Review1#:

The authors are grateful to the editor and two reviewers for their time and energy in providing helpful comments that have improved the manuscript. In our revised paper, we added more explanations on model parameterizations (e.g., CH_4 emissions) and improved descriptions on Figures (e.g., Figure 9) and Tables to help readers understand our manuscript better.

In this document, reviewers' comments have been addressed point by point. Referee comments are shown in black italics and author responses are shown in blue regular text. A manuscript with tracking changes is submitted separately.

General comments:

This manuscript describes the development and validation of the interactive Model for Air Pollution and Land Ecosystems (iMAPLE). This involves coupling the process-based water cycle module from Noah-MP to an updated version of the Yale Interactive terrestrial Biosphere (YIBs) model.

The manuscript is well written, provides a comprehensive documentation of the development work, and includes a substantial expansion of the observations used in the evaluation of earlier versions of the YIBs model.

➔We thank the reviewer for the positive evaluations.

Specific comments:

In Section 2.3, the simulations performed are described and called "BASE", "BASE_NW", "O3LMA" and "O3S2007" but they are not consistently referred to using these names during the rest of the manuscript. It would aid the reader if the simulation names were used to refer to them throughout, and in Figure captions.

➔Thanks for your suggestions. We added more references of simulations name on the manuscript (e.g., Lines 564-565) and Figure captions (e.g., Figures 3-12).

Line 56: could you be more specific here than "the ecosystem"

➔We corrected original descriptions using "the terrestrial ecosystem".

Line 57 – 61: as the size of the estimated net carbon sink is not constant over time (which you mention later in the Introduction) can you state a time period for the 2 Pg C yr^{-1} *value quoted here?*

➔We added specifical time periods on our descriptions as follows:
"leading to a net carbon sink of only ~2 Pg C yr^{-1} during 1960-2021 (Friedlingstein et al., 2022)." (Lines 64-65)

Line 212: Ws is mentioned here but I don't think it's defined (apologies if I missed that) and it's not currently clear how this relates to equation 7, could you clarify – perhaps it should be Wsoil?

➔Yes, we corrected W_S to W_{soil} in the revised manuscript.

Line 261: this is slightly confusing because "U" is defined in the sentence previously but "UP" is included in equation 20 and not yet defined. Could you rearrange the text to clarify?

➔We rearranged the descriptions to clarify these equations as follows:
"The burned area of a single fire (BA_{single}) is typically taken to be elliptical in shape associated with length-to-breadth ratio (LB), head-to-back ratio (HB) and rate of fire spread (UP) as follows:

$$BA_{single} = \frac{\pi \times UP^2}{4 \times LB} \times (1 + \frac{1}{HB})^2 \quad (20)$$

Then, LB and HB are related to changes of near-surface wind speed (U) as follows:

$$LB = 1 + 10 \times (1 - e^{-0.06 \times U}) \quad (21)$$

$$HB = \frac{LB + (LB^2 - 1)^{0.5}}{LB - (LB^2 - 1)^{0.5}} \quad (22)$$

Meanwhile, UP is computed as the function of relative humidity (RH):

$$UP = UP_{max} \times f_{RH} \times f_{\theta} \times G(W) \quad (23)$$

Here, UP_{max} is the maximum fire spread rate depending on PFTs" (Lines 284-293)

Line 266: I dont think f_{RH} and f_{θ} are defined

➔In our revised manuscript, we defined f_{RH} and f_{θ} as follows:
"f_{RH} and f_{θ} represent the dependence of fire spread on RH and on root-zone soil moisture, respectively." (Lines 293-294)

Line 328 – 330: could you expand on this, which plant related factors determine A_{CH4} in the model, is it parameterised?

➔In the revised paper, we added more explanations on parameters of A_{CH4} as follows:

"The plant-mediated transport of CH_4 through aerenchyma is dependent on the concentration gradient of CH_4 and the plant-related factors (Zhu et al., 2014). The A_{CH4} is determined by the oxidation factor of root and the aerenchyma factor of plant. The baseline value of the oxidation factor in root is 0.5, with a regulatory range from 0.2 to 1.0 determined by the types of plant in wetland. The plant aerenchyma factor is calculated by the ratio of plant root length density (typical value: 2.1 cm mg-1) and root cross-sectional area (typical value: 0.0013 cm2), along with the diffusion factor of methane from plant root to atmosphere which is modulated by plant species within a range of 0 to 1 (Zhang et al., 2002)." (Lines 379-387)

Line 399: where do the surface O_3 concentrations required for the parameterisations come from (in the absence of coupling to an atmospheric chemistry model)?

➔We added more descriptions on surface O_3 concentrations as follows:
"Surface hourly O_3 concentrations are adopted from the simulations with a chemical transport model used in our previous study (Yue and Unger, 2018)." (Lines 439-441)

Lines 424 – 431: would this description of the observations be better placed in Section 2.4 above?

➔Thanks for your suggestions. We moved this part into Section 2.4.

Line 436: 438: are you basing the point that iMAPLE improves GPP simulations as compared to YIBs on simulations presented here (i.e. BASE_NW) or referring to previously published evaluations of YIBs? If the former can you refer to any figures that demonstrate this, if the latter can you include any comparable statistics from previous work?

➔Thanks for your questions. We found that iMAPLE with coupled water cycle improved GPP simulations compared to previous evaluations using YIBs model in YU2015, and we further clarified this information and provided comparable statistics in the revised paper as follows:
"Compared to previous evaluations from the YIBs model (YU2015), iMAPLE with coupled water cycle improves the R of GPP simulations for ENF (from 0.65 to 0.86) and grassland (from 0.7 to 0.8) but worsens the predictions for other species such as EBF (from 0.65 to 0.59)." (Lines 494-498)

Line 462: should the second site mentioned here be US-Tw4 (as referenced in the next sentence)? Could you also include here what the simulated CH_4 flux is for the gridcell that contains these two sites, for the corresponding time period? It would be useful for the reader to understand whether the simulated value lies somewhere between the two observed values or not.

➔Thanks for your questions. We corrected US-Tw4 in the revised paper, and added more descriptions on simulated CH_4 flux as follows:
"For example, US-Tw1 and US-Tw4 are two nearby sites within a distance of 1 km, where our simulations present CH_4 flux of 14.35 g[CH_4] m^{-2} yr^{-1} during 2011-2017. However, average CH_4 flux shows a difference of 3.7 times with 66.31 g[CH_4] m^{-2} yr^{-1} in US-Tw1 and 18.16 g[CH_4] m^{-2} yr^{-1} in US-Tw4 during 2011-2017." (Lines 523-527)

Lines 554 - 565: This section describes the impact of O_3 damage on GPP under 2 different schemes but it would benefit from some clarity around the level of O_3 damage being simulated. I think panel (a) must represent the difference between GPP in the O3LMA simulation and the BASE simulation, but this needs to be stated in the discussion and Figure 12 caption. This is important because you go on to compare the impact on GPP to the value from Ma et al 2023 but it is not currently clear if the two % values are really comparable.

➔ Following this suggestion, we added more descriptions of simulations caused by two experiments on Figure 12 caption.

Lines 568 - 571: is this based on separating the FLUXNET or MERRA-2 shortwave radiation into diffuse and direct? It would be useful to add a note here to clarify that.

➔As suggested by the reviewer, we added descriptions on observed FLUXNET diffuse and direct radiation as follows:
"Here, we separate the diffuse (diffuse fraction > 0.75) and direct (diffuse fraction < 0.25) components using observed diffuse fraction and solar radiation at six FLUXNET sites, and aggregate the GPP and ET fluxes for different radiation periods at certain intervals (Figure 13)." (Lines 643-646)

Line 1086: specify in the caption for Figure 3 that this data is from the BASE simulation (if it is) - this suggestion applies to all Figures

➔Thanks for your suggestions. We added the names of simulations to all Figures.

Line 1097: refer to panels (a) and (b) in the caption. Can you label the axes in panel (b) to specify that these are observed / simulated CH_4 fluxes, with units.

➔Corrected as suggested.

Line 1104: please label the colour bars in Figure 6, or add the units to the title of each panel

➔Added as suggested, and we added the units into the title of each panel.

Line 1136: add to this caption that the anthropogenic emissions are taken from CMIP6 input (rather than being generated by iMAPLE)

➔Added as suggested.

Line 1142: specify the time period that the emissions represent. Assuming these are annual totals, do they represent the entire simulation period?

➔Added as suggested.

Technical corrections:
Line 58: "these" should be "this" and "respirations" should be "respiration"

➔Corrected as suggested.

Line 100: "matters" should be "matter"

➔Corrected as suggested.

Line 105: "assimilations" should be "assimilation"

➔Corrected as suggested.

Line 122: "BVOCs" should be "BVOC"

➔Corrected as suggested.

Line 393: "lighting" should be "lightning"

➔Corrected as suggested.

Line 429: "much" should be "many"

➔Corrected as suggested.

Line 544: I think "we" should be "as"

➔Corrected as suggested.