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Interactive comment on "Marine boundary layer structure as observed by space-based Lidar" *by* T. Luo et al.

Anonymous Referee #1

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Review of "Marine boundary layer structure as observed by space-based lidar" by Luo et al. for publication in Atmospheric Chemistry and Physics

The authors present an investigation of the marine boundary layer in the eastern Pacific, primarily during the MAGIC field campaign, but also extending to a 4 year (2006-2010) climatology using the lidar on the CALIPSO satellite. They examine processes related to decoupling within the boundary layer resulting in a well-mixed layer within the deeper boundary layer structure. In addition to CALIPSO, they examine soundings from the field campaign, AIRS retrieved soundings, and estimates from ECMWF among others. Several issues with the analysis and description need to be addressed before publication in ACP.

Major comments

1) You specify that you do not use any cloudy CALIOP profiles in your estimation of BLH structure and this needs further clarification. Did you remove every profile affected by clouds or only those meeting some threshold? Did this include thin cirrus? How did you calculate MLH under these conditions?

2) In your comparisons between MAGIC soundings and CALIOP, in order to be consistent, you should only examine clear-sky MAGIC soundings. Otherwise you are comparing different conditions. Also, you specify that the collocations are within 2.5 degrees, but you don't specify the time range. What temporal restrictions did you use for your collocations.

3) In general, parts of the analysis stating good correlation would greatly benefit from the authors providing correlation coefficients and a measure of the statistical significance. In multiple sections, the authors state that two things are well correlated, but show no quantitative evidence, other than an examination of the plots which can be subjective, especially since some of the plots are small and hard to read.

4) In the conclusions, you state that MBL decoupling is mainly controlled by EIS, but I don't think you've shown this. If that were the case, I'd expect to see a stronger relationship between the two. In a global analysis (i.e. not just over eastern Pacific), I would like to see the correlation coefficients and their significance and an explanation of the physical mechanisms and why other variables (e.g. SST) are not responsible before making this claim. Correlation does not equal cause and effect.

5) Please proofread the English grammar more carefully.

Specific comments 1) The title implies that this analysis relies primarily upon space-based lidar when much of the analysis relies on data from other instruments. In section 3.2, it is stated that only BLH estimated from clear-sky CALIOP profiles are used. Considering that much of the analysis concerns the presence of stratocumulus and cumulus clouds, conditions in which CALIOP is not used, the title is misleading and should be changed to reflect the broader array of instrumentation used.

2) Page 34066, line 19: "However, over oceans, the BLH is associated with the aerosol layer top (clear sky) or stratiform cloud top (cloudy sky), . . ." How does this differ from BLH and MLH over land?

3) Page 340066, line 20: the word below is misspelled

4) Page 34066, line 21: You state that there is a strong aerosol gradient at the top of the MLH. Is this not present also at the BLH top? If not, how does your threshold method detect the BLH?

5) Page 34066, line 25: "Difficulties in identifying stratiform clouds. . ." Do you mean difficulties in differentiating between cumulus and stratiform clouds?

6) Page 34067, lines 17-19: The phrasing here is awkward. Please reword. Please also specify that the 532 nm polarized backscatter is both perpendicular and parallel polarizations.

7) Page 34067, line 23: You need to introduce CloudSat (and later AMSR-E) and provide references.

8) Page 34068, lines 9-11: The explanation of EIS could be clearer. Perhaps including the equation would be helpful. Also, what level moist adiabatic lapse rate did you use?

9) Page 34068, line 8: The text says you use the surface potential temperature, but the equation here implies 1000 hPa potential temperature. Which did you use?

10) Page 34068, lines 25-26: How do you differentiate between the AMSR-E passes in your analysis; which did you use? What is the timescale of these maps? Did you use daily data, monthly, etc.?

11) Page 34068: Specify that AMSR-E is onboard Aqua and therefore is collocated with AIRS and AMSU and in the A-train with CALIPSO and thus the instruments are sampling similar conditions and time of day.

12) Page 34068, lines 26-27: You specify the RMS differences, but don't say relative to

what. This information is necessary for understanding the associated uncertainty.

13) Page 34069, line 1: Earlier, you state that AMSR-E data are on a 0.25 degree map, but here you say 25km. Which resolution is used?

14) Page 34069, line 7: Spell out GPCI

15) Page 34070, lines 6-10: If the HSRL signal is negatively impacted by cloud cover and much of the transect included clouds, what uncertainty is present in your aerosol distribution estimate?

16) Page 34070, line 12: Why is sonde in all capital letters and why is radiosonde or rawinsonde not spelled out?

17) Page 34070, line 22: Did you determine the method based on the structure? Please clarify or reword. Was the MLH detected by radiosonde or the lidar? If it was the radiosonde, how was this determined?

18) Page 34070, line 23: "Figure 1 presents the one transect. . ." was there only one transect?

19) Page 34070, line 24: Temperature is misspelled. Please use spell check.

20) Page 34070, lines 24-25: What is the correlation between the BLH and aerosol layer/Sc top?

21) Page 34070, lines 22-26: How close is the spatiotemporal location of the soundings with HSRL?

22) Page 34071, line 2 and Fig. 1: It is difficult to see the inversion associated with the MLH described in the text in this figure. It would be helpful to see one profile of theta with the associated TAB from HSRL.

23) Page 34071, line 8: How was the 0.05K/100m threshold identified?

24) Fig 1: What does it mean when the MLH in Fig. 1 is at the surface. To my eye, it

looks like MLH=BLH east of longitude 137 degrees W.

25) Page 34071, line 23: Since the sonde data are not the truth, do not say that the CALIOP derived BLH are biased lower. Just say that they are lower. And this is not true over the eastern domain.

26) Page 34071, lines 25-26: How large is the spatial mismatch? What is the temporal mismatch? How many observations go into both estimates? A better comparison would limit the radiosonde data to clear-sky only so they are more comparable to the CALIPSO estimates.

27) Page 34072, lines 1-4: Why would you expect a cloud-free regime and a cloudy regime to have similar BLH? And if the spatiotemporal mismatch is very large, such that one is not representative of the other, why is there good agreement?

28) Page 34071, line 6: indicates is misspelled. Please use spell check.

29) Page 34071, line 6: LCL is shown in Fig. 2c, not 2b.

30) Page 34071, lines 10-12: What are the correlation coefficients for these comparisons? Are they statistically significant? For instance, the BLH seems to be an average of 1-1.5 km so an error of 25-40% seems large. What is your justification for this being a good fit?

31) Page 34072, line 16: How is the MBLC dataset built?

32) Page 34072, line 24: Cold SST could also be partly responsible. If it was due solely to subsidence, the BLH would be low over the deserts.

33) Page 34072, line 26: How do you determine the clear-sky BLH when convection is occurring? Usually convection is associated with clouds.

34) Page 34073, lines 7-11: Please rephrase. First you say there are magnitude differences and then you provide an example where you say that McGrath-Spangler and Denning give a similar pattern and value. These two statements are inconsistent.

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35) Page 34073, line 17: There is a minimum in MLH/BLH over the equator, implying weaker mixing from 160W to 100W

36) Page 34073, lines 25-26: This is repetitive

37) Page 34073, lines 19-29: If clear-sky is included, how do you define a CTH in the case without clouds?

38) Page 34073, line 27: What cloud types are way from the coast with tops ~2.5km? Please state to be consistent with your statement about stratiform clouds in the previous line.

39) Page 34074, line 1: Specify what you mean by "approaching the central Tropical Pacific"

40) Page 34074, lines 6-7: Are these stratiform clouds included in Fig. 3a?

41) Page 34074, lines 8-12: Reword to make clear that heterogeneous conditions are less likely to precipitate than more homogeneously cloudy ones.

42) Page 34074, line 29: When you state something has a good positive correlation, please include the correlation coefficient and the significance.

43) Page 34075: There appears to be a seasonal cycle in the near coastal aerosol concentrations in the SPO transect. Can you comment on this?

44) Page 34075, line 12: "Sc occurrence and EIS correlate well…" this is not true near the coast. What other processes could be involved?

45) Page 34075, line 13: If drizzle occurrence isn't discussed other than to say it isn't correlated with EIS, why show it in this plot?

46) Page 34075, line 25: This doesn't seem to be the case for NPO during DJF. Do you have any explanation for the seasonal dependence?

47) Page 34076, lines 17-18: Please rephrase for clarity.

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48) Page 34077, lines 19-21: If Sc represent more than $\frac{1}{2}$ of the grid box and CALIOP has a small footprint, why would clear-sky MBL be represented in the average?

49) Fig. 7: In Section 3.2, you say you cannot use CALIOP to estimate BL structure in cloudy conditions so what is your justification for using it to show TAB under stratiform and Cu conditions?

50) Fig. 1 caption: The diamonds and circles are black, not magenta.

51) Fig. 2: Instead of showing the 1:1 line, it would be helpful to show a best fit line or lines.

52) Fig. 3: I don't believe Fig. 3h (u10m) is discussed. If not, please remove.

53) Fig 4: For consistency with Fig. 5 and to make it easier to determine proximity to the coast, change the x-axis to show longitude.

54) Fig. 6: Are these scatter plots? If so, please remove the connecting lines. What instrument is used to calculate the MLH/BLH here (6b)? Please label the y-axis in Fig. 6c.

55) Fig. 7: Are these associated with a particular season or the 4 year climatology? How many profiles are averaged in each? Are any cases better or worse sampled? If you're including BLH up to 1.6 km in Fig. 7c, extend the y-axis to include these values. Please include symbols to indicate the estimated BLH and MLH so your point is clear about decoupling between the two with varying EIS and BLH.

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