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AERONET is funded by the
NASA Earth Observing System project office and
the Radiation Sciences Program, NASA Headquarters

AERONET Update

David Giles

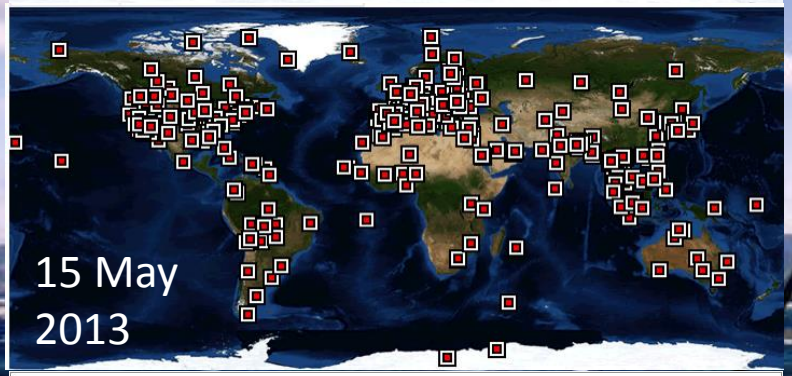
2013 Aerocenter Meeting

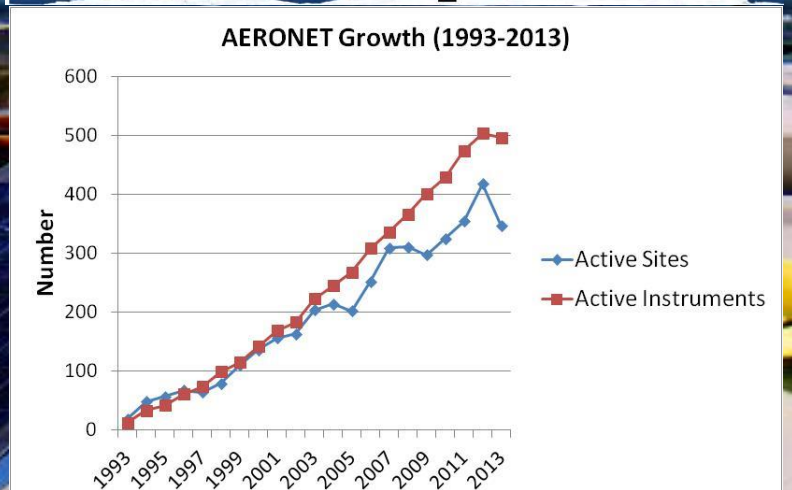
May 31, 2013

Outline

- 20 Years of AERONET
- Recent Publications
- AERONET Version 3
  - Cloud Screening and MPL Validation
  - Updated Corrections and Ancillary Data Sets
  - New Products and Retrievals
- AERONET DRAGONs
- Future AERONET Distribution and Instrumentation
- MPLNET Update

AERONET Aerosol Robotic Network-Twenty Years of Observations and Research





The AERONET program is a federation of ground-based remote sensing aerosol networks established by NASA and LOA-PHOTONS (CNRS) and has been expanded by collaborators from international agencies, institutes, universities, individual scientists and partners.

AERONET provides a long-term, continuous public database of aerosol optical, microphysical, and radiative properties for aerosol research and characterization, validation of satellite measurements, and synergism with other databases.

- >7000 citations
- >400 sites
- Over 80 countries
- http://aeronet.gsfc.nasa.gov

Recent Publications

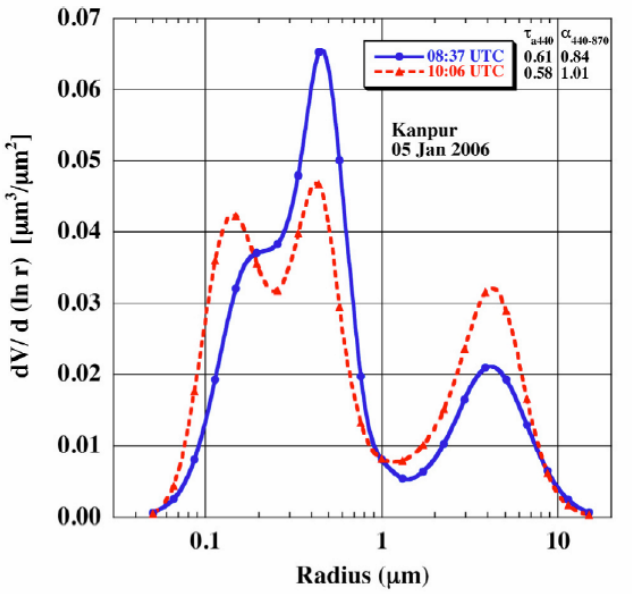


Figure 3. Almucantar retrievals of the aerosol volume size distribution at Kanpur on 5 January 2006 at 08:37 UTC (only 17 min after the Aqua MODIS image in Figure 2) and at 10:06 UTC. Note the bimodality of the submicron radius mode.

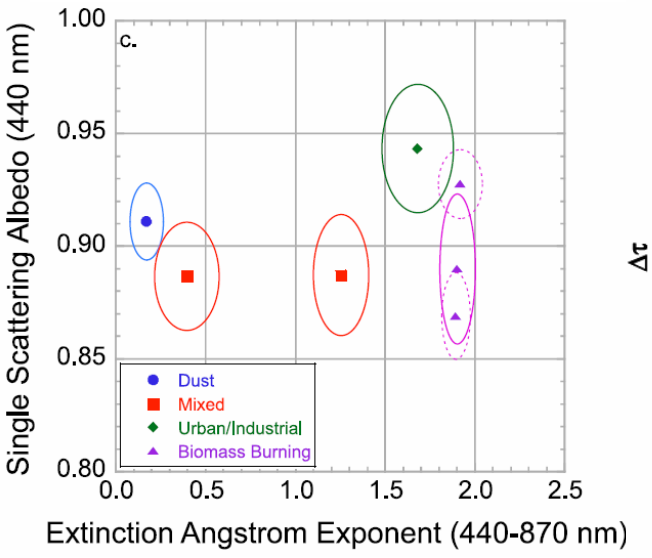


Figure 11c. Weighted cluster averages were grouped for each aerosol type category and relationship using Version 2, Level 2 data.

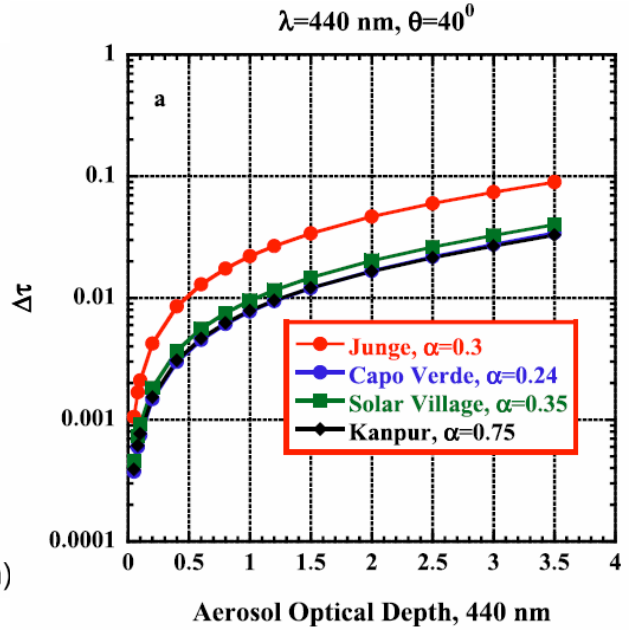


Figure 2a. Errors in AOD 440nm due to diffuse radiation scattered into the Cimel instrument FOV modeled for dust aerosols.

Eck, T. F., et al. (2012), Fog- and cloud-induced aerosol modification observed by the Aerosol Robotic Network (AERONET), JGR, 117, doi:10.1029/2011JD016839.

Giles, D. M., et al. (2012), An analysis of AERONET aerosol absorption properties and classifications representative of aerosol source regions, JGR, 117,doi:10.1029/2012JD018127.

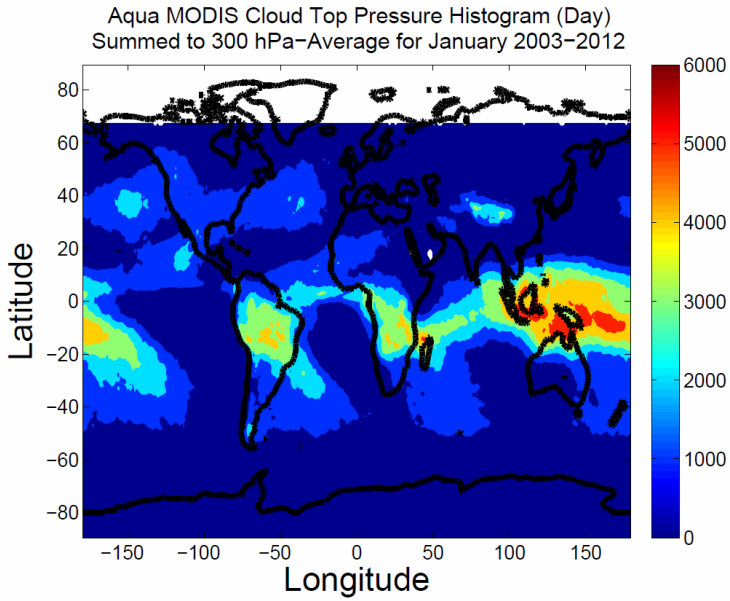
Sinyuk, A., et al. (2012), Assessment of error in aerosol optical depth measured by AERONET due to aerosol forward scattering, GRL, 39, doi:10.1029/2012GL053894.

AERONET Version 3 Update – Cloud Screening

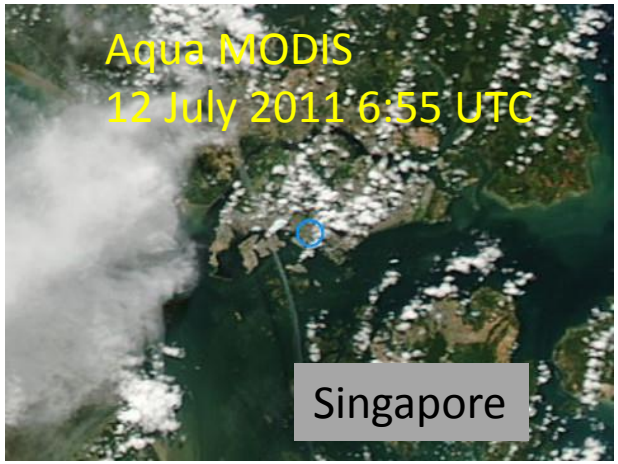
- Reevaluation of triplet and smoothness criteria (e.g., 0.02 and D16)
  - MPL-based Studies:
    Chew et al. [2011] and Huang et al. [2011]
- Emphasis on optically thin cirrus clouds as well as preserving observations of fine mode plumes and desert dust
- Comparison of test algorithms to AERONET Level 2 statistics (AOD, AE, and N) as well as MPLNET validation data set

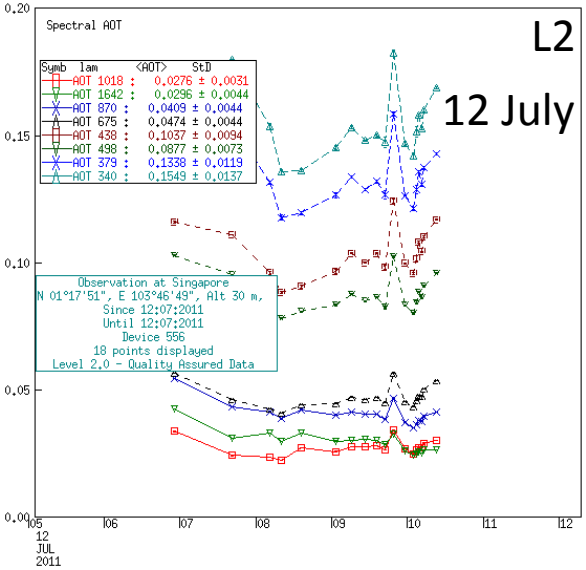
Analyzed numerous cloud screening algorithm combinations and pared down to a few remaining components

- Fixed Triplet or Variable Triplet
- Aureole Radiance Curvature

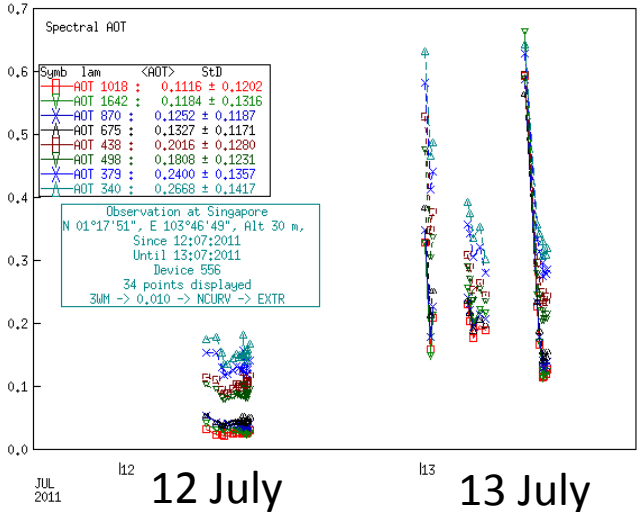


AERONET Version 3 Update – Cloud Screening

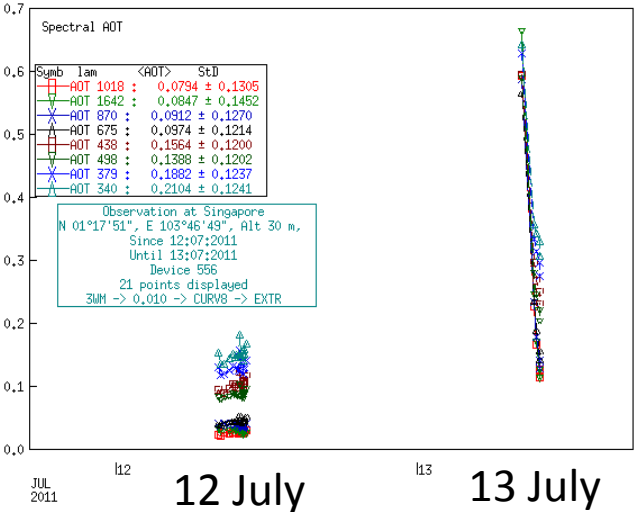




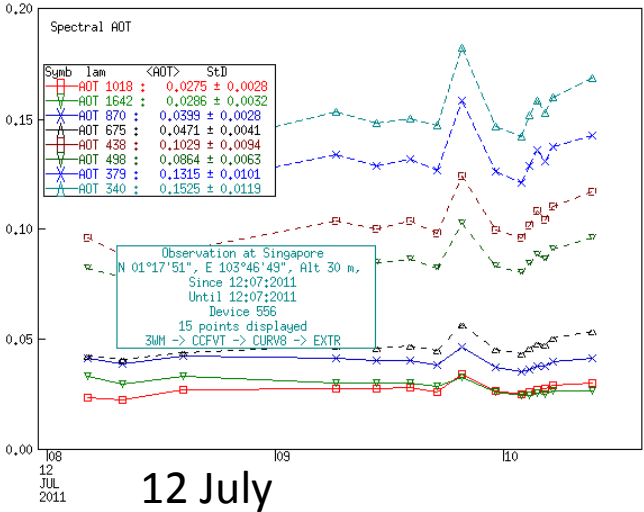
0.01 & No Curvature



0.01 & Curvature

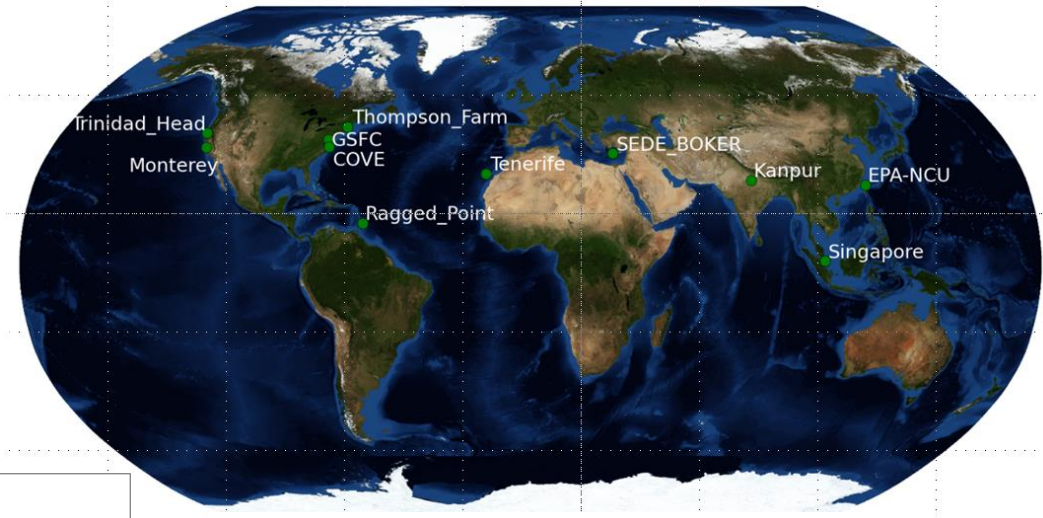


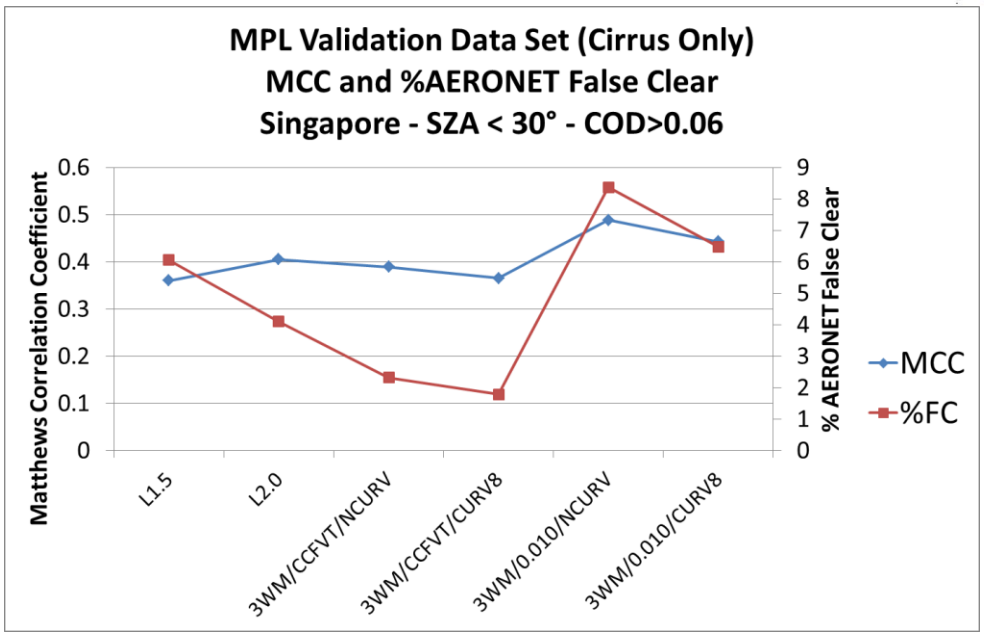
Variable Threshold & Curvature

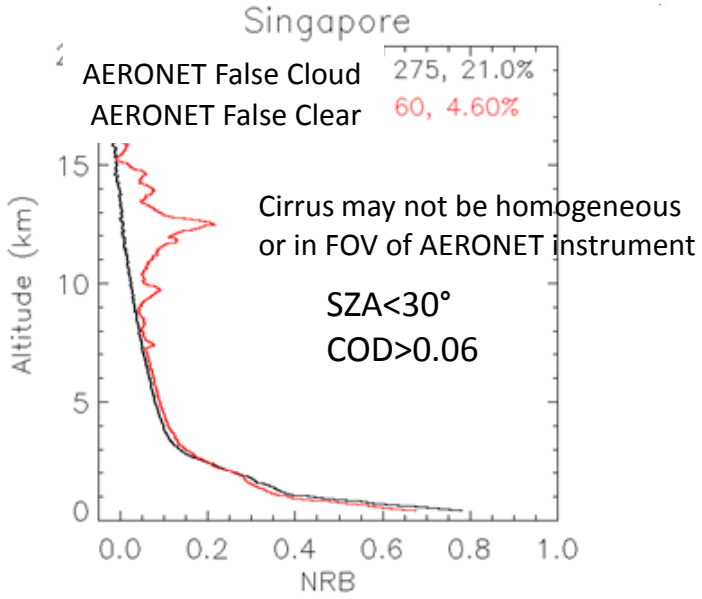


AERONET – MPL Validation Data Set

- MPLNET cirrus only detection within 20 minutes of AERONET measurement
- AERONET measurement within various solar zenith angles (e.g., 30°)
- Homogeneous cirrus conditions assumed

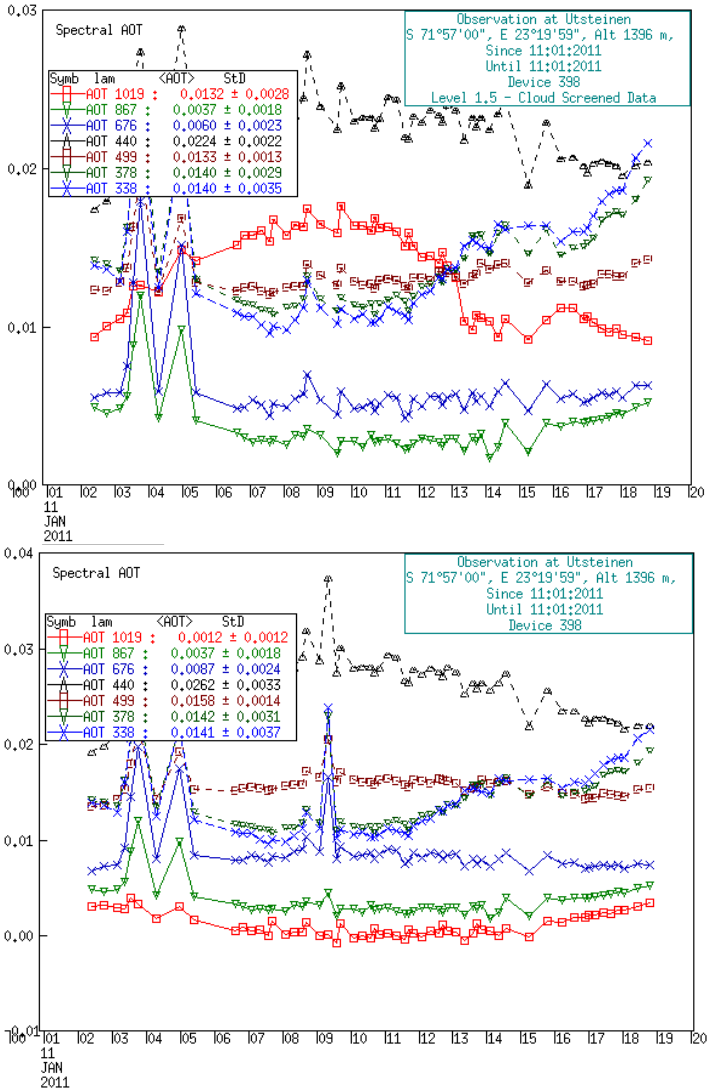






AERONET Version 3 Update – Additional Enhancements

- Temperature Characterization
- Level 1.5V NRT to provide real-time quality assured data set but will not have final calibration
- Update NO2 and O3 climatology (e.g., OMI)
- Update to new reanalysis data set (e.g., GMAO MERRA)

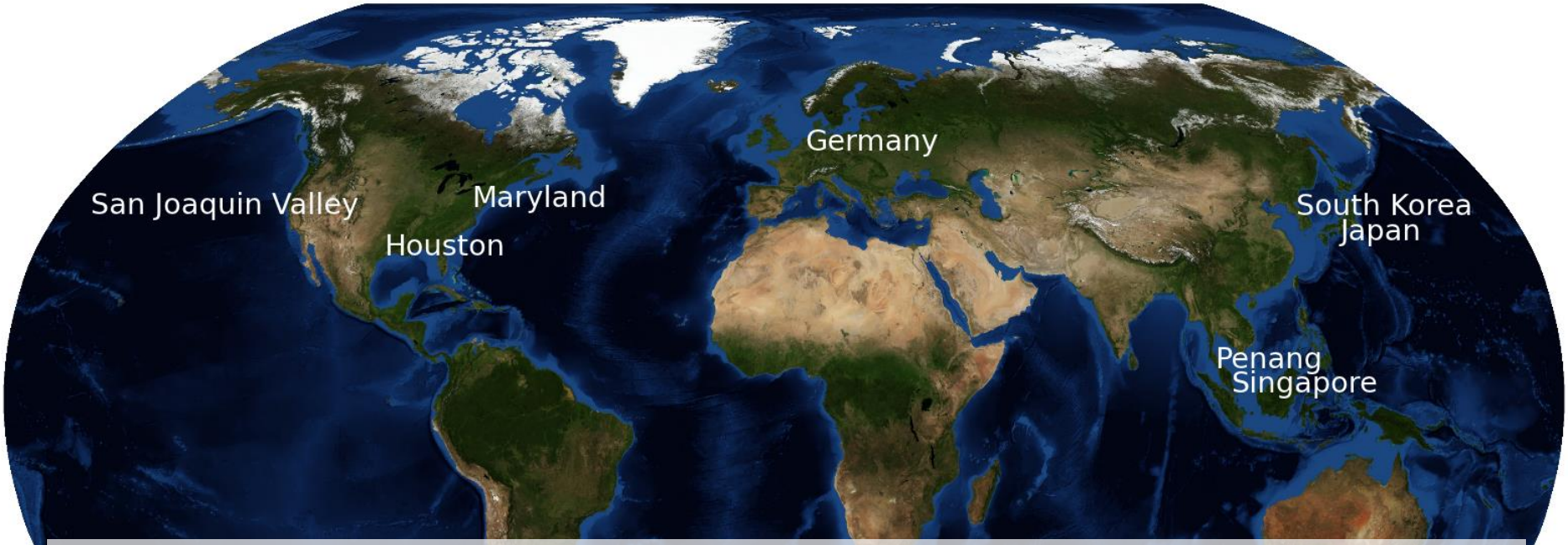


AERONET Version 3 Update
Sky Retrievals

- Possible Principal Plane Retrievals
- Lidar and Depolarization Ratios
- Implementation of a vector radiative transfer code
  - radiation field in UV (e.g., 380 nm retrieval)
  - degree of linear depolarization
- Uncertainty estimates for each retrieval (e.g., random error plus biases due uncertainty in AOD and sky radiance calibration)

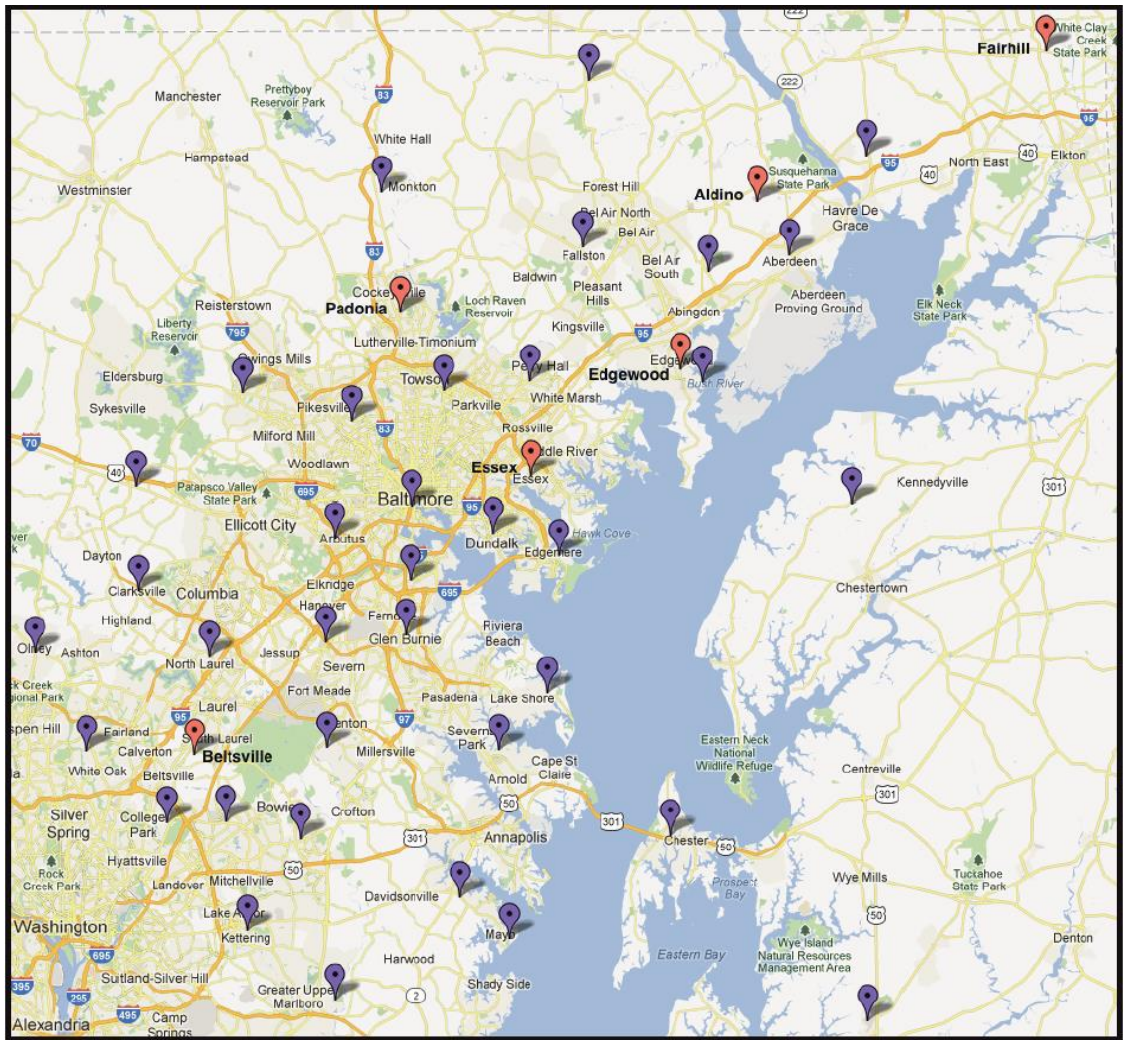
AERONET DRAGONs

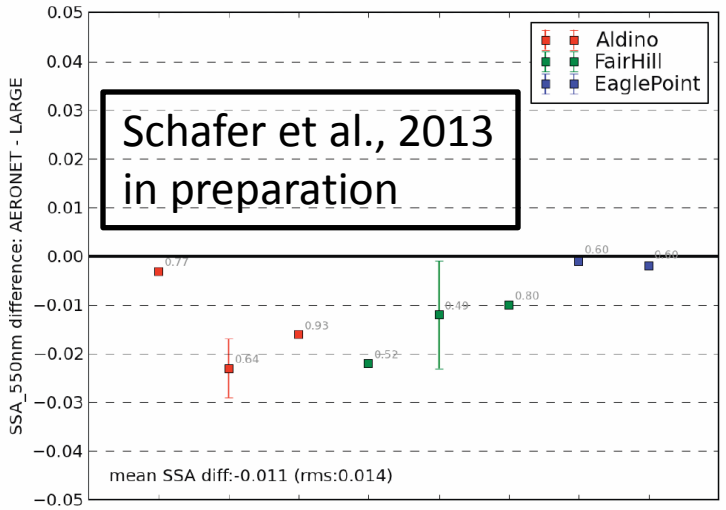
Distributed Regional Aerosol Gridded Observation Networks



- Past DRAGONs
  - 2011 Maryland (Urban)
  - 2012 South Korea (Urban/Asia Outflow)
  - 2012 Japan (Urban/Asia Outflow)
  - 2012 Singapore (Urban)
  - 2012 Penang, Malaysia (Urban)
  - 2013 San Joaquin Valley, California (Urban)
- Current DRAGONs
  - 2013 Germany (Industrial)
  - 2013 Houston (Urban/Industrial)
- Upcoming DRAGONS
  - Colorado?
  - ?

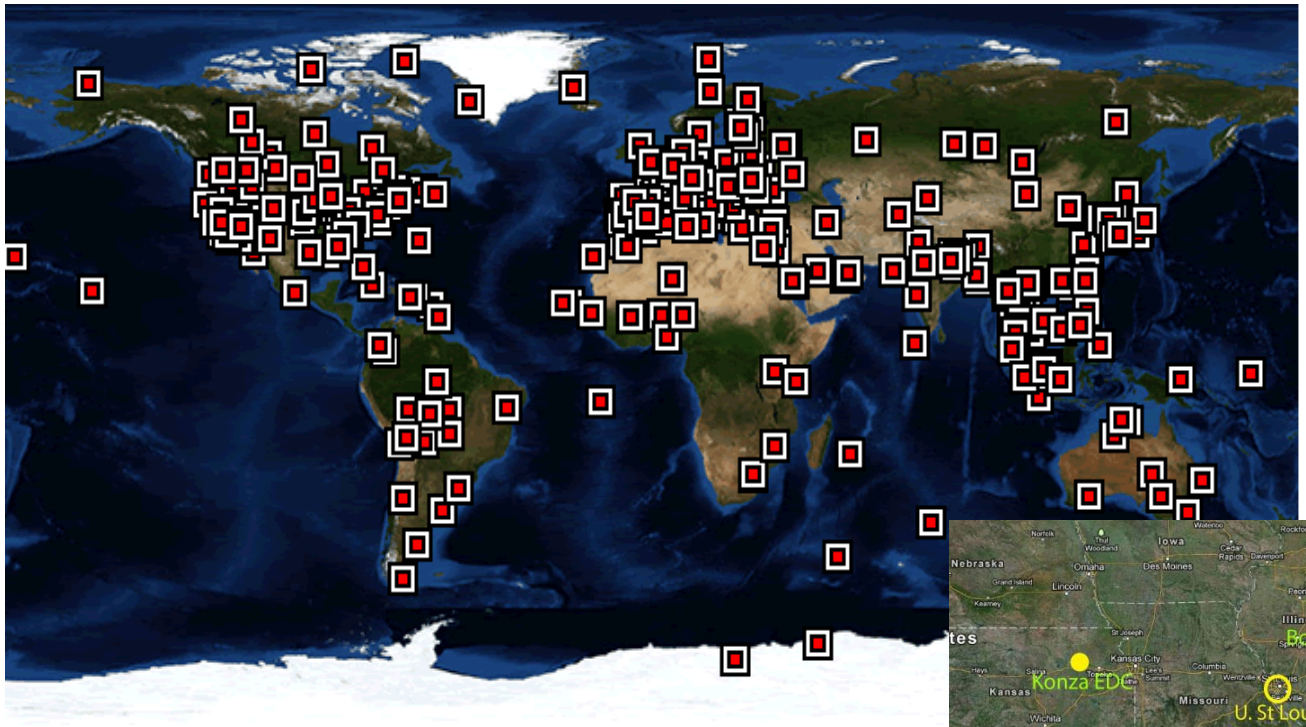
AERONET DRAGONs





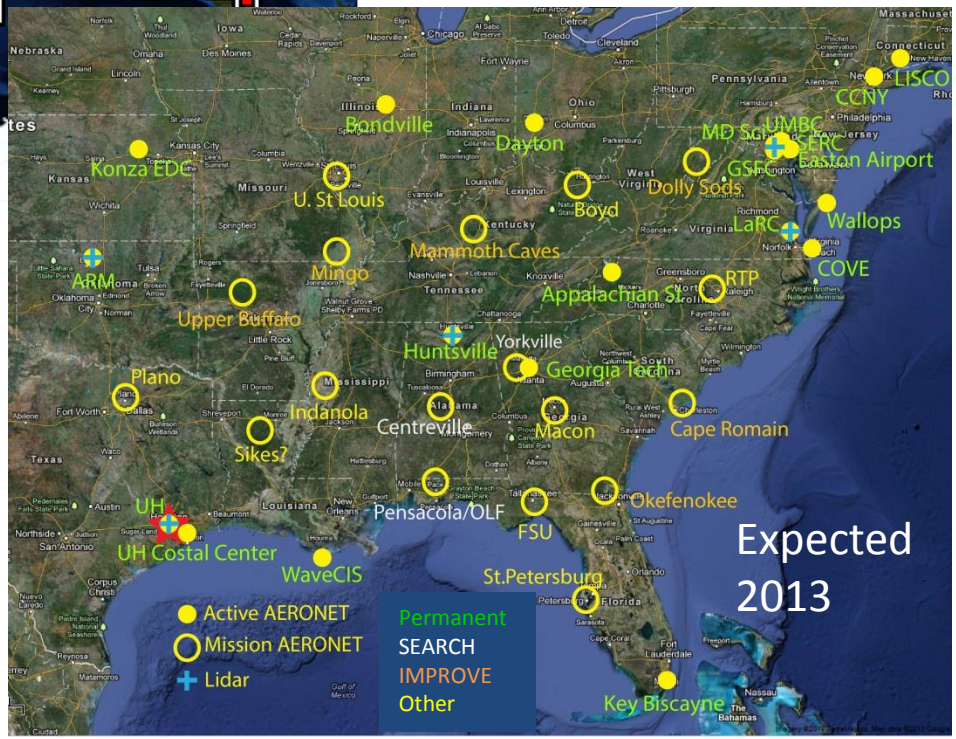
- Spatially distributed sun photometers deployed around aerosol sources (e.g., cities and industrial regions) over surfaces challenging for satellite remote sensing
- Provide 1 to several months of data in mesoscale distribution at high temporal sampling
- Complements air quality campaigns such as DISCOVER-AQ

AERONET Distribution



- Current holes in the net:
  - Most of Africa
  - Northern and Central Asia
  - Northern South America
  - Northeastern and Western Australia

- Plan: Fill in the gaps;
  Need increase in funding, staff, and facilities



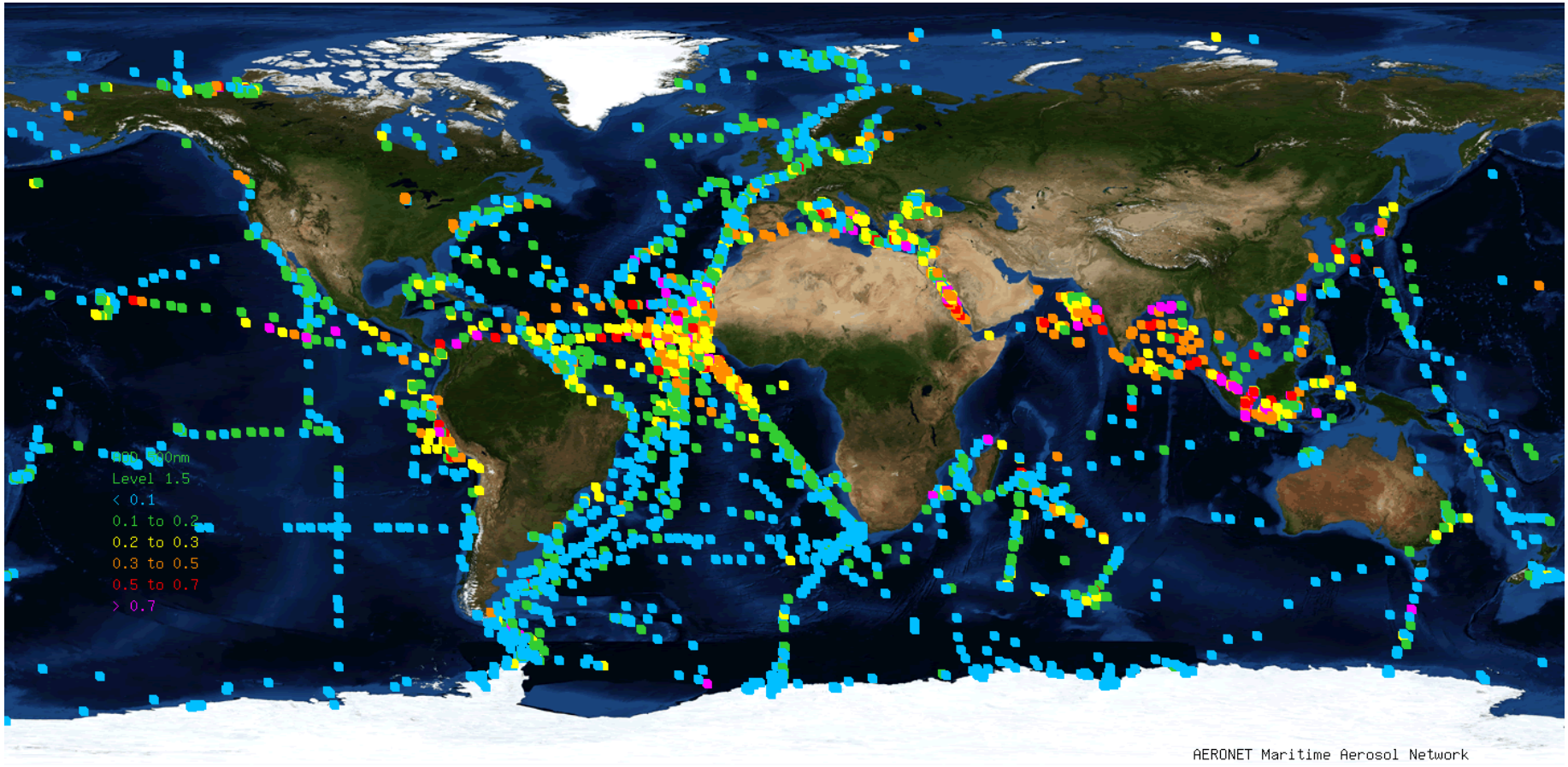
AERONET
New Instrumentation/Enhancements

- Greater control over instrument measurement scenarios (e.g., Hybrid)
- Additional capabilities such as SD card storage, GPS, USB, and Zigbee
- Development toward attachment for CO2 measurements
- Synergism with MPLNET, PANDORA, and in situ measurements

Maritime Aerosol Network as a Component of AERONET

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

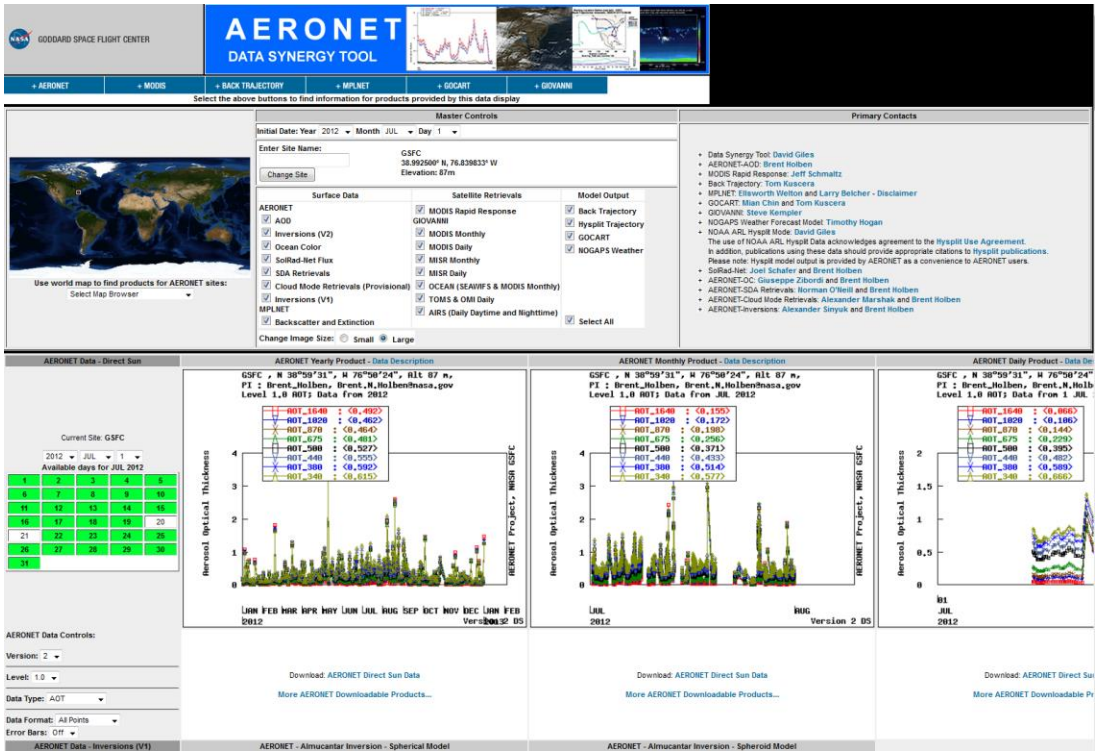
Maritime Aerosol Network global coverage from October 2006 to May 2013

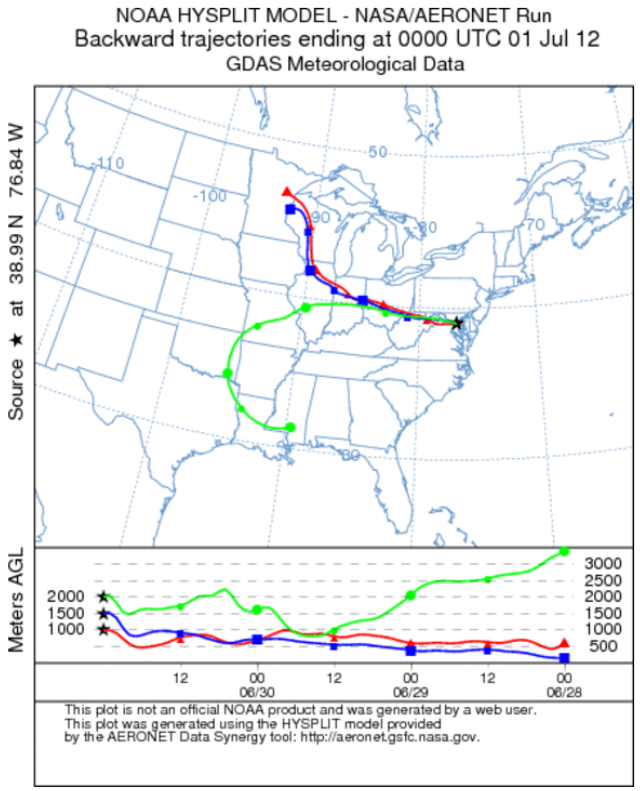


Smirnov, A., et al., Maritime Aerosol Network as a component of Aerosol Robotic Network, J. Geophys. Res., 114, D06204, doi:10.1029/2008JD011257, 2009.

SolRad-Net + Contributors as of May 2013

AERONET Data Synergy Tool





http://aeronet.gsfc.nasa.gov/cgi-bin/bamgomas_interactive

- Utilized for data discovery, data download, and analysis
- New Product:
  HYSPLIT back trajectories

Micro-Pulse Lidar Network (MPLNET)

Principal Investigator:
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Phillip Haftings, SSAI GSFC Code 612

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James Campbell, Naval Research Lab
Jasper Lewis, UMBC GSFC Code 612
Simone Lolli, UMBC GSFC Code 612

Administrative Support:
Erin Lee, SSAI GSFC Code 612

CALIPSO Validation Activities:
Judd Welton, James Campbell

AERONET & Synergy Tool Partnership:
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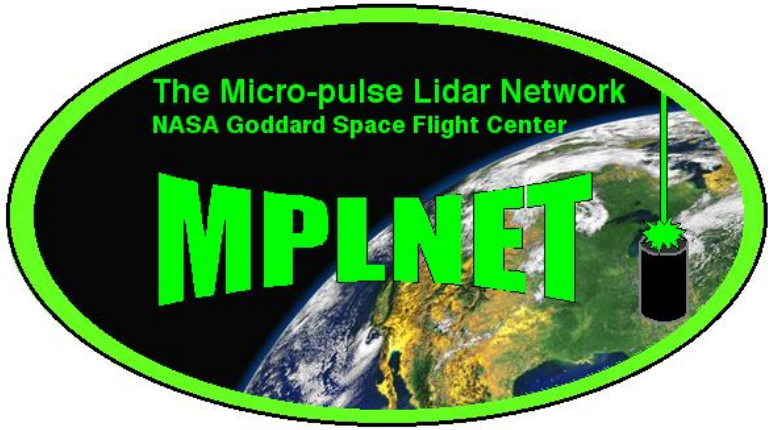
Dave Giles, NASA GSFC Code 614.4

NASA SMARTLABS Field Deployments:
Si-Chee Tsay, NASA GSFC Code 613
Jack Ji, UMCP GSFC Code 613

Site Operations & Science Investigations
…. many network partners around the world

MPLNET is funded by the NASA Radiation Sciences Program and the Earth Observing System

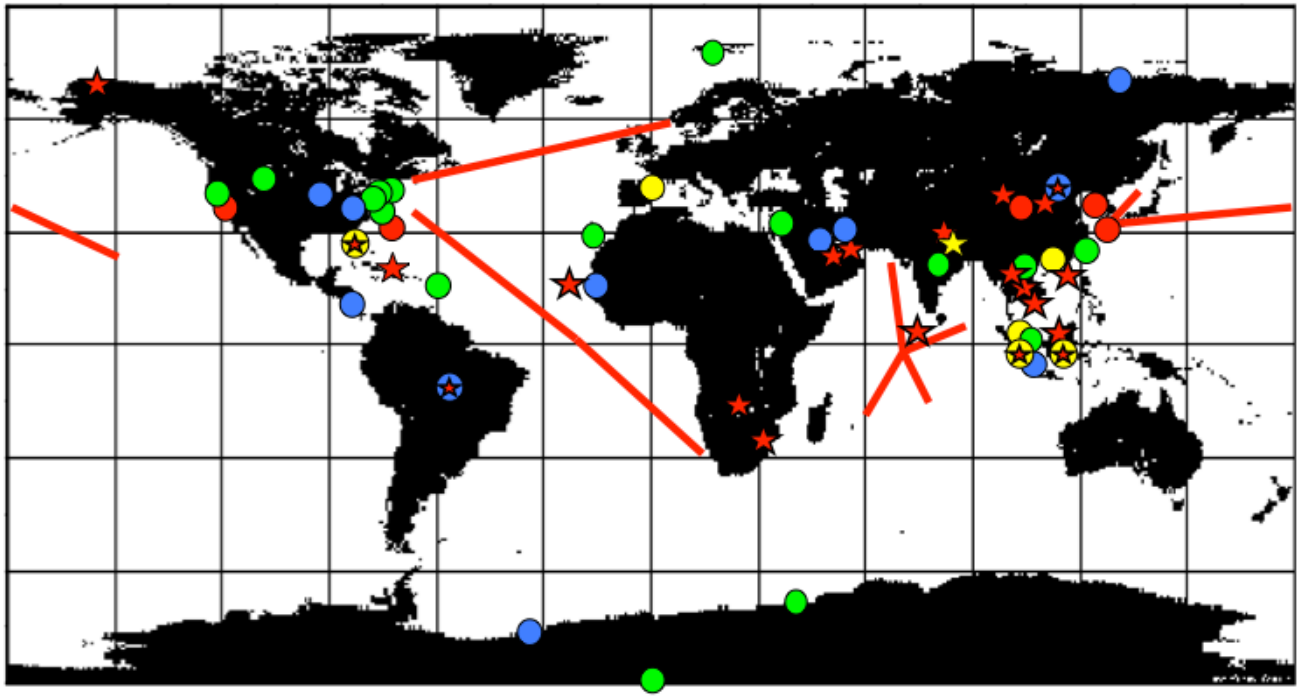


MPLNET information and results shown here are the result of efforts by all of our network partners!

The Micro Pulse Lidar Network (MPLNET): Status of Network

Major focus on SE Asia the past few years. Aircraft have fled the region, but ground pounders still there.
New focus for coming years: Southern Hemisphere (S America and Africa)

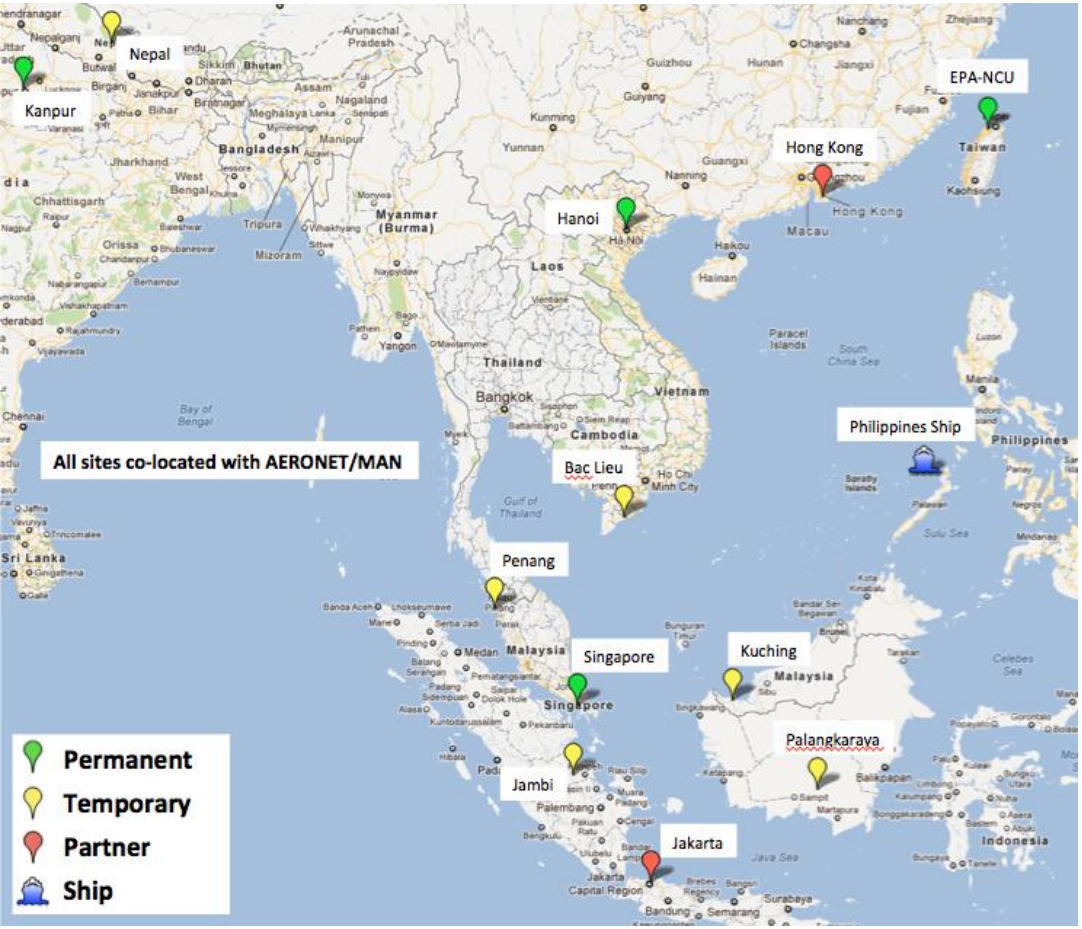
MPLNET Sites: 2000 - current



* most sites co-located with AERONET

MPLNET Deployments in Support of 7-SEAS/SEAC4RS in 2012

MPLNET in SE Asia: 7-SEAS and SEAC4RS



SEAC4RS Summer Sites 2012:

	Name	Location, Partner	Network Status	Lidar
1	EPA-NCU	Taiwan, NCU	Permanent	MPL
2	Hanoi	Vietnam, VAST	Permanent	MPL
3	Kanpur	India, ITT	Permanent	MPL
4	Singapore	Singapore, NUS	Permanent	MPL
5	Bac Lieu	Vietnam, VAST	Temporary	ALS
6	Penang	Malaysia, USM	Temporary	MPL
7	Kuching	Malaysia, NUS/MMD	Temporary ✗	ALS
8	Jambi	Indonesia, BMKG	Temporary ✗	ALS
9	Jakarta	Indonesia, BMKG	Temporary ✗	ALS
10	Palangkaraya	Indonesia, BMKG	Temporary ✗	ALS
11	Nepal	Nepal, U Virginia	Temporary	ALS
12	RV Vasco	Ship, NRL/Manila O.	Temporary	ALS
-	Hong Kong	Hong Kong, PolyU	Pending *	ALS

✗ International agreement not final

* Hong Kong group operates their own ALS lidar. They are not part of MPLNET due to current ban on bi-lateral NASA-China interactions

Now that the summer 2012 intensive campaign is over, we are working to add more permanent stations in SE Asia. In addition to existing permanent sites in Taiwan, Singapore, and Hanoi, we are planning to transform Sumatra and Kalimantan, Borneo 2012 sites to permanent MPLNET/AERONET sites.

The Micro Pulse Lidar Network (MPLNET): Current Activities

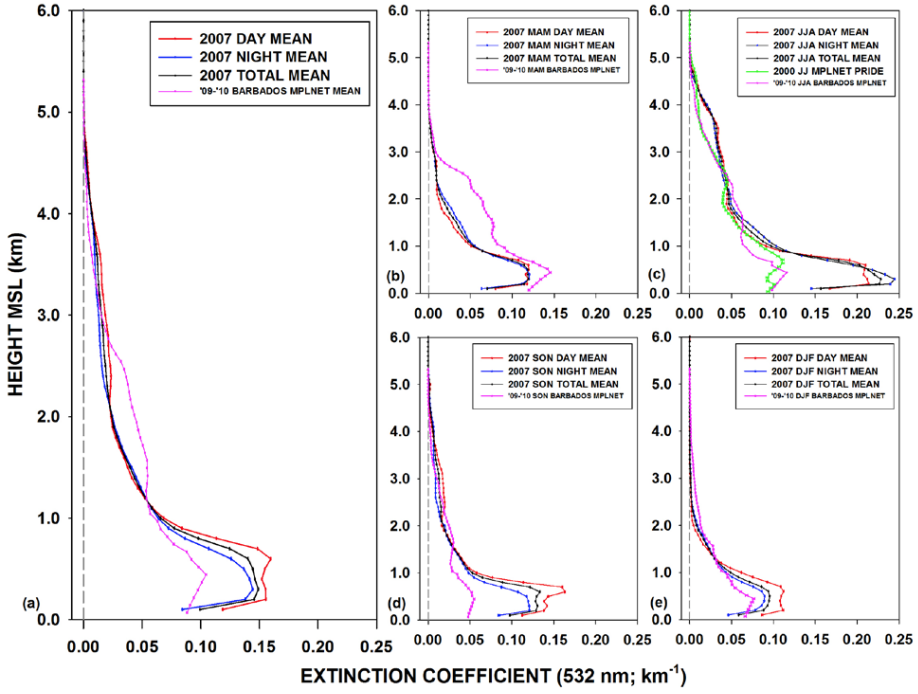
Evaluation of CALIPSO Extinction Profiles Using MPLNET

Campbell, J.R., et al. Evaluating Nighttime CALIOP 0.532 mm Aerosol Optical Depth and Extinction Coefficient Retrievals. *Atmos. Measure. Tech*., in review, 2012.

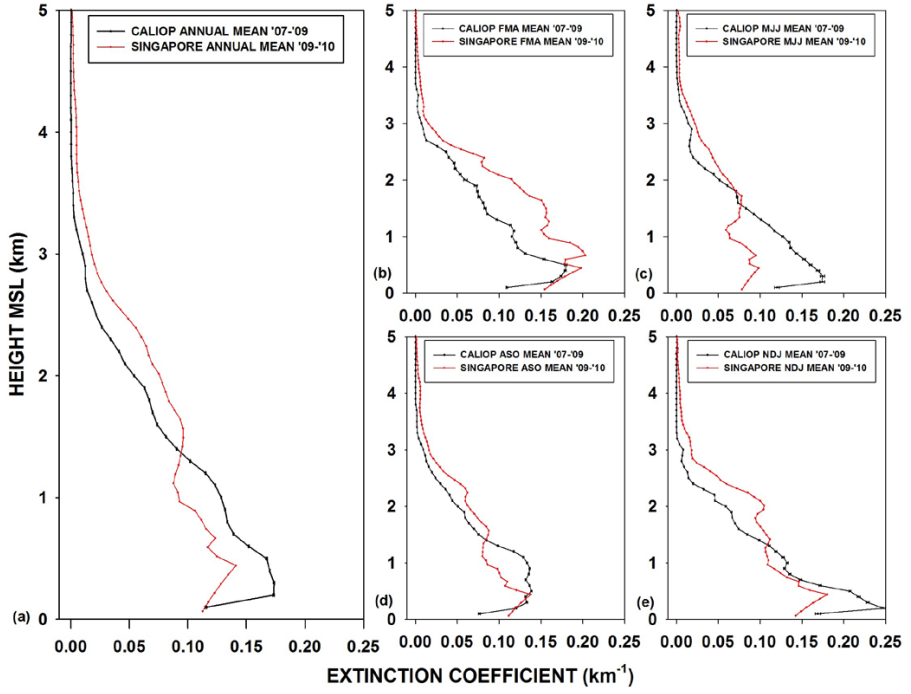
Campbell, J.R., et al. Characterizing Aerosol Particle Composition and the Vertical Profile of Extinction and Linear Depolarization over Southeast Asia and the Maritime Continent: The 2007-2009 View from CALIOP, *Atmos. Res*., in review, 2012

MPLNET extinction profiles are being used to determine the impact of CALIPSO aerosol typing on the satellite derived extinction retrievals. Boundary layer CALIPSO extinction tends to bias high over ocean due to assignment of "polluted dust" type.

Tropical Atlantic Results:
Purple: Barbados MPLNET
Green: PRIDE MPLNET
Other: CALIPSO Extinction



South East Asia Results:
Red: Singapore MPLNET
Black: CALIPSO Extinction



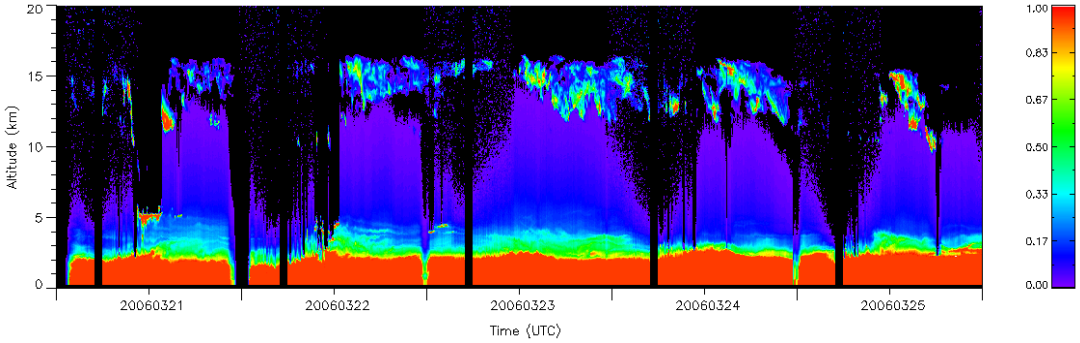
The Micro Pulse Lidar Network (MPLNET): Current Activities

AERONET Observations and Cloud Contamination: Detection of thin cirrus bias using MPLNET

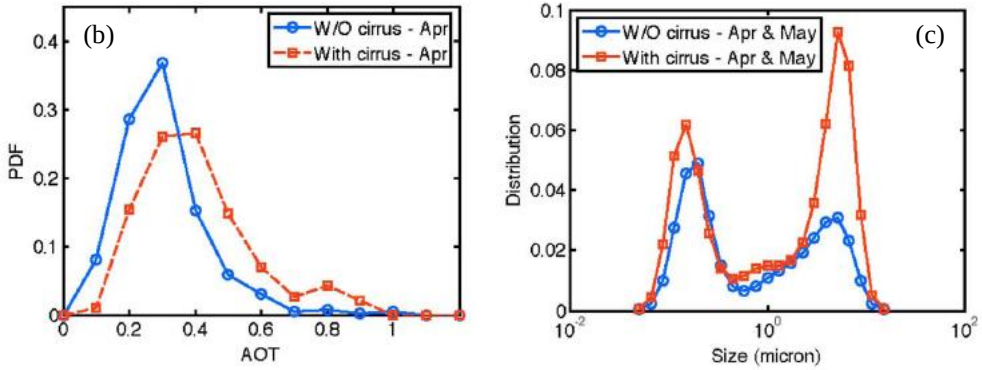
Huang, J., N. C. Hsu, S. Tsay, M. Jeong, B. N. Holben, T. A. Berkoff, and E. J. Welton. Susceptibility of aerosol optical thickness retrievals to thin cirrus contamination during the BASE-ASIA campaign, *J.G.R. Atmos.*, 116, D08214, doi:10.1029/2010JD014910, 2011.

Boon-Ning, C., J.R. Campbell, J.S. Reid, D.M. Giles, E.J. Welton, S.V. Santos, and S.C. Liew: Tropical Cirrus Cloud Contamination in Sun Photometer Data, *Atmos. Environ.*, 45, 6724-6731, 2011.

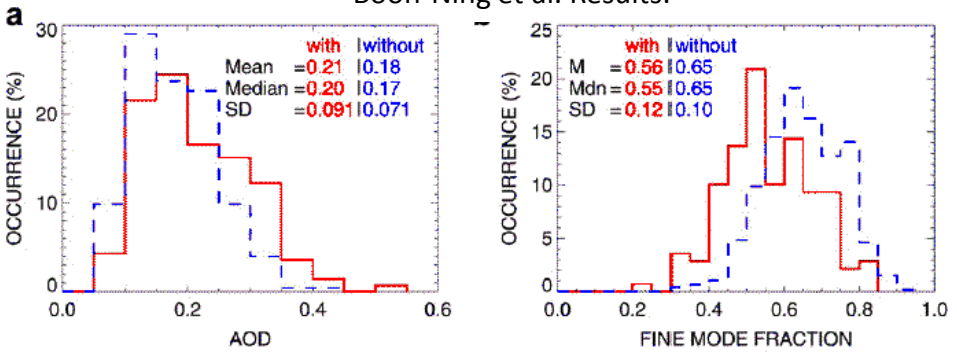
- Two recent studies of observations from South East Asia demonstrate the difficulty in screening thin clouds during passive aerosol observations.
  - with cirrus present
  - without cirrus
- When cirrus were present, AOT results were biased high and the retrieved aerosol size distributions show a corresponding increase in large particles.
- **A new improved AERONET data release is being developed. MPLNET cloud heights are used to verify the performance of the new cloud screening procedures.**



Huang et al. Results:



Boon-Ning et al. Results:



The Micro Pulse Lidar Network (MPLNET): Current Activities

A new MPLNET boundary layer depth algorithm has been developed, vast improvement over the current product.

Lewis, J.R. E.J. Welton, A.M. Molod, and E. Joseph, Improved boundary layer depth retrievals from MPLNET, JGR, final revision, 2013.

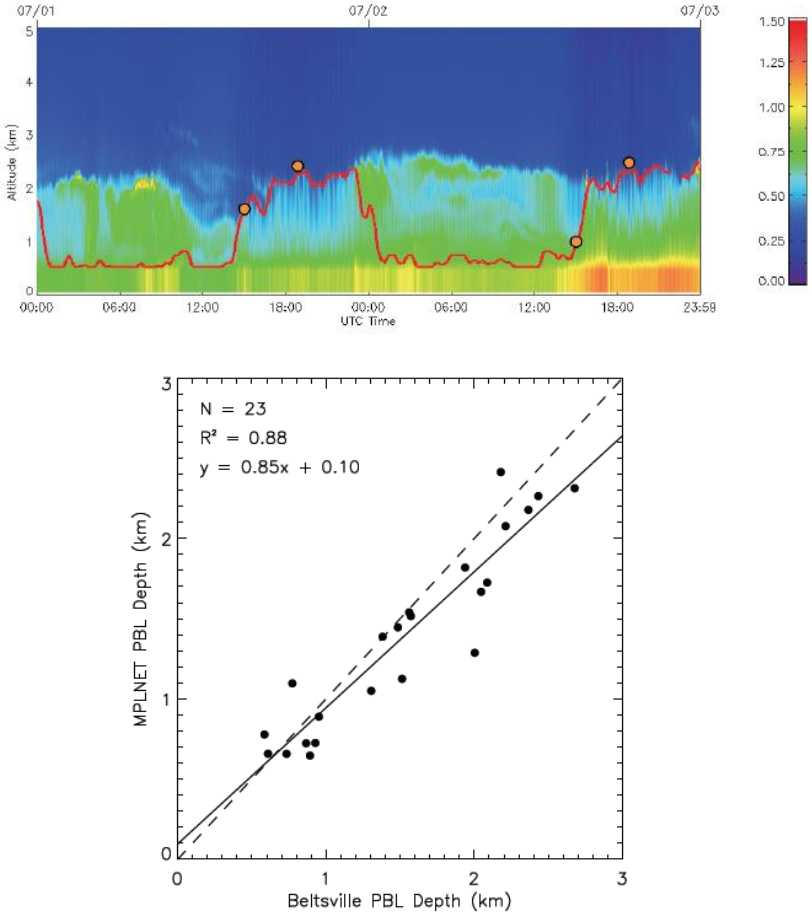


Figure 1: (top) Example of MPLNET signals from GSFC July 1-2, 2011. New PBL product shown as red line, circles indicate PBL height retrievals from HU-Beltsville radiosonde. (bottom) All comparisons between MPLNET and HU-Beltsville PBL heights.

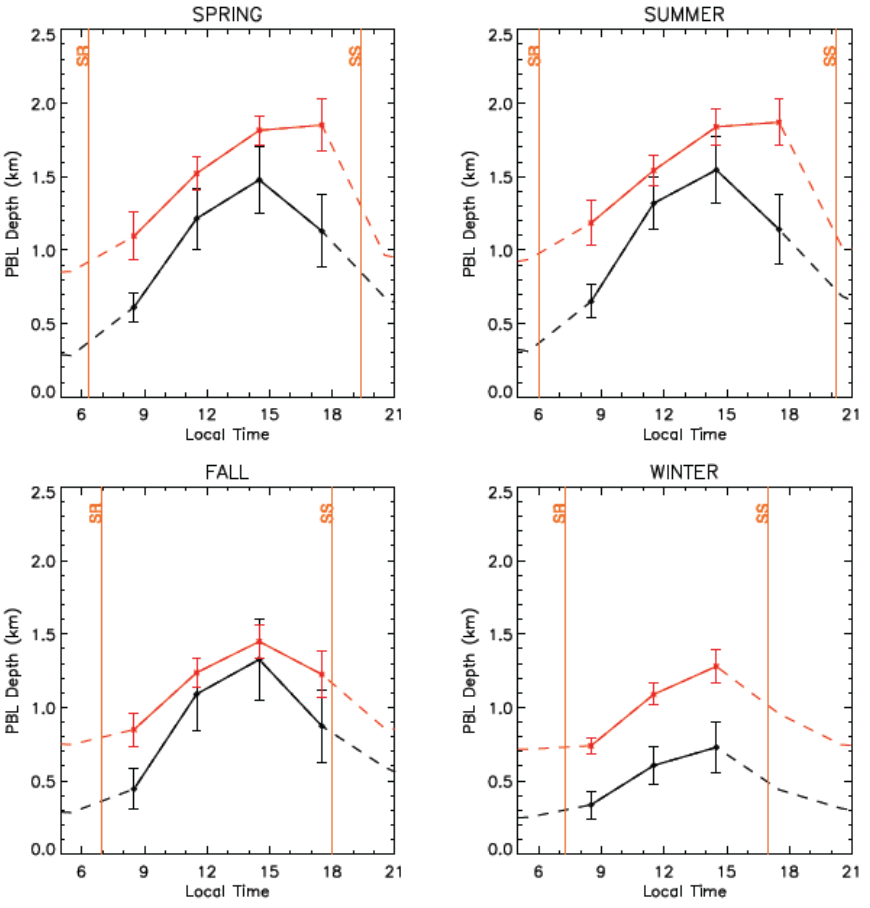


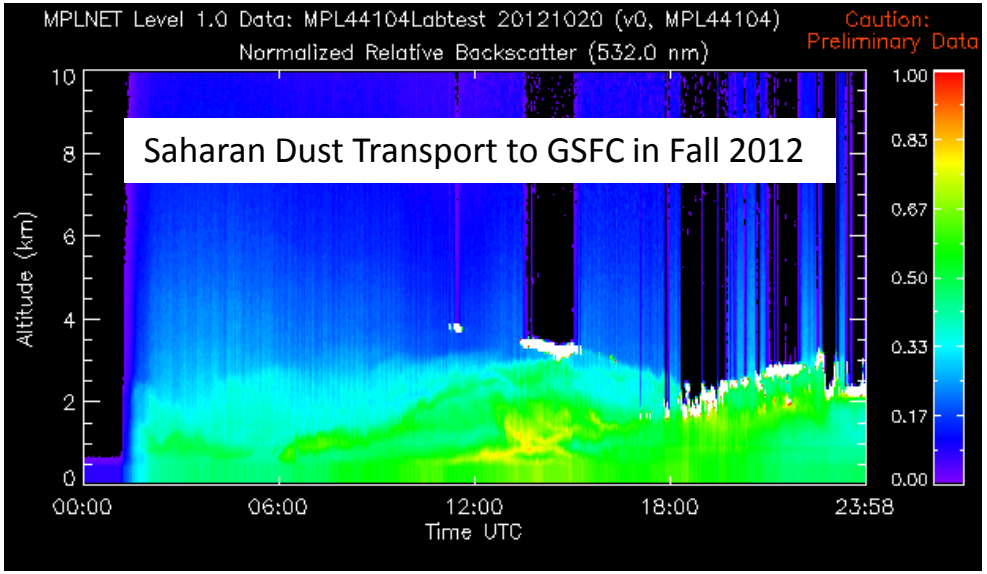
Figure 2: Comparison of seasonal diurnal cycles of the PBL height at GSFC for 2001-2008 using the new MPLNET algorithm (red) and GEOS-5 model (black). Orange vertical lines indicate the mean times for sunrise (SR) and sunset (SS).

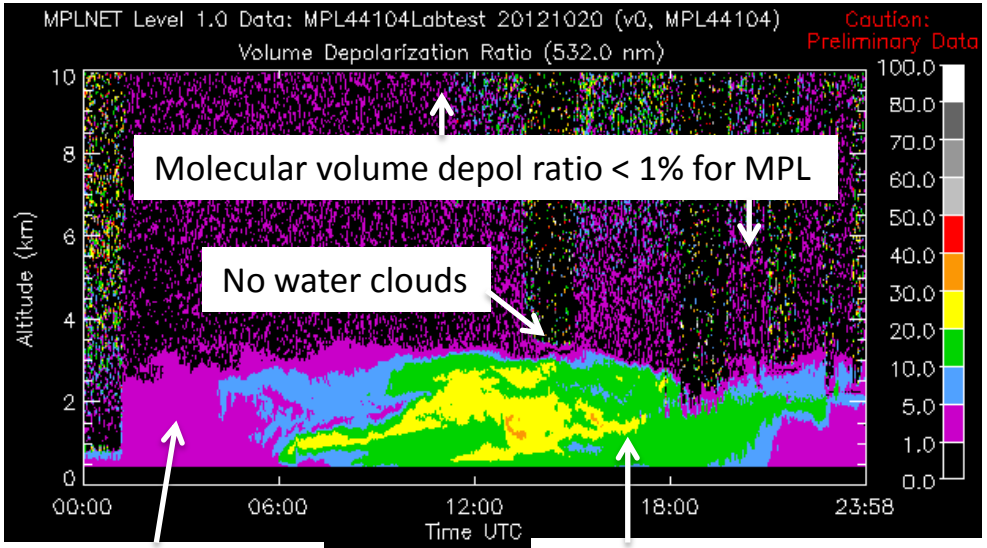
MPLNET Instrumentation: New Depolarization MPL

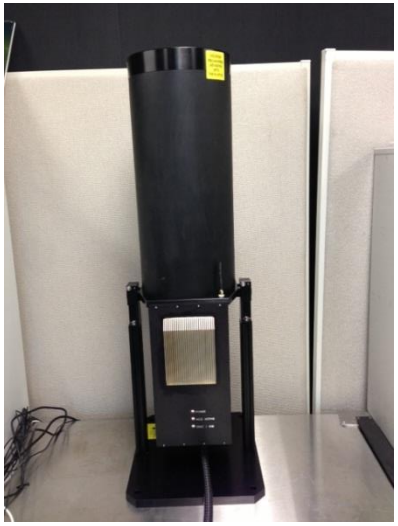
Depolarization MPL Approved for use in MPLNET

Original depol MPL developed at ARM/Sigma Space years ago. However it had slow switching between co and cross polarization and the system characterization, calibration, and accuracy studies were never completed.

New depol MPL product developed thru interaction with GSFC/Sigma includes fast switching. Full system characterization and calibration study at GSFC is almost complete.

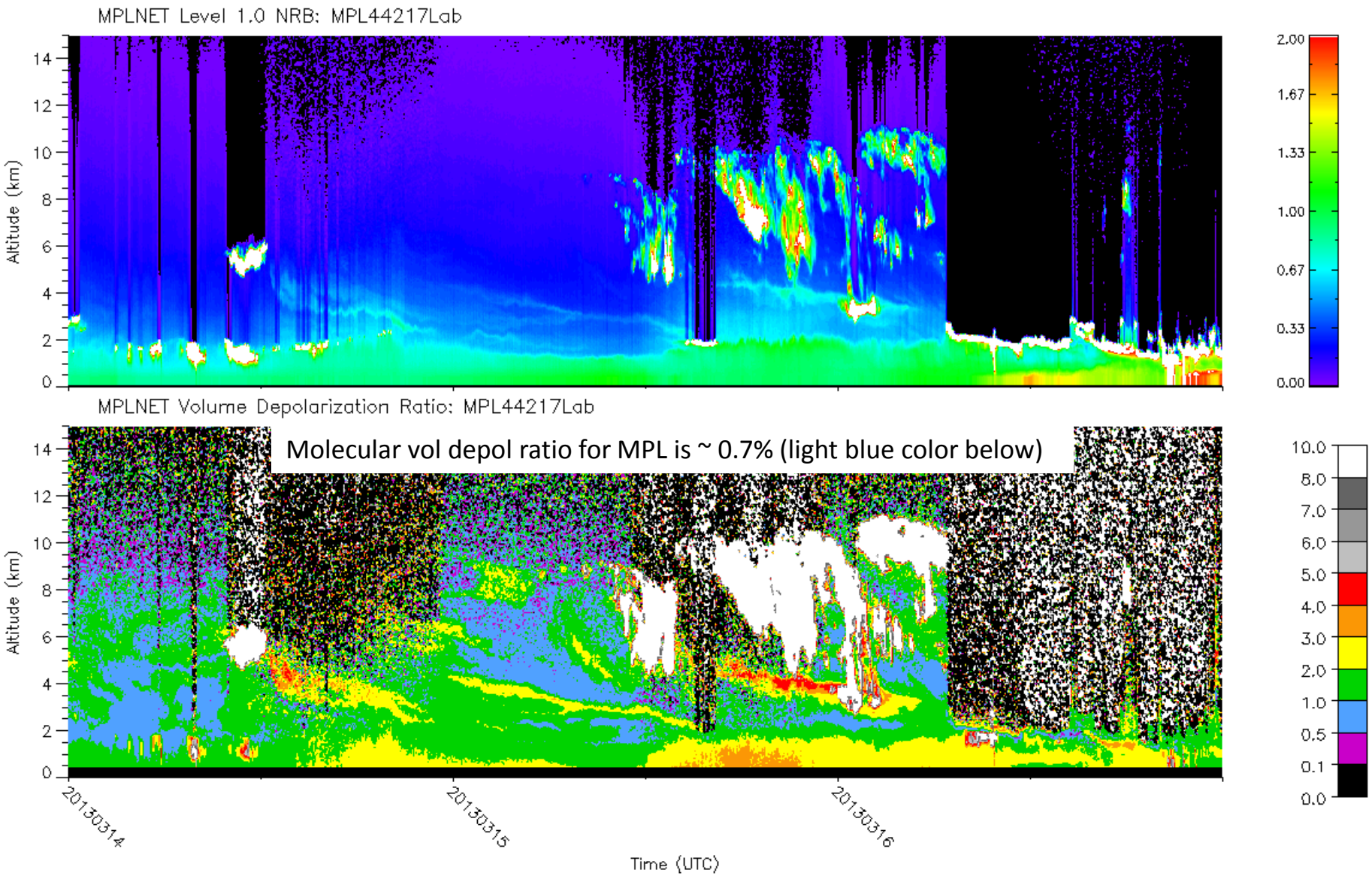






MPLNET Instrumentation: New Depolarization MPL

New depol MPL accuracy: ~ 1%. Discriminate aerosol features < 5% volume depol ratio



The Micro Pulse Lidar Network (MPLNET): Summary

Adding Depolarization Lidars to MPLNET

Development has started on our Version 3 Data release (with new website)

- Several new products: new PBL height, depolarization
- Improved high cloud/cirrus retrievals
- Enhanced, better performing continuous day/night aerosol retrievals
- More efficient data file search, request, delivery
- More online tools for data visualization

Working to develop an automated QC/QA tool for MPLNET verification of aerosol models (GEOS-5, NAAPS, etc).