Review of "The ratio of transverse to longitudinal turbulent velocity statistics for aircraft measurements" by Jakub L. Nowak, Marie Lothon, Donald H. Lenschow, and Szymon P. Malinowski

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General comments

This manuscript discusses an inherently difficult problem, local isotropy, in relation to aircraft turbulence measurements. It calls attention to the fact that the predicted 4/3 ratio of transverse to longitudinal velocity component spectra and structure functions in the inertial subrange is not observed in many such flights. Because isotropy is related to the accepted values for the Kolmogorov constant(s) in one-dimensional spectra, this is an important issue when one wants to estimate the rate ε of dissipation of turbulence kinetic energy.

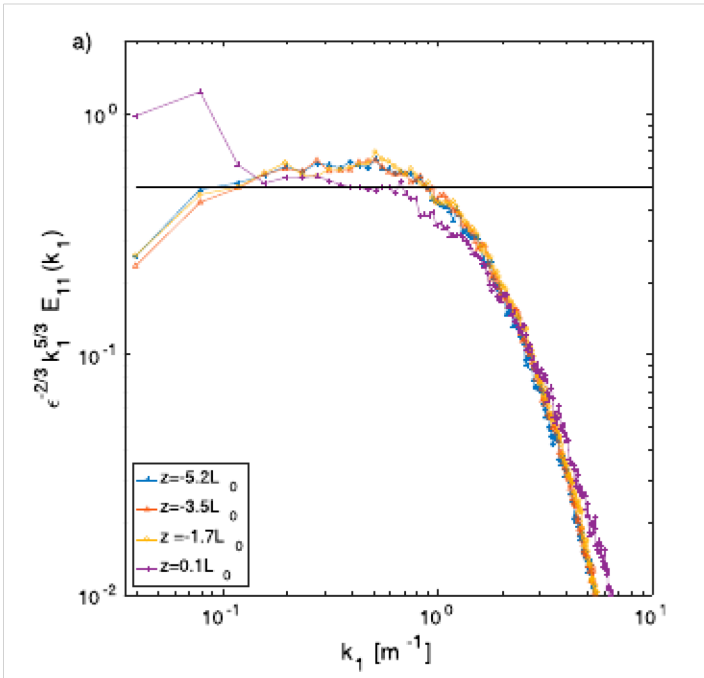
A related issue of the slope of the power spectra and structure functions is also investigated, and a large scatter *around* the predicted exponents is found.

The manuscript raises awareness to the problem, but does not bring a solution or new insights. This does not prevent it from being timely and deserving of publication. My comments therefore should be taken by the authors not as obligatory changes that need to be made to the manuscript, but rather as an interested dialogue about a few facets of a very difficult question.

First, I would like to mention that balloon measurements appear to agree more closely to isotropy; see Siebert et al. [2006]. Secondly, numerical analyses may bring insightfult results: Akinlabi et al. [2019] obtained results for the P_T/P_L ratio larger than 4/3 from DNS (contrary to the current manuscript's results). The authors may find their discussion of physical causes of anisotropy in the ABL useful. Finally, LES of the flow around the sensor has produced some very useful results regarding flow distortion in the case of sonic anemometers: see Huq et al. [2017]; maybe something similar could be proposed as a future study regarding aircraft measurements?

Specific comments

Fitting of power laws in figures 1 and 2 may be a little deceiving. Compensated spectra often display a concave curve, rather than a flat (horizontal) plateau in the assumed range of frequencies associated with the inertial subrange. Maybe you can discern further details about the departs from $-5/3$ and $2/3$ by plotting, for example, $k^{5/3}P(k)$ versus k? As an example, see the figure below from Akinlabi et al. [2019]:



Another rather interesting plot would be P_w/P_u versus k. This would allow to detect if at least the ratio is increasing with k, which would be indicative that local isotropy is being approached at higher (unresolved) frequencies. As usual, care has to be taken regarding noise, aliasing, and other high-frequency effects. In this regard, see next comment.

l. 130–134 Is it possible that the coarser spatial resolution of aircraft measuremnts in comparison to helicopter and balloon measurements is part of the problem? For example, Siebert et al. [2006] found ratios closer to 4/3 from sonic anemometer data. The onset of isotropy may be gradual across a perceived inertial subrange. See the figure below, from Kaimal et al. [1972]:

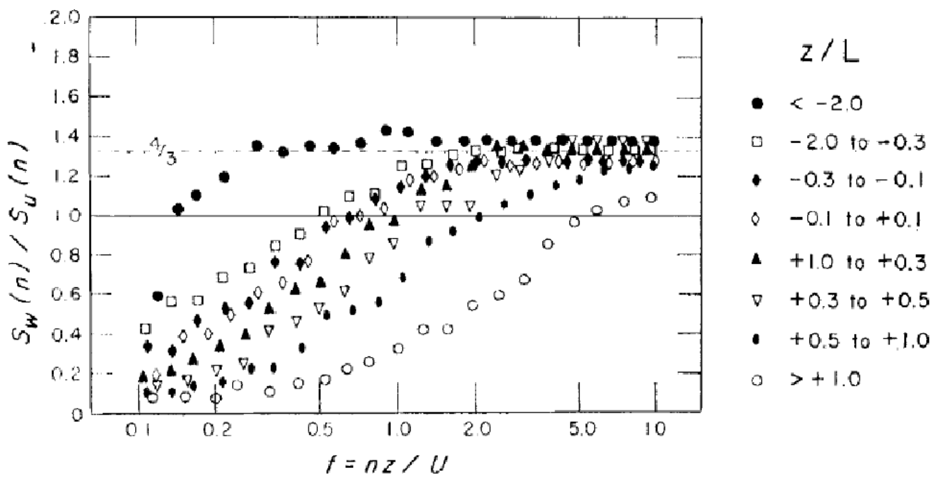


Figure 12. Plot of the ratios of w and u spectral estimates showing approach to the 4/3 ratio required for isotropy.

l. 140 Please clarify: if your coordinate system xyz is such that x is the direction that the aircraft flies, then there is a mean wind (with respect to the Earth) that in general *will not* be in the direction of x. On land stations, it is customary to rotate the data so that the mean wind vector is $(\overline{u}, 0, 0)$, but you do not mention a similar procedure. Therefore, it appears that in the aircraft reference frame there will be a $\overline{v}$ and possibly a $\overline{w}$. How does that impact, if at all, your results? Is this irrelevant because the aircraft's speed is so much greater than the average wind speed with respect to the Earth?

l. 254 Can the authors discuss more at length how buoyancy and possibly other effects impact isotropy? Some interesting discussion (as a starting point) can again be found in Akinlabi et al. [2019].

References

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