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THE PANTHERE PROJECT OF METEO-FRANCE : EXTENSION AND UPGRADE OF THE FRENCH RADAR NETWORK

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1. INTRODUCTION

With a total of 13 radars, and a maximum detection range of about 200 km each, the French metropolitan network was considered in 1995 as satisfying for precipitation detection (Dalle and Beringuer, 1994).

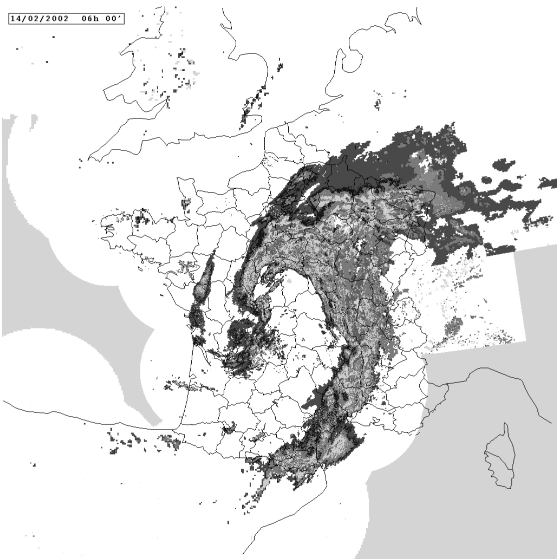

Figure 1 : example of 5' composite product with the French radar network. Feb. 14 2002, 6h UT.

Since 1995, it has become more and more evident that quantitative rain measurements could be obtained with radars. Meanwhile, several important floods occurred in the SE of France. A common project was then defined with the French Ministry of Environment, aiming at increasing the number of radars in that region and improving the radar rainfall estimation. Five new radars were deployed, the last two still being within their qualifications tests. A technical effort was done to stabilize the radar response (systematic electronic calibration of the receivers and comparison with gages, air conditioning of the rooms...) and to produce precipitation amount images (Cheze and Helloco 1999).

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The network, in its current state, consists of 18 non-Doppler conventional radars. The antenna rotation speed is relatively low (generally 5° per second) and the elevation angle smaller than 2° with a maximum of three rounds every 5'. Raw images are concentrated in Toulouse every 5 minutes and a composite product (see example in figure 1) is elaborated and supplied to the users by a satellite communication link.

More recently (2002), a new project has been launched by Météo-France once again in partnership with the French Ministry of Environment. Named PANTHERE, its main objectives are : (i) to fill the gaps within the current coverage by adding 6 new radars, (ii) to replace two of the oldest radars, and (iii) to evaluate the potential of modern technologies (volumetric observation, Doppler, dual polarization) in hydrology, nowcasting and numerical prediction.. This evaluation will be carried out in close collaboration with research laboratories.

Over the last three years, in parallel to other running projects, Météo-France has developed a second version of its radar computer, CASTOR2 (Parent et al., 2001) that is currently deployed within the network. This new version allows obtaining in real-time more information on the status of each component of the radar system and computing Doppler and polarimetric measurements.

II TECHNICAL CHARACTERISTICS OF THE 'NEW RADARS'

With the 6 new radar sites of the project, the French network will consist of 24 radars in 2006 (figure 2). Including the 8 neighbouring European radars, this number reaches 32. The major part of the country will be seen by at least one radar within a 100 km range, which is considered reasonable for accurate hydrological measurements. In order to be sure that the users needs are properly satisfied, users have been associated to the site selection and decision process (Cheze et al. 2003, this volume).

The main characteristics of the new radars are the following :

- C band

- 3 dB beam-width : 1°
- rotating speed : more than 15°/sec.
- peak power : 250 kW
- pulse duration 1 to 2 microsec.
- Doppler : I and Q for received and transmitted signals
- dual polarization : simultaneous H and V transmit and receive (only for the first unit)

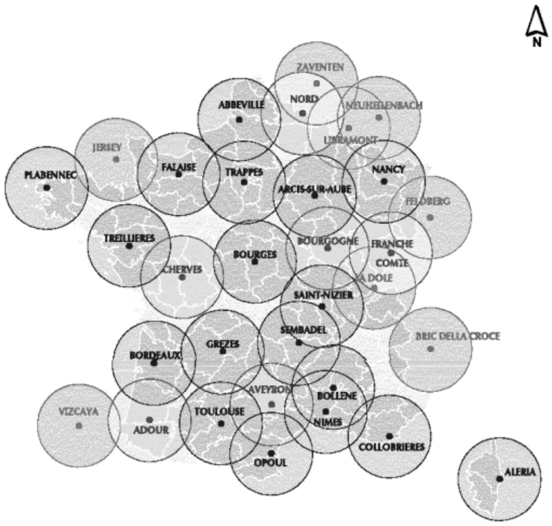

Figure 2. The French radar network in 2006. European neighboring radars are also shown. Each circle, 100 km radius , is centered around the position of a radar.

After a call for tender, the manufacturer Gematronik was chosen. The 8 radars (6 new sites and 2 renewals) are now under building and will be delivered over the period 2004 - 2006.
The first unit will be interfaced with CASTOR2, and installed in Trappes (near Paris) in the beginning of 2004, replacing the 20 years old operational existing radar.

III DOPPLER PROCESSING

The Doppler information can be used to satisfy the following needs : (i) filter-out ground clutter contributions to the signal, but other techniques are also available (Sugier et al, 2000), (ii) retrieve kinematical properties of the wind fields. Radial velocities can be processed to infer VAD wind profiles or directly assimilated by mesoscale models (Ducrocq et al, 2000). This last application will probably be operational in the future (2008-2010) in France as a new non-hydrostatic mesoscale model is currently being developed at Météo France (AROME project).
In the Panthere project, we consider that the need for Doppler products at our latitude is not strong enough to justify spending radar time, which would lead to less time for rain measurement. To avoid this problem, we decided to investigate “dual PRT techniques” (see for instance Sachidananda and Zrnic, 2002). Such a mode has been defined , with two pulse periods T1 and T2 alternately changed after each radar pulse, and the C band Trappes’s radar is now under test, with values of T1= 3.3ms and T2= 2.7 ms. Despite the fact that the radar was not originally designed to be Doppler and that the two PRTs are rather high and close to each other, first results are quite encouraging and will be analysed after October 2003, at the end of the test.
The first objective is to investigate, and test, an operational mode compatible with observations at ranges up to 250 km, and leading to an unambiguous radial speed up to +-30 m/s.

IV - VOLUMETRIC EXPLORATION

At present time, French radars operate with 3 rounds every 5 minutes, with a maximum of 3 elevation angles and a rotation speed of 5°/sec. For each pixel, data corresponding to the 3 elevations are combined to minimize the number of cluttered pixels: the higher elevation is used for lower ranges, where ground echoes are assumed to be stronger. On the opposite, lower elevations are used at large range to obtain low-altitude measurements.
A more ambitious volumetric scheme could lead to : (i) better suppression of ground echoes and correction for partial beam blocking on the basis of DTM-based numerical simulations, (ii) better estimation of the VPR (vertical profile of the reflectivity), (iii) knowledge of the 3D structure of the cloud, and (iii) discrimination between convective and stratiform rain, in order to adapt the Z-R relationship.
On the other hand, volumetric observation imposes to increase the antenna rotating speed, which decreases the number of degrees of freedom of the estimations and the efficiency of clutter identification.. Another drawback is to decrease the lifetime of some of the mechanical components (ball bearings, …) with the consequence of increasing the maintenance costs.
The objective of the project is to define volumetric schemes adapted to the network and to test it in an operational context with a double objective : (i) usefulness evaluation by the users, and (ii) evaluation of the maintenance cost increase.
A first volumetric test has been performed last autumn with the Bollène radar, a recent radar located in the Rhone Valley in a mountainous area (SE of France). A large amount of data, including several severe flood events, were recorded. The immediate objective is to define a better quantitative rain measurement that will be evaluated in real time by forecasters next autumn.
Depending on the forecasters reactions and on maintenance costs, volumetric exploration will be generalized to the entire network over the next years.

V - DUAL POLARIZATION

Even if radar data are perfectly corrected for VPR, ground echoes and beam blocking, we still need a good knowledge of the precipitation type to apply a correct Z/R relationship and give a good quality rain estimation. Dual polarization techniques may help overcoming this crucial problem [see for instance Testud et al. 2000, and Sauvageot 2000].

Our first new radar (in Trappes in 2004) will be equipped with simultaneous H and V polarization. Two CASTOR2 computers, linked by a local network, will be connected behind the radar: the first one to deliver the classical operational products, while the second will record raw data for further analysis and test the capacity of the new ZPHI algorithm to improve rain measurement. One year validation campaign is planed for 2004.

If the conclusion is positive, the remaining 5 new radars will be upgraded to polarimetry and the possibility to upgrade some of the old radars will be examined.

VI - CONCLUSION

Through the PANTHERE project, the French meteorological radar network will be increased by 6 radars within the next 3 years, and every point of the country will be within 100 km of at least one radar, leading to better quantitative rain measurements. Several important actions on Doppler, volumetric observation, and dual polarization, are ongoing. New modes of operation should be defined. They will be applicable to new radars, but also to older ones, with some restrictions due to their technical possibilities. Some of these modes would be adapted to the environmental relief of the radar (plain or mountainous). Before being operational, the new products should be tested and approved by users.

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