Aerosol Environment in South-East Asia: a MPLNET and AERONET perspective

Santo V. Salinas
Senior Research Scientist (CRISP)

email: crsscsv@nus.edu.sg
The disastrous 1997 haze event

Fig. 1. The 1997 smoke event (Source: NASA/TOMS aerosol index).
The recent 2015 smoke event

Fig. 2. The smoke event of August-September 2015 (Terra/AQUA MODIS view).

Source: Reid et al, Observing and understanding the Southeast Asian aerosol system by remote sensing: An initial review and analysis for the Seven Southeast Asian Studies (7SEAS) program. Atmos. Res. 2012, doi:10.1016/j.atmosres.2012.06.005.
Fig 4. MODIS true-color images of the Southeast Asian biomass burning system. (a) Terra MODIS for 7 April 2002, with regional smoke and fire (red) transporting over a stratus deck in Vietnam; (b) Zoom of (a); (c) Massive Indonesian fire event on Borneo and Sumatra captured by Aqua MODIS Sept. 18, 2002; (d) Zoom of (c) with contrast enhancement; (e) SPOT 2 image of forest burning in Riau, Sumatra August 8, 2005 (RGB = NIR, red, green; that is vegetation is red, no vegetation/burn scar is green, smoke is white); (f) SPOT 4 Image of agricultural burning in south Sumatra, September 28, 2006 (RGB = SWIR, Near IR, red; that is fire is red, vegetation green, burn scar black, smoke bluish white ). (Reid et al. 2013).
Fig 5: Simulated sources and transport of smoke in South-East Asia (courtesy NRL, 2007).
Satellite remote sensing

Fig 6. AOD from MODIS and MISR. Below: MISR Level 3 2001-2010 cloud cover statistics for two periods: Winter (Dec-May) and Summer (Jun-Nov). (Reid et al. 2011).
The AEROsol RObotic NETwork (AERONET)
Typical AERONET data
Typical AERONET data

Singapore, N 1.298, E 103.780, Alt 30 m,
PI: Soo-Chin Liew and Santo V. Salinas-Cortijo, scliew@nus.edu.sg and crsscsv@nus.edu.sg
Level 1.5 AOD; Data from SEP 2015
Typical MPLNET measurements

GEOS-5 Data: Singapore, 2014-09-23
Typical MPLNET retrievals
Some Case Studies
Singapore: AOD and Angstrom number distributions 2007-2009

Fig. 7: AOD and Angstrom number variability for 2007-2009. (Salinas et al. 2009)
Trans-boundary fires and PM2.5 measurements during October 2010

Photometric measurements at Kuching

Fig. 9. Left: Comparative environment between Kuching and Singapore. Right: AERONET AOD and Angstrom exp. numbers at Kuching.

*Santo V. Salinas, Boon Ning Chew, M. Mohamad, M. Mahmud, Soo Chin Liew, First Measurements of Aerosol Optical Depth and Angstrom Exponent Number from AERONET’s Kuching Site. Atmos. Env. 2013 (doi.org/10.1016/j.atmosenv.2013.02.016).
Cirrus cloud contamination on photometric measurements

Fig. 10. Left: Geometry of a collocated AERONET and MPLNET setup. Right: AERONET Level 2.0 observations with (blue solid) and without cirrus contamination (red dashed). The bin sizes for all panels are 0.05. (a) Distributions for AOD, (b) fine mode fraction, (c) coarse mode AOD and (d) fine mode AOD at 0.500 µm.

Vertical structure of the atmosphere

Fig. 11. Typical boundary layer over Singapore (0022 UTC 25 October 2009) and six major aerosol particle vertical distributions identified via PCA: (b) SCD (0.7 – 1.35 km), (c) EML (1.35 – 2.5 km), (d) EUL (2.4 – 3.525 km), (e) DCL (3.525 – 4.95 km) and (f) DML (> 4.95 km).

The AUG-OCT 2015 smoke episode

Fig. 12. Monthly fire spot count and cumulative aerosol optical depth as detected by the MODIS instrument on Aqua/Terra Satellites.
Fig. 17. Aerosol particle size classification and size distributions for Singapore.
The AUG-OCT 2015 smoke episode

Fig. 18. Time series of daily averages of AOD, Angstrom exp. Number and fine mode fraction for both Singapore and Kuching city.
The AUG-OCT 2015 smoke episode

Fig. 19. Lidar time series for normalized backscattering and depolarization ratios for 21st and 24th September 2015.
Remote sensing (satellite and ground) remains the best tool to monitor the SEA region.

An active atmospheric super-site has been set up at CRISP/NUS in partnership with NASA and NRL.

AERONET and MPLNET capabilities remain the pillars for ground-satellite validations.

Applications to air quality related studies are one of the many possible applications of local AERONET and MPLNET sites.

Regional network of AERONET and MPLNET sites are crucial for the monitoring of large scale biomass burning events.