# AERONET Version 3 +

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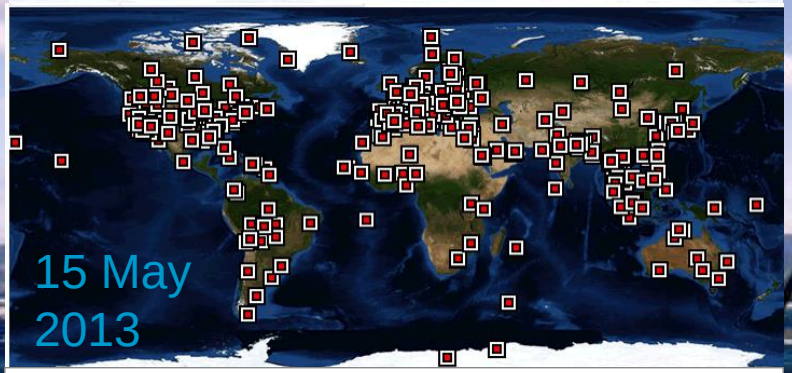
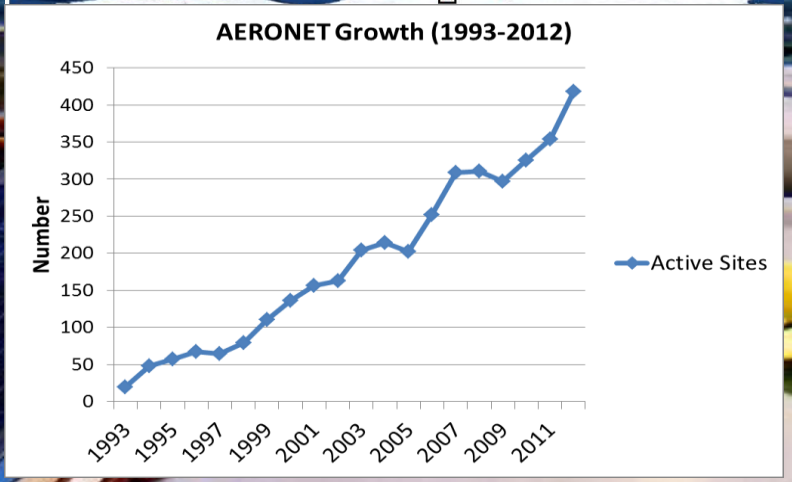
ICAP Tsukuba, Nov 5-8

# 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

# The Talk Outline

- Discuss Primary Elements of V3
- Development time line and release date
- Collaboration w/ SKYNET other networks
- Other AERONET considerations

# AERONET V3 Update
# What triggers a new version?

- Fundamental change is the data structure/management
- Fundamental change in the data processing algorithm(s):  Cloud screening

# Elements of Data Structure

- Every data point is geo-referenced
- Every data point is time stamped for each processing or data management action
- Data files organized by instrument rather than location—Multiple sites
- Data Processing-Auto processing of all requests—crash proof, faster processing
- Daily data indexing--small reprocessing jobs and up-to-date database
- Condensed data storage:  levels stored by product

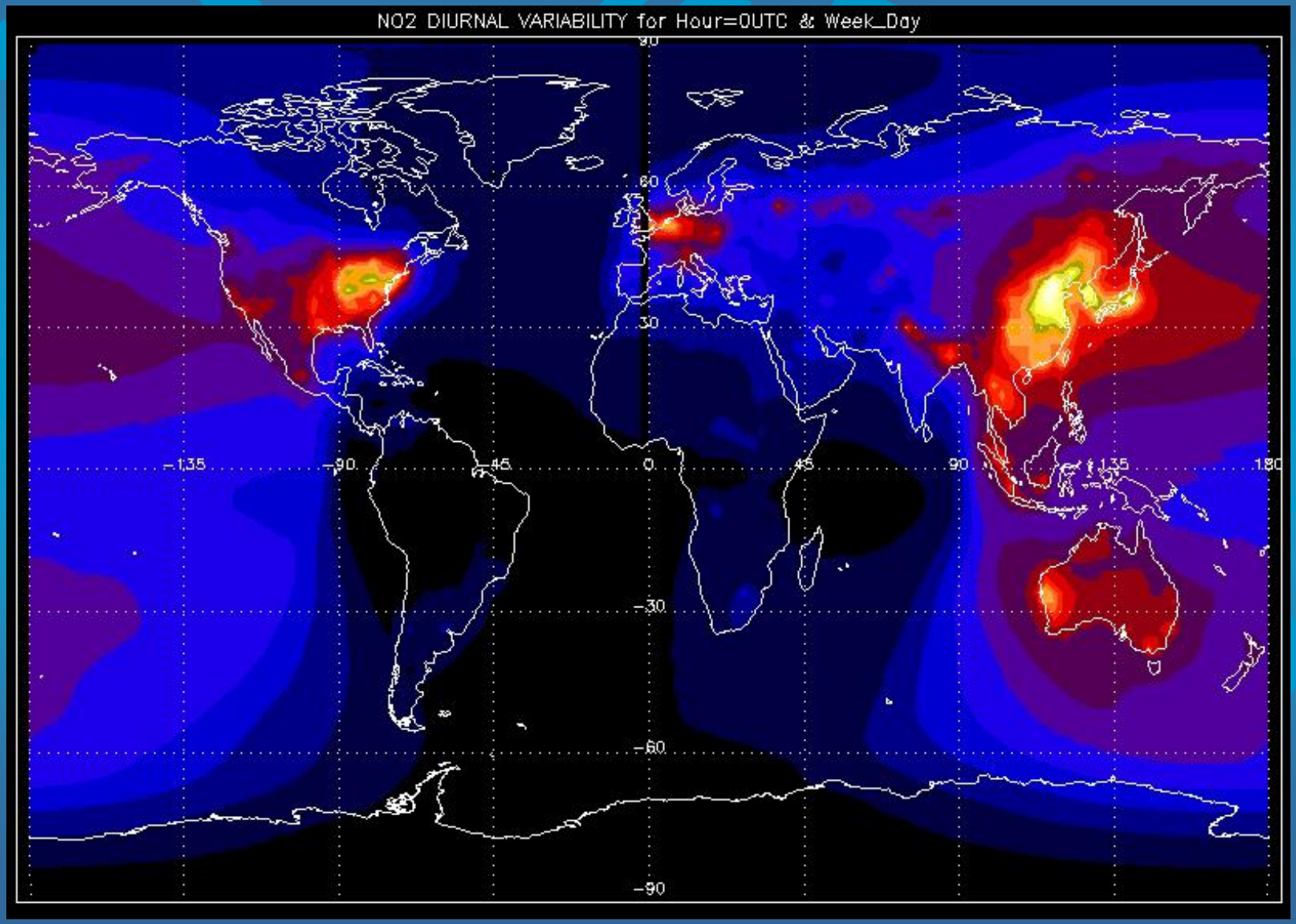
# AERONET Version 3 – AOD Enhancements

- Cloud screening-the big Kahuna
- Data cleaning-analyst to machine
- Temperature Characterization
- Update $NO_2$ monthly climatology (OMI, & diurnal Model)
- Reanalysis data set (e.g., GMAO MERRA vs NCEP): No Change
- $O_3$ climatology: No change

# Databases for $NO_2$ Corrections

- **$NO_2$ monthly climatology~ 25 km Res.: Archived OMNO2d files, PGE version 1.0.3.8 , from 2004-10 to 2013-08**
  - **produced from the daily Level-3 OMNO2d product using the grid cell data weights**
- **Diurnal model ~100 km Res: GMI-MERRA hourly model output for four years. (DC3 runs)**
  - **produced from the daily GMI profile run, sampled every 1 hour**

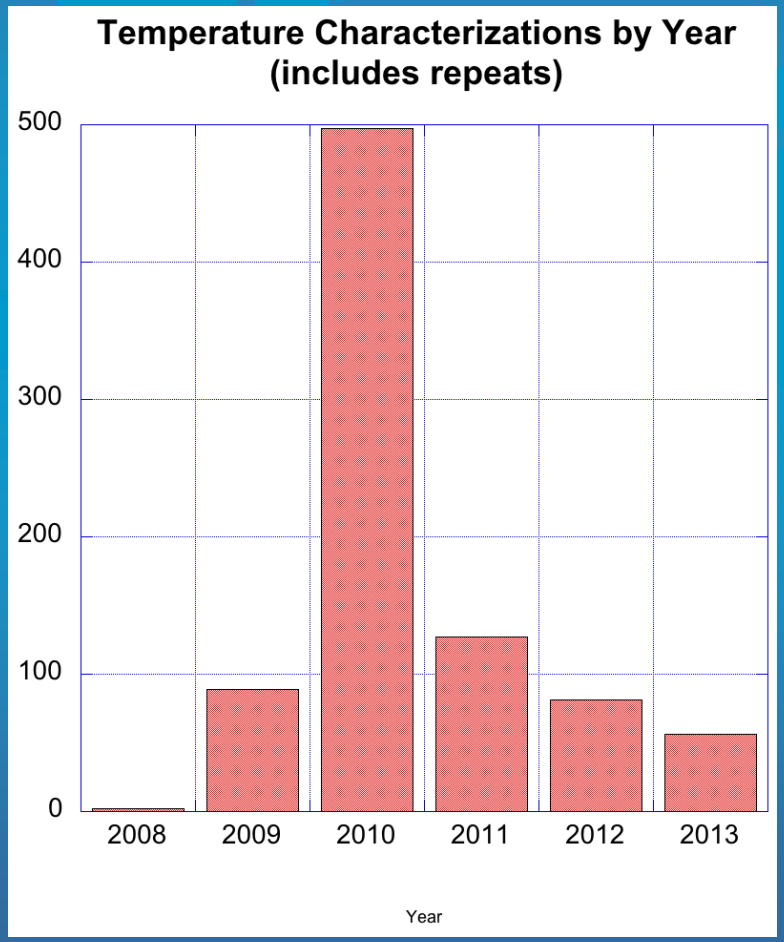
# Diurnal $NO_2$ Model example

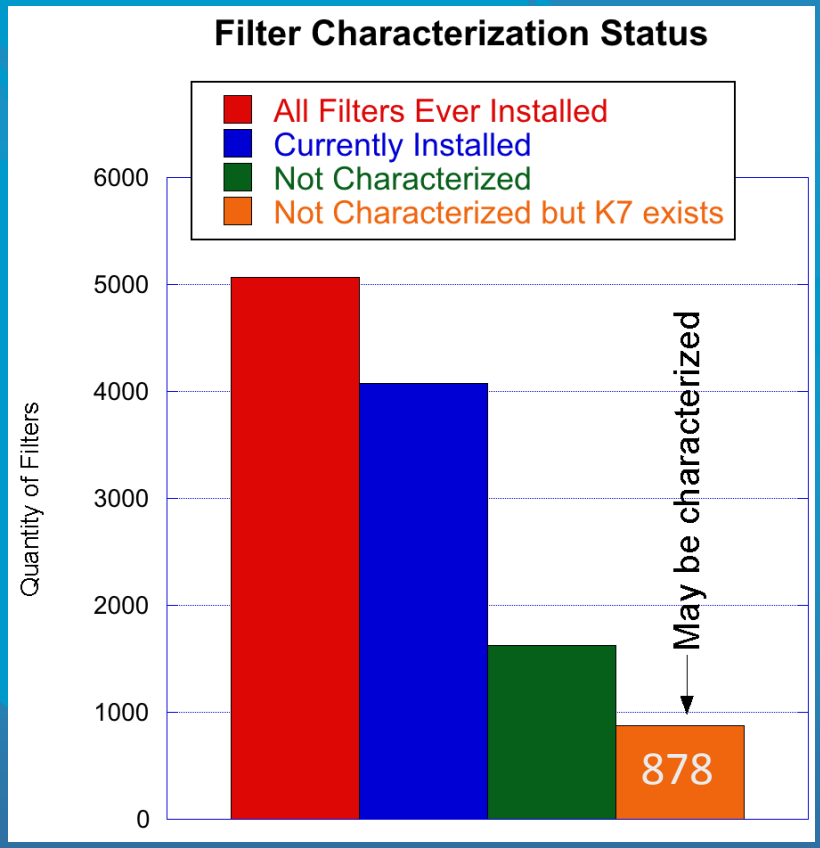


# Temperature chacterization issues

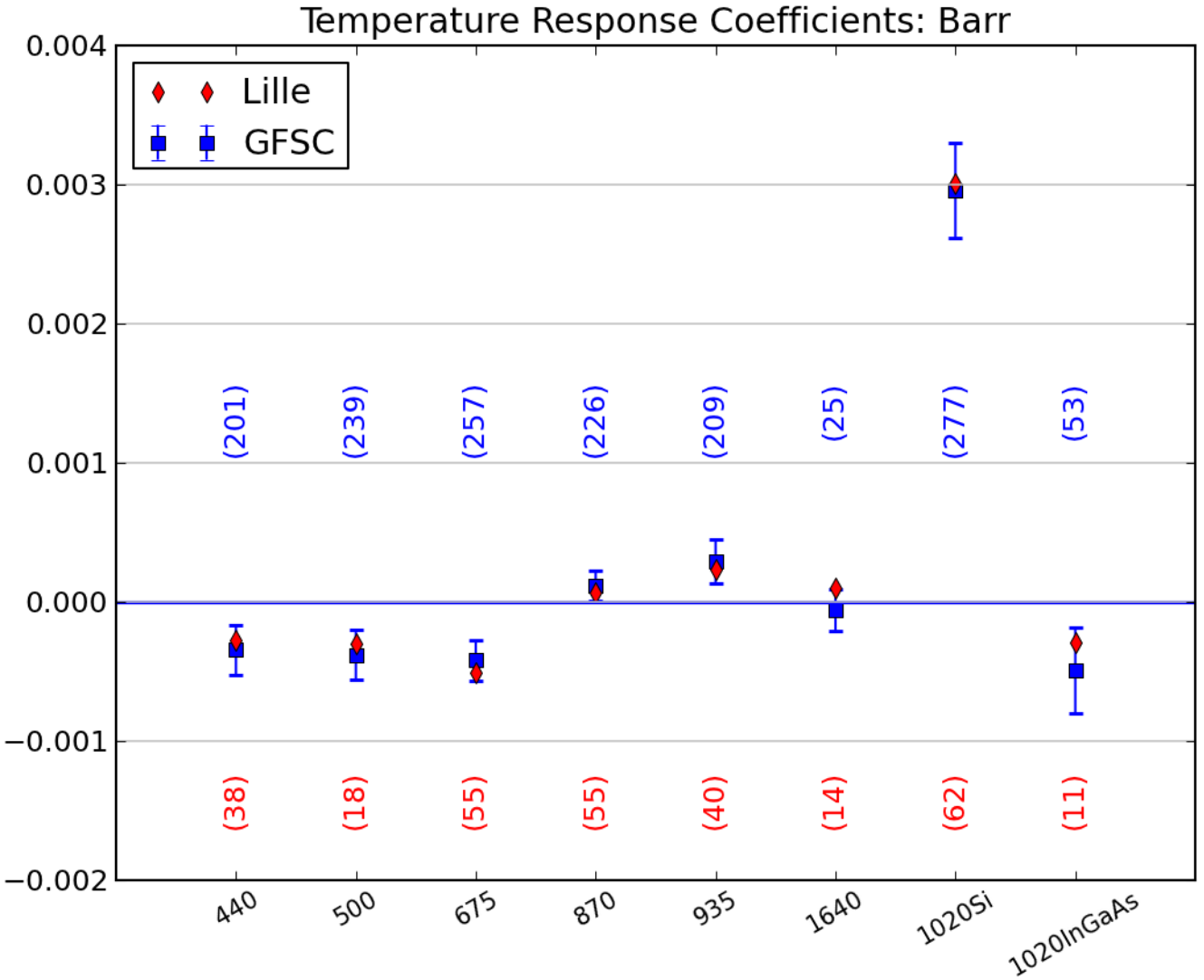
- V2 based on detector manufacture specs
- V3 based on lab Measurements
  - Corrections applied to all channels
  - Develop defaults based on filter type & detector for instruments that cannot be characterized
  - Net result little change in Database statistics however some instruments can show measurable changes
  - Langley, intercomparison and sphere are recomputed  before V3 implementation

# Temperature Characterization (Began in 2008)

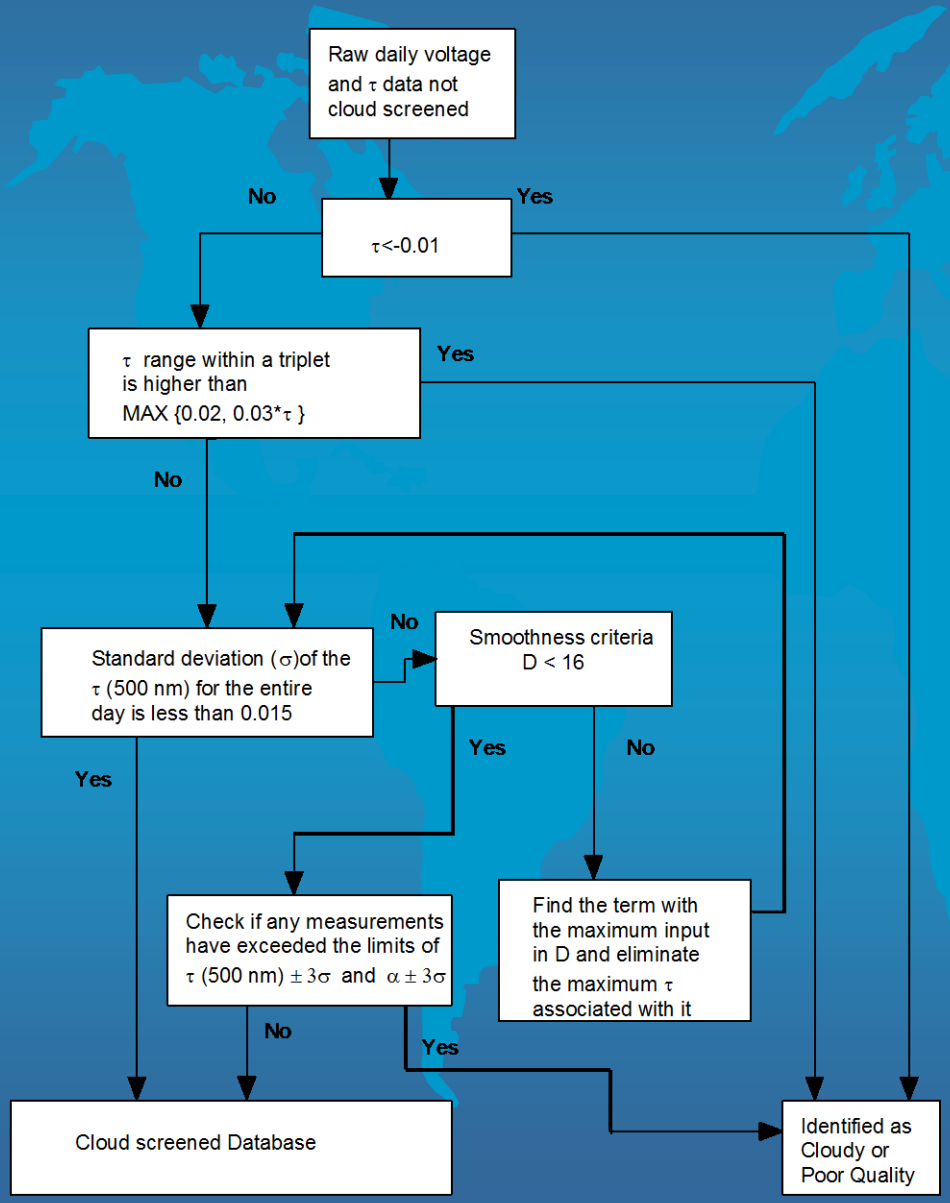


# Example of spectral temperature characterizations for 1 manufacture to develop part of the default database



# Cloud Clearing-V2 Algorithm




## Problems:

- Thin stable cirrus clouds
- Highly variable dust or smoke

# Key V3 modifications temporal checks

- **Triplet criterion** –THREE channels (675, 870 and 1020 nm): "Cloud" if:
  - ALL THREE wavelengths within a triplet (tau_max – tau_min) exceeds 0.01 or
  - 0.015*tau (whichever is greater).
- **Smoothness check** – Replaces "D16" with "N1": AOD at 500 nm (or 440 nm), Cloud if:
  - Delta AOD >0.01 per minute.

# Key V3 modifications Spatial check

- **Aurole Radiance Curvature check –**

  compute curvature for measured 1020 nm sky radiances within 3 – 6° SCATTERING angle.

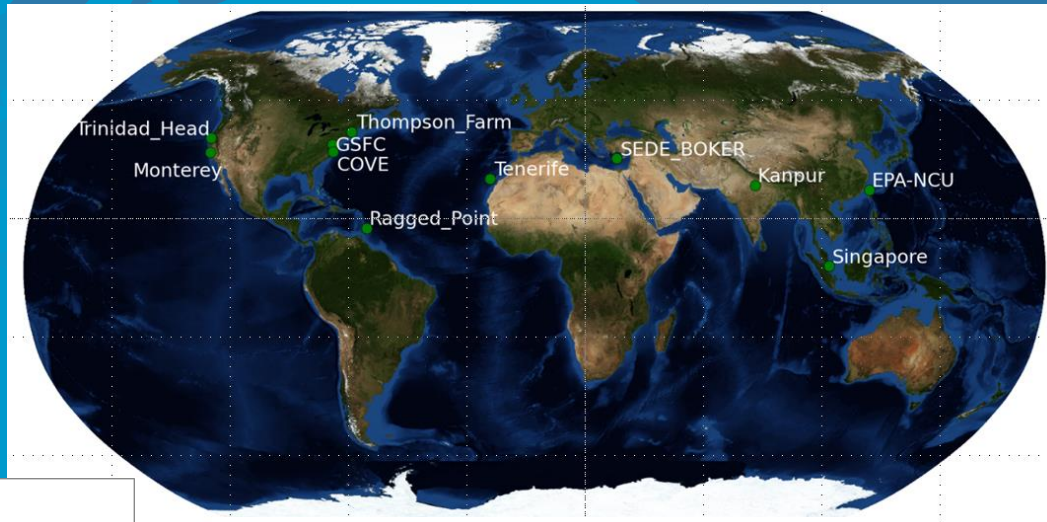
  – If curvature computed for the first available scattering angle is greater than 0.001 we do not apply a “curvature check”.

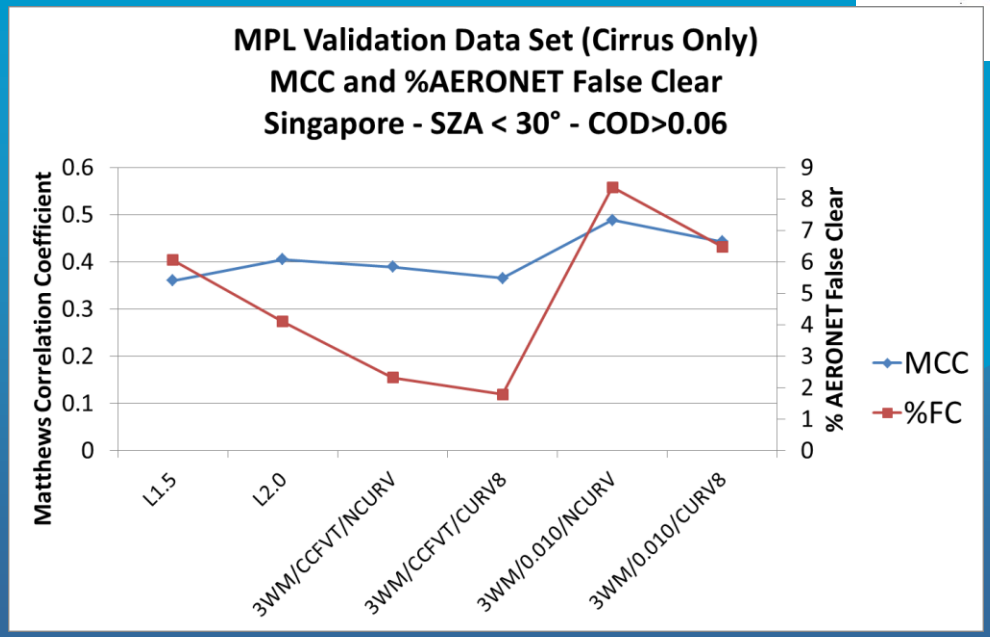
  – If curvature is less than 0.001 we compute a slope of Ln Curvature vs Ln Scat Angle.

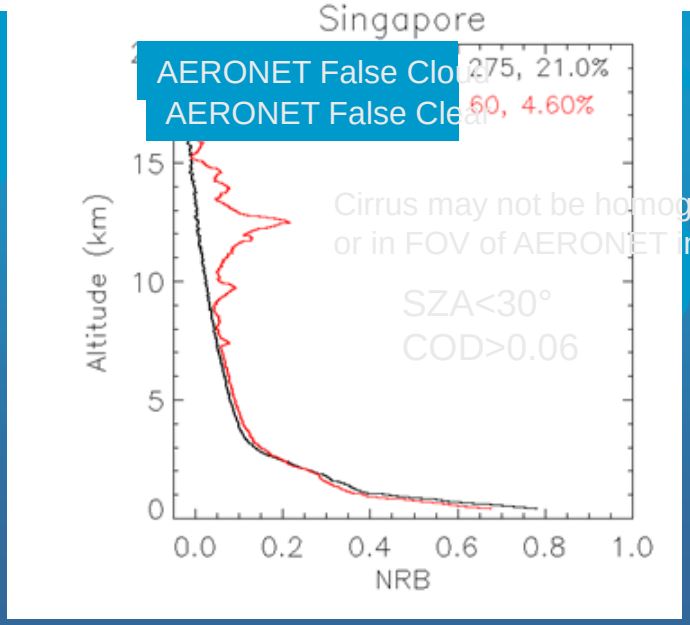
    - If the slope is greater than 8 (empirically found) we consider all points within +/- 30 minutes to be “cloud contaminated” and eliminate those points.

# AERONET – MPL Validation Data Set

- MPLNET cirrus only detection within ±10 minutes of AERONET measurement
- AERONET measurement within various solar zenith angles (e.g., 30°)
- Homogeneous cirrus conditions assumed



# Comparison to V2 database: Singapore, #22, 2007-2011 fine mode and Ci

| | N | AOD | Alpha |
|---|---|---|---|
| Lev 1.0 | 25500 | 0.61 | 0.58 |
| Lev 1.5 | 8680 | 0.45 | 0.79 |
| Lev 2.0 | 6920 | 0.34 | 1.21 |
| | | | |
| NEW (no/CURV) | 8640 | 0.35 | 1.17 |
| NEW (w/CURV) | 5029 | 0.33 | 1.40 |

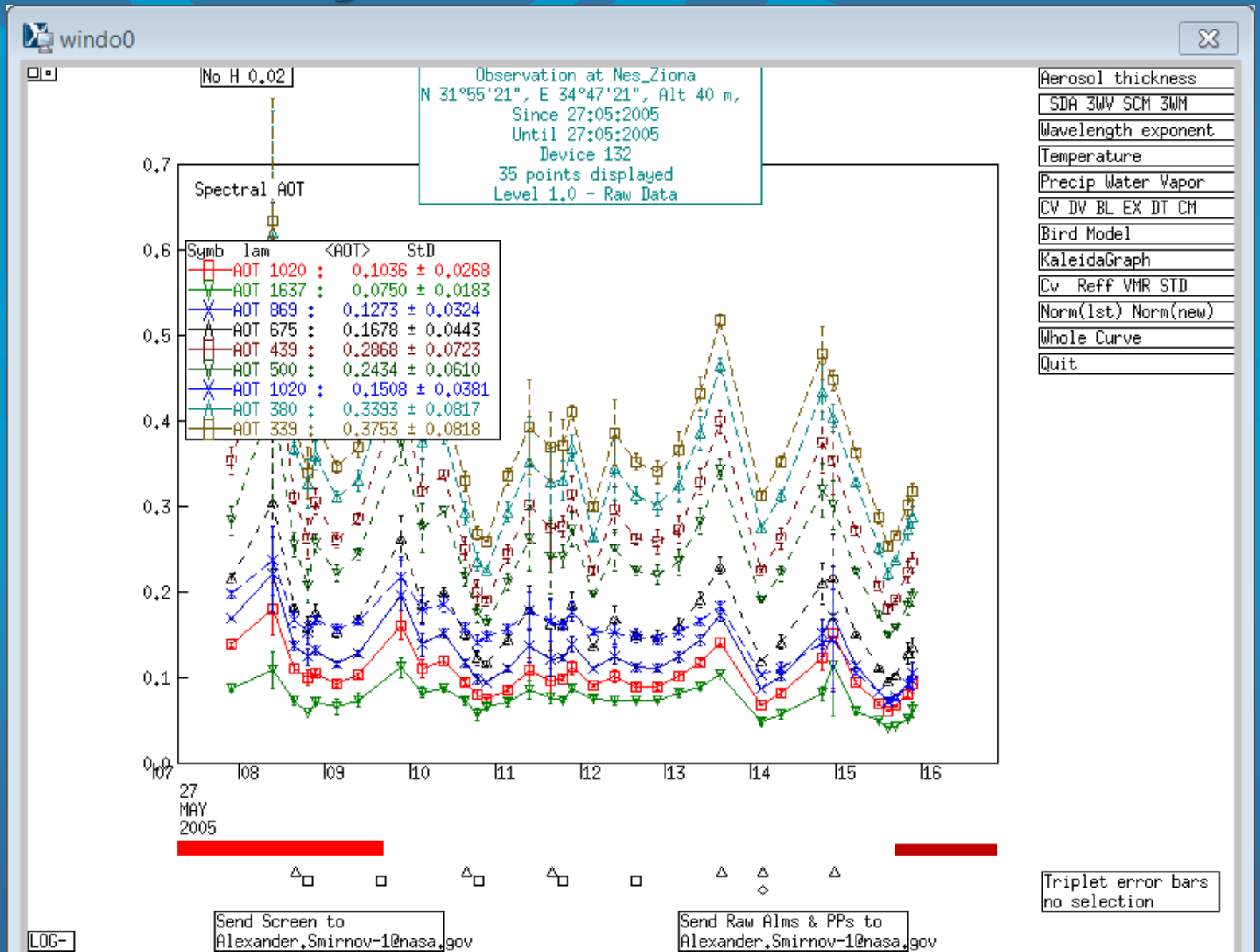
# Comparison to V2 database Nauru, #168, 2000-2005, 2010 Seasalt and Ci

| | N | AOD | Alpha |
|---|---|---|---|
| Lev 1.0 | 25579 | 0.23 | 0.09 |
| Lev 1.5 | 13326 | 0.11 | 0.33 |
| Lev 2.0 | 9371 | 0.08 | 0.58 |
| | | | |
| NEW (no/CURV) | 13048 | 0.09 | 0.45 |
| NEW (w/CURV) | 7879 | 0.08 | 0.55 |

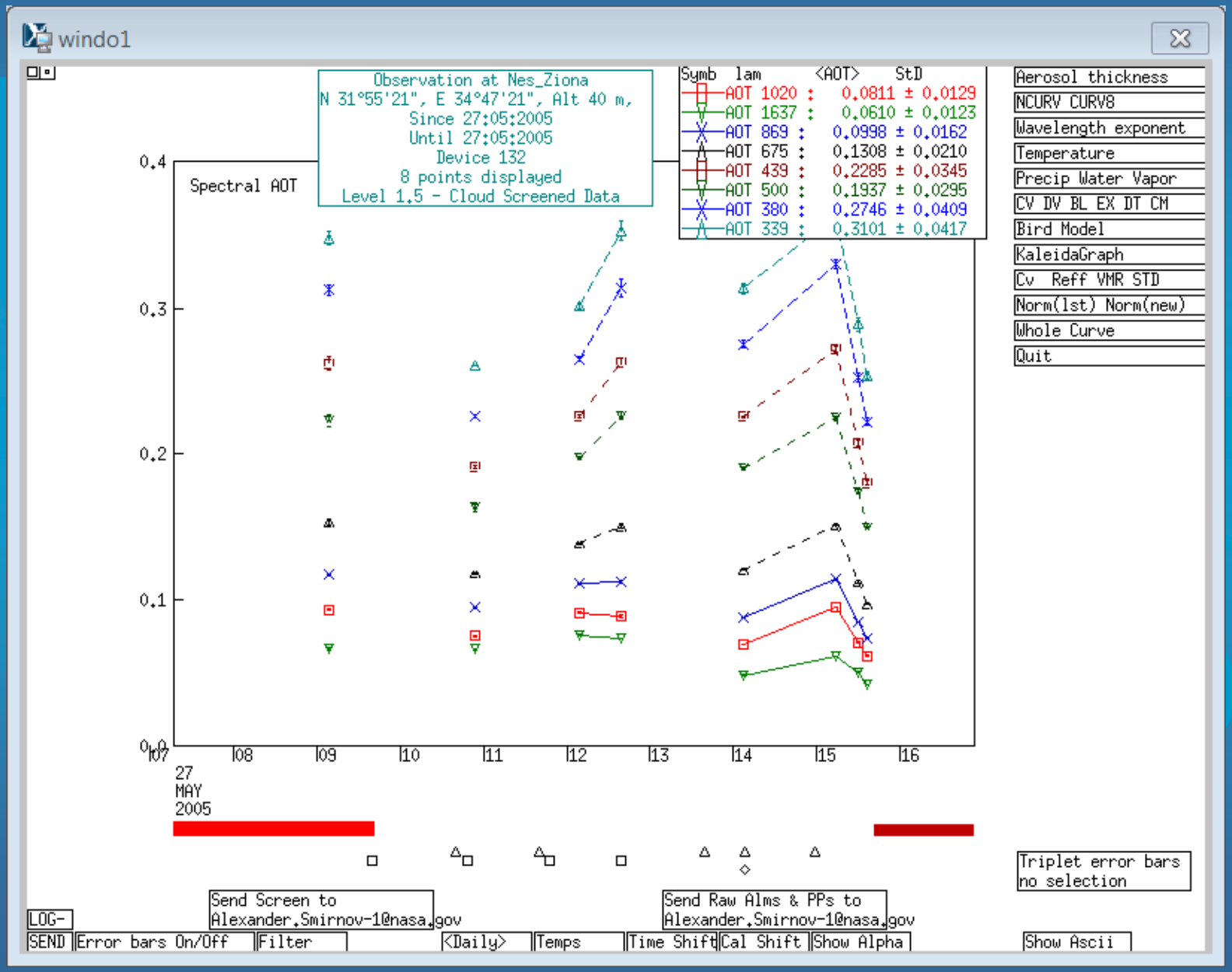
# Comparison to V2 database Ilorin, Nigeria: #29, 1998-2013 Mixed BB & Dust

| | N | AOD | Alpha |
|---|---|---|---|
| Lev 1.0 | 58151 | 0.84 | 0.42 |
| Lev 1.5 | 37370 | 0.84 | 0.46 |
| Lev 2.0 | 35392 | 0.77 | 0.51 |
| | | | |
| NEW (no/CURV) | 32601 | 0.73 | 0.55 |
| NEW (w/CURV) | 29348 | 0.76 | 0.55 |

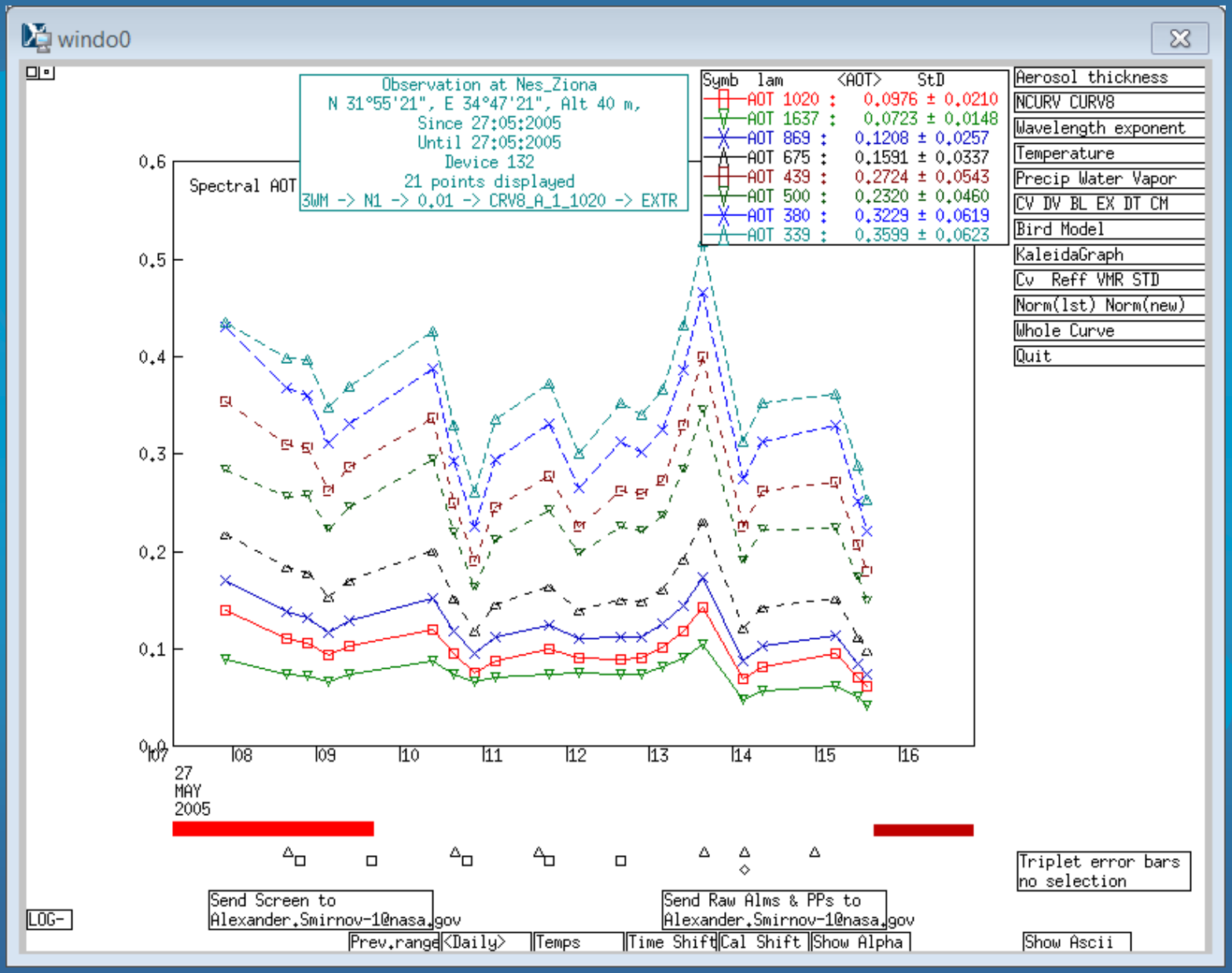
# Nes Ziona, 5/27/2005 – Level1.0
# Clear sky, variable fine mode



# Nes Ziona, 5/27/2005 –V2 Level1.5



# Nes Ziona, 5/272005– V3 Level1.5



# Advantages of the new cloud screening algorithm

- Automated algorithm delivers AODs and $\alpha$ at Level 1.5 statistically very close to current Level 2.0
- Improves screening of stable thin cirrus cloud contaminated data
- Partially restores highly variable fine mode dominated AOD data

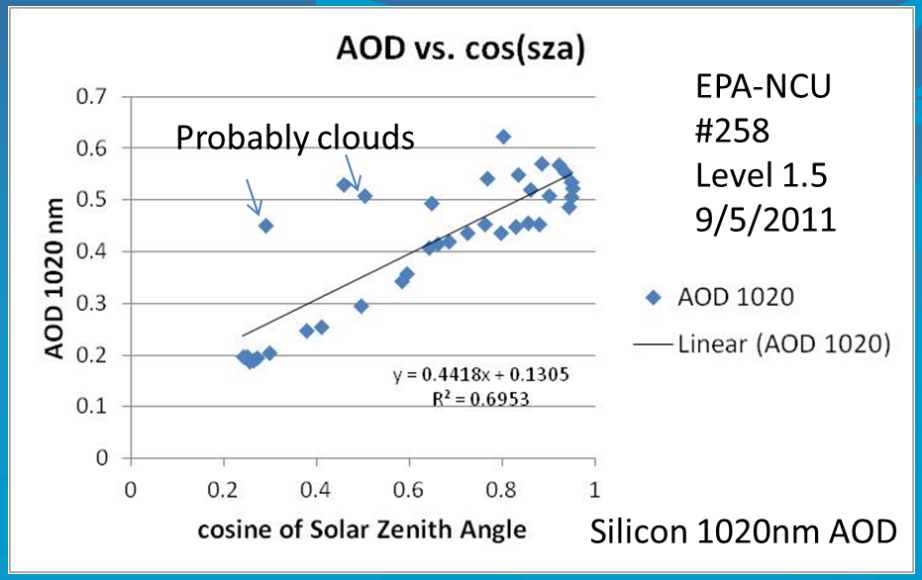
# Getting to L 1.5v and L 2.

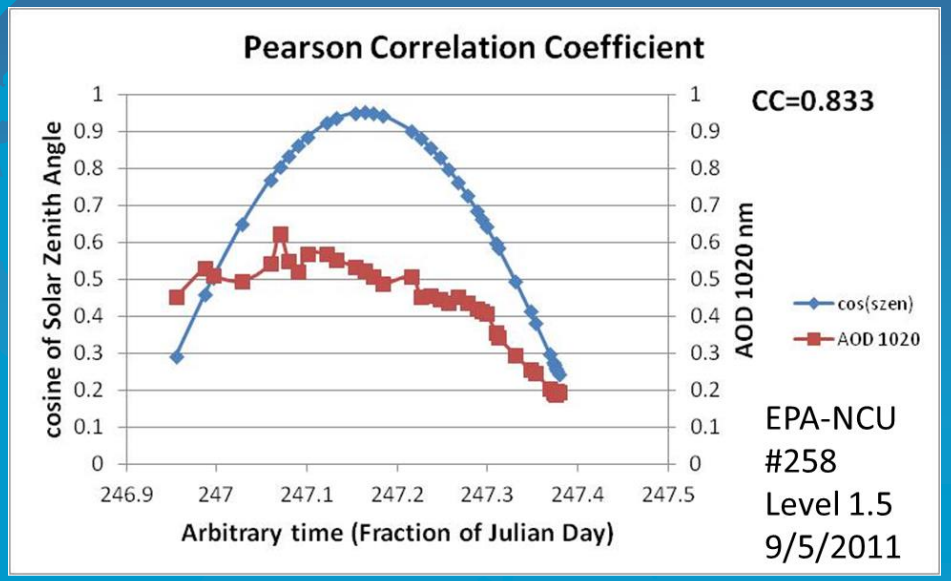
- V2: The human robot-A. Smirnov (Ret.?)
- V3: Automatic Quality Checks
  - L 1.5v NRT, publishable results from database
  - L 2.0 Minimal analyst assessment

# V3 QA Instrument checks-Under assessment

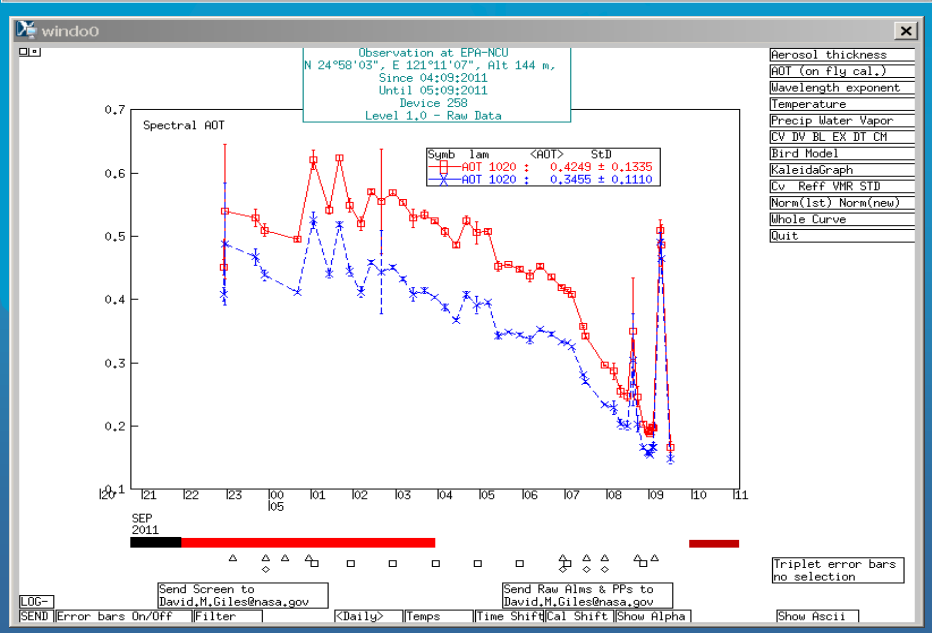
- Dark current check  (analog instruments: 4.8x)
- Temperature jumps (±Δ12°C/15 min)
- Temperature limits (>55°C or <-30°C)
- A or K voltages  Too low (<0.3v) 4.8x and 5.x standard only
- A/K Discrepancy (A> 10% of K) 4.8x and 5.x standard only
  - Evaluate A & K from PP & Almucantars
- Asymmetric sky scans (scattering angle: 3 to 6°)
- InGaAs vs Si 1020 nm (±Δ 0.06/m) AOD 5.x extended only
- Retrieval limits ($SSA_{440}$ < 0.70?)
- AOD Diurnal Dependence (analyzing techniques and thresholds)
- AOD triplet variability for each channel???
- Dual filter wheel/polar instrument?????

# AOD Diurnal Dependence




- Characterized by a non-linear change in the calibration due to various factors affecting the optics
  - Collimator obstruction (e.g., spider webs)
  - Moisture, dust, or obstruction on sensor head windows
  - Dust on filter inside the sensor head (e.g., filter wheel grinding or desiccant pack rupture)
  - Filter degradation increasing transmittance (produces opposite diurnal variability response than above)
  - Incorrectly set instrument gains (e.g., Medellin 10/6/2013) and producing AOD diurnal variability in both directions



# AERONET Version 3 Update
# Sky Retrievals

- Dubovik inversion code remains unchanged
- Implementation of a vector radiative transfer code
  - radiation field in UV (e.g., 380 nm retrieval)
  - degree of linear depolarization

# Version 3: Vector RT Model will replace scalar RT Model

- Approach
  - Select documented, published, community accepted RT models
  - Test against benchmark conditions to compare accuracy and speed

# Vector RT model Status

- Adding doubling (A/D, GISS)
- Discrete Ordinates w/APC (GSFC)
- Successive Orders of scattering (SO, Lille)
  - Accuracy:  Rayleigh Atmos all within 0.1%
  - Timing:  (Preliminary) A/D 2 to 10 times greater than scalar code
  - A/D dropped from further consideration
- Continue DO and SO development and assessments, planned completion:  01/2014

# Inversions: Est. Uncertainty (Not linked to V3 release)

- PSD, n, k, SSA, APF, Sphericity
- Error bars for each retrieval
- Account for random errors in optical measurements, calibration uncertainty, and estimated uncertainty of surface reflectance

# Level 2 retrievals

- Possibly revise V2 thresholds
- New retrieval products will be added as they are developed and are version independent

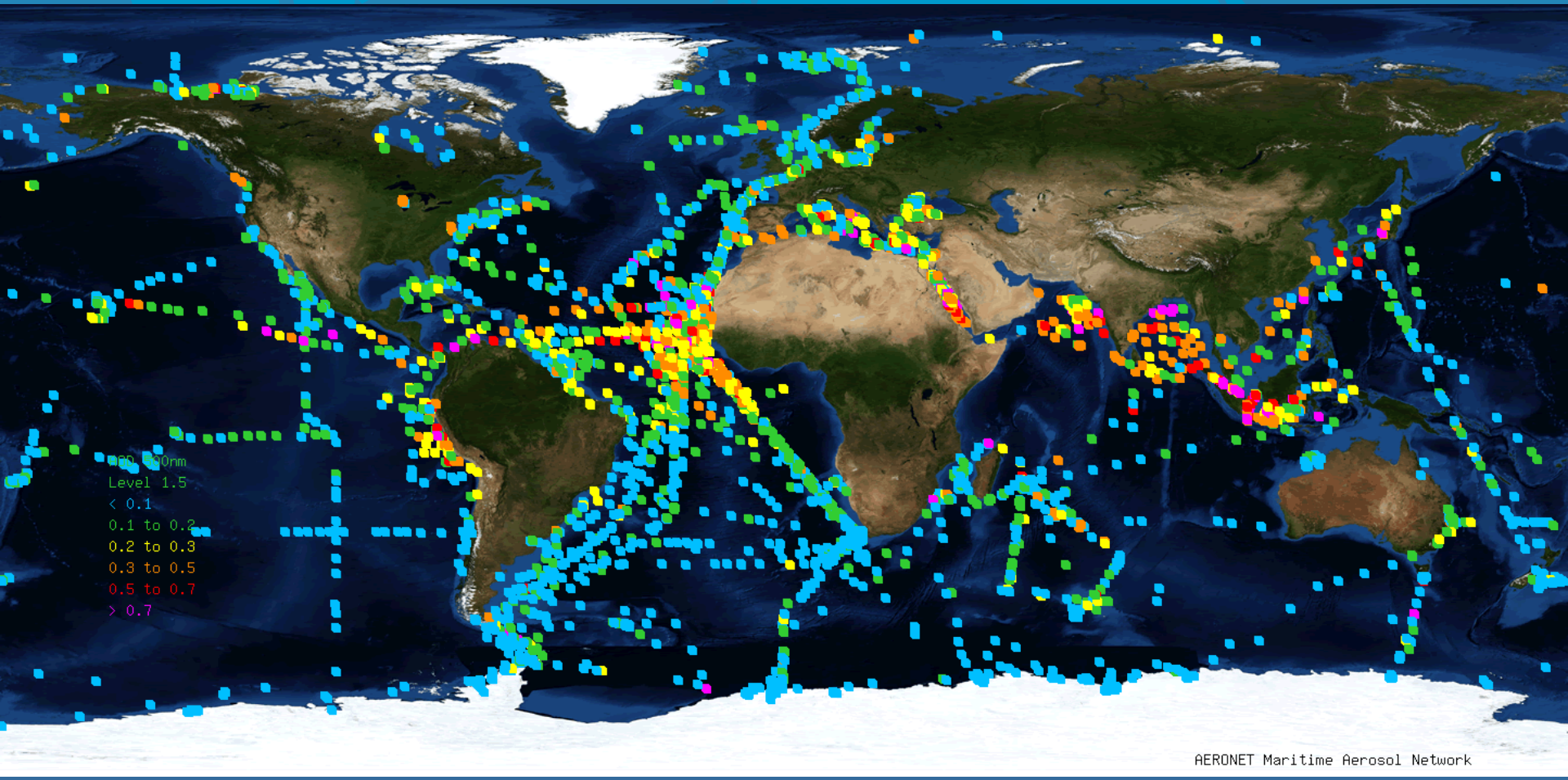
# Timeline for release of V3

- Data Structure (Dec 2013)
- $NO_2$ (Nov. 2013)
- Temperature (Nov. 2013)
- Cld Screening (Done)
- Data cleaning (Feb. 2014)
- Vector Code (Jan 2014)
- Integration (March 2014)
- Release (April-June  2014)

# 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 September 2013



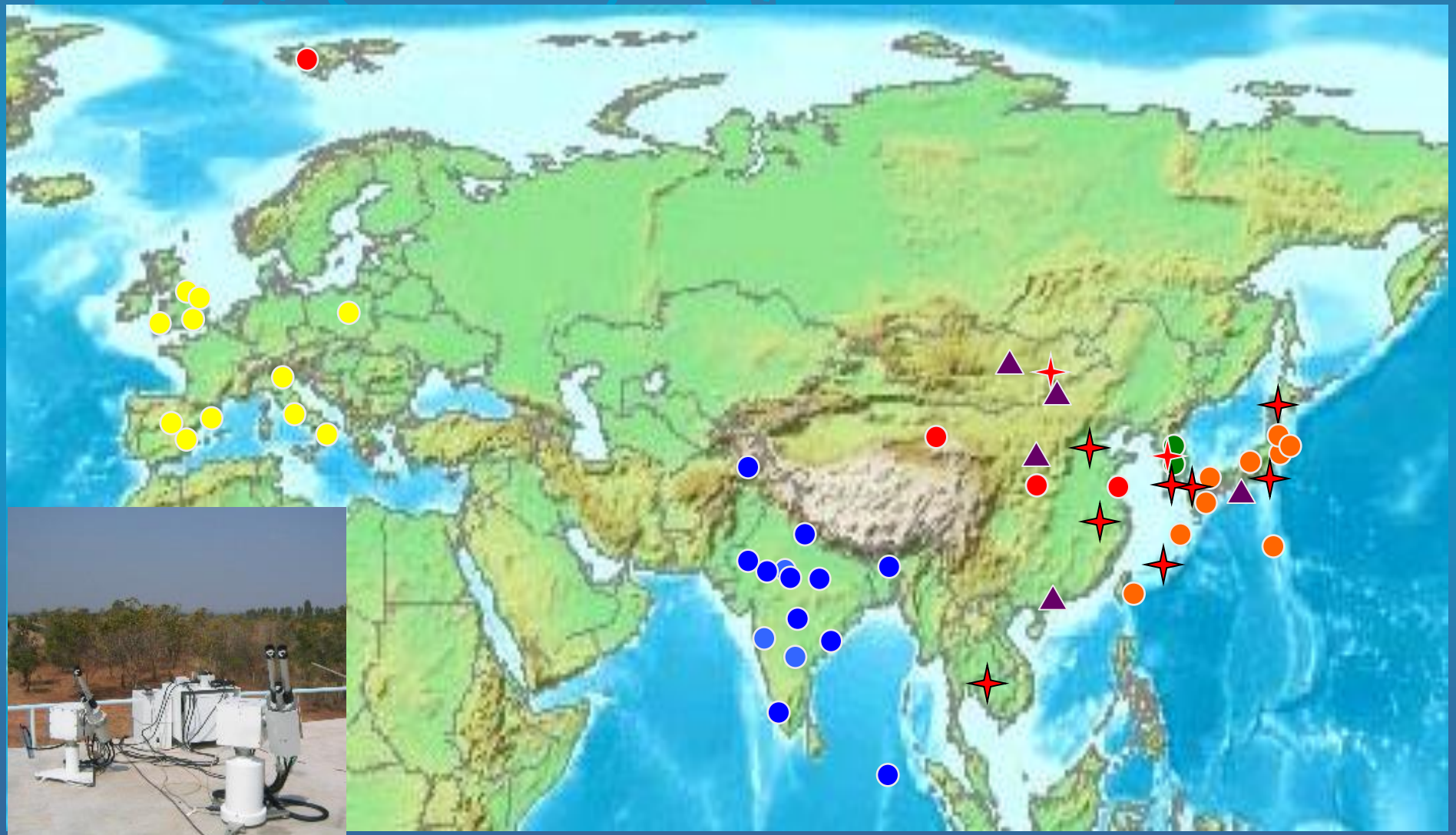

Smirnov, A., et al., Maritime Aerosol Network as a component of Aerosol Robotic Network, J. Geophys. Res., 114, D06204, 2009.

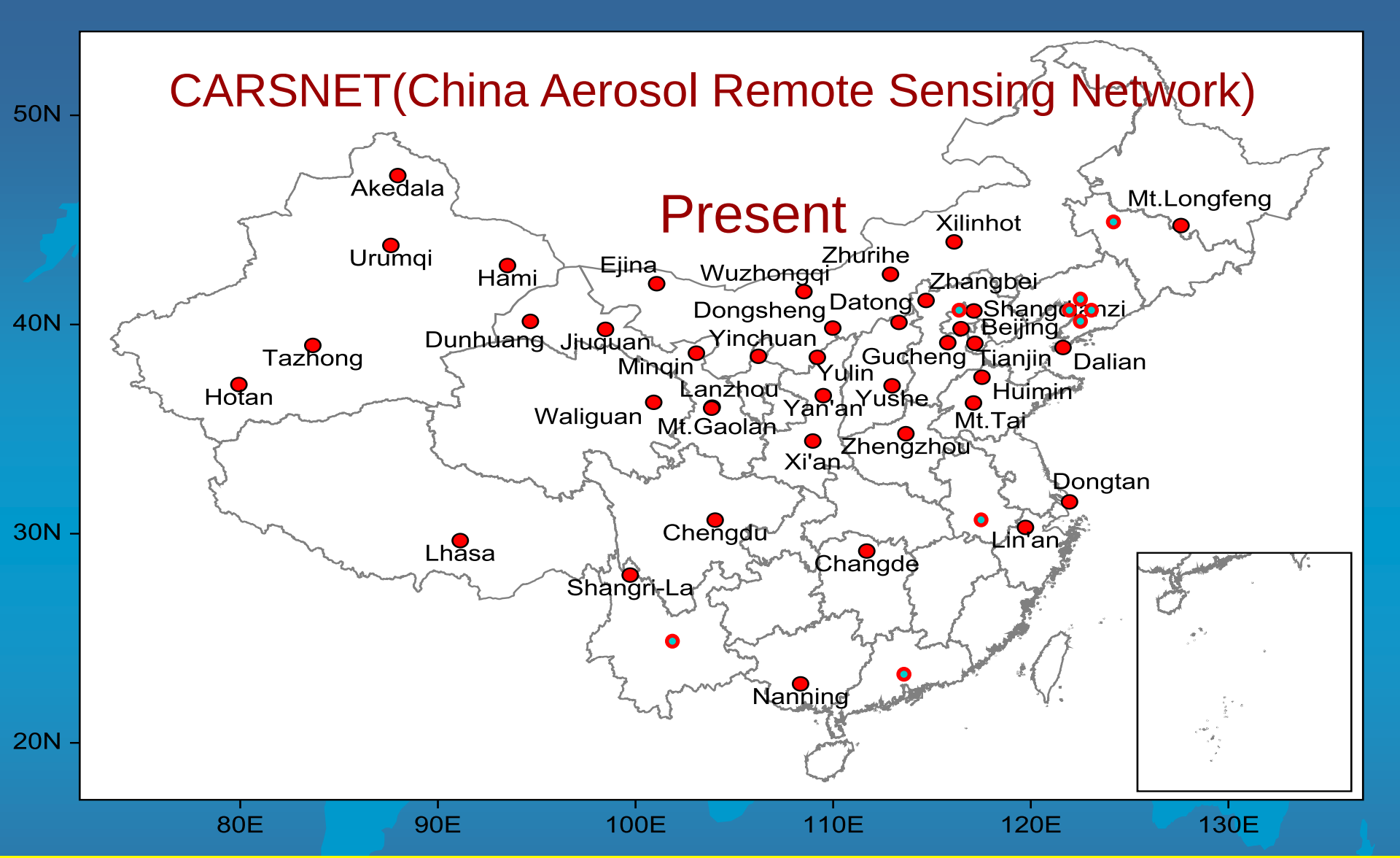
# The future bits

- Collaborative networks:  SKYNET & CARSNET
  - Proceedures being established for comparability with AERONET-a work in progress
- Develop regional synoptic scale networks
- Closing the spatial gaps - Africa
- Lunar Photometry

# Skynet radiation & lidar network

SKYNET
SKYNET&Lidar (microwave)
AD-net lidar

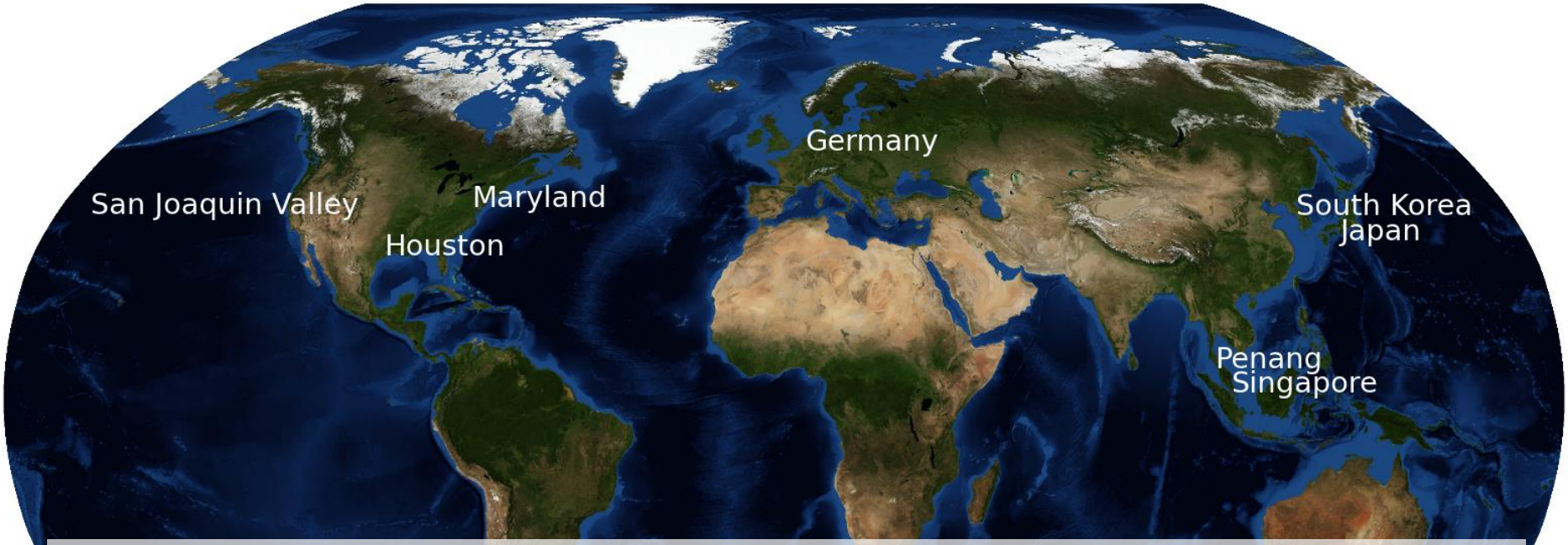





There are about 40 CARSENT operational site running at present.

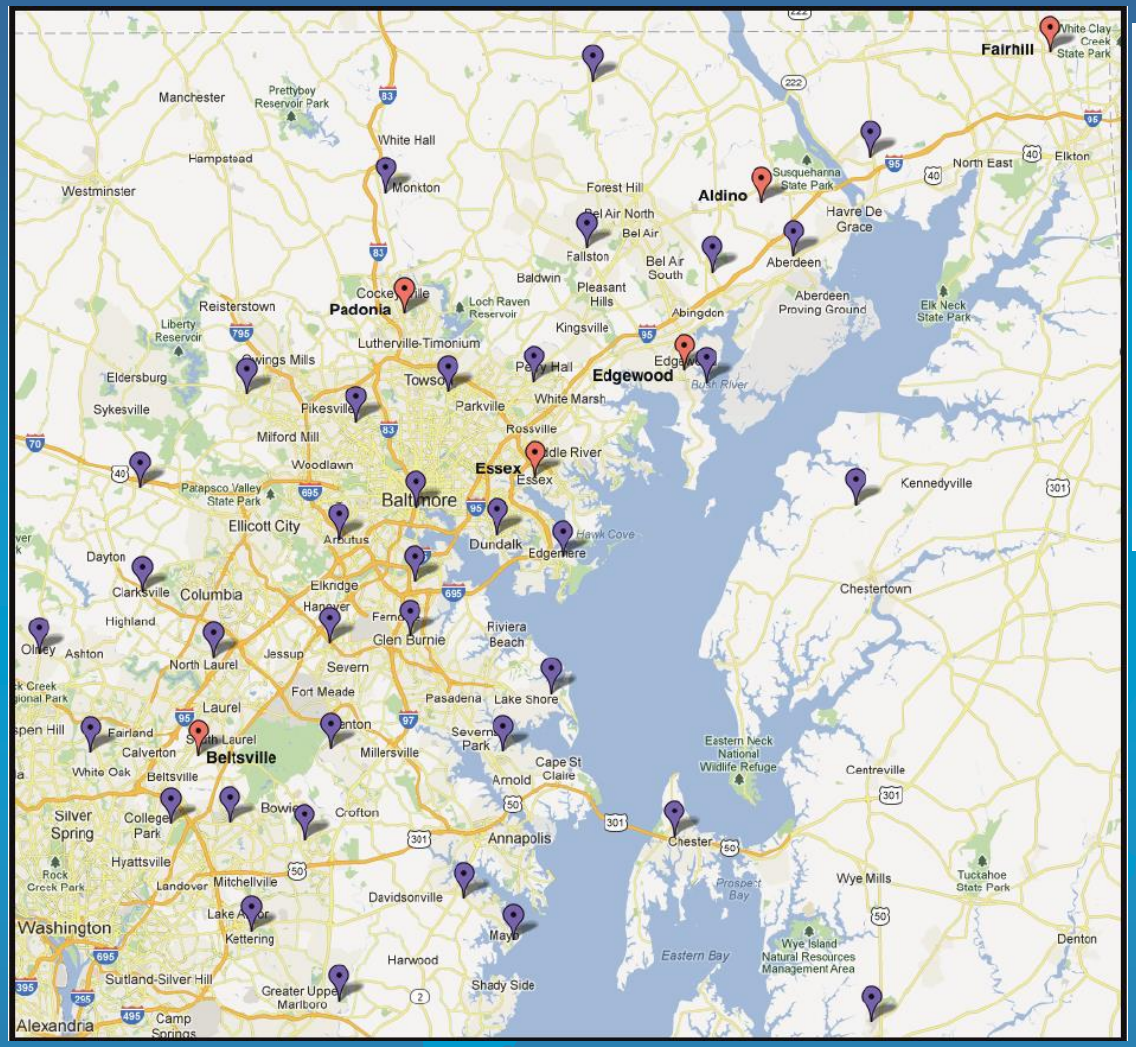
# AERONET DRAGONs

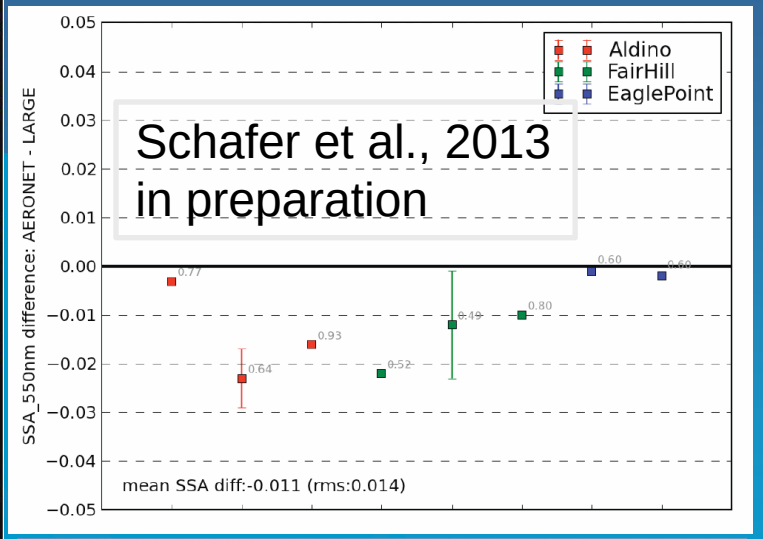
## Distributed Regional Aerosol Gridded Observation Networks




- 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?
  - ?

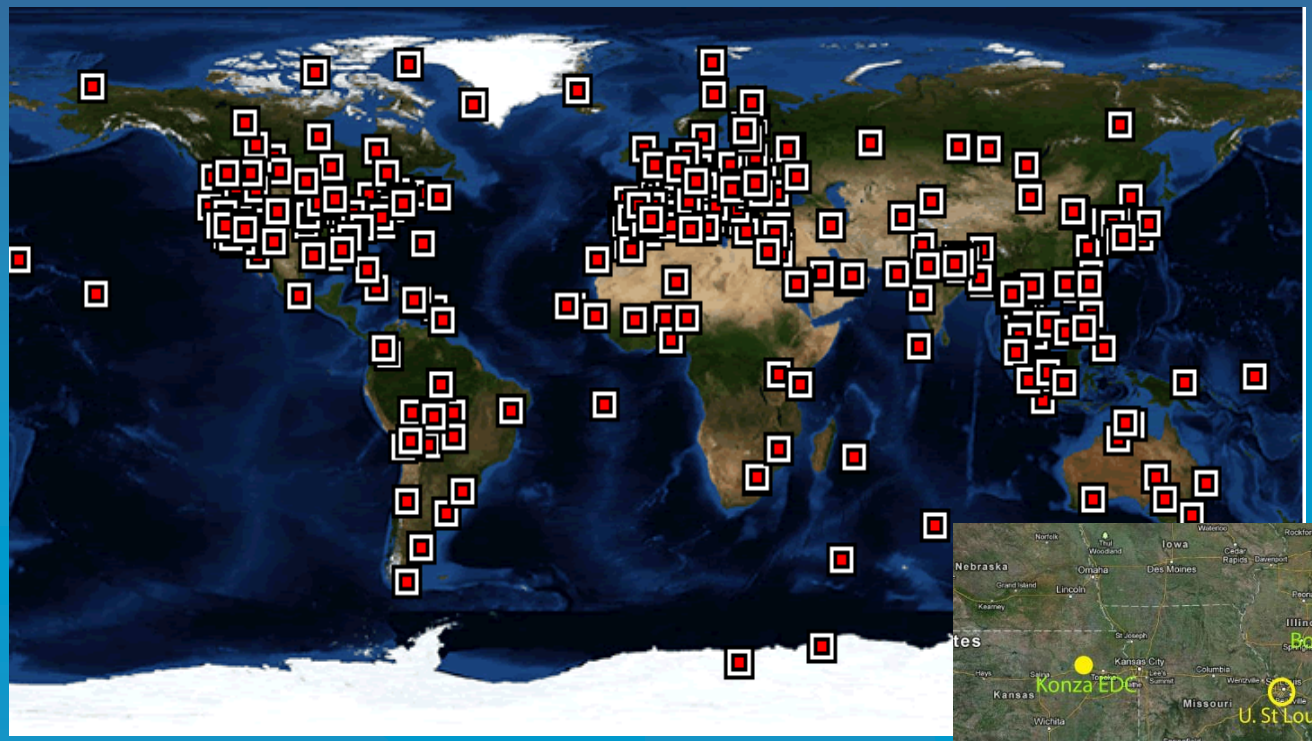
# AERONET DRAGONs

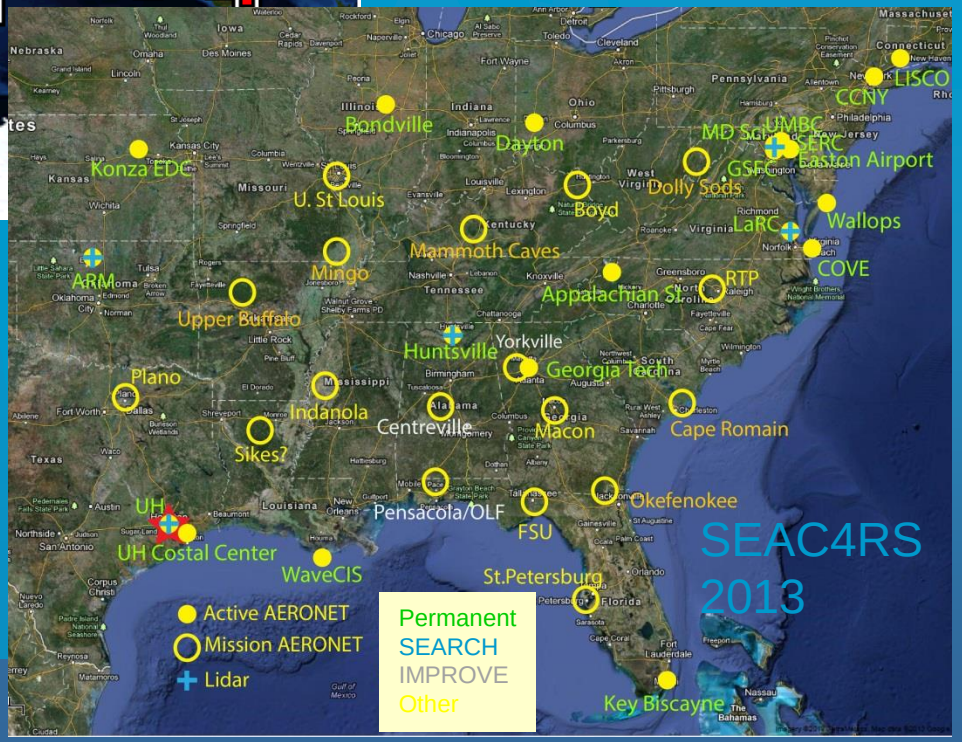



- Spatially distributed sun photometers deployed around aerosol sources (e.g., cities and industrial regions) over surfaces challenging for satellite remote sensing
- Provide 1 to several months of data in mesoscale distribution at high temporal sampling
- Complements air quality campaigns such as DISCOVER-AQ

# 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

# Misc. stuff at The End of the World

- Volcanic motivated networks
  - STRAPES (S. America), UK other European,
- Website will be updated before release of V3
- Lunar Photometer-future addition to AERONET: post V3 release
- African sites are few
- Caution on level 1 SDA fine/coarse retrievals