We are grateful to the referees for their time and energy in providing helpful comments and guidance that have improved the manuscript. In this document, we describe how we have addressed the reviewer's comments. Referee comments are shown in black italics and author responses are shown in blue regular text.

Referee 2

In this manuscript, the authors use the YIBs model to simulate ecosystem productivity under two pathways to 1.5 C warming: and ensemble based on RCP2.6 and an ensemble based on RCP8.5. Overall, the 1.5 C warming is delayed by 30 years in RCP2.6, and results in weaker carbon sink overall on this pathway to 1.5 C. But the authors demonstrate that reductions air pollution emissions from RCP2.6 (resulting in increased light availability and decrease surface O3) is better for land carbon uptake compared to RCP8.5. The slower warming scenario from RCP2.6 increases the allowable anthropogenic carbon emissions.

This is a very interesting study that replaces the more familiar "temporal" domain for a "temperature" domain. This results in some initial awkwardness, since the different carbon sinks are not being compared at/over equivalent time periods, but the authors make a clear argument in their introduction for why they have chosen this approach, and why this experiment is a useful exercise. In general, I think some points of clarification would help this manuscript, as I outline below. Overall, this is a sound and novel study with results that should be of interest to the ACP audience.

➔ Thank you for your positive evaluations.

First, I would encourage the authors to explicitly describe how they have calculated NEE. While it is an obvious term to some, many of the readers in ACP may not find it as intuitive. If I have interpreted the authors work correctly (e.g. Figure 4 and its discussion), it seems like NEE is being calculated here as: NEE = – [GPP – Reco], where the authors have taken the convention that a negative NEE means a net carbon sink. I'm not sure why this equation isn't explicitly included somewhere, even if it might seem obvious. Actually, I couldn't find where the authors even define the abbreviation "NEE" (presumably "net ecosystem exchange"). Nor would I necessarily even expect ACP readers to be so well acquainted with the term "gross primary production" that this doesn't require an explanation/definition.

➔ Sorry for the missing information. We added definitions of GPP and NEE in the revised paper to clarify: "We focus on the changes of gross primary productivity (GPP) and net ecosystem exchange (NEE). GPP represents the total canopy photosynthesis through gross carbon assimilation. NEE is the residue after subtraction of GPP from ecosystem (plant plus soil) respiration (Reco – GPP), indicating the net carbon sink from land to atmosphere. The larger the GPP values, the stronger carbon assimilation by ecosystems. In contrast, the more negative the NEE, the stronger carbon sink of land." (Lines 83-88).

Without these definitions being explicitly laid out, things are in danger of becoming a bit unclear. For example, it might not be immediately obvious whether an "enhancement" in NEE is referring to a "more negative" value (and therefore a "stronger sink"). We run into confusing instances such as that found in Line 316, referring to an "enhancement" in NEE of "0.03 Pg", which is somehow equivalent to a "-17%" difference. How can it be a simultaneously positive and negative difference, unless we know that enhancement refers to a more negative value? These instances could just use some clarification.

➔ In the revised text, we double checked that all the words "enhancement" or "enhance" are used only for GPP, not for NEE. For the descriptions mentioned above, we changed them as follows: "Projected NEE continues to be more negative in the RCP8.5 scenario after the year 2016 (Fig. S7b). Meanwhile, future NEE reaches the minimum value (or the maximum sink strength) around the year 2025 and then reverses to be less negative in the RCP2.6 scenario (Fig. S7b). By the period of 1.5°C global warming, NEE changes in China show opposite tendencies between the two pathways. Compared to the present day, NEE increases by 0.03 ± 0.03 Pg C yr^{-1} (-17.4±19.6 %) in RCP2.6 (Fig. 5d) but decreases by 0.14 ± 0.04 Pg C yr^{-1} (94.4±24.9 %) in RCP8.5 (Fig. 5e), suggesting that land carbon sink is slightly weakened in the former but strengthened in the latter." (Lines 329-337)

This clarification is especially important when the authors eventually start taking the differences in "NEE" between the two different pathways, further exacerbating the importance of keeping track of the sign convention. It isn't immediately obvious whether the authors are taking the difference of two negative numbers (E.g. (-1.5 – [-2]) = 0.5), or whether they are comparing absolute NEE values (i.e. so that in the hypothetical example above, (1.5 – 2) = -0.5). The choice is important since these deltas have opposite meanings! It is also possible I have misinterpreted the authors' approach. I encourage the authors to explicitly define all conventions, and repeat them appropriately, to help guide the reader.

➔ We carefully went through all descriptions related to changes in NEE and made following clarifications (underlined):

"The higher ΔGPP in RCP2.6 instead yields a weakened NEE (more positive) due to the CO_2 effects (Fig. 6b)" (Lines 352-353)
"Following the benefits to GPP, the lower O_3 decreases NEE (strengthens the sink) by 0.06±0.02 Pg C yr^{-1} in RCP2.6, offsetting more than half of the negative effect (weakens the sink) from CO_2 (Fig. 6b)." (Lines 378-380)
"Climate-induced ΔNEE is -0.02 Pg C yr^{-1} (strengthened sink) for both pathways (Fig. 6b)" (Lines 418-419)

We also flip y-axis of Figure 8 (see the end of this response) as suggested. The revised figure now shows carbon loss with positive numbers and carbon uptake (sink)

with negative numbers, consistent with the sign of NEE.

Nevertheless, despite some of this awkwardness, I suppose the implications of the results are usually clear to the reader: E.g. improvements in air quality result in more light availability and less ozone damage, which in turn drives a "better" land carbon uptake. (I would still encourage the authors to use clearer language than "better", see Line 399.)

➔ Yes, that's the main conclusion we achieved in this study. We removed the word "better" and revised the sentence as follows: "For a warming target of 1.5°C, our analyses suggest that a simultaneous reduction of CO_2 and air pollution emissions enhances the efficiency of land carbon uptake compared to a pathway without air pollution emission control." (Lines 424-426)

Specific comments:
Line 107: "We further remove…" Why is the word "further" here? Have the authors removed some models based on other criteria that weren't mentioned above?

➔ We deleted the word "further" to avoid confusions.

Line 138-139: "…apply the same protocols for anthropogenic and biomass burning emissions …" What do the authors mean by "same protocols?" Please be specific.

➔ The same protocols mean that these ACCMIP models all use the same anthropogenic and biomass burning emissions defined by CMIP5 RCP scenarios. In this case, the differences in the simulated air pollution originated from modeling structures and parameters, instead of emission inventories. To clarify, we revised this sentence as follows: "However, these models apply the same anthropogenic and biomass burning emissions specified for CMIP5 RCP scenarios (e.g., RCP2.6 or RCP8.5), though different models perform simulations at different time slices." (Lines 143-146)

Line 141-142: I'm curious about the approach used to account for the temporal gaps in O3 in the various ACCMIP models. The authors state they fill gaps using a linear fitting approach. Does this ignore seasonality? Or is it accounted for? This also means that Figure 3b is a bit misleading, since the ozone concentrations at some of these timeslices were not actually from any model output all, but from a very simple interpolation that might not capture multi-decade variability. For example, around the 2060 time slice of Figure 3b, I only see a couple of models in Table S3 that would actually have real output for this time slice. Most go from around 2030 to around 2090.

It seems to me that drawing a straight line between two time slices that are 70 years apart is a bit dubious, even if it doesn't change the direction of the overall conclusions. I think this limitation could be more explicitly mentioned/discussed. [Also: I see there must be a typo in the first row of Table S3, which says "2100-2019".]

➔ We retain the seasonality of ozone concentrations when interpolating ACCMIP data. Here, we use GFDL-AM3 model as an example (Fig. R2). The original model provides time slice simulations of 2001-2010 and 2031-2040. We perform linear interpolations for individual months. For example, we derive a linear fit using all the July concentrations during 2001-2010 and 2031-2040, and then estimate July values within 2011-2030 based on this linear fit. Using the same method, we estimate ozone concentrations in all months individually so as to retain the seasonality of O_3.

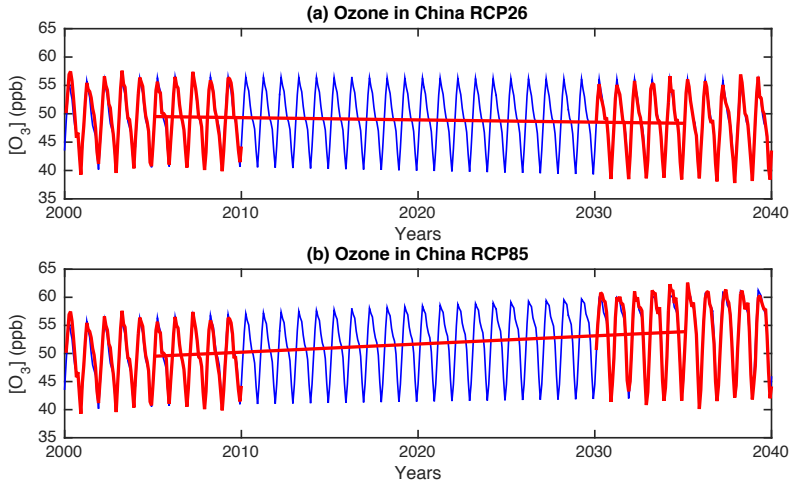

Fig. R2 Monthly ozone concentrations from GFDL-AM3 model for (a) RCP2.6 and (b) RCO8.5 scenarios. Time series from the original model are shown in red and the interpolations are shown in blue.

We agree that the linear interpolation may introduce some uncertainties in the gap filling. However, this is likely the best way we can consider in deriving unknown data. Other interpolation methods (e.g., polyfit, logfit) can also cause varied uncertainties. In addition, we believe that the multi-model ensemble average can in part smooth the data and achieve a reasonable time series of ozone concentrations that match the RCP emissions.

We corrected the typo in Table S3 (should be 2100-2109).

Line 284: "The YIBs simulations show variabilities of: : :" It wasn't immediately clear to me what the authors meant by "variabilities". It looks like they are referring to the full range of results from each YIBs ensemble?

➔ We explained that this variability is due to uncertainties in driven climate from CMIP5 models: "The YIBs simulations show variabilities of 0.41±0.23 Pg C yr^{-1} (6.2±3.9%, blue shading in Fig. 4a) due to uncertainties in climate from CMIP5 models" (Lines 299-301)

Line 334-340: I would have liked to see a more detailed discussion on the role of changes in ecosystem respiration on the difference in NEE between the two periods for each pathway. I had to spend a lot of time with Figure 6b to wrap my head around the "net" difference between "net ecosystem exchange" at two different times, and how GPP and Reco must each play a role in this separately.

➔ We explained more details about changes in GPP and soil respiration, and their joint effects on NEE as follows: "The higher ΔGPP in RCP2.6 instead yields a weakened NEE (more positive) due to the CO_2 effects (Fig. 6b). The stabilization of CO_2 concentrations in this scenario (Fig. 3a) results in a stabilized GPP after the year 2040 (Fig. S7a). Meanwhile, the 55-year (from 2005 to 2060) carbon accumulation enhances soil carbon storage by 10.5±1.3 Pg C and promotes soil respiration to 0.71±0.19 Pg C yr^{-1}. The stabilized GPP while enhanced soil respiration (NEE = Reco – GPP, Reco includes both soil and plant respiration) together lead to a weakened carbon sink (less negative NEE) by 1.5°C warming period (Fig. 7b). In contrast, soil carbon storage increases only 5.2±0.5 Pg C in RCP8.5 due to relatively short time period (from 2005 to 2031) for carbon accumulation, leading to lower soil respiration of 0.41±0.15 Pg C yr^{-1} in the fast warming pathway. The continuous increase of GPP and lower soil respiration jointly strengthen the land carbon sink (more negative NEE) in China by 0.1 Pg C yr^{-1} under RCP8.5 scenario (Fig. 6a)." (Lines 352-364)

Figure 4: I wondered about also showing the YIBs future projections timeseries in this plot (or somewhere in the Supplemental material). I understand that the focus of this paper is in "temperature" space, instead of "temporal" space, but I just kept wondering what the projections actually looked like in the more familiar time x-axis. Obviously the RCP8.5 line would end earlier than the RCP2.6 line, but this might actually help clarify other points in the paper.

➔ We plotted the changes of GPP and NEE along the temporal axis and added it as Figure S7 in SI as suggested.

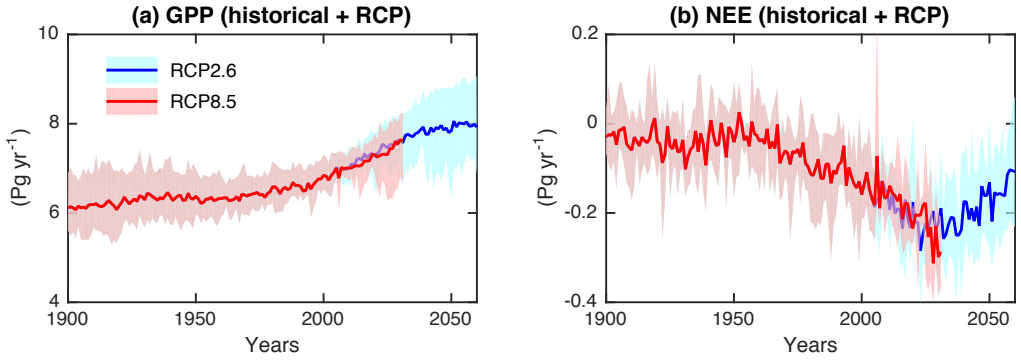

Figure S7. Projected historical and future carbon fluxes in China. Results shown are simulated (a) GPP and (b) net ecosystem exchange (NEE) during historical period (1901-2016) and future periods by 1.5ºC global warming (2017-2060 for RCP2.6 and 2017-2031 for RCP8.5). The bold lines are ensemble means with shadings for inter-

vegetation-model uncertainties (blue for RCP2.6 and red for RCP8.5). All YIBs simulations are driven with daily meteorology from CMIP5 models.

We included following descriptions in the main text: "Projected GPP continues to increase in both RCP2.6 and RCP8.5 scenarios after the year 2016 (Fig. S7a)" (Lines 322-323) and "Projected NEE continues to be more negative in the RCP8.5 scenario after the year 2016 (Fig. S7b). Meanwhile, future NEE reaches the minimum value (or the maximum sink strength) around the year 2025 and then reverses to be less negative in the RCP2.6 scenario (Fig. S7b)." (Lines 329-332)

Figure 6: Should there be "delta" signs in the Y-axis label of these panels? This was a source of initial confusion for me.

➔ Corrected as suggested.

Figure 8: Here the signs could potentially be confusing again (in this case, positive refers to a land sink), although I guess the meaning is clear overall. It just doesn't seem consistent with the choices elsewhere in the paper. Also, I would encourage panel b to include the word "net" somewhere, although perhaps this implicit in the word "accumulated" and would just add to the confusion?

➔ We agree with the reviewer's comment that the original figure 8 may cause confusion due to the inconsistency of signs. In the revised paper, we flip around the y-axis to make the variables (either carbon loss or carbon sink) consistent with the sign of NEE. We also added the word "net" in the title of panel b as suggested.