Simultaneous X-band and K-band study of precipitation to derive specific Z-R relationships

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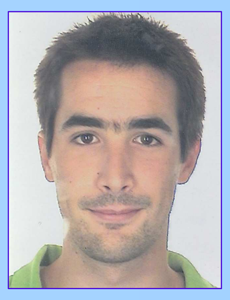


Introduction

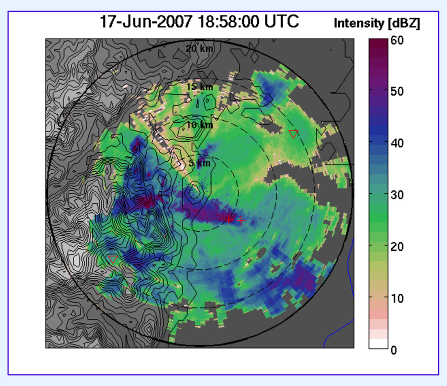
During more than 50 years of development, ground-based weather radar grew into an outstanding tool for quantitative rainfall measurements. The major source of errors lies in the conversion of the *radar reflectivity factor Z* ($mm^6\,m^{-3}$) to *rain rate* R ($mm\,h^{-1}$). These two parameters are related each other via the *raindrop size distribution* (DSD) which cannot be inferred by conventionnal weather radar measurements. Hence, it has been common practice to take a simple power law relationship between Z and R. DSD is extremely variable in space and time even within a single rain event. Thus, many of these relationships have been proposed, nevertheless, a unique relationship is generally used for one rain event.

The aim of this work is to categorize the different rain regimes that might occur even within individual precipitation cells to derive the corresponding specific relationships. Then we will confront the rain estimates with these specific relationships to the classical approach using one single relationship in order to investigate their potential for improve rain estimation. To do so, we analyse the simultaneous measurements of a scanning *X-band radar* and a vertically pointing *Micro Rain Radar* (MRR) in their common volume.

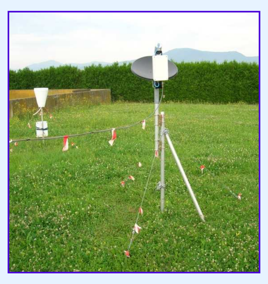
In this poster, we present this method with illustrations from the rain event which took place on June 17, 2007, during the international COPS (Convective and Orographically-induced Precipitations Study) campaign (Wulfmeyer et al., 2008).

X-band radar

- Elevation : 5°
- High resolution :
  - Time : 30 s
  - Azimuth : 2°
  - 60 meters
- Max range : 20 km



Micro Rain radar



- Doppler spectra of 63 bins over 32 range gates every 10s
- Profiles of DSD
- ➔ Derivation of rain parameters :
  - *Attenuation coefficient*

$$k = \int N(D)\sigma_e(D)dD$$

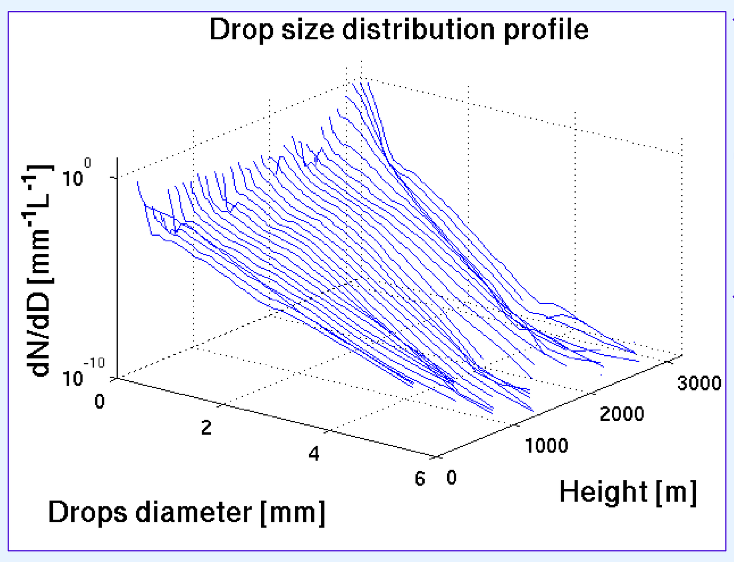
  - *Reflectivity factor*

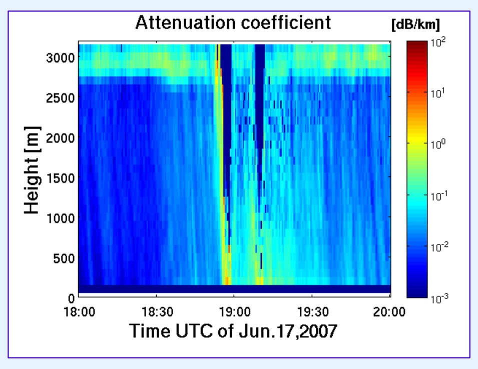
$$Z = \int N(D)D^6 dD$$

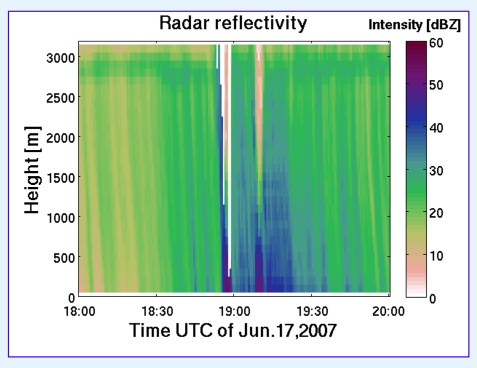
  - *Rain rate*

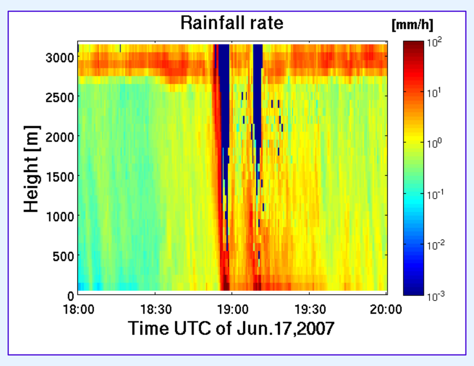
$$R = \frac{\pi}{6}\int N(D)v(D)D^3 dD$$

- Further details in Peters et Al. (2005)



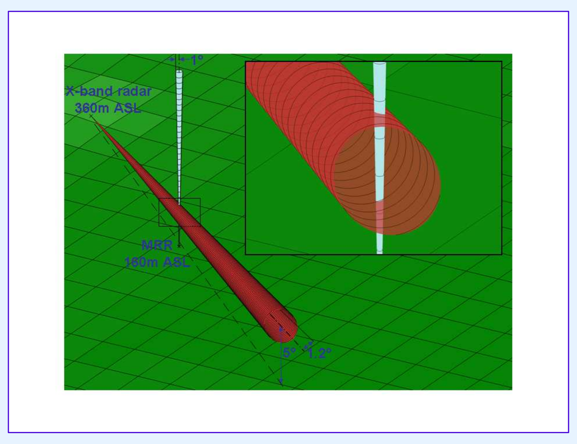


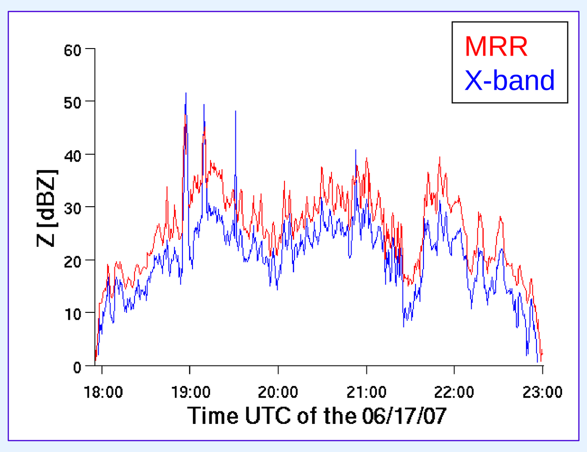


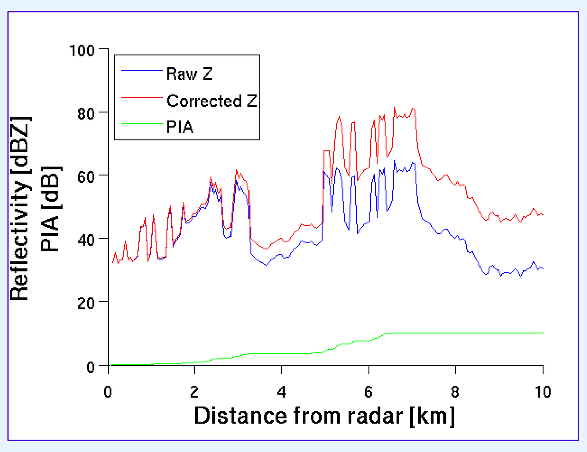


Common volume

- Experimental set-up which allow having a common volume of measurements between the two radars
- X-band radar reflectivity lower than MRR reflectivity by an offset of about 5dBZ
- ➔ Attenuation correction on X-band reflectivity :
  - Hitschfeld and Bordan (1954) algorithm : iterative correction from first to last range gate
  - $Z = \alpha k^{\beta}$ with coefficients deduced from MRR measurements in the common volume
  - Instable method in cases of heavy attenuation
  - *Path Integrated Atenuation* : $PIA(r) = 2\int_0^r k(s)ds$
  - Max PIA : 10 dB (Delrieu et al. 1999)
- ➔ X-band radar calibration with regard to the MRR

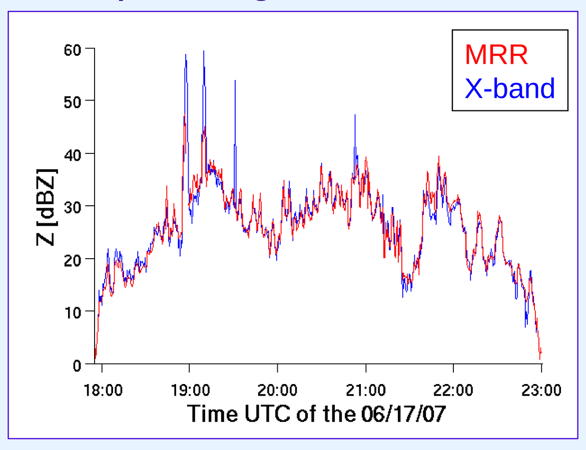


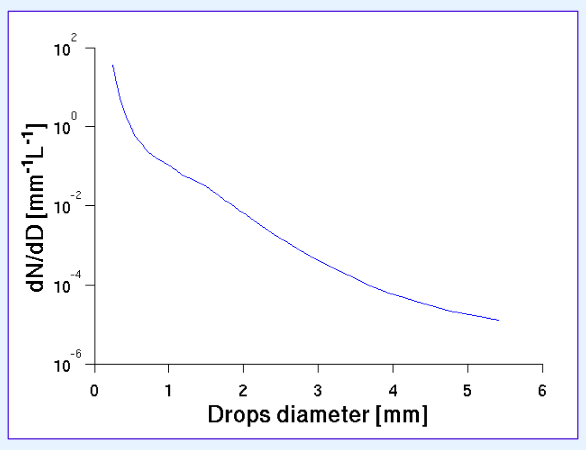


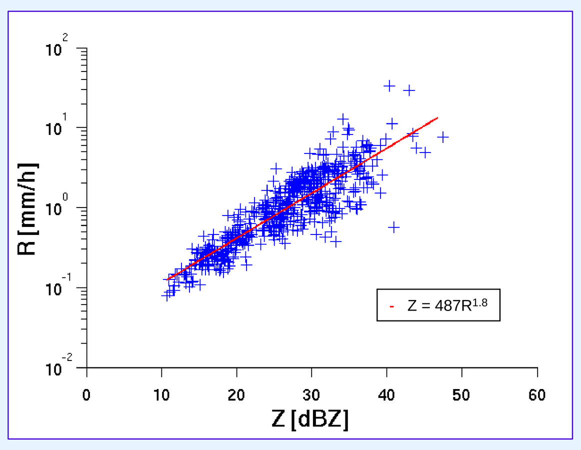


Mean rain characteristics

- Very similar features between the reflectivities of the two types of radars
- Determination of mean Z-R relationship from MRR measurements in the common volume to estimate the precipitation from the X-band radar reflectivity
- Corresponding mean DSD

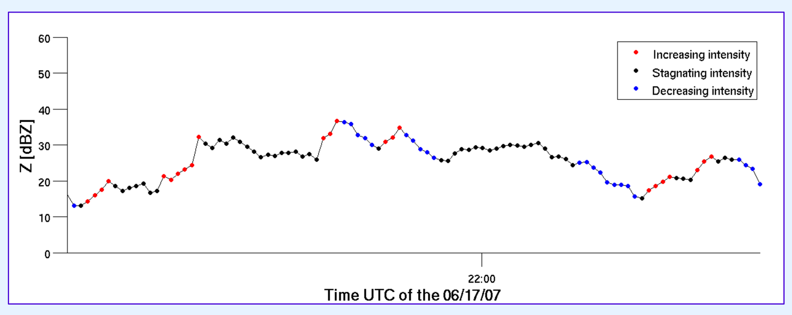


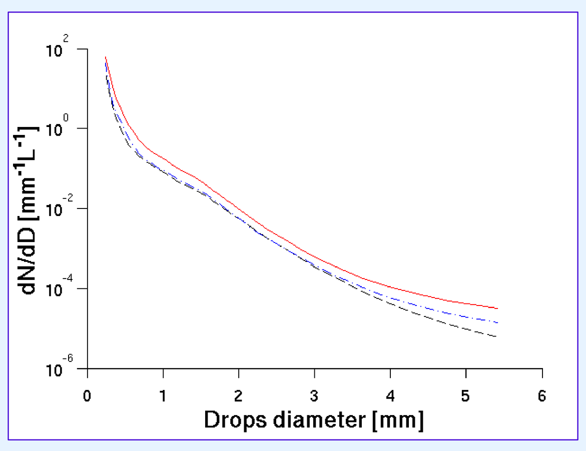


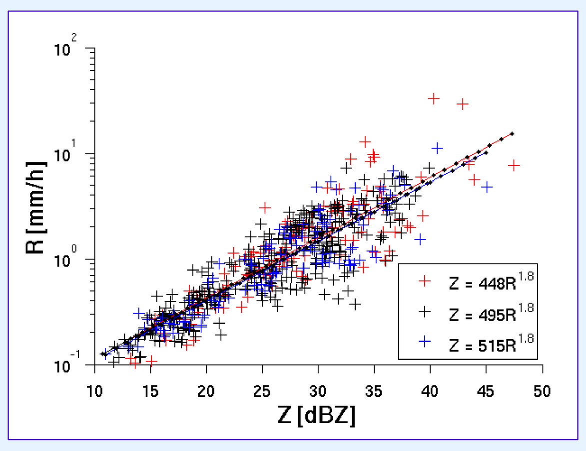


Rain regimes classification and specific rain characteristics

- Rain regimes classification to derive specific rain parameters in order to improve the rain rate estimation
- Classification scheme based on the intuitive fact that bigger drops are perceived when rain intensifies, while only smaller drops are left when rain decreases in intensity
- Development of a simple selection procedure which separate increasing, stagnating and decreasing intensity rain periods
- Determination of the corresponding specific DSD and Z-R relationships deduced from the MRR measurements







Rainfall estimation

- Application of these methods to the whole data set of COPS campaign :
  - About 100 hours of measurements corresponding to 25 events of various precipitation types from stratiform to convective rain
- The MRR estimation is taken as a reference
- The use of rain regimes classification and specific Z-R relationships improves slightly the rain estimation

Method	Total rainfall (mm)
MRR	73.51
Single Z-R relationship	68.23 (-7.18%)
Specific Z-R relationships	68.67 (-6.58%)

Conclusion and perspectives

We have shown the need in using specific Z-R relationships to account for the variability of rain regimes within the precipitation systems. To determine these specific Z-R relationships, a classification scheme based on the trend of reflectivity intensity (increasing, stagnating and decreasing) shows great promises for improvement of the rain estimation.

We are still working on the improvement of this classification scheme in order to extend and validate this study by rainfall comparisons with a network of raingages over the domain covered by the X-band radar.

Acknowledgements :

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