中央气象台
NATIONAL METEOROLOGICAL CENTRE

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

National Meteorological Center, China
Chinese Academy of Meteorological Sciences

OCT 31th, 2023, Tokyo, Japan

Contents

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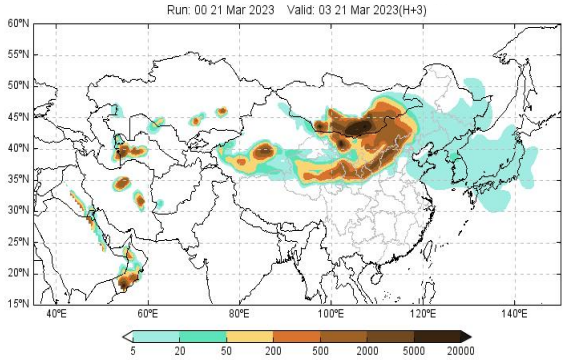
CMA
(FST: 0~168h / 3-hour step)



KMA
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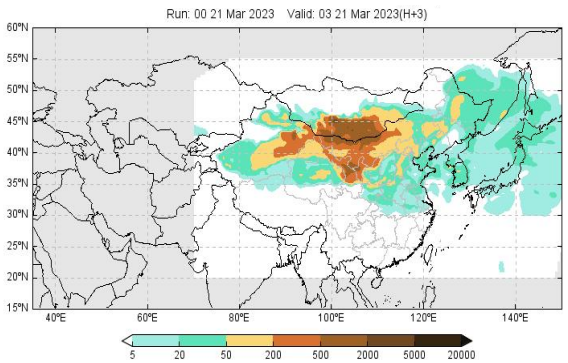

JMA
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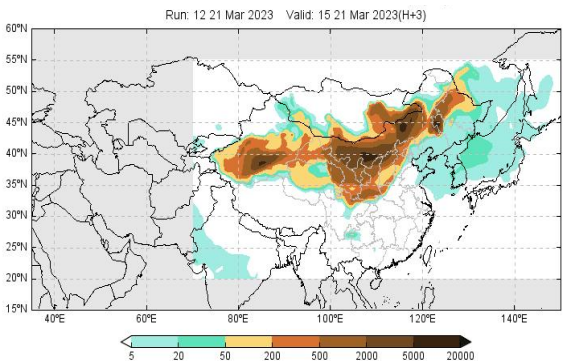
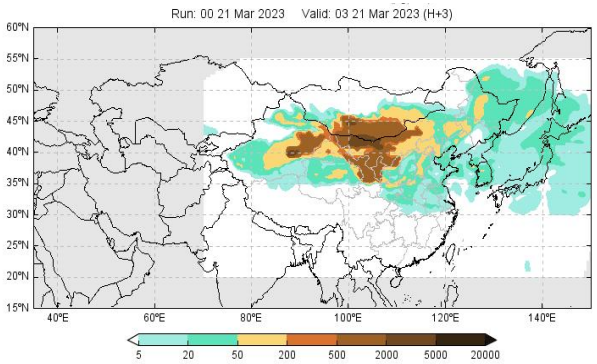
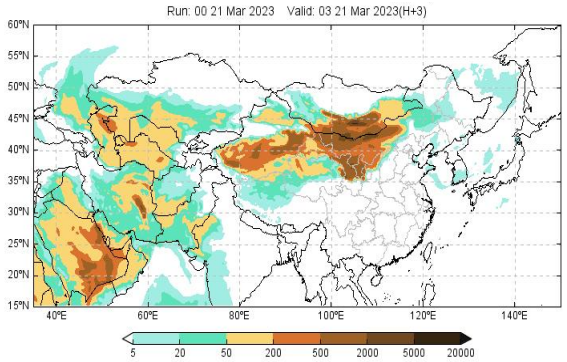


Ensemble
(Forecast Time: 0~72h /3-hour step)



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



EC
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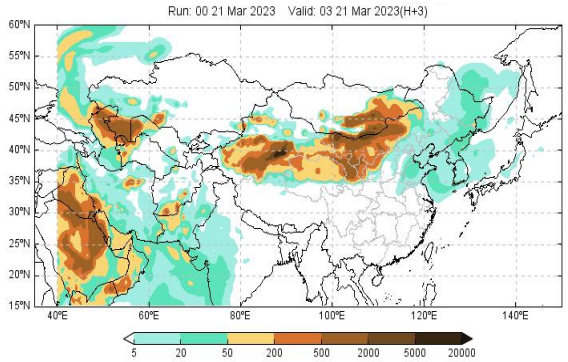

NCEP
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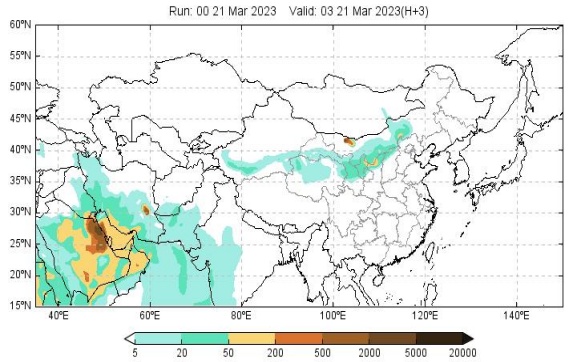
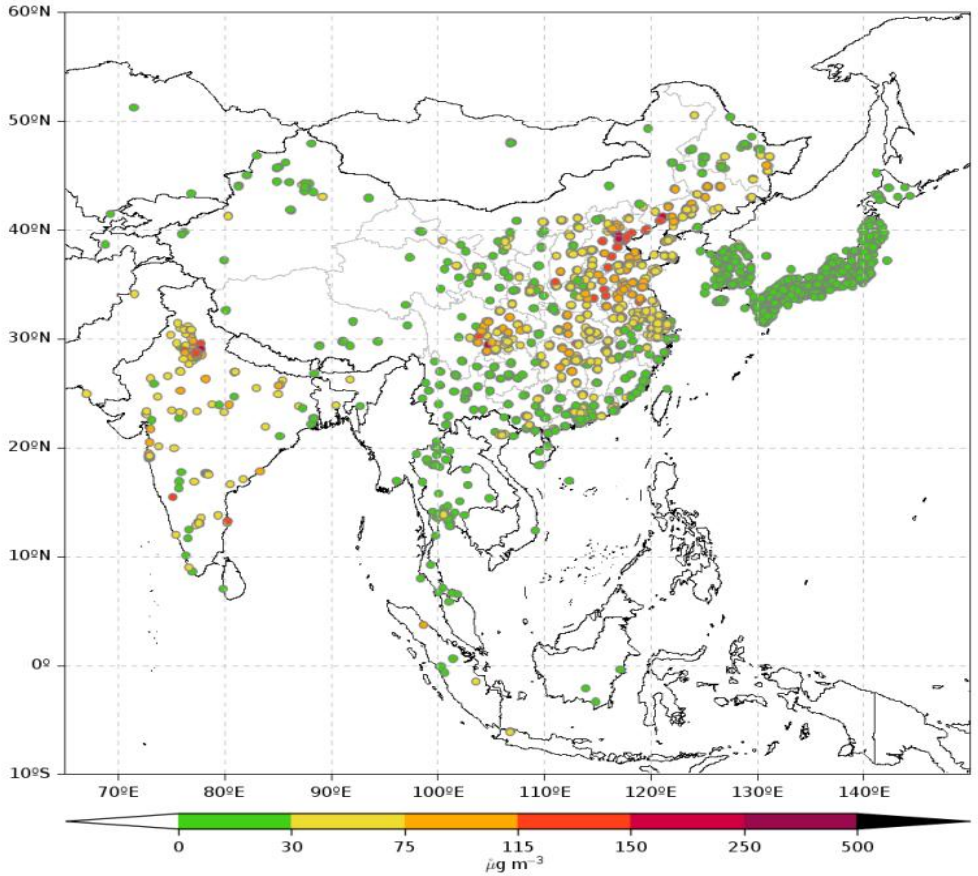


Can JMA and EC extend the forecast time of sharing data to 5 days?

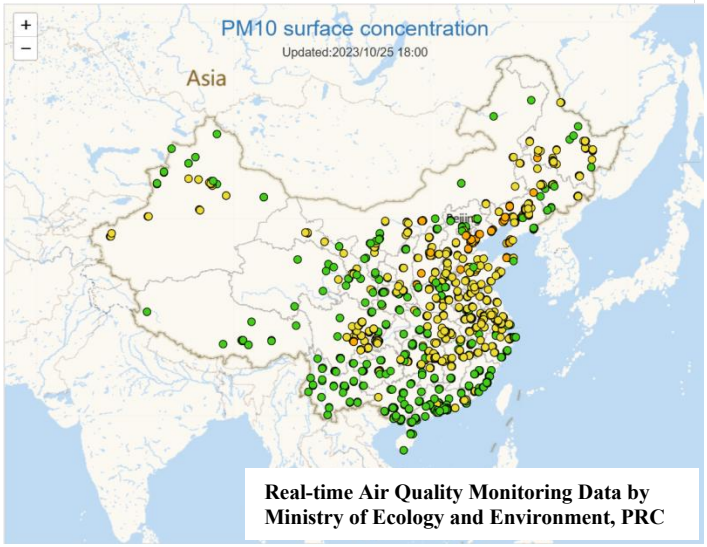
There are '6+1' numerical SDS forecasting models have been operational running in the RSMC-ADSF Beijing. Currently, the forecasting time of numerical products is between 3 and 7 days.

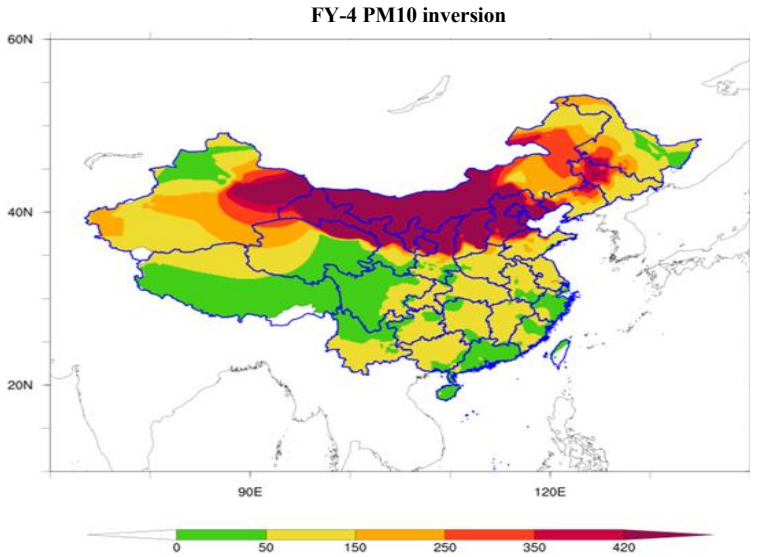
Observation Data

Surface Concentrations of $PM_{2.5}$

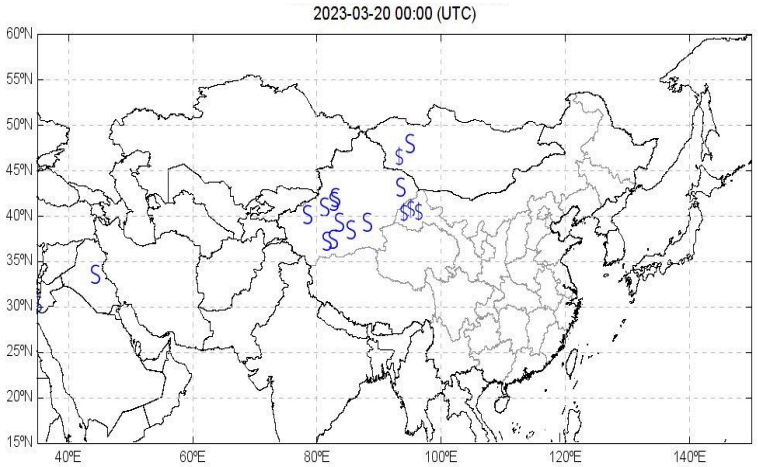


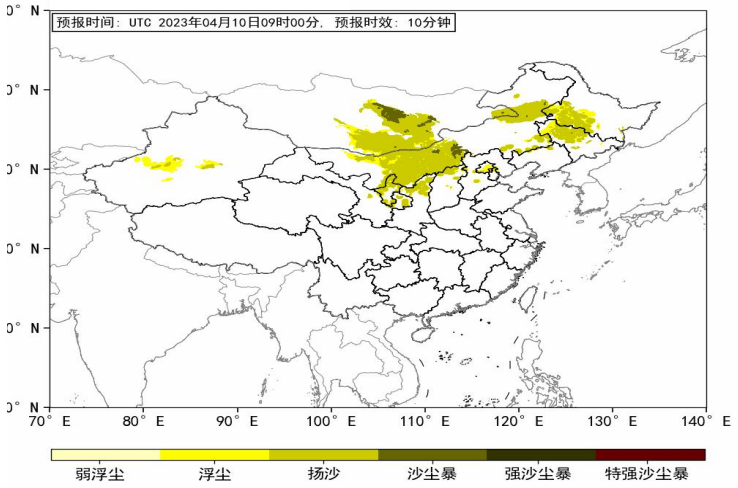
Surface Concentrations of PM_{10}





Observed Dust Weather Phenomena





Observation objects:

- PM_{10} surface concentration
- Dust weather phenomena

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- Background
- Verification
- Future Work

Comparisons with surface PM concentration

Evaluation Indicators

1. Normalized Mean Bias

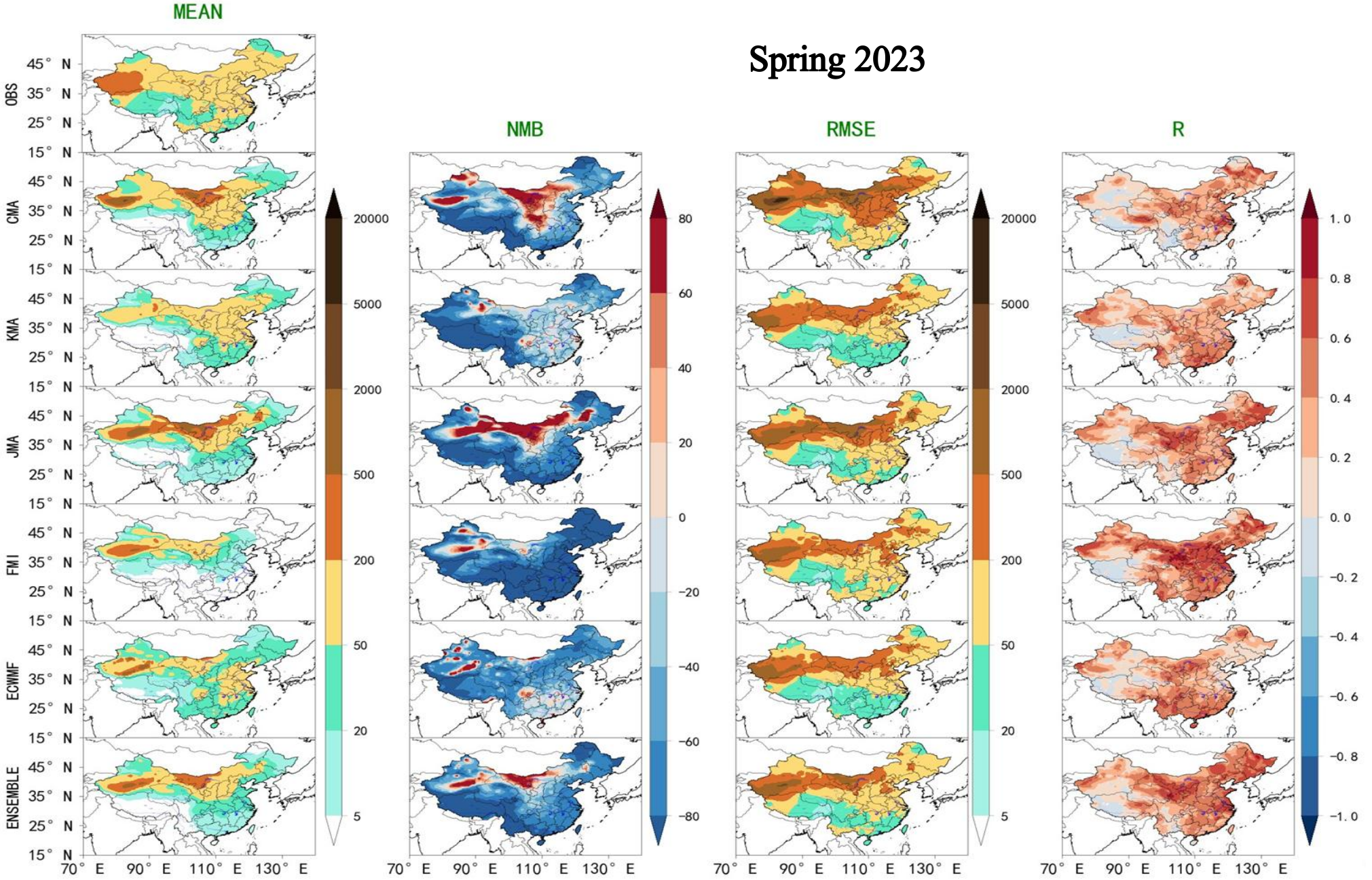
$$NMB = \frac{\sum_{i=1}^{n}(F_i - Obs_i)}{\sum_{i=1}^{n} Obs_i} \times 100\%$$

2. Root Mean Square Error

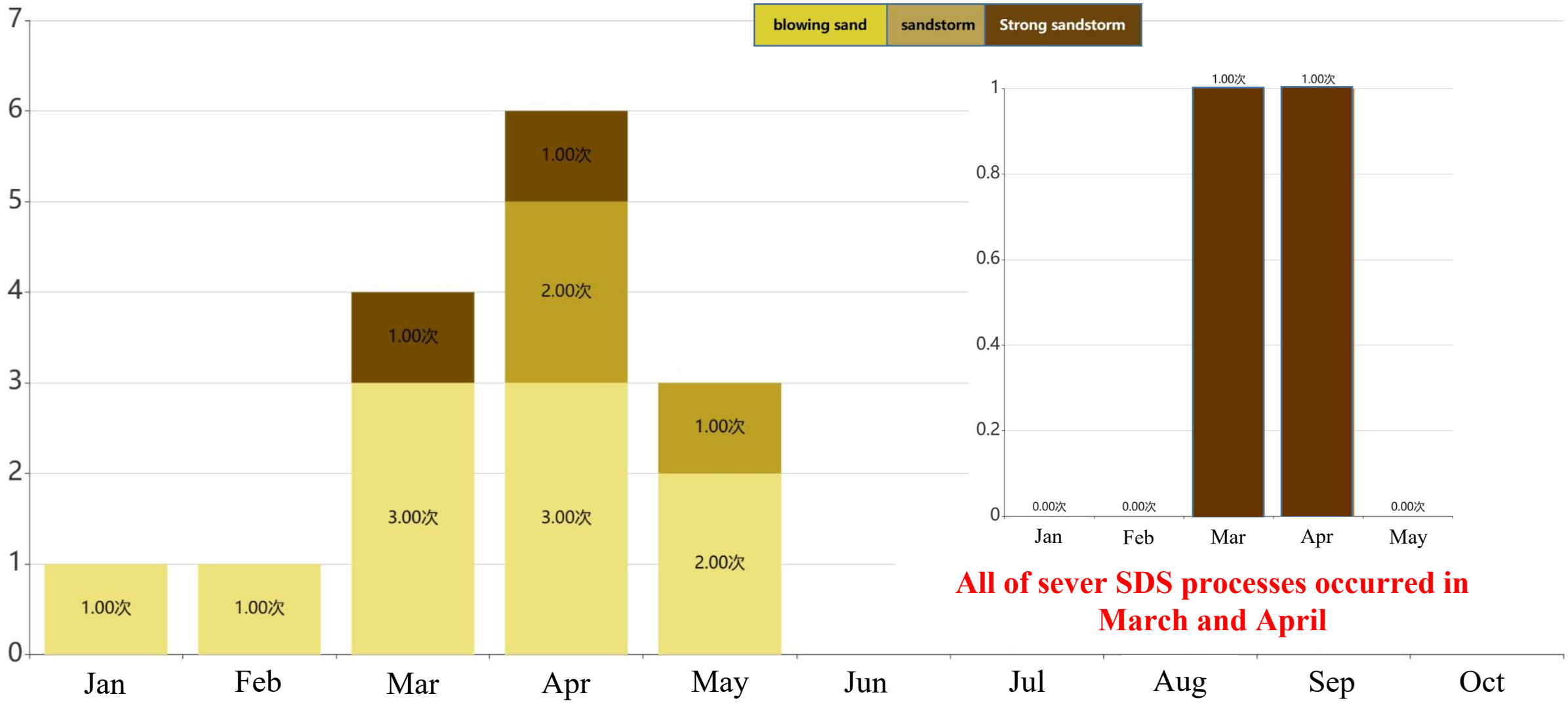
$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(F_i - Obs_i)^2}$$

3. Correlation coefficient

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

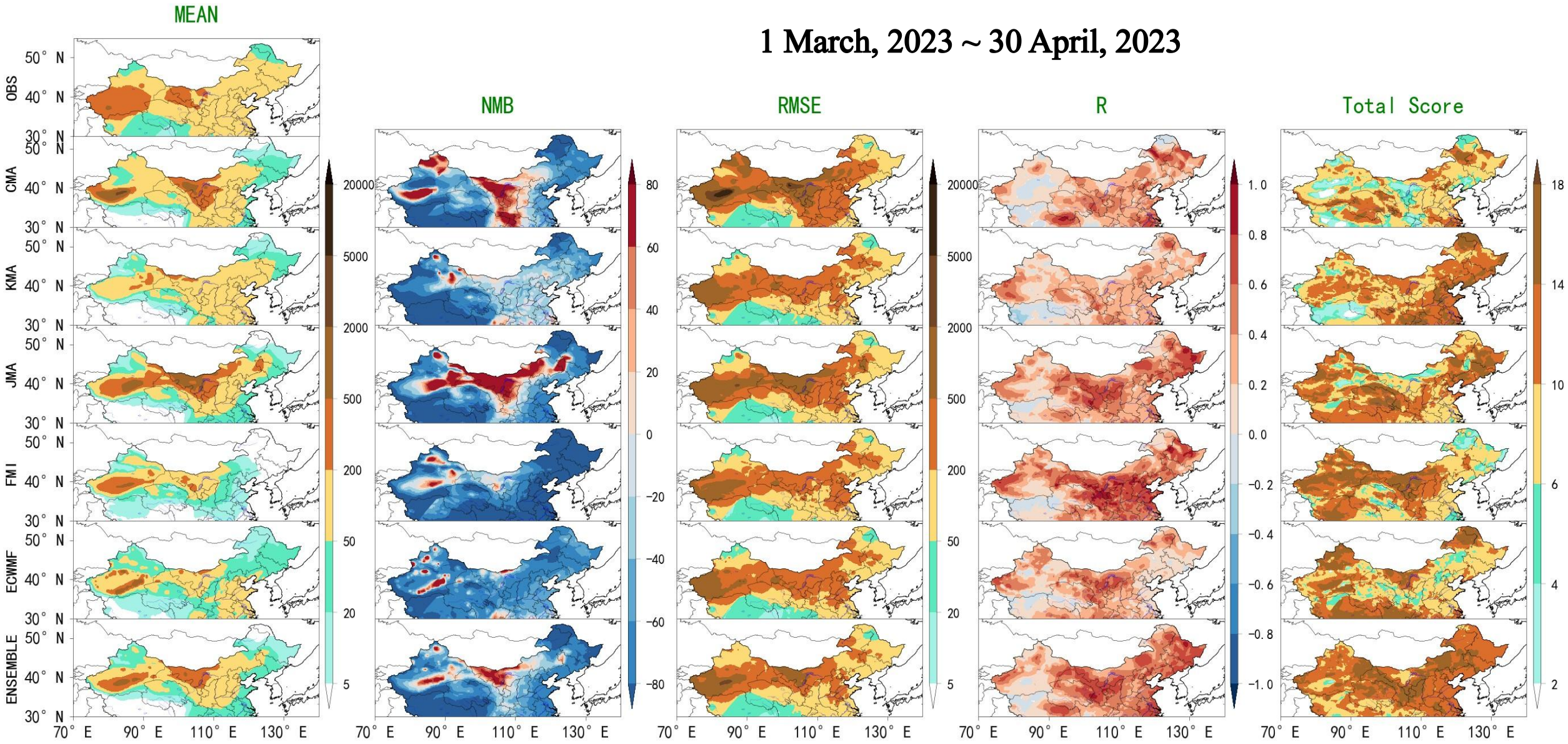


Monthly frequency of sand and dust processes of China in 2023



All of sever SDS processes occurred in March and April

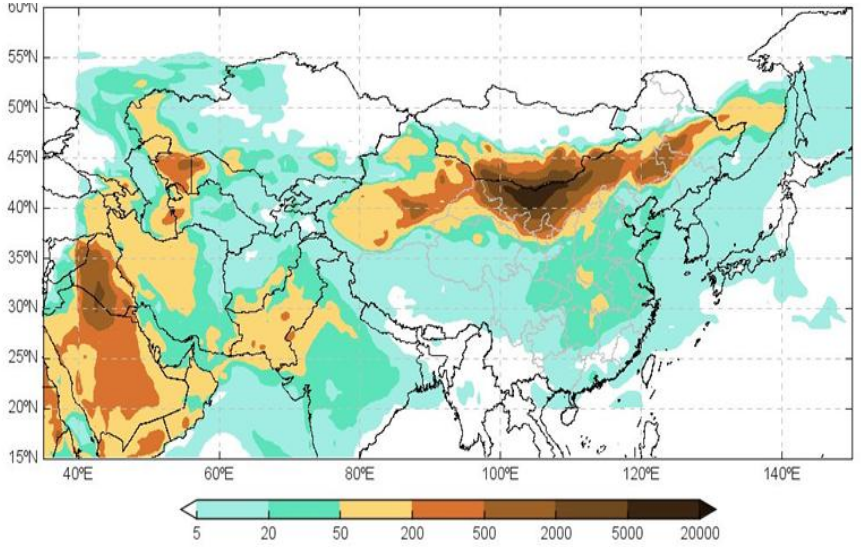
Comparisons with surface PM concentration



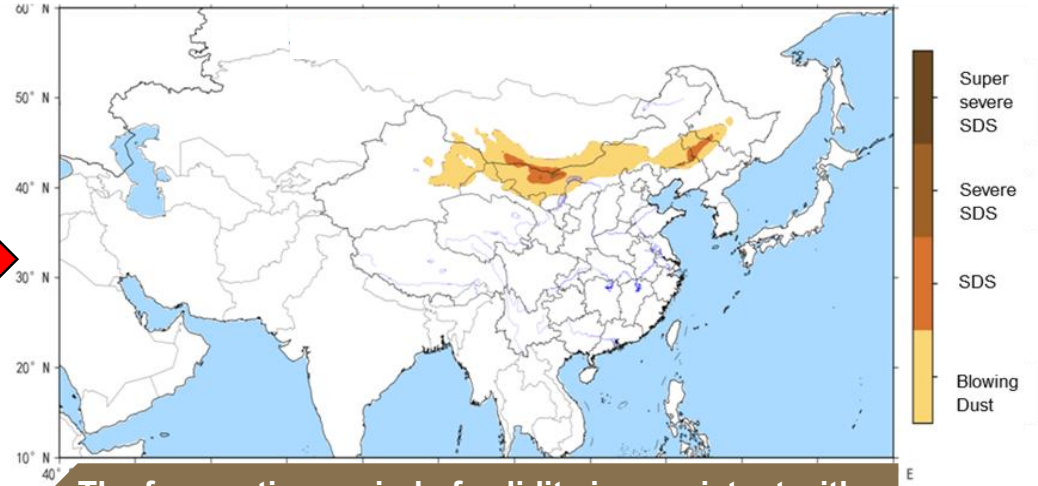
SDS graded forecast based on numerical model

Numerical Simulation

Dust surface concentrations

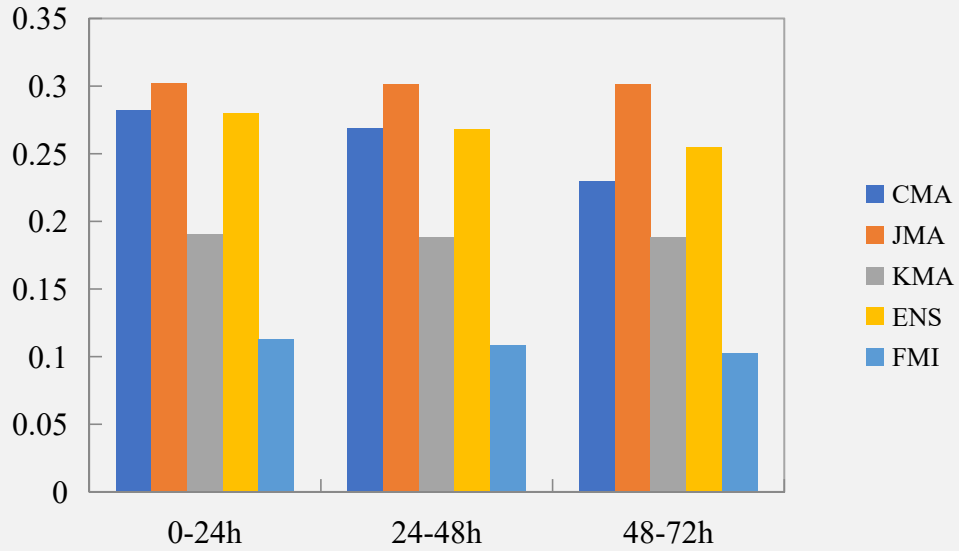


SDS graded forecast

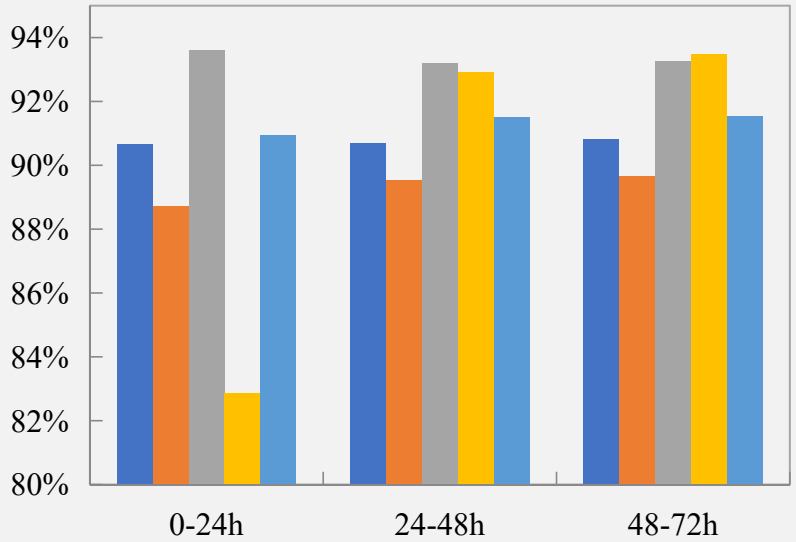


The forecasting period of validity is consistent with numerical forecast model respectively

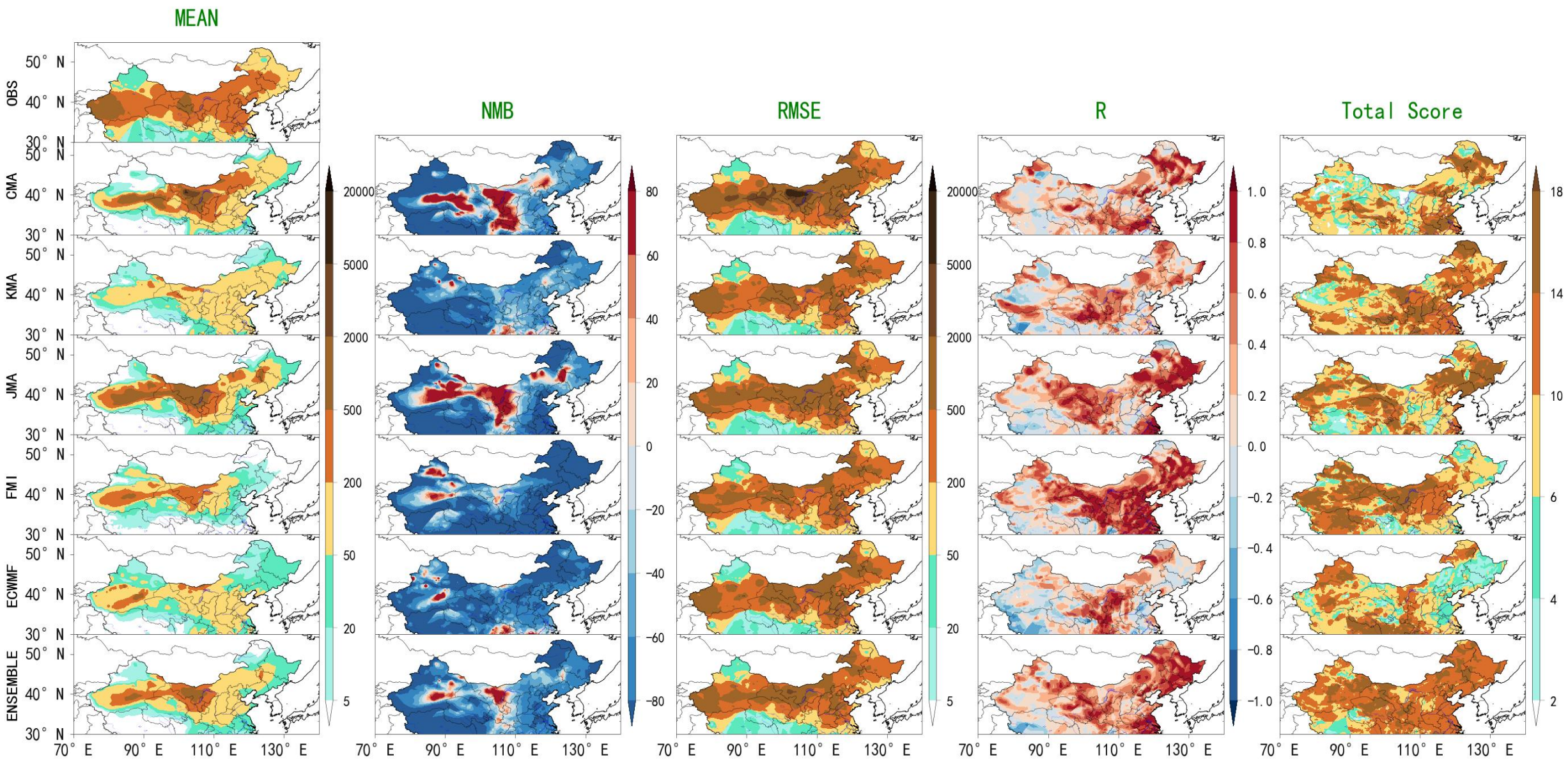
Threat Scores in spring 2023



Accuracy Rate



Case1: Severe SDS process of 19–24 Mar. 2023



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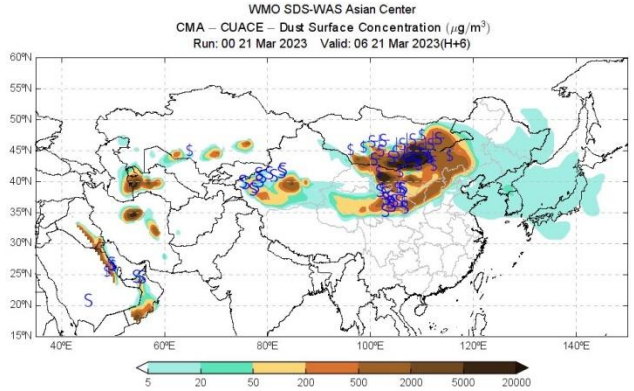

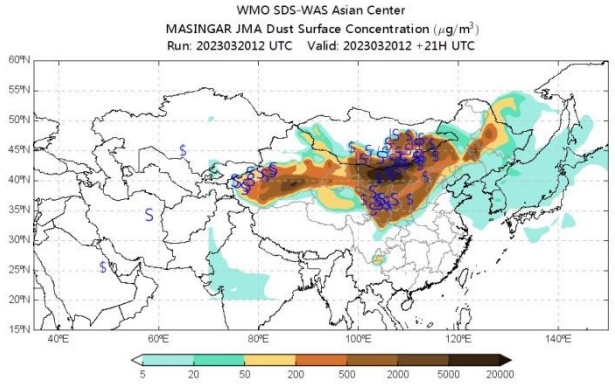

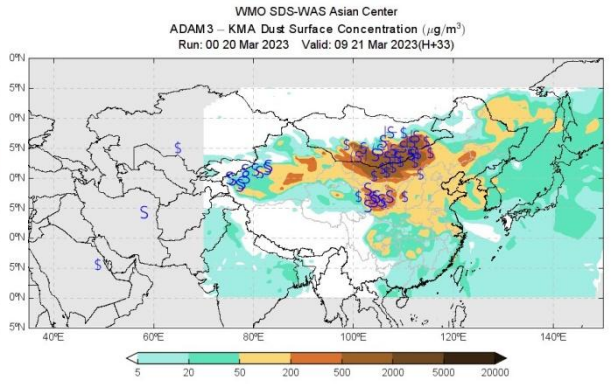

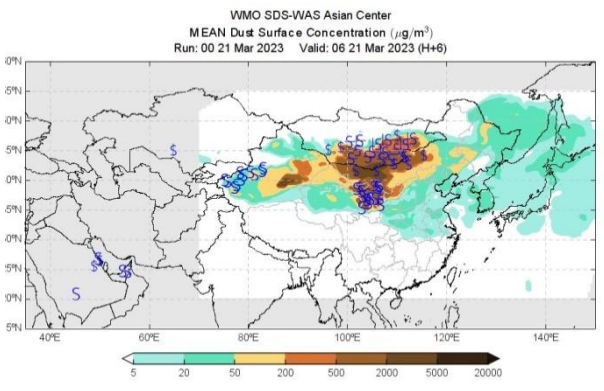

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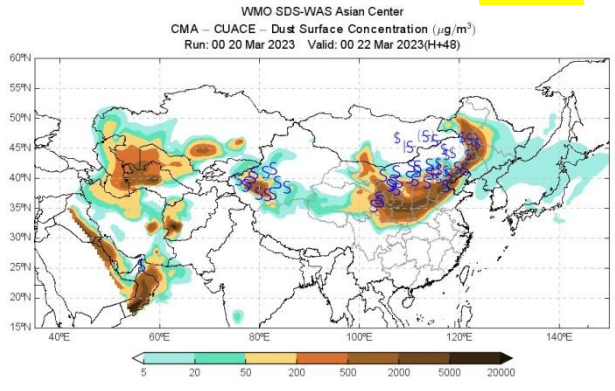
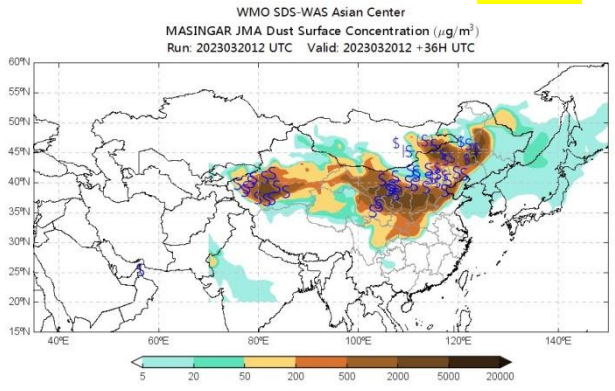
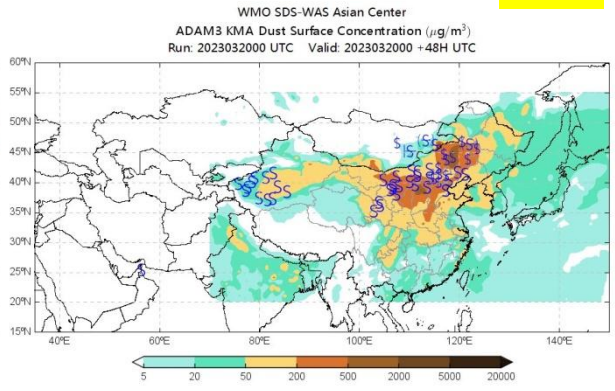
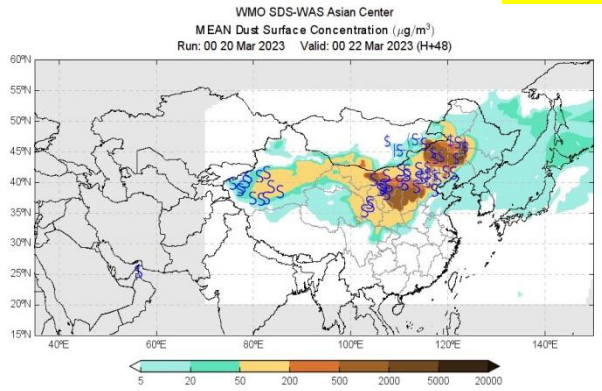
CMA JMA KMA ENS

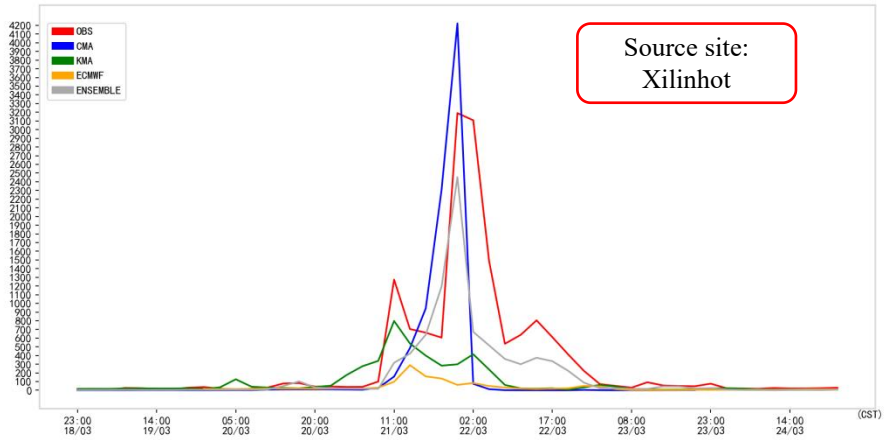


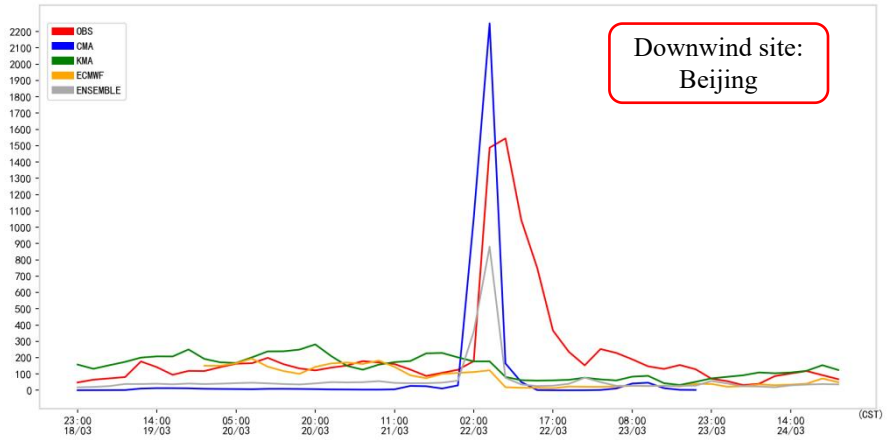


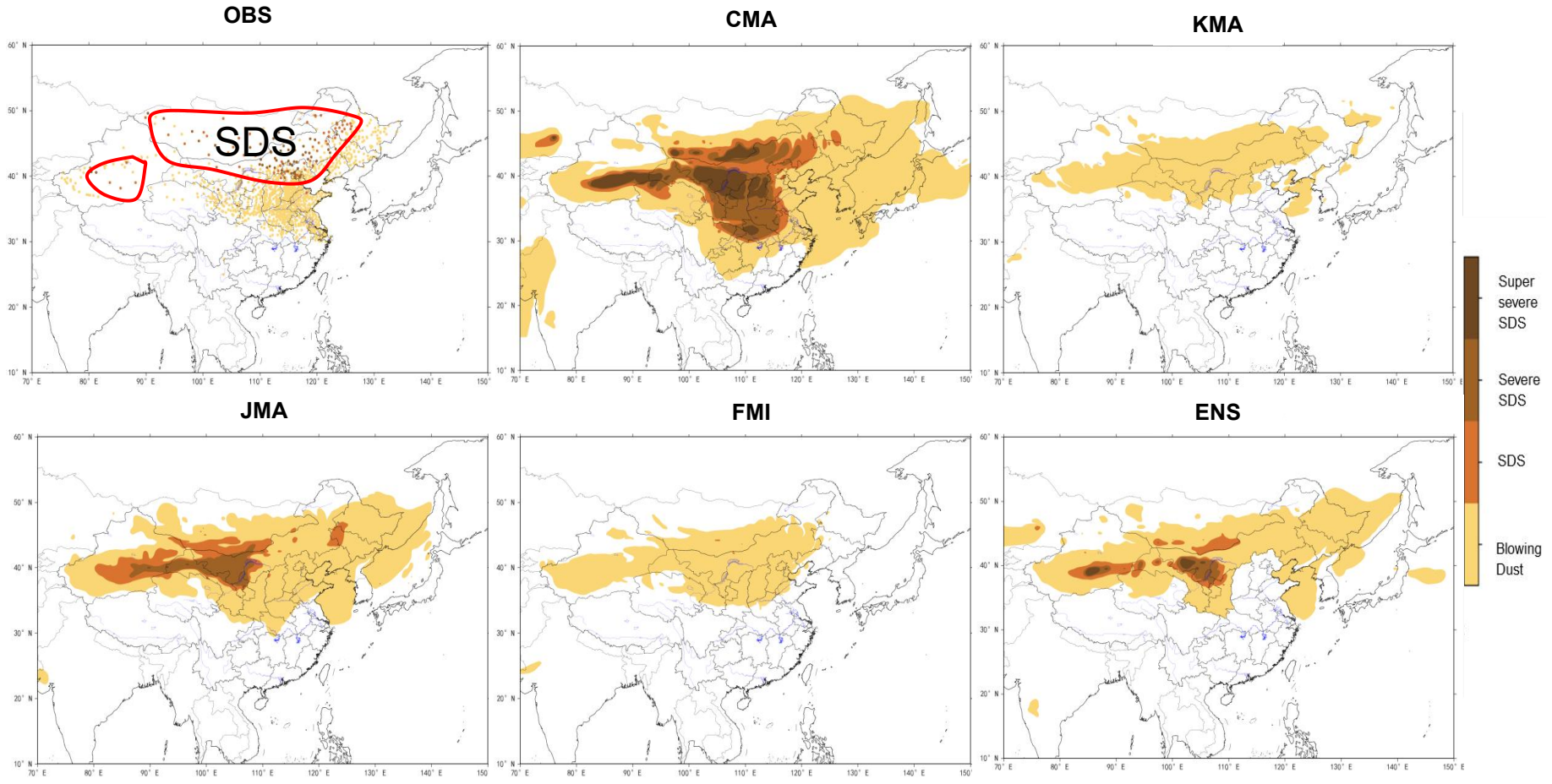


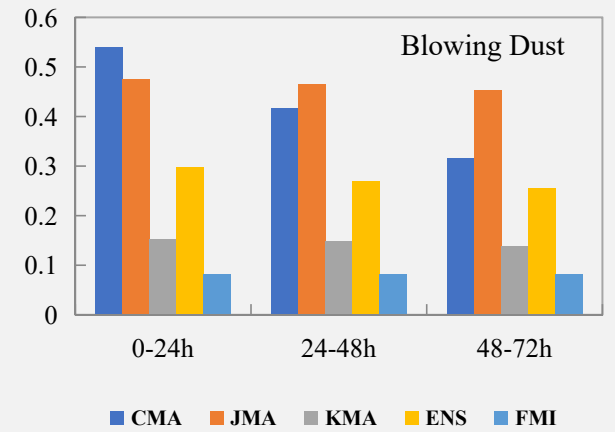


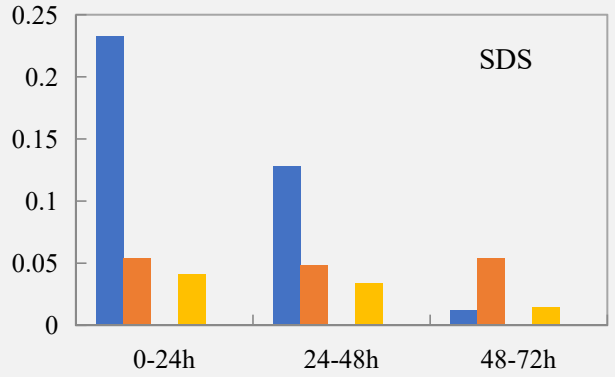
PM Concentration (Fcst vs. Obs)





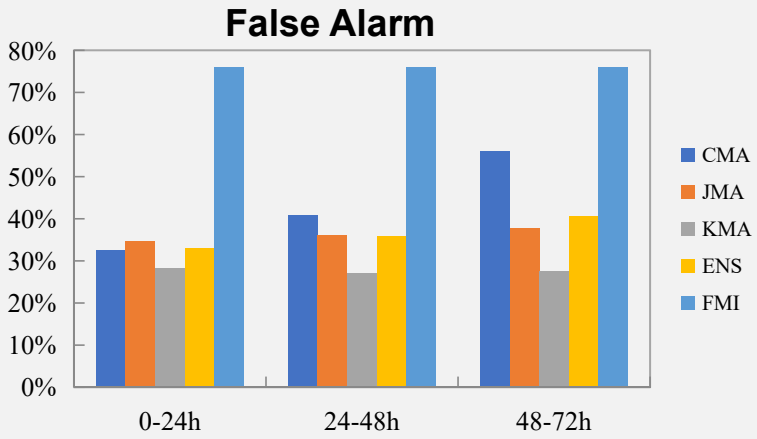


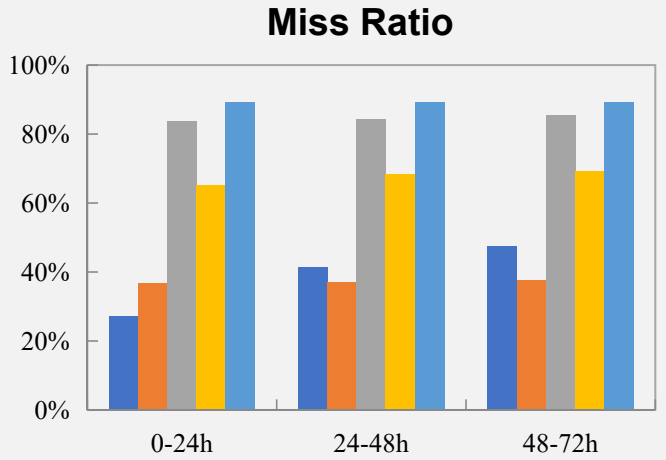




March 19-24, 2023 (CST)
Sever SDS Process

China and Mongolia





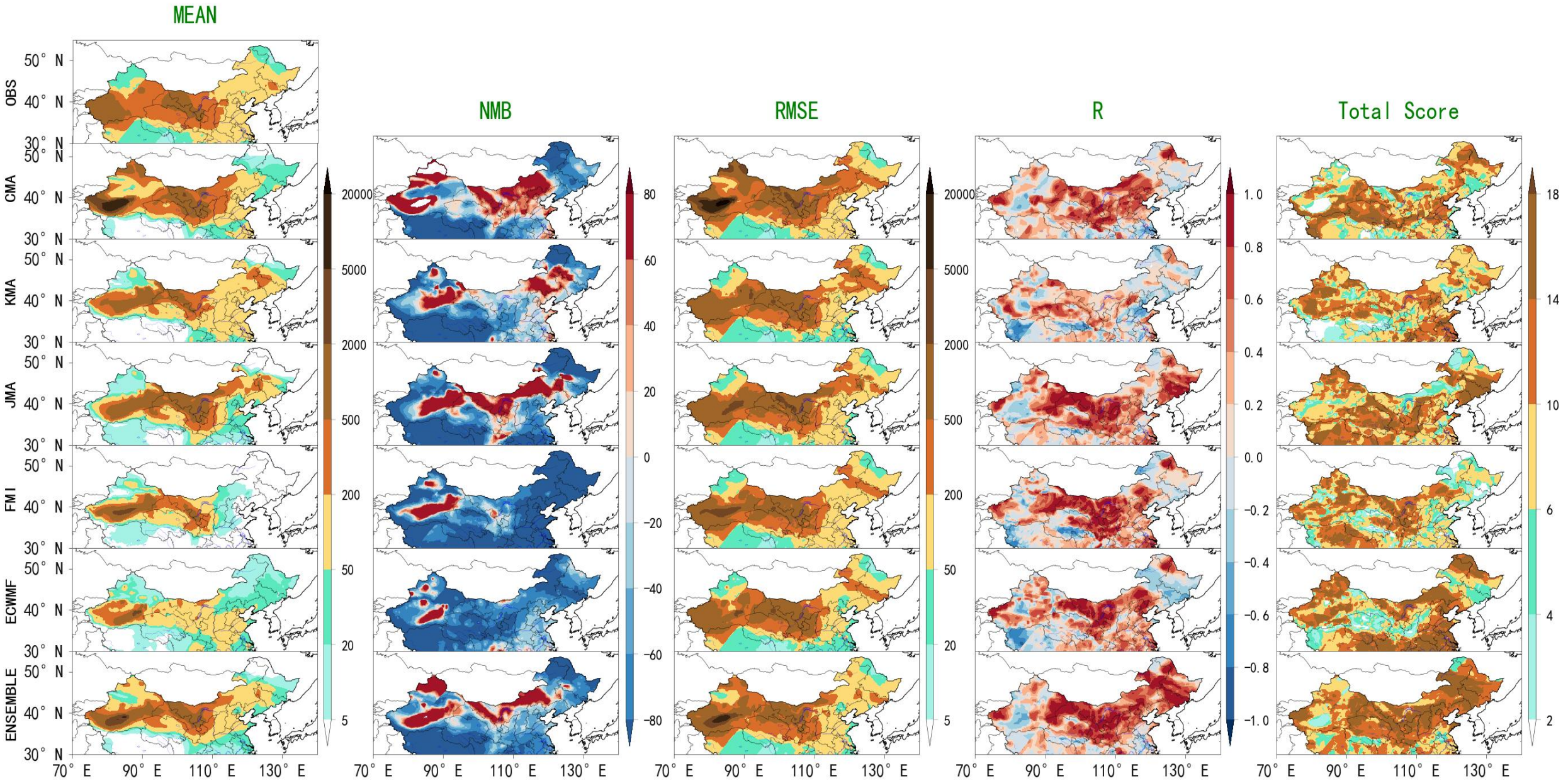
	SDS Observed		
SDS Forecasted		YES	NO
	YES	NA	NB
	NO	NC	ND

Threat Score: $TS=\frac{NA}{NA+NB+NC}$

Miss Ratio: $MR=\frac{NC}{NA+NC}$

False Alarm: $FAR=\frac{NB}{NA+NB}$

Case2: Severe SDS process of 18–21 Apr. 2023



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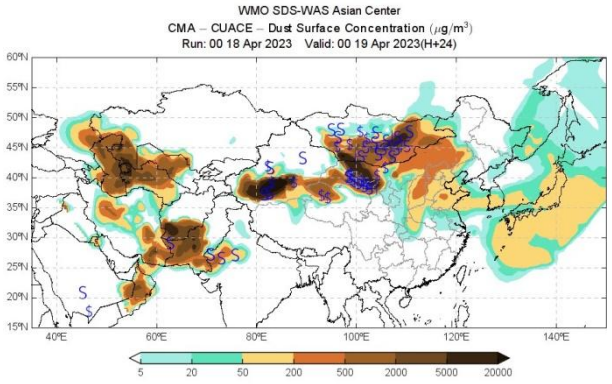

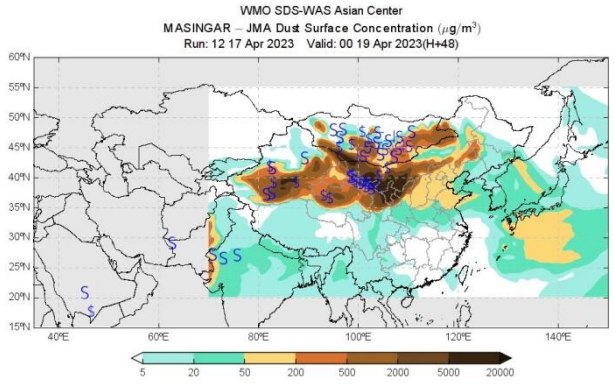

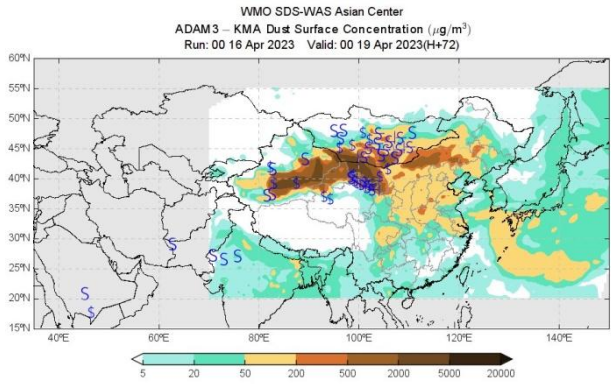

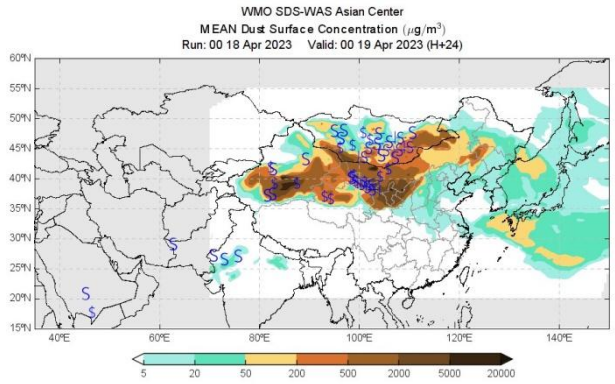

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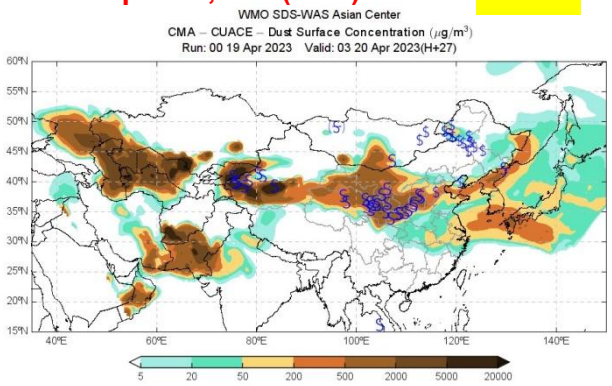
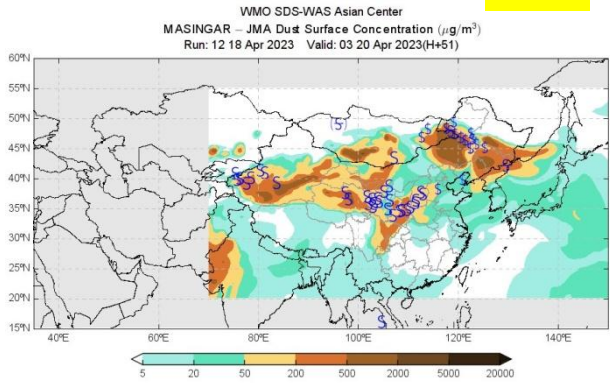
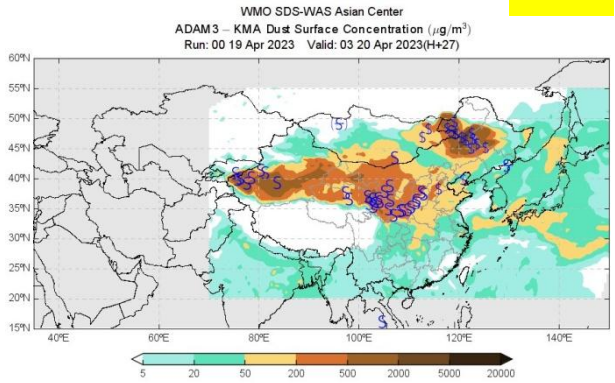
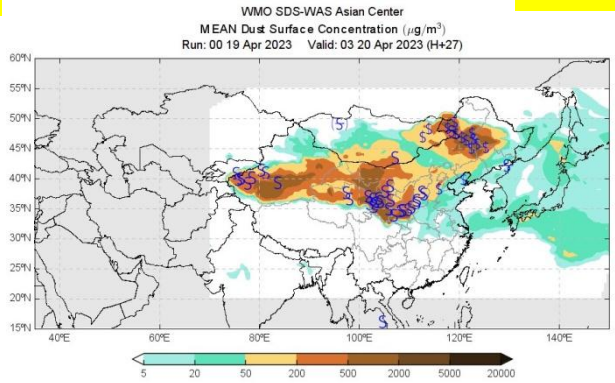
CMA JMA KMA ENS

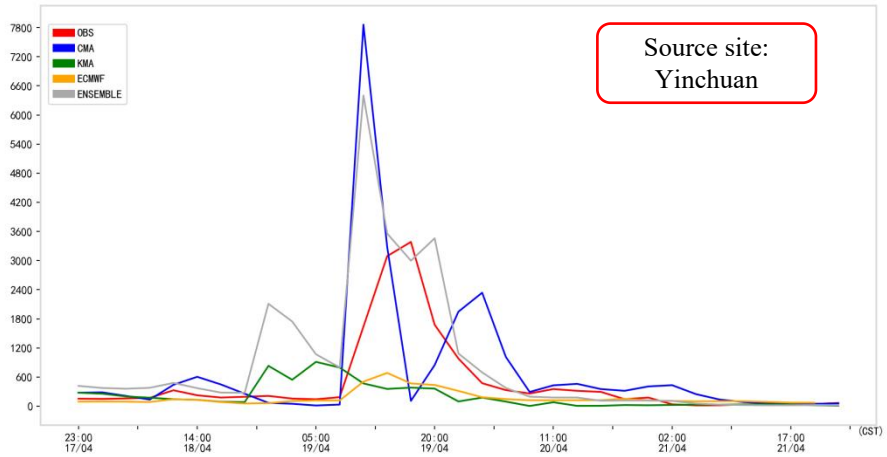


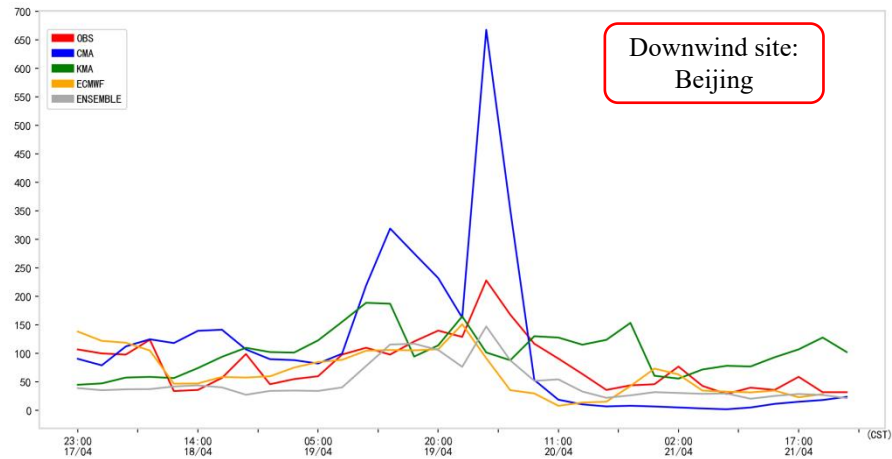


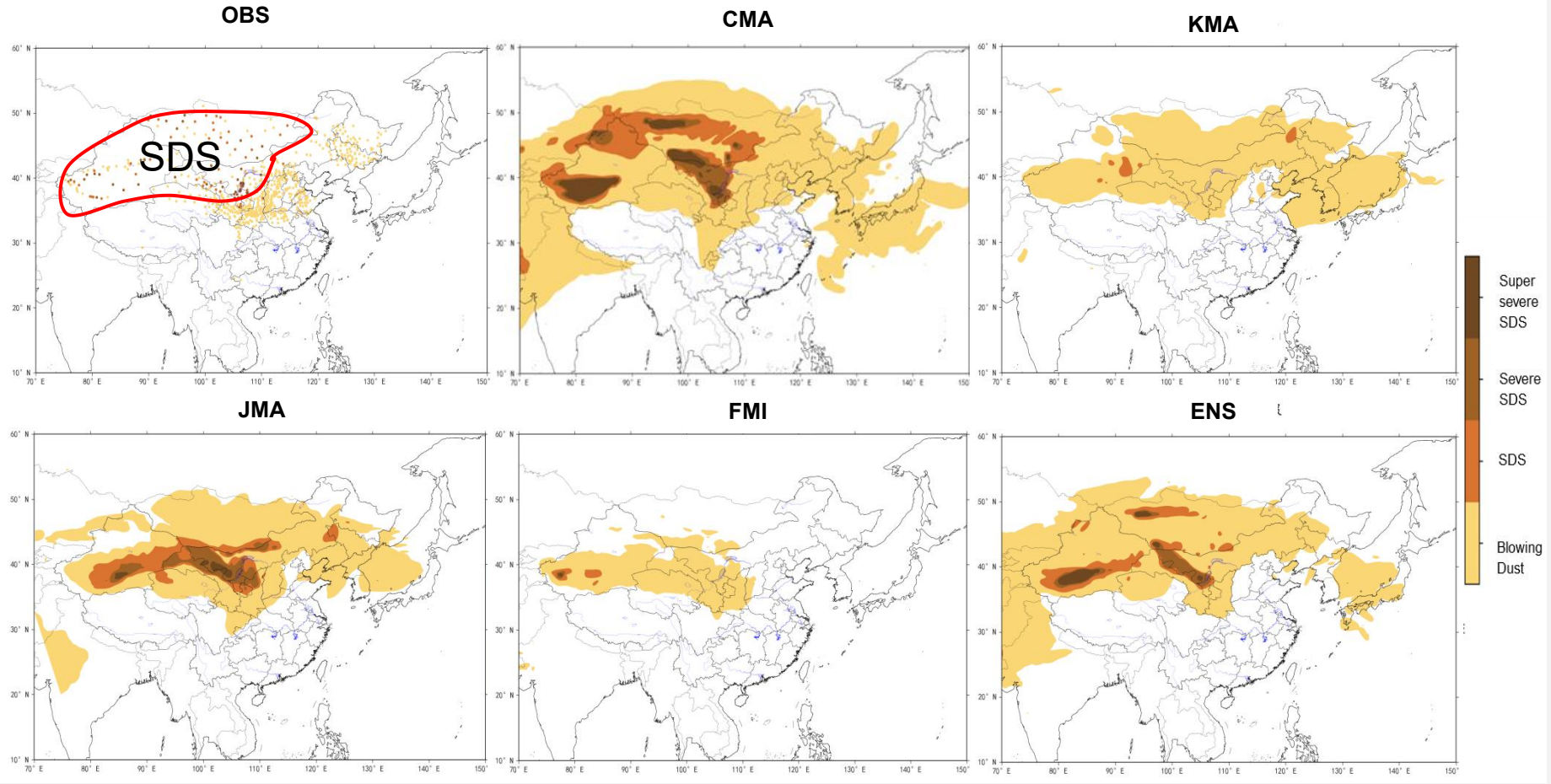


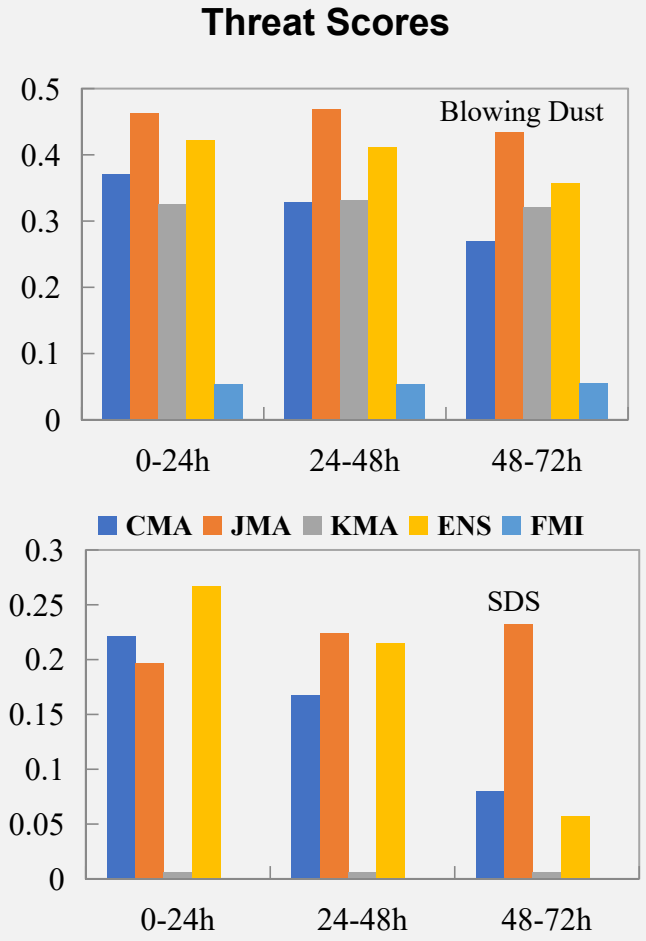


PM Concentration (Fcst vs. Obs)



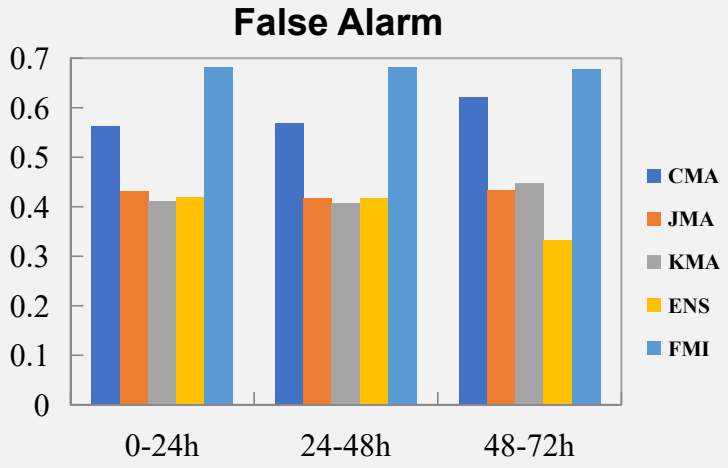


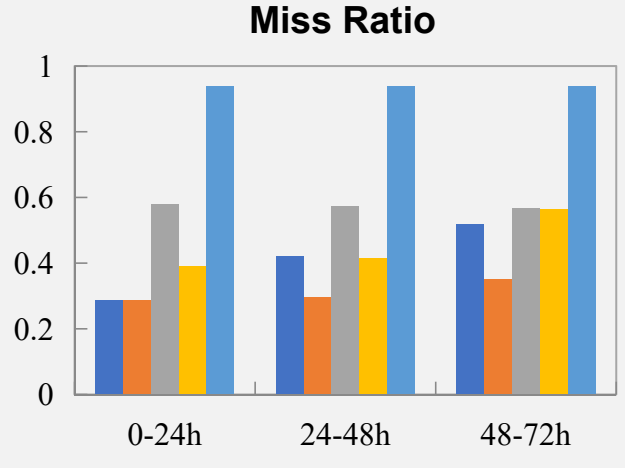




April 18-21, 2023 (CST)

Sever SDS Process





Focus on China and Mongolia

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. Especially for the variation trend of surface dust concentration, the CMA predictions were extremely consistent with observations. 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.

Contents

Future Work

- **Gridding observed dust concentration could be improved by merging of observations from FY4A satellite and surface PM concentration.**

- **Using spatial verification to analyze the time series variation of forecast attributes for each dust operational model, such as location, intensity and so on.**