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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Temperature profiles, plumes and spectra in the surface layers of convective atmospheric boundary layers" *by* Keith G. McNaughton and Subharthi Chowdhuri

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General Comments: This paper deals with an important geophysical issue, namely the scaling properties of plumes within and above the surface friction layer of convective atmospheric boundary layers, and therefore suits the scope of Nonlinear Processes in Geophysics (NPG) journal. Although the present version of this manuscript is mostly well-written, it does lack meticulousness in quite a few places but can be accepted for publication if the authors take into account the following comments and make the corresponding changes. Furthermore, the authors must consider the fact that the readers of NPG are not limited to the field of boundary layer meteorology

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Discussion paper

while making these changes.

Detailed Comments: Changes corresponding to the following comments need to be incorporated

1. Please use continuous line numbers.
2. Page 1 Line 10: Introduce vertical velocity similar to the way temperature is introduced (in the same line rather than in the next line).
3. Page 1 Line 15: plumes above the surface friction layer (SFL).
4. Page 1 Line 15: state that z, z_s are the observation and SFL heights respectively.
5. Page 1 Line 25: explicitly (but briefly) mention this contrasting interpretation of the role of buoyancy relative to Richardson's interpretation here.
6. Page 1 Line 40: solved analytically.
7. Page 1 Line 48: what do the authors mean by "form", do they refer to the geometry or shape of eddies and plumes? If they do, then scaling analyses along different directions could still be useful in determining such geometry or shape parameters (e.g., the determination of vertical stratification or anisotropy parameters using separate scaling analyses in the horizontal and vertical directions).
8. Page 2 Line 5: It would be better to explicitly state this rationale here (at least briefly).
9. Figure 1 caption: Obukhov length (L) "as defined by Eq. 3", where u_* is the friction velocity (as in Sect. 2).

10. Page 2 Line 60 Page 3 Line 28: Power Laws might even indicate generalized scale invariance in which case the underlying structures need not be self-similar (they could even be self-affine).

11. Page 2 Line 68: cite these previous works and briefly explain what has been attempted in these works.

12. Page 3 Line 8: It would be better if friction velocity is briefly defined here.

13. Page 3 Line 31: mention the scales replacing the scales in Eq. 2.

14. Page 3 Line 17 Line 42: If the authors imply that $u_* = 0$ by the term windless convection, it is better to mention this explicitly.

15. Page 3 Line 78: briefly define inversion height here.

16. Page 3 Line 85: inner-scaled $(\zeta = z/z_s)$ and outer-scaled $(\zeta = z/\lambda)$ versions.

17. Page 4 Line 35: briefly define the mixed layer here.

18. Section 3.3: the heading should be "plume mean velocity variance", and again in Page 4 Line 86, it must be plume mean velocity variance.

19. Page 5 Line 27, 28: the authors neither define the primed variables w', θ' (how are they related to the original variables w, θ) nor mention the significance of using them here. Do they indicate perturbation or fluctuation of the variables, why do they appear only in the heat flux equation?

20. Page 5 Line 57: How is the speed of the plume relevant in Eq. (23)?

21. Page 5 Line 71: wouldn't a horizontal cross-section of the 2T model show a two-dimensional comb where the third dimension (height) represents the temperature

(if the temperature in each point is plotted), and won't there be teeth of two different heights (θ_u and θ_d) rather than a single height, as mentioned in Line 72. The authors could provide a schematic diagram of this transect.

22. Page 6 Line 11: It isn't quite apparent how the 2T model explains this.
23. Page 6 Line 51: further explanation will be helpful here.
24. Figure 2 caption: θ_p has to be defined properly as the temperature corresponding to the peak value of the PDF (to avoid it being confused with the peak value of θ).
25. Page 6 Line 72: Does the prime indicate that the variables have been averaged over a number of runs? Once again, as mentioned in comment 19 this is not clear.
26. The heading of this section (Sect. 5.1) says T and wT probability distributions, but Fig. 2 shows $\theta - \theta_p$ distribution (the authors must explicitly state here if both temperature and potential temperature have the same probability distributions). Fig. 3, on the other hand, shows $w' - T'$ joint probability distributions weighted by the product $w'T'$ (not the probability distribution of $w'T'$), therefore it is not clear how it can be called the wT or heat flux probability distribution.
27. Page 7 Line 9: do the authors actually refer to "length" when they mention "size" here?
28. Page 7 Line 12: it would be apter if the authors use the term scale-invariant instead of self-similar following comment 10.
29. Page 7 Line 25: the authors could specify at least approximate wavenumber or scale values of these three ranges here while defining them.
30. Page 7 Line 41: a brief explanation as to how these scales were found in those works would be beneficial here.

31. Page 7 Line 53: plumes, where the scales l_1 and l_2 are greater than l_3.
32. Page 7 Line 64: this searching seems to be physical (dimensional) interpretation based trial and error rather than a rigorous mathematical procedure.
33. Page 7 Line 78: needs a mathematical explanation.
34. Page 7 Line 79: contradicts the scale mentioned in Table 1.
35. When the authors say temperature or velocity scale (e.g., Page 8 Line 11) they must be implying that the statistical average of temperature or velocity fluctuation scales as this particular term, since the power-laws discussed here are statistical ones (even though they are dimensionally correct, these laws need not hold good without averaging). The authors seem to obtain (based on observations) a term for the temperature or velocity variance scale (meaning that the statistical average of the square of the temperature or velocity fluctuation scales as this term) and take square root of this term to get the temperature or velocity scale. This means that the authors assume that square of average and average of square are equal, which is only valid for negligibly small fluctuations. This issue occurs multiple times throughout the paper (e.g. Page 5 Line 21, Page 7 Line 79, Page 8 Line 26, and Line 30).
36. Page 8 Line 18: how does the length scale as this term?
37. Page 8 Line 29: do the authors mean up-plume here?
38. Section 6.2, Figure 4, and Figure 5 on Page 10, 11: Once again the undefined primed variables are used.
39. Page 10 Line 21: it is better to give the empirical relation here.
40. Page 11 Line 28: the mixed scale and doubly mixed length scale seem to match at $\lambda = z_s$ and not at $z = z_s$ as mentioned here.

41. Figures 6 and 7: how is this scale chosen? (see comment 32)

42. Page 13 Line 6: needs more explanation.

Minor Comments: There are only a few minor issues

1. Page 1 Line 55: previous works.

2. Page 2 Line 55: discussion of (or about) the.

3. Page 3 Line 60: is a dimensionless length.

4. Page 5 Line 44: scales as.

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