Analysis of Critical Sand Emission Threshold in the Tazhong Region Based on Model Parameterization Schemes (Postprint)

Authors: Zhou Chenglong, Memeteli Memetimin

Date: 2018-10-23T00:00:00+00:00

Abstract

Utilizing field observation data from the Tazhong experiment during July 4-29, 2009, and based on two dust emission model parameterization schemes proposed by MARTICORENA and SHAO, this study preliminarily investigates the threshold wind speeds for dust emission under different dust weather conditions in the Tazhong region. The conclusions are as follows: (1) For non-dust weather, the number of dust impact particles is 10,000; for blowing dust weather, 10,001 number of dust impact particles 20,000; for dust storm weather, number of dust impact particles 20,001. (2) Based on the MARTICORENA dust emission parameterization scheme, the average threshold wind speed for dust emission is 4.88 m s ^{1}; based on the SHAO dust emission parameterization scheme, the average threshold wind speed for dust emission is 6.24 m s ^{1}. The threshold wind speed for dust emission is highest during non-dust weather and lowest during dust storm weather. (3) During the observation period, the horizontal dust flux was 732.9 kg m ^{1}, of which 125.2 kg m ^{1} occurred during non-dust weather, 80.9 kg m ^{1} during blowing dust weather, and 526.8 kg m ^{1} during dust storm weather. The SHAO dust emission parameterization scheme is suitable for estimating the total horizontal dust flux as well as the horizontal dust flux during non-dust and blowing dust weather, while the MARTICORENA dust emission parameterization scheme is suitable for estimating the horizontal dust flux during dust storm weather.

Full Text

Near-Surface Critical Threshold Velocity of Dust Emission in Tazhong Area Based on Parameterization Schemes

DOI: 10.12118/j.issn.1000-6060.2018.05.04
Journal: Arid Land Geography (ChinaXiv Cooperative Journal)

Authors: Zhou Cheng-long, Ali Mamtimin, Yang Xing-hua, Yang Fan, Huo Wen, Jin Li-li, He Qing
Affiliation: Institute of Desert Meteorology, Taklimakan Experimental Observation Station of Desert Atmosphere and Environment, Urumqi 830002, Xinjiang, China

Abstract

This paper investigates the threshold velocity (u) calculation for the Tazhong area of the Taklimakan Desert, Xinjiang, China, using parameterization schemes. Firstly, we classified dust weather events by combining data on sand saltation, then acquired the threshold velocity through the MARTICORENA and SHAO schemes respectively. To test the accuracy of u , we estimated the horizontal sand flux. The results are as follows: (1) In non-dust weather, the number of saltation particles was less than or equal to 10,000; during sand blowing events, the number of saltation particles ranged between 10,001 and 20,000; and in sandstorms, the number of saltation particles exceeded 20,000. (2) The average threshold velocity was 4.88 m • s ^{1} using the MARTICORENA parameterization scheme and 6.24 m • s ^{1} using the SHAO scheme, with the threshold velocity being highest in non-dust weather and smallest during sandstorms. (3) During the study period, the total horizontal dust flux was 732.9 kg • m ^{1}, with horizontal dust fluxes of 125.2, 80.9, and 526.8 kg • m ^{1} in non-dust weather, sand blowing, and sandstorm conditions respectively. The SHAO parameterization scheme was suitable for estimating horizontal dust flux during the study period, non-dust weather, and sand blowing conditions, while the MARTICORENA scheme was suitable for estimating horizontal dust flux during sandstorms.

Keywords: threshold velocity; parameterization scheme; Tazhong

1. Introduction

The study area is located in the Tazhong region of the Taklimakan Desert. Field experiments were conducted using BSNE (Big Spring Number Eight) samplers installed at heights of 0.05, 0.1, 0.2, 0.5, 1.0, and 2.0 m. The measurement system employed Sensit-HLI sensors to record saltation particle counts at 0.05 m height, with data logging intervals of 1 second and statistical aggregation over 5-minute periods.

2. Data and Methods

The classification of dust weather was based on saltation particle counts: non-dust weather (10,000 particles), sand blowing (10,001–20,000 particles), and sandstorms (>20,000 particles). Two parameterization schemes were applied to calculate threshold velocities: the MARTICORENA scheme yielding an average threshold of 4.88 m • s ^{1}, and the SHAO scheme yielding 6.24 m • s ^{1}. The horizontal dust flux was estimated using the equation $E = c\rho u^3$, where E represents the dust flux, c is a coefficient (0.8), ρ is air density, and u is wind velocity.

3. Results and Discussion

During the observation period from May 2009 to May 2010, the total horizontal dust flux reached 732.9 kg • m ^{1}. The flux distribution varied significantly by weather type: 125.2 kg • m ^{1} during non-dust weather, 80.9 kg • m ^{1} during sand blowing, and 526.8 kg • m ^{1} during sandstorms. The SHAO parameterization scheme demonstrated better performance for estimating flux in non-dust and sand blowing conditions, while the MARTICORENA scheme proved more suitable for sandstorm events. This difference in scheme performance may be attributed to variations in surface conditions and particle size distributions under different weather intensities.

References

[1] HOFFMANN C, FUNK R, WIELAND R, et al. Effects of grazing and topography on dust flux and deposition in the Xilingele grassland, Inner Mongolia[J]. Journal of Arid Environments, 2008, 72(5): 792-807.

[2] SHAO Y. Physics and modeling of wind erosion[M]. Netherlands: Kluwer Academic Publishers, 2000.

[3] SHAO Y P, WYRWOLL K, CHAPPELL A, et al. Dust cycle: An emerging core theme in Earth system science[J]. Aeolian Research, 2011, 2(4): 181-204.

[4] FRYE A D, BILBRO J, SALEH A, et al. RWEQ: Improved wind erosion technology[J]. Soil Water Conserv, 2000, 55: 183-189.

[7] MARTICORENA B, BERGAMETTI G. Modeling the atmospheric dust cycle: 1. Design of a soil-derived dust emission scheme[J]. Journal of Geophysical Research, 1995, 100(D8): 16415-16430.

[14] WANG Pengxiang, SUN Landong, YUE Ping, et al. Features of dust aerosol transportation during sandstorms over Yanchi Area of Ningxia Autonomous Region[J]. Journal of Desert Research, 2007, 27(6): 1077-1079.

[15] LEI Hang, LIN Chaohui, SUN Jianhua. An improved dust storm prediction system and its simulation experiments[J]. Climatic and Environmental Research, 2005, 10(3): 669-683.

[17] LI Xiaolan, ZHANG Hongsheng. Study on the threshold friction velocity of dust emission in Horqin Sand Land area in the Inner Mongolia[J]. Plateau Meteorology, 2012, 31(1): 38-46.

[19] YUAN Tiangang, CHEN Siyu, KANG Litai, et al. Temporal and spatial distribution characteristics and change trends of dust intensity in dust source regions of northern China during 1961−2010[J]. Journal of Arid Meteorology, 2016, 34(6): 927-935.

[22] ZHOU Chenglong, YANG Xinghua, ZHONG Xinjie, et al. Dust weather in hinterland of the Taklimakan Desert[J]. Arid Zone Research, 2017, 34(2): 324-329.

[23] SHEN Yanbo, SHEN Zhibao, DU Mingyuan, et al. Studies on dust emission in Gobi and oasis of northwest China[J]. China Environmental Science, 2004, 24(4): 390-394.

[26] YANG X H, HE Q, MAMTIMIN A, et al. Near-surface sand-dust critical threshold velocity in Tazhong area based on parameterization schemes[J]. Theoretical and Applied Climatology, 2015, DOI: 10.1007/s00704-015-1573-0.

[32] NEUMAN C M. Effects of temperature and humidity upon the entrainment of sedimentary particles by wind[J]. Boundary Layer Meteorology, 2003, 31: 303-317.

[33] LI X L. Observation and parameterization on dust emission over Horqin Sandy Land area[D]. Beijing: Peking University, 2014.

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