Updates on the Suomi National Polar-orbiting Partnership (SNPP) Cal Val and Data Products Performance

Lihang Zhou

NOAA/NESDIS/Center for Satellite Applications and Research (STAR) JPSS Program Manager

F. Weng*; I. Csiszar*; I. Guch*; P. Digiacomo*; X. Liu; M. Divacarla; T. Atkins*; J. Feeley[+]; B. Reed[+]; A. Layns[+]; E. Gottshall[+]; and M. Goldberg[+]

(*: NOAA/NESDIS/STAR; [+]: JPSS Program)

with contribution from

Algorithm and Data Products Algorithm Leads & Team Members

Outline

* Background
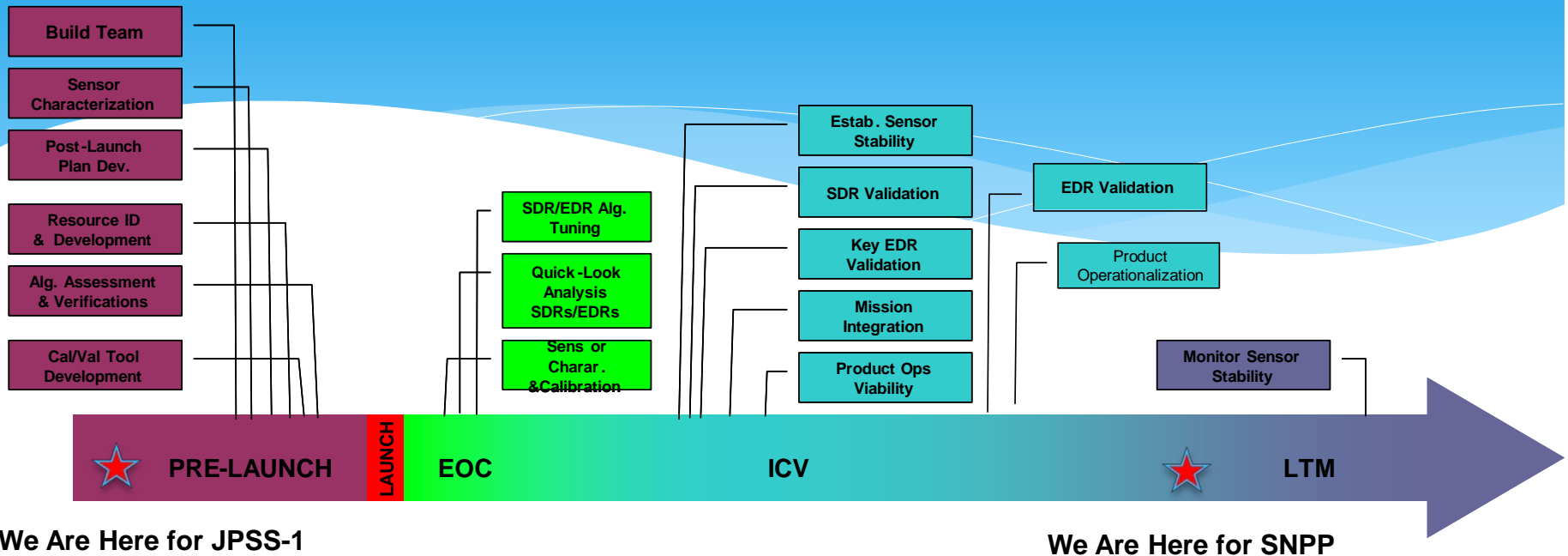 * SNPP Cal Val Progress Highlights
  * Cal Val Process
  * JPSS Products

* JPSS Data and Products Performance
  * SNPP Updates
  * Highlights of Future Capabilities

* Summary

SNPP Cal Val Progress Highlights

* ATMS, CrIS, and VIIRS Sensor Data Records (SDRs) have reached the validated maturity level; OMPS SDR are reaching validated status soon
* SNPP ATMS and CrIS SDR data are now used operationally in all major NWP centers
* NOAA Integrated CalVal System (ICVS) has been enhanced and went live since Fall 2013
* All Environment Data Records (EDRs) have achieved Beta status and are available through CLASS
* Most EDRs have reached Provisional status; reaching validated through the end of 2014
* Extensive interactions with end users, including product evaluation and demonstration, closely coordinated with JPSS Program Science
* 30 plus papers are accepted for publications in AGU Journal Geophysical Research Special Issue on Suomi NPP satellite calibration, validation and applications
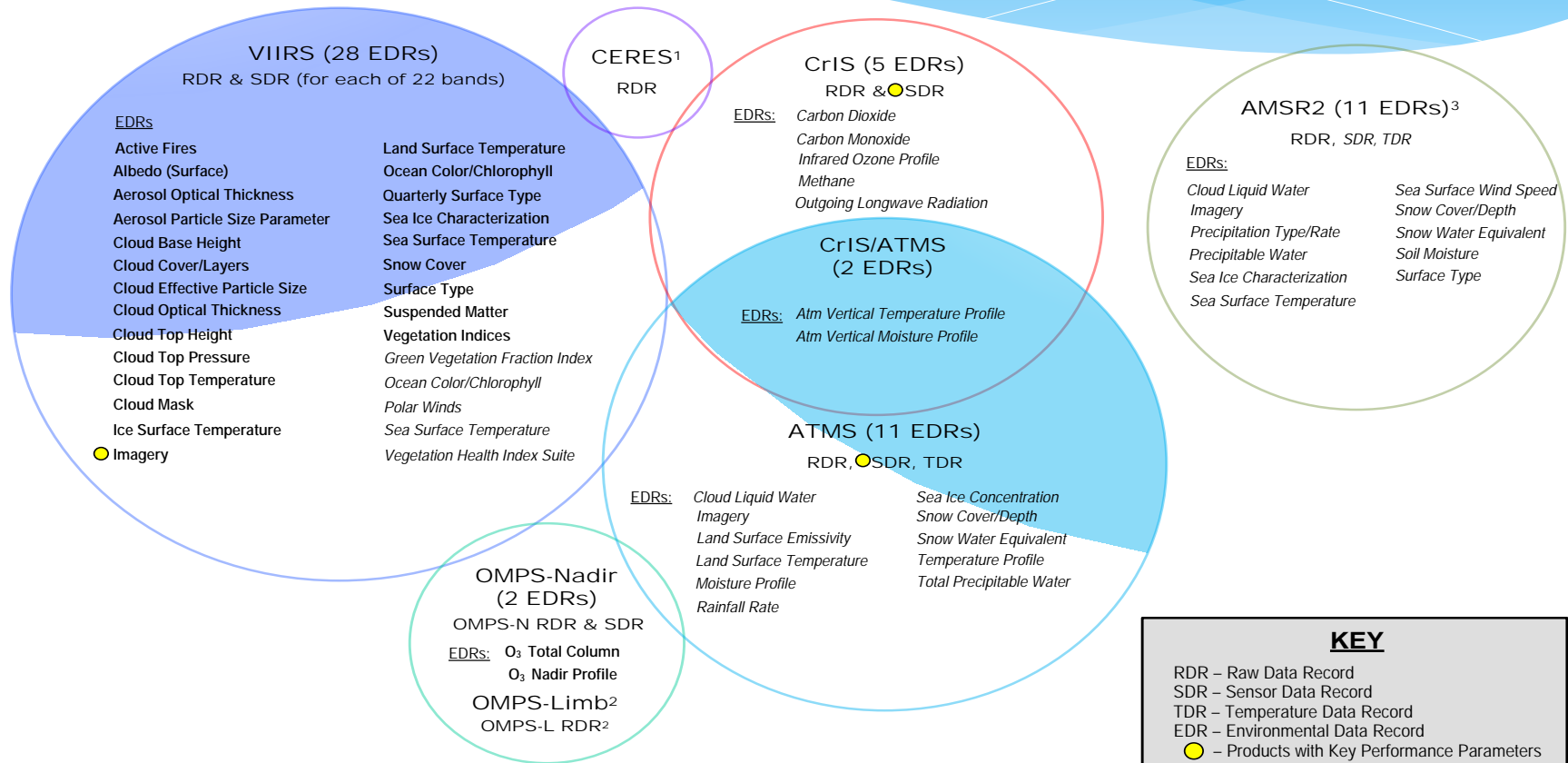
Cal/Val Process Overview

Build Team

Sensor Characterization

Post-Launch Plan Dev.

Resource ID & Development

Alg. Assessment & Verifications

Cal/Val Tool Development

SDR/EDR Alg. Tuning

Quick-Look Analysis SDRs/EDRs

Sens or Charar. &Calibration

Estab. Sensor Stability

SDR Validation

Key EDR Validation

Mission Integration

Product Ops Viability

EDR Validation

Product Operationalization

Monitor Sensor Stability

PRE-LAUNCH | LAUNCH | EOC | ICV | LTM

We Are Here for JPSS-1

We Are Here for SNPP

Four Phases of Cal/Val:

1. Pre-Launch – Algorithm verification, sensor testing, and validation preparation
2. Early Orbit Check-out (first 30-90 days) – System Calibration & Characterization
3. Intensive Cal/Val (ICV) – xDR Validation
4. Long-Term Monitoring (LTM); through life of sensors

4

JPSS Environment Products Production

VIIRS (28 EDRs)
RDR & SDR (for each of 22 bands)

EDRs

Active Fires	Land Surface Temperature
Albedo (Surface)	Ocean Color/Chlorophyll
Aerosol Optical Thickness	Quarterly Surface Type
Aerosol Particle Size Parameter	Sea Ice Characterization
Cloud Base Height	Sea Surface Temperature
Cloud Cover/Layers	Snow Cover
Cloud Effective Particle Size	Surface Type
Cloud Optical Thickness	Suspended Matter
Cloud Top Height	Vegetation Indices
Cloud Top Pressure	*Green Vegetation Fraction Index*
Cloud Top Temperature	*Ocean Color/Chlorophyll*
Cloud Mask	*Polar Winds*
Ice Surface Temperature	*Sea Surface Temperature*
○ Imagery	*Vegetation Health Index Suite*

CERES[1]
RDR

CrIS (5 EDRs)
RDR & ○ SDR

EDRs:
- *Carbon Dioxide*
- *Carbon Monoxide*
- *Infrared Ozone Profile*
- *Methane*
- *Outgoing Longwave Radiation*

CrIS/ATMS (2 EDRs)

EDRs:
- *Atm Vertical Temperature Profile*
- *Atm Vertical Moisture Profile*

AMSR2 (11 EDRs)[3]
RDR, *SDR, TDR*

EDRs:

Cloud Liquid Water	*Sea Surface Wind Speed*
Imagery	*Snow Cover/Depth*
Precipitation Type/Rate	*Snow Water Equivalent*
Precipitable Water	*Soil Moisture*
Sea Ice Characterization	*Surface Type*
Sea Surface Temperature	

ATMS (11 EDRs)
RDR, ○ **SDR, TDR**

EDRs:

Cloud Liquid Water	*Sea Ice Concentration*
Imagery	*Snow Cover/Depth*
Land Surface Emissivity	*Snow Water Equivalent*
Land Surface Temperature	*Temperature Profile*
Moisture Profile	*Total Precipitable Water*
Rainfall Rate	

OMPS-Nadir (2 EDRs)
OMPS-N RDR & SDR

EDRs: O_3 Total Column
O_3 Nadir Profile

OMPS-Limb[2]
OMPS-L RDR[2]

KEY

RDR – Raw Data Record
SDR – Sensor Data Record
TDR – Temperature Data Record
EDR – Environmental Data Record
○ – Products with Key Performance Parameters
Bold – Indicates JPSS Ground System xDR
Italics – Indicates NOAA Polar Legacy (ESPC) xDR

Notes:
[1]RDRs for the JPSS-2 Mission are contingent on NASA manifest of the Radiation Budget Instrument (RBI)
[2]Not applicable to JPSS-1; contingent on NASA manifest of OMPS-Limb on the JPSS-2 Mission
[3]Dependent on the Global Change Observation Mission (GCOM) provided by the Japan Aerospace Exploration Agency

The JPSS Program includes Ground System Support for the Metop, DMSP, GCOM, and Polar Free Flyer missions

December 12, 2013
This chart is controlled by JPSS Program Systems Engineering

JPSS-P Rev B

SNPP Sensor Data Records (SDRs) Status

SNPP SDR Validation Review in Dec 2013:
- ATMS, CrIS, and VIIRS have reached Validated Maturity Level
- *ATMS SDR Highlight:* May 22, 2012, operationally assimilated in NCEP; March 7th 2013 declared validated; Stripping in sounding channels have been greatly reduces; User notification system is being setup

Spacecraft	SNPP
Launch Date	Oct 28, 2011
Payload Instruments	
ATMS	G
CERES	G
CrIS	G
OMPS – Nadir	G
OMPS – Limb	G
VIIRS	G
Spacecraft Subsystems	

The STAR ICVS has been established as a vital cornerstone of the SNPP/JPSS Sensor Performance Monitoring
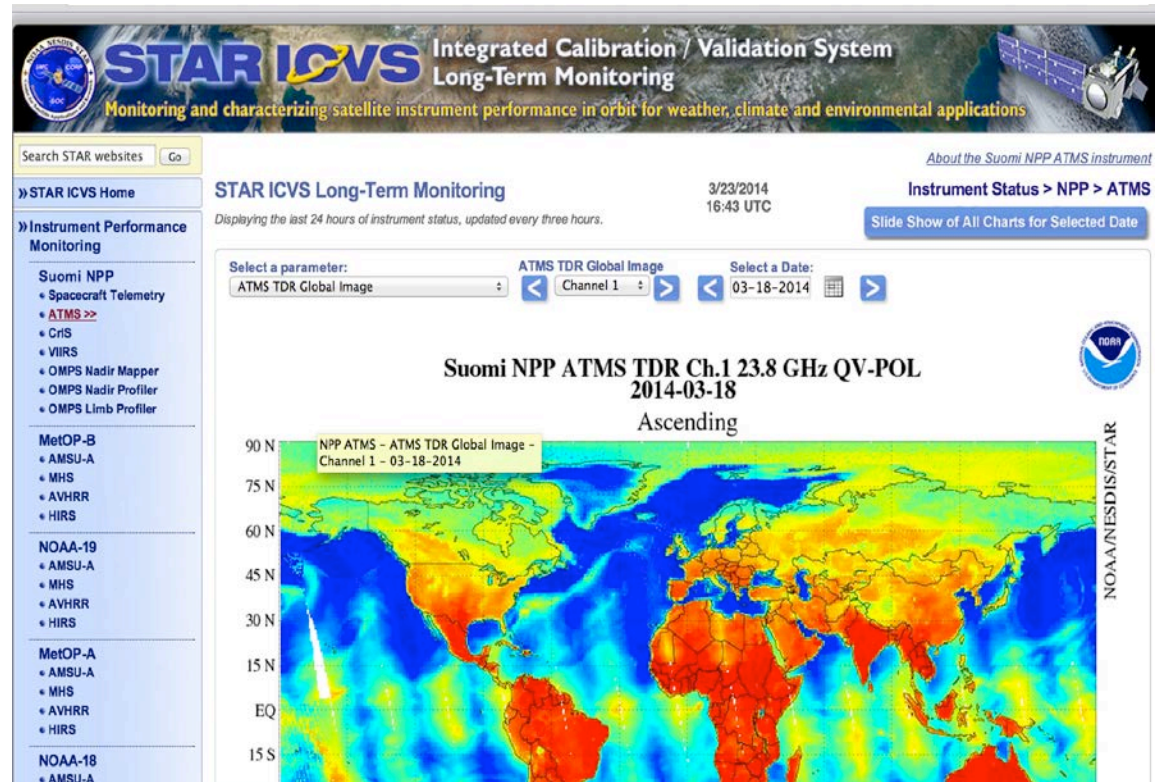
S-NPP CrIS SDR Reached Validated Status

CrIS SDR performance (blue) vs. specifications (black)

Band	NEdN @287K BB	Radiometric Uncertainty	Frequency Uncertainty	Geolocation Uncertainty

Radiative influences of Trace Gas

NUCAPS_HR CO @ 424.47mb (ppbv)
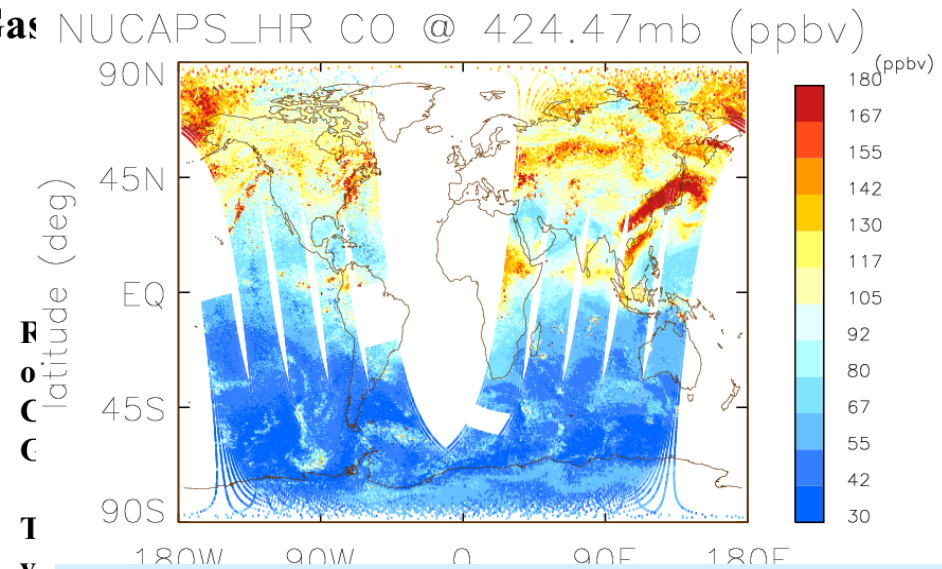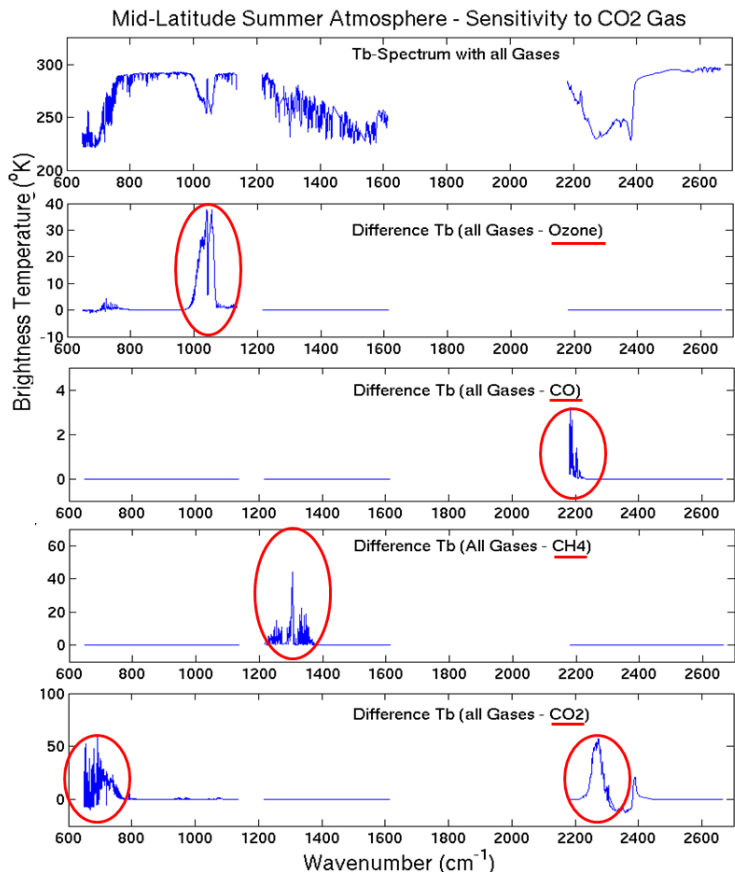
CO Retrieval using full spectral resolution from CrIS (data acquired on 8/27/2013). Figure courtesy Antonia Gambacorta.

Figure provided by Tim Schmit, NESDIS/STAR

Y. Han NOAA/NESDIS/STAR

S-NPP VIIRS SDR Reached Validated Status
Work is Ongoing to Improve Ocean Color Accuracy

* Ocean Color Products:
  * Normalized Water-leaving Radiance
  * Chlorophyll-a
  * Water Diffuse Attenuation Coefficient at 490 nm Kd (490)
  * Total Suspended Sediment, water Turbidity

* Provisional level has been demonstrated
  * Performance over coastal and inland water not optimal due to atmospheric correction problems

* **New Developments:** Algorithms improvements for coastal turbid and inland water are being developed
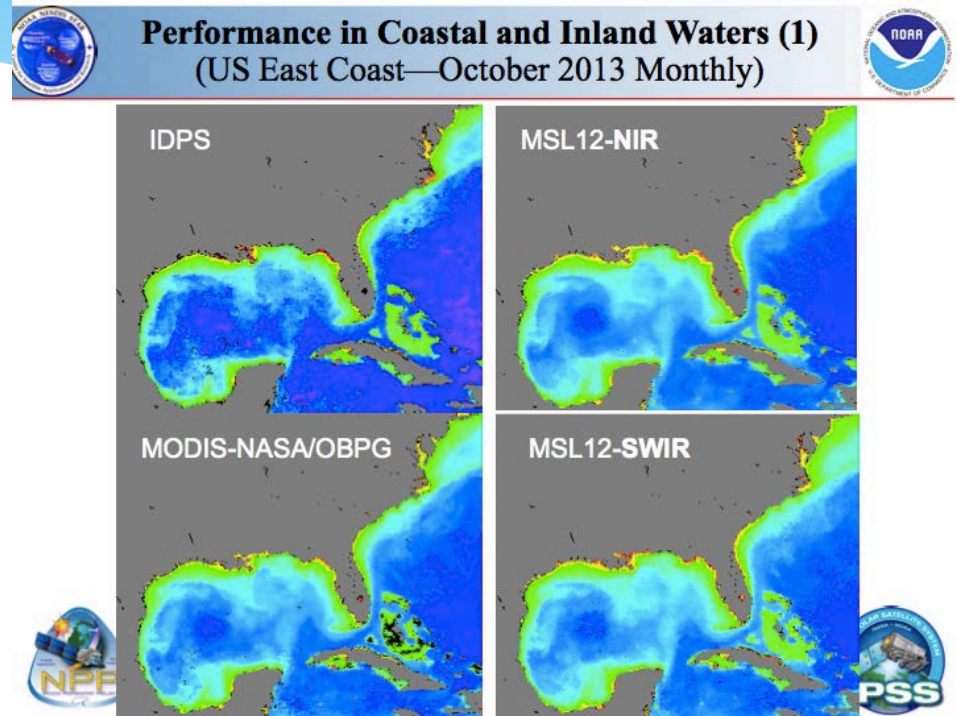
M Wang NOAA/NESDIS/STAR

CRITICAL ECOLOGICAL INFORMATION FOR FISHERIES AND INTEGRATED ECOSYSTEM ASSESSMENT

VIIRS Active Fire Product

S-NPP VIIRS IDPS product is Provisional and reaching Operational status

* Input SDR issues addressed

JPSS-1 improvements ready to be implemented:

* Full fire mask and fire radiative power from VIIRS 750m M-band data

* Fire detections from VIIRS 375m I-band data

CRITICAL INFORMATION AIR QUALITY, ECOSYSTEM, AND DISASTER MANAGEMENT

Ivan Csiszar, NOAA/NESDIS/STAR
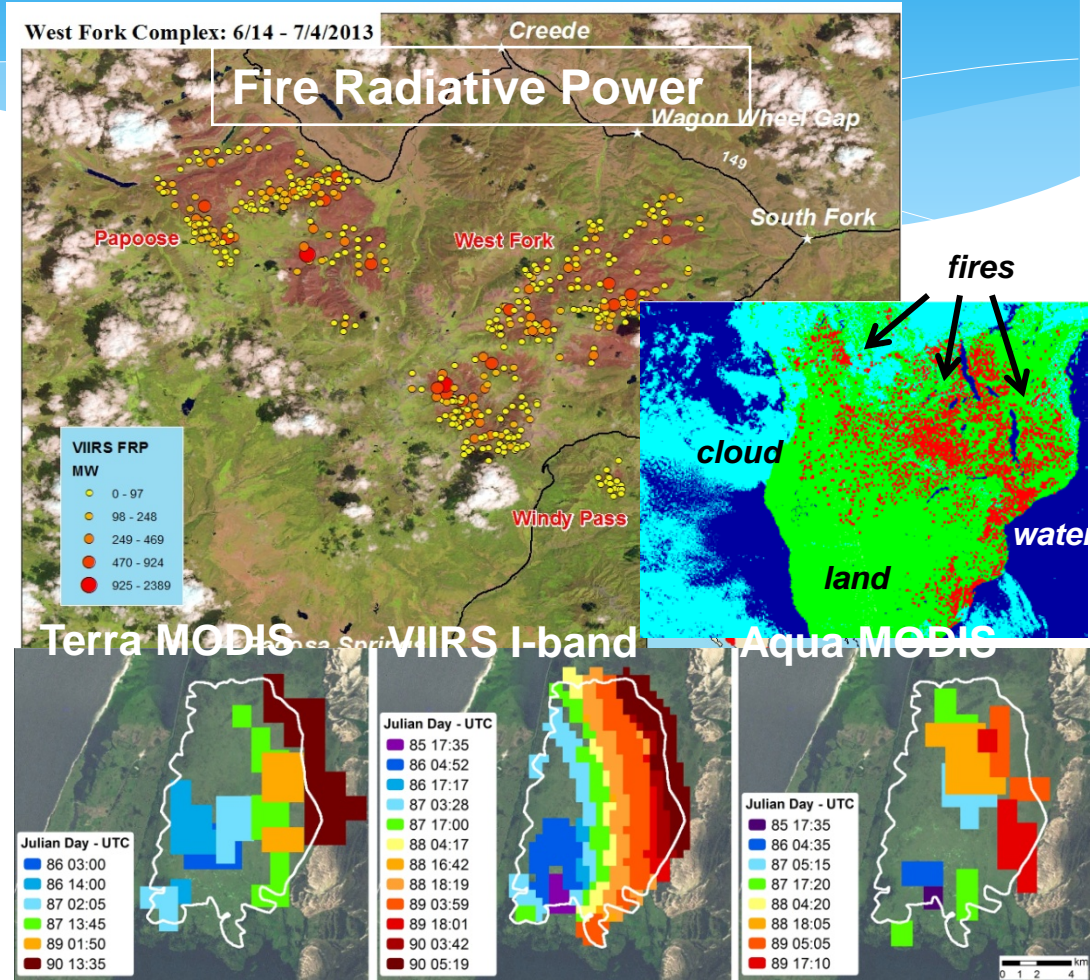
VIIRS Vegetation Index EDR

• **VI Product**: TOA-NDVI and TOC- EVI

• **Maturity Status**: Provisional

• **Archive**: CLASS

• **Validation 1 maturity :** scheduled for Summer 2014

• **Product Improvements**: Additional Quality Flags, VIIRS VI EVI Backup Algorithm

• **JPSS-1**: Add top-of-canopy (TOC) NDVI

10

M. Vargas, NOAA/STAR
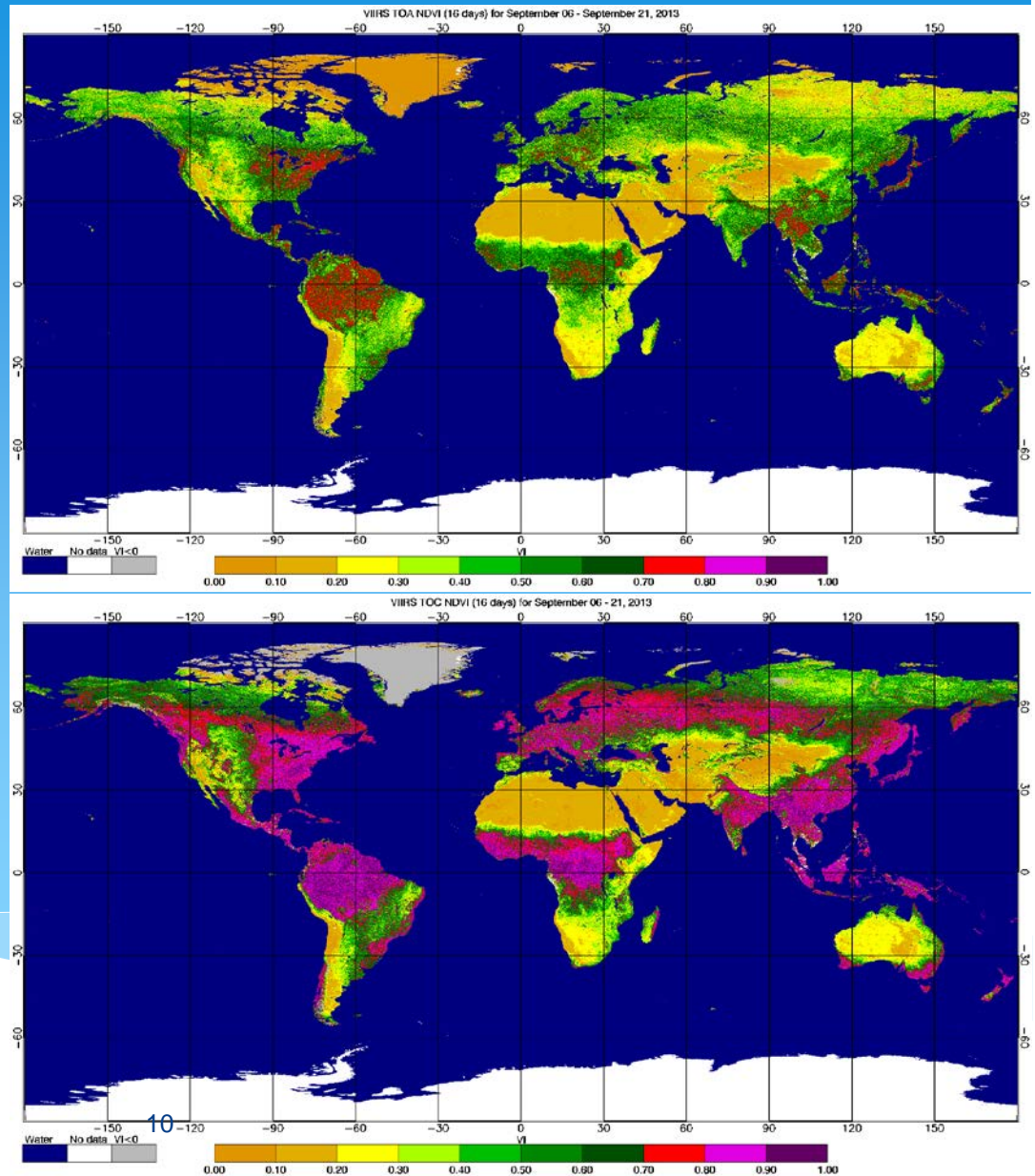
VIIRS Cryosphere EDR
Both IST and Snow Cover are at validated stage

NPP-Suomi VIIRS
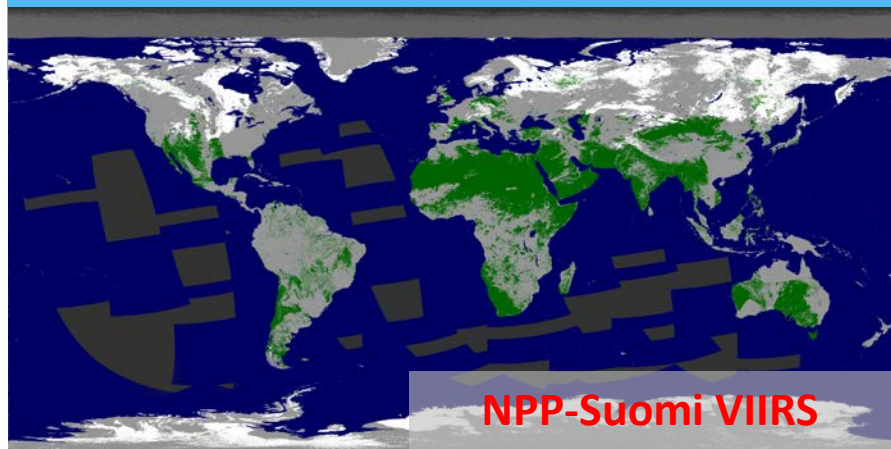
■ snow ■ land ■ cloud ■ No data

MODIS Aqua
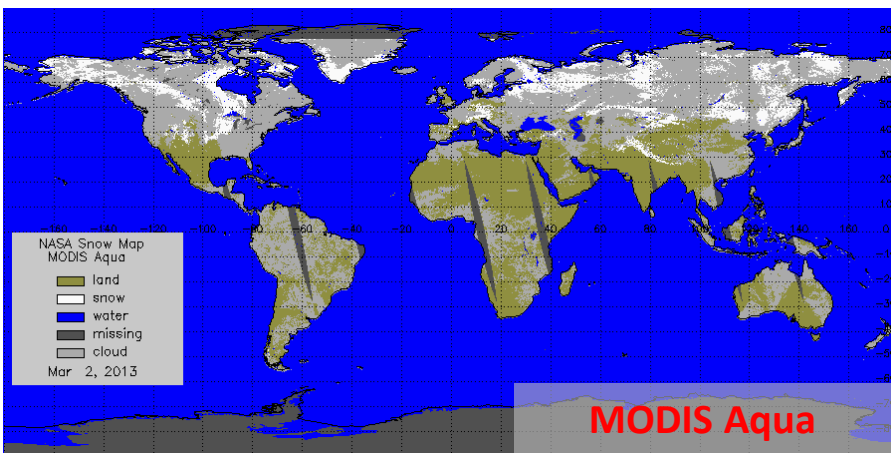
March 2, 2013 (day 2013061)

VIIRS binary snow maps compare well to MODIS Terra & Aqua snow maps. There are some differences in the cloud mask applied in the VIIRS and MODIS products.

Due to a **wider swath** VIIRS daily global snow map has no gaps between adjacent swaths inherent to the MODIS global daily snow product.

JPSS-1: VIIRS Snow Fraction Algorithm will be improved from the current 2x2 aggregation algorithm (750m) to pixel by pixel (375m) algorithm

11

VIIRS Aerosol Products:

2013
Week 1

0 ———— 1
VIIRS AOT
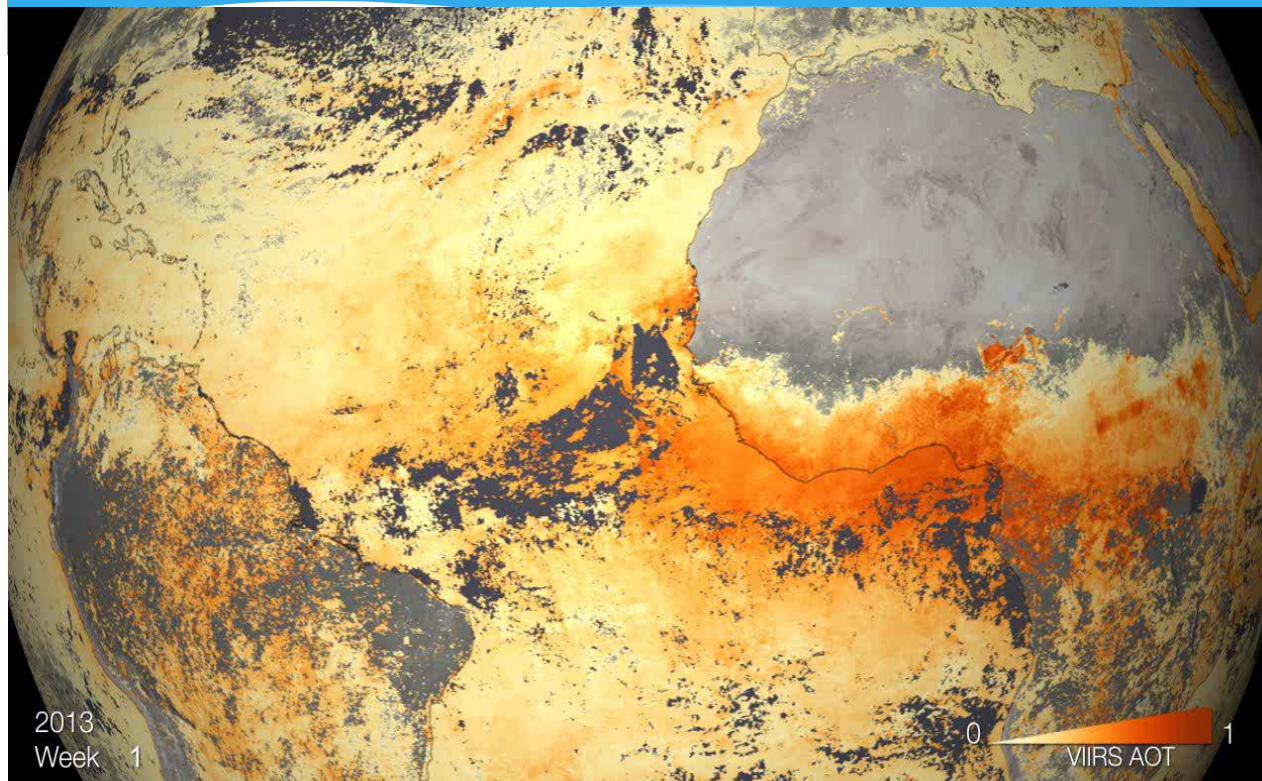
Weekly Mean Aerosol optical Thickness 2013. Movie prepared in collaboration with Dan Pisut, NOAA Environmental Visualization Lab

Future work: Suspended Matter (SM)

Current SM Algorithm not meeting accuracy requirement; Algorithm Improvement underway for probabilities of correct typing (i.e. Volcanic Ash)

S. Kondragunta/Istvan Laszlo NOAA/NESDIS/STAR

At NOAA Comprehensive Large Array-data Stewardship System (CLASS):

Intermediate Product (IP)
0.75-km pixel
AOT
APSP
AMI (Aerosol Model Information)
land: single aerosol model
ocean: indexes of fine and coarse modes and fine mode fraction
quality flags

Environmental Data Record (EDR)
6 km aggregated from 8x8 IPs filtered by quality flags
AOT
APSP
quality flags
0.75 km
SM

At NOAA/NESDIS/STAR
Gridded 550-nm AOT EDR
regular equal angle grid: 0.25° x0.25° (~28x28 km)
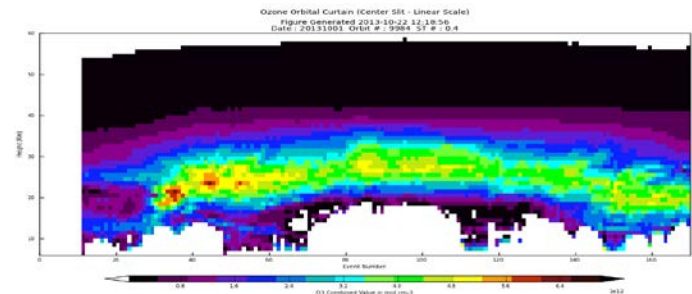only high quality AOT EDR is used

12

OMPS SDR & EDR Highlights

The overall operational retrieval algorithm is working well but cross-track calibration biases remains. These will be corrected by June 2014

The image shows three IDPS produced OMPS products – total ozone (top), effective reflectivity (middle), and absorbing aerosol index (bottom.) The cross-track issues that remain to be fixed are evident in both the ozone and aerosol products. Images are from ICVS.
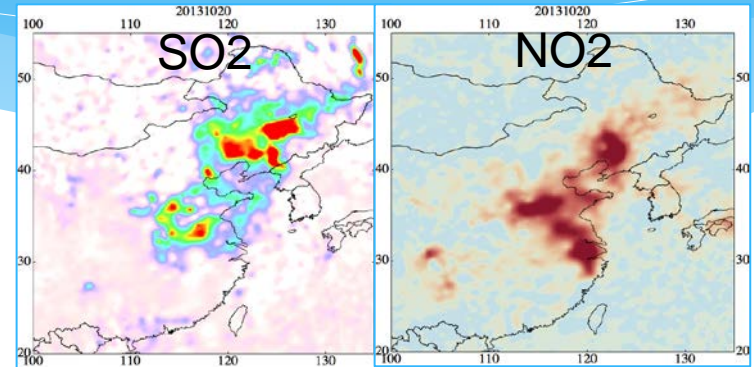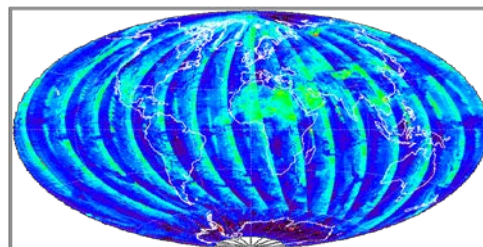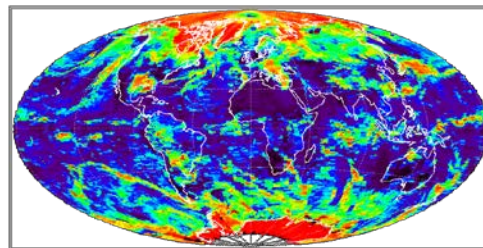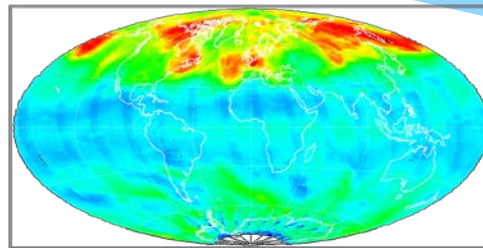
New Capability: SO_2 and NO_2 can be retrieved from OMPS NM for air quality and hazard applications. Examples above are for Asia for 10/20/2013
Retrievals/Figures: Yang NASA SNPP Science Team

Vertical structure of the Antarctic Ozone Hole

X. Wu/L. Flynn, NOAA/NESDIS/STAR

13

Sponsored by the NOAA JPSS Office.

SNPP IDPS Products Maturity

http://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php

• On February 12, the AERB approved the promotion of the CrIS SDR product to Validated maturity level, pending the release of IDPS Build Mx8.2 and the upload of Engineering Packet v36. These occurred on the afternoon of February 20, at which point CrIS became the first IDPS product to reach Validated Maturity.

• Other products are on track to pass the AERB after their reviews in December and January including the VIIRS Cloud Mask, ATMS, Imagery and some of the Cryosphere products which are expected to become Validated in March and Cloud products, SST, and Ocean Color which are on the road to Provisional status.

• In the upcoming months several more products will be up for review including AOT for Validated.

Sensor	Algorithm	Beta	Provisional	Val1	Val2	Val3
ATMS	SDR	Feb-12	Feb-13	Mar-14	N/A	N/A
VIIRS	SDR	Apr-12	Mar-13	Mar-14	N/A	N/A
VIIRS	Imagery (Non-NCC)	May-12	Feb-13	Mar-14	Mar-14	Mar-14
VIIRS	NCC Imagery	Oct-12	Oct-13	Mar-14	Mar-14	Mar-14
VIIRS	Cloud Mask	Oct-12	Feb-13	Mar-14	Mar-14	Mar-15
VIIRS	Cloud Properties	Oct-12	Mar-14	May-14	Nov-14	Nov-15
VIIRS	Aerosol Optical Thickness	Oct-12	Jun-13	May-14	Nov-14	Nov-15
VIIRS	Aerosols - Suspended Matter	Jun-13	TBD	TBD	TBD	TBD
VIIRS	Aerosol Particle Size	Sep-12	Jun-13	Mar-14	Nov-14	Nov-15
VIIRS	Sea Surface Temperature	Feb-13	Mar-14	May-14	Sep-14	Mar-15
VIIRS	Ocean Color	Jan-13	Mar-14	Dec-14	Jun-15	Jun-16
VIIRS	Land Surface Temperature	Dec-12	Jun-13	May-14	May-15	Dec-15
VIIRS	Surface Type	Feb-13	Mar-14	Sep-14	Sep-15	Dec-15
VIIRS	Land Surface Albedo	Jul-13	Mar-14	Nov-14	Nov-15	May-16
VIIRS	Active Fires	Oct-12	Oct-13	Sep-14	Sep-15	Dec-15
VIIRS	Vegetation Index	Feb-13	Jan-14	Aug-14	Jan-15	Jan-16
VIIRS	Land Surface Reflectance	Feb-13	Oct-13	Jul-14	Jan-15	Jan-16
VIIRS	Combined Surface Albedo	Jul-13	Mar-14	Nov-14	Nov-15	May-16
VIIRS	Ice Surface Temperature	May-13	Oct-13	Mar-14	May-14	Nov-14
VIIRS	Sea Ice Concentration	May-13	Dec-13	Mar-14	Aug-14	Jan-15
VIIRS	Sea Ice Age	May-13	Dec-13	Aug-14	Oct-14	Apr-15
VIIRS	Binary Snow Cover	May-13	Dec-13	Mar-14	Aug-14	Jan-15
VIIRS	Snow Cover Fraction	May-13	Dec-13	Aug-14	Aug-14	Jan-15
CrIS	SDR	May-12	Feb-13	Feb-14	N/A	N/A
CrIS	Soundings	Aug-12	Mar-13	Mar-14	Jul-14	Jan-15
OMPS	Total Column SDR	Mar-12	Mar-13	May-14	N/A	N/A
OMPS	Nadir Profiler SDR	Mar-12	Mar-13	May-14	N/A	N/A
OMPS	Ozone First Guess	Jul-12	Mar-13	May-14	Jul-14	Jul-15
OMPS	Total Column Ozone EDR	Jul-12	Apr-13	May-14	Jul-14	Jul-15
OMPS	Nadir Profiler Ozone EDR	Jul-12	Apr-13	May-14	Jul-14	Jul-15

Sponsored by the NOAA JPSS Office.

Summary

* Great progresses have been made for SNPP algorithms and cal val

* Lessons learned are being incorporated in J1 algorithm development and cal/val planning

* Algorithms will be updated towards higher level of product maturity and meet JPSS-1 requirements; as well as account for JPSS-1 instrument-specific characteristics

* STAR JPSS Science Team Annual Meeting is scheduled for May 12th – 16th, 2014, NCWCP, College Park, MD

Thank You!