

MFRSR Data Quality Assessment

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Motivation

- ▶ MFRSR data are collected at permanent and temporal ARM sites with world-wide distribution
- ▶ MFRSR data and products are important parts of several ARM-supported VAPs
- ▶ MFRSR data quality issues have not been fully recognized or effectively addressed



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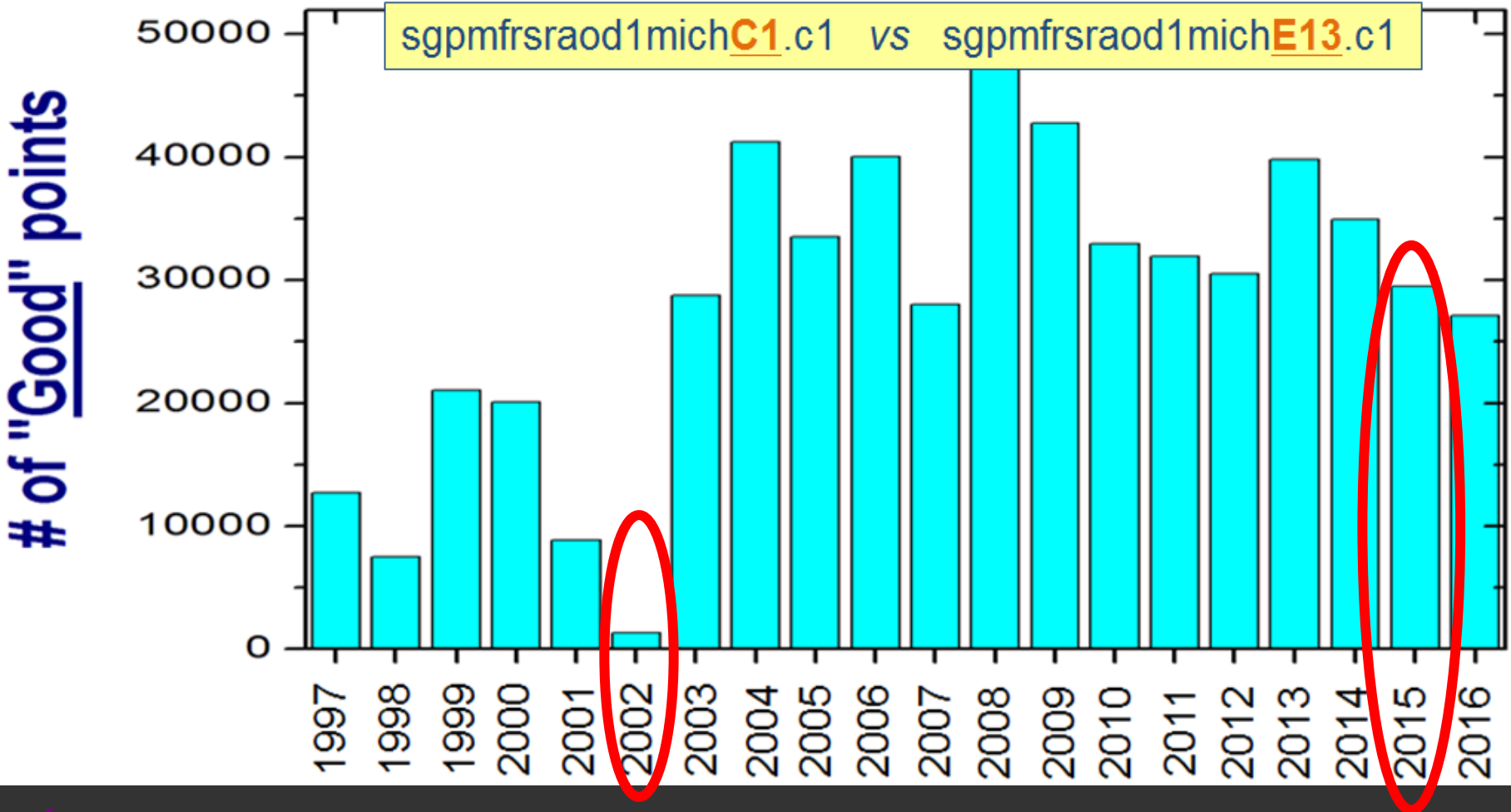
Approach

- ▶ **Screen “bad” cases** using information about (1) **head/logger** changes and (2) subtle instrument and **data quality** issues documented by Data Quality Reports (DQRs)
 - head_id and logger_id global attributes in mfrsr.b1 netCDF files
 - SGP instrument logs
 - MFRSR Ingest calibration files on ARM Data Management Facility server
- ▶ **Identify potential problems** through comparison of available concurrent measurements
 - **AOD**: MFRSR ([C1](#)), MFRSR ([E13](#)), AERONET



Number of “Good” Points

No hardware changes, data flagged by DQRs and automated QC removed



✓ Number of “good” points *tends to increase*

Screening of “Bad” Cases

	2002		2015	
	DQR	Period	DQR	Period
MFRSR (C1)	<i>channel leakage</i>	2002 0101 - 2002 1028	<i>time drift</i>	2015 0825 - 2015 1105
MFRSR (E13)	<i>hole in diffuser</i>	2002 0114 - 2002 0422	<i>heater board failure</i>	2015 1025 - 2015 1123
	Hardware changes	Time	Hardware changes	Time
MFRSR (C1)	<i>head and logger</i>	2002 1028	<i>none</i>	
MFRSR (E13)	<i>head</i>	2002 0422	<i>logger</i>	2015 0909
AERONET	<i>level <u>2.0</u></i>	through 2002 09	<i>level <u>1.5</u></i>	through 2015 12

AERONET data: Inconsistency

File name	Number of AOTs(λ)
sgpcsphotaotfiltC1.a1.20020101.145732.cdf	8
sgpcsphotaotfiltC1.a1.20020101.145733.cdf	16

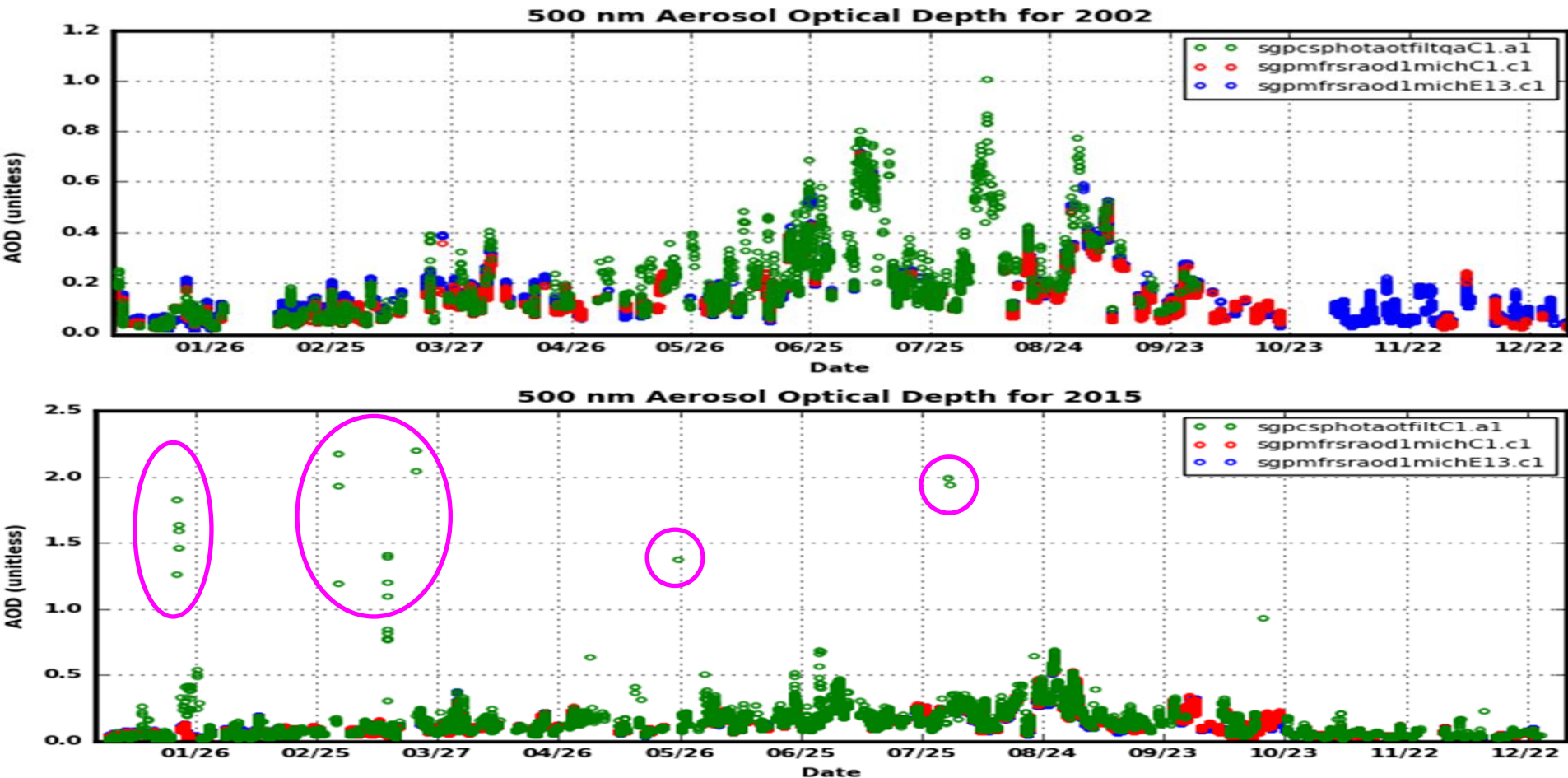
*32.cdf: 1640, 1020, 870, 670, 500, 440, 380, 340

*33.cdf: 1640, 1020, 870, 675, 667, 555, 551, 532, 531, 500, 490, 443, 440, 412, 380, 340

These files are located in the same directory.
The start times for them are one second apart.

✓ This inconsistency makes *concatenating* and *plotting* data extremely **difficult**

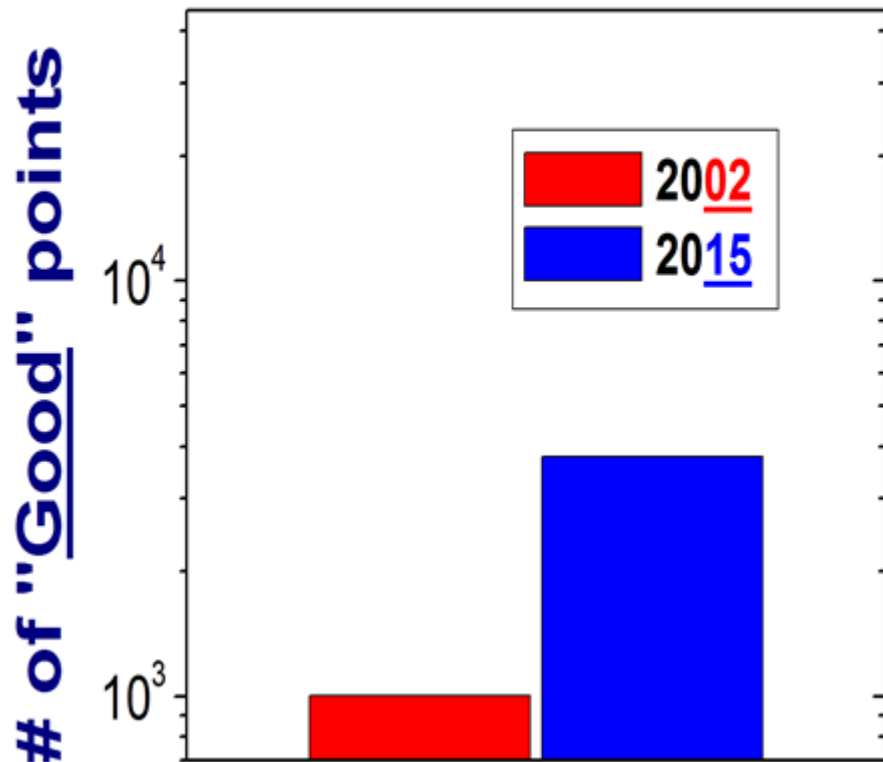
AOD: Time Series



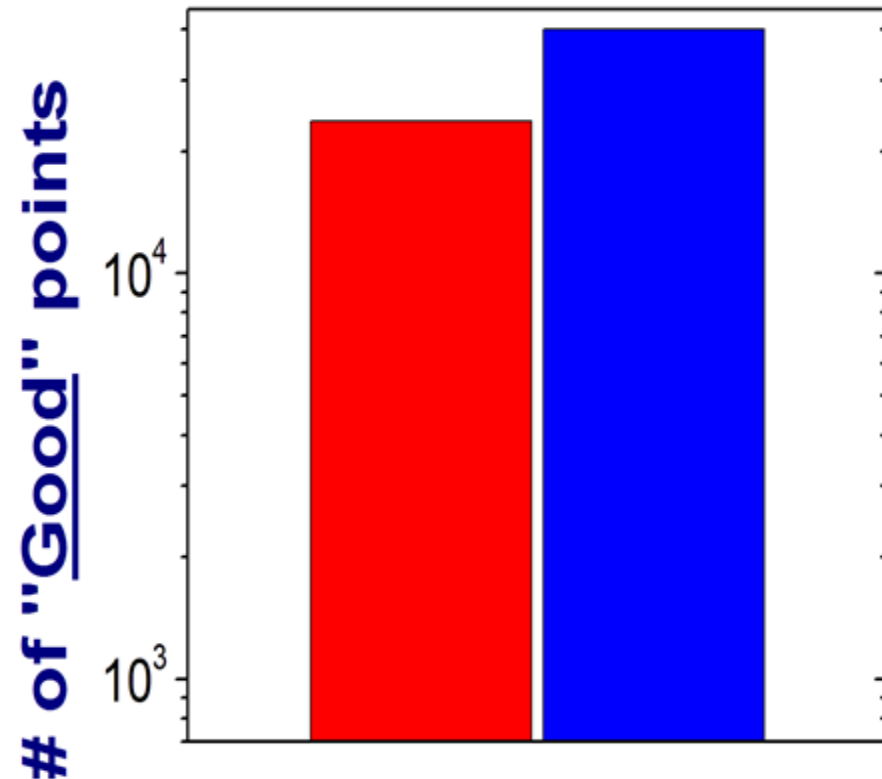
✓ Data availability *defines* “**overlapping**” periods

“Good” Points: Number

MFRSR(C1) vs AERONET



MFRSR(E13) vs MFRSR(C1)

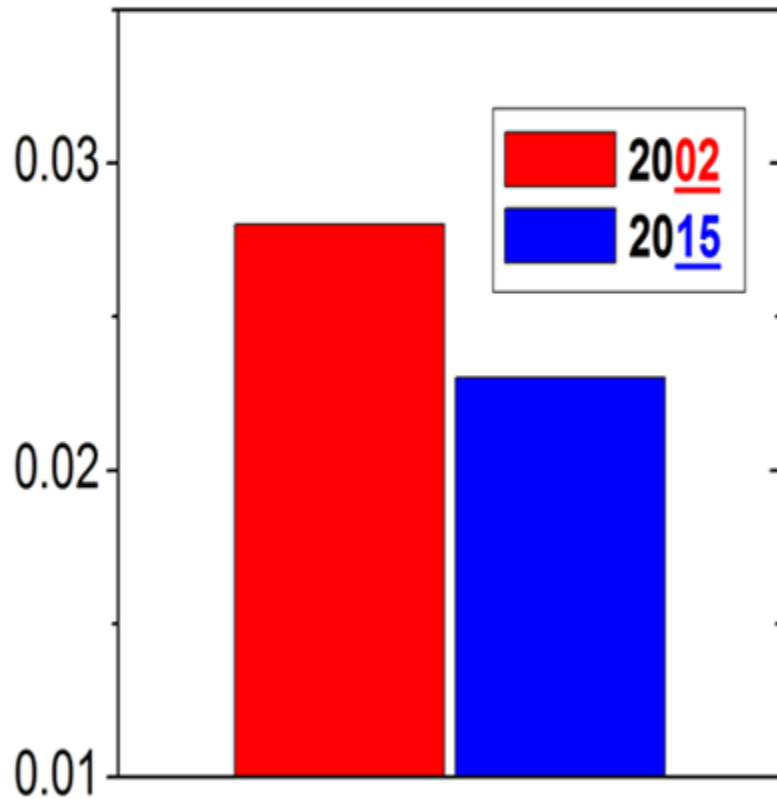


2002 vs 2015 : Number of “good” points *increases* **substantially** (up to **4** times)

AOD: Root-mean-square difference

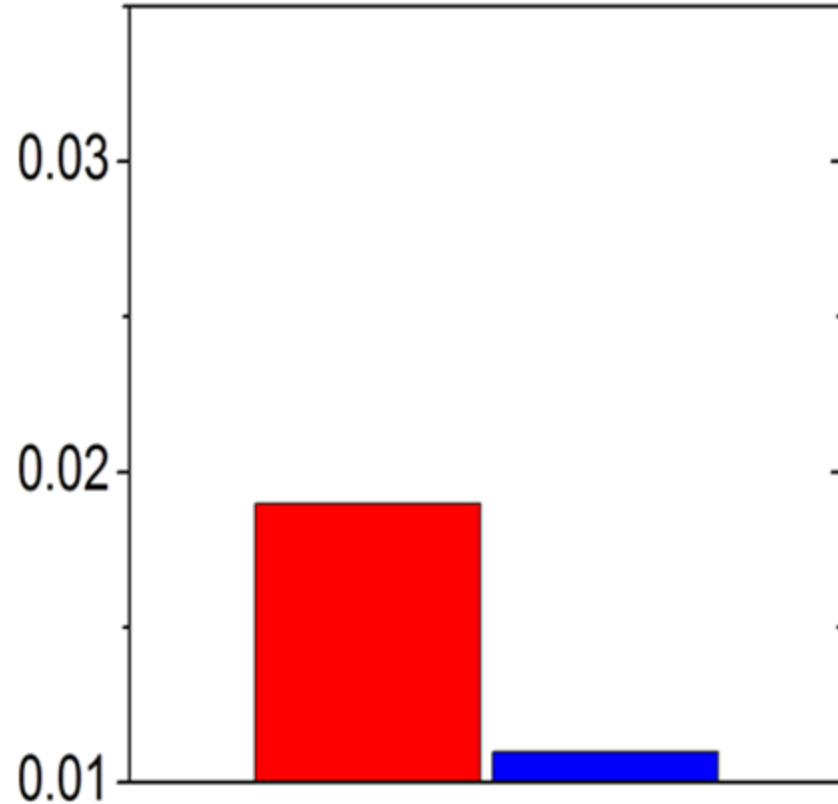
Root-mean-square difference

MFRSR(C1) vs AERONET



Root-mean-square difference

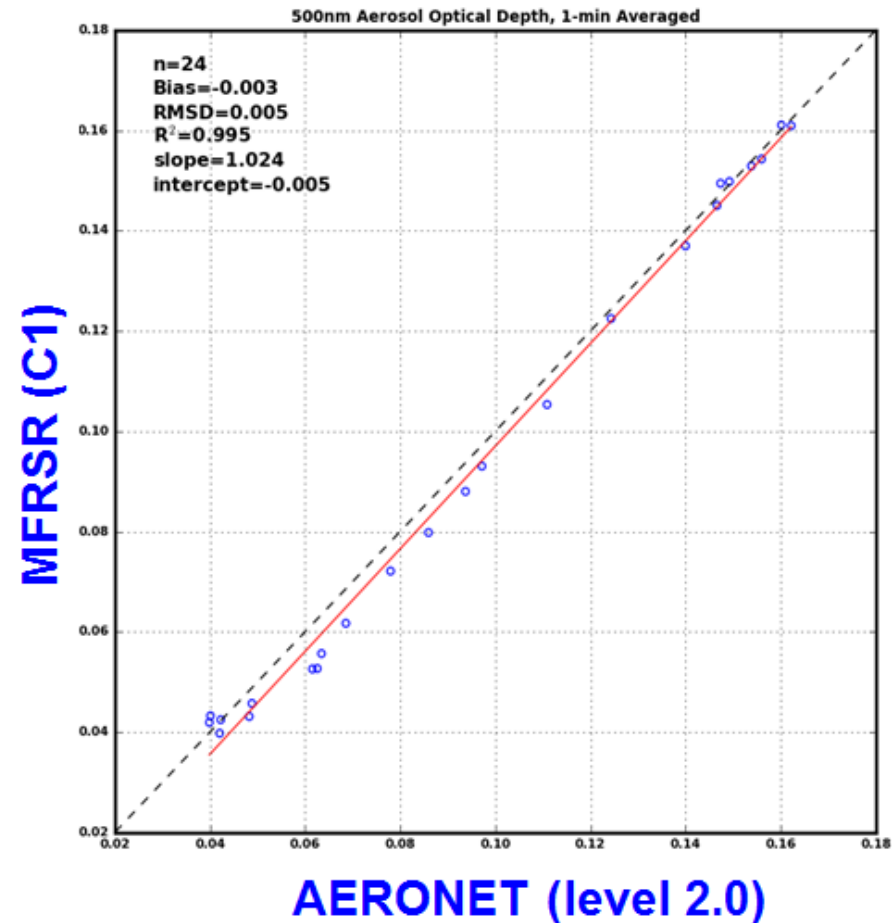
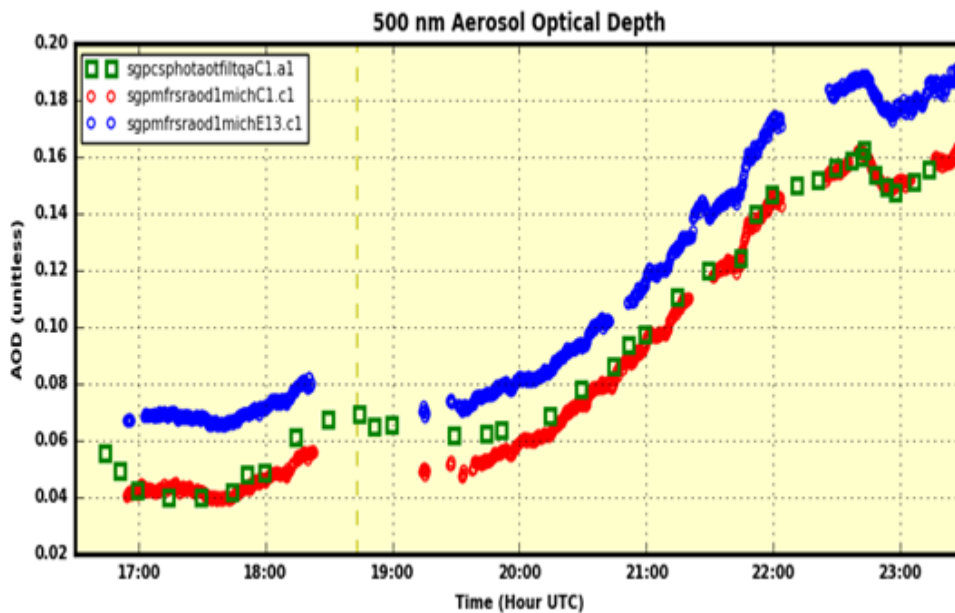
MFRSR(E13) vs MFRSR(C1)



2002 vs 2015 : Root-mean-square difference of AOD decreases **substantially** (up to **2** times)

2002-02-24: Suspect DQR

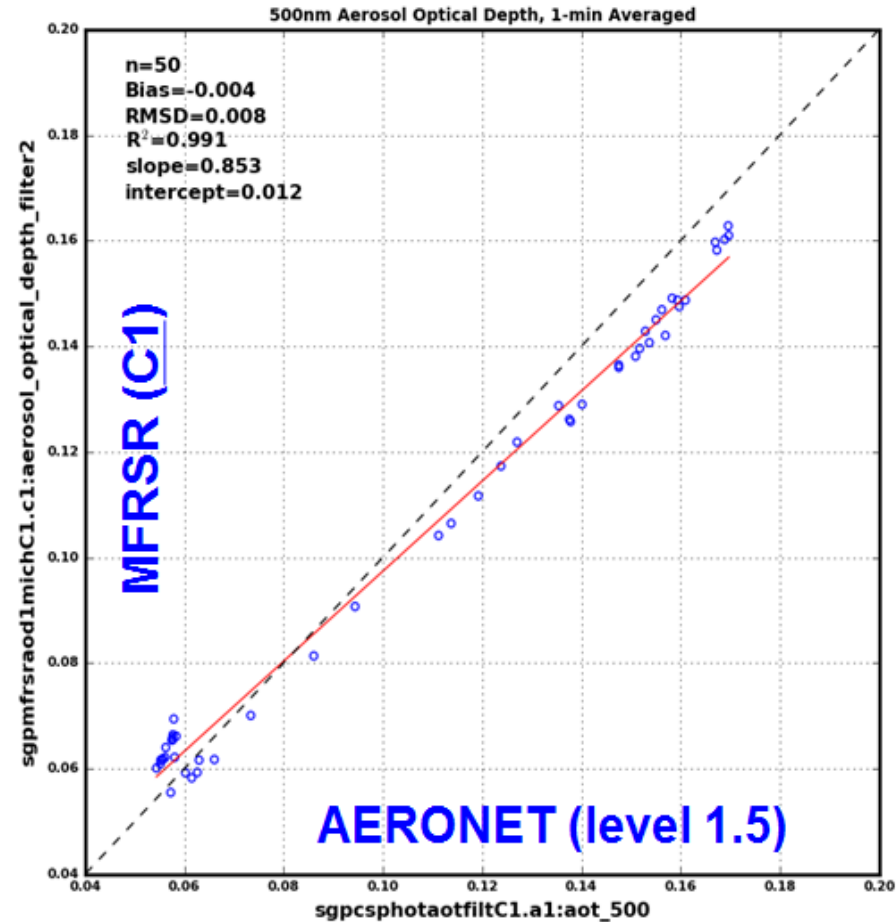
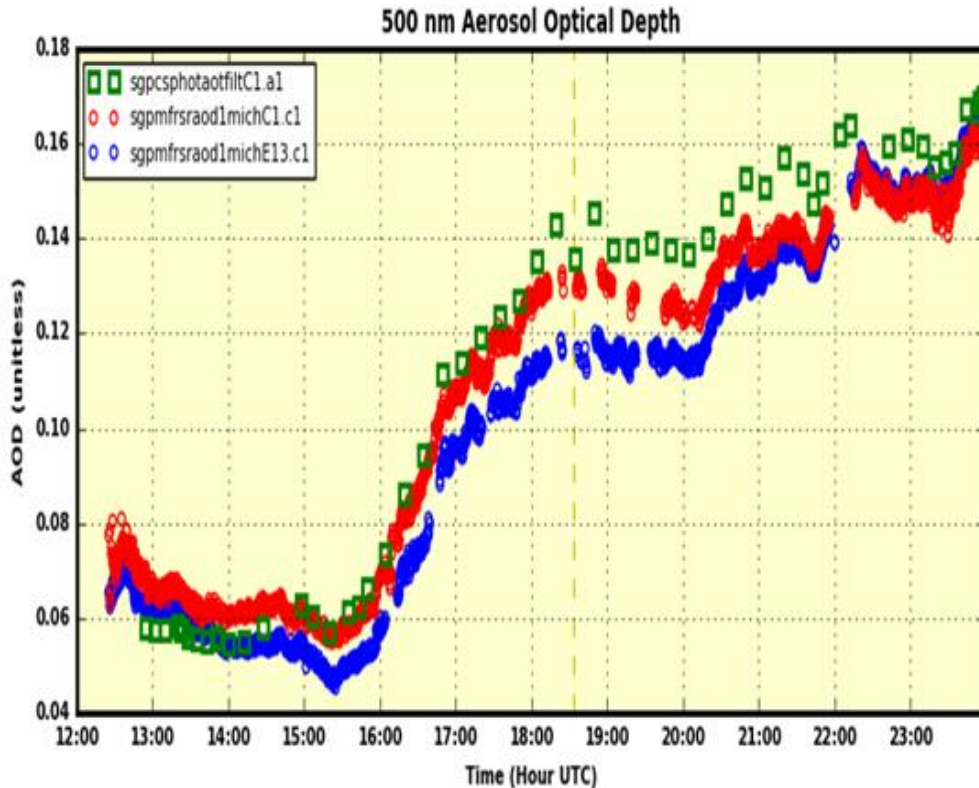
Suspect (Yellow) MFRSR DQR
[D020821.2](#) indicates *high bias* in
MFRSR (C1) Irradiance values due
to *light leakage* (1-2% at 500 nm)



✓ Despite the DQR issue, there is a **good** agreement between AODs from MFRSR and AERONET.

2015-08-20: No DQRs

No MFRSR DQRs



✓ There is a **good** agreement between AODs from MFRSR and AERONET.

Summary

- ▶ **Dates** when MFRSR **heads** and/or **loggers** were replaced (1997-2016) have been determined.
- ▶ **Dates** when **Langley calibrations** may have been impacted by multiple MFRSR heads and/or loggers have been determined.
- ▶ **Dates** with **Data Quality Reports** (DQRs) that mark data as “*Suspect*” or “*Incorrect*” for MFRSR datastreams have been documented.
- ▶ Yearly **comparison plots** of **AODs** from **MFRSR(C1)**, **MFRSR(E13)** and **AERONET** have been generated.
- ▶ **Comparison plots** of **AODs** for periods of interest (e.g., **annual statistics**, **DQRs**, and **hardware changes**) have been generated.



Future Activities

▶ Aerosol Optical Depth:

- *Normal Incidence Multi-Filter Radiometer (NIMFR)*
- *Shortwave Array Spectroradiometer-Hemispheric (SAS-He)*
- *Rotating Shadowband Spectroradiometer (RSS)*

▶ Direct-to-Diffuse Ratio:

- *MFRSR(C1/E13)*
- *SAS-He (C1), RSS (C1)*
- *Broadband instruments*

Machine Learning

▶ Cloud Optical Depth:

- *MFRSR, Broadband instruments (radiative flux analysis)*

Bayesian Approaches



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Additional Slides: DQRs

Annual MFRSR Hardware Changes and Suspect/Incorrect DQRs

HC=head change, LC=logger change, DQR=Data Quality Report

SGP C1 MFRSR:

- 1997: 0 HC, 0 LC, 1 DQR
- 1998: 2 HC, 2 LC, 1 DQR
- 1999: 1 HC, 1 LC, 0 DQR
- 2000: 1 HC, 1 LC, 1 DQR
- 2001: 1 HC, 1 LC, 1 DQR
- 2002: 1 HC, 1 LC, 1 DQR
- 2003: 0 HC, 1 LC, 3 DQR
- 2004: 0 HC, 0 LC, 3 DQR
- 2005: 0 HC, 0 LC, 2 DQR
- 2006: 0 HC, 0 LC, 0 DQR
- 2007: 0 HC, 0 LC, 0 DQR
- 2008: 0 HC, 0 LC, 0 DQR
- 2009: 0 HC, 0 LC, 0 DQR
- 2010: 0 HC, 0 LC, 1 DQR
- 2011: 0 HC, 2 LC, 2 DQR
- 2012: 0 HC, 0 LC, 1 DQR
- 2013: 0 HC, 0 LC, 0 DQR
- 2014: 0 HC, 0 LC, 1 DQR
- 2015: 0 HC, 0 LC, 1 DQR
- 2016: 0 HC, 0 LC, 2 DQR

SGP E13 MFRSR:

- 1997: 0 HC, 0 LC, 0 DQR
- 1998: 2 HC, 3 LC, 1 DQR
- 1999: 4 HC, 4 LC, 1 DQR
- 2000: 2 HC, 2 LC, 0 DQR
- 2001: 1 HC, 3 LC, 2 DQR
- 2002: 1 HC, 0 LC, 1 DQR
- 2003: 0 HC, 0 LC, 0 DQR
- 2004: 0 HC, 0 LC, 0 DQR
- 2005: 0 HC, 0 LC, 1 DQR
- 2006: 0 HC, 0 LC, 2 DQR
- 2007: 1 HC, 2 LC, 4 DQR
- 2008: 0 HC, 0 LC, 2 DQR
- 2009: 0 HC, 0 LC, 1 DQR
- 2010: 0 HC, 0 LC, 2 DQR
- 2011: 0 HC, 0 LC, 3 DQR
- 2012: 0 HC, 0 LC, 1 DQR
- 2013: 0 HC, 0 LC, 2 DQR
- 2014: 0 HC, 0 LC, 2 DQR
- 2015: 0 HC, 1 LC, 1 DQR
- 2016: 0 HC, 0 LC, 3 DQR

Years with MFRSR hardware changes highlighted by **red** rectangles

Years with no hardware changes and no suspect/incorrect DQRs highlighted by **green** rectangles

- ❖ No overlapping years without hardware changes and DQRs
- ❖ Logger changes after 2007 at SGP E13 not expected to impact calibration with switch from Yankee to Campbell

Additional Slides: Statistics

MFRSR 1-min Averaged 500 nm AOD Comparison for SGP E13 vs C1, (Data Flagged by Automated QC in Files Removed: n, Bias, RMSD, R², slope, intercept)

All data files:

- 1997: 12739, 0.001, 0.006, 0.985, 0.959, 0.004
- 1998: 17610, -0.002, 0.045, 0.676, 0.753, 0.024
- 1999: 29944, 0.005, 0.039, 0.524, 1.001, 0.005
- 2000: 31385, 0.004, 0.008, 0.986, 0.984, 0.005
- 2001: 28190, 0.014, 0.031, 0.806, 0.892, 0.024
- 2002: 23803, 0.009, 0.019, 0.944, 0.981, 0.011
- 2003: 37480, 0.004, 0.009, 0.986, 0.99, 0.005
- 2004: 41759, -0.001, 0.007, 0.987, 0.987, 0
- 2005: 37929, -0.004, 0.011, 0.983, 1.005, -0.004
- 2006: 41131, -0.004, 0.007, 0.988, 0.987, -0.002
- 2007: 32967, -0.013, 0.015, 0.988, 0.944, -0.007
- 2008: 48964, -0.013, 0.014, 0.991, 0.979, -0.011
- 2009: 43269, -0.005, 0.008, 0.981, 0.947, 0
- 2010: 34379, 0.001, 0.006, 0.982, 0.985, 0.002
- 2011: 43208, 0.002, 0.008, 0.982, 0.963, 0.005
- 2012: 37060, 0.002, 0.006, 0.992, 0.985, 0.003
- 2013: 42889, 0.001, 0.006, 0.991, 0.947, 0.005
- 2014: 35490, 0.006, 0.009, 0.989, 0.948, 0.01
- 2015: 40182, 0.003, 0.011, 0.967, 0.898, 0.011
- 2016: 27430, 0, 0.005, 0.984, 0.95, 0.003

Files not impacted by hardware changes and/or DQRs:

- 1997: 12739 (100%), 0.001, 0.006, 0.985, 0.959, 0.004
- 1998: 7483 (42.5%), 0.005, 0.013, 0.967, 0.96, 0.008
- 1999: 21054 (70.3%), 0.003, 0.005, 0.991, 1.038, 0
- 2000: 20104 (64.1%), 0.003, 0.007, 0.991, 1.003, 0.002
- 2001: 8870 (31.5%), 0, 0.005, 0.993, 0.948, 0.006
- 2002: 1348 (5.7%), 0.015, 0.016, 0.966, 0.975, 0.016
- 2003: 28745 (76.7%), 0.005, 0.008, 0.993, 1.001, 0.005
- 2004: 41193 (98.6%), -0.001, 0.007, 0.987, 0.987, 0
- 2005: 33483 (88.3%), -0.001, 0.006, 0.994, 1.008, -0.002
- 2006: 40056 (97.4%), -0.004, 0.007, 0.988, 0.987, -0.002
- 2007: 27994 (84.9%), -0.014, 0.015, 0.99, 0.951, -0.009
- 2008: 48119 (98.3%), -0.013, 0.014, 0.991, 0.979, -0.011
- 2009: 42772 (98.9%), -0.005, 0.008, 0.981, 0.948, 0
- 2010: 32937 (95.8%), 0.001, 0.006, 0.981, 0.984, 0.003
- 2011: 31884 (73.8%), 0.004, 0.005, 0.992, 1.007, 0.003
- 2012: 30498 (82.3%), 0.001, 0.006, 0.992, 0.988, 0.003
- 2013: 39800 (92.8%), 0.001, 0.006, 0.991, 0.947, 0.005
- 2014: 34907 (98.4%), 0.006, 0.009, 0.99, 0.946, 0.01
- 2015: 29484 (73.4%), 0.004, 0.01, 0.979, 0.906, 0.012
- 2016: 27111 (98.8%), 0, 0.005, 0.984, 0.951, 0.003