

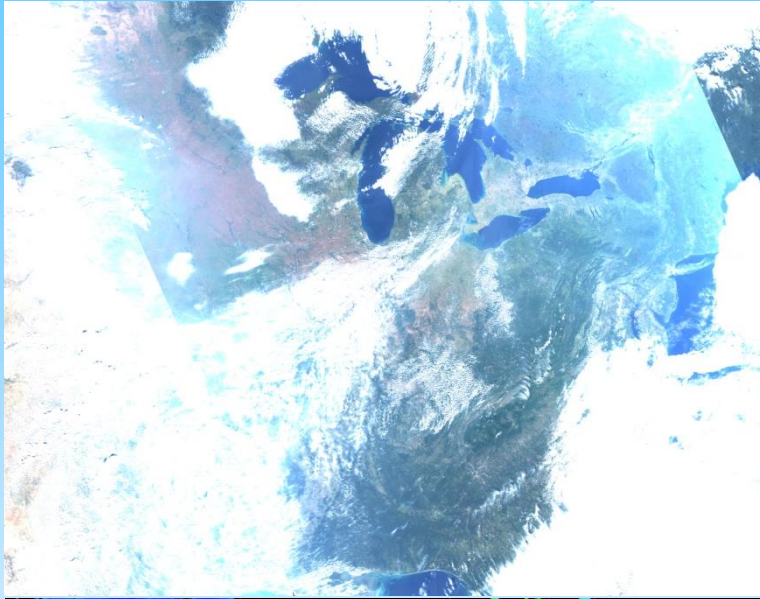
# *A New High Resolution Aerosol Dataset from Algorithm MAIAC*

*Alexei Lyapustin, GSFC, code 613  
Y. Wang (UMBC), S. Korkin (USRA)*

**13 AeroCom Meeting  
September 29, 2014**

# ***MAIAC = Time Series + Spatial Analysis***

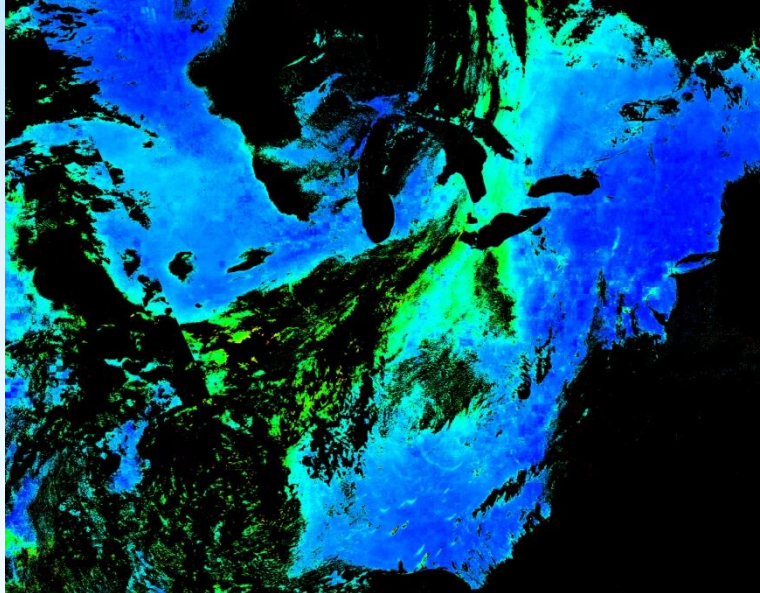
*MODIS, TOA RGB*



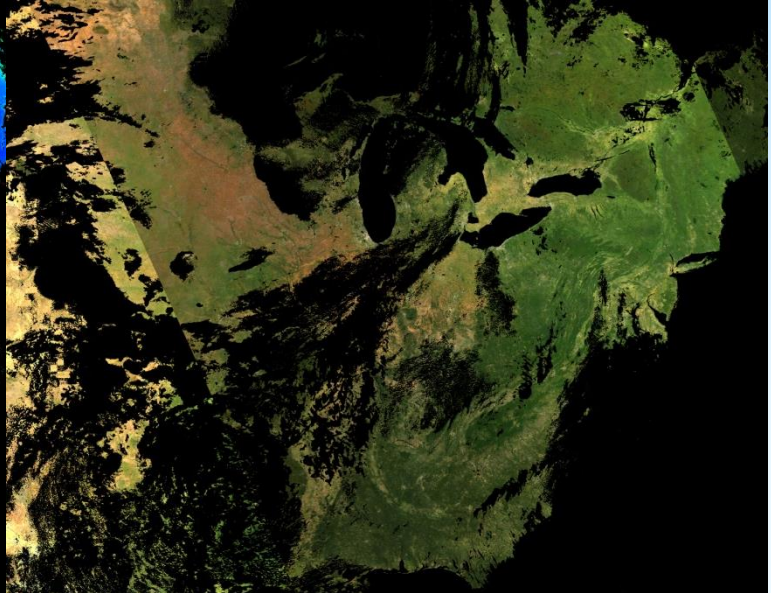
*NBRF*



*AOT*



*BRF*



# ***MAIAC: Standard and New Features***

- *Anisotropic surface model;*
- *Retrieval of Spectral Regression Coefficient;*
- *Detection and accommodation of seasonal and rapid surface change;*
- *Storing “static” (surface) information;*
- *Products: WV, CM, AOT, AE (over dark surfaces) and aerosol type (background/smoke/dust – in progress) @1km resolution and surface suite (spectral BRDF model, BRF (SR), albedo).*

## ***New Features***

- *Removed blockiness (25km) of AOT and SR images;*
- *Will provide uncertainty of AOT;*
- *Aerosol type classification (background/smoke/dust);*
- *Improvements in cloud detection.*

# Retrieval of SRC

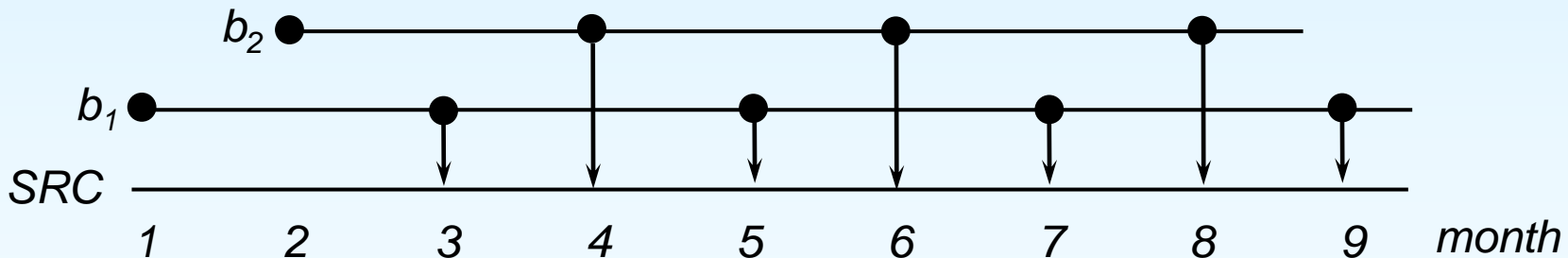
**Old: Multi-day minimization over 25x25km<sup>2</sup> blocks**

**New: Minimum Reflectance Method:**

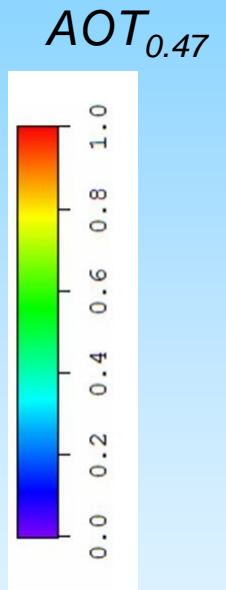
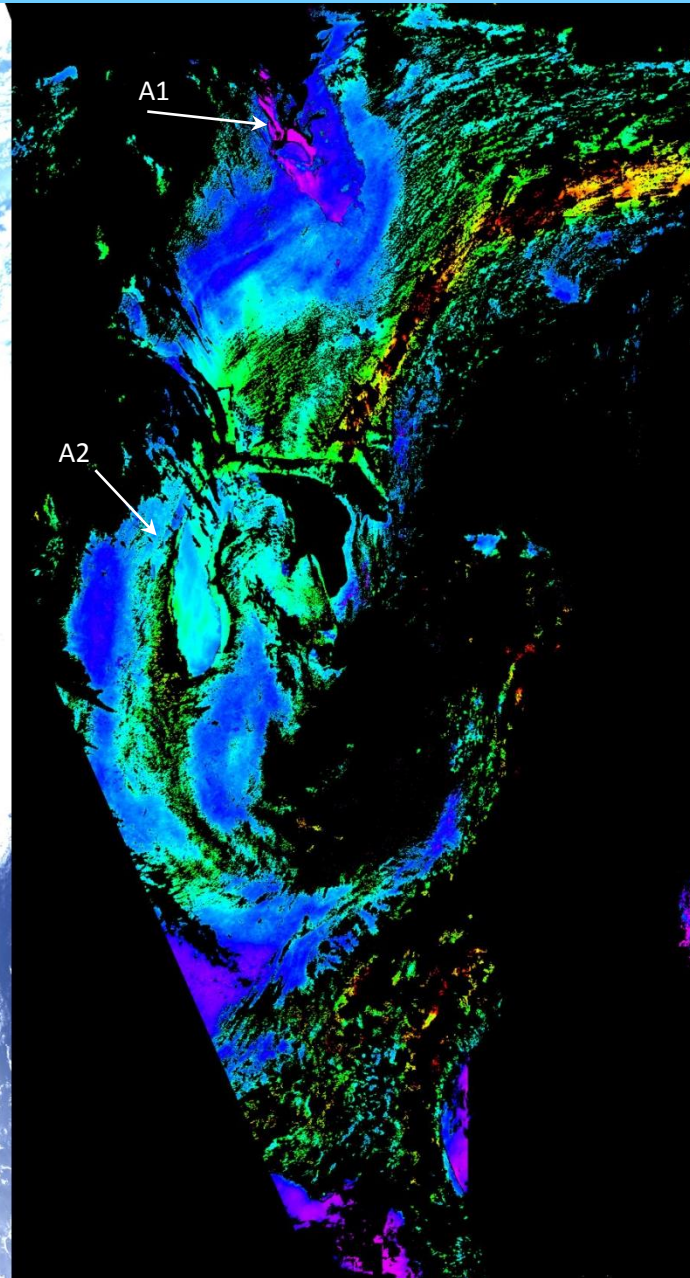
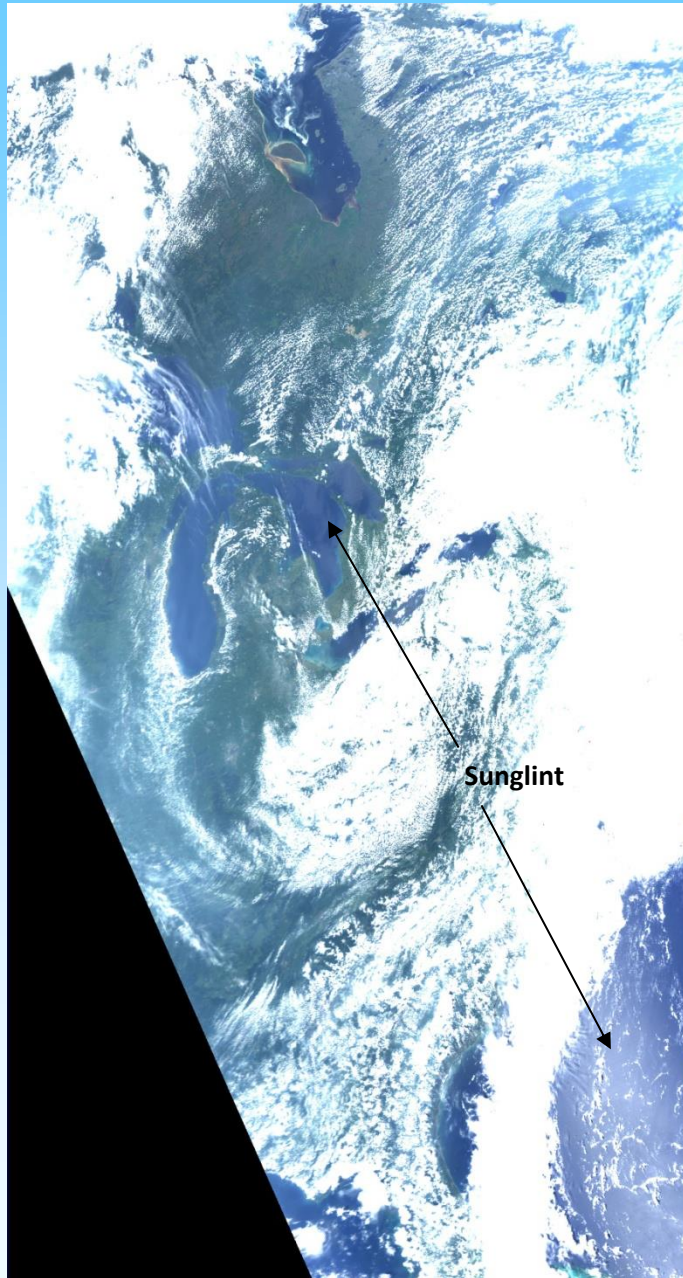
- We can express measured B3 radiance as a function of 2.1 $\mu$ m BRDF:

$$L^{B3} \cong D + L_s (b\rho^{B7})$$

- Compute  $b$  for the background aerosol (AOT $\sim$ 0.05);
- Blue band is “dark”, aerosols increase SRC ( $b$ );
- Select SRC as min over  $\Delta T$ ;
- Run 2 lines of SRC update: each line initializes over 2 months, and SRC is updated monthly



# Example, incl. coastal and inland water



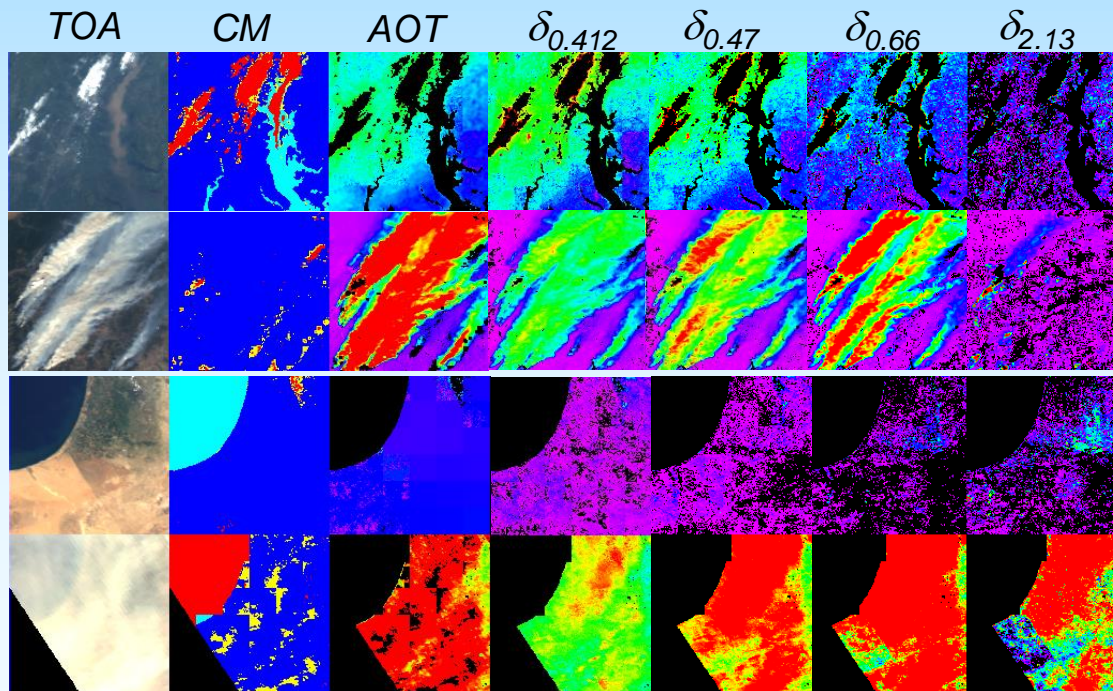
# Aerosol Type Discrimination (Smoke/Dust)

Lyapustin, A. et al., 2012: Discrimination of biomass burning smoke and clouds in MAIAC algorithm, *ACP*, 12, 9679–9686.

Phys. principles ( $\sim$ OMI) – **enhanced shortwave absorption** (Red  $\rightarrow$  Blue  $\rightarrow$  DB)

$$\delta_\lambda = R_\lambda^M - R_\lambda^T (\tau_{0.47}^a = 0.05) \quad - \text{proxy of aerosol reflectance}$$

1)  $n_i$  increases  $R \rightarrow$  DB; 2) Multiple scattering, and absorption, increase  $R \rightarrow$  DB, for absorbing aerosols.

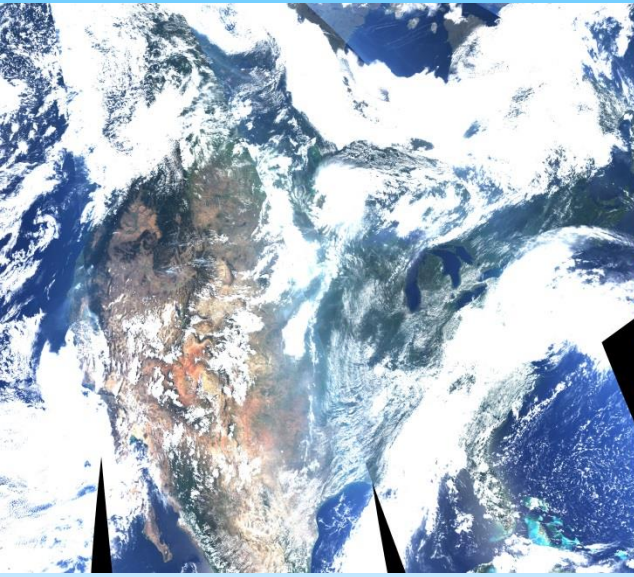


## Backgr./Smoke/Dust

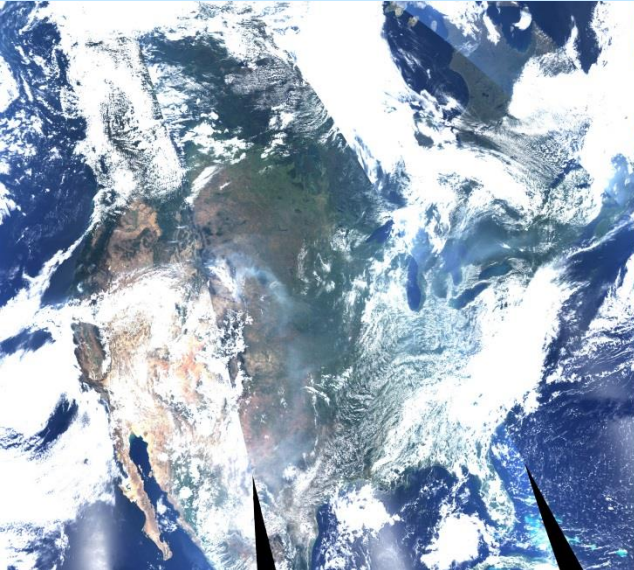
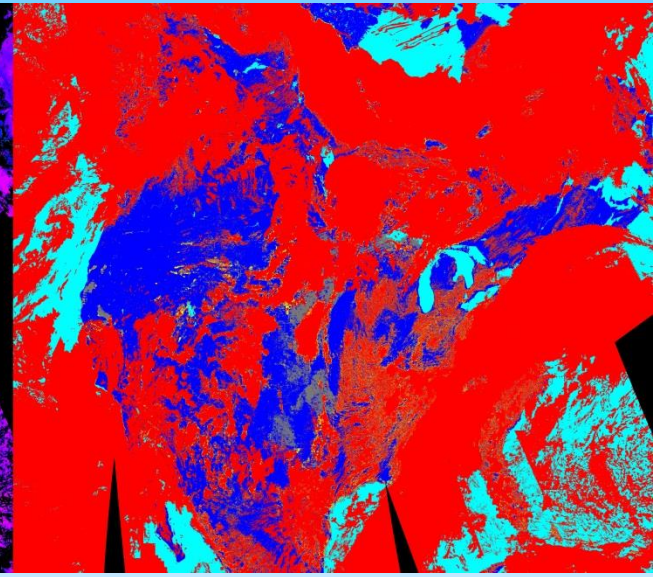
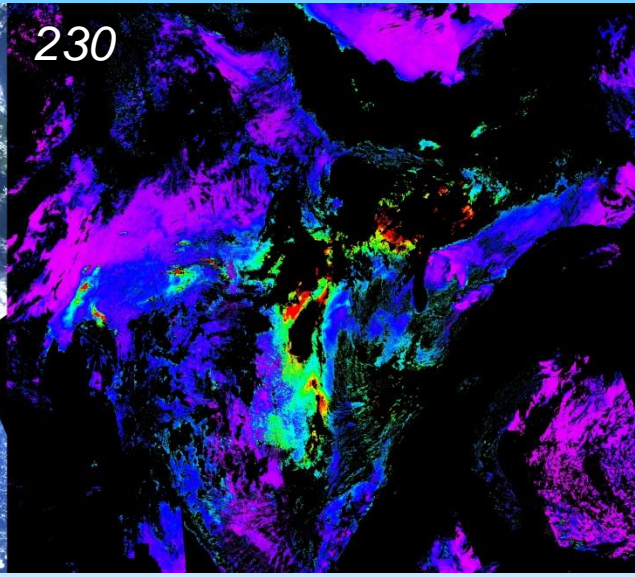
$$\delta_\lambda = R_\lambda^M - R_\lambda^T (\tau_{0.47}^a = 0.05)$$

Model	Abs.	Size
Backgr.	No	Small
Smoke	Yes	Small
Dust	Yes	Large

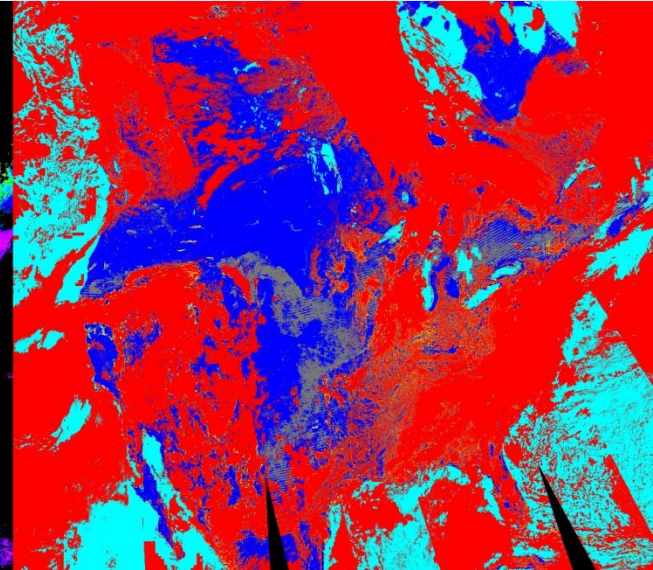
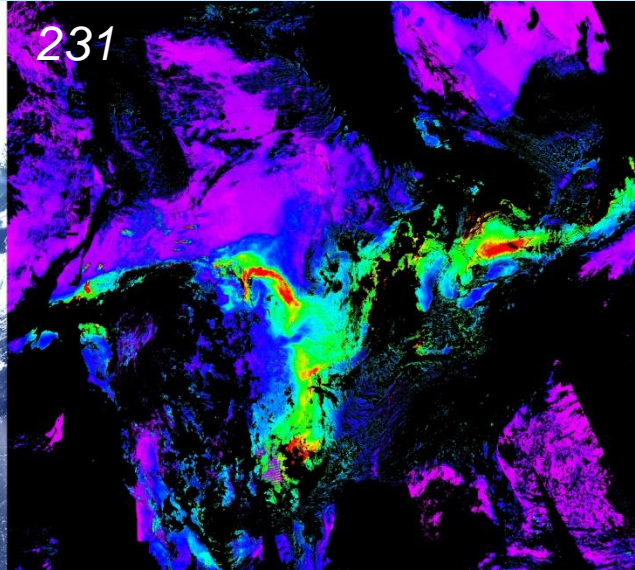
# Idaho/Wyoming – Yosemite Fires (08-2013)



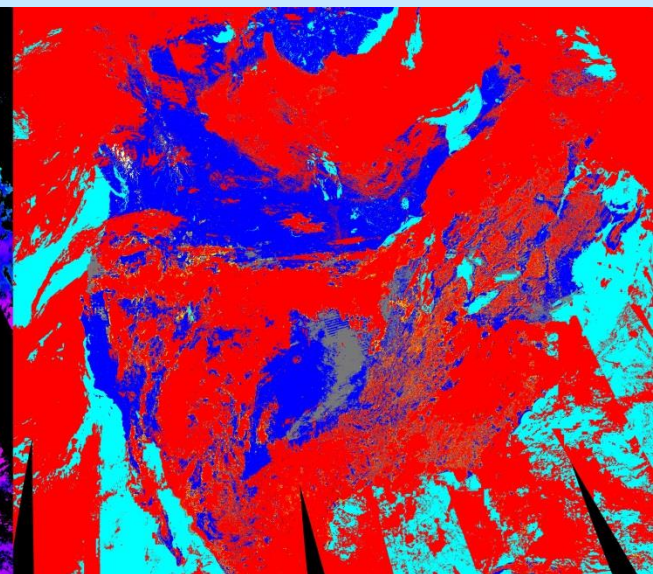
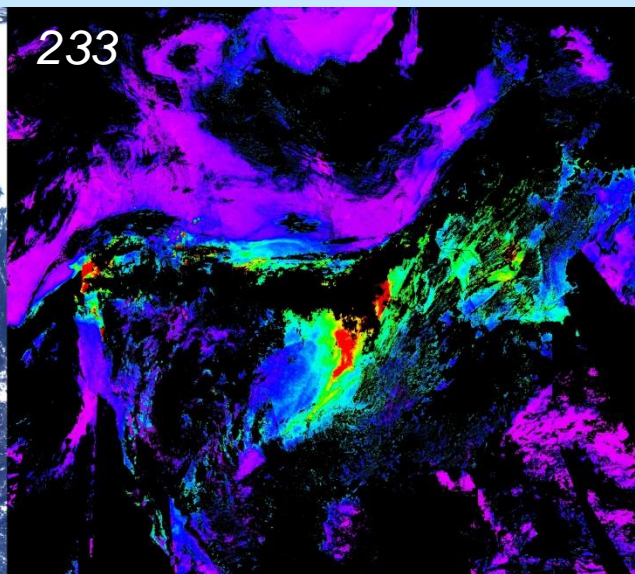
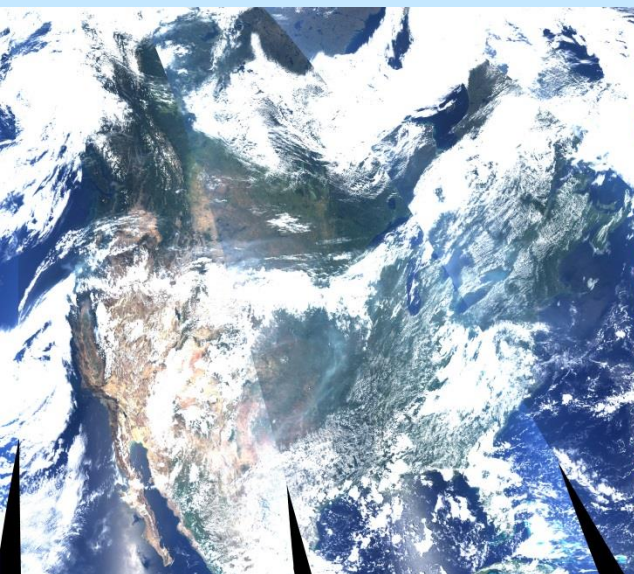
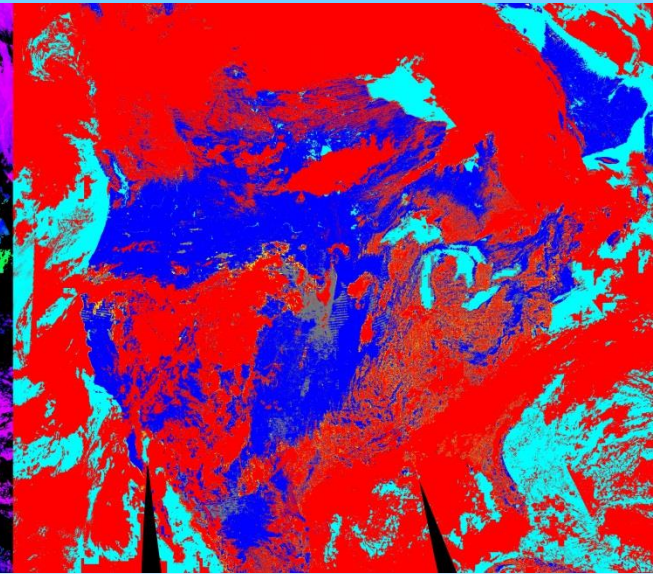
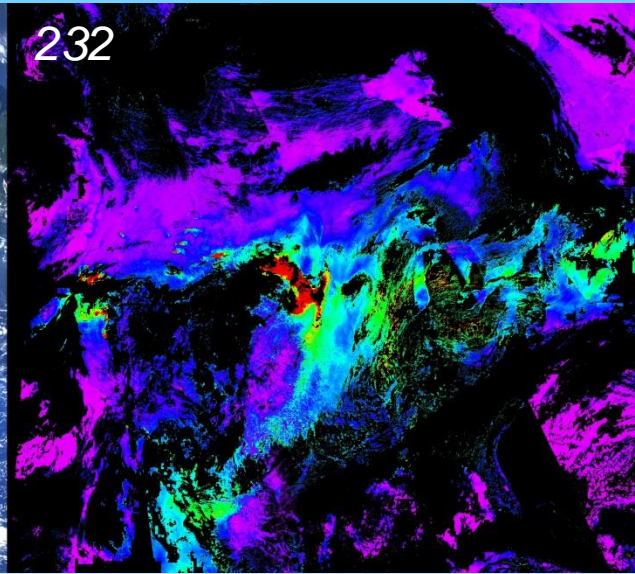
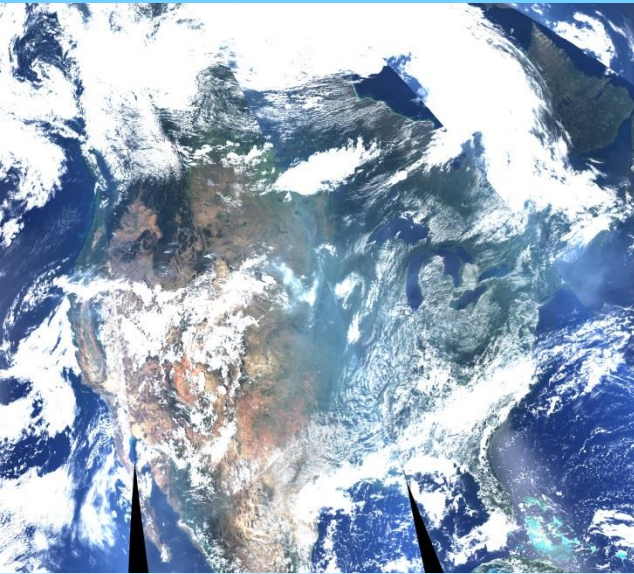
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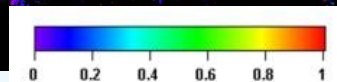
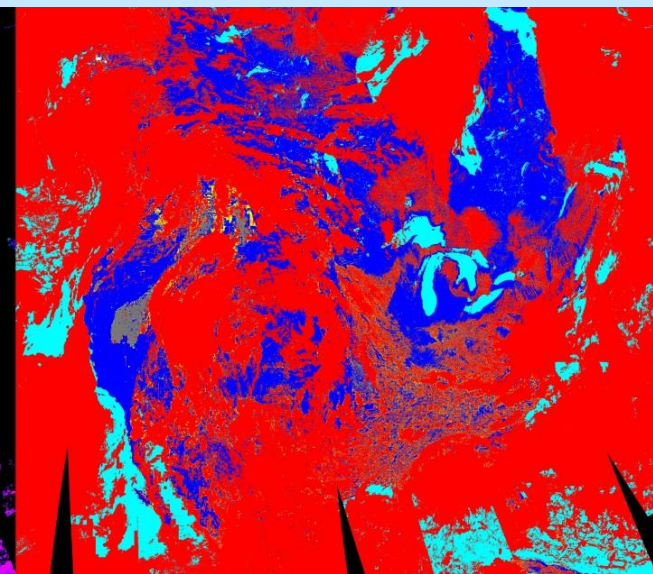
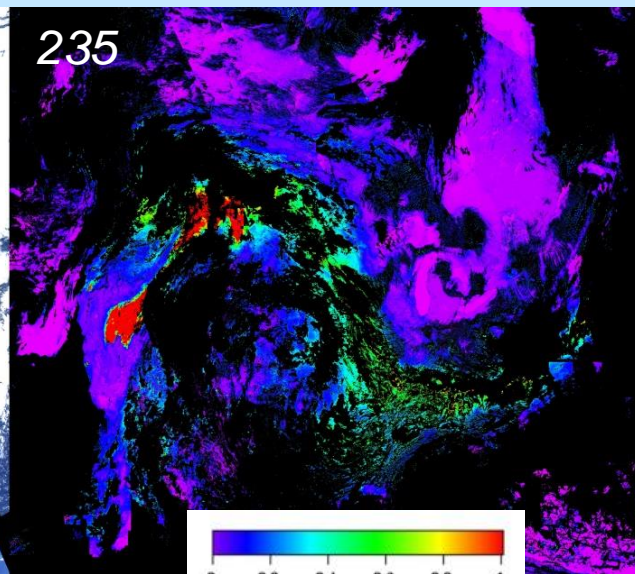
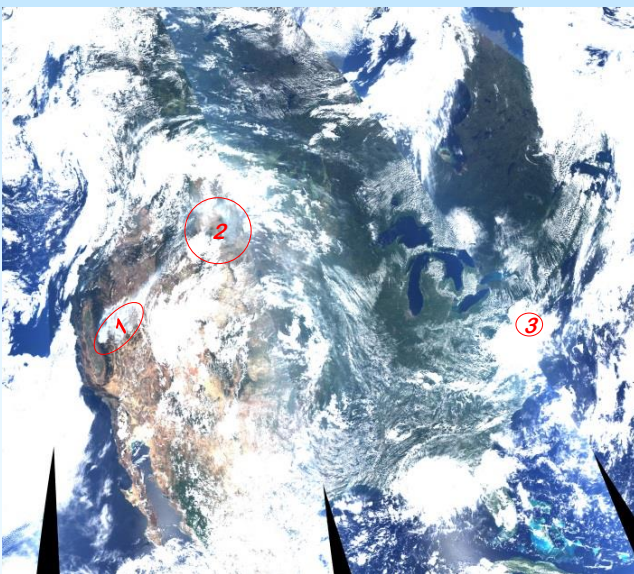
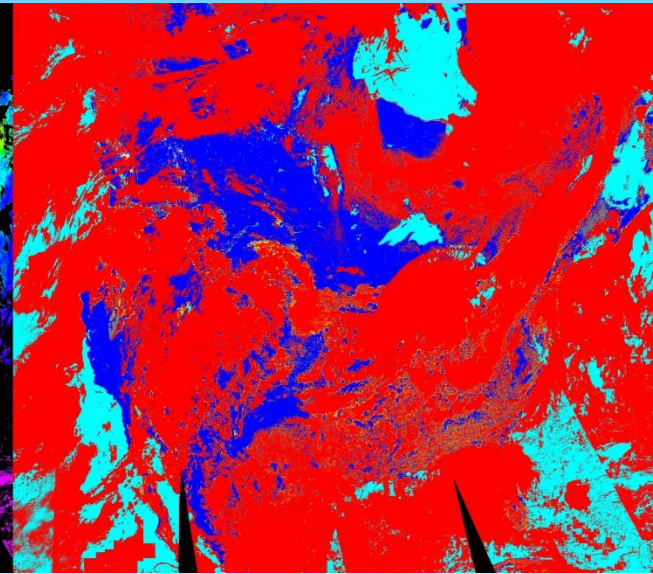
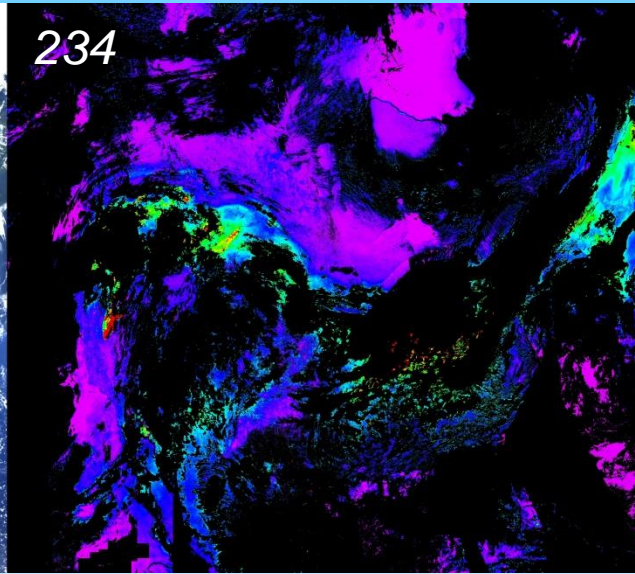
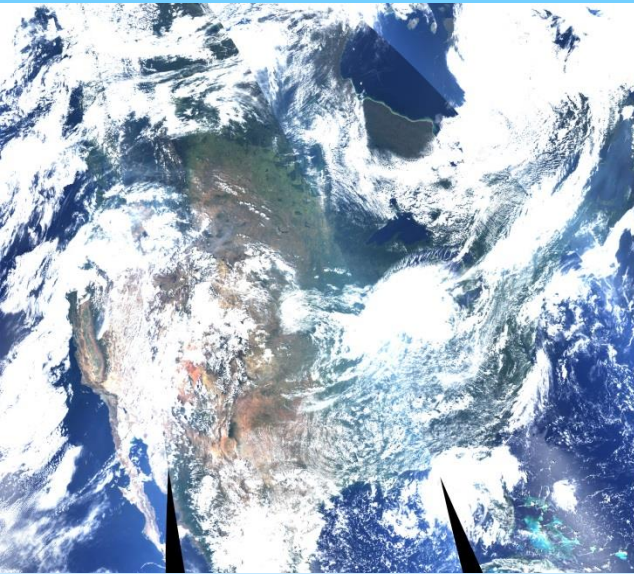


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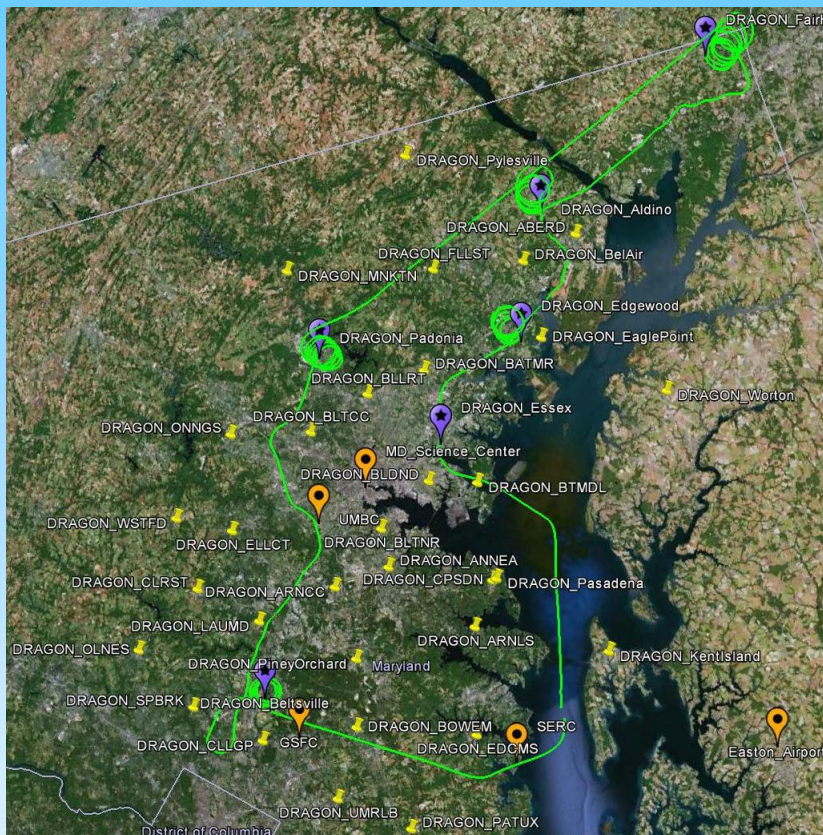




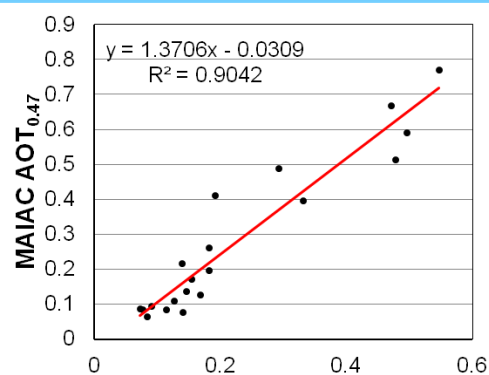
# Idaho/Wyoming – Yosemite Fires (08-2013)



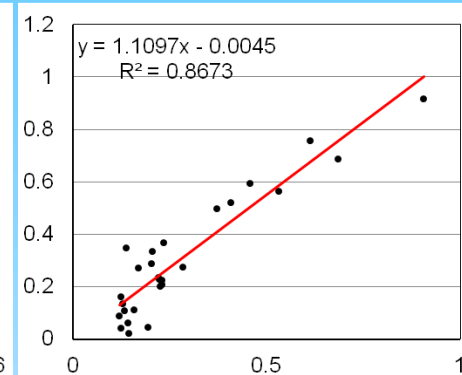
# DRAGON, USA: Balt. – Washington, 2011



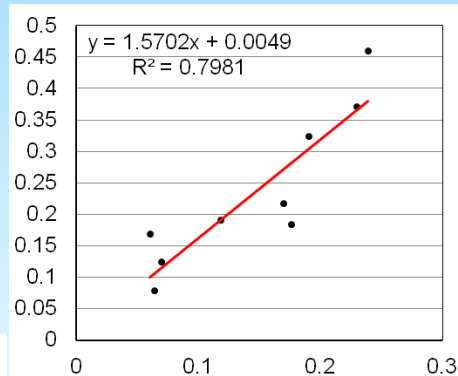
BATMR



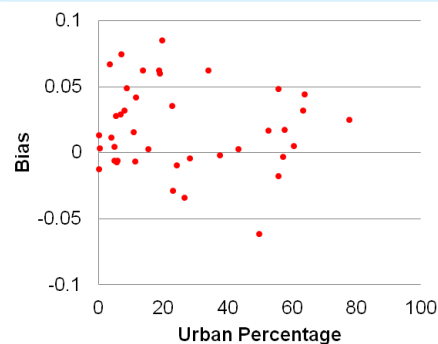
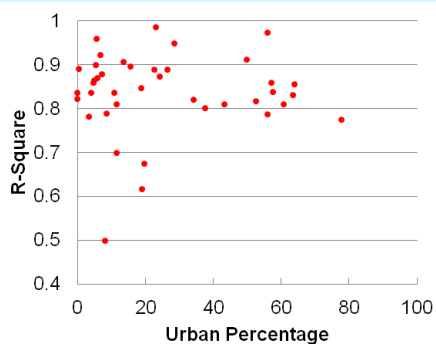
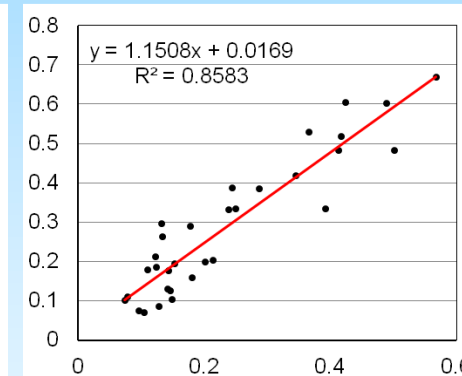
UMBC



MD\_SC\_CENTER



ESSEX



*MAIAC did not show decreased performance over urban surfaces over B-W area.*

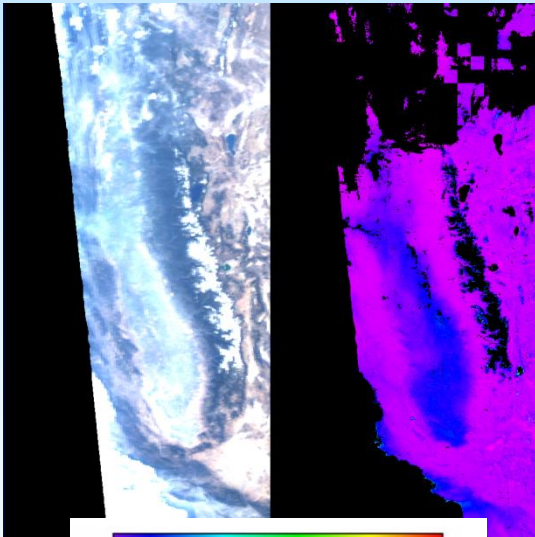
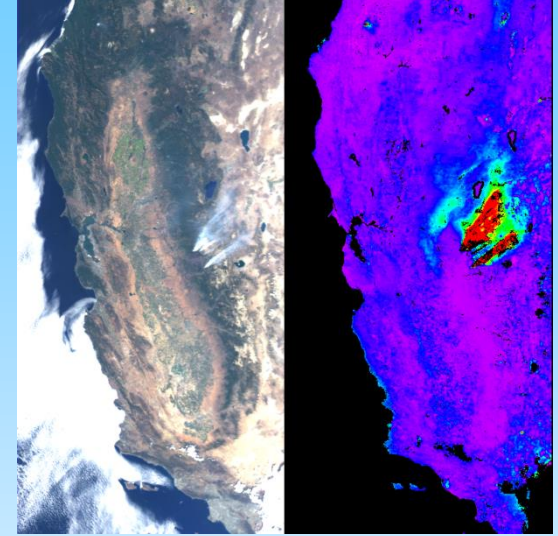
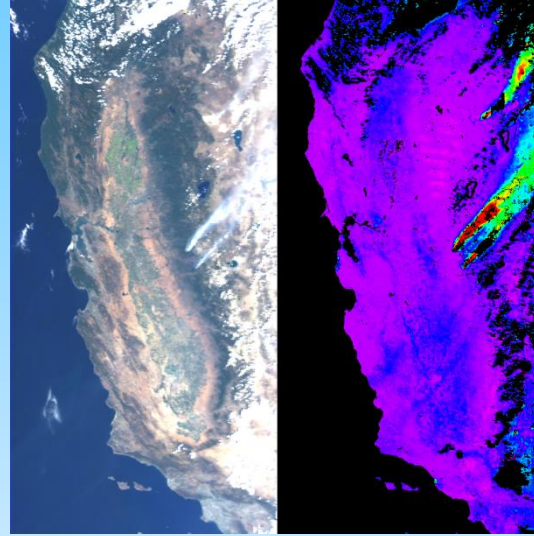
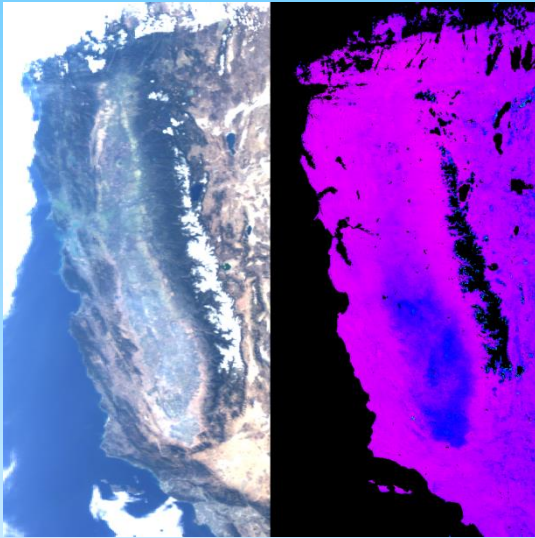
# San Joaquin Valley 2012-2013

Yosemite Fires, Aug. 2013

DOY: 329, 331, 2012

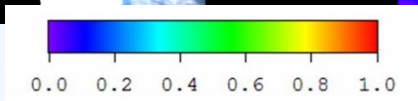
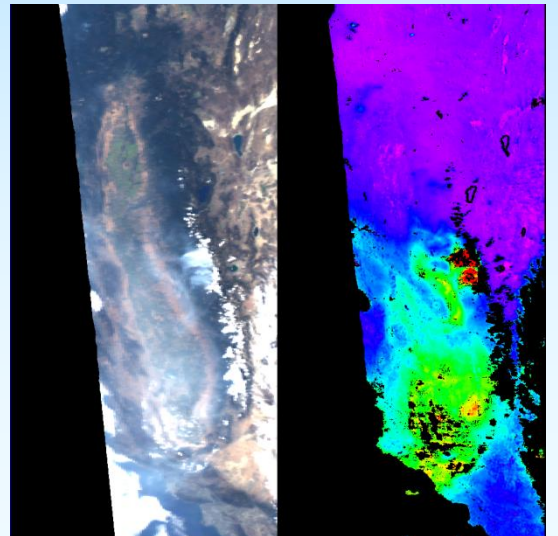
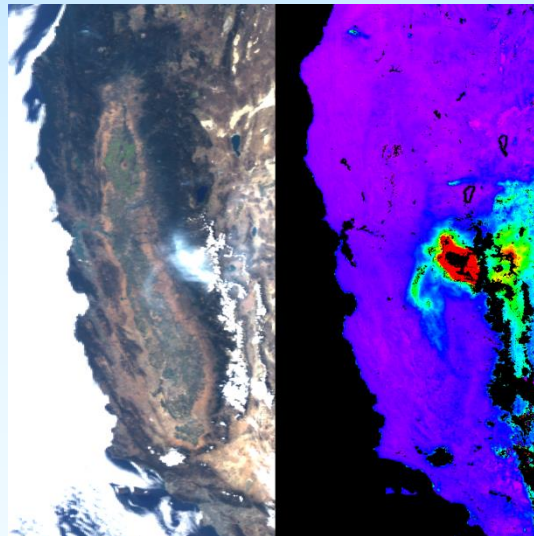
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250



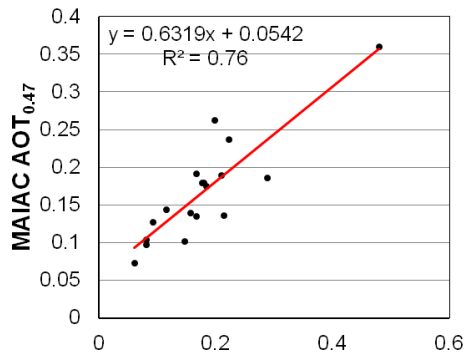
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252

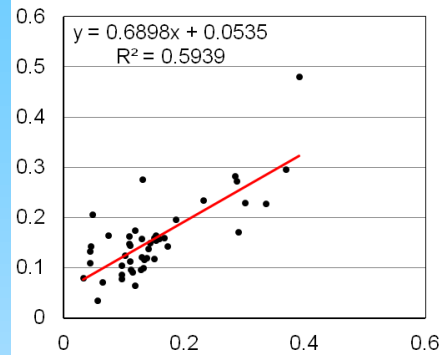


# San Joaquin Valley 2012-2013

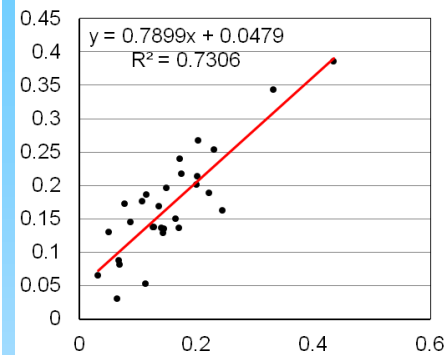
## Arvin



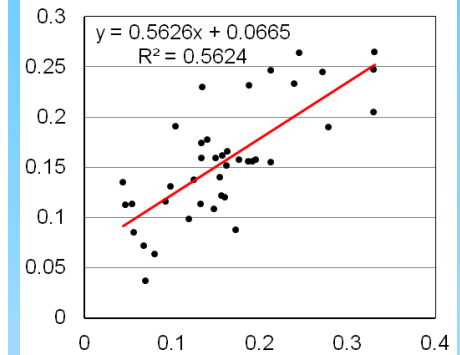
## Clovis



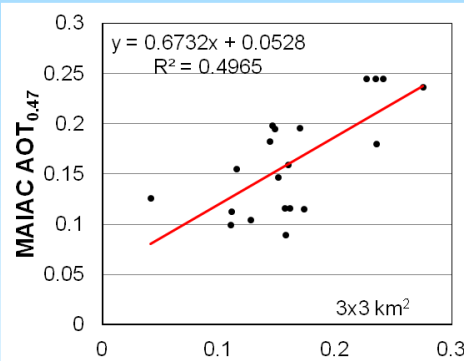
## Corcoran



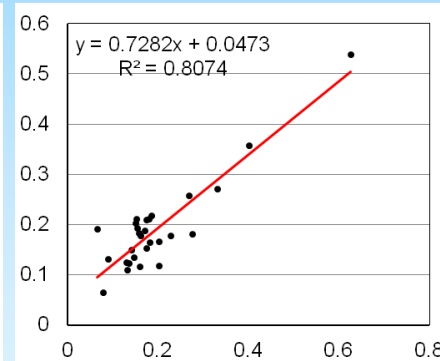
## Drummond



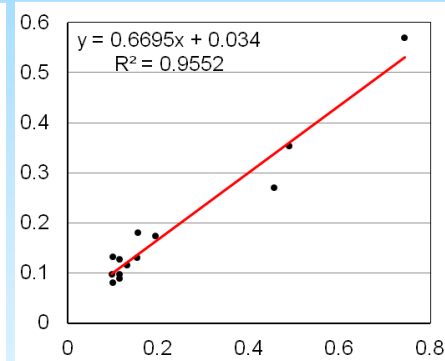
## Garland



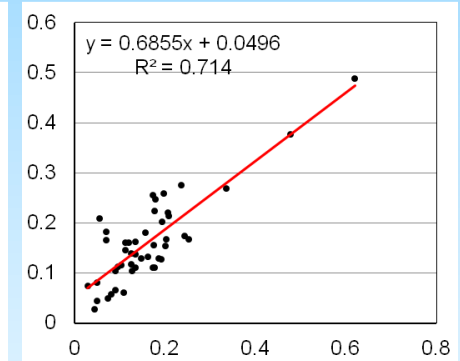
## Hanford



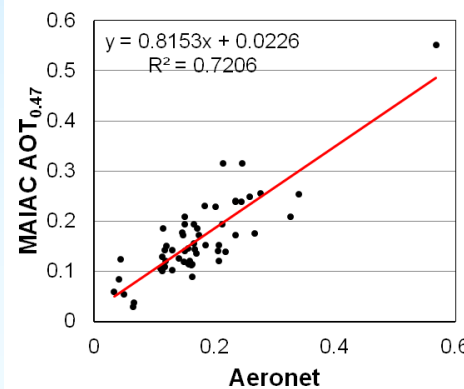
## Porterville



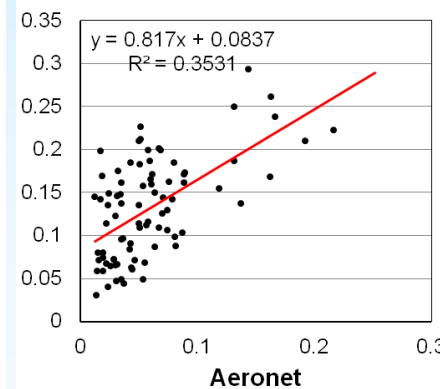
## Shafter



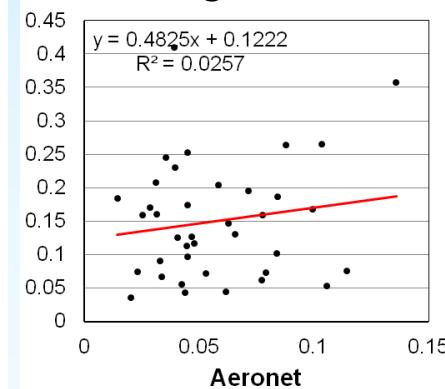
## Fresno



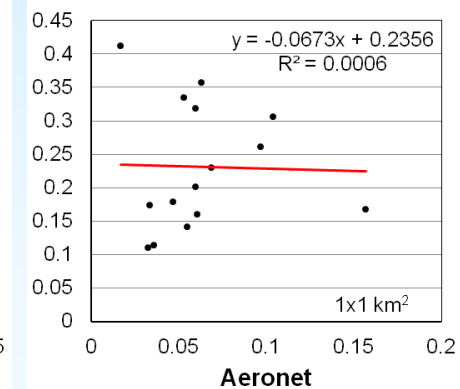
## UCSB (Huron)



## El Segundo



## Table Mountain



# C5 Trends: Aerosol and Clouds

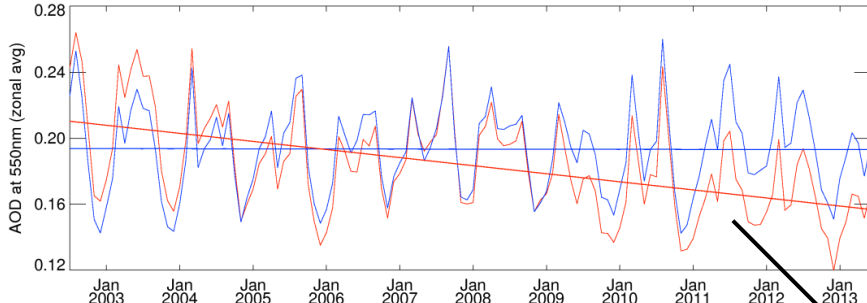
## DT Aerosol: AOD and AE (R. Levy)

## Cloud Opt. Properties: COT (S. Platnick)

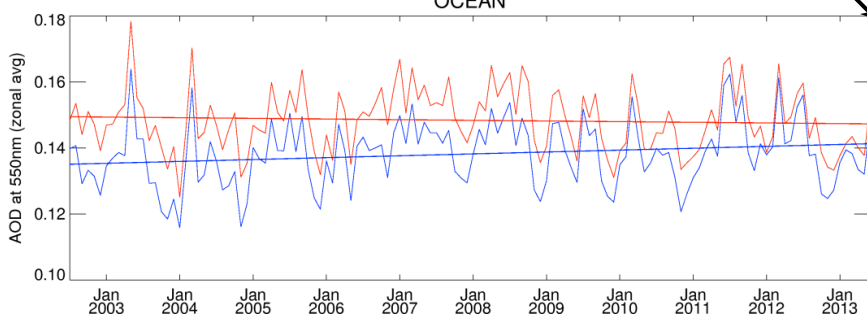
Aqua: JUL, 2002 to JUN, 2013 ; Terra: JUL, 2002 to JUN, 2013  
 AREA WEIGHTED = YES, PIXEL WEIGHTED = NO  
 C5(Aqua & Terra) AOD zonal avg [60S, 60N]

Terra  
Aqua

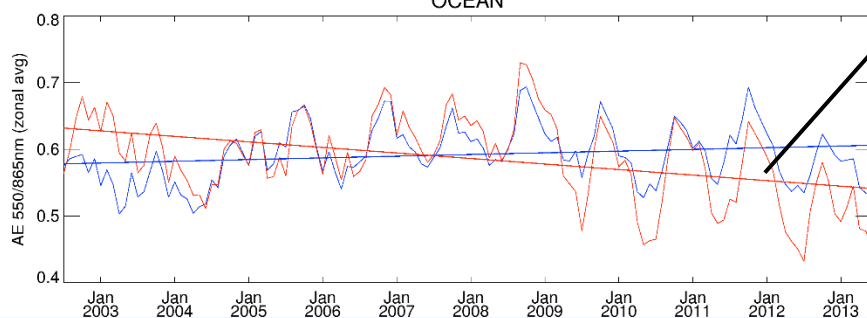
$\beta_B = -0.001$  per dec (abs)  $\beta_R = -0.049$  per dec (abs) LAND  $\beta_B = -0.003$  per dec (rel)  $\beta_R = -0.267$  per dec (rel)



$\beta_B = 0.006$  per dec (abs)  $\beta_R = -0.002$  per dec (abs) OCEAN  $\beta_B = 0.041$  per dec (rel)  $\beta_R = -0.013$  per dec (rel)



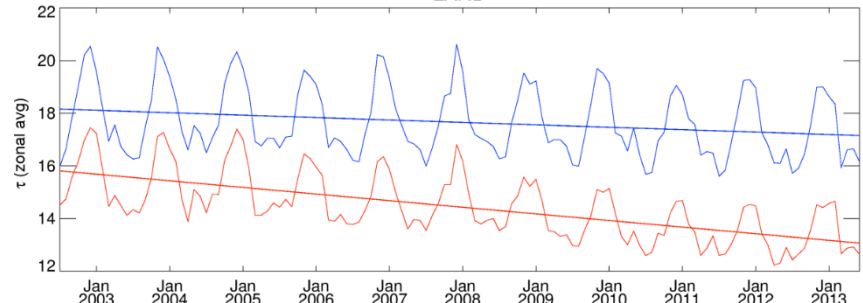
$\beta_B = 0.025$  per dec (abs)  $\beta_R = -0.083$  per dec (abs) OCEAN  $\beta_B = 0.043$  per dec (rel)  $\beta_R = -0.141$  per dec (rel)



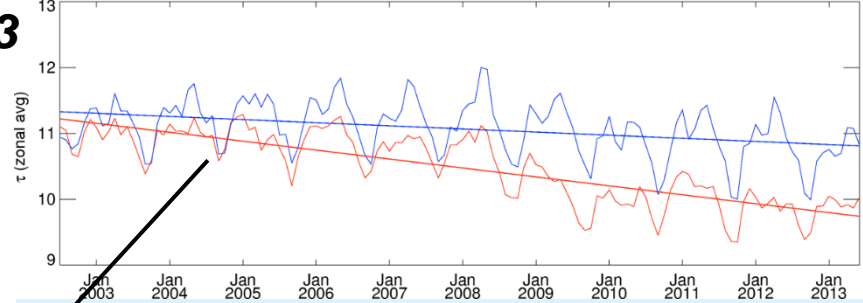
Aqua: JUL, 2002 to JUN, 2013 ; Terra: JUL, 2002 to JUN, 2013  
 AREA WEIGHTED = YES, PIXEL WEIGHTED = YES  
 C5(Aqua & Terra)  $\tau$  (LIQUID) zonal avg [60S, 60N]

Terra  
Aqua

LAND  $\beta_B = -0.052$  per dec (rel)  $\beta_R = -0.174$  per dec (rel)



OCEAN  $\beta_B = -0.043$  per dec (rel)  $\beta_R = -0.129$  per dec (rel)



**B3**

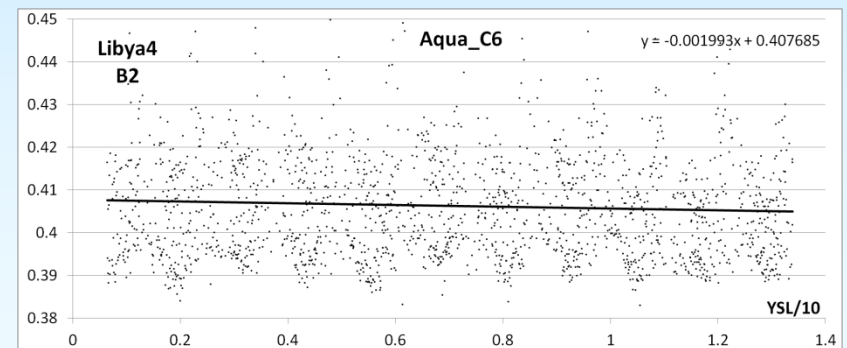
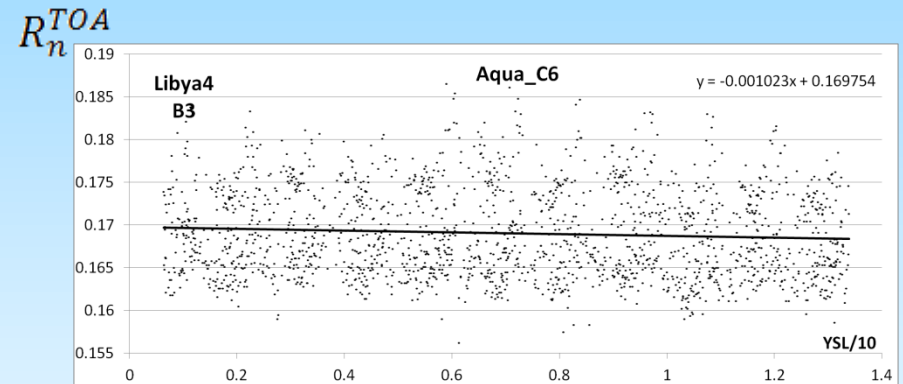
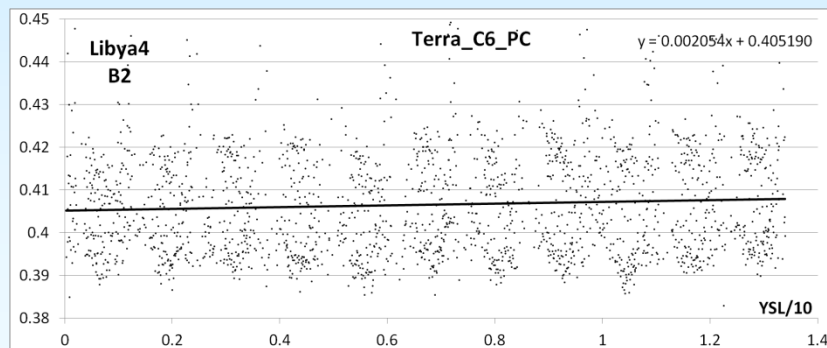
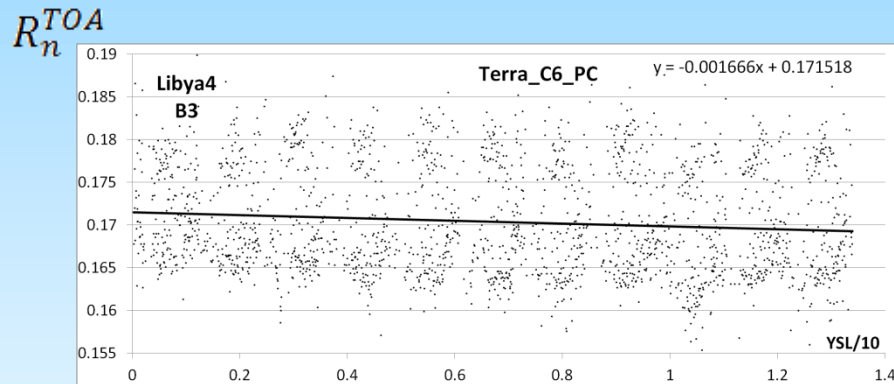
**B1-B2**

Levy et al. (2010), Global evaluation of the Collection 5 MODIS dark-target aerosol products over land, ACP.

Koukouli et al. (2010), Signs of a negative trend in the MODIS aerosol optical depth over the Southern Balkans, Atm. Environ.

# C6+: MODIS de-trending and X-calibration

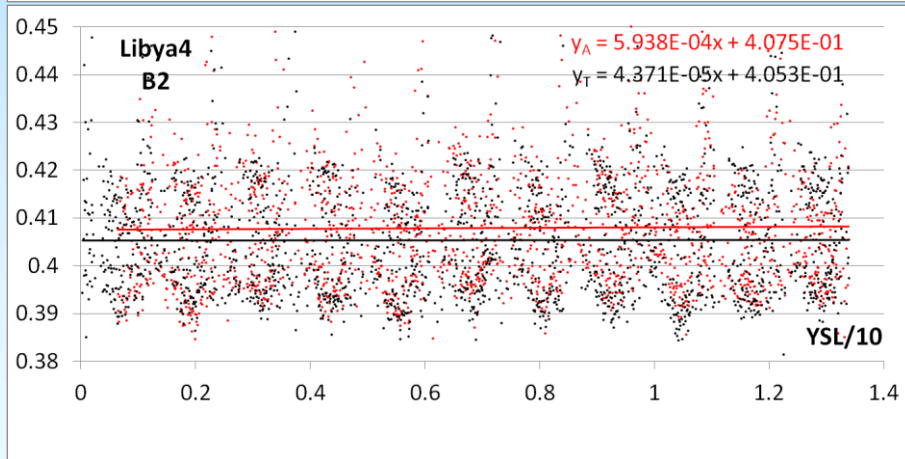
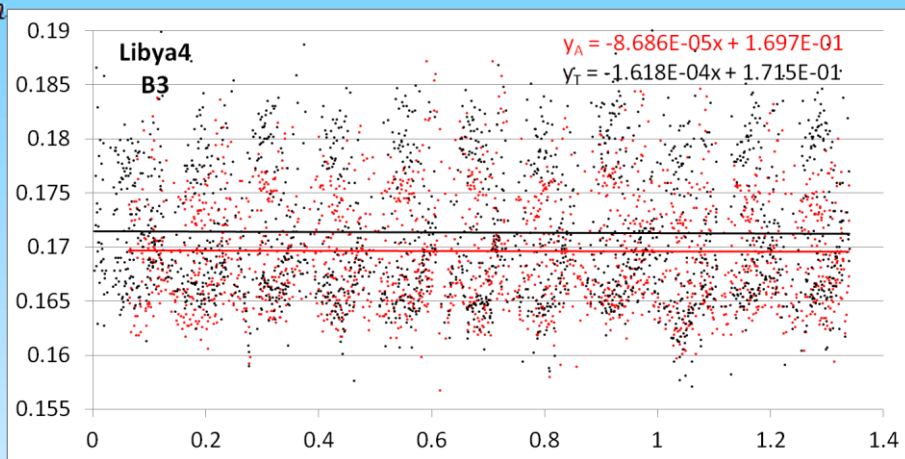
- MODIS C6 L1 removed major calibration trends of Terra;
- Remained: Terra polarization sensitivity (PC); Applied PC algorithm developed by GSFC OBPG => found residual trends of T&A;
- Used CEOS desert cal. sites => TOA reflectances ( $R_n$ ) for fixed geometry ( $VZA=0^\circ$ ,  $SZA=45^\circ$ );



# C6+: MODIS de-trending and X-calibration

- Use of  $R_n$  allows us to X-calibrate Terra vs Aqua!
- Based on C6+, MAIAC processes Terra & Aqua jointly.

$R_n^{TOA}$



*Average trend/decade/unit\_refl.*

Bands	$\Delta_T$	$\sigma$	$\Delta_A$	$\sigma$
B1	0.0048	0.0020	-0.0046	0.0022
B2	0.0035	0.0019	-0.0062	0.0027
B3	-0.0082	0.0015	-0.0048	0.0016
B4	0.0049	0.0022	-0.0021	0.0023
B8	0.0094	0.0015	-0.0015	0.0013

*Average X-gain for Terra*

Bands	Egypt1	Libya1	Libya2	Libya4	Xcal gain	$\sigma$
B1	1.017	1.023	1.021	1.019	1.020	0.0024
B2	1.004	1.008	1.007	1.006	1.006	0.0016
B3	0.989	0.992	0.992	0.990	0.991	0.0013
B4	1.006	1.013	1.010	1.009	1.009	0.0031
B8	0.997	0.996	0.998	0.994	0.996	0.0015

Lyapustin, A., Y. Wang, X. Xiong, G. Meister, S. Platnick, R. Levy, B. Franz, S. Korkin, T. Hilker, J. Tucker, F. Hall, P. Sellers, A. Wu, A. Angal, Science Impact of MODIS C5 Calibration Degradation and C6+ Improvements, AMTD, 7, 7281-7319, 2014.