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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Scalar turbulent behavior in the roughness sublayer of an Amazonian forest" *by* Einara Zahn et al.

Anonymous Referee #1

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Review of ACP-2015-1043 "Scalar turbulent behavior in the roughness sublayer of an Amazonian forest" by Einara Zahn et al.

The study by Zahn et al. focuses on the analysis of the atmospheric boundary layer structure in the roughness sublayer of an Amazonian forest. Measurements of atmospheric turbulence made at several levels of the 82-m tower are used to study turbulent fluxes, scaling laws for turbulent mixing, and dissipation rates of various scalars (temperature, water vapour, and carbon dioxide). In this paper, the authors extensive debate on the breakdown of Monin-Obukov similarity theory (MOST) in the roughness sublayer under unstable conditions. I understand that the authors have done an extensive data analysis and reported among other things the importance of the solar zenith angle for similarity of scalars. In general, the authors have set out the problem and carefully worked out what needs to be done to address several issues. The paper is

original, makes a significant contribution and is well written. I recommend acceptance of the paper for publication in the ACP with minor revisions, not so much in terms of redoing the analysis, but rather providing perspective on important questions and difficulties.

Specific Comments:

1. My main concern is associated with self-correlation (also referred to as artificial or spurious correlation), which occurs in some plots because of the shared variables. Awareness regarding the self-correlation has been increasing in the past several years (e.g., Andreas and Hicks, 2002; Klipp and Mahrt, 2004; Baas et al., 2006; Grachev et al. 2007 and papers surveyed therein). Authors say nothing about this problem. However, some of the results (e.g., plots of various similarity functions in Figures 4-7) may be suffered by self-correlation because have built-in correlation that is not associated with real physics. For example, increasing sigma_w/u* with increasing -z/L ('1/3' power law) is likely associated with self-correlation because same variables (friction velocity) appear in two quantities between which a functional relationship is sought. I would like to see here some discussion on this point.

2. Section 2.1 (page 4, line 111). Use of a CSAT3 sonic anemometer now requires flow distortion correction. The recent controversy concerning the underestimation of vertical wind speed by non-orthogonal sonic anemometers has largely been resolved (see papers by Horst et al. (2015, BLM - reference is below) and B51K-01 (Frank et al.) and B51K-02 (Horst et al.) at the 2014 American Geophysical Union Fall meeting). I recommend the authors download Tom Horst's AGU talk and BLM paper, available at his website http://www.eol.ucar.edu/homes/horst/ However, this likely would not affect the general results of this study.

3. Since the sonic anemometer measures the so-called 'sonic' virtual temperature (which is close to the virtual temperature) the moisture correction in the sonic anemometer signal is necessary to obtain the correct value of temperature itself and

sensible heat flux (e.g. Kaimal and Finnigan, 1994). Authors reported the standard deviation of the temperature (Figures 4-6) and temperature spectra (Eq.6). To value the present results the authors should either show that the moisture corrections and their impact on the results are small, or (if otherwise) apply moisture corrections to the sonic temperature following Schotanus et al. (1983) based on the data collected by LI-7500.

4. Authors say nothing about the Webb correction (called WPL or Webb effect after the paper by Webb et al. [1980]). This correction must be taken into account when the turbulent fluxes of minor constituents such as carbon dioxide or, in some cases, water vapor are measured (Webb et al. 1980).

5. Section 2.2. Important discussion on the QC recommendations by Klipp and Mahrt (2004) and Sanz Rodrigo and Anderson (2013, their Table 1) have been missed. I think the authors should also include these papers in their discussion.

Editorial/Technical Comments:

Page 6, line 164. Turbulence Kinetic Energy (TKE) has already been defined earlier in Section 3.1, line 136.

Section 5.1. Define the scalar's turbulent scales a_*, c_* etc. Because, c_* < 0, the similarity functions for 'c' in Figs. 4-6 should be defined as sigma_c/|c_*|.

Literature, not mentioned in the manuscript:

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flux-profile relationships in the stable atmospheric boundary layer. Boundary-Layer Meteorol. 124(3), 315–333. DOI: 10.1007/s10546-007-9177-6

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Sanz Rodrigo J, Anderson P.S. (2013) Investigation of the stable atmospheric boundary layer at Halley Antarctica. Boundary-Layer Meteorol. 148(3): 517-539. DOI: 10.1007/s10546-013-9831-0

Schotanus P., Nieuwstadt F.T.M., De Bruin H.A.R. (1983) Temperature measurement with a sonic anemometer and its application to heat and moisture fluxes. Boundary-Layer Meteorol. 26(1): 81–93. DOI: 10.1007/BF00164332

Webb E.K., Pearman G.I., Leuning R. (1980) Correction of flux measurements for density effects due to heat and water vapour transfer. Q. J. R. Meteorol. Soc. 106(447): 85–100. DOI: 10.1002/qj.49710644707

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