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Comment on acp-2022-77

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Community comment on "Toward targeted observations of the meteorological initial state for improving the $PM_{2.5}$ forecast of a heavy haze event that occurred in the Beijing–Tianjin–Hebei region " by Lichao Yang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-77-CC1, 2022

The study made the first attempt to apply the new observation strategy "target observation" to improve the air quality forecasts. A new approach of conditional nonlinear optimal perturbation (CNOP) was applied to find the sensitive area for targeting observations associated with the PM2.5 forecast of a heavy haze event that occurred in the Beijing-Tianjin-Hebei region. Then several OSSEs, with different lead times and observation distances, were designed to illustrate the sensitivity of the target observations. They also evaluate this new observation strategy through the comparison with other observation strategies revealed by other studies. In addition, they provided the physical reasons why the target observation strategy can greatly improve the PM2.5 forecasts.

The paper is well written, clearly structured. The study provides a new perspective on understanding the sensitivity of air quality forecasts to the meteorological initial field and can serve as a theoretical guidance on practical observation tasks for PM2.5 forecast. In the summary part, the authors also present a few sound recommendations for future work, which I think are worthy in-depth study and discussed. Overall this study will make a valuable contribution to the air quality studies. I recommend acceptance after addressing the issues as listed below.

Major comments:

- The authors adopted different observing distances but the same observation number to examine the role of observing distances in the sensitive areas in improving PM2.5 forecast. It was suggested that the observation arrays of large observing distances generally play important role in improving the forecast skill of PM2.5. Actually, it is not surprised because the observing array with larger observation distance covers larger area and more meteorological information are captured, which are then much favorable for improving PM 2.5 forecast skill. So I suggest the authors to conduct the following experiments and further examine the validity of the sensitive areas. For a given size of sensitive area, the observing arrays of different observation distances are assimilated to evaluate the role of observing distance. If the large observing distance is still much important for improving PM25 forecast (in this situation, the number of observations is

much small), the original result would be assured.

- Section 5, Line 593-597, the interpretations for the improvements during the accumulation process is a bit weak. Actually, there are two areas identified as sensitive areas for the forecasts at the AT. One lies in the south of BTH, the other is located at central Inner Mongolia. What role did each area play on improving the PM2.5 of BTH? Are there any relation between the meteorological field on these two areas? Such details are needed to be addressed and will help understand the meaning of sensitive areas.

Below are some minor comments:

- The "PM 2.5 concentration" in the whole paper means "PM2.5 surface air concentrations" (PM 2.5 can be aloft). Please define "PM 2.5 concentration" as "surface air concentrations of PM 2.5" when it is first appeared
- Line 40, "relative moisture" is few used. Modify it to "relative humidity".
- Figure 2-5, the color bars of T and QVAPOR are too small. Please modify.
- Line 75, "assimilating more observations may not lead to higher forecast benefits". References are needed.
- Line 339-343, this is not clear to me. Please rephrase it.
- Line 585. Clarify which observation array in CNOP-EXP is used when comparing the forecast differences between the CNOP-EXP and control run.