EXTENSION AND DEVELOPMENT OF THE SURFACE OBSERVING NETWORK OF THE NATIONAL METEOROLOGICAL SERVICE OF MOROCCO

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ABSTRACT

As part of the fight against extreme events, especially floods, the Moroccan department of meteorology has established a program to improve early weather warning. Among the actions undertaken in this direction, stretching and Automation the national weather observation network (VIGIOBS project) by implementation during the period 2010-2012 ninety automatic climatological stations, sixty automatic synoptic stations and six station automatic of mountain.

In that document i will describe the VIGIOBS project and explain the choices made by the Moroccan department of meteorology to reach the desired.

The following points will be treated:

- The local system of acquisition, processing, visualization and dissemination of data;
- Central concentration, processing, visualization and dissemination systems;
- Data transmission in near real time to the concentration systems;
- Power supply;
- Implementation into compliance with wmo standards for good representativeness of measured data;
- The choice of installation sites.

INTRODUCTION

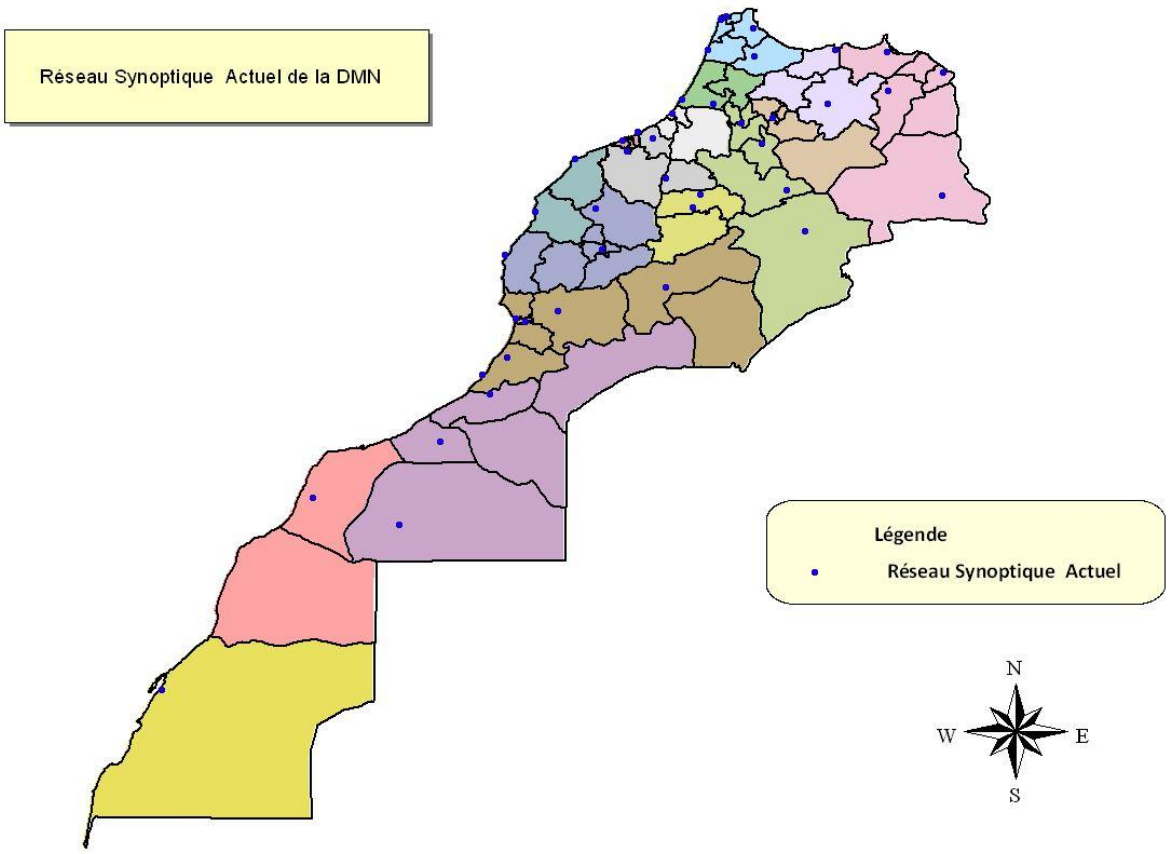
As part of the fight against extreme events, especially floods, the Moroccan department of meteorology has established a program to improve early weather warning. Among the actions undertaken in this direction, stretching and Automation the national weather observation network by implementation during the period 2010-2012 ninety automatic climatological stations, sixty automatic synoptic stations and six station automatic of mountain.

In my presentation i will explain the decisions and choices made by the Moroccan department of meteorology to reach the desired.

Currently the Moroccan observation network is not very dense and is partially automated. The weather observation in Morocco depends largely on the human presence. That implies necessarily the absence of meteorological data on large regions of Morocco and in case they are present their concentration and their treatment remains difficult.

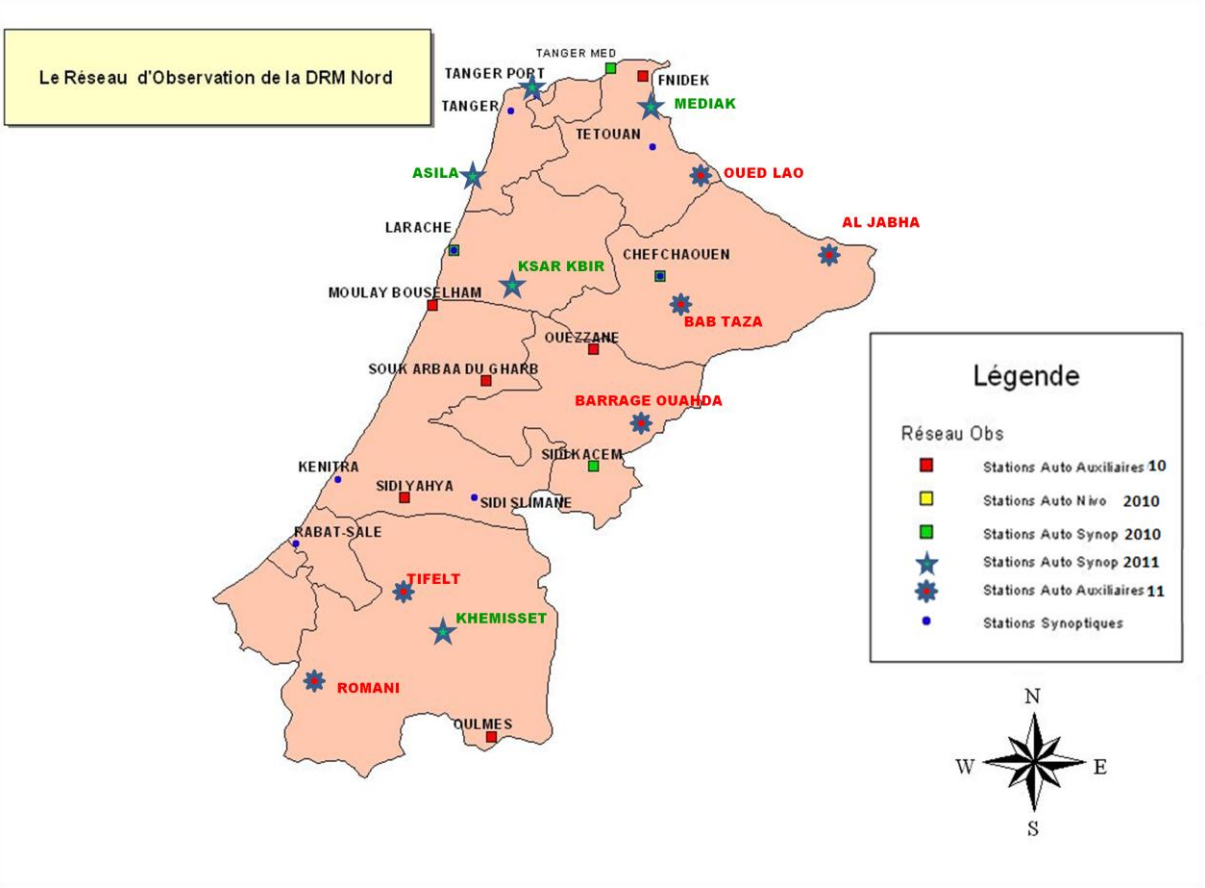
The Moroccan automatic weather station network presented several problems:

1. Low density of the network and bad distribution
2. Variety of data storage format
3. Lack of automatic transmission solution of the observed data
4. Not automatic coding meteorological message of observed data in accordance with WMO
5. Data transmission require in most cases human intervention and the passage through other local treatment system
6. Data transmission is done by technical means become obsolete and expensive: the analogue leased lines.



The VIGIOBS project comes to address these issues for a better distribution of the Moroccan observation network, a high availability of data for their easy storage and treatment at end of climate studying and weather forecasting.

In the period 2010-2011 the VIGIOBS project will allow the following coverage of Moroccan territory by the automatic weather stations:


Le Réseau d'Observation de la DRM Nord
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CHEFCHAOUEN
KSAR KBIR
MOULAY BOUSELHAM
BAB TAZA
OUEZZANE
SOUK ARBAA DU GHARB
BARRAGE OUARDA
SIDI KACEM
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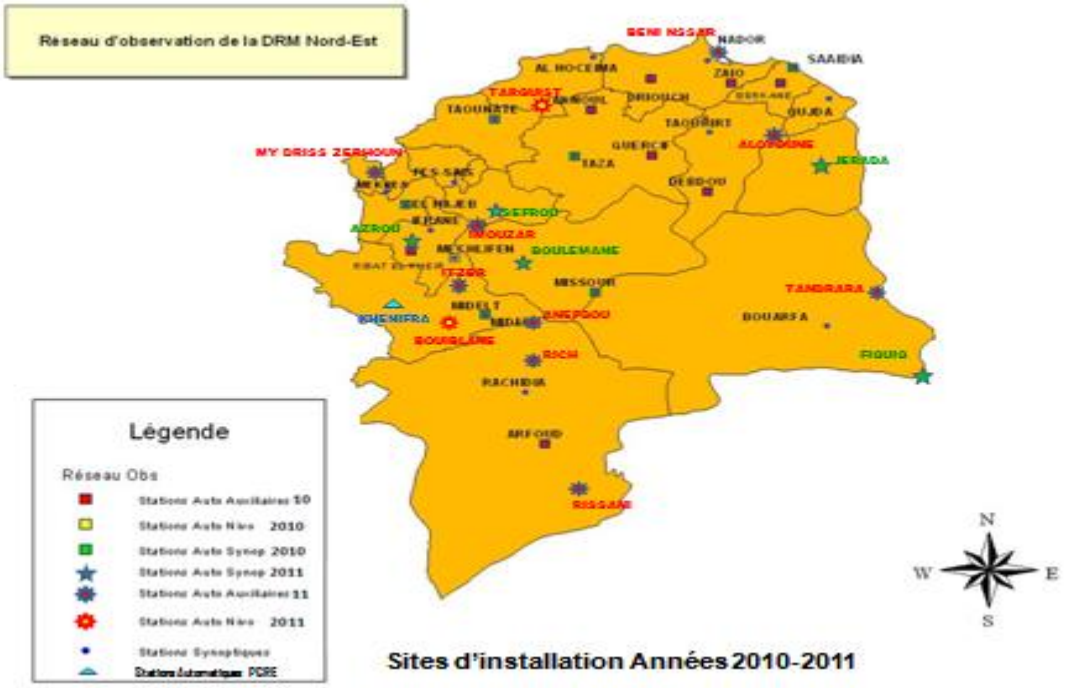
Réseau d'observation de la DRM Nord-Est
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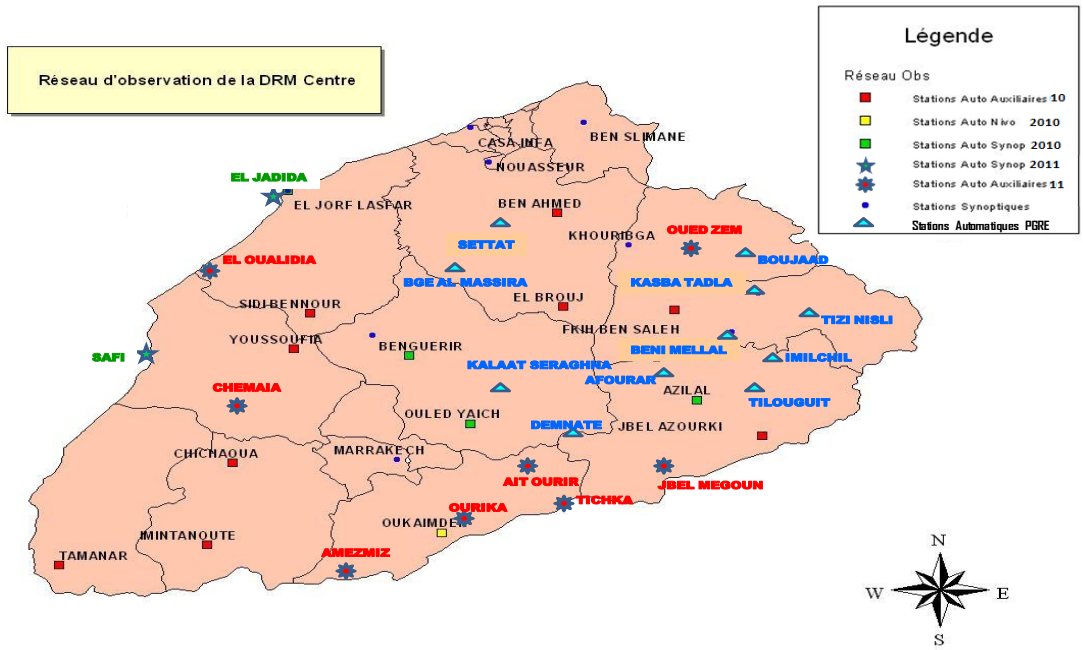

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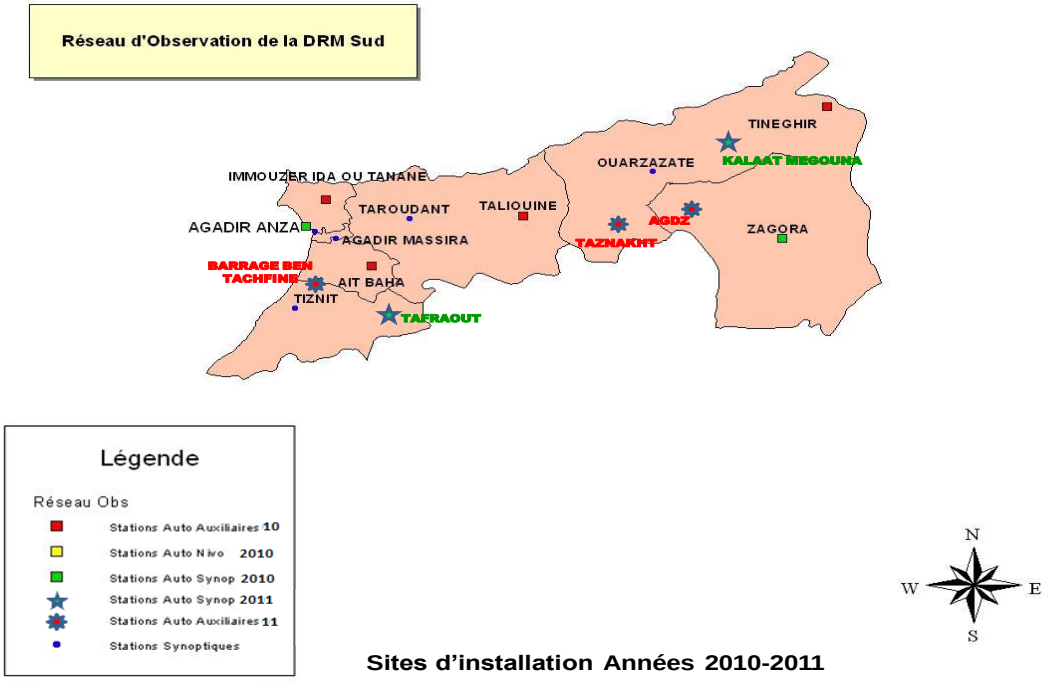

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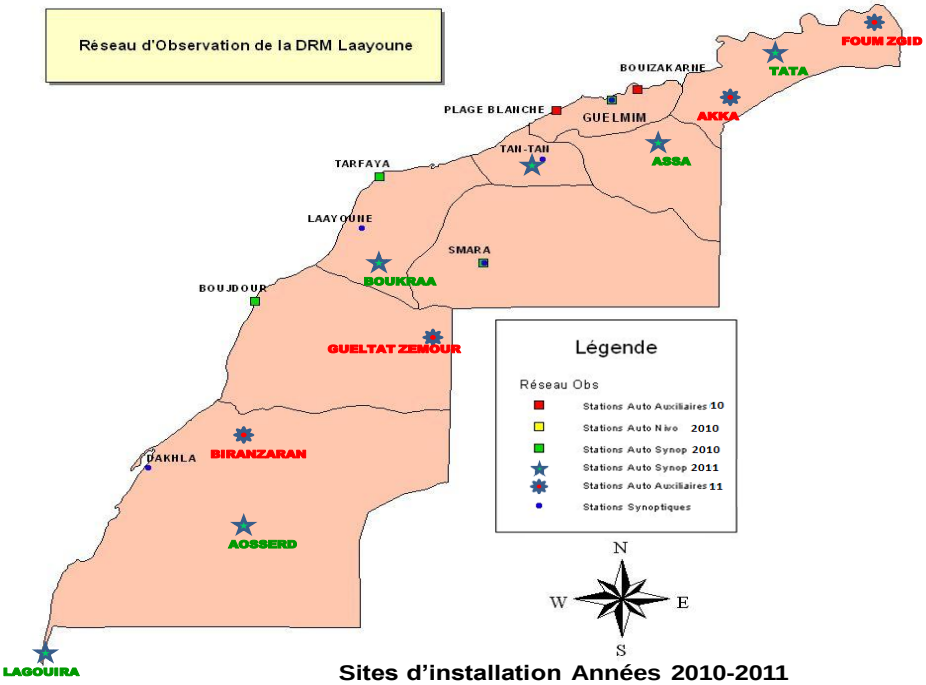
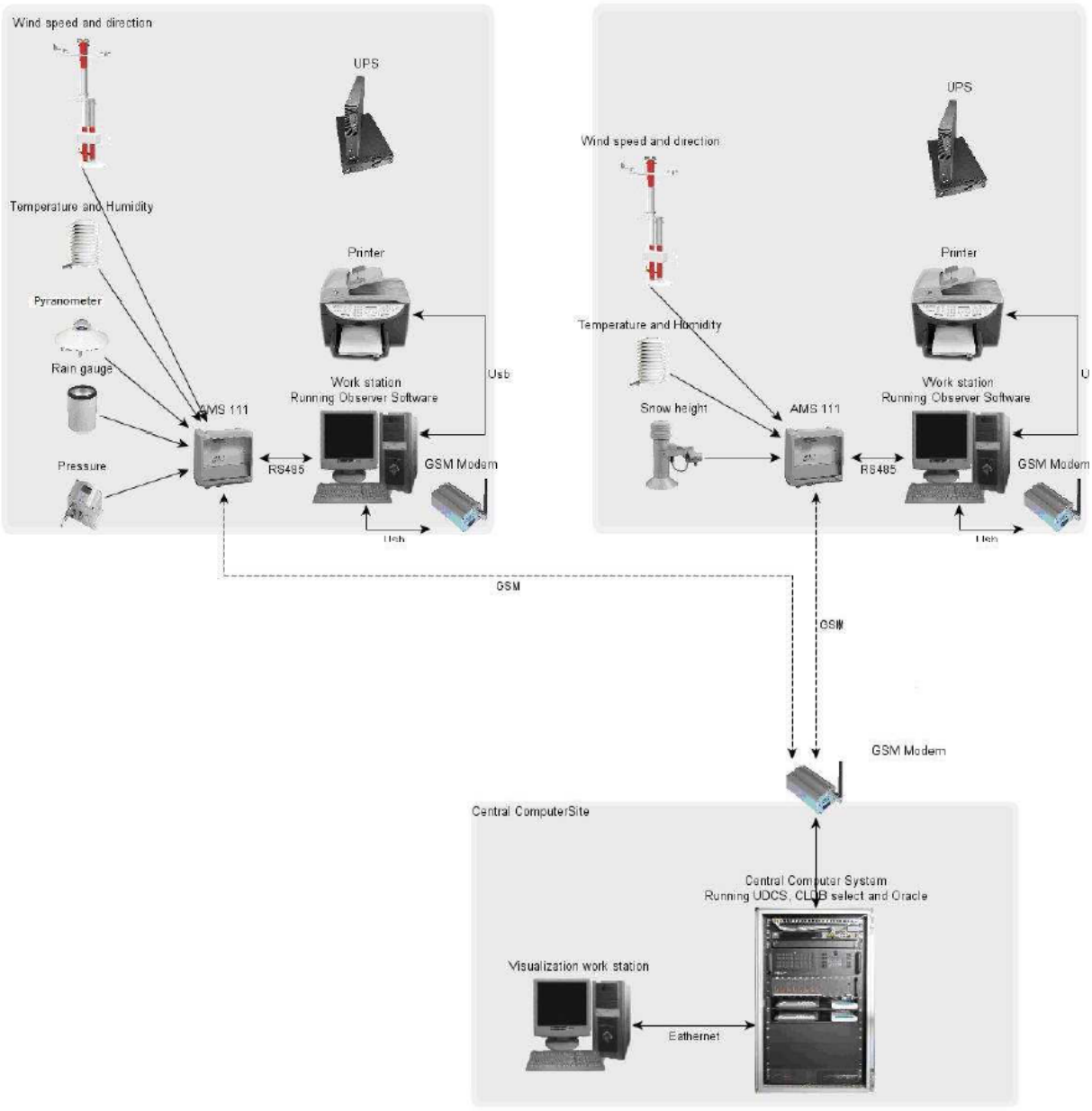


Sites d'installation Années 2010-2011

DESCRIPTION OF VIGIOBS PROJECT

VIGIOBS automatic stations



The project involves the installation of automatic weather stations with the following sensors and modules:

For each site:

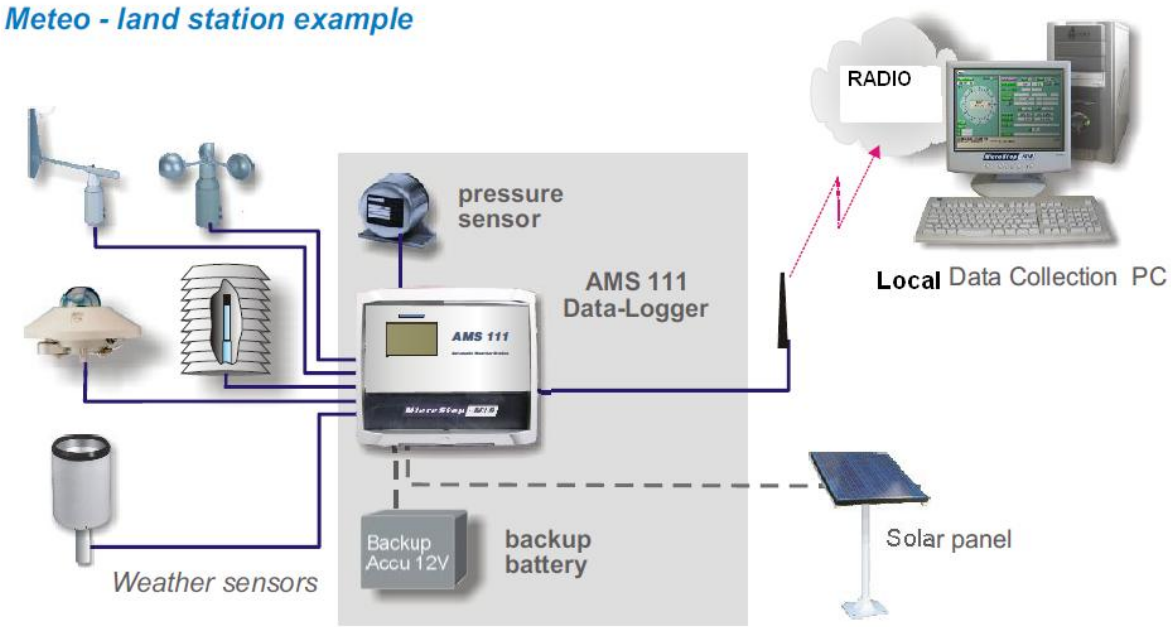
- A datalogger
- A sensor for measuring temperature and humidity
- A sensor for measuring global radiation
- A sensor for measuring wind direction and speed with 10 meters high mast
- A sensor for measuring pressure
- A sensor for measuring rain

- Radio modem for communication between the datalogger and the local system of concentration.
- A local system for concentration, processing, display and dissemination for each synoptic stations)
- A GSM modem for communication between the datalogger and the central concentration .system
- A sensor for measuring the height of the snow for each nivologic stations,

At central level:

- Two central servers (in normal and backup configuration) for concentration, processing, visualization and dissemination of data transmission with GSM modem

A- **The local system of acquisition, processing, visualization and dissemination of data :**



The software of the local data concentration system allow the acquisition, processing, visualization and automatic dissemination of meteorological data collected by automatic weather station sensors and compiled data :

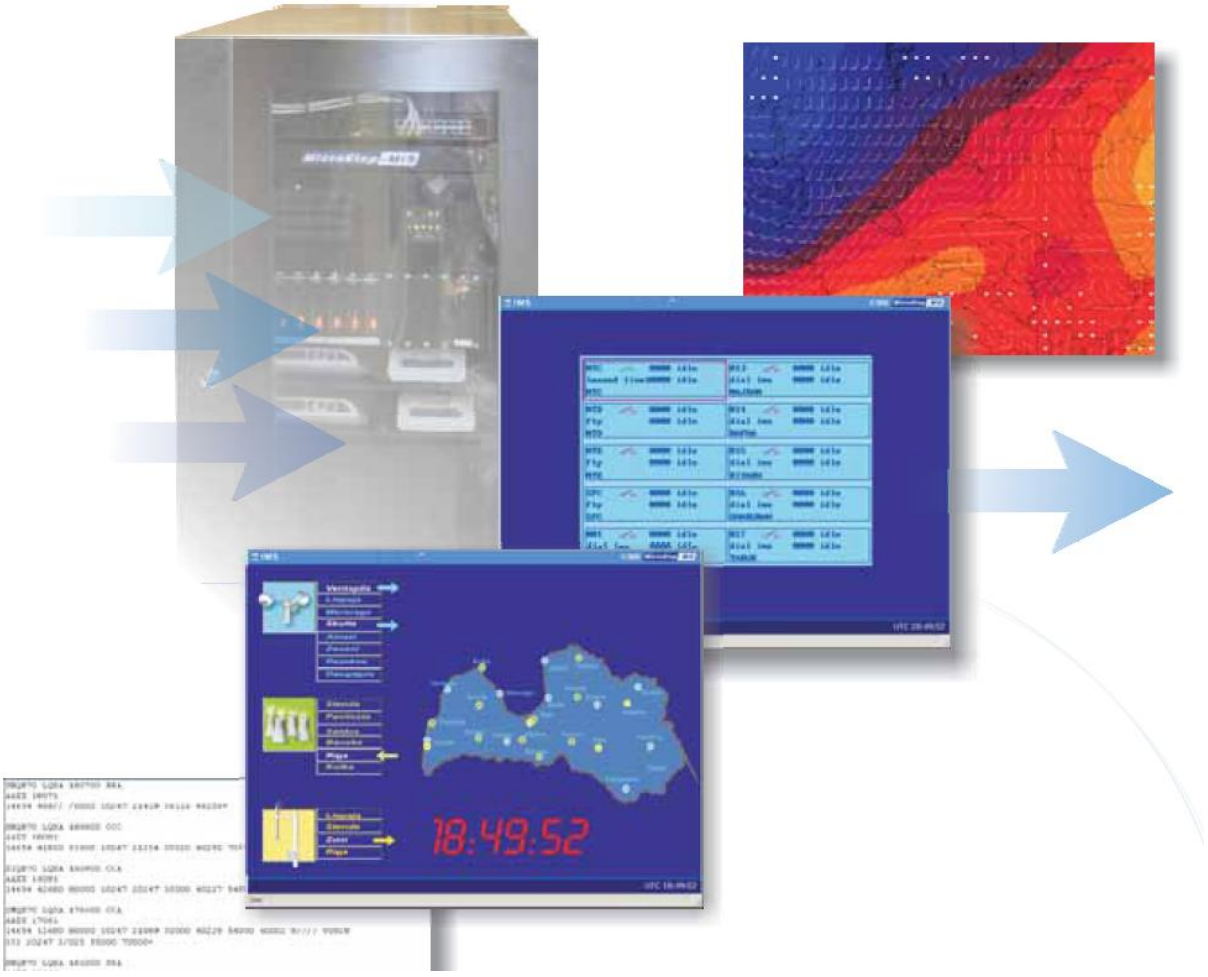
- Acquisition of data measured by sensors from the datalogger via a radio link
- Processing and management of data and other messages entered manually by the observer (overview ...)
- Audit, control and correction of meteorological data,
- Automatic coding of different meteorological messages: CLIMATE, METAR, PECI, SYNOP, etc ... in accordance with standards and procedures of the World Meteorological Organization (WMO).
- Storing and archiving as a database of all information and meteorological data.
- Display of meteorological data
- Delivery of data and messages to the central concentration system via the IP VPN network off Moroccan meteorology department.

B- **Central concentration, processing, visualization and dissemination systems :**

Both concentrations, processing and visualization servers of data from automatic weather stations use the **UDCS** and **CLDB** Microstep-MIS software. Those two software are opened and accept different data format from several types of automatic stations. The number of stations that can be concentrated by those servers is limited only by the communication infrastructure.

The central servers allow, through a Web interface, a near real-time access and display of all measured and developed parameters and state parameters of automatic stations.

a) Unified Data Collection System (UDCS) :



IMS UDCS is a data collection and switching system built on the field proven IMS platform for meteorological data acquisition and remote system maintenance.

The IMS UDCS runs on standard PC, or fault tolerant server with redundant components or even a high availability cluster of two servers running in a hot failover mode, providing more and more safety for your data.

The system fully supports standardWMOcodesSYNOP,METAR/SPECI, CLIMAT, GRIB, BUFR, and is open for thesupport of proprietary/national codes.

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In addition to WMO standards the UDCS supports numerous proprietary protocols and formats for communication with automatic weather and environmental stations and dataloggers, as well as for data distribution and exchange.

- **Supported Interfaces**

- LAN/WAN, Ethernet,
- TCP/IP, FTP, PPP,
- - GSM and dial-up lines with dial-in, dial-out options (both periodical and manual).

- **Built-in Web Server**

The IMS UDCS provides users with easy-to-use and efficient web interface. An authorized user has access to all data, statistics and full functionality from any computer on the network.

UDCS as Center of Large-Scale Meteorological Network

The UDCS provides all functionality necessary to operate and maintain large meteorological networks of automaticas well as manned stations.

The number of stations which can be interfaced by a single UDCS is limited only by the used communication infrastructure.

- **Data Collection**

The data from the stations can be collected in several modes using different communication protocols:

- PSTN/GSM (dial-in, automatic and on-demand dial-out),
- TCP/IP sockets and/or FTP through LAN, WAN, GPRS.

The time intervals of data collection are user-configurable for each station from minutes (or even seconds) to days.

In case of communication line failure the robust data collection mechanism allows automatic retrieval of missing data as soon as the connection to particular station is reestabilished.

- **Data Validation and Export**

The UDCS data validation and export options include:

- Data processing of WMO and various proprietar text and binary formats,
- Quality control of collected data (limits, internal consistency),

- Data export in various text and binary formats,
- Data export to relational database (Climatological Database of MicroStep-MIS or 3rd party one).

- **Monitoring and Confirmation**

The status of the network is visualized by status screens displaying the status of stations and /or communication channels and data flow. All communication events are archived in the UDCS logs. The user-friendly interface allows easy configuration of the network and station parameters.

b) Climatological Database System (CLDB)

Within the Climatological database (CLDB), an unified structure based on SQL Database Server and the standard data access is based on SQL language is used.The guarantee of data storage quality is the industry-proven Oracle Database Server, the world leader in database technologies.

CLDB is based on WMO recommended practices for climatological data processing (WMO Guide No. 100). It follows the WMO suggestion of a RDBMS (Relation Database Management System) application with wide use in climatology (World Climate Program efforts concerning new Climate Data Management Systems - CDMSs).

- **High Availability**

CLDB is easily extensible to dual system architecture to provide high availability solution. The dual configuration is based on the Oracle Replication technology.

- **Connection and Data Input**

The CLDB can hold textual and numerical data, graphical information and animations. The database is capable of receiving, decoding and storing of the following data types from different data sources:

1. Data electronically imported from third party database system: CLICOM.

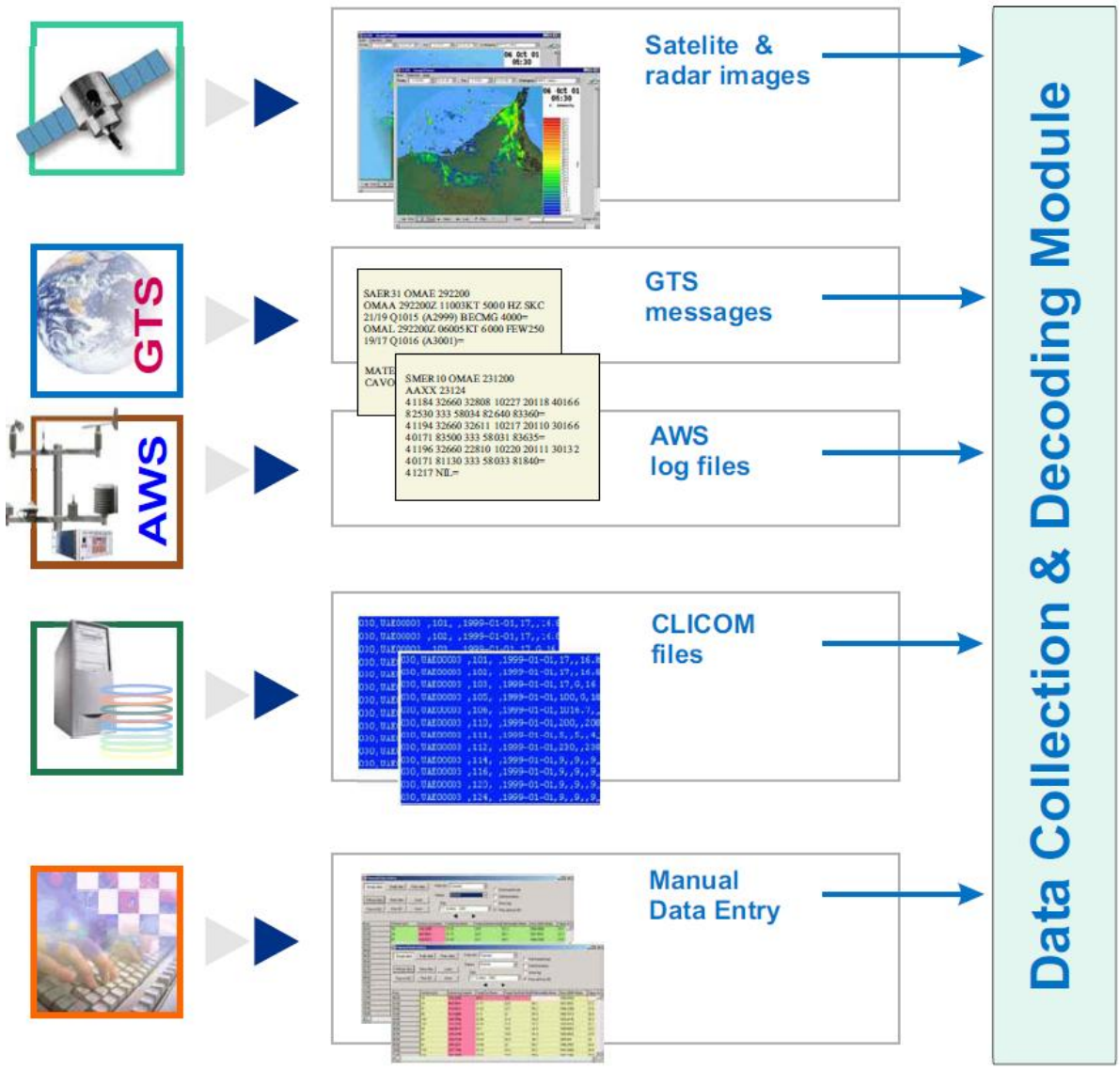
2. Data manually entered : Data from manned stations with regular or irregular observing schedule. Database stores complete information who and when inserted the data .

3. Data from meteorological messages received via GTS :
- SYNOP
- METAR
- TEMP
- PILOT
-Marine data (BUOY)
- binary messages (BUFR, GRIB).

4. Data collected from automated weather stations (AWS):
- Distributed in various formats.

5. Radar and satellite images:
- IR, WV, VIS channels, colored compositions
- Weather radar products Intensity, Rain Rate, Velocity.

6. Other numerical, textual, binary or graphical data according user requirements can be stored in CLDB.



- **Data Processing and Quality Control**

Climatological data in the CLDB system are processed through different modules before storing in database. They are collected from different sources by the data collection & decoding module. The decoding module decodes received data and passes them to the quality control module. All data must be checked. Data validity (elements limits), internal consistency (elements relationships), temporal and spatial consistency (rate of change, nearby stations) are considered. The checks are fully and user-friendly configurable by database administrator.

Manually entered data are checked immediately during the key entry process. Another more complex check is performed when complete (e.g. one day) dataset enters the database.

Data that passed quality control are stored in archive. Incorrect data can be repaired manually. During data processing, CLDB calculates derived values (e.g. pressure, humidity). User can define calculated elements and edit derivation formulas.

- **Accent on Metadata**

Detailed observing stations description and history metadata is inevitable part of climate data itself. CLDB extends CLICOM metadata system, i.e. metadata stored in CLICOM can be imported to CLDB and new types of descriptive information can be added (textual, graphical). Besides standard descriptive items, system administrator can define new station or element properties. Metadata are organized in three groups:

1. Station Geography
Contains station and region name, standard WMO, ICAO, hydrological and other identifiers, geographic location, vegetation description, possibility of graphical information storage (maps, Word documents, scan copies).

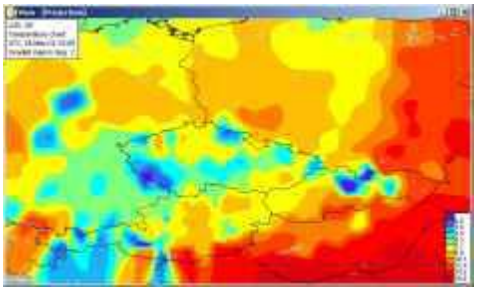
2. Observation Description
Extensive description of each observed element at each station (unit, accuracy, beginning/end of observation, instrument/sensor and its documentation, observation scheme/type description) and history of each element observations.

3. Station Extremes
Stores defined elements extremes for each station and month. This information interconnects three parts of CLDB: metadata, quality control and statistics generation.

Metadata reports and statistics are supported.

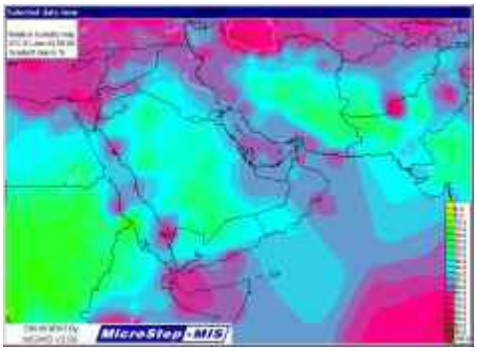
- **Climate Graphics Workstation**

Climate Graphics Workstation (CGW) is a flexible computer graphics system designed for professional climatological and meteorological usage. CGW system is a graphical extension built over climatological Database (CLDB). It cooperates with the CLDB, provides visualization of climatological information, and helps users by creation of more accurate view of historical and currently received data. Its use is extremely easy. Simple mouse clicks and drag-n-drop interface gives users higher performance in their work.



- ✓ **Image Products**

The function of CGW core is data field analysis and generation of several types of output fields: contoured charts, color gradient images, wind arrows. Sophisticated algorithms take into consideration all available climatic controls topography, water basins, etc… The calculation to be performed on individual numerical data before surface analysis can be specified averaging, summation, extremes selection or frequency of occurrence.
Samples of image products:
- Monthly Temperature Chart
- Probability of Tropical Days Chart
- Average Wind Direction and Speed Chart
- Wind Direction and Speed and Pressure Chart
- Relative Humidity Chart
- Solar Radiation Distribution Chart
- Rainfall Spatial Distribution Chart
- Rainfall 24 Hour Extremes
- Soil Temperature Chart
- …



✓ Cartographical Projections

It is possible to use various cartographical projections with Climate Graphics Workstation. The three most used in meteorological community are:
- Mercator Projection (areas near the Equator)
- Lambert Projection (Mid-Latitudes)
- Polar Stereographic Projection (near the Poles)

✓ Layers

For customer full satisfaction, there can be multiple informational layers composed in one image product from Climate Graphics Workstation. The product becomes rich in information. The following layers are supported:
- Shorelines
- Political borders
- Rivers
- Towns (position, label)
- Positions of meteorological stations
- Digital Elevation Model

other…

✓ Other Features

Since GTS is supported CLDB data source, real time data can be visualized by CGW software extensions:
- Synoptical 'station model' Chart for real time data

- **Web Interface**

The Web Interface provides Intranet and Internet access for CLDB. Architecture of Web Interface is modular and is composed of CLDB Web Screens, CLDB Web Reports and Web CGW software module.

- **Reports and Statistics**

The data stored in the database can be exported and viewed in many ways.

1. MicroStep-MIS selection tools

End user applications are provided by MicroStep-MIS for retrieving data from database. Maximally flexible export from CLDB to user-defined table is possible with user-friendly CLDB Select tool.

When selecting data, user can set element(s), variable(s), observation terms or time periods as retrieving criteria. User then selects output - all raw data within the period or aggregated data (minima, maxima, means, counts). In the last step, user defines the order of columns in the output table, if the default order doesn't suit. Such pre-prepared table is directly saved as Excel sheet or as text file (comma separated values, space separated values). The file is ® ® directly usable by standard mathematical/statistical software products (Instat+ , Statistica and many others…).

2. User's standard desktop tools

End user can work with database within standard desktop publishing, statistical and graphical tools which are capable of retrieving data using standard interfaces like ODBC or provide tools for direct connection to Oracle Database. E.g. end user can work with Microsof t Excel 2000 and retrieve data from CLDB to data sheets just by few clicks. With data retrieved from CLDB, the climatological characteristics can be explored:
- frequencies, cumulative frequencies
- characteristics of a distribution (measures of central tendency mean, mode, median, fractile, vector mean; measures of dispersion, coefficient of variation, …)
- other statistics

3. Reports - predefined CLDB statistics

The CLDB Reports application has easy to use interface for generating standard tabular and graphical daily, monthly and annual reports. Reports are generated directly in printable form or as Excel worksheets.
Tabular reports:
- climatic elements summaries (means, extremes, counts)
- long-term means and extremes
- percentage frequencies of occurrence of concurrent wind direction and speed
- frequencies of element occurrence below/above specified thresholds
- Upper Air summary
- counts of missing data
- custom tables
Graphical outputs:

- wind roses (user definable 4, 8, 12, 16 sectors)
- elements mean, max, min graphs
- rainfall bar graphs
- custom graphs

C- **DATA TRANSMISSION**

- **The transmission of data to the Local concentration system :**

  - ✓ **Transmitted data**

The parameters measured by sensors, concentrated and processed by the datalogger and the state of all elements of the automatic station

  - ✓ **Transmission media**

Connections between the datalogger and, local concentration system will be performed by wireless devices.

- **The transmission of data to the central concentration system (headquarters of the DMN in Casablanca):**

  - ✓ **Transmitted data**

It is possible to schedule the transmission of raw data (from the datalogger and the local system of concentration), coded messages (SYNOP, METAR,…) and state data from the local concentration system to the central concentration system. The administrator of the automatic station has the ability to configure a selected data transmission.

  - ✓ **Transmission media**

The automatic station send data to central level (central concentration systems at the headquarters of the DMN in Casablanca) by two media :

- VPN IP by the Ethernet interface of the local system of concentration
- GSM modem directly from the datalogger

The local and the central systems of concentration can send meteorological messages by FTP through Ethernet interface to the Moroccan AMSS who is connected to the **GTS**.

D- **POWER SUPPLY**

The datalogger is powered by solar energy through a battery sized for all external components of the automatic station. The operational autonomy is more than 30 days without significant sunlight.

E- **IMPLEMENTATION:**

In accordance with international standards automatic stations are installed in parks. For good representativeness of Measured Data realization of these parks is consistent with the standards prescribed in WMO references (including Chapter 1 of WMO

No. 8) especially as regards the dimensions of the park's protection, provision and sensors exposition ...

The instrument park is protected by a galvanized plasticized 150 cm height border
DMN chose to install the Automatics weather stations in the sites of these partners and sites belonging to other State Department....