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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Elevated ozone in boreal fire plumes – the 2013 smoke season" *by* T. Trickl et al.

Anonymous Referee #2

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The authors present a set of very interesting measurements showing the influence of North American boreal fires on ozone and aerosol in the free troposphere above a high elevation site in Germany. The title gives the impression that the elevated ozone they observed is the result of biomass burning, but the thrust of the paper is quite the opposite. A more appropriate title would be something like "Elevated ozone in boreal fire plumes-influence of descending stratospheric air"

The measurements are of high quality, but the interpretation is weakened by the tendency of the authors to expect too much from HYSPLIT back trajectory calculations. I don't question the conclusions, but the validity of any individual 315-hour (13+ days) back trajectory is highly questionable, particularly if it is calculated using the low resolution (2.5° x 2.5° horizontal) Reanalysis data. Extending the HYSPLIT trajectories

by running a second set as in Figure 19 seems particularly dangerous. The "astonishingly coherent" trajectories in Figure 18 are most likely due to the low vertical resolution of the Reanalysis model, which is confined to standard pressure levels (i.e. 1000,925,850,700,600,500,...) that are spaced much greater than the 100 m differences used in the calculations. The interesting profiles from July 13 are indeed consistent with differential transport that shifts from polar air with a stratospheric influence, to marine-influenced air from the Caribbean boundary layer, but is unlikely that HYSPLIT can resolve these narrow layers. It is unfortunate that the water vapour lidar wasn't operational, since any marine boundary layer associated with the "ozone hole" should also have had high water vapour.

More robust (and convincing) results might be obtained using HYSPLIT with the higher resolution GDAS1 model (1°x1° horizontal and more vertical levels) run in ensemble or matrix mode. The coherence (or lack thereof) seen in ensemble runs will provide a good idea of how many hours back the trajectories can be trusted. It would be much better to compare the measurements with FLEXPART. Satellite water vapour imagery might also be useful.

Style suggestion: It is common to read of "surprising" or "unexpected" results in the literature, but rare to come across the words "frightening" and "astonishing". The latter is used no less than three times in this manuscript. The authors might consider substituting more restrained adjectives (e.g. "unusual") in their text.

A few more specific points.

P13266, L27: Increased NOx in transported fire plumes has been attributed to thermal decomposition of PAN, not photo-decomposition.

P13268, L 26: A visual range of 1500 km is a meaningless quantity since humans can't even see 313 nm radiation.

P13282, L15: Wild fire plumes often contain significant quantities of water vapour

volatilized from the fuel source.

P13281, L1: There is no obvious increase in the in situ ozone in Figure 20.

Figures.

It would be useful to have the surface ozone data added to Figure 4 as it is in Figure 20. Also, the different multiplicative factors make the plot hard to read. It could be improved by adding a right-hand scale for CO, and arrows or vertical lines to mark the times of the ozone and aerosol profiles plotted in the other figures. Perhaps a second panel could be added here that expands the July period discussed in the text?

The information in Figures 5/6, 8/9, 10/11, and 15/16 would be easier to digest if each ozone profile was plotted together with the corresponding backscatter profile on a different horizontal axis. Each Figure could show four narrower plots. This would make it easier to see the relationships between aerosol and ozone. The ozone scale could be truncated since the stratospheric part above 12 km is not germane to the discussions.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 13263, 2015.