

Aerosol Optical Properties in Southeast Asia From AERONET Observations

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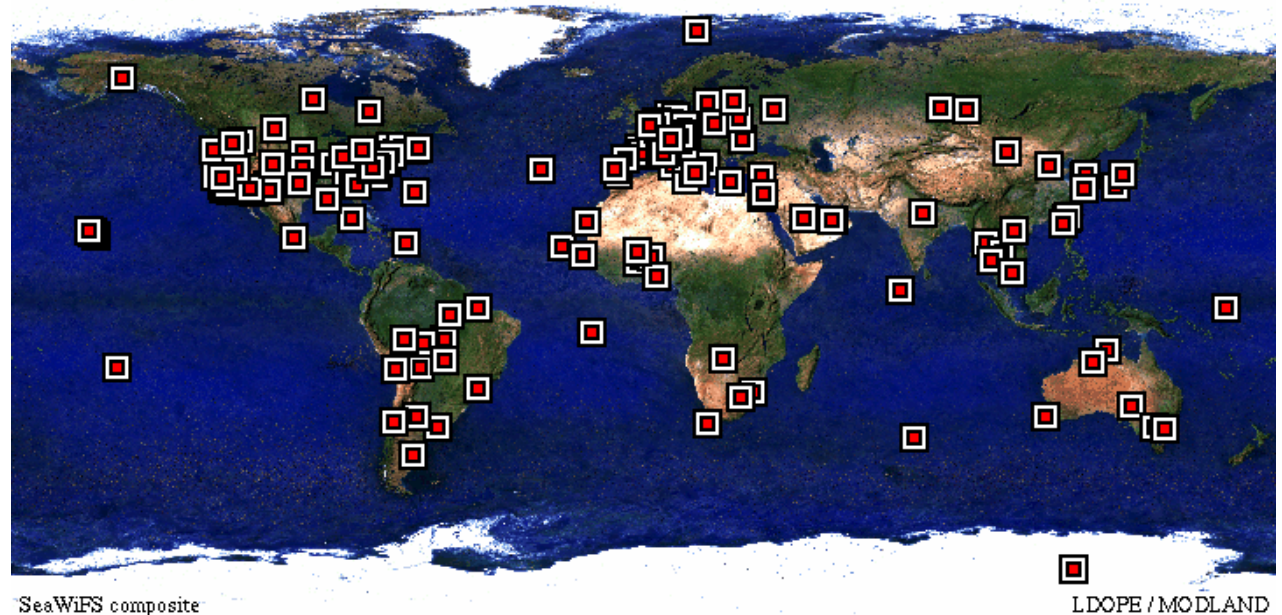
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⁴NRL, Monterey, CA, USA



AERONET - An Internationally Federated Network



- Characterization of aerosol optical properties
- Validation of Satellite Aerosol Retrievals
- Near real-time acquisition; long term measurements
- Homepage access <http://aeronet.gsfc.nasa.gov>

AERONET Monitoring of Aerosol Optical Properties in SE Asia

- Mid-February to Early May, 2003 : 2nd Half of the Dry Season at 6 Sites, Presently Continuing through the Wet Season at 4 sites
- First Year of AERONET Monitoring in Thailand and Vietnam, with Plans for Continuing Monitoring
- Preliminary Analysis Based on Level 1.5 Data: Awaiting Final Calibration for More Complete Analysis (2 sites have final level 2.0 data)

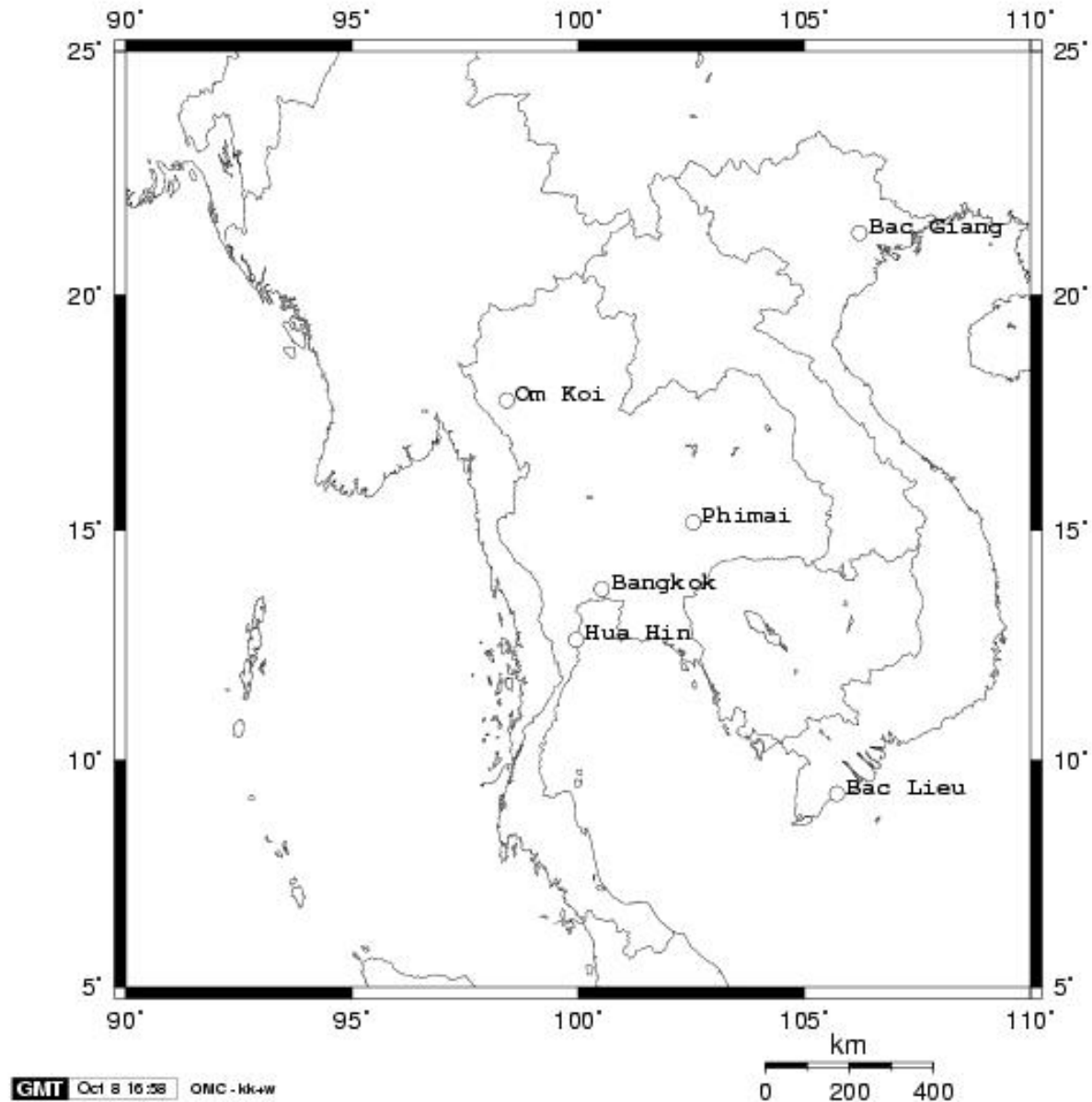


Chulalongkorn University, Bangkok



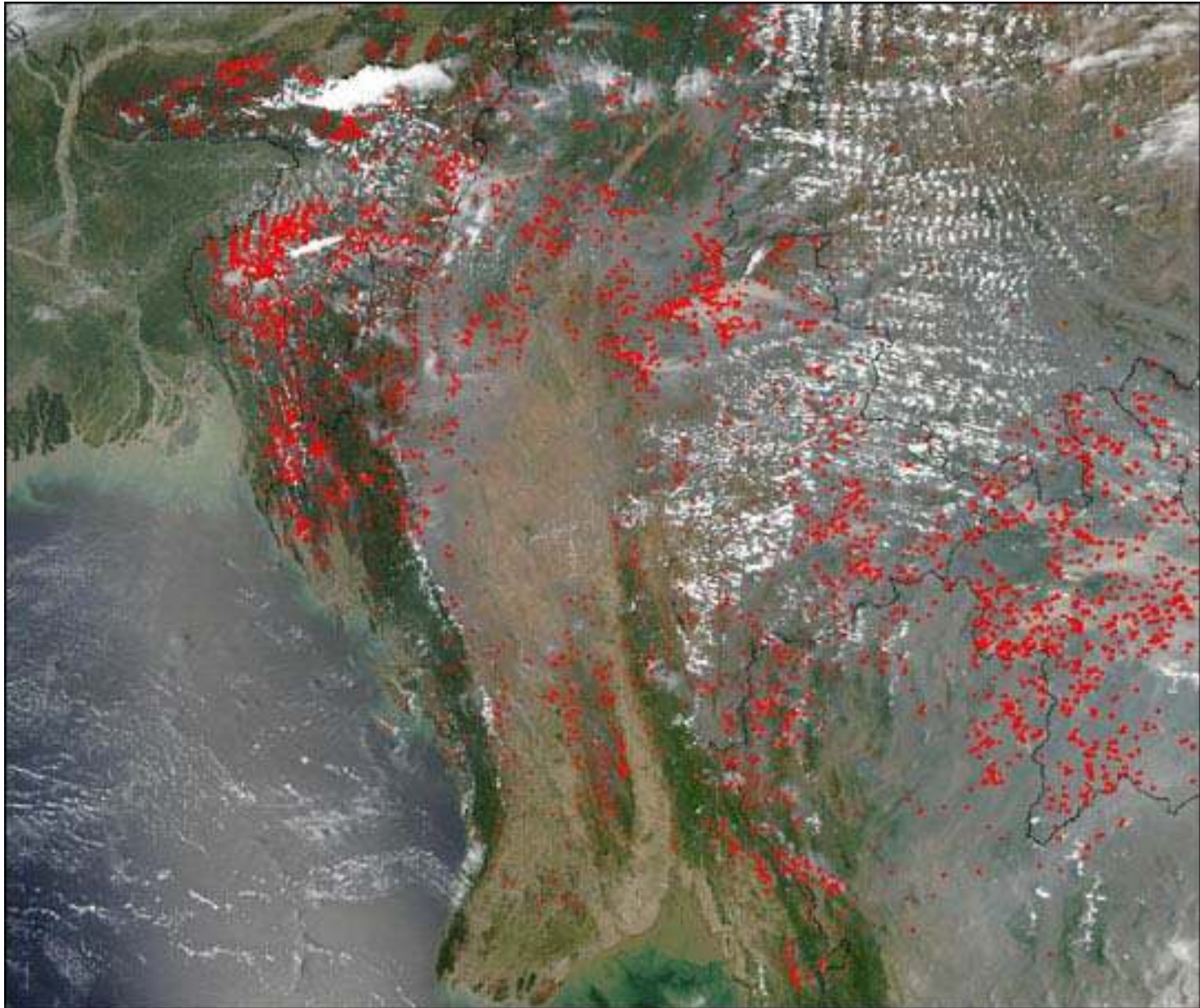
Phimai, Thailand site: Left to right- Mr. Khun Kamol (Site Manager); Tom Eck (AERONET); Dr. Jariya Boonjawat (Thailand coordinator of AERONET)

SE Asia AERONET Sites: February-May 2003

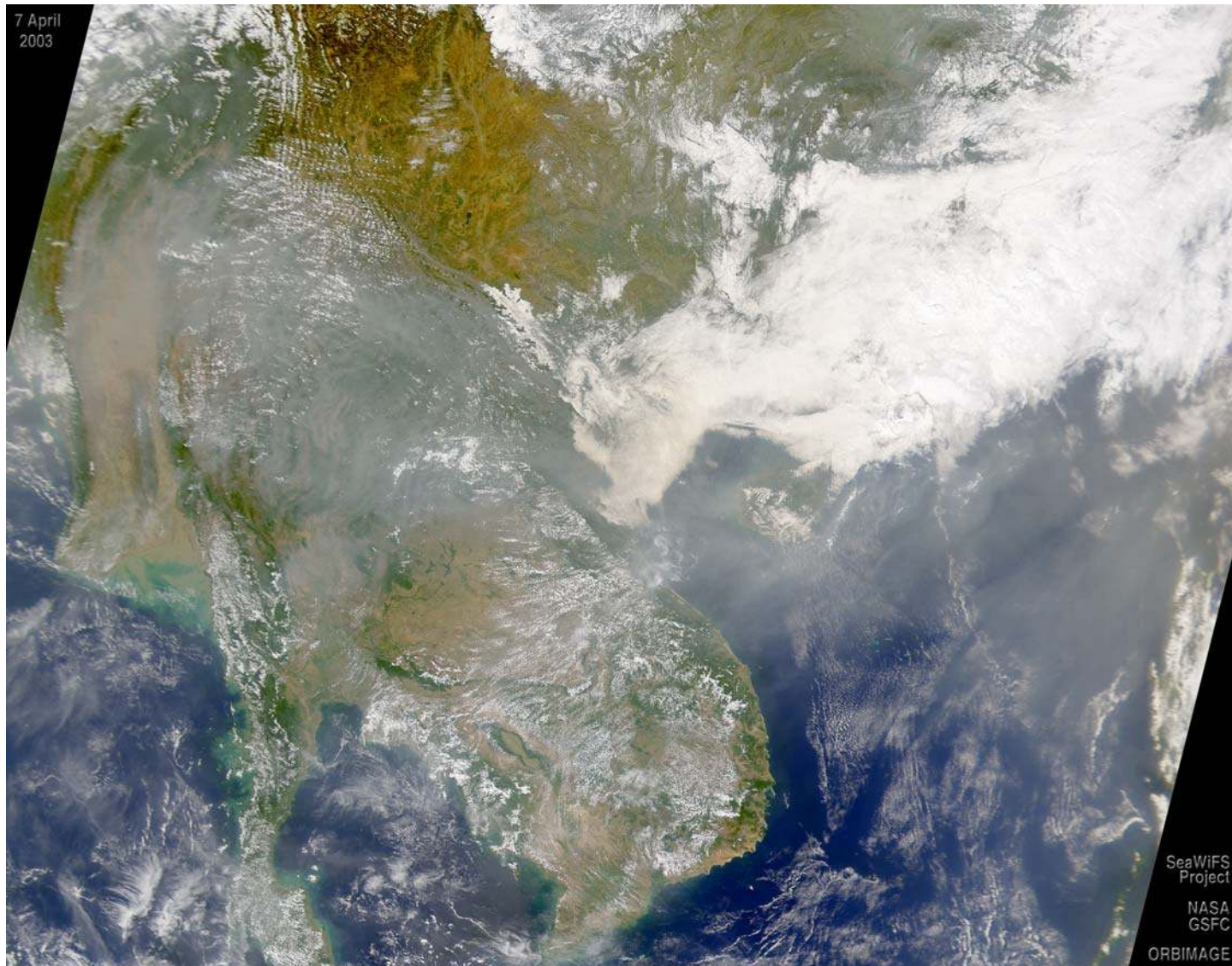


April 8, 2003 - Numerous fires in India, Burma, and Laos and NW Thailand -

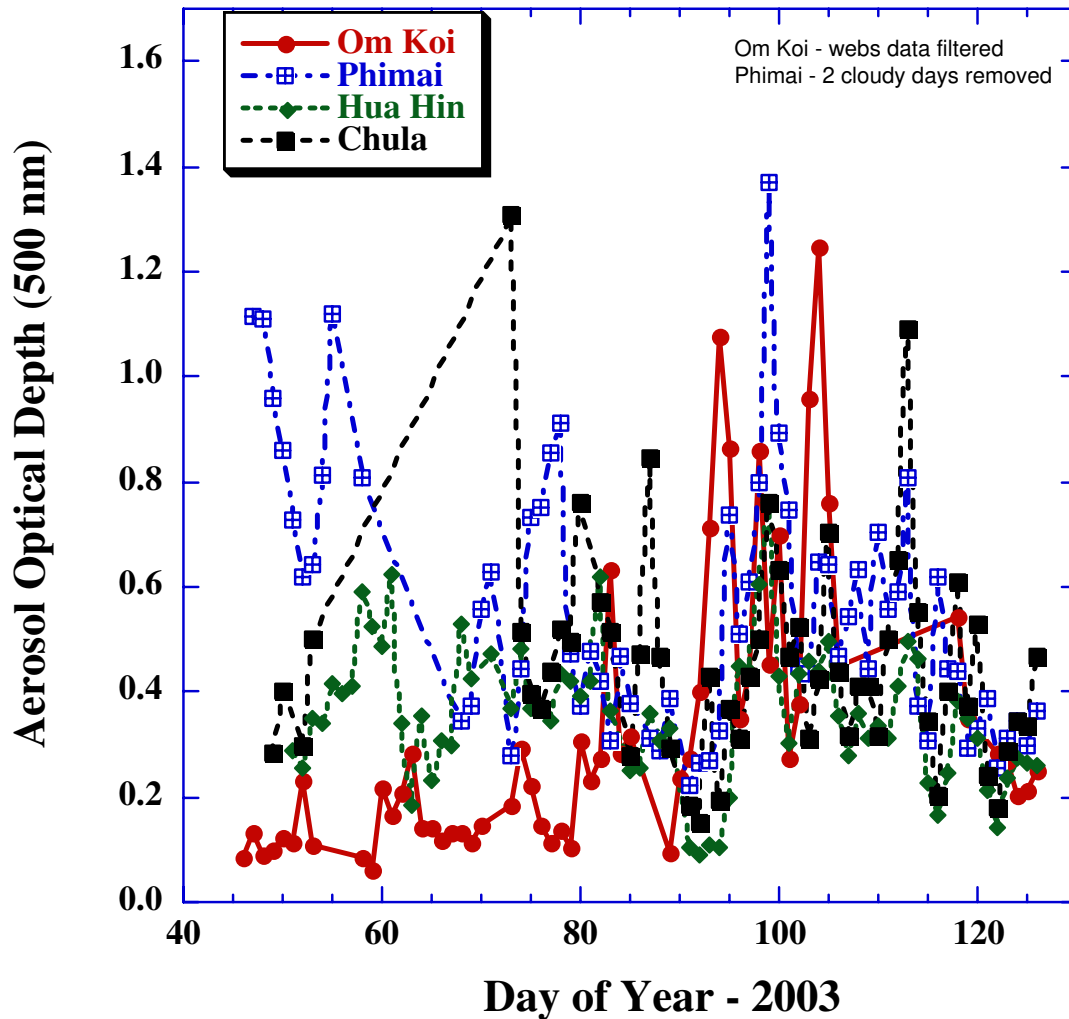
Om Koi: $AOD(500nm)=0.45$ at Aqua (MODIS) Satellite Overpass time



April 7, 2003; SeaWiFS image - Smoke and pollution covers a large portion of the SE Asia region and advecting out over the South China Sea

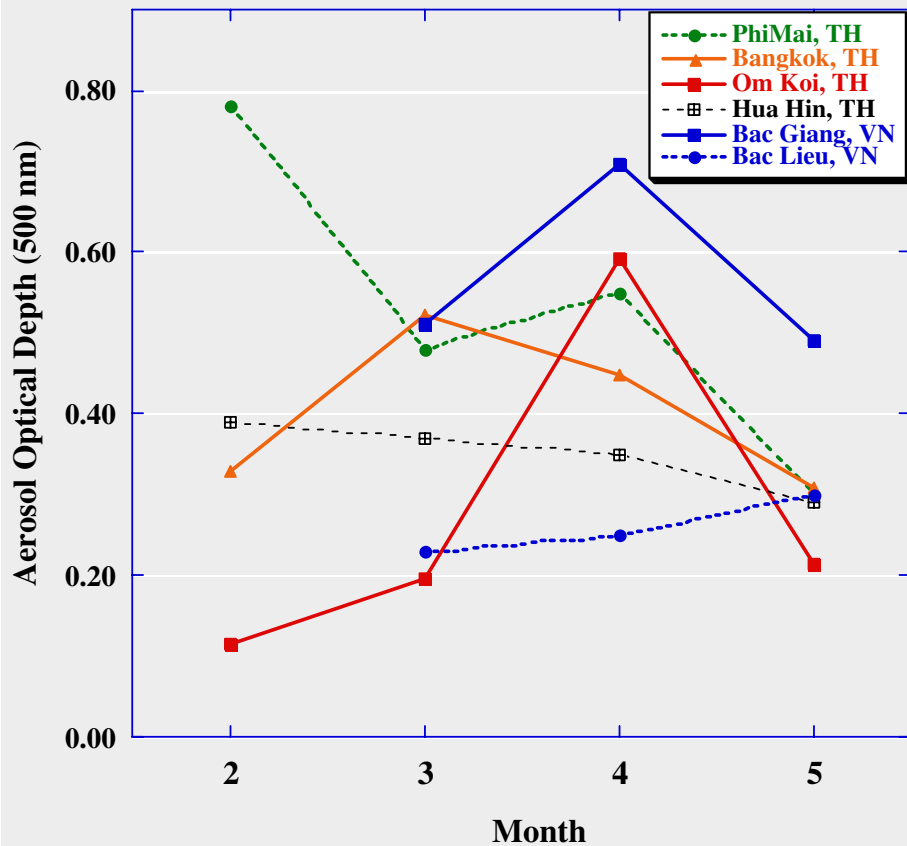


4 Sites in Thailand
Daily Ave. AOT Feb 16 - May 7, 2003
Level 1.5 Preliminary Cloud Screened

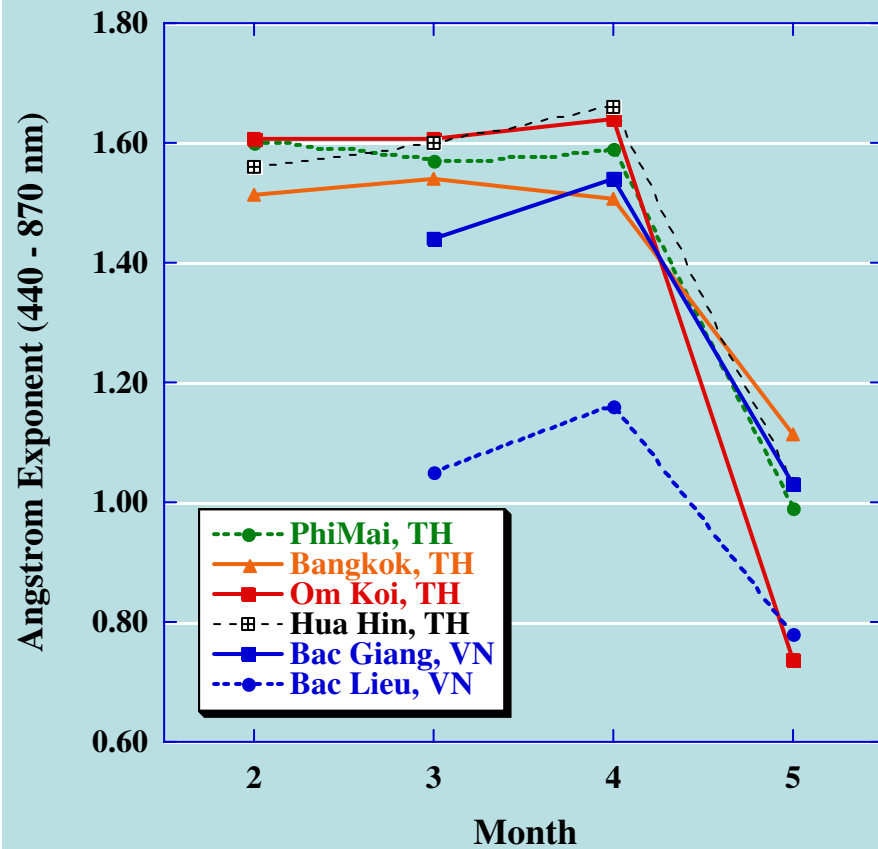


The first half of the monitoring period Feb 16 - Mar 21 (until Day 80) showed relatively low AOD in NW Thailand at the Om Koi site (1120 m elev) on mountain ridge top, and the highest AOD at the Phimai site. After Mar 21, the AOD was relatively high at all sites as large amounts of biomass burning smoke affected parts of the region.

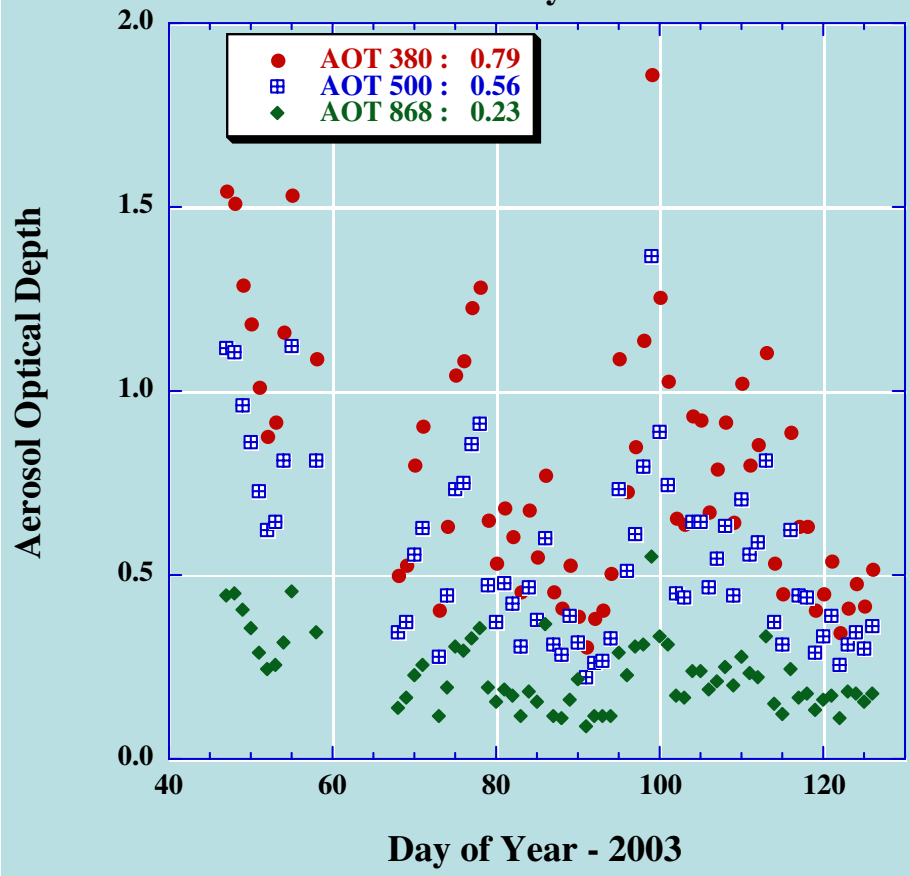
Monthly Average AOD (500 nm)
Dry Season (2nd half: Feb-May) Cloud Screened



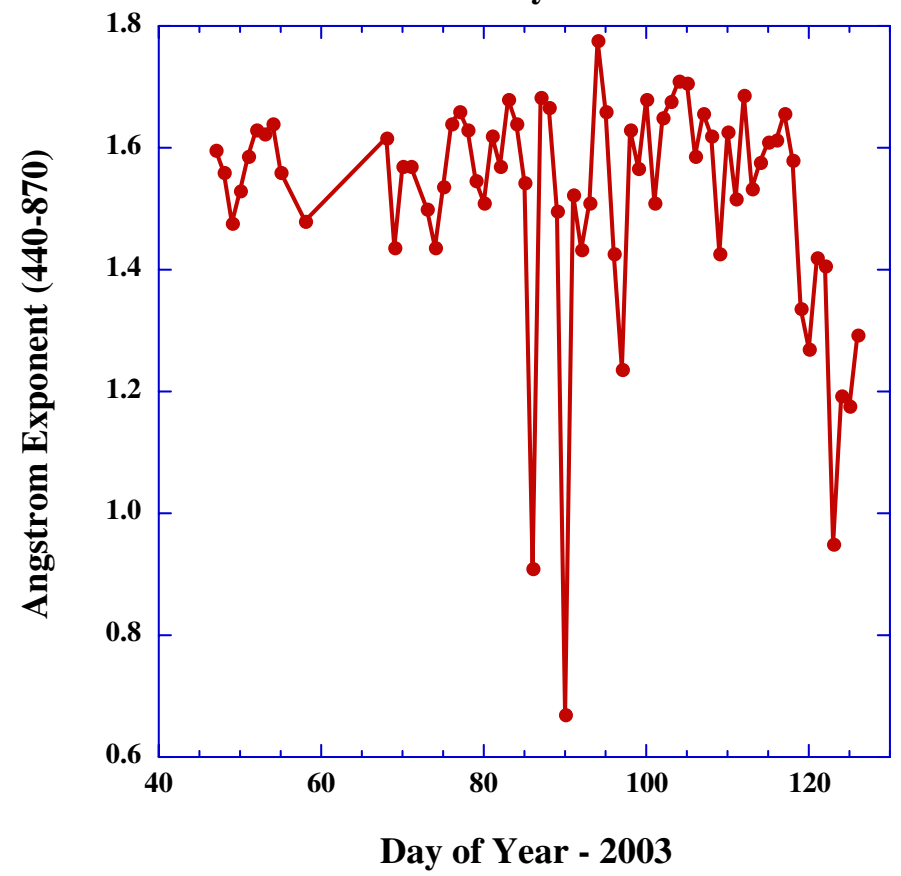
Monthly Average Angstrom Exponent
Dry Season (2nd half: Feb-May) Cloud Screened



Phimai, Thailand Elevation 220 m
Daily Ave. AOT Feb 17 - May 7, 2003
Level 1.5 Preliminary Cloud Screened

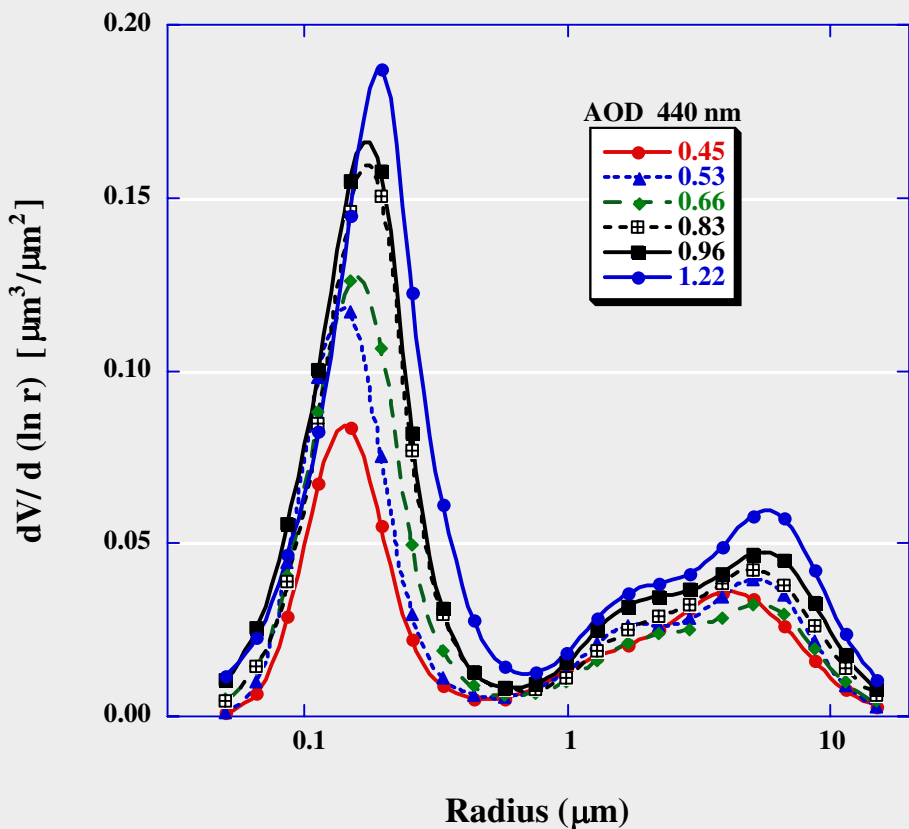


Phimai, Thailand Elevation 220 m
Daily Ave. Alpha Feb 17 - May 7, 2003
Level 1.5 Preliminary Cloud Screened

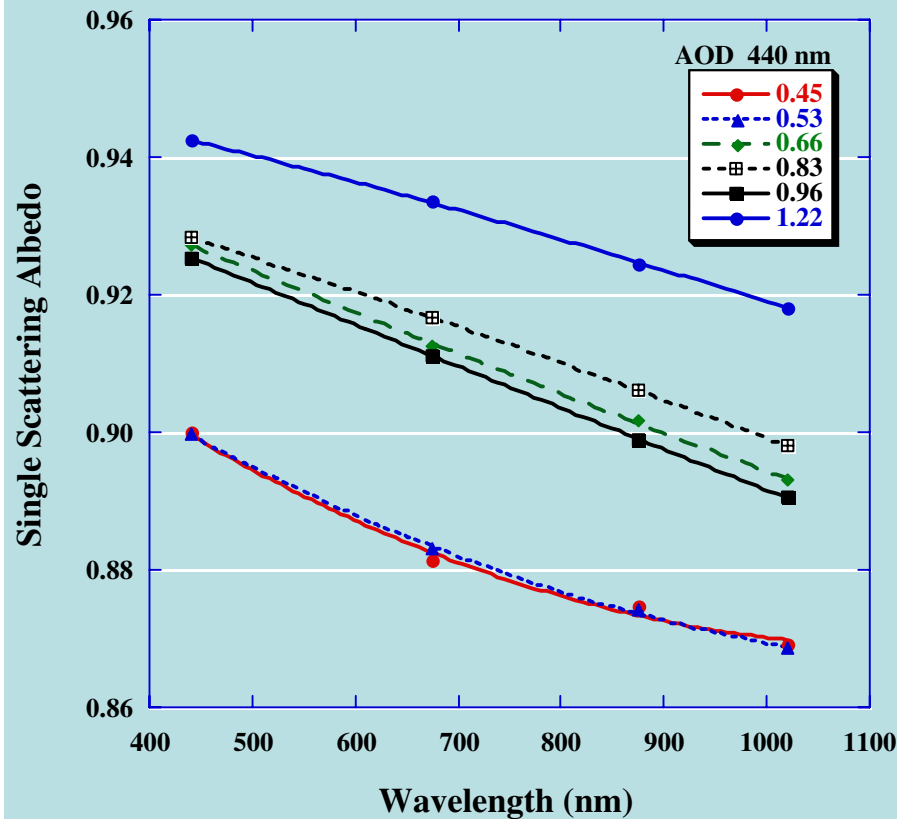


Angstrom Exponent was typically >1.4 : Therefore Fine mode particles (radius <0.6 micron) dominated

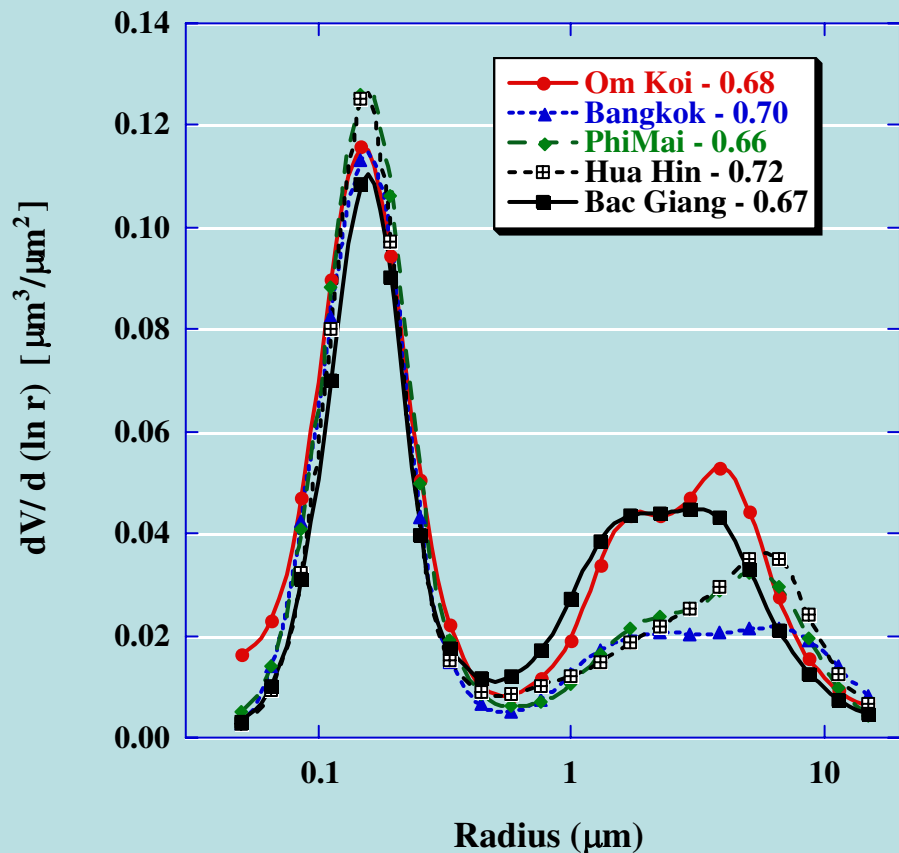
Phimai, Thailand Feb - May, 2003
13 Almucantars/ AOD bin; AOD(440)>0.4
Level 1.5 Preliminary Cal. & Cloud Screening



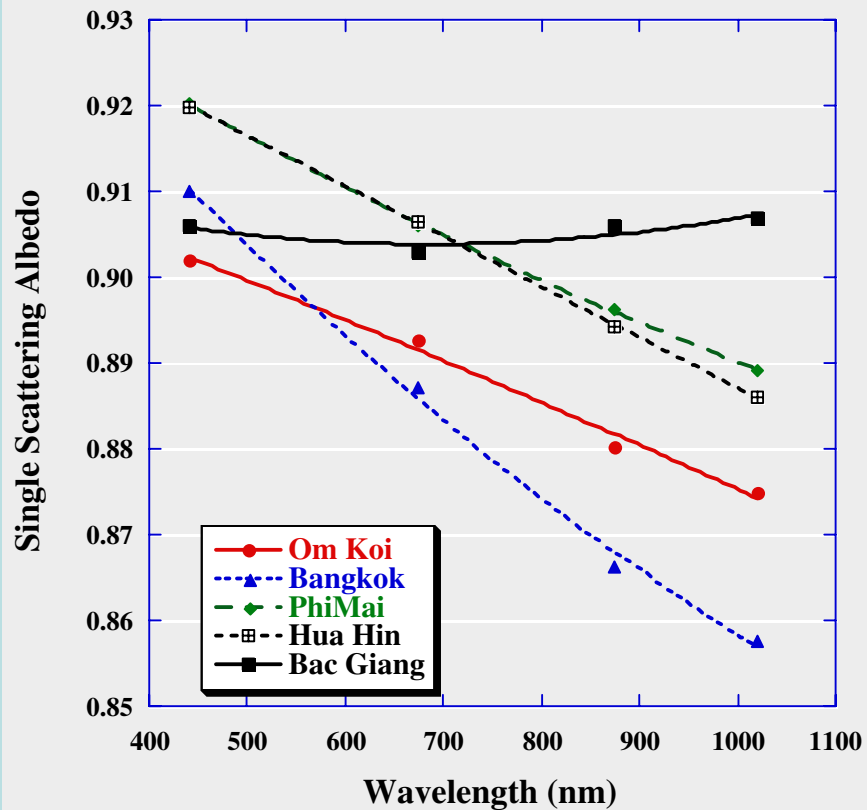
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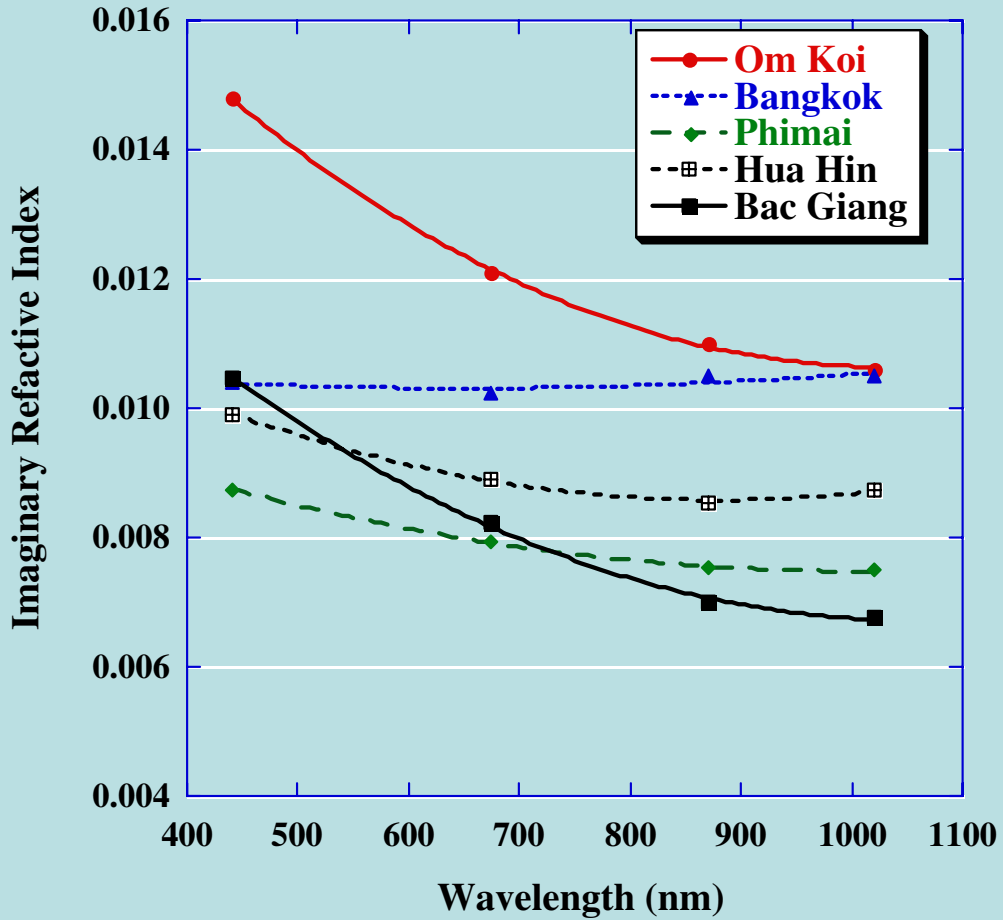
Comparison of SE Asian Aerosol Size Distributions for AOD (440 nm) ~ 0.70



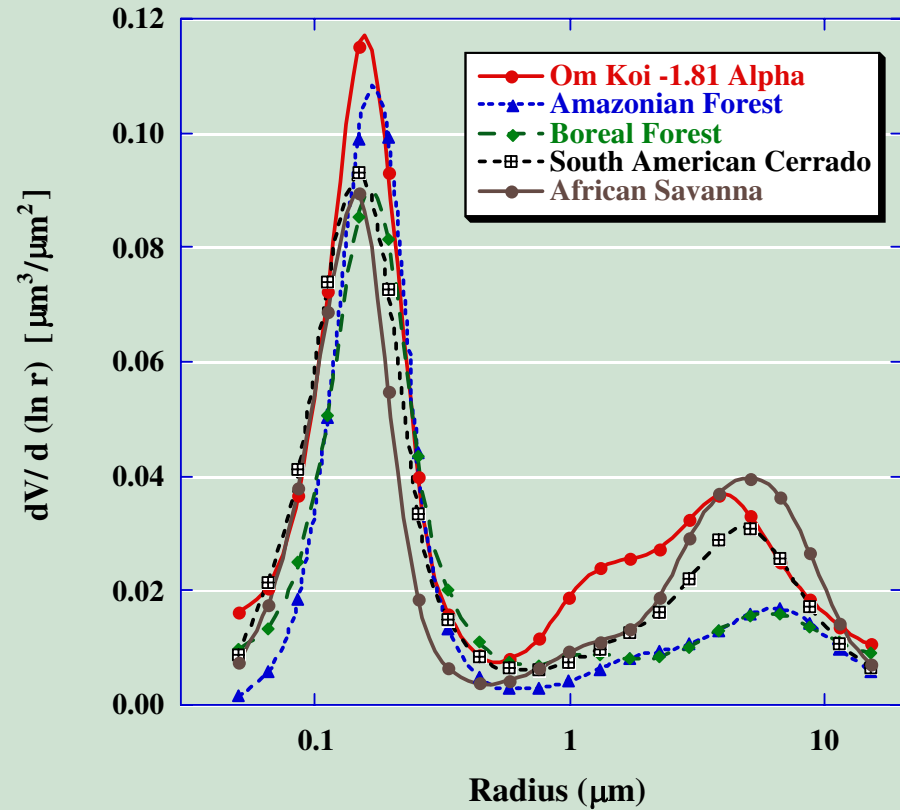
Southeast Asia AERONET Sites - 2003 Dry Season Single Scattering Albedo Comparison - AOD(440)>0.4 All Cloud Screened Observations



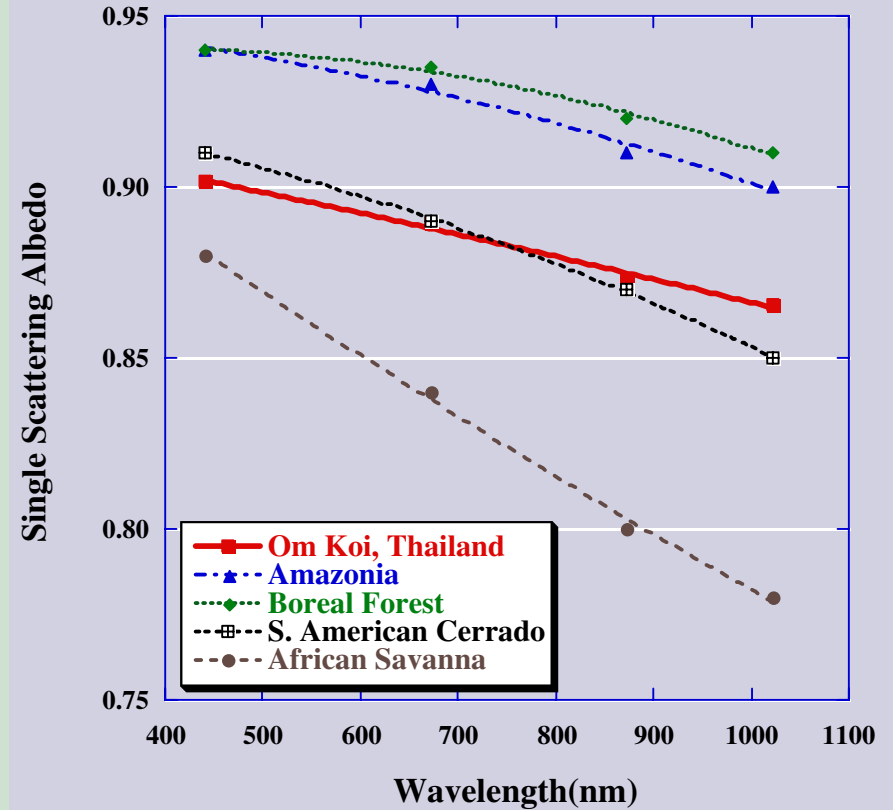
**Southeast Asia AERONET Sites - 2003 Dry Season
Imaginary Refractive Index Comparison - AOD(440)>0.4
All Cloud Screened Observations**



Comparison of Biomass Burning Regions - Size Distributions for AOD (440 nm) ~ 0.70

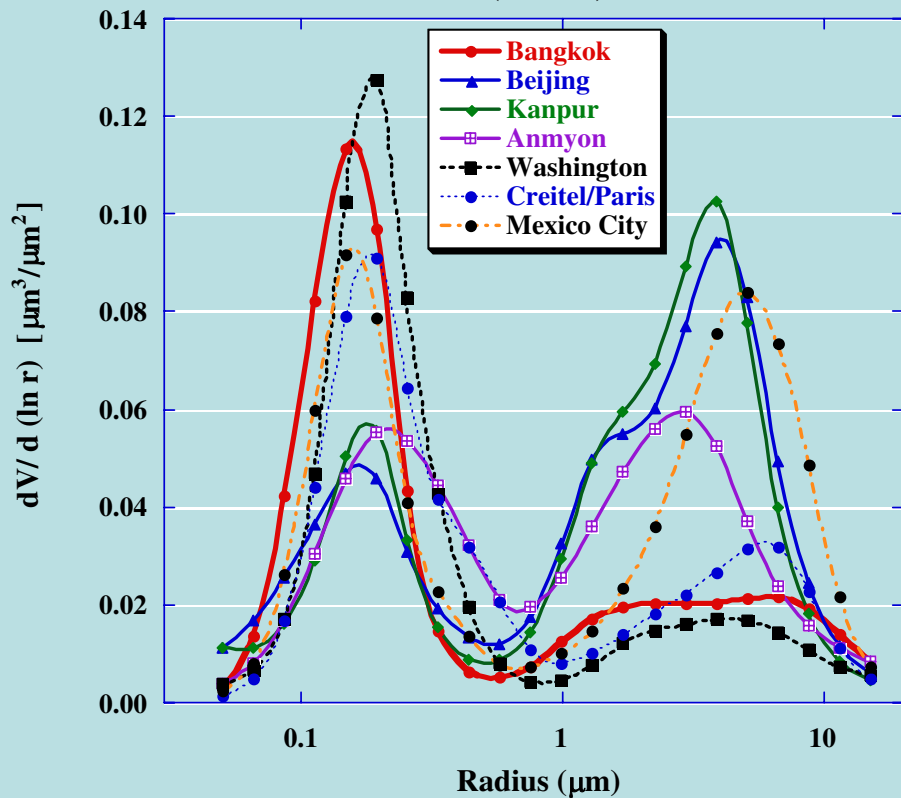


Comparison of Thailand Biomass Burning SSA versus Other Biomass Burning Regions

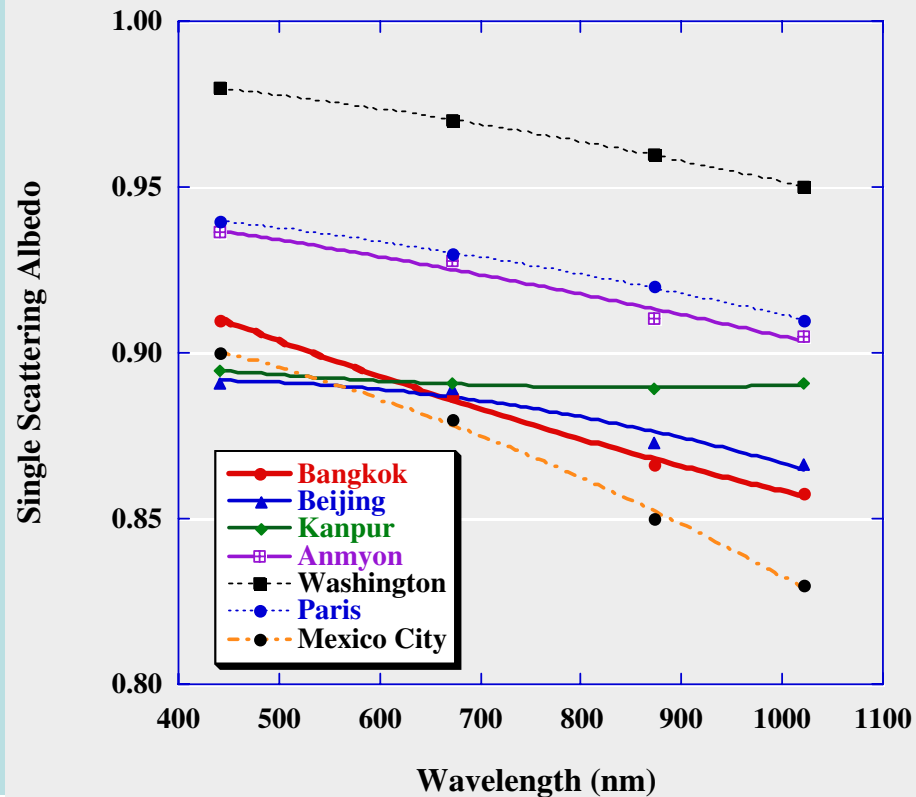


Amazon, Boreal, Cerrado, and Savanna data from *Dubovik et al. [2002] Table 1.*

Comparison of Urban Areas - Size Distributions for AOD (440 nm) ~ 0.70

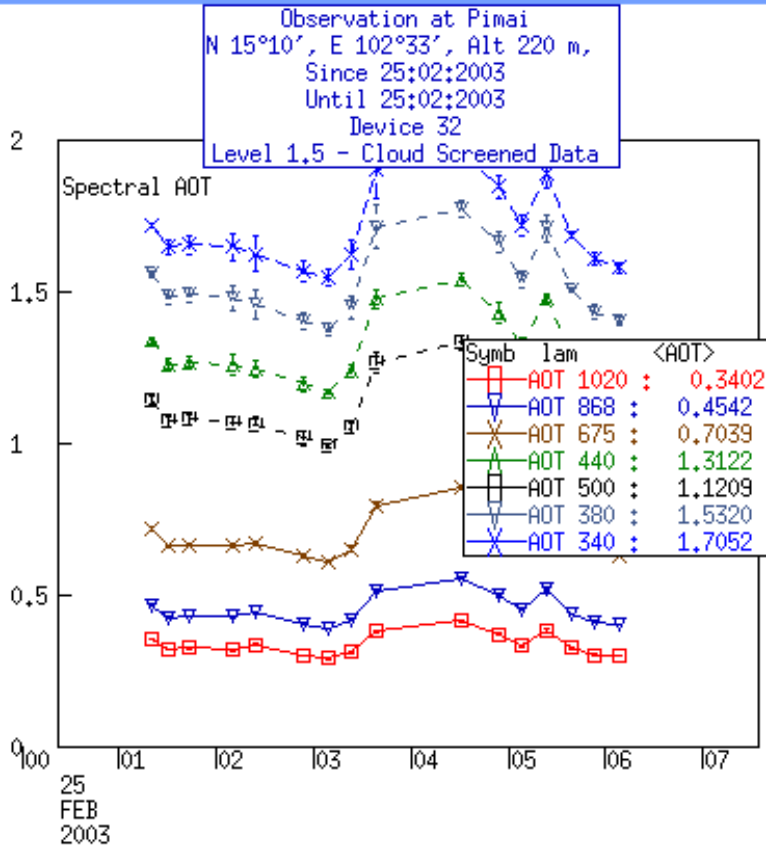


Comparison of Asian 'Urban' Single Scattering Albedo versus Other Urban/Industrial Sites



Washington, Paris, and Mexico City data from *Dubovik et al.* [2002] Table 1.

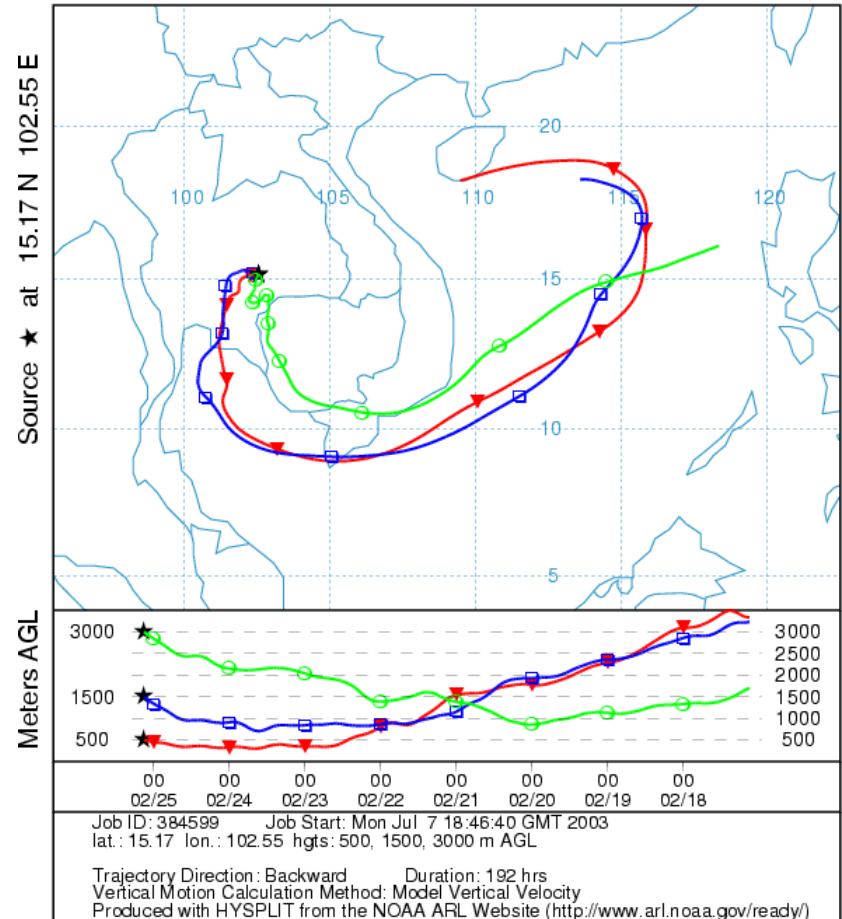
February 25, 2003 - High AOD (1.12 at 500 nm) at Phimai ; 8-Day Back Trajectory suggests transport of both pollution from industrial area SE of Bangkok and possibly also smoke and pollution from SW Cambodia and Viet Nam



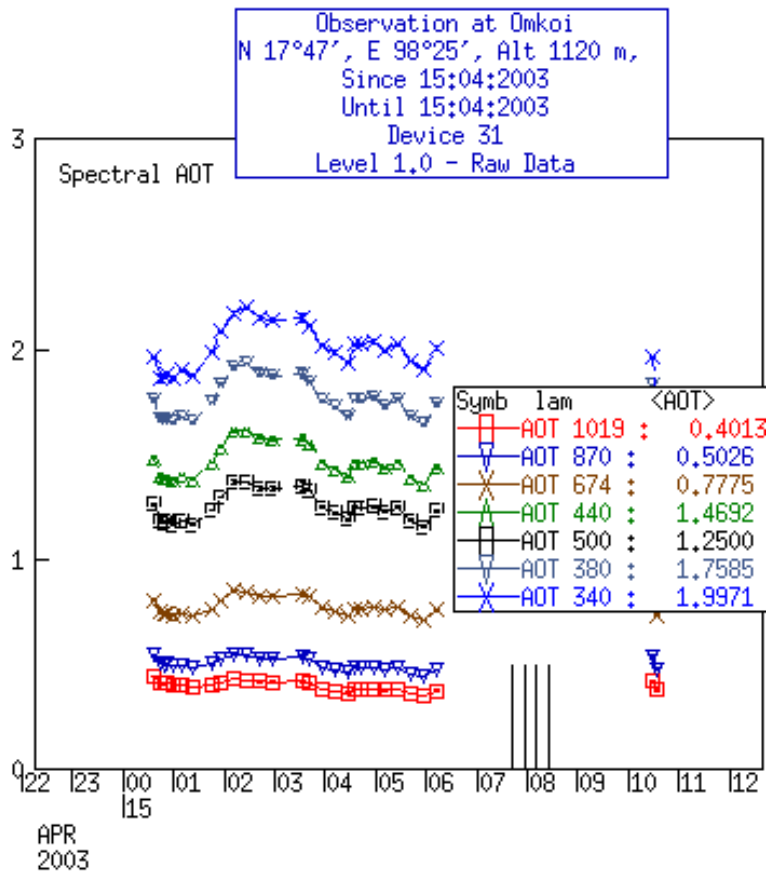
**Average Angstrom Exp (440-870 nm) = 1.56
 on Feb 25 at Phimai, Thailand**

SSA = ~0.94 - 0.92; $R_{v_{fine}}$ = ~0.17 μ m

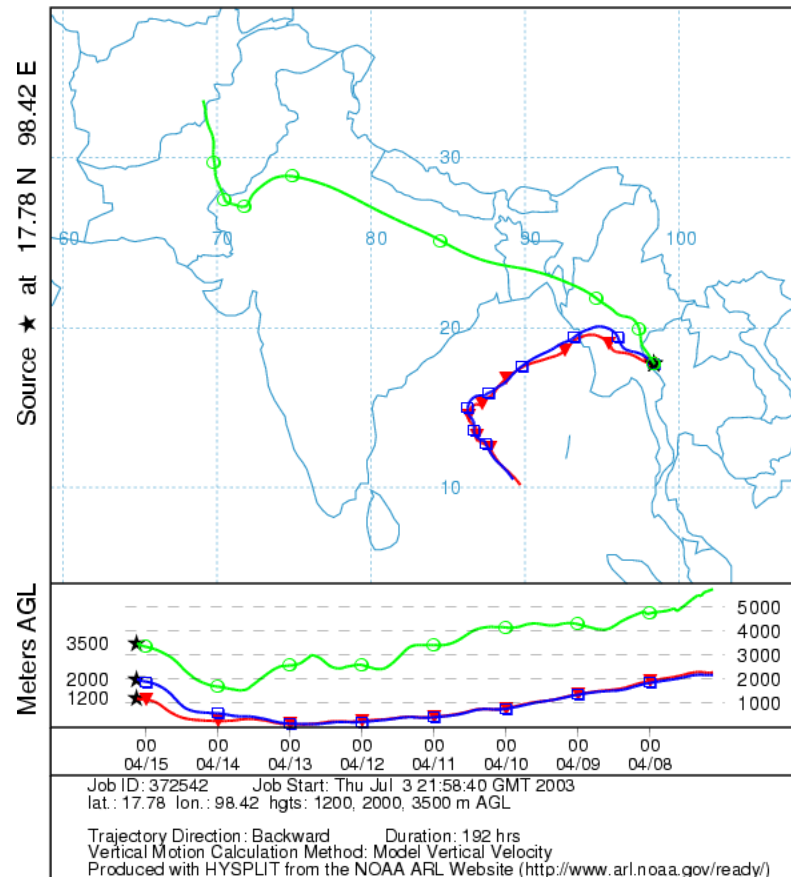
**Backward trajectories ending at 03 UTC 25 Feb 03
 FNL Meteorological Data**



April 15, 2003 - High AOD (1.25 at 500 nm) at Om Koi ; 8-Day Back Trajectory suggests transport of both smoke and pollution from Burma, the Bay of Bengal, India and Pakistan



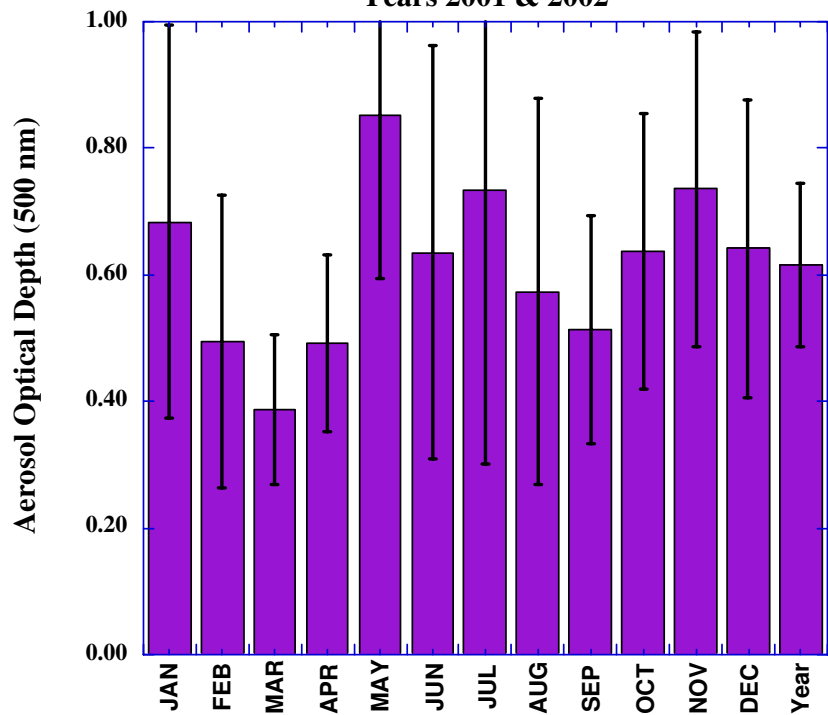
Backward trajectories ending at 03 UTC 15 Apr 03
 FNL Meteorological Data



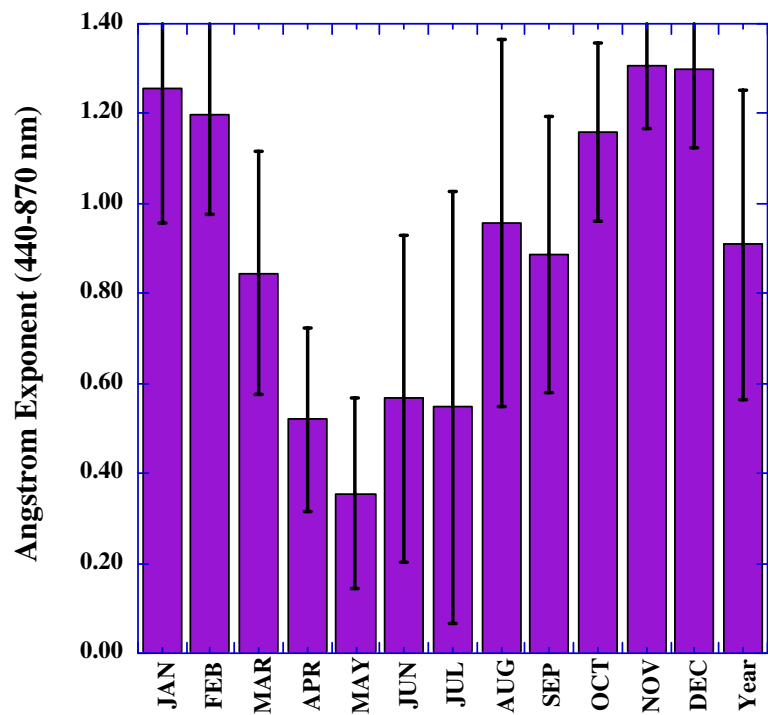
Average Angstrom Exp (440-870 nm) = 1.55 on Apr 15 at Om Koi

SSA = ~0.89 spectrally flat; $R_{v_{fine}} = \sim 0.15 \mu m$

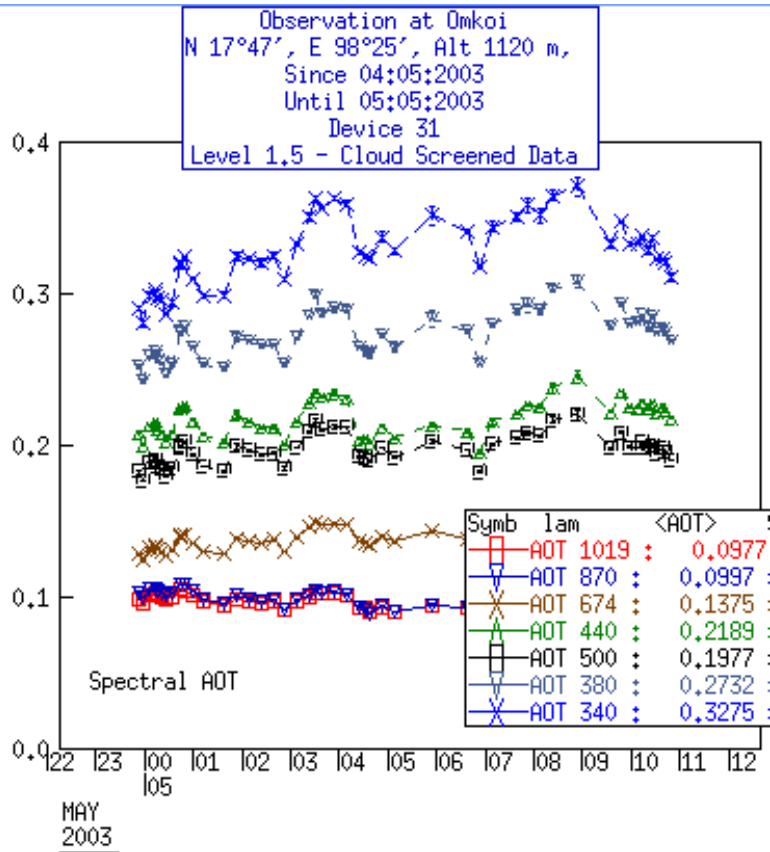
**Kanpur, India Monthly Ave. Aerosol Optical Depth (500 nm)
Years 2001 & 2002**



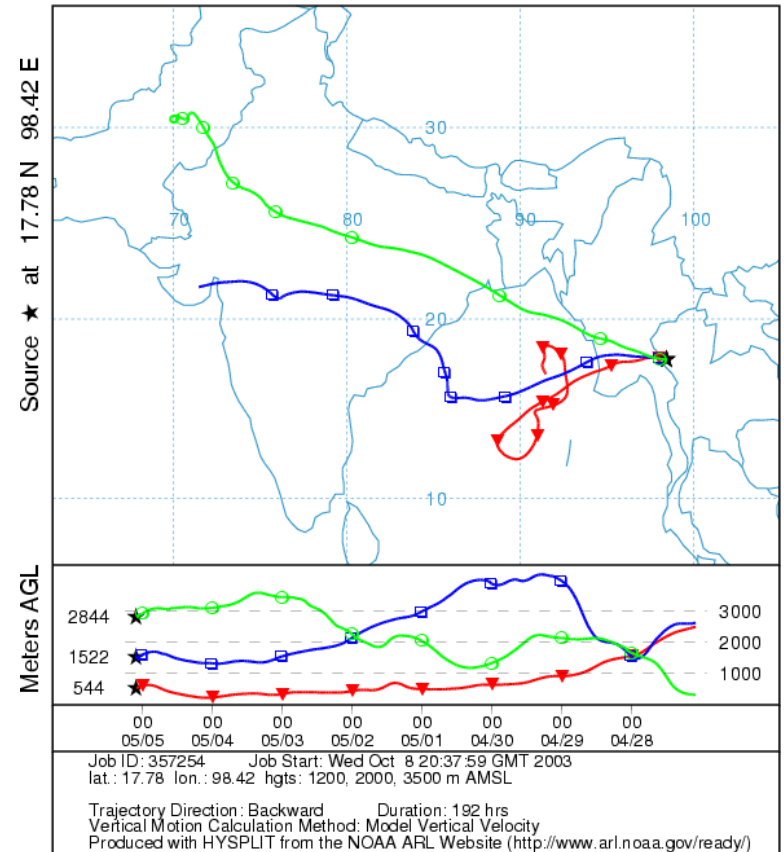
**Kanpur, India Monthly Ave. Angstrom Exponent
Years 2001 & 2002**



May 5, 2003 - AOD ~0.2 at 500 nm at Om Koi; 8-Day Back Trajectory suggests transport of mixed fine and coarse mode aerosol from India



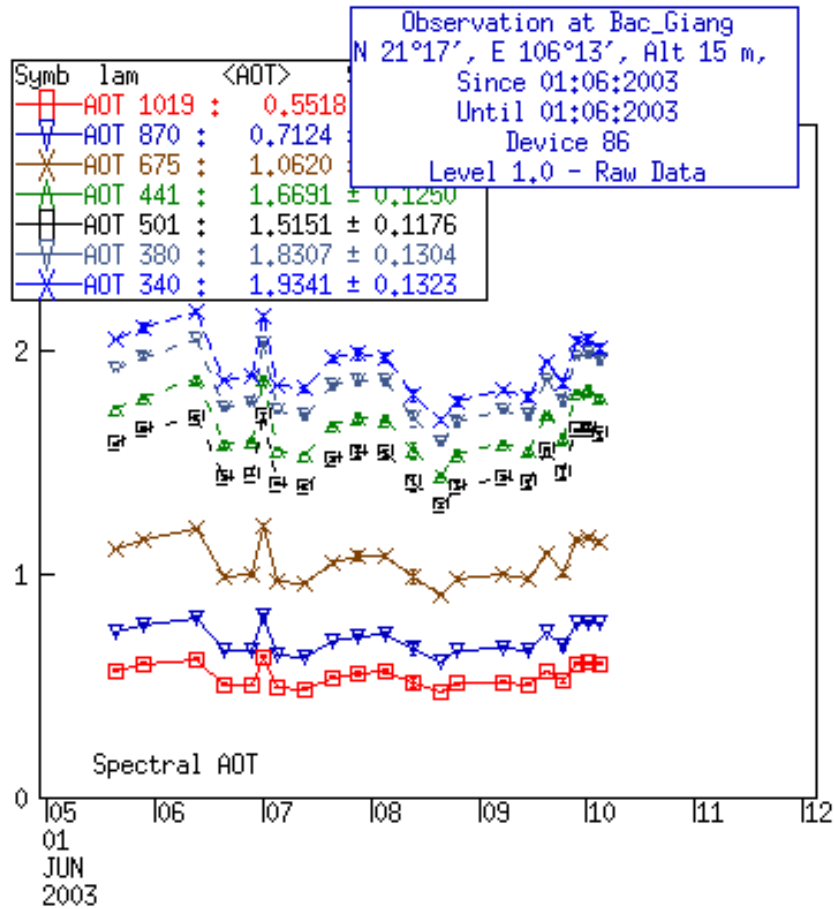
NOAA HYSPLIT MODEL
 Backward trajectories ending at 02 UTC 05 May 03
 FNL Meteorological Data



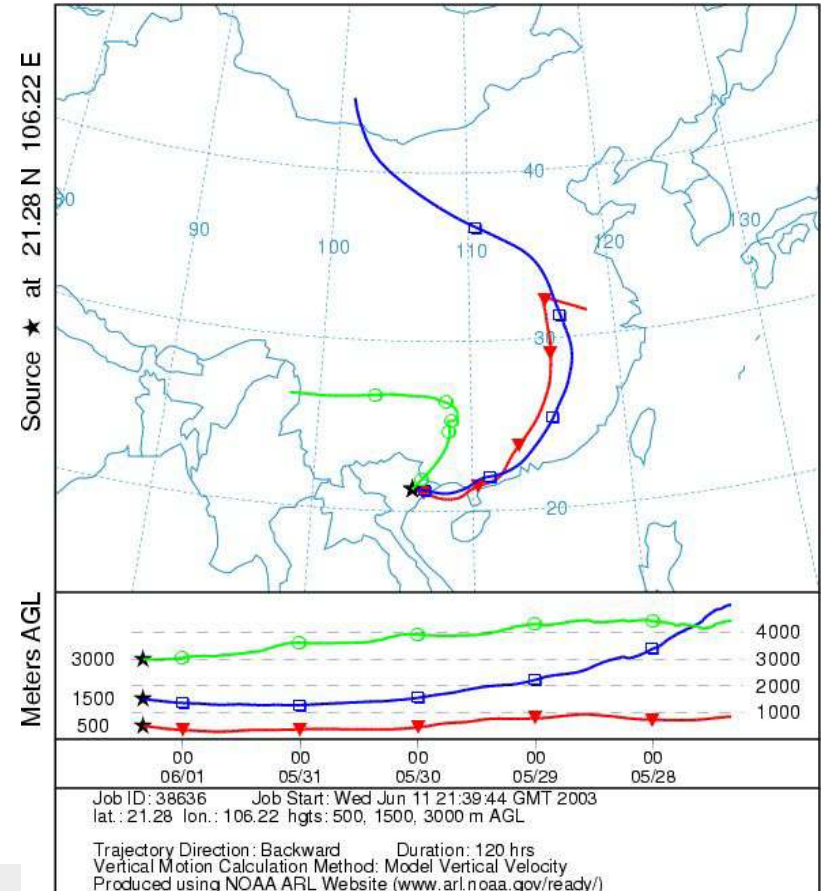
Average Angstrom Exp (440-870 nm) = 1.15 on May 15, 2003 at Om Koi

$R_{v_{fine}} = \sim 0.15 \mu m$

June 1, 2003 - High AOD (~1.50 at 500 nm) at Bac Giang; 5-Day Back Trajectory suggests transport of fine mode aerosol from China



NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION
 Backward trajectories ending at 08 UTC 01 Jun 03
 FNL Meteorological Data



SSA = ~0.96 spectrally flat; $Rv_{\text{fine}} = \sim 0.25 - 0.30 \mu\text{m}$

Average Angstrom Exp (440-870 nm) = 1.25 on Apr 15 at Bac Giang, Viet Nam

Pochanart et al.,
JGR, 2003

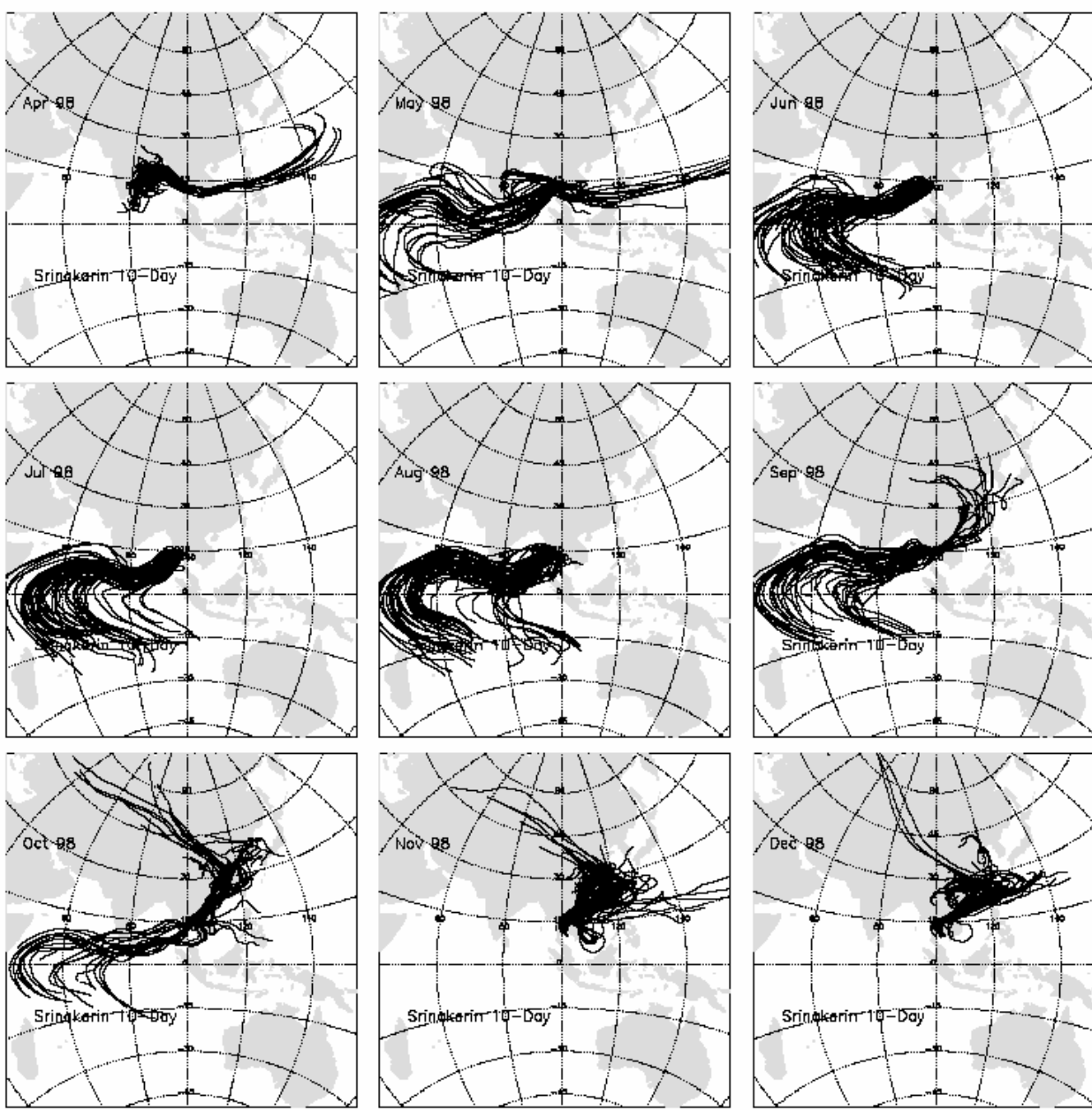


Figure 1. Monthly backward trajectories arriving at Srinagarin in 1998. For clarity in presentation, only the trajectories at the center point (exact location) of the five-trajectory clusters for each run are shown (see details in text).

SUMMARY AND CONCLUSIONS

- Preliminary data suggest that during the 2nd half of the dry season the aerosol is quite strongly absorbing in both urban and rural sites in SE Asia ($\omega_{0550} \sim 0.895 - 0.915$)
- Aerosol size distributions are dominated by fine mode particles (radius < 0.6 micron) with very consistent size of fine particles at all sites ($r_v \sim 0.15 - 0.16 \mu\text{m}$ at $\tau_{a440} = 0.7$)
- Preliminary data from Phimai suggest a dynamic aerosol model with particle size increasing as optical depth increases, and ω_0 also increasing as optical depth increases
- Continuing monitoring in the beginning of the dry season will characterize the regional aerosol before biomass burning aerosols are added to the mixture