On the Formation and Seasonal Properties of Topical Cirrus Clouds over Amazon Basin (2.89°S, 59.97°W): Observations from Lidar, Radiosonde and Satellite instruments

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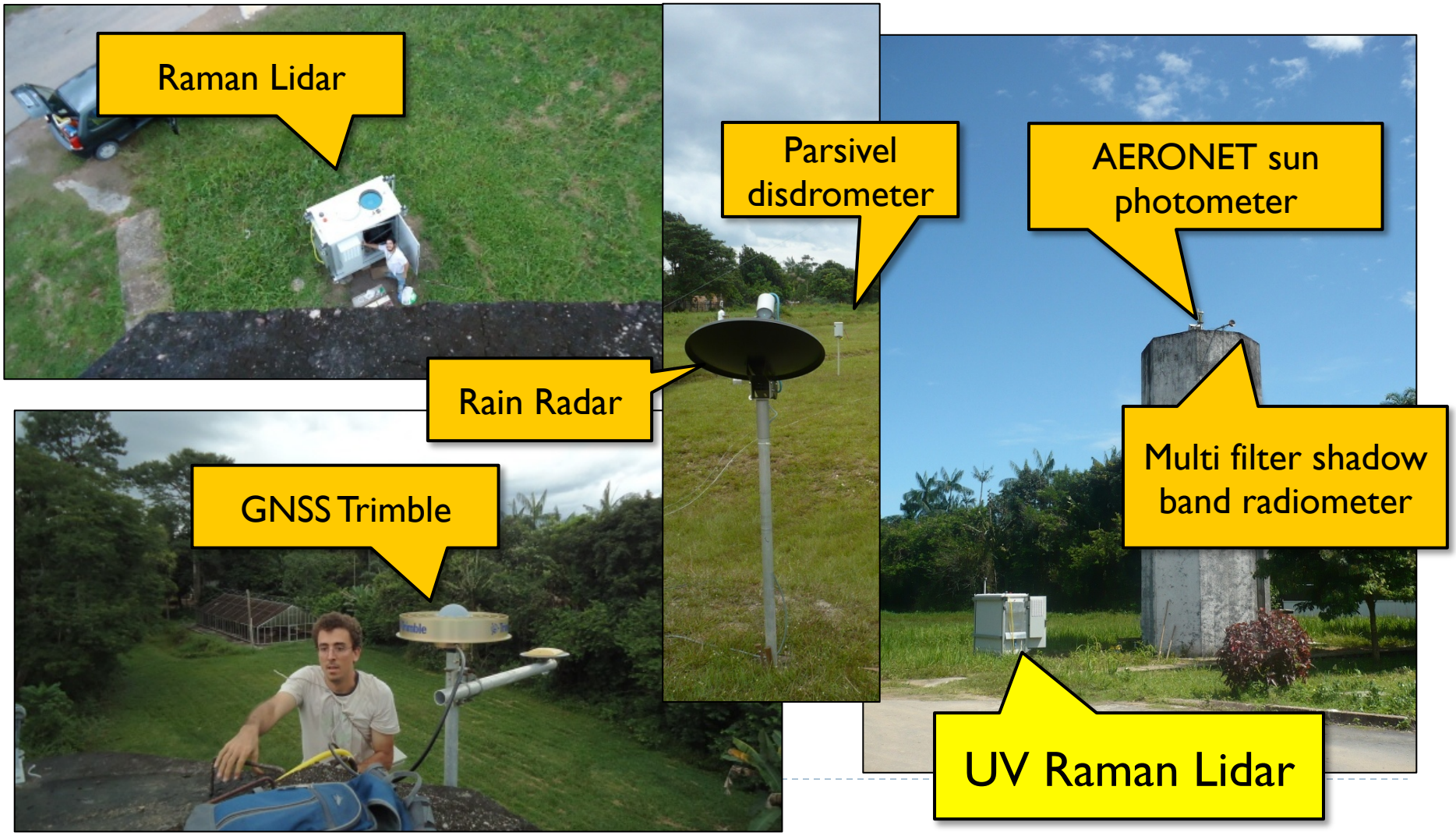
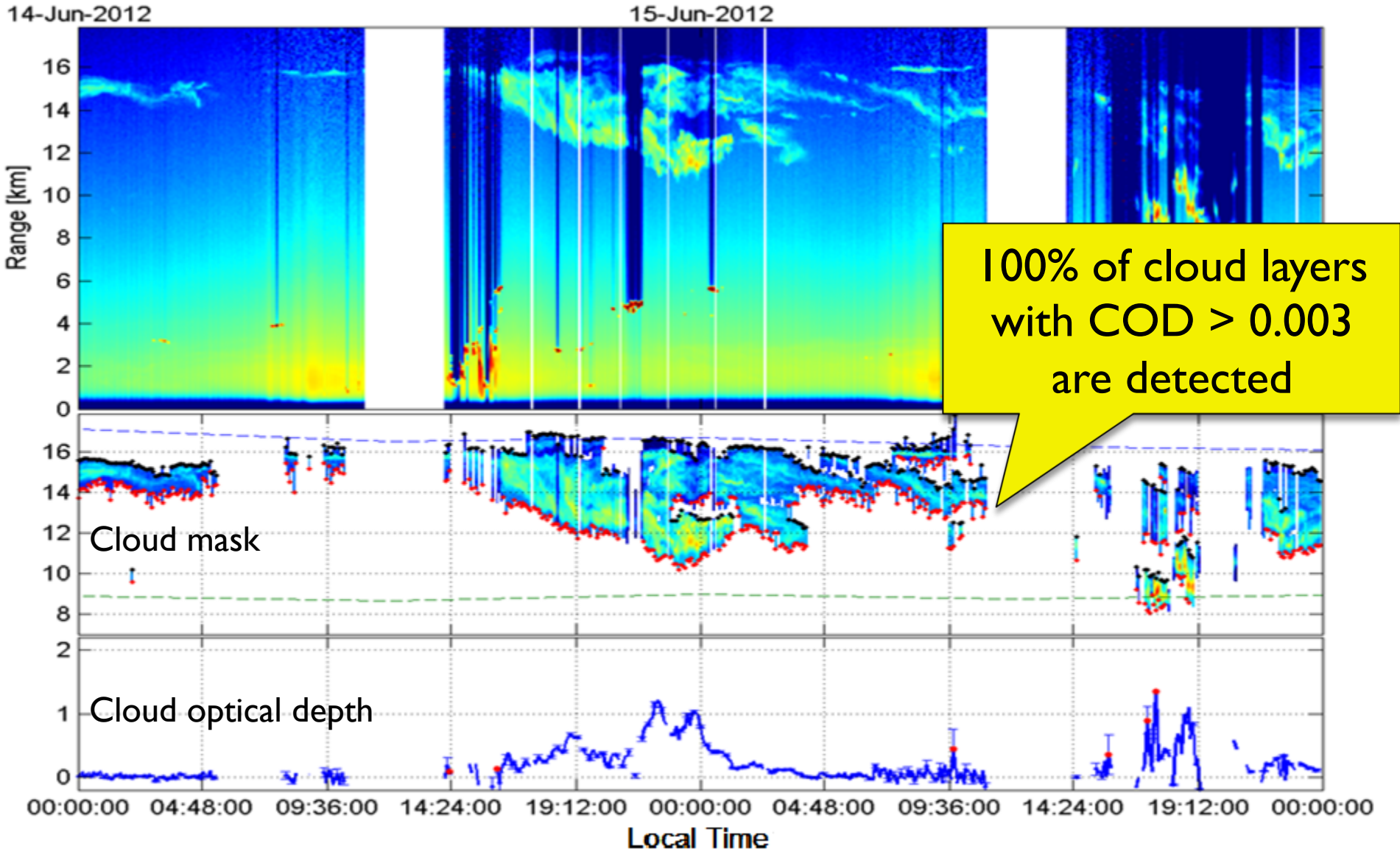
GOAL

To do a long-term characterization of cirrus clouds in the central Amazon region

ACONVEX – Aerosols, Clouds, Convection Experiment in Amazon – Since mid-2011



Method for cloud base/top
Gouveia et al, Opt. Pura y Ap. (2014)

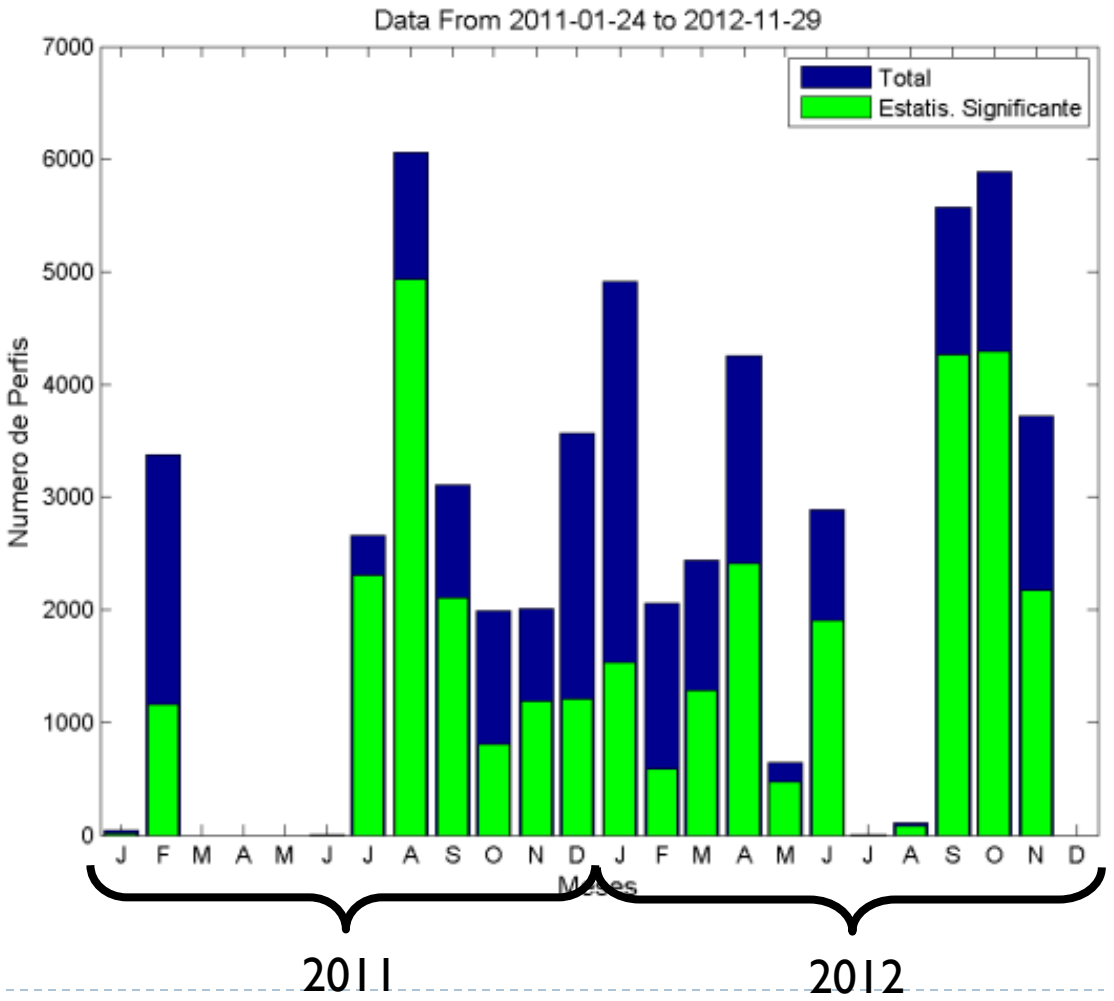


Results

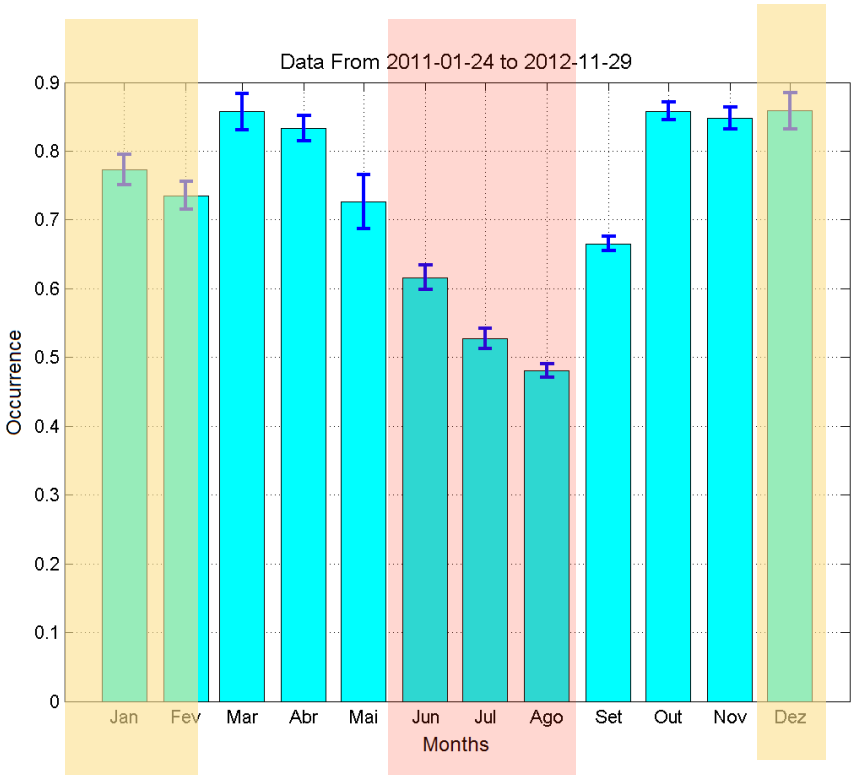
- Frequency of Occurrence
- Macrophysical Properties
- Optical Properties
- Microphysical Properties

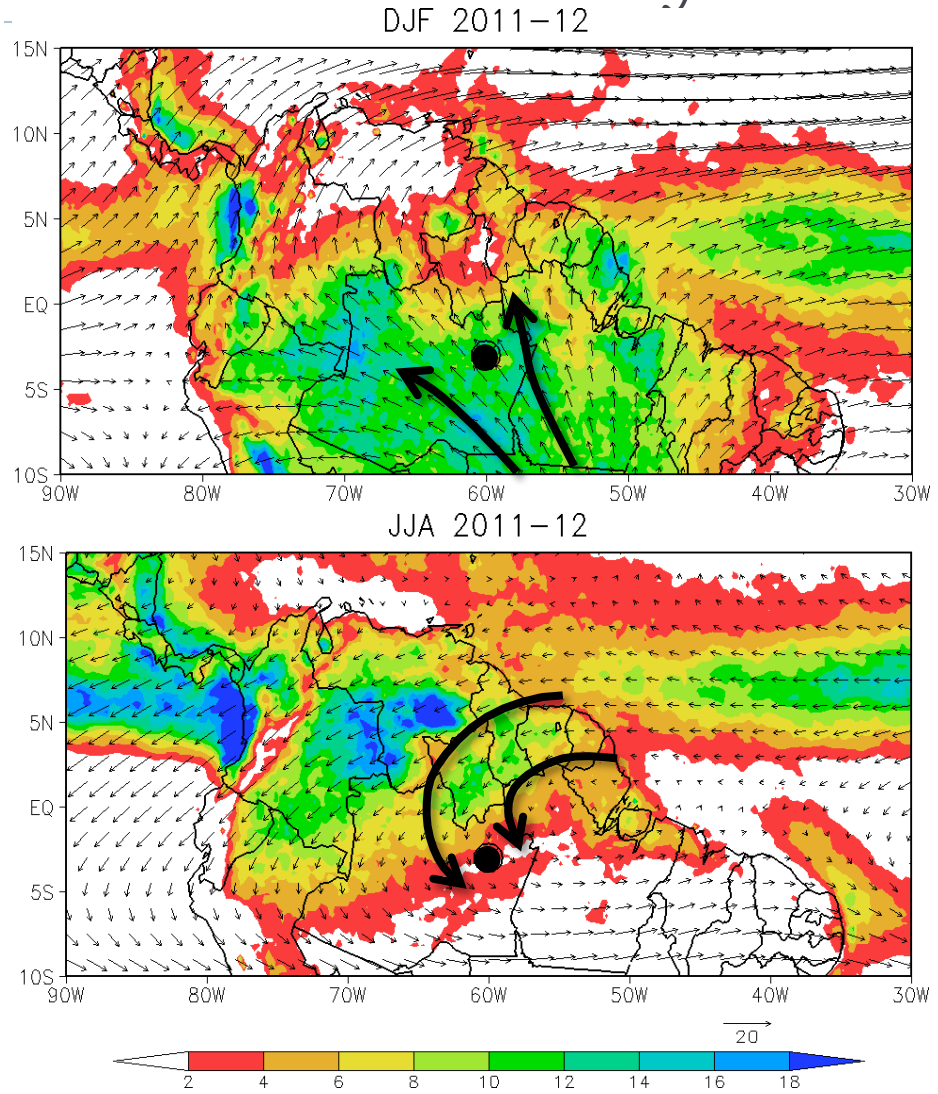
Data Base

- More than 55 k 5-minutes profiles
- 2/3 with good S/N
- Isolated clouds above 8km were considered cirrus



Frequency of Occurrence: Annual Cycle





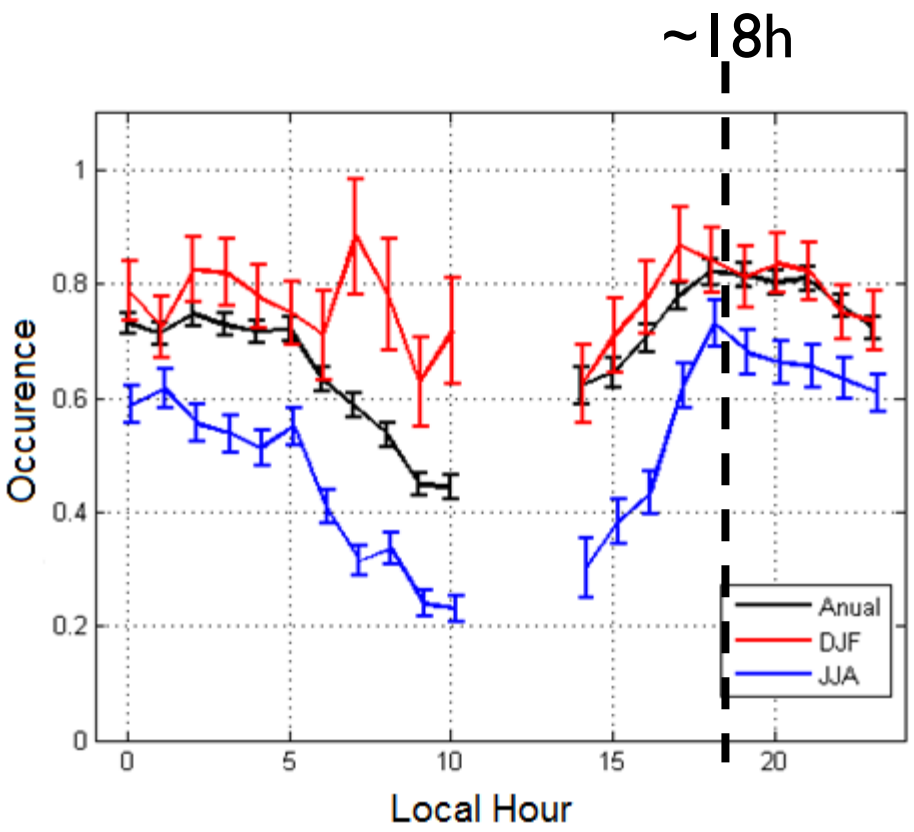
Mean: **71%**
Dec-Feb: 78%
Jun-Aug: 52%

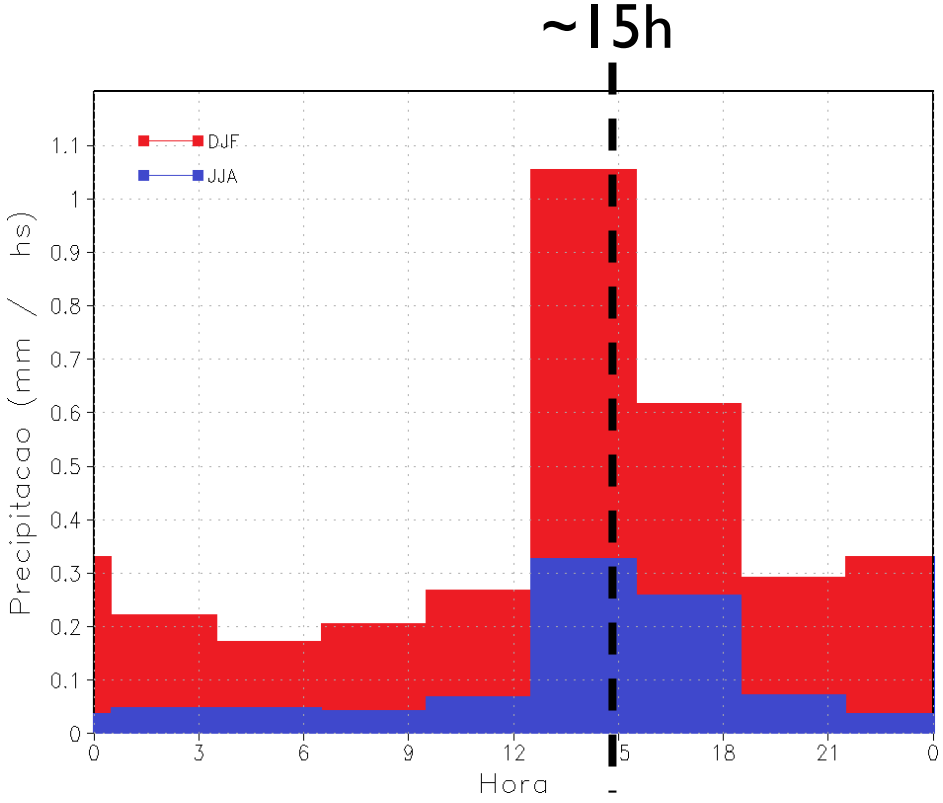
Colors: Preciptation (mm/dia) TRMM v7
Vectors: Wind (m/s) in 200 hPa ERA interim

Frequency of Occurrence

Local	Measurement year	Total	Wet Months	Dry Months
Manaus	**2011-12**	**71%**	**78%**	**52%**
Manaus (Calipso) NAZARYAN, 2008, JGR	2006-7	60-65%		
Maldivas (4.1°N, 73.3°E) SEIFERT et al., 2007, JGR	1999-00	43%	64%	35%
Ilha Nauru (0.5 °S, 166 °E) JM et al., 2002, JGRD	1999	55%		
Mahé, Seychelles (4.4 °S, 55.3 °E) PACE et al., 2003, JGR	2003	54%		
Sul da França (43.9◦ N–5.7◦ E) HOAREAU et al., 2013, ACPD	1996-07	37%		

Frequency of Occurrence: Daily Cycle





The cirrus clouds cycle does not follow exactly the rainfall cycle

Cirrus has a large residence time

Preciptation TRMMv7 (mm/hs) in a 2°× 2° area centered on site

Results

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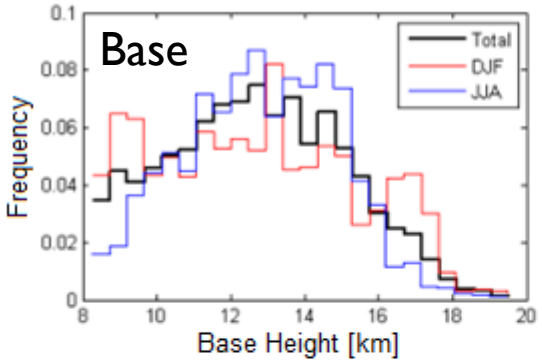
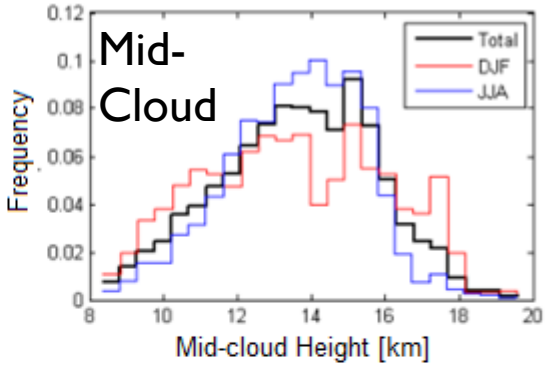
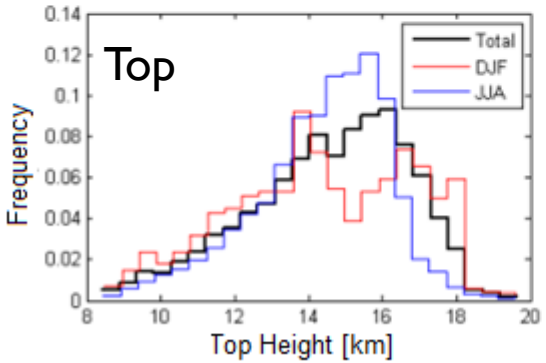
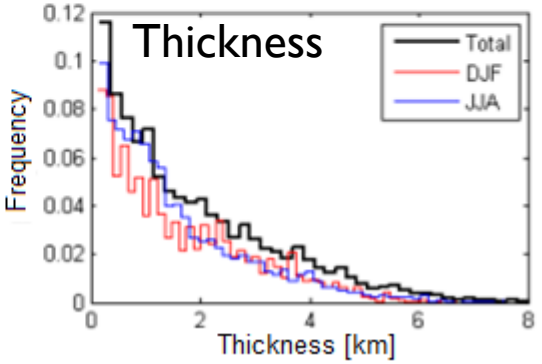
Macrophysical Properties

- Occurrence range 8-19 km
- Thickness up to 7-8 km
- Rupture between 14-15km in DJF
- Only 1.3% of the deep convection goes up 14 km (LIU; ZIPSER , 2005,JGR)









	Base (km)	Mid (km)	Top (km)	Thickness	Temperature
Manaus	12.5 ± 2.4	13.4 ± 2.1	14.3 ± 2.2	1.82 ± 1.53	-57 ± 15 °C
Maldivas SEIFERT et al 2007 JGR	11.9 ± 1.6	12.8 ± 1.4	13.7± 1.4	1.8 ± 1.0	-58 ± 11 °C
Zonal Tropical SASSEN 2008 JGR	13.0		14.8		
Zonal Tropical NAZARYAN 2008 JGR	12.5		15		

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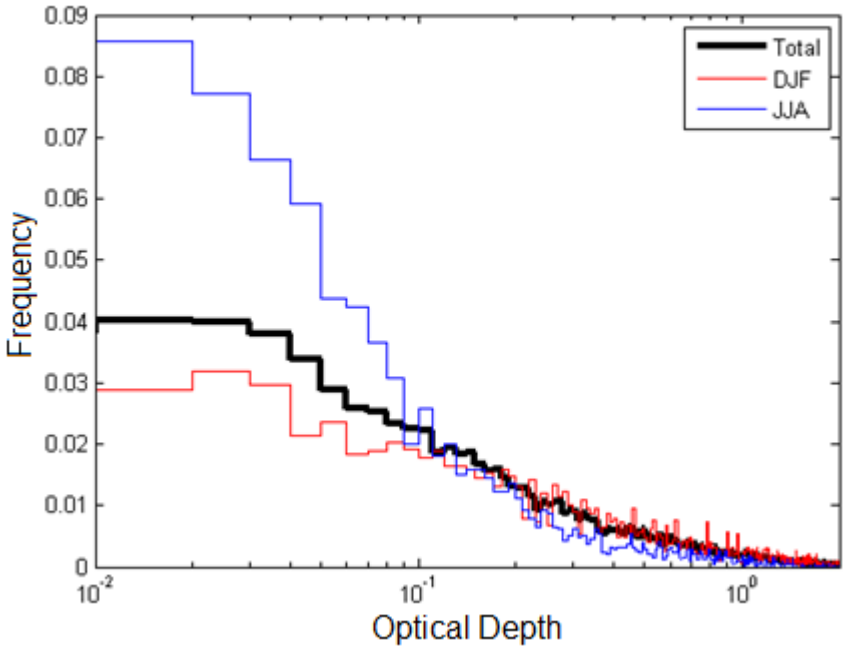
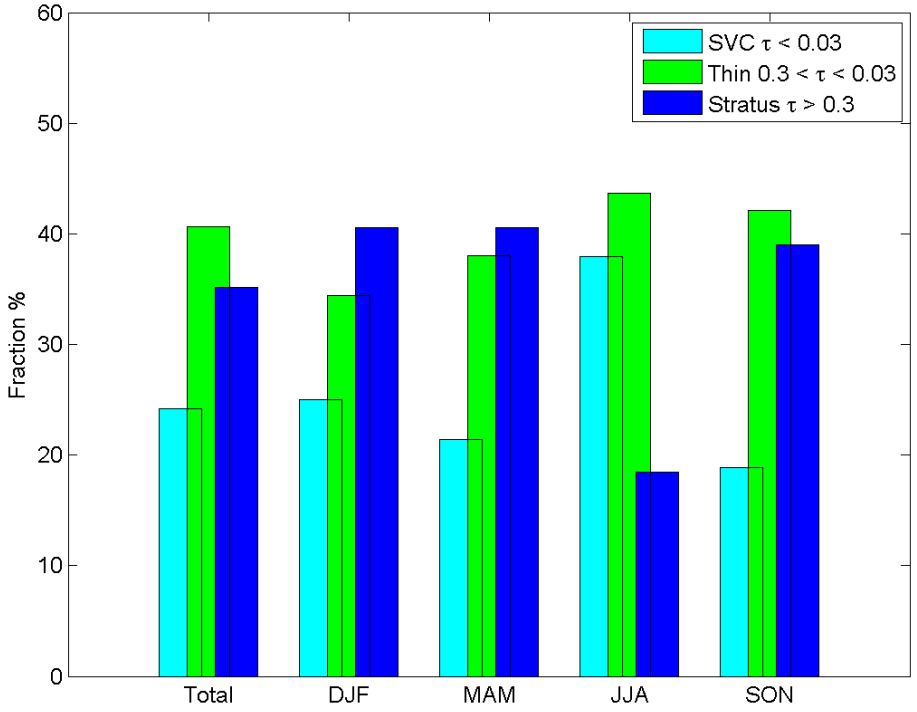
Optical Properties

- 24.6% Subvisuais ($\tau<0.03$)
- 40.7% Thin cirrus ($0.03 < \tau < 0.3$)
- 35.1% Cirrustratus ($\tau > 0.3$)





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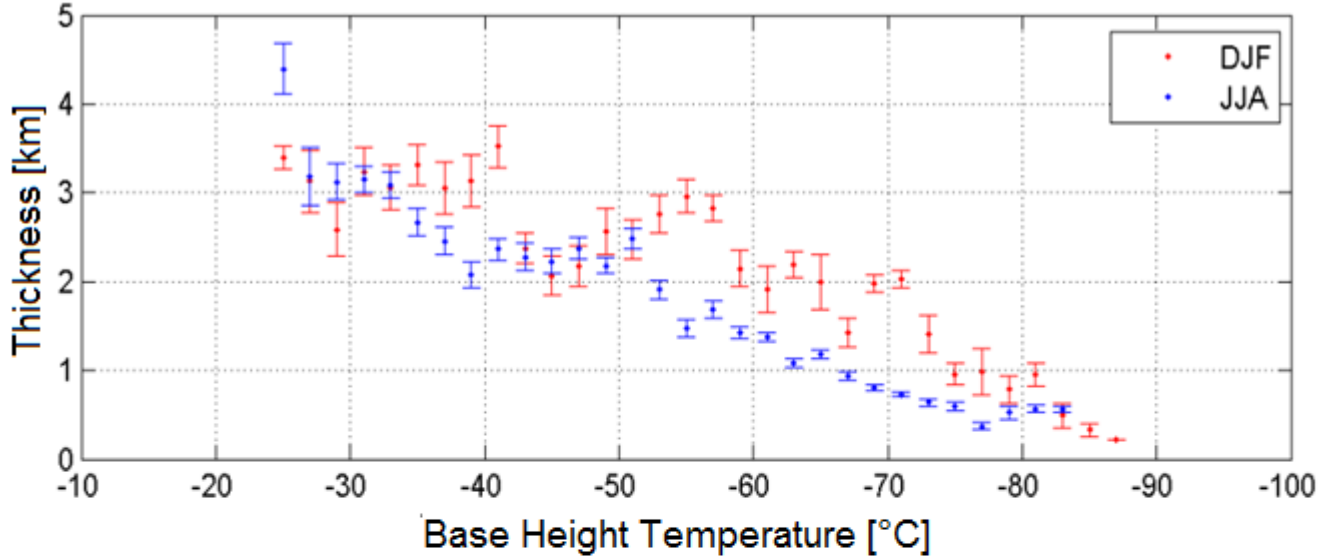
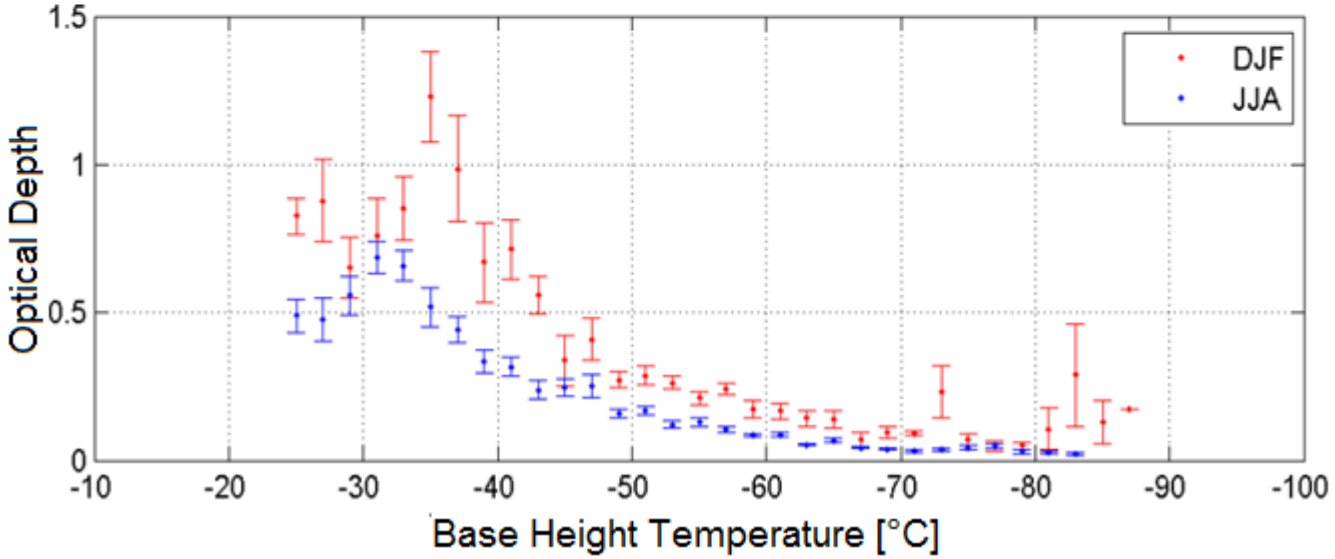
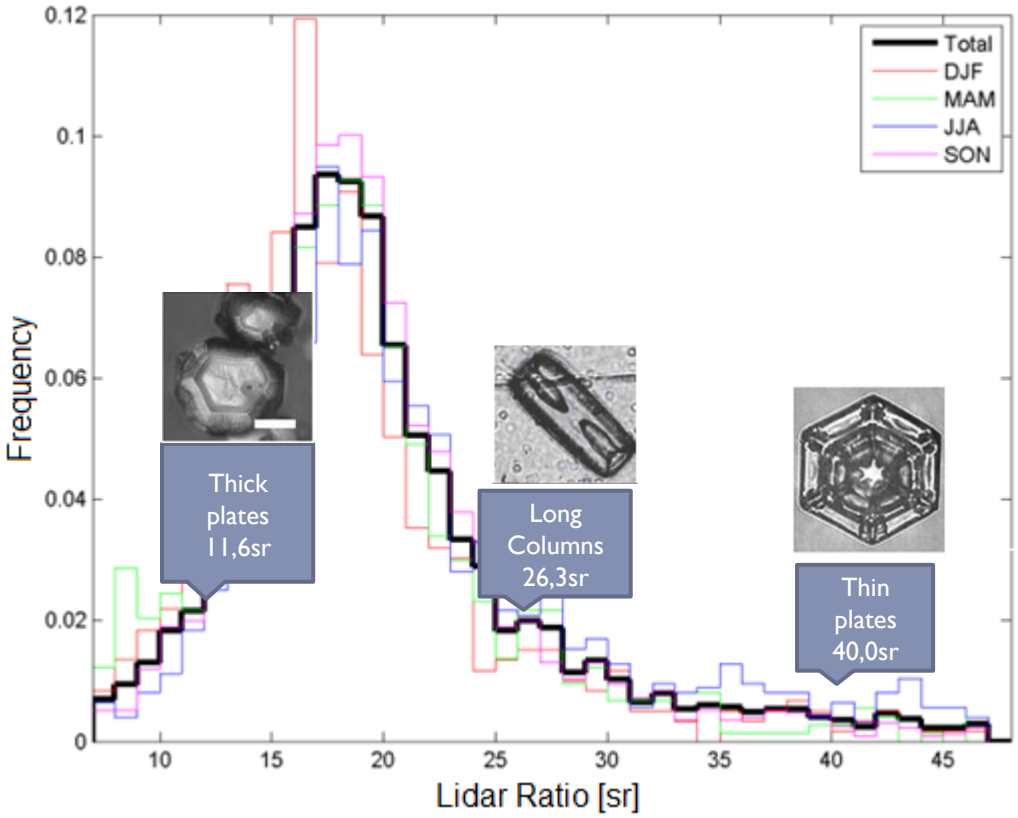
Microphysical Properties





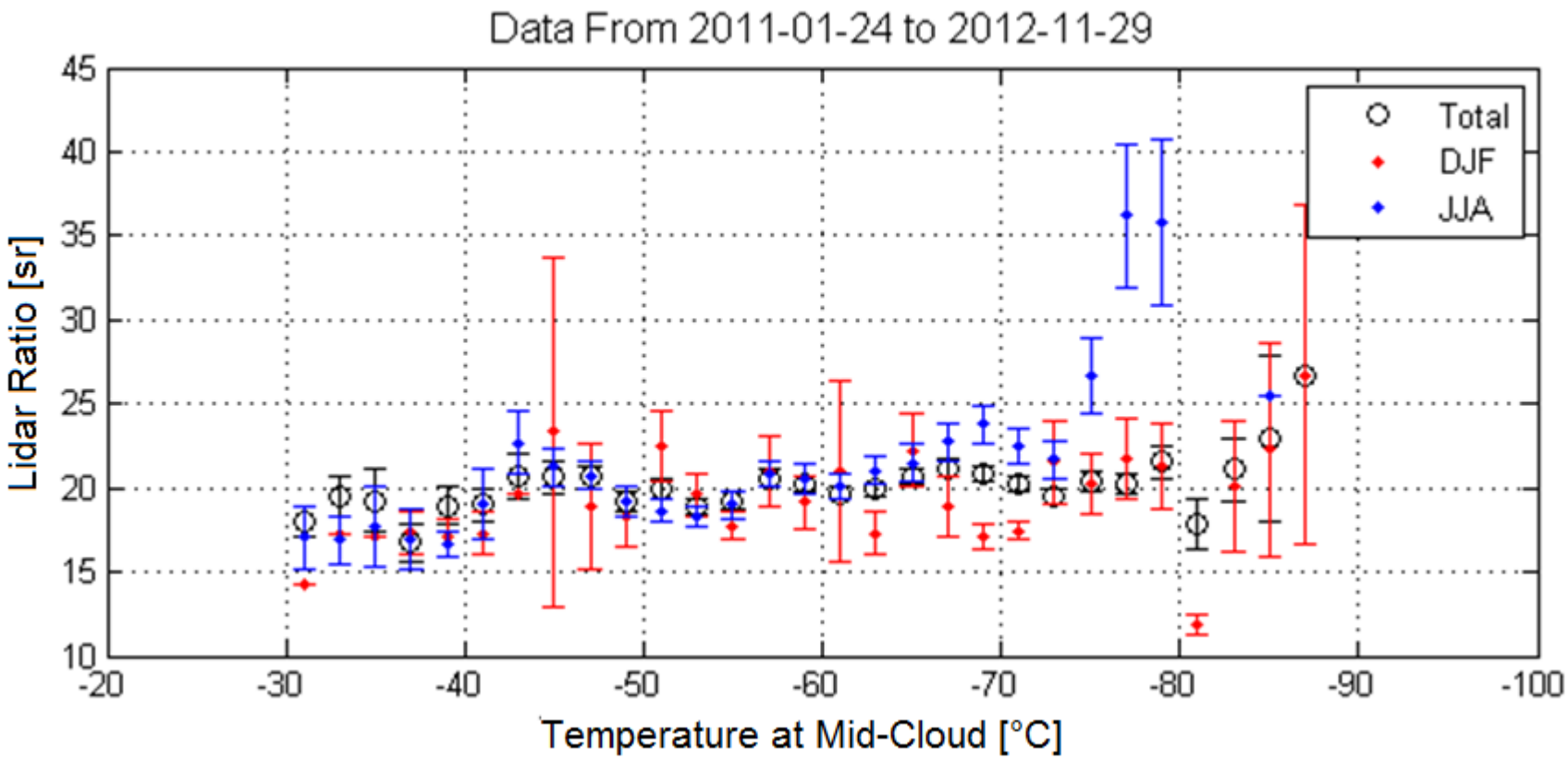
Microphysical Properties

- Lidar Ratio Mean Value: L_{par}= 20,0 ± 6,8 sr



	LR (sr)
Manaus	**20,6 ± 6,8**
Mahé, Seuchells.	19,6
Maldivas	30 ± 10 33 ± 10
Aspendale (Platt; Diley , 1984,AO)	18,2sr ± 20%
Sul da França (Giannakaki et al. 2007 ACP)	28 ± 17
Salt Lake City, Utah (Sassen; Comstock, 2001,JAS)	24 ± 38
São Paulo **(Larrosa, PhD, 2011)**	26 ± 12

Microphysical Properties



Conclusions

- Well defined annual cycle occurring in 50% to 85% of the time.
- Macrophysical properties, rainfall and wind direction patterns indicate deep convection and the transport from other regions as its main source
- 24% of the clouds are subvisual, 42% are optically thin and 35% of them are cirrus stratus, with a change only in JJA, showing more aged clouds
- The distribution of lidar ratio showed a wide range of values indicating thick plaques and long columns as the main composition of ice crystal. However, the behavior with temperature needs further investigation