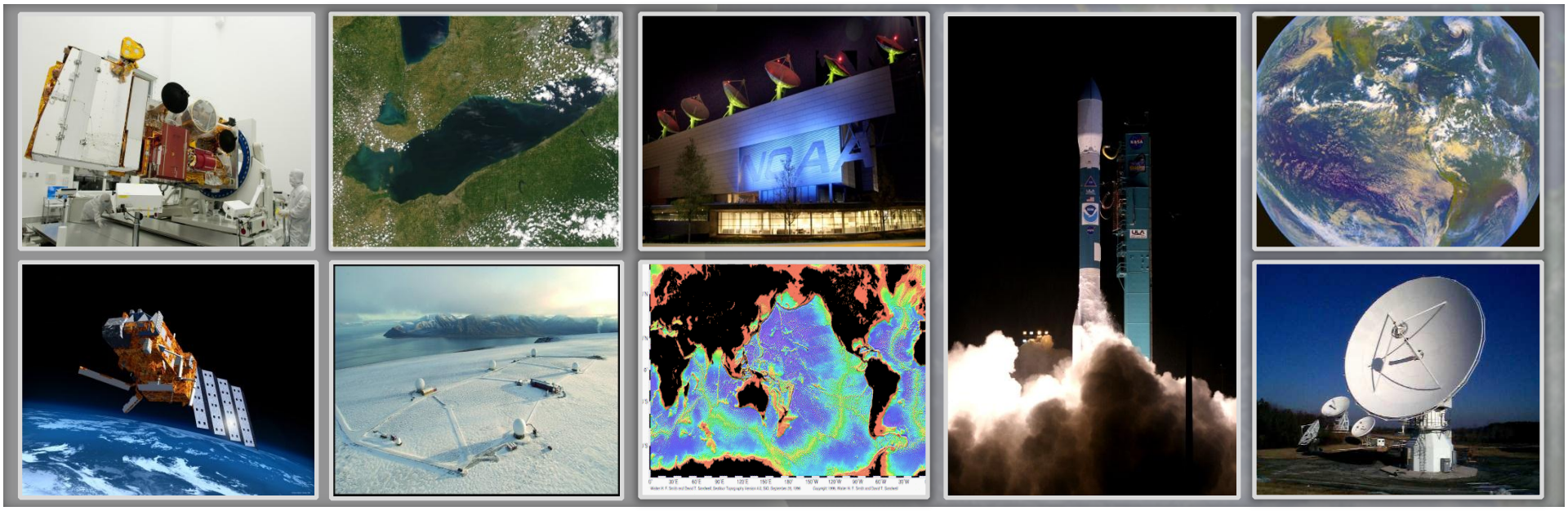
Joint Polar Satellite System

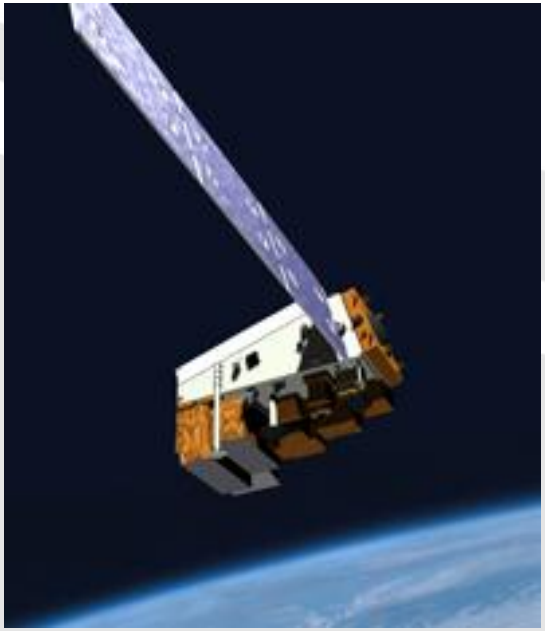


Mitch Goldberg, Program Scientist (Detailed)
Joint Polar Satellite System

JPSS Program Overview

Benefits

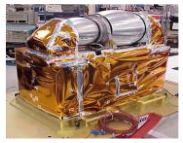
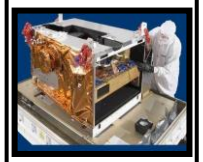
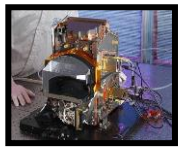
- Maintains continuity of weather/climate observations and critical environmental data from the polar orbit
- NOAA – JPSS provides improved continuity for POES
  - HIRS > CrIS
  - AMSU > ATMS
  - AVHRR > VIIRS
  - SBUV2 > OMPS
- NASA – JPSS provides continuity for EOS
  - AIRS > CrIS
  - AMSU > ATMS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



JPSS-1 Satellite

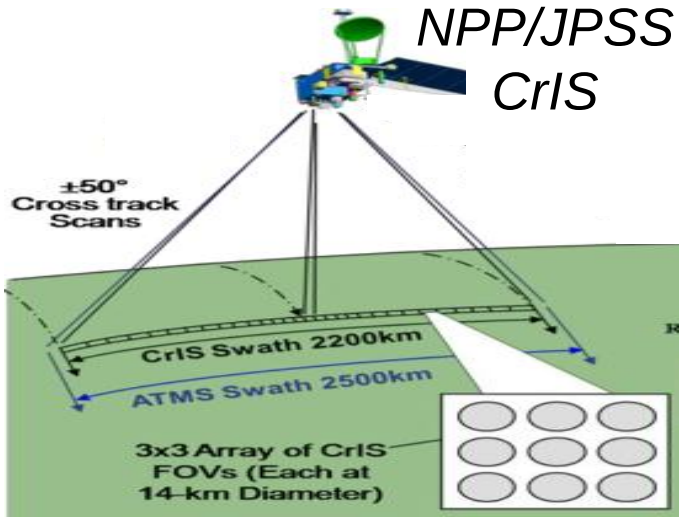
(NPP-clone)

System Description
(Space Segment)

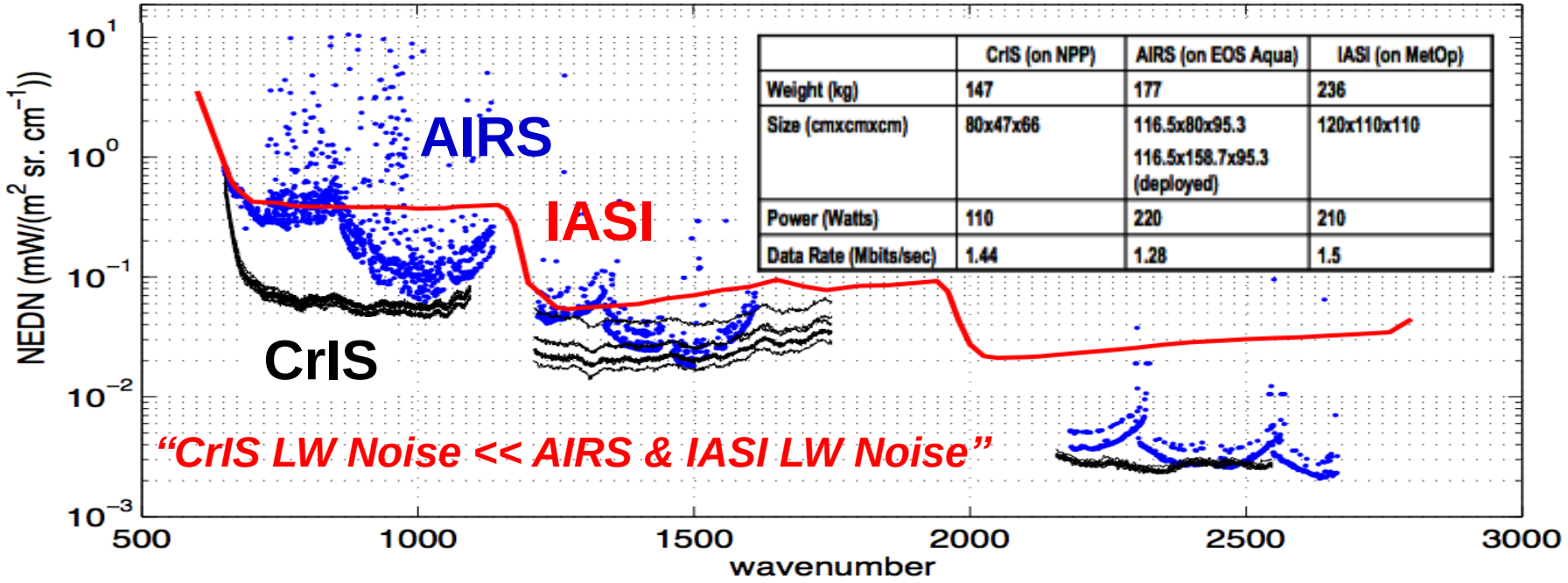
JPSS Instrument		Measurement	NOAA Heritage	NASA Heritage
	ATMS	ATMS and CrIS together provide profiles of atmospheric temperature, moisture, and pressure	AMSU	AMSU
	CrIS		HIRS	AIRS
	VIIRS	Provides daily high-resolution imagery and radiometry across the visible to long-wave infrared spectrum	AVHRR	MODIS
	OMPS	Spectrometers with UV and IR bands for ozone total column measurements	SBUV-2	OMI
	CERES	Scanning radiometer which supports studies of Earth Radiation Budget		CERES

Cross-Track Infrared Sounder (CrIS)

NPOESS Preparatory Satellite – Launch: October 2011



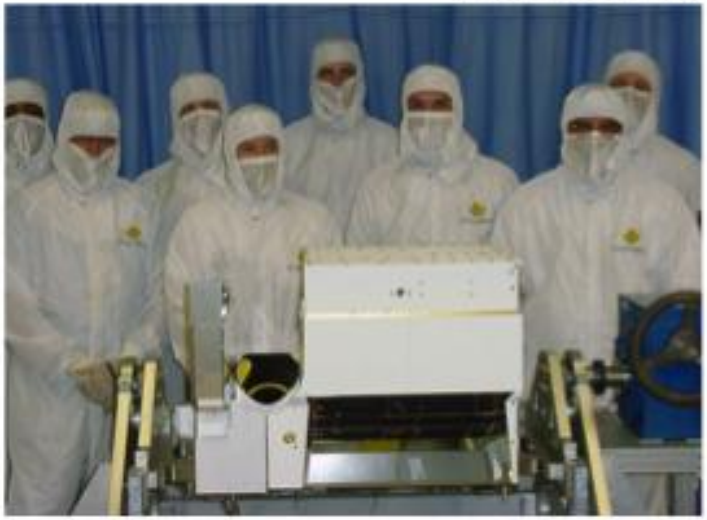
- Michelson Interferometer: 0.625,1.25, 2.5cm^{-1} (resolving power of 1000)
- Spectral range: 660-2600 cm^{-1}
- 3 x 3 HdCdTe focal plane passively cooled (4-stages) to 85K
- Focal plane 27 detectors, 1305 spectral channels
- 310 K Blackbody and space view provides radiometric calibration
- NEDT ranges from 0.05 K to 0. 5 K



	CrIS (on NPP)	AIRS (on EOS Aqua)	IASI (on MetOp)
Weight (kg)	147	177	236
Size (cmxcmxcm)	80x47x66	116.5x80x95.3 116.5x158.7x95.3 (deployed)	120x110x110
Power (Watts)	110	220	210
Data Rate (Mbits/sec)	1.44	1.28	1.5

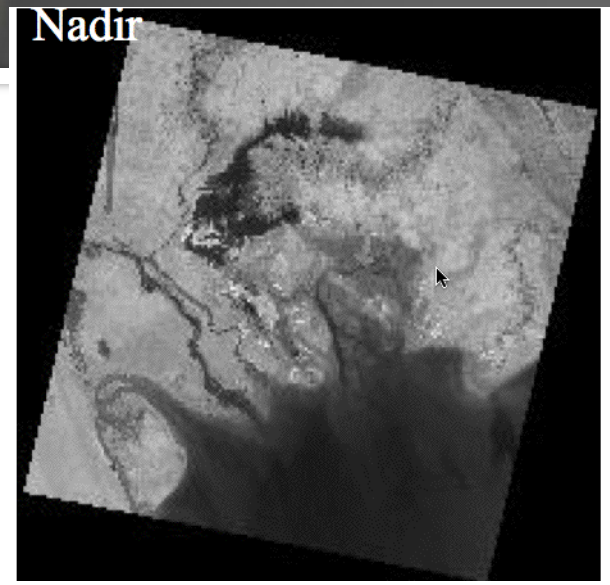
AIRS
Atmospheric InfraRed Sounder
Grating spectrometer
166 kg, 256 W
13.5 km FOV at nadir, contiguous
Launched on Aqua in 2002

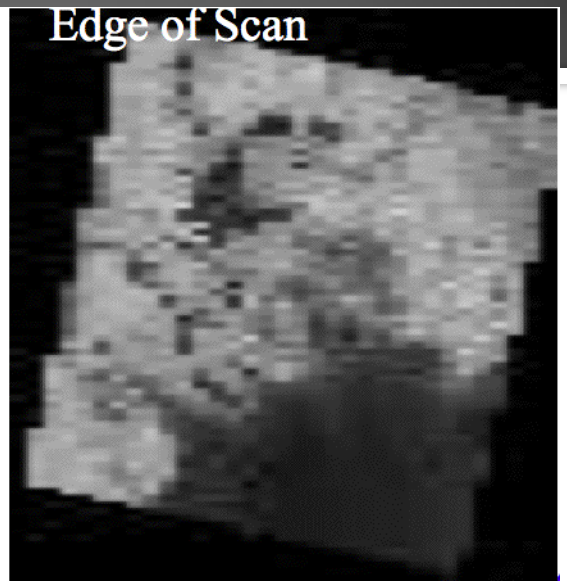
IASI
Infrared Atmospheric Sounding Interferometer
Michelson interferometer
236 kg, 210 W
2x2 12 km FOVs at nadir, non-contiguous
Launched on Metop-A in 2006

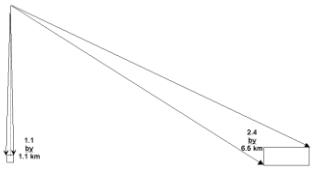


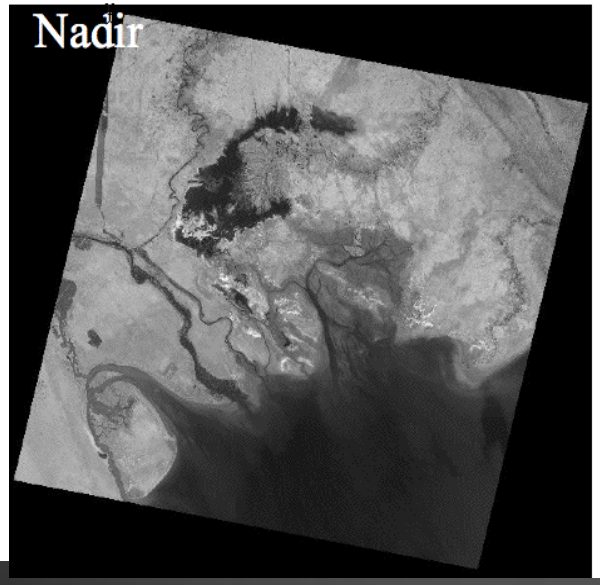
CrIS
Cross-track Infrared Sounder
Michelson interferometer
146 kg, 110 W
3x3 14 km FOVs at nadir, contiguous
To be launched on NPP

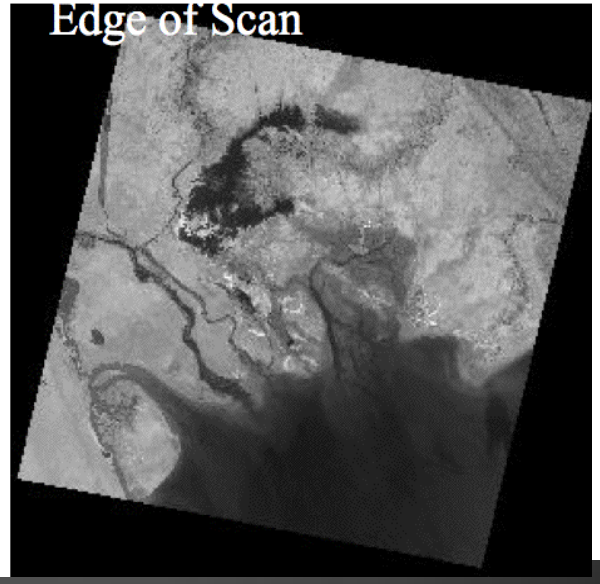
VIIRS Edge of Scan Spatial Resolution is significantly improved over AVHRR



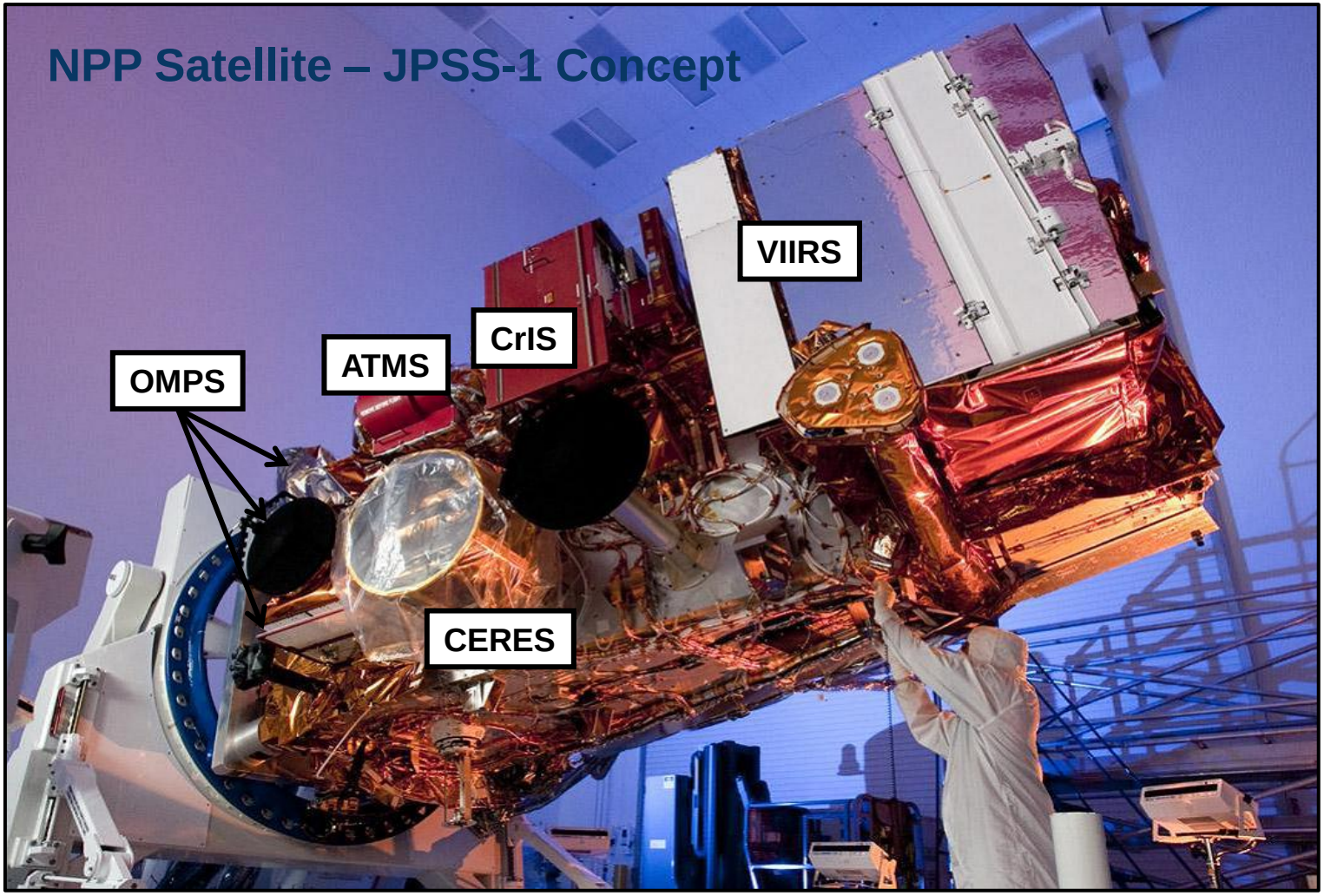




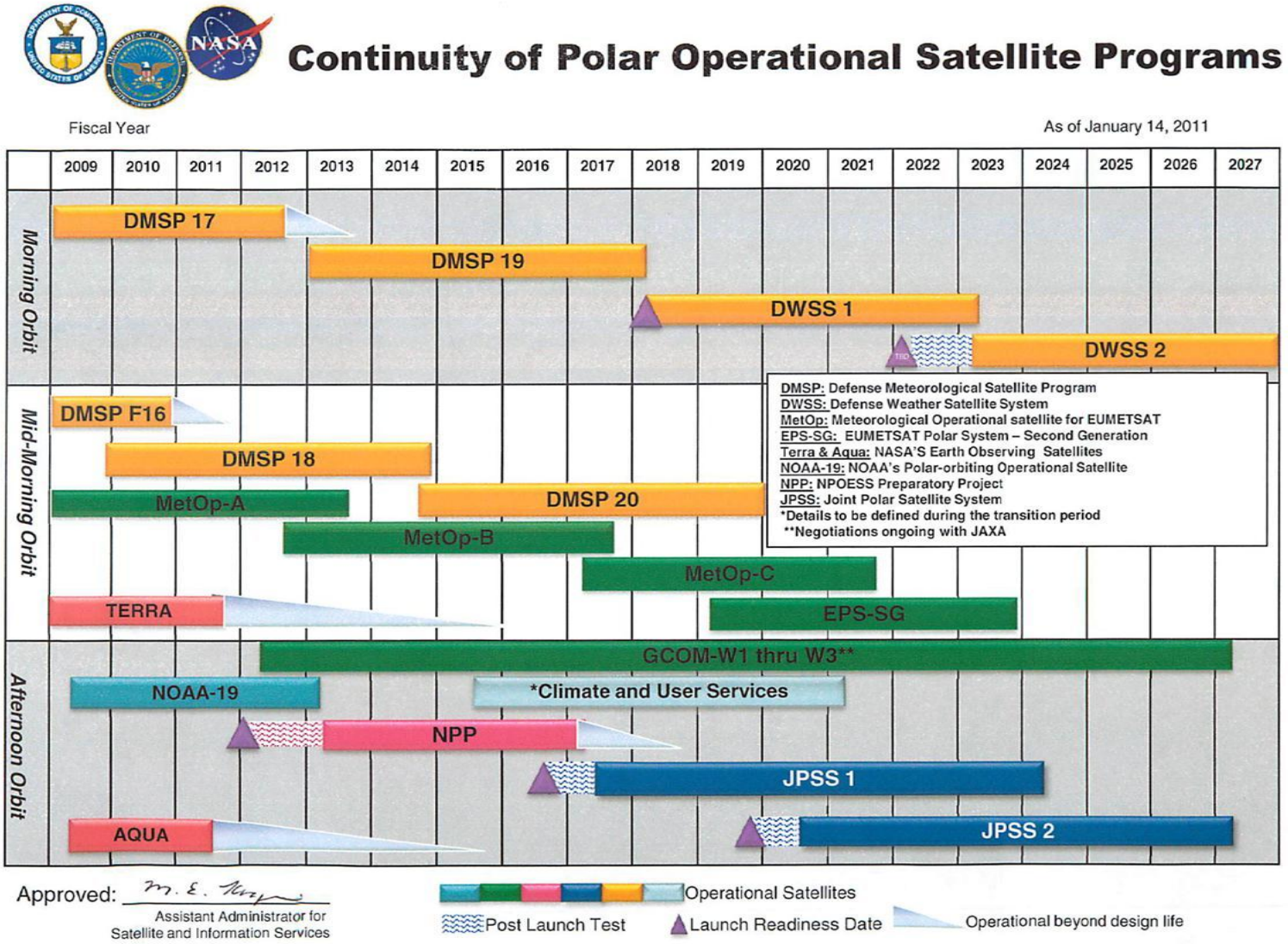




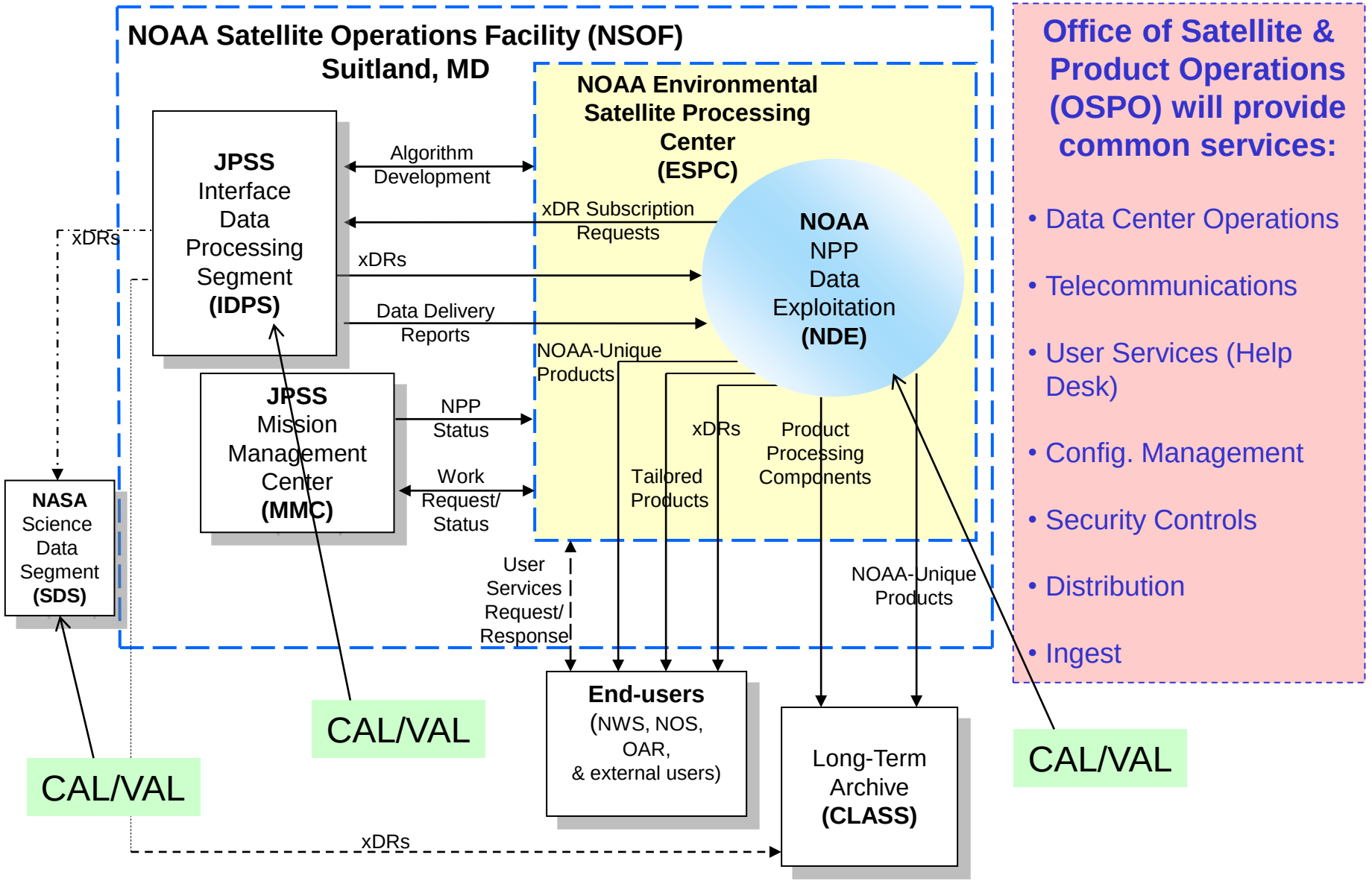
System Description
(Space Segment)



Continuity of Polar Operational Satellites



Functional Scope: The NESDIS Central



Office of Satellite & Product Operations (OSPO) will provide common services:

- Data Center Operations
- Telecommunications
- User Services (Help Desk)
- Config. Management
- Security Controls
- Distribution
- Ingest

System Description (Ground System)

VIIRS (22)

- ALBEDO (SURFACE)
- CLOUD BASE HEIGHT
- CLOUD COVER/LAYERS
- CLOUD EFFECTIVE PART SIZE
- CLOUD OPTICAL THICKNESS
- CLOUD TOP HEIGHT
- CLOUD TOP PRESSURE
- CLOUD TOP TEMPERATURE
- ICE SURFACE TEMPERATURE
- NET HEAT FLUX
- OCEAN COLOR/CHLOROPHYLL
- SUSPENDED MATTER
- VEGETATION INDEX
- AEROSOL OPTICAL THICKNESS
- AEROSOL PARTICLE SIZE
- ACTIVE FIRES
- ● IMAGERY
- SEA ICE CHARACTERIZATION
- SNOW COVER
- ● SEA SURFACE TEMPERATURE
- LAND SURFACE TEMP
- SURFACE TYPE

MIS (17 - TBR)

- CLOUD LIQUID WATER
- PRECIPITATION TYPE/RATE
- PRECIPITABLE WATER
- ● SEA SURFACE WINDS (1)
- CLOUD ICE WATER PATH
- SEA SURFACE WIND STRESS
- TOTAL WATER CONTENT
- ● SOIL MOISTURE
- IMAGERY
- SEA ICE CHARACTERIZATION
- SNOW COVER/DEPTH
- SEA SURFACE TEMPERATURE
- LAND SURFACE TEMP
- SURFACE TYPE
- ATM VERT MOIST PROFILE
- ATM VERT TEMP PROFILE
- PRESSURE (SURFACE/PROFILE)

SEM-N (5)

- AURORAL BOUNDARY
- AURORAL ENERGY DEPOSITION
- ENERGETIC IONS
- MED ENERGY CHARGED PARTICLES
- SUPRA-THERMAL THRU AE PARTICLES

VIIRS (22)

OMPS (2)

- O_3 TOTAL COLUMN
- O_3 NADIR PROFILE

CrIS/ATMS (3)

- ● ATM VERT MOIST PROFILE
- ● ATM VERT TEMP PROFILE
- PRESSURE (SURFACE/PROFILE)

CERES (4)

- DOWN LW RADIATION (SFC)
- DOWN SW RADIATION (SFC)
- NET SOLAR RADIATION (TOA)
- OUTGOING LW RADIATION (TOA)

GCOM AMSR-2 (11)

- CLOUD LIQUID WATER
- PRECIPITATION TYPE/RATE
- PRECIPITABLE WATER
- SEA SURFACE WINDS SPEED
- SOIL MOISTURE
- SNOW WATER EQUIVALENT
- IMAGERY
- SEA ICE CHARACTERIZATION
- SNOW COVER/DEPTH
- SEA SURFACE TEMPERATURE
- SURFACE TYPE

A-DCS

TSIS (1)

SOLAR IRRADIANCE

SARR & SARP

KEY

- ● EDRs with Key Performance Parameters
- JPSS-1
- DWSS
- GCOM
- JPSS Program (Host TBD)

GOES-R vs JPSS IDPS Products

- Aerosol Detection (including Smoke and Dust)
- Aerosol Particle Size
- Suspended Matter / Optical Depth
- Volcanic Ash Detection and Height
- Aircraft Icing Threat
- Cloud & Moisture Imagery (KPPs)
- Cloud Layers / Heights & Thickness
- Cloud Ice Water Path
- Cloud Liquid Water
- Cloud Optical Depth
- Cloud Particle Size Distribution
- Cloud Top Phase
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Cloud Type
- Clear Sky Masks
- Fire / Hot Spot Characterization
- (red = baseline)

- Aerosol Optical Thickness
- Aerosol Particle Size
- Imagery
- Cloud Base Height
- Cloud Coverage/Layers
- Cloud Effective Particle Size
- Cloud Ice Water Path
- Cloud Liquid Water
- Cloud Mask (IP)
- Cloud Optical Thickness
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Active Fires

GOES-R vs JPSS Products

- Probability of Rainfall
- Rainfall Potential
- Rainfall Rate / QPE
- Legacy Atm. Vertical Moisture Profile
- Legacy Atm. Vertical Temperature
- Profile Derived Stability Indices (5)
- Total Precipitable Water
- Land Surface (Skin) Temperature
- Surface Albedo
- Surface Emissivity
- Vegetation Fraction
- Green Vegetation Index
- Sea & Lake Ice / Age
- Sea & Lake Ice / Concentration
- Sea & Lake Ice / Extent
- Sea & Lake Ice / Motion
- Ice Cover / Landlocked: Hemispheric Snow Cover
- Snow Depth (Over Plains) Sea Surface Temps

- Atmospheric Vertical Moisture Profile
- Atmospheric Vertical Temperature Profile
- Ozone Total
- Column Ozone Profile
- Land Surface Temperature
- Albedo (Surface)
- Vegetation Index
- Sea Ice Concentration
- Ice Surface Temperature
- Snow Cover
- Sea Surface Temperature
- Ocean Color
- Suspended Matter

Validation Stages

Beta- Early release product, minimally validate, may contain significant errors, available to key users to gain familiarity with data formats

Provisional –Product quality may not be optimal –Incremental product improvements are still occurring

- Validated – Stage.1 –Product accuracy has been estimated from a small number of independent measurements obtained from select locations and time periods.
- Validated – Stage.2 –Product accuracy assessed over a widely distributed set of locations and time periods via several ground truth and validation efforts.
- Validated – Stage.3 –Product accuracy has been assessed and the uncertainties in the product well established via independent measurements in a systematic and statistically robust way representing global conditions.

Plans for CrIMSS SDR/EDR Maturity

Event	Date		SDR	EDR
launch	Oct. 25, 2011	L+0		
End of CrIS outgassing	Dec. 6, 2011	L+42d		
ITT Packet #32	Dec. 15, 2011	L+51d	Beta	
End of CrIS SDR EOC	Dec. 26, 2011	L+62d		
CrIS/ATMS Normal Op	Jan. 1, 2011	L+68d		Beta
ITT Packet #33	Jan. 23, 2012	L+90d	Provisional	
End of SDR ICV	Jun. 23, 2012	L+9m	Stage.1	
Provisional EDR	Oct. 25, 2012	L+1y	Stage.2	Provisional
End of EDR ICV	Apr. 22, 2013	L+18m		Stage.1
EDR updates	Oct. 25, 2013	L+2y		Stage.2
EDR updates	Oct. 25, 2014	L+3y	Stage.3	Stage.3

Note: Dates reflect delivery from algorithm teams and does not include transition to operations (IDPS) time.

History of IASI SDR/EDR Maturity

Event	Date		SDR	NOAA-EDR
launch	Oct. 19, 2006	L+0		
1st test orbit	Jan. 15, 2007	L+97d	Beta	functional
2nd test orbit	Feb. 11, 2007	L+4m	Provisional	
EUMETSAT SDR operational	July 18, 2007	L+9m	Stage.1	Beta
1st IASI Focus Day	Oct. 19, 2007	L+1y		
NOAA SDR operational	Oct. 30, 2007	L+1y	Stage.2	Provisional
EDR operational	Aug. 14, 2008	L+22m		Stage.1
EDR updates operational	Sep. 17, 2009	L+3y		Stage.2
EUMETSAT SDR updates	May 18, 2010	L+3.6y	Stage.3	

Jul 2012 Product Suite

- Products with NDE Operations Planning Dates
- Assumes Oct 25, 2011 launch

ATMS Radiances	Jul-12
ATMS Radiances (BUFR)	Jul-12
CrIS Radiances	Jul-12
CrIS Radiances (BUFR)	Jul-12
VIIRS Radiances	Jul-12
VIIRS Radiances (BUFR)	Jul-12
VIIRS Imagery	Jul-12

Blue – IDPS
Yellow - NDE

Sep – Dec 2012 Product Suite

- Products with NDE Operations Planning Dates

OMPS Radiances	Sep-12
Polar Winds (VIIRS BUFR)	Oct-12
Rainfall Rate (ATMS)	Oct-12
Total Precipitable Water (ATMS)	Oct-12
Snow Cover (ATMS)	Oct-12
Land Surface Emissivity (ATMS)	Oct-12
Temperature Profiles (ATMS)	Oct-12
Moisture Profiles (ATMS)	Oct-12
Cloud Liquid Water (ATMS)	Oct-12
Sea Ice Concentration (ATMS)	Oct-12
Snow Water Equivalent (ATMS)	Oct-12
Ice Water Path (ATMS)	Oct-12
Land Surface Temperature (ATMS)	Oct-12
Rain Water Path (ATMS)	Oct-12
Green Vegetation Fraction	Dec-12
Ozone Limb Profile Radiances	Dec-12

Jan – Feb 2013 Product Suite

Aerosol Optical Depth (AVHRR-like)	Jan-13
Atmospheric Moisture Profile (CrIS/ATMS)	Jan-13
Atmospheric Temperature Profile (CrIS/ATMS)	Jan-13
Clear Sky Brightness Temperatures	Jan-13
Cloud Top Fraction (CrIS)	Jan-13
Cloud Top Pressure (CrIS)	Jan-13
CO2 Slicing Derived Cloud Top Pressure (CrIS) [New]	Jan-13
CrIS Cloud Cleared Radiances	Jan-13
Ocean Optimized Cloud Mask	Jan-13
Ozone (CrIS)	Jan-13
Sea Surface Temperature (SST)	Jan-13
Sea Surface Temperature (SST) (BUFR)	Jan-13
SST (AVHRR-like)	Jan-13
Stability Products (CrIS)	Jan-13
Trace Gases (Carbon Dioxide, Methane, Sulfur Dioxide)	Jan-13
Blended Rain Rate	Feb-13
Blended SST (Imagery)	Feb-13
Blended Total Precipitable Water	Feb-13
Blended Total Precipitable Water Anomaly	Feb-13
Coral Reef Bleaching Indices/Alerts	Feb-13
SST Anomalies	Feb-13
SST Degree Heating Weeks	Feb-13
SST Hot Spots	Feb-13

April 2013 Product Suite

Active Fires	Apr-13
Aerosol Optical Thickness	Apr-13
Aerosol Optical Thickness (BUFR)	Apr-13
Aerosol Particle Size	Apr-13
Atmospheric Moisture Profile	Apr-13
Atmospheric Pressure Profile [New]	Apr-13
Atmospheric Temperature Profile	Apr-13
Cloud Base Height [New]	Apr-13
Cloud Cover/Layers	Apr-13
Cloud Effective Particle Size	Apr-13
Cloud Mask	Apr-13
Cloud Optical Thickness	Apr-13
Cloud Top Height (VIIRS)	Apr-13
Cloud Top Pressure	Apr-13
Cloud Top Temperature	Apr-13
Ice Surface Temperature [New]	Apr-13
Land Surface Temperature (VIIRS) [New]	Apr-13
Land Surface Type	Apr-13
Nadir Profile Ozone	Apr-13
Ocean Color/Chlorophyll	Apr-13

Ozone (BUFR)	Apr-13
Ozone Total Column	Apr-13
Quarterly Surface Type Gridded [New]	Apr-13
Sea Ice Characterization (VIIRS)	Apr-13
Snow Cover	Apr-13
Surface Albedo	Apr-13
Suspended Matter [New]	Apr-13
Vegetation Index	Apr-13

Jun 2013 – Sep 2014 Product Suite

Aerosol Optical Depth (OMPS LP)	Jun-13
Blended Ozone	Jun-13
Blended Snow Cover	Jun-13
Ozone Profile (OMPS LP)	Jul-13
Tropical Cyclone Intensity	Aug-13
AMSR-2 Radiances [New]	Sep-13
AMSR-2 SDR [New]	Sep-13
Fire & Smoke Analysis	Sep-13
Precipitable Water (GCOM) [New]	Sep-13
Precipitation (Type/Rate) GCOM [New]	Sep-13
Sea Ice Characterization (GCOM) [New]	Sep-13
Sea Surface Temperature (GCOM) [New]	Sep-13
Sea Surface Wind Speed (GCOM) [New]	Sep-13
Snow Cover/Depth (GCOM) [New]	Sep-13
Snow Water Equivalent (GCOM) [New]	Sep-13
Soil Moisture GCOM [New]	Sep-13
Surface Type (GCOM) [New]	Sep-13
Volcanic Ash [New]	Sep-13

AMSR-2 Radiances (BUFR) [New]	Dec-13
Chesapeake Bay Ocean Color [New]	Mar-14
Chlorophyll a (5 tailored regions) [New]	Mar-14
Emiliania huxleyi Bloom [New]	Mar-14
Harmful Algal Bloom Anomaly [New]	Mar-14
Near Coast Ocean Color (SWIR) [New]	Mar-14
Normalized Water Leaving Radiances [New]	Mar-14
Outgoing Longwave Radiation (CrIS)	Jun-14
Blended Rain Rate (GCOM) [New]	Sep-14
Blended Soil Moisture (GCOM)	Sep-14
Blended SST (GCOM) [New]	Sep-14
Blended Total Precipitable Water (GCOM) [New]	Sep-14
Blended Total Precipitable Water Anomaly (GCOM) [New]	Sep-14
Tropical Cyclone Intensity (GCOM) [New]	Sep-14
Tropical Rainfall Potential	Sep-14
Tropical Rainfall Potential (GCOM) [New]	Sep-14

JPSS Proving Ground focused initially on NWS and NOS applications

The JPSS Proving Ground program's primary objective is to maximize the benefits and performance of NPP/JPSS algorithms, data and products for downstream operational and research users (gateways to the public) through:

- Detailed characterization of data attributes such as uncertainty (accuracy and precision) and long-term stability
- Engaging users to enhance their applications (and develop new ones) by working together to facilitate optimal utilization of JPSS algorithms, data and products in combination with other data sources through onsite/offsite testbeds, experimental data streams, intercomparisons of enhancements with baselines
- Facilitating transition of improvements (new algorithms/applications) to operations.

Application Areas

Tropical Cyclone Applications

Cryosphere Applications

Severe Weather/Aviation Applications

Ocean/Coastal Applications (Coral Bleaching, Harmful Algae Bloom alerts)

Land Applications (Agriculture, Droughts)

Hazards Applications (Smoke, Fire, Aerosols, Air Quality, Flash Floods)

Data Assimilation Applications

Imagery/Visualization Applications

Climate Applications

Move forward

Need guidance from senior leaders on priorities

Need to identify current GOES-R projects which benefits from the use of JPSS data and establish co-sponsorship when it makes sense

Need to connect algorithm developers with user community.

Identify SMEs for each product (IDPS and NDE)

- Identify algorithm/product developer
- Identify the key user of the product

User Workshop to improve understanding of products and user applications

Attendance includes representatives from each line office with user subject matter experts for each product as well as the product/algorithm developer.

- Bridge the gap in understanding user applications and product contributions and attributes.
- Discuss current limitations of satellite products being used in applications and discuss efforts needed to maximize contribution of JPSS data
- Discuss the need for new applications

Application Team Assessment

- Review and Comment on the MRD Spec.
- Current State of Algorithms and any deficiencies
- Candidate Algorithms for GOES-R
- Instrument Requirements to meet MRD
- Proxy Data Needs
- Expectations for interaction and inputs from other teams
- Algorithm Action Plan
  - How are you going to reach consensus?
  - What issues must be resolved?
  - How are you going to intercompare algorithms?
  - Describe the testbed environment needed to select the algorithm
  - Schedule of activities needed to meet deliverables

From November 2005 AWG meeting ~ Initial Requirements Assessment

Seek proposals based on outcome of workshop

Introduction

- Identify and describe end user application(s) and importance, and the benefit JPSS data can provide
- Identify and describe any current limitation(s), requiring additional research and/or feedback to further realize this benefit.
- Identify a user that will be engaged, and describe how you will engage the user, regularly, to understand JPSS products, provide test datasets and to obtain feedback.

Proposed Work and Technical Approach

- Describe methodology to use JPSS data (and other data sources, if necessary) to improve the identified user application.

Milestones and deliverables

JPSS Current Portfolio of User Engagement activities

- **JCSDA CrIS/ATMS Radiance Assimilation Experiments**
  - POC – Sid Boukabara
  - Outcome - Impact assessments and improved utilization of radiances
- **Alaska High Latitude Proving Ground**
  - POC – Gary Hufford/Tom Heinrich
  - Outcome - Upgrade X-band receiver, generate NPP products, forecaster training, product evaluation and feedback, compare operational products with alternative products using CSPP.
- **Community Satellite Processing Package (CSSP)**
  - POC – Allen Huang/Liam Gumley
  - Outcome - Software package/testbed containing IDPS algorithms and capability of alternative algorithms for intercomparisons

JPSS Current Portfolio of User Engagement activities

- **Utility of NPP/JPSS Data to Improve Situational Awareness and Short-term Forecasts in WFO Operations**
  - ✓ POC – Gary Jedlovec, SPORT
  - ✓ Outcome - AWIPS/AWIPSII plug-ins for VIIRS SDRs/EDRs, RGB products, training of selected WFOs by adapting current MODIS and AIRS modules, feedback, close coordination with Alaska Proving Ground, and with NRL, CIRA and CIMSS.

SPoRT will use established collaborative partnerships to disseminate VIIRS data and products to various WFOs to engage forecasters in an evaluation of selected products to address specific forecast challenges.

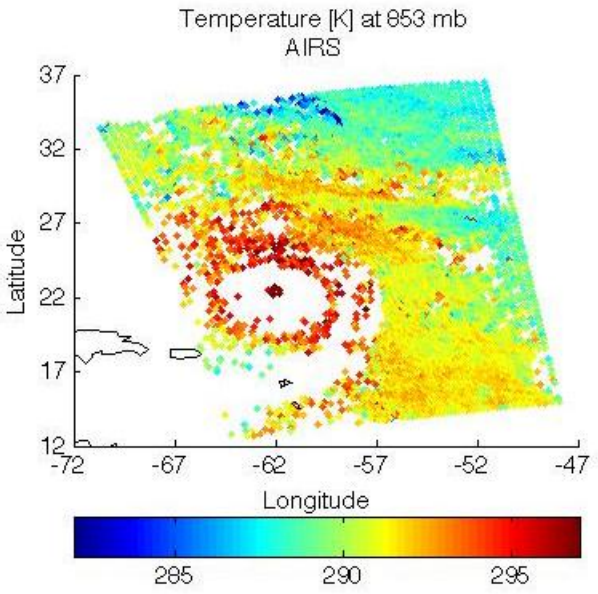
Table 1: Forecast issues and VIIRS products for regional applications.

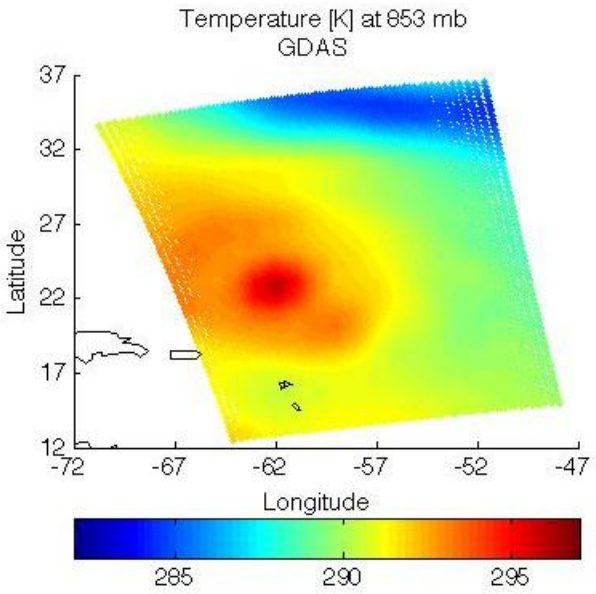
Forecast Challenge	Products	Regional Emphasis
Convective storm diagnostics	SDRs, RGB products, cloud properties, cloud-top height, TPW, lightning	CONUS – selected SR and CR WFOs OCONUS – AK and HI
Visibility and ceilings – day and night changes with local variability	SDRs, RGB products, cloud products (base, cover, layers), low cloud/fog/snow discrimination, and AOT, glacier dust	CONUS – selected SR and CR WFOs Alaska Region
Various marine weather issues – sea ice dynamics, freezing sea spray, winds, visibility, etc.	SDRs, RGB products, SST, ocean color, sea ice mapping and characterization	Alaska Region
Local surface forcing – local temperature forecasts, flooding due to snow melt/runoff	SDRs, RGB products, LST, snow cover / depth	CONUS – CR and WR WFOs Alaska Region

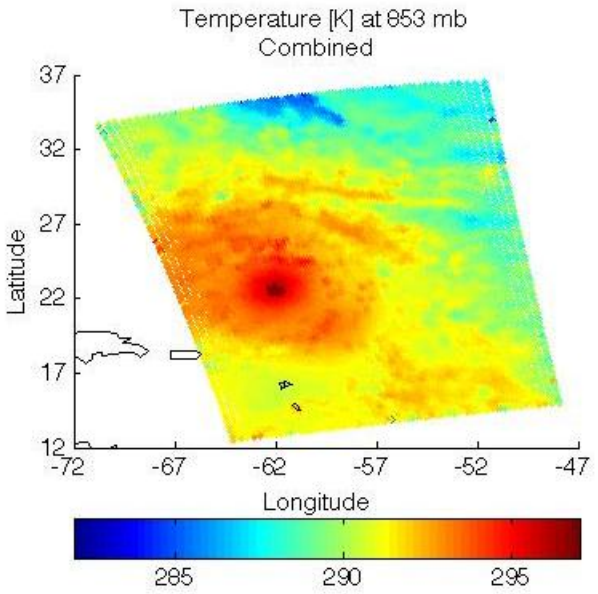
JPSS Current Portfolio of User Engagement activities

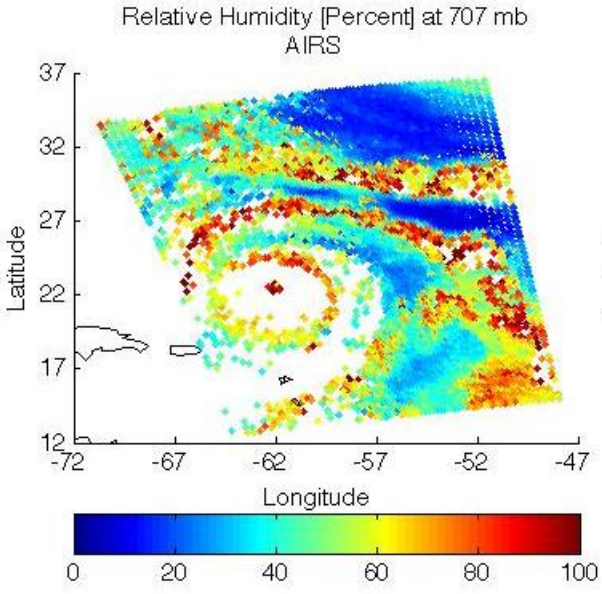
- **Application of JPSS Imagers and Sounders to Tropical Cyclone Track & Intensity Forecasting**
  - POC – Mark DeMaria, John Knaff, Steve Miller
    - Users – Brennan, Beven (NHC), Fukada (JTWC)
  - Outcome - VIIRS will improve center location, Soundings from CrIS and ATMS to improve intensity forecasting. Information used in existing operational statistical-dynamical intensity forecast model. Strong user engagement with forecasters at NHC and JTWC.
- **Establish Tropical Cyclone Application Team**

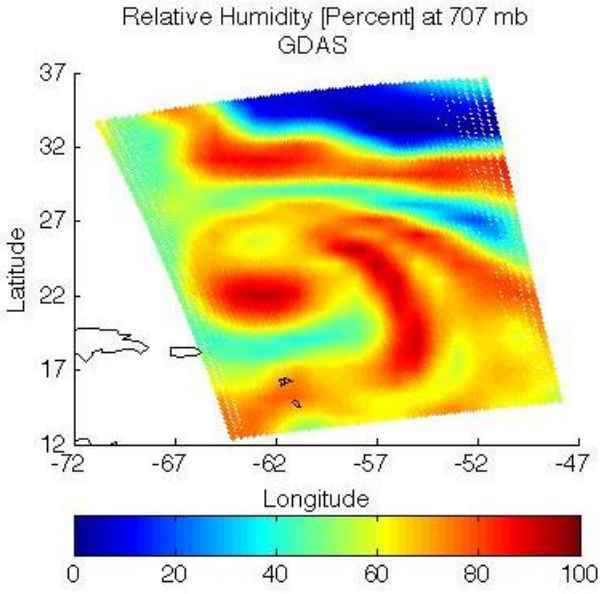
AIRS Temperature and Humidity (850/700 hPa)

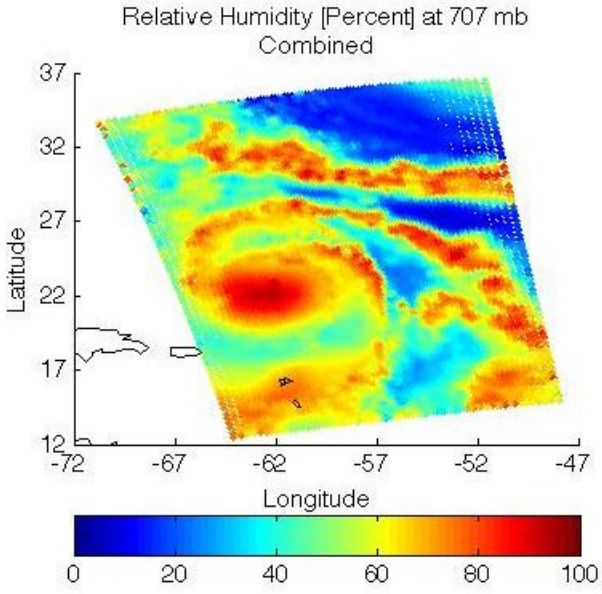




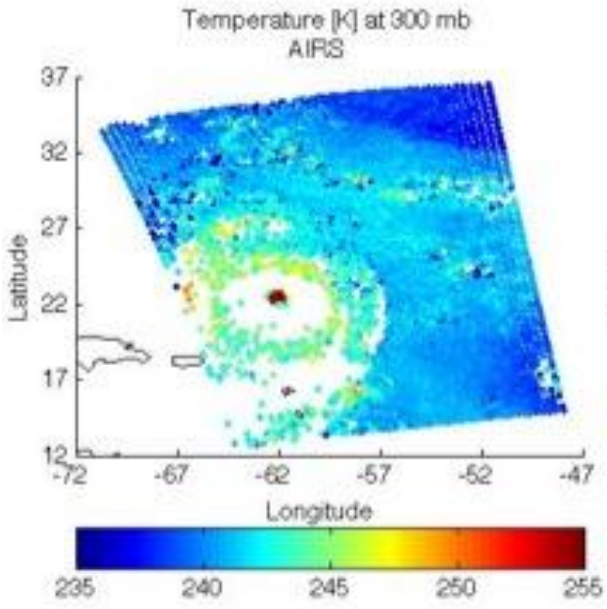


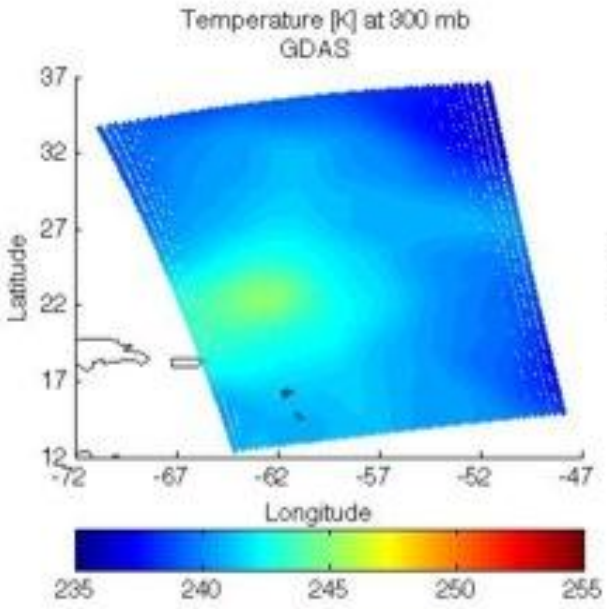


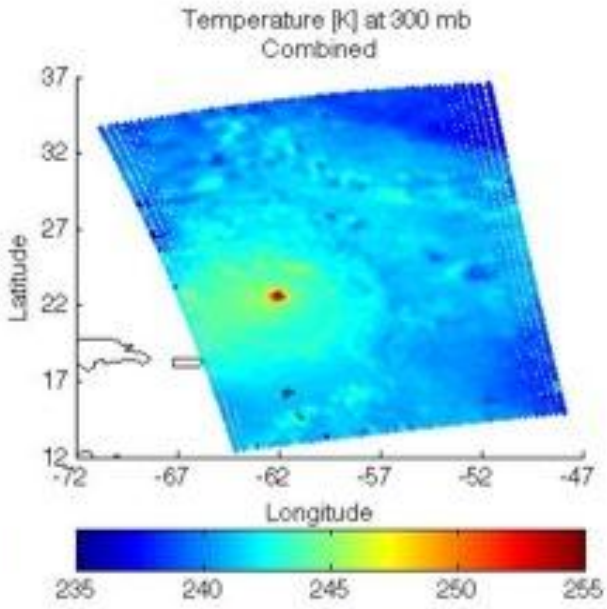


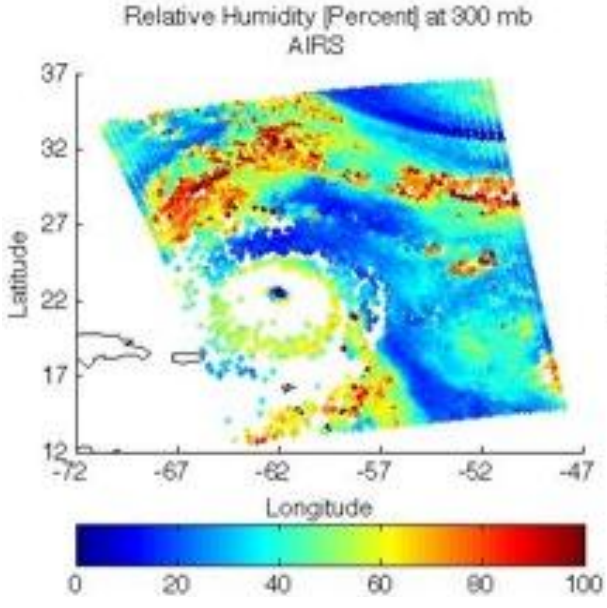


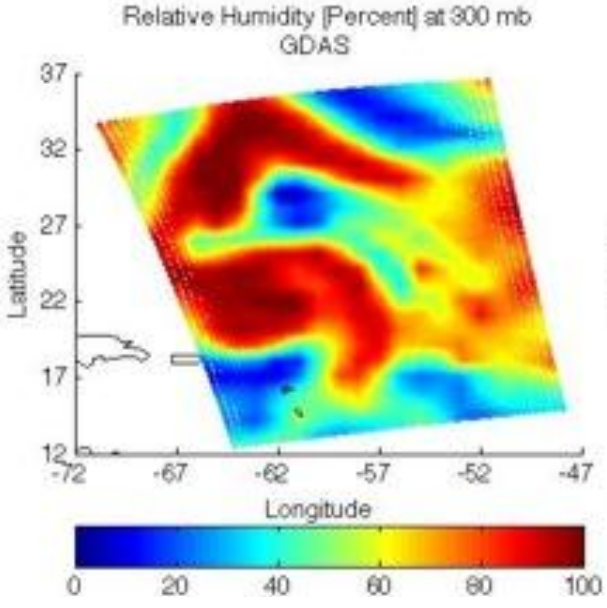
AIRS Temperature and Humidity (300 hPa)

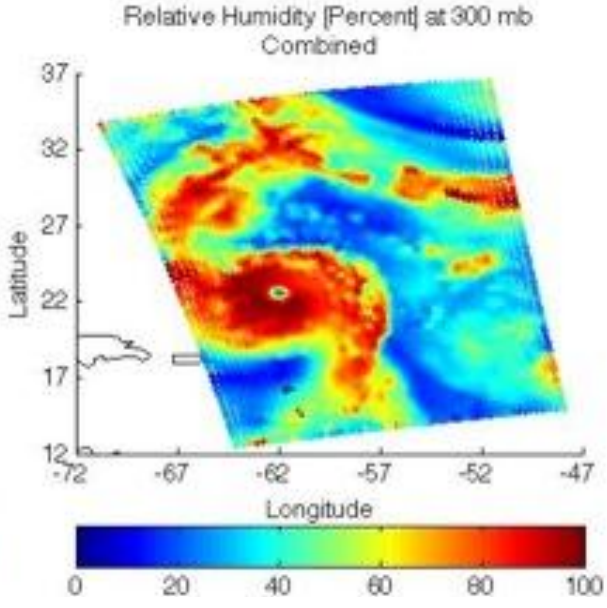




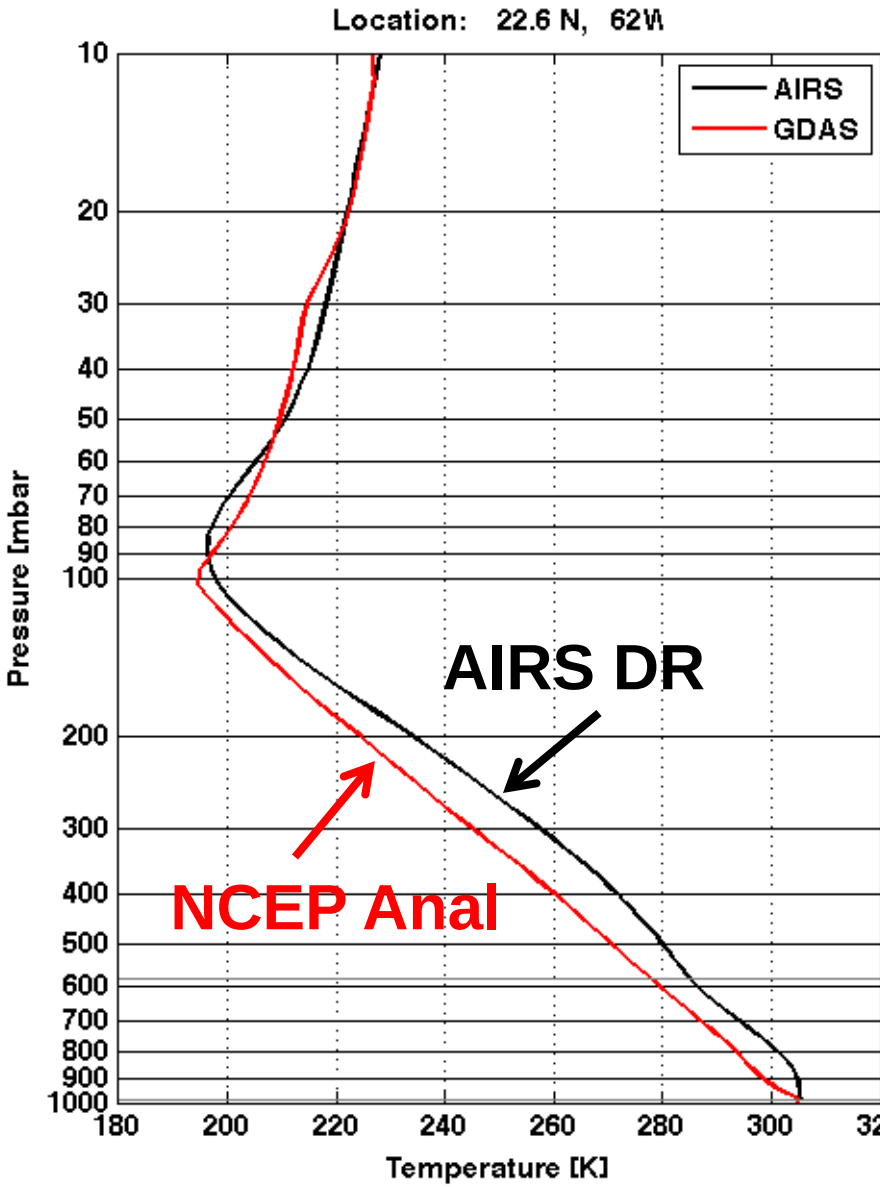


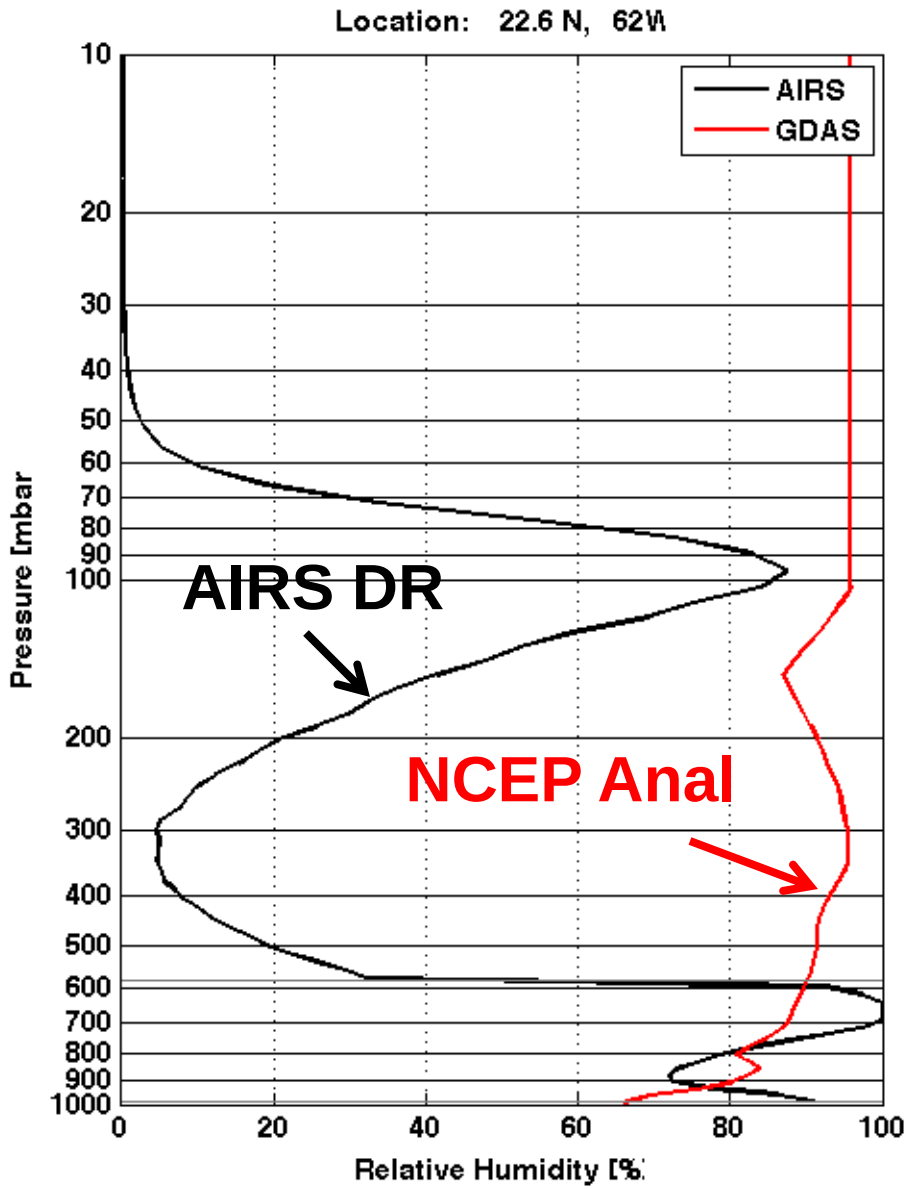






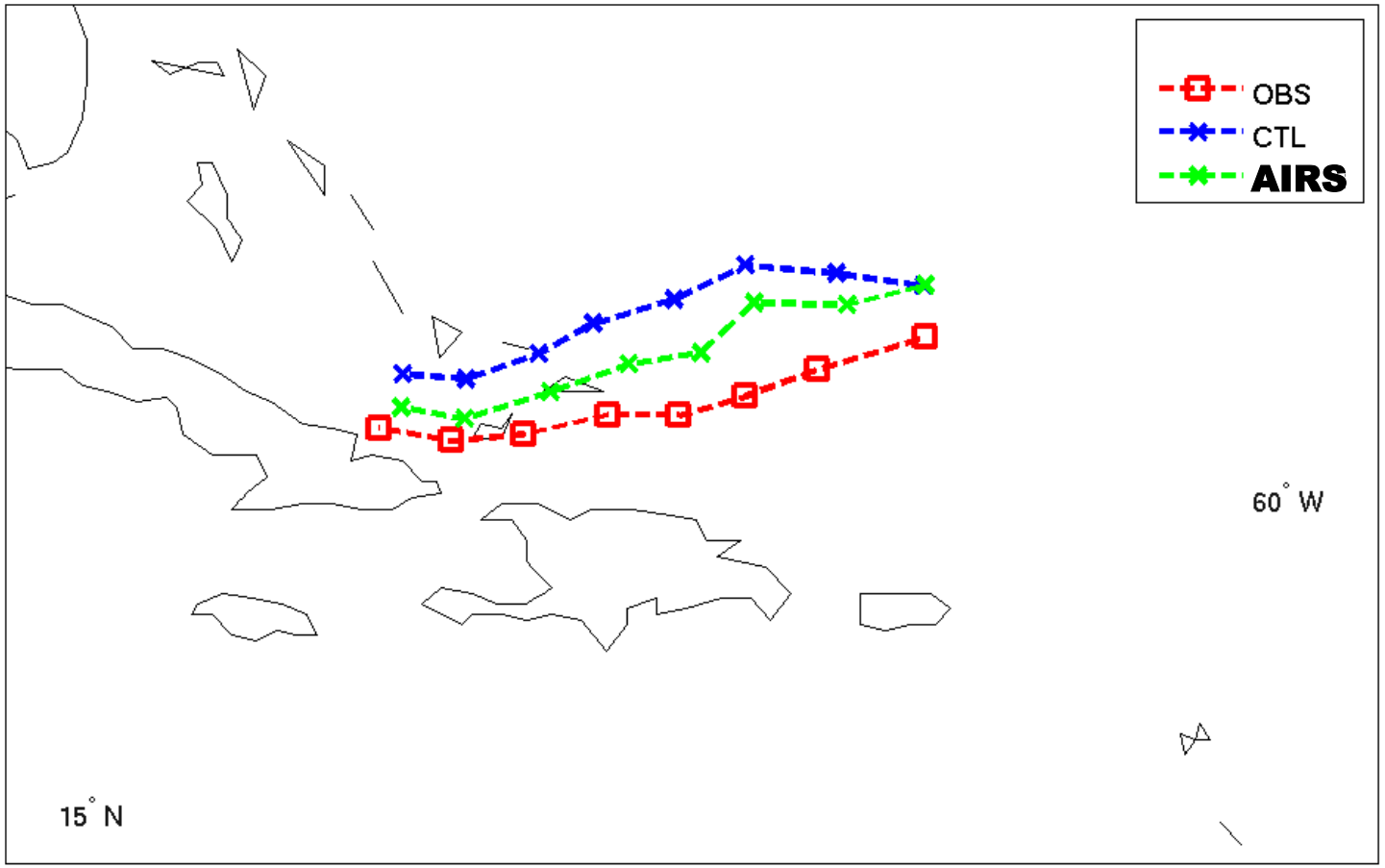
Isabel Eye Sounding





Tracks of ensemble mean analysis on Hurricane IKE

CTL run: **Assimilate radiosonde, satellite cloud winds, aircraft data, and surface data.**



Analysis from 06 UTC 6 to 00UTC 8 September 2008

JPSS Current Portfolio of User Engagement activities

- **VIIRS Proving Ground Fire Weather Operations**
  - POC – Ivan Csiszar (STAR), Peter Roohr (NWS)
    - Users – USFS, NWS, National Interagency Fire Center (NIFC)
  - Outcome - Demonstrate NPP Proving Ground products within an operational framework while collaborating with broader warning/forecast community towards fire weather CONUS hazards. Objective is for NWS/NIFC/USFS evaluation and preview of NPP VIIRS products before JPSS VIIRS is operational
- **Establish Fire Weather Application Team**

Application Areas

- ✓ Tropical Cyclone Applications
- ✓ Cryosphere Applications
- ✓ Severe Weather/Aviation Applications

Ocean/Coastal Applications (Coral Bleaching, Harmful Algae Bloom alerts)

Land Applications (Agriculture, Droughts)

- ✓ Hazards Applications (Smoke, Fire, Aerosols, Air Quality, Flash Floods)
- ✓ Data Assimilation Applications
- ✓ Imagery/Visualization Applications

Climate Applications

Developer - User Application Teams (DUAPs)

NWP Team

Tropical Cyclone Team

Fire Weather & Air Quality Team

Severe Weather and Transportation Hazard Team

Ocean Ecosystems Team

Land Ecosystems Team

Cryosphere Team

Hydrology Team

Testbed Team

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