

Review of “Observing Entrainment Mixing, Photochemical Ozone Production, and Regional Methane Emissions by Aircraft Using a Simple Mixed-Layer Model,” Trousdell et al., ACP (2016)

Summary

This paper presents results from two small flight campaigns in California. Observed trace gas concentrations and profiles are used to derive entrainment velocities and examine the boundary-layer budgets of ozone, methane and water vapor. Results are used to evaluate photochemical ozone production, regional methane emissions and evapotranspiration.

The presented data is new, and the analysis of boundary layer budgets is a useful technique that is perhaps under-utilized in our field. The paper is generally well-written, although the embellished language is distracting at times and some sections provide an over-abundance of contextual details. Revisions are necessary before publication.

General Comments

Section 2.1 provides a wealth of interesting but non-essential details on the topography and meteorology of the SJV. The first three paragraphs could probably be condensed down to one by removing such details –particularly those regarding specific orographic effects, which get confusing unless one constantly refers to a map or is familiar with the area. Indeed, the third paragraph (page 4, line 13) seems totally irrelevant given that the data presented is all daytime. The last paragraph in this section reads like a primer on mountain-valley flows and again seems only tangentially relevant to the results presented later.

The conclusions section is just a summary of main findings. It would be useful to add some discussion of needs for future work, in particular how some of the findings (such as dramatically incorrect emission inventories) could be further verified and eventually incorporated into better emission parameterizations. Is the ABL budget method a practical technique for grounding-truthing regional emissions on a model-relevant scale?

Specific Comments

P2/L27: Wolfe et al. (2015) is another relevant and recent citation.

Equations 4-7 and discussion thereof: Seems inconsistent. For example, the surface/entrainment terms are given different symbols for O₃ and water. And the entrainment flux sign seems wrong – a higher concentration of stuff in the ABL should give rise to a positive entrainment flux (stuff leaving the ABL) and a negative contribution to dX/dt . It might be more straightforward to show a generic budget equation for any scalar, and then discuss specific treatments for water, ozone and methane.

Page 8, Lines 16-22: suggest deleting.

Eqn. 5: How are the BL concentrations determined for this calculation? Is it an average over the whole ABL, or just the upper portion? Same question for FT? Are uncertainties from this averaging (e.g. std of mean) propagated through to entrainment flux?

P12/L7: how is this map generated? Is it an interpolation of ground site data? Please expound. Also, another way of stating the opposing O₃ and NO₂ advective terms is that O_x=O₃+NO₂ is conserved.

Section 3.2.3: These findings seem to suggest that NARR has serious flaws and should be adjusted, at least coarsely, to more accurately represent agricultural practices in some broad sense. A naïve question: would such issues impact the subsidence velocity derived from NARR?

Table 3: The third column is technically not a flux, but a flux divergence. Also, please give CH₄ production in ppmv/h for easy comparison with other terms.

Figure 9: is there any physical rationale behind a power-law fit?

Technical Comments

Fig. 2: Please label flight regions 1 and 2 as referenced in section 2.1.

RASS is defined twice.

P6/L32: delete “, which”

P6/L35: “as per the Fundamental Theorem of Calculus” is a gratuitously pretentious statement.

Equations 1-3: subsidence is referred to as both $W(z_i)$ and W . Pick one.

P9, L13: delete “the 5 hour period of late morning to early afternoon from”

P10/L17: delete “a remove of”