Uptake of O₃ by urban and peri-urban forests: evidences from laboratory, field and modeling approaches

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SUPPLEMENTAL MATERIAL

Appendix S1. The study reported in Figure 1 the ozone uptake measured on common tree species used in Rome. The measurements are carried out in large cuvette experiments fumigated with 100, 200 and 300 ppb of O₃. Cuvettes were 96 L rigid Plexiglas cuvettes, with an airflow of 8 L min⁻¹ 570 internally coated with a transparent Teflon film and entire plants were enclosed during the measurements, excluding pots. Ozone concentrations were measured with a Dasibi 1008 HC U.V. photometric ozone analyzer. Light was about 1000 μmol m⁻² s⁻¹. For more details, refer to Morani (2013).

Appendix S2. In the study reported in Figure 2 the ozone uptake was measured by a range of urban tree species (*Pinus pinea, Quercus ilex, Populus nigra*) using a Teflon coated cuvette (approximately volume of 0.5 L, Waltz, Germany) with a flow rate of 1 L min⁻¹ under light conditions of 1000 μmol m⁻² s⁻¹ and a temperature of 30 °C. Ozone concentrations were measured with a Dasibi 1008 HC U.V. photometric ozone analyzer.

Appendix S3. The study reported in Figure 3 is related to the Eddy Covariance tower in a Mediterranean *Quercus ilex* forest located inside the Presidential Estate of Castelporziano, 25 km SW from the center of Rome, Italy. In the experimental site the wind velocity and sonic virtual temperature fluctuations were measured at 10 Hz with a three-dimensional sonic anemometer (Gill Windmaster, Gill Instruments, Lymington, UK) mounted on a horizontal beam next to the inlet of the sampling line. Air was sampled continuously at 19.7 m height near the sonic anemometer. Ozone measurements were made by chemiluminescence using Coumarin dye with a custom-made instrument developed by the National Oceanic and Atmospheric Administration (NOAA, Silver
Spring, MD, Fares et al., 2014). The chemiluminescence signal was calibrated against 30-min average ozone concentrations from the UV ozone monitor (Thermo scientific, mod. 49i). The raw analog data were recorded at 10 Hz. Data collection and sampling system control were performed using a data logger (CR3000, Campbell Scientific, Shepshed, UK). More details on data filtering, corrections and quality tests can be found in Fares et al. (2014).

Appendix S4. The results shown in Figure 4 and Figure 5 are modelled hourly ozone fluxes in urban and periurban trees carried out in several studies using the i-Tree (previously UFORE, Urban Forest Effect) model (www.itreetools.org). The downward pollutant flux (F; in µg m\(^{-2}\) s\(^{-1}\)) is calculated as the product of the deposition velocity (Vd; in m s\(^{-1}\)) and the pollutant concentration (C; in µg m\(^{-3}\)) (F = Vd C). Hourly O\(_3\) concentrations are obtained from local air quality monitors. Deposition velocity is calculated as the inverse of the sum of the aerodynamic (Ra), quasi-laminar boundary layer (Rb) and canopy (Rc) resistances. Hourly estimates of Ra and Rb are calculated using standard resistance formulas and hourly weather data from local weather stations. Hourly canopy resistance values for O\(_3\) are calculated based on a modified hybrid of big-leaf and multilayer canopy deposition models (Baldocchi et al. 1987; Baldocchi 1988). Canopy resistance (Rc) has three components: stomatal resistance (rs), mesophyll resistance (rm), and cuticular resistance (rt), such that: 1/Rc = 1/(rs+rm)+1/rt. Mesophyll resistance is set to 10 s m\(^{-1}\) for O\(_3\) (Hosker and Lindberg 1982). Base cuticular resistance is set at 10,000 s m\(^{-1}\) for O\(_3\) to account for the typical variation in rt exhibited among the pollutants (Lovett 1994). Model estimates assume ample soil moisture (trees do not go into drought conditions). To limit deposition estimates to periods of dry deposition, deposition velocities are set to zero during periods of precipitation. Total tree cover (m\(^2\)) is based on local measurements. Single-sided leaf area index within the canopy covered area and percent evergreen tree population are based on measured field data or estimates. Regional leaf-on and leaf-off dates are used to account for seasonal leaf area variation. Total removal of a pollutant in an area is calculated as the annual flux value (µg m\(^{-2}\) yr\(^{-1}\)) times total tree cover (m\(^2\)). More detailed information on modeling methods are given in Nowak et al. (2006, 2014) and Hirabayashi et al. (2011, 2012).

References


