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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The influence of local oil exploration, regional wildfires, and long range transport on summer 2015 aerosol over the North Slope of Alaska" *by* Jessie M. Creamean et al.

Anonymous Referee #3

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Comments on Creamean et al., 2017 –Anonymous referee 3

This study reports new aerosol observations from the summertime ARM ACME-V field campaign on the North slope of Alaska. Their results indicate that oil exploration activities in Prudoe bay may contribute significantly to local aerosol concentrations. In particular, they observed high concentrations of nucleation mode particles in the area. These observations are novel and interesting and certainly add to the scientific discourse. However, many of the conclusions presented I feel are not fully justified by the results discussed. Additionally, the paper is difficult to read in several sections and requires clarification on several points. Please see below for specific instances.

Major comments

Page 2 lines 3-4 This entire sentence is very confusing, what do the authors mean by 'beyond greenhouse gases' and which 'climate feedback' are they referring to? Please refer to the specific feedback (I assume ice-albedo) and rewrite the sentence to improve clarity.

Page 2 line 5 'indirectly impact radiation through their role in cloud lifecycle' Aerosol can indirectly result in radiative forcing by increasing cloud lifetime, changing albedo and (in the case of INP) changing cloud phase. Please rewrite the sentence to address generalities (cloud microphysics) or specific processes.

Page 3 line 3 'The Arctic atmosphere can be highly stratified' This statement is included without explanation or more (crucially) reference. Please cite a supporting reference.

Page 3 lines 3-4 'at the height at which cloud modulation by aerosols occurs' This statement is very vague. To what height are you referring? Cloud base in the Arctic can be extremely low.

Page 3 lines 4-5 'have focused in evaluating Alaskan Arctic aerosol sources' Why would focusing on aerosol sources help our understanding of higher altitude aerosol in the Arctic? I assume the authors mean specifically sources of higher altitude aerosol?

Page 3 lines 23-26 This statement seems to be conflating future and present sources of aerosol in the Arctic and while forest fires are indeed an important source the relative importance of local vs transported aerosol is not well understood. Thus, while 'great importance' may be justified for boreal forest fires (during some periods of the year) I would prefer more nuance when discussing local fossil fuel and BB combustions (by which I'm assuming the authors mean domestic wood burning?).

Page 4 line 7 'predominantly decoupled' Why is the summertime Arctic decoupled? And is this also true for the sub-Arctic region that this paper focuses on? If the Arctic is less polluted in the summer (because as your references suggest it is decoupled from

the mid-latitudes) does this not suggest that local sources are unimportant?

Page 6 lines 23-24 'Hotspots of larger particles. . ... were not observed near Prudhoe bay (not shown)' I don't understand why you include this sentence were you expecting to see larger particles?

Page 7 lines 2-10 Here you suggest that predominance of larger particles above the BL is the result of growth during vertical transport and dynamical restriction of nucleation mode particles in the BL. It surely can't be the result of both?

Page 8 lines 4-9 beginning 'in terms of indirect forcing' Is the argument here that accumulation mode aerosol derived from nucleation have an impact on cloud properties or that the nucleation mode particles affect cloud directly? If the latter, please explain why marine aerosol may be more hydroscopic then sulphate. Petter et al., (2007, ACP) suggest similar kappa values for both.

Page 8 line 9-11 beginning 'In general, our results' Given your previous statement that the aerosol appears to have a trivial direct forcing effect and extremely uncertain indirect effect is your final statement really justified?

Page 8 lines 27-29 Why would you expect to observe an 'abundance of coarse and accumulation mode particles' if the wildfires generate secondary organic aerosol?

Page 8 line 31 'Which are higher than standard summertime and even springtime haze concentrations' what is the 'standard' concentration and why have you not provided citations here?

Page 9 lines 11-13 'Our observations are parallel to previous summertime observations from regional boreal fires in that they produce substantial quantities of aerosol. . ..' I'm genuinely unsure what you mean by this sentence although I am confident that it is not your observations producing aerosol. Please clarify.

Page 11 lines 10-11 ',but demonstrating the larger impact of nucleated aerosol in the vicinity surrounding Prudoe bay' Assuming you mean climate impacts I fail to see how

this study demonstrates any impact from these aerosol. You state on page 7 (lines 31-33) that you didn't observe any direct forcing. I also see no evidence (from these observations) of the indirect impact. Please clarify whether the observations reported here do or do not suggest a significant indirect aerosol forcing from emissions in Prudoe bay and provide greater justification for this conclusion.

Page 11 lines 18-21 'With both fire activity and oil exploration projected to increase in a warming climate, these sources will likely continue to make significant contributions. . ..' Previously the authors have stated that emissions in Prudoe bay have a localized impact only, with this in mind can the authors justify so strong a statement on the importance of future oil exploration to Arctic aerosol?

Minor comments

Page 2 line 3 Missing 'the' before climate feedbacks. However, to improve clarity I would suggest replacing 'climate feedback' with 'ice-albedo feedback' (please see first major comment)

Page 2 line 6 Use of the phrase 'hinges' is colloquial I would suggest changing to 'depends'

Page 2 line 7 'inherently depends' is a redundancy please delete inherently

Page 2 line 7 Replace 'atmospheric processing' with age

Page 4 line 9 'important sources of aerosol' You mean important local sources of summertime aerosol?

Page 4 line 11 To improve clarity please replace 'such' with local

Page 6 line 31- Page 7 line 32 Please split your citations to differentiate between those referencing flaring emissions and those referencing nucleation mechanisms.

Page 7 line 2 Please change 'removal of particles' to 'transfer of particles' or equivalent. Removal suggests removal of the particles from the atmosphere.

Page 7 line 13 Please cite Stohl et al., 2013 (https://www.atmos-chem-phys.net/13/8833/2013/) in reference to BC emissions from flaring

Page 7 line 27 Please replace 'loss' with 'transition'. The particles aren't lost there just bigger.

Page 8 line 7 Are you referring to diameter or radius here in reference to CCN?

Page 8 line 16 'evidenced by the elevated AOD originating from central Alaska' The elevated AOD is the result of aerosol originating from central Alaska. I would suggest rewording to 'the elevated AOD originating from central Alaskan wildfires' or equivalent.

Page 8 line 17 'extended until the end of Jul' What was extended until the end of July?

Page 10 lines1-2 I agree with this statement but both of the papers cited are concerned only with the Alaskan Arctic. I would also suggest citing Garrett et al., 2010 http://journals.co-action.net/index.php/tellusb/article/view/16525/0 , Browse et al., 2012 https://www.atmos-chem-phys.net/12/6775/2012/ or Eckhardt et al., 2003 https://www.atmos-chem-phys.net/3/1769/2003/acp-3-1769-2003.html (among others)

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