

The authors adopt one ensemble learning model by integrating three Machine Learning models, including Gradient Boosting Regression Trees (GBT), eXtreme Gradient Boosting (XGB) and Random Forest (RF), coupled with ridge regression to generate robust predictions, to fill the gap of the element carbon (EC) data from 2013 to 2023 in Yangtze River Delta, China. The reconstructed EC dataset is valid by the intercomparison of EC with other datasets. Lastly, ensemble learning was used to design a fixed emission approximation method to disentangle and quantify the contribution of anthropogenic drivers to EC reduction.

This work is well organized. The authors present sufficient evidence to prove their robust and good performance in terms of the ensemble learning method. However, I'm sceptical about certain results of this study, particularly on the fixed emission approximation method. The acceptance of this manuscript is contingent upon the authors thoroughly validating those results. In addition, several places in this manuscript require an improvement. I recommend the acceptance after the authors address the comments and concerns detailed below.

General comment:

After reading this manuscript, my initial impression is that the authors have a wide knowledge of Machine Learning. However, I have some concerns as follows: As you mentioned in the 2.4.3 section (**Line: 225**): the errors increase when 2018 and 2019 are used as baseline years. 1) I am confused by the reason you provided, which is due to the missing meteorological parameters. As far as I know, ERA5 is a continuously updated dataset. It should not have missing values in 2018 and 2019. Please clarify this point. 2) If possible, try to use the ground-based measurements of meteorological factors rather than ERA5; 3) Please clarify how you retrieved the meteorological factors from the ERA5 in four cities in the 2.1 section. 4) In principle, the choice of the baseline year is critical. Basically, the baseline year is representative of typical conditions. If the selected year is an anomaly (e.g. huge emission reduction in COVID year), it could lead to an overestimation/underestimation. Could you explain how you chose the baseline year?

Specific comment:

1) **Line 27**: Rephase the sentence: from 2013 to 2020 (-0.24 to $-0.15 \mu\text{g m}^{-3} \text{ a}^{-1}$) from $3.26 \mu\text{g m}^{-3}$ to $1.59 \mu\text{g m}^{-3}$

2) When narrating, maintain consistency in sentence tenses. For example, we evaluated... in Line 199 and we propose... in Line 206

3) **Line 214:** If the FEA method were.... Please double-check the whole text and use the singular and plural correctly.