NPP VIIRS
Atmosphere Data Products Validation Plan

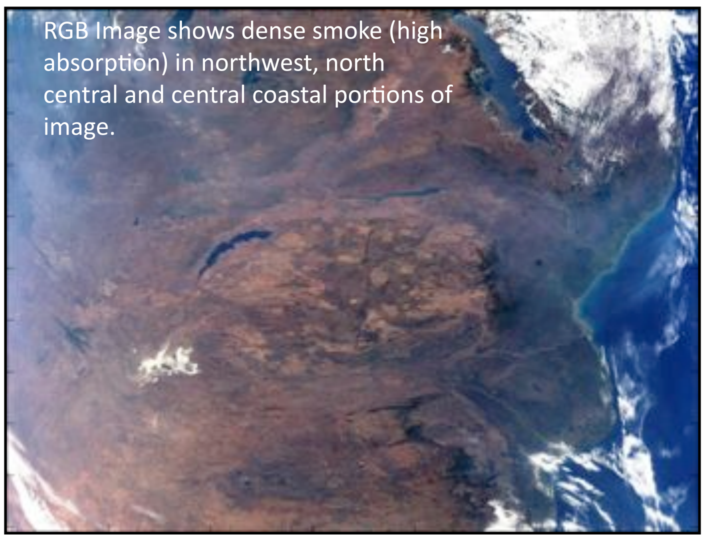
David Starr, NASA GSFC
IPO Atmosphere Validation Lead

MODIS Science Team Meeting
27 January 2010

VIIRS Atmosphere EDR's

- **No KPPs in Atmosphere Discipline**

- **Aerosol**
  - **Aerosol Optical Thickness (AOT)**
  - **Aerosol Particle Size Parameter (APSP)**
  - **Suspended Matter (SM)**



VIIRS Atmosphere EDR's

Clouds

- Cloud Top Properties
  - > Cloud Top Height (CTH)
  - > Cloud Top Temperature (CTT)
  - > Cloud Top Pressure (CTP)
- Cloud Optical Parameters
  - > Cloud Optical Thickness (COT)
  - > Cloud Particle Size Parameter (CPSP)
- Cloud Base Height (CBH)

Cloud Mask & Imagery Team

- VIIRS Cloud Mask (VCM)
- Cover/Layers (CC/L)

VIIRS Atmosphere Validation Plan

Characterize global Aerosol and Cloud EDR performance including regional, seasonal, and phenomenological/scene dependencies.

Purpose (in priority order)

- Enable rapid implementation of EDR's by Operational Centers
  - > Support VCM and SDR Assessment/Tuning
  - > AFWA (CCL)
  - > NRL (Aerosol EDR's)
- Support Assessment of Contract Performance (Specifications)
  - > Provide Independent Contract assessment to IPO
  - > Facilitate NGAS's Assessment
  - > Advise IPO regarding algorithm improvements
- Facilitate Early Broadening of Science User Community

Validation Team Members

EDR	Name	Organization	Funding Agency
Lead	David Starr	NASA/GSFC	IPO
AOT, APSP, SM	Christina Hsu	NASA/GSFC	IPO & NASA
AOT, APSP, SM	Istvan Laszlo	NOAA/NESDIS/STAR	IPO
AOT, APSP, SM	Jeff Reid	NRL Monterey	IPO & DoD
AOT, APSP, SM	Sid Jackson	NGAS	
AOT, APSP, SM	Alexei Lyapustin	UMBC/GSFC	IPO Land
AOT, APSP, SM	Brent Holben	NASA/GSFC	IPO & NASA

Validation Team Members

EDR	Name	Organization	Funding Agency
Lead	David Starr	NASA/GSFC	IPO
CTP, COP, CBH, CC/L	Bryan Baum	U. Wisconsin	IPO & NASA
CTP, COP, CBH, CC/L	Robert Holz	U. Wisconsin	IPO
CTP, COP, CBH	Paul Menzel	U. Wisconsin	IPO
CTP, COP, CBH, CC/L	Andy Heidinger	NOAA/NESDIS	IPO
CTP, COP, CBH	Jay Mace	U. Utah	IPO
CTP, COP, CBH, CC/L	Eric Wong	NGAS	
CTP, COP, CBH	Ed Eloranta	U. Wisconsin	IPO & NSF
CTP, COP, CBH	Dave Whiteman	NASA/GSFC	IPO
CTP, COP, CBH	Steve Platnick	NASA/GSFC	NASA

Key Entities and Roles

NASA PEATE - Data and Computational Engine

- data acquisition and access
- data subsetting and match-ups
- automated processes
- visualization tools

NGAS (initiated but developing)

- Provide insight into algorithm details
- Develop "cell" level validation from pixel level results
- Implementation of algorithm improvements as necessary

GRAVITE - role is beginning to get defined
(mostly interface to IDPS and data products)

Aerosol EDR Validation Approach

- **Inter-Satellite Comparison (Heritage) - GLOBAL**

  Prelaunch

  - VIIRS (MODIS proxy) vs MODIS, MISR, AVHRR & CALIPSO

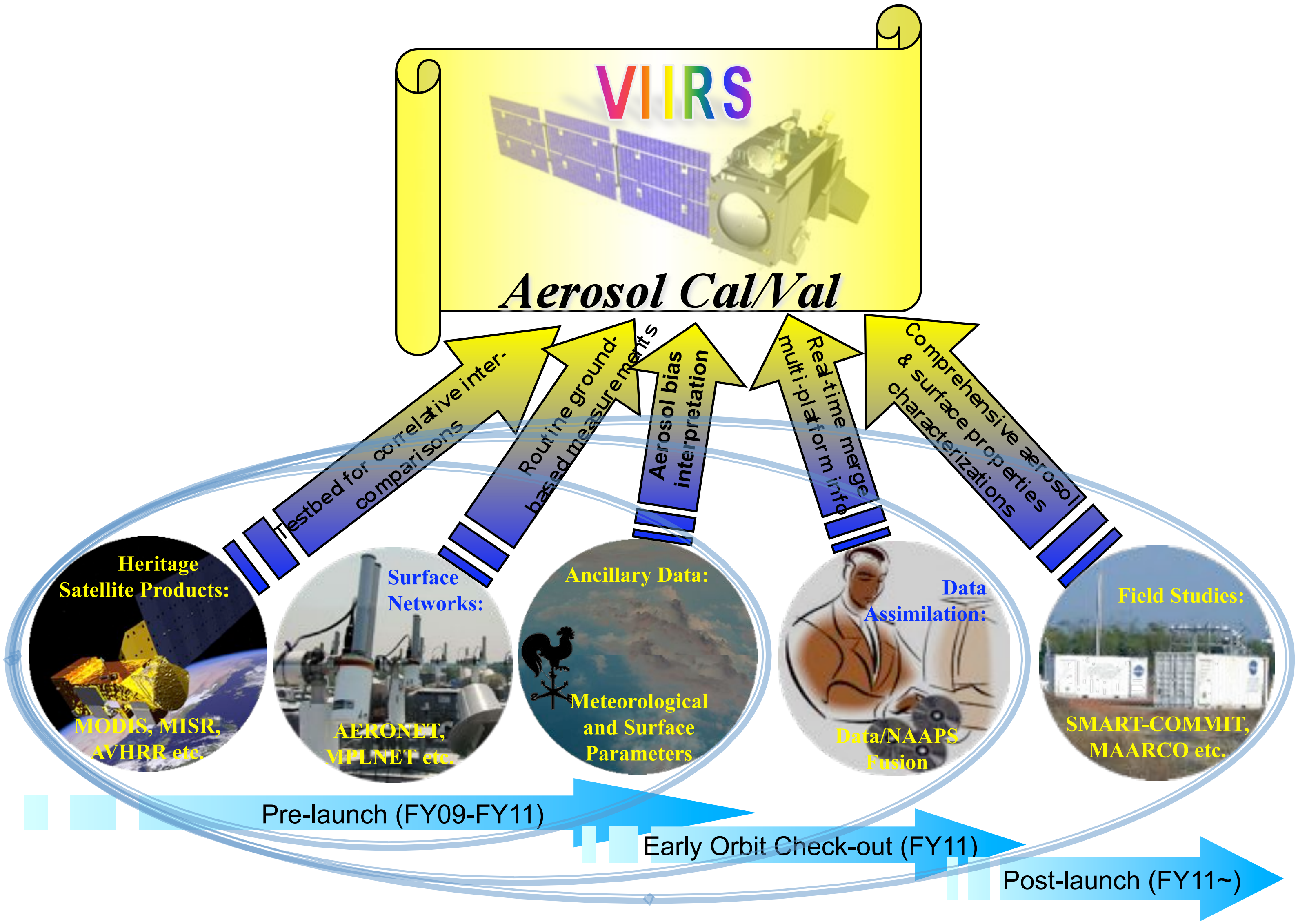
  Postlaunch

  - VIIRS EDR vs MODIS, AVHRR & CALIPSO (if still alive)

- **Correlative Data Comparisons**
  - **AERONET and MPLNET (select subset of sites)**

- **Data Assimilation**
  - **Provides quick global assessment of "Day 1" NPP VIIRS Aerosol EDR, primarily AOT, versus heritage. Vector increments provide indication of nature of "problems" including regional & phenomenological dependencies.**

VIIRS Aerosol EDR Strategy



N. Christina Hsu
NPP Deputy Project Scientist

Aerosol EDR Validation Approach

Field campaign data (TBD….$?)

– Key to understanding algorithm performance is understanding dependence on selection of aerosol models and compositional and height dependencies thereof.

=> Tightly-focused acquisitions of in-situ observations are needed.

Concerns

- Timing of field campaigns wrt/ launch is problematic (risky)
- Effective participation in field campaigns requires early commitment, may be somewhat mitigated for aerosol EDR Validation in contrast to cloud EDR.

VIIRS Atmosphere Validation Plan

Differences between Aerosol and Cloud EDR Validation

Aerosols - Excellent ground-truth data (AOT & APSP) is available. Data being operationally assimilated (FNMOC). Field data needed to understand error characteristics, especially for APSP & SM. (models, surface)

Clouds - COP ground-truth data problematic for most cloud types.

- particularly challenging for ice and mixed phase clouds.
  => Alternative approaches are needed, e.g., **closure** calculations.
- CALIPSO-CloudSat-MODIS is key for CTP and CC/L => learn NOW !!
- Multilayered clouds are huge challenge, little heritage for CBH

IPO Team will focus on “pixel” level (IP) validation for Clouds (i.e., retrieval physics). Translation to EDR via aggregation is additional step. For aerosols, focus will be more directly on EDRs, mostly due to greater horizontal homogeneity at cell scale (less data violence via aggregation), absence of parallax correction, and more readily traceable physics.

Cloud EDR Validation Approach

- **Inter-Satellite Comparison (vs Heritage) - GLOBAL**

  1) VIIRS (MODIS proxy) vs MODIS (5 and/or 6) and AVHRR (PATMOS)

  2) VIIRS (MODIS proxy) & MODIS vs CALIPSO & CloudSat

  3) VIIRS (MODIS proxy) vs SEVIRI

  EARLY REQUIREMENT: Validate PEATE implementation of VIIRS operational algorithm

- **Correlative Data Comparisons**

  - **DoE's ARM sites via U.Utah relational database**
  - **HSRL and Raman lidar observations for COT (τ < 3)**
  - **Field campaign data ? TBD**

Priority Partnerships/Leveraging

- NASA NPP Science Team & PEATE
- DoE: ARM Program
  - Leveraging past/current DoE and NASA EOS investments via IPO Team member support (Mace)
- HSRL and Raman Observations
  - IPO support of collection and analysis of such measurements recommended for COT validation.
- NRL & NASA field campaigns
  - Very preliminary discussions have occurred
  - General agreement on overall principles
  - Implementation requires capacity for timely commitments

Aerosol EDR Issues

- Cross talk and radiometric performance may compromise aerosol algorithm performance, i.e., highly sensitive to SDR
- Heritage algorithm performance over land surface may be inadequate => major AOT algorithm upgrade may be required.
- Aerosol retrievals (AOT) are tied to retrieval of surface properties, especially for land surface properties.
- Must ensure continuity of AERONET for validation of EDR's
- Aerosol data (MODIS) are now used in operational forecast/ assimilation stream at NRL => elevation of AOT priority (KPP ?).
- Present capabilities must be expanded in maritime regions
- Field data (airborne in-situ & remote sensing) may be required to quantify error characteristics associated with composition, such as absorbing aerosols and mixtures (aerosol models), and aerosol vertical distribution.

Cloud EDR Issues

- Non-heritage cloud algorithm performance may be inadequate, especially for ice phase clouds => algorithm tuning and/or upgrade may be required.
- Cloud algorithm tuning may be quite challenging and expensive given the computationally intensive task of regenerating the operational LUT's.
- Cloud top properties (CTP) may exhibit major biases in the case of optically thin upper tropospheric (cold) clouds due to lack of information from CO_2 channels.
- Continuity of ARM site data streams (DoE funded) is essential for Cloud EDR validation, especially if A-Train elements fail, i.e., no matchup data sets with CALIPSO & CloudSat. Also essential for CBH and to enable integrated closure approach for COP and CTP.
- Strong leveraging of NASA's PEATE activity in support of NPP => Requires continuity of the Atmospheric PEATE activity under NASA NPP funding. ??? NPOESS.
- Quality correlative data for COT is lacking => leveraged investment in acquisition of selected high-quality HSRL and Raman lidar observations.
- Aggregation & correction of pixel level retrievals (IP's) into EDR's presents some significant challenges for validation which is most naturally done at pixel level.
- Field data (airborne in-situ & remote sensing) may be required to quantify error characteristics associated with high-impact, complex cloud scenes, especially multilayered clouds. Complex cloud scenes in heavy aerosol environment may also be challenge. (eMAS)

Schedule

- FY10:
  - Build & test data flow linkages (IDPS – PEATE, U.Utah – PEATE, AERONET – PEATE)
  - Use A-Train (C&C) and ARM matchup data to assess MODIS C5 and then NGAS algorithm (MODIS proxy)
  - Develop necessary protocols, tools and workplans
  - Identify algorithm issues & hotspots and develop post launch assessment plan
- FY11
  - Participate in commissioning phase SDR validation, including airborne underflights
  - Begin validation assessment of Aerosol and Cloud EDR's as planned, focusing 1st on most fundamental EDR's and simple scenes
- FY12
  - Complete preliminary validation assessment
  - Begin preparations for NPOESS
  - Contribute to algorithm improvement
  - Identify requirements for specific field campaign measurements
  - Participate, highly leveraged, in PACE (major NASA NRL field experiment in SE Asia)
- FY13-FY15
  - Perform validation of VIRRS EDR's from NPOESS C1
  - Participate in further field activities (small highly focused activities)

Backup Charts

Atmosphere

Cal/Val Plan Overview by EDRs

Table 0-1

EDR Group/EDR	Horizontal Cell Size (Nadir) [Km]	Precision	Accuracy	Uncert
Cloud Optical Properties (COP)				
Cloud Optical Thickness (COT)	6 ± 1 km	Greater of 5% or 0.025	Greater of 10% or 0.05	
Cloud Effective Particle Size (CEPS) Water	6 ± 1 km	Greater of 2 μm or 10%	Greater of 2 μm or 5%	
Cloud Effective Particle Size (CEPS) Ice	6 ± 1 km	Greater of 3.5 μm or 10%	Greater of 2 μm or 5%	
Cloud Top Properties (CTX)				
Cloud Top Temperature (CTT) $\tau \geq 1$	6 ± 1 km	1.5 K	2 K	
$\tau < 1$	6 ± 1 km	1.5 K	6 K	
Cloud Top Height (CTH) $\tau \geq 1$	6 ± 1 km	0.3 km	1 km	
$\tau < 1$	6 ± 1 km	0.3 km	2 km	
Cloud Top Pressure (CTP) $t \geq 1$	6 ± 1 km		100 mb at <3 km to 25 mb at 7 km	
Cloud Base Height (CBH)	6 ± 1 km			2 km

Table 0-2

EDR Group/DR	Horizontal Cell Size (nadir) [km]	Precision	Accuracy	Uncert
Aerosol Optical Thickness (AOT) Over Ocean	6 km	.02 + .03 Tau		.03 + .05 Tau
Aerosol Optical Thickness (AOT) Over Land	6 km	.04 + .10 Tau		.05 + .15 Tau
Aerosol Particle Size Parameter (ASPS) Over Ocean	6 km		.3 alpha units	.3 alpha units
Aerosol Particle Size Parameter (ASPS) over Land	6 km		.6 alpha units	.6 alpha units
Suspended Matter (SM)	1.6 km	Prob. of correct typing 80 – 85%		