HIGHLIGHTS OF AEROSOL CAL/VAL TEAM ACTIVITIES

NOAA/NESDIS/STAR

Istvan Laszlo and Shobha Kondragunta

Aerosol Cal/Val Team

Outline

- Cal/Val Team Members
- Highlights of Activities to Date
- Algorithm Overview
- S-NPP Products
- JPSS-1 Readiness
- Summary and Path Forward

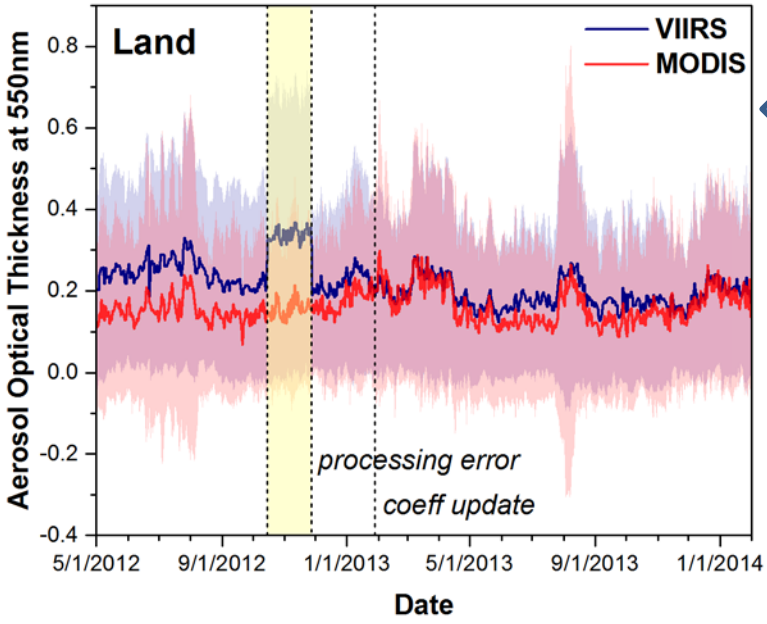
Cal/Val Team Members

Name	Organization	Roles and Responsibilities
Pubu Ciren	IMSG/NOAA	ADP algorithm development/validation
Bigyani Das	IMSG/NOAA	Algorithm integration
Brent Holben	NASA/GSFC	AERONET observations for validation work
Jingfeng Huang	UMD/CICS	AOT product validation
Edward J. Hyer	NRL	Product validation, assimilation activities
Shobha Kondragunta	NOAA/NESDIS	Co-lead
Istvan Laszlo	NOAA/NESDIS	Co-lead
Hongqing Liu	IMSG/NOAA	Visualization, algorithm development, validation
Lorraine A. Remer	UMBC	Documentation and validation
Hai Zhang	IMSG/NOAA	Algorithm coding, validation within IDEA
Stephen Superczynski	IMSG/NOAA	Data management and user outreach

Accomplishments to Date

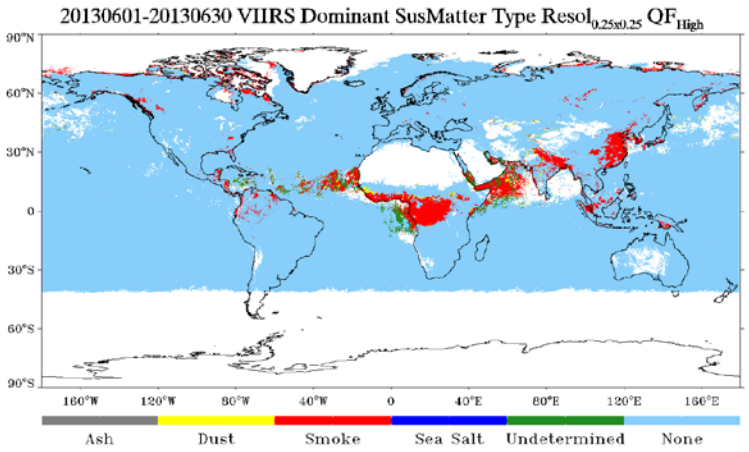
- **Evaluated current operational S-NPP/IDPS aerosol products for maturity levels**
  - Reference data: AERONET, MODIS, MISR, CALIPSO
  - Demonstrated initial AOT retrieval had a large positive bias over land
  - Demonstrated SNPP/IDPS SM product does not meet requirements
- **Evaluated IDPS AOT EDR and IP products with AERONET L2 data**
  - Published results in JGR paper(2016)
- **Developed EPS AOT and AD (formerly SM) algorithms**
  - Designed to work on both VIIRS and ABI (AHI)
  - Improved aerosol detection (AD)
    - Dust detection published in JGR (2014)
  - Improved surface reflectance ratios and high AOT retrieval over land
    - Manuscript in preparation
  - Added AOT retrieval over bright snow/ice-free land
    - Manuscript submitted to JGR (2016)
- **Reprocessed 2015 S-NPP/VIIRS AOD and AD products with EPS algorithms**
- **Provided reprocessed data of AOT and AD to users**

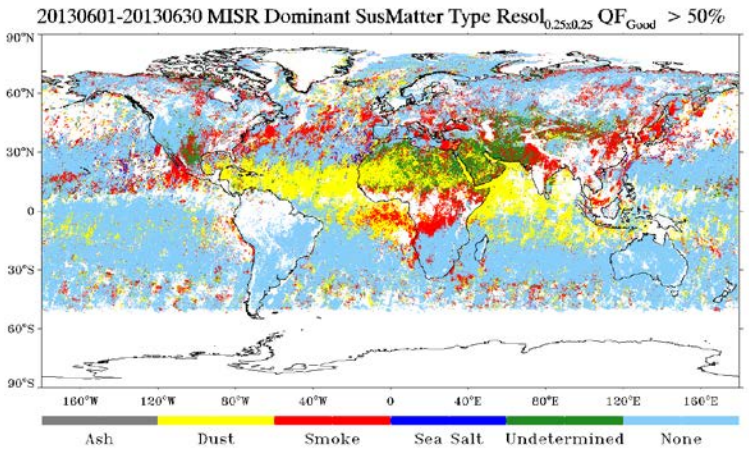
Accomplishments – IDPS Products



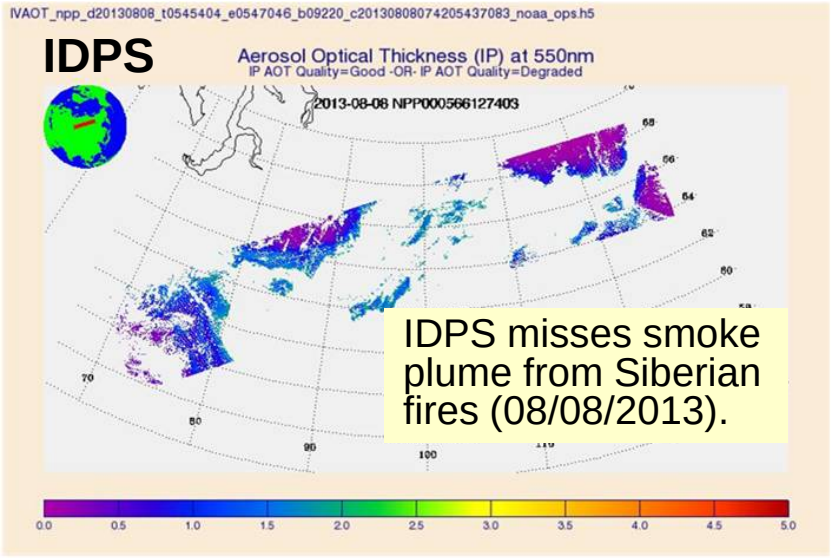
AOT over land has large bias relative to MODIS before revising relevant coefficients

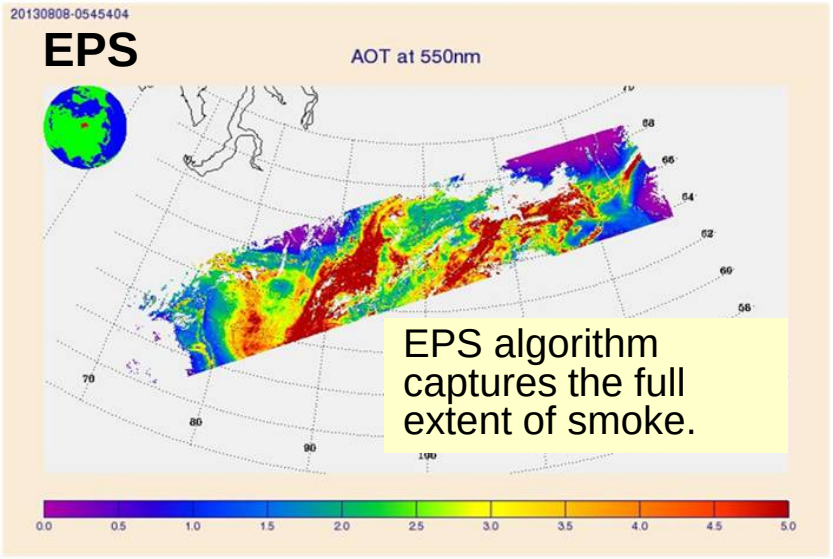
SM product accuracy (20%) (established by comparison to MISR) product does not meet the 80% accuracy requirement

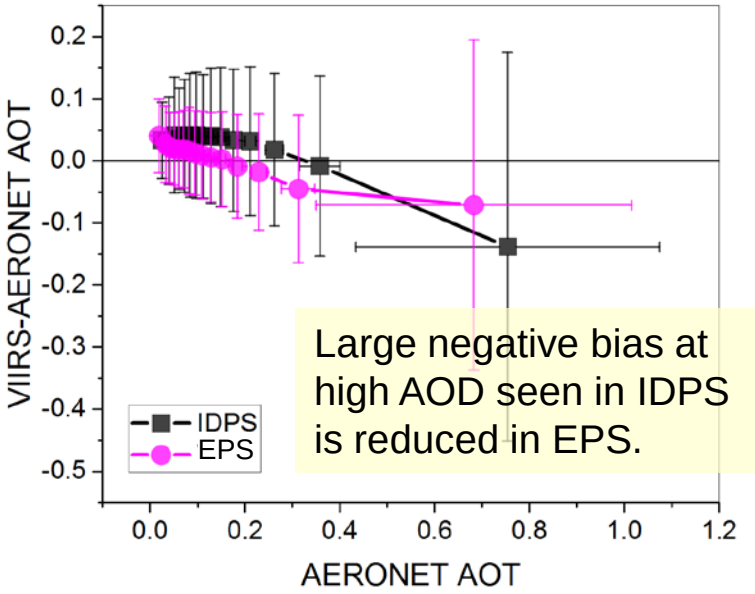


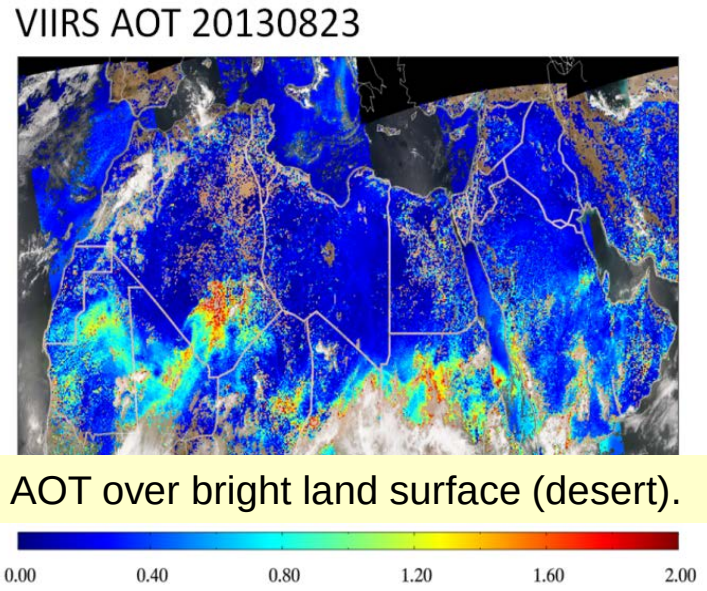


Accomplishments – EPS Products









EPS AOT, APSP Algorithm Overview

- Designed to work with VIIRS and ABI (AHI) observations
- Separate algorithms over land and water
  - **Water**: MODIS heritage; based on Tanré et al. (1997)
    - Includes large inland water bodies
  - **Land**: separate paths for dark and bright surface
    - Dark surface: combines two "flavors" of the "dark-target" approach
      1. M3/M5 (works better for low AOT)
      2. M3/M11 (works better for high AOT)
    - Bright (snow-free) surface: regional ratios of surface reflectances
      - M3/M5 for North Africa/Arabian Peninsula
      - M1/M5 for the other regions
- Uses SW for AOT, SW+IR for internal test, masks (cloud, snow/ice, etc.), ancillary data (P, TPW, ozone, wind)
- **Output:** AOT at 550 nm and at SW channels (range: -0.05 to 5.0), Ångström exponents over water, aerosol model, fine-mode weight over water, quality flags, diagnostics (residual, AOD for each land aerosol models, surface reflectance, etc.)

EPS AD Algorithm Overview

Input Reflectances:

412, 440, 2250 nm

Internal Tests:

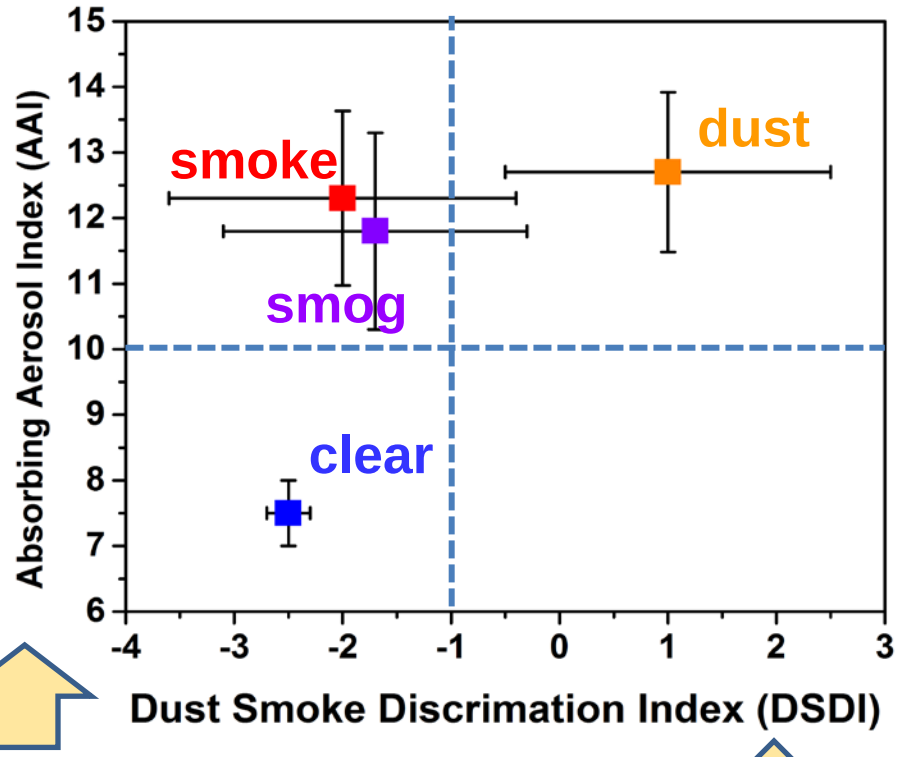
Spatial Variability Test: 412 nm (land); 865 nm (water)

Turbid Water Test: 488 nm, 1.24 µm, 1.61 µm, 2.25 µm

Bright Pixel Test:1.24 µm, 2.25 µm

NDVI Test: 640 nm, 865 nm

Snow Test: 865 nm, 1.24 µm + IR



Absorbing Aerosol Index

$AAI = -100[\log_{10}(R_{412}/R_{440}) - \log_{10}(R^{RAY}_{412}/R^{RAY}_{440})]$

Dust Smoke Discrimination Index

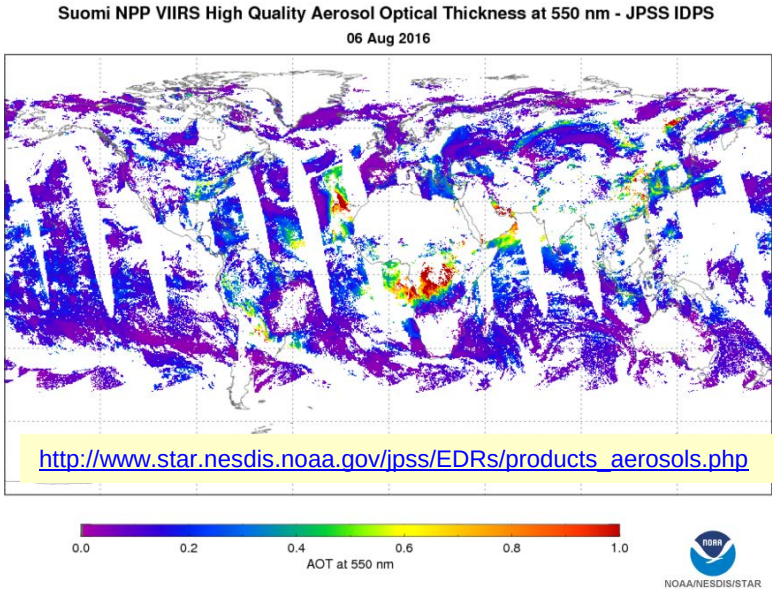
$DSDI = -10[\log_{10}(R_{412}/R_{2250})$

S-NPP AOT Product Overview (1)

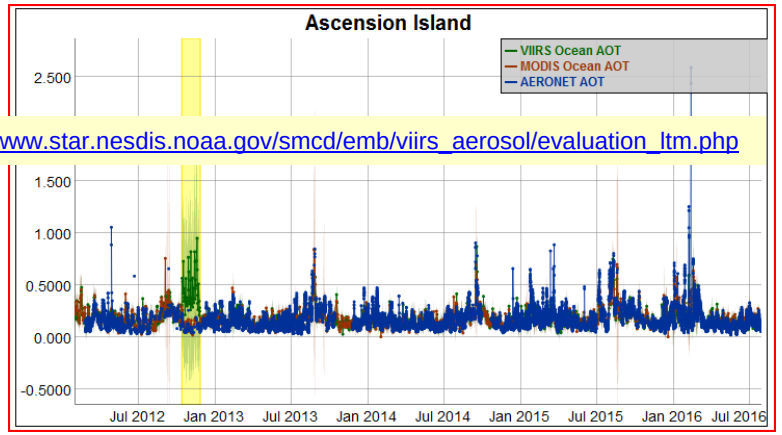
AOT - Land	L1RDS	Performance
AOT550 < 0.1		
Accuracy	0.06	0.03
Precision	0.15	0.07
0.1 ≤ AOT550 ≤ 0.8		
Accuracy	0.05	-0.01
Precision	0.25	0.11
AOT550 > 0.8		
Accuracy	0.20	-0.05
Precision	0.45	0.38

AOT - Water	L1RDS	Performance
AOT550 < 0.3		
Accuracy	0.08	0.03
Precision	0.15	0.04
AOT550 >= 0.3		
Accuracy	0.15	0.01
Precision	0.35	0.11

- Long Term Monitoring (IDPS)



http://www.star.nesdis.noaa.gov/jpss/EDRs/products_aerosols.php

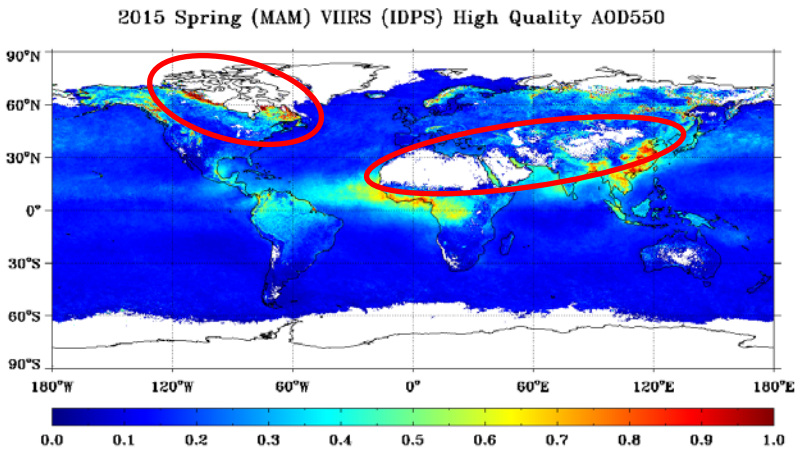


http://www.star.nesdis.noaa.gov/smcd/emb/viirs_aerosol/evaluation_ltm.php

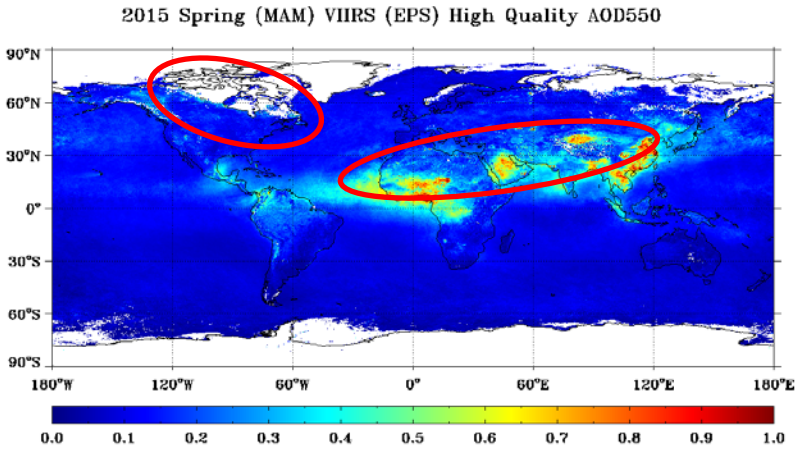
S-NPP AOT Product Overview (2)

- **Enterprise AOT Algorithm Status:**
  - Algorithm is ready
  - Scheduled for operational implementation in 2016
- **Reprocessing:**
  - with EPS algorithm
  - 2015 completed
  - Output Data
    - Pixel-level retrieval and diagnostic outputs in compressed HDF5 format for each granule
    - Total size 7.7T (about 22G per day)
  - Provided data to users at
    - NOAA Earth System Research Laboratory (ESRL)
    - NOAA Joint Center for Satellite Data Assimilation (JCSDA);
    - NOAA National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC)
    - University at Albany, State University of New York
    - Naval Research Laboratory (NRL)

IDPS



EPS

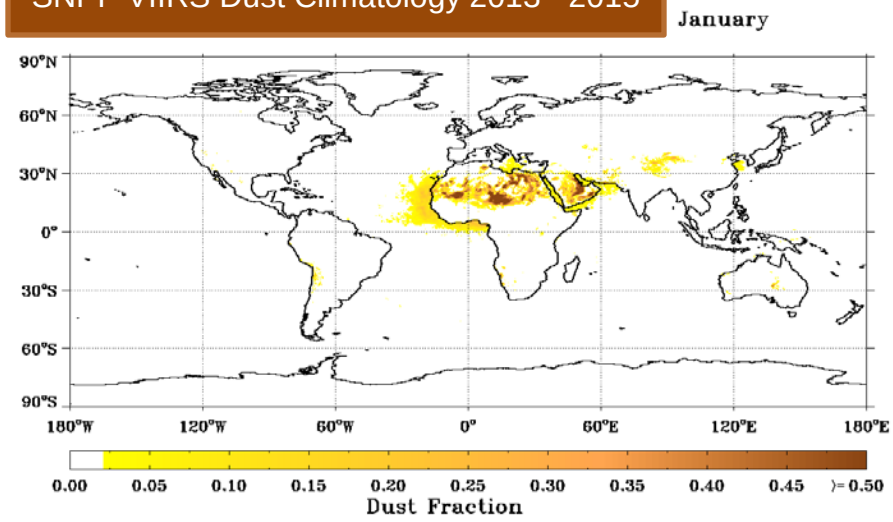


S-NPP AD Product Overview

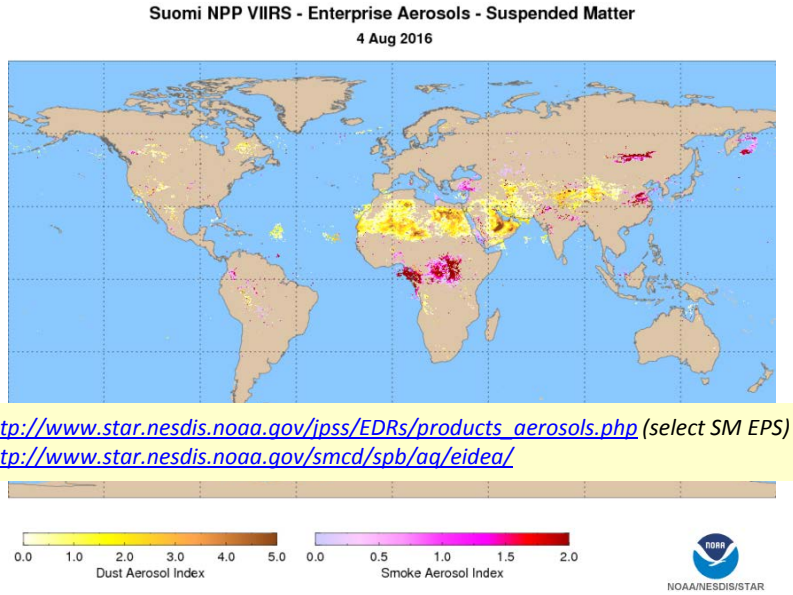
Product	L1RDS	Performance	
		Land	*Water*
Accuracy (%)			
Smoke	70	98	94
Dust	80	84	95
Ash	60		

Both dust and smoke products meet requirements

SNPP VIIRS Dust Climatology 2013 - 2015



- **Long Term Monitoring (EPS)**

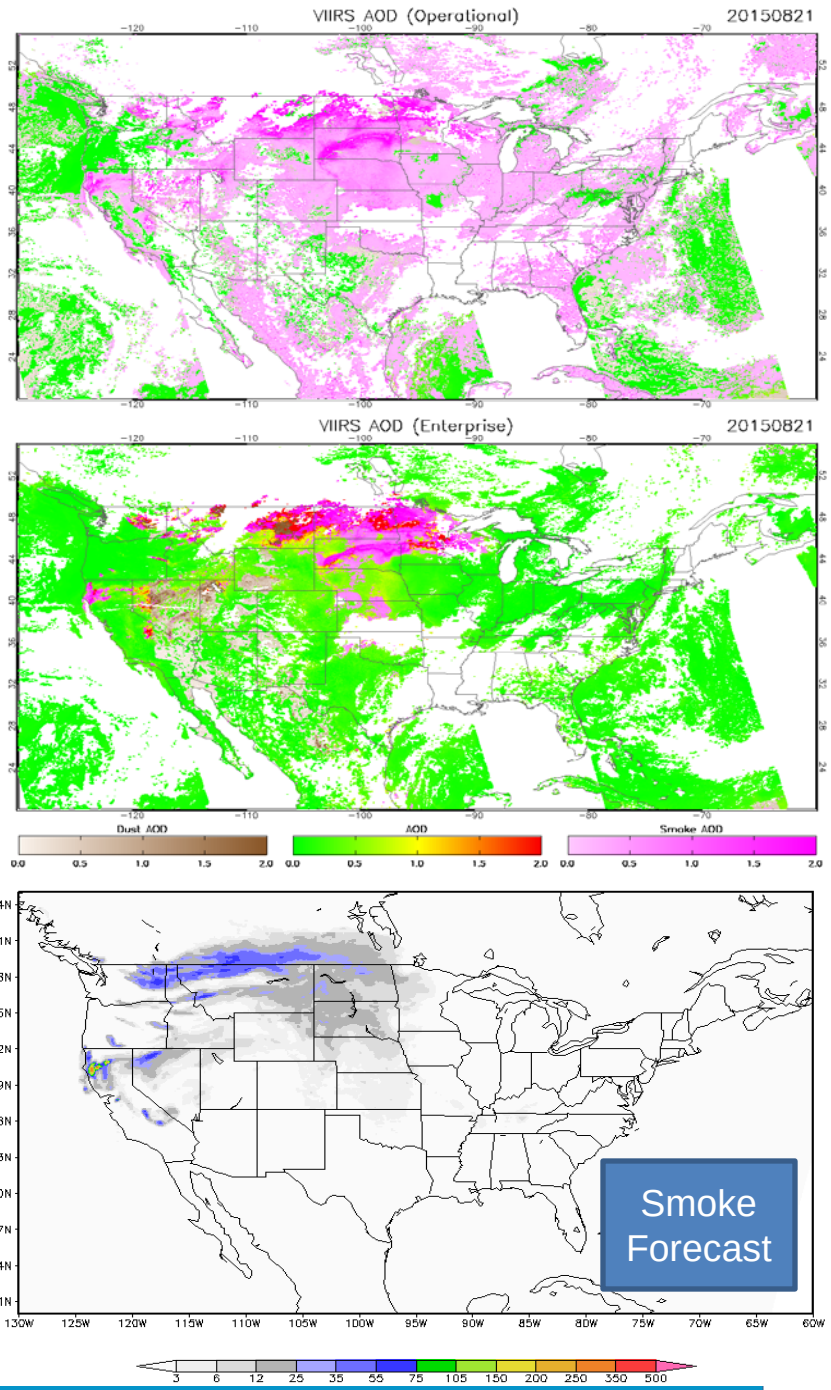


http://www.star.nesdis.noaa.gov/jpss/EDRs/products_aerosols.php *(select SM EPS)*
http://www.star.nesdis.noaa.gov/smcd/spb/aq/eidea/

- **Enterprise AD Algorithm Status:**
  - Algorithm is ready
  - Scheduled for implementation in NDE in summer 2016
- **Reprocessing:**
  - with EPS algorithm
  - 2015 completed; other years ongoing

User Feedback

- **Overall user feedback is positive.**
- ***NRL*:**
  - Data assimilation testing of EPS product is underway. Compared to MODIS it has reduced bias and includes high AOT. "*Much happier with this product*".
- ***NCEP:***
  - EPS AOT and smoke/dust products provide a unique opportunity for direct comparison between observed and modeled smoke and dust concentrations.
  - The high resolution, extension to bright-surface and to higher upper bound in EPS provide better areal coverage for comparison with model output.
- ***OAR:***
  - Implemented assimilation of VIIRS AOT in the Gridpoint Statistical Interpolation (GSI).
  - Developed assimilation of dust and smoke masks and indices to improve assimilation for dust storm and forest fire forecast.
  - Evaluated performance of assimilation of *VIIRS AOT and dust masks* during storms over Southwestern USA and over Northern Africa.
  - Currently evaluating performance of the assimilation of *VIIRS AOT and smoke products* for forecasting of smoke during summer 2016 using WRF-Chem. Upon completion, will consider assimilation of these products in r-t forecasting.



JPSS-1 Readiness

- Algorithm changes from S-NPP to JPSS-1
  - No major changes. Minor changes associated with thresholds for spatial/spectral tests and for surface reflectance ratios are expected and will be implemented.
- Post-Launch Cal/Val Plans
  - Comparisons to SNPP VIIRS, CALIPSO, CATS, MISR
  - Field campaign data as available
  - Beta: L+4m; Provisional: L+12m; Validated: L+16m
- Accomplishments and Highlights Moving Towards J1
  - EPS aerosol algorithms are ready for J1; codes and ATBDs delivered
- Major Risks/Issues/Challenges/ and Mitigation
  - No major risks or issues
- Collaboration with Stake Holders/User Agencies
  - Yearly meetings (e.g., with data assimilation scientists and air-quality forecasters) to provide updates on product status (next is in Sep 2016)

Summary & Path Forward

- EPS AOT and AD algorithms have been developed, tested with S-NPP data, and shown to meet/exceed requirements; algorithm software have been delivered.
- LTM capability has been developed.
- Reprocessing of S-NPP aerosol data with EPS algorithms has started.
- **Algorithm improvements**
  - *ADP*:
    - Account for surface contribution to TOA reflectances in computing absorbing aerosol index.
    - Introduce geometry and location dependent thresholds used in spectral tests.
    - Develop an approach to determine surface smoke and dust concentrations.
  - *AOT*:
    - Update spectral surface reflectance relationships to minimize seasonal and regional biases.
    - Examine causes of systematic error in spectral AOT; apply fix.
- **Path Forward**
  - Participate in J1 readiness reviews
  - Conduct cal/val work
  - Investigate instrument/product anomalies