Postprint: Multi-scale Characteristic Analysis of Near-surface Meteorological Elements in a Sandstorm Weather Process in Minqin

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Abstract

Using near-surface layer observational data from Minqin station, the multi-scale characteristics of near-surface meteorological elements during a dust storm event on March 27, 2007, were analyzed, yielding the following conclusions: During the dust storm occurrence, near-surface elements at Minqin station exhibited distinct multi-scale characteristics, with wind speed showing two periods of approximately 2.5 h and 1 h, PM10 concentration having a dominant period of about 1.5 h, the dominant period of perturbed air temperature at 20 m height being identical to that of near-surface wind speed, and relative humidity showing no dominant period shorter than 3.5 h. Compared with the wind speed signal at the ~2.5 h scale, the wind speed signal at the ~1 h scale emerged 3 h earlier, indicating that during the dust storm development, near-surface wind speed exhibited significant inverse-scale development characteristics; compared with near-surface wind speed and PM10 concentration signals, the perturbed temperature signal at the ~1 h scale appeared earlier and gradually weakened during the dust storm occurrence phase. During the dust storm occurrence phase, near-surface wind speed and PM10 concentration signals varied in phase, while a significant phase difference existed with the temperature perturbation signal, which may imply that gravity wave development during dust storm events plays an important role in the sand-raising process.

Full Text

Multiscale Meteorological Characteristics during a Sandstorm in Minqin

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Abstract

The multiscale meteorological characteristics during a strong sandstorm in Minqin on 27 March 2007 were analyzed using data from Minqin Meteorological Station. The results were as follows: The development of meteorological elements was characterized by multiscale variations in the surface layer during the strong sandstorm. Specifically, there were two main periods of wind speed near the surface: 2.5 hours and 1 hour, respectively, which matched the disturbed temperature at 20m height. Unlike wind speed and disturbed temperature, the PM10 concentration period was 1.5 hours, and there was a relative humidity period longer than 3.5 hours. The wind speed signal on a scale of about 1 hour occurred 3 hours earlier than that on a scale of about 2.5 hours, revealing an adverse scale development of wind speed during the sandstorm. Compared with the signals of wind speed and PM10 concentration, the perturbed temperature signal on a scale of about 1 hour merged earlier and its intensity reduced when the sandstorm occurred. The wind speed signal varied synchronously with the change in PM10 concentration signal during the sandstorm; however, its temporal variation was not synchronous with the disturbed temperature signal, which likely indicates that the development of gravitational waves played a critical role in sand raising.

Keywords: sandstorm; wavelet analysis; time series; timescale; Minqin

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Figure Captions

Fig. 2 Variation of wind speed observed at different heights and PM10 concentration at Minqin Meteorological Station from 00:00Z on March 27 to 00:00Z on March 28, 2007.

Fig. 3 Variations of wind speed and temperature observed at 20m height and surface pressure at Minqin Meteorological Station from 00:00Z on March 27 to 00:00Z on March 28, 2007.

Fig. 4 The time-frequency variation of the real part of Morlet wavelet coefficient transformed from the time series of wind speed averaged every 5 minutes at different heights (1, 2, 4, 10 and 20m), perturbed temperature and relative humidity observed at 20m height and PM10 concentration at Minqin Meteorological Station from 00:00Z on March 27 to 00:00Z on March 28, 2007.

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