$PM_{2.5}$ variability with meteorology from reanalysis and ground-based monitors

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BACKGROUND

- Air Pollution Prevention and Control Action Plan implemented in China in 2013 aiming to reduce ambient $PM_{2.5}$ concentration by 10-25% at Beijing and other areas.
- Pollutant concentration at a place at time t, C(t) is a function of the emission E(t) and the meteorological variability M(t) there at that time. C(t) = f[E(t), M(t)]

OBJECTIVES

- **How much is meteorology responsible for the $PM_{2.5}$ pollution concentrations in Beijing, China?**
- **Is the recent policy implementation effective?**
- **Is the reanalysis dataset reliable for such studies?**

DATA

- PM2.5 data: AirNow Beijing, **ground-based monitors**
- Meteorological variables: **reanalysis model** Climate Forecast System version 2 [CFSv2]
- Daily data (2011-2018) scaled before processing such that the resulting distribution has a mean of 0 and a standard deviation of 1.

METHODS

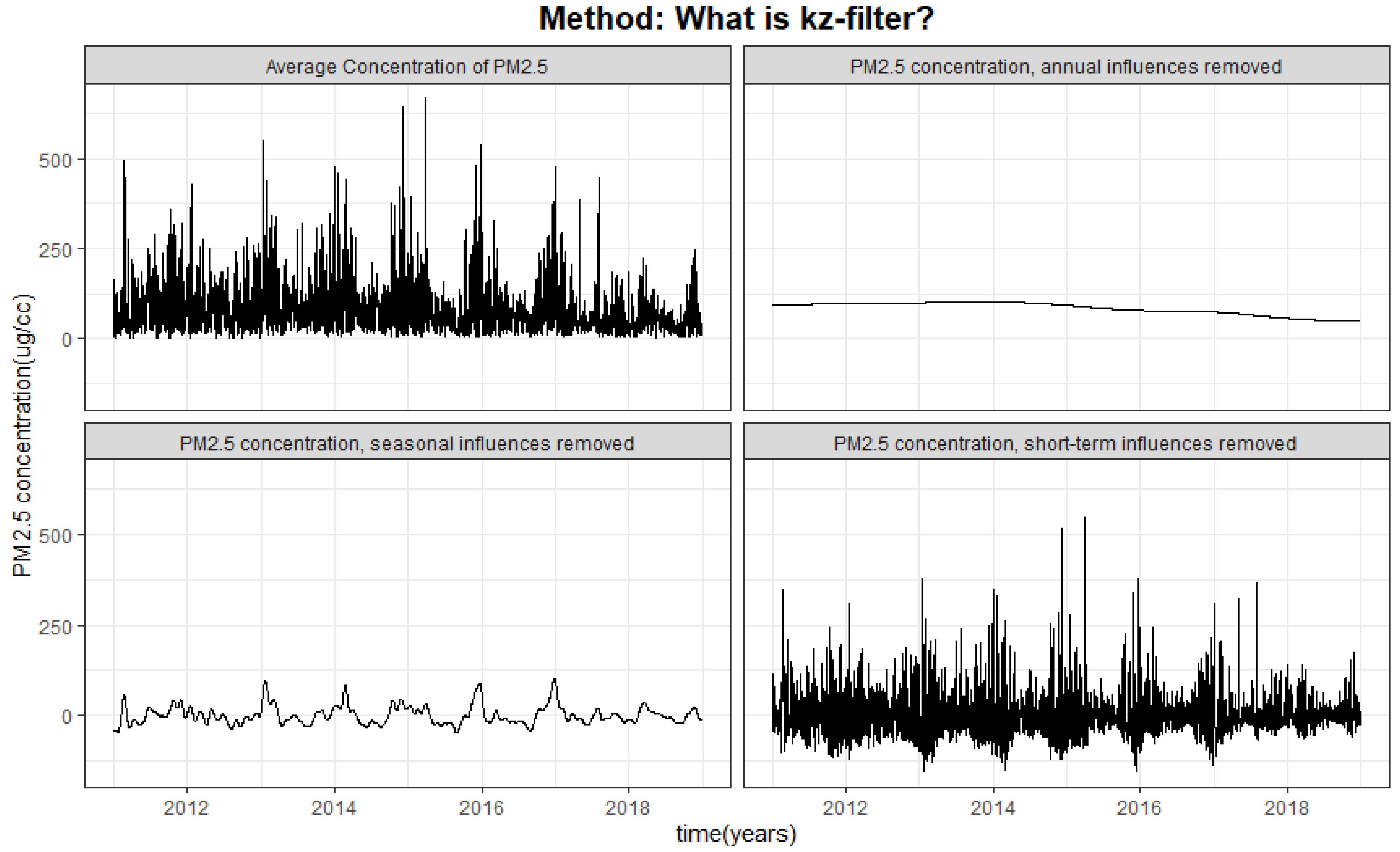
Meteorological detrending: Applying KZ-filter to remove high-frequency meteorological variations at different time scales.

Linear regression model:

$S_m = M_m * T_m * \beta_m$

S: Statistical sensitivity for pollutant concentration (C_i),
M_i: Meteorological variability,
T: Temporal variable (year),
β: regression coefficient

Method: What is kz-filter?

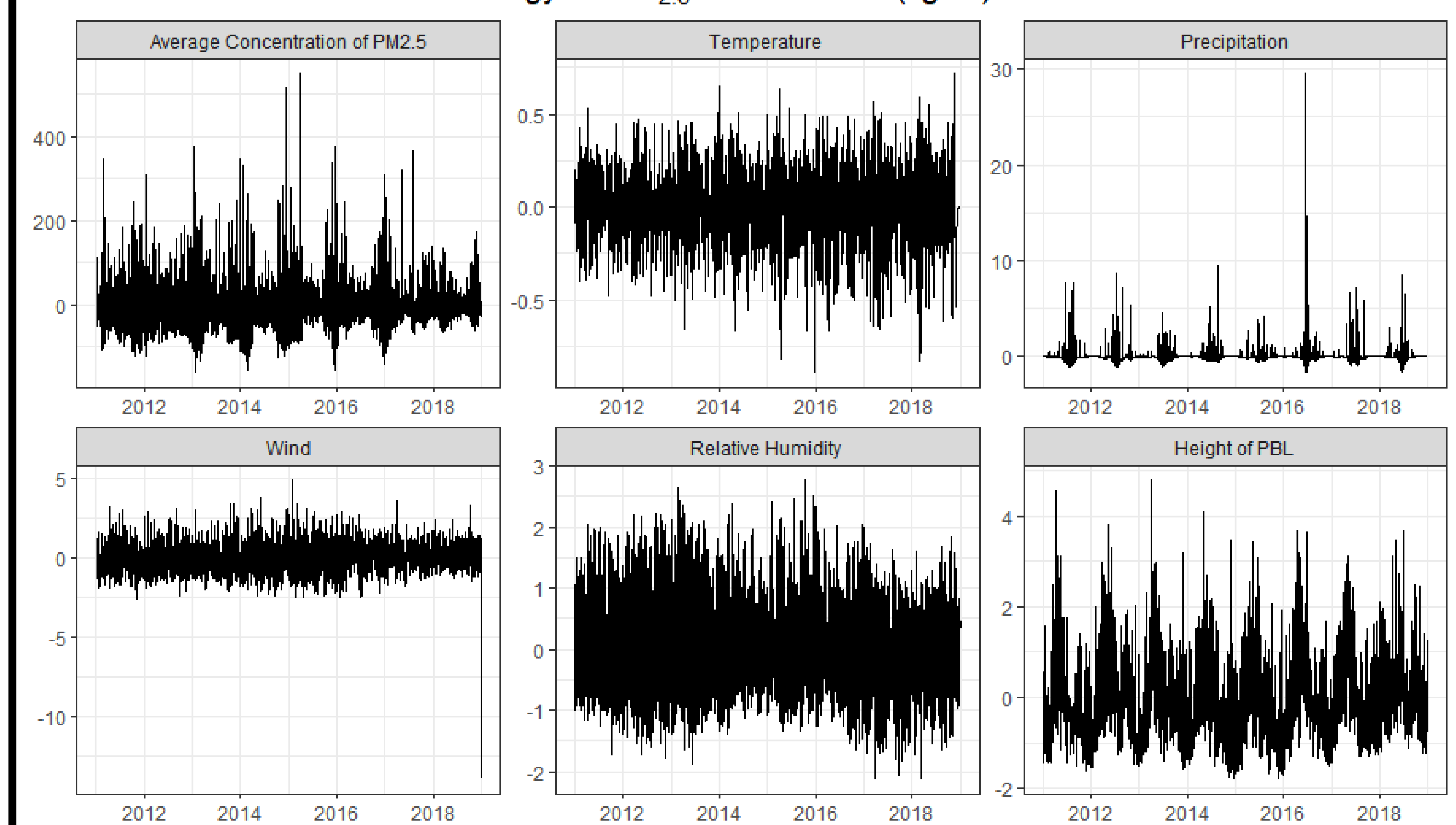


(temperature, relative humidity, precipitation, wind speed, planetary boundary layer height)

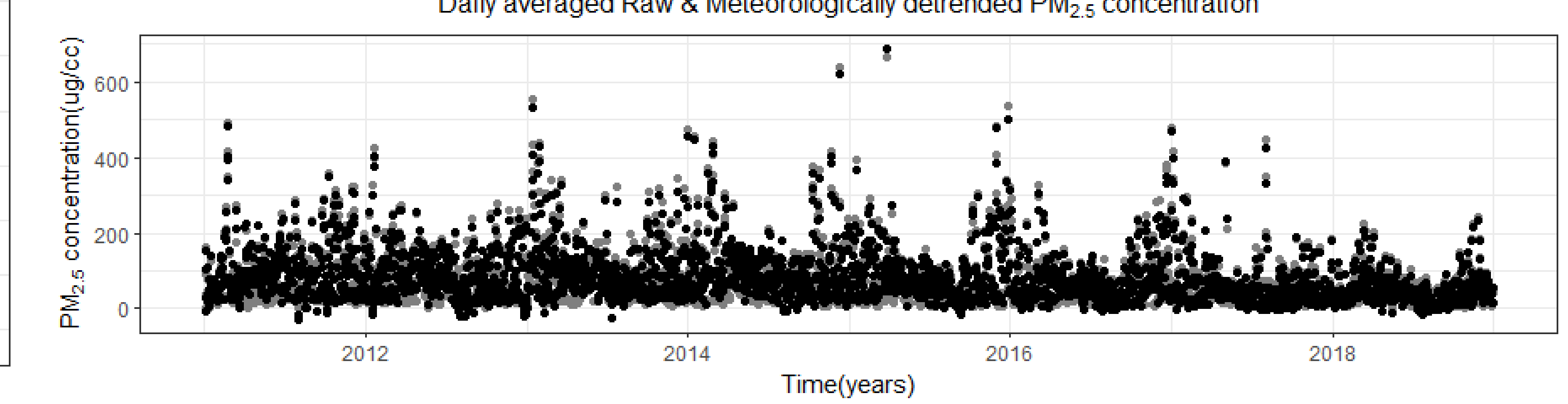
RESULTS

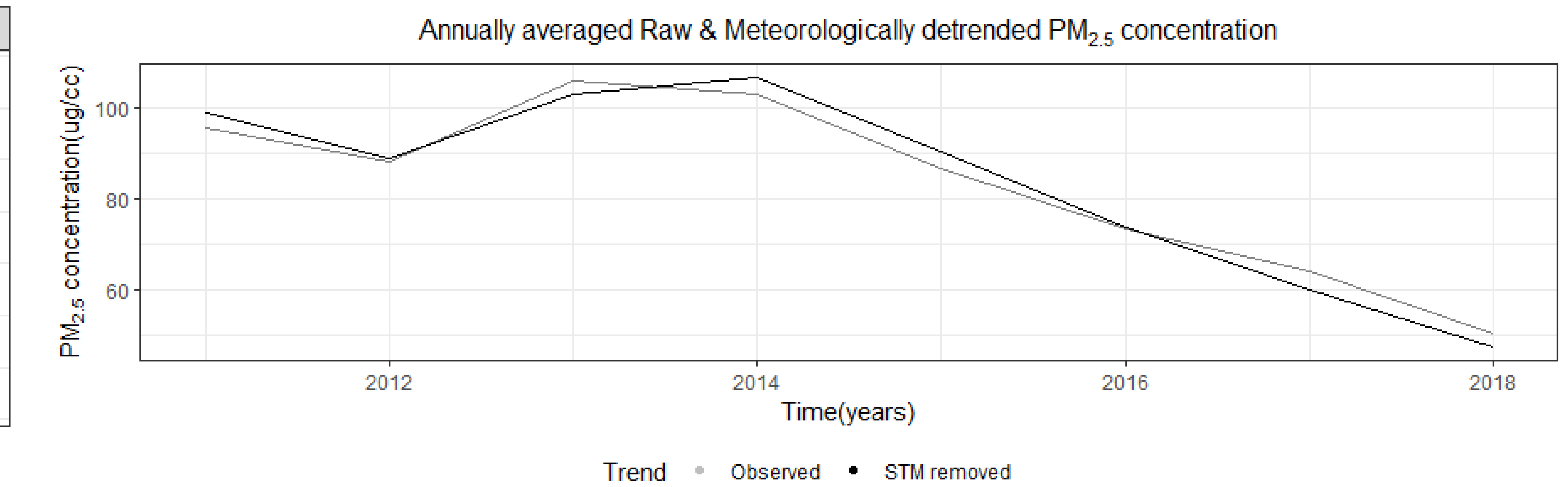
At the short-term scale, only the PBL height seems significantly related to $PM_{2.5}$ concentration at 95% significance level.

Effect of meteorology on $PM_{2.5}$ concentration (ug/cc) at short-term scale



- Continuous reduction of $PM_{2.5}$ emissions since its peak in 2013 till 2018 (overall 52.29% decrease) in Beijing, China
- Contribution from sources which are non-meteorological at the short-term scale for this decrease is 54.97%





DISCUSSIONS

- On repeating the same study with observed meteorological variables, we get more significant relationships with the $PM_{2.5}$ concentration
- We plan to continue this study using other models and across other locations.

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CONCLUSION

- **Contribution from meteorological variability** at short-term scale for the recent decrease in $PM_{2.5}$ pollution is **46.03%**
- Since more than 50% contribution for $PM_{2.5}$ decrease in the recent years comes from non-meteorological sources at the short-term, we can say that the **recent policy implementation** might have played a **major role**.
- For this model, the **reanalysis dataset does not seem to be as reliable a source** as the observed dataset National Climatic Data Center [NCDC] for the meteorological variables for Beijing, China.

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