ARM Science Products Update

JENNIFER COMSTOCK

ARM Associate Director for Research

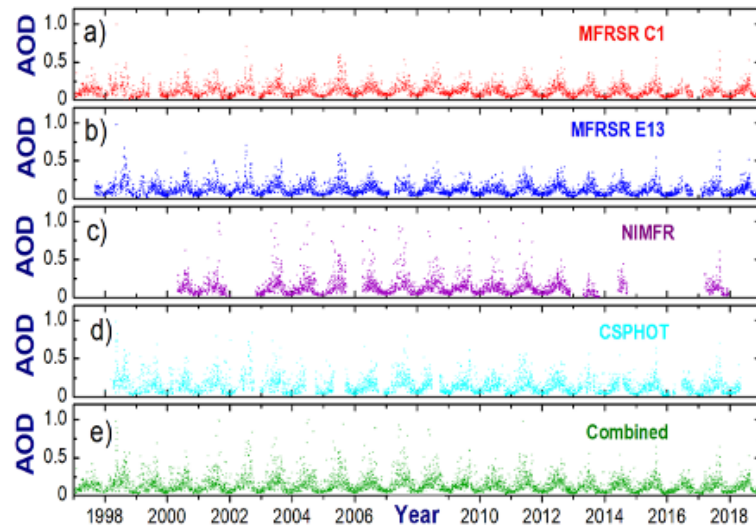**Pacific Northwest National Laboratory**

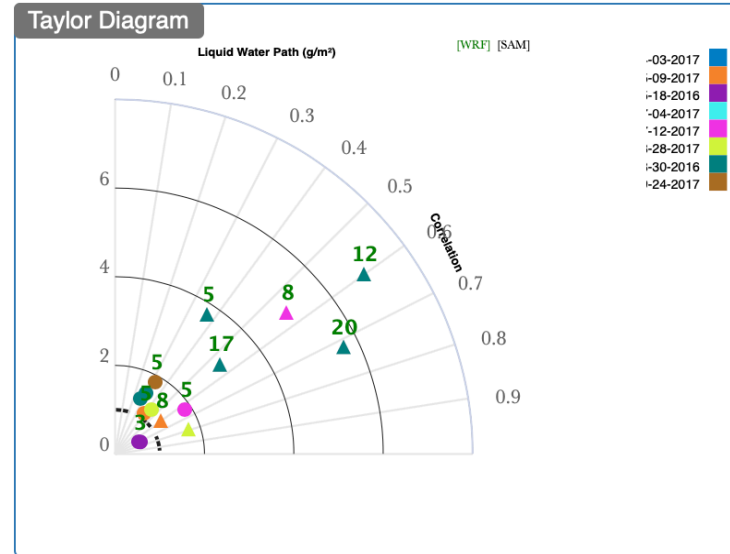ARM/ASR Joint Meeting, Rockville, MD, Oct. 24-27, 2022

ARM Provides Advanced Science Products for Atmospheric and Climate Science

Aerosol Optical Depth

▶ **High-quality, multidecadal data sets**

▶ **Value-added products**

▶ **Open-source software**

▶ **LASSO – Observation-modeling framework**

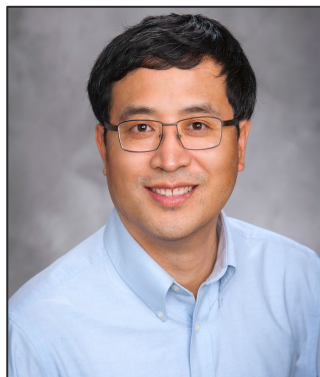▶ **Data products, metrics, and diagnostics for modelers**

▶ **Community Outreach**
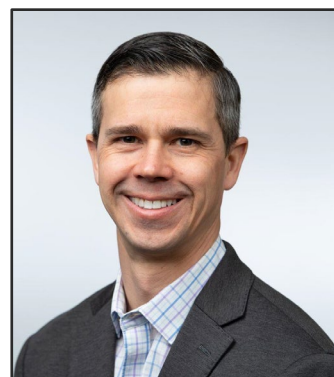
▶ **Tutorials & Short Courses**

Science Product Development Led by a Team of Scientists
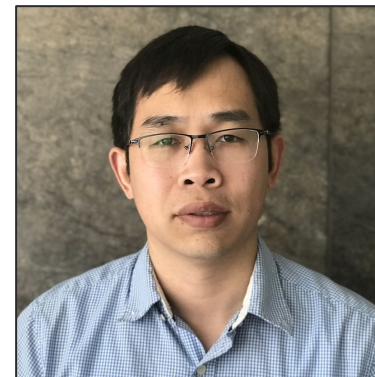
ARM

ARM Translator Group

Translators are liaisons between the scientific community and ARM software developers that develop Value-Added Products (VAPs) and open-source tools for the user community.

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
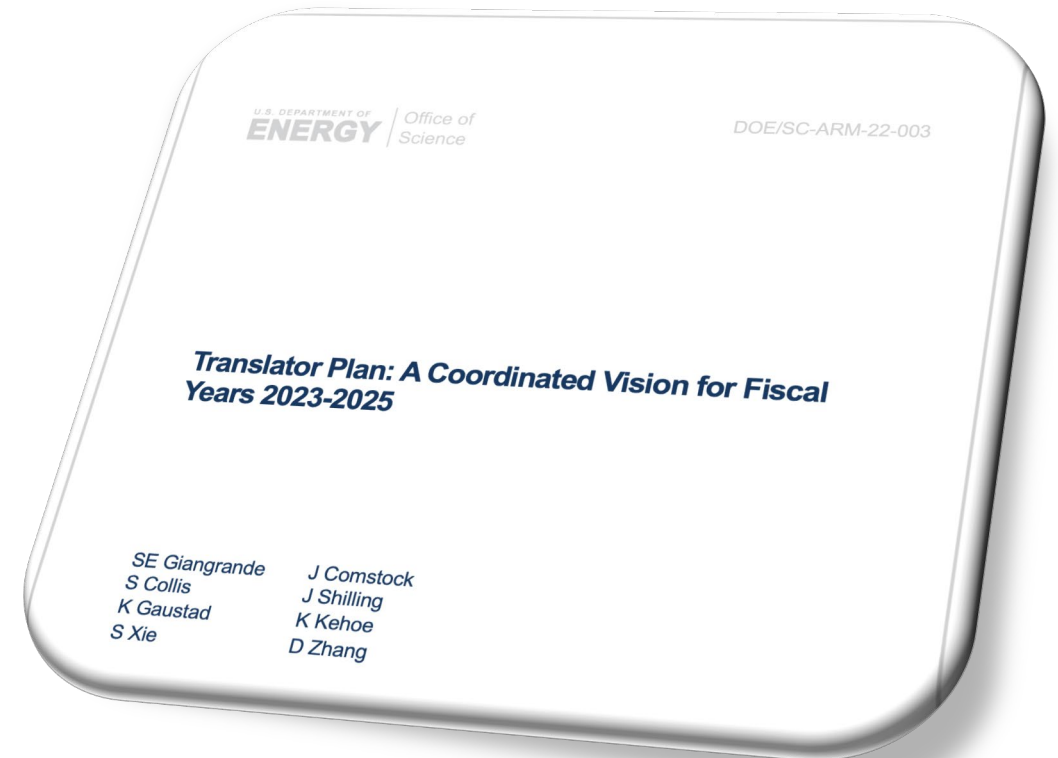Lead Translator
COMBLE POC

Krista Gaustad
Software Development

Ken Kehoe
Data Quality

New Translator Plan 2023 – 2025

► Support for core Value Added Products (VAPs) and new data products

► Improve user experience and accessibility through open-source tools

► Support for ARM Mobile Facility campaigns

► Uncertainty

► Community Engagement

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DOE/SC-ARM-22-003

Translator Plan: A Coordinated Vision for Fiscal Years 2023-2025

SE Giangrande
S Collis
K Gaustad
S Xie

J Comstock
J Shilling
K Kehoe
D Zhang

Expanding ARM Open-Source Resources

Open-Source Python Based Analysis Tools

► Data oriented metrics and diagnostics

► Resources for exploring, visualizing, consolidating ARM data

- ■ Python-ARM Radar Toolkit (Py-ART)
- ■ Atmospheric data Community Toolkit (ACT)
- ■ PyDSD – drop size distribution
- ■ ARM Data Integrator (ADI)

► https://github.com/ARM-DOE/

Future Plans

► Modernization of ARM's code base

► Expand model diagnostic packages

► Data consolidation resources for users

► Open workforce development tutorials

► Develop cookbooks for running and visualizing VAPs

New VAP Development Plans

▶ **Aerosol Properties**

  ■ Merged size distributions, AOD Best Estimate, CCN vertical profiles

  ■ Aerosol vertical profiles – feature detection and aerosol size distribution (HSRL+RL)

▶ **Cloud and Precipitation**

  ■ RWP products – gridding, cloud mask, precip modes

  ■ Advanced ARSCL – Python-based with additional parameters

  ■ Snowfall rate retrievals

  ■ Scanning radar columns matched to ground in situ observations

▶ **PBL height best estimate – 4 sources**

▶ **Modeling Products**

  ■ Expand model diagnostics to new processes
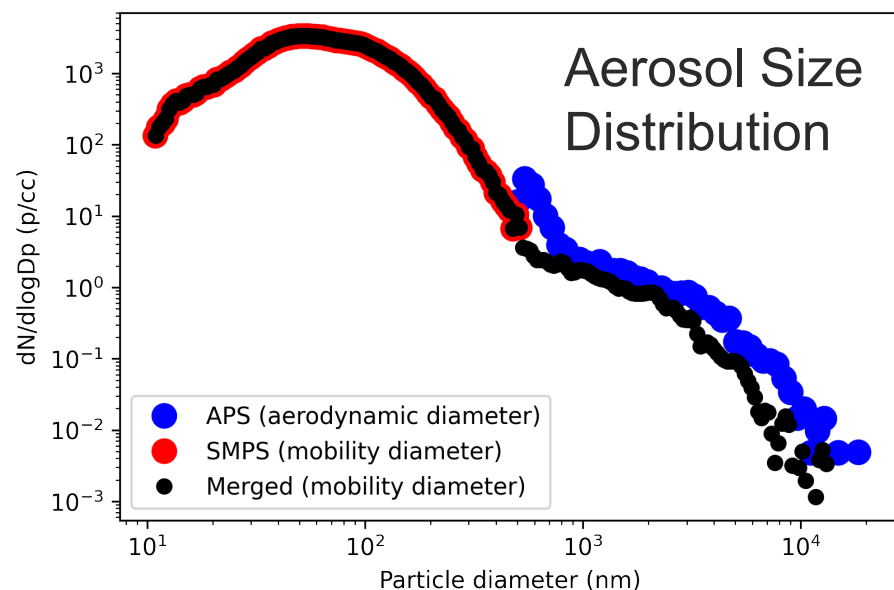
  ■ Radar-lidar simulator – COSP and EMC^2 modules

▶ **Data epochs and Virtual Field Campaigns**
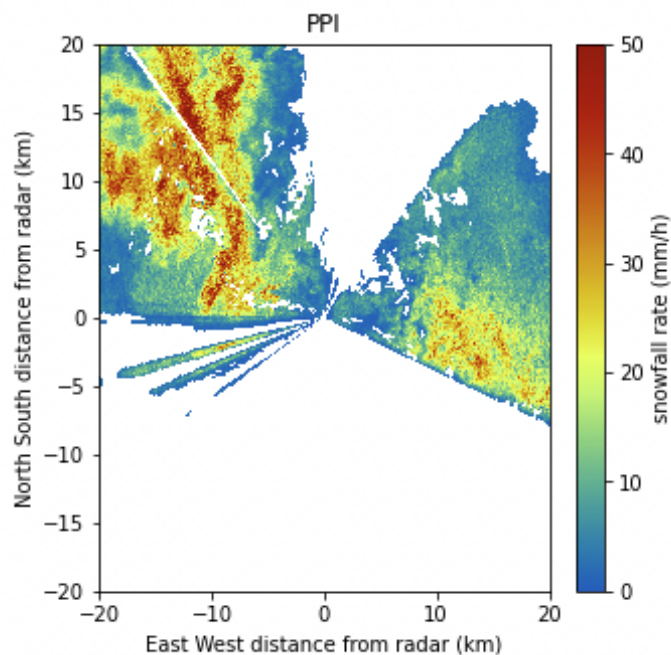
Snowfall retrievals from SAIL
Contact: Scott Collis

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New Aerosol Products

Contact: John Shilling john.shilling@pnnl.gov

Aerosol Size Distribution

CCN Profile 4% Supersaturation

► Merged Size Distribution VAP

► Single mobility size distribution with SMPS and APS data (Beddows et al. 2010)

► Data: Hourly at SGP 2017 – Aug. 2022

► Integrated number, surface area and volume are calculated.
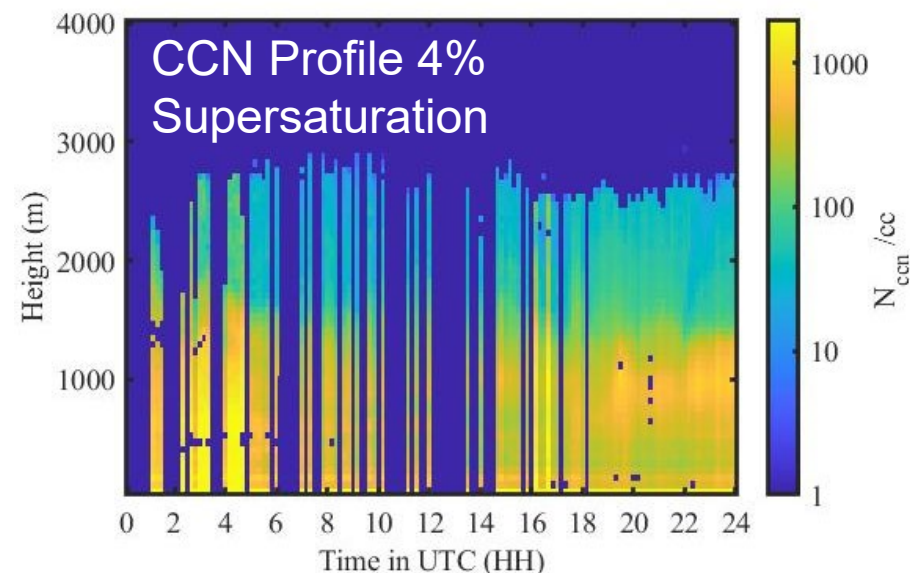
► Vertical distribution of CCN as a function of supersaturation

► Uses Raman lidar, CCNC, f(RH), and met data

► Based on McFarlane, Ghan, Collins algorithm with updates to inputs and QA/QC

► Data: SGP 2016 – extending through 2022

► Comparing to in-situ G-1 data from HI-SCALE (G. Kulkarni – Breakout 6 on Wed. 4:15)

ARM Cloud Radar Products

*Contact: Karen Johnson kjohnson@bnl.gov and Meng Wang mwang@bnl.gov*
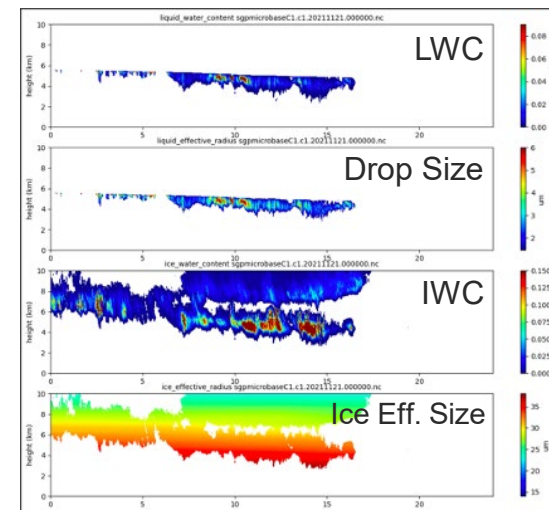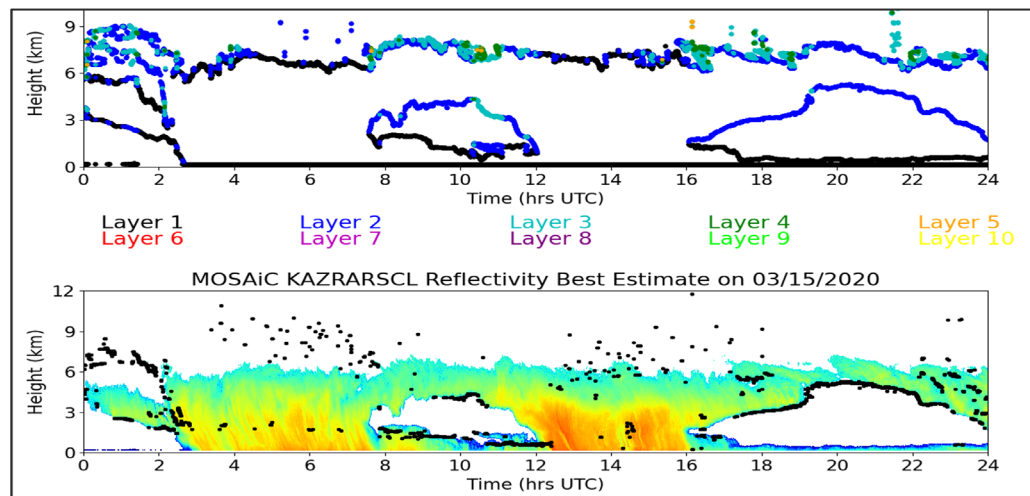
▶ Active Remote Sensing of Clouds (ARSCL)

▶ Applies masks and corrections to zenith cloud radar data

▶ Available within 1-month of collection (uncalibrated)

▶ Advanced ARSCL

▶ Most recent: TRACER, SAIL, MOSAiC

▶ Baseline Microphysical Retrieval (MICROBASE)

▶ Liquid & ice content and effective size

▶ Updates: Uncertainty and validation using radiative closure

▶ Available: SGP, ENA, TCAP, LASIC, & AMIE-GAN

Cloud and Thermodynamic Properties

Contact: Damao Zhang damao.zhang@pnnl.gov

**MPL Cloud Mask ML**
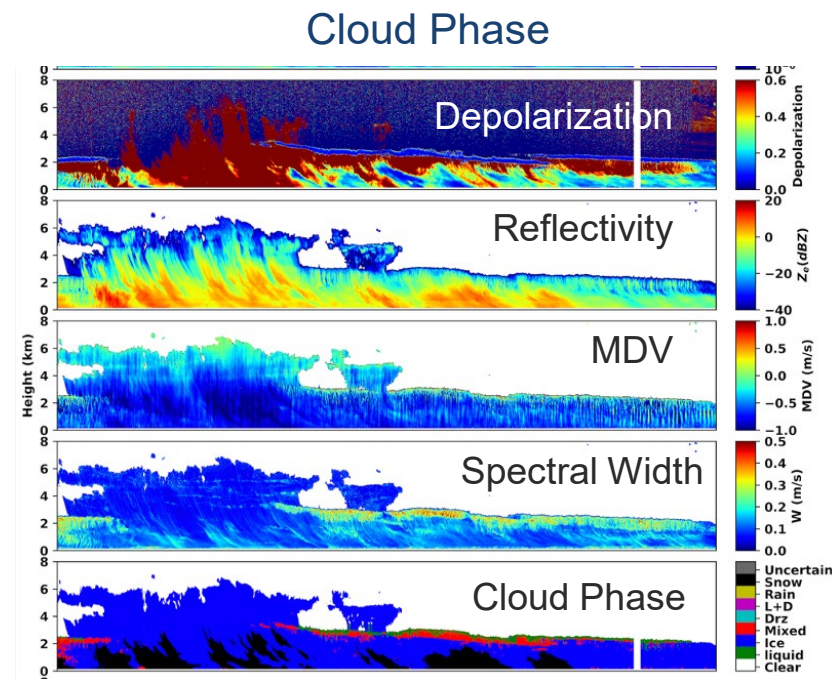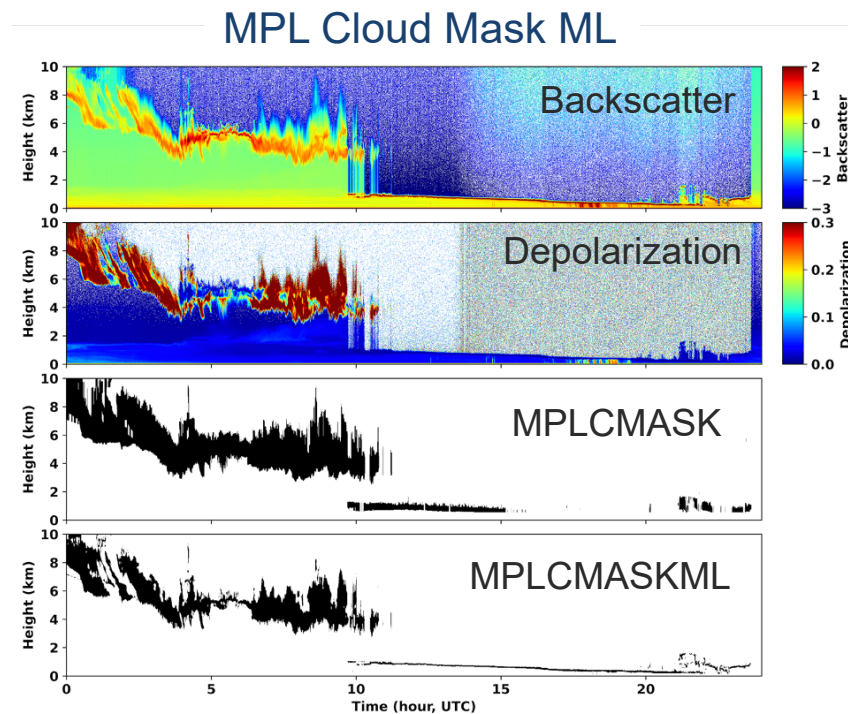
Cloud Phase

- ► A fully convolutional network (FCN) model was trained with 'hand-labeled' cloud mask
- ► Data at AWARE, CACTI, OLI, ENA, NSA, & SGP
- ► Dev. by D. Flynn, E. Cromwell

- ► Thermodynamic Cloud Phase
- ► Combined remote sensor algorithm (Shupe 2007)
- ► Hydrometeors classified as ice, snow, mixed-phase, liquid, drizzle, or rain
- ► Data at NSA and COMBLE

Aerosol-CCN Activation Diagnostics Package
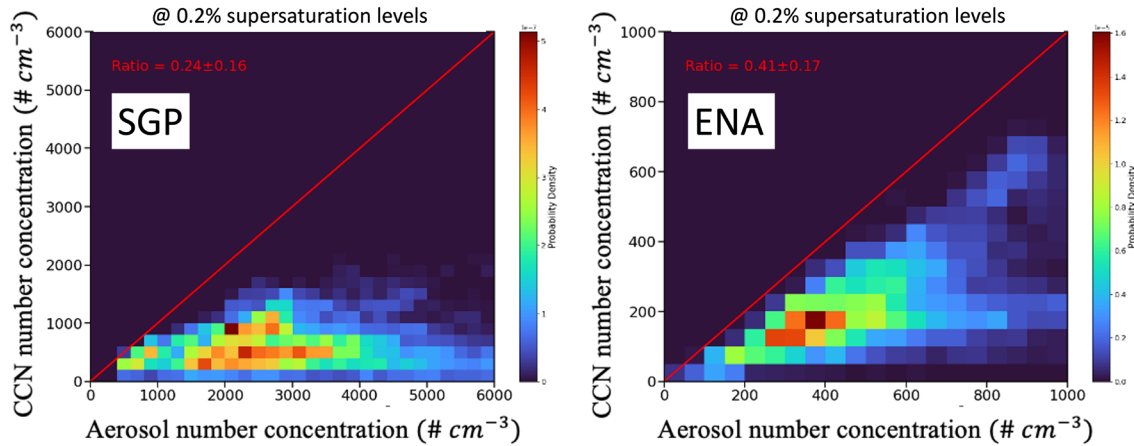
- ARM Diagnostics v3.0 – open-source process-oriented diagnostics code and data
- Processes include convection onset, aerosol-cloud interactions, and aerosol-CCN activation
- Now includes more ARM sites and CMIP6 reference datasets
- Adding land-atmosphere coupling and warm-bias attribution diagnostics
- Contact: Cheng Tao tao4@llnl.gov

Contoured Frequency by Altitude Diagram (CFAD)
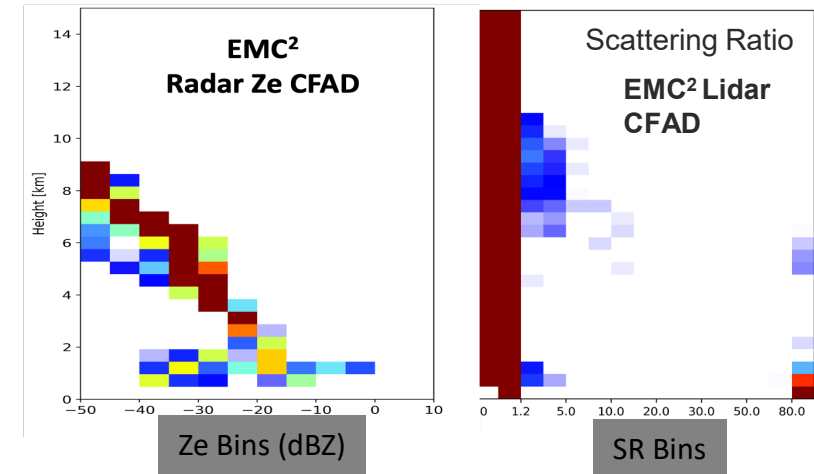
- ARM Cloud Radar/Lidar Simulator package for statistical evaluation of E3SM
- COSP statistical module into EMC^2
- Provides CFAD and cloud fraction
- Contact: Yuying Zhang zhang24@llnl.gov and Jingjing Tian

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LASSO-CACTI Dataset Available as Beta

Contact: William Gustafson, PNNL

ARM

► New LASSO scenario focusing on deep convection during CACTI campaign

► Released the LASSO-CACTI Beta Release in May 2022

► Dataset pre-staged on ARM's Cumulus-2 cluster

  ■ 33-member ensembles at Δx=2.5 km for 20 case dates

  ■ 2 example LES at Δx=100 m with others available upon request

  ■ Additional tools such as skill scores and example Jupyter notebooks

► More info in the Beta's documentation (QR above)

► Contact lasso@arm.gov about requesting access, which requires an ARM HPC account

**WRF, Δx = 100 m
Vertical Velocity of Cloud Core Region
and Streamlines, 25-Jan-2021 20 UTC**
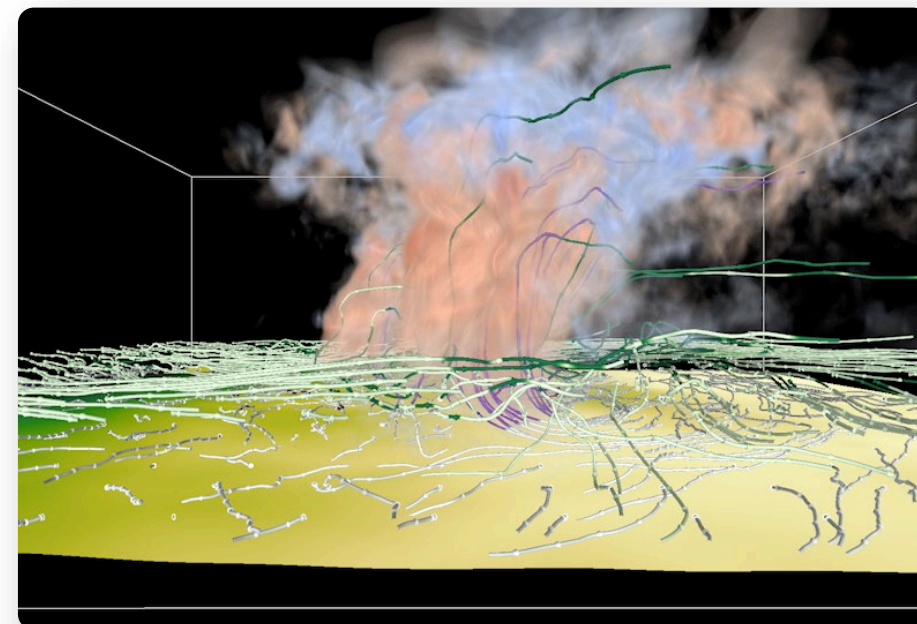
Shading: Red=W Up; Blue=W Down
Streamlines: Seeds at 2 km AMSL (white-to-purple) and
5 km AMSL (light to dark green)
Produced with VAPOR software from NCAR

Improve Accessibility of ARM Science Products

- ► Updated VAP web page design and information content
- ► New science products landing page
- ► Routine data announcements and blog posts in ARM newsletter
- ► Improve metadata consistency across web pages and data discovery
- ► Recommended datastreams

CAPABILITIES > VAPS
ACSMCDCE

TECHNICAL REPORT | CITE DATA | BROWSE DATA

ACSMCDCE > ACSM, CORRECTED FOR COMPOSITION-DEPENDENT COLLECTION EFFICIENCY

VAP TYPE(S) > BASELINE

This value-added product (VAP) corrects aerosol chemical speciation monitor (ACSM) data for non-unity particle detection. The VAP is based on a procedure described in Middlebrook et al. (2012). The procedure applies the Middlebrook composition-dependent collection efficiency (CDCE) correction to the ACSM data to improve their accuracy, and it brings the data into better agreement with other co-located aerosol measurements.

Reference: Middlebrook AM, R Bahreini, JL Jimenez, and MR Canagaratna. 2012. "Evaluation of Composition-Dependent Collection Efficiencies for the Aerodyne Aerosol Mass Spectrometer using Field Data." ☐ *Aerosol Science and Technology*, 46(3): 258–271, https://doi.org/10.1080/02786826.2011.620041.

PRIMARY DERIVED MEASUREMENTS

Aerosol concentration

Inorganic chemical composition

RELATED DATA ANNOUNCEMENTS

Aerosol Chemical Speciation Monitor VAP Moves to Production
22 February 2022

Corrected Aerosol Chemical Speciation Monitor Data Available for Evaluation
16 February 2021

Zawadowicz, M., & Howie, J. ACSM, corrected for composition-dependent collection efficiency (ACSMCDCE). Atmospheric Radiation Measurement (ARM) User Facility. https://doi.org/10.5439/1763029

Community outreach – building stronger ties with the modeling community

ARM Engagement with the Community

- ► Engage directly with Principal Investigators
  - VAP development, mobile facility campaigns, working groups and breakout sessions
- ► DOE Science Programs – ASR & E3SM
- ► ARM constituency groups – CPMSG, AMSG, UEC
- ► Broader Community – e.g., GEWEX PAN-GASS; satellite community
- ► Scientific Societies – AMS & AGU
- ► Short courses and workshops

Focus on Demonstrating and Improving Impact of ARM Data

- ► Publications and citations analysis
- ► Outreach to modeling centers to understand how ARM data are used and identify challenges and data gaps
- ► Develop collaborative projects (e.g., ARM – E3SM) to work directly with model developers on specific challenges

Thank you!