Comment on acp-2022-204
Anonymous Referee #1

Referee comment on "What caused the interdecadal shift of the ENSO impact on dust mass concentration over northwestern South Asia?" by Lamei Shi et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-204-RC1, 2022

This manuscript presents an investigation of the influence of large-scale climate variability on the surface dust concentration over northwestern South Asia, in particular the decadal shift in the ENSO-dust relationship. I appreciate the effort of disentangling the role of different large-scale climate variations on northwestern South Asian dust activity. While this is an interesting topic and have broad implications for changing climate, this study is not convincing to me in its current form. Therefore, I recommend reject/resubmit.

Major concerns:

- The most concerning point is that this study only investigates the regression/correlation type of relationship between large-scale modes of climate variability, e.g. SSTAs, and dust. In absence of any atmospheric and land surface drivers (e.g. precipitation, wind, soil moisture, vegetation cover, etc) of dust, it is hard to believe any causal link between remote SSTAs and regional dust concentration. While I notice the authors have cited many previous studies, I don't feel their results are directly applicable to your scientific questions, due to different analyzed datasets, time periods, etc.
In this study, the authors investigated surface dust mass concentration from reanalysis. My understanding is that reanalysis covers a longer period than satellite aerosol products. But it is worthy of checking the quality of the reanalysis product over the study area, with ground observations (AERONET) (Holben et al., 2001), direct remote-sensing product (e.g., MISR nonspherical AOD) (Garay et al., 2020), particulate matter concentrations (PM$_{10}$) (Yu et al., 2021), visibility and weather observations from weather stations (Xi, 2021). I guess another purpose of analyzing surface dust concentration is to focus on locally emitted dust, rather than complicating the result interpretation with transported dust from, for example, the Arabian Peninsula. But I suspect the uncertainty of reanalysis surface dust concentration is higher than columnar dust concentration, because the former requires an accurate representation of dust vertical distribution beyond the total dust amount required by the latter metric.

The whole manuscript is not well-organized. The main objective of this paper is to test different hypothesized modulators of the ENSO-dust relation on the decadal scale; those hypothesized modulators include Indian Ocean SST, Atlantic Ocean SST, land-ocean thermal contrast, rapid warming versus slow warming, different ENSO types, etc. I personally feel confused about the role of all these different factors. Maybe a schematic diagram illustrating the key findings will help. I would also recommend reorganize the whole manuscript, including introduction and results sections to clearly present these hypotheses and testing results.

I’m not sure the sample size allows to draw any conclusions regarding decadal shift in ENSO types. Moreover, the emerging and continuing ENSO events are particularly confusing. From the definition of these events, for example, [(0)Mar. – (0)May] > 0.5 (< -0.5)STD, did you mean that in continuing El Niño event, March Niño-3 should be greater than May Niño-3 for 0.5 standard deviation? Then why do you call it continuing, given that the SST anomaly is decaying fast? I did not find significant differences between the currently examined EM and CT ENSO years from their SST evolutions provided by CPC for example (https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php).

The sliding regression analysis is a smart way to analyze the relatively short data record. My understanding is that you can identify changing point from the sliding regression. But it might not be necessary to show all the sliding regression results in
the main text. I personally would replace those panels with more in-depth investigation of the mechanisms underlying the teleconnections, e.g. response in precipitation, wind, soil moisture, vegetation to those SSTAs.

- I noticed that there has never been a climatological dust concentration map or a regression map of dust onto ENSO.

Minor comments:

- On line 37, dust can travel, not dust storm.
- On line 55, it is not accurate to say that “global warming came to an end in 2013”, almost everyone agrees that global warming is continuing.
- On line 79, while in the introduction you mention the role of IOD. I suspect Indian Ocean Basin mode would have an effect (Yang et al., 2007). Why don't analyze IOD and Indian Ocean Basin mode separately, rather than regional average SSTAs as in the current analysis?
- Lines 86-88, this sentence does not flow well. The first part talks about ENSO impacts DUSMASS due to its influence on winter precipitation, the second part talks about interdecadal change in ENSO-Indian Summer Monsoon Relationship.
- Lines 98-99, AOD cannot be provided by meteorological stations.
- Lines 129-133, do you mean that the prevailing wind shifts from May to June? But the above sentence states that the July to Sep is the summer monsoon season. Then why do you focus on June to July?
- Figure 1, I recommend replacing with a mean DUSMASS map.
- Line 147, this reference is probably too old for MERRA2, which came out in 2017.
- In section 2.3.1, Z refers to ocean SSTAs, while in 2.3.2, Z refers to ENSO.
- Line 234, why don't you show a map of correlation between DUSMASS and Niño-3 for before 1990s and afterwards? And maybe MCA of Pacific SST and DUSMASS.
- Table, the sample size is too small.
- Lines 422-423, I would not be surprised if ISMR is affected by land-sea thermal contrast over Tropical Indian Ocean and Indian subcontinent, but not Europe and Arabian Peninsula.
- Line 540, I think a longer time series is crucially needed for this type of analysis. Maybe you need to first obtain the atmospheric and land surface regulator for dust, then analyze a longer timeseries of those atmospheric and land surface variables to infer the role of different ENSO types on the variability of these atmospheric and land variable thereby dust.
- Finally, there are a lot of grammar errors and typos. Please check.
Reference:


