

# Evaluation of Operational SDS Forecasting System for East Asia: Model Inter-comparison

National Meteorological Center, China  
Chinese Academy of Meteorological Sciences

Sep 23th, 2024, New Delhi, India

# Contents



**Background**



**Verification**



**Requirement**



# Background



REGIONAL SPECIALIZED METEOROLOGICAL CENTRE FOR ATMOSPHERIC SAND AND DUST STORM FORECASTING BEIJING  
(RSMC-ASDF BEIJING)  
SAND AND DUST STORM WARNING ADVISORY AND ASSESSMENT SYSTEM ASIAN REGIONAL CENTER  
(SDS-WAS ASIAN-RC)

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Forecast

Observation

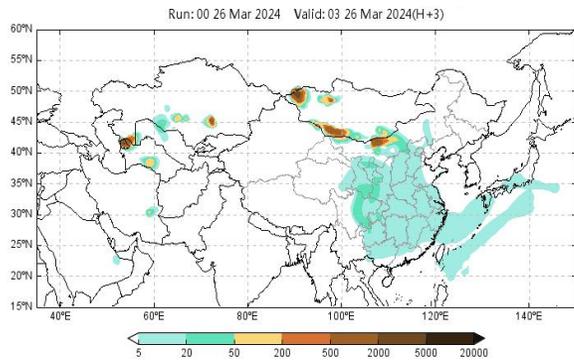
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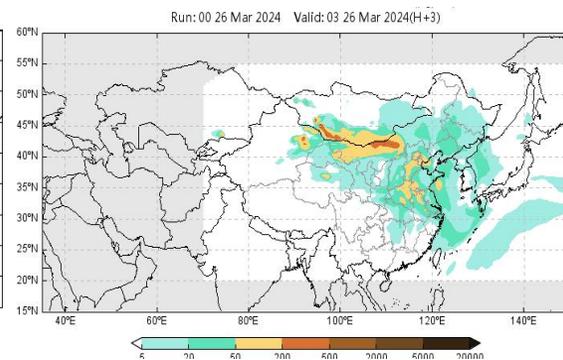
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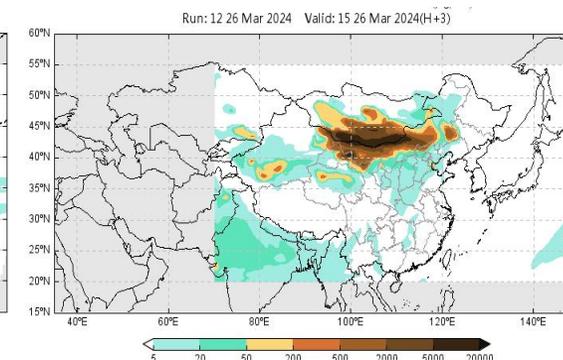
**CMA**  
(FST: 0~168h / 3-hour step)



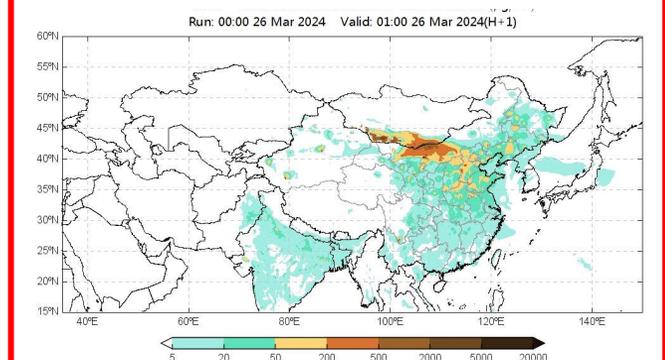
**KMA**  
(FST: 0~120h / 3-hour step)



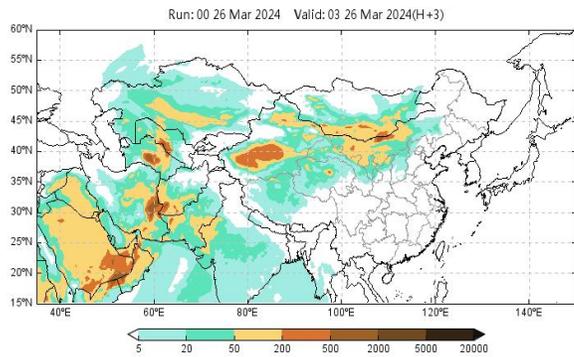
**JMA**  
(FST: 0~72h / 3-hour step)



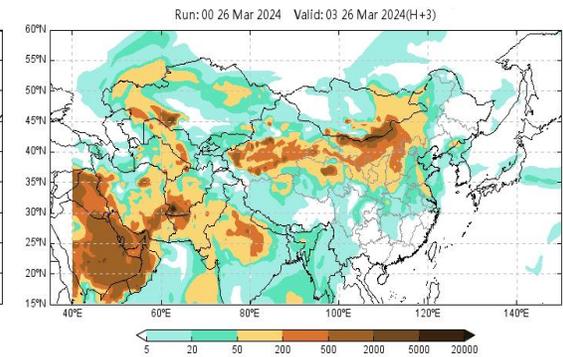
**CMA-meso**  
(Forecast Time: 0~120h / 1-hour step)



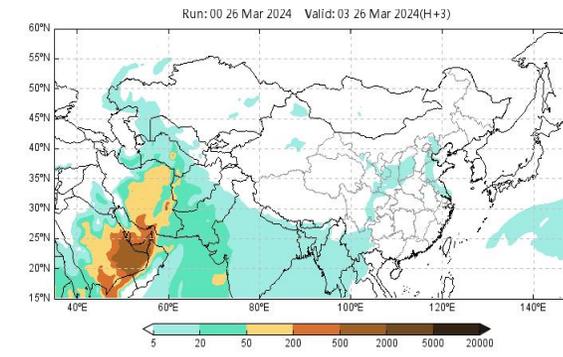
**FMI**  
(FST: 0~168h / 3-hour step)



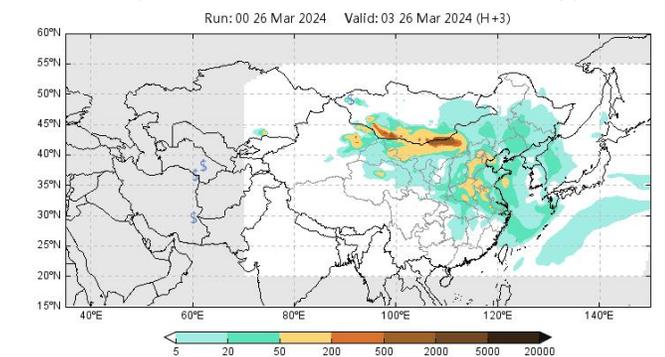
**EC**  
(FST: 0~72h / 3-hour step)



**NCEP**  
(FST: 0~120h / 3-hour step)



**Ensemble**  
(Forecast Time: 0~72h / 3-hour step)



There are '6+1' numerical SDS forecasting models have been operational running in the RSMC-ADSF Beijing. In this year, **we have developed a new numerical forecasting model (CMA-meso) running in spring.**

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# Comparisons with surface PM concentration

## Evaluation Indicators

### 1. Normalized Mean Bias

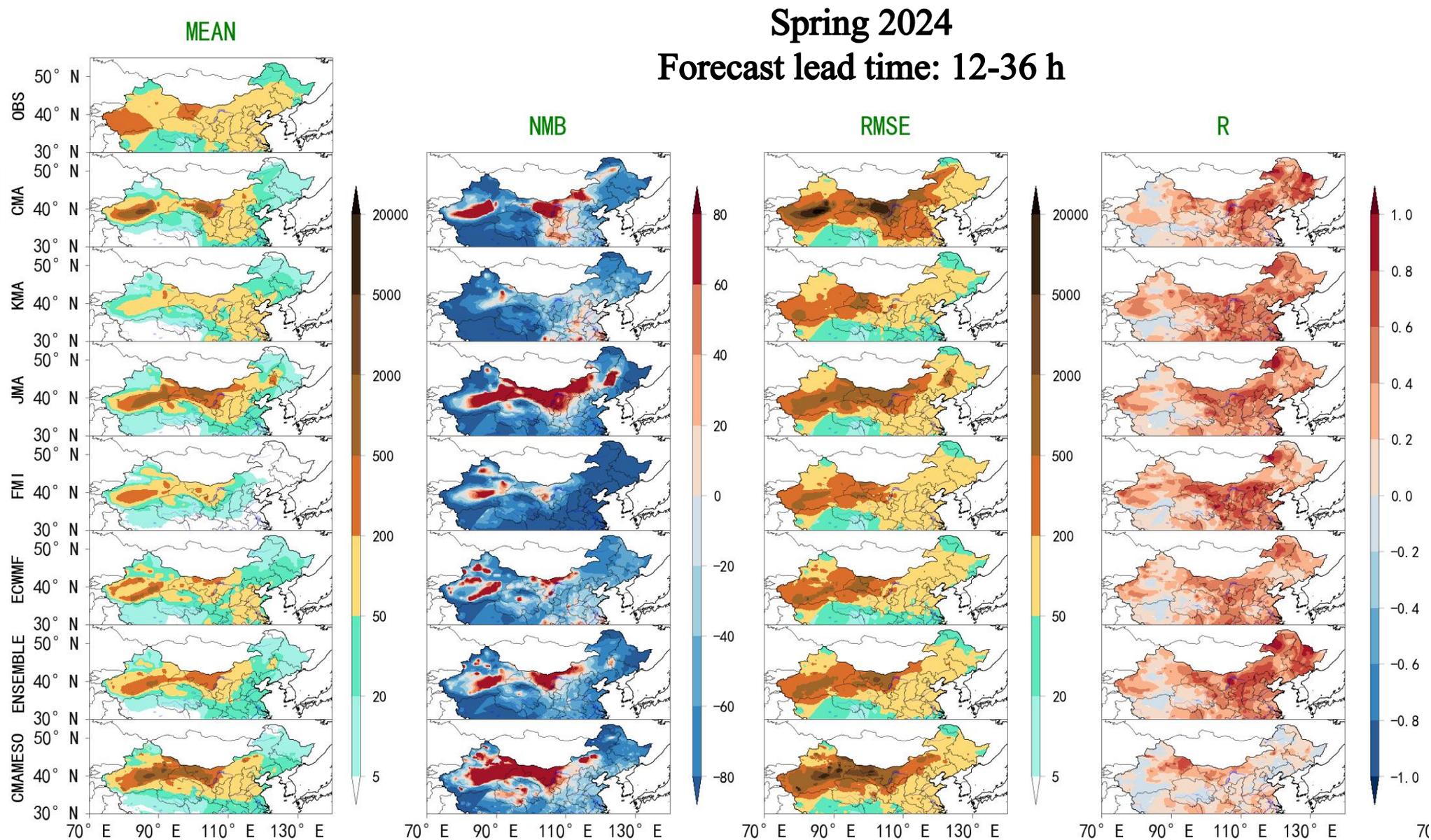
$$NMB = \frac{\sum_{i=1}^n (F_i - Obs_i)}{\sum_{i=1}^n Obs_i} \times 100\%$$

### 2. Root Mean Square Error

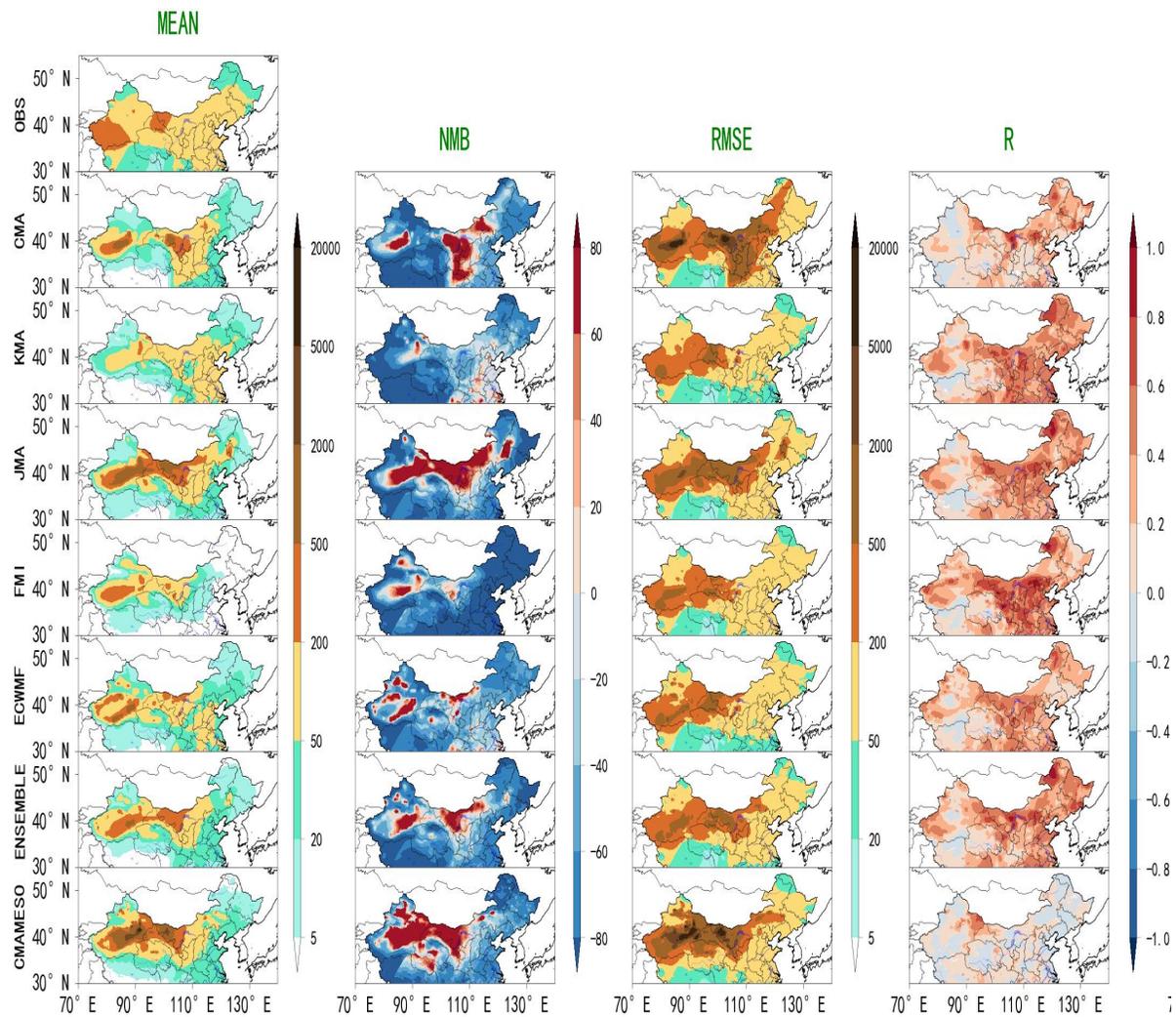
$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (F_i - Obs_i)^2}$$

### 3. Correlation coefficient

$$R = \frac{\sum_{i=1}^n (F_i - \bar{F})(Obs_i - \bar{Obs})}{\sqrt{\sum_{i=1}^n (F_i - \bar{F})^2 (Obs_i - \bar{Obs})^2}}$$

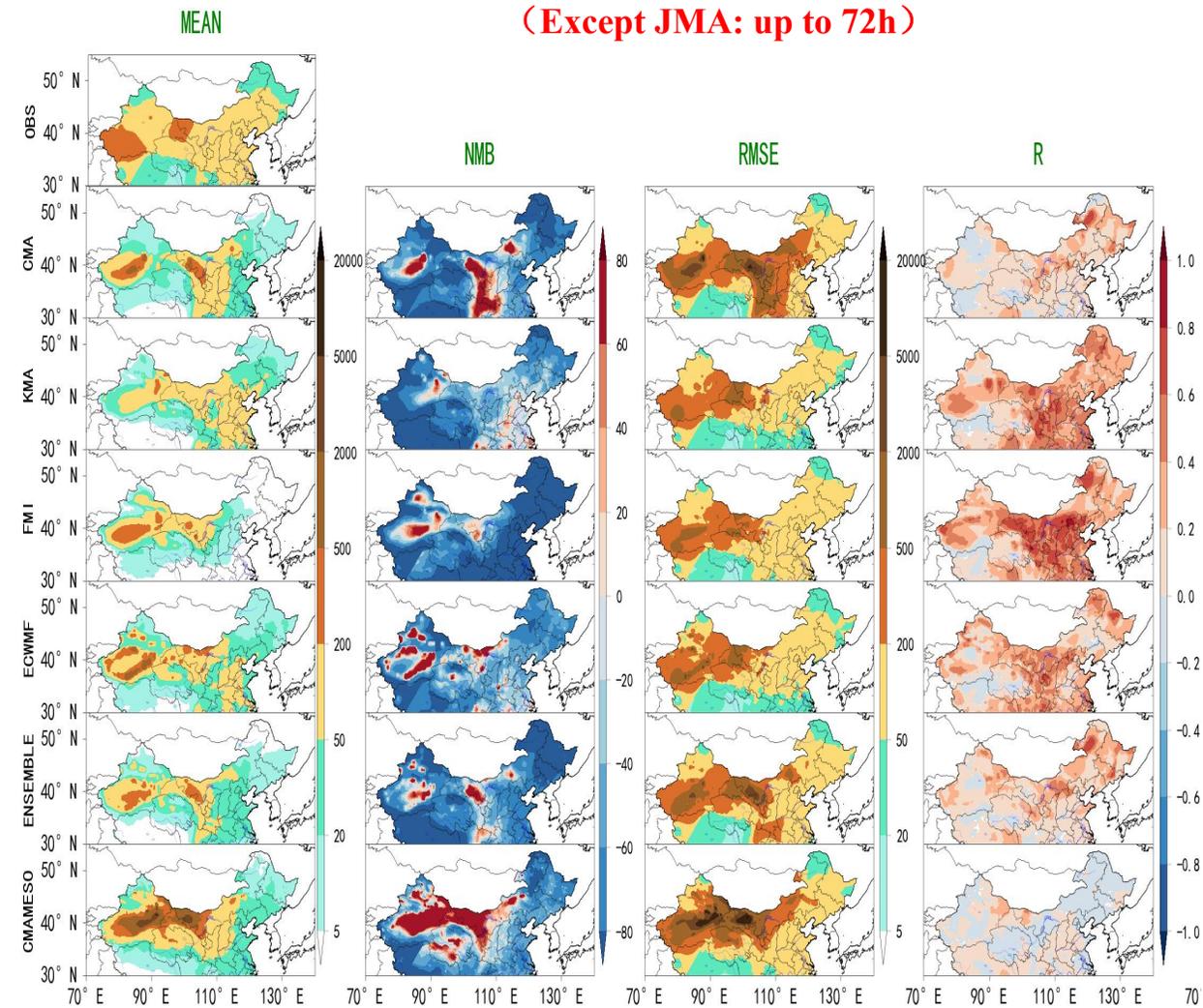


## Forecast lead time: 36-60 h



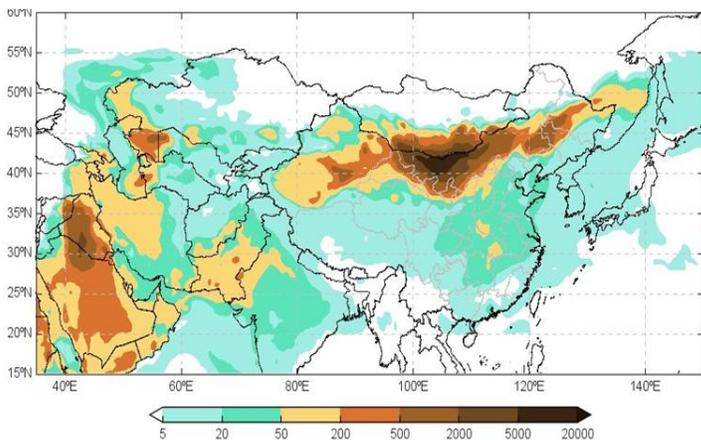
## Forecast lead time: 60-84 h

(Except JMA: up to 72h)

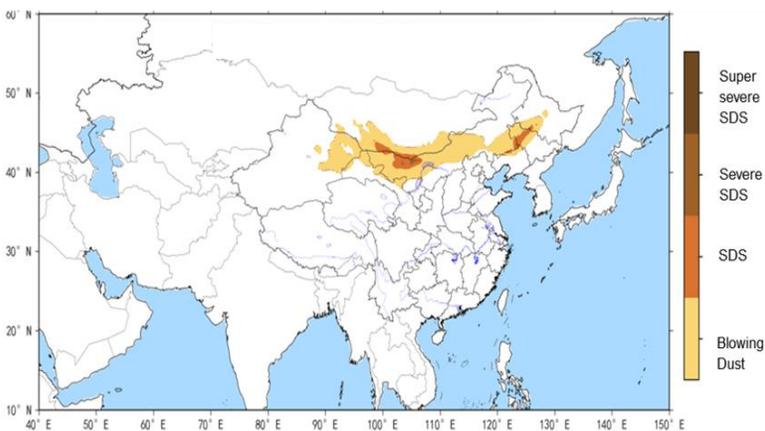


# SDS graded forecast based on numerical model

Dust surface concentrations

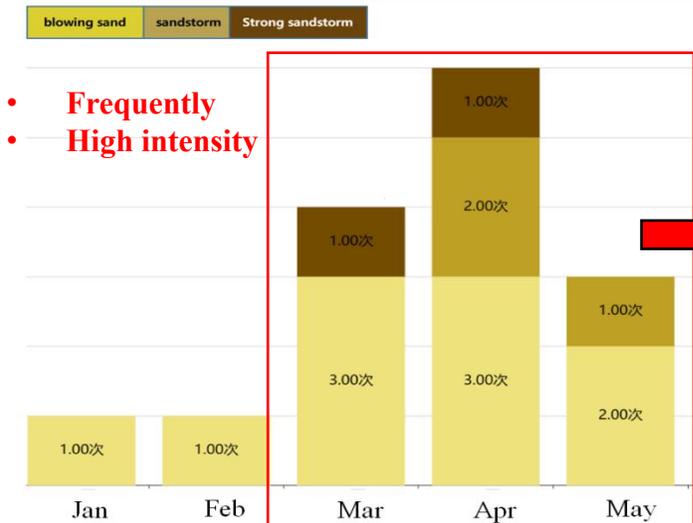


SDS graded forecast



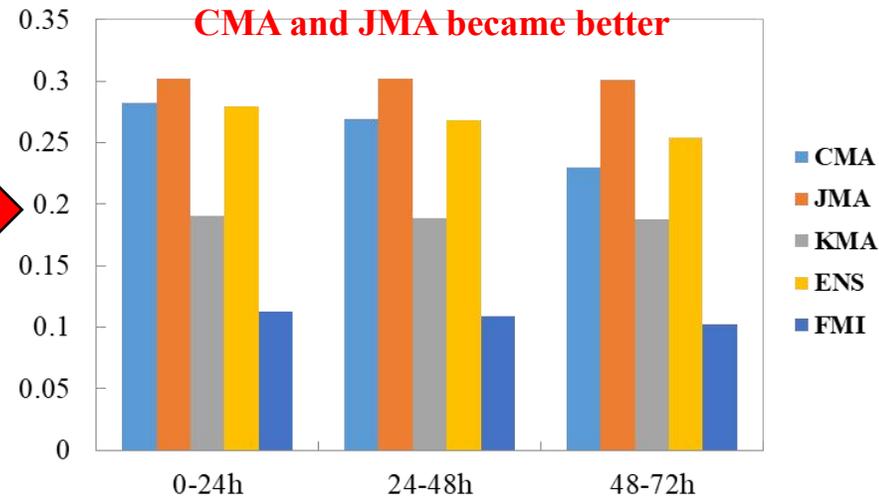
The forecasting period of validity is consistent with numerical forecast model respectively

Monthly frequency of SDS events of China in 2023

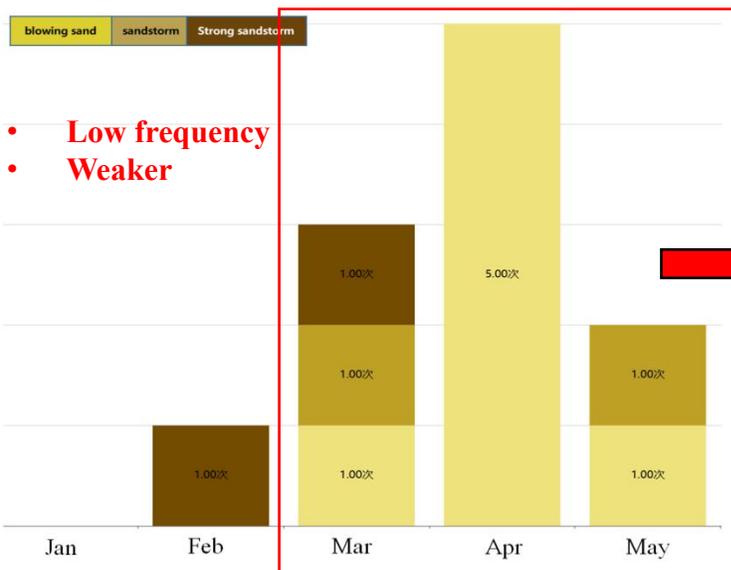


- Frequently
- High intensity

Threat Scores in spring 2023

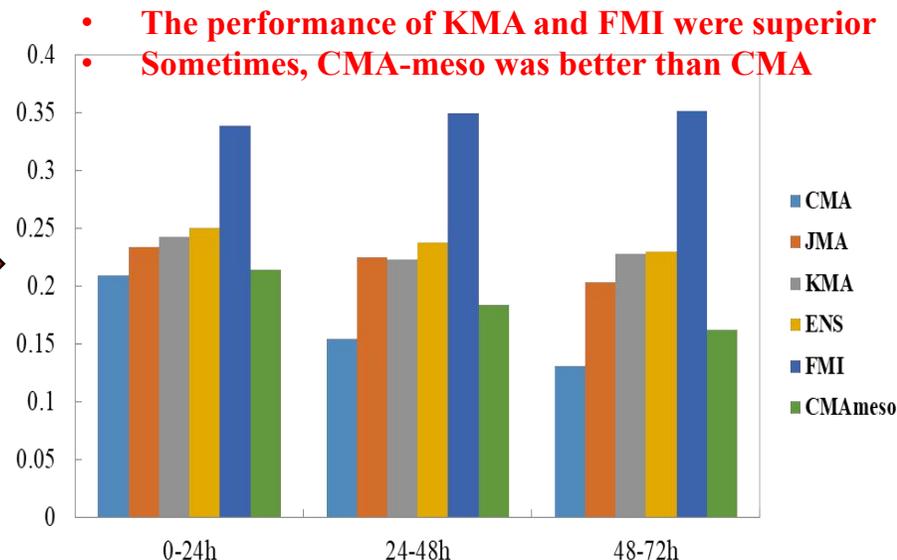


Monthly frequency of SDS events of China in 2024



- Low frequency
- Weaker

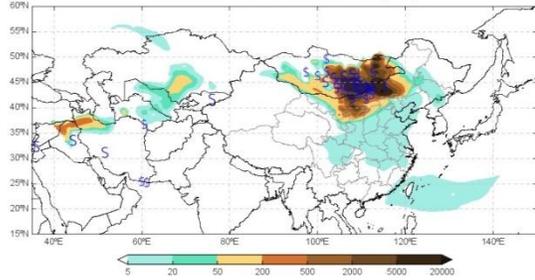
Threat Scores in spring 2024



# Case: SDS process of 27–29 Mar. 2024

**CMA**

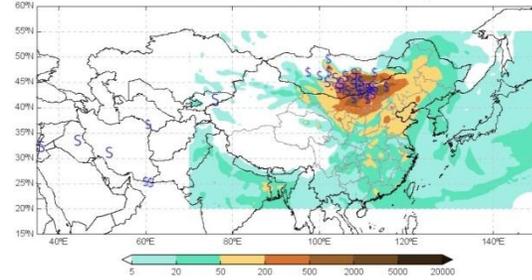
WMO SDS-WAS Asian Center  
CMA - CUACE Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:26 Mar 2024 Valid: 06:27 Mar 2024(H+30)



**Dust-lifting phase**  
06:00 on March 27,  
2024 (UTC)

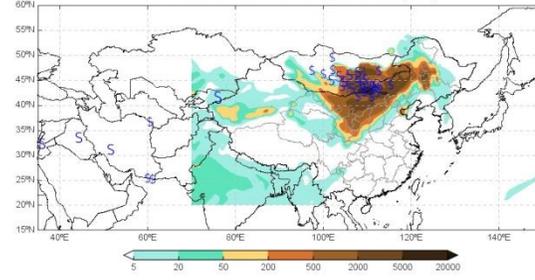
**KMA**

WMO SDS-WAS Asian Center  
ADAM3 KMA Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 26 Mar 2024 Valid: 06:00 27 Mar 2024(H+30)



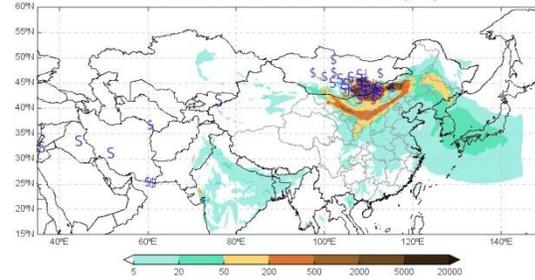
**JMA**

WMO SDS-WAS Asian Center  
MASINGAR JMA Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 12:00 26 Mar 2024 Valid: 06:00 27 Mar 2024(H-18)

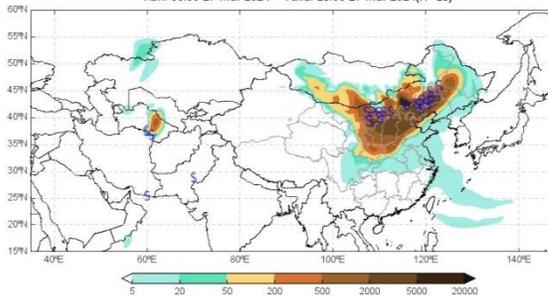


**CMA-meso**

WMO SDS-WAS Asian Center  
CMA Meso CUACE Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 26 Mar 2024 Valid: 06:00 27 Mar 2024(H+30)

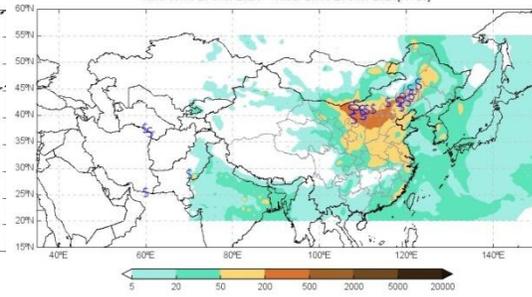


WMO SDS-WAS Asian Center  
CMA CUACE Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 27 Mar 2024 Valid: 18:00 27 Mar 2024(H+18)

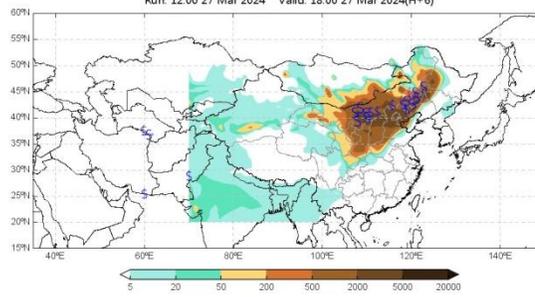


**Transport and  
deposition phase**  
18:00 on March 27,  
2024 (UTC)

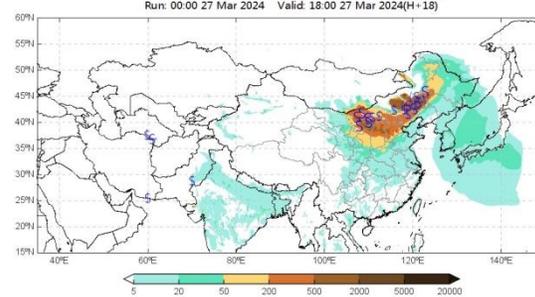
WMO SDS-WAS Asian Center  
ADAM3 KMA Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 27 Mar 2024 Valid: 18:00 27 Mar 2024(H+18)



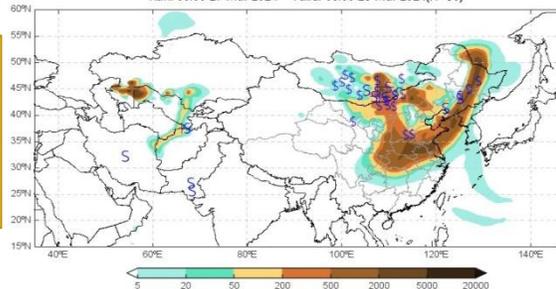
WMO SDS-WAS Asian Center  
MASINGAR JMA Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 12:00 27 Mar 2024 Valid: 18:00 27 Mar 2024(H+6)



WMO SDS-WAS Asian Center  
CMA Meso CUACE Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 27 Mar 2024 Valid: 18:00 27 Mar 2024(H+18)

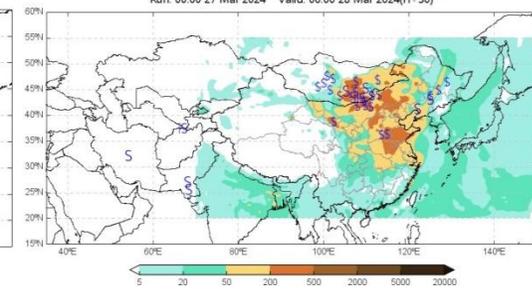


WMO SDS-WAS Asian Center  
CMA CUACE Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 27 Mar 2024 Valid: 06:00 28 Mar 2024(H+30)

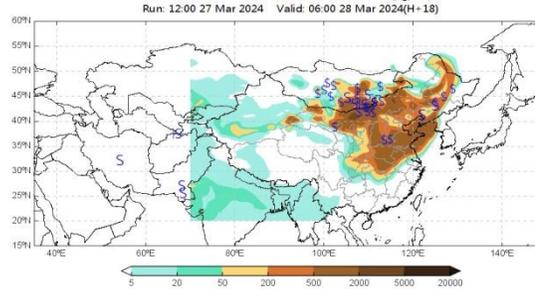


**Secondary sand-  
lifting phase**  
06:00 on March 28,  
2024 (UTC)

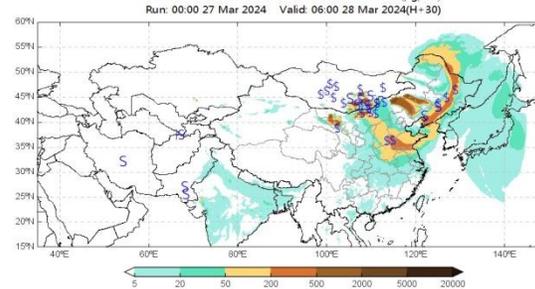
WMO SDS-WAS Asian Center  
ADAM3 KMA Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 27 Mar 2024 Valid: 06:00 28 Mar 2024(H+30)



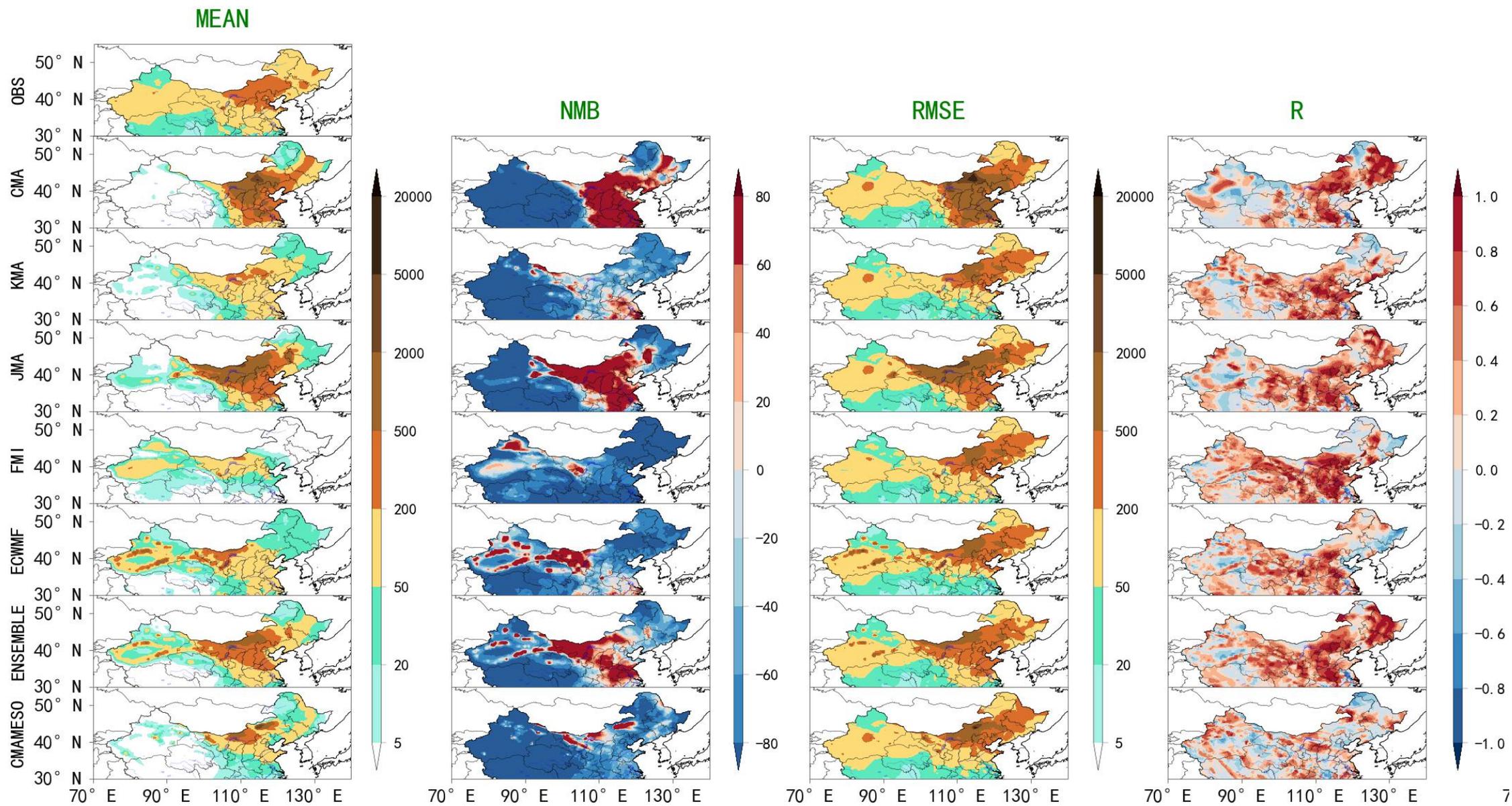
WMO SDS-WAS Asian Center  
MASINGAR JMA Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 12:00 27 Mar 2024 Valid: 06:00 28 Mar 2024(H+18)

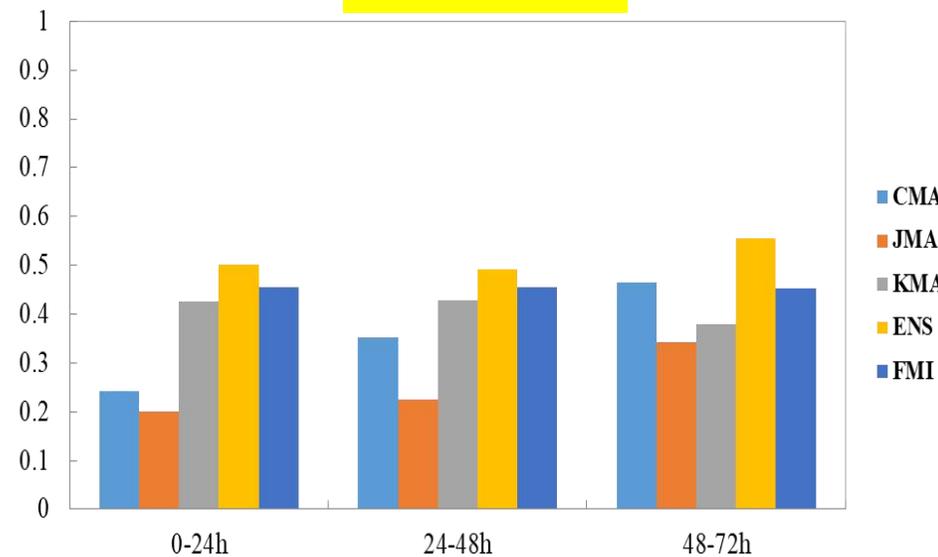
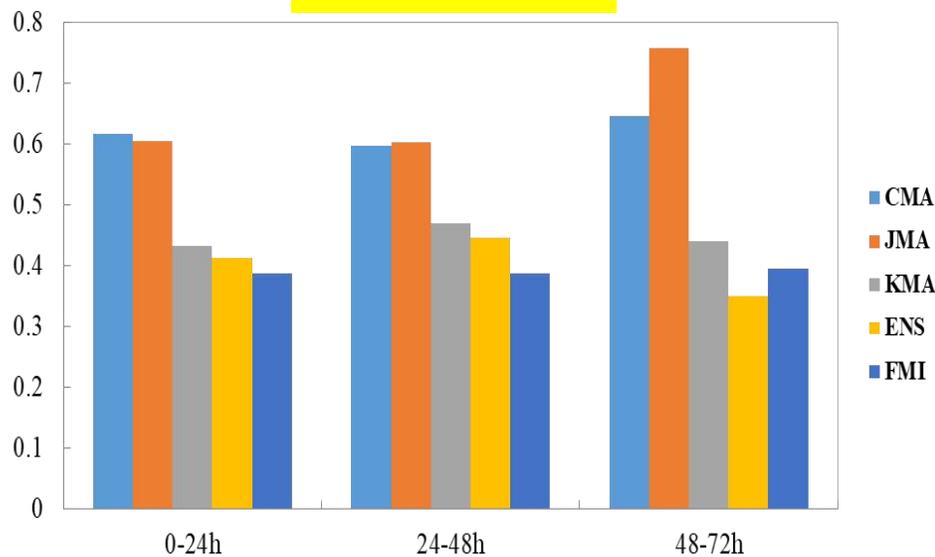
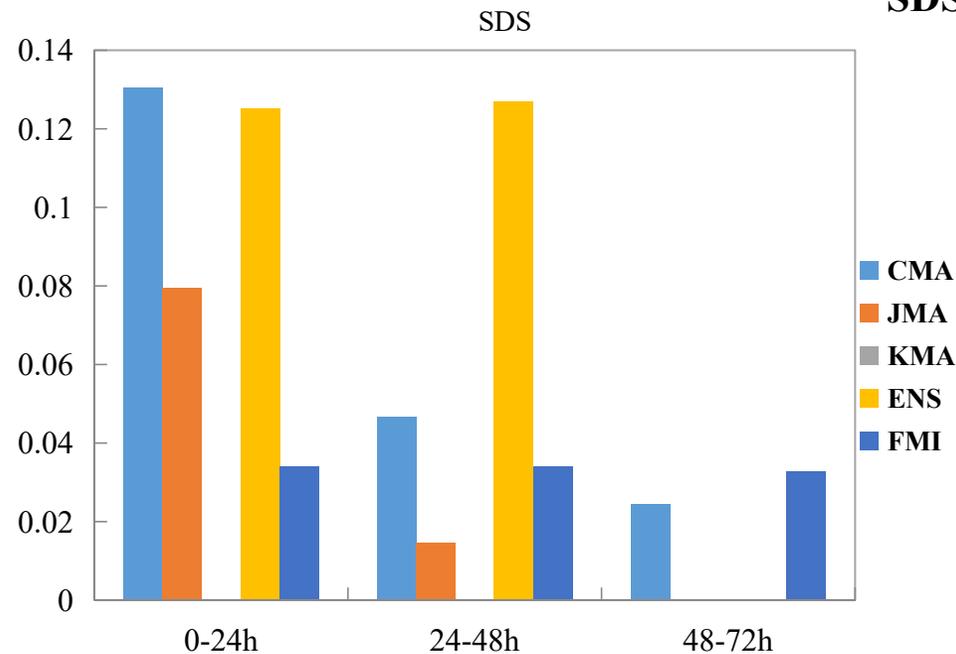
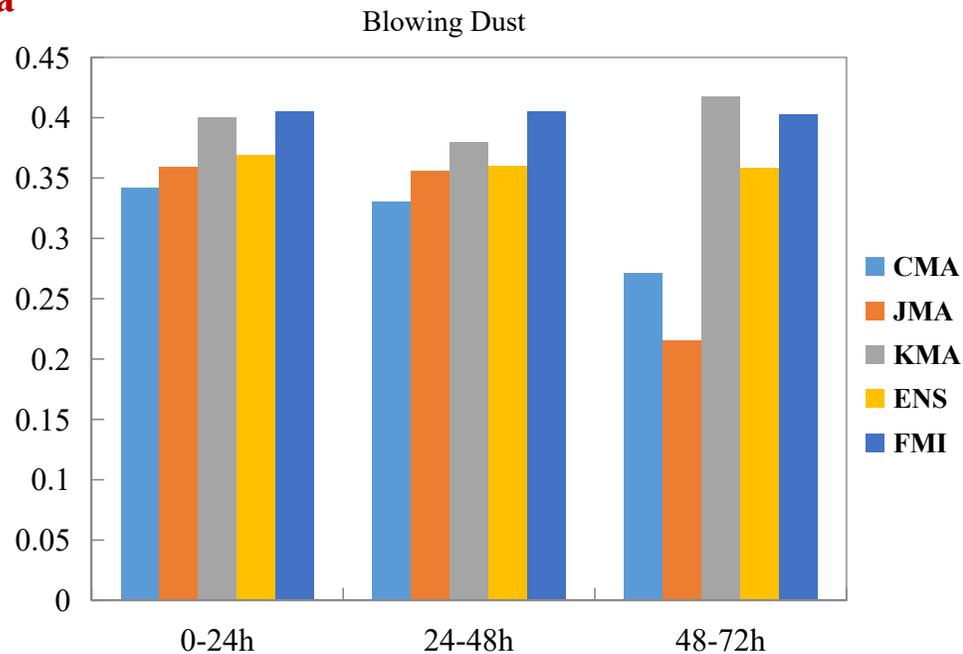


WMO SDS-WAS Asian Center  
CMA Meso CUACE Dust Surface Concentration ( $\mu\text{g}/\text{m}^3$ )  
Run: 00:00 27 Mar 2024 Valid: 06:00 28 Mar 2024(H+30)



# Case 1: SDS process of 27–29 Mar. 2024



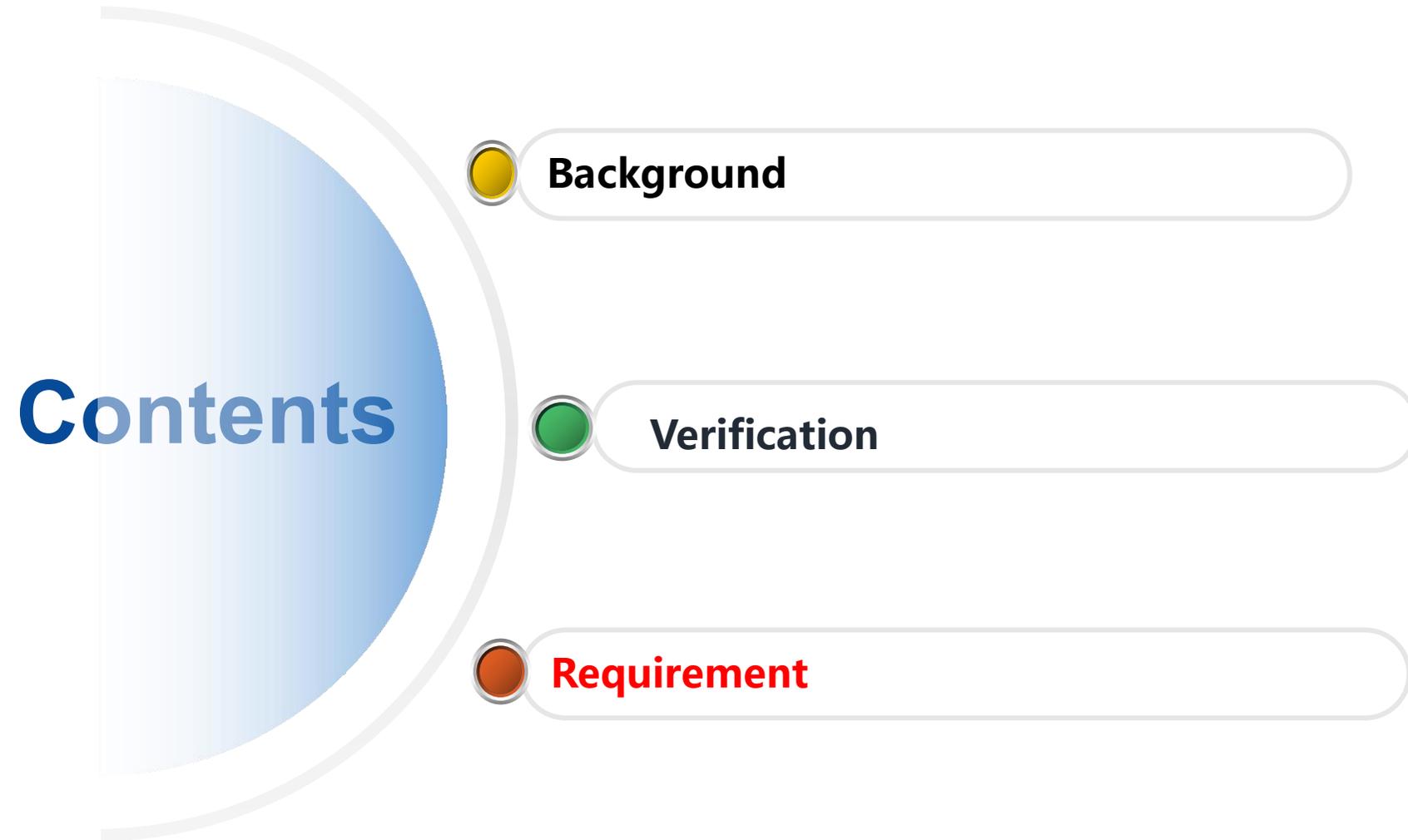


# Conclusion

Comparing with the surface concentrations and synoptic SDS records, **all of operational SDS forecasting models can successfully captured the production and evolution of SDS processes in East Asia except NCEP.**

- ❑ Focused on CMA and JMA separately, its robust forecast ability had been demonstrated through predicting sever SDS processes in spring. For KMA, the movement paths of forecasting were consisted with reality.
- ❑ In sometimes, CMA was faster for the prediction of dust deposition in the transmission stage. JMA simulated dust emission flux in northwestern China was higher compared with observations, but KMA was lower in China and Mongolia.

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**Background**

**Verification**

**Requirement**

# Data sharing requirement

- ❑ **Sincerely hope that JMA can extend the forecasting time to 5 days of sharing data in the future.**
- ❑ **Sincerely invite Mongolia to join the particulate matter observation sharing network.**