

Interactive comment on “Sand/dust storms over Northeast Asia and associated large-scale circulations in spring 2006” by Y. Q. Yang et al.

Anonymous Referee #2

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Interactive comment on “Sand/dust storms over Northeast Asia and associated large-scale circulations in spring 2006” Y. Q. Yang et. al.

Two highlights of this paper are 1) to introduce a definition of sand dust storm (SDS) process making a new standard of SDS in Northeast Asia and 2) to analyze the large-scale circulations in the atmosphere associated with to the SDS processes in spring of 2000 to 2006. The paper is certainly appropriate for publication in ACP because the subject matter is important to our understanding of Asian dust storm and forecast. However, some parts of the descriptive contents of the manuscript are not well written and important information is confusing. Before the paper is accepted for publication I think that it requires a great deal of revisions:

To emphasize the above-mentioned highlights of this paper, a title such as: " Sand dust storm processes in Northeast Asia and associated large-scale circulations" seems more appropriate.

Abstract should be revised to summary your study with the highlights of your paper. Below I have suggested revisions to the abstract:

Abstract

This paper introduces a definition of sand storm process as a new standard of sand dust storms (SDS) groups a number of SDS-events in a period and region according to the synoptic system controlling the SDS-events in Northeast Asia. Based on the metrological data from WMO-monitoring network, 2456 Chinese surface stations and NCEP-NCAR reanalysis, the sand storm processes in Northeast Asia in spring 2000-2006 are investigated, and the evolutions and anomalies of general circulations in the troposphere are analyzed by comparing the spring having most and least occurrences of SDS in year 2006 and 2003. Associated with the noticeably increased occurrence of SDS-processes in spring 2006, the anomalies in 3-D structure of general circulation especially in the mid- and high latitudes of the Northern Hemisphere (NH) are revealed. The transition period from the winter of 2005 to spring 2006 has witnessed a fast-developed high center over the circumpolar vortex area in the upper troposphere, which pushes the polar vortex more southwards to mid-latitudes with a more extensive area over the east NH. In spring 2006, there are the significant cyclonic anomalies in the middle troposphere from the Baikal Lake to northern China with a stronger northwest jet over Northeast Asia. Compared with a normal year, stronger meridional (??) and zonal winds in the lower troposphere prevail over the arid and semiarid regions in Mongolia and northern China during spring 2006. The positive anomalies of surface high pressure registered an abnormal high of 4-10 hPa in the Tamil Peninsular make a stronger cold air source for the repeated cold air outbreak across the desert areas in spring 2006 resulting in the most frequent SDS seasons in the last 10 years in northeast Asia. In the introduction, the first sentence should be changed to "Spring

2006 was regarded as one of the most frequent sand/dust storms (SDS) seasons in the last 10 years in northeast Asia”, because “31 dust storm processes recorded, 19 of which happened in China” is concluded from this paper and should not be presented in the introduction.

Page 9261: line 9 and 10 “In the latitude band of 35-40ž N where arid and semiarid areas are located” is geographically wrong. A lot of deserts in Mongolia and China are beyond the band of 35-40ž N. Please delete it.

Page 9261: line 24-26 “Locally, the surface conditions in the desert areas such as the vegetation and snow covers and soil moisture govern the frequency of dust occurrence (Gong et al., 2003).However, the synoptic patterns of global or regional circulations control the production and transport of dust storms” is not completely correct for SDS in the deserts and surrounding areas in Northeast Asia. The correct understanding should be “Surface conditions and winds in the desert areas are two factors controlling dust production (Gong et al., 2003). Global and regional circulations govern the frequency of SDS-occurrence in Northeast Asia through their impacts on surface winds and surface conditions including vegetation, snow covers and soil moisture in the desert areas, and the circulations could also influence Asian dust transport ”. Please revise these sentences and the discussions in section 3 accordingly, too.

Page 9262: line 7 “northern oscillation” and line 11 “northern oscillation” should be deleted, because both are never used in the following text.

The title of section 2: “SDS processes across the northeast Asia in 2006” could be better to change to “SDS processes in Northeast Asia” in page 9262, because you show the SDS processes across the Northeast Asia from 2000 to 2006 in this section.

Page 9263: line 5 please revise “definetion” into “definition”; line 8 “or σ” is not used in the following text. Please delete it. line 12 please change “international” to “global”. Line 13, please add “Chinese” before “domestic”

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What is the “comparative and relative standard” in line 5 of page 9263?

The criteria for classifying a SDS process are clearly defined. I suggested these definitions from line 18 of page 9263 to line 4 of page 9264 as follows:

1. Within the existing WMO- and CMA - monitoring network of meteorological stations in Northeast Asia, the number of stations observing sand dust phenomenon could be used to determine the sand dust area. A blowing dust storm (BLDS) process begins when a blowing dust phenomenon meantime occurs in five or more adjacent stations over an area under the same synoptic system. The BLDS process ends with the termination of the synoptic system or the disappearance of blowing dust phenomenon.
2. The definition of SDS- and SSSDS (severe SDS)- process is base on the same principle for BLDS above-mentioned. The only difference is a SDS- or SSSDS- process is registered as onset, when the SDS- or SSSDS- phenomena are observed from three or more adjacent stations over an area at a given time.
3. The more or most severe dust storm process is recorded if two or three processes of BLDS, SDS and SSSDS are met under the same synoptic system . In section 2.2: please delete one “2.2” (line 5 of page 9264).

Page 9264, line 17-19 “This makes the year 2006 having most sand/dust storms since 2000, or 39% higher than the average of the preceding seven years” can not be drawn from table 1. Please move this sentence to the discussion on table 2 in the next paragraph.

Table 1: please explain the calculation of percentage in the title of table 1 and substitute “Korean Peninsula” for “DPRK, Republic of Korean”. (page 9275)

Section 2.3: title of this section is better to use “Synoptic features” for “synoptic footprints” (also in the text).

Please change table 2 with table 3 in the section 2.3, because table 3 is discussed there.

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It could be better to revise the subtitles from “Earlier onset for severe SDS” to “Early onset for severe SDS”, from “Most sand/dust in April” to “Most frequent SDS in April” in line 5, 18 (page 9265) and from “Serious damages” to “Heavy dust fall” in line 1 (page 9266).

Page 9265: line 8, please change “Mongolian cyclone” with “cold air outburst”, which is more general for Northeast Asia.

According to the given definitions of SDS process, you first check the synoptic systems in the investigation of SDS processes in spring 2000 to 2006. It will be better to present the dominant synoptic systems for SDS in Northeast Asia in spring 2000 to 2006 (or 2003 and 2006) in section 2, because the large scale (synoptic) circulations analyzed in section 3 are directly associated with these dominant synoptic systems for SDS .

Section 3. The title “Variations and anomalies of general circulation” could be more appropriate for the discussion (page 9266, line 6 and 7).

Page 9266: line 12, “boundary layer weather systems” should be deleted. line 19, “seasonal transitional period” is changed to “seasonal transition”

In the caption of Fig.1 (page 9278), please substitute “geopotential height” (geopotential is one word) for “geo-potential” and add the unit used there.

Page 9267: line 16. the title of section 3.2 should be changed to “anomalies of mid-tropospheric circulations”, because the anomalies of circulations in fig. 2 are much more noticeable than the westerly jets there. Synoptically for SDS-events in Northeast Asia, the meridional circulation causing southward cold air break is more important than westerly jet in mid- and lower troposphere there.

Fig. 2. Please explain how to calculate the anomalies of wind field in the caption. Are they relative to the mean from year 2000 to 2006 or else?

In section 2.3, It is presented that “earlier onset for severe SDS” in March is one synoptic footprint of SDS processes in spring 2006. But you just give wind field anomalies of

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April and May in Fig. 2. Why do you not show wind field anomalies in March in Fig. 2? There should be a relationship between anomalies of the midtropospheric circulations and the earlier onset for severe SDS” in March, 2006. If not, why?

In section 3.2, 3.3 and 3.4, you discuss the anomalies of winds and pressure shown in fig. 2, 3 and 4. Please note: these are wind field (or circulation) anomalies, not wind field (or circulation) itself. Please correct the confusions in your discussion (e.g. “cyclone circulation” in line 24 of page 9267 and line 18 of page 9268; “northwest jet” in line 25 of page 9268, “northwesterly jet” in line 20 of page 9258 and “southerly jets” in line 23 of page 9268; et al.). To clearly discuss the anomalies of 500hPa wind fields (or circulations) in section 3.2, it could be more logically that you first describe the mean circulations of 500hPa in spring as a normal year background instead in the first paragraph from line 17 to 22 in page 9267 in the beginning of section 3.2.

Section 3.3. Please change the subtitle from “Evolution of momentum field at the lower troposphere” to “Anomalies of momentum field in the lower troposphere”, because the anomalies of spring momentum field in the lower troposphere (but not the evolution) are discussed in this section.

Please delete the first paragraph of section 3.3 from line 2 to 12 of page 9269, because 1) “perturbation vorticity field (line 2)” is not discussed the this section, 2) “large scale anti-cyclone jets (line 5)” is not indicated in section 3.2, 3) the description and understanding on dynamics between the middle and lower troposphere is not correct and 4) the major factor of onset blowing dust process (the last sentence of this paragraph) is unclear.

In fact, the meridional winds are more important factor that triggers up the onset of sand dust process than zonal winds in the lower atmosphere (especially from 850hPa to surface). It is well known that Asian dust storms are caused by cold air break associated with cold fronts with the strong meridional (north) winds sweeping southwards across Northeast Asia. Therefore, please analyze meridional winds in addition to zonal

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winds for the momentum field in the lower troposphere in section 3.3.

Section 3.4, It could be more appropriate to change the subtitle from “Abnormal sea level pressure of northeast hemisphere” to “Evolution of sea level pressure anomalies”, because the evolution of sea level pressure anomalies from winter to spring is analyzed in your discussion in this section.

Please delete the second paragraph from line 19 to 23 of page 9270, most of which is repeated in the next paragraph.

Page 9271, line 4: 1) “a counter-clockwise manner” depends the observation positions. Please change it to eastwards (or westwards); 2) “8090 degree” is a print error. Please correct it.

You mention a lot of province names in north China in the discussion of section 3. It could be better for non-Chinese readers to give the geographic regions in north China (e.g. northwestern, northeastern or center China) instead of Chinese provinces.

In section 4, conclusion:

1) please emphasize two highlights of this paper are 1) to give a definition of sand dust storm (SDS) process making a new standard of SDS in Northeast Asia and 2) to analyze the large-scale circulations in the atmosphere associated with to the SDS processes in spring of 2000 to 2006, 2) please make the corresponding revisions in the summary, 3) and English grammar and style should be improved.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 9259, 2007.

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