Atmospheric
Measurement
Techniques
Discussions

Interactive comment on "Improved Observations of Turbulence Dissipation Rates from Wind Profiling Radars" *by* Katherine McCaffrey et al.

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We thank the reviewer for their detailed reading and critique of our manuscript. We have addressed their concerns, and hope they find this work acceptable for publication!

(1) Referee Comments (2) Author Response (3) Change in manuscript

1 General comments In this article, the authors attempt to measure the dissipation rate of turbulence in the atmospheric boundary layer using vertically oriented, high spectral resolution, wind profiling radars (WPRs). They compare their measurements with a collocated array of sonic anemometers, and they find a degree of comparison. For the most part, I found this paper clear, easy to read, and interesting. While I don't share the enthusiasm of the authors in their conclusion, I do think that the techniques and the results presented contribute to scientific progress. I recommend this article

for publication, with the condition that the authors address the scientific and technical questions I've listed below.

2 Specific comments (1) In the first paragraph of Section 3.1, an important point is made on how dissipation rate can be measured by a WPR. However, the reference is to another article, under review, by the lead author of this article. Is there not a more authoritative reference, perhaps Hocking (1985) or Cohn (1995)? Further, this sentence would be a better fit in Section 3.2. (2) We included a previous, better-known reference for the different scales of turbulence measurements from WPRs in Angevine et al 1994. This sentence was removed from section 3.1, and the reference was made after the second sentence in Section 3.2. (3) line 119: "inertial range. Using the..." line 152: "spectral width (Angevine et al., 1994; McCaffrey et al., 2016)."

(1) References to McCaffrey et al. (2016) are again used in Section 4.2, in Section 5, and in the Conclusions. Might a more canonical reference be appropriate in these locations, as well? (2) The results mentioned here are unique to the McCaffrey (2016) manuscript. It received reviews of minor revisions, and is expected to be accepted shortly, and will likely be published before this one.

(1) In the third panel of Figs 3 and 6, the lower bound of the y-axis should be zero, since the fractional bias values are never less than zero. In the current Figures, this causes the bias values to appear closer to unity than they actually are. (2) Yes, you are right. This has been fixed. (3) Updated (new) Figs 4c and 7c.

(1) Further (and we can argue about this, because perhaps I'm being too picky), in Figs 3, 6, and 8-11, the fractional biases should be plotted as a ratio, not as a percent. Plotting as a ratio would decrease chart junk. Moreover, plotting as a ratio would make it clearer just how different the values calculated from the different sources can be. For example, in Fig 11, the 449-MHz WPR measures bias-corrected values that are remarkably close to those captured by the sonics, but only over a range of $[3 \times 10-4, 6 \times 10-2]$ m2 s -3 . Outside of this range, the values differ by a factor of two to a

factor of 100. (An aside: an explanation is offered for why the WPRs don't match the sonics for these large and small values of at the end of Section 5. Perhaps this could be expanded and included in the Conclusions?) (2) We have changed the fractional biases to be ratios, rather than percentages, as requested. As to the final comment, we do not have an explanation why this behavior exists, and therefore don't include any conjectures. (3) Updated (new) Figs 4c and 7c, as well as (new) Figs 10 and 11.

(1) Figs 12 and 14 would also benefit from additional detail. I'd like to see R2 values for the plots in Fig 12. They look like blobs. In Fig 14, a subplot of residuals would give a more accurate view of the differences between the dissipation rates measured by the sonics versus those measured by the WPRs. By eye, the plots look close, but the residuals might show otherwise. (2) We've added the statistics onto the scatterplots. As for Fig 14, the large range of turbulence values would require plotting the residuals on log axes also, adding no more information than the time series. The scatter plots and box plots are used to show the variations in log-log format.

I also have a short list of secondary scientific comments. Line numbers are given where appropriate. (1) 71: It would be helpful to move the description of ΔR to Eqn 11 (I had to flip back to find it) (2) We have included a repeated description here as well. (3) line 164: "pattern and ΔR is the height of each range gate."

(1) In Eqn 8, $\varphi E(k)$ isn't defined; is this the 3D spectrum? (2) It is defined in Eq 3, but was missing the second subscript specifying the direction. It has been added: (3) Eqn 8: $\varphi E,i(k)$

(1) In Figure 1, it's difficult to distinguish the pale and bright colors (2) We've updated the figure to include circles on one set of lines, and dash the other, to better distinguish the two, even when virtually equal. (3) (new) Fig. 2 caption: "...with (bright colors with circles) and without (pale colors, dashed lines) the adjustments..."

(1) 135: I suggest "interval" instead of "inertial range", since you can't be sure that this is the inertial range (2) Instead, we state that it is an assumption that this interval is the

inertial range: (3) line 138: "...inertial range (here, identified by visual inspection to be from..."

(1) 136: I would prefer a more authoritative reference than the one given (2) We've replaced it with the more definitive Kaimal reference (3) line 139: "as in Kaimal et al. (1968), to solve for ε:..."

(1) In Figs 9 and 10, the purple is really close to the red; could a different color be used? (2) We've changed it to green, to stand out more. (3) Updated (new) Figs 10 and 11.

(1) 392: Strike "very" (2) Fixed. (3) line 404: "...compared well..."

3 Technical corrections There are several run-on and clumsily structured sentences. One more read-through by the authors, which will likely come about through the review process, will undoubtedly help. (1) 21 "Wind profiling radars...": Run-on sentence, with "introduced" used twice (2) Fixed. (3) line 21: "Wind profiling radars (WPRs) showed the possibility of observing profiles of turbulence in the planetary boundary layer (PBL) in Hocking (1985), wherein turbulence intensities and dissipation rates were observed using backscatter intensities and Doppler spectral widths."

(1) 41 "A 300-meter...": Run-on sentence (2) Fixed. (3) line 43: "...located at the site. During the..."

(1) 44: "6" should be "six" (2) Fixed. (3) line 45: "six"

(1) 45: "wind profiling radars" should be "WPRs" (2) Fixed. (3) line 46: "WPRs"

(1) 46: Strike "the" after "BAO" (2) Fixed. (3) line 47: "the BAO Visitors' Center"

(1) 76 "If desired...": Run-on sentence (2) This paragraph has been re-written, adjusting this sentence as well. (3) paragraph starting at line 65

(1) In Eqn 3, the subscript i is used to represent velocity components, while on line 121, xx is used (2) Fixed. (3) line 123 and Eq 9: "Tii"

(1) In Eqns 4, 6, and 11, three different symbols are used for mean wind speed (2) Fixed. (3) line 161 and Eq. 12: uses over-bar for mean

(1) 114: The end of the sentence might read better as "which operate at sufficiently high frequencies to resolve the inertial range" (2) Fixed. (3) line 119: "which operate at sufficiently high frequencies to resolve the inertial range"

(1) 120: Strike "used to move from frequency to wavenumber space" (2) Fixed (3) line 122: "...Taylor's hypothesis, Wyngaard..."

(1) 133: Strike "It is seen that" (2) Fixed. (3) line 136: "...adjustments. That..."

(1) 151: Run-on sentence (2) Fixed. (3) line 162: "...properties. For a vertically-pointing beam, the contribution is determined..."

(1) 164, 255: Use "percent" instead of symbol (2) The second reviewer requested these biases in ratios, rather than percentages, so this has been removed in line 255 (3) line 174: "40 percent line 264: "fractional bias equal to 1"

(1) 175: Sentence might read better as "The integral in Equation 12 can be solved by converting to spherical coordinates" (2) Fixed. (3) line 184: "The integral in Equation 13 can be solved by converting to spherical coordinates:"

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