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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Advances in understanding mineral dust and boundary layer processes over the Sahara from Fennec aircraft observations" *by* C. L. Ryder et al.

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" "Advances in understanding mineral dust and boundary layer processes over the Sahara from Fennec observations" is a comprehensive review of the Fennec field campaign observations and the findings thus far. The manuscript is well-written and detailed, serving as a technical document that also includes a summary of current results and future work involving the Fennec campaign data. Several interesting areas of research are highlighted, including measurements of very large dust aerosol, dust uplift during nocturnal LLJ breakdown, potential ozone depletion via dust uptake, vertical structure and mixing within the SABL, and dust acting as CCN and IN (at relatively

warmer than expected temperatures). The manuscript details a wealth of exciting data that has been collected during the Fennec campaign that will greatly aid in our understanding of meteorological processes driving dust emission and transport, and the resulting radiative impacts in this important region. I therefore recommend this article for publication after addressing the comments below."

We are pleased that Dr Ridley found our article interesting, and would like to thank him for his detailed comments, which we have addressed below, and have no doubt improved the article.

"Major points Beyond a reference point for future Fennec research articles, I believe the major benefit of this manuscript to the wider community comes from (1) the summary of findings based on the campaign and (2) the individual flight and observation details that will direct researchers to specific data of interest to them. To better address these points I would like to see a summary table of the findings and the associated references rather than the current conclusion section that, while concise, is largely a repetition of the preceding sections. Something akin to the tables within Ansmann et al. (2011) summarizing the SAMUM campaign findings would be very helpful to the reader. The conclusions could then be limited to an extension of the general summary detailed on pg 252 lines 1-11, reducing the text in the conclusions of this lengthy manuscript."

We have significantly altered the conclusion section based on this comment and Reviewer 2's comment. We have added Table 8, which provides a summary of the Fennec aircraft publications, research topic and brief key findings, as well as references to 4 of the key papers relating to the introduction of the Fennec project and ground-based observations. Several sections of the conclusion have been shortened, and the main findings to come from the paper have been bulletized (as suggested by reviewer 2) to make clear what is a new scientific finding.

"To address the second point, I think some effort should be made to detail where the data is available to the wider scientific community. Are their plans to store the data in

a public repository? For example, in the same way the NASA Discover-AQ campaigns have been. The comprehensive information on flights, instrumentation and meteorology in this manuscript can then be used to help the community make best use of specific flights within the wealth of data collected."

We have added a Section (2.3 Data Availability) to the article to provide this information. Fennec aircraft data is freely available subject to registration via the British Atmospheric Data Centre (Fennec-UK) and Sedoo (Fennec-France) (more detail is provided in the revised manuscript).

"The remaining smaller points are concerned with errata, brevity, and clarity in the text and figures."

"Minor Points"

pg 204 - Consider dropping lines 1-26 altogether. The paper is long and some of this comes across unnecessary and repetitive. If so, the last paragraph on pg 203 can be merged with the following text.

We feel this paragraph is important in demonstrating the motivations of presenting a summary of the Fennec aircraft observations. Nevertheless, we realise the paper is long, and we have shortened this paragraph to around half its original length.

pg 205, line 17 - reword to "Finally, the Sunphotometer Airborne Validation Experiment (SAVEX) was designed to use the island of Fuerteventura as an operating base by conducting an intercomparison of...

Changed

pg 205 line 27 - "insight"

Changed

pg 207 - can you quote what the uncertainty decreases to above 2 km?

The uncertainty above 2km can be computed when the invertion from backscatter to extinction is performed. This has not been calculated for cases presented in this paper, and also depends on the ambient aerosol conditions. For cases involving Brazilian biomass burning aerosol (Marenco et al,. 2014) the uncertainty above 2km was 10-20%, and 10% in the majority of cases, but we prefer not to cite these figures in the article in case they are applied out of place, since these figures apply for a different aerosol type and loadings. Instead we have added, “but this uncertainty quickly decreases above, the extent of which is dependent on the ambient aerosol conditions (e.g. Marenco et al., 2014).”

pg 209 line 20 - Ryder et al. (2013c) appears to be the same reference as Ryder et al. (2013b) in the references section.

This has been changed to 2013b and 2013c removed.

pg 209 line 26 - "Interestingly, "

Changed

pg 210 line 1 - replace ": clearly" with ". Hence, "

Changed

pg 210 line 9 - replace "are" with "is"

Changed

pg 211 line 25 - "post-processing"

Changed

pg 212 line 5 - should this be "pitch, roll and heading."?

Yes, changed

pg 214 line 19 - 2102 should be 2012

Changed

pg 216 line 20 - "Such..." it is not clear what is being referred to here. Both of the preceding dust generating processes? Consider rewording.

Reworded to reflect that yes, we do mean both the preceding processes.

pg 218 lines 7-12 - A long sentence! Consider changing to "...Fennec flight domain: a northern extension of..."

This was previously 2 sentences and has now been split into 3.

pg 220 line 15 - typo: "sampling"

Changed

pg 223 line 19 - "Interestingly, "

Changed

pg 224 line 26 - is a unit of volume missing from the "10 ug"?

No, this is correct – it is the mass loading over a filter sample. We have added clarifying text to explain this.

pg 227 line 13 - should this read "(GCCN)"?

Changed

pg 228 line 28 - is the fact the PCASP does not represent the full CCN size range problematic at all?

Number concentrations actually include PCASP+CDP. This has been corrected in the text and added to the figure caption.

pg 229 line 9 - remove the first "further" Changed

pg 230 lines 7-12 - Four instances of "could" in this section! Is there any plan/way to

test this hypothesis?

This paragraph has been rewritten to be clearer in stating the hypothesis, the measurements and their consistency. There is a new cloud aerosol interaction model in the final stages of development for the Met Office UM. This includes tracking cloud droplet aerosol content from condensation through to droplet evaporation. Discussions are in progress regarding whether we can run this case using this model to provide additional tests of the hypothesis and put the aircraft data in context.

pg 230 lines 20-22 - Fragment. Please revise the sentence.

Changed

pg 231 - This is interesting but the inability to separate out air mass effects from dust ozone effects is a pain and always crops up... I suppose some kind of Lagrangian study is needed.

Correct, we have added a few words to mention this.

pg 235 line 1 - typo: "complicated"

Changed

pg 236 - repetition between lines 3-5 and 10-12, please revise.

Lines 10-12 have been deleted

pg 237 line 7 - delete open bracket

Sentence re-worded.

pg 237 - Recent work by Kok et al. (2014) has shown that the dust uplift is likely nonlinear with threshold velocity. This may not affect the broad results here but a caveat that the DUP is a simplification should probably be inserted.

Done. We have added an extra sentence to this effect and included the Kok reference.

pg 243 line 16 - Reorder so that :up to about 2.8 km above MSL" follows "grew".

Changed

pg 245 line 14 - change "from heating" to "in heating"

Changed

pg 246 - This is a little confusing. The albedo on Figure 18 shows no decrease at 21.6N (possibly because it is off the flight track) but this makes relating the CBL depth and albedo difficult - the figure doesn't seem to back up the text well. Is there a way to improve this?

An extra line showing the surface albedo one degree west of the flight track has been added to the figure to demonstrate this decrease, and explanatory text added to Section 4.2.2.

pg 250 line 15 - Here it says the SEVIRI comparison is good, but there appears to be a high bias relative to MODIS and the LIDAR in the case show.

We have changed the relevant text in the conclusion to read, "In one case, a comparison of aircraft LIDAR data with satellite measurements from SEVIRI and MODIS show good agreement as to the spatial distribution of dust but disagree as to the loading, which may be indicative of different sensitivities to varying meteorological conditions. Further detailed comparisons have taken place (see Table 8), demonstrating the value of aircraft-satellite validation studies."

pg 262 - Ryder 2013b and 2013c appear to be duplicated.

We have deleted 2013c and citations

pg 263 - Sodemann reference is "in preparation" in references but says "submitted" in the main text.

The manuscript is submitted, errors have been corrected the references.

pg 263 line 23 - remove "last access..."

ACP requires last access date for web references

Table 4 - retain brackets for mount location abbreviation as in Table 3

Changed

Figure 5 - no legend entry for the data points from previous campaigns (black dots).

This has been added.

Figure 7 - please be consistent with the panel labelling throughout the figures – the (a,b,c) format in Figure 5 is preferable.

This has been changed. Please see response to reviewer 2 for more detail on figure changes.

Figure 8 - Write out "Potential temperature" before the symbol in the caption. – Make the "large circles" larger and more visible.

This has been done

Figure 10 - Again, please use the (a,b,c) labelling format for clarity and consistency.

This has been changed. Please see response to reviewer 2 for more detail on figure changes.

Figure 12 - Colour bar label should read "uplift", not "uptake".

This has been changed. Please see response to reviewer 2 for more detail on figure changes.

Figure 13 - BAe146 flight track is barely visible, please thicken the line

This has been changed. Please see response to reviewer 2 for more detail on figure changes.

Figure 15(b) - should the top axis units be Mm-1?

Yes, the axis label was wrong and has been corrected, and also the figure re-worked to display its results more clearly.

Figure 17 - define CBL and SRL in the caption (unless ACP guidelines state otherwise) - the mauve line at the bottom does not appear to be defined in the caption

Changed. The purple line indicates ground level and has been added to the caption. The figure has also been recreated based on revisions to Engelstaedter et al. (2015), now in press, and the text in Section 4.4.1 altered to reflect revisions in Engelstaedter et al. (2015) and comments from reviewer 2.

Figure 18 - are the k/kg units meant to be g/kg?

Yes. This has been changed in Figure 18 and added to the caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 199, 2015.