Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-3-RC2, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Using Doppler lidar systems to detect atmospheric turbulence in Iceland" *by* S. Yang et al.

Anonymous Referee #2

Received and published: 10 June 2019

This manuscript implements different methods for deriving turbulent parameters from scanning Doppler lidar observations in the lower atmosphere. Retrieving turbulent parameters is of high interest, both scientifically and operationally, as described in the manuscript introduction. Data from this challenging location is also of major interest.

The topic is introduced well but the promise of the paper is not fulfilled in the remaining sections. The methodology and results sections are quite sparse and the discussion on error sources and method intercomparisons, in particular, inadequate. The plots also need to be improved.

Please include more information on the instrument and scanning parameters employed (e.g. for VAD scans, how many azimuths per scan and how many pulses integrated per azimuth; how many pulses integrated per profile for vertical stare). These are

important for estimating the uncertainties associated with the measurements, and then the retrieved quantities. Uncertainty in the velocity estimate depends on the carrier-to-noise ratio, CNR, therefore, a single CNR threshold is valid for determining reliable velocity estimates. The theoretical relationship between CNR and velocity uncertainty given by the Cramer-Rao lower-bound method can be calculated from the instrument parameters (e.g. Rye and Hardesty, 1993), and this should be calculated and plotted for the instrument used in this study as it provides the basis for the uncertainties, filters and thresholds used. The definition of CNR and CI presented in the paper should be improved.

There are plenty of papers discussing different techniques for retrieving turbulent parameters from Doppler lidar, and the expected uncertainties (e.g. Sathe and Mann, 2013; Banakh et al., 2017; Smalikho and Banakh, 2017). These also show how the uncertainties from the initial velocity estimates propagate through to the retrieved tubulent quantities. This would then aid the intercomparison of the different methods.

Some additional issues points to consider: Figure 2 and text. It should be stated that the energy spectrum will follow the expression given in Eq 2.2 for frequencies within the inertial subrange. There are no values on the axes - add these or give typical values for the different ranges.

Figure 3. Please provide the typical CNR values for the 'good' and 'bad' cases. I am surprised by the increase in power density for high frequencies in Fig. 3a; is this noise or an atmospheric feature? I would usually expect the noise contribution to be 'white noise' which is spectrally flat, as is seen in Fig. 3b. Time-height plots of the original signal and Doppler velocity values that these spectra are taken from would aid interpretation.

Please describe the tests you made to determine the optimal CNR threshold of -32 dB. What does this mean in terms of velocity and dissipation rate of turbulent kinetic energy (EDR) uncertainty estimates? It should be noted that, since EDR depends on the velocity variance, the reliability threshold for good EDR estimates may not require a constant CNR threshold, but be described in terms of the relative contribution of velocity uncertainty to the EDR estimate; higher values of EDR can cope with more uncertain velocity estimates.

Figure 5. Without the original signal and velocity plots it is not possible to see the impact of filtering. The range axis is not obvious in these plots; it might be clearer to use standard x-y axes.

Figure 6. It is difficult to compare the methods as the panels don't use the same vertical axes. It is interesting to see that the different methods show similar features but, in most cases, very different values.

Figure 7. If it is known that the 'hot spots' are noise, why are these not filtered? Why do the filters applied not capture these? Or should additional filters be applied? Figure 7 could be plotted with a maximum range of 2 km, then the features in the regions of good signal would be more evident.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-3, 2019.