Development of Value-Added Products from the Scanning ARM Cloud Radar (SACR) Systems

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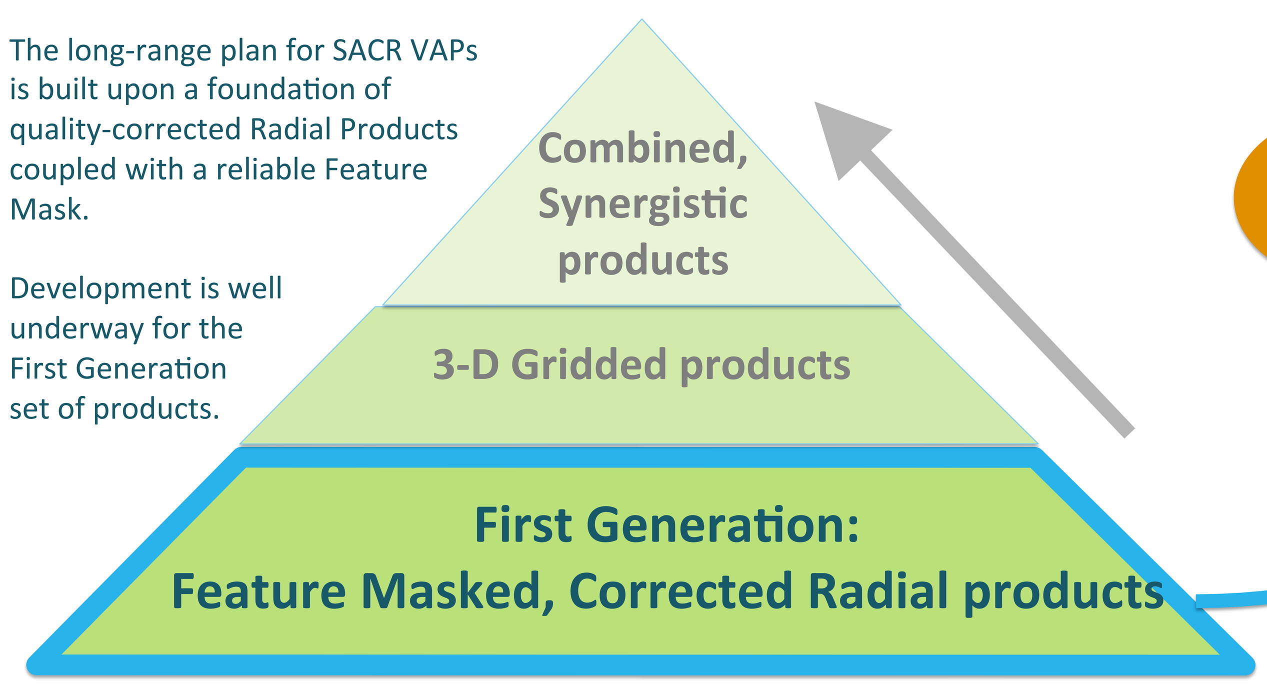
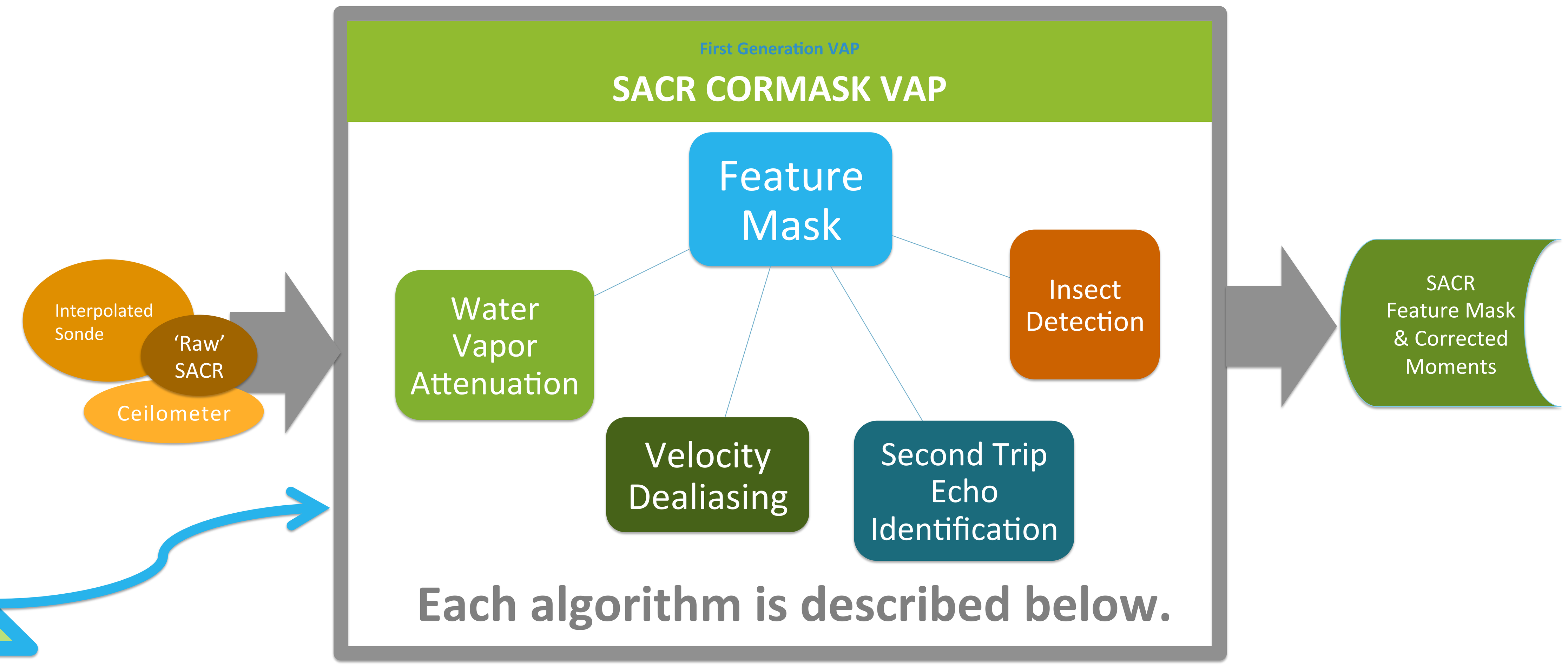
SACR VAPs

Scanning ARM Cloud Radar Value-Added Products

The long-range plan for SACR VAPs is built upon a foundation of quality-corrected Radial Products coupled with a reliable Feature Mask.

Development is well underway for the First Generation set of products.





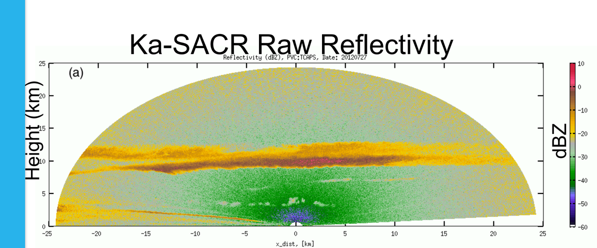
The SACR Radars

ARM continuously operates Scanning ARM Cloud Radars (SACRs), co-scanning dual-frequency pairs of dual-polarization cloud radars. Ka/W-band SACRs operate at the Southern Great Plains and North Slope of Alaska sites and at the ARM Mobile Facility site, currently on Cape Cod, MA. X/Ka SACRs will accompany future AMF-2 deployments.

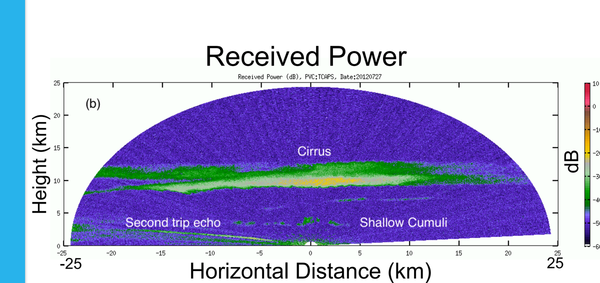
ARM Cloud Radar Band	Frequency (MHz)	Wavelength (mm)
W	94	3.2
Ka	35	8.6
X	9.7	31

Feature Mask

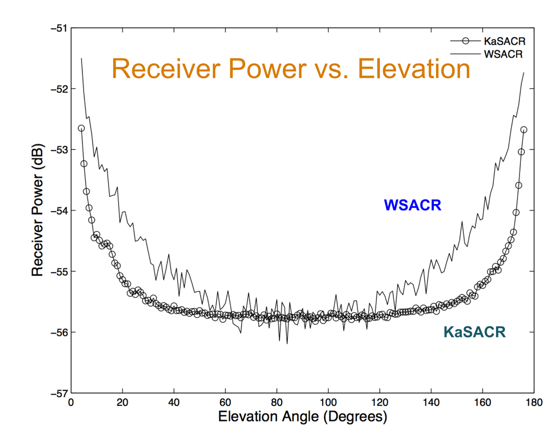
The SACR Feature Mask identifies significant returns from hydrometeors, and also from ground clutter, insects, and second-trip echoes.



The background reflectivity field increases with range, so is not suitable for feature identification.



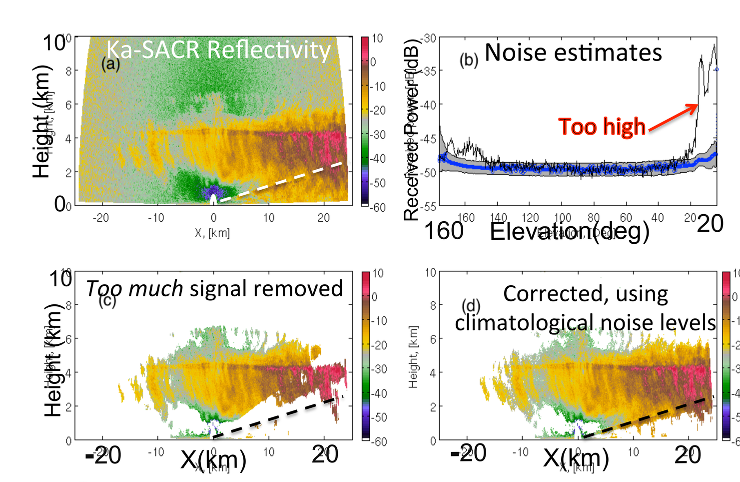
Received power is the basis for noise identification. However, power can be a function of elevation angle, so we must determine noise power separately for each elevation.



Noise power can be affected by the presence of atmospheric gases (primarily water vapor), particularly at low elevation angles. W-band is more sensitive that Ka-band.

Other factors affecting noise level are other environmental conditions and hardware malfunctions.

A radial-by-radial noise level estimate is determined using the Hildebrand and Sekhon (1974) technique. An upper value, climatological, value for noise is used to avoid problems in radials containing all or mostly hydrometeor signal.



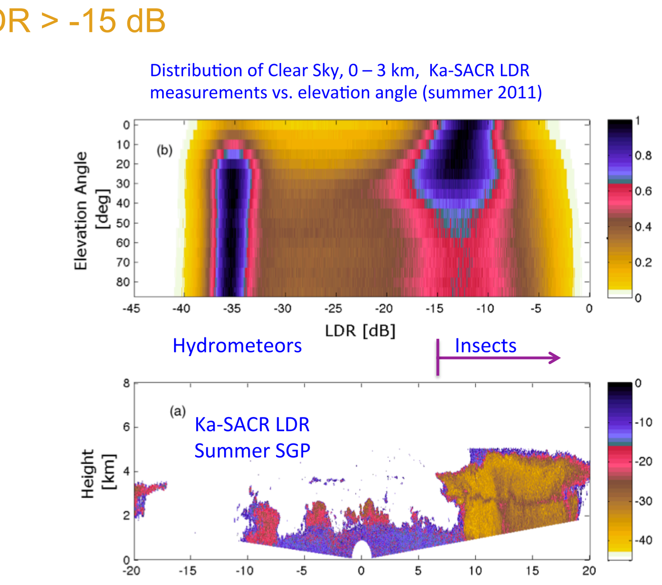
Insect Detection

Insect detection is primarily a problem at Southern Great Plains site, in the lowest few kilometers.

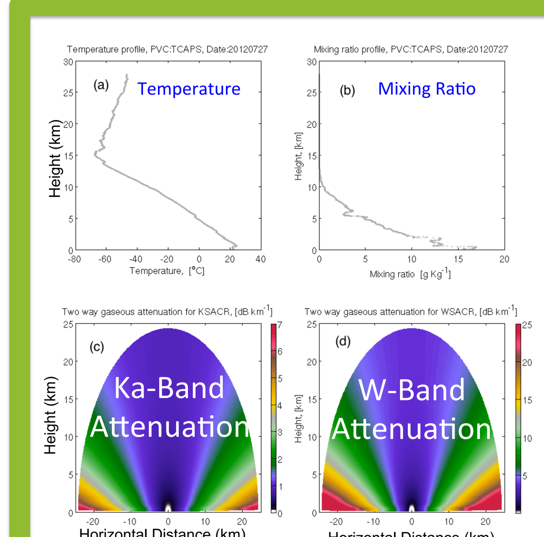
While scanning, we do not collect spectra, so we rely primarily on single frequency LDR measurements.

Insect filtering done for

- Temperatures > 5°C
- Heights below likely ceilometer cloud base
- LDR > -15 dB

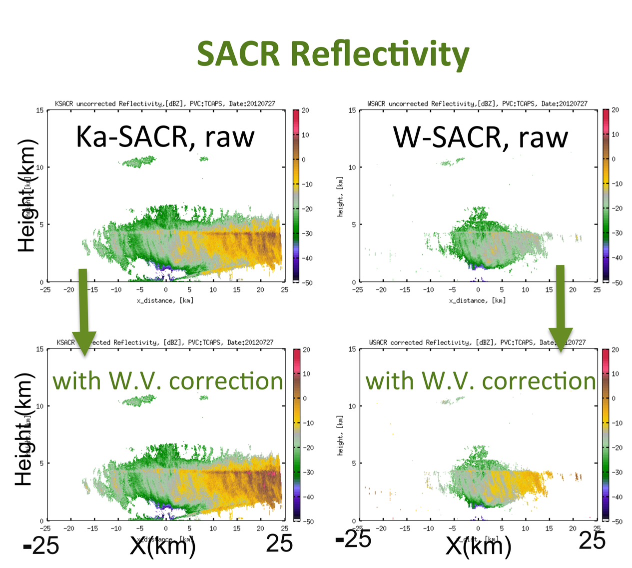


Water Vapor Attenuation Correction



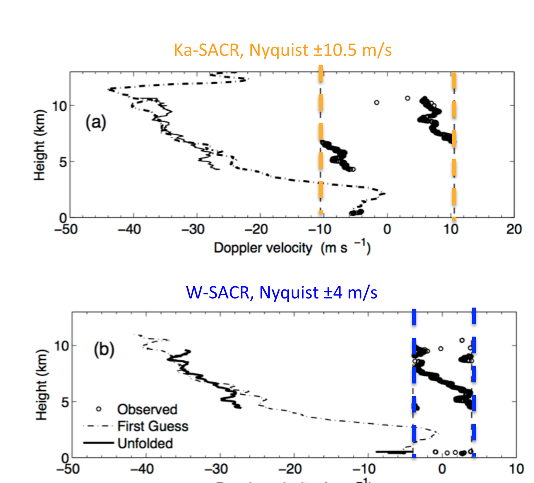
Reflectivities are corrected for the effects of gaseous absorption. Water vapor attenuation is greatest in humid atmospheres, particularly at shorter millimeter wavelengths.

At each ARM site, interpolated atmospheric soundings provide temperature, pressure and water vapor density for calculating the attenuation correction, following Liebe (1985).

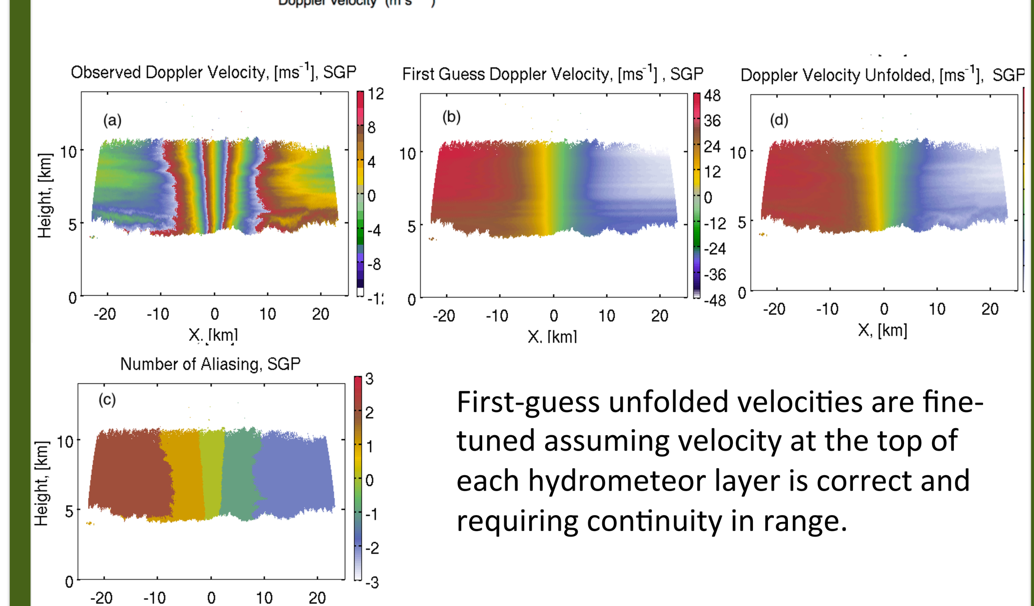


Velocity Dealiasing

Low SACR Nyquist velocities lead to likelihood of multiple velocity foldings, especially for upper level clouds.



We project winds from the interpolated sounding VAP onto the radial plane to give a first guess of expected Doppler velocities



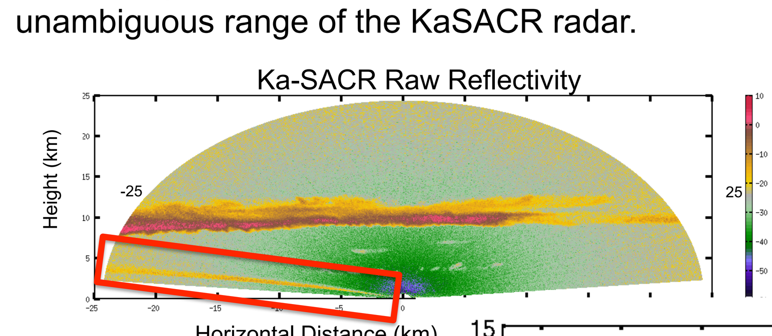
First-guess unfolded velocities are fine-tuned assuming velocity at the top of each hydrometeor layer is correct and requiring continuity in range.

Second Trip Echo Identification

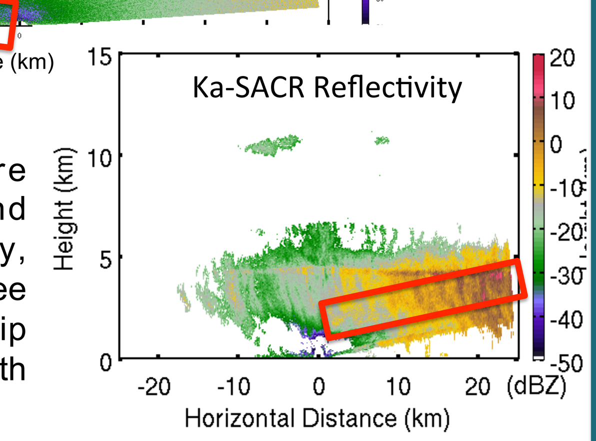
Second trip echoes, returns from targets outside the unambiguous range of the radar, must be flagged and, whenever feasible, removed.

Second trip echoes are not coherent in the SACRs. We use this characteristic to apply a comparison in a 5x5 box filter. If the standard deviation calculated for all points around the center is greater than a critical threshold (currently = 1) we consider the point a second trip echo.

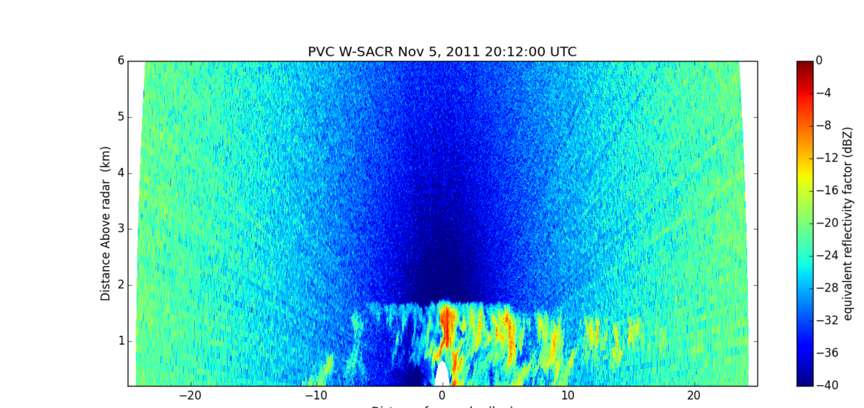
Some cases are reasonably straightforward to identify, as in the cirrus deck below. The returns outlined in red below are second trip returns from the cirrus which extend beyond the unambiguous range of the KaSACR radar.



Other cases are more difficult to identify and remove automatically, particularly in cases (see right) where second trip returns are intermingled with cloud echoes.



Py-ART data model



The radar data structure and processing framework provided by the open source Python ARM Radar Toolkit (Py-ART) will be used to develop advanced data products from the SACR data. The use of Py-ART will accelerate the development of these products, allow the methods developed to be utilized by other ARM radars and allow reuse of existing integration tools for moving these products into ARM's production environment.

SACR VAPS development timeline

Apr '14 – Transfer of algorithms to BNL/ANL

May '14 – Adaptation into PyART

Jul '14 – SACRCOR Evaluation Release