV's per FOR
- AIRS/AMSU & CrIS/ATMS have 9 IR FOV's per FOR
- ATMS is spatially over-sampled can emulate an AMSU FOV

Co-locate infrared and microwave instruments

.

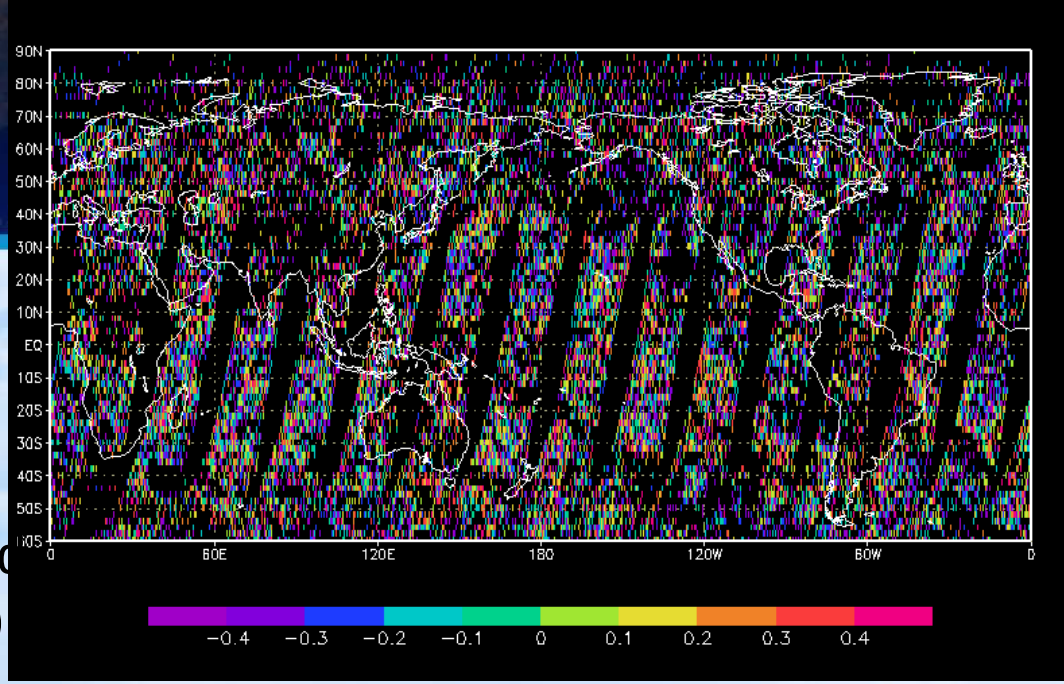


AIRS, IASI, and CrIS all acquire 324,000 FOR's per day!

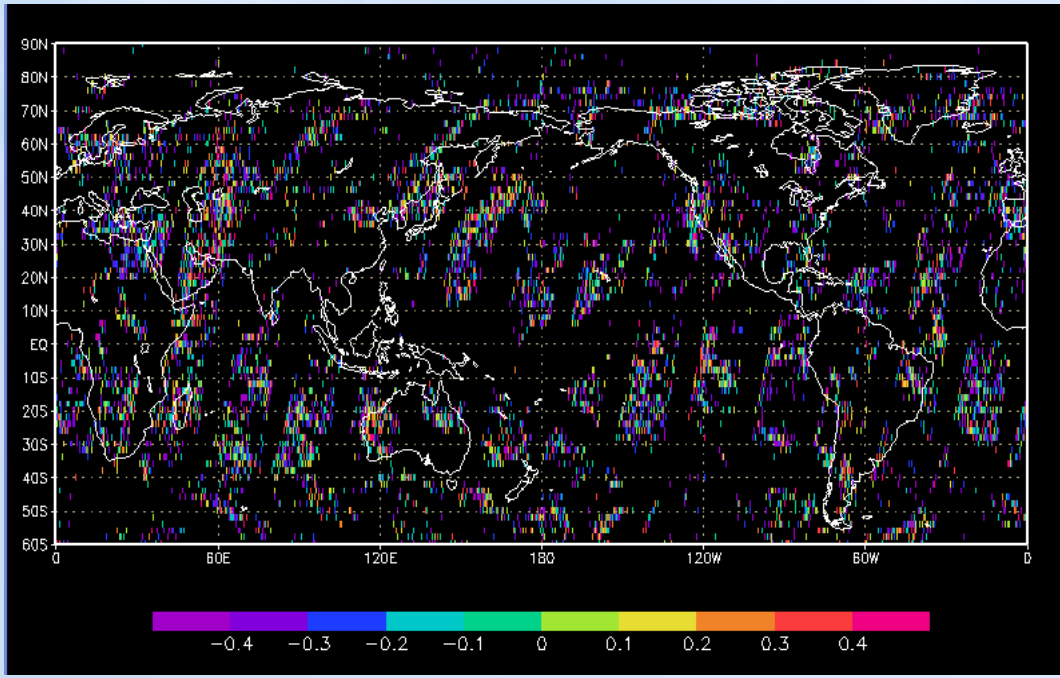
735.69 cm-1 (peak ~ 700 mb)

ALL diff < +- 0.5 K

Cloud-cleared minus clear simulated brightness temperatures (ECMWF)



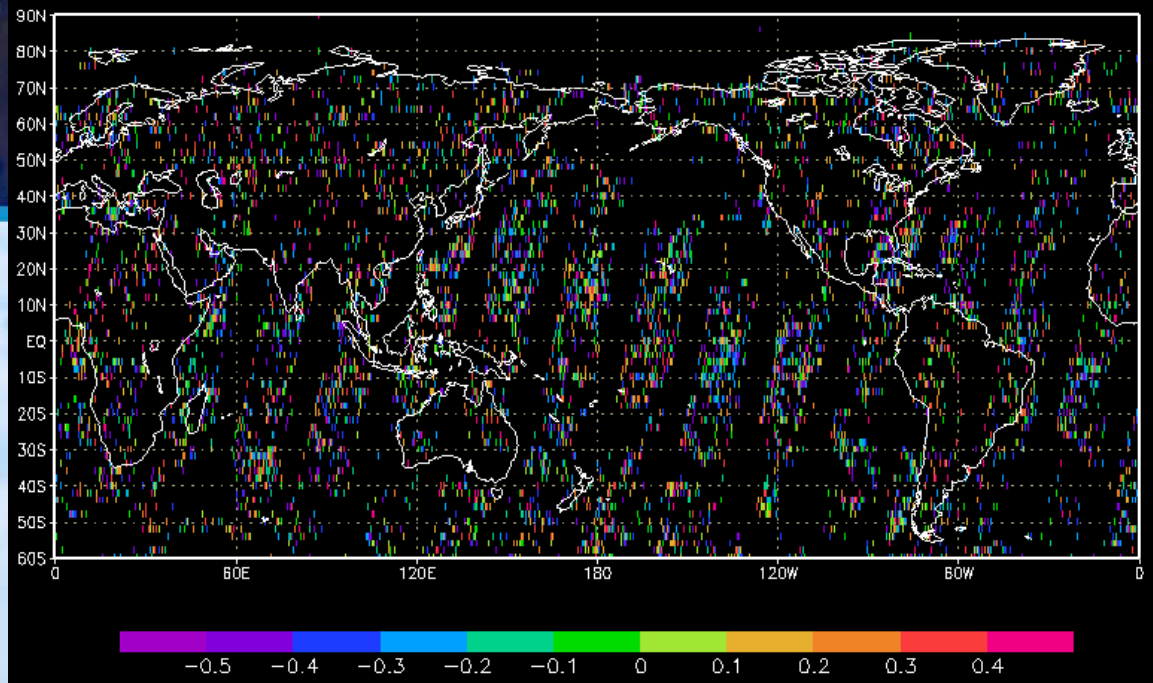
Observed minus clear simulated brightness temperatures (ECMWF)



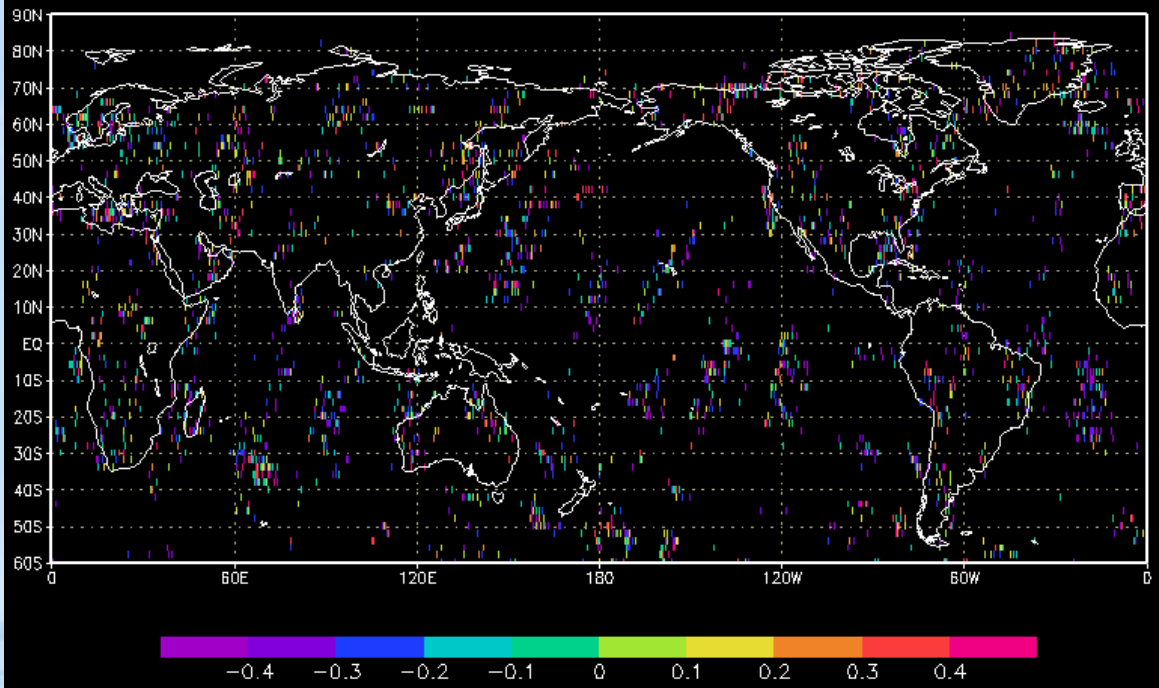
965 cm-1 (window)

ALL diff < +- 0.5 K

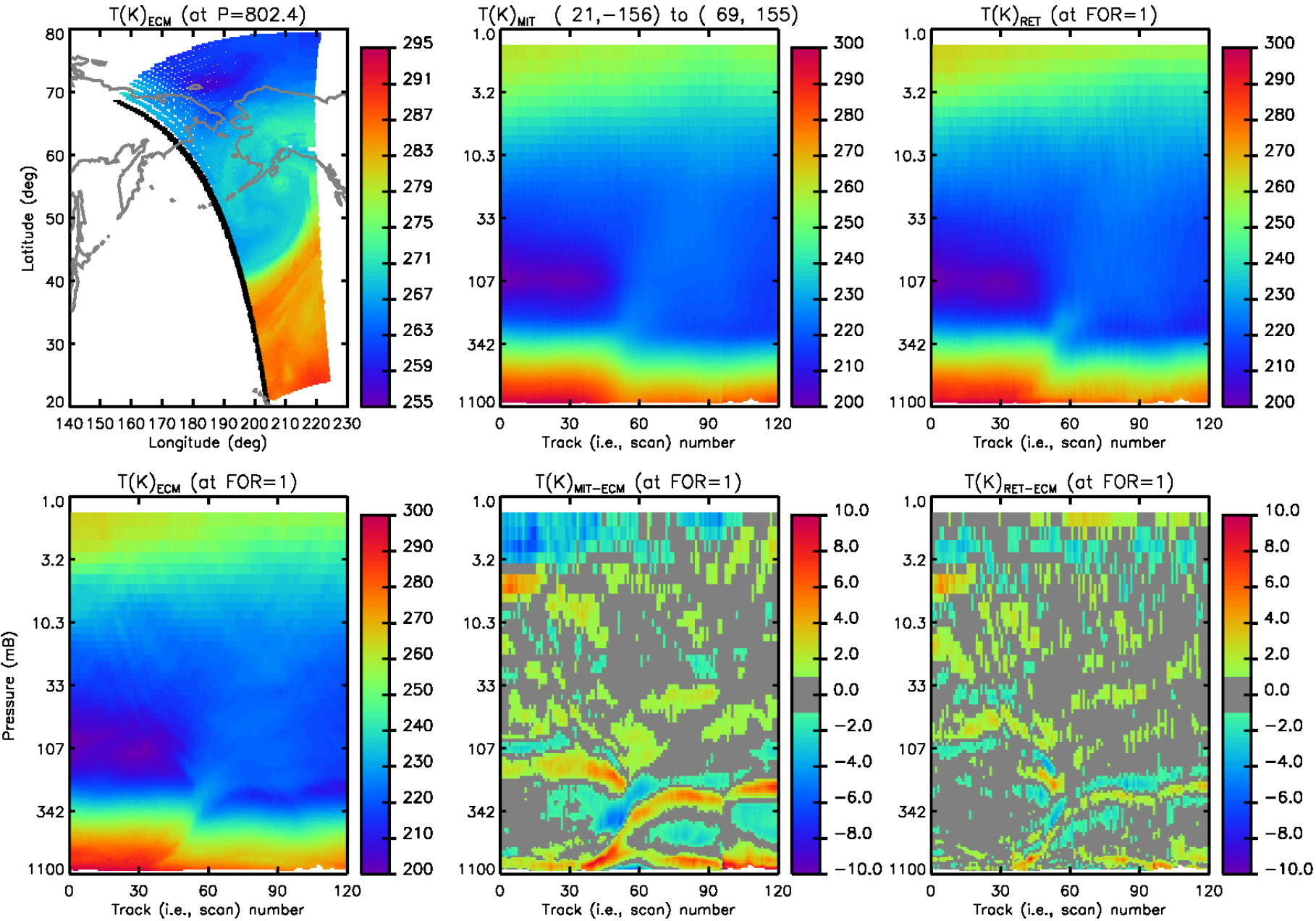
Cloud-cleared minus ECMWF



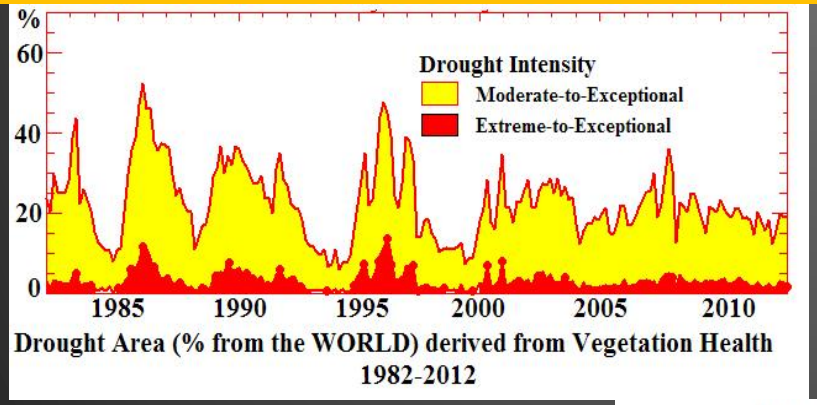
Raw minus ECMWF

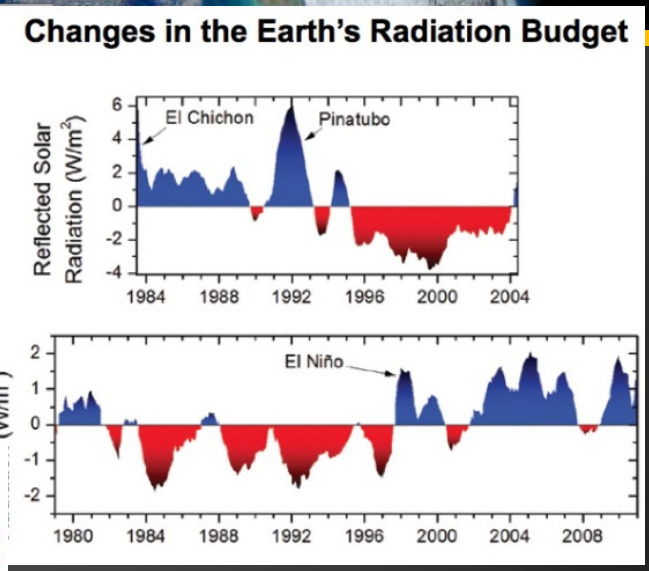


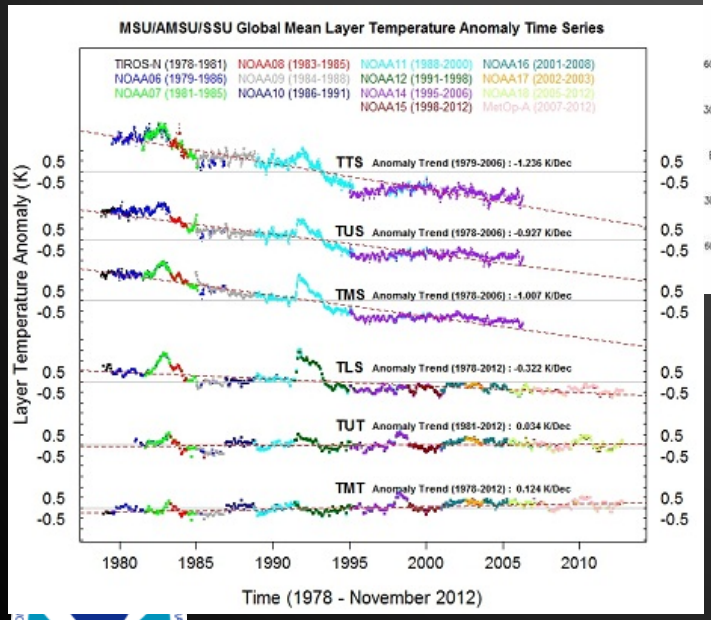
(Chris Barnet , STC)



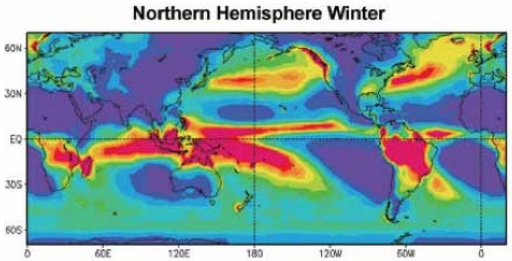
JPSS provides Critical Observations to Extend Climate Data Records

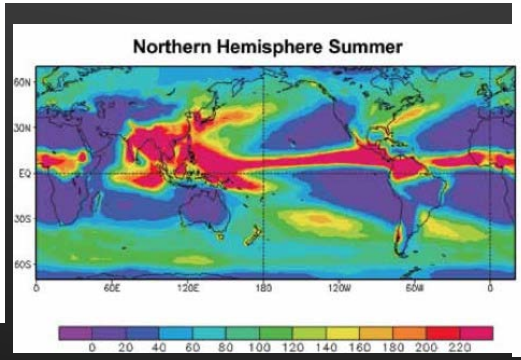




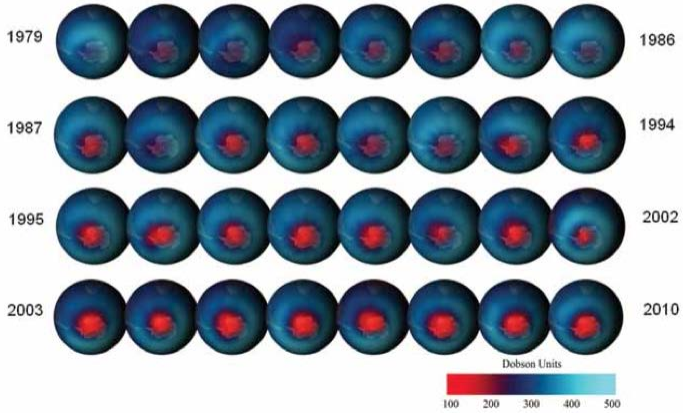


Average Rainfall





The Antarctic Ozone Hole: 1979 to 2010



Summary

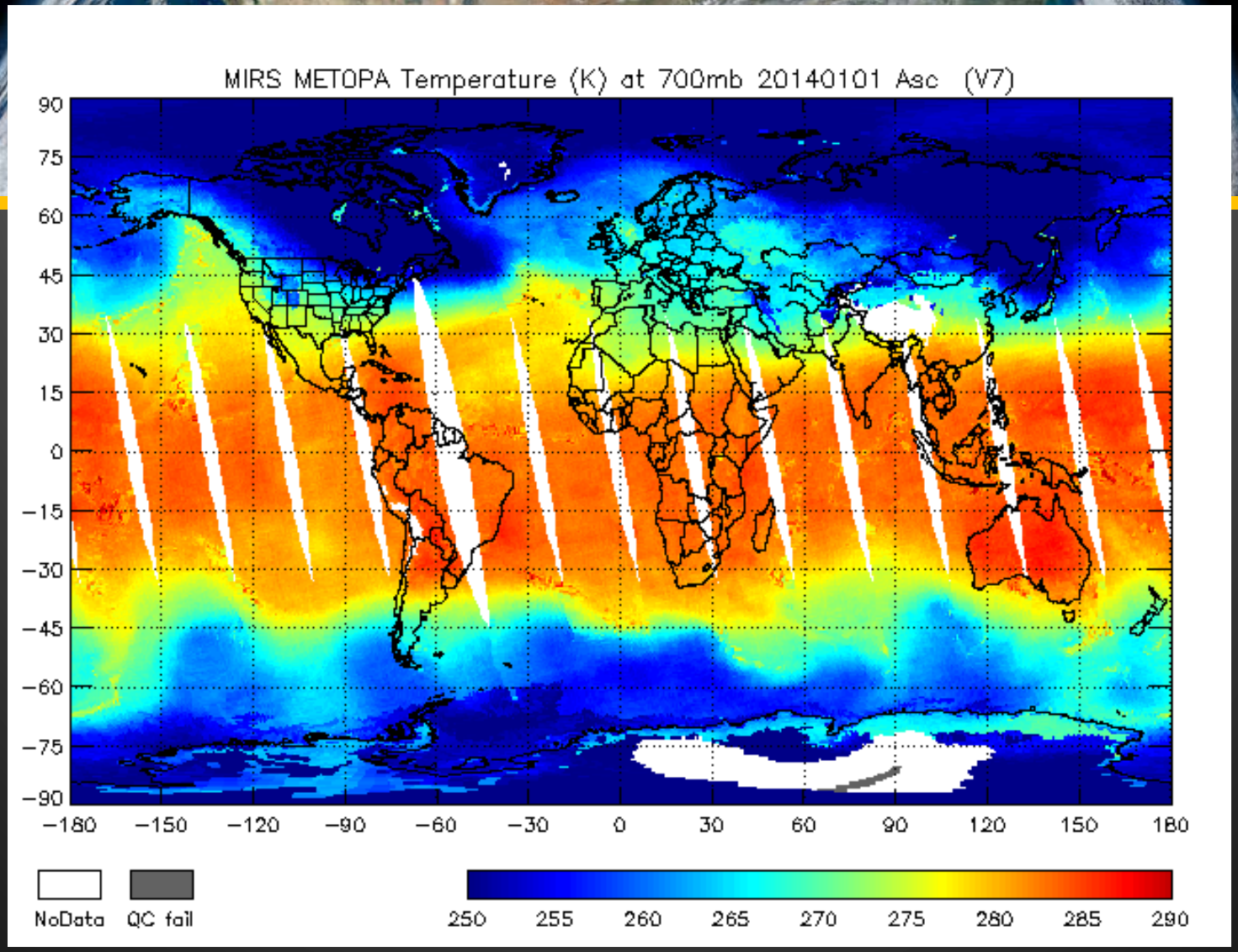
JPSS is a major contributor to the global observing system.

Suomi NPP instruments are performing exceptionally well!!

Many applications will benefit and JPSS has a data exploitation proving ground effort with each NOAA line office to improve product and services.

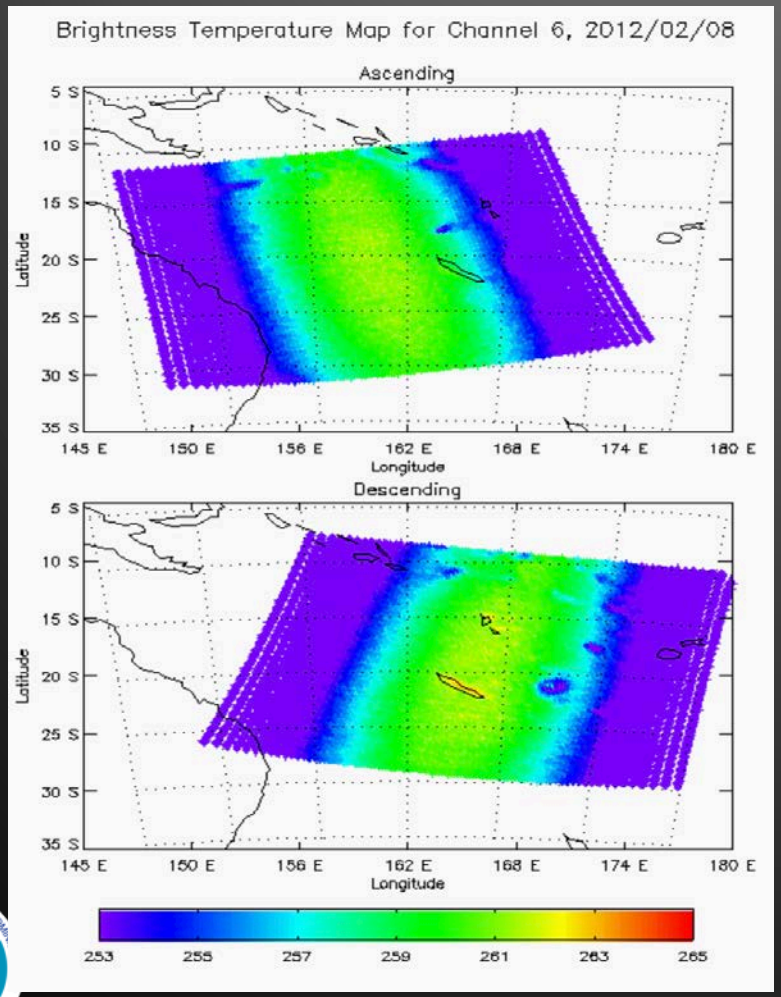
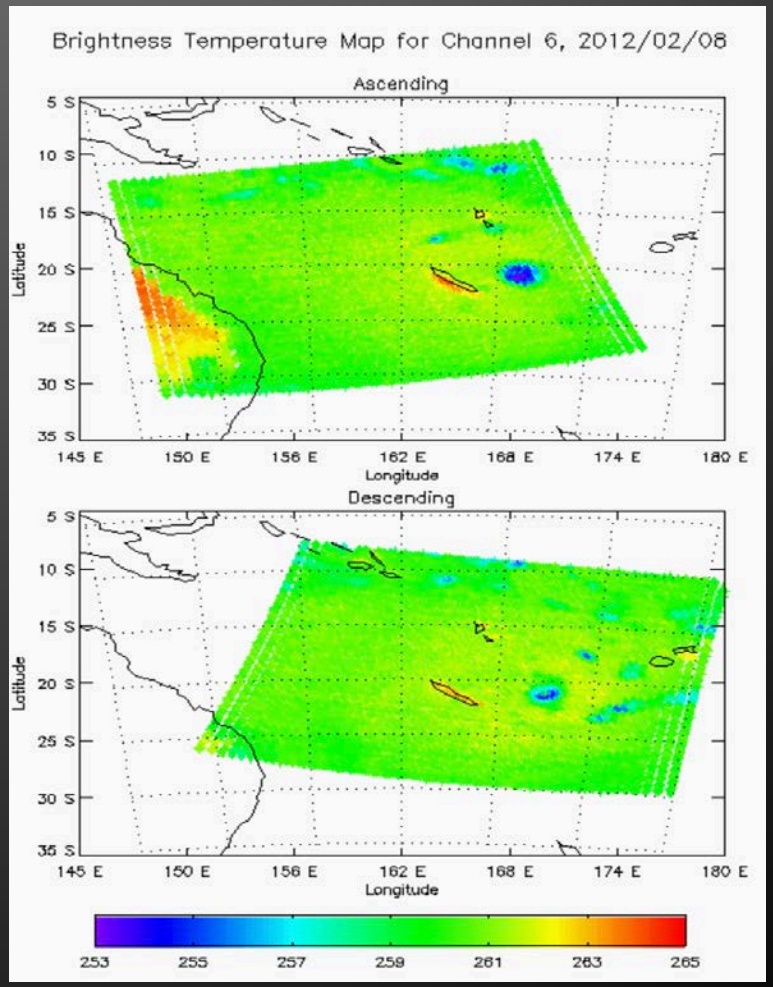
International partnerships are essential.

Observations coupled with modeling, data fusion, with the underpinning research, are essential for transforming observations to the products, applications, and services needed to address environmental impacts on society.



Jan 24th Fairbanks high temp = 45 , climatological average = -1 F

Jan 24th DC high temp = 24, climatological average = 44 F

ATMS IMAGERY via Limb Adj.

(from Kexin, Lihang)