Measurement Certainty and Measurement Confidence

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A Unified Approach for Reporting ARM Measurement Uncertainties (Campos and Sisterson, 2015 DOE/SC-ARM-TR-170. www.arm.gov/publicaton - Technical Report)

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

- **Field uncertainty (or measurement uncertainty)**, which corresponds to the variability of repeated measurements under field conditions with well-calibrated sensors.
- **Calibration uncertainty (or instrument uncertainty)**, which corresponds to instrument calibration, use of well-established calibration references (traceability), and performance under ideal conditions to constrain known measurement errors.
- **Resolution,** which corresponds to the minimum detectable signal or instrument response.
- **Other**, which indicates an expression of uncertainty that either uses a retrieval or insufficient information to classify by above definitions (i.e., no traceability provided).
- **None**, which indicates that measurements have unknown uncertainty. That is, no estimates could be provided, because the instrument has not been characterized.

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Table 1. Hierarchical approach for uncertainty estimation methods.

Uncertainty class	Method confidence
Field uncertainty	Highest
Calibration uncertainty	Good
Other	Fair
Resolution	Low
None	Lowest

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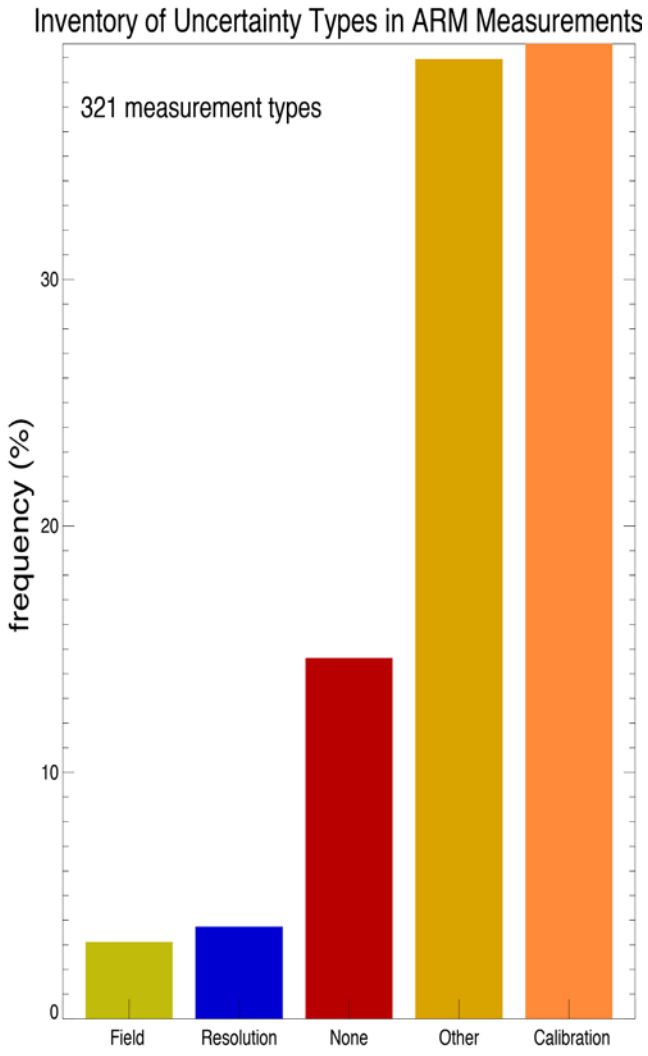
Currently, resolving the "Other" and "None" category.

Also, adding instruments that were new after 2012 that not included in this study: CH4FLX, IRSI, LDIS, MAWS, NAV, RPY, RPH, PGSISO, STAMP, APS, TWRCAMs and retired instruments 50RWP, GRAMS, and WSI.



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	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

Environmental Factors That Contribute to Measurement Uncertainty

Unique Measurement/Instrument Problems (New) - **Addresses how the instruments are operated in the field.** If there are instrument specific or deployment environment specific issues to be considered, they must be documented. ARM should be operating its instruments uniformly with "best practices", but best practices may depend on the operating environment.

Issues for ARM - This is something that was identified by Users that is not uniformly addressed in the Handbooks.

- What instruments are operated differently at fixed and mobile sites to **compensate for local environmental conditions?**
- What **metadata** is used to evaluate the impact instruments (data) operating in different operating conditions?
- Are we operating all our instruments with **"best practices" in harsh environments**?
- How does the **operating environment** contribute to instrument uncertainty?
- **Do calibrations consider the uncertainty of the operating environment?**
- Are there other ways to **determine measurement error due to environmental factors**?
- Are there **references that provide estimates of measurement uncertainty** that apply to instruments?
- **What and when are corrections are applied** in the processing of B1 and C1 level data?