Breakout Session Report
ARM/ASR User and PI Meeting
March 16-20, 2015

Session Title: Ice Properties (IcePro)
Session Date: Monday, March 16, 2015
Session Time: 3:30–4:45 p.m.
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Main Discussion

Discussion centered on the following three questions:

1. What new measurements or data products are needed to inform your science? What scientific impact will these new capabilities bring?
2. What level of importance would you rate developing transparent data quality assessment and measurement uncertainty quantification versus developing new instruments or data products?
3. What would make ARM data more accessible (i.e., visualization tools, merged data sets, etc.)?

Key Findings

1. A strong emphasis of the IcePro Focus Group is mining ARM Aerial Facility data sets to quantify ice properties.
    a. These data are only available from intensive operational periods (IOPs).
    b. Need continued funding for advanced processing of past IOP data.
    c. Good idea to put resulting single-particle databases into ARM Data Archive, but uncertainty regarding balance of quality and quantity regarding principal investigator (PI) products versus infrastructure products when so much quality control is now required and procedures are not canned (e.g., currently interacting with modelers adds database fields).
    d. Models universally represent single-particle mass, but no modern measurements are available to inform models. Noted that Multi-Angle Snowflake Camera (MASC) could conceivably measure mass with photographs instead of fall speed (which may not be a still-air fall speed needed by models). If a prototype hot-plate under development at University of Utah were commissioned to be completed, noted that a second measurement of fall speed could be better, noted that backing mass out of fall speed requires still-air fall speed and maximum projected area and is not likely to be better than 20% accurate using state-of-the-art method such as Heymsfield and Westbrook (JAS 2010).
2. A strong interest within IcePro is data from tethered balloon.
    a. Noted that balloon platform avoids issues of blowing snow and shattering; allows profiling of sizes, aspect ratios, riming versus aggregation.
    b. Noted that learning how to do things on the ground first would be a good route, identifying payload from ground studies with proven instruments.
    c. Noted that measuring above ground instruments such as MASC would be valuable.

   d. Measurements needed for distinguishing processes (e.g., Cloud Particle Imager for riming), for ice nucleation studies (e.g., large-aerosol PSD).

   e. Measurements needed above cloud, at cloud top, throughout cloud, and below cloud base, depending on question and application.

3. What are general data set needs within IcePro?

   a. Single-particle mass, currently adequate at surface for many applications.

   b. Terminal velocity, mass flux, cross-sectional area, extinction and particle size distributions.

   c. Super-micron aerosol size distributions for ice nucleation (need for aerodynamic sizer).

   d. SACR-2 fields in an accessible value-added product (VAP), strongly encourage development of tools and techniques to develop remote-sensing methods of establishing ice properties, sensitive to habit.

   e. KAZR-2 moments and spectra, radar monitoring and continuous calibration to allow long-term data set use for microphysics studies.

   f. Doppler radar spectral simulator development, with emphasis on ice scattering libraries.

   g. Systematic way of modularly using different people's simulators and scattering libraries.

   h. Extinction profiles from Raman lidar/High Spectral Resolution Lidar (HSRL), including more in situ data in lidar volumes.

   i. Progress is needed in the area of uncertainty estimates.

4. Data accessibility for IcePro members.

   a. Noted value of on-line tool to put different data sets on same space and time grids of user's choice, which may account for non-linear scaling (e.g. hsrl.ssec.wisc.edu provides excellent example).

   b. Noted value of easily accessible quick looks with manually adjustable parameters of data to identify case studies of interest without downloading multiple huge data sets.

Decisions

The following group recommendations and statements were made during the session.

1. ARM Aerial facility and new MASC data sets from the North Slope of Alaska.

   a. Recommend infrastructure develop operational single-particle software for MASC as first non-PI single-particle database for archive.

   b. Recommend continued support for PI analysis of past IOP ARM Aerial Facility data sets, and archiving of results as PI VAP.

   c. Recommend investigation of first measurements of single-particle mass, which are widely used in models but nowhere currently measured, whether by extension of prototype hot plate under development for MASC (which ASR could commission) or by

proof that methods of measuring still-air terminal fall speed achieve better accuracy in mass estimation.

2. **Tethered balloon.**
    a. Good idea to learn how to do any new things on the ground first.
    b. Good idea to further evaluate payload adequacy for stated purposes, including any integration with ground measurements (e.g., science plan linking data set properties to specific applications).
3. **Data set needs (not in order of priority).**
    a. Ice single-particle properties from IOPs via PIs, from MASC via infrastructure, from new instrument development (mass; relevant size, projected area, aspect ratio measures; process indicators).
    b. Integral ice properties from radar, lidar, IOPs, multi-instrument retrievals (total mass, projected area, fall speed measures, and extinction).
    c. New SACR-2 and KAZR-2 fields calibrated, continuous, made accessible.
    d. Doppler radar spectral simulator and ice scattering libraries.
    e. Reliable uncertainty estimates.
4. Data accessibility needs.
    a. On-line tools to put multiple data sets (e.g., radar and lidar) on same time and space grids.
    b. Readily accessible quick-looks to identify cases of interest without large data downloads.

Future Plans

1. Continue work pace towards 12 deliverables in current white paper (http://asr.science.energy.gov/science/working-groups/clc/ice, link at bottom) with various group members as point of contact (http://www.giss.nasa.gov/staff/afridlind/icepro/).
2. Seek joint session with Doppler spectra interest group at ASR Fall Working Group Meeting; seek to integrate ice-related elements of QUICR effort.