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AERONET Update

Brent Holben
David Giles

ICAP Workshop
October 22, 2014

AERONET is funded by
the NASA Earth Observing System project office
and the Radiation Sciences Program (NASA HQ),
Joint Polar Satellite System (NOAA),
and large field campaigns such as
SEAC4RS and DISCOVER-AQ

Outline

- V3 Automatic Cloud Screening
- V3 Automatic Quality Assurance
- V3 Current Status
- Data Acquisition Methods: Current and Planned
- Summary

AERONET Version 3 Cloud Screening

- New Level 1.5 AOD_{500nm} and $\alpha_{440\text{-}870nm}$ statistically very close to V2 Level 2.0
- Improperly filtered highly variable AODs (dominated by fine aerosols) will be, at least partly, restored in the V3 database
- Stable thin cirrus becomes less of a problem (less residual contamination)

Nauru, #168, 2000-2005, 2010

	N	AOD	α
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 Lev 1.5	7879	0.08	0.55

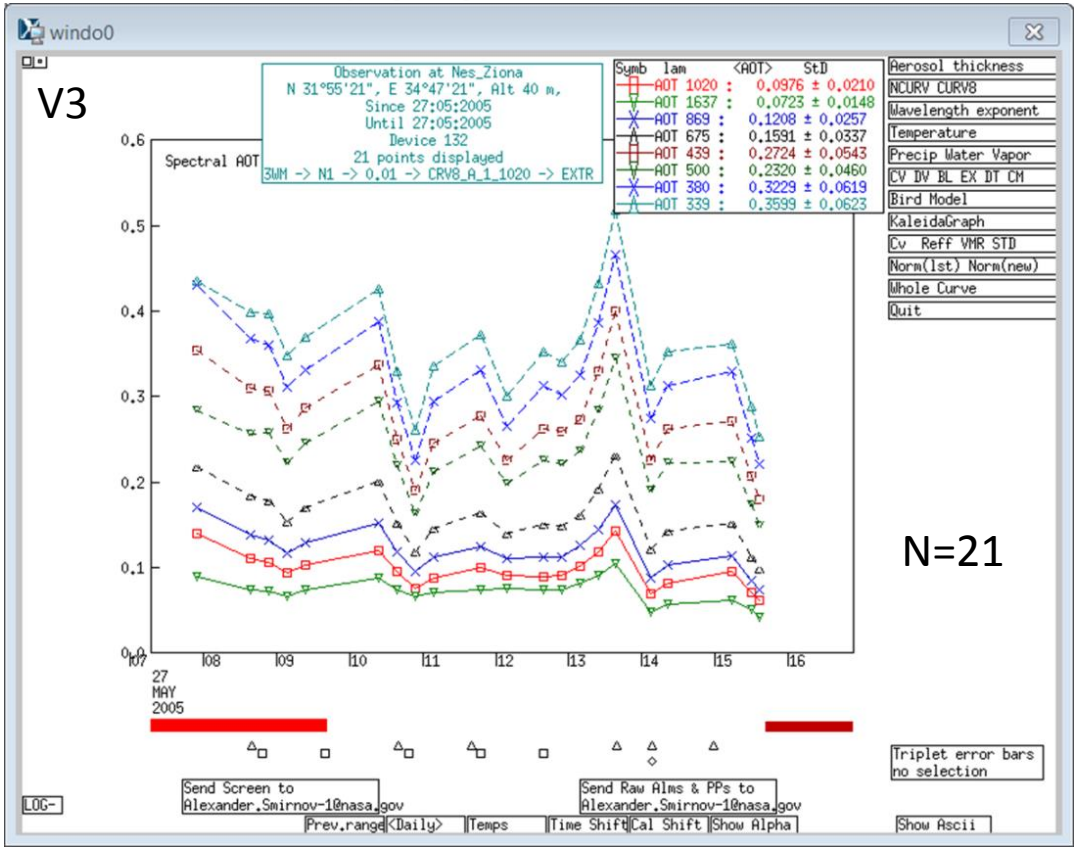
Singapore, #22, 2007-2011

	N	AOD	α
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 Lev 1.5	5029	0.33	1.40

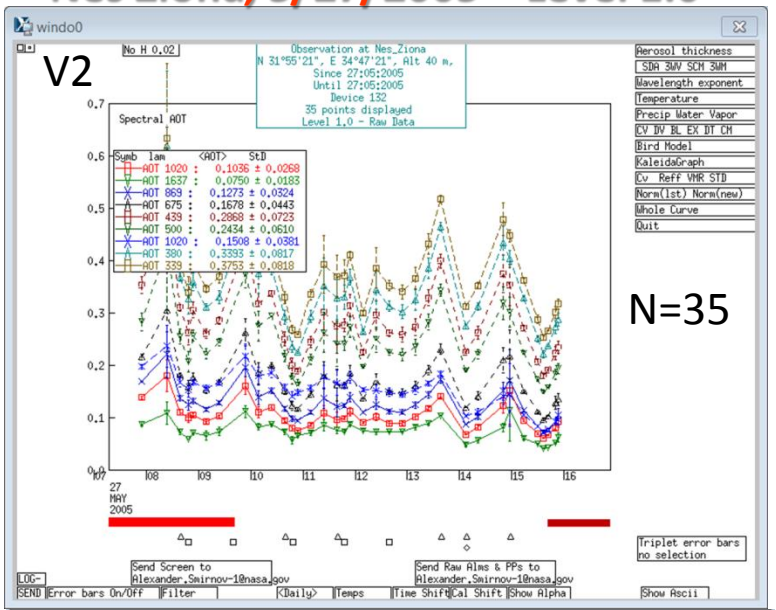
AERONET Version 3 Cloud Screening

- More highly variable AOD preserved

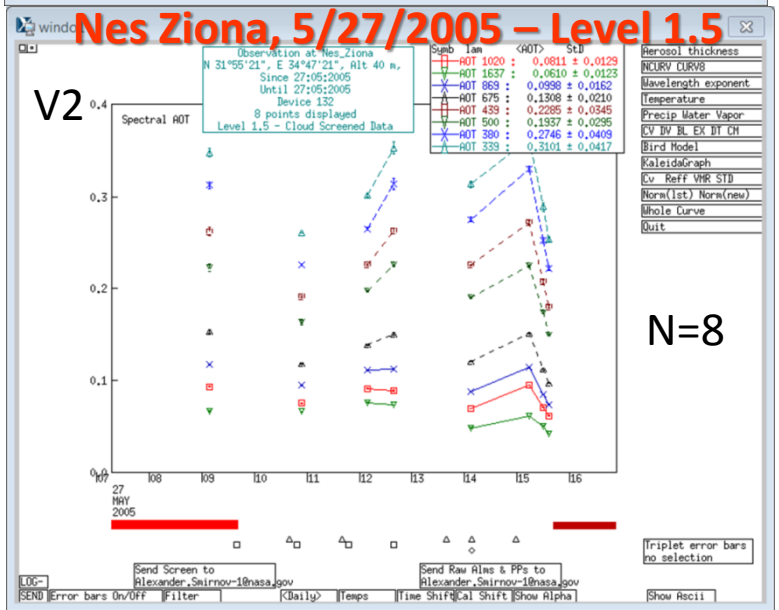
Nes Ziona, 5/27/2005– New Level 1.5



Nes Ziona, 5/27/2005 – Level 1.0



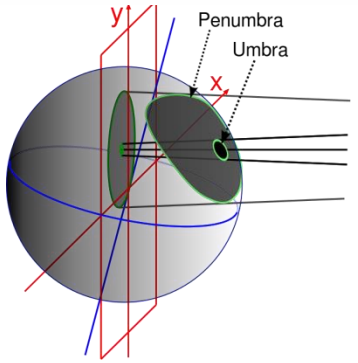
Nes Ziona, 5/27/2005 – Level 1.5



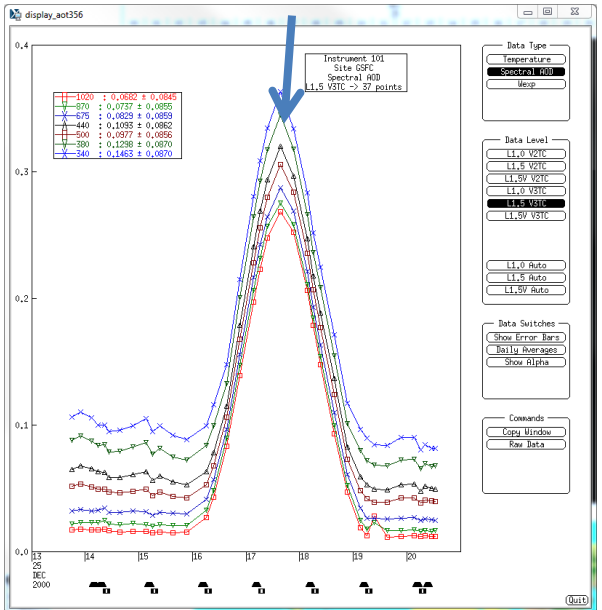
AERONET Version 3 Automatic QA Solar Eclipse Screening

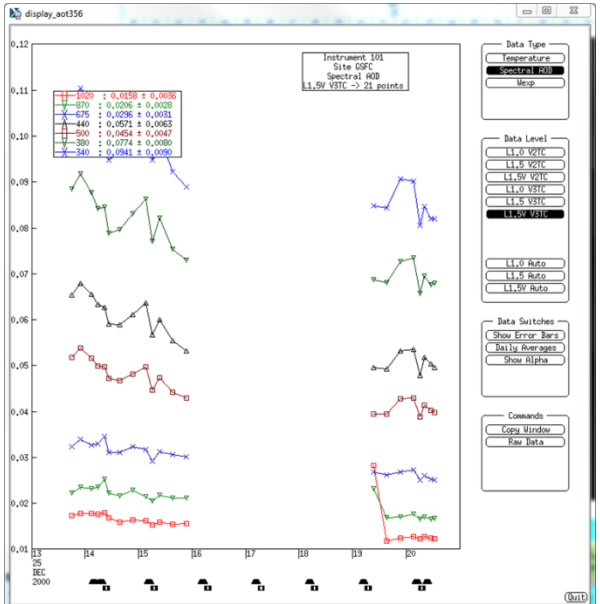
- AOD affected periodically by solar eclipses of varying magnitudes
  - Partial, Annular, Total, Hybrid
- Given extraterrestrial radiation is changing during an eclipse (Vo), the resulting reduction in measured irradiance (V) during an eclipse using a constant (Vo) results in increasing AOD
- Eclipse-induced increase in AOD results in poor almucantar inversion results (e.g., very low SSA)

Obscuration of the sun
Mollmann and Vollmer, 2006



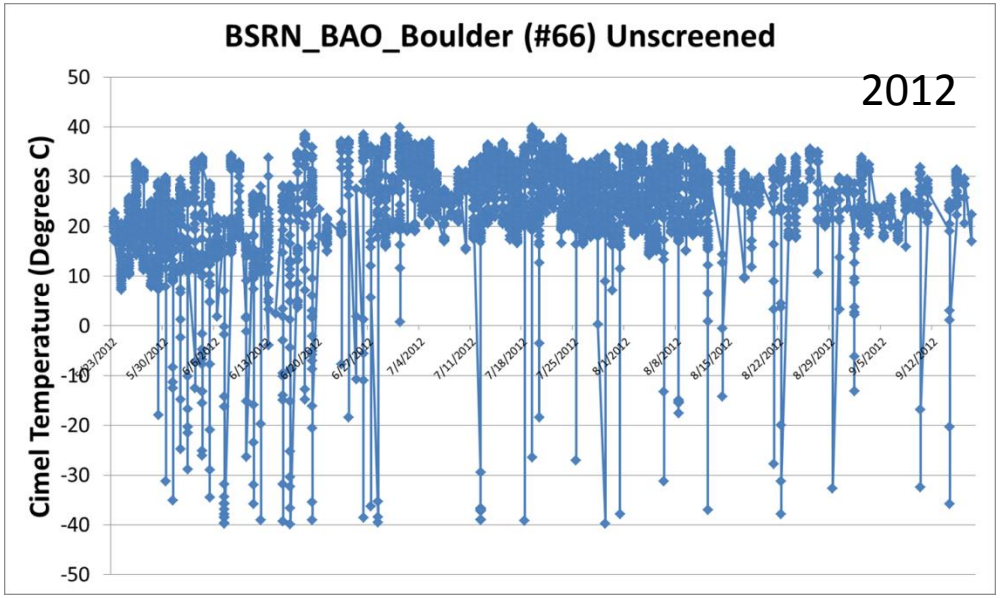
Maximum Solar Eclipse

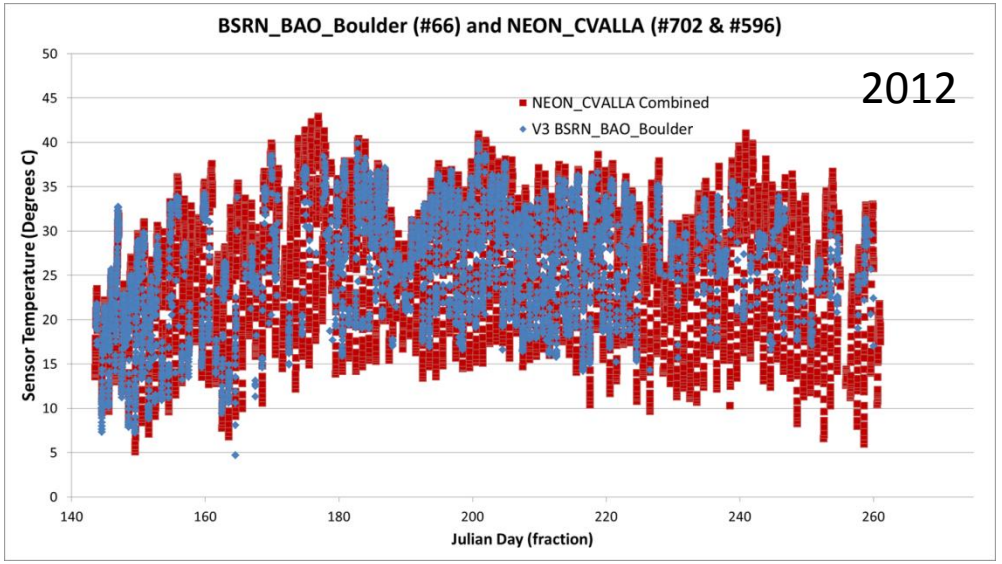




AERONET Version 3 Automatic QA Sensor Head Temperature Screening

- Sensor Head Temperature Anomalies
  - Control box saves erroneous sensor head temperature values due to electronic issues inside the control box, sensor head cable, or sensor head.
  - Issue: Erroneous sensor head temperatures adversely affect the magnitude of AOD for temperature sensitive channels (mainly 1020nm).



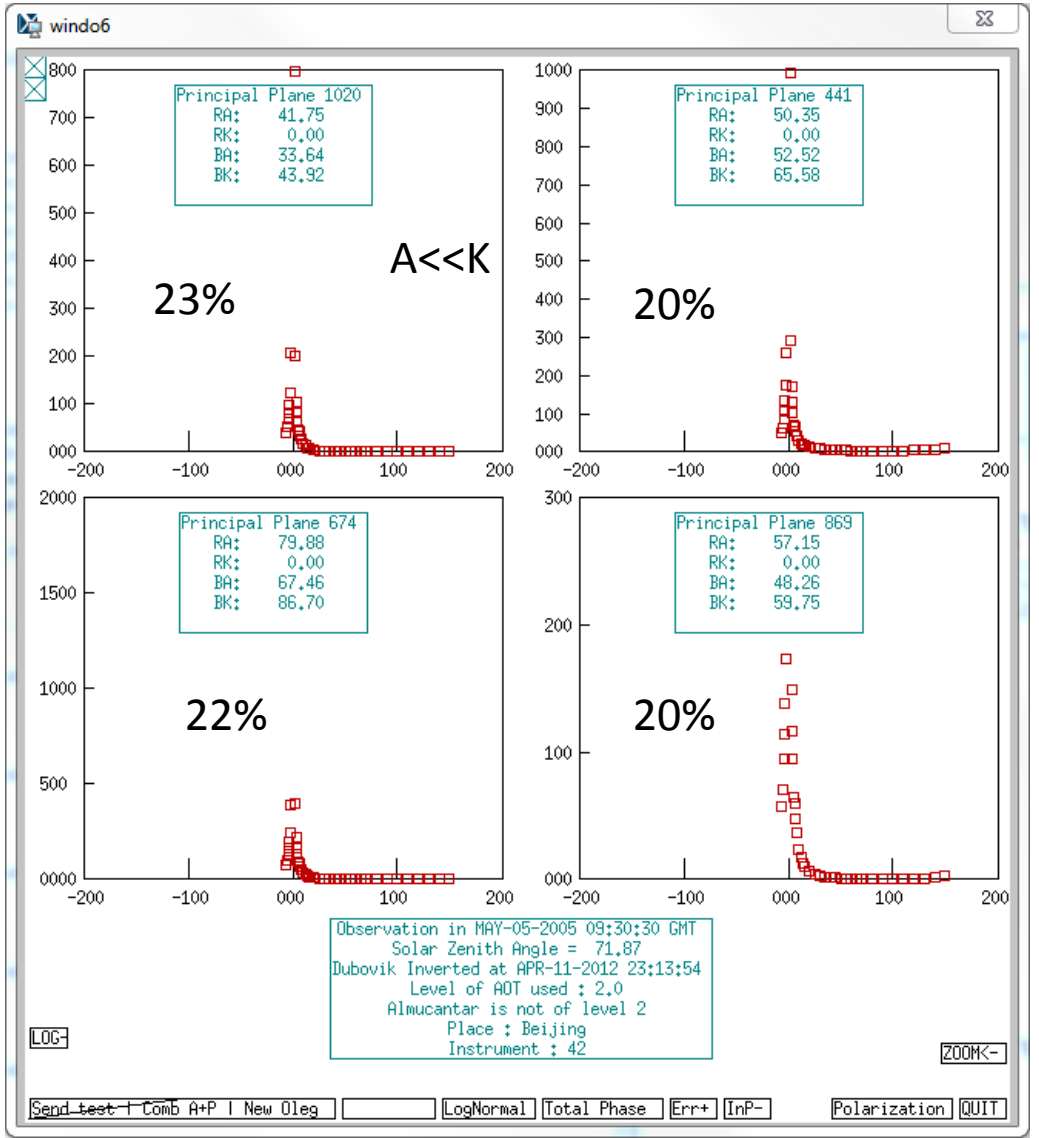


AERONET Version 3 Automatic QA Collimator Consistency Check

- %AK Difference: Calculate left and right %differences in 6° scattering angle aureole A and K radiances for each sky wavelength of Principal Plane

$$|\%\Delta AK| = | [[R_a(6°) - R_k(6°)]/\max(R_{ak}(6°))] *100 |$$

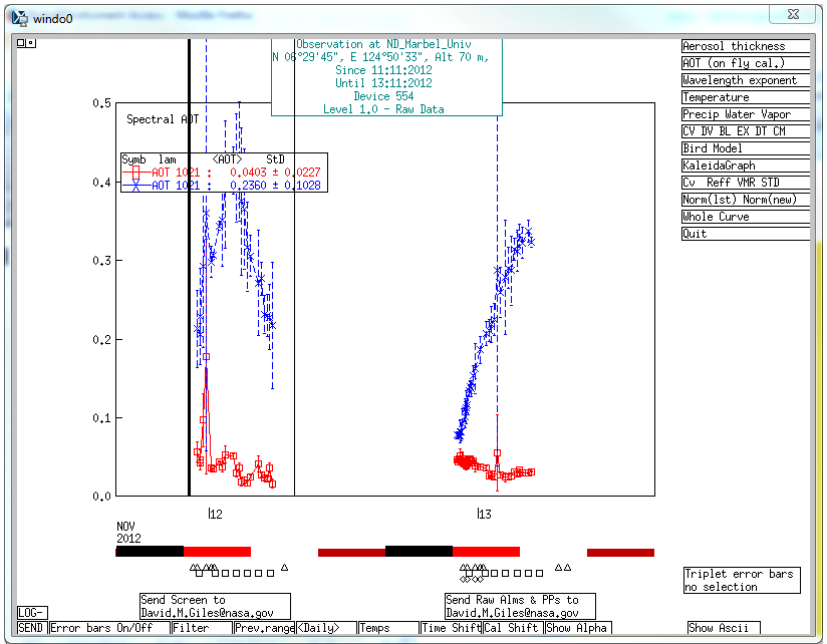
  - All instrument types (detects incorrect filter gains in InGaAs instruments)
  - Determine if %AK difference exceeds 10% for three or more wavlengths

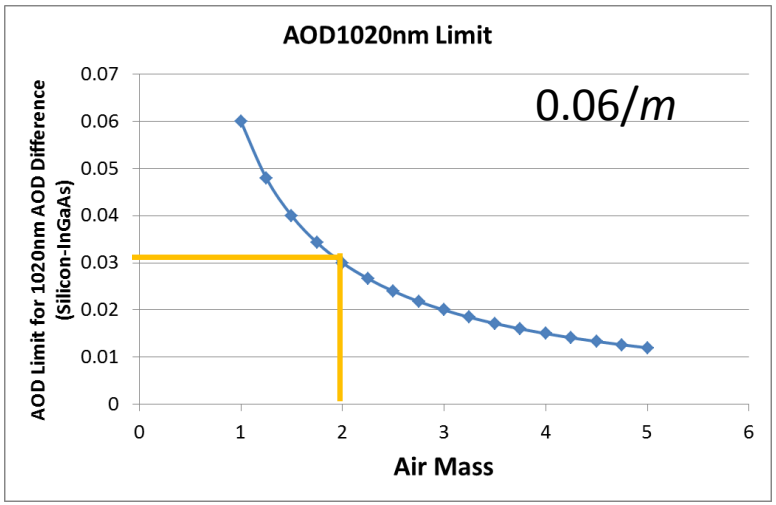


AERONET Version 3 Automatic QA Collimator Consistency Check

- 1020nm AOD Difference: Calculate 1020nm AOD Difference (Silicon-InGaAs)
  - Only instruments with InGaAs detector (SWIR)
  - Determine if the value exceeds the limit of 0.06/*m* (where m is the air mass)

$$|\Delta\tau_{1020nm}| = |\tau_{Silicon} - \tau_{InGaAs}| > 0.06/m \quad \textit{[Giles et al. 2012]}$$





AOD limit as a function of air mass

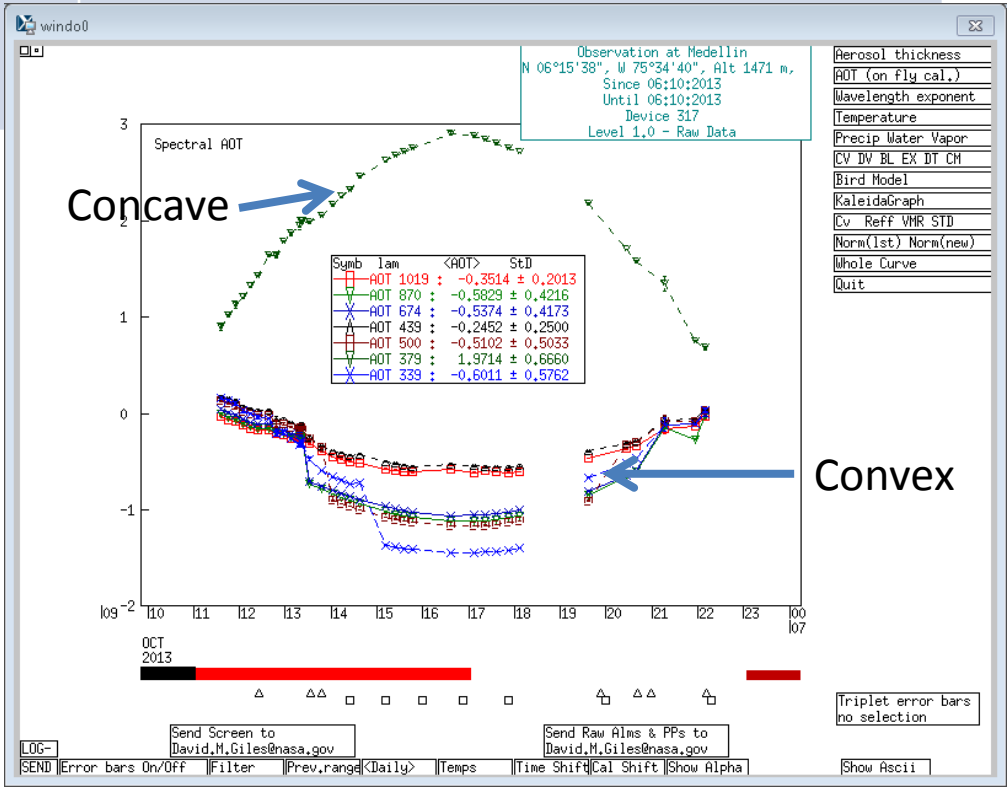
AERONET Version 3 Automatic QA Diurnal Dependence of AOD Check

Concave	Convex
-- Decreased filter transmittance -- Obstruction in collimator or on sensor head window -- Filter dust or broken desiccant pack inside the sensor head -- Incorrect gain setting	-- Increased filter transmittance -- Filter degradation -- Incorrect gain setting

- Error in AOD is dependent on the c.a. cosine of the solar zenith angle

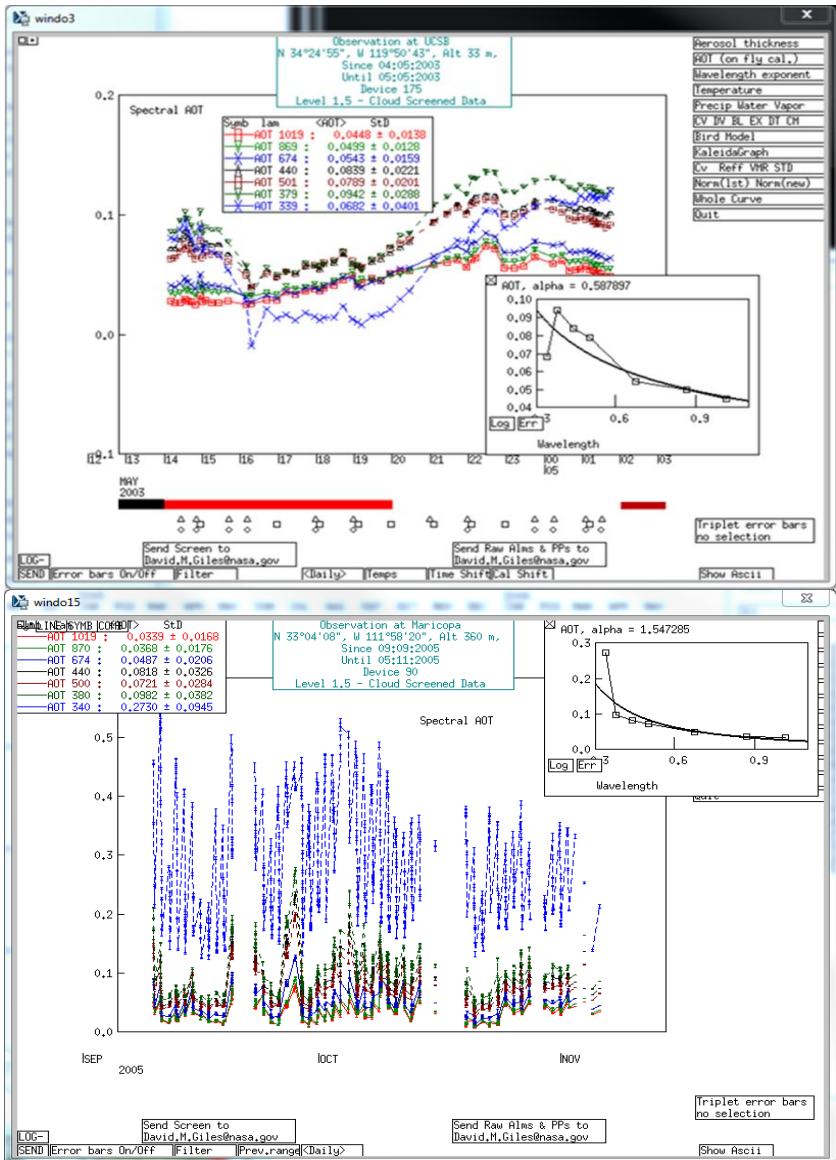
$$\delta\tau = 1/m * \delta Vo/Vo$$

- For the morning, afternoon, or day and AOD versus the cosine of the solar zenith angle relationship, calculate the slope, correlation coefficient, and rms



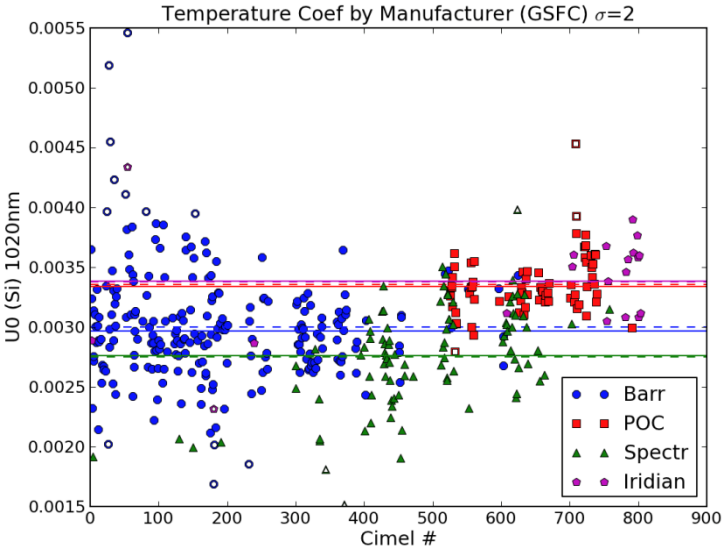
AERONET Version 3 Automatic QA Spectral Dependence of AOD Check

- AOD with channel out of spectral wavelength dependence
  - Non-linear calibration change
  - Out of band leakage
  - Improperly set gain(s)
  - Dust on filter(s)
  - Dark current too high
  - Electronic
  - Bad temperature affecting temperature sensitive AOD

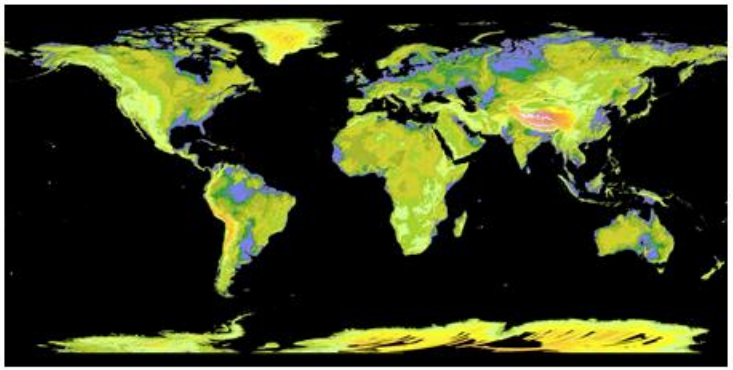


AERONET Version 3 Current Status
Ancillary Data Sets

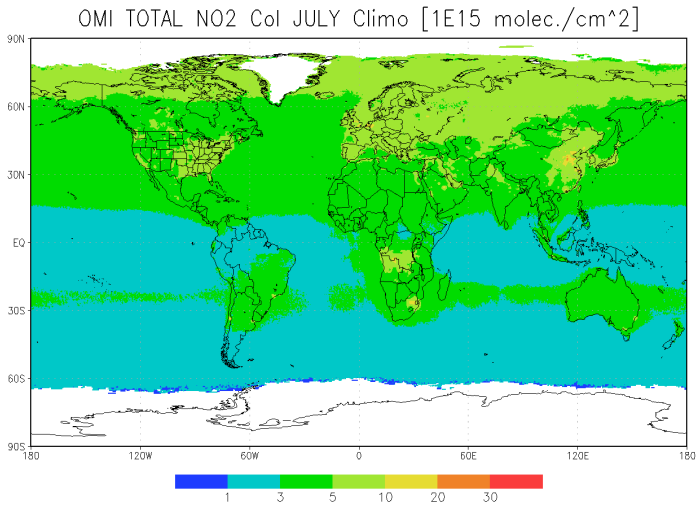
- Implement spectral temperature corrections (-40°C to +60°C)
- Update to OMI L3 NO_2 climatology (2004-2013)
- Continue to use TOMS O_3 climatology (1978-2004)
- Continue to use NCEP Reanalysis for atmospheric pressure (1993-present)
- Utilize ASTER Global Elevation Model



ASTER Global Digital Elevation Model (GDEM) Version 2



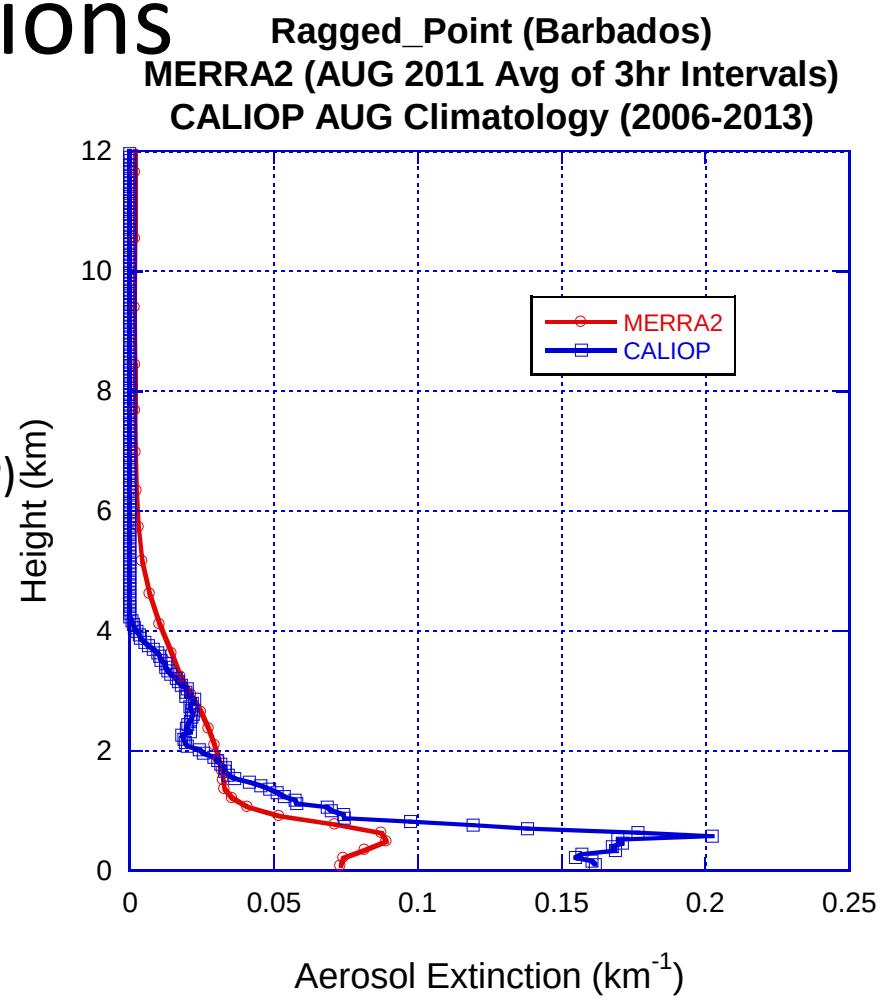
Source: Ministry of Economy, Trade, and Industry (METI) of Japan and NASA



AERONET Version 3 Current Status

Inversions

- Implement a vector radiative transfer code
  - radiation field in UV (e.g., 380 nm retrieval)
  - degree of linear depolarization
- Integrate extinction profiles to estimate aerosol vertical profile (MERRA2 or CALIOP)
- Provide lidar ratio and depolarization ratio products
- Estimate uncertainties for each retrieval (e.g., random error plus biases due uncertainty in AOD and sky radiance calibration)
- Update inversion quality assurance criteria



Version 3 database release expected in mid-2015

AERONET Data Acquisition Methods

Method	Current	Planned
Download Tool	V2 AOD and Inversions by Site	V3 AOD and Inversions by site
Download All Sites and All Points	V2 L2.0 AOD V2 L1.5 & L2.0 Inversions (single file generated weekly)	V3 L1.5V & Level L2.0 AOD V3 L1.5, L1.5V & L2.0 Inversions (Level 1.5V generated daily, others weekly)
Web Service	V2 AOD and Inversions (all levels) One site Define start date & end date (e.g., print_web_data_v2)	V3 AOD and Inversions (all levels) Multiple sites Define date/time periods Set satellite overpass time ISO8601 date format option
Special Requests	Contact Ilya or Dave for specific data transfer or data product	Contact Ilya or Dave for non-standard transfer or data products *Most requests should be fulfilled by Web Service

Summary

- Version 3 algorithm development
  - Completion and first results: Winter 2014
  - Final integration, processing, evaluation: Early 2015
  - V3 database release: Expected in mid-2015
- New V3 Level 1.5V product will provide near real time AOD data at the highest quality possible for satellite, forecast model, and data assimilation applications
- Data dissemination web service will accommodate data download needs and most special requests