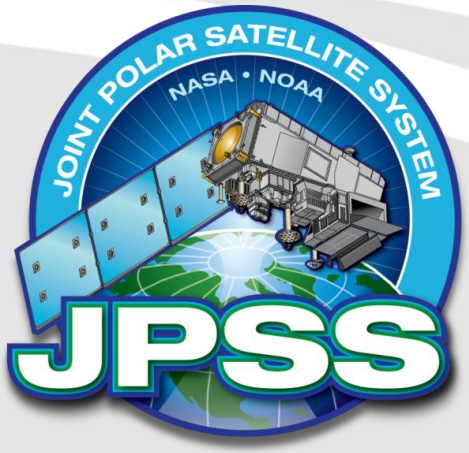


NPP Program Overview and User Readiness

Mitch Goldberg, JPSS Program Scientist (NOAA)
Jim Gleason, JPSS Project Scientist (NASA)
John Furgerson, JPSS User Liaison (NOAA)

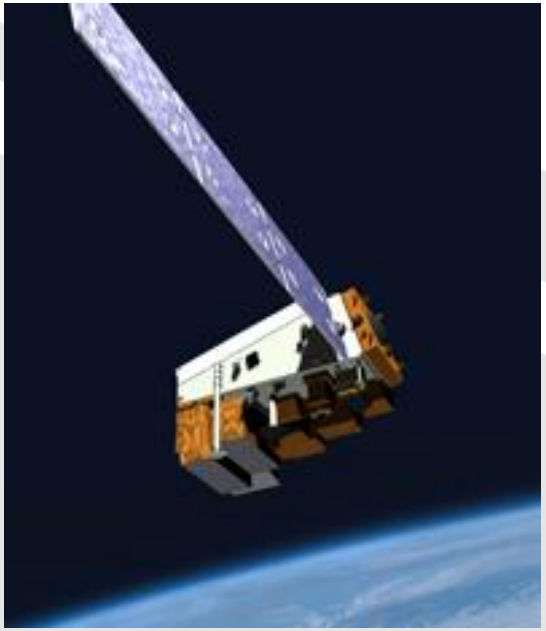
PRESIDENTIAL DECISION 2 FEB 2010

- **NPOESS Program Terminated 30 Sep 2010**
  - NOAA assigned 1330 orbit – Joint Polar Satellite System (JPSS)
  - DoD assigned 0530 orbit – Defense Weather Satellite System (DWSS)
  - EUMETSAT MetOp will provide 0930 orbit
  - Common Ground System (GCS) using systems developed for NPOESS
    - Command, Communications & Control (C3S)
    - Data production system (IDPS)
    - Globally Distributed Receptor Network (DRN)
  - Advanced sensors developed for NPOESS will be continued
    - VIIRS (MODIS heritage)
    - CrIS (AIRS/IASI heritage)
    - OMPS (OMI/TOMS heritage)
    - ATMS (AMSU heritage)
    - CERES/ERBS

JPSS Program Overview

Benefits

- Maintains continuity of weather/climate observations and critical environmental data from the polar orbit
- NOAA – JPSS provides improved continuity for POES
  - HIRS > CrIS
  - AMSU > ATMS
  - AVHRR > VIIRS
  - SBUV2 > OMPS
- NASA – JPSS provides continuity for EOS
  - AIRS > CrIS
  - AMSU > ATMS
  - MODIS > VIIRS
  - OMI > OMPS
  - AMSR-E > AMSR2 (JAXA-GCOM-W)



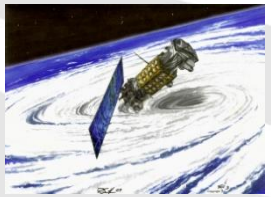
JPSS-1 Satellite

(NPP-clone)

Evolution of The Polar Satellite Programs

NPOESS C-2

Early Morning Orbit

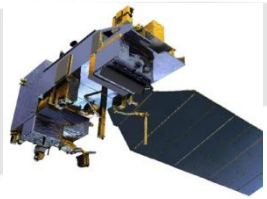


DWSS

MetOp

Mid-morning Orbit

MetOp

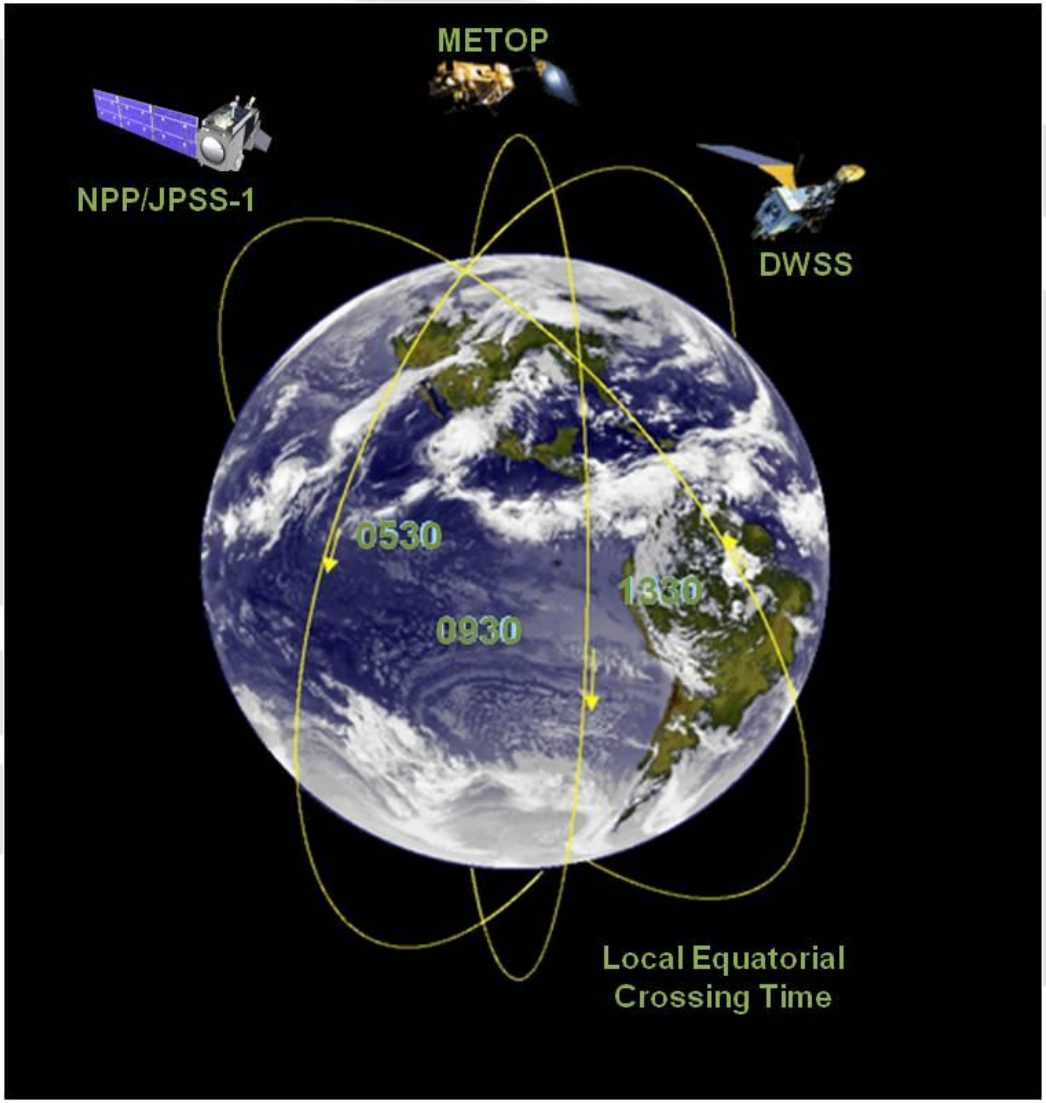


NPOESS C-1

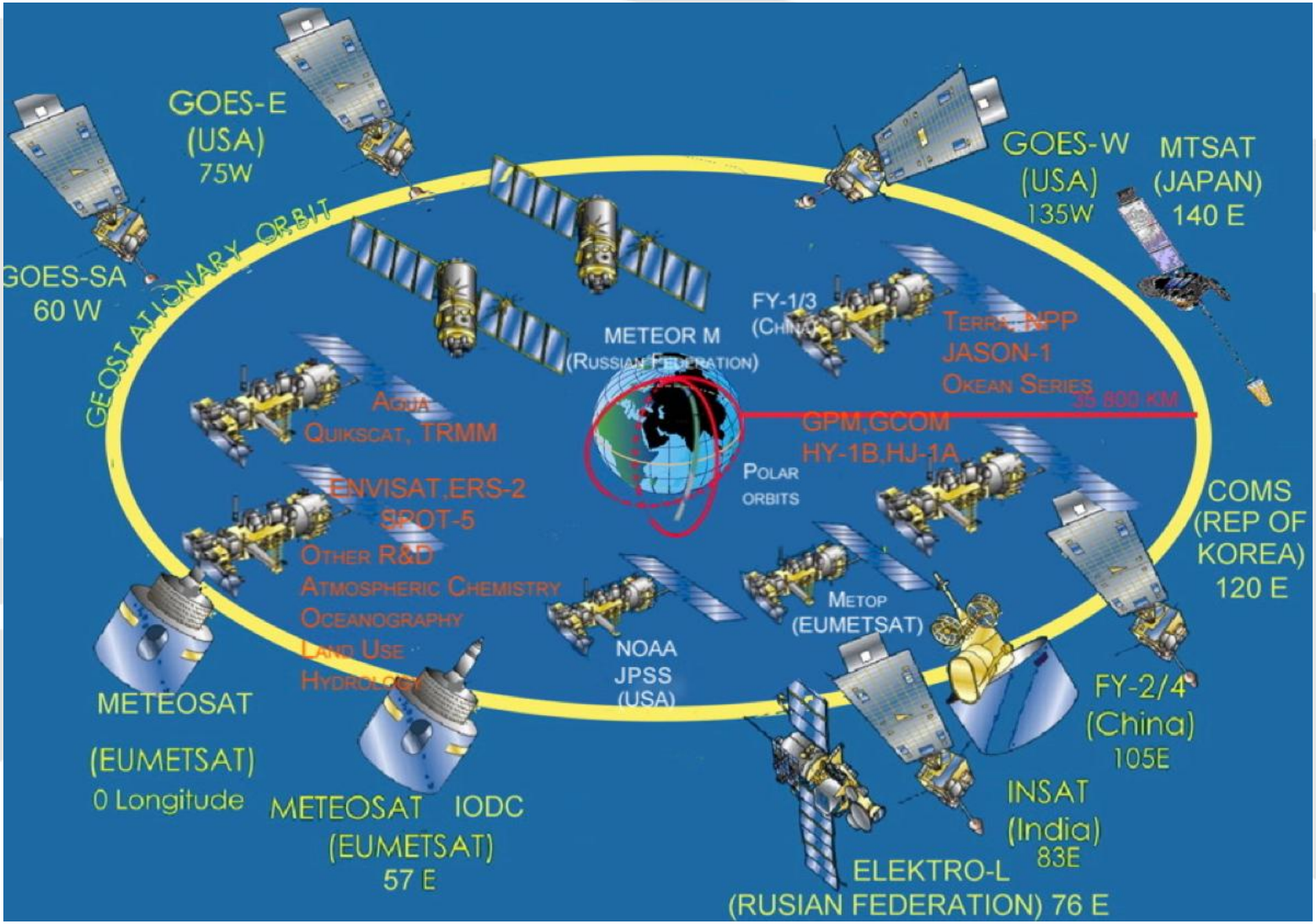
Afternoon Orbit

JPSS

US SATELLITE CONSTELLATION IN JPSS ERA



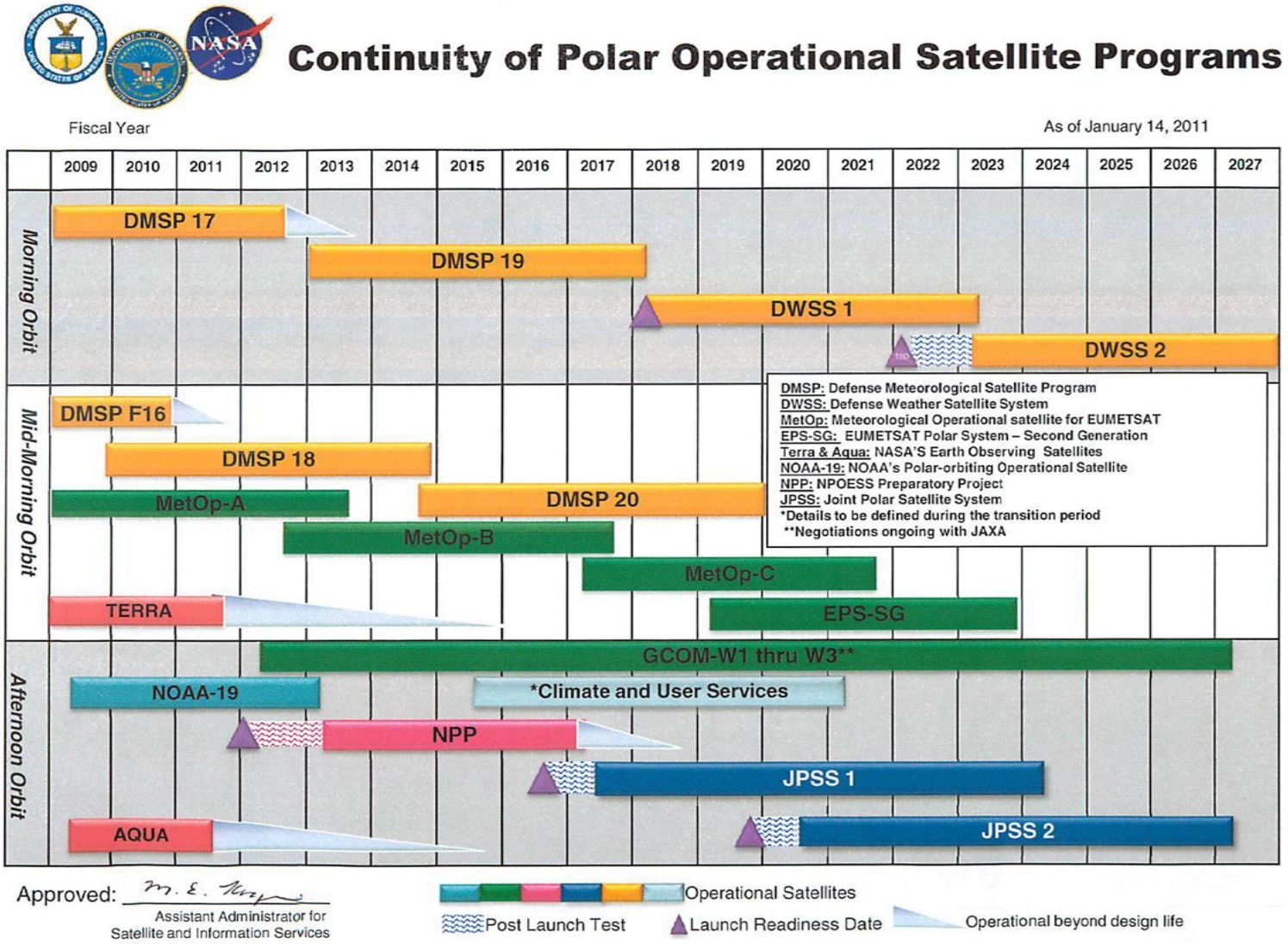
GLOBAL OBSERVING SYSTEM



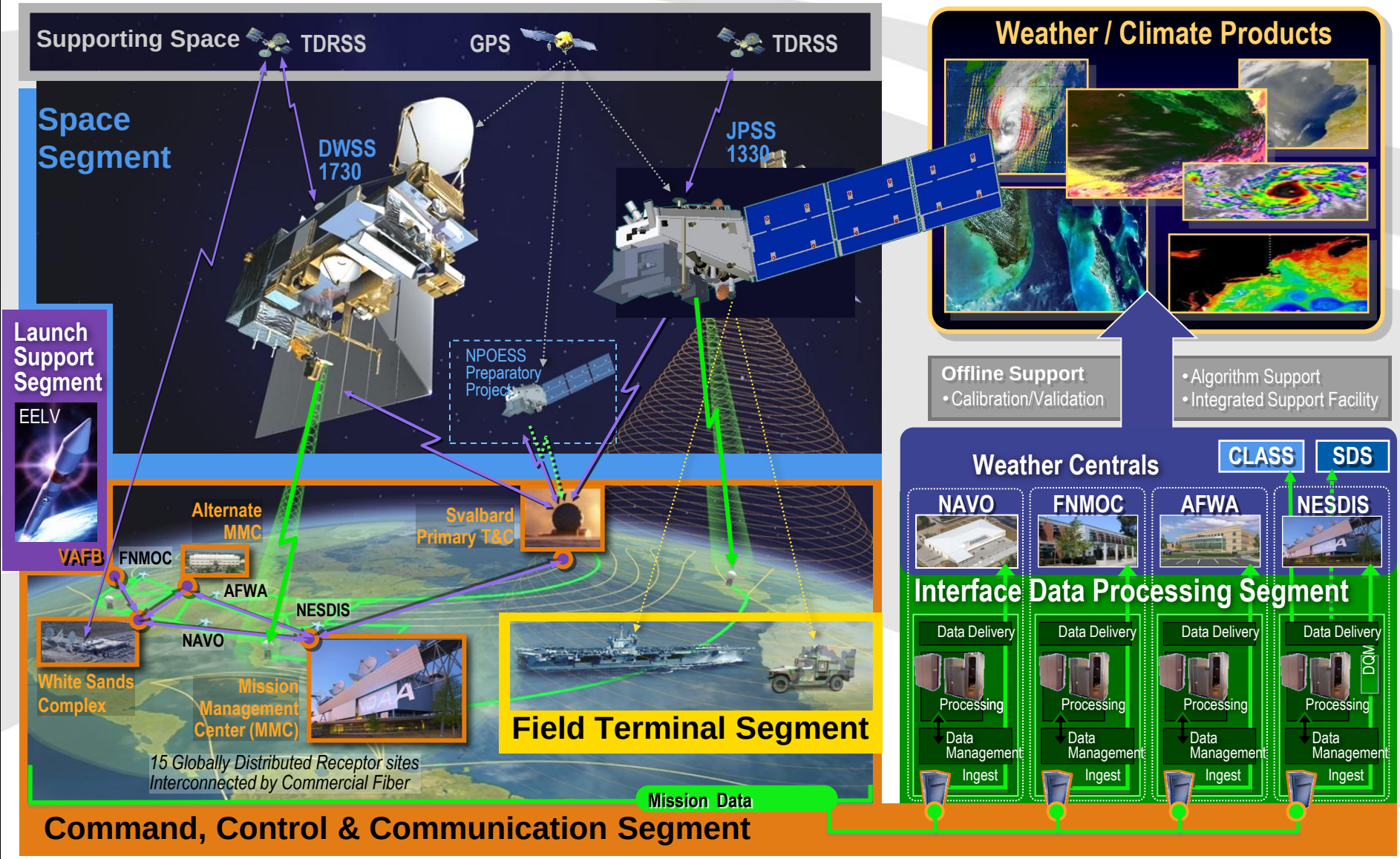
JPSS PROGRAM PLANS

- **NASA will procure and integrate JPSS for NOAA**
  - POES / GOES model
- **Algorithm development and Cal/Val led by NOAA**
- **NPOESS Preparatory Project (NPP) will be completed as planned**
  - Five Sensors (VIIRS, CrIS, ATMS, OMPS, CERES)
  - NPP will use C3S and IDPS developed for NPOESS
- **NOAA/NASA will develop JPSS series for 1330 Orbit**
- **JPSS-1 will be NPP Clone**
  - SARSAT and A/DCS will likely fly on separate satellite
  - JPSS-1 will use Distributed Receptor Network
- **JPSS-2 and beyond will be competed**
- **DoD plans for DWSS being developed**
  - DoD will launch remaining inventory of DMSP in the interim

Continuity of Polar Operational Satellites

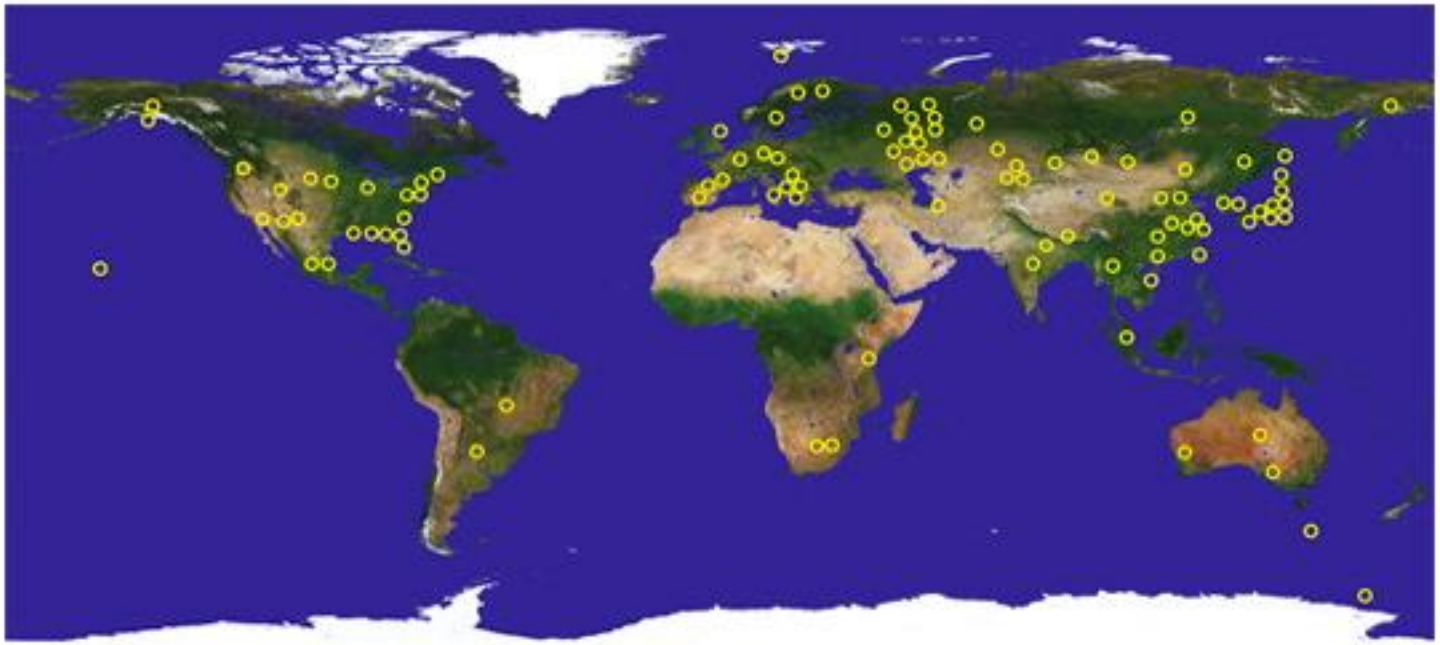


JPSS System Architecture



Direct Readout Stations using Xband

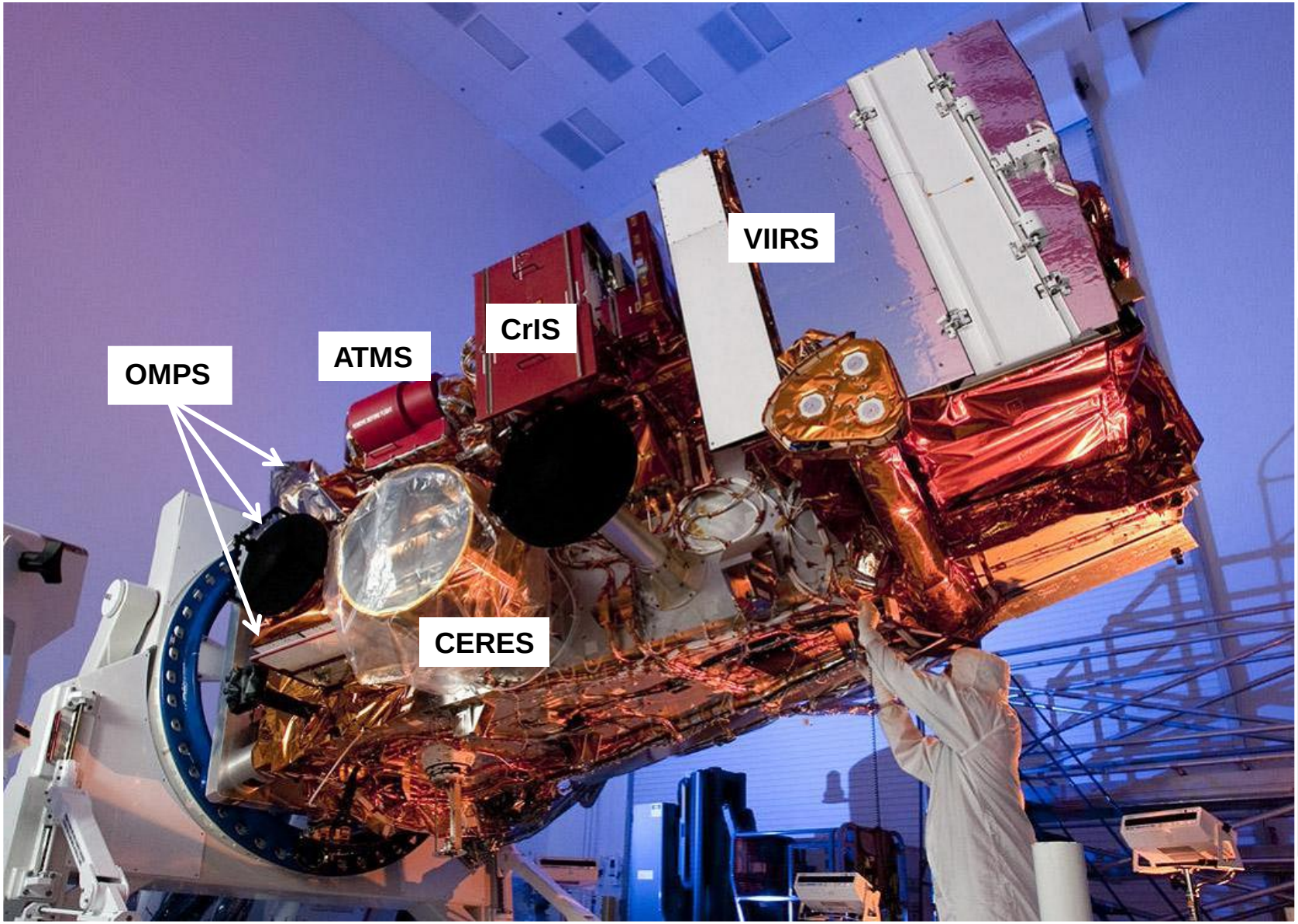
Terra/Aqua DB Sites



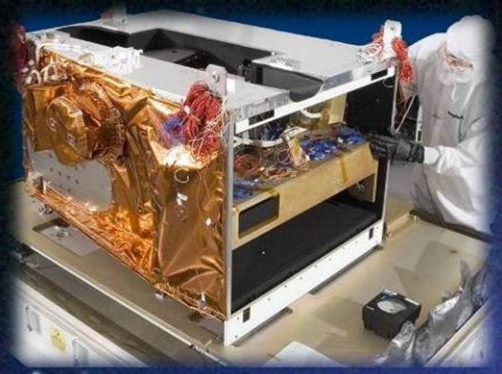
EOS Direct Broadcast Sites Worldwide – Updated January 25, 2010

ANTARCTICA ARGENTINA AUSTRALIA BELARUS BRAZIL CHINA FINLAND FRANCE GERMANY INDIA IRAN ITALY JAPAN KAZAKHSTAN KENYA MEXICO NORWAY RUSSIA SCOTLAND SINGAPORE SOUTH AFRICA SOUTH KOREA SPAIN SWEDEN TAIWAN THAILAND UNITED ARAB EMIRATES USA VIETNAM

NPP Spacecraft (JPSS-1 Concept)

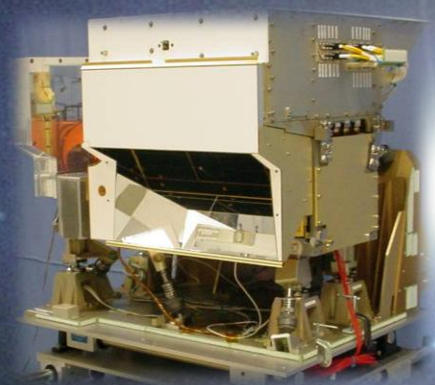


NPP/JPSS-1 SENSORS



Visible/Infrared Imager Radiometer Suite (VIIRS) Raytheon

Cloud and Earth Radiant Energy System (CERES) (FM5 for NPP) Northrop Grumman

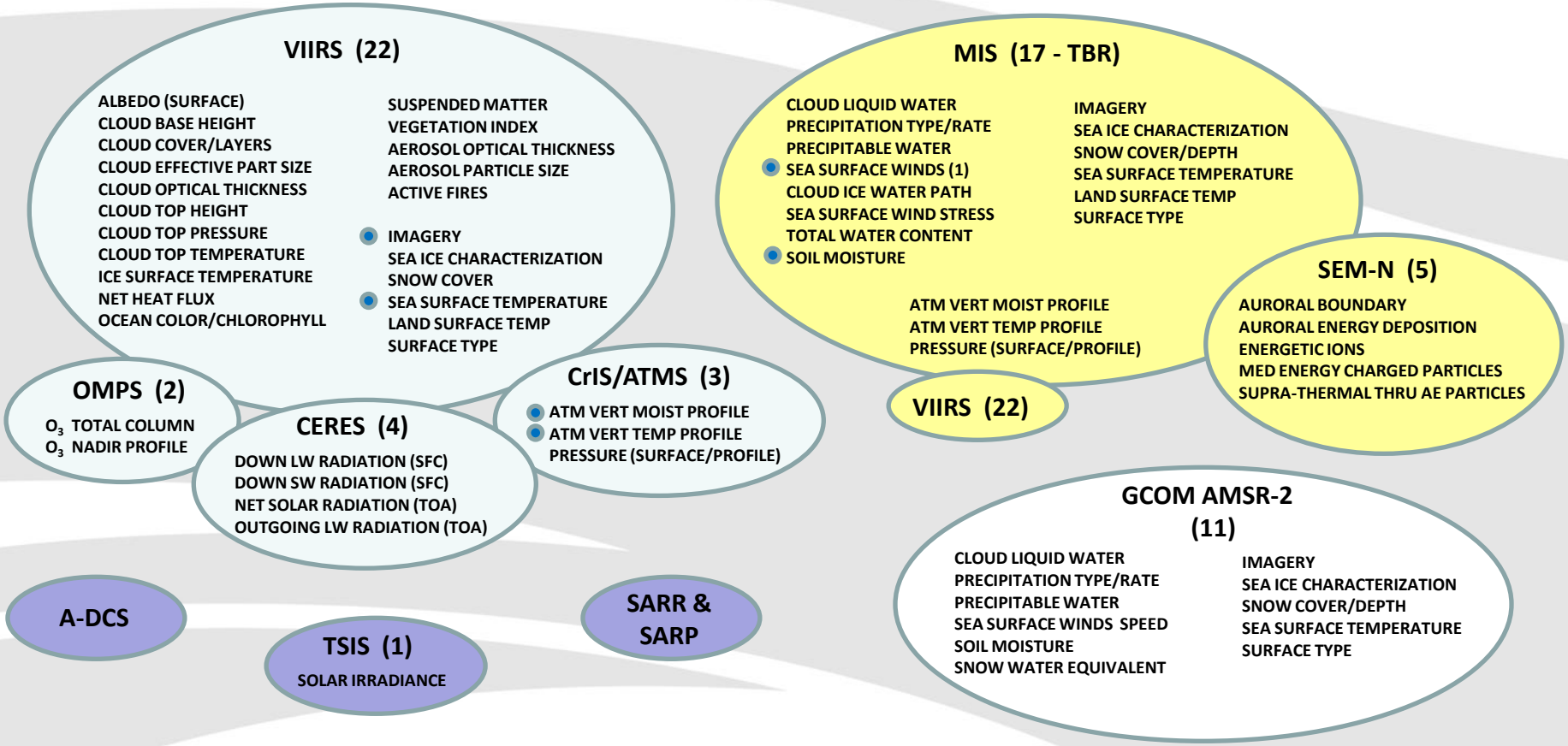


Cross-track Infrared Sounder (CrIS) ITT Corporation

Ozone Mapping and Profiler Suite (OMPS) Ball Aerospace

Advanced Technology Microwave Sounder (ATMS) Northrop Grumman

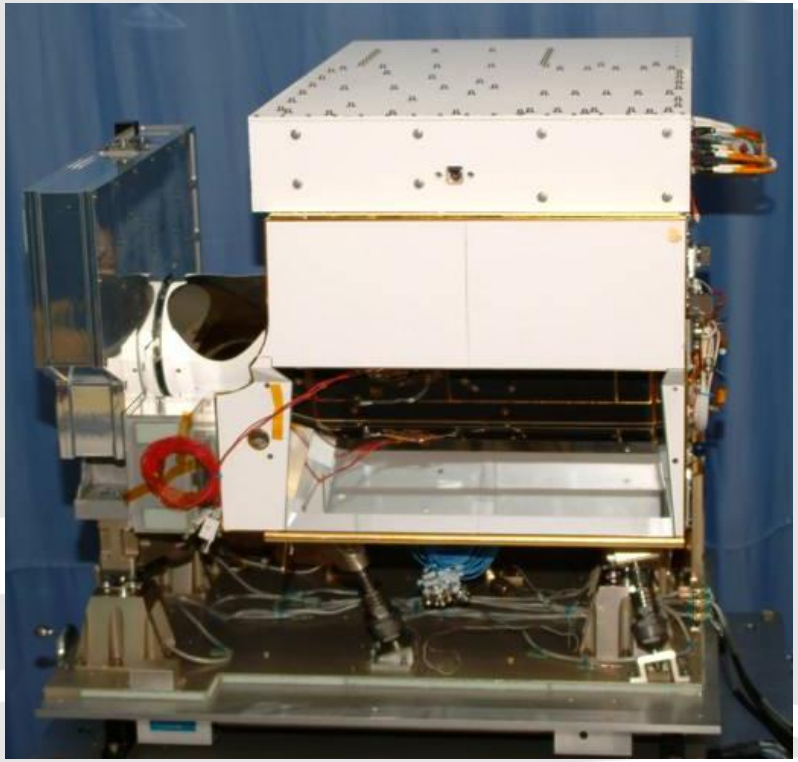
JPSS L1RD Defined Environmental Data Records (EDRS)



Notes:

(1) Delivered as two MIS products – Speed (Key EDR) and Direction

CrIS Overview



	Spec
Mass, kg	165
Average Power, W	135
Average Data Rate, Mbps	1.5

- **The Cross-track Infrared Sounder (CrIS) is a key sensor**
  - Fourier Transform Spectrometer providing high resolution IR spectra:

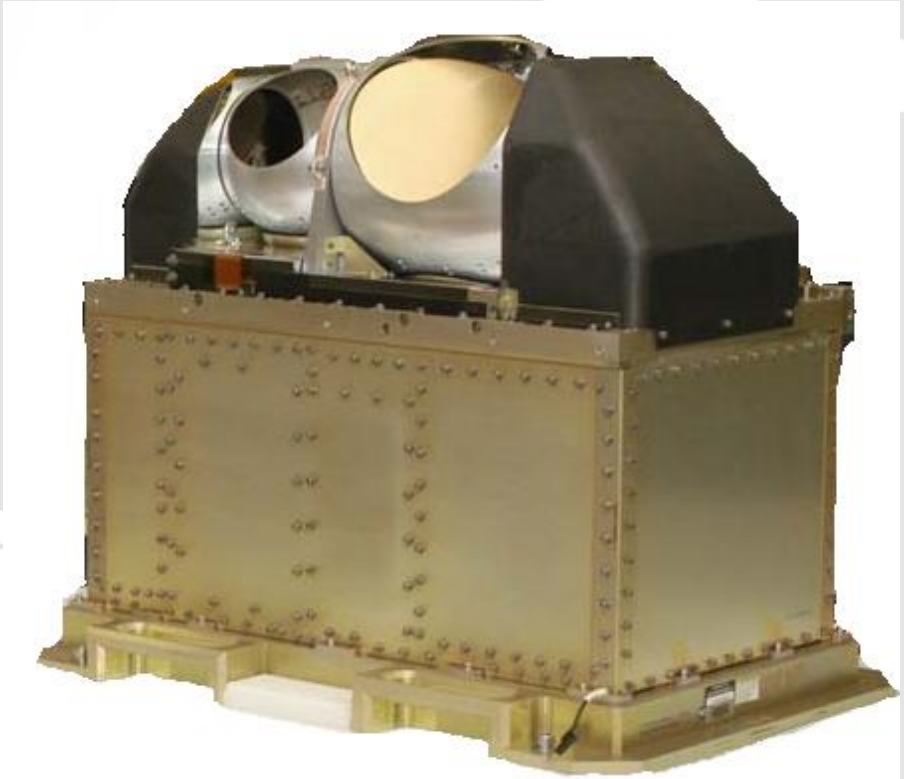
Band	Wavelength Range (cm-1)	Wavelength Range (mm)	Sampling (cm-1)	No. Chan.
SWIR	2155-2550	4.64-3.92	2.5	159
MWIR	1210-1750	8.26-5.71	1.25	433
LWIR	650-1095	15.38-9.14	0.625	713

  - Fields of Regard each 3 x 3 FOVs
  - Photovoltaic Detectors in all 3 bands
  - 4-Stage Passive Detector Cooler
  - 14 km nadir spatial resolution
  - 2200 km swath width
  - On-board internal calibration target
- **Science pioneer: AIRS on EOS Aqua, IASI on METOP-A**
- **Supplier: ITT Industries**
- **Key subcontractors:**
  - ABB Bomem, Interferometer, ICT
  - DRS, detectors
  - AER, EDR algorithm

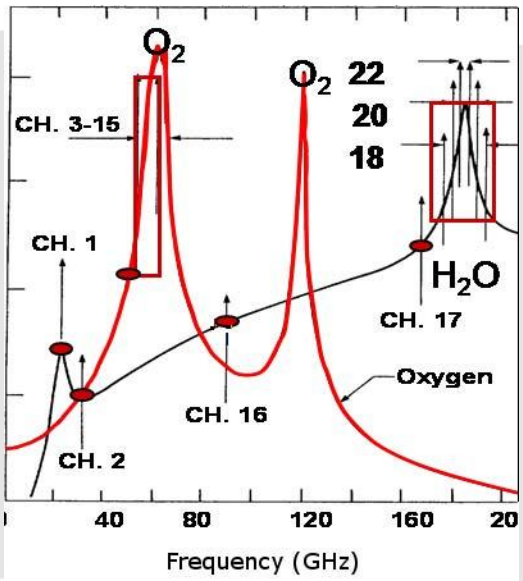
Advanced Technology Microwave Sounder
Northrop Grumman Electronic Systems

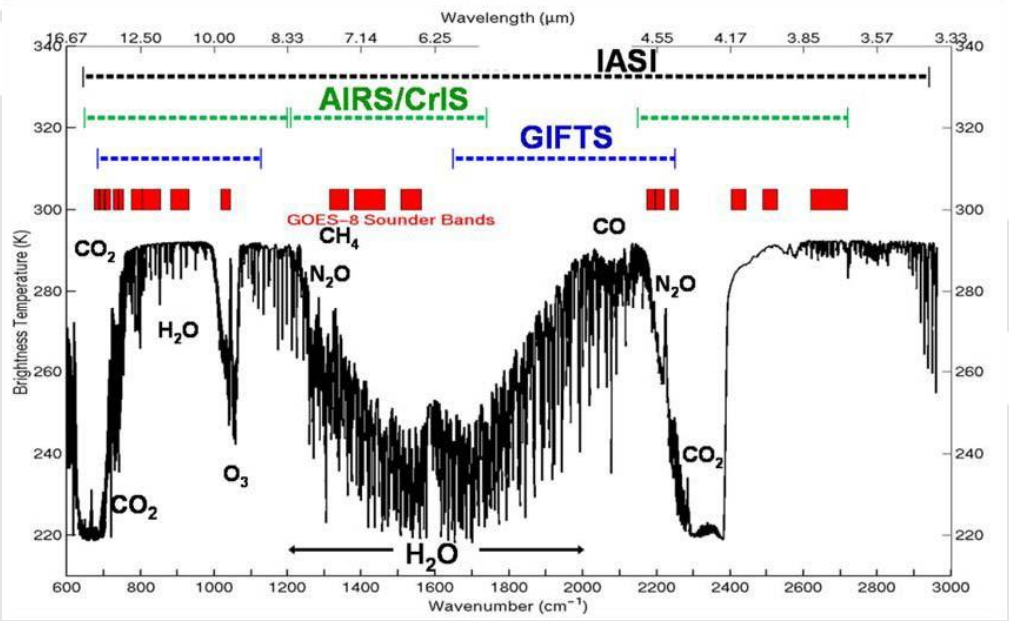
Description

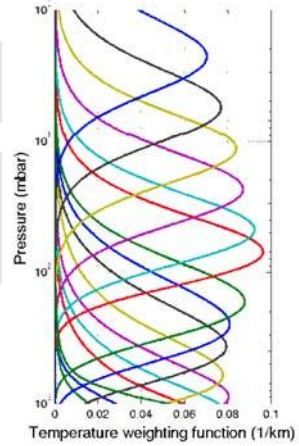
- **Purpose:** In conjunction with CrIS, global observations of temperature and moisture profiles at high temporal resolution (~ daily).
- **Predecessor Instruments:** AMSU A1 / A2, MHS
- **Approach:** Scanning passive microwave radiometer
- 22 channels (23GHz - 183GHz)
- **Swath width:** 2300 km
- **Co-registration:** with CrIS

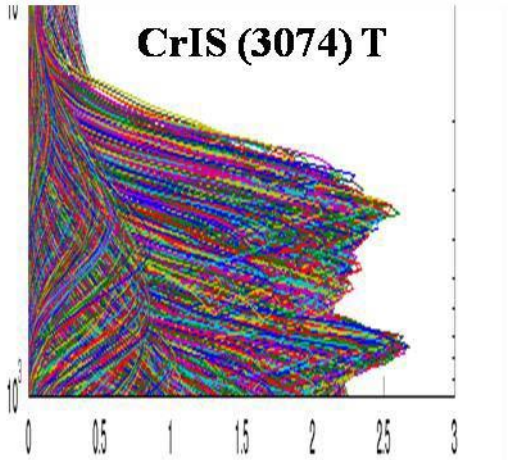


Microwave and Infrared Earth Spectra







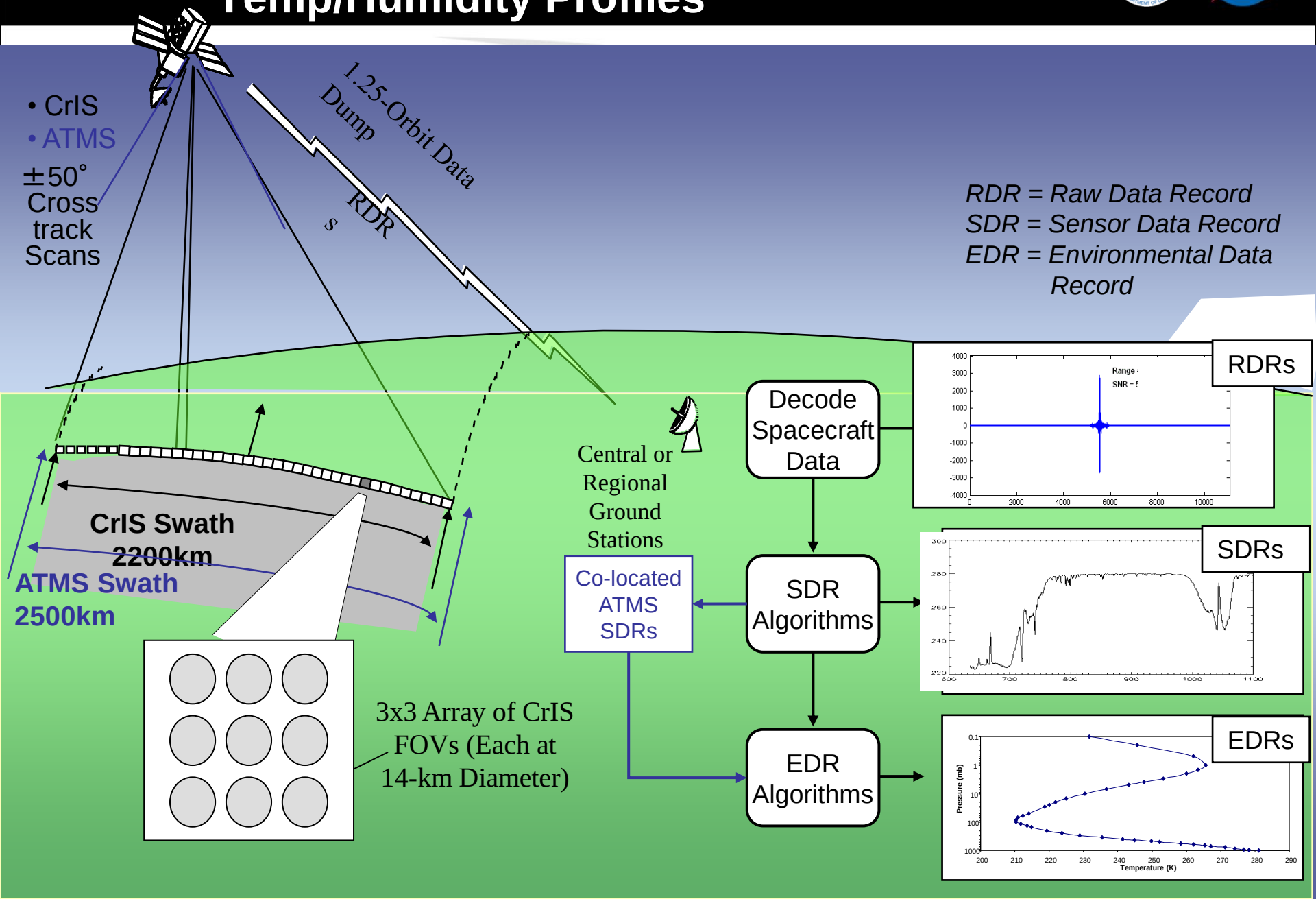


The NPOESS Cross-track Infrared Sounder (CrIS) and Advanced Technology Microwave Sounder (ATMS) as a Companion to the New Generation AIRS/AMSU and IASI/AMSU Sounder Suites

Gail A. Bingham, Utah State Univ./SDL, Logan, UT; and N. S. Pougatchev, M. P. Esplin, W. J. Blackwell, and C. D. Barnet

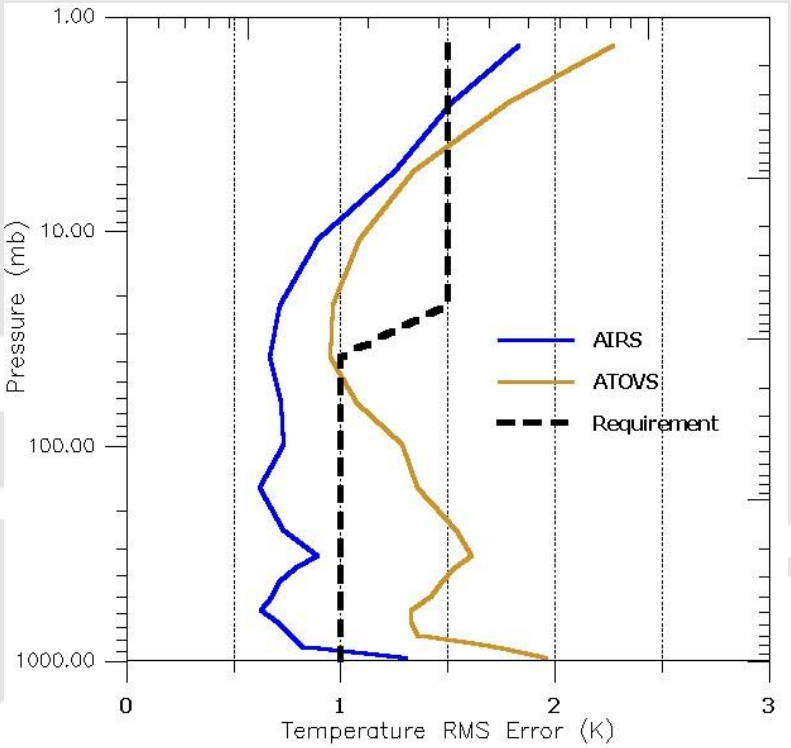
http://ams.confex.com/ams/90annual/techprogram/paper_163196.htm

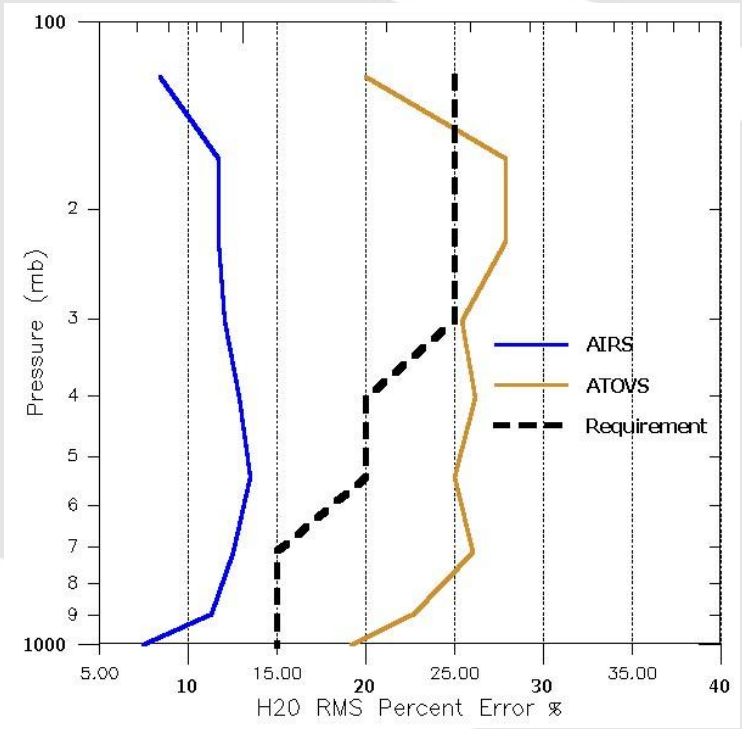
ATMS/CrIS Sensors Produce Atmospheric Temp/Humidity Profiles



Improved Soundings

AIRS provides significant improvements in temperature and moisture soundings over older generation instruments.

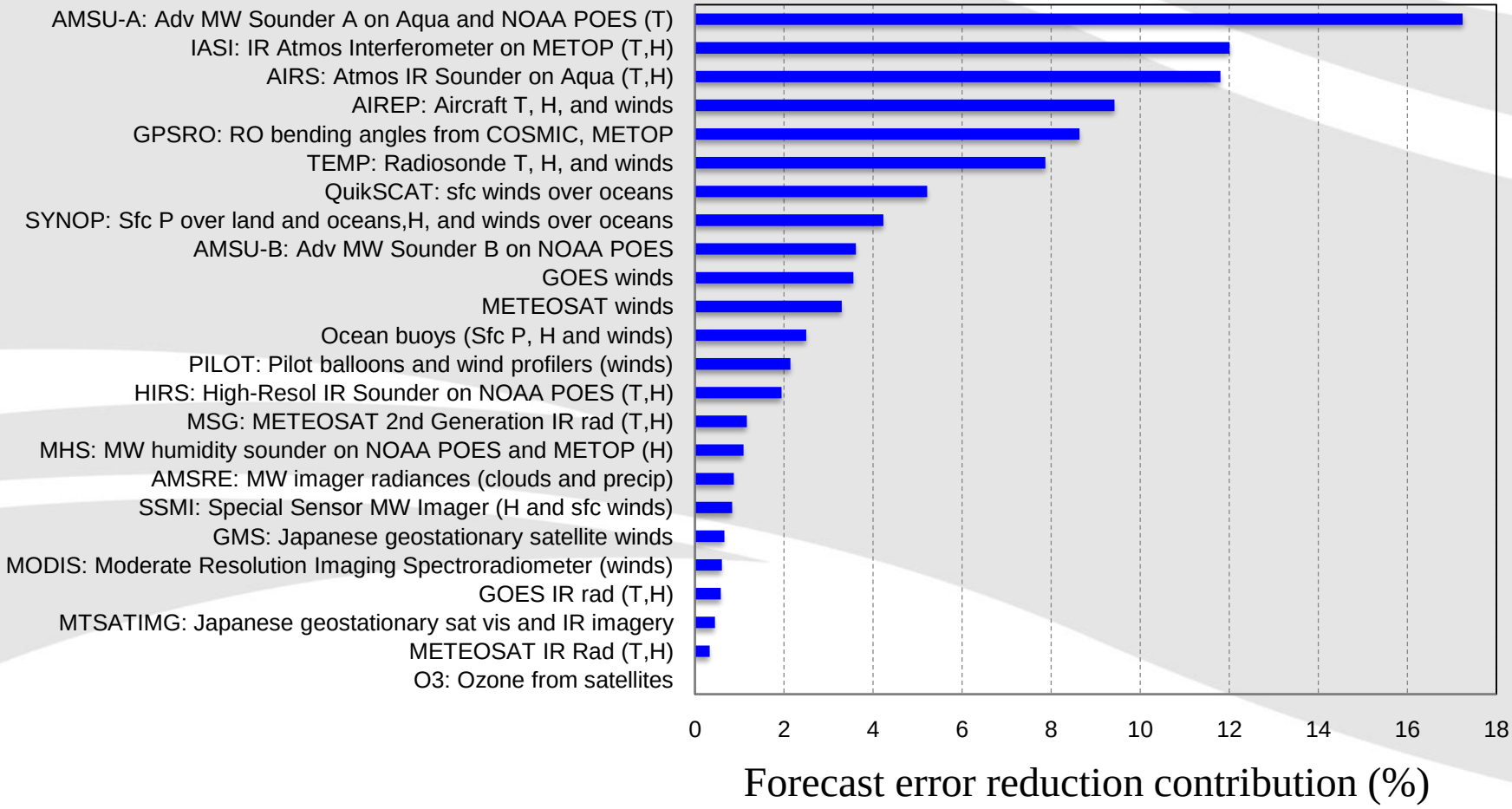




Vertical resolution has improved from 3 – 5 km to 1 – 2 km.

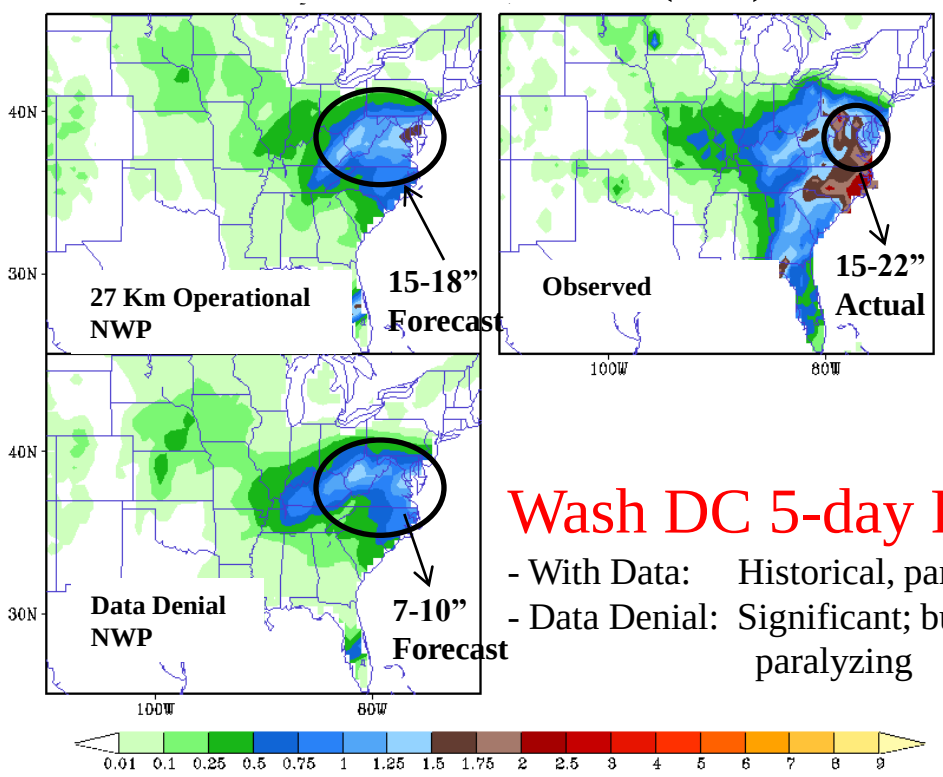
CriS and ATMS provide continuity of essential atmospheric sounding information for weather forecasting

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



Afternoon orbit has large impact on forecasting major weather events

Forecast Period: 5 Feb (am) – 6 Feb (am)



Wash DC 5-day Forecast:

- With Data: Historical, paralyzing event
- Data Denial: Significant; but not paralyzing

- **6 Feb: Models without PM data under-forecasted snow totals:**
  - Operational forecast shows paralyzing event
  - Data Denial
    - Did not forecast paralyzing event in DC— at least 10" too low at Day 5
    - Low confidence in extreme snowfall at this point
  - Future errors of this scale could result in:
    - Aircraft and airline passengers stranded
    - Ground commerce halted with no mitigation plans
    - Population unprepared for paralyzing snow-depth

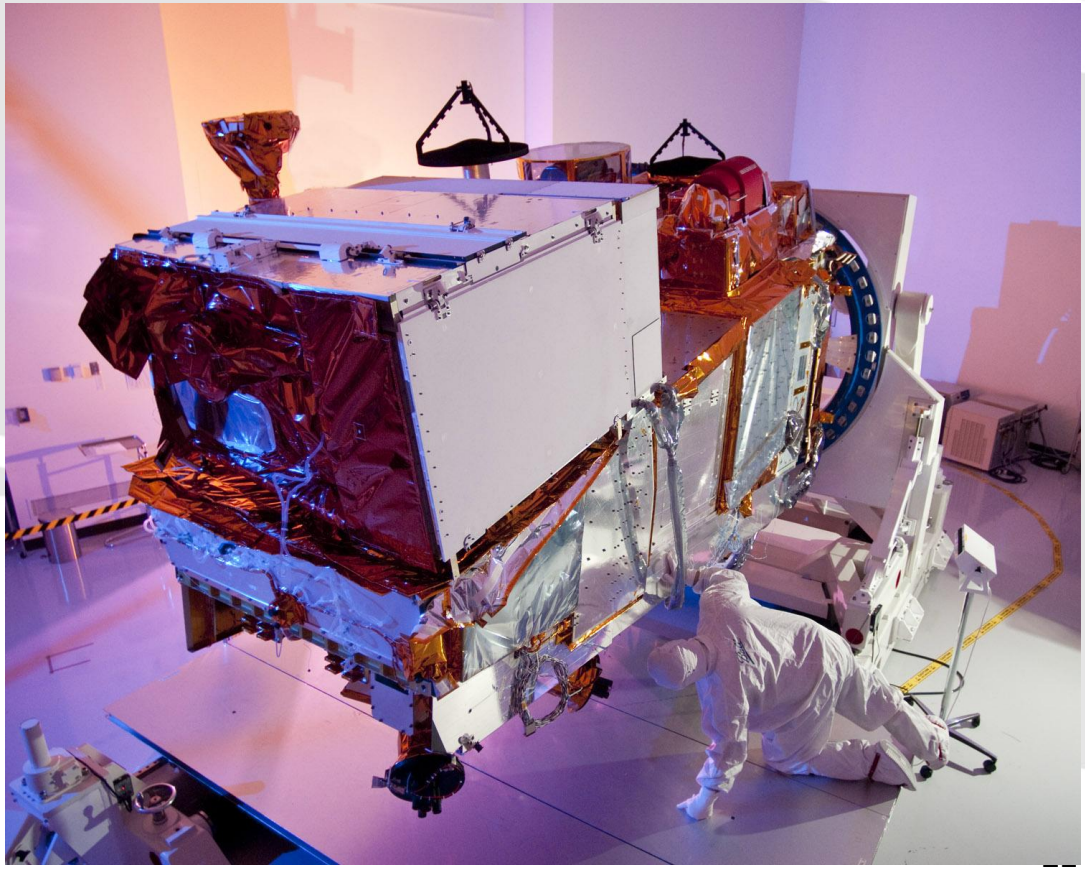
Visible Infrared Imaging Radiometer Suite
Raytheon SAS El Segundo, Ca

Description

- **Purpose:** Global observations of land, ocean, & atmosphere parameters at high temporal resolution (~ daily)
- **Predecessor Instruments:** AVHRR, OLS, MODIS, SeaWiFS
- **Approach:** Multi-spectral scanning radiometer (22 bands between 0.4 µm and 12 µm) 12-bit quantization
- **Swath width:** 3000 km

Spatial Resolution

- 16 bands at 750m
- 5 bands at 325m
- DNB



VIIRS on NPP

VIIRS Data Products

Land

- Active Fire
- Land Surface Albedo
- Land Surface Temperature Ice Surface Temperature
- Sea Ice Characterization
- Snow Cover/Depth
- Vegetation Index
- Surface Type

Imagery & Cloud

- Imagery
- Cloud Mask [IP]
- Cloud Optical Thickness
- Cloud Effective Particle Size Parameter
- Cloud Top Parameters
- Cloud Base Height
- Cloud Cover/Layers

Ocean

- Sea Surface Temperature
- Ocean Color/Chlorophyll

Aerosol

- Aerosol Optical Thickness
- Aerosol Particle Size Parameter
- Suspended Matter

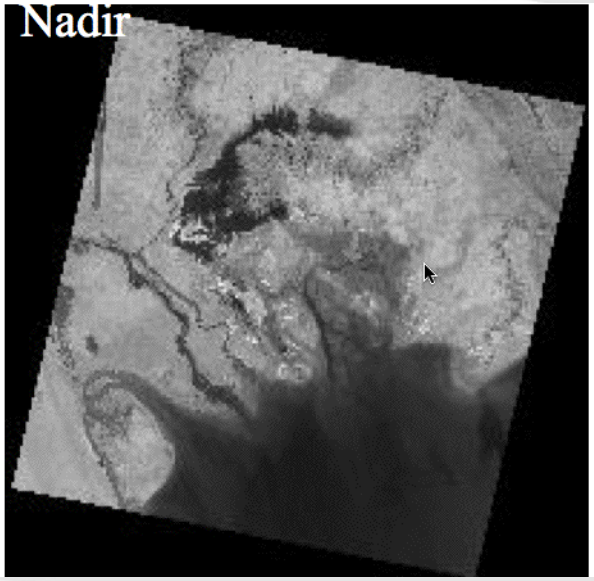
VIIRS Improvements From AVHRR: Radiometric properties

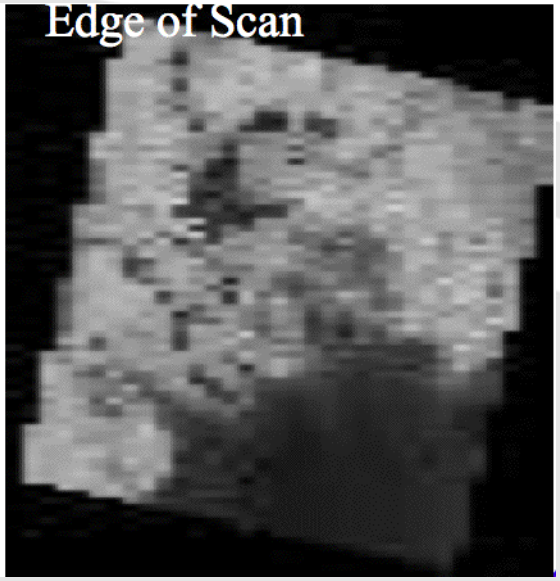
Greater spectral coverage with increased radiometric quality

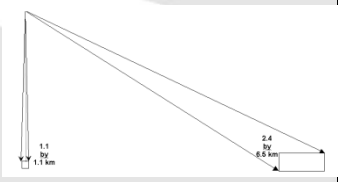
VIIRS			MODIS Equivalent			AVHRR-3 Equivalent			OLS Equivalent		
Band	Range (um)	HSR (m)	Band	Range	HSR	Band	Range	HSR	Band	Range	HSR
DNB	0.500 - 0.900	750				Low light capabilities			HRD PMT	0.580 - 0.910 0.510 - 0.860	550 2700
M1	0.402 - 0.422	750	8	0.405 - 0.420	1000						
M2	0.436 - 0.454	750	9	0.438 - 0.448	1000						
M3	0.478 - 0.498	750	3 10	0.459 - 0.479 0.483 - 0.493	500 1000	Ocean Color, Aerosol					
M4	0.545 - 0.565	750	4 12	0.545 - 0.565 0.546 - 0.556	500 1000						
I1	0.600 - 0.680	375	1	0.620 - 0.670	250	1	0.572 - 0.703	1100			
M5	0.662 - 0.682	750	13 14	0.662 - 0.672 0.673 - 0.683	1000 1000	1	0.572 - 0.703	1100			
M6	0.739 - 0.754	750	15	0.743 - 0.753	1000	Atm Correction					
I2	0.846 - 0.885	375	2	0.841 - 0.876	250	2	0.720 - 1.000	1100			
M7	0.846 - 0.885	750	16	0.862 - 0.877	1000	2	0.720 - 1.000	1100			
M8	1.230 - 1.250	750	5	SAME	500	Cloud Particle Size					
M9	1.371 - 1.386	750	26	1.360 - 1.390	1000	Thin Cirrus					
I3	1.580 - 1.640	375	6	1.628 - 1.652	500	Snow Map					
M10	1.580 - 1.640	750	6	1.628 - 1.652	500	3a	SAME	1100			
M11	2.225 - 2.275	750	7	2.105 - 2.155	500	Cloud					
I4	3.550 - 3.930	375	20	3.660 - 3.840	1000	3b	SAME	1100			
M12	3.660 - 3.840	750	20	SAME	1000	3b	3.550 - 3.930	1100			
M13	3.973 - 4.128	750	21 22 23	3.929 - 3.989 3.929 - 3.989 4.020 - 4.080	1000 1000 1000	SST, Fire					
M14	8.400 - 8.700	750	29	SAME	1000	Cloud Top Propoerties					
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000	4	10.300 - 11.300	1100			
I5	10.500 - 12.400	375	31 32	10.780 - 11.280 11.770 - 12.270	1000 1000	4 5	10.300 - 11.300 11.500 - 12.500	1100 1100	HRD	10.300 - 12.900	550
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000	5	11.500 - 12.500	1100			

VIIRS Edge of Scan Spatial Resolution is significantly improved over AVHRR

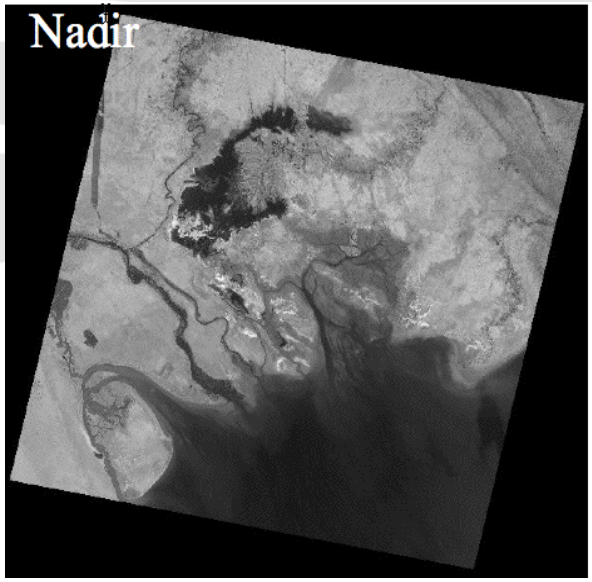
AVHRR

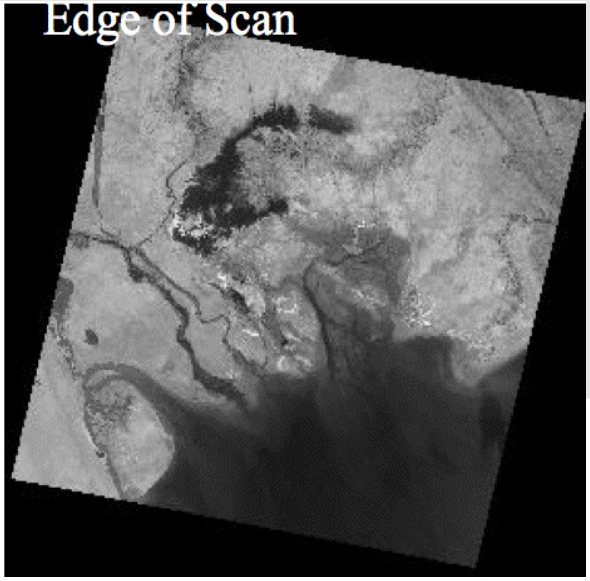






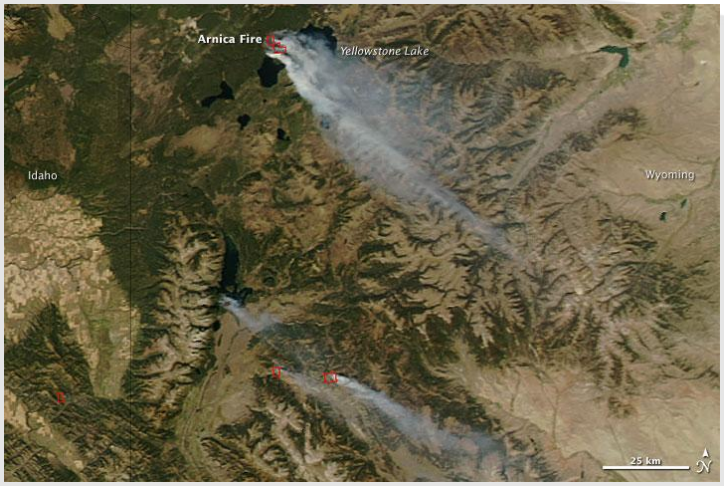
VIIRS



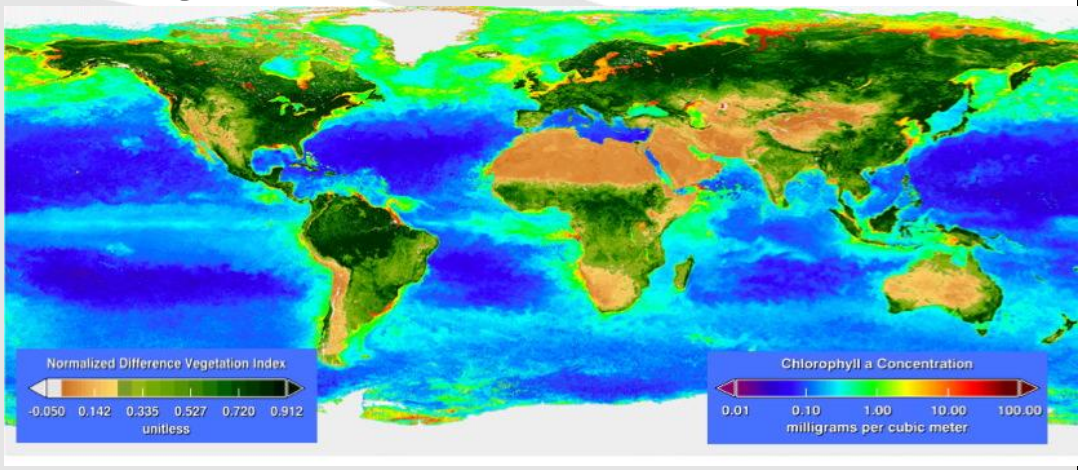


In addition to clouds and SST, VIIRS provides continuity of essential environmental monitoring from AVHRR and MODIS

Fire monitoring and mapping

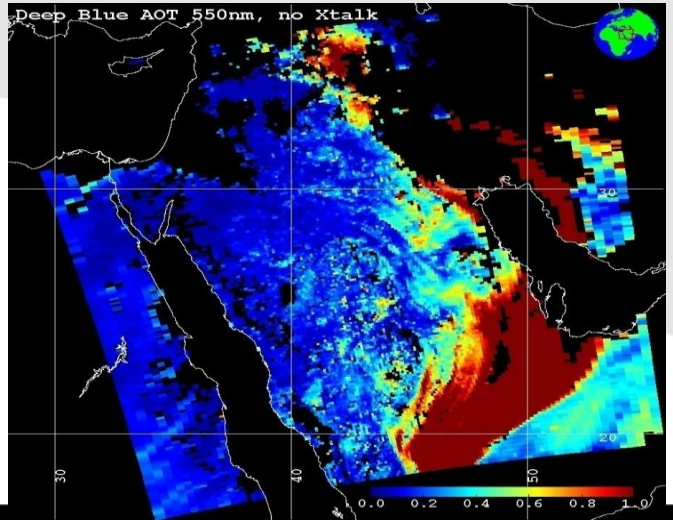


Biosphere monitoring:
Vegetation and Ocean Color



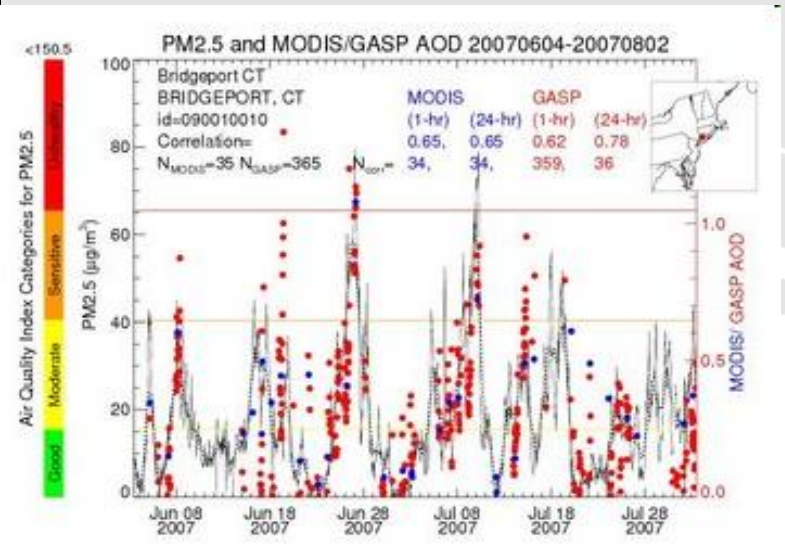
Oil slick monitoring and mapping

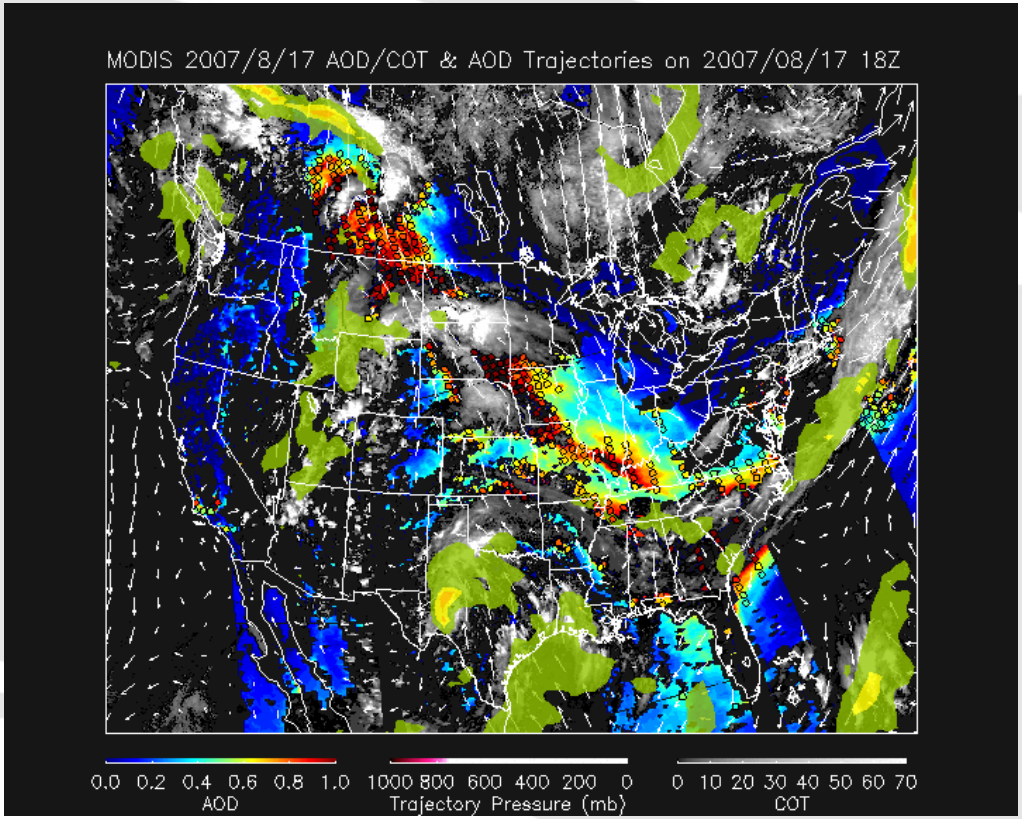
Aerosols for air quality and aviation safety



Air Quality Applications

Integrated observations, products and synthesis to support air quality forecasters

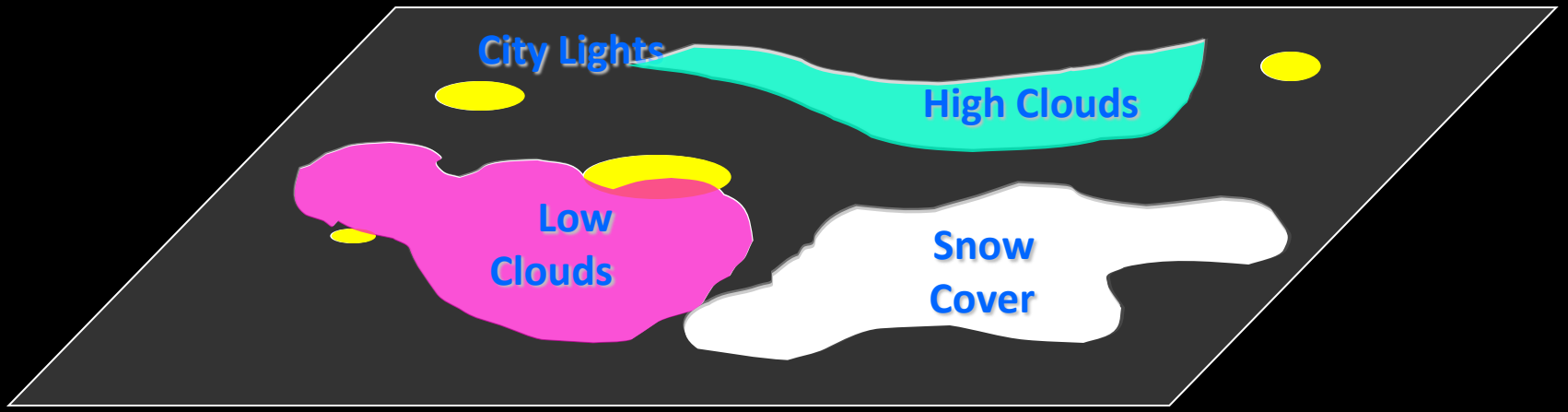




Snow Cover at Night

Ambient Moonlight

- Nighttime Visible Band Only (DMSP/OLS)
- Add Stable Nighttime Lights Mask (OLS)
- Add High/Low Cloud Detection (GOES)

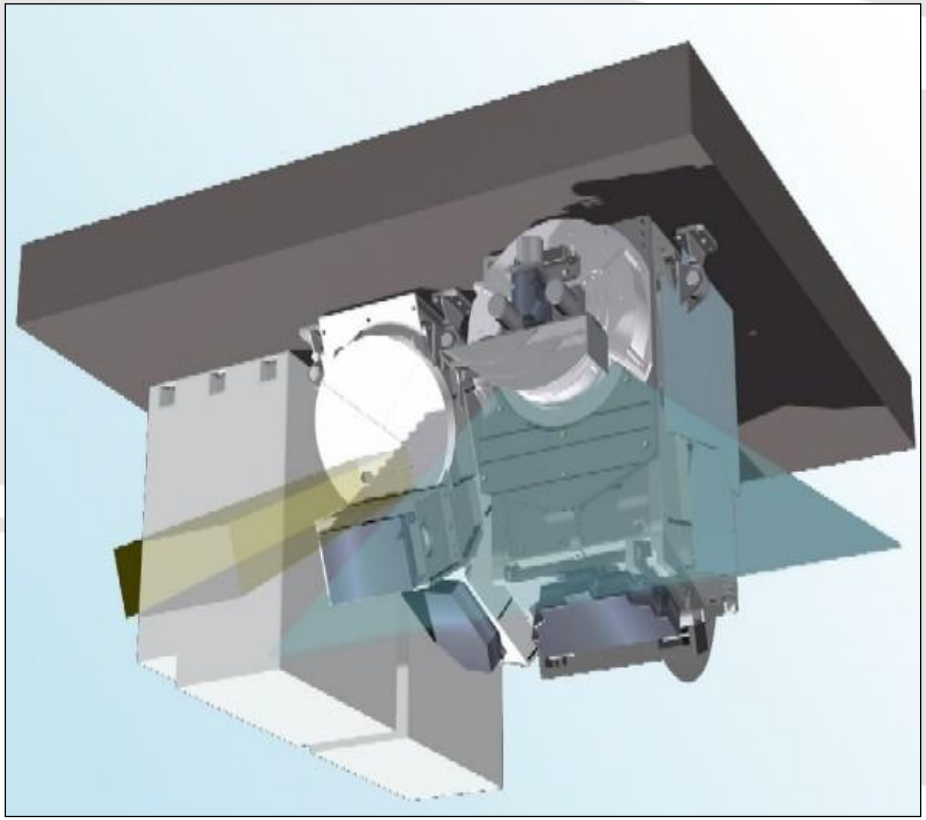


→ Combine LEO and time-matched GEO obs to provide augmented channel suite for improved discrimination.

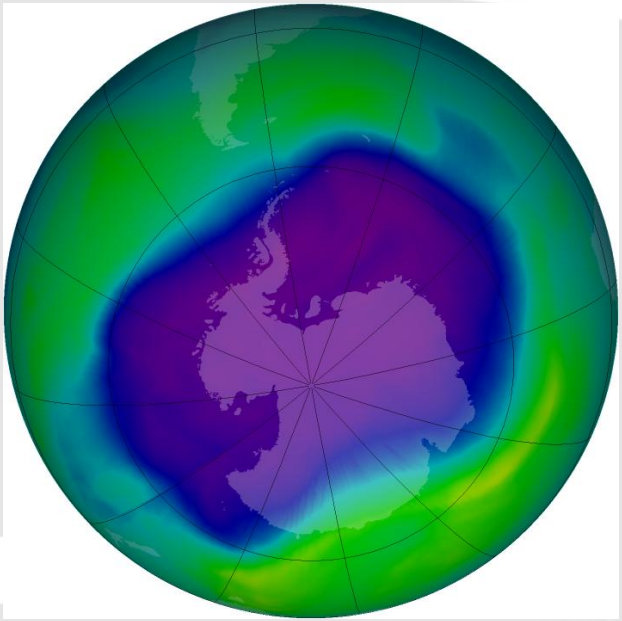
Ozone Mapping Profiler Suite
Ball Aerospace and Technologies Corp.

Description

- **Purpose:**
  Monitors the total column and vertical profile of ozone
- **Predecessor Instruments:**
  TOMS, SBUV, GOME, OSIRIS, SCIAMACHY
- **Approach:**
  Nadir and limb push broom CCD spectrometers
- **Swath width:**
  2600 km

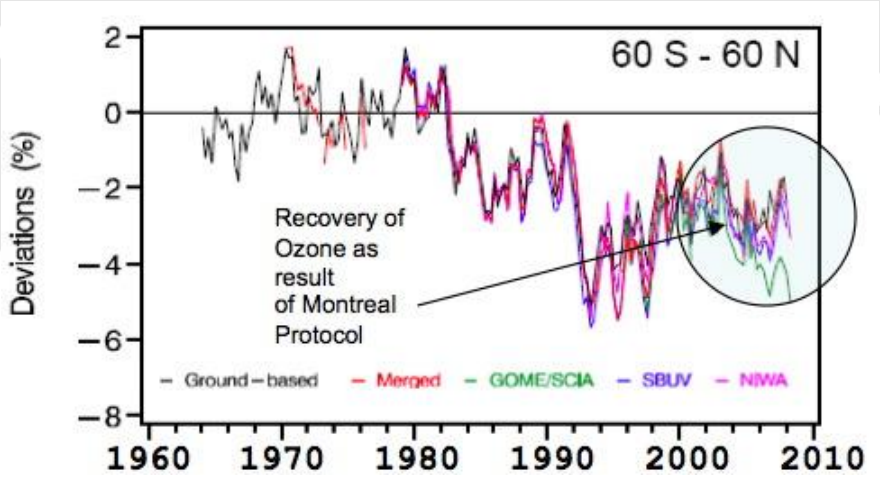


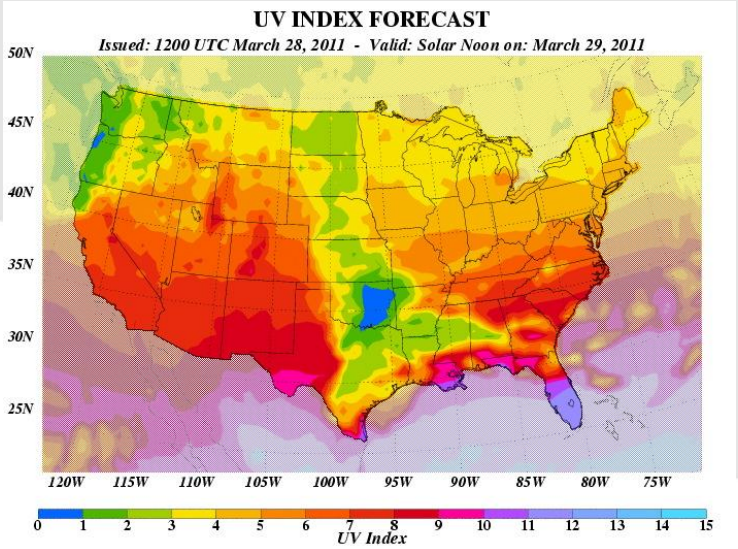
OMPS provides continuity of essential ozone products and applications



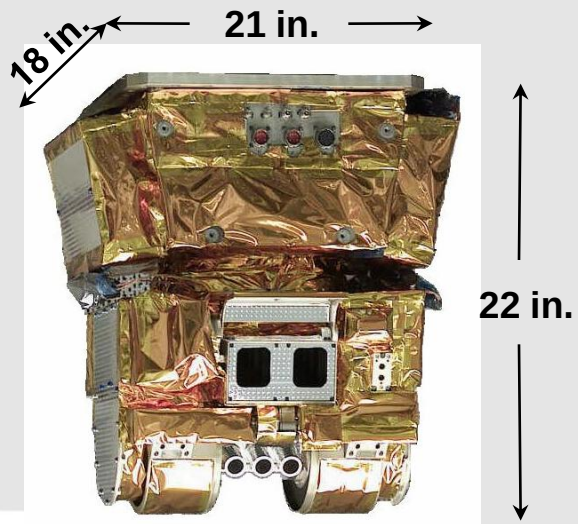
Monitoring ozone hole and recovering of ozone due to the Montreal Protocol for eliminating Chlorofluorocarbons (CFCs)

Used in NWS UV Index forecast to allow public to avoid overexposure to UV radiation





CERES Instrument Overview



CERES scanning radiometer measuring three spectral bands at TOA

- Total (0.3 to >50 μm)
- Shortwave (0.3 to 5.0 μm)
- Longwave (5 to 50 μm)

Operations, Data Processing, Products, and Science are a continuation of experience developed on

- TRMM (1), EOS Terra (2), EOS Aqua (2), in I&T on NPP

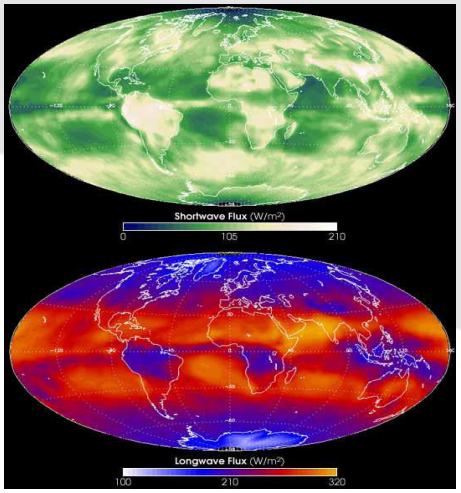
Critical Resource Margins

	CERES Value	Allocation	Margin
Mass, kg	46.8	54	13.3%
Power: Operational, Watts	45.85	50	8.3%
Power: Peak, Watts	60	75	20.0%
Power: Survival, Watts	39.5	40	1.3%
Heat Transfer - Hot Case, Watts	4.1	±5 W	18.0%
Heat Transfer - Cold Case, Watts	-1.7	±5 W	66.0%
Data Rate, Kb / sec	10	10	0
Pointing Control, arcsec	< 114	194	41.2%
Pointing Knowledge, arcsec	< 107	180	40.6%

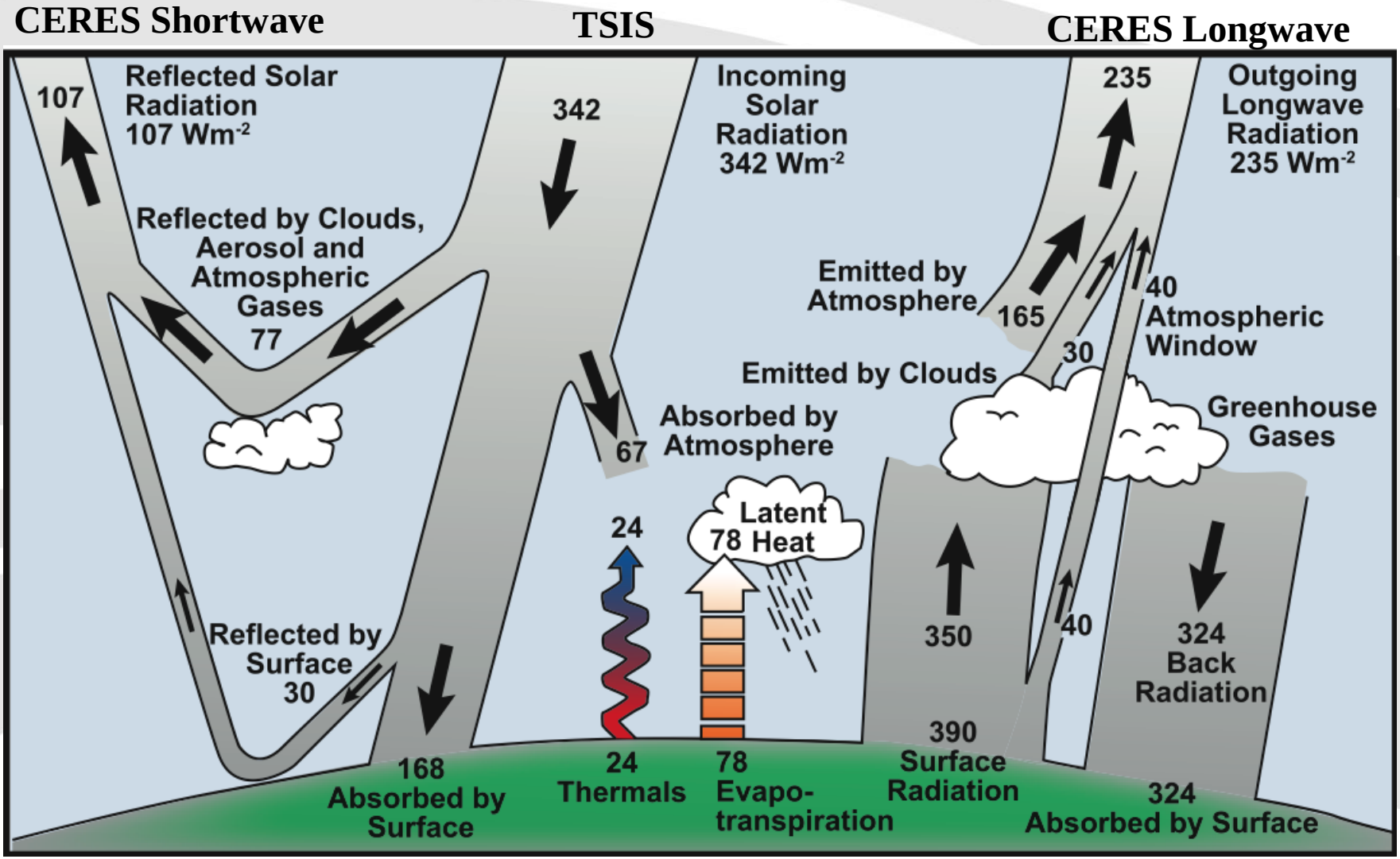
Primary CERES Climate Data Records

Reflected Solar Energy

Emitted Thermal Energy

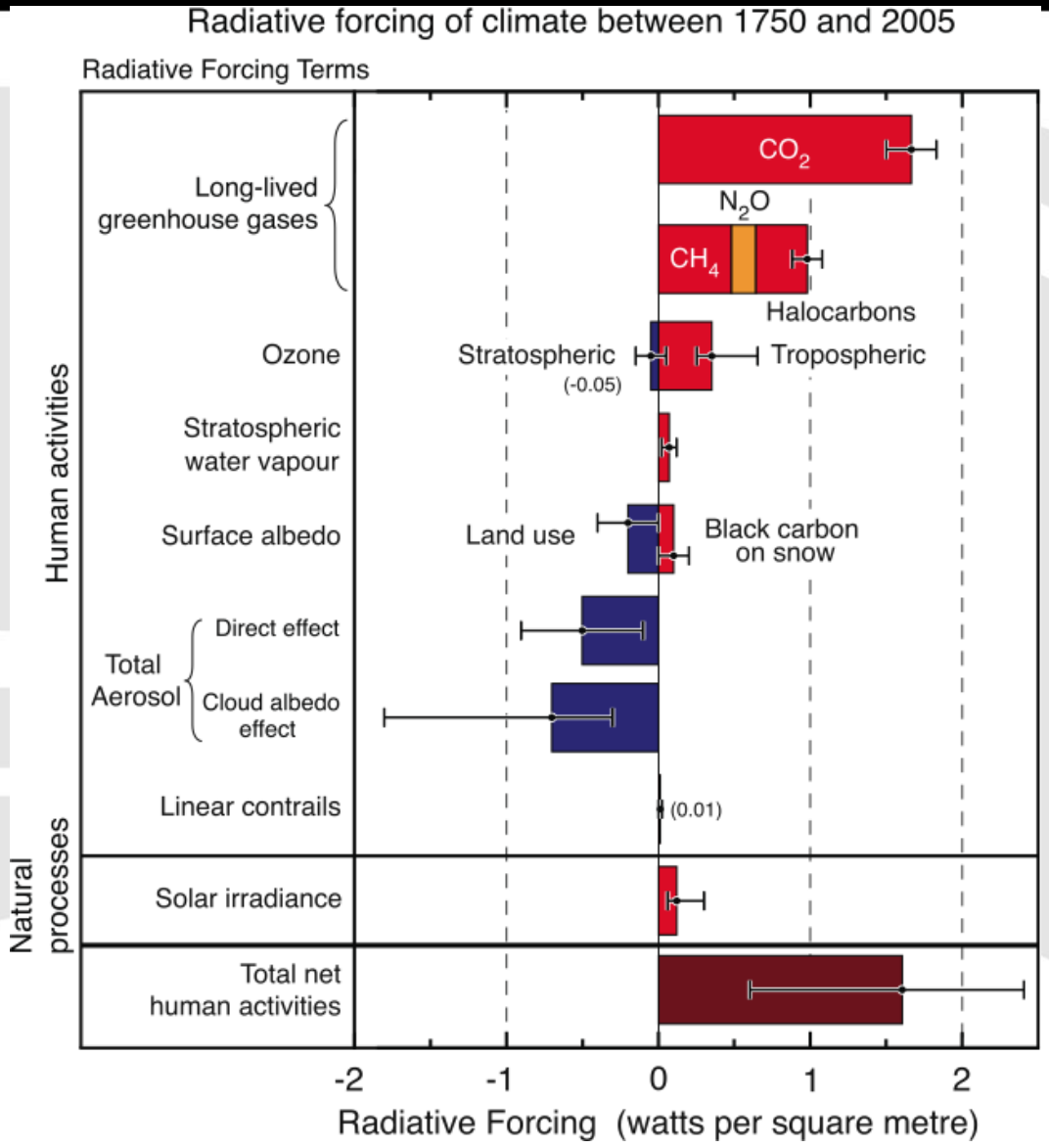


Earth Radiation Budget



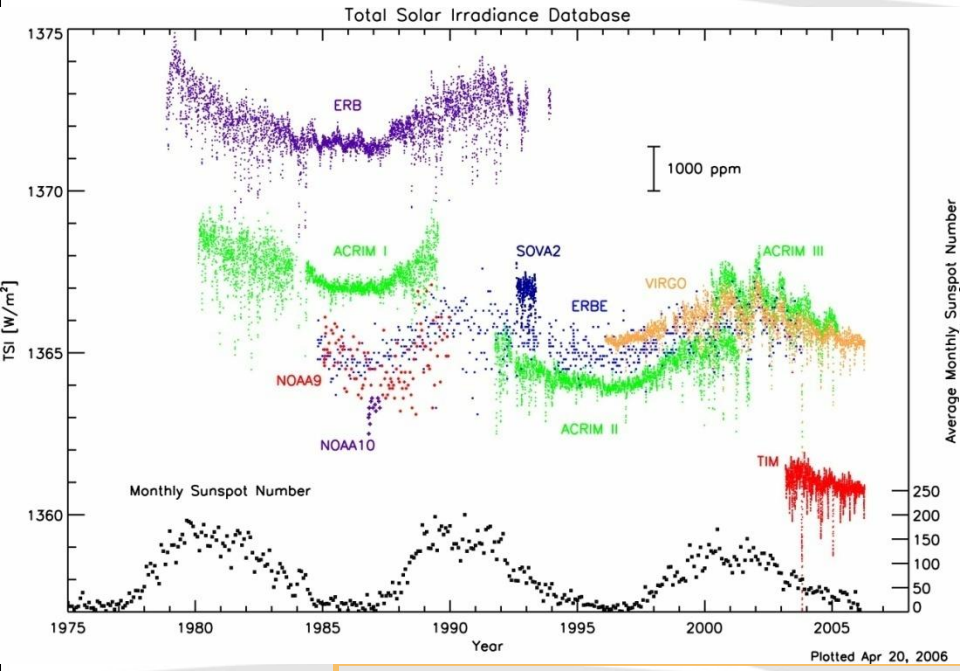
From IPCC AR4 FAQ

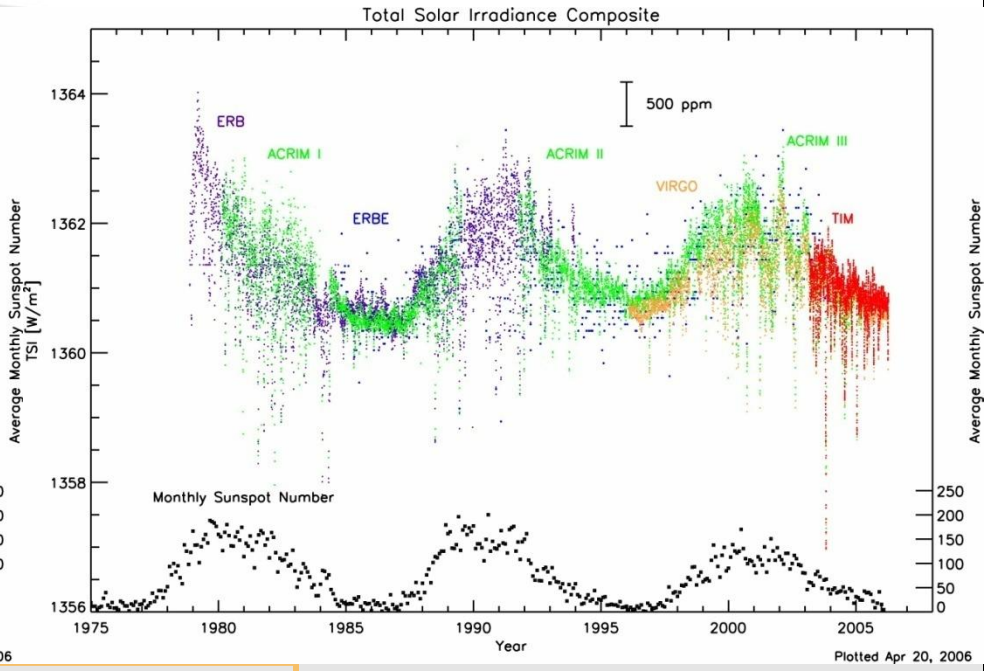
IPCC Radiative Forcing

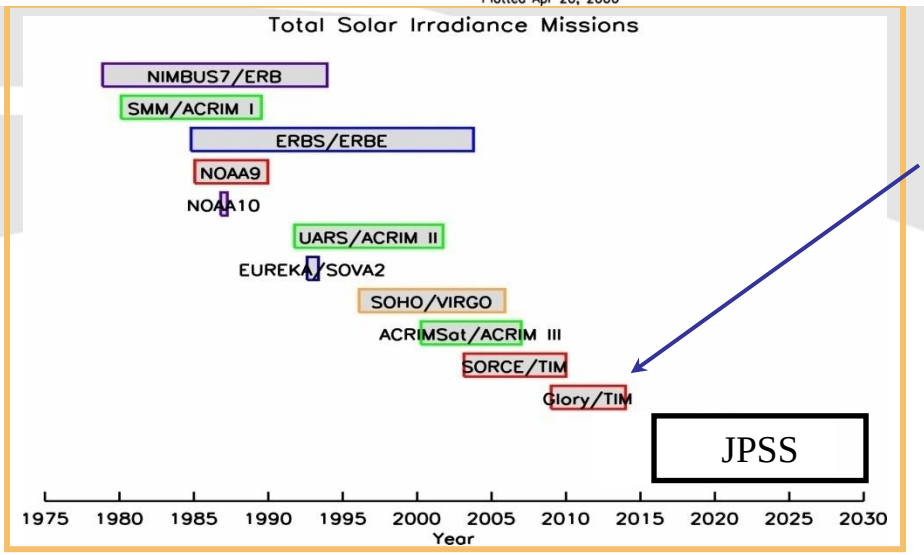


From IPCC AR4 FAQ

27-Year TSI Record Relies on Continuity

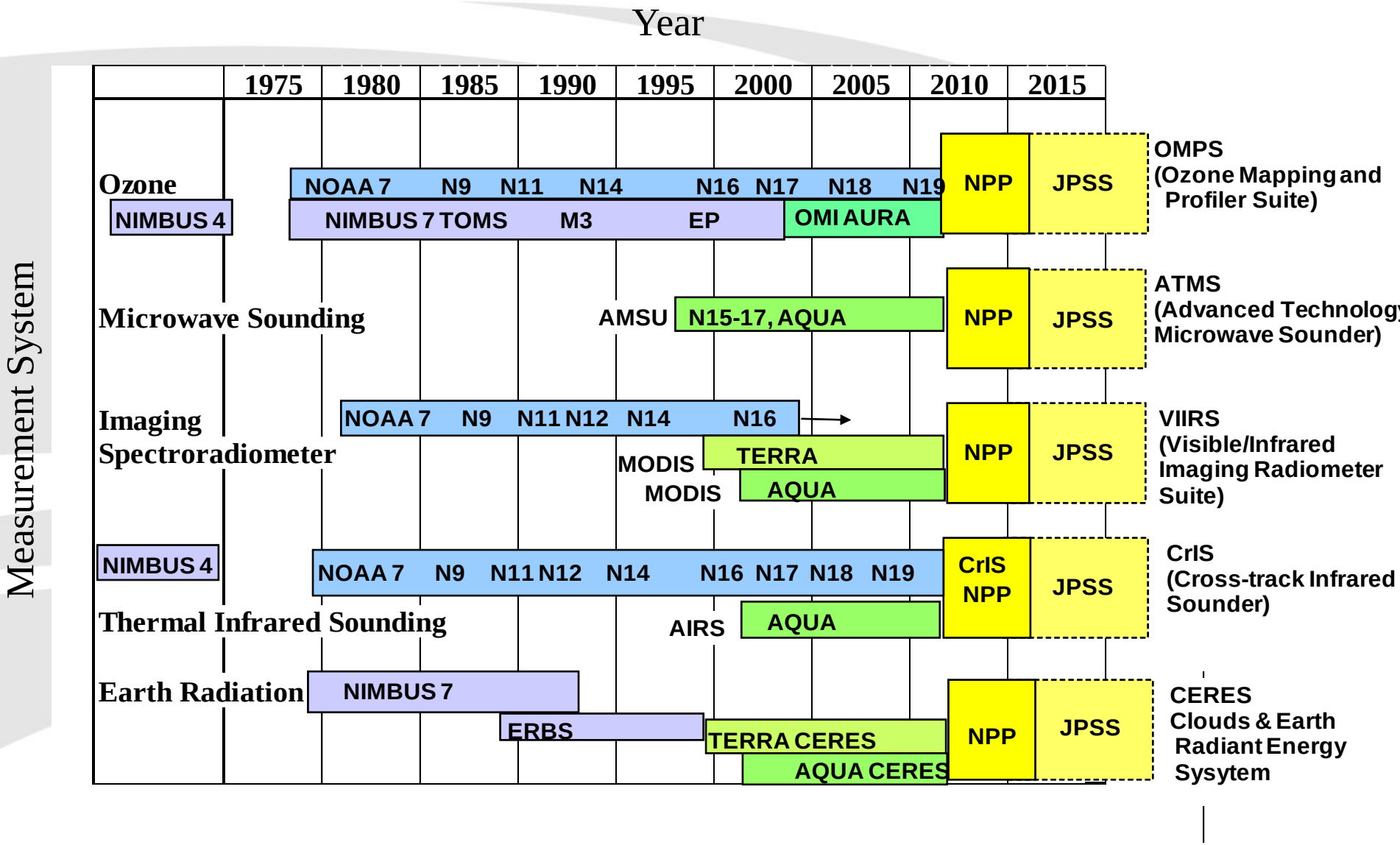






The Glory mission was to fill TSI record between SORCE and JPSS, which continues TSI EDR.

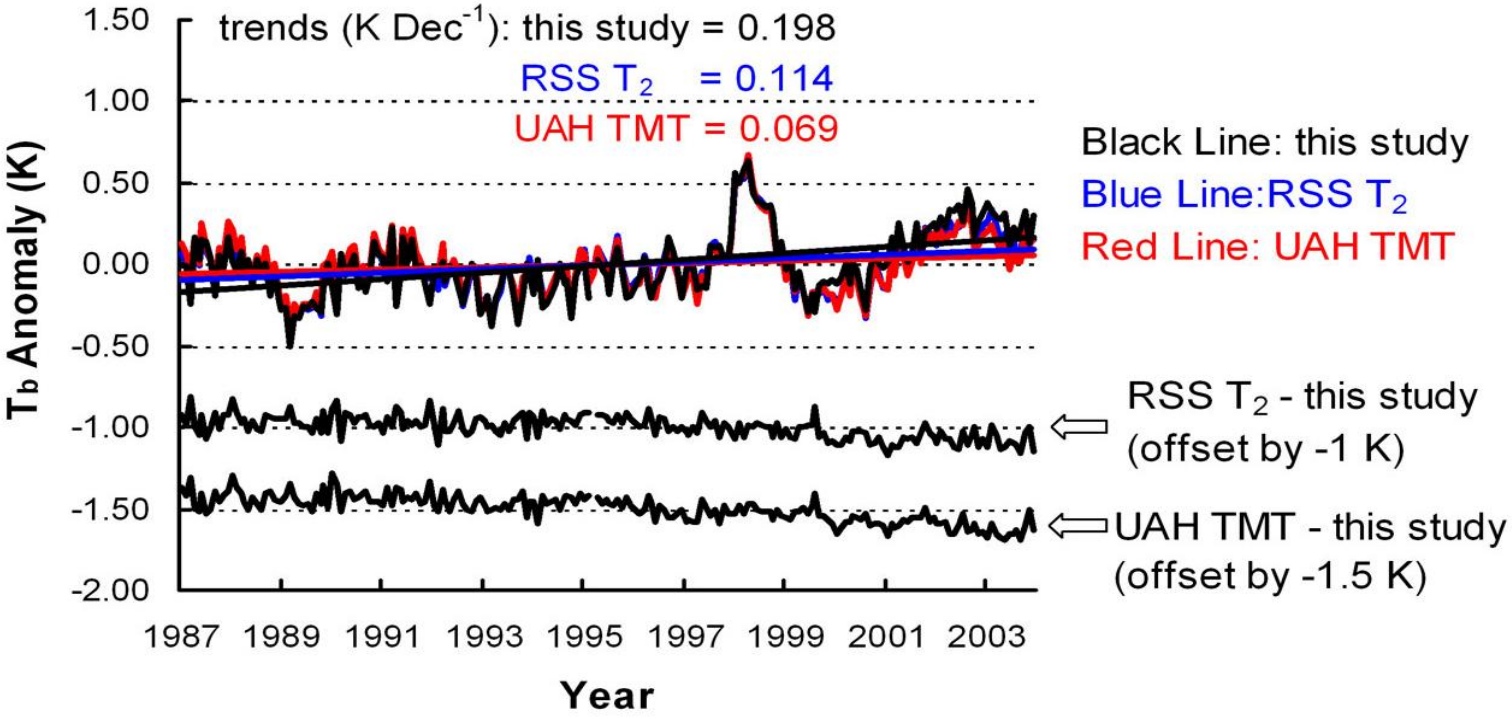
JPSS Continues Data Time Series

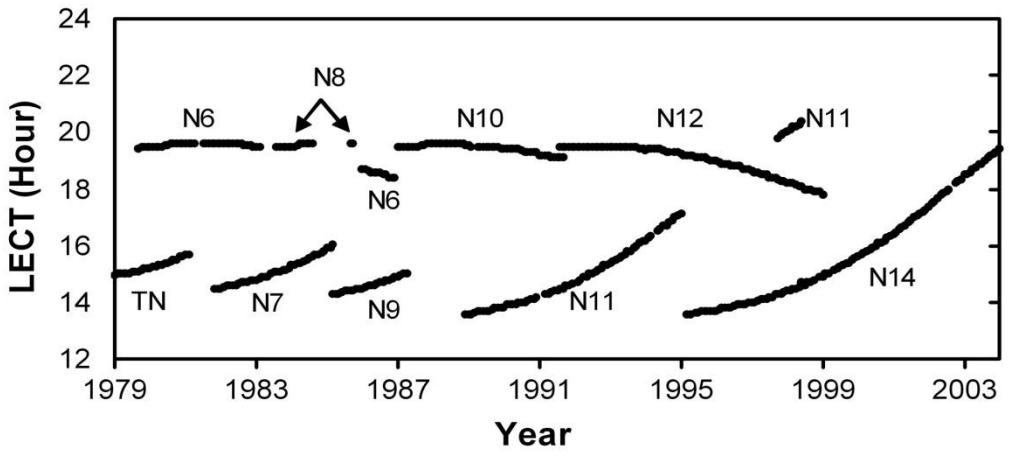


Conventional Operations EOS Technology Jump Research Quality Operations

MSU Tropospheric Temperature Trends

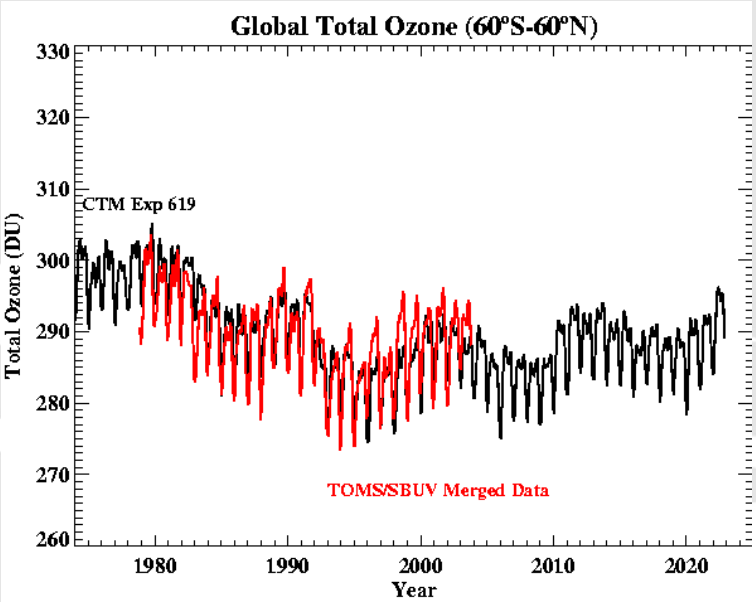
Zou et al., JGR-Atm, 111 (D19): D19114 OCT 14 2006



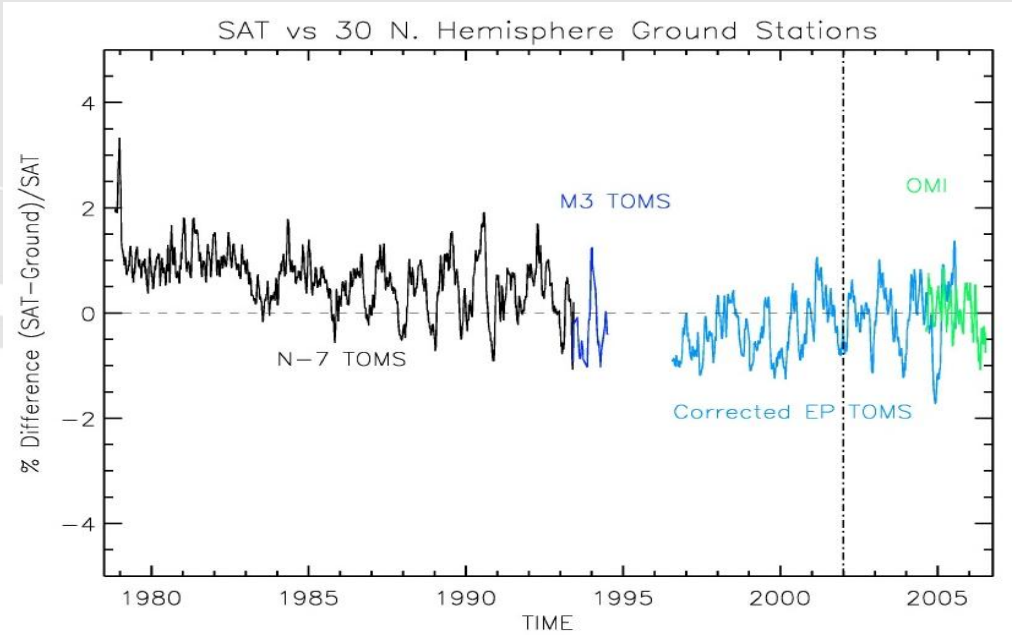


Climate Science Questions
Can we use past performance to predict the future?

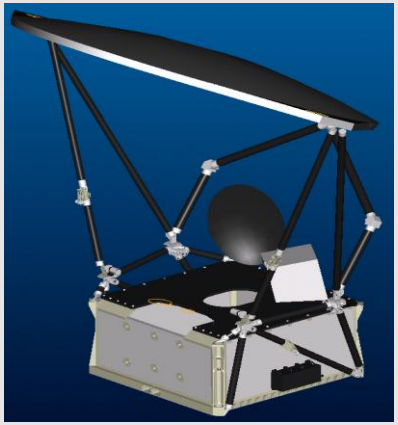
Does the model data reproduce the satellite observations?

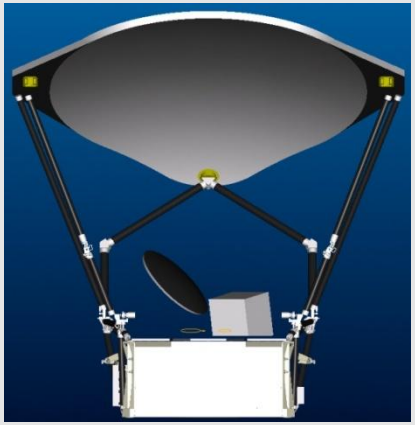


How much confidence do we have in the observations?

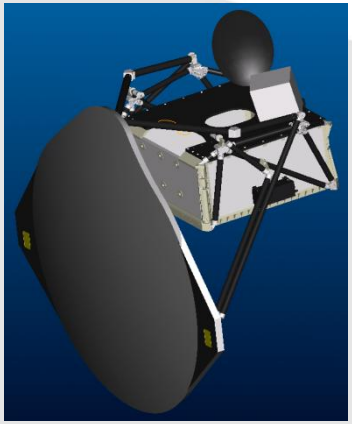


Overview of AMSR2 instrument on GCOM





Deployed



Stowed

- Deployable main reflector system with 2.0m diameter.
- Frequency channel set is identical to that of AMSR-E except 7.3GHz channel for RFI mitigation.
- 2-point external calibration with the improved HTS (hot-load).

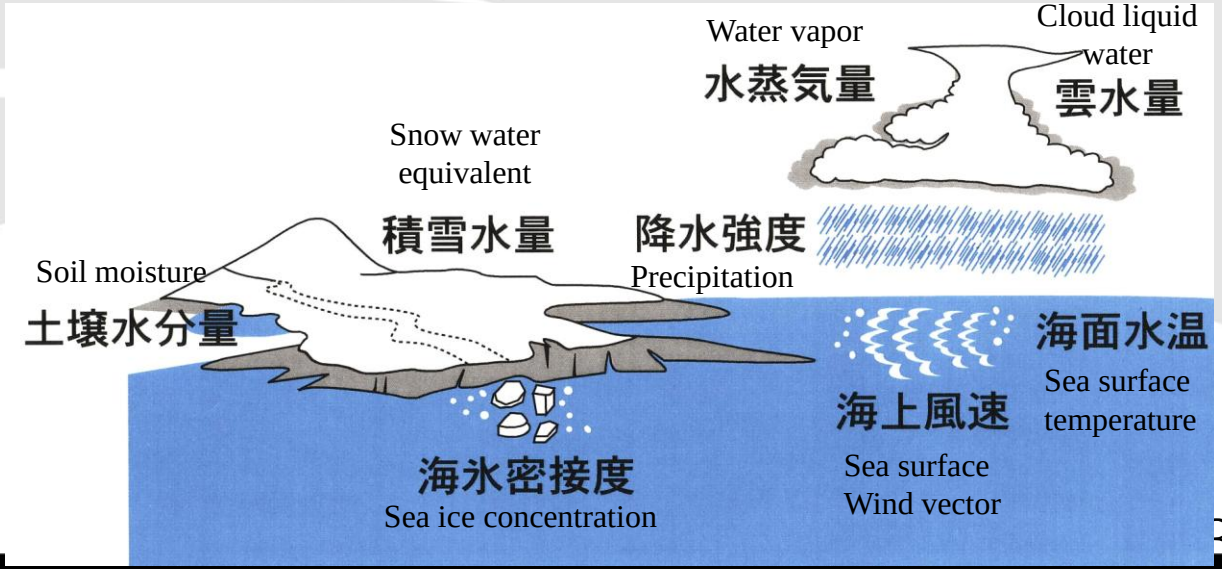
AMSR2 characteristics	
Scan	Conical scan
Swath width	1450km
Antenna	2.0m offset parabola
Digitalization	12bit
Incidence angle	nominal 55 degree
Polarization	Vertical and Horizontal
Dynamic range	2.7-340K

AMSR2 Channel Set				
Center Freq. [GHz]	Band width [MHz]	Polarization	Beam width [deg] (Ground res. [km])	Sampling interval [km]
6.925/ 7.3	350	V and H	1.8 (35 x 62)	10
			1.7 (34 x 58)	
10.65	100		1.2 (24 x 42)	
18.7	200		0.65 (14 x 22)	
23.8	400		0.75 (15 x 26)	
36.5	1000		0.35 (7 x 12)	
89.0	3000		0.15 (3 x 5)	5

37

Overview of AMSR2 EDRs

Geophysical products	Comments
Integrated water vapor	Over global ocean*, columnar integrated value
Integrated cloud liquid water	Over global ocean*, columnar integrated value
Precipitation	Global (except over ice and snow), surface rain rate
Sea surface temperature	Global ocean*
Sea surface wind speed	Global ocean*
Sea ice concentration	High latitude ocean areas
Snow depth	Land surface (except dense forest regions)
Soil moisture	Land surface (except ice sheet and dense forest regions)



User Feedback

Objective is to obtain critical user feedback on the impacts from NPP/JPSS

Demonstrate importance of NPP data to the Nation and to critical operational product and services

Engaging JCSDA (NCEP,NESDIS,NRL, NASA) on early impact data assimilation studies using CrIS and ATMS SDRs.

OMPS -- Engaging NWS Climate Prediction Center – compare OMPS products with SBUV-2, GOME-2 and generate analyses with and without OMPS.

Additional User Feedback

NWS- Alaska Region use DB software to provide feedback on:

- Cloud products, snow, ice, volcanic ash, aerosols
- Soundings

NASA-SPORT will directly engage more than 20 NOAA /NWS Weather Forecast Offices to facilitate use of NPP data and to provide feedback on VIIRS and CrIMSS products.

NRL NEXSAT – uses VIIRS Imagery and EDRs for environmental assessments.

Need other user engagements

Need to extend to other products

Training and outreach are both essential:

UCAR - COMET/METeD Program

SPORT

Conclusions

JPSS Mission will provide:

Input Observations for Weather Forecast Models
CrIS, ATMS, VIIRS, OMPS & GCOM

Short term Environmental Observations
(Events)
VIIRS, OMPS, CrIS, ATMS & GCOM

Long term Environmental Observations
(Climate Change Detection)
CERES, TSIS, VIIRS, OMPS, CrIS, ATMS & GCOM

User Engagement is critical for ultimate mission success