We thank the Editor and the Reviewers for their comprehensive comments. Below, we provide a point-by-point reply to each comment. The comments by the Reviewers are in black, and our replies in blue. The changes made in the manuscript are in *italics*.

'Comment on esd-2021-72', Anonymous Referee #2, 11 Dec 2021

Major comments:

The manuscript focuses on an important scientific problem and draws some enlightening conclusions. The authors estimated the impacts of large-scale land-use change (LUC) on the carbon cycle feedbacks under the Shared Socioeconomic Pathway (SSP) overshoot scenario. They used five ESMs of CMIP6 to estimate the global β and γ contributions to the changes in land carbon pools in LUC/noLUC areas and found that BECCS areas lose their β-driven carbon uptake potential but do not escape γ-driven carbon losses even though the SSP5-3.4-OS scenario is designed for bioenergy crops expansion to utilize already low-carbon areas.

Thank you for the positive review and comprehensive comments that helped to improve the manuscript.

However, the following issues need to be figured out before the manuscript is published:

1. It is difficult for me to understand the biophysical meaning of a negative β value. From the perspective of the land and ocean reservoirs, β is positive, and β-feedback reduces the impact of CO_2 emissions on atmospheric CO_2 concentrations and then global warming (*Zhang X, Wang Y P, Rayner P J, et al. A small climate-amplifying effect of climate-carbon cycle feedback[J]. Nature communications, 2021, 12(1): 1-11*). When the decline of carbon uptake (ΔC_{BGC}) is mainly driven by LUC rather than the change in atmospheric CO_2 concentration, is it still appropriate to use ΔC_{BGC} to calculate the feedback of land carbon uptake to the change in CO_2 concentration? Please clarify this.

   Indeed, the negative β value would indicate that the changes in carbon pool are dominated by LUC rather than by the CO_2 fertilization effect. In the revised manuscript, discuss the LUC impact on the carbon uptake in terms of the cumulative carbon fluxes rather than the β and γ feedback parameters, e.g., as below.

   The losses from LUC surpass the benefits from the CO_2 fertilization effect, so that the LUC ecosystems become a carbon source to the atmosphere during the study period.

   As it is impossible to decouple the carbon cycle response to CO_2 and climate from the LUC state due to the differences in the potential impacts of CO_2 and climate on the old and new land cover, we introduce a new Section 5 to the manuscript where we make a discussion using the β and γ feedback framework. Here we use terminology more carefully, so that we instead of decomposing the feedback parameters to the LUC and noLUC contributions, we explicitly discuss β and γ of the simulations with and without LUC.

   The land carbon uptake and the β and γ feedback parameters are affected by LUC, they are lower in the simulations with LUC (Figure 6). Moreover, the difference in the β parameter estimated by IPSL-CM6A-LR in simulations with LUC and without LUC after year 2040 suggests that LUC for bioenergy crops expansion affects the hysteresis behaviour of the carbon cycle feedback parameters under declining CO_2 concentration and temperature.

2. The result section is not easy to read. Although the results and discussion can appear in the same section, they should be as separated as possible. It is suggested that the result comparison between different methods, data, and studies should be placed at the end of the section.

   We revised the manuscript to improve its flow. In section 4.3, particularly, we placed the comparison between studies at the end.

3. The line charts (Figure 2, 3, and 4) need to be simplified. There are so many lines in each subfigure that readers can not clearly distinguish all lines and colors.

4. We simplified all figures. Note that we still kept the lines in Figure 2 (now 3) because its purpose was to evaluate the three approaches, although we reduced the number of panels in that figure from eight to two. In the improved figure we show only the cumulative carbon fluxes in BGC and COU simulations and not the carbon cycle feedbacks parameters.

Minor comments:

1. Line 67~70: Please divide this sentence into two sentences.

   Divided accordingly (now in the Section 5.1).

2. Line 102: Please give the full name of "fLuc", such as forest land-use change.
   We added its full CMIP6 definition that is "net carbon mass flux into atmosphere due to land-use change". Here "f" refers to a flux.

3. Line 191~192: Please modify this sentence. For example: Under the SSP5-3.4-OS pathway, the cropland area increases by 8.1×106 km^2 (~50%) from the 2010 level in the 21st century to 2100 (Hurtt et al., 2020).
   Thank you, corrected accordingly.

4. Line 198~200: It is suggested to revise this sentence like "*global cropland area in A dataset is larger/less than in B dataset by X km^2 in XXXX, and ~* ".
   Changed to

   "The global cropland area in LUH2 is less than in REMIND-MAgPIE by 0.3 × 10^6 km^2 in 2015, and larger by 2.9 × 10^6 km^2 in 2060…"

5. Line 276: Please add [*under the "cropland threshold" approach*] at the end of the sentence.
   Added.

6. Line 675: It is recommended to keep only the average and range of land carbon uptake in LUC and noLUC in Figure 3.
   We simplified the figure by showing the mean and SD of all data (now Figure 4).