Comment on acp-2021-933

Anonymous Referee #1

Referee comment on "Record-breaking dust loading during two mega dust storm events over northern China in March 2021: aerosol optical and radiative properties and meteorological drivers" by Ke Gui et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-933-RC1, 2021

For more than 10 years there was an absence of dust storms across North China. This study applies multiple satellite retrievals, in-situ observations, and reanalysis measurements to characterize two unexpected sand and dust storm (SDS) events in March 2021, formed across northern China. The investigation of those two SDS events is particularly valuable in many ways. More specifically, the presented work investigates the synoptic factors that favor that kind of extreme SDS and highlights the way that different measurements can be combined to interpret the dust transport and emission. The recorded high dust loads originated by the dust storms are also interpreted by calculating the 20-year climatological DOD values across the study area in March. Finally, great effort has been made for interpreting the possible meteorological anomalies that triggered this extreme dust emission. Overall, the manuscript is well-written and well-structured, and the quality of language and visuals are in general satisfactory.

General comments:

This is a reference work of how to treat data and make a thorough study on the way that meteorological (wind speed, temperature etc.) and geophysical factors (soil moisture) can regulate SDS events, receiving information from different sources, and it would be a perfect example for future works in the field.

However, I am very confused regarding the novelty of this work. Looking in the already published literature in the field, I have found some works that have been already published, covering the main subject of the presented study. Let me be more concrete.

The recently published studies of Filonchyk (2022) and Liang et al. (2022) analyze similar datasets (in-situ, remote sensing and models) with the current study, focusing on 3.15 SDS event. As Section 3.3 of this study, the atmospheric circulation conditions, that triggered the exceptional 3.15 SDS (the strong Mongolian cyclone including its day-by-day movement) are in detail explained in Filonchyk (2022) (their Section 3.1 using ERA5 data)). Also, like the presented Section 3.1, the spatiotemporal evolution of the SDS using ground-based along with satellite-based measurements is covered by Filonchyk (2022) (their Section 3.2 and 3.3) and Liang et al. (2022) (their Figure S3, using ERA5 data). The sources of the dust aeolian aerosols have also been demonstrated using model simulations (Filonchyk (2022)) and HYSPLIT backward trajectories (Liang et al. (2022)). In addition, as here, the vertical distribution of dust aerosols has also been investigated by CALIPSO retrievals in both Filonchyk (2022), and Liang et al. (2022) works. Furthermore, like the presented Section 3.5, the climate conditions and anomalies across the study area that could trigger the 3.15 SDS (and not only) event have also been investigated by Zhicong et al. (2021).

The Authors need to clarify the way that this study contributes meaningfully to the existing published literature.

Therefore, in my point of view, this analysis does not expand or fill the gaps of the recently published works and my recommendation is to reject the paper in this form. However, I believe the paper could eventually be published but significant supplement analysis must be added to the revised manuscript. For instance, the effect of these sudden SDS events, including a huge amount of dust burden, on the incoming solar radiation and thus Earth's climate could be a very interesting topic for further investigation.

If you decide to proceed in this manuscript form it is necessary to define the contribution of your work.

Finally, find below some minor recommendations.

Specific comments:

- Lines 114−117: Since Pu and Ginoux (2018) relied on MODIC C6.0 AOD data, did this work, by using the MODIS C6.1, found a better representation of satellite-derived DODs against AERONET? Please add this validation analysis in the supplement.
- Line 140: please change "ERA5 and MERRA-2 reanalyses" to "Reanalysis datasets".

- Line 148: please remove the dash in "10-m".
- Line 217: the value of AEC is missing in the parenthesis.
- In Section 3.1, five (three satellite-based and two ground-based) datasets are used to characterize the two SDS events. The quantitative contribution of each satellite-based dataset against in-situ measurements should be included in this section. What's extra information gives the UVAI against MODIS-DOD? Again, UVAI and MODIS-DODs against PM_{10}? If not, authors should choose the most appropriate datasets to reduce the redundant information.
- In Figs. 2, 4 etc. the latitude and longitude information on the y-axis and x-axis respectively is missing. For instance, in line 235 you mentioned: "(confined within 40-50 ^{o}N)" but there is no such information in the graph. Please add this information.
- On Mar-28, can you please explain the differences between DOD and PM_{10} values in Liaoning (122 ^{o}E, 42 ^{o}N). DOD documents notably high values (>2.5) while PM_{10} lies within $100-400$ μg/m^3.
- Lines 252−254: Please rephrase, to show that the peak in UVAI is documented near the Bohai Sea on Mar-20.
- Wind magnitudes and directions between Fig. 2 and Fig. 5 are unanticipated different. Please check again. What's the correct underlying meteorology?
- Line 362: I think you mean 2000−2020 instead of 2001−
- Lines 382−383: Please add a reference here.
- Lines 392−399: What's extra information gives this paragraph to the already existing analysis?
- Line 410: Delete "S" from "Fig. S15".

References:

Mikalai Filonchyk. Characteristics of the severe March 2021 Gobi Desert dust storm and its impact on air pollution in China, Chemosphere, Volume 287, Part 3, 2022, 132219, ISSN 0045-6535, https://doi.org/10.1016/j.chemosphere.2021.132219.

Peng Liang, Bo Chen, Xiaoping Yang, Qianqian Liu, Airui Li, Lydia Mackenzie, Deguo Zhang. Revealing the dust transport processes of the 2021 mega dust storm event in northern China, Science Bulletin, Volume 67, Issue 1, 2022, Pages 21-24, ISSN 2095-9273, https://doi.org/10.1016/j.scib.2021.08.014.

Yin, Zhicong, Wan, Yu, Zhang, Yijia, Wang, Huijun. Why super sandstorm 2021 in North China, National Science Review, Natl Sci Rev, 2021, https://doi.org/10.1093/nsr/nwab165.