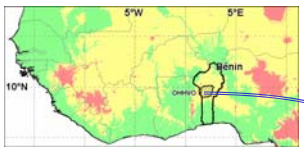
X-port, a compact radar for hydrological application

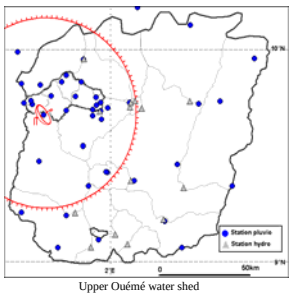
F. CAZENAVE, M. GOSSET, J. DOSSOUGOIN
LTHE/IRD 08 BP 841 Cotonou Benin.

Objectives :

For the needs of the AMMA experiment, Xport, a dual polarization X band Doppler radar, has been installed in Djougou, in the northern Benin (Africa), since May 2005. The primary objective is to sample with a high spatial and temporal resolution the rain fields associated to the precipitating systems which cross the Donga shed, a sub-shed of the Ouémé 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.



West Africa



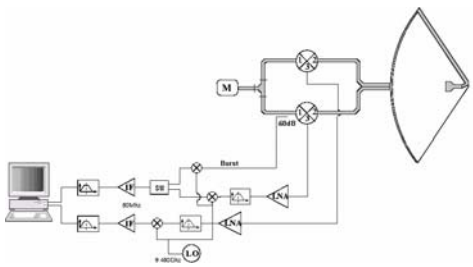
Upper Ouémé water shed

The RADON Software :

To control radar motion and data acquisition, the software RADON, has been designed. The server has to run on the computer attached to the radar and the GUI could be connected either through a remote link or on the local machine. RADON is endowed with a small vocabulary. It's possible to establish a communication between the GUI and the server. Thus, a script built on the GUI is sent to the server to be executed by itself. Today, only the basic functionalities have been implemented : PPI, RHI, FIXE, WHILE, WAIT and WAIT_UNTIL. Soon, we will code some more vocabulary to add intelligent functionalities such as cell detection with automatic modification of the current script. Once the script as been sent to the server, the link between the GUI and the server could be broken without damage on its behavior. The display of the different products on the GUI is a new request for the server, so it is possible to connect few GUI at the same time, located on different places over the network.

Hardware description :

Xport is a pulse magnetron radar_ (Pt 100 kW). The power transmitted by the SD349 CPI magnetron is sent to the H and V channels through a balanced magic tee. Thus transmission and reception are simultaneous thanks to an orthomode feed. The characteristics of the transmitted pulse, amplitude, phase and frequency, are computed in the acquisition PC. This measure can be done on a sample taken directly on the wave guide through a directive coupler , so called burst mode, or on the signal provided by the transmission leakage through the circulator, the leakage mode. This choice of mode is controlled by a IF switch connecting the burst channel during a few microseconds after the trigger or in bypass mode.



To have a good reception of the small echoes we have chosen a LNA with a strong amplification. In order to achieve a better dynamic and avoid saturation in the first kilometers, we added a 2 step 20 dB attenuator before the LNA. This attenuator works only for short distance.

Real Time acquisition control :

The data acquisition is done by a low cost board ECDR-GC214-PCI, provided by the Echotek company, formally Mercury Computer Systems Inc. Due to the under sampling technique used by the acquisition board , the IF signal at 60 Mhz can be directly digitalized and then send to the numerical receivers. This off the shelf product, can be mounted on a standard PC trough the PCI bus. It guaranties to get the last processor, bus and chipset performances of the market for a very low price.

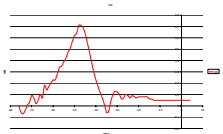
In the same way, all the control programs have been developed over free software operating systems. To guaranty the real time acquisition control of the ECDR board, we have designed our own driver under the RTLinuxFree real-time system and Linux core 2.4.29 and higher so we can take benefit of all the tools done under linux in terms of development, graphic libraries, network and security.

RTLinux guaranties the acquisition and the computation of the pulse pair products in respect of the PRF (1000Hz). The use of the Intel Compiler ICC, gives enough improvement to the real-time part that is possible to run all the application on a single P4 at 3 GHz.

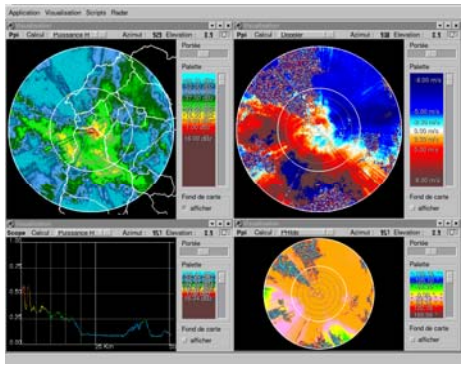
Limit of the ECDR-GC214 :

The Analog Devices ADC on the channels H and V are not matched. So the resulting Zdr is not linear and it is necessary to correct the computed values with an offset depending of the input power.

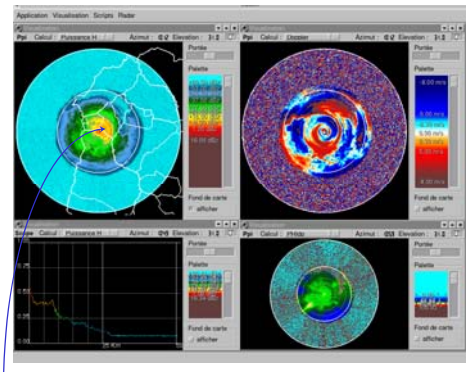
The curve beside shows the difference between the 2 channels connected to the same test signal



Data examples :



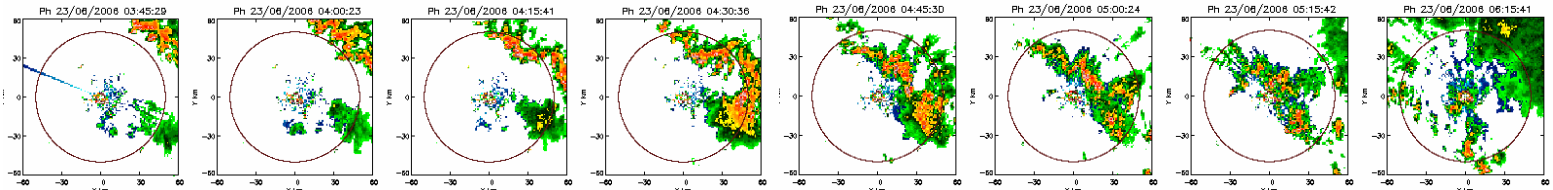
Convective system crossing the Upper Ouémé water shed, the 5th September 2006 at 16h30.



Detection of the bright band at an altitude of 4.1km for the same system as above, a few minutes later.

IRD
Institut de recherche pour le développement

LTHE



Contact :cazenave@ird.fr gosset@ird.fr (+229) 21 30 64 90