

# ***Interactive comment on “Interannual and seasonal variations in aerosol optical depth of the atmosphere in two regions of Spitsbergen Archipelago (2002–2018)” by Dmitry M. Kabanov et al.***

**Dmitry M. Kabanov et al.**

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We thank the reviewer for the careful reading and the generally positive review. We answered and corrected all remarks. Our modifications are:

Quote line 65: The warming of Spitsbergen and the possible relation to changed atmospheric circulation pattern was shown here: (Isaksen et al. 2016) <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016JD025606>

The impact of the West Spitsbergen current on the local climate is described here

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<https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.2338>

We include this quote in the new version of the manuscript Isaksen, K.; Nordli, O.; Forland, E.J.; Lupikasza, E.; Eastwood, S. and Niedzwiedz, T. Recent warming on Spitsbergen – Influence of atmospheric circulation and sea ice cover, *J. Geophys. Res. Atmos.*, 121, 11,913–11,931, doi: 10.1002/2016JD025606. 2016

Walczowski, W.; Piechura, J. Influence of the West Spitsbergen Current on the local climate. *Int. J. Climatol.* 31: 1088–1093, doi: 10.1002/joc.2338. (2011)

Quote line 125: The possibility to derive differences on aerosol properties comparing neighboring stations for Spitsbergen is described in the coming paragraph with corresponding quote. For this reason we include a more general quote here (Sakerin et al. 2010) <https://link.springer.com/article/10.1134/S1024856010020028> The importance of Arctic intercomparison campaigns with error estimation was provided by Mazzola et al. 2011 <https://repositorio.aemet.es/bitstream/20.500.11765/11692/1/Mazzola-Atm-Env-2011.pdf>

We include this quote in the new version of the manuscript Sakerin S.M., Kabanov D.M., Nasrtdinov I.M., Turchinovich S.A., and Turchinovich Yu.S. The results of two-point experiments on the estimation of the urban anthropogenic effect on the characteristics of atmospheric transparency // *Atmospheric and Oceanic Optics*, 2010, Vol. 23, No. 2, p. 88–94. DOI: 10.1134/S1024856010020028.

Mazzola, M.; Stone, R.S.; Herber, A.; Tomasi, C.; Lupi, A.; Vitale, V.; Lanconelli, C., Toledano, C.; Cachorro, V.E.; O'Neill, N.T.; Shiobare, M.; Aaltonen, V. et al. Evaluation of sun photometer capabilities for retrievals of aerosol optical depth at high latitudes: The POLAR-AOD intercomparison campaigns. *Atmosph. Environ.* doi: 10.1016/j.atmosenv.2011.07.042. 2011

Paragraph lines 135 – 140: on the differences in AOD over both stations. In his works [Toledano et al., 2012; Pakszys and Zielinski, 2017] had already compared AOD, mea-

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sured at the neighboring stations Hornsund and Ny-Ålesund. The difference in the seasonally and annually average values of AOD between these stations reached 0.01-0.02, mainly due to situations with high atmospheric turbidities. We obtained about the same result after hourly average AOD in Ny-Ålesund and Barentsburg were compared (when measurements were within one hour of each other). How can the difference in AOD between the neighboring regions be explained? Even without local anthropogenic impact, the difference in AOD between stations, separated by mountains and distances 100 km (or longer) apart may be due to the Arctic Haze phenomena and transports of smoke plumes. (They are not conservative and homogeneous structures, blown by wind without changes). The Arctic Haze or plumes may be observed in the region of any station, and may be observed (to a lesser extent) or not (due to spatial inhomogeneities) at another one. When AOD, measured at two stations within an hour (as in our work), are compared, the number of such inhomogeneous situations can only be reduced partly sometimes, but can never be eliminated at all. Resort to data from trajectory analysis or to any correction (or shift) in time makes no sense for two reasons. First, this cannot be made due to spatial inhomogeneities in AOD: for instance, there was the thickest part of the plume in the region of one station, and a thinner part in the region of another one. Second, the AOD observations are not continuous, being carried out only in situations when Sun is not covered by clouds. That is, the measurements were in the period of AOD maximum at one station, and only during AOD decay or commencing AOD growth at another one. Taking into consideration the Reviewer's comment, we corrected slightly the text in this paragraph: "Comparison of measurements with the two photometers showed a large dispersion of the data under the conditions of strong atmospheric turbidities, namely, during outflow of smoke plumes from forest fires and in the Arctic Haze situations. Due to large spatial inhomogeneity of these structures, AOD, measured in two regions, may strongly differ, making the comparison incorrect".

Line 165: thanks, we added a short explanation to the Ångström formula in the new manuscript: The attenuation of radiation by atmospheric aerosol varies as a function of

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wavelength, depending on sizes and refractive index of aerosol particles. To characterize the AOD, measured at different wavelengths, the Ångström formula is widely used: , (1) where  $\beta$  and  $\alpha$  are the approximation parameters of the spectral dependence of AOD;  $\beta$  is the turbidity coefficient, which is close in value to AOD at the wavelength of  $1\ \mu\text{m}$ ; and  $\alpha$  is the selectivity exponent (power-law decay).

Line 180: Thanks – we explain now that  $m$  corresponds to  $\beta$  and  $n$  to  $\alpha$  in eq. 1.  
 Line 185: Thanks we changed the wording: with independent data we mean additional information. We write: “But, precisely what caused changes in the selectivity of AOD is almost impossible to determine without the use of additional information like e.g. aerosol in-situ measurements”.

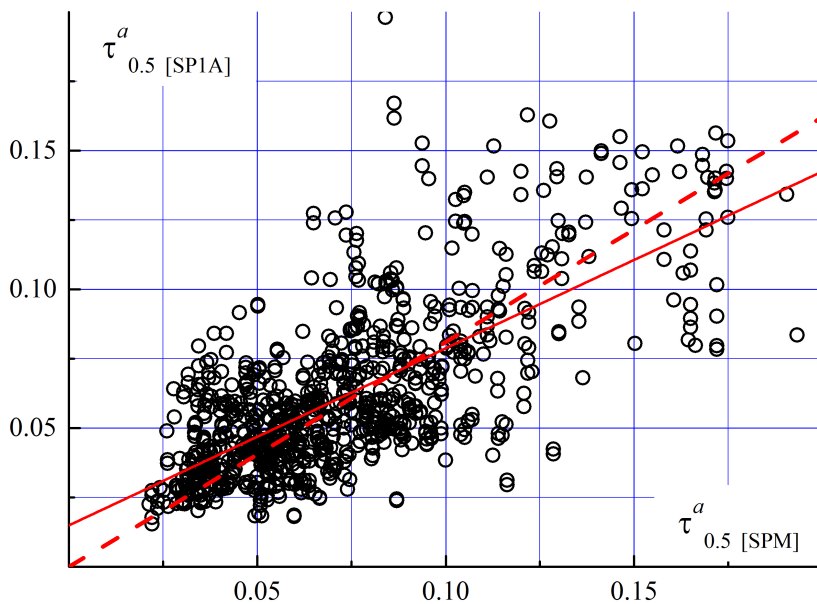
Line 300: In this paragraph, we compare two periods of measurements at a single station (Ny-Ålesund) and indicate a tendency toward a small AOD decrease in 2011-2018 relative to 2002-2010. The location of this station, orography, or something else did not change. By the wording “no explicit predominance” we wanted to express that no single value for the variation coefficient for fine or coarse mode for the three places and times: Ny-Ålesund: early, Ny-Ålesund: later, Barentsburg: later dominate over the others. This means that there is no clear shift in aerosol properties neither in time nor from Barentsburg to Ny-Ålesund. We rewrite the sentence for clarity: No explicit predominance of the variation coefficients for any AOD component can be seen. The relative variations  $\tau_{0.5}$  and  $\tau_{1.0}$  are about the same: their variation coefficients  $V$  are 14-29%. Neither AOD component shows a clear predominance of variation coefficients.

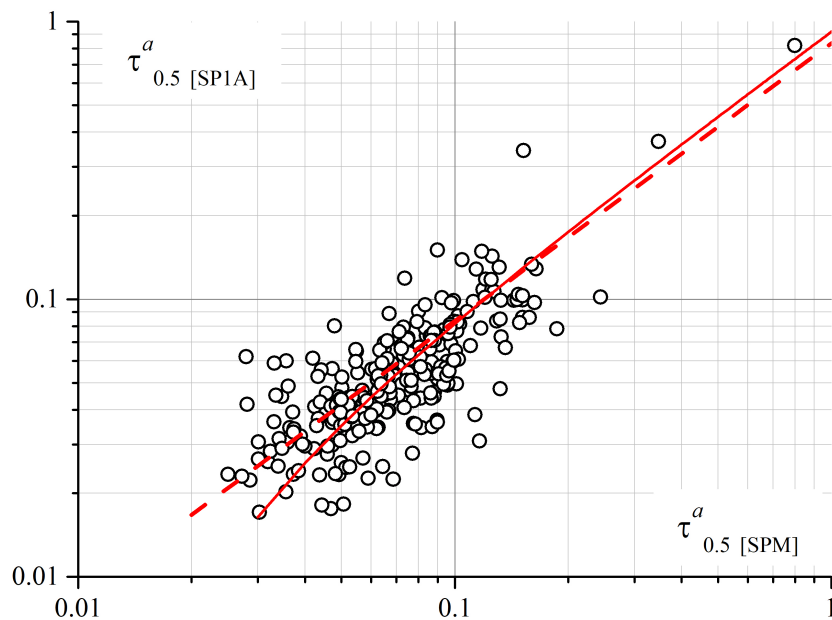
We fixed the Fig. 1 and 9, as suggested by the Reviewer.

Please also note the supplement to this comment:

<https://amt.copernicus.org/preprints/amt-2020-83/amt-2020-83-AC4-supplement.pdf>

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-83, 2020.

**Fig. 1.**

**Fig. 2.**