Comments on 'Turbulence parameters measured by the Beijing Mesosphere–Stratosphere–Troposphere radar in the troposphere/lower stratosphere with three models: Comparison and analyses' by Z. Chen et al.

Summary

In this study, three formulations for estimating broadening components of radar spectral widths proposed in previous studies are compared using three-year observations by a VHF radar at Xianghe Station, China. The debroadening algorithm is necessary for accurate estimation of turbulent energy dissipation rates because overestimation of broadening components will lead to negative energy dissipation rates. This study may include interesting results based on thorough comparison of broadening components and resulting energy dissipation rates, and I feel that the overall logic of the study is well organized. However, there seems to be an error in the calculation of the broadening component. Specifically, in the small vertical shear region, the three formulations should yield almost same results, but there is a significant difference between them. I suspect that the authors misunderstand the one-way and two-way beam width. I recommend the authors to recalculate them and reorganized the overall manuscript.

General comments

1. If there is no vertical shear ($|\partial \boldsymbol{u}/\partial z| = \sqrt{(\partial u/\partial z)^2 + (\partial v/\partial z)^2} = 0$), the three formulations are almost same:

Hocking (1985): $$\sigma_\mathrm{b} = \frac{\theta_{1/2}^{(2)} V}{\sqrt{2 \ln 2}} = \frac{\theta_{1/2}^{(1)} V}{2\sqrt{\ln 2}},\ \sigma_\mathrm{s} = 0,$$

Nastrom (1997): $$\sigma_\mathrm{s\&b}^2 = \frac{\left(\theta_{1/2}^{(1)} V\right)^2}{3} \cos^2 \chi,$$

Dehghan and Hocking (2011): $$\sigma_\mathrm{s\&b}^2 = \frac{\left(\theta_{1/2}^{(1)} V\right)^2}{4 \ln 2} \cos^2 \chi,$$

where $\theta_{1/2}^{(1)}$ and $\theta_{1/2}^{(2)}$ are one-way and two way half power half width of radar beam, respectively; V is horizontal background wind; χ is the zenith angle of the beam (15°); and $4 \ln 2 \approx 2.77$. Note that the formulations of Hocking (1985) and Dehghan and Hocking (2011) are identical in no shear condition except for $\cos^2 \chi$, which is approximately 0.93 (Table 1 in the manuscript). Figure 4 shows the vertical profiles of mean horizontal wind speed and vertical shear. It is found that mean vertical shear is very small around an altitude of 12.5 km, and thus the broadening components estimated from three formulations are expected to have similar values at the altitude. However, from Figure 5, $\sigma_\mathrm{b\&s}^2$ from Hocking (1985)'s formulation is much larger than those from Nastrom (1997) and Dehghan and Hocking (2011). Other figures (e.g., Figure 2c, 3, 6, etc.) also show similar results. I am sure that something is wrong with the calculation of broadening components. One possibility is that the authors are not aware of the difference between one-way and two-way half power half width ($\theta_{1/2}^{(1)} = \sqrt{2}\theta_{1/2}^{(2)}$).

2. P.16, L.349-352: I wonder why the difference of median energy dissipation rates between including negative values and excluding them is so small. In general, mean energy dissipation rates without negative values included will be quite large compared to that calculated from both positive and negative values. For example, Kurosaki et al. (1996) showed that median K_z calculated from both positive and negative spectral widths are significantly different from that from only positive spectral width. Dehghan and Hocking (2011) showed a similar example for a radar with two-way beamwidth comparable to that used in this study. One of the exceptions is Kohma et al. (2019), who used an algorithm developed by Nishimura et al. (2020) to estimate the beam broadening component accurately. As a result, the difference of medians between with and without negative energy dissipation rates is small.

Specific comments

About notation: The notation for several variables is problematic in the present manuscript, e.g., θ is used as potential temperature (P. 3, L. 90) and half-power half width (P.9, L. 208), and both $\left|\frac{\partial u}{\partial z}\right|$ and $\left|\frac{\partial v}{\partial z}\right|$ are vertical gradient of horizontal wind. I recommend the authors to use consistent notations through the manuscript.

Typos etc.

Please specify the definition of vertical shear of horizontal wind:
Is it defined as $\sqrt{(\partial u/\partial z)^2 + (\partial v/\partial z)^2}$ (u and v is zonal and meridional wind, respectively)?

References

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