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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Polarization properties of aerosol particles over western Japan: classification, seasonal variation, and implications for air quality" *by* X. L. Pan et al.

Anonymous Referee #3

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General comments

This paper analyzes polarization properties of aerosol particles over western Japan by using polarization optical counter (POPC) data of observation period of October 2013 to January 2015. Authors also used chemical composition data, and also performed backward trajectory analysis as part of their study. I have seen three main shortcomings in this paper. Firstly, the instrumentation and data analysis method are not clearly described (see Specific comment 3). Secondly, observed data are not logically discussed (See specific comments 10-14). There are several places where authors left discussion incomplete by leaving queries to the readers. Thirdly, the conclusion of the paper is relatively weak. Some statements given in abstract are well known facts for

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last several years, which may not be considered as the finding of this study. For example, it is stated that western Japan is affected by dust and air pollutions in the spring and winter season. Authors should explicitly state their new finding(s) in the abstract section. Overall, I do not think that the present study meets requirements to get published in ACP in the present form. However, on seeing the novel data sets, I suggest authors to revise the manuscript thoroughly and resubmit. If possible, authors may also use data from other sources (e.g., lidar, sky radiometer) to strengthen their discussion.

Specific comments

1. Page 1, Lines 4 and 5: Correctly arrange affiliation according to increasing number.

2. Page 1, Line 1 "By conducting an analysis of online measurements..."–> "By simultaneously conducting an analysis of online measurements..." may be better.

3. Page 1, Line 19: "..three typical aerosol types (anthropogenic pollutants, dust, and sea salt)."–> This is confusing to me. What type of aerosol is "anthropogenic pollutants"? You may use the word "dominant" somewhere to clarify what you want to say.

4. Page 1, Line 20: What is the size for "super micron" particle? State within the parenthesis.

5. Page 1, Lines 27-30: It is hard to understand the meaning of this sentence unless one reads the whole manuscript. The abstract section should be understood even without reading the whole manuscript.

6. Page 2, Line 20: why 532nm within parenthesis?

7. Page 3, Line 5: What is the size for "super micron" particle? State within the parenthesis.

8. Pages 3-4: Section 2. Measurements:

(i) What is the size range (e.g. Dp > 1um, 2 um etc.) for measurements by POPC?

(ii) What is the time resolution of observation by POPC?

(iii) How do you calibrate the instrument? A brief description may be useful.

(iv)Have authors validated observation data of this instrument (POPC) by comparing with some standard instruments? If not, is there any literature that did such study in the past? Explain about it in the manuscript.

(v) Were ACSA-12 and POPC operated simultaneously at the same place during observation? If not, how far were they?

(vi) ACSA-12 observed at 1 hour interval. How to you integrate POPC data while using ACSA-12 and POPC data together?

(vii) dV/dlogDp is widely used in this study. How do you determine it? To know it, it is also necessary to describe Dp as indicated in (i).

(viii) Regarding Figure 2, make the caption clear. For example, MODIS data of which year and month have been used to generate Figure 2? And also what is the source of wind speed data? They should be explained in the caption as well as text.

9. Pages 4-5, Section 3.1. Temporal variation:

(i). Page 4, Line 33: Daily average->Do you mean average of 24 hours? Indicate hours within the parenthesis.

(ii). Page 4, Line 33: different aerosol size bins: Figure 1 shows Dp from 1 to 10. Are they mean diameters of size bins?

(iii). What are the criteria to determine "P", "D", and "M" in Figure 3?

(iv) No unit for dV/dlogDp and MDR in Figure 3.

(v) page 5, Line 1: What are the size ranges for submicron and coarse mode ?

10. Pages 5-6, Section 3.2: Size distribution:

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(i) The interesting and strange thing for me is that why there is not distinct difference in dV/dlogDp at different diameters. For summer, it is nearly flat. It is quite interesting to me. Is it natural phenomenon or instrument related issue? Unfortunately, authors did not explain the reason for this type of observation. Authors should give proper reasons to readers for this type of observation. Otherwise, one may suspect in the quality of observation data.

(ii). Regardless of the season, we can also see large depolarization ratio (DR) in right hand side of Figure 4 and its distribution as function of aerosol size is nearly same. Though the median value is relatively low in summer, but the mean value is still high According to authors, sea salts are dominant in this season. What types of aerosols are responsible for such large DR in summer? Unfortunately, authors skipped this discussion in the manuscript. Similarly, regardless of all seasons, there is an increase of DR for aerosols of Dp=0.5 micron. Why do you observe this behavior in all seasons? Are they natural phenomenon or instrument related issues? They need to be clarified in the manuscript.

11. Pages 6-7, Section 4.1. Size polarization properties of aerosol particles:

(i) It is not reasonable to assume that only a single type of aerosol (Dust or sea salt) can exist in the atmosphere; it is better to use word "dominant" somewhere while classifying group in this section.

(ii) Total number of hours is given in Table 1, but date and time are not given. Specify date and time for each event shown in Table 1.

(iii) I do not understand how you make Figure 5. Are they the average values of whole event period? If so, write clearly in the text as well as Figure. I further do not understand why median value is used for only DR.

(iv) DR value of 0.1 is said to be a threshold value to distinguish spherical and non-spherical particles. It is also one of the important conclusions of the paper; however,

mode DR of specific period, rather than DR of instantaneous observation time, is used in Figure 5. In fact, how do you determine this mode DR and why is it important to discuss your result, taking into account mean DR, median DR can be also calculated? Probably, this value may change depending on the number of samples, I doubt this threshold value is applicable for all situations. More data analysis of different scenarios is required before recommending such threshold value.

(v) RH value is discussed in this section. What is the source of RH data?

12. Pages 7-8, section 4.2. Contributions of different aerosol types to local air quality

(i) What criteria do you use to classify on different groups, namely "Dust", "Sea salt" , and so on? Specify those criteria specifically and quantitatively (e.g., DR range).

(ii) As I wrote in 11 (iv), DR of Figure 5, which is the foundation for classifications in this section, is a mode value of specific period, which is subject to change depending on the situation. Do authors perform a type of cross-check for classification results discussed in this section?

(iii) Classifications are made based on plot of each day starting from 00:00-24:00 local time. However, it is hard to say that air mass of same origin exists for the whole day. It also raises question on classification discussed in this section.

(iv) Only "mixed" is shown in Figure 6(c). Does it represent pollution and dust mixed or what ?

13. Pages 8-9, Section 4.3. Polarization properties of aerosols from different origin

(i) Similar to Figure 5, I do not understand how you plot Figure 7 (right). Is dV/dlogDp the mean value or median value or what ? Unit is also missed for dV/dlogDp in Figure 7(right). Make it clear both in text as well as figure caption.

(ii) Page 8, line 22: "..spherical particles (e.g., sea salt) in fine mode..."–> Sea salt may be in fine mode, but the contribution of anthropogenic pollutants may be significant that

sea salt. Give logical discussion with proper evidence.

14. Pages 9-10, section 4.4. Fraction of spherical particles as a function of RH

(i) page 9, line 18: It is said that RH was calculated from back ward trajectory. How do you calculate RH from backward trajectory?

(ii) Describe about background points of Figure 8 in both text and figure.

(iii) Chemical composition data shown in Figure 9 are for fine mode aerosols (according to caption of Figure 9); however Figure 8 discusses results for relatively large particles , including diameter larger than 3 micron. Is it reasonable to use such different data sets to discuss your results?

(iii) Probably, the lines of Figure 8 represent the average value. It is important to note that aerosol concentration as well as their chemical composition cannot be considered to be unique for air masses coming from any region. For example, Region II can have aerosols of different origins depending on the season as well as meteorology. I do not think that Figure 8 represent aerosol characteristics of each region. For this type of study, authors should divide data depending on season by carefully taking into account backward trajectory and chemical composition. For example, how confidently can you say that dust aerosols are always present when air mass comes from Region II? Authors are suggested to gather more evidence and then discuss the results more logically based on gathered information.

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