

## Dust storms

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### Abstract

Dust storms are remarkable natural phenomena. They affect many countries in the Northern Hemisphere and, as such, have become an interesting research topic. We show that nowadays China is the number one publishing country of articles related to their study. On a world scale the number of publications on this topic is increasing exponentially.

**Keywords:** dust storms, publication and citation analysis, exponential increase, China, topical h-index.

### Introduction: the meteorological phenomenon of dust storms

A recent News Focus in the journal *Science* (Normille, 2007) discusses the recurring phenomenon of dust storms in Northeastern China, Korea and Japan. It was pointed out in this article that the economic toll in China alone is approximately 650 million US dollar (= 4.9 billion Yuan RMB), citing Wang Tao, a physical geographer based at the Cold and Arid Regions Environmental and Engineering Research Institute of the Chinese Academy of Sciences (CAS) in

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Lanzhou. The article then goes on describing a successful approach, lead by Jiang Gaoming from CAS, to grassland restoration in Bayinhushu, a village in Inner Mongolia.

According to Wikipedia (2008) a dust storm (or sandstorm in some contexts) is a meteorological phenomenon common in arid and semi-arid regions. It arises when a gust front passes or when the wind force exceeds the threshold value where loose sand and dust are removed from the dry surface. Particles are transported through the air, causing soil erosion in one place and deposition in another. In North China dust storms are one of the most noticeable environmental phenomena. They not only affect the living conditions in China but also in neighbouring countries. China's storms deposit dust in the Pacific while the Sahara and drylands around the Arabian peninsula are the main source of airborne dust that reaches the Northern Atlantic Ocean, playing an important role in sustaining ocean life (Mather et al., 2008). Moreover, Iran, Pakistan and India deposit dust into the Arabian Sea. Recently, poor management of the earth's drylands are increasing dust storms from desert margins and change the local and global climate. As mentioned above for the case of China, these storms have a considerable impact on the economy of the countries where the phenomenon occurs. Clearly dust storms constitute an international environmental problem in the Northern Hemisphere.

As dust storms occur more and more frequently and have a considerable economic impact we want to find out how much research is done on this phenomenon, if this research has increased over the latest years, and what the contribution of China is to the publication output about dust storms.

### **Data collection**

As data source we used Thomson/Reuters' Web of Science. After some preliminary searches we observed that sand storms are often discussed in relation with the planet Mars. These instances were removed leading to the search string:

("dust storm\*" OR "sand storm\*") NOT (Mars OR Martian\*)

After we performed the search we found out that the phrase "sand storm" is often written as one word, namely as sandstorm. Moreover, the word 'sand dust' was also often used in this connection. Hence results given below are based on the revised query:

("dust storm\*" OR duststorm\* OR "sand storm\*" OR sandstorm\* OR "sand dust")  
NOT (Mars OR Martian\*)

Actual data collection took place on August 6, 2007 and again on August 6, 2008. We mention our initial error because the topic h-index (Hirsch, 2005; Banks, 2006; STIMULATE-6, 2007) for the original query was 42, while for the revised

query, yielding 122 records more) it turned out to be just one more, namely 43 (over the period 1972-2007). For the period 1972-2008 the h-index had increased to 48. The first-mentioned finding illustrates the robustness of the h-index (Rousseau, 2007; VanClay, 2007): even relatively large errors in the data collection for the calculation of the h-index have no or just a small influence on the obtained value. Of course, when time goes on and the field increases also the h-index increases.

### Results: dust storms

Which countries published the most articles on dust storms and is the total number of dust storm-related articles increasing over the years? Table 1 answers the first question, while Figure 1 illustrates the results related to the second question. Clearly the field is dominated by the United States and the People's Republic of China. Among the countries or regions occurring in this list we see mostly countries that suffer from the phenomenon of dust storms, although also some other countries such as the United Kingdom occupy a high rank.

Table 1. Countries and regions publishing the most articles on the subject of dust storms

Rank	Country or region	Number of publications 1972-2007	Number of publications 1972-2008	Increase (%)
1	China	262	333	27.1
2	USA	266	298	12.0
3	Japan	106	120	13.2
4	South Korea	46	63	37.0
5	United Kingdom	50	53	6.0
6	Taiwan	41	50	22.0
7	Canada	35	45	28.6
8	Israel	42	44	4.8
9	Germany	36	43	19.4
10	Australia	40	41	2.5
11	France	32	35	9.4
12	India	25	31	24.0
13	Saudi Arabia	24	24	0.0
14	Russia	20	22	10.0
15	Belgium	14	15	7.1

UK (in Table 1) stands for England, Scotland, Wales and Northern Ireland (after checking for collaborations). During the period August 2007 – August 2008 China

has published 71 articles on dust storms, while the second most active country, namely the USA, has published only 32 articles during this same period (data from the WoS). During the year 2008 China has overtaken the United States in total output since 1972. Yet, South Korea and Canada had an even larger percentage increase than China. We found six articles resulting from a collaboration between Mainland China and Taiwan, two of which published during the most recent year.

As it is the case for most topics in the Web of Science the large majority of articles is published in English (98.3%). A few are published in Russian or Chinese.

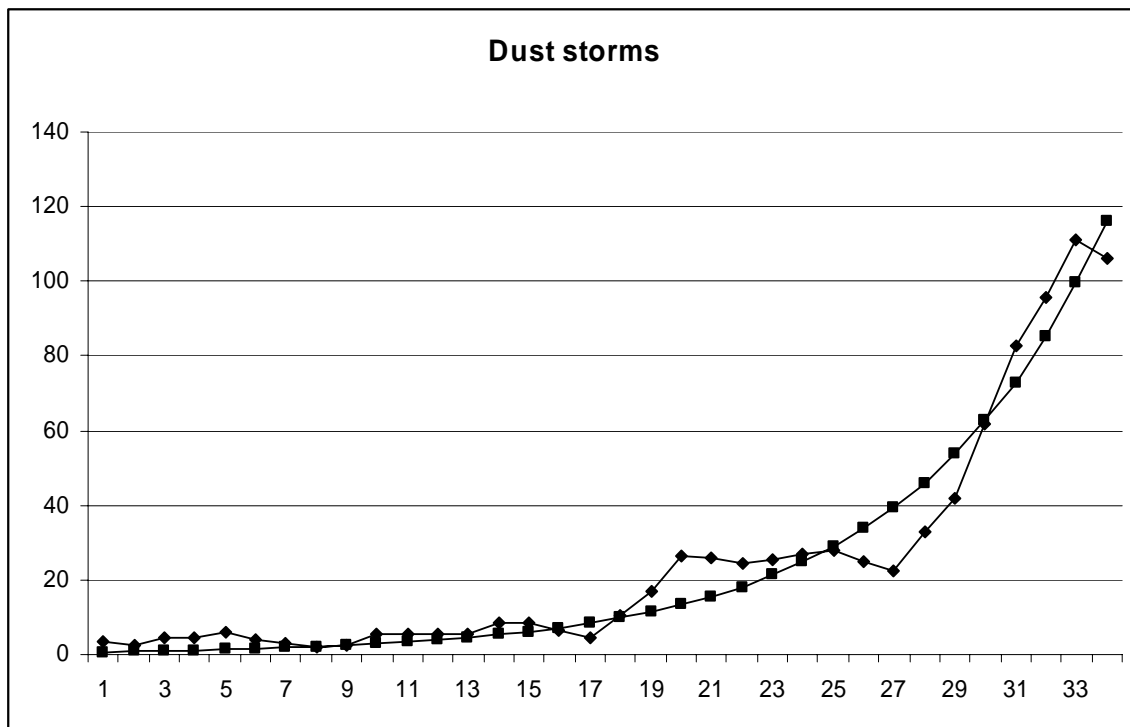


Fig.1 Publications on dust storms and best fitting exponential curve

As data are rather fluctuating we show in Fig.1 three year running averages. The point 1 corresponds to 1972-1974; point 2 to 1973-1975 and point 34 to 2005-2007. The number of publications on dust storms was clearly very low till 1988-1990 (point 17), then the numbers more or less quadrupled (period 1991-2000). From the year 2001 on the phenomenon of dust storms really caught on, showing a fast increase. The complete curve can be described by the exponential equation

$$y = 0.607 e^{0.1545n}$$

where  $y$  is the number of publications and  $n$  represent the number on the x-axis of figure 1 ( $R^2 = 0.949$ ).

The most active institutes are shown in Table 2. Results for Beijing University were added to those of Peking University. Among these 12 institutes or universities five are situated in China. Moreover Lanzhou University, situated in a region where many dust storms occur, has the largest percentage increase in publications.

Table 2. Most active institutes in the field of dust storms

Institute	1972-2007	1972-2008	Increase (%)
CHINESE ACAD SCI (China)	142	171	20.4
METEOROL RES INST (Japan)	31	33	6.5
BEIJING NORMAL UNIV (China)	29	35	20.7
LANZHOU UNIV (China)	26	35	34.6
NASA (USA)	25	28	12.0
PEKING UNIV (China)	24	27	12.5
GRIFFITH UNIV (Australia)	21	22	4.8
NOAA (USA)	20	22	10.0
NAGOYA UNIV (Japan)	19	20	5.3
TEL AVIV UNIV (Israel)	18	19	5.6
UNIV WASHINGTON (USA)	18	19	5.6
CHINA METEOROL ADM (China)	16	21	31.3

Journals publishing the most articles on this topic are presented in Table 3.

Table 3. Journals publishing the most articles related to dust storms

JOURNAL	1972-2007	1972-2008
ATMOSPHERIC ENVIRONMENT	102	121
JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES	97	110
GEOPHYSICAL RESEARCH LETTERS	36	41
CHINESE SCIENCE BULLETIN	22	24
JOURNAL OF ARID ENVIRONMENTS	19	23
ATMOSPHERIC ENVIRONMENT PART A-GENERAL TOPICS	17	17
JOURNAL OF THE METEOROLOGICAL SOCIETY OF JAPAN	17	18
GLOBAL AND PLANETARY CHANGE	14	17

We further mention that *Nature* published five articles, *PNAS* three and, surprisingly the journal *Science* just four, among which the one that inspired us to write this contribution. If the relative number of journals publishing  $y$  articles is denoted as  $f(y)$  then it turned out that the topic 'dust storms' (2007 data) yields a perfect Lotka distribution (negative power law) :

$$f(y) = \frac{0.645}{y^{2.11}}$$

Fitting has been done using LOTKA, a program freely available on the Internet (Rousseau & Rousseau, 2000). This fit is accepted at any reasonable level.

Finally, Table 4 shows the top-10 Thomson/Reuters categories in which these publications were placed (more precisely: the journals in which these articles were published). Recall that a journal may belong to more than one category.

Table 4. Subject categories in which articles related to dust storms are published

Subject category	1972-2007	1972-2008
METEOROLOGY & ATMOSPHERIC SCIENCES	362	419
ENVIRONMENTAL SCIENCES	261	311
GEOSCIENCES, MULTIDISCIPLINARY	162	183
GEOGRAPHY, PHYSICAL	61	69
MULTIDISCIPLINARY SCIENCES	56	60
ENGINEERING, ELECTRICAL & ELECTRONIC	37	39
WATER RESOURCES	29	34
OCEANOGRAPHY	28	30
ECOLOGY	27	33
GEOCHEMISTRY & GEOPHYSICS	26	34

We next perform a test to find out if China and the United states have different specializations within the topic of dust storms. We consider the top-3 categories of Table 4 and perform a test on independence using the technique of contingency tables (Egghe & Rousseau, 1990; section I.3.5.3).

Table 5. Contingency table (based on 2007 data)

	China	USA	other countries
meteorology	106	126	289
environmental sciences	83	77	192
geosciences	61	52	113

The null-hypothesis of independent classifications is not rejected ( $p = 0.337$ ). This means that we have no reason to say that China, the United States and the other countries have different preferences with respect to categories in which research on dust storms is classified.

### Note

We also performed a search on the related notion of desertification\*. It yielded 1544 records over the period 1972-2007, and 1716 records over the period 1972-2008. As a topic search its Hirsch indices were 50 (2007) and 54 (2008). We did not continue our research on desertification as it is actually a different topic.

### Conclusion

Dust storms are one of the most noticeable environmental phenomena in the Northern Hemisphere and in particular in China. They not only affect the living conditions in China but also in neighbouring countries. Clearly dust storms

constitute an international environmental problem and hence their study has become an important research topic. It has been shown that the number of articles related to dust storms is much lower than one may expect based on their – negative - economic impact. Yet, China, a country that suffers a lot from this phenomenon, has considerably increased its scientific activities in this field. During the last year it has overtaken the United States of America in the total number of publications since 1972. Yet, since 2001 China published more articles on dust storms on a yearly basis than any other country in the world. Maybe the fact that the 2008 Olympic Games took place in Beijing has accelerated an evolution that had been going on for some time.

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