This manuscript investigates drivers of $PM_{2.5}$ and PM_{10} changes in the Beijing–Tianjin–Hebei (BTH) and Yangtze River Delta (YRD) regions between 2015–2020 by combining national monitoring data, GEOS-FP meteorological fields, the CEDS emissions inventory, and a LightGBM machine-learning model. This manuscript documents significant declines in PM concentrations and attributes most of the reductions to anthropogenic emission decreases, while identifying specific meteorological variables and pollutant co-variations that modulate PM variability. Generally, I think the topic of this study is within the scope of ACP journal. The dataset and method applied here are reasonable. This manuscript is also well written, structured and analyzed convincingly. I recommend that this manuscript can be published in ACP after revisions.

Major concerns:

1. Please explain the meaning of "co-emissions-chemical transformation-meteorological synergy". This term is not explained in the paper but appears frequently in the abstract and main text.
2. This article reveals the impact of anthropogenic emissions on $PM_{2.5}$ and PM_{10}. I am very curious whether this effect is consistent with the trends in anthropogenic emission inventories. It would be very meaningful if this method could be used to verify emission inventories.
3. The introduction to the methods of calculating feature importance is missing. Please introduce the method for calculating feature importance.
4. For SO_2 and NO_2 correlations, please elaborate on how these relate to specific primary emission control measures (e.g., desulfurization, denitrification) and shifts in secondary aerosol formation pathways, to better substantiate the proposed "synergy" mechanism.
5. The strong $PM_{2.5}$–CO correlations and their source attribution implications are a central result of this study. However, recent multi-platform observation and top-down constrained studies have revealed similar mechanisms linking CO, NO_x, and carbonaceous aerosols to combustion-related $PM_{2.5}$ sources. For example, Wang et al. (2025, npj Climate and Atmospheric Science), Wang et al. (2021, Earth's Future), and Tiwari et al. (2025, Communications Earth & Environment) provide global and regional evidence that such emission linkages are also major contributors to CO_2 and black carbon emissions, consistent with the "co-emission–chemical transformation–meteorological synergy" framework. Citing these works would contextualize your findings within the broader emission research landscape and strengthen the scientific relevance of your results.

Minor concerns:

1. There are many places in this article where there are no spaces such as P8, Lines 200, and P9, Lines 205. Please check and improve it.
2. The color bars in many images should be adjusted to correspond to positive and negative values. For example, the range in Figure 1 is -9 to 3, which should be changed to -9 to 9. Please check and improve it.
3. The image sizes in Figure 2 should be kept consistent.
4. P20, Lines 435, Please give the full name of PMF, CMB.
5. Please check this manuscript for grammatical errors.
6. In the reference list, some entries have inconsistent journal name abbreviations (e.g.,

"Atmospheric Chem. Phys." vs. "Atmos. Chem. Phys.") and DOI formatting — unify them according to ACP style.

7. Occasional double spaces or missing spaces between words and numbers (e.g., "to2020" in p. 5 line 117 should be "to 2020").
8. The Zenodo DOI in line 452 is presented without a clickable hyperlink. For ACP style, this should be fully hyperlinked.

Reference:

- Wang, S., Cohen, J. B., Guan, L., Lu, L., Tiwari, P., & Qin, K. (2025). Observationally constrained global NOx and CO emissions variability reveals sources which contribute significantly to CO2 emissions. npj Climate and Atmospheric Science, 8(1), 87.
- Wang, S., Cohen, J. B., Deng, W., Qin, K., & Guo, J. (2021). Using a new top-down constrained emissions inventory to attribute the previously unknown source of extreme aerosol loadings observed annually in the monsoon Asia free troposphere. Earth's Future, 9(7), e2021EF002167.
- Tiwari, P., Cohen, J. B., Lu, L., Wang, S., Li, X., Guan, L., ... & Qin, K. (2025). Multi-platform observations and constraints reveal overlooked urban sources of black carbon in Xuzhou and Dhaka. Communications Earth & Environment, 6(1), 38.