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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cloud Characteristics, Thermodynamic Controls and Radiative Impacts During the Observations and Modeling of the Green Ocean Amazon (GoAmazon2014/5) Experiment" *by* Scott E. Giangrande et al.

Anonymous Referee #1

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This manuscript summarizes observational data collected during the GoAmazon campaign, emphasizing on cloud/precipitation-related properties, the dry-vs-wet season contrast, as well as diurnal variation.

As the first field campaign in tropical rainforest region so comprehensive, I think the results presented here are interesting, and will be useful to the community. Overall the manuscript is well-written, and I look forward to seeing this manuscript published on ACP. I do have four general comments that the authors could consider, and would, in my opinion, make the manuscript more accessible and useful to readers, especially

those from modeling side.

General comments:

First, proxies of uncertainty/variability (e.g., standard error, standard variation, or interquartile range) could be added to Figure 7 and Table 2 (and Table 3 if the authors have the necessary data). While Table 2 has been visualized, with some variation/extension, in Figures 10 and 11, an additional figure with values listed in Table 2 plus uncertainty/variability could make the results easier to digest.

Second, some analysis of TRMM 3B42 data have shown that the diurnal cycle at/around the GoAmazon site is rather unique compared with other tropical locations over land because the precipitation at the site peaks around noon instead of late afternoon (e.g., this figure from the AMWG Variability Diagnostics website: http://www.cgd.ucar.edu/cms/cchen/VDIAG_cam5_F2000_var/hourly/obs/TRIMM_PRECT.5(and Hourdin et al. 2013 (LMDZ5B: the atmospheric component of the IPSL climate model with revisited parameterizations for clouds and convection. Clim. Dyn. Figure 17, lower panel) seems to be able to reproduce this intriguing pattern of diurnal cycle with their modified convective scheme (of course, with a caveat, i.e., how the diurnal cycle is defined). This characteristic of precipitation diurnal cycle is somewhat consistent with Figure 7 in Tang et al. 2016 (ACP) or Figure 7 in the present manuscript. I think it would be helpful if the authors could, to the best of their current knowledge, and with the dry-vs-wet season contrast at the GoAmazon site in mind, add a short paragraph or two to comment on the uniqueness of the GoAmazon site (i.e., whether the diurnal cycle at this site is really different from other sites) and, if this site is indeed unique, to synthesize the similarities and differences of the precipitation/CF diurnal cycle at the GoAmazon site compared with other tropical locations over land (e.g., the larger Amazon basin, and/or Congo basin and maritime continent).

Third, partitioning precipitation (e.g., into convective vs stratiform precipitation) can be tricky, and the way adopted by different parameterizations differ. In some cases,

it may be difficult (if not impossible) to draw an analogy between observation and a parameterization. Therefore, it would be helpful if the authors could add a line or two to give some details regarding the definition of convective and stratiform rain (I thought the former is defined as all precipitation associated with shallow, congestus, deep convective, and altocumulus, but this would be inconsistent with the description in p11, l. 3: '... stratiform precipitation (identified as "Deep Convection" in ... ' which is not obvious to me since bright band is not used as a criterion for the could-type algorithm ...). Furthermore, given the potential issue of precipitation partitioning, precipitation rate conditioned on different cloud types could eventually be even more valuable for modeling groups (e.g., add an additional figure like Figure 11, but for precipitation rate; this last suggestion is totally optional for the authors).

Fourth, both Figures 10 and 11 seem to put more emphasis on SW than LW. Both SW and LW are important for quantifying local energy budget, and some recent modeling studies have demonstrated that LW could impact the development and maintenance of organized system, which has been documented by Bu et al. 2017 (The influences of boundary layer mixing and cloud-radiative forcing on tropical cyclone size. JAS), and the LW feedback is essential to convective self-aggregation under certain conditions, which has been summarized in Wing et al. 2017 (Convective self-aggregation in numerical simulations: a review. Surv. Geophys. Sec. 3.2). Given this increasing interests in LW-related processes, the authors could consider to add additional LW information to Figures 10 and 11.

Specific comments:

p3, l. 13: "...unique precipitation cycles as compared to the conditions over the larger Amazon basin". Please see my second general comment.

p3, l. 24: "environmental forcing datasets" could be more specific.

p4, l. 7: "a cloud-type classification algorithm" refers to Table 1?

p4, l. 27: "Figure 2 ... average daily profile ... " it would be nice if the original temporal frequencies of the raw data can be mentioned here (from p. 8, l. 17, hourly profile estimates are used).

p5, l. 2: "CAPE, CIN and ... and heightened moisture." Figure 3 (not 2) shows that CIN behaves differently in wet vs dry seasons, but not so much for CAPE. But in any event, the behavior of CAPE and CIN described here is not clear from Figure 2.

p5, l. 22: "increased CIN" in terms of magnitude, regardless of its sign?

p5, l. 26: "total advection... of moisture". I assume that this means $-u \cdot \nabla q$ instead of $u \cdot \nabla q$.

p5, l. 33: "The evening and early morning hours exhibit upward air motion confined below 3-4 km". How should we interpret this feature? For instance, based on the first law of thermodynamics, we have $\omega = \dot{p} = p\dot{Q}/c_v T - \gamma p \nabla \cdot u$, where $\dot{Q}$ represents the diabatic heating/cooling rate. Can wc explain the feature by low-level radiative cooling?

p6, l. 2: "positive advection of moisture" means $-u \cdot \nabla q > 0$? (and p9, l. 8.)

p6, l. 2: "Between 4-8 km ... (Fig. 4g)." This is not clear from the figure.

p7, l. 2: "The ARM 95-GHz W-band ARM ..." one of the two ARMs seem redundant.

p7, l. 32: "highlighting locations ... ARSCL methods." It seems to me that the determination of cloud-top is improved by RWP, and cloud-base by MPL. Is this summary correct?

p8, l. 16: "... Table 2." Please see my first comment. It would be helpful to mention at this point that a variation of Table 2 is plotted in Figures 10 and 11.

p8, l. 18: "Measurable precipitation (> 1 mm) ... light/trace precipitation (< 1 mm)." Is this accumulated precipitation over one day or one hour?

p8, l. 24: "... below normal ..." A number representing the "normal" accumulated

precipitation could be helpful.

p8, l. 27: "... convective and stratiform ..." Please see my third general comment.

p9, l. 30: "inspection of large-scale ... thermodynamics." Totally understandable statement, but isn't it true that the diurnal cycle of high-level clouds is tied to the diurnal cycle of the large-scale dynamics and thermodynamics through deep convection?

p10, l. 13: "profile methods also distinguish columns with convective vertical air motions...as 'convective'." Please see my third general comment. And further details regarding the profiler methods could be informative.

p10, l. 24: "the difference in the mean rainfall rate are less pronounced, implying dry season convection as stronger (instantaneously), since the convective cell coverage is also reduced during the dry season..." Recently Schiro 2017 (Thermodynamic Controls on Deep Convection in the Tropics: Observations and Applications to Modeling) examined animated radar data for the GoAmazon campaign period, and reached a similar conclusion.

p10, l. 28: "... organized systems pass over T3 primarily in the morning hours during the wet season..." Is this consistent with Figure 8(d)?

p10, l. 32: "... with the dry season having less organized cloud contributions ..." Will Figure 9 be similar to Figure 8 if both figures are composed for only precipitating days?

p11, l. 3: "... stratiform ..." Please see my third general comment.

p11, l. 6: "... consistent with a response to increased surface heating and an increase in the surface latent heat flux..." The increments are defined with respect to certain reference values, but it is not clear what these reference values are.

p11, l. 13: "This pattern suggests ... under wet season conditions." If the shielding issue mentioned right after this statement is real, the pattern is also due likely to the suppressed contrast of cirrus cloud, isn't it?

p12, l. 22: "... sample sizes are potentially too small ..." Please see my first general comment. Including uncertainty/variability is a potential solution.

p12, l. 31: "... precipitating convective clouds..." Please see my third general comment. The definition of precipitating and non-precipitating clouds, i.e., the threshold, is not clear.

p16, l. 15: "... suggest clouds influenced by aerosol tend to have larger concentration of smaller droplets and fewer precipitation sized drops for clouds with similar LWC." With the evidence presented in the manuscript (no information about chemical composition, though seasonal wind direction might implicate), it is unclear that how the wet-vs-dry season contrast for larger-scale environment dynamic/thermodynamic conditions would affect the cloud-microphysical processes (e.g., collision-coalescence, precipitation scavenging, ... I suspect that this question can only be answered by later modeling studies), I would modify this sentence as something like "... is consistent with the hypothesis that clouds influenced by aerosol tend to have larger concentration of smaller droplets and fewer precipitation sized drops for clouds with similar LWC."

Figure 2(a), I suppose the hydrometeor frequency is defined with respect to a threshold. Assuming this is true, it would be nice to know the threshold.

Figure 2(c), two additional horizontal lines could help the readers better capture the evolution of CAPE and CIN.

Figure 5(d), the rain rate is discretized with non-trivial units.

Figure 7(b), it is not clear in the caption how a precipitating day is defined by the condition > 1 mm/hr. Does it mean the daily accumulated precipitation > 24 mm, or hourly accumulated precipitation > 1 mm for any hour of the day (also note p12, l. 28)?

Figure 7(c), it is not clear that whether the fractions are calculated for all days or for only precipitating days.

Figure 10(a), the frequency of altostratus is 0 from 6 to 16 (assuming my reading of

the color bar is accurate). Following the usual definition of conditional average, the frequency should be in the denominator. If this is how conditional SW CRE is defined, how could it be well defined for the same period when frequency is 0?

Figure 12(f), The units of LWP are g/kg, which is different from the conventional definition and Figure 5(d). A typo maybe?

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