

## Forest monitoring towards the definition of stomatal-flux critical levels for forest protection against ozone: the MOTTLES approach



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## **MOTTLES project**

contributes to the NEC (National Emission Ceiling) Italy and ICP Forests network for O<sub>3</sub> monitoring in 17 sites in France, Italy and Romania.

Tropospheric ozone  $(O_3)$  is a significant phytotoxic air pollutant and a greenhouse gas, which results from the emission of precursors such as nitrogen oxides (NOx) and volatile organic compounds (VOCs) produced by human activities.  $O_3$  concentration has doubled since pre-industrial times with harmful effects on forest health.

Current European directives for the protection of vegetation from the phytotoxic ozone  $(O_3)$  are based on atmospheric exposure (AOT40) that are not always representative of the actual field conditions. Such discrepancy is known to be related to the fact that O3 effects on forests depend on gas uptake through stomata (stomatal fluxes).

We have installed active  $O_3$  monitors allowing to: (1) estimate the accumulated exposure AOT40 and stomatal  $O_3$  fluxes (PODY) with an hourly threshold of uptake (Y) to represent the detoxification capacity of trees (POD1, with Y = 1 nmol  $O_3$  m<sup>-2</sup> s<sup>-1</sup> per leaf area); and (2) collect data of forest-response indicators, i.e. crown defoliation and visible foliar  $O_3$ -like injury over the time period 2017–2019. The soil water content is the most important parameter affecting forest trees and is a key factor in the PODY estimation, particularly for water-limited environments.



## Challenge for setting a flux based standard for the protection of forests against ozone

An assessment based on stomatal flux-based standard according to real plant monitoring is more appropriated than the exposurebased method for protecting vegetation. From flux-effect relationships, we derived flux-based critical levels (CLef) for forest protection against visible foliar  $O_3$ -like injury. We recommend CLef of 5 and 12 mmol m<sup>-2</sup> POD1 for conifers and broadleaved species, respectively. Before using PODY as legislative standard in Europe, we recommend using the CLec for  $\geq 25\%$  of crown defoliation in a plot: 17,000 and 19,000 ppb h AOT40 for conifers and broadleaved species, respectively.

AOT40 was high in Italian forest sites. However, the discrepancy was found in the distribution between AOT40 and POD1. POD1 can consider not only  $O_3$  concentration but also climatic condition and species-specific characteristics for stomatal uptake of  $O_3$ .



## **Exceedance of the critical levels**





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