# Precipitation studies over the Clermont-Ferrand urban area

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## Introduction

Since late October 2006, the "Laboratoire de Météorologie Physique" from the "Observatoire de Physique du Globe de Clermont-ferrand" has acquired a prototype X band scanning radar for local precipitation studies. When at his home institute in Clermont-Ferrand, this radar operation is augmented by a Micro Rain Radar, two disdrometers (one Joss-Waldvogel and one Parsivel) and by a network of 16 rain gages mostly from the water service from "Clermont Community" through a collaborative agreement.

## Instrument descriptions

The scanning radar is based on a marine X-band (9.41 GHz) radar which was converted into a low cost weather radar by replacing the original fan beam antenna with a 2.4° degree pencil beam offset parabola and by adding a data acquisition system suitable for weather observation. The X-band radar is usually operated with a fixed elevation of 5.5°, and with 60m, 2° and 30s range-, azimuth-, and time resolution, respectively

The MRR is a vertically pointing K band (24,15 GHz) radar which provides Doppler spectra with 64 lines over a range of 0 – 12.2 m/s in 30 range gates. Profile of drop size distributions are derived, as well as reflectivity and rain rate profiles. The MRR is normally operated with a 100 m range and a 20 s time resolution. The MRR is located at an instrumented site about 5 km away from the X band radar. The disdrometers and a rain gage are also located on that instrumented site as the Parsivel is currently under validation for our purpose.

The network of rain gages is distributed around the entire domain of the Clermont-Ferrand urban area.

## Research objectives

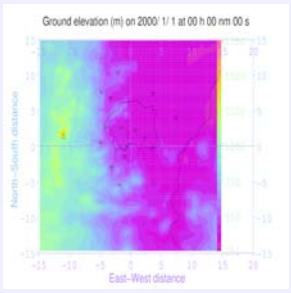
Given the high resolution of the X band radar and the availability of a large set of rain measurements on a continuous basis, the ongoing scientific objectives that will be pursued are the following:

The study of the precipitation heterogeneity at scales smaller than the precipitation event itself,

The characterization of the different rain regimes encountered within individual rain events and the development of adapted Z-R relationships for improved rainfall estimates,

The development of algorithms capable to identify those various rain regimes within the X band radar without the support of the other measurements for stand alone capability

The study of the urban area precipitation in order to support general water and storm basin management over the Clermont-Ferrand area which is characterized by three different catchment basins prone to eventual flash-floods.



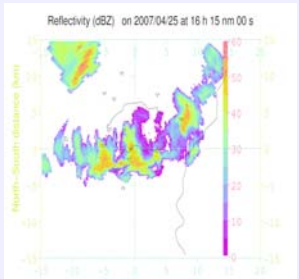

## Examples of ongoing investigations

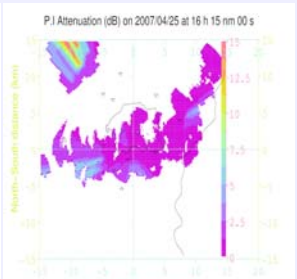
To illustrate some of the work carried out with this et of instruments, we will show results from the 25 of April 2007 event with was characterized with some intense localised precipitations.

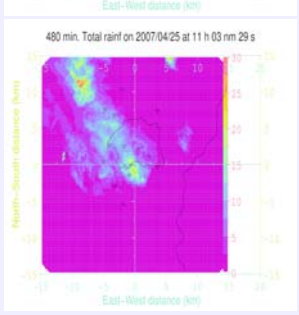
Figure 2 presents the reflectivity of the radar which is expressed as Z = C P r2, where P is the received power , r the range and C a calibration constant. Furthermore, ground clutter (determined as a 5 minutes average of received power and very clear sky conditions) has been removed. Figure 3 shows the Path Integrated Attenuation derived using the algorithm of Hitschfeld and Bordan (1954) which is sensible as long as the attenuation is less than about 10 dBZ. Once data have been corrected for attenuation, rain rate is calculated using, in this case, a standard Z-R relationship. Figure 4 shows the resulting 8 hour accumulated rain field associated with this event. In the future, the study of the common volume between the X band radar and the vertically pointing MRR will allow us to define Z-R relationships specific to the rain regime which characterizes the event (or parts of the event) considered.

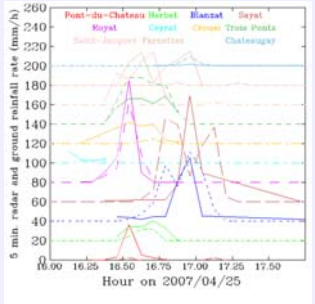
In order to asses our results (i.e., rainfall rate estimates with the X band radar), we performed comparisons with the various rain gages available through out the area. Figure 5 shows the time series of 5 minutes averaged rainfall rates (in mm/h) for the reporting rain gages at that time, each in a different colour, while the dash lines correspond to the rain gage data and the solid lines to the radar estimated results.

Overall the agreement is satisfactory although discrepancies can be noted while the radar seems to produce overestimates at times. Off course we need to verify such trend on many more cases and also adopt adapted Z-R relationships rather than a standard distribution.




## Conclusion

The instrument ensemble that has been put together to monitor the Clermont-Ferrand basin should provide a very interesting data base over time in order to study precipitation heterogeneity and develop adapted Z-R relationships for rain regimes at scales smaller that the event itself. Furthermore it will also help assess rain rate estimations with this very simple but low-cost x band radar for urban management purposes.

***Acknowledgements:***

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