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FIRST MEASUREMENTS WITH AN X-BAND POLARIMETRIC RADAR IN WEST AFRICA : THE XPORT EXPERIMENT IN DJOUGOU, DONGA, BENIN

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1. Introduction

The X-band polarimetric radar Xport, developped by an IRD team, has been installed in Djougou, in the northnern Benin, since June 2005. This radar was set up as part of the AMMA Enhanced Observation Period (EOP) strategy. The primary objective of the radar measurements is to sample with a high spatial and temporal resolution the rain fields associated to the precipitating systems which are feeding with water the Ouémé water shed and its sub-catchment such as the densely equipped Donga water shed.The main application is to derive from radar measurement the Quantitative Precipitation Estimates (QPE) which are needed as a forcing field to run hydrological models. As the radar is equipped with dual polarization and with 3D scanning possibilities, volumetric exploration of the Mesoscale Convective Systems and detailed observation of the microphysical processes and vertical profiles in rain will also be allowed.

Figure 1 and 2 present the radar and the general location of the experimental site, in Djougou. It can be seen that Xport is part of a network of instrument which were gradually installed over the mesoscale observatory of the Upper Ouémé Valley, in order to measure and quantify the different terms of the water cycle. This experimental set up will be further densified in 2006, with the installation of several instrument during the AMMA Short Observation Period (SOP). This includes Doppler and precipitation radars, lidars and radiometers , all to be installed within 20 km from each other to document the details of dynamical and microphysical processes within Precipitating systems. A similar set up will be installed in the Niamey area in Nigern and this will allow to compare the characteristics of the rainy events observed in the moist Soudanese region (Bénin) and in drier sahelian environnement (Niger). During the SOP ground observations in Bénin will be coordinated with the numerous instrument flights which are planned during the summer 2006.

Fig 1 : The Xport radar on its tower in Djougou.

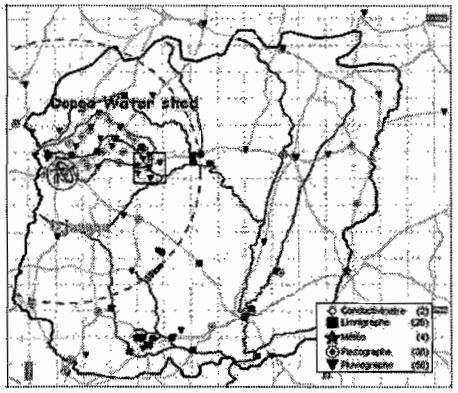

Fig 2 : Location of the Djougou radar site and the Donga Water shed, within the Mesoscale Observatory of the Upper Ouémé River Valley, in Bénin.

The network of raingages deployed on the Upper Ouémé basin and densified in the Donga area, with a high resolution target at about 20 km from the radar provides a good data set for validation or for the application of mixed gage/radar techniques for QPE. An optical disdrometer was also installed (08/2005) in Nangatchori, about 10 km west from Djougou.

For the 2005 rainy season the scannin g mode was restricted to low elevation scans with a high repetition rate : a very good strategy to analyse the spatio-temporal variability of rain, usefull for hydrological applications.

Sucessive 'PPIs' scans at a low elevation angle (1.°) and resampling time of about half a minute were performed for about 4 months. This provides a significative set of data to study the spatio-temporal structure of 2D rain fields in a region characterized by a variety of rainfall event types .

2. Preliminary examples

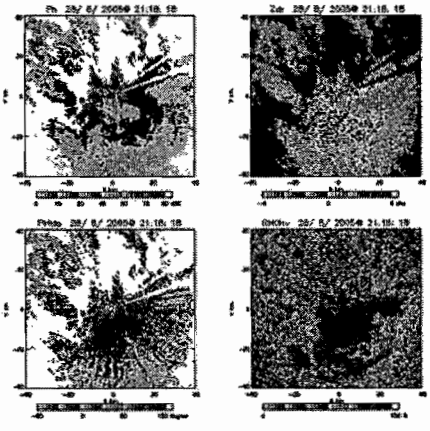

Fig 3 : Example of radar measurements : Top Left :reflectivity Zh derived from the Horizontal power channel, Top Right : differential reflectivity Zdr (here uncorrected),Bottom left : the differential phase shift (PHIdp) usefull for attenuation correction, Bottom Right : coherency indicator (RHOhv) used to discriminate rain and qualify the data.

Table 1 : main characteristics of the radar

Transmitter	
Frequency	9.4 GHz
Peak power	up to 100 kw
Pulse width	0.4 0.5 1 us
Duty cycle	0.001
Antenna	
Size	1.8m (6 feet)
Beamwidth	1°2
Gain	42dB
First side lobes	Better than 24dB
Polarisation	H and V (orthomode feed)
Receiver	
H and V simultaneously	
Noise power	- 114 dBm
Radar Noise	4.4 dB
Variable attenuator	0 – 20 dB
LNA Gain	36 dB
Dynamic range	90 dB
LO Driver	Pulse peer on leakage of Gate0
Motion	
Scanning	Full 3D scanning, free choice of Scanning strategy
Azimuth speed	Up to 5 rpm
Elevation speed	Up to 1.6 rpm

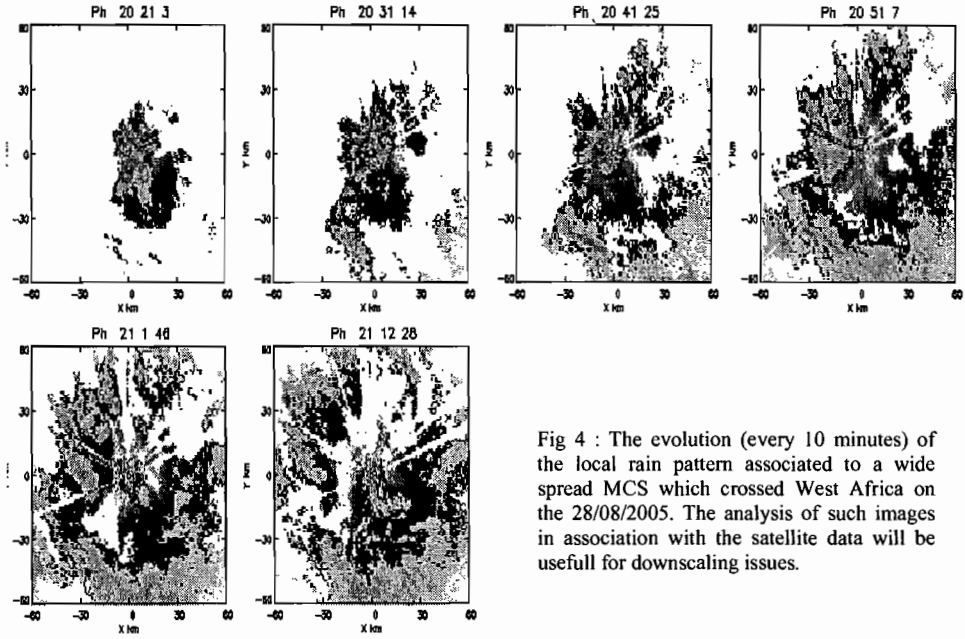

Fig 4 : The evolution (every 10 minutes) of the local rain pattern associated to a wide spread MCS which crossed West Africa on the 28/08/2005. The analysis of such images in association with the satellite data will be usefull for downscaling issues.

3. First conclusions from the 2005 Campaigns

- Despite the numerous difficulties associated to installing a High-Tech instrument in a region with little ressources, isolated from the main centers and facilities, and subjected to power supply instabilities, the 2005 campaign was rather sucessfull :
- About a 100 events were recorded, between mid June and mid October 2005, totalizing more the 200 hours of data. The processing and analysis of the data set is on its way. Self-calibration techniques and tests of radar data consistency were performed on a few events and the results are satisfactory.
- Further validation and the production of quantitative rainfall products using the rain gages network and the disdrometer data available from the Nangatchori site, are starting while this complementary data set will be available and validated. This will allow a final assessment of the 2005 radar data quality.
- Some problems with the elevation (vertical plan) positionning system prevented us from doing 3D scanning this year. The problem is to be solved and the sampling of vertical profiles in rain should be possible next year (2006, SOP).
- Some hardware improvement are also planned to enhance the quality of the phase reference measurement and the Doppler products.

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Convective wind system with aerosols, named "haboob", Hombori in Mali, West Africa.