P10R.9 THE CUBAN WEATHER RADAR NETWORK: CURRENT STATUS AND TRENDS

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1. INTRODUCTION

Cuban Meteorological Institute operates seven weather radars. Three of them are RC-32B (Mitsubishi), which were introduced in Cuba in 1972-73. The other four are MRL-5 (Russian) which were introduced in the late 80´s.

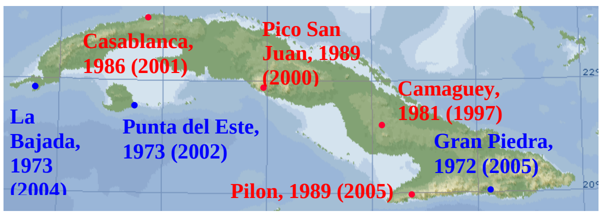

Fig. 1 Weather radar network distribution

In Fig. 1 there is shown their distribution according to vendor (blue: RC-32B, red: MRL-5), and there is also shown year of deployment and in parenthesis year of modernization.

Taking into account that MRL-5 is a dual wavelength (3cm and 10cm) radar with excellent parameters for weather surveillance and research, even without Doppler or polarimetric capabilities, and that revamping the original design is now possible within a small budget (Pérez et al., 1999) using available computer cards, commercial PC systems and an open architecture, in 1997 it was begun a project intended to modernize firstly Camaguey´s MRL-5, and later it was extended to the other radars too. Modernization concludes this year with the two eastern radars: Pilon and Gran Piedra.

After modernization, radar parameters are as follows (S band and X band are shown separately):

Table 1. Radar parameters after modernization

Parameter	MRL-5 S	MRL-5 X	RC-32B
Frequency	2950 MHz	9595 MHz	2750 MHz
Peak power	850 kW	250 kW	400 kW
Pulse length	2 (1) μs	2 (1) μs	4 (0.5) μs
PRF	250 (500) Hz	250 (500) Hz	160 (590) Hz
Sensitivity	-110 dBm	-104 dBm	-110 dBm
Beam width	1.5º	0.5º	1.9º
Antenna gain	40 dB	49 dB	37.5 dB
Pos. accuracy	± 0.1º	± 0.1º	± 0.1º

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2. MODERNIZATION ESSENCE

The heart of the modernization is the introduction of an industrial PC with I/O cards which performs: radar control, timing, signal processing and data acquisition.

I/O cards are wired directly to transmitter, receiver, and antenna, checking status and sending commands and timing signals to them. Manufacturer's name and models are irrelevant because functions provided by these components are widely available in the market. This way, the original architecture is dramatically simplified, allowing an unprecedented performance and higher reliability.

Operating console and all old man-radar interfaces are substituted by a computer friendly interface which shows all radar parameters and allows complete manual or automatic (scheduled) operation.

Receivers are modernized with the introduction of low noise amplifiers. Transmitters are kept untouched, and antenna drives are substituted by modern solid state, computer driven devices; antenna position is read by means of serial synchronous encoders.

Hardware and software solutions are equals for both types of radars.

3. SIGNAL PROCESSING

Signal processing is performed by means of high speed PCI acquisition card (two 2 MHz channels, one for each logarithmic video) together with range and time integration performed by VESTA/RDA software. This very flexible combination of hardware and software allows collecting data in different formats depending on accuracy and resolution needed. Signal processing parameters are summarized in Table 2.

Table 2. Signal Processing parameters

Parameters	
Number of Channels	2
Range gates per channel per pulse	4096
Number of bits for A/D	12
Min. bin spacing [m]	75
Pulse averaging	1-1024
Range averaging	1-256

4. SOFTWARE

There are four levels of software.

VESTA|RDA is a client/server application which allows data acquisition and radar control (local or remote, manual or scheluled), as well as radar parameters checks.

VESTA|Proceso is a radar product generator as well as data viewer. This software allows generation and visualization of standard products: PPI, CAPPI, RHI, Vertical cuts, Tops, Maximum projections, VIL, Rain accumulates, etc. Figure 2 shows a session in VESTA|Proceso.

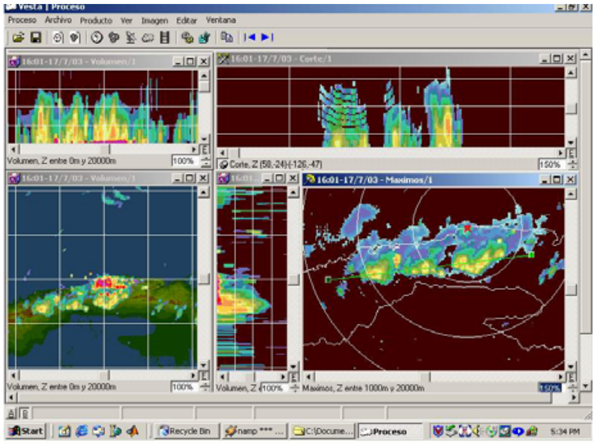

Fig. 2 Session in VESTA|Proceso

VESTA|Distribuidor is an application which makes VESTA|Proceso generate products and images according to some schedule, and sends them to different users using e-mail or ftp protocol. VESTA|Distribuidor can send raw data files as well.

VESTA|Mosaico is the network integrator, intended to generate national mosaics, employing different algorithms (maximum value, nearest value, weighted average).

4. DATA ACQUISITION

The system is very flexible and allows many different acquisition schemes, but for weather surveillance some standardization is needed.

Every hour each radar should make a volume scan. Depending on the weather situation, the operator turns to 30 or 15 minutes regimes as needed.

Each volume scan consists of 21 tilts, to be completed in 6 minutes. Following McGill practice, antenna is elevated according to an exponential sequence, denser in the lower part. Data is acquired in 300 m. range gates, and 0.7º in azimuth, up to 450 km.

Raw data is archived in VESTA format proprietary files (Rodríguez et al., 2001). VESTA|Proceso is able to translate raw data to netCDF format (HDF-5 and NEXRAD Level 2 will be available soon) to make it available to external users.

5. DATA FLOW

Raw data files are sent to Radar Center (located in Camaguey city) via Frame Relay channel. In the Radar Center they are processed to generate products and images aimed to Cuban Meteorological Institute Web site and also to some other government users. Raw data and products are available to Provincial Meteorological Center, to be used by local forecasting offices, via Frame Relay channel.

Raw data is archived in the Radar Center and duplicated in each radar.

Images from all modernized radars are routinely available at www.insmet.cu as can be seen in Fig.3

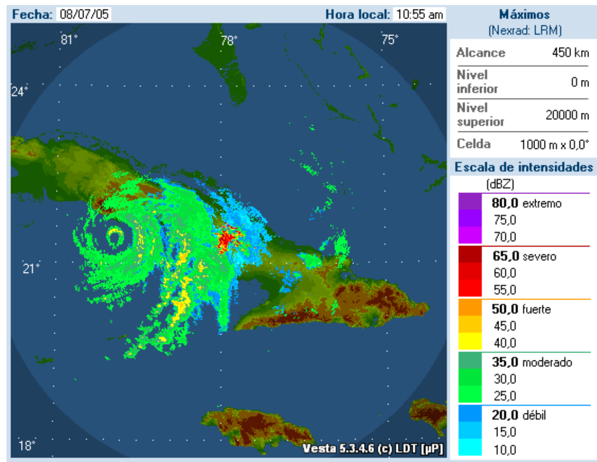

Fig. 3 Image from hurricane Dennis, posted in the web site

6. COVERAGE

These seven radars guarantee an excellent coverage in the surveillance mode (450 km) as can be seen in Fig. 4, most of the territory is covered by 4 radars at the same time (blue). Area covered by 3 radar is shown in green, and area covered by 2 radars is shown in red. Red contours indicate maximum 450 km coverage.

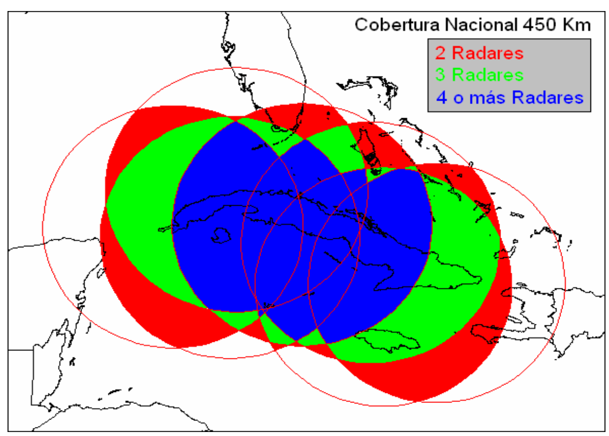

Fig. 4 National coverage in surveillance mode (450 km)

Even in quantitative mode (200 km) there is a very good coverage: major part of the territory is covered by 2 radars (red), and some parts are under the umbrella of 3 radars (green), as can be seen in Fig. 5.

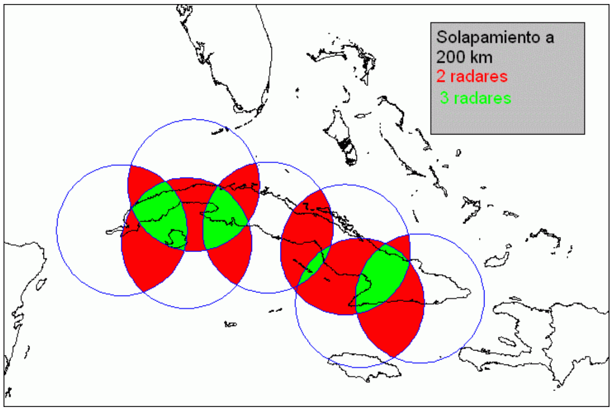

Fig. 5 National coverage in quantitative mode (200 km)

7. MAINTENANCE

Personnel at the radars sites perform routine checks daily, weekly and monthly. Once a year, a general maintenance activity is organized under the auspices of the Radar Center.

Calibration checks are performed according to what is described in Rodríguez, et al. (2003).

8. FUTURE UPGRADES

The Technical Development Laboratory (belonging to the Radar Center) is developing a Doppler digital receiver to upgrade all the seven radars in the near future.

In a more distant future, transmitters and antenna pedestal are in plan of modernization.

9. CONCLUSIONS

Radar modernization program undertaken by the Ministry of Science, Technology and Environment (to which belongs the Cuban Meteorological Institute) has proven itself very successful.

After modernization radars became more reliable, and the information available to users is incomparably more plentiful.

Other neighbor nations also benefit from the information posted in the INTERNET, especially in cases of hurricanes.

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