

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## Comment on acp-2022-744

Anonymous Referee #1

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Referee comment on "Improving Ozone Simulations in Asia via Multisource Data Assimilation: Results from an Observing System Simulation Experiment with GEMS Geostationary Satellite Observations" by Lei Shu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-744-RC2>, 2023

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The paper presents the OSSE experiments results to demonstrate the benefit of GEMS ozone observations in future applications. Both the methods and the data assimilation results with additional OMI and surface synthetic observations are well presented. However, improvement can be made if the authors can address the following concerns.

General:

When the influence of assimilation frequency is investigated, it is not clear how data assimilation experiments with a longer assimilation time window of 3-hr are carried out. Are the hourly surface station observations averaged inside the 3-hr time window? Are the satellite data inside the 3-hr time window assumed to be valid at one particular instance? If so, when are they supposed to be valid?

The authors found that sometimes the data assimilation has negative effects. For instance, "In Japan and Mongolia, the assimilation of GEMS data generally contributes to a deterioration of simulated ozone and even counteracts the positive impact of surface observations when performing the joint assimilation." It is not impossible to encounter such cases. When this happens, it is probably worth to investigate the reason for such a behavior. With the current OSSE setting, it is probably not too hard to investigate the underlying causes.

Specific:

Line 20: It is probably better to replace "data assimilation better represents" to "data assimilation improves"

Line 22: RMSE is a accuracy metric rather than a precision measure.

Line 113: Is "optimal estimation" the same as "optimal interpolation"?

Equation 5: It would be better to use "y" for variables in observation space.

Line 196:  $x_{ap}$  should be in a vector in observation space, but it appears as a state vector. It is better to clearly differentiate state and observation vectors.

Line 211: It is reasonable to assume no correlation between surface station observations. But it is probably questionable to assume no correlation for satellite observations.

Figure 6d: What do the two different shades of color represent in the lower two panels?