# Research on the development of the sand-dust weather numerical prediction model based on GRAPES in northwest China and its application

Yaohui Li, et al
Civil Aviation Flight University of China
Institute of Arid Meteorology, China Meteorological Administration

## Introduction

Because dust cloud can sharply reduce visibility in the atmosphere, and the concentration of coarse sand and dust particles in the air increased significantly, which seriously damaged the aircraft engine and other important components. Sand-dust weather is always the high-risk factor to flight safety. In this study, a sandstorm numerical model forecasting system (SDM) coupled with GRAPES---GRAPES_SDM was established in northwest China, which can provide important technical support for civil aviation flight safety and even the regions affected by sandstorms in the world.

## Sand-dust Forecast Equation

GRAPES_SDM includes such detail physical processes as dust emission, transport, dry deposition and clear sky process, which can forecast and simulate the initial and sand/dust concentration of sand-dust weather. The sand particle size spectrum is divided into 12 grades, and given the particle size $d_i$ of each grade, the sand dust concentration $C_i$ with the particle size of $d_i$ is the prediction quantity, and the forecast equation is as follows:

$$\frac{\partial C_i}{\partial t} = \frac{\partial C_i}{\partial t}\Big|_{trasport} + \frac{\partial C_i}{\partial t}\Big|_{source} + \frac{\partial C_i}{\partial t}\Big|_{clear air} + \frac{\partial C_i}{\partial t}\Big|_{dry} + \frac{\partial C_i}{\partial t}\Big|_{below-clouds}$$

$C_i$, is the i grade of dry sand mass ratio content(kg/kg), and its local variation is composed of dynamic transfer, source, clear sky process, dry deposition and under-cloud removal

## Results & Discussion

Four experiments were designed to evaluate the application effect and ability of GRAPES_SDM, the results are as fallows:

Table1 Experiment schemes

| Experiment name | Sounding data | $PM_{10}$ data | AMSU emissivity data |
|---|---|---|---|
| CTRL | no | no | no |
| noPM | yes | no | no |
| PM | yes | yes | no |
| NOAA | yes | no | yes |

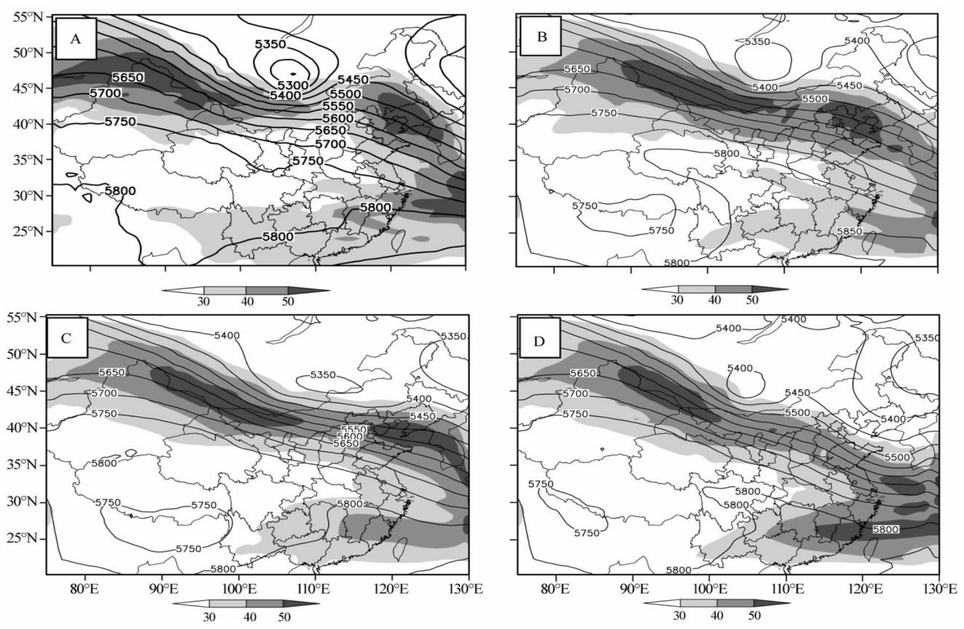


Fig.1 Windspeed (>30 $m \cdot s^{-1}$) fileds at 200 hPa (shaded, unit: $m \cdot s^{-1}$) and atmospheric circulation pattern fileds Integration. A: observation; B:CTRL experiment; C: PM experiment (noPM experiment is as the same); D: NOAA experiment

As shown in Fig.1 and Fig.2, after assimilating, the simulation results of 500 hPa circulation and 200 hPa upper-level jet are improved. Meanwhile, the distribution and intensity of dust concentration have been greatly revised.

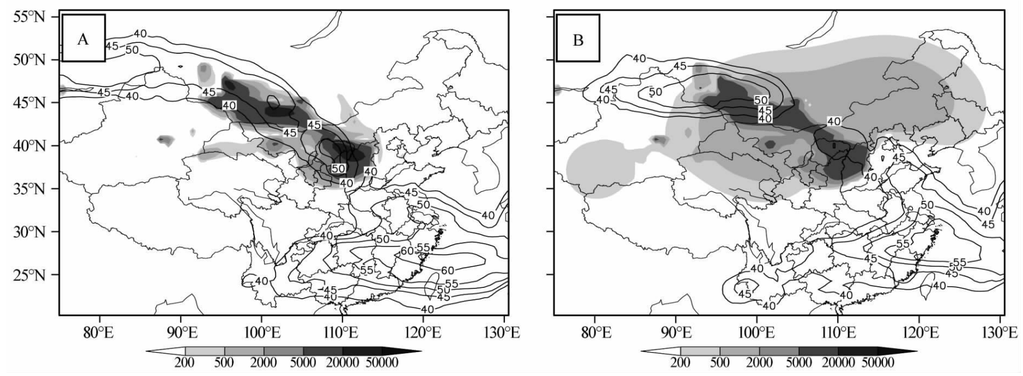


Fig.2 Background filed (A) and analysis filed (B) of assimilating $PM_{10}$ date at12: 00 on 28 April, 2011

GRAPES_SDM can obviously improve the forecast accuracy of sand-dust weather. It can also accurately capture the development process of sand-dust emission, transport, diffusion and dissipation in sand-dust weather.

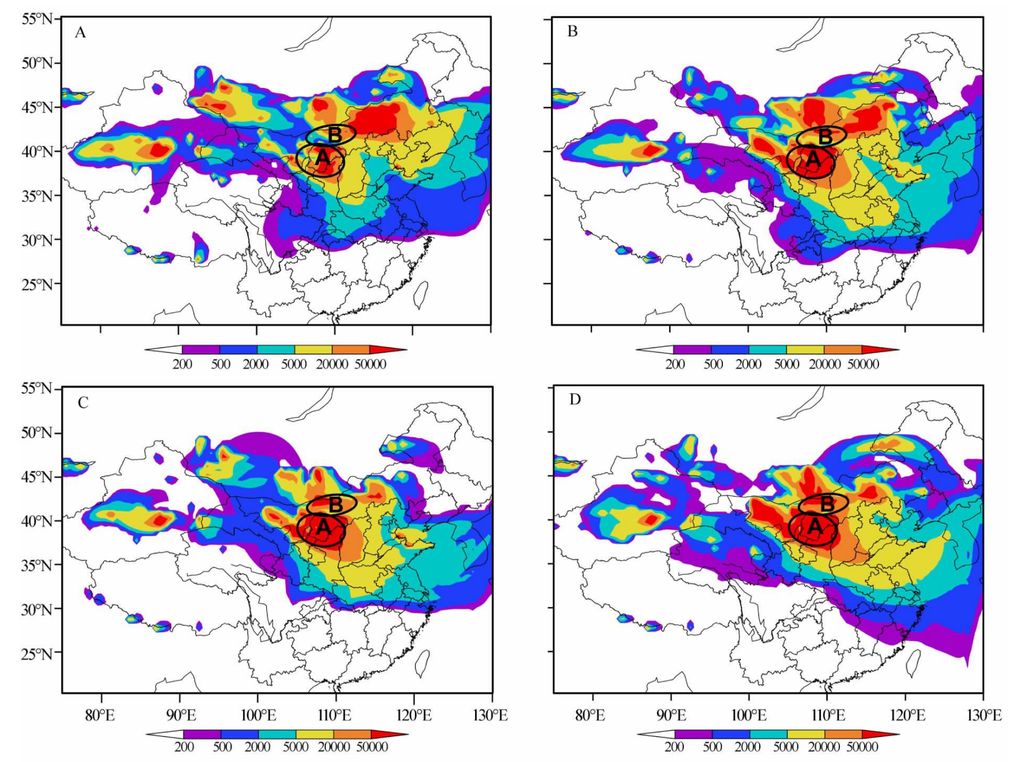


Fig.3 Simulate dust concentration form 08: 00 on 28 April to 21: 00on30 April, 2011. A: CTRL experiment; B: noPM experiment; C: PM experiment; D: NOAA experiment

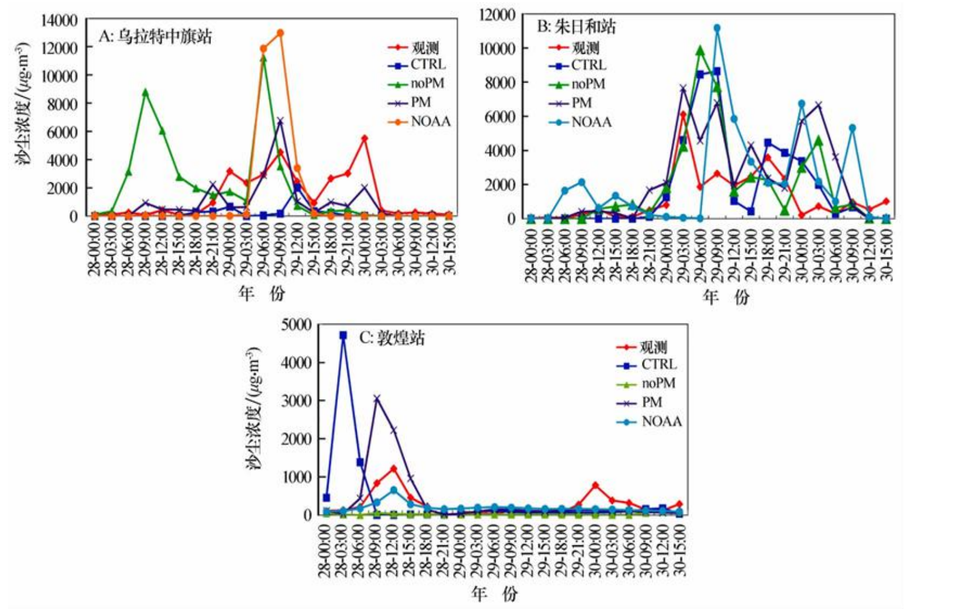


Fig.4 Simulate dust concentration form 00: 00 on 28April to15: 00 on 30 April 2011 in Wulane Middle Banner, Zhurihe and Dunhuang

## Conclusion

GRAPES_SDM can obviously improve the forecast accuracy of sandstorm area, movement and dust concentration in the air and accurately capture the development process of sand-rise, transport, diffusion and dispersion in sandstorm weather, which can provide important technical support for civil aviation flight safety in northwest China and even the regions affected by sandstorms in the world.

## Acknowledgement / Hongli zhang, Institute of Plateau Meteorology, China Meteorological Administration, Chengdu