Peer-Review of "Quantifying the role of ozone-caused damage to vegetation in the Earth system: A new parameterization scheme for photosynthetic and stomatal responses"

Title: Quantifying the role of ozone-caused damage to vegetation in the Earth system: A new parameterization scheme for photosynthetic and stomatal responses
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Reviewed by Ye Liu

Summary

This manuscript presents a comprehensive study on the development of a new parameterization scheme to quantify the damage caused by surface ozone (O3) on vegetation. The proposed scheme integrates extensive observations from O3 fumigation experiments to improve the accuracy of simulating photosynthetic and stomatal responses in large-scale models. The authors compiled 4210 paired data points from peer-reviewed literature, significantly expanding the dataset used in previous studies. The new scheme demonstrates improved performance in the Community Earth System Model (CESM2.2) compared to earlier schemes, showing a reduction in global photosynthetic rate and stomatal conductance estimates, and enhancing the simulation of global Gross Primary Production (GPP).

This manuscript advances this topic with the following developments: (1) Development of a new parameterization scheme based on an extensive dataset, which is over six times larger than those used in previous studies. (2) Improved accuracy in simulating the response of various vegetation types to O3 exposure, including needleleaf trees, broadleaf trees, shrubs, grasses, and crops. (3) Incorporation of nonlinear response functions that reflect the decreasing sensitivity of plants to increasing O3 doses, capturing the variability in plant ozone tolerance. (4) Integration of the new scheme into CESM2.2, resulting in more accurate simulations of global leaf photosynthetic rate, stomatal conductance, and GPP.

Major Remarks

I understand there is generally a lack of observational data to validate many levels of processes related to plant photosynthesis. The manuscript could benefit from a more detailed discussion of the potential uncertainties and limitations associated with the observational data and model implementation.

1. Figure 5 shows the simulated O3 concentration. Is there any way to quantify the uncertainties and how this uncertainty would affect the impact of POD?

2. Figures 3 and 4 set the foundation of the new scheme, as mentioned by Reviewer #1, the spread of the data point suggesting POD may not be the dominant factor driving the photosynthetic response. For instance, the fitted line for crop indicates a large reduction in photosynthetic rate with POD increase from 0 to 10 mmol m-2. Considering the large spread of the data points within this POD range, the concern would be this fitting line could be associated with large uncertainties. This uncertainty can propagate in the model and affect the O3 impact GPP, An, and gs analysis, such as the large reduction of An and gs of the crop in response to O3 in Figure 8.

Specific Remarks

1. BT and NT are defined in Line 336, but used before this line.

2. Line 449-450: The manuscript states that the global reduction in leaf photosynthetic rate and stomatal conductance is 8.5% and 7.4%, respectively. It would be useful to provide a comparison with previous estimates from earlier schemes, either at global or regional scales, if any.