Dealing with disjunct concentration measurements in eddy covariance applications: a comparison of available approaches

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BACKGROUND

Until the time-of-flight proton-transfer-reaction mass spectrometry (TOF-PTR-MS) has sufficiently matured to be routinely applied for eddy covariance flux measurements, conventional proton-transfer-reaction mass spectrometers (PTR-MS) have to be used for quantifying the biosphere-atmosphere exchange of **volatile organic compounds (VOC)**. As a consequence, concentrations of different VOC have to be measured **sequentially**, resulting in repeat rates in the order of a few seconds (depending on how many VOC species are targeted and the respective integration times), as opposed to the true eddy covariance method, where repeat rates of ten to twenty times a second are standard.

Here we simulate the effect of disjunct sampling on eddy covariance lag times by progressively decreasing the time resolution of CO2 fluxes measured at 20Hz above a temperate mountain grassland in the Stubai Valley (Austria) - to this end one month of data obtained in July 2007 was used. Following up an approach put forward by Spirig et al. (2005) we used **three different methods** to transform the disjunct concentration data to a time series equidistant with the sonic anemometer data (20Hz).

METHODS

DESCRIPTION of the three methods used:

(i) **fill**: an individual data point of a particular cycle is repeated over the length of one measurement cycle until the next data point is available. This repeated data point is therefore regarded to be representative for the whole time period of the measurement cycle, as proposed by Spirig et al. (2005).

(ii) **adjusted fill**: a data point is repeated 'in advance', resulting in a centralized version of the 'fill method'.

(iii) **interpolated fill**: gaps are filled by linear interpolation between two data points.

Fig.1 shows the resulting time series of the three methods in comparison to the **original data.**

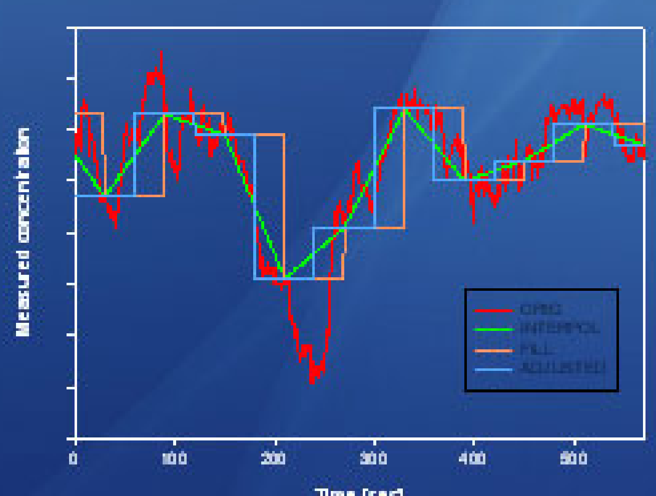


Fig. 1 Illustration of the respective TIME SERIES of each method compared to the original time series of a certain scalar.

RESULTS & CONCLUSION

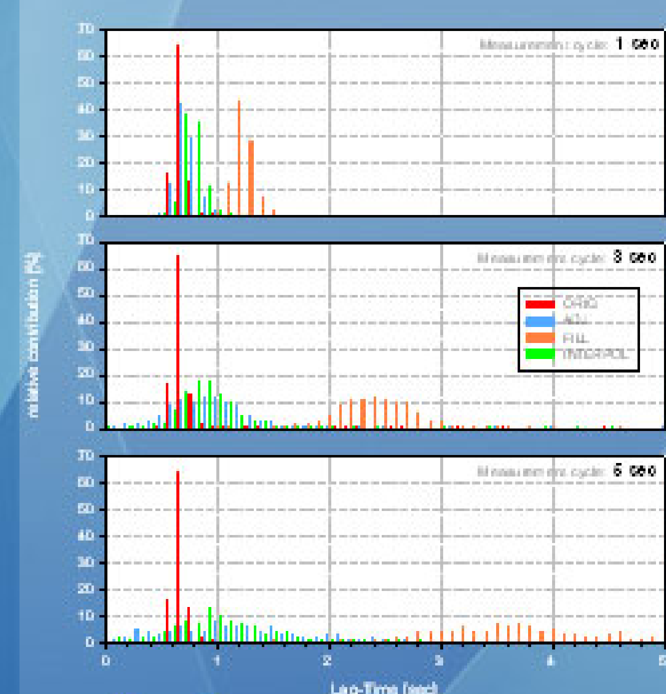


Fig. 2 Resulting tube LAG TIMES for the different approaches.

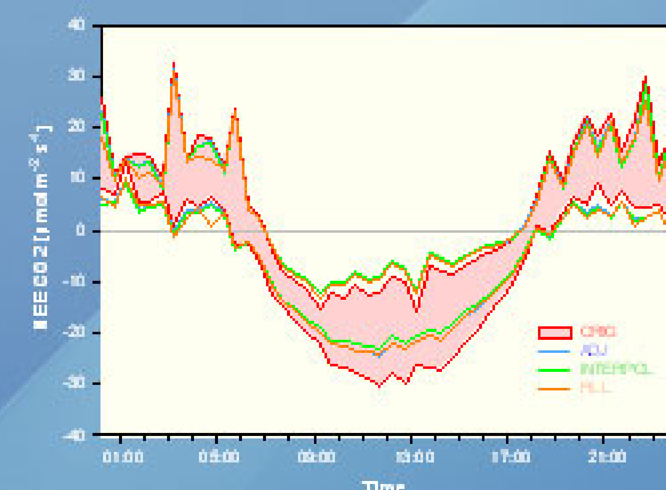


Fig. 3 NET ECOSYSTEM CO_2 EXCHANGE in July 2007, calculated by using the three different methods

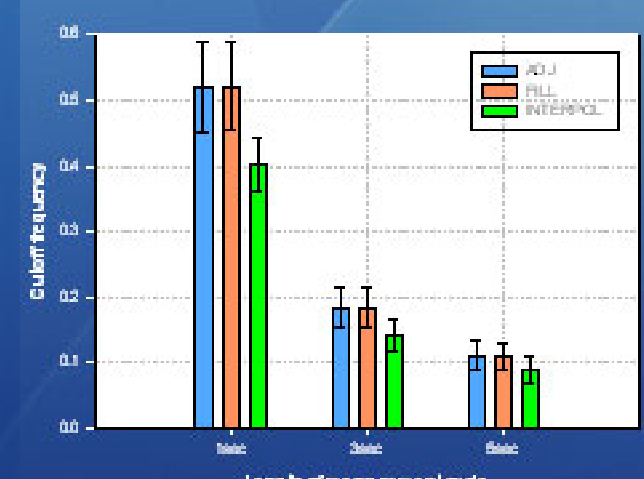
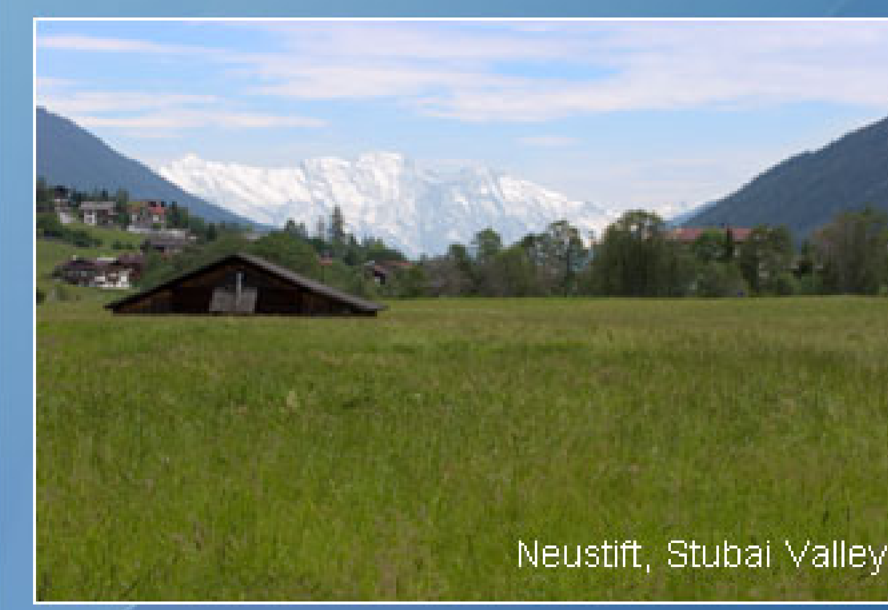


Fig. 4 CUTOFF FREQUENCY for the 3 different methods.

All 3 methods showed a shift of lag times towards longer lags (Fig. 2) and an underestimation of the resulting fluxes (Fig.3) compared to the original 20 Hz data.

After looking at the different cutoff frequencies (Fig. 4) we have developed a method to correct for this underestimation using a transfer function proposed by Aubinet et al. (2000). Fig. 5 illustrates the preliminary result of this correction.

The FILL method suggested by Spirig et al. (2005) leads to much longer lags, but the flux underestimation is similar to the ADJUSTED FILL.



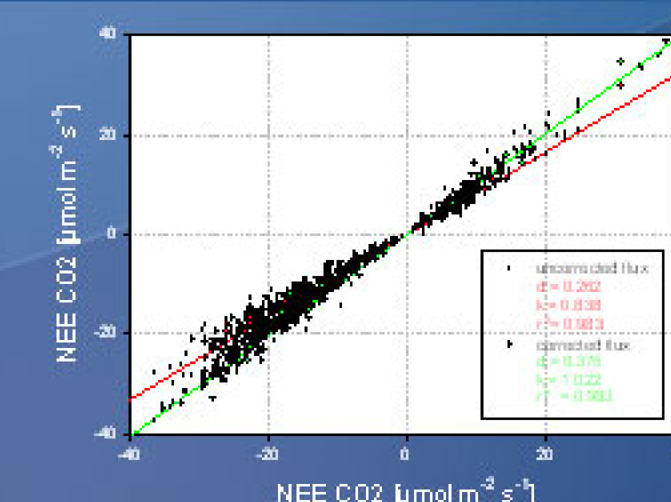


Fig. 5 FLUXES: original 20Hz data (x-axis) vs. ADJUSTED FILL METHOD used on 0,3 Hz data (y-axis) – a comparison of corrected and uncorrected fluxes.

LITERATURE: Aubinet et al. 2000: Estimates of the Annual Net Carbon and Water Exchange of Forests: The EUROFLUX Methodology, in: Advances in Ecological Research Vol. 30, 113 – 175.
Spirig et al. 2005: Eddy covariance flux measurements of biogenic VOCs during ECHO 2003 using proton transfer reaction mass spectrometry, in: Atmos. Chem. Phys.,5, 465 – 481.

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