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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Airborne and ground-based measurements of aerosol optical depth of freshly emitted anthropogenic plumes in the Athabasca Oil Sands region" *by* Konstantin Baibakov et al.

Anonymous Referee #2

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Summary:

Overall, this is a well-written paper that presents a case study of two flights during an aircraft campaign in the Athabasca Oil Sands Region near Alberta, Canada. The focus of the paper is on how the 4STAR aerosol optical depth (AOD) observations on-board the aircraft compare with the ground-based AERONET observations at nearby sites. The aircraft observations are also compared with in situ aerosol measurements to provide additional context about the composition and size distributions of aerosols associated with individual pollution plumes. The campaign and data are clearly presented

and the conclusions seem sound. While the findings are not particularly surprising, this paper would be valuable to the community as an additional data point for interpreting how ground-based remote sensing observations of aerosol optical properties at specific sites compare to the variability associated with pollution plumes in the atmosphere, specifically in this case in the context of industrial pollution sources. I can recommend the paper for publication after some minor revisions and clarifications.

General Comments:

While this paper is presented as a specific case study, I wonder if it would be possible to comment more on the representativeness of the variability of spatial scale observed here. Since the focus was on comparing the aircraft AOD observations with the AERONET observations, it might be useful to understand more about how this compares with observations from previous aircraft campaigns. Are the spatial scales of the plumes observed during the OSMC campaign similar to what is typically observed by 4STAR?

I agree with Reviewer 1 that some additional context, such as satellite measurements, would be helpful for giving the reader a better overview of what is happening. Were there any lidar measurements on the flights that could help to provide context?

Specific Comments:

Line. 5 p. 2. "The fact that industrial plumes can be associated with significantly higher AODs in the vicinity of the emission sources than previously reported from AERONET can potentially have an effect on estimating the AOSR radiative impact." "Cursory radiative transfer calculations" indicating 25% increase over background were mentioned at the end of the paper. Could this be expanded upon? 25% increase in terms of what, W/m2 or AOD? This was not clear from the discussion on p. 13, lines 10-15. What were the assumptions going into the calculation here? Presumably this would be a smaller effect than 25% once it is averaged over the entire grid box that the AERONET observations of AOD might be used to estimate.

Figure 2. It might be useful to also show the variance on the average AOD values for each month over the 13 year period. That would be useful for understanding the context of the flight observations.

Figure 3. There are some points in the AOD time series in pane 1 that appear to potentially be artifacts during periods where there were changes in aircraft altitude (e.g. the very smooth lines between 15:42-15:44, 15:50-15:52, 15:58-16:00, and 16:08-16:10). This is also the case for the UHSAS fine mode observations in pane 2 – can you comment on whether these are interpolation artifacts (and if so remove this data from the plot) or whether there is some other reason (like differences in averaging time) that the observations during these periods are significantly smoother than during the horizontal legs of the flight observations? Figure 6 and Fig. S4 also show similarly smooth periods in some of the time series.

Figure 4. It might be nicer visually to plot so that the organic aerosol mass portion starts at the bottom of each bar. This would make it easier for the reader to directly compare the organic aerosol mass across altitude levels/plumes and see that it stays relatively constant.

Can you speculate about the origins of the June 9th flight plume A and plume B based on their composition?

p. 8 . For context, could you add more details about what this facility is? Is it an oil processing plant?

Is there any way to judge the vertical extent of plume A relative to plume B?

p.10. Was there any estimate of the contribution of the AOD below flight level for the 4STAR measurements?

Figure S5. Could you similarly show the relative comparison between the Fort McMurray and Ft. McKay AERONET observations? This might help support the point in the first paragraph on p. 11.

p. 11 – Can you comment on the relative time scales expected for the plume's AOD to increase because of SOA formation compared with the time scale for the plume's AOD to decrease due to plume dilution with the background? Also, can you compare with the SSA observations, as SSA would also tend to be correlated with SOA formation?

Figure 7. Was there variability in AOD for different times of the day for the AERONET observations? Were the AERONET observations at approximately the same time as the flight observations? Also, can you clarify if the time shown on the axis for Figures 3, 6, and S4 is local time or UTC?

Typos: P. 7 Line 29-31 – This is referencing Figure 2, but it should be Figure 1.

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