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2015. **Ozone and plants** [editorial].

Editorial

Ozone and Plants

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The International Conference on Ozone and Plants was held on May 18-21, 2014, in Beijing, China, hosted by the Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences (http://english.rcees.cas.cn/), on behalf of the IUFRO Research Group 7.01.00 “Impacts of Air Pollution and Climate Change on Forest Ecosystems” (http://www.iufro.org/science/divisions/division-7/70000/70100) and the ICP Vegetation (http://icpvegetation.ceh.ac.uk). A special session was organised by the Task Force on Hemispheric Transport of Air Pollution (http://htap.org) of the UNECE Long-range Transboundary Air Pollution Convention (http://www.unece.org/env/lrtap). The conference gathered more than 110 scientists from 17 countries to share the state of the art of ozone research and discuss scientific gaps in the understanding of the interaction between ozone and plants. The 2nd International Conference on Ozone and Plants is scheduled for 2017.

The conference provided an important opportunity to summarise the recently updated scientific knowledge on ozone atmospheric chemistry and its exchanges with the biosphere; ozone monitoring, modelling and risk assessment; plant and ecosystem responses to ozone exposure. It was appropriate and timely to have the conference in China because large parts of China are currently suffering from serious surface ozone pollution in the summer. A field survey around Beijing found a total of 28 species or cultivars exhibiting typical visible ozone foliar injury in 2013 (Feng et al., 2014). As a secondary air pollutant, ozone is a product 35 from photochemical reactions of volatile organic compounds (VOCs) and nitrogen oxides (NO_x). The increasing emissions of precursor substances coupled with a rise in air temperature results in an elevation of the ground-level ozone concentration (The Royal Society, 2008). Ozone is a serious air pollution problem in most parts of the world, particularly in Asia, causing significant damage to crops, forest trees and ecosystems, due to rising global background and/or regional peak concentrations (Paoletti, 2007; The Royal Society, 2008). In North America, Europe and Japan, ozone is being widely monitored. However, many developing regions with higher ozone concentrations countries have a limited and no continuous ozone monitoring networks, thus lacking suitable assessments of ozone effects on plants. The conference discussed how to set up coordinated surface ozone monitoring programmes across the world to validate modelled surface ozone concentrations and fluxes. Also, it is necessary to collate further field-based evidence for the impacts of ambient ozone on vegetation, especially in Asia and South America.

A strong focus of the conference was on the ozone effects on crop yield quality and quantity. Given the continuous and fast rise of the world population, pressure on food supply is expected to dramatically increase. Methods for assessing yield quality and approaches for improving yield quantity as a mitigation option in ozone-polluted environments were discussed, with an emphasis on breeding for more ozone-tolerant cultivars, especially for the two World's most important food crops, rice and wheat. Ozone toxicity mechanisms and effects on cropland soil microbiology diversity and function were also presented and discussed. There is a need for more cross-disciplinary collaboration between plant- ozone effects experts, plant breeders and agriculturalists.

Effects of ozone on ecosystem services, provided by forests and grasslands, such as carbon sequestration, control of the water cycle, and biodiversity conservation in the current and expected future climate also attracted much attention. This topic can be investigated in the field, e.g. by the antiozonant ethylenediurea (Manning et al., 2011), free-air ozone fumigation experiments (O_3-FACE) (Hoshika et al., 2015), *in situ* open-top chambers (OTCs) (Hoshika et al., 2014), micrometeorological approaches (Fares et al., 2013) and epidemiological investigations (Braun et al., 2014), which is an important improvement relative to the prevalent laboratory and greenhouse studies of the past. These various approaches allow for simultaneously investigating effects of many different factors together with ozone. The reseach tendency in the future is to investigate mature plants in long-term experiments at ecosystem level with a focus on the carbon, nitrogen and water cycles, and utilization of the non-destructive techniques such as sap-flow, eddy-covariance, and minirhizotrons. There is also a need of increased cross-disciplinary collaboration, involving experts with different backgrounds (plant ecophysiologists, biochemists, molecular biologists, atmospheric chemists, meteorologists, soil scientists, risk assessment experts, modelers, and statisticians).

Regional assessments of the effects of ozone on crop yield and forest health are usually based on exposure indexes derived from ozone concentrations (Paoletti and Manning, 2007). However, more and more scientific evidence has shown that the stomatal ozone flux appears superior by taking account of the biological and environmental factors that affect diurnal stomatal ozone uptake (LRTAP Convention, 2014; Mills et al., 2011). The development of stomatal flux modelling for different plant species and climate conditions, and thus ozone flux-effect relationships, were also discussed. Establishing regional stomatal ozone flux models is essential to assess the magnitude of ozone impact on crop yield and carbon sequestration by vegetation. It is warranted to further develop ozone flux-effect relationships and critical levels for vegetation, in particular under Asian climatic conditions and using Asian species and cultivars.

This special selection of Environmental Pollution includes four peer-reviewed contributions from this conference, focusing on the interactions of ozone and plants: an overview of the current and projected ozone effects on crop yield in China (Feng et al., 2015a), a meta-analysis of ozone effects on wheat grain quality (Broberg et al., 2015), principles of rice breeding for O_3-resistant cultivars (Frei, 2015), and different responses of soil microbiology to ozone between rice cultivars (Feng et al., 2015b).

We hope that these results can represent an input for future strategies of protecting plants against ozone, especially in terms of food security.

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