Ministério da
Ciência, Tecnologia
e Inovação

GOVERNO FEDERAL
BRASIL
PAÍS RICO É PAÍS SEM POBREZA

ICE WATER PATH STUDY USING PASSIVE MICROWAVE SENSORS DURING THE CLOUD LIFE CYCLE

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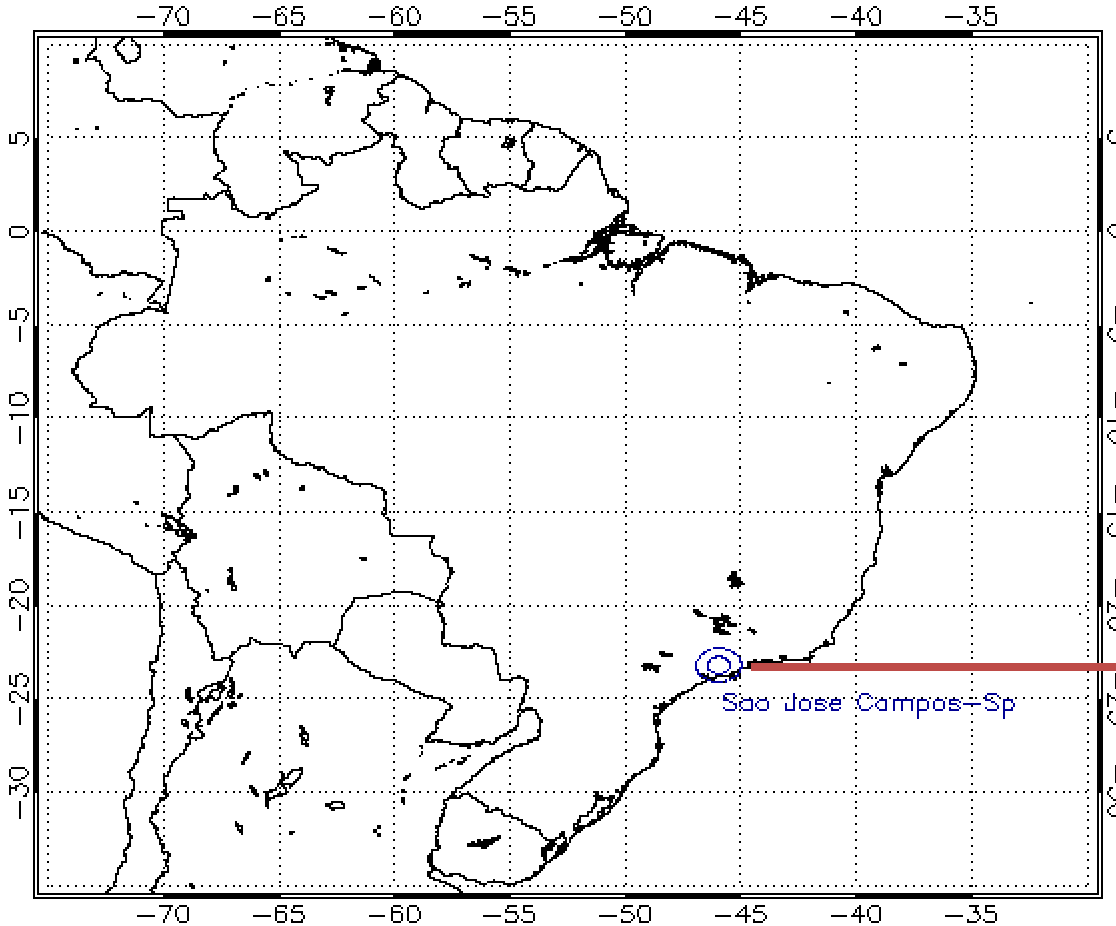
OBJECTIVES

- Study the relation between *IWP* and its rain rate (*RR*) over São José dos Campos (SJC) region, using information from AMSU-B and MHS sensors.

- The focus of this study is to compare *IWP*, in the cloud life cycle stages determined by FORTRACC;

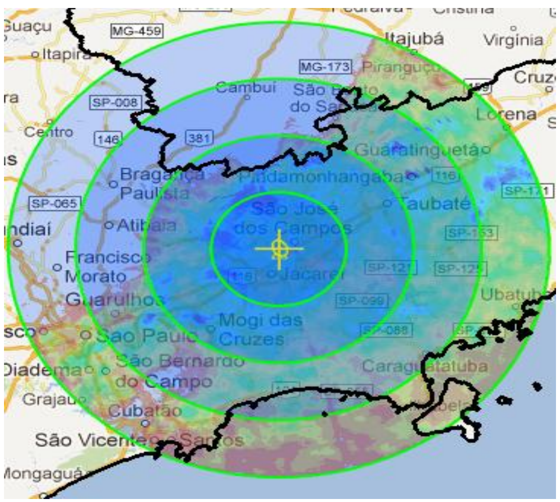
- The rain rates from satellites will be compared with radar data (*RRx*);

REGION OF STUDY



São José dos Campos-Sp

- ZCAS
- Cold Fronts
- Orographic Precipitation



DATA

-Satellite (MW)

SATELLITE	SENSOR	CHANEL	FREQUENCY (GHz)	TRACK	RESOLUTION (km)
NOAA-16	AMSU-B	1,2,3,4 e 5	89 , 150, 183+/-1, 183+/-3 e 183+/-7	CROSS-TRACK	16*
NOAA-17	AMSU-B	1,2,3,4 e 6	89 , 150, 183+/-1, 183+/-3 e 183+/-7	CROSS-TRACK	16*
NOAA-18	MHS	1,2,3,4 e 7	89 , 157, 183+/-1, 183+/-3 e 183+/-7	CROSS-TRACK	17*
NOAA-19	MHS	1,2,3,4 e 8	89 , 157, 183+/-1, 183+/-3 e 183+/-7	CROSS-TRACK	17*

-Satellite (IR)

SATELLITE	CHANEL	WAVELENGHT(μm)	GRID(km)
GOES-12	4	10.7	4X4

-Radar

RADAR	CAPPI(RAIN)	GRID(Km)	CAPPI (REFLETIVITY)	GRID(km)	PERIOD
SJC	2KM	0.2 X 0.2	2KM	1 X 1	NOV-MAR(2011-2012)

METHODOLOGY

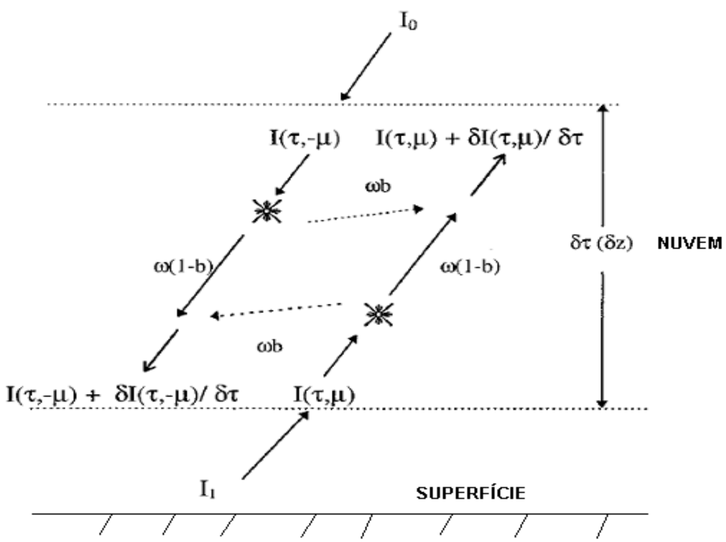
Methodology Steps:

- 1º) Screening of NOAA 16-19 passages over SJC's radar region (until 50km) with 2 min. máx. information delay, and assimilation of *IWP*, *De*, convective fraction, rain rate (radar and MSPPS) and cloud life cycle (FORTRACC);
- 2º) Variable analysis in function of cloud life cycle;
- 3º) MSPPS rain rate analysis over SJC.

METHODOLOGY

MSPPS *IWP* and *RR* estimation

- The *IWP* calculation is based on a two flux radiative transfer model, considering only scaterring effect of cold clouds at 89 GHz and 150GHz (157 GHz for MHS) from AMSU-B e MHS sensors (Ferraro et al., 2005).



$$I(0,\mu) = \frac{I_1 + 2Ba^2\Omega(\mu) + I_0\Omega(\mu)(1-a^2)}{1+\Omega(\mu)(1+a^2)}$$

$$I(\tau,-\mu) = \frac{I_0 + 2Ba^2\Omega(\mu) + I_1\Omega(\mu)(1-a^2)}{1+\Omega(\mu)(1+a^2)}$$

$$I(\tau,\text{-}\mu) = \frac{I_0}{1+\Omega(\mu)} \qquad \Omega(\mu) = \frac{T_B(z_b,\mu) - T_B(z_t,\mu)}{T_B(z_t,\mu)}$$

Two flux Radiative transfer scheme for a cloud layer

Font: Adapted from Weng and Grody (2000).

METHODOLOGY

- *RR* calculation: (FERRARO et al., 2005) e (WANG et al., 1997)

$$RR = 0.322 + 16.504 IWP - 3.342 IWP^2 \longrightarrow \quad CI=1 \text{ or } 2$$

$$RR = 0.089 + 20.819 IWP - 2.912 IWP^2 \longrightarrow \quad CI=3$$

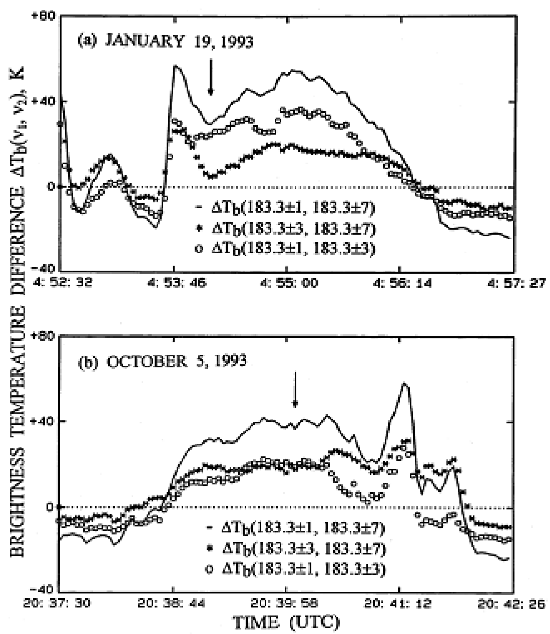
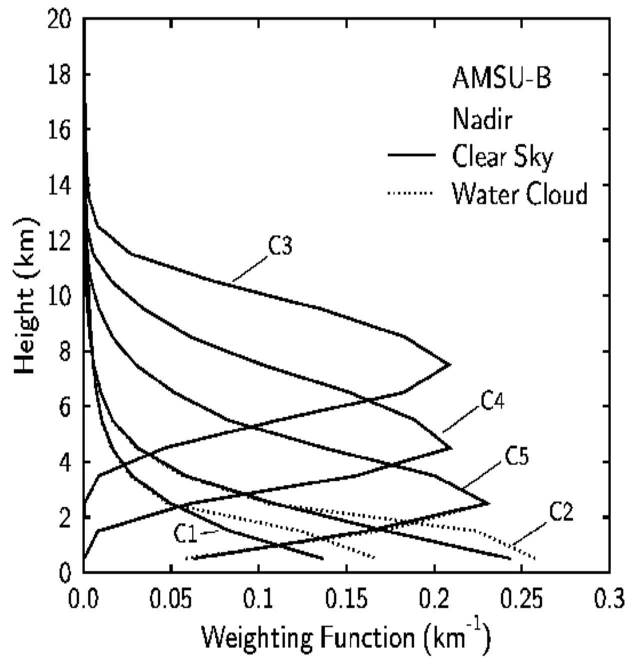


FIG. 18. The time variations of the brightness temperature differences observed from the MIR water vapor channels on (a) 19 January 1993 and (b) 5 October 1993.



METHODOLOGY

- *RRx* from X-band radar of CHUVA Project (Cloud Processes of the Main Precipitation Systems in Brazil: A Contribution to Cloud Resolving Modeling and to the Global Precipitation Measurement).

- *RRx calculation*:

$$Z = \begin{cases} Z < 35 \; e \; Kdp \leq 0.3 & Z = 200 RRx^{1.6} \\ Z \geq 35 \; e \; Kdp > 0.3 & RRx = 19.63 \, | K_{dp} |^{0.823} \end{cases}$$

(GEMATRONIK,2007)

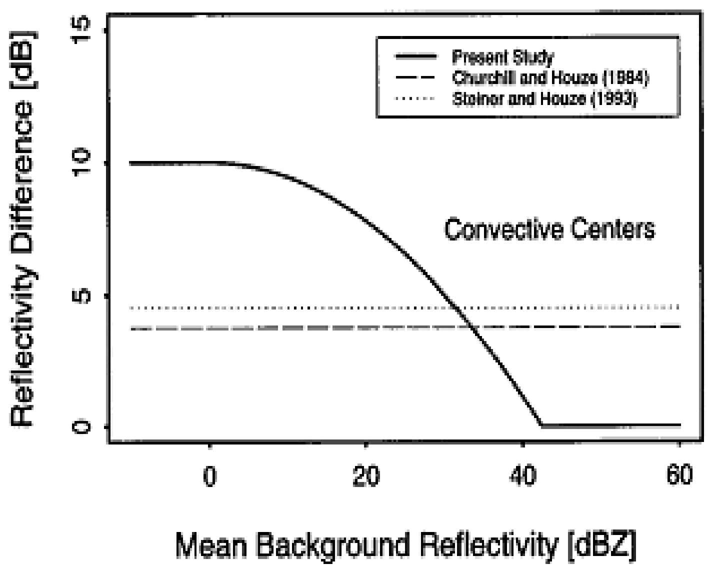
METHODOLOGY

- The radar cloud classification is performed by the use of the horizontal reflectivity in an specific level (2 Km): (STEINER et al., 1995)

1) If Z > 39dBz, convective;

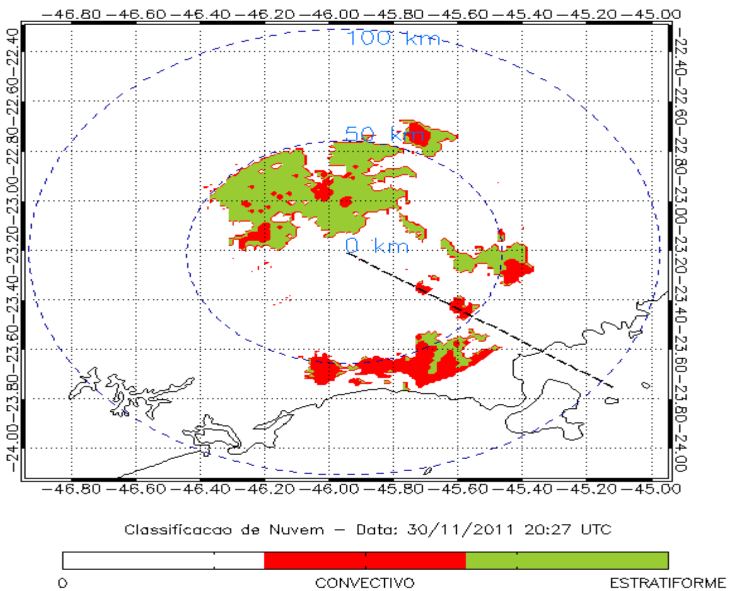
2) $$\Delta Z = \begin{cases} 10, & Z_{bg} < 0 \\ 10 - Z_{bg}/180, & 0 \le Z_{bg} < 42.43 \\ 0, & Z_{bg} > 42.43 \end{cases}$$

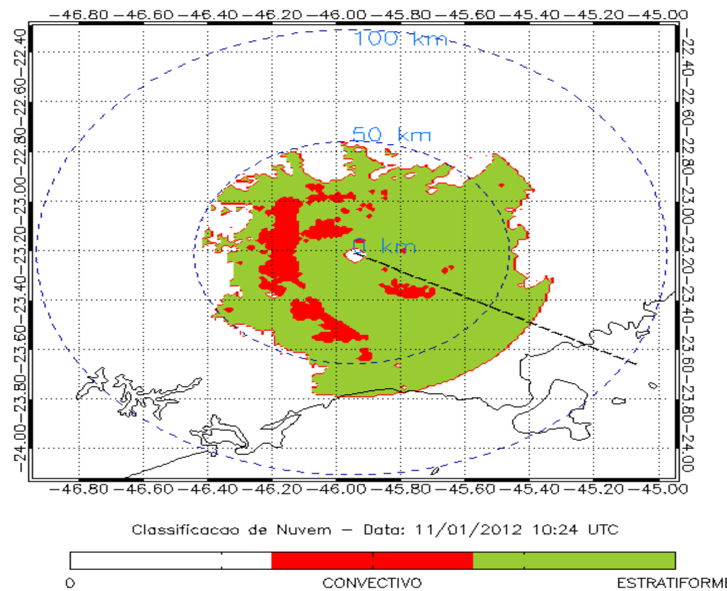
3) Z > 5, stratiform.

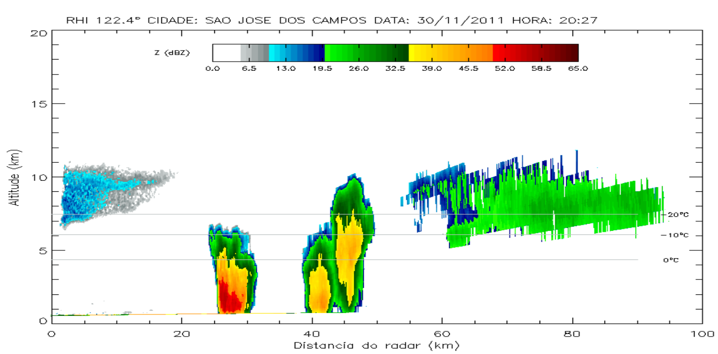


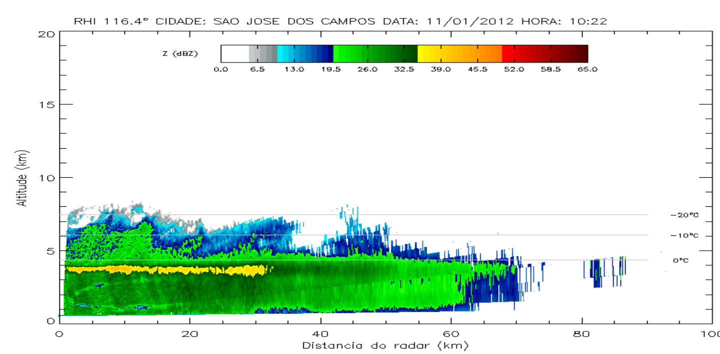
METHODOLOGY

- Case of Study for cloud classification









METHODOLOGY

- FORTRACC (Vila et al., 2008)

Cloud Life cycle considerations:

a) Intensifying: A↑ e T_{Bmin}↓;

b) Dissipating: T_{bmin} >0 ou ΔA<=0;

c) Not identyfied: The FORTRACC didn't identified the rain event.

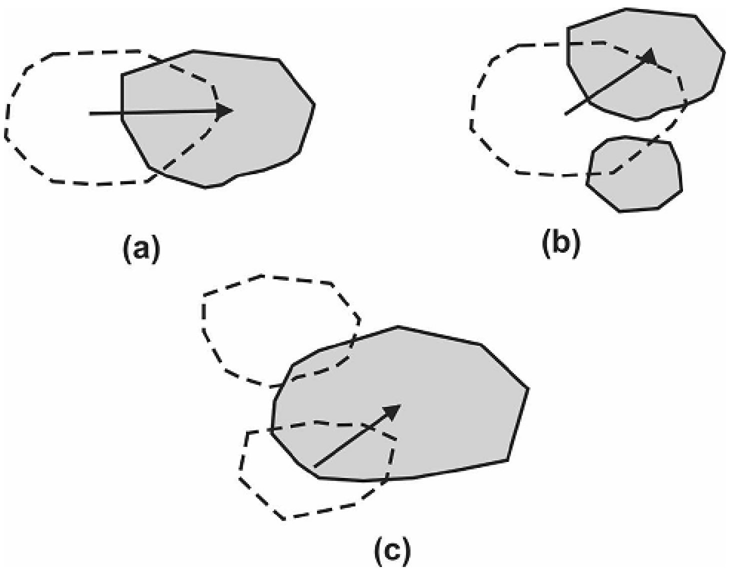
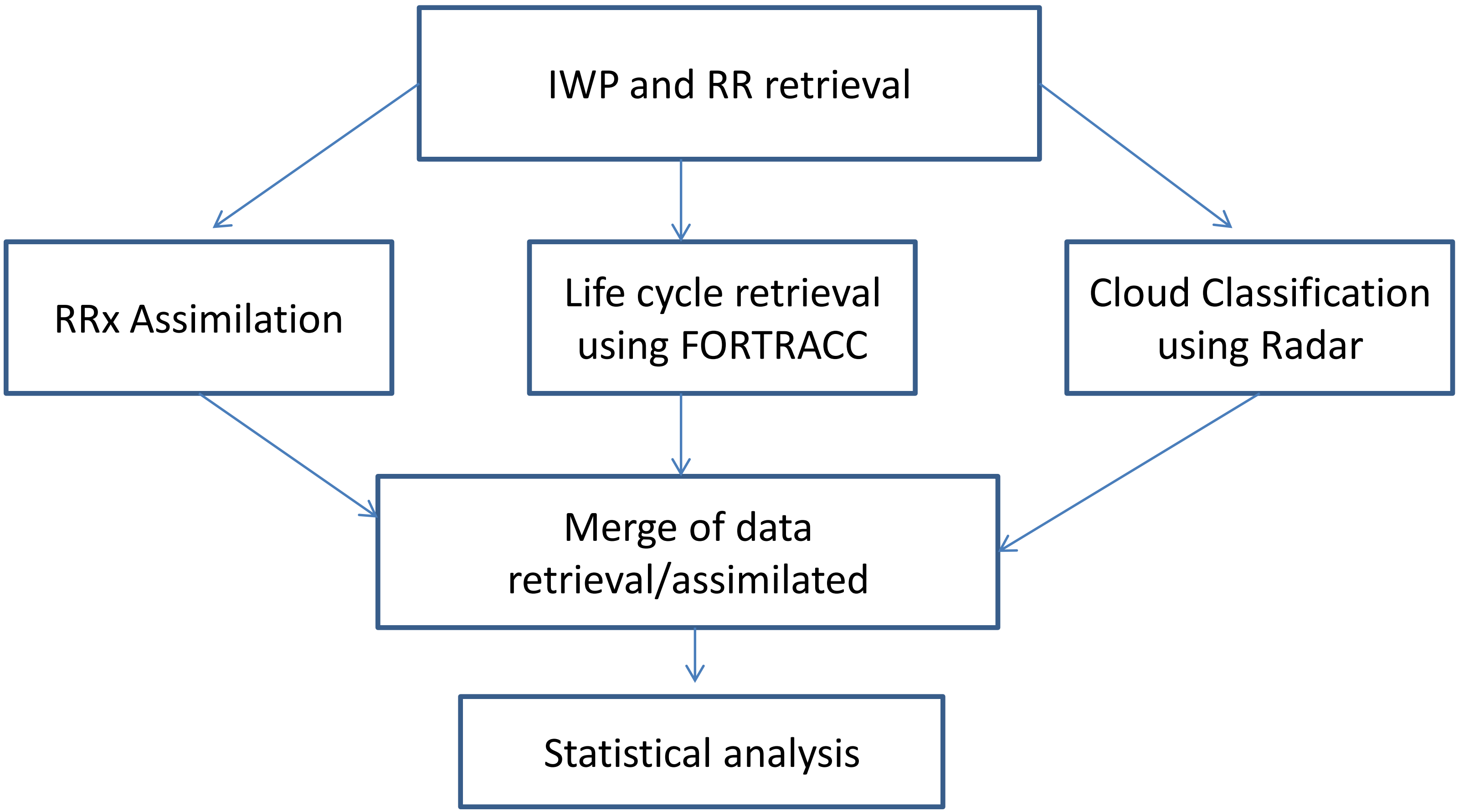


FIG. 2. Schematic representation of the tracking situations. White dotted figures represent MCSs in the first time step while gray figures represent the second time step. Arrows represent MCS evolution. Gray lines represent the previous time step evolution, and solid lines represent the actual evolution for (a) continuity, (b) splitting, and (c) mergers.

METHODOLOGY

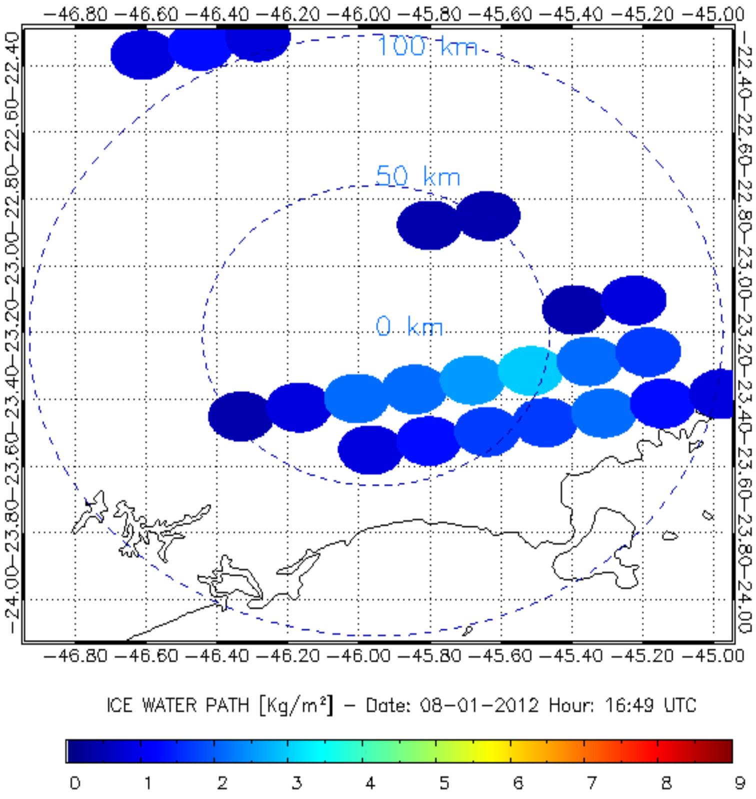
- Flowchart



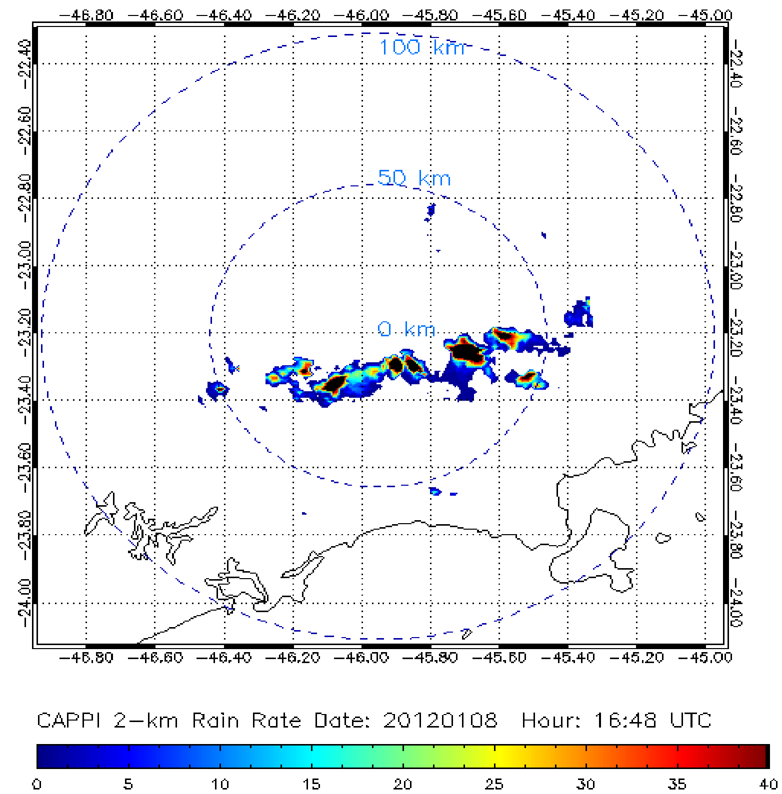
METHODOLOGY

- Case study Date: 08/01/2012 at 16:45UTC

IWP



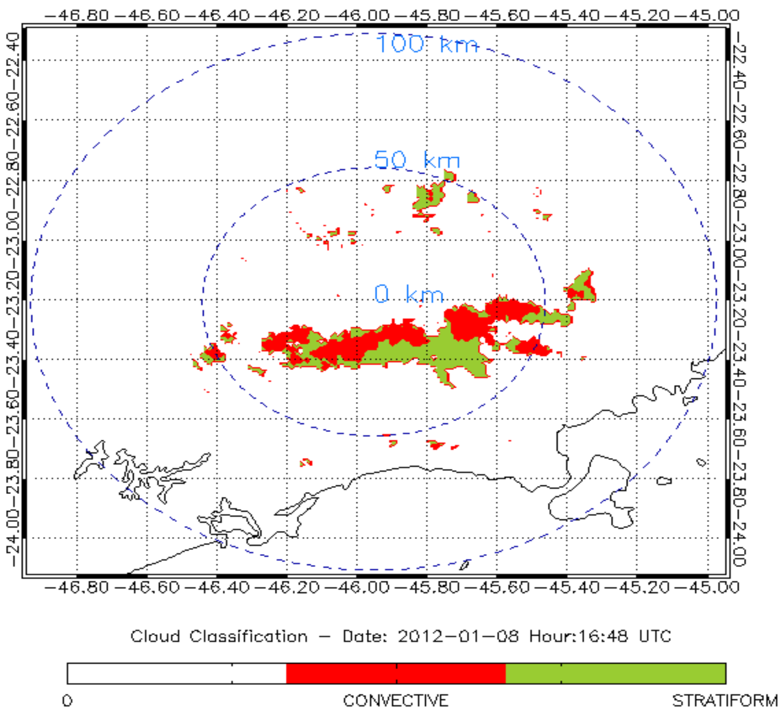
RRx



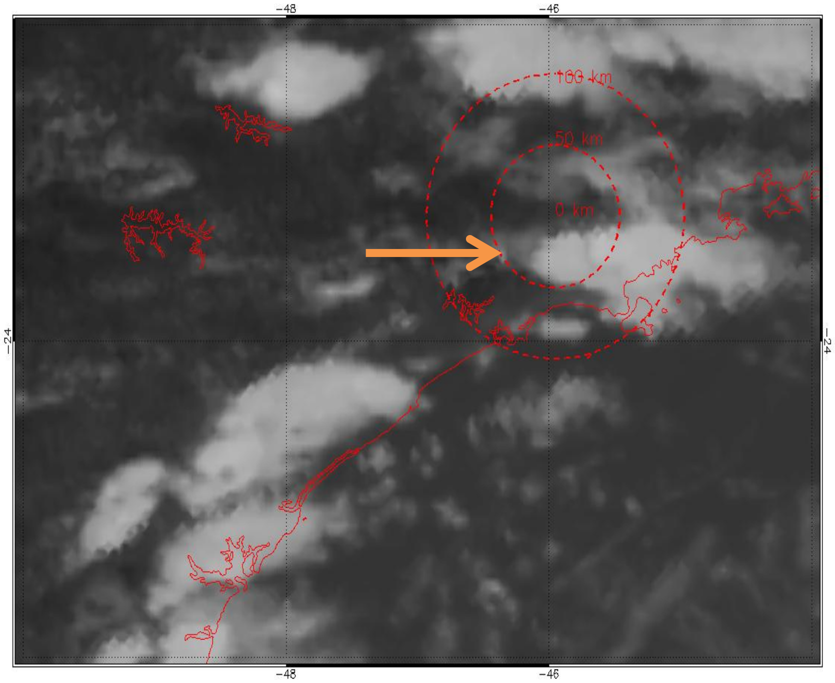
METHODOLOGY

- Case study Date: 08/01/2012 at 16:45UTC

Radar Cloud Classification



GOES-12 Image

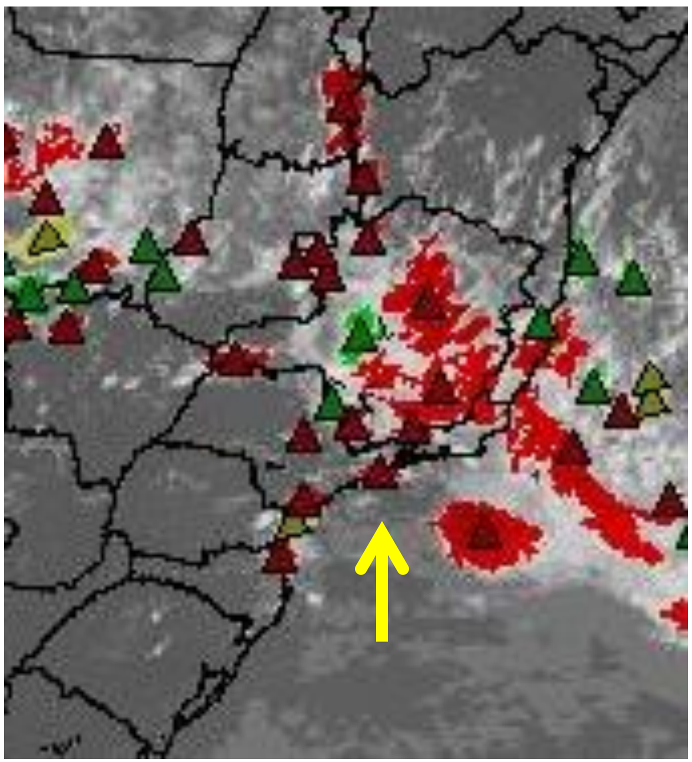


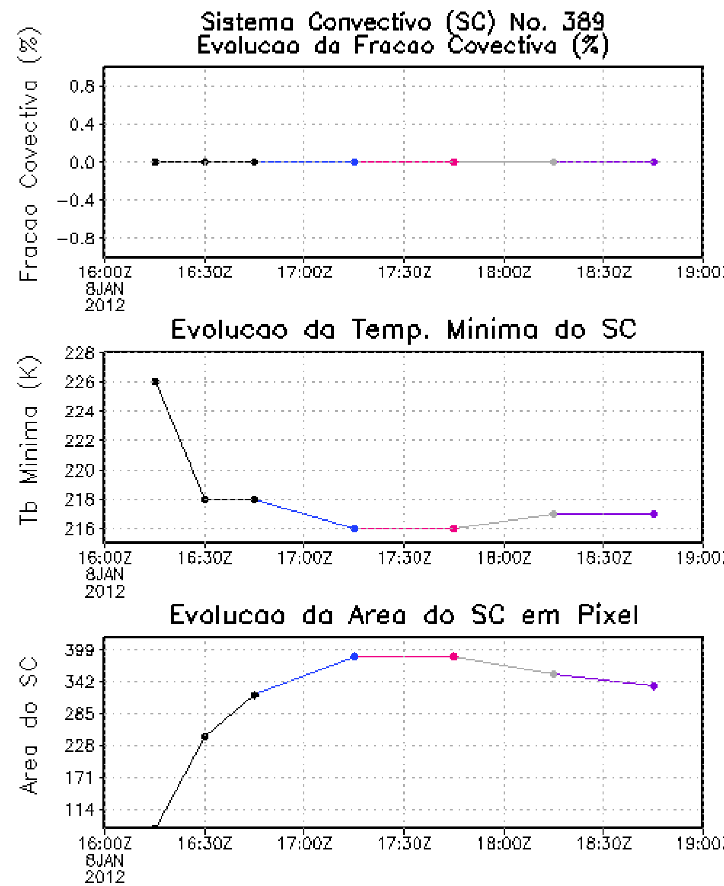
GOES−12 Image (10.7um)− Date: 08/01/2012 Hour: 16:45 UTC

METHODOLOGY

- Case study Date: 08/01/2012 at 16:45UTC

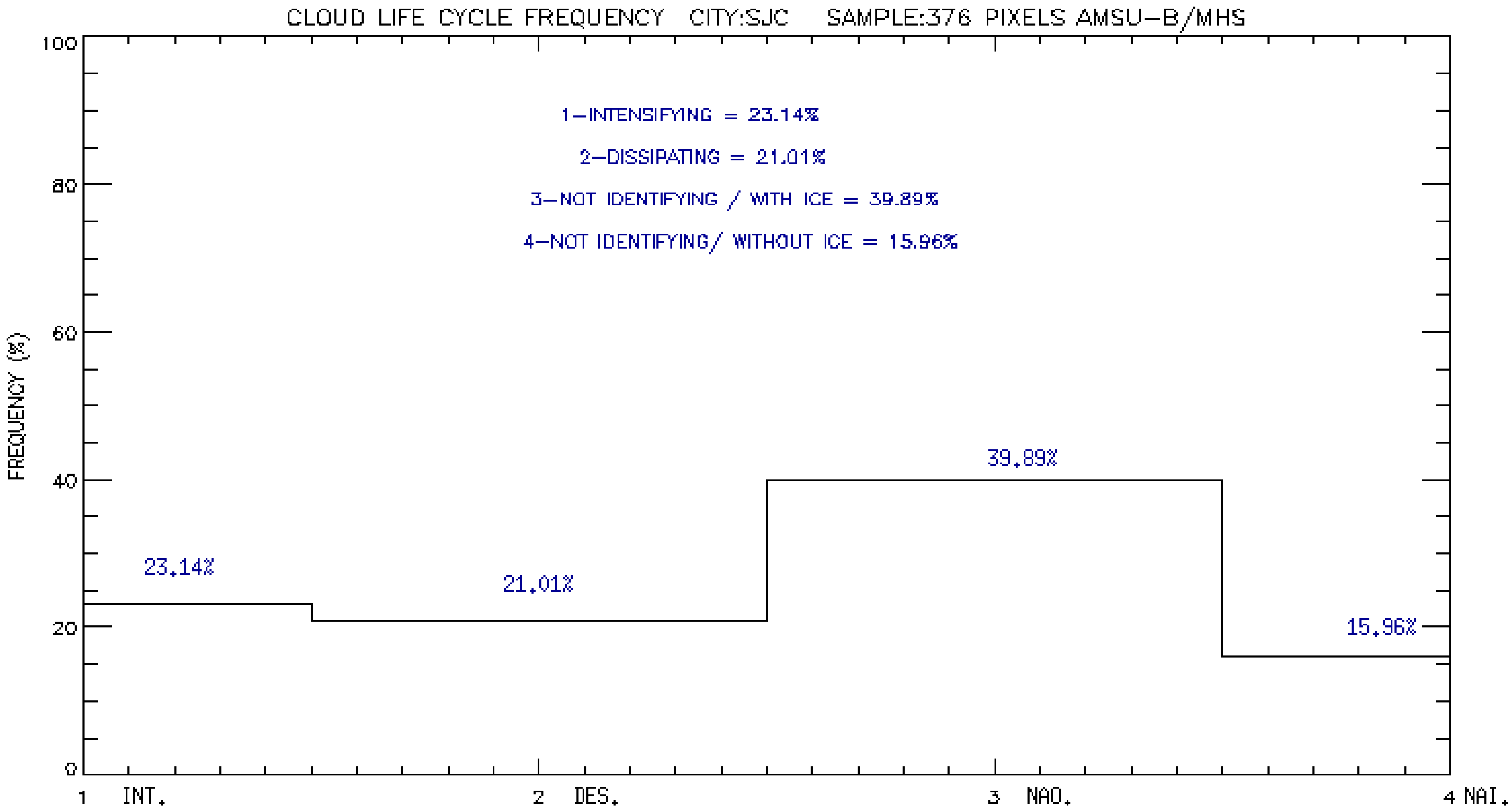
FORTRACC Identification





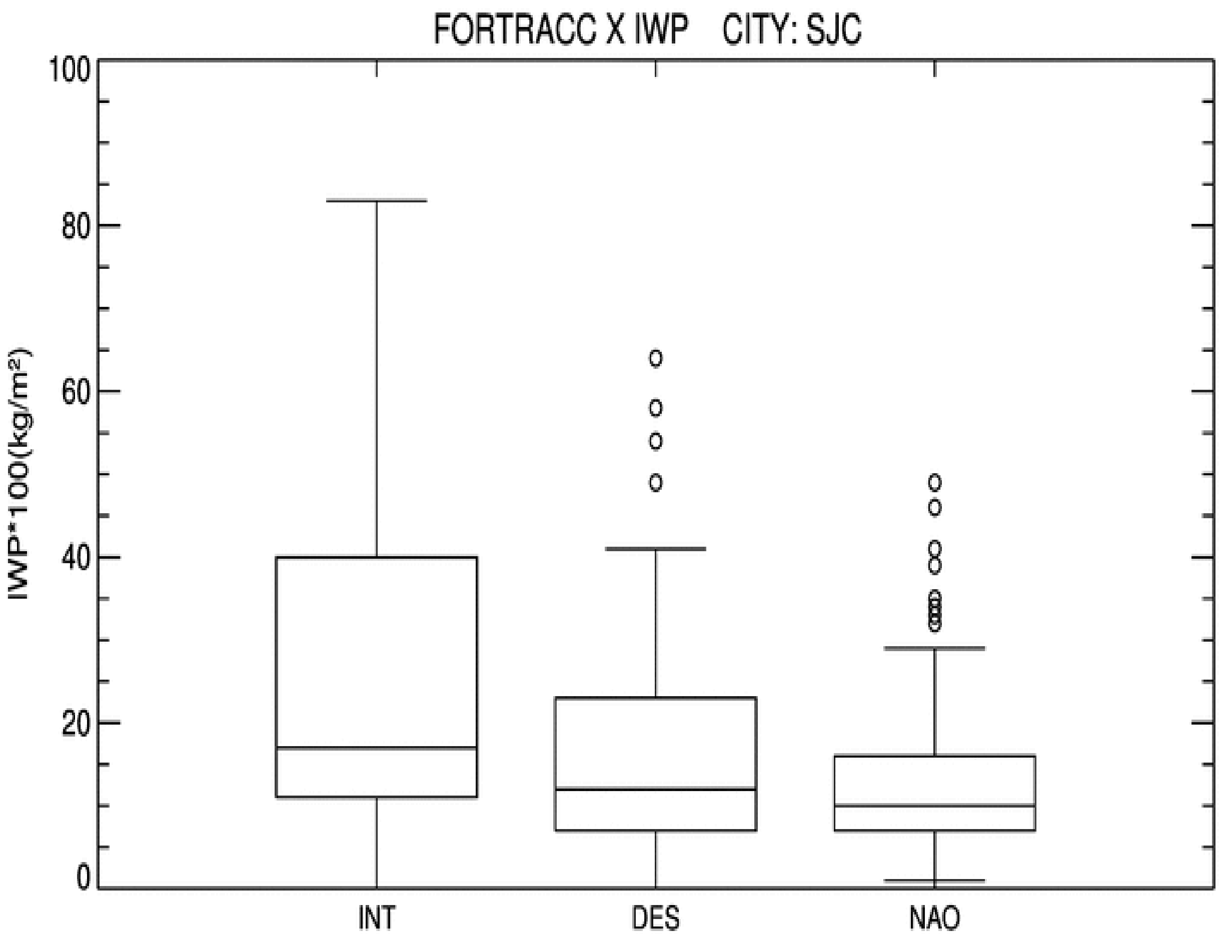
RESULTS OF *IWP* AT CLOUD LIFE CYCLE

- Cloud life cycle frequency histogram (NOAA passages: 413; rain events: 87)



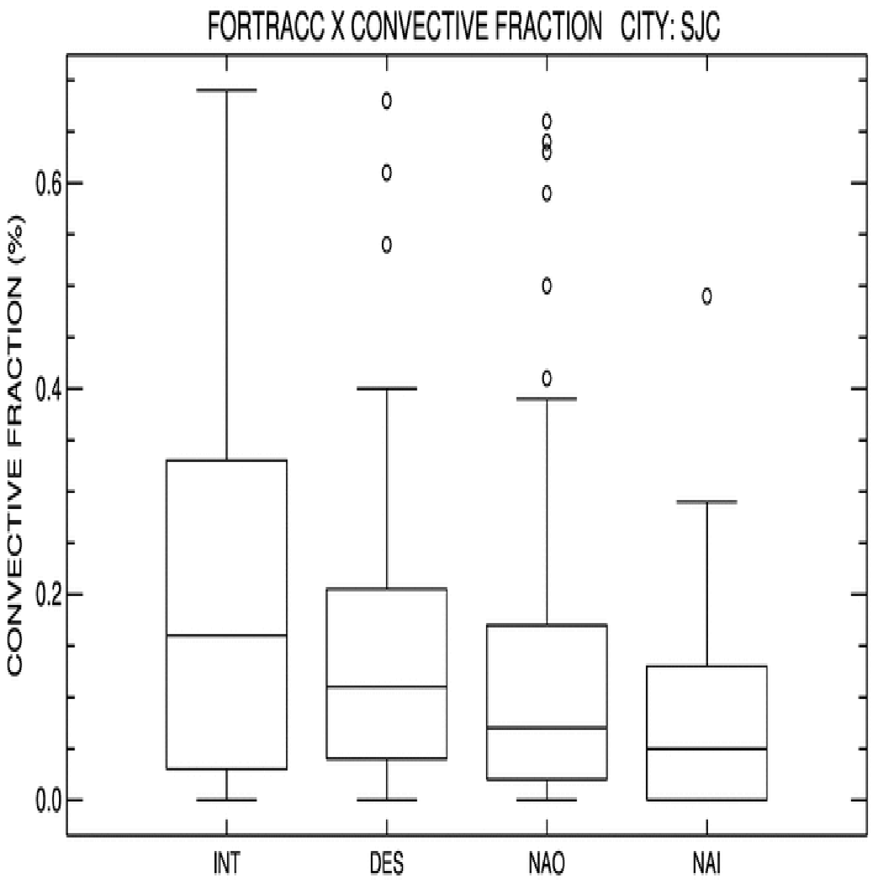
RESULTS OF *IWP* AT CLOUD LIFE CYCLE

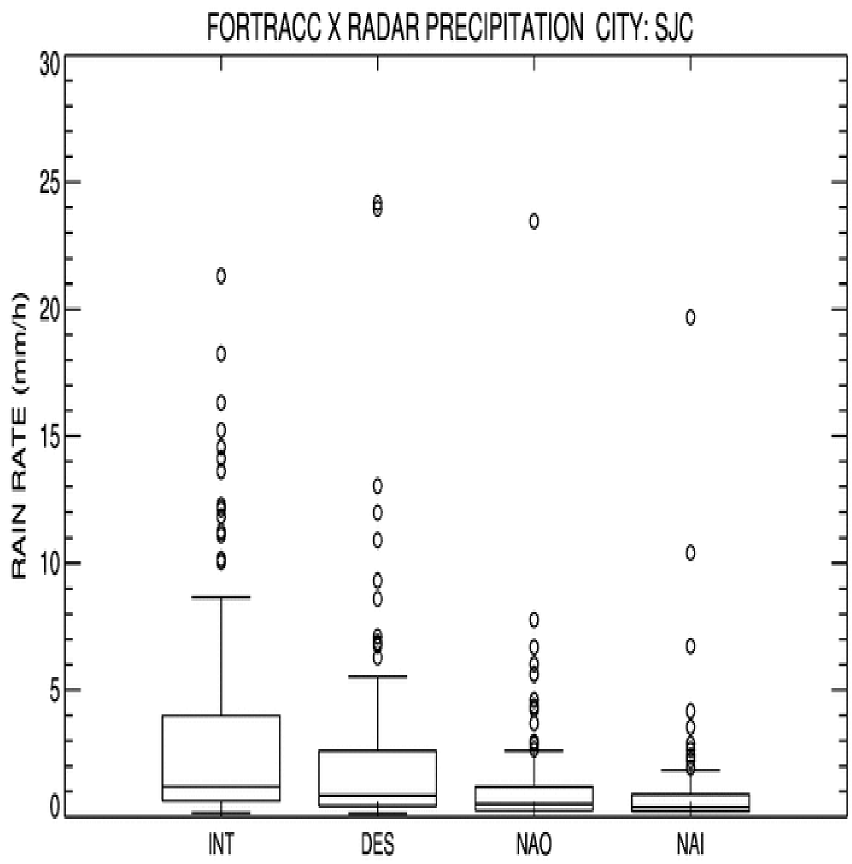
- IWP Analysis



RESULTS OF *IWP* AT CLOUD LIFE CYCLE

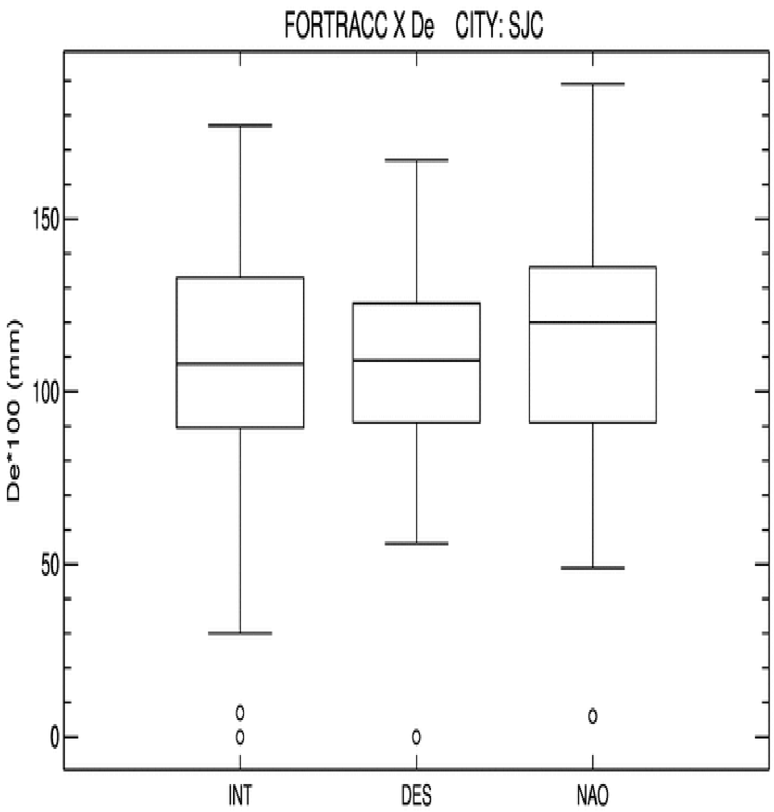
- Convective fraction and rain rate analysis

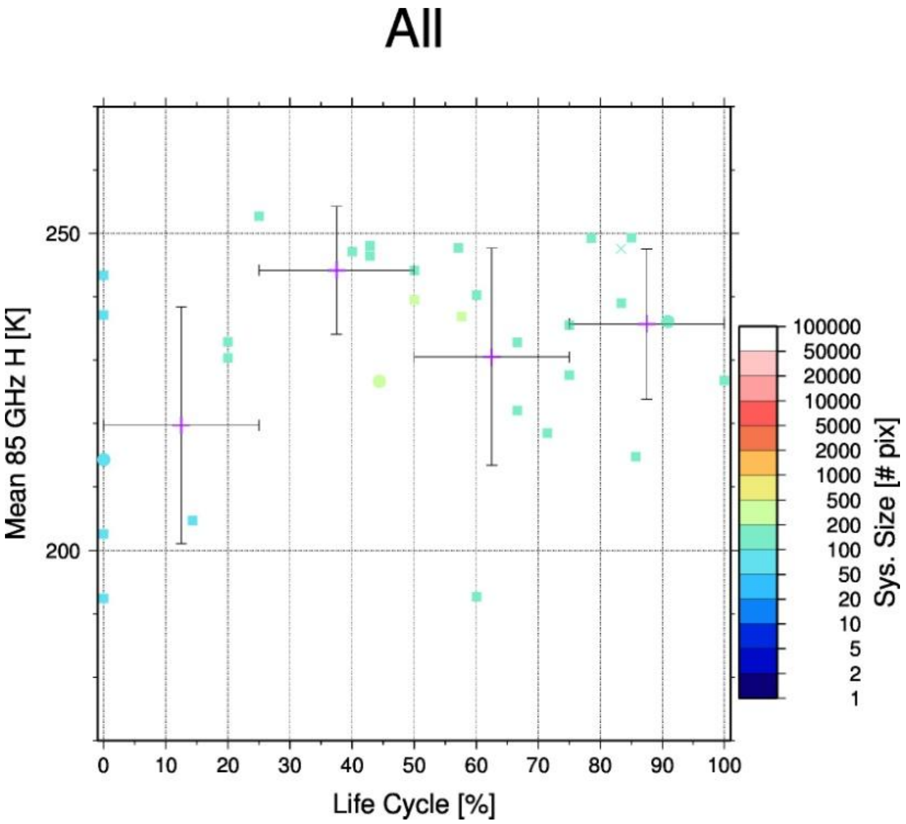




RESULTS OF *IWP* AT CLOUD LIFE CYCLE

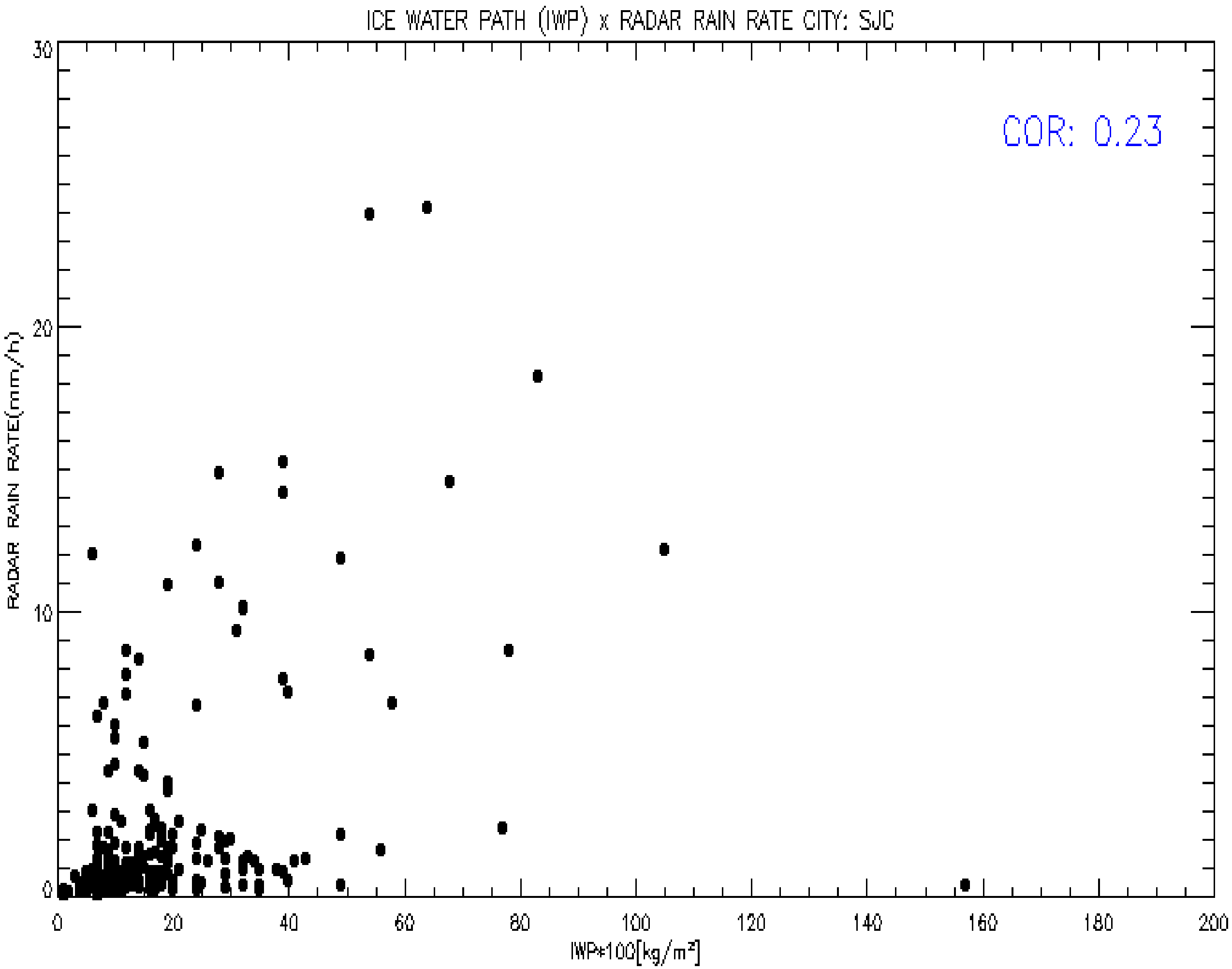
- *De* Analysis





Thanks N. Viltard

RESULTS OF *RAIN RATE* APPLICATION

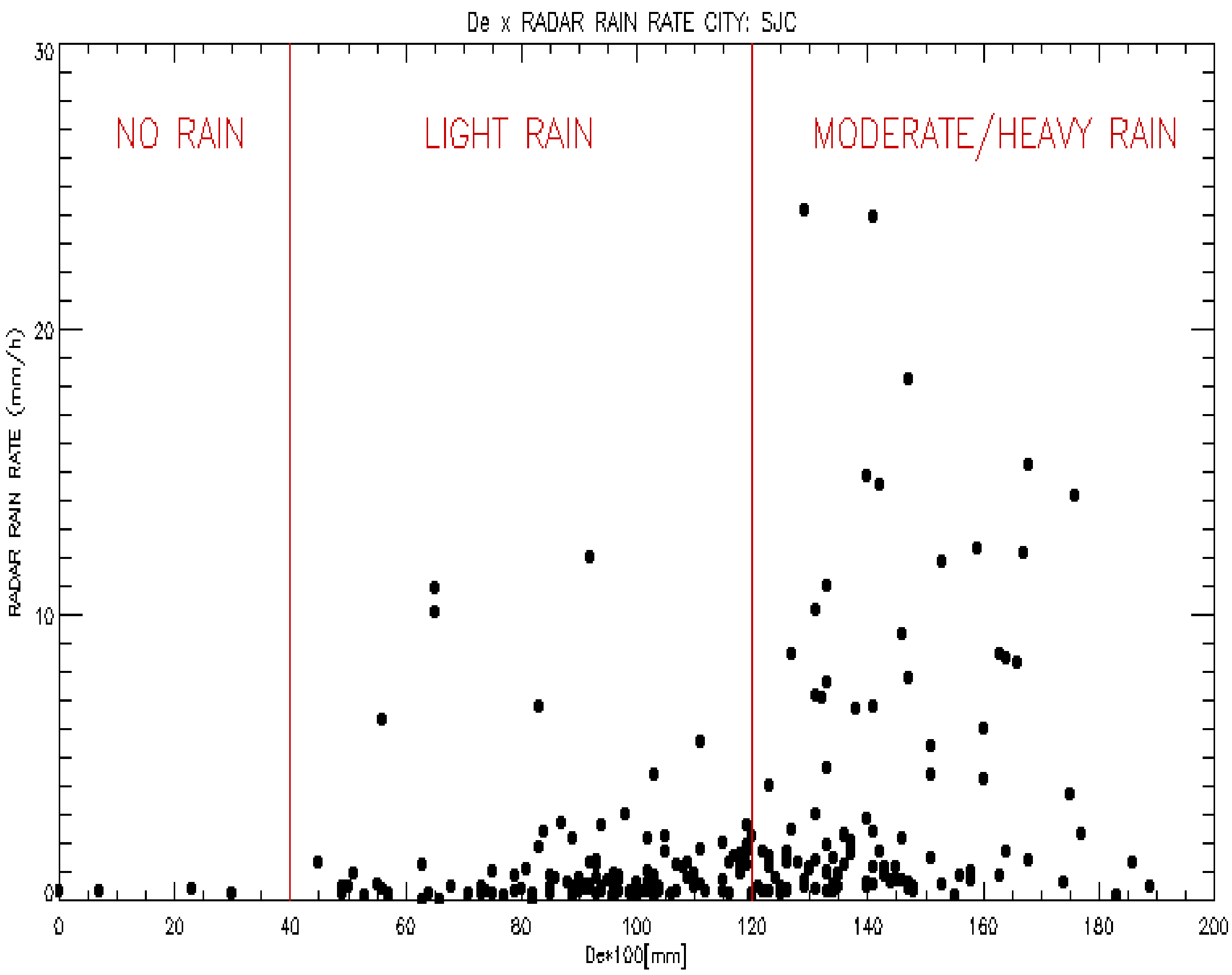


We know that:

•For *De* larger than 1mm, the lightning probability in clouds is higher than in small sizes and, consequently, more convection is observed (Mattos and Machado, 2011; Wang et al., 2012);

•The *IWP*, *RRx* and cloud fraction convection distributions during the life cycle are larger in intensification processes.

RESULTS OF *RAIN RATE* APPLICATION



Analysis proposal:

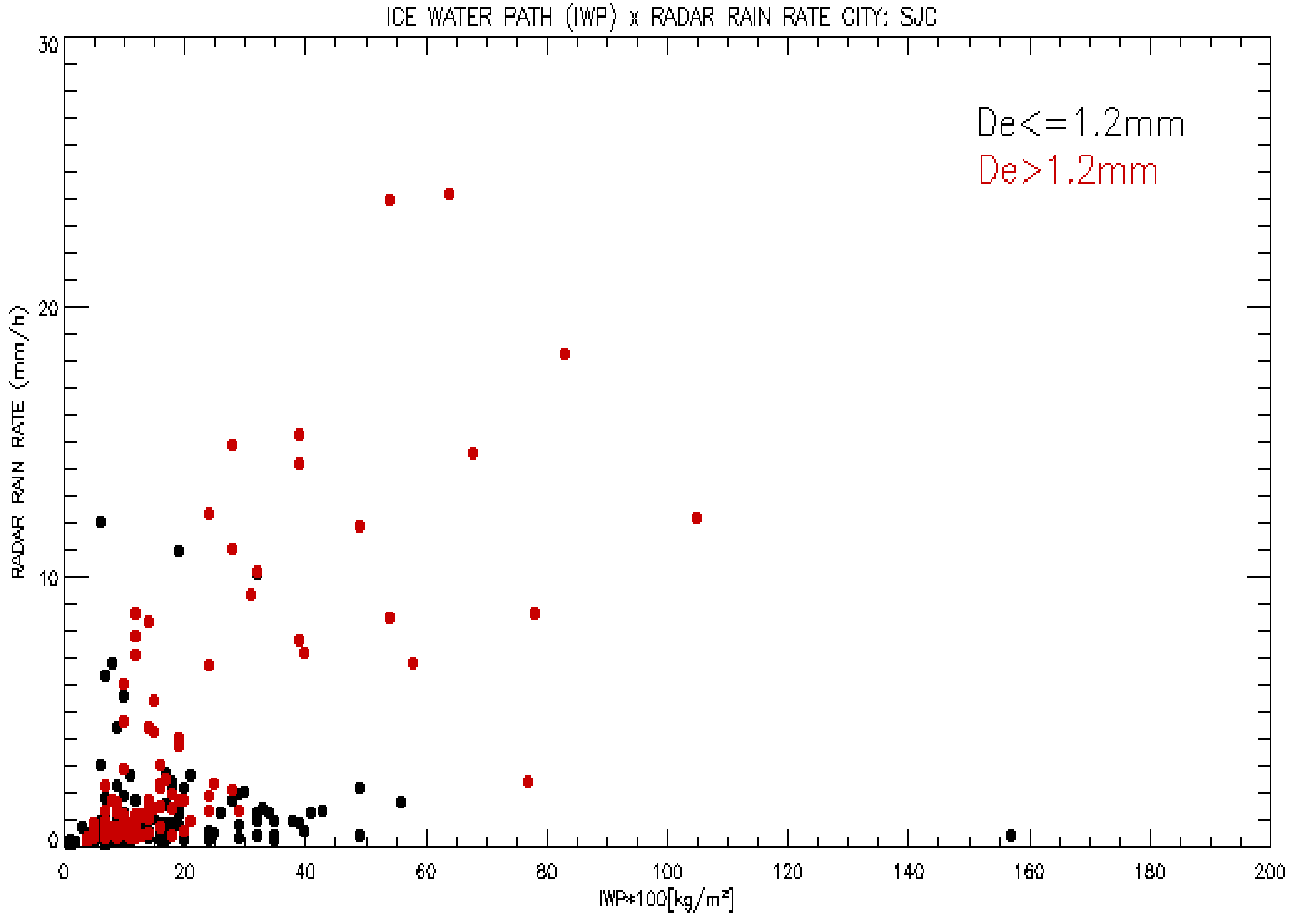
Based on these observations, empirical functions were performed with data analysis (70%) and further validated with tested sample (30%). The functions developed for the new rain rate estimation over SJC are:

If *De* <= 0.4mm:
RR = 0 mm/hr

If 0.4mm < *De* < 1.2mm;
RR = 1.38**IWP* + 0.9953

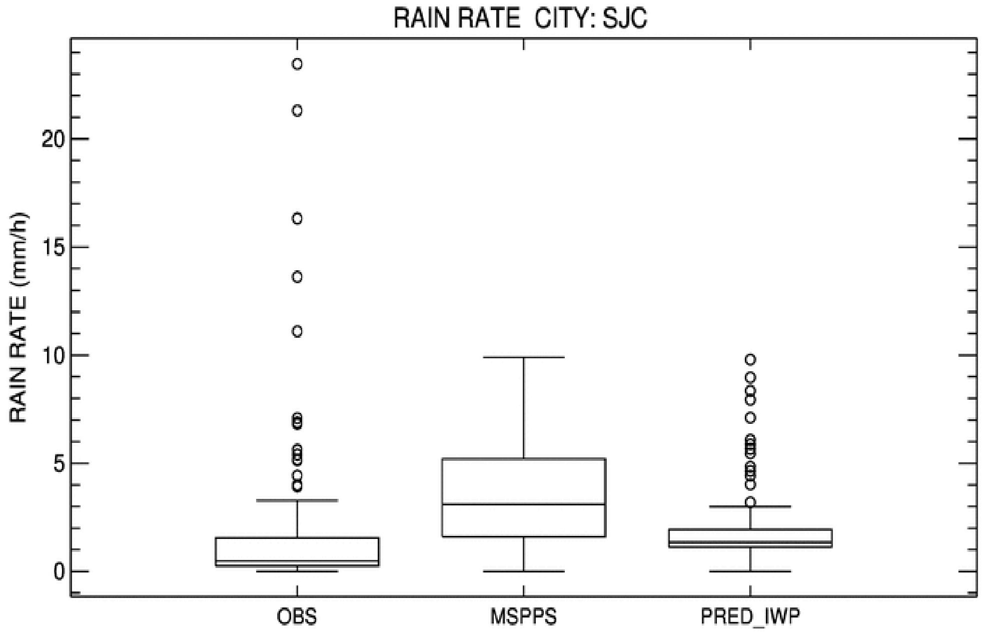
If *De* >= 1.2mm; *RR* = 20.64 * *IWP* – 0.5237

RESULTS OF *RAIN RATE* APPLICATION



RESULTS OF *RAIN RATE* APPLICATION

- VALIDATION



MODELS	Acumulated Rain
OBS	219,63mm
MSPPS	437,8mm
PRED_IWP	253,55mm

MODEL	COR	BIAS	POD	FAR	RMS
MSPPS	0,28	1,82	0,94	0,69	4,22
PRED_IWP	0,53	0,28	0,97	0,68	3,13

THANK YOU