

***Interactive comment on “Aircraft study of the
impact of lake-breeze circulations on trace gases
and particles during BAQS-Met 2007” by
K. L. Hayden et al.***

Anonymous Referee #1

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This paper analyzes flights through a complex lake breeze system during a polluted day. On the whole, the analysis is good, except for an estimation of aerosol generation rates associated with a circulation pattern that is not likely to actually exist (see my first comment below). Otherwise, the paper is generally well-written and clear, though I'd prefer that the figures generally be larger.

p. 11514, lines 1-4: The key hypothesis of the paper is that "pollutants in the CBL were lofted upward at the LSC lake-breeze front, transported northward in the synoptic flow, transported in the downdraft on the north side [of] the front, and then confined by the

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LSC onshore flow along the south shore of LSC." This is possible, but the more likely explanation should be considered first: that pollutants behind the LSC lake-breeze front were lofted upward at the front, transported northward, transported in the downdraft, and confined along the south shore of the LSC. This is a known circulation pattern, while the trajectory described in the hypothesis has not previously been documented anywhere. Further, the paper does not provide convincing evidence of this. The trajectory analyses show recirculation, but the recirculation seems to be consistent with my "more likely explanation". Nowhere in the trajectory analysis is it shown that air initially landward of the lake breeze front actually becomes ingested in the lake breeze air. The two air masses will not be completely separate, because mixing does take place along and behind the lake breeze front. Note that the air behind the lake breeze front can be dirty because polluted air can be transported over LSC during the early morning and post-dawn hours prior to the development of the lake breeze, and concentrations will be relatively high because the air will not be mixed within a CBL while the air resides over LSC during the morning. In the absence of stronger evidence, this portion of the analysis (including a large part of section 3.7) should be removed.

p. 11506, line 3: Show Sarnia on Fig. 1 or refer to what's already on Fig. 1.

p. 11509, lines 5-12: Make it clear that you are looking for evidence that the LSC front is present beneath the flight level of the aircraft, rather than supposing that the front itself extends up to 800m.

p. 11509, lines 13-18: Since the LSC front is expected to be shallower than 800 m, no dew point change is expected at flight level. Since it's not relevant to the rest of the paper anyway, I suggest not attempting to infer the LSC front location north of LSC. This idea is further supported by the lack of evidence of a front at 300 m.

Fig. 4: Are the time labels misplaced? For example, the text (p. 11510, lines 17-18) talks about a feature at 16:36 at 800 m, but according to Fig. 4's x axis, 16:36 occurs to the left of the start of the flight-level data.

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p. 11511, line 10: The relevant assumption is of slow processes, not stable processes.

Figs. 5 and 6: Single locations are given for the frontal positions, yet the fronts moved between aircraft passes at different altitudes. Did you correct for this motion by applying a horizontal adjustment to the flight-level data? If not, indicate the frontal location on each pass and note in the text that the vertical sections don't actually represent the vertical structure of the atmosphere at any given time.

p. 11513, lines 10-13: The TIBL growth does not limit vertical mixing. Any pollutant will take time to be lofted upward, and when the air mass is especially unstable (lake breeze air moving over hot land), the lofting should be especially rapid. The mixing limit is provided by the lake breeze inversion.

p. 11513, lines 20-22: A simpler (or alternative) explanation is that there are fewer industrial pollutant sources on the north side of Detroit, where the air came from according to the trajectories.

p. 11516, line 15: What is "LSC inflow"? How are you diagnosing along-shore transport from the vertical sections?

p. 11516, lines 20-23: Fig. 9a doesn't show a complete circuit. At most half a circuit is shown, and it's relevant to my main point above whether the circuit ever includes air ahead of the LSC breeze front. With half a circuit taking 2 h, a complete circuit would be 4 h, consistent with Fig. 9b.

p. 11517, lines 17-19: The dashed grey arrow is incorrect. The text correctly diagnosed the light wind regime as the return flow aloft, where the air is "returning" only in a front-relative sense. Thus the light wind area corresponds to the top part of the solid gray arrow, where it's pointing slightly to the south. But then, as you showed, there's nowhere that the air is actually moving toward the south. The key to this paradox is the fact that the front is moving to the north. Streamlines and trajectories cannot be parallel to the front, or else it would not move. All along the front, the northward or

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upward flow must be sufficient to propel the front forward, so there must be flow toward the front (horizontally or vertically) within the lake air adjacent to the front.

p. 11519, lines 6-10: I'm having difficulty reconciling the units and description in the text with Fig. 12.

p. 11521, lines 13-14: If there's subsidence between 4.2 km and 12 km, it's not at all discernable in Fig. 5. Use a color palette that clearly depicts the downdraft. Up to this point, I had thought the downdraft referred to in the text was the one just behind the LSC front, since that's the only one I could see.

p. 11521, lines 17-18: As I've argued above, I do not believe that the air has made a circuit from ahead of the LSC front to behind it. Thus the calculation of aerosol generation rates is dubious. But if the air did make such a circuit, the estimate of the time required for the circuit is off because it neglects the time air spends within the downdraft over the lake at levels where the horizontal wind is very weak.

p. 11521, lines 18-20: The difference in our interpretations could be settled with a model-output trajectory that originates ahead of the LSC front and ends up at 300 m behind it. In the absence of such a trajectory, there's no point in estimating the circuit time of a hypothetical trajectory with the model wind speeds.

p. 11521, lines 27ff: The calculation relies on the unstated (and dubious) assumption that the air in the CBL is completely unchanged for 1-2 (or, by my calculation, 4) hours. Discuss this.

p. 11522, lines 11-13: The important issue is not the enhancement of reaction rates above the regional background, but rather the enhancement of reaction rates above the undisturbed CBL.

p. 11522, lines 14-19: This explanation works the wrong way. Air within the CBL will spend much of its time within the clouds topping the CBL, while air within the LSC circulation will only experience clouds near the LSC front.

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Fig. 8: Enlarge these panels to at least the size and aspect ratio of Figs. 5 and 6 to which they are to be compared.

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