X-Band Radar Precipitation Estimates for the Surface Atmosphere Integrated Field Laboratory (SAIL) Field Experiment

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SAIL Field Experiment

The Surface Atmospheric Integrated Field Laboratory (SAIL) field experiment is designed to advance the understanding of the water cycle within complex terrain, specifically the relationship between precipitation and river runoff within a portion of the Upper Colorado River Basin known as the East River Watershed. One of its primary scientific objectives is to characterize the spatial distribution of orographic and convective precipitation processes in the Upper Colorado, on diurnal to seasonal time-scales, and their interaction with the large-scale circulation.

Colorado State University X-Band Precipitation Radar (XPrecipRadar)

SAIL is collecting observations with a scanning X- Band dual-polarimetric radar provided by Colorado State University (CSU) (DOI: 10.5439/1844501). As the East River Watershed has sparse radar coverage from the National Weather Service (NWS) Next-Generation Weather Radar (NEXRAD) system, the CSU X-Band scanning radar provides observations at a high spatiotemporal resolution for the calculation of precipitation estimates within the watershed.

Figure 1. Colorado State University XPrecipRadar overlooking the East River Watershed (Image taken from *camweathermainmovie* datastream; **DOI:** 10.5439/1888377)

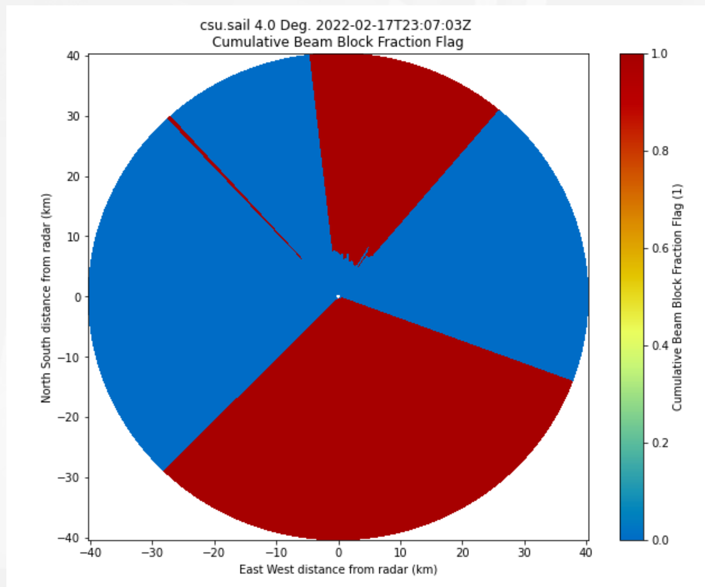

Figure 2. Cumulative Beam Blockage for the Colorado State University's XPrecipRadar at four degrees elevation scan.

Corrected Moments to Antenna Coordinates (CMAC)

To have the greatest impact to stakeholders, the CSU XPrecipRadar observations are corrected for all the issues of propagation and processing to provide high quality calibrated and corrected moments and measurements. This processing, Corrected Moments to Antenna Coordinates (CMAC), additionally calculates quantitative precipitation estimates (QPE) based off the corrections observations. CMAC processing corrects for:

- Dealiased doppler velocities
- φ_{DP} corrected for non-uniform beam filling and phase shift on backscatter
- Specific differential phase K_{DP}
- Specific Attenuation
- Reflectivity corrected for liquid water path attenuation

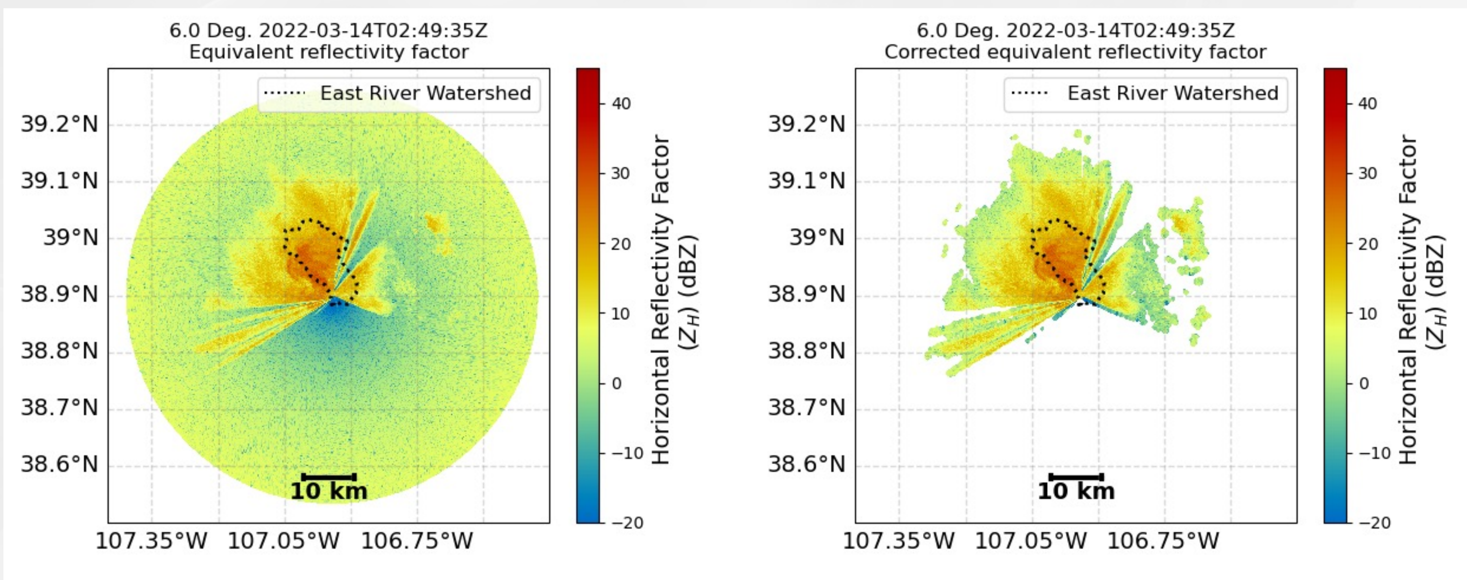

Figure 3. (Left) XPrecipRadar equivalent reflectivity factor with (right) CMAC corrected equivalent reflectivity factor for 14 March 2022.

Extracted Radar Columns and In-Situ Sensors (RadCLss)

To constrain the CMAC calculated QPE, the Extracted Radar Columns and In-Situ Sensors (RadCLss) product was developed to bridge the gap between the radar derived precipitation estimates and precipitation observations taken at various SAIL in-situ ground observation sites throughout the East River Watershed. The radar observations above these sites are extracted from the volume scan and collocate with in-situ observations, allowing for direct comparison of QPE.

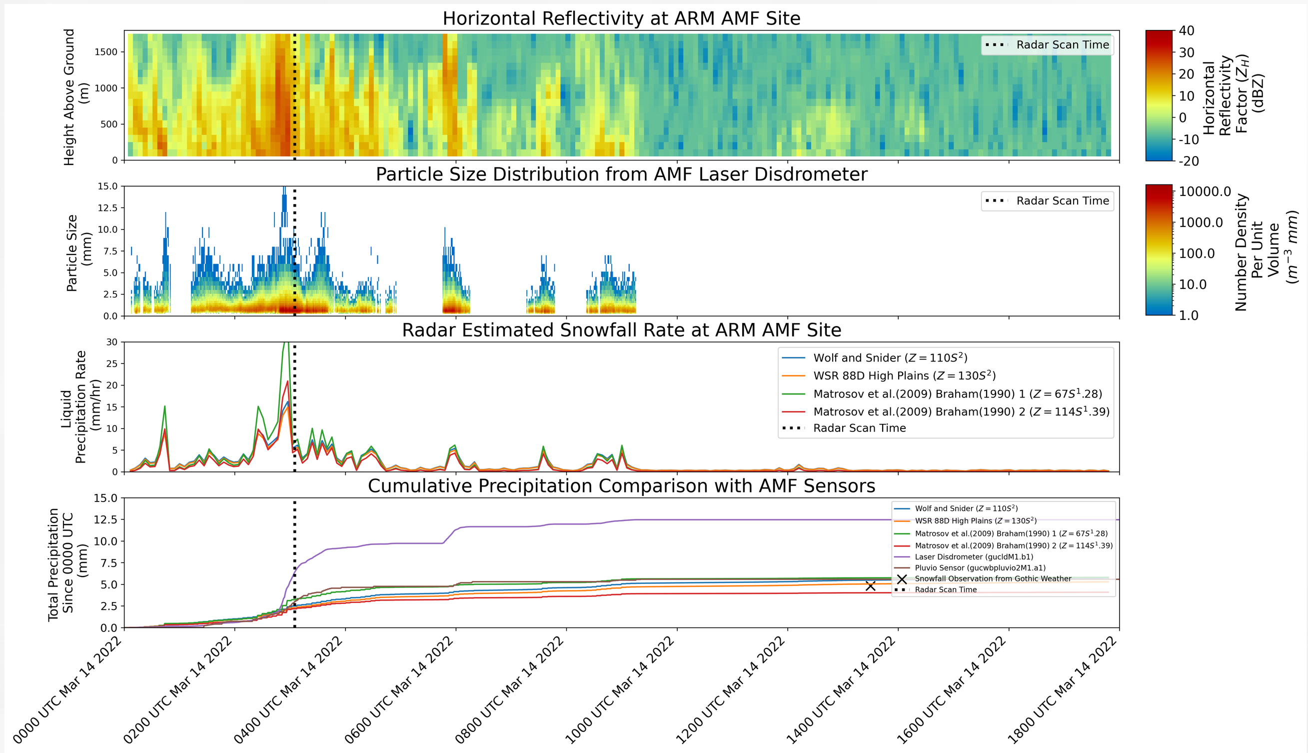

Figure 4: RadCLss example for SAIL M1 site on 14 March 2022, showcasing the XPrecipRadar extracted column and cumulative precipitation comparison with in-situ sensors (*xprecipradarradclss* datasteam; DOI: 10.5439/1884520).

Surface QUantitatIve pRecipitation Estimation (SQUIRE)

To make the CMAC calculated QPE more accessible to the general SAIL community, the Surface Quantitative pRecipitation Estimation (SQUIRE) product was developed to translate the CMAC radial coordinates into a gridded product of the lowest elevation.

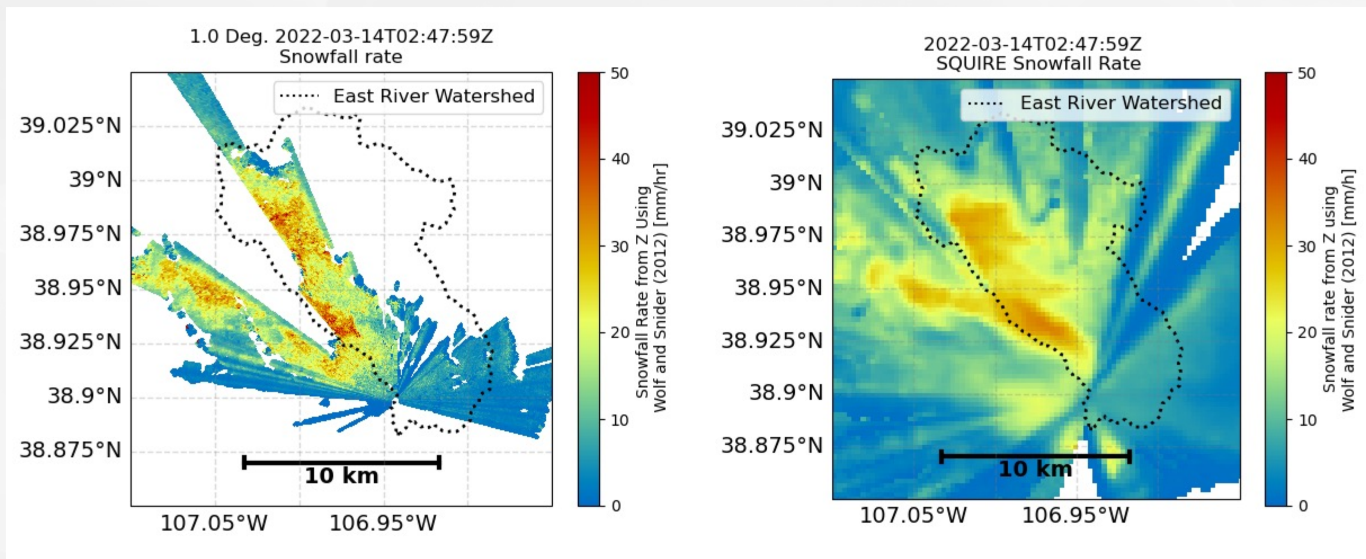

Figure 5. (Left) CMAC estimated snowfall rates with (right) SQUIRE gridded estimated snowfall rates for 14 March 2022 (*xprecipradarsquire* datastream; DOI: 10.5439/1884979).

Table 1 : CMAC empirical relationships used to calculate estimated snowfall rates from radar

Source	Z(S)	A Coefficient	B Coefficient	Radar Band
Wolfe and Snider (2012)	$Z = 110S^2$	110	2	S
WSR-88D High Plains	$Z = 130S^2$	130	2	S
Braham (1990) 1	$Z = 67S^{1.28}$	67	1.28	X
Braham (1990) 2	$Z = 114S^{1.39}$	114	1.39	X

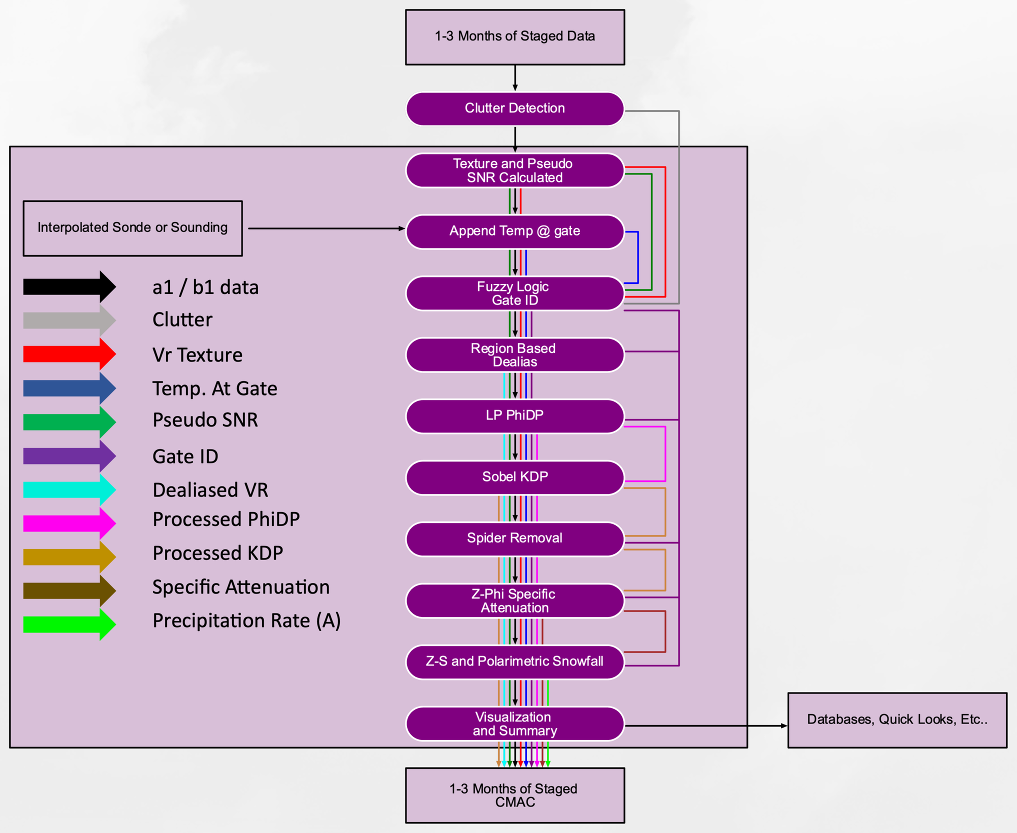

Figure 6. CMAC processing workflow, outlining the various corrections and calculations for the SAIL *xprecipradarcmacppi* datastream (DOI: 10.5439/1883164)

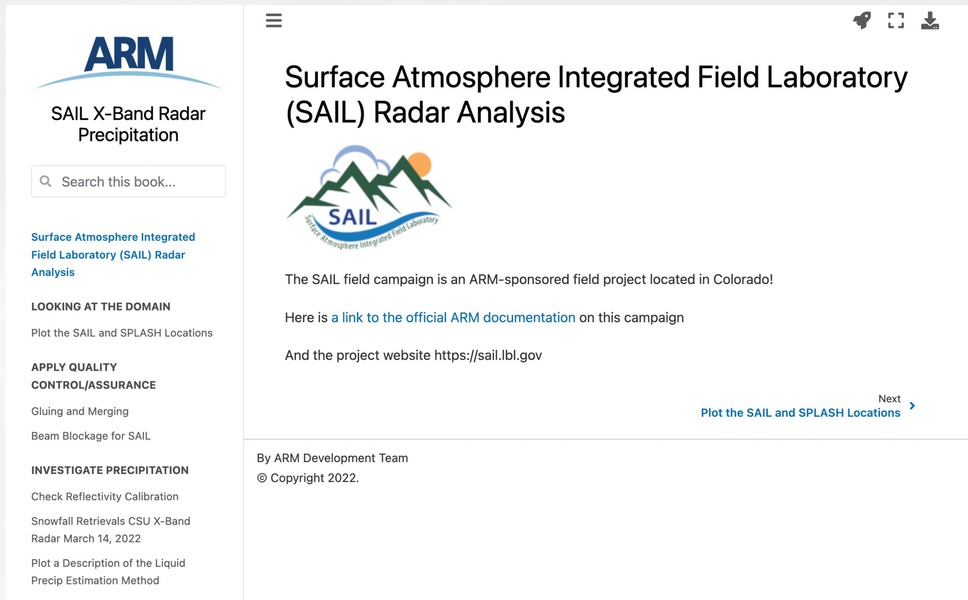

Figure 7: Open Science initiative to showcase all the methodology and workflow for quantitative precipitation estimates for the SAIL XPrecipRadar (https://arm-development.github.io/sail-xprecip-radar/overview.html)

Take a picture to view methodology and cookbooks!

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