May, 2024

GBON National Gap Analysis

Dominican Republic

Systematic Observations
Financing Facility

Weather
and climate
data for
resilience

Screening of the National Gap Analysis (NGA) of Dominican Republic

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 peer advisor and beneficiary country, WMO Technical Authority confirms that the National Gap Analysis is consistent with GBON regulations. While the WMO GBON Global Gap Analysis identified the need for 2 surface stations and 1 upper air station over land to meet the GBON horizontal requirement, the **WMO Technical Authority confirms the NGA results which indicate the need for 4 surface land stations and 0 upper station based on specific national circumstances.**

Date: 29 July 2024

Signature:

Albert Fischer

Director, WIGOS Branch, Infrastructure Department, WMO

GBON National Gap Analysis Report
Dominican Republic

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1.- Basic Geography and Climatology of the Dominican Republic

The Dominican Republic is a warm country located in the heart of the Caribbean, surrounded by the Atlantic Ocean to the north, the Caribbean Sea to the south, and the eastern center of Central America. It occupies two-thirds of the eastern part of the island of Hispaniola, which it shares with the Republic of Haiti. It is the second largest country in the Caribbean, with an area of 48,442 square kilometers and a forest area of 16 thousand square kilometers. The country's relief is the deepest of all the Antilles, formed by three mountain ranges: Central, Northern or Sierra de Monte Cristi and Eastern or Sierra El Seibo.

Fig.1: Map of the Dominican Republic

In the Dominican Republic the climate is governed by the large general circulation systems of the atmosphere: semi-permanent anticyclones, migratory cyclones, secondary circulations and local influences. This influence of the North Atlantic anticyclone, regulator of the trade winds regime and humid tropical maritime air (disturbed by summer easterly waves), causes much of the precipitation over the Dominican Republic.

Annual precipitation can vary from 500 millimeters to more than 3000, in areas with favorable exposure to trade winds as well as orographic and convective rains.

Two normally dry regions are distinguished, the Southwest and the Northwest. The rainiest regions are the Northeast, part of the Southeast and the North. The above is explained by its exposure to the trade winds and orographic and convective rains.

There is therefore great spatial variability in the distribution of precipitation, as shown in the map of average annual precipitation.

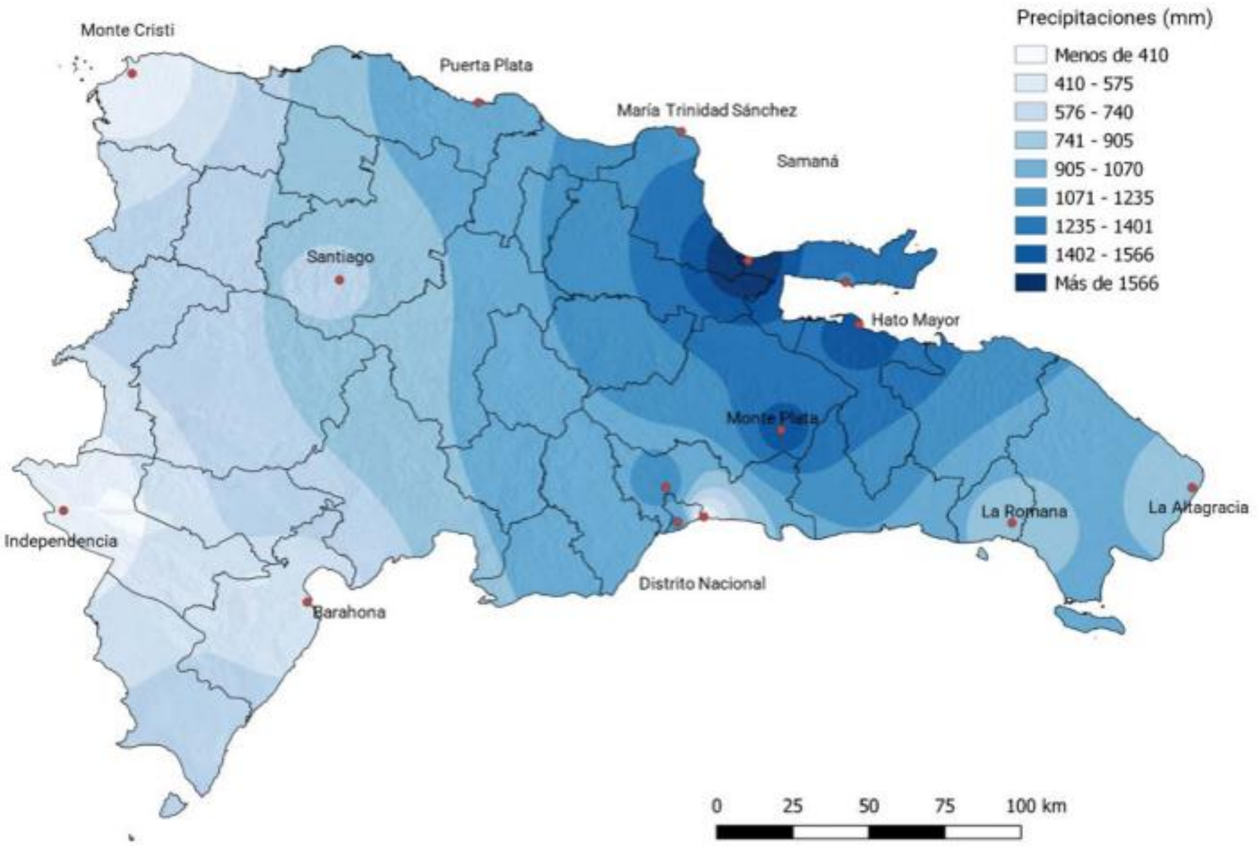


Fig. 2: Average annual precipitation in the Dominican Republic (Source: ONAMET)

The average annual temperature of the country is 25.5° C, however, due to the great variations of the relief, there are temperature differences of the order of 28° C to 26° C in the lowest areas and from 22° C to 18° C in the area of meteorological stations with higher altitude where extreme minimums below zero (-1.0° C) have been recorded during the period of frontal activity.

The average annual maximum temperature is 31.0° C, varying in the warmest places. Extreme maximum temperatures between 43° and 39° have been recorded in the warmest areas of the country in the time period between July and September.

Three rainy seasons are observed in the Dominican Republic:

- **Frontal Season (November - April):** During this period, in addition to the cold fronts, medium-level troughs and pre-frontal troughs predominate, which according to Dominican climatology generate their most important rainfall accumulations on the northern slope of the central mountain range, the Cibao Valley, the plains coastal areas of the Atlantic and the northeastern area. Accumulated smaller amounts of rain are observed to the east, the south of the central mountain range, the Caribbean coastal plain and the southwest sector. It should be noted that with this period the Seasonal Drought (period of rainfall deficit) also manifests itself, which is observed in the southwest and northwest, which is disturbed when one of the El Niño/Southern Oscillation phases is developed.

- **Convective Season (May - July): This period is characterized by the formation of clouds with extensive vertical development, associated with** convective processes over the country and sometimes associated with the Intertropical Convergence Zone (ITCZ). Many meteorologists call this period the lightning season, because of showers accompanied by thunderstorms. Tornadoes have also been observed on occasion during this period.
- **Tropical activity (August - October)**: Under normal conditions, rains caused by tropical phenomena typical of summer are increasingly frequent, making their influence felt over the country and presenting a more uniform distribution of the same.

2.- Information for the GBON Global Gap Analysis in Dominican Republic

ONAMET has access to data from various types of weather stations for different purposes, as shown in the following image. But many of them are not automatic stations.

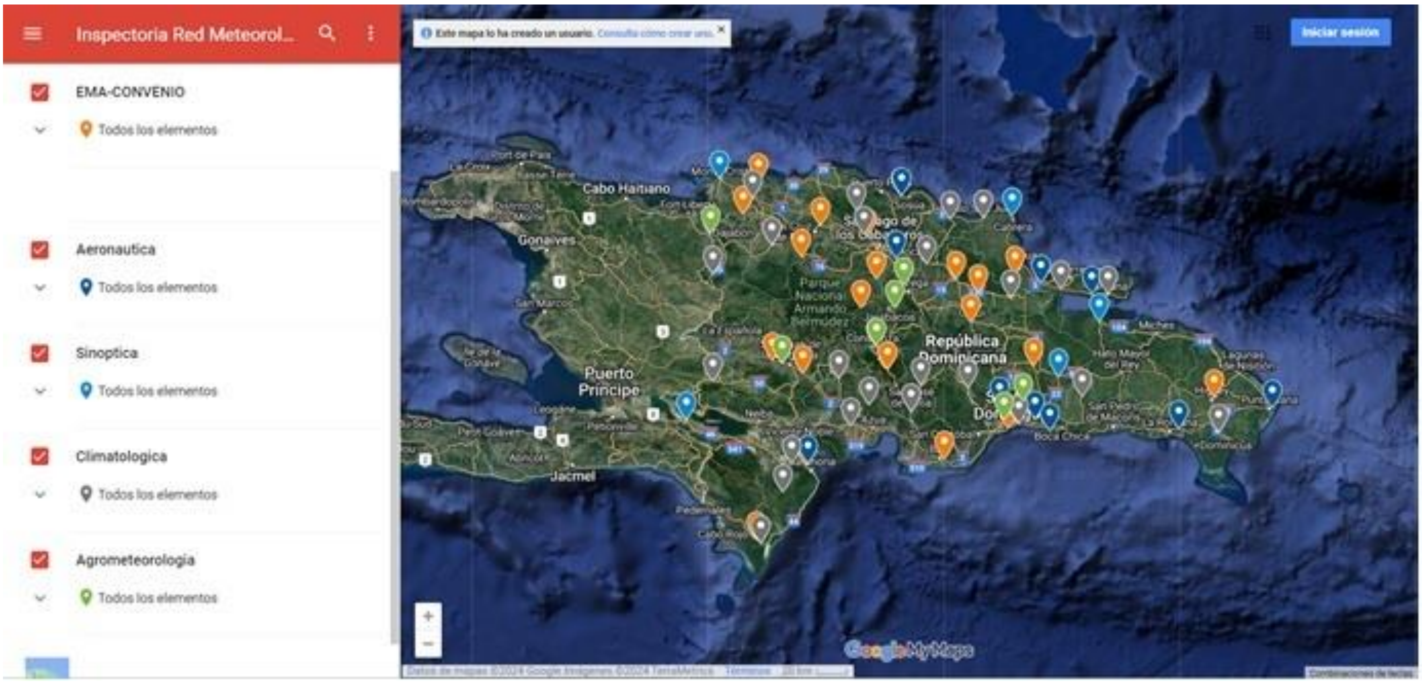


Fig. 3: Weather stations available in ONAMET.

The previous 2023 WMO analysis on the minimum necessary number of automatic surface stations to be included in GBON in the Dominican Republic (table I) seems clearly insufficient, due to the spatial variability and orography of the country and the different meteorological phenomena coming from different systems that affect it with sometimes severe weather and great impact in some areas, as has been described in the climatology section. For this reason, it is necessary to have a somewhat broader network that allows for enough information to feed both the early warning systems and the process of assimilation of numerical weather prediction models that allow better monitoring and simulation of the weather in the area and in the Caribbean environment.

A. GBON horizontal resolution requirements	B. GBON Target (# of stations)	C. Reporting to req	D. Gap to improve	E. Gap new	F. Total gap
Surface stations Horizontal resolution: 200 km	2	0	2	0	2
Upper-air stations over land Horizontal resolution: 500km	1	1	0	0	0

Table I. WMO GBON Global Gap Analysis (2023) for the Dominican Republic.

3.- Analysis of the automatic weather stations of the Dominican Republic and the GBON requirements

3.a.- Criteria for including automatic surface stations in GBON

For the proposal of automatic weather stations (AWS) to be part of GBON, the following criteria have been taken into account:

- AWS already existing and with assured quality, 1 station (Barahona: María Móntez International Airport) is manual
- Coverage of the Dominican Republic with a minimally adequate density according to the criterion of circles of 200 km radius.
- Appropriate maintenance and accessible and safe places.
- Ready to disseminate data internationally through WIS 2.0 in the near future.

And following these criteria we arrive at the next map of proposed AWS for GBON, which are briefly described in annex I.

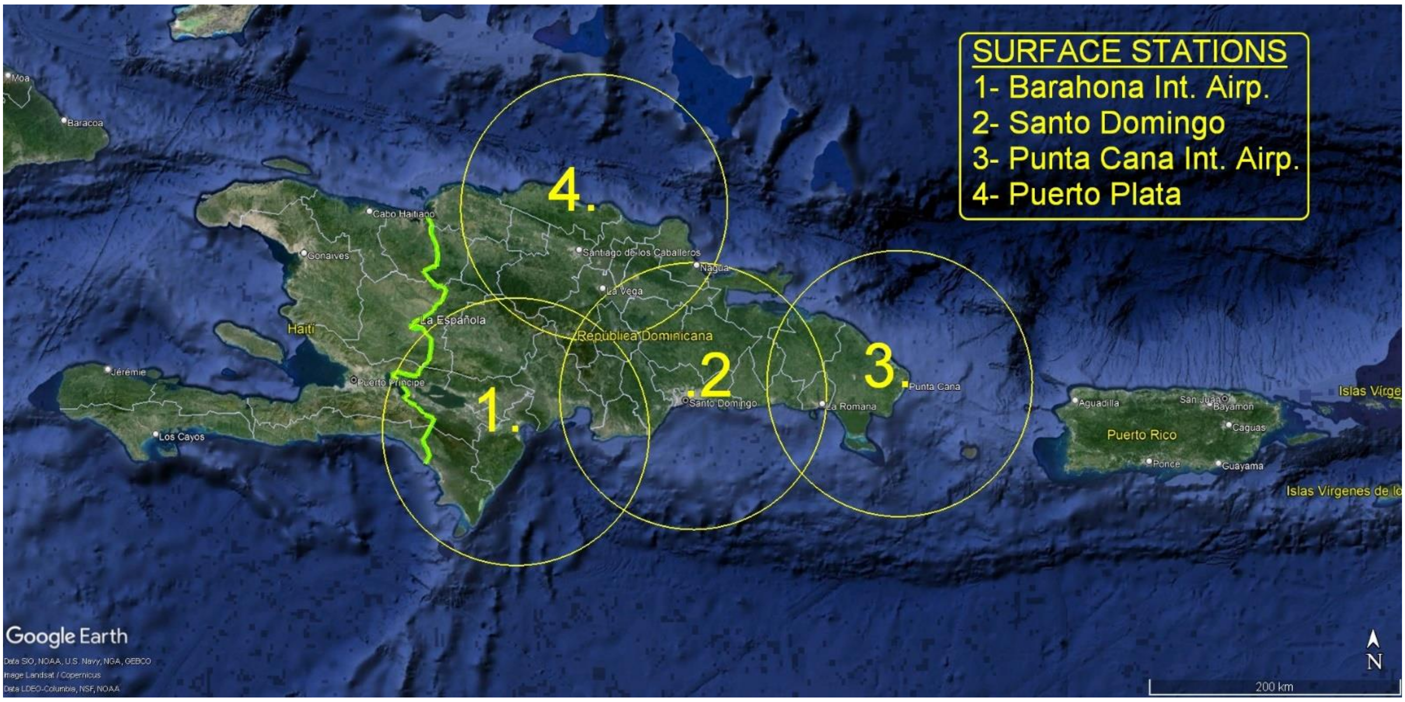


Fig. 4. Map of the location of the 4 AWS proposed for the GBON network.

3.b.- Criteria for including upper-air stations in GBON

For the selection of upper-air stations to be part of GBON in the Dominican Republic, the following criteria have been taken into account in the proposal:

- Already existing stations with assured quality, operated by ONAMET with its own personnel,
- Coverage of Dominican Republic with a minimum adequate density according to the criterion of circles of 250 km radius,
- Appropriate maintenance,
- Able in near future to use WIS 2.0 as an international data dissemination system.

There is currently an upper-air station operated by ONAMET in Santo Domingo, which has been operating since 1959. The station has two hydrogen generators, one electromechanical (old) and other digital. The operation and maintenance of the equipment is carried out by ONAMET personnel (certified by NOAA). Spare parts, equipment and software are supplied by NOAA. Likewise, NOAA carries out annual supervision and evaluation visits to that station. Observations are made twice a day (00 and 12 UTC), with the data generated sent to the National Climatic Data Center (NCDC-NOAA) and to different users.

Fig.5. Map of the upper-air station proposed for the GBON network in Santo Domingo

The ideal in this case is to ensure the launch of the Santo Domingo radiosonde so that it is disseminated through WIS 2.0. With this upper-air station consolidated, investment in a new one in another location does not seem a priority, especially taking into account that there are also upper-air stations in Puerto Rico and Jamaica.

3.c - Proposal to include stations from the Dominican Republic in GBON

Taking all of the above into account, Table II presents the number of stations that disseminate data regionally and those that would need to be improved to meet the GBON requirements, both for AWS and upper-air stations (radiosonde).

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

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

There are currently 7 ONAMET AWS operating, out of the 12 existing.

*2 ONAMET AWS to improve and 1 new. ** 1 third-party network to improve. ***Actually the upper-air station is ready to be incorporated into GBON.

Finally, Table III contains the stations proposed to be included in GBON.

STATION NAME	Station type (S/UA/M)	Owner (NMHS/3rd party)	Funding source	GBON variable measured							Reporting cycle (obs / day)		GBON Compliant (Y/N)
				SLP	T	h	W	Q	S. D.	SST			
BARAHONA (María Móntez International Airport)	S	ONAMET **(manual)**		x	x	x	x	x			60 minutes	24 obs/day	N
SANTO DOMINGO	S	ONAMET	JICS	x	x	x	x	x			10 minutes	144 obs / day	N
PUNTA CANA AIRPORT	S	IDAC	IDAC	x	x	x	x	x			5 min	288 obs / day	N
PUERTO PLATA (Gregorio Luperón International Airport)	S	ONAMET	JICS	x	x	x	x	x			10 minutes	144 obs / day	N
SANTO DOMINGO UPPER-AIR	U.A.	ONAMET	NOAA	x	x	x	x	*			12 h	2 obs / day	N

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).*

4. Results from GBON National Gap Analysis

In the SOFF mission to the Dominican Republic carried out between February 5 and 16, the team conducted interviews with ONAMET personnel, visited facilities at the headquarters and other external organizations (Civil Defense and the Emergency Operations Center, Vice Minister of the Presidence among others), to obtain information on the current status of the observation network and international data exchanges and also to highlight the importance of SOFF for the Dominican Republic and the Caribbean. The existing information in OSCAR and WIGOS was analyzed and the list of existing stations was reviewed. The elements of the communications systems, personnel capacity and maintenance protocols of the available stations were also studied.

A series of visits were carried out to the following stations (with information in annex III):

- AWS in Santo Domingo (ONAMET headquarters)
- AWS in Punta Cana (airport),
- AWS in Nagua (El Factor).
- Upper-air meteorological station (radiosonde) in Santo Domingo (ONAMET headquarters).

Table IV and Table V show the numerical result of the GBON analysis carried out by the team for Dominican Republic.

GBON requirements	Global GBON target (# of stations)	Approved national target (# of stations)	GBON Compliant stations (#)	Stations gap	
				To improve	New
Surface land stations. High density 100 km	2	4	0	4*	0
Upper-air stations operated from land Standard density 500 km	1	0	1	0	0

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**.**

Station name	Station type (S/UA/M[1])
BARAHONA (María Móntez International Airport)*	**S**
SANTO DOMINGO ESTE	**S**
PUNTA CANA AIRPORT	**S**
PUERTO PLATA (Gregorio Luperon International Airport)	**S**
SANTO DOMINGO UPPER-AIR	**UA**

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

The maps of recommended stations to be designated to GBON can be seen in figures 4 and 5.

*1 Manual ONAMET station *(María Móntez International Airport)* in Barahona will be replaced by a new automatic weather station

4.1.- Main conclusions

In order to include the proposed AWS in GBON, what essentially remains to be fulfilled is that all these stations must disseminate their hourly data in BUFR through WIS 2.0.

***It is understood that the Santo Domingo upper-air station operated by ONAMET would be ready to be incorporated into GBON, ensuring that the data must be issued through WIS 2.0.

In addition, there are other needs that are described in the following subsection.

4.2.- Needs and recommendations

Below are a series of proposals for improvement, some necessary, in different areas.

4.2.1.- Needs of AWS

- **Datalogger** model in the 2 selected ONAMET stations, ZENO-3200, does not meet some of the desirable characteristics in terms of data acquisition and processing, such as the sampling frequency of the wind vector, which does not go below 1 second , when the recommendation is 4 Hz. Therefore, it is **recommended to update it with more modern**, robust ones with lower energy consumption, with programming capacity to be able to internally generate a BUFR bulletin and with the capacity for redundant data transmission.
- There is currently a **manual station in Barahona (María Móntez International Airport), which should be converted into an automatic weather station**.
- The current **communications** of the ONAMET stations candidates for inclusion in GBON are based on data transmission via UHF radio in a unidirectional manner, transmitting information frames every 10 minutes. This form of communication is inadequate to meet GBON requirements, due to the lack of control over the station for basic remote maintenance tasks such as synchronizing the datalogger time, or causing a *remote* reset. Therefore, it is **necessary to provide the 3 ONAMET stations with a communication system that allows them to be controlled remotely**. A redundant communication system is recommended using a 4G router or modem of the mobile telephone network and by satellite communication using Vsat or Iridium satellite platforms.
- In the case of the **AWS at the Punta Cana airport**, **owned by IDAC** (Dominican Institute of Civil Aviation), the ideal is to strengthen the **Letter of Agreement between IDAC and ONAMET** so that this station can be included in GBON. To do this, ONAMET should be able to have operational access to a shared folder on an IDAC server with the data from mentioned station for automatic data recovery and subsequent generation of a BUFR file to be transmitted to the international community through WIS 2.0. The maintenance that IDAC carries out on that station is considered very exhaustive and it is understood that the most convenient thing is for it to be included in GBON despite not officially belonging to ONAMET, although the Letter of Agreement between both institutions seems sufficient. Of course, the location of the station seems strategic and absolutely necessary for different reasons.
- It is advisable to develop a **documented maintenance and calibration plan** for the ONAMET AWS, as well as **data quality control**, all with enough personnel to address these tasks. To comply with this plan, an estimated supply of spare parts is needed to cover needs for at least two years. To ensure the **quality of the measurements**, it is recommended to have traveling patterns of at

least the variables of pressure, temperature and relative humidity. These semi-standards would maintain traceability by periodically checking against the NOAA-calibrated equipment that exists at the radiosonde station at ONAMET headquarters. In addition, data quality control is convenient to allow faults to be detected instantly.

- To the extent possible, it would be appropriate in the future to have in ONAMET a **calibration laboratory**.

4.2.2.- Needs of the upper-air station

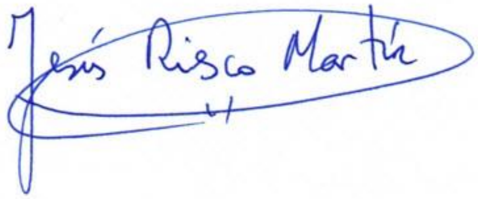
- It is considered absolutely essential **to consolidate the current agreement between NOAA and ONAMET**, so that both the material supplied by NOAA and the maintenance of the instrumentation, as well as the training of ONAMET personnel in this field, are guaranteed in the future.
- **Safety of the hydrogen generation equipment** must be ensured.
- The upper-air station should **be operated by an ONAMET human team as now**.
- With the transmission of the two daily bulletins (0 and 12 UTC) in **WIS 2.0 in BUFR format, it is understood that the observation of the Santo Domingo radiosonde would already be in the process of being included in GBON**. One possibility is that each bulletin generated at the ONAMET radiosonde station is BUFR encoded and disseminated directly from ONAMET itself through WIS 2.0.

4.2.3.- WIS 2.0 and communications needs

- It is **imperative hourly information** in the case of AWS and twice a day for upper-air. Also must **be disseminated internationally in BUFR format through WIS 2.0**, which is the system that provides a framework for WMO data sharing in the 21st century, for all members to enable the unified WMO data policy and support the global core observing network. WIS 2.0 is up and running, flexible, powerful and easy to adapt. The following link shows a video explaining how WIS 2.0 works: https://vimeo.com/761382308
- Needed in ONAMET to **acquire a server for specific use of WIS 2.0** and dissemination of bulletins (after generation of the BUFR code). The server has to be able to operate WIS 2.0. The following reference may be of great interest https://community.wmo.int/en/activity-areas/wis/wis2-implementation
- It is necessary to ensure **remote communications between the stations and the ONAMET headquarters** to retrieve the information from there in the appropriate manner and time frame, as well as generate the corresponding BUFR format to proceed to disseminate the information through WIS 2.0.
- The continuity of at least a **minimum number of IT staff at ONAMET must be ensured** to supervise the communications process with the stations as well as the correct generation of BUFR bulletins (with external training if necessary) and transmission via WIS 2.0.
- It is necessary to give exclusivity to the **room** where the ONAMET servers are housed so that the servers have adequate air conditioning.
- **Training of ONAMET technological personnel in the use of the WIS 2.0 system** may be convenient or necessary. For this, it may be interesting to contact the INSMET of Cuba, since they already have this system implemented there.

5. Signatures

Peer Advisor signature



WMO Technical Authority Screening signature

Beneficiary Country signature

Annex I. Automatic surface stations candidates for inclusion in GBON

AI.1.- ONAMET automatic weather stations (current situation)

The National Meteorological Office (ONAMET) currently has a network of automatic weather stations (AWS) as a result of a donation made in 2016 by the NGO Japan International Cooperation System (JICS).

This network was initially made up of a total of 13 automatic weather stations, of which seven are currently operating. Four of them have been selected to be updated and thus be able to include them in GBON. Each of these stations consists of a 10-meter-high lattice-type wind tower to support the different sensors: anemometer, solar radiation sensor, temperature and relative humidity, UHF antenna, solar panel and lightning rod.

Attached to the tower is also the field cabinet containing inside the datalogger, UHF communication elements, pressure sensor, battery charge regulator and sensor circuit protections.

Under this cabinet there is another one that contains the 12 V and 50 Ah capacity battery.

Separated from the tower is the rain gauge attached to a mast.

Electrical power is provided only by a solar panel and battery.

The datalogger is from the Zeno-3200 brand, it is data acquisition equipment designed for unattended applications.

All configuration data is stored in internal EEPROM memory, remaining in its entirety even in the event of power failure.

The datalogger interrogates sensors, processes the data, checks alarms, controls functions and transmits the data to a remote location.

The unit includes the functions of analog signal conversion, digital inputs/outputs, serial communication, programming and data storage in memory.

The list of sensors and auxiliary equipment that equips each EMA is as follows:

- The wind vane is from the Aneos brand , model WS-BN6
- The temperature sensor is Aneos , model TS-301C-1
- The relative humidity probe is NP110A (Nippon Electric Instrument)
- The pyranometer is EKO model MS-402
- The rain gauge is Aneos brand , model RS-104N
- The pressure sensor is NBS18 (Nippon Electric Instrument)
- The UHF radio transmitter is Maxon brand , model SD-125U2
- The battery charge regulator is from the Toa brand Denki Kogyo, model SPC-100

The communications scheme between the ONAMET Headquarters and the automatic stations is as follows.

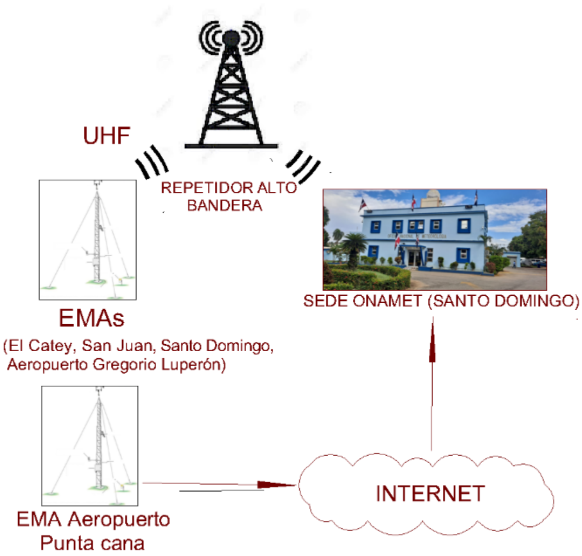


Figure AI.1. Communications scheme each AWS with ONAMET

According to the previous scheme, each AWS sends through its UHF transmitter every 10 minutes and in a staggered manner a frame of instantaneous data in ASCII format separated by commas with these fields: Identifier, date, time, temperature, relative humidity, 24-h precipitation, solar radiation, wind direction, wind speed, battery voltage and presence of errors.

Due to the orography of the country and to guarantee coverage, in the location known as Alto Bandera there is a UHF repeater station that links the automatic weather stations with the ONAMET headquarters.

This unidirectional communication system has the disadvantage that it requires that the AWS be perfectly synchronized, since the transmissions must be carried out in a specific time window and sequentially one AWS after the previous one. Since none of the stations has an internal time synchronization system, it is not possible to remotely act on the datalogger to set the time periodically.

Below are photos of each of the ONAMET stations proposed to be included in GBON.

Figure AI.2. Automatic weather stations in ONAMET proposed to be included in GBON (Santo Domingo, Catey Airport, San Juan and Puerto Plata -Gregorio Luperón Airport-)

AI.2.- Punta Cana airport automatic station (current situation)

The fifth automatic weather station proposed as a candidate to be part of GBON is the one located at RWY 26 of the Punta Cana International Airport. This station has optimal characteristics for inclusion in the network due to the exhaustive maintenance applied by its owner organization - Dominican Institute of Civil Aviation (IDAC) - with personnel dedicated daily to maintenance, calibration and data processing.

The location at the eastern end of the island of Hispaniola, as well as the robustness of the communications systems, facilities and infrastructure as it is the most important airport in the Dominican Republic, are factors that motivate the inclusion of this station in GBON.

The station is equipped with the most modern components. It consists of a 10-meter-high frangible and foldable polycarbonate wind tower to support the different sensors: redundant sonic wind sensor, UHF antenna, lightning rod, solar radiation sensor and temperature and relative humidity sensor.

Attached to the tower is also the field cabinet containing inside the datalogger, UHF transmitter, pressure sensor, battery charge regulator, two parallel batteries of 12 V and 12 Ah capacity. Under this cabinet there is a box that contains the protections.

Separated from the tower is the rain gauge attached to a mast.

Electrical power comes from the airport facility and is backed up by batteries.

The datalogger is Vaisala brand model QML201, which sends a data frame every 5 minutes to the airport meteorological office permanently attended by ONAMET personnel.

A configuration file contains all programming of static and dynamic parameters.

The datalogger interrogates sensors, processes the data, checks alarms, controls functions and transmits the data to a remote location.

The unit includes the functions of analog signal conversion, digital inputs/outputs, communications via RS-232 and RS-485, programming and data storage in memory and periodic dumping to a Compact Flash card, as well as double power input.

The list of sensors and auxiliary equipment that equips each EMA is as follows:

-Vaisala brand sonic wind sensor, model WMT700

Vaisala temperature and relative humidity probe, model HMP155

-The pyranometer is Kipp & Zonnen brand, model CMP6

-The rain gauge is Vaisala brand, model RG13

-The pressure sensor is Vaisala, model PTB330

-The UHF radio transmitter is Satel brand, Satelline model.

Figure AI.3. IDAC (Dominican Institute of Civil Aviation) automatic weather station at RWY 26 of the Punta Cana airport.

Annex II. Radiosonde station candidate for inclusion in GBON

Radiosonde station is located in Santo Domingo on a plot of land next to the ONAMET headquarters, being operated by ONAMET personnel with two launches per day (0 and 12 UTC).

Figure AII.1 . Radiosonde station in Santo Domingo (ONAMET) .

The video https://youtu.be/N9Q4LSR-sS0 shows how it works.

Currently, the information generated in both 0 and 12 UTC bulletins is sent by email to the NOAA NCDC from where it is disseminated internationally as can be seen in the survey graph available at the University of Wyoming on February, 14.

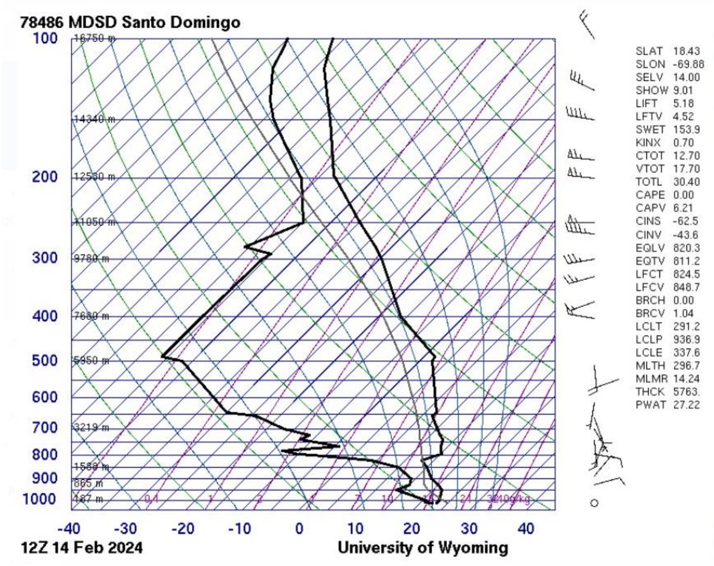


Figure AII.2. Thermodynamic survey of Santo Domingo on February 14, 2024. Source: University of Wyoming

The survey actually belongs to ONAMET (78486 MDSD), although there is currently a supply of material from NOAA, such as consumable equipment and spare parts.

NOAA also trains ONAMET personnel, both in the operational part of the survey process and in maintenance.

Currently there are 5 people from ONAMET covering the high altitude observation service (radiosonde).

Surface data is collected from:

- calibrated barometer (pressure),
- sentry box (temperature and humidity), and
- information provided by the ONAMET forecast observer (wind).

In some situations, upon request, additional observations are made outside the usual twice a day.

Annex III. Photos of visits by the AEMET SOFF team

Figure AIII.1. Stay at OAMET headquarters

Figure AIII.2. Visit to Civil Defense and the Emergency Operations Center (COE).

Figure AIII.3. Visit to the Vice Minister of the Presidency of the Dominican Republic.

Figure AIII.4. Visit to the automatic weather station of Santo Domingo (ONAMET)

Figure AIII.5. Visit to the Santo Domingo upper-air station (ONAMET)

Figure AIII. 6. Visit to the automatic weather station of the Punta Cana airport

Figure AIII.7. Visit to the automatic weather station of El Factor (Nagua)