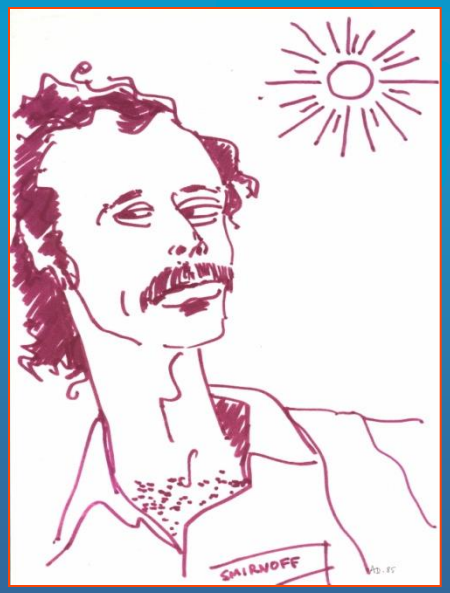
Version 3 AERONET processing – data product assessment for model validation and assimilation

AEROCOM Workshop, Steamboat Springs, Colorado, September 29 – October 3, 2014

AERONET (Aerosol Robotic Network)

- Alexander (Sasha) Smirnov - presenter on behalf of the AERONET Project Leader Brent Holben and AERONET Team



Piers Sellers is on our side !

We Have Friends in High Places

Principal Investigator:
Brent Holben, NASA GSFC

Administrative Support and Shipping:
Amy Scully

Instrumentation, Calibration & Maintenance:
Mikhail Sorokin, Jon Rodriguez, Jason Kraft

Calibration & Quality Assurance:
Thomas Eck, Alexander Smirnov, Joel Schafer

Data Processing, Database, & Web Support:
Ilya Slutsker, David Giles

Scientific Research:
Brent Holben, Thomas Eck, Alexander Smirnov, Aliaksandr Sinyuk, David Giles, Joel Schafer

AERONET - the ground based Satellite

Over 20 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

AERONET Federated Calibration Center Coordination:

NASA GSFC (U.S.), PHOTONS (France), RIMA (Spain)

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

V3 development schedule

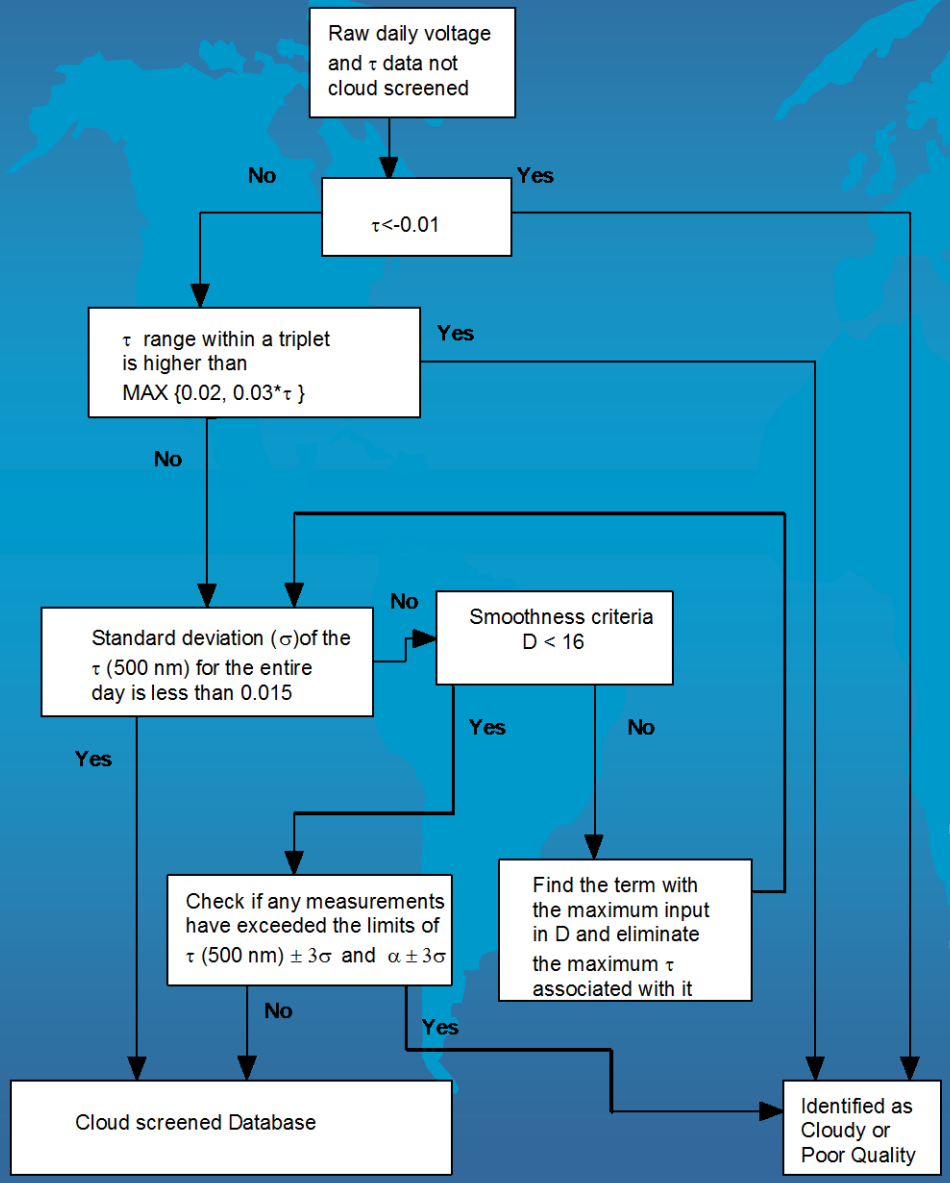
- Demonstrat Development and implementation (Ilya)
  - Level 1
    - O_3 correction: use current V2 corrections
    - NO_2 correction Monthly diurnal high res: (Tom and Dave late August)
    - Reanalysis: (Dave ~Sept. 1)
    - Temperature corrections (Iridian filters remain): (Ilya and Joel end of August)
    - Recalibrations: (Ilya and Tom late August)
    - Case study computations of AOD (use 70 cld clearning case studies Sept. team to evaluate)
    - Case study computations of sky radiance w/all corrections: Sept. team to evaluate
    - Case study computations of inversion products: Sept 15 (Ilya & Sinyuk)
  - Level 1.5
    - Cld screening: Completed, Algorithm defined.
  - Level 1.5v/2.0
    - QA instrument Check: Dave/Brent September
    - Pattern recognition: Ilya and Joel September
    - AOD comparisons to V2 results (mid Sept)
    - Inversions (Sinyuk)
      - Vector Code assessment (Sinyuk late August)
        - » Timing & Code selection
      - Quality assessments: SZA dependence, fine vs coarse, dynamic criteria (Sinyuk O
      - SSA, size dist. etc Comparison to V2 results using V2 criteria (Sinyuk September)
      - Inversion products recomputation and assessment (October 1)
- AOD V3 database re-computation and assessment (Oct. 1)
- Inversion V3 re-computation and assessment (Nov. 1-??)
- Release of V3 Jan 1 2014 (rather optimistic)
- New product development

Brent's notes after team meeting on Aug 30, 2013

V3 QA Instrument checks first steps (refer to current weekly checks)

- Assess fraction of L2 retrieval database affected by:
  - Dark current check (Mikhail to provide written explanation of digital DC and effect on voltages)
  - 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 Almucantars/PP/Hybrids (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 (refer to wkly check for details)
  - AOD triplet variability for each channel
  - Dual filter wheel/polar instrument?????

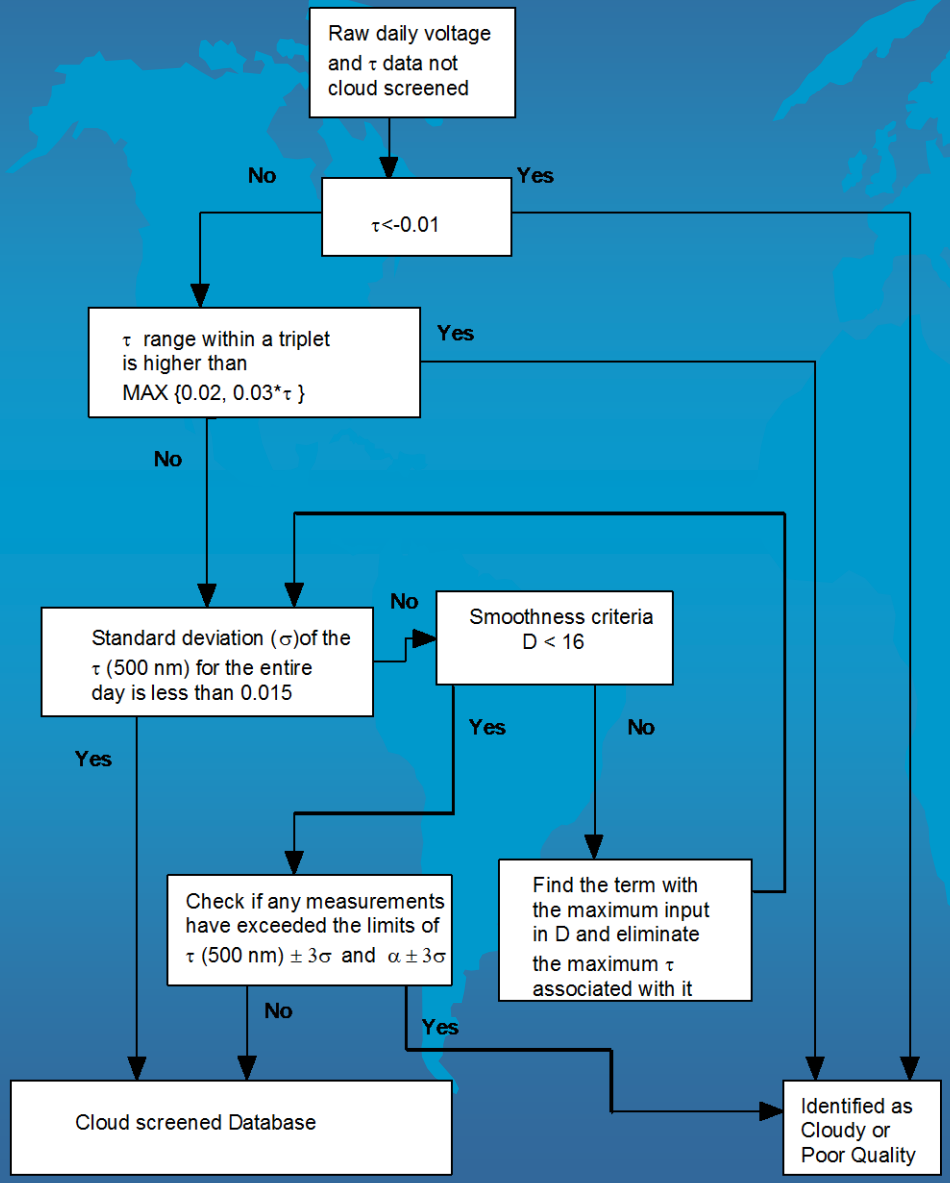
Current cloud screening algorithm



Advantages:

- Simplicity
- Reliability
- Standardization
- Proven to be operational
- Treats all aerosol types equally

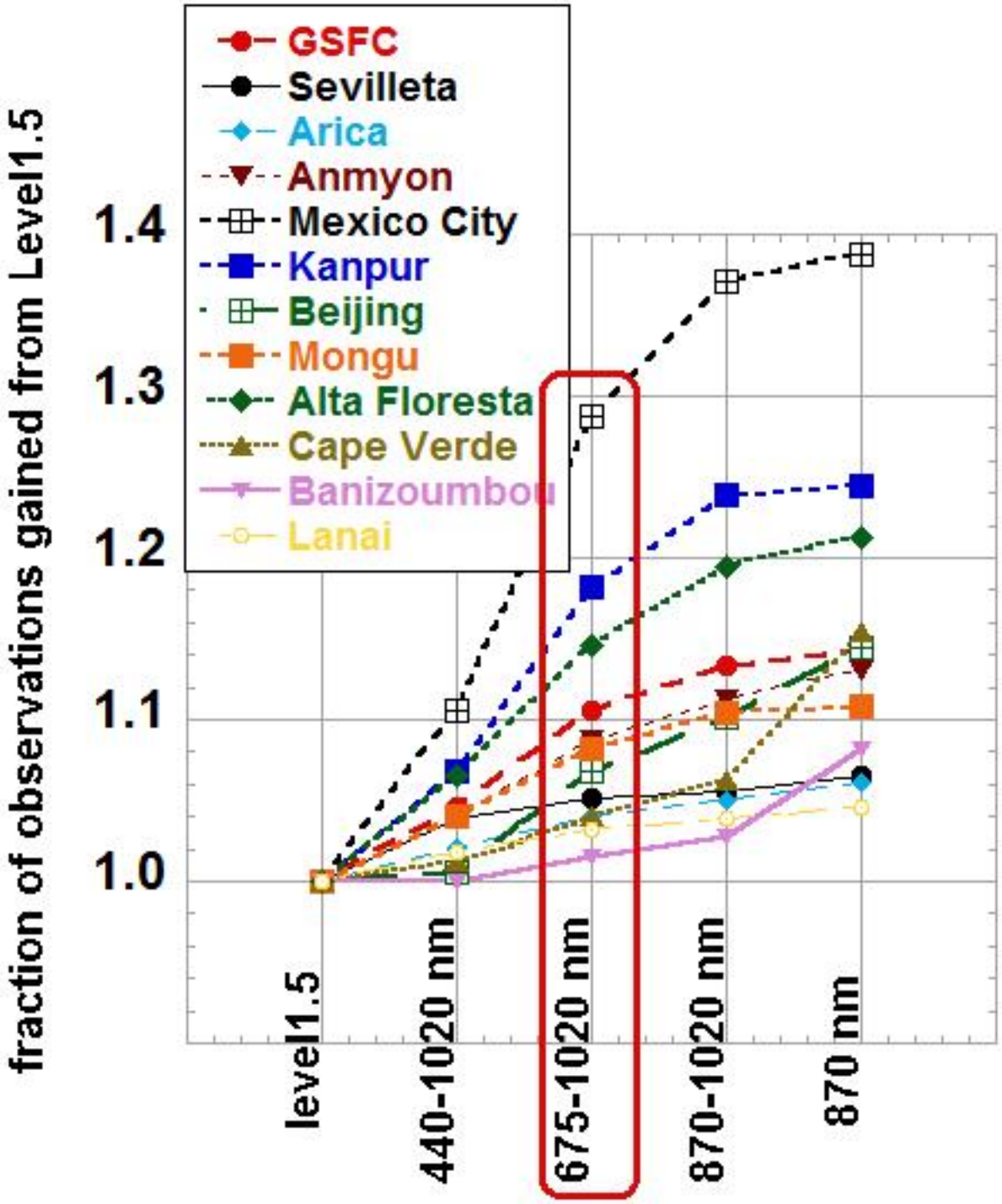
Current cloud screening algorithm



Problems:

Thin stable cirrus clouds

Highly variable dust or smoke



attempt to modify AERONET cloud screening algorithm in 2006

Current cloud screening algorithm

AOD data not cloud screened

AOD < -0.01

AOD range within a triplet is higher than MAX {0.02, 0.03*τ_a}

Standard deviation (σ) of the τ_a(500 nm) for the entire day is less than 0.015

Smoothness criterion D<16

Find the term with the maximum input in D and eliminate the maximum τ_a associated with it

Check if any measurement have exceeded the limits of τ_a(500 nm)$\pm 3\sigma$ and $\alpha \pm 3\sigma$

Cloud screened database

Identified as cloudy or poor quality

Problems:

Thin stable cirrus clouds

Highly variable dust or smoke

Air mass range will be extended from 7 to 7.

Compute number of potential measurements: It is equal to number of SUN measurements plus a number of humidity statuses. We will reject a day if after all checks below are applied the number of the remaining measurements is less than 3 or 10% of "potential" measurements (whatever is greater).

Triplet criterion – only THREE channels (675, 870 and 1020 nm) are considered. Measurement is considered "cloudy" when at ALL THREE wavelengths within a triplet (tau_max – tau_min) exceeds 0.01 or 0.015*tau (whatever is greater).

AOD stability check – if daily averaged AOD at 500 nm (or 440 nm if 500 nm channel is not available) is less than 0.015 we do not perform a 3 sigma check.

3 sigma check – AODs at 500 nm (or 440 nm) and corresponding Alphas (computed using available channels within 440-870 nm range) should be within MEAN +/- 3 Standard deviations.

Smoothness check – instead of D16 as in the current version we presume that AOD at 500 nm (or 440 nm) should not change greater than by 0.01 per minute. For any pair when AOD exceeds this threshold the highest AOD is eliminated. Then the process repeats itself.

Curvature check – we compute curvature for measured at 1020 nm sky radiances within 3 – 6 degrees 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 point to be "cloud contaminated". Also we expand this to +/- 30 minute time period and eliminated points within.

Standalone and Extras. We call a point a "standalone" point when it does not have any measurements left within plus or minus one hour. In this case we reject a standalone point. However if Alpha for such point is greater than 1 (one) we retain it.

Number of measurements left should be either 3 or 10% of the potential (actual plus humidity statuses) measurements, whatever is greater.

If the number of measurements left is LESS than 3 or 10% of the potential measurements we eliminate measurements with Alpha<1 and keep measurements with Alpha>1.

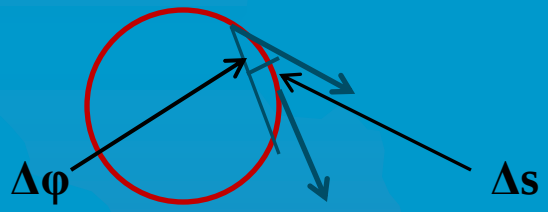
Suggested modifications

- **Triplet criterion – only THREE channels (675, 870 and 1020 nm) are considered. Measurement is considered "cloudy" when at ALL THREE wavelengths within a triplet (tau_max – tau_min) exceeds 0.01 or 0.015*tau (whatever is greater).**
- **Smoothness check – instead of D16 as in the current version we presume that AOD at 500 nm (or 440 nm) should not change greater than by 0.01 per minute.**

Parameterization of sky radiance shape

The angular shape of sky radiances is conveniently parameterized by curvature which give the rate of turning of tangent vector, see below

$$k = \lim_{\Delta s \to 0} \Delta\varphi / \Delta s = \frac{|\ddot{f}|}{(1 + \dot{f}^2)^{3/2}}$$

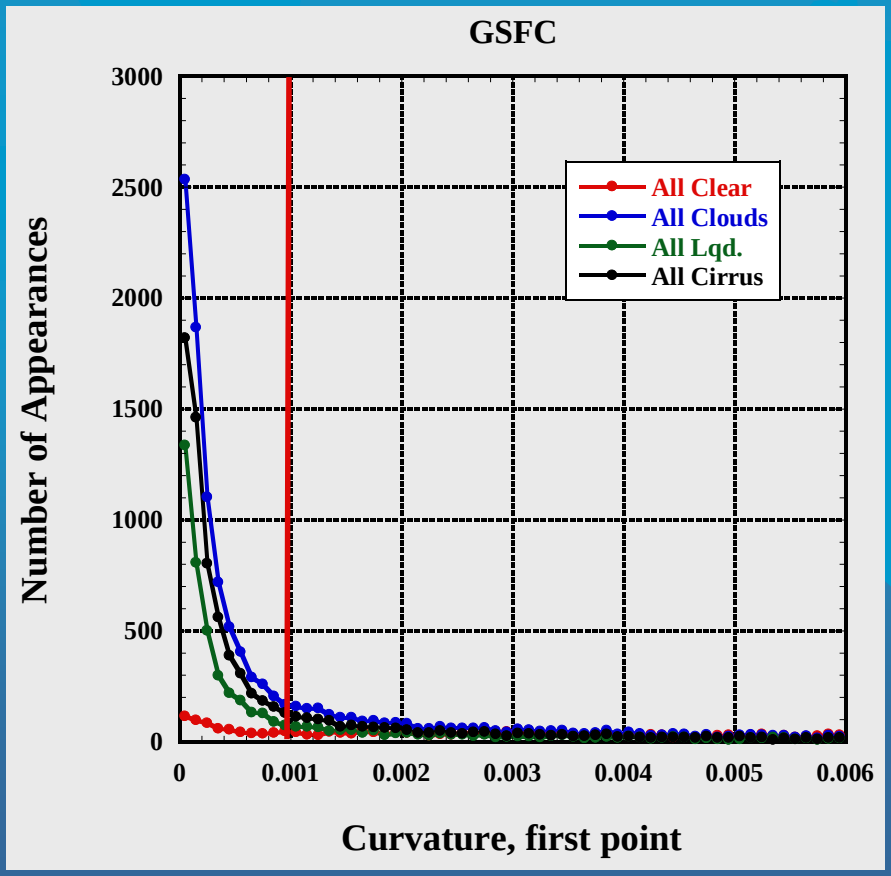


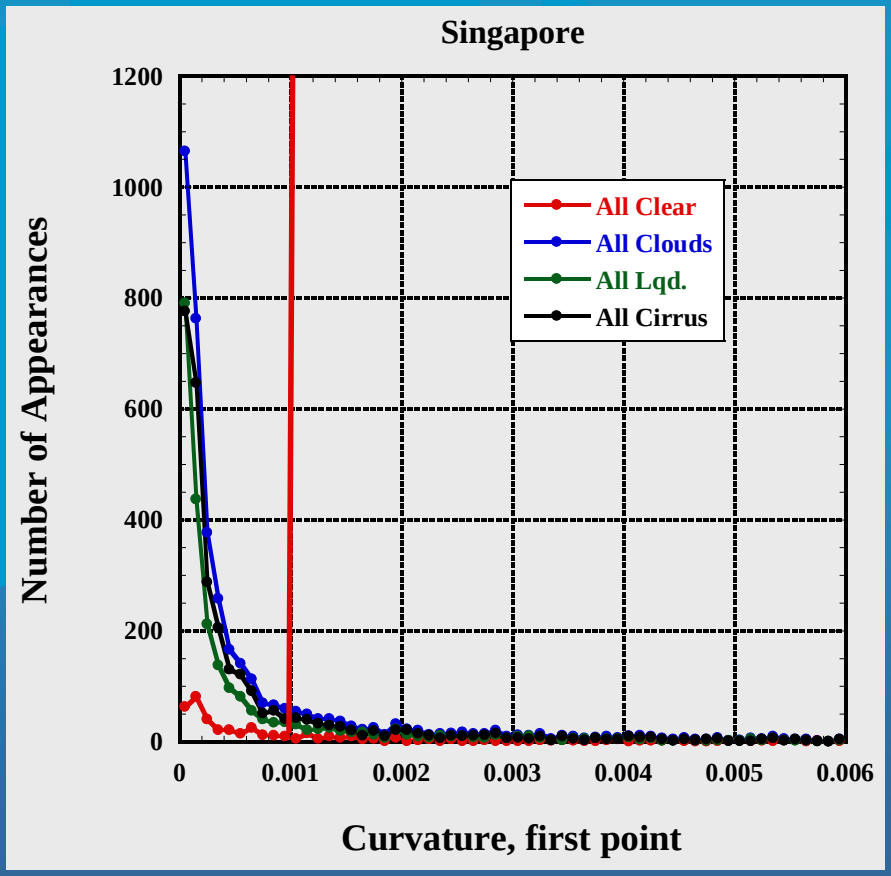
$$\dot{f} = \frac{dy}{dx}$$

According to the formula above the stronger the forward scattering peak the smaller the curvature value (it is inverse proportional to the first derivative)

The first curvature value: fine mode aerosols

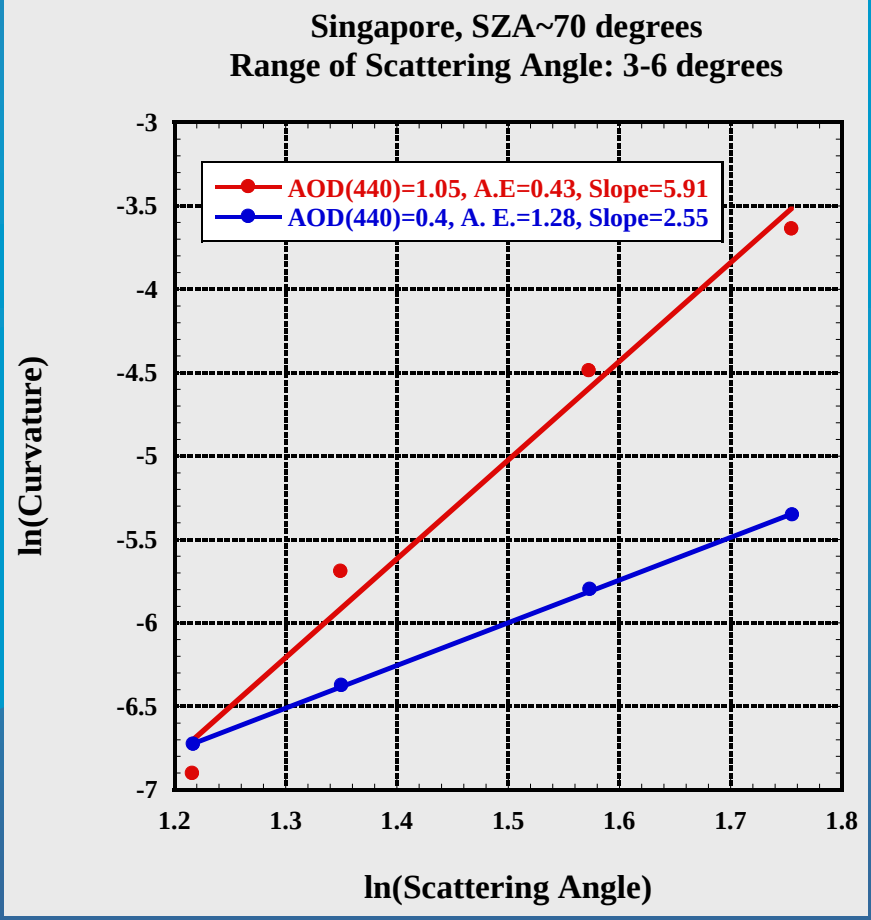
Curvature value at the smallest scattering angle (K) in the 3 to 6 range is sensitive to the presence of large particles. The fraction of clouds with K greater than 0.001 is relatively small. This can be used as an additional constrain in cloud screening.





Effect of cirrus cloud on sky radiances

Slope of curvature in ln - ln scale for the 3 to 6 degrees range of scattering angles is sensitive to cirrus cloud presence.

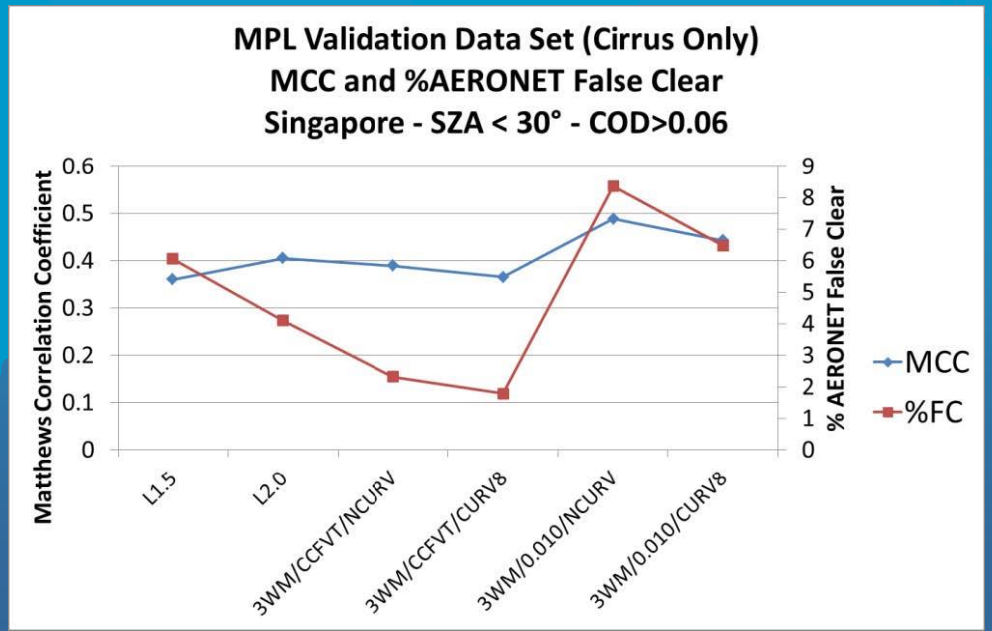


Suggested modifications

- Curvature check – we compute curvature for measured at 1020 nm sky radiances within 3 – 6 degrees 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 point to be "cloud contaminated". Also we expand this to +/- 30 minutes time period and eliminate points within.

AERONET – MPL Validation Dataset

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



Singapore, #22, 2007-2011
Fine mode aerosol 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			
Lev 1.5 (no/CURV)	8640	0.35	1.17
Lev 1.5 (w/CURV)	5029	0.33	1.40

Nauru, #168, 2000-2005, 2010
Sea salt aerosol 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			
Lev 1.5 (no/CURV)	13048	0.09	0.45
Lev 1.5 (w/CURV)	7879	0.08	0.55

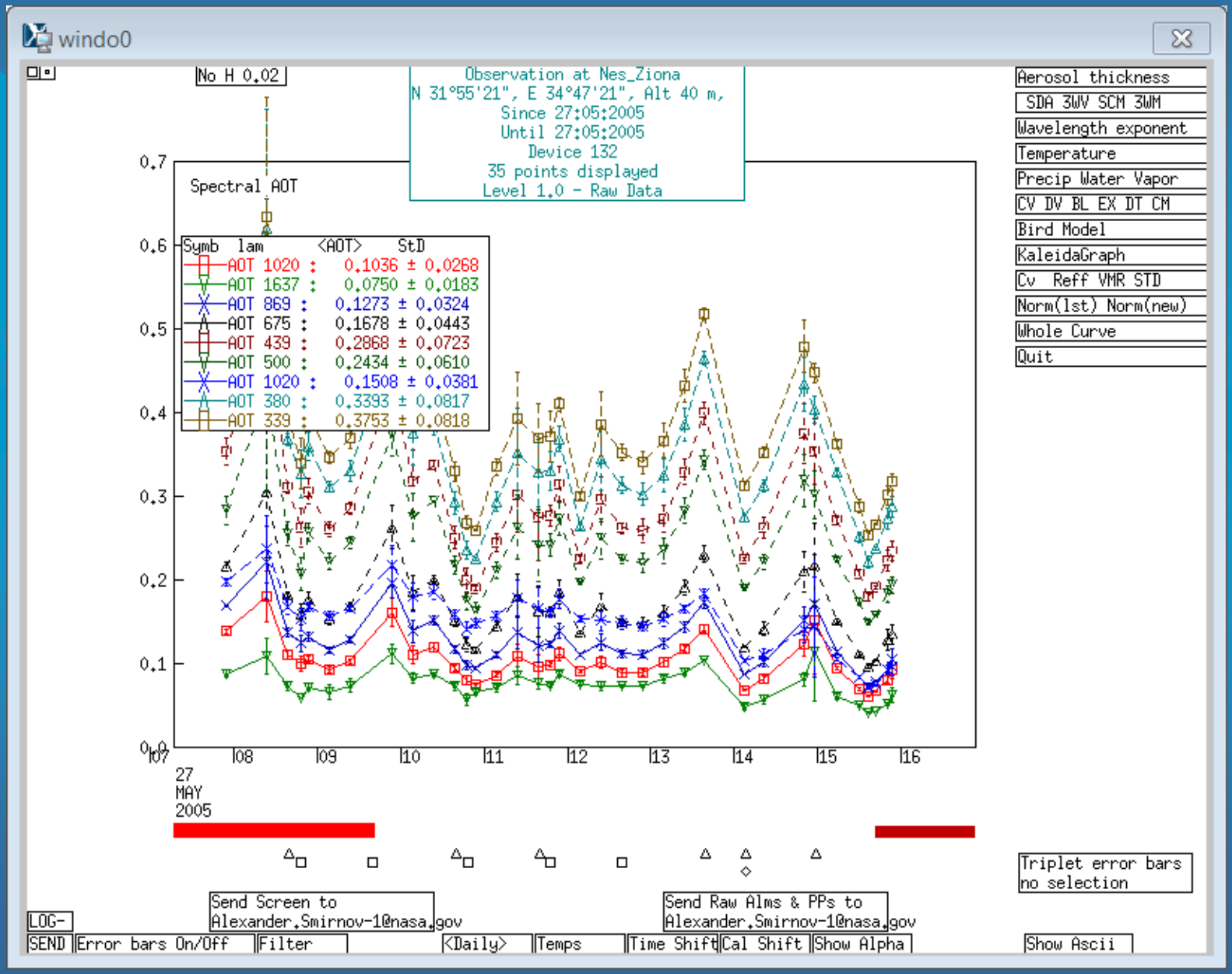
Ilorin, #29, 1998-2013
Biomass Burning and Dust

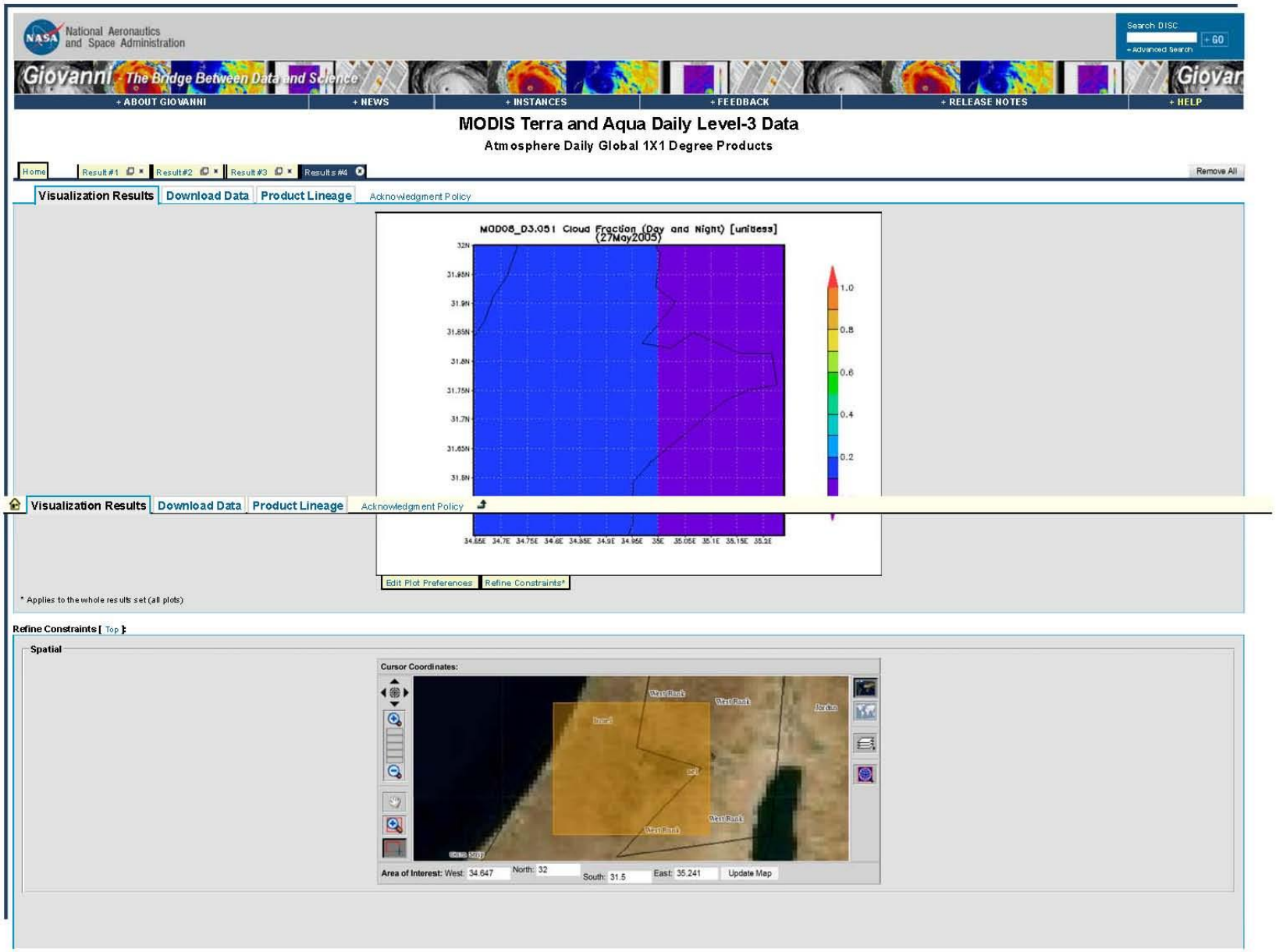
	N	AOD	Alpha
Lev 1.0	58151	0.84	0.42
Lev 1.5	37370	0.84	0.46
Lev 2.0	35392	0.77	0.51
NEW			
Lev 1.5 (no/CURV)	32601	0.73	0.55
Lev 1.5 (w/CURV)	29348	0.76	0.55

Mexico City, #10, 2000-2004
Fine mode aerosol

	N	AOD	Alpha
Lev 1.0	26354	0.44	1.20
Lev 1.5	11394	0.32	1.45
Lev 2.0	10548	0.31	1.54
NEW			
Lev 1.5 (no/CURV)	14534	0.32	1.61
Lev 1.5 (w/CURV)	12070	0.32	1.67

Nes Ziona, 5/27/2005 – Level1.0

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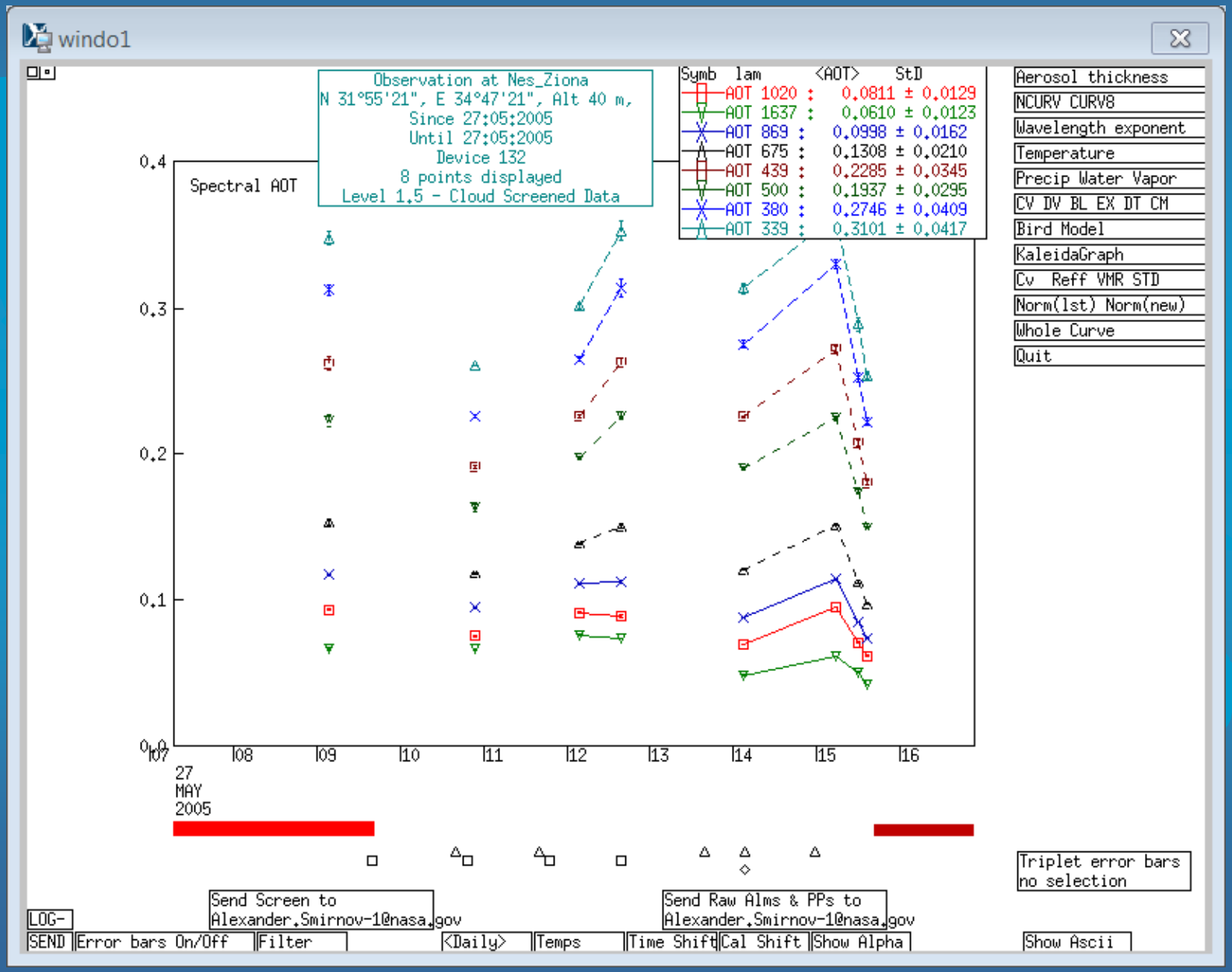
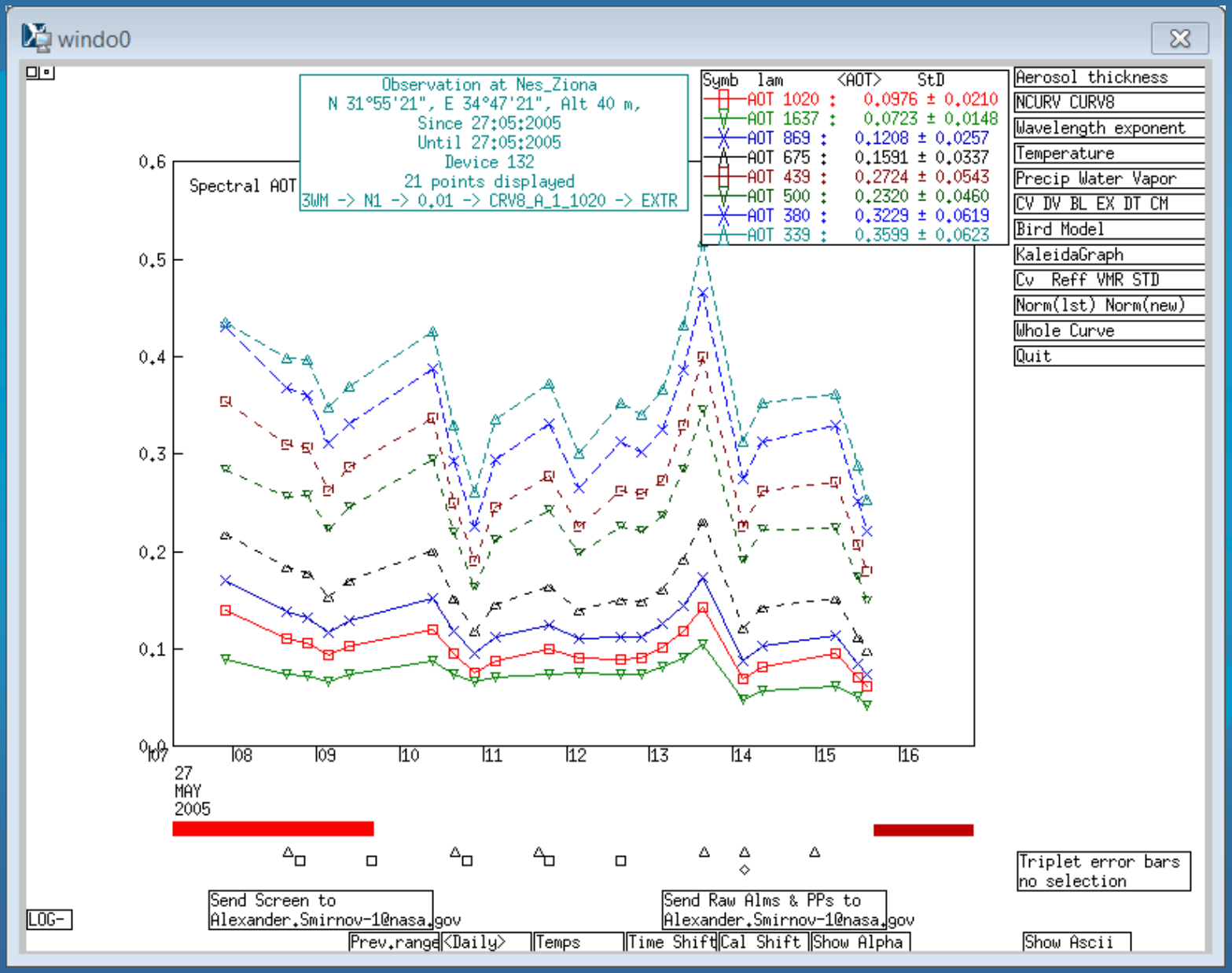
MODIS Terra and Aqua Daily Level-3 Data
Atmosphere Daily Global 1X1 Degree Products
Home
Result #1
Result #2
Result #3
Results #4
Remove All
Visualization Results
Download Data
Product Lineage
Acknowledgment Policy
MOD08_D3.051 Cloud Fraction (Day and Night) [unitless]
(27May2005)
32N
31.95N
31.9N
31.85N
31.8N
31.75N
31.7N
31.65N
31.6N
34.65E 34.7E 34.75E 34.8E 34.85E 34.9E 34.95E 35E 35.05E 35.1E 35.15E 35.2E
1.0
0.8
0.6
0.4
0.2
Visualization Results
Download Data
Product Lineage
Acknowledgment Policy
Edit Plot Preferences
Refine Constraints*
* Applies to the whole results set (all plots)
Refine Constraints [Top]
Spatial
Cursor Coordinates:
Area of Interest: West: 34.647 North: 32 South: 31.5 East: 35.241 Update Map

Nes Ziona, 5/27/2005 –Level1.5



Nes Ziona, 5/272005– new Level1.5



Advantages of the new cloud screening algorithm

- Automated algorithm delivers AODs and α at Level1.5 statistically very close to current Level2.0
- Stable thin cirrus clouds became a lesser problem (less residual cloud contamination)
- Wrongly filtered in the current version highly variable AODs (dominated by fine aerosols) will be (at least partly) restored in the database

What is behind new cloud screening

3WM/N1/0.010/F/CRV8.0A_1_1020/EXTR (AOD)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Alta_Flore	-0.00215	0.001134	0.01178	0.021332	-0.00668	0.001289	0.026635	0.001701	-0.03441	-0.03527	-0.02021	-0.00148
Tucson	0.01849	0.019249	0.014653	-5.8E-05	0.000376	0.00059	-0.00201	0.006924	0.000315	0.001011	0.000283	0.009737
GSFC	0.007607	0.002372	0.000739	0.004768	0.010272	0.015369	0.002275	-0.00566	0.000098	0.007046	0.001636	0.004271
Harvard_F	-0.00362	0.000567	0.00227	-0.00066	-0.00259	0.016906	-0.00106	0.01887	0.014567	0.013075	0.04263	-0.00055
Wallops	0.001828	0.003734	0.005246	0.017089	0.005725	0.006575	0.017939	0.017636	0.014328	0.002513	0.002244	0.003508
Ussuriysk	-0.00514	0.031107	0.015673	0.004088	-0.0075	0.007585	0.009716	0.044411	0.013475	0.015043	-0.00326	0.000153
Waskesiu	0.014351	0.002544	0.027151	-0.00008	-0.00966	-0.01714	-0.01705	0.002281	0.000067	0.006194	0.00302	n/a
Key_Biscay	0.003255	0.0055	-0.00569	0.010021	0.019886	-0.00426	-0.01161	0.000438	0.010083	0.003119	-0.00024	-0.00211
Sevilleta	-0.00137	-0.00095	0.001272	0.000257	0.002164	0.002225	-0.00484	-0.00026	0.00002	0.000266	0.000612	0.000668
Cart_Site	0.008441	0.010066	0.022242	0.02843	0.012131	0.0021	0.014109	0.003785	0.00529	0.002041	0.00318	0.002135
Bonanza_(	n/a	n/a	0.020431	0.017349	0.00255	-0.00279	-0.0053	-0.00287	-0.00209	0.010162	n/a	n/a
Thompson	n/a	n/a	n/a	n/a	0.003999	-0.01979	0.004335	0.005472	0.025628	0.009352	n/a	n/a
HJAndrew:	n/a	n/a	-0.00338	-0.00243	0.003545	0.006616	0.000925	0.002144	0.006887	0.000517	0.002467	0.012872
Missoula	0.02492	0.032931	0.003587	0.024233	0.010101	-0.00155	0.020909	0.013564	-0.00045	0.000539	0.013361	-0.00648
Capo_Verc	0.011327	0.004611	0.014101	0.01578	0.006495	0.038818	-0.01241	-0.01267	0.00673	0.005083	0.010942	-0.01572
Ouagadou	-0.04341	-0.0485	-0.09369	-0.04221	-0.07567	-0.01148	-0.0327	-0.04073	-0.02942	0.003947	-0.01659	-0.00761
UCSB	0.004336	0.011379	0.013731	0.009181	0.000685	0.005546	0.01354	0.000579	0.007587	0.015318	0.004392	0.000053
SERC	0.00259	0.004329	0.008403	0.003937	0.004276	0.008673	-0.00414	0.004375	0.006865	0.00211	0.001549	0.000541
La_Jolla	0.001409	-0.00134	-0.00176	0.001093	-0.00578	-0.00448	-0.00016	0.003868	-0.00318	-0.00484	-0.0013	0.00097
Barcelona	-0.00461	0.013136	0.00558	0.007067	0.000395	-0.00029	0.004667	0.006511	-0.00736	-0.0012	0.000931	-0.0011
SEDE_BOK	0.006827	-0.00498	-0.00061	-0.00883	-0.00086	0.001811	0.000677	0.000942	0.000096	-0.00256	0.000007	0.001537
Tuxtla_Gu	-0.00144	-0.00541	-0.00217	-0.01802	-0.0566	-0.01019	0.010281	-0.00142	0.006385	0.003425	-0.00022	-0.00114
Trinidad_H	0.045366	0.022922	0.026998	0.039591	0.044038	0.016918	0.009954	0.054045	0.087468	0.03882	0.01618	0.022421
CARTEL	0.004199	0.003245	0.006974	0.007017	0.0136	0.00696	0.005426	0.007371	0.001546	0.008792	0.009843	-0.01216
Toronto	0.00622	0.004472	0.01633	0.001687	0.001226	-0.00107	0.006659	0.014152	-0.0035	0.000325	0.012265	0.025929
Mongu	-0.00862	0.000995	-0.00152	0.002835	0.000528	0.017339	0.003244	-0.00178	0.017106	-0.00996	-0.0084	-0.01126
SANTA_CR	0.004609	0.006811	-0.00228	0.00816	-0.00145	0.001227	0.006398	0.007956	0.082005	0.018944	0.008282	0.010778
Banizoumb	-0.02928	-0.03043	-0.06007	-0.03213	-0.03304	-0.02723	-0.00729	-0.02617	-0.0135	-0.0125	-0.00819	-0.00671
Lanai	0.000981	-8.4E-05	-0.00133	-0.00299	-0.00124	0.000329	-0.00163	0.000825	-0.00066	0.002676	-0.00066	0.000261
Coconut_I:	-0.00285	0.038556	-0.00115	-0.00146	-0.00015	0.000323	-0.00875	0.000057	0.001843	0.003997	0.019716	-0.00152
Bermuda	-0.00431	-0.00305	0.012823	-0.00075	0.023557	0.008998	0.014331	0.001965	0.004919	0.013017	0.014949	0.008058
Dry_Tortu	0.008091	0.001464	0.001423	0.002938	0.01434	0.004256	-0.01011	-0.03424	-0.01975	0.001771	-0.00211	0.004545
Ascension_	-0.00354	-0.00346	0.00252	0.004684	-0.00241	0.001116	0.010017	0.012813	0.003157	0.006272	0.000945	-0.00057
Barbados	0.002718	-0.00612	0.011256	-0.00291	-0.00339	0.059029	0.047266	0.07055	0.096607	0.050914	-0.00444	-0.00039
Tahiti	-0.0046	-0.00431	-0.00284	0.001673	0.009141	0.00146	0.000326	0.001691	0.001924	0.001291	0.00043	-0.00202
Barrow	n/a	n/a	0.026377	0.040242	0.006362	0.004952	0.026581	0.023497	0.002135	n/a	n/a	n/a
REUNION_	-0.00419	-0.00477	0.001819	0.006139	0.002248	0.001321	-0.00062	0.008795	0.00203	0.002062	-0.00016	0.003333
Dakar	-0.0203	-0.00719	-0.00747	-0.00366	-0.00876	-0.01282	-0.02572	-0.00404	0.006841	-0.01058	-0.00787	-0.00596
Guadeloup	-0.00827	-0.00628	-0.00993	-0.00499	-0.01082	0.001111	0.002047	-0.0237	-0.00467	-0.01977	-0.00148	-0.00061
BONDVILLI	0.013502	0.008273	0.002678	0.007222	-0.00066	0.020968	0.006796	-0.00595	0.001378	0.015121	0.003866	0.014717
Bratts_Lak	-0.00074	-0.0009	0.000186	0.007291	-0.00041	0.001196	0.002372	0.005948	-0.00132	0.000338	0.009468	0.003202
Dalanzadg	0.005347	0.003477	-0.01777	-0.00038	-0.01039	-0.00268	-0.00146	-0.00855	0.002545	-0.00574	-0.0016	0.00411
Venise	0.009285	0.007953	-0.01948	-0.00101	-0.00612	0.000801	0.000372	0.001578	-0.00077	0.001566	-0.00156	0.002203
San_Nicola	0.00057	-0.00092	0.0026	0.002725	-0.00301	0.000442	0.003154	0.004849	0.000582	0.003369	0.000607	-0.00319
Sioux_Fall:	0.009737	0.004408	0.001135	0.010853	0.011641	0.005504	0.004533	0.002909	0.027172	0.00062	0.004901	0.002749
Walker_Br	0.003237	0.014412	0.011361	0.005169	0.019786	-0.02258	-0.00249	0.009235	0.003409	0.013533	0.01317	0.009101
Egbert	0.012209	0.012264	0.018409	0.016644	0.009843	0.016804	0.001862	0.012799	0.00791	-0.00436	0.016637	0.008786
Ispra	-0.00218	-0.00712	0.005783	-0.02388	-0.001	0.008191	0.003873	0.023358	0.001612	-0.01577	0.005827	-0.00013
Mainz	0.002611	0.009724	0.002403	0.003134	-0.00299	-0.00452	-0.00689	0.00517	0.002919	0.003267	0.01075	0.007031
Brookhave	0.056783	0.011821	0.03389	0.017841	0.033464	0.022703	0.018428	-0.00439	0.020814	0.012759	0.041607	0.008336
Saturn_Isl	0.006977	0.007889	0.002988	0.007657	0.056681	-0.00186	0.000067	0.002517	0.032156	0.000922	-0.00183	0.003683
Kaashidho	0.001191	-0.00028	-0.00363	-0.01969	0.01931	-0.00442	0.02382	0.001831	-0.00691	0.004057	-0.00786	0.008312
Surinam	-0.03397	-0.02481	0.006754	-0.04376	0.026815	-0.00229	-0.0047	-0.00016	-0.00329	-0.03105	n/a	0.004106
NCU_Taiw	-0.02704	-0.00752	0.015583	0.0829	0.004851	0.088992	0.125545	0.033812	0.014606	0.037139	0.042529	0.048552
Ilorin	-0.03221	-0.01663	-0.065	-0.05345	0.056508	0.11875	0.045946	-0.03122	-0.0499	-0.04517	-0.02727	-0.02151
Dongsha_I	0.025737	0.015055	0.035341	0.025785	-0.0122	0.023769	0.008864	n/a	0.001211	n/a	n/a	0.067139

Arica	-0.01018	-0.04873	-0.0215	-0.00952	-0.00178	-0.00304	-0.00584	-0.00872	-0.00518	-0.00973	-0.00517	-0.00186
Tinga_Ting	0.000468	-0.0008	0.001159	-0.00081	0.027897	0.003277	0.00049	0.001651	0.000367	0.006525	0.003872	-0.00031
MCO-Hani	-0.00035	-0.001										
Pickle_Lak	n/a	0.0049										
IMAA_Pot	0.01755	0.0209										
Kejimkujik	n/a	0.1215										
Skukuza	0.013684	0.0551										
Bahrain	0.005646	-0.007										
TABLE_MC	0.006851	0.0178										
Chequame	n/a	n/a										
Solar_Villa	-0.00477	-0.010										
Abracos_H	-0.01173	-0.01										
Mexico_Ci	0.022069	0.0164										
Rimrock	0.00544	-0.001										
Helgoland	n/a	n/a										
Nauru	0.003799	0.0063										
Gotland	n/a	n/a										
Palaiseau	0.004712	0.0146										
Paris	0.00694	0.0002										
Moldova	0.008876	0.0035										
MD_Scien	0.002635	0.002										
Belterra	0.021715	0.0050										
Balbina	-0.02726	-0.019										
CEILAP-BA	0.02336	0.0226										
Anmyon	0.002347	0.0250										
Cordoba-C	0.008946	0.0195										
COVE	-0.00203	0.0029										
IMS-METU	0.003029	-0.014										
Avignon	-0.00042	0.0024										
Rogers_Dr	0.000585	0.0032										
Stennis	0.005953	0.031										
El_Arenosi	-0.01073	-0.001										
UCLA	0.001772	0.0135										
Nes_Ziona	-0.00228	-0.017										
Maricopa	0.002412	0.0037										
Kyiv	0.003651	-0.003										
Churchill	n/a	n/a										
IMC_Orist	0.00206	0.0109										
Azores	n/a	0.0179										
Hamburg	0.000233	0.0027										
KONZA_ED	0.000206	0.00										
Modena	-0.00163	0.0023										
La_Pargue	0.005574	0.0012										
Rio_Branc	-0.00765	-0.001										
Lampedus	0.006265	-0.002										
Osaka	-0.00186	0.0129										
Shirahama	0.007949	-0.002										
BSRN_BAC	0.01045	0.0044										
Kanpur	-0.00505	0.0133										
Midway_Is	0.000562	-0.001										
Billerica	0.001212	0.0051										
Moscow_N	0.019051	0.0021[illegible]	-0.00245	0.007951	0.012328	0						
Minsk	0.048052	-0.00337	-0.00856	0.008237	0.022723	0.0						
Beijing	-0.00308	-0.00761	-0.08524	-0.11518	-0.05948	-0						
Kelowna	0.01312	0.006227	0.009553	0.049395	0.014178	-0						
Kuopio	n/a	n/a	n/a	0.018572	0.010871	0.0						
Agoufou	-0.05169	-0.02107	-0.0853	-0.00238	-0.02159	0						
Sao_Paulo	0.034848	0.017905	0.014213	0.004386	0.008345	-0						
Rome_Tor	0.013385	0.00286	-0.0045	0.001981	0.00824	0.0						

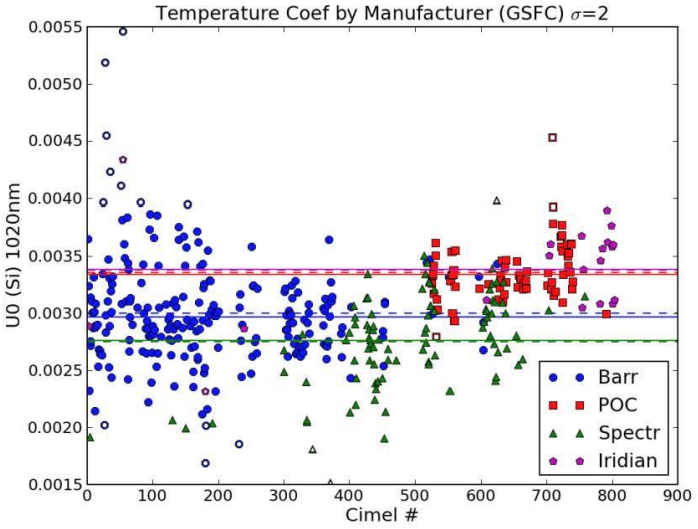
SMHI	n/a	n/a	0.009588	0.031021	0.008336	0.001635	0.004824	0.017272	0.011871	-0.00345	n/a	n/a
Rottnest_I	0.001825	0.001136	-0.00333	0.002434	-0.00884	-0.00555	-0.00294	-0.00843	-0.00163	0.001278	0.001134	0.000872
Gosan_SN	0.119205	-0.00536	0.010647	-0.01145	0.023153	-0.00986	0.022363	-0.00167	-0.00183	0.028538	n/a	0.032462
CUIABA-M	0.000806	0.03719	0.003842	-0.00142	0.003942	0.002906	0.019741	-0.00229	-0.0059	-0.01217	0.017299	0.005579
XiangHe	-											
Noto	n/											
IFT-Leipzig	-											
Railroad_V	0											
Oostende	0											
Davos	0											
CCNY	-											
The_Hague												
Columbia_	0											
Jabiru												
Lake_Argy												
Munich_U	0											
Lecce_Uni	0											
Kuwait_Ur	0											
Hermosillo												
Yekaterinb	0											
Mussafa	0											
Tomsk	0											
Yakutsk	n/											
ATHENS-N												
ISDGM_CN	-											
Taipei_CW												
Chen-Kung												
Fontainebl	-											
Monterey	-											
Belsk	0											
Fresno												
Toravere	n/											
Andenes	n/											
Halifax	0											
Villefranch	0											
Wits_Univ	0											
Kuujjuarap	n/											
FORTH_CR	0											
Palencia												
Canberra	0											
Amsterdar	0											
Pimai												
Bac_Giang	-											
Bac_Lieu	0											
Kellogg_LT	n/											
Cabauw	-											
Toulon												
Dunkerque	0											
Irkutsk	0											
Evora	0											
ETNA	0											
Sao_Marti	-											
Petrolina_	-											
Campo_Gr	0											
Hyytiala	n/											
MVCO												
Laegeren	0.025998	-0.00212	-0.01									
Blida	0.009159	0.013147	-0.0									
Dhabi	-0.00769	-0.0004	-0.02									

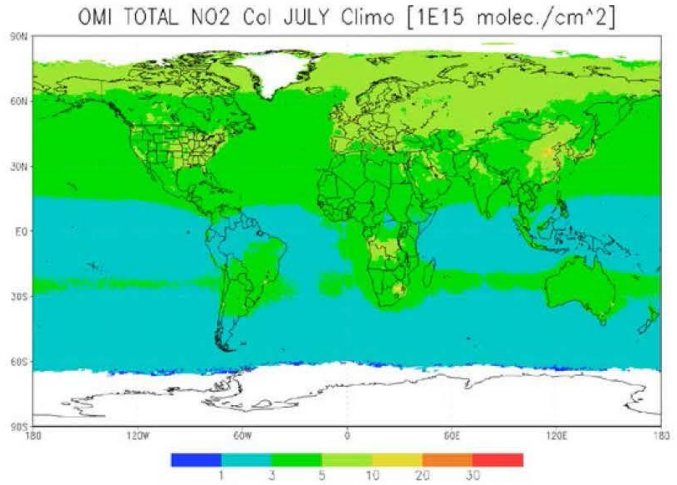
[illegible]

[illegible]

AERONET Version 3 Update – AOD Additional Modifications

- 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)





Temperature Characterization

Need a temperature characterization for every filter+detector combination

Also, filter response differences between manufacturers often require separate characterization for each

1020Si filters are the most temperature sensitive (> 3x greater). Other filters exhibit sensitivity ranging from negligible to moderate.

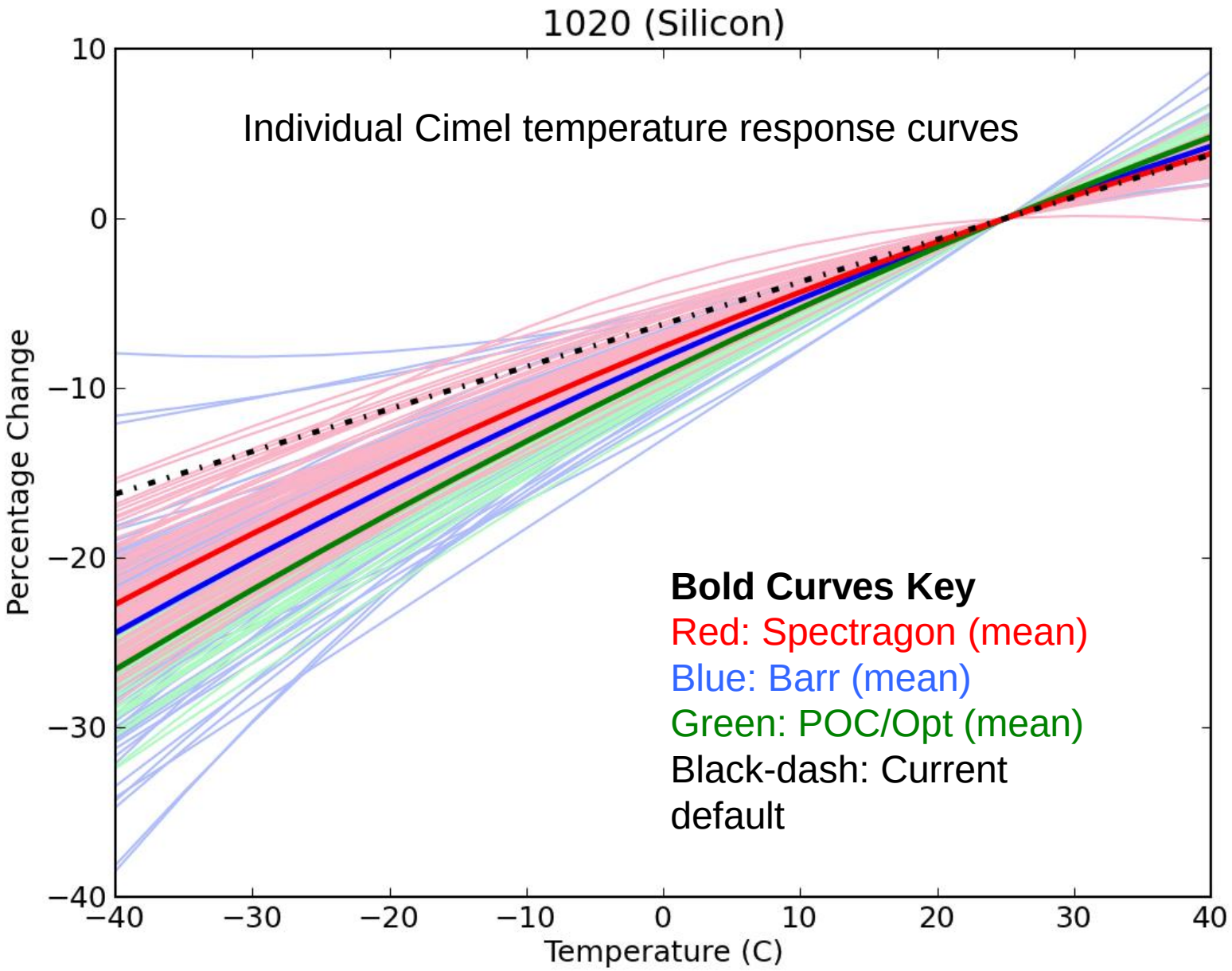
For a typical 1020Si case, a 10 degree change in temperature results in ~ 3% change in signal

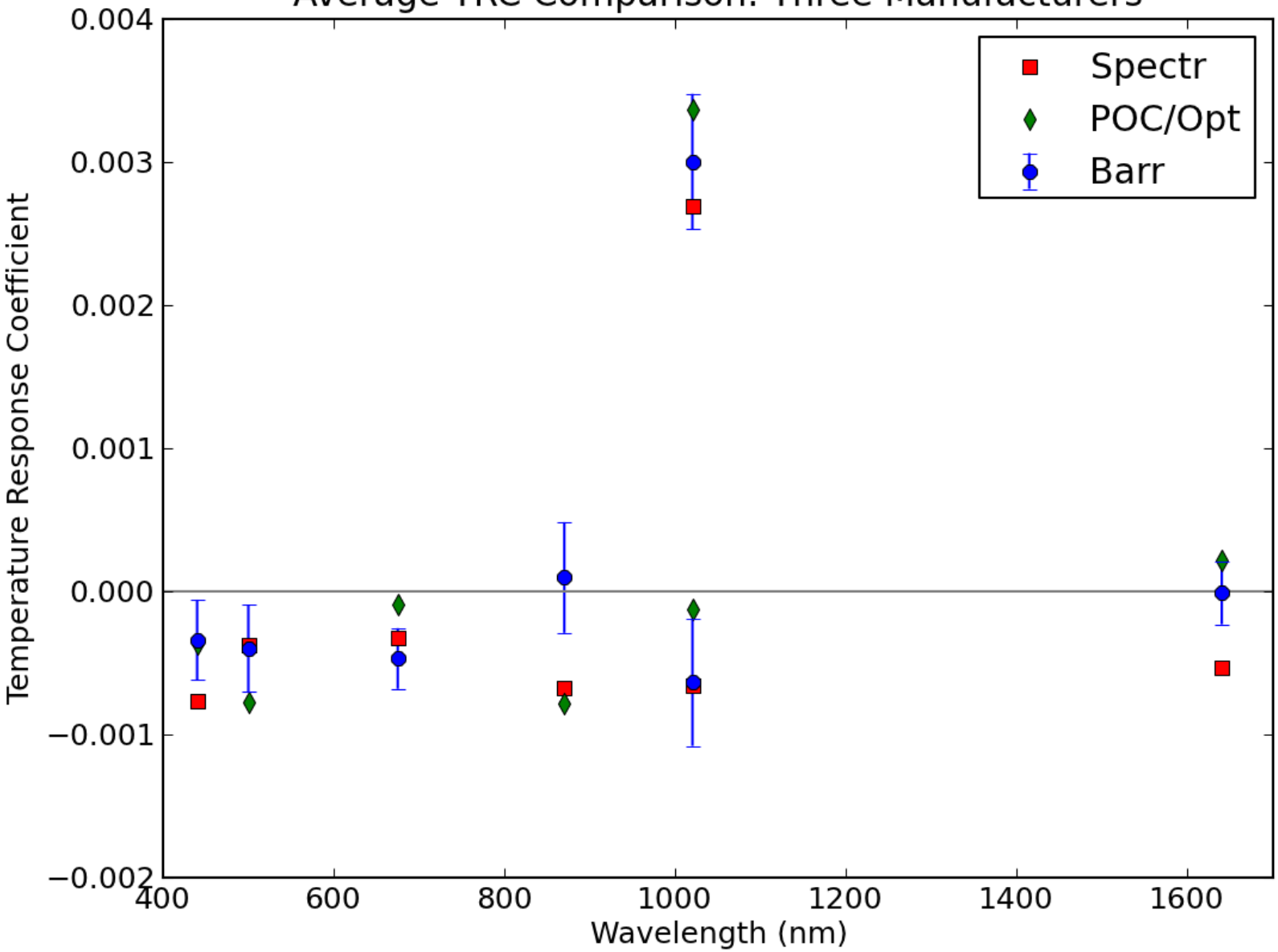
Default Sensitivity Determination

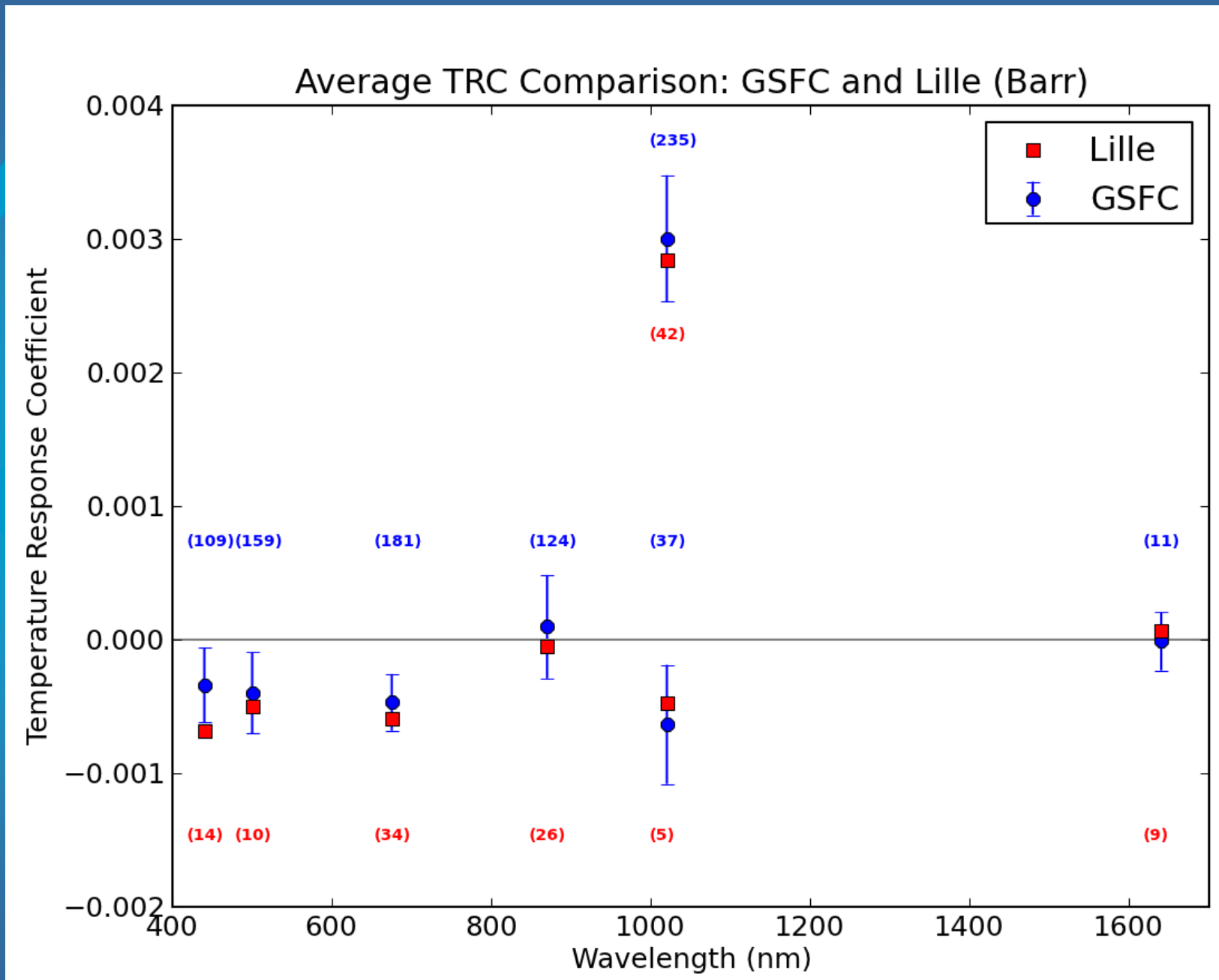
All valid temperature data files are used in calculation of defaults, with a 2 sigma outlier filter

Individual CIMELs may have temperature sensitivity that departs **significantly** from the default values– *default only used for some of the older historical data*

Agreement between independent characterizations at GSFC and Lille is good for all manufacturers

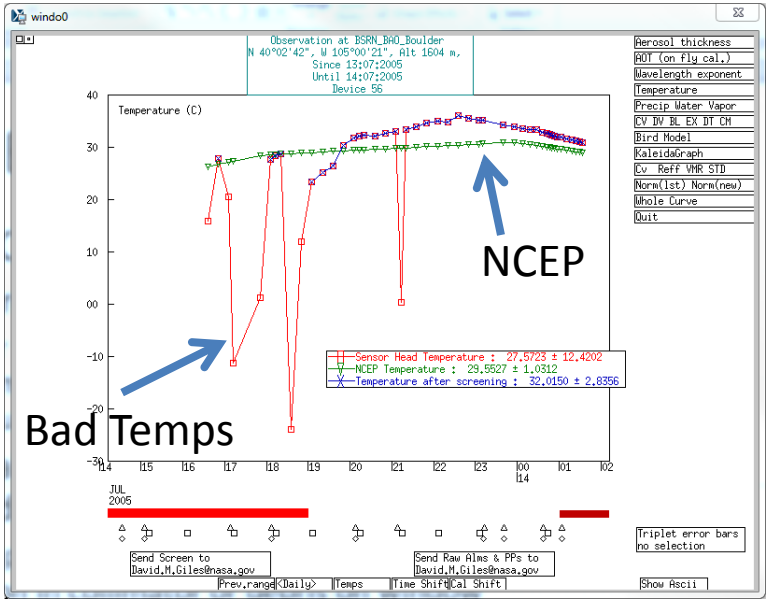

1020 (Silicon)
Individual Cimel temperature response curves
Bold Curves Key
Red: Spectragon (mean)
Blue: Barr (mean)
Green: POC/Opt (mean)
Black-dash: Current default
Percentage Change
Temperature (C)
10
0
−10
−20
−30
−40
−40
−30
−20
−10
0
10
20
30
40

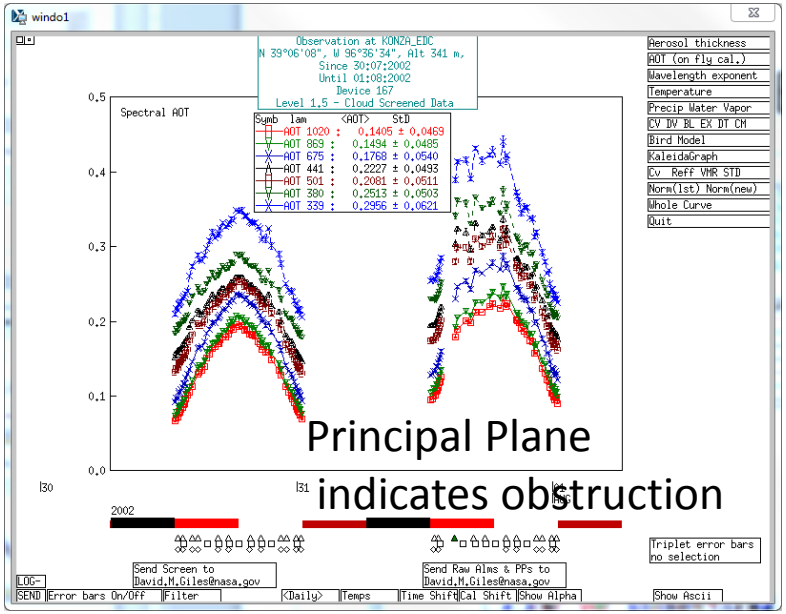

Average TRC Comparison: Three Manufacturers
Temperature Response Coefficient
Wavelength (nm)
Spectr
POC/Opt
Barr
0.004
0.003
0.002
0.001
0.000
−0.001
−0.002
400
600
800
1000
1200
1400
1600


Average TRC Comparison: GSFC and Lille (Barr)
Lille
GSFC
Temperature Response Coefficient
Wavelength (nm)
0.004
0.003
0.002
0.001
0.000
−0.001
−0.002
400
600
800
1000
1200
1400
1600
(235)
(42)
(109)
(159)
(181)
(124)
(37)
(11)
(14)
(10)
(34)
(26)
(5)
(9)

AERONET Version 3 Update - AOD

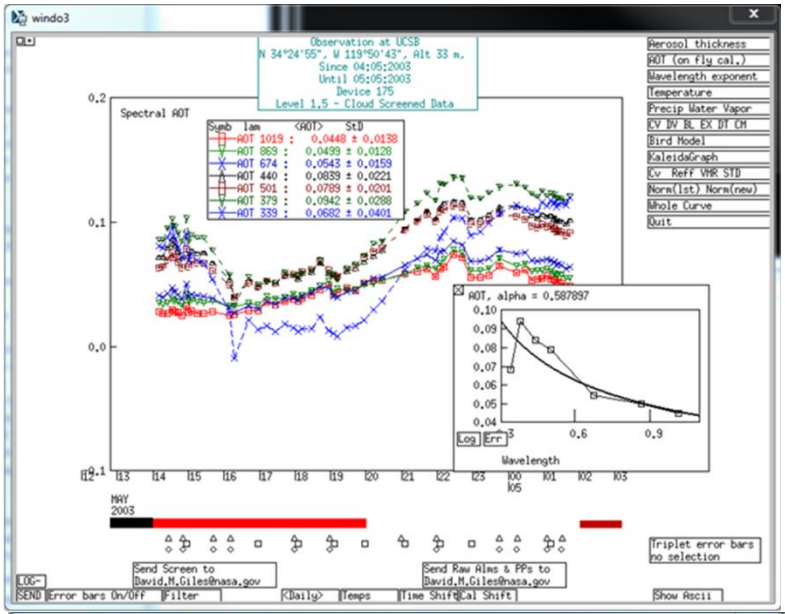
- Level 2.0 Automated Quality Assurance
  - Temperature anomalies
    - Allows for restoration of 1020nm data affected by bad sensor temperatures partly based on NCEP surface temperature climatology
  - AOD diurnal dependence
    - Removes persistently affected data mainly due to obstruction in collimator or debris on window

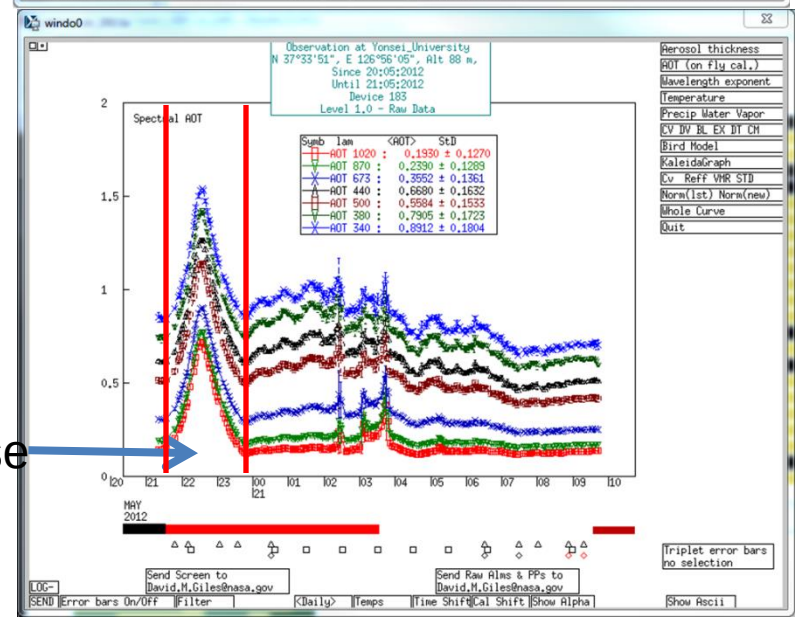




AERONET Version 3 Update - AOD

- Level 2.0 Automated Quality Assurance (in development)
  - AOD with channel out of spectral wavelength dependence
    - Remove channel due to systematic instrument anomaly
  - Solar eclipse AOD increase
    - Remove AOD affected during solar eclipse period
    - Possibly implement an eclipse correction

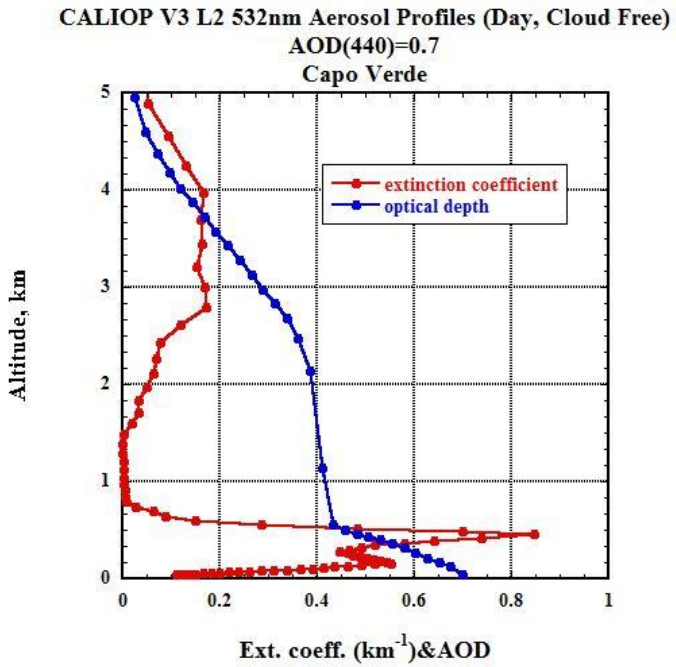




Eclipse

AERONET Version 3 Update - Inversions

- Implement a vector radiative transfer code
  - radiation field in UV (e.g., 380 nm retrieval)
  - degree of linear polarization
- Integrate CALIOP monthly climatology of extinction profiles (or MERRA assimilated profile) to estimate aerosol vertical profile
- Provide lidar 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



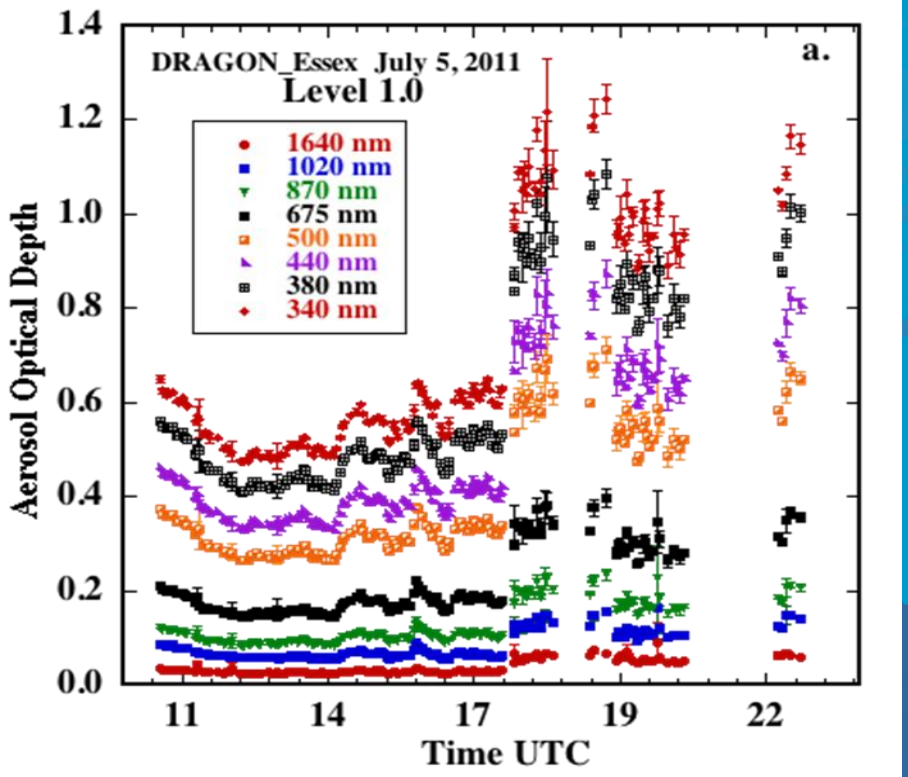
Accounting for polarization in modeling of atmospheric radiation is important:
-at short wavelengths where contribution of molecular scattering is significant
- for fine mode aerosol particles exhibiting high degree of linear polarization
In version 3 scalar RT model is replaced by vector RT model.

Approach:
-several well known RT models were selected as candidate for version 3 :
Adding/Doubling (AD;GISS), Discrete Ordinate (DOM; Korkin, Lyapustin, GSFC), Successive Order of Scattering (SO; Lille)
- the agreement between different RT models was found to be within 1%
- SO RT model finally was selected due to its superior speed for small and moderate AOSs

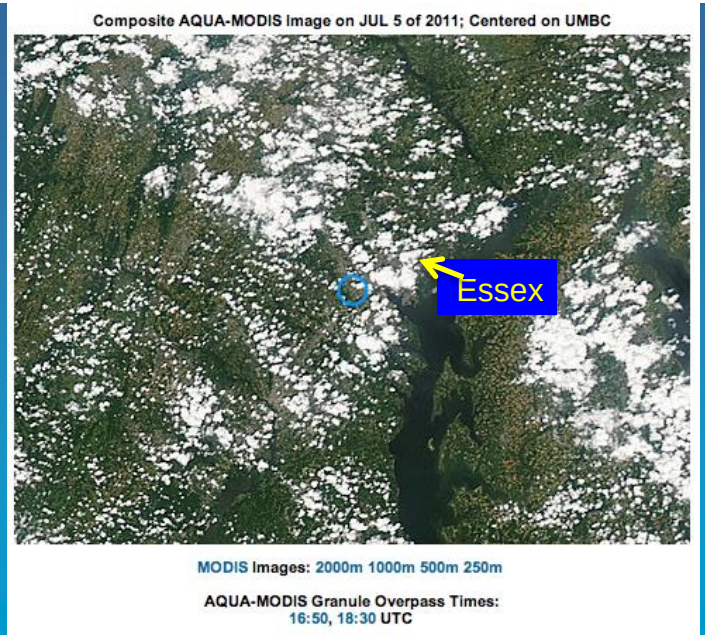
As alternative to error bars based on sensitivity studies, new error bars
estimates will be provided for each individual retrieval:
-the approach is based on Dubovik, 2004
- the error bars estimates accounts for effect of random errors in optical
measurements as well as effect of biases such as calibration uncertainty

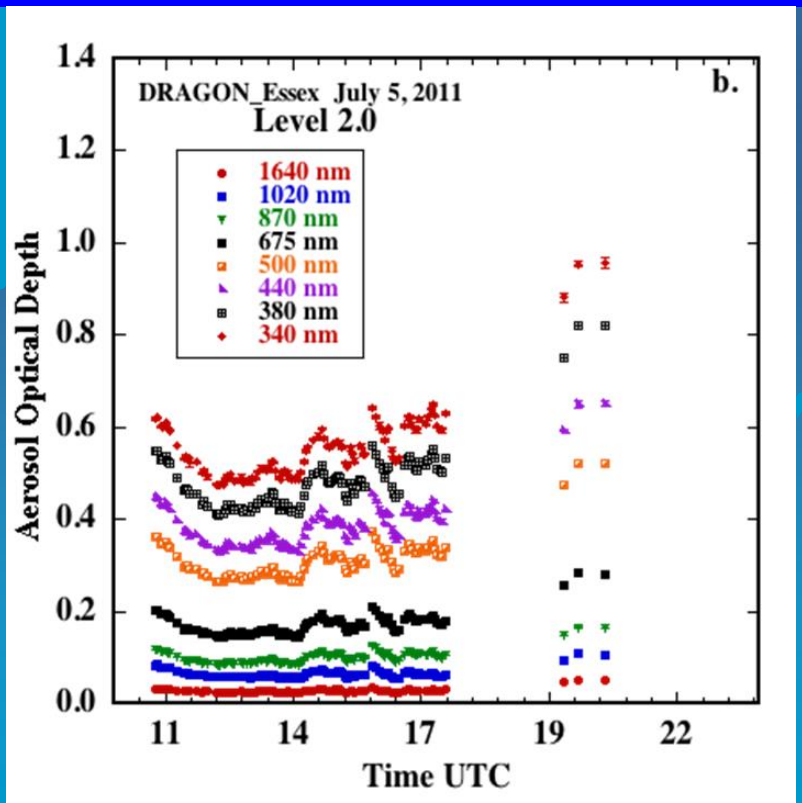
The above approach does not accounts for errors due to model assumptions such as uncertainties in prescribed surface albedo or BRDF. These uncertainties are estimated using sensitivity studies assuming maximum absolute error in surface albedo ~ 0.05 (according to MODIS team estimations).

Error bars for the following aerosol parameters will be provided :
particle size distribution, complex refractive index, single scattering albedo, aerosol phase function, sphericity
parameter.

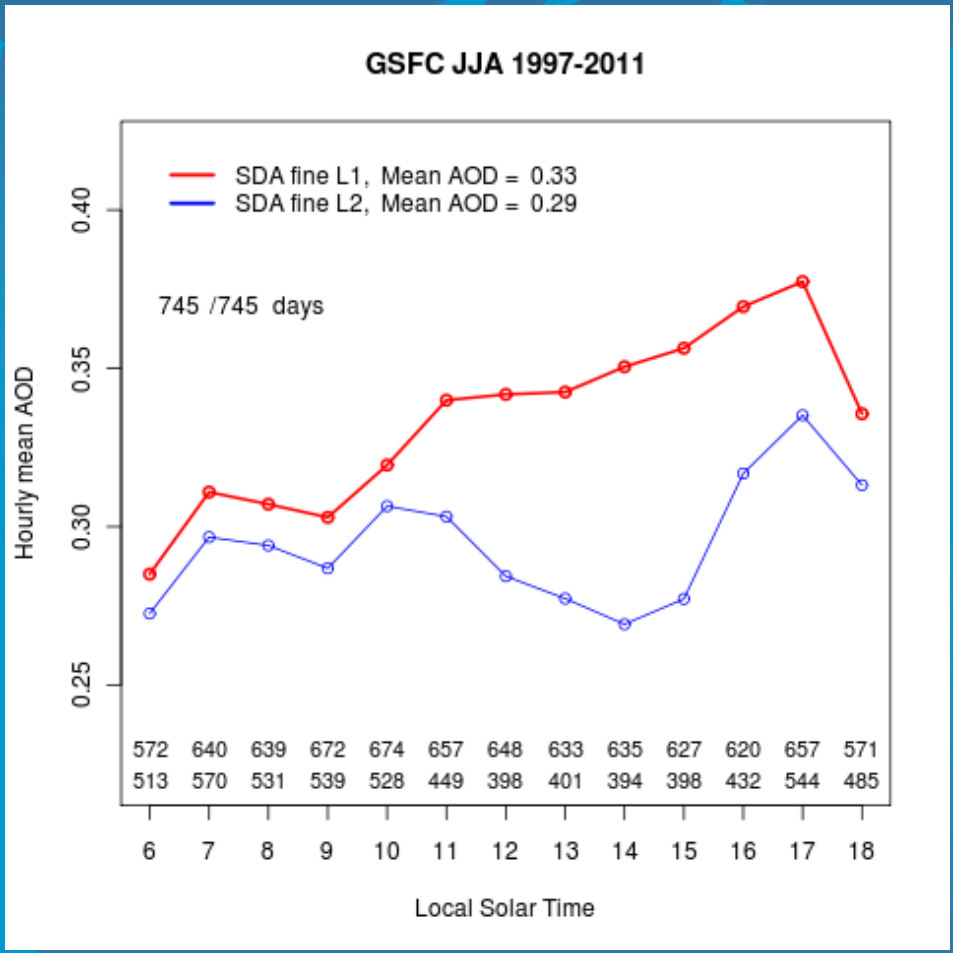


Large jump in AOD (~0.3 at 440 nm) at the DRAGON Essex site occurred just after solar noon on July 5 (No Cloud Screening). However, the Angstrom exponent (440-870 nm) remains very high (>1.9) suggesting possible new particle formation in the cloud environment since a particularly dense cluster of clouds is seen in the vicinity of the Essex site. Also note the larger variance of AOD (1 min intervals) in the afternoon versus morning indicating relatively high frequency variation in columnar aerosol.





Average AOD computed for each Hour independently – Mid Afternoon drop in AOD in L2 (Cloud Screened & QA) likely due to missing Variable AOD associated with enhanced aerosol near Cumulus clouds



Observations of rapid aerosol optical depth enhancements in the vicinity of polluted cumulus clouds

T. F. Eck, B. N. Holben, J. S. Reid, A. Arola, R. A. Ferrare, C. A. Hostetler, S. N. Crumeyrolle, T. A. Berkoff, E. J. Welton, S. Lolli, A. Lyapustin, Y. Wang, J. S. Schafer, D. M. Giles, B. E. Anderson, K. L. Thornhill, P. Minnis, K. E. Pickering, C. P. Loughner, A. Smirnov, and A. Sinyuk

Atmos. Chem. Phys. Discuss., 14, 18785-18848, 2014

AERONET
New Instrumentation/Enhancements

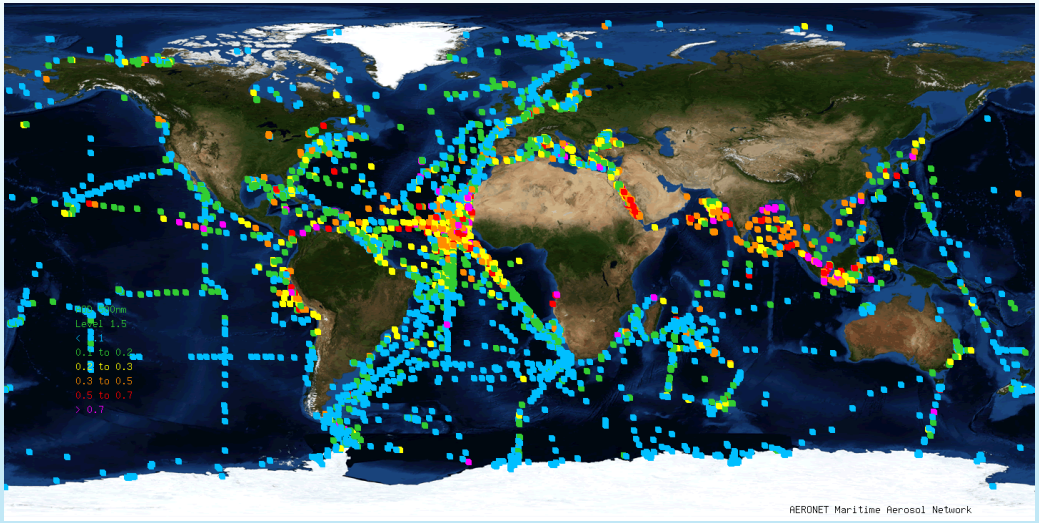
- Greater control over instrument measurement scenarios (e.g., Hybrid)
- Additional capabilities such as SD card storage, GPS, USB, and Zigbee
- Lunar measurements
  - 1st to 3rd quarter lunar phase (waxing to waning gibbous)
  - Processing for lunar measurements (e.g., ROLO, Tom Stone)
- Development toward attachment for CO2 measurements (Emily Wilson)
- Synergism with MPLNET, PANDORA, and in situ measurements

Cimel Sun/Sky/Lunar Radiometer

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
- In the last several years data acquisition was extended to the areas that previously had very little or no coverage at all
- Data are easily accessible in the web-based public data archive and will stimulate research and international collaboration in various scientific areas

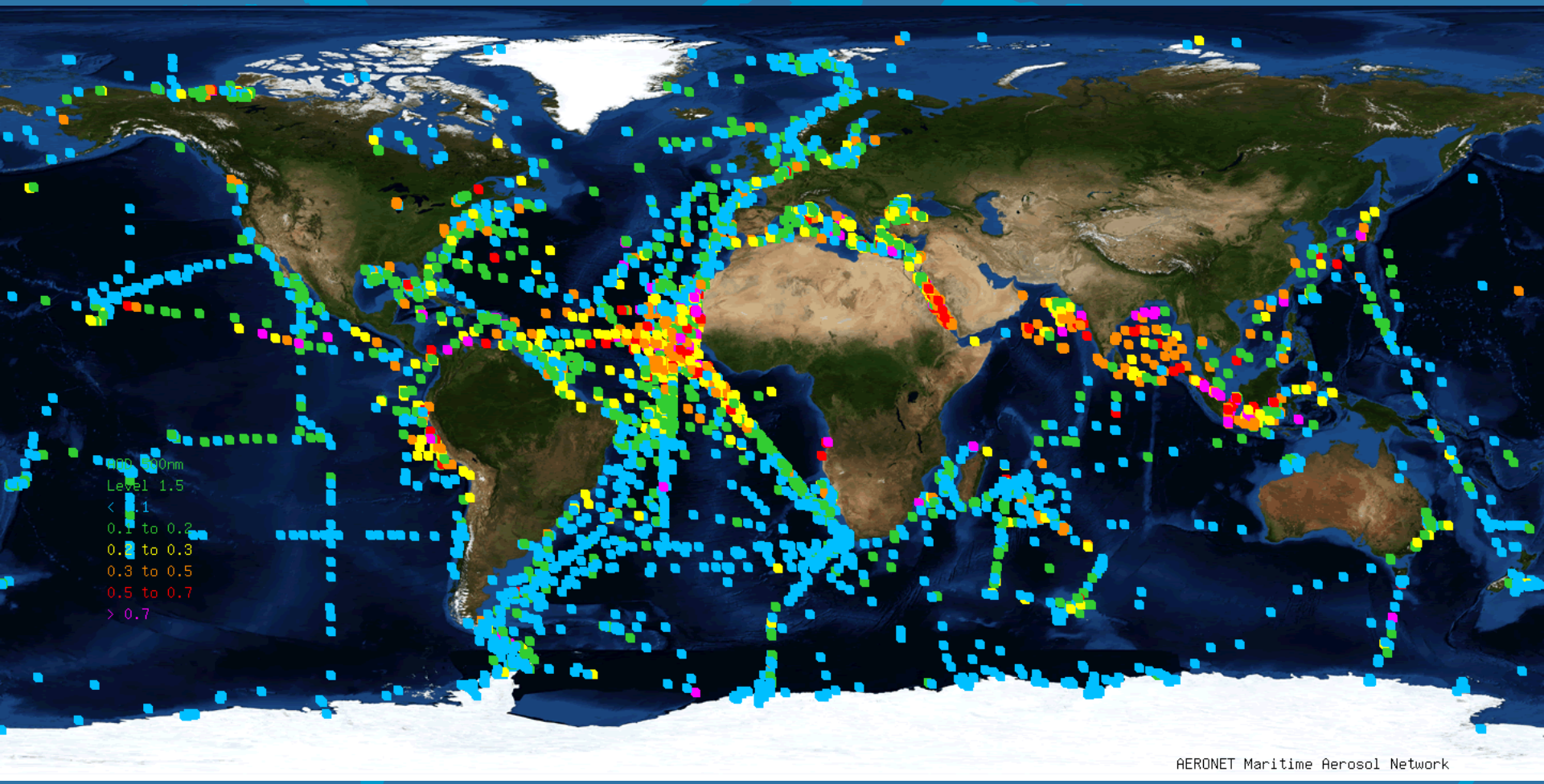
Maritime Aerosol Network global coverage from October 2006 to September 2014



Cruise tracks and daily averages of aerosol optical depth at 500 nm (squares are colored with respect to AOD values, i.e. blue – AOD<0.10, green – 0.1≤AOD<0.2, yellow – 0.2≤AOD<0.3, orange – 0.3≤AOD<0.5, red – 0.5≤AOD<0.7, purple – AOD≥0.7)

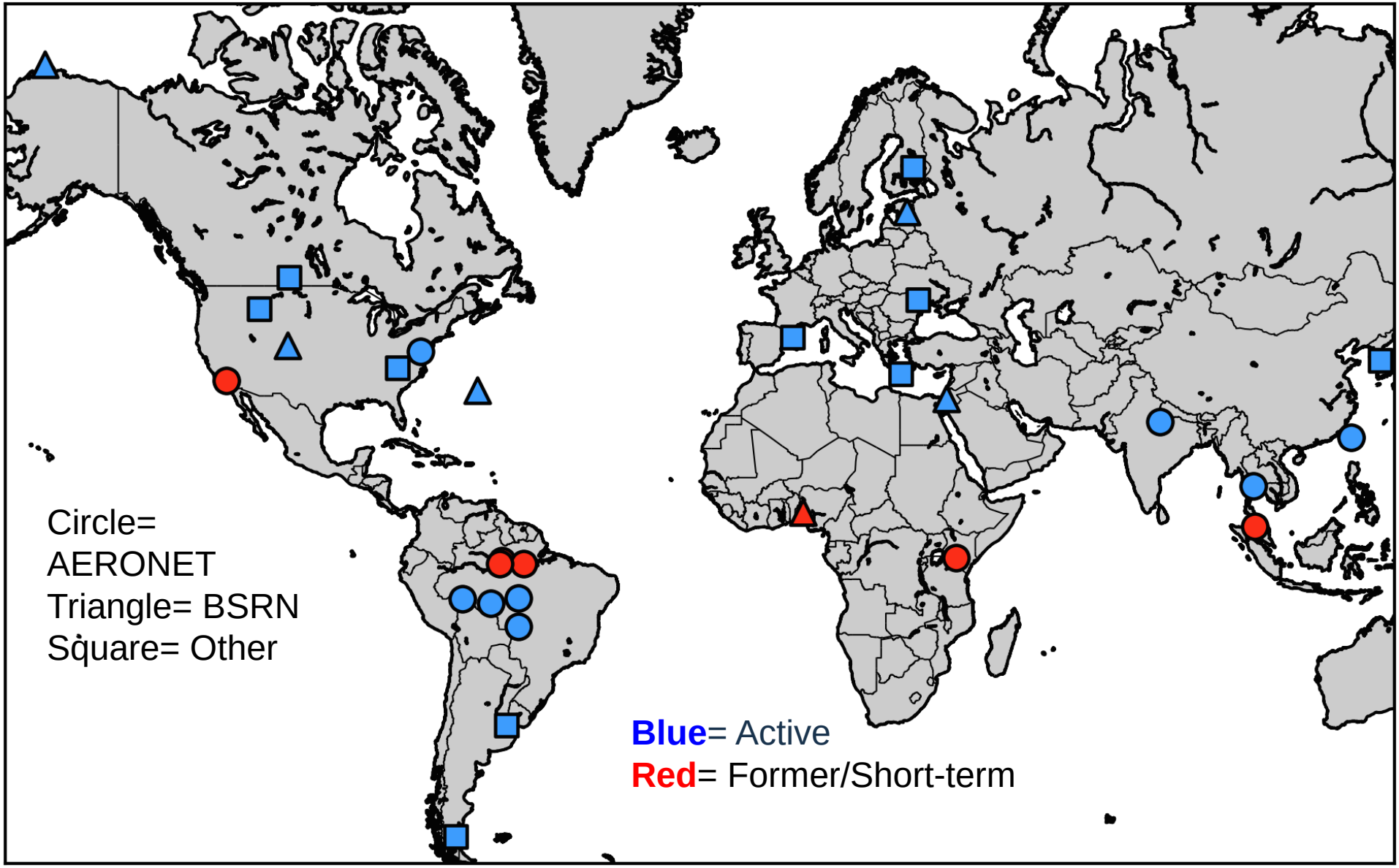
Smirnov, A., B. N. Holben, I. Slutsker, D. M. Giles, C. R. McClain, T. F. Eck, S. M. Sakerin, A. Macke, P. Croot, G. Zibordi, P. K. Quinn, J. Sciare, S. Kinne, M. Harvey, T. J. Smyth, S. Piketh, T. Zielinski, A. Proshutinsky, J. I. Goes, N. B. Nelson, P. Larouche, V. F. Radionov, P. Goloub, K. Krishna Moorthy, R. Matarrese, E. J. Robertson, and F. Jourdin, Maritime Aerosol Network as a component of Aerosol Robotic Network, J. Geophys. Res., 114, D06204, doi:10.1029/2008JD011257, 2009.

Maritime Aerosol Network current status

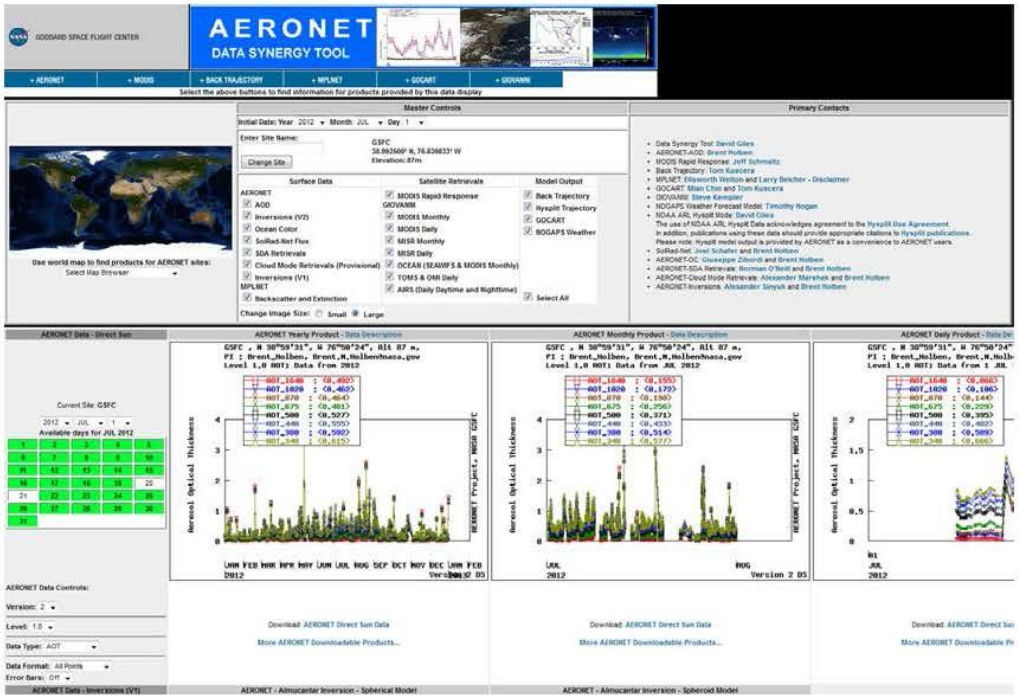


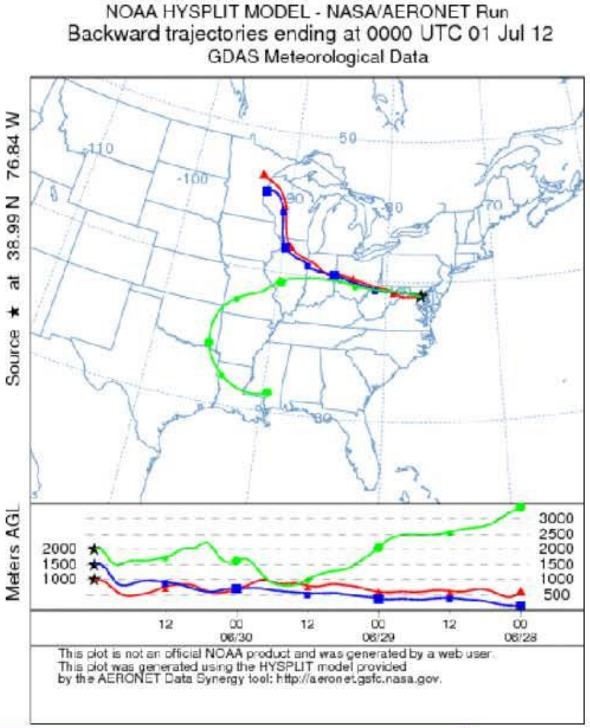
Cruise tracks and daily averages of aerosol optical depth at 500 nm (squares are colored with respect to AOD values, i.e. blue – AOD<0.10, green – 0.1≤AOD<0.2, yellow – 0.2≤AOD<0.3, orange – 0.3≤AOD<0.5, red – 0.5≤AOD<0.7, purple – AOD≥0.7).

SolRad-net and contributed flux data



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

Acknowledgments

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