Ozone – Deposition at a Forest Site

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INTRODUCTION

The deposition flux of ozone to surfaces such as vegetation, water, and soil is an important issue because (i) it is a significant sink for tropospheric ozone, and because (ii) the deposited O₃ may act toxic to the vegetation. The scope of our studies is the quantification of the diurnal and seasonal variations of the deposition flux of O₃ to a forest stand, and to understand the driving processes and parameters.

METHODS

On the one hand, we predict the deposition flux by use of simple BIG ‐ LEAF ‐ model (after Hicks et al., 1987, modified). The model is kept as simple as possible in order to minimize adjustable parameters:

\[ F_{O_3} = -c_{O_3} \frac{1}{R_a + R_s + \left( \frac{1}{R_{stom}} + \frac{1}{R_{soil}} \right)} \]

where:
- \( F_{O_3} \) is the deposition flux of O₃ (µmol m⁻² s⁻¹)
- \( c_{O_3} \) is the ozone concentration (ppb)
- \( R_a \) is the turbulent atmospheric resistance (calculated from turbulence measurements)
- \( R_s \) is the laminar boundary layer resistance (deduced from measurements)
- \( R_{stom} \) is the stomatal resistance, from plant physiological model (Falge, 2000)
- \( R_{soil} \) is the surface resistance, parameterized to be 1000 s m⁻¹ < \( R_{soil} \) < 2000 s m⁻¹, as function of the measured leaf surface wetness.

On the other hand, the deposition flux was measured with the eddy covariance method. The vegetation periods of 1999 and 2000 were fully covered. We focus our studies on the ecosystem research site "Waldstein" in the "Fichtelgebirge" mountains in NE Bavaria, at 780 m a.s.l. The forest vegetation consists of Norway Spruce (by 95 %). The experimental setup for ozone fluxes is similar to that of Güsten and Heinrich (1996).

RESULTS

The measured ozone deposition fluxes are generally larger than the modelled ones (except for the high mid ‐ day model deposition fluxes in spring). The measured fluxes hardly show any diurnal cycles. The nights exhibit no clear diurnal closure of stomata during the nights and a seasonal cycle due to decreasing solar radiation and shorter days in fall.

CONCLUSIONS

- The measured ozone deposition fluxes are generally larger than the modelled ones (except for the high mid ‐ day model deposition fluxes in spring).
- The measured fluxes hardly show any diurnal cycles.
- There is no significant correlation between the ozone deposition and the ozone concentration. This puts the usefulness of concentration ‐ based toxicology concepts such as AOT₄₀ into question.

REFERENCES


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