Outline

- Actions from last WGCV 38th meeting
  - » Altimeter radiometer inter-comparison (NOAA/ESA)
    - Jason-2 AMR Envisat RA-2 Inter-comparison
- Suomi-NPP/JPSS Program Update
  - » Suomi-NPP VIIRS post-launch characterization and Cal/Val activities
    - GOSAT inter-comparison (supports “CEOS Strategy for Carbon Observations from Space” WGCV actions)
    - **Active light sources for DNB cal/val - new capability**
- GOES-R Program Update
  - » GOES-R pre-launch and post-launch Cal/Val readiness activities
    - Pre-launch Support
    - Post-launch tests & long-term monitoring
    - JMA collaboration
    - Field Campaign Preparations
      - **Near Surface Measurements - new capability**

Action from CEOS/WGCV38

- Collaboration project on Altimeter Microwave Radiometer inter-comparisons (Action from a side meeting with Albrecht von Bargen, Bojan Bojkov, Xiaolong Dong, and Changyong Cao)

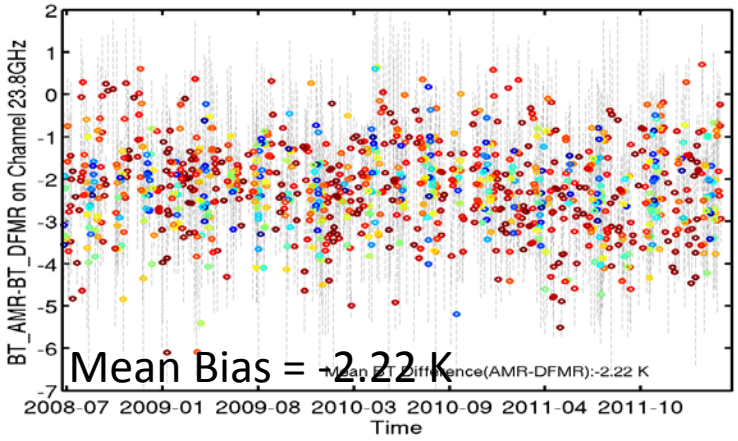
- Since WGCV38, NOAA scientists have performed inter-comparisons between Jason 2 Advanced Microwave Radiometer and Envisat RA-2 for the 23.8 GHz channel.

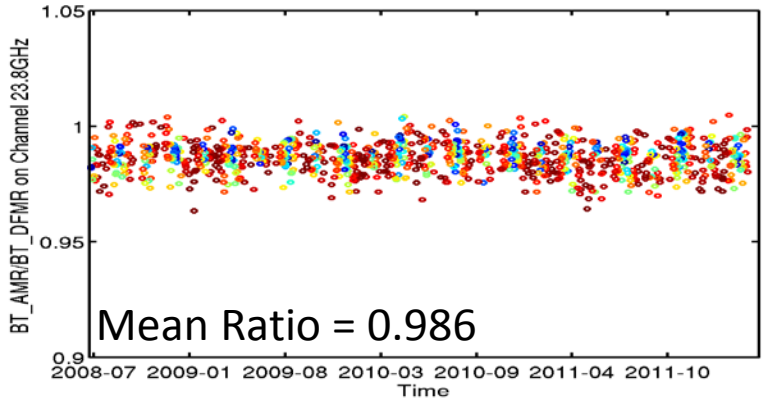
- Preliminary results are now available (see next slide)

- Future work will further collaborate with Bojkov and Dong.

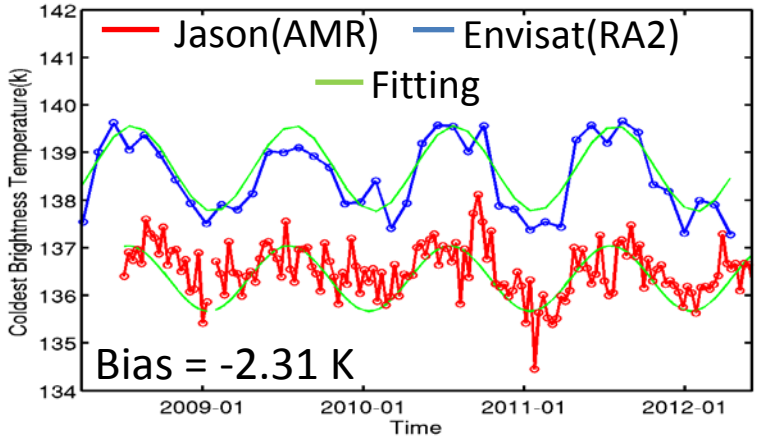
Inter-Comparison between Jason-2 AMR and Envisat RA-2 (23.8 GHz channel)

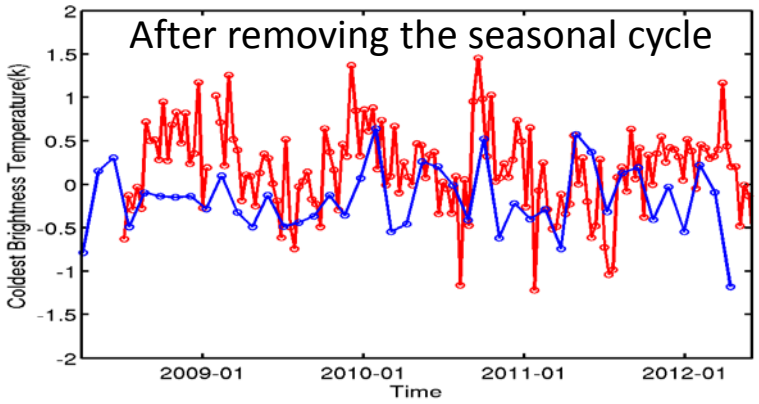
SNOs





Coldest Ocean

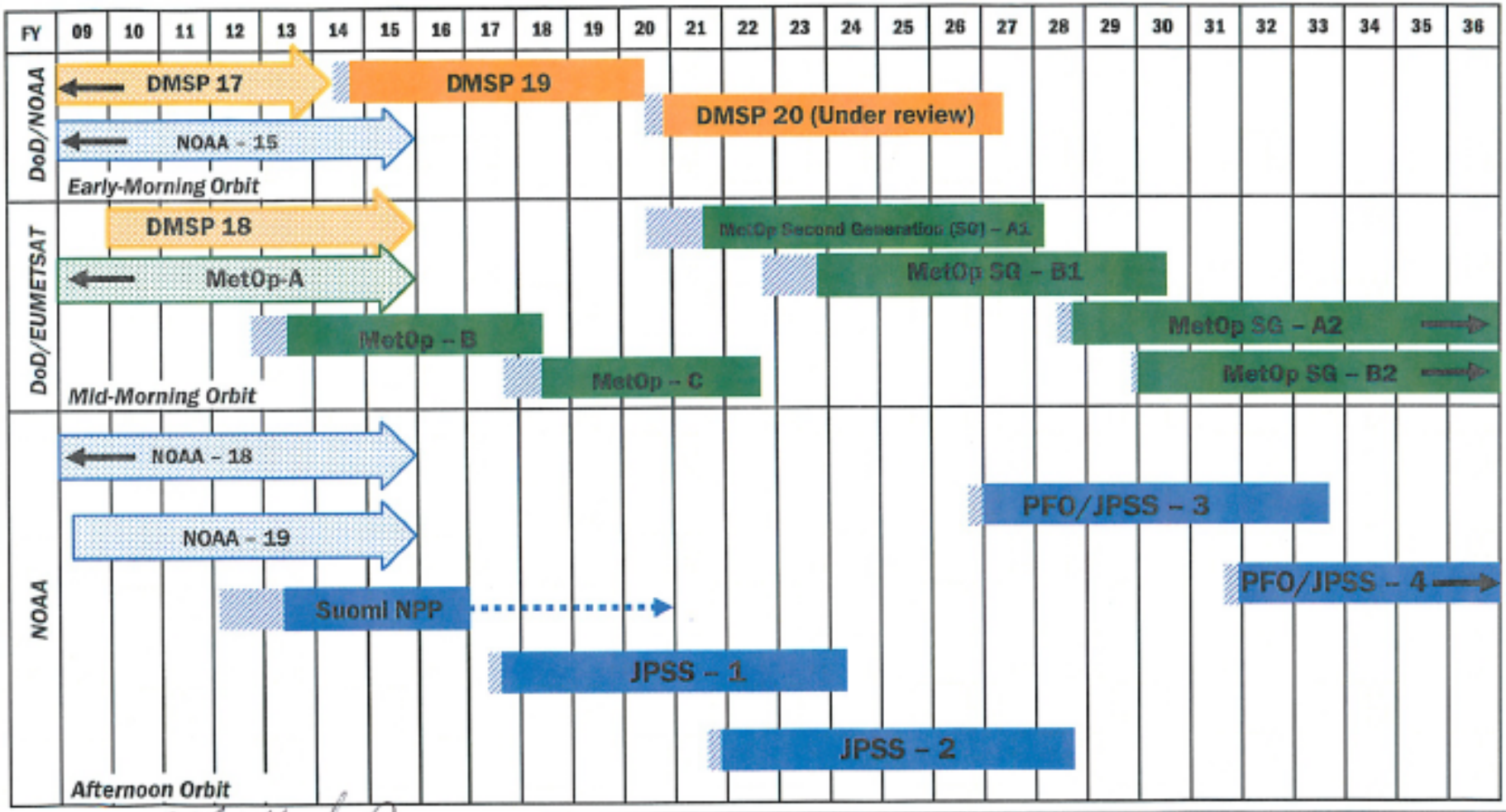




Courtesy of Bin Zhang, Changyong Cao and Laury Miller

NOAA & Partner Polar Weather Satellite Programs
Continuity of Weather Observations

As of April 2015



Approved: Mark S. Paese
for Assistant Administrator for Satellite and Information Services

Note: Extended operations are reflected through the current FY, based on current operating health.

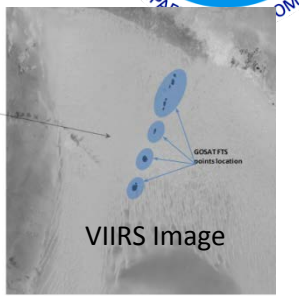
DMSP: Defense Meteorological Satellite Program
JPSS: Joint Polar Satellite System Program
Suomi NPP: Suomi National Polar-orbiting Partnership

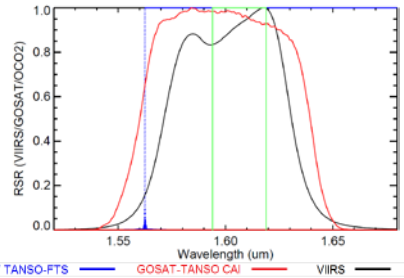
Note: DoD and EUMETSAT data provided for reference only

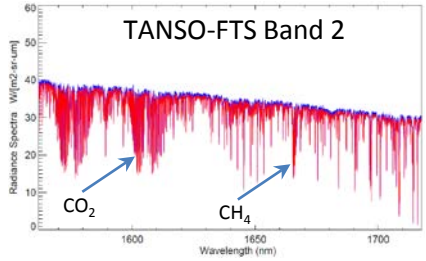
- Post Launch Test
- Operational based on design life
- Secondary
- Operational beyond FY 2036
- Extended mission life
- Launched before Oct 2008

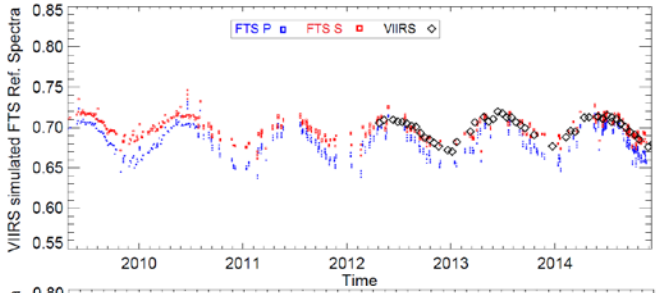
S-NPP VIIRS and GOSAT TANSO-FTS Inter-calibration

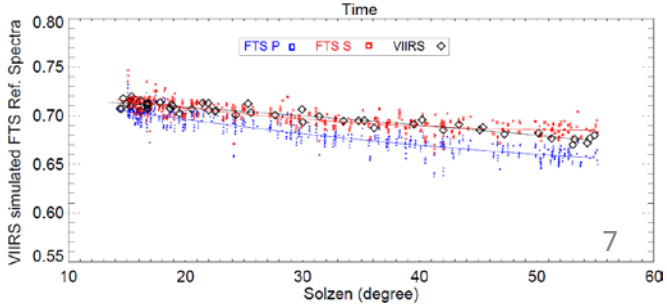
- *Supports CEOS work plan and Strategy on Carbon Observations from Space actions:*
  - *Cross-calibration of carbon (CO2- and CH4) measuring sensor to evaluate and improve radiometric accuracy*
  - *Ensure consistent, well-calibrated, bias free satellite time series carbon products*
- The Greenhouse gases Observing SATellite (GOSAT):
  - » Joint effort of JAXA, NIES, & MOE
  - » launched on January 23, 2009
  - » Payloads: Thermal and Near Infrared Sensor for Carbon Observation - Fourier Transform Spectrometer(TANSO-FTS) and a Cloud and Aerosol Imager (TANSO-CAI)
  - » TANSO-FTS measures P and S polarized light
- VIIRS M10 (1.61 µm) inter-calibration with TANSO-FTS band 2 at Libya-4 region.
- TANSO-FTS S polarized observations agree very well to within 0.3% with uncertainty less than 1%.
- Larger radiometric inconsistency between VIIRS and P polarized measurements: 1.2% @16° solar zenith angle to nearly 3% @55° solar zenith angle.











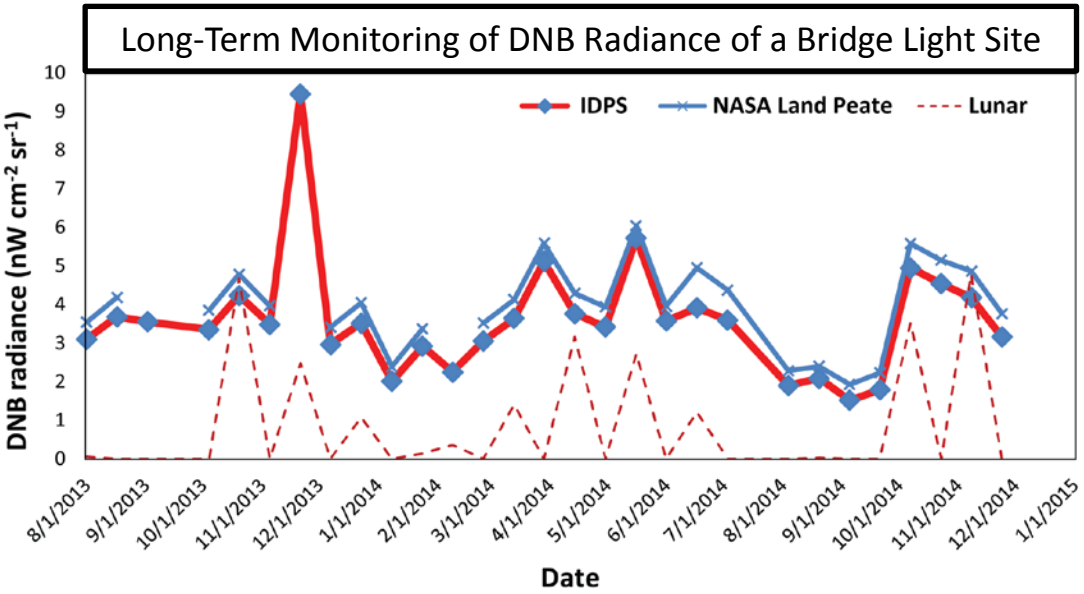
Active Night Light Sources for DNB Calibration

- Investigated vicarious validation sites suitable for DNB (at low radiances):
  - » Analysis of nightlight point sources (from bridges, fishing vessels, cities) showed the potential to validate DNB calibration (Cao & Bai, *Remote Sens* 2014)
  - » Emphasizes the need and feasibility of developing active light source references
- New SBIR initiative to develop active nightlight for VIIRS DNB validation, working closely with NIST and NASA scientists
- Potential collaboration with RADCALNET

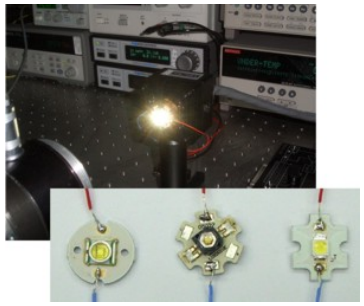
Source properties to consider
- Spectral distribution
- Flux (radiant exitance)
- Stability
- Calibration uncertainty

Candidate types
- Power LEDs
- Tungsten lamps

Other considerations
- Atmospheric impacts
  - » Modeling for active sources
  - » Cloud impacts
  - » Source altitude
- Stray light contamination
  - » Lunar light
  - » Air glow, starlight, zodiacal light
  - » Anthropogenic light

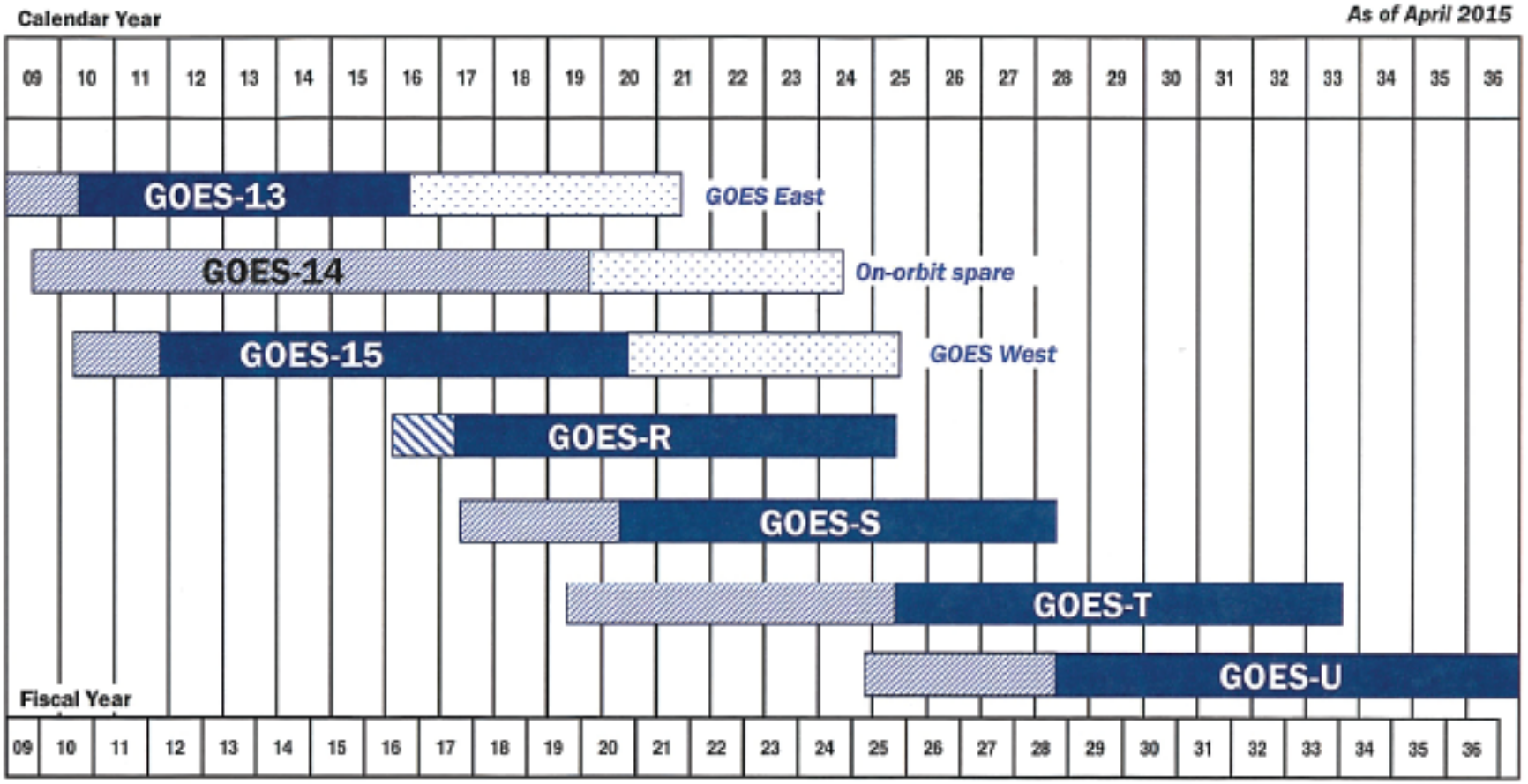


(Cao & Bai, *Remote Sens* 2014)



Measurement of high power LED (www.nist.gov)

Continuity of GOES Mission



Approved: Stephen Volz 4/21/2015

Assistant Administrator for Satellite and Information Services

GOES: Geostationary Operational Environmental Satellite

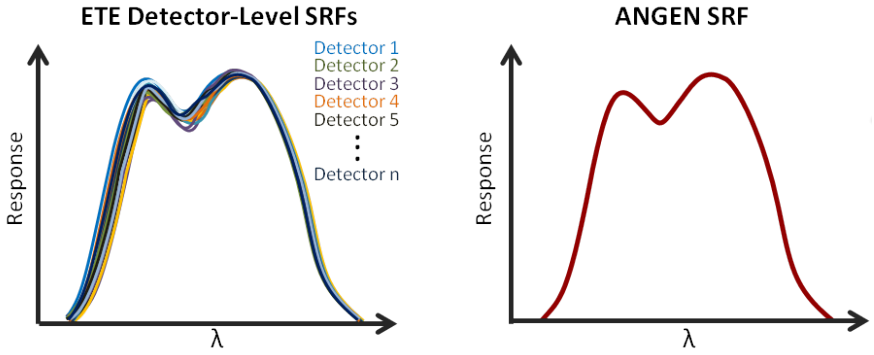
- On-orbit Storage
- Test & Checkout
- Operational
- Fuel-Limited Lifetime

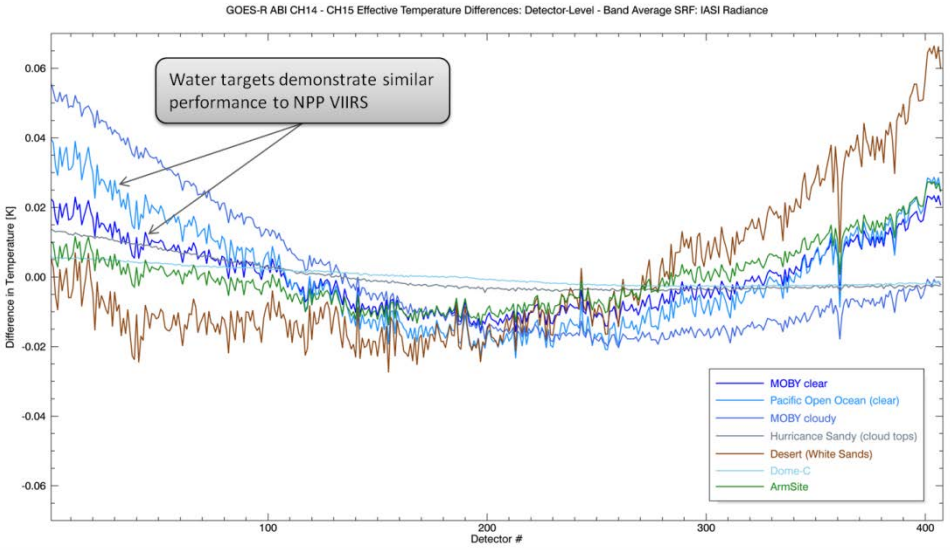
GOES-R Advanced Baseline Imager (ABI) Pre-launch Cal/Val Support

Instrument Status:

- » Calibration Working Group (CWG) pre-launch assessment of GOES-R and GOES-S ABI complete:
  - ABI FM1 is undergoing spacecraft-level testing

- » CWG is continuing pre-launch support for GOES-S & GOES-T ABI
  - » Detector-level SRF impacts (to be presented at IGARSS 2015, SPIE Remote Sen. 2015)
  - » Polarization sensitivity impacts (to be presented at SPIE Optical Engineering + Applications 2015)





Preparations for Post-launch:
Post Launch Tests, Science Tests, & Long-Term Monitoring

Developing capabilities and tools for post launch instrument performance characterization and monitoring:

PLT: focus on instrument functionality and meeting specification

Science Tests (PLPTs): focus on instrument performance and meeting user/science needs

Leveraged VIIRS 57 tasks, heritage GOES PLT, similar programs, and international partners
[Cao et al. 2013 *JGR*]

Post-Launch Validation Areas

Functional Performance
- » Instrument calibration file contents and formatting checkout

Calibration System Evaluation
- » Verification and characterization of on-board calibration systems

Image Quality Evaluation
- » Assessment for image artifacts and spatial quality

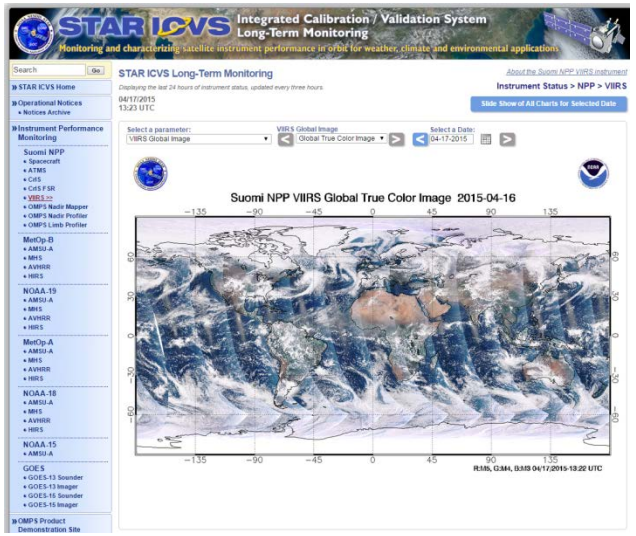
Radiometric Evaluation
- » System science performance validation

Geo-Location Evaluation
- » INR performance validation

Performance Evaluation and Trending
- » Long-term monitoring and anomaly investigation

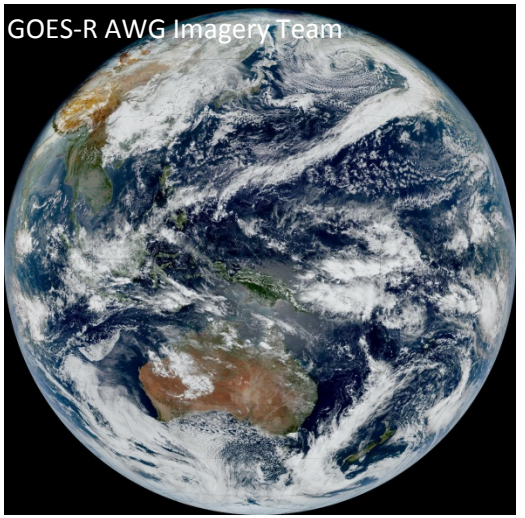
Monitoring through NOAA/NESDIS/STAR Integrated Calibration/Validation System (ICVS)

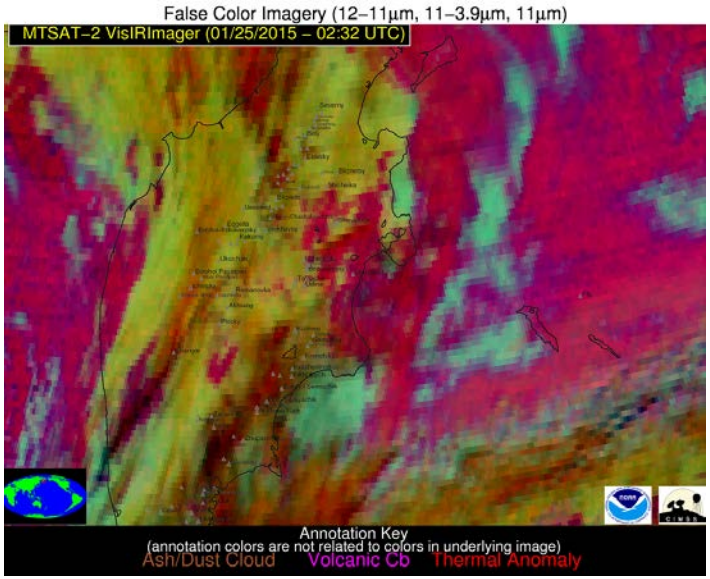
- » Supports Suomi NPP, MetOP-A, MetOP-B, NOAA-18, NOAA-19, DMSP, & GOES instruments
- » Extending ICVS for GOES-R

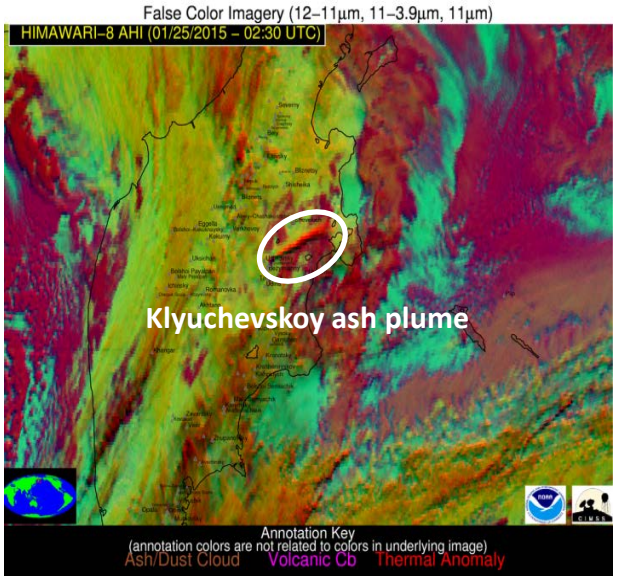


Preparations for Post-launch: NOAA-JMA Collaboration

- Collaborating with Japan Meteorological Agency (JMA) to enhance GOES-R Readiness
  - » Himawari-8 Advanced Himawari Image (AHI), was launched in the Fall of 2014, a sister instrument to the future GOES-R ABI
  - » JMA hosted NOAA experts:
    - Exchanged data, analyses, and expertise
    - Supports ABI risk reduction
  - » NOAA received and analyzed early on-orbit calibration instrument performance
  - » NOAA analyzing AHI data to evaluate ABI L1b & L2+ products







GOES-R Field Campaign Overview

The purpose of the GOES-R field campaign is to support post-launch validation of L1b & L2+ products:

- **Advanced Baseline Imager (ABI) & Geostationary Lighting Mapper (GLM):**
  - » An integrated approach is planned that includes both high-altitude manned & near surface unmanned systems coordinated with ground-based observations over several Earth targets (desert, ocean, land and lightning producing storms)
  - » These activities will be coordinated with WMO GSICS partners and low Earth orbit environmental satellites which include S-NPP, Terra/Aqua, METOP, Landsat and ISS
  - » ER-2 Campaign Timeframes: October – November 2016 & April – June 2017

Completed GOES-R Field Campaign Workshop (April 8-9, 2015):

- Achieved a baseline consensus of the initial GOES-R Field Campaign plan
  http://www.goes-r.gov/users/2015-Campaign-Workshop.html

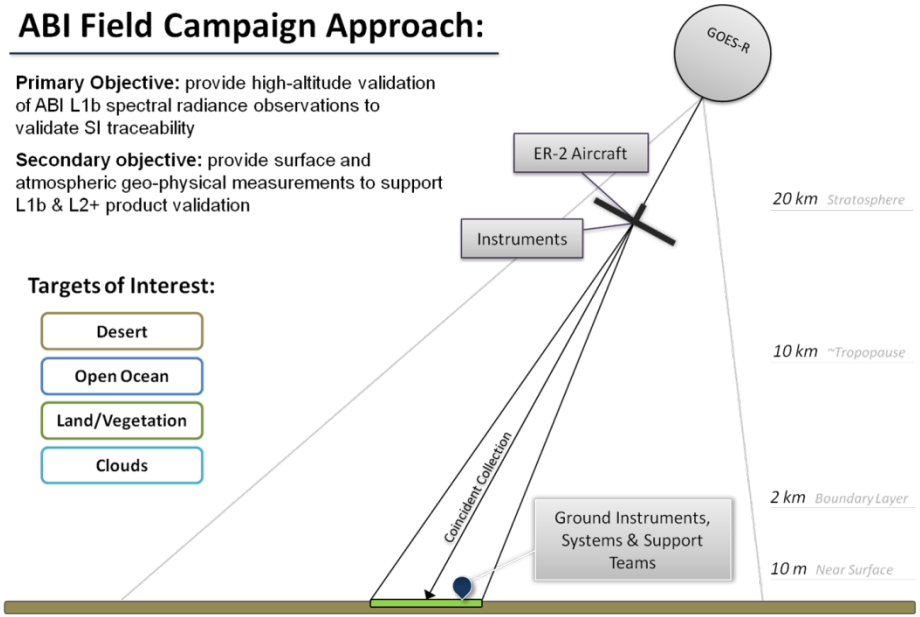
ABI Field Campaign Approach:

Primary Objective: provide high-altitude validation of ABI L1b spectral radiance observations to validate SI traceability

Secondary objective: provide surface and atmospheric geo-physical measurements to support L1b & L2+ product validation

Targets of Interest:

- Desert
- Open Ocean
- Land/Vegetation
- Clouds



GLM Field Campaign Approach:

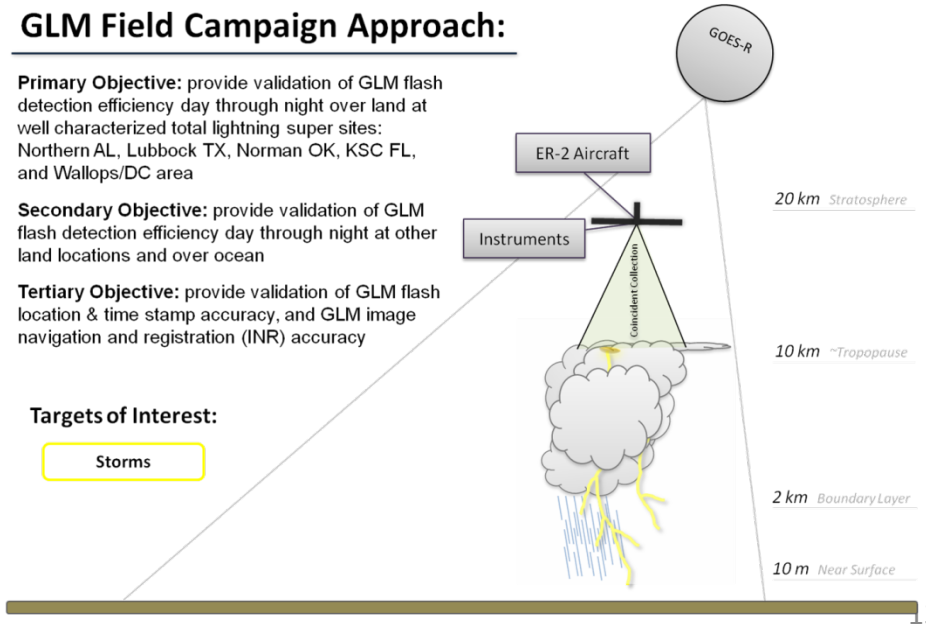
Primary Objective: provide validation of GLM flash detection efficiency day through night over land at well characterized total lightning super sites: Northern AL, Lubbock TX, Norman OK, KSC FL, and Wallops/DC area

Secondary Objective: provide validation of GLM flash detection efficiency day through night at other land locations and over ocean

Tertiary Objective: provide validation of GLM flash location & time stamp accuracy, and GLM image navigation and registration (INR) accuracy

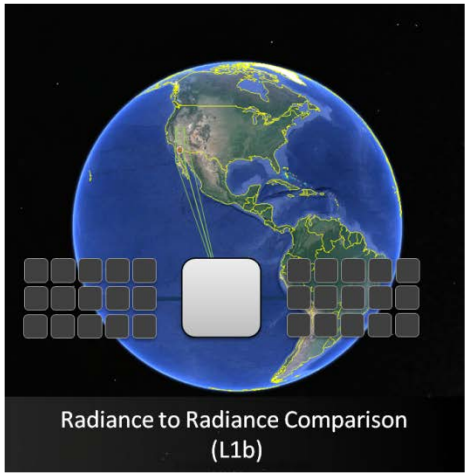
Targets of Interest:

- Storms

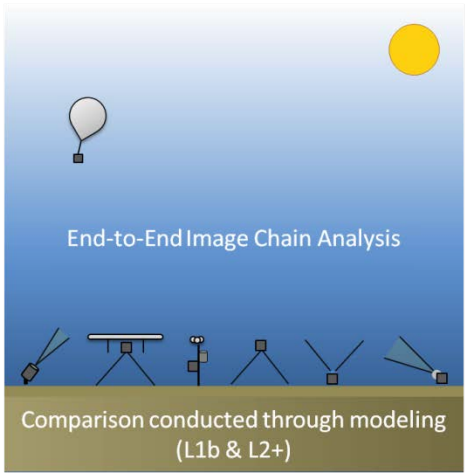


Field Campaign: Geostationary Validation of L1b & L2+ Products

Direct Comparison of Observations from SI Traceable Aircraft Sensor(s)



SI Traceability through Earth Surface Reference Observations



SI Traceability Validation Strategy

High Altitude Aircraft (ER-2) Based Sensors – Direct Radiance comparison (L1b validation)

Ground and Near Surface – End-to-End Image Chain Analysis (L1b & L2+ validation)

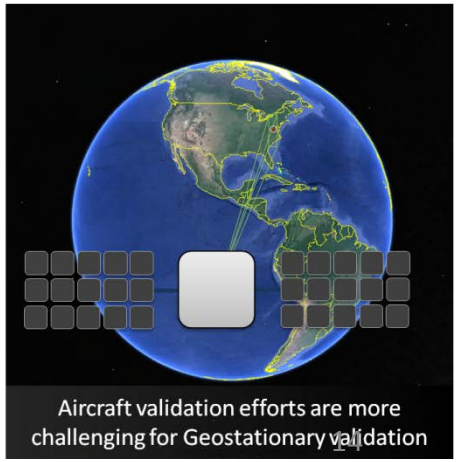
Addressing Validation Challenges

Matching View Geometry – Broad coordination & collaboration between NOAA and NASA science teams

Ground & Near Surface Collection of Representative Geophysical Reference Data – Developing new post-launch validation measurement capabilities using small low cost Unmanned Aircraft Vehicles (UAVs)

Low Earth Orbit

Geostationary Orbit

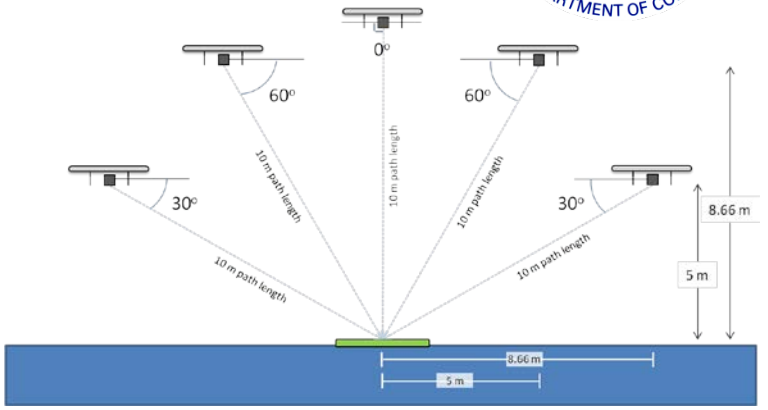


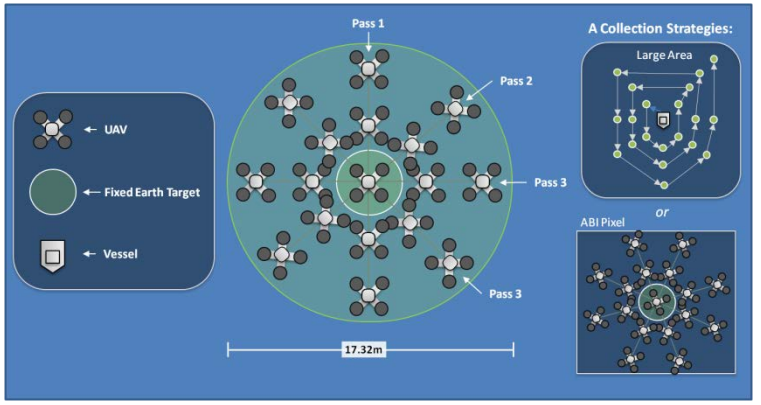
NOAA Developing New Operational Validation Capabilities

Objective is to transition a commercially available off-the-shelf technology into operations in support of GOES-R post-launch validation efforts:

Small UAVs provide an unmatched surface observation capability:

- » Large geospatial coverage (especially if swarmed)
- » Collection does not disturb the surface collection environment
- » Ability to collect goniometric measurements

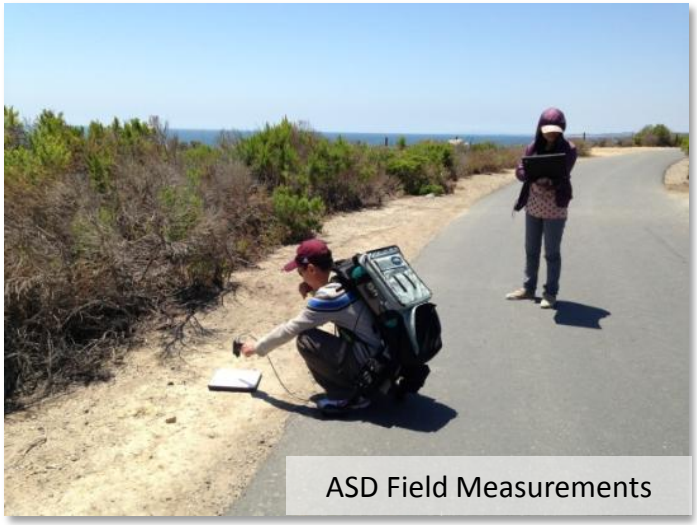




- Deployment of UAV(s) at several different locations within a satellite footprint can characterize the degree of uniformity within the footprint:
  - Ideally, this could be done for all reference Cal/Val sites in different seasons
- Enduring capability for Cal/Val scientist
  - Near surface UAV campaigns can be replicated numerous times throughout the year at significantly reduced costs in comparison to heritage approaches
- BRDF surface measurements can be used to check components of model values used in retrieval algorithms
- Unprecedented capability to collect measurements that are representative of satellite observations

Developing and Maturing Ground-Based Measurements Capabilities

- NOAA ground instruments for deployment to support validation efforts:
  - Sun photometer – Deployed for NASA HYSPIRI mission collaboration
  - Spectroradiometer – Deployed for NASA HYSPIRI mission collaboration & around NOAA NCWCP
  - Thermal IR camera – Context imager
  - Spectral Polarimeter – Deployed at NCWCP & UMD
    - Recent upgrade provides lower uncertainty measurements and measurement automation capability



ASD Field Measurements

Spectral Polarimeter Testing

Courtesy of L-1 Standards & Technology, Inc.

GSICS-CEOS Interaction

Background

- The initial concept of GSICS was brought forward by people involved in calibration activities with some links with CEOS WGCV.
- Important interaction on the QA4EO in (2009-2010). Resulted in GPPA (inherited from QA4EO).
- *WGCV Chair in the GSICS Executive Panel, and the GSICS EP Chair in WGCV.* ***Lots of overlap among group members.***

Interaction in 2014

- In Feb 17-21, 2014, 37th **CEOS** WGCV-36 held in **Frascati**, Italy. GSICS members Jerome Lafeuille (GSICS EP Member) and Tim Hewison invited to the meeting.
- In Sept – Oct 2014 NOAA hosted, 38th **CEOS**, Mitch Goldberg (GSICS EP Member), Lawrence E Flynn (Director GCC) and Manik Bali (Deputy Director GCC) presented GSICS, GSICS Coordination Center activities and GSICS Procedure for Product Acceptance (GPPA).

Outcome of 38th CEOS Meeting at NOAA

Meeting resulted in following action items on GSICS

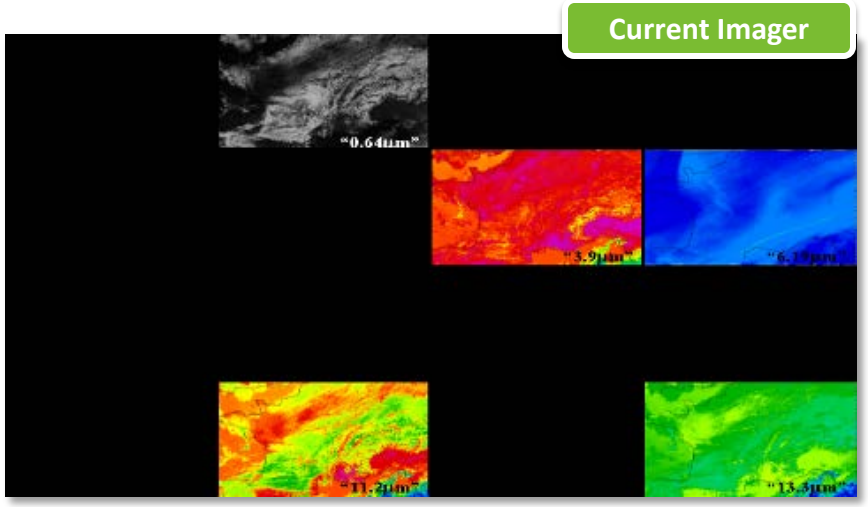
- MWSG Chair to have a communication with GSICS on how WGCV can offer support on best practices.
  - ***Cheng-Zhi Zou (GSICS MW subgroup Ex Chair) is exploring possibility to have a joint GSICS-CEOS Microwave subgroup meeting to exchange ideas and calibration/inter-calibration methodologies.***
- WGCV Secretariat to send out the list of potential GSICS-WGCV Cooperation items outlined by GSICS to each subgroup chair
- WGCV (Completed) Subgroup Chairs to identify and prioritize specific activity areas for interaction with GSICS.
- Mitch Goldberg suggested to WGCV to establish surface reference sites, and help with procedures for best practices.
- CEOS members invited to publish their work in GSICS Newsletter .
- More interaction required in formalizing GSICS SNO Coding standards (for eg Unit Testing)

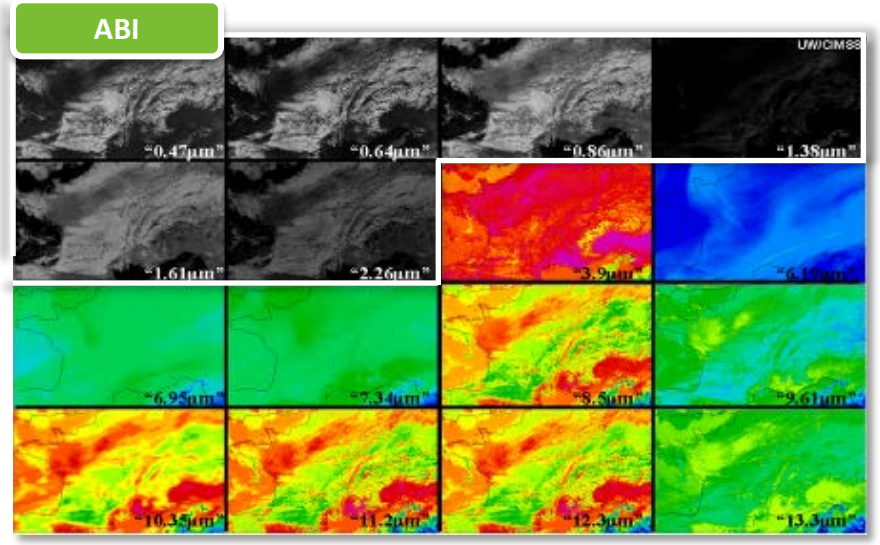
Summary

- NOAA continuing to ensure data quality through inter-comparisons:
  - » Jason-2 AMR and Envisat RA-2
  - » Suomi-NPP VIIRS and GOSAT
- We continue to prepare for GOES-R launch by supporting pre-launch testing, developing post-launch test plans and analysis tools, & extending our long-term monitoring capabilities (ICVS)
- NOAA is developing new validation capabilities for VIIRS & GOES-R validation:
  - » Active Light Sources for VIIRS DNB
  - » Near Surface Measurement Validation

BACKUP

GOES-R Advanced Baseline Imager (ABI)





http://cimss.ssec.wisc.edu/goes/abi/

ABI is the next generation GOES Imager

GOES-R is scheduled to launch in 2015

	Current	ABI
Spectral Coverage	5 Bands	16 Bands
Spatial Resolution		
0.64 μm visible	1.0 km	0.5 km
Other visible/near-IR	N/A	1.0 km
1.38 μm	N/A	2 km
Bands > 2μm	4 km	2 km
Spatial Coverage		
Full disk	Scheduled (3 hrs)	4 per hour
Visible (Reflective)		
On-orbit calibration	No	Yes

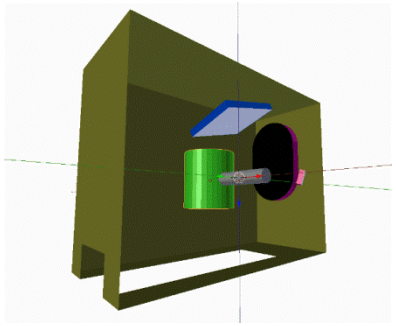
- **Increase in spectral coverage facilitates more quantitative products**
- **Increased emphasis on calibration**

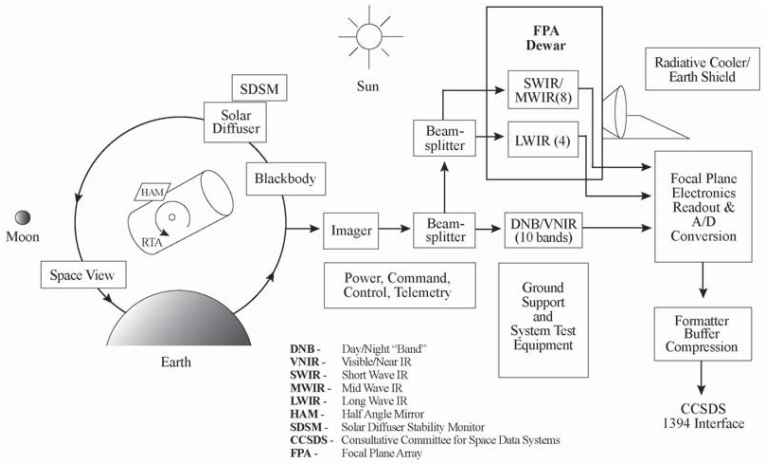
Overview of VIIRS Data Products

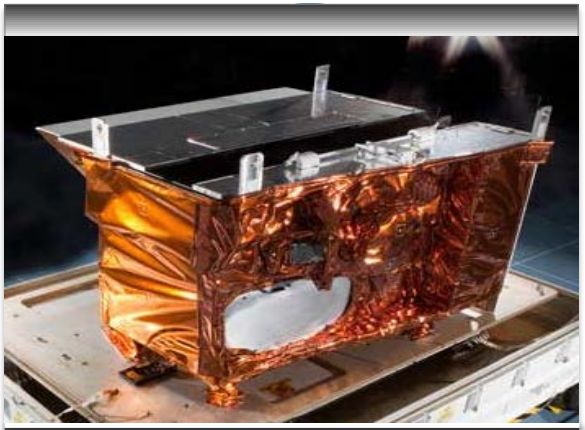
National Polar-orbiting Partnership satellite

Bridge mission between NASA's EOS (Earth Observing System) & the next-generation NOAA's JPSS (Joint Polar Satellite System)

- **SDRs (Sensor Data Records) = Level 1b**
  - » Calibrated and geo-located: radiance, reflectance, and brightness temperature
- **VIIRS SDR team** consists of experts from NOAA, NASA, The Aerospace Corp., University of Wisconsin, MIT/Lincoln Lab, NGAS & Raytheon
- Providing life cycle/end-to-end calibration support to S-NPP/JPSS VIIRS (pre-launch, post-launch, & long-term monitoring)
- VIIRS SDR product is used to produce 20+ Environmental Data Records (EDRs)







Suomi NPP VIIRS
Launched: October 28, 2011

22 SDRs Types

16 Moderate resolution bands
M-Bands (0.75 km):

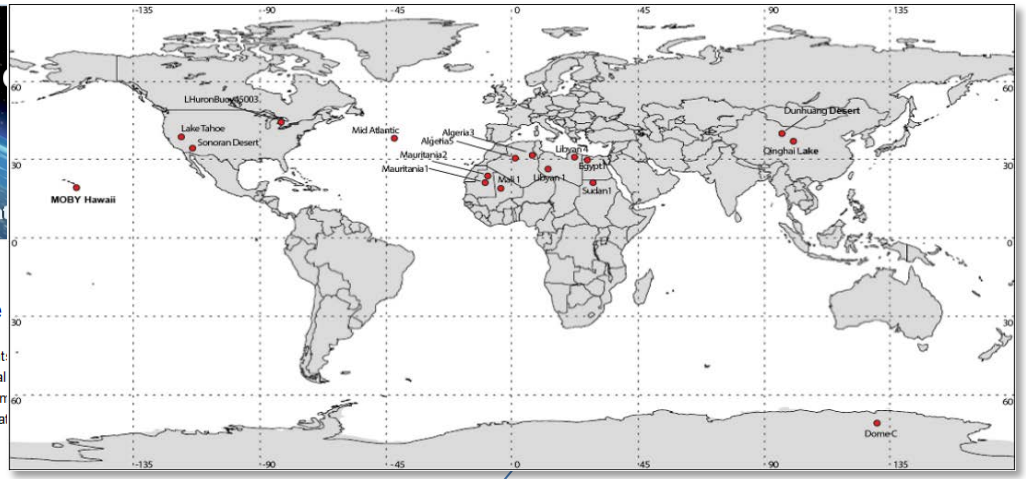
11 Reflective Solar Bands (RSB)
5 Thermal Emissive Bands (TEB)

5 Imaging resolution bands
I-Bands (0.375 km):

3 RSB
2 TEB

1 Day Night Band (DNB) broadband
DNB (0.75 km)

NCC Calibration Knowledge Base Updated



NCC

- Home
- Terms of Reference
- Publication Database
- About
- GOES-R
- NPP/JPSS/VIIRS
- NPP/JPSS/OMPS
- NOAA/AVHRR
- NOAA/SSU
- MetOp
- JASON
- DSCOVR
- Space Weather
- Standards
- Lunar Calibration
- Calibration Sites
- Calibration Facilities
- Portable Instruments
- Tools

You are here: Foswiki > NCC Web > VIIRS (06 Feb 2014, ChangyongCao)

Visible Infrared Imaging Radiometer Suite

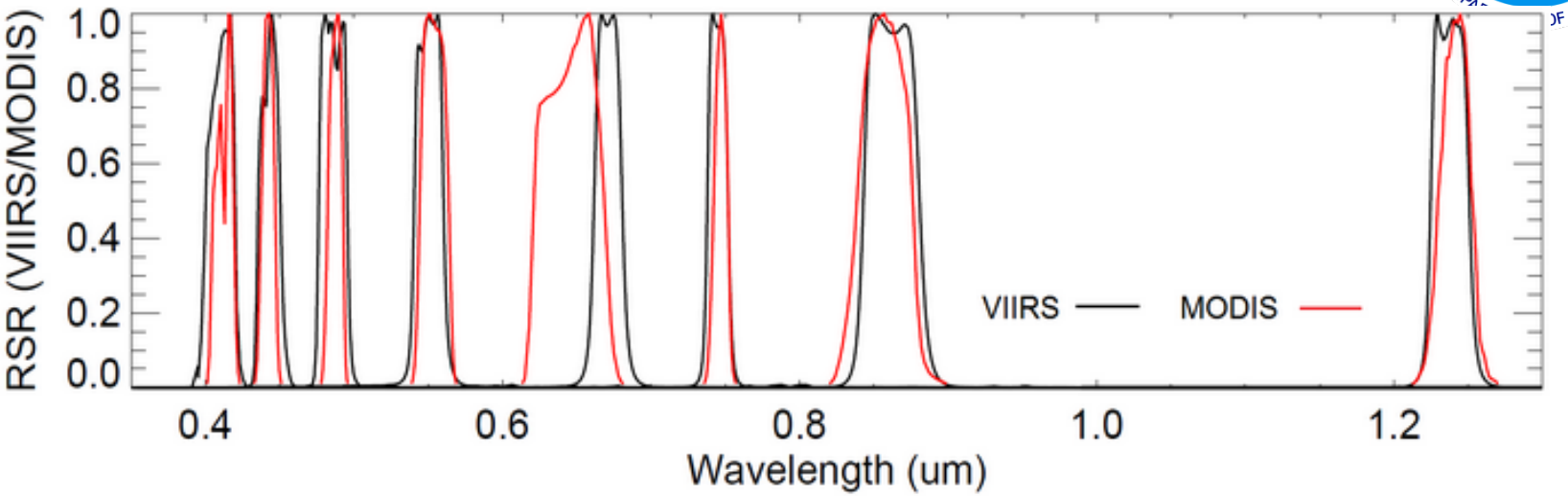
The Visible Infrared Imaging Radiometer Suite (VIIRS) is one of the key instrument
was opened on November 21, 2011, which enables a new generation of operational
operational environmental monitoring and numerical weather forecasting, with 22 in
records including clouds, sea surface temperature, ocean color, polar wind, vegeta
calibration and validation have shown that VIIRS is performing very well.

News and Documents	VIIRS Performance and Monitoring	Data and Software
News	VIIRS Longterm Monitoring	VIIRS Image Gallery
Publication Database	VIIRS On-orbit Performance Table	VIIRS data on CLASS
VIIRS Users Guide	Standardized Calibration Parameters	VIIRS data on ftp site (90 days)
VIIRS Calibration ATBD	VIIRS Spectral Response Functions	Data on GRAVITE
Conference Presentations	VIIRS Event Log Database (experimental)	VIIRS Software Tools
VIIRS Novel Applications	NPP/AQUA SNO Predictions	Planck Calculator for Infrared Remote Sensing
VIIRS SDR Data Format	Radiometric Intercomparison with MODIS	VIIRS Line Spread Function along scan
VIIRS SDR Meetings	VIIRS at Cal/Val Sites	
VIIRS FAQ	Lunar Calendar for DNB	SDR/EDR Team
About VIIRS	Moon in Space View Events	Standard Radiometric Test Scenes
	Validation Site Time Series	

VIIRS paper: Cao, C., X. Shao, X. Xiong, S. Blonski, Q. Liu, S. Uprety, X. Shao, Y. Bai, F. Weng, Suomi NPP VIIRS sensor data record verification, validation, and long-term performance monitoring, Journal of Geophysical Research: Atmospheres. DOI: 10.1002/2013JD020418. 2013. (click here)

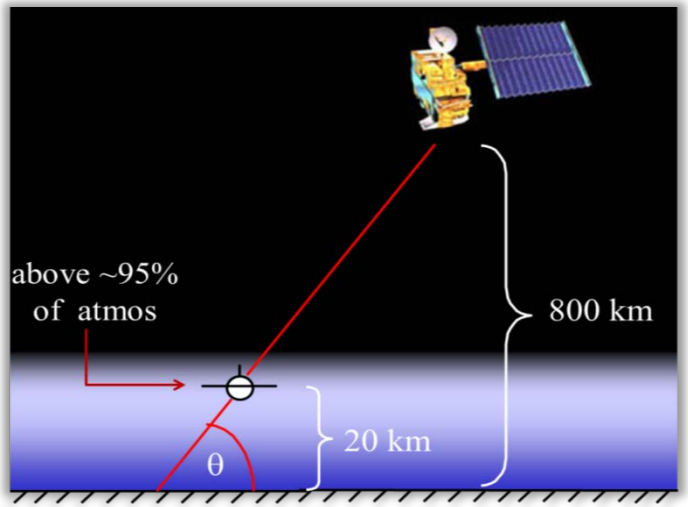
https://cs.star.nesdis.noaa.gov/NCC

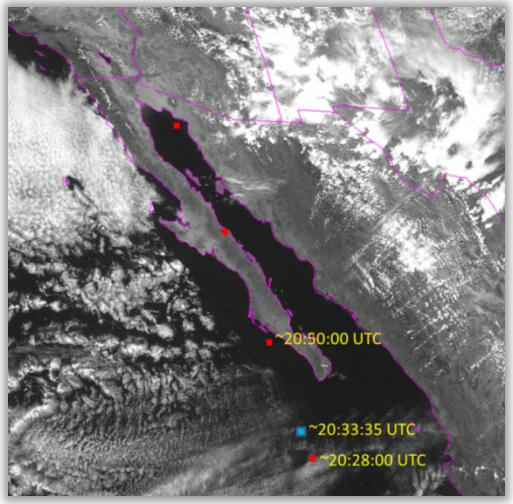
Backup slide



VIIRS and MODIS matching bands used in the inter-comparison			
VIIRS		MODIS	
Band	Wavelength (μm)	Band	Wavelength (μm)
M1	0.402 - 0.422	8	0.405 - 0.420
M2	0.0.436 - 0.454	9	0.438 - 0.448
M3	0.0.478 - 0.498	10	0.483 - 0.493
M4	0.0.545 - 0.565	4	0.545 - 0.565
M5	0.662 - 0.682	1	0.620 - 0.670
M6	0.739 - 0.754	15	0.743 - 0.753
M7	0.846 - 0.885	2	0.841 - 0.876
M8	1.230 - 1.250	5	1.230 - 1.250

S-NPP Field Validation Campaigns: NASA ER-2 Underflights





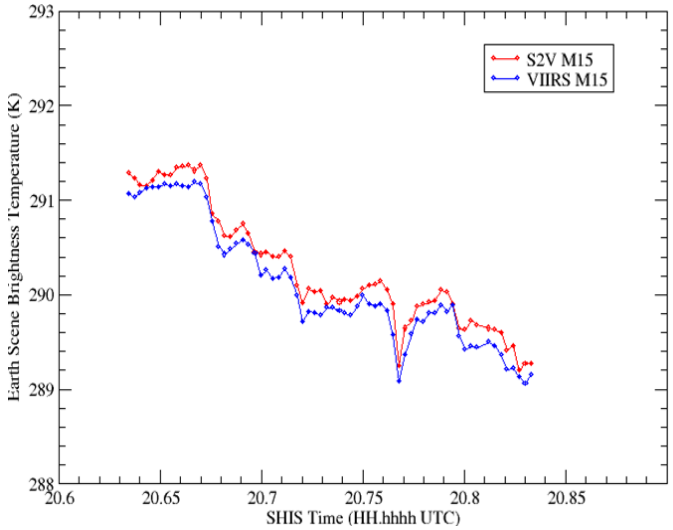
- VIIRS SDR accuracy evaluation
- SHIS (NIST-traceable blackbody source, 0.1 K)
- MASTER (50 m spatial resolution mapping)
- 3 underflights for S-NPP

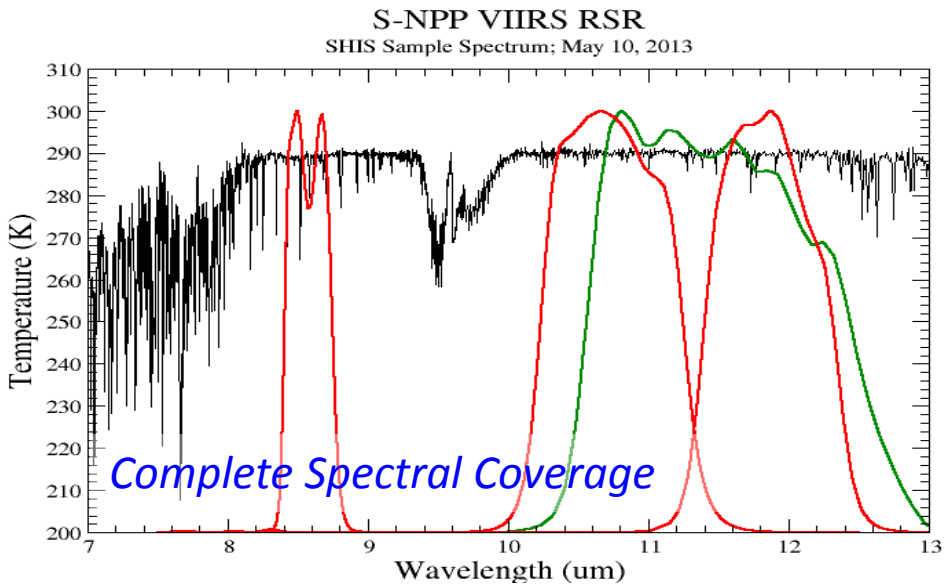
RSS Total Uncertainty Estimate

~0.12 K (I4, I5, M12, M13, M15, M16)

0.21 K (M14)

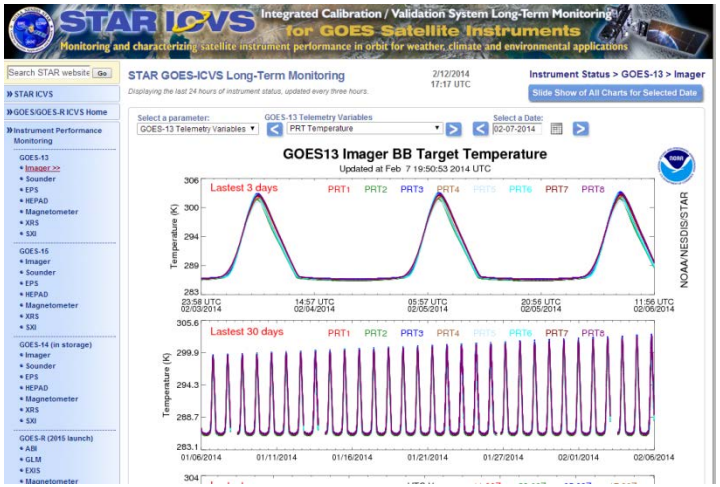
SHIS – VIIRS Comparison



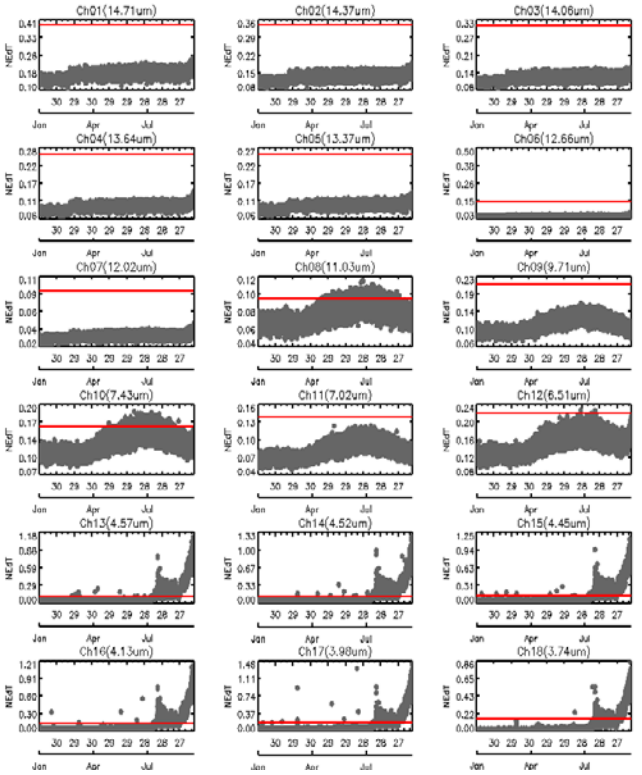


GOES/GOES-R ICVS Development

- To provide instrument scientists with calibration healthy status and users with the information regarding the satellite data quality for product generation
- As part of NOAA STAR ICVS, the GOES ICVS continues to evolve for the instrument performance and radiance quality monitoring
- While still under development, it already played a key role in detecting the calibration anomaly, diagnosing the root cause and assessing the impacts of anomalous events.



Current GOES/GOES-R ICVS Development.

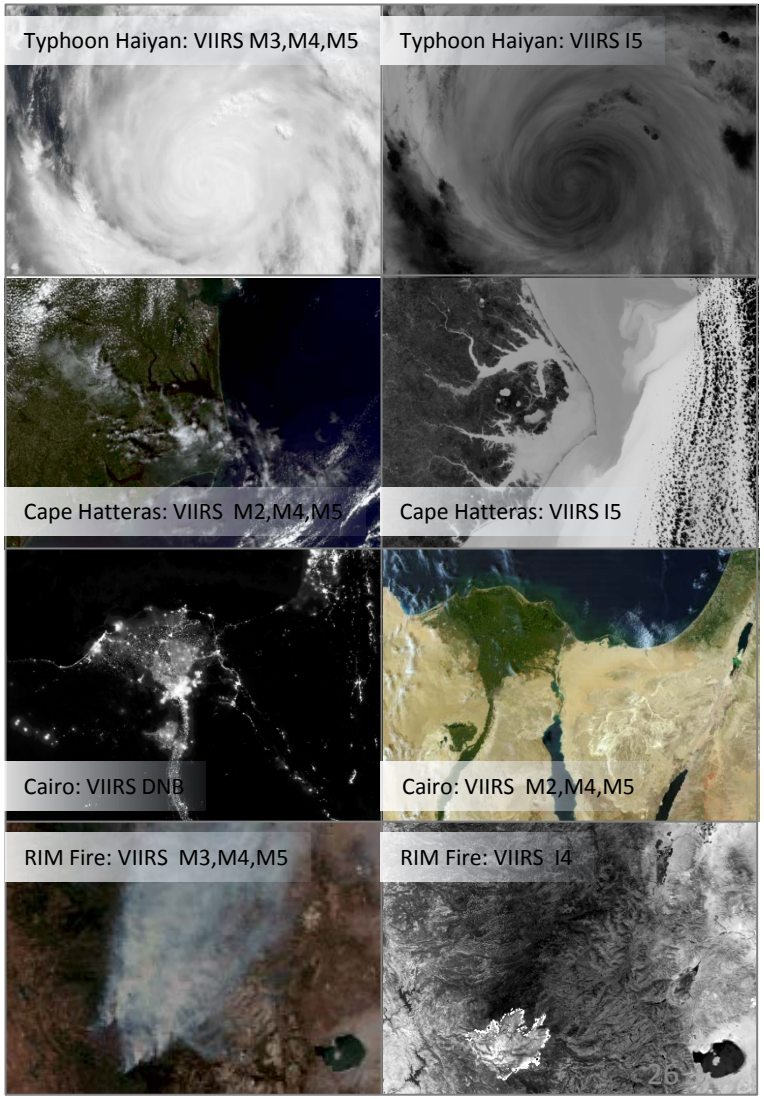


An example of GOES-13 Sounder IR noise expressed as NEdT@300K from Jan. 1, 2012 to Sept. 23, 2012 before the GOES-13 shutdown event on Sept. 23, 2012. The jumped and elevated noise at LW channels were apparent since July 2012.

SDR Team Support To EDR Teams

- **Working closely with VIIRS EDR teams to address VIIRS performance issues**
- **SDR Team has demonstrated strong positive action in response to user inputs:**
  - » Support spans from addressing:
    - Clear errors impacting data quality to questions that challenge the state-of-the-art of space-based imaging system performance
  - » Sea Surface Temperature EDR Team
    - Small yet apparent striping pattern (at noise level)
  - » Ocean Color EDR Team
    - Discrepancies between VIIRS and MODIS-Aqua chlorophyll-a since early 2013
  - » Fire EDR Team
    - Data quality and saturation limits

EDR Product Maturity Readiness Review Slides:
http://www.star.nesdis.noaa.gov/star/meeting_SNPPEDR2014_agenda.php



Images Courtesy: https://cs.star.nesdis.noaa.gov/NCC/GalleryPage04