The Cloud and Rain Liquid Water Characteristics of Different Precipitation Regimes in Brazil

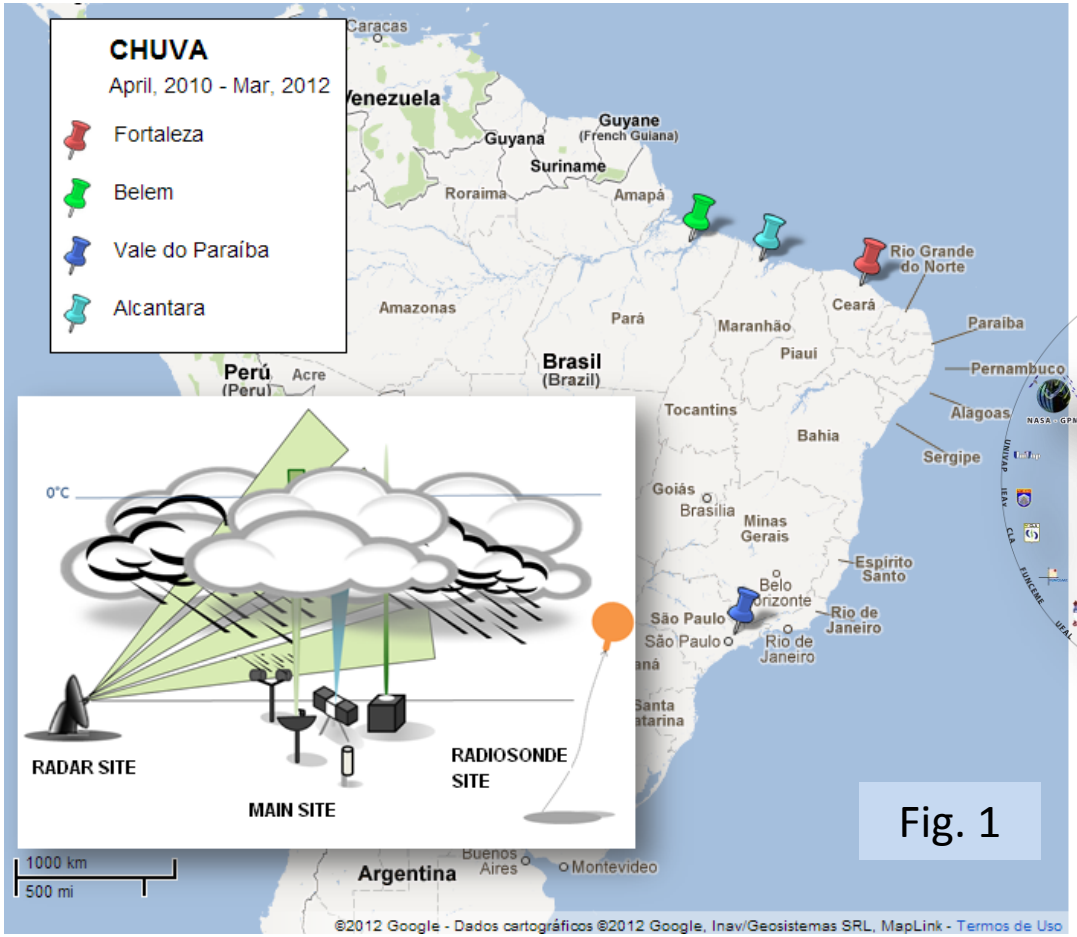

Fig. 1

GOALS:

To determine the water content of precipitating and non-precipitating clouds

To characterize the quantities on regionally and by cloud type

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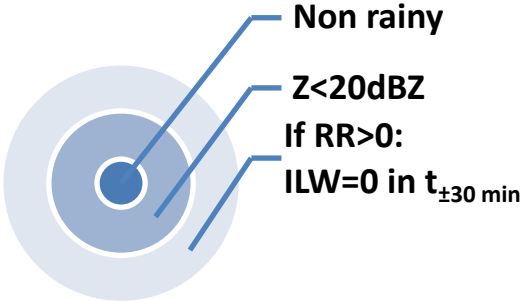
Cloud

- ILW_C and ILW_{adi} Regional
- ILW_C *vs* thickness



ILW_C
- **Ground based radiometer**
- **Neural network** (Solheim et al. 1998)

ILW_{Adi}
- **Radiosonde**
- **Ingold et al. (1998)**

Rain

- ILW_R Regional
- ILW_R by Rainy Systems
- LWC_R profiles and DSD

RR > 0.1mm/h = Rainy event

LWC_R/ILW_R
- **Greene and Clark (1972)**

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Cloud Liquid Water

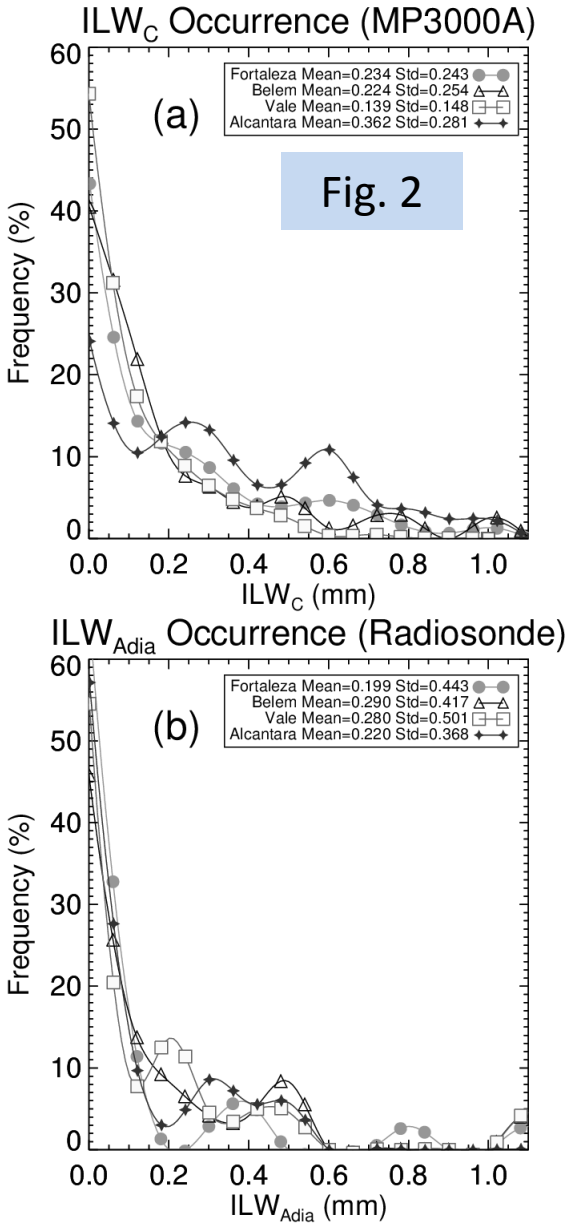


Fig. 2

Tab. 1

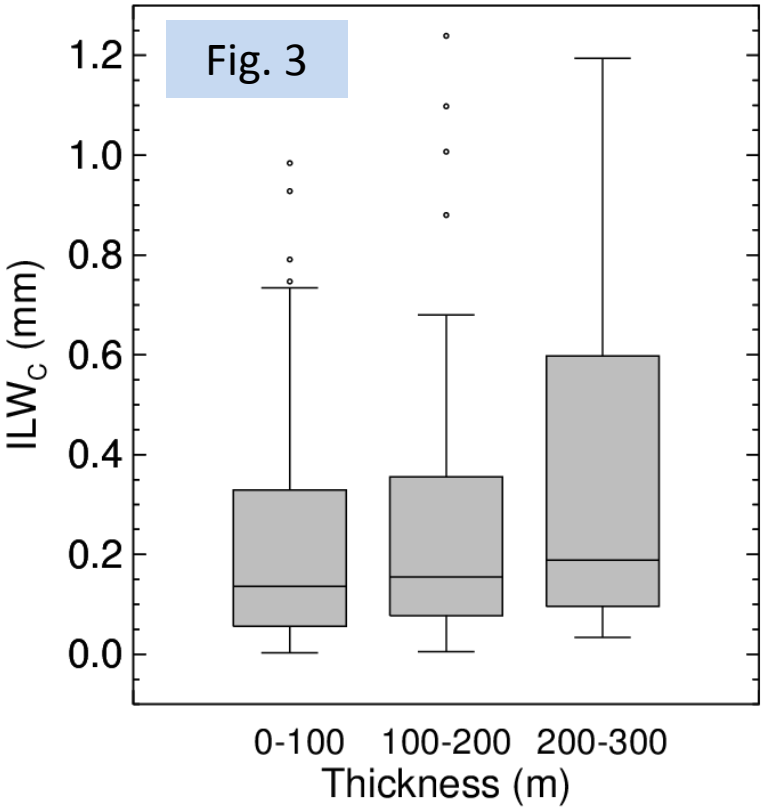
Site	Stat	ILW$_C$	ILW$_{adia}$
		Non rainy	
Fortaleza/CE	Mean	0.23	0.19
	Std	0.24	0.44
Belem/PA	Mean	0.22	0.29
	Std	0.25	0.41
Alcântara/MA	Mean	0.36	0.22
	Std	0.28	0.36
Vale do Paraíba/SP	Mean	0.14	0.28
	Std	0.15	0.50

- **ILW$_C$↑/ILW$_{Adi}$↓: Alcantara and Fortaleza**
- **ILW$_C$↓/ILW$_{Adi}$↑: Vale and Belem**

coastal sites contain more liquid water than the clouds of continental sites

- ***Important coalescence processes instead of entrainment on the coast***

Cloud Liquid Water vs Cloud Thickness



The median ILWC increases with cloud thickness

Greater variability in the values obtained for thicker clouds

Thanks **Riad Bourayou** for the LIDAR cloud retrieval

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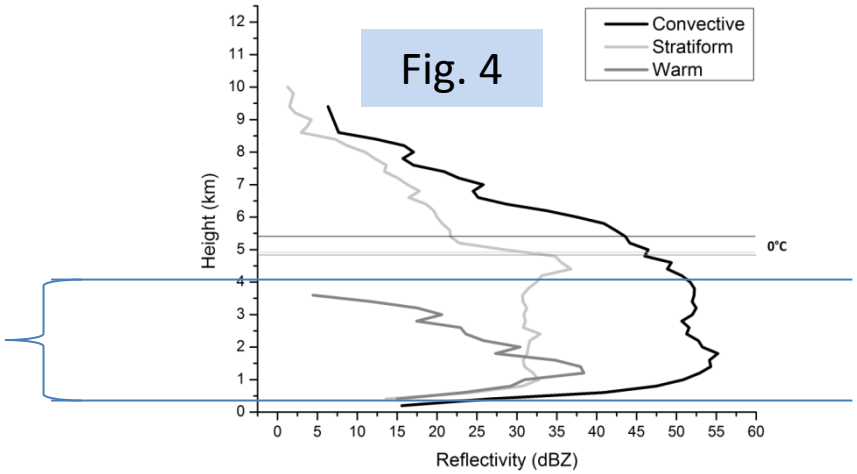
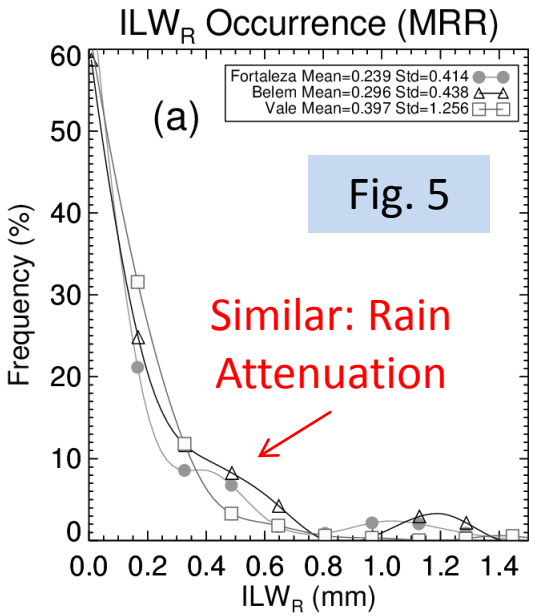
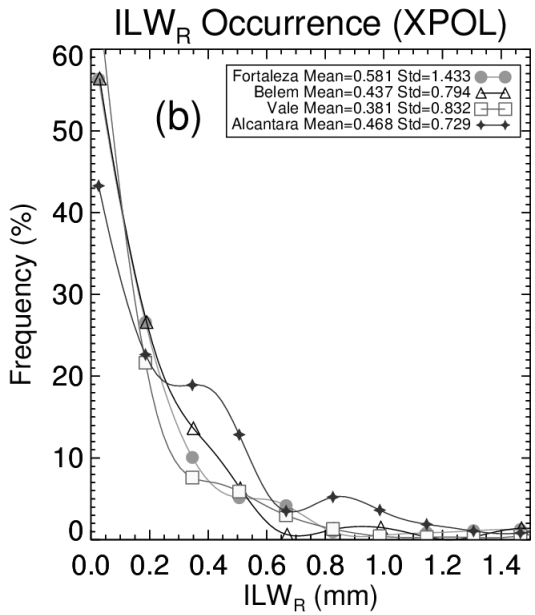
Integrated Rain Liquid Water

$$\int_{base}^{H_{0C}-1km}$$





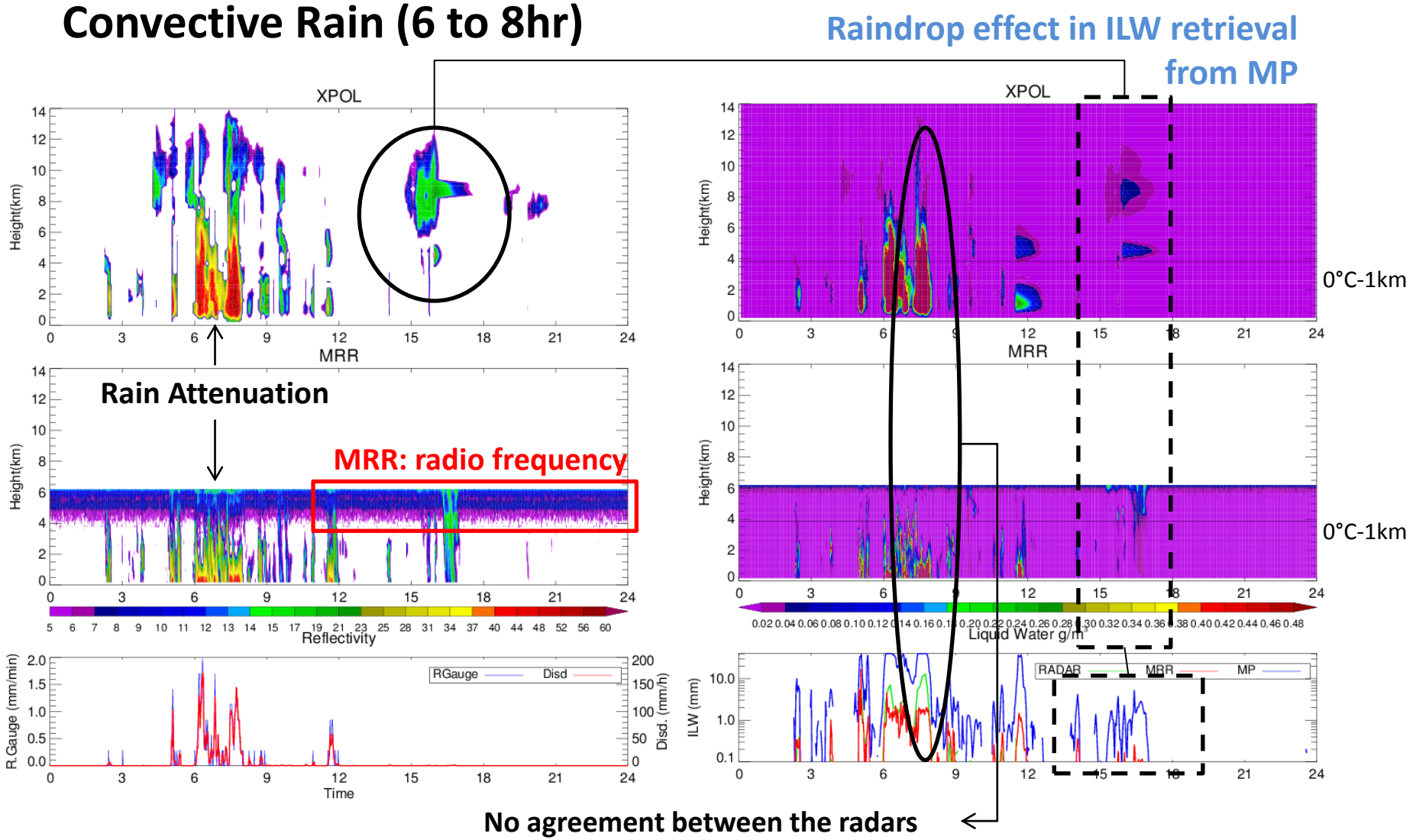


Integrated Liquid Water (mm)

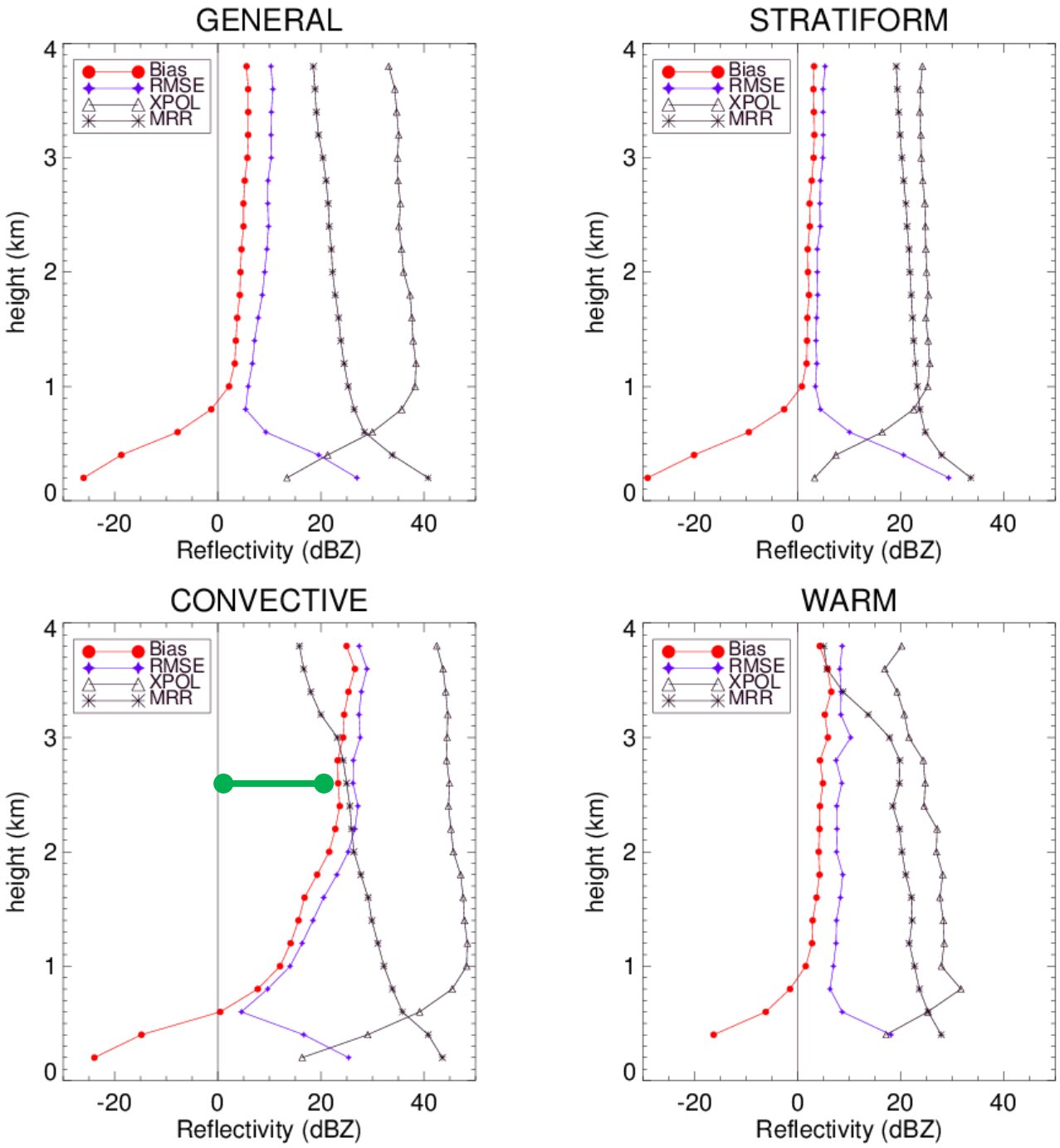
Tab. 2

Site	Stat	Rainy			
		MRR	XPOL		
		ILW$_R$ (H_{LCL}–$H_{0°C-1km}$)	**VIL**		
		General		Mixed	Glaciated
Fortaleza/CE	Mean	**0.24**	**0.58**	**0.09**	**0.02**
	Std	0.41	1.43	0.17	0.03
Belem/PA	Mean	**0.29**	**0.44**	**0.12**	**0.09**
	Std	0.44	0.80	0.29	0.17
Alcântara/MA	Mean	-	**0.47**	**0.06**	**0.01**
	Std	-	0.73	0.08	0.03
Vale do Paraíba/SP	Mean	**0.39**	**0.38**	**0.14**	**0.02**
	Std	1.26	0.83	0.54	0.06

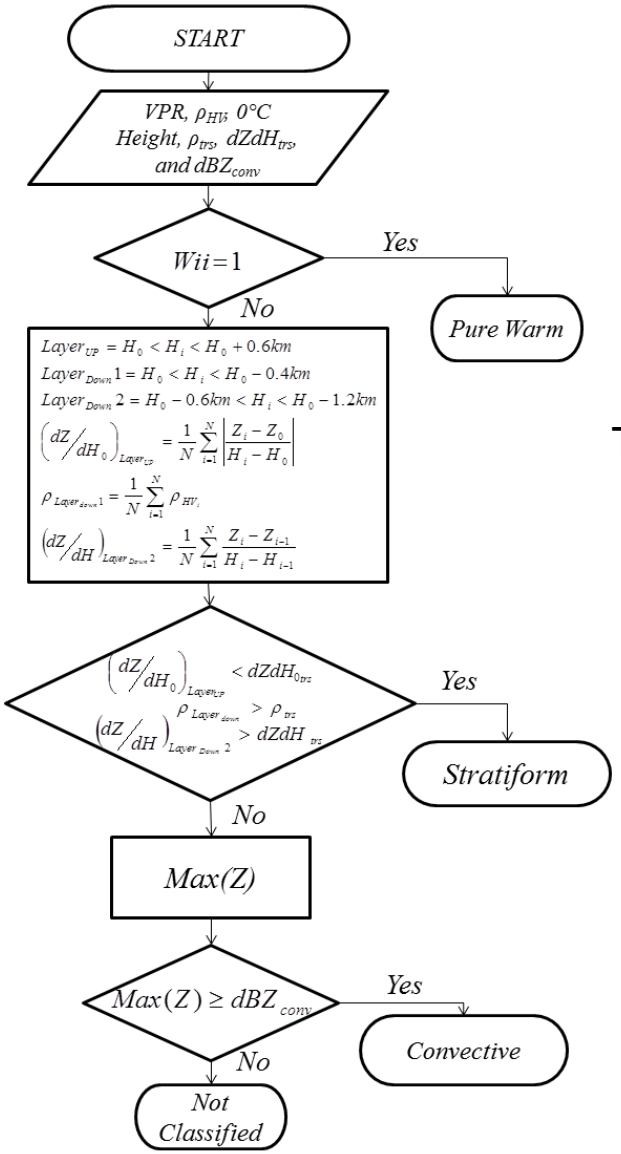
XPOL versus MRR and MP raindrop effect



XPOL versus MRR



Rain Liquid Water by rainy system: Classification

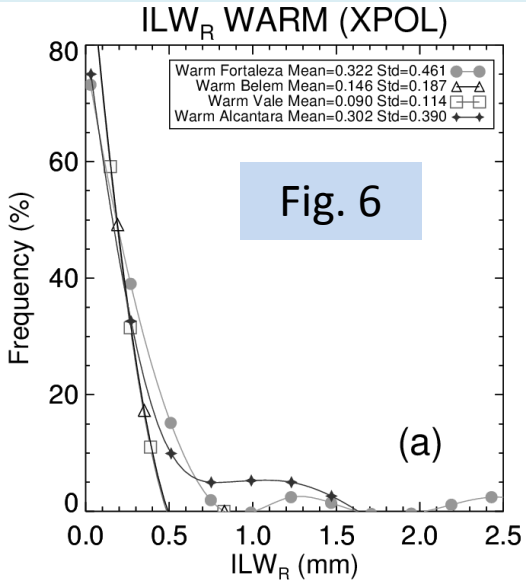


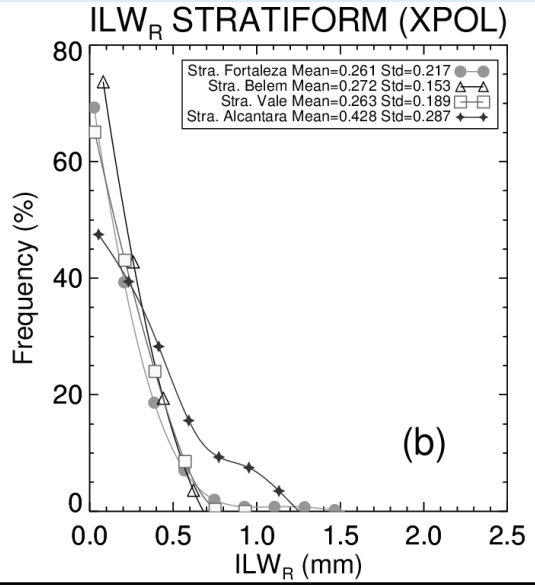
Tab. 3

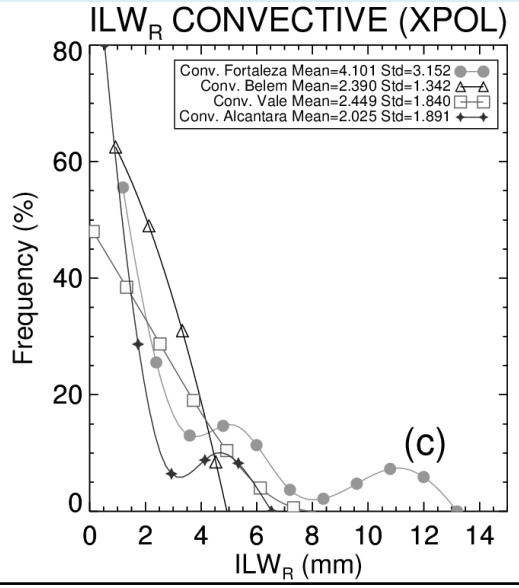
Site	Fortaleza		Belem		Vale		Alcantara	
Type	%	RR_{Mean}	%	RR_{Mean}	%	RR_{Mean}	%	RR_{Mean}
Stratiform (with BB)	36	1.8	19	1.8	27	2.4	26	**3.7**
Convective	8	46.2	8	**61.6**	6	**62.5**	6	27.5
Warm Pure	12	3.6	25	4.9	14	1.94	19	**7.2**

High efficiency to Belem and Vale associated to the upper level

Rain Liquid Water by rainy system







- **Warm ~ Stratiform (Except Vale)**
- **The warm clouds had a greater variability (life cycle)**
- **Stratiforms were quite similar (Except Alcantara)**
- **Convective exhibit the higher values**

Tab. 4

Integrated Liquid Water (mm)

Site	Stat	Rainy XPOL ILW$_R$ (H_{LCL}–$H_{0°C\text{-}1km}$)		
		Warm	Stratiform (BB*)	Deep Convection
Fortaleza/CE	Mean	**0.32**	**0.26**	**4.10**
	Std	0.46	0.22	3.15
Belem/PA	Mean	**0.15**	**0.27**	**2.39**
	Std	0.19	0.15	1.34
Alcântara/MA	Mean	**0.30**	**0.43**	**2.03**
	Std	0.39	0.29	1.89
Vale do Paraíba/SP	Mean	**0.09**	**0.26**	**2.45**
	Std	0.11	0.19	1.84

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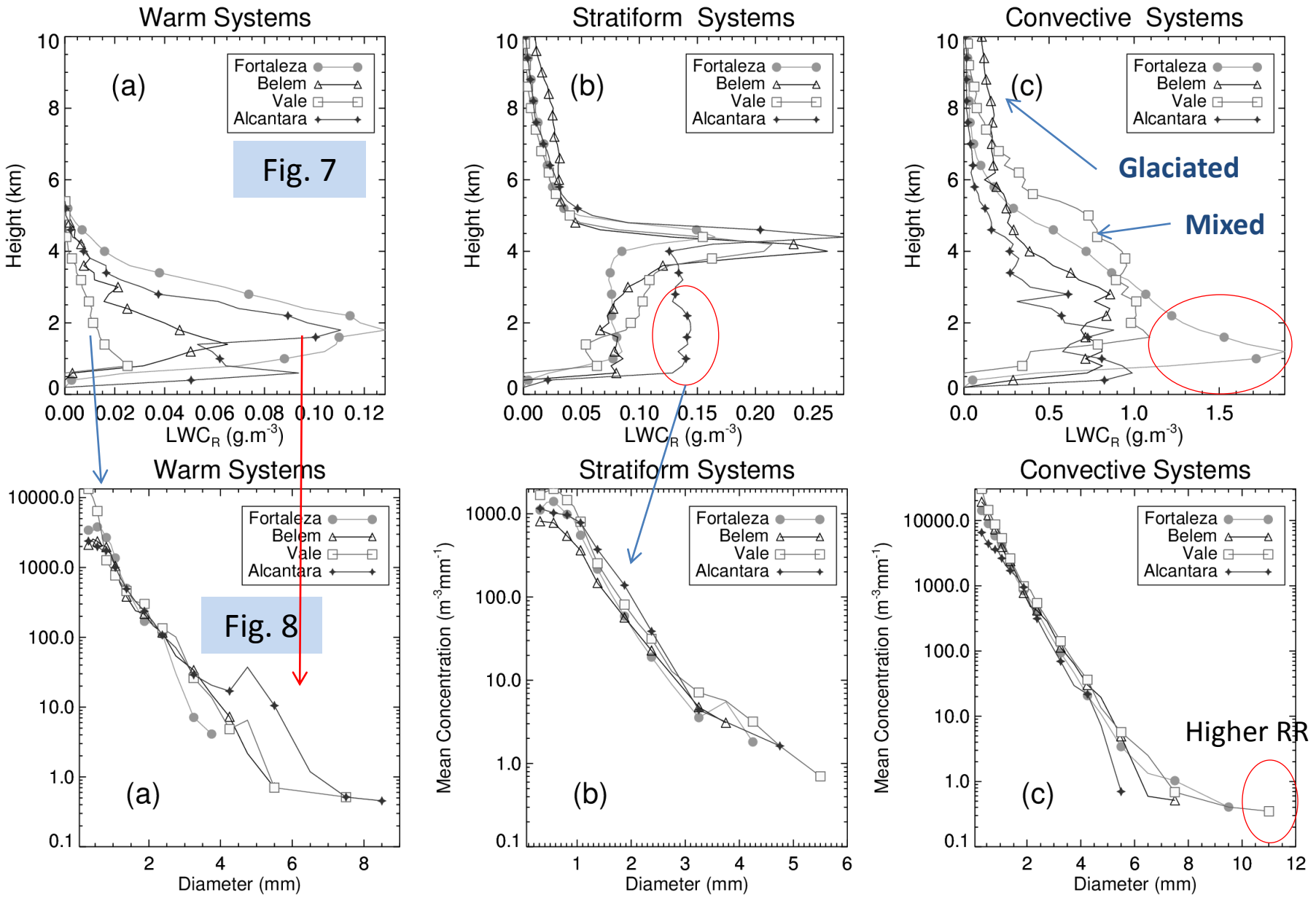
Rain Liquid Water Profiles and Raindrop Size Distribution (Bottom)



Conclusion

- For non-precipitating clouds, the ILW_C values were larger for the sites in Northeast Brazil near the coast than for the other regions.
- For rainy cases, distinct LWC_R profiles and ILW_R were observed for different rain classifications and regions with a distinctive rainfall regime.
- The ILW_R for the convective systems show the highest values, followed by stratiform and warm systems.
- The clouds in the Vale do Paraiba and Belem showed the largest reflectivity in the mixed and glaciated layers, respectively.

Acknowledgements:

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THANKS FOR YOUR PATIENCE!!!