20th November 2024

GBON National Gap Analysis

Systematic Observations Financing Facility

Weather and climate data for resilience

WEATHER CLIMATE WATER

Screening of the National Gap Analysis (NGA) of The Bahamas

WMO Technical Authority screens the GBON National Gap Analysis to ensure consistency with the GBON regulations and provides feedback for revisions as needed. *The screening of the NGA is conducted according to the SOFF Operational Guidance Handbook, version: 04.07.2023 and the provisions in Decision 5.7 of the SOFF Steering Committee.*

Following iterations with the peer advisor and beneficiary country, WMO Technical Authority confirms that the National Gap Analysis is consistent with GBON regulations.

Date: 10/02/2025

Signature:

Albert Fischer

Director, WIGOS Branch, Infrastructure Department, WMO

GBON National Gap Analysis Report
The Bahamas

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1. Country information from the GBON Global Gap Analysis

Table I. WMO GBON Global Gap Analysis (June 2023). Illustration of the information that the WMO Secretariat provides to each country

A. GBON horizontal resolution requirements	B. Target	C. Reporting (GBON compliant)[1]	D. Gap to improve	E. Gap new	F. Gap total
	[# of stations]				
Surface stations Standard density[2] 500 km	**3**	0	**3**	**0**	**3**
Upper-air stations over land Standard density[2] 1000km	**1**	**0**	**1**	**0**	**1**

2. Analysis of existing GBON stations and their status against GBON requirements

The Bahamas Department of Meteorology's surface weather observation network consists of mostly automatic stations and two manual stations (in Freeport and Nassau). The inventory of new stations consists of 15 automatic stations, of which 8 of have been installed. All stations have the capability to report all GBON parameters excluding snow-depth which is not applicable in the country. Besides synoptic stations, the BDM hosts a network of rainfall stations (a part of the Community Collaborative Rain, Hail and Snow Network CoCoRaHS). The listing of stations also includes a few old stations that report some of the meteorological parameters, as broken and obsolete sensors have not been replaced (the spare parts have been discontinued). The BDM plans to replace these old stations with a few of the new ones from its' the inventory.

[1] The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, June 2023). Stations with data availability more than 80% on at least 80% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved.

[2] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

In many of the islands', the BDM operates airport observation stations (AWOSs) to serve the needs of the aviation community. Unfortunately, these systems do not satisfy the synoptic needs as the airport systems are unable to function during tropical cyclones/hurricanes (masts unable to withstand winds above 40 knots). Therefore, it is imperative to have automatic weather stations (AWSs) alongside the AWOSs.

Table II. Assessment of existent stations per their operational status and network ownership

GBON Requirements	Existing observation stations (# of stations)			
	NMHS network		Third-party network	
	Reporting (GBON compliant) [3]	To improve	Reporting (GBON compliant) [3]	To improve
Surface land stations Standard density [4] 200km Variables: SLP, T, H, W, P, SD	**2**	**1**	**0**	**0**
Upper-air stations operated from land Horizontal resolution[4]: 500km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	**0**	**0**	**0**	**1**
Surface marine stations in Exclusive Economic Zones:[7] 500 km Variables: SLP, SST	**0**	**0**	**0**	**0**
Upper-air stations operated in Exclusive Economic Zones:[5] 1000 km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	**0**	**0**	**0**	**0**

In The Bahamas, there is a mixture of private observation stations (both marine and weather stations) operated by private companies and homeowners. These stations are not part of the national network, they have not acquired station identification numbers from the BDM and

[3] The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period during the development of National Gap Analysis Stations with data availability more than 80% on at least 80% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved.

[4] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations.

[5]Although GBON marine stations and stations in EEZ are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the status of current marine stations for future GBON marine observations investments.

their data is not shared with the BDM. The BDM plans to identify the private stations and networks and assign station numbers while conducting site surveys. These surveys will reveal the representativeness of the exposure, the effectiveness of the instrument and will confirm whether these stations would be included in the BDM's data network.

The BDM has registered five GBON stations to the WDQMS GBON database. Two of these stations: Lynden Pindling International Airport in New Providence and the Grand Bahama International Airport in Grand Bahama have existing automatic surface weather stations compliant with GBON specifications, that is transmitting the required data on an hourly basis. At this moment, there seems to be issues in receiving and processing the data to the WDQMS database from these stations, although the BDM is sending the data as requested. For example, on 28th of April, only 5 datasets from Freeport station has been ingested by DWD, 3 by ECMWF and JMA, and For Nassau Airport 8 datasets by DWD and JMA and less by others. The problem is currently being investigated, hopefully a resolve will be obtained as soon as possible.

The remainder of the WDQMS registered stations: George Town, Abraham's Bay and Matthew Town, have no or severely lacking equipment for synoptic surface weather observation.

Table III. Assessment of existing GBON stations per station characteristics. Station type: S: Surface, UA: Upper-Air; M: Marine; Owner of the station: NMHS or name of third-party; GBON variables: SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature; Reporting cycle: Number of observation reports exchanged internationally per day (0-24); GBON compliance: whether the station is GBON compliant or not (see GBON guide on compliance criteria).

Station name	Station type (S/UA /M[6])	Owner (NMHS /3rd party)	Funding source	GBON variable measured							Reporting cycle (obs/day)	GBON Compliant (Y/N)
				SLP	T	H	W	P	SD	SST		
Lynden Pindling Int Airport, New Providence (Nassau)	S	BDM	BDM	X	X	X	X	X	-	-	hourly	Y
Freeport, Grand Bahama	S	BDM	BDM	X	X	X	X	X	-	-	hourly	Y
George Town, Exuma	S	BDM	BDM	-	-	-	-	-	-	-		N
Abraham's Bay, Mayaguana	S	BDM	BDM	-	-	-	-	-	-	-		N
Matthew Town, Inagua	S	BDM	BDM	-	-	-	-	-	-	-		N
Lynden Pindling Int Airport, New Providence (Nassau)	UA	NOAA	NOAA	-	X	X	X	-	-	-		N

[6] Please see guidance on marine stations in Section 2 on Scope.

Crooked Island	S	BDM	BDM	-	-	-	-	-	-		N

The BDM has one upper-air sounding station in Nassau. This station is a part of the Cooperative Hurricane Upper Air Station network and is therefore supported by US National Weather Service (NWS) and the National Oceanic and Atmospheric Administration (NOAA). It has not been operational in recent years due to problems with the balloon hydrogen generator. The hydrogen generator, by Proton, has been repaired several times with the support of NOAA with a number of parts being replaced with no success. It is recommended that new hydrogen generator be purchased along with a line-conditioner for the site however, the NWS has not allocated a budget for the investment. Prior to ceasing operation, the generator functioned enabling the BDM to successfully operate soundings twice a day or more during the hurricane season. Other operational sounding stations close by, reporting to WDQMS database are located in Miami and Key West.

3. Results of the GBON National Gap Analysis

The Bahamas consists of an archipelago of 700 islands and spans over an area of nearly 14000 square kilometers. The requirement of the horizontal resolution for the GBON surface stations (500km for SIDS) can be theoretically achieved with three stations. However, the existing GBON compliant stations (Lynden Pindling International Airport in New Providence and the Grand Bahama International Airport in Grand Bahama) are situated only 200km from each other covering only the northern portion of the island chain (see Figure 2.). To fulfill GBON's minimum compliance, it is recommended that an automatic surface weather station be shipped from the BDM's warehouse in Nassau to Crooked Island for installation.

Considering the scarcity of observations in the area and the strategic importance of observations for hurricane forecasting, it is recommended that consideration in the future to be given to implementing a higher resolution network in this area. It is recommended that further consideration be given to the installation of stations in George Town, Exuma and/or Matthew Town, Inagua. As both stations have pre-existing infrastructures, therefore installation of the new stations would be an easy fix.

To meet the GBON requirements for the upper-air sounding system, it is recommended that a new hydrogen generator be purchased along with a line-conditioner for the sounding station located in Nassau (Figure 1.). NOAA is prepared to continue support by providing the consumables and operation assistance.

It is recommended to support the BDM in implementing the WIS2.0 protocol, which is new for them, and to support data transfer, quality and management processes in the BDM to ensure the reliability and quality of international data dissemination as required by GBON.

Table IV. Results of the GBON national gap analysis. SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature**.**

GBON requirements	Global GBON target	Approved national target	Reporting	Gap	
				To improve	New

	[# of stations]				
Surface land stations	3	3	2	**1**	**0**
Upper-air stations operated from land	1	1	0	**1**	**0**
Surface marine stations in Exclusive Economic Zones:[7] Density 500 km Variables: SLP, SST Observing cycle: 1h	0	0	0	**0**	**0**
Upper-air stations operated in Exclusive Economic Zones: [8] Density 1000 km Vertical resolution: 100 m, up to 30 hPa Variables: T, H, W Observing cycle: twice a day	0	0	0	**0**	**0**

3.1 Recommended existing surface, upper-air and marine[10] stations to be designated to GBON

According to WMO GBON density requirements the Bahamas is covered with three surface weather stations and one upper air stations. The stations to be included as the GBON stations are the Lynden Pindling International Airport in Nassau, New Providence which is an existing and fully GBON compliant station, Grand Bahama International Airport in Freeport, Grand Bahama also an existing and almost GBON compliant station and a weather station to Crooked Island (22.74597°, -74.17669°) to be located at the airport. The BDM has procured an automatic weather station for Crooked Island but will need SOFF support to ship the equipment, prepare the site and to cover the needed installation and civil works.

[7] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements.
[8] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements.
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[10] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements.

The GBON designated upper-air station is located in Lynden Pindling International Airport, New Providence. The station facilities have been newly renovated by the BDM, but key equipment (hydrogen generator) will need to be replaced to initiate GBON required operations.

Table V. Recommended existing surface, upper-air and marine stations to be designated to GBON.

Station name	Station type (S/UA/M[11])
Lynden Pindling International Airport, New Providence	S
Grand Bahama International Airport, Grand Bahama	S
Lynden Pindling International Airport, New Providence	UA
Crooked Island	S

[11] Please see guidance on marine stations in Section 2 on Scope.

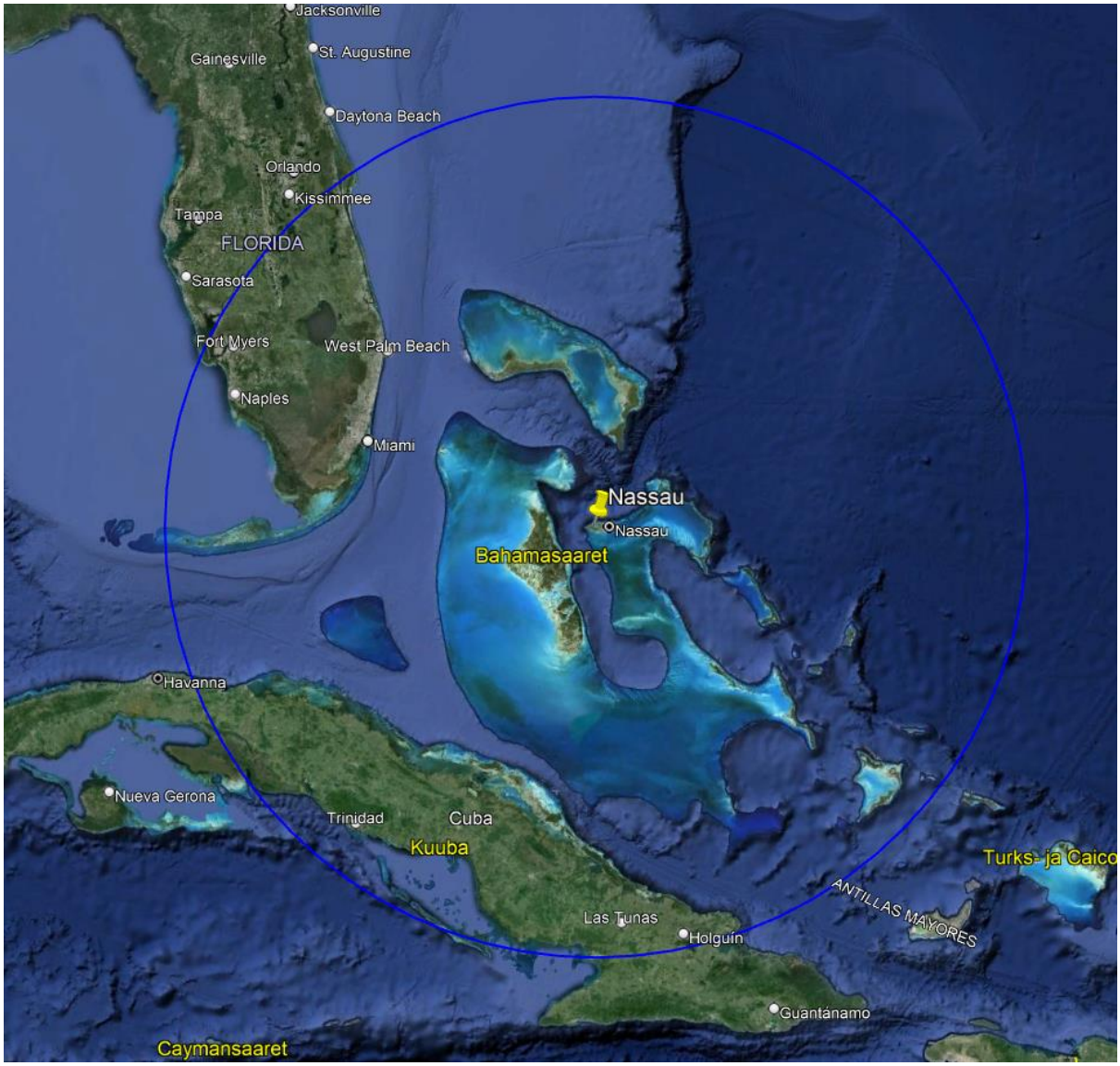

Figure 1. Location of the GBON upper-air sounding station. Circle indicated with 500km radius.

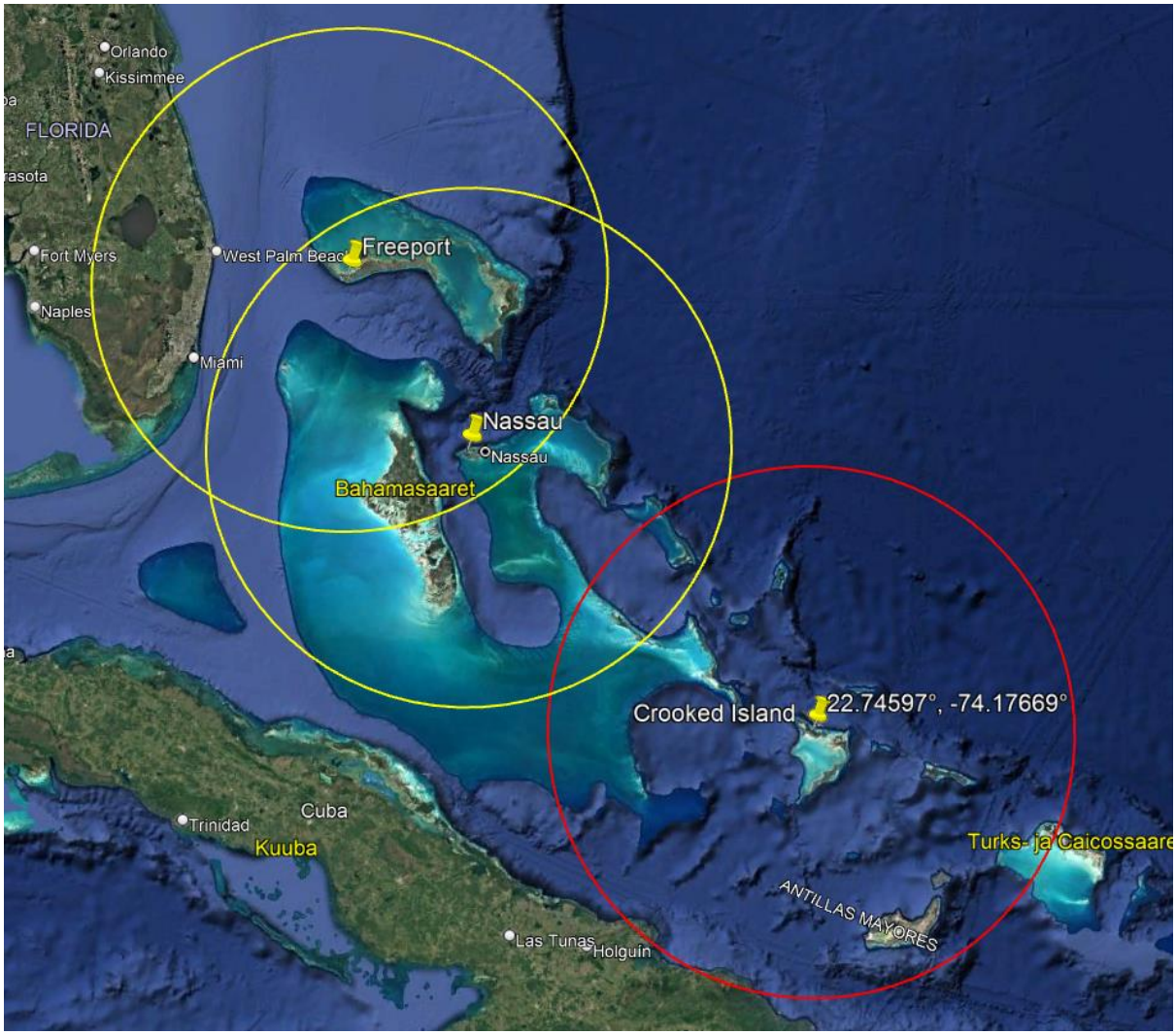

Figure 2. Location of the GBON surface weather station. Circles indicated with 250km radius. Yellow circles for Freeport and Nassau stations that are GBON compliant. Red circle for Crooked Island station that requires SOFF support for functioning.

Report completion signatures

Peer Advisor signature    
Beneficiary Country signature  Government of The Bahamas Department of Meteorology JAN 30 2025 Director's Office Nassau, N.P., The Bahamas
WMO Technical Authority signature 

Annex 1.

Review of GAPs in capacity

In addition to the number of GBON compliant observation stations, the discussions of Gap Analysis included a short review of Quality Management System (QMS), the status and capacity gaps in data transfer, database management, sensor maintenance and calibration, metadata, and quality control.

QMS

BDM is in the progress of upgrading the quality management systems primarily designed around it's aviation service line, to meet the requirements of the ISO9001:2015 standard, and to expand the scope to include all lines of services of the department such as Public, Marine, Warning and Climatology. The BDM target for conformance with the standard is during 2025 resulting in the certification of the entire quality management system. Previously only aeronautical operations have been ISO9001:2008 compliant. The work in the QMS is supporting many of the needed actions for full GBON compliancy.

Identified gaps:

- Benchmarking other organizations.

Central database

BDM operates a central database with Climsoft as the front end. Observations are downloaded to the database manually from the NOAA DCS system. The current configuration will need strengthening to support automatic data downloading to the local database. Data management, improvements to the quality control mechanisms, capability to communicate with APIs for importing and exporting open data are needed. It is important to store data from different sources in one place to simplify the system of the data pipeline.

Identified gaps:

- IT support in observation data, transmission, quality control, processing and archiving.
- Need to train more staff with the required skillsets.
- Benchmarking other organizations.

Data transfer

Data transfer from the automatic weather stations are mainly done by satellite GOES link to the DRGS operated by NOAA in the US. Observations are redistributed from there to WIGOS and to the NOAA Data Collection System (DCS), where they are extracted for use by the BDM. Data is manually downloaded from DCS to BDM Climsoft database.

Data communication with the regional WMO data centre is manual and none of the stations have been registered in the WDQMS GBON database although operational stations are registered and reporting to OSCAR database on RBON status.

The BDM is not familiar with the WIS2.0 requirements and has not yet been acquainted with the wis2box regional solution.

Identified gaps:

- Lack of training on WIS2.0 which will replace GTS system.
- Regional collaboration on the wis2box platform
- Lack of training in OSCAR and WIGOS portals
- Benchmarking other organizations.

Metadata

Metadata input for the database is under development.

Identified gaps:

- Metadata to be updated to GBON station web tool and national database.

Data quality control and assurance

No real-time quality control. Quality checks are done manually when data is downloaded into climatological database. Climsoft database inbuilt limits and thresholds are used to spot unreliable data. There is a need to improve the capacity for automated data quality assurance (QA) and control (QC) throughout the value chain of observation. As BDM plans to include third party networks to the national observation pool in the future, the continuous assessment of the quality of the observations will be key in ensuring high data quality.

Identified gaps:

- Human capacity building needs, including programming skills.
- Automated CQ/QA methods and algorithms
- Benchmarking other organizations.

Sensor maintenance and calibration

Some or the station network (Vaisala AWS) have a remote diagnostics tool and are maintained with yearly preventive maintenance as recommended by the supplier. The supplier has assisted during the maintenance calls and trained BDM staff to independently operate the systems as the supplier's service contract comes to an end. Sensor calibration is done using supplier calibration kits and supplier calibration services. BDM has a comparison kit for pressure and temperature to determine if the sensor need calibration.

Stations (Sutron) delivered in the CCCCC's project do not have spares or a similar maintenance plan. Nor is there yet a plan to calibrate the sensors. All these stations are installed close to BDM headquarters in order to facilitate faster response to maintenance.

Identified gaps:

- Lack of maintenance personnel, need to recruit additional technical staff member.
- Strengthening of staff capacity to maintain and calibrate sensors.
- Plan for the future of calibration processes either continuing with a service agreement with the sensor provider or utilizing regional calibration services available.
- WMO regional calibration centre hosted at the Caribbean Institute of Meteorology and Hydrology will need strengthening to cover the calibration of required GBON parameters,

provide reliable services and to service the selected GBON station systems (supplier specific modifications).

Annex 2.

List of existing surface weather stations in Bahamas

Station name	Station owner	Comment
West End, Grand Bahama	NOAA	
Freeport Manual, Grand Bahama	BDM	GBON station. Compliant but issues with data transfer to WDQMS.
Freeport AWS, Grand Bahama	BDM	
Freeport, Grand Bahama	BDM	
East End, Grand Bahama	BDM	Communication link currently down
Sandy Point, Abaco	BDM	
Paradise Island	Private	
Fresh Creek, Andros	BDM	
Lynden Pindling Int Airport, New Providence (Nassau)	BDM	GBON station. Compliant but issues with data transfer to WDQMS.
North Eleuthera	BDM	
Rock Sound, South Eleuthera	BDM	
The Bight, Cat Island	BDM	
Moss Town, Exuma	BDM	Obsolete observation system. Site to be refitted with new AWS.
Duncan Town, Ragged Island	BDM	
Abraham's Bay, Mayaguana	BDM	Obsolete observation system. Site to be refitted with new AWS.

List of existing airport weather observation systems.

Station name	Station owner	Comment
Freeport, Grand Bahama	BDM	AWOS
Lynden Pindling Int Airport, New Providence	BDM	AWOS

Marsh Harbour, Abaco	BDM	AWOS not operational
Treasure Cay, Abaco	BDM	AWOS not operational.
Governor's Harbour, Eleuthera	BDM	AWOS
Matthew Town, Inagua	BDM	AWOS