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Editorial

SI: Air Pollution and Plant Ecosystems

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Abstract: Air pollution continues to be a serious issue for plant health and terrestrial ecosystems. In this issue of climate, some papers relevant to air pollution and its potential impacts on plant health and terrestrial ecosystems are collated. The papers provide some new insights and offer the opportunity to further advance the current understandings of air pollution and its linked impacts at different levels.

Keywords: air pollution; carbon dioxide; ethylenediurea; gross primary production; plant protection; tropospheric ozone; plant ecosystems

1. Introduction

Air pollution, and especially ground-level ozone (O_3) pollution, is a major issue for vegetation, challenging scientific and regulatory communities in a continuing effort to better understand air pollution and its impacts on vegetation [1–3]. Notable research progress has been observed over recent decades, highly advancing our understandings of air pollution spatiotemporal characteristics and trends [4–6] as well as air pollution effects on plants, from the molecular level to communities and ecosystems [1–3,7–9]. While air pollution spatiotemporal patterns and trends became clearer and air pollution impacts better understood, a vast array of these research programs suggests that there is still much to accomplish. Recognizing the need for more research in these topics, a Special Issue on "Air Pollution and Plant Ecosystems" is published in *Climate*. This Editorial presents the collective findings in the papers published in the *Climate* Special Issue "Air Pollution and Plant Ecosystems".

2. Special Issue Content

A total of 11 papers were submitted for potential publication within the Special Issue. Finally, six papers have been accepted for publication [10–15], translating to an acceptance rate of about 55%.

Fumagalli et al. [10] exposed grapevine (*Vitis vinifera*) to different O_3 levels over two growing seasons and revealed that high O_3 levels affected grapevine weight and yields. Their study suggests that wine quality can be affected by reduced polyphenols that can decrease the nutritional value of the agricultural product and induce a more aggressive taste to wine. This project provides evidence of potential O_3 impacts on the quality of grapes and wine, encouraging the implementation of further studies to examine the potential effects on animals consuming such products altered by O_3.

Tobita et al. [11] exposed *Fagus crenata* plants to ambient air, elevated CO_2 (550 μmol mol^{-1} CO_2), elevated O_3 (2 × ambient O_3), and elevated CO_2 combined with elevated O_3 during two growing seasons. They found that the total plant biomass and elongation of second-flush shoots were increased more by elevated CO_2 combined with elevated O_3, and less by elevated CO_2 alone. Both elevated O_3 and elevated CO_2, as single stresses, decreased biomass allocation to the roots. This research suggests that elevated concentrations of CO_2 mitigate the negative impacts of O_3 on net CO_2 assimilation.

Kitao et al. [12] analyzed the fate of absorbed light energy, including photosynthesis, photorespiration, and regulated and nonregulated nonphotochemical quenching, by using data from experiments studying the effects of nitrogen limitation and drought on Japanese white birch (*Betula platyphylla* var. *japonica*), as well as the effect of elevated O_3 on Japanese oak (*Quercus mongolica* var. *crispula*) and Konara oak (*Q. serrata*) under elevated CO_2 concentrations. The rate of regulated nonphotochemical quenching (J_{NPQ}) could compensate for decreases in the photosynthetic electron transport rate (J_{PSII}) under the different stresses. It was also found that even decreases in nonregulated nonphotochemical quenching (J_{NO}) occurred under limited nitrogen and elevated O_3, irrespective of CO_2 conditions. These may indicate a preconditioning adaptive response preparing plants to cope with predicted environmental challenges. The results of this study can be used as a platform upon which to base new studies directed at revealing whether elevated CO_2 may not affect the plant responses to environmental stresses in terms of susceptibility to photodamage occurring in different experimental systems.

Proietti et al. [13], considering the importance of soil water availability as a driver of vegetation productivity, analyzed the spatiotemporal variation of a proposed temperature vegetation wetness index as a proxy of soil moisture and evaluated its effect on gross primary production using 19 representative tree species in Europe over the time period 2000–2010. The Modified Temperature Vegetation Wetness Index (mTVWI) displayed minimum soil water availability in Southern Europe and maximum soil water availability in Northeastern Europe. Furthermore, gross primary productivity decreased from 20% to 80% by mTVWI, depending on the site, tree species, and meteorological conditions. This wetness index adds a new dimension in understanding the impacts of water deficit stress which often occurs in tandem with air pollution.

Pandey et al. [14] treated 11 Indian wheat (*Triticum aestivum*) cultivars grown in high ambient O_3 (twice the critical threshold for wheat yield) with the antiozonant chemical ethylenediurea (300 mg L^{-1}), and found a high variation in resource allocation strategies among cultivars. They found that plants treated with ethylenediurea (EDU) produced more grain yields and had a higher photosynthetic rate and stomatal conductance as well as lower lipid peroxidation. They also observed varied responses of superoxide dismutase activity, catalase activity, and oxidized and reduced glutathione content. Responses to EDU (or O_3 assuming the differences were due to ambient O_3) varied across cultivars and plant developmental stages and sites. Authors grouped cultivars into four groups according to their response strategies. This research provides useful information to better understand the determinants of tolerance/susceptibility of Indian wheat to ambient O_3.

El-Tahan [15] used data of the Total Ozone Column (TOC), yielded from the Atmospheric Infrared Sounder (AIRS) and the model Modern-Era Retrospective analysis for Research and Applications (MERRA). The long-term trend and the spatial distribution over Egypt are studied, and a comparison between both sources of TOC is made. According to the results, the spatial maps from AIRS could identify the location of both high and low concentrations of O_3. Conversely, spatial maps from MERRA-2 underestimated TOC and were not effective in capturing the variability identified by AIRS. The study concludes that the MERRA-2 dataset also underestimated the temporal TOC over Egypt compared to the AIRS dataset. Among others, this study indicates the need to construct TOC from numerical models, such as, for example, numerical weather research and forecasting models coupled with chemistry.

3. Conclusions

A total of six papers on a variety of topics related to air pollution and its impacts were published in this special issue, constituting an orchestrated collection for researchers, environmentalists, educators, and local or regional regulators interested in air pollution and its impacts on plant ecosystems. We wish you an enjoyable and informative reading.

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