

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

National Meteorological Center, China
Chinese Academy of Meteorological Sciences

Sep 25th, 2025, China

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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

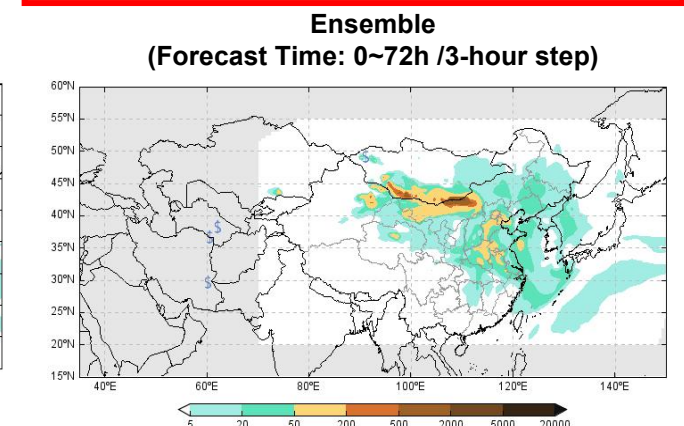
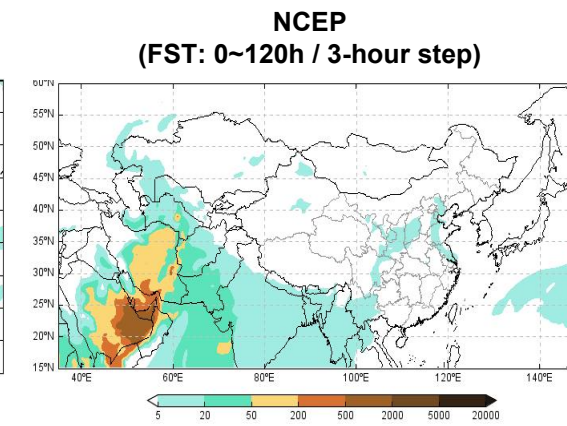
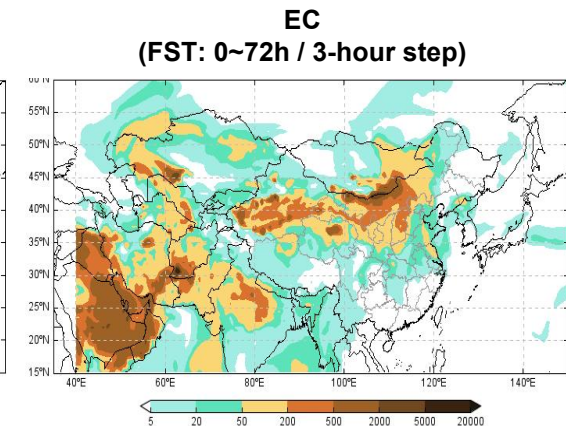
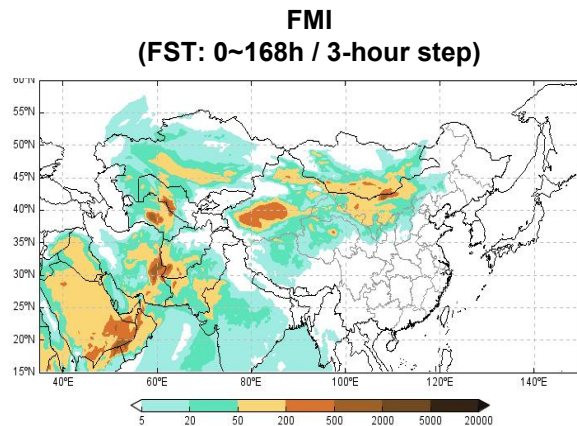
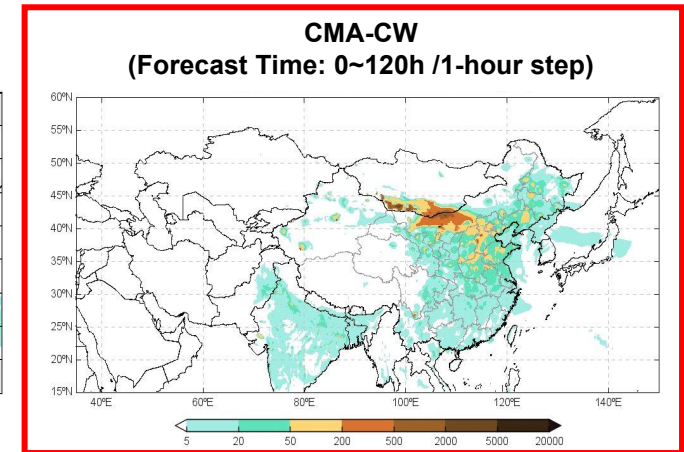
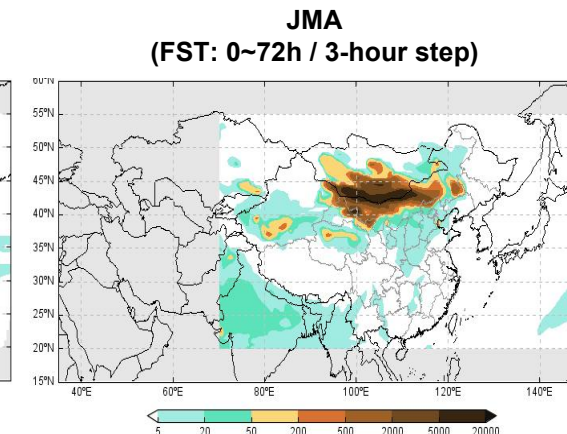
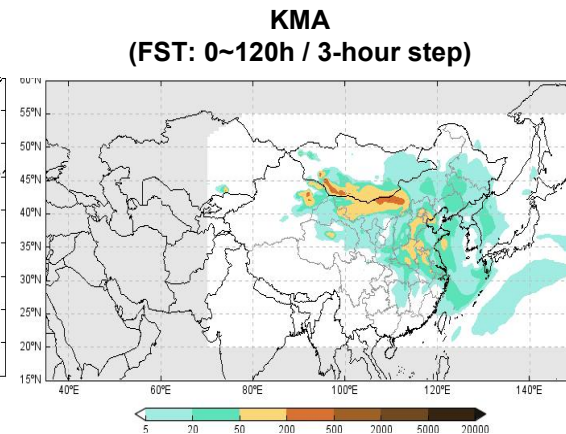
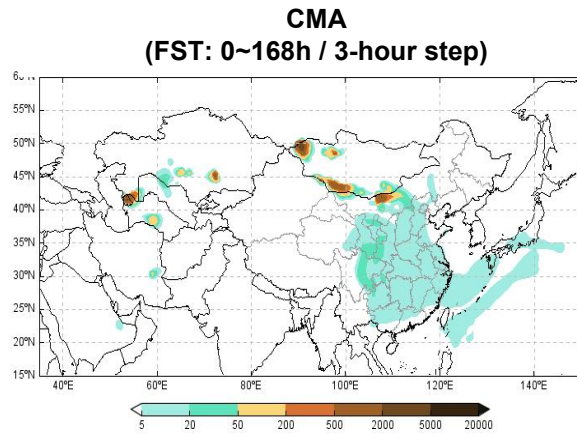
Observation

Verification

News & Event

Publications

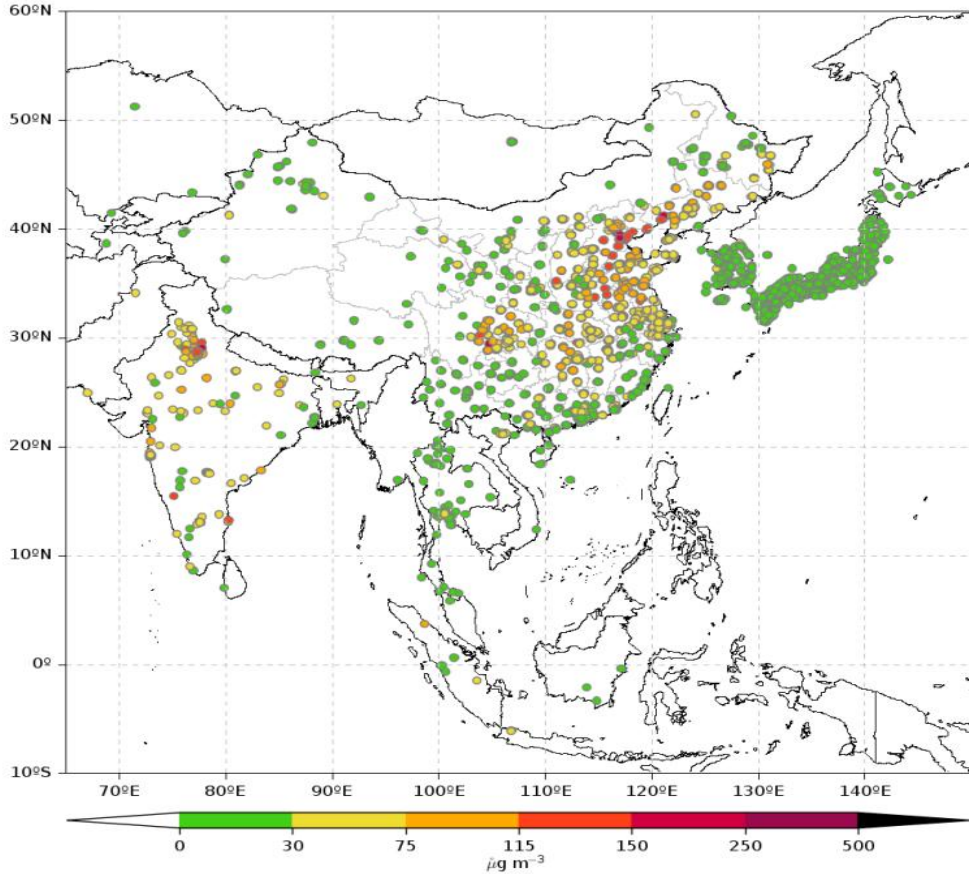
About us



There are '6+1' numerical SDS forecasting models have been operational running in the RSMC-ASDF Beijing. In this year, **CMA-CW and Fengqing-Dust model have been running in spring.**

Observation Data

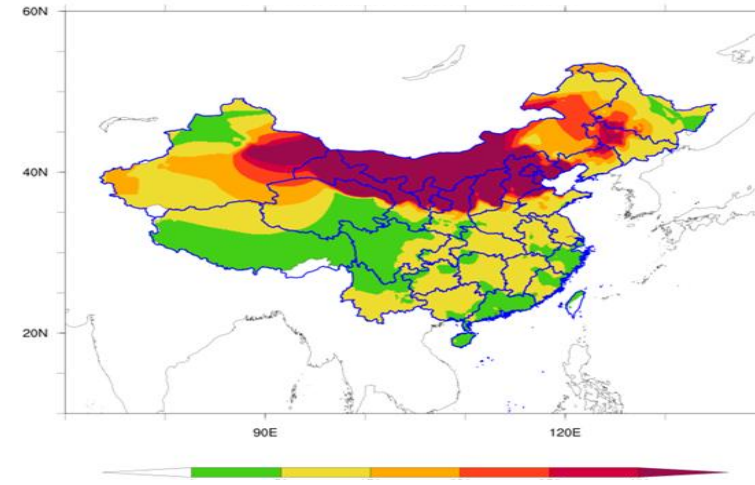
Surface Concentrations of PM_{2.5}



Surface Concentrations of PM₁₀



FY-4 PM10 inversion

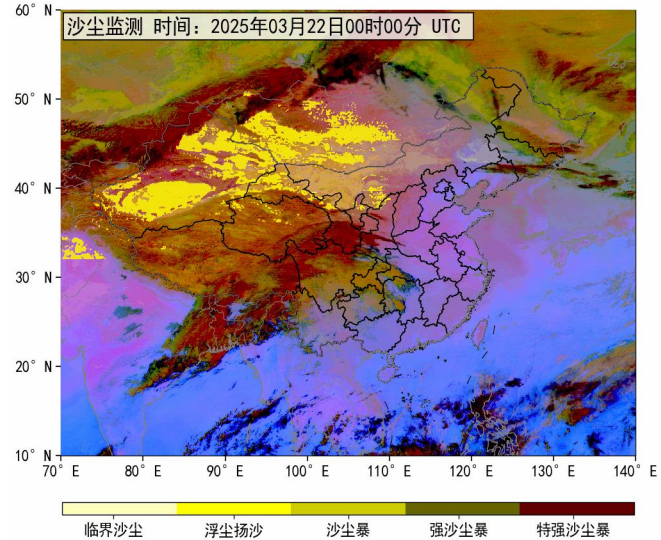
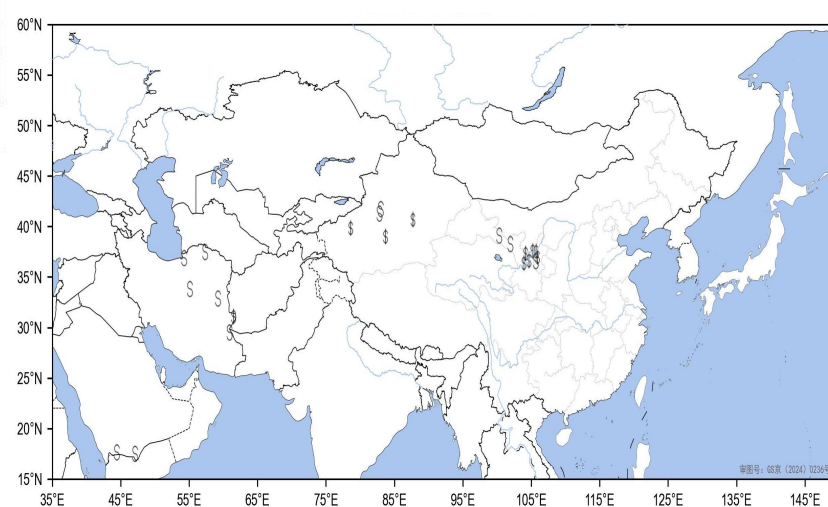


Observed Dust Weather Phenomena

Observation objects:

◆ PM₁₀ surface concentration

◆ Dust weather phenomena



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Comparisons with surface PM concentration

Evaluation Indicators

1. Normalized Mean Bias

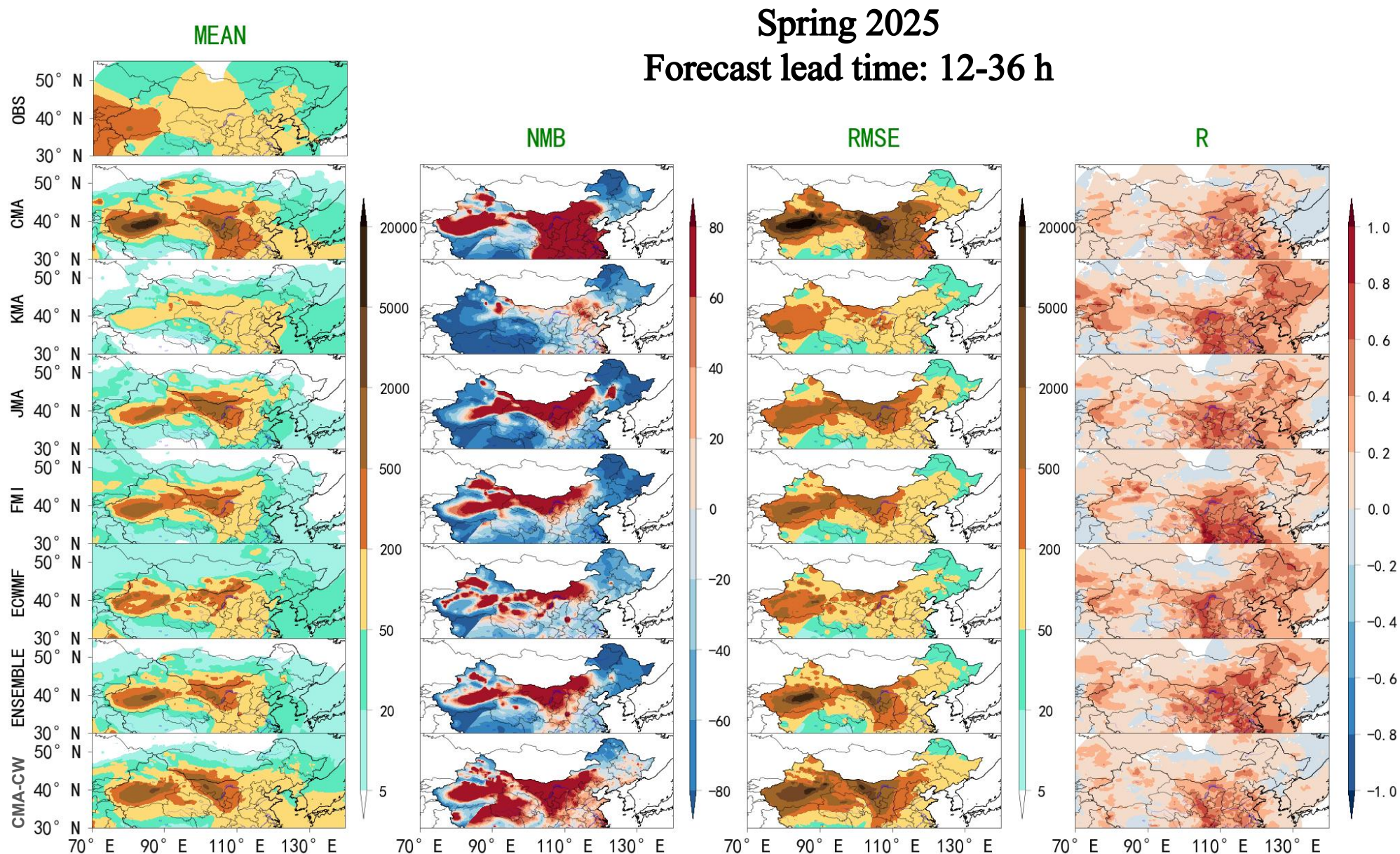
$$NMB = \frac{\sum_{i=1}^n (F_i - Obs_i)}{\sum_{i=1}^n Obs_i} \times 100\%$$

2. Root Mean Square Error

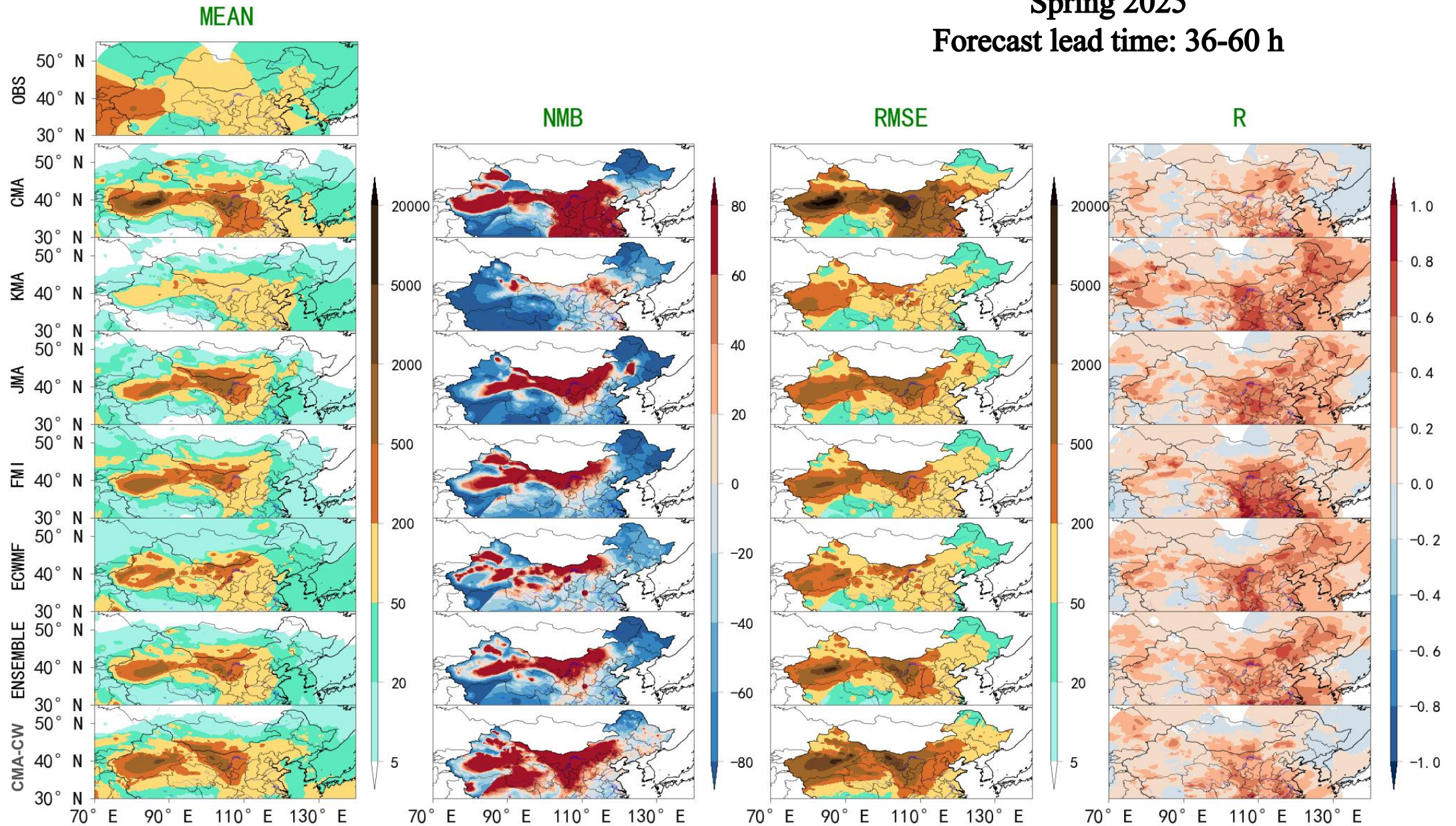
$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (F_i - Obs_i)^2}$$

3. Correlation coefficient

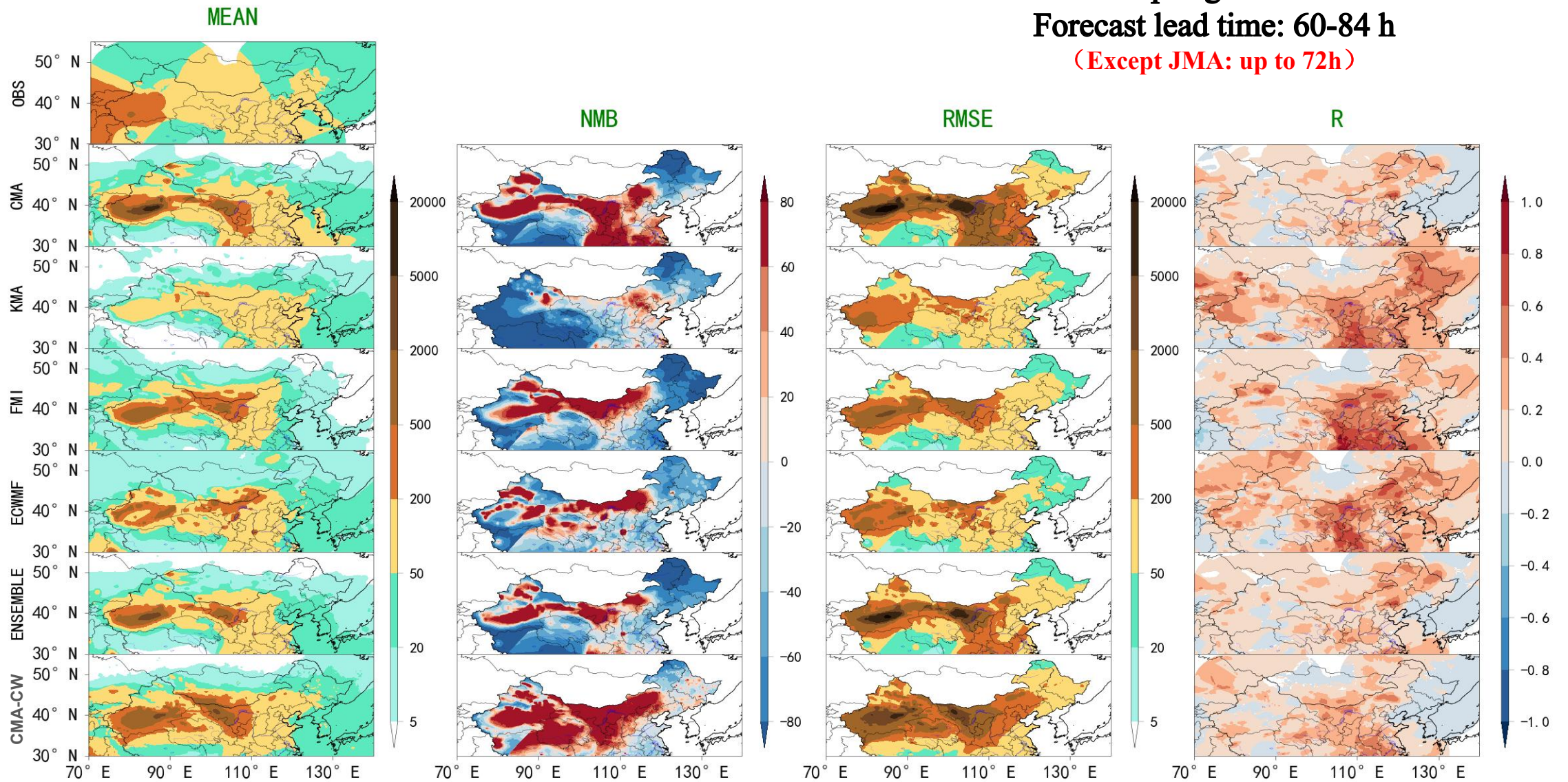
$$R = \frac{\sum_{i=1}^n (F_i - \bar{F})(Obs_i - \bar{Obs})}{\sqrt{\sum_{i=1}^n (F_i - \bar{F})^2 (Obs_i - \bar{Obs})^2}}$$



Spring 2025
Forecast lead time: 36-60 h

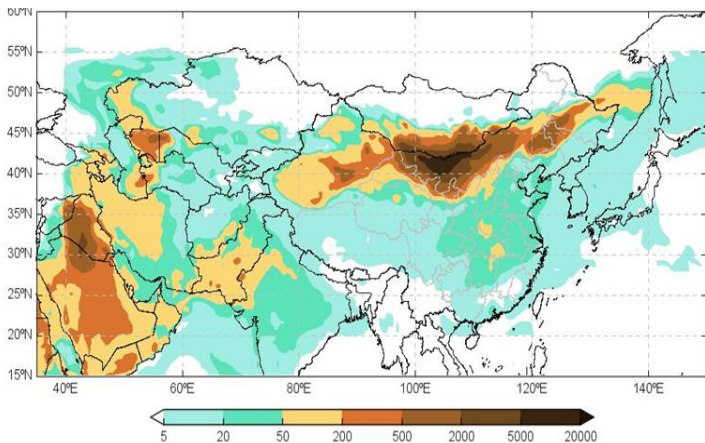


Spring 2025
Forecast lead time: 60-84 h
(Except JMA: up to 72h)

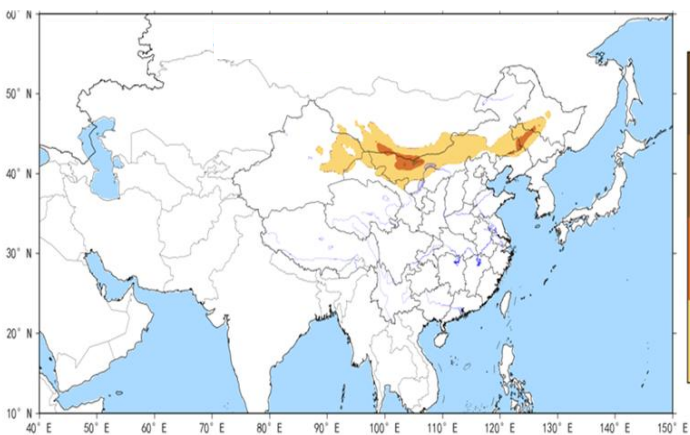


SDS graded forecast based on numerical model

Dust surface concentrations

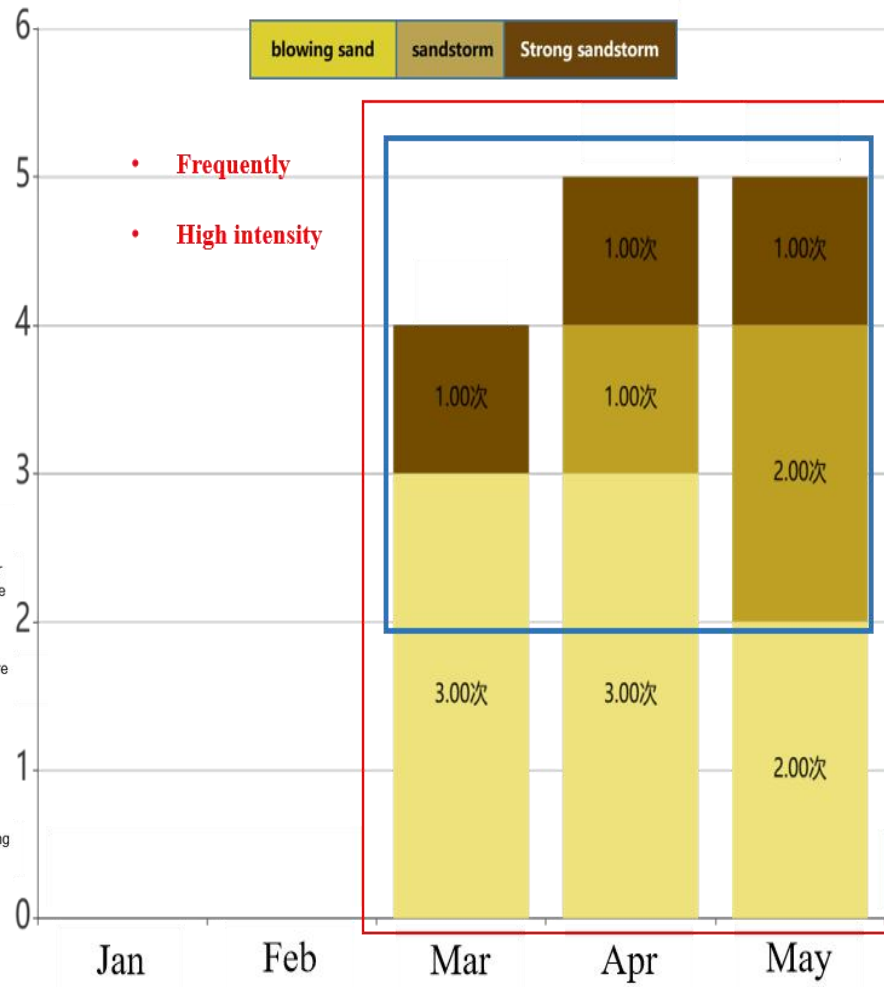


SDS graded forecast



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

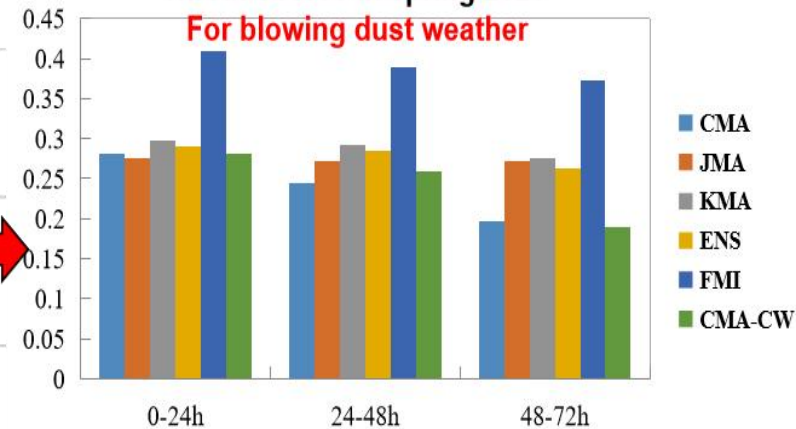
Monthly frequency of sand and dust processes of China in 2025



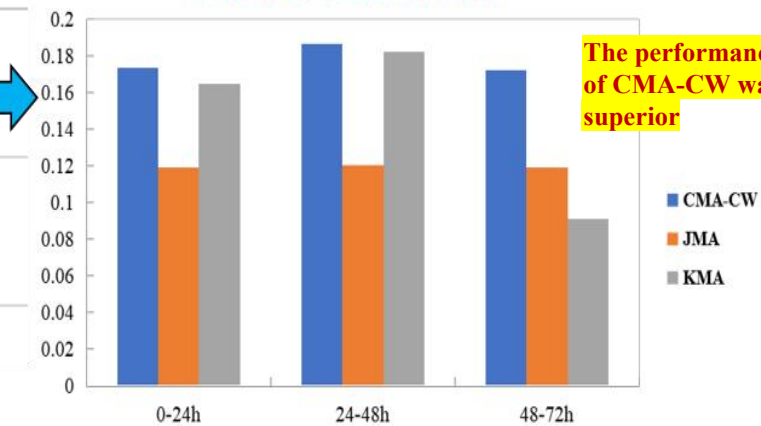
- Frequently
- High intensity

Threat Scores in spring 2025

For blowing dust weather



For sandstorm weather

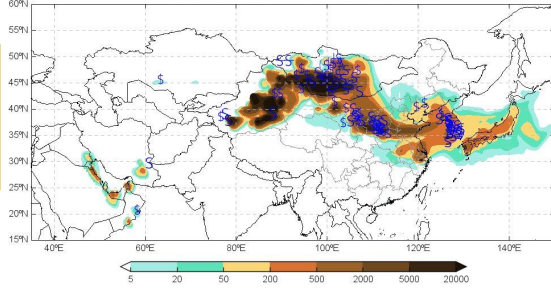


The performance of CMA-CW was superior

Case: Severe SDS process of 25–28 Mar. 2025

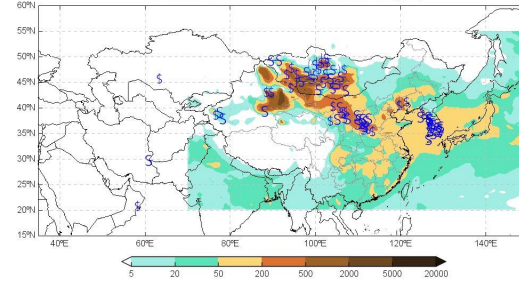
CMA

WMO SDS-WAS Asian Center
CMA CUACE Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00:00 25 Mar 2025 Valid: 06:00 25 Mar 2025(H+6)



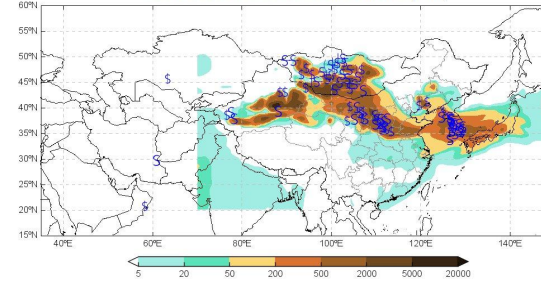
KMA

WMO SDS-WAS Asian Center
ADAM3 KMA Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00:00 25 Mar 2025 Valid: 06:00 25 Mar 2025(H+6)



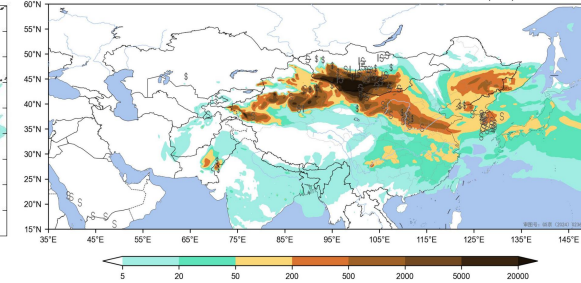
JMA

WMO SDS-WAS Asian Center
MASINGAR JMA Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12:00 24 Mar 2025 Valid: 06:00 25 Mar 2025(H+18)



CMA-CW

WMO SDS-WAS Asian Center
CMA-CW v1.0/DUST Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Base time: 2025-03-25 00:00 UTC Valid time: 2025-03-25 09:00 UTC (T+9)

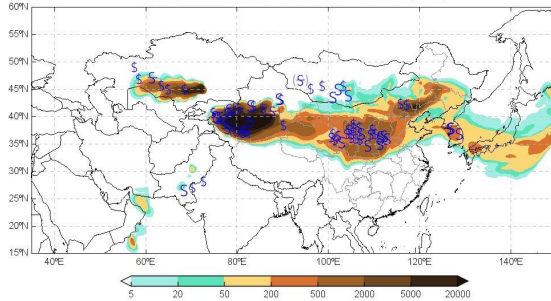


Dust-lifting phase
06:00 on March 25,
2025 (UTC)

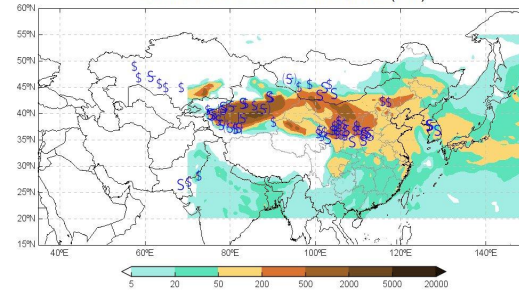
**Transport and
deposition phase**
12:00 on March 26,
2025 (UTC)

**Secondary sand-
lifting phase**
09:00 on March 27,
2025 (UTC)

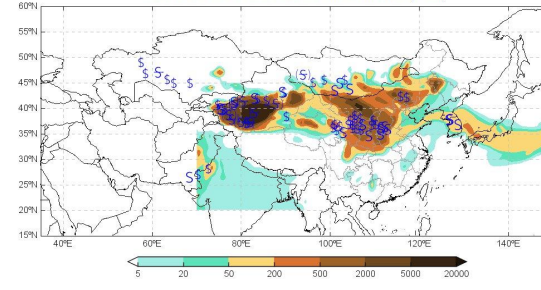
WMO SDS-WAS Asian Center
CMA CUACE Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00:00 26 Mar 2025 Valid: 12:00 26 Mar 2025(H+12)



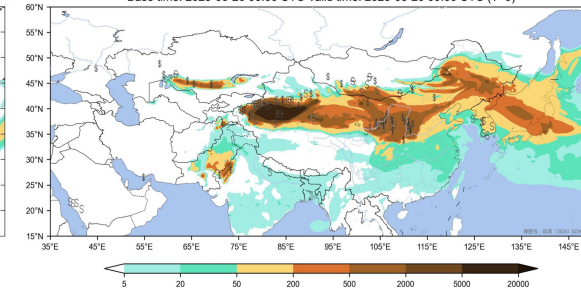
WMO SDS-WAS Asian Center
ADAM3 KMA Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00:00 26 Mar 2025 Valid: 12:00 26 Mar 2025(H+12)



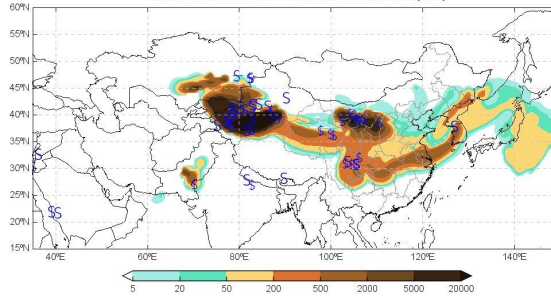
WMO SDS-WAS Asian Center
MASINGAR JMA Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12:00 25 Mar 2025 Valid: 12:00 26 Mar 2025(H+24)



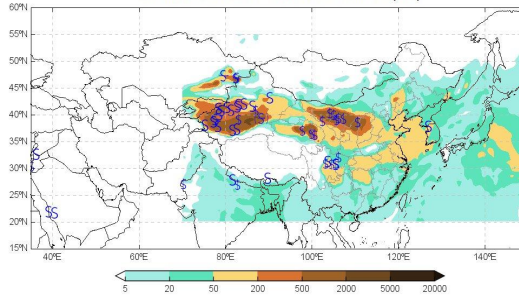
WMO SDS-WAS Asian Center
CMA-CW v1.0/DUST Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Base time: 2025-03-26 00:00 UTC Valid time: 2025-03-26 09:00 UTC (T+9)



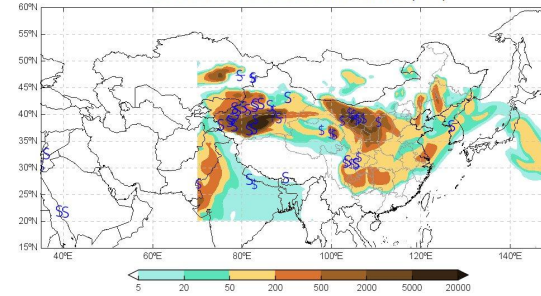
WMO SDS-WAS Asian Center
CMA CUACE Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00:00 27 Mar 2025 Valid: 09:00 27 Mar 2025(H+9)



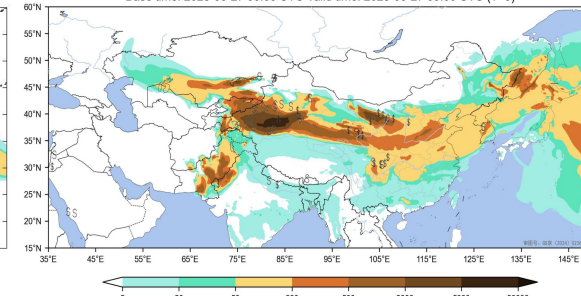
WMO SDS-WAS Asian Center
ADAM3 KMA Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 00:00 27 Mar 2025 Valid: 09:00 27 Mar 2025(H+9)



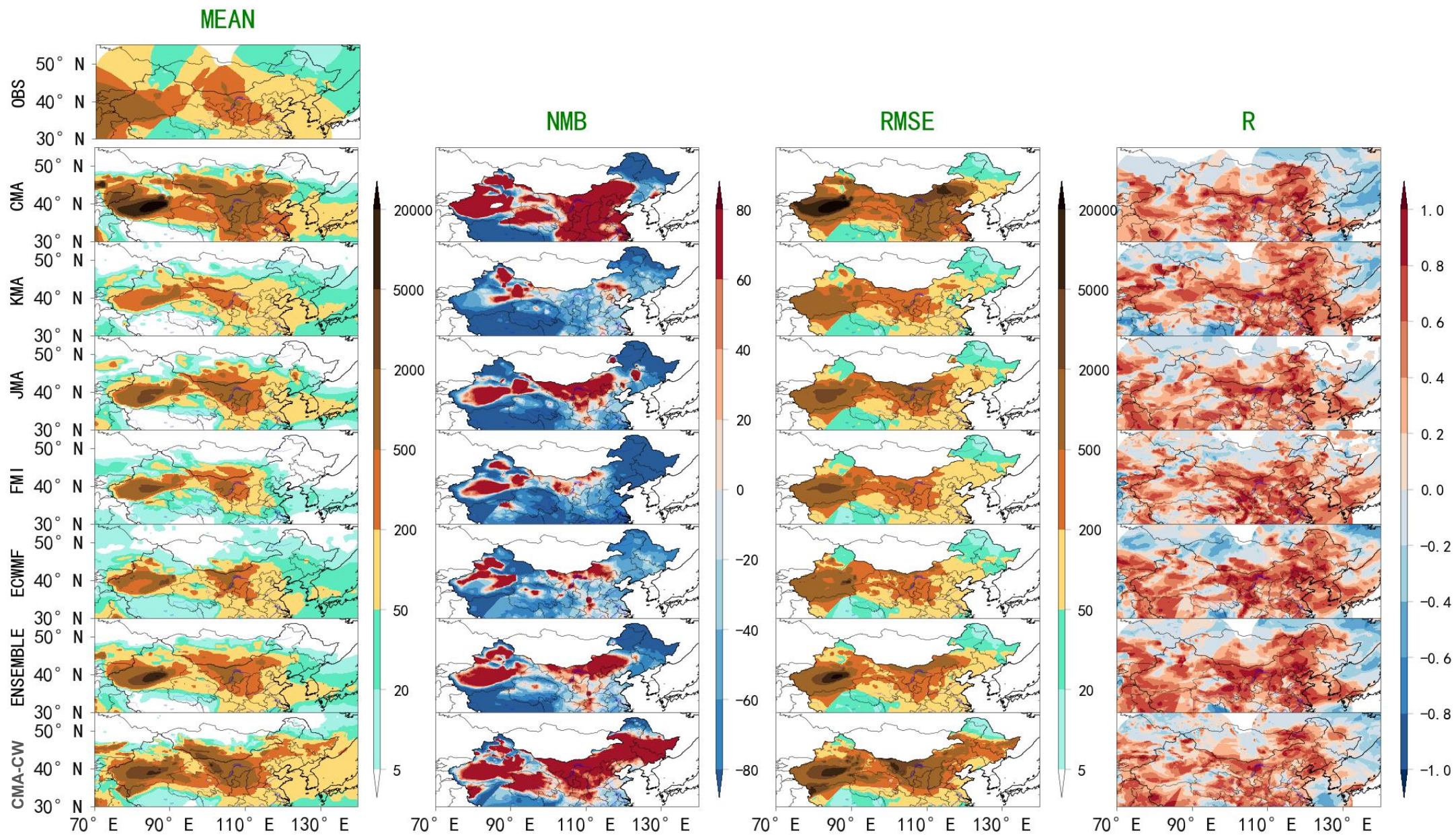
WMO SDS-WAS Asian Center
MASINGAR JMA Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Run: 12:00 26 Mar 2025 Valid: 09:00 27 Mar 2025(H+21)



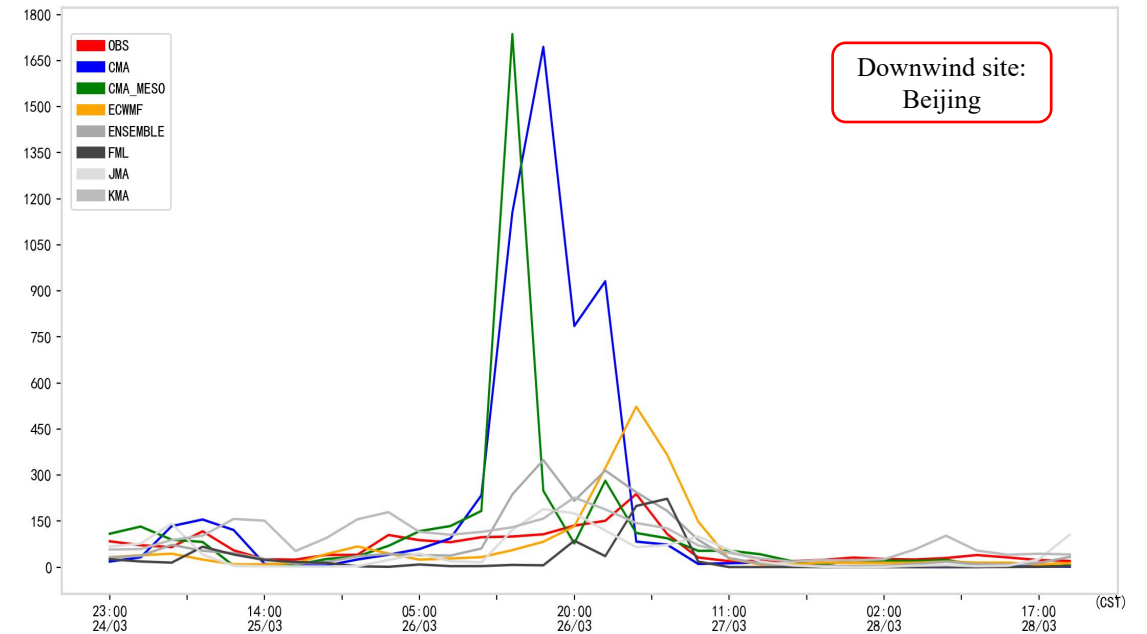
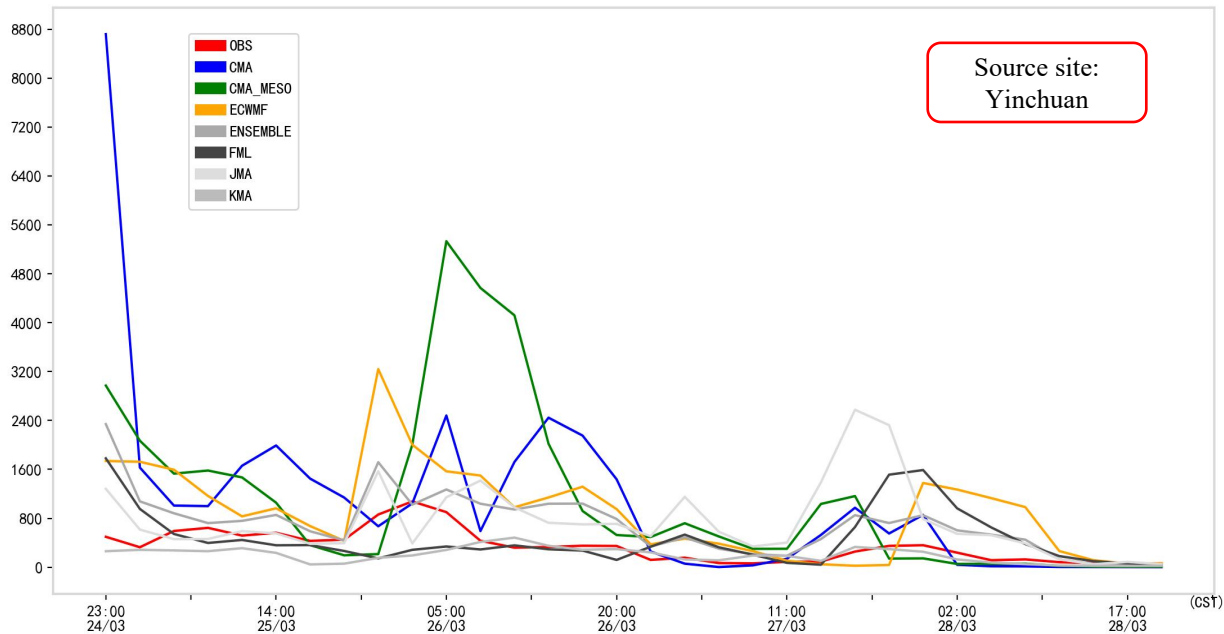
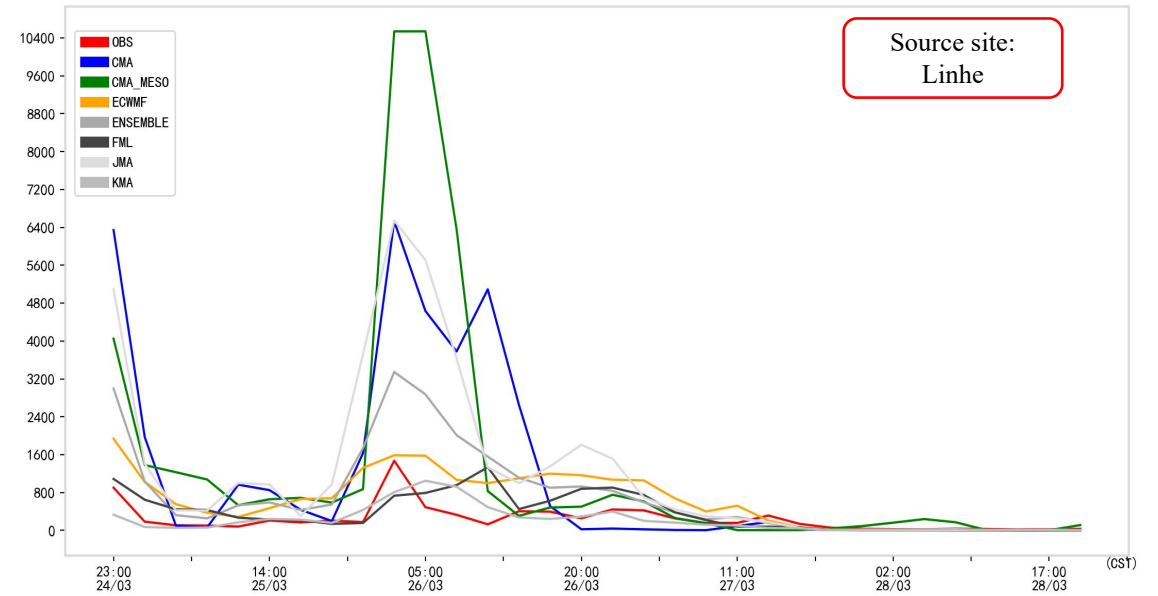
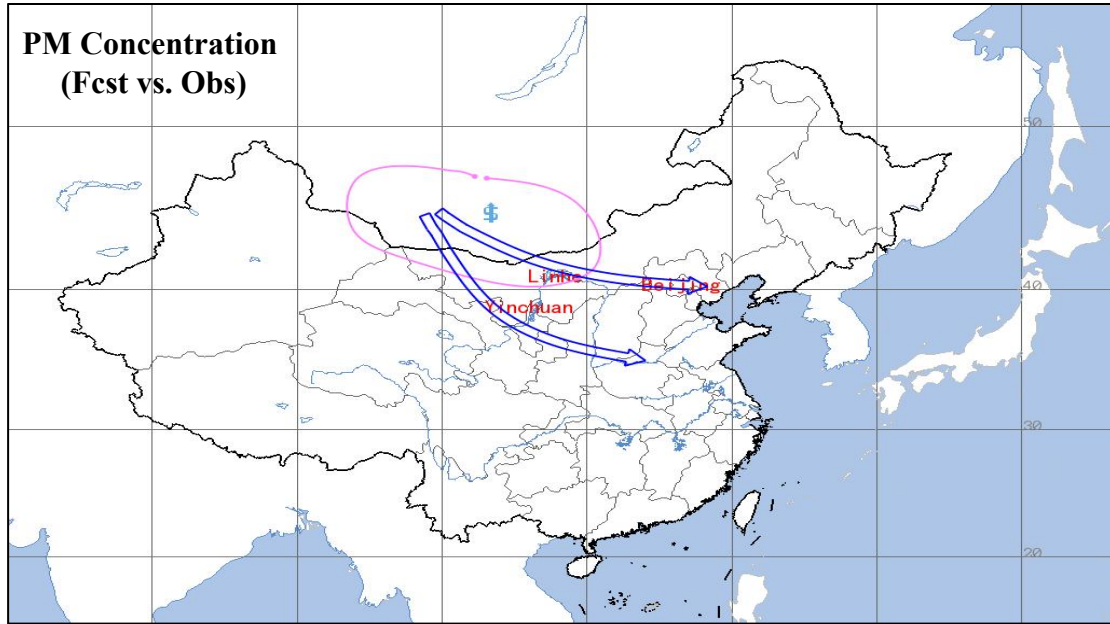
WMO SDS-WAS Asian Center
CMA-CW v1.0/DUST Dust Surface Concentration ($\mu\text{g}/\text{m}^3$)
Base time: 2025-03-27 00:00 UTC Valid time: 2025-03-27 09:00 UTC (T+9)



Case: Severe SDS process of 25–28 Mar. 2025

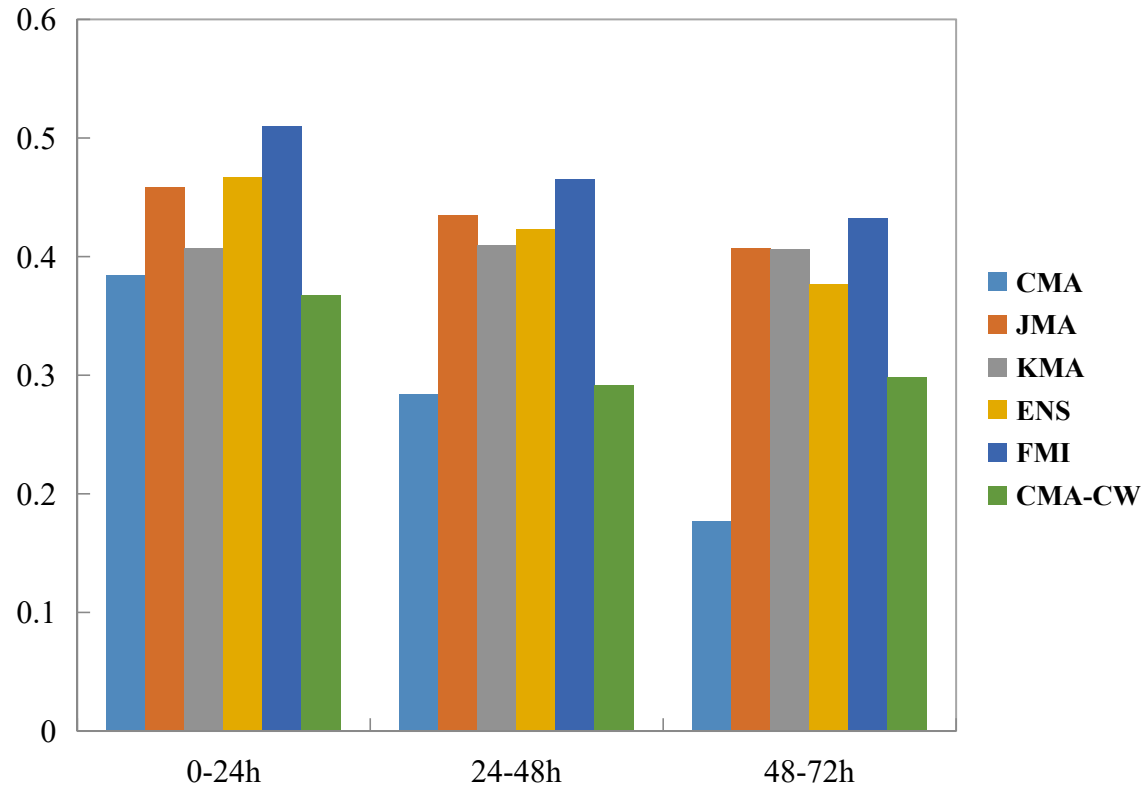


Case: Severe SDS process of 25–28 Mar. 2025

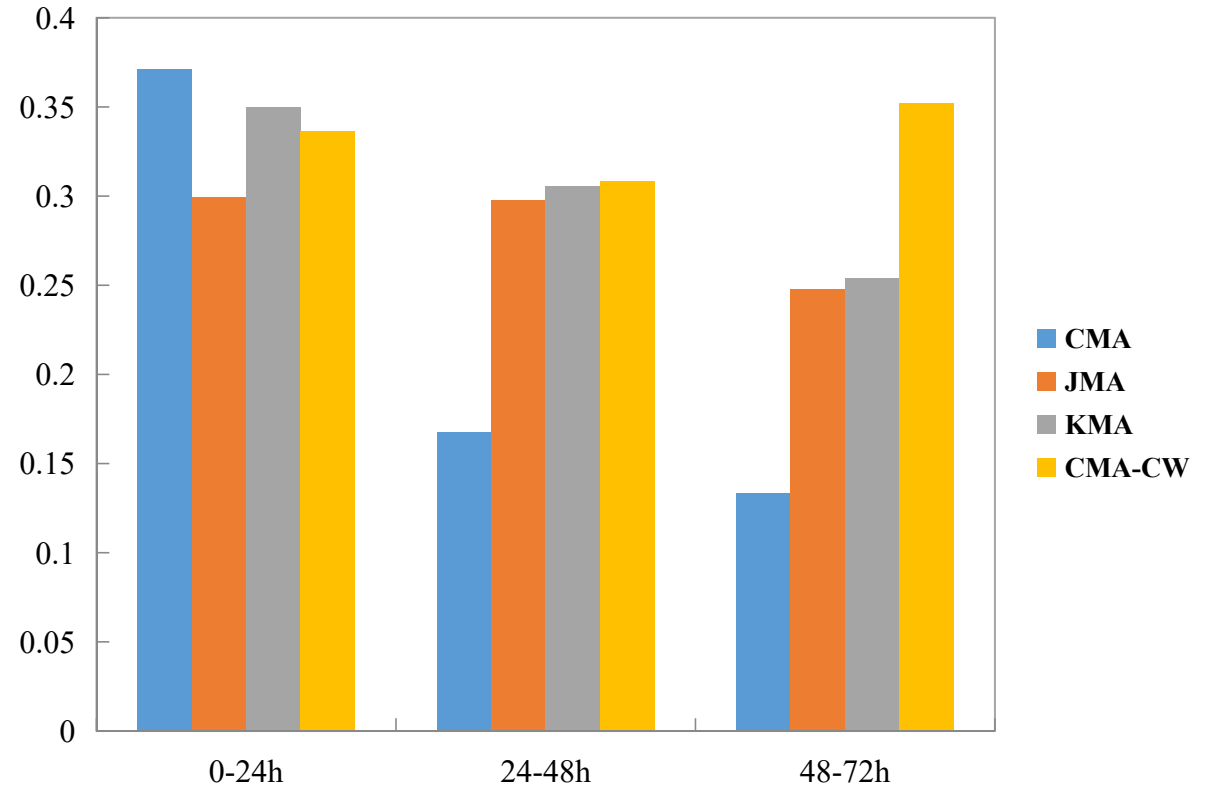


Threat Scores

Blowing Dust



SDS



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.**

- For years experiencing intense dust storms, we can confidently rely more heavily on the forecast intensity forecasted by CMA-CW and JMA. In contrast, during years with weaker dust storms or when assessing the specific impacted regions, it is advisable to give greater attention to the predictions of KMA and FMI.

Contents



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 **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.**
- ❑ Sincerely hope that each model can share more about the vertical profile concentration.**