

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

Environmental Meteorological Center of CMA

OCT 18th, 2022, Beijing, China

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**Background**



**Verification**



**Future Work**



# 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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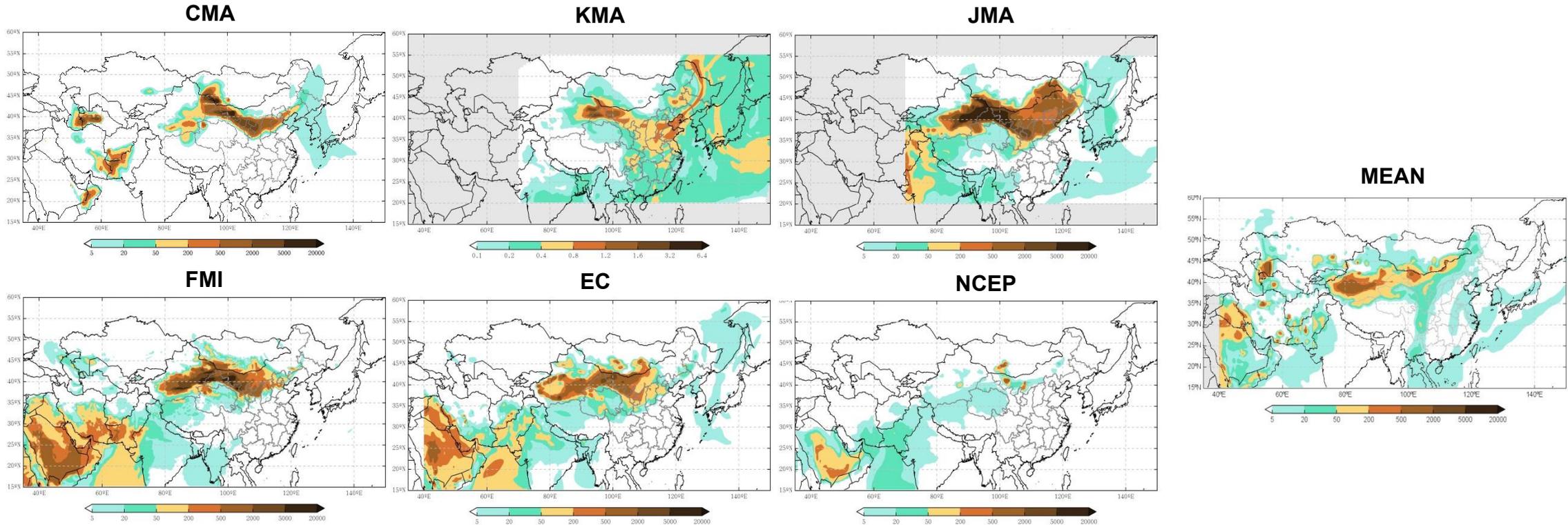
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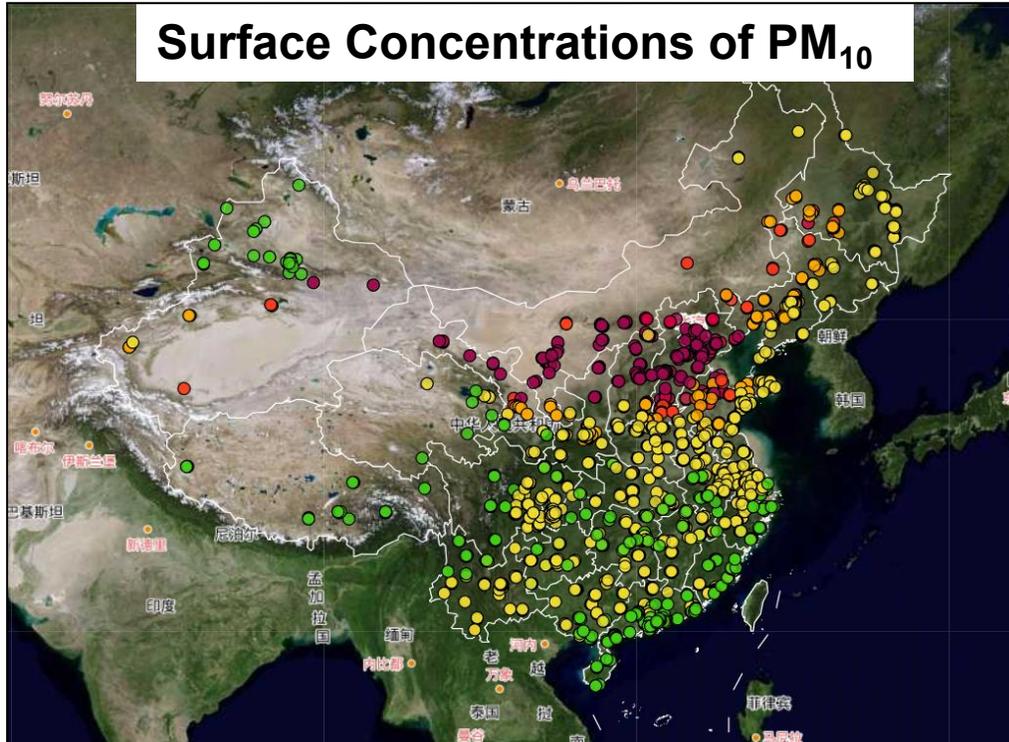
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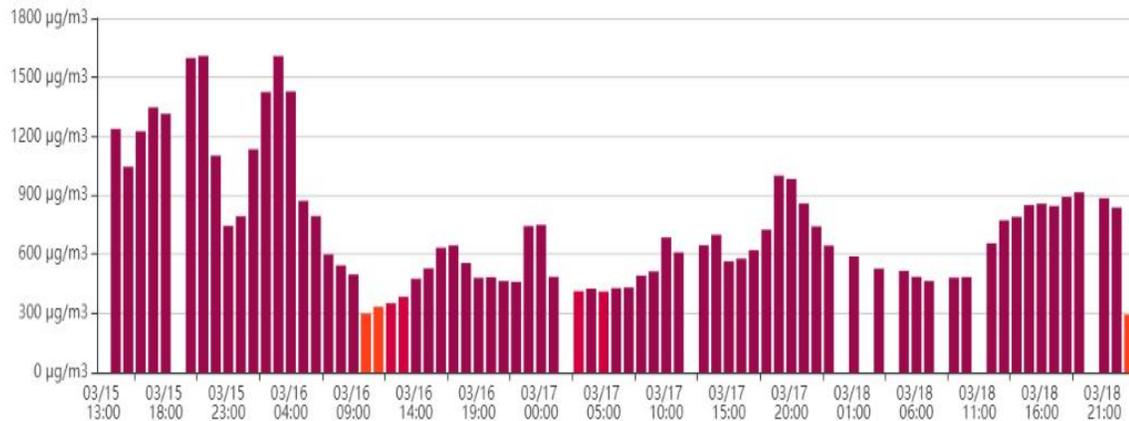
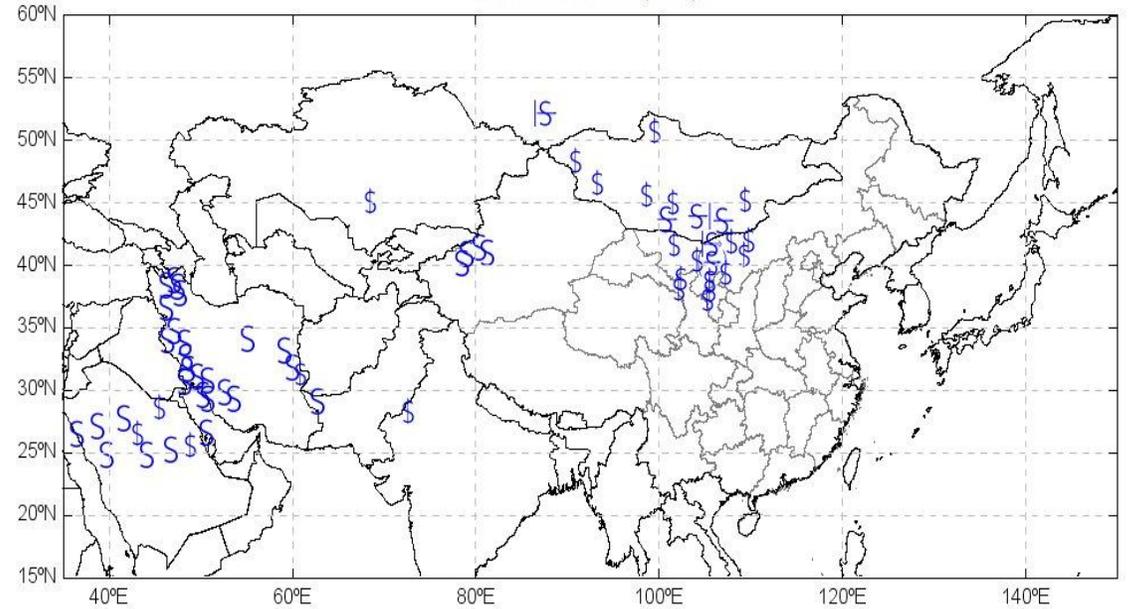


There are ‘6+1’ numerical dust forecast models have been running operationally in the RSMC-ASDF Beijing.

# Routine Observation Data



## Observed Weather Phenomena

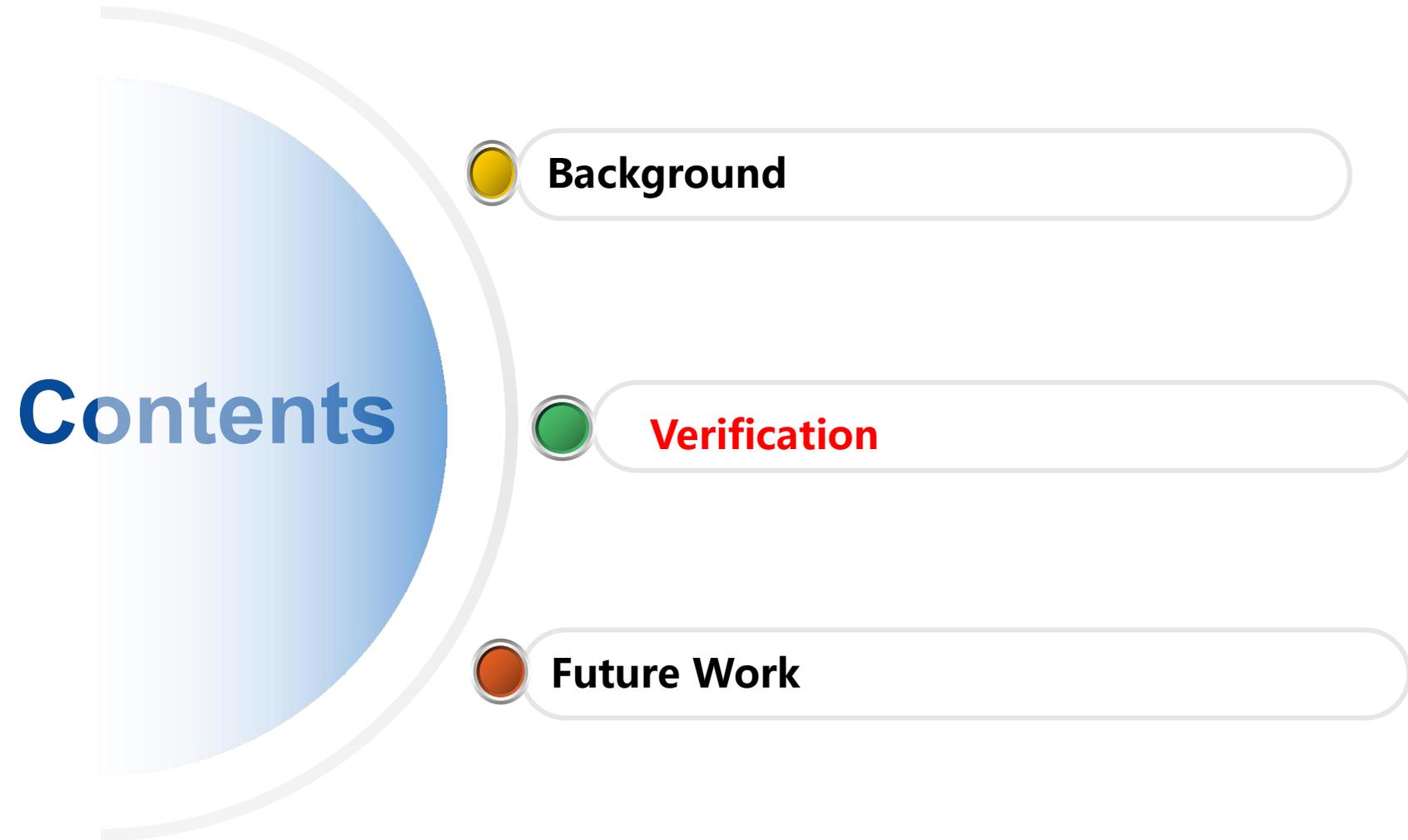


## Observation objects:

◆ PM<sub>10</sub> surface concentration

◆ Dust weather phenomena

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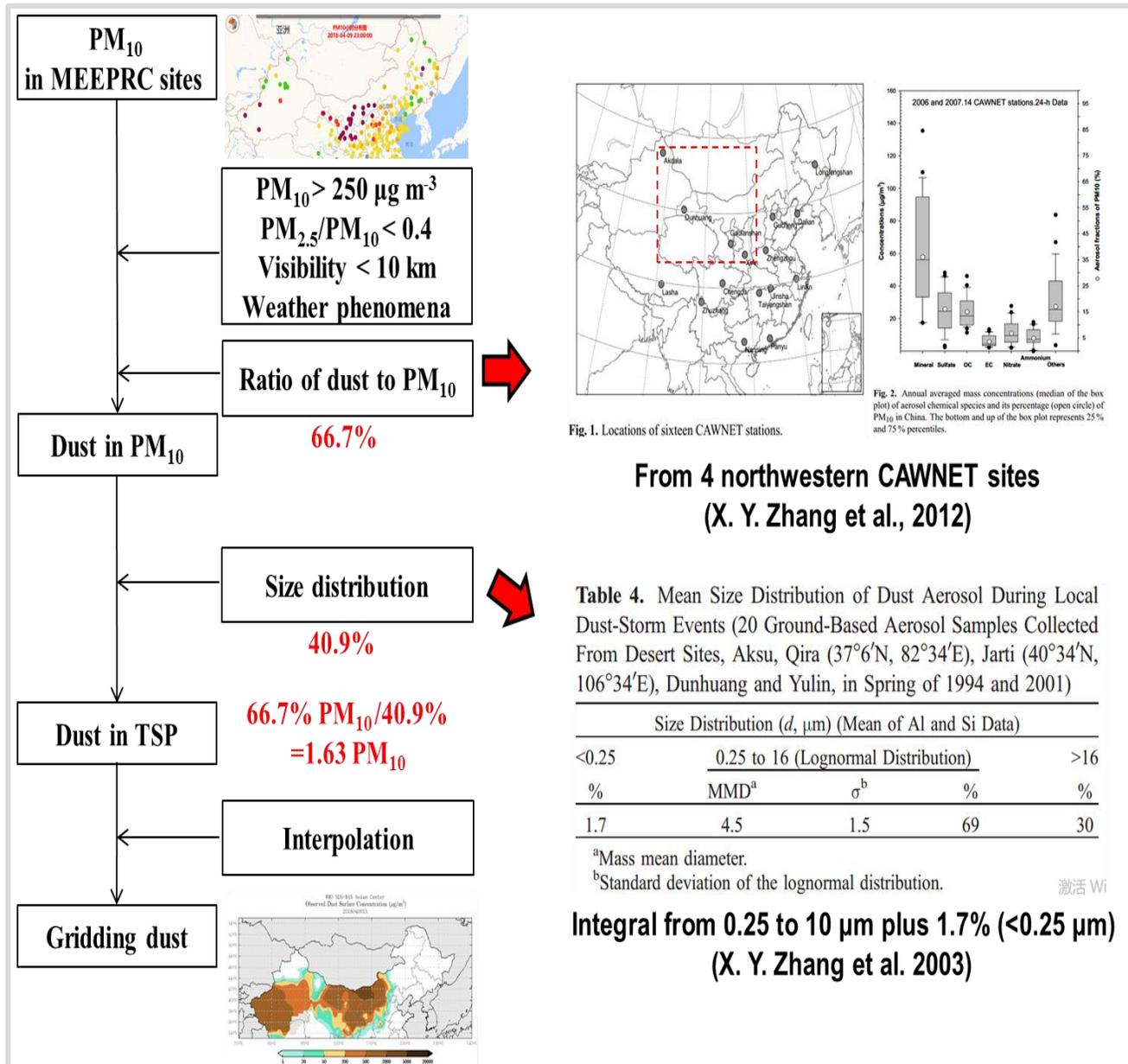


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# Evaluation Indicators



**Absolute value of NMB**

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

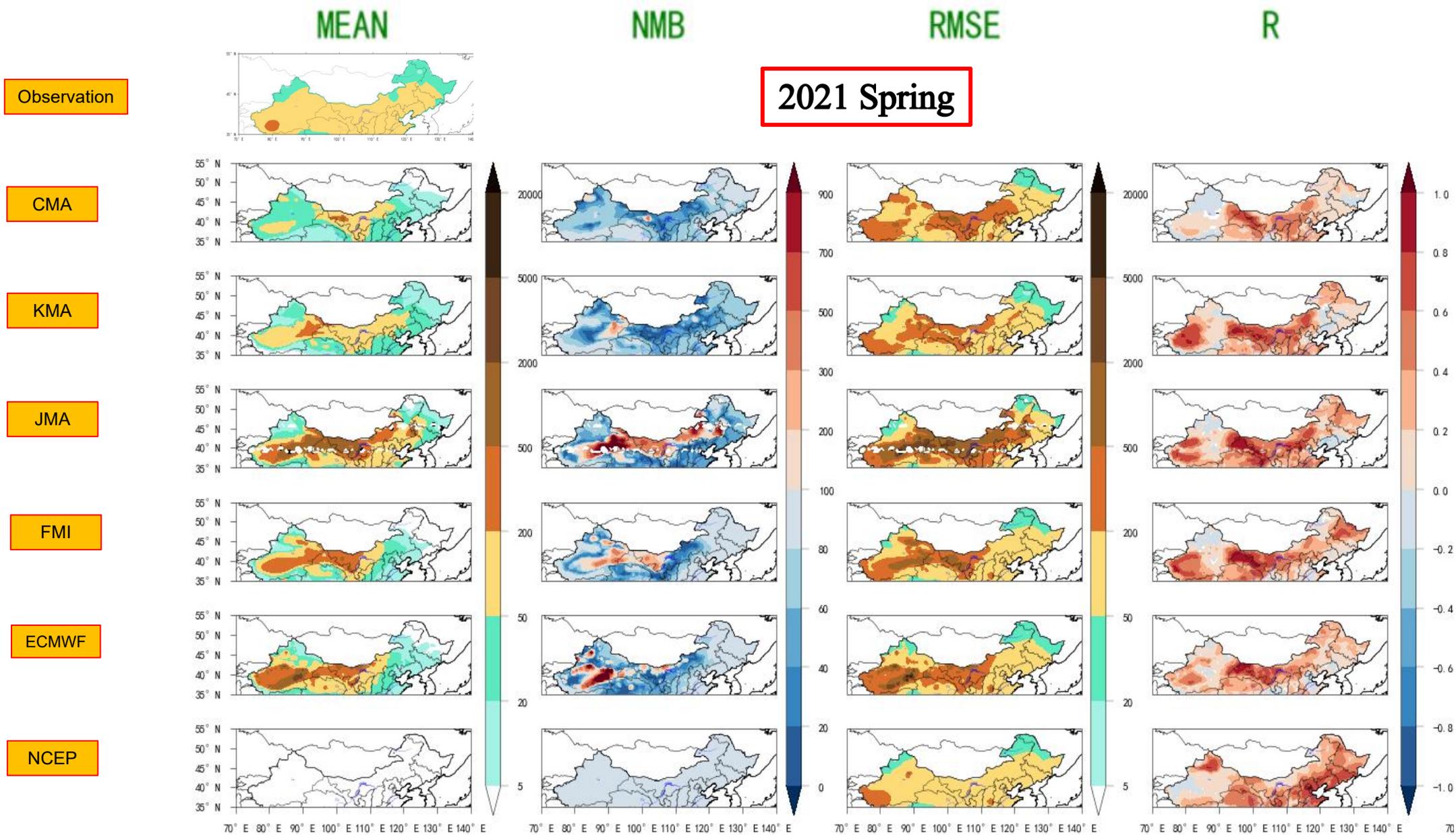
**Root Mean Square Error**

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

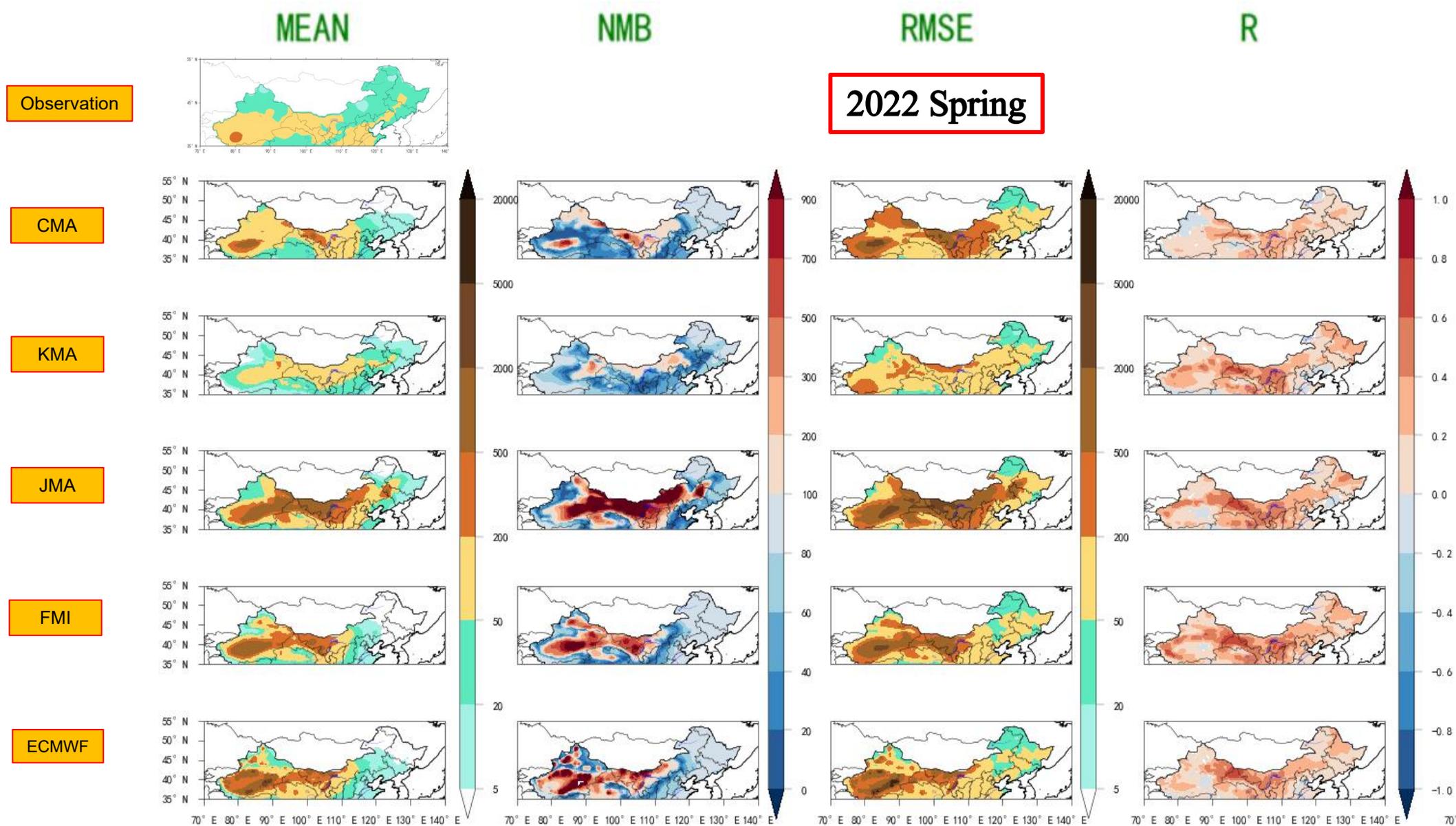
**Correlation coefficient**

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

# Comparisons with surface PM concentration



# Comparisons with surface PM concentration



# Severe SDS process of 13–18 March 2021

CMA

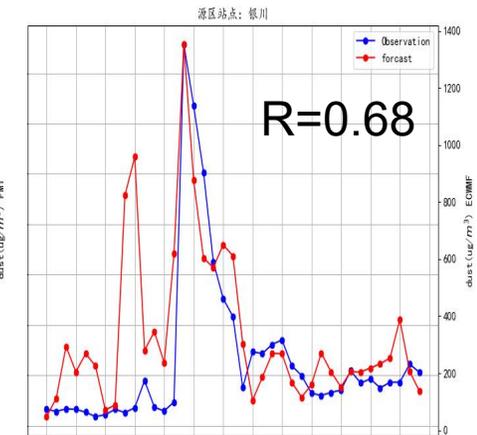
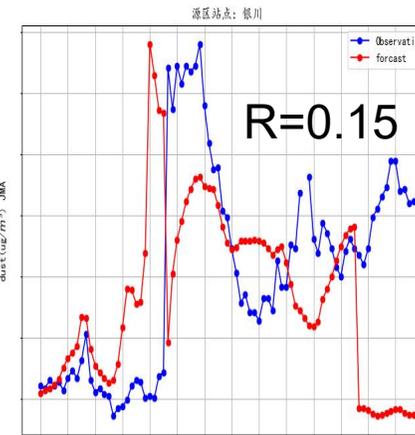
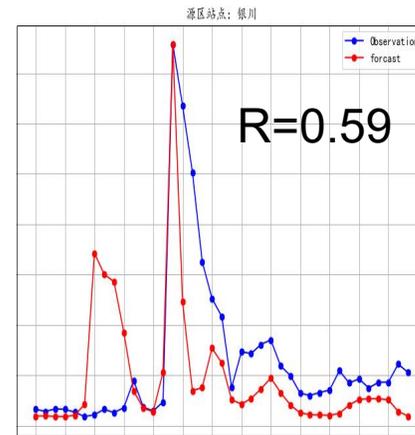
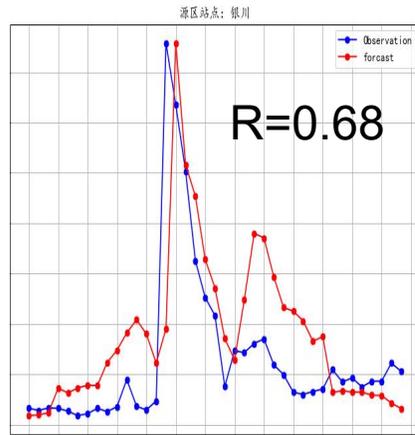
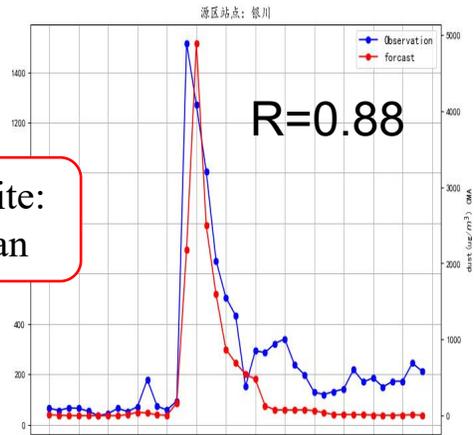
KMA

JMA

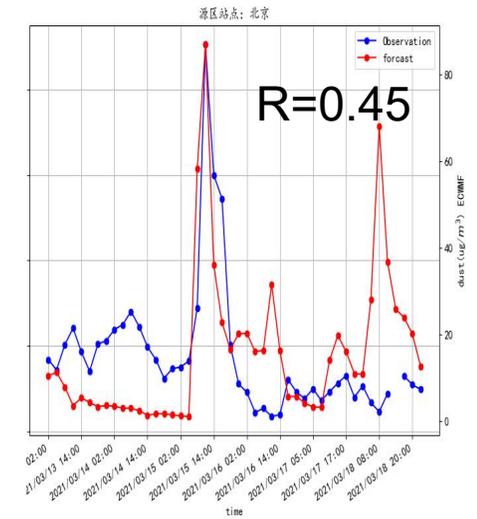
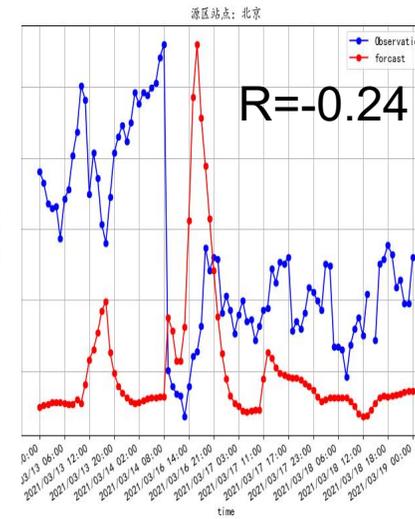
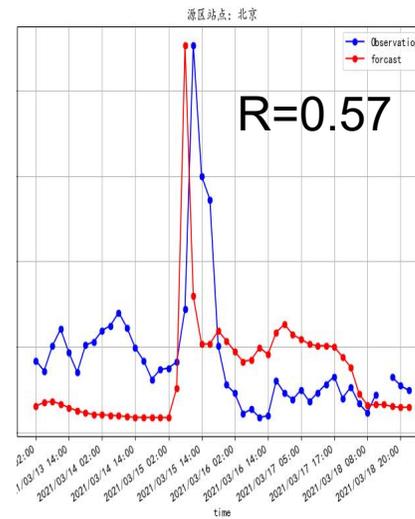
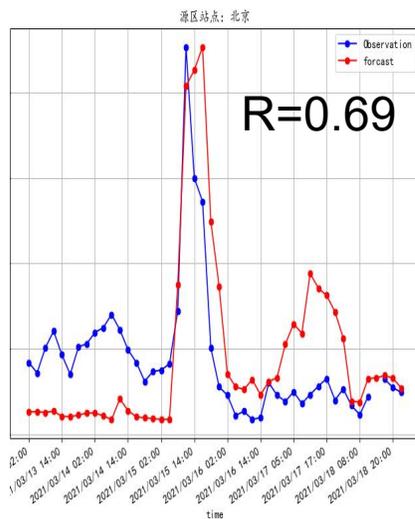
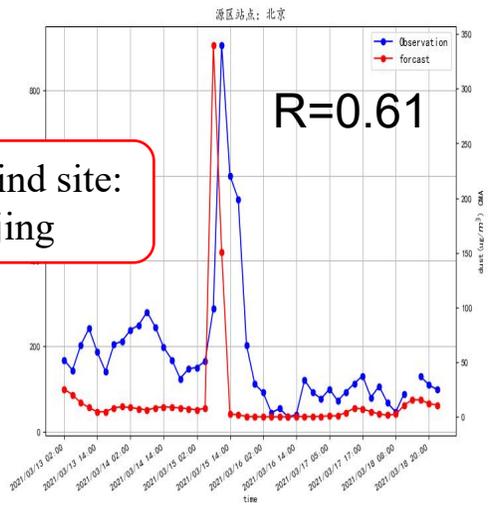
FMI

ECMWF

Source site:  
Yinchuan



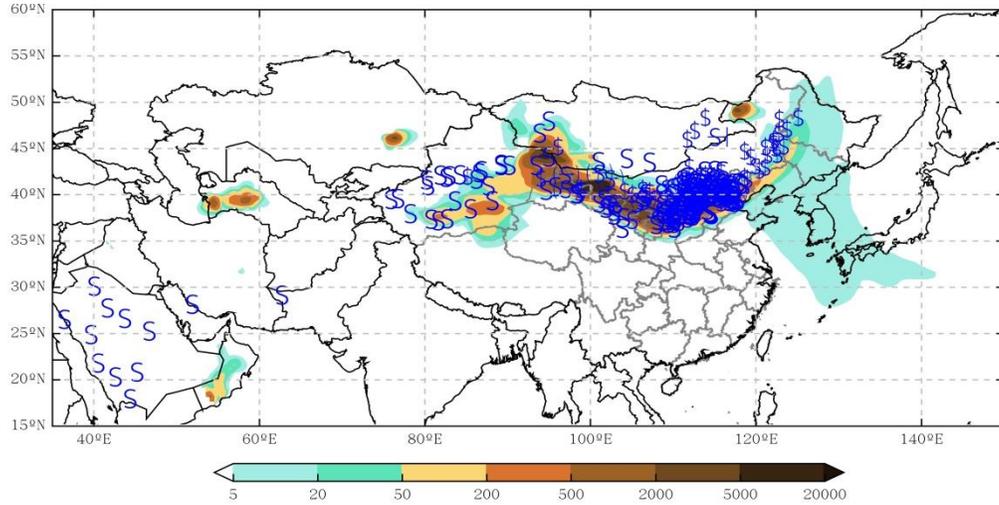
Downwind site:  
Beijing



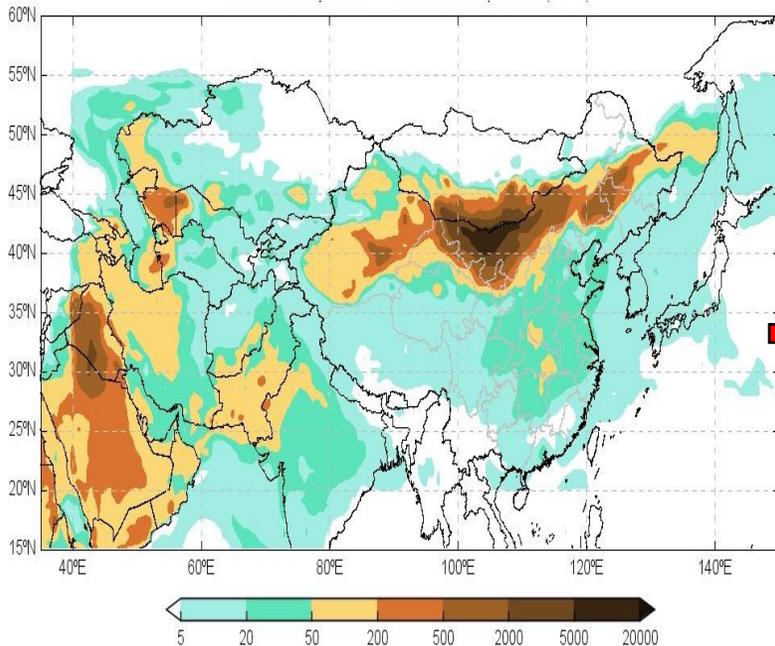
# Upgrade to SDS graded forecast

Can we develop a method that can convert the surface concentration into dust weather phenomena?

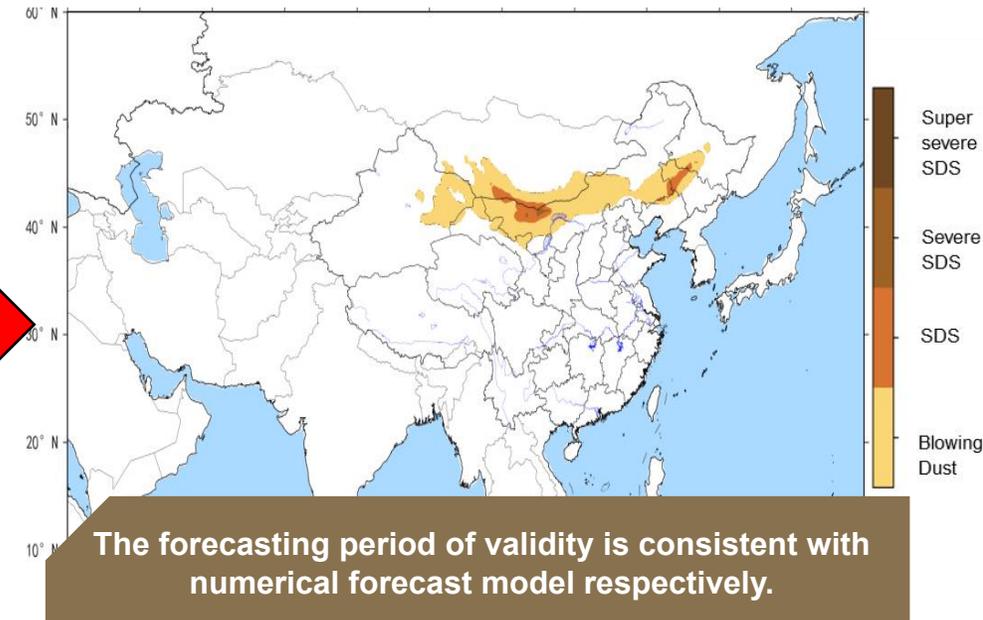
Based on operational dust model forecast dataset and observation weather phenomena during spring from 2018 to 2020, the quantitative relationships between dust weather grades and forecasting concentration have been established by probability matching.



How about the accuracy?



	Blowing Dust	SDS	Severe SDS	Super Severe SDS
Southern Xinjiang Basin	510~3400	3401~11500	11501~35100	≥35101
Northwestern	730~18500	18501~43700	≥43701	--
Northeast	870~5800	5801~23800	≥23801	--
Other	1040~6900	6901~18900	≥18901	--



# Evaluation based on SDS weather phenomena

## Threat Score (TS) system

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

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

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

Forecast Accuracy:  $AC = \frac{NA + ND}{NA + NB + NC + ND}$

## Mean TS scoring in spring time

2021	CMA	KMA	JMA	FMI	MME	2022	CMA	KMA	JMA	FMI	MME
TS	0.29	0.33	0.23	0.2	0.32	TS	0.18	0.2	0.2	0.28	0.3
MR	0.67	0.44	0.53	0.48	0.43	MR	0.69	0.59	0.52	0.39	0.36
FAR	0.67	0.55	0.68	0.76	0.62	FAR	0.68	0.72	0.74	0.66	0.63
AC	0.93	0.94	0.92	0.88	0.92	AC	0.95	0.95	0.94	0.95	0.95

## SDS processes during spring from 2021 to 2022

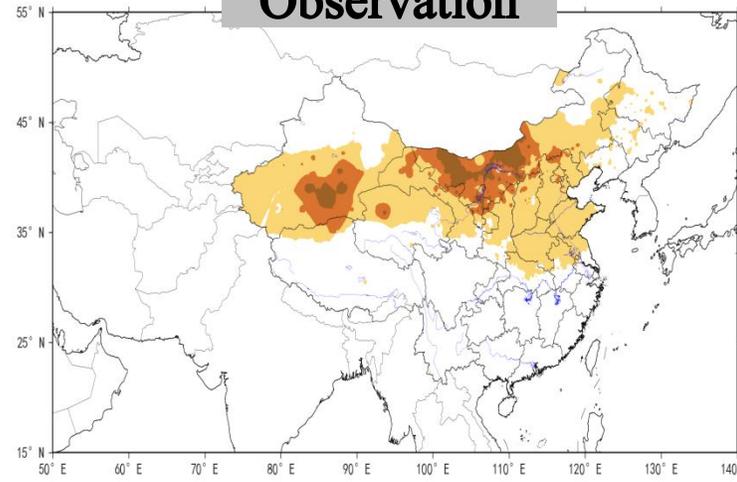
	SDS Observed		
	YES	NO	
SDS Forecasted	YES	NA	NB
	NO	NC	ND

Class	TS-24					TS-48					TS-72				
	CMA	KMA	JMA	FMI	MME	CMA	KMA	JMA	FMI	MME	CMA	KMA	JMA	FMI	MME
2021.3.13-3.18 Severe SDS	0.33	0.42	0.31	0.26	0.44	0.31	0.38	0.34	0.3	0.34	0.2	0.35	0.23	0.33	0.35
2021.3.27-4.1 Severe SDS	0.32	0.36	0.35	0.15	0.31	0.28	0.32	0.17	0.19	0.29	0.14	0.16	0.1	0.07	0.12
2021.4.14-4.16 SDS	0.5	0.62	0.5	0.56	0.55	0.36	0.49	0.38	0.43	0.48	0.11	0.29	0.03	0.2	0.27
2021.5.6-5.8 SDS	0.48	0.59	0.41	0.48	0.51	0.32	0.35	0.11	0.25	0.32	0.14	0.16	0.09	0.11	0.21
2022.3.13-3.16 SDS	0.35	0.37	0.38	0.44	0.43	0.29	0.25	0.29	0.37	0.36	0.29	0.1	0.23	0.2	0.26

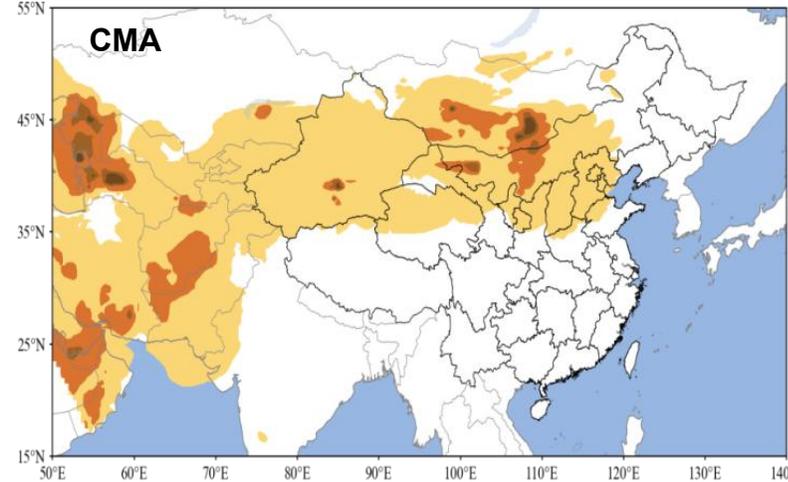
# Severe SDS process of 13–18 March 2021

## SDS Graded Forecast

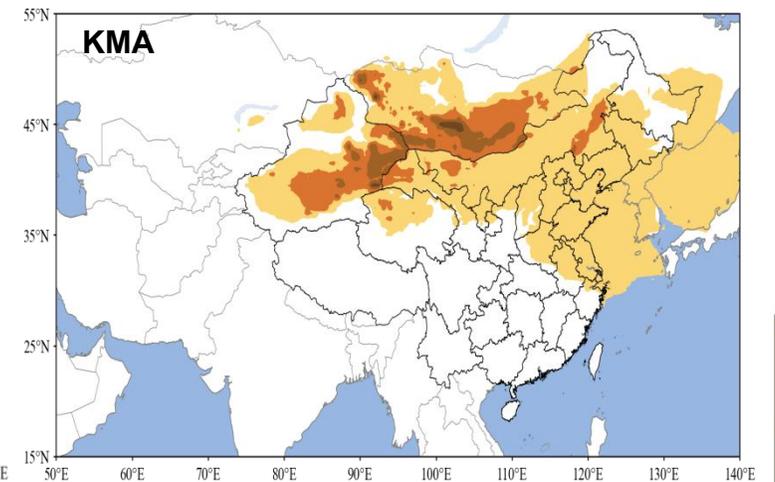
### Observation



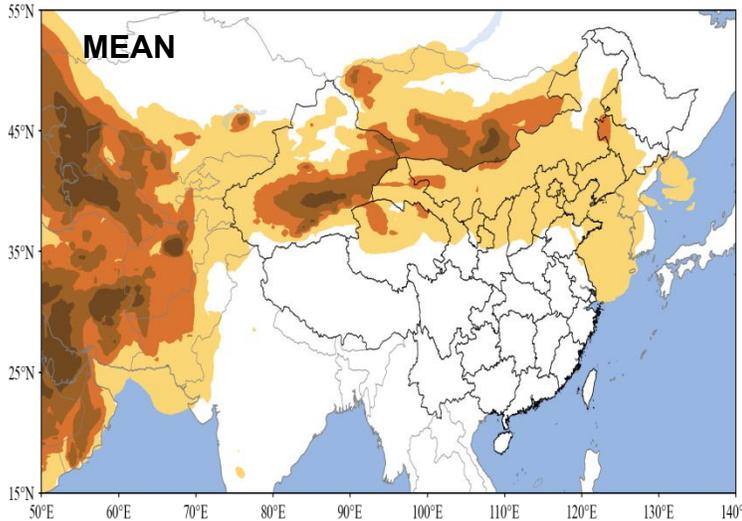
### CMA



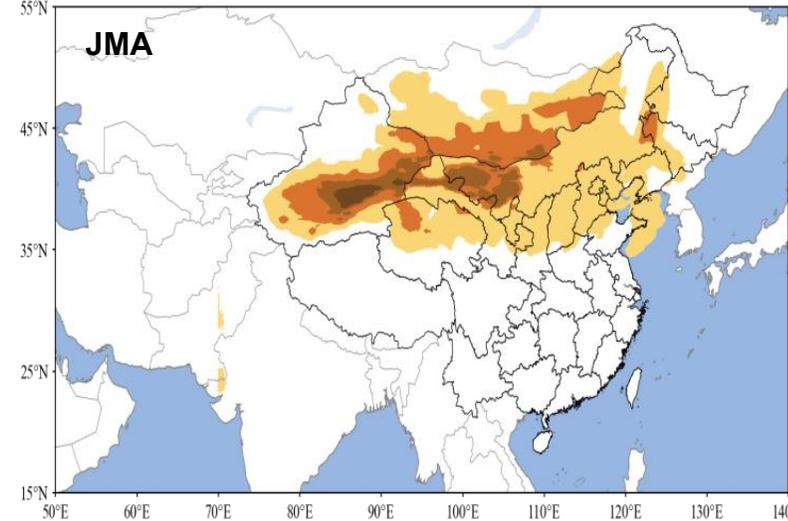
### KMA



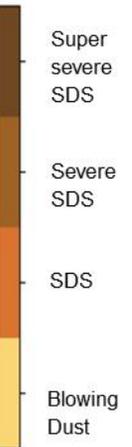
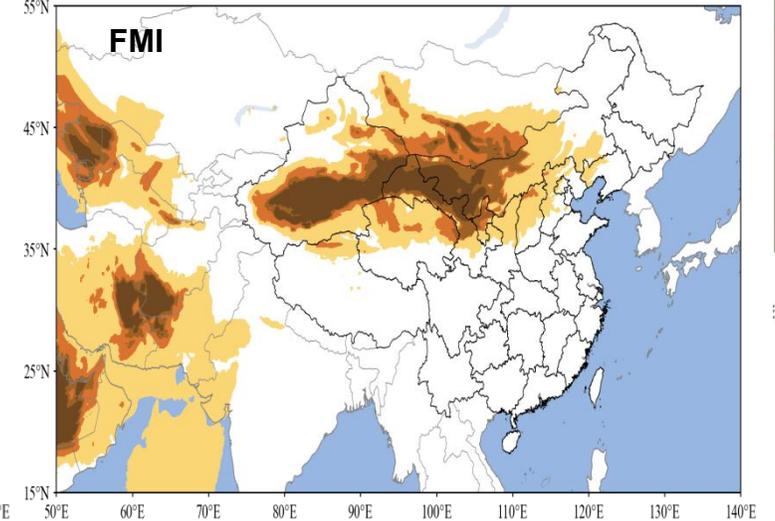
### MEAN



### JMA

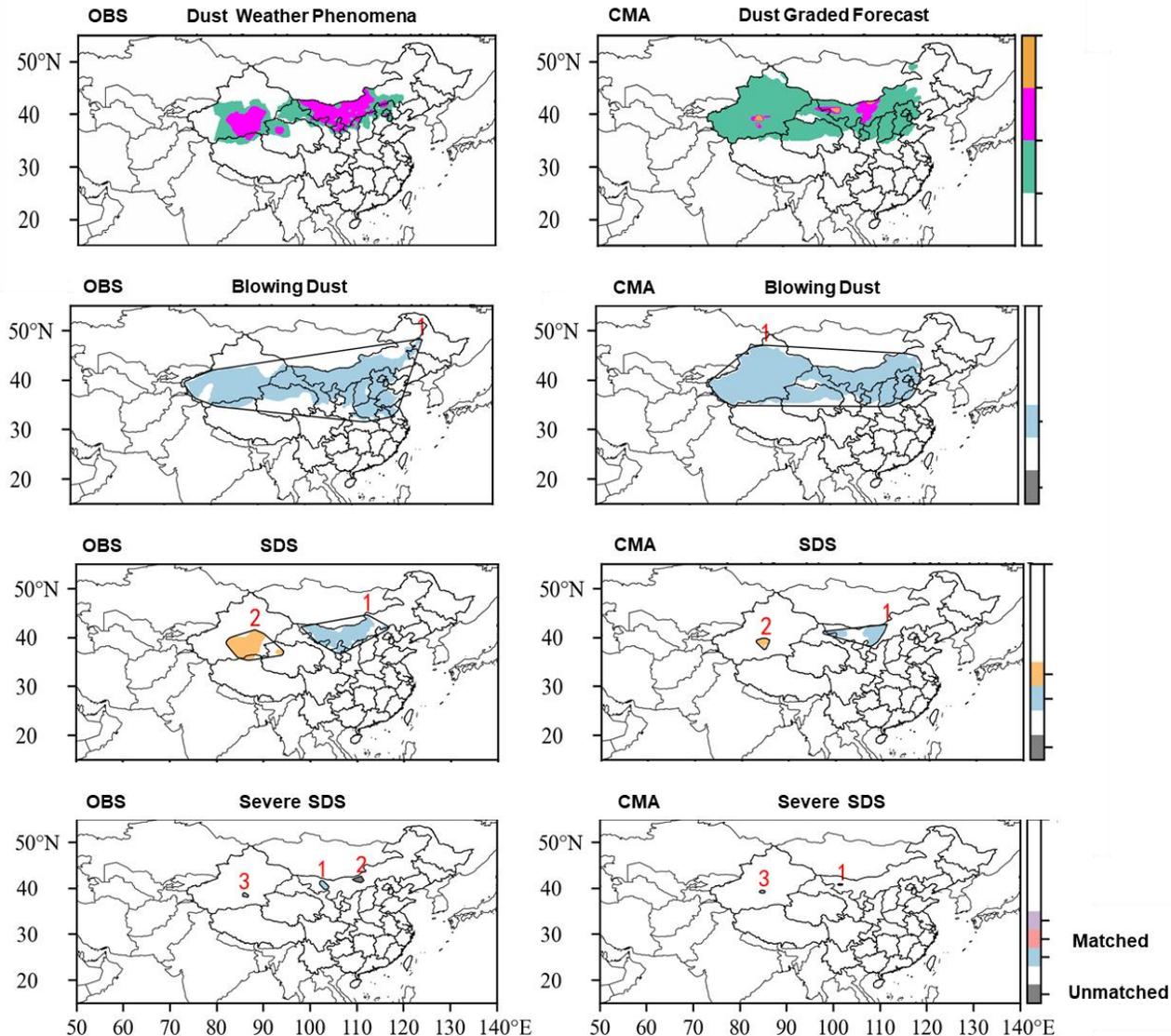


### FMI

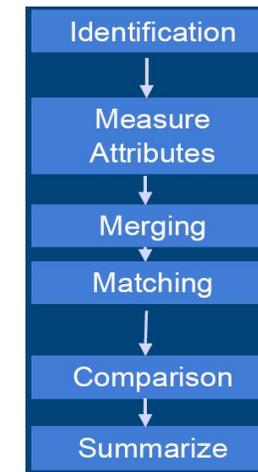


# Spatial evaluation results of a typical case

## CMA



- Spatial evaluation is based on target recognition technology, which can evaluate the deviation of the position, shape, area, intensity and other attributes of matched targets, and take the overall **similarity** as a comprehensive indicator to reflect the prediction performance of the model.



Target Similarity: BD : 0.74  
 SDS: 0.73 (T1), 0.59 (T2)  
 SSDS: 0.53(T1) , 0.69 (T3)

# Observation

# KMA

# JMA

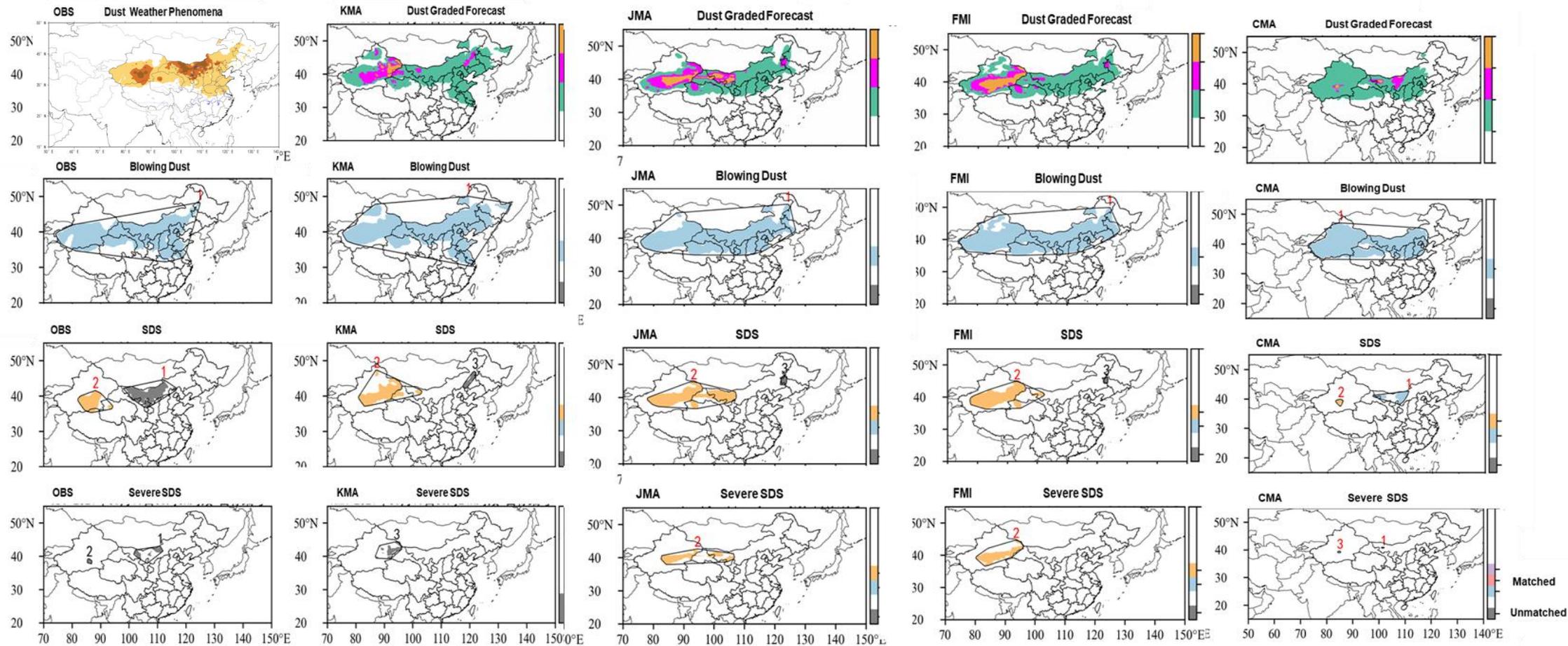
# FMI

# CMA

Blowing Dust

SDS

Severe SDS



Target Similarity:

BD :	0.73	0.84	0.86	0.74
SDS:	0.63(T2)	0.67(T2)	0.58(T2)	0.73 (T1), 0.59 (T2)
SSDS:	--	0.52(T2)	0.13(T2)	0.53(T1) , 0.69 (T2)

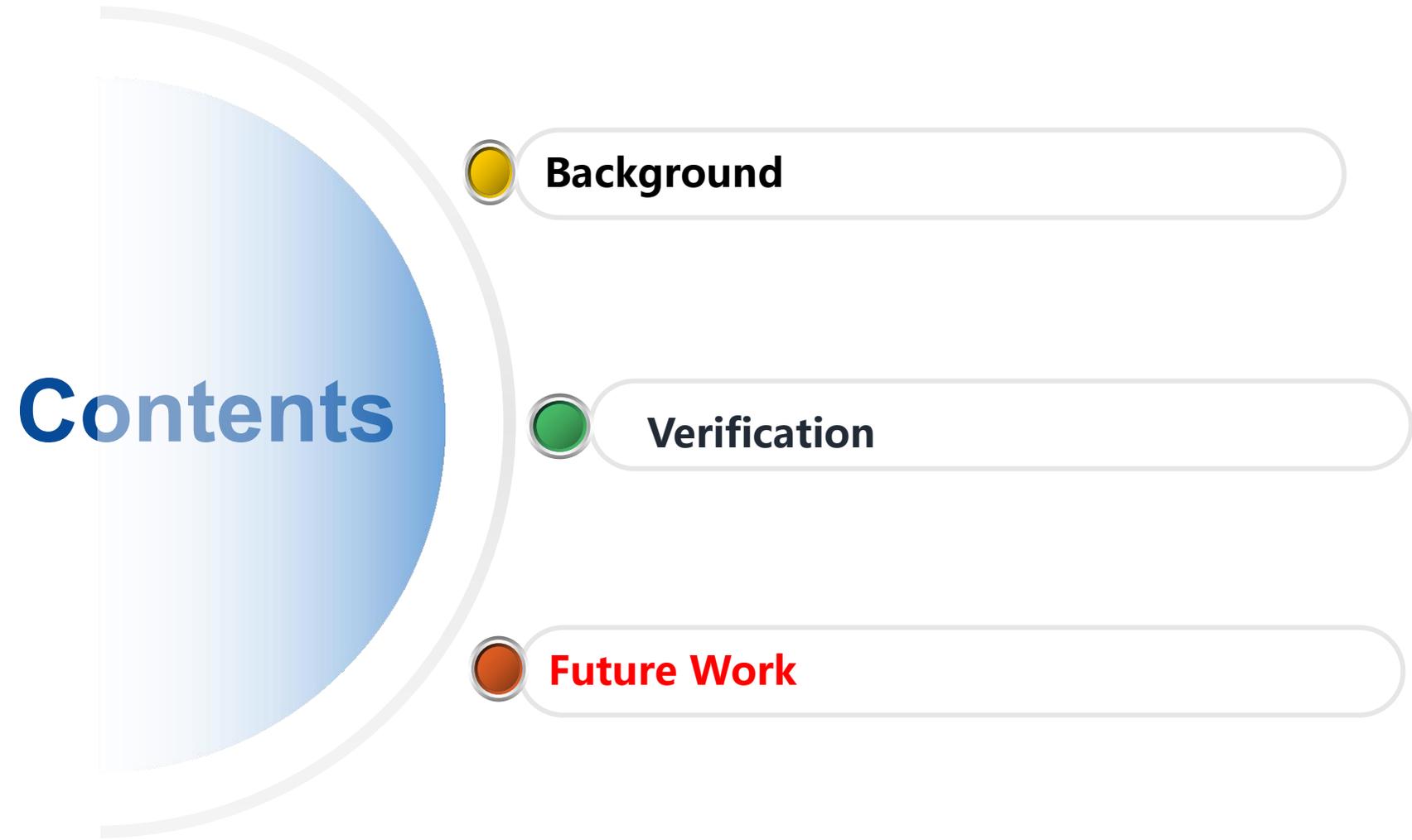
## Conclusion

In the severe SDS process, operational mean dust forecast could catch the trend of time series of observed dust concentration in both dust source and downwind sites.

In spring, operational mean dust forecast showed a strong positive correlation with observations in northern China, but overestimated the dust concentration in dust source regions, especially in central and western Inner Mongolia.

The above means that mean dust forecast can provide a reference for forecasters, especially judging the occurrence and end time of SDS for a certain region.

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# Future Work

- The gridded dust concentrations could be achieved by merging FY4A satellite observations with surface PM concentration.**
- Using spatial verification to evaluate the performance of each dust operational model, including location, intensity and so on.**