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Reply on RC1

Olga B. Popovicheva et al.

Author comment on "Siberian Arctic black carbon: gas flaring and wildfire impact" by Olga B. Popovicheva et al., Atmos. Chem. Phys. Discuss.,
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Anonymous Referee #3, 24 Jan 2022

General

The paper presents BC measurements at a new Arctic site, on the Bely Island in the Kara Sea, Western Siberian Arctic. The origin of the measured EBC and the main contributing sources were assessed using atmospheric transport modelling coupled with the most updated emission inventories for anthropogenic and biomass burning sources of BC.

Bely Island is an important addition to the Arctic network of BC measurement stations because there are not many of them in the vast Siberian Arctic. The fact that it is not far from the oil and gas drilling areas makes it even more important since BC emitted from flaring is a significant climate forcing aerosol in the Arctic.

The comparison of the measured and modeled BC concentrations is excellent. There are many cases when they agree very well. This is important because it shows that the model works. Then there are other cases when there is no agreement at all. This is also a good and important result because it can be used in developing the emission inventories.

The paper is good and I can recommend publishing it in ACP after some minor corrections and additions I suggest below in the detailed comments.

Response: We appreciate reviewer's kind comments and help in improving this manuscript.

Detailed comments

L137 "...Island located in the Kara (Western Siberian Arctic)..." Should it be "Kara Sea", is the word "Sea" missing?

Response: Indeed, this should be "Kara Sea" and we have corrected accordingly. Please see manuscript with Track Changes page 5.

L137-138 There is a link:

<https://peexhq.home.blog/2019/12/11/newresearch-aerosol-stations-in-the-russian-arctic>,

When I click it I get this answer

"Oops! That page can't be found. It looks like nothing was found at this location. Maybe try a search?"

Please check the link.

Response: The link that is posted above is misleading. Perhaps this is the reason. We have checked once again and the link that is written in the manuscript (<https://peexhq.home.blog/2019/12/11/new-research-aerosol-stations-in-the-russian-arctic>) seems to work properly.

Section 2.1 Aerosol station "Island Bely"

I wish you would give some more detailed description of the site and the measurements. After all, this appears to be the first paper on any aerosol measurements at this station so it would make sense to give some more details. I think all the info I suggest you would add would be useful also for future studies at the site.

The site does get heavy snowfall, so was the inlet heated? How was the inlet? Flows? Flow checks?

Response: We have now included a more detailed description. Please see Track Changes page 6: "An aerosol sampling ... blocking the system."

L205-207 "For screening the BC data, we used the measured wind direction. In that case, strong BC spikes that coincided with wind directions related to local diesel sources were removed from further data analyses...wind speed and direction were obtained every 3 hours..."

The AE33 measured at 1-min time resolution and you cleaned them using the wind data at 3-hour resolution. Right?

Response: We have now included more information on how the data screening was performed. Please see manuscript with Track Changes at page 7-8: "Cleaning of 1-min ... " until end of the paragraph.

Did you just assume wind speed and direction remained constant for 3 hours? Ok, if those are the data, that is what can be done. Can you give the contamination sector in degrees? On the other hand, when wind speed is low enough, air will be contaminated regardless of wind direction. That is typical at practically every measurement station. Did you consider this? Note: I don't require you would start reprocessing your data. Can you estimate, how large fraction of data had to be removed due to local contamination?

Response: We did not assume constant winds of course. Wind speed and direction can change within 3 hours. Even in the extreme case where wind blew from the sector 240-250 degrees for 3 consecutive hours (with respect to the meteorological measurements), we did not observe the spike lasting continuously. In such cases, background values are frequent, while the duration of spikes never extends one-two hours even if the wind blew from that sector during a whole day. We have also commented on what happens in low windy conditions. We have now reported the contamination sector in detail and the fraction of data we removed (see manuscript with Track Changes at page 7-8).

Yet another thing is that I think it would make sense to move lines 203 – 208 right after L169.

Response: For the sake of a smoother flow during reading of the current manuscript, we think it would make more sense to present the AE33 instrument and associated parameters first (line 170-203), and then the way we used it at Bely, in order to take the measurements of BC. We leave the paragraph it as it is now, and if Reviewer further insist, we will correct in a future step.

In the small photograph inserted in the map in Fig.1 I see many inlets on the roof of the container. Would you just mention what other aerosol or trace gas measurements you run there? The readers – including myself – could be interested in waiting for followup papers.

Response: We have now added the missing information at page 6, lines 170-175 (please see manuscript with Track Changes).

L233-234 "The source contribution can be displayed as a function of time elapsed since the emission has occurred (i.e., "age")". I am sorry but I don't quite understand this. I assume "source contribution" means the fraction (in %) of BC observed at the site, coming from some selected source. But the transport time from a source to the station is in hours, both for small and large sources. Please clarify.

Response: We appreciate Reviewer for catching this mistake, because it does not really make sense, as it was written in the manuscript. We have now corrected the whole paragraph. Please see Track Changes at page 8.

L280 3.1 Monthly climatology of black carbon

I have a suggestion: why don't you present the main results also in a table? I am addicted

to tables. For future readers and authors it would be very handy to find the results in the table and refer to it, wouldn't it? It is up to you.

Response: Of course! This can be very useful! We have added a new table in Supplementary information for the monthly climatology of BC (see Table S1).

L312-313 "... monthly median EBC in September 2020 demonstrated the unprecedented high value of 72 ng/m³, twice as much as in September 2019."

In Fig 4a, is the black line denoted by "EBC(880)" the median EBC? If so, when I draw a horizontal line from its September 2020 value to the y axis it is clearly lower than 50 ng/m³, not even close to 72 ng/m³. Please check either the data in the figure or the statement above. And by the way, the lines in the legend for EBC(880), quartile25 and quartile75 look just the same. You could use some different line types. And further, please try to avoid plotting data using red and green lines in the same figure, I have colleagues who don't see the difference.

Response: We thank the reviewer for observing this. 72 ng/m³ is mean value for September 2019 and NOT 2020! We have corrected both the value and the Figure to be visible for people who cannot distinguish colors (see Track Changes and updated Fig.4).

L411 " Looking closely to specific episodes, during pollution P1, three events...". Add the word "episode" after "P1"

Response: We have corrected this part everywhere in the manuscript (please see Trach Changes).

About naming the episodes. Now you call them with the same codes P1, P2, ... for both the cold and warm seasons. Sometimes this is a bit confucing. In Fig. 5 you show all of them, there are 15 episodes. Consider giving unique numbers for example by simply running numbers P1 ... P15 or P1c ... P8c and P1w ... P7w. Again up to you, but I think it unique names would make it easier to follow.

Response: We have now renamed all episodes as C1, C2, etc... for the Cold period and W1, W2, etc... for the Warm (see updated figures).

L 481 "... "Island Bely" station (Figure 5c)...." There is no Fig 5c, just 5a and 5b. Correct something.

Response: Reviewer has a point here; it should be Figure 5b. We have corrected accordingly. Please see Trach Changes in page 16.