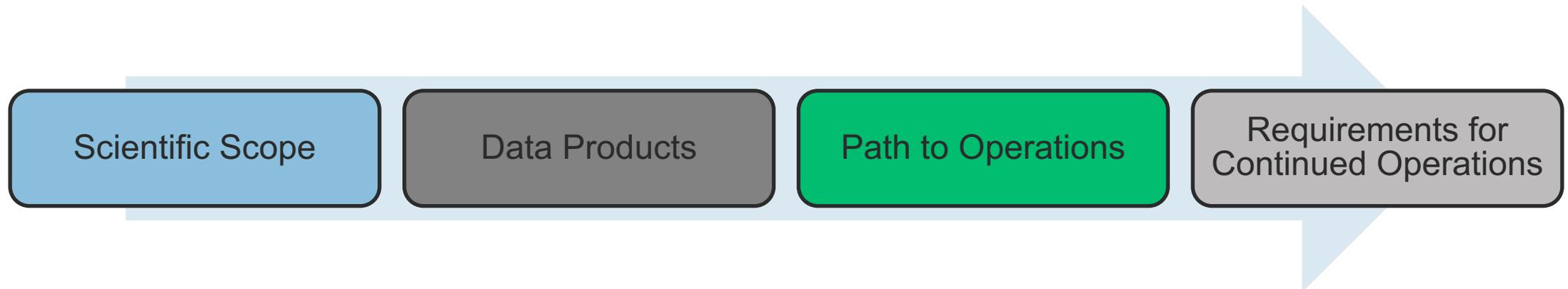


Radar Roadmap to Operations

Background

- ▶ In order to better understand the needs and requirements of ARMs radars and the community, information was collected through four-part listening session, mentor feedback, and one-on-one discussions.
- ▶ Identified four key areas we needed to understand
 - Scientific Scope for each site/radar
 - Data Products available and additional data products that might be useful
 - Path to Operations for each inoperative radar
 - Requirements for Continued Operations



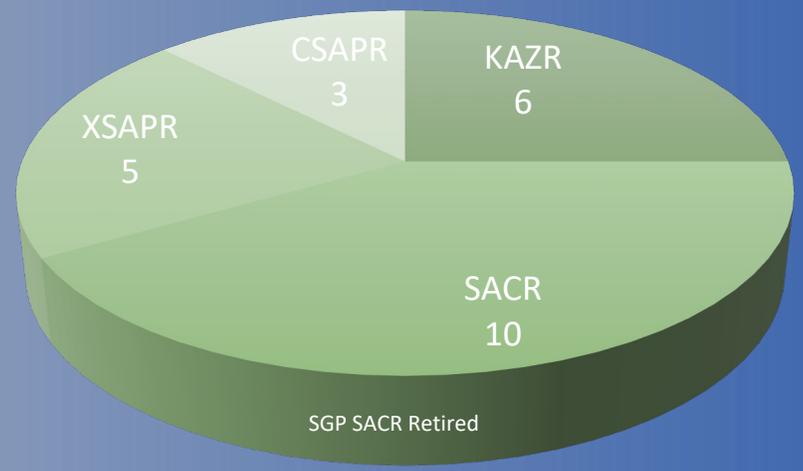


Radar Roadmap Results

FTE Required for Maximum Radar Operations

- All radars brought back online
- 24/7/365 Operations
- Routine Data Monitoring
- Routine Calibration and Characterization
- Routine calibrated (b1-level) data products

Number of Radars Operational for "Maximum" Operations



FTE REQUIRED VS AVAILABLE FOR MAXIMUM RADAR OPERATIONS





ARM

Southern Great Plains

0.15

FTE required to bring all 3 XSAPRs online

0.63

FTE for 3-months of operations (3 XSAPRs) including the production of b-level products

Radar Assets

- X-Band Scanning ARM Precipitation Radar x 3 (polarimetric)
- C-Band Scanning ARM Precipitation Radar x 1 (polarimetric)
- Ka-Band ARM Zenith Radar (First Generation)

Scientific Objectives:

- Primary Timeframe: Spring
- Deep convection, Multi-Doppler, Microphysics, Transition Events

Path to Operations

- Install and test new transmitters (I4, I5, I6)
- Dehydrator Maintenance (I4, I5, I6)
- Small miscellaneous part replacement (I6)
- Field calibration, characterization, and data evaluation (I4, I5, I6)
- CSAPR will be evaluated in the spring if time permits

Continued Operations

- Winter/early-spring preparations for 3-months of spring operations (AMI) including b-level products
- Discussing options to contract out maintenance and operations
- Potential focus on ARM directed IOP periods

Data Product Needs

- Composite QPE product using both X and C-band radars
- 4D environmental characteristics (Cloud masks, wind, phase)
- Gridded products of winds (multi-doppler, DL, SONDE, RWP, etc)
- Mergesonde-like products at the profiling facilities

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Precipitation Radar												
XSAPR (I4)												
XSAPR (I5)												
XSAPR (I6)												
CSAPR												
CMAC												
QPE												
MMCG												
Cloud Radar												
MMCR												
KAZR												
KASACR												
WSACR												
ARSCL (MMCR)												
KAZRARSCL (Internally Calibrated)												
KAZRARSCL (Uncalibrated)												
KAZRARSCL-CLOUDSAT												
MICROBASEKAPLUS (Evaluation)												
SACRADV3D3C												
SACRADVVAD												

Available Radar Data Products



North Slope of Alaska

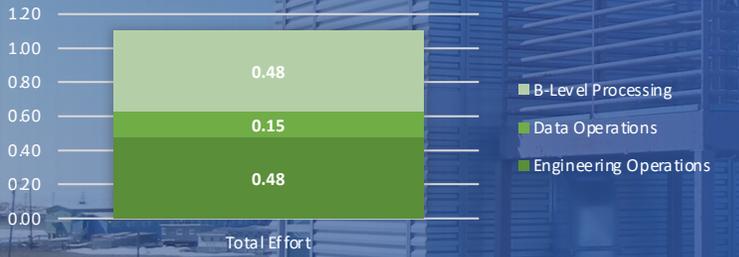
0.0

FTE required to bring XSAPR online with a repaired transmitter

1.11

FTE for 6 months of operations including b-level products for the XSAPR and SACR2

FTE BREAKDOWN FOR 6-MONTHS OF OPERATIONS



Radar Assets

- X-Band Scanning ARM Precipitation Radar (Polarimetric)
- Ka/W-Band Scanning ARM Cloud Radar (2nd Generation, Polarimetric)
- Ka-Band ARM Zenith Radar (1st Generation)

Scientific Objectives:

- Primary Timeframe: Fall/Winter
- Multi-wavelength microphysics, short fetch cold-air outbreaks, horizontal cloud structure, ice conditions

Path to Operations

- XSAPR, SACR2 and KAZR are operational
- Reinstall corner reflector

Continued Operations

- Mentor visit in the summer timeframe to perform maintenance and repairs
- Instruments will operate as long as possible through the fall and winter
- Simple repairs and maintenance will be performed on the XSAPR only during the winter

Data Product Needs

- Better coordinated scan strategies between radars to maximize the impact of the data
- Snowfall retrievals
- Extracted columns over the precipitation sites (NSA C1, NSA E12)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Precipitation Radar																									
XSAPR																									
CMAC																									
Cloud Radar																									
MMCR																									
KAZR																									
KASACR/KASACR2																									
WSACR/WSACR2																									
ARSCL (MMCR)																									
KAZRARSCl (Internally Calibrated)																									
KAZRARSCl (Uncalibrated)																									
MICROARSCL (Evaluation)																									
RADARCFAD																									

Available Radar Data Products

Eastern North Atlantic



0.93

FTE for Engineering Operations for 1 year

0.20

FTE for Data Monitoring for 6-months

0.35

FTE for 3-months of b-level processing

Radar Assets

- X-Band Scanning ARM Precipitation Radar (2nd Generation, Polarimetric)
- Ka/W-Band Scanning ARM Cloud Radar (2nd Generation, Polarimetric)
- Ka-Band ARM Zenith Radar (2nd Generation)

Scientific Objectives:

- Primary Timeframe: Summer/Winter
- 4D Precipitation, organization of mesoscale convective/boundary layer complexes, liquid water content

Path to Operations

- SACR2 and KAZR are operational
- XSAPR2 is at a decision point on replacing the transmitter or upgrading to solid-state (discussion at end)

Continued Operations

- Mentor visit in the spring timeframe for maintenance and repairs
- Depending on priorities, a second visit may be viable for repairs/maintenance
- Site operations to support as much as possible for continued operations throughout the year
- Intensive scan strategies in the summer/winter with low-impact scan strategies in the Spring/Fall
- Data monitoring for 6-months and b1 products for 3-months in FY23 (summer timeframe)

Data Product Needs

- Develop scan strategies for primary and secondary seasons (may need to consider that multiple strategies will need to be coordinated)
- Quantitative Precipitation Estimates (Drizzle focus)
- Better in-situ drizzle measurements

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Precipitation Radar										
XSAPR2										
Cloud Radar										
KAZR										
KASACR2										
WSACR2										
KAZRARSCSCL (Uncalibrated)										

Available Radar Data Products



General Timeline of Activities for Fixed Sites

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
North Slope of Alaska (NSA)									Mentor Maintenance Trip				
	Operations (Limited Repair Capability)											Operations	
	Data Monitoring									B1 Data Processing			
Southern Great Plains (SGP)				Mentor Maintenance Trip				Operations					
							Data Monitoring						
											B1 Data Processing		
Eastern North Atlantic (ENA)						Mentor Maintenance Trip							
	Operations												
	Data Monitoring												
						B1 Data Processing (Summer/Winter)							



ARM Mobile Facilities



Radar Assets

- Ka/W/X-Band Scanning ARM Cloud Radar (1st Generation, Polarimetric)
- Ka-Band ARM Zenith Radar (1st Generation)

Scientific Objectives:

- Dependent on supported field campaign

Path to Operations

- KAZR and SACR generally undergo preparations in the year leading up to the campaign

Continued Operations

- Systems are considered high-priority for mentor focus
- Contract with vendors for in-field support as appropriate

Data Product Needs

- Dependent on supported field campaign

FTE to Prepare and Install for an AMF Deployment



0.37

FTE to Maintain KAZR Operations and Produce b-Level Data for 1 Year

1.59

FTE to Maintain SACR Operations and Produce b-Level Data for 1 Year

0.70

FTE to Maintain CSAPR Operations and Produce b-Level Data for 1 Year

CSAPR

SACR

KAZR

External Partner Engagement

- ▶ “ARM will continue to leverage vendors, universities, and other national laboratory groups to support the radars”
 - Activities to date
 - CSU radar deployment in support of the SAIL campaign
 - Vendor field support for the TRACER CSAPR2
 - Vendor software support for the SACRs
 - Vendor software support for the CSAPR2 upgrade to support cell tracking input
 - BNL cell-tracking software development and operations

External Partner Engagement

▶ Universities

■ Workforce Development

- Create opportunities and internships for students to get hands-on experience
- Create pipelines for future ARM radar engineers and scientists
- Coordinate SULI projects across labs for coordinated projects (hardware/software/data)

■ Communication

- Communicate with users and universities on SULI internships
- Communicate the usability of the ARM Observatories to deploy guest radars/instrumentation

▶ Commercial

- Partner with vendors for hardware, software, and upgrade support

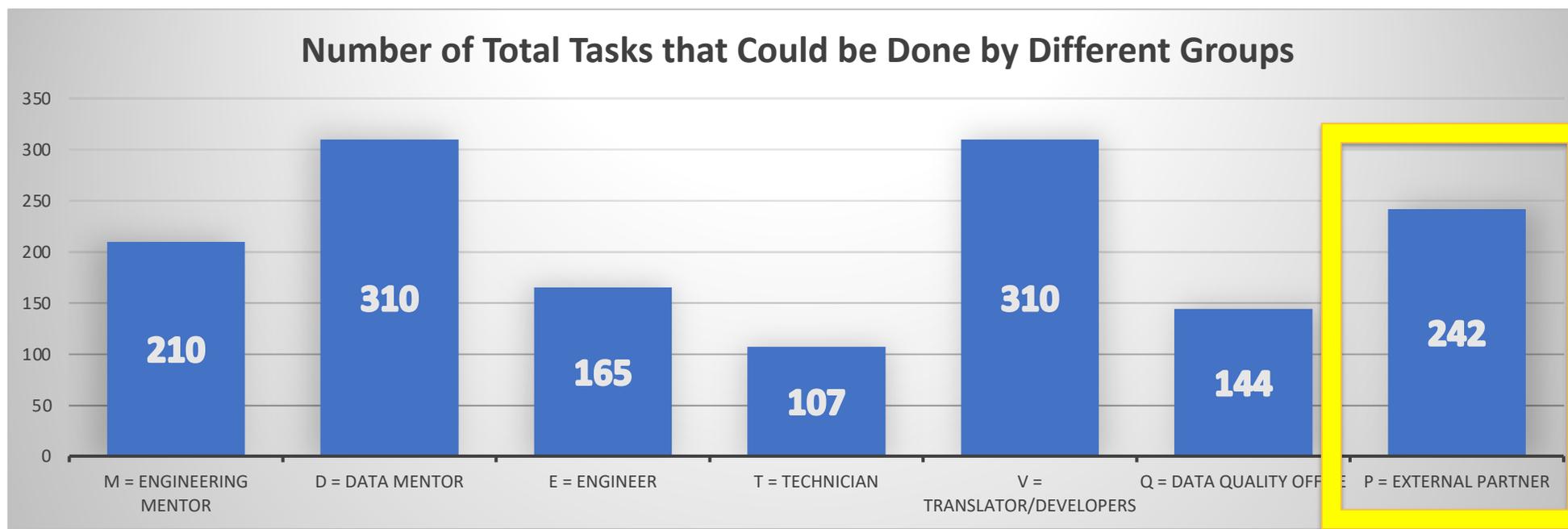
▶ Both

- Mentor team support (monitoring, repairing, troubleshooting, etc...)

External Partner Engagement

► Activities identified in the Roadmap include but are not limited to

- Hardware upgrades
- Hardware maintenance and repairs
- System/data monitoring
- Data quality
- Calibration and Characterization



Path Forward

- ▶ Roadmap was already used to develop a more detailed FY23 Radar Plan and develop general timelines for the fixed site activities
- ▶ Guide future activities and prioritization for routine operations
- ▶ Engage with the translator team on the products that were brought up to gauge viability
- ▶ Re-evaluate this information on a regular basis to ensure we are still meeting the needs of the community and the radar team

Questions

Discussion Topics

Discussion Activities

- ▶ Deployable C-Band system
- ▶ Mobile X-Band System from DOD
- ▶ KAZR Upgrades
- ▶ ENA XSAPR Solid State Upgrade
- ▶ SGP CSAPR would take a few weeks of work
 - Could retire and use the deployable C-band system when available

Deployable C-Band System

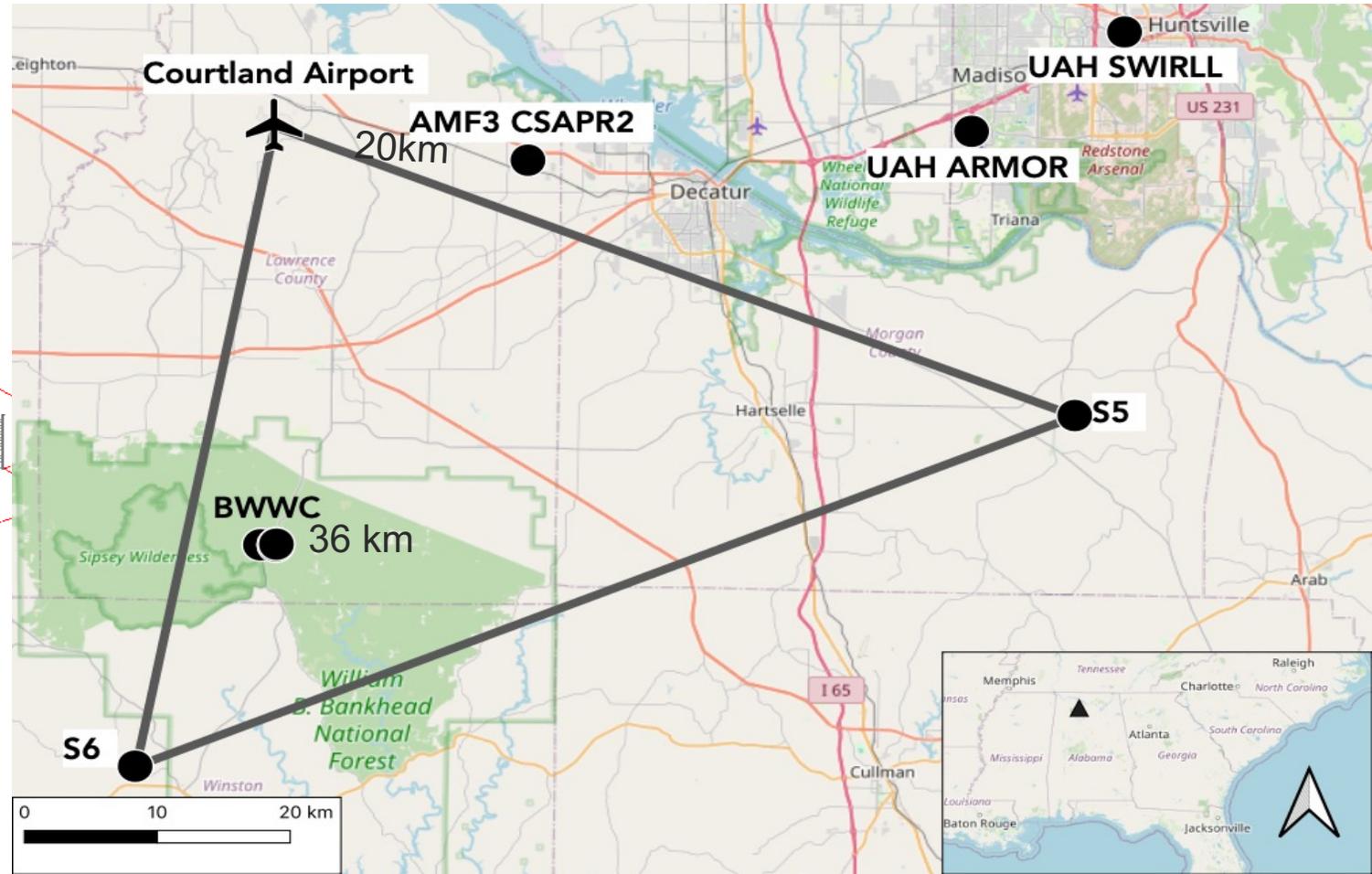
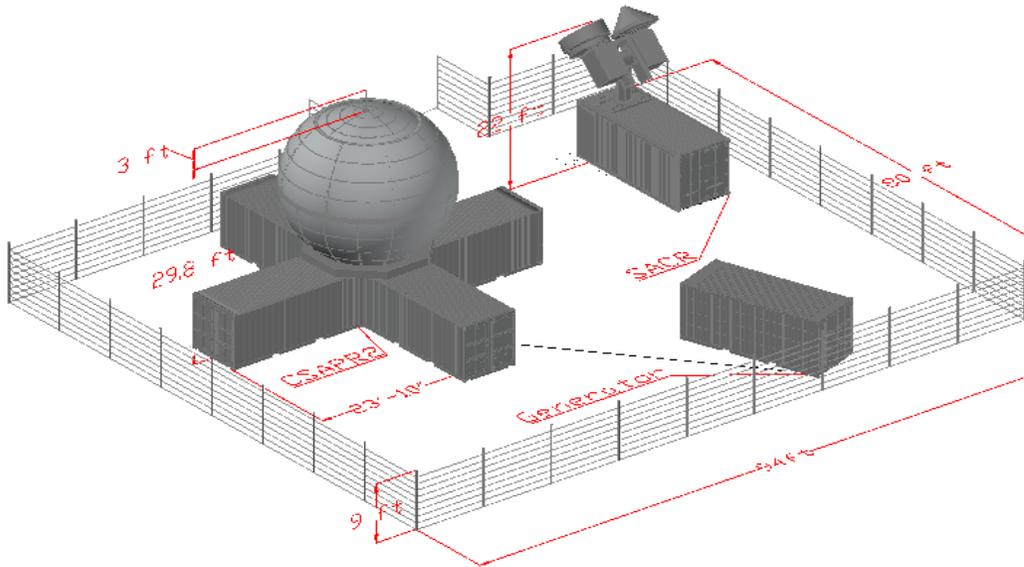
- ▶ RFP going out soon!
- ▶ Initial Specs
 - Operating Frequency tunable between 5200 – 590 MHz
 - Solid state polarimetric system
 - Beamwidth $\leq 1.0^\circ$
 - Cell tracking/external tracking control
 - Sensitivity comparable to CSAPR2

BNF Ka/XSACR



► Is there a scientific need for the SACR?

- TRACER range: 39km



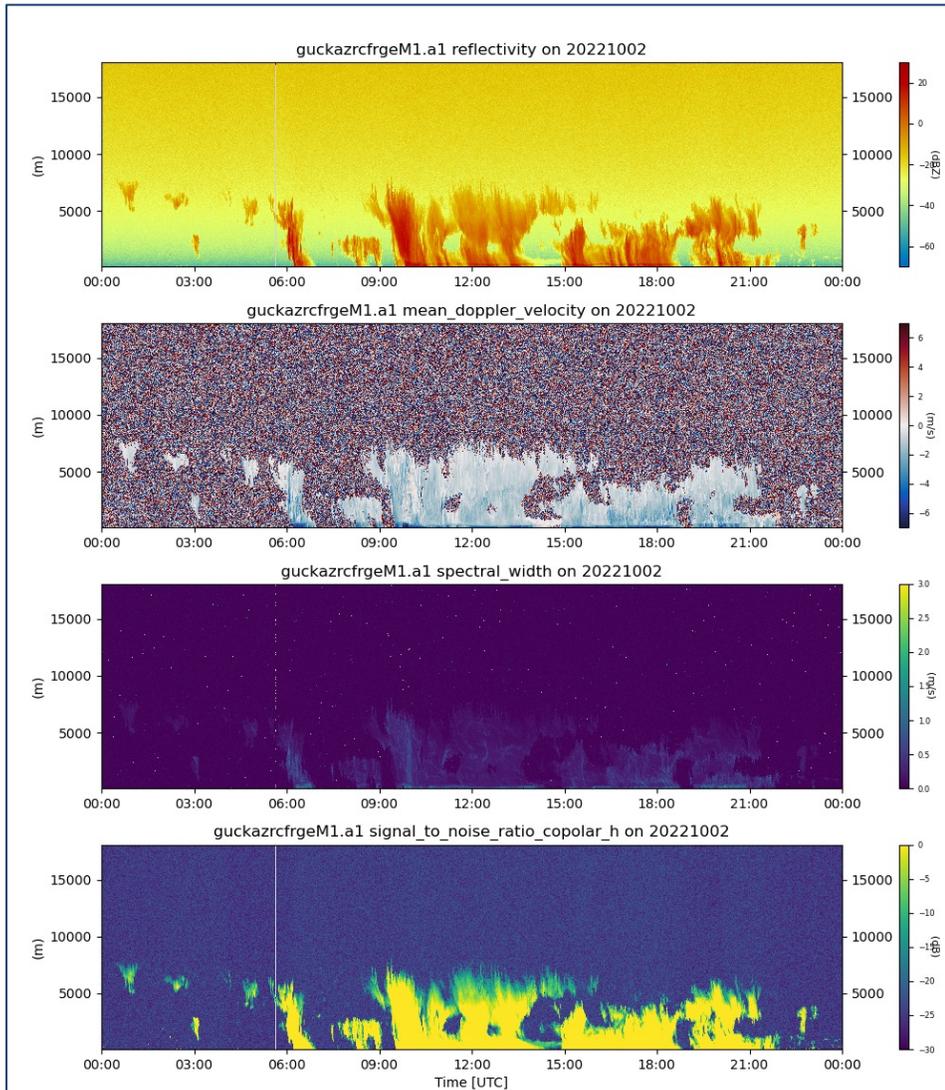
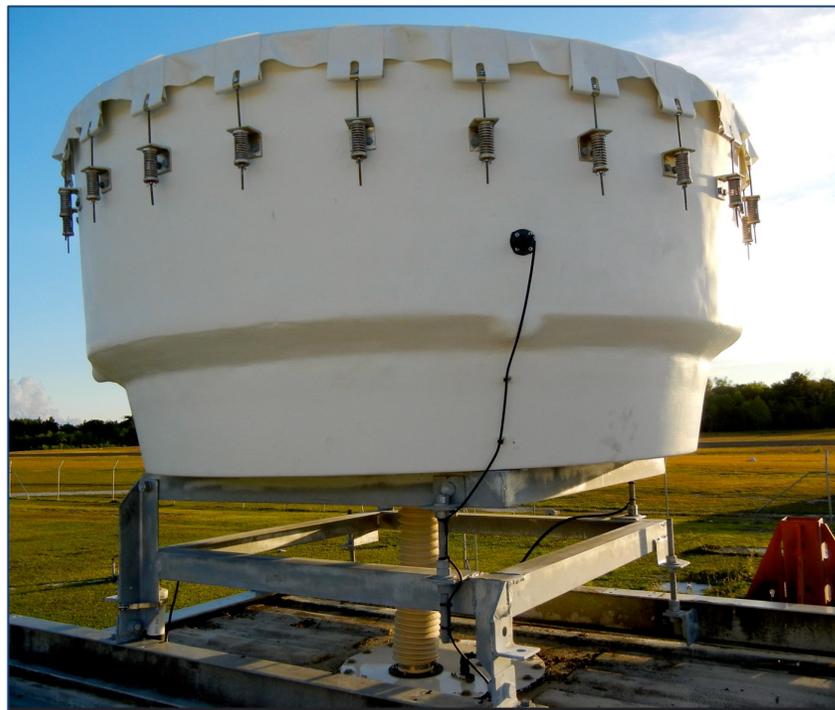
Mobile X-Band System

- ▶ Opportunity to transfer this radar to ARM if there is scientific justification
- ▶ EEC designed and built on an International Duramax chassis with a little over 8000 miles on it. The system can be powered from commercial grid power using an Appleton plug or using the onboard generator. Truck has hydraulic stabilization feet for leveling.
- ▶ Freq - 9360.5Mhz
- ▶ Tx Power - 200kW
- ▶ Antenna 2.4m, Gain 44.5dB
- ▶ Simultaneous transmit dual-pol.



KAZR Upgrades

- ▶ New Radomes
- ▶ Conversion of old TWP KAZRs to receive both co/crosspolar returns
- ▶ Conversion to digital signal processing
- ▶ Pulse configuration strategy updates
- ▶ Others?



ENA Solid State

- ▶ X-band transmitters have significant failure rates and to continue with the current transmitters would likely cause significant downtime
- ▶ Mentor team proposal to upgrade the system to solid state
- ▶ Would there be concerns with potential decreases in sensitivity for a more robust system?

SGP CSAPR Refurbishment

- ▶ A formal evaluation needs to be performed but initial estimates put the effort at 3-4 weeks of work to bring the CSAPR back online
- ▶ Listening session feedback indicate that there is significant benefit to having a C and X-band system operational at SGP
- ▶ Option to retire the CSAPR and plan for ARM-directed IOPs where we deploy the new deployable CSAPR for short periods of time in the spring