

# Aerosol VAP updates

JOHN SHILLING

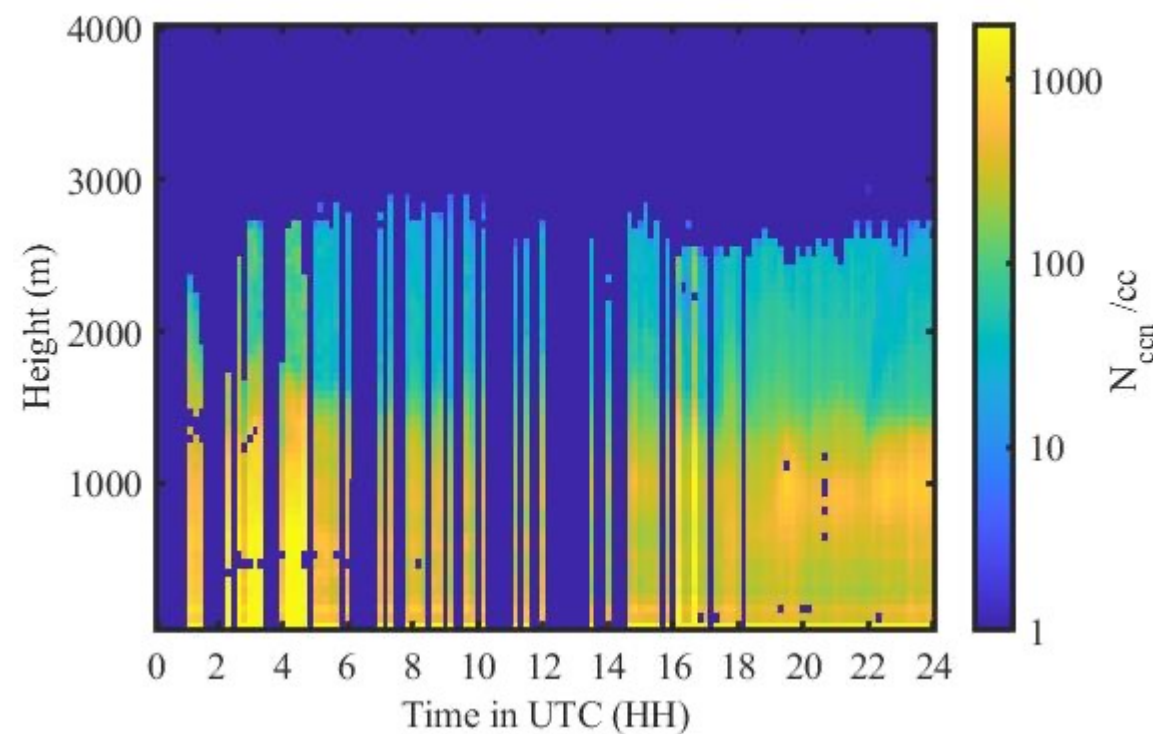
PNNL

AMSG workshop

## 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,  $f(\text{RH})$ , 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 – 2023.
- ▶ Working on updating QA/QC.
- ▶ Working on processing ENA data.
- ▶ Will extend to other sites with a CCNC and RL in the future.

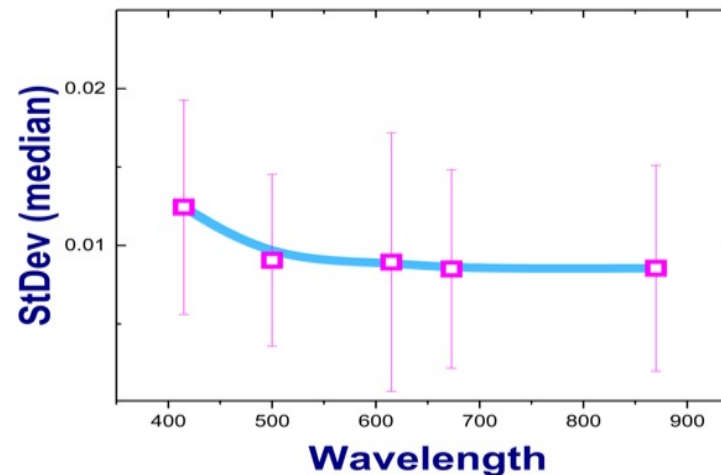
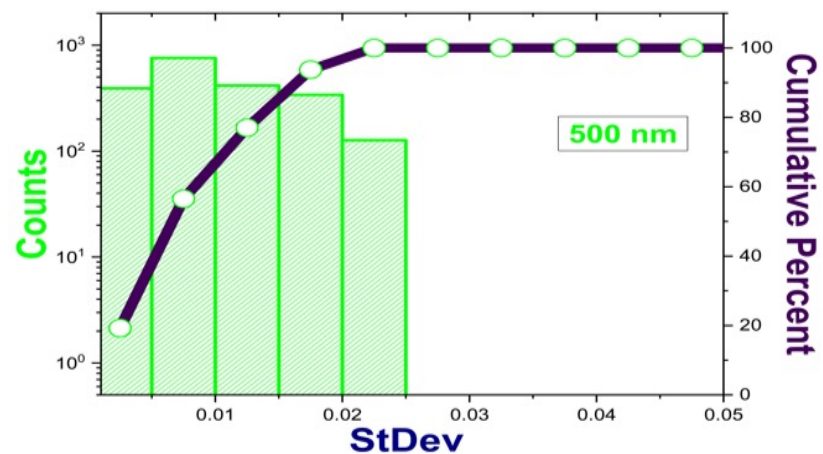
Vertical CCN profiles at 0.4% supersaturation



Missing values indicates bad input data and poor met data.

# Aerosol Optical Depth Best Estimate (AOD)

- ▶ 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**).
- ▶ Currently available for SGP and ENA.
- ▶ Processing NSA data.

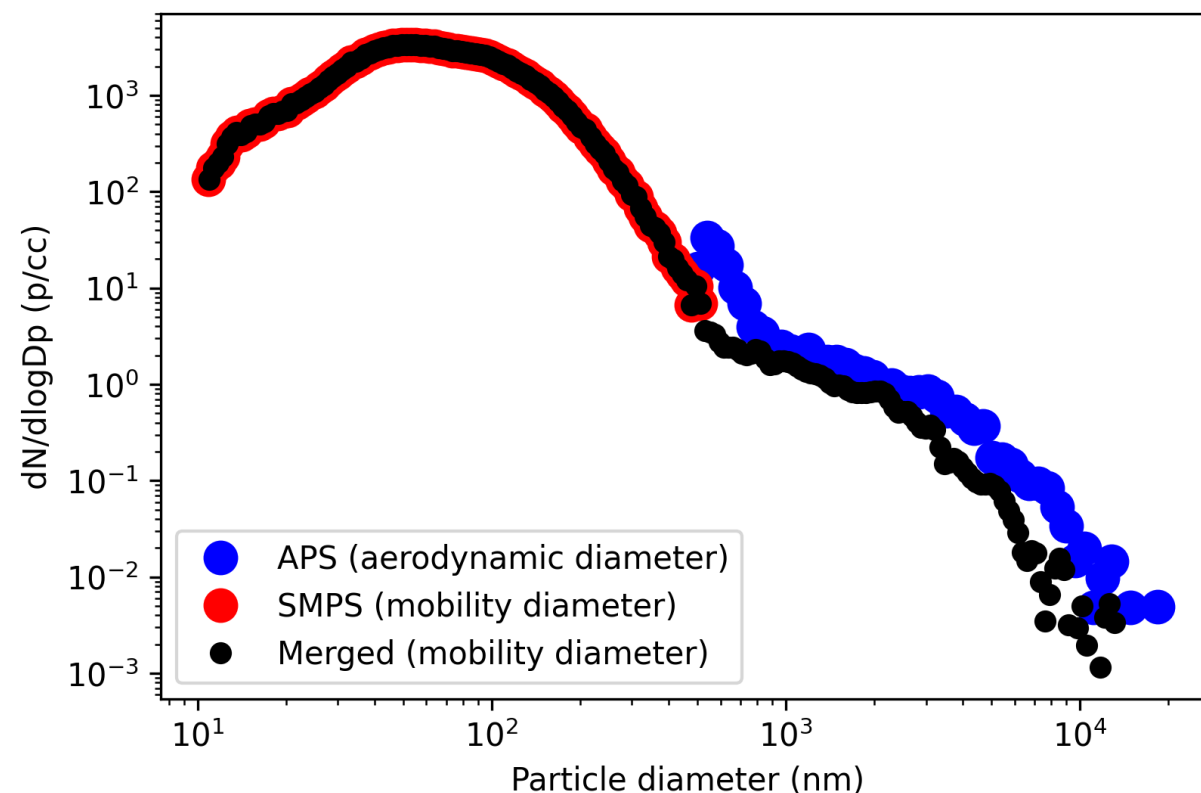


- **StDev** is **small** ( $< 0.02$ ) for the majority of cases ( $>90\%$  of time).
- On average, **StDev** depends **weakly** on wavelength.

## Merged Size Distribution VAP (Merged SMPS/APS)

- ▶ 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 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 in near real-time.
  - Let me know if you find missing datasets.
- ▶ Translator welcomes any comments or concerns about this VAP.

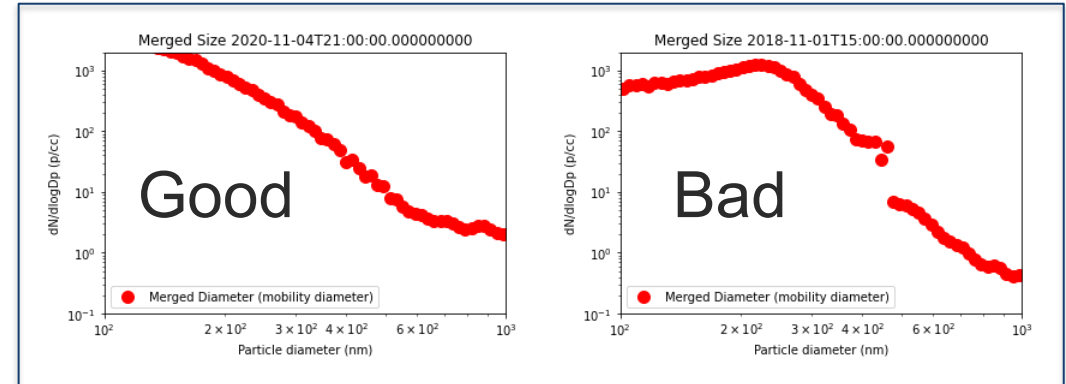
### Example of Merged Size Distribution Data



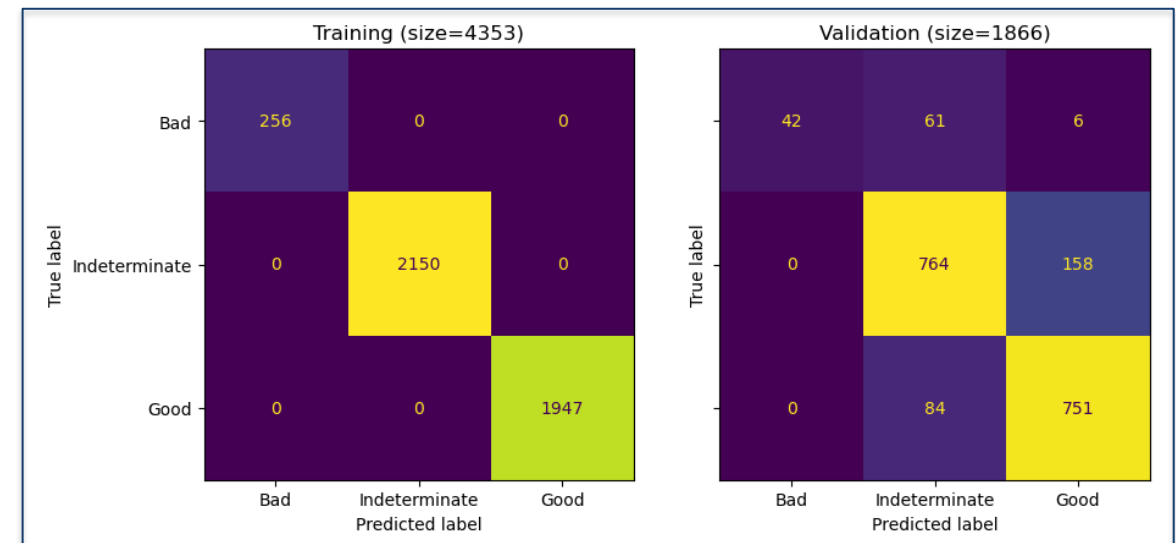
# Merged Size Distribution VAP QA/QC using Machine Learning



- ▶ 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.
- ▶ Currently, the trained RF model is achieving approximately 90% accuracy.



Machine Learning



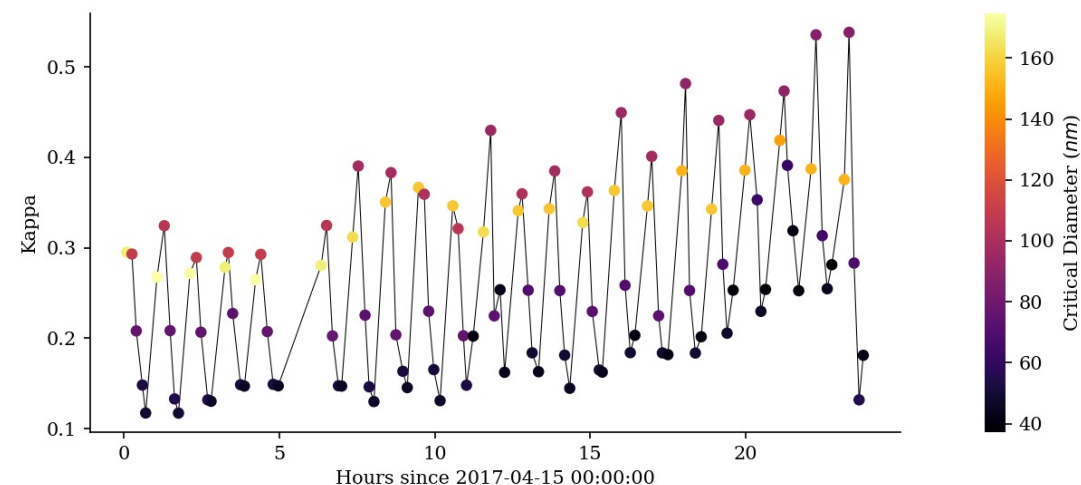
## Merged Size Distribution VAP (Merged SMPS/UHSAS)

- ▶ Similar to SMPS/APS VAP, this VAP creates a single **mobility size** distribution, with TSI-SMPS bin structure, from the SMPS and UHSAS data.
- ▶ 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.
- ▶ Adjusts the UHSAS size from calibration aerosol (PSL) to refractive index of ambient particles based on ACSM measurements.
- ▶ Currently, data only available for SGP.
- ▶ UHSAS appears to systematically undercount, so we are considering options on how to proceed.
  - Translator welcomes any comments or concerns about this VAP.

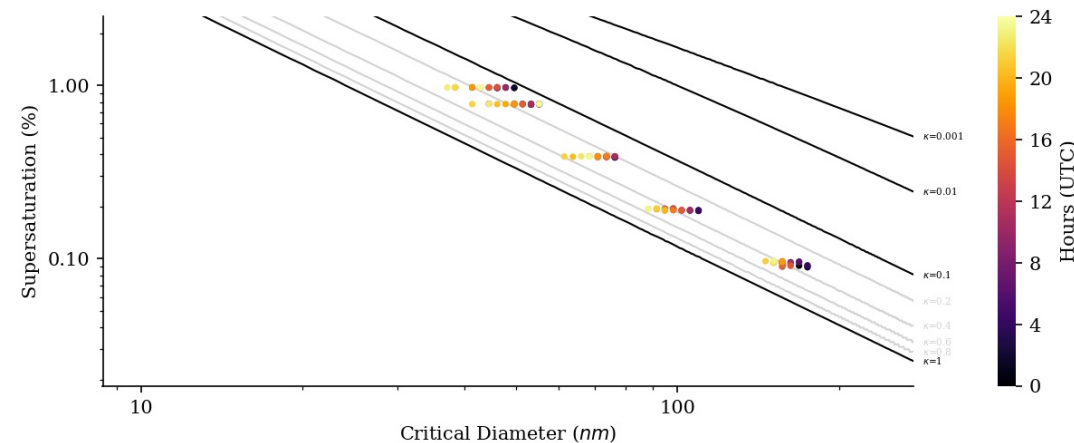
# CCN Kappa (hygroscopicity) VAP updates

- ▶ CCN kappa VAP uses CCNC and SMPS or UHSAS 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.
- ▶ Kappa data are now available for all sites with a CCN and an SMPS or UHSAS.
  - Data typically released a few months after campaign end.
- ▶ Note that kappa calculated by this method is very sensitive to number count accuracy, particularly at low SS values.
  - To mitigate this difficulty, we are developing a HTDMA kappa VAP.

sgpaosccnsmpskappaE13.c1.20170415.kappa\_vs\_time



sgpaosccnsmpskappaE13.c1.20170415.kappa\_vs\_critical\_diameter

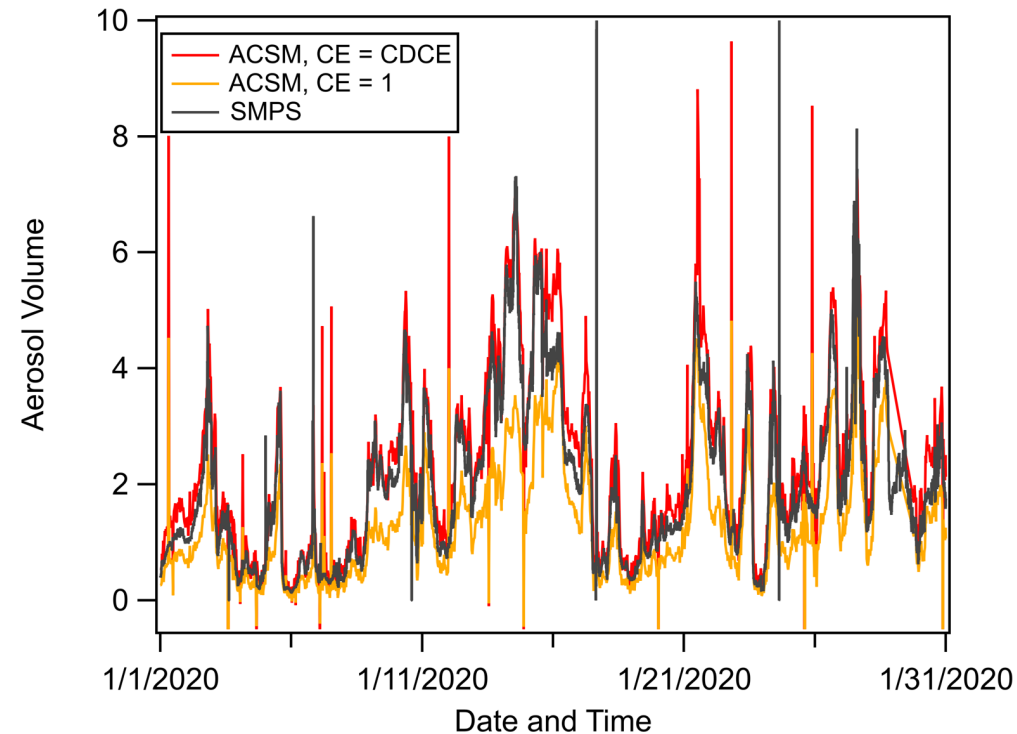


Kappa constant lines are drawn from analytical expression number 10 from Petters and Kreidenweis (2007).

## 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

## AOD VAP

- ▶ AOD VAP uses MFRSR and NIMFR data to calculate AOD (remote sensing) at 5 or 6 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.
- ▶ Currently processing data for HOU/TRACER, GUC/SAIL, and EPC/EPCAPE.
- ▶ Recently updated VAP datastream to include new 1.6  $\mu\text{m}$  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  $\mu\text{m}$  impactor states.

# VAP plans for FY 24/25

- ▶ Merged Size Distributions:
  - Continue releasing data for new sites/campaigns.
  - Extend ML QA/QC analysis to more sites.
  - Investigate SMPS/UHSAS counting discrepancy.
- ▶ CCN Vertical Profile:
  - Process data for ENA.
  - Comparison of remote sensing and in-situ data during HISCALE and TBS deployments.
  - Improving QA/QC.
- ▶ Kappa:
  - Continue processing data from campaigns with a CCN and an SMPS or UHSAS.
  - Developing a HTDMA kappa.
- ▶ ACSM CDCE:
  - Continue processing new data.
- ▶ AOD:
  - Process AOD for SAIL, GUC, EPC including 1.6um channel.
- ▶ AOD-BE:
  - Process AOD-BE for NSA including.
- ▶ AOP:
  - Continue processing new data.
- ▶ NEW VAP: Aerosol Best Estimate
  - Based on feedback from modeling communities, I will generate a single file consolidating multiple aerosol datastreams.
  - Seeking feedback on time resolution and what quantities to include.

# Science Product Development Led by a Team of Scientists

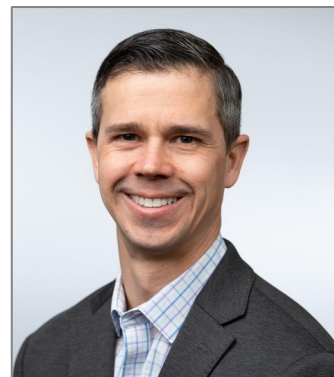


## ARM Translator Group

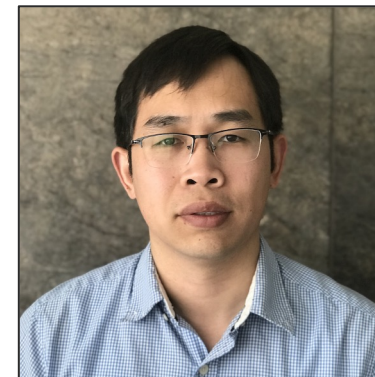
Translators are liaisons between the scientific community and ARM infrastructure staff members, and develop Value-Added Products, or VAPs, from the direct output of ARM instruments.



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