Aerosol VAP updates

JOHN SHILLING

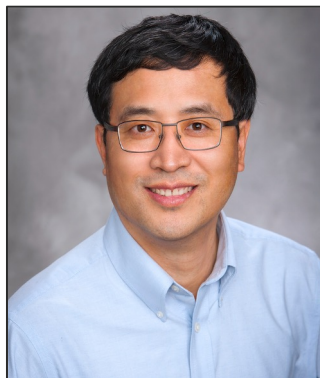**PNNL**

ASR/ARM PI meeting

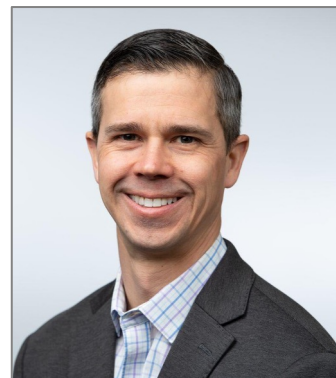# Science Product Development Led by a Team of Scientists
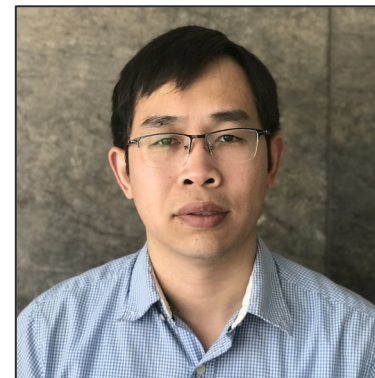
ARM

ARM Translator Group

Translators are liaisons between the scientific community and ARM infrastructure staff members, and develop Value-Added Products, or VAPs, from the direct output of ARM instruments.

Shaocheng Xie
Warm Clouds POC
EPCAPE POC

John Shilling
Aerosol POC
TRACER POC

Damao Zhang
High-Latitude POC
SAIL POC

Scott Collis
Convective POC
AWAKEN POC

Scott Giangrande
Lead Translator
COMBLE POC

**Krista Gaustad**
Software
Development

Ken Kehoe
Data Quality

CCN Vertical Profile VAP (RNCCN)

▶ 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.

▶ Data available at SGP for 2016 - 2022.

▶ We are continuously updating QA/QC.

▶ Will begin working on EAN data in FY24.

Vertical CCN profiles at 0.4% supersaturation
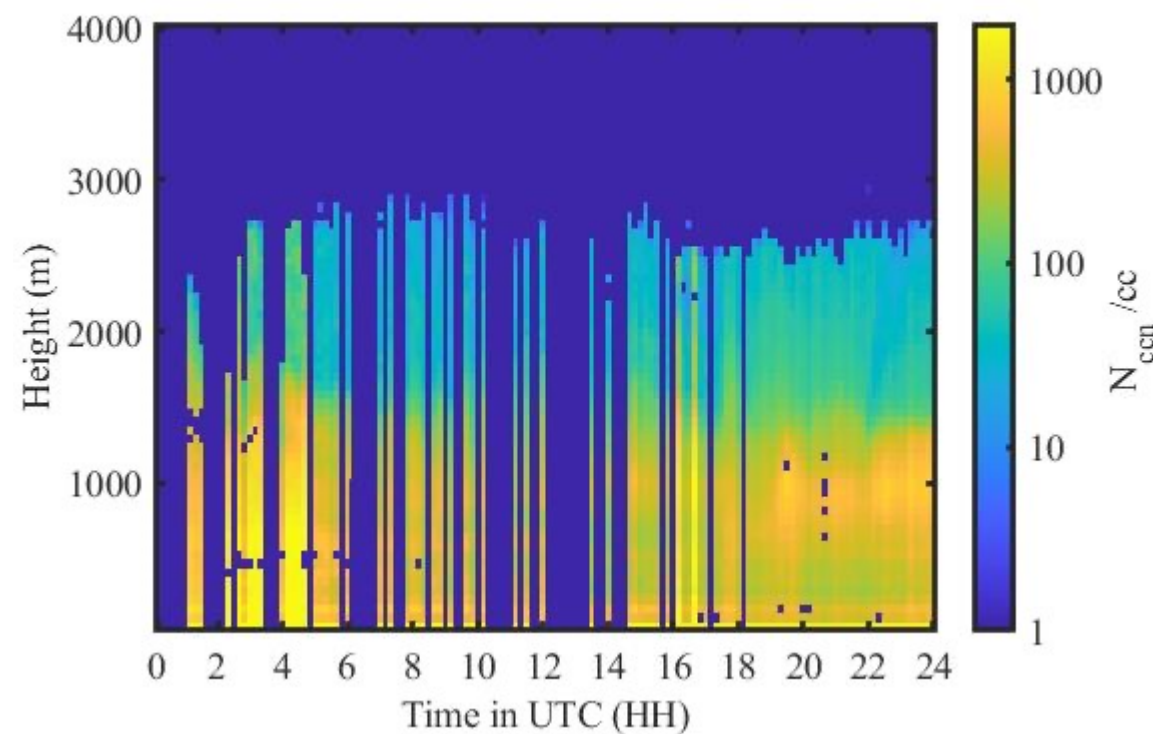
Missing values indicates bad input data and poor met data.

Aerosol Optical Depth Best Estimate (AODBE)

▶ This VAP combines AOD measurements from multiple instruments to:
- ■ Provide a single best AOD value at 5 (or 7) wavelengths: 415, 500, 615, 673, 870,1625 nm
- ■ Improve the temporal resolution and fill in data gaps.
- ■ Provide an error range (e.g., *standard deviation*, **StDev**).

▶ Released AOD at five wavelengths for 1997-2021 at the SGP site with 1-min resolution. In the process of releasing ENA data (expected by end of FY).

▶ Will extend to other ARM sites and add in the 7th channel next FY.
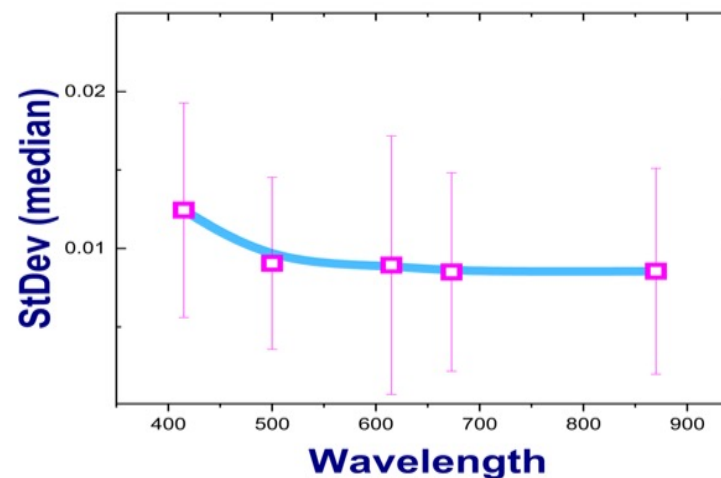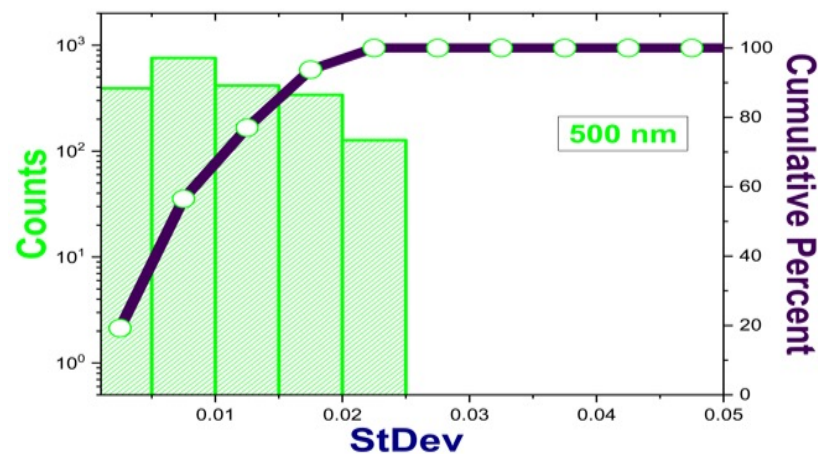
o **StDev** is **small** (< **0.02**) for the majority of cases (>**90**% of time).
o On average, **StDev** depends **weakly** on wavelength.

Merged Size Distribution VAP (MergedSMPSAPS)

- ► Merged Size Distribution VAP creates a single **mobility size** distribution, with TSI-SMPS bin structure, from the SMPS and APS data.
- ► Algorithm based on Beddows et al. 2010.
- ► Data are now available for SGP from 2017 – August 2022.
  - ■ Data are averaged for 1 hour to improve S/N
  - ■ Integrated number, surface area and volume are calculated.
  - ■ Effective density and solution metrics also provided.
- ► Currently processing data for sites with an SMPS and APS.
- ► Will run in near-real time in FY 24.
- ► Translator welcomes any comments or concerns about this VAP.

Example of Merged Size Distribution Data
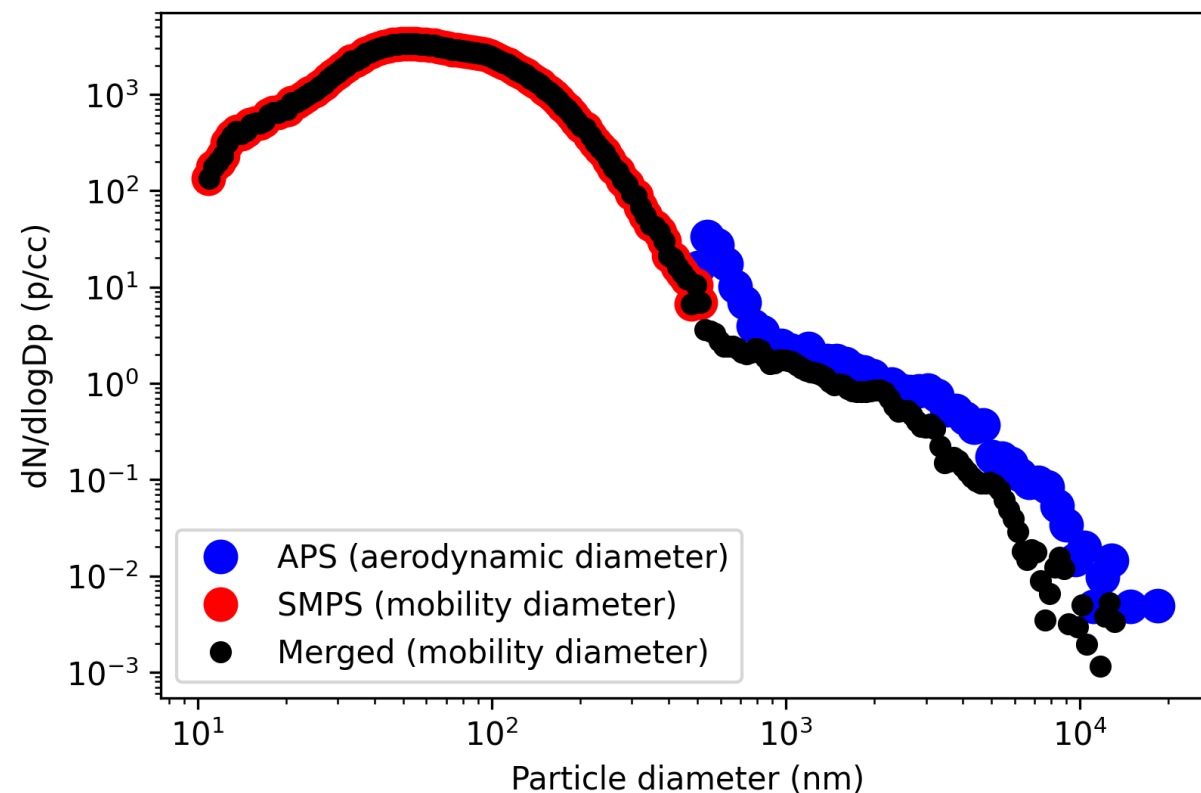
Merged Size Distribution VAP QA/QC using Machine Learning

- ► The merged size VAP merges SMPS and APS sizing data into a single file.
- ► We've used ML to automate an advanced QA/QC assessment after finding simple QA/QC tests were inadequate.
- ► Manually-labeled dataset was assembled from 1 year of SGP + HOU +COR merged size VAP data.
- ► Model was trained on a portion of the data and evaluated with another portion.
  - ■ Many types of classifier models and a neural network were evaluated.
  - ■ Neural Network and Stacking Classifier produced best results.
- ► The trained RF models are both achieving approximately 90% labeling accuracy.
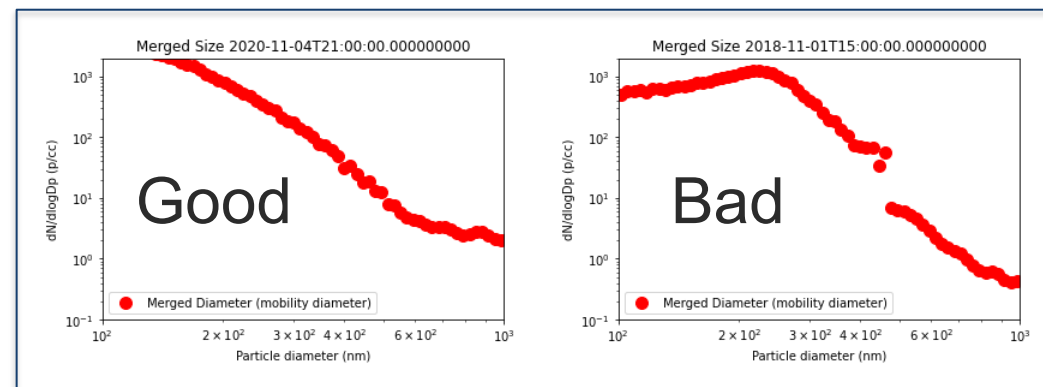

Machine Learning
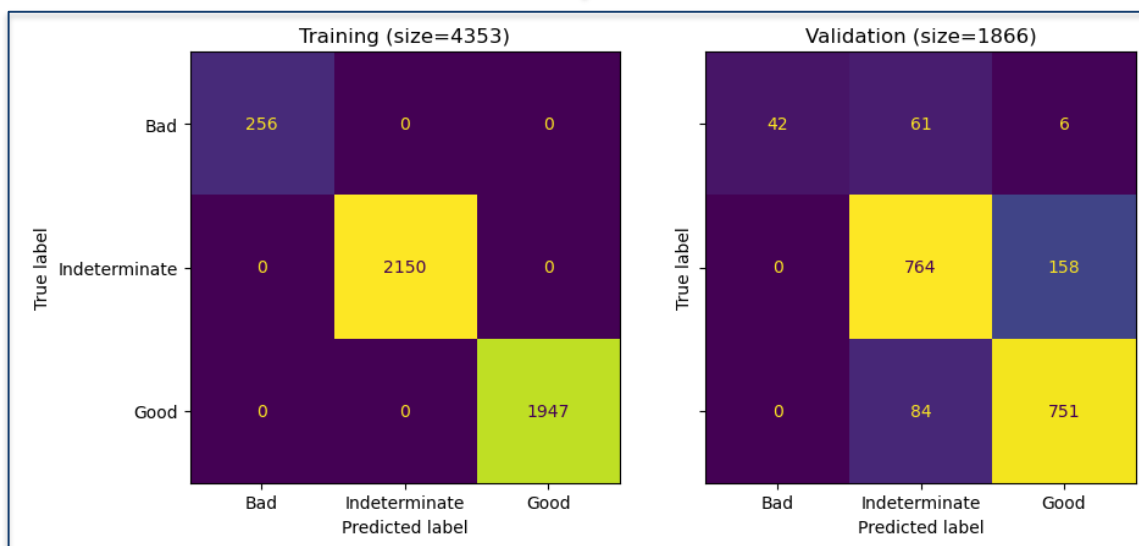
CCN Kappa (hygroscopicity) VAP (CCNSMPSKappa)

- CCN kappa VAP uses CCNC and SMPS measurements to parameterize hygroscopicity using Kappa-Kohler Theory (Petters and Kreidenweis, 2007).

- Kappa value is calculated for each value of SS using size distribution measurements.
  - Currently based on SMPS.

- Kappa data are now available for all sites with a CCN and an SMPS.
  - Data typically released a few months after campaign end.

- Participating in an intercomparison of methods of calculating CCN kappa.

- Will soon release kappa data based on UHSAS, for sites lacking an SMPS.

sgpaosccnsmpskappaE13.c1.20170415.kappa_vs_time
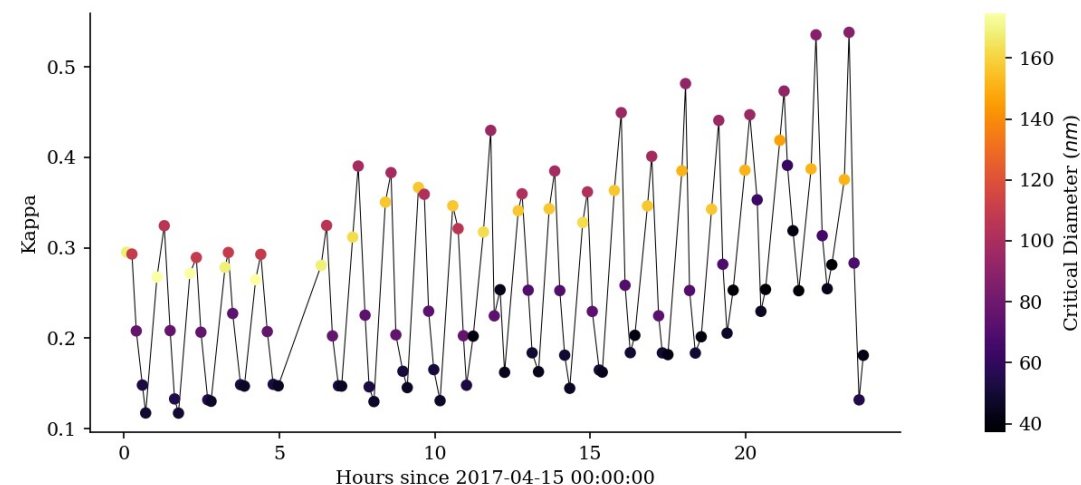
sgpaosccnsmpskappaE13.c1.20170415.kappa_vs_critical_diameter
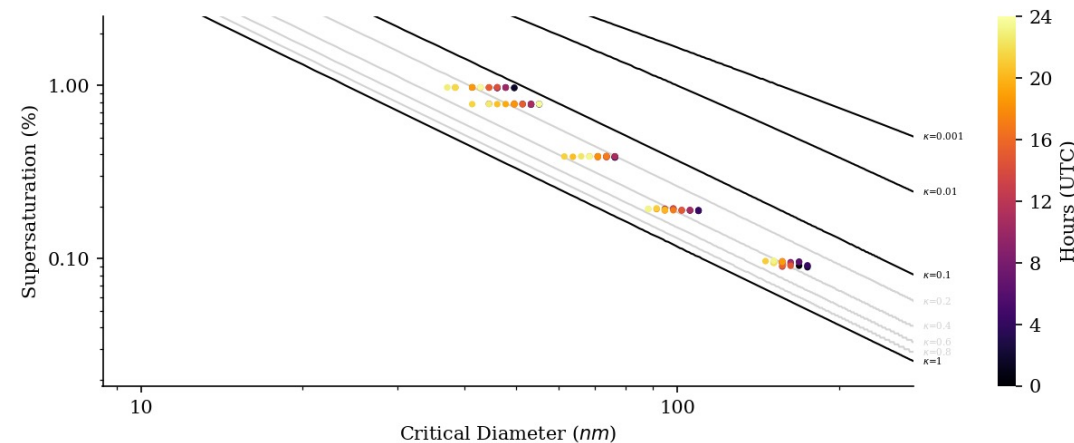
Kappa constant lines are drawn from analytical expression number 10 from Petters and Kreidenweis (2007).

ACSM Corrected mass (ACSMCDCE)

▶ We have applied the composition dependent collection efficiency calculation from Middlebrook et al. 2012 to the autonomous ACSM b1 data.

▶ VAP is currently running in near real-time for all sites with an ACSM (including ToFs), providing high-quality data to users in a timely fashion as **.C1** data.

▶ The automated CDCE algorithm significantly improves the ACSM/SMPS comparison at SGP, but it isn't perfect.

▶ Mentor is also manually processing data and periodically releasing it as **.C2** data.
- ■ Autonomous- and mentor-processed data are in good agreement.
- ■ We suggest use of **.C2** data whenever it is available, followed by **.C1** data.

Example ACSM CDCE Data from SGP
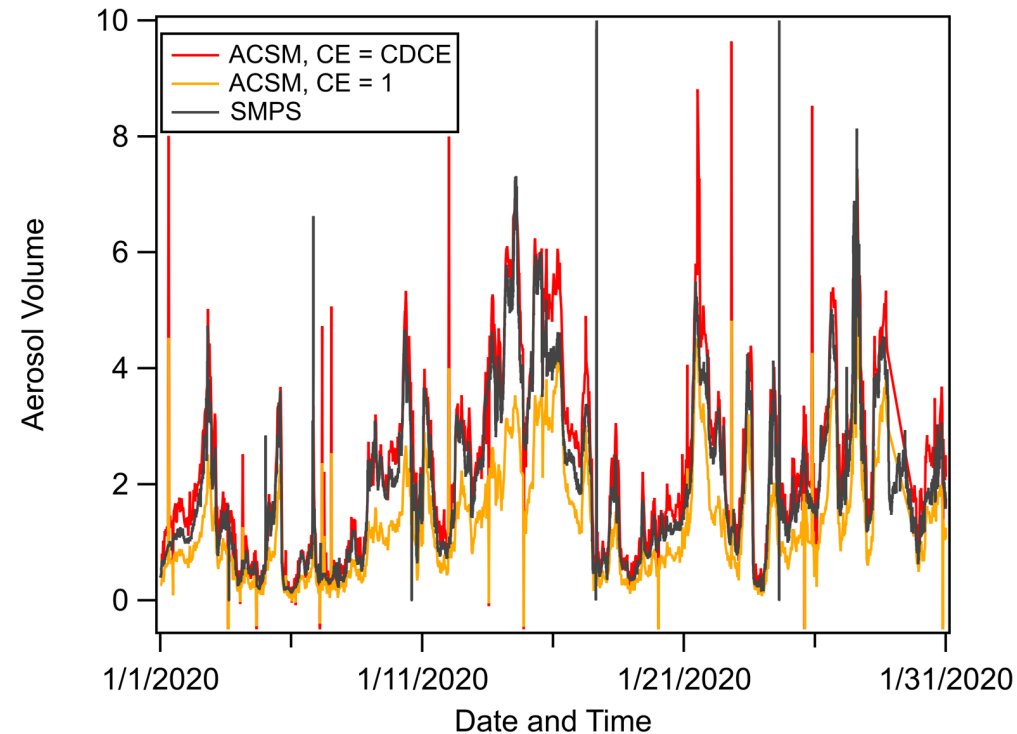
Baseline VAPS – AOD and AOP

ARM

AOD VAP

► AOD VAP uses MFRSR and NIMFR data to calculate AOD at 2-5 wavelengths.
  ■ Provided QA/QC metrics.
  ■ Outliers are removed.

► This VAP requires more manual labor than most, so it is available by request 1-2 years after a campaign.

► Recently released data for CACTI (COR).

► Recently updated code for new 1.6 μm channel added to instruments.

AOP VAP

► AOP VAP combines PSAP extinction and Nephelometer scattering data at 3 wavelengths to calculate:
  ■ aerosol absorption coefficients
  ■ corrected scattering
  ■ SSA
  ■ angstrom exponent (absorption and scattering)

► Data are most campaigns in near real-time and at 1 or 10 minute frequency.
  ■ NOTE: 1 minute frequency has mix of 1 and 10 μm impactor states.

VAP plans for FY 24

- ▶ Merged Size Distributions:
  - ■ Continue releasing data for new sites/campaigns.
  - ■ Extend ML QA/QC analysis to more sites.
  - ■ Begin working on ML QA/QC for SMPS/UHSAS merge.
- ▶ CCN Vertical Profile:
  - ■ Process data for ENA.
  - ■ Comparison of remote sensing and in-situ data during HISCALE and TBS deployments.
  - ■ Investigate possible use of HTDMA data as input.
- ▶ CCN Kappa:
  - ■ Finalize CCN/UHSAS kappa.
  - ■ Continue processing new data.
  - ■ Process TBS data.

- ▶ ACSM CDCE:
  - ■ Continue processing new data.
- ▶ AOD:
  - ■ Process AOD for SAIL, AWARE including 1.6um channel.
- ▶ AOD-BE:
  - ■ Process AOD-BE for ENA, NSA including 1.6um channel.
- ▶ AOP:
  - ■ Continue processing new data.
- ▶ HSRL Feature Detection VAP:
  - ■ HSRL used to detect aerosol layers at SGP
  - ■ Detects more layers than RL, especially in lower atmosphere.