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Atmospheric Chemistry and Physics Discussions

ACPD

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Interactive Comment

Interactive comment on "An observation-based approach to identify local natural dust events from routine aerosol ground monitoring" *by* D. Q. Tong et al.

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The authors thank the reviewer for constructive comments on our manuscript. We answer the comments point by point below in the same order as provided:

Responses to General Comments:

We have modified the manuscript to address the reviewer's concerns as follows.

Regarding the novelty of the method, we have now added two paragraphs in the Introduction to review existing methods for dust identification. While we acknowledge our review does not present a complete list of all relevant works, we have not found any previous study that uses the same dust identification approach. In this study, we combined the well-established identification indicators with hierarchical cluster analysis to construct an eight-year dust records that could be useful to air quality and climate studies. The role of cluster analysis is two-fold. It allows us to process a large dataset using a proven statistical tool, and the results of cluster analysis helps set the dust identification threshold. We have provided the above discussion in the introduction section. We have also removed the word "new" throughout the text.

Since our paper relies mostly on ground data for dust identification, satellite data is used here for the purpose of data training, i.e., to find out the best dust indicators. Although more satellite data can be used here, the three well-defined dust events chosen here provide adequate information to demonstrate the common characteristics of windblown dust records. Therefore, we consider sufficient this small number of satellite-based events for this purpose. In addition, the emphasis of this work is to construct dust climatology from ground monitoring, which can work complimentarily with several previous studies using satellite data to identify dust sources.

We concur that the IMPROVE-based data analysis is useful to the Regional Haze Rule than the Exceptional Events Rule (EER). There is also nothing to stop states from using the IMPROVE data to argue about an exceptional event (personal communication with Marc Pitchford of Desert Research Institute). We have removed the concerned statement here, since we have no direct knowledge that any state has used IMPROVE data in their routine operations.

Responses to Specific Comments:

Page 3

Line 67: Corrected in the text;

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Lines 92-93: This sentence has been revised. See Lines 129-133.

Page 4

Line 97: Local dust events here are determined by both high PM10 concentrations and low PM2.5/PM10 ratios in the aerosol samples. It excludes transcontinental transported dust and long-range dust originated within North America.

Lines 101-107. See our response to the General Comment

Line 124: Changed as suggested.

Page 5

Line 145: Corrected.

Lines 142-144: We have added explanation of the choice of PM2.5/PM10 ratio in the revised manuscript (Lines 197-211). The US EPA uses a value of 0.15 - 0.26 for PM2.5 to PM10 ratio for soil dust emissions from human activities (MRI, 2005). In this work, we remove the high PM data with the PM2.5/PM10 ratio higher than 0.35, considering these samples being contaminated with non-local dust sources. This ratio is chosen based on the emission splitting factors used fugitive dust particles by the US EPA (MRI, 2005), and previous field measurements of the PM2.5 to PM10 ratio during dust events (e.g., 0.45 in Cheng, et al., 2005). Considering that most IMPROVE are not in the immediate proximity of dust source areas, we allow the cutoff ratio to be slightly larger (0.39) in the data processing. A simple sensitivity test was conducted in the Discussion to examine how sensitive the results are to the choice of the cutoff value.

“Alternatively, we consider here three simplified methods that use only basic aerosol mass concentrations, and compare their capability to pinpoint dust events to that of the full method using all five indicators. The first simplified approach uses two dust indicators, the PM10 mass concentration (> 40 ug/m3) and the PM2.5/PM10 ratio (< 0.35) as the filtering criteria. The PM10 cutoff and the PM2.5/PM10 ratio cutoff are taken from the lower and upper 95

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Please see Table 2 in the revised mansucript for details.

Page 6

Line 162: We have replaced Chow et al (2003) with another paper that reported chemical composition for both PM2.5 and PM10 (Chow et al., 1993).

Line 170: Changed to Taylor and McLennan (1985);

Line 183: We have revised the “small region” with “dust source region”.

Page 7

Line 212: Corrected.

Page 8

Lines 218 and 242: Corrected.

Lines 244-245: Western TX is included while Kansas is excluded. We have clarified it in the text (east of Colorado are excluded).

Page 9

Line 269: See our responses to general comments. We agree that the satellite data is a great source for dust identification. In response to the general comments, we have provided a review of some satellite-based approaches for this purpose (see the revised Introduction).

“With the rapid expansion of remote sensing data, several studies have attempted to detect dust outbreaks using satellite images and other derived products (Kauffman et al., 2000; Prospero et al, 2002; Rivera-Rivera et al., 2010; Lee et al, 2009). The pioneer works by Prospero and colleagues have associated dust sources with barren areas with “depressed” elevations relative to their surroundings (Ginoux et al., 2001) based on satellite-based global observations from the NIMBUS 7 Total Ozone Mapping Spectrometer (TOMS) (Prospero et al., 2002). They found that the major dust

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sources are invariably associated with topographical lows in arid or semiarid regions with rainfall below 250 mm (Prospero et al., 2002). A recent work by Ginoux et al (2010) combines land use data with the Moderate Resolution Imaging Spectroradiometer (MODIS) Deep Blue algorithm to identify natural and anthropogenic dust sources over the western Africa. This approach is further developed to pin-point active dust sources in the North America by selecting grid cells based on the frequency of high aerosol optical depth (AOD) events (AOD = 0.75) (Draxler et al., 2010). In an effort to quantify the relative impacts of Saharan and local dust in Elche in Southeastern Spain, Nicolas et al. (2008) combined satellite images from the NASA SeaWiFS, two dust prediction models (NAAPS and DREAM), a back-trajectory model (HYSPLIT) and NCEP meteorological reanalysis data to detect the outbreaks of African dust events. Using Positive Matrix Factorization (PMF), they identified six PM10 sources, including local soil and African dust, which are distinguished by the correlation of the source intensity with Ti. In Asia, an operational dust retrieval algorithm has been developed based on the FY-2C/SVISSR through combining visible and water vapor bands observations of the geostationary imager to distinguish dust plumes from surface objects and clouds (Hu et al., 2008). In the United States, data from both polar-orbiting and geostationary satellites have been used to characterize source areas of large dust outbreaks (Lee et al., 2009; Rivera-Rivera et al., 2010). It should be mentioned that all of these dust source identification methods are based on satellite remote sensing that needs to be independently verified using ground observations. For instance, Schepanski et al. (2007, 2012) combined a back-tracking method with high temporal satellite aerosol data (15-min Aerosol Index (AI) from the Ozone Monitoring Instrument (OMI)) to identify dust sources over the Saharan region. They found that the spatial distribution of dust source areas inferred from OMI 15-min AI is distinctly different from that by using the daily MODIS Deep Blue aerosol data (Schepanski et al., 2012). ”

In this work, we use NASA Earth Observatory's Natural Hazards dust products. During this study period (2000-2007), the dust satellite data captured 13 dust events occurring over the southwestern United States. Among these, there are only three events for

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which concurrent IMPROVE observational data were available, i.e. April 15, 2003 in Texas and New Mexico, November 27, 2005 in Texas and April 12, 2007 in south California. The above information has been added to the manuscript.

Page 12

Line 375: "-generated" has been added after "wind".

Line 375: corrected.

Page 14

Line 424: corrected. Thanks.

Page 15

Line 447: this statement has been removed.

Page 16

Line 488: Corrected as suggested.

Page 17

Line 499: The ratio of 0.2 is the fine particle fraction used by the US Environmental Protection Agency to split PM10 emissions into PM2.5. This value, instead of 0.35, represents a more rigorous indictor to guarantee local dust events in the absence of other chemical safeguards. We have added this discussion to the revised text. The effects of using different ratios are examined by a sensitivity test in Section 5.1. Line 500: We have quantified the effectiveness of the simplified approach by the comparing the identified dust events by the simple method to that by the comprehensive method (with chemical analysis).

Line 518: Our work emphasizes on using ground monitoring data for dust identification. In this approach, the use of satellite data is limited to selecting independently identified dust events for the purpose of methodological training. Therefore, our approach does

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not fit into the category of remote-sensing based dust pin-pointing methods. Instead, our work proposes an alternative way to pin-point dust events that can work complimentarily with other methods to identify dust events. The above clarification has been added to the revised manuscript.

Page 23

The site name has been corrected in both legend and caption.

Pages 24-25

The percentiles shown in the box plots are 25

Page 26

The scale was scaled in this way so that the time series of PM2.5/PM10 ratio can be distinguished from other parameters. See the readjusted figure with the PM2.5/PM10 ratio set between 0-1.0 (top), and the original figure (bottom). There are several overlaps at high PM10 data points, which are the focus of dust identification. See the attached Figure 1 for details.

Page 27 The abbreviations in Figures 6 and 7 are defined in the caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 4279, 2012.

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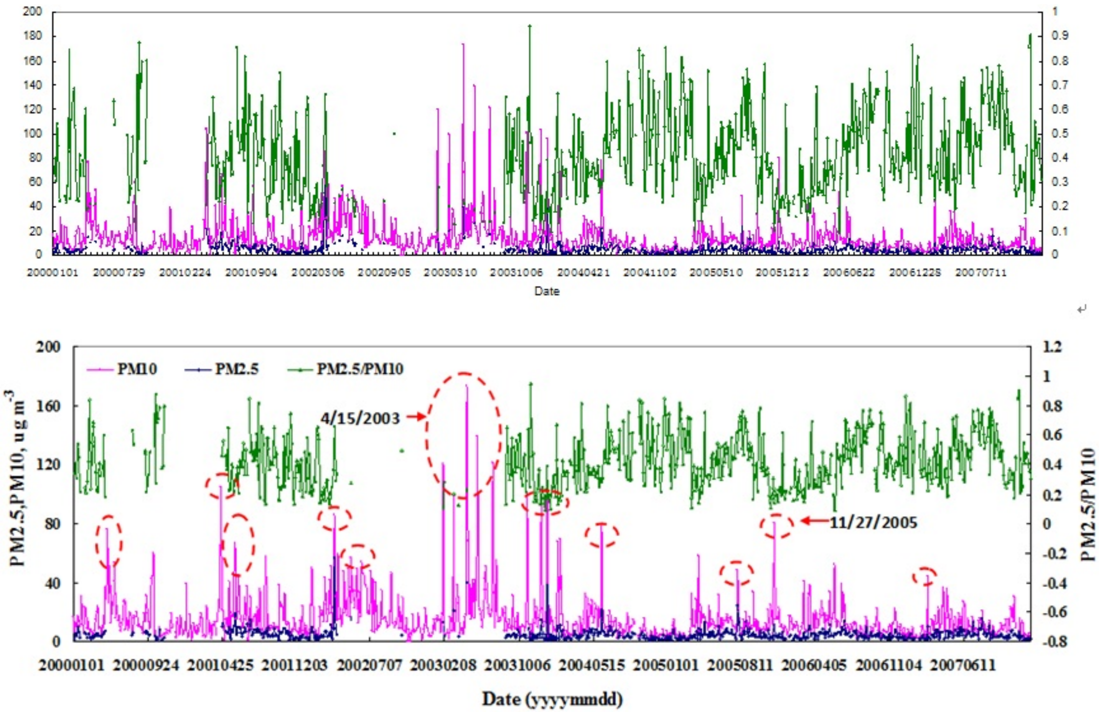

Comparisons of the choices of PM2.5/PM10 ratios for the time series figure. The scale was scaled in this way so that the time series of PM2.5/PM10 ratio can be distinguished from other parameters. See the readjusted figure with the PM2.5/PM10 ratio set between 0-1.0 (top), and the original figure (bottom). There are several overlaps at high PM10 data points, which are the focus of dust identification.

Fig. 1. Comparison of using different scaling ranges for PM25/PM10 ratios

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Interactive Discussion

Discussion Paper