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Interactive Comment

Interactive comment on "Unraveling the complex local-scale flows influencing ozone patterns in the southern Great Lakes of North America" *by* I. Levy et al.

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General Comments:

This paper provides a thorough sythesis and analysis of surface-based and airborne ozone and meteorological measurements during the BAQS-Met field campaign in 2007. Synthesis of complex and sometimes contradictory data in a region of complex topography is a difficult challenge, but this paper does it well. It provides a clear description of the different summertime meteorological regimes in the area during quiescent periods and how they affect ozone at the ground and aloft. The paper is a solid contribution to the literature. Only two aspects need fixing: the figure quality and the discussion of the nighttime oscillations. See my substantive comments below.

Substantive Comments:

Many of the figures use a character size that is unacceptably small. Someone printing the paper would be unable to read much of the figure text.

19786, lines 21-22: I don't understand this sentence. The figure shows that temperature and ozone oscillate simultaneously, so clearly there's something happening in the atmosphere that's affecting them both. If the dew point changes are related to the oscillations in ozone, then they are also related to the oscillations in temperature. Periodic condensation of water vapor to the surface (and evaporation of water from the surface), with less water vapor (more condensation) when the temperature is colder, would imply that the dew point is related to the oscillations in temperature and ozone, so the two alternatives proposed by the sentence in the manuscript are in reality just a single alternative. This is true whether the authors envision periodic condensation and evaporation producing the oscillations or whether they envision surface condensation establishing a vertical gradient of dew point, so that dew point varies with the up-and-down motion of the local atmosphere in the same way that temperature does.

19787, lines 8-11: It is not clear how the Huron breeze is supposed to create the circumstances for the oscillations. I can come up with two possibilities, but both are extremely unlikely. The first is that the lake breeze is so shallow (< 10 m) that the oscillations represent the top of the sea breeze inversion rising and falling past the sensors, but such a shallow lake breeze over such a large horizontal extent is impossible. The second is that the leading edge of the lake breeze moves back and forth periodically over the station location, but that is highly unlikely given the strong observed periodicity, its simultaneous occurrence at several stations, and the lack of observed horizontal wind oscillations farther inland to alter the speed of lake breeze advance. (see also 19788, lines 8-12).

19787, lines 20-22: If the temperature inversion is generated by nocturnal radiational

ACPD

10, C7505–C7508, 2010

Interactive Comment

cooling of an initially well-mixed layer, the difference between the air masses at the surface and aloft would lie mainly in temperature and ozone (due to NOX titration and dry deposition). Unless the surface layer was cold enough to permit dew to form, there would be no mechanism to generate a dew point gradient between the two air masses and no dew point variations would be expected.

19788, lines 15-22: It is difficult to see how buoyant adjustment of air in a shallow layer would bring warmer air to the surface. The tendency would be for warmer air to rise and be replaced laterally by cooler air. The lack of dew point oscillations, however, is not a problem with this explanation, since radiative cooling by itself does not alter the dew point.

19788, lines 22-27: The front would be a single density current; injections of air from higher elevations from the surface would be caused by Kelvin-Helmholtz billows rather than additional density currents.

19787-19788: It seems to me that intermittent turbulence, a common nocturnal phenomenon, could easily be responsible for the oscillatory features in the temperature and ozone. This possibility should at least be mentioned here and at the end of the final section.

19790, lines 24-26: I presume this passage is referring to Figure 4. If so, Figure 4 only shows a large reservoir of ozone centered over Lake Erie at 21:00 EDT. The term “large reservoir” is misleading because it implies that the ozone remains there for a while. The ozone pattern aloft at sunrise is much more relevant to ground-level ozone levels than the ozone pattern aloft in the evening. I do not know why the 21:00 EDT ozone pattern aloft is thought to be important enough to merit mention in the conclusions and the abstract.

Trivial Comments:

19765, line 7: The time-varying nature of the land-sea temperature difference is more

ACPD

10, C7505–C7508, 2010

Interactive Comment

important than the existence of a temperature difference itself, as it assures that the winds never come into gradient balance. Insert “time-varying” before “temperature”.

19766, line 16: As written, the smallest change was 60 ppb and the largest change was 100 ppb. I think you meant to say that the “ozone levels ranged from 60 ppb to 100 ppb”, so use that or similar language.

19770, line 3: The AURAMS surface types do not have a 1:1 correspondence to the observation site types. Change “corresponding” to “various”.

19774, lines 19-22: Another cause of the difference is the decreased vertical exchange of ozone over land at night.

19776, lines 26-27: The detailed analysis of the meteorological conditions is useful for showing the spatial extent of the different modes of transport, but the Harrow transport sequence described in the remainder of this sentence is deduceable exclusively from the station time series (Fig. 6a) with no detailed analysis required. Rephrase.

Technical Corrections:

19765, line 23: Change “have” to “has”.

19765, line 27: Change “models” to “model”.

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ACPD

10, C7505–C7508, 2010

Interactive Comment