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New initiative

Quantification of ozone uptake at the stand level in a *Pinus canariensis* forest in Tenerife, Canary Islands: An approach based on sap flow measurements

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Sap flow measurements can be used for estimating ozone uptake at the stand level and for parameterisation of O_3 uptake models.

Abstract

Ozone uptake was studied in a pine forest in Tenerife, Canary Islands, an ecotone with strong seasonal changes in climate. Ambient ozone concentration showed a pronounced seasonal course with high concentrations during the dry and warm period and low concentrations during the wet and cold season. Ozone uptake by contrast showed no clear seasonal trend. This is because canopy conductance significantly decreased with soil water availability and vapour pressure deficit. Mean daily ozone uptake averaged 1.9 nmol m^{-2} s^{-1} during the wet and cold season, and 1.5 nmol m^{-2} s^{-1} during the warm and dry period. The corresponding daily mean ambient ozone concentrations were 42 and 51 nl l^{-1}, respectively. Thus we conclude that in Mediterranean type forest ecosystems the flux based approach is more capable for risk assessment than an external, concentration based approach.

Keywords: Heat dissipation; Canopy conductance; Ozone uptake; Mediterranean

1. Introduction

Analysis on the impact of ozone (O_3) impact on forest stands requires the knowledge of site-specific O_3 formation, transport, and deposition. Within the canopy, the leaves are the primary site of O_3 uptake, with the stomata representing the interface for O_3 uptake from the atmosphere into the foliage. Methods for quantifying O_3 uptake at the canopy level include eddy covariance techniques (Zeller and Nikolov, 2000) and modelling approaches (Emberson et al., 2000). Eddy correlation measurements assess total deposition and stomatal O_3 uptake can hardly be separated from adsorption onto non-transpiring external surfaces (Zeller and Nikolov, 2000). Models by contrast, need a site-specific parameterisation, especially with respect to evaporative demand and soil water availability (Wieser and Emberson, 2004).

O_3 uptake at the canopy level can also be derived from sap flow measurements. Because transpiration and O_3 flux into the foliage are coupled via the stomata, sap flow measurements in the trunk of entire trees (Wieser et al., 2003) combined with stand density data provides a basis for estimating O_3 uptake at the canopy level. In addition, this latter technique is inexpensive, assesses foliage gas exchange in the presence of the actual site conditions neglecting non-stomatal deposition, and can be used in heterogeneous and mountainous landscapes

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where aerodynamic methods are strongly limited due to the patchiness of the vegetation and gusty winds. Therefore, in this study we combined micro-climatic, ambient air O_3 concentration data, and sap flow measurements through tree trunks with stand density data in order to estimate whole-canopy ozone uptake. The focus is on a *Pinus canariensis* stand in Tenerife, Canary Islands, a habitat with strong seasonal changes in water availability and evaporative demand.

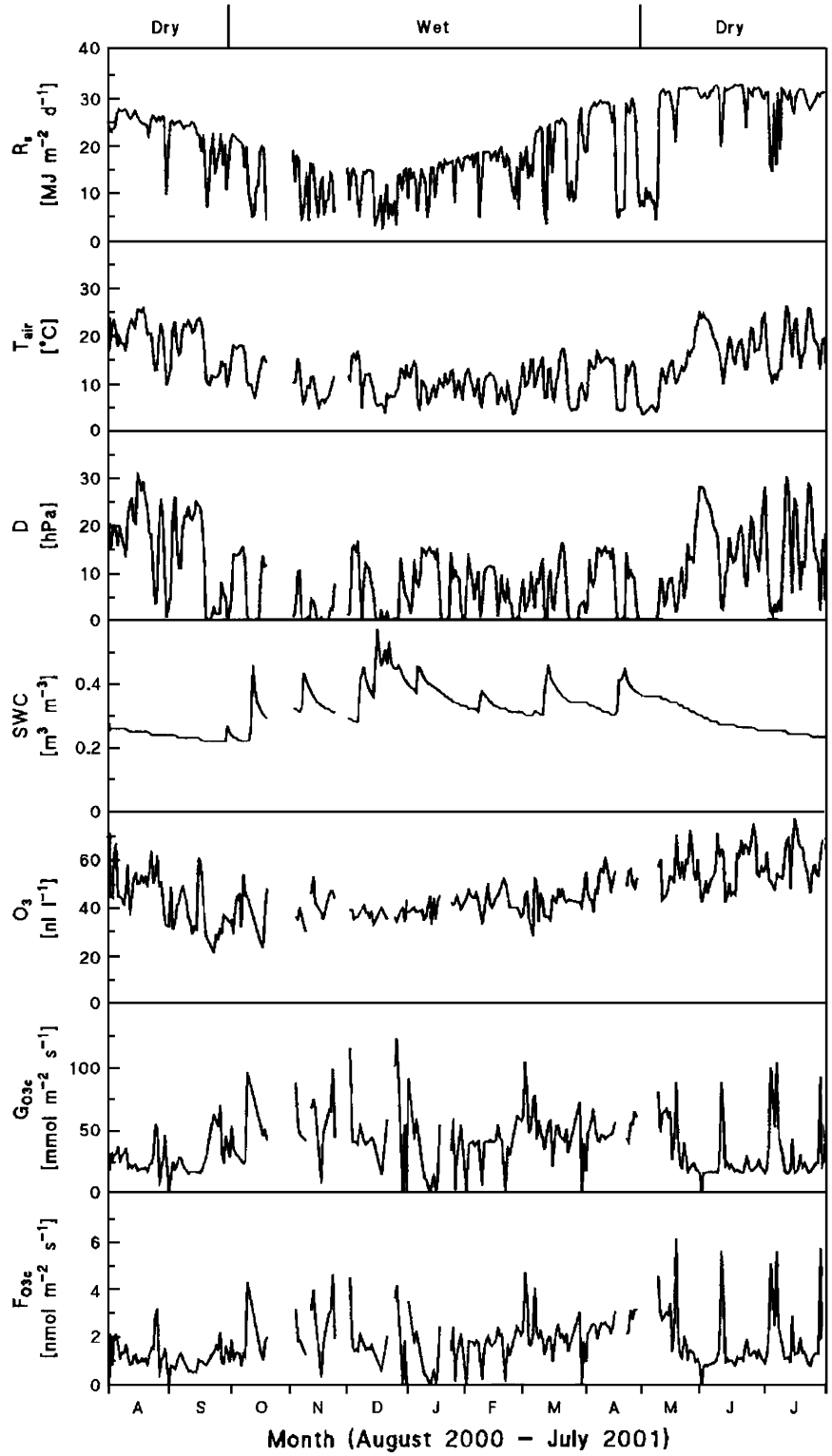

Fig. 1. Seasonal course of daily sum of solar radiation (R_s), daily mean air temperature (T_{air}), daily mean vapour pressure deficit (D), daily mean soil water content (SWC), daily mean ambient ozone concentration (O_3), ground area scaled canopy conductance for ozone (G_{O3c}), and ground area scaled ozone flux (F_{O3c}) in a *Pinus canariensis* forest at Tenerife, Canary Islands during the period 1 August, 2000 to 31 July, 2001.