Advanced Aerosol Sampling for Advancing Aerosol Science

Aerosol Measurement Science Group
Aerosol Processes Working Group

1) continuous operation versus intensive operation periods
2) single-point versus distributed sampling
3) bulk versus single-particle analysis

ARM

ASR
Atmospheric System Research

Advanced Aerosol Sampling for Advancing Aerosol Science Agenda

4:15 Overview & Objectives

4:20 Overview of AMSG sub-groups

- Measurement techniques – Allison McComiskey
- Measurement quality – Rich Moore
- Measurement modeling – Jerome Fast
- Measurement sampling – Jim Smith

Discussion, 15 min

Following on the last sub-group, discuss three sampling modalities that are being considered for implementation:

4: 55 Continuous operation versus intensive operation periods: Tim Onasch/Gannet Hallar
Discussion, 15 min

5:15 Single-point versus distributed sampling: Chongai Kuang/Jerome Fast
Discussion, 15 min

5:45 Bulk versus single-particle analysis: Nicole Riemer
Discussion, 15 min

6:15 Adjourn

Aerosol Measurement Science Group (AMSG)

Coordinates ARM infrastructure, measurements, and data products of aerosols and trace gases with the scientific objectives of improving climate science and model forecasts.

AEROSOL MEASUREMENT SCIENCE GROUP CO-CHAIRS

Gannet Hallar
Timothy Onasch

SCIENCE REPRESENTATIVES

Jerome Fast
Colette Heald
Olga Mayol-Bracero
Allison McComiskey
Richard Moore
Lynn Russell

ARM AEROSOL DATA TRANSLATOR

John Shilling

ASR AEROSOL PROCESSES WORKING GROUP CO-CHAIR

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James Smith

ARM DATA QUALITY OFFICE

Alyssa Sockol

ARM INSTRUMENT MENTORS

Chongai Kuang
Damao Zhang

ARM INSTRUMENT OPERATIONS MANAGER

Adam Theisen

ARM Technical Director: Jim Mather

ARM Atmospheric Observatories

- SGP – Southern Great Plains - largest, long-term climate facility in the world
- NSA – North Slope of Alaska – Utqiaġvik (formerly Barrow) and Oliktok point (now inactive) with large controlled airspace
- ENA – Eastern North Atlantic – mid-Atlantic site focusing on marine stratocumulus clouds
- AAF – ARM Aerial Facility – Bombardier Challenger 850 regional jet, Unmanned aerial systems, tethered balloons
- AMF – ARM Mobile Facilities – 3 x units (AMF2 built for shipboard deployments), can host guest instruments
- SEUS – Southeastern US – new site to be developed in coming years

Aerosol Measurement Science

The term **measurement science** is used in the context of creating critical-solution enabling tools – metrics, models, and knowledge.

This includes development of:

- New measurement technologies
- Calibration and uncertainty assessments
- Measurement performance metrics (e.g., intercomparison studies)
- Measurement operational protocols and reference materials
- Site selection and sampling methodologies
- Data product generation and evaluation
- Predictive modeling and simulation tools

AMSG activities

Collect **inputs** from - and provide **outputs** to –
Scientific Communities and ARM Technical/Administrative Staff

Inputs

- ASR scientists
- AMSG Workshops
- ARM / ASR
  - Technical Director / Managers
  - Mentors / Translators
  - User Executive Committee (UEC)
  - Cloud and Precipitation Measurements and Science Group (CPMSG)
  - AMF3 Site Science Team (SEUS)
  - ASR Working Groups
- External communities/networks

Outputs

- Direct feedback to ARM Technical Director
- ARM Aerosol Measurement Plan
- Breakout sessions at ASR/ARM Joint Meetings
- AMSG Workshop reports

AMSG activities

Collect **inputs** from - and provide **outputs** to –
Scientific Communities and ARM Technical/Administrative Staff

- **We solicit your input!**

- Find us (**AMSG members**) and tell us about your measurement needs, science ideas, instrument development, sampling issues, data quality concerns, data product development, modeling approaches, and important critical science gaps

AMSG Subgroups

Gannet Hallar and Tim Onasch (co-chairs)

AMSG has formed four subgroups to help focus and facilitate **Aerosol Measurement Science** coordination activities

Measurement **Techniques -** Allison McComiskey

- Selections / Upgrades
- Appropriate application

Measurement **Quality** - Rich Moore

- Calibrations
- Uncertainties
- QAQC flags

Measurement **Modeling** - Jerome Fast

- Measurement packaging
- Measurement products

Measurement **Sampling -** Jim Smith

- Site selection
- Sampling strategies

- Designate formal subgroups with rotating themes
- Subgroups provide structure to AMSG and help keep important topics in focus over the long-term
- Each subgroup has 1 leader
- AMSG members serve on 2 subgroups
- Helpful to have ARM representative in each subgroup

AMSG Measurement Techniques Subgroup

Allison McComiskey, Jim Smith, Lynn Russell, Damao Zhang, Rich Moore,
Adam Theissen, John Shilling, Tim Onasch

What science will these measurements enable?
How will they advance ARM's ability to support ASR research?*

1) North Slope of Alaska aerosol measurements – establishing a suite of ARM instruments
2) Absorption – replacement for PSAP/filter-based measurements
3) Rethinking gas measurements – should we be measuring NOx, VOCs or other gases

- Defining needed remote sensing/hyperspectral measurements
- System and instrument RH control for reducing impacts on size distribution and scattering
- Optimizing HTDMA measurement
- Consistency and closure – archived observations for size distribution and optical properties are consistent in assumptions they employ (e.g., refractive index)

Overlapping with other sub-groups: connecting remote sensing and vertical profiling appears in both quality and sampling

*capability needs template capability gap form

AMSG Measurement Quality Subgroup

Nicole Riemer, Damao Zhang, Adam Theissen, Olga Mayol-Bracero, Rich Moore, Gannet Hallar, Alyssa Sockol

Current priorities:

- Reconciling remote sensing and in situ observations. Some challenges to overcome are, e.g.,
  - Aerosol hydration (ambient RS vs. dry IS)
  - Vertical structure & mixing (column or vertically-resolved RS vs. surface/balloon IS)
- Encouraging technical papers that motivate quality discussion & best practices. e.g.,
  - ARM inlet characterizations
  - ACSM quantification
  - PSAP (and related filter-based absorption) filter comparisons
- Making data available through WMO for inclusion in global model comparisons
- Look for opportunities to leverage & encourage the development of open-source software for data processing (e.g., PySP2 for SP2)
- Survey the instrument teams and the community regarding their confidence in specific ARM aerosol measurements, retrievals in order to identify priority areas for improvement

AMSG Modeling Subgroup

Jerome Fast, Nicole Riemer, John Shilling, Adam Theisen, Lynn Russell

How can ARM data be made more conducive to modeling?

E3SM groups are developing new diagnostic tools (e.g. ESMAC, Tang et al. GMD 2022) that use ARM data to evaluate predictions of aerosols and ACI relationships.

- Would user-friendly “data bundling”, similar to LASSO, make such diagnostics easier to develop and maintain? Merged aircraft datasets are being developed, which is a form of bundling.
- Diagnostic tools need to make sure to use datastream updates
- A high level of QA is needed for aerosol data. Diagnostic tool developers have to spend time revisiting the rationale for existing QA flags, developing flags to denote local contamination, etc.
- Would an “Aerosol Best Estimate” be useful? Will need to define what that means.
- Would it be useful to have trace gas and aerosol predictions (e.g. NOAA, NCAR) at ARM sites to provide species ARM does not measure? This would be like availability of ECMWF subsets.
- Should ARM provide aerosol predictions with bundled data, similar to LASSO?

AMSG Measurement Sampling Subgroup

Jim Smith, Allison McComiskey, Adam Theissen, Olga Mayol-Bracero, Jerome Fast, Tim Onasch

What are priorities in the area of aerosol sampling that should be addressed in the near term by ARM ?

Current priorities:

- **Sampling Modalities (e.g., "IOP mode," "single vs. distributed sites," etc.)**
- Measurement "footprint" for aerosols and key trace gases
- Coordinating flights and **vertical profiles** with *in situ* measurements at various sites (e.g., Session 6 on vertically-resolved aerosol properties)
- Identifying **which aerosol types / properties** are needed to inform models, satellite algorithms, etc.
  - Where do we have lots of data? (e.g., continental, organic-sulfate aerosol systems, biomass burning?)
  - Where are we missing data? (e.g., dust, remote marine, biomass burning?)
  - Which new instrument capabilities motivate revisiting some locations (e.g. SEUS)?
  - **Single particle vs. bulk properties?**