

ARM FY2023 Radar Plan

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Acronyms and Abbreviations

AMF	ARM Mobile Facility
ANL	Argonne National Laboratory
ARM	Atmospheric Radiation Measurement
ARSCL	Active Remote Sensing of Clouds Value-Added Product
AWARE	ARM West Antarctic Radiation Experiment
BNF	Bankhead National Forest
BNL	Brookhaven National Laboratory
CMAC	Corrected Radar Moments in Antenna Coordinates Value-Added Product
COMBLE	Cold-Air Outbreaks in the Marine Boundary Layer Experiment
CSAPR	C-band Scanning ARM Precipitation Radar
CSU	Colorado State University
DOE	U.S. Department of Energy
DQO	Data Quality Office
DQPR	Data Quality Problem Report
DQR	Data Quality Report
ENA	Eastern North Atlantic
FTE	full-time equivalent
FY	financial year
IOP	Intensive Operational Period
KASACR	Ka-band Scanning ARM Cloud Radar
KA/WSACR	Ka/W-Band Scanning ARM Cloud Radar
KAZR	Ka-band zenith radar
MARCUS	Measurements of Aerosols, Radiation, and Clouds over the Southern Ocean
MICROBASEKAPLUS	Improved MICROBASE with Uncertainties Value-Added Product
MMCG	Precipitation Radar Moments Mapped to a Cartesian Grid Value-Added Product
MMCR	millimeter-wavelength cloud radar
MOSAiC	Multidisciplinary Drifting Observatory for the Study of Arctic Climate
NSA	North Slope of Alaska
PNNL	Pacific Northwest National Laboratory
Py-ART	Python-ARM Radar Toolkit
SACR	Scanning ARM Cloud Radar
SACRGRID	Gridded SACR Value-Added Product
SAIL	Surface Atmosphere Integrated Field Laboratory
SAPR	Scanning ARM Precipitation Radar

SAPRQVP	SAPR Quasi-Vertical Profile Value-Added Product
SAPRVAD	SAPR Velocity Azimuth Display Value-Added Product
SGP	Southern Great Plains
TBD	to be determined
THERMOCLDPHASE	Thermodynamic Cloud Phase Value-Added Product
TRACER	Tracking Aerosol Convection Interactions Experiment
VAP	value-added product
WARNO	Watchdog for ARM Radar Network Operations
XSACR	X-band Scanning ARM Cloud Radar

Contents

Acronyms and Abbreviations	iii
1.0 Introduction	1
2.0 Fiscal Year 2022 Summary	1
2.1 Primary Activities	2
2.1.1 Mobile Facilities.....	2
2.1.2 Other.....	2
2.2 Secondary Activities	3
3.0 Fiscal Year 2023 Priorities	3
4.0 Primary Activities.....	6
4.1 KAZR Operations	6
4.1.1 Tasks	6
4.2 SAIL Campaign Operations	7
4.2.1 Tasks	7
4.3 EPCAPE Campaign Installation and Operations	7
4.3.1 Tasks	7
4.4 BNF (AMF3) Campaign Preparations, Installations, and Operations.....	8
4.4.1 Tasks	8
4.5 TRACER b1 Data Analysis and Processing.....	8
4.6 AMF Deployable Radar	8
4.7 AMF Radar Preparations for FY24.....	9
4.8 KAZR Upgrades.....	9
5.0 Secondary Activities.....	9
5.1 ENA Radar Operations.....	9
5.1.1 Tasks	10
5.2 NSA Radar Operations.....	10
5.2.1 Tasks	10
5.3 SGP Radar Operations	10
5.3.1 Tasks	11
6.0 Translator and Data Product Activities.....	11
6.1 Routine b1-Level Processing	11
6.2 Radar Open Science Support.....	11
6.3 Precipitation Radar Advanced Products.....	12
6.4 Cloud Radar Advanced Products	12
7.0 Fiscal Year 2023 Communication Plan	13

Figures

- 1 Gantt chart of activities. Color-coded by engineering (gray), data (blue), and other (yellow). 6

Tables

- 1 Inventory of ARM radars, including frequency, at each site..... 1
2 List of activities planned for FY23 Radar Team. 4

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1.0 Introduction

The fundamental objective of the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) user facility's radar capability is to provide high-quality radar observations to the scientific user community with an overarching goal of improving the treatment of clouds and precipitation in climate models. ARM has a complement of 32 radars, including scanning and zenith-pointing varieties (Table 1). The effort to maintain and operate these radars is significant and requires a large, distributed staffing commitment. It has not been feasible to ensure the continuous, high-level operations expected by the ARM user community for all radars at all times, so priorities are established to routinely manage select radar operations every fiscal year. These priorities for FY23 are listed herein.

Table 1. Inventory of ARM radars, including frequency, at each site. Frequencies are approximate and can be slightly different in the field.

	Radar	Frequency
SGP	3 - X-Band Scanning ARM Precipitation Radars (XSAPR) 1 - C-Band Scanning ARM Precipitation Radar (CSAPR) 1 - Ka/W-Band Scanning ARM Cloud Radar (Ka/W-SACR) - Retiring 1 - Ka-Band zenith radar (KAZR)	9.35 GHz 6.25 GHz 35.3/94.0 GHz 35 GHz
NSA	1 - X-Band Scanning ARM Precipitation Radar 1 - Ka/W-Band Scanning ARM Cloud Radar (2nd generation) 1 - Ka-Band zenith radar	9.35 GHz 35.3/94.0 GHz 35 GHz
ENA	1 - X-Band Scanning ARM Precipitation Radar (2nd generation) 1 - Ka/W-Band Scanning ARM Cloud Radar (2nd generation) 1 - Ka-Band zenith radar (2nd generation)	9.5 GHz 35.3/94.0 GHz 35 GHz
AMF1	2 - Ka-Band zenith radar	35 GHz
AMF2	1 - W-Band Marine ARM Cloud Radar 1 - Ka/W-Band Scanning ARM Cloud Radar (rotational) 1 - Ka/X-Band Scanning ARM Cloud Radar (rotational)	95 GHz 35.3/94.0 GHz 35.3/9.71 GHz
AMF3	1 - Ka-Band Zenith Radar (2nd Generation)	35 GHz
Other	1 - C-Band Scanning ARM Precipitation Radar (1st generation) 1 - C-Band Scanning ARM Precipitation Radar (2nd generation) 1 - Ka-Band zenith radar (spares) 2 - Ka/X-Band Scanning ARM Cloud Radar (rotational/spares) 1 - Ka/W-Band Scanning ARM Cloud Radar (SGP)	6.25 GHz 5.7 GHz 35 GHz 35.3/9.71 GHz 35.3/94.0 GHz

2.0 Fiscal Year 2022 Summary

Significant effort was put into the radars in FY22 previously defined primary activities (first ARM Mobile Facility-Tracking Aerosol Convection Interactions Experiment [AMF1-TRACER], second ARM

Mobile Facility- Surface Atmosphere Integrated Field Laboratory [AMF2-SAIL], Ka-band zenith radar [KAZR] operations, etc.) and secondary activities (Eastern North Atlantic [ENA], North Slope of Alaska [NSA], Southern Great Plains [SGP]) along with data processing and value-added product (VAP) activities.

2.1 Primary Activities

2.1.1 Mobile Facilities

TRACER scanning radars proved to be problematic for the early portions of the AMF1 campaign, but all radars were operational for the majority of the Intensive Operational Period (IOP). Cell-tracking with the C-band Scanning ARM Precipitation Radar (2nd generation) (CSAPR2) was successfully implemented and was operational for the IOP as well. Data expectations are as follows for the CSAPR2:

- Data prior to November 23, 2021 will not be available due to instrument issues.
- Data between November 23 and April 20 will be documented with a Data Quality Report (DQR) at the a1 level as incorrect and note that ARM will not be providing b1-level files. This data may still be useful for some purposes.
- Data from April 20 onwards will be considered operational and have the expectation for b1-level data.

The Scanning ARM Cloud Radar (SACR) was not operating optimally leading up until the IOP date but there should be usable data sets available. The Ka-band Scanning ARM Cloud Radar (KASACR) Nyquist was modified on July 12, 2022, after which both the KASACR and X-band Scanning ARM Cloud Radar (XSACR) were operating as per the principal investigator's preference. The KAZR performed without issue, and it should be possible to provide b1-level calibrated data sets. The Active Remote Sensing of Clouds (ARSCL) VAP was also run during the campaign with a 1-month delay, which was a first for the translator team.

SAIL KAZR and ARM-supported Colorado State University (CSU) X-band were installed and have been mostly operational with a few periods of downtime that were quickly addressed. Efforts are underway from the precipitation radar VAP team to develop and implement snow retrievals for the CSU X-band. ARSCL data, as with TRACER, were delivered within a month and there should be b1-level data products for the KAZR.

2.1.2 Other

KAZR operations have been maintained and operational with a few short outages at sites.

As part of the radar roadmap development efforts to better plan radar priorities and operations, a series of listening sessions were held with the scientific community to gather feedback about scientific priorities for the fixed-site radar systems. Key takeaways from each session are posted on ARM's Discourse tool: <https://discourse.arm.gov/c/radar/12>.

Additionally, the Cold-Air Outbreaks in the Marine Boundary Layer Experiment (COMBLE) calibrated b1-level radar data products have been released (KASACR, KAZR) and the Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) data products at the end of FY22 but may carry over 1-2 months into FY23.

2.2 Secondary Activities

ENA Ka/W-Band Scanning ARM Cloud Radar (2nd generation) (KA/WSACR2) is operational after a trip by the radar mentors and an initial scan strategy is being implemented and will be discussed with the science community, further detailed in the communication section. The SAPR transmitter was problematic and unable to be brought online. Discussions on the path forward are ongoing.

NSA KA/WSACR2 is operational after a trip by the mentor team in August 2022. The XSAPR was operational for a short period before a transmitter failure but is expected to be operational before the winter.

3.0 Fiscal Year 2023 Priorities

As the radar roadmap is being developed and the radar strategy is further implemented, these radar plans will evolve to include more information and better timelines and move away from simple base priorities. At a high level, the activities listed in Table 2 are planned for FY23. These include many new activities but also activities that are currently ongoing. At the time of writing, there are currently 3.25 FTEs (1 FTE to be hired but counted as 0.5 FTE to account for the hiring process and training) dedicated to the data mentor team and roughly 5.0 FTEs dedicated to the radar engineering team (2.5 FTE mentors [0.5 to be hired; planned for 1 FTE after onboarding], 2.5 FTE engineers and technicians). The generic tasks listed in Table 2 are defined as:

- (Radar) operations – Entails the routine maintenance, troubleshooting and repairs, calibrations, and site technician training by the engineering team.
- (Radar) data monitoring and operations – Routine monitoring of the data and calibration, troubleshooting and updates, and data quality efforts (Data Quality Problem Report [DQPR], Data Quality Report [DQR]) by the data team.
- (Radar) b1 data analysis and processing – Standard ARM process to analyze the data and provide offsets/corrections for the a1-to-b1 processing by the data team for the ARM radars deployed. This includes data-based calibrations, cross-comparisons, configuration generation, and report generation.
- (Radar) maintenance and operations – Efforts to bring the radar(s) back online and monitor them from a hardware perspective during their planned period of activities.

Table 2. List of activities planned for FY23 Radar Team. Note: Engineering-related tasks are highlighted in gray and data-related tasks in blue.

#	Activity	Start Date	End Date	Staffing	Priority	Planned FTE
1	KAZR operations	10/1/2022	9/30/2023	Wendler, Lindenmaier, Castro, Argay, Houchens, Breedlove, Androes	Primary	0.69
2	KAZR data monitoring and operations (NSA, ENA, SGP, SAIL, EPC, BNF)	10/1/2022	9/30/2023	Feng, Matthews, Johnson, Schuman, TBD	Primary	0.53
3	SAIL Radar operations	9/1/2021	6/15/2023	See below	Primary	0.14
4	CSU X-band radar operations	9/1/2021	6/15/2023	Chandrasekar,	Primary	0.25
5	SAIL b1 data analysis and processing (first year of campaign, KAZR)	9/1/2021	12/15/2023	Feng, Matthews, Schuman	Primary	0.13
6	SAIL X-band advanced products	5/1/2022	12/15/2023	Collis, Chandrasekar	Primary	0.44
7	EPCAPE radar operations	2/15/2023	2/14/2024	Lindenmaier, Wendler, Argay, Feng, Matthews	Primary	0.39
8	EPCAPE installation	11/1/2022	12/31/2022	Lindenmaier, Wendler, Castro	Primary	0.06
9	EPC data monitoring and operations	2/15/2023	2/14/2024	Feng, Matthews, Johnson, TBD	Primary	0.22
10	BNF radar operations	9/1/2023	Onward	Lindenmaier, Wendler, Castro, Houchens, Feng, Matthews	Primary	0.08
11	BNF radar preparations (CSAPR2, Ka/XSACR, KAZR)	1/1/2023	6/1/2023	Lindenmaier, Wendler, Castro	Primary	1.04
12	BNF radar installation (CSAPR2, Ka/XSACR, KAZR)	7/1/2023	7/31/2023	Lindenmaier, Wendler, Castro, Houchens	Primary	0.11
13	BNF data monitoring and operations	7/1/2023	Onward	Feng, Matthews, Johnson, TBD	Primary	0.12
14	TRACER b1 data analysis and processing	10/1/2021	3/30/2023	Feng, Matthews, Johnson, Schuman, TBD	Primary	0.9
15	AMF deployable radar	10/1/2022	3/30/2024	Lindenmaier	Primary	0.17

#	Activity	Start Date	End Date	Staffing	Priority	Planned FTE
16	AMF radar preparations for FY24 (1 month effort in FY23)	9/1/2023	Unknown	Lindenmaier, Wendler, Castro	Primary	0.21
17	KAZR upgrade	1/1/2023	1/1/2026	Lindenmaier, Wendler, Castro	Primary	0.1
18	ENA radar operations	4/27/2022	Onward	Lindenmaier	Secondary	0.93
19	ENA radar maintenance, repairs, and possible upgrade	5/1/2023	5/31/2023	Lindenmaier, Argay	Secondary	0.08
20	ENA data monitoring and operations (6-months)	5/1/2022	11/1/2023	Feng, Matthews, Johnson, TBD	Secondary	0.20
21	ENA b1 data analysis and processing (3 months, summer 2022 data; KAZR2, SACR2, XSAPR)	4/1/2023	10/1/2023	Feng, Matthews, Johnson, Schuman, TBD	Secondary	0.35
22	NSA radar operations (6-months)	9/1/2022	3/1/2023	Lindenmaier, Houchens	Secondary	0.54
23	NSA data monitoring and operations (6 months)	9/1/2022	3/1/2023	Feng, Matthews, Johnson, TBD	Secondary	0.19
24	NSA b1 data analysis and processing (6-months)	7/1/2023	9/30/2023	Feng, Matthews, Johnson, Schuman, TBD	Secondary	0.35
25	NSA radar preparations for FY24 winter	7/1/2023	9/30/2023	Lindenmaier, Houchens, Wendler	Secondary	0.1
26	SGP XSAPR maintenance and operations (3-months)	3/1/2023	7/1/2023	Lindenmaier, Breedlove, Androes	Secondary	0.28
27	SGP data monitoring and operations (3 months)	4/1/2023	6/30/2023	Feng, Matthews	Secondary	0.08
28	SGP b1 data analysis and processing (3 months, spring 2023; XSAPRs)	7/1/2023	9/30/2023	Feng, Matthews, Schuman	Secondary	0.18
	Total FTE	(Not including SAIL X-band)				8.51
	Data Mentor FTE	(Not including SAIL X-band)				3.25 (3.25)
	Engineering Mentor FTE	(Not including SAIL X-band)				4.92 (5.0)
	Translator FTE	Not including other VAP activities at the moment				0.44

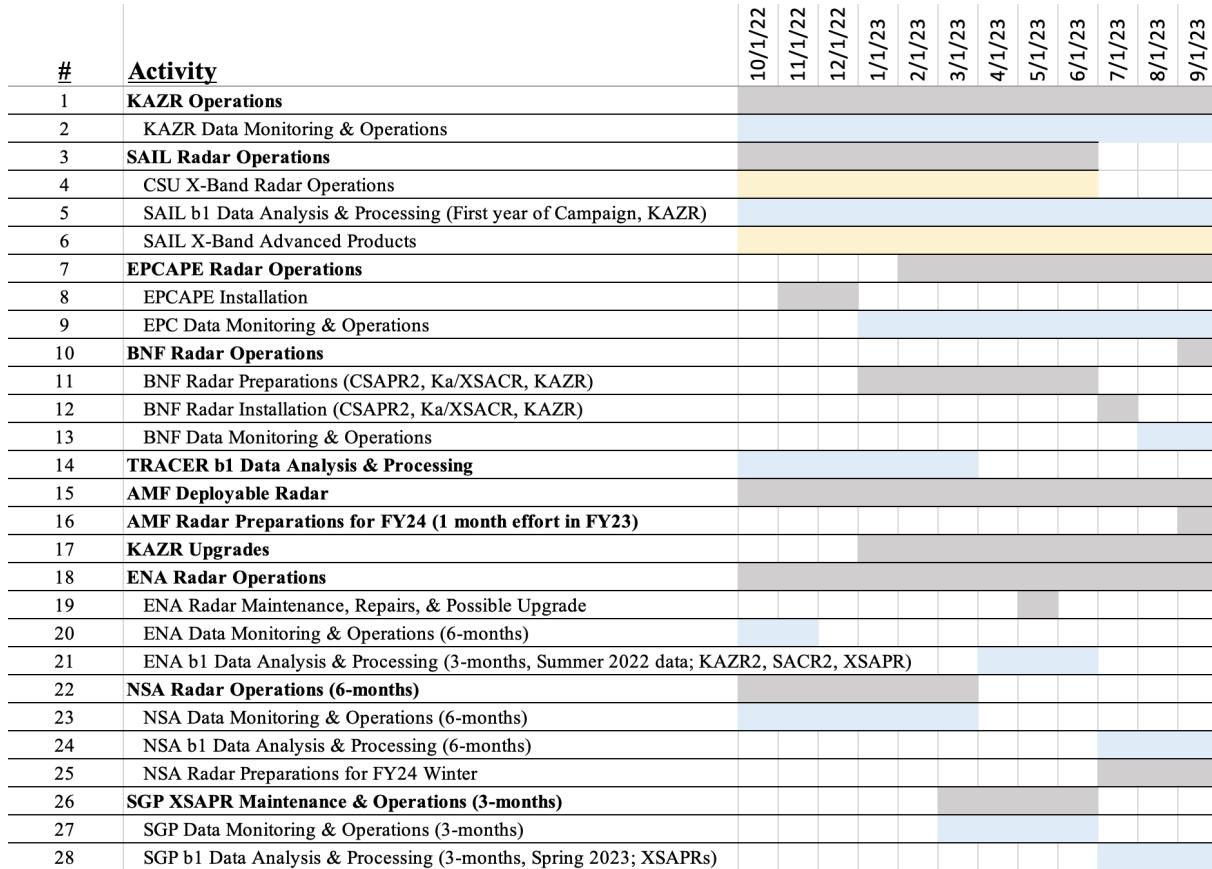


Figure 1. Gantt chart of activities. Color-coded by engineering (gray), data (blue), and other (yellow).

4.0 Primary Activities

4.1 KAZR Operations

Task #: 1 and 2, FTE: 1.09, Continuous

Mentor Staffing: Wendler, Lindenmaier, Castro, Argay, Houchens, Breedlove, Androes, Feng, Matthews, Johnson, Schuman, TBD

The KAZRs are workhorses for ARM's radar measurements and are a continued high priority at all ARM sites (fixed and AMF deployments). Engineering mentors, radar engineers, and radar technicians will perform routine maintenance and repairs as required. As travel and time permit, the KAZR receivers will undergo periodic calibration. The radar data team, led by the radar data mentor, is responsible for monitoring operational radar data sets with support from the ARM Data Quality Office (DQO) and other members of ARM's infrastructure. Processing the KAZR data to a b1 level is standard for the mobile facilities and a process to start this processing for the fixed sites will be implemented as time permits.

4.1.1 Tasks

- KAZR operations/routine maintenance/repairs: 0.69 FTE
- KAZR data monitoring and operations: 0.40 FTE

4.2 SAIL Campaign Operations

Task #: 3, 4, 5, and 6, FTE: 0.71, 9/1/2021-12/15/2023

Staffing: Chandrasekar, Lindenmaier, Wendler, Castro, Argay, Feng, Matthews, Johnson, TBD, Collis

The AMF2 will be deployed for an extended period in Colorado for the SAIL campaign (September 1, 2021-June 15, 2023). The KAZR will be deployed as part of the standard AMF complement of sensors, while CSU has deployed their X-band radar for ARM in place of an ARM scanning cloud radar system (FTE not included in the above total, non-ARM mentorship). The radar data team will process the SAIL KAZR data into b1-level calibrated and corrected data products. The translator team will work closely with the CSU team to include any necessary offsets/corrections in their product development, which is expected to produce Corrected Moments in Antenna Coordinates (CMAC) and a snowfall retrieval product.

4.2.1 Tasks

- CSU X-band radar operations 0.25 FTE
- SAIL b1 data analysis and processing (KAZR only) 0.13 FTE
- SAIL X-band advanced data products 0.44 FTE

4.3 ECAPE Campaign Installation and Operations

Task #: 7, 8, and 9, FTE: 0.66, 1/1/2023-2/14/2024

Staffing: Lindenmaier, Wendler, Castro, Argay, Feng, Matthews, Johnson, TBD

A KAZR and Ka/W-SACR will be installed in November/December 2022 to support the Eastern Pacific Cloud Aerosol Precipitation Experiment (ECAPE). Campaign operations are expected from February 15, 2023, to February 14, 2024 and will be considered a high priority if any of the radar systems fail or become problematic. The KAZR is planned to be deployed on the Scripps Pier in La Jolla, California and the Ka/WSACR on Mt. Soledad. The data team will monitor the data and report and document any problems that arise (0.22 FTE) with processed b1-level data expected after the campaign in FY24.

4.3.1 Tasks

- ECAPE installation 0.06 FTE
- ECAPE radar operations 0.39 FTE
- ECAPE data monitoring and operations 0.22 FTE

4.4 BNF (AMF3) Campaign Preparations, Installations, and Operations

Task #: 10, 11, and 12, FTE: 1.35, 1/1/2022-Onward

Mentor Staffing: Lindenmaier, Wendler, Castro, Houchens, Feng, Matthews, Johnson, TBD

The AMF3 will be deploying in Northern Alabama in the Bankhead National Forest (BNF) for an approximately five-year campaign. The KAZR2 and CSAPR2 are currently being prepared or will need to be prepared for installation in the summer of 2023. The Ka/XSACR is currently under discussion and if deployed, would be deployed at the CSAPR2 supplemental site. The KAZR will be deployed at the main AMF3 site. We expect that there will be a maximum of three months of data collection in FY23 depending on installation dates.

4.4.1 Tasks

- | | |
|--------------------------------------|----------|
| • BNF radar preparations | 1.04 FTE |
| • BNF radar installation | 0.11 FTE |
| • BNF radar operations | 0.08 FTE |
| • BNF data monitoring and operations | 0.12 FTE |

4.5 TRACER b1 Data Analysis and Processing

Task #: 14, FTE: 0.9, 10/1/2022-3/30/2022

Mentor Staffing: Feng, Matthews, Johnson, Schuman. TBD

The expectation is that the b1-level radar data for the KAZR, SACR, and CSAPR2 will be available, along with a report, six months after the campaign ends on 9/30/2022. We note that the CSAPR2 had numerous issues plaguing it from November 23, 2021, to April 20, 2022. The data from this period will not be processed to b1 level. Users should expect CSAPR2 b1-level data from April 20, 2022, onward. SACR and KAZR data during normal operational periods (i.e., no major hardware or data issues) are expected to be processed.

4.6 AMF Deployable Radar

Task #: 15, FTE: 0.17, 6/1/2022-Onward

Mentor Staffing: Lindenmaier

The CSAPR2 will be deploying with the AMF3 to the Southeast U.S., leaving a gap in C-band radar capabilities for other campaigns. Some initial information has been gathered, but the mentor team and ARM management will be working on replacing that capability. This process will include requirements development and putting those requirements out to bid by interested vendors. We expect that a new system will be delivered in FY24.

4.7 AMF Radar Preparations for FY24

Task #: 16, FTE: 0.21, 9/1/2023-Onward

Mentor Staffing: Lindenmaier, Wendler, Castro

As part of the latest round of AMF proposals for deployment, a domestic deployment could occur as early as December 2023. Depending on the proposal selected, the radar team may need to have a KAZR and SACR prepared and ready for that December 2023 start date. The total effort will be roughly 0.63 FTE but only one month of work is expected to fall in FY23.

4.8 KAZR Upgrades

Task #: 17, FTE: 0.10, 1/1/2023-1/1/2026

Mentor Staffing: Lindenmaier, Wendler, Castro

The KAZRs are the workhorse radars for ARM and were derived from the original ARM millimeter cloud radars (MMCRs). Most of the KAZRs operating today were not totally new systems but were upgrades from the MMCRs, circa 2010. The upgrades particularly focused on conversion to digital signal processing and replacement of the original antennas. The KAZRs are now 10 years old or more and represent three different configurations. This upgrade of the KAZRs will provide better homogeneity across the KAZR network, address deficiencies to the extent possible and provide new hardware where necessary to prepare for the next decade of operations. We expect that the contract for the first upgrades will be placed in FY23 and that upgrades of all the KAZRs will be phased in over two-three years.

5.0 Secondary Activities

These activities are planned for FY23 but could be reconsidered if any of the existing primary activities require more effort. Additionally, any new primary activities will need to be reviewed and the secondary activities adjusted as necessary.

5.1 ENA Radar Operations

Task #: 18, 19, 20, and 21, FTE: 1.57, 5/1/2022-Onward

Mentor Staffing: Lindenmaier, Wendler, Castro, Argay, Feng, Matthews, Johnson, Schuman, TBD

After a recent trip by the radar team in the spring of 2022, the Ka/WSACR2 has been operational at ENA along with the KAZR2. Due to failures in the XSAPR2 components, the system was not able to be brought online. The radar team and ARM management will be discussing plans to replace the failed components or upgrade the system to solid state. The effort required for the replacement is minimal but the effort to upgrade could be substantial. If ARM decides to repair the system, another trip to ENA will be planned in spring 2023 to bring the XSAPR2 online and perform additional maintenance on the other radars. Any instrument problems will be dealt with remotely or in coordination with site operations. If the system cannot be repaired, it will remain offline until the mentor visit. The data team will continue to monitor the data from the operational radars at ENA. Due to time constraints, only a three-month period

of data will be processed to b1 level. Based on discussions from the ENA Radar Listening Session, the summer is the primary interest with strong interest in winter as well, which could be processed at a later date.

5.1.1 Tasks

- ENA radar operations (6-months) 0.93 FTE
- ENA radar maintenance, repairs, and possible upgrade (minimum) 0.08 FTE
- ENA data monitoring and operations (6 months) 0.20 FTE
- ENA b1 data analysis and processing (3 months summer 2022) 0.35 FTE

5.2 NSA Radar Operations

Task #: 22, 23, 24, and 25, FTE: 1.18, 8/1/2022-Onward

Mentor Staffing: Wendler, Houchens, Lindenmaier, Feng, Matthews, Johnson, Schuman, TBD

The engineering team made a trip to the NSA site in August 2022, successfully bringing the KA/WSACR back to operations for the winter season. Failures in the XSAPR transmitter are being repaired and we expect that the system will be online for the winter season. We also expect that this summer trip will be routine in the future to ensure operations for winter. The radars will remain operational as long as possible but no repairs on the SACR will be undertaken in the winter and limited repairs on the XSAPR will be attempted if necessary. The data team will perform routine monitoring and data quality reporting for up to six months of wintertime data collection. The data will be processed to a b1-level product in the last quarter of FY23.

5.2.1 Tasks

- NSA Radar maintenance and return to operations (6 months operations) 0.54 FTE
- NSA data monitoring and operations (6 months data monitoring) 0.19 FTE
- NSA b1 data analysis and processing (6 months of data) 0.35 FTE
- NSA radar preparations for FY24 winter 0.1 FTE

5.3 SGP Radar Operations

Task #: 26, 27, and 28 , FTE: 0.54, 3/1/2023-12/30/2023

Mentor Staffing: Lindenmaier, Breedlove, Androes, Feng, Matthews, Johnson, Schuman, TBD

The radar engineering team will make a trip in winter/spring 2023 to bring the SGP XSAPR network back to operations. The magnetrons have mostly been replaced at time of writing with some other known repairs required for one of the radars. The goal is to have the XSAPR network operational for the spring 2023 convective season (April/May/June) and then the radars will be put into maintenance mode to conserve the transmitter. The data team is expected to monitor and quality-control the data during these

three months along with producing b1-level data for the three XSAPRs. Note that the b1-data analysis and processing task also includes the effort to evaluate the radars once they come online.

5.3.1 Tasks

- SGP XSAPR maintenance and return to operations (3 months operations) 0.28 FTE
- SGP data monitoring and operations (3 months) 0.08 FTE
- SGP b1 data analysis and processing (3 months spring 2023) 0.18 FTE

6.0 Translator and Data Product Activities

6.1 Routine b1-Level Processing

Timeframe: Ongoing

Staff: Feng, Matthews, Johnson, Schuman, TBD

Calibrated b1-level data for the COMBLE and MOSAiC cloud radar deployments (KAZR, SACR) should be available in late FY22, but the MOSAiC data release may carry over into FY23. Additionally, the radar data mentor team will be monitoring and prioritizing the data collected during the FY23 AMF1 and AMF2 deployments, but the standard expectation is that b1-level data are not available until after AMF campaigns. As noted above, the TRACER data (KAZR, SACR, CSAPR) processing will be a primary activity in addition to the processing of the first year of SAIL data. TRACER data processing may need more effort, such as masks on biological signals or second trips. Processing of the fixed-site data to b1-level will begin with ENA and advance to SGP and NSA as time permits.

As part of this FY, the broader ARM radar team will be gathered to review the a1-to-b1-level processing to determine if any areas of improvement, automation, or otherwise could lead to streamlined processing efforts. With the growing number of radars coming online, it will be vital to ensure the process is efficient and can produce calibrated data sets in a timely manner.

6.2 Radar Open Science Support

Timeframe: Ongoing

Staff: Sherman, Grover, Collis

Support and further development of the Python-ARM Radar Toolkit (Py-ART). Py-ART is used by internal and external stakeholders and is specifically engineered to work with ARM radar data. Py-ART has supported well over 100 publications and is used across academia, government, and industry. Py-ART is also the main tool used for VAP development on the precipitation radars. Py-ART also acts as a conduit to get science codes back into infrastructure.

Additionally, the translator teams are working to develop a set of executable “cookbooks” or guides for using Py-ART that will be available on GitHub and based on project Jupyter. Users will be able to use these cookbooks for their research as a starting point for basic parts of the analysis and visualization.

6.3 Precipitation Radar Advanced Products

Timeframe: Ongoing

Staff: Jackson, Sherman, Grover, O'Brien, Collis

The precipitation radar advanced products team will provide product support for the CSAPR2 deployment to TRACER. Products will include Corrected Radar Moments in Antenna Coordinates (CMAC2.0), Precipitation Radar Moments Mapped to a Cartesian Grid (MMCG), SAPR Velocity Azimuth Display (SAPRVAD), and SAPR Quasi-Vertical Profiles (SAPRQVP), along with new development of a moving-frame-of-reference MMCG to support cell-tracking activities.

This team will coordinate closely with the CSU X-band radar team to ensure that there are useful products for the SAIL campaign, including maps of quantitative precipitation estimates. This will include analyzing data from the radar, comparison to external measurements (e.g., disdrometer), rainfall retrievals where needed, and updating delivered data to ensure it conforms to ARM standards. There is also likely a role for outreach and ensuring the ARM SAIL community (which includes new ARM users from the Watersheds Science Focus Area) knows the data exists and how to apply the data to achieve DOE science. ARM standard data products are expected to be produced.

6.4 Cloud Radar Advanced Products

Timeframe: Ongoing

Staff: Ma, Johnson, Wang, Giangrande, TBD, Zhang

The cloud radar advanced products team has been working with the mentor team to produce calibrated b1-level data sets for the KAZR and SACR AMF deployments. The standard ARSCL and Gridded SACR products (SACRGRID) will be performed on the available a/b-level data during TRACER, SAIL, and ECAPE to help with the data quality monitoring of the KAZR/SACR, respectively. High-priority activities include traditional core VAP delivery, which for FY23 involves continuing the multi-year plan towards modernizing the ARSCL code base to an open/Python status and improvements therein working with the BNL radar data mentors and translators for radar VAP ‘cookbooks’. Additional microphysical retrieval value-added products that benefit from these radars (e.g., Improved MICROBASE with Uncertainties [MICROBASEKAPLUS] - drop effective radius, rain/drizzle and/or cloud echo classification products contingent on data quality) are also anticipated from several translator-led activities.

Timeframe: Ongoing

Staff: Levin, D. Zhang

ARSCL is a key input for the new thermodynamic cloud phase (THERMOCLDPHASE) VAP. THERMOCLDPHASE relies on ARSCL for cloud boundaries detections using combined lidar and radar measurements. Furthermore, radar reflectivity, Doppler velocity, and radar spectrum width measurements are used for cloud hydrometer thermodynamic phase identifications in the VAP. THERMOCLDPHASE data are released as an evaluation data set at the NSA site and will be available for recent field campaigns including COMBLE, MOSAiC, Measurements of Aerosols, Radiation, and Clouds over the Southern Ocean (MARCUS), and the ARM West Antarctic Radiation Experiment (AWARE) in FY23.

7.0 Fiscal Year 2023 Communication Plan

As ARM advances its radar efforts, it will be important to communicate internally and externally about the plan, expectation, and results of all activities from the engineering and data mentor to the translator activities. Currently, there is a limited monthly call that the data mentor team holds for the science community to attend. ARM will seek to expand the awareness and visibility of this monthly meeting by inviting all radar data users. The goal will be to have three to four structured sessions with set topics that are communicated in advance, with the other sessions being open for general Q&A and discussion as originally intended. Initial topics may include ENA scan strategies, AMF precipitation radar requirements, and more. Internally, there is already a weekly operations call between the engineering team, site operations, and the data mentors that has been extremely valuable for communication. ARM will seek to implement a quarterly call with additional parties of interest (DQO, translators, ingest developers, etc.) with the goal of improving and automating workflows and processes for the radars along with general coordination of effort.

Additionally, there will be a capability review of the radar.arm.gov webpage, including Watchdog for ARM Radar Network Operations (WARNO). There is a need to easily communicate radar status to the science community and do so in an automated manner. The existing capability and process is manual and unreliable.



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