Taranis: Advanced Precipitation and Cloud Products for ARM Radars

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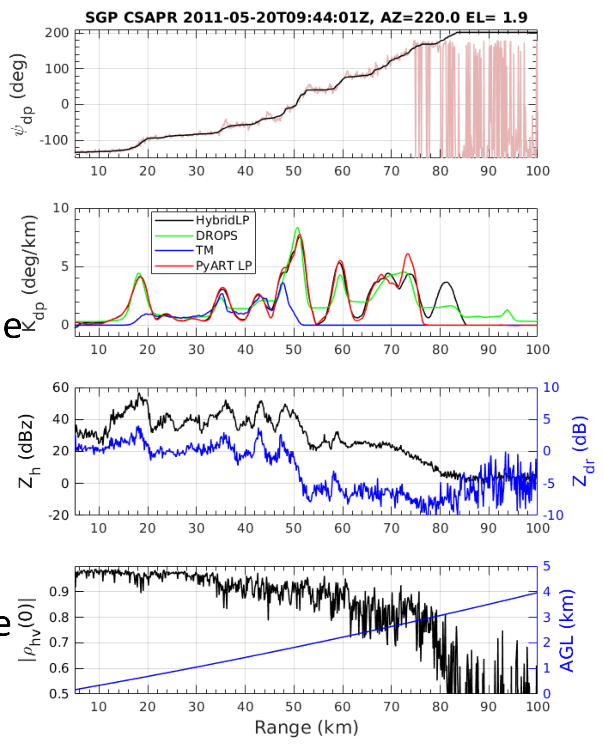
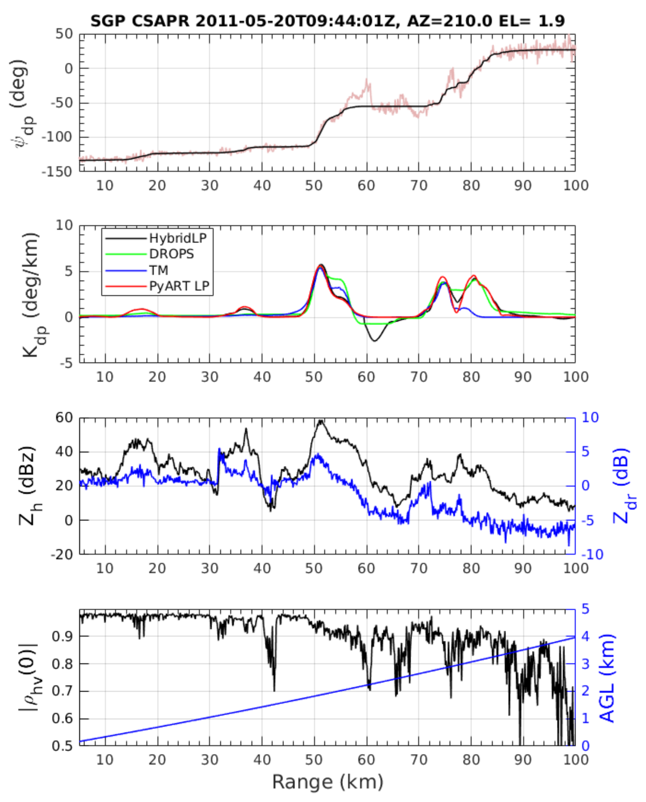
1. Introduction

- Climate Model Development and Validation – Mesoscale Convective System (CMDV-MCS) is a BER project to develop and validate DOE's Accelerated Climate Model for Energy (ACME) model capability in simulating MCSs by bringing together a group of observationalists, scientists, and modelers.
- A task area for CMDV was to develop a new suite of products from ARM radars to support model evaluation that scaled to multiple campaigns.
- This poster examines this suite of products (**Taranis**) that includes corrections, gridding, and retrievals of various quantities from cloud and precipitation radars.
- These products have been used in comparison with model and aircraft observations.
- Taranis has since been extended to work with other sites and radars across multiple frequencies.

2. KDP Estimation

- Taranis utilizes a new KDP estimation algorithm that combines the best of the spline approach from Yanting & Chandrasekar (2019) and the linear programming approach of Giangrande et. al. (2013).
- Fast C-based multi-threaded implementation with Python interface.
- Hybrid retrieval reworks the constraints in LP to incorporate spline based processing.

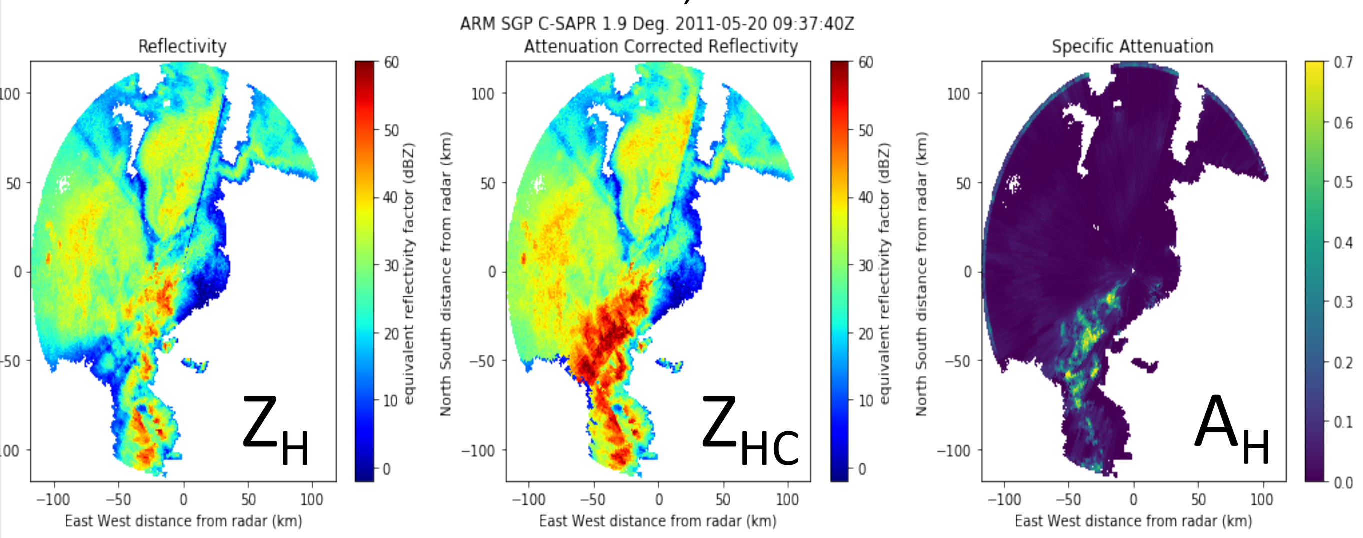




- Additional global constraints on total delta Φ_{DP} provides a weighting between local and global scope effects.
- Works in situations with backscatter differential phase effects.
- Gives estimates with and without positivity constraints on K_{DP}.

3. Attenuation Correction

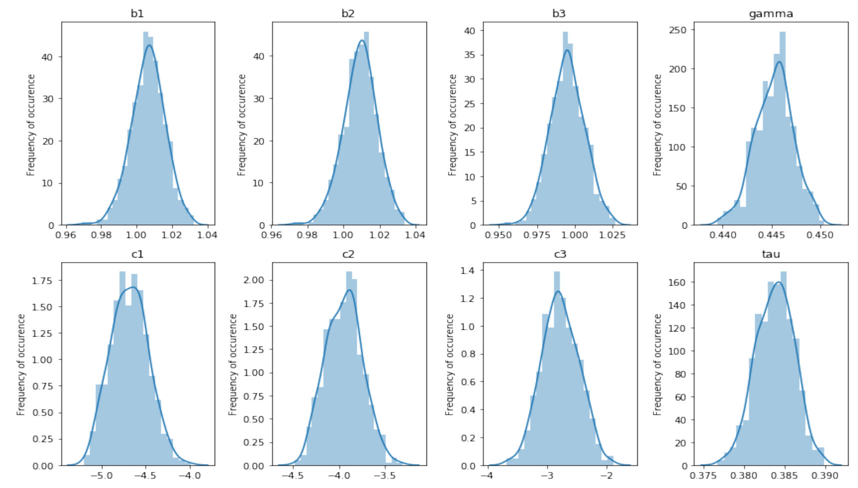
- Modification of the Lim & Chandrasekar (2016) attenuation correction algorithm.
- Utilizes a series of self-consistency relationships for different shape relationships and temperatures based on scattering models.
- Cost optimization over several candidate solutions.
- Can be tailored to individual sites, or used as-is.

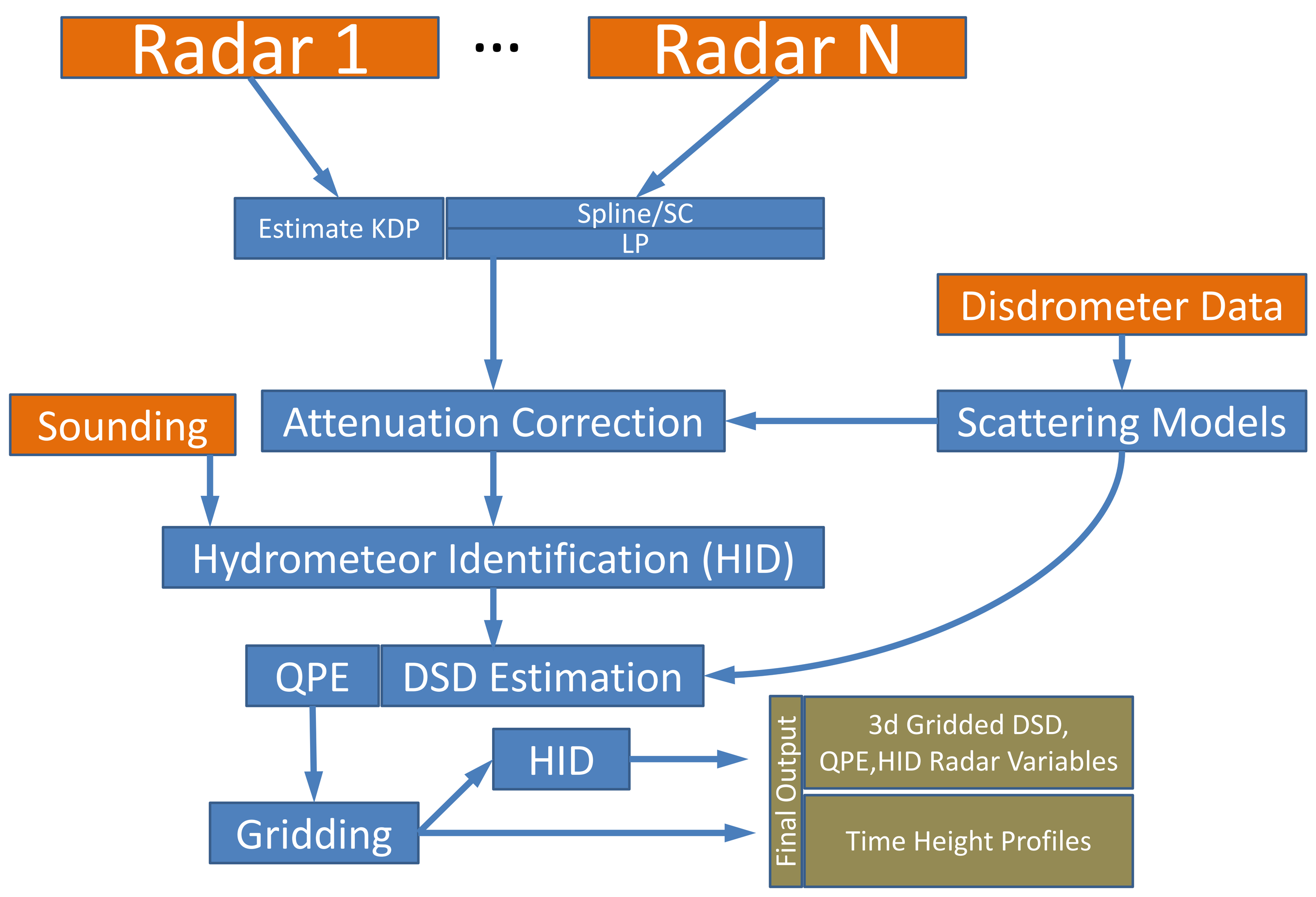


4. Self-Consistency Scattering Models

- The attenuation correction processing utilizes a series of scattering models that incorporates variation in drop shape relationship and temperature.
- Cost minimization over fitted models selects an appropriate model based on physical self-consistency.
- Incorporates site-specificity by using disdrometer data.
- Allows for scaling to higher frequencies.
- Bootstrap estimates show SC fits are stable and well constrained.
- Parts of processing are now in PARSQUANTS VAP from ARM.

$$\alpha_h = a_1 Z_h^{b_1} Z_{DR}^{c_1}$$
$$\alpha_v = a_2 Z_h^{b_2} Z_{DR}^{c_2}$$
$$\alpha_{dp} = a_3 Z_h^{b_3} Z_{DR}^{c_3}$$
$$K_{dp} = a_4 \frac{\alpha_h^{b_4+1}}{Z_h^{b_4}}$$
$$\delta_{co} = \frac{a_5 + c_5 Y^{b_5}}{b_5 + Y^{b_5}} \quad \text{where} \quad Y = \frac{K_{dp}}{\alpha_{dp}}$$
$$K_{dp} = a_6 Z_h^{b_6}$$

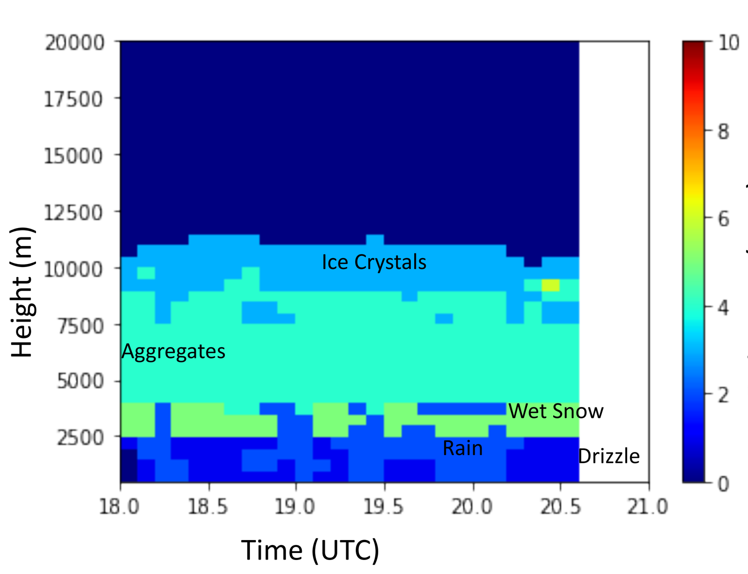




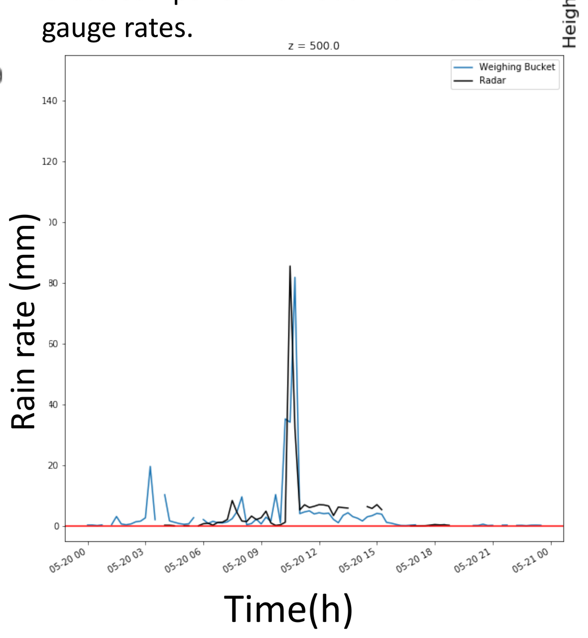
5. Output Products include:

- Attenuation Corrected Variables (Z_{hc}, Z_{drc}), and other radar variables
- Data Quality Masks (**Significant detection, second trip**, etc)
- **HID** class from CSU Radar Tools (10 Class).
- QPE from a blended decision tree (**Rain Rate, Rain Water Content**)
- DSD Estimation (**D_m, N_w, N_0, D_0**)
- **Gridding** (Py-ART or RadX depending on use)
- **Vertical Profiles** over key sites

Time-Height Display of HID from Gridded PPIs.



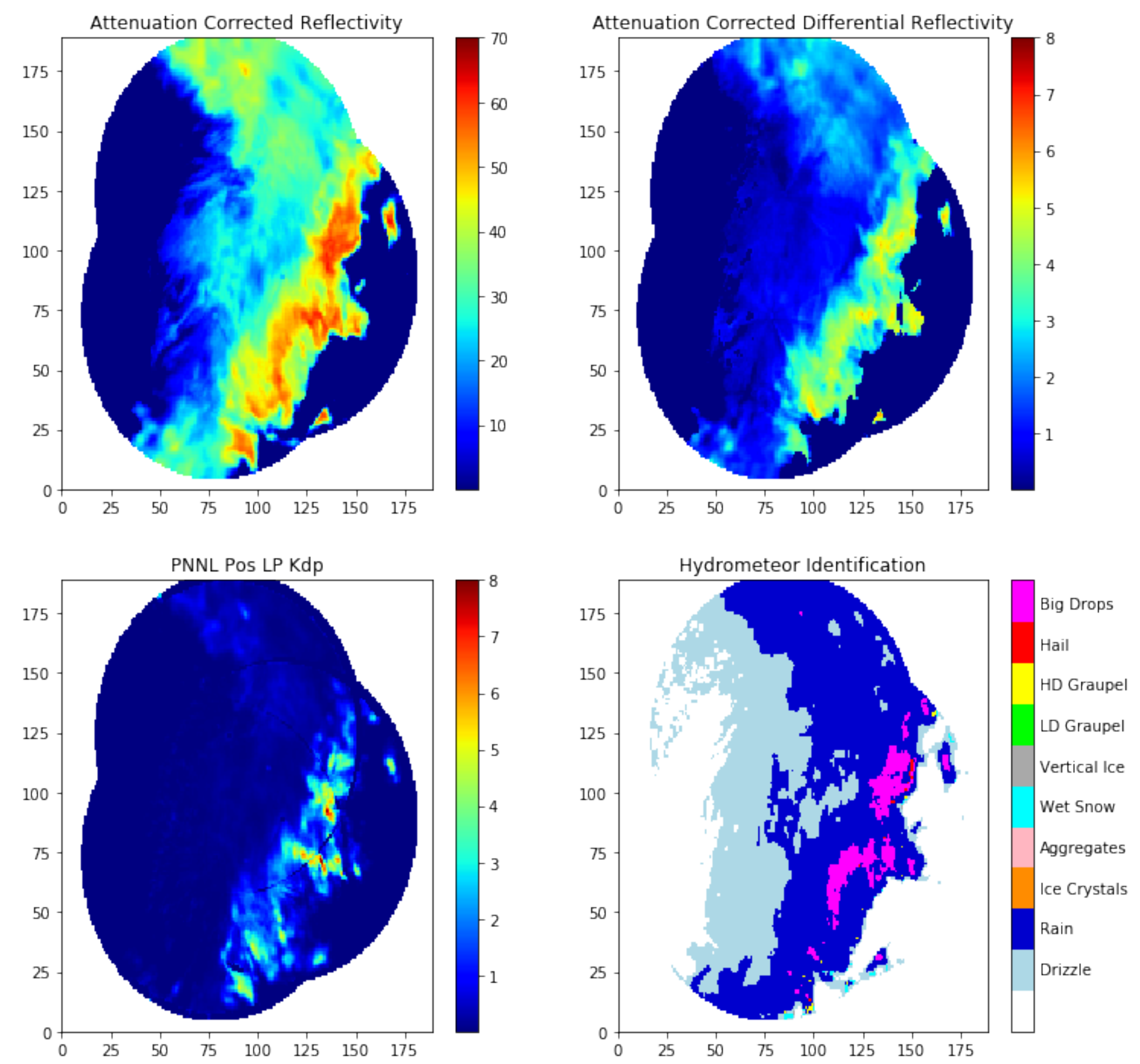
Cross-comparison of radar rain rate with gauge rates.



6. MC3E

- Several of the MC3E "golden days" have been processed using a mixture of CSAPR and XSAPRs for the CMDV project.
- Grids were generated to match model simulations for cross-comparisons.
- Additional comparisons with airplane and ground data.

June 11th 2018 19:06Z : ARM XSAPR Mosaic 2km CAPPI



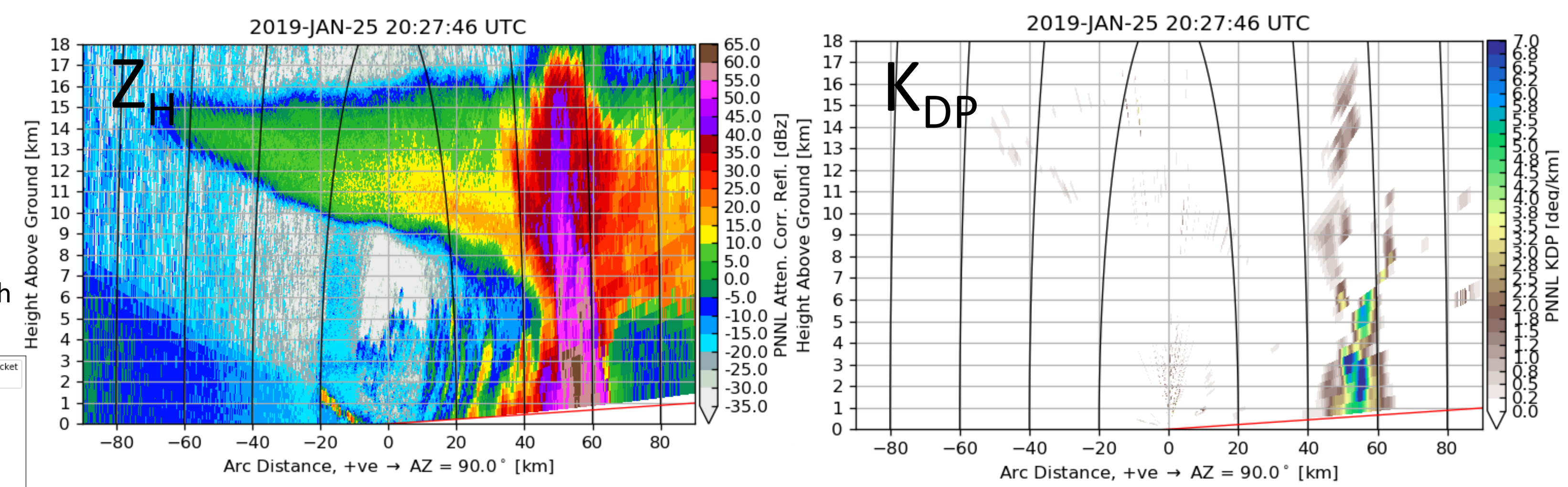
7. Verification

Verification and Validation based on several independent estimates:

- Disdrometer Comparisons
- NEXRAD comparisons
- Simulation based methodology for generating arbitrary wavelength and configuration radar networks from existing data.

8. CACTI

- While originally designed for the radar network at MC3E, Taranis runs equally well at other ARM sites.
- Processing will be done for the entirety of CACTI dataset.
- Processing was ran in real-time during CACTI field campaign.



9. Future work will focus on:

- Integrating melting layer handling.
- Extending full processing to higher frequencies.
- Processing remaining CACTI data.
- Integrating with FLEXTRKR storm tracking framework for CACTI and MC3E. FLEXTRKR provides storm tracks that include lifecycle and morphology measurements.

For more information about datasets or processing contact joseph.hardin@pnnl.gov.

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