

## **Review report acp-2020-813**

The current study deals with the analysis of dust long-term variability over the major deserts of the planet and the main downwind regions. To realize, observations from weather stations, derived by the NOAA Integrated Surface Database (ISD), have been analyzed. Overall, it is a very nice and comprehensive study which fits very well to the issues covered by the Atmospheric Chemistry and Physics journal. Moreover, the structure of the work is well defined and the manuscript it is very well written. Therefore, I recommend the submitted study to be published after taking into account the following minor comments and suggestions.

1. **Lines 50-55:** Here you have to add satellite sensors (SEVIRI, CATS, IASI, CALIPSO) which have been widely used in various studies focusing on dust aerosols.
2. **Lines 63-65:** It is missing a discussion about the advantages of passive satellite sensors (e.g. spatial coverage) as well as few sentences about the benefits and the drawbacks of active satellite sensors (e.g. CALIOP).
3. **Line 121:** Could you please explain better this sentence?
4. **Equation 1:** Please provide a definition for the FR abbreviation.
5. **Lines 167 – 173:** MERRA-2 winds have been also used for the sea-salt aerosols.
6. **Lines 177 – 180:** Few corrections must be implemented here. MODIS radiances, instead of AOD, are used and are transformed to bias-corrected AOD with respect to AERONET. MISR AODs, without bias correction, are assimilated in MERRA-2 only over bright surfaces whereas AERONET measurements are taken into account until 2014.
7. **Line 187:** What do you mean “*even false recording*”? If it is not reliable, then why it is considered in the analysis?
8. **Figure 3:** It is hard to distinguish among the curves and the dashed lines. It is better to produce separate plots (for individual codes or groups) and give the all-time averages in a table or insert them in the plots.
9. **Figure 7:** Which MODIS DOD are you using? From Voss and Evan (2020)? Have you tried to reproduce the same plot but considering only the coincident measurements among MODIS, CAMS and MERRA-2 for the common period? Please keep in mind that MODIS provides single measurements per day whereas the reanalyses datasets take into account the diurnal cycle. Can you comment on this? Moreover, it is needed an explanation of how the global means have been calculated. In Figure 5 in [Levy et al. \(2009\)](#), it is evident that the calculation of the domain averages is affected by the selected approach. This is quite critical for the satellite data in which there are gaps due to the inability of the applied algorithm to provide a retrieval.
10. **Figure 8:** Please consider to reproduce the plot with the collocated data for the common period.
11. **Tables 3 and 4:** It would be interesting to include also other dust optical depth databases such as MIDAS ([Gkikas et al., 2020](#)) and LIVAS ([Amiridis et al., 2015](#)).
12. **Lines 305 – 306:** As I have already mentioned above, MERRA-2 assimilates MISR AODs above bright surfaces. Likewise, in MERRA-2 the anthropogenic dust sources are not considered.
13. **Figure 9:** I would like to see the results at station level. More specifically, three global maps are needed with the stations colored based on the correlation coefficient of VI with scPDSI, soil moisture and wind.
14. **Lines 324-325:** The vertical structure of the dust layers plays a key role when attempting to compare spaceborne retrievals with near-surface observations (see Section 4.4 in [Gkikas et al. \(2016\)](#)).
15. **Line 338:** How the global means from the weather stations are calculated? Are you using any weight based on the data availability?
16. **Figures 11, 13 and 15:** Same comment as for Figure 9. In addition, please use always red and blue color for the positive and negative phases, respectively, for the teleconnection patterns.