

Review of an ‘ARCTAS-A ground-based observational campaign and meteorological context, interior Alaska, April 2008’ paper by Atkinson et al., 2011.

General Comments

This manuscript presents aerosol measurements during the NASA ARCTAS field project (25 March – 30 April 2008). During this time period, four aerosol mass types were found in the measurements: Arctic haze, low aerosol load, Asian dust/smoke, and Asian smoke. My opinion is that this paper is very poorly written and poorly organized (See list of technical comments on first part of the paper. Similar problems are evident in the second part but not highlighted in detail). Due to the low quality of the paper, it is very difficult to understand and discuss the science presented. There is an extreme lack of information about how the measurements were obtained. The analysis methods are difficult to understand and do not support the conclusion presented. The synoptic analysis does not add much to the paper. I suggest focusing just on the back-trajectories. There is so much work that is needed (lots of additional information, removing and adding figures, re-organization, change of focus) that a new paper should be written and submitted to enable the science to be discussed. There may be a useful paper in relating the different time period to the source region; however, these different time periods need to be clearly determined by some set of objective measurements which is not currently in the paper. The work presented is not close to containing enough information to be repeatable by another scientist; hence, there is no value in the work as presented. While this opinion is based on reading the whole paper, most detailed comments are on the first half due to the number of issues highlighted.

Introduction: There is very little in the introduction about the motivation for this research. Why is this research important. Why study aerosol types in the Arctic and the meteorological conditions under which they form?

Section 2.1: This seems to be a poorly written abstract for a conference, instead of providing information about the methodology used. Best to use present tense (is instead of were).

Section 2.2: Details are lacking on the instruments and methods used in this section. Without the addition of these details there is no reason to read further since there is no reason to believe the measurements are any good. Furthermore, there is no discussion of the particular instrument performance tests that were conducted during the operation of the instruments, nor any indication of when the instruments (OPC, CPC, etc) were last calibrated.

Section 3.1: This stuff is out of order. This section should be deleted and the paper re-organized. The poor organization of the paper, makes the science difficult to understand and impossible to discuss.

Section 3.2: This section needs to be totally re-organized. The interpretation needs to be moved to the end. The discussion of Figure 2 needs to be cleaned up.

Section 3.4: I see no point to the SMPS data presented. It only covers a fraction of the time period under study (for some reason which is not explained). As presented, I don't see how this section adds anything to the analysis.

Section 3.5.1: I see very little point to this section.

Specific Comments

Pg 16503 Line 19: What are the exact ground-based observations being referred to here. Is it aerosol type?

Pg 16504 Line 16: There are three options available. What was used to obtain the data in this study?

Pg 16504 Line 17: “A delay in servicing ...” Not performing routine maintenance on an instrument does not mean the laser output would be reduced. Exactly what was the problem with the instrument? How exactly did this result in reduced performance? What was this reduction, a reduction in the intensity of the laser? How was this known to be the case? What evidence can be provided that increasing the averaging time produced good data? What performance checks were done that indicated that the CPL was performing correctly? What about a reference that describes in detail the CPL?

Pg 16505 Line 3-7: Not sure what is referred to as “total signal” When clouds are present, you'll measure properties of the clouds, it is only when clouds are not present that you measure a signal that is the result of the molecules in the atmosphere and the aerosols. It would seem that to study aerosol, you would need to screen for clouds and remove the backscatter that results from molecules. Has this been done?

Pg 16505 Line 25: Can not aged aerosol obtain a new moisture coating if the relative humidity is high enough? Isn't the fact that aerosols have a moisture coating or not more of a function of their relative humidity history than of their age? It could be that aged aerosols are more likely to be found in low relative humidity environments, and hence not have moisture coating. The Sassen et al., 1989 is about stratospheric aerosols, can this research be applied to lower tropospheric aerosol, which is the focus of this research?

Pg 16505 Line 5: What were the exact channel thresholds used in the OPC measurements?

Pg 16508 Line 8: Please give a reference to the instrument itself and not just projects where it was used. In these other projects, was the OPC used on a balloon?

Pg 16506 Line 7: What quality-checks were conducted on the recorded data? Were zero (filter) air checks conducted on the OPC? Was the OPC spectrum compared to the SMPS spectrum?

Pg 16506 Line 18: Where was the X-Ray analysis performed? How were the samples stored before analysis? How long after the project was the analysis conducted?

Pg 16507 Line 5: The logged time doesn't really matter. What was the sampling time for a scan? Were both up and down scans conducted, used in the analysis?

Pg 16507 Line 7: Why do the charge equilibrium first and the drying afterwards? This is typically done the other way around.

Pg 16507 Line 9: The use of a reference stream is very confusing. An SMPS does not need a reference stream. It is not clear how it is being used, nor what is being done with it. Combining a reference stream and aerosol stream will just increase the total concentration of aerosol. Why would this need to be done? This paragraph does not describe a standard usage of an SMPS. Either the limited description is wrong or it needs a lot more explanation because it is some special configuration.

Pg 16508 line 19: Wouldn't “dust” have a higher depolarization ratio?

Pg 16509 line 3-4: Don't understand this reference to time averaged values. Averaged over what time interval? When referring to time averaged values, a different symbol should be used.

Pg 16509 line 4-6: Sure it could be interpreted as pollution but why can't it also be interpreted as non-pollution aerosols?

Pg 16509 line 6: What evidence is there of this gradual build up until 13 April? Can you add a plot showing the hourly 1-2 km (or some height interval) average measurement for the same time period on each day that the lidar was operated.

Pg 16509 line 14: It may be clear to you that a change happened in mid-April, but it is not clear to me from reading the paper up to this point. Can you provide a plot showing the time series of average data

that will make this change evident?

Pg 16509 line 22-24: Since this paper is about aerosols, can a cloud mask be applied to eliminate (show in one color) areas of clouds?

Pg 16510 line 4-6: This suggestion is not useful. Without upwind measurements showing that this low level is not present, there is no way to infer that it is local. Furthermore, the lidar measurements give no information about the source of the aerosols.

Pg 16510 line 6-7: On 9 April the extent of the boundary layer is lower; however, the aerosol are distributed over a smaller vertical extent. Hence, the concentration increases and more backscatter. The “slight” increase in vertical structure may be the result of increase sensitivity in the measurement with the increase in concentration. This statement need more evidences to support it.

Pg 16511 line 6-7: What was the reason for the element concentrations being below minimum. Was it an unusually low aerosol year, or was the experimental design to use 3 hour sampling in error?

Pg 16511 line 9: “... the largest concentrations ...” What type of concentration is referring to here, number concentration or mass?

Pg 16511 line 14: Both size fraction have accumulation mode particles, so the fact the aerosol grow into accumulation mode particle is not important. The large particles due to long-range transport are likely in elevated layers. Having less mass in the upper size range could also be the result of a poor sampling inlet. This is a reason that the paper need to present a lot more information on the sampling method. Including a detailed description of the sampling inlet used. Were the particles sampled wet or dry? Was the relative humidity controlled and/or monitored? The Seinfeld and Pandis, 2006 reference is useless in this context.

Pg 16511 line 20: It is not clear what is defining these time periods. Are they defined based on the elemental filter measurements? If so, why talk about “trajectories that cross Northern Russia near Norilsk”? This sentence doesn't go here. I can't see what defines the “Arctic Haze” time period.

Pg 16511 line 28: If this time period is defined by the total of all aerosol components, this time series needs to be included in Figure 3. What elements are included in this “total”?

Pg 16512 line 1-6: What about changes in the height of the boundary layer? The lidar measurements show that on the April 9 and 13 the boundary layer was a lot lower than on April 4. Hence, the increase in this time period is that the aerosols are trapped closer to the surface, therefore the increase. Can the aerosol concentrations be normalized by the height of the boundary layer? Can this height be given in the time series?

Pg 16512 line 14-15: Why was the SMPS not run during 7 April to 15 April?

Pg 16518 line 18-19: What three time series? I don't see this. The SMPS doesn't cover enough of the period to be useful. The lidar data presented is only on certain days. The impact data shows changes that are probably related to changes in the height of the boundary layer. There is not enough information given to know how to reproduce these time periods in another data set or for another scientist to find them in this one.

Figure 2: The caption needs to define what is being presented. There is no need to repeat the date in the caption since it is given in the plot titles. State where these measurements are made, with what Lidar. State what is given on the top (black and white) and bottom plots. These look like just different representation of the same data at a quick look but I assume the black and white plots are the signal return and the color is the backscatter of some wavelength (which is not given). Without this information how can these figures and the paper be understood? Make horizontal extent of the plots

fill a page. The x and y axis titles and labels need to be larger. All fonts in figures should be approximately as large as the text in the figure caption. What the color bar at the top represents needs to be defined in the caption. What wavelength is the data for? Caption should state that these are all the measurements obtained on these days (assuming this is the case). The same y-axis range should be used for all days or an explanation given as to why that is not possible. The text refers to Fig. 2A etc.; hence, letters (a,b,c,d,e,f) need to be included in the figure on each plot as labels. Also, need to indicate what white areas in the backscatter plots are the result of.

Figure 3: Again in this figure, the fonts are too small. Should be about the same size as in the figure caption. Figure caption needs lot more information. Where were the samples obtained. What was the sampling frequency. What type of analysis was conducted to obtain the component measurements? What size range are these measurements over? Would not showing symbols for each sample be better? Legend should include the symbols for each element. The time period for each epoch should be indicated on each plot in this figure.

Technical Corrections

Pg 16501 Line 23: “In April 2008 the NASA” The 'In April 2008' is an introductory phrases and a comma is required after 2008. See <http://englishplus.com/grammar/00000074.htm> as one example that explains the correct usage of commas after Introductory Phrases. There are many places in the paper where Introductory Phrases are not followed by the required comma. Each sentence in the paper needs to be reviewed by the author to see if a comma is required after an Introductory Phase. The lack of commas makes the science difficult to understand.

Pg 16501 Line 25: “... with a broader objective of placing this in the context of radiative forcing and climate change.” This is a long and confusing sentence that seems to be a collection of phrases. When you get to 'placing this' it is not clear what 'this' refers to. I suggest breaking this up into two sentences and being direct by stating what 'this' refers to.

Pg 16502 Line 5: “... the project oversaw ...” I do not understand how a project can oversee things. People oversee and have oversaw things. Better to say the project included ...

Pg 16502 Line 6: “of atmospheric chemistry state”. Isn't there a 'the' missing here?

Pg 16502 Line 8: “... focuses on the meteorological context ...”. Really? There is nothing about the meteorology presented in the abstract. The conclusion given in the abstract talks about finding four different types of aerosols.

Pg 16502 Line 11: Another example of a comma needed for Introductory Phrase.

Pg 16502 Line 15: “Each provided ...” Be direct and state that it is “Each instrument provided ...”

Pg 16502 Line 15-16: Don't believe the hyphen is used correctly here. Probably want to enclose things in parentheses. The inclusion of nature, and quantity is confusion in the list. Seems like this should not be in the list but a description of type of measurements. Please re-word and make clearer.

Pg 16502 Line 17: Another example of a comma needed for Introductory Phrase.

Pg 16502 Line 17: Defining the measurement focus for this paper does not belong in the Introduction Section but in the Methods section. Here define and give background on the general objectives and questions to be addressed.

Pg 16502 Line 20: “... companion papers” It doesn't do the read any good to talk about these papers without given reference to them. Are these only planed paper and hence can't be referenced? If so, I

don't think should be mentioned.

Pg 16502 Line 22: Another example of a comma needed for Introductory Phrase. I'll stop pointing these out from now on.

Pg 16502 Line 22-26: Please don't just state the Fuelbuer et al., 2010 talk about things but instead summary what was most important from that paper for understanding the research presented in this paper.

Pg 16502 Line 26: "The synoptic objective" There doesn't seem to be a non-synoptic objective. Isn't this just the objective of the paper that is being talked about here? Be more direct, "The objective is to build upon the ..." or "Our objective is to build upon .."

Pg 16503 Line 5: There is nothing related to this task presented in the abstract.

Pg 16503 Line 11: A reference to the Web or FTP site where the data was downloaded from would be useful.

Pg 16503 Line 19: The use of 'were used'. The paper is reporting on this project so shouldn't it be present tense?

Pg 16503 Line 19: "The extent to which patterns ..." I see no point in this sentence. Describe the patterns and then state if they are typical or anomalous. This type of foreshadowing just goes to make scientific paper unnecessary long.

Pg 16503 Line 21: "typically mid to low-troposphere pressure level were used ..." Simply state what is done in the analysis methodology. Exactly what levels are used? Again, the use of past tense here is confusing.

Pg 16503 Line 23: "selected trajectory analyses ..." What exactly are these analyses?

Pg 16504 Line 2: "observational array" Figure 1 does not indicate sampling locations. Just gives the location of Fairbanks and Anchorage. Figure caption states that measurements were obtained at Fairbanks "or" Poker Flat. Hence, two locations, with different instruments at both does not make an "observational array".

Pg 16504 Line 5: This sentence is mixing an instrument description with analysis method. First describe the instrument and then talk about how measurements from them were used. Furthermore, talking about a case study analysis does not belong in a section describing the measurements used in the research.

Pg 16504 Line 21: "To obtain ..." This sentence is unnecessary long and confusing.

Pg 16505 Line 2: Missing some words in this sentence. The subscripts are defined but not the variables (beta, P)

Pg 16506 Line 10: This foreshadowing is not necessary. Delete sentence and add more information about the instrument. For example, what is the angle over which the aerosol light scattering is measured with the OPC. What frequency is the data recorded at? Is any dilution system used with the instrument? Was conductive tubing used throughout the aerosol inlet? What flow rate was the air flow sampled at? What aerosol reflective index was used to obtain particle size?

Pg 16506 Line 13: It has already been stated that the Poker Flat facility is 50 km north of Fairbanks, don't need to repeat it here again.

Pg 16506 Line 15: The Mylar strips are part of the sample so it is not possible for the instrument to "deposit" aerosol onto them. Please rephrase.

Pg 16506 Line 16: “was operated continuously ... “ between is better to use that over. Please give what the three size ranges are.

Pg 16506 Line 23: Again, it is not right to refer to a companion paper without providing the reference. Information about performance tests of the impact sampler is needed. Were blanks used? Were zero air performance test conducted? What procedure were used so samples were not contaminated?

Pg 16507 Line 12: “... these data” Be direct, state exactly what data you are talking about. How much variance in the data did the first two principal components account for. Need more details. Maybe this should be moved to a later section. After reading the rest of the paper, I see that this is talked about later; hence, delete here.

Pg 16507 Line 15: Again, don't talk about another paper without a reference.

Pg 16507 Line 20: Things are backwards here. A conclusion is stated before showing any time series data. Move remarks such as these to a Discussion Section. Present the data here.

Pg 16508 line 4-6: The need to state what is presented below and what will be present later indicates that the paper is not organized correctly. In a well organized paper, these types of statements are not needed. Delete/move this overview section, just start talking about the data collected.

Pg 16508 line 8-9: Again, this is an interpretation which needs to go after the data (measurements) are presented.

Pg 16508 line 13: “aerosol physical depth”, This is not good terminology. There are aerosols throughout the troposphere even if the Lidar doesn't get a backscatter return from them. Could use “that the depth of the lower troposphere increased”; however, you'll have to define what “lower troposphere” means or provide a reference or both.

Pg 16508 line 19-20: Sentence that tell what is discussed in other section indicate poor organization.

Pg 16508 line 21-25: The paragraph is out of place. Be direct and say these are periods when the Lidar was operated.

Pg 16508 line 26-27: Delete

Pg 16508 line 26-: Out of place, conclusion before showing the data.

Pg 16509 line 16-20: This information needs to go into the figure caption, not in the text. Figure captions should fully describe what is being presented in the figure, independent of the text. The text should discuss what interpretations the author believes show be taken from figure. The figure should include a legend showing the range of lidar power returns.

Pg 16509 line 21-22: Already discussed. Delete

Pg 16510 line 1: The plots should indicate that they start at 0.5 km. This is not clear in the plot. Label the lowest value. The figure caption show note that data in the first 200 m are not given because they are unreliable. This should not be noted in the text but in the figure caption.

Pg 16510 line 8: Again the conclusion is presented before the argument that leads to the conclusion. This is problem is apparent throughout the paper.

Pg 16510 line 9-11: Don't see what the discussion about the clouds add to this paper. I suggest to stay focused on the aerosols.

Pg 16510 line 19: “fine horizontal layers” Can a reference be provided to back up the statement that this is common for associated with long-range transport?

Pg 16511 line 15-19: Again the conclusion comes before the argument. Need re-organization. Also, I

personally don't like the use of the term "epochs". Epoch is a "time in history". These time periods are not historical, they just refer to this time series of data. Better to use "multiday time period" or "time period".

Pg 16512 line 16-17: I had the question of how much of the variance was accounted for by the two components previously when reading the paper; hence, the paper is not well organized. Please address. Please give how much was accounted for in the first component and how much in the second.

Pg 16512 line 17: The component score needs to be defined.