Comparison of cirrus optical depth from ground-based lidar and radiometer with data from CALIOP and MODIS over Amazon region (2.89° S 59.97° W)

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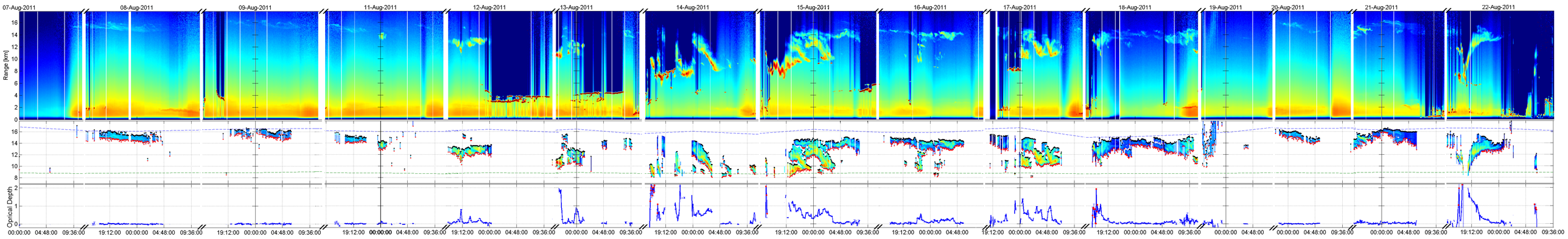
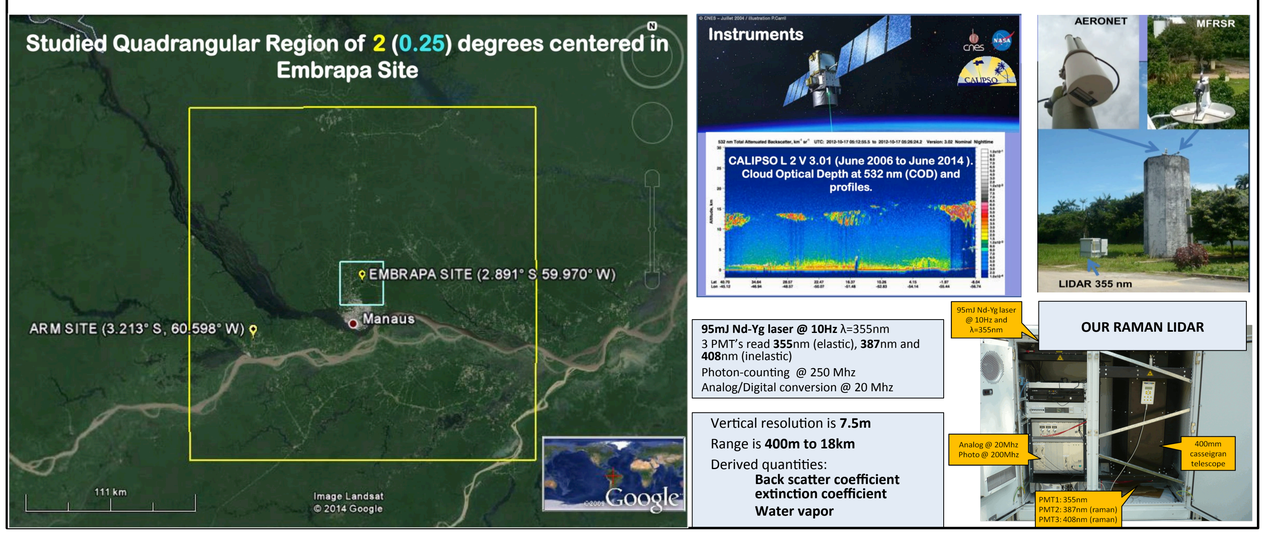


ABSTRACT

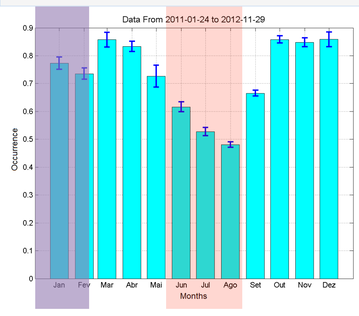
The determination of optical characteristics of clouds is very important to evaluate the planetary radiative balance. For cirrus clouds, which are formed mainly by ice crystals and are found in the upper troposphere, a precisely determination of optical depth is crucial to evaluate its radiative impact. Depending on the shortwave albedo effect of the incoming solar radiation and the longwave absorption
and reemission, cirrus clouds can act either as cooling or warming agents of the climate system. Its importance grows due to its lifetime that can go from hours to a few days and large coverage area. Since 2011, a UV Raman-Lidar system and a Multi Filter Rotating Shadowband Radiometer (MFRSR) are operational on the ACONVEX site located 30 km up-wind from Manaus-AM (2.89° S 59.97° W). As the results from the first two years of measurements using a ground-based lidar system, we found that the occurrence of high clouds with base altitude higher than 8 km (temperatures below -20°C) was approximately 71% of the total time of observation, varying between about 50% in the dry season (JJA) and about 80% in the wet season (DJF). In this work, we compared the cirrus clouds optical depth measured by these ground based instruments (lidar system and the MFRSR radiometer) and satellite measurements (CALIOP and MODIS). We found that the probability density function of the observed cirrus optical depth from both gound-based lidar and radiometer instruments were very similar.

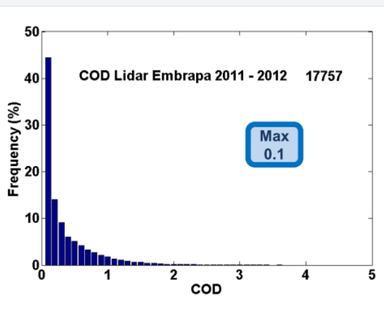
Experimental Site and Instrumentation

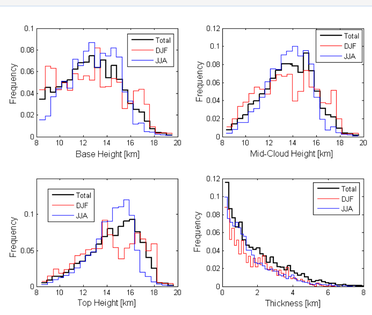


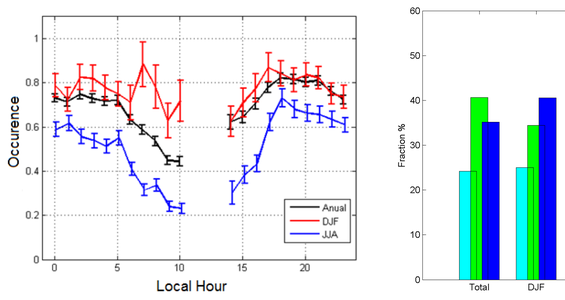
Ground-Based Lidar: Characterization of Cirrus Clouds – 2011 e 2012

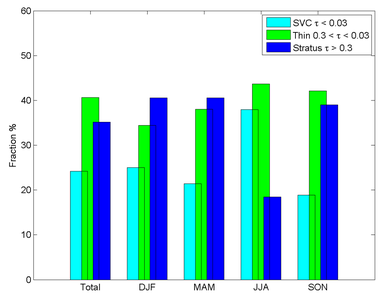
Results of cirrus cloud measurements using the ground-based lidar at the EMBRAPA site. More than 50,000 vertical profiles with time resolution of 5 min were measured. For the ground-based lidar, we consider as cirrus clouds any cloud detected over 8km, having temperatures lower than -20 ° C

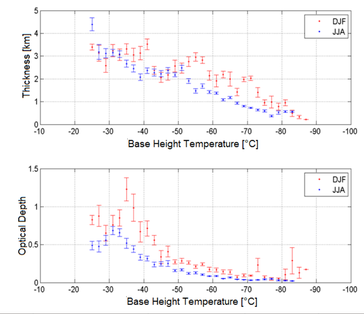


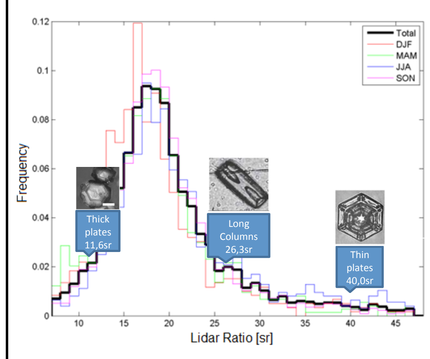






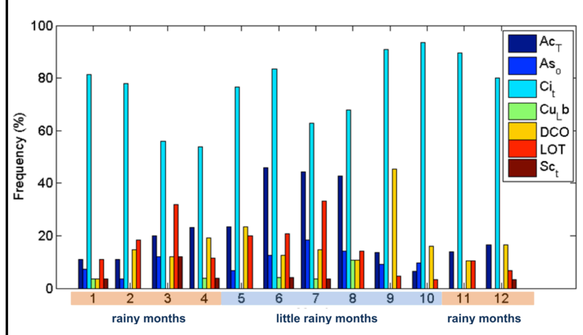


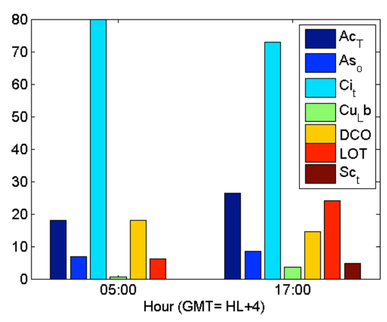




	Total	DJF	MAM	JJA	SON
Temporal Frequency of Occurrence [%]	71.0	78.1	82.8	52.0	77.3
Base Altitude [km]	12.5	12.5	12.6	12.6	12.4
std. dev.	2.4	2.7	2.5	2.1	2.3
Top Altitude [km]	14.3	14.1	14.4	14.1	14.4
std. dev.	2.2	2.4	2.2	1.8	2.3
Thickness [km]	1.82	1.61	1.87	1.52	2.00
std. dev.	1.53	1.30	1.62	1.30	1.63
Maximum Backscatter Altitude [km]	13.0	13.0	13.1	13.1	13.0
std. dev.	2.4	2.7	2.5	2.0	2.3
Temperature at Max. Backs. Altitude [° C]	-56.9	-56.8	-57.1	-57.5	-56.5
std. dev.	17.2	19.7	17.6	14.7	17.2
Lidar Ratio [sr]	20.0	18.6	19.0	21.5	19.8
std. dev.	6.8	6.5	6.5	7.7	6.2
Subvisual Cirrus [%]	24.2	25.0	21.4	37.9	18.9
Thin Cirrus [%]	40.7	34.4	38.0	43.6	42.1
Cirrus Stratus [%]	35.1	40.6	40.5	18.5	39.0

Caliop Cloud products – 2011 to 2014





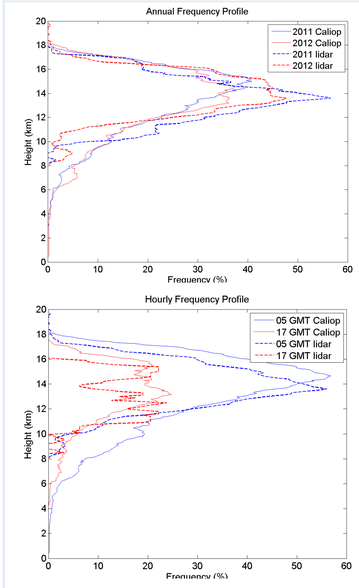
Cloud subtype	Symbol
Low Overcast, Transparent	LOT
Low Overcast, Opaque	LOO
transition Stratocumulus	Sct
low, Broken Cumulus	Culb
Altocumulus (transparent)	Act
Altostratus (opaque)	Aso
Cirrus (transparent)	Cit
Deep Convective (Opaque)	DCO
All subtypes	ALL

Atmospheric Volume Description (AVD) in combination with CAD Score and Extinction QC Flag 532 are used to find cloud subtypes presence. COD of clouds subtypes are assumed when this cloud subtype are alone in the atmospheric column. Cloud frequency is calculated as a ratio of amount of cloud subtype and amount of all column measurements. Cloud frequency profile is computed as the ratio of cloud amount and all measurements in each altitude.

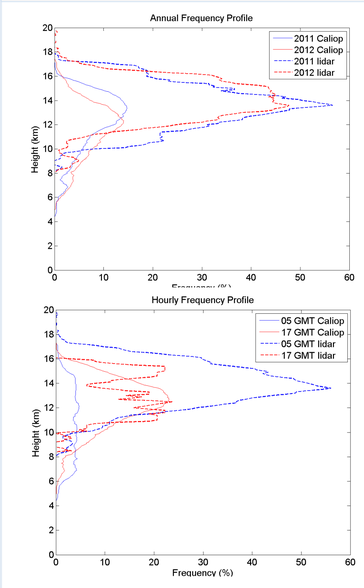
Cirrus Cloud Comparison between CALIOP and Ground-Based Lidar

Comparison between cirrus clouds measurements with ground-based lidar (clouds over 8km) and CTI and DOC CALIOP products for the big box

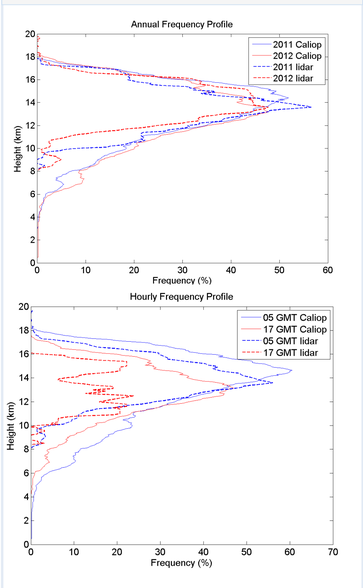
Cirrus (transparent) Subtype

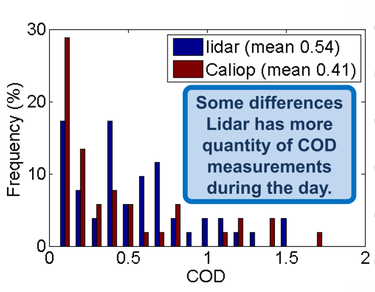


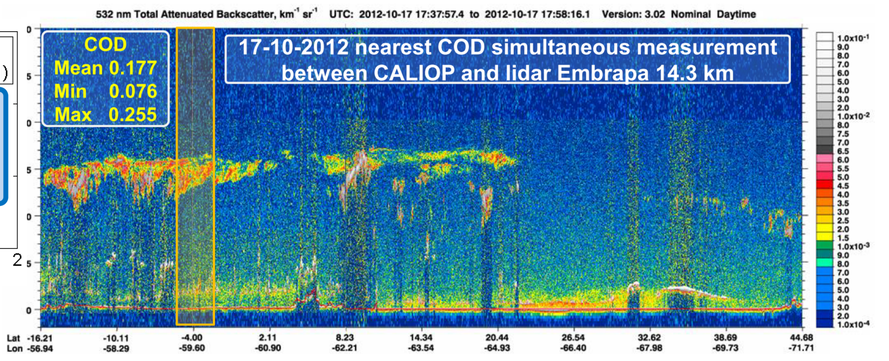
Deep Convective (opaque) Subtype



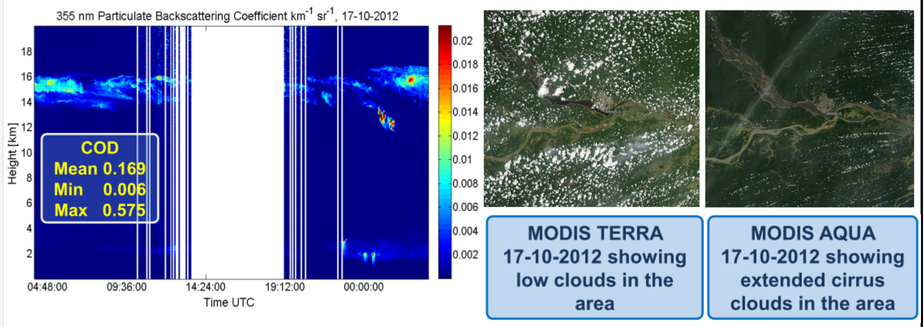
Cti + DCO subtypes







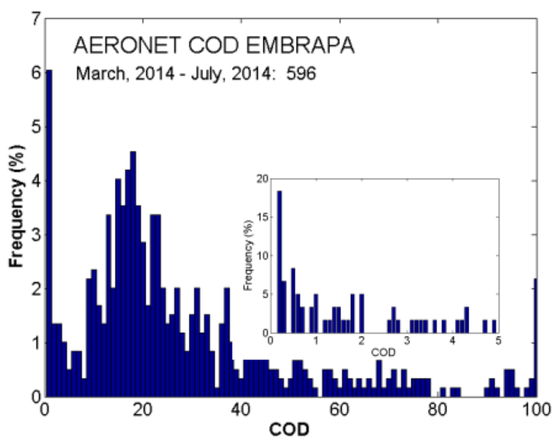
There are differences between COD determined by both instruments due the distances that separates the measurements the maximum distance (92 km) and minimum (14.3 km). The nearest measurements during the day October 17, 2012, shows a similar results in the COD and the altitude of the cirrus clouds determined from the both instruments.

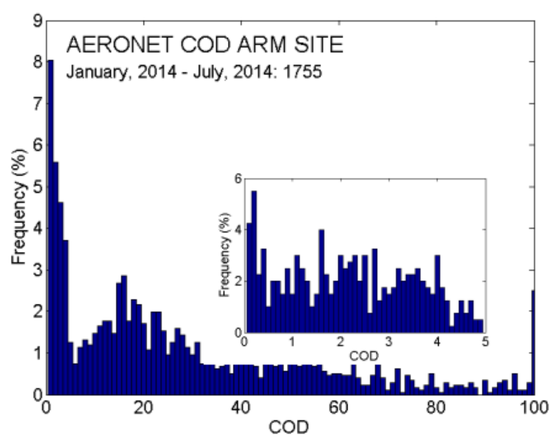


MODIS TERRA 17-10-2012 showing low clouds in the area

MODIS AQUA 17-10-2012 showing extended cirrus clouds in the area

COD from Sunphotometro CIMEL CE-318





The maximum frequency is found in the COD interval centered in 1. There are other peak in the COD histograms in both sites in the intervals centered at 16 and 18. There is not enough values of COD.

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Laboratório de Física da Atmosfera Thanks for INPA-LBA and EMBRAPA-Amazônia Ocidental Support