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Discussion on the implementation of Quantitative Precipitation Estimations (QPE) on operational polarimetric radars

Marie-Laure Segond [1], Pierre Tabary [1], Jacques Parent-du-Châtelet [1], Anthony Illingworth [2] and Katja Friedrich [3]

[1] Meteo France (E-mail: marie-laure.segond@meteo.fr), [2] University of Reading, UK, [3] MeteoSwiss, Switzerland

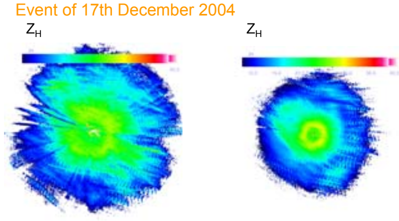
INTRODUCTION

A C-band dual polarisation radar was installed in Trappes, Southwest of Paris, in March 2004. This poster reports on possible interferences affecting the polarimetric variables. The aim is to revisit the analysis carried out by Gourley et al. (2006), apply it to lower elevation angles and extend it to a larger number of events in order to characterise the variations of the raw polarimetric variables with azimuth. Provided these are systematic, empirical correction procedures can then be implemented to remove these interferences prior conversion of reflectivity measurements into rainfall rate. Special emphasis is directed at differential reflectivity, for which a precision of ± 0.1 dB is necessary (Thompson, 2006).

DATA

Measurements of Z_H, Z_{DR}, Φ_{DP}, ρ_{HV} and σ (pulse-to-pulse fluctuation of the radar signal) are used. These are available in polar coordinate with bin size of 240 m × 0.5° recorded every 15 minutes from up to 12 elevation angles for the period December 2004 - September 2006. The radar umbrella extends to a 250 km radius (1066 bins on each radial). A library of 19 events, illustrated in Table 1, constituted of data aggregated to a 24 hours time-scale, collected at 0.4, 0.8, 1.5 ° and 90° served the analysis.

Radar extend at different elevation angle
Event of 17th December 2004



METHODOLOGY

Selection criteria at 0.4, 0.8 and 1.5 °:

Z_H between 20-22 dBZ	To reduce natural variability on Z_{DR}. The 'true' mean Z_{DR} should be about 0.2 dB ± 0.2
Range r < 50km	Local homogeneity hypothesis
Altitude < Isotherm0° - 500m	To be in the rain medium and below the melting layer
σ > 2.5 dB	To reduce the impact of ground clutter
Φ_{DP} around the offset Φ_{DP}<10° and Φ_{DP}>240° in 2005 5°< Φ_{DP}<10° in 2006	To reduce effect of attenuation
ρ_{HV}	No criteria

Table 1: Characteristics of selected events

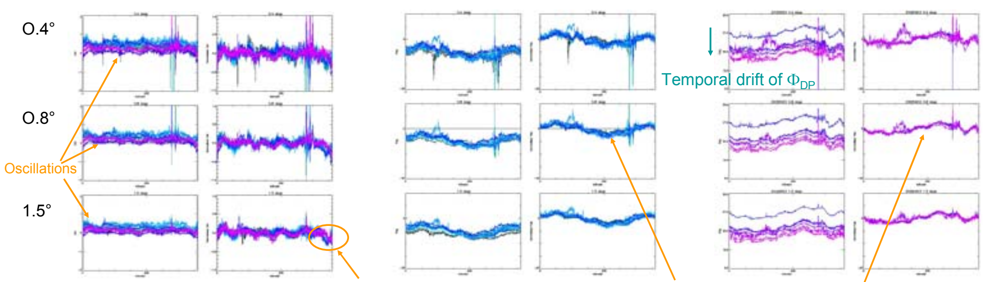
Events	Isotherm 0° (km)	$Z_{DR90°}$ [1]	$\Phi_{DP90°}$ [1]
17th December 2004	1.0	0.02	-7
24th March 2005	1.8	-0.07	-2
24th April 2005	2.1	-0.01	-2
12th May 2005	2.4	0.12	-5
13th May2005	2.5	0.23	-3
14th May 2005	2.4	0.01	-2
6th June 2005	2.6	0.02	-3
23rd June 2005	3.5	-0.04	-2
26th June 2005	3.6	0.00	-3
28th June 2005	3.3	-0.05	-2
30th June 2005	2.8	0.01	-2
4th July 2005	3.5	-0.01	-2
20th May 2006	2.0	-0.24	27
12th August 2006	2.3	-0.20	22
13th August 2006	2.1	NA	NA
29th August 2006	1.6	-0.17	21
14th September 2006	3.3	-0.17	19
15th September 2006	3.1	-0.12	19
23rd September 2006	3.2	-0.14	18

[1] Mean Z_{DR} and Φ_{DP} at vertical incidence 15<ZH<45 dBZ, ρHV >0.97, 1<r<6 km, n>50% for each radial

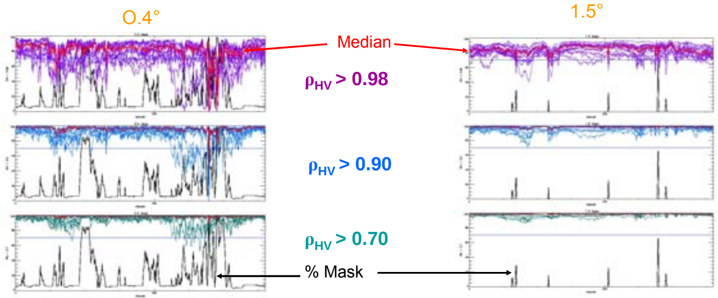
Rotary joint replaced on 12th May 2006

Temporal trend in system offset

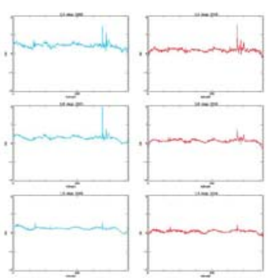
AZIMUTHAL VARIATIONS OF Z_{DR} AND Φ_{DP}



OCCURRENCE OF ρ_{HV} WITH AZIMUTH



For each event, the percentage of ρ_{HV} above a certain threshold is computed and plotted as a function of azimuth. Low value of ρ_{HV} were observed at 0.4 and 0.8° elevations in masked areas, however imposing a threshold on ρ_{HV} (>0.96) as a criterion for data selection did not improve the reproducibility of Z_{DR} and Φ_{DP}. NB: high SNR and region is free of ground clutter.



CORRECTION PROCEDURE FOR Z_{DR}

The measured differential reflectivity can be seen as the sum of the expected ("true") differential reflectivity, a system bias, which can be measured at 90° elevation, and an azimuthal bias such that:

$$Z_{DR}^{m} = Z_{DR}^{T} + \Delta Z_{DR_0} + \Delta Z_{DR_{AZ}}(AZ) \qquad (1)$$

At horizontal incidence, for Z_H within 20-22 dBZ, the expected Z_{DR}^{T} =0.2 dB consequently, for each event, the azimuthal bias can be written as:

$$\Delta Z_{DR_{AZ}}(AZ) = Z_{DR}^{m_{20-22}} - 0.2 - \Delta Z_{DR_0} \qquad (2)$$

Equation (2) is derived for each event and the median of the curves for 2005 and 2006 separately, can be taken as the azimuthal variation correction curve to be applied subsequently to all range of Z_H in rain. Hence for all range of Z_H in rain, the expected Z_{DR}^{T} can be obtained as follow:

$$Z_{DR}^{T} = Z_{DR}^{m} - Z_{DR_0} - \Delta Z_{DR_{AZ}}(AZ) \qquad (3)$$

DISCUSSION ON THE NORMALISATION OF THE Φ_{DP} PROFILE

- 1st method: Use the systematic azimuthal variation of Φ_{DP} to be substracted to all Φ_{DP} measurements.
- 2nd: method: The Path Integrated Attenuation (PIA) algorithm is applied dynamically on each ray (see Tabary et al. 2007) according to:

$$PIA = \gamma\left(\Phi_{DP}^{m} - \Phi_{DP_0}\right) \qquad (4)$$

where Φ_{DP_0} is the mean Φ_{DP} in the first few bins recording precipitation and is calculated for each elevation angle, γ is a coefficient depending on the precipitation type. Assuming that both Φ_{DP_0} and Φ_{DP} have the same variations, the attenuation correction should remove the azimuthal bias affecting the differential phase shift.

CONCLUSIONS

Systematic variations of Z_{DR} with azimuth were observed due to the influence of the radome. In addition, a system bias was also affecting the value of Z_{DR}. A correction scheme was proposed depending on azimuth, elevation angle and the value of the system bias, which can change on a daily basis.

Systematic variations of Φ_{DP} were reported due to the effect of the rotary joint. This can be corrected either using a systematic azimuthal variation curve or via the atttenuation correction scheme. Continuous monitoring of this variable is recommended.

Next stage involves the testing of rainfall rate conversion algorithmns (Testud et al., 2000 and Thompson, 2006)

REFERENCE

- Gourley, JJ et al. (2006), Data quality of the Météo France C-band polarimetric radar, *J. Atmos. Oceanic Technol* , 23, No. 10, 1340–1356.
- Tabary, P. et al. , 2007, Current status of the French dual-polarisation project , EGU 07
- Testud J. et al.(2000), The rain profiling algoritmn applied to polarimetric weather radar. *J. Atmos. Oceanic Technol* 17: 332-356.
- Thompson, R. J. (2006), Rainfall estimation using polarimetric weather radar, PhD thesis, The University of Reading, 183 pp.

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