

1. Figures 3 and 4: I acknowledge that these data are sourced from diverse literature and encompass a variety of environmental conditions and locations. Consequently, expecting a clear linear relationship might be unrealistic. Nonetheless, given the big unexplained variation, there may be potential to improve the fitting. I wonder if incorporating environmental factors or applying region-specific fitting functions could better capture the photosynthetic response. I recommend that the authors discuss potential strategies to account for the remaining variation in the data.

Reply: Introducing other explanatory variables or doing PFT/biome/regional fitting rather than the current broader vegetation-category fitting may improve the fitting skill (i.e., explain the remaining variation in the data).

In the revised version, we have acknowledged the limitations of the new scheme by adding “Even though the new scheme has advantages over earlier schemes, as listed in the previous section, there are still noticeable variations in observations that have not been explained (Figs. 3 and 4).”

We have also added your suggestions in potential development directions 3 and 4 in Sec. 5.1.4, which discuss the new scheme's future development as follows.

In direction 3 (introducing other explanatory variables), we have added: “Furthermore, earlier studies found that environmental factors (e.g., CO₂ concentration, nitrogen availability, drought, and temperature) can influence the O₃ photosynthetic response through changing POD (e.g., Wittig et al. 2007; Hansen et al. 2019; Xu et al., 2020). These factors may also affect the relationship between POD and O₃ photosynthetic response, although there have been no analyses to verify this and identify the underlying mechanisms. Based on our dataset and by collecting data on environmental factors in corresponding experiments, we may be able to investigate this in the future. If the influence exists, introducing environmental factors will improve the fitting.”

In direction 4, we have revised the first sentence to: “In addition, conducting PFT, biome, or regional fitting rather than the current broader vegetation type fitting may reduce the unexplained variation in observations.”

2. Line 63-67: The sentence is too long. Consider separating it into two sentences.

Reply: Separated.

3. Line 87: “physical” I would say “biophysical”.

Reply: It has been revised to “biophysical” as you suggested.

4. Line 115-116: Better put the version number of CLM and CESM and mention whether the current implementation is on the same or different versions of CLM and CESM. So, the reader will know whether or not L15 is comparable with this ozone stress scheme.

Reply: We have included the version numbers (CLM5 and CESM2.2).

It's on the same version of CLM and CESM. In Section 2.3.2, we mentioned that the comparison between L15 and the new scheme, with results analyzed in Section 4 (Application), is based on the same model platform, input data, and protocol; only the O₃ stress schemes are different.

5. Line 166-167: “only data categorized as high and medium confidence defined by Lombardozzi et al., (2013)” Need generally mention the confidence level is defined based on what standard in Lombardozzi et al., (2013).

Reply: We have added the definition of confidence level in Lombardozzi et al. (2013) as “In Lombardozzi et al. (2013), data were assigned high confidence if POD was presented, medium confidence if the publication contained multiple stomatal conductance measurements throughout the course of the experiment and other enough information to calculate POD, and low confidence otherwise”.

6. Line 169-171: “if the data are previously or more completely reported in another article” do you mean the data is repeatedly reported?

Reply: Yes, it sometimes happens that the data is reported in multiple articles.

7. Line 290-291: “2000Clm50Sp” and “2000Clm45Sp” Better use a simple description rather than the CESM configuration abbreviation, which will be more friendly for those who don't use CESM.

Reply: Thanks for the suggestion. We have added “(present-day offline simulations of the land model CLM5.0 with prescribed vegetation)” after "I2000Clm50Sp," and “(present-day offline simulations of the land model CLM4.5 with prescribed vegetation)” after "I2000Clm45Sp," to make it more user-friendly for readers with varying familiarity with CESM.

8. Line 306: 1.9° should be 1.875°.

Reply: We have confirmed the latitude and “1.9°” has been revised to “1.895°”.

9. Line 311: Missed one atmospheric forcing “Downward longwave radiation”

Reply: Thanks for pointing this out. We have added “incident longwave radiation”.

10. Line 313-314: “have no interannual variability” mislead. MODIS data, of course, have interannual variability. Maybe you just want to say “you use a prescribed climatology of vegetation distribution and structure, which is based on present-day MODIS satellite observation”

Reply: We have changed the sentence to “The input data of the prescribed present-day vegetation distribution and structure (LAI and canopy height) have no interannual variability, which is derived from MODIS satellite observations.”.

11. Line 319: “28.9655/47.9982” I'm not sure if we really need such high precision.

Reply: The unit conversion equation is provided by ECMWF, from which we obtained the O₃ concentration reanalysis data (EAC4) used as the input for CLM5.

Although the high precision may not be necessary, it does not cause any adverse effects.

12. Line 340-341: “there is no need to use a function from one vegetation type for another” reads obscure. “no need” assumes readers know the original scheme derives the function from observation of another vegetation type. But I guess most of them don’t unless reading further. I suggest a direct introduction like “Each vegetation type owns its individual function based on observation.”

Reply: According to your suggestion, we have revised it to “each vegetation type has its own function based on observations.”.

13. Line 481-486: I wonder how these modeled relative responses compare to the literature. More discussion would be helpful.

Reply: Our results on O₃ affecting trees are similar to the Meta-analysis of Wittig et al. (2007), and that crops are most sensitive to O₃ is consistent with earlier observational analyses (Reich, 1987; Wang et al., 2024) and modeling works (Ma et al., 2023). The comparisons are discussed in Sec. 5.2, along with other comparisons with literature.

14. Line 631: “decouple”. How the results show the decouple? Maybe need more specific discussion. Also, I was expecting a photosynthetic rate versus stomata conductance scatter plot to show the decoupling.

Reply: "Decouple" means that the O₃ influence on global photosynthetic rate and stomatal conductance differs. This is an extension of the conclusion of our scheme application results we presented before the sentence: “Our results indicate that present-day O₃ exposure leads to an 8.5% reduction in global leaf photosynthetic rate and a 7.4% reduction in stomatal conductance, with the largest reductions in eastern and southern Asia, Europe, the eastern United States, and the boreal evergreen forest zone for the former, and in eastern and southern Asia for the latter.”. That is, the Sitch et al. (2007) scheme, which assumed the photosynthetic response equals stomatal conductance response, is not correct, partly because it misses the O₃ non-stomatal limitation to photosynthesis found in earlier mechanism analyses based on site-scale observations (described in our Introduction section).

To clarify this, we have revised the sentence to “Our results that O₃ influence on photosynthetic rate and stomatal conductance differs at a global scale support the findings of observational analyses that chronic O₃ exposure decouples the photosynthetic rate and stomatal conductance partly due to O₃ non-stomatal limitation to photosynthesis (Tjoekler et al., 1995; Wittig et al., 2007; Lombardozzi et al., 2012; Kinose et al., 2020).”. In addition, Fig. 7 already clearly shows the decoupling, so we haven’t added the scatter plot.