Review for Wu et al. Reduced-complexity air quality intervention modelling over China: development of the InMAPv1.6.1-China and comparison with the CMAQv5.2 model

The idea of this manuscript is of interest in the air quality modeling domain. A new reduced-complexity air quality model system called InMAP-China has been developed by linking a regional air quality model (extracting and converting parameters), a reduced-complexity air quality model, emission processing database, and a health calculation model at the resolution of 36 km, aiming at quickly quantifying the air quality and health impact in China. The total $PM_{2.5}$ concentrations together with its component and the sectoral contribution scenarios, have been assessed to evaluate the newly developed model. The manuscript has been well structured and written, just with some minor typo issues.

However, I am a little bit concerned about the benefits/advantages when developing this new proposed InMAP-China model. Firstly, the important part of the InMAP-China model is the InMAP model (a reduced-complexity model producing the pollutant concentration), which is actually under-estimating the $PM_{2.5}$ by 8.1 μg/m^3 (Line 239-242). This reduced-complexity model also has difficulties in capturing the SOA (Line 335-336). The simulated concentrations will directly affect the accuracy of health calculations. On the other hand, computing power running chemical transport models is not an issue nowadays. Running it on a coarse resolution such as 36 km is remarkably faster. The running time of a CMAQ model at a resolution of 36 km is around half an hour for one-day output (varies depending on different machine cores). Running the InMAP-China model still needs the CMAQ model outputs for providing extracted parameters. So why not directly using the CMAQ model (in 36 km resolution) to produce the concentration maps for calculating the health? Although the authors mentioned in the conclusion of the manuscript (Line 341-342) that this newly developed model could be used for evaluating the effects of individual coal-fired power plants, the uncertainties of doing that are hard to quantify with 36 km resolution. Scenario settings usually using chemical transport models will not evaluate hundreds of individual power plants or hundreds of scenarios. Running only a few carefully selected representative scenarios, even with year-long simulations, is expensive using computers nowadays. It is also reasonable and doable to have more accurate results with even longer running time as pursuing science. In conclusion, the current implemented reduced-complexity model with 36 km resolution is weak in supporting the statement that it has the advantage of being time-efficient in conducting air quality predictions (Line 312-313; Line 337). The rationale/motivation for implementing the InMAP_China needs to be reconsidered.

Another important issue is about the model resolutions relating to the health calculation. It would be better if the reduced-complex model could be implemented with a CMAQ model at a finer resolution (4 km or 1 km). Existing literature shows that higher resolution concentration maps would be better for calculating health exposure in the US and Beijing. (Tao et al. 2020; Jiang and Yoo, 2018; Biggart et al. 2020). Although the authors mentioned the model resolution discussion would be in 3.3.1, there is no such a section in the manuscript at the moment.

More detailed points are listed below:

1. Line 39-41: It seems the literature is a little bit outdated. The $PM_{2.5}$ concentrations have been decreasing in the past few years, while the O_3 pollution becomes severe (Zhao et al. 2021, Zhang et al., 2020). Li et al. (2019) showed the reduction in $PM_{2.5}$ since 2013 resulted in the increase of O_3, which became a major environmental issue in China. Please rephrase the statement based on the above findings.
2. Line 46: CTM is usually short for Chemistry Transport Model?

3. Line 49-50: please use full names of WRF-CMAQ, WRF-Chem, and WRF-CAMx when they are firstly used in the paper, although we are quite familiar with them.
4. Line 53: CTM, please use a full name when you first use it in the paper.
5. Line 54: “this challenges” should be “this challenge” or “these challenges”?
6. Line 78: InMAP should be spelled out when it is firstly used in the paper.
7. Line 82: “includes” should be “including”?
8. Are there any special meanings of v1.6.1? If not, suggest using consistent InMAP-China in the manuscript instead of using both InMAP-China and InMAPv1.6.1-China (line 89 and the title?), which would be confusing readers.
9. Line 102; 103: repeat “Figure 1 shows the model framework”, please rephrase the statement.
10. Table 2: Please adjust the format to make the table clearer.
11. Line 231-232: please indicate clearly how the InMAP-China model simulates the $PM_{2.5}$ concentrations? What are the inputs and outputs for different scenarios? In table 3, please indicate clearly which version of CMAQ results are used to extract and convert the parameters for InMAP-China.
12. For the $PM_{2.5}$ component evaluation, it could be understood that comparing the InMAP-China results with the CMAQ model (figures S4-S7) is a good way. But, if possible, comparing the $PM_{2.5}$ component simulations of InMAP_China model with the observational component measurements would give more confidence in the newly developed model.
13. Line 209: It seems there is no section 3.1.3 for discussing the effects of the model spatial resolution on $PM_{2.5}$ concentration predictions, although the authors mentioned here.
14. Line 396 and 399: keep using a consistent format for journal titles. Other places: Line 411; 417, 420, 450 …… Please check all the reference formats to meet the journal requirement.

Zhao, H., Chen, K., Liu, Z., Zhang, Y., Shao, T., & Zhang, H. (2021). Coordinated control of PM2.5 and O3 is urgently needed in China after implementation of the “Air pollution prevention and control action plan”. *Chemosphere*, *270*, 129441.

Zhang, X., Fung, J.C.H. , Zhang, Y., Lau, A.K.H., Leung, K.K., & Huang, W.W. (2020). Assessing PM2.5 emissions in 2020: The impacts of integrated emission control policies in China. *Environmental Pollution*, *263*, 114575.

Li, K., Jacob, D.J., Liao, H., Shen, L., Zhang, Q., & Bates, K.H. (2019). Anthropogenic drivers of 2013–2017 trends in summer surface ozone in China. *Proceedings of the National Academy of Sciences*, *116*(2), 422-427.

Tao, H., Xing, J., Zhou, H., Pleim, J., Ran, L., Chang, X., ... & Li, J. (2020). Impacts of improved modeling resolution on the simulation of meteorology, air quality, and human exposure to PM2.5, O3 in Beijing, China. *Journal of Cleaner Production*, *243*, 118574.

Jiang, X., & Yoo, E. H. (2018). The importance of spatial resolutions of community multiscale air quality (CMAQ) models on health impact assessment. *Science of the Total Environment*, *627*, 1528-1543.

Biggart, M., Stocker, J., Doherty, R. M., Wild, O., Hollaway, M., Carruthers, D., ... & Shi, Z. (2020). Street-scale air quality modelling for Beijing during a winter 2016 measurement campaign. *Atmospheric Chemistry and Physics*, *20*(5), 2755-2780.