CARIBBEAN METEOROLOGICAL ORGANIZATION

CARIBBEAN METEOROLOGICAL COUNCIL **Doc.10**
SIXTY-FIFTH SESSION
PORT OF SPAIN, TRINIDAD AND TOBAGO
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CMO WEATHER RADAR NETWORK
(Submitted by the Coordinating Director)

Introduction

1. The Caribbean region has a reasonably good network of installed weather radars (Fig. 1) providing real-time information for observing, monitoring, and forecasting heavy rainfall and strong winds, volcanic ash, and other severe weather, but not all the radars are functional. The regional weather radars are the primary tool used by regional and international forecasters when impending severe weather is within 400 km of land, and also a commonplace benefit in everyday life; while crucial information from the radars enables better numerical weather prediction and ultimately better severe weather warnings. The reliance on the radar network has been growing within and outside of the region and, particularly under the auspices of the *World Meteorological Organization* (WMO) Hurricane Committee and Severe Weather Forecasting Programme Eastern Caribbean. Members of the CMO continue to contribute to the operation and applications of this joint facility of CMO.

2. The CMO Weather Radar Network comprises six (6) Doppler weather radars in Barbados, Belize, Grand Cayman, Guyana, Trinidad, and Jamaica (Fig. 1). The radar network remains a vital component of the Caribbean weather observation and monitoring capability. However, most CMO radars have reached the mature stage of their mechanical life (typically 10 – 15 years) and now require more consistent maintenance and repair, update in technology, and, in some instances, physical infrastructure upgrades. The Council is reminded that the radars are complex and are the most expensive observation platforms in which the CMO and radar host Members have invested. The CMO radar network is vital to early warnings for hurricane and other severe weather forecasts, and meteorological services to aviation, disaster risk management, water, and other weather and climate-sensitive sectors and the sustainable development of the region. The Council is asked to note that, given the importance of the information from the radars and the expected lifetime of weather radar systems, provision needs to be made for ongoing operational costs that will likely well exceed the initial system cost.

3. This document examines the operational status of the CMO Weather Radar Network and other activities regarding the radars since CMC63 (Grand Cayman, November 2022), including pressures from physical and cyber threats. Two Members faced either existential threat to their radar operations or radar relocation threat to accommodate other sectoral radars. The document also raises awareness on emerging radar issues and provides recommendations for the Council to consider in making decisions and determining strategies for sustainability of the network. The CMO Operational Radar Group (CORG) activities will also be reported to the Council followed by information about risk management for the radars and extending the longevity of the network.

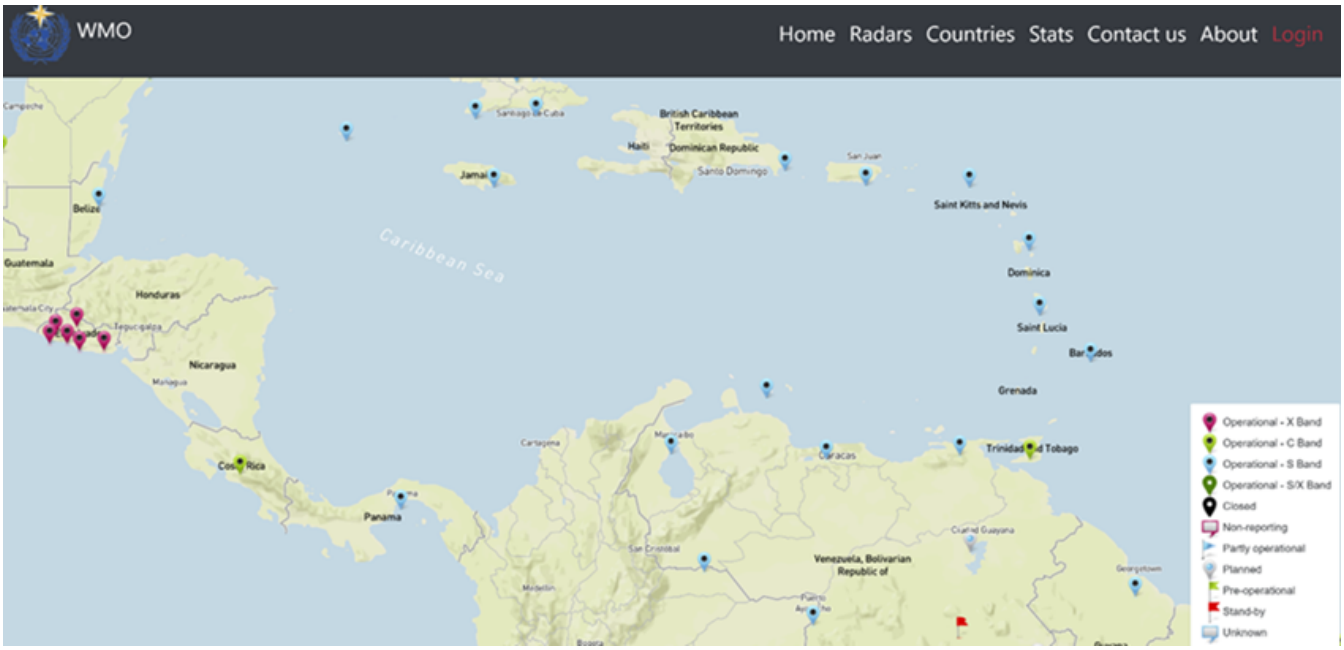

Figure 1. Map extracted from the WMO Weather Radar Database showing Caribbean Radars

(a) Previous Status Report

4. The Council will recall that at CMC63, it was reported that Trinidad and Tobago's radar outage, which started in February 2020, continued into 2022. Recommendations for repairs and upgrading of the radar were made following a technical study in July 2022. At the same time, Tobago benefited from the installation of a new X-band radar with a 150-km range (compared with the 400-km range for S-band radar in Trinidad); however, the forecasters at Piarco did not have operational access to the Tobago radar data. The Council will also recall that Jamaica benefited from the installation of a new radar under the Pilot Program for Climate Resilience (PPCR) project in 2021, but major mechanical defects occurred in March 2022. Barbados successfully upgraded its radar to a dual-polarization radar system in March 2022. The Council was also apprised that that the regional radar network was poised for significant operational expansion, with three additional radars set to supplement the network, namely Saint Lucia, Sint Maarten and Martinique.

(b) Current Status of the CMO Weather Radar Network and other Caribbean Radars

Trinidad Radar

5. Progress has been on the repairing of the Trinidad radar, which continued to be in radar outage due to several mechanical issues with the unit. Replacement parts have been acquired to refurbish the radar, most of which had to be custom built, adding to the prolonged radar outage. The last shipment of radar replacement parts was received on the island in October 2023; however, work on repairing the radar is not scheduled to start until the completion of ongoing structural work at the radar site, which started in March 2023. The completed work thus far includes, the sealing of leaks in the radome, external and internal painting, the replacement of windows, a refurbished security booth, and the installation of a new UPS system. Once the structural work is completed (likely by the end of November), the technicians from Leonardo Germany will be invited to start repairing the radar.

Figure 2. Status of Radar Refurbishment for Trinidad and Tobago radar

Tobago Radar

6. Tobago's radar remains fully functional and up-to-date in terms of manufacturer maintenance schedules and software licenses. However, there are challenges with irregular voltage at the office building that are causing operational radar instability, including radar freezing and at times a complete radar shutdown. The router for the radar was also damaged in August 2023, which inhibits responding to radar data requested from the Meteorological Service. Currently, the radar data are not being archived and the process to get the radar images on the TTMS mobile app and online platforms has stalled.

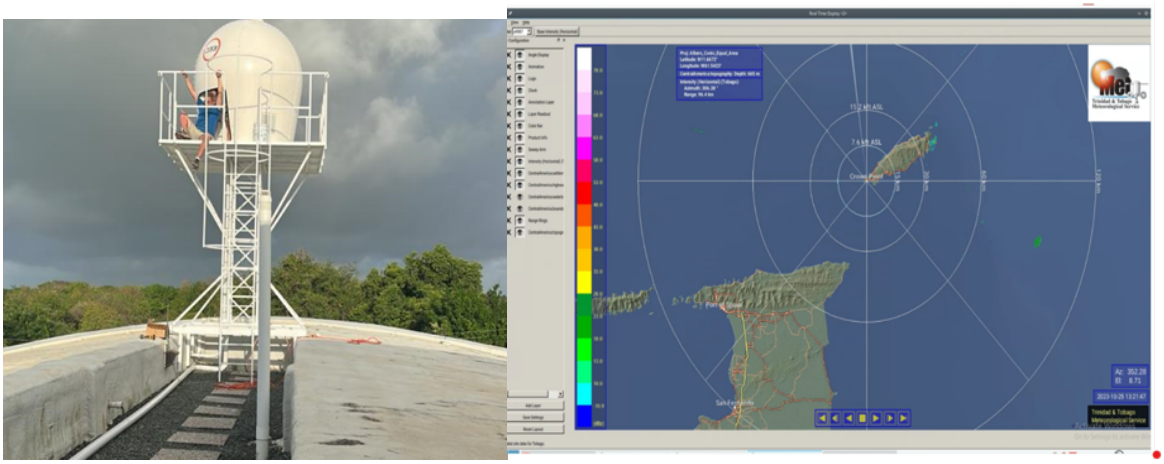

Figure 3. Tobago X-band radar (left) and sample image (right)

Barbados Radar

7. The Barbados weather radar unit remained in good physical condition during the intersessional period and is insured. During the past year, the Barbados Meteorological Services (BMS) upgraded its UPS system to a dual-system organized with a parallel UPS bypass that allows for UPS redundancy should one of the UPSs fails. The BMS also arranged visits by Leonardo's experts under its bi-annual experts visit arrangement with the company and replaced its aged standby generator with a new one. However, the BMS encountered a number of challenges with radar support equipment during the year. The BMS had to replace a failed microwave network that is responsible for data transfer between the radar site and the operational office, as well as a failed firewall at the radar site that caused the radar to appear offline even though it was operational. The BMS also encountered issues with a faulty dehydrator, which it had to replace. Also, the BMS had to contend with security challenges. There were two security-concerning events at the radar site during November 2022 and June 2023, when perpetrators breached the gates/fences and proceeded to steal stored diesel for the standby generator. This led to the construction of a concrete structure with burglar-bar to secure the diesel tank and the installation of a security camera system.

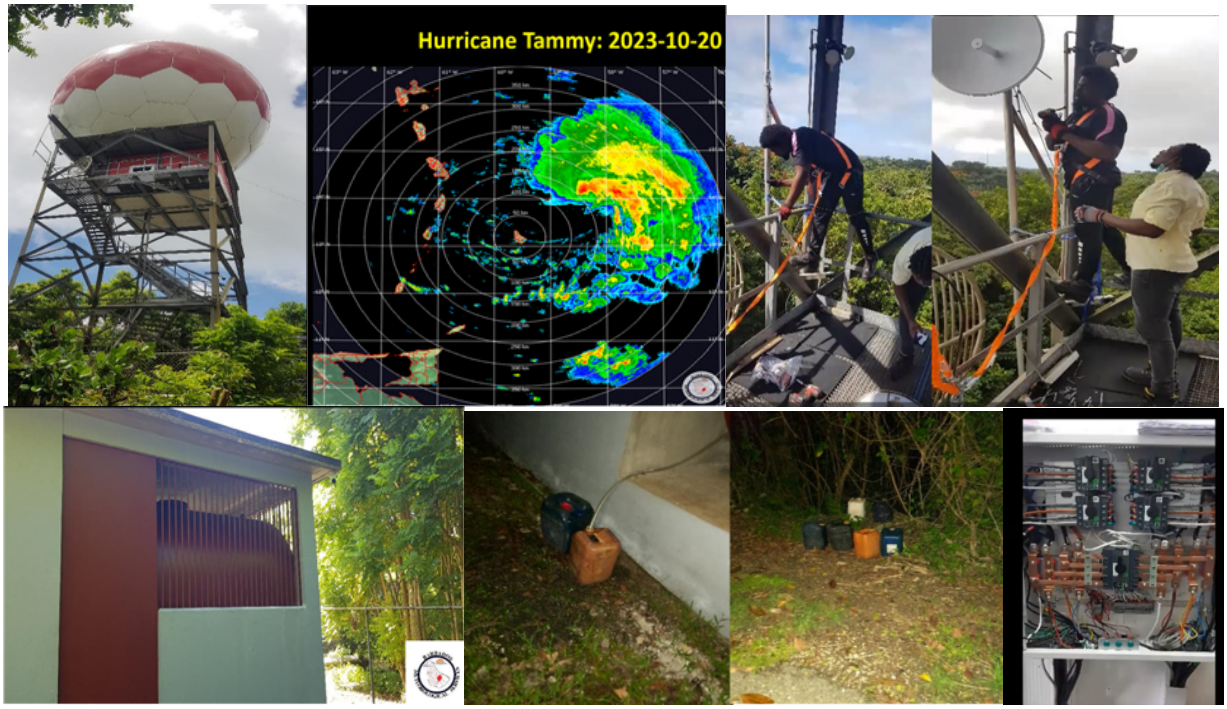

Figure 4. Barbados weather radar infrastructure and sample image of Hurricane Tammy (2023)

Belize Radar

8. The National Meteorological Service of Belize (NMSB) Doppler weather radar continued to be well maintained but the NMSB has faced challenges with sourcing parts. Additionally, radar testing instruments have not been calibrated, and contributes to errors when calibrating the radar. Recently the NMSB signal generator became faulty and needs replacement. The archiving of the raw radar continues to be performed manually. During 2023, the NMSB radar came under direct threat from a proposal to relocate the weather radar to accommodate an S-band airport Primary Surveillance Radar (PSR) or replace it with the PSR due to gross misunderstanding of the two types of radars. This led to the NMSB engaging the CMO Headquarters to intervene on its behalf. The CMO Headquarters provided an extensive technical report in response, including optimal options for reducing the impacts on the weather radar operations, to the parent Ministry of NMSB. Subsequently, three meetings were held between the NMSB, CMO Headquarters, Belize Department of Civil Aviation, and Central American Cooperation for Air Navigation Services (COCESNA-Belize). Presently, an S-band primary surveillance radar (PSR) is being installed at the headquarters of COCESNA-Belize, which is about 300m away from the Doppler weather radar. When operational, the PSR will be set to the lower end of the S-band and have radio frequency transmission signal blanking enabled when the PSR is pointing towards the NMSB Doppler weather radar, which transmits at 2860 MHz nominally.

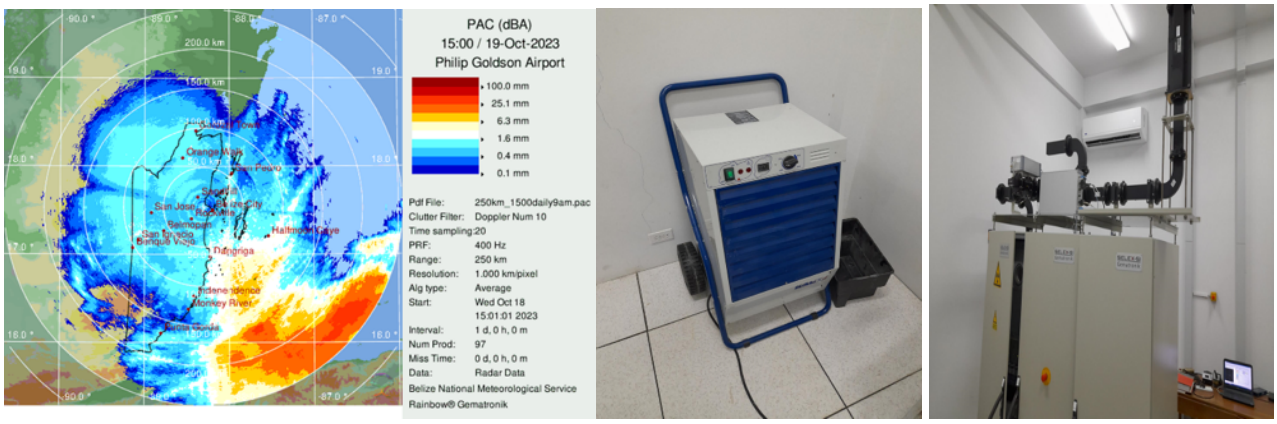

Figure 5. Belize radar components and a sample image of estimated accumulated precipitation

Cayman Islands Radar

9. The Cayman Islands National Weather Service (CINWS) radar is experiencing a recently-started outage due to a faulty slip ring and brush block. Efforts are being made to procure the parts and arrange for a Leonardo expert to visit and fix the problem. However, the CINWS does not have an active service contract with the company. This could lead to a slow response. Earlier in the year the CINWS was faced with a request by the Civil Aviation Authority (CIAA) to deploy its L-Band aircraft surveillance radar at the same geographical location as the CINWS Dual Polarization S-band Doppler Weather Radar that required the intervention of the CMO Headquarters.

Guyana Radar

10. Guyana Hydro-meteorological Service (GHMS) did not encounter any major radar hardware issues. The most repeated issues occurred with the software, including the software going offline, while the radar continued to function. With regard to the hardware, radar parts were repaired whenever there was a major issue. There was an recurrent ACU error mostly on the El Servo drive resolver. The Safety PLC was replaced in August and the radar has been working fine since.

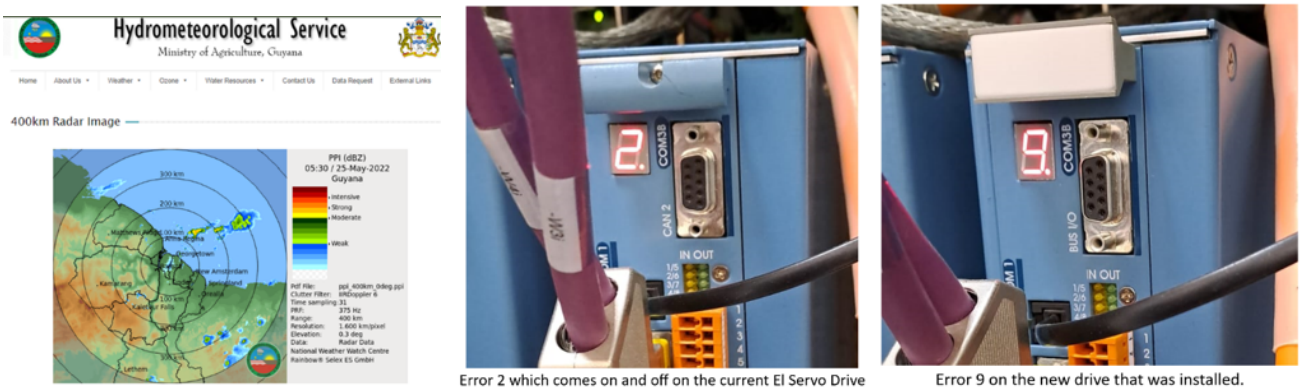

Figure 6. Guyana radar image and faulty drive resolvers

Jamaica Radar

11. The Meteorological Service of Jamaica (MSJ) continued to experience weather radar outage as the plans of the radar manufacturer to restore the radar to an operational state by December 2022 did not materialize. The period was fraught with considerable delays, even though the MSJ received weekly updates on related matters from the manufacturer. Among the positives was the fact that MSJ procured the radar under an extended warranty. Therefore, the costs associated with the repairs are

being borne by the manufacturer. To date, all the replacement parts have arrived in Jamaica, with only the antenna to be cleared from customs. Once installation commences, it is expected to last for approximately four weeks, but installation may not start before December 2023. The resumption of radar operations is therefore not expected before January 2024.

Figure 7. Jamaica's radar radome and tower.

Saint Lucia radar

12. The Saint Lucia Meteorological Services (SLMS) has an ELDES X-Band Radar System, which was provided and installed by ELDES, an Italian company. The radar is a Doppler radar with dual polarization and a range of 120 km. The radar was handed over to the Meteorological Services in November 2021. However, in February 2022, there was a mishap, and a complete radar outage until June 2023, when the company rectified the problem. Currently, the radar is operational (see Figure 7), but the Meteorological Service is experiencing setbacks since the training on the radar was provided during the COVID-19 period, and most of the forecasters did not attend the training. As a result, there is no dedicated operational staff or fully trained technicians for the maintenance of the radar. The initial training provided was on basic maintenance over a two-week period. The SLMS is challenged with providing access to the radar data to the public, which is constrained by resources, but work is in progress to have the radar data integrated into the regional composite, facilitated by Saint Lucia's participation in the CMO Operational Radar Group.

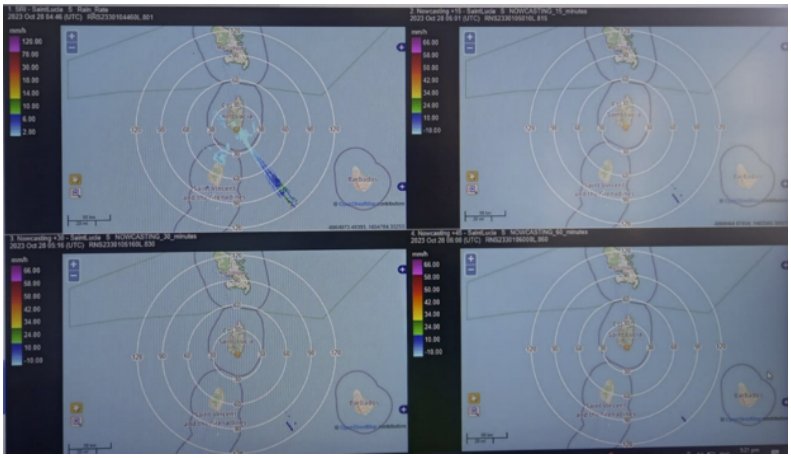

Figure 8. Saint Lucia weather radar console

St Maarten Radar

13. The Meteorological Department of Sint Maarten (MDS) has a newly installed Vaisala-made dual-polarization, C-Band Doppler weather radar system with a scan range of 400km. During installation, some cyber-security issues were encountered, including hacking that required the installation of a firewall. The radar images are available at the MDS operational office and on the MDS website. The intention is to share the raw data with Météo-France Martinique, regionally and internationally using BUFR. A backup generator and a webserver have also been installed. During the

ongoing testing, the MDS also experienced issues with intermittent interference, possibly due to a newly installed microwave link.

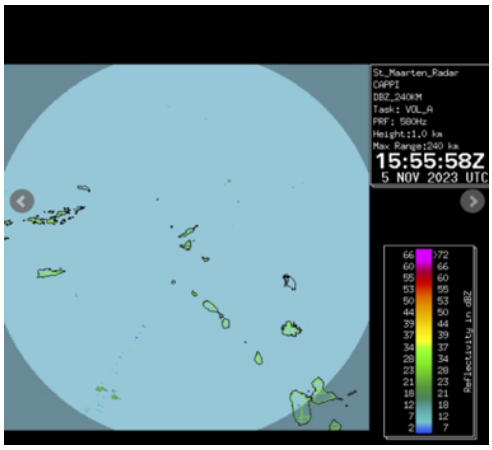

Figure 9. Sint Maarten weather radar screen image

Météo-France Martinique radar

14. Météo-France Martinique installed a new Selex/Leonardo S-band dual polarization radar with a 400-km scan between mid-April and early May 2023. Following this, there was a qualification period from May to October before data became available on Météo-France's Martinique's website on 19 October 2023.

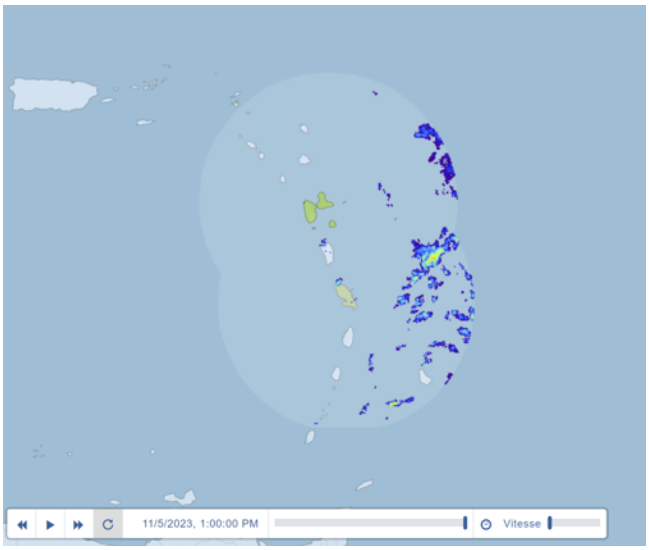

Figure 10. Martinique & Guadeloupe weather radar mosaic

(c) Caribbean Weather Radar Mosaic and other Regional and International Obligations

15. The Council is reminded that the Barbados Meteorological Service continues to make great effort in creating the Caribbean radar composite maps of base reflectivity every 15 minutes, currently from nine (9) regional radars, and now provides mosaic products for rainfall rates and accumulations derived from these radars. This is made possible through regional and international data exchange of national radar data outside of Members countries through the WMO Global Telecommunications System.

16. The radar composite is of high quality and is needed in the regional and international exchange of radar data and also locally in geographically complex terrains. In this regard, the smaller

meteorological radar locally installed in Saint Lucia and Tobago could supplement the information on the lower layers of the atmosphere that remain invisible for the large 400-km radars. Further, these radars higher temporal and spatial resolution can contribute to a more detailed characterization of rainfall systems and severe weather phenomena. Efforts should be made to integrate these radars into the regional radar composite.

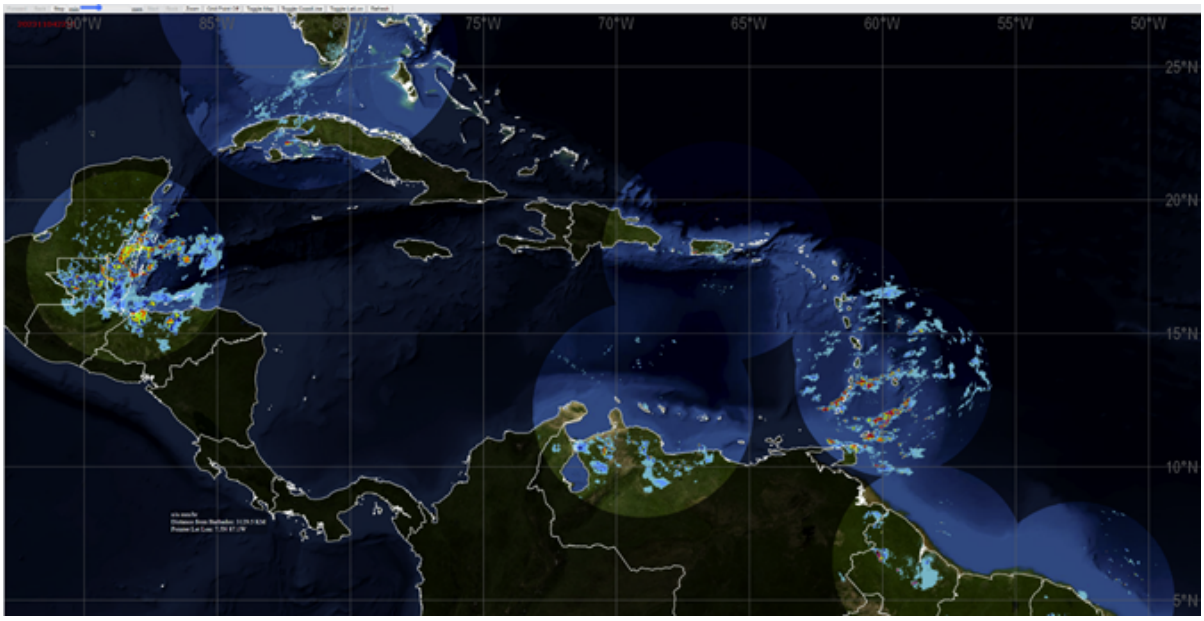

Figure 11. Caribbean Radar Composite provided by the Barbados Meteorological Service

17. The CMO Headquarters led the coordination on the development of a Multi-sensor Precipitation Grid dataset comprised of data from the Barbados radar, rain gauges from multiple islands, and satellite-estimated precipitation. The project was implemented by the World Bank, through a contract with the Centro Internazionale in Monitoraggio Ambientale (CIMA) Foundation. The project was completed in December 2022 and the grid is easily accessed via a website hosted by CIMH (https://mspg.cimh.edu.bb/#/home, Figure 10). The resulting dataset is a valuable regional resource for early warning systems, risk analysis for flooding, water resource management, and climate monitoring.

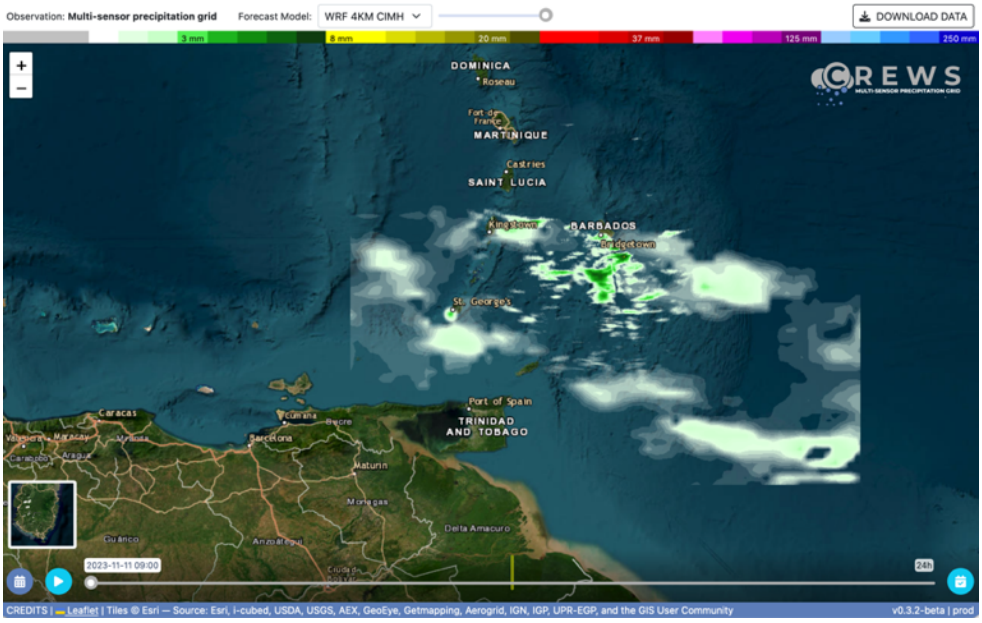

Figure 12. Sample data from Multi-Sensor Precipitation Grid centred on Barbados radar ()

18. Council is reminded that the CMO Weather Radar Network also has considerable potential for climate risk analysis and other scientific applications. Approaches for better utilizing of Caribbean radars and archived data, including setting up easy access to the full data archives; more usage would increase benefit to the region. With climate change, the Caribbean is expected to experience high variability in precipitation and radar information will offer guidance on the "new normal" for setting infrastructure standards and other necessary adaptation.

(d) Maintaining WIGOS Weather Radar Metadata

19. At CMC63, the Council was made aware of a WMO recommendation for Members operating weather radar systems to nominate a National Focal Point (NFP) for weather radar metadata and to keep their weather radar metadata up to date. **The WMO Radar Database (WRD)**, which is currently maintained and operated on behalf of WMO by the Turkish State Meteorological Service, is the recommended portal through which Members should submit their weather radar metadata. The following table provides radar metadata extracted from the WRD and NFPs taken from the **Weather Radar Metadata**. Gaps or errors found in the required metadata are highlighted in the table. Members are encouraged to address these gaps, where required.

Table 1.0 Radar Metadata Extracted from WMO Radar Database

Code	Name	Country	Band	Tx Type	Rx Type (Anologue or Digital)	Pol. (Single or Dual)	Radar Data Exchange Format	Continent	Ins. Year
0-21010-0-565	Barbados	Barbados	S		D	S		North America	2013
0-21010-0-566	Belize	Belize	S	Magnetron	D	S		North America	2019
0-20010-0-78385	Grand Cayman	Cayman Islands	S	Magnetron	D	D	BUFR	North America	2012
0-21010-0-568	Guyana	Guyana	S		D	S		South America	2013
0-21010-0-567	Kingston	Jamaica	S		D	S		North America	2013
0-21010-0-177	Brasso 90cas	Trinidad and Tobago	C	Magnetron	A	S		South America	2008
Saint Lucia	**No matching records found**								
Tobago	**No matching records found**								
0-21010-0-602	Juliana Airport, St. Maarten	Sint Maarten	S		D	S		North America	2013

(e) CMO Operational Radar Group (CORG)

20. The Council is reminded that the CMO Operational Radar Group (CORG) is tasked with, *inter alia*, the responsibility to provide advice and recommendations to the CMO and Directors of Meteorology on methods to improve the use of the radars and to serve as a clearinghouse for operational weather radar data information to assist Members with radar management, preventative maintenance and other maintenance issues.

21. Council is informed that since CMC63 the CORG has met five times during which it operated as a community of practice by:

- Sharing radar status reports, common operational radar problems, challenges, concerns, solutions, and lessons learned;
- Documenting radar data archiving, scan schedules, maintenance, and troubleshooting best practices; and
- Capturing knowledge learned practically from actually solving radar problems not found in the manuals and creating new knowledge with the common goal of optimizing, advancing and sustaining the radar network.

22. Sharing knowledge, best practices, and lessons learned of radar maintenance and operation from Members across the radar network directly connects to capacity building in radar operations and maintenance techniques in each country and will enhance severe weather monitoring and efficient early warning.

CORG Initiatives

I. **Slack channel-based workspace**: During the period, the CORG established a Slack channel-based workspace as a centralized online repository for communication, knowledge sharing, and exchange platform to make information easily discoverable and build a knowledge-sharing and collaborative-culture among the operational radar members. The Slack workspace currently has channels that host presentations, videos, meeting minutes, lessons learned, and best practice methods. Some of the channels with content are:

- Best practices for radar data archiving
- Best practices for radar monitoring and calibration
- Best practices for retrieving radar data
- Best practices for radar upgrade
- CORG members radar metadata
- CORG meeting minutes

II. **Exposure to Various Tools for Operational Radar Monitoring:** The CORG Secretariat arranged for Members to receive a presentation from Leonardo Germany on various tools for operational radar monitoring at the 4th CORG. This presentation focused on calibration, network monitoring, and metric monitoring and their importance to the radar system. Members were exposed to the following:

- *RAVIS-Radar Visualization Control Software,* which is used to maintain radar calibration information and perform guided calibrations using built-in equipment
- *SNIP-data extraction and inter-comparison***,** which is used for monitoring the inter-comparison between radar output and the data quality of a radar system.

III. **Conference Abstract Accepted:** The CORG submitted an abstract entitled "*CMO Operational Radar Group: A Model for Capacity Development in Radar Operations and Coordination, Supporting Early Warnings for All*" to the American Meteorological Society (AMS). This abstract has been accepted for presentation in the AMS 40th Conference on Environmental Information Processing Technologies, to be held as part of the 104th AMS Annual Meeting, January 28 to February 1, 2024, in Baltimore, Maryland, USA.

Challenges and Threats to Radar Operations

23. The CORG noted that most of the CMO radars have fallen behind in terms of current operational Doppler radar capability and were encountering operational challenges. In keeping with its mandate and responsibilities, the CORG is referring key radar-related matters and challenges to the Council. The CORG also noted that radar challenges, threats, and needs were similar across radar operators, which may be best served by taking a regional approach to solutions.

24. The CORG had extensive discussion on cyber and physical security phenomena as real threats that can have long-term effects on weather radar data availability. Cyber and physical site breaches and vandalism have safety consequences and can cause considerable financial losses and reputational damage to a NMHS, especially if the radar system becomes compromised during a high-impact weather event.

Biggest Operational Challenges

25. The main operational problems experienced by Members came from issues external to the actual radar unit, including problems with electricity supply, telecommunications reliability, availability of spare parts, approved maintenance schedules, radar security, radar site protection, and access to international radar expertise. Among radar-related problems, the dehydrator, transmitter, and pedestal electronics take the lead. The longest periods of radar unavailability come from waiting for spare parts.

26. The CORG is advising that to maximize the CMO Weather Radar network reliability, sustain the radars' life-cycle support, reduce overall operational costs and reduce radar outage, a mixture of contingency and strategic risk reduction activities must be undertaken across the network. The CORG thus provides the following recommendations to the Council.

27. **CORG Recommendations to Council**

1. **Improve management and sustainability of CMO weather radar systems.**

   a) Explicitly budget annually for radar maintenance, operational monitoring, and infrastructure.

   b) Improve the management of operational radar systems by upgrading existing radars to dual-polarization technology to improve radar data quality and radar capability.

   c) Strengthen the availability of spare parts, improve maintenance schedules to include manufacturer requirements, develop and implement methodologies across the region to enhance current maintenance schedules.

   d) Encourage Members to invest in standard radar calibration instruments for maintenance.

   e) Members make all efforts to minimize the frequency of radar outages as much as possible and, where possible reduce outage periods when they occur.

   f) Install solar-powered systems with battery back-up systems to overcome challenges posed by an unreliable electricity grid or electricity fluctuations and keep radars continuously operational.

2. **Enhance radar data transmission, collection and archiving**

   g) Enhance radar data collection, archiving, and sharing on appropriate servers that enable data query and retrieval.

h) Develop data-archiving and data-sharing policies to support establishment of free and unrestricted exchange of radar data and products at the regional level among teaching and training institutions and operational radar countries in the Caribbean.

i) Encourage all Members participating in the CMO Weather Radar Network to freely share core products, necessary for safeguarding life and property.

j) Encourage the BMS to include a velocity product on the mosaic to track wind features to assist in making efficient decisions during operations.

3. Enhance Radar Cybersecurity and Site Security

k) Strengthen operational radar ICT assets and infrastructure to reduce outages and ensure protection against cyber-security attacks, along with the radar unit site security as key priorities.

l) Install CCTV coverage with video analytics to provide automated detection of a potential intruder or other breaches for 360-degree perimeter protection at radar sites and include these as operational cost line items in budget estimates.

4. Insure Radars against Damage.

m) Explore the feasibility of insuring the radars to protect the Members from financial loss, and to reduce and manage losses, and damages, and radar outage duration.

(f) CMO Weather Radar Network Risk Management & Path Forward

Radar Network Risk Management

28. Members with operational radars continue to invest in improving their radar systems, but challenges remain and may grow in some instances and thus pose risks. Underfunding, prolonged wait-time for spare parts, deficient maintenance schedules, and limited human resources were identified as core and recurrent risks.

29. Even though some Members with radars have well-maintained radars, the radar technology may be dated in terms of current standards for operational forecasting. Additionally, some radar hosts have limited trained radar specialists and inadequate data management for archiving and retrieval. Additionally, each of the radar system components is vulnerable to a variety of threats, which can be exploited by attackers, such as cyberattacks, radar facility breaches and vandalism.

30. There is also risk that commitment to radar operations at the national level may weaken, especially with regard to the relevant parent Ministry's commitment. This could lead to underfunded radar operations and maintenance. Every effort must be taken to reduce this risk.

31. Some identified risks are preventable, such as those that arise from the radar operators. Examples of preventable risks include: not implementing the radar manufacturer recommended maintenance and calibration schedules, or not providing staff with up-to-date radar calibration equipment or not acting on a recommendation by the manufacturer to change a part within a specific period. Such risks should be eliminated by Directors.

Path Forward: Upgrading Radars to Dual Polarization

32. Through the decades, CMO Headquarters has implemented radar projects for the region and worked to extend the operational life of the radar network, through upgrading or installing new radar systems, to satisfy national and regional needs. This follows the example of other radar systems,

such as the US WSR-88D radars, which were first deployed in 1988 and have undergone various upgrade cycles over the past decades.

33. CMO has been collaborating with the Caribbean Development Bank (CDB) on a project to upgrade the CMO Doppler Weather radars in Belize, Guyana, and Trinidad. The project, aimed at strengthening hydro-meteorological and early warning services in the Caribbean, is being advanced under a new *Scaling Up Framework* between the ***Green Climate Fund* (GCF) *Simplified Approval Process* (SAP)** and the ***Climate Risk and Early Warning Systems* (CREWS)** initiative. The CDB is the Accredited Entity of the GCF for this project, having worked closely with CMO Headquarters for some time to develop a proposal and to identify resources to support the radar upgrade**.** Further information on the radar upgrade project will be provided under Agenda Item 11.

34. Based on the success of the CREWS Caribbean project (2017-2022), CREWS has chosen to scale up action for the benefit of all countries covered by the radars in Belize, Guyana, and Trinidad and Tobago, for the Regional Hurricane Warning System, and the Severe Weather Forecasting Programme Eastern Caribbean. As a regional partner of the CREWS Caribbean Project, CMO Headquarters successfully implemented several projects that strengthened hydro-meteorological services and early warning systems in CMO Member States, thereby becoming well-placed to obtain **fast track access to scaled up support for early warnings.**

35. Council is reminded that radars can operate for 15 or more years and cost estimates indicate that the ongoing life-cycle costs of the radar and the radar programme exceeds the initial capital costs. Therefore, the CMO has been seeking resources to support not only the initial cost of the radar network upgrade but to also plan for funding ongoing maintenance and development over the expected lifetime of the radars, in line with the WMO Guide to Operational Weather Radar Best Practices (2023)**.** Capacity building and radar data utilization are also components of the project to address some of the challenges of the current network and significantly advance the region's radar-based now-casting, severe weather forecasts, watches, and warnings capabilities.

36. Council is reminded that country ownership is a fundamental principle of the GCF, so CMO Headquarters and the CDB have engaged with the National Designated Authorities (NDAs) about the *Scaling up Framework* and the project under development, to ensure alignment with country climate policies and standards. Additionally, the project is aligned with CMO Headquarters mission, priorities, and strategic goals. Its Strategic Plan (2020-2023) speaks specifically to developing more projects with regional and international partners, supporting the strengthening and maintenance of observation networks, and enhancing disaster preparedness for extreme hydro-meteorological events and severe weather.

37. The CMO Weather Radar Network has a robust foundation of collaboration and cooperation as evident by Members support for the CMO Radar and Rawinsonde Network Fund and continuing at the technical level with the CMO Operational Radar Group. These existing mechanisms lend support for sustained operations and cooperation when the project is fully implemented.

Action Proposed to Council

38. The Council is invited to:

(i) **Note** the status, challenges, and risks faced by weather radars in CMO Member States.

(ii) **Urge** CMO Members with radars to **commit** to sustainable funding and budgetary allocations for radar preventative and corrective radar maintenance programmes, and human resource capacity.

(iii) **Support** the CMO Headquarters in advancing a project to upgrade the radars in Belize, Guyana, and Trinidad and Tobago to dual polarization status, through the Green Climate Fund-CREWS Scaling-up Framework, in collaboration with the Caribbean Development Bank.

(iv) **Note** the progress and initiatives of the CMO Operational Radar Group (CORG), including **actions** to deepen the technical and operational cooperation on radar operations across the Caribbean.

(v) **Further note**, and **urge** Members with radars to **act on** the recommendations of the CORG to improve management of radars; data transmission, archiving and retrieval; sharing of core radar products for public safety; and secure the digital assets and the physical radar site.

(vi) **Request** the re-establishment of Memoranda of Understanding for the Weather Radar Network Warning System in the Caribbean Region with the Members operating radars and the CMO Headquarters, to ensure sustainability of the network.

(vii) **Encourage** CMO Members operating radars on the network to adopt and implement policies and practices to safeguard further deterioration and reduce radar outages, in line with the WMO guidance, including seeking to insure their radars against damage as a protective mechanism.

CMO Headquarters

November 2023