Update on Algorithm MAIAC

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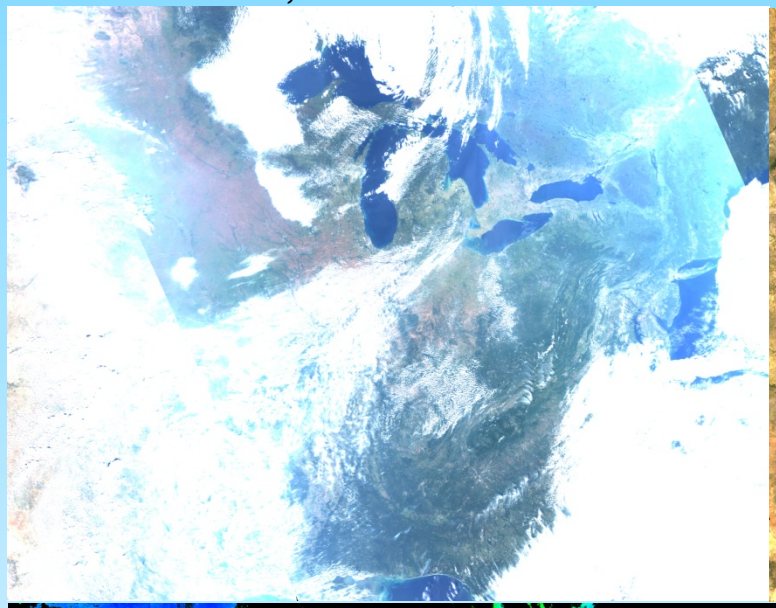
MODIS Science Team Meeting
April 30, 2014

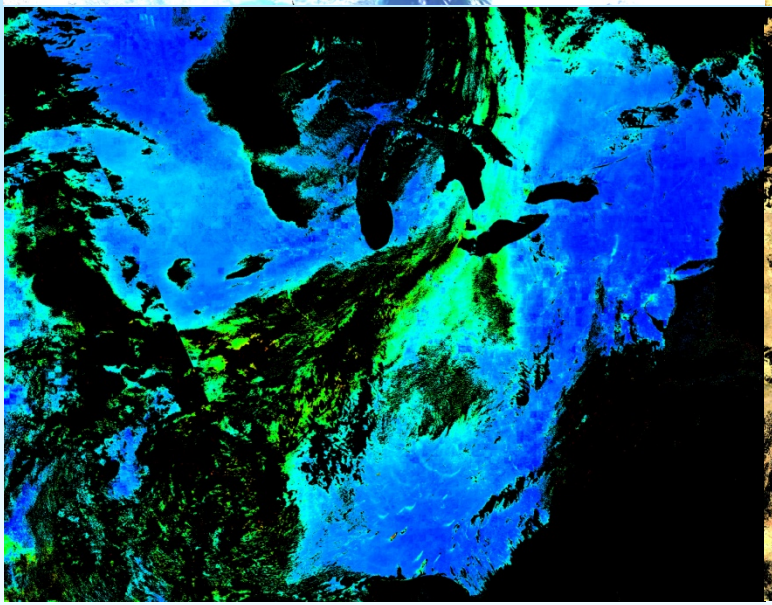
MAIAC = *Time Series + Spatial Analysis*

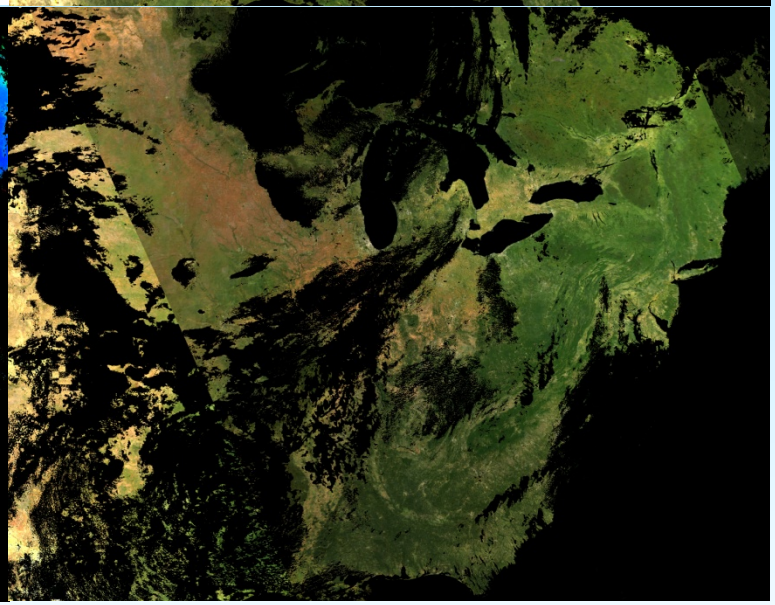
MODIS, TOA RGB

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;

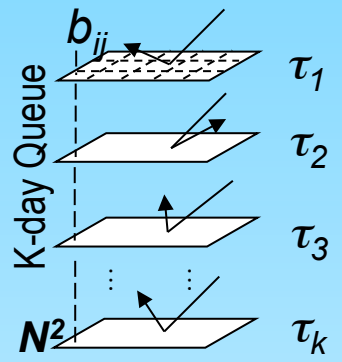
- Storing "static" (surface) information;

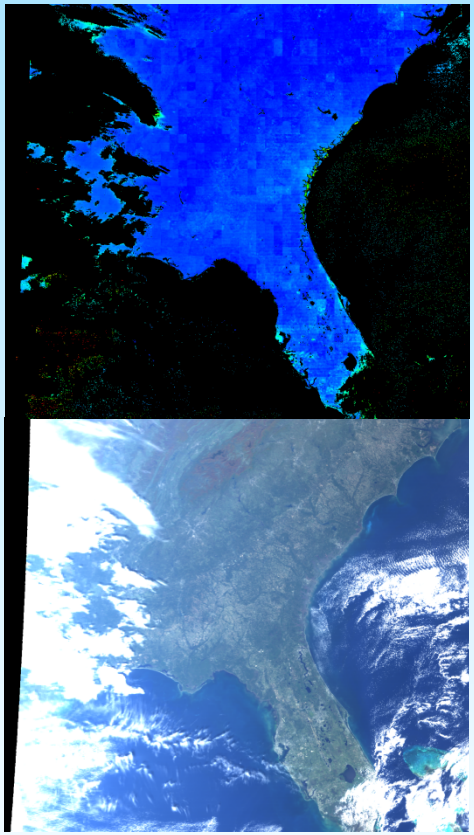
- Products: WV, CM, AOT, AE (over dark surfaces) and aerosol type (background/smoke/dust – in progress) @1km resolution and surface suite (spectral BRDF model, BRF (SR), albedo).

New Features

- *Removed blockiness (25km) of AOT and SR images;*
- *Expanded range of bright surfaces for AOT retrievals;*
- *Will provide uncertainty of AOT;*
- *Aerosol type classification (background/smoke/dust)*
- *Improvements in cloud mask*

Retrieval of Spectral Regression Coefficient (SRC, $\rho_{ij}^{Blue} = b_{ij}\rho_{ij}^{B7}$)





Original approach:

- *Accumulate N>3 days of mostly cloud-free observations;*
- *Assume:*
  - *AOT is ~constant @ 25km;*
  - *Surface doesn't change much;*
- *Invert dataset of N days for 25 km blocks for AOT on each day and SRC for each pixel.*

Issues:

- *Complex;*
- *Land-water boundaries (few land pixels);*
- *Unpredictably unstable, leading to blockiness in AOT and SR.*

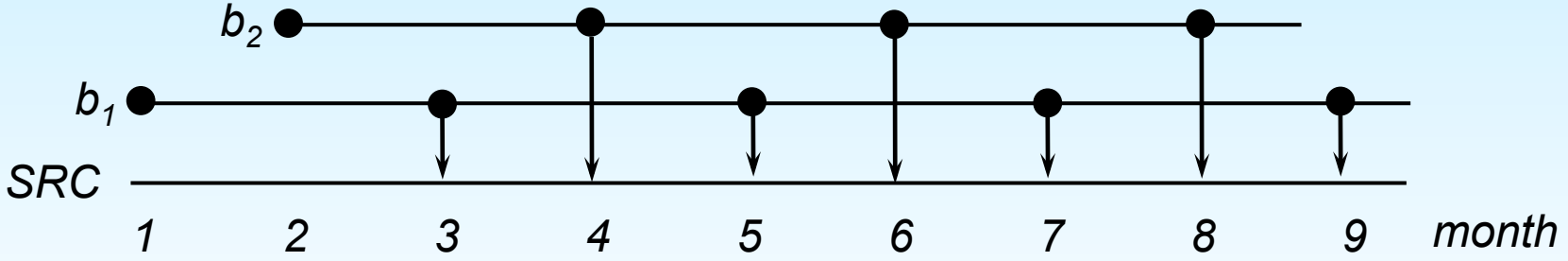
Retrieval of SRC, New Approach

Minimum Reflectance Method:

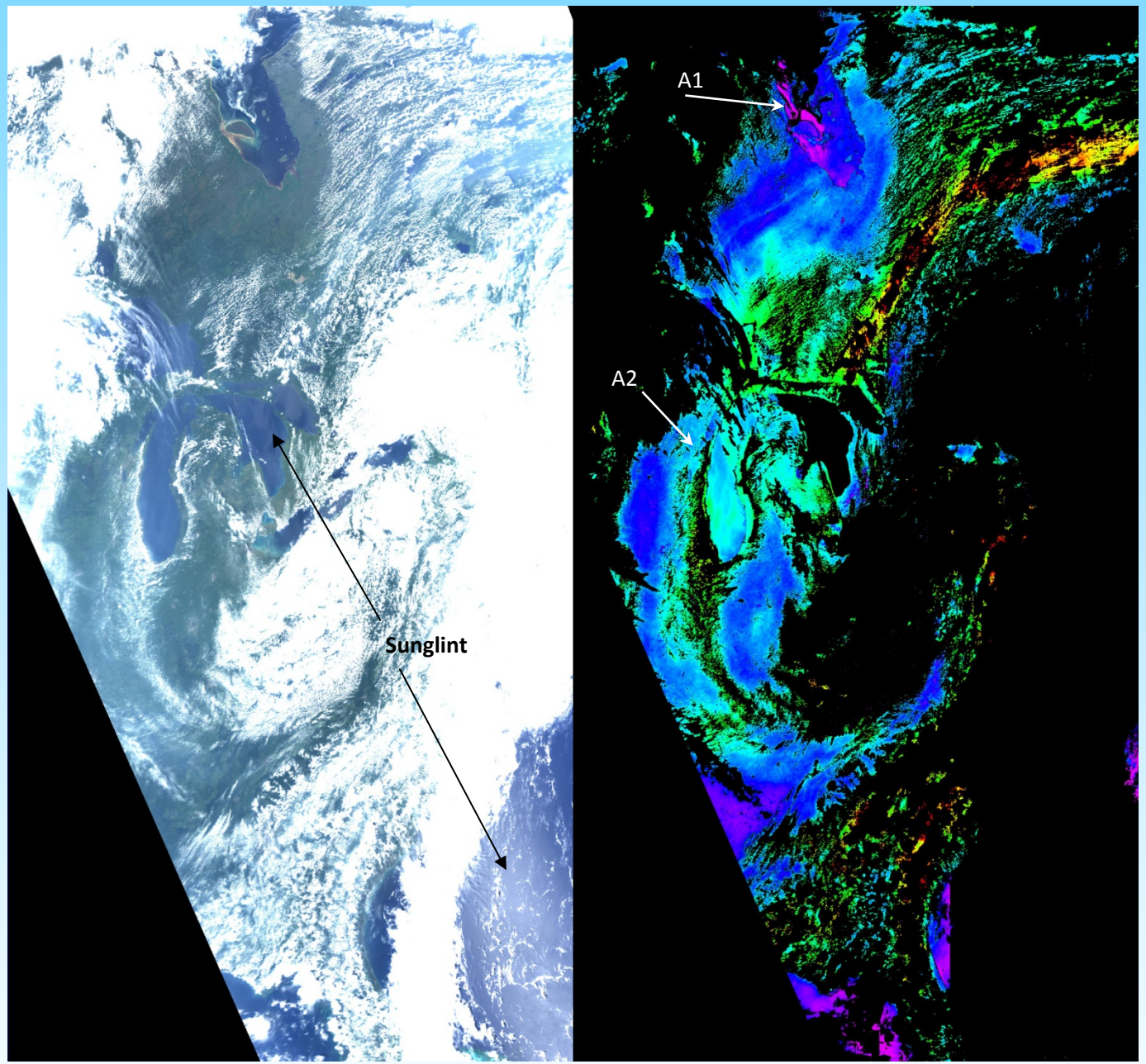
- *We can express measured B3 radiance as a function of 2.1μm BRDF:*

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

-*Compute b for the background aerosol (AOT~0.05);*
- *Blue band is "dark", aerosols increase SRC (b);*
- *Select SRC as min over ΔT;*
- *Run 2 lines of SRC update: each line initializes over 2 months, and SRC is updated monthly*



Example, incl. coastal and inland water



On Spectral Invariance Assumption

(idea of Y. Knyazikhin, BU)

SRC algorithm assumes the BRDF shapes in Blue and SWIR are the same: $\rho_{ij}^{Blue} = b_{ij}\rho_{ij}^{B7}$. *Are they?*

- *The 1st order of scattering must be the same as 3D structure of surface is the governing property:* $\rho_B^{(1)} = b\rho_{SWIR}^{(1)}$

- *The total reflectance:* $\rho_\lambda = \rho^{(1)} + \rho^{(2)} + \rho^{(3)} ... \cong \rho^{(1)} + \frac{\eta^2}{1-\eta}$

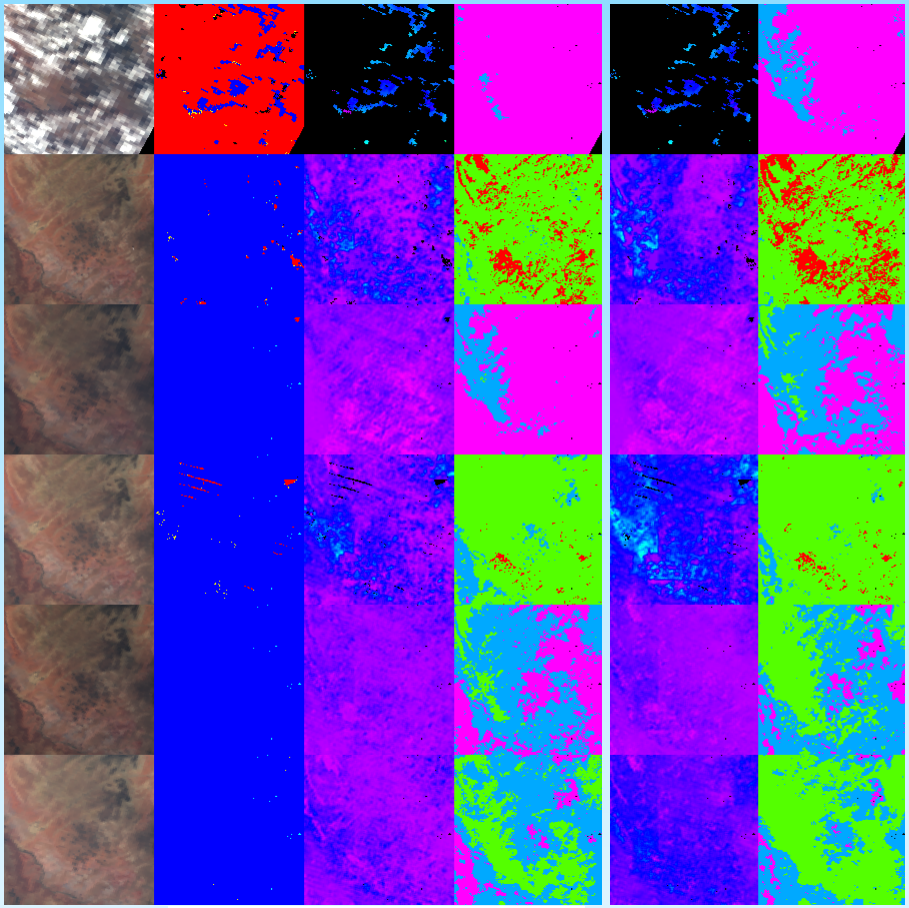
where $\eta \approx \int\int_{\Omega^+\Omega^-} \rho^{(1)}(s,s')dsds'$ *is "spherical" albedo.*

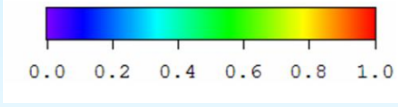
- *With linear RTLS model,* $\eta = k_L^{(1)} + k_v\nu_v + k_g\nu_g$.

- *Further, the RTLS parameters become:* $\{k_L^{(1)} + \frac{\eta^2}{1-\eta}, k_v, k_g\}$

Example: Flagstaff, AZ

DOY 262-268, 2009





What is Dark/Bright Surface?

$$\delta R^{TOA} = \underbrace{R'_{\tau}\delta\tau}_{\delta R^{AOT}} + \underbrace{R'_{src}\delta src}_{\delta R^{SRC}}$$

We can assess uncertainties:

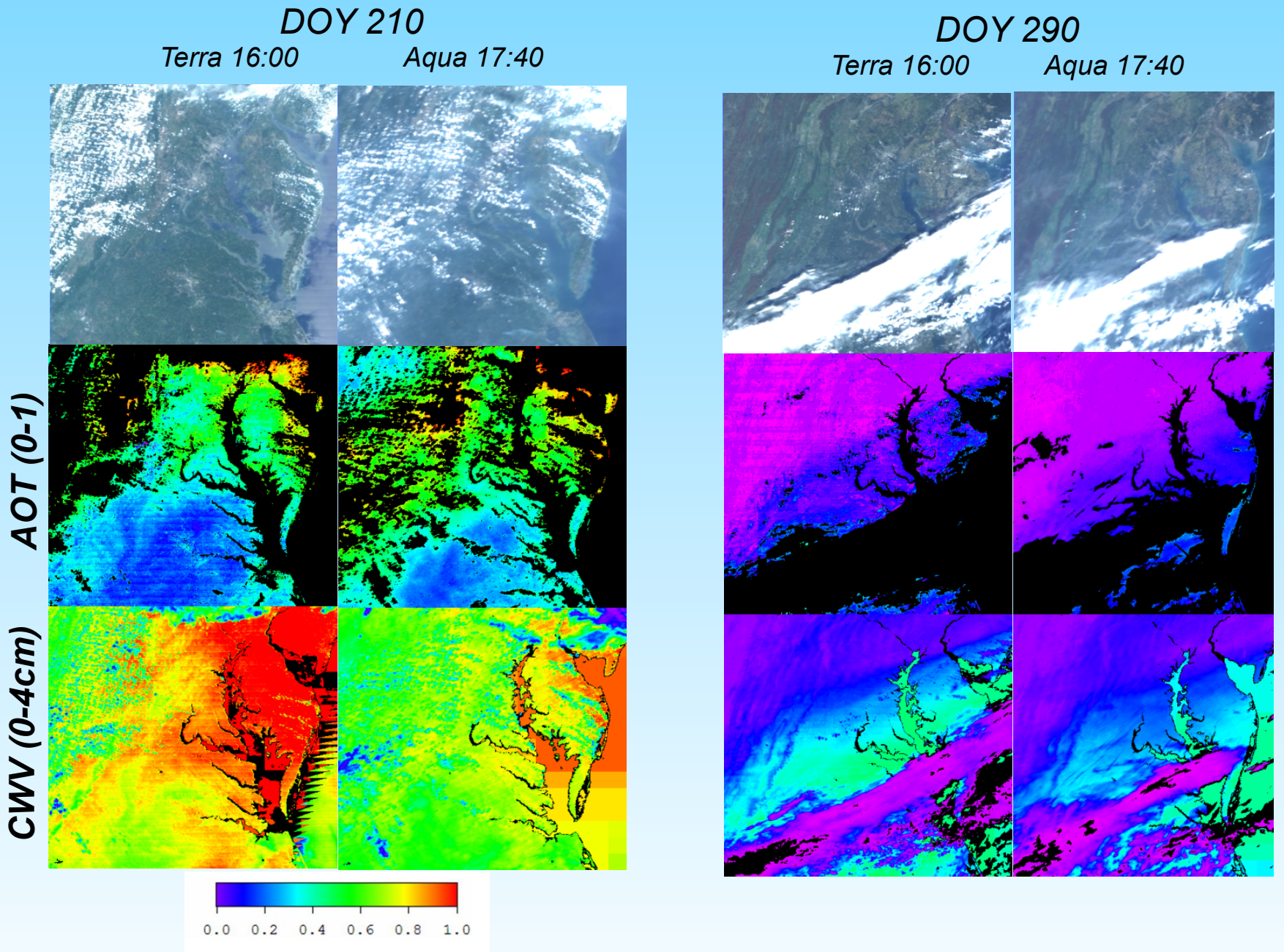
$$\delta\tau \sim 0.05 \quad \delta SRC \sim 0.02$$

$$\beta = \delta R^{SRC} / \delta R^{AOT}$$

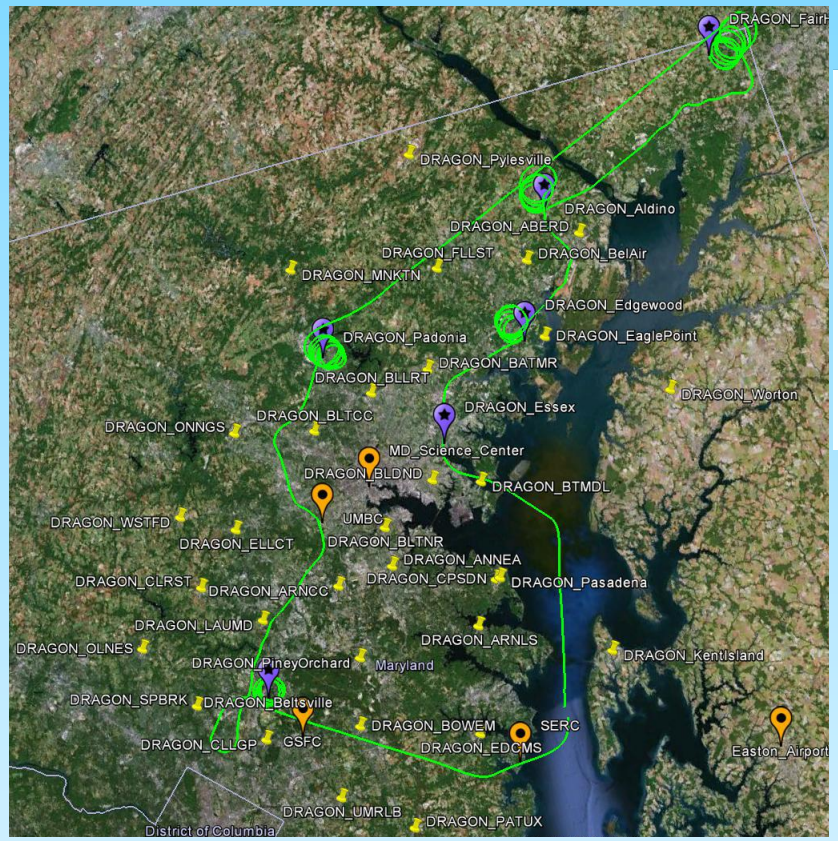
Surface Brightness Mask

Dark (β<0.7)
Dark-Bright (β<1.5)
Bright (β<4)
Very Bright

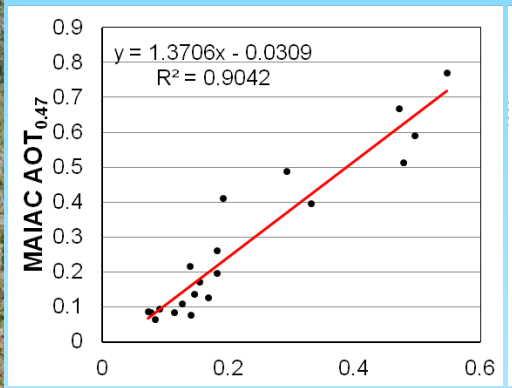
DRAGON USA 2011



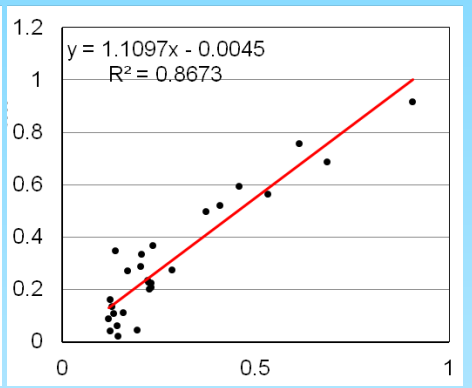
Baltimore – Washington, 2011



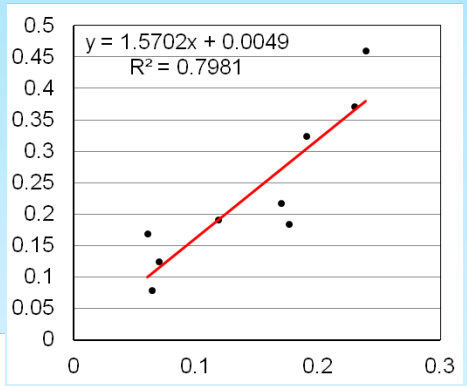
BATMR



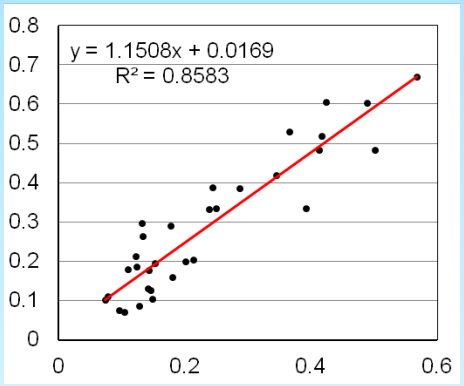
UMBC

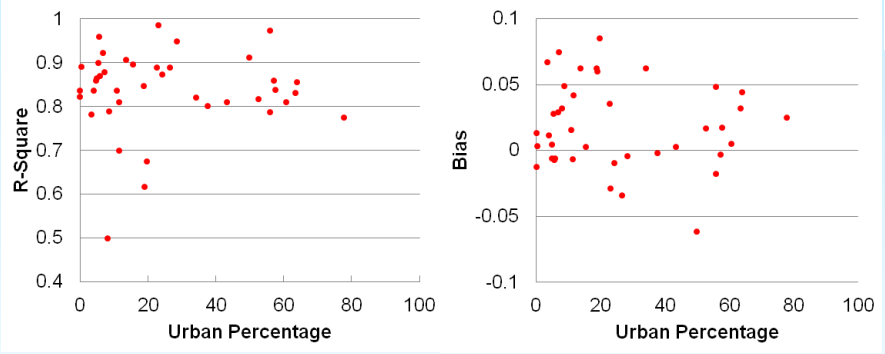


MD_SC_CENTER



ESSEX

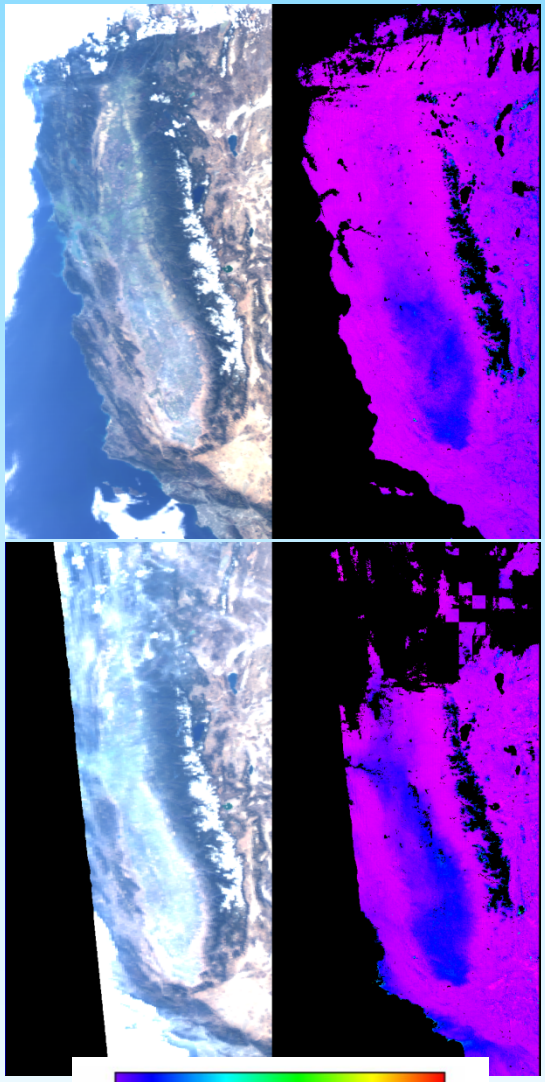




MAIAC did not show decreased performance over urban surfaces over B-W area.

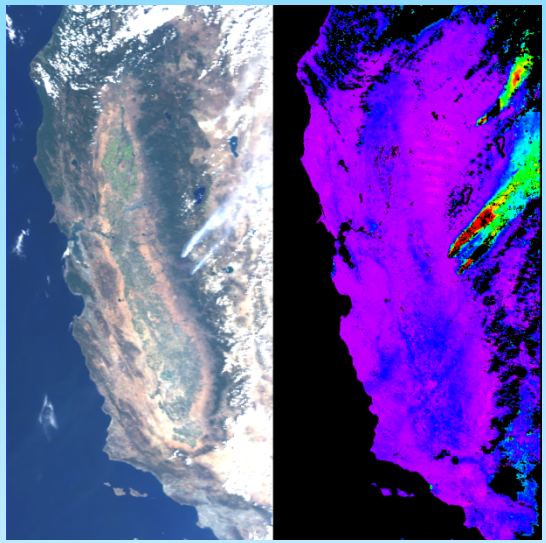
San Joaquin Valley 2012-2013

DOY: 329, 331, 2012



Yosemite Fires, Aug. 2013

248



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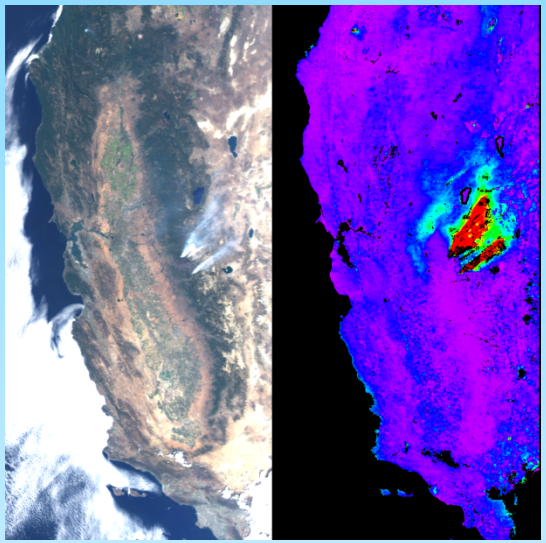

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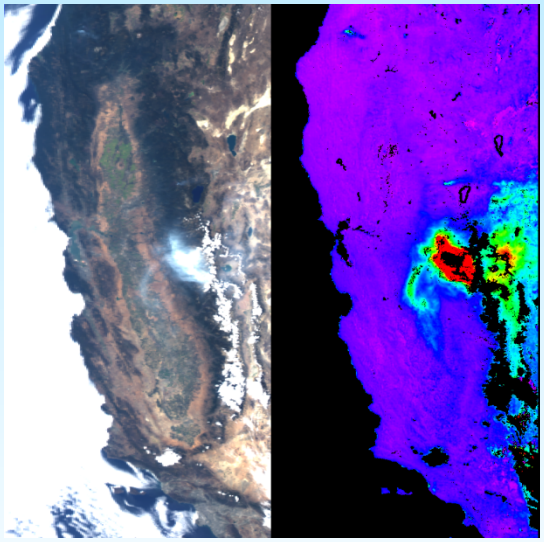

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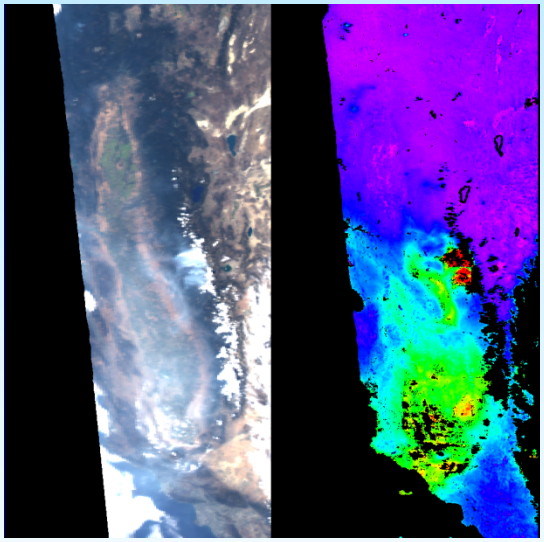
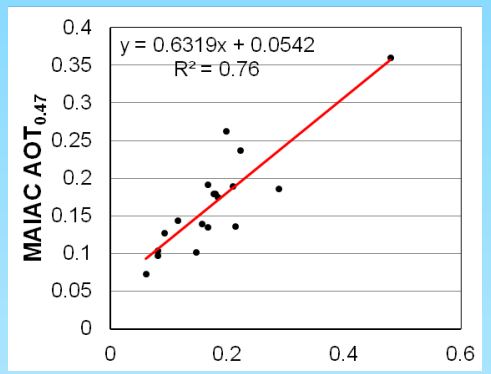
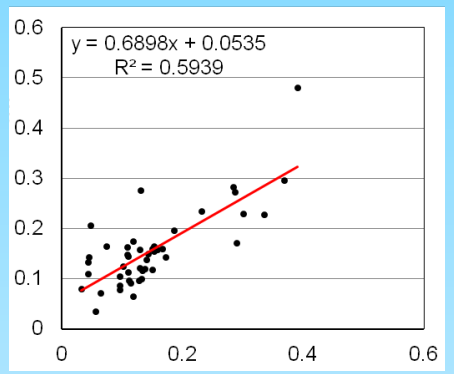


San Joaquin Valley 2012-2013

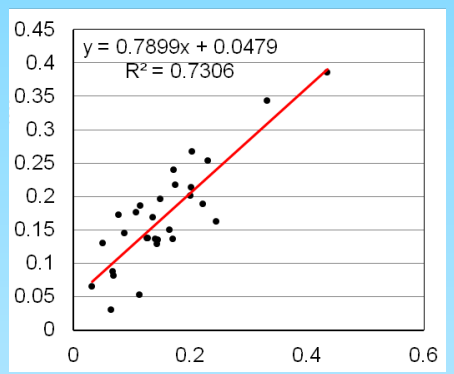
Arvin



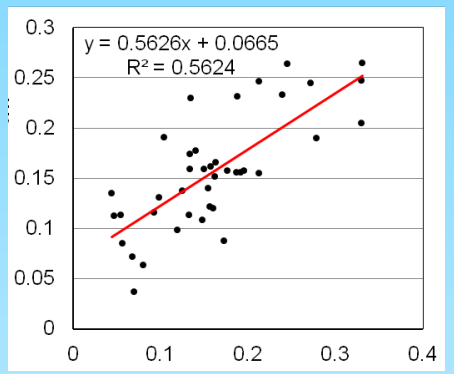
Clovis



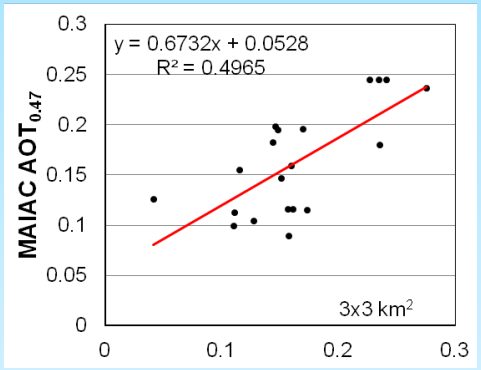
Corcoran



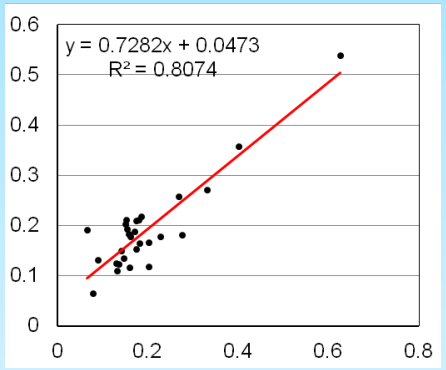
Drummond



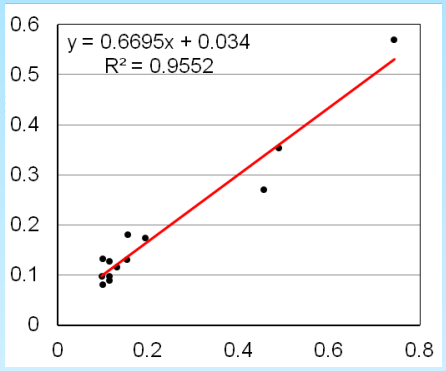
Garland



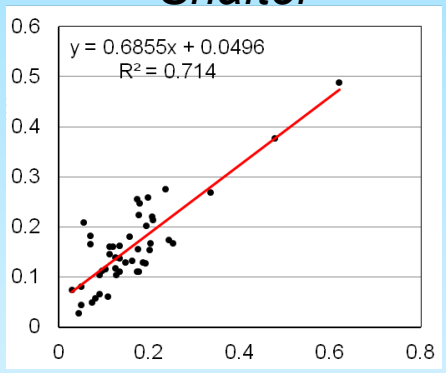
Hanford



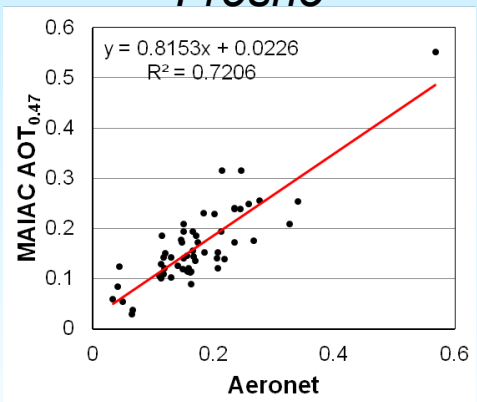
Porterville



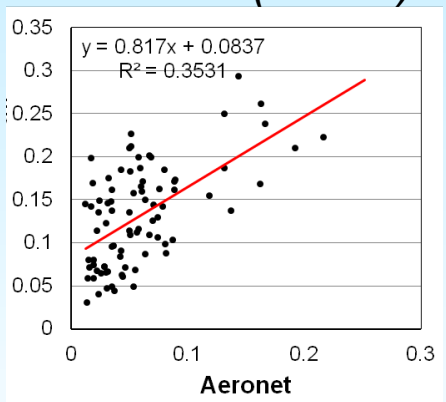
Shafter



Fresno



UCSB (Huron)



El Segundo

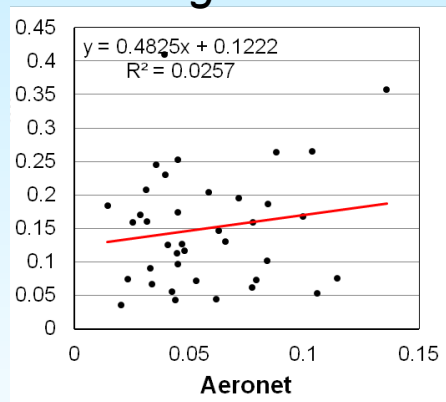
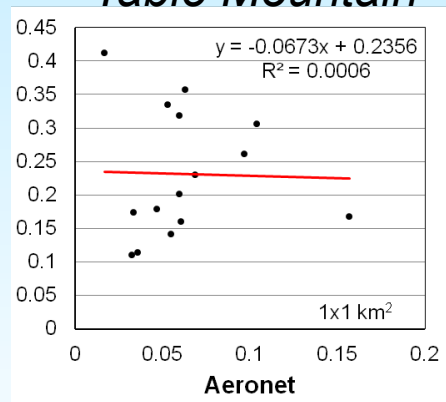
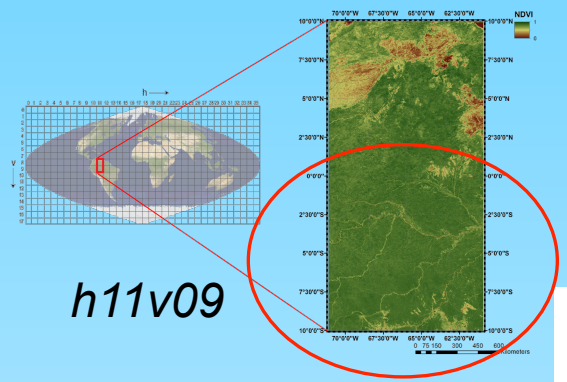


Table Mountain



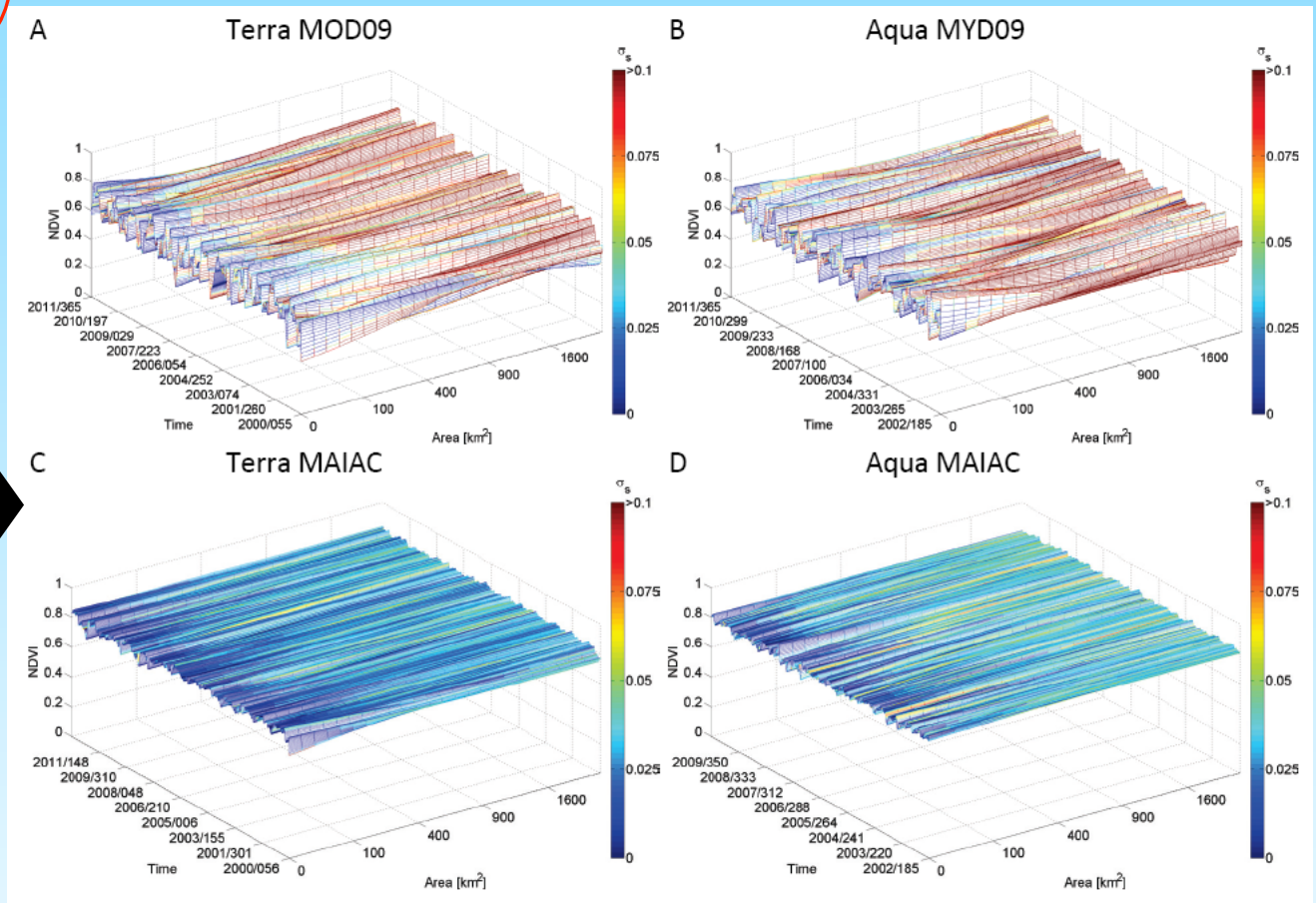
Latest on Amazonia

From T. Hilker



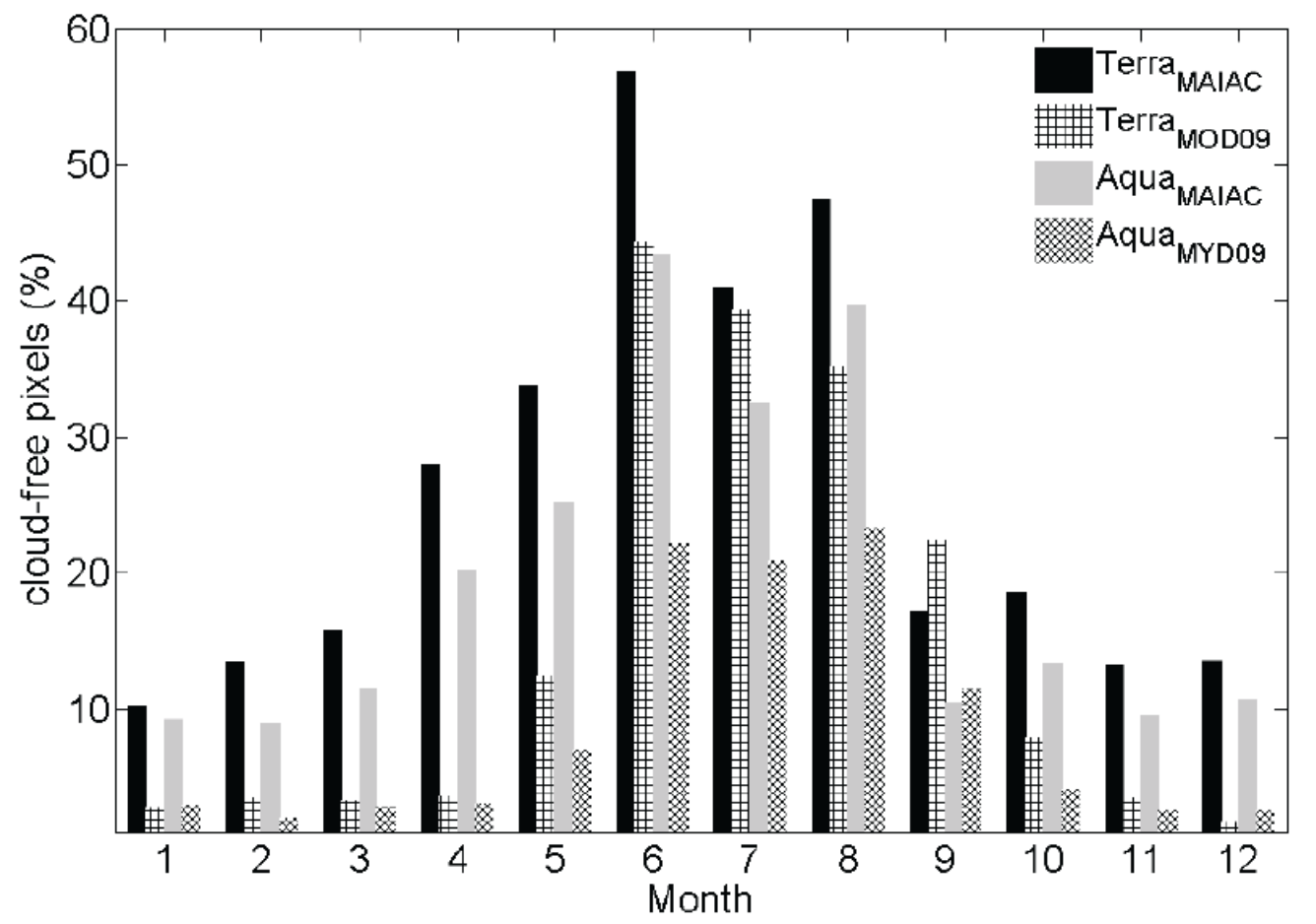
h11v09

Time series of MOD09 and MAIAC NDVI aggregated over area of (2km)^2 to (50km)^2 for MODIS Terra and Aqua. The color shows a standard deviation.



Hilker, T., A. Lyapustin, J. Tucker, P. Sellers, F. Hall, Y. Wang, "Remote Sensing of Tropical Ecosystems: Atmospheric Correction and Cloud Masking Matter," RSE, 2012

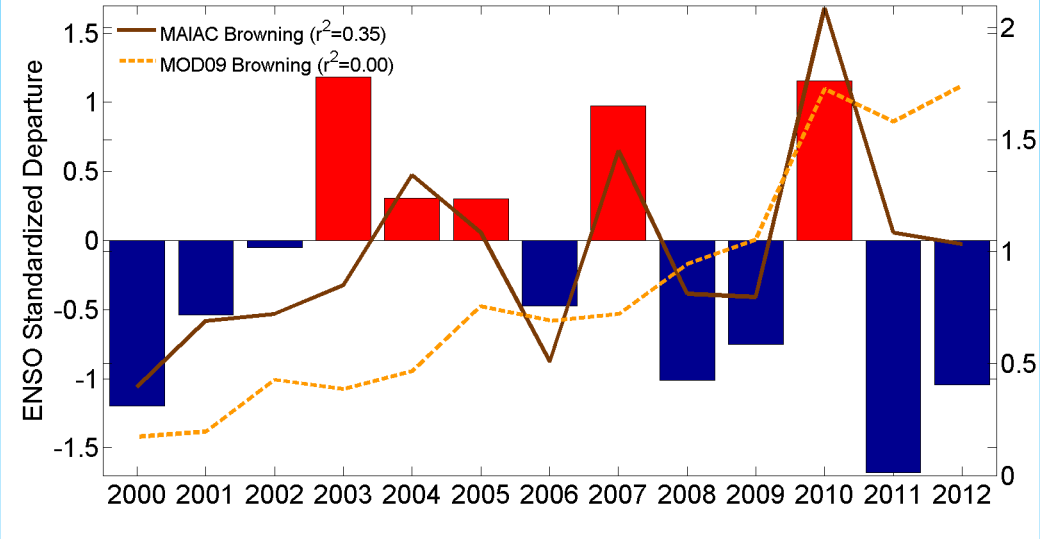
Amazonia: Cloud Mask



Number of cloud-free observations from MAIAC and MOD09 for MODIS Terra and Aqua (yr. 2007)

Amazonia: Anomalies

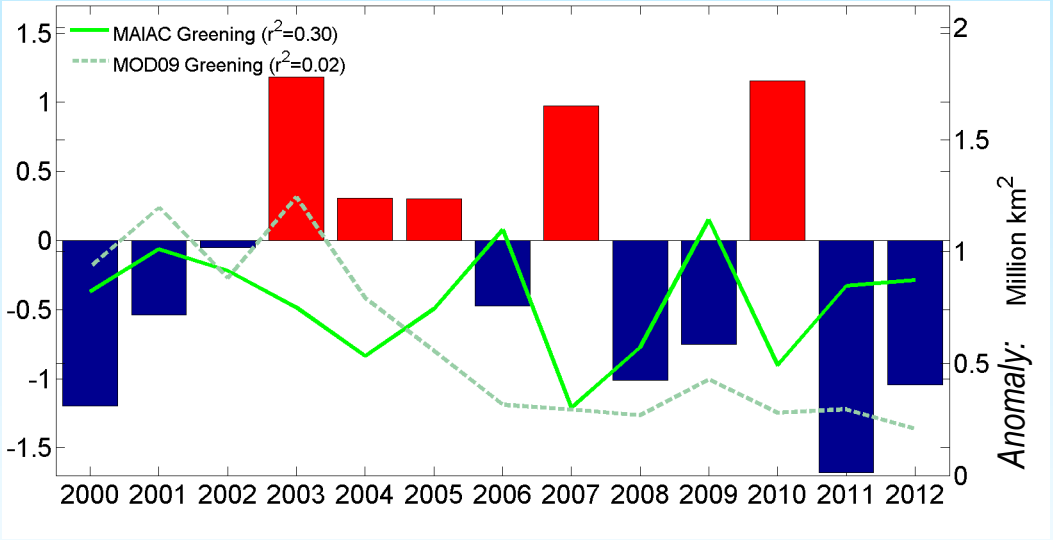
El Ninõ



***Amazon** Browning and Greening Anomalies from MOD09 C5 (dashed) and MAIAC C6 L1B data (solid).*

Anomaly Analysis – Myneni & Jian (BU)
Correlation with MEI – Hilker & Lyapustin

La Ninã



Significant interannual variability in MAIAC B/G anomalies and expected physical correlation with the short-term climate variations.