Manuscript ID AMT-2016-322

Title: Improved observations of turbulence dissipation rates from wind profiling radars

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General comments:

The authors present and discuss observations of the turbulent kinetic energy dissipation rate ε retrieved from collocated sonic and clear-air wind profiling radar (WPRs) measurements. While the measurements were collected with state-of-the-art instrumentation, the authors appear to not have taken full advantage of the potential of their data. In particular, the authors rely on spectra estimated from unnecessarily long time series, thereby averaging out most of the ε variability that is characteristic of the intermittent atmospheric boundary layer. Moreover, the authors do not present any raw data (sonic time series, WPR signal time series) or any conclusive intermediate steps in the data processing, such as Doppler spectra and dwell-time-by-dwell-time time series of spectral-width estimates. So there is no way to find out why the ε correlograms (figures 4, 5, and 7) show such excessive discrepancies between the sonic retrievals and the WPR retrievals of ε (about three orders of magnitude).

The abstract does not contain any quantitative and hard information that would substantiate the claim in the title ("Improved observations ..."). The introduction lists a number of relevant articles but says almost nothing about the underlying physics. I would have expected the introduction to contain a critical discussion of the strengths and weaknesses of the various techniques to retrieve energy dissipation rates from high-resolution point measurements (sonics) and from radar windprofiler measurements. (Note that the paper does not even have a dedicated discussion section.)

I cannot recommend this paper for publication. The following specific comments may help the authors to rethink their approach and to re-process the data.

Specific comments:

1. 5f.: *". . . two WPRs operated in an optimized configuration, using high spectral resolution for increased accuracy of Doppler spectral width . . ."* — The spectral resolution of a Doppler spectrum is determined by the dwell time (and not, as one might erroneously believe, by the pulse repetition period or by the sampling rate or by the coherent integration time). So a high spectral resolution requires a long dwell time. On the other hand, the dwell time should not be excessively long because the dwell time determines also the achievable time resolution. Because the energy dissipation rate ε in the atmospheric boundary layer is a highly intermittent quantity, one might want to limit the dwell time such that "coherent structures" can be captured. So in what sense is the WRP operation mode optimized here? What is the "optimum" compromise between good spectral resolution and good time resolution?
2. 12f.: *"Resulting measurements of turbulence dissipation rates correlated well (R^2 = 0.57) with sonic anemometers . . ."* — Is this the correlation coefficient between WRP- and sonic-retrieved estimates of ε, or the correlation coefficient between WRP- and sonic-retrieved estimates of the *logarithm* of ε? The figures 4, 5, and 7 appear to indicate the latter. A moderate correlation coefficient between the logarithms of ε-estimates that vary over five orders of magnitude does not speak in favor of the quality of the retrievals. Please explain.

3. 21f.: *"Wind profiling radars (WPRs) introduced the possibility of observing full profiles of turbulence in the planetary boundary layer . . ."* — What do you mean by "full profiles of turbulence"? First, what is a "full" profile? Second, turbulence is characterized by many different parameters, such as the energy dissipation rate, the temperature structure parameter, the inner scale, the temperature variance dissipation rate, the sensible heat flux, the vertical-velocity variance, etc. So what do you mean with "turbulence"?

4. 90-95: The TKE budget equation is not relevant for the retrieval of ε from sonic or WPR measurements discussed in this paper, and therefore should be deleted.

5. 104: *". . . where α_i is a constant."* — Do you mean to say that there are three different Kolmogorov constants, one for each velocity component? This is misleading. There are only two different Kolmogorov constants: one for the longitudinal velocity component (the velocity component parallel to the direction of the wave vector) and one for the transverse (lateral) velocity component. The underlying physics can be found in Monin and Yaglom (1975, p. 355).

6. 115: *"WPRs do not collect data at a high enough frequency to observe the inertial range, and therefore must rely on spectral widths for their small-scale variance measurements . . ."* — According to Table 1, the WPRs' interpulse periods are 33 and 45 μs. Because no coherent integration is performed, this means that the sampling period of the complex WPR signal is higher than 20 kHz, about 1000 times the sonics' sampling rate. So it is definitely not the sampling rate that matters here. Please explain!

7. 117f. *"Using the high-sampling frequency measurements by the sonic anemometers, the variance observed can be directly obtained from the energy spectrum for the dissipation rate."* — It is not the "variance observed" that is used for the retrieval of ε. Please clarify!

8. 138: *"Spectra were computed for each 15-minute interval, with corresponding dissipation rates. The dissipation rates were then averaged over 30 mins to compare with those obtained from the WPRs."* — Why do you average over such long periods? It should be possible to get clean ε estimates from the sonic data *and* from the WPR spectral widths for periods of 1 min or even shorter! At a sonic sampling rate of 20 Hz, you have 1200 velocity data points per minute, which is more than enough to provide a clean estimate for ε. The same should be the case for ε-estimates retrieved from the Doppler spectral widths obtained from 1-min long WPR signal time series.

9. 145: *"The spectral width of the Doppler spectrum is twice the standard deviation, σ_m, of the unresolved velocities in the measurement volume during each dwell."* — Whether or not this statement is correct depends on what exactly you mean by "unresolved velocities in the measurement volume." Moreover, the width of the Doppler spectrum has the unit Hz while the unit of σ_m is $\mathrm{m\,s^{-1}}$, so the ratio between spectral width and σ_m is not a dimensionless number. Please clarify!

10. 180: *"The dissipation rates were estimated for the 30 minutes of turbulence mode, when the backscatter intensity time series were collected . . ."* — The dissipation rates are not retrieved from *intensity* time series but from time series of amplitudes and phases (i.e., from time series of the complex radar signal). Please clarify!

11. 186: *". . . backscatter intensity time series filtering . . ."* — See previous comment. Please clarify!

12. 291: *"Each dwell collected by the 449-MHz WPR spans about 13 seconds (and the 915-MHz, about 17 seconds; see Table 1), capturing only a short period of the atmosphere's motions."* — For short dwell times, the Doppler spectral width provides information about the *spatial* variability of the radial wind velocity v_r within the radar's resolution volume. For long dwell times, the spectral width is contaminated by *temporal* variations of the mean (averaged over the radar's resolution volume) v_r. It is the *spatial* variability of v_r *within the radar's resolution volume* that provides the most direct information of ε. The fact that ε-estimates vary erratically from dwell time to dwell time must not be misinterpreted as instrumental noise that has to be averaged out; more likely, the "noise" represents the intermittent nature of ε in the high-Reynolds number ABL (Kolmogorov, 1962; Obukhov, 1962). The local energy dissipation rate in high-Reynolds number turbulence (as in the ABL) is approximately lognormally distributed, such that variations of ε over many orders of magnitude within short time scales (i.e., minutes or less) are to be expected. It would be very interesting to see to what extent the collocated sonic and WPR ε retrievals track each other at time scales between 10 s and 10 min, rather than at time scales larger than 10 min.

Bibliography

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