Thermodynamic indexes and comparison between radiosonde and Era-Interim reanalysis

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Introduction

Thermodynamic indexes are important to determine the atmospheric conditions of a certain region. They are LCL, LFC, CINE and CAPE, and can be calculated from thermodynamics diagrams like the figure 6. This diagram can be generated by radiosondes (figure 3) or atmospheric models. The radiosondes cover only a small area, while the model covers large areas around the globe, and has data since 1979 (Era-Interim reanalysis). Therefore, it's of great importance to know if it's possible to replace the radiosonde data by model data. The objective of this work, was to study the seasonality (wet season is Jan/Mar and dry season is Aug/Nov) of the thermodynamic indexes during the GOAmazon2014/5 experiment (radiosondes) and compare the results obtained with the same generated by the model.

Data and Methods

The set of data was obtained by radiosondes launched on T3 site near Manaus (figure 2) during GOAmazon2014/5 campaign and the model data was obtained at the nearest grid point where the radiosondes were launched (3 S, 60 W) by the electronic page of the European Centre for Medium-Range Weather Forecasts (ECMWF). We used to calculate the LCL, the same equation documented on the page of the University of Wyoming, using as input values, averages of T and RH (temperature and relative humidity) in the 0-100 and 0-500m layers. The other thermodynamic indexes were obtained by graphical methods using the thermodynamic diagram of the figure 6

Figure 1: Image of T3 site

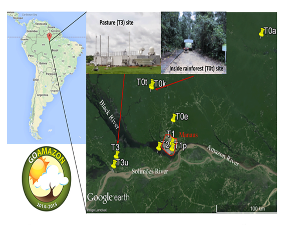

Figure 2: T3 site location (-3.2 S,-60.6 W).

Figure 3: Radiosonde Vaisala model RS92-SGP.

Figure 4: weather balloon with coupled radiosonde.

Figure 5: Cloud with large vertical development.

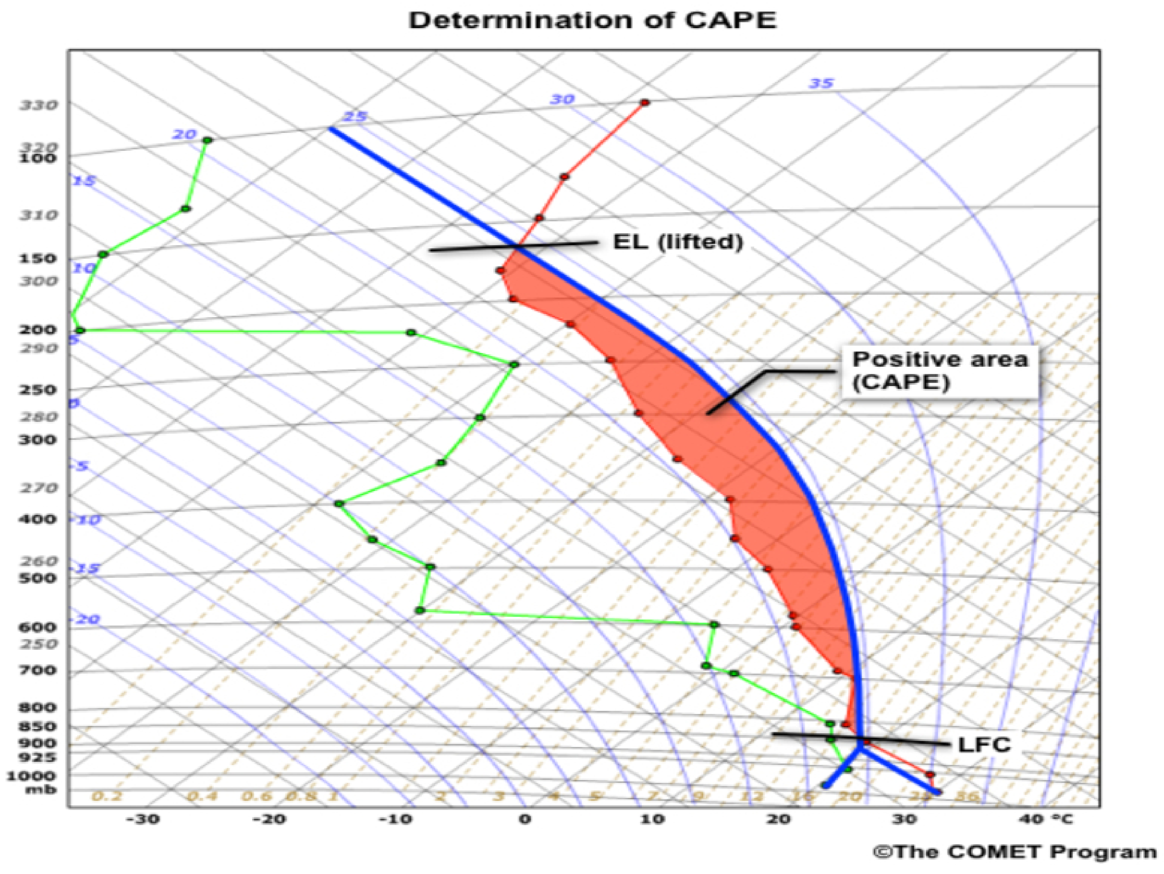

Figure 6: Thermodynamic profile.

Results

The analysis of the average profiles of RH (generated by radiosonde) by the figure 7, shows that 2015 had a more intense dry season than 2014, especially at high altitudes. This generates higher LCLs in dry season of 2015, as shown in figure 9 (global maximum in 2015-dry). As expected from the paper of Collow et.al (2016), in the dry season of 2014, LCL and CAPE increased, however, in the dry season of 2015, the CAPE decreases (figure 9), which was not expected. The figure 8 shows that the model hits RH on the surface at 18 Z, less in the dry season of 2015. As we can see by the adjustment coefficients of the figure 10 in the table 1, the model has good compatibility with the radiosondes at 18 Z for the 0-100m methodology. This table also shows that despite an improvement in the linear coefficient of 0, 6 and 12 Z, the linear coefficients remain incompatible with 1. Finally, the figure 11 shows that even on average, the CAPE of the model is significantly smaller than the radiosonde, both being totally incompatible.

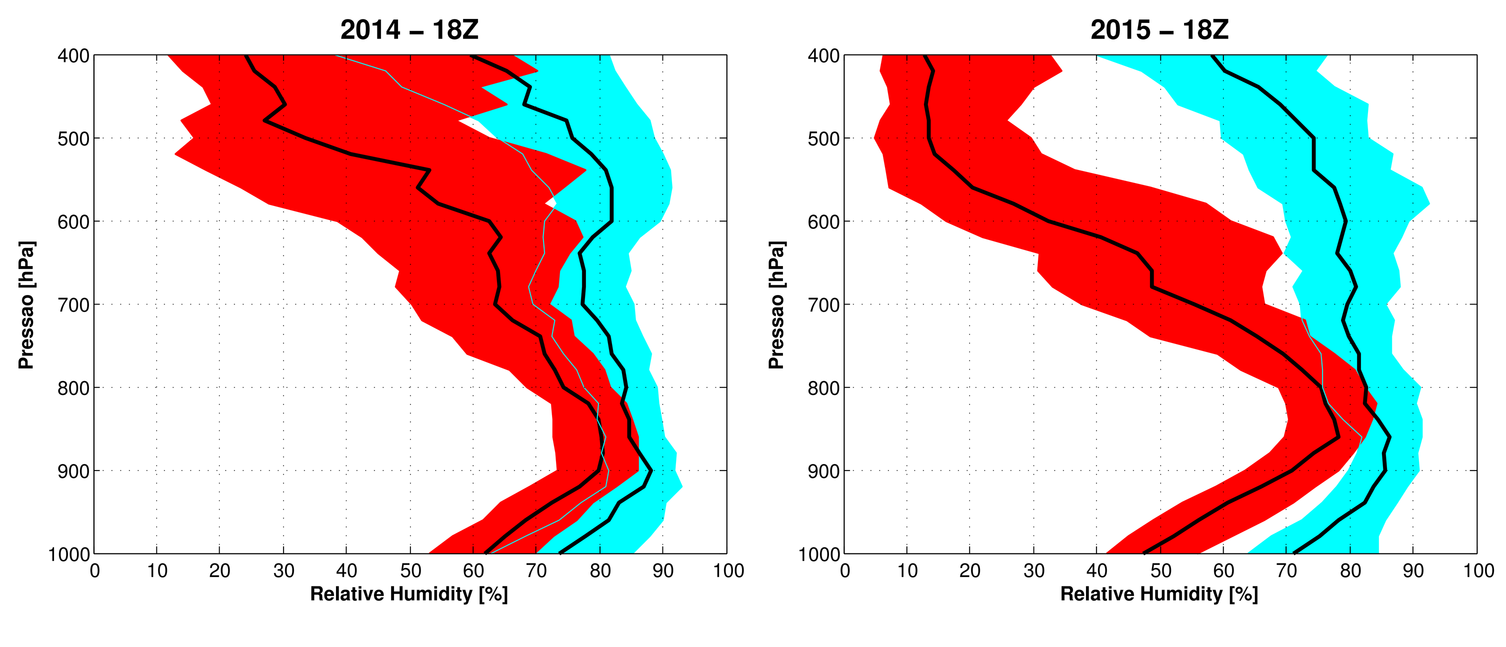

Figure 7: Average relative humidity profiles at 18 Z of the **radiosonde**, for the dry (red) and rainy (blue) seasons of 2014 (left) and 2015 (right).

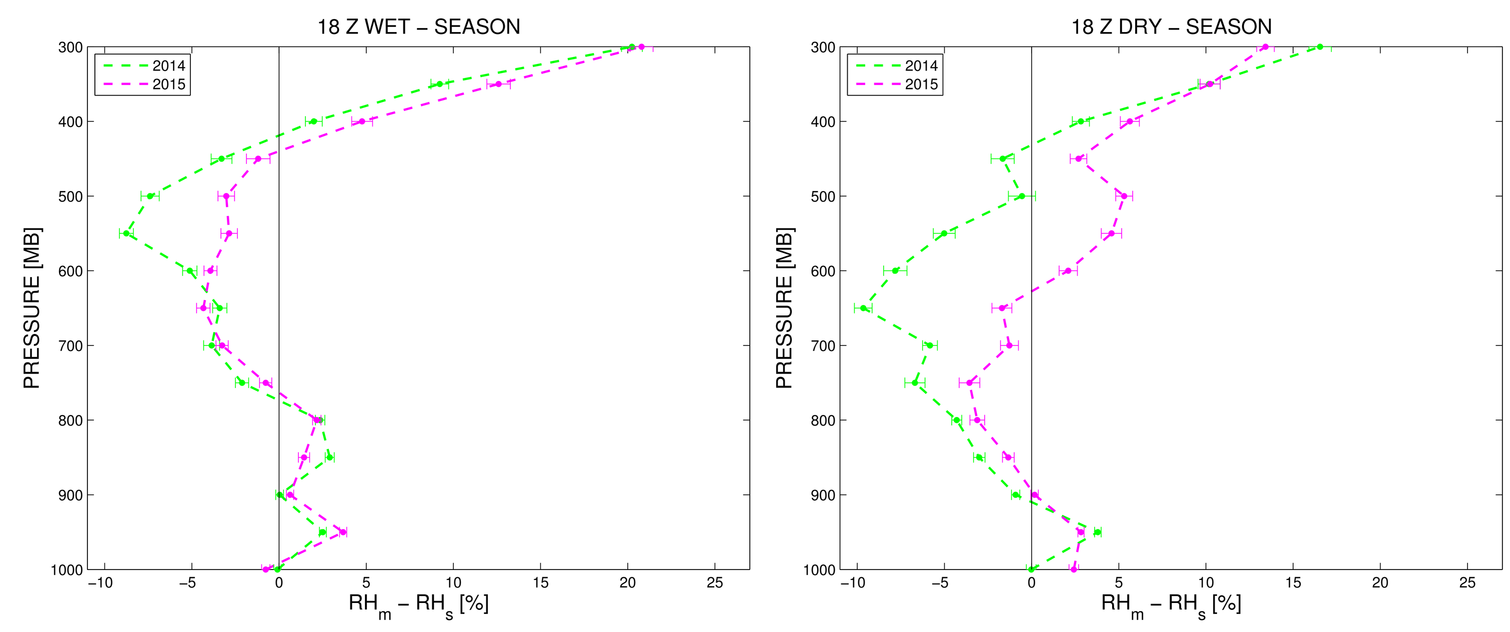

Figure 8: Profile of relative humidity differences between model and radiosonde.

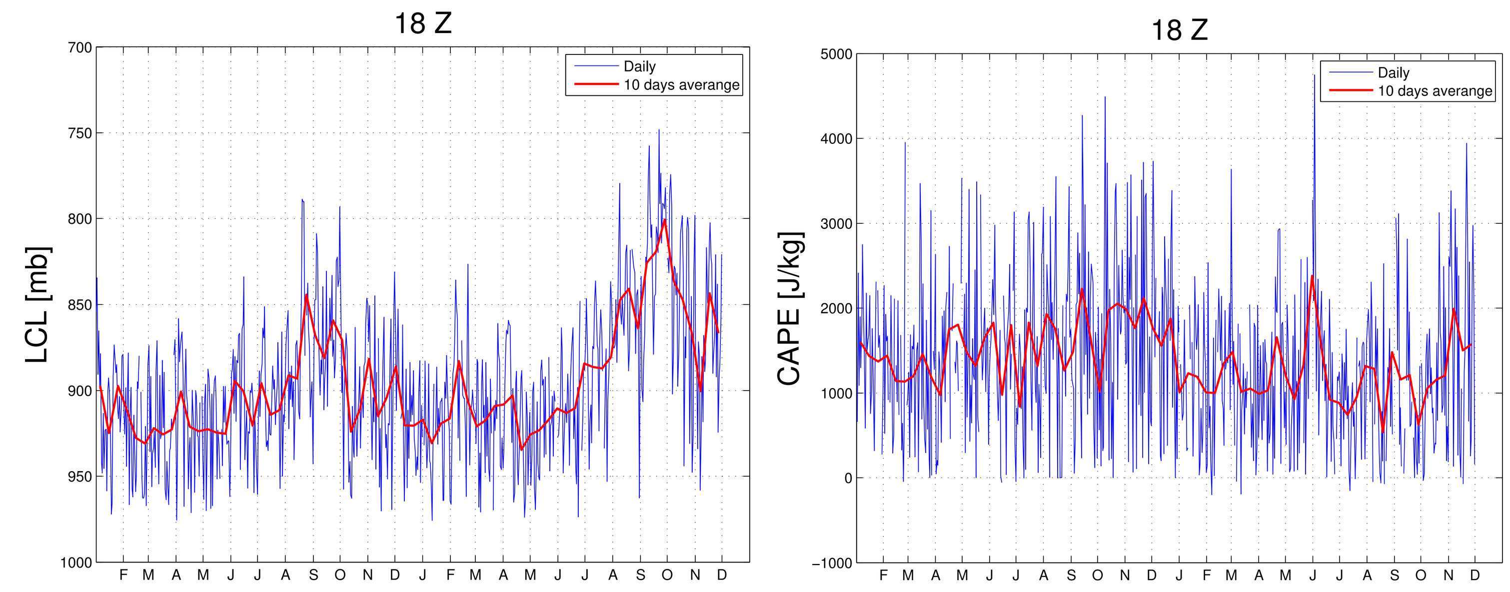

Figure 9: Time series of LCL and CAPE

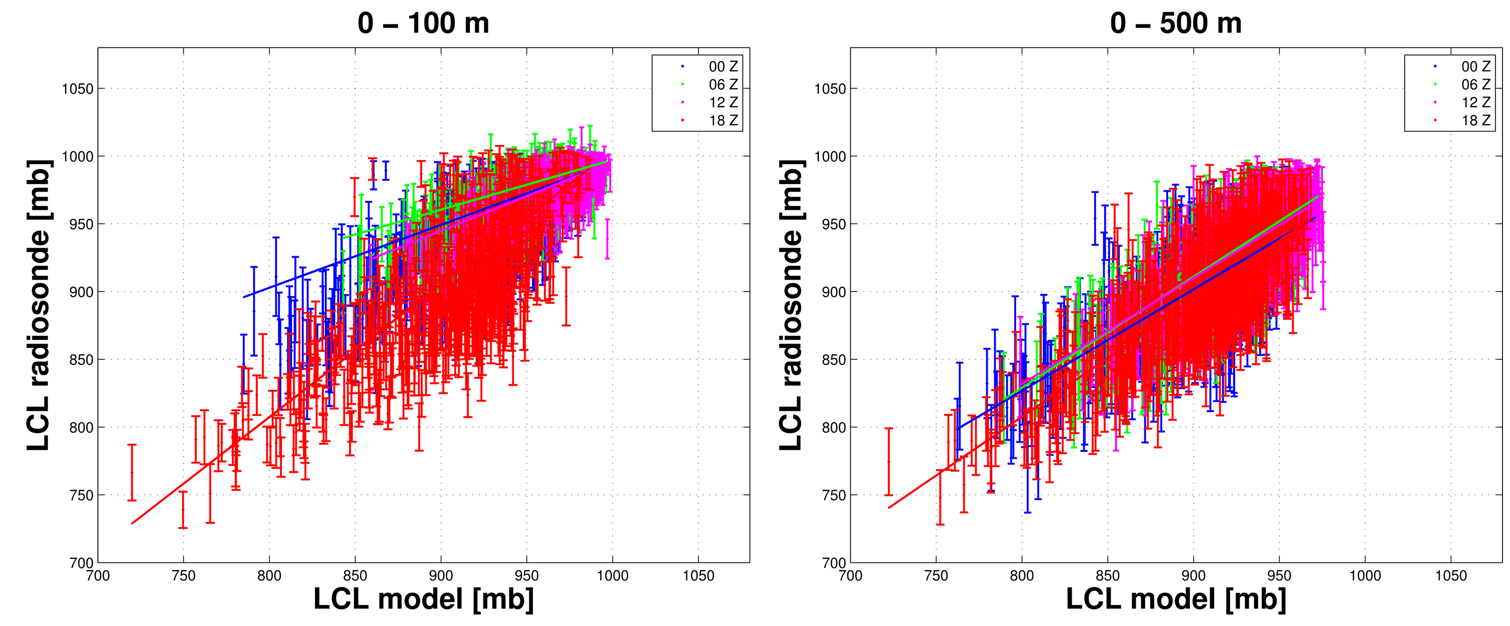

Figure 10: LCL linear adjustments between model and radiosonde for each time of all values over two years (2014 and 2015).

0 - 100 m			0 - 500 m		
Time	**Angular**	**Linear[mb]**	**Time**	**Angular**	**Linear[mb]**
00 Z	0.46(1)	531(13)	00 Z	0.75(2)	229(22)
06 Z	0.37(2)	630(18)	06 Z	0.82(4)	175(33)
12 Z	0.51(2)	483(20)	12 Z	0.78(4)	206(34)
18 Z	0.98(1)	22(11)	18 Z	0.87(2)	114(18)

Table 1: Table of coefficients of the linear adjustment of the figure 10.

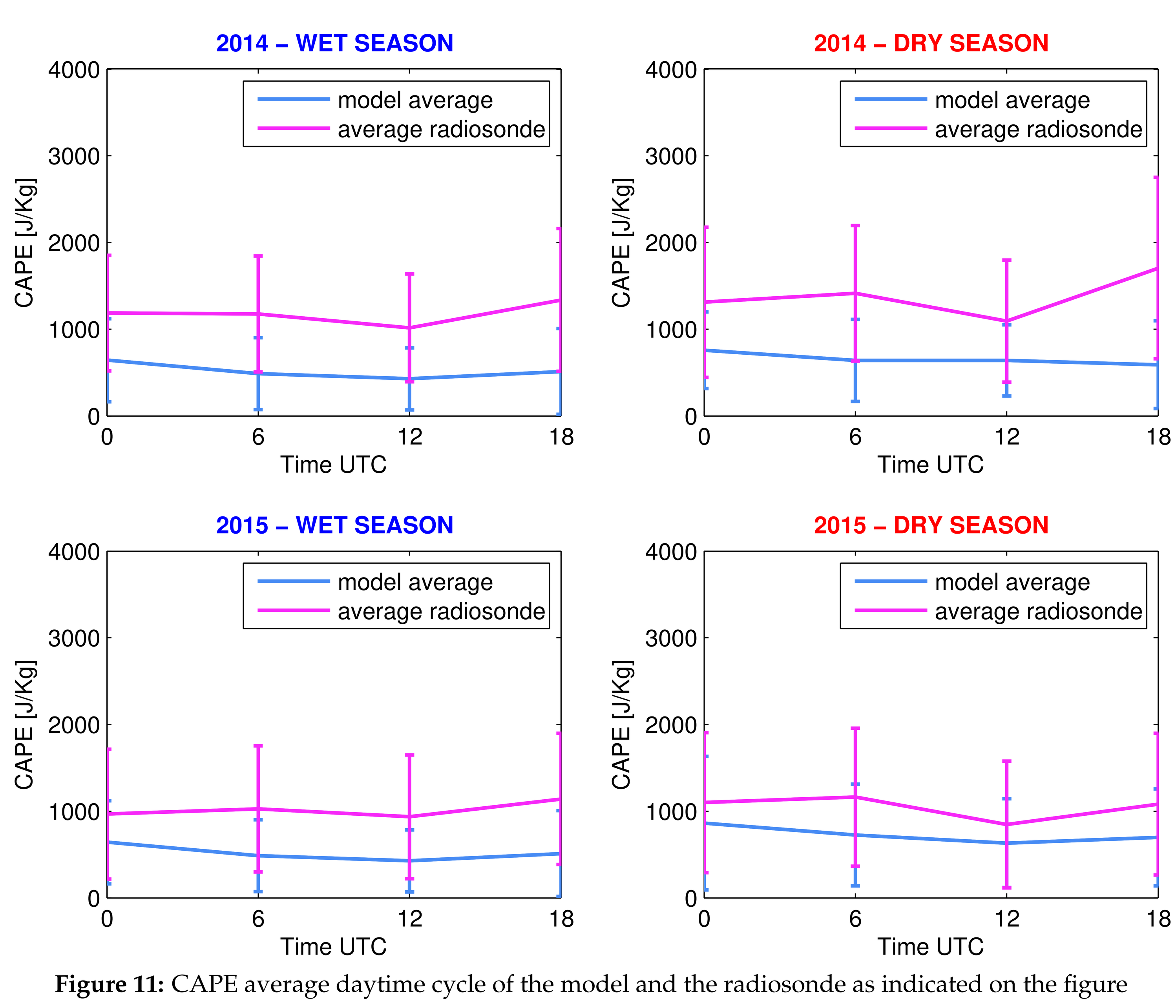

Figure 11: CAPE average daytime cycle of the model and the radiosonde as indicated on the figure

Conclusions

- For the data of the radiosonde, we obtain the seasonal behavior expected by the theory in 2014. In other words, LCL, LFC, CINE and CAPE increased their value in the dry season. This does not happen in 2015 which was not expected.
- The LCL of the model is compatible with radiosonde at 18 Z for the 0-100m methodology. For the 0-500m methodology, the LCL values of the model are only on average compatible with radiosondes.
- On average, the CAPE of the model was totally incompatible with the radiosonde.

References

Collow, A. B. M., M. A. Miller, and L. C. Trabachino (2016), Cloudiness over the Amazon rainforest: Meteorology and thermodynamics, J. Geophys. Res. Atmos., 121, 79908005, doi:10.1002/2016JD024848.