Aerosol-Related Data Products and VAPS

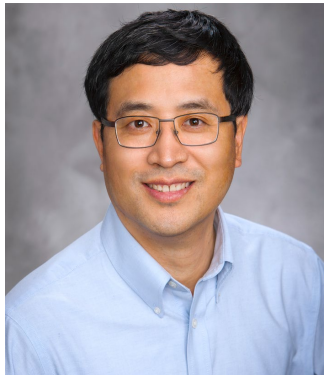
JOHN SHILLING AND PNNL TRANSLATOR TEAM

PNNL

ASR Science Team Meeting 2021

Science Product Development Led by a Team of Scientists

Translator Group



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Modeling POC

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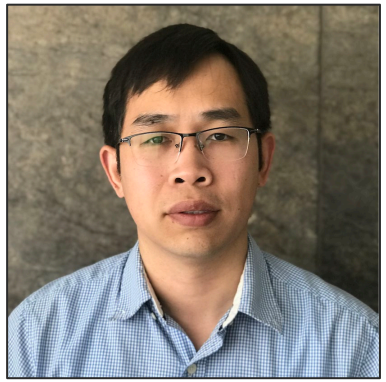
Aerosol POC
TRACER POC



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Warm Clouds POC
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Data Quality

New Data Products – Size Distributions

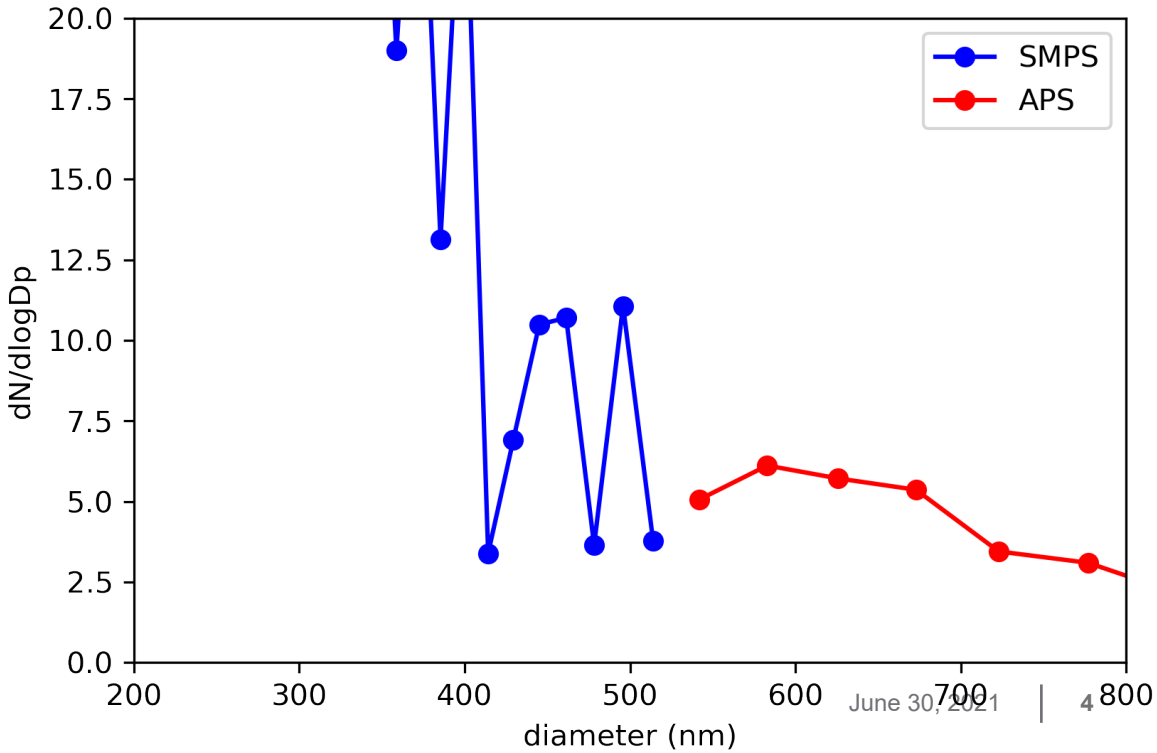
- We have generated harmonized b-level datastreams at most sites for:
  - Nano-SMPS
  - SMPS
  - UHSAS
  - APS
  - Some data from older campaigns is being reprocessed.
- These harmonized datastreams standardize variable names and units, including:
  - Size distributions in dN/dlogDp units.
    - This will facilitate size distribution inter-comparison.
  - Size bin diameter midpoints and upper and lower bounds
  - Integrated number concentration, volume, and surface area.
    - Will facilitate inter-comparison.
  - QA/QC checks on the data.

Merged Size Distribution VAP Development – Strategy and Challenges

- Start by merging SMPS and APS data.
  - Physics of conversion is well-known.
  - These instruments cover most of the relevant aerosol size range
  - SMPS: 10.9 – 514 nm mobility diameter
  - APS: 542 – 19,810 nm aerodynamic diameter
- Algorithm based on Beddows et al. 2010, but modified and translated to Python.
- Challenges:
  - Very small overlap region (0 – 5 bins for reasonable aerosol density).
  - Very few particles in overlap region; data are noisy.
  - Instruments less accurate at edge of their sizing region.

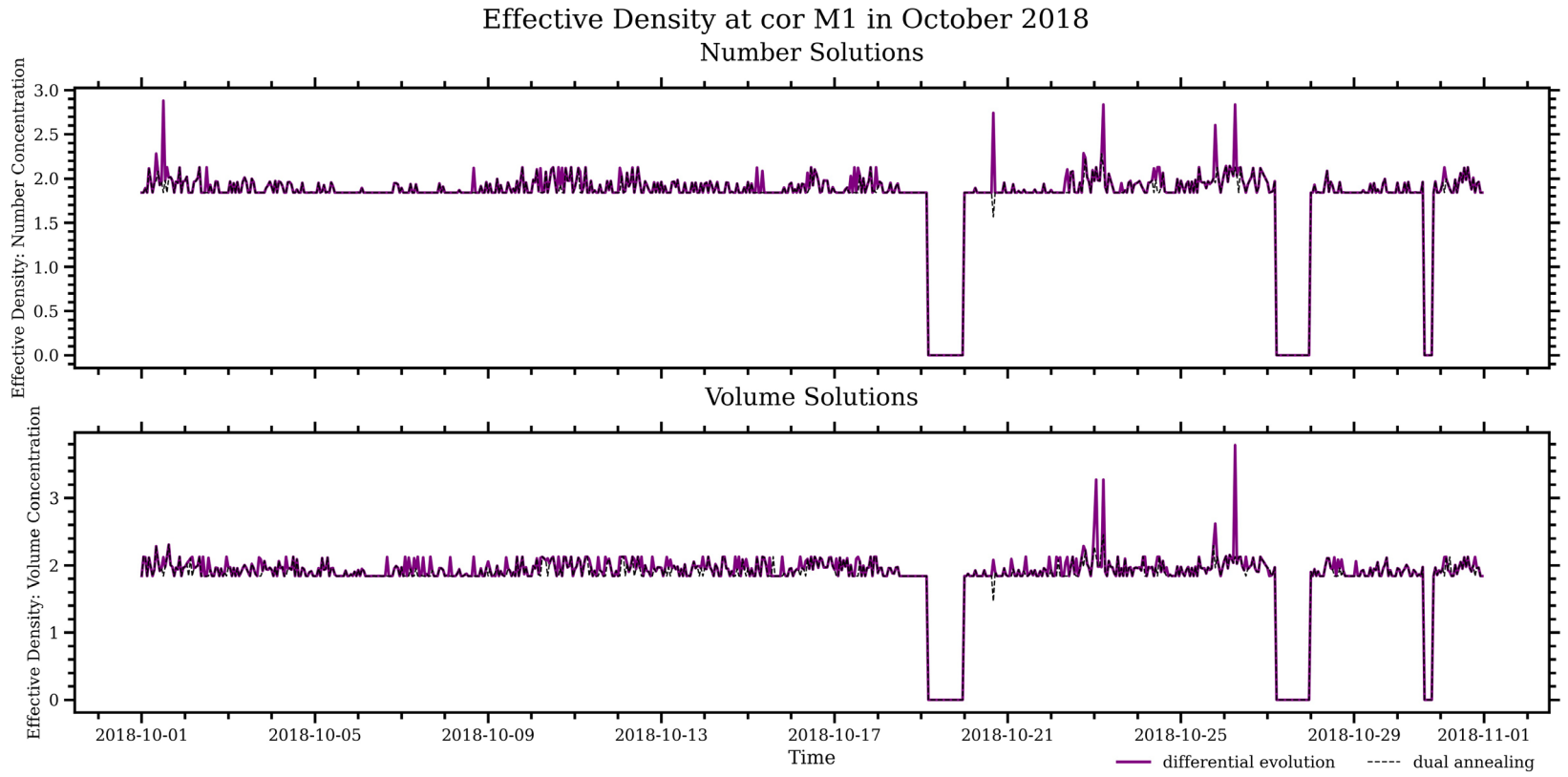
$$d_{mob} = \frac{d_{aero}}{\sqrt{\rho_{eff}}}$$

$$\rho_{eff} = \frac{C(d_{mob})\rho}{C(d_{aero})\rho_0 \chi}$$



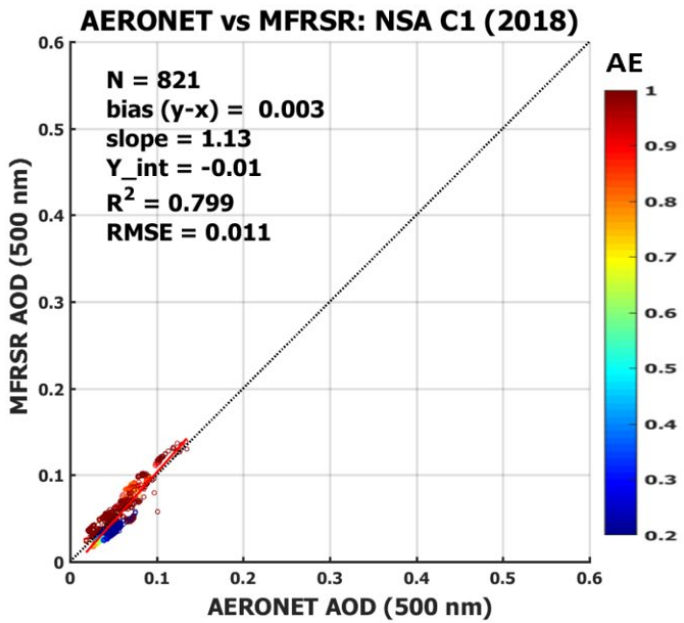
Merged Size Distribution VAP Development – Progress

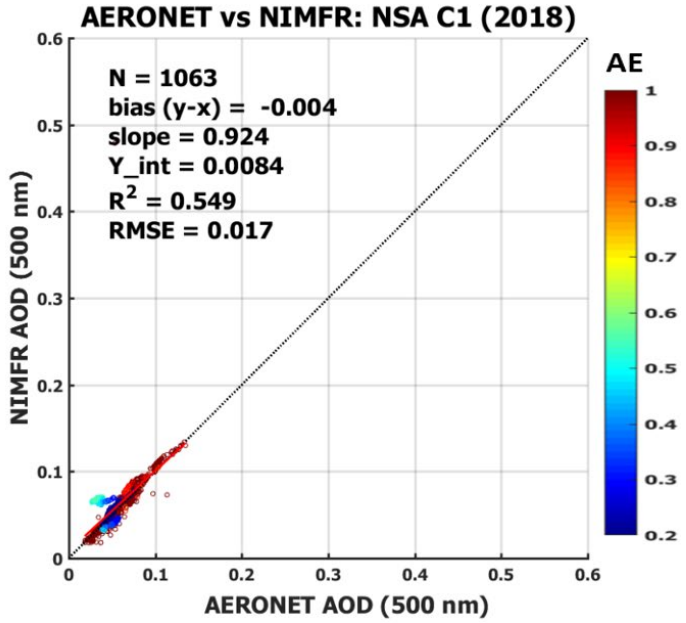
- We've run VAP for COR and SGP.
- Averaged data to 1 hr. to improve S/N; calculate number and volume-based results.
- Results are reasonable for COR, noisier for SGP.
- Goal is to release an evaluation dataset for COR at the end of the FY.



AOD VAP: Update

- AOD VAP uses MFRSR and NIMFR data to calculate AOD at 2-5 wavelengths.
  - Provided QA/QC metrics.
  - Outliers are removed.
- Currently evaluating AOD at the NSA site for 2017 – 2020.
  - Expect release by end of FY.
- Recently released AOD for MCQ.

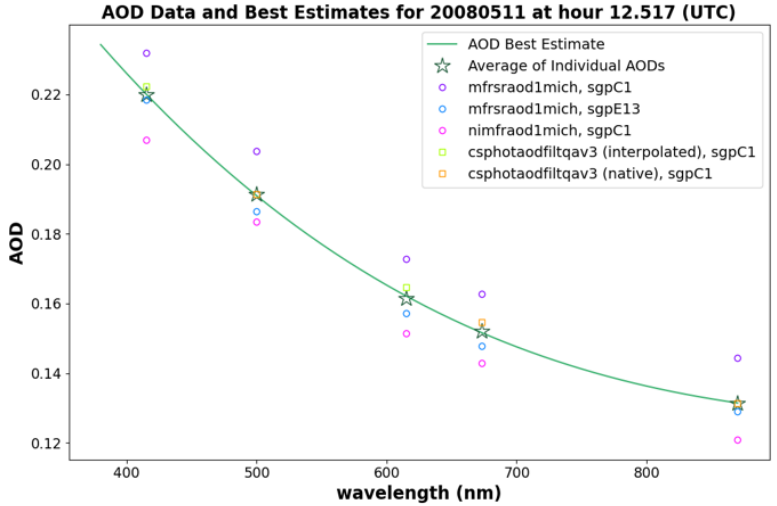


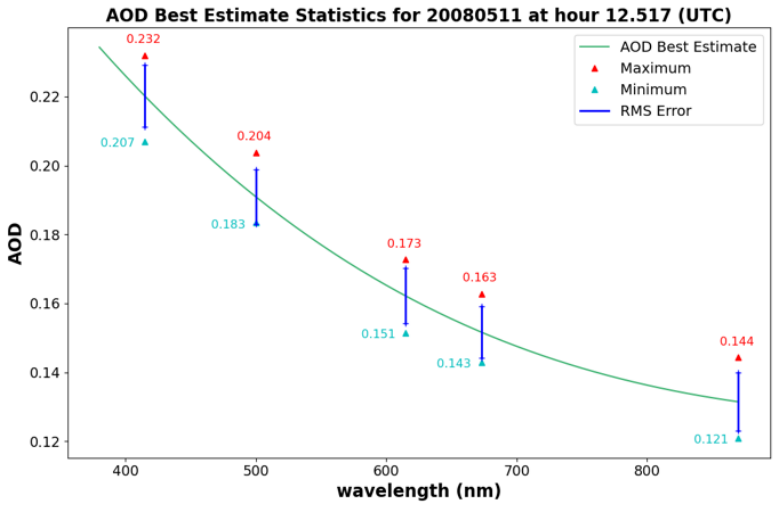


Quality Controlled AOD VAPS QCAOD and AODBE: Update

- These VAPS combine AOD measurements from multiple instruments to:
  - Provide a single best AOD value at 2 (QCAOD) or 5 (AODBE) wavelengths.
  - Improve the temporal resolution and fill in data gaps.
  - Provides an error range.
- Progress: Released AOD at 500 and 870 nm for 1997-2018 at the SGP site with 1 minute resolution.[1]
- Currently adding additional wavelengths at SGP.
- Will extend to other ARM sites with multiple AOD instruments next FY.

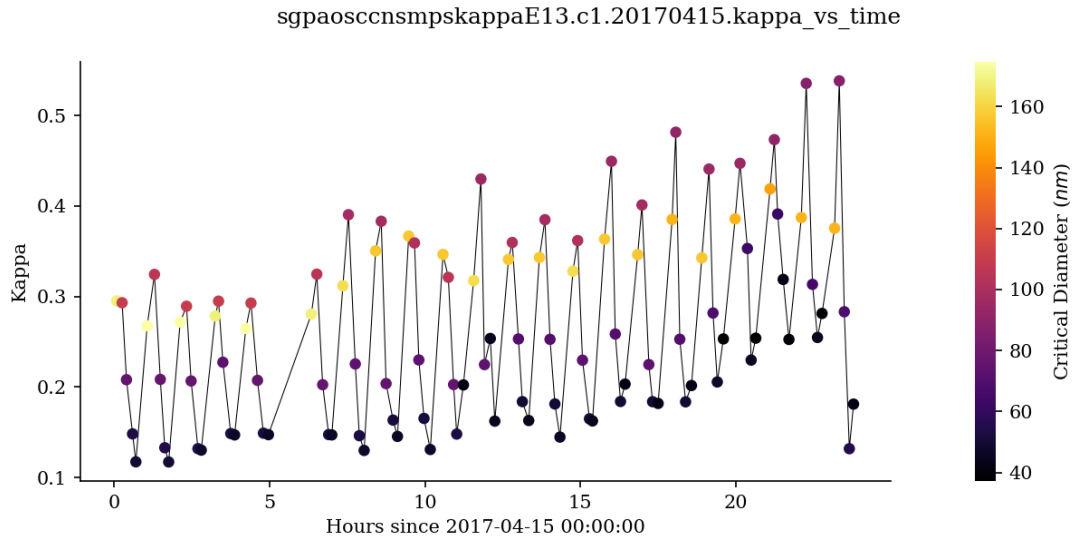
[1]Kassianov, E., *et al.* 2021: Harmonized and high-quality datasets of aerosol optical depth at a US continental site, 1997–2018. *Sci Data.*

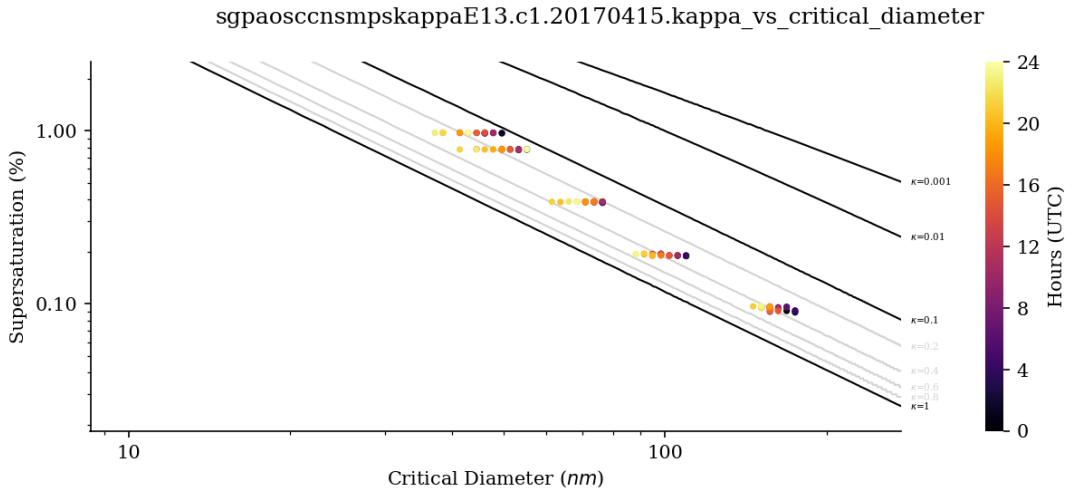




CCN Kappa (hygroscopicity) VAP : Update

- CCN kappa VAP uses CCNC and SMPS measurements to parameterize hygroscopicity with the kappa parameter.
- Kappa value is calculated for each value of SS using size distribution measurements.
  - Currently based on SMPS.
- Kappa data for April 2017 – February 2021 at SGP are newly available and we welcome comments.
- Will extend to other sites/deployments (ANX, ASI, COR, MOS) in coming FY.

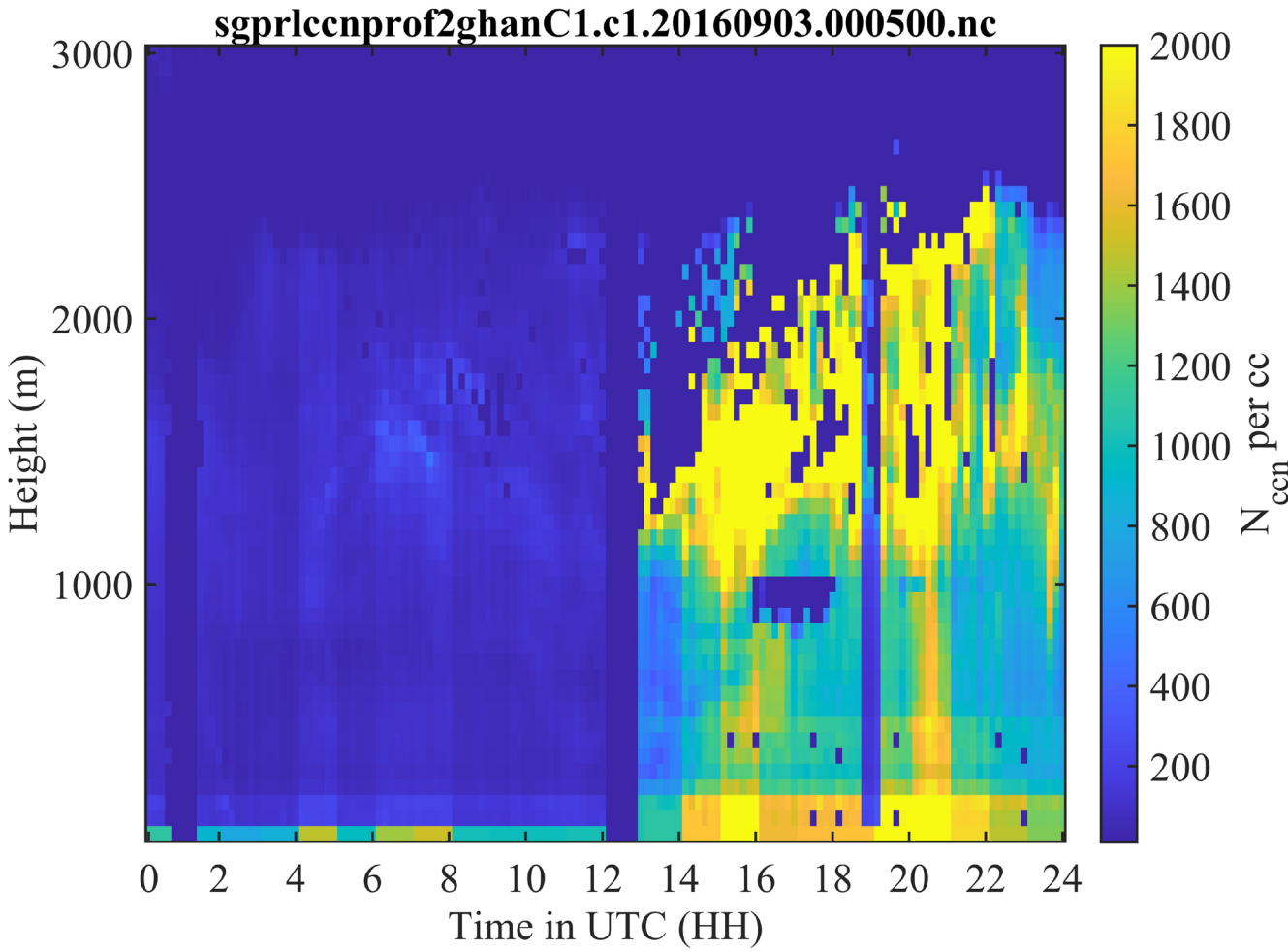




Kappa constant lines are drawn from analytical expression number 10 from Petters and Kreidenweis (2007).

CCN Vertical Profile VAP: Update

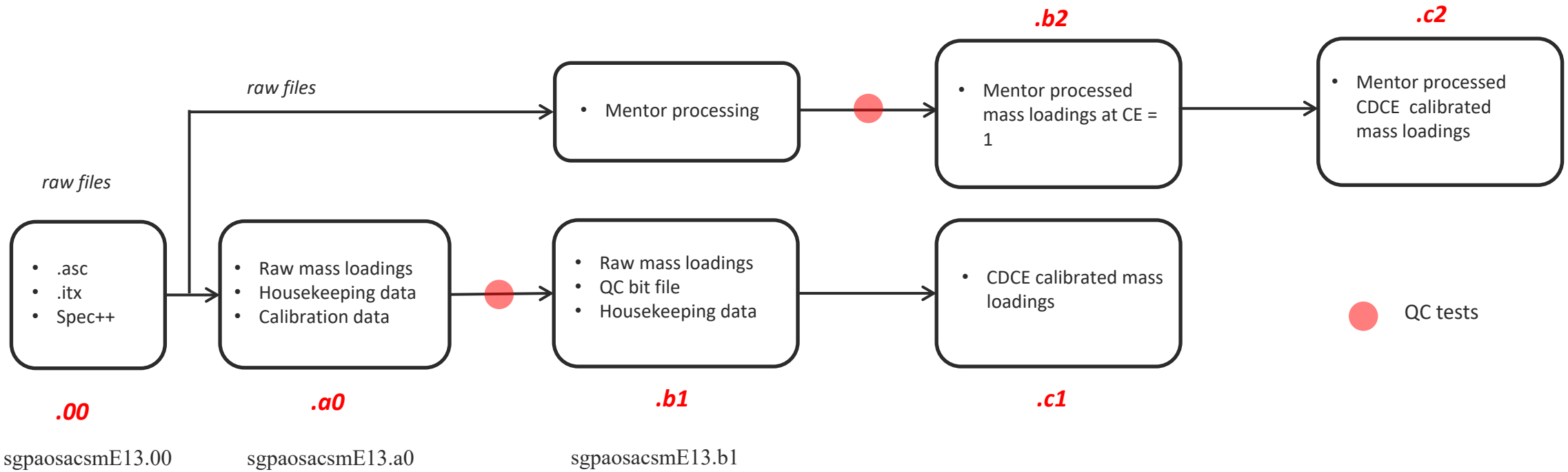
- CCN profile VAP estimates the vertical distribution of CCN as a function of supersaturation.
  - Combines measurements from the RL, CCNC, f(RH), and met data.
  - Valid up to cloud base.
- Based on McFarlane, Ghan, Collins algorithm with updates to inputs and QA/QC.
- Currently working on 2016 SGP data and comparing to in-situ G-1 measurements from HI-SCALE.
  - Working on QA/QC tests.
- Starting to derive f(RH) for ENA.



Vertical CCN profiles at 0.4% supersaturation

ACSM data processing strategy

- ACSM is a complicated instrument that requires mentor processing to ensure highest quality data.
- In an effort to balance timely data release with the desire to generate high-quality data, we developed a two-pronged data processing strategy.



ACSM Data Processing: ACSM CDCE

- We have applied the composition dependent collection efficiency calculation from Middlebrook et al. 2012 to the autonomous ACSM b1 data.
- VAP will run in near real-time for most sites, providing high-quality data to users in a timely fashion.
- The CDCE algorithm significantly improved the ACSM/SMPS comparison at SGP, but it isn't perfect.
  - Need to look into other sites.
  - Also compares well to mentor data.
- SGP data is available for Sept 2019 - present.
  - Plan on extending to other Quadrupole ACSM data.