Review of Zahn et al. (2016) – "Scalar turbulent behavior in the roughness sublayer of an Amazonian forest".

General comment: The work reports new data in the roughness sublayer (RSL) above tall forests and features them in relation to Monin-Obukhov similarity theory (MOST). The main result of interest is that when the zenith angle is low, the radiation load appears to force higher spatial uniformity thereby making the flow resemble surface layers (and hence follow MOST) – at least for heat and some of the biologically active scalars such as CO2 and water vapor. All in all, the data are unique, and the analysis opens up new ways to thinking about the RSL. For these reasons, the paper may be published in Atmos. Chem. Phys. The comments below are mainly for the authors to consider – and should be viewed as lines of improvement.

1. The choice of variables analyzed (σ's, velocity skewness, ϕ_ϵ, the temperature variance dissipation, and b) have not been justified in an integrated manner. Perhaps the authors meant to state that some of the variables are used to identify whether the flow statistics are in the RSL or not – and some variables are relevant to the stated goal of analyzing VOC measurements using flux-gradient relations and REA. May be structuring the rationale along those lines upfront is worthwhile. That is, the work will be dealing with variables that describe the turbulent Schmidt (and Prandtl) numbers and eddy diffusivity for momentum in the RSL – as well as the similarity in *b* across scalars (and momentum) in the RSL.
2. The linkage between equations (8) and (9) is not entirely clear. The excursions represented by c' are not synonymous to $\overline{c^+} - \overline{c^-}$. I think the authors can do a much better job at justifying the high-order velocity and scalar statistics to *b*.
3. A follow-up on comment 2, since this work is all about simulations to determine *b*, it is worth comparing *b* for scalars and momentum – that is

$$\overline{w'u'} = b_u \sigma_w \left(\overline{u'^+} - \overline{u'^-}\right).$$

Whether b_u/b_s (where s is a scalar) is constant for various zenith angles and stability conditions is worth reporting (as b_u may be far more sensitive to the roughness elements here than the source-sink distribution).

4. The equality in coefficients b_s does not necessarily require perfect similarity. For example, for two scalars say s1 and s2, then $R_{w,s1} \frac{\sigma_{s1}}{\left(\overline{s1'^+} - \overline{s1'^-}\right)} = b_{s1}$, and $R_{w,s2} \frac{\sigma_{s2}}{\left(\overline{s2'^+} - \overline{s2'^-}\right)} = b_{s2}$. Equating b_{s1} to b_{s2} does not necessarily require that $R_{w,s1} = R_{w,s2}$ as should be evident from the aforementioned definitions.
5. Horizontal and vertical velocity skewness values – the flume experiments by Poggi et al. (2004) – figure below suggests that the cross-over height of skewness sign reversal dependence on the

vegetation density per se. For dense canopies, the figure below suggests that both skewness values switch signs – and at different levels. This hints that the definition of the RSL thickness will vary with the statistic being analyzed (as expected).

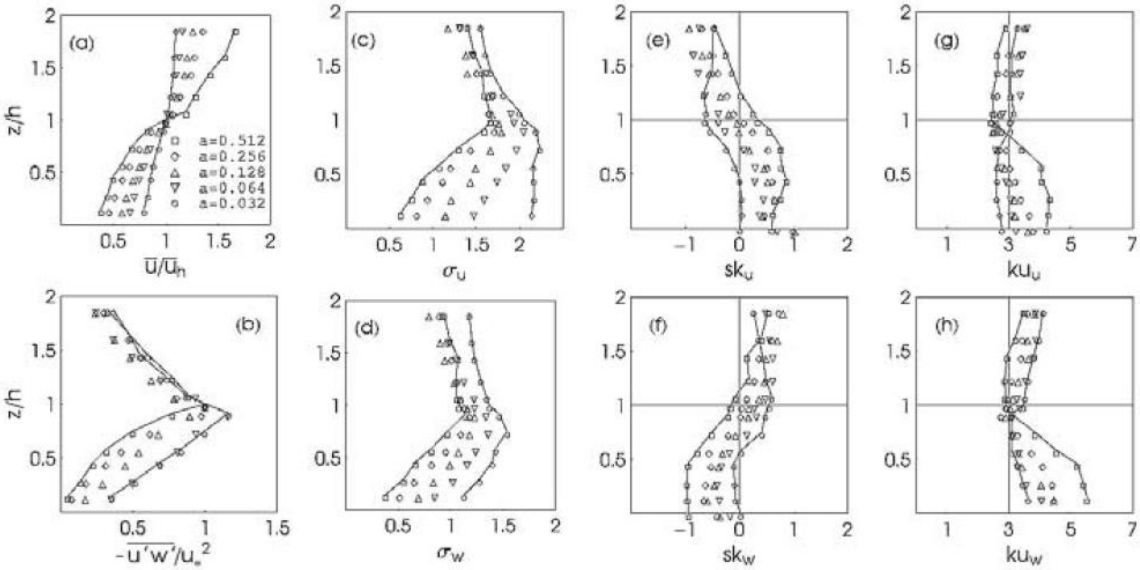

Figure 3. Variation of temporally- and horizontally-averaged moments with normalized height (z/h) for (a) mean longitudinal velocity, (b) mean shear stress, (c) longitudinal velocity standard deviation $(\sigma_u = \overline{u'^2}^{1/2}/u_*)$, (d) vertical velocity standard deviation $(\sigma_w = \overline{w'^2}^{1/2}/u_*)$, (e-f) longitudinal and vertical velocity skewness ($sk_u = \overline{u'^3}/\sigma_u^3$ and $sk_w = \overline{w'^3}/\sigma_w^3$), and (g-h) longitudinal and vertical velocity kurtosis ($ku_u = \overline{u'^4}/\sigma_u^4$ and $ku_w = \overline{w'^4}/\sigma_w^4$). Solid lines represent the sparsest and densest canopies.

6. The apparent agreement between $\frac{\sigma_w}{u_*}$ and MOST scaling may be due to self-correlation (see Cava et al., 2008). Certainly, more needs to be done to make a convincing case it is not all about self-correlation.

7. The authors should comment that all the normalized variances are above MOST predictions – but as discussed in Katul et al. (1995), inhomogeneity in the RSL impacts variances (i.e. the variance exceeds what would have predicted by the flux alone) but not necessarily fluxes. So, why is this result significant to VOC measurements – the fluxes may be the same but the variances higher in the RSL? Unless the authors meant to tie this finding to their REA and similarity theories (i.e. to quantities such as $\frac{\sigma_{s1}}{\left(\overline{s1'^{+}}-\overline{s1'^{-}}\right)}$).

8. A corollary comment to point 7 - Why did the authors focus only on the unstable conditions? Stable conditions (i.e. cooling) are equally important to shed light on the de-activation here, especially for heat and CO2 (sources and sinks switch signs) may be worth exploring.

9. Pages 14-15, the role of storage may be significant (see Detto et al.,2010). Also, the authors may want to inspect Figure 7 in Detto et al. (2008).

10. The conclusions need to present a revised picture of the RSL – does this mean production and dissipation of TKE and temperature variance does not hold – and if so – what does that imply to the usage of K-theory or even the interpretation of constant fluxes with height? More important, the authors should attempt to explore $\frac{dF_s}{dz} \neq 0$ and its relation to zenith angle? Or $g_\theta(\zeta)$ or χ? This has the most practical consequence of whether fluxes are constant with height or not.

References:

Detto et al., 2008, *Agricultural and Forest Meteorology*, 14, 902-916.

Detto et al., 2010, *Boundary-Layer Meteorology*, 136, 407-430.

Cava et al., 2008, *Boundary Layer Meteorology*, 128, 33-57.

Katul et al., 1995, *Boundary Layer Meteorology*, 74, 237-260.

Poggi et al. 2004, *Boundary-Layer Meteorology*, 111, 565-587.