Towards a unified central information processing system to operate the various automatic weather stations composing the Moroccan AWS network.

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Abstract:

The Automatic Weather Stations (AWS) network of the national meteorological service of Morocco is composed by three AWS networks totally independent and belonging to three different suppliers.
Each sub-network of automatic weather stations is managed by a dedicated solution of concentration, processing, archiving and quality control of measured data.
This paper addresses the basic principles to be followed in order to establish a unified solution for managing the data measured by the various automatic weather stations implemented in the whole Moroccan territory including those from the ministry of agriculture. It also describes the technical difficulties to be overcome as well as the opportunities to be grasped in order to have a single web interface allowing access, processing, archiving and quality control of data received from all automatic weather stations composing the national network and lists the associated requirements to be met for any new acquisitions.

1. Introduction

In an effort to promote and enhance its observing meteorological network, the National Meteorological Service (NMS) of Morocco has embraced the use of Automatic Weather Stations (AWS) since 1992, but it was until the year 2008 that the NMS decided it was high time to complete the lack of observational data on the Moroccan territory with a AWS network fully compliant to WMO guidance and thus began the real experience. The first network that was set up in 22010 contained 32 AWS with dedicated Central Information Processing System (CIPS) operating the acquired AWS and allowing real time access to measured data through a web solution. Due to budget related matters, it wasn't possible to set up more AWS and was decided that the network should be gradually expanded over the years to come to reach a total of 156 AWS by the year of 2013.NMS of Morocco failed to rightly assess the technical difficulties that could emerge from the limitations of a CIPS as well as the problems that our public procurement law could cause which made matters even more difficult.

In fact, the CIPS that was firstly set up could only support specific brands of AWS and since the call for tenders is open by its nature, we couldn't control which brands of AWS we could end up with and were faced with a situation in which we had to acquire a new CIPS to operate the second set of AWS and so on.

Furthermore, NMS of Morocco was also charged in 2016 to manage the AWS network of the ministry of agriculture composed by almost 170 operational AWS.

This made things difficult for our forecasters and network managers who needed to access data in real time through a single and unique solution including the various AWS, as well as our climatologists who needed to access data through a single database. And therefore come the challenge to satisfy those needs by the design of unified web interface providing near real time access to observation collected from the different AWS networks implemented.

2. Heterogeneity of the Morrocan AWS networks

The main feature of the Moroccan meteorological AWS networks is their heterogeneity not only in terms of brands but also in terms of telecommunication means used. Following are described the main AWS networks in use:

- The manned synoptic stations:

Almost 40 manned synoptic stations are all equipped with AWS. Measured data are processed locally and the synoptic WMO messages are transmitted to the central automatic message switching system (AMSS) using the national VPN network.

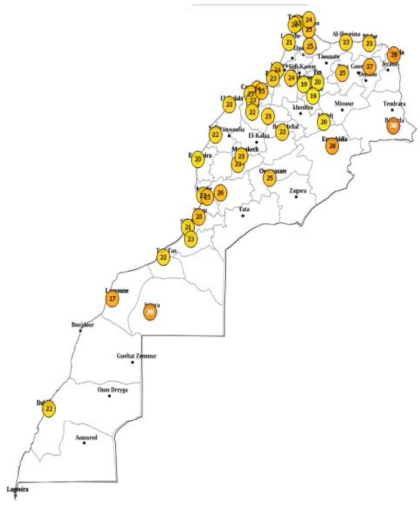

Figure 1. Synoptic manned stations of DMN.

- The AWS Network:

The AWS Network of the NMS of Morocco is composed by 156 automatic weather stations serving several purposes. All of them are equipped by sensors measuring the usual parameters such as: temperature, humidity, air pressure, solar radiation, wind and precipitations. 20 of them include an additional sensor for the measurement of the snow height.

In reality, the AWS network is a combination of two networks with two different brands and, as a consequence, two different telecommunication protocols and two different software solutions. Each network is accessible using dedicated web portal.

Each AWS network has its own quality control procedures and its own database and each AWS network has also its own telecommunication protocols and means.

Each AWS network has its own CIPS that can communicate only with the associated distant dataloggers (the same brand).

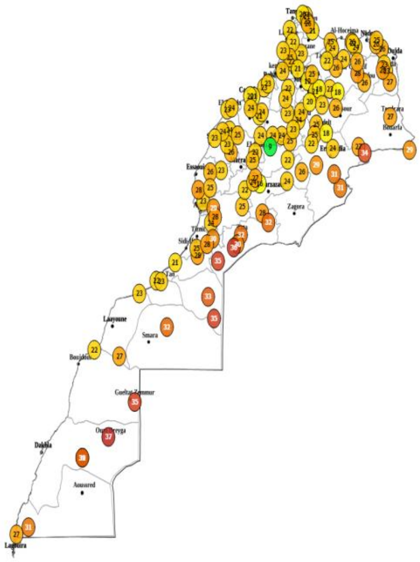

Figure 2. The AWS network of DMN.

- The AWS network of the Ministry of Agriculture

During the last decade, the ministry of Agriculture decided to modernize its observing network. Each year, since 2005, a dozen of automatic weather stations are acquired and implemented in the different provincial centers of agriculture.

Currently the network of the Ministry of Agriculture has more than 280 observing sites (Fig 3.). 165 among them are equipped with automatic weather stations measuring wind velocity at 2.5 m above the ground, temperature and humidity of the air, solar radiation and rainfall amount (Fig 4.).

Since 2016, NMS of Morocco is charged of the study, upgrade and exploitation of this network including the provision of its metadata.

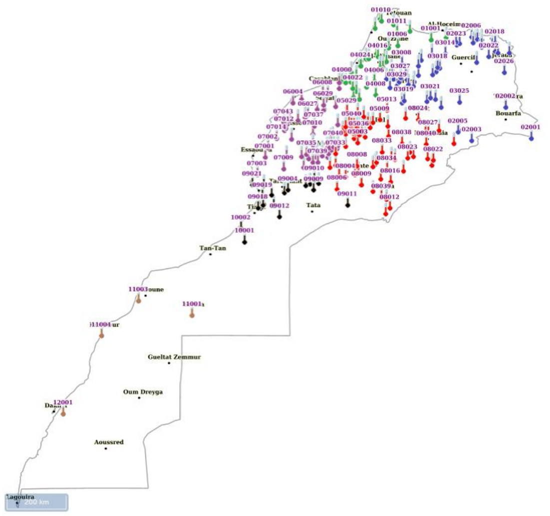

Figure 3. Observing Network of the Ministry of Agriculture

Figure 4. Observing site of the ministry of Agriculture

3. Difficulties to overcome

If we refer to the CIMO guide, the main purposes of an automatic weather station are providing data from new sites and from sites that are difficult to access and inhospitable as well as satisfying new observational needs and requirements. In this light, the National Meteorological Service of Morocco took action to acquire automatic weather stations in an effort to make data available to its forecasters and climatologists both in real and deferred time.

It was previously mentioned that each set of AWS came with its own CIPS and its associated web interface. For the forecaster and in particular for nowcasting activities, access to real time data should be made through a single solution on which all sites are present. The same thing could be the said about the databases that are distributed between the different offered solutions which makes accessing data a hard task.

What makes matters even more challenging is that we have to also figure a way by which we can make best use of the available AWS that comes from our partners.

4. Possible solutions and technical difficulties

In order to propose a solution, we have to first decide on the level of integration that we're aspiring. In other terms, are we going to try to fully command the AWS or are we going to just extract data from AWS datalogger.

Both approaches are feasible; If we go for the first one, it means that we should have access to a fully detailed technical documentation of the AWS in question and that is for each supplier. Keeping in mind what was said about the heterogeneity of our network and taking into consideration that gaining access to the technical documentation is not always possible, this approach will be very difficult, laborious and time consuming.

We're left with the second approach which seems much more doable, but nevertheless challenging. Under this approach, various scenarios were studied among which the three following scenarios:

1st case scenario:

Intervening on the level of the datalogger, collecting the data and transmitting it towards a central server where it would be processed, meteorological messages could then be coded and transmitted to our Automatic Message Switching System (AMSS) solution where they could again be transmitted to feed our local meteorological databases. Data would then be available and could be presented on our local web portals.

Since most of the AWS offer the possibility to transmit data, this solution seems doable but still very laborious since each AWS should be re-configured to send data toward a dedicated server instead of using its CIPS if it has any.

In the following scenarios, we studied how we could make use of the existing CIPS.

<u>2nd case scenario:</u>

In this scenario, we're intervening on the level of the CIPS. Since they already do the task of data collection from a set of AWS, we can directly access the data (raw data) and send it toward a central server in which this data will undergo the same checks and quality control procedures and thus offering an homogenous database from which meteorological messages could then be coded and sent to our AMSS as well as to our local web portals. This solution is a very rigorous one and will result in obtaining homogeneous data since the data undergo the same checks, but considerable efforts needs to be done to develop the tools that will performs the quality checks of data. It's the best solution for delayed mode for the data access.

<u>3rd case scenario:</u>

This scenario is a little bit similar to the previous one with the exception that this time we'll be dealing with the messages that are coded by the existing CIPS instead of the raw data. We won't go through a central server to process data this time, we'll directly send the coded messages to our AMSS and then feed our local databases from which the data will then be extracted and presented on our local web portals. This solution is best suitable when you need real time access to the data.

5. Adopted solution

Taking the heterogeneity of our AWS into account as well as the technical difficulties and efforts that comes with adopting a specific approach, it was clear that what we needed the most was an hybrid solution between the first and the third scenarios (Figure 5).

We made use of the existing CIPSs to code meteorological messages and send them to our AMSS and we also had to adopt the first scenario with the AWS that we weren't able to integrate through the existing CIPSs.

A considerable amount of time was also spent on developments to visualize observations issued from our whole network on a singular web interface.

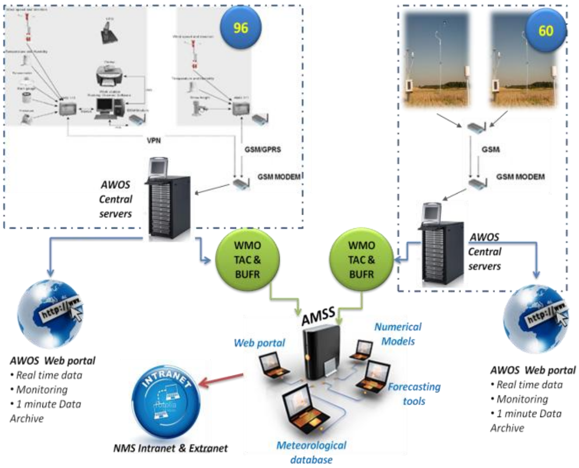

Figure 5. Integration of AWS observations in the operational workflow of the DMN.

The AMSS is the unique entry of the developed web interface. Information at the entry is essentially meteorological coded messages. The main function is to decode the message, to apply the necessary quality controls and to insure the appropriate visualization in form of tables or geographically referenced maps.

All AWS are represented including those of the manned stations network sorted by type, by variable or by regional offices.

6. Conclusion

The implementation of the AWS network led to a significant improvement of weather forecasts in Morocco, the observations issued from these stations came in very handy when they were added in the assimilation process of numerical models. And they were a great source of real time monitoring of meteorological conditions on areas in which it wasn't previously possible to get any data from.

It should be noted that a lot of efforts could have been spared if we were to rightly assess the technical and legal difficulties that we could come across, this is why it's very important to take your time to arrange for the agreement on the technical and functional requirements in a CIPS or an AWS before you decide to acquire them.

We most certainly spent long days and great efforts in order to overcome these difficulties and present the data in a suitable and practical way for the final user but it was an experience full of lessons and what we gained in compensation was really worth putting our efforts into this work.