

Interactive comment on “Regional Contributions to Particulate Matter Concentration in the Seoul Metropolitan Area, Korea: Seasonal Variation and Sensitivity to Meteorology and Emissions Inventory” by Eunhye Kim et al.

Anonymous Referee #2

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This manuscript quantifies trans-boundary anthropogenic contributions to Korean modal particle distribution using brute-force sensitivity in annual simulations with two different mesoscale implementations of the CMAQ model driven by different meteorology and identical emissions inventories. The applied scientific value of the article is to set a realistic operational standard for the quality and quantity of evidence supporting spatial attribution of anthropogenic particle source contributions in East Asia, and the expected findings of substantial seasonal and sub-seasonal variability in foreign and domestic contributions that warrant annual simulations for such studies. While not a true ensemble, the two CMAQ implementations are both mature operational forecast-

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ing systems, and they are truly different, with fundamental differences in simulated daily meteorology and chemical transport that add confidence to the similarity in source attribution. The article generally succeeds in what it attempts to achieve, limited mostly by the apparent absence of dust and wildfire emissions in all baseline and sensitivity simulations, the difference in vintage between emissions and simulation period, and the resultant low biases in simulated concentrations.

Major comment

The authors do not list a source for regional dust, wildfire, and biomass burning emissions, beyond the domestic fugitive dust from CAPSS, and only state that dust and biomass burning are excluded from the INTEX-B and MEGAN emissions inventories. The reader assumes this to mean no such emissions were employed, which is an obvious explanation for consistent low biases in simulated concentrations and pollution events, and a major limitation in the representation of primary and secondary PM and the linearity of emissions sensitivities. The authors must clarify the sources for these emissions in the regional and domestic inventories or clearly state that none were used. Their absence would obviously contradict the authors' claim that they "have no clear evidence for the reason models, including those in the current study, consistently underestimate SMA surface PM," especially after citing six sources on the impacts of dust storms on air pollution in the region. While their absence would not affect the attribution or linearity of anthropogenic sources to primary particle concentrations, it would substantively impact the resultant percentages, and would challenge the linearity in attribution for secondary particles and net particle concentrations. These are major limitations that may reduce the value of the results in applied decision support, even if the direct assessment of anthropogenic spatial attribution were otherwise accurate. Moreover, most of the value of the article for readers beyond Korea is in the transferable experimental framework for trans-boundary source apportionment, and the complete absence of known major emissions sources in the region limits the value of this study as representing a minimum operational standard for such assessments.

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If it is the case that the simulations do not include dust and wildfire emissions, a minimum of one annual baseline simulation and one BFM sensitivity simulation in one of the models with such emissions would be warranted. Those additional simulations would then allow the authors to quantify the contributions of those sources relative to anthropogenic sources, quantify sensitivity and non-linearity under more realistic chemical conditions, quantify net international attribution, and instill confidence in simulations that otherwise exhibit profound and consistent low biases. If prior studies with one of the modeling systems have already sufficiently quantified these contributions for the same year, or one with similar dust and biomass burning emission, citation and summary might suffice. A second set of simulations to assess the role of transported biogenic emissions would be valuable, but less critical.

Technical comment

The authors do not define the simulation period until the results section. Specific start and end dates for the simulation and any initialization period should appear in the first paragraph of section 2.

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