Aerosols, Southeast Asia and the AERONET program

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LCLUC Regional International Meeting, Yangon, Myanmar
Talk Topics

• The Challenge: Understanding aerosol particles and their metrological & climate impact in SE Asia (7-SEAS perspective)

• AERONET contributions and improvements for the future

• Summary
Aerosol Particles as an Interdisciplinary 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.
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
- Pearl River Delta
- Manila
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: \( \tau, \omega, \Theta, \text{size}, n, k \) and WV, clds, \( L_{\text{wn}} \)
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 ...

Holten, Holben, Brent, et al. (1998)
Seasonal variation of AOD from 5 selected AERONET sites:

- Chiang Mai
- Dongsha
- Lulin
- Mukdahan
- Bangkok
Maritime Aerosol Network (MAN) as a Component of AERONET

- MAN represents an important strategic sampling initiative and ship-borne data acquisition complements island-based AERONET measurements.


MAN coverage - October 2006 – September 2012

In the last several years data acquisition was extended to the areas that previously had very little or no coverage at all.
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

* 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

% Difference in the Number of Points Removed for Concurrent Level 1.5 (All)

%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

Cloud cleared NRT data (Level 1.5)

Aqua MODIS
20151005T06:05 UTC

Palangkaraya

Cirrus contamination
Smoke not detected
Version 3 L1.0 Raw Data
Version 3 L1.5 Cloud Screened

Optically thin cirrus clouds removed

Biomass burning smoke restored for high aerosol loading events
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