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Comment on acp-2021-257

Anonymous Referee #3

Referee comment on "Investigation of near-global daytime boundary layer height using high-resolution radiosondes: first results and comparison with ERA5, MERRA-2, JRA-55, and NCEP-2 reanalyses" by Jianping Guo et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-257-RC1>, 2021

The manuscript entitled "Investigation of near-global daytime boundary layer height using high-resolution radiosondes: First results and comparison with ERA-5, MERRA-2, JRA-55, and NCEP-2 reanalyses" presents a near-global assessment of high-resolution radiosonde derived boundary layer height (BLH) and provides a quantitative assessment of four reanalysis products. This paper is generally well written and makes an important contribution to characterizing the BLH at the global scale and providing useful information on reanalysis data usage. However, I have the following major comments concerning the bias attribution.

First, in the case study at Chongqing, the fine-scale vertical structures of R_i , WS, RH, and T seem to have a larger impact in determining BLH compared to the overall bias of the basic parameters. It appears that both overestimation (in JRA-55) and underestimation (in NCEP-2) of WS and RH lead to a smaller BLH. Discussions on the impact of vertical structure including the vertical resolution would provide useful information on the bias attribution.

Relatedly, is there a specific reason for choosing this case as an example to show BLH biases in the reanalysis data? It would be helpful to provide a comment on other cases.

Second, the biases of the BLH in reanalysis data are attributed to the complex topography and static stability based on their correlation coefficient. The afternoon sounding during the warm season leads to large biases over the TP and western US, where the terrain is complex. Assessing the relationship between BLH bias and DEM spread using data collected at similar LST would provide useful information on the robustness of the results.

Meanwhile, because of the coarser temporal resolution, MERRA-2, JRA-55, and NCEP-2 are

not able to match LST of all soundings during IOP. The time mismatch between the sounding and reanalysis data may also introduce biases due to the distinct diurnal variation of BLH. It is necessary to discuss if the result will significantly change with/without IOP data used.

Fig. 4 nicely shows the diurnal variation of BLH. The authors mention "some soundings that are released at 0000 and 1200 UTC are excluded for collecting samples in the daytime." In my understanding, for instance, the 14 LST results in both Fig.4a and Fig. 4b should include all soundings collected at 14 LST. It is not very clear why some soundings at 0000 and 1200 UTC are removed to only show daytime results in Fig. 4b?

Besides, how does the application of additional soundings during IOP lead to the differences between Figs. 4a and 4b?

Is there a specific reason for presenting the difference using radiosonde (the reference dataset) minus reanalysis rather than reanalysis minus radiosonde in Figs 5-8? It seems counterintuitive to use positive differences in those figures to represent underestimated BLHs.

Specific Comments:

Line 56: Suggest changing to "boundary layer height".

Line 192: How many layers below 500 hPa in ERA-5?

Line 218: Change to 0000 and 1200 UTC.

Line 220: This section introduces calculations for both normalized sensible heat and latent heat fluxes. Suggest changing the section title to include both fluxes.

Line 225: Add a period after the parenthesis. Can you further explain why small latent heat flux means more energy being available for PBL growth?

Line 236: Remove "sensible".

Line 237: Sections 2.4 and 2.5 introduce BLH calculation which may be more connected to section 2.2. Suggest moving those two sections forward.

Line 272-273: Is this an extra step only required by observations during IOP, as the regular synoptic times are included in all reanalysis data? Meanwhile, JRA-55 and NCEP-2 have a temporal resolution of 6 hours, which may be not able to hit every weather balloon launch time with hour difference. Would it result in a significantly smaller sample size compared to ERA-5 and MERRA2?

Line 282: Is there a specific reason for arranging the panels in the order of a, b, d, c?

Line 345-346: The authors mentioned that the reanalyses and observations show the deepest BLH in the afternoon of summer, from which I think it is insufficient to conclude that "both capture the diurnal and seasonal variations" at this point.

Line 365-366: Did the authors mean "latitude" and "67.6 °N/°S"?

Line 385: Remove "/".

Line 392: What is the "ensemble mean"?

Line 413: Change "WD" to "WS", and at other places.

Line 423: Fig. 9b marks significant correlations between BLH and Ps. I think this was simply left out by mistake.

