Breakout Session Report
ARM/ASR Virtual User and PI Meeting June 23-26, 2020

Breakout session reports serve as a record of discussion results from breakout and working group presentations. These reports serve as a resource for program managers when asked to provide highlights of programmatic results with short notice. They also provide information to the ARM Facility management about science needs of ARM users. In addition, they can help the program managers evaluate the progress of self-organized groups within the ARM and ASR communities.

Please provide a concise narrative discussing key findings, decisions, issues, needs, and/or future plans and action items. Not all session narratives will necessitate touching on all topics, but session report authors should aim to provide as much information as possible to address relevant points. Session reports are not expected to exceed two pages of text. Because the meeting has a detailed schedule, it is not necessary to list who presented what. Send completed reports by July 30, 2020, to Sally McFarlane, Shaima Nasiri, and Jeff Stehr.

Note: We recognize that discussion may be more limited at the virtual meeting than at our normal in-person meetings and so breakout session reports may be shorter than usual.

Session Title: ARM Aerial Instrumentation Update and Discussion Agenda
Session Conveners: Beat Schmid, Fan Mei, Dari Dexheimer
Session Date: June 24, 2020
Session Time: 2:00-4:00 pm EST (11:00-13:00 PST)
Number of Attendees: 100-120
Summary Authors: Fan Mei, Beat Schmid, Dari Dexheimer, and Jason Tomlinson

Main Discussion

This session started with Beat Schmid's overview of the invitation-based Aerial Instrumentation Workshop, which was held on March 2 and 3 at the Pacific Northwest National Laboratory. Forty-two white papers had been submitted before the workshop. Twenty-seven invited expert atmospheric scientists gathered in Richland, Washington, to advise 28 ARM infrastructure and program staff on potential new instrument capabilities for the Challenger 850, ArcticShark and TBS. Attendees engaged in 45 talks that primarily focused on potential instruments and how the user community can benefit from the implementation of those measurements.

Then, Beat summarized the contributions from the retired G-1 aircraft. For the past 30 years, the G-1 had supported DOE's Biological and Environmental Research Mission through several programs. From 2010 to 2018, the G-1 operated by AAF has been deployed to 10 ARM campaigns. Beat also briefly mentioned missions where AAF relied on contracted aircraft and pointed out that at least 185 peer-reviewed papers have been published from AAF led missions. With the newly purchased AAF Bombardier Challenger 850 regional jet, the AAF will maintain the capability of the G-1 for "low and slow" flights while embracing the future opportunities, which the Challenger 850 offers. The current timeline projects science and engineering flights with the modified aircraft in CY 2022 and CY 2023 for the 1st science mission. The first opportunity for the research community to propose a research mission with the Challenger 850 will be in response to ARM's regular call for proposals in ~March 2022 with a decision in ~October 2022. For CY2023 missions will be restricted to SGP or SEUS, in CY2024 missions will be restricted to locations in the continental US (including Alaska), and international locations are possible for CY 2025 and beyond. The future home of the Challenger 850 is nearly ready: The new

18,000 ft^2hangar is a merged operations facility for both the piloted aircraft and the ArcticShark UAS and expects to host up to 15 staff.

During the update on the ArcticShark status, two mishaps that occurred in 2019 were mentioned by Beat. PNNL performed a mishap analysis and subsequently issued a corrective action plan. In addition, AAF performed an alternatives analysis for BER. Some engineering efforts continued during the pause. Acceptance test flights with the repaired/modified ArcticShark are scheduled for June 2021. Meanwhile, the AAF UAS team will work with partners from MSU (and possibly NAVAIR) to conduct a science mission on one of their TigerShark platforms. This possible 1st science mission will be a clear air flight over the SGP site under a COA approved in Summer 2019 (valid for two years).

Following Beat's presentation, Jason Tomlinson updated the session attendees with exciting progress with the Challenger 850 modification. The aircraft modification contract was signed on June 7, 2020, and the aircraft arrived at Voyageur Aviation in Ontario, Canada, on June 22, 2020, which is two days before this session. Jason reminded everyone that the modifications presented were notional and subject to change during the design review stage. Then, Jason reviewed the cabin modifications, which illustrate that ease of access, durability, safety, rapid integration and modularity, and safety were all put into consideration. The proposed cabin infrastructure layout includes not only various panels, such as rack access panel, operator access panel, and system interface panel, but also different functional modules, such as vacuum source, the exhaust line, and compressed air source. In the research power and distribution portion, Jason explained the primary power distribution panel and excited to share that the Nova Electric combined Frequency Converter and UPS will be implemented and maintain the whole payload with uninterrupted power for up to 4 mins. The wing pylons modification brings another favorable outcome – 3 attachment points on each wing, which will allow the AAF to have an exceptional underwing carrying capability. The zenith and nadir mounting apertures open a door for AAF to integrate instruments flown by other agencies (as they are sized based on inter-agency "standard"), e.g., for the potential lidar deployments, which received higher attention from the audience (see table below). Another hot spot is the fuselage mounted instrumentation. The RHS galley service door will likely be the main carriers for two inlets (isok and CVI inlets), and several other instruments to provide the fundamental meteorology parameters.

Additionally, window plates can be installed into windows 1 and 2 and satisfy the need for further fuselage mounting locations. Jason also discussed the pathway to global operations that will require avionics updates.

Fifty participants voted to prioritize the options for modifications that would go beyond what is currently in the contract. The polling questions result is in the below table.

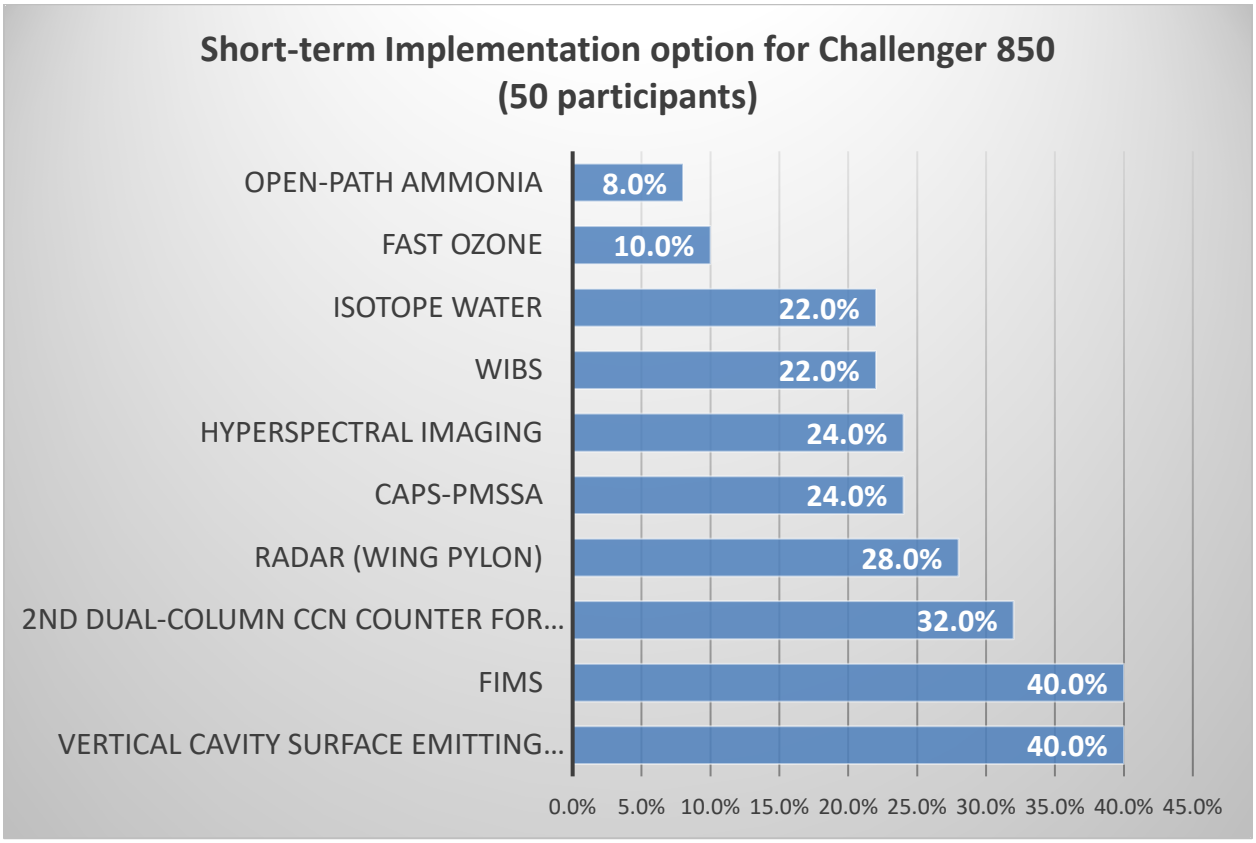
	1st	**2nd**	**3rd**	**4th**
Dropsonde unit and chute	7	12	19	11
LiDAR (port window, cover)	27	15	8	2
Turbulence Radar for aircraft	6	10	11	19

Radar beyond PMS canister based	9	10	12	16

Fan Mei used two ARM campaign highlights to demonstrate the current AAF capabilities and emphasized that the Challenger aircraft will maintain the sampling capabilities of the G-1 while providing enhanced performance with increased payload capacity, higher ceiling, larger geographical range, and improved endurance. Based on AAF's operational and scientific experience, AAF has grouped the instruments proposed at the workshop into options that could be implemented in the short term or mid/long term. The short-term implementation options include the proposed instruments, which are commercially available or can be built through contracts, have a reliable deployment history with other agencies, and can potentially serve as a facility instrument. The mid/long term implementation options include the proposed instruments, which are still in the concept phase but have a strong science driver, and/or require significant funding to support their deployment; and/or require significant aircraft additional modification. The list of instruments in each group was discussed. However, due to time limitations, Fan focused on the short-term options and gave the introductions to the instruments below:

- Vertical Cavity Surface Emitting Laser (VCSEL) hygrometer
- 2nd Dual-column CCN counter for scanning flow operation
- FIMS
- CAPS-PM_{SSA}
- WIBS
- Fast ozone
- Open-path ammonia
- Water Isotopes
- RADAR (Wing pylon mounted)
- Hyperspectral imaging

The polling results based on 50 participants suggest that FIMS, VSCEL, and 2nd dual-column CCN counter should be implemented first. The polling results are shown below.

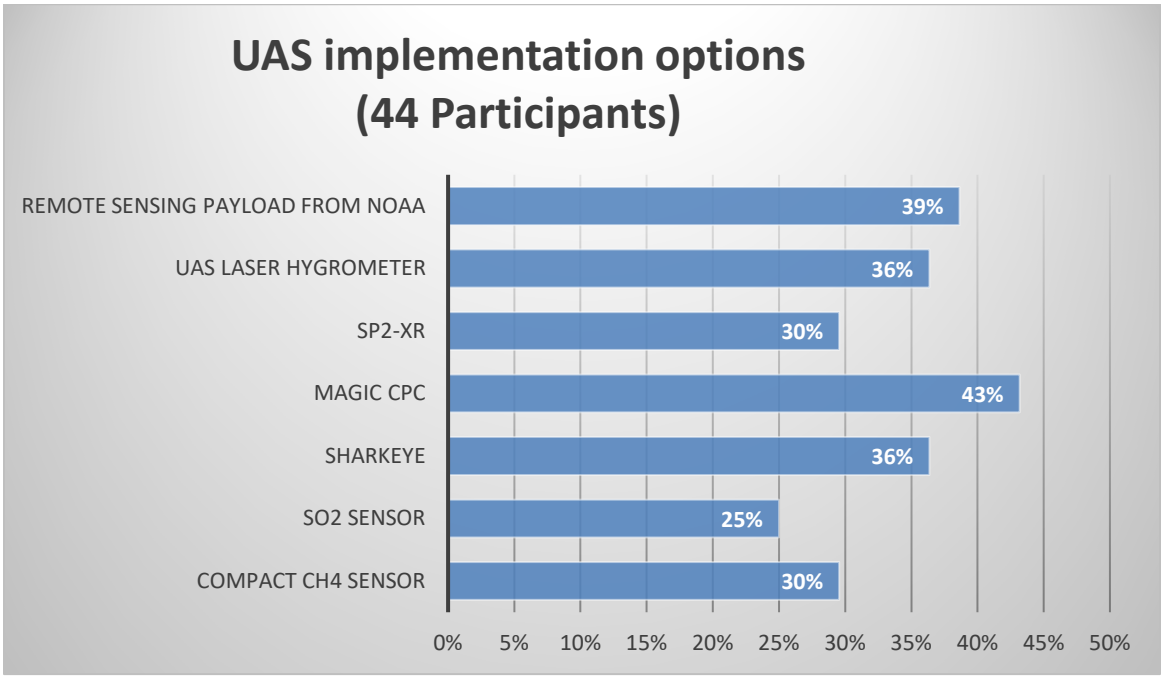


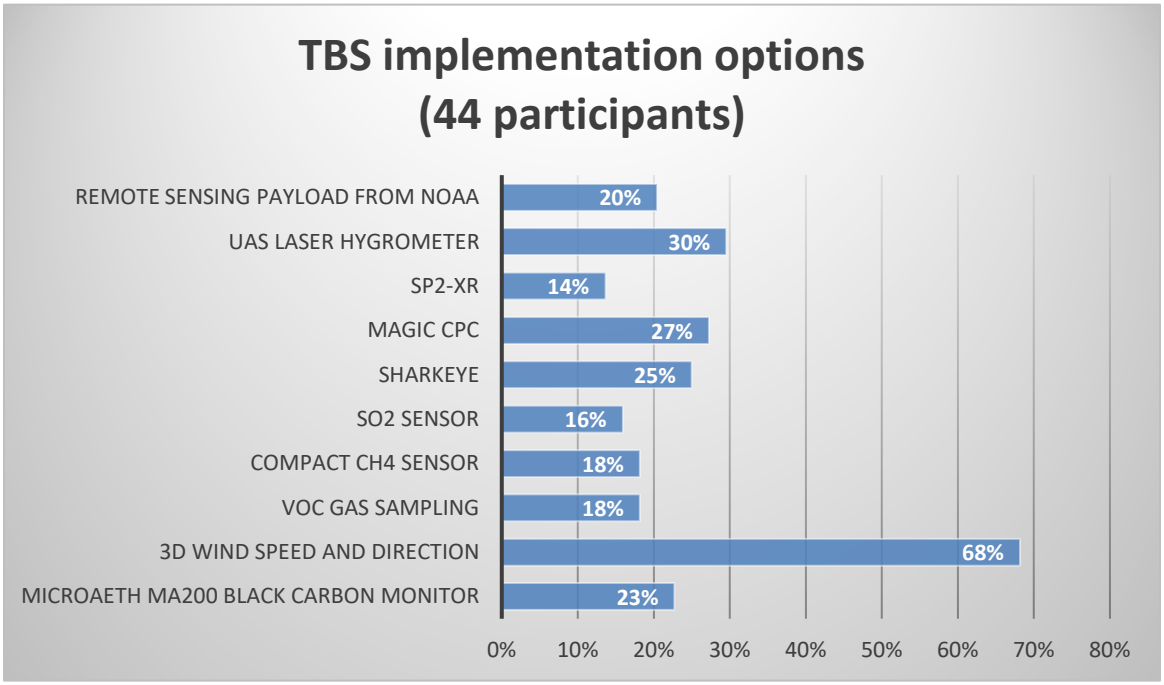
During her presentation, Dari Dexheimer introduced the current capabilities of the TBS managed by Sandia National Laboratories, which included both the deployment equipment and the payload instruments. AAF and TBS groups have deployed the baseline instruments which provide the aerosol properties and meteorological parameters. During the past several TBS IOPs, many guest instruments were also deployed on the TBS and demonstrated new potential capabilities, which the current TBS payload can be adapted to include. Fan reviewed the comprehensive payload instruments, which have been integrated into the ArcticShark and operated by the AAF UAS group. Then, Dari and Fan shared the miniaturized instruments proposed for both TBS and UAS. The polling results based on 44 participants highly suggest implementing 3D wind speed and wind direction measurement. Several other capabilities were voted with similar attention, such as laser hygrometer, Magic CPC, Sharkeye, and MicroAeth MA200 Black Carbon counter, followed by the NOAA NightFox aerosol payload. The poll questions and resulting plots are shown below.

Please choose the first **THREE** capabilities you think that ARM should implement for vertical profiling (TBS) flights.

- microAeth MA200 Black Carbon monitor
- 3D wind speed and direction
- VOC gas sampling
- Compact CH_4 sensor
- SO_2 sensor
- Sharkeye

    - Magic CPC
    - SP2-XR
    - UAS laser hygrometer
    - Aerosol/gas payload from NOAA NightFOX
- Please choose the first **THREE** capabilities you think that ARM should implement for UAS flights.
    - Compact CH_4 sensor
    - SO_2 sensor
    - Sharkeye
    - Magic CPC
    - SP2-XR
    - UAS laser hygrometer
    - Remote sensing payload from NOAA NightFOX





Key Findings

We received 37 interactions through Q/A features during the session. Among those interactions, we received 23 questions related to the potential payload requirement and operation conditions. The community is very excited about the new capabilities the Challenger 850, ArcticShark and TBS will bring to the users.

Action Items

AAF will forward the priorities established by these community votes to the IMB and implement as many as feasible/advisable based on the IMB's and ARM Program Management decisions.