MEASURING VERTICAL PARTICLE FLUXES OVER A CONIFEROUS FOREST USING EDDY COVARIANCE

Andreas Held[a], Andreas Nowak[b], Alfred Wiedensohler[b], and Otto Klemm[a]

[a] Bayreuth Institute for Terrestrial Ecosystem Research, University of Bayreuth, Germany
[b] Institute for Tropospheric Research, Leipzig, Germany

INTRODUCTION

Input of nutrients and pollutants into terrestrial ecosystems through **dry deposition** of gases or particles is a key issue in ecosystem research in a changing environment. The application of micrometeorological methods to measure turbulent deposition of aerosol particles is still focus of fundamental research. Recently, the **eddy covariance (EC)** method has been used to determine vertical particle fluxes over forests (*e.g.*, Lamaud et al., 1994; Gallagher et al., 1997; Buzorius et al., 1998).

Fig. 1
The EC system over coniferous forest dominated by Norway Spruce.

METHODS

We applied an **EC system** combining an ultrasonic anemometer (YOUNG 81000) and two condensation particle counters (TSI CPC 3760A and TSI UCPC 3025, **Fig. 1**). Particle size distributions (3 nm to 800 nm) were measured using a **twin differential mobility particle sizer** (TDMPS, Institute for Tropospheric Research, Leipzig).

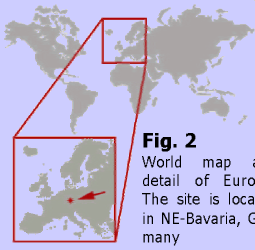


Fig. 2
World map and detail of Europe: The site is located in NE-Bavaria, Germany

The instruments were operated within the framework of the **BEWA2000** joint project at the "Waldstein" ecosystem research site of the Bayreuth Institute for Terrestrial Ecosystem Research (BITÖK) in the "**Fichtelgebirge**" mountain range in Central Europe (**Fig. 2**). The sampling inlets for both systems were mounted at 22 m above ground level in the SE corner of a 30 m research tower (776 m a.s.l.).

We present particle number fluxes and the evolution of the particle size distribution and compare results and implications of these two independent measurements.

Fig. 3 displays the diurnal development of the particle size distribution (PSD). Particle concentrations are visualized through different colors (blue indicates low, red high particle concentrations).

In the morning, a sudden increase in the number of small particles can be observed. The "banana-shaped" evolution of the PSD demonstrates growth of these particles through processes such as coagulation and condensation.

Particles with diameters < 50 nm dominate the total concentration. The peak concentrations in **Fig. 4** correspond with orange / red areas of high particle concentrations in **Fig. 3**.

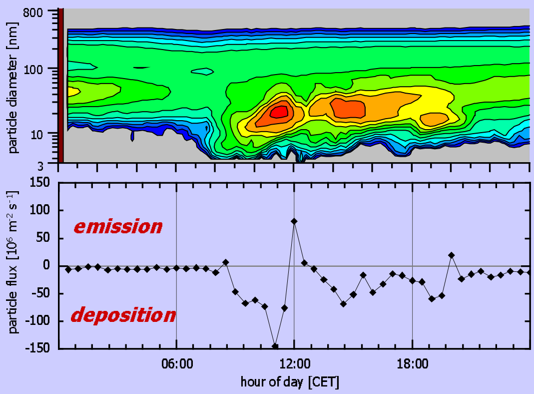
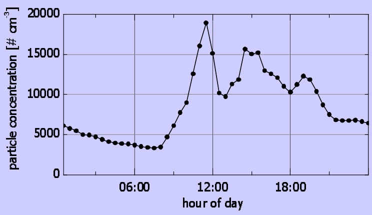


Fig. 3
Evolution of particle size distribution (upper panel) and particle number fluxes (lower panel on August 2, 2001.

Fig. 4
Diurnal pattern of particle concentration on August 2, 2001.



Vertical particle fluxes (**Fig. 3**, lower panel) are close to zero during nighttime. The nighttime PSD evolution is driven by particle transformation processes rather than vertical fluxes.

During daytime, however, the sudden occurrence of small particles (upper panel) and the start of increasing particle concentrations (**Fig. 4**) coincides with the onset of significant deposition fluxes at 08:00.

Although deposition fluxes are prevailing during daytime, particle emission was observed at noon (consistent with a steep concentration drop; **Fig. 4**).

Fig. 5 shows the latent heat and CO_2 fluxes. The patterns of these two fluxes correspond very well with each other, however, there is no clear correlation with the particle fluxes (**Fig. 3**).

Latent heat and CO_2 fluxes are driven by the available energy and directly linked to plant activity (assimilation / respiration), whereas particle fluxes are further dependent on complex physical and chemical particle transformations in the atmospheric boundary layer.

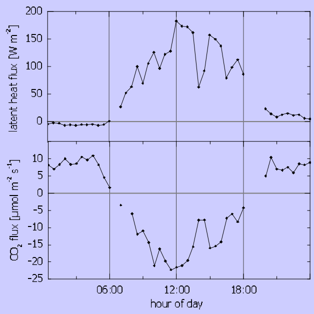


Fig. 5
Latent heat flux (upper panel) and CO_2 flux (lower panel) on August 2, 2001.

CONCLUSIONS

Particle deposition seems to dominate over emission throughout the day.

The atmospheric processes yielding the observed deposition patterns (including an emission episode around noon) need to be further studied.

REFERENCES

Buzorius, G., Rannik, Ü., Mäkelä, J.M., Vesala, T., and Kulmala, M. (1998). Vertical aerosol particle fluxes measured by eddy covariance technique using condensational particle counter. *J. Aerosol Sci.* 29, 157-171.

Gallagher, M.W., Beswick, K.M., Duyzer, J., Westrate, H., Choularton, T.W., and Hummelshoj, P. (1997). Measurements of aerosol fluxes to Speulder forest using a micrometeorological technique. *Atmos. Environ.* 31, 359-373.

Lamaud, E., Brunet, Y., Labatut, A., Lopez, A., Fontan, J., and Druilhet, A. (1994). The Landes experiment: Biosphere-atmosphere exchanges of ozone and aerosol particles above a pine forest. *J. Geophys. Res.* 99, 16511-16521.

ACKNOWLEDGEMENTS

The authors appreciate the help of J. Gerchau, Th. Wrzesinsky and the participants of the BEWA2000 field campaign 2001. This study was supported by the German federal research ministry (BMBF) through grant PT BEO 51-0339476C (BITÖK funding) and grant PT UKF 07ATF25 (BEWA2000).

For more information visit our website at http://www.bitoek.uni-bayreuth.de
email: andreas.held@bitoek.uni-bayreuth.de