NPOESS Preparatory Project Validation Program for the VIIRS Aerosol and Cloud Data Products

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Overview

The Joint Polar Satellite System (JPSS) Program, formerly NPOESS, will launch the NPOESS Preparatory Project (NPP), a risk reduction and data continuity mission, prior to the first operational NPOESS launch. The Program will execute the NPP Validation program to ensure the data products comply with the requirements of the sponsoring agencies. Data from the NPP Visible/Infrared Imager/Radiometer Suite (VIIRS) will be used to produce Environmental Data Records (EDR's) for aerosol and clouds:

• Aerosol Optical Thickness	AOT
• Aerosol Particle Size Parameter	APSP
• Suspended Matter	SM
• Cloud Optical Thickness	COT
• Cloud Effective Particle Size	CEPS
• Cloud Top Temperature	CTT
• Cloud Top Height	CTH
• Cloud Top Pressure	CTP
• Cloud Base Height	CBH

The Aerosol and Cloud EDR Validation Program is a multifaceted effort to characterize and validate these data products. The program involves systematic comparison to heritage data products, e.g., MODIS, ground-based correlative data, such as AERONET and ARM data products, and possibly airborne field measurements. To the extent possible, the domain is global. The program leverages investments made by various national funding agencies in such resources. It also leverages data assimilation for rapid day-1 assessment, such as at the Naval Research Lab (NRL).

This is an overview of the approaches, key datasets, activities, and recent progress toward validation of the NPP VIIRS Aerosol and Cloud environmental data products.

Key Datasets

- Heritage Satellite Datasets
  - MODIS, MISR, CALIPSO, CloudSat,
  - AVHRR, HIRS,
  - IASI, SEVIRI, *etc.*
- Correlative Observations
  - AERONET, SURFRAD,
  - ARM, MPLNET, CloudNet, and
  - Airborne Campaign Observations

Approach

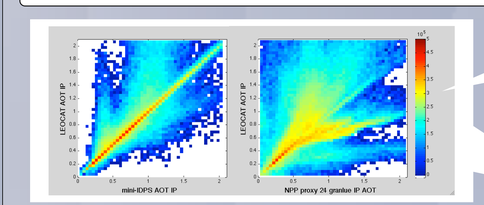
The Validation Program for the Cloud and Aerosol EDRs combines heritage experience from previous science and operational missions to fully characterize the data product performance and to demonstrate operational viability to the operational Customers/Centers.

Key strategic elements necessary to accomplish the Plan's objectives are as follows:

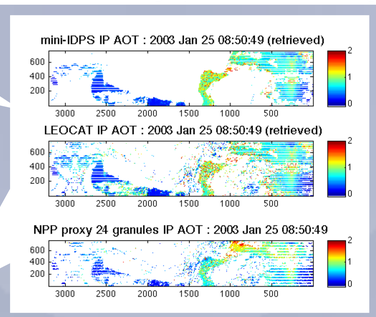
- Team of subject matter experts (SMEs) and representatives from the Customer/User and science communities to
  - leverage heritage knowledge and tools as well as on-going activities, and
  - assure understanding of customer mission success criteria.
- Coordinate and collaborate closely with the SDR team to assess/validate SDRs in the mission's Early Orbit Checkout Phase.
- Identification, development, and access *in situ* data resources necessary for activities in the *Intensive Validation* and *Long-term Monitoring Validation* phases of the mission, where the latter overlaps JPSS.
- Strong collaborative relationships with the NASA Atmosphere Product Evaluation And Test Element (PEATE) at the University of Wisconsin for pre-launch assessment and post-launch validation.
- Partner with other agencies to plan post-launch field campaigns to target needed measurements that are not currently available from field sites.

Priority Targets for atmosphere validation have been identified to cover the range of conditions that will best characterize the data products:

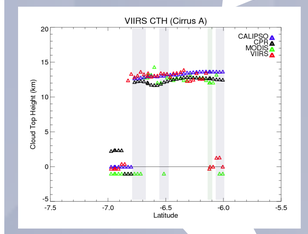
- *Surface Types/Conditions*: open ocean, costal, dark vegetation, bright land, mixed land, and ice
- *Aerosol*: light to heavy loading, composition (including dust, smoke, urban, and sea salt), and height dependence
- *High clouds*: cumulonimbus, cirrus (synoptic cirrus as well as convectively-generated cirrus such as tropical anvils), and mixed-phase clouds.
- *Low clouds*: stratus, stratocumulus, cumulus, over diverse ocean backgrounds and inhomogeneous land backgrounds.



2-D histogram of pixel-to-pixel comparisons between LEOCAT (ordinate) and Contractor AOT retrievals, mini-IDPS in the left panel and NGAS in the right panel. Colar bar is in log 10 scale.



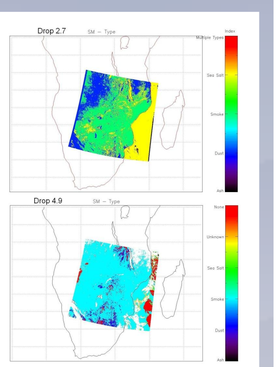
Comparisons of cirrus cloud CTH retrievals.



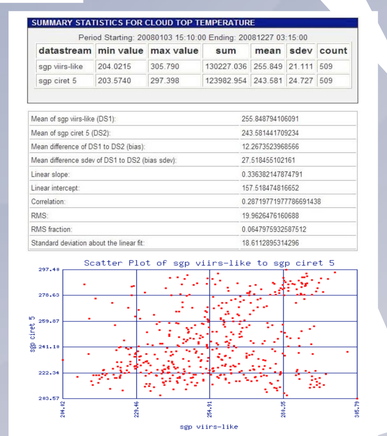
Progress

Aerosol

- **Implemented operational NGAS VIIRS Aerosol code in Atmosphere PEATE's LEOCAT Linux cluster environment. (Holz & Johnson)**
- **Aerosol assimilation operational at NRL for rapid assessment of aerosol algorithm performance. (Reid)**
- Compared results from various releases of the NGAS VIIRS aerosol retrieval, including SM. (Laszlo)
- Systematically evaluated differences between MODIS and VIIRS-like (generated by LEOCAT) data. (Hsu)
- Adapted MAAPS that compares AERONET and other sensor retrievals for VIIRS. (Hsu)
- Toolbox of routines developed to enable rapid quantitative evaluation of both satellite AOD data and aerosol data assimilation results. (Reid)



Suspended Matters (SM) retrieved from Drop 2.7 (left) and from Drop 4.9 (right) version of the VIIRS SM algorithm.



Results from query comparing MODIS C6 with CIRET 5 derived parameter. The upper and middle panels show summary statistics. The lower panel show a scatter plot.

Team Members

Aerosol Validation Team

Name	Org.	Sponsor
David Starr, *Lead*	NASA/GSFC	IPO
Istvan Laszlo	NOAA/STAR	IPO
Christine Hsu	NASA/GSFC	IPO & NASA
Jeffrey S. Reid	NRL	NRL
Sid Jackson	NGAS	NGAS
Alexei Lyapustin*	UMBC	IPO
John Eylander	AFWA	AFWA

*Land EDR Team

Cloud Validation Team

Name	Org.	Sponsor
David Starr, *Lead*	NASA/GSFC	IPO
Andrew Heidinger	NOAA/CIMSS	IPO
Bryan Baum	SSEC/Univ WI	IPO & NASA
Robert Holz	SSEC/Univ WI	IPO & NASA
Jay Mace	U. Utah	IPO
Paul Menzel	SSEC/Univ WI	IPO
Steve Platnick	NASA/GSFC	NASA EOS
Keith Hutchison	NGAS	NGAS
Eric Wong	NGAS	NGAS
John Eylander	AFWA	AFWA

Progress

Cloud

- **Working to implement operational NGAS VIIRS Cloud code in Atmosphere PEATE's LEOCAT Linux cluster environment. (Holz)**
- Developed and implemented matchup data generation software and analysis tools at the PEATE, and tested on MODIS and CALIPSO. (Holz)
- Developed methodology and software for cloud Accuracy, Precision, and Uncertainty (APU) assessments on matchups of VIIRS and "truth" data. Tested it using matchups of CloudSat and CALIPSO data to generate cloud APU for MODIS data. (Hutchison & Wong at NGAS)
- Adopted a tool from EUMETSAT making comparisons of MODIS, SEVIRI, AMRe, CloudSat and CALIPSO and used it to compare CTH. (Heidinger)
- Compared VIIRS Cloud Mask to MODIS Cloud Mask with favorable results. (Hutchison)
- Developed realistic scattering properties for ice particles based on particles with roughened surfaces. (Baum)
- Developed software for Simultaneous Nadir Overpass (SNO) radiance inter-comparison between IASI and VIIRS and tested it on Terra and Aqua MODIS. (Menzel)
- Revived relational database application developed for MODIS and ARM correlative matchups and comparisons. (Mace)

Activities

Pre-Launch
- Define team and partnerships.
- Define responsibilities and schedule, identify available and needed data and computing resources.
- Characterize algorithm performance using proxy and correlative data.
- Build tools to generate matchups of satellite obs. and correlative data and needed analysis software.
- Develop PEATE comparison capabilities

Early Orbit Check-out
- Examine PEATE-processed SNO-matched comparisons between MODIS, AVHRR and NPP radiance, cloud, and aerosol products
- Monitor sensor performance by analyzing quality of aerosol data

Intensive Cal/Val
- Repeat global pre-launch analyses to discover anomalies between heritage and NPP algorithms
- Validate through inter-satellite and correlative-observation comparisons.
- Generate regional and global statistics of EDRs based on aforementioned comparisons.
- Assess error characteristics of EDRs with emphasis on the identification and understanding of error sources and dependencies.
- Demonstrate fulfillment of operational viability.
- Participate in focused field campaigns for calibration and validation.
- Compare IR radiance measurements to those of CrIS

Long-Term Monitoring
- Transition applicable tools and techniques to Operations and Sustainment team for monitoring product performance
- Monitor product performance and correct when needed
- Monitor sensor performance and analyze impact on product performance

Phases of the Cal/Val Program