

Review of Discussion Paper ACP_2021_690

The Fires, Asian, and Stratospheric Transport-Las Vegas Ozone Study (*FAST-LVOS*)

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General comments

The manuscript describes in detail an overwhelming data set obtained in six weeks and clearly deserves publication. The material is well suited to discuss the air-quality issues addressed. However, because of the complexity the description of the data is sometimes difficult to follow. The scientific guidance could be somewhat improved, maybe also by including the processes in the section titles. The low role of long-range transport to the surface could be emphasized and discussed somewhat more, also based on existing literature.

Specific comments

Abstract: “and illustrate some of the challenges facing air quality managers tasked with O₃ attainment in the SWUS during late spring and early summer”: A few of these issues could be listed here. What are the main findings of Zhang et al.?

P. 3, line 66: Reference for “stratosphere”!

P. 3, lines 66-67: The mountains (specify altitude ranges) are certainly higher and more susceptible to intrusions (Elbern et al., *Atmos. Environ.*, 31, 3207–3226, 1997; Trickl et al., ACP 2010; ACP 2020). However, there are no cities up there. What are typical altitudes in the states mentioned, what is the chance of intrusions to reach the valleys?

P. 3, Figure 1: Specify length of boxes in capture in km.

Figures 4,5, others: Specify “alt” in captions (at least once).

P. 5, line 118: “*Deep* STT refers to those intrusions ...”: This is the case in the Zürich modelling studies, but not in general. Please, rephrase!

P. 5, line 122: “Clean or polluted”

P. 6, line 155: A lower-lying site implies the advantage of a coverage of a larger vertical range.

P. 7: Figure caption: Add information to identify the panels.

P. 9, line 231: CO concentrations in the lowermost stratosphere, relevant for the intrusions, are not that low (Trickl et al., ACP 2014); “much” is perhaps too strong!

P. 9, line 236: Please, add reference for low concentrations of both in the marine PBL.

P. 12, line 335: Add date to “until the end of the campaign”, which reduces the effort for the readers to look for the date elsewhere.

P. 17, Fig. 6: g/kg is a terrible unit that is unfortunately frequently used in the H₂O community. These numbers are difficult to understand since they do not directly reflect the ideal gas law. The volume mixing ratio is better. RH is also more meaningful for judging dryness. It would be helpful to have a second time scale above the top panel.

P. 17, lines 424-425: Add C and D (etc.) in the brackets specifying the times. Please, add this also elsewhere, wherever it makes sense.

P. 18, line 431: Is “unique” needed here? If this is the case, briefly specify why (e.g., lowest angle if this is special for ozone lidars). Writing “unique” is dangerous anyway.

P.19, Fig. 7: Please, add time scale above the top panel.

P. 20, line 467: “performance” is misleading or ambiguous. What I see are typical data products.

P. 21, lines 474-475: Is the resolution of RAQMS sufficient for reproducing intrusions (e.g., Roelofs et al., JGR 2003)? If this is not the case, the subsequent finer model will miss also it. Please, give more information in Sec. 3.4.

P. 25, line 535: Are there RH data from the balloon ascents? 0-5 % RH is typical of intrusions. The RS92 sonde is rather quantitative at low RH, the RS41 sonde has a slight positive bias of about 3 % RH intrusions. I not so sure about other sensors, possibly used onboard the aircraft. The impact of Asian contributions on the humidity would be an interesting topic.

P. 25, lines 558-563: Is there prefrontal advection? This means rising air (as verified by the rise of the trajectory), polluted if pollution sources are present. Is this what is named synoptic forcing?

P. 27, line 580: How dry?

P. 29, line 628-629: This observation is important. However, I do not understand why the situation before the arrival of the intrusion could influence the composition of the intrusion itself. What is the role of PBL formation? Do night-time intrusions penetrate deeper (see Trickl et al., ACP 2020)? Did the dry layer move out of the observational area?

P. 29, line 635: You need a high-resolution model for this purpose. Still, there is the issue of numerical diffusion. I am not sure if the models can quantify entrainment. Observations indicate a very small vertical exchange across the top of the PBL. I suggest to reformulate this paragraph slightly.

P. 30, line 653: This is really spectacular and normally not that clearly visible! Is this penetration perhaps caused by the fast descent?

P. 35, line 708: Please, explain the role of the Mauna Loa data for the situation in Nevada.

P. 38, line 775: “As expected”: why?

Sec. 10: Does one learn anything from a comparison with the 2013 campaign? Does it sense to add a table with some statistics, here or in the preceding chapters?

Style:

Line 6 and may other occurrences: Although frequently used \sim is not good style. It is also the mathematical symbol for “proportional to”.

Lines 76, 373, 528: Colour or color? There is mixed use of B.E. and A.E. all over the paper.

Lines 123, 140, 242, 372, 496: “, thus,”

Line 167: “to continuously measure” is a split infinitive and should be avoided.

Line 379: “, although”? (see “, but”)

Line 423: “the early morning”

Line 39: Consider rephrasing “dropped down”.