# ARM Climate Research Facility – FY 2018 and Beyond

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## Site Report Updates:

- Submitted GRUAN Site certification request for SGP radiosondes.
- Working on GRUAN Site membership application process for ARM Sites.
- Implementing a strategic plan for improving liquid and solid precipitation measurements using multiple instruments (2016-2017).
- Developing best estimate for liquid and solid precipitation products (2018).

# ARM Climate Research Facility – FY 2018 and Beyond

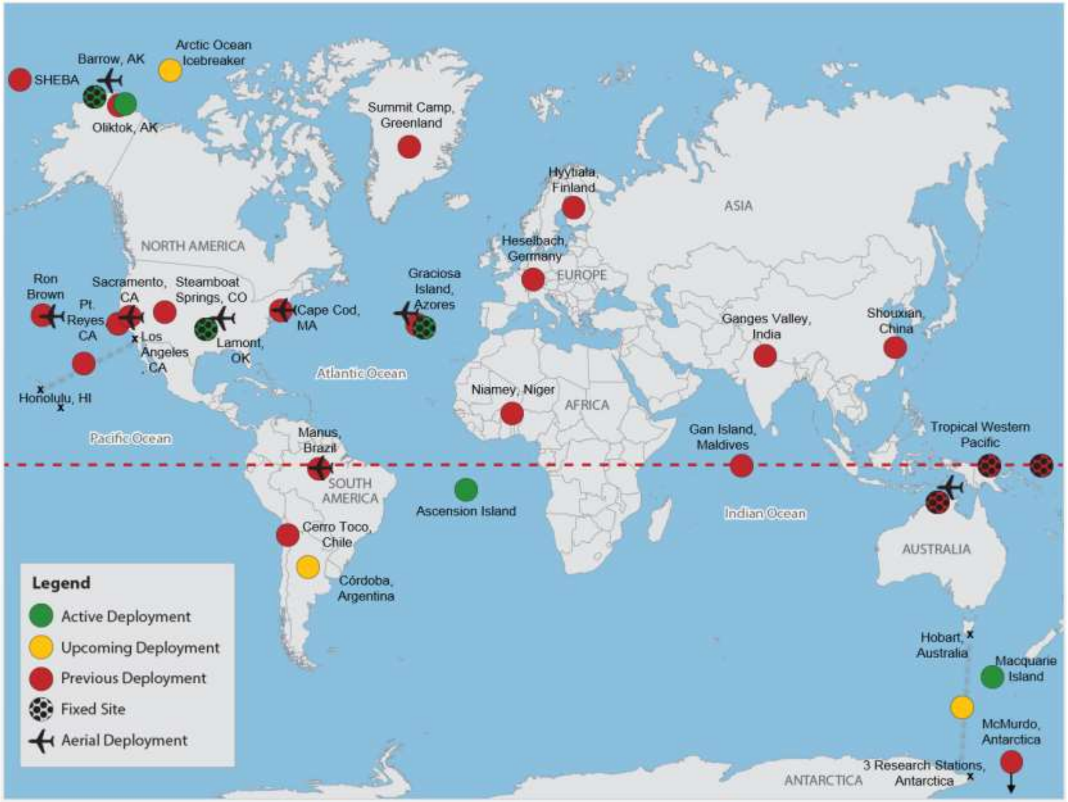
## ARM BUDGET ISSUES:

The FY 2018 Congressional Budget Request:

Guidance:

Maintain SGP (Lemont) and Barrow Sites
Maintain an aerial capability
Eliminate Oliktok
Eliminate one ARM Mobile Facility
Limited Operations in ENA (Azores)

**ARM FY 2018 Funds proposed ~48% cut**




The guidance does not come close to the budget target. Therefore, ARM would be forced to cut significantly more than the guidelines provided.

**THIS IS ONLY A BUDGET REQUEST! The Senate must agree with the proposed Congressional budget request – and they don't! There will be significant budget debate, proposals and counter proposals. Based on the current administration's rhetoric and aggressive pursuit of eliminating climate science research and environmental safeguards, it seems likely that ARM will have a significant reduction in budget – but how much is unclear.**

# Atmospheric Research Systems (ASR)– FY 2018 and Beyond

## ASR BUDGET ISSUES:

The FY 2018 Congressional Budget Request:

ASR will conduct research on cloud, aerosol, and thermodynamic processes using data collected during observations conducted in FY 2018 by Unmanned Aerial Systems, and the full suite of data from campaigns conducted in Alaska, Oklahoma, Antarctica, the Southern Ocean, and Azores, will be utilized.

Research activities will focus on early research studies on the physics governing cloud-aerosol-precipitation interactions in Antarctica and the Southern Oceans, i.e., two regions that are high priority earth system modeling challenges yet have lacked field data until now. There is no funding included for analysis of anthropogenic aerosols and black carbon.

**ASR FY 2018 Funds proposed 55% cut.**

**THIS IS ONLY A BUDGET REQUEST! The Senate must agree with the proposed Congressional budget request – and they don't! There will be significant budget debate, proposals and counter proposals. Based on the current administration's rhetoric and aggressive pursuit of eliminating climate science research and environmental safeguards, it seems likely that ARM will have a significant reduction in budget – but how much is unclear.**

# Measurement Certainty &Measurement Confidence


Sisterson D. 2017. A Unified Approach for Reporting ARM Measurement Uncertainties Technical Report: Updated in 2016. Ed. by Robert Stafford, ARM Climate Research Facility. DOE/SC-ARM-17-010.

**What do we mean by "good" data. Specifically addresses the importance of assessing *total* measurement uncertainty to improve measurement confidence – it's more than instrument calibrations.**

**Field uncertainty (or measurement uncertainty):**

For the uncertainty to be reported as *field (measurement) uncertainty*, the method used to characterize the quantification of uncertainty had to be provided. The information had to include one of the following:

- A measure of the variability of field samples [a function of the statistical mean (needed to compute relative uncertainties (GUM 2008, JCGM 100:2008) and standard deviation of a number of in-the-field instrument measurements, collected over a defined period of time, under defined environmental conditions] and the results of a calibration of the instrument under ideal conditions.
- The results of a field calibration of the instrument under normal operating conditions.
- Other sources of uncertainties are described in the manufacturer specifications, the results of a calibration of instrument under ideal conditions, data loggers specification, maintenance, sample time and cable losses, need for radiation shields, engineering judgment and the scientific literature.

# Measurement Certainty & Measurement Confidence

## Calibration uncertainty:

**For the uncertainty to be reported as based on *calibration uncertainty*, our study required that one of the following had to be available about the calibration reference:**

- **A traceable standard** (i.e., a calibration reference value that is traceable to international references of the appropriate units of the International Systems of Units or traceable to a reference standard developed and maintained by National Institute of Standards and Technology (NIST), World Radiometric Reference (WRR), or World Infrared Standard Group (WISG).
- **A consensus procedure** (peer-reviewed article describing a method used to obtain a calibration reference).
- **Expert judgment**, in which the Instrument Mentor or vendor clearly states his/her practice for obtaining a calibration reference. For this study, we considered the vendors and/or Instrument Mentors to be subject matter experts. Vendors did not always share the details of how they determined the reported uncertainty for their instruments, but there is a body of research literature that has independently addressed instrument measurement error that is consistent with vendor stated values.

## Resolution:

**For uncertainty to be reported as *resolution*, the method used to determine the instruments minimum detection level and indicate small changes in measurement had to be provided.**

- **A traceable standard** (i.e., a reference value that is traceable to international references of the appropriate units of the International Systems of Units or traceable to a reference standard developed and maintained by National Institute of Standards and Technology (NIST), World Radiometric Reference (WRR), or World Infrared Standard Group (WISG).
- **A consensus procedure** (peer-reviewed article describing a method used to obtain a resolution reference).
- **Expert judgment**, in which the Instrument Mentor or vendor clearly states his/her practice for obtaining a resolution reference. For this study, we considered the vendors and/or Instrument Mentors to be subject matter experts. Vendors did not always share the details of how they determined the reported uncertainty for their instruments, but there is a body of research literature that has independently addressed instrument measurement error that is consistent with vendor stated values.

# Measurement Certainty and Measurement Confidence

Specifically addresses the importance of assessing total measurement uncertainty to improve measurement confidence – it's more than instrument calibrations.

Table 1. Hierarchical approach for classification of measurement uncertainty.

| Uncertainty class | Method confidence |
|---|---|
| Field uncertainty | Highest |
| Calibration uncertainty | Good |
| Resolution | Fair |
| None | Lowest |

# Measurement Certainty and Measurement Confidence

Figure 1 summarizes the distribution of 417 unique primary measurements by uncertainty classification. The results show that uncertainty is provided as *resolution* for 4.32% of the samples (18 measurement types), as *field uncertainty* for 5.27% (22 measurements), as *calibration uncertainty* for 79.38% (331 measurements), and as *none* for 11.03% (46 measurements), because the instruments had not been fully characterized to estimate measurement uncertainty.

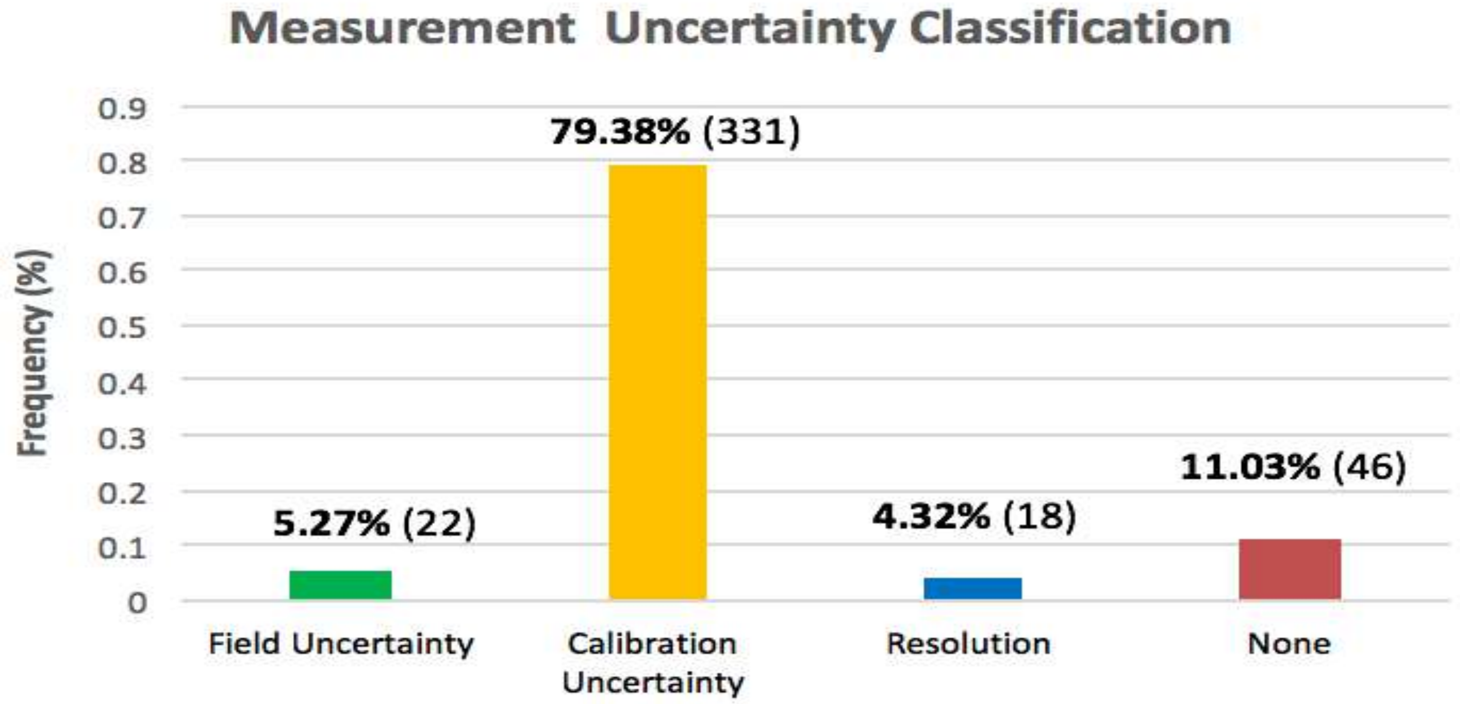



FIGURE 1. Distribution of instrument uncertainty measurements by uncertainty classification.

# Measurement Certainty and Measurement Confidence

| | Instrument | Measurement | Uncertainty Estimate | Uncertainty Type |
|---|---|---|---|---|
|  | Flask Samplers for Carbon Cycle Gases and Isotopes **(FLASK)** | Isotope Ratio: $C^{13}(O^{16})_2$ / $C^{12}(O^{16})_2$ | ± 0.03% | Precision: the variability of field samples, estimated when the field samples are brought into the lab. Calibration is done previously using a consensus procedure. |
|  | Multifilter Rotating Shadowband Radiometer **(MFRSR)** | Clear Skies total horizontal irradiance | ± 2.1 % | Accuracy: Calibration reference from consensus procedure (using a lamp traceable to a NIST standard, Langley plots, and night time observations). |
|  | C-band Scanning Precipitation Radar **(C-SAPR)** | Absolute Reflectivity | 4 dB | Other: Combination of calibration of various components, literature review, and expert opinion. Calibration is highly idealized, assumes no atmospheric losses, a known target in the far field, the return is from the target only, and no multi-path to the target. |
|  | Rain Gauge – Belfort Model AEPG 600 Weighing Bucket | Rainfall amount (accumulation) | ± 0.25mm (0.01 inches) | Resolution: Minimum detectable signal. |

One suggestion for displaying the information on ARM web page. Another would be using the Data Discovery Tool at the ARM Archive – that would allow data quality information reports, calibration information, and measurement uncertainty to be fields to display.

# Future Work?

**Representativeness: Measurements can be made accurately and precisely – but are they representative of the environment?**

**Aerosol and trace gas data:**

ARM is exploring the use of Machine Learning.

A "mask" uses aerosol and trace gas measurements from several instruments to provide a yes/no flag for suspected local source plumes. The flag indicates representative vs locally biased data. The standard deviation divided by the average concentration as a function of time has been found to be a good indicator of representativeness over a time. The flag is not meant to indicate "bad" data – no judgement of the data is intended. The flag is intended to indicate short excursions in concentrations – that are likely due to local emissions. The mask can be biased to minimize false positives.

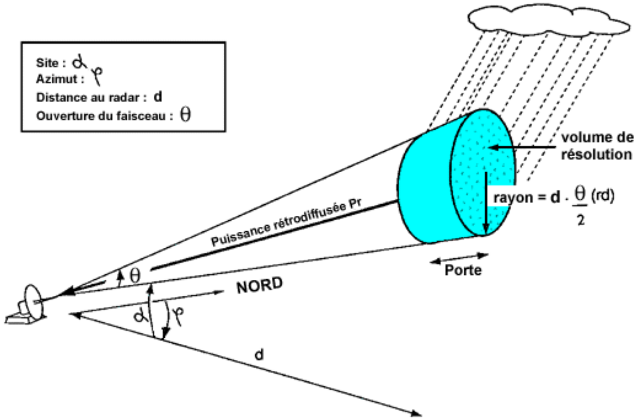
**CSPHOT Data quality:**

Has already been demonstrated to be useful for automated data quality reviews.

# Future Work?

**Improvement in liquid and solid precipitation measurement uncertainty:**

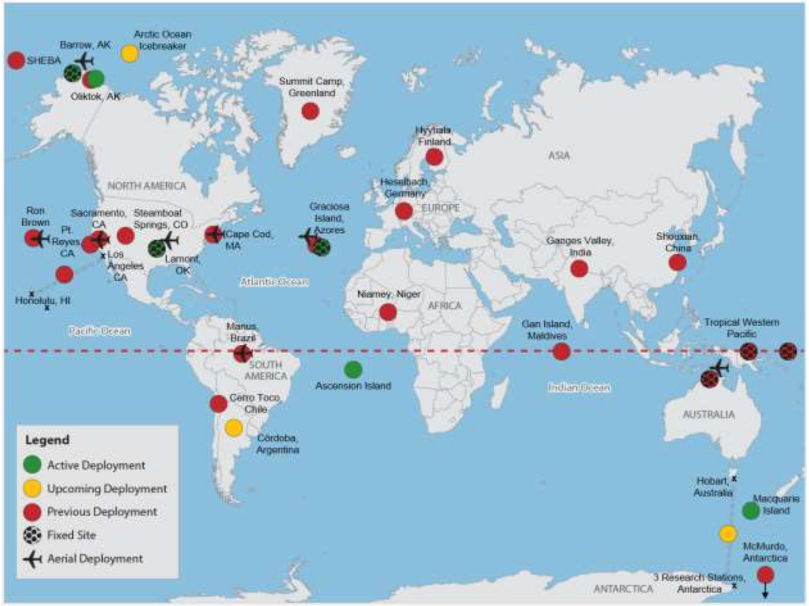
- Best estimate product for liquid precipitation
- Best estimate product for Arctic precipitation
- Identifying hygrometeors for cloud and precipitation radar algorithms to evaluate radar precipitation algorithms.



# ARM Facility Radiosonde Operations and Improvements

# ARM MW41 Upgrades

- SGP (Lamont, Oklahoma): 5 systems (3-MW31, 2-MW21) upgraded April 12, 2017
- OLI (Oliktok Point, Alaska): 1 system (MW31) upgraded May 19, 2017
- NSA (Barrow, Alaska): Autosonde upgrade contract in place.  Upgrade to be scheduled for September 2017
- NSA (Barrow, Alaska): 1 system (MW21) configured and ready for install
- Yet to be upgraded:
  - ENA (Graciosa Island, Azores) (MW31)
  - AMF1 Mobile Facility (MW31)
  - AMF2 Mobile Facility (2-MW31 systems)
- Order placed for RS41-SGP radiosondes to be delivered in September 2017
- Transition to RS41 radiosondes will occur as RS92 supplies are depleted




ARM has 11 manual launch systems and 1 Autosonde system.

# ARM Radiosonde Operations Upgrades

- Expansion of Autosonde deck at NSA (Barrow, Alaska) completed May 2017.

- Proposed to upgrade to 600g balloons/larger launcher cart to achieve burst above 10hPa, cost/budget concerns are being evaluated.

**The Autosonde deck was expanded to house a container/enclosure for the manual system and for a hydrogen generator**

# ARM Radiosonde Operations Summary and Future

- Proposed addition of Standard Humidity Chamber (SHC) to SGP site in Oklahoma, cost/budget concerns are being evaluated
- Proposed to upgrade to 600g balloons/larger launcher cart to achieve burst above 10hPa, cost/budget concerns are being evaluated
- In process of adding mass flow controllers to our helium supply lines for regulated gas delivery amounts
- MAWS operational and integrated with BBSS at SGP, OLI, ENA providing dedicated surface observations for radiosonde systems
- Field Campaign proposal under ARM review for RIVAL (Borg, et al.) to fund one-year, weekly dual (RS92/RS41) launch study
- Thinking about recording radiosonde descent data.

**Thank You!!**