# GOES-R AWG Product Validation Tool Development

## *Aerosol Optical Depth/Suspended Matter and Aerosol Particle Size*

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# OUTLINE

- Products
- Validation Strategies
- Routine Validation Tools
- “Deep-Dive” Validation Tools
- Ideas for the Further Enhancement and Utility of Validation Tools
- Summary

# Products

- Aerosol Optical Depth (AOD) / Suspended Matter (SM)
- Aerosol Particle Size (APS)
  - Angstrom Exponent is reported
- at 2 km every 15 minutes for CONUS and FD

# Monitoring & Validation Background

- Functions of tools:
  - routine monitoring (may not need reference data)
  - routine validation (reference data, matchup procedure)
  - deep-dive validation (reference data, other correlative data, matchup)
- Basic elements:
  - data acquisition (ABI, ground, other sat products)
  - spatial and temporal matching
  - analysis (computing statistics)
  - present results (display maps, scatter plots)
- Reference data:
  - ground: Level 2.0 aerosol products from AERONET
  - independent satellite data: standard aerosol products from MODIS

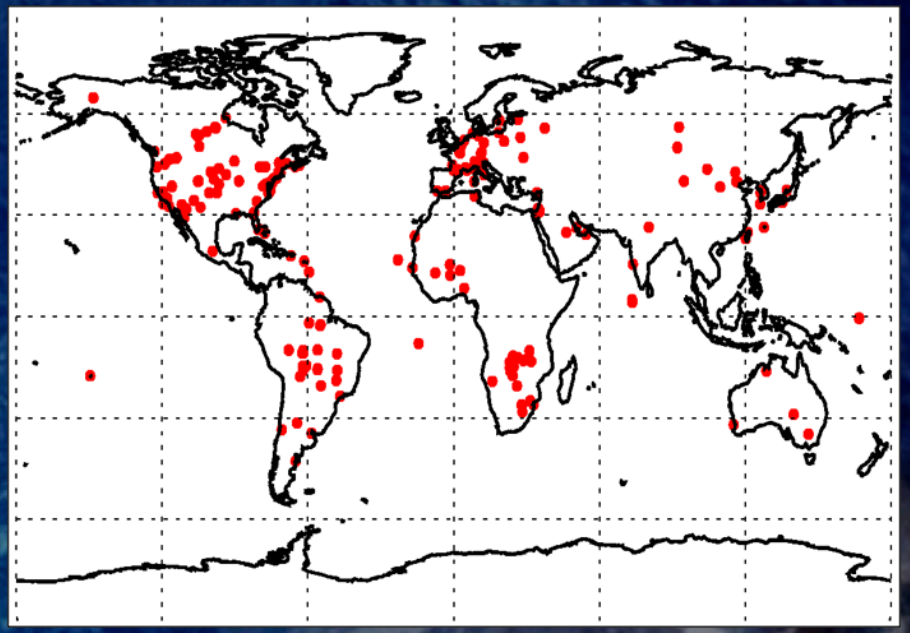
# "Routine" Validation Strategy

- **Spatial and temporal match-up with ground "truth" AERONET**
  - ground data are temporally averaged within a 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
- **Quality control comparison data set**
  - AERONET uses level 2 quality assured product (no additional QC)
    - Interpolating AERONET AOD to 550nm on logarithm scale
  - Good ABI retrievals indicated by the overall quality flag
    - Temporary measures until ABI clear mask is not available:
      - Highest 50% and lowest 20% of ABI retrieved AODs in 50x50-km boxes are filtered out
      - Spatial variability test on ABI AOD for screening out possible cloud contamination
- **Appropriate statistics (bias, std) are calculated and compared to F&PS**

# Primary Reference Data

- **AERONET aerosol product**
  - The ground-based AERONET remote sensing network provides a comprehensive dataset of aerosol properties and has been widely used for evaluating satellite retrievals and model simulations in the aerosol community.
  - All-Points AERONET Level 2.0 AOD data can be downloaded at the website http://aeronet.gsfc.nasa.gov/cgi-bin/combined_data_access_new. The ground measurements are at 15 minutes temporal resolution.

***AERONET Stations***



# More Reference Data

- **MODIS aerosol product**
  - AOD, Ångström Exponent, fine-mode weight over ocean, surface reflectance over land, aerosol type over land from MODIS collection 5 aerosol products that can be downloaded from ftp://ladsweb.nascom.nasa.gov/allData/5/.
  - Current state of the art, extensively validated product.
  - Large variety of atmospheric and surface conditions.
- **CALIPSO**
  - AOD and aerosol type from CALIPSO Lidar Level 2 5 km aerosol layer data at http://eosweb.larc.nasa.gov/cgi-bin/searchTool.cgi?Dataset=CAL_LID_L2_05kmALay-Prov-V3-01
  - Provide aerosol model profile
- **MAPSS**
  - A Multi-sensor Aerosol Products Sampling System in development at http://disc.sci.gsfc.nasa.gov/aerosols/services/mapss/mapssdoc.html#caliop
  - Provides co-located MODIS-AERONET, CALIPSO-AERONET, and MISR-AERONET data

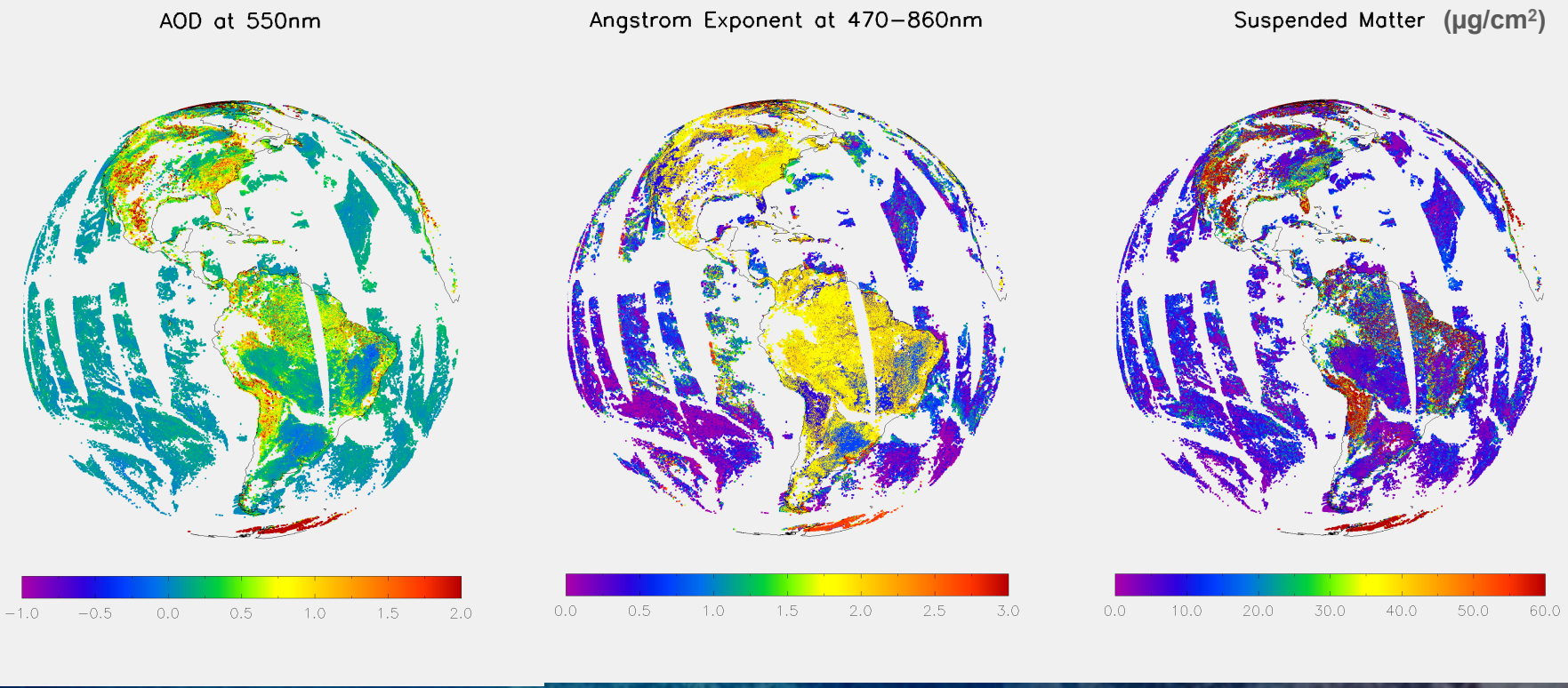
09/2007

# "Routine" Tools

- Monitor operational Level-2 aerosol products
  - Displays images of product and quality flags
  - Plots histograms for specified granules
- Collocate aerosol products with the reference ("truth") observations
- Compare with ground truth
  - Time series for collocated AERONET stations
  - Frequency scatter-plot and linear regression
  - Statistics for comparison with F&PS requirements
- IDL is used for visualization and calculation of statistics

# “Routine” Tools (1)

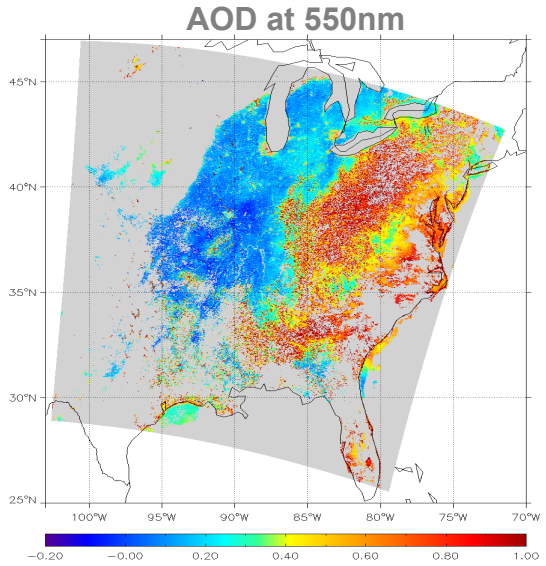
***Example of Product Displays of GOES-east region for Aqua Day 2006213 from framework output***

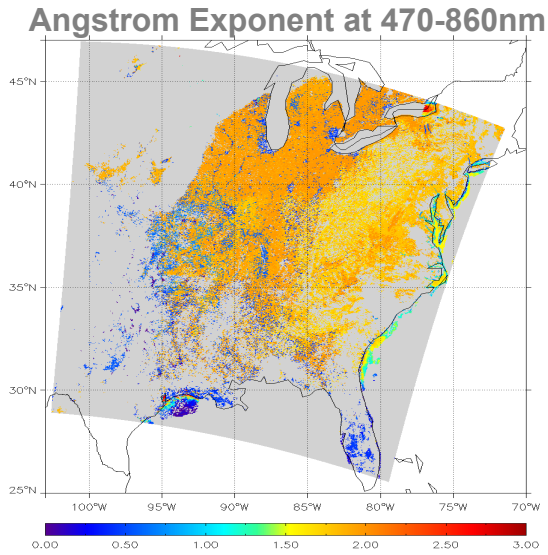


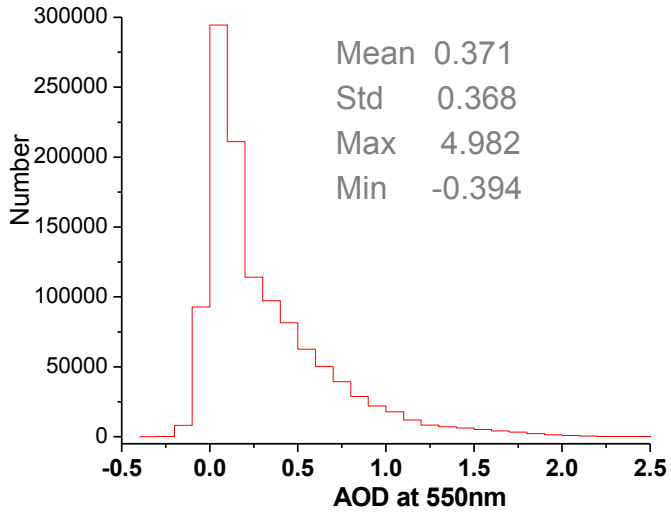
# "Routine" Tools (2)

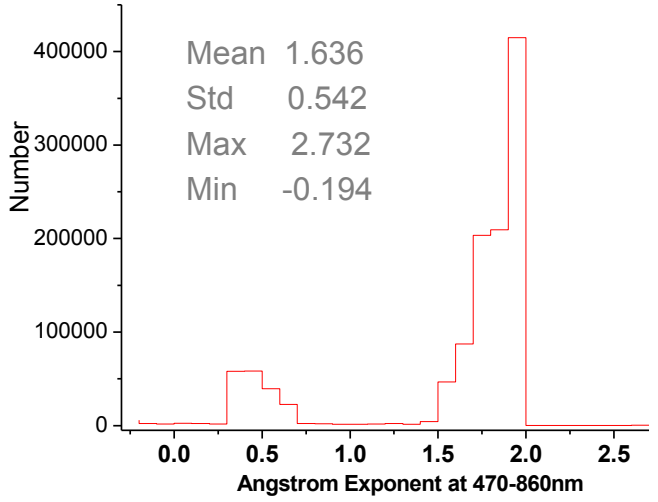
## *Granule Display*

***Terra granule 2006213_1645 from framework output***



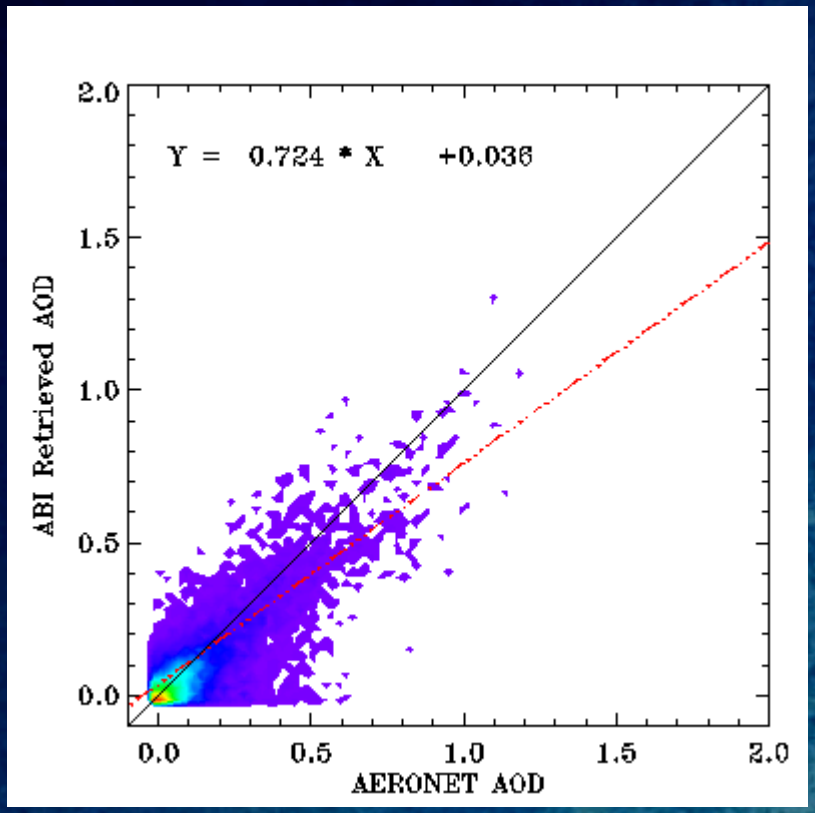



# "Routine" Tools (3)

*Example of frequency scatter-plot and the calculated statistics in comparison with requirements (in red) using co-located AERONET-MODIS data set for year 2006*




*Accuracy/Precision/# of matchups*

| | Land | |
|---|---|---|
| *<0.04* | *[0.04,0.8]* | *>0.8* |
| *-0.06 / 0.05 /3633* | *0.04 / 0.12 /15800* | *0 .17 / 0.34 /567* |
| *0.06 / 0.13* | *0.04 / 0.25* | *0.12/ 0.35* |

# "Routine" Tools (4) – GUI

http://www.orbit2.nesdis.noaa.gov/smcd/spb/pubu/validation_new/aod_abi_aeronet.p

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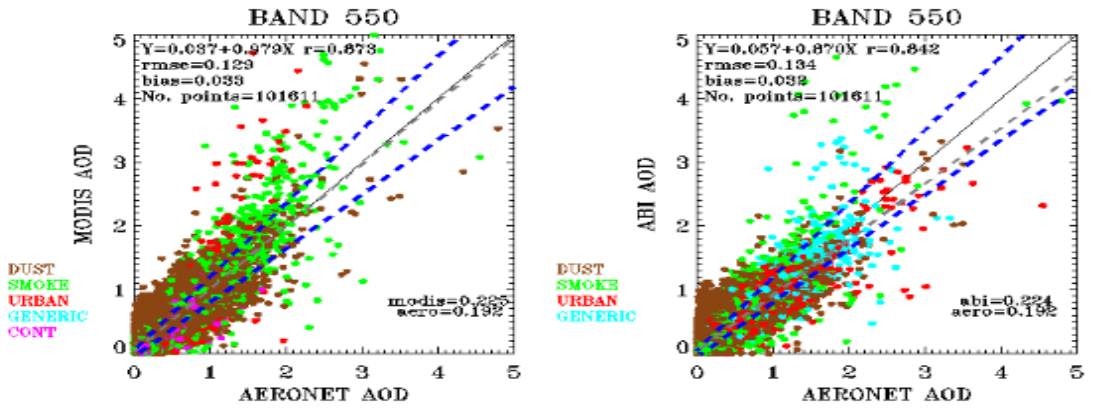
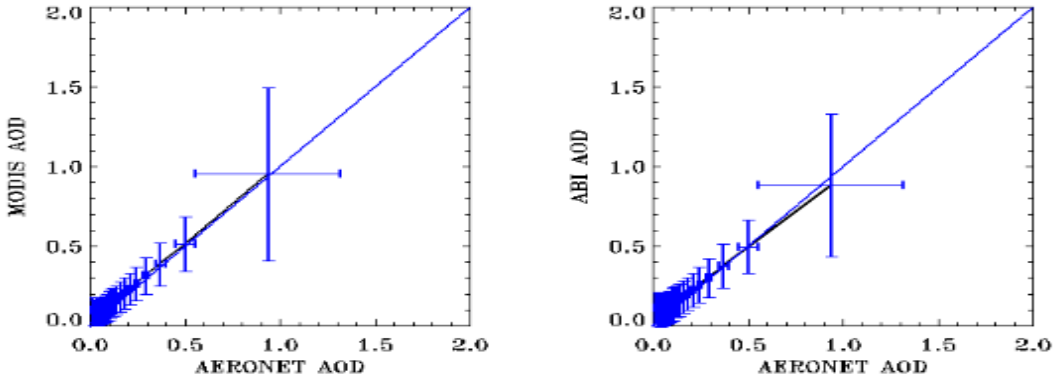
**: ABI AOD v.s. AERONET AOD**

Type: Land (--surface type-- / Land / Water) Location: Global (—Location— / Global / Goese / Goesw / Conus) Season: All (—Season— / All / Spring / Summer / Autumn / Winter) Parameter: AOD (—Parameter— / AOD / FMW) Refresh

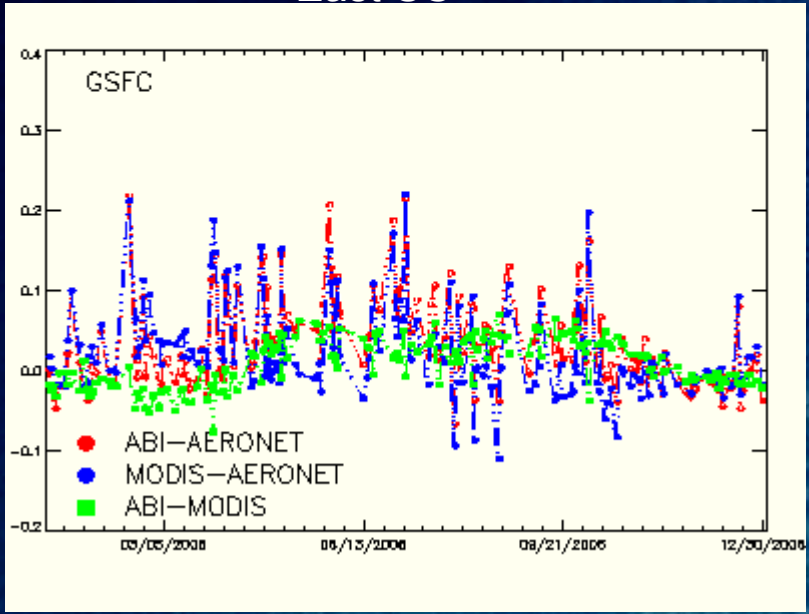


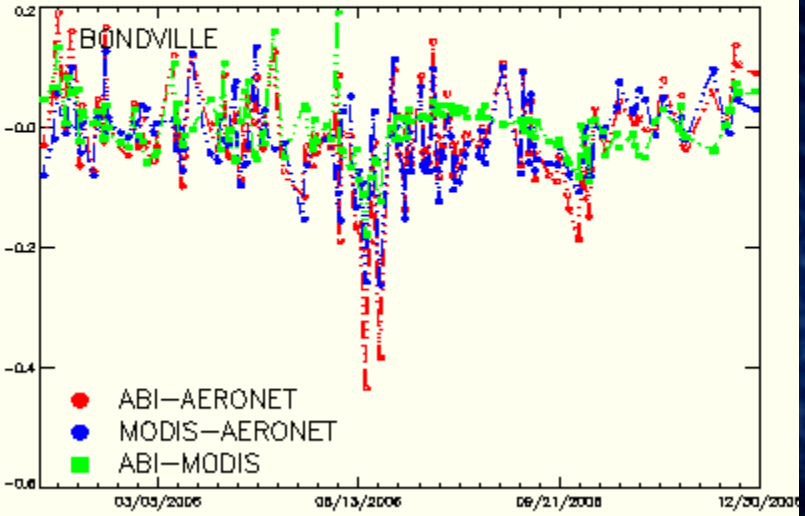



# “Routine” Tools (5)

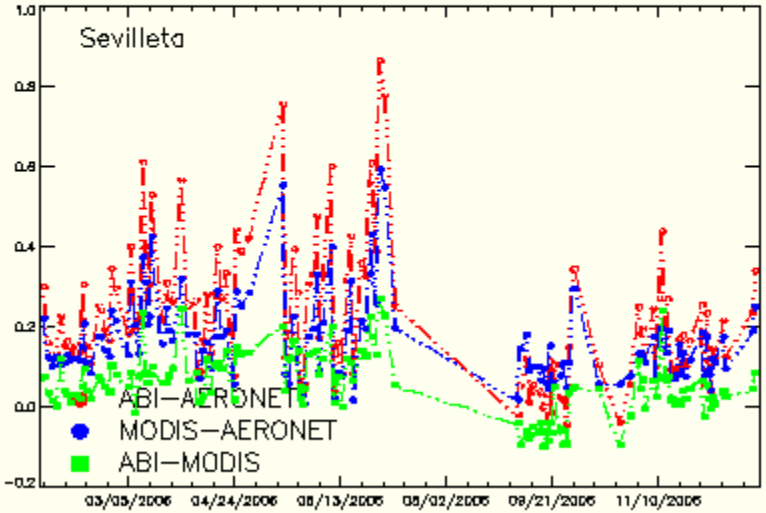
***Time series of retrieval error***

East US




West US



# Deep-Dive Tool

# "Deep-dive" Validation Strategy

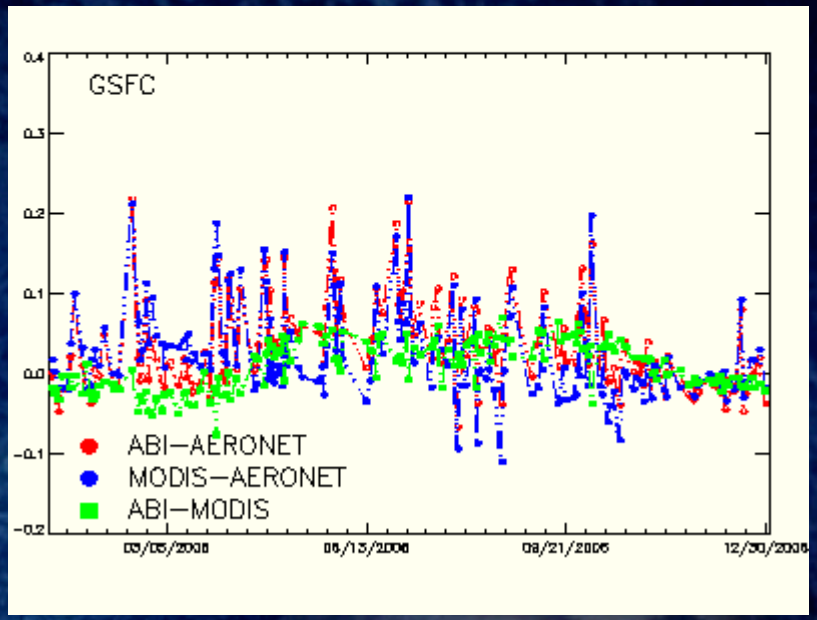
- ABI retrievals are co-located with reference data in space and time
- Expanded comparison data set to include input / diagnostic / intermediate parameters in addition to aerosol product, such as
  - Surface reflectance and aerosol type over land from MODIS
  - Quality flag of aerosol product from MODIS
  - Aerosol model profile from CALIPSO
- Detailed analysis, for example, dependence of aerosol products on input, correlation with diagnostic / intermediate parameters
- Analysis of deep-dive validation results in re-processing
  - To check proposed solution fixes the problem

# "Deep-Dive" Tools

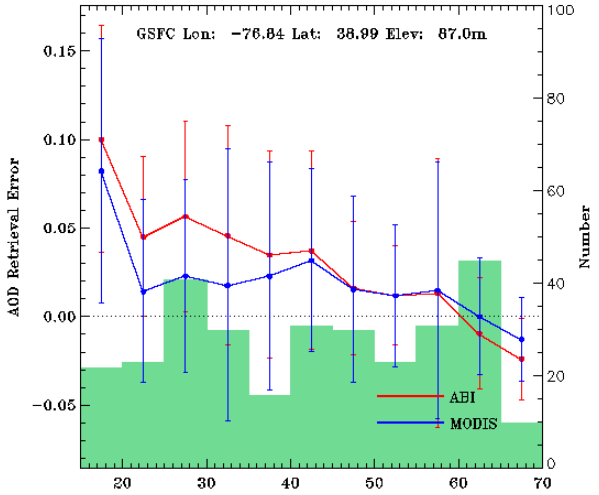
- Assumes access to all ancillary and intermediate data used to generate the product; and performs detailed analysis of the retrieval error dependence on various parameters:
  - Geometry: solar zenith angle, satellite zenith angle, scattering angle and relative azimuth;
  - Ancillary input: water vapor, ozone, ocean surface wind speed / direction
  - Intermediate data: surface reflectance, aerosol type
  - Quality flags such as cloud masks, land surface type, snow/ice mask
  - Season
  - AOD
- Display input, intermediate and/or diagnostic data (not shown)
- IDL is used for visualization and calculation of statistics

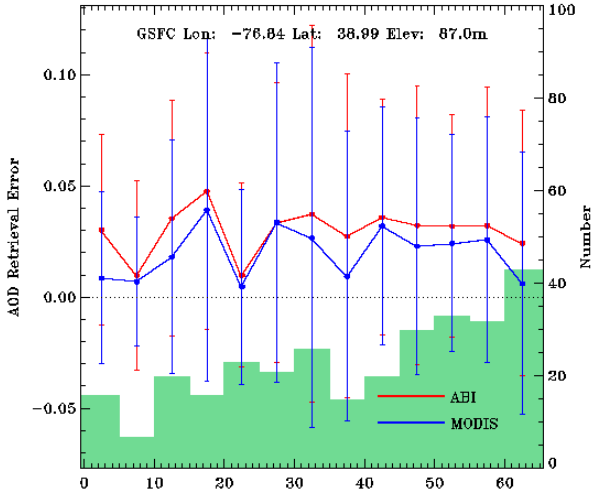
# What Triggers "Deep-Dive"?

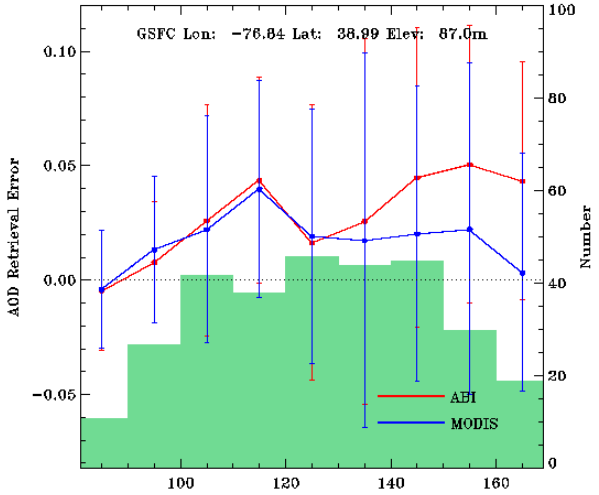
- When consistent over- or under-estimation over a prescribed threshold is observed at a station "deep-dive" assessment is triggered
- Analysis of the retrieval error dependence on various parameters (geometry, ancillary input, intermediate data, quality flags, season, and AOD) is conducted to identify problems
- When problem is identified, say due to incorrect input of satellite zenith angle, the offline-algorithm is re-run and the time series is re-plotted.

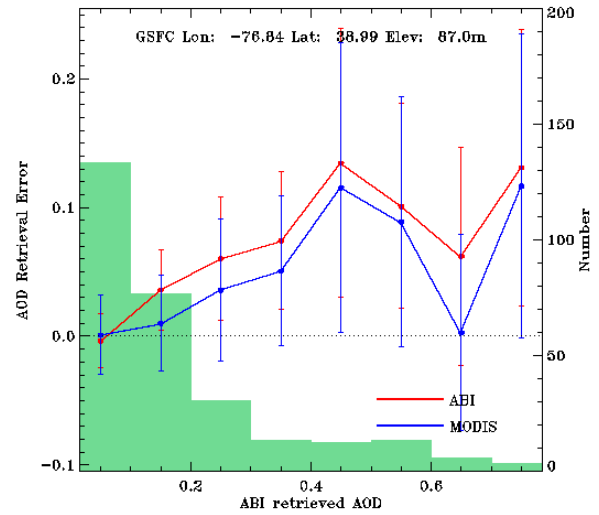


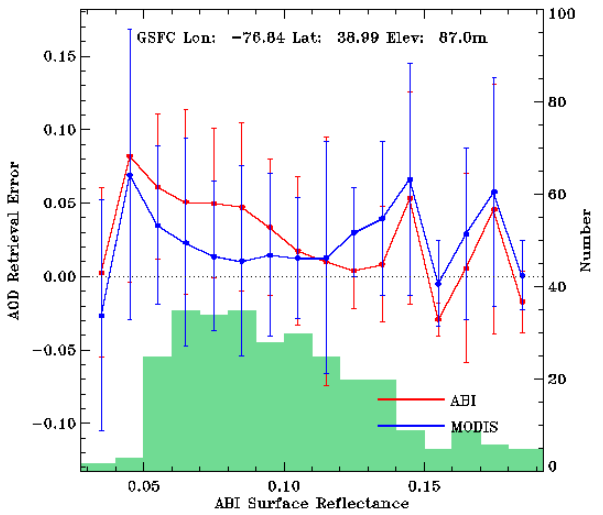
# "Deep-Dive" Tools - Dependence on Angle, etc.

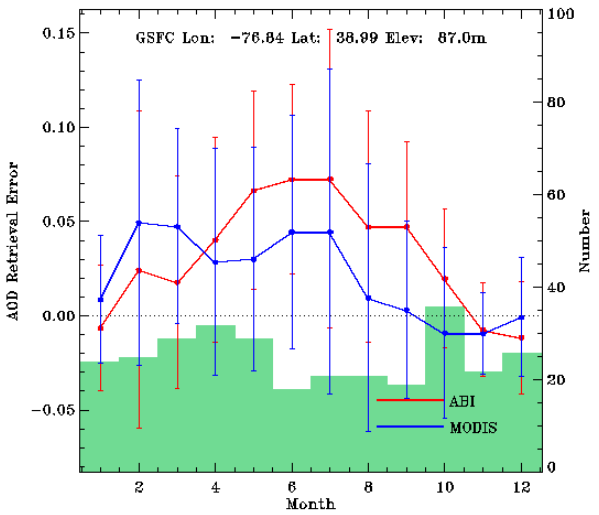


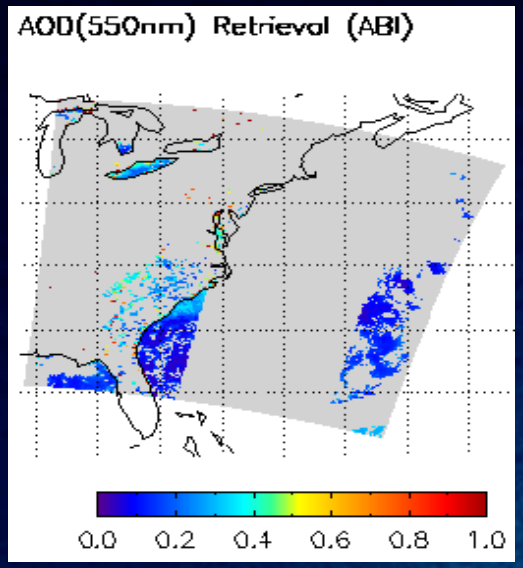



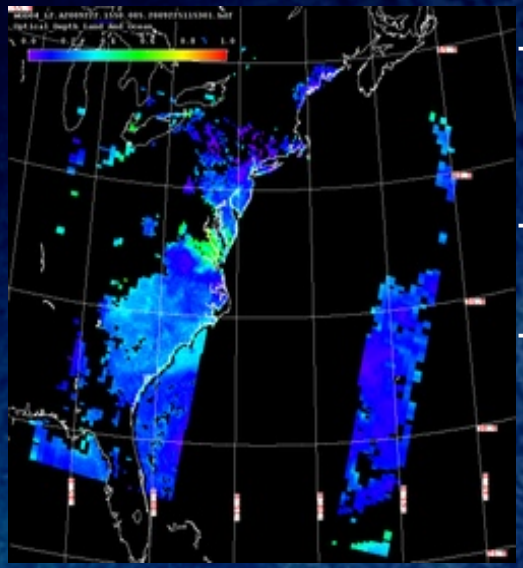



# Example use of "Deep-Dive" Tools

ABI retrieval

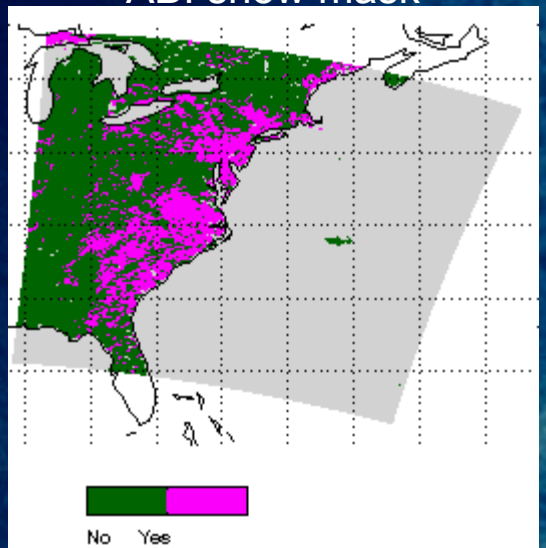



MODIS retrieval



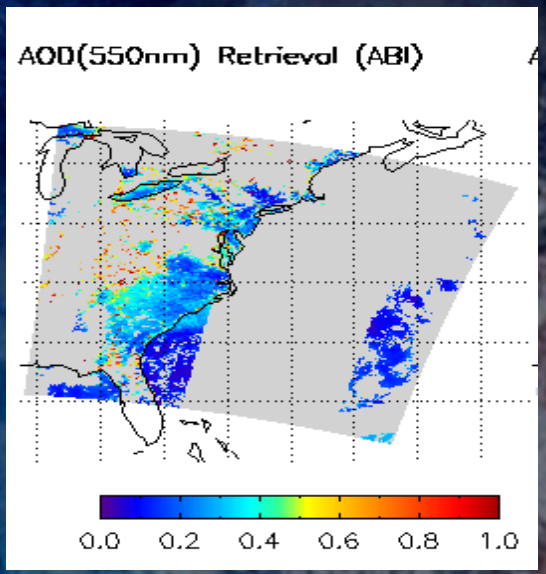
- ABI image vs. MODIS image has much less valid retrievals;
- Plotting of inputs suggests it is due to bad snow mask
- Correct snow mask and reprocess this granule

ABI snow mask




Correct ABI snow mask

Reprocessed ABI retrieval



# “Deep-dive” Tools - GUI

http://www.orbit2.nesdis.noaa.gov/smcd/spb/pubu/validation_new/aod_abi_calipso.p

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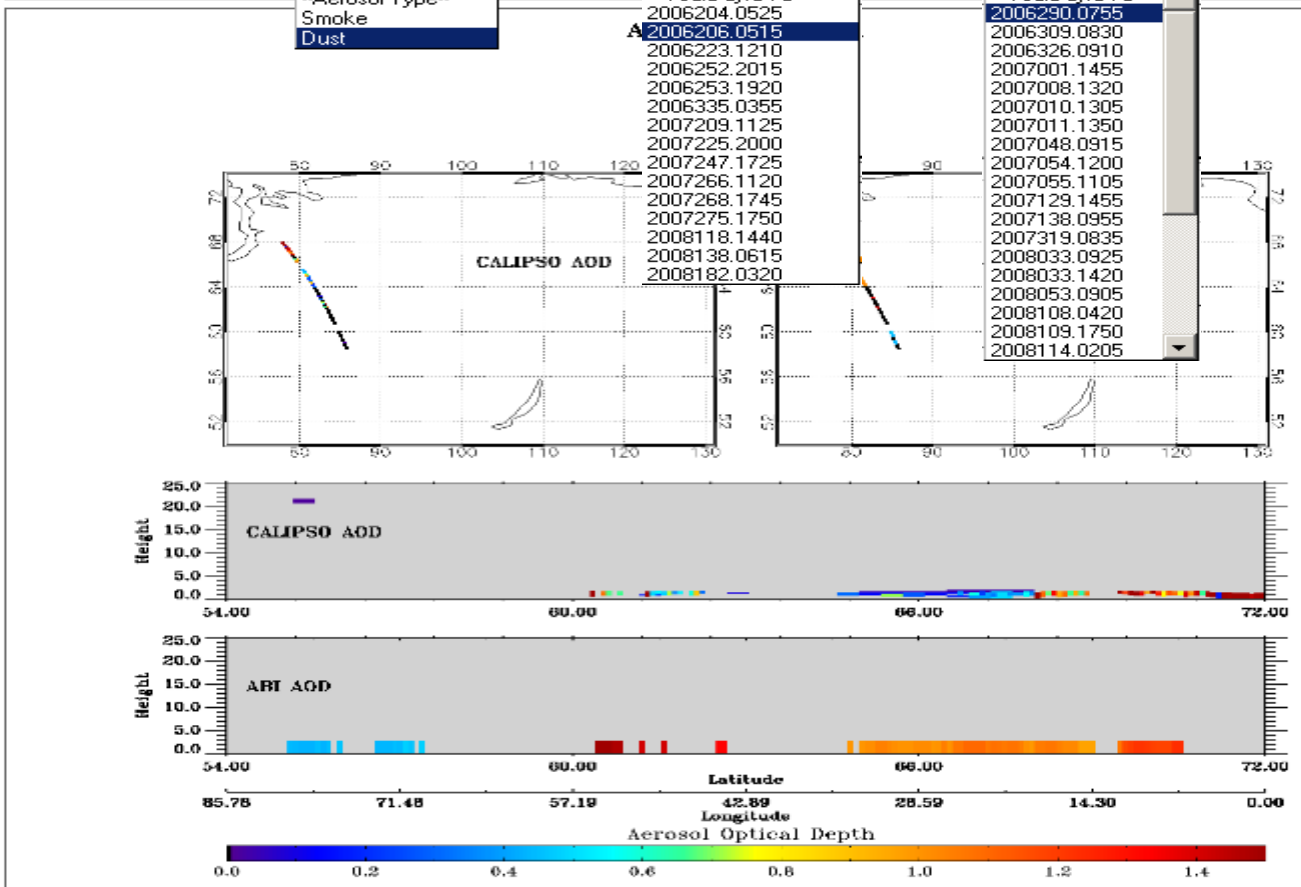
: ABI AOD v.s. CALIPSO AOD

Aerosol Type: Smoke (--Aerosol Type-- / Smoke / Dust)
Smoke cases: 2006204.0525 (-- YearDay.UTC --; 2006204.0525; 2006206.0515; 2006223.1210; 2006252.2015; 2006253.1920; 2006335.0355; 2007209.1125; 2007225.2000; 2007247.1725; 2007266.1120; 2007268.1745; 2007275.1750; 2008118.1440; 2008138.0615; 2008182.0320)
Dust cases: 2006290.0755 (-- YearDay.UTC --; 2006290.0755; 2006309.0830; 2006326.0910; 2007001.1455; 2007008.1320; 2007010.1305; 2007011.1350; 2007048.0915; 2007054.1200; 2007055.1105; 2007129.1455; 2007138.0955; 2007319.0835; 2008033.0925; 2008033.1420; 2008053.0905; 2008108.0420; 2008109.1750; 2008114.0205)
Refresh



# Ideas for the Further Enhancement and Utility of Validation Tools

- Calculate and display
  - additional statistics
  - temporal averages on different scales (daily, weekly, monthly)
- Identify signatures by which even non-experts can identify potential problems – needed for routine operational monitoring
- Implement automatic detection of possible systematic drift or continuous abnormal retrieval in routine validation.
  - establish “reference” (expected) statistics from good data
  - compare time series of actual statistics with reference stats
  - trigger action (e.g., sending warning email) when actual stats exceed reference stats + x std.
- Uniform (common) web interface for all ABI products.

# Summary

- Current tools perform three functions:
  - routine monitoring of product
  - routine validation with reference data
  - deep-dive validation with reference and intermediate data
- Validation truth data have been identified and processed
- Planned enhancements include:
  - more stats
  - automatic detection of problems