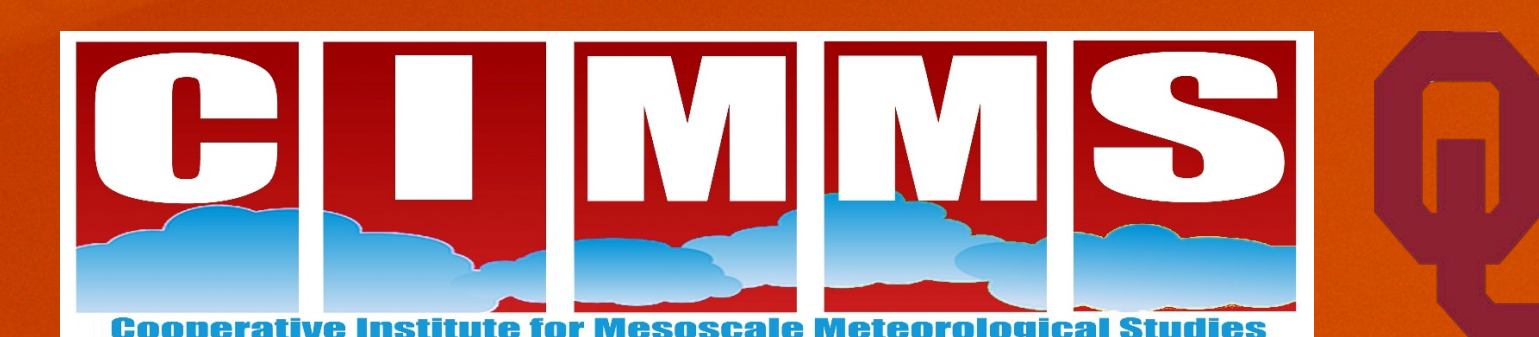


# Development of AOD Best Estimate Product at ARM SGP Site



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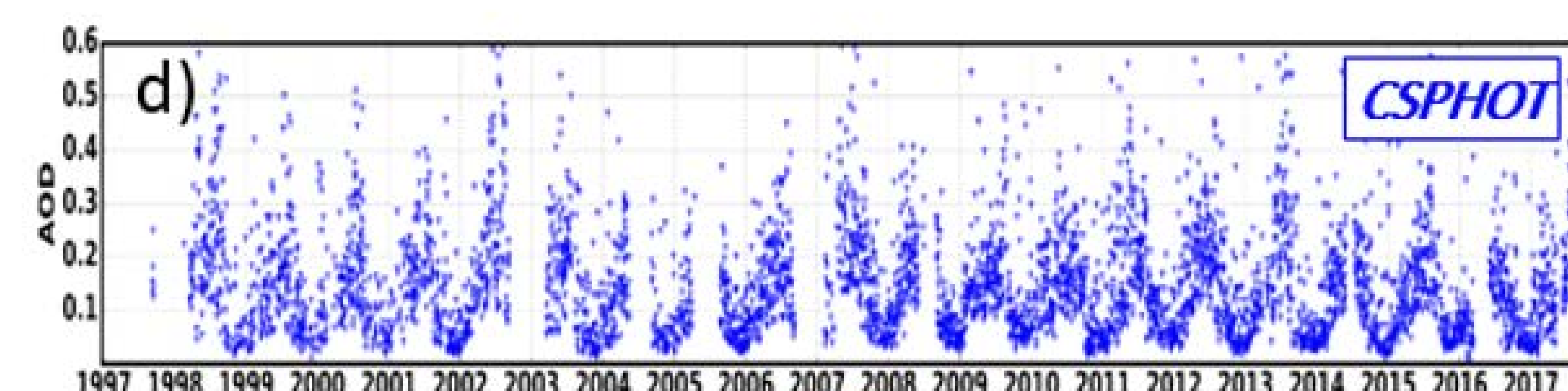
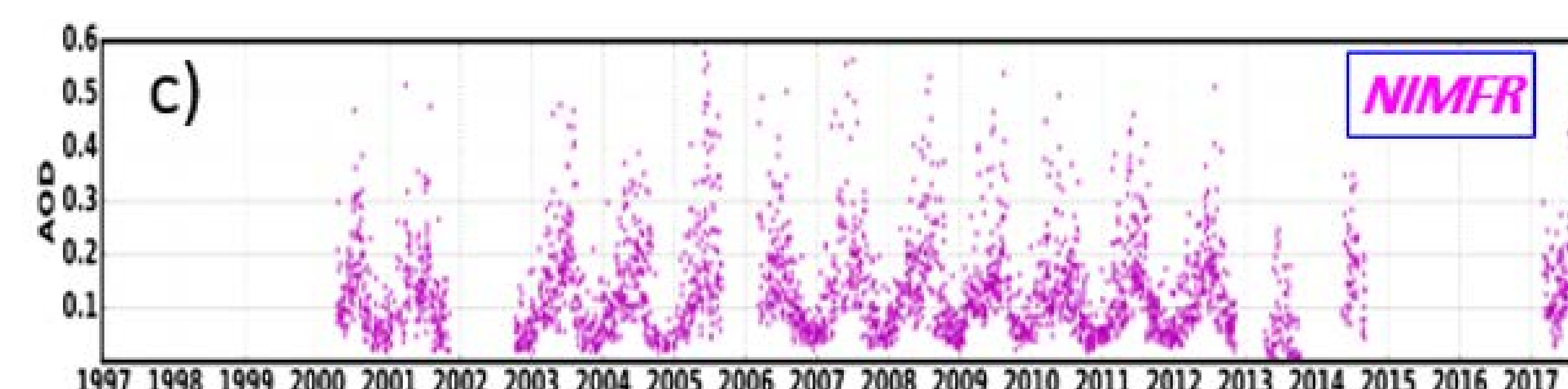
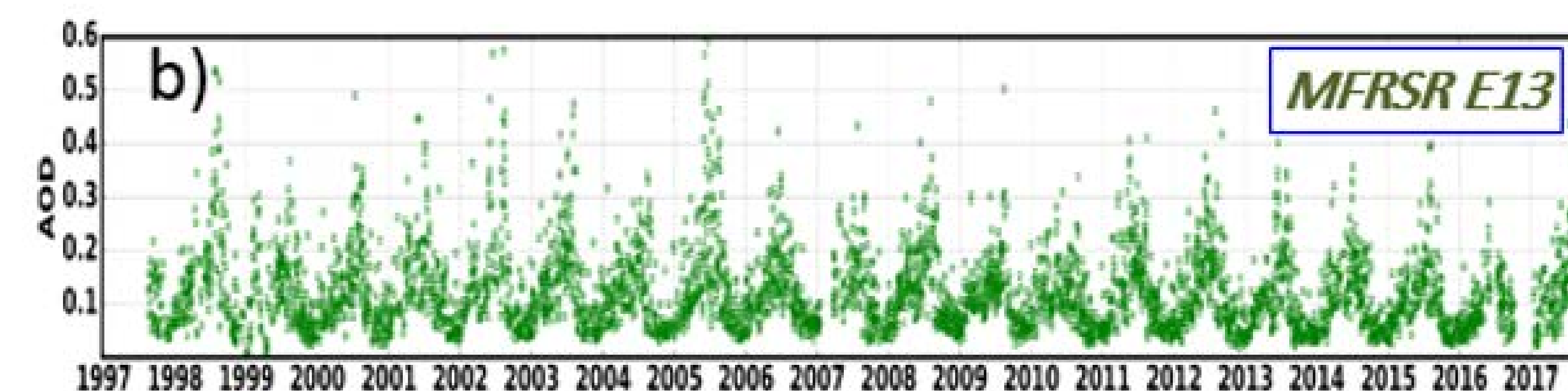
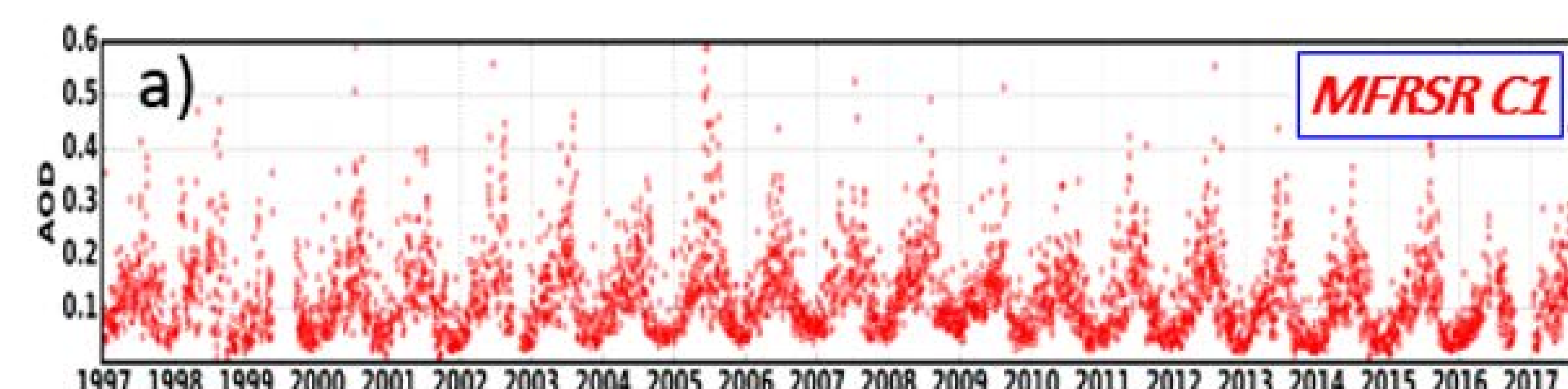
Proudly Operated by Battelle Since 1965

## Motivation

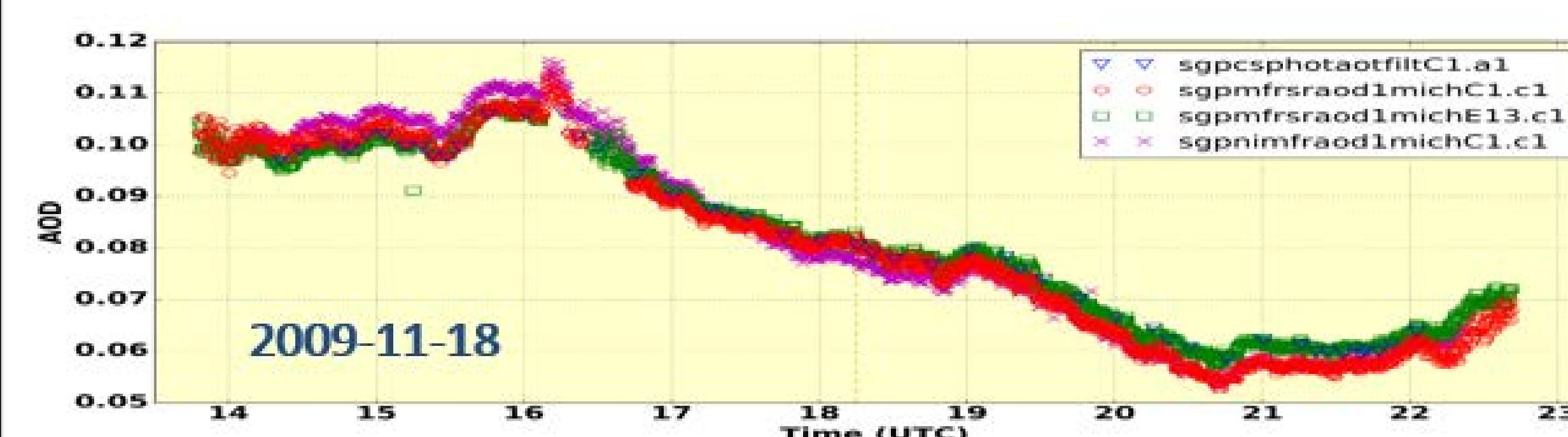
- A continuous multi-year record of aerosol optical depth (AOD) is required for improved understanding of complex aerosol-related processes.
- Development of the required record is a challenging task mainly due to two main issues: (1) discontinuous and partially overlapping AOD records provided by individual instruments; (2) instrument- and time-dependent data quality information.
- **How can individual AOD records be used to develop Best Estimate Product at the ARM SGP CF?**



Images of three ground-based instruments for measuring AOD: **MFRSR** (left), **CSPHOT** (center) and **NIMFR** (right)



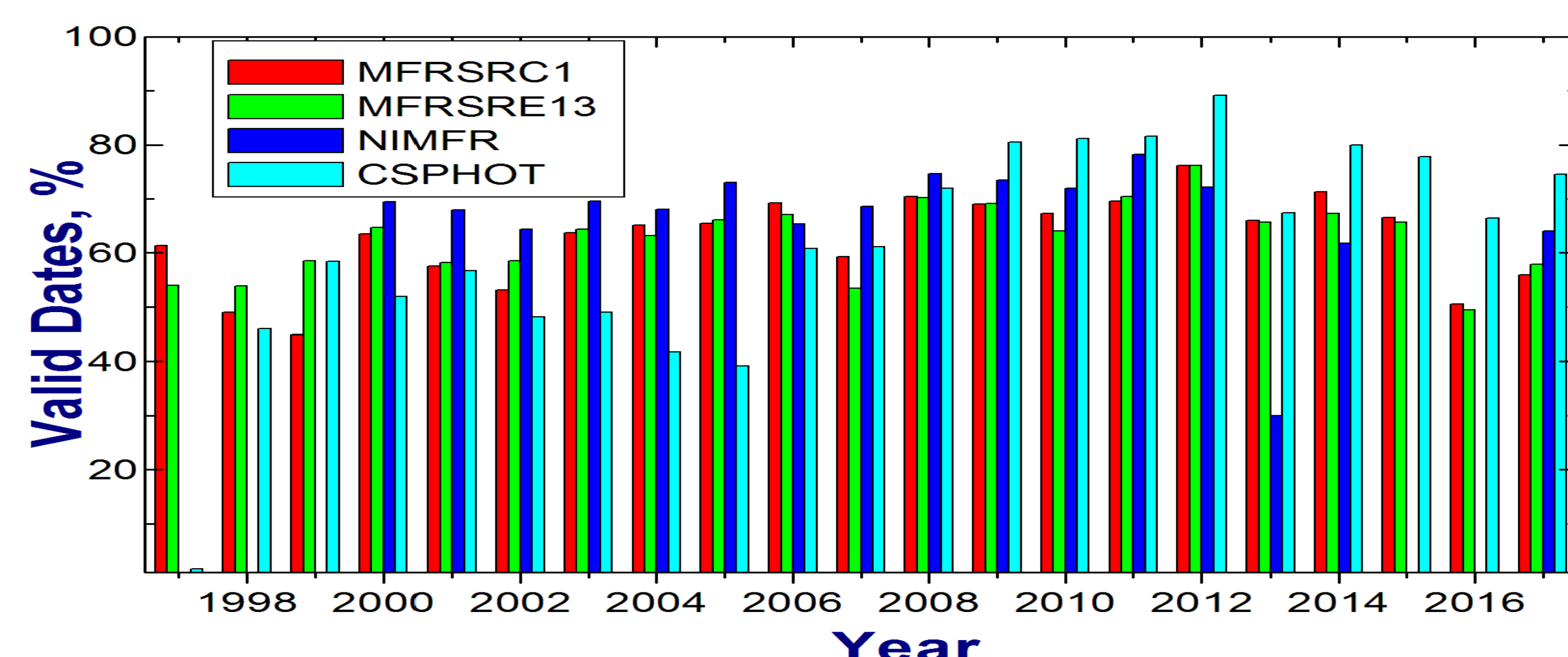
Time series of AOD (500 nm) from 4 instruments for 20-year period (1997-2017): **MFRSR C1** (a), **MFRSR E13** (b), **NIMFR** (c), **CSPHOT** (d).



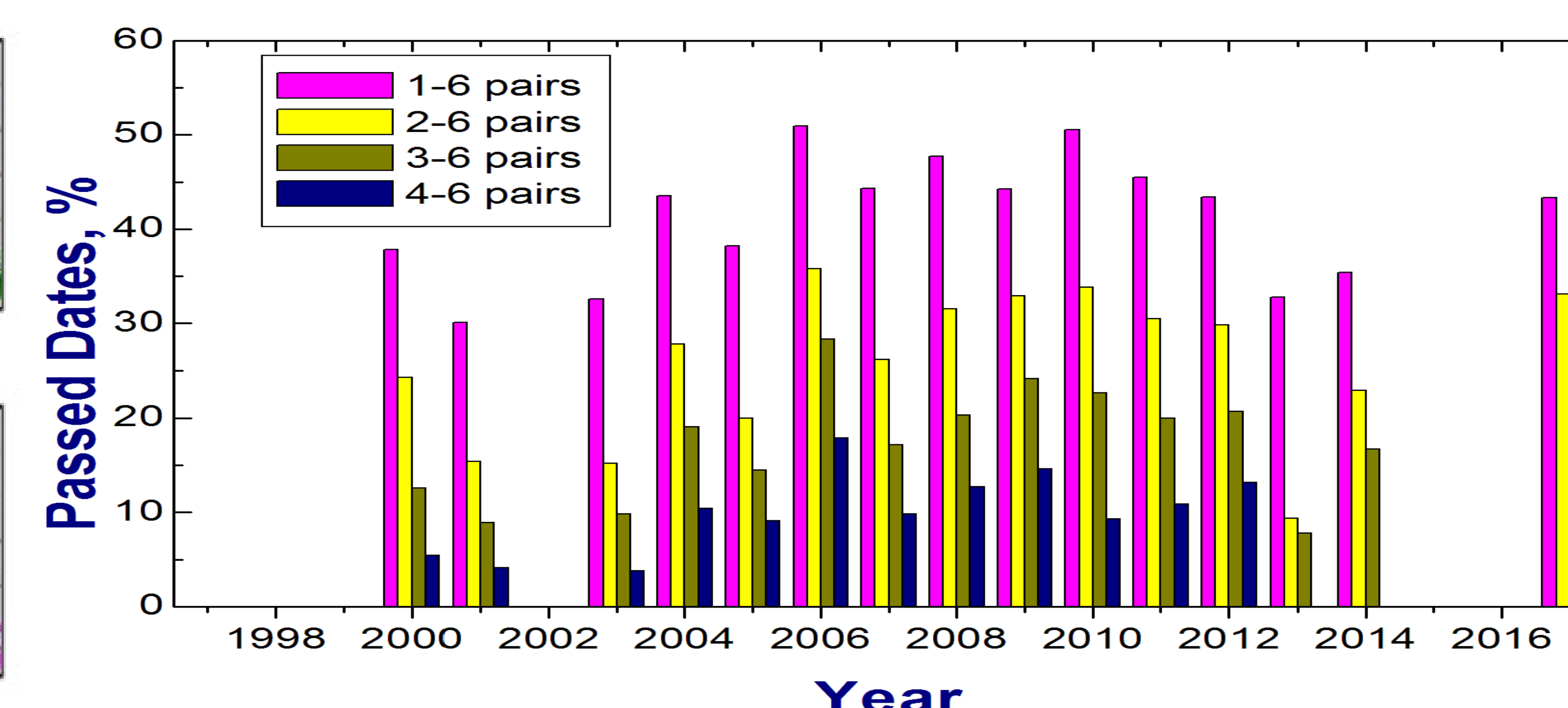
Example of time series of AOD from 4 instruments: **good agreement** for **all** AOD pairs (top), **noticeable disagreement** for **one** AOD pair (bottom). Data from both dates passed comparison testing thresholds.

## Conclusion

- We introduce an approach for development of a **multi-year** (1997-2017) record with focus on **good AOD data epochs** at the ARM SGP CF.
- Our approach merges historical time series of AOD from **four** collocated individual instruments (**MFRSR-C1, MFRSR-E13, NIMFR, CSPHOT**) and the corresponding data quality information.
- Our approach goes beyond established methods (e.g., Michalsky et al., 2010) by (i) enhanced flexibility (e.g., more data streams) and (ii) possibility to provide **uncertainty** of the good AOD data epochs over increased temporal coverage.



Fraction of **valid dates** for a given instrument (colored bars). For **MFRSR/NIMFR**, this fraction is a ratio of "Number of Valid Dates" to "Total Dates Available". **Valid date** is a date that has at least one AOD after removing data that fail QC tests. For **CSPHOT**, this fraction is "Total Dates Available"/365 (or 366 in leap year).



Fraction of **passed dates** (colored bars) as function of specified number of comparison tests (or number of pairs of AOD from four individual instruments). This fraction represents only **valid dates** available for **all four** instruments. Comparison tests use **criteria** from Approach section.

## AOD Measurements

- Two Multifilter Rotating Shadowband Radiometers (**MFRSRs**) at co-located sites (C1 and E13)
  - [sgpmfrsraod1michC1.c1](#)
  - [sgpmfrsraod1michE13.c1](#)
- Normal Incidence Multifilter Radiometer (**NIMFR**)
  - [sgpnimfraod1michC1.c1](#)
- Cimel sunphotometer (**CSPHOT**)
  - [sgpcsphtaotfiltqa.a1](#) (1997-2007, level 2.0)
  - [sgpcsphtaotfilt.a1](#) (2007-2017, level 1.5)
- **Period examined: 1997-01-16 – 2017-12-31** (align with start of [sgpmfrsraod1michC1.c1](#) data).

## Approach

- Remove all **MFRSR/NIMFR** AOD data that fail QC tests.
- Resample **MFRSR, NIMFR, CSPHOT** AODs by calculating 1-min mean values (nearest-neighbor in 1-min window for **CSPHOT**).
- Perform **daily** AOD comparisons by calculating **linear best-fit** and using the following **criteria** (e.g., Michalsky et al., 2010):
  - **MFRSR/NIMFR vs MFRSR:**

$$N \geq 100, R^2 \geq 0.9, |Bias| \leq 0.02, 0.8 \leq Slope \leq 1.2$$
  - **MFRSR/NIMFR vs CSPHOT:**

$$N \geq 10, R^2 \geq 0.9, |Bias| \leq 0.02, 0.8 \leq Slope \leq 1.2$$
- Process ~20 years of data, catalog dates that pass all threshold tests indicating "consistent agreement". Maximum of **6 comparisons** (pairs of individual AODs) is possible.