CARIBBEAN METEOROLOGICAL ORGANIZATION

CARIBBEAN METEOROLOGICAL COUNCIL **Doc. 10**
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CMO WEATHER RADAR NETWORK

(Submitted by the Coordinating Director)

Introduction

1. The CMO Weather Radar Network (CWRN) is an observing and weather forecasting and climate analysis asset, jointly implemented by the Caribbean Meteorological Organization (CMO) and six (6) Member States. The CWRN, which is a key component of a modern early warning system benefiting the entire Caribbean, is also an important supporting component of the WMO World Weather Watch Programme. The CWRN currently comprises Doppler radars, located in Barbados, Belize, Grand Cayman, Guyana, Trinidad and Tobago, and Jamaica. The network is bolstered by additional radar data from other pre-existing and new weather radars across the region and will benefit from recently installed weather radars in Tobago, Saint Lucia, Sint Maarten/St Martin, and the Bahamas. Members of the CMO continue to contribute to the operation and applications of the collective regional facility.

2. The radars are critical infrastructure for weather monitoring, forecasts, and warnings in the Caribbean, including heavy rainfall, severe weather, and volcanic ash, which benefit sectors such as disaster risk reduction, aviation, agriculture, water resource management, etc. The network allows “nowcasting” or “take immediate action” type of weather warnings, as well as analysis of trends to guide climate actions. The purpose of this report is to provide an overview of the status of the CRWN, including operational status, radar applications, network strengthening, human resource development, and other ongoing considerations. This report also advocates for weather radar management to extend the life of the radars and strongly encourages collaboration among Members, including knowledge and data sharing.

(a) Status of the CMO Radar network

Caribbean Radar Operating Environment

3. Council is asked to be mindful of the operational environment of the CWRN, and the increasing value of the radar network in a warming climate. The Caribbean region is expected to experience more intense thunderstorm systems with warmer seas. Radars are the primary means of weather observations within 400 km of land, with the ability to detect and warn on rapidly-developing storms, especially at night-time when visible satellite images (the highest resolution satellite images) are not available. Furthermore, radar data archives provide information about trends in rainfall intensity and accumulation, as the climate varies, and are also useful for verification of forecasts. To mitigate the risks posed by extreme weather, it is necessary to monitor real-time precipitation widely and accurately using national and regional radar observations, in combination with surface and satellite observations.

Operational Status

4. During the reporting period of November 2021 to October 2022, four (4) of the six (6) CWRN radars functioned reasonably well (see samples in Annex 1). This notwithstanding, Members experienced challenges operating their national radars during the period. These challenges were associated with technical issues that led, at times, to unexpected but relatively short-lived radar outages. The CWRN along with other available radar data in the region generally strengthened risk knowledge and increased the responsiveness of territories to meteorological risks. As evident in Figure 1, the value of having operational radars on the CWRN was powerful during the 2022 hurricane season. The exchange of weather radar data freely among regional and international countries enabled zooming in on more localized information and accurate locations.

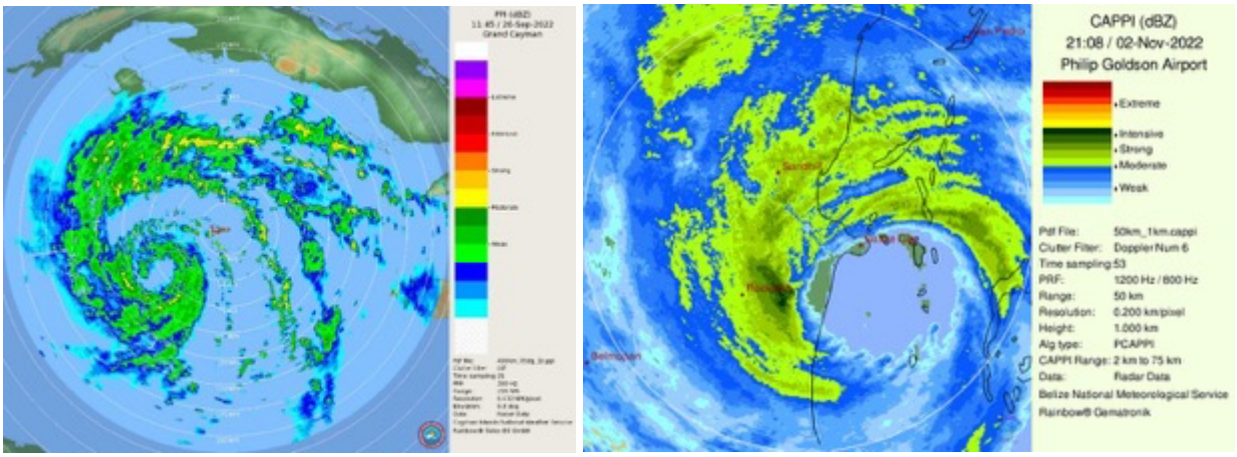

Figure 1 (left) Cayman Islands radar at 400 km range, showing the location of precipitation in Hurricane Ian (eye southwest of Grand Cayman). (right) Belize radar showing the eye and eyewall precipitation of Hurricane Lisa at landfall.

Barbados Radar

5. Over the reporting period, Barbados upgraded its radar to a LEONARDO Germany Dual Polarization radar system, which was commissioned in March 2022. During the radar upgrade project, all radar hardware and software were replaced, while a new radar dome was installed. The project also included structural repairs to the floor and waterproofing to the cockpit, while the existing main structural support for the radar remained in place. During the upgrade, the main challenge resulted from heavy rainfall, which caused water to leak into the radar cockpit while the radar dome was removed. Since the radar upgrade, Barbados increased the use of its radar data, which are now ingested into a high-resolution, multi-sensor precipitation grid as part of a project sponsored by the World Bank under the *Climate Risk and Early Warning System* (CREWS) Initiative. The precipitation grid is being developed as a collaborative project with the CIMA Research Foundation, CIMH, and CMO Headquarters Unit.

Belize Radar

6. Belize radar worked almost continually, except for radar outages during scheduled maintenance and unforeseen interruptions due to component failures or power outages. The radar experienced four (4) radar outages during the period due to prolonged power outages and standby generator failure. This resulted in the installation of a new standby generator. Belize continues to conduct its maintenance schedule according to the maintenance manual, with inspection and preventative maintenance occurring approximately three (3) times weekly. However, there remain challenges in radar maintenance resulting from issues such as

unexpected failure of power supplies, cooling fans, and signal boards and the unavailability of replacement spare parts in stock.

Cayman Islands Radar

7. The Cayman Islands experienced a prolonged radar outage from October 21 to August 2022 due to a faulty HV transformer. They were able to return the radar to operational status with assistance from LEONARDO Germany technicians who visited the island and carried out maintenance checks. LEONARDO Germany has recommended the replacement of the radar rotary joint, slipring orbital gear oil, and elevation grease, which the Member plans to attend to, as well as installing a dehumidifier in the radome to remove residual moisture from the air conditioning system.

Guyana Radar

8. The Guyana radar remains in generally very good conditions. Guyana performs maintenance activities on a weekly basis, which involves observation of various measurements taken while the system is in operation as well as visual hardware checks. Few radar outages were reported, mainly as a result of power issues at the location and not with the radar itself. There were also a few other instances when the radar went offline due to internal network issues caused by lightning as well as the emergency backup generator's failure and not the Doppler Radar itself. None of these issues however, lasted for more than 24 Hours. There were four (4) operator-induced outages during the period to facilitate antenna inspection and corrective maintenance.

Jamaica Radar

9. The Jamaica Meteorological Service benefitted from the installation of a new Radar under the Pilot Program for Climate Resilience (PPCR) project in 2021. The Doppler weather radar passed the operational tests in December 2021, while six (6) meteorologists and three (3) instrument technicians received training on the new radar software and operations. The radar was to be commissioned on the 28th of March 2022; however, on March 9, 2022, a loud crashing sound was heard and an investigation showed there was a mechanical defect. The manufacturer has since visited, conducted an investigation, and has committed to repairing the system by December 2022.

Trinidad Radar

10. Trinidad and Tobago radar outage continued for a second year. Spare parts for troubleshooting were purchased, which enabled the local Equipment Repairmen to further the troubleshooting process. However, a juncture has arrived whereby special external expertise, tools, and equipment are required to return the radar to operational status. During March 2022, the meteorological service hosted an on-site troubleshooting execution exercise by a LEONARDO engineer. The recommendations are for Trinidad and Tobago to further engage the services of LEONARDO and purchase additional spares to get the radar operational. Two (2) Leonardo Engineers are expected to visit during the first quarter of 2023. There is also an ongoing project to completely refurbish the existing radar tower and associated building infrastructure, together with the backup generator and other supporting equipment. This work is expected to commence by the end of December 2022.

Tobago Radar

11. In May 2022, Tobago installed an EEC Ranger X-Band dual-polarization radar, which has a scan radius of 150km range. Arrangements are ongoing to allow public access to products from the radar system. The Tobago Meteorological Service Division has implemented a preventive maintenance schedule in line with the manufacturer's requirement.

Saint Lucia Radar

12. Council will recall that, in October 2021, Saint Lucia installed an X-band weather radar, which has a radius of 120km radar. The radar is part of a Geo-Information Centre (GIC) being implemented by agreement between the Governments of Saint Lucia and Italy. The radar worked for approximately three (3) months then encountered technical and mechanical issues that are yet to be resolved. Since then, additional issues have developed and radar outage continues. The Member is challenged in resolving the issues due to limited resources and expertise but is engaged with the supplier to have a resolution and an operational radar by the end of 2022. This radar when operational, will overlap with neighbouring radars, providing some redundancy in case of outages.

Sint Maarten/St Martin Radar

13. Sint Maarten/St Martin installed a new dual-polarization C-Band radar in August 2022. The radar has a radius of 400km and is currently undergoing operational testing. This radar, which was funded under the European Territorial Cooperation policy through the Interreg Caribbean Cooperation Program will increase the radar coverage northeast Caribbean islands that are on the far range of the Guadeloupe and Puerto Rico radars. The new radar overlaps with neighbouring radars, ensuring redundancy in case of any outage.

Radar Expertise, Capacity Challenges, and Annual Operating Cost

14. Council should note that in the Caribbean, knowledge, and techniques on radar utilization, radar optimization, radar data mining, and interoperability are emerging niches but many challenges remain concerning the maintenance and manipulation of weather radar data. Increasing the number of radar experts at the national level and maintaining the functionality of the radar network remain urgent challenges for radar host countries. Preventative and corrective maintenance is an absolute necessity, even though all radars will fail at some point in time, and the reasons for failure are often not related to the radar itself, but to associated infrastructure, such as power reliability, air conditioning failure, and telecommunications issues.

CMO Operational Radar Working Group (CORG)

15. Council is reminded that the *CMO Operational Radar Group* (CORG) was approved by CMC59 (Anguilla, 2019) as a mechanism for collaboration and exchange of knowledge and expertise on radar maintenance matters. The CORG is facilitating a consultative process that will enable radar technicians and related Information Technology (IT) personnel to share experiences and technical information for the benefit of the region. The knowledge exchanged will assist our Member States that host these systems with radar management, preventative and other maintenance issues and in turn minimize radar down-time and keep network operations at an optimal level. Further, the National Meteorological and Hydrometeorological Services should be in a better position to meet their current and future national and regional obligations with regard to the provision of radar data.

16. Council will recall that the first working group meeting of the CORG was rescheduled for 2022, after postponement of the May 2020 workshop due to the pandemic. The first CORG meeting was held on June 7, 2022, with fifteen (15) participants in attendance from Member States with weather radars, CMO Headquarters, and CIMH. Historical information on CMO weather radars and the necessity of the CORG were provided by the Coordinating Director. After reviewing the CORG Terms of Reference, the meeting featured presentations on the upgrade of the Barbados radar to dual-polarization and an overview of weather radar principles, operations

and maintenance. Views were exchanged on the expectations and plans of the CORG, to build capacity.

17. The meeting agreed that there will be two Co-Chairs. Participants were invited to share their CVs with everyone. Subsequently, four (4) CVs were shared, and, based on suggestions that the Co-Chairs have technical experience in radar maintenance and operations, ***Mr Brian Murray*** of the Barbados Meteorological Service and ***Mr Ian Persad*** of the Trinidad and Tobago Meteorological Service were nominated as co-Chairs. The second meeting of the CORG is scheduled for December 2022. For the coming year, plans are to focus on different topics from the recently published *WMO Guide to Operational Radar Best Practices* (endorsed by WMO INFCOM-2, October 2022).

18. Council is asked to consider the following:

Overall Immediate Challenges

- The biggest challenge for Members with radars is sustaining the financial and technical resource commitment necessary for the continued maintenance and development of their radar programme.

- Radars deployed in 2009-2010 are approaching mechanical life cycle expectancy, requiring preventative and corrective maintenance with adequate supplies of spares.

- One of the many challenges in developing a radar program is recruiting and funding the required human resources with suitable skills and technical capacity. Having people with the right skill sets remains crucial, particularly for first-time radar implementations.

- Staff trained in radar operations will be attractive to other industries. Thus, retention of highly qualified staff will continue to be a challenge, and impact the operational cost.

Radar Repair and Maintenance Responses

Members with radars are encouraged to:

- Actively participate in the CORG, to benefit from knowledge exchange and cooperation

- Establish a feasible but robust maintenance schedule, including remote monitoring capability to reduce travel cost.

- Ensure allocation of radar maintenance funding in their budgetary submission for annual funding. CMO Members who have few disruptions in their operations have had targeted funding for their radar operations.

- Continuous training and training of multiple people could be a mitigation strategy.

Regional Radar Expertise Capacity Development Responses

Council is asked to note that the proposed upgrading of the radars include capacity-development in radar operations for sustainability. This will need to be complemented by similar efforts in IT, to improve access to, and for effective manipulation and utilization of radar observations, data and products, and related technologies. Building capacity will involve:

(a) Assisting radar host Members in implementation, operation, and management of existing and emerging radar systems;

(b) Filling the existing gaps in radar operation and maintenance of Members' radar observing systems, including both the infrastructure and human capacity development;

(c) Technological innovation, technology transfer, technical assistance, and decision-support tools to optimize use of available and future radar data.

National Focal Points for Weather Radar Metadata

19. Council is being made aware that CMO radar host Members are requested to follow WMO recommendations on radar operations. Accordingly, they should adopt WIGOS and WIS standards and make their data and metadata available through WIS 2.0 for delivery or discovery, access, and retrieval services. In this regard, WMO recommends that all WMO Members, either operating or intending to operate weather radar systems in support of the World Weather Watch Programme, should nominate a National Focal Point (NFP) for Weather Radar Metadata who would have responsibility for seeding and maintaining the weather radar metadata within the WMO Radar Database (WRD). The list of National Focal Points for Weather Radar Metadata available from the WMO Community Platform database (**here)**, shows the British Caribbean Territories, Jamaica, Belize, and Trinidad and Tobago have NFP for weather radar metadata, while NFP were not listed for Barbados, Saint Lucia, and Guyana. Members are urged to nominate NFP and ensure that the NFP list is kept up-to-date in the WMO community NFP portal.

Review of CMO Radar Network Radars

20. Council is reminded that the CMO Headquarters been collaborating with World Bank CREWS consultant, Dr. Jeffery Keeler, on a technical study that reviewed four (4) of the weather radars on the CWRN, namely Barbados, Belize, Guyana, and Trinidad and Tobago. The study focused on the radars that need to be upgraded to dual-polarization, assessing their potential for a dual-polarization upgrade and enhancement of their reliability relative to strong hurricane-driven winds and lightning strikes, and functionality and data availability for their respective meteorological services. The consultant visited the four (4) sites and has submitted his final report, to CMO and the World Bank, and shared with CDB to guide the proposal for upgrading the radar.

Plans to Upgrade Radars to Dual Polarization

21. Apart from Barbados and Jamaica, most of the CMO radar infrastructure are beyond 12 years and in need of upgrading. In this regard, Council is reminded that the CMO has been working with the Caribbean Development Bank (CDB) on proposal development to get funding from the CDB and other developmental partners to upgrade the radars and further strengthen the region's early warning systems and climate risk management. Radars can operate for 15 or more years and cost estimates indicate that the ongoing life-cycle costs of the radar and the radar program exceeds the initial capital costs. Therefore, the CMO has been approaching the funding agencies 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 new guidelines.

Regional and International Radar Operations Obligations & Regional Radar Composite

22. Over the Caribbean region, a relatively densely deployed weather surveillance radar network has been established in the past 15 years, by the CMO. The network of national radars, which is set to become even more densely populated with new radar installations by NMHSs,

conforms to the standards of radar weather surveillance of the WMO and provides the foundation for long-term large spatial coverage over the Caribbean.

23. Council will recall that in recent years, the Barbados Meteorological Services (BMS) has made great efforts to create Caribbean radar composite maps of base reflectivity. This was made possible through international data exchange within CMO, WMO Regional Association IV, and the Hurricane Committee. The lowest-level radar scans are shared every 15 minutes on the RA IV GIFS Server, hosted by the US NOAA/ National Weather Service.

24. Three cooperation statements in the MoUs, that CMO Radar Host Members committed to for the EU-funded CMO radar project, related to the sustainability of the national radars and the radar composite, are:

- *At the regional level, the data and images generated by all the Radar Stations will be collected and integrated into real-time composite radar images and made available to the NMHSs of all CMO Member States, as well as non-CMO States in the region.*
- *The CMO is also charged with the responsibility of monitoring the technical and operational aspects of the Radar Stations after commissioning to ensure that the overall short- and long-term objectives of the Project are realized.*
- *The CMO will guide its Member States on future application programmes and system upgrades for the radar systems.*

25. The BMS composite radar base reflectivity map (Figure 2), which is made publicly accessible in real-time at 15-minute intervals, are highly relevant and valuable for national, regional, and international Disaster Risk Reduction (DRR) initiatives and decision-making.

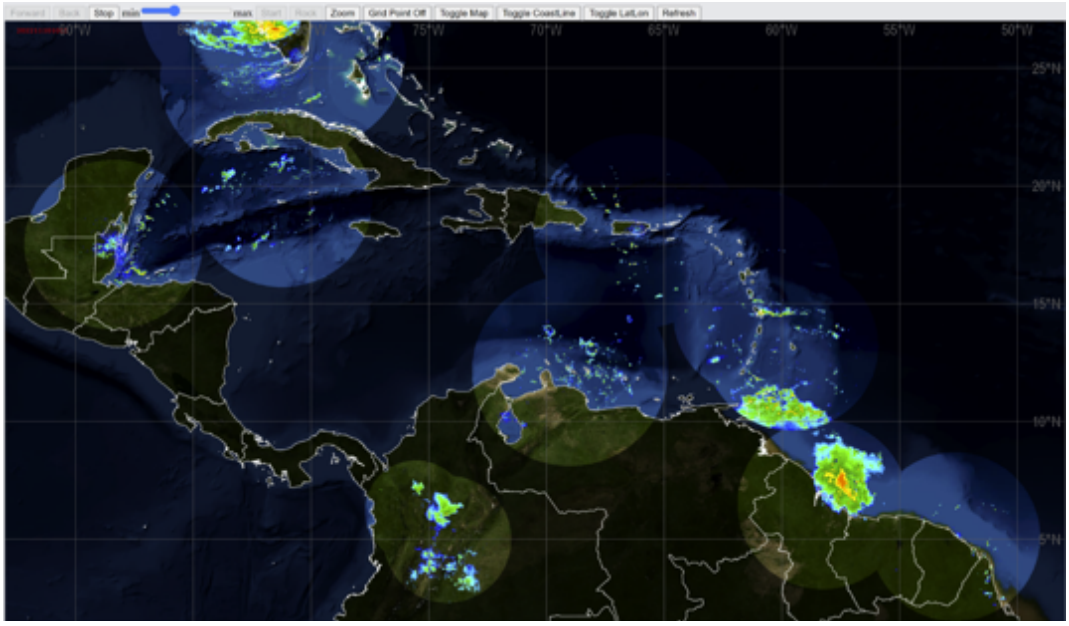

Figure 2. Base Reflectivity Radar Composite (courtesy, Barbados Meteorological Service website, accessed November 10, 2022).

26. Council is reminded of previous discussions that a core problem with the current arrangement is that there is no formal arrangement. At CMC61 (Virtual Platform, 2021), it was reiterated that many users of regional radar data require access to observations from multiple radars simultaneously and value the composite. Council is asked to request Barbados to create a formal arrangement or long-term commitment by Barbados concerning the generation of the Caribbean radar composite maps.

Action Proposed to Council

27. The Council is invited to:

(i) **Note** the status of weather radars in the CMO Member States, and the potential for expansion of the network of radars when newly installed radars become operational.

(ii) **Further note** that, human and financial resources will be needed to sustain the CMO weather radar network and that Members should place greater emphasis on ensuring those resources**.**

(iii) **Commit** to sustainable funding and budgetary allocations for radar preventative and corrective radar maintenance and enhancement programs.

(iv) **Note** the formal establishment of the CMO Operational Radar Group (CORG), and its recent and planned activities, and **encourage** Members with radars to actively participate in the CORG.

(v) **Support** the CMO's urgency to upgrade the remaining radars to dual polarization status and acquire such funding that includes capacity development and sustainable inventories of spare parts for repair and maintenance**.**

(vi) **Further support** and **encourage** targeted radar expertise and capacity development at Members NMHSs, including radar-related IT expertise and capacity development and hiring.

(vii) **Urge** CMO Members with radars to engage in training multiple persons in radar technology, operations, and maintenance at the same time.

(viii) **Further urge** CMO members with radars to adhere to the Memoranda of Understandings (MoUs) for Weather Radar Network Warning System in the Caribbean Region and consult with the CMO on radar enhancement programmes.

(ix) **Encourage** the Barbados Meteorological Services to develop and commit to formal arrangements for generating and submitting composite radar data in line with the WMO WIGOS guidelines and WMO Unified data policy.

(x) **Discuss** and **provide feedback** and **guidance** to the CMO HQ on how to improve and extend the life expectancy of the CMO Weather Radar Network.

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CMO Headquarters
November 2022

Annex I

Figure 3a Belize at 400km, November 10, 2022

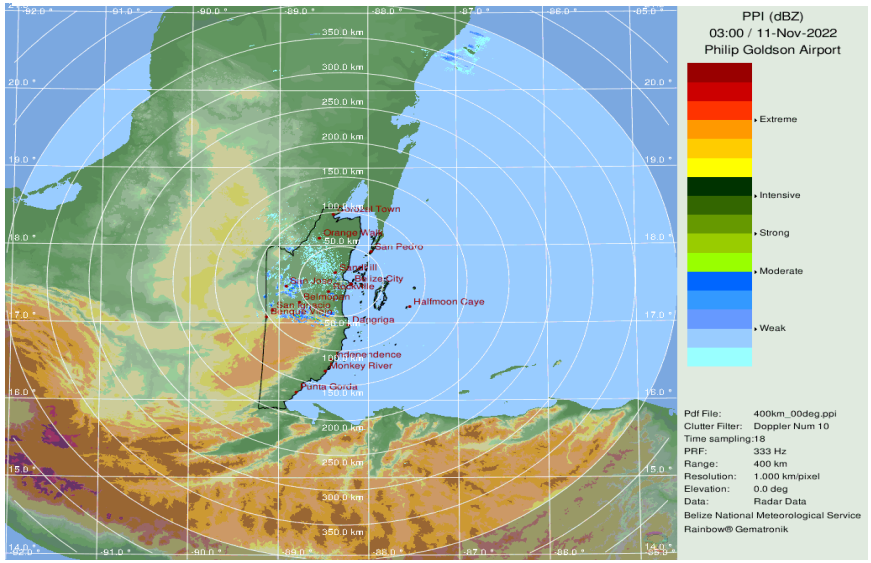

Figure 3b. Guyana at 400km, November 10, 2022

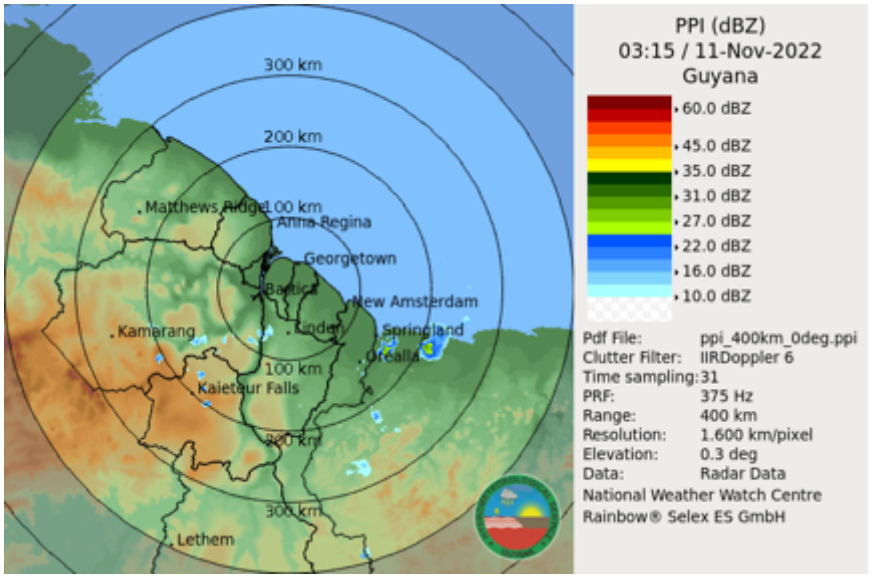

Figure 3c. Barbados at 400km, November 10, 2022

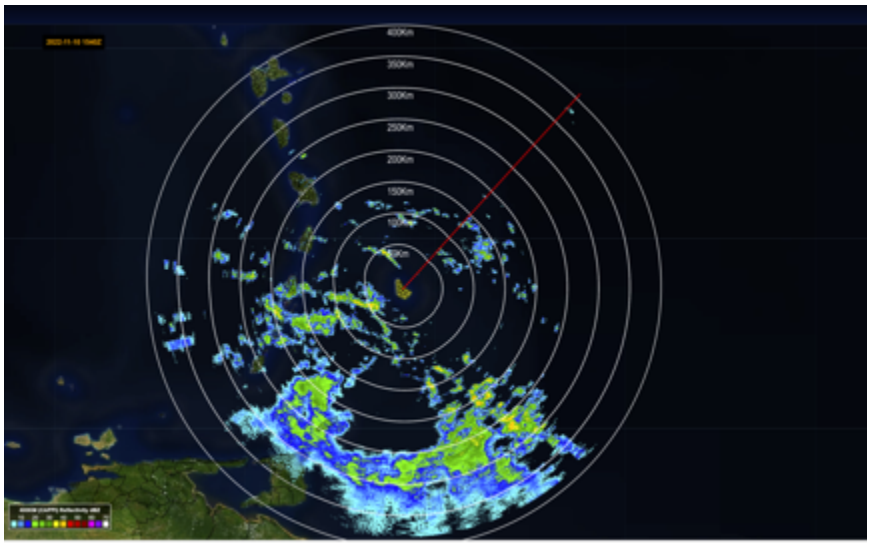

Figure 3d. Cayman Islands at 400km, November 10, 2022