Many thanks to the reviewers for the careful reading and critical comments. We have revised the figures (clearer land-sea boundary, include EXP-LCE to figures in section 4.2) and some typos. We hope that we have addressed the concerns.

Response to reviewer 1:

The authors addressed all my remarks. I may not fully agree with them, but since these points are mostly about style, I think the authors should do what they feel is best. I therefore recommend publishing of this article, after the authors have addressed the following few minor points.

Why not include EXP-LCE in the plots of section 4.2 and section 4.3? Particularly Figures 9 and 13. Section 4.1 is about showing the performance of COLA against the a priori. It is strange that there is a paragraph comparing EXP-LC and EXP-LCE there. This comparison should be discussed when the impact of CEnKF is investigated, which the authors explicitly state they don't do in section 4.1 ("Thus, before discussing the CEnKF impacts on ....")

Response: Thanks for the suggestion. We have added EXP-LCE to Figures in section 4.2. And we moved the paragraph comparing EXP-LC and EXP-LCE to section 4.2.

Also, I already mentioned this in the first round reviews, but it would be nice to show in Figure 13a the imbalance ensemble variance of the EXP-LC experiment. The imbalance of the ensemble mean would be zero off course, but each member might have an imbalance. This is important information to understand the difference between EXP-LC and EXP-LCE.

Response: Thanks for the suggestion. In the orignal manuscript, the imbalance ensemble variance is showed. We deleted it in the last revision. We agree that this information is important, and we add it back to the figure.

line 156: "the inflation step will destroy the balance within each member" This is confusing, as the authors do present an experiment where the mass is preserved in each member (EXP-LCE). I believe that the inflation method the authors use would not destroy the mass balance in each member as long as each member has the same mass. Is that the case? Please clarify.

Response: Thanks for the comment. First, because each member of CO2 is forced by their corresponding flux, the mass in each member is different. The mass in each member is dynamically changing with similar but different mass. In both EXP-LC and EXP-LCE, the inflation step will increase the ensemble spread of CO2. The ensemble mean CO2 is mass conserved, but the ensemble members are not. The CEnKF step can maintain the mass in each member, but the inflation step can not. This is one of the reasons that why we prefer to apply CEnKF to ensemble mean only.

line 186: "negative ensemble variance --> reduced ensemble variance"

Response: Thanks for pointing out this mistake. We have revised it.

Response to reviewer 2:

The revision answered my previous comments. It can be accepted for publication after minor changes.

Major:

1. The manuscript does not show the benefits for inclusion of CO2 concentrations as part of state vectors. In my opinion it is much cleaner and easier to implement to run CTM simulation for a single tracer forced by the posterior surface fluxes at each assimilation step, which can automatically ensure mass conservation, no matter how long the DA window is.

Response: Thanks for the comment. The unique part of COLA is including CO2 as part of the vectors. 1) Using the analysis (a posteriori) flux to drive the CTM can maintain the mass but requires running the model again, which can not fully take the advantage of the EnKF persistent forecast. For some of the EnKF system, they use the a priori (flux modeled by vegetation models) as the first guess for each assimilation window. This set-up sacrifices the advantage of EnKF as a sequential algorithim. 2) Update of the CO2 can better use the observation information since the observation itsself is CO2 concentration but not the flux. 3) As discussed in the disscussion section (Sec. 5), the transport error is a major problem for the CO2 inversion community that has not been addressed. If we want to explicitly quntify the transport error together with the flux, we need to perturb the meteorology field which will inevitably update the CO2. In summary, inclusion of CO2 concentrations as part of state vectors is a default set-up in COLA and it's not practical for us to do an experiment that only update the flux. We believe this joint CO2 and flux update stretegy can be further applied to coupled weather-carbon data assimilation studies.

2. The authors claim that CEnKF performance better over regions with less observation constraints. But I do not see much explanation (while I personally think inversion approaches with short assimilation window would prefer dense observation coverage.

Response: Thanks for the comment. We have showed the regional RMSER and found that EXP-LC and EXP-L performs similar over norther hemisphere regions (Fig. A2). And EXP-LC is slightly better than EXP-L over tropical and southern hemisphere regions. Well observed regions are expected to be better constrained by CO2 observations that the imbalance problem is expected to be slight. Thus, the CEnKF will then help those poorly oberved regions. The short window would prefer dense observation coverage in the LETKF step, but the CEnKF is an independent step that only one 'observation' (reference) are assimilated without localization.

Minors

1. Careful checks are needed for plots and their captions to ensure they are clear and accurate.

Response: Thanks for the suggestions. We have checked them.

2. In Figures 8 and 11, the unit of CO2 fluxes should be KgC/m2/yr (instead of KgC m2/yr). Also data range of colorbar in Figure 11 is too small, compared to Figure 8.

Response: Thanks for pointing out this mistake. We have revised them. Figure 8 is the seasonal plots while Figure 11 is the annual plot. The magnitude of seasonal cycle is larger than the annual mean. Thus, we have to use a larger range for Figure 11.

3. In map plots (such as Figure 8 and Figure A3 etc) coast lines should be thinner. It is difficult for me to see what colours are over tropical Asia or over boreal North America in Figure 8

Response: Thanks for the suggestion. We have revised the figures.

4. Line 59, Page 2: '…remain or close to linear…'

'close to linear' seems not right.

Response: Thanks for the comment. The dynamic model (transport model) is nolinear and LETKF can solve the nolinear problems. However, LETKF can only provide sub-optimal analysis if the forecast uncertainties are not linear. The deviation of suboptimal analysis from optimal analysis is proportional to the deviation of forecast uncertainties from linear. We revised the statement to avoid misleading. "To obtain the optimal assimilation, the forecast uncertainties are expected to remain linear"

5. Line 446, Page 22: '…the future observations in the OW…'

It is not clear what 'the future observations' does mean.

Response: Thanks for the comment. The future observations are the observations in the OW that are outside of the AW. We replace the word 'future' with 'additional'.