Update on EPIC MAIAC V2 Algorithm: Atmospheric Correction

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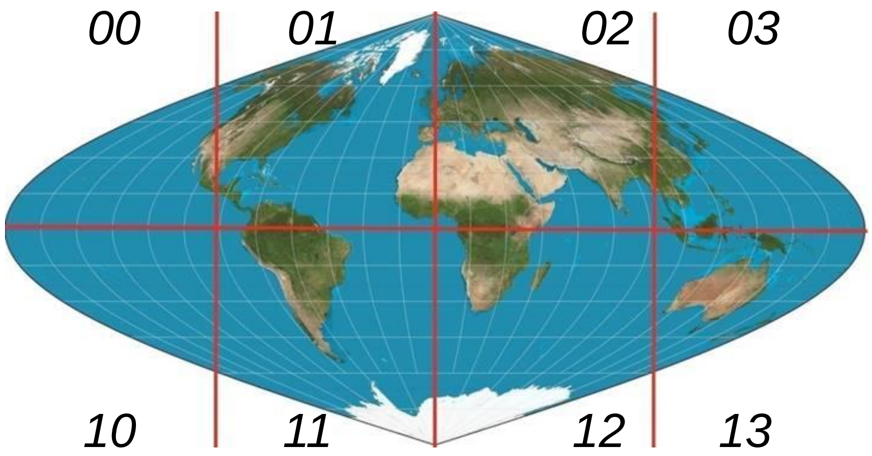
Overview

- *MAIAC v1 processed 2015 – 2019 data*
- *Reported products: CM, QA, $AOD_{0.44}$, spectral BRF, and BRDF model parameters over land; AOD-FMF, water leaving reflectance over ocean*
  - *Global Sinusoidal Projection at 10km resolution (oversampling all bands except Blue)*
- *MAIAC v2 re-processing started, expect to finish within 2-3 weeks*
- *MAIAC V2 features:*
  - *Introduced regional Sinusoidal projection;*
  - *Added anisotropic atmospheric correction using ancillary MAIAC MODIS monthly BRDF (RTLS) database;*
  - *Introduced flexible aerosol algorithm retrieving AOD and spectral refIM(λ) for smoke and dust aerosol*

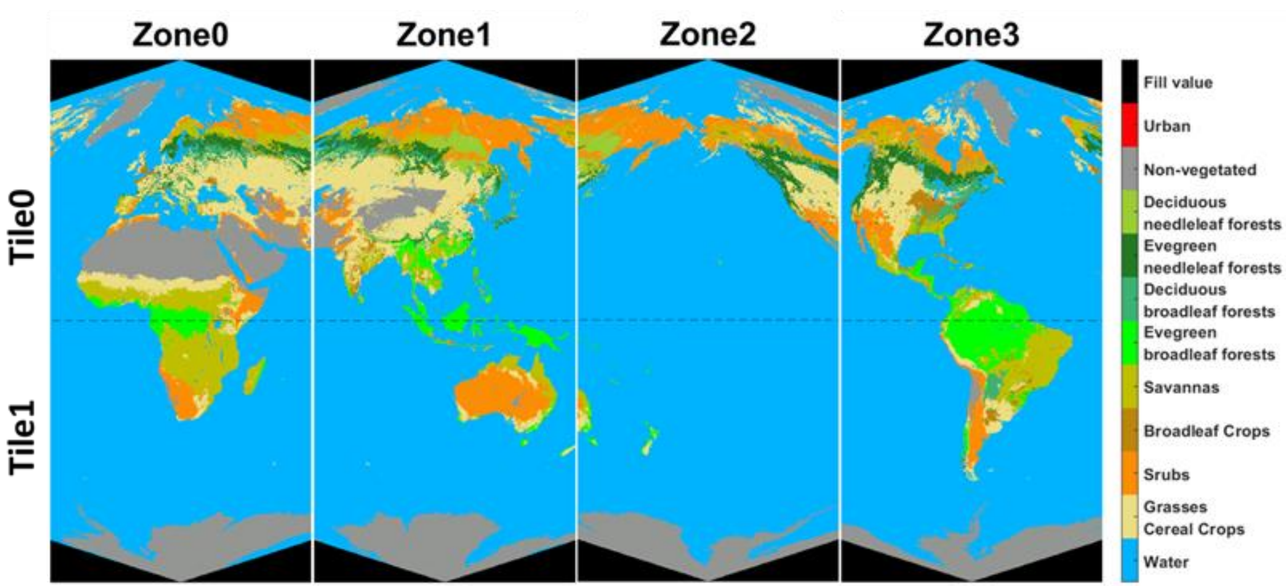
MAIAC v2: Projection



v1 Global Sinusoidal Projection

v2 Regional Sinusoidal Projection

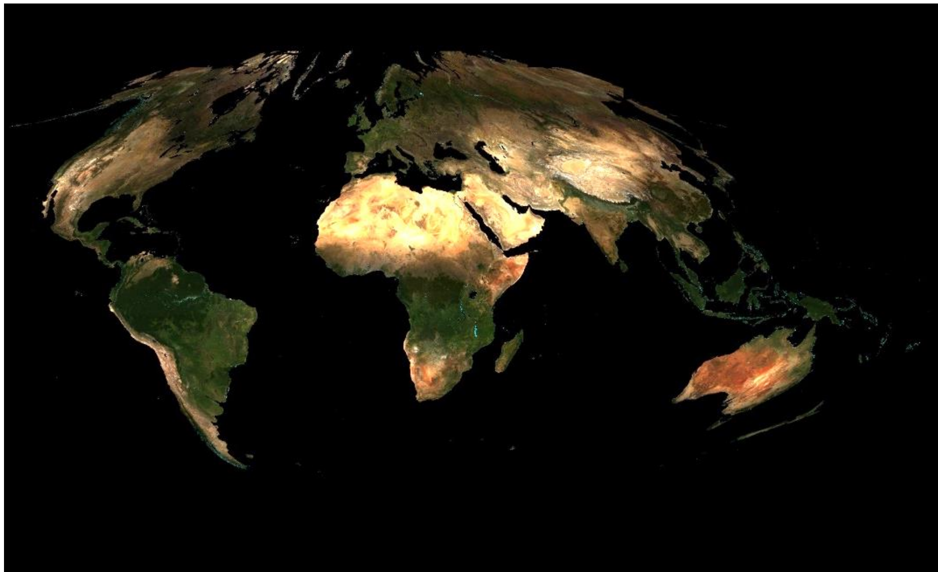
- *The same # pixels*
- *Some limited oversampling*
- *Almost undistorted compared to global Sin*
- *Can be re-projected in global projection without loss of information*



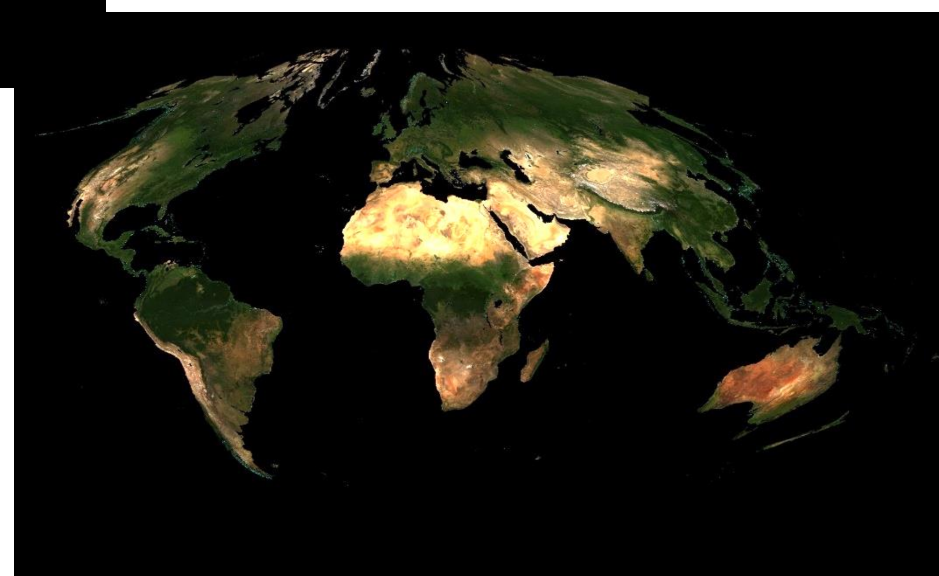
(from Yuri Knyazikhin)

v2: Ancillary MAIAC$_{MODIS}$ RTLS

February 2016



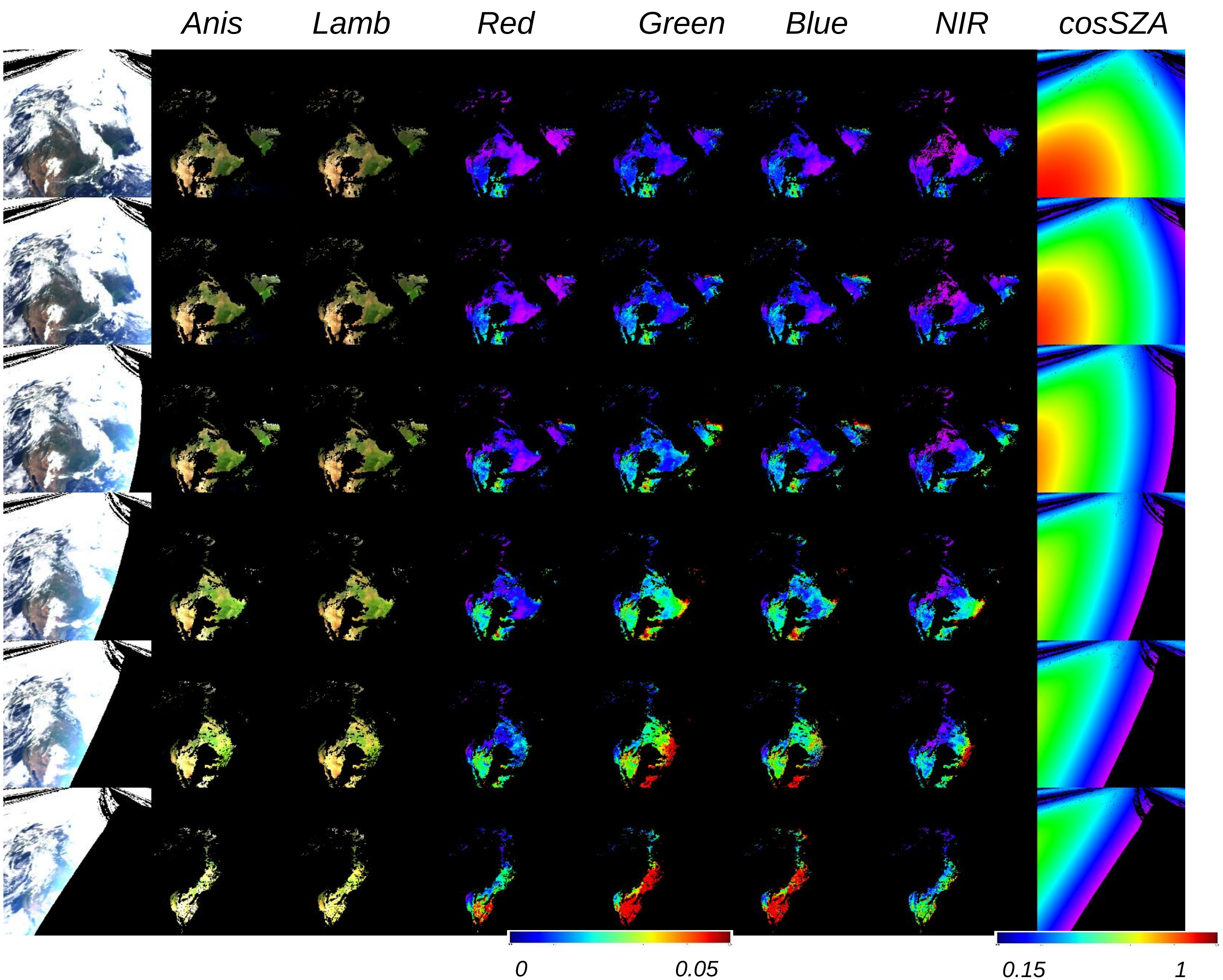
July 2016



Monthly average surface BRDF for every year in RGB and NIR bands from MAIAC MODIS MCD19A3 product

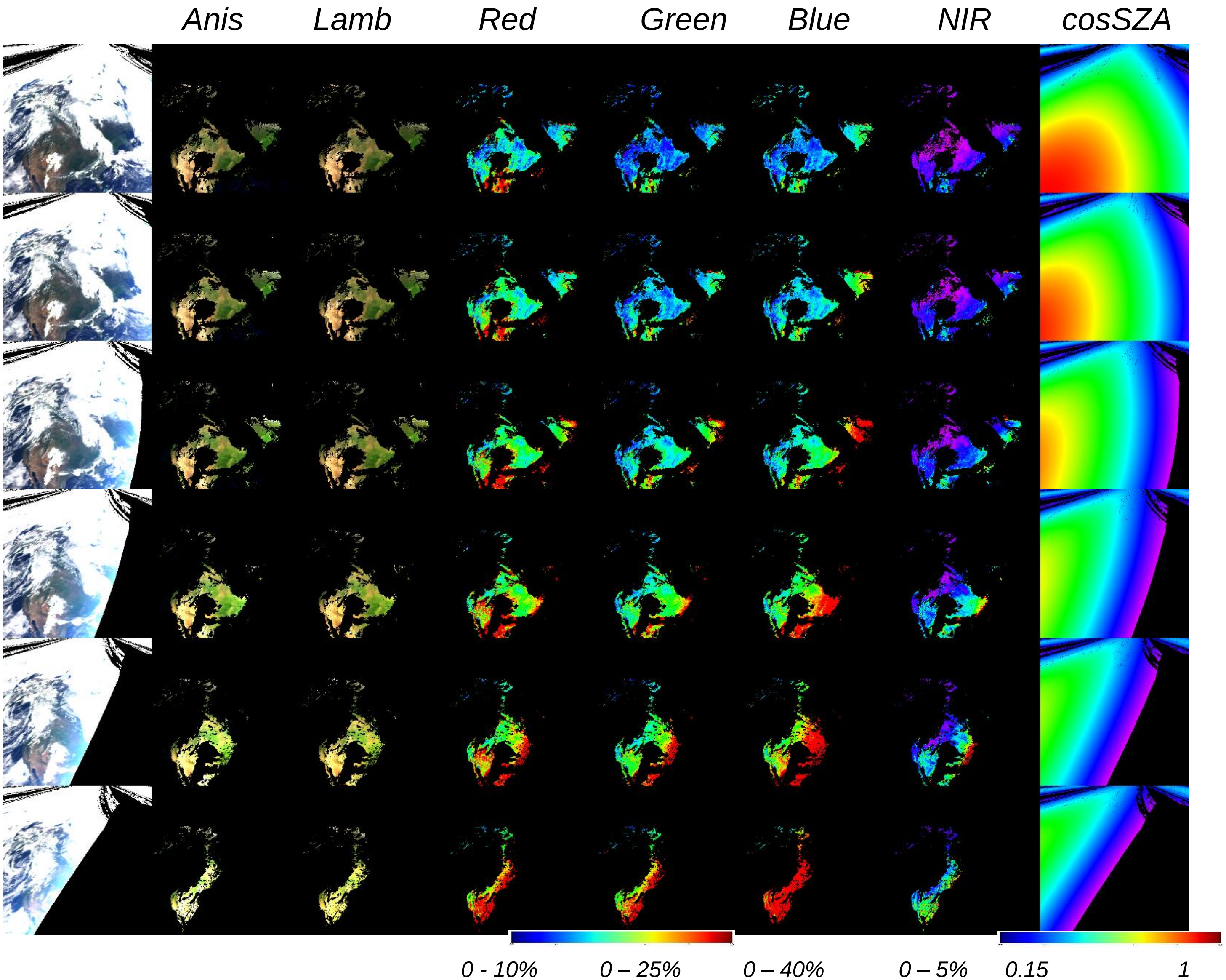
v2 - Atmospheric Correction:

Anisotropic vs Lambertian: Absolute Difference (June 3, 2018)



v2 - Atmospheric Correction:

Anisotropic vs Lambertian: Relative Difference (June 3, 2018)



V2: Processing over Ocean

- *Aerosol is modeled by the fine and coarse modes which are mixed using Linear Mixing Method (LMM). The aerosol retrieval gives AOD and FMF (fine mode fraction) at 0.55 um using optimal fit to measurements at 443, 550, 680 and 780nm.*

- *The atmospheric correction then provides water leaving reflectance at 6 bands, 340, 388, 443, 550, 680 and 780nm.*

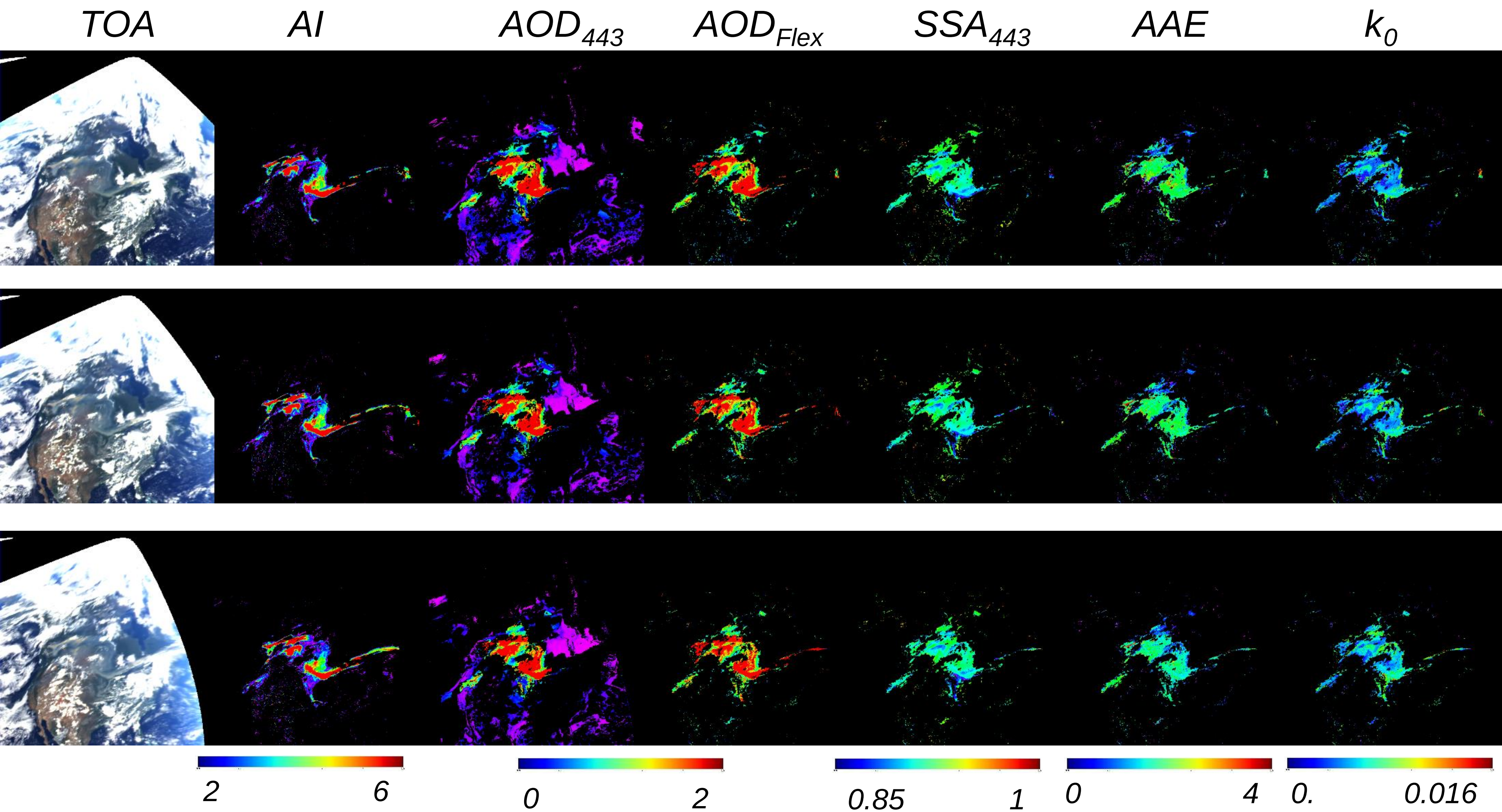
- *The LMM method is designed to mix the diffuse radiation components (e.g. path radiance, diffuse transmittance) only. In v2, we added a rigorous treatment of the direct spectral transmission improving the total accuracy.*

v2: Retrieving AOD and Spectral Absorption

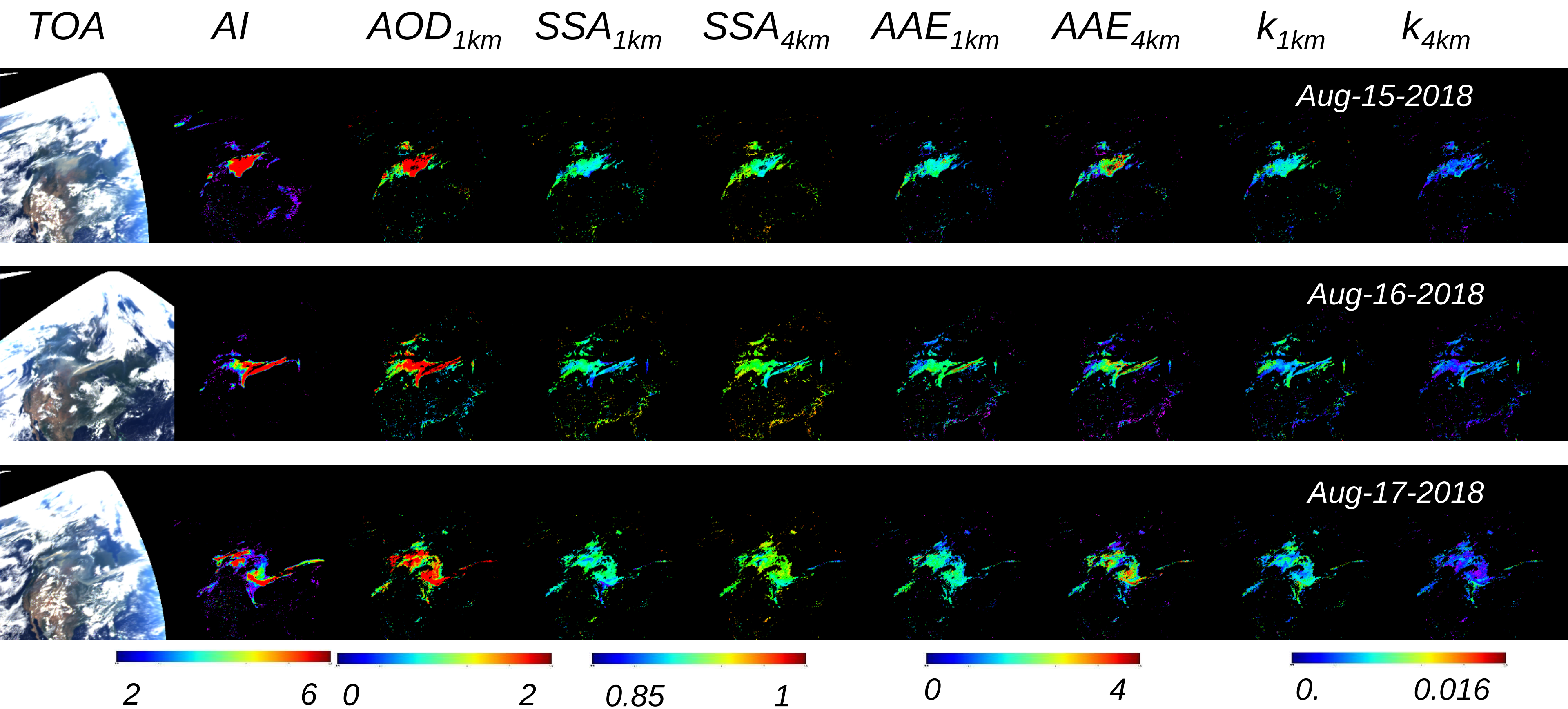
- *Aerosol absorption is a very important property for both direct and indirect (semidirect) aerosol effects. Uncertainty in aerosol absorption is one of largest sources of uncertainty in climate projections (IPCC 2013).*
- *Knowledge of spectral aerosol absorption is a path to aerosol speciation. For instance, black-organic carbon partitioning for smoke is an essential information for the climate/RB models and for the air quality – epidemiology (health associations) studies.*
- *TOMS, OMI were the first instruments providing initially qualitative (AI) and later quantitative (SSA) information on aerosol absorption from pioneering works of Torres et al (Herman et al., 1997; Torres et al., 1998, 2002, 2018; Jethva et al., 2014). UV channels are key.*
- *The baseline OMAERUV algorithm (Torres et al., 2007) retrieves AOD-SSA from 2 channels 340-388nm assuming spectral dependence of absorption. Because of aerosol height sensitivity, it is reported for several heights (0, 1.5, 3, 6, 10 km). Later versions use ancillary information on spectral absorption (AERONET) and regional-seasonal height (CALIOP CALLIPSO) (Torres et al., 2013).*
- ***v2 algorithm**:*
  - *Absorbing smoke and dust aerosols detection using AI (340-388);*
  - *New AOD-refIM-AAE retrieval using Levenberg-Marquart optimal fit of 340, 388, 443 and 680nm. Absorption model:* $k_\lambda = k_0 (\lambda / \lambda_0)^{-b}$ *for* $\lambda < \lambda_0$ *, where* λ_0 *= 680nm;*
  - *Real refIM and size distribution are fixed. The results are reported for* H^a*=1 and 4km.*

Biomass Burning: NA, 2018

August 17, 2018



Effect of Aerosol Height



1. Retrieved aerosol absorption is lower for elevated aerosols (as it should be).
2. Knowledge of height is important for interpretation: an apparent increase of AAE and decrease of refIM (k) for elevated layer would point to more organic carbon and less black carbon in aerosol particles.

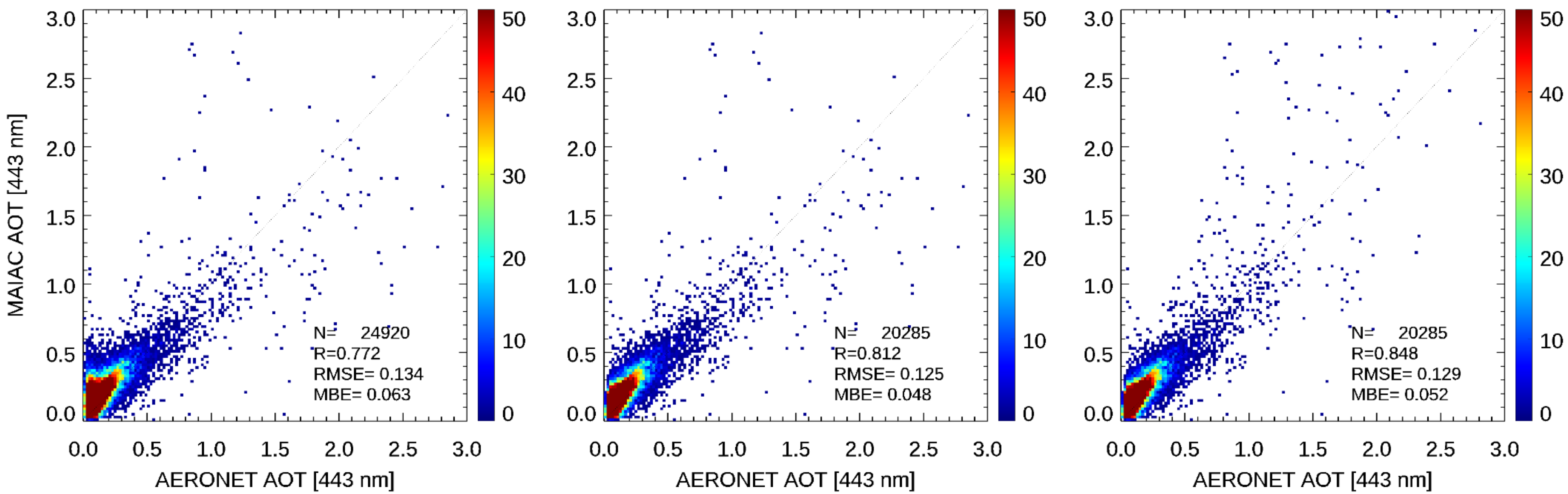
AOD Validation: NA, 2018

All sites (114)

Excluded 11 bright surface sites (103)

w/o LevMar

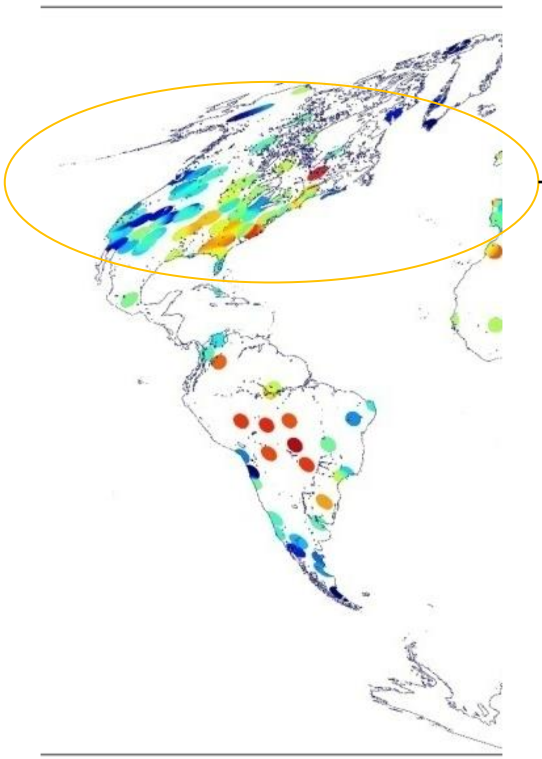
w/ LevMar



Excluded sites: Bakersfield; Goldstone; KeyBiscayne; Neon_ONAQ; Railroad Valley; Sandila_NM_PSEL; TableMountain_CA; Tucson; UACJ_UNAM_ORS, White_Sands_HELSTF, Yuma

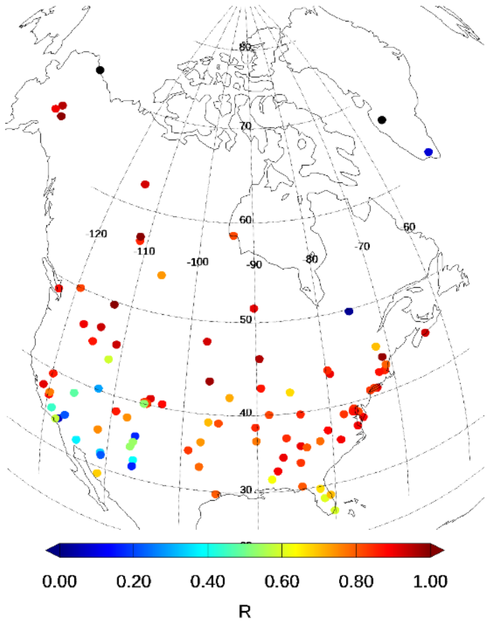
AOD Validation: NA-SA, v1 vs v2

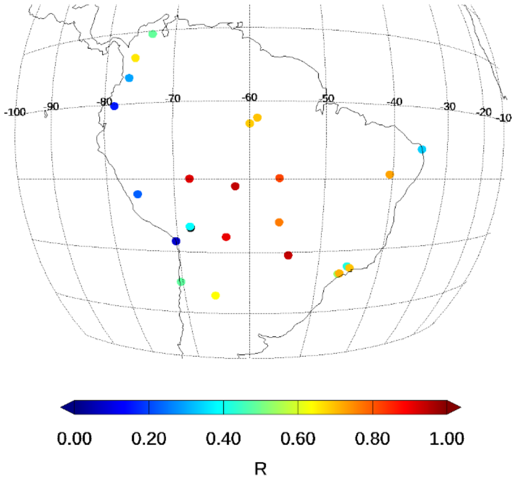
v1



Significant improvement

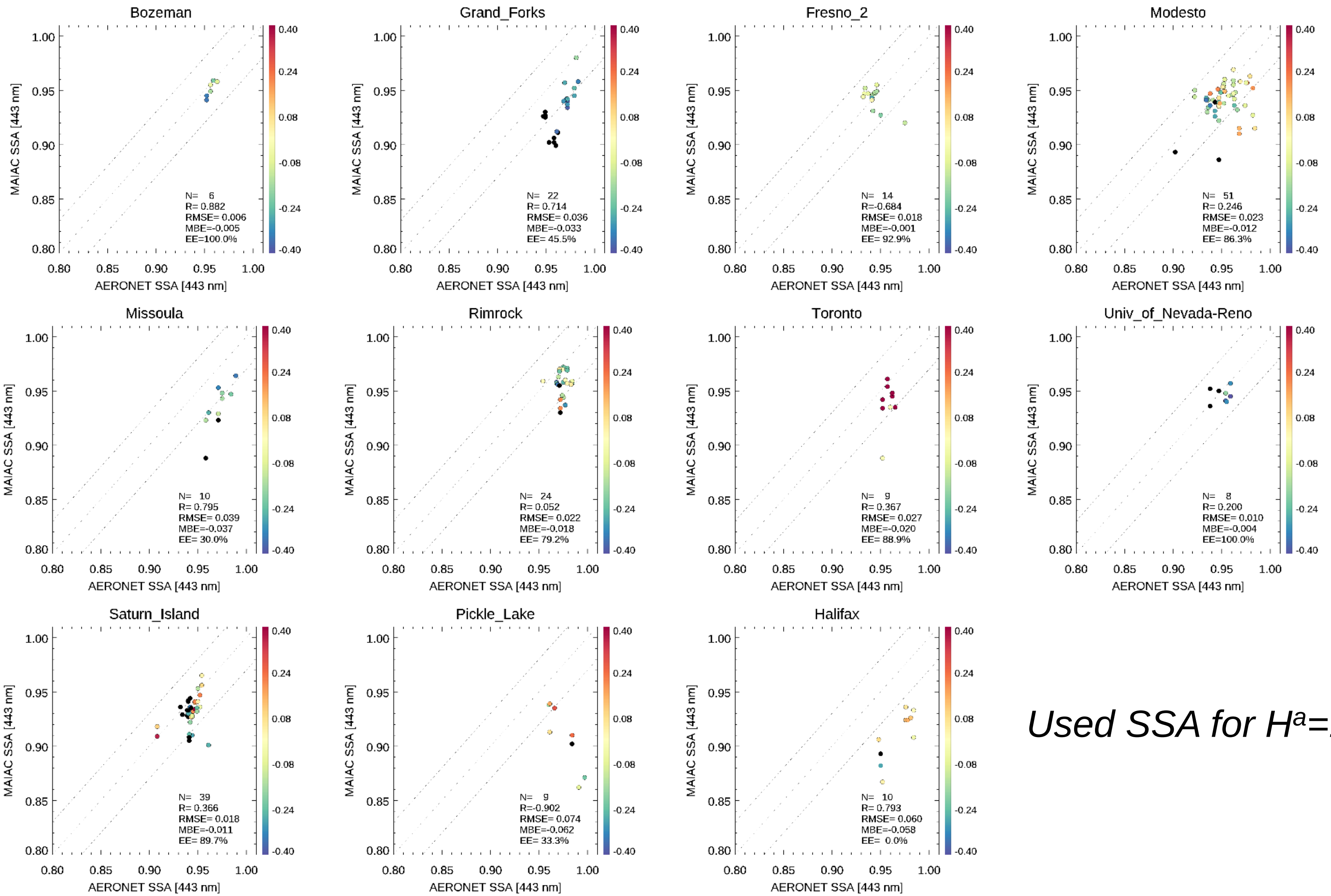
v2





SSA_{443} Validation: NA, 2018

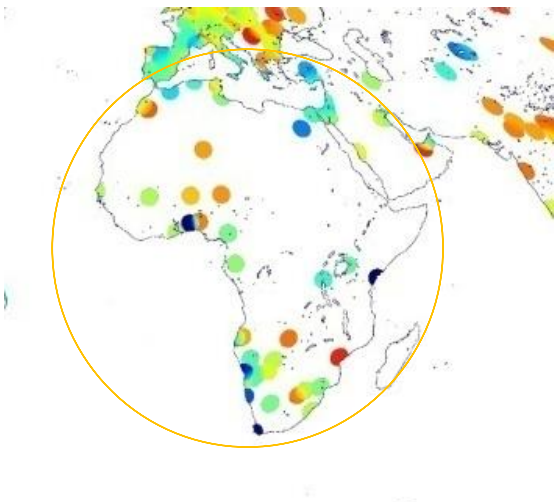
MAIAC AOT > 0.6, AERONET AOT > 0.6



Used SSA for H^a=1km

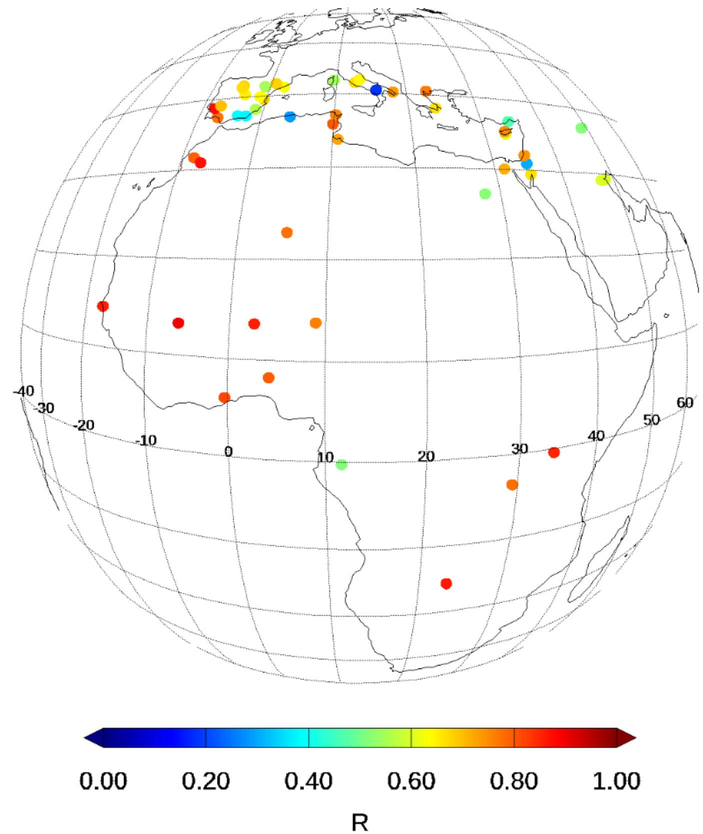
Mineral Dust, 2018
AOD Validation: Africa, v1 vs v2

v1



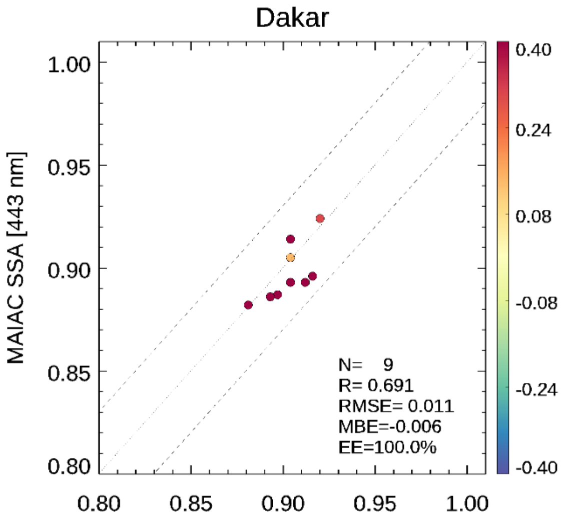
improvement

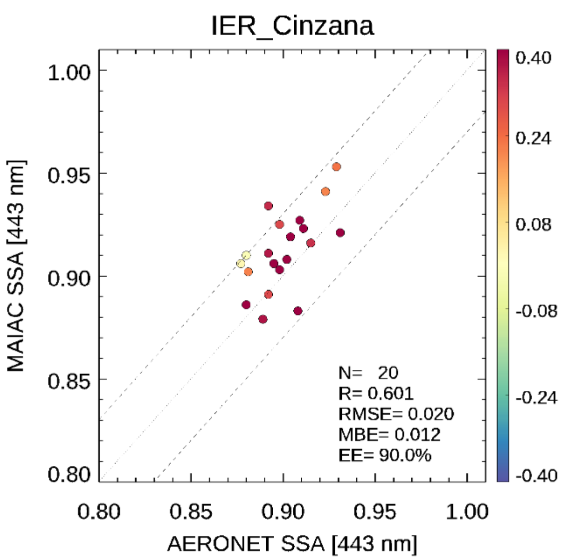
v2



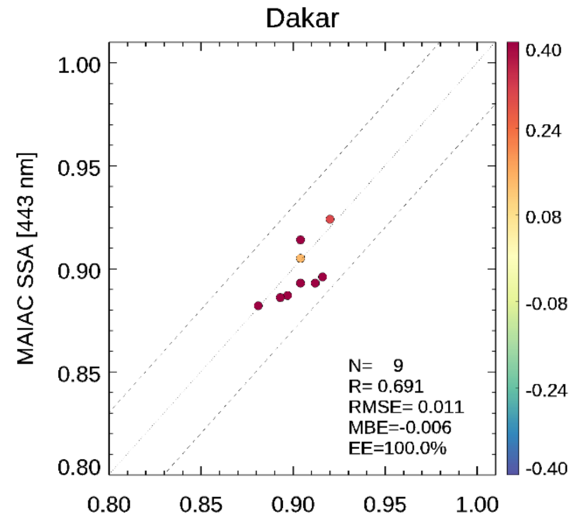
SSA_{443} Validation: 2018

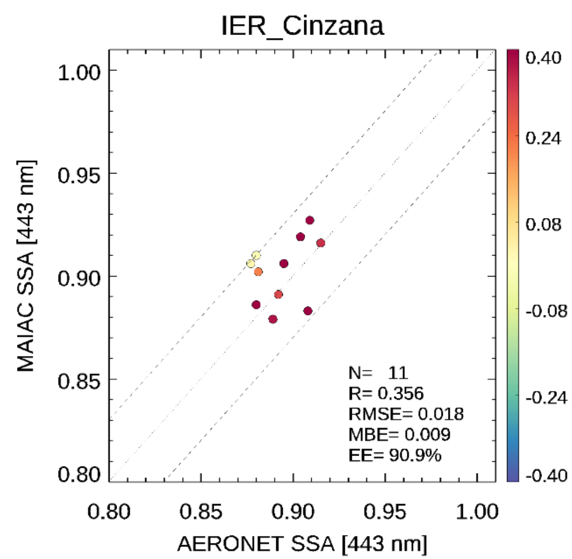
MAIAC AOT > 0.6
AERONET AOT > 0.4





MAIAC AOT > 0.6
AERONET AOT > 0.6

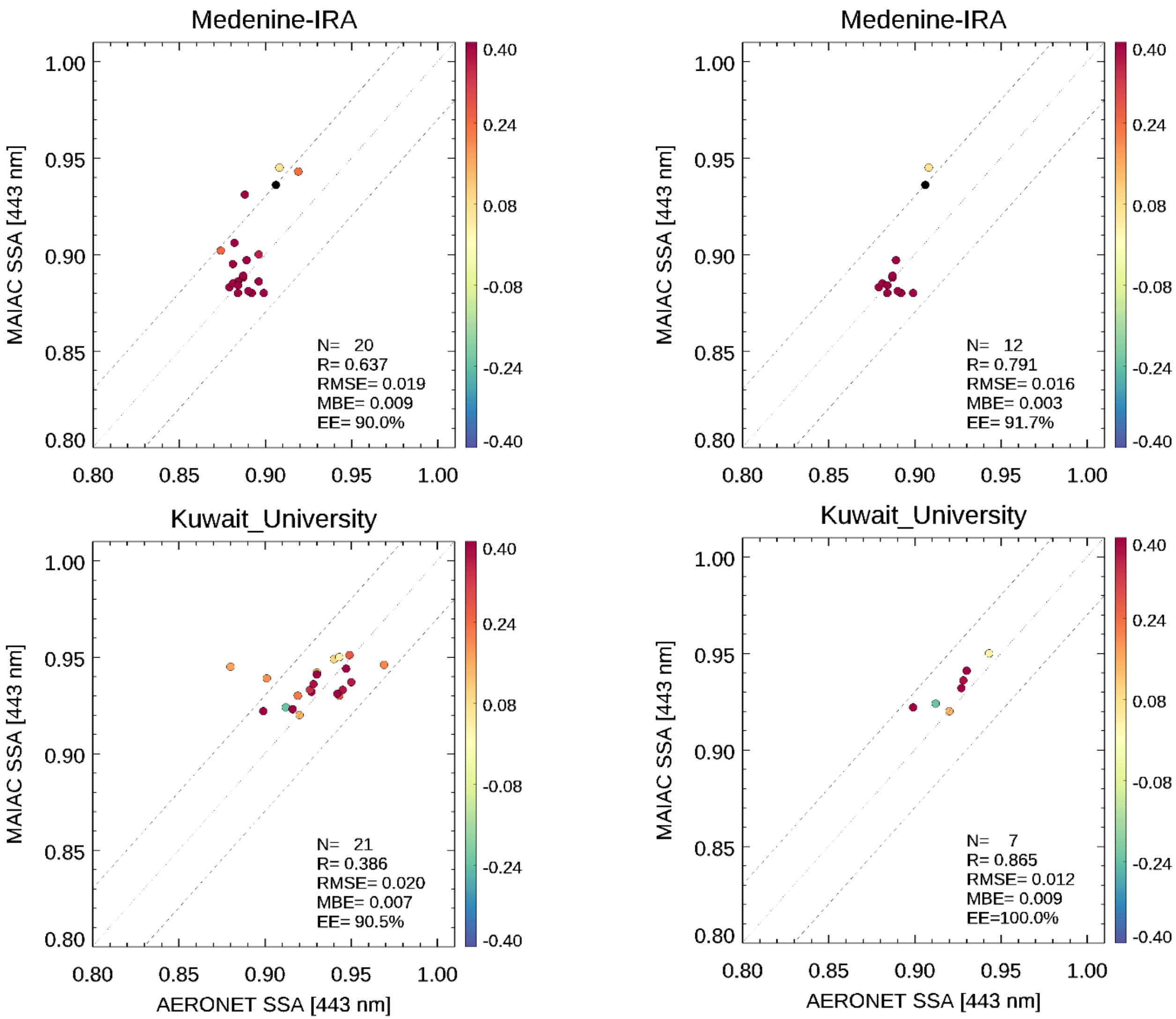




SSA_{443} Validation: 2018

MAIAC AOT > 0.6
AERONET AOT > 0.4

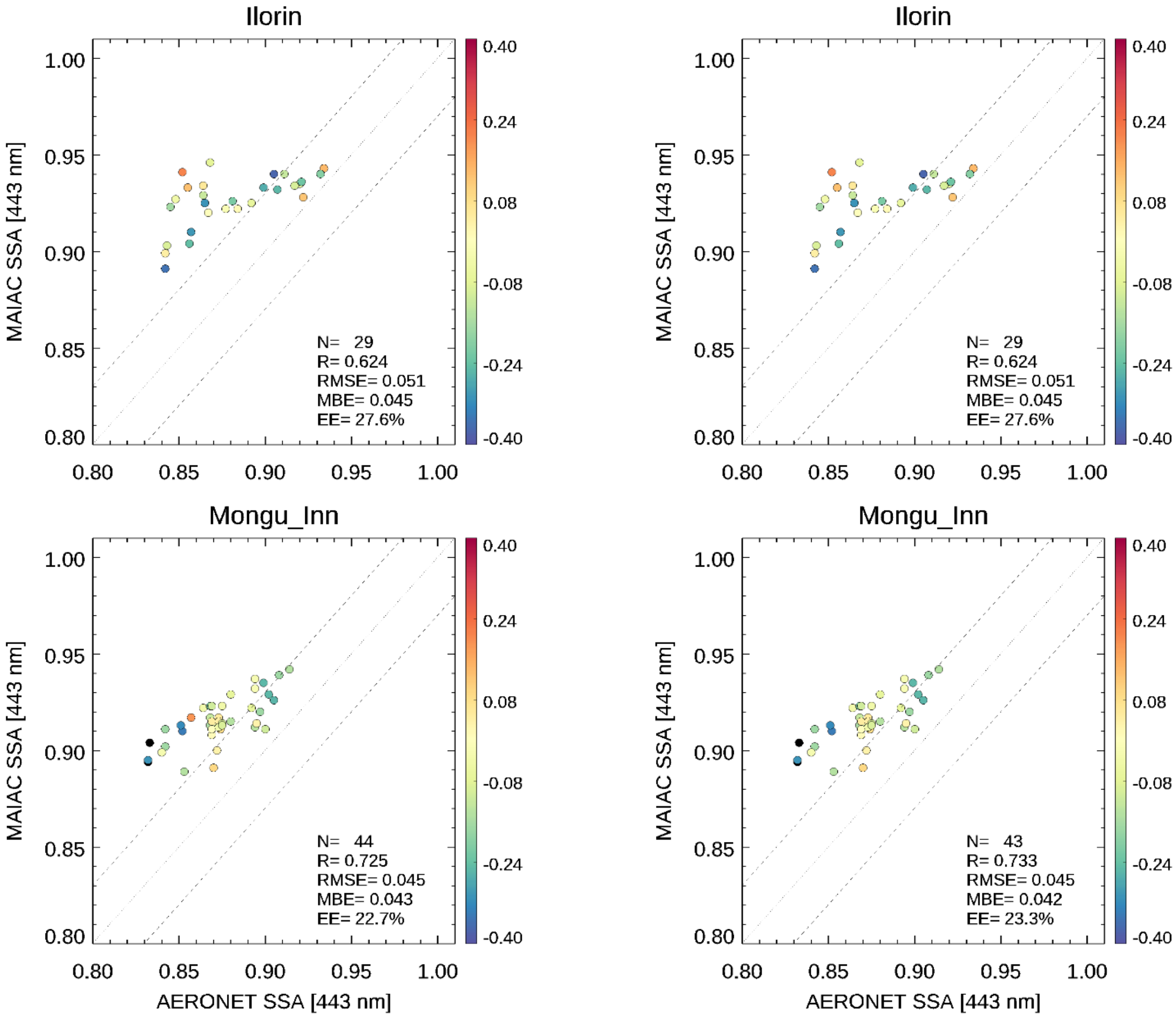
MAIAC AOT > 0.6
AERONET AOT > 0.6



SSA_{443} Validation: 2018

MAIAC AOT > 0.6
AERONET AOT > 0.4

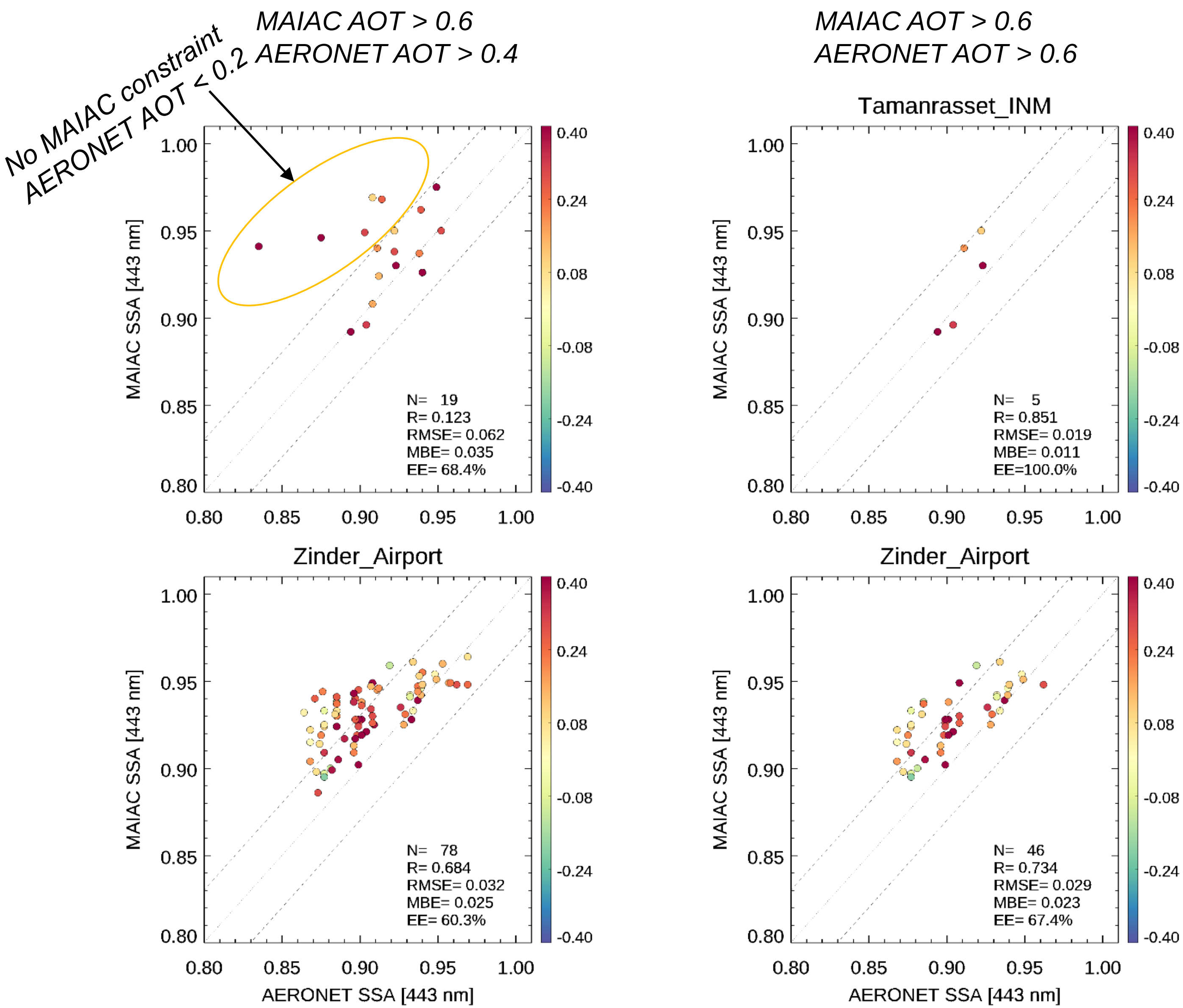
MAIAC AOT > 0.6
AERONET AOT > 0.6



Mixture of Dust and Biomass Burning

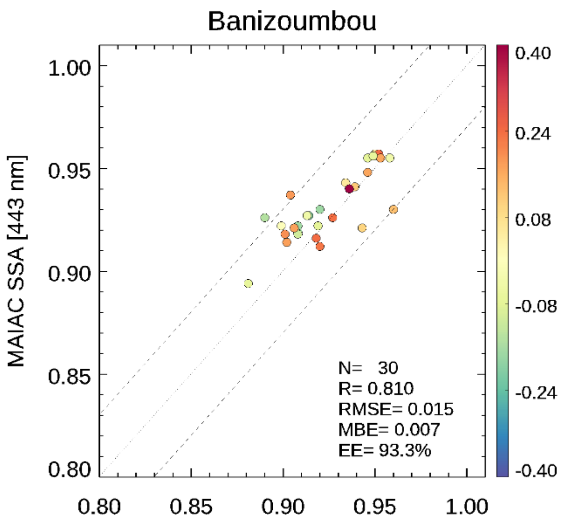
Biomass Burning

SSA_{443} Validation: 2018



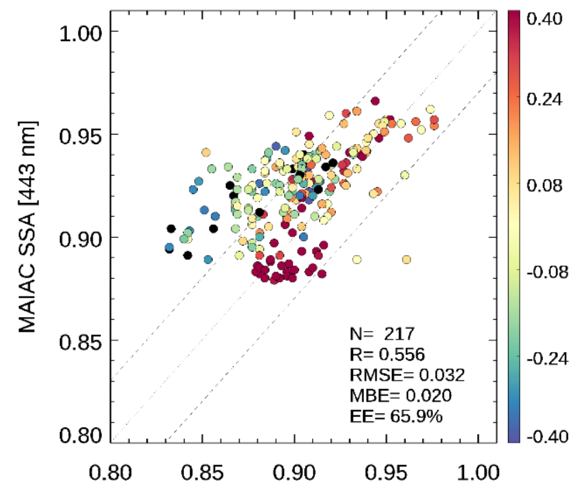
Dust SSA_{443} Validation: 2018

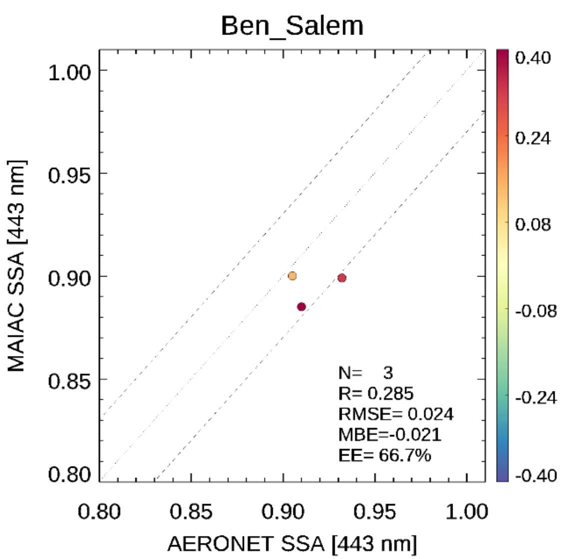
MAIAC AOT > 0.6
AERONET AOT > 0.6



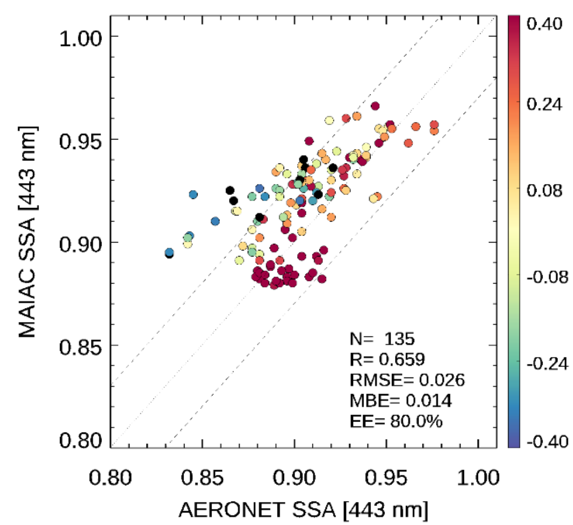
Total

MAIAC AOT > 0.6
AERONET AOT > 0.6

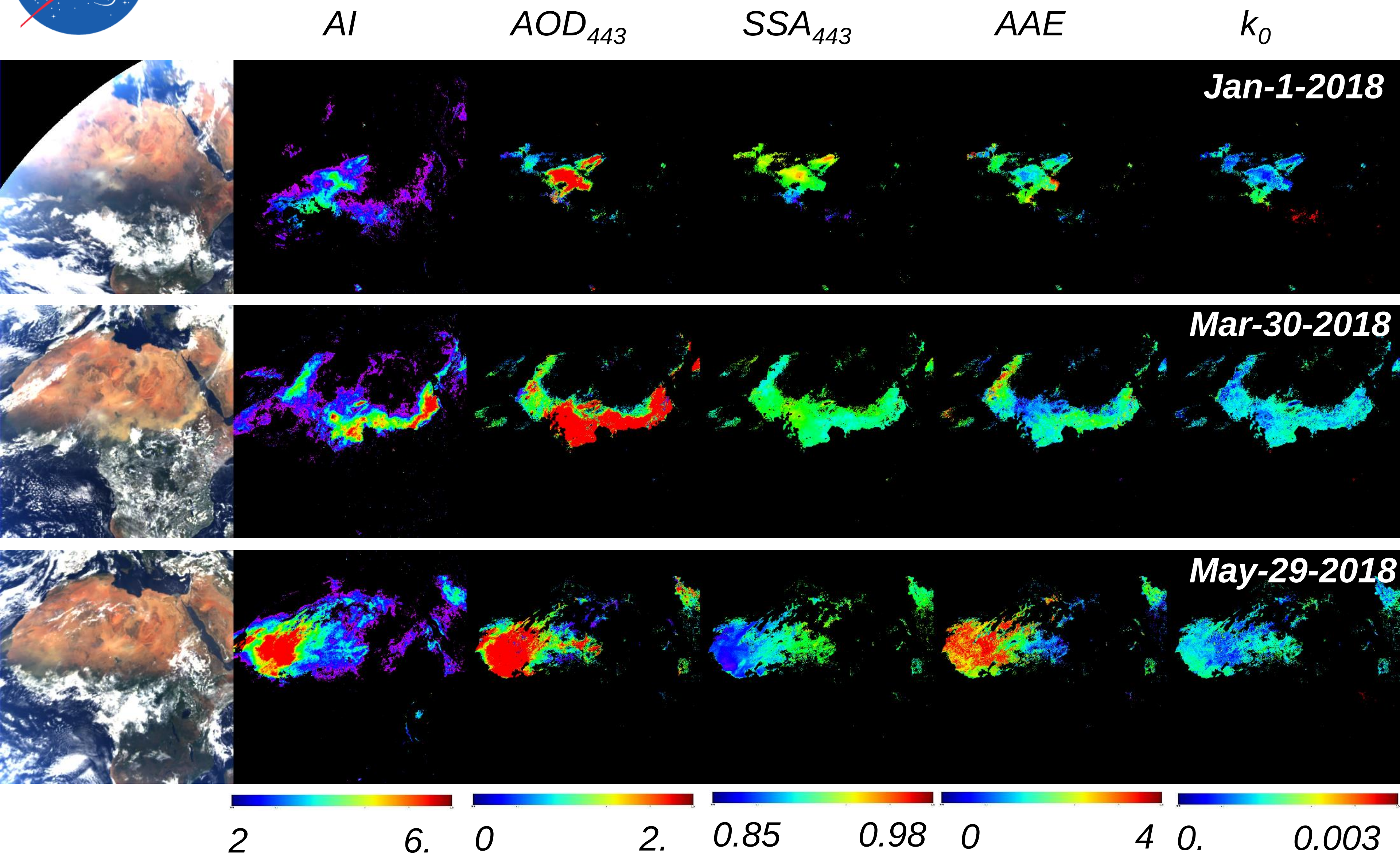




MAIAC AOT > 0.8
AERONET AOT > 0.6



Dust Sources: Different Absorption



Conclusions

- ***MAIAC v2 is entering re-processing***
- ***MAIAC v2 features:***
  - *Anisotropic atmospheric correction which is important in the EPIC's backscattering sun-view geometry;*
  - *Improved aerosol retrievals vis-a-vis v1*
  - *New joint retrieval of AOD and spectral absorption*
- ***Near term plans:***
  - *2-3 publications in preparation*
  - *Compare with other sources and make global analysis of absorption data from EPIC*
  - ***Study possibility of simultaneous aerosol height retrieval by adding A, B O_2-bands***