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Eddy covariance flux measurements of ozone: Three stations side-by-side

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Since about two decades, fast response ozone analyzers, based on gas-phase chemiluminescence ("Güsten type"), became more and more available and emerged to be operational in atmosphere-biosphere exchange studies using the eddy-covariance technique. While there are first preliminary reports about measurements of the vertical profile of ozone fluxes in forest canopies (addressing the question of vertical flux divergence), measurements by ozone flux stations distributed in a horizontally arranged array (addressing questions of horizontal divergence and/or footprint) might be feasible.

For all these measurements, the precision of ozone flux stations is of particular interest, because it defines the vertical/horizontal resolution of expected flux divergence. As a first step in this direction, we performed a 9 week, side-by-side experiment of three ozone flux stations on a small airfield in Mainz-Finthen/Germany (49.969° N, 8.148° E, 227 m a.s.l.) in late summer/autumn 2011.

Turbulent fluctuations of ozone concentration (in arbitrary units) have been measured by three identical gas-phase chemiluminescence anaylzers (enviscope GmbH/ Germany) with a sampling frequency of 20 Hz. Absolute ozone concentrations have been monitored by three slow-response UV-absorption based analyzers (model 205, 2BTechnologies/U.S.A.; model 49i, ThermoInstruments/U.S.A.) every 2 and 10 seconds, respectively. Three 3D sonic anemometers (model USA-1, METEK/Germany; model CSAT3, Campbell Scientific/U.K.) have been applied to obtain fluctuations of 3D wind vectors and temperature (20Hz). All fast response sensors were mounted at 3 m above ground, the three flux stations have been aligned in cross-wind direction in a distance of about 5.5 m to each other. Sensor separation (3D anemometer - ozone intake) was 0.3 m, the length of ozone intake tubes were about 3 m. Ozone monitors have routinely been calibrated every 15 days. For the calculation of turbulent fluxes of ozone, momentum, and sensible heat from the observed time series we used the well-known TK3 algorithm (Department of Micrometeorology, University Bayreuth, Germany), particularly to provide TK3's quality assurance and quality control (QA/QC) measures.

We will present results of different sensor combinations to elucidate the impact of instrumental variability (among fast-response and slow-response ozone analyzers, as well as among 3D ultrasonic anemometers) on the evaluation of the ozone flux. Finally, we will quantify the precision of ozone flux stations under field conditions.