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Comment on acp-2022-204

Anonymous Referee #2

Referee comment on "What caused the interdecadal shift in the El Niño–Southern Oscillation (ENSO) impact on dust mass concentration over northwestern South Asia?" by Lamei Shi et al., Atmos. Chem. Phys. Discuss.,
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Review of the manuscript entitled "What caused the interdecadal shift of the ENSO impact on dust mass concentration over northwestern South Asia?" by Lamei Shi et al.

Based on MERR-2 dust concentration data, this study investigated the interdecadal change of the association of the surface dust concentration in northwestern South Asia with ENSO and its possible causes. The relevant research results are interesting and provide useful clues for understanding the interdecadal variability of the regional dust activities. However, only some simple statistical analyses are given in this manuscript, and there is a lack of physical mechanism or process research on the link between the SSTA and the regional dust, which cannot support the causal link between the two, so it cannot be recommended for publication in the current form. The following comments are for the authors' reference.

1. Most of the arguments in this manuscript are mainly based on a series of sliding correlations (Figures 3, 4, 8, 11 & 12) and scatter diagrams (Figures 6, 7 & 9), without any analysis of dynamical processes associated with atmospheric circulation and climate elements. In fact, dust activities are mainly controlled by the local surface wind, precipitation or soil moisture (e.g., Goudie and Middleton, 1992). The teleconnection between the South Asian dust anomaly and the ENSO cycle is achieved through various mechanisms including the Walker Circulation variation (e.g., Huang et al., 2020). The existing analysis in this manuscript is not enough to establish the causal relationship between ENSO and the regional dust activities.

2. This study discussed various factors influencing the interdecadal change of the ENSO-dust relationship, such as tropical Atlantic SST, Indian ocean SST, Eurasian continent temperature (or land-sea thermal contrast) and PDO. However, the role of some factors is unclear or unconvincing because the analysis is too superficial. Instead of dealing with so many factors in general, it is better to focus on one most important factor for in-depth discussion. So, I suggest deleting all parts related to factors insignificant for modulating

the ENSO-dust relationship in the text and adding the relevant process analyses. For example, how does Atlantic SST affect the downstream dust? In particular, why can the spring SST control the summer dust? How can the large-scale SSTA affect the regional dust activities in northwestern South Asia far away from the SSTA region?

3. In some figure captions (e.g., Figures 5 and 10), the months in which the SST are used should be clearly indicated. This is very important for how to explain the lag correlation between the SST and the dust. It seems that the March-May SST in the Atlantic Ocean while the September-May SST in the Indian Ocean has been used. However, the manuscript failed to give the physical mechanism through which the preceding SSTA affects the dust activity in the subsequent summer. Although several literatures have been cited to try to explain the possible connection between the two, for example, Atlantic SST affects the Indian monsoon (e.g., Rong et al., 2010; Kucharski and Joshi, 2017), most of these literatures only discuss the simultaneous correlation between the SST and the monsoon, rather than the lag correlation.

4. In Line 132 of the text, it is mentioned that "the DUSMASS used in this study is averaged from June to July and May is neglected to weaken the disturbance of seasonal climatological differences". Actually, it is very important to understand the difference of ENSO impact on the pre-monsoon and monsoon season dust activities. This should be moderately discussed in the manuscript.

References

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