2022 ARM/ASR Joint User Facility and PI Meeting

Sponsored by U.S. Department of Energy, Office of Biological and Environmental Research

X-BAND RADAR OBSERVATIONS in SAIL and SPALSH

V.Chandrasekar(Chandra)
On behalf of the full
SAIL and SPLASH TEAM

Dual-polarization X-Band Scanning Radars in SPLASH and SAIL

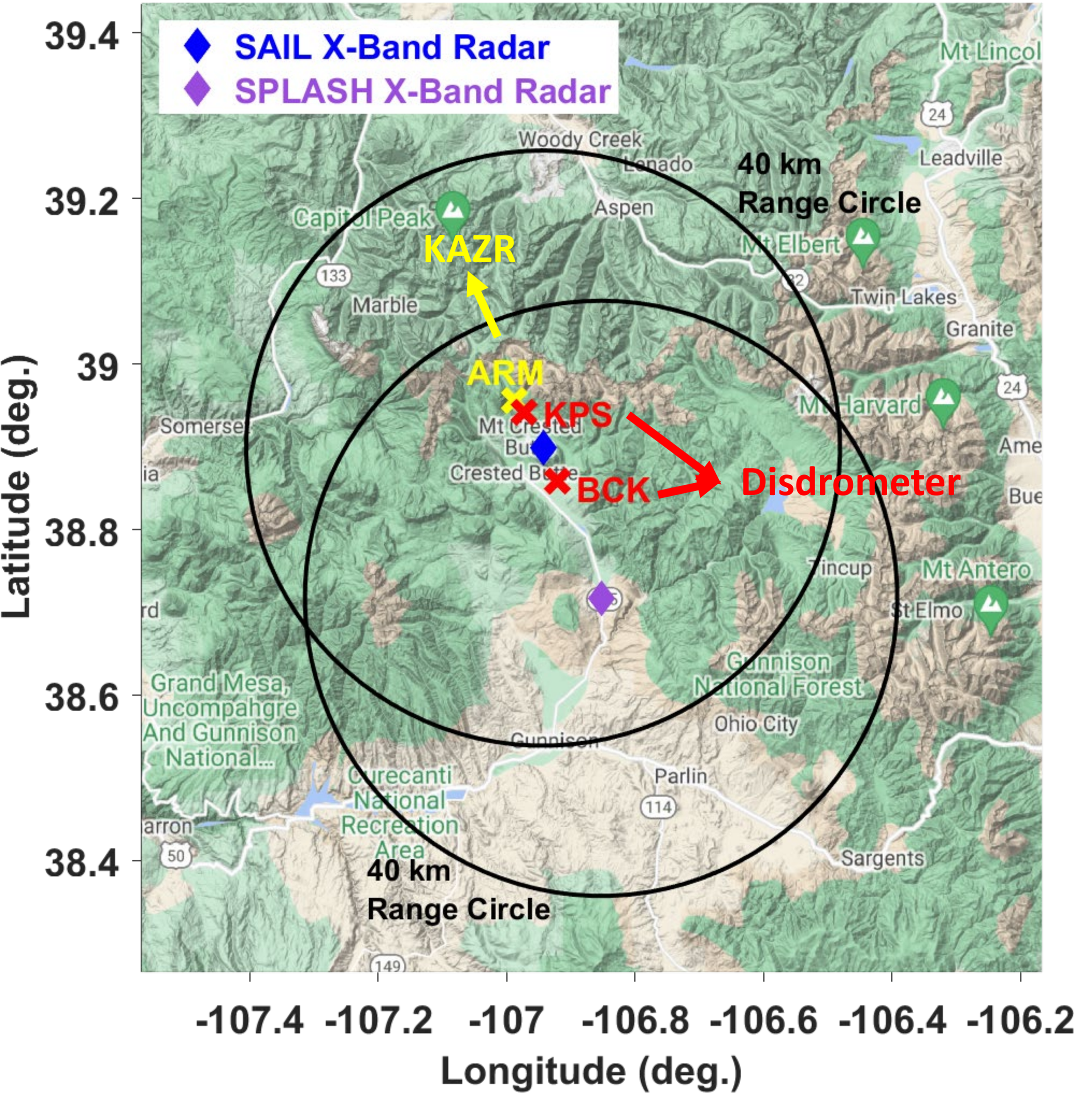


Image Reference: https://www.psl.noaa.gov/splash/

Image Courtesy: Francesc Junyent

SPLASH X-Band Radar
Lat: 38.7168^{o} N
Lon: -106.8529^{o} W
Height: 2504 m (MSL)

SAIL X-Band Radar
Lat: 38.8984^{o} N
Lon: 106.9432^{o} W
Height: 3149.2 m (MSL)

X-Band Radar Technical Specifications & Scan Configuration

Few Important Technical Specs.

Tx. Frequency	9.4 GHz
Range Resolution	60 m
PRF	4193 Hz
3 dB Beam Width	1.25°
Antenna Gain	42.5 dBi
Polarization	H,V (Dual-Pol)

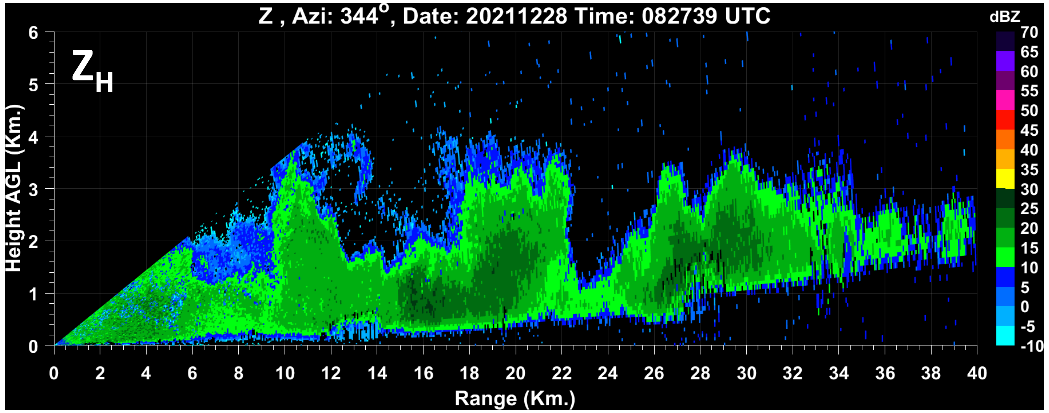
SPLASH X-Band Radar Scan Strategy

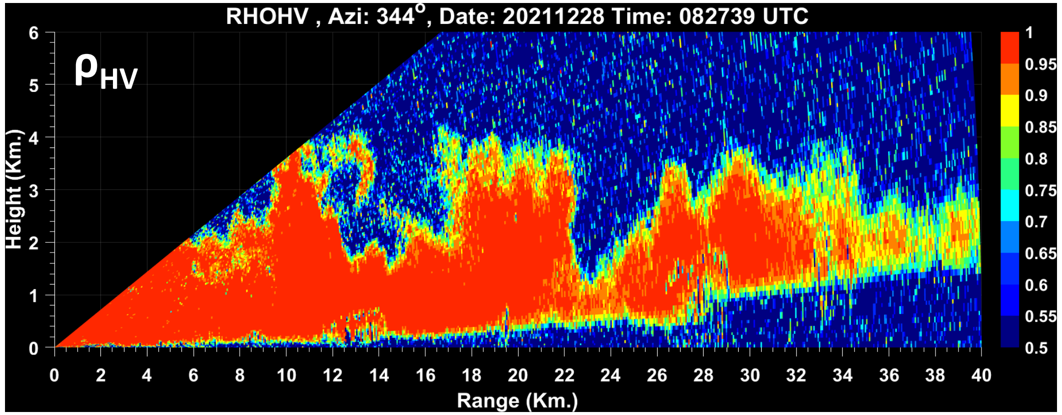
- PPI scans every **~5 minutes** at elevations **1°,2°,4°,6°,8°,10°,12°, & 15°.**
- Wintertime RHI scans every **~5 minutes** along the azimuths **175°, 176°, 177°, 178°, 179°, 180°, 181°, 182°, 183°, 184°, 185°, 332°, 334°, 336°, 338°, 340°, 342°, 344°, 346°, 348°, 350°, & 352°.**
- Summertime RHI scans every **~5 minutes** along the azimuths **175°, 177°, 179°, 181°, 183°, 334°, 336°, 338°, 340°, 342°, & 344°.**

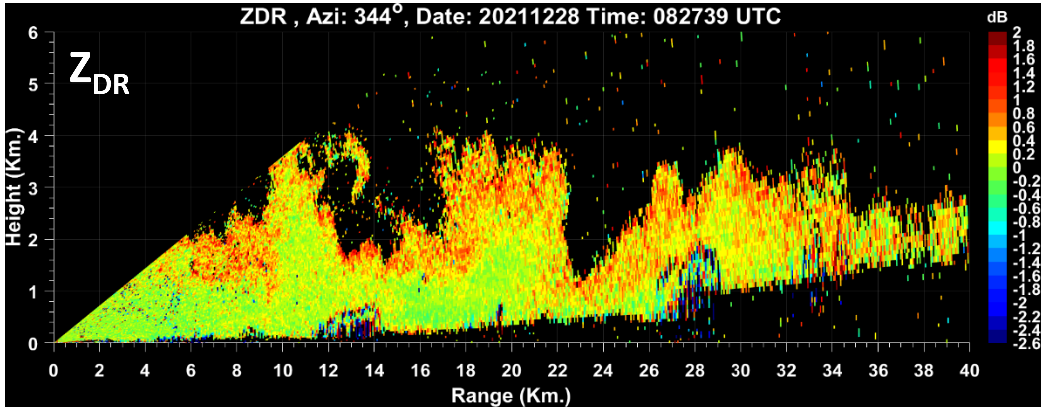
SAIL X-Band Radar Scan Strategy

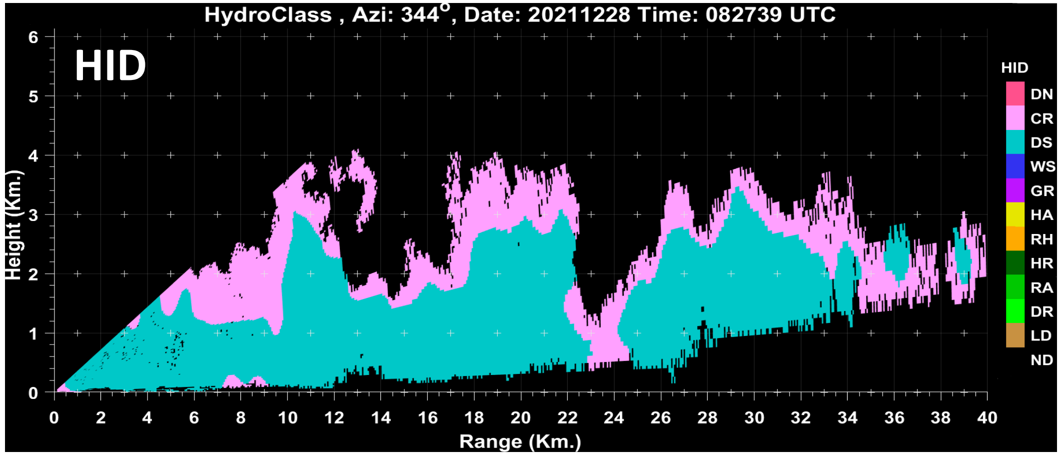
- PPI scans every **~5 minutes** at **1°, 2°,4°,6°,8°,10°,12° & 15°.**
- Wintertime RHI scans every **~5 minutes** along the azimuths **326°, 328°, 330°, 332°, 334°, 336° & 339°.**
- Summertime RHI scans every **~5 minutes** along the azimuths **326°, 327°, 328°, 329°, 330°, 331°, 332°, 333°, 334°, & 336°.**

Example of X-Band Radar RHI Scan Observations in SPLASH from Dec 28th, 2021



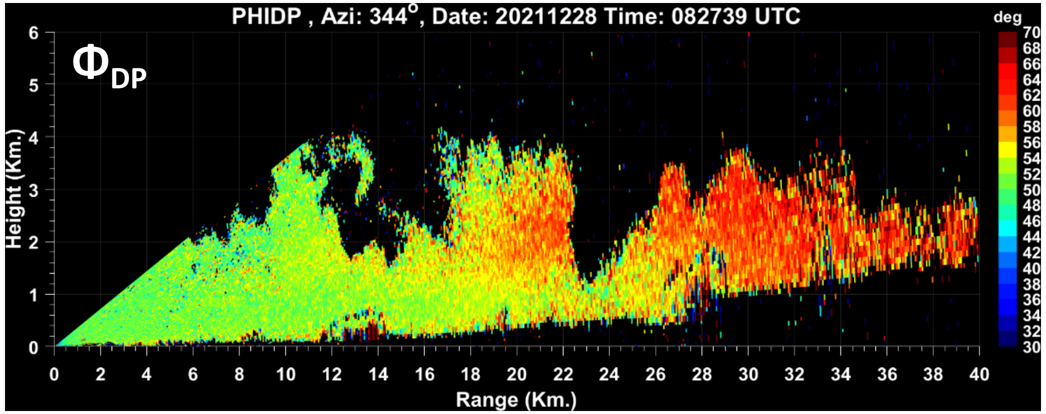






CR (Pink) - Ice Crystals

DS (Light blue) - Dry Snow Aggregates



Hydrometeor classification based on Bechini & Chandrasekar (2015)

Spatial & Temporal Matching of Simultaneous Observations Between SAIL X-Band Radar and KAZR

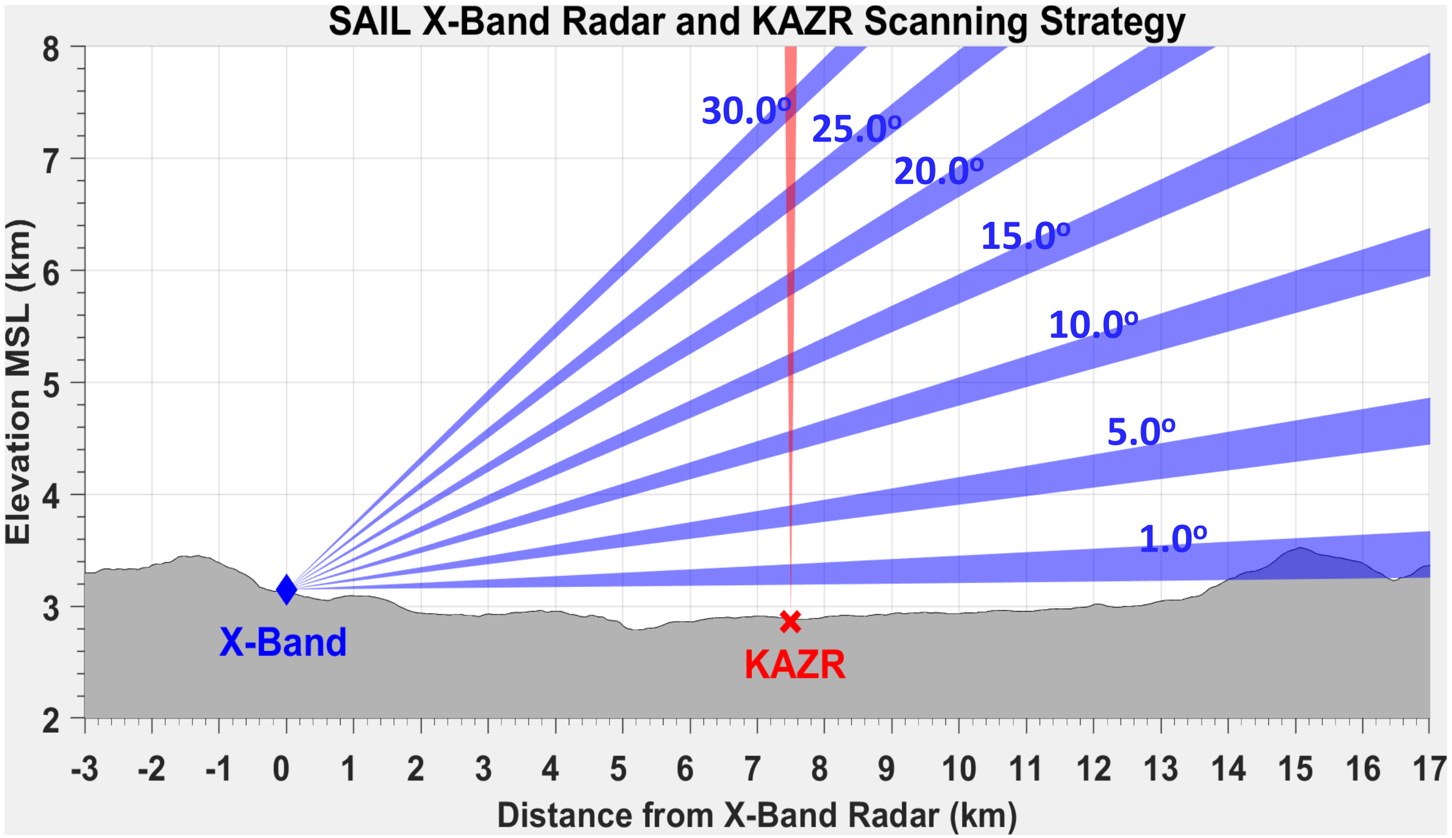


Image shows the relative location of the X-Band Radar and KAZR with the terrain profile along the line of sight azimuth which is 328.87°.

Radar beams at different scan angles are shown in the picture with blue shaded area.

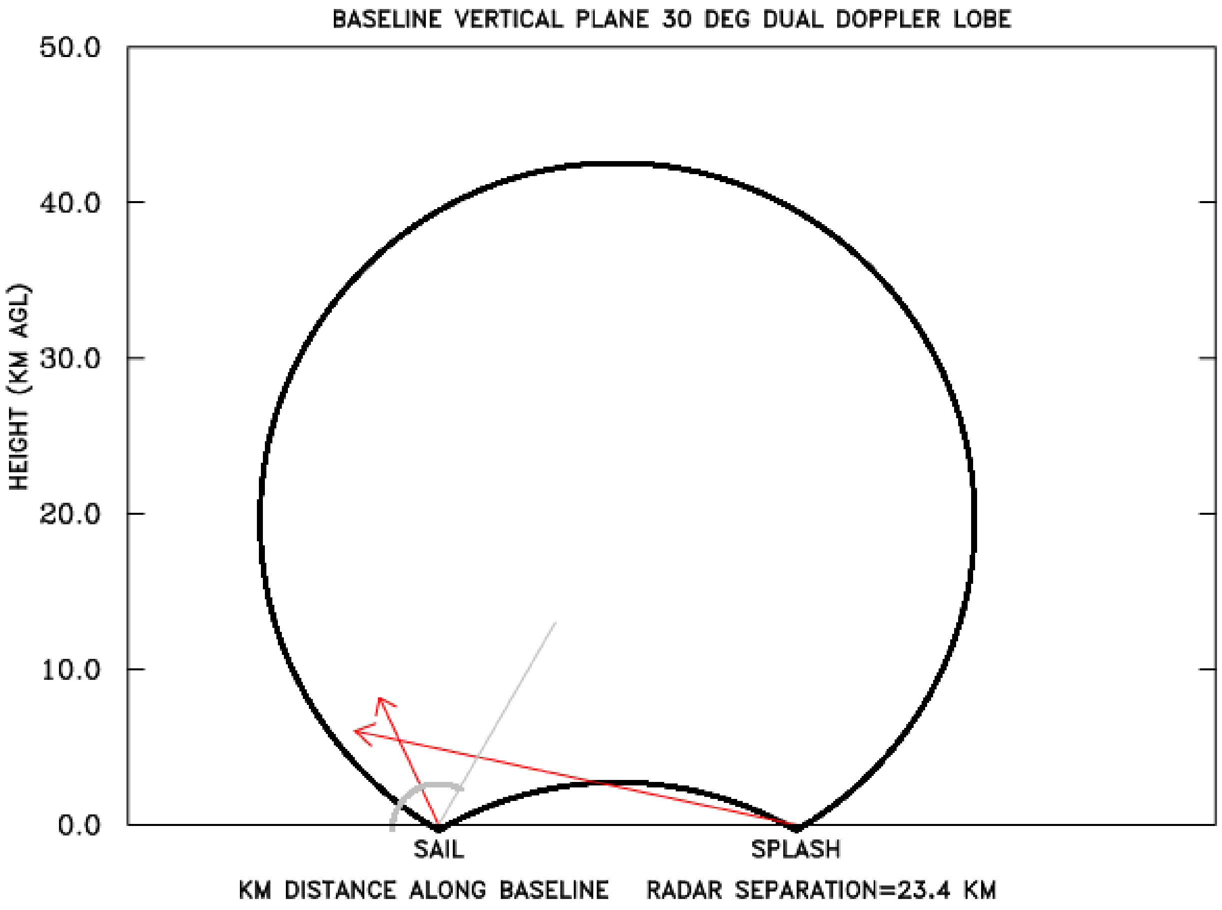
The KAZR beam is vertically pointed which is shown with red shaded area.

This image also depicts how the KAZR beam is intersected by the X-Band radar beams at different volumes.

KAZR scan s: Vertically pointing scans

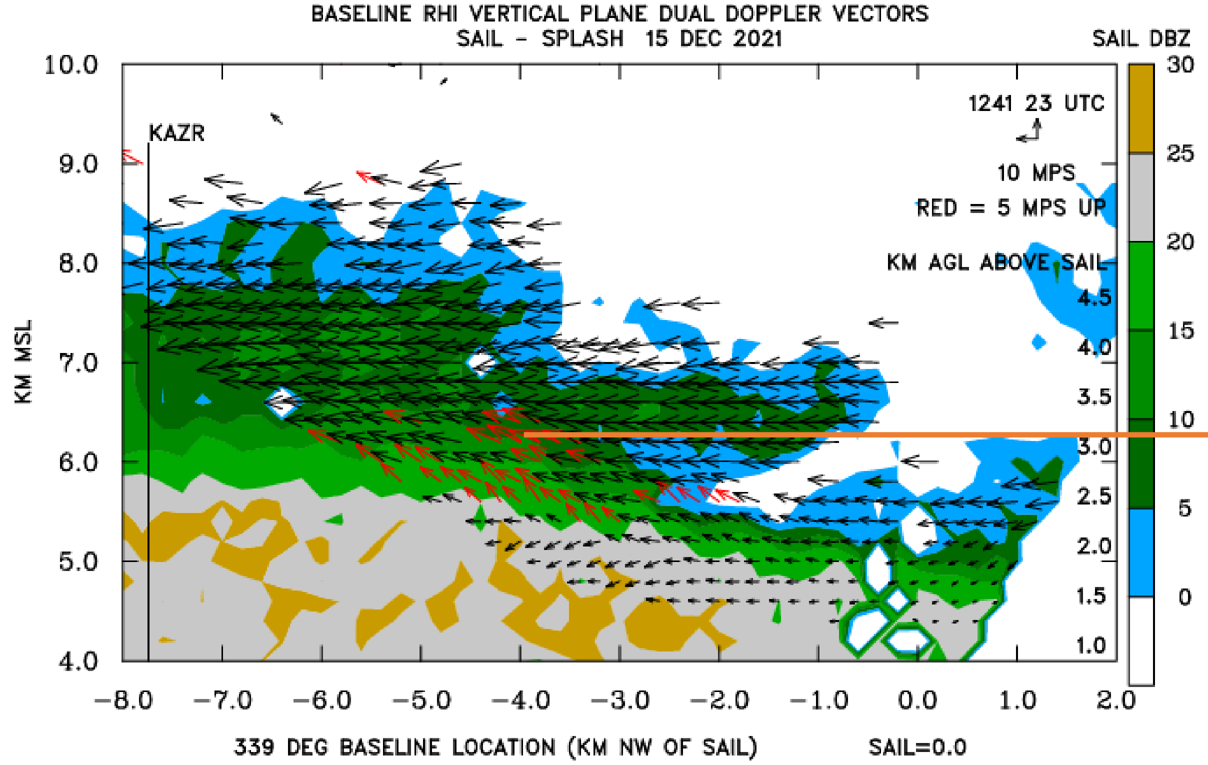
Vertical Plane Dual Doppler Synthesis based on Synchronized RHI scans

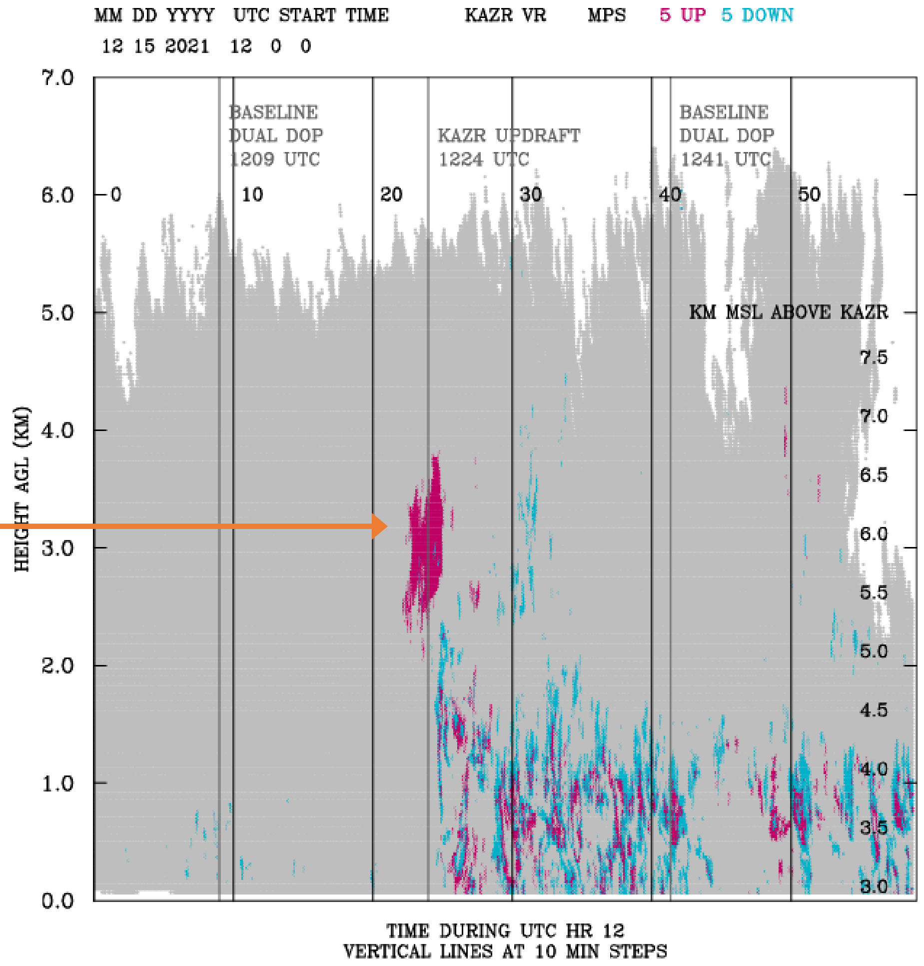
Direct recovery of hydrometeor along-baseline and vertical motion components via COPLANE method.



Due to nearby ski hill, SAIL does 120^{o} elevation travel / overhead RHI scan (grey arc).
Suitable beam intersections occur near and northwest of SAIL (red arrows).

Vertical plane dual Doppler synthesis during intense frontal snow band event on Dec 15th, 2021.



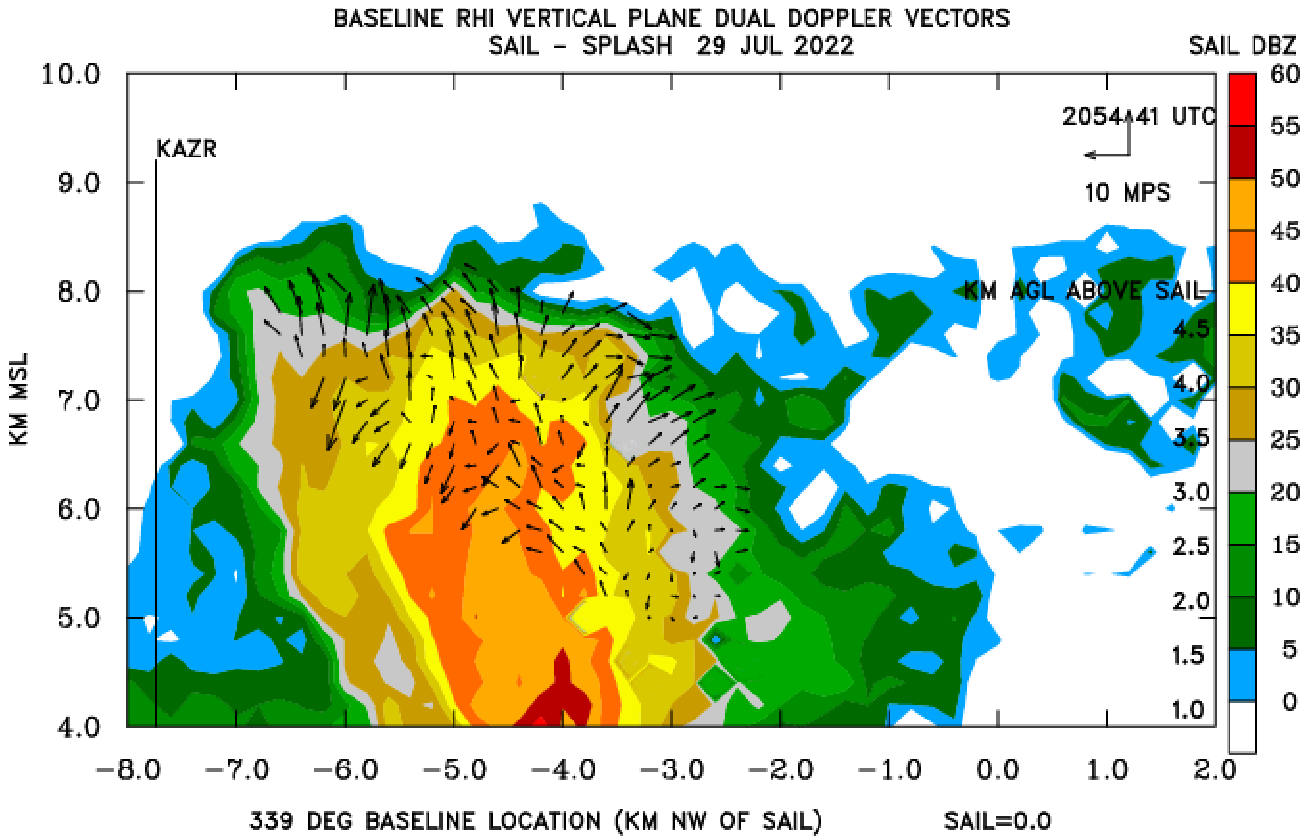


Red vectors are > 5 ms^{-1} upward motions.
Vertically-pointed KAZR radial velocities confirm these local updraft magnitudes.

Vertical plane dual Doppler synthesis during a thunderstorm event on July 29th, 2022.

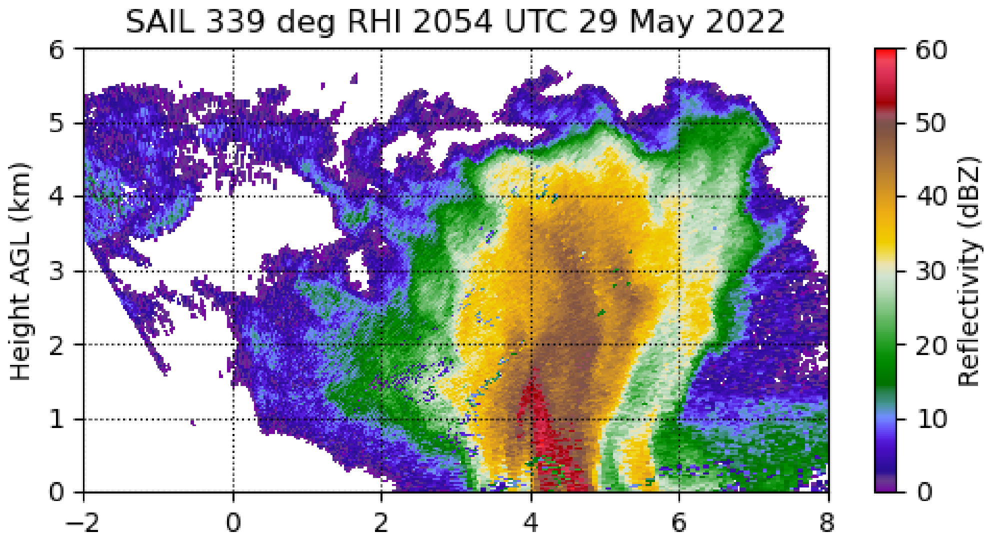
Vertical baseline plane synthesis applied to a thunderstorm. Storm approaching SAIL from the northwest while weakening. "Ascending" dual Doppler lobe defines wind vector coverage to the northwest of SAIL.

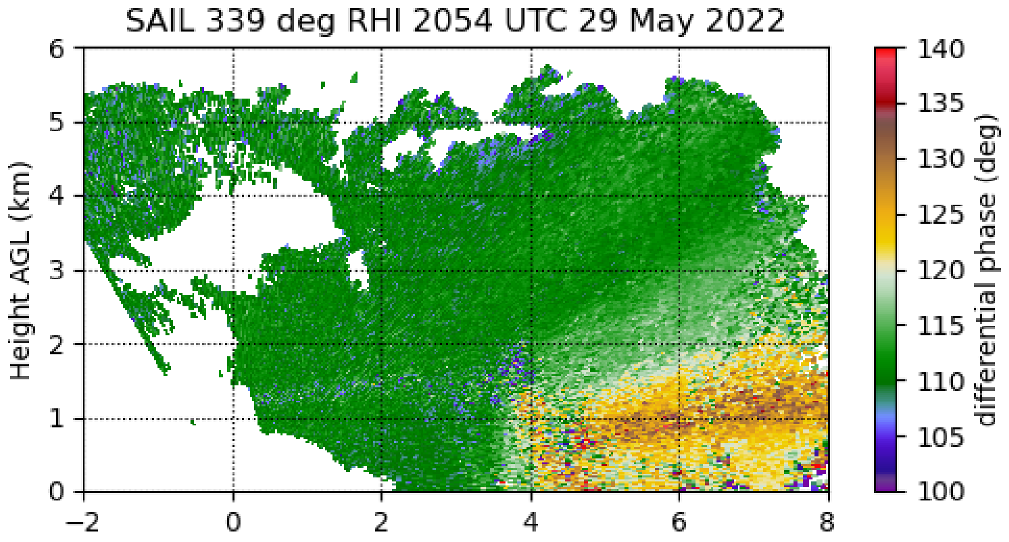
- **Sloping updraft and associated divergence apparent above ~7 km MSL.**
- **Indications of downward motion in echo core 6 – 7 km AGL.**



Dual polarization fields (continued):

- **High differential phase accumulation pattern agrees with differential attenuation indications of high concentrations of oblate hydrometeors.**



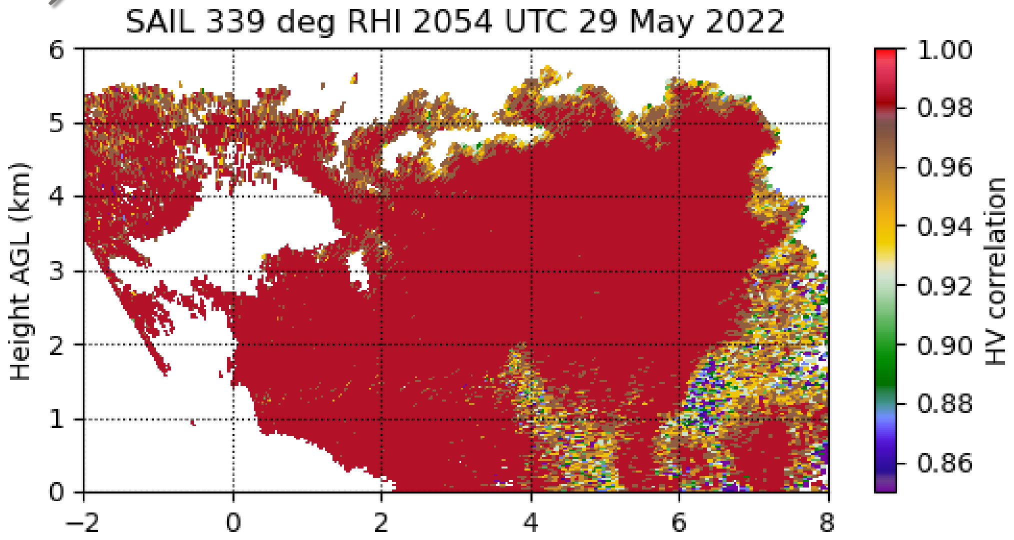


Summary:
Thunderstorm vertical structure observed in high altitude, mountainous terrain setting shares many radar characteristics with US central plains, lower elevation storms.

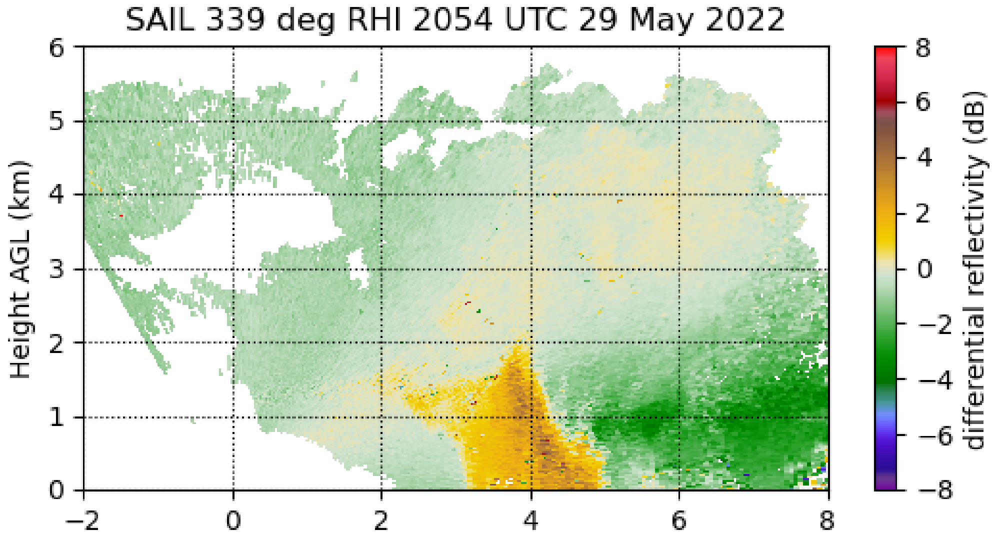
Dual polarization fields (continued):

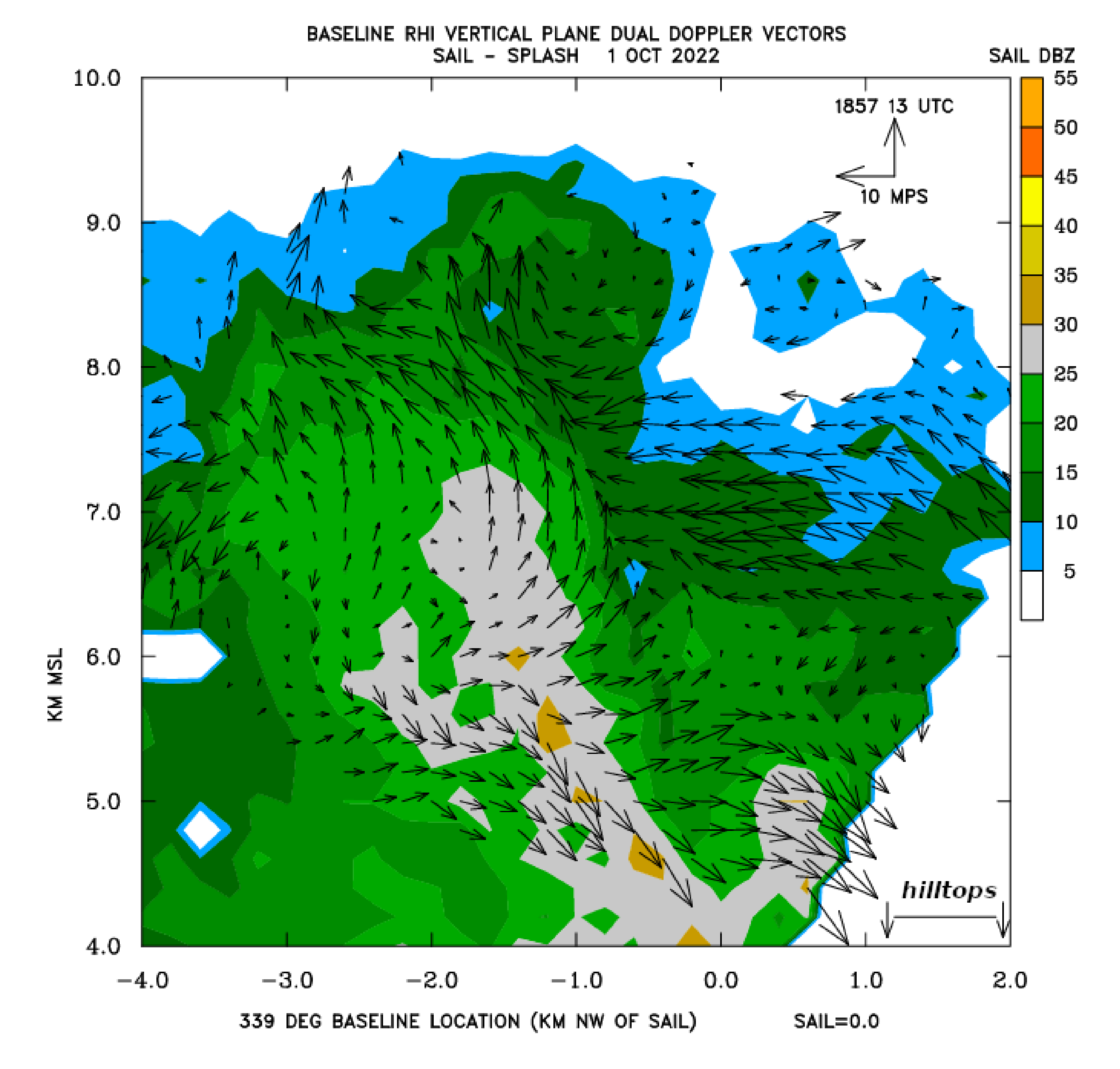
Dual polarization fields.
Sounding 0°C level ~1.8 km AGL

- **Reduced correlation in low-level core probably due to mixture of water coated, melting hailstones and rain drops.**



- **Positive ZDR / significant oblate hydrometeor component at >0°C heights in core.**





This appears to be related to downdraft / outflow from shower just NW of the radar. However, curvature is opposite of usual gust front precipitation roll. More speculation: cold outflow airmass does not readily flow uphill towards local mountain crest??

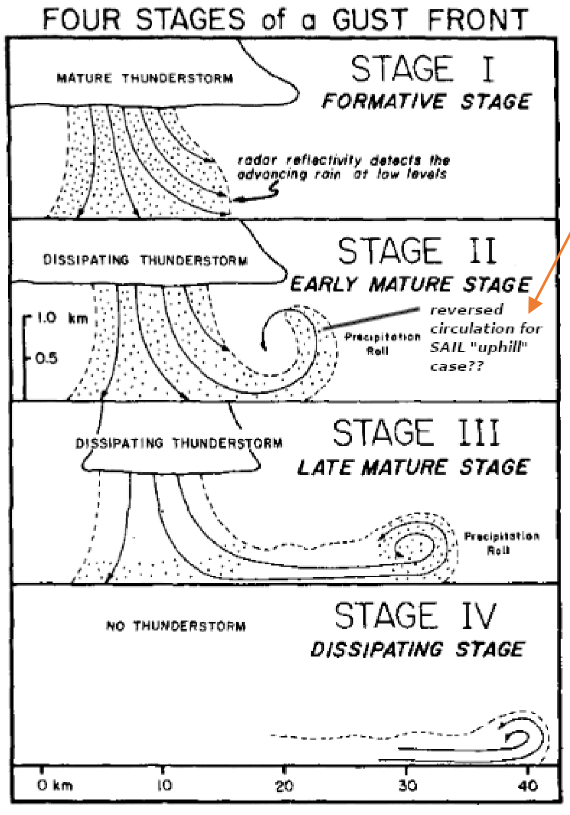
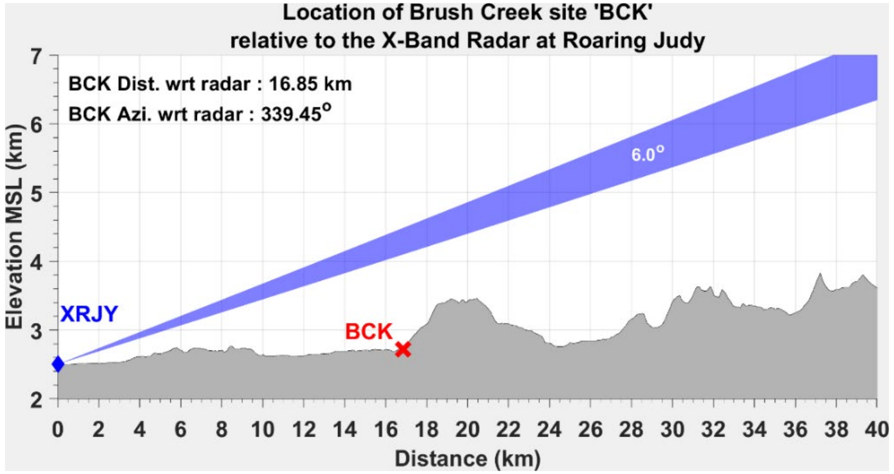


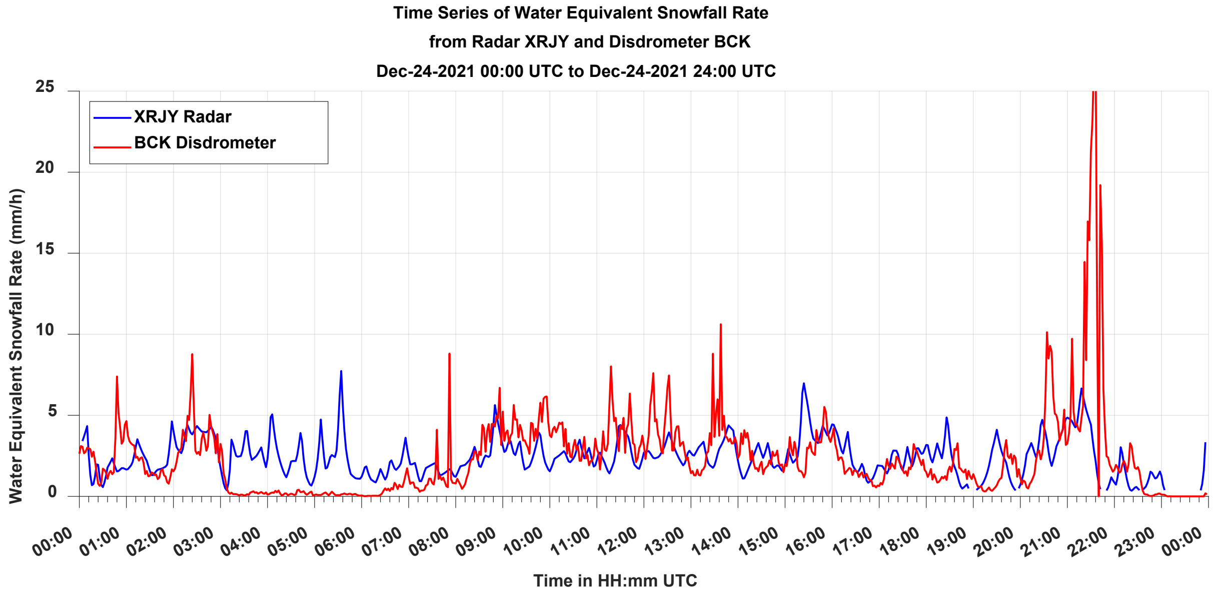
FIG. 3. The four stages of a thunderstorm gust front. The advancing precipitation at low levels is detected by the radar. The "precipitation roll" is a horizontal roll formed by airflow that is deflected upwards by the ground.

Wakimoto MWR August 1982

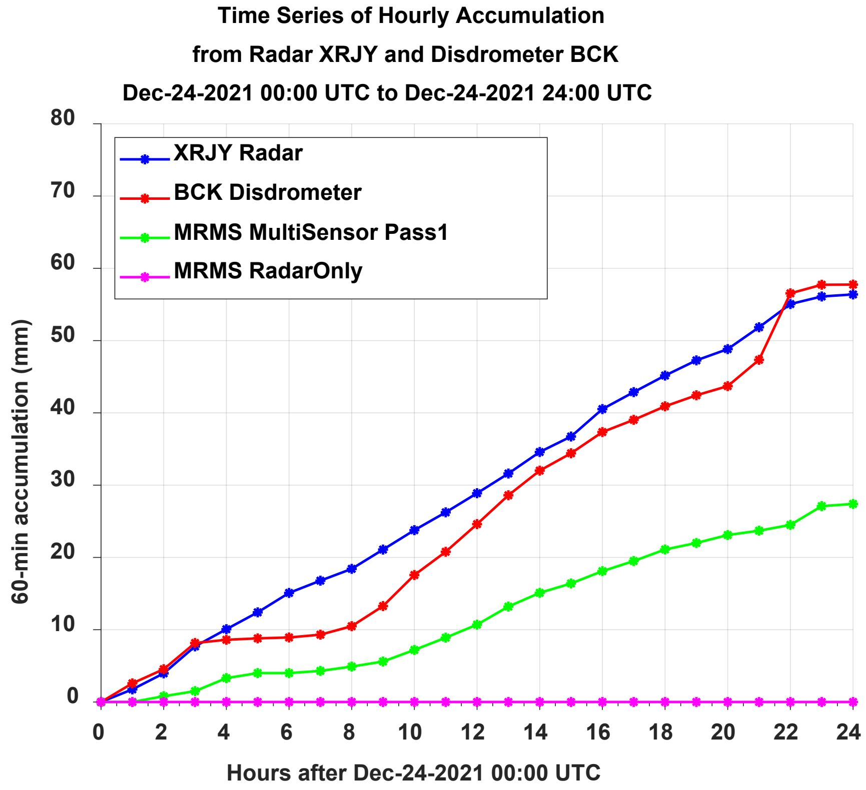
Roger's thesis results came from observations in flat northern Illinois terrain (NIMROD project). Maybe outflow above blocked surface layer gives reversed roll circulation in SAIL case?

Water Equivalent Snowfall Estimates Comparison Between SPLASH Radar and Disdrometer for Dec 24th, 2021



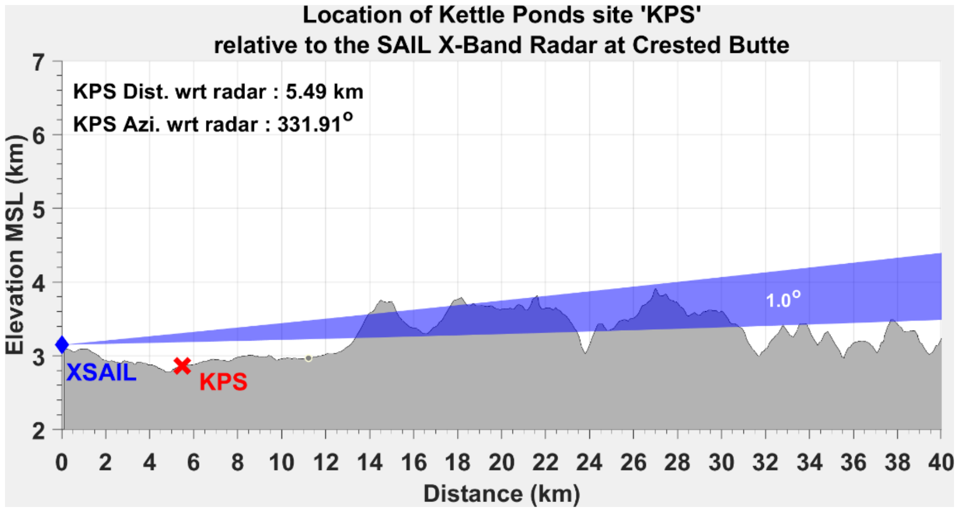


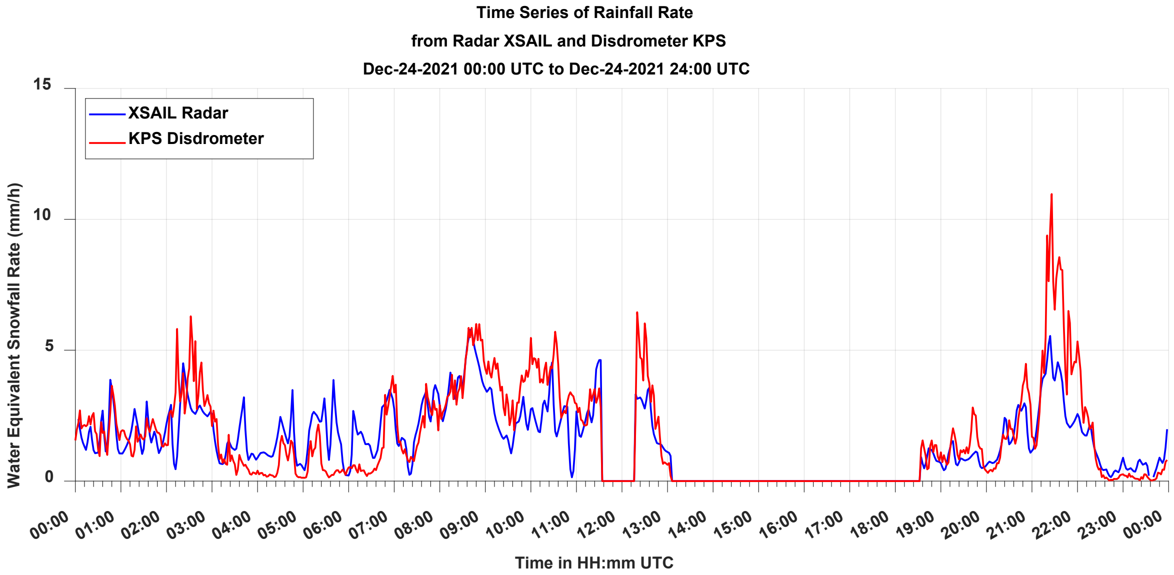
Comparison of X-Band SWE rates from the 6° PPI scans with disdrometer estimates at the BCK site.



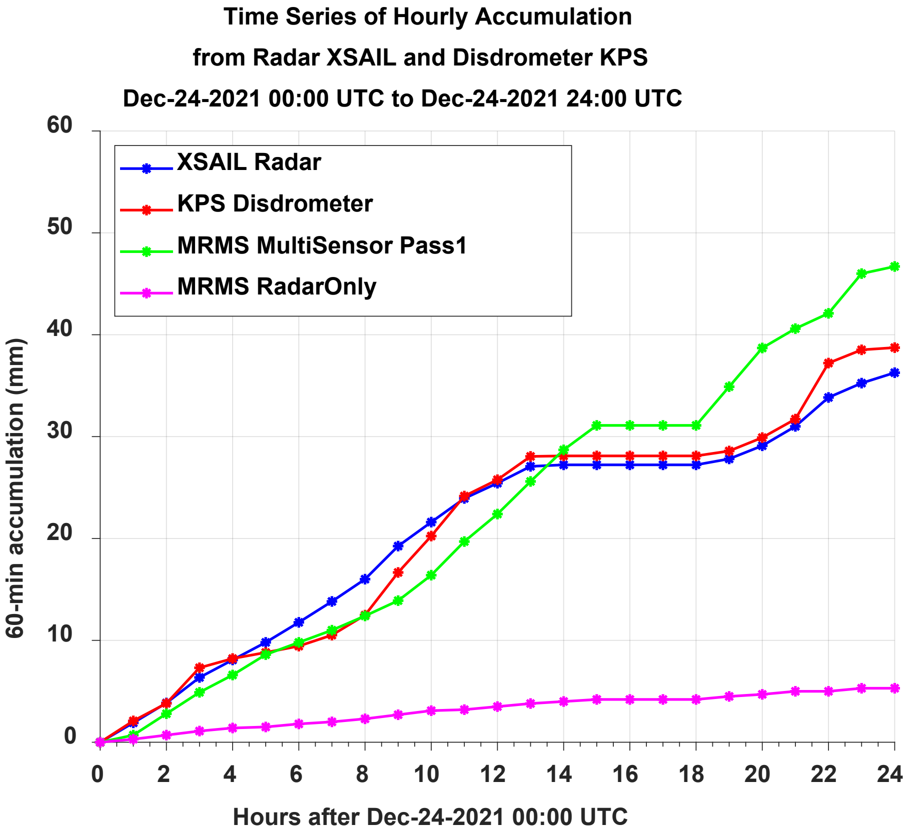
Comparison of cumulative accumulation of precipitation amounts at the BCK site computed from SPLASH X-Band radar estimates, disdrometer measurements. In addition two operational products from the Multi Radar Multi Sensor (MRMS) are also shown. The MRMS MultiSensor and RadarOnly product do not show good performance.

Water Equivalent Snowfall Estimates Comparison Between SAIL Radar and Disdrometer for Dec 24th, 2021





Comparison of X-Band SWE rates from the 1° PPI scans with disdrometer estimates at the KPS site.



Comparison of cumulative accumulation of precipitation amounts at the KPS site computed from SAIL X-Band radar estimates, disdrometer measurements. The MRMS MultiSensor product performance is reasonable whereas the MRMS RadarOnly product is poor.

THE END

THANK YOU!