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Supplement of

Carbon dioxide and methane fluxes from different surface types in a created urban wetland

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Alternative gap-filling method

Besides the gap-filling method using artificial neural network (ANN) as described in the manuscript, we also gap-filled the missing net ecosystem exchange (NEE) measured by eddy covariance techniques without using the dissolved gas concentration in the water. We used the following parameterization based on biological principles (Aurela et al., 2009):

$$NEE = \frac{PI \times \alpha \times PPF D \times GP_{max}}{\alpha \times PPF D + GP_{max}} + R_0 \exp \left[E \left(\frac{1}{T_0} - \frac{1}{T_{air} + T_1} \right) \right],$$

where NEE is the net ecosystem CO₂ exchange, GP_{max} is the gross photosynthesis rate in optimal light conditions, PI is an empirically determined effective phytomass index (Aurela, Tuovinen et al. 2001), α is the initial slope of NEE versus PPF D, R_0 is the rate of ecosystem respiration at 10 °C, E is a physiological parameter (in degree Kelvin), T_{air} is the air temperature, $T_0 = 56.02$ K, $T_1 = 227.13$ K (Lloyd and Taylor 1994). PI was calculated by subtracting the nighttime (PPFD < 20 $\mu\text{mol m}^{-2} \text{s}^{-1}$) respiration flux from the daytime (PPFD > 500 $\mu\text{mol m}^{-2} \text{s}^{-1}$) flux. The PI was calculated on a six-day basis. During summer time (day of year 90 – 283), E was determined by fitting the respiration to the nighttime data through the year, which was 342.24 K. α , GP_{max} and R_0 were fitted in bi-weekly periods: an R_0 value was first determined by fitting the respiration to the nighttime data for each of these periods, then the values of α and GP_{max} were obtained by fitting the NEE equations to the daytime and nighttime data. During winter when no uptake of CO₂ was observed, the gaps were filled by a moving average with a 30-day window. At the beginning and end of the winter periods, the window was 8 days.

For gap-filling CH₄ flux during year 2013, we explored the dependence of methane emission on air temperature and water temperature. Only days with data coverage better than 33% was used in this analysis, which resulted 94 daily averages based on measured data. As the behavior of the flux seems to be different before and after day of year (DOY) 160, two exponential curves were fitted separately to the data within these two periods. The fitting results can be described in the equation below

$$F = a \exp[b T],$$

where T indicates air temperature or outflow water temperature. When fitted with air temperature, $a = 0.433$ $\text{mg m}^{-2} \text{h}^{-1}$, $b = 0.093$ °C for data before DOY 160 and $a = 0.265$ $\text{mg m}^{-2} \text{h}^{-1}$, $b = 0.057$ °C for data after day 160. The correlation coefficients were 0.95 and 0.72, respectively. When fitted with outflow water temperature, $a = 0.362$ $\text{mg m}^{-2} \text{h}^{-1}$, $b = 0.105$ °C for data before day 160 and $a = 0.181$ $\text{mg m}^{-2} \text{h}^{-1}$, $b = 0.077$ °C for data after DOY 160. The correlation coefficients were 0.94 and 0.78, respectively. To maximize the goodness of fit, air temperature was used in gap-filling for data points before DOY 160 while outflow water temperature was used for after DOY 160.

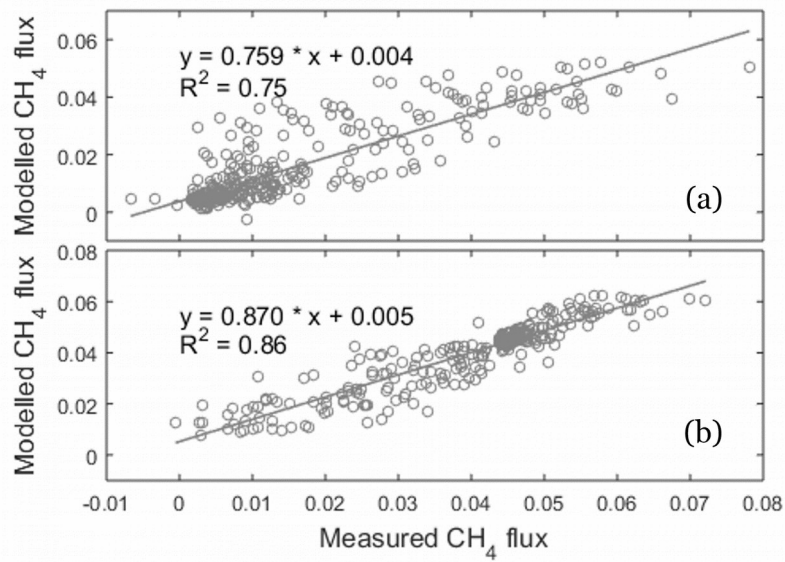


Figure S1: Comparing the modelled and measured ecosystem flux (using CH₄ as example) (a) without or (b) with dissolved gas concentration in open water ([CH₄] in this case) in artificial neural network architecture.

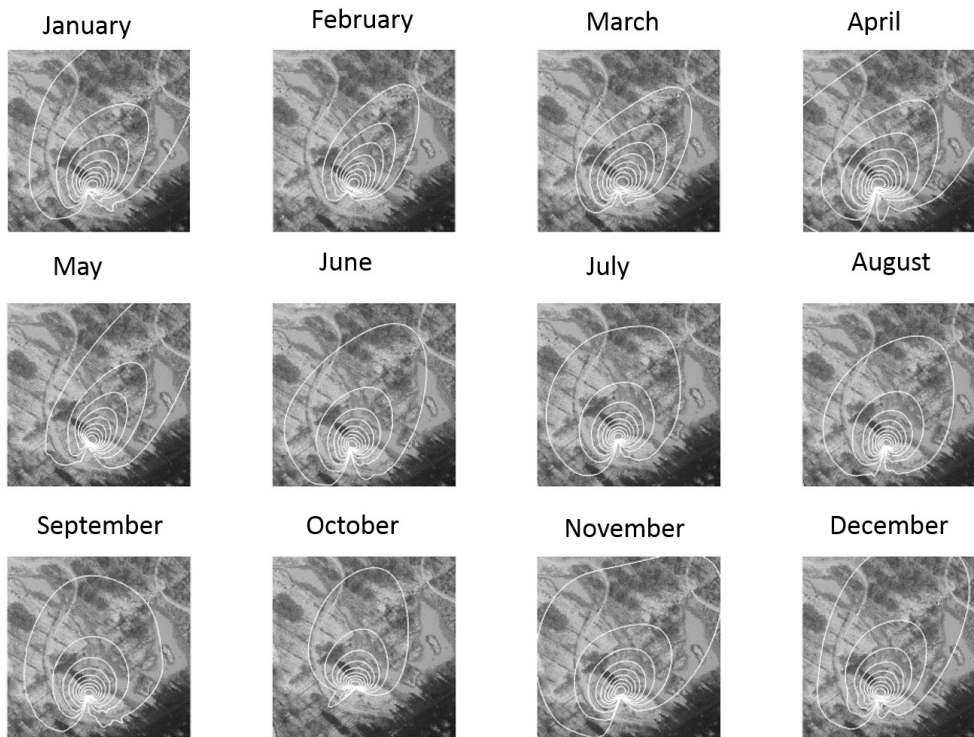


Figure S2: The aggregated footprint climatology of Nummela wetland during each month in year 2013. White contour lines show 10 % - 90 % flux footprint climatology.

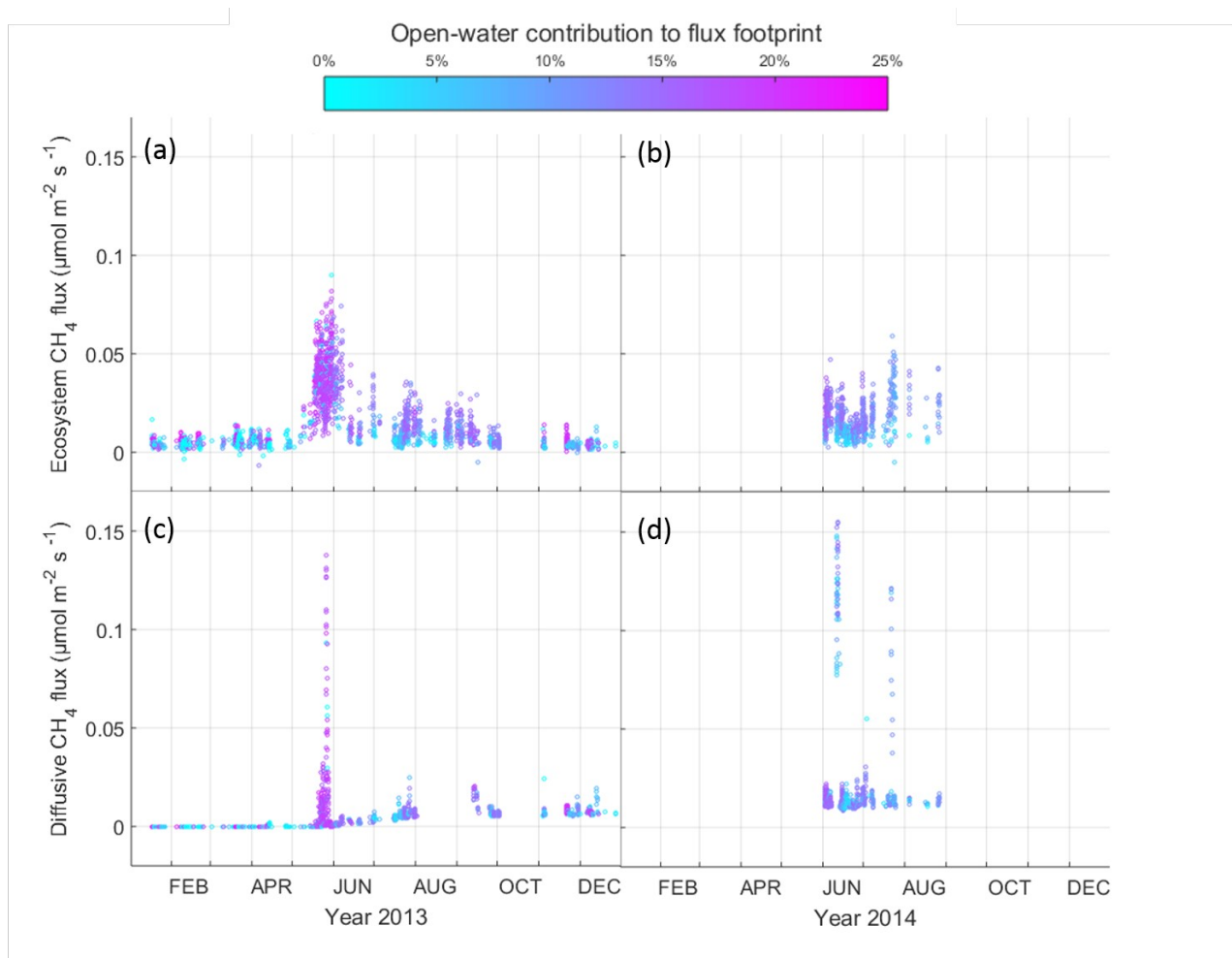


Figure S3: Ecosystem CH₄ flux measured by eddy covariance tower ((a) and (b)) and diffusive CH₄ flux modelled from open water ((c) and (d)). The colour bar indicates the footprint-weighted spatial contribution from the open water.