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Open path measurements of carbon dioxide and water vapor under foggy conditions – technical problems, approaches and effects on flux measurements and budget calculations

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To estimate carbon dioxide or water vapor fluxes with the Eddy Covariance method high quality data sets are necessary. Under foggy conditions this is challenging, because open path measurements are influenced by the water droplets that cross the measurement path as well as deposit on the windows of the optical path. For the LI-7500 the deposition of droplets on the window results in an intensity reduction of the infrared beam. To keep the strength of the infrared beam under these conditions, the energy is increased. A measure for the increased energy is given by the AGC value (Automatic Gain Control). Up to a AGC threshold value of 70 % the data from the LI-7500 is assumed to be of good quality (personal communication with LICOR). Due to fog deposition on the windows, the AGC value rises above 70 % and stays there until the fog disappears and the water on the windows evaporates.

To gain better data quality during foggy conditions, a blower system was developed that blows the deposited water droplets off the window. The system is triggered if the AGC value rises above 70 %. Then a pneumatic jack will lift the blower system towards the LI-7500 and the water-droplets get blown off with compressed air. After the AGC value drops below 70 %, the pneumatic jack will move back to the idle position.

Using this technique showed that not only the fog droplets on the window causing significant problems to the measurement, but also the fog droplets inside the measurement path. Under conditions of very dense fog the measured values of carbon dioxide can get unrealistically high, and for water vapor, negative values can be observed even if the AGC value is below 70 %. The negative values can be explained by the scatter of the infrared beam on the fog droplets. It is assumed, that different types of fog droplet spectra are causing the various error patterns observed.

For high quality flux measurements, not only the AGC threshold value of 70 % is important, but also the fluctuation of the AGC value in a flux averaging interval. Such AGC value fluctuations can cause severe jumps in the concentration measurements that can hardly be corrected for. Results of fog effects on the LI-7500 performance and its consequences for flux measurements and budget calculations will be presented.