

Table of contents

Figure S1. PM2.5 concentration sequences.	2
Figure S2. PM2.5 concentrations for different seasons.	2
Figure S3. EMD decomposition of the PM2.5 sequence of Beijing 1005A Station.	3
Figure S4. EMD decomposition of the PM2.5 sequence of Wuhan 1328A Station.	4
Figure S5. EMD decomposition of the PM2.5 sequence of Kunming 1454A Station.	5
Table S1 Statistical analysis of PM2.5 dataset.	6
Table S2 Results of the one sample t-test.	6
Table S3 Classification of IMFs.	7
Table S4 Features selected by mRMR at Beijing 1005A station.	7
Table S5 Features selected by mRMR at Wuhan 1328A station.	8
Table S6 Features selected by mRMR at Kunming 1454A station.	8
Table S7 Prediction performance evaluation metrics in forecasting PM2.5 concentration for next multiple hours.	8
Table S8 prediction performance evaluation metrics of the comparative models at the Beijing 1005A Station in forecasting PM2.5 concentration for next multiple hours.	9
Table S9 prediction performance evaluation metrics of the comparative models at the Wuhan 1328A Station in forecasting PM2.5 concentration for next multiple hours.	9
Table S10 prediction performance evaluation metrics of the comparative models at the Kunming 1454A Station in forecasting PM2.5 concentration for next multiple hours.	10

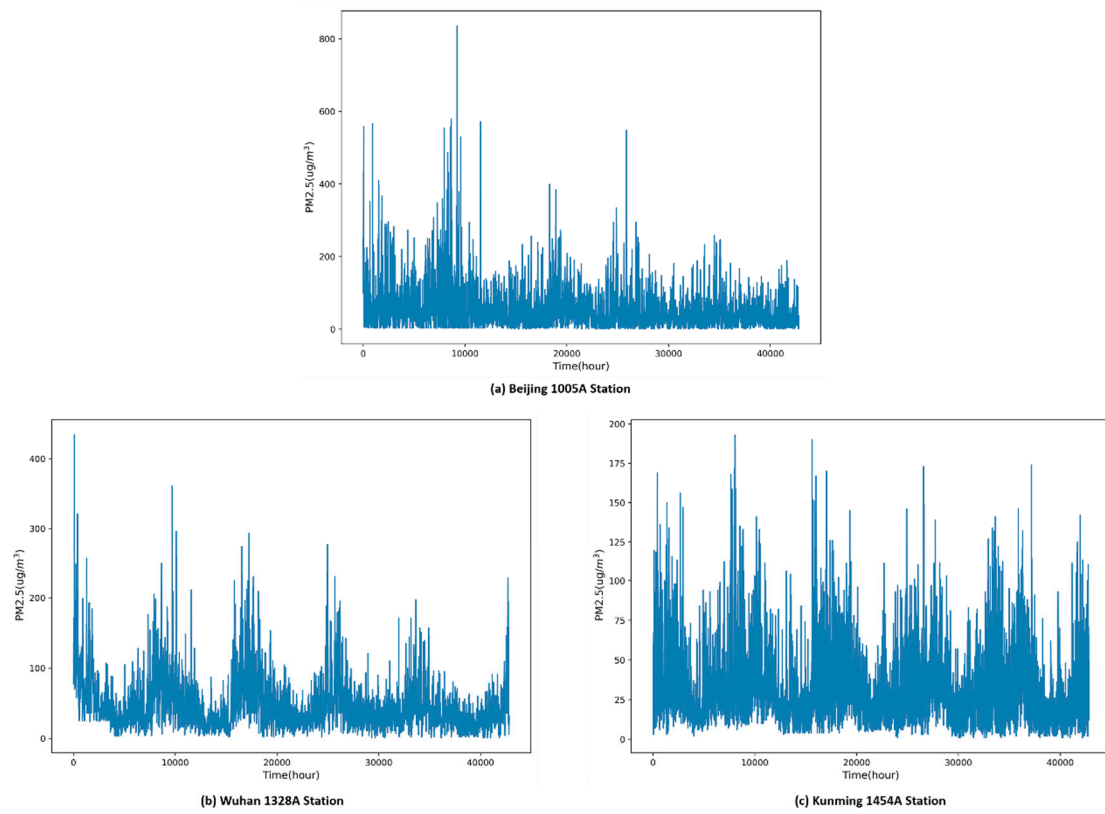


Figure S1. PM2.5 concentration sequences.

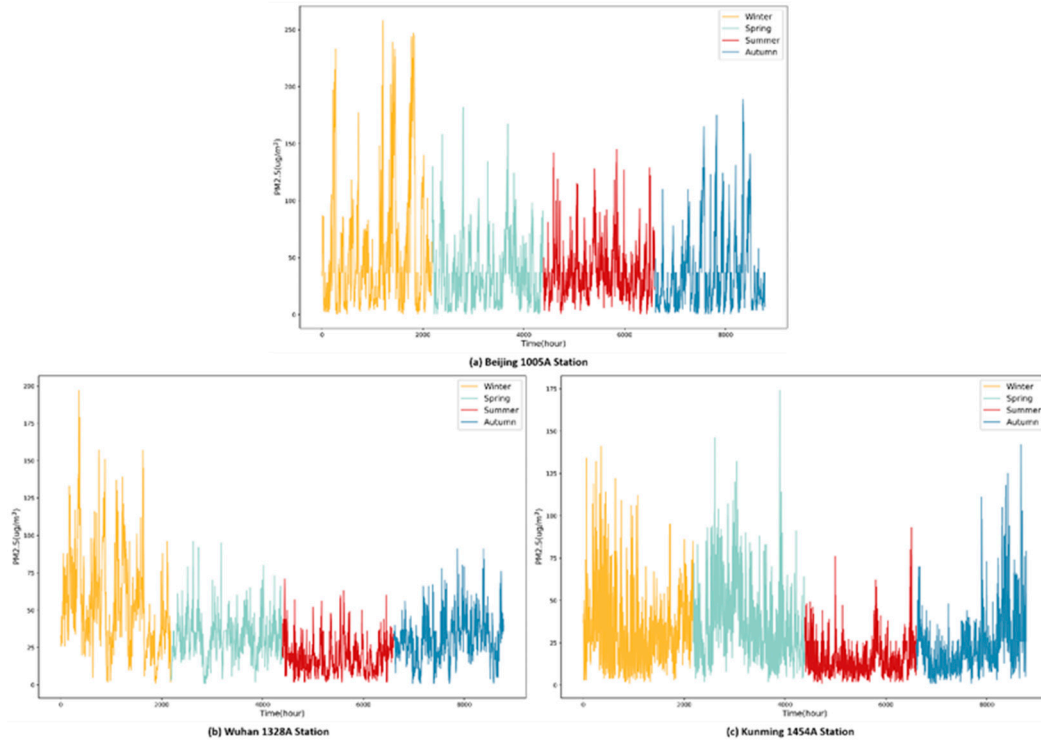


Figure S2. PM2.5 concentrations for different seasons.

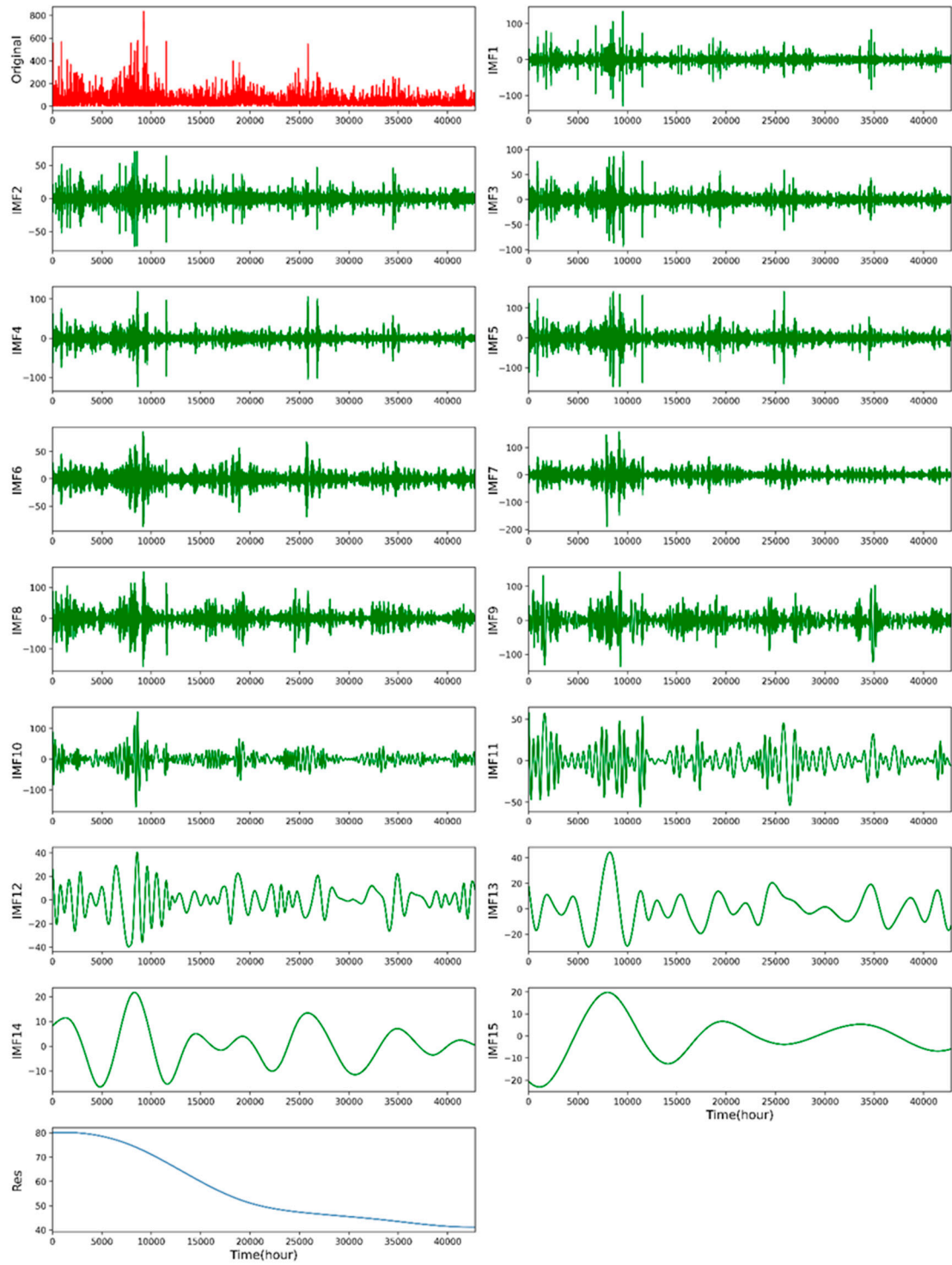


Figure S3. EMD decomposition of the PM2.5 sequence of Beijing 1005A Station.

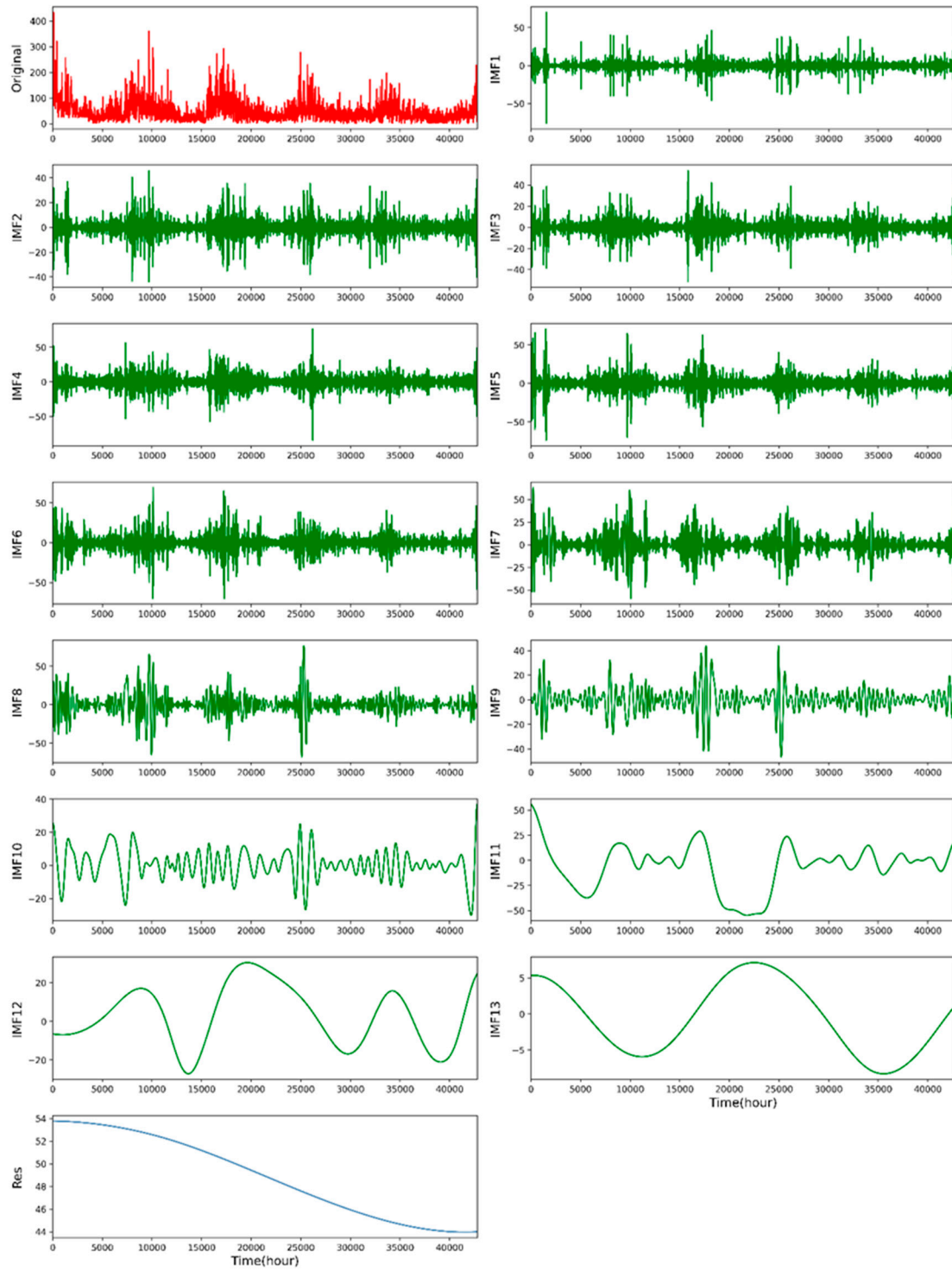


Figure S4. EMD decomposition of the PM_{2.5} sequence of Wuhan 1328A Station.

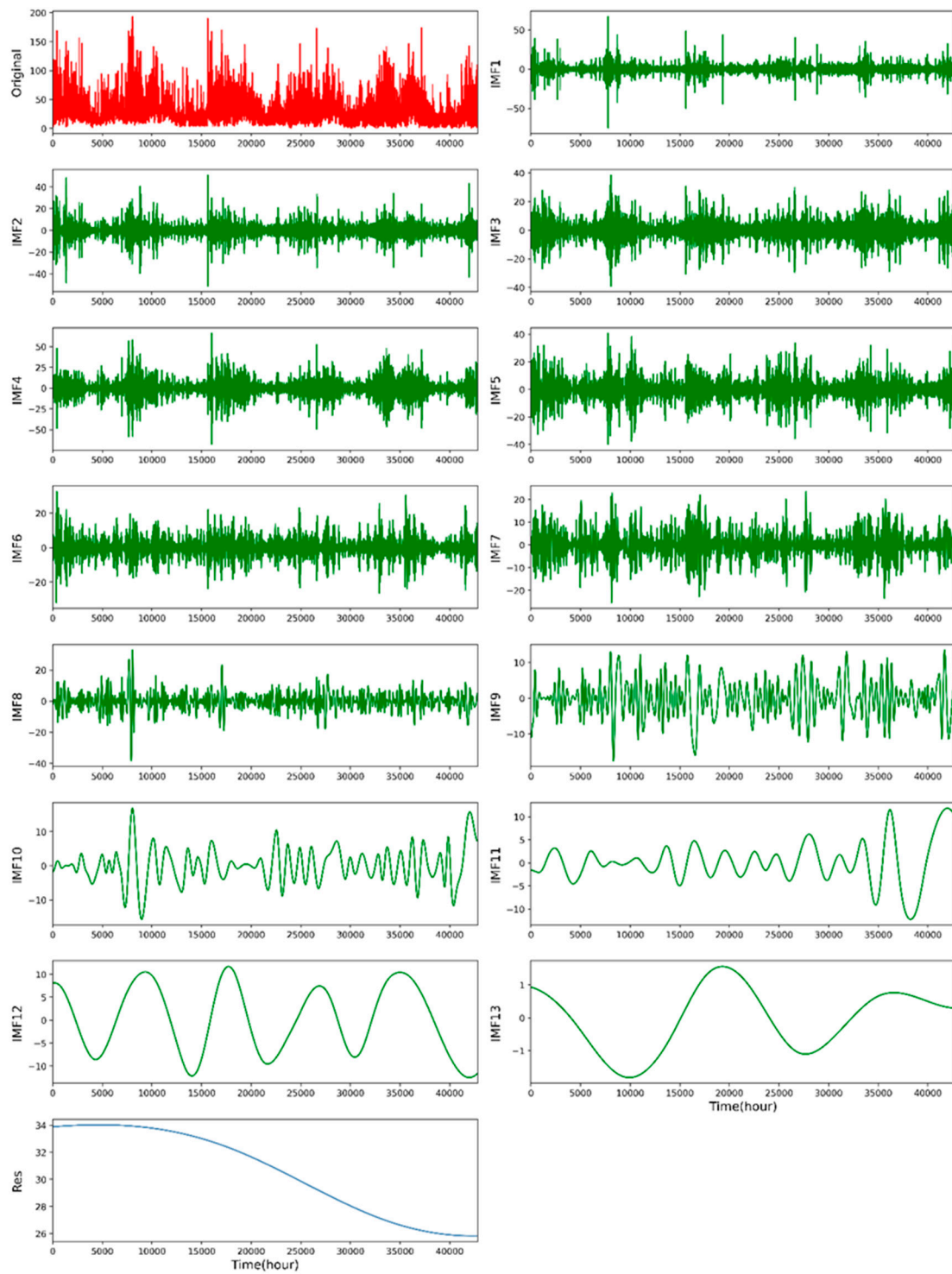


Figure S5. EMD decomposition of the PM2.5 sequence of Kunming 1454A Station.

Table S1 Statistical analysis of PM2.5 dataset.

Dataset	Station	Min	Max	Mean	Std
Beijing	1005A	1.00	835.00	54.31	58.53
Wuhan	1328A	1.00	434.00	45.39	35.24
Kunming	1454A	1.00	193.00	30.41	20.40

Table S2 Results of the one sample t-test.

IMF	P-value ($\alpha = 0.05$)		
	Beijing 1005A	Wuhan 1328A	Kunming 1454A
IMF ₁	0.8850	0.7021	0.5828
IMF ₂	0.9595	0.8085	0.0158
IMF ₃	0.3973	0.4073	0.0351
IMF ₄	0.3313	0.0100	0.0499
IMF ₅	0.0014	0.0584	0.0004
IMF ₆	0.0311	0.0096	0.7690
IMF ₇	0.0006	0.5495	0.0042
IMF ₈	1.8506e-13	0.0140	0.6716
IMF ₉	3.0023e-13	0.2958	4.0936e-5
IMF ₁₀	0.0159	8.3912e-34	3.1106e-9
IMF ₁₁	0.0191	0	1.3414e-16
IMF ₁₂	0.3657	0	0.0055
IMF ₁₃	6.2534e-6	5.1540e-170	4.6722e-17
IMF ₁₄	8.0691e-38		
IMF ₁₅	1.1175e-60		

Table S3 Classification of IMFs.

Station	High-frequency components				Low-frequency components			
Beijing 1005A	IMF ₁	IMF ₂	IMF ₃	IMF ₄	IMF ₅	IMF ₆	IMF ₇	IMF ₈
	IMF ₁₂				IMF ₉	IMF ₁₀	IMF ₁₁	IMF ₁₃
					IMF ₁₄	IMF ₁₅		
Wuhan 1328A	IMF ₁	IMF ₂	IMF ₃	IMF ₅	IMF ₄	IMF ₆	IMF ₈	IMF ₁₀
	IMF ₇	IMF ₉			IMF ₁₁	IMF ₁₂	IMF ₁₃	
Kunming 1454A	IMF ₁	IMF ₆	IMF ₈		IMF ₂	IMF ₃	IMF ₄	IMF ₅
					IMF ₇	IMF ₉	IMF ₁₀	IMF ₁₁
					IMF ₁₂	IMF ₁₃		

Table S4 Features selected by mRMR at Beijing 1005A station.

Selected features								
High-frequency component				Low-frequency component				
PM2.5 _{t-1}				PM2.5 _{t-1}	PM2.5 _{t-2}	PM2.5 _{t-3}	PM2.5 _{t-5}	
				PM2.5 _{t-4}				
PM10 _{t-20}				PM10 _{t-2}	PM10 _{t-1}			
SO2 _{t-7}				SO2 _{t-1}				
NO2 _{t-3}				NO2 _{t-1}				
O3 _{t-17}				O3 _{t-18}	O3 _{t-6}			
CO _{t-10}				CO _{t-1}				
High _{t-1}	High _{t-8}	High _{t-14}	High _{t-2}	Low _{t-1}	Low _{t-2}	Low _{t-7}	Low _{t-3}	Low _{t-20}
High _{t-21}	High _{t-11}	High _{t-17}	High _{t-24}	Low _{t-4}	Low _{t-12}	Low _{t-5}	Low _{t-24}	
High _{t-3}	High _{t-19}	High _{t-12}	High _{t-15}	Low _{t-9}	Low _{t-6}	Low _{t-15}		
High _{t-23}	High _{t-9}	High _{t-20}	High _{t-13}					
High _{t-16}								
High ₄								

Table S5 Features selected by mRMR at Wuhan 1328A station.

Selected features							
High-frequency component				Low-frequency component			
PM2.5 _{t-1}	PM2.5 _{t-18}			PM2.5 _{t-1}	PM2.5 _{t-3}	PM2.5 _{t-21}	PM2.5 _{t-2}
PM10 _{t-1}				PM10 _{t-1}			
SO2 _{t-10}				SO2 _{t-15}			
NO2 _{t-8}	NO2 _{t-1}			NO2 _{t-19}	NO2 _{t-2}	NO2 _{t-8}	
O3 _{t-24}	O3 _{t-15}			O3 _{t-24}			
CO _{t-1}	CO _{t-16}			CO _{t-1}			
High _{t-1}	High _{t-3}	High _{t-8}	High _{t-2}	Low _{t-1}	Low _{t-2}	Low _{t-4}	Low _{t-18}
High _{t-22}	High _{t-5}	High _{t-12}	High _{t-4}	Low _{t-10}	Low _{t-3}	Low _{t-24}	Low _{t-6}
High _{t-6}	High _{t-10}	High _{t-24}	High _{t-7}	Low _{t-14}	Low _{t-5}	Low _{t-21}	Low _{t-8}
High _{t-17}	High _{t-9}			Low _{t-12}			

Table S6 Features selected by mRMR at Kunming 1454A station.

Selected features							
High-frequency component				Low-frequency component			
PM2.5 _{t-4}				PM2.5 _{t-1}	PM2.5 _{t-23}	PM2.5 _{t-2}	
PM10 _{t-8}	PM10 _{t-1}			PM10 _{t-1}	PM10 _{t-2}	PM10 _{t-5}	
SO2 _{t-13}	SO2 _{t-24}			SO2 _{t-1}			
NO2 _{t-1}				NO2 _{t-1}			
O3 _{t-21}				O3 _{t-12}	O3 _{t-9}		
CO _{t-7}	CO _{t-23}	CO _{t-16}	CO _{t-1}	CO _{t-3}	CO _{t-1}	CO _{t-24}	CO _{t-2}
High _{t-1}	High _{t-3}	High _{t-4}	High _{t-2}	Low _{t-1}	Low _{t-21}	Low _{t-4}	Low _{t-2}
High _{t-5}	High _{t-6}	High _{t-7}	High _{t-8}	Low _{t-24}	Low _{t-16}	Low _{t-3}	Low _{t-9}
High _{t-9}	High _{t-24}	High _{t-10}	High _{t-11}	Low _{t-23}	Low _{t-19}	Low _{t-6}	

Table S7 Prediction performance evaluation metrics in forecasting PM2.5 concentration for next multiple hours.

Prediction hours	Station	Prediction performance evaluation metric		
		RMSE	MAE	R ²
4	Beijing 1005A Station	9.5625	6.1901	0.9262
	Wuhan 1328A Station	6.6182	4.1042	0.9350

	Kunming 1454A Station	7.2362	5.0514	0.8737
8	Beijing 1005A Station	11.6617	8.1642	0.9044
	Wuhan 1328A Station	8.5453	5.7982	0.8991
	Kunming 1454A Station	9.6942	7.3415	0.8310
12	Beijing 1005A Station	13.4983	9.6436	0.8941
	Wuhan 1328A Station	10.4294	7.8071	0.8829
	Kunming 1454A Station	11.1412	8.9208	0.8106

Table S8 prediction performance evaluation metrics of the comparative models at the Beijing 1005A Station in forecasting PM2.5 concentration for next multiple hours.

Prediction hours	Model	Prediction performance evaluation metric		
		RMSE	MAE	R ²
4	LSTM	11.3307	7.4324	0.9117
	GRU	11.1802	7.4585	0.9108
	GWNN	10.5917	7.12037	0.9194
	mRMR-GWNN	10.1433	6.4424	0.9246
	EMD-mRMR-GWNN	9.5625	6.1901	0.9262
8	LSTM	13.2038	9.3952	0.8926
	GRU	13.4089	9.4121	0.8899
	GWNN	12.8583	9.1683	0.8947
	mRMR-GWNN	12.7021	8.5800	0.8969
	EMD-mRMR-GWNN	11.6617	8.1642	0.9044
12	LSTM	15.9237	10.9516	0.8711
	GRU	16.2873	11.0350	0.8668
	GWNN	15.1590	10.6168	0.8732
	mRMR-GWNN	14.3328	10.1320	0.8844
	EMD-mRMR-GWNN	13.4983	9.6436	0.8941

Table S9 prediction performance evaluation metrics of the comparative models at the Wuhan 1328A Station in forecasting PM2.5 concentration for next multiple hours.

Prediction hours	Model	Prediction performance evaluation metric		
		RMSE	MAE	R ²
4	LSTM	7.8529	5.2437	0.9081
	GRU	7.9757	5.3104	0.9061
	GWNN	7.5774	4.7391	0.9208
	mRMR-GWNN	7.1175	4.3898	0.9267
	EMD-mRMR-GWNN	6.6182	4.1042	0.9350
8	LSTM	9.8435	6.9186	0.8844
	GRU	9.9877	7.1226	0.8808
	GWNN	9.5903	6.6195	0.8876
	mRMR-GWNN	9.0077	6.0367	0.8918
	EMD-mRMR-GWNN	8.5453	5.7982	0.8991
12	LSTM	12.0502	9.4467	0.8646
	GRU	12.1305	9.2576	0.8659

GWNN	11.5736	8.7433	0.8704
mRMR-GWNN	10.83892	8.1691	0.8789
EMD-mRMR-GWNN	10.4294	7.8071	0.8829

Table S10 prediction performance evaluation metrics of the comparative models at the Kunming 1454A Station in forecasting PM2.5 concentration for next multiple hours.

Prediction hours	Model	Prediction performance evaluation metric		
		RMSE	MAE	R ²
4	LSTM	9.0164	6.2296	0.8312
	GRU	8.8119	6.0551	0.8334
	GWNN	8.7029	5.8663	0.8395
	mRMR-GWNN	8.3945	5.5060	0.8435
	EMD-mRMR-GWNN	7.2362	5.0514	0.8737
8	LSTM	11.1223	8.3705	0.8137
	GRU	10.9491	8.4109	0.8107
	GWNN	10.8900	8.1956	0.8190
	mRMR-GWNN	10.2392	7.9683	0.8251
	EMD-mRMR-GWNN	9.6942	7.3415	0.8310
12	LSTM	13.9136	10.2953	0.7924
	GRU	13.8432	10.2029	0.7918
	GWNN	13.4732	10.0328	0.7960
	mRMR-GWNN	12.7180	9.6119	0.8015
	EMD-mRMR-GWNN	11.1412	8.9208	0.8106