Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2021-598-RC2, 2021

Comment on acp-2021-598

Anonymous Referee #2

Referee comment on "Wind lidars reveal turbulence transport mechanism in the wake of a tree" by Nikolas Angelou et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-598-RC2, 2021

In this manuscript the authors perform turbulence measurements in the field, in the wake of an isolated large tree.

This is a quite complete work, done with relatively heavy measurement devices: a multi-lidar and several sonic anenometers placed on two meteorological masts. This results in an important database which is statistically analyzed in this manuscript.

This is an important work, the observation efforts needed to record this data base is very appreciable. It will be a useful database for the community. I have not seen a data availability statement: it would be useful to provide this information. Below I have several suggestions and comments.

Specific comments:

I did not understand figures 2a-b, concerning the orange dots. I understand that there are two meteorological masts, one of them (M2) being on the red dot. Why is the orange dot in a different location?

For each grid, it is indicated that there is approximately 25 iterations per 10 minutes period. Since the whole data set is recorded during a 3 hours periods, I understand that there are 18x25 = 450 values at each grid point, to perform the statistics. Is this correct? If correct it does not seem to be a large sample size to perform statistics. This point should be clarified in the manuscript and discussed in the discussion section.

I don’t understand the normalisation indicated in line 131: “the wind speed measurements of each iteration were normalized by the corresponding 26-second mean wind speed”. The normalisation should be the same for all data. If normalization depends on the samples, one needs to understand what are the statistics of these normalization values. This should be clarified.

The stresses <u’w’> and <v’w’> are estimated, as well as normal stresses. Since instantaneous values are taken every 25 secondes, it is not the real stress which is estimated (the real stress would need to resolve turbulent scales, of the order of seconds or lower). The estimates <u’w’> and <v’w’> are done using coarse-gained estimates of u', v', w', as their fluctuations are likely to be much smaller than real values of stresses. This should be mentioned in the text and also discussed in the discussion section.

The gradients along y and z of the mean velocity are estimated (fig 4b,c). How this gradient is estimated numerically should be indicated in the text (central différence, some smoothing is done with a kernel?).

Figure 4c plots one normal stress. It could be interesting to plot the 2D kinetic energy and also to estimate the turbulence intensity, by dividing fluctuations by the mean velocity, to obtain a percentage.

Equation 2 is not the correct expression for the eddy-viscosity closure. This should be done using the mean strain tensor. On each side of the equation there should be a tensor (in LHS the anisotropic Reynolds stress tensor). Here a vectorial expression is proposed. The correct hypothesis involves the normal stresses, which are not included in the vectorial representation. The main problems in closures are coming from the normal stresses. In the same equation K should be replaced by the standard notation (\nu_T). The authors claim in the abstract, in the discussion and in section 4.3 that the Boussinesq hypothesis has been tested and validated. These claims should be modified because the tensorial expression has not been considered. Furthermore, the authors have access here to a 2D data base; they cannot claim that the full eddy-viscosity assumption, involving 3D closure of a tensorial expression, was tested. The flow behind a tree, with all forcing scales involved (through the complex structure of the tree and the tree branches) is a complex flow for which very likely the eddy-viscosity assumption cannot be valid.

Sonic anenometer data provide time series of the velocity done at a larger frequency (20 Hz). This could be used to perform Fourier power spectra, helping to characterize the flow (Reynolds number, injection scale, dissipation scale…). Such scales may be useful for comparison with the mixing length data which are estimated in section 4.4.