How does meteorology affect major pollutant concentrations over Beijing, China?

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BACKGROUND

Pollutant concentration at a place at time t, C(t) is a function of the emission E(t) and the meteorological variability M(t)

$$C(t) = f[E(t), M(t)]$$

OBJECTIVES

- How much is meteorology responsible for the $PM_{2.5}$ and ozone pollution concentrations in Beijing, China?
- Which model is best able to relate meteorology with the PM2.5 and ozone concentrations?

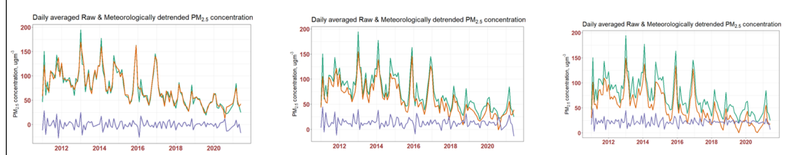
DATA

- Pollutant data: AirNow Beijing, ground-based monitors
- Meteorological data: China Meteorological Data Service Centre (CMDC) and Climate Forecast System version 2 [CFSv2]

RESULTS

For $PM_{2.5}$, the RF model has lower error and higher correlation with observations

Linear Model | GAM | RF

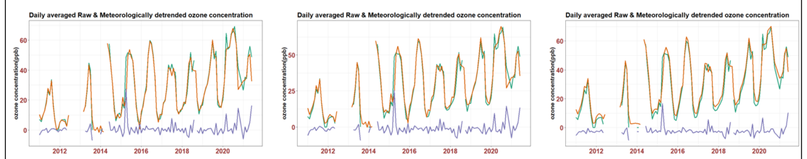


Model	MAE	MBE	NMBE	NMAE	R2	RMSE
LM	33.65	0.02	0.00	0.06	0.58	50.62
GAM	32.23	-0.69	0.00	0.06	0.62	47.84
RF	31.08	0.71	0.00	0.06	0.65	46.33

Trend: pm, pm_detrended, difference

For Ozone, all the models have almost similar correlations with observations

Linear Model | GAM | RF

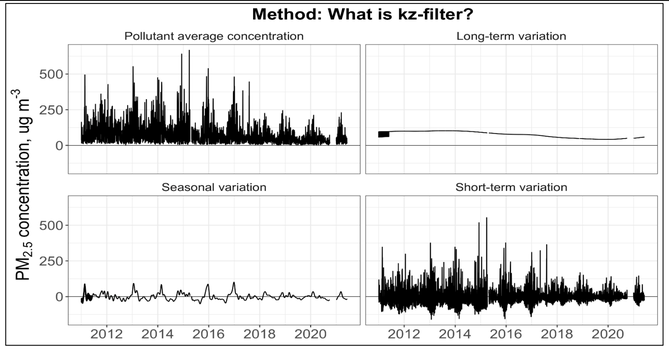


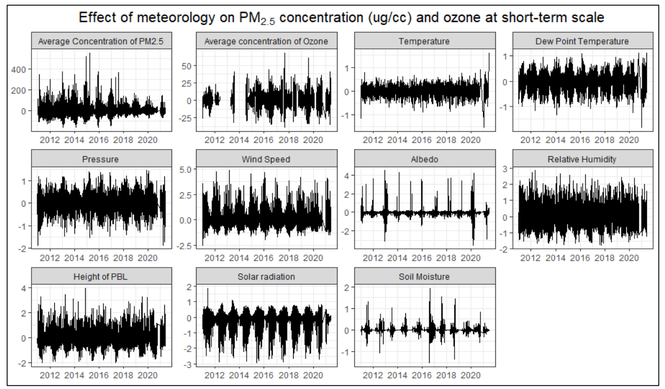
model	MAE	MBE	NMBE	NMAE	R2	RMSE
LM	7.55	0.12	0.00	0.09	0.35	10.19
GAM	7.57	-0.05	0.00	0.09	0.37	10.18
RF	6.97	0.26	0.00	0.08	0.48	9.57

Trend: pm, pm_detrended, difference

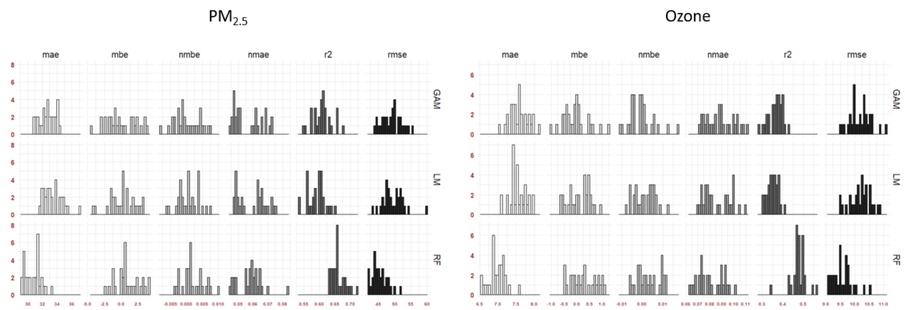
METHODS

- Meteorological detrending: Removing high-frequency meteorological variations from pollutant concentration signals
- Effect of meteorology studied on the pollutant concentrations at the short-term scale using models of various complexity





Comparison of evaluation for models for pollutants show that RF had lower errors and higher correlations with observations than LM and GAM



DISCUSSIONS

- Precipitation, wind direction, day of week and cloud cover also show significant relationships with the pollutants
- We plan to continue this study over other locations
- We plan to integrate regional meteorological variables into the analysis

CONCLUSION

- The RF is best able to reproduce observations in the holdout analysis
- Overall, all the models agree on the magnitude of variability attributable to meteorology, although the quantifiable relationships vary from model to model
- Most meteorological contributions for the daily concentration of PM2.5 and Ozone at the STM level comes from Temperature, Wind speed and Dew point temperature.

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