COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

Sep, 2024

Cuba Peer Review Report

Reviewing Agency: Agencia Estatal de Meteorología - AEMET

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List of Acronyms

AEMET	Agencia Estatal de Meteorología- State Meteorological Agency
AMA	Agencia de Medio Ambiente- Cuban Environment Agency
AWS	Automatic Weather Stations
CAP	Common Alerting Protocol
CATHALAC	Centro del Agua del Trópico Húmedo para América Latina y el Caribe-Water Center for the Humid Tropics of Latin America and the Caribbean
CITMA	Ministerio de Ciencia, Tecnología y Medio Ambiente- Ministry of Science, Technology and Environment
CHD	Country Hydromet Diagnostics
CIMHET	Conferencia de los SMHN Iberoamericanos-Iberoamerican NMHSs Conference
CPT	Centro de Pronósticos del Tiempo-Weather Forecasting Centre
CREWS	Climate Risk and Early Warning Systems
ECMWF	European Centre for Medium-Range Weather Forecasts
EMNDC	Estado Mayor Nacional de la Defensa Civil- National Civil Defense Staff
EPS	Ensemble Prediction System
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EW4All	Early Warning for All
EWS	Early Warning System
GBON	Global Basic Observing Network
GCF	Green Climate Fund
GFS	Global Forecast System
GHG	Greenhouse Gases
GTS	Global Telecommunication System
HPC	High Performance Computing
ICAO	International Civil Aviation Organization
ICT	Information and Communication Technologies
IDRC	International Development Research Centre
INRH	Instituto de Recursos Hidráulicos-Institute of Hydraulic Resources
INSMET	Instituto de Meteorología-Institute of Meteorology
MHEWS	Multi Hazard Early Warning System
NASA	National Aeronautics and Space Administration
NHC	National Hurricane Centre
NMHS	National Meteorological and Hydrological Service
OSCAR	Observing Systems Capability Analysis and Review
QMS	Quality Management System
RA	Regional Association
RSMC	Regional Specialized Meteorological Centre
SOFF	Systematic Observations Financing Facility
SOP	Standard Operating Procedure
UNDP	United Nations Development Programme
WDQMS	WIGOS Data Quality Monitoring System
WFP	World Food Programme
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting Model

Executive Summary

The Country Hydromet Diagnostic (CHD) was conducted as part of the planned activities for the development of the "Systematic Observations Financing Facility" (SOFF) initiative in Cuba. The purpose of the report is to assess the Institute of Meteorology (INSMET) of Cuba through a peer review, evaluating the 10 elements outlined in the CHD methodology. The assessment provides a maturity level for each element and offers recommendations for enhancing maturity levels.

INSMET is the nationally recognized authority in Cuba for issuing alerts regarding hydrometeorological hazards, having substantial prestige in various social sectors, including early warning-related institutions.

A significant challenge hindering INSMET's service improvement efforts is the substantial difficulty in procuring spare parts for the various systems in place, both for infrastructure and meteorological and climate service provision.

Among some of the main effects imposed by the blockade on Cuba are the limitations on the supply of technologies and equipment produced under license or that use more than 10% of U.S. components, which implies that they have to be bought in other markets much further away, with a great increase in costs. Also, in many cases, equipment cannot be repaired due to the lack of access to original spare parts

Additionally, a notable issue is the ongoing decrease in personnel availability and the ageing of the INSMET workforce, primarily stemming from the organization's low salary competitiveness compared to other institutions, particularly in the private sector.

The maturity levels of INSMET based on the CHD methodology are outlined in the following figure and table:

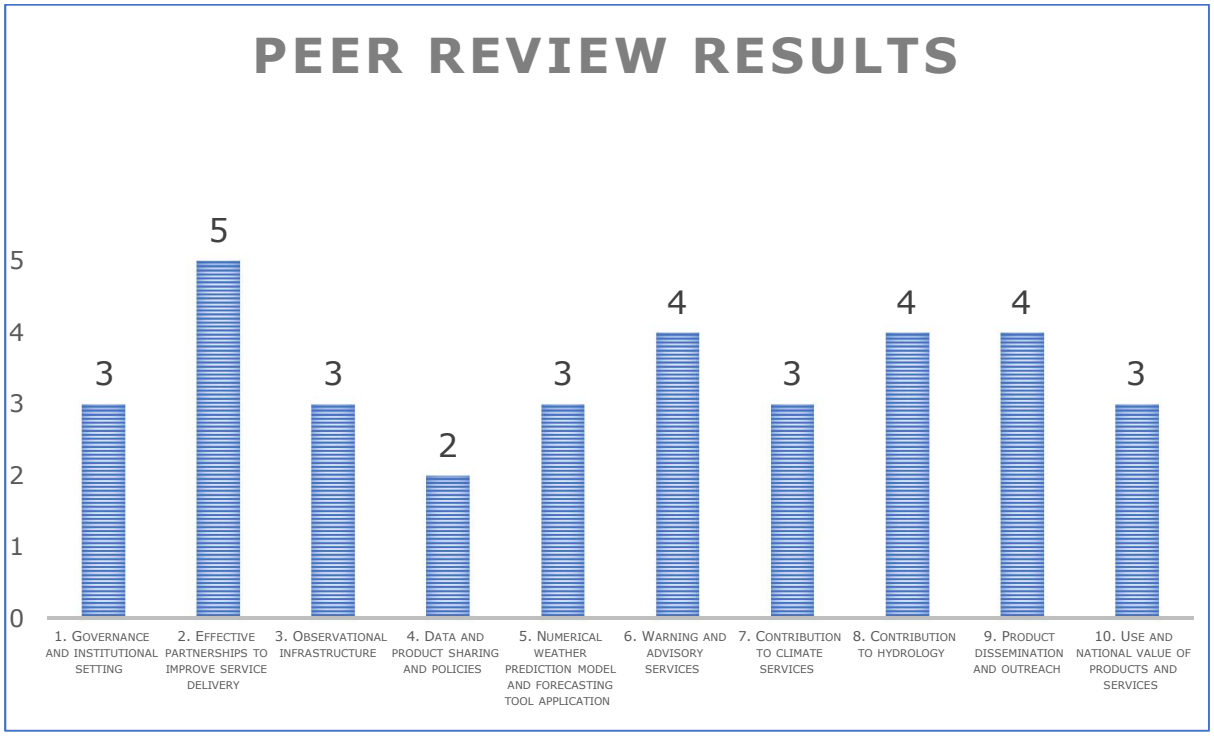


Figure 1: Peer Review Results of the Ten (10) Critical Elements

Element	Maturity level score
1. Governance and institutional setting	3
2. Effective partnerships to improve service delivery	5
3. Observational infrastructure	3
4. Data and product sharing and policies	2
5. Numerical weather prediction model and forecasting tool application	3
6. Warning and advisory services	4
7. Contribution to climate services	3
8. Contribution to hydrology	4
9. Product dissemination and outreach	4
10. Use and national value of products and services	3

Table 1: Peer Review Results of the Ten (10) Critical Elements

The main recommendations to raise or maintain the level of maturity of each of the elements are as follows:

Element	Recommendations
Element 1. Governance and Institutional Settings	• INSMET should have a plan for the incorporation of new staff in the medium and long term, with active policies to ensure their continuity in the institution.
Element 2. Effective Partnerships to Improve Service delivery	• INSMET must continue with the leadership role in collaboration with other institutions. There is a risk of not being able to continue with certain activities if staff continues to be lost in the institution
Element 3. Observation Infrastructure	• Have at least 2 additional stations in the SE of the island that report to WIS2.0 • Consolidate the calibration center, repairing or replacing equipment with problems and including missing systems. • Ensure the maintenance of existing equipment, recovering automatic stations that have stopped working • Use CIMHET's horizontal cooperation mechanism to exchange experts related to the calibration and maintenance of equipment. • Analyze the establishment of a second technical center with maintenance experts to provide coverage to the stations in the eastern area of the island, leading to decreased travel distances and fuel consumption
Element 4 Data and Product Sharing and Policies	• Adapt at least 11 surface stations to comply with GBON requirements, incorporating them in the National GBON Contribution Plan • Install at least two upper-air stations

	• Implement the National WIGOS Association
Element 5 Numerical Model and Forecasting applications	• Establish protocols with other NMHSs that have HPC to be able to run their models on them, with assimilation of observational data • Process the grid data of the models used to develop products appropriate to the Cuban meteorological characteristics, in addition to those already existing on the websites of the Centers. • Take advantage of horizontal cooperation mechanism of CIMHET for the exchange of experts in numerical modelling and in the use and interpretation of prediction models
Element 6 Early warning and advisory services	• Establish a meteorological alert system by levels that take in account the thresholds and possible impacts, involving other institutions such as Civil Defense or INRH • Systematize how feedback information is received, especially from society in general. • Digitize alert and forecast bulletins, currently available on paper • Include more phenomena in warnings, such as wildfires, air quality, or UV radiation • Implement the CAP • Take advantage of CIMHET's horizontal cooperation mechanism for the assistance of experts on issues related to the implementation of the CAP, impact-based forecast, and the inclusion of warnings of other phenomena.
Elemento 7 Contribution to Climate Services	• Develop governance systems for coordination in service delivery, at least in the agriculture and health sectors • Disseminate climate information in digital form, in formats that are useful for the systems used by different user sectors • Establish indicators to assess the socio-economic benefits of the services provided, in collaboration with the different user sectors • Establish mechanisms to train technicians from different sectors in the use and interpretation of the services provided. • Continuar con el proceso de digitalización de la información climática, con plazos e hitos claros en su desarrollo
Element 8 Contribution to Hydrology	• Work together INSMET and INRH for the development of operational products related to hydrological monitoring and prediction
Elemento 9 Product dissemination and outreach	• Develop a level alert system that allows society to quickly and easily assess risk • Designing presentation formats for meteorological information on social media that are attractive to young people.
Elemento 10 Use of National Products and Values	• Conduct studies on the socio-economic benefits of products supplied by INSMET. To do this, it can draw on the experience available at WMO and CIMHET. • Development of sectoral workshops with users to gather needs and establish the usefulness of the products supplied. • Implement a quality management system in all areas of the institution, especially those necessary for the

	accreditation of the calibration laboratory and those related to early warning services.

Chapter 1: General information

Introduction

The Cuban archipelago consists of the island of Cuba, the Juventud Isle and numerous islets and cays, with a total area of 109,884 km^2 (Figure 2). Its coasts are very irregular and extend over 6,073 km. From the political-administrative point of view, the Republic of Cuba is divided into 15 provinces and 168 municipalities. There are mountain massifs distributed throughout the island, alternating with plains and marshes, highlighting the Sierra Maestra in the east crowning the 1,974-metre-high peak Real del Turquino.

Cuba lies to the west of the North Atlantic, to the north is the Straits of Florida and the Old Channel of the Bahamas; to the east, the Paso de los Vientos; to the south, the Strait of Columbus and the Caribbean Sea and to the west, the Yucatan Channel. The island of Cuba makes up most of the territory of the Cuban state. It stretches 1,250 km across, 191 km at its widest point and 31 km at its narrowest point. The largest island of the Cuban state, outside of it, is the Juventud Isle, to the southwest, with an area of 2,204km² (327 km of coastline). The nearest territories are: The Bahamas (Cayo Lobos) at 22.5 km, Haiti at 78 km, Jamaica at 148 km, United States (Key West) at 150 km, and Mexico at 210 km.

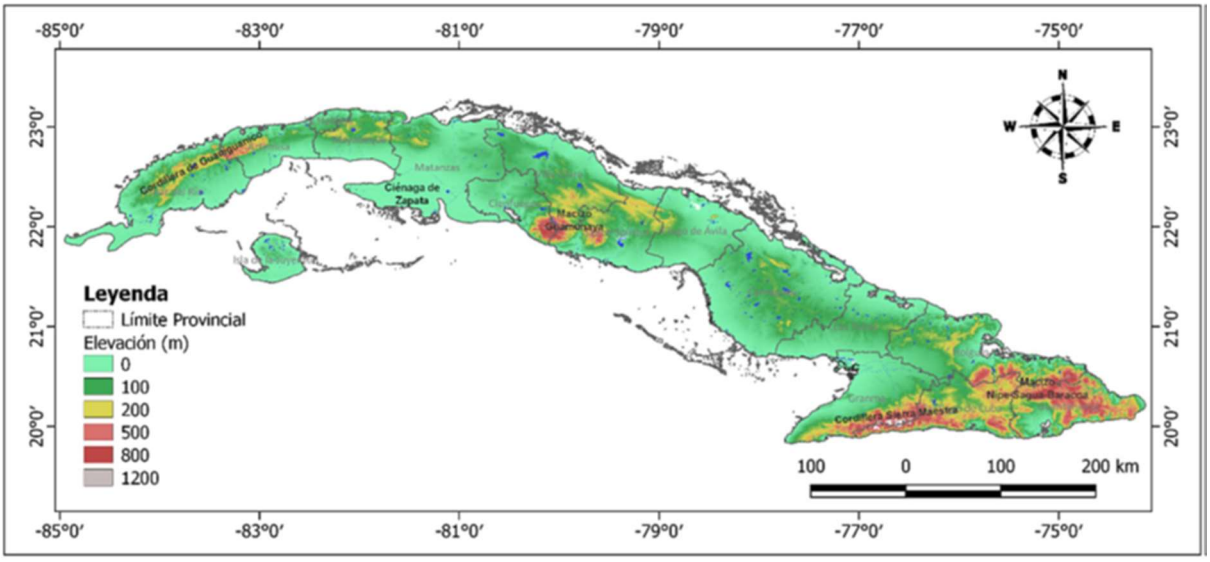


Figure 2. Cuban orography. Source: IPF, INSMET y ASTER Global DEM (ASTER GDEM)

As Cuba is at a latitude very close to the Tropic of Cancer, it has high values of solar radiation throughout the year. The predominant climate in most of Cuba, according to Köppen's classification, is Warm Tropical type, with a rainy season in summer, maritime influence and features of semi-continentality. In the southern coastal strip of the provinces of Santiago de Cuba and Guantánamo, it is classified as Relatively Dry Tropical with little rainfall.

The average annual air temperature varies from 22°C to 28°C. Records of the average maximum temperature fluctuate between 27ºC and 32ºC, and the average minimum temperature between 17ºC and 23ºC, with notable differences between the eastern and western provinces due to the great extension in length of the country.

In relation to rainfall, there are two main seasons, rainy season, from May to October, where approximately 80% of the total annual rainfall is recorded, and little rainy season,

from November to April. The average annual rainfall is 1,335 mm, with notable geographical differences, ranging from 3,000 mm in the mountainous areas to 600 mm in the provinces of Guantánamo and Santiago de Cuba (Figure 3).

Tropical cyclones and severe local storms are the weather events associated with one of the greatest disaster hazards, and are responsible for some of the observed climate extremes, particularly heavy rainfall, large rainfall accumulations and coastal flooding. The hurricane season runs from June 1 to November 30, and in it, the September-October two-month period is the one with the highest number of intense hurricanes.

In recent years, important changes have been observed in Cuba's climate, which have been influencing the climatic characteristics described above. The greatest evidences are the increase in the average annual temperature, conditioned mainly by the increase in the minimum temperature; the decrease in cloud cover; more intense and prolonged, but less frequent, droughts; increase in rainfall greater than 50 mm; and greater anticyclonic influence.

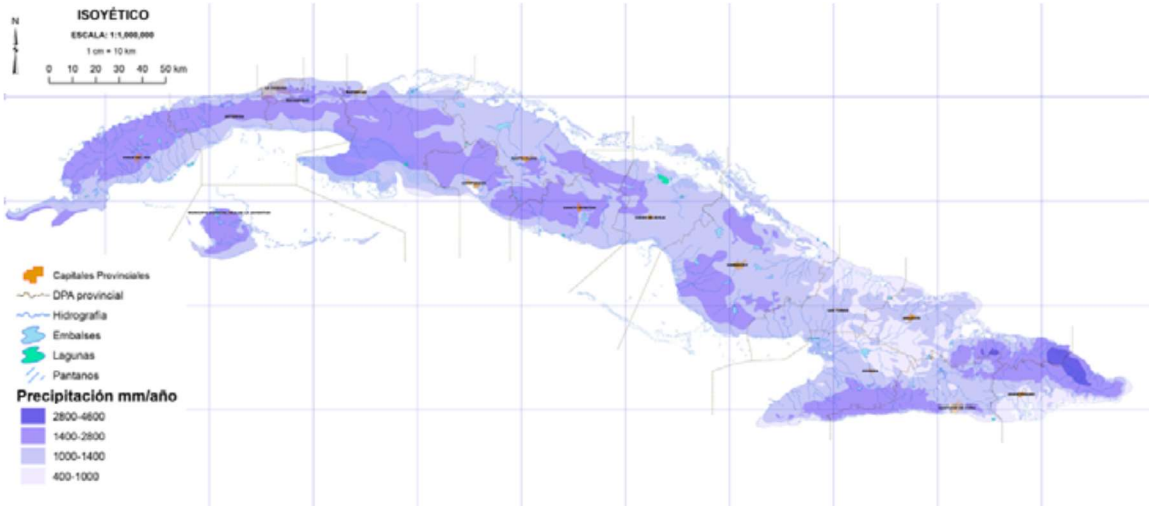


Figure 3. Annual rainfall distribution for Cuba. Source INSMET

It is important to note that the island is located on the border between the tropical and extratropical circulation zones, receiving the influence of both seasonally. In the season that runs from approximately November to April, the variations in weather and climate become more noticeable, with sudden changes in the daily weather, associated with the passage of frontal systems, the anticyclonic influence of continental origin and extratropical low pressure centers.

CHD methodology

The Country Hydrometeorological Diagnostics (CHD) for Cuba has been carried out using a peer review by staff of the Spanish State Meteorological Agency (AEMET) in close collaboration with INSMET staff, carrying out an assessment of the institution, its operating environment and its contribution to meteorological, climatic, hydrological services and weather warnings.

Has been used the information provided by INSMET to WMO in the questionnaire on the elements of CHD, various preparatory videoconferences have been held with INSMET management staff and finally an on-site assessment has been carried out, both at INSMET headquarters and at various meteorological observatories.

Meetings have been held with the management and technical staff of INSMET, with the President of the Cuban Environment Agency (AMA) and with staff from the project implementing institution, the office of the United Nations Development Programme (UNDP) in Cuba.

In collaboration with INSMET staff, the 10 elements included in the CHD methodology have been analysed, establishing a maturity level between 1 and 5 for each of them and recommending a series of actions to raise the level of each element.

Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1: Existence of Act or Policy describing the NMHS legal mandate and its scope.

In Cuba, hydrometeorological services are provided by two institutions. Meteorological by the Institute of Meteorology (INSMET), under the Environment Agency (AMA), an entity of the Ministry of Science, Technology and Environment (CITMA) and hydrological by the Institute of Hydraulic Resources (INRH).

INSMET is neither the aeronautical meteorological authority of Cuba nor the provider of aeronautical meteorological services. These are provided by the Institute of Civil Aeronautics of Cuba.

The activities of INSMET are regulated by Resolution 24 of 2 September 1965 of the President of the National Commission of the Academy of Sciences of Cuba. To access this resolution, you must consult the physical archives at the institution. In addition, Resolution 106 of 6 December 1999 of the Minister of CITMA establishes the general rules for the management, organization and operation of INSMET.

INSMET is a Government Agency with commercial activities. Its main areas of responsibility being Meteorology and Climatology, having areas of shared responsibility with other institutions in Air Quality, Hydrology and Agrometeorology. Its main mission is to provide authoritative, reliable and timely meteorological and climate information on the future state and behavior of the atmosphere

With regard to the responsibilities with respect to meteorological warnings, their role is set out in Decree 279 of 19 March 2007 of the Executive Committee of the Council of Ministers, which regulates the general principles of organisation, preparation and assurance of the hydrometeorological system for exceptional situations, indicating what each institution must do in each of the phases of the situation.

INSMET is recognized as the national warning authority on hydrometeorological hazards in Cuba, including the 5 most important ones dealt with by the Service:

- Tropical cyclone
- Storm surge/Coastal flood
- Thunderstorms/Squall lines
- Flash-floods
- Drought/Dry spell

In terms of cross-border exchange of alerts, INSMET prepares weather forecasts and alerts for Haiti and exchanges Tropical Cyclone warnings with the National Hurricane Center (NHC).

INSMET, as the National Meteorological Service of Cuba, belongs to the Conference of Ibero-American NMHSs (CIMHET), a network of the Ibero-American Community that includes all the NMHSs of the community. This allows access to the different activities approved by the Conference, especially those related to training and horizontal cooperation

1.2. Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

INSMET has, as an internal, unpublished document, an annual strategic plan, approved by the Environment Agency. In order to draw up the plan, which covers all issues related to

the development and operation of the institution, the staff has been consulted for its preparation, and it has been disseminated within INSMET.

1.3 Government budget allocation: (consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions)

The annual budget of INSMET in 2024 is 143.000.000 CUP, 24% for staffing, 64% for operational costs and 12% for investments. It comes from the Government.

The provision of commercial services is regulated by Resolution 569 of 22 October 2013 of the Ministry of Economy and Planning. In addition, the internal resolution 50/2015 of the Director General of INSMET approves the provision of eventual secondary and support activities (leasing, installation of equipment for other institutions...) which can be an additional source of income.

INSMET has no funding for aeronautical cost recovery.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS

As of December 30, 2023, INSMET has a strong staff of 1,342 people, although this is below the theoretical total of the institution, which is 1,512 people. Staff departures are occurring continuously and are difficult to replace, mainly because staff leaving for other institutions with better salaries. This is a problem that is likely to worsen over time.

Staff Categories	Value (self-reported)
Number of Staff (Management)	59
Meteorologist	278
Meteorological Technician	402
Hydrologist	0
Hydrological Technician	0
Climate Services	221
Researcher	67
Other	315
Total Staff number Male (Male): Female (F)	1.342 (M= 859, F=453)

Table 2. INSMET Staff

There are several ways to hire personnel by INSMET. The main one is through agreements with universities, especially with the University of Havana, which provides exclusively in Cuba for a degree in meteorology, so that some students can carry out their diploma work in the institution, becoming an active part of it once they graduate. The other channels are through calls on social networks or the mass media for job offers or through the dissemination channels of the Ministry of Science, Technology and Environment or the Ministry of Labour and Social Security.

In the case of positions in the meteorological stations, every year local calls are launched in the places where these facilities are located, to cover the necessary meteorological observer positions.

A continuous assessment of the competencies of the staff is carried out, declaring them able/unable to carry out the corresponding functions. There is an internal training policy

1.5 Experience and track record in implementing internationally funded HydroMet projects as well as research and development projects in general.

INSMET in 2023 is the coordinating institution for the development and implementation of four international projects:

- "Building Drought Resilience in Cuba", funded ($904,051) by the International Development Research Centre (IDRC) of Canada and the Humid Tropics Water Centre for Latin America and the Caribbean (CATHALAC)
- "Strengthening of the Cuban Marine Meteorological System", funded (1,159,420 USD) by the Italian Ministry of Environment and Energy Security
- "Strengthening national and local capacities for integrated drought management to reduce its food impact on Food and Nutrition Security and public water supply in eastern Cuba and Camagüey", funded ($975,288) by the World Food Programme (WFP) and UNDP.
- "Crop monitoring", funded (US$240,000) by WFP 2030 Fund.

In addition, in 2023 INSMET has participated in another 39 international projects coordinated by other institutions.

Summary Score, Recommendations, and Comments for Element 1

INSMET has clearly defined its mandate and responsibility to act in the response to severe hydrometeorological systems. It has a strategic plan, approved by AMA and known by the staff of the institution. Its staff is adequately trained, and their competencies are assessed for the accomplishment of their tasks. However, there is a continuous decrease in the number of staff, either because the staff is leaving for other institutions or companies with better remuneration, which is beginning to affect the operational capacity.

Of great importance for the institution is the participation in different international projects that allow it to access resources for the specific training of its staff and to obtain equipment and spare parts.

Taking into account the situation described above, and especially considering as the main problem the continued decline in staff numbers, which is expected to increase in the future, Element 1, Governance and Institutional Environment is rated as **Maturity Level 3, Moderately well mandated, managed and resourced and clear plans for, and sufficient capacity to address operational gaps**.

To raise this level:

- INSMET should have a plan for the incorporation of new staff in the medium and long term, with active policies to ensure their continuity in the institution.

Element 2: Effective Partnerships to Improve Service Delivery.

2.1. Effective partnerships for service delivery in place with other government institutions.

INSMET is the only provider of meteorological information, apart except for aeronautical meteorology, authorized by Cuban legislation.

There are agreements with government institutions for the provision of services, such as the INRH, the Civil Defense General Staff, the Ministry of Agriculture, Public Health, the Ministry of the Interior or the Electricity Union

Weekly meetings are held with INRH and other state institutions on the Rational Use of Water.

The National Forum on Climate Prediction and Applications is held twice a year.

2.2 Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects

INSEMT, as the National Meteorological Service, is the only institution authorized in Cuba to provide meteorological and climatic information, including to the media.

By internal resolution 50/2015 of the Director General of INSMET, the installation of meteorological equipment in other institutions can be supported by means of a corresponding fee.

In 2023, INMSET has participated in 66 national and 43 international research projects, in four of them, detailed in section 1.5, as coordinator. The main sources for research funding are the National Research Funding Agency, regional research funding, and development assistance.

2.3. Effective partnerships in place with international climate and development finance partners.

As a member of CIMHET, INSMET uses the different services included in the annual action plan approved by the members of the network, on three strategic axes: Institutional strengthening and resource mobilization; Provision of climatic and hydrological meteorological services; Training and horizontal cooperation.

Se dispone de acuerdos con instituciones de Naciones Unidas, como OMM, PNUD o PMA para la gestión de proyectos relacionados con tiempo y clima

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

INSMET is providing services related to:

- Greenhouse gas research and support to climate mitigation
- Weather research
- Services in support of ecosystem
- Oceanography research
- Hydrological research
- Climate research

Topics of research activities include:

- Nowcasting
- Subseasonal-to-seasonal forecasting
- Climate predictions

- 1 km scale modelling

170 technical and scientific publications have been produced in the last two years (106 in 2022 and 64 in 2023). Due to the costs, it is difficult to publish in international journals, unless they are included in a funded project.

Summary Score, Recommendations, and Comments for Element 2

INSMET is the institution recognised as the only provider of meteorological and climatic services in Cuba, with agreements with the main related institutions in the country. It holds regular meetings with different sectors, being the main organiser of many of them.

It participates in numerous national and international research projects. It has highly qualified research staff to develop the different established lines of research.

In consideration of the above, the maturity level in Element 2, Effective partnerships to improve service delivery, is rated at **Level 5: NMHS is regarded as major national and regional role player. It has extensive and productive partnerships and is viewed as an honest broker in bringing parties together and provides national leadership on relevant finance decisions**.

It is recommended that INSMET continue to take the lead in collaborating with other institutions. There is a risk of not being able to continue certain activities if the institution continues to lose staff.

Element 3: Observational Infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

INSMET has 69 surface synoptic observatories, staffed by its own personnel, two of which, reference stations, are not currently operational. All the observatories have Automatic Weather Stations (AWS), but only 20 of them have automatic observations, due to problems in access to spare parts, while the rest only have manual observations.

In the manual stations, the reports are produced with a tri-hourly frequency, except in the case of hurricanes, when they switch to an hourly frequency. The AWS issue reports with an hourly frequency, with a 10 minutes measurements frequency. With this, the horizontal resolution of surface observation is 80 to 100 km.

There are 14 AWS that report through WIS2.0 and that meet GBON requirements, although they do not uniformly cover the entire Cuban territory, especially in the SE of the island (Figure 4). Many of these stations have instrumentation that is already at the end of its useful life, with great difficulties in replacing it.

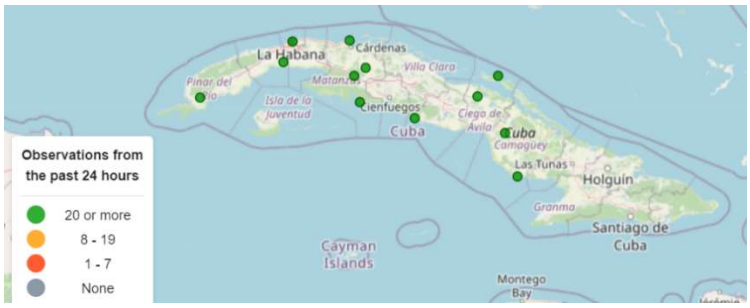


Figure 4. Stations that share data internationally through WIS2.0

There are currently no Upper-Air stations. Between 2005 and 2019, INSMET carried out atmospheric sounding in Camagüey, with a French-made Meteomodem station, not continuously, but to support some artificial weather modification campaigns that were carried out in collaboration with Russia. Only consumables for these campaigns were guaranteed and in 2015 the hydrogen generating plant was definitively decommissioned

Given the GBON minimum spatial resolution requirements for this type of observations, 500 km, and given the length of the island, 1,200 km, at least two radiosonde stations would be necessary in Cuba.

In mountainous areas there is a lack of observations. There are no AWS installed in these areas.

No wave observations are available at INSMET, which are important for monitoring, in addition to those already available (atmospheric pressure, precipitation and wind direction and strength) for Tropical Cyclones and Storm Surges/Flash Floods.

3.2. Additional observations used for nowcasting and specialized purposes.

In Cuba there is a network of eight weather radars, with Doppler capability, maintained and operated by INSMET (Figure 5).

Figure 5. Weather Radar Network

There is a data exchange agreement with the INRH, accessing precipitation data, which are used in the monitoring of Tropical Cyclones, Storms/Squall Lines, Flash Floods and Drought.

There is access to GOES satellite imagery and lightning information provided from the global detection network of the company Earth Networks.

Although it does not have GHG observation networks, it has a mobile station and provides service for measuring CO2, ozone and the precursors NOx, SO2, VOC, CO, MP10, MP2.5.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations, and quality assurance of the observational network.

INSMET has an instrument calibration centre. It has a wind tunnel for calibrating wind sensors and instrumentation for calibrating temperature, pressure and humidity sensors. The pressure gauge, which currently needs spare parts due to failure and is unreliable, should be repaired or replaced, and a simple development should be made available for the calibration of rain gauges from AWS. The instrument management system is ISO 17025 compliant.

Should the above gaps be addressed, the Instrument Calibration Centre could be established as a WMO Regional Calibration Centre for RAIV.

A preliminary calibration of the new meteorological equipment is carried out prior to its installation, additional to the factory calibration of the sensors.

Preventive maintenance at the weather stations is carried out by INSMET staff who are on site up to 24 hours a day. These personnel provide support to the specialist technicians as a first step and immediate response, carrying out basic checks in the event of breakdowns. Even so, it is necessary to travel expert specialists from the INSMET headquarters in Havana in cases of serious damage, new facilities or calibrations, for which, given the difficulties of fuel availability in Cuba, it is necessary to establish a mechanism to ensure its supply for the trips, which can be up to 1,000 km.

Since it has not been possible to transmit information via ftp to the GTS for about 20 years, due to the restrictions that exist in the country and the WDQMS has not yet been implemented in the WIS2.0, INSMET does not receive data on the quality of the observations.

There are four people trained in OSCAR/Surface, from the Centre for Instruments and Methods of Observation and the Climate Centre.

3.4 Implementation of sustainable newer approaches to observations.

At present, there is no National Plan for the implementation of the WMO Integrated Global Observing System (WIGOS) that could allow access to agreements with other institutions to sustain INSMET networks.

To ensure power supply in the event of a power failure, most automatic stations are being equipped with solar panels and batteries. In the event of a long supply interruption, diesel-powered generators are also available, although given the country's fuel supply constraints, their operation may be compromised. It is therefore advisable that the batteries of solar power systems can have enough capacity to support the system for 2 or 3 days, especially in the case of hurricanes, since on these occasions the solar panels are removed to avoid damage.

Travel to carry out maintenance at weather stations is being complicated by the lack of vehicles and limitations in fuel consumption.

Due to the restrictions that Cuba suffers, it is difficult to have spare parts for observation stations, especially automatic ones.

There is an agreement with the company Earth Networks, which manages a global lightning detection network, whereby INSMET accesses the network's data in exchange for the cession of a site to install an antenna by the company, who is maintained by INSMET.

3.5. Percentage of the surface observations that depend on automatic techniques.

Although the synoptic network (69 stations) is fully automated, only 30% of the network is automatically operational, mainly due to problems in accessing spare parts, operating the rest manually, providing data in real time or almost real time to the central headquarters.

There is a network of 8 meteorological radars with Doppler capability, used operationally by the prediction and surveillance units and maintained by INSMET technical staff.

Summary score, recommendations, and comments for Element 3

INSMET has a surface observation network of 69 stations, all of them with AWS, although only 20 of them work automatically and the rest manually. There are no observations at altitude and there is a network of 8 meteorological radars.

At INSMET there is a calibration laboratory with some elements that need to be repaired, but with the potential to become not only a national facility but even a regional centre.

There is no National Implementation Plan for WIGOS.

Due to the restrictions imposed on Cuba, there has been no possibility of data exchange for about 20 years through the GTS. Currently they have been able to access the exchange of information through WIS2.0, although this system does not yet have all its possibilities implemented, such as the information from the WDQMS.

In view of the above, the Maturity level for Element 3, observational infrastructure at INSMET is assessed as Level 3**: Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues**.

In order to increase this level, it is recommended:

- Have at least 2 additional stations in the SE of the island that report to WIS2.0
- Consolidate the calibration center, repairing or replacing equipment with problems and including missing systems.
- Ensure the maintenance of existing equipment, recovering automatic stations that have stopped working
- Use CIMHET's horizontal cooperation mechanism to exchange experts related to the calibration and maintenance of equipment.
- Analyze the establishment of a second technical center with maintenance experts to provide coverage to the stations in the eastern area of the island, leading to decreased travel distances and fuel consumption

Element 4: Data and Product Sharing and Policies

4.1. Percentage of GBON compliance - for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

As of the end of January 2024, 13 stations are reporting data internationally through WIS2.0. All of these stations are declared in OSCAR as contributing to the GBON, although the spatial coverage for Cuba as a whole does not meet the required resolution criteria strictly. The instrumentation of these stations is very old, having completed their useful life and with little possibility of repair in case of breakdowns. The sent data are not received in the WIGOS Data Quality Monitoring System, as it has not yet been updated and only accepts transmission via GTS.

To meet the spatial resolution required in GBON, it is necessary to have 11 adequately distributed surface stations,

There is no upper-air station operated by INSMET. According to the horizontal resolution requirements of GBON, 500 km, at least two radiosonde stations in Cuba would be needed to meet them.

There are no Greenhouse Gas measurement stations.

Since August 2023, INSMET is using the WIS2.0 system for data dissemination.

4.2. A formal policy and practice for the free and open sharing of observational data

In Cuba, in addition to INSMET, there are currently only two other institutions that manage hydrometeorological observation networks, the National Institute of Hydraulic Resources and the Institute of Civil Aeronautics, with a network of 16 stations.

At the time, the meteorological networks that other institutions, such as those of the Ministry of Agriculture, had were transferred to INSMET for their operation and maintenance.

There is no national partnership agreement for WIGOS, although there is a bilateral agreement with INRH for the exchange of precipitation data and another is pending with the meteorology department of the Institute of Civil Aeronautics of Cuba.

There is no policy of providing data free of charge, except for research, master's and doctoral projects.

4.3. Main data and products received from external sources in a national, regional, and global context, such as model and satellite data.

INSMET has a system that receives GOES16 satellite data, with servers dedicated to processing the images. In addition, satellite information is received via Geonetcast. They also have a receiving station for polar-orbiting satellites.

Data and products disseminated by WMO can be accessed through WIS2.0.

The internet bandwidth, of 512 Mbps, is very stable. In Cuba there is a private data network exclusively for INSMET, financed by the Institute itself. A redundant system is currently being established with Cuba's telecommunications company, ETECSA.

Summary score, recommendations, and comments for Element 4

There are currently 12 stations that report data internationally through WIS2.0, although they are not received in the WDQMS, as this communications system is not yet adapted for this option.

It is necessary to carry out actions in the network to ensure that the stations are in full compliance with all the GBON requirements.

There are no upper-air or GHG observation stations.

Systems are in place to receive and process data from GOES16 and polar-orbiting satellites.

In view of the above, the maturity for Element 4, Data and Product Sharing and Policies, is **Level 2: A limited amount of GBON-compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing.**

To increase the level of maturity, it is suggested:

- Adapt at least 11 surface stations to comply with GBON requirements, incorporating them in the National GBON Contribution Plan
- Install at least two upper-air stations
- Implement the National WIGOS Association

Element 5: Numerical Model and Forecasting Tool Application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

The products available on the websites of the different Numerical Weather Prediction Centres are used. The most commonly used products are those provided by the European Centre for Medium-Range Weather Forecasts (ECMWF), especially the EPSgrams as well as those of the Global Forecasting System (GFS). In the event of hurricane forecasts, the number of models consulted is increased.

Access to the products provided by these centers is highly reliable, with the level of access having improved in recent years due to the increase in bandwidth.

The network of meteorological radars managed by INSMET provides acceptable coverage for most of the island.

Equipment is available to receive data from GOES16 satellite as well as polar-orbiting meteorological satellites.

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

The grid data of the GFS model are received and used to initialize the two high-resolution SisPi models that are run at INSMET, one for the country as a whole with a resolution of 3 km and the other for the Havana area, with a resolution of 1 km.

To run the SisPi, there are two clusters of 80 CPUs, one at the INSMET headquarters, and another cluster at the headquarters of the -Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) in Panama, also owned by INSMET.

Due to limited computer processing power, observational data assimilation is not performed to initialize the models.

Currently, there is no system that allows the integration of all meteorological information, both from models and from surface observation and remote sensing. The Smartmet system was once available, but it has been out of service for years.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

No short-term probabilistic forecasts (0-2 days) are made. The medium and long-term predictions (3 to 10 days) are probabilistic, based on the information provided by EPS.

Seasonal predictions are also probabilistic in nature, based on statistical methodologies for climate prediction.

Summary Score, Recommendations, and Comments for Element 5

Most of the products used for weather forecasting and warnings are available on the websites of the different Numerical Prediction Centers.

There is some capacity to run high-resolution models such as the WRF, but with little processing power. A high-performance computing (HPC) system is not available

The maturity level for Element 5 is **Level 3. Prediction based mostly on model guidance from external and limited internal sources (without data assimilation)**

and remoted sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges.

To improve this level of maturity it is recommended:

- Establish protocols with other NMHSs that have HPC to be able to run their models on them, with assimilation of observational data
- Process the grid data of the models used to develop products appropriate to the Cuban meteorological characteristics, in addition to those already existing on the websites of the Centers.
- Take advantage of horizontal cooperation mechanism of CIMHET for the exchange of experts in numerical modelling and in the use and interpretation of prediction models

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

The warning and alert service operates 24/7. INSMET issues early warnings and special warnings about dangerous weather phenomena and from them Civil Defense proposes and takes preventive measures for the population and goods.

The Early Warning System (EWS) implemented in Cuba covers hydrometeorological phenomena, including storm surges, but not other hazardous phenomena included in a Multi Hazard Early Warning System (MHEWS).

The weather prediction system is made up of the Weather Forecasting Centre (CPT), located at the INSMET headquarters, which is responsible for issuing warnings, and seven regional forecast groups located in each of the provinces. These groups are in operational contact with the CPT, with regular videoconferences, which present some problems in the quality of connections.

The current staff of the CPT is 22 people, divided into 4 daily H-24 shifts as well as research staff. The provincial forecasting groups each have a staff of 7 forecasters.

In recent years, there has been a gradual loss of staff, so that there is currently a shortage to cover all forecasting needs, especially in the remote sensing monitoring post. It would be desirable to rehire staff who have left the institution and also to incorporate new staff. Also problematic is the situation of the loss of expert staff as they are close to retirement.

There is an operational manual on Hazardous Meteorological Phenomena, which includes the deadlines for issuing warnings, which is up to 120 hours before the impact.

The warnings are issued as text bulletins, and there is no system based on alert levels by thresholds or impacts.

Weather alerts reach the entire Cuban population through the procedures established by the Civil Defence.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

INSMET provides forecasts and warnings for Tornado, Storm surge/Coastal flooding, Drought, Wind, Tropical Cyclones, Thunderstorms/Squall lines, Rain, Hail, and Flash-

floods. This information is issued in the form of text bulletins, available on the INSMET website.

Products provided by the U.S. National Hurricane Centre (NHC) for hurricane monitoring and CATHALAC for drought monitoring are used.

Feedback is received from users on the effects of the phenomena, usually in real time or near real-time, especially through social networks and radio amateurs.

INSMET conducts a daily internal assessment of forecasts, comparing the forecast and observed data for temperature, precipitation, cloud cover and wind in 16 sub-regions.

The Civil Defence General Staff carries out an assessment of the impacts produced by the different hydrometeorological phenomena in order to improve both forecasting techniques and the preparation, issuance and dissemination of information.

Annually, before the hurricane season, on the third weekend of May, the METEOR exercise is carried out, in which the estimated behaviour of the hurricane season is presented and warning drills are carried out.

A classification of the hourly intensity of precipitation that can lead to Flash-floods is available.

Bulletins of alerts and forecasts have been available since 1916, although in paper format, so some of them are quite deteriorated and at risk of disappearing.

There is a power generator set at the INSMET headquarters as well as a protected space to ensure the continuity of the service in the event that the facilities are affected by severe phenomena, especially in the case of hurricanes.

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure, and vulnerability information into account and with registered alerting authorities.

The Common Alerting Protocol (CAP) format has not been implemented in Cuba.

There is a Handbook of Ordinary Procedure and an Operational Handbook for Hazardous Meteorological Phenomena. They include an updated register of authorities related to alerts in Cuba.

Information on the impacts of severe phenomena is received, especially through Civil Defence, INRH and radio amateurs, as well as from agricultural producers in the case of droughts.

Hazard, Vulnerability and Risk Studies, as well as studies on the influence and effects of hurricanes by region in Cuba, are used as inputs to improve warning services.

Hazard, Vulnerability and Risk (HVR) studies are carried out in Cuba, organized and executed by multisectoral commissions made up of specialists from different scientific and academic institutions, under the direction of the Environment Agency (AMA). Methodologies have been created to identify, evaluate and monitor disaster risks and improve early warnings. The hydrometeorological disaster hazards identified for Cuba are: flooding due to intense rains and sea penetrations, effects from strong winds and intense droughts. INSMET, INRH, the related specialties of the University and the Civil Defense, coordinated AMA by the National HVR Group, participated in the creation of the methodologies to carry out the HVR studies associated with these hazards. These HVR studies cover the entire national territory and are updated periodically. Each of these hazards is associated with a Monitoring System that is activated as required by the

hydrometeorological situation and that results in a greater frequency of observations, weather forecasts and warnings to the population by all available means of dissemination. Cuba's experience in HVR studies has been shared with other countries through South-South collaboration.

There is no impact-based forecasting and alerting service provided by INSMET, nor does it currently have sufficient computer tools to address this activity. The CREWS project, is supporting INSMET to start the process of establishing this service.

Summary score, recommendations, and comments for Element 6

INSMET has a 24/7 weather alert service. The alerts are issued through bulletins from which Civil Defense establishes prevention measures for lives and goods, reaching the entire population.

The CAP is not being implemented. Impact prediction has not been developed.

The Maturity for Element 6, is **Level 4: Weather-related warning service with strong public reach and standard operational procedures driving close partnership with relevant institutions, including disaster management agencies**

To improve this level of maturity it is recommended:

- Establish an meteorological alert system by levels that take in account the thresholds and possible impacts, involving other institutions such as Civil Defence or INRH
- Systematize the way in which feedback information is received, especially from society in general.
- Digitize alert and forecast bulletins, currently available on paper
- Include more phenomena in warnings, such as wildfires, air quality, or UV radiation
- Implement the CAP
- Take advantage of CIMHET's horizontal cooperation mechanism for the assistance of experts on issues related to the implementation of the CAP, impact-based forecast, and the inclusion of warnings of other phenomena.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

There is currently no general governance system in Cuba regarding the provision of climate services by INSMET. Governance for the provision of services in agriculture and health is currently being developed. It is well developed in terms of hydrometeorological disaster reduction.

The meteorological observing network, as noted in Element 3, has some gaps in terms of its spatial coverage and problems associated with its maintenance, which limits the provision of adequate climate services for different sectors.

For the most part, the way to distribute climate information is through bulletins, websites and the media.

The National Forum on Climate Prediction and Applications is held twice a year.

The main products and services provided, accessible from the INSMET website, are:

- Climate Watch Bulletin
- Meteorological Drought Monitoring Bulletin
- Monthly and Seasonal Climate Forecast
- Daily Tropospheric Ozone Forecast
- National Agrometeorological Bulletin

Particularly noteworthy are the climate services related with Climate-Health. INSMET produces a series of products related, among others, to meteorological conditions conducive to virus transmission, which are sent to the Ministry of Public Health and are used internally by the different departments of the ministry.

There is currently no system in place to identify the socio-economic benefits of the provision of climate services. Some information, not systematic, is available at the local level. Work is underway to develop indicators that will allow progress in the evaluation.

There is no systematisation of advisory services to different user sectors. It is carried out in the framework of specific projects as it is normally included in the project objectives.

A data rescue process is currently underway, including graphic records.

Summary Score, Recommendations, and Comments for Element 7

Given the current conditions in the provision of climate services, the maturity level for Element 7 is considered as **Level Three: Essential Capacity for Climate Services Provision.**

To increase this level, it is recommended:

- Develop governance systems for coordination in service delivery, at least in the agriculture and health sectors
- Disseminate climate information in digital form, in formats that are useful for the systems used by different user sectors
- Establish indicators to assess the socio-economic benefits of the services provided, in collaboration with the different user sectors
- Establish mechanisms to train technicians from different sectors in the use and interpretation of the services provided.
- Continuar con el proceso de digitalización de la información climática, con plazos e hitos claros en su desarrollo

Element 8: Contribution to Hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

In Cuba, the institution responsible for the different fields of hydrology is the Institute of Hydraulic Resources (INRH).

INSMET provides INRH mainly with data from the meteorological observation network and precipitation information provided by the numerical models managed by INSMET. There is

no exchange of information between and coordination between the INRH and the meteorology unit of the Cuban Civil Aeronautics Institute.

Data from INSMET meteorological radars are not included in the hydrological models managed by INRH.

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

There is a Standard Operating Procedure (SOP) between INRH and INSMET, whereby precipitation data from stations in the meteorological observation network are included in the National Rain Gauge Network of the INRH.

Joint weekly and monthly meetings are held on the Rational Use of Water, chaired by the Deputy Prime Minister of the Republic of Cuba, with the participation of the Central State Administration Agencies.

The Risk Reduction plan, coordinated by the Civil Defence, includes studies of danger, vulnerability and risk associated with floods.

The Risk Management Group, coordinated by the Cuban Civil Defence, coordinates disaster risk reduction activities associated with hydrology.

8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

There is a formal data exchange agreement between INMET and INRH.

8.4 Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation.

The EUROCLIMA programme project is being developed to strengthen the network of automatic stations in the provinces of Ciego de Avila and Camagüey and the Radar Centre Node**.**

Summary Score, Recommendations, and Comments for Element 8

Relations between the institutions responsible for hydrology and meteorology in Cuba are fluid, with both participating in the weekly and monthly roundtables on the Rational Use of Water, where, among other issues, the current and forecast situation of water resources is regularly analysed on the basis of meteorological information.

There is a protocol for the exchange of data, including precipitation data from the INSMET network in the National Rain Gauge Network of the INRH.

In view of the situation shown above, the maturity level of Element 8 is considered to be **Level Four: The meteorological, hydrological and water resources sectors have a high-level formal agreement in place and an established working relationship and data sharing take place, but institutions still tend to develop products and services in isolation.**.

To increase this level it is recommended:

- Work together INSMET and INRH for the development of operational products related to hydrological monitoring and prediction

Element 9: Product Dissemination and Outreach

9.1 Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video, or audio production facilities? Does it effectively use cutting-edge techniques?)

INSMET makes extensive use of the media to disseminate its information. The weather presenters on the TV channels are INSMET staff, selected for both their technical and communication skills, which provides great visibility to the institution and also ensures the rigor and technical quality of the information provided.

There is extensive outreach through social media, with Twitter and Facebook accounts for the Forecast Centre. A mobile phone application is available, as well as the website.of the institution.

Weather warnings are sent to the Civil Defence, which is responsible for disseminating them at the provincial and local level

9.2. Education and awareness initiatives in place.

Visits to the different INSMET facilities are organized for students of different levels of education and outreach activities are carried out at the open days of the Universities.

Among the existing Circles of Interest in Cuba, spaces for research and reflection, are those dedicated to meteorology, from primary education to university.

Informative television programs are made on Meteorology, Climatology and Tropical Cyclones.

Participation in Job Fairs to show the activities carried out by INSMET

9.3. Special measures in place to reach marginalized communities and indigenous people.

There are no special measures to make meteorological information available to indigenous peoples, young people and the elderly in a differentiated manner.

Summary Score, Recommendations, and Comments for Element 9

INSMET has various means to disseminate the information generated, being especially relevant that the weather presenters are selected from among its staff, which, in addition to ensuring the reliability of the information provided, provides great visibility to the institution.

Multiple activities are carried out to raise knowledge of meteorology and climatology, as well as the institution itself, both through the central headquarters and the different provincial centres.

For all of the above, the maturity level for element 9 is **Level four: A large fraction of the population is reached using various communication techniques and platforms, in collaboration with partners, and a user-friendly and informative website and apps. Outreach and education activities occur regularly.**

To improve this level, it is suggested:

- Develop a level alert system that allows society to quickly and easily assess risk

- Designing presentation formats for meteorological information on social media that are attractive to young people.

Element 10: Use and National Value of Products and Services

10.1. Formalized platform to engage with users in order to co-design improved services.

There are different platforms in which INSMET actively participates. Among these is the National Platform for Disasters Risk Reduction, led by the National Civil Defence Staff (EMNDC). Every year, at the beginning of the hurricane season, all interested parties meet, convened by civil defence. At the end of the season, a summary of the season is carried out, made by INSMET.

Weekly and monthly meetings are held with INRH and other agencies of the Central State Administration on the Rational Use of Water, already mentioned above.

The National Forum on Climate Prediction and Applications is held twice a year.

Promoted by INSMET, two annual meetings are held in each province with the predominant socio-economic sector in these provinces.

There is no procedure for the production of tailor-made services, and no studies have been carried out on the socio-economic benefits of weather, climate and water services.

There is a social communication department, responsible, among others, for managing the institutional Twitter and Facebook accounts, as well as web content.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

INSMET regularly carries out an analysis of the quality of the forecasts provided, as well as of the climatic and agrometeorological services. Currently, the level of reliability of the general prediction made by INSMET is 93%.

No user satisfaction surveys are conducted.

Although they do not carry out a formal evaluation of the quality of the products supplied, every year the Ministry of Economy and Mines, responsible for the installation and operation of the wind and solar energy parks of Cuba, sends a letter of recognition on the usefulness of the service provided by INSMET

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

INSMET has not developed a Quality Management System (QMS) in any of the areas. Among other consequences, it has impeded the accreditation of the calibration laboratory, as there must be QMS implemented in the various related areas.

Although internal quality controls are carried out in different areas such as forecasting, observing systems or provision of climate services, these are not done according to standards and are not certified by existing regulations. There are no plans to implement any QMS in the next three years.

Summary Score, Recommendations, and Comments for Element 10

INSMET is an important player in different national platforms, especially those related to disaster risk reduction and water management.

There is no procedure for the development of tailor-made products in collaboration with the different stakeholders.

Standard QMS are not available and are not planned to be implemented in the medium term.

The maturity level for element 10 is **Level three: Services development draws on regular dialogue with major stakeholders.**

To improve this level of maturity it is suggested:

- Conduct studies on the socio-economic benefits of products supplied by INSMET. To do this, it can draw on the experience available at WMO and CIMHET.
- Development of sectoral workshops with users to gather needs and establish the usefulness of the products supplied..
- Implement a quality management system in all areas of the institution, especially those necessary for the accreditation of the calibration laboratory and those related to early warning services.

Annex 1 Consultations (including experts and stakeholder consultations)

To carry out the CHD, the following actions and meetings have been held:

- Virtual meetings between AEMET and INSMET staff, to analyze the information included in the CHD EW4All Data Sheet for Cuba
- Face-to-face meetings, at the INSMET headquarters in Havana between January 22 and 26, 2024, with the following INSMET managers:
    - Celso Pazos Alberdi, General Director
    - Yinelis Bermudez Souza, Basic Systems Director
    - Daysaríh Tápanes Robau, Senior Specialist for Science, Technology and Environment
    - Orlando Osa, Director of Centre for Instruments and Methods of Observation, Informatics and Communications
    - Felix Avila, Centre for Instruments and Methods of Observation, Informatics and Communications
    - Luz Zaldivar, Human Resources Director
    - Miriel González, Economic Director
    - Vladimir Guevara, Scientific Director
    - Cecilia Fonseca, Director of Climate Centre
    - Miriam Teresita Llanes, Director of Forecasting Centre
    - Rosemary López, Director of Atmospheric Chemistry Centre
    - Eduardo Rodríguez, Director of the Provincial Center of Havana, Artemisa and Mayabeque
- Visit to the INSMET calibration laboratory and forecasting centre
- Visit to the weather stations of Mariel and Santiago de las Vegas
- Meeting with the President of the Environment Agency of Cuba, Maritza García García
- Meeting at UNDP headquarters in Havana with the staff responsible for the phase of implementation of the project

Annex 2 Urgent needs reported.

Chapter 2 discusses each of the 10 elements considered for carrying out CHD, establishing a maturity level for each of them and providing a series of recommendations for raising that level.

Among the recommendations raised, the following are considered the most critical or urgent

- Ensure the continuity of staff at INSMET
- Have systems in place to ensure continuity in the receipt of spare parts for the different INSMET equipment
- Adapt at least 11 surface stations to meet GBON resolution requirements
- Implement the observation network at height, with two stations
- Implement the national WIGOS system
- Implement a Quality Management System in the areas of INSMET related to the certification of the calibration laboratory and Early Warning Systems

Annex 3 References and information supplied through WMO

Hydromet GAP Report 2021. Alliance for Hydromet Development

The gaps in the Global Basic Observing Network (GBON). SOFF, 2020

The Global Basic Observation Network (GBON). EC-76/Doc. 3.2 (3) ANNEX, 2023

Curso WIGOS Learning Portal. ETRP Moodle Site (wmo.int).

CHD Operational Guidance for SOFF. SOFF, 2023

Country Hydromet Diagnostics. WMO-Alliance for Hydromet Development, 2022

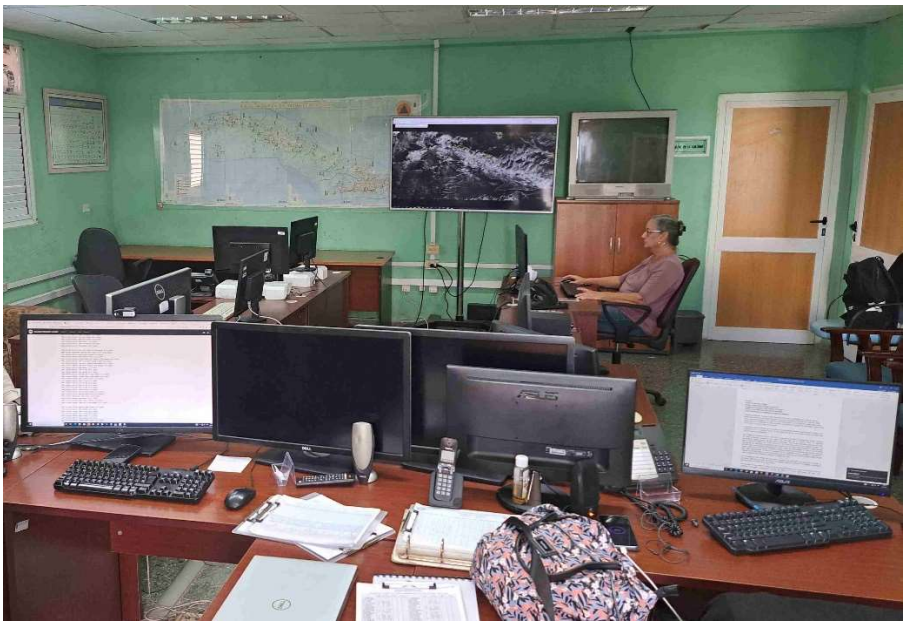
Multi-hazard Early Warning Systems: A Checklist. WMO, 2018

The WMO Strategy for Service Delivery and its implementation plan. WMO nº1129, 2014

CHD EW4All Data Sheet v1.3 Cuba

Annex 4 Pictures

INSMET Headquarters



INSMET forecasting room

INSMET Calibration Laboratory Wind Tunnel

Mariel Weather Station

Santiago de las Vegas Weather Station