Annual greenhouse gas budget for a recently rewetted raised bog ecosystem

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a place of mind

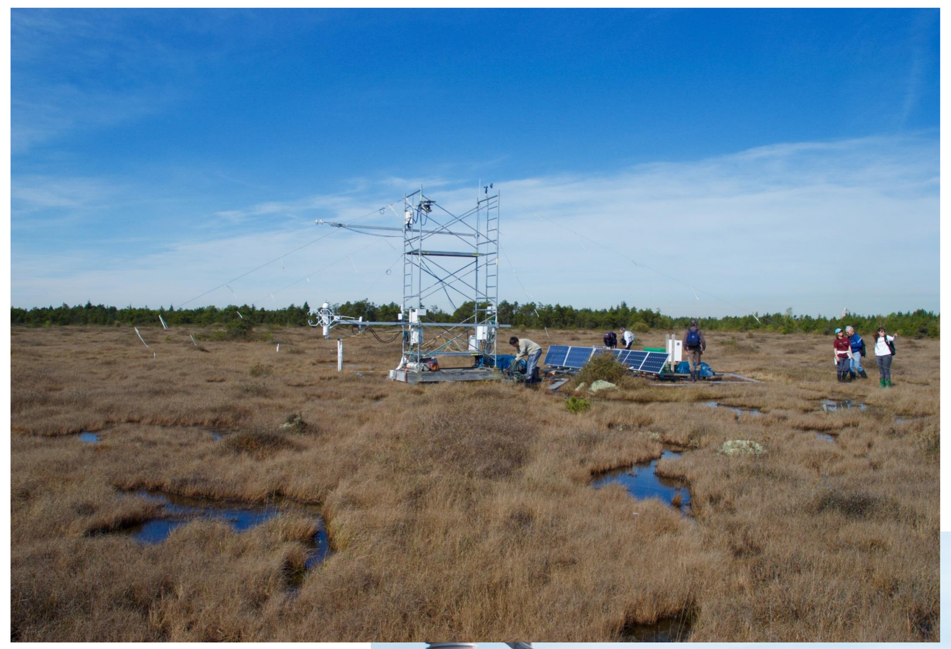
Introduction

Rewetting of peatlands, which have been drained and disturbed by peat mining, facilitates their ecological recovery, and may help them revert to carbon sinks[1]. However, rewetting of disturbed peatlands may cause substantial emissions of methane (CH_4)[2].

Burns Bog Ecological Conservancy Area is located in the Fraser River Delta near Vancouver, Canada, and is recognized as the largest raised bog ecosystems on North America's west coast[3]. Historically, it has been substantially reduced in size and degraded by peat mining and agriculture. Since 2005, the bog has been declared a conservancy area, and restoration efforts focus on rewetting disturbed ecosystems. A pilot study measured CH_4, carbon dioxide (CO_2) and nitrous oxide (N_2O) fluxes from various surfaces in summer 2014 and found substantial summertime CH_4 emissions from recently rewetted sites, while fluxes of N_2O were negligible. Here, we monitor CO_2 and CH_4 fluxes year round to determine whether the rewetted areas of the BBECA are annually a net source or a net sink of greenhouse gases (GHGs)[4].

Methodology

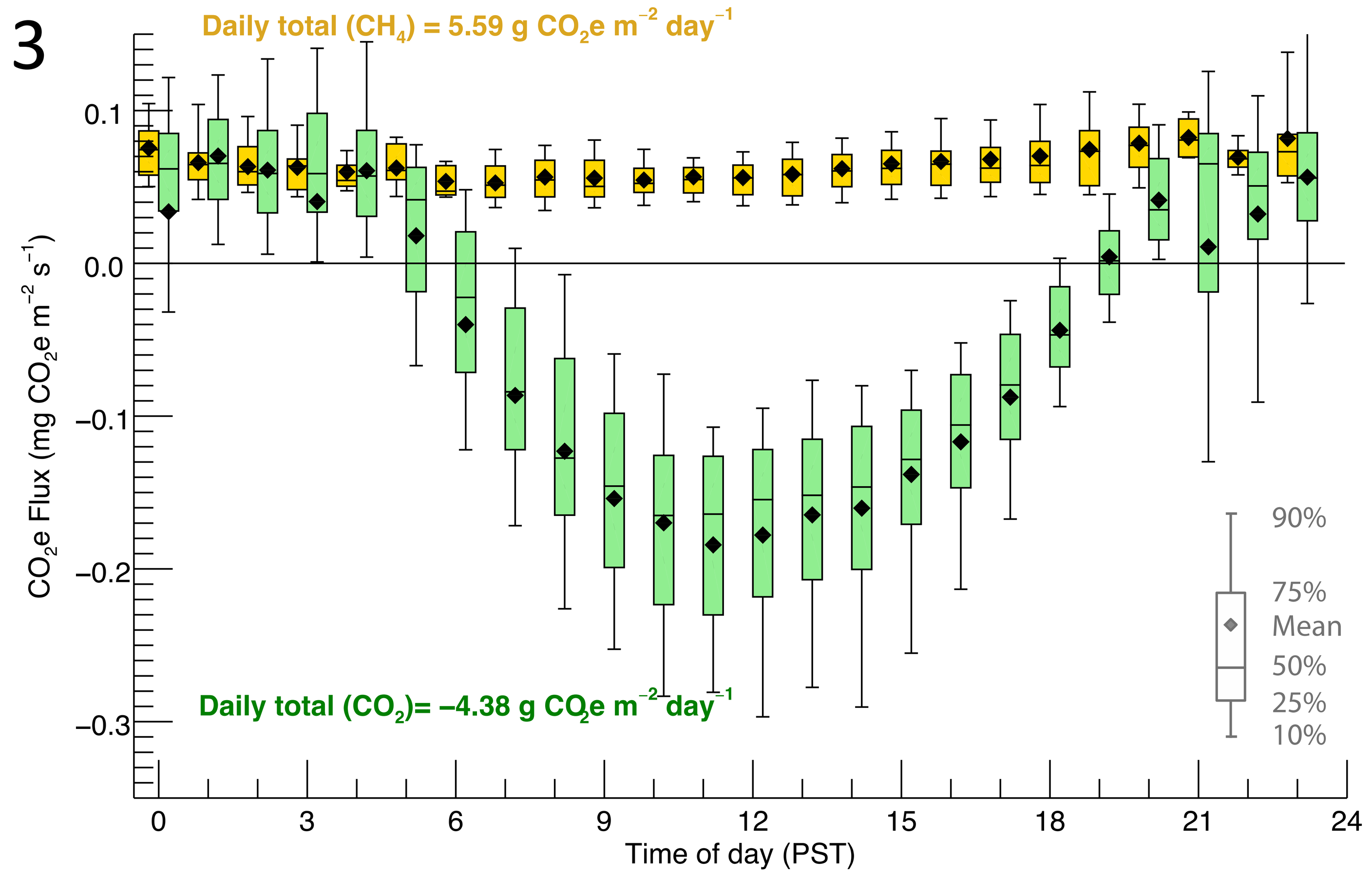
We measured year-round turbulent fluxes of CO_2 and CH_4 using the eddy-covariance (EC) approach from a disturbed and recently rewetted raised bog ecosystem located in the BBECA. Plant communities are primarily dominated by *Sphagnum* and ericaceous plants[5]. The average height of vegetation was about 0.3 m.



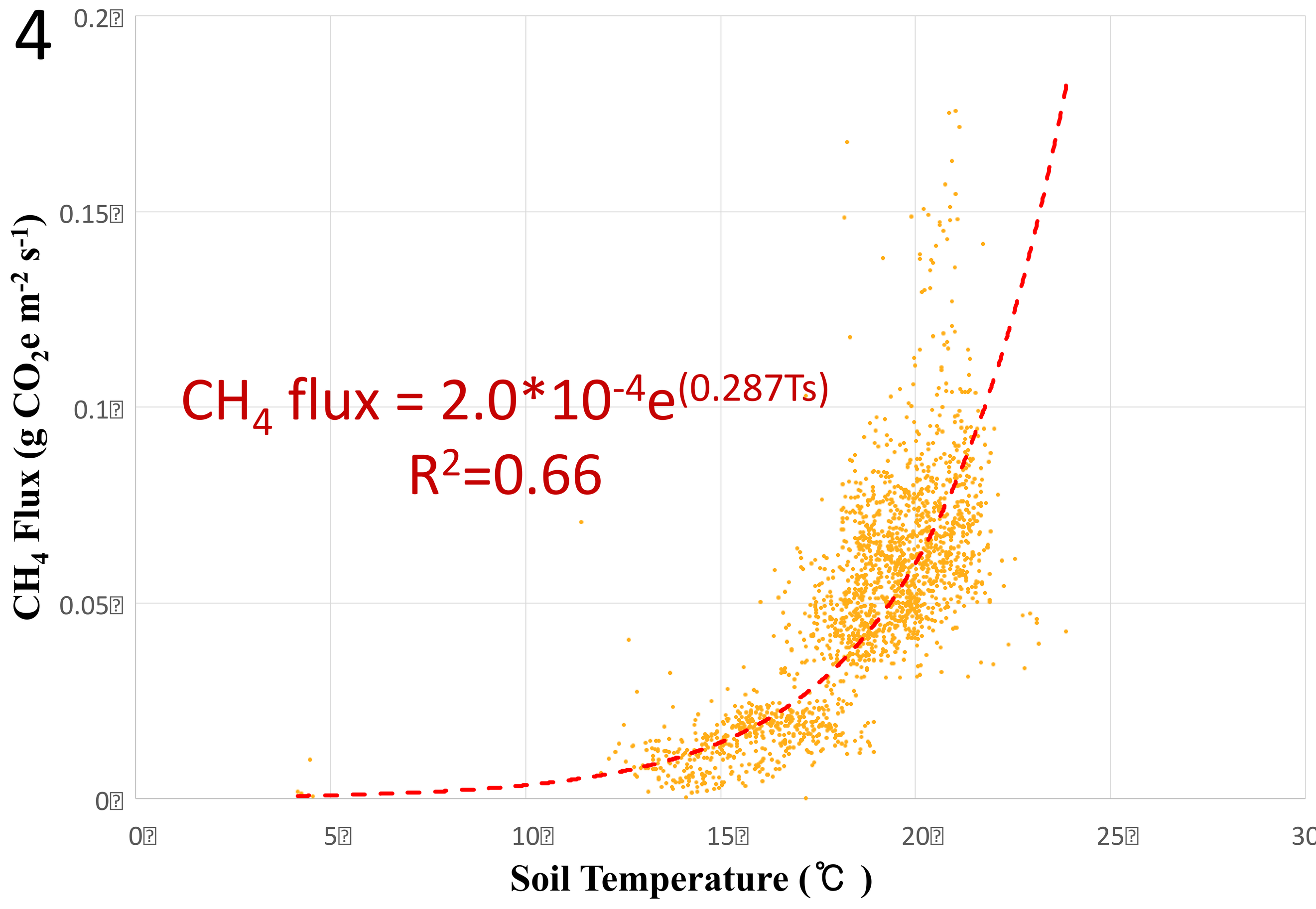
←**Fig. 1.** Photograph of the environment surrounding the EC tower. The flux tower was erected on a floating platform.

↓ **Fig. 2.** Photograph of the two EC systems at 1.8 m height for both CO_2 (open-path, LI-7500; closed-path, LI-7200) and CH_4 (open-path, LI-7700).

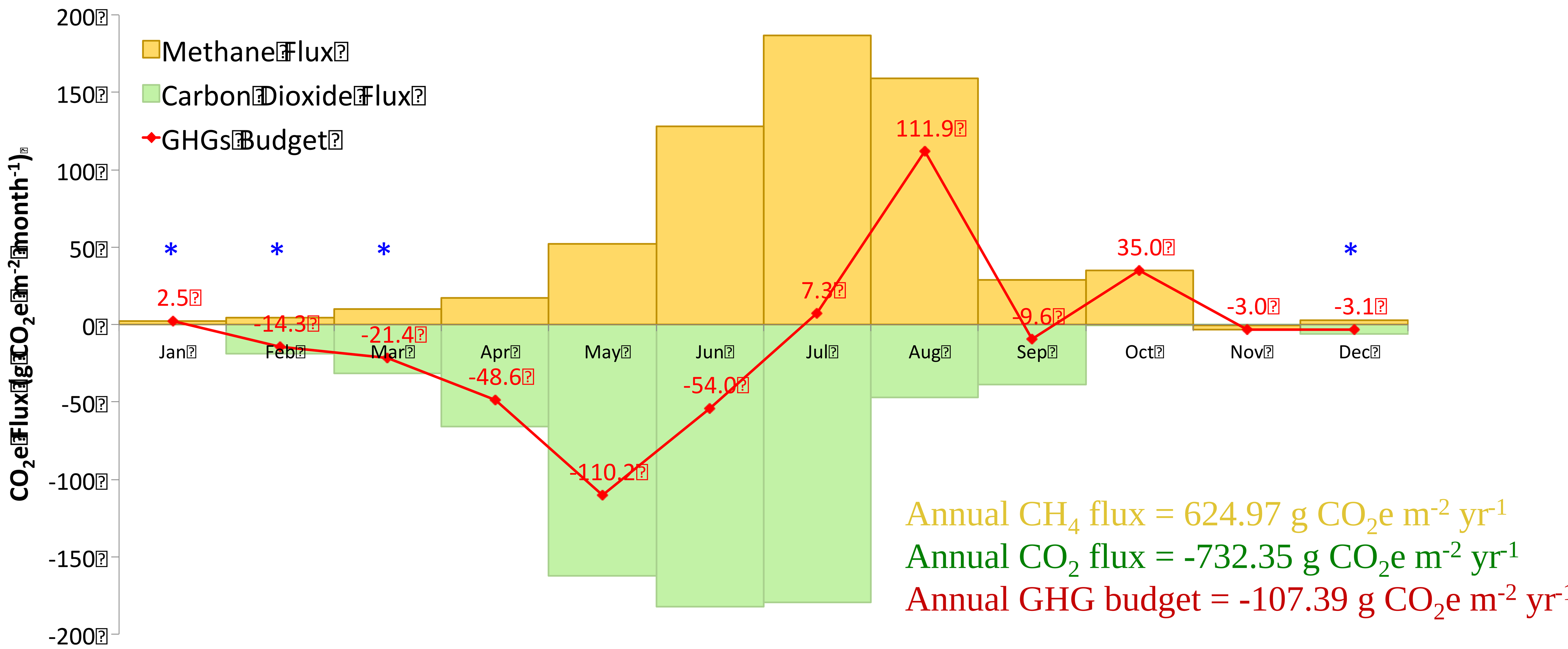
Results



←**Fig. 3.** Ensemble-averaged diurnal courses of hourly CO_2 and CH_4 fluxes shown as carbon dioxide equivalents (CO_2e) by using 100-yr global warming potentials[6] (GWP) during summer (June 1st 2015 to August 31st 2015). The u_* threshold was 0.08 m s^{-1}.



↑ **Fig. 4.** Relationship between CH_4 fluxes and soil temperatures at the 5cm depth (Ts). The u_* threshold was 0.08 m^{-2} s^{-1}. The fitted curve is the best result of the exponential equation.



←**Fig. 5.** EC-measured monthly CO_2, CH_4 and net GHGs fluxes shown as CO_2e totals. Data in Jan, Feb, Mar and Dec were gap filled using the relationship in Fig 4 using 30-min data. All other months are gap-filled using the mean diurnal course approach[7].

Conclusions

1. Considering both, CO_2 and CH_4 fluxes with a 100-yr GWP, over the full year, the **rewetted area was a slight net sink of GHGs** – net uptake by CO_2 (-732.35 g CO_2e m^{-2} year^{-1}) was slightly higher than year-round CH_4 emissions (624.97 g CO_2e m^{-2} year^{-1}).

2. **CH_4** was continuously emitted day and night, and **strongly depending on soil temperature**.

3. The **critical time period** for both, CO_2 and CH_4 fluxes, was the **growing season**. During spring and early summer, (Apr – Jun) CO_2 uptake was stronger than CH_4 emissions. In late summer and fall, CH_4 fluxes dominated and caused highest net emissions in August.

4. Compared to other restored wetlands, the **study area sequestered less CO_2**, and also CH_4 emissions were smaller [8, 9].

References

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