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# Effects of water vapour pressure deficit on bulk canopy conductance in a beech forest.

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It is well known that turbulent water vapour fluxes measured with closed-path eddy covariance (EC) systems can suffer from low pass filtering by the system. The fluxes are underestimated and need to be corrected. Recently it has been shown that the cut-off frequency of EC systems for water vapour concentration measurement is not a constant, but may increase exponentially with relative humidity, as an effect of water sorption and desorption on the surfaces of the EC-system (Ibrom et al. 2007). These effects must also lead to a cross-sensitivity between the flux measurement and the water vapour pressure saturation deficit ($D$).

In order to maintain transpiration within certain boundaries forest trees often reduce stomatal conductance at high $D$. This physiological control mechanism can be investigated with the help of atmospheric water vapour flux measurements. By inverting the Penman-Monteith equation bulk stomatal conductance ($g_b$) can be estimated from latent and sensitive heat fluxes ($\lambda E$ and $H$, respectively) and wind measurements. We investigate here, which effect the observed cross-sensitivity of the water vapour flux measurement to relative humidity has on the estimation of $g_b$. For this we used turbulent flux data from the Sorø beech forest site on Zealand, Denmark.

The correction increased $\lambda E$ on average by 44% - under humid conditions much more: the averaged low-pass filter correction factor increased from 1.15$\pm$0.05 ($D > 1000$

Pa), to 1.45 $\pm$0.1 (500 Pa $< D <$ 100 Pa) to 2.3 $\pm$0.5 ($D <$ 500 Pa).

The $g_b$ values from corrected $\lambda E$ ($g_c$) were 1.5 times larger than those from uncorrected $\lambda E$ ($g_u$). However not only the average values, but also the shape of the response to $D$ changed. A hyperbolic curve that was fitted to the maxima from $D$ classes of the relationship $g_b$ versus $D$ revealed that the maximum conductance of $g_c$ was 2.6 times larger then those of $g_u$. This effect was accompanied by a stronger $g_b$ reduction with increasing $D$. The $D$ value, when $g_b$ reached was reduced to 50 % of its maximum value was 390$\pm$80 Pa for $g_c$ and 1227$\pm$261 Pa for $g_u$. If $\lambda E$ were not corrected, the sensitivity of $g_b$ to $D$ would be underestimated by 2/3.

The findings show impressively that flux measurements have to be carefully corrected before they are used for biogeochemical analyses. Ibrom et al (2007) found the new relative humidity dependency of the low-pass filter correction for water vapour also in another completely different EC system and concluded that there will be most likely more results from closed-path EC measurements that are affected by this systematic error.

**References**

Ibrom, A., E. Dellwik, N.O. Jensen, H. Flyvbjerg and K. Pilegaard. 2007. Strong low-pass filtering effects on water vapour flux measurements with closed-path eddy correlation systems. Agric. For. Meteorol. 147:140 -156.