Cirrus clouds observation and instrumental intercomparison from three lidar systems operated during IOP#2

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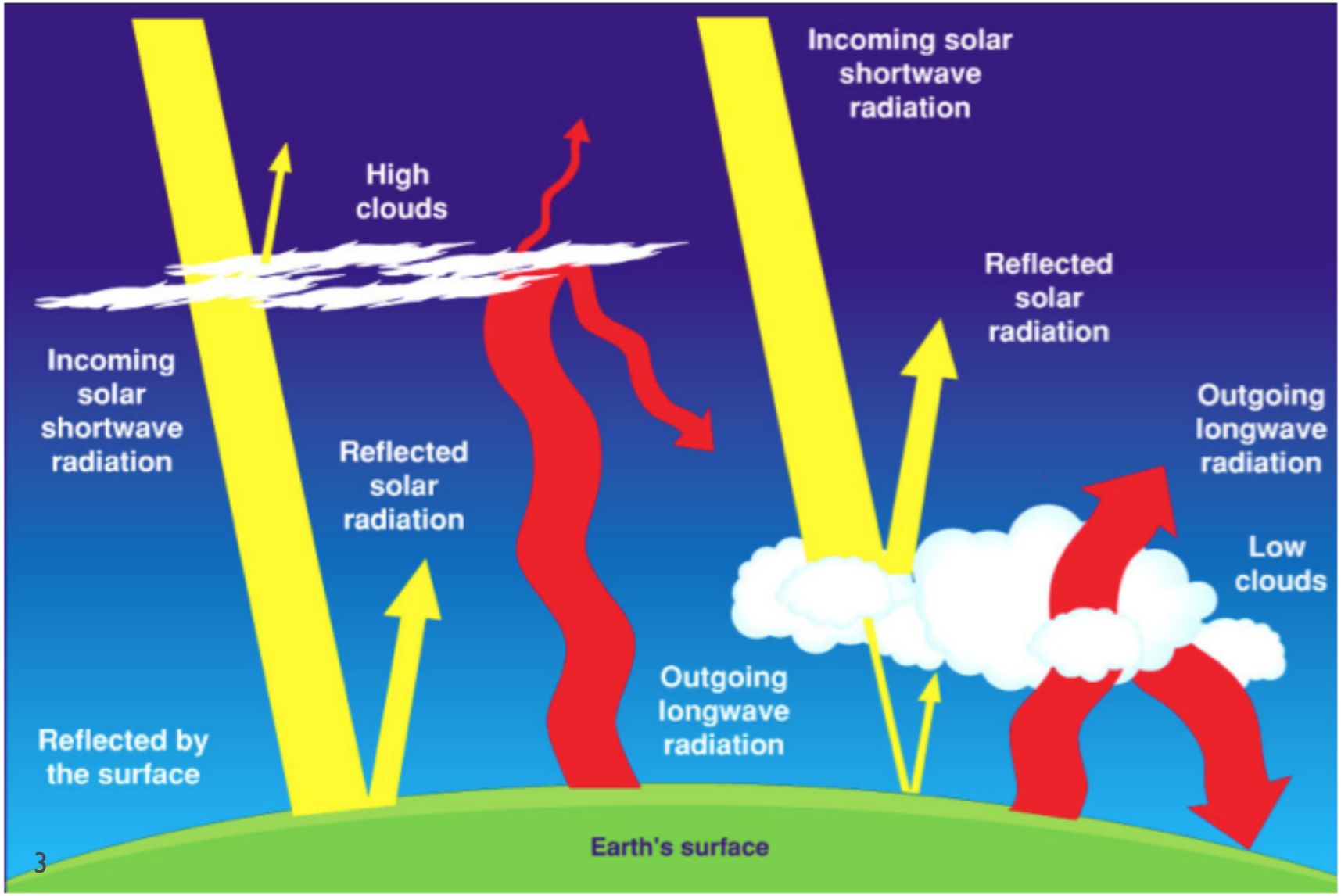
Outline

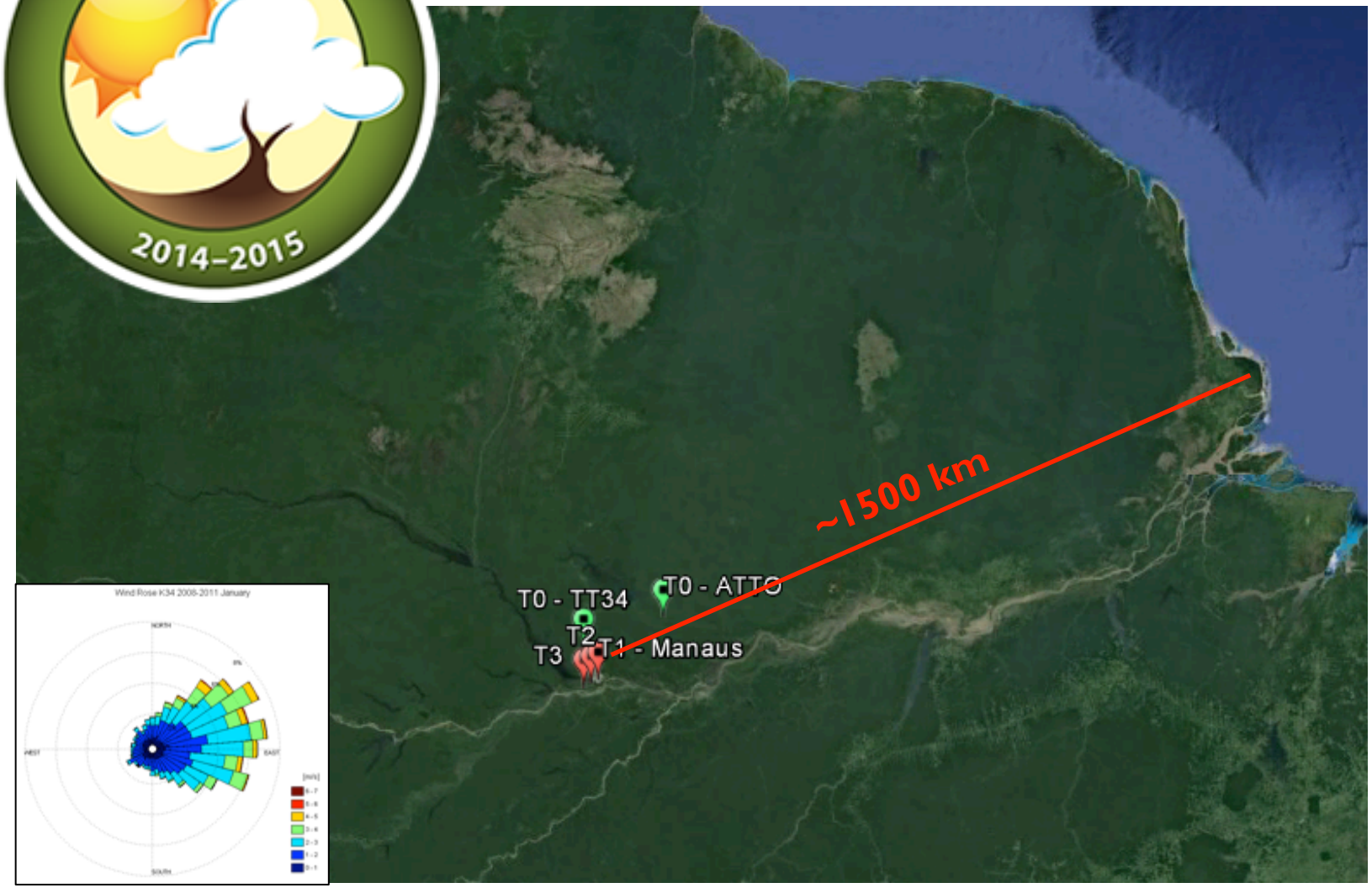
IOP2 Lidar Network

- Cirrus Clouds
- Lidar Setup and Experimental Site
- Side-by-Side Intercomparison
- Cirrus Clouds Measurements

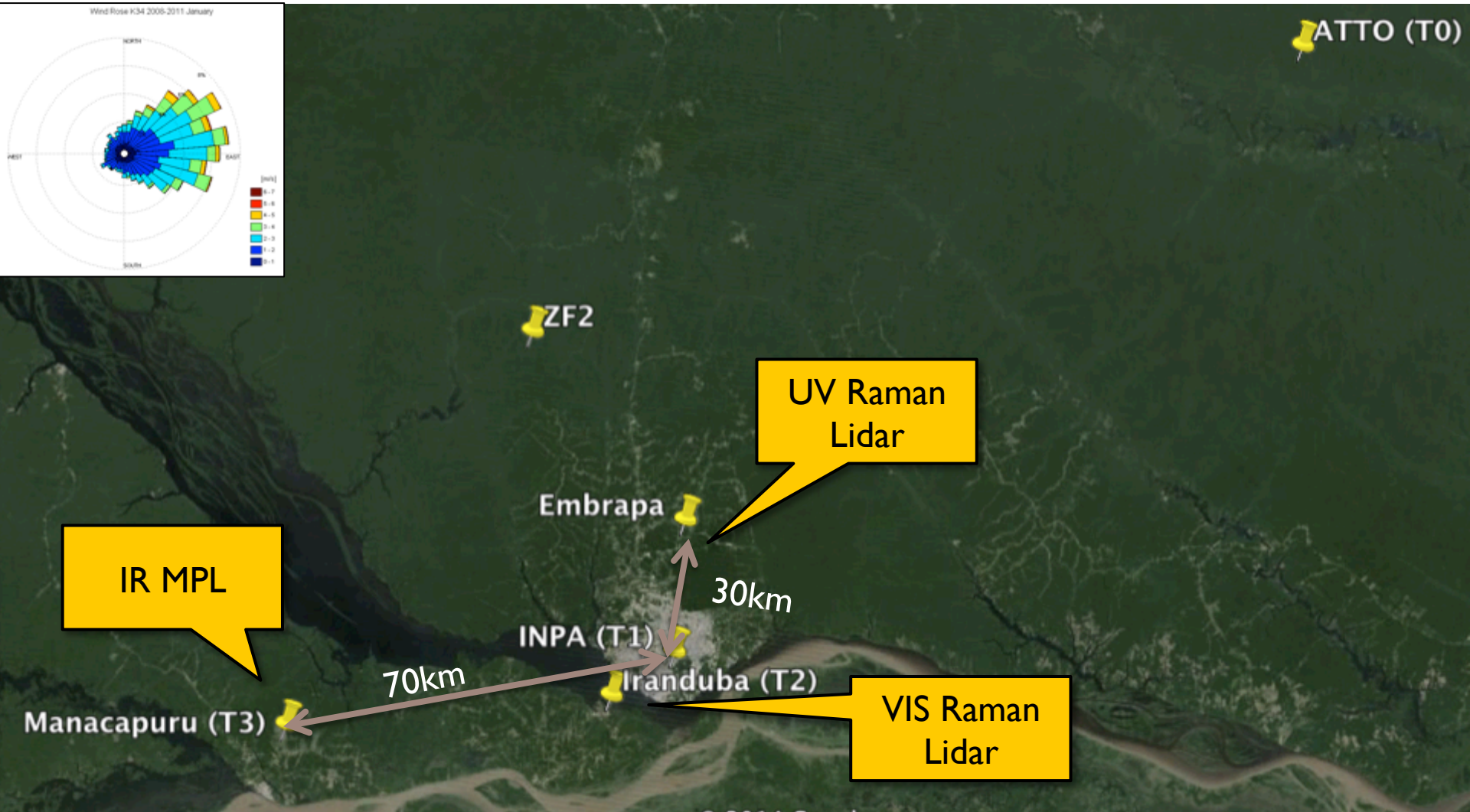
Cirrus Radiation Balance



The GoAmazon 2014/15 project



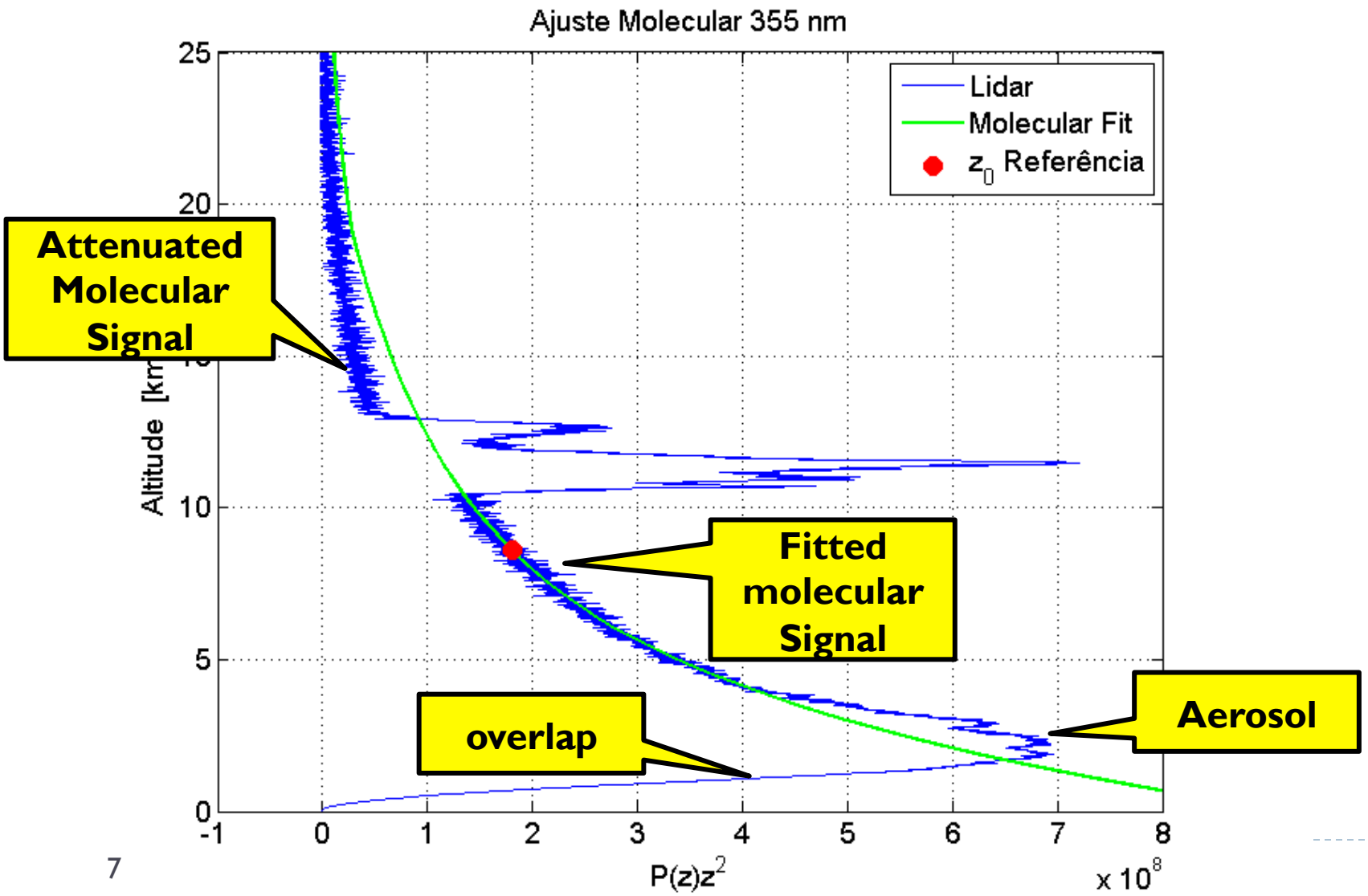
Experimental Sites



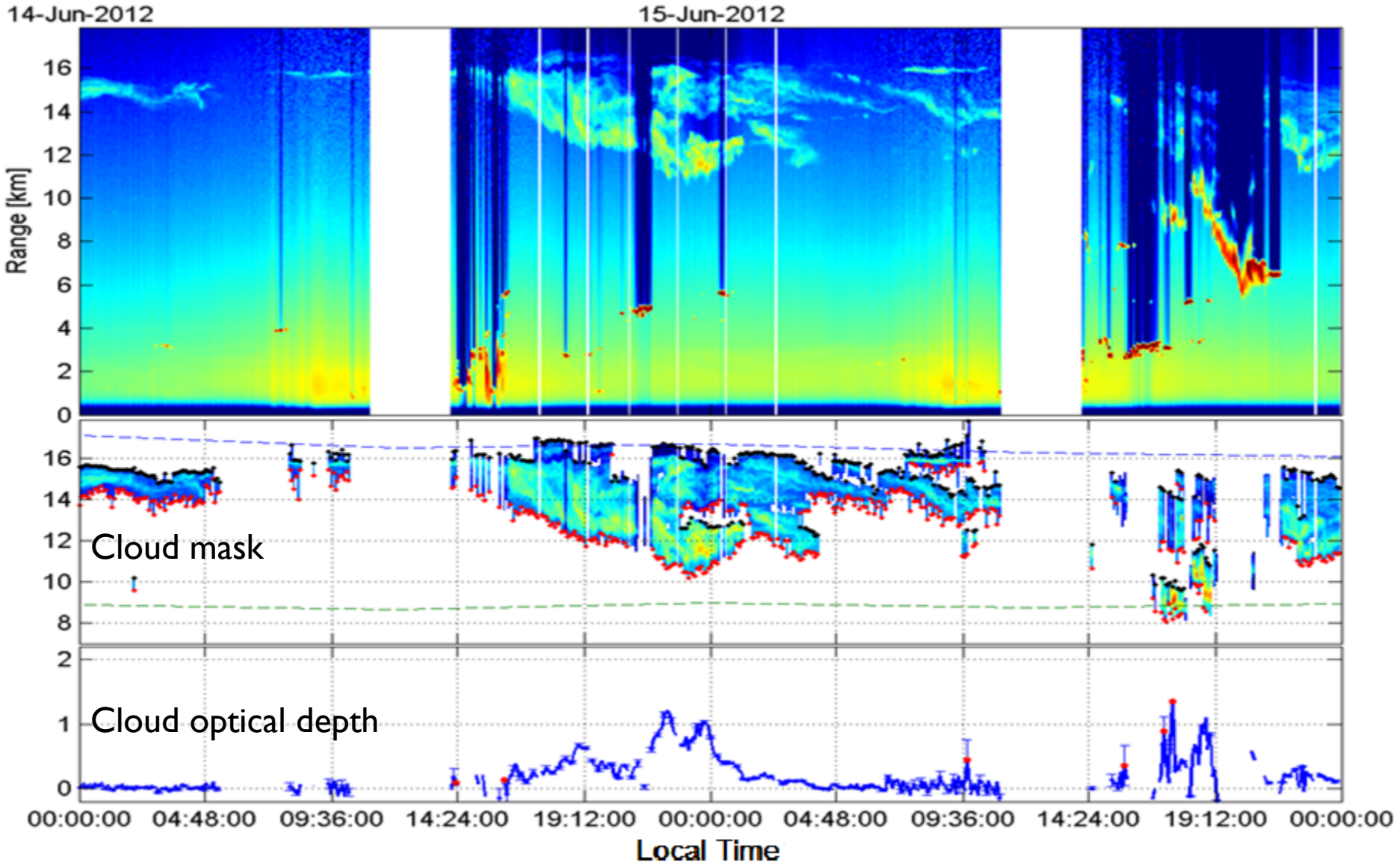
Lidar Systems

	UV Raman Lidar LFA (T0)	VIS Raman Lidar IPEN (T2)	IR MPL ARM mobile facil
Manufactor	Raymetrics	Raymetrics	Sigma Space
Laser	Nd-YAG	Nd-YAG	Nd-YLF
Wavelangth	355 nm	532 nm	1047 nm
Vertical Resolution	7.5 m	7.5 m	15 m
Detection	355 nm (elastic), 387nm (N2) and 408nm (H20)	532 nm (elastic) and 608 nm (N2)	Co and Cross Pol

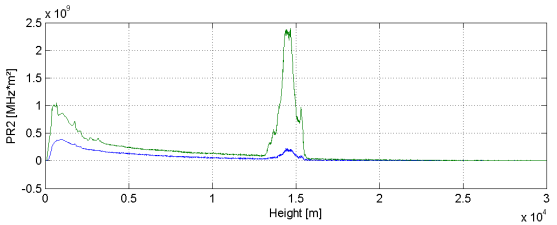
Lidar Signal

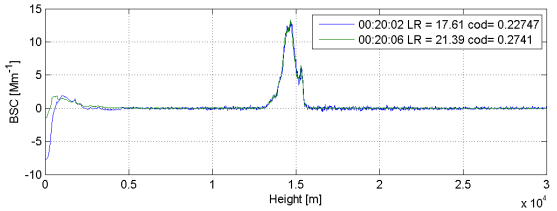


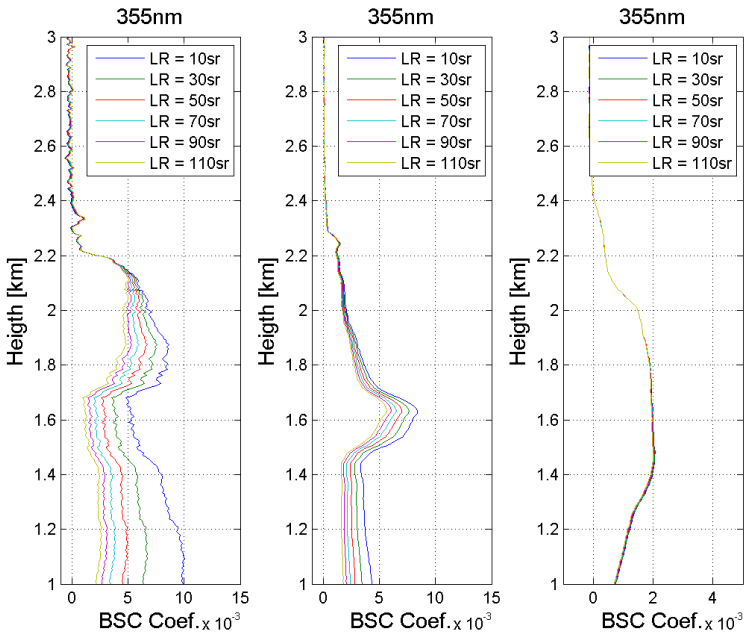
Method for cloud base/top
Gouveia et al, Opt. Pura y Ap. (2014)



Side-by-Side Intercomparison





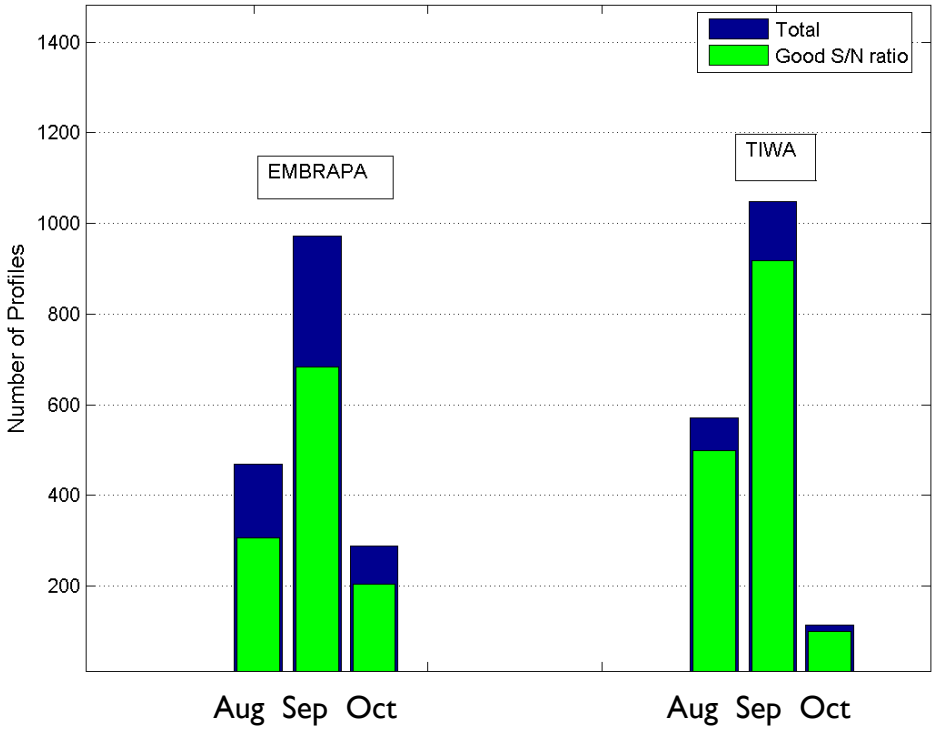


Results

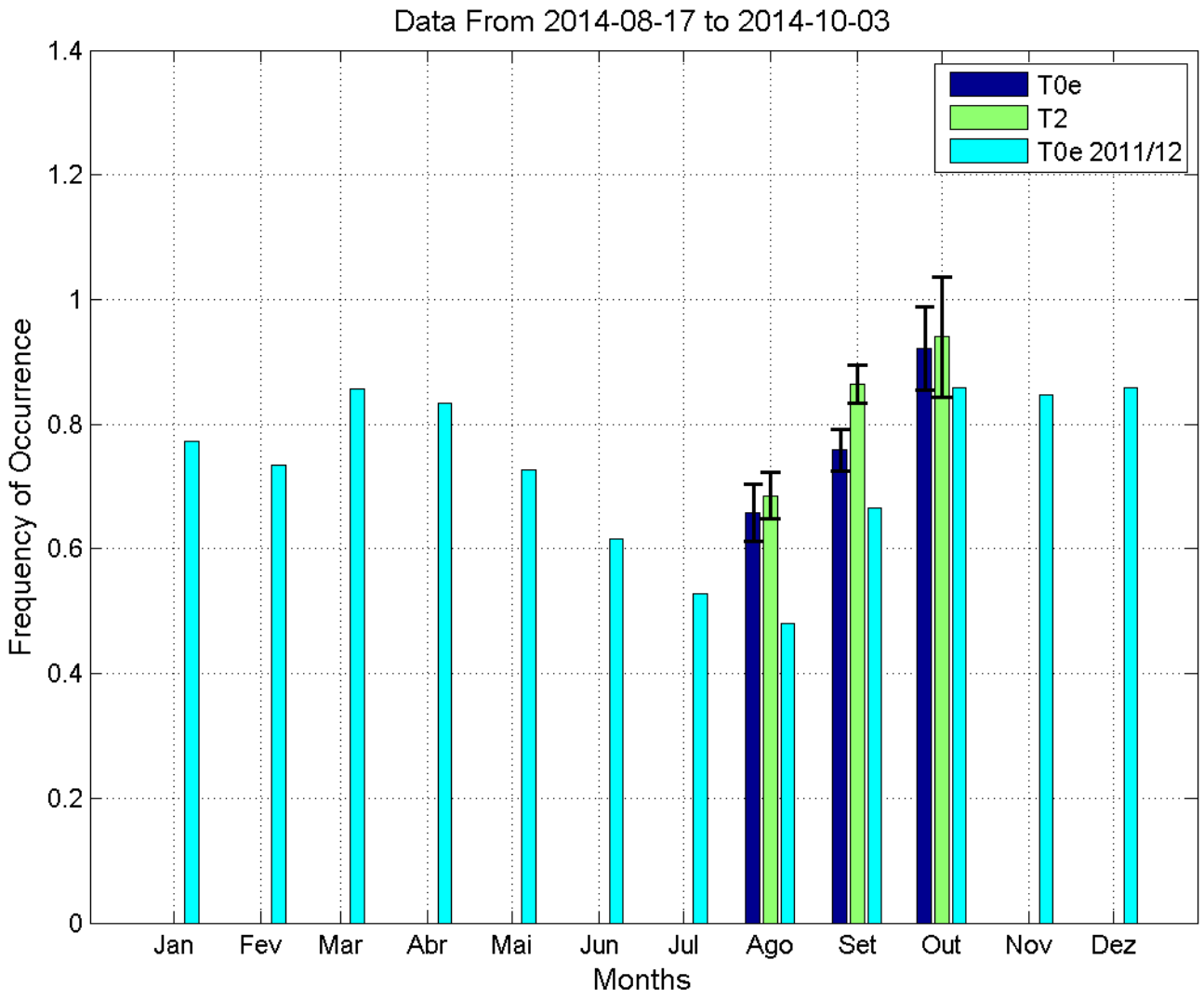
- Frequency of Occurrence
- Macrophysical Properties
- Optical Properties
- Microphysical Properties

Data Base

- Running almost continuously in the IOP#2
- more than 2/3 with good S/N
- Isolated clouds above 8km were considered cirrus



Frequency of Occurrence: Annual Cycle

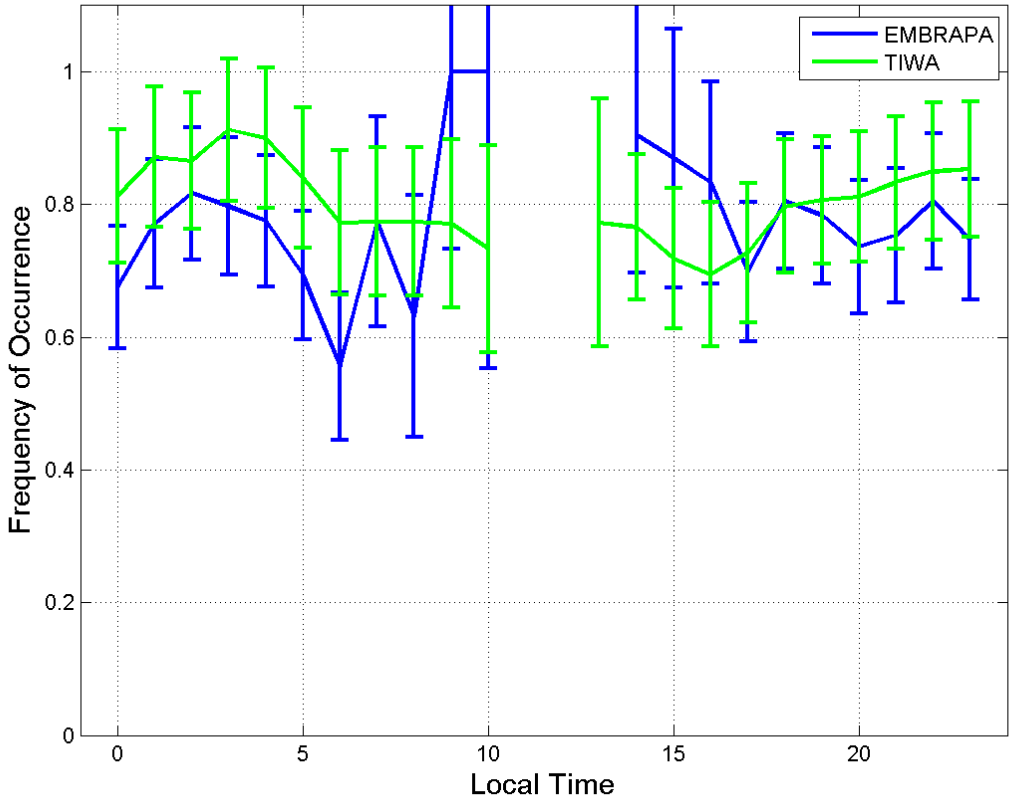


Mean:
T2: 76%
Jun-Aug: 81%

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

Results

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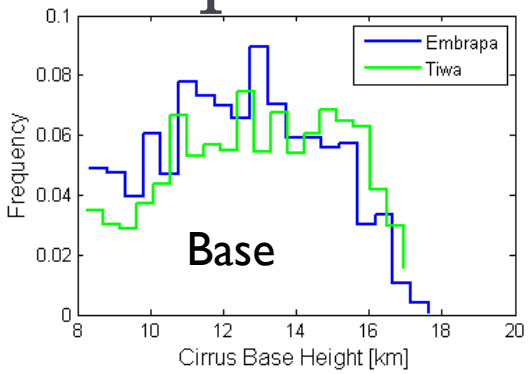
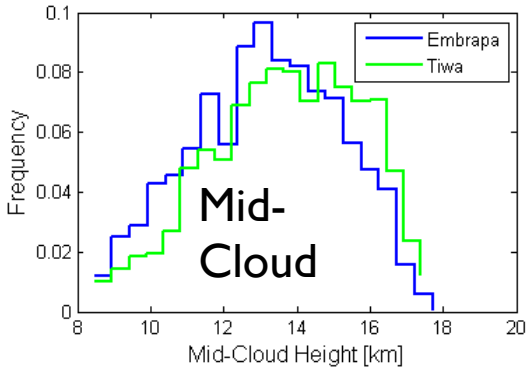
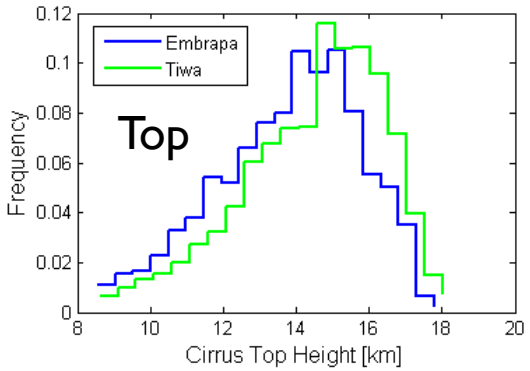
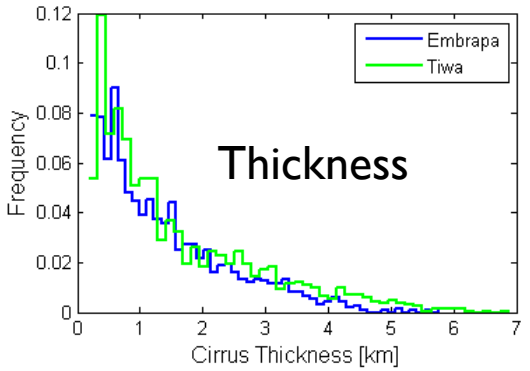
Macrophysical Properties

- Occurrence range 8-19 km
- Thickness up to 7-8 km
- Apparent difference between Embrapa and Tiwa sites









	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		

Results

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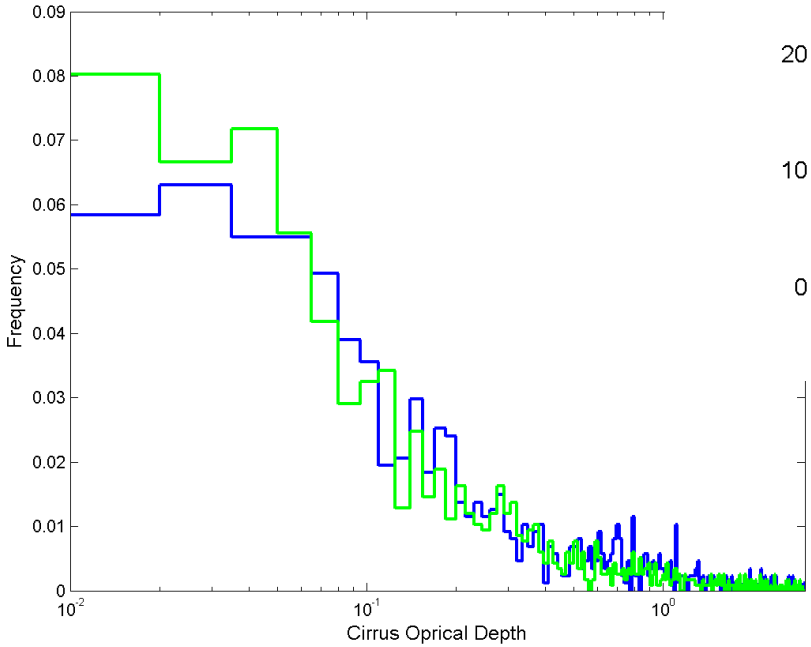
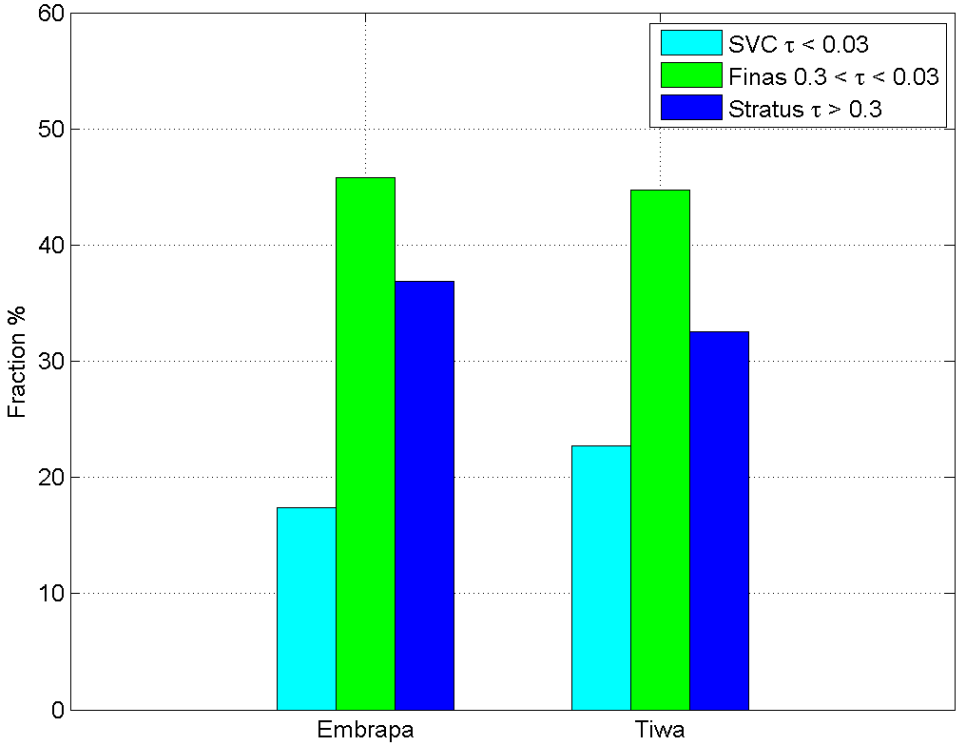
Optical Properties

- Subvisuais (τ<0.03)
- Thin cirrus (0.03 < τ < 0.3)
- Cirrustratus (τ > 0.3)





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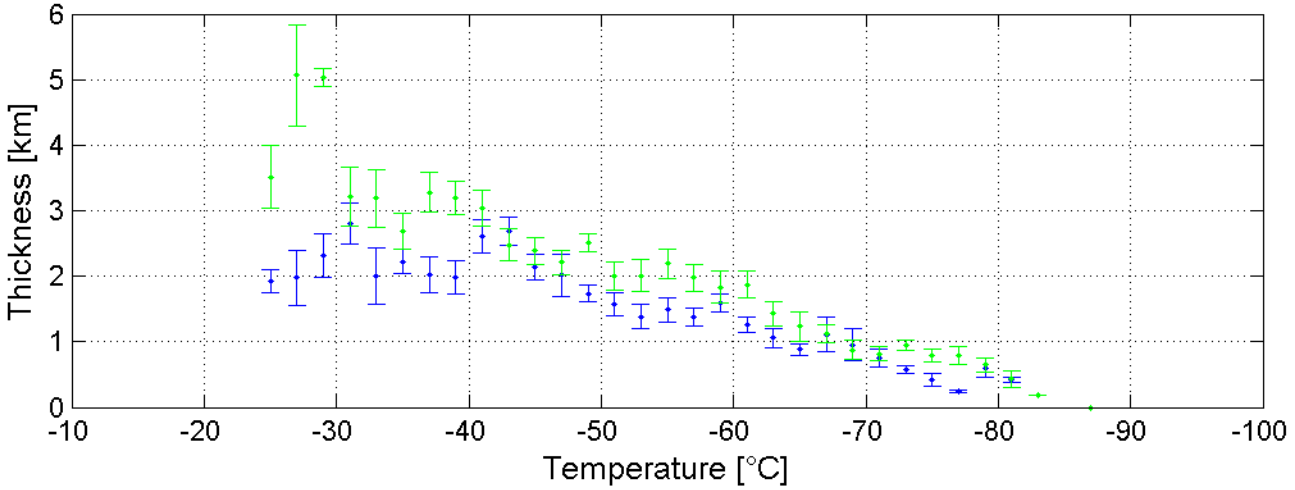
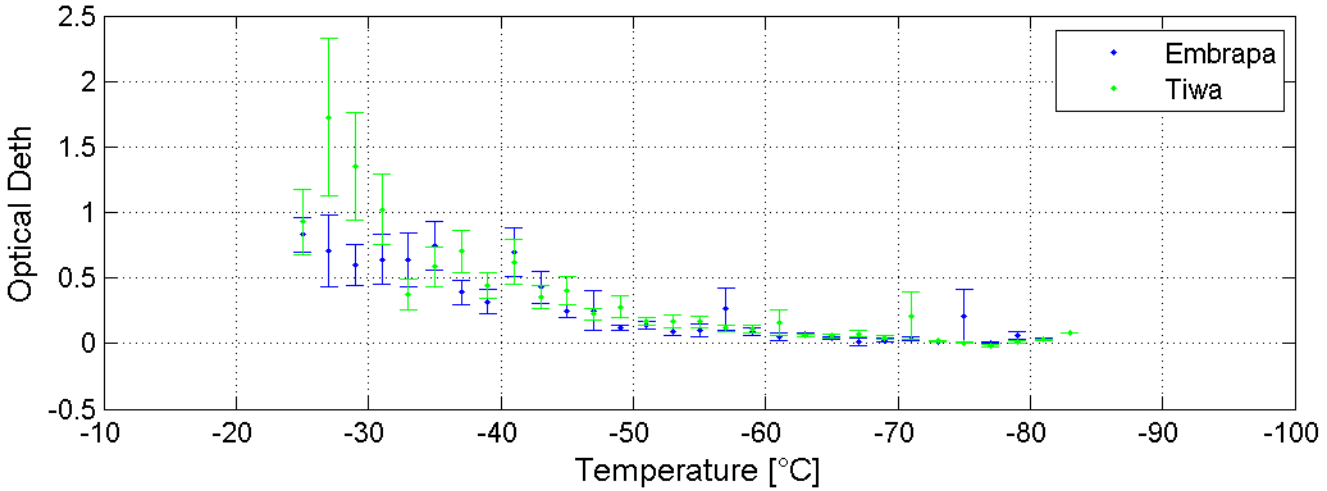
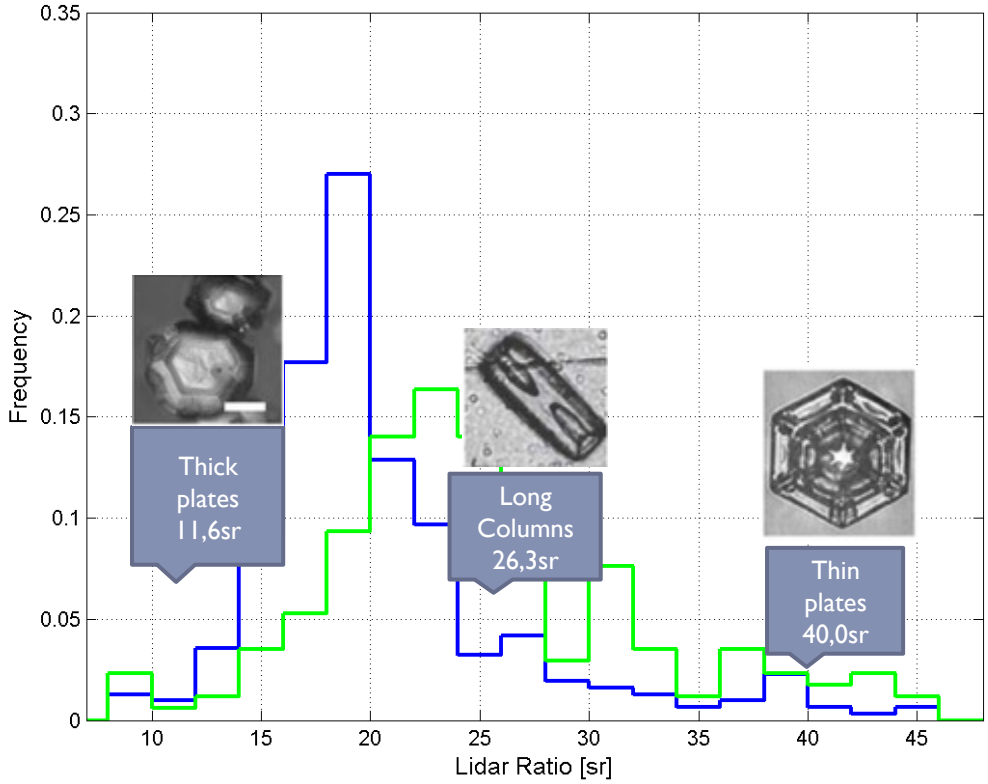
Microphysical Properties





Microphysical Properties



	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

Conclusions

- Higher occurrence of clouds compared to 2011/12.
- Apparent difference in the macrophysical properties between Embrapa and Tiwa sites.
- approximately the same depth for different optical measuring equipment, with about 65% considered as thin 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

Obrigado!