Photo - Gina Mills, CEH

Global Challenge Network on Tropospheric Ozone

Ecosystem effects of ozone

How does ground-level ozone affect vegetation?

Ground-level ozone damages ozone-sensitive vegetation. Effects include visible leaf injury, increased or premature die-back and reduction in growth and seed production of sensitive species. These can result in an increase in abundance of ozone-tolerant species and effects on the functioning of ecosystems and the services they provide.

Ground-level ozone is formed by a series of complex chemical reactions which take time to build up ozone concentrations. High concentrations are therefore found in rural and upland areas, some distance downwind of cities and other areas where the chemical precursors of ozone are emitted. Hot, sunny weather leads to the highest concentrations.

Examples of ozone-induced leaf damage on trees and grassland

Photos: *Gina Mills, Marcus Schaub (http://www.ozone.wsl.ch/)*

Key Facts

Ground-level ozone affects ecosystems as follows:

- Reduces biomass in sensitive species, e.g. reducing timber production in forests;
- Reduces the occurrence of sensitive plant species, potentially affecting biodiversity;
- Reduces carbon uptake in sensitive vegetation resulting in a positive feedback stimulating further global warming;
- Changes water cycling in vegetation, affecting water flow at the catchment scale;
- Changes the timing of flowering and floral scent trails, potentially affecting pollination by insects;
- Vegetation affected by ozone might become more susceptible to other environmental stresses such as drought, high wind, pests and diseases.

Links

icpvegetation.ceh.ac.uk

www.eclaire-fp7.eu

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Recent developments

Background concentrations of ozone due to intercontinental transport are rising whereas peak ozone concentrations during ozone episodes are declining across Europe, including the UK, due to the implementation of European air pollution abatement policies. Background concentrations are now at a level where they can affect sensitive species.

Critical levels of ozone for plant species have been defined based on the uptake of ozone by leaves rather than based on the ozone concentration in the air. The uptake of ozone by vegetation through the leaf pores is affected by light, temperature, air humidity, soil water availability and plant development.

Methods have been developed to quantify ozone impacts on timber production, carbon sequestration and livestock yield (via feed production), allowing economic implications to be assessed.

A smart-phone application has been developed to record and map incidences of ozone leaf damage across the globe.

What is needed?

In the past, many studies have been conducted on individual plant species at high peak ozone concentrations to identify ozone-sensitive species. However, less is known about the impacts on ecosystems of chronic exposure to background ozone concentrations with lower peaks.

Therefore, there is a need to assess the impacts of ozone on ecosystem processes (including plant and soil processes) and services (including carbon sequestration, biodiversity, food and timber production) in field-scale ozone exposure systems.

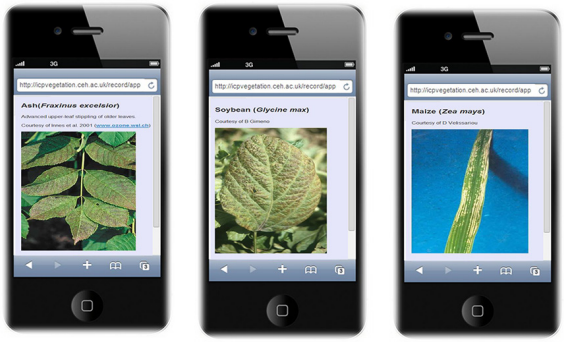
More information is needed about the impacts of ozone on vegetation in a future climate and in interaction with other pollutants.

Hence there is a need to study impacts of ozone on ecosystems in simulated future climates (e.g. warming, increased drought, elevated carbon dioxide), taking into account the interactions with other pollutants such as nitrogen.

To better estimate the costs of ozone pollution on vegetation, there is a need to further develop and improve methods to value (in monetary and non-monetary terms) impacts of ozone on ecosystems and the services they provide. This will improve cost-benefit analyses of control measures put in place to reduce ozone pollution.

Considering that ozone is a global pollutant, control measures to reduce ozone pollution need to be implemented world-wide.

Open air ozone exposure facility at the Centre for Ecology & Hydrology, Bangor



App for recording ozone injury on vegetation
http://icpvegetation.ceh.ac.uk/record

The Ozone Challenge

Ozone is formed in the lower atmosphere by the action of sunlight on nitrogen dioxide (NO_2), which is naturally present from lightning, biomass burning and soil emissions; man-made contributions to NO_2 from burning fossil fuels dominate in developed regions. Ozone formation is accelerated by the presence of organic gases, both biogenic and man-made. Ozone is toxic to plants, animals and humans; toxic concentrations are found in polluted air, downwind of NO_2 sources and especially in strong sunlight. Ozone is removed from the atmosphere by deposition to plants, and also by reaction with nitric oxide (NO) to form NO_2.

Further information and contact details:

www.ozone-net.org.uk

Other Fact sheets in the series:

- Ozone monitoring
- Ozone modelling
- Health effects of ozone
- Agricultural and crop-effects of ozone