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Atmospheric Measurement Techniques Discussions

Interactive comment on "Assessment of Mixed-Layer Height Estimation from Single-wavelength Ceilometer Profiles" *by* Travis N. Knepp et al.

Anonymous Referee #1

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Review of "Assessment of Mixed-Layer Height Estimation from Single-wavelength Ceilometer Profiles" by Knepp et al. (2017) in Atmospheric Measurement Techniques Discussions:

Summary:

This paper presents an intercomparison study of Vaisala CL51 ceilometer-derived mixed layer heights (MLH) using different data collection and processing procedures, along with comparisons against co-located radiosonde and Micropulse Lidar measurements. CL51 data were collected at three locations (two in Colorado, one at LaRC in Hampton, VA) using both the proprietary Vaisala software BLView, and a custom

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Python logging script. The authors find that while there is little MLH dependence on choice of the two data collection techniques, significant discrepancies in calculated MLH heights are observed when comparing two different data processing techniques. As with the actual data collection, one processing method is from the proprietary Vaisala BLView software, and the other is open-source (STRAT) and currently used in European networks.

Comparisons of the two CL51 data collection methods processed only with STRAT show good agreement (MLH r = 0.72-0.87). However, correlation coefficients drop to r $\sim$ 0.5 and lower when the CL51 data are processed with the different STRAT and BLView processing algorithms. Comparisons between radiosonde-derived atmospheric boundary layer (ABL) heights and CL51 MLH were decent, with exceptions during morning hours. CL51 and MPL comparisons at the Golden, CO, seemed to be a bit worse than the radiosonde comparisons.

Given the dependence of calculated MLH on the data processing algorithm, the authors recommend a single processing algorithm be used for ceilometer networks. The authors seem to imply, but do not state, that open-source logging of data is preferred so the full 15.4 km CL51 backscatter profile (rather than only up to 4.5 km) can be collected.

General Comments and Recommendation:

Though the reader will be left wondering which data collection and processing methods are best in terms of validation with independent data, this is an important and well-motivated study that will lead to those types of efforts. Agreement and consistency in data collection and processing is something with which many measurement networks struggle. The BLView software appears to be a bit of a black box, and elucidating differences between it and open-source methods are a priority. Given upcoming efforts to include MLH measurements as part of the US air quality monitoring network, this type of technical analysis is a necessary step.

I have several comments which I think should be mostly minor. These involve being as clear as possible such as when describing averaging time and vertical resolutions, and exactly which CL51 data processing algorithm is being depicted in each figure and why (e.g. Figures 9 and 12). After these are addressed I feel comfortable recommending publication in AMT.

Specific/Technical Line-by-Line Comments:

Page 2, Line 21-23: Do you have a reference for this statement from the US NRC?

Page 2, Line 24: This reference seems incomplete.

Page 2, Lines 29-34: These lines are written in passive voice. Please rewrite.

Page 2, Line 34: The way this line is written makes it seem like you are comparing three CL51s from Colorado against sondes from CAPABLE.

Page 3, Line 26: It's never stated why BLView truncates data at 4.5 km. Are there concerns about measurement uncertainties or S/N ratios at higher altitudes? I realize this probably doesn't have an effect on the MLH calculations.

Page 4, Line 12: Are the 1 min and 30 m resolutions from the MPL what you've chosen to record specifically for this study? Please state.

Page 5, Line 25: Delete "to be."

Page 5, Line 26: clouds not cloud.

Page 6, Figure 2: The .5s are missing on the y-axis labels.

Page 7, Line 3: What parameters specifically? Averaging time? Vertical resolution?

Page 7, Line 10: "A detailed description of the UMBC algorithm has been published in Compton et al. (2013)."

Page 7, Lines 10-14: These lines contain jargon that receives no other mention. You can probably tack the single sentence on line 10 to the end of the previous paragraph

and delete the rest.

Page 8, Line 2: farther not further.

Page 9, Line 11-13: Are you saying that there were two CL51s at the BAO-Tower? I'm confused about the instrument set up here.

Page 9, Line 15: "CL51 data were collected. . ."

Page 9, Line 19: A figure showing average diurnal MLH from each of the three sites would be very helpful here and would give context for the statement that Golden often does not observe a well-developed boundary layer.

Page 9, Line 25: Only the CL51 and MPL data were averaged to 5 min resolution, correct? There are a lot of time and vertical resolution averaging numbers being thrown around and they should all be clear.

Page 10, Line 23: ". . .the standard deviation of MLH was calculated. . ."

Page 11, Figure 3: Somewhere in the text it would be useful to state that all times presented are in local standard time.

Page 11, Lines 4-9, Figure 5: I found Figure 5 to be confusing and in need of some clarification. How should this figure be interpreted? That variability within the 5 min measurement period is generally very low when the methods agree, and peaks when the difference between the two methods is between .5 and 1km? Shouldn't relative standard deviation (σ/xbar) be unitless? It has units of km on Figure 5. Please clarify.

Page 15, Figure 7: The color bar and what's plotted on the z-axis are not the same as Figure 6. Did you mean to plot data density rather than relative standard deviation? The current Figure 7 seems to present similar data as Figure 5 in a different way.

Page 19, Line 8: According to Figure 9, the correlations are actually 0.81, and 0.82, not 0.82 and 0.83.

Page 19, Figure 9: Do these statistics significantly change based on processing method? What do the error bars represent? In general, many of the figures would benefit from more detailed captions.

Page 19, Figure 9: Can you add additional plots to Figure 9 showing the STRAT and sonde comparison?

Page 19, Figure 9: Please adjust the axes to less than 7 km so spread in the data can be better visualized.

Page 19, Figure 9: I'm curious what the correlation of MLH with all sondes is. Better or worse than the individual sites?

Page 19, Line 20: "It is somewhat surprising that the filtered. . ."

Page 19, Line 20: It's difficult to definitively say that correlations at one site are "better" than another given the small sample size. What are the 90 or 95% confidence interval limits on these correlations?

Page 20, Line 20: Yes, there is similar behavior at CAPABLE in the comparisons on Figure 8. This is worth future exploration for the BLView output. Did you look at STRAT processing vs. the MPL? Does this invariance feature disappear? Can you add additional plots to Figure 12 showing the MPL vs. STRAT?

Page 20, Line 21: "Removal of MLH below 500 m. . ."

Page 21, Figure 10: Why do the CL51 profiles only go up to 3 km here? Same with Figure 11.

Page 23, Figure 13: Please adjust the y-axis on plot C so we can better observe the variability in MLH differences.

Page 24, Line 17: Should be 0.58 not 0.38.

Page 24, Line 20: sites' not sites

Page 24, Line 22: A good up-to-date reference from DISCOVER-AQ Colorado on these types of circulations and how they affect pollution distribution is Sullivan et al. (2016, JGR): http://onlinelibrary.wiley.com/doi/10.1002/2016JD025229/full

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