7.A.6 THE FRENCH COMMUNITY QUANTITATIVE PRECIPITATION ESTIMATION (QPE) RE-ANALYSIS PROJECT : ESTABLISHMENT OF A REFERENCE MULTI-YEAR, MULTI-SOURCE, NATION-WIDE, HOURLY QPE DATA BASE FOR HYDROLOGY AND CLIMATE CHANGE STUDIES

Moulin, L. (1, 2, 3), Tabary, P. (2), Parent du Châtelet, J. (2), Gueguen, C. (2), Laurantin, O. (2), Soubeyroux, J.-M (2), Dupuy, P. (2), L'Hénaff, G. (2), Andréassian, V. (1), Loumagne, C. (1), Andrieu, H. (4) and Delrieu, G. (5)

(1) Cemagref, Hydrosystems and Bioprocesses Research Unit, Antony, France
(2) Météo France, France
(3) EDF – DTG, CHPMC, Toulouse France
(4) Laboratoire Central des Ponts & Chaussées, Bouguenais, France
(5) Laboratoire d'étude des Transferts en Hydrologie et Environnement, Grenoble, France

1. Introduction

When dealing with quantitative precipitation estimation (QPE), raingauges are often considered as giving the ''true'' rainfall; at least, at ground level, at a given point and for a given accumulation time step. However, they generally fail to provide a spatial estimate of precipitation, even if interpolation methods are used and even if raingauges network's spatial density is high. They also failed to provide precipitation data with a high temporal resolution.
Radar images can answer to some of these highlighted difficulties associated with raingauges data. They can supply for a visualization of precipitation-rate in space and time with a high degree of complexity. In particular, radar technology could provide both a mean to follow the spatial dynamics of rainfall fields and a quantitative evaluation of precipitation depths Nevertheless, quality of radar data is very variable in space and time. Moreover this indirect measurement needs some treatments before a use in a quantitative way. This requirement of pre-processing associated to the shallowness of the radar archive can explain that up to now, in spite of their obvious interest, the weather radar images have not been used systematically in a quantitative way neither for hydrological nor for climatological applications. Combined together, information from rain gauges and from meteorological radar would provide spatially distributed rainfall depths that are potentially more informative than traditional ground rain gauge networks that only give point rainfall estimate.

As in many other countries, in France, weather radar images are now available for more than ten years on the most part of the national territory. In 2009, the radar network is composed of 23 radars on the continental France. Radar images provide instantaneous reflectivity (dBZ) at 5 minutes intervals and 1 km² resolution.

The network has been progressively improved as in number of radar that in quality and type of data. More over, the continuous and rapid evolution of radar technology has made both the assessment of the operational value of radar rainfall estimates very difficult and the obtained information potentially very valuable and interesting for quantitative estimations. Then using these data is a very promising challenge.

2. French QPE Re-analysis project

In that context, Météo-France (the French national weather service), in close relationship with several French hydrometeorology labs, has decided to launch a national collaborative project aiming at producing a more than 10-year reference database of Quantitative Precipitation Estimations (QPE). The objective is to make use optimally at any time of all available information (radars, hourly and daily rain gauges, satellite data, model freezing level heights, etc.) to obtain the best surface precipitation estimation. Subsequently, the goal is to make the resulting database, consisting of hourly, 1km² both QPE and associated estimation uncertainties, covering the entire French territory, a common reference for scientists in the fields of climatology or hydrology. In particular, for hydrological applications, these data could be used for calibrating the model parameters, assessing the added value of input high space-time resolution in hydrological models,...

The multi-source QPE re-analysis requires automated process of radar data and combination of all available data sources, in particular combination of radar data with hourly and daily rain gauge network.
In a first time, two radars near from Paris (Trappes and Arcis) were selected to constitute a bench test -- without difficulties linked to pronounced orography.

3. Automated process of weather radar data

Methodology for automated identification and treatment of radar measurement artefacts (ground clutter, partial beam blocking, clear air echoes, anthropogenic targets, bright band...) was developed and tested. This initial step is particularly important when re-analysing old radar products, which were not corrected for many error sources. From this point of view, systematic comparison of accumulated radar data (reflectivities converted to rainfall-rate with a Marshall-Palmer law) with interpolated daily rain gauges data is very informative (Fig. 1).

Very pragmatic methods have been processed for ground clutter identification and elimination of isolated echoes (most of the time, anthropogenic targets). The former is based on a simple moving filter. The latter uses the contingency of non-zero echoes for each pixel over a year : pixels with more that 15% of non-zero echoes are considered as ground clutter echoes.

By comparison of accumulated raw radar data over 1997 and 2008, it appears that partial beam blocking is not stable in time. As for ground clutter echoes, it was decided to identify and then define a correction map for each year and for each weather radar. Data accumulated over a whole year were analyzed (Fig.2) : data are compared with a spline fitted on maxima over a narrow moving window (5° in azimuth). This comparison enables to get a percentage of beam blocking for each point of radar image (Fig. 3).

Treatments for advection correction and clear air echoes elimination are in development.

4. Combination of radar and rain gauges data

Two rain gauges network are available in France : a climatologic network with 24h accumulated precipitation measurements and an automated network (with a temporal resolution of 1 hour). In a first time, several methodologies for combination of radar data with daily rain gauges were tested in order to optimally benefit from these two sources of information (Gjertsen et al., 2004, Rubel and Brugger, 2009).

In particular, both additive and multiplicative corrections of radar data were tested. Additive correction enables to interpolate (kriging) residuals between daily rain gauges (considered as ''true'' rainfall for the concerned pixel) and radar value for this pixel. This very classical solution (e.g. Haberlandt, 2007) has been assessed and seems to bring satisfying results (Luxen and Testelin, 2009).

Multiplicative corrections is more innovative. It is based on the computation of a ratio between rain gauges and radar data. In order to avoid influence of local pixel and to smooth this ratio : data were averaged over a moving circular window of radius 30 km (Fig. 4d. and 4e). Then the obtained ratio between the two smoothed images is used to "correct" raw weather radar data, knowing daily rain gauges values. Results of this correction (Fig. 4.c) have not been yet systematically quantitatively assessed. Qualitatively, it seems that this method enables to obtained in the same time precise information about spatialization of rainfall fields (furnished by radar) with a consistency with precipitation field structure given by rain gauges (especially when pixels are far from radar).

5. Conclusions and perspectives

This project is in its first steps, it remains a lot of works (quality data, meta data, combination of many radars, coping with mountainous regions, etc.), but a lot of difficulties has already appeared. After only few months, first results are very exciting. Especially concerning the data merging. Next steps will be (1) the systematic quantitative assessment of the proposed R/P combination method and (2) methodological work for combination with both daily and hourly raingauges (Overeem et al., 2009). In parallel, development are made for automated treatment of old radar data (clear air echoes, advection, etc).

In parallel, hydrological applications will soon begin to answer to the two main questions :
- what is the best way to use radar data (QPE re-analyses) in hydrological model, especially in lumped operational hydrological models?
- in a lumped rainfall-runoff model, what is the benefit to use a distributed rainfall input?

References

Gjertsen, U., Salek, M., Michelson, D., 2004: Gauge adjustement of radar-based precipitation estimates in europe. In Proceedings of ERAD, pages 7–11, http://publications.copernicus.org/other_publications/proceedings.html.

Haberlandt, U., 2007: Geostatistical interpolation of hourly precipitation from rain gauges and radar for a large-scale extreme rainfall event. J. Hydrol., 332(1-2), 144–157.

Luxen, C. and Testelin, S., 2009: Elaboration expérimentale et évaluation de lames d'eau climatologiques. Rapport de stage de fin d'étude n° 1169, Météo-France.

Overeem, A., Holleman, I, Buishand, A., 2009: Derivation of 10-year based climatology of rainfall. *J. Appl. Met. Clim.* 48(7), 1448.

Rubel, F., Brugger, K., 2009: 3-hourly quantitative precipitation estimation over central and northern europe from rain gauge and radar data. Atmospheric Research, In Press, Corrected Proof :–.

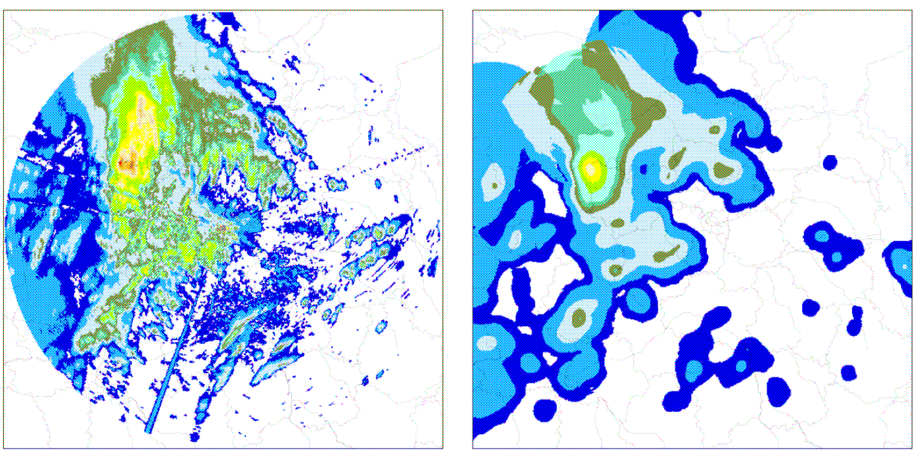

Fig.1 Comparison of accumulated 24h precipitation from raw radar image (left) and from daily rain gauge network (right) with the same scale. (Trappes, 12th august 1997).

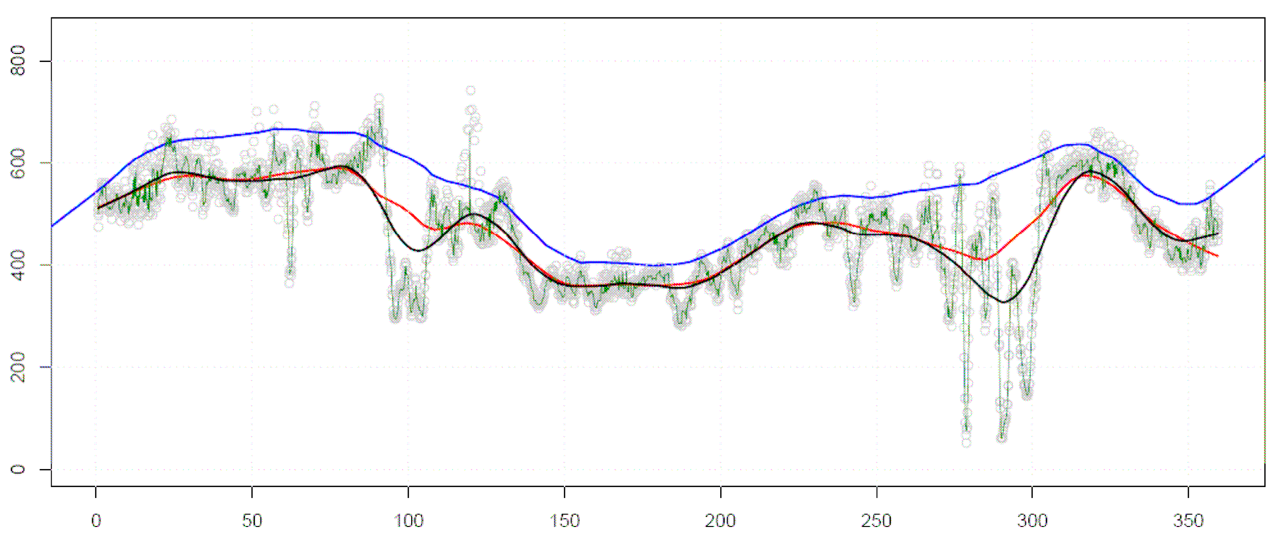

Fig. 2. Analysis of data at a distance from radar comprised between 40 and 50 km. X-axis indicates data's azimuth and y-axis the accumulated values. A spline (in blue) is fitted to the local maxima on a moving window of 5°. (Trappes, year 2006)

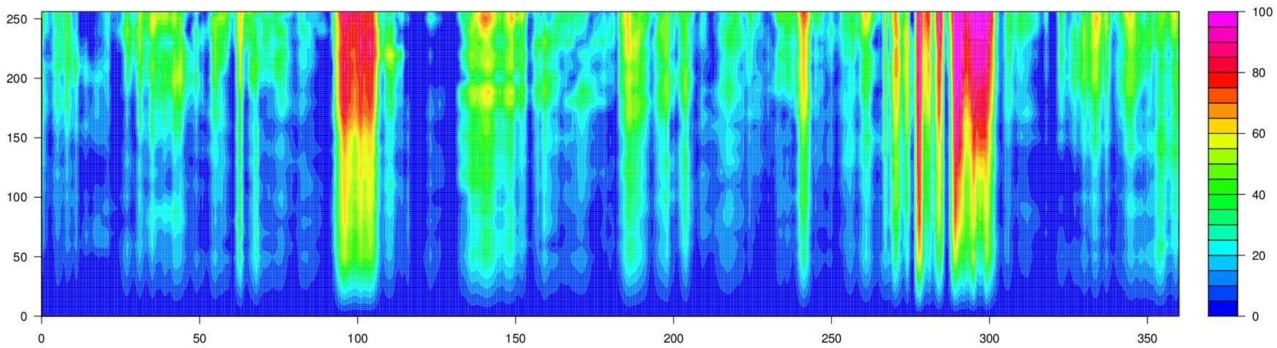

Fig.3. Result of automated estimation of partial beam blocking for Trappes radar in polar coordinates (x-axis : 0°= North ; 90°= East). 100% = total bea m blocking ; 0% = no beam blocking.

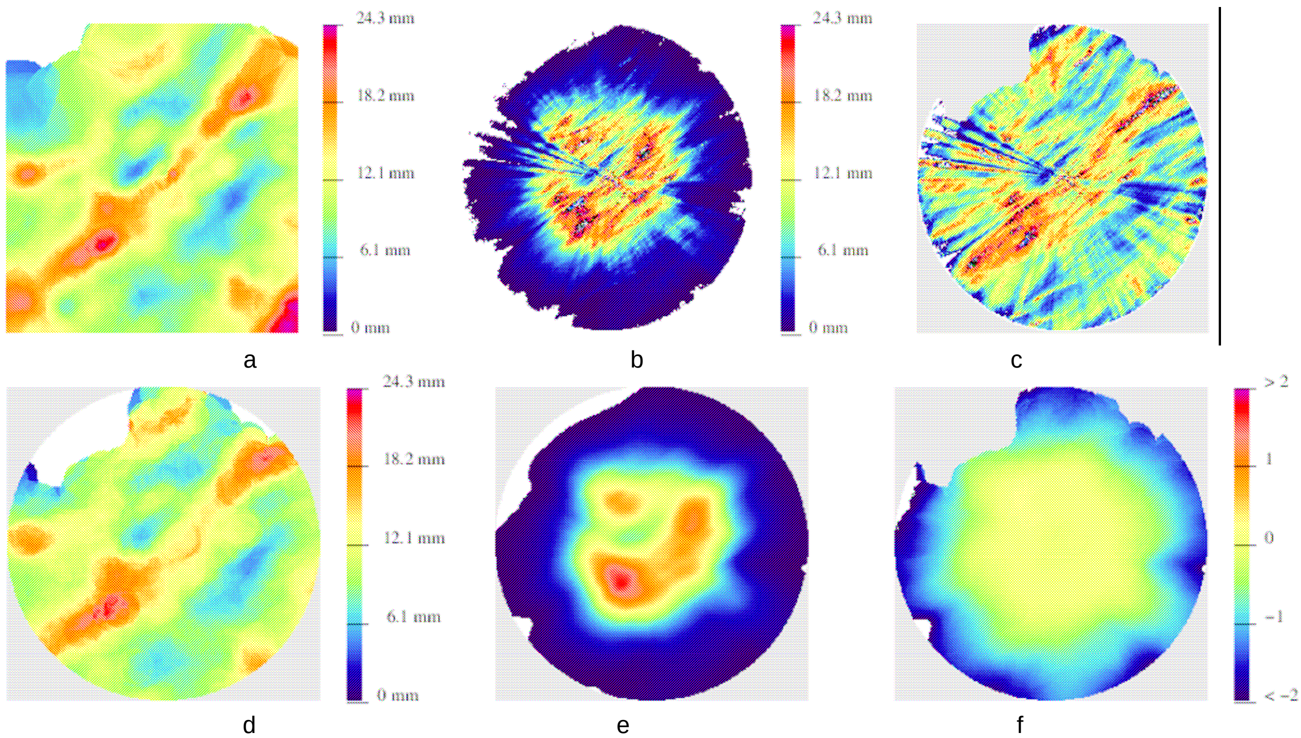

Fig.4. Raw kriged daily rain gauges data (a) and 24h-accumulated radar data (b). Mean of these raw data on a moving circular window (d: rain gauges ; e: radar). Ratio of (e) over (d) is computed to get a R/P factor (f). This factor (f) is used straightly on radar data (b) to compute a merged precipitation field (c). (Trappes, 5th may 1997)