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Attenuation correction of water vapor fluxes from closed-path eddy-covariance systems

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In recent work we have investigated errors that are prevalent and systematic in the closed-path eddy-covariance measurement of latent heat flux: the attenuation of fluxes through dampened cospectral power at high frequencies. This process is especially pronounced during periods of high relative humidity through the adsorption and desorption of water vapor along the tube walls. These effects are additionally amplified during lower air temperature conditions. Fortunately, such effects can be identified using the lag time of the cross-correlation peak between the water vapor and vertical wind velocity signals, and can be modeled by computing the cospectral attenuation relative to the cospectral power of simultaneous sensible heat-flux measurements. This work found that including the role of temperature in modifying the attenuation–humidity relationship is essential for unbiased flux correction, and that physically based cospectral attenuation methods are effective characterizers of closed-path instrument signal loss relative to the unattenuated flux value.

In this presentation, we demonstrate the large magnitude of this effect on the vertical H2O flux. Using an H2O-CO_2 eddy covariance dataset taken during the 2006 growing season in a polygonal tundra ecosystem in the Lena River Delta in Northern Siberia (72˚22' N, 126˚30' E), we quantify under-estimation of the water vapor flux by the closed-path measurement system. Because environmental conditions at this site are both humid and relatively low in temperature throughout nearly the entire year, these effects are greater here than in other ecosystems. The water vapor flux derived without proper accounting of the tube-based attenuation "misses" 45% of the actual water vapor flux as corrected for the tube adsorption effects. The ecological consequences of such a measurement correction are substantial, as site evapotranspiration is tightly coupled to the vertical fluxes of CO_2 and CH_4, and the water use efficiency of plant species could be overestimated.