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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Meteorological factors controlling low-level continental pollutant outflow across a coast" *by* D. L. Peake et al.

Anonymous Referee #1

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This paper takes a much needed look at the quantity of pollution transported from eastern North America into the western North Atlantic Ocean, and provides a quantified estimate of mass transport showing that horizontal advection is as important as vertical transport for ventilating the eastern US/Canada boundary layer. While the model exercise is well planned and executed, in terms of quantifying tracer transport budget terms, the study makes very poor use of the extensive ICARTT observational database to evaluate the model. I expect an ACP paper that focuses on modelling to provide rigorous evaluation of the model output against observations. As I describe below the evaluation needs to be expanded and I will not recommend publication until this aspect of the paper is improved. Another major short-coming of the paper is that the major conclusion that horizontal advection of pollution from the eastern USA is comparable

to that of vertical transport, is not even discussed in the paper (at least I couldn't find any clear discussion of the topic). My remaining comments are relatively minor and deal with improving the writing style or presenting results with additional tables.

Major Comments:

page 10854, line 26 I don't understand why this definition of coastal outflow does not include transport within the marine boundary layer. I realize that pollution in warm continental air will rise above cold air in the MBL when blown out to sea. But if a cold front advects from land out to sea the pollution is emitted into very cold air over land. When this cold polluted air mass moves over the relatively warmer waters of the Gulf Stream along the US east coast an unstable situation arises. As a result, mixing occurs from the surface of the ocean to the top of the convective clouds that are typically produced in this scenario (this truly is a common occurrence along the US east coast in winter and spring). Furthermore, Lee et al. [2011] show CO in excess of 200 ppbv at altitudes less than 500 m downwind of New York City, which is pollution that advected offshore within the MBL.

Lee, S.-H., et al. (2011), Modeling ozone plumes observed downwind of New York City over the North Atlantic Ocean during the ICARTT field campaign, Atmos. Chem. Phys., 11, 7375–7397

A paper that needs to be referenced is Fang et al. [2009] which examines 15 summers of pollutant outflow from the eastern USA: Fang, Y., et al. (2009), Estimating the contribution of strong daily export events to total pollutant export from the United States in summer, J. Geophys. Res., 114, D23302.

Figure 4 compares the modeled surface tracer (emitted uniformly from the land surface) to CO measurements made at 121 EPA stations across the eastern USA. I find this comparison to be essentially meaningless and suggest a more appropriate measurement/model comparison method. The modeled tracer is released uniformly across the eastern North America land surface which is predominantly rural. In contrast the

CO monitors are mainly in urban areas, which is evident from the very high mean CO mixing ratios of 400-600 ppbv. These EPA monitors are only useful in urban areas because their poor detection limit is about 200 ppbv, higher than typical rural CO mixing ratios. I realize that the authors are not trying to exactly reproduce CO mixing ratios, but the very high modeled CO mixing ratios demonstrate that the emission rate needs to be reduced. Seeing as the goal of the study is to understand export out of the boundary layer a much better comparison is to compare the vertical distribution of the modeled tracer to vertical profiles of measured CO. For example: 1) Fang et al. [2009] show in their Figure 2 mean CO mixing ratio profiles as measured by the NASA DC8 during ICARTT. 2) Lee et al. [2011] compare WRF-Chem to NOAA P3 CO profiles downwind of New York City on several days during ICARTT. 3) Cooper et al. [2006] show CO profiles above Texas, Atlanta, the northeastern USA and Montreal Canada during ICARTT. These data are freely available from the IAGOS/MOAZIC database: www.iagos.org

The authors need to obtain the CO data from the NASA DC8, NOAA P3 and MOZAIC/IAGOS and produce a composite CO profile above the eastern USA and above the western North Atlantic Ocean. They then need to see if their modeled tracer has the same general shape as the measured profile, examining the model standard deviation as well as the mean. They also need to carefully compare their tracer's vertical distribution to the CO profiles from the NOAA P3 flights downwind of New York City on July 20-21, 2004 as described by Lee et al. [2011]. This is the only way to see if the model provides a realistic simulation of offshore transport.

Cooper, O. R., et al. (2006), Large upper tropospheric ozone enhancements above midlatitude North America during summer: In situ evidence from the IONS and MOZAIC ozone measurement network, J. Geophys. Res., 111, D24S05, doi:10.1029/2006JD007306.

The authors need to add a figure that shows the percent of tracer advected horizontally into the ocean each day, along with the percent transported vertically. They also need

to add discussion of these budget terms that are presently only briefly mentioned in the conclusions.

Minor Comments If no explanation is given for a comment, please insert the suggested text into the appropriate place in the manuscript.

page 10854, line 6 and quantifies their importance

page 10854, line 18 The abstract would flow better if the sentence beginning with "Short-lived tracers" came before the sentence on line 16 that begins with "For short-lived tracers"

p10857 line 15 that have the most influence

p10857 line 19 North Atlantic Ocean

p10858 line 14 cumulus-capped

p10858 line 15 I don't understand why the number to turbulent mixing levels would be capped at the cloud base. A convective cloud has vertical mixing from the cloud base to the top of the cloud so I don't see how you can cap NTML at cloud base.

p10858 line 20 Hmax has a single value determined from all the daily values, so how can Hmax vary from day to day when it has a single value?

p10858 line 21 The free troposphere must, by definition, only extend to the tropopause but you state that it extends to the top of the model which is located at 39 km (near the top of the stratosphere).

page 10860 line 11 importance of convection can be quantified

page 10863 line 11 minus the tracer that excluded the convective mass

page 10865 line 20 maximum height of the continental

page 10868 line 6 an analytic solution

page 10868 line 8 and a simple finite

page 10869 line 18 I'm confused by this sentence. Here you state that decreasing the decay rate causes an increase in coastal outflow. But Figure 8a appears to show the opposite. As you move down the y-axis 1/alpha increases, not decreases, while the percent of tracer in the outflow box increases.

page 10872 line 5 please specify that 100 km applies to 1 day of transport

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 10853, 2014.