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Interactive comment on “Characteristics of dust storm events over the western United States” by H. Lei and J. X. L. Wang

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Responses to comments of Reviewer 1

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We wish to express our great appreciation to Reviewer 1 for the careful review, instructive comments, and recognition of the value of our work. We have revised the manuscript following these comments. We have incorporated all other comments. In the response below, we address each of these comments. The Reviewer's comments are italicized and our responses immediately follow.

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General comments Reviewer 1: This manuscript presents an interesting study on investigating the characteristics of dust storms in the western United States based on analyses of multiple datasets. This study aims at (1) analyzing characteristics of dust storm events based on different datasets and (2) identifying of historical dust storm events and reconstructing dust climatology. Overall, this manuscript is technically sound and addressing a topic within the scope of Atmospheric Chemistry and Physics. I recommend the following revisions before acceptance for publications.

Thanks for recognition of the value of our work.

Major Comments 1. Historical dust storm events over the western United States were not well archived. This study used available dust storms collected from media and NASA records. Dust storms in NASA earth observatory record have already been confirmed by satellite images. However, how did you confirm the dust storm events recorded by media?

Re: In addition to dust storm events captured by NASA satellites, media have recorded a series of dust storm events in forms of newspaper, web news, and shared personal video records. These media information is treated as evidences to confirm the corresponding events. We only extract the temporal information for dust storms from these records and do the analysis on observations to better understand these events.

2. Dust storms are classified into four types. What meteorological characteristics are associated with each type of dust storms? For example, surface wind speed, vertical wind speed or boundary layer conditions, precipitation, air pressure etc. : : These would make it much easier for the audience to find take-home messages from this study, and also could be useful for others dust related efforts. Minor comments 1. Isn't it expected that PM10 is a good indicator of dust in the air? Does this need to be stated? Or is it better compared to PM2.5? 2. Several ratio indicators are used in this study. The descriptions of them are in different format. It is better to unify the description of them.

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Re: We have revised the text and tables to include more analyses on meteorological characteristics of these dust storm events. The added meteorological information can further contribute to dust storm identification. (1) PM10 is not a good individual indicator of dust. Although the dust process can increase the PM10 concentration in the air, many other processes (e.g. wildfire, industrial pollution episodes) may also cause the high PM10 concentration. In addition, different regions have different base-level PM10 concentrations. The non-dust storm day PM10 value in Arizona may over the dust-storm day PM10 concentration in Washington state. Therefore, the PM10 cannot be individually used as an indicator for dust. But, high PM10 is an important characteristic of dust processes. After tested in the recorded events, low value for PM2.5/PM10 is also a significant characteristic for dust processes. We have revised the text to clearly express this information. (2) We have modified the text to unify the expressions for these ratio indicators.

3. Section 2 - how do you know if these particular cases are representative of each group of dust storms?

Re: We give the statistics of group characteristics of these dust storm events in each type. The typical events are chosen mainly based on the availability of data. It is one of the case in the pool of each type. The use of typical events is to link the characteristics of the same dust event in air quality observations, stationary optical observations and satellite observations. That will benefit the development of a comprehensive method for dust storm identification with combinations of all available data.

4. Page 14203, Lines 20 - and PM2.5 can be high for non-dust sources.

Re: Yes, high PM2.5 concentrations can be caused by a variety of pollution events other than dust. We improve the expression to better interpret this point.

5. Fig. 6. AOD could be showing "dust" (particulate) aloft that is not seen in surface measurements.

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Re: Yes, the AOD information also includes dust particles aloft. That is why we can see the stationary AOD last longer peak values than the peak values in surface mass observations. Toward the dust identification, we only link the similar properties of them in describing the variation and process of dust storms.

6. Page 14207, Lines 8 - "this property". What is "this" referring to?

Re: "this property referring to the large standard deviation in satellite AOD during dust storm days. We revise to make it clear.

7. related to Fig.2. Ideally data from all instruments would have been available for all 4 cases, however that was not the case. Why wasn't IMPROVE data used for D1? Could add EPA standards for PM10 and 2.5 in the text.

Re: We have added EPA standard for PM10 and PM2.5. The EPA AQS data have incorporated the observations of PM from IMPROVE network. Most of IMPROVE sites recorded every 3 days and some sites with only a daily average concentration, which could miss many dust events and may not capture the fast dust event just in a few hours. However, by incorporating more sites, EPA AQS data have hourly records on most of days. The PM records in D1 case is not available from IMPROVE networks but be available from other EPA AQS incorporated networks. We revised the text to clearly express the relationship between EPA AQS records and IMPROVE records.

8. Fig 6 shows load AOD values (purples) for all 4 cases. Shouldn't these low values be seen here?

Re: We added the spatial characteristics of dust storm events from meteorological records in this revision. The purple region actually is not dust storm events but base-level AOD for these area. Dust storm occurs in limited areas. Four types of dust storms spread over areas with different sizes (within a scale of 50 miles to 300 miles over the western US). This may affect the high value region on figure 6.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 14195, 2013.

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