Aerosols, Southeast Asia and the AERONET program

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LCLUC Regional International Meeting, Yangon, Myanmar

January 13-15, 2015

Talk Topics

- The Challenge: Understanding aerosol particles and their metrological & climate impact in SE Asia (7-SEAS perspetive)
- AERONET contributions and improvements for the future
- Summary

Aerosol Particles as an Interdisiplinary Environmental Problem in SE Asia (From the literature)

- *Environmental quality and chemistry:* Biological and visual air quality, acid deposition, photochemistry, food contamination.
- *Direct radiative forcing:* Atmospheric heating and cooling, surface cooling.
- *Semi-direct:* PBL stabilization, surface fluxes, cloud feedback
- *Clouds & Storms:* Cloud lifetime, precipitation, severity
- *Geochemical cycles:* Carbon & Nutrients
- *Inference/tracers:* Indicators of air mass types and transport
- *Oceans:* Radiation perturbations can impact ocean photochemistry and have even been seen in the coral record.

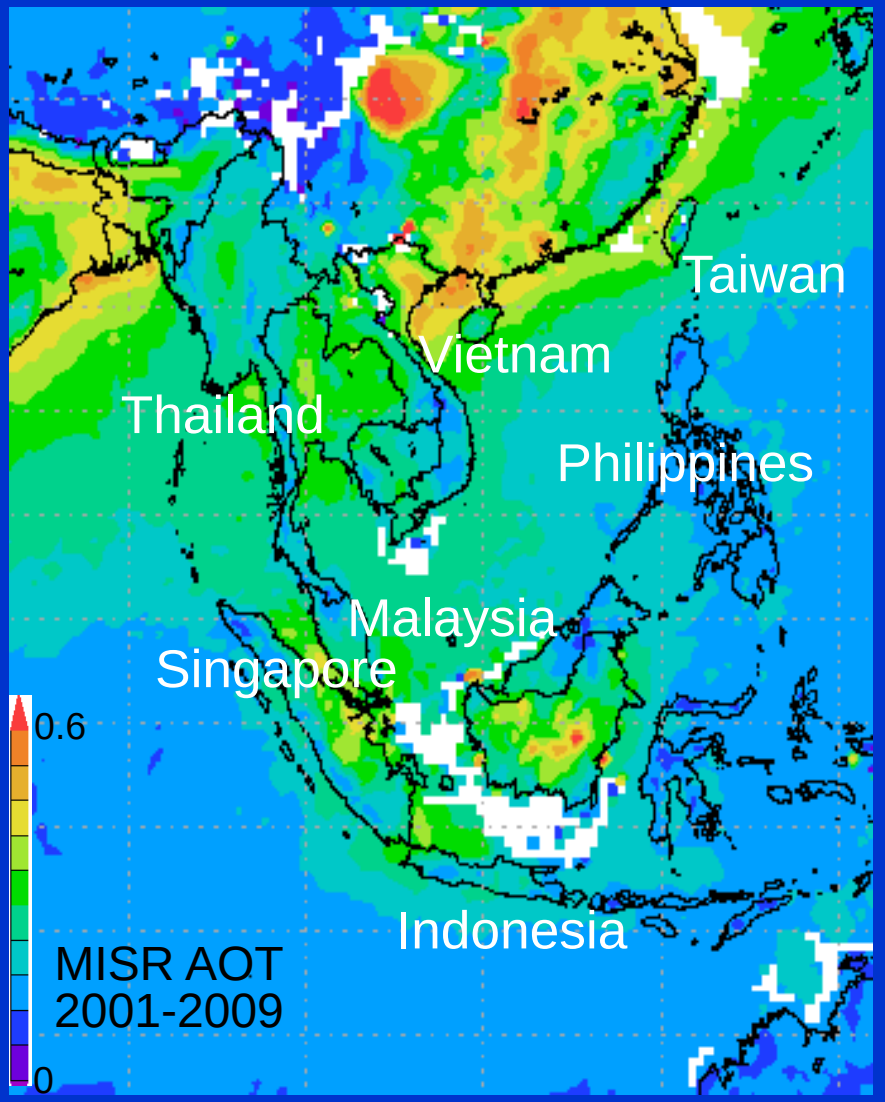
Response-Seven South East Asian Studies: (7 SEAS)

A grass roots effort to understand SE Asia aerosol environement

Investigate the impacts of aerosol particles on *weather and the total SE Asian environment*

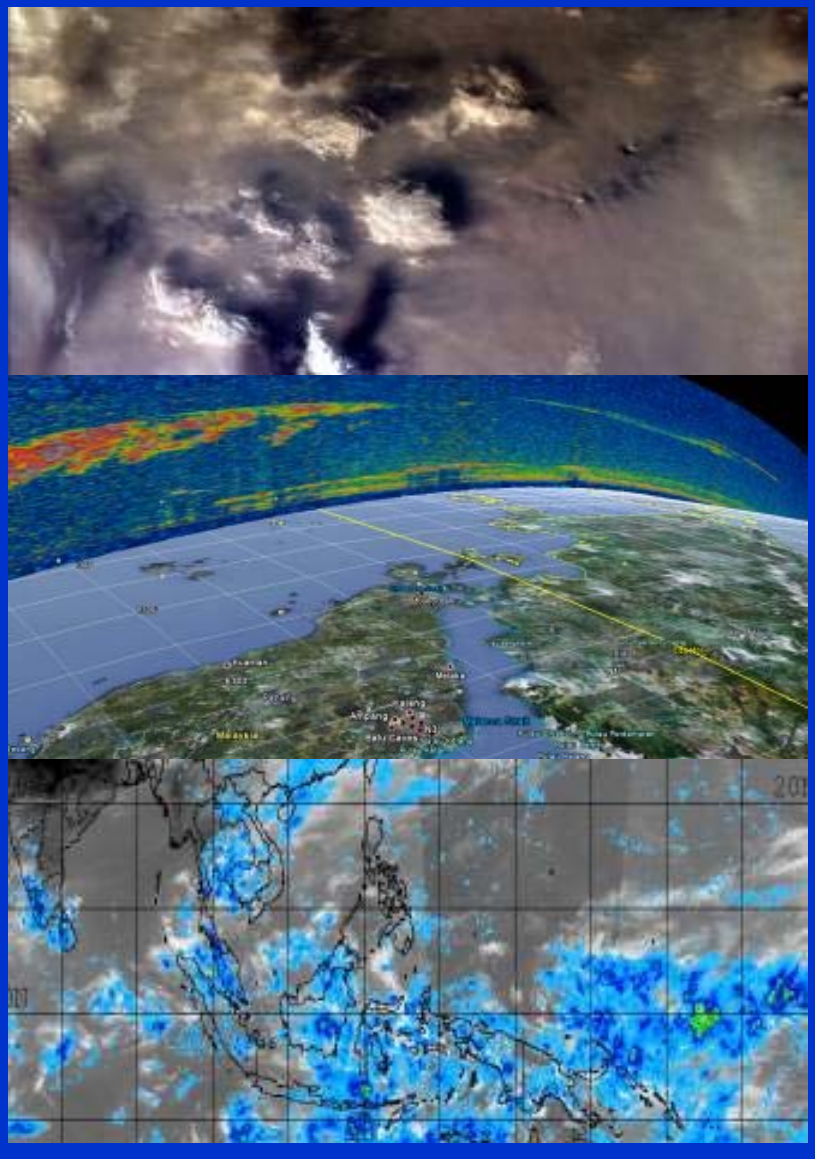
In order to do this, we need input from seven science areas:

- Aerosol lifecycle and air quality
- Tropical meteorology
- Radiation and heat balance
- Clouds and precipitation
- Land processes and fire
- Oceanography (phys. and bio.)
- Verification, analysis and prediction



Remote Sensing: A Fundamental Tool for Aerosol Science

- We are at the pinnacle of remote sensing observations: Passive solar and IR, lidar, radar, and microwave.
- Space based remote sensing knows no international boundaries and ground based sun photometer and lidar sites are expanding regionally.
- Everything from fire detection to surface winds can be integrated or assimilated into models now.
- Almost all meteorological indicators are remote sensing based.
- But:
  - most aerosol products are underdetermined.
  - SE Asia represents one of the most complex observing environments on the planet.



MISR 2001-2011 Average AOD

Products tells a good story of aerosol emissions and transport. But how quantitative is it?

Chinese pollution and dust

Indian Pollution

Pan SE Asian Smoke

Hanoi Superplume

Thai and Myan. Pollution and Smoke

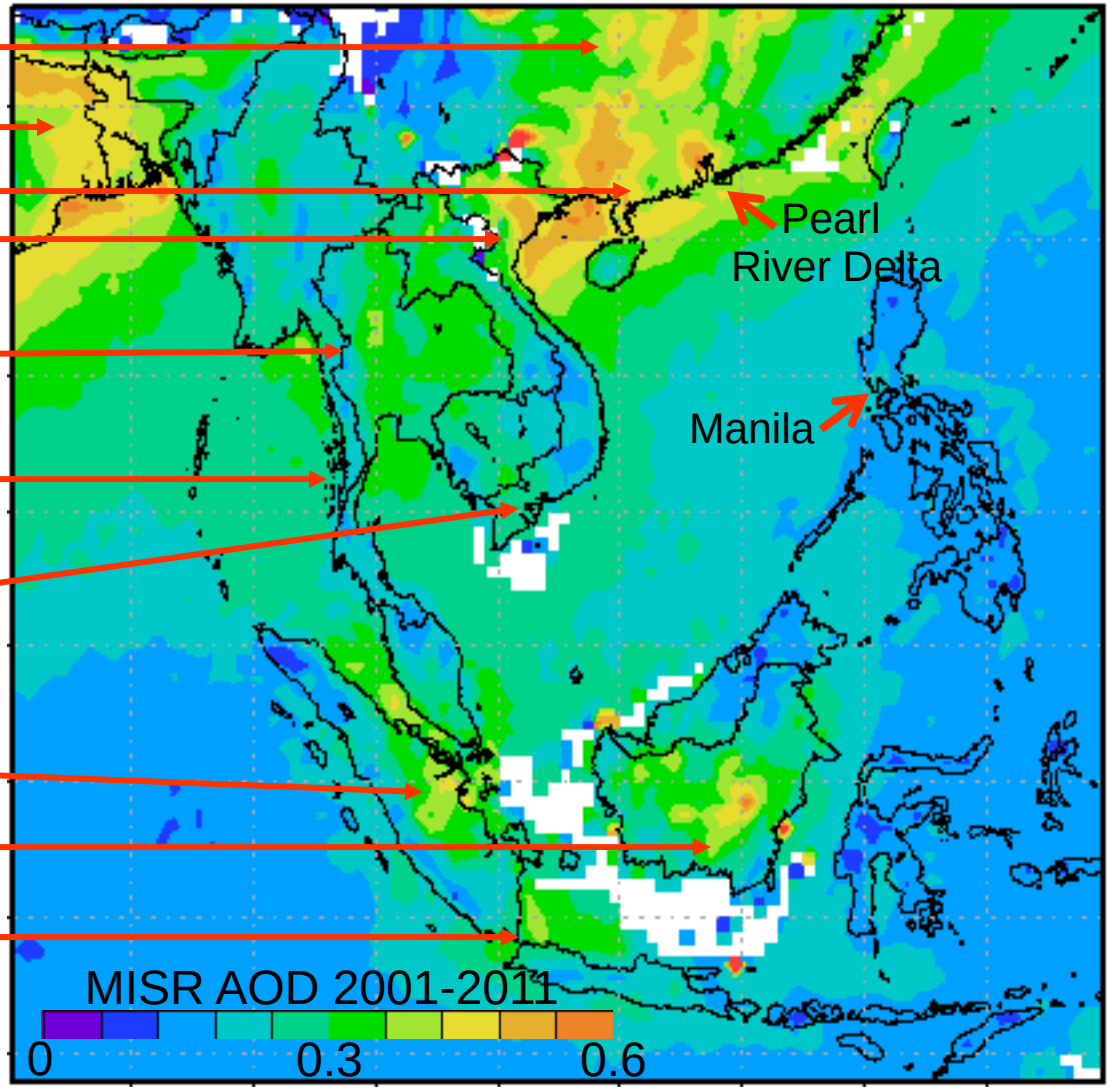
Thai Pollution and Smoke

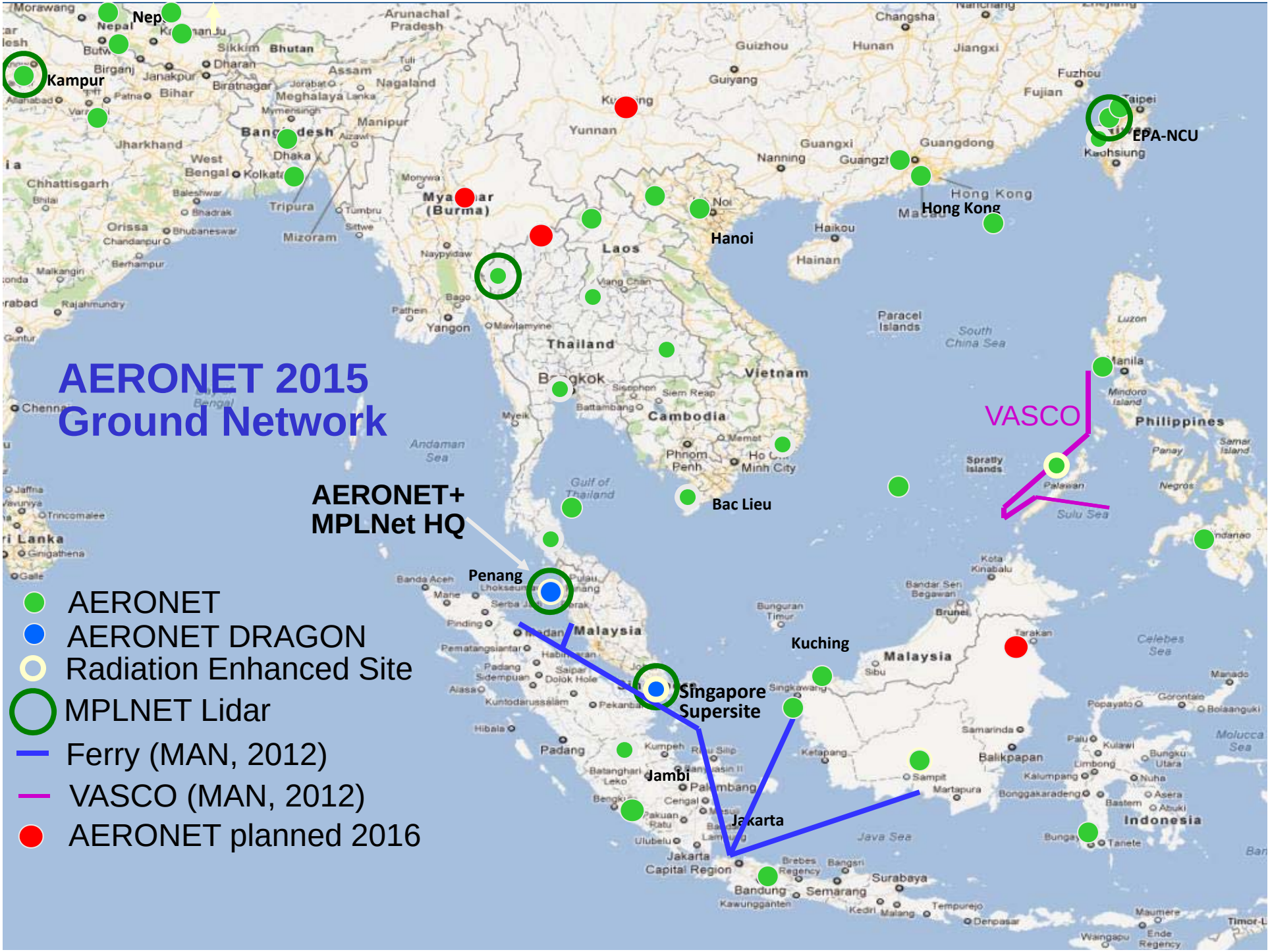
Cambodia Smoke And Ho Chi Min

Central Sumatra Burning

Southern Kalimantan Burning

Jakarta Superplume




AERONET 2015
Ground Network
AERONET+
MPLNet HQ
Penang
Singapore
Supersite
Kampur
Hanoi
Hong Kong
EPA-NCU
VASCO
Bac Lieu
Kuching
Jambi
Jakarta
AERONET
AERONET DRAGON
Radiation Enhanced Site
MPLNET Lidar
Ferry (MAN, 2012)
VASCO (MAN, 2012)
AERONET planned 2016

AERONET- The Ground-Based Satellite

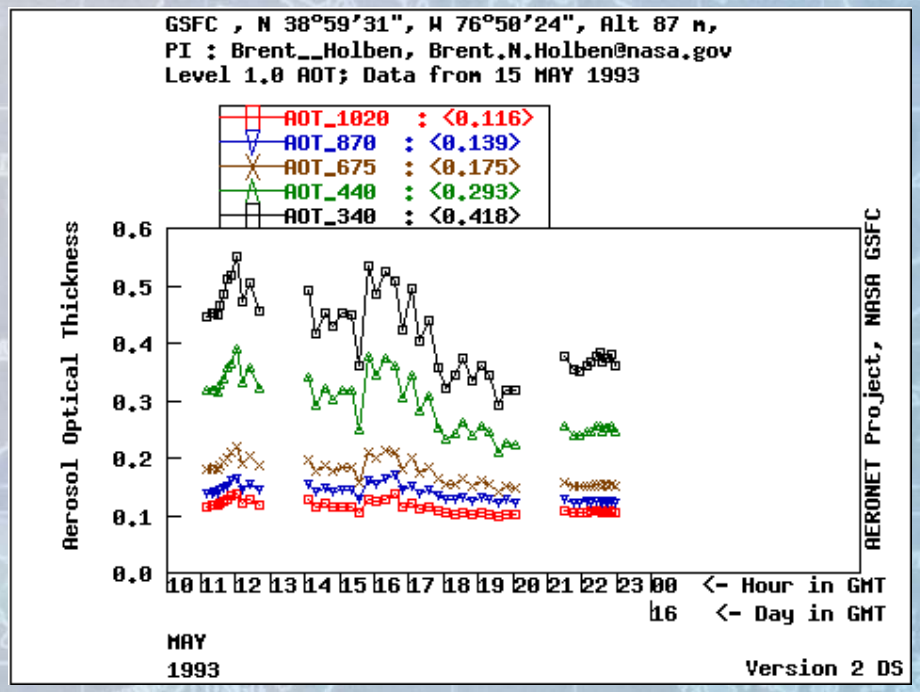
Mission Objectives:
- Characterize aerosol optical properties
- Validate Satellite & model aerosol retrievals
- Synergism with Satellite obs., ESS and CC

- Internationally Federated
  - GSFC & PHOTONS (Fr)
  - Spain, Australia, Brazil, Russia
  - Canada, Italy, China, SE Asia…
- ~600 instruments
- ~450 Operational sites
- >5. x 10^8 AOD obs since 1993
- Expansion to Asia, Africa high latitudes and over water sites
- Support NASA ESS activities

Parameters measured: τ, ω_o, Θ, size, n, k and WV, clds, L_{wn}

Open data access via website: http://aeronet.gsfc.nasa.gov/

AERONET's First Light (1993)

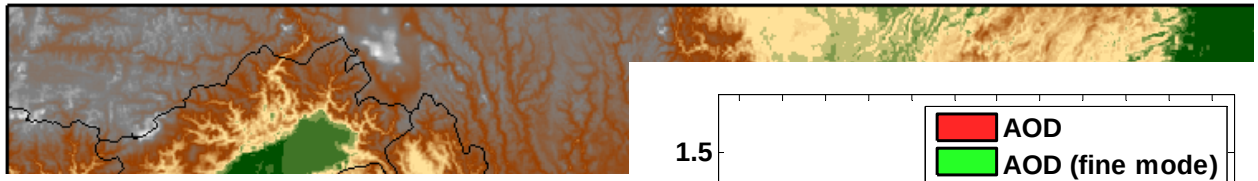


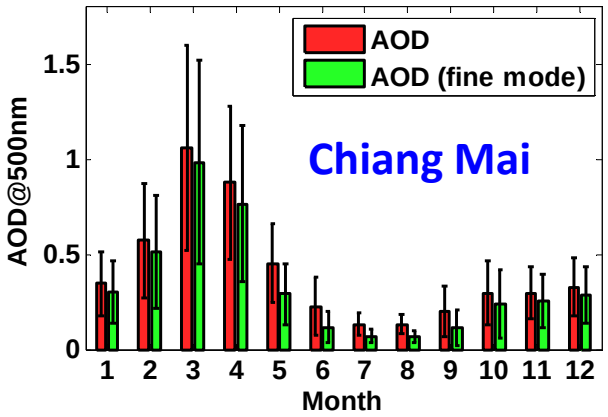
Holben et al., 1998

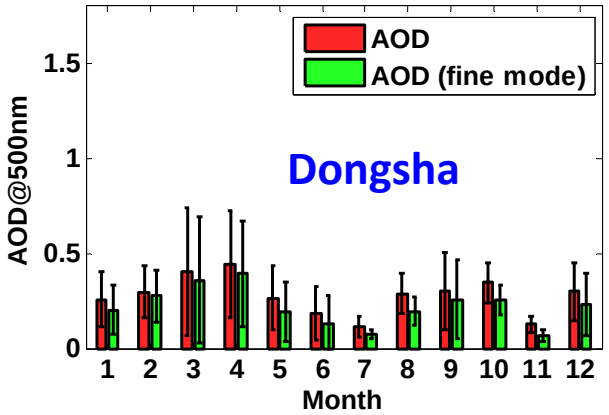
Dubovik and King 2000

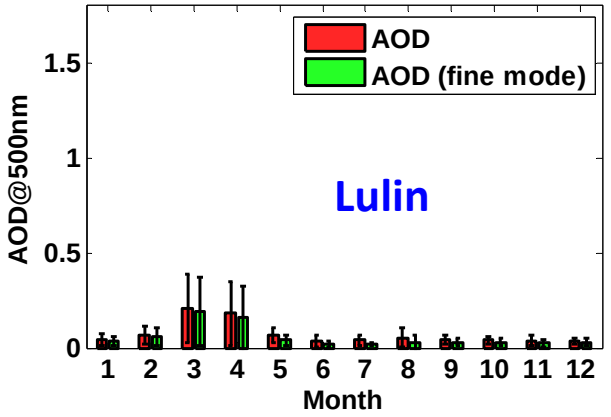
- No assumptions...
- Absorption, Shape ...

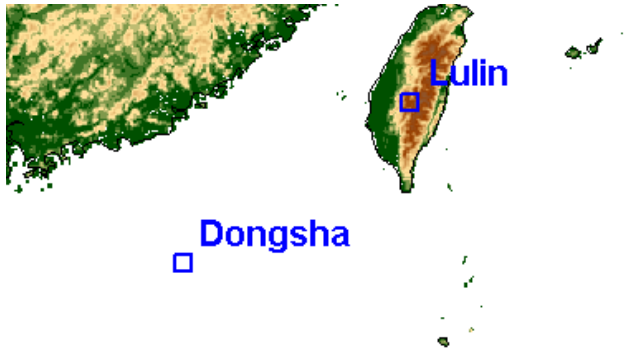
Seasonal variation of AOD from 5 selected A

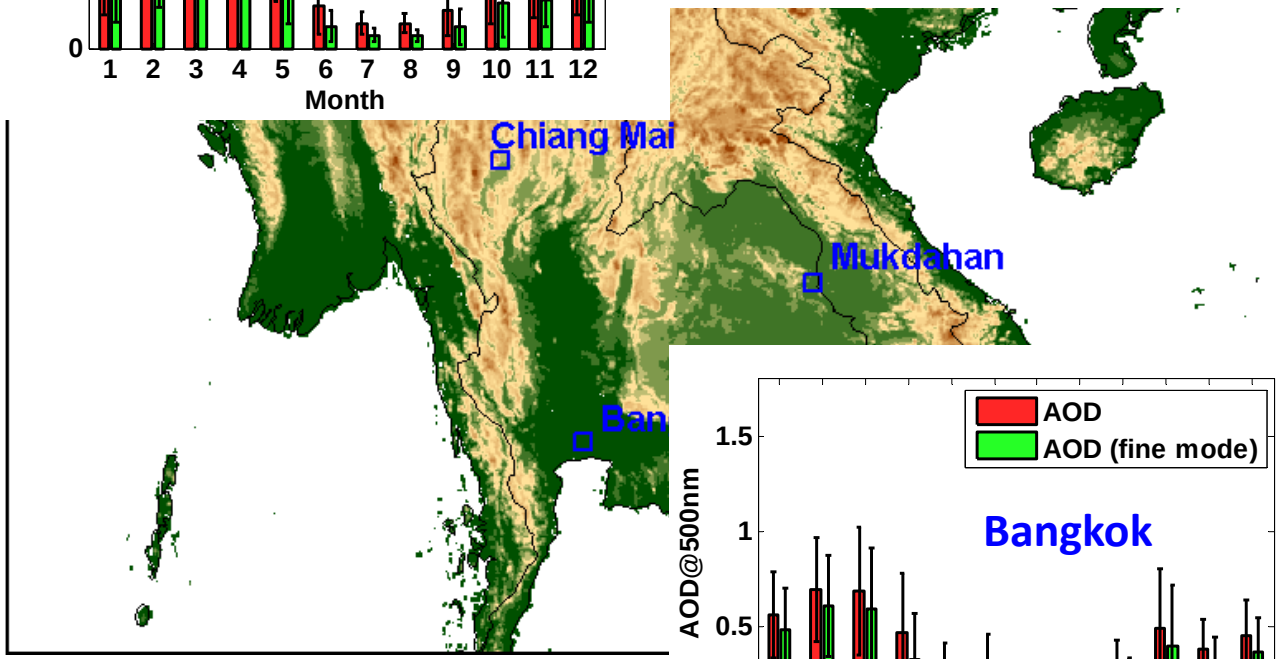


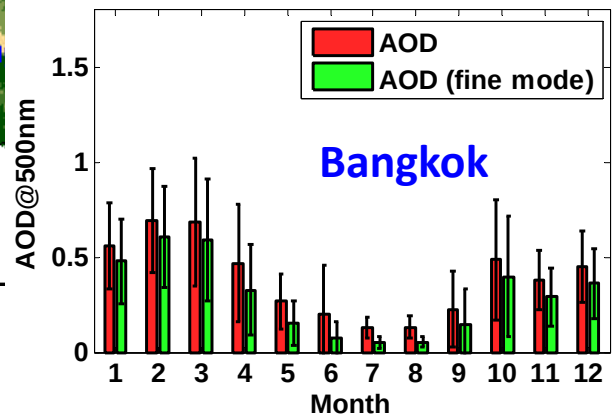


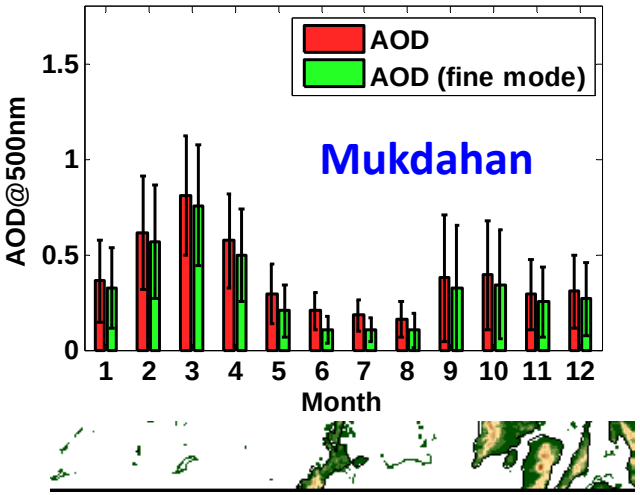






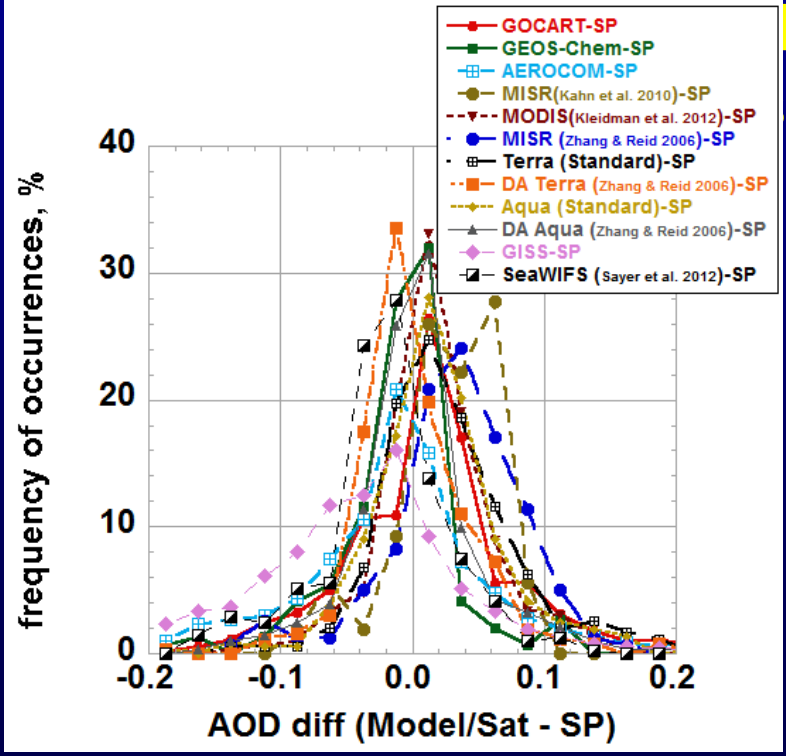


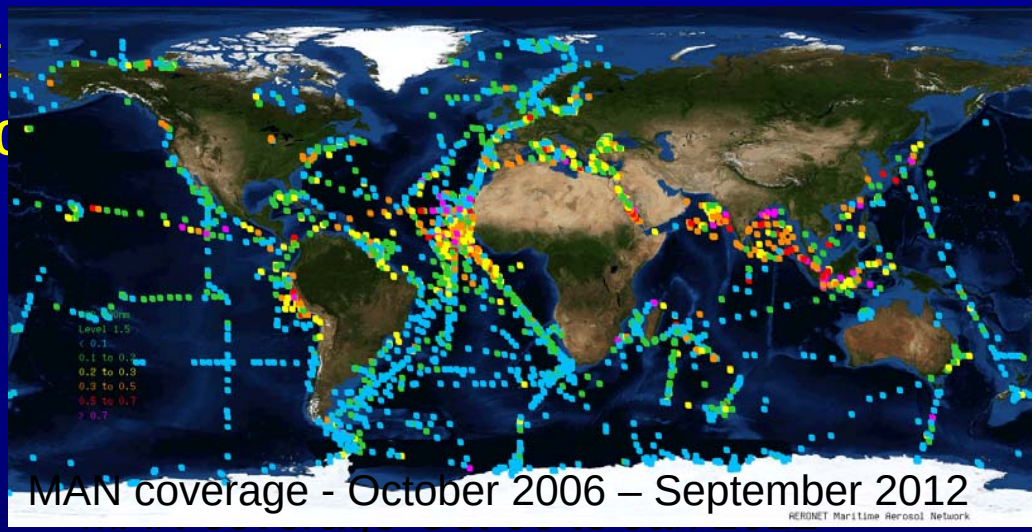


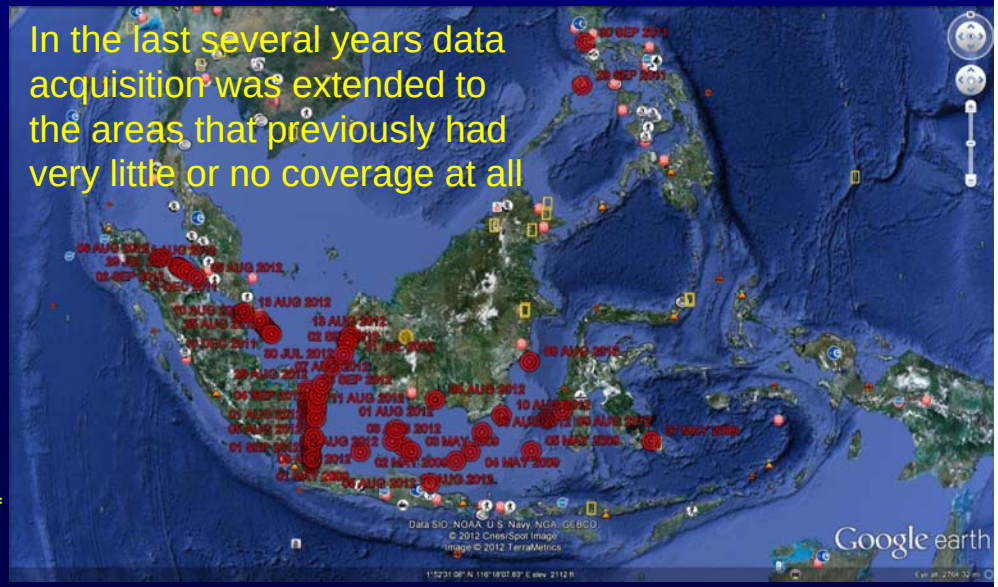


Maritime Aerosol Network (MAN) as a Component of AERONET

- MAN represents an important strategic sampling initiative and ship-borne data acquisition



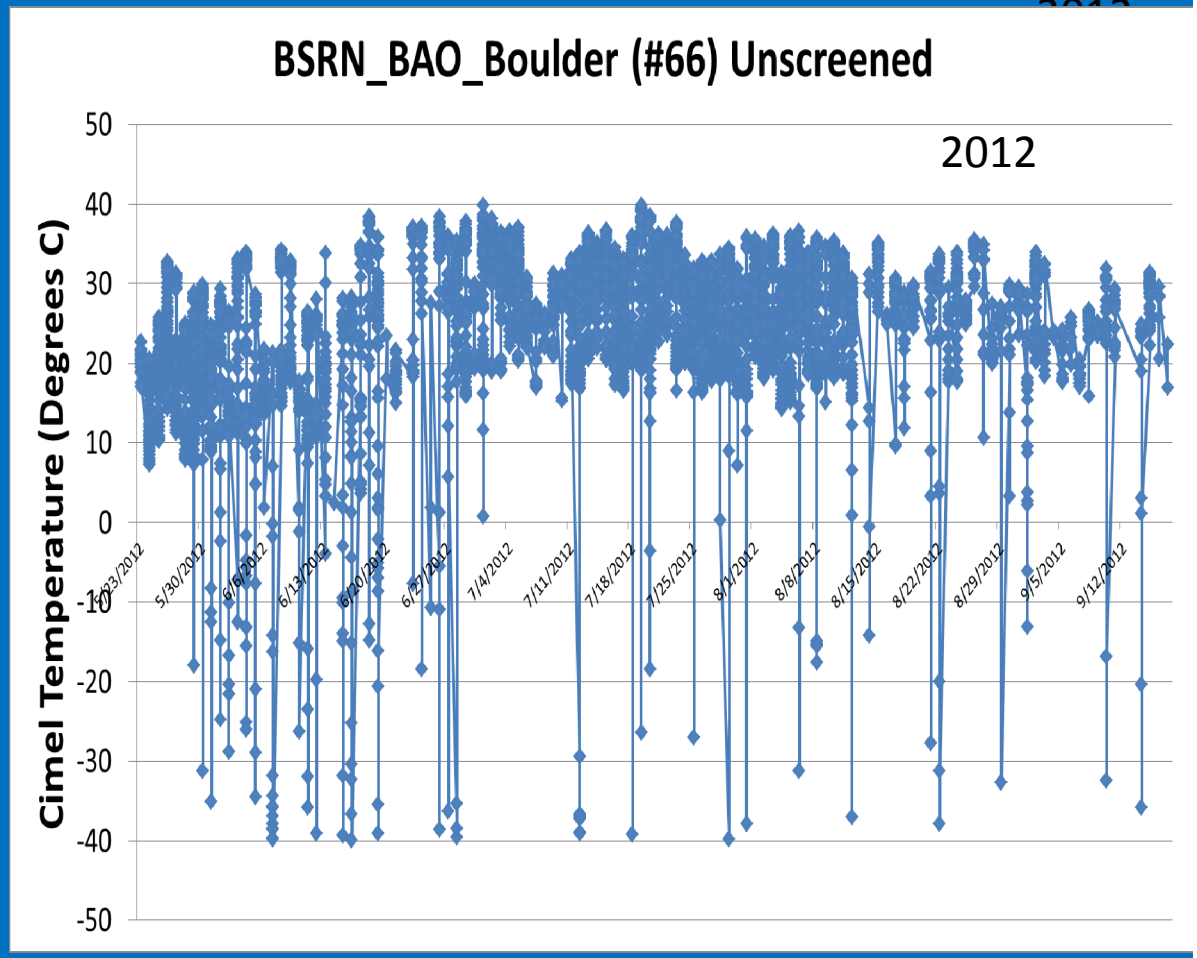




Smirnov, A., B.N.Holben, D.M.Giles, et al., Maritime Aerosol Network as a component of AERONET – first results and comparison with global aerosol models and satellite retrievals, Atm.Meas.Tech., 4, 583–597, doi:10.5194/amt-4-583-2011, 2011.

AERONET V3 L1.5V: Sensor Head Temperature Screening

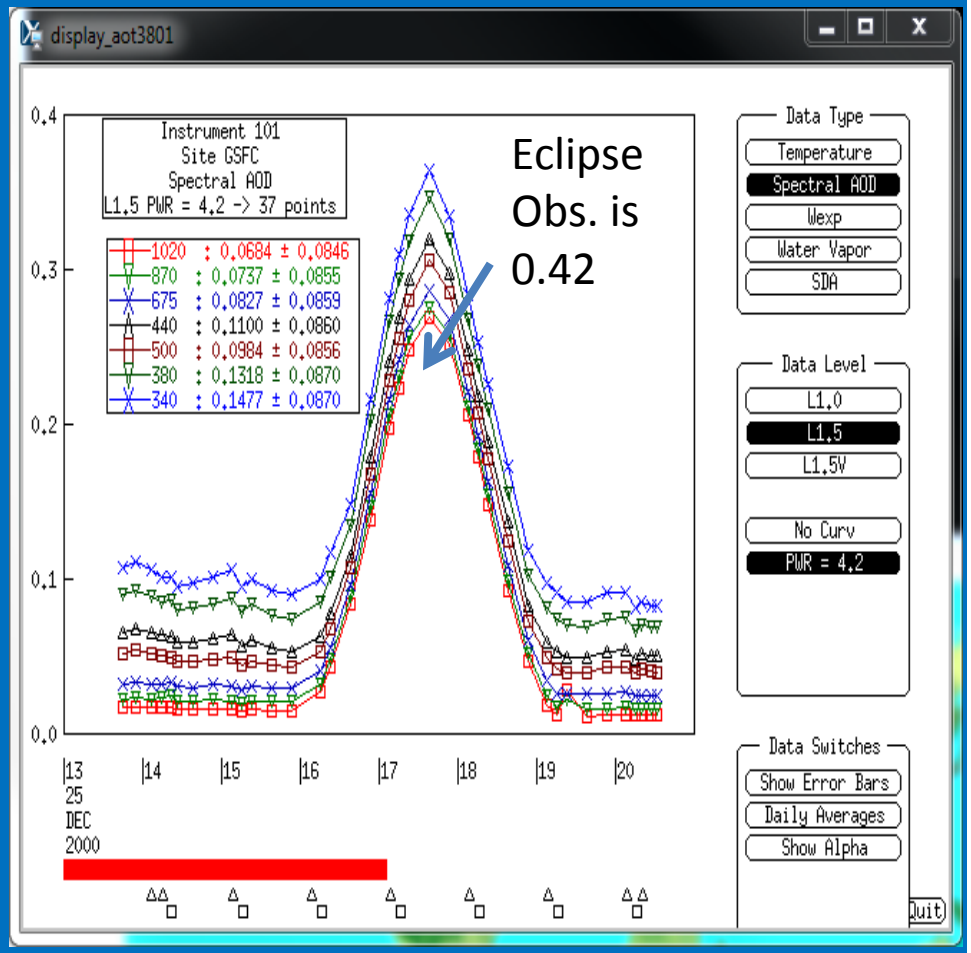
- Sensor Head Temperature Anomalies
  - Erroneous sensor temperatures adversely affect the magnitude of AOD for temperature sensitive channels



Utilizes NCEP temperature as ambient baseline

AERONET Version 3 L1.5V: Solar Eclipse Screening

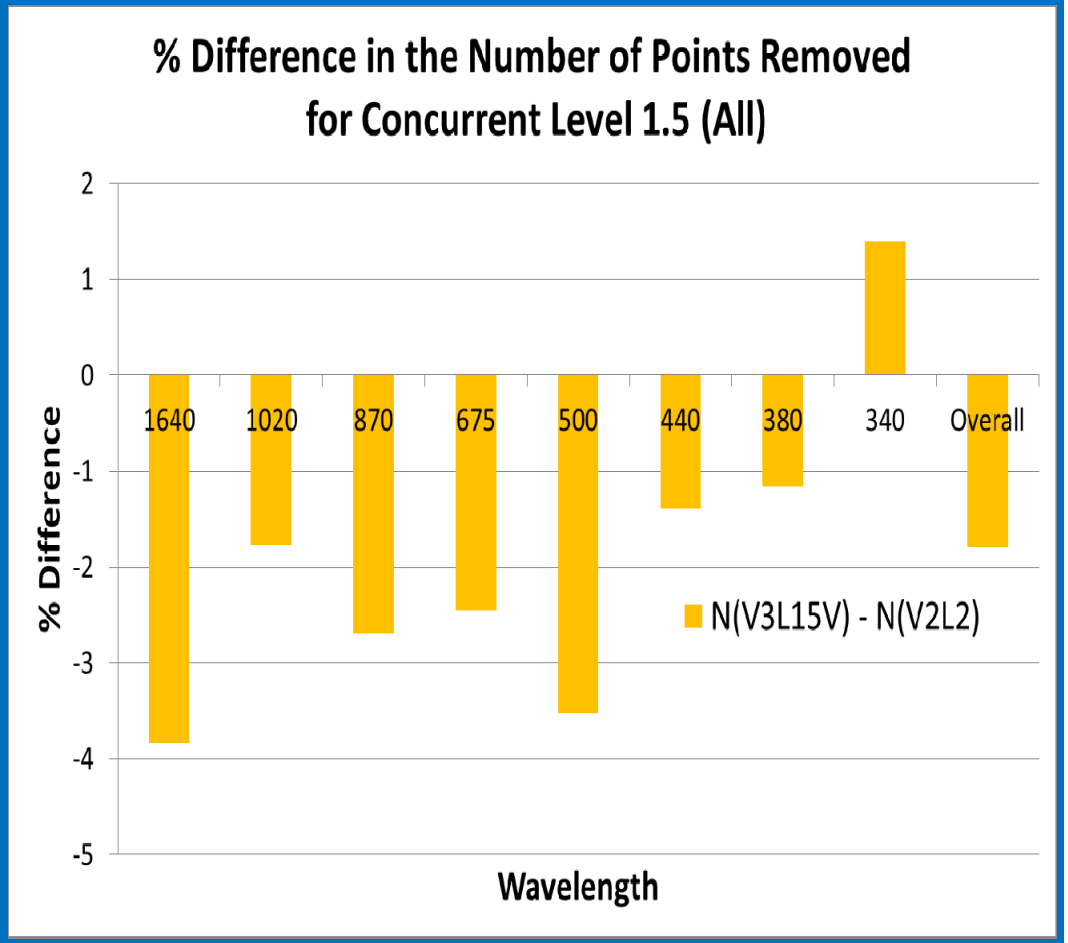
- Various solar eclipses affect AOD by changing incident extraterrestrial radiation
- AOD is maximum at maximum obscuration of the Sun
  - AOD calculation uses calibration coefficient that is not adjusted for eclipse
- NASA eclipse database utilized for screening: http://eclipse.gsfc.nasa.gov



* AOD correction may be implemented

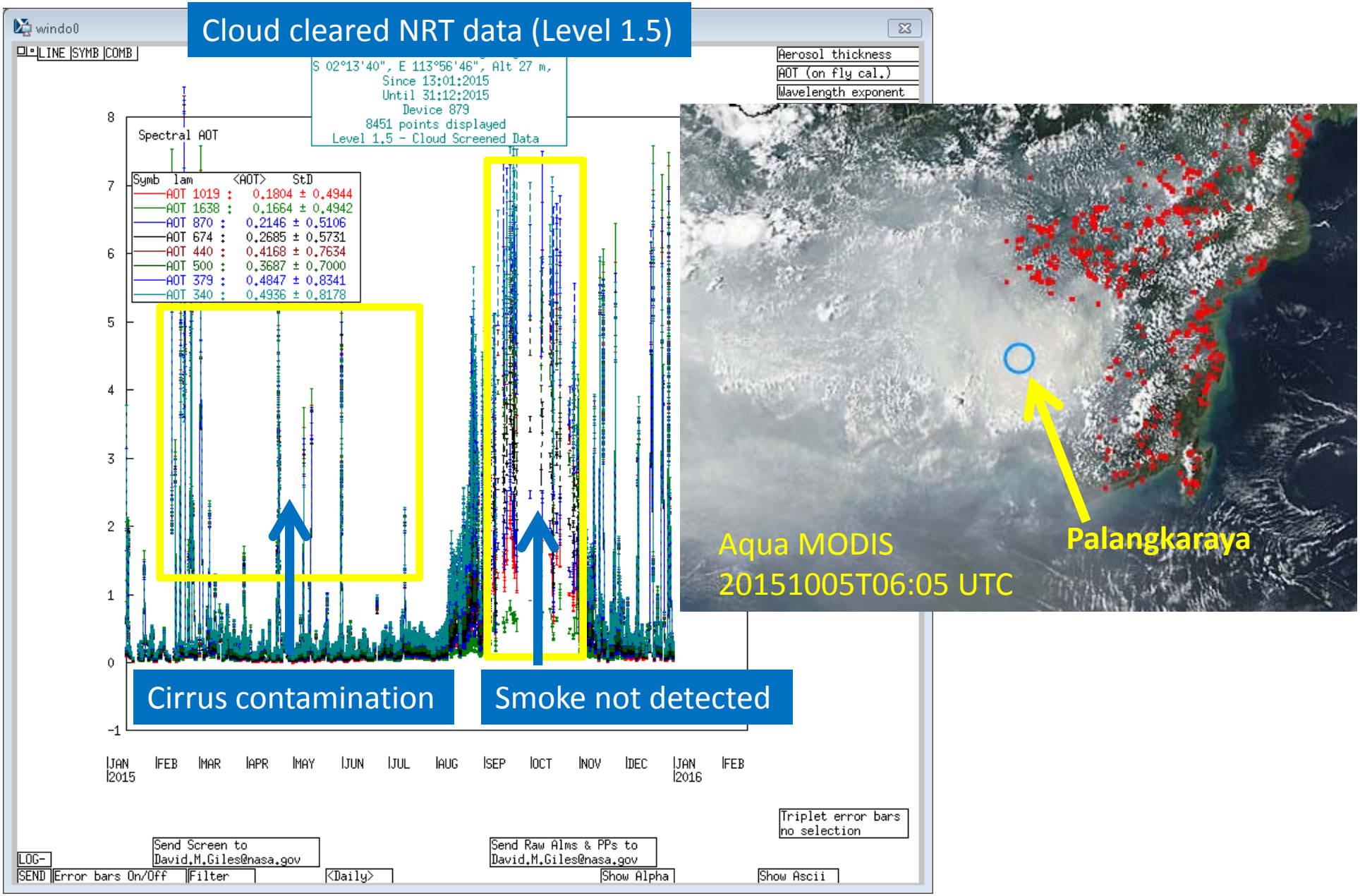
V2 L2 vs. V3 L1.5V
All Instruments (1993-2015)

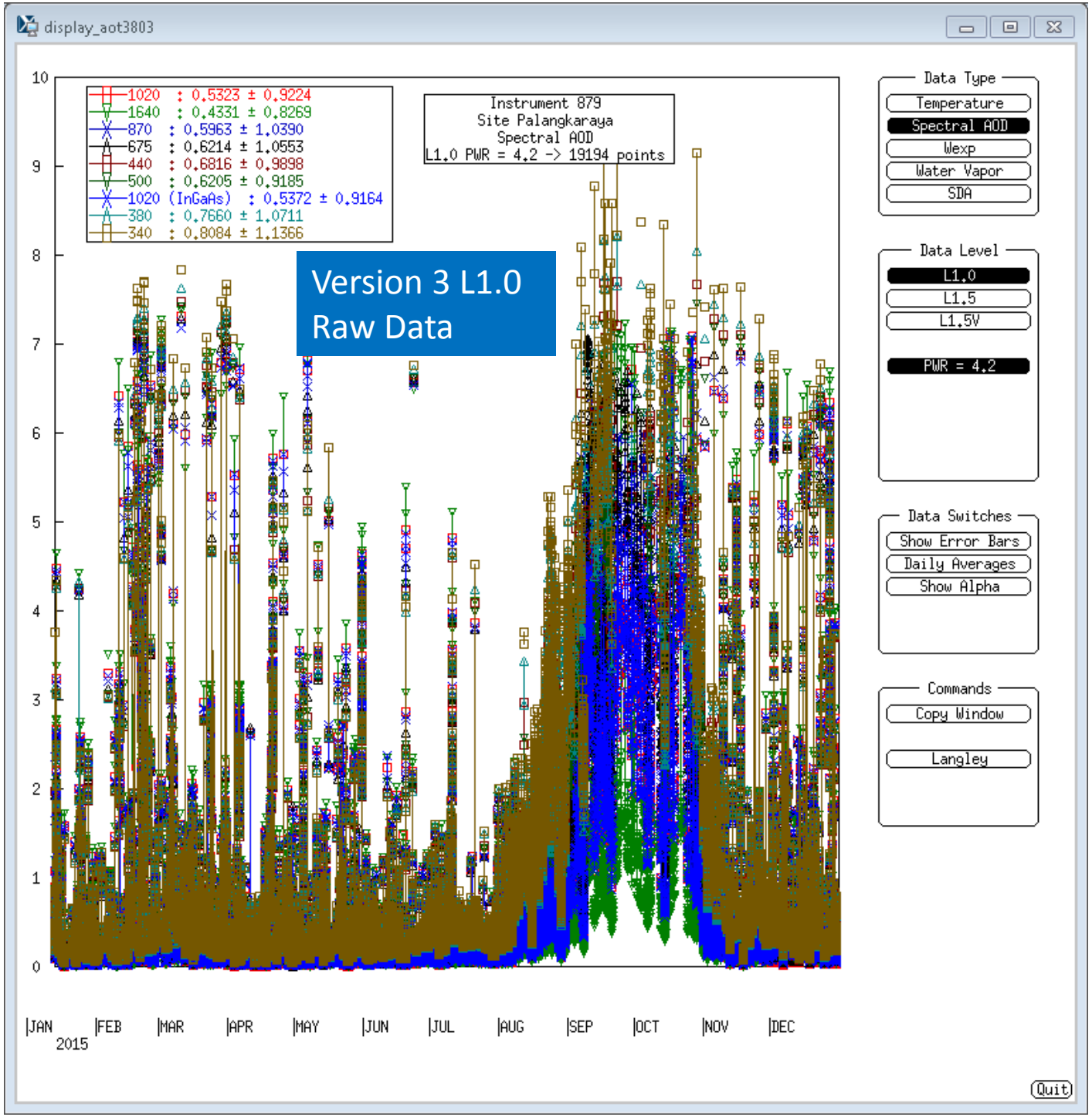
- V2 and V3 compared for the same L1.5 points
- V3 L1.5V point removal is comparable to V2 L2
- V3 L1.5V retained ~2% more data overall



%Diff<0: V3 L1.5V retained more than V2 L2
%Diff>0: V3 L1.5V removes more than V2 L2

Indonesian Fires 2015 (Palangkaraya) – Current V2




display_aot3803
1020 : 0.5323 ± 0.9224
1640 : 0.4331 ± 0.8269
870 : 0.5963 ± 1.0390
675 : 0.6214 ± 1.0553
440 : 0.6816 ± 0.9898
500 : 0.6205 ± 0.9185
1020 (InGaAs) : 0.5372 ± 0.9164
380 : 0.7660 ± 1.0711
340 : 0.8084 ± 1.1366
Instrument 879
Site Palangkaraya
Spectral AOD
L1.0 PWR = 4.2 -> 19194 points
Version 3 L1.0
Raw Data
Data Type
Temperature
Spectral AOD
Wexp
Water Vapor
SDA
Data Level
L1.0
L1.5
L1.5V
PWR = 4.2
Data Switches
Show Error Bars
Daily Averages
Show Alpha
Commands
Copy Window
Langley
Quit
0
1
2
3
4
5
6
7
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JAN
2015
FEB
MAR
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OCT
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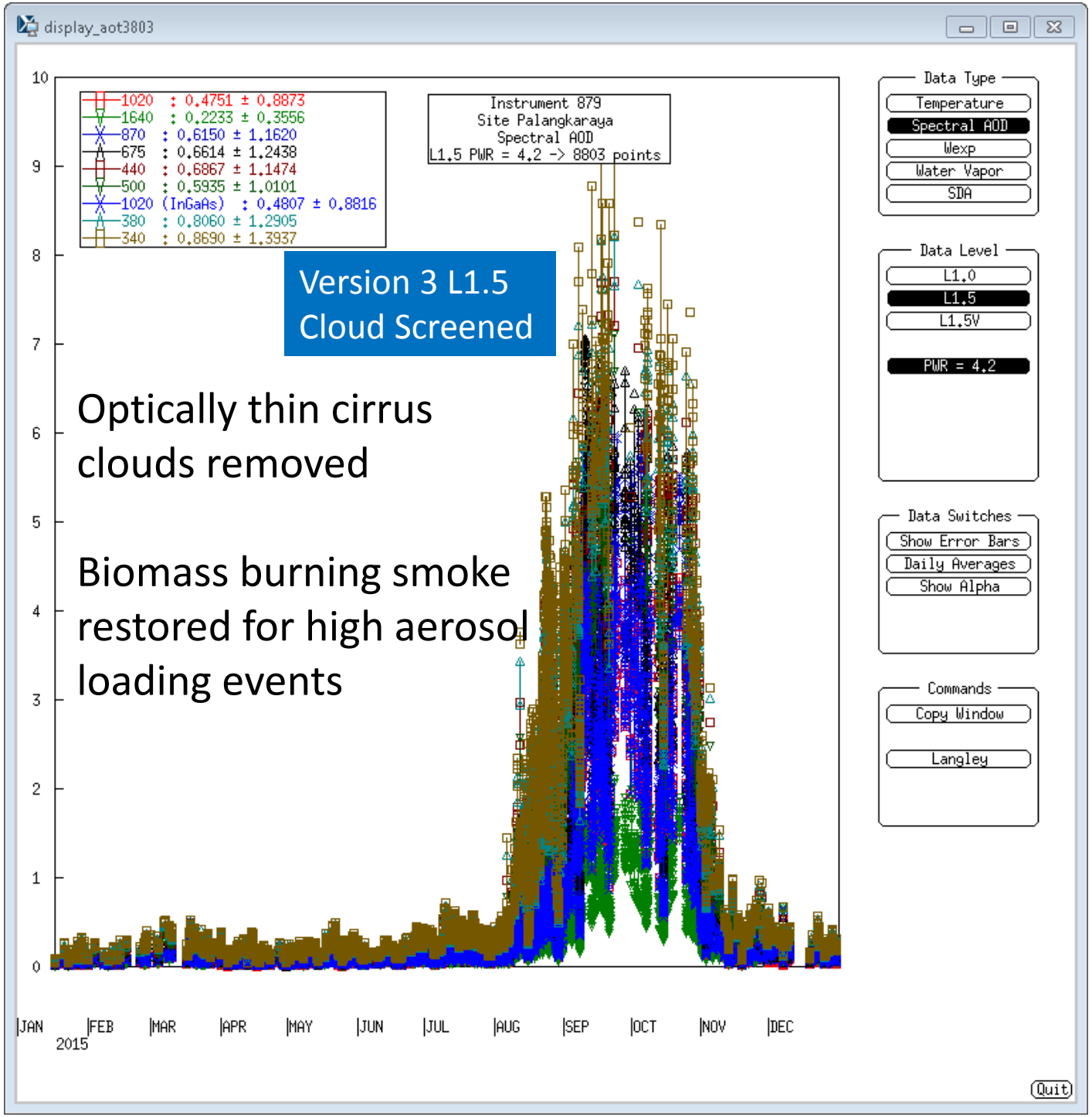
DEC


display_aot3803
1020 : 0.4751 ± 0.8873
1640 : 0.2233 ± 0.3556
870 : 0.6150 ± 1.1620
675 : 0.6614 ± 1.2438
440 : 0.6867 ± 1.1474
500 : 0.5935 ± 1.0101
1020 (InGaAs) : 0.4807 ± 0.8816
380 : 0.8060 ± 1.2905
340 : 0.8690 ± 1.3937
Instrument 879
Site Palangkaraya
Spectral AOD
L1.5 PWR = 4.2 -> 8803 points
Version 3 L1.5
Cloud Screened
Optically thin cirrus clouds removed
Biomass burning smoke restored for high aerosol loading events
Data Type
Temperature
Spectral AOD
Wexp
Water Vapor
SDA
Data Level
L1.0
L1.5
L1.5V
PWR = 4.2
Data Switches
Show Error Bars
Daily Averages
Show Alpha
Commands
Copy Window
Langley
Quit
0
1
2
3
4
5
6
7
8
9
10
JAN
2015
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Summary

- AERONET has provided a valuable contribution to aerosol science in SE Asia through regional assessments and validation of satellite and model forecasts
- AERONET continues to expand and considers Myanmar a high priority
- Automatic quality controls perform objective assessments throughout the entire database and provide comparable results to manual screening
- Higher quality AOD data will be available in V3 NRT
  - Due to temperature characterization, improved cloud screening, and quality controls
- High aerosol loading will be characterized under Ver. 3

➢ Version 3 AOD expected release: **Spring 2016**