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Numerical Simulation of Northeast Asian Dust Storms Using an Integrated Wind Erosion Modelling System

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Introduction

The emission of dust from the deserts and the adjacent areas in Northeast Asia contributes greatly to the global mineral aerosol balance. To predict continental scale dust storm activities, it is necessary to develop an integrated wind erosion modeling system coupling various dynamic models and a geographic information database. Westphal et al. [1988], Joussaume [1990] and Gillette and Hanson [1989] provided early examples of such an approach. Shao and Leslie [1997] and Lu and Shao [2001] developed a fully integrated wind erosion modeling system that simulates all stages of wind erosion, from particle entrainment and transport to deposition. In this study, this integrated modeling system is further developed by incorporating the new wind erosion scheme of Shao [2001].

Northeast Asian dust storms were active between March and May 2002 and a severe event occurred on 19 and 20 March 2002. We carried out intensive numerical experiments using the integrated wind erosion modeling system and were able to successfully predict all major dust storm events during the period between March and May. The simulation area is (30E, 5N) to (180E, 65N) with a spatial resolution of 50km. The area of data analysis is (72E, 5N) to (148E, 53N). The atmospheric data required for model initialization and boundary conditions are derived from the T213-GCM of the China Meteorological Administration.

Results

The 20 March 2002 northeast Asian dust storm is associated with the development of an intense cyclone located in the vicinity of (115E, 47N), accompanied by very strong NW and WNW winds behind the cold front, reaching 16ms^{-1}. As a consequence, wide spread dust storms occurred in Northeast China. The predicted dust concentration is shown in Figure 1 for 08hr 20 March 2002. The prediction shows wide spread dust storms occurring in South Mongolia and Northwest China. During the next hours, the system moved further eastward, affecting a much larger area. These predictions are in excellent agreement with the surface observations, demonstrating the capacity of the integrated modeling system. It can also be shown that the spatial and temporal evolutions of entire dust storm episode are well predicted. The results presented in this study are genuine predictions, because only the atmospheric model is forced using pre-specified boundary conditions. The system has the capacity of predicting many other physical variables for the quantification of dust cycle, including dust emission, transport and deposition, apart from dust concentration and load.

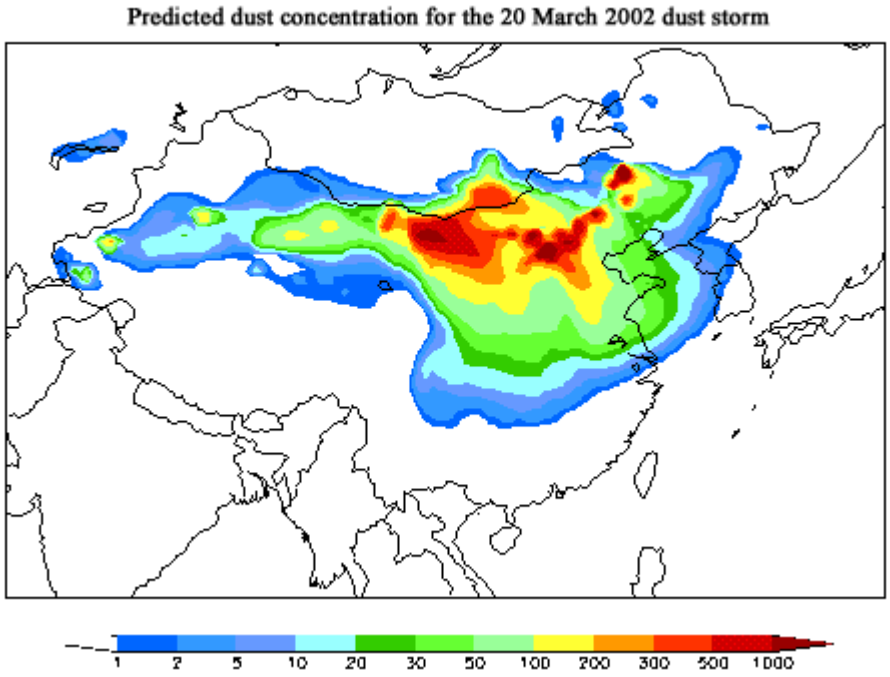

Figure 1 Simulated near surface dust concentration in ug/m3 for the 20 March 2002 dust storm event.

References

Gillette, D. A. and K. J. Hanson, 1989: Spatial and temporal variability of dust production caused by wind erosion in the United States, J. Geophys. Res., 94D, 2197-2206.

Joussaume, S., 1990: Three-dimensional simulation of the atmospheric cycle of desert dust particles using a general circulation model, J. Geophys. Res., 95, 1909-1941.

Lu, H. and Y. Shao, 2001: Toward quantitative prediction of dust storms: an integrated wind erosion modelling system and its applications. Env. Modelling and Software, 16, 233—249.

Shao, Y. and L. M. Leslie, 1997: Wind erosion prediction over the Australian continent. J. Geophys. Res., 102, 30091—30105.

Shao, Y., 2001: A model for mineral dust emission. J. Geophys. Res. 106, 20239—20254.

Westphal, D. L., Toon, O. B. and Carson, T. N., 1988: A case study of mobilisation and transport of {Saharan} dust, J. Atmos. Sci., 45, 2145-2175.