CARIBBEAN METEOROLOGICAL ORGANIZATION

CARIBBEAN METEOROLOGICAL COUNCIL **Doc.10, Rev 1**
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CMO WEATHER RADAR NETWORK
(Submitted by the Coordinating Director)

Introduction

1. The Caribbean experiences tropical cyclones and other convective systems that bring torrential rainfall from the Tropical North Atlantic, such as tropical waves, low-level troughs, the Inter-Tropical Convergence Zone (ITCZ) during the second half of the year (wet and hurricane season). In the dry season, there can be localized heavy downpours, strong winds, and other severe weather associated with cold fronts. significant socio-economic and environmental impacts every year.

2. Doppler weather radars are a cornerstone of the region’s multi-hazard early warning systems and one of the most critical infrastructures for ensuring weather and climate resilience. Radar data underpins day-to-day public weather services, aviation safety, disaster risk management, agriculture, and water resource management.

(a) CMO Weather Radar Network

3. The CMO Weather Radar Network (CWRN) comprises multiple Doppler S-band weather radars in six (6) Member States: Barbados, Belize, Cayman Islands, Guyana, Jamaica, and Trinidad and Tobago. The overlapping coverage among regional radars enables one Member State’s radar to detect hazardous weather affecting neighbouring countries, an essential feature of the region’s collective early-warning capability.

4. For example, the Barbados radar provides early detection for Saint Lucia, St. Vincent and the Grenadines, and Grenada when weather systems move westward from the tropical Atlantic. Likewise, the radar in Trinidad offers coverage for Grenada and Barbados for systems moving northward. When integrated with the radars in Tobago, Saint Lucia, Martinique, Guadeloupe, and Sint Maarten, the resulting Caribbean radar network significantly strengthens the regional multi-hazard early warning systems. Against the foregoing framing, this document examines the status of the Radar Network and raises awareness on emerging radar issues. It also informs on the **CMO Operational Radar Group (CORG)** activities and its recommendations for consideration by the Council.

(b) Performance of Key Entities in the CMO Weather Radar Network

5. During 2025, the CWRN capability was sustained by experts from National Meteorological and Hydrological Services (NMHSs), the CMO Headquarters, and the Caribbean Institute for Meteorology and Hydrology (CIMH), working collaborative through the CORG.

6. The NMHSs, through their annual recurrent budgets, and in some instances, the CMO Radar Network Fund held at the CMO Headquarters, operated and maintained their meteorological radar systems as best as they could. These NMHSs participated in national and regional archiving, managing, and real-time sharing of radar data via national NMHS websites and platforms of WMO, NOAA National Weather Service, the Barbados Meteorological Service (BMS), and Meteo-France.

7. Council is reminded that the CMO Headquarters has a coordination and leadership role in the development, strategic evolution and interoperability of the CWRN, securing technical support from partners such as WMO, USA, Canada and radar manufacturers. During 2025, the CMO Headquarters provided policy guidance and facilitated integration of weather radar data for the Caribbean composite. CMO Headquarters coordinated with the BMS, the WMO Regional Office, and partners in the Dominican Republic and Brazil in cooperation related to integrating their radars into the Caribbean composite, thus expanding coverage and strengthening regional early warning capacity.

8. The CIMH supports the regional radar network by providing specialized education and training in radar meteorology, data interpretation, and applications such as nowcasting. CIMH also serves as a regional hub for radar data archiving and supports Members through the management of a shared spare-parts pool.

(c) Securing the Caribbean Radar Network Operations as a Regional Public Good

9. Any lapse in the operational integrity, reliability, through reduced performance or downtime in any single radar on the CWRN weakens early warning capacity for multiple Member States, directly increasing risks to lives, livelihoods, and infrastructure.

10. Council is asked to:

(i) **Note** that the CWRN should be treated as a mission-critical asset—that requires consistent investment, skilled technical support, maintenance, and adequate funding for operations.

(ii) **Recognize** that securing and safeguarding the integrity, reliability, and continuity of the CWRN as a regional public good is a strategic imperative for protecting lives, enabling climate adaptation, and ensuring that regional governments can fulfil their national and regional obligations and global initiatives such as the UN Early Warnings for All.

(d) Scheduled Radar Maintenance and Technical Support

11. Maintenance routines across the Caribbean Weather Radar Network vary from daily to weekly to bi-weekly to monthly operational checks and annual servicing by the manufacturer. Where manual checks or physical visits are not possible, the radar system is checked remotely by NMHSs with that capability.

12. Radar systems are managed by a small team responsible for 24-hour operations, monitoring and maintenance. Staff shortages remain a consistent challenge, particularly for technicians trained in radar engineering, electronic and data systems.

13. Some NMHSs reported that a major challenge to maintenance is scarcity of in-country radar and Radio Frequency expertise, insufficiently trained staff to perform specialized radar repairs and calibration and limited staff for efficient maintenance. Dependence on the foreign manufacturers for troubleshooting and parts replacement, leads to long repair times.

14. To address this gap, NMHSs are advised to form partnership with in-country institutions such as The University of the West Indies (UWI), Mona, Cave Hill and St Augustine, the University of Technology (UTech), Jamaica, University of Trinidad and Tobago (UTT), Advanced Solutions Technical Institute (ASTI), and MIC Institute of Technology (MIC-IT), Trinidad and Tobago, and the University of Guyana to integrate radio frequency modules designed to enhance local expertise, promote knowledge exchange, and reduce dependence on external contractors.

15. NMHSs also indicated inadequate recurrent budget allocations for radar maintenance, and the lack of readily available spare parts. A number of NMHSs maintain formal service agreements with radar manufacturers, which enables capacity-building when technicians visit and shared maintenance services; however, these are costly and limited by funding availability.

(e) Radar Data Transmission and Storage

16. The majority of radar stations on the CMO weather radar network use internet connectivity for radar data transmission between the radar system and the forecasting system. However, the stability and bandwidth of some of these communication links vary widely, with remote radar sites being particularly vulnerable to outages during severe weather.

17. Challenges reported include unreliable or low-bandwidth connectivity, data corruption or transmission delays during heavy rainfall, insufficient redundancy, and limited built in redundancy that increases the risk of prolonged outages. These issues are compounded by external factors such as reliance on third-party internet providers, outstanding invoice issues, to service providers that lead to denial of services, inadequate firewall configurations, and the absence of backup systems.

18. The remoteness of certain sites increases their exposure to communication failures caused by damage to power-lines—such as fallen trees during severe weather events. To strengthen network resilience, fiber-optic connectivity should be deployed, where feasible, restoring radio link capabilities as backup, implementing redundant network configurations, and integrating radar data transmission with the *WMO Information System* (WIS) 2.0 regional node managed by the CMO.

19. At most of the NMHSs radar data are typically archived on shared on premises servers, but not all the NMHSs have adequate digital storage or backup systems to retain high-resolution datasets. As a result, valuable data for at times impactful events are sometimes lost or overwritten after short periods.

20. CMO Members also archive radar data on the CIMH managed data repository, which offers built-in redundancy, and long-term data retention without the need for significant local hardware investment. This existing approach would be strengthened by developing a regional radar data archiving and accessibility policy coordinated by the CMO Headquarters.

21. CMO Headquarters, with technical assistance from the WMO, is exploring a **common regional radar data format** that complies with the WMO radar data structure. This initiative aims to enhance the usability and accessibility of radar data. By standardizing radar data outputs, the region will benefit from improved interoperability, more efficient data sharing, and easier integration across forecasting platforms.

(f) Data Processing and Quality Control

22. Post-processing transforms raw radar measurements into clean, corrected, and operationally useful datasets and products by applying quality-control procedures to remove noise, ground clutter, and other interference. Without effective post-processing of radar data, radar images and visualizations can become noisy, misleading, or difficult to interpret, limiting their operational usefulness (Figure 1.)

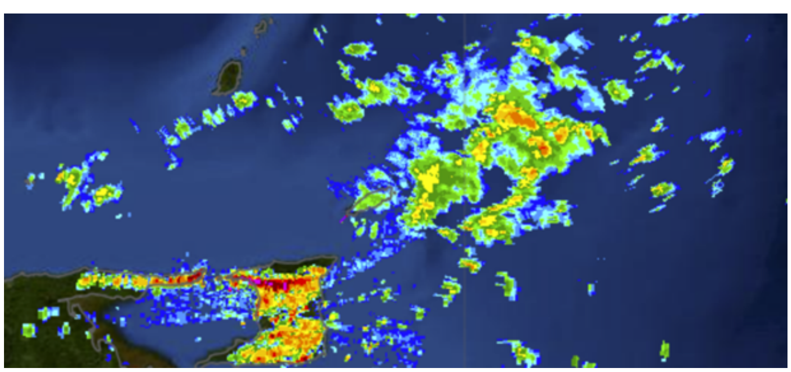


Figure 1. Demonstrates false echoes or clutter, such as ground returns, buildings, or birds, obscuring actual weather targets over Trinidad on 15 November 2025.

23. Few Members of the CWRN currently engage in systematic post-processing of radar data, mainly due to limited technical capacity and software constraints. One solution is a standardized, regionally-supported post-processing framework coordinated through the CMO Operational Radar Group (CORG).

(g) Spare Parts Management

24. Four of the CMO six radars have been in operation for more than 10 years. In some cases, parts for these legacy models are no longer manufactured, which leads to delays in corrective maintenance and leaving radars inoperative during critical periods of the hurricane season. Some NMHSs have adopted innovative stopgap measures, such as using components from decommissioned radars or fabricating replacement parts locally. However, these solutions are not sustainable.

25. Radar failure due to lack of access to spare parts in a timely manner will continue to hinder early warning priorities in the region unless there is a strategy to reduce periods of unavailable spare parts.

26. To ensure long-term operational reliability of the radars, Council is invited to:

(i) **Consider** conducting a reconciliation of the existing regional radar spare parts pool coordinated by the CIMH;

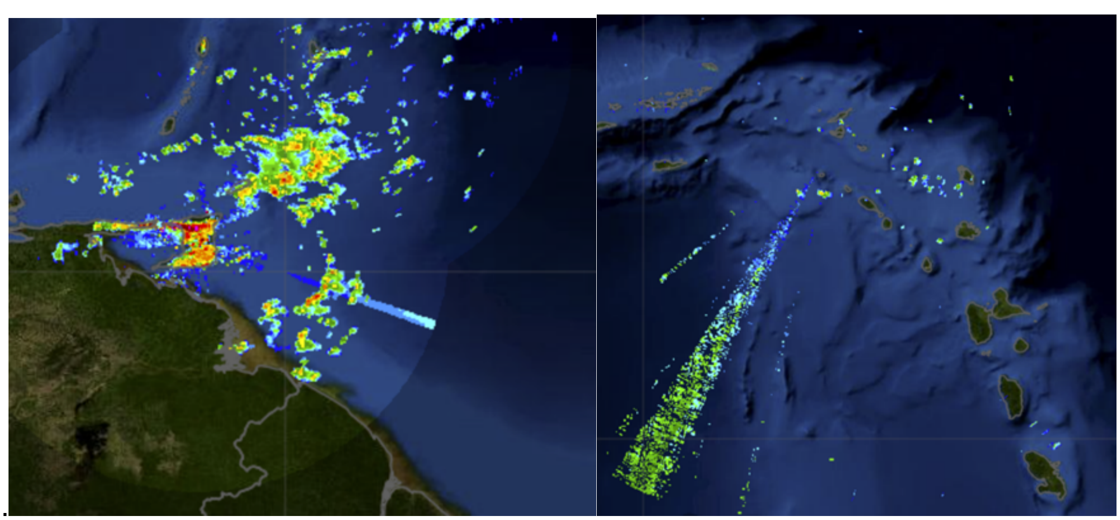
(ii) **Recalibrate** the existing pool into a new regional spare parts pool underpinned by a regional arrangement and policy for procurement and access to spare parts in the pool.

(iii) **Establishing** a refreshed policy and mechanisms for sharing radar data on the pool with the NMHSs, coordinated through the CMO Headquarters;

(iv) **Consider** seeking alternative small-scale donor funding to negotiate group procurement of spare parts to populate the pool, reduce costs and shorten delivery times.

(h) Radio Frequency Interference

27. The issue of radio frequency interference to meteorological radars remains top priority for the meteorological community local, regionally and globally. Radio frequency (RF) interference continues to be a significant challenge for NMHSs on the CWRN in 2025 (Figure 2) for various reasons, including spectrum allocation management, where weather radars frequency bands are increasingly being crowded with commercial, governmental, and personal communication systems; new wireless technologies; mobile telecommunications networks; satellite communications and Wi-Fi.



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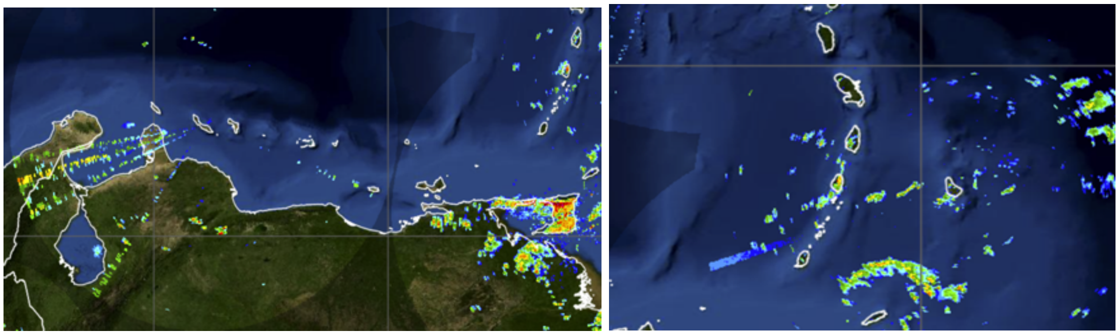

Figure 2. Radio frequency interference on radar detection of meteorological echoes for Barbados, Trinidad and Tobago, Sint Maarten and Curacao on 15 November 2025

28. Given the size of the islands, the radar systems are in relatively close proximity to densely populated coastal areas and reflective surfaces like mountains or buildings, which can exacerbate Radio Frequency (RF) signal scattering, thus reducing radar accuracy. Also, limited local knowledge of the meteorological community RF needs and limited local capacity for RF monitoring and coordination also makes it difficult to detect, resolve, or mitigate sources of interference quickly. Additionally, radio signals transmitted from one island can easily spill over into the airspace of neighbouring island.

29. In light of the increasing risks of RF to accurate and efficient operational weather radar systems, the Council is asked to:

(i) **Urge** establishing mandatory national protocols for NMHSs across the Caribbean to work proactively and continuously with their national Spectrum Management Authorities to safeguard radar frequency bands, improve monitoring, and address interference sources swiftly.

(ii) **Further urge** NMHSs to strengthen collaboration through joint monitoring, shared protocols, and regular technical engagement, ensuring the accuracy, reliability, and uninterrupted availability of radar data that protect lives, livelihoods, and national resilience across the region.

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

(a) Jamaica

30. The 67th Council was informed that Jamaica's new radar, installed under the *Pilot Program for Climate Resilience* (PPCR) project in 2021, which had experienced major mechanical defects in March 2022, continued to have extensive delays and repeated setbacks from the contracted radar company. As such the Jamaica's Doppler radar had remained non-operational since March 2022.

31. The Council is now informed that by accessing a portion of the CMO Radar Network Fund held at the CMO Headquarters, a structured restoration of Jamaica's radar system began in April 2025. The work proceeded in four phases—removal of the damaged antenna, installation of a structurally sound dish, and comprehensive repairs to the servo system, cabling, and waveguides—culminating in the **radar returning to full functionally on 23 June 2025**, which was followed by rigorous testing. The CMO Headquarters was pleased to have supported the successful repairs, in time for the hurricane season. The radar was a vital tool for monitoring and forecasting of Hurricane Melissa. Work is ongoing to establish data transmission connection to the Barbados Meteorological Service for integration into the regional radar mosaic.

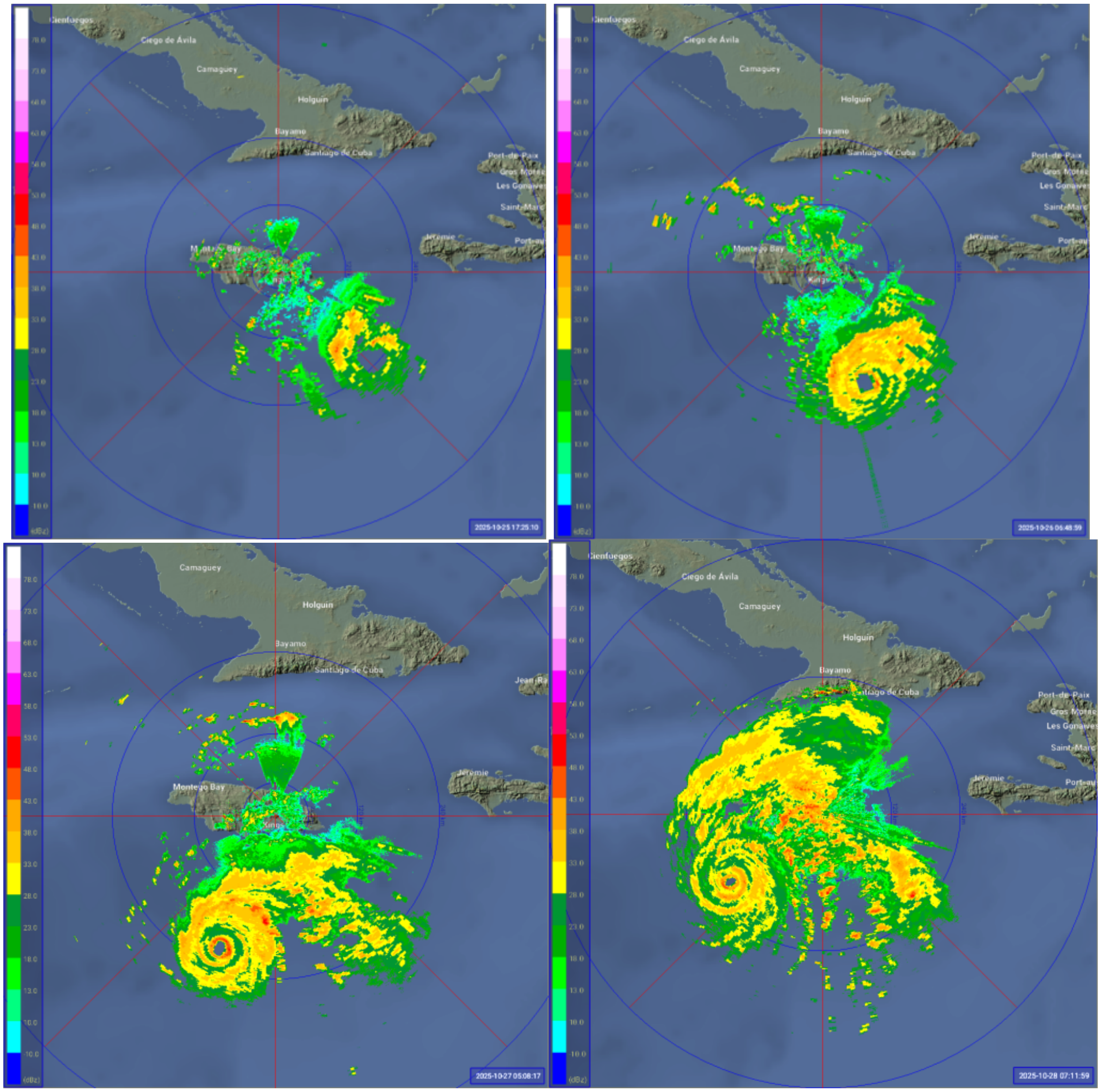

Figure 3. Jamaica weather radar reflectivity, Hurricane Melissa**.**

32. During testing, final commissioning was delayed due to an observed elevation drop as a result of displaced counterbalance weights, which required further assessment by the manufacturer. The observed elevation drop observed at the Jamaica weather radar was due to the failure in the public electrical supply, which caused the antenna elevation to fall below –2 degrees, thus activating an automatic system shutdown designed to protect the radar. Once this was clarified by the manufacturer, the local radar technicians cleared the errors, re-established antenna control, and restored normal operations. This latter event highlighted the importance of **understanding the radar's built-in safety systems**. Jamaica has since taken steps to strengthen internal troubleshooting capacity to ensure continued reliable operation.

33. Jamaica reported during the 12th CORG meeting that one of the key lessons to be learned from the process was the **risks associated with relying primarily on lowest-cost tendering** during procurement, where lower price **may not always align with long-term operational reliability or aftersales support required for critical infrastructure** such as weather radars.

34. Another key lesson identified was the critical importance of the CORG community of practice as a regional mechanism for sharing expertise, identifying reputable service providers, and accessing financial and technical support. Jamaica emphasized that these collective capabilities were instrumental in reviving the radar and will guide future procurement, maintenance, and operational decisions. The Jamaica Doppler

Radar webpage was fully restored and reintegrated into the organization's website, enabling both public users and internal clients to regain access to near-real-time radar products. Additionally, a dedicated workstation was installed at the main office, providing a direct connection to the radar site and improving the ability of key staff to monitor system performance, manage scheduling, and troubleshoot issues as they arose.

35. **During the passage of Hurricane Melissa in late October 2025, the radar performed exceptionally well, delivering continuous, high-quality observations until its eventual failure**. It successfully captured the structure of the storm as it approached Jamaica, clearly tracking the eye and providing essential measurements during the system's most critical operational window.

36. However, as Hurricane Melissa made landfall, the radar experienced a major operational breakdown. Its scheduled scanning modes became inoperable, forcing it into basic surveillance mode and preventing the collection of volumetric data and continuation of Doppler wind analysis. Further compounding the failure, extreme winds forced open the dome access door; in response, built-in safety protocols automatically shut down the radar to protect the system from structural damage.

37. In the weeks following the hurricane, technicians restored radar service, and all major functions briefly returned to normal before a new failure emerged. The 24-volt azimuth power supply malfunctioned, though the faulty component was replaced, allowing the radar to resume operations. Soon afterward, however, the radar began exhibiting antenna positioning problems affecting both azimuth and elevation alignment. As of 28 October 2025, the antenna positioning fault remains under investigation, and full operational capability has not yet been restored.

Trinidad Radar

38. Council will recall that at CMC67 it was reported that the Trinidad & Tobago Doppler S-Band single-polarization radar was successfully restored in June 2024 after nearly four years offline due to major component failures.

39. The Trinidad & Tobago Doppler S-Band radar remains functional but has experienced intermittent offline periods in 2025 due to recurring power, cooling, and system faults. Outages were caused by frequent power surges that triggered UPS bypass mode, while there is a limited cooling system in place due to only one functional air-conditioning unit, which has led to elevated cabinet and magnetron temperatures. Added to this, the diesel generator remains non-functional, reducing backup power capacity.

40. Recurrent Voltage Standing Wave Ratio (VSWR) alerts intermittently take the radar offline, and elevated lubrication warnings and sensor errors persist. Recent maintenance, including switchboard replacement, fan repairs, dehumidifier installation, and improved ventilation, has restored functionality; however, critical actions remain, including full cooling restoration, diesel generator repair, VSWR measurement, and sensor inspections. Remote diagnostics with Leonardo continue for VSWR and lubrication issues.

41. While the radar continues to contribute to regional early warning and weather monitoring, persistent infrastructure and technical vulnerabilities pose risks to operational reliability. Timely completion of outstanding corrective actions is essential to ensure continuous, dependable service for multiple Member States. These vulnerabilities, if unaddressed, threaten regional early warning capabilities, making prompt corrective action vital to safeguard lives, infrastructure, and economic stability across the region.

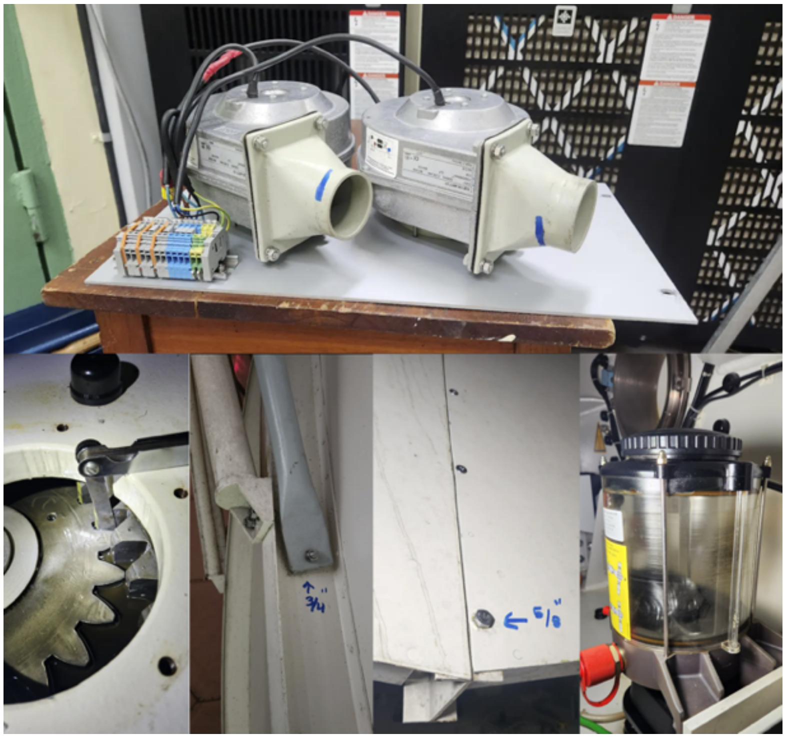

Figure 4. Radar components repaired or changed or substituted during radar repairs in 2025, Trinidad and Tobago.

Barbados Radar

42. In 2025, the Barbados Weather Radar remained fully operational, providing continuous weather monitoring throughout the year. During the year, several minor incidents were addressed promptly to maintain uninterrupted operation. On March 12, a high-pitched noise was detected in a switchboard, and faulty cooling fans were replaced using spares from older units.

43. On March 28, a General Doppler Receiver/Transmitter Exchange (GDRX) warning was corrected remotely without affecting radar performance. A brief period of inaccessibility of radar imagery due to a network firewall issue, was resolved through firewall replacement. Scheduled annual maintenance and calibration resulted in short offline periods from March 10–12, August 18–22, and August 28–29, 2025.

44. To ensure continuous readiness, the Barbados Meteorological Service's technical team performed weekly physical inspections at the radar site, supplemented by remote monitoring when on-site visits were not possible.

45. Bi-annual technical visits by Leonardo specialists, along with the availability of critical spare parts, further minimized potential downtime. Key components, including the modulated power supply, dehydrator, UPS units, and magnetron blowers, were routinely monitored and tested to maintain optimal performance.

46. The radar page (link) now offers enhanced features including animated loops, zoom, selective image display, lightning overlays, USV layers, and adjustable loop speed, while meteorologists continue to access all necessary radar data via the RainDART system.

47. Planned improvements for the upcoming year include upgrades to the radar site servers and the acquisition of additional spare parts to reduce potential downtime further. These measures are critical to maintaining the radar as a dependable regional asset.

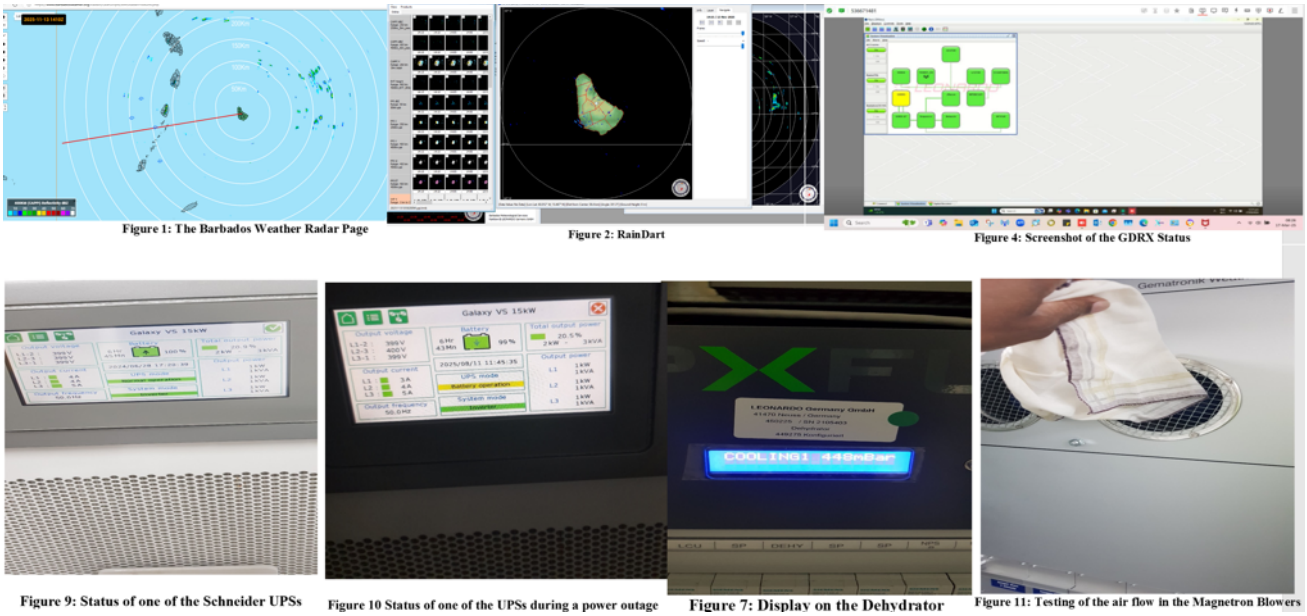

Figure 1: The Barbados Weather Radar Page
Figure 2: RainDart
Figure 4: Screenshot of the GDRX Status
Figure 9: Status of one of the Schneider UPSs
Figure 10 Status of one of the UPSs during a power outage
Figure 7: Display on the Dehydrator
Figure 11: Testing of the air flow in the Magnetron Blowers

Figure 5. Barbados radar GDRX status, Schneider UPSs status during a power outage, testing of the air flow in the Magnetron Blowers, display on the Dehydrator, and RainDart used by forecasters.

(b) Belize Radar

48. Belize faced an urgent operational challenge with its radar system in early October 2025. The weather radar experienced a significant outage due to multiple technical failures, compounded by the imminent retirement of the National Meteorological Service of Belize's (NMSB) sole trained radar technician. The two critical technical failures were a feed horn leak and a Main Power Supply (MPS) voltage fault, which rendered the radar non-operational during the hurricane season.

49. To address these challenges, the CMO Headquarters coordinated closely with Leonardo (the radar manufacturer) and the WMO to secure an urgent on-site visit by a Leonardo engineer/specialist to perform diagnostics, repair and restore the radar's functionality. The specialist had already been scheduled to provide hands-on training for five (5) new local technicians, avoiding delays associated with factory-based instruction. The onsite training, which was conducted from 6–10 October 2025 at the NMSB by a Leonardo engineer with five local technicians participating was meant to strengthen long-term technical capacity, address longstanding gaps in knowledge transfer and ensure greater operational resilience going forward.

50. The first two days focused on diagnosing, repairing, and completing a mechanical inspection of the radar. The remaining three days provided hands-on instruction in routine maintenance, calibration, diagnostics, and use of the manufacturer's maintenance checklists. This intervention successfully restored the radar to operational status and established a foundation of local capacity to sustain operations going forward. As a result, Belize is now better positioned to maintain continuous radar maintenance thus strengthening its operational radar resilience.

51. During the training, several critical maintenance and modernization needs were identified, including replacement of the receiver front-end, software updates, and procurement of essential diagnostic tools such as a signal generator, power meter, and radiation detector.

52. Further, while the radar performs adequately at low sensitivity, its aging components and limited diagnostic functions underscored the urgency of a broader system upgrade.

53. Additional priorities include improving the local technicians understanding and knowledge of the radar's data flow, resolving issues with FTP transmission to the CIMH, and ensuring continued training in radio frequency (RF), mechanical, and electrical engineering for the IT and instruments team.

54. Overall, the training significantly strengthened the technical team’s confidence and competence in operating and maintaining the radar. However, targeted upgrades, enhanced diagnostic tools, and sustained external technical support remain vital to ensure long-term reliability and operational continuity.

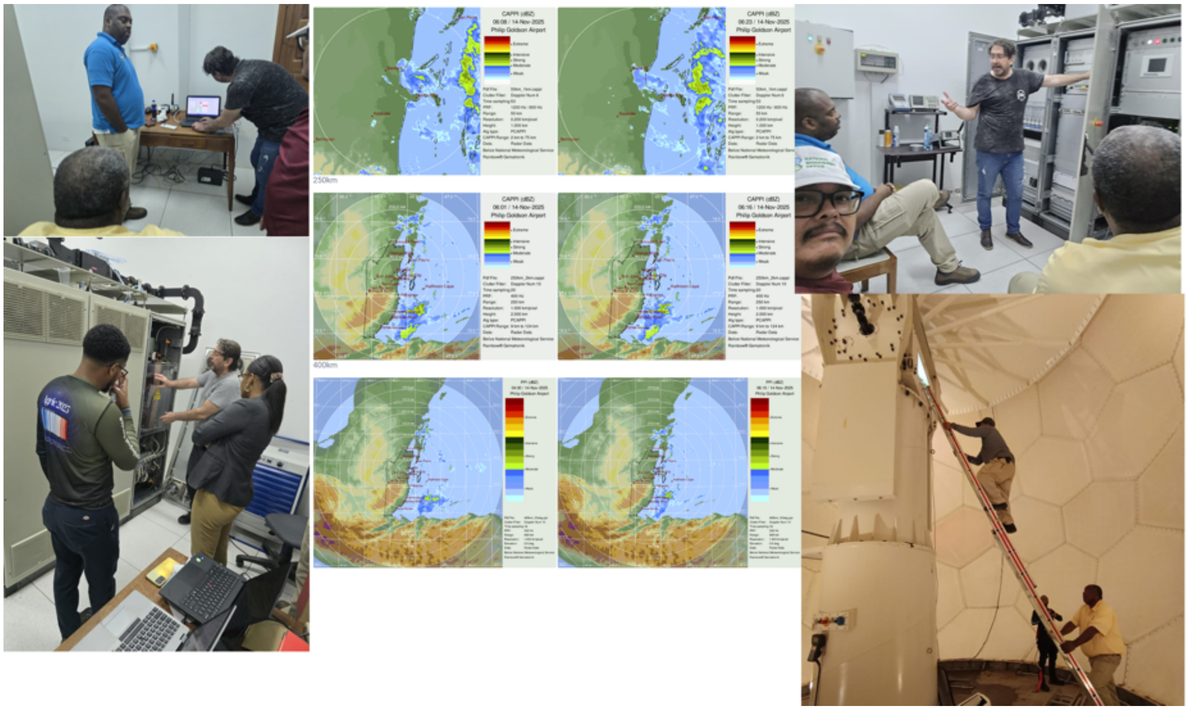

Figure 6. Belize radar diagnostics, repair and training sessions conducted onsite by a Leonardo Technician (facilitated by CMO Headquarters with funding from CREWS).

(c) Cayman Islands Radar

55. During 2025, the Cayman Islands reported stable and uninterrupted operation of their weather radar, with no outages affecting core radar functionality. A few issues were encountered with website and the wider IT network, which temporarily prevented radar products from being disseminated to the public; however, these were resolved without impacting radar data collection. In parallel, remedial work was ongoing at the radar facility, including repainting and minor civil upgrades to improve the building’s overall condition and resilience.

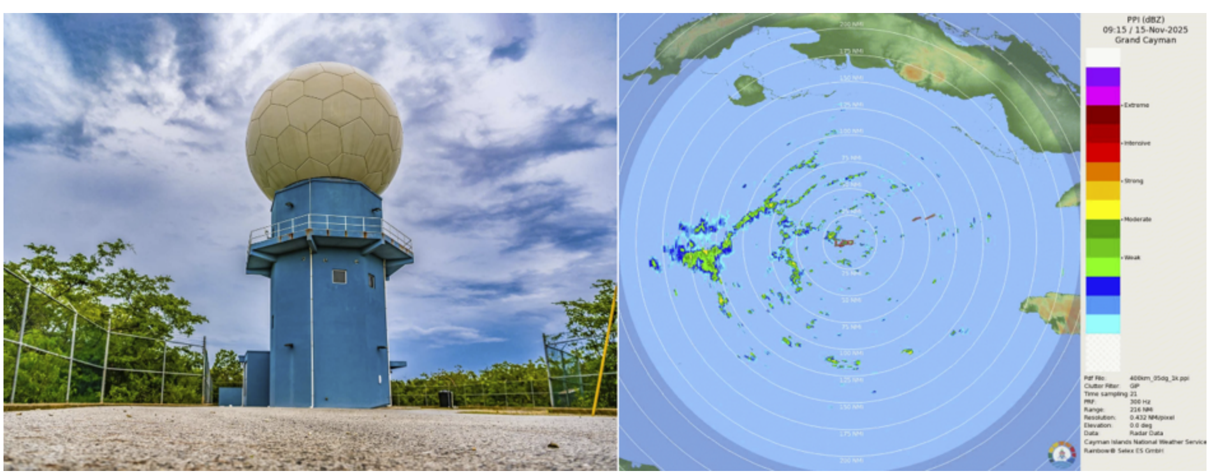

Figure 7. Cayman Islands radar reflectivity and radar accommodation, 2025

56. With the 2025 hurricane season near its end, the Cayman Islands have also commenced a planned radar upgrade in collaboration with Leonardo, marking an important step toward enhancing system

performance, reliability, and long-term sustainability. The upgrade will replace aging components and will incorporate modern technological enhancements to improve detection, data accuracy, and system efficiency and improve overall reliability.

(d) Guyana Radar

57. The Council will recall that at the 67th Session it was reported that, beginning in June 2024, the Guyana Hydro-meteorological Service (GHMS) experienced a significant radar outage due to extensive structural and mechanical damage to the radar system. This interruption severely impacted GHMS's capacity to provide real-time weather monitoring and early-warning services during a critical period of the primary rainy season.

58. The Council is now informed that Guyana's radar was fully restored, recalibrated, and returned to operational functionality on 7 March 2025. During the diagnostic phase, an engineer from Leonardo Germany GmbH conducted a comprehensive on-site assessment, identifying the full extent of the structural and mechanical failures. The engineer's recommendations included a structural assessment of the radar tower and radome housing, as well as a mechanical inspection of the damaged pedestal, struts, and associated moving components. These evaluations were critical for ensuring that the restoration work addressed both immediate failures and underlying vulnerabilities.

59. After an extended restoration effort involving multiple interventions, local structural engineers confirmed that the radar building remained sound and did not contribute to the failure. A mechanical engineer further verified that the primary moving components of the radar system were not compromised. All funding for the restoration, including the procurement of specialized parts and engineering services, was provided by the Government of Guyana.

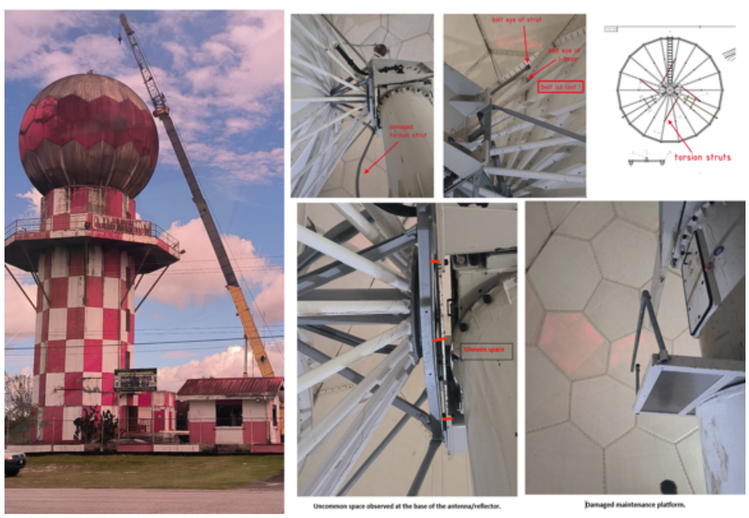

Figure 8. Guyana radar compound and mechanical damage that caused the radar outage

Saint Lucia radar

60. The Saint Lucia Meteorological Service weather radar continue to operate with very limited functionality and requires a comprehensive maintenance check and corrective repairs. Identified priorities include activating the full dual-polarization capability, improving data access for public and partner agencies, and implementing systematic maintenance protocols to ensure long-term operational reliability. Communication with the radar supplier, ELDES, has been ongoing since June 2025. The initially planned maintenance and repair period, scheduled for November 10–14, 2025, was rescheduled, with the next available window for corrective works now set for January 2026.

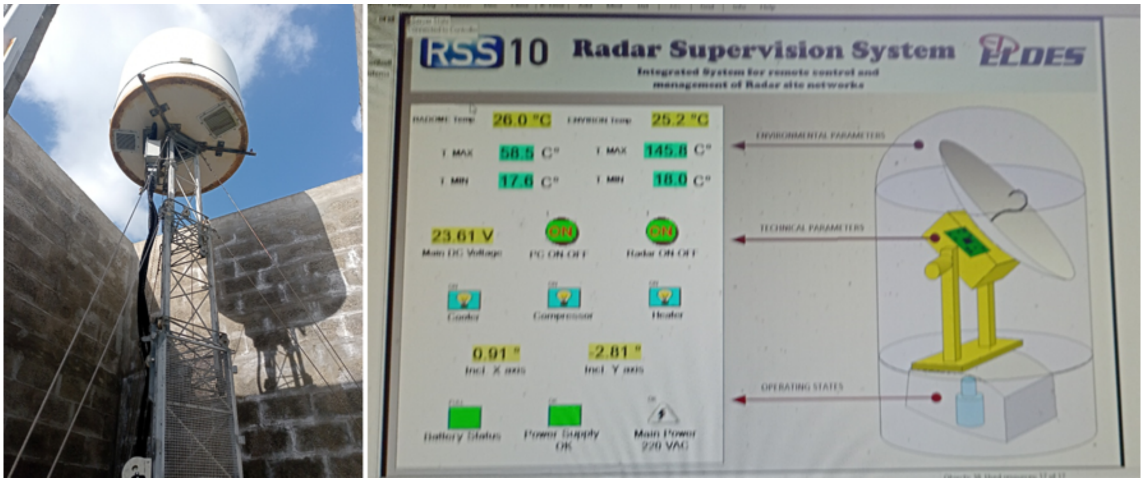

Figure 9. Saint Lucia radar system and status in 2025

(e) Caribbean Weather Radar Mosaic and Regional Benefit

61. The Caribbean Weather Radar Mosaic is poised to enter a new phase of growth, resilience, and strategic importance as the region modernizes the systems that support it. What began as a modest composite produced in 2013 has evolved into a critical regional asset, one that now integrates radar data from across the wider Caribbean, parts of Central and South America.

62. At the 11th CORG, the Barbados Meteorological Service (BMS) delivered an in-depth report on the status and strategic future of the Caribbean Weather Radar Mosaic, underscoring its central role in regional early-warning systems and the broader hemispheric forecasting community.

63. In 2025, BMS with support of its parent Ministry, the CMO Headquarters and WMO's regional office continued to work to integrate regional radars into a single mosaic. This brought together experts and national meteorological leaders across the Caribbean and Central America, overcoming language barriers and technical challenges to share radar data and enhance regional forecasting capabilities. The Dominican Republic has been a key partner, contributing multiple radars to the mosaic and engaging actively in expanding regional coverage.

64. Brazil has also become an important contributor to the regional radar mosaic, with its radar in Boa Vista successfully integrated in 2025. While some additional Brazilian radars that have indicated an interest to participate on the mosaic are yet to share data, the inclusion of Boa Vista demonstrates the mosaic's expanding reach beyond the Caribbean to South America. This integration enhances regional forecasting capabilities, strengthens early warning systems, and provides a model for future collaboration with other Latin American countries.

65. Also in 2025, the mosaic software was significantly upgraded, introducing faster processing, improved logic for stitching radar data, and potential for advanced filtering in future iterations. These enhancements reduced processing times from around 10 minutes to just seconds and allowed integration of radars from the United States and Brazil, creating a truly hemispheric radar mosaic, soon to be publicly available on the Zamasu geospatial system. Plans are underway to expand further across Latin America, with ongoing discussions involving Mexico, Colombia, Panama, Costa Rica, and Guatemala to include their data and strengthen regional collaboration.

The BMS upgraded platform, will serve as a central hub for radar and meteorological products, fostering capacity-building across the Caribbean and represents a major step in improving early warning systems and climate resilience for small island states. As highlighted by the BMS, CMO Headquarters at the center of regional cooperation continue to be pivotal in driving the initiative forward, ensuring long-term sustainability and regional integration of meteorological services.

66. The BMS has identified two key challenges in integrating additional radars into the mosaic. These include insufficient staff capacity to meet the required data standards for generating and transmitting BUFR data, and software provided by some radar manufacturers that is incompatible with the standards needed to produce correctly formatted BUFR and NetCDF data files.

67. With NOAA retiring legacy services such as the GIF server, the region is proactively moving to strengthen its data independence. The BMS has establish a dedicated data facility that enables radar operators to exchange data directly with the BMS, which provide redundancy, secure storage, and uninterrupted mosaic generation, while still allowing Members to meet their WMO obligations through the regional telecommunication hub and global brokers.

68. This transformation positions the mosaic not only as a technical product, but as a strategic pillar of the Caribbean early-warning system supporting aviation, hydrology, disaster preparedness, agriculture, and climate resilience.

69. The upgraded mosaic system, now redesigned by the BMS to handle greater radar density and improved algorithms without additional computational burden, is also being reconfigured to produce a unified regional composite instead of multiple sector views. Through this transition, the region will maintain operational independence, improve data quality and accessibility, enhance its ability to ingest modern formats such as BUFR, NetCDF, and HDF5, and ensure that mosaic products remain available to forecasters, disaster managers, aviation users, and international partners even amidst external service disruptions.

70. Collectively, these steps represent a significant strengthening of the regional radar infrastructure and a proactive effort to secure the long-term sustainability of one of the Caribbean's most important early-warning assets.

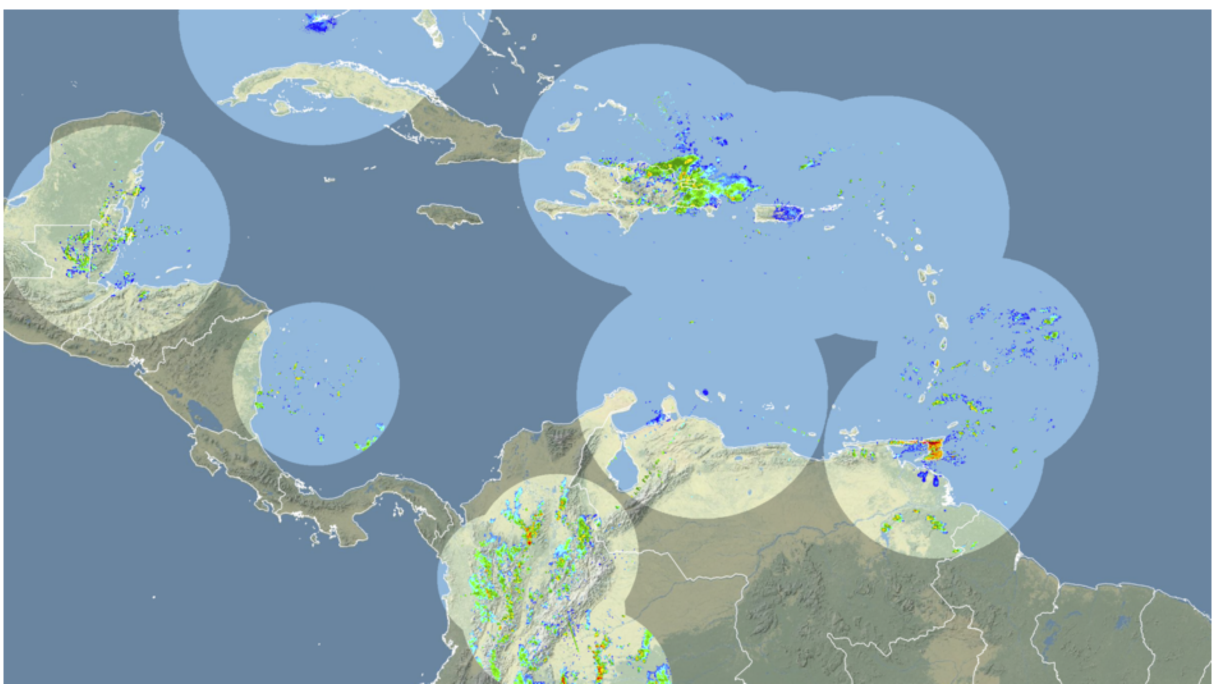

Figure 10. Sample of Caribbean Radar Composite provided by the Barbados Meteorological Service. Note that data will be missing for some periods because of outages or delay in data transmission.

(f) CMO Headquarters Radar Modernization Project

71. The Council will recall that it was informed at CMC 67 that the CMO Headquarters had submitted, on 13 November 2024, its first draft of the Green Climate Fund (GCF) Simplified Approval Process Funding Proposal (FP) to scale-up Caribbean Hydrometeorological and Multi-Hazard Early Warning Services in

Belize and Trinidad and Tobago, which included major activities in relation to upgrading the Doppler weather radars in Belize and Trinidad and Tobago along with supporting services.

72. The Council is informed that at the Forty-third meeting of the Board of the GCF (B.43) held in the Republic of Korea on 27–30 October 2025, the **USD 24.1 million** GCF Grant Funding Proposal was approved.

73. The proposal will support Belize and Trinidad and Tobago to enhance and maintain their Doppler weather radar systems through a comprehensive program of upgrades, technical training, and infrastructure improvements, totaling approximately USD 6.8 million, with each country scheduled to receive approximately USD 3.3 and 3.5 million respectively.

74. Key sub-activities include upgrading Doppler radars with the latest dual-polarization components to improve monitoring of heavy rainfall and severe weather, nowcasting; procuring sufficient spare parts to support a five-year maintenance schedule; enhancing lightning suppression measures at both radar sites; refreshing radar software, acquiring additional software licenses for meteorological education and training centres and universities, and providing technical support and training programs, including a training programme focused on maintenance and operational sustainability targeting technical staff training (factory and other), remote support, and service level agreement contract for manufacture technical visit at least once per year

75. Additional country-specific activities include procuring computer servers for the radar system to enhance data storage; enhancing telecommunication, network/bandwidth and internet infrastructure at radar sites to facilitate improved radar data transfer; support the UWI St Augustine Campus to develop a training module for radar use and maintenance within an engineering programme; partnering with CIMH and The UWI to develop products in radar applications focused on EWS; testing and calibrating the Doppler weather radar annually.

76. Other activities include:

- Implementing cybersecurity measures, including the procurement and installation of software, to protect the integrity and functionality of the radar network in both countries, ensuring uninterrupted forecasting services and data collection.
- Providing specialized training for forecasters (Belize and Trinidad and Tobago) on the use of the upgraded radar products in weather prediction, enhancing the accuracy and timeliness of forecasts for extreme weather events.
- Pilot and operationalize a common radar data format for sharing radar data to increase usage, including in the media, research and academia, products for tailored services in the public and private sectors, and integration into NWP to benefit Belize and Trinidad and Tobago and the region as whole.
- Expansion of prototype multi-sensor precipitation grid to Belize and Trinidad and Tobago
- common radar data format for operational use and sharing of radar data from Trinidad and Tobago across the region

77. Another important activity under project is the development of regional arrangements for procurement and access to spare parts and policy and mechanisms for sharing radar data with partners and stakeholders in MHEWS. The aim is to establish a coordinated regional framework to streamline procurement processes for essential spare parts, ensuring timely maintenance and operational readiness of meteorological equipment across both nations and coordination with the current spare parts depot maintained by CIMH.

78. This activity will strengthen the policy and mechanisms by which pooled radar spare parts would be shared and replenished and will also involve strengthening mechanisms by which radar data will be archived by partners and stakeholders with Letters of Agreements requirements.

79. The project will ensure that radar data are exchanged and archived nationally and regionally, including at the CIMH, as a backup to the national archives, ensuring sustainability, easy access to the full data archive for applications in early warnings, climate and climate risk analysis, education and training, research and case studies, and other applications.

80. The Council is invited to:

(i) **Acknowledge** the successful approval of the CMO Green Climate Fund (GCF) project, *Scaling-up Caribbean Hydrometeorological and Multi-Hazard Early Warning Services in Belize and Trinidad and Tobago,* and **recognize** the importance of the project for upgrading the Doppler Weather Radar systems in Belize and Trinidad and Tobago.

(ii) **Note** the commitment of CMO Headquarters to executing the project in accordance with GCF guidelines, with oversight of the Caribbean Development Bank, the Accredited Entity with GCF.

(iii) **Formally endorse** the CMO Headquarters implementation of the approved GCF project, *Scaling-up Caribbean Hydrometeorological and Multi-Hazard Early Warning Services in Belize and Trinidad and Tobago,* which includes the upgrading of the CMO-procured weather radars in Belize and Trinidad and Tobago.

(g) CMO Operational Radar Group (CORG)

81. The CMO Operational Radar Group (CORG) convened three times in 2025, strengthening its role as a key regional mechanism for coordinated technical support, shared learning, and capacity development among NMHSs managing operational weather radars. During the year the CORG provided expert guidance on operational challenges, and strengthened regional interoperability for radar operations and maintenance.

82. The Group also facilitated direct engagement with radar manufacturers and the WMO and participated in radar conferences, ensuring that Caribbean needs are represented in global radar discussions, including through its designated representative on the WMO Expert Team on Operational Weather Radars (ET-OWR).

83. In terms of its activities as a community of practice the CORG engaged in technical consultations, facilitated peer-to-peer support among radar engineers and technicians, regional discussions on regional data sharing, and emerging technologies including common radar data generation and distribution, reinforcing its role as a critical mechanism for strengthening regional radar operations and early warning capabilities.

(h) Selected CORG Activities

<u>Advantages of Having an Open Radar Data Format (FM 301)</u>

84. The CORG benefited from a detailed technical presentation by Dr. Daniel Michelson, Research Manager with Environment and Climate Change Canada and the Chair of the WMO Expert Team on the advantages of open radar data and the implementation of the FM301 global radar data standards and emerging open-source tools supporting radar operations. The discussion highlighted several important developments relevant to Caribbean NMHSs as the region advances its efforts toward interoperability and integrated early-warning systems.

85. Adoption of the FM 301 data format will ensure interoperable exchange of radar volumes across national boundaries and provide confidence that radar files are compliant once the WMO compliance checker is deployed. It will also allow for smoother integration into WIS 2.0 and regional composite products.

86. The Group was informed that several major radar manufacturers operating in the Caribbean, such as Leonardo, Vaisala, and EEC, were already offering FM 301 as an optional output within their systems,

reflecting strong industry interest in aligning with WMO standards. However, it was noted that these implementations are unlikely to be fully compliant at this stage, primarily because vendors began their development work before the existence of a formal FM 301 compliance checker.

87. As alternatives, two mature open-source operational radar tools were identified as key solutions that were already in use internationally. These were: (1) ELROSE (NCAR, USA), a long-established system widely used for research and operational processing; and (2) BALTRAD (Sweden/Canada), which was currently used in real-time operations in Canada.

88. The CORG was also provided with information about XRadar, a Python-based in-memory radar representation framework enabling FM 301-compliant outputs; as well as the FAIR Open Radar Data Initiative, promoting discoverability, usability, and transparency across radar datasets.

CORG Presentation at AMS 41st International Conference on Radar Meteorology

89. Council is informed that the CMO Operational Radar Group (CORG) submitted an abstract titled “Advancing the Sustainability of the Caribbean Weather Radar Network through the CMO Operational Radar Group: A Paradigm Shift and Community of Practice” to the 41st International Conference on Radar Meteorology, hosted by the American Meteorological Society (AMS) from 25–29 August 2025.

90. The abstract was accepted as an excellent fit for the conference theme “Weather Knows No Boundaries” and the CORG was invited to deliver a **keynote address**. The presentation was delivered by Mr. Kenneth Kerr, Science and Technology Officer of the CMO, who also participated in a panel discussion titled “Radar4All: A Panel Discussion of Equity Issues in Radar Meteorology.”

91. The CORG’s participation ensured that the Caribbean’s operational radar challenges, needs, achievements, and best practices were prominently represented. It also highlighted how coordinated regional collaboration strengthens radar sustainability and supports early-warning services for the populations of CMO Member States.

92. The conference provided significant technical insights and valuable networking opportunities. These engagements deepened dialogue on sustaining weather radar capacity in the Caribbean and other underrepresented regions and promoted international collaboration, shared best practices, and innovative approaches. As a result, the region has strengthened its knowledge base on radar operations and maintenance and further solidified its partnerships, particularly with Environment and Climate Change Canada.

Environment and Climate Change Canada National Weather Radar Network- Operations and Maintenance Best Practices

93. Following the networking opportunities generated at the 41st International Radar Conference, the Science and Technology Officer organize a special presentation to the CORG on best practices in radar maintenance and management by Mr. Steve Brady, Manager of the National Radar Programme of Environment and Climate Change Canada (ECCC).

94. Drawing on decades of experience, including a tripling of Canada’s radar network over the past 45 years, his presentation provided insights into effective strategies, practical lessons, and operational innovations. This context provided the CORG with an in-depth overview of best practices for weather radar maintenance, monitoring, and governance, illustrating how a well-structured national programme supports reliability, data quality, and long-term sustainability.

95. Mr Brady detailed Canada’s radar evolution from legacy systems to a fully upgraded dual-polarized Leonardo S-band network, supported by rigorous maintenance standards, asset management, advanced monitoring tools, and a tiered training and certification system. The presentation highlighted challenges familiar to the Caribbean—such as staffing limitations, radio frequency interference, supply chain delays,

and maintaining institutional knowledge—demonstrating shared operational realities and underscoring the value of collaboration.

96. The discussion also emphasized opportunities for the Caribbean to apply similar structured approaches, including systematic documentation, integrated monitoring, capacity development, and strengthened vendor and international partnerships.

97. The importance of accountability, structured implementation, and building operational systems from the national level outward was highlighted. Key lessons include setting measurable targets, such as 95% uptime, developing standard operating procedures, and proactively managing maintenance and spare parts, recognizing that unexpected failures, such as HVAC or waveguide issues can occur.

98. Canada's approach prioritizes national implementation first, with gradual regional expansion, and highlights the value of knowledge transfer through structured training, partnerships, and targeted allocation of technician resources. Data sharing is facilitated through cost-recovery mechanisms for both domestic and international stakeholders, while infrastructure policies, follow consultation-based guidelines. Overall, the presentation demonstrated that systematic planning, adaptive management, and incremental scaling are critical to achieving operational efficiency, sustainability, and resilience in complex radar networks.

99. Council is asked to note the following for effective and efficient management of the CWRN:

- It is important for NMHSs operating weather radars to establish clear metrics, such as uptime and availability, to measure system performance to ensure responsibilities are defined and progress is trackable.
- Radar systems sustainability requires planning, since even with a well-designed radar system, unforeseen issues will arise. Thus, establishing robust processes, spares management, and failure tracking is critical to maintain operational continuity.
- Limited technical staff with responsibilities across multiple observing domains requires creative ways to maintain knowledge and balance resources and, which is critical.
- Effective engagement with system providers (e.g., Leonardo) and understanding proprietary versus off-the-shelf components is crucial for maintenance, troubleshooting, and long-term planning.
- Lessons from challenges are invaluable – Learning from failures, such as unexpected HVAC or power issues, underscores the importance of proactive risk management and system redundancy.
- To overcome lack of trained staff in radar technology, NMHSs should consider cross-sector knowledge transfer for training and technical expertise. Explore sectors such military, telecommunication, aviation, and universities to expand the pool of RF and radar-skilled personnel.

CORG Road-Map 2025-2027

100. The CORG has agreed on an Operational Roadmap 2025–2027 that provides a structured, strategic framework for executing the group's mandate under its Terms of Reference and strengthening the performance, sustainability, and value of the CWRN.

101. The roadmap outlines short- to medium-term priorities—ranging from radar maintenance, calibration, data quality control, and frequency protection to improved data sharing, integration into forecasting and numerical weather prediction, and enhanced radar security—while assigning clear responsibilities and timelines for CORG Members and partners.

102. It also focuses on building technical capacity through training, workshops, mentorship programmes, and collaboration with national, regional, and international experts. In addition, the roadmap establishes mechanisms for documenting operational limitations, improving data transmission systems, standardizing radar data formats, and advancing the development of the regional radar mosaic.

103. Collectively, the plan aims to strengthen radar reliability, promotes knowledge sharing, supports early warning services, and provides a basis for continuous monitoring, reporting, and coordinated action across the region.

(i) Actions Proposed to Council:

104. The Council is invited to:

(i) **Note** the status of the radars in the CMO Member states during 2025.

(ii) **Note** that the CMO Weather Radar Network should be treated as a mission-critical asset—that requires consistent investment, skilled technical support, maintenance, and adequate funding for operations**.**

(iii) **Recognize** that securing and safeguarding the integrity, reliability, and continuity of the radar network as a regional public good, is a strategic imperative for protecting lives, enabling climate adaptation, and ensuring that regional governments can fulfil their national and regional obligations and global initiatives such as the UN Early Warnings for All.

(iv) **Acknowledge** the successful approval of the CMO Green Climate Fund (GCF) project and **recognize** the importance of the project for upgrading the Doppler Weather Radar systems in Belize and Trinidad and Tobago.

(v) **Note** the commitment of CMO Headquarters to executing the project in accordance with GCF guidelines, with oversight of the Caribbean Development Bank, the Accredited Entity with GCF.

(vi) **Formally endorse** the CMO Headquarters implementation of the approved GCF project, *Scaling-up Caribbean Hydrometeorological and Multi-Hazard Early Warning Services in Belize and Trinidad and Tobago,* which includes the upgrading of the CMO-procured weather radars in Belize and Trinidad and Tobago.

(vii) **Acknowledge** the valuable role of the CMO Operational Radar Group in the ensuring the sustainability of the CMO Weather Radar Network and radars in neighbouring states that support early warning services in the Caribbean.

(viii) **Note** that the CMO Operational Radar Group has been recognized internationally as an exemplar community of practice for weather radar operations.

(ix) **Urge** NMHSs to strengthen collaboration, through joint monitoring, shared protocols, and regular technical engagement, to ensure the accuracy, reliability, and uninterrupted availability of radar data across the region.

(x) **Consider** conducting a reconciliation of the existing regional radar spare parts pool hosted by the CIMH and to guide the future of the pool and the development of regional arrangements and policy for procurement and access to spare parts in the pool.

(xi) **Encourage** automated mechanisms for sharing data about the spare parts pool with the NMHSs, coordinated by CMO Headquarters and CIMH.

(xii) **Consider** seeking small-scale donor funding to negotiate group procurement of spare parts to populate the pool, reduce costs and shorten delivery times.

CMO Headquarters

November 2025