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► **To cite this version:**

Ambinintsoa Volatiana Ramanamahefa, Thiruvengadam Padmanabhan, Guillaume Lesage, Joël van Baelen. Rain gauges and x-band radar hourly comparison under complex orographic conditions in Reunion Island. 40th Conference on Radar Meteorology, Aug 2023, Minneapolis, United States. . hal-04428985

HAL Id: hal-04428985

<https://hal.science/hal-04428985v1>

Submitted on 31 Jan 2024

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Rain gauges and x-band radar hourly comparison under complex orographic conditions in Reunion Island

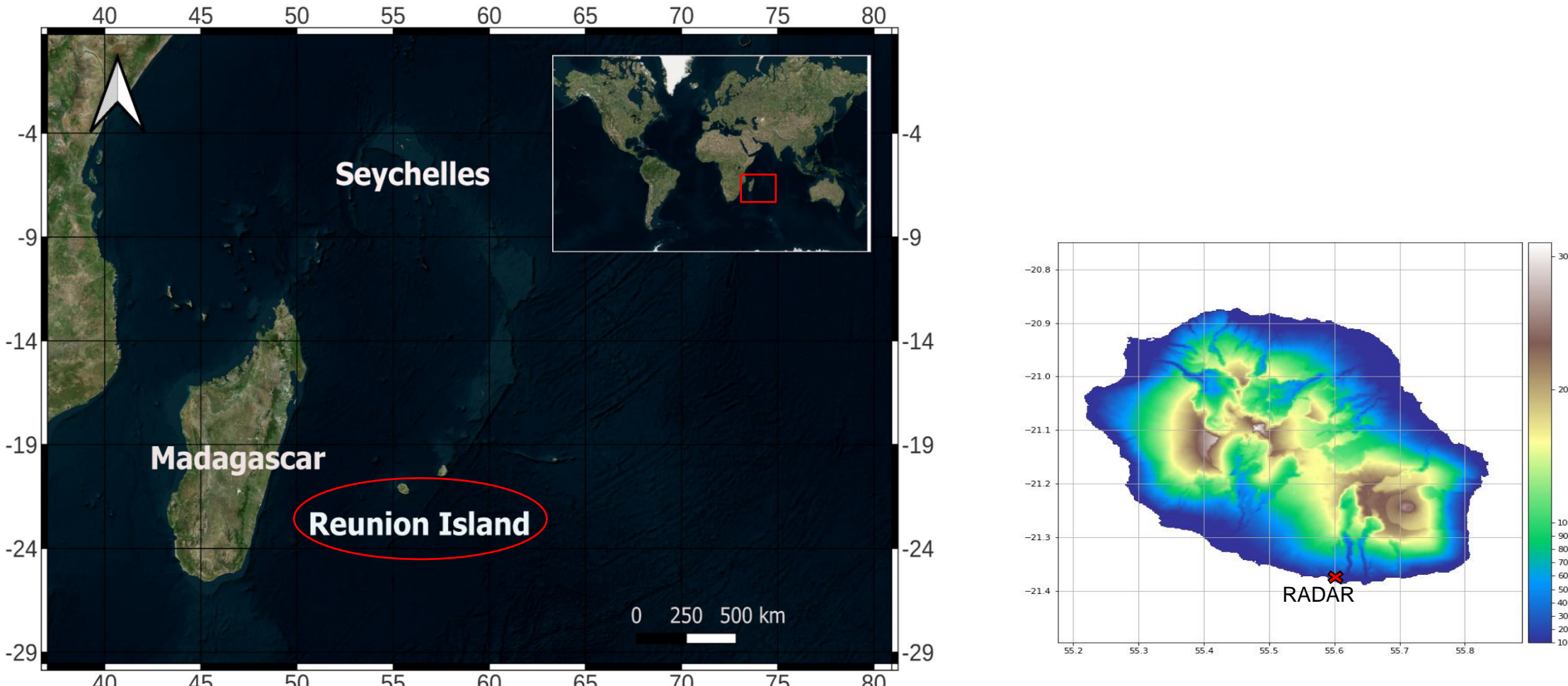
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INTRODUCTION and OBJECTIVES

Reunion Island :

- Located in the south-west Indian Ocean cyclogenesis basin
- A volcanic island characterized by steep mountains and deep valleys
- Broke rainfall world records in 72 hours with 3 930mm (2007)



One of the primary goal of the ESPOIRS project is to investigate how orography influences precipitation patterns. To delve into this phenomenon, an X-band radar has been acquired due to its high-resolution capabilities.

Challenges for X-band radar in tropical conditions:

- Which algorithm is suitable to correct attenuation?
- How can accurate rainfall estimation from radar data be achieved?

→ Validation is required through the comparison of radar data with rain gauge measurements, taking into consideration the specific tropical volcanic island context.

Data



X-band radar



rain gauge

Radar:

- spatial resolution: 125 m
- temporal resolution: 10 min
- range: 75 km
- 12 volume scans: 1.0°, 2.2°, 3.3°, 4.4°, 7°, 9°, 11°, 15°, 19°, 21°, 25° and 29°

Rain gauges:

- temporal resolution: 1h
- Data from 6 rain gauges compare with radar data
- Data during Batsirai cyclone: February 3rd 2022



MATERIALS & METHODS

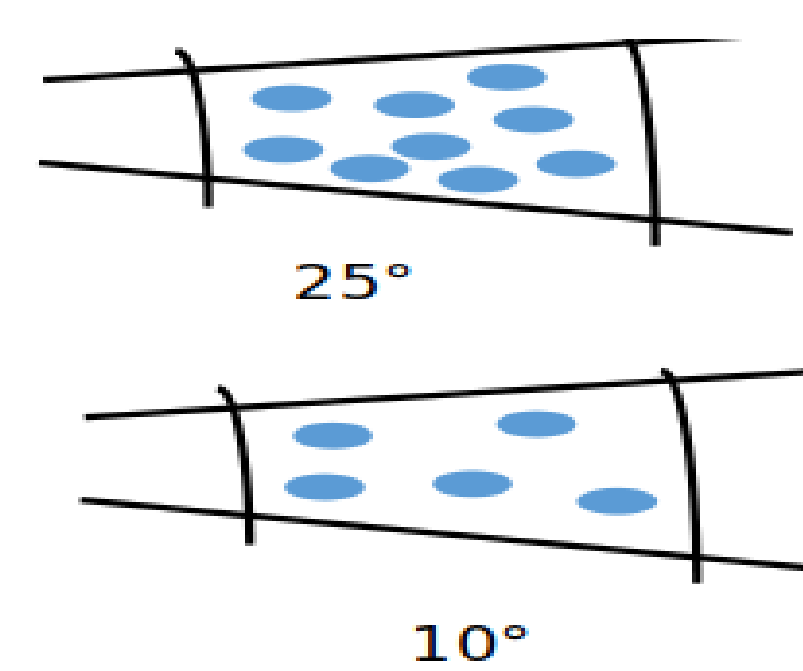
I. Attenuation correction:

1) **Hitschfeld and Bordan 1954:**

$$\text{Specific attenuation : } A = cZ^d \text{ (db/km)}$$

$$\text{Path integrated attenuation : } \text{PIA}_i = c \left(Z_i + \sum_{j=0}^{i-1} cZ_j^d \right)^d \cdot 2\Delta r$$

$$\text{Corrected reflectivity : } Z_{\text{corr},i} = Z_i + \text{PIA}_i$$

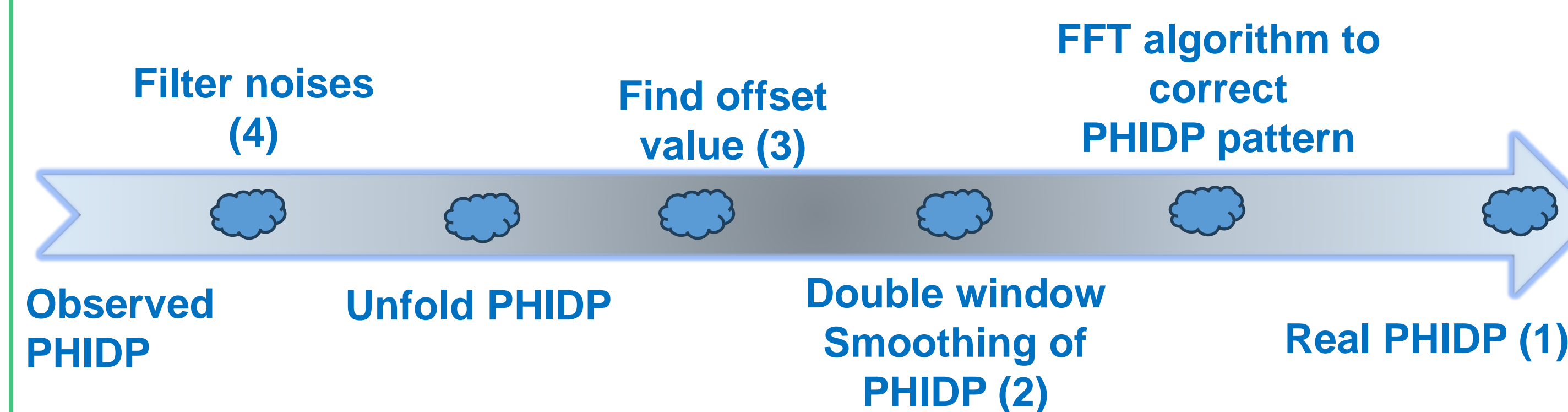


2) **Philinear algorithm:**

$$\text{Corrected reflectivity : } Z_{\text{corr},i} = Z_i + \alpha \text{PHIDP}$$

$$\text{Observed Phidp : } \Psi_{\text{dp}}^{\text{obs}}(r) = \phi_{\text{dp}}(r) + \delta_{\text{co}}(r) + \phi_{\text{dp}_0} + \sigma_{\phi_{\text{dp}}}$$

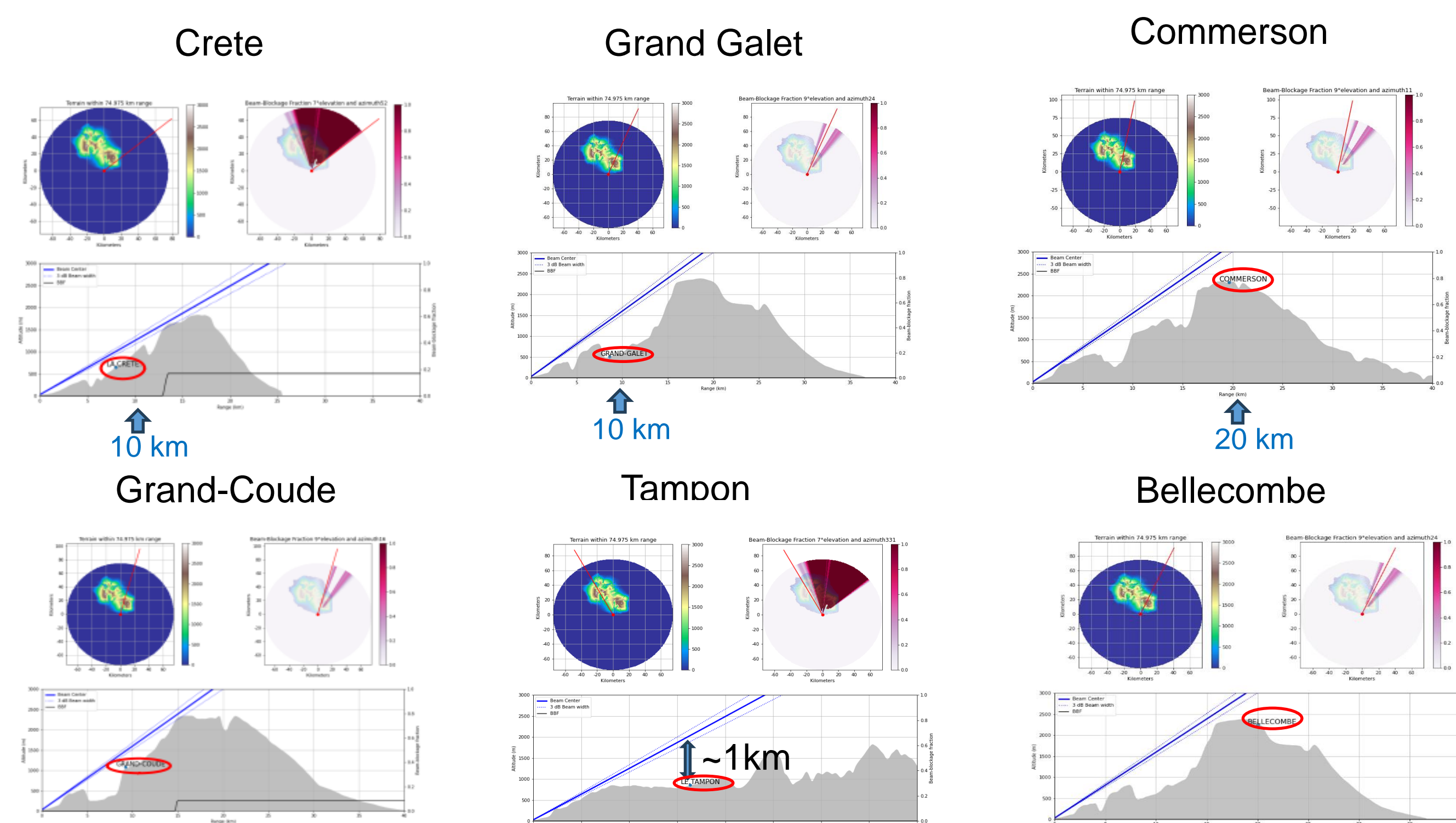
Process to get real PHIDP ($\phi_{\text{dp}}(r)$) from PHIDP observed ($\Psi_{\text{dp}}^{\text{obs}}(r)$)



II. Rainfall from radar measurement:

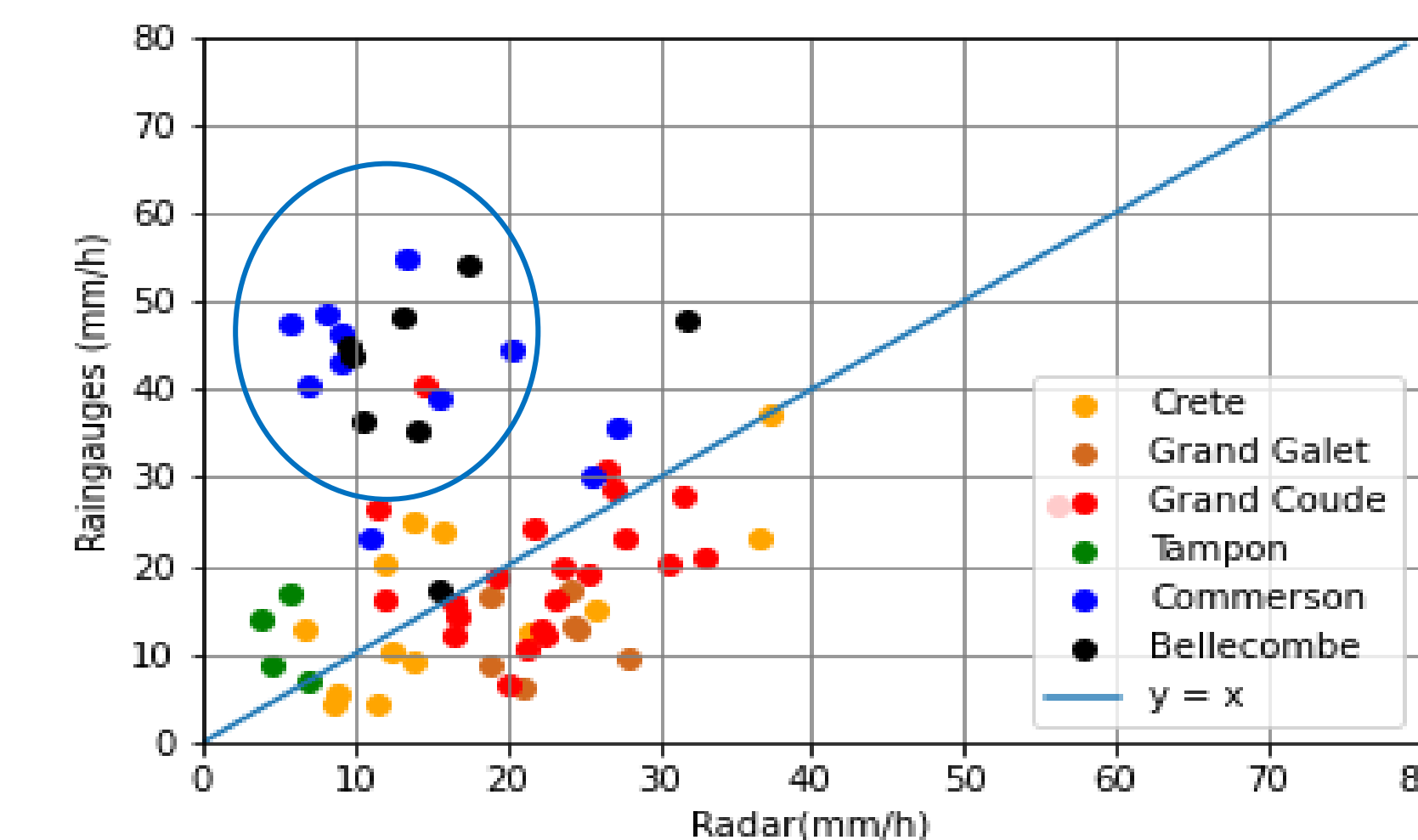
- 1) Z-R relationship for Reunion Island : $Z = 300R^{1.35}$
- 2) R(KDP) rain from KDP estimated : $R = 7KDP^{0.7992}$

III. Radar beam and raingauges location

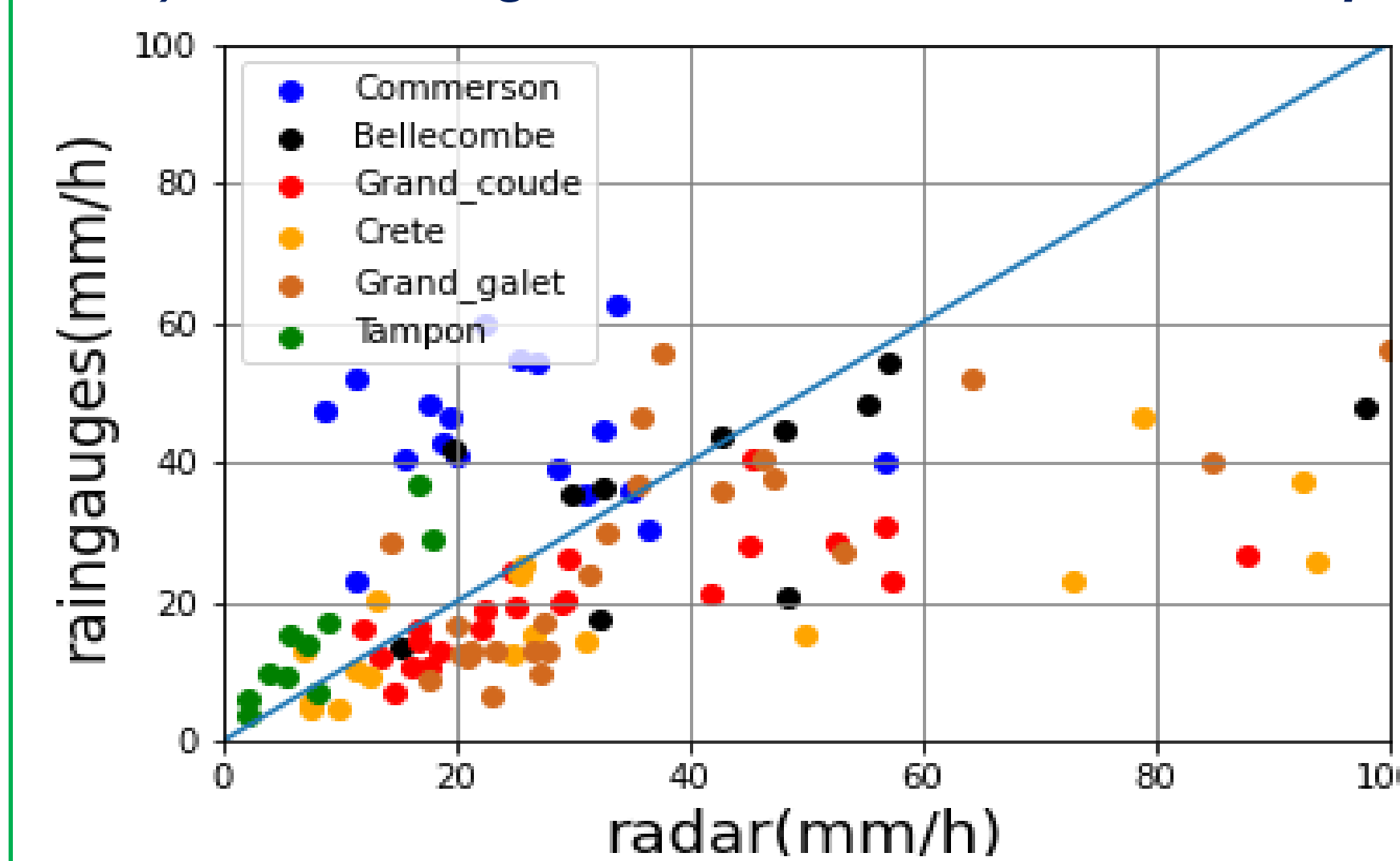


RESULTS

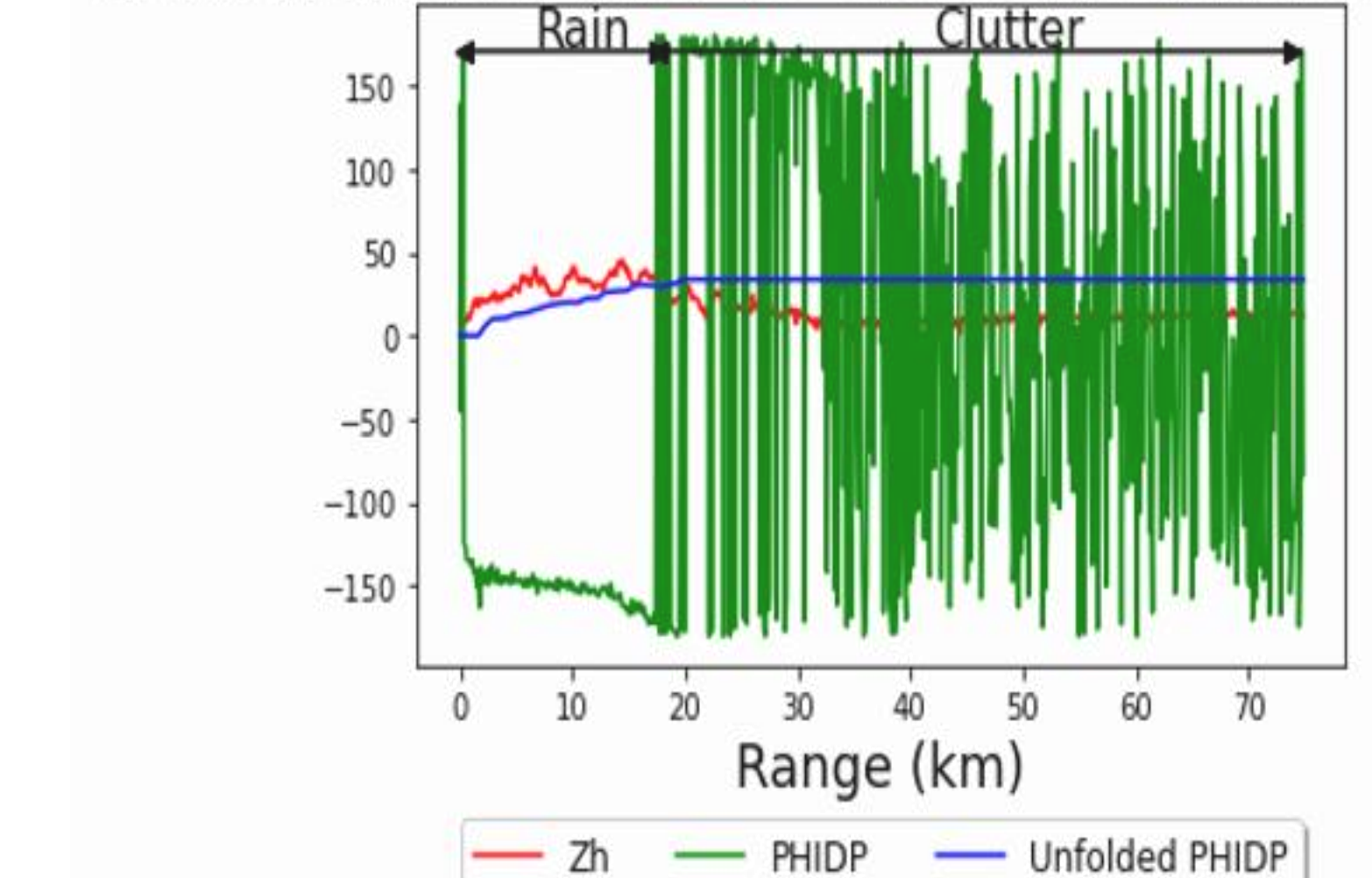
1) **Hitschfeld and Bordan 1954: RR from Z-R relation**



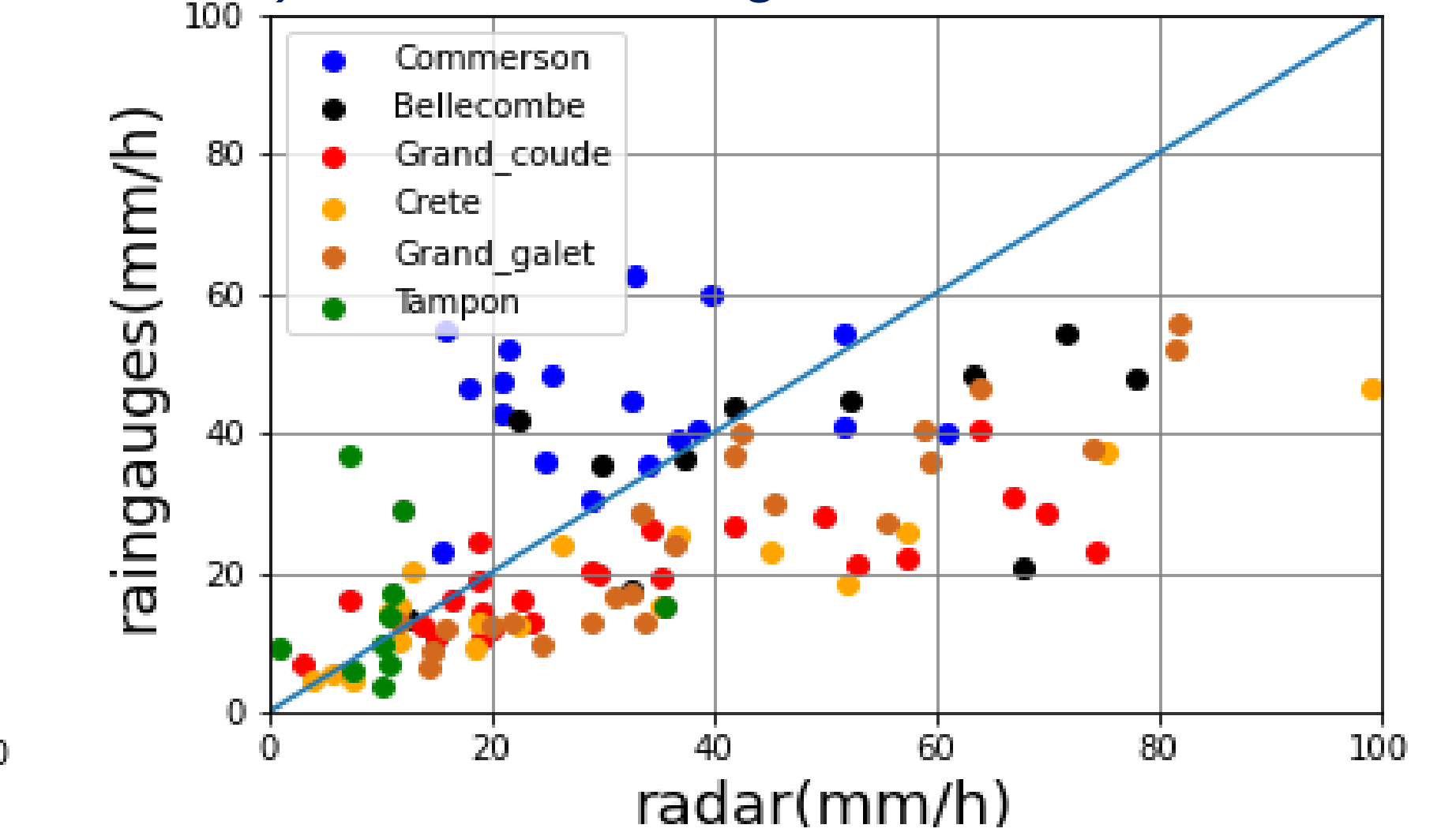
2) **Philinear algorithm: RR from Z-R relationship**



2 - 0) **Real PHIDP from Phidp observed**
 Z, PHIDP, unfolded PHIDP : 9° elevation, 03/02/2022 0001 UTC



3) **Without correcting attenuation: RR from KDP**



stations	Rainrate from reflectivity: $Z = 300R^{1.35}$		Rainrate from kdp: $R = 7KDP^{0.7992}$	
	Hitschfeld and Bordan, 1954	Philinear	Strat and conv	stratiform
crête	0,69	0,92	0,7	0,92
Grand-coude	0,150	0,879	0,6	0,96
Grand-galet	-0,089	0,425	0,73	0,26
Tampon	-0,395	-	0,93	0,75
Bellecombe	0,187	0,151	0,55	0,57
Commerson	-0,35	-0,004	0,07	0,211

Conclusion

- Hitschfeld and Bordan 1954 cannot correct attenuation correctly during the observation of cyclone Batsirai, only the station (Crete) close to the radar can show a good correlation.
- Correlations between radar and rain gauges are better after correcting for attenuation using the philinear algorithm, an algorithm based on the dual pol parameter, most of the stations have better correlation, except commerson.
- The result also get improved by using directly kdp to estimate precipitation especially during stratiform precipitation,
- The location of stations: Grand Galet, Bellecombe and especially Le Tampon and Commerson are far (vertically) from the radar beam and show less correlation. The rain does not have the same drop size distribution on the ground as at the altitude where the radar sampled it.

ACKNOWLEDGEMENTS

Acknowledgements : This work is part of the INTERREG V project ESPOIRS. The ESPOIRS scientific program is led by LACy (University of La Réunion /CNRS / Météo France) and funded by the European Union (ERDF program - GURDTI/20201589-0021087), the Région Réunion, the SGAR-Réunion, the French State (CPER) and the University of La Réunion.