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# Impacts of a decadal drainage disturbance on surface–atmosphere fluxes of carbon dioxide in a permafrost ecosystem

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**Supplement: Discussion of data processing and uncertainties**

The Burba correction was applied to adjust for the surface heating effects on the measurement performance of the open-path gas analyzer (LI-7500, LI-COR Biosciences); however, our approach is different from the original formulation of this procedure as detailed by Burba et al. (2008). Our approach was to customize the original equation for a non-vertical orientation of the instrument. Since our analyzer was mounted in an inclined position, the majority of the self-induced heating did not affect the measurement path; as a result, only a small fraction of the original Burba correction term needed to be applied (Jarvi et al., 2009; Rogiers et al., 2008). We used a dataset of closed-path fluxes as a reference (data not shown), and found that 7 % of the original Burba correction optimized the agreement between open-path fluxes and the reference closed-path fluxes. As this value is dependent on changes in the reference closed-path dataset (e.g., data processing or software), the fraction of the applied correction might still be subject to change in future experiments. Still, with data processing based on standardized methods (Fratini and Mauder, 2014), the estimated fractionation factor is comparable to that presented by Jarvi et al. (2009). A good correlation between open- and closed-path data after the correction ($R^2 = 0.92$; slope = 1.05 mmol $m^{-2}$ $s^{-1}$ and offset = -0.0001 mmol $m^{-2}$ $s^{-1}$) was also obtained. We therefore assume that our correction is representative to remove systematic effects of sensor heating from the open-path flux data used in the present study.

Since the longest gaps have been present during pre-season - a critical transition period between winter and the growing season when environmental conditions change rapidly - even relatively short data gaps can have an impact on the final time series of $CO_2$ fluxes. For instance, as seen in the 2015 Tower 1 dataset, a poor performance of the gap-filling algorithm produced a sharp transition between winter (with near-zero fluxes) and the pre-season (with pronounced release, Fig. 8b). However, for long-term budgets, this short period with relatively low flux rates is not relevant, and during the remaining sub-season only short gaps occur, during which the algorithm performs well.

To account for the strong inter-seasonal variability, we computed flux-partitioning algorithms separately for each sub-season. With this approach we ensured that our method is based on adequate relationships between temperature and respiration rates at each point in the growing season. This seasonal separation also prevents potential overestimation of base respiration (Mahecha et al., 2010), which is related to growth in both microbial and plant biomass with increasing thaw depth and rising soil temperatures. Overall, the output of such a flux-partitioning algorithm is subject to increased uncertainties based on the chosen methodology and user-defined settings; the results on the component fluxes presented in the present study must be interpreted accordingly.

The comparability of the flux datasets between observation years has some technical limitations due to changes in instrumental setup (eddy-covariance equipment). For the historic dataset, both open-path (LI7500) and closed-path (LI6262) infrared gas analyzers (IRGAs) were used, while recent data are based on an open-path (LI7500) IRGA and a different type of closed-path analyzer (Los Gatos FGGA, off-axis integrated cavity output spectroscopy). Differences in the analyzer type also require different data post-processing and correction, and can result in deviations in the final flux rates even if the observed signals are similar. When integrating eddy-covariance fluxes over longer time periods (e.g., weeks, months, years), previous studies indicate that averaged cumulative NEE tends to be more positive when results are based on $CO_2$ signals from an open-path system (Bowling et al., 2010; Clement et al., 2009; Haslwanter et al., 2009). Even though most of these studies have been based on a newer version of the closed-path instrument (LI7000), their results suggest that part of the differences found between the historic and recent datasets presented in the present study might be related to changes in the instrumental setup.

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