# GOES-R ABI Aerosol Product Validation and Tools – An Update

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## 1. Abstract

The Advanced Baseline Imager (ABI) aerosol optical depth (AOD) retrievals from MODIS Aqua data using ABI cloud mask have been found to overestimate AOD in comparison with AERONET. A detailed analysis shows that such AOD overestimation results from the overestimation of reflectance used in the AOD retrieval, suggesting that the ABI cloud mask may not be sufficient for ABI aerosol retrieval. We show that the internal cloud checks developed for aerosol retrieval substantially improve the ABI AOD retrievals.

Visualization tools for ABI AOD validation have been developed. An IDL-based GUI and a web-based client-side on-line validation system have been developed for monitoring, routine and deep-dive validation of the AOD product .

The validation dataset over ocean has been expanded to include the Maritime AERONET Network (MAN) from 2004 to current. The "moving" AERONET stations on board various research cruises provide an unique opportunity for evaluating satellite retrieval over open ocean.

## 2. Improving Cloud Masking in ABI Aerosol Retrieval

### Validating One Month Framework Run for Aqua, 2006

- Framework run uses MODIS L1B reflectances at 1km resolution as proxy for ABI aerosol retrieval
- Other data used includes ABI cloud mask and MODIS geolocation data, water vapor and ozone
- NWP GFS data used for surface pressure, surface height, ocean surface wind speed/direction
- Retrievals are matched up with AERONET ground measurements in space and time
- Ground data are temporally averaged within 1-hour window around the MODIS overpass time and the MODIS data are spatially averaged in a 50x50 km box centered on the ground station
- Appropriate statistics are calculated and compared to F&PS for bias and precision

| | Land | | | | Water | | | |
|---|---|---|---|---|---|---|---|---|
| Range | AOD | Accuracy | Precision | # of points | AOD | Accuracy | Precision | # of points |
| Low | <0.04 | 0.08 (0.06) | 0.16 (0.13) | 100 | | | | |
| Medium | 0.04 - 0.8 | 0.03 (0.04) | 0.14 (0.25) | 733 | <0.4 | 0.09 (0.02) | 0.12(0.15) | 56 |
| High | > 0.8 | 0.05(0.12) | 0.19(0.35) | 6 | >0.4 | 0.05 (0.10) | 0.04 (0.23) | 3 |

**numbers in parenthesis are F&PS requirements**

**Framework AOD retrievals do no meet requirements everywhere (numbers in red)**

### Case Study for AOD Overestimation

- Aqua granule MYD20062181840 was selected with co-location with AERONET at station CCNY
- 1-km framework reflectances are processed the same way as that in the MODIS aerosol algorithm for gas correction, snow/ice mask, sediment mask, data selection procedure, but employing ABI cloud mask to generate the reflectance at 10km
- 10-km ABI framework reflectance > MYD04 product by 0.03 at 0.47 µm ⇨ the overestimation of 0.30 in ABI AOD compared to MYD04

**Case study suggested that the ABI cloud mask may not be sufficient for ABI aerosol retrieval.**

### Developed Internal Cloud Check for ABI Aerosol Algorihtm

- Follow MODIS aerosol algorithm strategy;
- Use available ABI channel and ABI cloud mask.

| |
|---|
| LAND |
| Channel 0.47 um reflectance threshold test |
| Channel 1.38 um reflectance threshold test |
| Channel 0.47 um reflectance standard deviation for a 3x3 array |
| Channel 1.38 um reflectance standard deviation for a 3x3 array |
| OCEAN |
| Channel 0.47 um reflectance threshold test |
| ABI Cloud Mask test RUT : Std of 0.65 um 3x3 pixel array / 0.65 um clear-sky reflectance with a threshold of 0.2 |
| ABI Cloud Mask test CIRREF: Channel 1.38 um reflectance for cirrus with a threshold of 5% |
| Dust call back 0.47/0.66 ratio |
| ABI Cloud Mask test PFMFT: Absolute Channel 11 and 12 um brightness temperature difference for cirrus cloud |
| ABI Cloud Mask test CIRH2O : Cirrus water vapor test using Channel 7.3 um |
| ABI Cloud Mask test RFMFT: BT (11- 12 um) / BT(11um) for cirrus cloud |

### Updated AOD Validation Results using Internal Cloud Checks

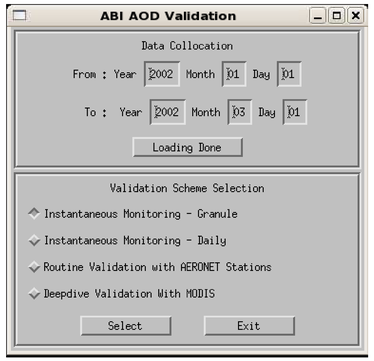
| | Land | | | | Water | | | |
|---|---|---|---|---|---|---|---|---|
| Range | AOD | Accuracy | Precision | # of points | AOD | Accuracy | Precision | # of points |
| Low | <0.04 | 0.04 (0.06) | 0.13 (0.13) | 93 | | | | |
| Medium | 0.04 - 0.8 | -0.002 (0.04) | 0.13 (0.25) | 696 | <0.4 | 0.01 (0.02) | 0.04 (0.15) | 54 |
| High | > 0.8 | -0.06 (0.12) | 0.15 (0.35) | 6 | >0.4 | 0.07 (0.10) | 0.06 (0.23) | 3 |

**AOD retrievals meet requirements**

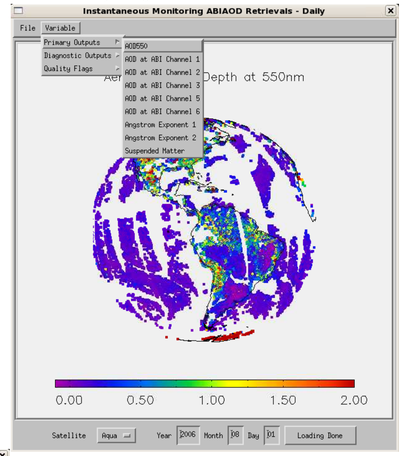
## 3. Visualization of Validation Tools

### IDL-based Graphical User Interfaces (GUI)

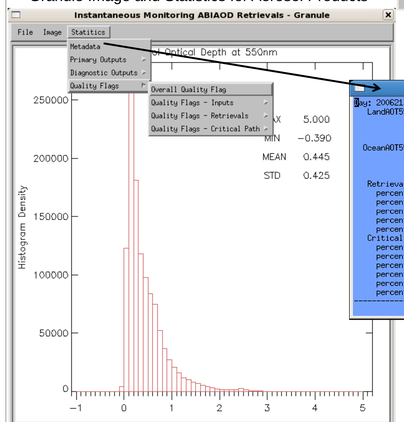
Main Menu



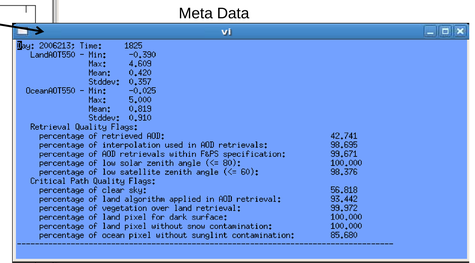

Daily Image for Aerosol Products



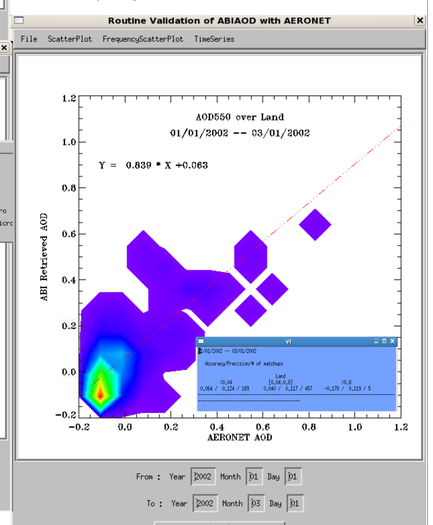

Granule Image and Statistics for Aerosol Products

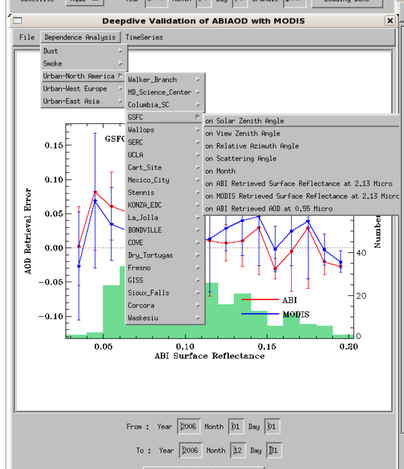



Meta Data



Routine Validation with AERONET for Scatter Plot, Frequency Scatter Plot and Time Series

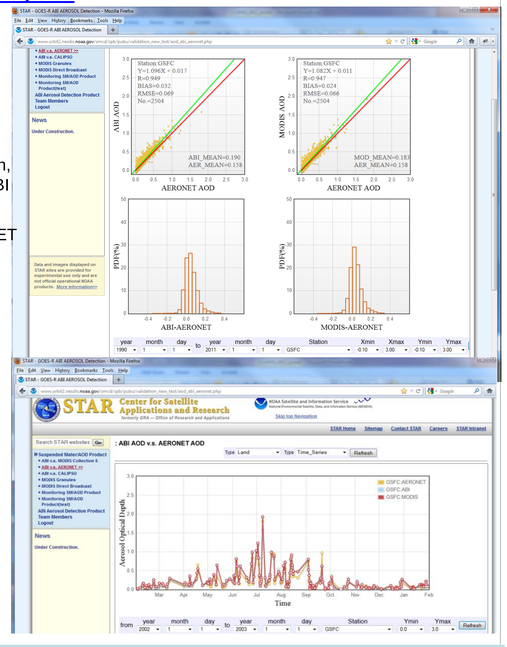



Deep-dive Validation with MODIS at AERONET Stations for Dependence Analysis and Time Series

### Web-based Client-side On-line System

- Monitoring
  - Time series of daily global mean, bias and standard deviation of ABI AOD compared to MODIS;
- Validating ABI AOD with AERONET
  - Scatter plot
  - Histogram and statistics
  - Time series
  - Dependence of AOD bias on various (input) parameters

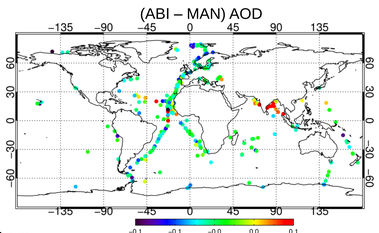


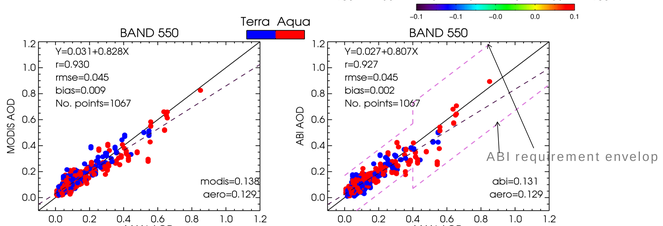

## 4. Expanding Validation Dataset to Include MAN

- Traditional AERONET observations over ocean are usually located on islands and in coastal regions.
- Maritime AERONET Network (MAN), a "moving" AERONET station on board various research cruises, provides an unique opportunity for evaluating satellite retrieval over open ocean.
- MAN data from 2004 to current have been processed; ABI/MODIS AODs are spatially and temporally matched with MAN observations.

The figure on right shows ABI AOD is generally able to capture the geographic distribution of MAN AOD.

Scatter plot of ABI AOD vs. MAN AOD shows a good agreement between ABI and MAN, and is comparable with MODIS products.




## 5. Summary

- The proposed internal cloud checks have been applied to ABI aerosol algorithm for one month run from MODIS Aqua data in August 2006. The result shows that the AOD product can meet the F&PS requirements when the internal cloud checks are used.
- Visualization of validation tool results have been improved with an IDL-based GUI and a web-based client-side on-line system.
- The comparison with MAN indicates that ABI-retrieved AOD over ocean is comparable with that from MODIS retrieval, and also agree well with MAN AOD.