A simple-but-realistic fuzzy logic hydrometeor classification scheme for the French X, C and S-band polarimetric radar

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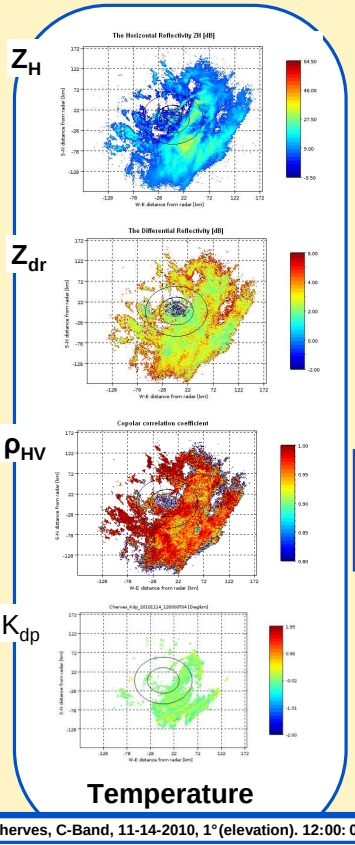
Goals :

- **Have a unique classification scheme (*in term of probability function and approach, but different Membership Functions MBF)* for all radar Bands (C, S and X-Band).**
- **Take into account the measurement conditions in the classification algorithm.**

Means :

- **Modelled empirical MBF.**
- **Use real data with theory simulation (T-Matrix) to establish the MBF.**
- **Study the second choice of the algorithm of classification.**

Hydrometeor Classification Algorithm



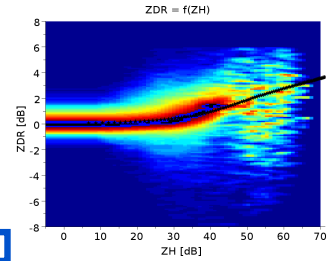
Cherves, C-Band, 11-14-2010, 1°(elevation). 12:00: 00

Measurement conditions (Φ_{DP}, SCR*, SNR, PBB, distance, …)**

***: Signal to Clutter Ratio**
****: Partial Beam Blocking**

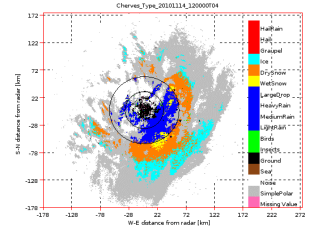
Fuzzy Logic Algorithm

$$P_F{}^i = F_Z^i(Z_H)\,F_T^i(T)[F(Z_H,Z_{DR}) + F(Z_H,K_{DP}) + F(Z_H,\rho_{HV}) + F_{BB}^i(BB)]$$

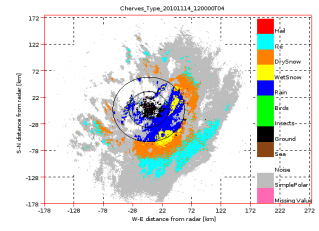


Type

Old

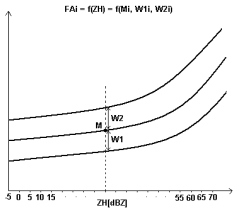


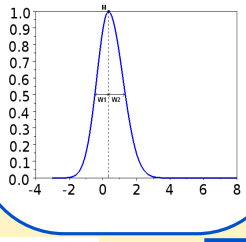
New



Enlargement function

$$MF_i = f(M_i; W_1^i; W_2^i)$$





Measurement conditions (Φ_{DP}, SCR, SNR, PBB, distance, …)

Enlargement function

$$W_1{}^{i'} = f(W_1^i; SCR; \Phi_{DP})$$
$$W_2{}^{i'} = f(W_2^i; SCR; \Phi_{DP})$$

$$MF'_i = f(M_i; W_1{}^{i'}; W_2{}^{i'})$$

Variation rate of The Two half-Gaussian function

X-band	Z-Z_{DR}		Z-K_{DP}		Z-ρ_{HV}	
(%)	W_1	W_2	W_1	W_2	W_1	W_2
A	39.7	10.9	14.9	16.7	15.6	8.9
B	34.7	12.6	16.7	28.4	35.6	8.3
C	38.9	14.4	8.4	25.1	64.9	8.2

S-band	Z-Z_{DR}		Z-K_{DP}		Z-ρ_{HV}	
(%)	W_1	W_2	W_1	W_2	W_1	W_2
A	1.0	1.0	1.0	1.0	1.0	1.0
B	35.6	27.5	14.3	4.8	8.4	5.6
C	62.4	45.6	14.3	15.9	8.4	5.6

C-band	Z-Z_{DR}		Z-K_{DP}		Z-ρ_{HV}	
(%)	W_1	W_2	W_1	W_2	W_1	W_2
A	30.6	12.2	15.0	1.0	34.3	1.0
B	19.5	10.1	11.3	13.5	15.5	1.0
C	7.5	27.3	6.9	20.2	16.3	1.0

A : is the variation of SCR from [0,10] to [10,30] with Φ_{DP} < 10°.
B : is the variation of Φ_{DP} from [0,10] to [10,30] with a SCR between [10,30].
C : is the variation of Φ_{DP} from [0,10] to [10,30] with a SCR between [0,10].

Conclusion:

- Using one probability function reduces the number of parameters and the idea of having one algorithm for the C, S and X-band radar is more powerful than having an algorithm for each radar band.
- The enlargement of the weights of the MBF gives to the study more reality and more flexibility.
- The study of the difference between the first and the second choice of the hydrometeor classification algorithm shows the capacity of the algorithm to separate two hydrometeor types, especially when the common area of MBF is scientifically large.

Future work:

- Long term statistical analysis and scores calculation.
- Improve the temperature calculation.
- Study of the Hail to extend it to 3 types : small Hail (diameter < 5 mm), medium Hail (diameter between 5 – 20 mm) and large Hail (diameter > 20 mm).

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