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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Pagami Creek smoke plume after long-range transport to the upper troposphere over Europe – aerosol properties and black carbon mixing state" *by* F. Dahlkötter et al.

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The manuscript describes aircraft measurements of an aged forest fire plume encountered over northern Europe. The analysis focuses on the microphysical properties of black carbon measured by a single particle soot photometer (SP2). Comparisons are made with previous SP2 measurements in smoke plumes with particular attend paid to the phenomenon of disintegrating BC-containing particles (or "negative time delay" particles) measured by the SP2. They authors also compare the impact of long-range transported forest fire emissions and aircraft emissions on BC loadings in the upper troposphere/lower stratosphere (UTLS) region over Europe.

The manuscript is a little long and has a large number of tables and figures and I believe could be condensed to focus more on the key findings related to the BC observations. The number distribution results could be moved to supplementary material, as they are not really central to the main thrust of the paper, as could some of the details on the SP2 analysis.

The comparisons of rBC mass concentrations presented in Section 5.2, which compares the results to previously reported biomass burning measurements, are not particularly useful given the extreme differences in sampling locations and the plume age. If possible, a comparison of rBC/CO ratios would be more helpful. It would also be useful to know if any of the other previously reported emission measurements featured PyroCb, as this could affect the mixing state comparisons made in later sections.

The discussion of the disintegrating BC-containing particles could be expanded somewhat. A comparison is made between a UTLS background sample and the forest fire plume, but results for the polluted boundary layer segments could be added. Was there any correlation between coating thickness and disintegrating particle number fraction in the background or boundary layer regions? This might help determine if the disintegrating particle phenomenon is unique to biomass burning emissions or a feature of thickly-coated particles that are just more common in smoke plumes, as discussed. A figure or two would also be helpful, perhaps one showing the fraction of disintegrating particles versus total particle and BC core size in the smoke plumes.

I recommend its publication in ACP once these and the following specific comments have been addressed.

Specific comments

28754, 27: Cappa et al. (2012) also compared ambient measurements to laboratory observations of coating enhancements.

28762, 7: "spare to mention this mode" please re-phrase.

28762, 9: capitalize STP or write out

28766, 19-23: Please clarify that the added uncertainty due to fresh/small rBC particles in the boundary layer arises from a mode of particles not captured by the log-normal fitting. I assume if the mode shifted you would capture the change in un-measured fraction fairly well.

28767, 25: suggest combining this material with Section 3.2

28771, 17: The paragraph describing the lidar depolarization ratios is a bit off topic compared to the rest of the paper and could be omitted to shorten the paper a bit.

28777, 15: Suggest noting that our analysis in Akagi et al. (2012) relied on the time delay approach to classify coatings. Also remove “Anyway” in line 22.

28780, 9-13: I don’t quite follow this. Wouldn’t you also see a stabilization of the scattering cross-section from coincidence of a BC and non-BC containing particle? The BC particle vaporizes, so the scattering signal degrades, but then flattens as the second, non-BC particle continues transiting through the laser?

28781, 5: It becomes obvious in subsequent sections, but it should be explicitly stated here that the reported value of 50% is for in-plume measurements.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 28751, 2013.