Fine tuning of Radar Rainfall Estimates based on Bias and Standard Deviations Adjustments

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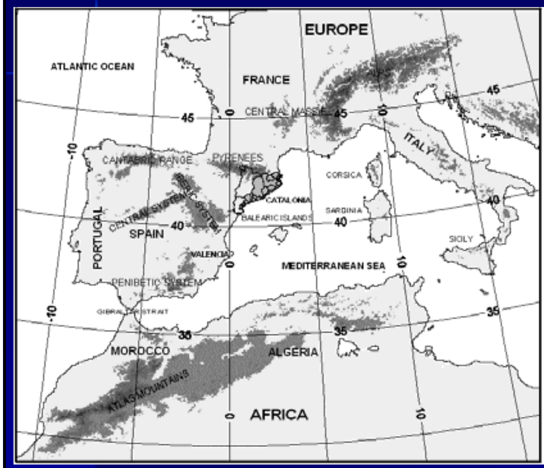
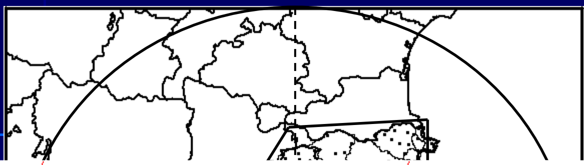
Introduction

WESTERN MEDITERRANEAN REGION



BASINS OF CATALONIA

A detailed synoptic and numerical analysis of this case of study can be found in the article of Martin *et al* (2006). Authors have deduced that the atmospheric instability over Catalonia were caused by an active cold front.



- •Spanish Provinces.
- •Catalonian internal basins.
- •126 ACA rain gauges and kriging area.
- •Barcelona radar spatial coverage.

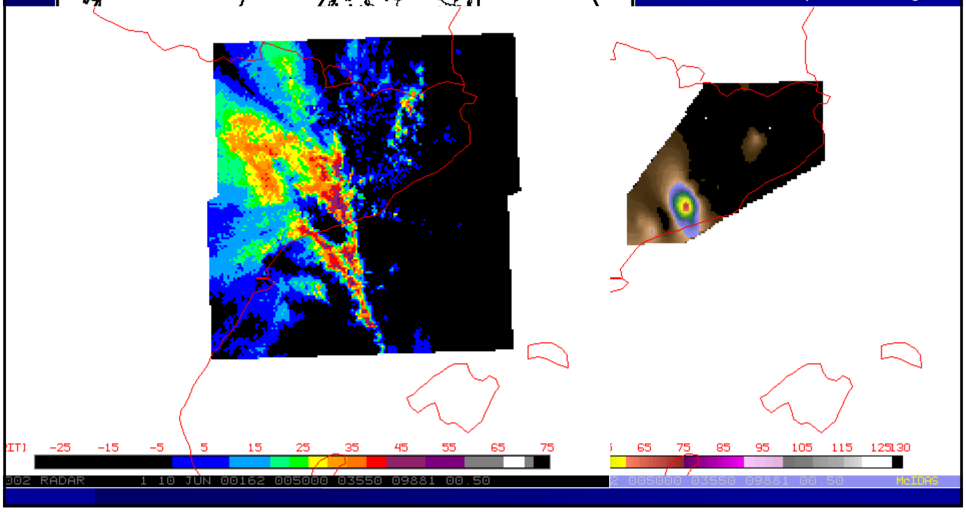
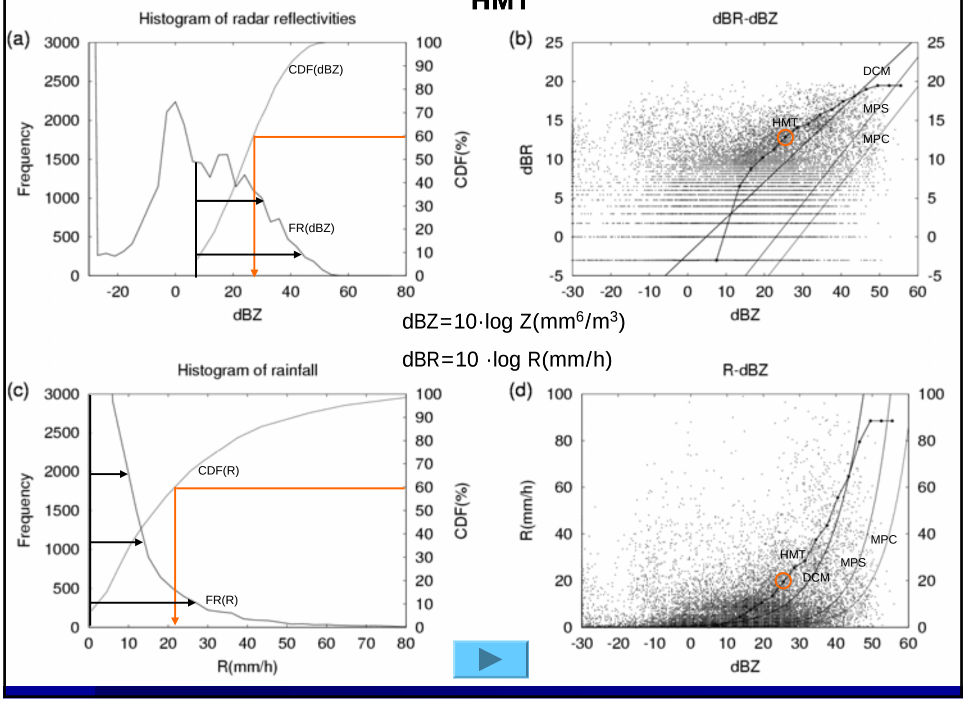


Table 1. Radar-rain images used for the calibration file generation.

Day	Hour (UTC)	Number of collocated Z, R points in the domain	Comments
June-10-2000	00:20	5430	Radar-Rain images present
“	00:50	5430	“
“	01:20	5430	“
“	01:50	5430	“
“	02:20	5430	“
“	02:50-04:20	0	Radar error
“	04:50	5430	Radar-Rain images present
“	05:20	5430	“
		38010	Total number of Z, R points in the calibration file

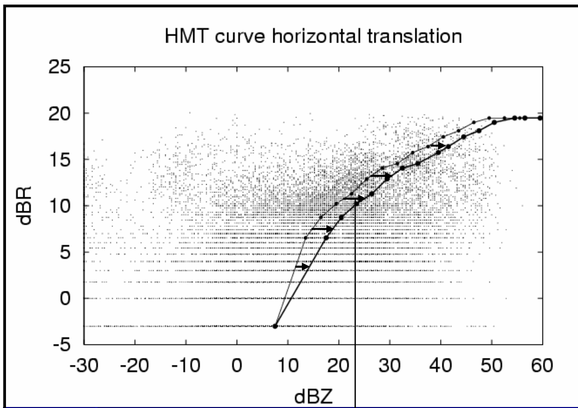
- •Radar maximum temporal resolution is 10 minutes.
- •ACA maximum temporal resolution is 5 minutes.

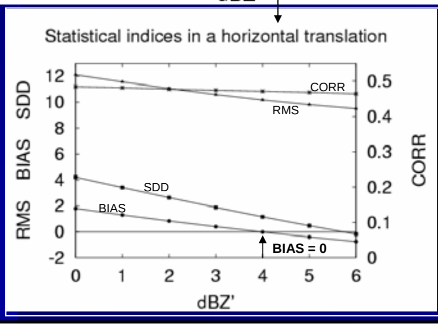
HMT



$dBZ = 10 \cdot \log Z(mm^6/m^3)$

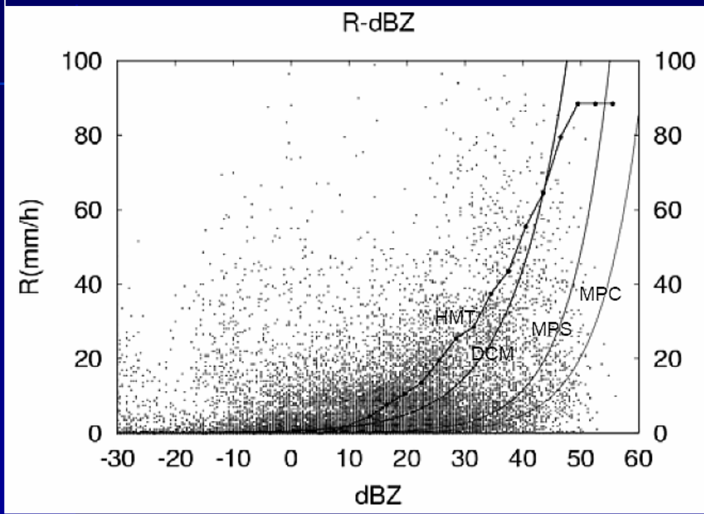
$dBR = 10 \cdot \log R(mm/h)$





	HMT	HMT*
BIAS	1.81	**-0.01**
SDD	4.22	**1.16**
RMS	12.11	**10.18**
CORR	**0.48**	0.47
POD	0.63	0.63
FAR	0.22	0.22
CSI	0.54	0.54
FRC	0.78	0.78

ACA rain rates versus radar reflectivities and rain curves
(Luque et al. 2006)



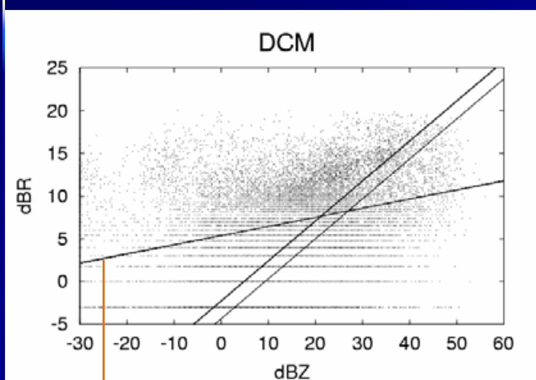
HMT	
Zi(dBZ)	*Ri*(mm·h⁻¹)
7.5	0.2
13.5	1.5
17.5	4.5
20.5	7.5
23.5	10.5
26.5	13.5
29.5	19.5
32.5	25.5
35.5	28.5
39.5	37.5
41.5	43.5
44.5	55.5
47.5	64.5
50.5	79.5
54.5	88.5
56.5	88.5

$R(mm/h) = 0.0485 \cdot Z^2 - 0.7099 \cdot Z + 4.8289$ $r^2 = 0.997$

Direct Calibration Method (DCM)

$Z = A \cdot R^B$ → $dBZ = B \cdot dBR + 10 \cdot \log(A)$ DZDF (Marshall & Palmer, 1948)

where $dBZ = 10 \cdot \log(Z)$ and $dBR = 10 \cdot \log(R)$



dBZ → y

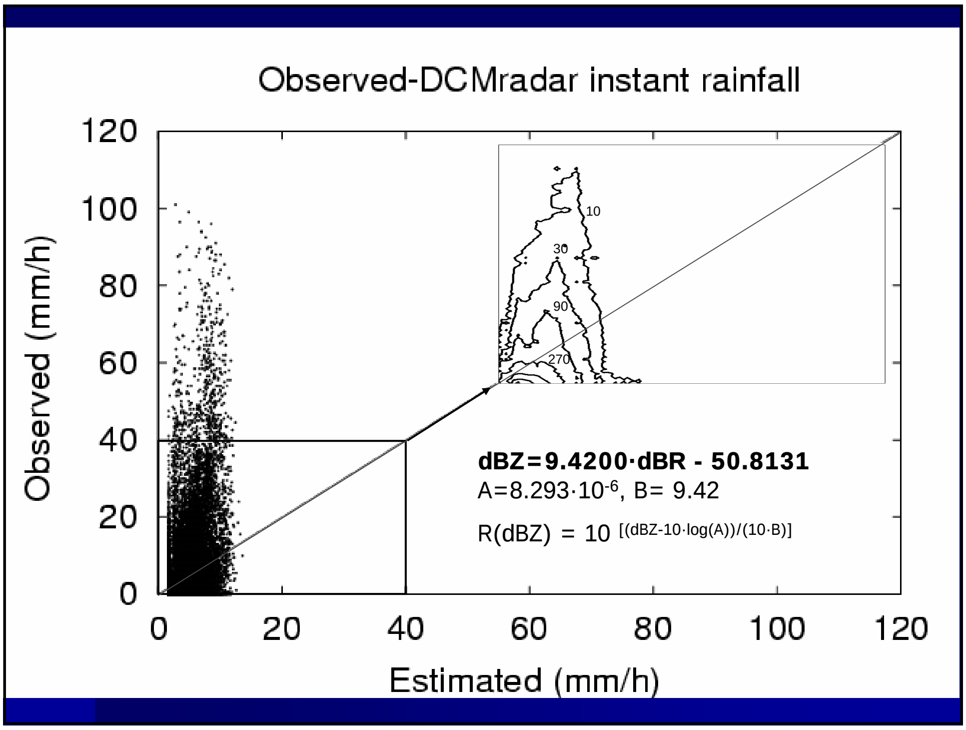
dBR → x

B → slope

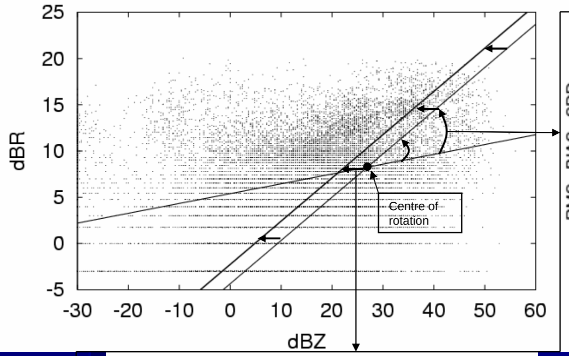
10·log(A) → intercept

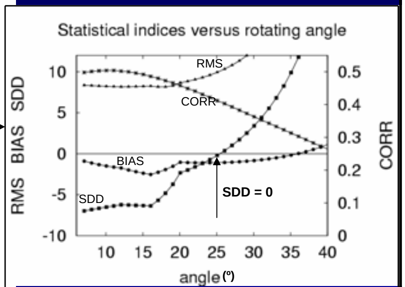
$dBZ = 9.4200 \cdot dBR - 50.8131$ $A = 8.293 \cdot 10^{-6}$, $B = 9.42$

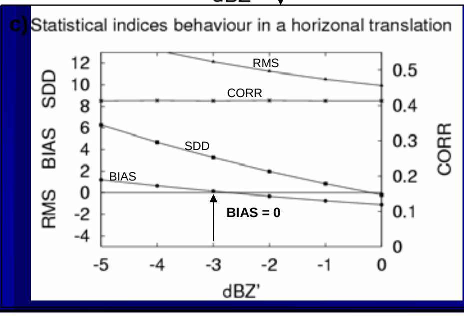
$R(dBZ) = 10^{[(dBZ - 10 \cdot \log(A))/(10 \cdot B)]}$



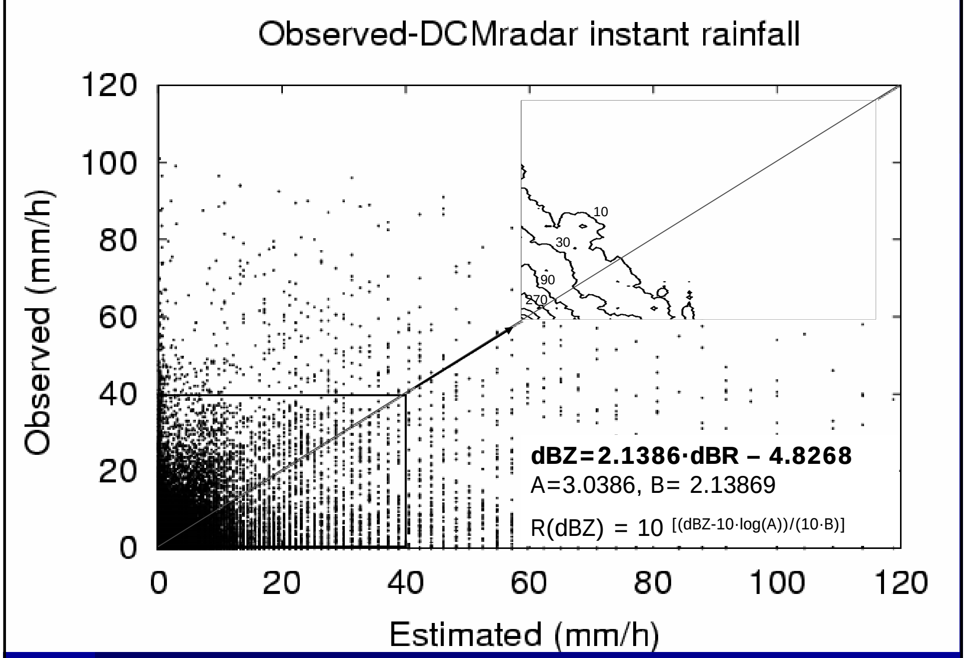
DCM rotation and translation corrections







	DCM	DCM*	DCM**
BIAS	-0.63	-1.09	**0.13**
SDD	-7.15	**-0.20**	3.25
RMS	**8.43**	9.94	12.12
CORR	**0.49**	0.41	0.41
POD	**1.00**	0.49	0.76
FAR	0.58	**0.27**	0.34
CSI	0.42	0.41	**0.54**
FRC	0.42	**0.79**	0.74



Standard Coefficients (MPS, MPC)

$Z= A \cdot R^B$ → dBZ= B·dBR+10·log(A) DZDF (Marshall & Palmer, 1948)

where dBZ=10·log(Z) and dBR=10·log(R)

$R(dBZ) = 10^{[(dBZ-10 \cdot \log(A))/(10 \cdot B)]}$

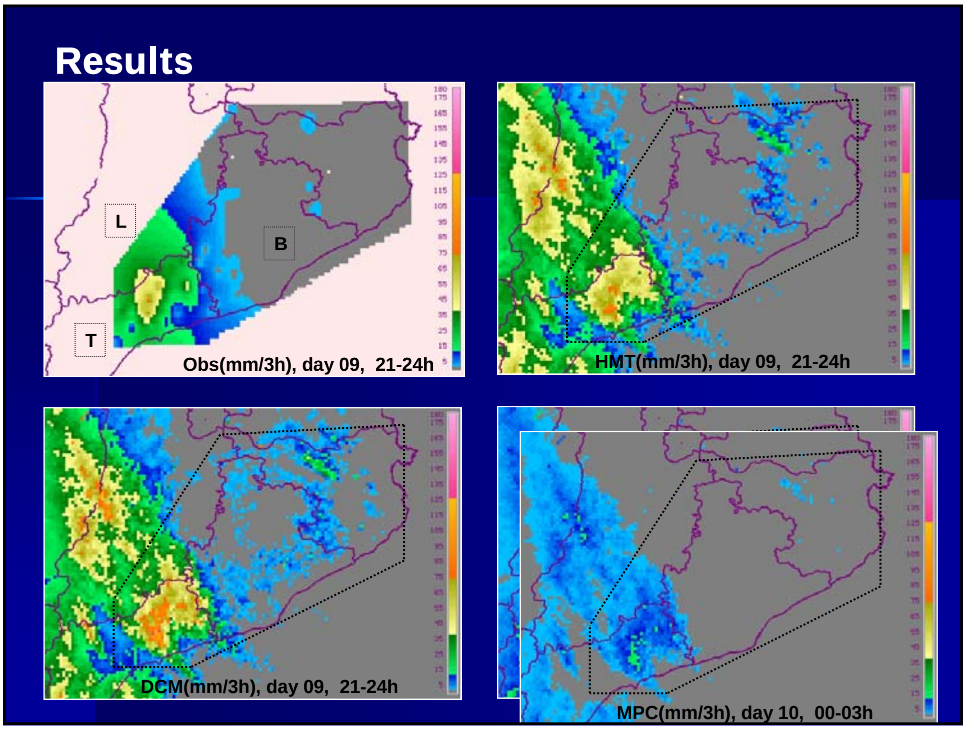
Stratiform coefficients (MPS) → A=200, B=1.6

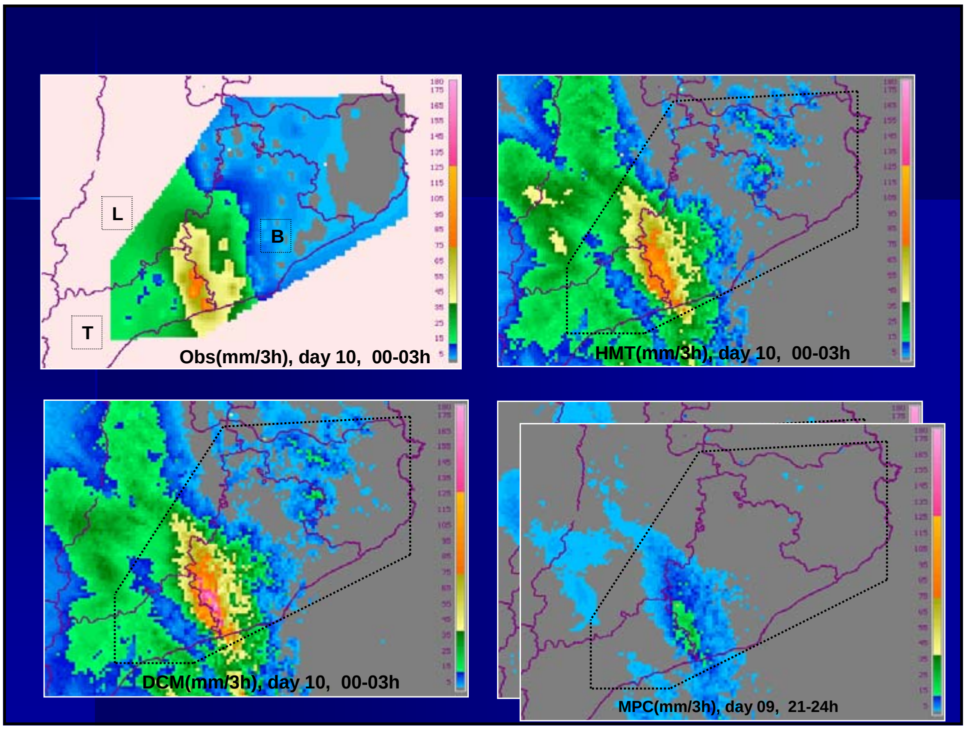
Convective coefficients (MPC) → A=800, B=1.6

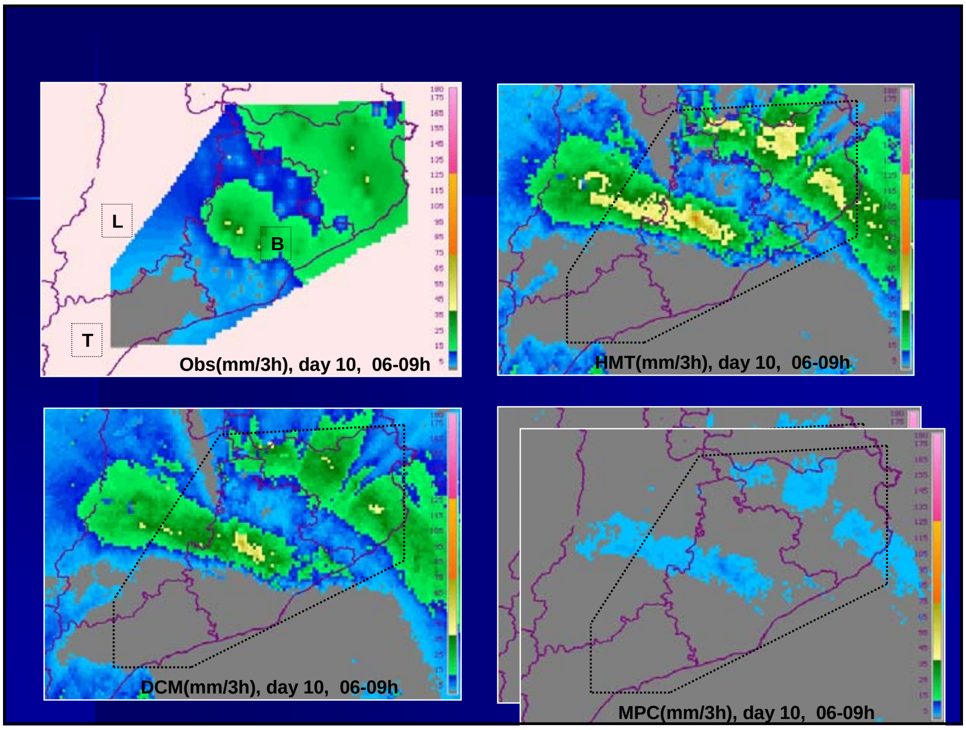
Figure

Verification of the methods

- Qualitative and numerical intercomparison of 3 hours rainfall accumulations.
- HMT, DCM, MPS and MPC estimations versus the ACA observations


Results
L
B
T
Obs(mm/3h), day 09, 21-24h
HMT(mm/3h), day 09, 21-24h
DCM(mm/3h), day 09, 21-24h
MPC(mm/3h), day 10, 00-03h


L
B
T
Obs(mm/3h), day 10, 00-03h
HMT(mm/3h), day 10, 00-03h
DCM(mm/3h), day 10, 00-03h
MPC(mm/3h), day 09, 21-24h



	OBS	HMT	DCM	MPS	MPC	Day/period (hours)
Size				5430		09/21-24 UTC
Mean	5.8	8.2	9.4	2.2	1.0	
SD	10.4	15.3	18.0	5.3	2.2	
BIAS		2.5	3.7	-3.5	-4.8	
SDD		5.0	7.6	-5.1	-8.2	
RMS		8.7	11.5	7.3	8.8	
CORR		0.84	0.80	0.75	0.75	
Size				5430		10/00-03 UTC
Mean	12.8	12.7	13.5	3.1	1.3	
SD	16.5	20.2	23.6	7.1	3.1	
BIAS		-0.1	0.7	-9.6	-11.5	
SDD		3.7	7.1	-9.4	-13.5	
RMS		12.0	15.2	12.5	14.5	
CORR		0.81	0.77	0.71	0.70	
Size				5430		10/06-09 UTC
Mean	11.5	12.2	10.2	1.6	0.6	
SD	8.0	14.6	11.2	2.0	0.9	
BIAS		0.6	-1.4	-10.0	-10.9	
SDD		6.6	3.1	-6.0	-7.2	
RMS		11.0	8.0	6.9	7.5	
CORR		0.70	0.70	0.64	0.61	
Size				16290		09/21-24 UTC + 10/00-03 UTC + 10/06-09 UTC
Mean	10.0	11.0	11.0	2.3	1.0	
SD	12.6	17.0	18.4	5.3	2.3	
BIAS		1.0	1.0	-7.7	-9.1	
SDD		4.5	5.8	-7.3	-10.3	
RMS		10.7	12.1	9.7	11.2	
CORR		0.78	0.76	0.66	0.68	

Conclusions

- radar and rain gauges can be combined to improve the spatial distribution of the precipitation field and to gain accuracy in rainfall amounts within an operational context.
- old radar algorithms not adjusted or corrected for a specific area can produce significant errors in rainfall rates and accumulations.
- the HMT adjusted by the BIAS is the method that provides the best results and the MPC method is the worse one.
- The HMT is an ATI (Area-Time Integral) method and it needs rain rate fields well distributed in time and space to be appropriately developed. The DCM curve can be performed with few rain gauges that can provide rain rates at high time frequency.
- Our results in radar calibration are derived under the circumstances of a flood case and should not be applied directly to events in other areas and situations.

Detailed Paper

Luque A., Martin A., Romero R., and Alonso S., 2006, Assessment of Rainfall Estimates Using Standard Z-R Relationships and the Histogram Matching Technique Applied to Radar Data in a flood case in Catalonia. Submitted the 21-Jun-2006 to the *International Journal of Remote Eensing*, first version of the work available in ftp://eady.uib.es/pub/Angel in the **radar-draft-submited.pdf** file.

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Thank you