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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observing Entrainment Mixing, Photochemical Ozone Production, and Regional Methane Emissions by Aircraft Using a Simple Mixed-Layer Model" *by* Justin F. Trousdell et al.

Anonymous Referee #3

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Review: Observing Entrainment Mixing, Photochemical Ozone Production, and Regional Methane Emissions by Aircraft Using a Simple Mixed-Layer Model

This paper describes the design and execution of two flight experiments in the San Joaquin Valley of California to quantify entrainment rates and then uses these entrainment velocities to solve for: (a) ozone production rates, (b) methane emissions, and (c) evapotranspiration. The authors are attempting numerous things here, which makes the paper difficult to read and, at times, the results difficult understand. The work is interesting, but paper would benefit from better organization around a clear goal prior

to publication. Adding clarity may be as simple as removing the excessive inessential detail.

General comments:

The Introduction should be reorganized to better frame the work. Some specific issues are as follows. In paragraph 2, the text does not define "tracer method" or "budget of the inversion base height" when describing what is done in the forthcoming analysis. This makes it difficult for the reader to know what is done here and how this work is different from past work. The sentence, "by way of targeted airborne campaigns we are able to probe the regional ABL vertically and horizontally and calculate entrainment rates and mesoscale advection," seems key, but is placed awkwardly in the middle of paragraph 3. The fourth paragraph returns to the idea of scalar budgeting, but still does not define, instead suggesting I should already be familiar with the concept (done through the particular way the references are discussed). While I agree with the content in paragraph 5, this paper is not actually about, "better understand[ing] the diurnal behavior of the wintertime boundary layer in the San Joaquin Valley." The discussion in paragraph 6 should more relevant to the analysis performed. For example, the paper never significantly discusses PM, but investigates ozone production, methane emissions, and evapotranspiration. While there is some text on ozone and drought here, methane is absent entirely. The last paragraph presents an outline of the paper, but the preceding text has not setup these goals, nor does the outline mention the ozone production, methane emission, or evapotranspiration applications.

Most of Section 2.1 is irrelevant. The authors should relate the descriptive information directly back to their analysis and delete superfluous detail.

Sections 2.6 and 2.7 should be framed around what was done here, rather than as done currently, as a general discussion of the two methods using the author's dataset as an example. The last sentence of Section 2.7, "ultimately the approach using the budget of boundary layer inversion height, outlined in Section 2.6 was taken to calculate

the entrainment rate," should be given to the reader up front. Additionally, the last paragraph in 2.7 is described almost narratively of how the analysis was done. Please reorder such that results are presented to convey the logic of the analysis to the reader.

What are the results for Ox, as opposed to O3 and NO2 separately? Use of P(Ox) would be especially important in the wintertime and better suited for a winter/summer comparison. Secondly, has wintertime P(O3) been found to be NOx-limited also? That seems unlikely; please clarify.

Broadly, the outline of the paper is to compute the entrainment rate and then use this rate to explore three things: (a) ozone production rates, (b) methane emissions, and (c) water. Adding text or a dedicated section after discussion of the three studies, but prior to the Conclusion, that ties everything back together would do two valuable things. First, it would clarify the narrative and logic of the paper, and second, it would reinforce the significance of the work.

Specific comments:

Page 2, lines 3–4: Citation needed on, "this mixing tends to be a significant contributor to the ABL budget of the scalar."

Page 3, lines 17–18: Should this be 105 exceedances "per year"?

Page 7, line 7: w(e) is not defined in the text (it is instead defined on page 8, line 23).

Page 10, lines 18–20: What is the evidence for: "For the purposes of estimating regional source strengths or regional in situ photochemistry, we suggest that the more pertinent mixing process is the dilution of the anthropogenically influenced ABL air mass by the more global 'baseline' FT air."

Page 11, lines 34–35: How is this shown in Fig. 7: "the importance of entrainment mixing on an ozone exceedance day."

Page 12, lines 35–36: It is difficult to see that methane is an appropriate proxy for

total VOC. Even if dairies and gas production are the dominant source of VOCs, what matters more is that the drivers of methane emission match the drivers of the other VOC, which might not be true even if the sources are the same.

Page 13, lines 3–5: Can an estimate of the uncertainty be given?

Section 4: I recommend moving Section 4 to precede Sections 3.2.1–3.2.3.

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