EGU General Assembly 2022

Correspondence: yao.yao@cug.edu.cn
hzq77@cug.edu.cn

Variation characteristics and driving factors of $PM_{2.5}$ and PM_{10} concentrations in the Yangtze River Economic Belt

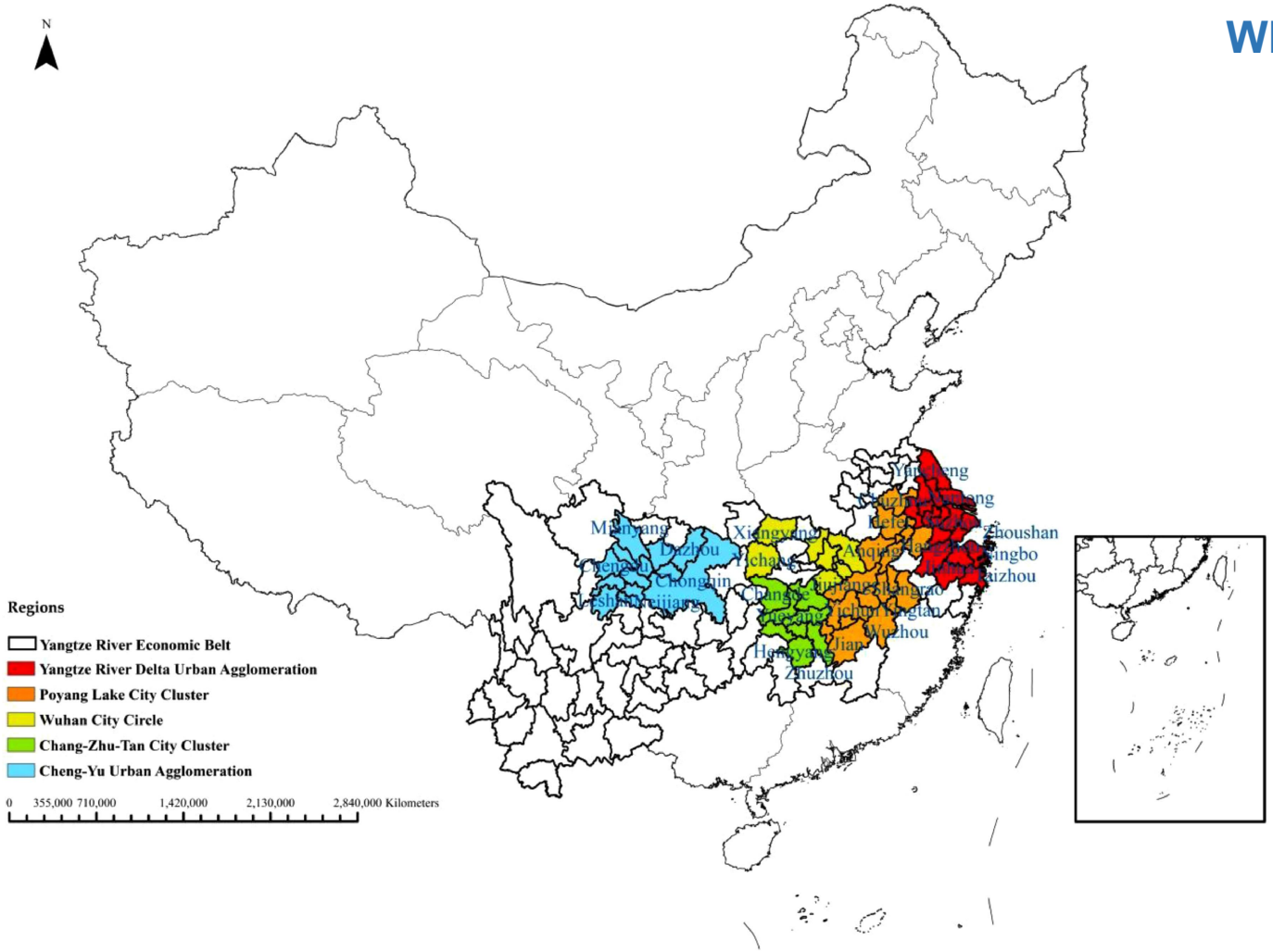
Yao Yao[1] and Ziqi He[2]

[1]China University of Geosciences, School of environmrntal studies, Department of Environmental Science and Engineering, Wuhan, China
[2]China University of Geosciences, School of environmrntal studies, Department of Hydrology and Water Resources Engineering, Wuhan, China

QR code

26 May 2022

Background & Motivation



Liu et al. (2020) Technological Forecasting and Social Change

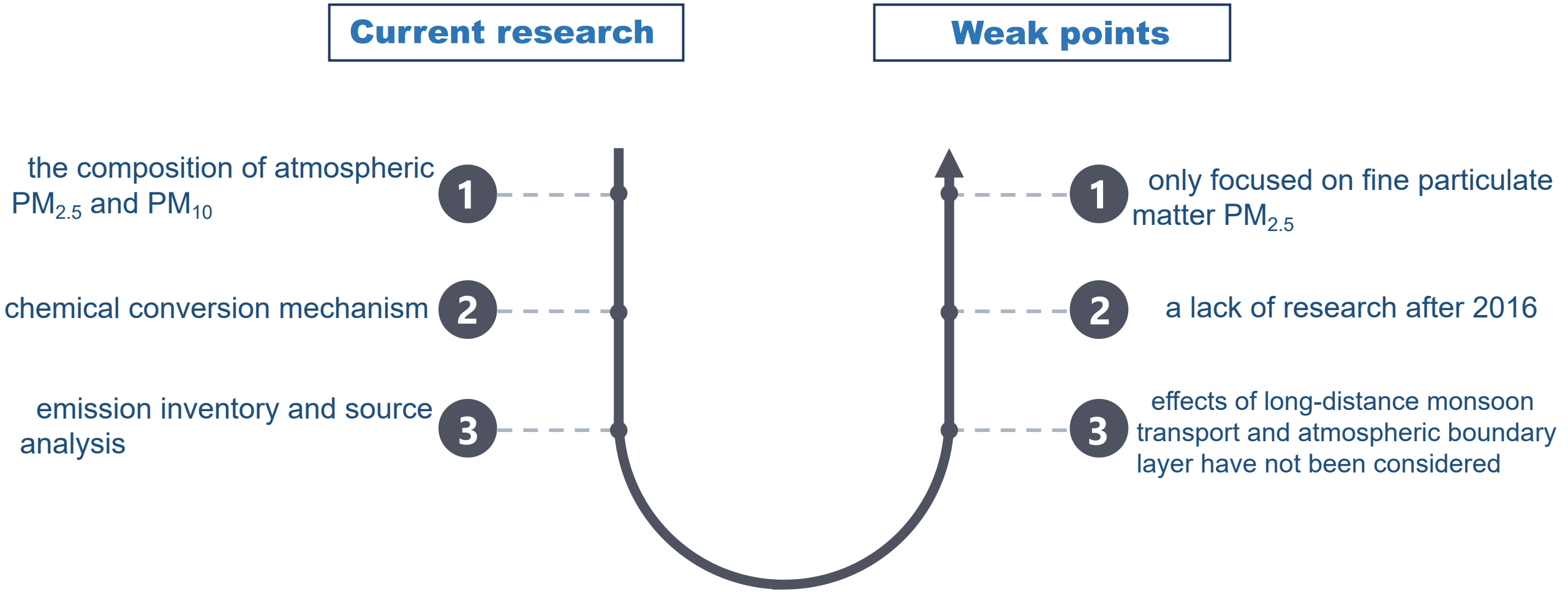
What is the Yangtze River Economic Belt?

- spans the three major regions of East, Central and West China
- covering 11 provinces and cities
- regional GDP accounts for more than 40% of the country's total

The current grim situation

- ✓ high density of population, industry layout and energy consumption
- ✓ highly polluting production lifestyle

Current research progress & Weak points



Data source and quality control

Air pollutants concentration:

- China's environmental monitoring station national urban air quality real-time publishing platform (http://106.37.208.233:20035/)
- air quality monitoring analysis of online platform (https://www.aqistudy.cn/)

Social and economic indicators:

- the Yangtze river economic belt big data platform (http://yreb.sozdata.com/)
- the National Bureau of Statistics released by the China city statistical yearbook
- each city national economic development and statistical bulletin in 2018

Temporal variation characteristics of $PM_{2.5}$ and PM_{10} concentrations

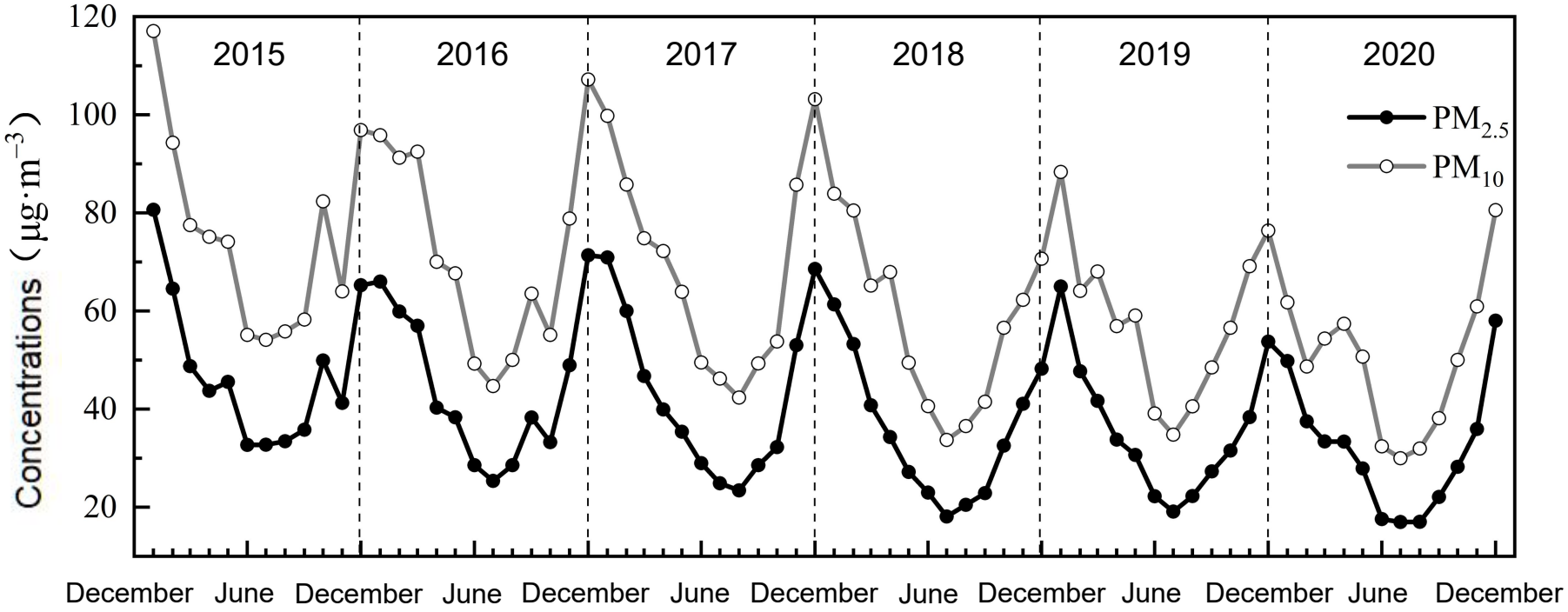


Fig.1 Time series of $PM_{2.5}$ and PM_{10} concentration in the Yangtze River Economic Belt from 2015 to 2020

- The concentrations of $PM_{2.5}$ and PM_{10} in the Yangtze River Economic Belt both decreased significantly with time from 2015 to 2020, accompanied by obvious seasonal cycle characteristics.
- $PM_{2.5}$ and PM_{10} in the Yangtze River Economic Belt generally show the characteristics of high in winter and low in summer.
- Overall, the atmospheric $PM_{2.5}$ and PM_{10} pollution in the Yangtze River Economic Belt is gradually improving.

Temporal variation characteristics of $PM_{2.5}$ and PM_{10} concentrations

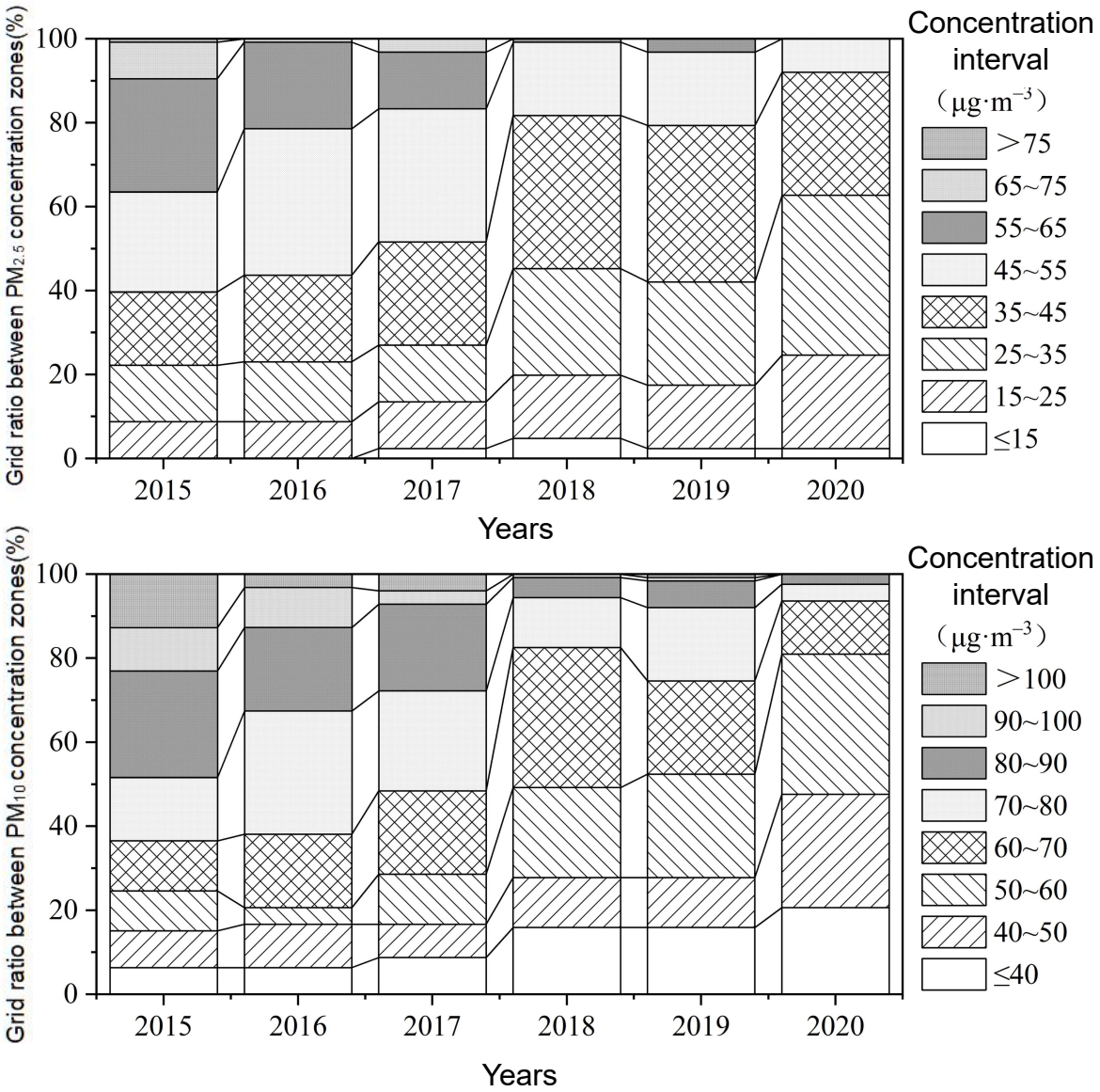


Fig. 2 Raster percentage of $PM_{2.5}$ and PM_{10} concentration by range in the Yangtze River Ecinomic Belt from 2015 to 2020

- From 2015 to 2020, the proportion of grids with annual average $PM_{2.5}$ concentration ≤35 μg·m^{-3} has experienced a process of first increasing, then slightly decreasing and then increasing.
- An inflection point appeared in 2018 and 2019.
- After rising from 22.22% in 2015 to 45.24% in 2018, then slightly dropped to 42.06% in 2019, and then increased back to 62.70% in 2020.

Correlation analysis of $PM_{2.5}$ and PM_{10} and other air pollutants in different seasons

Table 1 Pearson correlation coefficients of six atmospheric pollutant concentrations in the Yangtze River Economic Belt in different seasons

(spring)	$PM_{2.5}$	PM_{10}	SO_2	CO	NO_2	O_3
$PM_{2.5}$	1.000					
PM_{10}	0.955***	1.000				
SO_2	0.836***	0.873***	1.000			
CO	0.870***	0.877***	0.918***	1.000		
NO_2	0.761***	0.753***	0.478*	0.680**	1.000	
O_3	-0.602**	-0.437	-0.351	-0.469*	-0.445	1.000

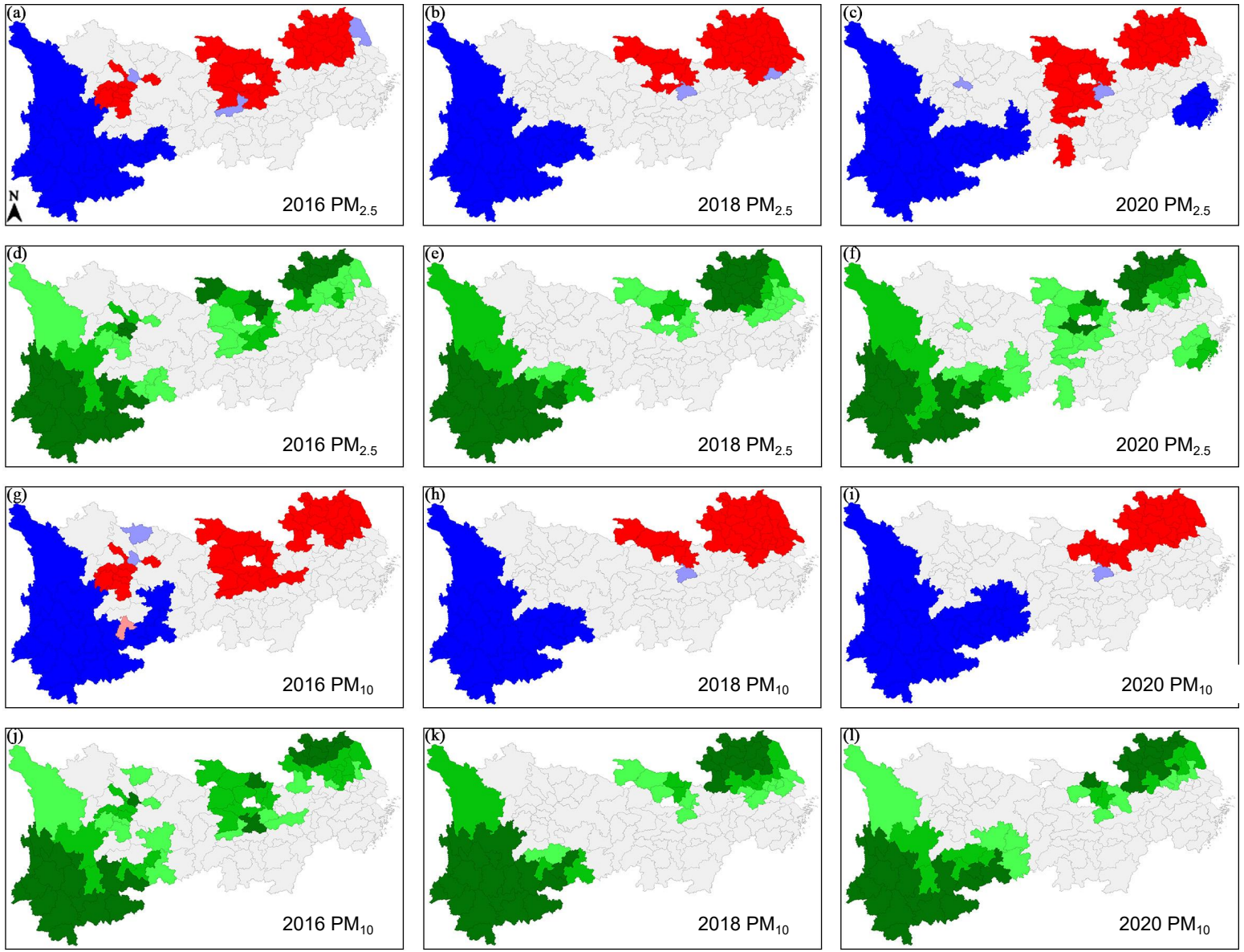
(summer)	$PM_{2.5}$	PM_{10}	SO_2	CO	NO_2	O_3
$PM_{2.5}$	1.000					
PM_{10}	0.994***	1.000				
SO_2	0.936***	0.940***	1.000			
CO	0.820***	0.852***	0.805***	1.000		
NO_2	0.881***	0.898***	0.771***	0.894***	1.000	
O_3	0.110	0.157	-0.088	0.202	0.307	1.000

(fall)	$PM_{2.5}$	PM_{10}	SO_2	CO	NO_2	O_3
$PM_{2.5}$	1.000					
PM_{10}	0.983***	1.000				
SO_2	0.747***	0.697**	1.000			
CO	0.759***	0.673**	0.821***	1.000		
NO_2	0.875***	0.877***	0.391	0.591**	1.000	
O_3	-0.496*	-0.437	-0.228	-0.552*	-0.692**	1.000

(winter)	$PM_{2.5}$	PM_{10}	SO_2	CO	NO_2	O_3
$PM_{2.5}$	1.000					
PM_{10}	0.976***	1.000				
SO_2	0.858***	0.899***	1.000			
CO	0.956***	0.940***	0.894***	1.000		
NO_2	0.745***	0.758***	0.506*	0.618**	1.000	
O_3	-0.297**	-0.262	-0.079	-0.210	-0.658**	1.000

- The Pearson correlation coefficients of $PM_{2.5}$ and PM_{10} in spring, summer, autumn and winter of the Yangtze River Economic Belt are all above 0.950, close to 1, and significantly correlated at the level of 0.001, indicating that there is a significant positive correlation between $PM_{2.5}$ and PM_{10}, and the homology is good.

The spatial agglomeration characteristics of atmospheric $PM_{2.5}$ and PM_{10} concentrations



- The atmospheric $PM_{2.5}$ and PM_{10} in the Yangtze River Economic Belt have obvious agglomeration characteristics in local space.

Fig. 3 Spatial cluster feature and significance feature of $PM_{2.5}$ and PM_{10} in the Yangtze River Economic Belt based on local Moran′s I

Backward trajectory analysis of atmospheric $PM_{2.5}$ and PM_{10} pollution process

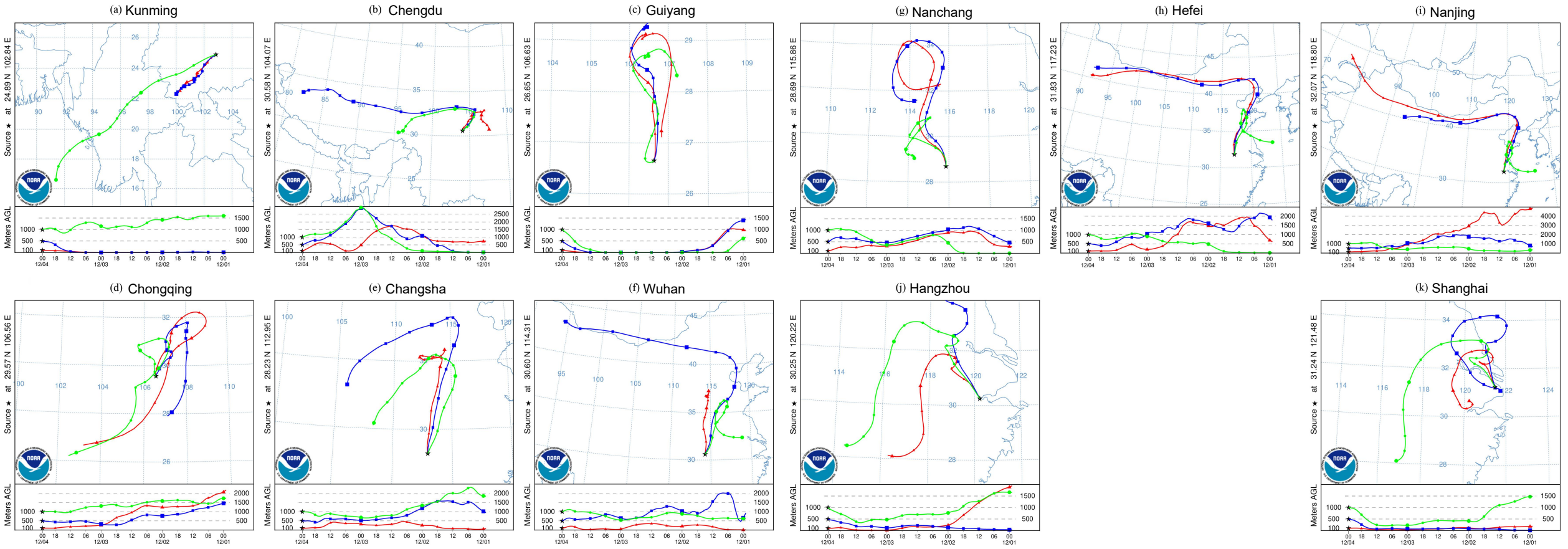


Fig. 4 72 h backward trajectrories analysis of air masses of capital cities in the Yangtze River Economic Belt in December, 2018 (red line: 100 m AGL; blue line: 100 m AGL; green line: 100 m AGL)

- The long-distance air transport and atmospheric boundary layer conditions have significant impact on the accumulation, transport, diffusion and deposition of $PM_{2.5}$ and PM_{10} in the Yangtze River Economic Belt.

The influence of socio-economic factors on changes in $PM_{2.5}$ and PM_{10} concentrations

Table 2 Estimation results of OLS, SLM and SEM

Variable	OLS				SLM				SEM			
	$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}		$PM_{2.5}$		PM_{10}	
	coefficent	t	coefficent	t	coefficent	Z	coefficent	Z	coefficent	Z	coefficent	Z
lngdp	0.103***	3.578	0.070**	3.039	0.084***	3.476	0.059**	2.936	0.097***	4.728	0.062***	3.827
lnindustry	0.449**	3.089	0.313**	2.679	0.281*	2.288	0.202*	1.957	0.379***	3.669	0.294***	3.581
lngreen	0.259	0.996	0.187	0.899	0.254	1.181	0.183	1.011	0.137	0.718	-0.004	-0.023
lnpopden	-0.007	-0.251	0.014	0.650	-0.012	-0.538	0.007	0.391	0.004	0.208	0.020	1.391
Constant term	-0.755	-0.670	0.903	1.00	-0.863	-0.923	0.670	0.890	-0.070**	-0.087	1.734**	2.705
$W \ln PM_i$	/	/	/	/	0.315***	5.795	0.218***	5.071	/	/	/	/
$W\varepsilon$					/	/	/	/	0.748***	11.894	0.746***	11.800
R^2	0.202		0.162		0.425		0.342		0.652		0.643	
LogL	-6.161		18.117		10.701		30.841		29.966		55.547	
AIC	22.323		-26.234		-9.403		-49.682		-49.933		-101.094	
SC	35.870		-12.687		6.854		-33.425		-36.385		-87.546	
N	111		111		111		111		111		111	

- The influence intensity on $PM_{2.5}$ and PM_{10} concentration in the Yangtze River Economic Belt is as follows: GDP > ratio of secondary industry > green coverage rate of built-up areas > population density.

Conclusion

- From 2015 to 2020, the annual average concentrations of $PM_{2.5}$ and PM_{10} in the Yangtze River Economic Belt showed a decreasing trend year by year, accompanied by significant seasonal periodic fluctuations, and generally showed a trend of high in winter and low in summer.
- There is a very significant correlation between $PM_{2.5}$ and PM_{10} with good homology.
- There is a positive spatial correlation between $PM_{2.5}$ and PM_{10} due to the joint action of themselves and neighboring region, and the spatial accumulation is relatively obvious.
- The changes in $PM_{2.5}$ and PM_{10} concentrations in the Yangtze River Economic Belt are also affected by long-distance monsoon transportation and atmospheric boundary layer conditions, and there are significant differences in the backward trajectory directions of air masses in urban agglomerations on the upper, middle and lower reaches of the Yangtze River.
- The influence degree of the four socio-economic variables on $PM_{2.5}$ and PM_{10} is as follows: GDP > ratio of secondary industry > green coverage rate of built-up areas > population density.

Reference

- Zhao X J, Zhao P S, Xu J, et al. Analysis of a winter regional haze event and its formation mechanism in the North China Plain[J]. Atmospheric Chemistry and Physics, 2013, 13(11): 5685-5696.
- Qin S, Liu F, Wang C, et al. Spatial-temporal analysis and projection of extreme particulate matter (PM_{10} and $PM_{2.5}$) levels using association rules: A case study of the Jing-Jin-Ji region, China[J]. Atmospheric Environment, 2015, 120: 339-350.
- Song X, Hao Y. Vehicular Emission Inventory and Reduction Scenario Analysis in the Yangtze River Delta, China[J]. International journal of environmental research and public health, 2019, 16(23): 4790.
- Hu J, Wang Y, Ying Q, et al. Spatial and temporal variability of $PM_{2.5}$ and PM_{10} over the North China Plain and the Yangtze River Delta, China[J]. Atmospheric Environment, 2014, 95: 598-609.
- Zhu W, Wang M, Zhang B. The effects of urbanization on $PM_{2.5}$ concentrations in China's Yangtze River Economic Belt: New evidence from spatial econometric analysis[J]. Journal of Cleaner Production, 2019, 239: 118065.
- Stępalska D, Myszkowska D, Piotrowicz K, et al. High Ambrosia pollen concentrations in Poland respecting the long distance transport (LDT)[J]. Science of The Total Environment, 2020: 139615.

This presentation participates in OSPP

Outstanding Student Poster & PICO Contest

EGU General Assembly 2022

Correspondence: yao.yao@cug.edu.cn
hzq77@cug.edu.cn

Thank you for your attention !

We look forward to the follow-up exchanges and discussions.

QR code

26 May 2022