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Interactive comment on "Development of the WRF-CO2 4DVar assimilation system" *by* Tao Zheng et al.

Anonymous Referee #1

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General comments:

1) The introduction includes quite a bit of information related to offline and online meteorology. However, I have a hard time understanding why the online system was chosen if the feedback of CO2 to the meteorology was ignored for the convenience. Why not instead choose development on an offline regional model? Also, will the system be updated periodically to account for the regular updates in the WRF model family?

2) As the authors noted, meteorology is critical to the quality of CO2 transport. Throughout the paper, I am surprised that there is no evaluation of the WRF meteorology, but this could be easily done considering the numerous observations available within the CONUS domain. In fact, I do have some concerns on the WRF setup as in specific comments 2)-3) below.

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3) The comparison of L-BFGS-B and the CG has been done before. It'd be good to relate the prior results to yours and highlight any unique findings from your work.

4) Information on computation requirement and cost would be helpful.

Additionally, here are some places where clarifications or corrections are needed:

1) The cost functions, etc, are not quite consistent with literature on the similar topic. Vectors should be in bold.

2) Page 9, Line 26: Was indirect soil nudging enabled when PX LSM was used? It is recommended to enable it in retrospective analysis because little testing has been done for running PX with the indirect soil nudging disabled. See the WRF users guide and literature.

3) Page 10: Met IC/LBC from CFS on which resolution? Potential problems of down-scaling that to 48km should be discussed. Again, some model evaluation should be added.

4) Page 10: any biomass burning emissions included? Does daily emission include any diurnal variability? Please include the emission amount in Section 3.1, to help understand the figure and results in Section 3.4.

5) Page 10, line 7-8: More details on the global WRF-Chem simulation is neededâĂŤI assume it was done on a coarser resolution than 48 km. Would the sensitivity and other tests in the global domain differ much from the regional results? Some simple comparison can highlight the benefit of using a regional scale 4dvar system.

6) Figure 1 and 2 need to be cited in the text. As red is already included in your emission color scheme, I suggest using a non-red color to show the locations of towers sites in Figure 3.

7) It'd be good to show Figure 5 and 6 along with trajectory calculations as in some prior works.

Some typos and grammar errors:

1) Page 5, line 19: according -> according to

2) Page 12, line 28: facotr -> factor

3) Page 37, Table 5 caption: givne ->given

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