Characteristics of Dust Storms in the Eastern Hexi Corridor and the Influence Mechanisms of Surface Meteorological Factors (Postprint)

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Abstract

Using hourly sandstorm data from Minqin, Liangzhou, and Yongchang in the eastern Hexi Corridor from 1961–2015, together with daily temperature, ground temperature, precipitation, maximum frozen soil depth, snow cover days, snow depth, average wind speed, average gale days from the representative station Minqin, and hourly temperature, ground temperature, and wind speed data for the recent 10 years, conventional climatic statistical methods were employed to investigate the characteristics of sandstorms in the eastern Hexi Corridor, and the Pearson correlation coefficient method was further adopted to analyze the influencing factors of sandstorms. The results indicate that in the eastern Hexi Corridor, sandstorm frequency occurs most frequently from afternoon to evening and least frequently in the early morning; sandstorm frequency begins to increase in the morning in spring, at noon in autumn and winter, and in the afternoon in summer. Sandstorms lasting 60–180 min occur most frequently in the eastern Hexi Corridor, while those lasting 1–30 min are most frequent in summer; long-duration sandstorms begin to increase in the morning, whereas short-duration sandstorms mainly occur from afternoon to evening. The monthly and seasonal variations of sandstorm frequency show the highest occurrence in April and spring, and the lowest in September and autumn; over the past 55 years, sandstorm frequency has exhibited a decreasing trend, primarily caused by factors such as reduced gale days, decreased wind speed, increased ground temperature and air temperature, increased precipitation, and improved ecological conditions of the underlying surface.

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Full Text

Preamble

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1. Data and Methods

Meteorological and sandstorm data from Minqin, Liangzhou, and Yongchang stations were used to analyze change characteristics and mechanisms of sandstorm frequency in east Hexi Corridor during 1961–2015. Meteorological elements included monthly air and ground temperature, precipitation, maximum frozen soil depth, snow cover duration and depth, wind speed, and gale days, obtained from representative Minqin Meteorological Station.

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2. Results Analysis

2.1 Diurnal Variation

Sandstorms exhibited significant hourly variations in east Hexi Corridor [Figure 3: see original paper]. The frequency was highest in the afternoon and evening (14:00–20:00), accounting for 52.4% of total events, and lowest in the early morning (02:00–05:00), representing only 5.5%. Spring sandstorms began increasing in the morning, while autumn and winter events started increasing at noon. Summer sandstorms showed a distinct afternoon peak.

The 60–180 minute duration category dominated overall sandstorm frequency. However, 1–30 minute events peaked in summer, while longer-duration storms tended to begin in the morning and shorter events occurred primarily in the afternoon and evening.

2.2 Monthly and Seasonal Distribution

Monthly distribution showed April had the highest frequency (18.2%), followed by March (15.7%) [Figure 4: see original paper]. September had the lowest occurrence at only 1.57%. Seasonally, spring accounted for 47.5% of all sandstorms, summer 24.9%, winter 7.4%, and autumn 6.0% [Figure 5: see original paper].

2.3 Interannual Variation

Over the 55-year period (1961-2015), sandstorm frequency showed a decreasing trend of 3.6 days per decade ($P<0.10$) [Figure 6: see original paper]. The 1970s marked a turning point, with higher frequency before the 1970s and lower frequency after. The period 2011-2015 had the lowest frequency, averaging only 1 day per year.

2.4 Duration Characteristics

Analysis of duration patterns revealed that 60–180 minute events were most common across all seasons [Figure 8: see original paper]. In spring, 1–30 minute events ranked second, while in summer, the order reversed with 1–30 minute events being most frequent. Autumn and winter patterns resembled spring, with 60–180 minute durations dominant.

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3. Correlation with Meteorological Factors

Surface meteorological factors showed significant correlations with sandstorm frequency [FIGURE:9, FIGURE:10, TABLE:1]. The primary influencing factors included:

- **Wind conditions:** Gale days and wind speed showed the strongest positive correlations with sandstorm frequency
- **Thermal factors:** Ground temperature, air temperature, and maximum frozen soil depth were significantly correlated
- **Moisture factors:** Precipitation and snow cover showed negative correlations

The decreasing trend in sandstorm frequency was attributed to reduced gale days and wind speed, increased ground/air temperature and precipitation, and improved underlying surface ecological conditions.

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4. Discussion

The diurnal variation pattern, with afternoon/evening peaks, reflects solar heating and atmospheric instability development. Seasonal patterns align with spring being the driest, windiest period in northwest China. The long-term decreasing trend corresponds to regional climate change and ecological restoration efforts.

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Note: Figure translations are in progress. See original paper for figures.