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North Slope of Alaska Snow Intensive Operational Period Field Campaign Report

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ARM
CLIMATE RESEARCH FACILITY

DISCLAIMER

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Acronyms and Abbreviations

ARM	Atmospheric Radiation Measurement
DOE	U.S. Department of Energy
DOS	Disk Operation System (Microsoft)
IOP	intensive operational period
m	meter
NSA	North Slope of Alaska
PI	Principal Investigator
s	second

Contents

1.0 Summary

The campaign was motivated by the need to improve the quantification of measurements of ice-phase precipitation in the Arctic and was by the acquisition and deployment of the new X- and Ka/W-band radars. These radars opened up an opportunity for the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility to obtain spatial estimates of snowfall rates using the polarimetric X-band measurements and dual-frequency measurements (using different combinations of the three wavelengths). However, calculations of X- and Ka-band radar back-scattering of ice crystal aggregates with their complex structure suggest that the commonly used T-matrix approach (Matrosov et al. 2007) for modeling the radar back-scattering underestimates the reflectivity by several decibels, with errors increasing with increasing radar frequency (Botta et al. 2010, 2011). Moreover, the X-band polarimetric measurements and the Ka/W-band measurements are sensitive to the assumed shape of the snow (Botta et al. 2011).

One of the five ARM two-dimensional video disdrometers (manufactured by Joanneum Research) were deployed in Barrow at the ARM North Slope of Alaska (NSA) site from 1 October, 2011 to 31 May, 2012 in an attempt to use the instrument in a novel way. The instrument was originally designed to measure the drop size distribution of rain but it seemed worthwhile to explore its capability to quantify ice precipitation particle size and shape distributions in the cold north for scattering calculations and precipitation estimations. Furthermore, this deployment gave us an opportunity to see how reliable it could be in arctic conditions.

2.0 Results

Soon after deployment to Barrow, Alaska, the reflecting material on one of the mirrors in the instrument started peeling. The repaired instrument came back on line in mid-February. A preliminary look at the data revealed that the processing software was optimized for fast-falling rain drops (fall speeds on the order of meters per second), which failed for the slow falling (< 1 m s^{-1}) snowflakes. As a result, none of the standard output data from the instrument contained usable information.

The manufacturer, Joanneum Research, was approached and asked to provide either software to read the proprietary raw data files, or else make the data format available to ARM. They were willing to sell the (DOS-based) software to ARM for 5,000 Euro. Given the instruments' poor performance in the Arctic, and the antiquated software, the PI decided that the required investment was not warranted.

3.0 Publications and References

Botta, G, K Aydin, and J Verlinde. 2010. "Modeling of microwave scattering from cloud ice crystal aggregates and melting aggregates: A new approach." *IEEE Geoscience and Remote Sensing Letters* 7(3): 572-576, doi:10.1109/LGRS.2010.2041633.

Botta, G, K Aydin, J Verlinde, AE Avramov, AS Ackerman, AM Fridlind, GM McFarquhar, and M Wolde. 2011. "Millimeter wave scattering from ice crystals and their aggregates: Comparing cloud model simulations with X- and Ka-band radar measurements." *Journal of Geophysical Research – Atmospheres* 116(D1), doi:10.1029/2011JD015909.

Matrosov, SY. 2007. "Modeling backscatter properties of snowfall at millimeter wavelengths." *Journal of the Atmospheric Sciences* 64(5): 1727-1736, doi:10.1175/JAS3904.1.

4.0 Lessons Learned

The manufacturer of any purchased instrument should be required to make known the format structure of the base-level recorded data.

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