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Atmospheric Measurement Techniques Discussions

Interactive comment on "LiSBOA: LiDAR Statistical Barnes Objective Analysis for optimal design of LiDAR scans and retrieval of wind statistics. Part I: Theoretical framework" *by* Stefano Letizia et al.

Anonymous Referee #1

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Within this manuscript the authors present a modified version of a Barnes Objective Analysis technique that is uniquely designed to reconstruct atmospheric properties from remote sensing data. After presenting the technique, the authors discuss how it can be applied to Doppler lidar data to determine the spatial variability of the flow and its features (i.e., variability) by analyzing repeated scanning measurements over a period of time. To this reviewer who is familiar with boundary-layer process and Doppler lidar but has little expertise in use of the Barnes analysis, the technique seems novel and shows promise in enabling new analyses with Doppler wind lidar. This paper will

certainly be a nice contribution to the field by revising an expanding the capabilities of an established technique, and AMT is an appropriate journal for the material. However, there are several significant limitations in using the technique that the authors need to more clearly and directly address. This will likely require significant additional discussion to the paper to address the concerns listed below, prompting major revisions.

Specific Comments

a) Line 1: I think the name LiDAR Statistical Barnes Objective Analysis (LiSBOA) is a little misleading. In reading through the description of the technique, it's unclear to this reader what makes this technique particularly applicable to LiDAR, as it seems like it could be used to a large number of remote sensing measurements. Is this an incorrect assumption? In fact, there is an entire section (Sect. 4) devoted to explaining how this technique can be applied to wind LiDAR data. This technique could actually be of use to researchers using other instruments, as well.

b) Line 22: One primary systematic error of cup anemometers is overspeeding (Busch and Kristensen, 1976), which should be mentioned here.

c) It would be beneficial to add a list of symbols to the start of the article, as is done for the companion paper. Not being overly-familiar with the Barnes analysis technique, the symbol meaning was very difficult to keep track of.

d) Line 46: Fog and low clouds should be added to this list of adverse weather conditions.

e) Line 65: Should be 'horizontal homogeneity of the mean flow', as the turbulent portion may vary over the scanning volume.

f) Line 71-76: These sentences seem out of place, considering the previous paragraph discussed methods to estimate turbulence. They would better fit in there.

g) Line 123: Throughout this discussion, it is clear that the Barnes analysis can only be applied to a scalar field, and not a vector field such as a wind field composed of a 3-D

vector (u, v, and w). The method described here is to be applied to Doppler wind lidar measurements, which is actually the projection of the 3-D wind vector along the beam. Please discuss limitations, assumptions, and other issues that need to be considered when applying this technique, which was developed for scalar quantities, to analyzing any components of a vector wind field. Within this discussion, it must be considered that a Doppler lidar only measures the wind vector reprojected to be along the radial, thus for a scan it is actually sensitive to varying components of the wind based on the azimuth and elevation.

h) Line 354: Based on this figure, it seems like the flow characteristics are critical to design the optimal scan. However, often the flow characteristics are not known and are the objective of the study is to quantify the flow characteristics. In the absence of knowing the flow characteristics, how does one determine the ideal scan and retrieval of statistics especially for flows that have not been studied extensively previously?

i) Line 391: Given the strict limitations of being able to use the technique to reconstruct the flow and its properties, it is a bit of a stretch to state that this is likely to become a standardized method for LiDAR data collection and analysis. While the proposed technique seems highly valuable to investigate the properties of low-altitude atmospheric flows with LiDAR, the chief limitation of needing to assume an unvarying mean flow (wind direction and speed unchanging) over the course of the time period of analysis will significantly limit when this technique can be used, especially given that conditions within the PBL are often highly variable particularly during transitional time periods (around sunrise and sunset, most notably). This significant limitation will limit any use for routine automated analysis, but it will certainly be useful in select case studies. This significant limitation must be more directly discussed within the manuscript, to mitigate the misuse of this technique for analyzing flows when it is not appropriate to use. By using this during time periods when the mean conditions are even slightly changing, there will be a significant overestimate of any variance in the flow and other properties (length scales, etc) will also not be representative of the true properties of the flow.

Editorial Corrections

a) Line 26: Should be volume of 0.01 mˆ3.

b) Line 36: This (“In particular . . . anemometry”) is an incomplete sentence.

References

Busch, N.E. and Kristensen, L., 1976. Cup anemometer overspeeding. Journal of Applied Meteorology, 15(12), pp.1328-1332.

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