

## ***Interactive comment on “Seasonal features and origins of carbonaceous aerosols at Syowa Station, Antarctica” by Keiichiro Hara et al.***

**Anonymous Referee #2**

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This research paper presents approximately 10 years of black carbon (BC) measurements from Swoya station in coastal eastern Antarctica. It also presents the seasonality in equivalent BC (EBC), its sources during different seasons, comparison of measured data with model and finally determining potential pathways of transport and source regions affecting the station during the observation period. The dataset used in the article is very important in the present scenario due to the importance of BC aerosols/ polar region as well as lesser data availability over the Antarctic region, but the representation is confusing. For easy readability of the article and understanding the conclusions without confusion, I think the restructuring of the different sections of the article is required. I have some general and a few specific comments as detailed below.

General:

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1. I would suggest authors provide a clear explanation of data screening procedure (from measured data to useful data for BC). This is very important when we want to find trends and account the data for background concentration values. Authors do refer to an article (Hara et al., 2010) for the data screening procedure but it is not available in that article. Hara et al., 2010 cites Hara et al., 2008 (doi: 10.5194/acpd-8-9883-2008) for these procedures but unfortunately Hara et al., 2008 is not mentioned anywhere in this article, even though it represents the BC concentration from the same location. The best way is to make sure that the data is screened and explained clearly as authors claim it as background values over Antarctica, which in turn would be used by modelers for future studies.

2. I found abstract and conclusion a little confusing, vaguely written, especially with the division of potential source areas (PSA), types of aerosols, and the CHASER model part is not mentioned explicitly. In general, I think abstract and conclusion fails to clearly represent the content of the paper in general, and emphasis on such huge dataset from the remote environment is missing. Acronyms (for ex EBC) appears without expansion, and sentences are misleading (for ex: Fossil fuel combustion in South America and southern Africa also have important contributions).

3. The primary data of the paper is presented in Figure 3. While looking at it, I got the first impression as high variability in daily EBC values between the years 2005 to 2009, which diminishes after that. It might be possible that more local influences during those years than in other years. I would suggest discussing if any change of location of instrument occurred. Is aethalometer calibrated? Or anything which authors wish to comment on that? Is the sampling line is heated or any changes? I do believe the background values of EBC in the paper, but I think explaining all the above things would make it more satisfactory. 4. Airmass history and classification are explained very nicely, but it stands suddenly out of context. Authors have dedicated Figure 5, Figure 6 and Figure 7 especially for explaining this and they only connect it with EBC in Figure 8. I would suggest the authors make a good connection in meteorology and

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aerosol in these figures and sections. Also, classifications and their sub-classifications are not explained and connected for better readability.

5. Based on the CHASER model, EBC origins were classified into three sections (biomass, fossil fuel, and other combustion). Later it is stated that "other combustion" is broadly biomass burning, which makes it as two classifications, which could be inferred from angstrom absorption exponents (AAE) of Figure 3. Is it possible to add information about the mixed state (Internal or external) or aging (fresh or aged) of BC, used in the CHASER model, which showed promising results in monthly values and seasonality of BC in Figure 9?

6. At many places, authors replace "Swoya" with "coastal Antarctica" or "Antarctica coast". It might be useful to replace "Antarctica" in the title with "coastal Antarctica". But I would leave this totally on authors choice. Specific: My suggestion of adding a word(s) is in bold and removing a word(s) is crossed Page 1: Line 10: We measured equivalent black carbon (BC) [ I think you measured BC and corrected it to make it EBC) Line 10: Feb 2005 to Feb 2016 [ adding the end month of measurement] Line 25: the First statement needs a reference Line 34: Antarctic regions; BC concentrations Page 2: The Antarctic is referred to here as one of the remote regions. I think calling it as "Antarctic region" throughout the manuscript is appropriate than "Antarctic regions"? I also think it is worth mentioning and dividing Antarctica as Eastern and Western Antarctica in the introduction as this section talks about tourism and transport from South America and the African region Line 14: please specify where in Antarctica? Page 3: Section 2 heading could be "Measurements, Modelling, and Analysis" Line 5: "Research" is missing in JARE expansion Line 6: It would be worthy to mention the altitude of sampling station at Swoya with latitude and longitude Line 7 To Syowa, the icebreaker ship Shirase approaches every summer (mainly between end-December to – early February) for the transportation of fuel and materials for wintering operations and scientific activity Line 21: I think data screening procedure needs more clarity as it is not in Hara et al., 2010. Hara et al., 2010 cites Hara et al., 2008 and I would suggest

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citing the right paper here. Line 23 to 34: what is the value of multiple scattering and loading parameter used in making BC to EBC? Would be a good idea to mention it explicitly here. Line 28: Attenuation at 880 nm is used widely for BC retrievals, I would suggest making changes in the statement accordingly Line 35: the statement "We use a multi-wavelength....." could be rephrased like "using the spectral (or multi-wavelength) aerosol absorption values retrieved from aethalometer, we estimated AAE Page 4: Line 10-14: CHASER could be expanded. There are other acronyms also need to be expanded. I think it would be helpful for readers who are not modelers. Line 39: "cooking" not "cocking" Page 5: Section heading "Discussions" Line13-14: Any seasonal long-term trend at Swoya? It would be worth seeing whether there is an increase or decrease in summer (like Neumayer) or spring Line 25-42: It is not much clear. I would suggest defining seasons and maintain uniformity in the discussion of seasonality and comparison with other stations. The possible sources in each season could be also be highlighted. Page 6: Line 21: BrC Brown Carbon(BrC) Line 29: larger negative values (<-0.4) Line 24: What is a high correlation means here? R2 values are lesser for June-Aug, in comparison to other months Page 7: Line 6: Slopes >1 but AAE was lesser in spring (Figure 3d), so how you suggest it is biomass burning aerosol of organic origin? Please clarify Line 15: "First, we compare EBC data to the air mass history at Syowa" this line does not seem appropriate here

Line 17: for the 3rd classification, do you mean outflow from the high-latitude Antarctic continent to coastal Antarctica? Please clarify

Line30: It appears that the probability density of air mass arriving at Swoya shows an East-West spread from one month to another month, as compared to North-South spread. In that case, transport from inland Antarctica is more important than long-range transport from populated continents. Is it the case?

Line 41: could specify an approximate tropopause height.

Line 35-43: From Figure 6, it appears that Swoya is influenced by high-latitude inland

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Antarctica airmass during all months (which is relatively less in January). What is the final take from Figure 6?

Page 8:

Line 3-5: Is this subclassification of the classification on page 7 (Line 16-18)? I think it is 2 sub-classifications of the previous classification, but it is not clear in the text.

Line 6: classification of airmass origin > 75S could be renamed as remote continental or Antarctic continental, as naming it continental confuses with polluted and populated continents.

Line 8: statement is not clear

Line 29-30: Is an increase in MBL airmass origin EBC, could be due to Ship emissions in the Antarctic circle (for fishing or tourism)?

Page 9:

Line 25-26: Filter biased problems and related uncertainty were not discussed while detailing EBC. I am glad that the authors bring it up here.

Line 28-29: This is already discussed in section 3.1

Line 34-36: So basically, this classification is biomass and fossil fuel? As authors said other combustion is also biomass in the broad sense, so how this is different than AAE of section 3.1, besides it is from CHASER model?

Line 37-39: As the text says biomass burning is dominant in spring, and Figure 8 says it is Marine BL and Marine FT contributing to the EBC at Swoya, so what would be the conclusion? It is not clear

Page 10:

Line 1: It is difficult to identify the August-October peak in Figure 10b

Line 6: "contribution of BB" or "contribution from BB". Also, the difference is significant if

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you compare magnitudes of BC, which showed a 25 to 50 % decrease from 2011-2012 to 2015-2016

Line 24-25: I am not clear about the statement which ends with a question mark. The explanation is given in the next lines and I consider that statement as a misfit.

Is it possible to use a symbol for "BB-model-BC concentrations", something like the BB(BC) model? Similarly, for FFC and OC

Line 30-35: It is quite difficult to follow the month to month explanation from Figure 10. Authors should either include minor labels or ticks or any other way to the identification

The authors might consider a stacked column chart (by normalizing it with total concentrations) for all panel 10b, c, and d. So, the stacked column length would be total, partitions in the column would represent the contributions of South America, Southern Africa, and Australia. I think in that way, all the description in the text would be clearer. But I leave this to authors.

Page 11:

Line 1-6; I think as the southern America coastline extends much to the southern latitudes (near to western Antarctic peninsula), and the westward transport along coastal Antarctica, might be also a reason for the higher influence on the Antarctic BC, in addition to the GDP. This could be also clarified and detailed in the manuscript.

Conclusion section: It should be rephrased to highlight important data set period, seasonality of BC, transport patterns at Swoya, model comparison and regional contribution from South America, South Africa, and Australia.

Figure 1: I think it would be better to place Swoya station as a different symbol or by placing the name next to the current symbol. Identifying regions like South America and Africa could be also a good idea as it comes quite often in the manuscript  
Figure 2: I would suggest adding first and last labels in the Y axis too. Authors may consider writing Swoya near the red circle.  
Figure 3: Y-axis scale for panel c is missing. It

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doesn't seem matching with panel a. Blue line mentioned in the caption is not visible in the panel a Figure 5: Swoya location could be shown in a different color/symbol for better visibility. I would suggest using a latitude scale too for this figure Figure 9: In panel b, the regression coefficient could be shown Figure 10: Caption for the panels are not clear. Do authors mean BB aerosols from South America as a whole or BB from South America, contributing to EBC at Swoya.

List of Acronyms: Some Acronyms from the manuscript are missing in the list, like HYSPLIT, CHASER.

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