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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Long-range pollution transport during the MILAGRO-2006 campaign: a case study of a major Mexico City outflow event using free-floating altitude-controlled balloons" *by* P. B. Voss et al.

Anonymous Referee #1

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This manuscript reports on balloon flights used to track the downwind transport of pollution from Mexico City during the MILAGRO campaign. Observations of urban tracers on the NSF C-130 in proximity to the balloons are used to verify success in tracking the Mexico City plume as it was transported far downwind over the Gulf of Mexico. Comparison with trajectories from the WRF-FLEXPART model demonstrate good agreement on the axis of outflow but reveal a significant difference as balloon trajectories remain aloft while model trajectories follow the terrain as they advance from Mexico City to the coast. This difference is notable in terms of expected chemical

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evolution as well as surface level impacts downwind of Mexico City.

Much of the manuscript is devoted by necessity to describing how the balloons were operated and the verification of their success through comparison with C-130 observations. What makes this use of the balloons notable, however, is the clear difference in how the model represents the outflow versus the balloons. While it appears that models might have been sufficient to guide the C-130 to find the outflow over the Gulf of Mexico, the model trajectories would have clearly given an inaccurate view of the outflow history. In my view, this point is not emphasized enough and is absent from both the abstract and the conclusions.

There are also several details regarding the operation of the balloons that are not adequately addressed. For instance, how long does it take to perform a profile? How does this affect the trajectory of the balloon in cases of strong wind shear? From Figure 2, it appears to me that the red trajectory experiences a significant shift of nearly a degree in longitude during the sounding of lower altitudes, while the blue trajectory experiences a visible (but smaller) jaunt to the northwest while sounding higher altitudes. These shifts also appear to be consistent with the general flow indicated in Figure 8. These shifts introduce deviations from the original trajectory and could be large enough to separate the balloon from the plume. It would be helpful if the authors would provide some discussion of this possibility.

Finally, many of the figures are difficult to visualize. Some suggestions for making it easier to quickly grasp the data in the figures are provided in the comments below.

I would emphasize that this is already a very good manuscript that with some revision would become an excellent contribution to the results coming from the MILAGRO study.

Specific comments:

1. The abstract concludes with a rather weak statement about how these findings "should prove useful. . ." The authors should provide a more compelling reason for this

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paper. Why not highlight the fact that the balloons guided sampling in a way that models would have failed (i.e., aloft transport versus terrain following)?

2. Page 3357, line 8: What is meant by "the exact altitude determined by the flight plan"? Is this predetermined based on model predictions? Do airborne observations influence this decision? What role does the initial sounding play in selecting the initial altitude? In the absence of any pollutant tracer observations, how confident can you be in this altitude selection?

3. Page 3358, lines 10-15: As a follow on to the previous comment. These two balloons were launched to altitudes of 4500 m and 4100 m, respectively. What was the rationale for these two altitudes?

4. Page 3359, line 16: It is stated that, "The balloons ascended to their nominal float altitude of 3450 m. . ." As in previous comments, it is not clear why this is the chosen (or resulting) altitude.

5. Page 3373, line 17: The authors comment on the width of the plume intercept versus the width of the polluted airmass observed the previous day. Given the deviations in the balloon trajectories due to the soundings, I am surprised that there is any expectation of a precise match in the airmass observed on the 18th and 19th by the C-130.

6. Page 3374, line 6: Authors state that "Figure 15b shows that this intercept had higher levels of all urban tracers. . ." This is somewhat overstated. I would agree that MTBE values stand out for this intercept, but the differences in CO between plots a and b as well as HCN between plots b and c are not statistically significant. Even O3 is problematic in that it has a natural vertical gradient that increases with altitude and is consistent with the observed differences between the three intercepts.

7. Page 3374: The authors note differences in CO background and speculate on differences in dilution rate versus altitude. I would comment here that estimates of background mixing could be misleading if they are based on observations just above the

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pollution layer. More often than not, plume dilution is dominated by horizontal mixing as the atmosphere is often stratified into layers that do not effectively mix, especially under subsident conditions. It is possible that the 65 ppbv background CO (which is likely to be stratospherically influenced) is in a layer above the plume layer that is not effectively mixing into the plume and is thus an underestimate of the background value being more effectively entrained horizontally.

8. Figure 2b: There are several changes that could be made to this figure that would greatly enhance the ability of readers to interpret information presented throughout the paper. First, it would be very helpful to somehow indicate where soundings are being executed along these trajectories. This could either be done with changes in line thickness or color. It is also important to show a top-down view of the C-130 flight track which is shown later in Figure 10. Along this C-130 flight track, the three plume intercepts shown in figure 15 should be annotated. Finally, the physical locations of the two balloons and the C-130 for the data shown in figure 3 should be annotated. While this may require the figure to be enlarged, it would greatly reduce the mental gymnastics required to interpret some of the 3-D plots presented throughout the paper.

9. Figure 6: From the discontinuities in this figure, I am inferring that this curtain has been stitched together from four different parts of the flight. It would be helpful to either add a map or mark on the previous figure those locations that correspond to the lidar data.

10. Figure 7: It is possible, but not easy, to differentiate the C-130 data from the balloon data in this figure.

11. Figure 8: The background data in this figure is described as an interpolation in the text, but it seems more like extrapolation which is just as likely to mislead as it is to inform. I would prefer to only have the coloring along the balloon trajectories in this figure.

12. Figure 10: It would be very helpful to also have an accompanying top-down view

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of this figure.

13. Figure 12: There is no x-axis labeled on this plot, but I assume it is latitudinally oriented. This should be clarified.

Errata:

Page 3354, line 12: “question” should be “questions”

Page 3370, line 10: The text referring to figure 12 mentions a “green line” which is actually dark blue as is correctly noted in the figure caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3347, 2010.