Study Case of Cirrus Cloud Radiative Effect Using Lidar Backscatter Data, Radiative Transfer Code And Solar Radiation Measurements In Manaus Region.

Boris BARJA, Henrique BARBOSA, Diego GOUVEIA and JORGE ROSAS

Atmospheric Physics Laboratory. Institute of Physics. University of São Paulo. Brazil.

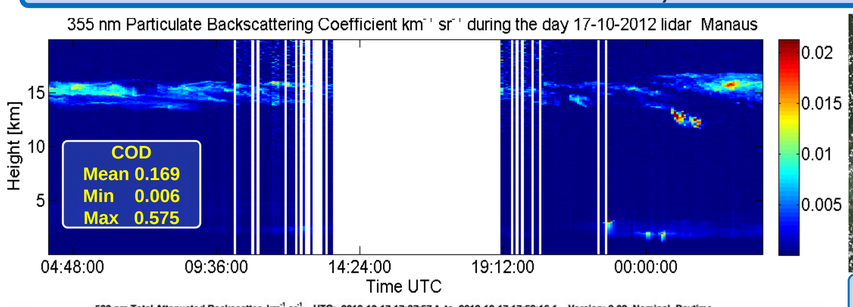
Atmospheric Optics Group of Camagüey. Meteorological Institute of Cuba. Cuba.

Corresponding author email: bbarja@if.usp.br

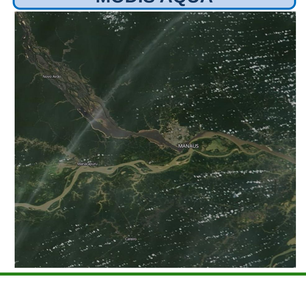
Abstract:

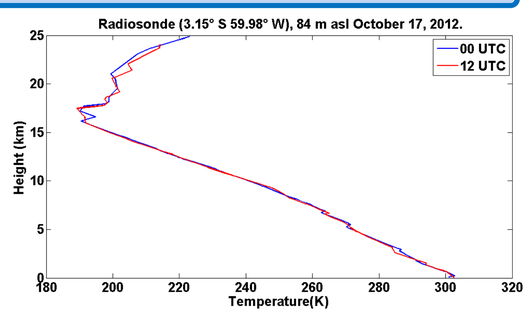
Cirrus clouds radiative effects on shortwave radiation (CRE) have been studied combining lidar measurements with a radiative transfer code and solar radiation measurements at ground. For this purpose, during one day October 17, 2012 with persistent cirrus clouds over the Lidar site was analyzed. The radiative transfer code was run with the local conditions at the site, using water vapor and temperature profiles from the operational radiosondes (~30 km) as well as locally measured surface albedo (0.16). Runs of the atmospheric radiative transfer code were conducted both under the presence of cirrus clouds and in clear sky conditions. The calculated CRE values have negative sign, the instantaneous cloud radiative effect during the day ranging from **−0.003 W/m² to −9 W/m²**, at the top of atmosphere and lower modular values in the surface. The CRE vary according to the different optical depths of thin cirrus clouds. A close correlation between the negative cirrus radiative effect and optical depth (anticorrelation) was found at the top of the atmosphere and at the surface when broadband solar irradiances calculations are analyzed. This was found also for different intervals of wavelength in the solar spectrum (near infrared, visible, and ultraviolet).

October 17, 2012. Occurrence of cirrus cloud.

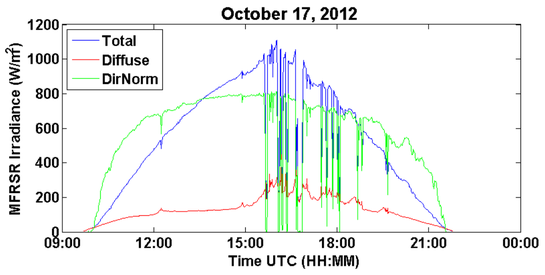


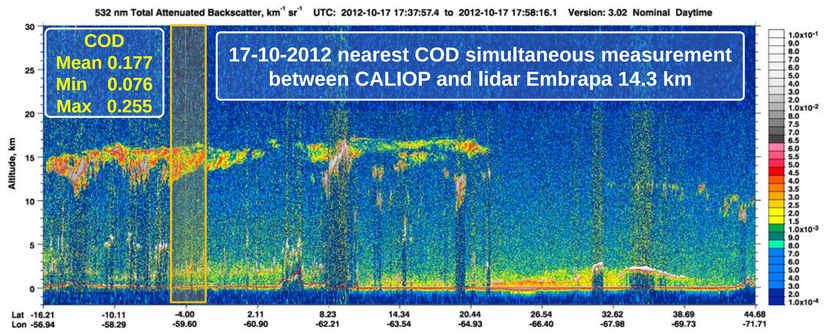
MODIS TERRA 17-10-2012 showing low clouds in the area and extended cirrus clouds MODIS AQUA



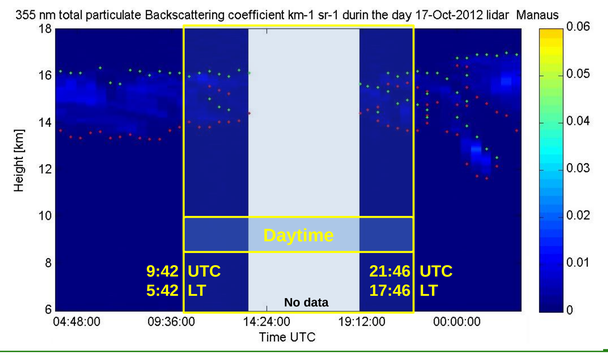


Presence of some low clouds after midday and cirrus clouds during all the day

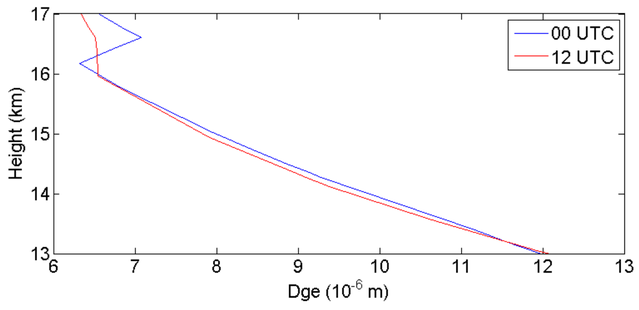




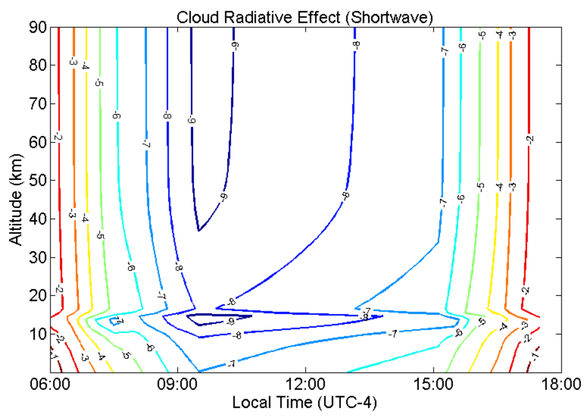
Inputs to the radiative transfer model: cloud optical depth and particle size.

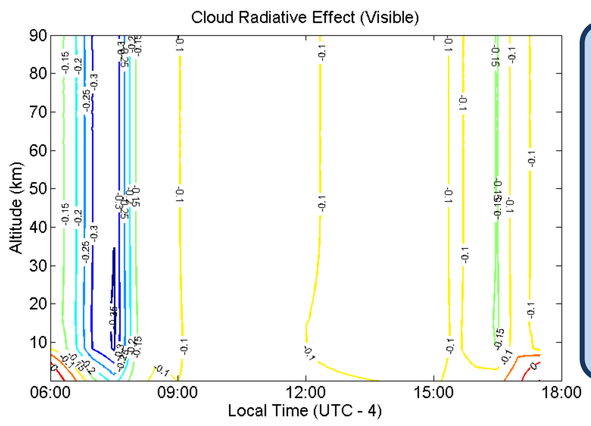


30 minutes mean backscattering coefficient profiles [$km^{-1}sr^{-1}$]. Multiplied by a constant lidar ratio in altitude. In order to obtain the extinction coefficient profile. The particle effective radius is obtained from the empirical expression ussing the temperature sounding.

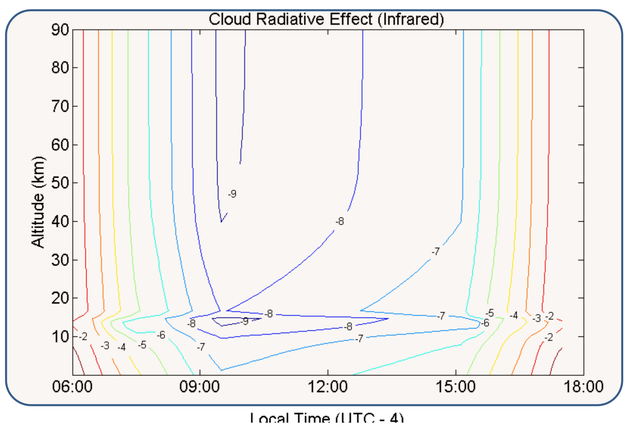


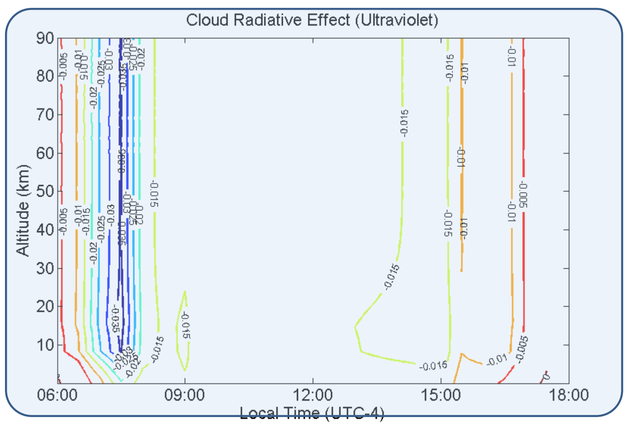
Cloud Radiative Effect in the Shortwave Broadband and Spectrum





There are no data during the midday time, the highest CRE occur during near the midday in the Top of the Atmosphere and Surface. Also in the atmospheric column where the cirrus are present. The Higher contribution to the CRE in the solar spectrum is in the near infrared wavelength interval. The lower contribution in the ultraviolet wavelength range.

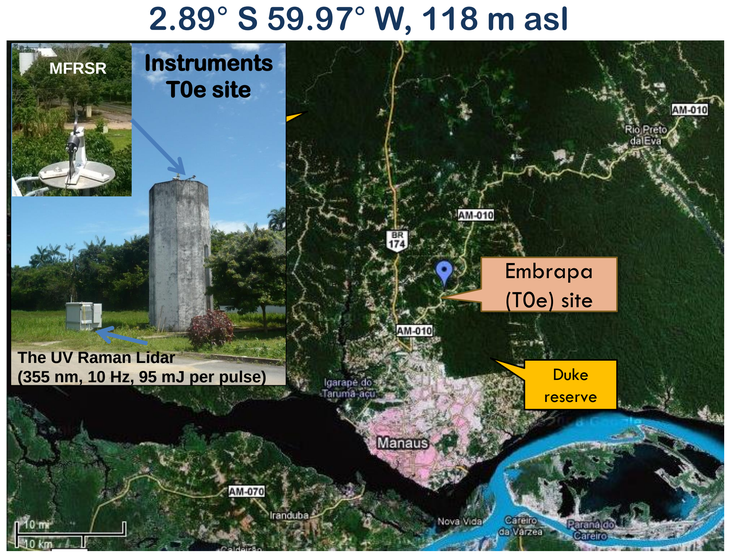




There is necessary to extend the study to more number the cases. And to evaluate the possibility to obtain measurements during the midday with lidar.

EMBRAPA T0e Site

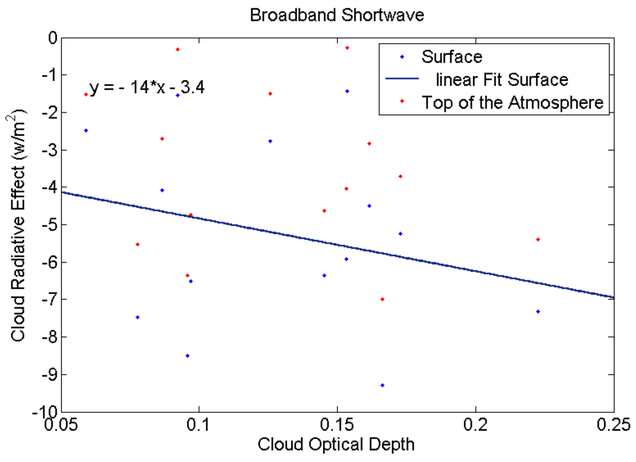
2.89° S 59.97° W, 118 m asl



Radiative transfer model:

- Geophysical Fluid Dynamics Laboratory. (Freidenreich, and Ramaswamy, 1999).
- Particulate scattering and absorption, Rayleigh scattering, and gaseous absorption by O2, O3, CO2, and H2O.
- 25 pseudo-monochromatic bands.
- δ-Eddington method and the "adding" technique.
- Temperature and water vapor mixing ratio vertical profiles obtained from the mean aerological sounding in the site with the dataset from 1981 to 1988.
- Fu´s parameterization represent the solar radiative properties of cirrus clouds.
- Input to the model of the optical depths and the generalized effective size ($D_{ge} = 7.698 \exp\left(\frac{T+75}{39}\right)$).
- We use the extinction profile of the cirrus clouds obtained with lidar to get the "optical depth profile" of the cirrus cloud that will be introduced in the radiative transfer code. Assuming the same cirrus clouds during the midday period without Lidar measurements.
- Aerosols was considered in the altitude below 2 km, with an aerosol type clean continental and optical depth of 0.2.
- A surface albedo of 0.16 reported for this period in the region was assumed in the calculations.

COD and CRE Relation



There is an anticorrelation between COD and CRE, there is a low quantity of data only for one day and instantaneous values of CRE.

Remarks:

1. Maximum CRE occur during the midday, the contribution to the shortwave broadband CRE is higher for the near infrared interval and lower for the ultraviolet wavelength interval.
2. The influence of the cirrus clouds on the radition is clear in the region where there arre present also affect the net solar radiation in the top of the atmosphere and surface.
3. There is a linear anticorrelation between CRE and COD in the broadband shortwave interval.
4. There is necessary to extend the study to more number the cases.

Acknowledgment to the CALIPSO Search and Subsetting web application team.