
# ICAP Meeting
# AERONET Update

**GSFC Team**

David Giles

Brent Holben (Emeritus)

Tom Eck

Alexander Smirnov

Aliaksandr Siniuk

Joel Schafer

Ilya Slutsker

Mikhail Sorokin

Jason Kraft

Amy Scully

Arsenio Menendez

Giuseppe Zibordi

**University of Lille-1 Team**

Philippe Goloub

Luc Blarel

Thierry Podvin

Alexander Lapionak

Gael Dubois

Qjaoyun Hu

**Universidad de Valladolid Team**

Victoria Cachorro

Carlos Toledano

Ramiro Caton

**NEON Team**

Janae Csvina

Steven Matthews

**CARSNET Team**

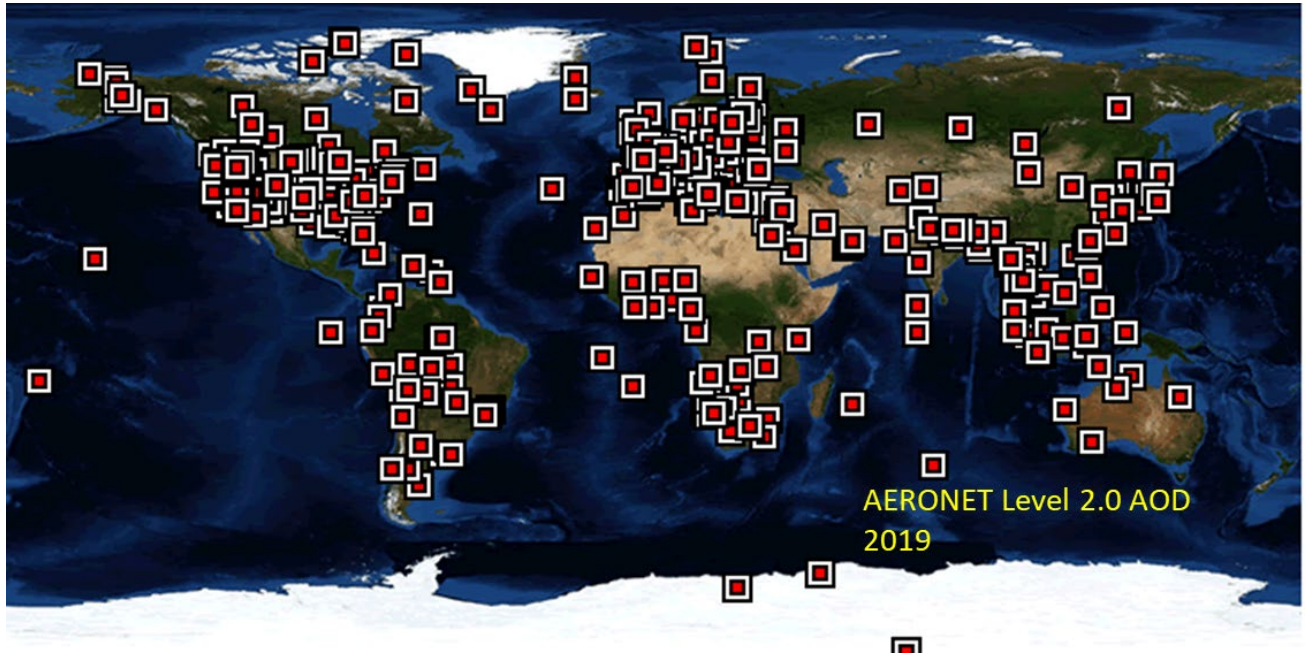
Huizheng Che

Yu Zheng

October 19, 2022

# Outline

- V4 Algorithm Development Plans
- Field Campaigns
- AERONET Component Networks




# AERONET Science and Operational Objectives

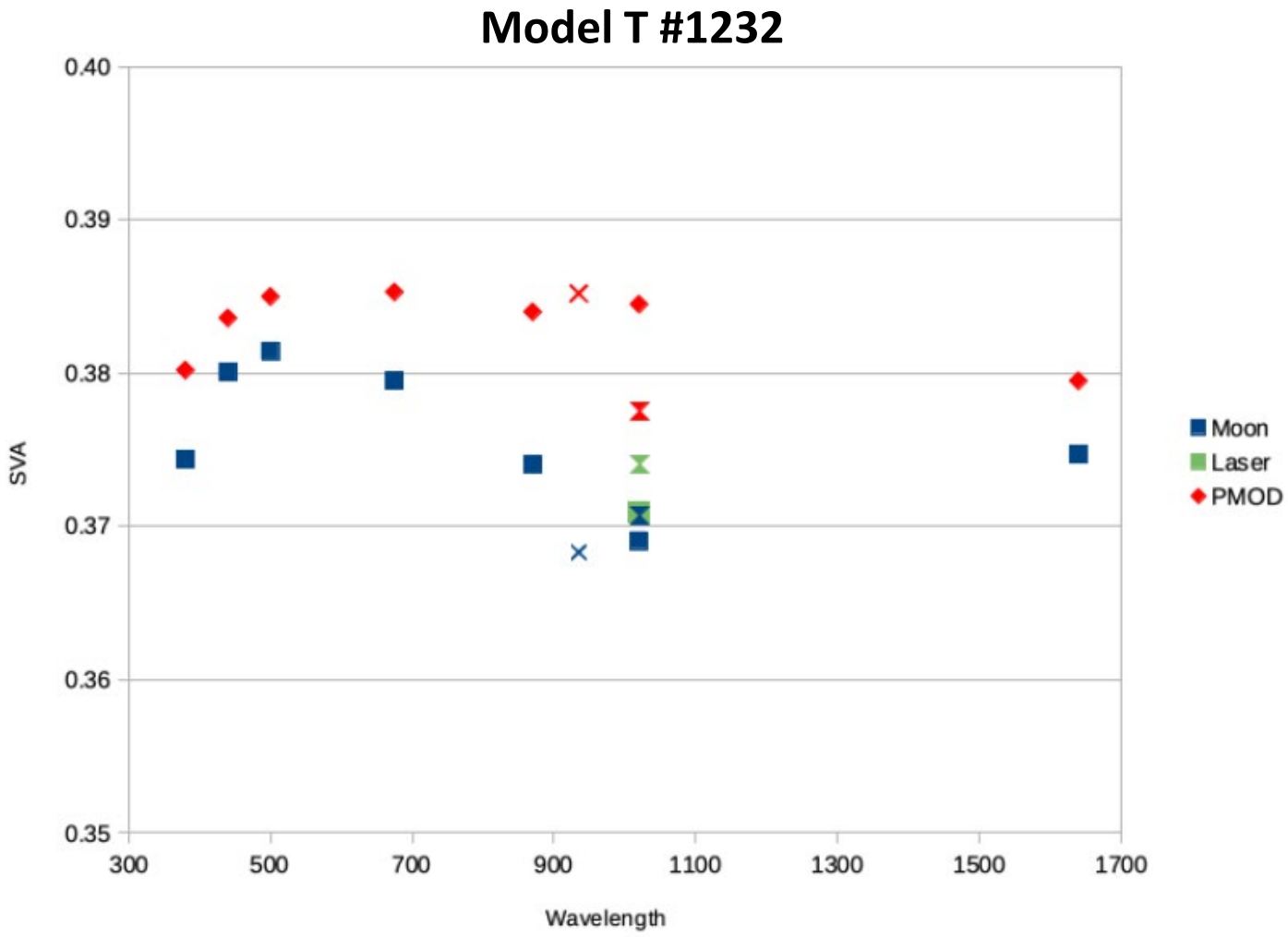
- Maintain and expand NASA AERONET network to under-sampled regions important for
  - atmospheric correction (e.g., ASVRN, 6SV for OLI)
  - validation of satellite retrievals (e.g., VIIRS, AOS, PACE, MAIA, TEMPO, MODIS, OMI)
  - model forecasting (e.g., GOCART, ICAP, NAAPS, AEROCOM, NCEP, UKMET, ECMWF)
  - reanalysis assessments (e.g., MERRA, ERA)
  - synergy of surface-based remote sensing (e.g., MPLNET, Pandora, TOLNET, SKYNET, SPARTAN, IMPROVE) to assess air quality
- Maintain and advance AERONET component networks such as AERONET-OC, Maritime Aerosol Network (MAN), and Solar Radiation Network (SolRad-Net)
- Design and execute AERONET DRAGON measurements for NASA field campaigns (e.g., ASIA-AQ) and missions (e.g., TEMPO, PACE, AOS) as well as other future domestic and international field campaigns

# V4 - Overview

- Provide Version 4 quality assured data sets
  - Direct Sun AOD
  - Direct Moon AOD
  - Spectral Deconvolution Algorithm (SDA) and SDA+ AOD
  - AOD and sky scan inversions of aerosol characteristics
  - Normalized water leaving radiances
  - Solar flux
  - Cloud Detection?

# V4 - Overview

- Update calibration procedures reducing the need for integrating spheres
  - Measure solid viewing angle (SVA) of instrument
  - Empirically determine vicarious SVA from Sun and sphere calibrations
  - Perform sky intercalibration (analogous to the Sun intercalibration method)
- Implement new UV and visible wavelengths into inversions for Model T instruments
- Enable automatic quality assurance of normalized water leaving radiances (AERONET-OC)



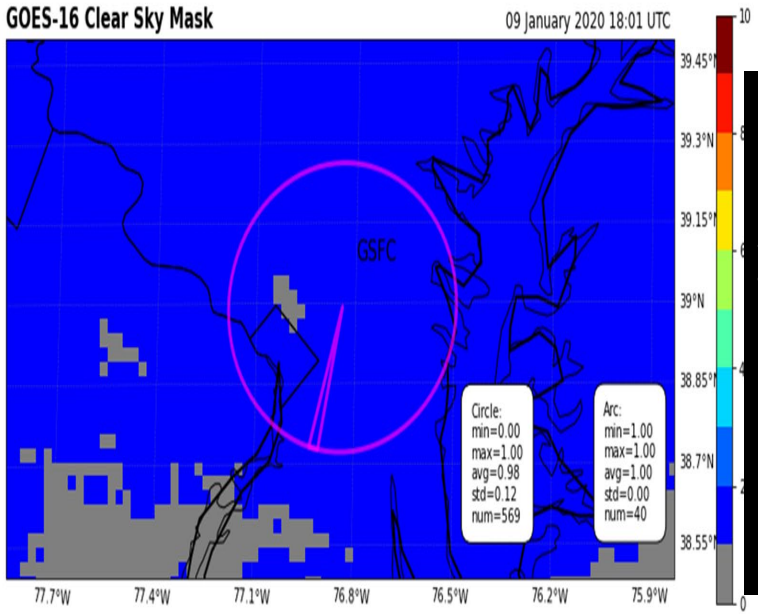

The Physikalisch Meteorologisches Observatorium Davos, World Radiation Center (PMOD/WRC) & NASA GSFC

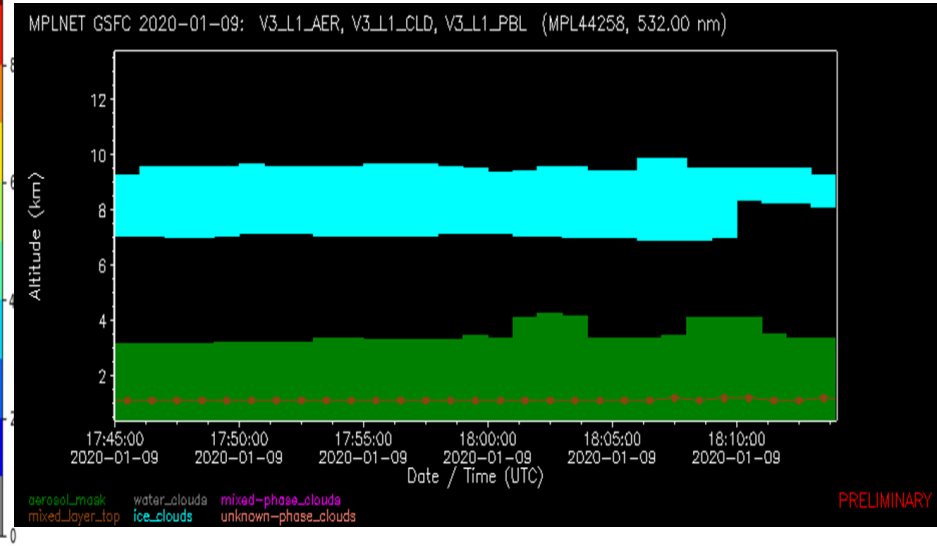
# V4 - AOD

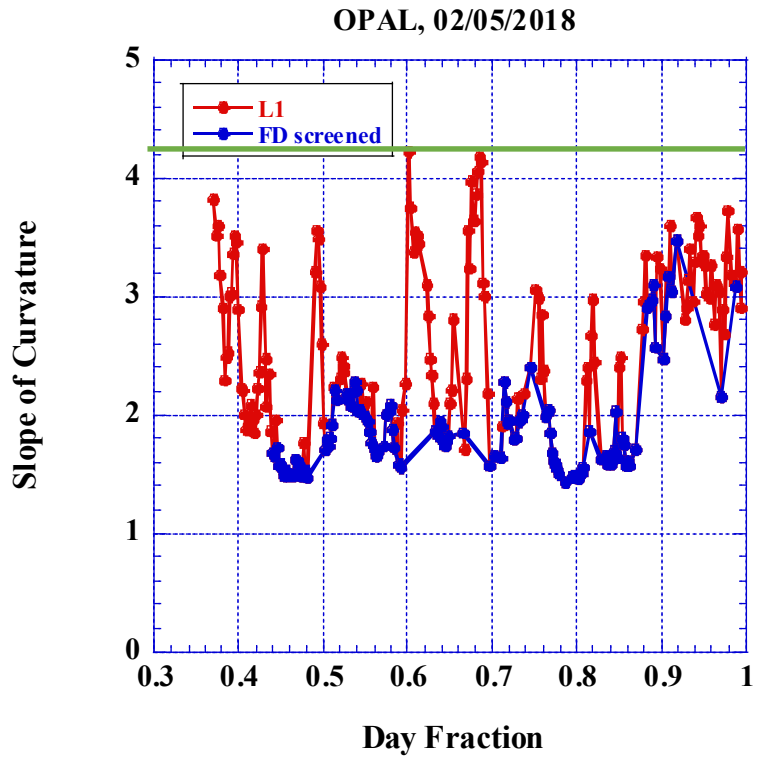
- Improve evaluation of cirrus cloud detection using synergized data sets

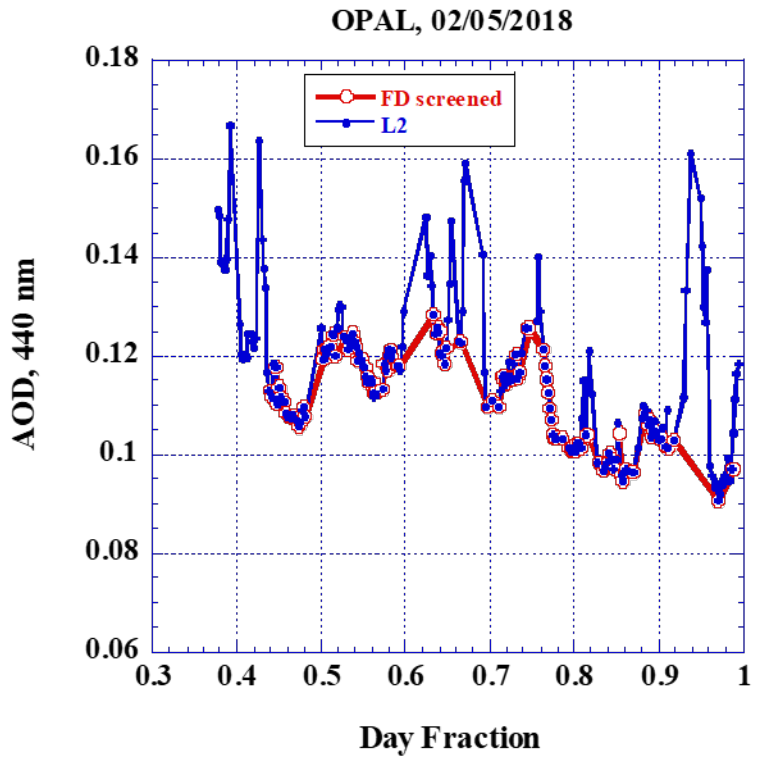
- Employ smoothness of time series of frequent solar aureole radiances measured at 3.3° scattering angle for cirrus cloud detection

$$FD(t_i)=I(t_{i+1})-I(t_i),\ i=1,\ldots,N-1$$



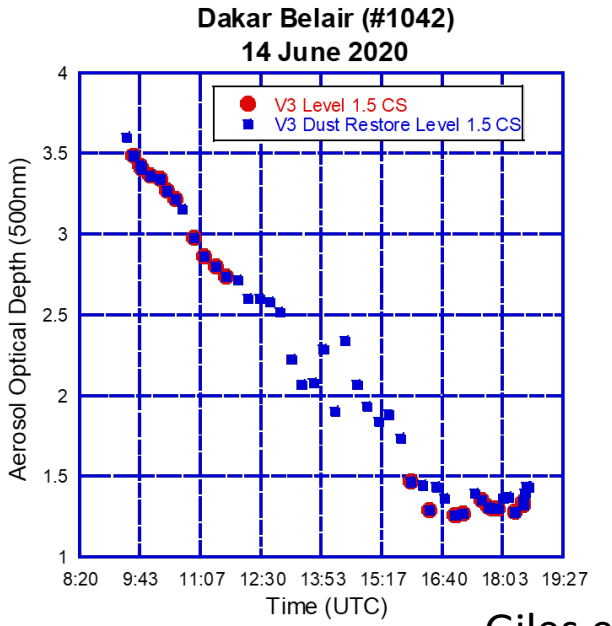



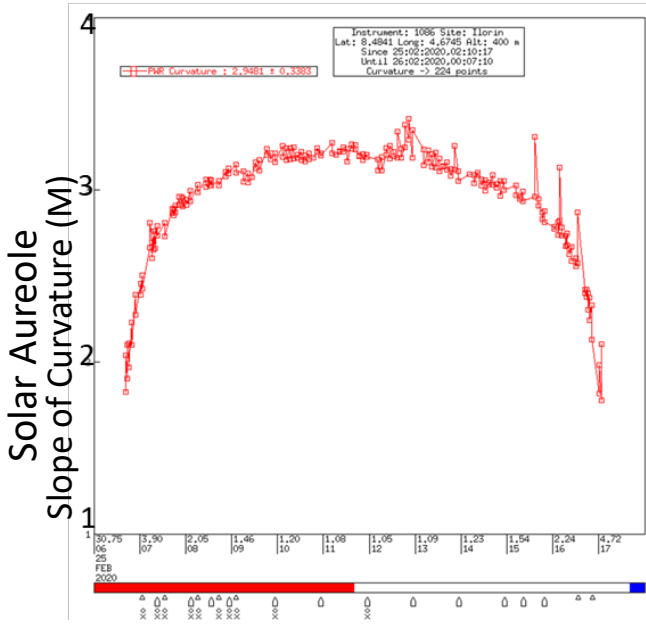



# V4 - AOD

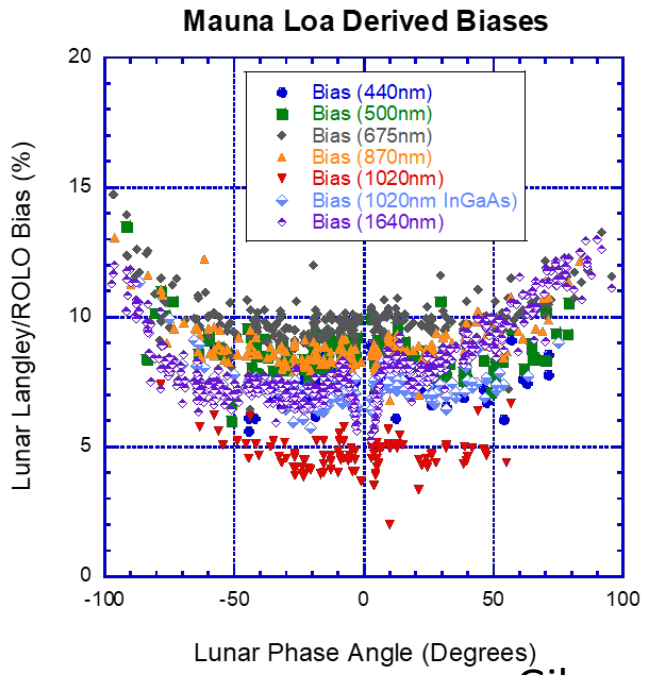
- Retain AOD measurements removed due to highly variable dust and smoke

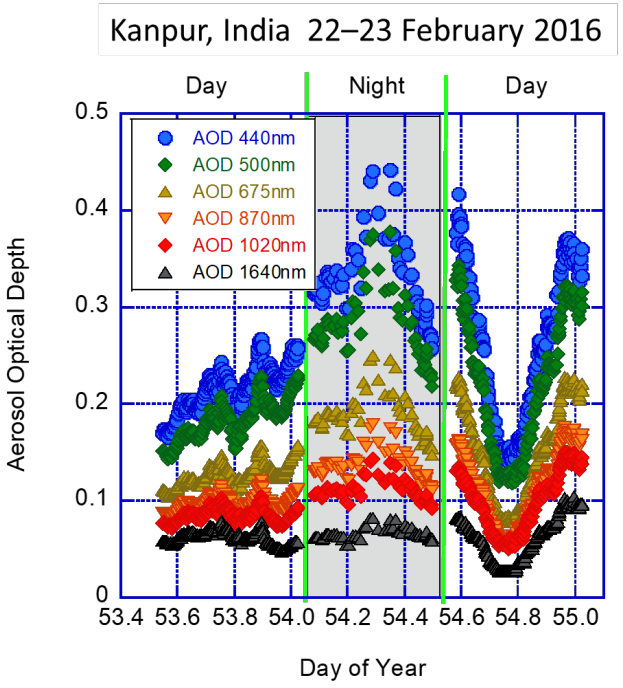
- Improve cloud detection and establish a quality assured data set for direct Moon AOD




Giles et al., 2021

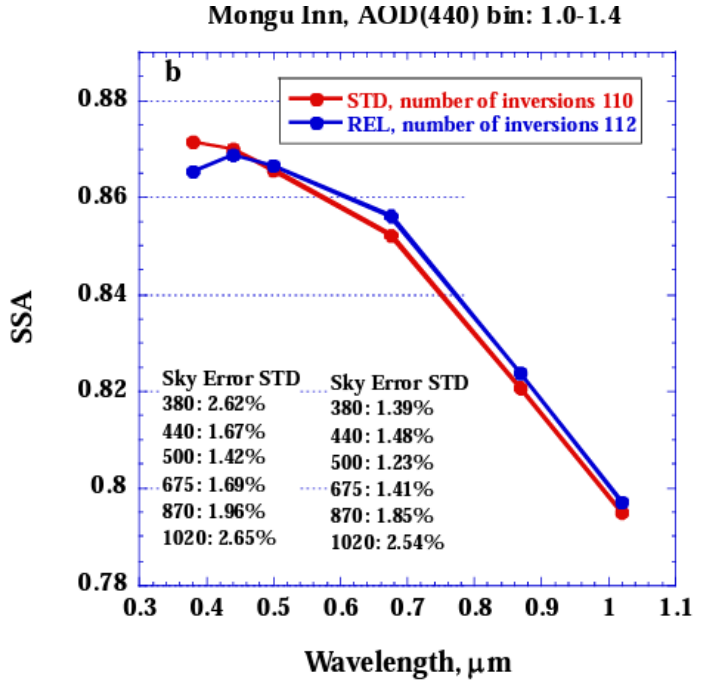


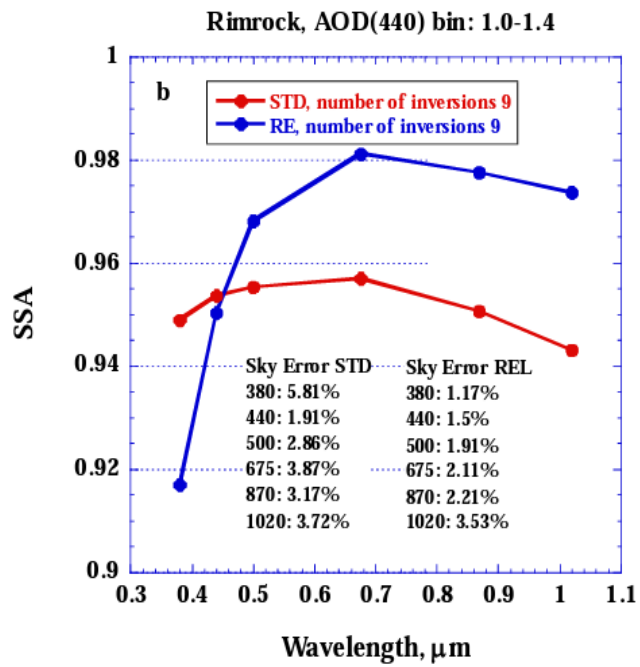




Giles et al., 2020

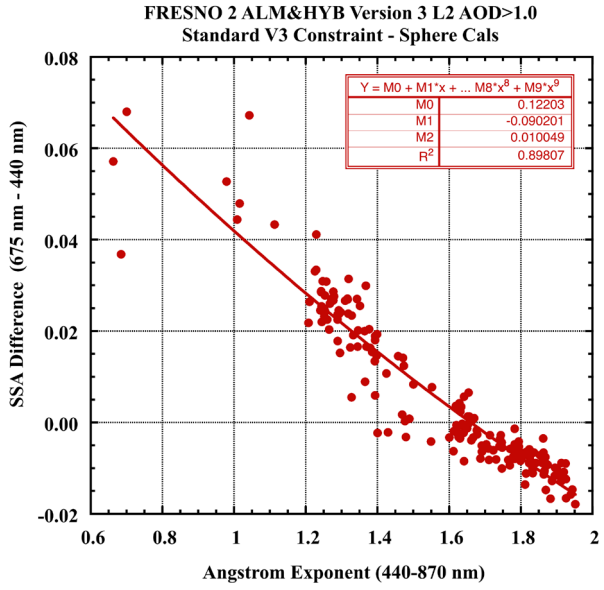
# V4 - Inversions

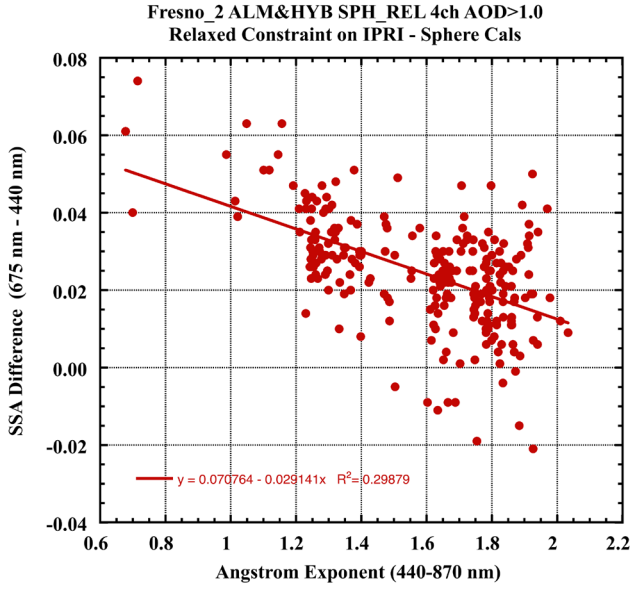
- Implement relaxed constraints of imaginary part of refractive index at short wavelengths to account for strong variability of light absorption by brown carbon containing aerosols

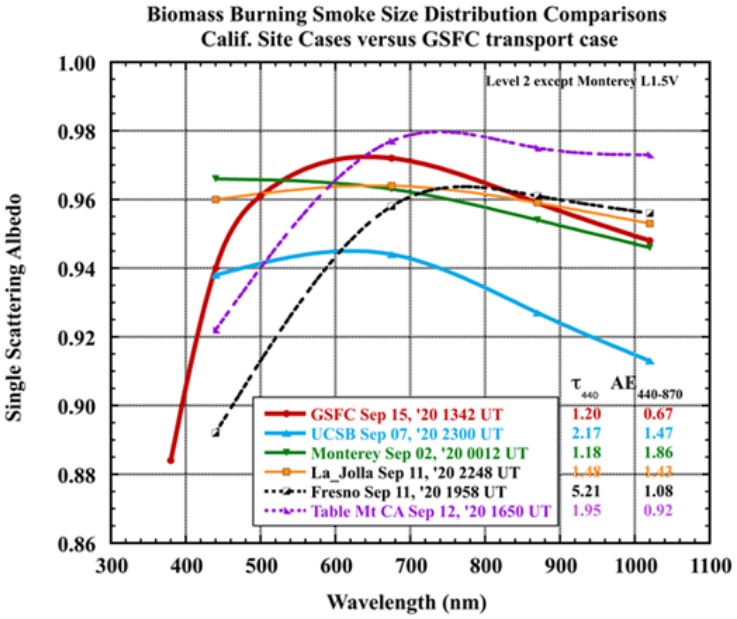



Sinyuk et al, 2022



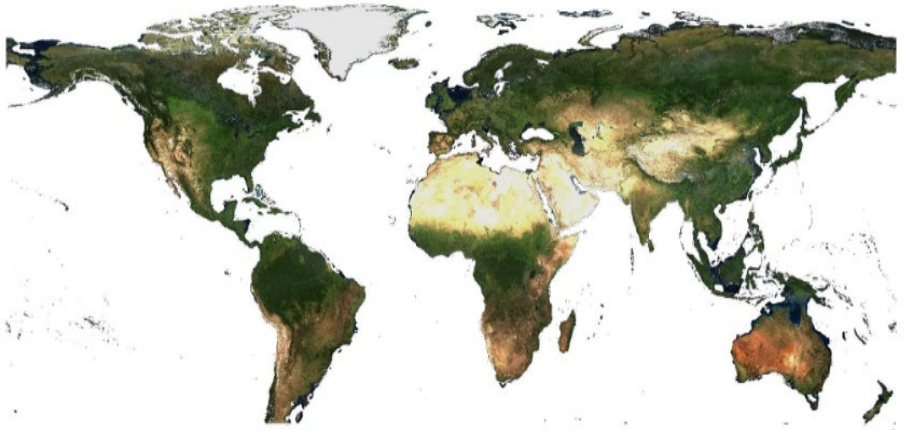



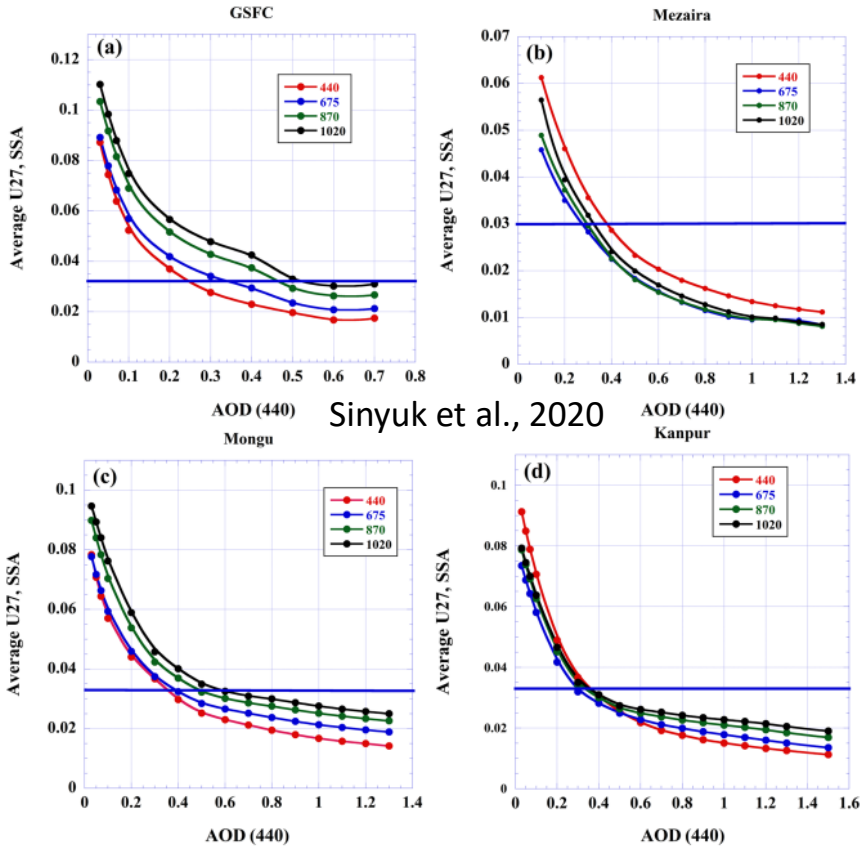

Eck et al. 2022, in preparation

# V4 - Inversions

- Assess and update surface reflectance scheme
  - MODIS BRDF Snow-free
  - Version 2 Moody methodology
  - Possible Hybrid approach
  - Snow BRDF?
- Calculate new inversion and SDA/SDA+ uncertainties



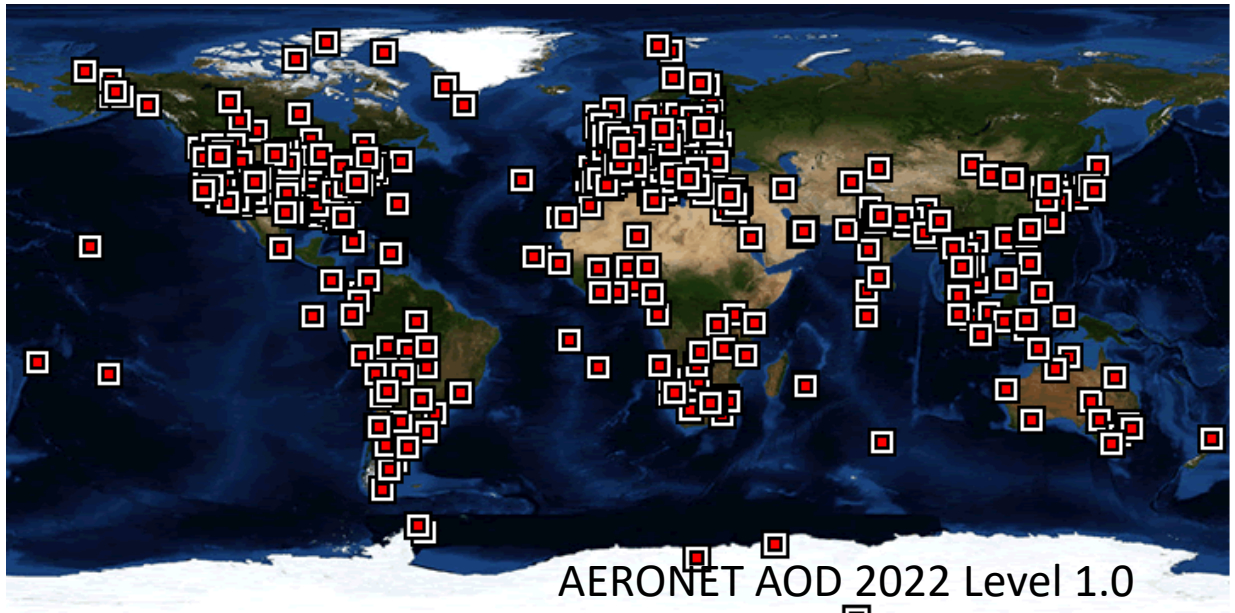
Sun et al. 2017

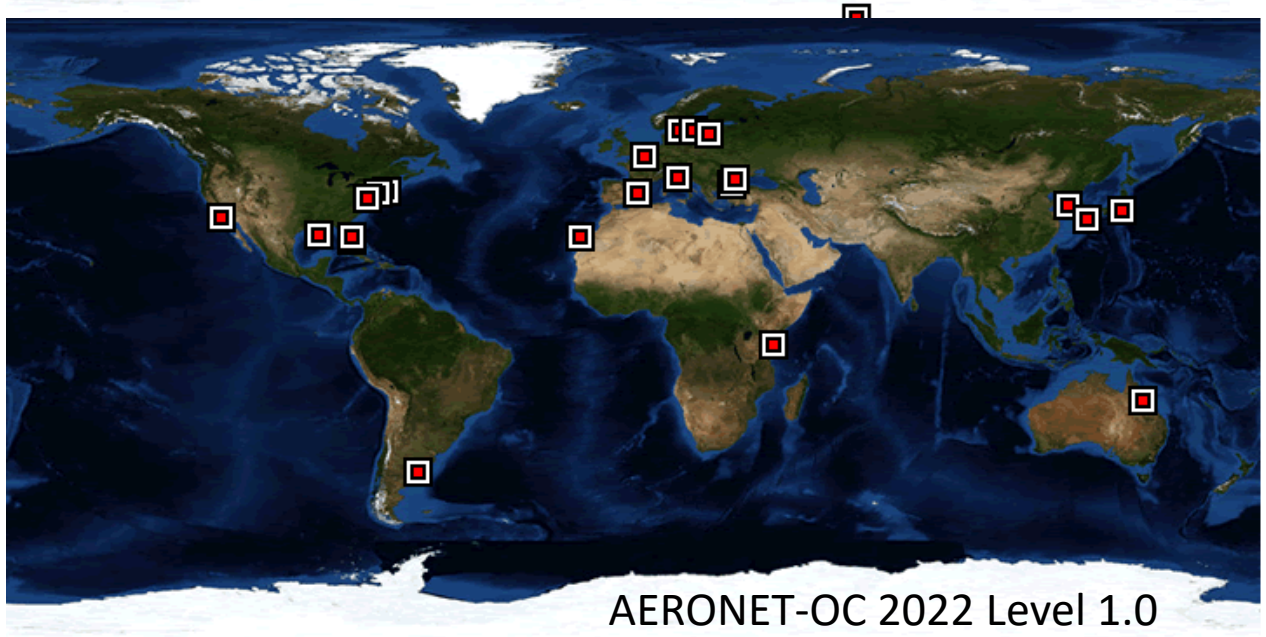



Sinyuk et al., 2020

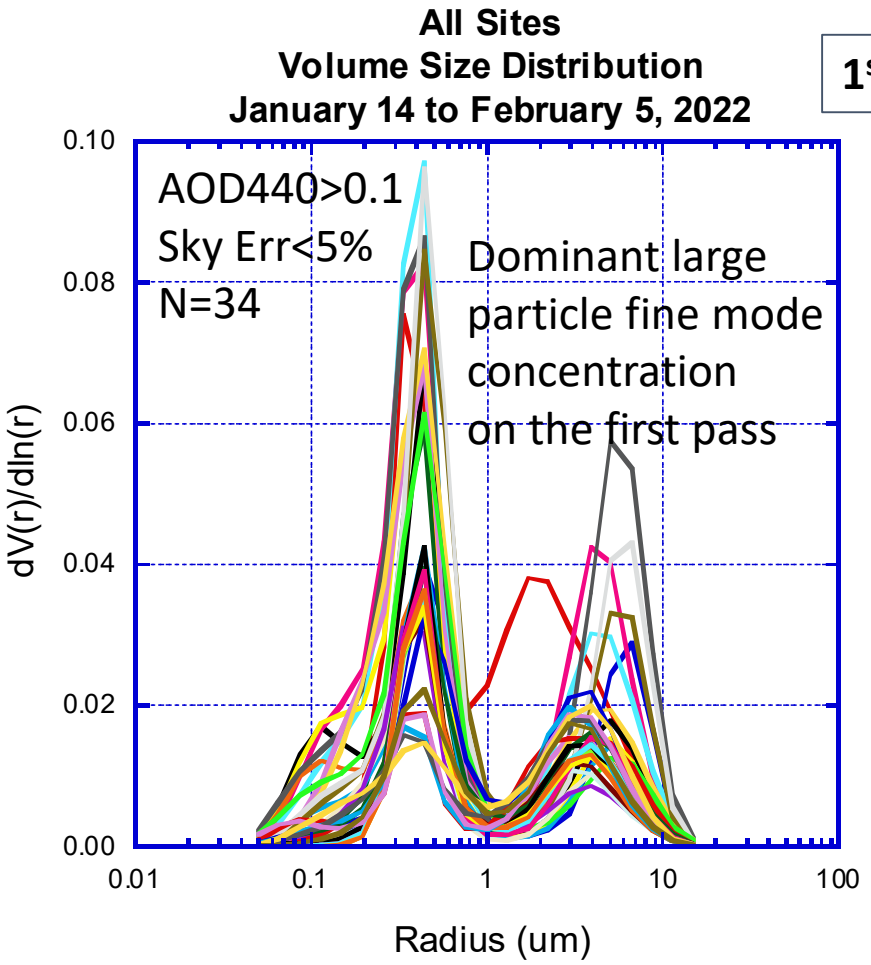
# Site Distribution

- Increase geographic representativeness by establishing several new AERONET sites focusing on data sparse regions of Central Asia, Central America, South America, and Africa
- Establish sites on islands and in coastal regions and mountainous terrain where satellite retrievals have larger uncertainty
- Expand AERONET-OC sites in the US and abroad in oceanic and inland waters as opportunities and resources allow


AERONET AOD 2022 Level 1.0


AERONET-OC 2022 Level 1.0

# Hunga Tonga Plume Measured by AERONET



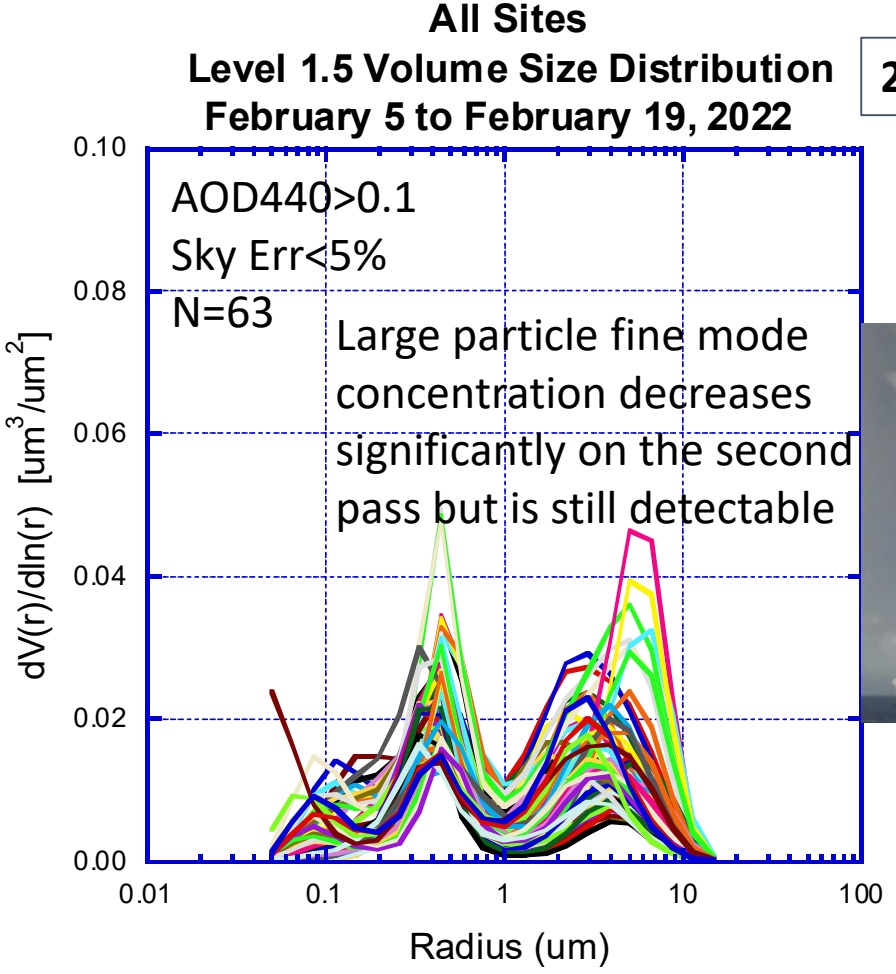



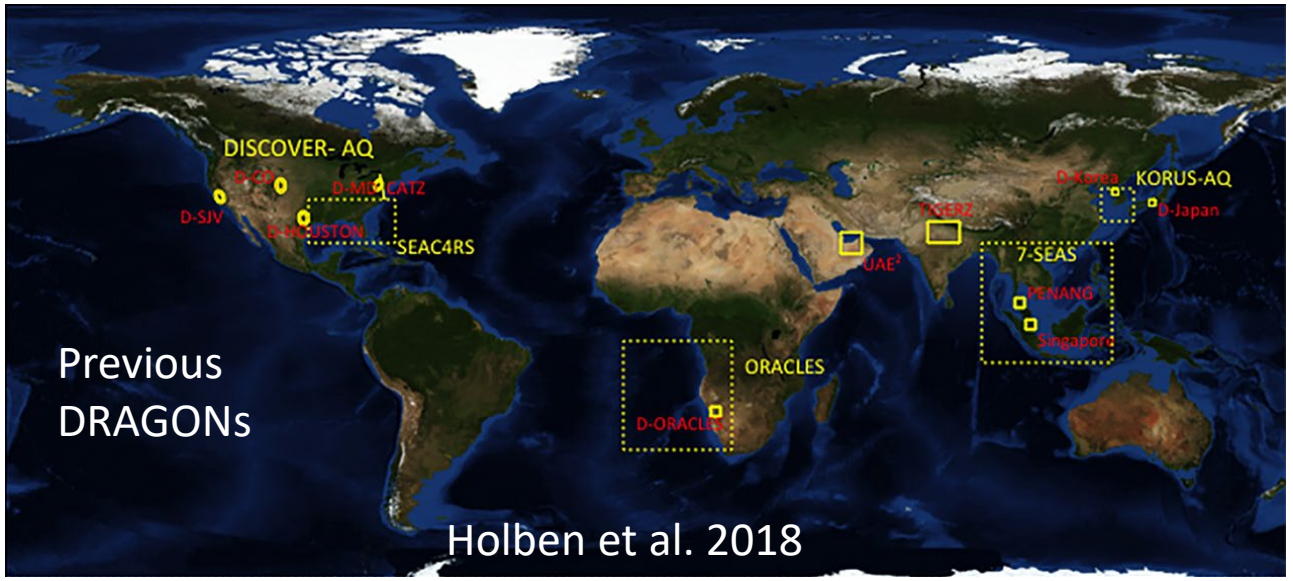

Image from Tonga Geological Services

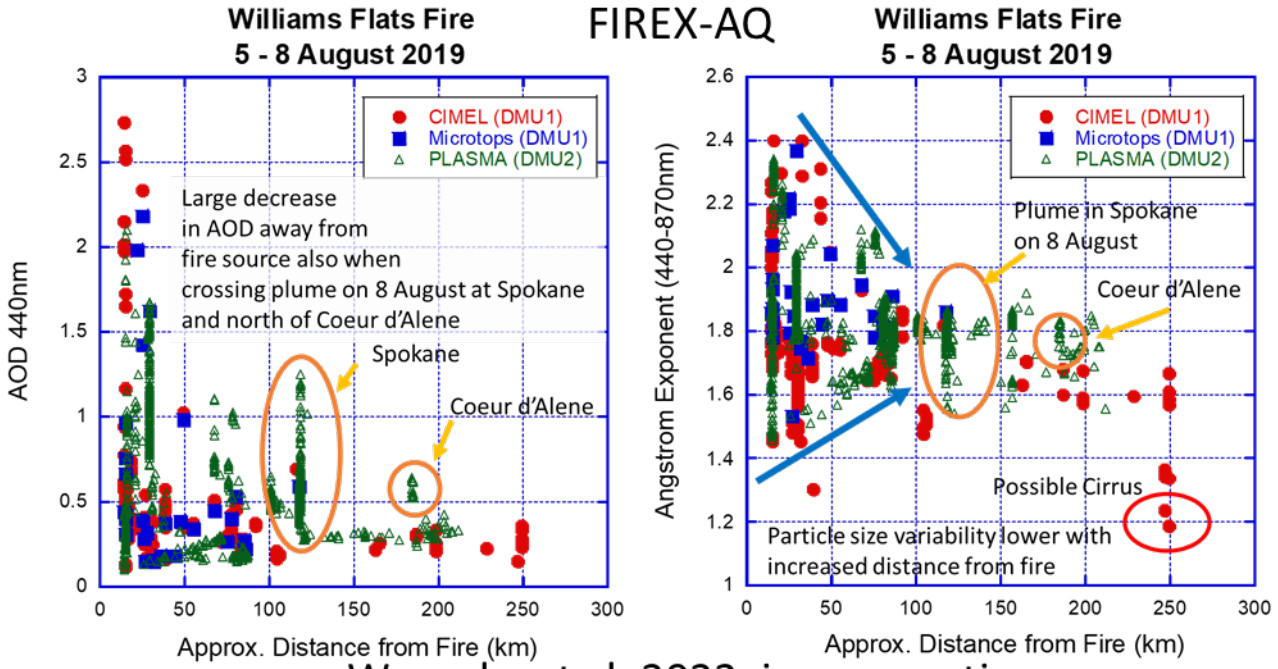
- Plume analyzed at >10 AERONET sites in Northern Australia, Indian Ocean, Southern Africa and Central South America
- Significant hygroscopic growth of sulfate particles and aging likely contribute to the large particle fine mode due to anomalous stratospheric water vapor as reported by Vömel et al. 2022 in the southern hemisphere.

Giles et al., 2023 in preparation

# Field Campaigns

- MAIA Supported AERONET Target Areas (2021+)
- NSF/DOE TRACER – Houston DRAGON (2021-2022)
- NOAA Ron Brown – Cimel Shipborne Demonstration (2023-2024+)
- AEROMMA/Cupids/STAQS/GOTHAAM (renamed "AGES") – NYC, LA (2022-2023) - DRAGONs
- Asia-AQ – South Korea, Thailand, Philippines (2024) - DRAGONs
- PACE-PAX (Aug-Oct 2024) - DRAGON
- AOS Supported AERONET DRAGONs (2028-2030)



# LA Area Active and Potential Deployments

- 5 Active AERONET sites in LA vicinity
- Potentially ~5 DRAGON instruments could be deployed depending on resources

**Legend**

- Active AERONET
- AERONET (Possible Long-Term)
- No PANDORA (Short-term)
- PANDORA (Short Term)

Expected Flight Domain

Lancaster
Palmdale
Victorville
Hesperia
TABLE_MOUNTAIN_CA
Ventura
Mount_Wilson
CalTech
San Bernadino
Pomona
San Bernardino
Los Angeles
Santa Monica
Santa_Monica_Colg
Rivers
Riverside
Corona
Dominguez Hills
Anaheim
Long Beach
Irvine
USC_SEAPRISM



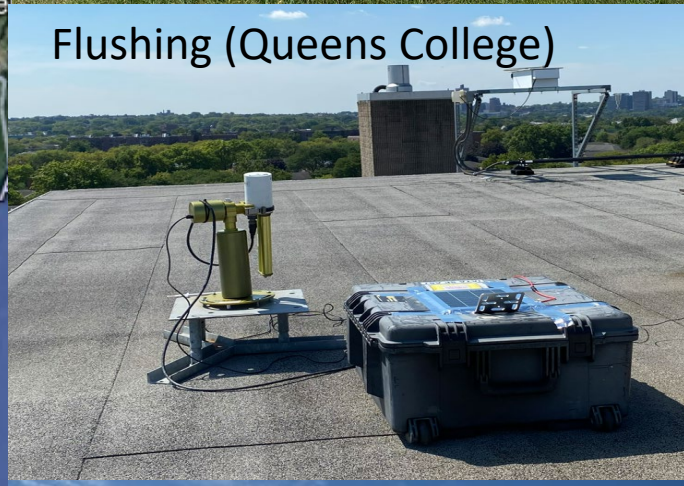
# NYC Area Active and Potential Deployments

**Legend**

- Active AERONET
- AERONET (Possible Long-Term)
- No PANDORA (Short-term)
- PANDORA (Short Term)

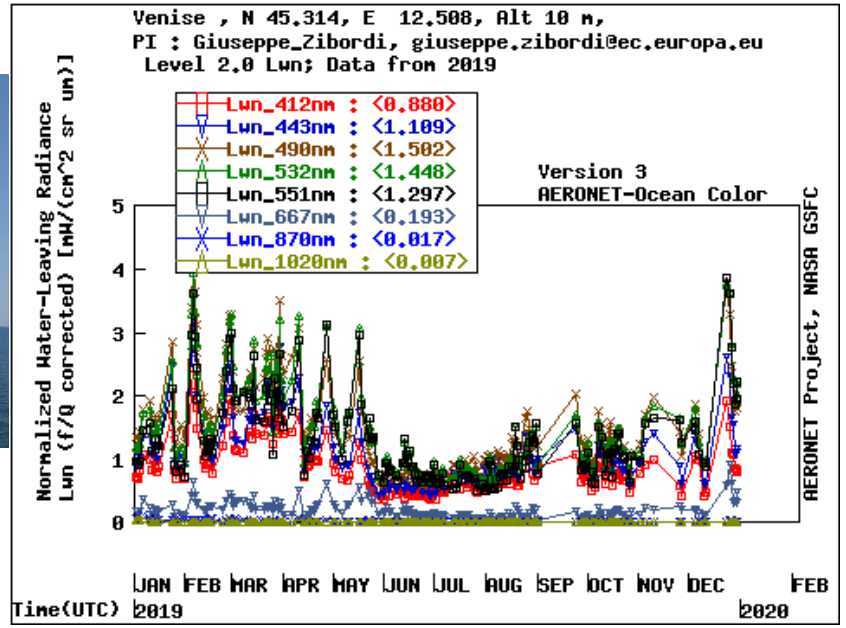
Expected Flight Domain

- DRAGON Phase 1
  - Deployed 5 sites week of August 22, 2022
- DRAGON Phase 2 (~April 2023):
  - Madison, Westport and possibly Liberty Science Center, Pittstown

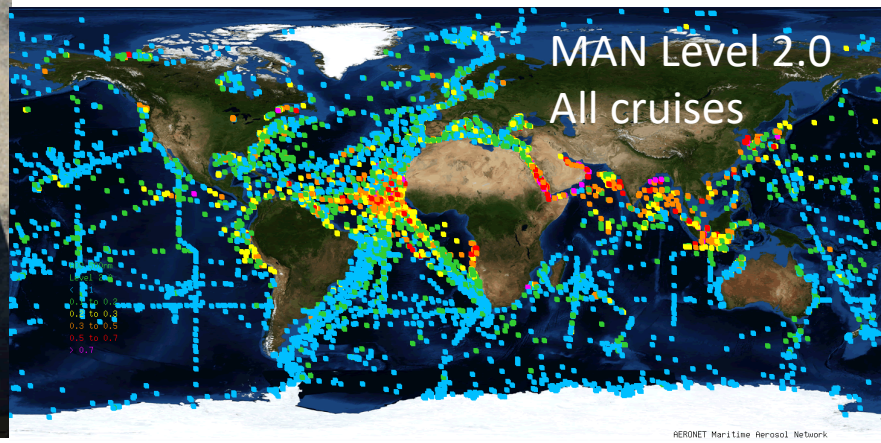




# AERONET Component Networks

- AERONET-OC
  - Normalized water leaving radiances: ocean, coastal, and inland waters
- AERONET-MAN
  - AOD:  Handheld Microtops II measurements on ships of opportunity
- Solrad-Net
  - Solar flux measurements (unfiltered pyranometers, PAR (energy/quantum), UV-A and UV-B)



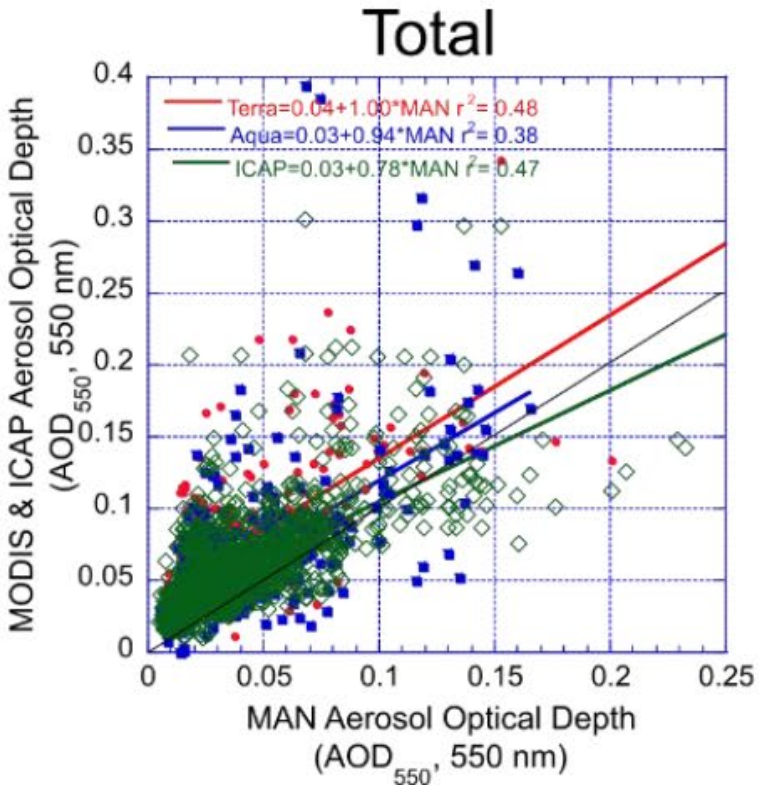


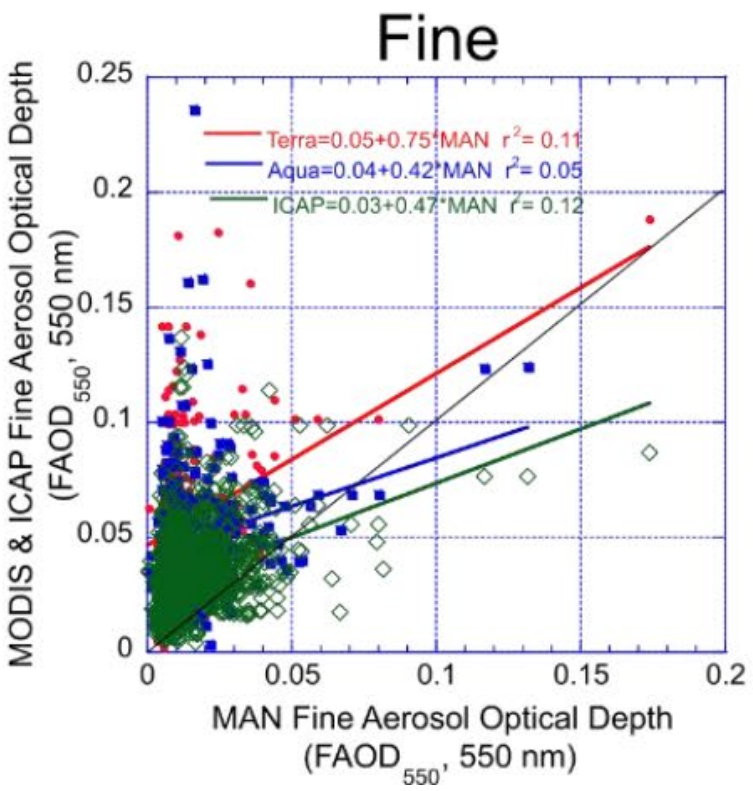


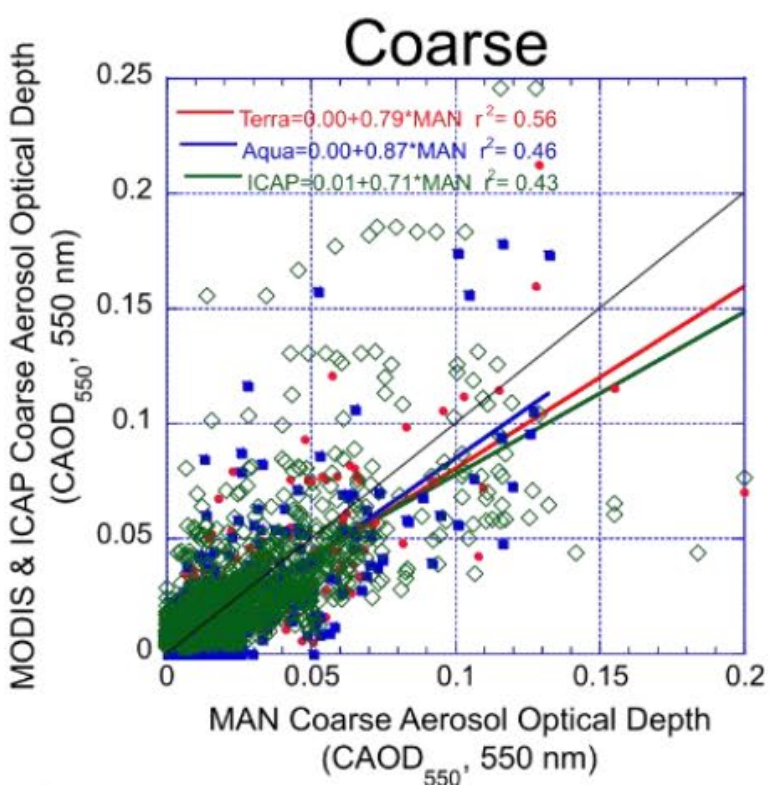
# AERONET Component Networks

- Recent MODIS and ICAP/C4C publication using AERONET-MAN

<30° S




Reid et al., 2022

# Summary

- Version 3 AOD will be largely unchanged in V4
  - Improve removal of cirrus clouds
  - Implement further restoration of aerosols measurements in plumes
  - Modify cloud screening at nighttime to reduce cloud contamination and raise to quality assured level

- V4 SDA retrievals from direct sun AOD will be updated
  - Provide retrievals for SDA and SDA+ based on latest code from Norm O'Neill
  - Compute uncertainties using the "U27"-like method
  - Evaluate the SDA fine mode effective radius

# Summary

- V4 inversions will have significant changes
  - Improved calibration techniques (*significant effort*) could reduce the uncertainty of inversion products
  - Implement relaxed IPRI constraint at shorter wavelengths to account for brown carbon absorption
  - Increase spectral range of inversions by including 380nm, 500nm, and 1640nm
  - Compute new uncertainties for Version 4 inversion wavelength combinations
- V4 release is expected in 1 to 2 years with AOD released first.