Response to Referee #3:

This is a one-stop modeling tool development to study various pollution scenarios and associated mortality rates. This is a well written document and easy to follow. I see that the authors have put in a significant effort to make this tool functional. This work will provide a foundation for the InMAP-China model for future work to be conducted.

The main objective was to develop a tool for a faster turn-around time estimating mortality rate as the end point topic. However, the authors need to add some discussions as to how fast this new tool is as compared to CMAQ model operating at the same grid resolutions. It was not clear to me as to (1) what was the grid spacing used in the WRF-CMAQ model and (2) what were the computational speeds of each models-e.g., CMAQ vs InMAP-China. Though authors used the coupled WRF-CMAQ model, it is possible to estimate CPU time used up for CMAQ alone. If authors wanted to minimize computational burden of InMAP-China, then why not limit vertical layers to top of PBL and provide top boundary conditions to speed up computations? Just have fewer layers in the PBL and none in the free troposphere!

Response: We thank the referee for the valuable comments to improve our manuscript. We have followed the reviewer's suggestions and revised the manuscript. The specific comments are addressed below:

Thanks for this valuable comment. (1) The grid spacing used in the WRF-CMAQ model is 36km and it is already presented in Table S2. (2) The vertical layers in this study are 14 layers ranging from the surface to the tropopause. If we further reduce the vertical layer, the computation is expected to be speeded up. However, it is limited to reduce the total consumed time, especially when conducts a lot of simulations. InMAP-China simplifies the physical and chemical process in $PM_{2.5}$ simulations and reduces the running time to approximately one hour to simulate the annual averaged $PM_{2.5}$ concentrations. The high efficiency in $PM_{2.5}$ simulations promotes us to develop the version of the reduced-complexity air quality model in China.

The total CPU time to conduct the $PM_{2.5}$ simulation for the entire year in 2017 using the conventional CMAQ model is about 1460 core*hours and the total CPU time to predict $PM_{2.5}$ concentrations in 2017 using InMAP-China model is 24 core*hours. In the InMAP-China simulation, the annual averaged air pollutants concentrations are solved based on the particle continuity equation, while the hourly concentrations need to be solved using the CMAQ model.

It is kind of a weak point that InMAP-China depends solely on WRF-CMAQ simulations. It will be a great service to the CTM community had the authors tested and evaluated the InMAP-China using the GEOS-Chem modeling platform since it uses

a very coarse grid resolution plus it is global. Thus, in that case, the newly developed tool could be used for any region or country of choice without any major effort. This seemed to be truly a missed opportunity for now, but it is not too late I believe for the authors.

Response: Thanks for this valuable comment. That's a great idea to develop the reduced-complexity air quality model using the GEOS-Chem modeling platform on a global scale. The original research group who developed the InMAP (for the United States) has already focused on this topic to develop a global reduced complexity air quality model. If it is finished, the modeling tool can be expected to be used in other regions on a global scale.

Reason(s) for under-predictions over southern China are not speculated or explained – or I could not find those reasons.

$PM_{2.5}$ under-predictions are about -23%, a large bias given the magnitude of the $PM_{2.5}$ concentrations over China and is being attributed to using a different chemical mechanism as compared to CMAQ. What were the reasons for NOT using CMAQ chemical mechanism in the InMAP-China model beside computational constraints? For demonstration, one additional simulation using the CMAQ chemical scheme would have shed more light on this matter.

Response: Thanks for this valuable comment. In the InMAP-China, the chemical process is simplified as mentioned in Text 1 in the main part of this paper. The way to deal with chemical mechanisms in InMAP-China is simplified, which is based on the concentration results derived from the CMAQ model. To be more accurate to present, the corresponding sentence has been modified into "the uncertainty of the simplification of chemical process in the InMAP-China".

Text 1 The simplification of chemical reactions is different among pollutants. For NO_x, NH_3, and volatile organic compound (VOCs) precursors, the annual averaged gas-particle partitioning is adopted and calculated before using the output concentrations of species from CMAQ. For SO_2 pollutants, the annual oxidation rate of two major conversion pathways for SO_2 is calculated using concentrations of hydroxyl radical (HO) and hydrogen peroxide (H_2O_2) in CMAQ, and the conversion is estimated in InMAP-China.

Authors stated that advection was weakened due to averaging wind vectors. I am not sure why authors could not average zonal and meridional wind components separately and then re-compute the vertical wind to maintain mass balance. If this is what was

done, then it should be stated accordingly and, in that case, averaging impacts should be minimal in my opinion since each wind component is processed separately.

Response: Thanks for this valuable comment. The zonal and meridional wind components are averaged separately in this model, the weakening effects of wind components refer to the offset of the opposite directions in the annual average process to obtain the annual wind speed.