Ground Based Remote Sensing and In Situ Measurements of Tropical and Anvil Cirrus Properties. Radiative effects study in Amazonia during September – October 2014.

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Abstract:

Geometrical characteristics through the period of two years 2011 and 2012, are the mean values of 12.4 ± 2.0 km, 14.3 ± 2.2 km to base and top altitude respectively. During one week of measurements between 30th August and 7th September of 2011, maximum/minimum were 17.9 km/6.0 km, 19.5 km/6.5 km and 19.2 km/6.4 km, for base, top and maximum backscattering heights, respectively. The optical properties of cirrus clouds determined for this period with lidar shows the Cloud Optical Depth (COD) diurnal variation, low values during local night and high values during local daytime. But the COD values are not higher than 0.7.

These results show there are cirrus clouds in the altitude where the HALO aircraft has their maximum flight range (12.501 km). Thus, it is possible to implement some measurements on tropical cirrus and anvil clouds in the ACONVEX site with the set of instruments on the HALO aircraft. Using collocated lidar and HALO in situ microphysical measurements could be possible to develop some studies about shortwave radiative transfer in tropical anvil and cirrus clouds. This is a proposal to implement the study as a part of the ACRIDICON - CHUVA Campaign during September-October 2014.

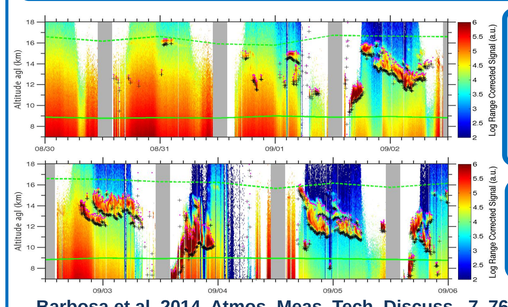
Proposed Objectives:

Characterize the changes of cirrus cloud and anvils properties during their life cycle and the effects of cirrus on radiation.

Can we obtain the radiative forcing exerted by tropical subvisible cirrus and anvils by using simultaneous measurements in situ and ground - based remote sensing; and radiative modeling?

Cirrus Characteristics with lidar at EMBRAPA:

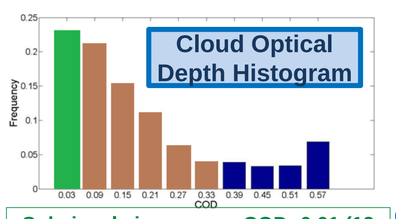
Week 30th August - 7th September of 2011



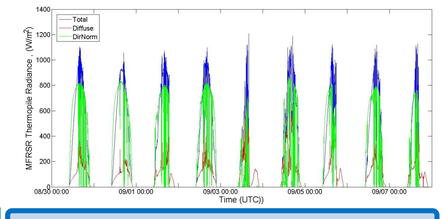
Lidar range corrected signal
Cloud base (+, black) and top (o, magenta). Full and dashed green lines indicate the −25 °C and tropopause heights. Gray regions correspond to local solar noon.

Base: 11.5 ± 5.4 km
Top: 13.4 ± 6.5 km

Barbosa et al, 2014, Atmos. Meas. Tech. Discuss., 7, 769-817, doi:10.5194/amtd-7-769-2014,



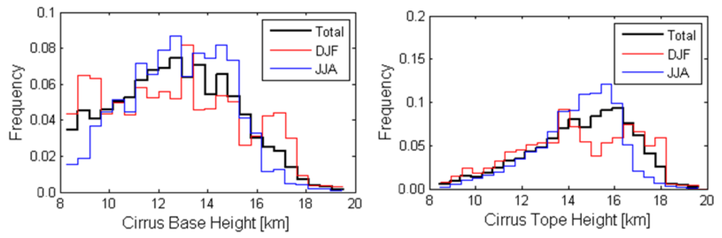
Cloud Optical Depth Histogram



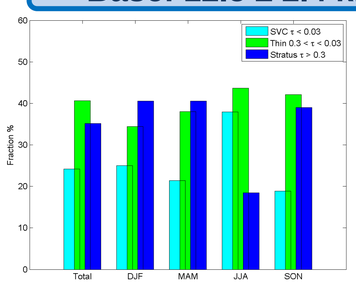
Solar radiance measured with Multi Filter Shadow band Radiometer

Subvisual cirrus mean COD: 0.01 (13 %)
Thin cirrus mean COD: 0.13 (65 %)
Thick cirrus mean COD: 0.48 (22 %)

Years 2011 – 2012



Cloud Base and Top Histograms
Base: 12.5 ± 2.4 km Top: 14.3 ± 2.2 km



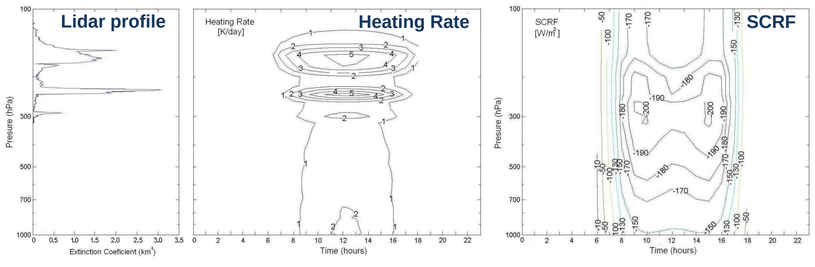
Frequency of the three types of Cirrus Clouds
Subvisual cirrus 24 %
Thin cirrus 41 %
Thick cirrus 35 %

Gouveia et al, 2014, Poster No. 10 ACRIDICON – CHUVA.

Expected Studies:

Profiles of Cirrus clouds and Anvils Radiative Effect

Example of study in Camagüey Cuba



Barja and Antuña, 2011, Atmos. Chem. Phys., 11, 8625–8634, 2011, doi:10.5194/acp-11-8625-2011

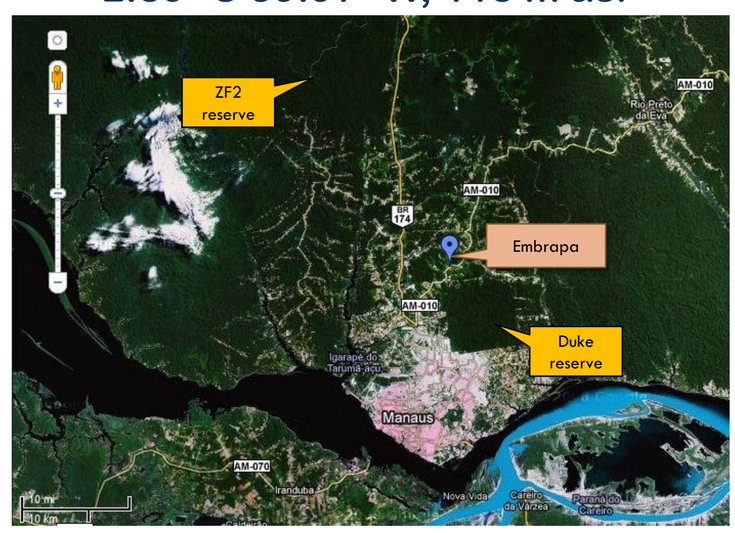
The radiative transfer modeling needs to be fed with size of cloud particles, cloud optical depth, etc. Usually some of these values are assumed from studies in other regions. With measurements from the instruments onboard HALO (CCP, CAS-DPOL, CVI and UHSAS-A) will be possible to obtain these magnitudes for the studied clouds.

Comparison of the measured and modelling magnitudes

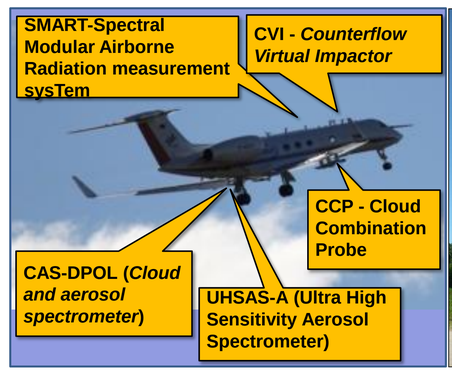
The profiles of cloud radiative forcing obtained by modeling could be compared with measurements radiance and irradiance from SMART onboard HALO inside cirrus clouds. Also the values of radiative transfer modelling could be contrasted with ground based measurements of solar irradiance (MFSR).

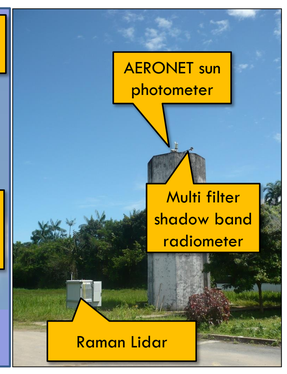
The installation of the WALES H_2O DIAL + HSR channel on the HALO could be an added value to the mission and will enable the intercomparison with lidar on the ground.

EMBRAPA Site
2.89° S 59.97° W, 118 m asl



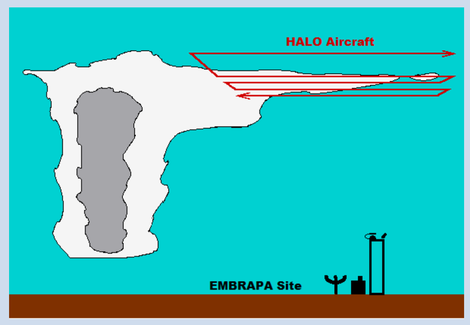
Instruments





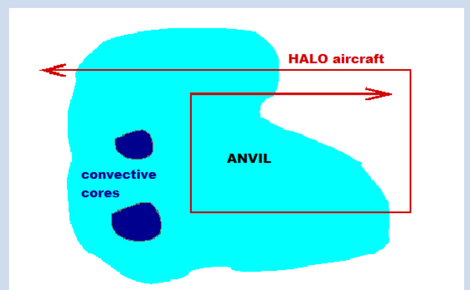
Possible Flight Plans:

Side view



Sampling at different altitudes within cirrus and anvils.

Top view



Horizontal sampling at different distances from the convective cores.

Adapted from https://cloud1.arc.nasa.gov/crystalface/flightplans.html

Valuable issues:

1. Simultaneous measurements of the selected anvil and cirrus clouds with instruments onboard HALO and ground-base lidar and radiometers.
2. Sample the anvil microphysical properties with as much vertical and horizontal coverage as possible and through as much of the anvil lifecycle as possible using instruments onboard HALO.
3. Measure the radiative fluxes above and below the cirrus and anvils using instruments onboard HALO and ground-based radiometers.
4. Is there a possibilities to install a lidar in HALO? The WALES H_2O DIAL + HSR channel was used in ML-Cirrus mission.
   http://www.pa.op.dlr.de/ML- CIRRUS/instrumentation.html

Workshop on convective clouds planned to be studied within the joint ACRIDICON – CHUVA Campaign, May 20 - 22, 2014, São José dos Campos, INPE, Brazil .