



# Assimilation of Satellite Aerosol Observations Into NASA LaRC's CERES SYN1deg Data Product – Validation and Effect on Surface Radiative Transfer Results



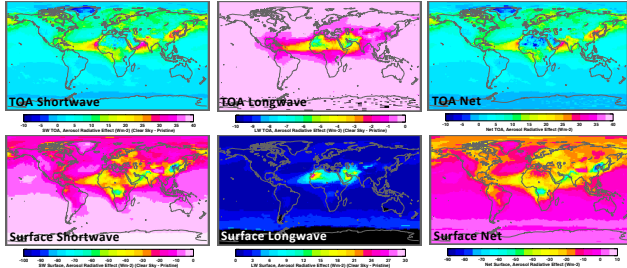
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## CERES: SYN1Deg Ed 4.1 Data Product

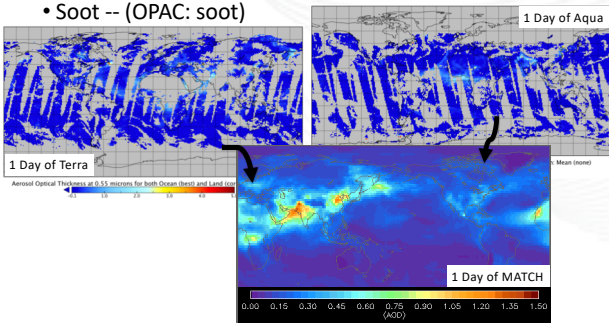
Globally complete radiative transfer solution. Hourly temporal 1° spatial resolution. 7 Vertical levels (Sfc, 850, 500, 200, 70, 0hPa). Complete Mar 2000 through Oct 2018.

### Aerosol Direct Radiative Effect (Clear-Pristine) (Jul 2010)



## Model of Transport and Atmospheric Chemistry (MATCH)

- “Small GCM” running chemistry package at ~2° resolution, interpolates 3 hr wind fields for 30min step for physics package.
- Assimilate MODIS aerosol optical thickness:
  - Col6.1 swath level Terra (MOD04\_L2) and Aqua (MYD04\_L2)
  - Dark Target Ocean, Dark Target Land, Deep Blue Land
  - Average where both exist, weight MODIS AOD higher than climatological sources.
- Aerosol type determines optical properties:
  - Single scatter albedo, scattering phase function
  - Radiation transfer model includes up to 7 weighted profiles.
    - Small/Large Dust (</>0.5µm) -- (Sinyuk et al. (2003) )
    - Sea Salt -- (D’Almeida (1991) maritime)
    - Stratospheric -- (OPAC: suso)
    - Soluble/Insoluble -- (OPAC: waso/inso)
    - Soot -- (OPAC: soot)

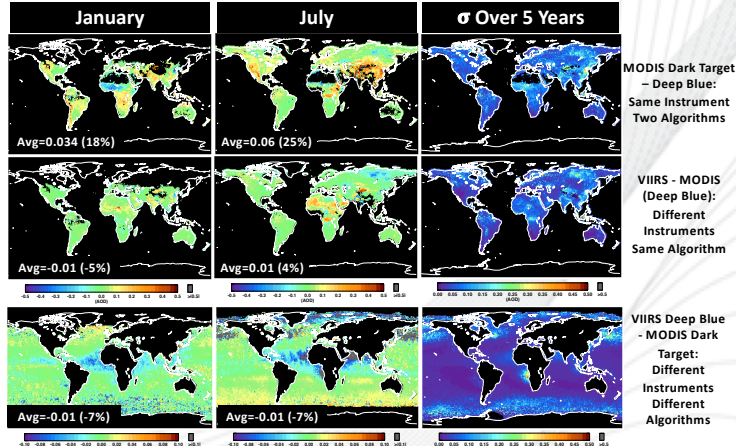


MATCH runs in advance of RT model to provide globally complete maps of AOD and aerosol types at hourly temporal resolution.

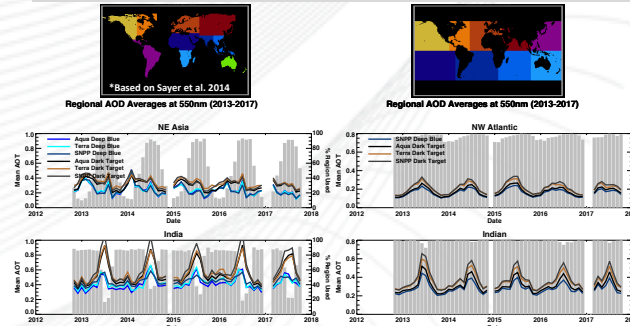
## MATCH Depends Heavily on Satellite Retrieval of AOD

With advent of VIIRS on Suomi NPP and JPSS1 new AOD streams exist and will need to be used.

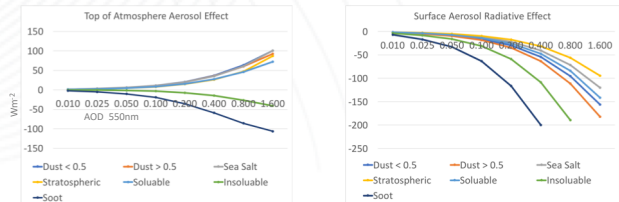
### Canonical Mean Differences (2012 to 2017) (AOD 550nm)



### Regional Time series show monthly mean AOD (550nm)



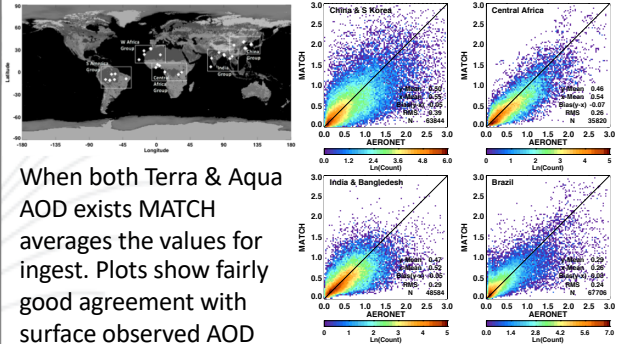
### Direct Aerosol Effect by Type (Langley Fu & Liou RT Code)



Spatial and temporal plots above give sense of AOD variance of associated with different instruments and algorithms. Bottom two plots indicate sensitivity of direct aerosol radiative effect on RT model to varying AOD.

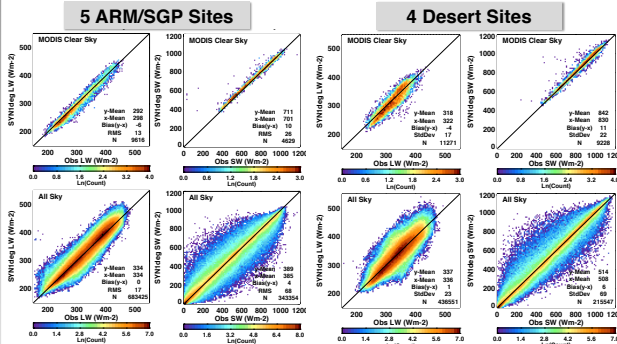
## MATCH AOD compared to AERONET

After assimilation through the MATCH model, AOD has been ‘smoothed’. Compare directly to AERONET:



When both Terra & Aqua AOD exists MATCH averages the values for ingest. Plots show fairly good agreement with surface observed AOD with mean bias on the order of 10% to 15%.

Overall, uncertainty of clear sky calculations can only be assessed using surface observed fluxes. (Define clear sky here as a grid box in which site is located is 100% clear according to MODIS pixel cloud estimates for the local hour of overpass. 19 Years 2000 through 2018)



We estimate hourly uncertainty of clear sky surface down calculations as weighted averages of group statistics:

Hourly SYN1deg Clear Sky Surface Uncertainty	BSRN (19)	SGP(5)	SURFRAD (7)	Desert (4)	Buoys (46)	All	
<b>SW</b> (All Wm2, except “Count”)	Obs Avg Bias (σ)	714 8(32)	701 10(26)	746 1(26)	830 11(22)	871 6(73)	773 8(28)
	Count	2422	4629	3833	9228	544	20656
<b>LW</b> (All Wm2, except “Count”)	Obs Avg Bias (σ)	290 0(16)	298 -6(13)	293 -5(14)	322 -4(17)	378 -4(26)	305 -4(15)
	Count	4914	9616	9156	11271	620	35577