General response

The authors thank the reviewer for his/her helping to improve this manuscript and the English langrage. We greatly appreciate your detail comments and creative suggestions. We revised the paper according to your suggestions. Our replies to the comments are given below.

Anonymous Referee #3

Received and published: 31 December 2015

This paper uses clear sky aerosol back scattering signal to estimate boundary layer height (BLH) and mixing layer height (MLH) and then studies the relation between MBL decoupling (MLH/BLH) and the estimated inversion strength (EIS). The overall research topic is interesting and approach is good. However, the analysis needs to be more quantitative and there should be more descriptions on the data processing. I would be happy to recommend the publication of this paper when the following concerns are addressed.

1) Provide quantitative measures whenever possible. I list here a few examples for reference. The uncertainties in the estimated BLH and MLH using the aerosol back scattering are estimated by comparing with SONDE-derived heights. (See first paragraph in page 34071.) But, for MLH, is +/-0.45km a good precision? How would it affect the relation between the ratio BLH/MLH and EIS? For fig 2b, it would be useful to report also the correlations between SONDE and CALIPSO-derived heights to tell how tightly the heights derived by SONDE and CALIPSO are connected.

Reply:

The MAGIC soundings are mostly under cloudy conditions and are difficult to be collocated with CALIPSO overpass. Thus, we have to relax the temporal difference for the collocation to 1-day. Therefore, the large spatial and temporal separations result in large differences between the two measurements. The main purpose of the evaluations of CALIOP with MAGIC soundings was to show that the CALIOP-observed clear-sky MBL structure could be similar to the structure of the nearby cloudy MBL in some extent. This is the basic assumption for the discussion in section 4.2. Statements were added to make the points more clear now.

To better evaluate the lidar-base MLH and BLH detection with radiosonde measurements, we analyzed 2-year (2007-2008) collocated clear-sky Atmospheric Radiation Measurement Program (ARM) Climate Research Facility (ACRF) radiosonde and micropulse lidar (MPL) observations (Xie et al., 2010, Mather and Voyles, 2013) at Nauru (marine site). Compared to radiosonde-derived BLH, the bias and root mean square error (RMSE) of MPL derived BLH is -0.12 ±0.24 km and correlation coefficient between each other is 0.75. Compared to radiosonde-derived MLH, the bias and RMSE of MPL derived MLH is -0.06 ±0.16 km and correlation coefficient between each other is 0.66. Compared to radiosonde-derived MLH/BLH, the bias and RMSE of MPL derived MLH/BLH is -0.02 ±0.1 and correlation coefficient between each other is 0.61. All the correlation coefficients are reported at confidence level of 0.01. These evaluations indicate the good accuracies of our lidar based BLH and MLH determinations for clear-sky MBL structure study. Relative statements were added into this section. These new evaluation results were added into this section.

In fig 3, it is also useful to use spatial correlations to quantify similarity between patterns.

Reply: The correlation coefficient between MLH and BLH is 0.6 at confidence level of 0.01 in spatial pattern. The correlation coefficient between stratiform cloud occurrence and EIS is 0.78 at confidence level of 0.01 in spatial pattern. The correlation coefficient between non-drizzled stratiform cloud top and the drizzled stratiform cloud top is 0.53 at confidence level of 0.01 in spatial pattern. Relative statements were added.

In fig 4,5, correlations with wind and EIS should be quantified.

Reply: The EIS over NPO shows negative correlation with the U_{10m}, with the correlation coefficient of -0.64 at confidence level of 0.01, but shows positive correlation with the U_{10m} when EIS <3 K over SPO, with the correlation coefficient of 0.6 at confidence level of 0.01. A statement was added.

In fig 6, the uncertainties of MLH/BLH, and EIS should be quantified.

Reply: Errors was added into the plot and into the figure caption.

2) provide more details about data processing. Here are some examples. For fig 3c, when computing MLH/BLH, is it computed as the ratio of average MLH and average BLH or the average of ratio over the 4 year? Is EIS only computed for clear sky? How do we connect with cloud, for example, in the discussion of last paragraph in page 34073?

Reply: Figure 3c is computed with the average of ratio over the 4 year.

The AIRS-derived EIS can only be obtained under clear-sky and broken cloud cover conditions. However, as shown in Yue et al. (2001), AIRS can provide reasonable the seasonal mean EIS as compared to model simulations and the AIRS-derived-EIS has strong connection with low cloud. It can also be seen in Figs. 3 that the correlation coefficient between the spatial distributions of stratiform cloud occurrence and EIS is 0.78 at confidence level of 0.01. A relative statement was added.

For fig 6, how are data points computed? Are they time averages of data at different spatial locations?

Reply: For Fig. 6 (a) and (b), there is no time averages of data, and data was sorted and averaged into different bins of EIS or LTS.

For Fig. 6 (c), data was averaged into 2.5-degree grid-box to provide seasonal means. Then the seasonal-mean data was sorted and averaged into different bins of EIS.

Details were added into the manuscript now.