

## ***Interactive comment on “Large but decreasing effect of ozone on the European carbon sink” by Rebecca J. Oliver et al.***

### **Anonymous Referee #1**

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This paper investigated the interaction between CO<sub>2</sub> and O<sub>3</sub>, the two greenhouse gases that directly affect plant photosynthesis, and indirectly gs. The goal of the paper is to quantify the impact of tropospheric O<sub>3</sub>, and its interaction with CO<sub>2</sub>, on gross primary productivity and land carbon storage across Europe from 1901 to 2050 using the JULES land-surface model. In principle, the analysis is highly topical and needed.

Throughout the abstract, it should be more quantitative in nature. For example, line 37-38, by how much does the tropospheric O<sub>3</sub> suppress terrestrial carbon uptake?

Line 40-41, How much of the combined effects of elevated future CO<sub>2</sub> (acting to reduce stomatal opening) and reductions in O<sub>3</sub> concentrations resulted in reduced O<sub>3</sub> damage? Moreover, elevated future CO<sub>2</sub> will lead to climate warming simultaneously, so how do the authors remove the response of GPP and land carbon uptake to climate

warming due to the increased CO<sub>2</sub> concentration? Warming will also increase evaporation (evapotranspiration) and reduce soil water availability, is this also considered?

Line 43, how large are the regional variations in temperate boreal regions?

Overall, some specific problems should be described in Introduction. For the O<sub>3</sub> effect on the land C sink, what have we learned from the previous studies? What bioregions, and with what methods, have been studied?

Line 81-83, The authors mentioned few studies have considered the simultaneous effects of exposure to both O<sub>3</sub> and CO<sub>2</sub>, so what have learned from these previous studies? Please specify previous findings.

Line 86-99, Please describe the O<sub>3</sub> concentration for historical and current level in quantity. How does the O<sub>3</sub> change over the last decades?

Line 103-104, High levels of O<sub>3</sub> are reducing the land carbon sink. How many carbon loss was led to by O<sub>3</sub> at regional and global scale based on previous studies?

Line 121-122, are you also going to study the effects of high temperature and drought? Please explain the CUO1 in Figure S2 caption. As shown in Table S1, the g<sub>1</sub> parameter in NT (Needle leaf tree) is similar to that of shrub. Does it mean plant water use efficiency in NT and SH are same?

Figure1, could you provide some O<sub>3</sub> concentration data from observations?

Line 342-345, what is the uncertainty (or SD) for these percentage number? It may be better if the authors mentioned how these number are calculated in methods. Line 352-353, For the broadleaf tree and C3 herbaceous PFT, the Medlyn model simulates a larger conductance and therefore a greater flux of O<sub>3</sub> through stomata compared to Jacobs, but it also led to a greater flux of CO<sub>2</sub> through stomata simultaneously, which may be helpful for increasing photosynthesis.

Line 366-368, Some Boreal and Mediterranean regions show increased GPP over this

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period, associated with O<sub>3</sub> induced stomatal closure enhancing water availability. But O<sub>3</sub> induced stomatal closure also reduce the flux of CO<sub>2</sub> through stomata simultaneously, which have a negative impact on GPP.

Line 373-375, is the different response of GPP to low and high plant O<sub>3</sub> sensitivity are significant?

Line 437-440, CO<sub>2</sub> induced stomatal closure can help alleviate O<sub>3</sub> damage by reducing the uptake of O<sub>3</sub>, but it will also increase available soil moisture simultaneously.

Contradictions are reported in Figure 4 and 5. In Figure 4a, the areas with great increasing in plant available soil moisture have less change in *g<sub>s</sub>* in Figure 5a. Why? In figure 4c, the areas with decreasing in plant available soil moisture have large reduction in *g<sub>s</sub>*.

In table 1, O<sub>3</sub> increased GPP but decreased land carbon over the period 2001-2050. Why does land C decrease when GPP is increasing?

The discussion could be improved by using subtitles more clearly.

Line 525-541, the authors listed a lot of results from the literatures, but the reader is left to decide what and why is the difference between this study and previous studies? More discussion on comparing this study with previous studies in detail would be helpful.

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