

Comment on acp-2022-42

Anonymous Referee #1

Referee comment on "Long-range transport of Asian dust to the Arctic: identification of transport pathways, evolution of aerosol optical properties, and impact assessment on surface albedo changes" by Xiaoxi Zhao et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-42-RC1>, 2022

Zhao et al. presented a detailed study on investigating the transport routes of Asian dust to the Arctic, the variation of aerosol properties during the long-range transport, and the impact of particle deposition on the surface albedo. Dust has been recognized as an important natural contributor to the global aerosol budget while its climate forcing is highly uncertain. Zhao et al. found that Asian dust has high probability reaching the Arctic and two typical transport events are well verified by various methods. The variations of the aerosol optical properties between the two events are compared, suggesting the importance of transport routes in modifying the aerosol properties. At last, the reduction of surface albedo due to the deposition of particles is demonstrated significant, which could be a crucial factor of the aerosol indirect climatic effect in the Arctic region.

Overall, this study is a nice work as it expands the current understanding of the Arctic haze. Hence, I recommend this manuscript for publication after the following comments have been addressed.

Major comments:

- In the identification of dust particles by using the Lidar observation (e.g., Figure 6 and Figure 8), high extinctions aloft can be seen. How to differentiate the extinction between dust and clouds?
- In Figure 10, the analyzed periods of AOD and AE are not consistent. Please state the reason. Also, in Figure 10c, why AOD in the source region is even lower than the downwind regions?
- In Section 3.7.1, it is feasible to use the calculated ratio of the particulate matter in the snow versus that in the atmosphere. However, this ratio is derived based on the measurement of black carbon in snow and in the atmosphere. The authors should

clarify how can be this ratio used for the estimation of dust in snow.

Other comments:

- Line 36: "This study implied that the dust long transport from China to the Arctic was ubiquitous and may be a potential contributor to the Arctic regional climate and ecosystem." The term "ecosystem" is suggested omitted.
- Line 47 – 48: "origin of aerosol, transport, and deposition". This expression is confusing and not clear.
- Section2., how was the aerosol absorption measured?
- Line 153: "height resolution" should be "vertical resolution".
- Line 154 – 165: relevant references about the satellite sensors should be cited.
- Line 255-257: The writing "the presence of a low pressure system over northern Japan in spring" needs more evidence.
- Line 279: the expression of time and date should be consistent throughout the paper.
- As for the geopotential height fields that are used in Figure 4 and Figure 5, it is not clear which pressure level data is used.
- Line 344: "particle spheric information" should be "particle morphology information".
- Line 358: When Angström exponent first appears here, its wavelength range should be provided.
- As for the aerosol types observed by CALIPSO, the visualization is not clear enough to be determined in Figure 7 and 9.
- Line 468 – 470: Please provide more supporting information on this statement.