30th September 2024

GBON National Contribution Plan for Antigua and Barbuda

Systematic Observations Financing Facility

Weather and climate data for resilience

GBON National Contribution Plan

Antigua and Barbuda

Beneficiary Country Focal Point and Institute	Dale Destin, Antigua and Barbuda Meteorological Service (ABMS)
Peer Advisor Focal Point and Institute	Ali Price, UK Met Office

Table of contents

Module 1. National Target toward GBON compliance

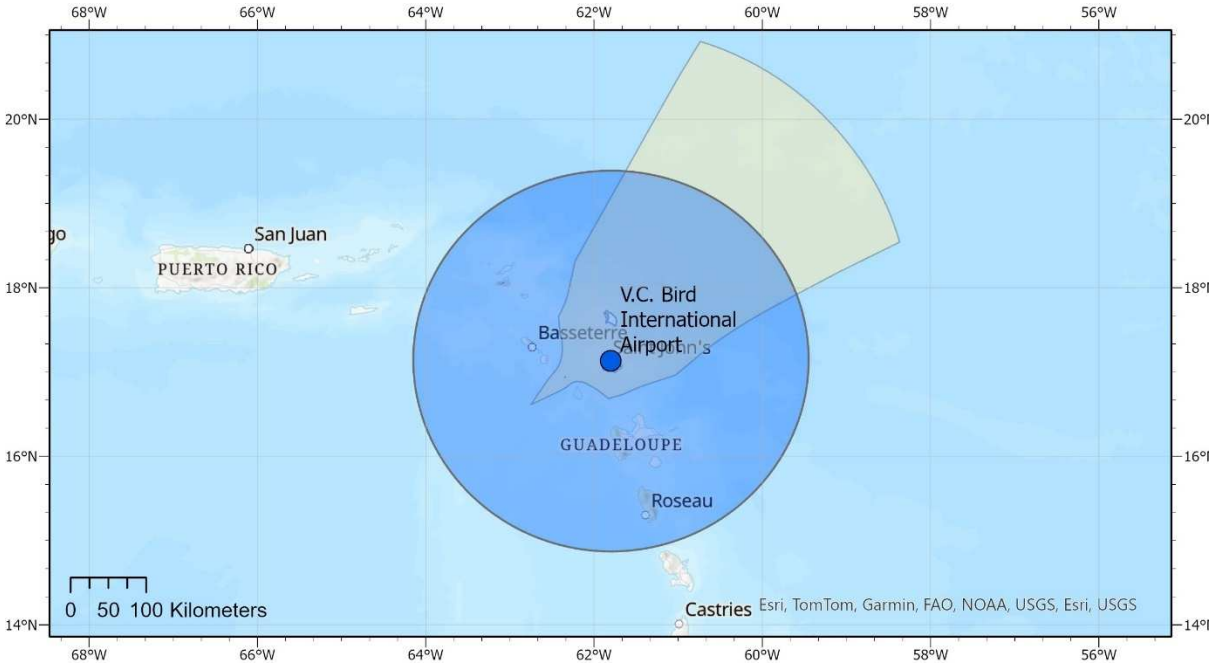
Summarize the national target toward GBON compliance in the Table below and provide the technical details as needed

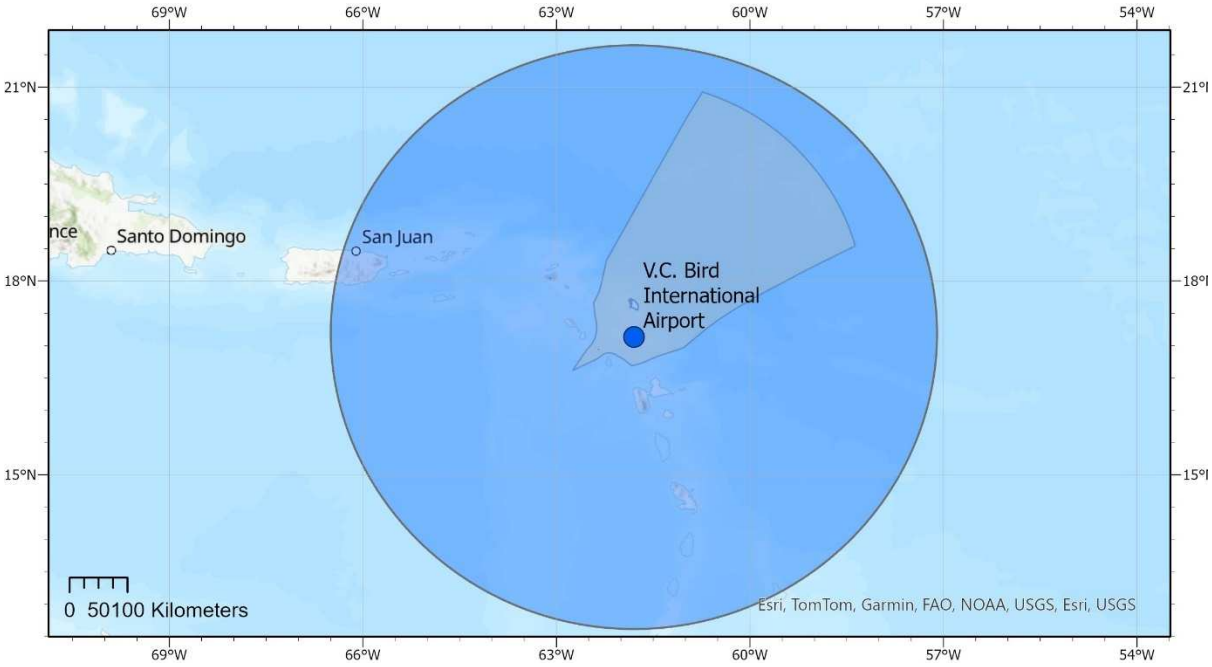
Table 1. GBON National Contribution Target

Type of station	WMO GBON Global Gap Analysis, June 2023				GBON National Contribution Target	
	Target	Reporting	Gap		To improve	New
			To improve	New		
	[# of stations]				[# of stations]	
Surface	1	0	1	0	1	0
Upper-air	1	0	0	1	0	1*
Marine	**when applicable					

**Note: Subject to further regional evaluation of GBON Global Gap Analysis UA requirement*

Figure 1. Map of (i) existing surface station with 500 km diameter SIDS circle and (ii) proposed upper-air station with 1000 km diameter SIDS circle (in BLUE) to indicate station coverage (note A&B EEZ underlaid in YELLOW)




69°W
66°W
63°W
60°W
57°W
54°W
21°N
18°N
15°N
nce
Santo Domingo
San Juan
V.C. Bird
International
Airport
0 50100 Kilometers
Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGS

Module 2. GBON Business Model and Institutional Development

2.1. Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON

Identify:

· Governmental stakeholders operating and acquiring meteorological observations or with the potential to support GBON;

· Private sector operators providing meteorological observations and data services in the country (for ship-based observations, identify fleet of ships government-owned or private and research owned) to install instrument packages)

Provide recommendation on how they could contribute to the implementation of the Plan and required activities to materialize the proposed partnerships:

a. Existing partners and relationships;

b. Potential new partners and their roles.

The Antigua and Barbuda Met Service (ABMS) is a department within the Ministry of Tourism, Investment, Civil Aviation and Transportation and produces a range of weather and climate services to the public, government and transport. ABMS collaborates with the Antigua and Barbuda Airport Authority (ABAA) in order to provide services and data to the V C Bird International Airport (VCBIA) in Antigua. ABMS provides information to other government ministries on a contingency basis, specifically where advisories or warnings of severe weather are issued. The provision of these services is currently not supported by formal agreements or reciprocal funding arrangements but financed from the overall ABMS budget provision. ABMS currently has no private-sector collaborations and there are no public or private sector organisations that ABMS are aware of that are undertaking meteorological observations apart from ABMS. ABMS also provides regional weather forecast services from this national budget for the adjacent nation of St Kitts and Nevis and the British Caribbean Territories of Montserrat, Anguilla and the British Virgin Islands.

The ABMS receives automated observations from 23 stations across Antigua and Barbuda, which are used in the delivery of their forecast products and directed in near-real time to users. These stations have been implemented via a number of projects and providers which, along with no dedicated ongoing funding, have introduced challenges to the ABMS with regards to maintenance and integration. Further information is available in Module 3.1.

Upper Air (UA) observations in Antigua were previously undertaken by the United States Air Force (USAF) – this was discontinued when the USAF withdrew from Antigua. It is worth noting that other nations in the region have UA stations as supported by the US National Weather Service (NWS) as part of a regional arrangement between the US NWS and several countries in the Caribbean region, referred to as the Caribbean Hurricane Upper Air System (CHUAS).

2.2. Assessment of potential GBON sub-regional collaboration

Identify neighboring countries and regional organizations of relevance for potential sub-regional collaboration.

Provide recommendations for potential optimization of the observing network through sub-regional network design and other sub-regional partnerships for the implementation of the Plan.

Antigua and Barbuda is in close vicinity to a number of neighbouring Caribbean nations and territories, including St. Kitts & Nevis to the NW, Montserrat (UK) to the SW and Guadeloupe (France) to the South and thus there is significant potential for overlap and efficiency in meteorological service provision. Notably, ABMS currently provides aviation forecast services to the neighbouring British Overseas Territories of Monserrat, British Virgin Islands and Anguilla under a Letter of Agreement between the BOTs and the Antigua and Barbuda government, though this agreement is unfunded and does not allow for ABMS to benefit from any cost recovery for these services. Recognising such existing cross-border interactions, Caribbean PRs, the SOFF Secretariat and Peer Advisors have concluded that there is a fundamental need for a regional or sub-regional design to best target investments in observations across the Caribbean. This is further outlined in Section 3.1.2.2 and is to be referred to Regional Association IV and other appropriate bodies (eg Caribbean Meteorological Organisation, CMO).

Regional organisations of particular relevance to GBON include the Caribbean Meteorological Organisation (CMO) and the Caribbean Institute for Meteorology and Hydrology (CIMH). CMO is a specialized agency of the Caribbean Community that coordinates joint scientific and technical activities in weather, climate and water–related sciences in sixteen (16) English-speaking Caribbean countries. CIMH in Barbados acts as the WMO Regional Instrument Centre (RIC) and seeks to deliver training, research and investigations, and the provision of specialised services (eg calibration) and advice to NMHSs in the region. A WIS2Box/node pilot scheme has also been undertaken in the Caribbean with participation and collaboration from several countries, including Antigua and Barbuda, coordinated by WMO. The continued development of SurfaceCDMS software and implementation of WIS 2.0 within that platform, which will be made freely available for use by national met services by NMS Belize under the CMO banner - has the potential to strongly benefit countries in the region. Coordination will be required with the Regional WIGOS Centre (RWC), also based in Barbados, which monitors regional WIGOS compliance – this may require some training on eg Jira incident system interaction for ABMS technical staff.

It is recommended that, where appropriate, ABMS continues to collaborate with regional organisations in particular relation to activities including training and the installation, operation and maintenance of the GBON network. There are several items within the National Contribution Plan that lend themselves to taking a regional approach, for example:

- Provision of calibration services and staff training on eg routine maintenance of observation equipment could be organised on a regional basis, assuming suitable CIMH capacity.
- Regional coordination through CMO/RWC/WMO to provide support, training and advice for the implementation of WIS 2.0, as well as the potential for development and regional deployment of SurfaceCDMS which could create economies of scale in the implementation of data management and transmission systems in the region.
- Training key NMHS staff on gender, equality and social inclusion understanding and activity.

Recommendation 2.2(1): ABMS and the Implementing Entity should investigate the benefits of regional collaboration in delivering investment in observations in Antigua and Barbuda

2.3. Assessment of a business model to operate and maintain the network

Assess the current funding sources, budget allocations and financial status related to operations of the NMHS-owned observing network.

Provide recommendation of a business model for public-private collaboration for the implementation of the Plan, based on the SOFF private sector business models,1 including:

a. Recommendation of a business model to operate and maintain the GBON infrastructure, considering arrangements for SOFF financial support during the Compliance phase

b. Identify potential private sector operators depending on the proposed business model

c. Develop a financial plan for operating the modernized infrastructure, including considerations on the total cost of ownership

The ABMS is currently funded through a budget allocation from the central government via the Ministry of Tourism, Investment, Civil Aviation and Transportation, the owning ministry of the department. The majority of this funding has been allocated to staffing costs, with very limited funding for the maintenance and development of the observing network. ABMS holds no formal store of spares, instead relying on moving instrumentation from site to site or ad hoc purchases of sensors when this is not possible. There is often a significant lead time to both securing the funding and delivery timescales for replacement sensors, upwards of six months.

The ABMS has no commercial services and no current grant-funded projects that support either the running costs of the service or the observation network.

The current observation network has primarily been financed by project funding from a range of sources including Japan, Italy, the National Oceanographic and Atmospheric Administration (NOAA), the CIMH and the Caricom Community Climate Change Centre (5Cs). These projects have not made any sustainability provision with respect to ongoing maintenance, spares, calibration or training of staff to support the network.

The proposed surface investment will cover 100% of the land mass of Antigua & Barbuda and approximately 50% of the national EEZ using SIDS criteria; if an upper air facility is implemented, this would cover all of the EEZ. Given the limited extent of the GBON observation network required in Antigua and Barbuda, it is recommended that ABMS operate the network independently (Public model – Fully State/NMHS owned and operated), with the support of SOFF to ensure that training and resource requirements are available. It is recommended that SOFF financial support is sought in the compliance phase for maintenance costs, the provision of spares and replacement equipment and the operating costs including IT infrastructure and data storage and transmission systems. This funding should be kept ringfenced from existing ABMS operational budgets.

The following support through SOFF, with indicative costs to be finalized in the investment phase funding request, is required to reach GBON compliance in Antigua and Barbuda:

- Observation equipment: Physical infrastructure, enclosure, sensors, and communications equipment for one proposed Surface GBON station at the VC Bird International Airport, Antigua, plus spare equipment for repairs and resilience. Physical infrastructure including buildings, power supply, hydrogen generation for one proposed Upper Air GBON station at a site to be determined in Antigua, plus consumables
- IT infrastructure: Upgraded data ingestion server, uninterruptable power supply, and additional data storage drives
- Software: Implementation of Surface CDMS
- Human capacity/Other: Establish all necessary functions to run the GBON in ABMS, including NMHS institutional capacity and human capacity

As above, funding for the ABMS comes from their ministry with very limited allocation for observations. In addition, the overall funding amount falls below the requirements for ABMS to deliver many of the key services expected of an NMHS or allow for any development of the ABMS to meet current and future challenges.

The ABMS's continued delivery of essential services to government and public stakeholders is driven through committed leadership and a competent and focused team that understands the value of weather and climate services to their users. It is recommended that the existing links with the government are strengthened, and evidence is provided for an increase in recognition and sustainable funding. This can be achieved by broadening the skillset within the organisation, across both technical and stakeholder management skills. In addition, as Peer Advisor, we support the request of the ABMS to undertake a socioeconomic benefit (SEB) analysis of both the service and more broadly weather and climate services in Antigua and Barbuda. This would aim to provide the evidence to the government and other external bodies, for investment opportunities with the NMS. This is also in line with WMO's Strategic Plan 2024-2027, overarching priority number 3 – enhancing the socioeconomic value of weather, climate, hydrological and related environmental services. These activities will support the development of a sustainable financial and operating model for GBON compliance in Antigua and Barbuda.

A SEB analysis of the ABMS could provide numerous benefits, including funding justification, showcasing the value of services to government authorities, private organisations and the general public, and starting the process of quantifying the broader socioeconomic impacts. These benefits include enhanced disaster preparedness, improved agriculture, public health, infrastructure efficiency, environmental conservation, tourism capabilities & challenges, and capacity building. A SEB analysis would also contribute to the knowledge in meteorology, providing valuable data, research opportunities, and best practices for enhancing meteorological services globally, and would provide a basis for a model that can be used in the development of other nations.

Recommendation 2.3(1): ABMS and the Implementing Entity to strengthen ties across the Antigua & Barbuda government and undertake SEB assessment to provide evidence to government of the value of and need to maintain weather and climate services

2.4. Assessment of existing national strategies and projects related to observing networks

Review the national strategies for establishing and improving observing networks *Review of existing or planned hydromet development projects related to GBON* *Provide recommendation on activities to ensure consistency and complementarity of current and planned investments and development projects of relevance for GBON*

The ABMS has produced a draft strategic plan with the support of the WMO ("ANTIGUA & BARBUDA METEOROLOGICAL SERVICE NATIONAL STRATEGIC PLAN AND FRAMEWORK FOR WEATHER, WATER AND CLIMATE SERVICE 2021-2025"). This strategic plan has not yet been adopted and implemented due to lack of resource and investment but should be revisited and updated to capture the wide-ranging strategy for the development of the ABMS, including considerations for structure, future

staffing requirements (workforce and facility planning), ongoing development of the observations network and the overall enhancement of skills and capacity within the service. Indeed, the current strategic plan is approaching its final year and thus a refresh of the themes within would be welcome – but this would need to be funded and supported and at present there is no timeline envisaged for this refresh.

There are no current existing or planned hydromet development projects directly related to GBON, but other proposed projects have, unfortunately, not progressed where they have not addressed fundamental needs of the ABMS in terms of infrastructure and development. A grant of US$37,500 was made available through the Caribbean Catastrophe Risk Insurance Facility (CCRIF) to contribute to the cost of spares and repairs of existing stations and towards improving the transmission and collection of data at ABMS including the development and improvement of IT infrastructure. The grant has not yet been released by government but can contribute towards operational spares and underpinning necessary development that would complement the recommendations for investment through SOFF.

Green Climate Funding (GCF) funding for proposal development was made available under Component 3 of a 5-year GCF Build Project being implemented by the Department of the Environment (DOE) within the Government of Antigua & Barbuda. Overall, the project aims to begin the process of shifting Antigua and Barbuda's building sector toward climate resilient sustainable development by facilitating the upgrade of selected build infrastructure, including the branch of the VC Bird International Airport which houses ABMS, to withstand extreme weather events, notably Category 4 and 5 hurricanes. *More specifically, Component 3 would directly benefit ABMS by strengthening weather and climate information services to facilitate early action in the building sector to respond to extreme (weather) climate events, including activities that contribute to the development of early warning for all.* The allocation for this component is US$746,012 and US$100,000 from the GCF and the Government of Antigua and Barbuda respectively, of which some would be available for items such as training and travel in relation to project objectives. Both aspects of GCF investment (building resilience and early warning initiatives) would benefit SOFF objectives in terms of building capacity within the ABMS and mitigating risks of extreme weather on both the NMS's infrastructure and on the wider population of Antigua & Barbuda. Unfortunately this investment remains uncertain and ABMS has been unable to progress the Component 3 proposal due to poor initial scoping and resource constraints. UNDP are now rescoping this proposal to align with the EW4All (Early Warnings for All) project.

Proposed GBON investment should enable consistency and complimentary of approach to the above outlined opportunities, the ABMS strategy and existing observations networks and ICT management already in operation via investments from donors including Japan, Italy, the NOAA, the CIMH and the 5Cs – note that existing network investments are reviewed in Section 3.1.1.1. The Peer Advisor recommends that an operational plan is developed to support both the implementation of the SOFF investment phase in alignment with existing investments and to ensure readiness within ABMS for both the investment phase and ongoing GBON compliance.

Recommendation 2.4(1): ABMS should revise its Strategic Plan and implement an Operational plan, linking the strategic to the SOP levels. It is recommended that as ABMS move into the investment phase of the SOFF framework regular reviews of existing and upcoming national investments are undertaken to ensure the continued complementarity of the projects.

2.5. Review of the national legislation of relevance for GBON

Review the national legislation related to responsibility for measuring and providing weather observations related to GBON.

Review the legislation related to procurement, importation and customs processes of relevance for the proposed Plan's activities and investments.

Provide recommendation on how to address any constraints related to the national legislation required to implement GBON.

ABMS are the Meteorological Authority for Antigua and Barbuda, under the Civil Aviation Authority Act Regulations. However, no national legislation relating to responsibility for providing weather observations currently exists in Antigua and Barbuda. Draft legislation has been produced and submitted to the owning Ministry ("DRAFT ANTIGUA AND BARBUDA METEOROLOGICAL SERVICE BILL"), but this has not been progressed and is currently considered to be a low priority by the government of Antigua and Barbuda with no date given for advancing this initiative. *It is recommended that this draft paper is revisited and that the ABMS aim to strengthen their relationship management with government, to ensure policy and legislation is appropriate for GBON and other essential services.*

The mechanism for procurement in Antigua and Barbuda includes a tender process, with options for selective tenders and tender waivers, overseen by a dedicated government department. The Antigua and Barbuda Government Deputy Financial Secretary advises that the main legislation governing this activity is the Procurement Administration Act 2011 and the Customs Act 2013. ABMS advises that (eg when procuring observing equipment) government bodies will normally pay for services to clear port when importing, but are exempt from paying duties on that import. If challenges in tender and import duties, ABMS can approach the Cabinet to waive.

Module 3. GBON Infrastructure Development

3.1. Design the surface and upper air observing network and observational practices

Provide recommendation on a harmonized observing network design, including siting and instrumentation of new and improved stations, including:

a. A map of observing network distribution and a list of the required new or rehabilitated GBON stations;

b. A list of observation instruments and systems per site; and

c. Investments and activities needed for the installation of new stations and the improvement of existing stations

d. Observational practices defined per network

e. Preliminary maintenance plan for existing and improved/new stations, including calibration practices / - equipment / - facilities

f. Technical specification for new instruments and observing systems for the procurement process

g. Considerations for stations' security, constant power supply, communication and related contingencies (risks can be incorporated in section 5).

3.1.1 Current Network

3.1.1.1 Surface Observations

The ABMS currently operates a network of 23 Surface Automatic Weather Stations across the country – see Table 2 below and subsequent maps figures below. Two stations at the VC Bird International Airport (VCBIA) runway secure area, including the main VCBIA GBON site, are funded by ABMS's budget. The AWS network away from VCBIA is a composite of different initiatives via different one-off funding sources (no ongoing funding, cost absorbed by ABMS), delivering different instrumentation and infrastructure in varying exposures:

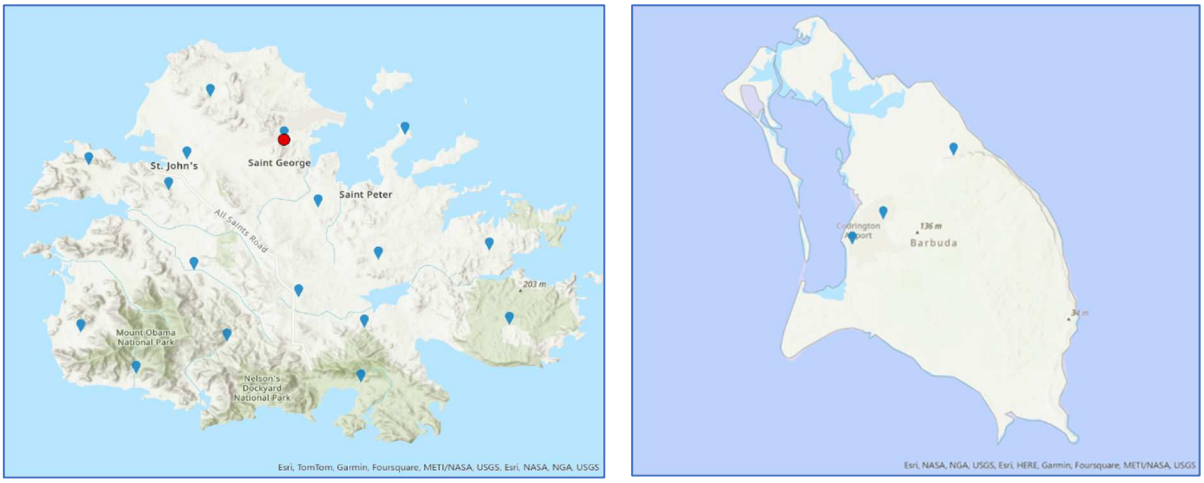
- Japan donor-funded network (10 AWS stations): implemented c.2018. Climatech/other equipment, mobile transmission, and some spares were retained due to non-implementation of all planned stations, but maintenance of software and hardware was not fully understood. The network is not calibrated;
- Italy (5Cs) donor-funded network (4 AWS stations): implemented c.2016. Range of equipment, not calibrated, mobile transmission to separate bespoke software package;
- CIMH-funded (NA) weather stations (6 AWS stations): implemented over many years, Sutron instruments not calibrated, data extracted via satellite and cannot be decoded/used directly by the ABMS;
- BARA9 Marine tide gauge station: implemented c.2011 by NOAA at Barbuda dock, logging and mobile comms, etc, kept on a surge-proof pedestal; accessed from bespoke server – but been offline for approximately 2 years now.

Table 2 - Assessment of existing stations per station characteristics

Station name	Station type (S/UA)	Owner (NMHS/third-party)	Funding source	GBON variable measured			Reporting cycle				GBON Compliance (Y/N)
				SLP	T	H	W	P	SD		
VC Bird International Airport *(Main for Synops and METARs)*	S	ABMS	Gov. of Antigua and Barbuda; R. Allan Stanford	x	x	x	x	x		24	Y
VC Bird International Airport *(Runway 070 Threshold)*	S	ABMS	Gov. of Antigua and Barbuda	x	x	x	x	x			N
VC Bird International *(Makeshift Backup to Main)*	S	ABMS	Japan	x	x	x	x	x			N
Bethesda	S	ABMS	Japan	x	x	x	x	x			N
Botanical Gardens	S	ABMS	NA	x	x	x	x	x			N
Cobbs Cross	S	ABMS	Japan	x	x	x	x	x			N
Diamonds	S	ABMS	Japan	x	x	x	x	x			N
Dunbars	S	ABMS	Japan	x	x	x	x	x			N
Five Islands	S	ABMS	NA	x	x	x	x	x			N
Free Town	S	ABMS	NA	x	x	x	x	x			N
Gray Hill	S	ABMS	NA	x	x	x		x			N
Viv Richards Stadium	S	ABMS	Japan	x	x	x	x	x			N
Crabbs	S	ABMS	Japan	x	x	x	x	x			N
Orange Valley	S	ABMS	Japan	x	x	x		x			N
Sir McChesney (Barbuda)	S	ABMS	Japan	x	x	x		x			N
Hannah Thomas (Barbuda)	S	ABMS	Japan	x	x	x	x	x			N
Willikies	S	ABMS	5Cs	x	x	x	x	x			N
All Saints	S	ABMS	5Cs	x	x	x	x	x			N
John Hughes	S	ABMS	NA	x	x	x		x			N
Green Castle	S	ABMS	5Cs	x	x	x	x	x			N
Willie Bob (Barbuda)	S	ABMS	5Cs	x	x	x	x	x			N
Cades Bay	S	ABMS	NA	x	x	x	x	x			N
BARA9 (Barbuda Marine station)	S	ABMS	NOAA	x	x	x	x	x			N

***Notes*: Assessment of existing GBON stations per station characteristics.** Station type: S: Surface, US: Upper-Air; Owner of the station: NMHS or name of third-party; GBON variables: SLP: Sea-level pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; Reporting cycle: Number of observation reports exchanged internationally per day (0-24); GBON compliance: weather the station is GBON compliant or not (see GBON guide on compliance criteria). Current GBON station shown in RED.

Figure 2. Existing Antigua (left) & Barbuda (right) Surface stations incl V C Bird International Airport GBON station (in RED)



Instrumentation is of varying quality and condition across these networks with separate and non-interoperable visualisations and operating systems; calibration is not undertaken, with a preference for instrument replacement due to the high cost of transporting equipment for calibration in the Leeward Islands and lack of current capability at the CIMH. Site maintenance visits for routine checks on Antigua are relatively regular and also reactive in the event of a fault being identified, subject to availability of the small team of technical staff at the ABMS. It should be noted that Barbuda stations are more problematic, with the last service c.3 years ago, due to resourcing and capacity challenges. Many sites in Antigua are well maintained, however, some sites (including the main GBON site) can become overgrown and dilapidated due to lack of maintenance agreements in place with local landholders. This is a high-density network with a lack of spares, dedicated ongoing support funding and calibration and some user requirements unclear – *as such it recommended that ABMS review the need to maintain all sites where the technical challenge is diverse, especially where data is inaccessible (eg CIMH Sutron sites).*

Currently, only one of these stations, located at VCBIA, is transmitting data globally hourly onto the WIS. In terms of both data and spatial resolution, *the GBON Global Gap Analysis based on the June 2023 baseline assessment indicates that Antigua & Barbuda was non-compliant with the GBON national contribution requirement for surface weather stations on WDQMS and led to the Global Gap Analysis recommendation to improve the station at VCBIA.* The station has failed to consistently achieve compliance since that time as a result of periodic outages due to inability to maintain appropriate operational support. The station is well-exposed with a large enclosure under the control of the Antigua and Barbuda Airport Authority (ABAA), a government owned statutory body, which has all the required security, etc, of an international airport. The site infrastructure is over 20 years old and has significant structural issues, notably the wind mast collapsing over recent years – the mast has been re-welded back to its concrete base but has rusted through again at the base making this an unsafe working environment. The internal enclosure fence is falling over and the vegetation on site is overgrown to several feet height with fenceline trees/shrubs needing to be cut back. The site is successfully powered by a large 100 watt solar panel and supporting large batteries – mains power is not currently used.

Table 3 – list of current network Surface observation instruments and infrastructure

Item	VCBIA Current model
Instrument enclosure	Large fenced area on VCBIA land. No current maintenance agreement in place so overgrown and fence dilapidated. CSL logger enclosure on mast
Tower and platform for wind instruments	Concrete base, red and white airport standard tri-frame metal tower, unsafe rusted condition at base
Solar panel	1x 100w solar panel assumed, make unknown
Battery	100amp Deka Solar x2
Power regulator	Morningstar Sunsaver MPPT SSMPTT-15L
Data logger	CR10X
4g Modem	Fixed link
Enclosure monitor	CSL
Rain gauge	Texas Electronics (+Climatech Japanese comparison). (for comparison Pluvio on W runway)
Temperature + RH sensor	Dual T+RH - make not known - cannot replace (for comparison CSL EE181-L17-PT E+E temp/RH probe on W runway alternate)
Wind speed and direction	RM Young 05108-L30 PT Wind Monitor-HD Cup & Vane replaced 1 year ago (CSL), under-reading. Also Sonic Gill ultrasonic (only for comparison purposes)
Atmospheric pressure	Vaisala PTB330 - needs calibration every 5 years. Inside - should ventilate doors to equalise. Keep in office for check, add station PTB for actual
Visualisation	CSL PC208W 3.01 old software on XP tower, not backed up. Not open internet, just Air Traffic Control (ATC) (for comparison, the W runway alternate met site is on Win 7/LoggerNet)

Of the 5 key relevant GBON parameters, Rain, Wind, Temperature and Humidity are measured at site by a combination of uncalibrated equipment of unknown exact age (and no spare parts available for redundant equipment), but pressure is measured inside the ABMS office on the opposite side of the runway – see Table 3 for full site instrumentation. Additionally, the cup and vane wind head, installed a year ago, is seen as unreliable and to under-read the actual, and thus wind is taken instead from the W runway station instead (installed by Campbell Scientific in 2019, using a Gill ultrasonic wind sensor), meaning the actual GBON station is in fact a composite of differently-located instruments. Data is received to the Met Office from the main VCBIA site via fixed link and then manually entered into a locally configured EDIS-compliant interface for dissemination of SYNOP (with additional non-automated cloud, visibility and present weather elements) plus the METAR. The station is not considered fully functional, safe or sustainable, but lack of finance has hampered the need for urgent replacement of the AWS at this site. Despite only occasional issues being flagged at the current VCBIA Surface station on WDQMS, the condition and lack of calibration of instruments plus the lack of subsequent data management means there is in fact low confidence in the sustainability and climate quality of the observations recorded from the GBON site.

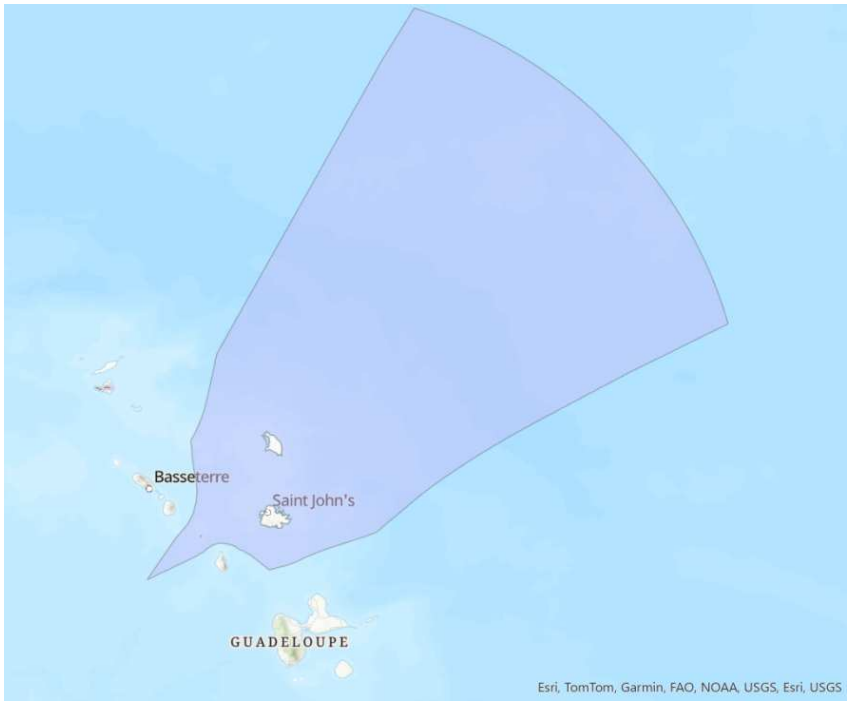
3.1.1.2 Upper air observations

There is no current upper air observation station in A&B, although there was one previously operated by the US Air Force at the old PANAM Air Station near Winthorpes Bay, adjacent to VCBIA - there could be benefit in re-establishing the UA station at the same location, noting a pre-existing climate record.

3.1.1.3 Marine observations

There are currently no marine observations in Antigua and Barbuda, which has an Exclusive Economic Zone (EEZ) of 111,568 km^2 in a data-sparse region, especially with respect to the marine space for which WMO encourages marine services. This is currently inconsistent with the Decade of the Ocean and the need to sustainably develop the blue economy.

Figure 3. A&B Marine EEZ



3.1.2 Recommended GBON Network Design

3.1.2.1 Surface Observations – Network Design

There is a requirement to ensure the future sustainability of the VCBIA surface observing station, noting that data from several stations in neighbouring countries can also often be non-compliant with Surface GBON requirements according to WDQMS (availability and quality). Even if Small Island Developing State (SIDS) 500 km surface station separation distance criteria is applied to network design, there are no GBON stations out to the North and East over the Atlantic Ocean and Antigua's Exclusive Economic Zone (EEZ – see Figure 1). This is also the direction of the prevailing North-Easterly Trade Winds and first landfall for tropical cyclones (tropical depressions, tropical storms and hurricanes) moving westwards across the Leeward Islands, making the VCBIA site essential to maintain.

As stated in the GBON National Gap Analysis, it is recommended that the ABMS improves/replaces the existing GBON surface observation site at VCBIA. All 5 key GBON parameters should be installed in the single station enclosure and should be read as the official station data outputs to WIS2.0 – ABMS may additionally wish to retain their existing barometer in the office for check/resilience, but should open office doors for a sufficient period to ensure full equalization of the indoor environment when doing so. Best practice will be to supply all observations from the single enclosure location for the BUFR report - timely maintenance should be employed to rectify station faults where they do occur rather than artificially combine data from across more than one separate location. The implementing entity should investigate whether the existing concrete base for the wind mast in the main enclosure can be re-used, but it would be beneficial to move the station to the centre of this large enclosure to improve exposure of instruments away from the overgrown enclosure fenceline, especially if appropriate and timely perimeter maintenance cannot be guaranteed at all times.

The activities required for the proposed replacement of the VCBIA station will include the procurement and installation of upgraded instruments at each site. The installation process will be undertaken by the contracted supplier in association with ABMS technicians and the Peer Advisor, wherever necessary. Some existing infrastructure, for example, fences and concrete platforms, may be able to be re-used alongside the upgraded equipment to be procured through SOFF. The station is currently successfully powered by solar panels and large storage batteries and, given the location of the site on the south side of the runway away from current mains power access, it is not recommended to change this practice. Refurbishment of the site will require thorough investigation and implementation of enhanced site tenancy and maintenance support SLAs with the Airport Authority, but replacement of equipment and masts is recommended in full, with spares, given the state of the current enclosure and issues with regional calibration.

There are some key players in the market for providing high-quality instrumentation for GBON purposes and indicative commercial quotations have been acquired to underpin cost estimates for implementation. A full set of spare instruments for each site should be procured to enable swift replacement in the event of instrument failure and to accommodate current regional calibration challenges. Field calibration kits for temp, humidity, rainfall pressure and wind should be procured, along with ongoing assistance to support calibration of all instruments in accordance with the relevant calibration schedules. The specifications for upgraded and replacement instruments at the two GBON surface observation sites are recommended to align with TT-GBON approved material | World Meteorological Organization (wmo.int) for each observation instrument and observing system, specifically: GBON Tender Specifications for AWS. Recommended instruments from trusted suppliers should meet or exceed these specifications in all cases and should alternative instruments or systems be identified as part of the procurement process, these must meet the specifications referred to above.

ABMS may also wish to nominate one additional *RBON (Regional Basic Observing Network)* station in Barbuda at the new airport to reflect the dual island nature and varying climatologies of Antigua and Barbuda, noting also the need for enhanced resilience in a hurricane-prone region. Indeed, Antigua & Barbuda has recent experience of the significant impacts of a full Category 5 hurricane with Hurricane Irma bringing sustained 180 mph winds and widespread damage to Barbuda in 2017. Based on GBON density requirements, where a Barbuda station would be <100 km from the VC Bird GBON station, there is *no current requirement for a second station on Barbuda to be funded via SOFF.* However, SOFF guidance on High Density Surface stations states that "…in countries with high-density networks (100km), peer advisors are encouraged to assess whether the existing high-density network can also benefit from the SOFF interventions for the standard network, e.g., information and communications technology improvements for data exchange". *Such a RBON implementation must be executed by ABMS outside of the scope of the SOFF-funded project* but may be able to take advantage of improvements in process and infrastructure implemented. ABMS should ensure that ABAA or their owning ministry provides sufficient budget and resource for implementation, spares and maintenance travel in order to maintain RBON status. Indeed, outside of SOFF funding, ABMS may also wish, long term, to invest in the same instrumentation and infrastructure for all of its surface network sites to reduce support challenge, should funding become available.

Recommendation 3.1(1): ***Replace and refurbish the existing VCBIA station GBON observation capability with instruments measuring the 5 key relevant GBON parameters and supporting infrastructure, with a focus on producing sustainable, high-quality observations in line with the GBON National Gap Analysis. All relevant airport tenancy & access, health & safety and resource-related agreements must be established by the ABMS. This investment should be coupled with enhanced data and metadata management for the GBON site, and a review of existing legacy networks, especially with respect to equipment stores and maintenance.***

Table 4 - Details of recommended GBON surface observation site locations

Station name	Station type (S/UA)	Lat	Lon	GBON variable measured					
				SLP	T	H	W	P	SD
VCBIA, Antigua	S	17.14N	61.79W	Y	Y	Y	Y	Y	N (N/A)

3.1.2.2 Upper Air Observations – Network Design

There are currently no Upper Air observations in Antigua and Barbuda, though noting that the US Air Force have previously operated a radiosonde station in the vicinity of VC Bird International Airport. As explained in the Gap Analysis, the *GBON Global Gap Assessment indicates a requirement to implement a new UA station in the country* and there is some support for this in an assessment of regional provision in the Leeward Islands using standard GBON 500km station spacing resolution. Noting that the Eastern Caribbean is an entry point for hurricanes to the region, this would be consistent with the approach taken to neighbouring larger islands further west that may not,

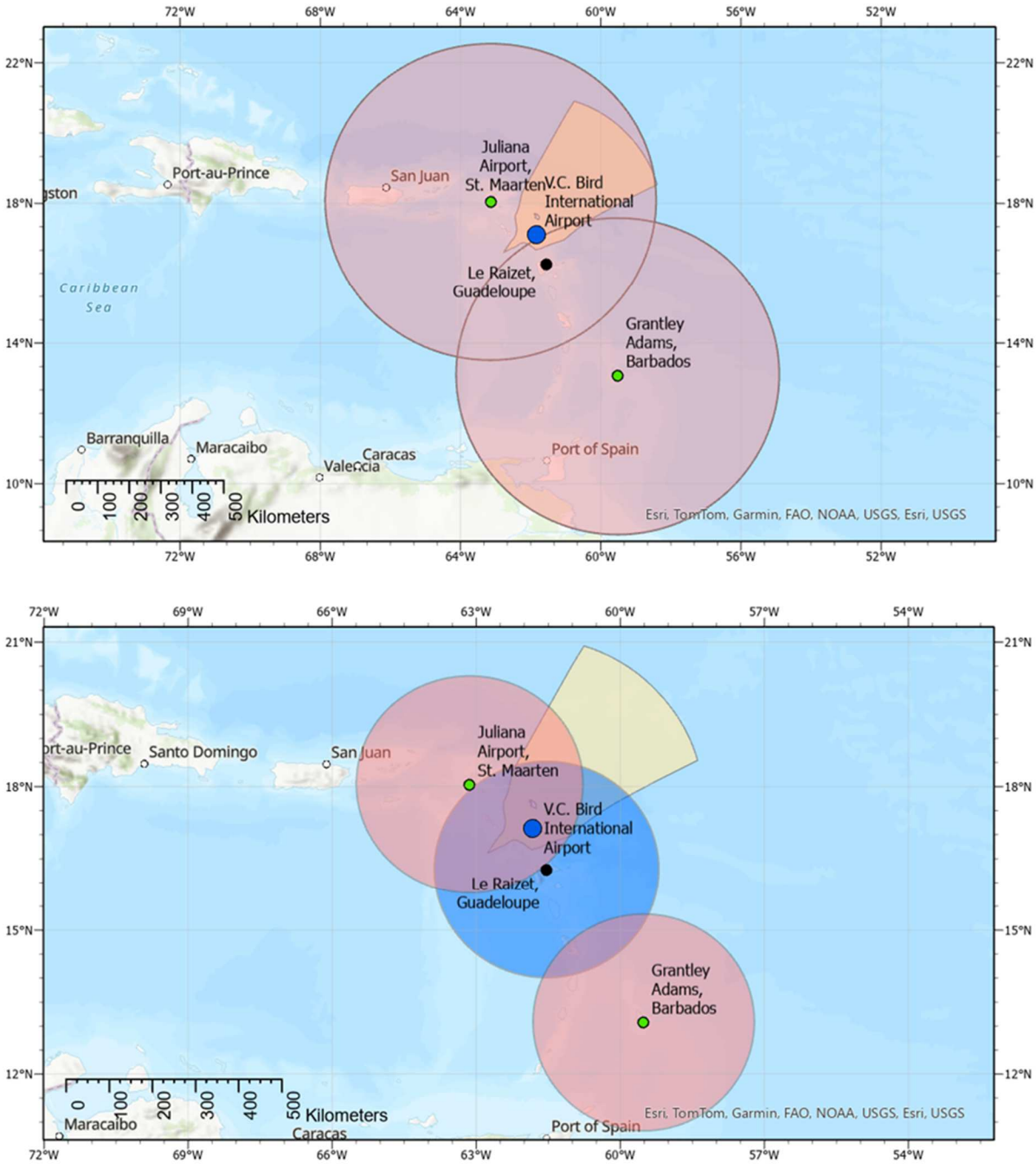
technically, be considered as Small Island Developing States (SIDS) with accompanying 1000k resolution – see Figure 4 below.

Figure 4 GBON 500km Standard Upper Air circles applied to stations across the Caribbean on WDQMS (as opposed to larger 1000km circles for the Eastern Caribbean states if considered under SIDS criteria)

The Lesser Antilles in the Eastern Caribbean have a string of routinely-operated UA stations running along the archipelago from Juliana Airport in Sint Maarten (c.170 km NW of V C Bird; operated by the Meteorological Department Sint Maarten) through Le Raizet station in Guadeloupe (c.100 km South of V C Bird; operated by Meteo France) to Grantley Adams station in Barbados (c.500km SE from VC Bird; operated by the Barbados Met Service). The next nearest stations after that to the South in a data-sparse region subject to developing hurricanes are then to be found in Trinidad & Tobago and on the South American coast. In the immediate vicinity of Antigua & Barbuda, the St Maarten UA station lies downwind in the easterly Trade winds, but while Guadeloupe offers a nearby representative radiosonde ascent in an optimal location for the region, it does not consistently meet GBON data availability requirements throughout the year. Guadeloupe produces two or more ascents a day in the hurricane season but this falls to only one ascent in the dry season - Meteo France have an agreed GBON compliance exemption for Guadeloupe to cover this mode of operation. This also presents a regional compliance gap (in the dry season) where the Barbados station is c.670 km from St Maarten, exceeding the 500 km Standard GBON station density requirement. As a result, unless Guadeloupe can increase output for year-round compliance, then it *may* be desirable to operate UA capability in Antigua, with 500km station separation from Barbados, if standard criteria is applied.

If SIDS criteria is applied, then St Maarten and Barbados would be within 1000km of each other (see Figure 5 below) and thus there would in principle be less dependence on Guadeloupe to operate year-round. *A new UA station in Antigua & Barbuda would not be required*, however representativity of these ascents for Antigua & Barbuda at this range may be questionable. Indeed, St Maarten's 500km radius SIDS circle (diameter/station spacing = 1000km) would cover the entirety of the Antigua & Barbuda EEZ, though, as above, it should be noted that a radiosonde would in fact likely head west on release into the easterly Trades, thus diminishing any notional benefit here.

Figure 5 Existing GBON Upper Air stations in A&B vicinity with (i) 1000km SIDS and (ii) 500km Standard station spacing distance (RED circles); including St Maarten and Barbados (currently compliant) and Guadeloupe (seasonally compliant



In summary, it may be advantageous, in line with the Global GBON analysis, to establish an upper air station in Antigua & Barbuda, depending on the outcome of discussion on the Caribbean regional design required, including whether standard or SIDS criteria is applied. A new VC Bird station may provide some valuable infill and redundancy, given its eastern location in the Lesser Antilles (with first landfall for Atlantic Hurricane tracks and greater regional coverage given westbound travel of radiosondes in the easterly trade winds).

Discussion has been undertaken between the SOFF Secretariat, Caribbean PRs, representatives of the US CHUAS (Cooperative Hurricane UA Station) programme and SOFF Peer Advisors, concluding that a

regional design is required to best target investments across the Caribbean. Where this is not expected to be undertaken rapidly within RA IV, it has been agreed to undertake a ***phased approach to SOFF investment in Antigua & Barbuda with an initial funding request only seeking implementation of a Surface Station at VC Bird****, retaining the option to request an UA station at a later time if the requirement is agreed regionally.*

Recommendation 3.1(2): ***It is recommended to undertake a phased approach to SOFF investment in Antigua & Barbuda with an initial funding request only seeking implementation of a Surface Station at VC Bird International Airport (see Recommendation 3.1(1). The option to request an UA station will be subject to review and revisited at a later time if the requirement is agreed regionally.***

If a UA facility is eventually agreed to be implemented, ABMS has suggested the former PANAM USAF Air Station site for the upper air station, adjacent to VCBIA, noting the operational proximity to the VCBIA GBON Surface site, the potential to continue a historic record and property with several acres of secure fenced land for the installation of a radiosonde facility. The property has been used by the Antigua and Barbuda Defence Force (ABDF) but is now under the control of the Social Security Board (a pension scheme and Gov statutory body). No government/military 24/7 staff would be available for the release of a manual sonde and ABMS cannot undertake sufficient breaks away from observations and product dissemination within their meteorologist/observer operational roster to leave the VCBIA office and ensure safe and timely radiosonde release. *As such it is recommended if implementation was to proceed that an autosonde facility is implemented with the ABMS technical team supporting, generally in normal working hours, subject to severe weather requirements.*

A visit to the proposed site by the ABMS and the Met Office was made during the Peer visit, engaging with local property management representatives; however, the old site could not be located and it is believed that USAF deprecated or took all infrastructure with them on departure from Antigua. The Social Security Board is looking to re-use the land so ABMS will need to engage the Antigua and Barbuda government to secure either this preferred location or another government-held landholding (eg at VCBIA) by formal agreement in order to progress SOFF investment. If the rest of the PANAM, property is being re-purposed, secure fencing around a sufficiently sized site to allow balloon launches should be established. An autosonde installation would require groundworks for the autosonde itself and storage, utilities (including power) and hydrogen generation on site (as opposed to the more expensive use of hydrogen cylinders which may be difficult to source on the island). Hydrogen should be used in preference to the more expensive helium but it brings health and safety management risks and will require appropriate SOPs and Risk Assessment Measures to be put in place to ensure staff safety – training should be acquired from the supplier. A site tenancy agreement should be explicit on permissible hydrogen use and the ABMS will also need to establish general agreement and working-level SOPs with the ABAA and VCBIA ATC regarding the need to transmit on certain frequencies and deconflict launches that may cross or impinge the adjacent VCBIA runway. Risks for the establishment of this station away from the ABMS office at VCBIA (including security, power supply, communication and related contingencies), as well as the Surface station within the VCBIA estate, are captured in Section 5.

Again, as per the potential Surface investment, the specifications for a potential UA implementation should align with TT-GBON approved material | World Meteorological Organization (wmo.int). GBON guidance indicates that *"Members shall operate… upper air stations over land that observe temperature, humidity and horizontal wind profiles, with a vertical resolution of 100 m or higher, twice a day or better, up to a level of 30 hPa or higher, located such that GBON has measurements spaced…*

1000 km or less apart for these observations" (for SIDS). To achieve this, the SOFF-sponsored Radiosonde tender requirements document will be used as input to tender specifications for radiosonde-related procurements. Recommended instruments from trusted suppliers should meet or exceed these specifications in all cases and should alternative instruments or systems be identified as part of the procurement process, these must meet the specifications referred to above.

Several manufacturers offer radiosonde systems that meet GBON specifications, including MODEM, Vaisala, Graw, Intermet and Meisi. Both manual and auto-sonde solutions have been considered by the ABMS and the Peer Advisor team and indicative pricing has been provided by the regional Vaisala representative. For resilience, it is recommended that two radiosonde ground tracking systems be purchased and installed at the site. These should be used alternately to make sure that both systems are maintained in good working order. Depending on the location chosen for the auto-sonde facility, it is suggested that the radiosonde ground station is connected to the internet via a mobile phone modem. This is a cheap way of ensuring resilience – however, if a UA site can be located at a site at the VCBIA with power and line of sight to the ABMS office, then a fixed link would be a direct and more suitable approach. It is also recommended that a backup power supply is provisioned within the procurement to account for temporary power outages. It is recommended that an extended 3rd line service agreement with training is maintained with the supplier throughout the SOFF compliance phase so that any issues with the systems can be quickly resolved. This would be advisable as the supplier will also be required to maintain a supply of consumables (sondes and balloons) and spares throughout this period.

Table 5 – Details of potential future GBON upper air observation location

Station name	Station type (S/UA)	Lat	Lon
Winthorpes Bay	*UA*	*17.15N*	*61.79W*

3.1.2.3 Marine Observations – Network Design

SOFF Guidance states that: "Marine meteorological stations may be considered by SOFF at a later stage, including potentially through sub-regional/regional cooperation modalities. Therefore, SOFF peer advisors are encouraged to include in their GBON National Gap Analysis the assessment of country marine stations and related GBON requirements when considered relevant". This is an area subject to tropical storm passage and it is recommended that future consideration be given to implementation of ship, buoy or drifting buoy coverage at a later stage, if considered sustainable. There is currently no specific plan for the implementation of marine observations, and it is, as such, recommended that when SOFF support extends to include marine observations where there is potential for contribution towards the implementation of the observation network and partnership in relation to deployment and maintenance of the observing equipment.

Recommendation 3.1(3): ***It is recommended that as SOFF support extends to include marine observations, forthcoming investments in Antigua and Barbuda are assessed for their potential to contribute to marine observations for GBON.***

3.1.3 Observational practices defined per network / preliminary maintenance plan for existing and improved / new stations including calibration practices

WMO provides guidance to NMHSs for the operation of observational stations in its Guide to Instruments and Methods of Observation (WMO-No. 8). The ABMS currently undertake maintenance on an ad-hoc at observation sites when errors are identified. This has been highlighted as a significant need by ABMS, particulalry as new regulations will demand improved observation site management.. Barbudan sites are not currently accessed routinely as described above. Instrumentation records are incomplete, with no recording of routine maintenance inspections. The surroundings of the site are also assessed but no metadata is currently held on site condition. As set out in WMO-No. 8 Vol V, an optimum frequency of site inspection visits cannot be generally specified; however, it is strongly recommended that metadata records of site visits, instrument movements, stores holding and incidents are implemented.

Outline Maintenance Plan for GBON Surface Stations

In line with international best practice, a four-stage maintenance process is proposed for the GBON surface stations. The maintenance plan comprises the following elements:

1. Remote monitoring

Remote monitoring will be conducted by the ABMS technical team. They will check the availability of data via the proprietary software provided with the new installation and also the WIS2BOX. Monthly statistical analysis will identify trends in the data over time that could indicate calibration drift, or complete sensor failure. The technical team will maintain a backlog of potential faults which should be updated once potential faults have been investigated and resolved. In this way any systematic faults can be identified and addressed.

2. Routine site inspection and maintenance

The technical team will be responsible for conducting routine inspection and maintenance of GBON sites, as well as fault resolution site visits. The VCBIA station can reasonably be accessed, but it is expected that each site should be routinely visited at least once every six months as a minimum with separate (non-SOFF) budget to accommodate travel and subsistence accounted for, should Barbuda Airport be implemented as a GBON station. Provision must be made either within local staffing or via MoU or contractual SLA with the ABAA to ensure sites are kept in good order, with fences maintained and vegetation controlled. The team will also conduct calibration checks using a travelling standard during each visit and carry spares so that sensors and other hardware (e.g. solar panels, batteries and loggers) can be exchanged if they are found to be out of tolerance. Sensors should also be rotated during these visits and sent back to the ABMS main office for more thorough calibration/investigation where necessary. A central maintenance log will be updated and any changes to metadata recorded as part of each visit.

Metadata enhancements and archiving are seen as a key deliverable to establish in accordance with WMO-No. 8 Volume V - Quality Assurance & Management of Observing Systems - Section 1.9 Data homogeneity & metadata. It is essential to record information on the occurrence, type and time that all network inhomogeneities occur so that this can inform quality control and use by climatologists, enabling identification and flagging of changes in measurement records that are not due simply to changing meteorological conditions (eg – change of instrument, instrument out of calibration, environmental factors such as poor exposure and poorly-maintained grounds, etc). Recommendations for the establishment of a functional metadata system are articulate in Section 1.9.4 of the above guidance.

3. Fault resolution

If a potential fault at a station has been identified, the technical team will undertake a fault resolution visit. These visits will take priority over routine maintenance visits in order to maintain GBON compliance on data availability. It is expected that most faults will be resolved by the team swapping out a component at a site with a spare. It is expected that during a fault resolution visit, the regional team will also conduct routine site inspection and maintenance of the site (in line with point 2 above).

4. Calibration and supplier support

Calibration of the measurement is a key aspect in ensuring data quality and providing traceability of measurement results – this should be undertaken in alignment with WMO No.8 Volume V – Section 4.3 Calibration It is expected that some instruments will need to be either directly replaced or calibrated through an ongoing relationship with the AWS supplier. Historically the ABMS and other met services in the region have struggled to calibrate instruments due to high costs of implementation or transportation amongst the islands to specialist facilities and have thus tended simply to replace instruments when past reasonable use. The implementing entity should work with other SOFF peer advisors and funding recipients in the region (many of which are currently peer advised by FMI, including Barbados where the CIMH is based) to understand the best approach to calibration testing against known standards. CIMH is considered a potential option for collective calibration amongst neighbouring Caribbean meteorological services, but this would require a collective investment and the ability to overcome obstacles (related to jurisdiction and the current specialist capability of CIMH) in order to properly establish, noting also potential costs and challenges of transporting and importing calibrated equipment between Barbados and Antigua. An ongoing service agreement with the VCBIA enclosure instrument supplier may enable a more pragmatic alternative mechanism for ongoing calibration support or direct replacement than CIMH are currently able to offer. It would also provide 3rd line support to the ABMS staff in maintaining the network and in dealing with more complex issues. It would be expected that this agreement would provide training throughout the SOFF investment and compliance phases, so that the ABMS technical staff continually increase their capacity and skill, including the ability to undertake field inspection to check calibration status eg via a travelling standard during maintenance visits. Each instrument should be supplied with a paper and electronic (pdf) calibration certificate when deployed to the field that specifies the following:

- Manufacturer
- Model
- Instrument type/Principle of Operation
- Serial number
- Hardware/Software version [if applicable]
- Calibration Date
- Validity period of calibration/Recommended next date of calibration
- Calibration range
- Traceability of calibration (including applicable standard)
- Calibration method
- Calibration factor and uncertainty
- Name and signature of calibration technician that performed the calibration.

Outline maintenance plan for Upper-Air station

If an UA station is agreed for later implementation in Antigua & Barbuda, the ABMS technical team will be required to routinely load the sonde cartridges and undertake routine inspection and maintenance of the auto-sonde system. SOPs will be established with the operators to routinely cross check the

ground system against the AWS measurements at that location and ensure minimum height requirements are met. It is recommended that a service agreement is established with the radiosonde supplier as part of the procurement, this will provide third line support in the event of ground system failure; the technical team should undertake training from the provider to undertake routine maintenance and safety checks of the station.

Recommendation 3.1(4): ***The Implementation Phase Peer Advisor will work with ABMS to develop Standard Operating Procedures to support the monitoring, maintenance and calibration of the GBON surface (and upper-air) stations and develop maintenance. Leases, maintenance agreements and/or resource considerations for station maintenance must be established by ABMS. Discussion should be undertaken with other regional partners on shared calibration or a dedicated support and calibration supplier contract be put in place for the VCBIA installation.***

Recommendation 3.1(5): ***Metadata recording and archiving should be implemented to provide quality assurance of observations in line with GBON standards.***

3.2. Design of the ICT infrastructure and services

Provide recommendation on ICT infrastructure and services design and solutions on data transmission from an observing station to the national real-time data management system and GTS and WIS 2.0, including:
a. Detailed description of the ICT infrastructure and services design
b. Technical specifications for the data collection system from the observing station to the collection point
c. Technical specifications of the data services (compatible with the requirements of WIS 2.0)
d. Detailed description of the measures to ensure resilience and continuity of the full data processing chain

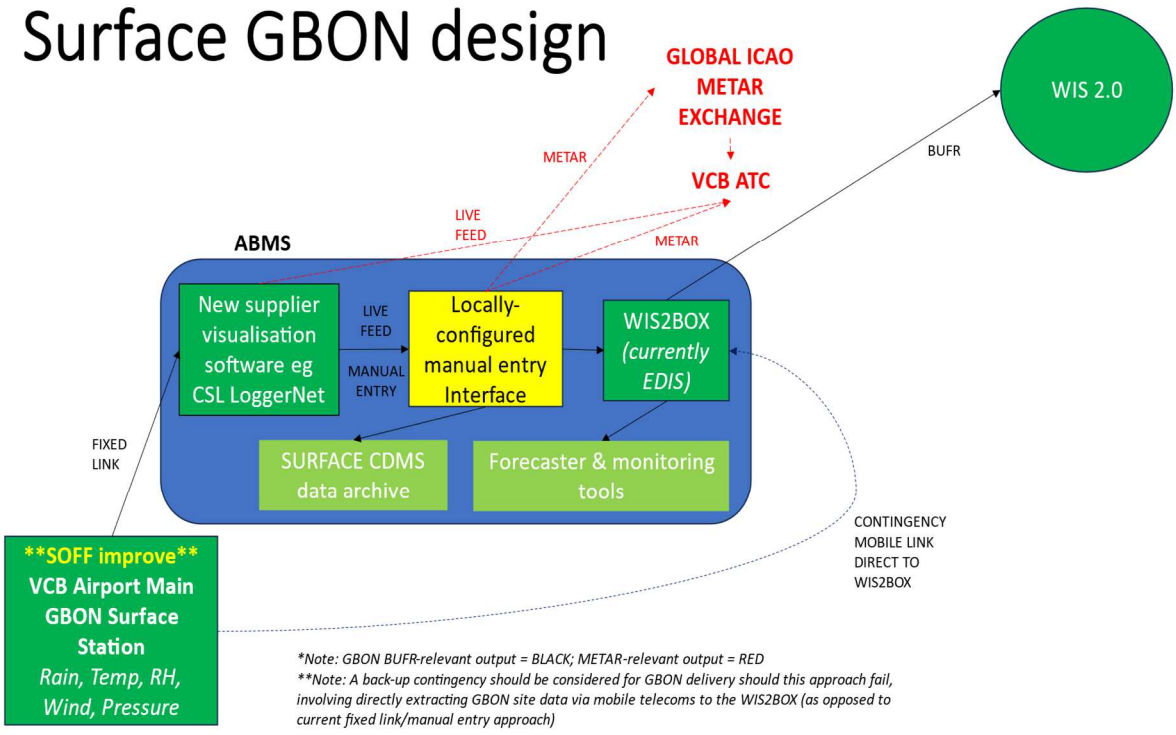
ABMS currently have a complex legacy ICT infrastructure system for the reception, storage, processing and transmission of meteorological data and improvements are required in order to ensure the resilience of the network and expand the capabilities of the data management and transmission systems. Data collected by dataloggers at AWS sites are transmitted via reliable 4G mobile modem connections (or fixed radio link within the VCBIA site) but there is significant risk held around ageing single in-situ office PCs with old and unsupported software and operating systems (eg Windows XP and 7) where that data is then held, with no back-up routines in place. Additionally, with the various network hardware donations over time, the ABMS is forced to operate multiple ingestion systems, servers, software and hardware, presenting the technical team with a growing challenge of inefficiency and obsolescence. ABMS has used their ageing COROBOR (Campbell Scientific France) forecast workstation to send and view surface SYNOP observation messages to the WIS, but it frequently has communication issues and is currently out of service. An internally-configured manual interface is now used to disseminate METARs and send SYNOP messages from the main VCBIA GBON site to the WIS via EDIS (US NWS Email Data Input System). This includes re-typing of automatic site parameters displayed on obsolete Campbell Scientific software relating to the CR10 logger plus observer estimation of cloud base/coverage, visibility and present weather; the daily record is also completed to provide some resilience in data records.

A significant improvement to IT infrastructure is required at ABMS to fully realise the benefit of the implementation of GBON stations supported through SOFF, including provision of updated proprietary software for real time data display with the replacement of the physical observing enclosure equipment, related data ingestion and storage servers/hardware and ability to interact with/share

data internationally via WIS 2.0. Transition from local hard drive to cloud storage is recommended where affordable and achievable, but recurring costs associated with cloud storage mean that local server-based storage for data backups is probably the more sustainable and resilient option in this instance.

The preferred mechanism for sharing GBON observation data from automated instruments available to WIS 2.0 would be via direct feed from site via MQTT to the WIS2BOX. As above, however, ABMS's current approach to providing WMO synoptic and METAR messages is manual and they wish to continue that approach in order to ensure timely and full delivery of both messages for business critical purposes. This notes potential impacts to both data types where: a) they would lose manual parameters including cloud base/amount, visibility and present weather in the BUFR message; and b) WIS2BOX would have a visualization latency that could result in an unacceptable delay to VCBIA METAR production in terms of aviation safety (a key part of ABMS's core task). As such, the following design is recommended for replacement of the current Surface station ICT infrastructure (including CDMS and visualization tools via WIS2BOX – see Section 3.3 for more information), balancing the business needs of the ABMS whilst enabling complimentarity with WIS 2.0 requirements.

Figure 6. Surface station - proposed ICT infrastructure design

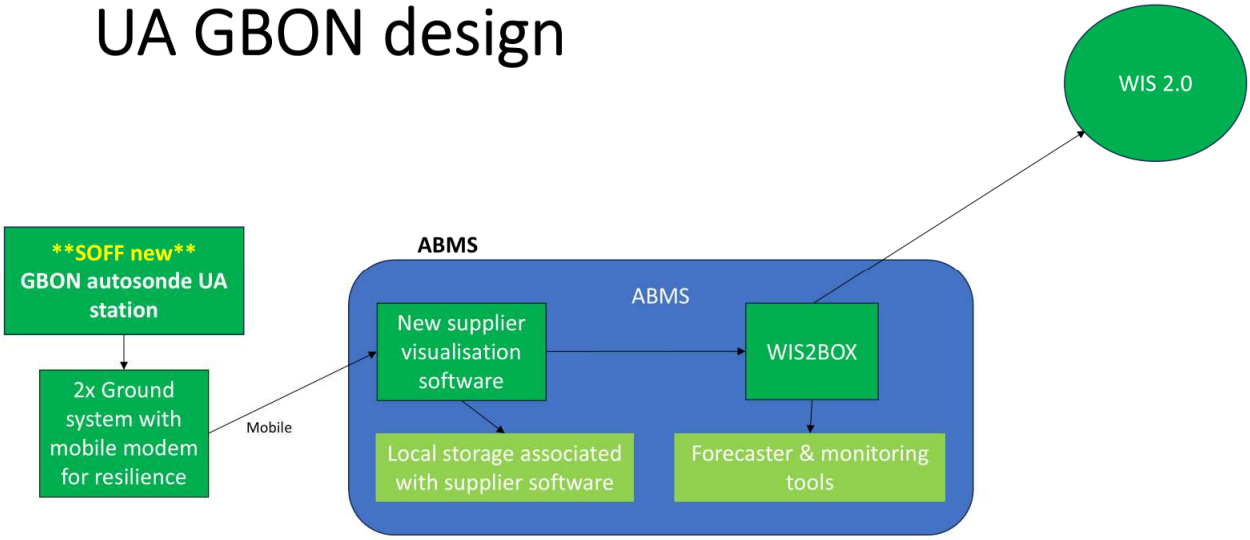


The lead technician at ABMS has configured the current local interface to EDIS and, having undertaken WIS2.0 training in June 2023, can replicate that functionality when use of EDIS transitions to WIS2BOX. A back-up contingency should be considered for delivery on GBON investment should this approach fail, involving directly extracting the 5 key automated GBON parameter data from the enclosure via mobile telecoms direct to the WIS2BOX/dissemination onto WIS 2.0. Given expected latency issues of visualizing that data, in that scenario, it would then be prudent, for the business-critical purposes of completing the VCBIA METAR, to configure the station logger to send a separate message via fixed link to the ABMS office for manual METAR entry with additional parameters. If the Barbuda RBON solution

is also later put in place, then the ABMS should work with the ABAA and the contracted solution supplier to acquire a real time feed if required to support for GBON and aviation services. *This will build on existing VCBIA SOFF GBON investments in ICT management but must not incur direct expenditure from SOFF.*

Should GBON investment proceed for a UA station, then the proposed ICT infrastructure should be as follows below. This would be a simpler configuration utilizing proprietary software for radiosonde data/metadata management, noting the differing requirements for this type of data.

Figure 7. Upper air station - proposed ICT infrastructure design



Recommendation 3.2(1): The ABMS technical team will configure the proposed/optimum Surface ICT design in concert with the Implementing Entity to bring data from the VCBIA station into the existing manual data entry interface for dissemination to EDIS/WIS 2.0. Back-up contingency arrangements should be considered for SOFF investment which would require direct automated message submission to WIS.

Recommendation 3.2(2): Existing in-situ PC hardware and software must be replaced with new PCs, updated operating systems and relevant proprietary software. If ABMS data systems cannot be migrated to the cloud and sustainably funded, then routine back up procedures must be implemented to safeguard data on local hardware and industry standard security protocols implemented where required.

Recommendation 3.2(3): If the UA requirement is subsequently confirmed, SOFF should support implementation of the proposed UA ICT design in alignment with supplier provision

3.3. Design the data management system

Provide recommendation on requirements for a data management system aimed to provide access to data used by operational applications on a real-time basis and the capability to deliver data to a Climate Data Management System (CDMS) for long-term archiving purposes. The system should provide the following:

a. Short-term data storage and access through the services and protocols required by applications for national and international operational activities

b. Acquisition of data to and from WIS/GTS, WIS 2.0 and other national or international sources required for operational activities

c. Data delivery to the national CDMS

d. Discovery and descriptive metadata management

e. Monitoring of data, processing and services

Section 3.2 (including Figures 6 & 7) outlines the methodology for transmission of data from site, preferred manual entry to an interface configurable to the WIS2BOX and WIS 2.0 dissemination (and potential contingency direct dissemination), transfer of data into a CDMS (see further explanation below) and interaction with business-critical METAR production which is a core aspect of ABMS's mission.

In terms of short and long term data storage, data from the VCBIA station (dating back to 1960) is currently only stored on a single XP tower in the forecast room with no back up procedure – to mitigate this significant risk, the operational observing desk continue to complete a paper Daily Record, but no analysis is undertaken of these data records where not in a QCable or configurable archive. All other networks have either no data storage after receipt or retain unmanaged csv files on, in some cases, obsolete hardware. *The ABMS do not currently operate a managed climate archive of data.*

The ABMS should refer to WMO NO.1131 specifications as a guide in developing a National Climate Data Management System (CDMS) and embedding this approach culturally within the organisation, both for the proposed GBON investment and in applying it for benefit across all networks. The data management system that is implemented must be capable of serving as real-time and long-term data storage and provide relevant mechanisms for data ingestion (eg APIs and support MSQT and SFTP protocols for data transfer where interacting with WIS 2.0). The system must also be capable of storing all relevant metadata relating to stations, networks and observations and should be able to support updating the WMO/OSCAR system. ABMS should aim to establish a quality control module which supports real-time quality control and/or manual quality control as an independent part of the system. To properly ingest, store and process these large datasets going forwards the following technology should be used to run a number of applications locally:

- Proprietary software and servers from GBON Implementation supplier to receive and visualise data in real time
- Ability to ingest that data into a CDMS package such as SURFACE CDMS
- If using local hardware solutions rather than the cloud, all physical hardware must be updated appropriately with current operating systems and CDMS back-ups at regular intervals should be undertaken where not using cloud-based approaches

A regional CDMS is currently being developed which this investment proposal should aim to employ for surface AWS station data. SURFACE CDMS (System for Unified Real-time Forecasting of Atmospheric and Climatic Events) provides data storage and access, data delivery, descriptive metadata management (where network changes should be recorded) and real-time monitoring of data, processing and services. SURFACE CDMS was adopted as one of the systems involved in the

creation of OpenCDMS and should incorporate full interoperability with WIS2.0. The advantages of combined development with OpenCDMS and wider adoption of the system would result in better financial and technical support for the software in the long term and enable the inclusion of WIS2.0 as part of the system. SURFACE CDMS uses Python as its main backend language and uses a REST API to allow secured backend connections to specific datasets; it uses PostgreSQL/PostGIS and TimesecaleDB as the database for storing data eg high resolution time-series data. The frontend is currently using Vue.JS and the application is deployed as an open source, industry standard Docker stack using six containers. SURFACE CDMS is available for the cloud (enabling real-time data processing and BUFR format sharing via WIS 2.0) or can locally be installed on hardware.

A review of what is achievable should be undertaken by the Implementing Entity, including whether a cloud-based version of this CDMS would be workable within the constraints of ABMS operation. ABMS advise that WMO and CMO have an agreement for cloud services for use by regional members, but it is unclear if this is permanent and ABMS would find it difficult to pay subscriptions in a timely fashion or train relevant staff in appropriate skills. If, as expected, it is more practical for ABMS to (initially at least) use on-premise downloaded versions of SURFACE CDMS, then ABMS must ensure that all appropriate measures are undertaken to maintain the CDMS including: maintaining and updating hardware; downloading latest versions of SURFACE CDMS as they become available; undertaking routine back-ups of archives across multiple computers; ensuring anti-virus/security/operating systems/etc are regularly updated; and implementing a structured approach to recording and curating data and metadata as per WMO 1131. If an offline version of Surface CDMS is implemented locally, then data will be supplied to WIS 2.0 in real-time via the locally-configured manual interface to the WIS2BOX and VCBIA GBON data must either be acquired in real time from WIS 2.0, discovered and accessed from the regional GISC or a copy requested directly from ABMS should they add value via additional quality control measures on data locally.

ABMS have a nominal Oscar National Focal Point (NFP) to manage and update descriptive metadata on Oscar and if pursuing a continued manual WIS 2.0 data upload/local hardware-based approach to CDMS, then Oscar updates regarding the GBON site will need to be rigorously ensured via embedding in SOPs whenever a significant change at site occurs (further to Recommendation 3.1(6) on establishing appropriate metadata recording and archiving processes). In terms of monitoring, ABMS have nominated staff to be the WDQMS NFP and would need to nominate one, but do regularly review WDQMS outputs with respect to the VCBIA station in order to ensure GBON compliance. Monitoring of GBON station performance can also be undertaken in real-time locally via the forecast/observing shift rosters via WIS2BOX visualization (see also Section 3.1.3 regarding remote monitoring procedures to be implemented), through analysis of an established CDMS or WIS Centre data availability and timeliness statistics and via continuous monitoring of the state of physical and IT-based technology at ABMS.

Recommendation 3.3(3): As part of SOFF investment, the ABMS should implement the following data management practices:

- **Undertake a thorough review of the available software solutions in the investment phase in consultation with the Implementing Entity to support the design and implementation of the system.**
- **Acquire proprietary software and servers from GBON Implementation supplier as part of the observation site procurement to receive and visualise data in real time**

- **Implement Surface CDMS or equivalent package, preferably with data stored in the cloud or with appropriate safeguards if locally, and adopt data management and quality management practices as outlined in WMO 1131**
- **Ensure that all physical hardware used is updated with appropriately current operating systems/windows versions and undertake CDMS back-ups at regular intervals**
- **Ensure that Oscar and WDQMS NFPs are nominated and that regular metadata update/data monitoring processes are embedded and routinely followed within ABMS operations**

3.4. Environmental and sustainability considerations

Recommend pragmatic approaches and measures for environmentally responsible design and evolution of the national networks to achieve GBON requirements, including:

a. Development and use of specifications that consider environmental sustainability for procurement of measurement instrument equipment to meet the GBON requirements
b. Integration of sustainability considerations for the management of operations of GBON stations, including installation, calibration, and maintenance
c. Careful material selection for the development, shipping and day-to-day operations of GBON stations, with a focus on developing and using reusable instruments and sustainable methods of observation (e.g., elimination of single-use plastics).

Environmental and sustainability considerations should be incorporated into the procurement process as part of the specifications including the use of reusable instruments where possible and sustainable methods of observation. Surface instruments should be reusable where appropriate and consideration of the environmental and sustainability impacts of maintenance (including associated travel) should be made as part of the SOP for maintenance and calibration. Similarly, consideration of the use of biodegradable materials for upper air observations should be made where possible as well as the environmental impact of shipping methods and materials.

The project will be governed by UNDP's consolidated framework covering environment, involuntary resettlement, and indigenous peoples. The project will undergo environmental and social due diligence at appraisal to help the UNDP decide if the project should be financed and, if so, the way in which environmental and social risks and impacts should be addressed in its planning, implementation and operation. The appraisal process also identifies opportunities for additional environmental or social benefits. Of particular importance to the SOFF project, Section 3 'Resource Efficiency and Pollution Prevention' sets out objectives to:

- Avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- Promote more sustainable use of resources including energy and water;
- Avoid or minimize project-related emissions of GHG and
- To avoid or minimize generation of waste.

The objectives and policies set out in the framework should be adhered to throughout the project lifecycle and should be used to guide environmental considerations in the procurement process, strategic development plan for the ABMS and SOPs generated in relation to observations, maintenance, calibration and working practices.

Recommendation 3.4(1): Implement best practice in environmental design of the solution, in alignment with UNDP policies and practices.

Module 4. GBON Human Capacity Development Module

4.1. Assessment of human capacity gaps

Provide a summary of staff skills, education levels, and capacity gaps for technicians, experts, and management, including Port Meteorological Officers (PMO) when applicable, gender balance and gender opportunities.

ABMS has national, regional and international responsibilities, covering a diverse range of activities. These include making observations to GBON and ICAO standards, forecasting the impacts of tropical cyclones and other severe weather, and representing Antigua and Barbuda at WMO, the Regional COF and IPCC. The ABMS is comprised of an Administrative Section, four technical sections – Operational Meteorology, Applied Meteorology, Information/Technical Systems and Quality Management – and a communication section.

4.1.2. Education Levels

Approximately 48% of the staff hold certificates, 28% holds bachelor's degrees, while 14% has obtained secondary levels education. The remaining 10% possesses master's degrees. This distribution reflects a relatively diverse range of educational backgrounds within the ABMS, with a strong emphasis on undergraduate and graduate-level qualifications.

4.1.3 Gender Balance

In terms of gender balance, the ABMS consists of 59% male staff and 41% female staff. While there is a higher representation of male staff, the staff is trending female. Of the last eight people hired, seven are female. In the next month, another female degreed meteorologist will be hired. A balance is likely to be reached in the next five years without any specific effort by the ABMS, as girls in our country and region continue to outperform boys. There will likely come a time when measures may be needed to recruit males to maintain a gender balance.

In order to deliver the requirements of the SOFF investment phase and future GBON compliance it is proposed that two new roles are established:

- **Project manager**: This temporary role will be contracted to the Implementing Agency in order to manage the delivery of the SOFF Investment phase and provide change management support to the ABMS during this phase where ABMS does not have sufficient resource to underpin project management. *It is only intended to permanently employ one new role to support this GBON investment going forwards and the GBON Network & Data Manager role (below) will ultimately supercede this headcount addition.*
- **GBON Network and Data Manager**: This will be a new permanent role within the Information/Technical Systems section of ABMS with responsibilities for the initial integration and establishment of the GBON network and data services (including CDMS) during the investment phase, and the ongoing dedicated monitoring and maintenance of this service in the future to ensure GBON compliance. This role should implement and maintain appropriate network management, ICT/data management, CDMS, metadata collection/archiving and calibration/replacement procedures in relation to the GBON investment, building on process efficiencies to expand to the wider ABMS-operated network where possible, in tandem with others working in the observations area. *As such, this role should have appropriate IT and technical skills to undertake tasks such as configuration of the WIS2BOX, SURFACE CDMS, etc.*

Other than in the proposed roles above, there are broader skills gaps in areas such as general project management and delivery, stakeholder management, financial management and strategic planning. There is also a need to ensure the technical skills base, including those responsible for network maintenance have a plan, opportunity, and funding to maintain the essential skillset in maintenance and calibration of observing equipment. Similarly, the IT and data management skillset needs to be fully supported to strengthen the capability of the NMS to administer and maintain the network.

Recommendation 4.1(1): Recruit additional (temporary) GBON Project Manager and (permanent) GBON Network and Data Manager posts

Recommendation 4.1(2): Provide Peer Advisor support through the Implementation Phase to advise Project Manager and the ABMS

Figure 8. Current ABMS Organogram

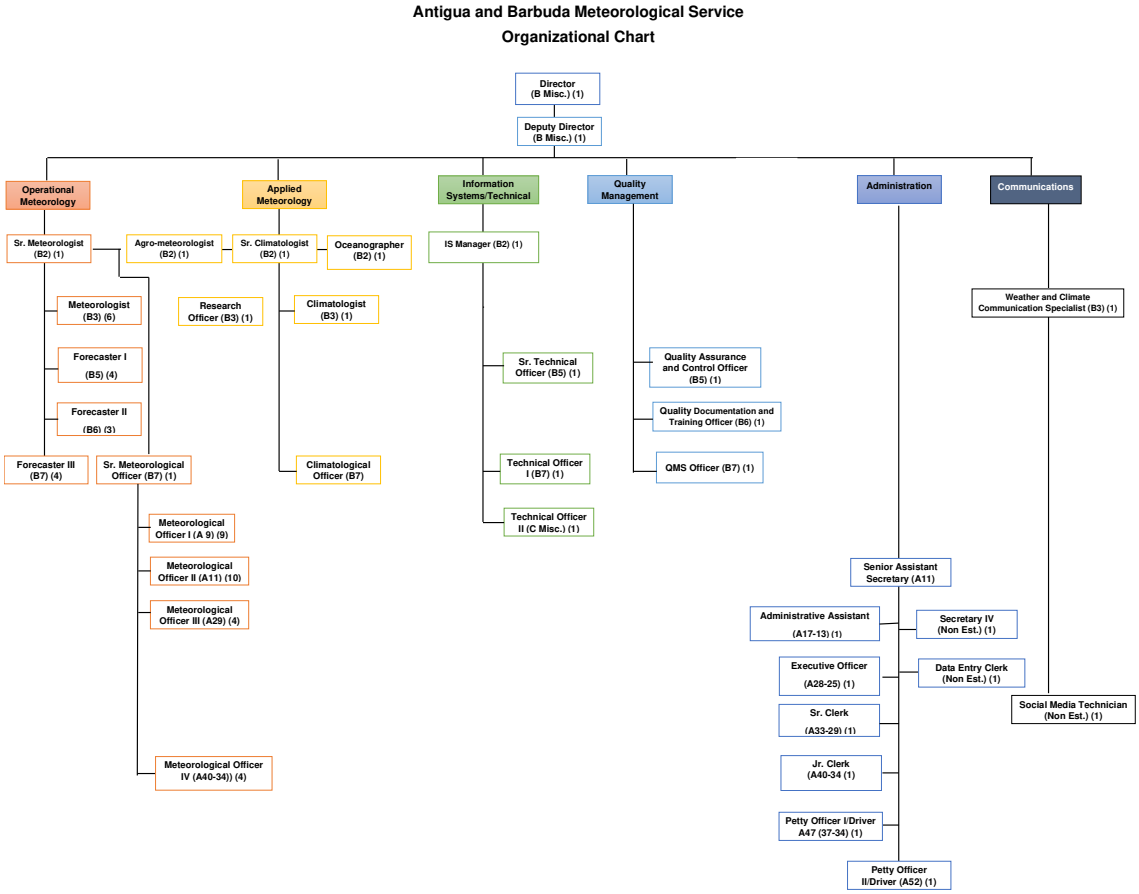
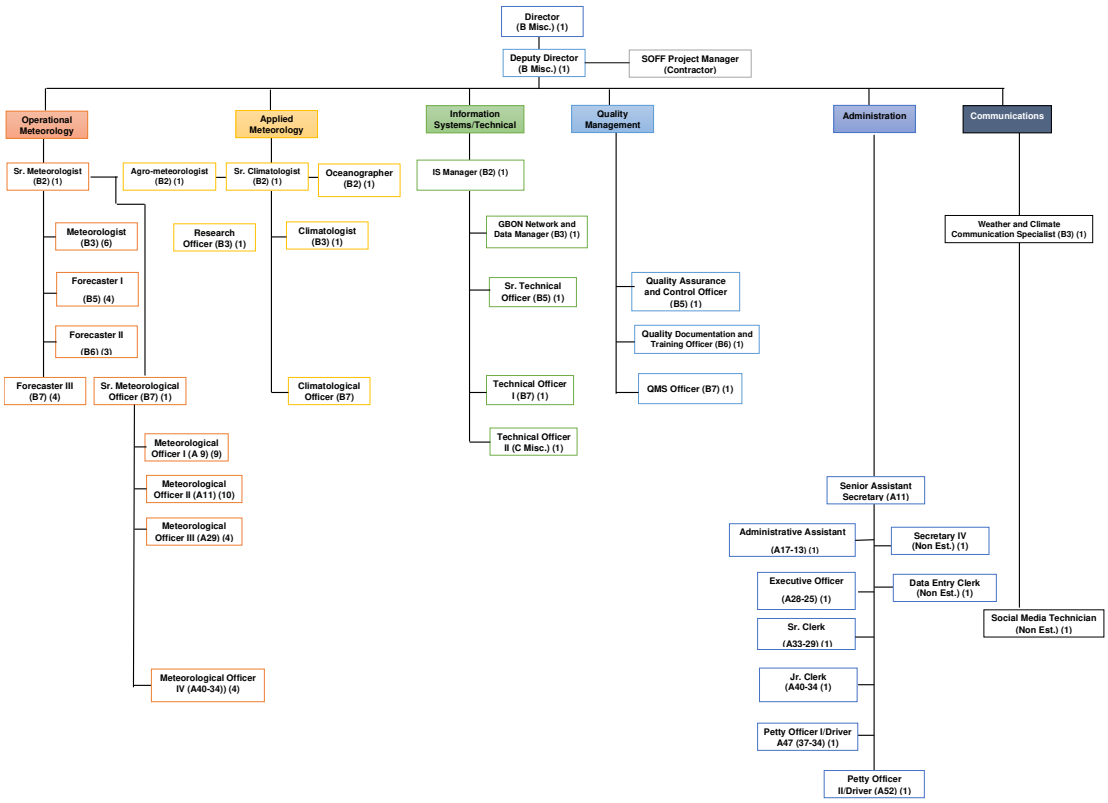


Figure 9. Proposed new ABMS Organogram



4.2. Design capacity development activities for technical staff

Provide recommendation on training activities and recruitment for technical staff, including:

a) Instrument and station maintenance at site
b) Calibration and maintenance at the workshop
c) Network monitoring
d) ICT system operations

In order to ensure that the maintenance and operations of observing and network equipment is high quality and consistent, it is recommended that an ongoing programme of formal and informal training is undertaken across the technical staff at the ABMS.

As outlined above, we recommend that the implementation phase activity is managed by the dedicated project manager that is to be established under this project. The project manager will work with the ABMS and the Peer Advisor in the Implementation Phase to determine the optimal approach for the installation of the new GBON Surface and Upper Air sites. The ABMS will assume specific responsibility for operations and maintenance of the GBON sites and the GBON network and data management provision.

Technical staff in the Information/Technical Systems section require formal training in the operation and maintenance of the instruments which should be sourced from the manufacturer or supplier of the instruments and coordinated through the CIMH / CMO. Specific training on the maintenance and observation practices associated with the new observations should be provisioned for existing technical staff in this section and extended to new staff as necessary. It is recommended that a repository of reusable training materials be developed and made available to ensure consistent training can be efficiently provided in the case of staff turnover.

Similarly, training on the calibration of instruments should be provisioned for the technical staff at the workshop and updated in the event of staff turnover. It is recommended that this is coordinated through the CIMH / CMO as a regional training workshop activity including other SOFF beneficiary countries in the region. With respect to calibration, given the local challenges in access to calibration services, the implementation phase will examine the relative merits of calibration and sensor replacement as approaches for maintaining GBON compliance.

In addition, it is recommended that technical staff utilise existing online resources including the WMO training materials in the WMO Education and Training Programme, in particular courses under the Instruments and Methods of Observation section and the available training and workshops on the implementation of WIS2.

In summary, indicative training programme topics that could be considered are as follows:

- WMO Competency framework overview
- Weather/climate
- Instruments and measurements
- Validation/Verification/Calibration
- Planning and drafting a routine inspection and maintenance plan including quality assurance
- Data transfer, telemetry, and integration
- Modem configuration and testing
- Network monitoring, troubleshooting & fault repair

- ICT Management and metadata/CDMS implementation (specifically Surface CDMS if regional collaboration)
- Data storage and quality management
- Products and client services
- Sector/user engagement, decision support and risk management

The ABMS will be responsible for the maintenance of the network and IT infrastructure and relevant training will be sourced by the Project Manager for both the new GBON Network and Data Manager and existing technical staff. It is recommended that this training programme be undertaken as soon as practicable within the SOFF programme to ensure that the network and software implementation of Surface CDMS and WIS2 are robust and maintainable. The Implementation Peer Advisor will support capacity development, in particular offering informed advice on the establishment of SOPs, calibration/maintenance practices and other expert areas of technical focus.

Recommendation 4.2(1): Project Management in the Implementation Phase should determine required training to deliver desired capacity development outcomes under the advice of the Implementation Phase Peer Advisor

4.3. Design capacity development activities for senior management

Provide recommendation on training activities and recruitment for management in
a) Strategic and financial planning
b) Project management

The ABMS has a broad and diverse range of responsibilities, and demand for more services from the NMHS is also increasing. This situation puts an increasing burden on the NMHS across operational, technical and leadership teams, and puts their ability to sustain the GBON investment at risk.

In order to position the ABMS to face up to this demand, and mitigate the risks presented, it is recommended that the ABMS strategic plan is refreshed, and an operational plan is developed. This will identify priorities for the SOFF implementation phase and ensuring operational and GBON stability and compliance. It will also provide evidence to government and future investors of the current and future risks to sustainable service provision by the ABMS.

Training of the Senior Leadership Team should also be undertaken. This should include off-the-shelf training packages, such as Management and Leadership training, Managing Successful Projects training, Financial Management and Human Resource Management training. Further training should be focused on the implementation of the ABMS Observation Strategy and Operational plans, ideally through the peer advisory process, to deliver GBON compliance during and beyond the project.

Outputs from this should also include the development of standard operating procedures for quality assurance, maintenance, and sustainability, and their adoption into a Quality Management System (QMS).

In recognition of the existing significant tasking on ABMS, as is recommended above, a contracted project manager should be provided by the project, reporting in to the ABMS Senior Leadership Team (SLT)This post will be responsible for the effective introduction of all SOFF funded outputs to the ABMS including training and development of strategies and processes, under the advice of the Implementation Phase Peer Advisor.

Recommendation 4.3(1): Training for Senior Leadership should be undertaken to best position the ABMS for future success and sustain the benefits of SOFF investment and GBON compliance.

4.4. Gender and CSOs considerations

Provide recommendations on activities, consultations, and areas of collaboration for the implementation of the Plan to ensure active CSOs participation and promotion of gender balance and gender opportunities.

It is recognized at the ABMS the importance of Gender, Equality and Social Inclusion (GESI) and the crucial role of the ABMS to address the issues of GESI and support people and communities disproportionately impacted by extreme weather, seasonal events and climate change. It is the responsibility of all NMHS to proactively support women, girls and marginalised people who are more likely to be negatively affected by the impacts of climate and weather-related extreme events. ABMS has not previously conducted any formal gender assessments and does not have a specific gender action plan, but notes the trend towards female staff where increasing STEM requirements favour those with stronger communication skills/qualifications. It is recommended that the ABMS formalize action plans relating to gender and engagement with Civil Society Organisations (CSOs). The proposed investment in GBON sites across Antigua & Barbuda will require cooperation with CSOs and an event

should be held to engage with this sector to highlight the important role of these observations in the value-chain that provides high impact weather information within the national context of women's empowerment.

Furthermore, it is recommended for all ABMS staff to undertake GESI training as part of a broader activity to ensure GESI is mainstreamed into the ABMS working practices. The following guidelines from the WISER GESI Minimum Standards should be followed and adhered to on all SOFF activities:

1. Is there a GESI context analysis to inform programming which identifies:
    a. Barriers and enablers to people of different genders, ages and ability, social economic constraints, or marginalised groups accessing project services.
    b. The risks of project activities which might negatively impact GESI and how to mitigate such risks?
2. Can people of different genders, ages and abilities, social economic constraints, or marginalised groups with differing abilities meaningfully participate in the design, implementation and monitoring, evaluation and learning (MEL) of the project, so they can build individual agency, change gender and group relations, transform systems and structures
3. How does the project contribute to the gender equity, protection, and longer term empowerment of different genders, ages and ability, social economic constraints, or marginalised people?
4. Is there a plan for building the capacity of local partners on GESI using these Minimum Standards and GESI upskilling?
5. Does the MEL system enable analysis of GESI issues and does the project Logframe or results framework integrate qualitative and quantitative:
    a. Gender and social inclusion targets, that capture evidence of leadership, empowerment and meaningful participation in decision-making?
    b. Sex, age, and differing ability disaggregated data and account for intracommunity diversity and complexity?

During the implementation of the National Contribution Plan, and any further modernisation, recruitment and training should aim to follow these guidelines:

- Women should represent at least 50 % of all participants in SOFF-related and supported training
- Women should represent at least 50 % of all participants in SOFF consultations, planning workshops, etc.
- Women should represent at least 50 % of staff for operating and maintaining GBON stations
- Women should represent at least 50 % of decision-making and project management positions where applicable

The importance of engaging with Civil Sector Organisations is also recognised in terms of raising awareness of the ABMS, its observations and services and how they play an important role in the value-chain that provides high-impact weather information, especially to women and girls and marginalized communities within Antigua & Barbuda. The proposed investment in GBON sites across Antigua will require cooperation with CSOs and an event will be held to engage with this sector to mitigate against the risk of theft and vandalism.

Recommendation 4.4(1): All ABMS staff should undertake GESI training to deliver required organisational benefits; a consultation event should also be held with CSOs, including those focused on the empowerment of women and marginalized communities within Antigua & Barbuda.

Module 5. Risk Management Framework

5.1 Assess the risks of the observing network and propose mitigation measures

Based on the SOFF Risk Management Framework, identify risks and recommend a risks management framework, including:

a) Identification and analysis of risks

b) Mitigating measures and responsible

c) Monitor and evaluation

The primary risks to the observation network are set out in the risk register below. This risk register should be owned and maintained by the Director of the ABMS and updated on a quarterly basis.

Operational risks to the observations network						
Risk description	**Impact description**	**Impact level**	**Probability level**	**Priority level**	**Mitigation**	**Owner**
Station operations & security	Risk to station security, constant power supply, communication and related contingencies	High	Medium	High	Adequate funding, skills and planning to manage the network. ABMS and project/permanent resource will need to engage with local providers to ensure delivery	Dale Destin, ABMS / Implementing Authority
Operational hardware failure	Inability to provide the full GBON compliant observations to GTS/WIS2	High	High	High	Adequate funding, skills and planning to manage the network. Resilience and redundancy measures to be included in network design and operational plans / SOPs.	Dale Destin, ABMS / Implementing Authority
Insufficient trained resource	Inability to maintain the observations network	Very High	Medium	Very high	Collaborate with other stakeholders to provide support and maintenance to the network where necessary. Highlight to ministry the proposed SOFF training both for technical skills and leadership and management.	Dale Destin, ABMS / Implementing Authority

Conflicts in government priorities	Potential lack of alignment of A&B government priorities may lead to counter-demands on ABMS reducing capacity to deliver GBON compliance	High	Medium	High	Build relationships and understanding of the importance of weather and climate services across the A&B government, in particular those produced by ABMS	Dale Destin, ABMS
Finance	Risk to project funding and delivery if insufficient separation of project funds from normal operational funds via A&B government	High	Low	Medium	Recommended flow of project investment funds direct through project and Implementing Entity	Dale Destin, ABMS / Implementing Authority
Natural disaster impact on ABMS or GBON observation sites	Eg hurricane damage to building and ingress of water to damage electrical equipment: physical damage to the equipment or communications infrastructure	Very High	Low	Medium	Proposal being developed to build a stronger more hurricane resistant building; also proposal to repair and fortify current structure. Pre-deploy staff and spares to the vicinity in a safe location.	Dale Destin, ABMS / Implementing Authority

Recommendation 5(1): Undertake review of risks to the observations network and incorporate into strategic plan and manage through the operational plan

Module 6. Transition to SOFF investment phase

This module involves supporting the beneficiary country and the IE in preparing the Investment phase funding request based on the recommendations provided in the Plan.

Please provide any additional recommendation relevant for the translation of the National Contribution Plan into an Investment Phase Funding Request.

It is recommended that, on approval of the Investment Phase Funding Request, a virtual workshop including the ABMS, UNDP and the Met Office is arranged to review the outputs of the readiness phase and discuss the transition to the investment phase. The regular project meetings undertaken in the readiness phase should continue under the coordination of the UNDP and should include the Peer Advisor wherever necessary.

Recommendation 6(1): Undertake workshop with the Peer Advisor and implementing entity on transition to investment phase

Summary of GBON National Contribution Plan

Components	Recommended activities
Module 2. *GBON business model and institutional development*	*Recommendation 2.2(1): ABMS and the Implementing Entity should investigate the benefits of regional collaboration in delivering investment in observations in Antigua & Barbuda*
	Recommendation 2.3(1): ABMS and the Implementing Entity to strengthen ties across the Antigua and Barbuda government and undertake SEB assessment to provide evidence to government of the value of and need to maintain weather and climate services
	Recommendation 2.4(1): ABMS should revise their Strategic Plan and implement an Operational plan, linking the strategic to the SOP levels. It is recommended that as ABMS move into the investment phase of the SOFF framework regular reviews of existing and upcoming national investments are undertaken to ensure the continued complementarity of the projects.
Module 3. *GBON infrastructure development*	*Recommendation 3.1(1): Replace and refurbish the existing VCBIA station GBON observation capability with instruments measuring the 5 key relevant GBON parameters and supporting infrastructure, with focus on producing sustainable, high-quality observations in line with the GBON National Gap Analysis. All relevant airport tenancy & access, health & safety and resource-related agreements must be established by ABMS. This investment should be coupled with enhanced data and metadata management for the GBON site, and review of existing legacy networks, especially with respect to equipment stores and maintenance*
	Recommendation 3.1(2): It is recommended to undertake a phased approach to SOFF investment in Antigua & Barbuda with an initial funding request only seeking implementation of a Surface Station at VC Bird International Airport (see Recommendation 3.1(1). The option to request an UA station will be subject to review and revisited at a later time if the requirement is agreed regionally.
	Recommendation 3.1(3): It is recommended that as SOFF support extends to include marine observations, forthcoming investments in Antigua and Barbuda are assessed for their potential to contribute to marine observations for GBON.

	Recommendation 3.1(4): The Implementation Phase Peer Advisor will work with ABMS to develop Standard Operating Procedures to support the monitoring, maintenance and calibration of the GBON surface (and upper-air) stations and develop maintenance. Leases, maintenance agreements and/or resource considerations for station maintenance must be established by ABMS. Discussion should be undertaken with other regional partners on shared calibration or a dedicated support and calibration supplier contract be put in place for the VCBIA installation.
	Recommendation 3.1(5): Metadata recording and archiving should be implemented to provide quality assurance of observations in line with GBON standards.
	Recommendation 3.2(1): The ABMS technical team will configure the proposed/optimum Surface ICT design in concert with the Implementing Entity to bring data from the VCBIA station into the existing manual data entry interface for dissemination to EDIS/WIS 2.0. Back-up contingency arrangements should be considered for SOFF investment which would require direct automated message submission to WIS.
	Recommendation 3.2(2): Existing in-situ PC hardware and software must be replaced with new PCs, updated operating systems and relevant proprietary software. If ABMS data systems cannot be migrated to the cloud and sustainably funded, then routine back up procedures must be implemented to safeguard data on local hardware and industry standard security protocols implemented where required.
	Recommendation 3.2(3): If the UA requirement is subsequently confirmed, SOFF should support implementation of the proposed UA ICT design in alignment with supplier provision
	Recommendation 3.3(3): As part of SOFF investment, ABMS should implement the following data management practices: • *Undertake a thorough review of the available software solutions in the investment phase in consultation with the Implementing Entity to support the design and implementation of the system.* • *Acquire proprietary software and servers from GBON Implementation supplier as part of the observation site procurement to receive and visualise data in real time*

	• *Implement Surface CDMS or equivalent package, preferably with data stored in the cloud or with appropriate safeguards if locally, and adopt data management and quality management practices as outlined in WMO 1131* • *Ensure that all physical hardware used is updated with appropriately current operating systems/windows versions and undertake CDMS back-ups at regular intervals* *Ensure that Oscar and WDQMS NFPs are nominated and that regular metadata update/data monitoring processes are embedded and routinely followed within ABMS operations*
	• *Recommendation 3.4(1): Implement best practice in environmental design of the solution, in alignment with UNDP policies and practices.*
	Recommendation 4.1(1): Recruit additional (temporary) GBON Project Manager and (permanent) GBON Network & Data Manager posts
	Recommendation 4.1(2): Provide Peer Advisor support through the Implementation Phase to advise Project Manager and ABMS
	Recommendation 4.2(1): Project Management in the Implementation Phase should determine required training to deliver desired capacity development outcomes under the advice of the Implementation Phase Peer Advisor
	Recommendation 4.3(1): Training for Senior Leadership should be undertaken to best position ABMS for future success and sustain the benefits of SOFF investment and GBON compliance
Module 4. *GBON human capacity development*	*Recommendation 4.4(1): All ABMS staff should undertake GESI training to deliver required organisational benefits**;** ABMS should formalize action plans relating to gender and engagement of CSOs.*
	Recommendation 5(1): Undertake review of risks to the observations network and incorporate into strategic plan and manage through the operational plan
Module 5. *Risk Management Framework*	*Recommendation 6(1): Undertake workshop with peer advisor and implementing entity on transition to investment phase*
Module 6. *Transition to SOFF investment phase*	*N/A*

Annex 1 - ABMS Staff Summary

Name	Job title	Gender	Education level
Dale Destin	Director	M	MA Climatology BSc Information Technology, Meteorology and Mathematics
Lorne Salmon	Deputy Director	M	MA Hydrology BSc Meteorology
xx	Climatologist	M	BSc Meteorology
xx	Meteorologist	M	BSc Geoscience - Operational Meteorology MSc Leadership- Disaster Prepared and Crisis Management
xx	Meteorologist	F	BSc Meteorology Post Graduate Diploma: Management Studies
xx	Forecaster I	M	Class II- Senior Level Technician
xx	Forecaster I	M	BSc Meteorology
xx	Forecaster II	M	Certificate: WMO Senior Level Technician
xx	Forecaster II	F	Certificate: WMO Senior Level Technician
xx	Forecaster III	F	BSc Meteorology
xx	Forecaster III	F	BSc Meteorology
xx	Quality Management System Officer	F	Undergrad Certificate: Quality Management Certificate: WMO Entry Level Technician
xx	Meteorological Officer I	M	Certificate: WMO Entry Level Technician
xx	Meteorological Officer I	M	Certificate: WMO Entry Level Technician
xx	Meteorological Officer I	M	Certificate: WMO Entry Level Technician
xx	Meteorological Officer I	M	BSc Computer Science Certificate: WMO Entry Level Technician
xx	Meteorological Officer II	M	Certificate: WMO Entry Level Technician
xx	Meteorological Officer II	F	Certificate: WMO Entry Level Technician
xx	Meteorological Officer III	F	Certificate: WMO Entry Level Technician
xx	Meteorological Officer III	F	Certificate: WMO Entry Level Technician
xx	Meteorological Officer III	M	Certificate: WMO Entry Level Technician
xx	Meteorological Officer III	F	BSc Structural Geology Certificate: WMO Entry Level Technician
xx	Information Systems Manager	M	BSc Information Technology and Mathematics

xx	Technical Officer	F	Diploma: Electronics and Electrical Engineering
xx	Senior Assistant Secretary	F	Certificate: AA Business Administration
xx	Secretary	F	
xx	Data entry Clerk	M	
xx	Driver/Petty Officer	M	
xx	Social Media Technician	M	

Report completion signatures

Peer Advisor signature  Helen Bye - Head of International Engagement Met Office 30/09/2024
Beneficiary Country signature  Dale Destin - Director ABMS Antigua & Barbuda Meteorological Services V. C. Bird International Airport Antigua
WMO Technical Authority signature