TEMPO Aerosols

Need for TEMPO-ABI Synergy

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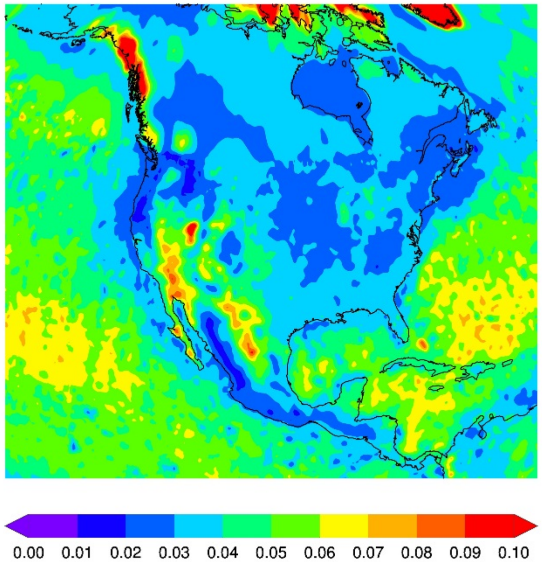
Use of near UV Satellite Observations for retrieving aerosol properties over land

Observations in the 340-400 nm range can be used to derive aerosol properties.

Advantages:
- Low surface albedo at all terrestrial surfaces
- (.01 to .03 for vegetation; .08 - .12 deserts)
- Sensitivity to aerosol absorption.
- Negligible gas absorption interference.



July, Surface Albedo

Disadvantages:
- Aerosol absorption detection is aerosol layer height sensitive.

Historically, near UV measurements have been associated with coarse spatial resolution sensors (TOMS, OMI) primarily designed for trace gas retrieval.

Although TEMPO’s 2.1x4.7 km resolution is unprecedented for hyper-spectral near UV sensors, it is still too coarse for accurate aerosol retrieval.

The associated sub-pixel cloud contamination (SCC) results in low yield and low accuracy of AOD retrievals.

From OMI to TEMPO

	OMI	TEMPO
Nadir Native Resolution	13X24 km	2.1x4.7 km
Cloud Masking Approach	Single pixel thresholds	Spatial homogeneity (8 pixels)
Nadir Product Resolution	13X24 km	8.4X9.4 km
Aerosol Typing	UVAI, CO (AIRS)	UVAI, CO {CrIS (S-NPP, JPSS-1)} CO (GeoCARB) ? CH2O (TEMPO) ?
Resolution Surface Albedo climatology	0.25°x 0.25° (~ 25 km)	GOSAT Cloud Aerosol Imager ?
Aerosol Layer Height (dust / smoke)	1.0°x 1.0° (CALIOP-based)	?

Aerosol typing and surface albedo characterization must be adapted to meet TEMPO's requirements.

Advanced Baseline Imager

ABI channels:

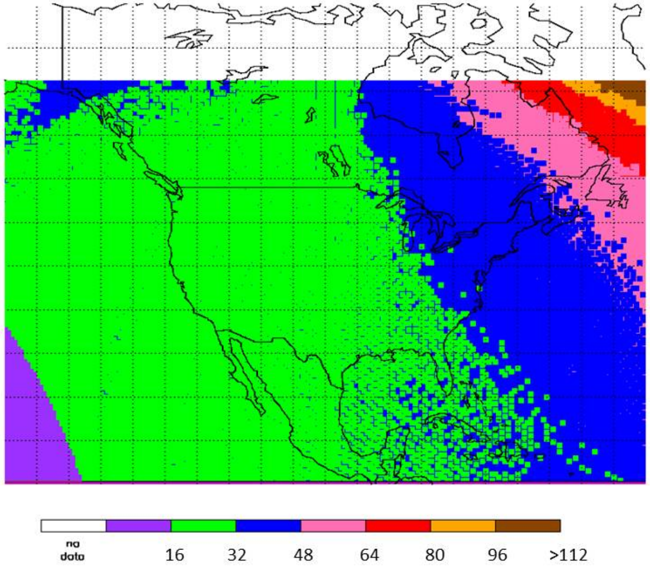
- Visible: 0.47, 0.64 μm
- Near IR: 0.86, 1.37, 1.6 μm
- SWIR/Thermal IR: 2.2, 3.9, 6.2, 6.9, 7.3, 8.4, 9.6, 10.3, 11.2,12.3, 13.3 μm

Spatial Resolution
0.47 μm 1.0 km
0.64 μm 0.5 km
> 2.0 μm 2.0 km

Spatial Coverage

Full Disk: 4 per hour
CONUS: 12 per hour

Satellite: GOES-16 / 17
Launch dates: November 19, 2016
March 1, 2018



Number of GOES-16 (75°W) 0.64 μm pixels per TEMPO pixel

ABI's much higher spatial resolution measurements allow the application of spatial homogeneity and spectral techniques for cloud masking.

Availability of SWIR and thermal IR channels may contribute to aerosol type determination.

Using TEMPO and ABI observations

Scenarios	AOD Yield	SCC	Absorption	AAE/ZAE
1. TEMPO	Low	High	Yes	No
2. ABI	High	Low	No	No
3. TEMPO+ABI cm	Low	Low	Yes	No
4. TEMPO+ABI cm + ABI AOD	High	Low	Yes	Yes

1. Use TEMPO near UV algorithm to retrieve AOD and SSA from near UV observations

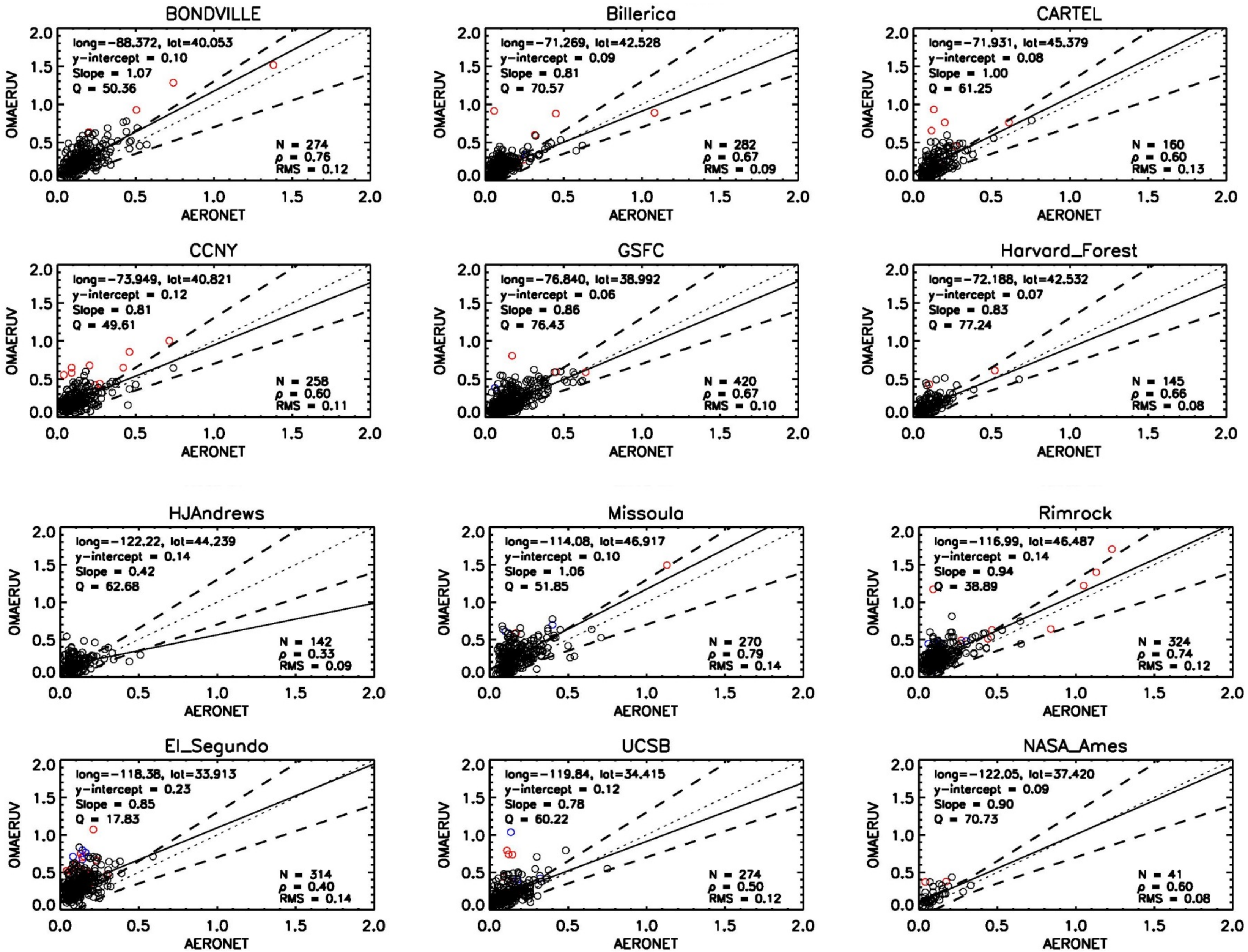
2. Use ABI observations to retrieve AOD from VIS-near IR measurements.

3. Use collocated TEMPO ABI to retrieve AOD and SSA from near UV observations using ABI cloud mask

4. Use collocated TEMPO -ABI observations to retrieve AOD from visible observations and SSA and either Absorption Angstrom Exponent (AAE) or aerosol layer height (ZAE) from near UV observations

Scenario 1

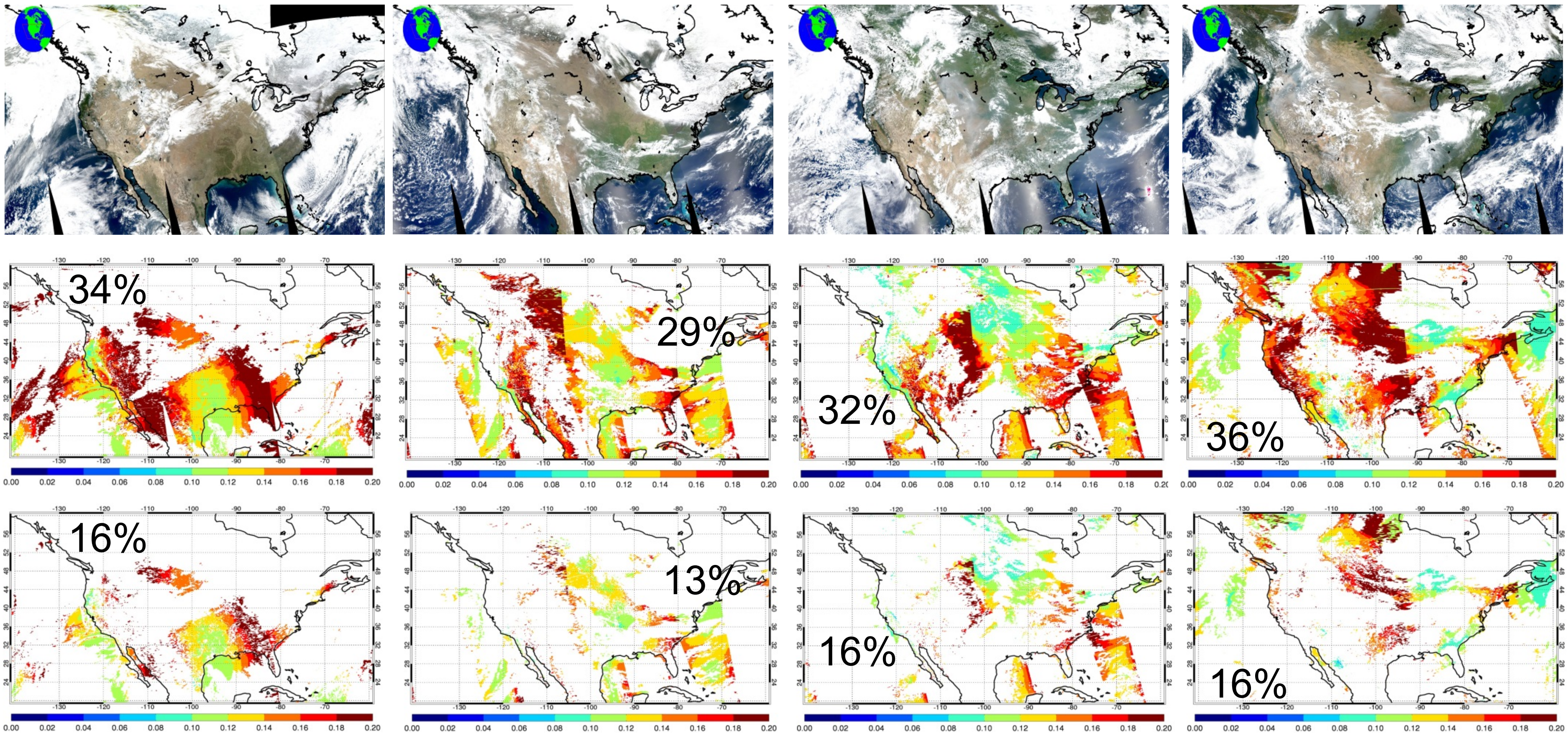
OMI AOD Validation/USA sites



Scenario 2

Improved Cloud Masking Analysis

Jan 3, 2012 | Apr 10, 2012 | Jul 1, 2012 | Sept 25, 2012



At the TEMPO resolution the number of retrieval opportunities reduces by 50% in relation to a MODIS-like sensor.

Retrieving AOD from ABI observations

(scenario 3)

-High spatial resolution visible/near IR observations from the Advanced Base Imager (ABI) on NOAA's GOES R and S satellites can be used to generate land AOD product.

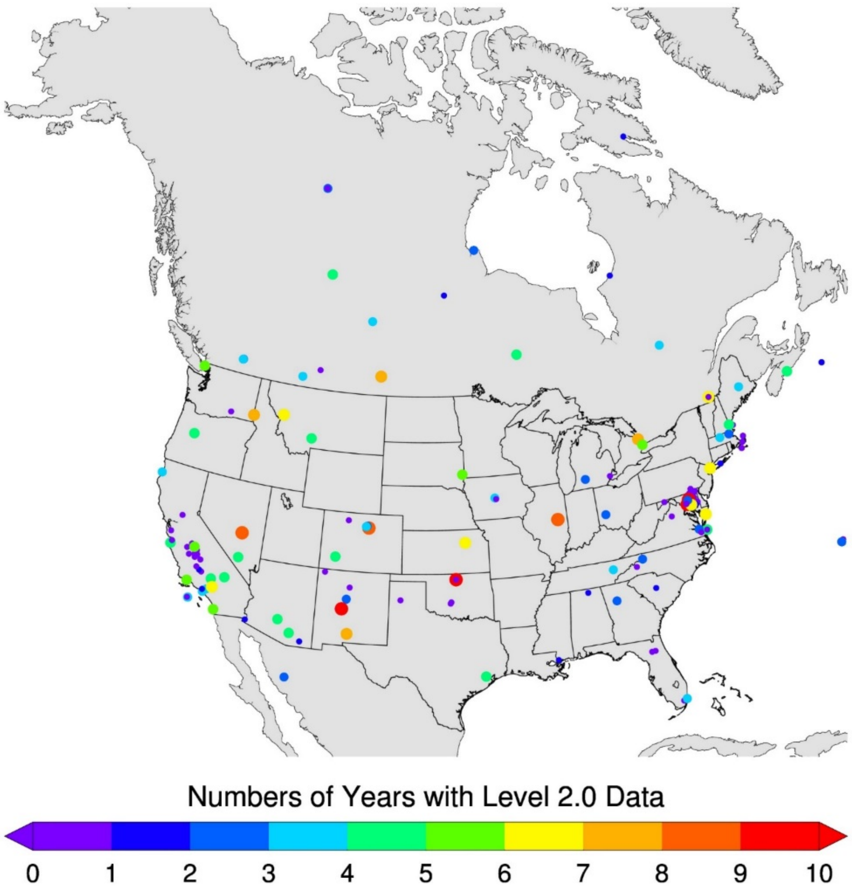
-ABI's multi-spectral capability is similar to that of the EOS-MODIS (Terra and Aqua) sensors.

-Three land AOD algorithms are currently applied to Aqua-MODIS observations: Dark Target (DT), Deep Blue (DB), and Multi-Angle Implementation of Atmospheric Correction (MAIAC).

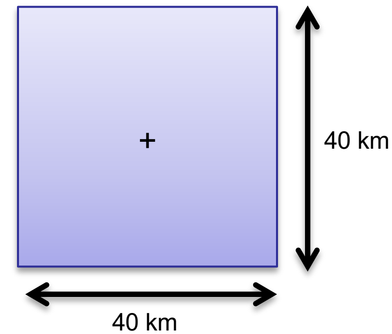
-The performance of each algorithm was evaluated using AERONET's measurements over the continental United States over 15 years.

Ground-Satellite Collocation criteria

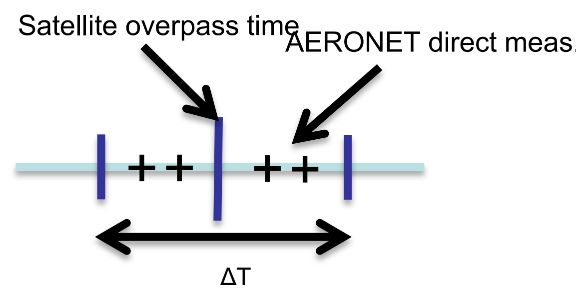
Geographical Distribution of AERONET Sites over North America



Spatio-Temporal Approach



N_{min}=160 ΔT =±30 mins.

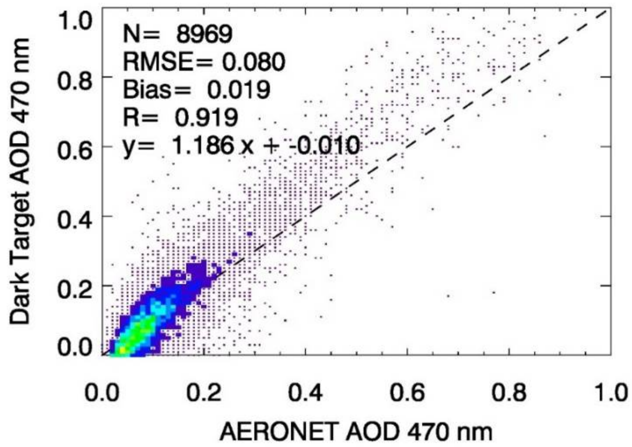


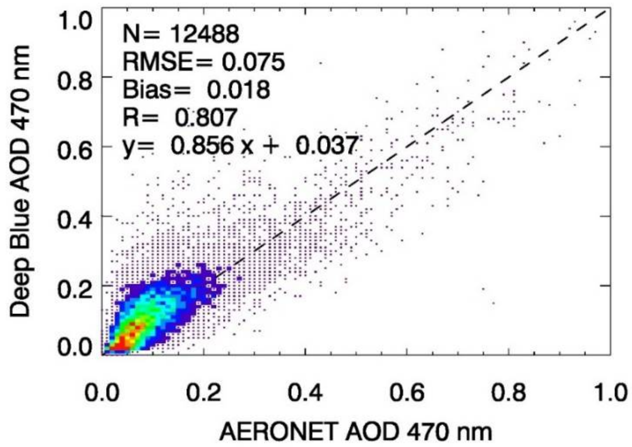
Only best quality satellite AOD retrievals are considered in this analysis.

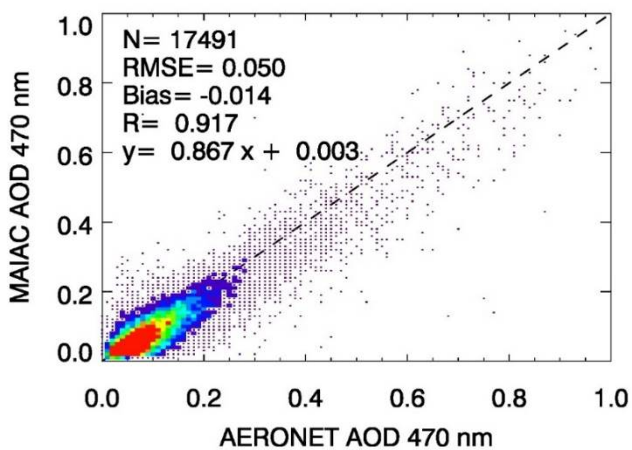
Eastern N.A. Composite

Independent comparison

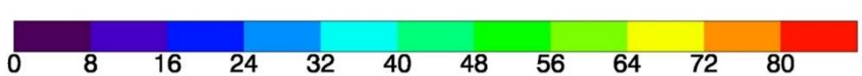
eUS 0.4x0.4_30min





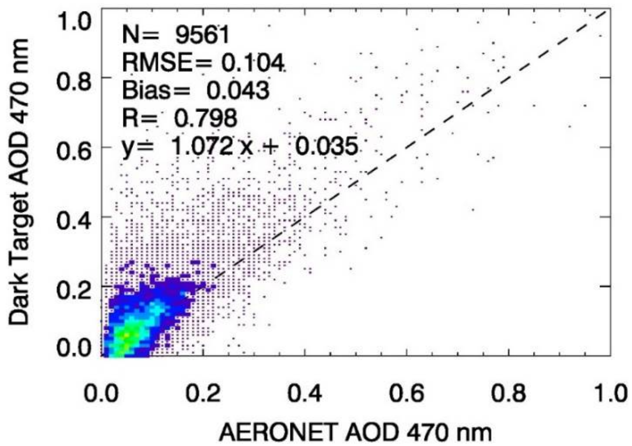


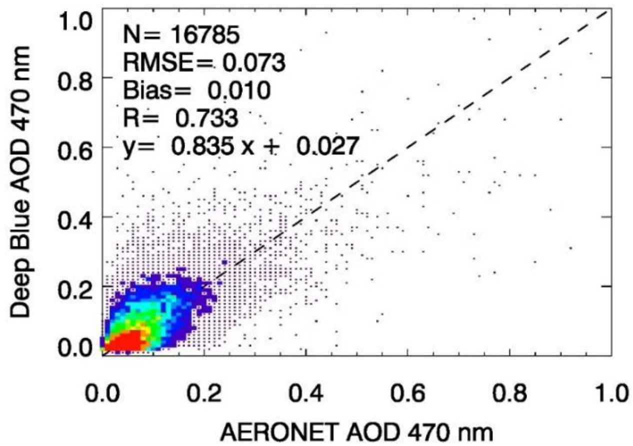
	DT	DB	MAIAC
N	8969	12488	17491
Corr.	0.919	0.807	0.917
Slope	1.186	0.856	0.867
Y-int	-0.010	0.037	0.003
RMSE	0.080	0.075	0.050
Bias	0.019	0.018	-0.014

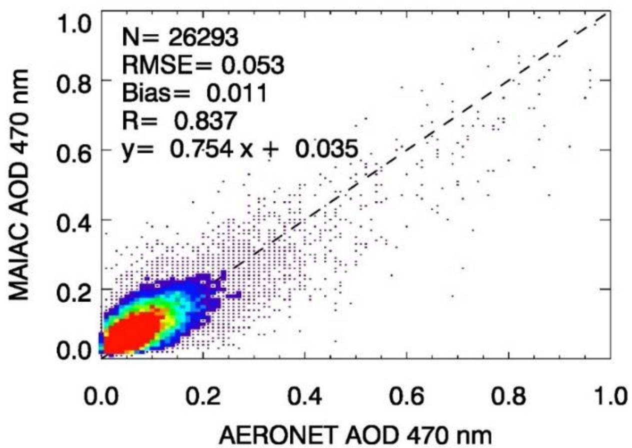


Western N.A. Composite

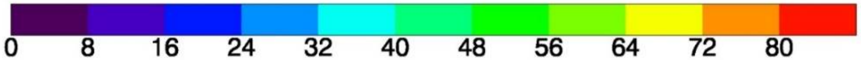
wUS 0.4x0.4_30min



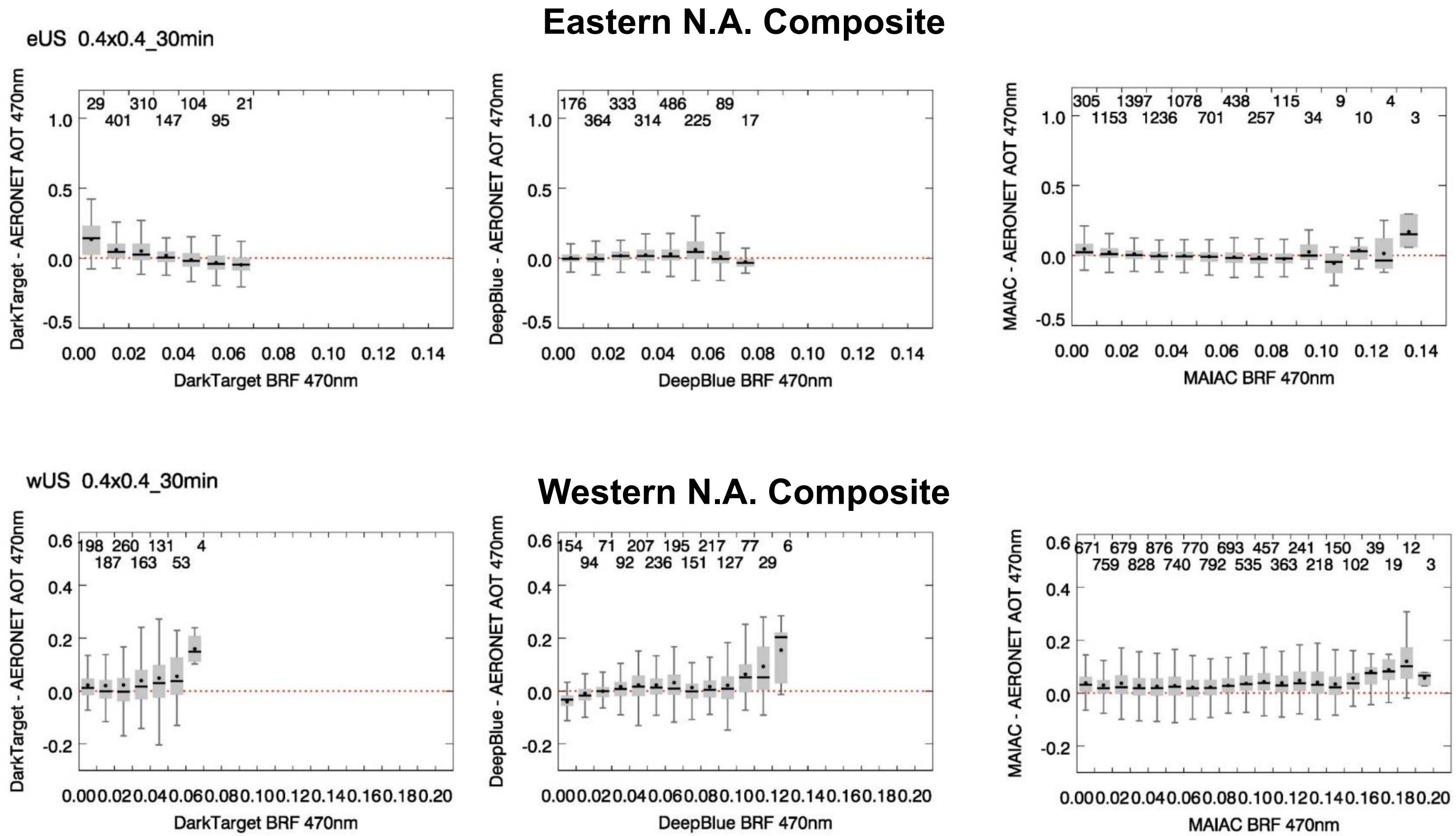




	DT	DB	MAIAC
N	9561	16785	26293
Corr.	0.798	0.733	0.837
Slope	1.072	0.835	0.754
Y-int	0.035	0.027	0.035
RMSE	0.104	0.073	0.053
Bias	0.043	0.010	0.011



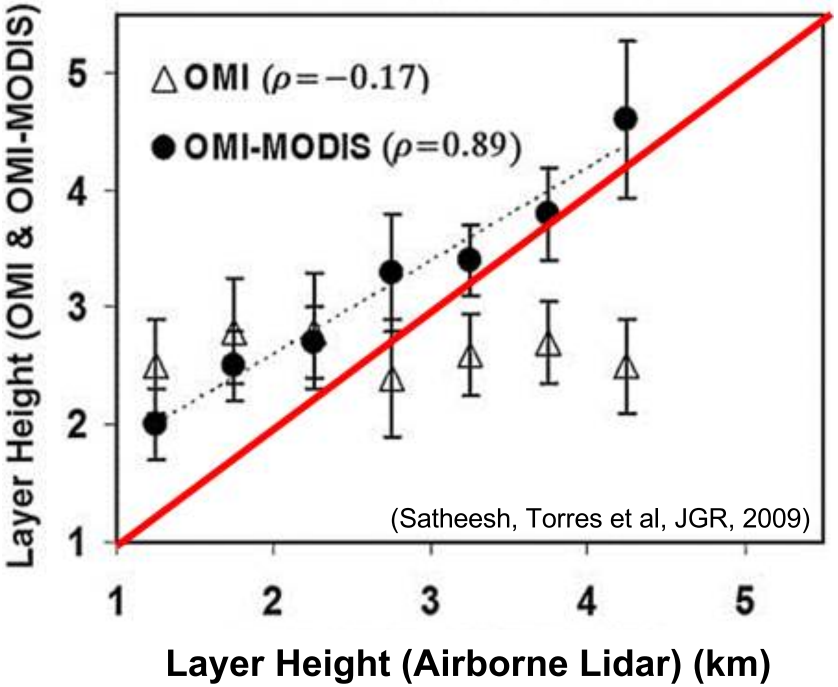
AOD Difference as a function of Surface Reflectance

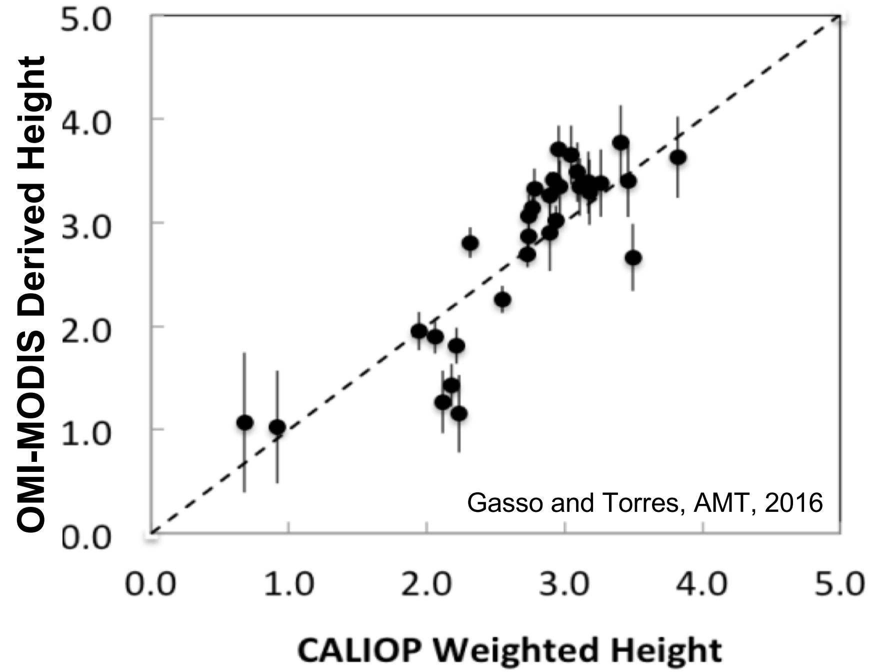


- Overall, MAIAC retrievals compare better to AERONET observations
- MAIAC's accurate retrieval capability extends to bright arid/semi-arid surfaces
- MAIAC retrieval frequency is significantly higher than those of the DT and DB algorithms

Combined use of TEMPO-ABI to derive aerosol layer height (scenario 4)

Application to collocated OMI – Aqua-MODIS observations





Comparison of retrieved aerosol layer height to lidar observations

Summary

-Adaptation of OMI aerosol algorithm to TEMPO is in progress (TEMPO support)

-Benefits of the combined use of TEMPO-ABI have been demonstrated (GEOCAPE funded)

-Funding is needed for implementation of a TEMPO-ABI application