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Dealing with disjunct concentration measurements in eddy covariance applications: a comparison of available approaches with particular reference to VOC fluxes measured with a PTR-MS

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Using proton-transfer-reaction mass spectrometers (PTR-MS) technology to quantify the biosphere-atmosphere exchange of volatile organic compounds (VOC), concentrations of different VOC have to be measured sequentially. Depending on how many VOC species are targeted and their respective integration times, each VOC is measured at repeat rates on the order of a few seconds. This represents a significant difference compared to the true eddy covariance method, where repeat rates of ten to twenty times a second are standard. Here we simulate the effect of this disjunct sampling on eddy covariance flux estimates by progressively decreasing the time resolution of CO2 and H2O fluxes measured at 20 Hz above a temperate mountain grassland in the Stubai Valley (Austria). Fluxes for one month are calculated with the true eddy covariance method and compared to fluxes calculated based on respective disjunct data (1, 3 and 5s repeat rates) using the following approaches: i) Method after Spirig et al. (2005: ACP 5, 465-481), ii) a linear interpolation variant of the Spirig method, and iii) virtual disjunct eddy covariance (vDEC). It is shown that the two variants of the Spirig method result in additional low-pass filtering of the time series, resulting in a flux loss of 4-28 %. A correction procedure based on a transfer function approach is developed to correct for this flux underestimation, resulting in improved correspondence (within 2 %). The vDEC method yields fluxes which approximate the true (20 Hz) fluxes within 1 %, but exact calculation of tube lag times proofs critical in this case.