Measurements of greenhouse gas exchange over a conventionally managed highbush blueberry field in the Fraser River Delta, BC, Canada

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INTRODUCTION

- Agricultural soils are significant sources of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).
- Most studies used static chamber methodologies, but increasingly micrometeorological methods such as eddy-covariance[1] (EC), relaxed EC[2] and the flux-gradient method[3] are used to measure GHG emissions. In Canada, studies are limited to eastern and central regions.
- The purpose of this project was to measure year-round GHG fluxes using EC and to study relationships between GHG fluxes and controlling soil and meteorological variables.

SITE DESCRIPTION AND MEASUREMENTS

- The research site was a conventionally-managed highbush blueberry (*Vacinium corymbosum* L. cvs. Reka and Duke) field on Westham Island, BC (49.08°N, 123.15°W). The rows were mulched with sawdust and separated with a grass-interrow.
- The soil series is Westham or Crescent (rego humic gleysol or ortho gleysol) and well-drained due to sub-surface drain tiles.
- The crop was fertilized with ~110 N ha^{-1} via four surface applications of ammonium nitrate. The field received ~75 m^3 ha^{-1} y^{-1} of sawdust mulch.
- Measurements were taken between 21 November 2017 and 1 January 2019; annual 2018 measurements are presented.

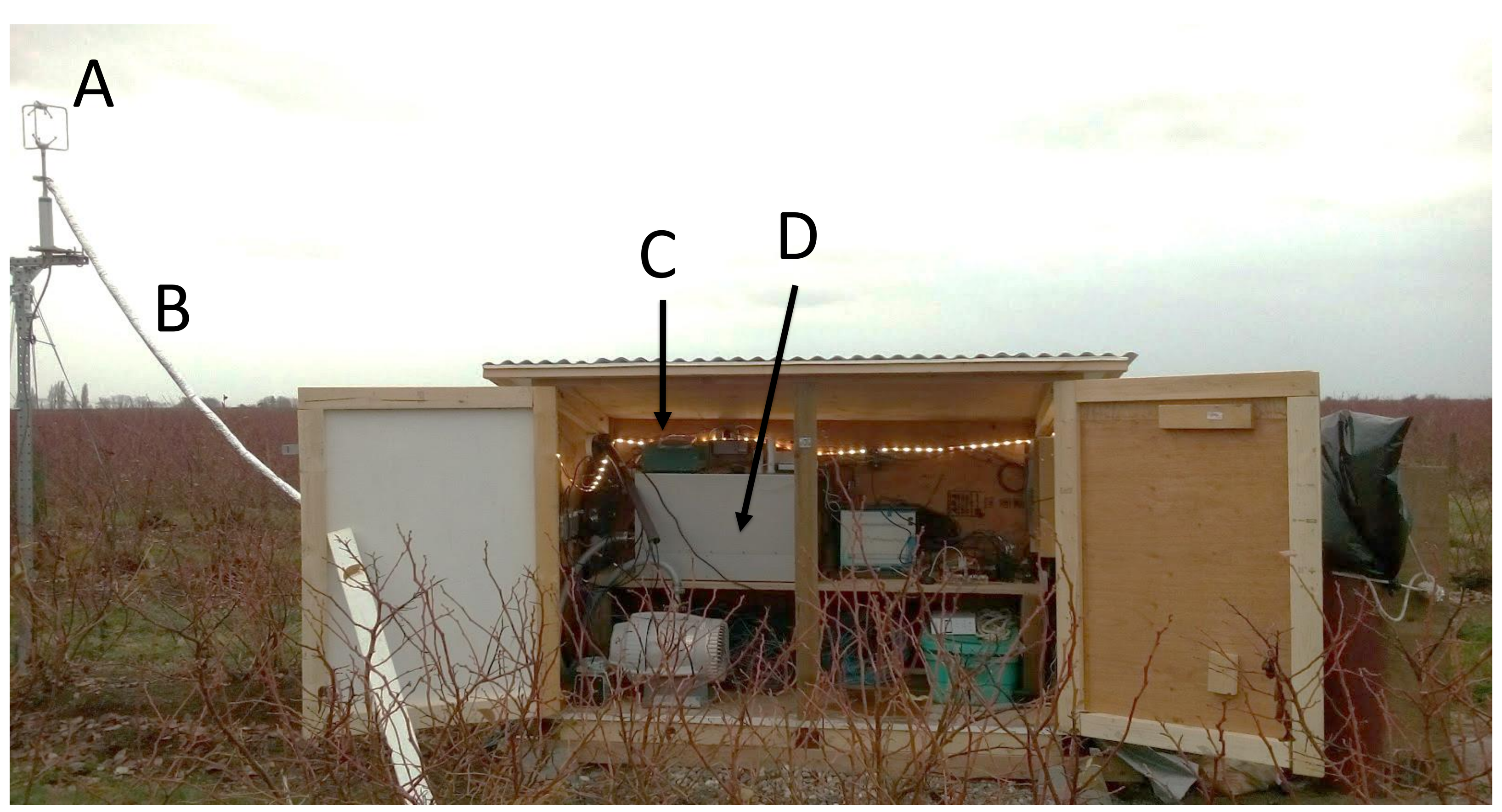

Fig 1. Photo of EC system including: (A) sonic anemometer (Gill R3-50, 20 Hz), (B) heated sampling line, (C) infrared CO_2/H_2O gas analyzer (LI-COR LI-7000, 20 Hz) and (D) continuous-wave laser spectrometer (Los Gatos Research CH_4/N_2O/H_2O Analyzer, 8-12 Hz).

- Instrumentation included a net radiometer (Kipp & Zonen CNR1) and other standard climate and soil sensors.
- Annual energy balance closure, measured as the slope of the energy balance closure plot $LE + H$ vs. $R_n - G - S_p$, was 0.81 (RMSE $= 37$ W m^{-2}, n = 17,520).
- Comparison of the two gas analyzers showed excellent agreement. The slope of the regression of the water vapour fluxes between the two gas analyzers was 0.99 (RMSE $= 3.2$ W m^{-2}, n = 14,167).

RESULTS

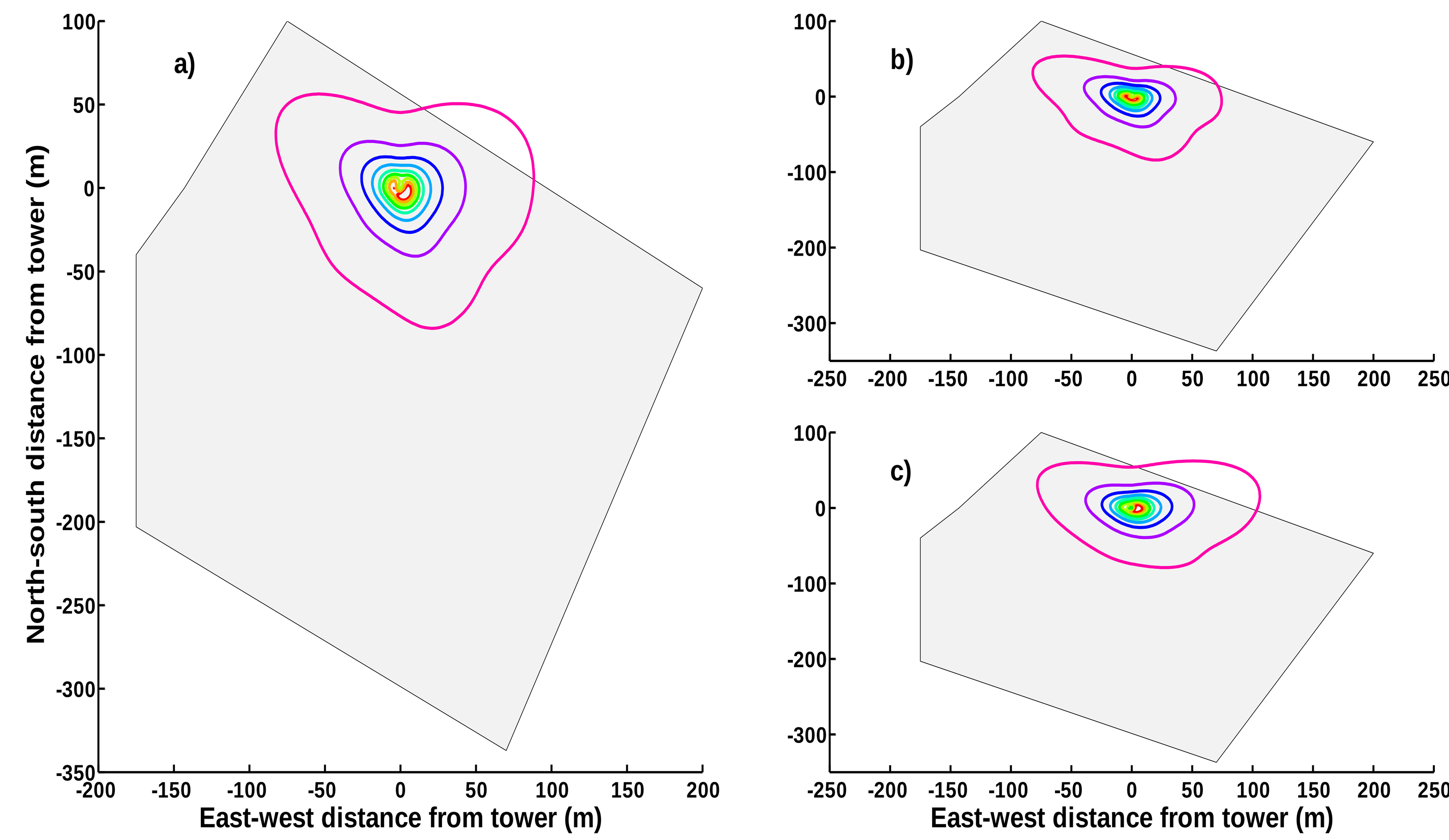

Fig 2. Annual flux footprint climatology using the Kljun et al. (2015) model[4] for a) 24-hour, b) daytime, and c) nighttime periods during the study period. The *x*- and *y*-axes indicate the distance east-west and north-south from the tower, with the origin indicating the tower location. The solid contour lines indicate from 10 to 90% the cumulative probability of source area for the measured turbulent fluxes at the tower. The area enclosed by the polygon indicates the boundaries of the blueberry field.

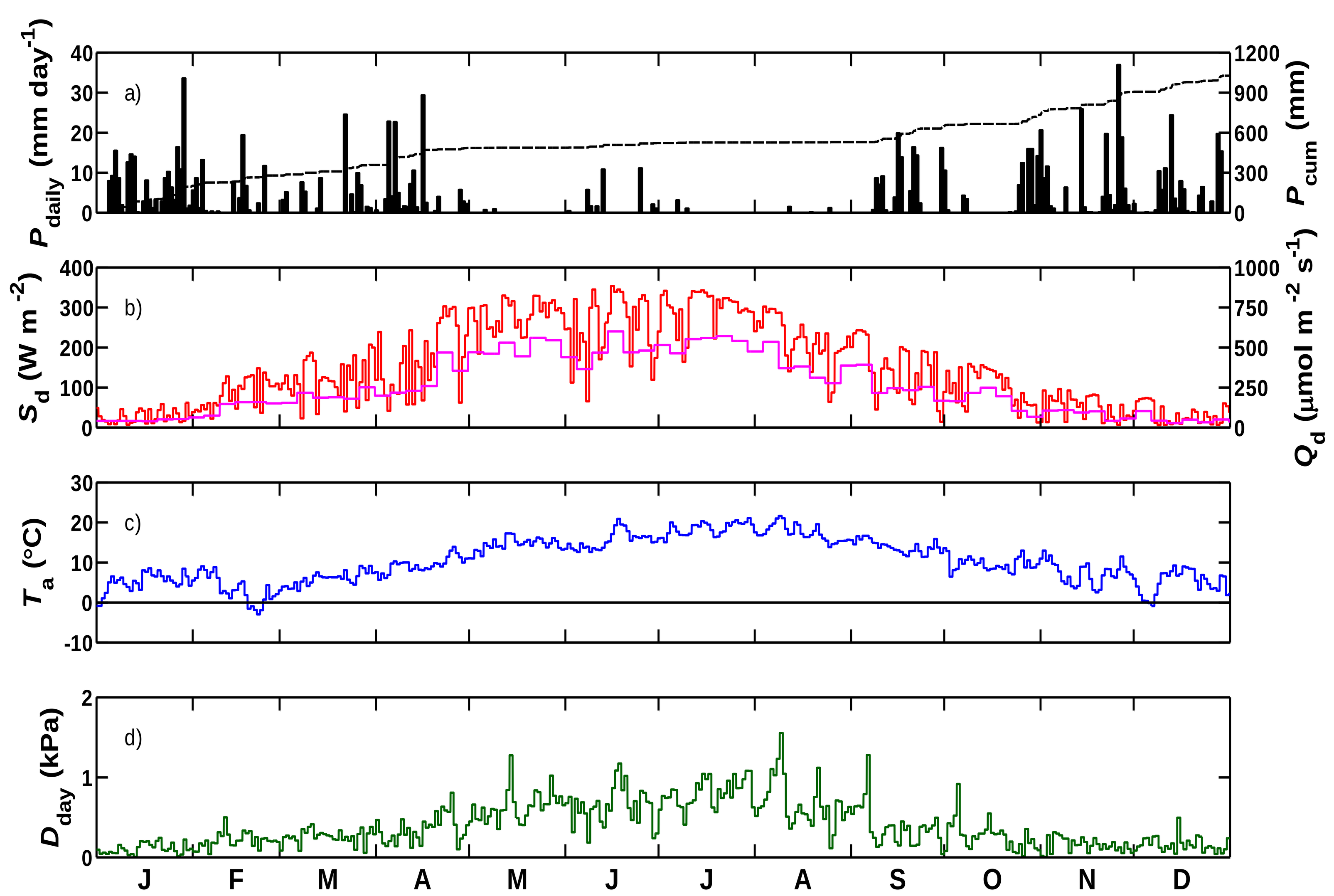

Fig 3. Climate variables at the site during the study year (2018): a) 24-hour precipitation (P_{daily}) and cumulative precipitation (P_{cum}), b) daily mean downwelling shortwave radiation (S_d, red line) and photosynthetically active radiation (Q_d, purple line), c) daily mean air temperature (T_a), and d) daytime mean vapour pressure deficit (D_{day}).

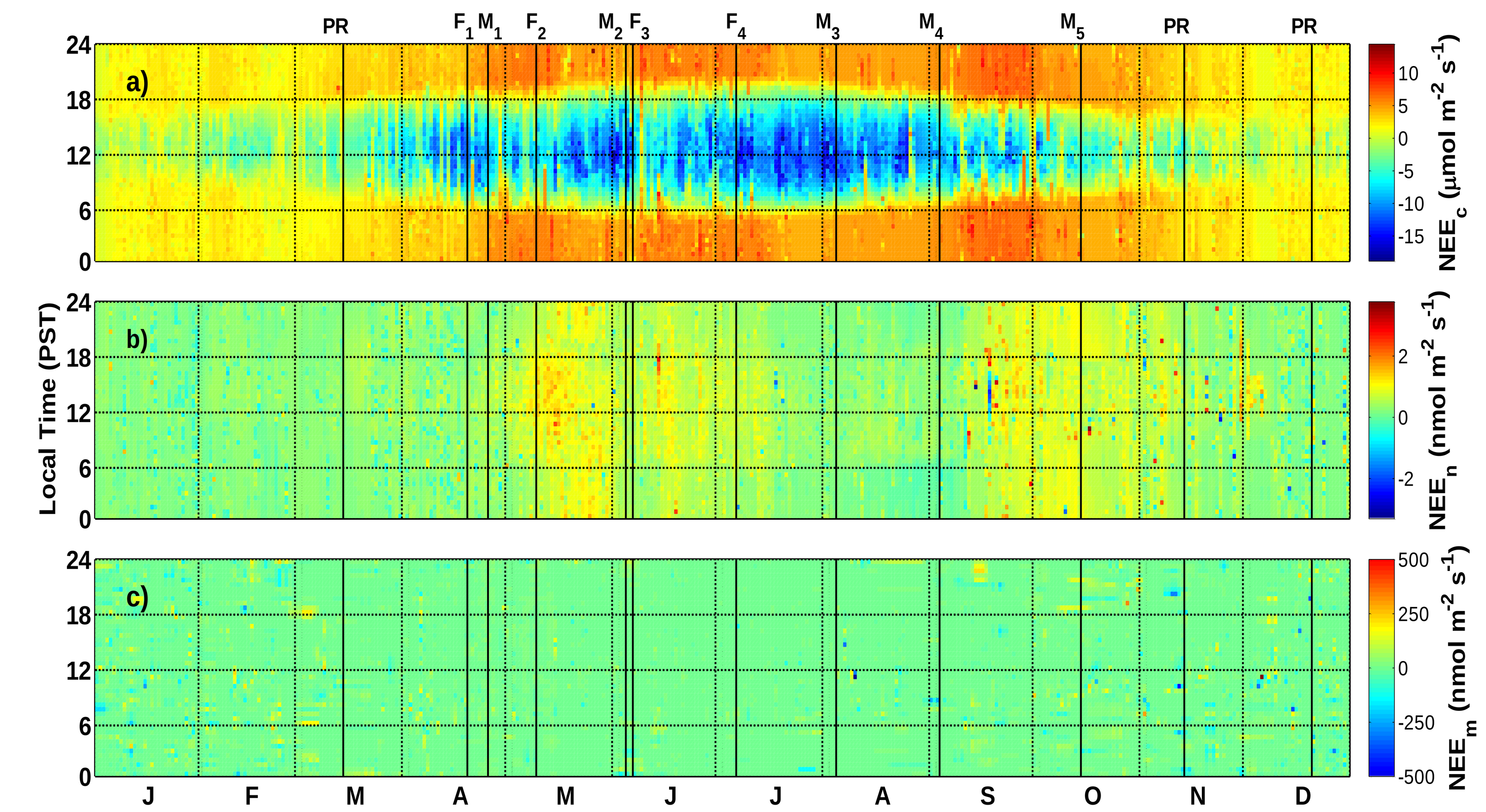

Fig 4. Half-hourly net ecosystem exchange of a) carbon dioxide (NEE_c) b) nitrous oxide (NEE_n) and c) methane (NEE_m). Vertical lines indicate pruning (PR), N-fertilization (F1 – F4) and interrow mowing (M1 – M5).

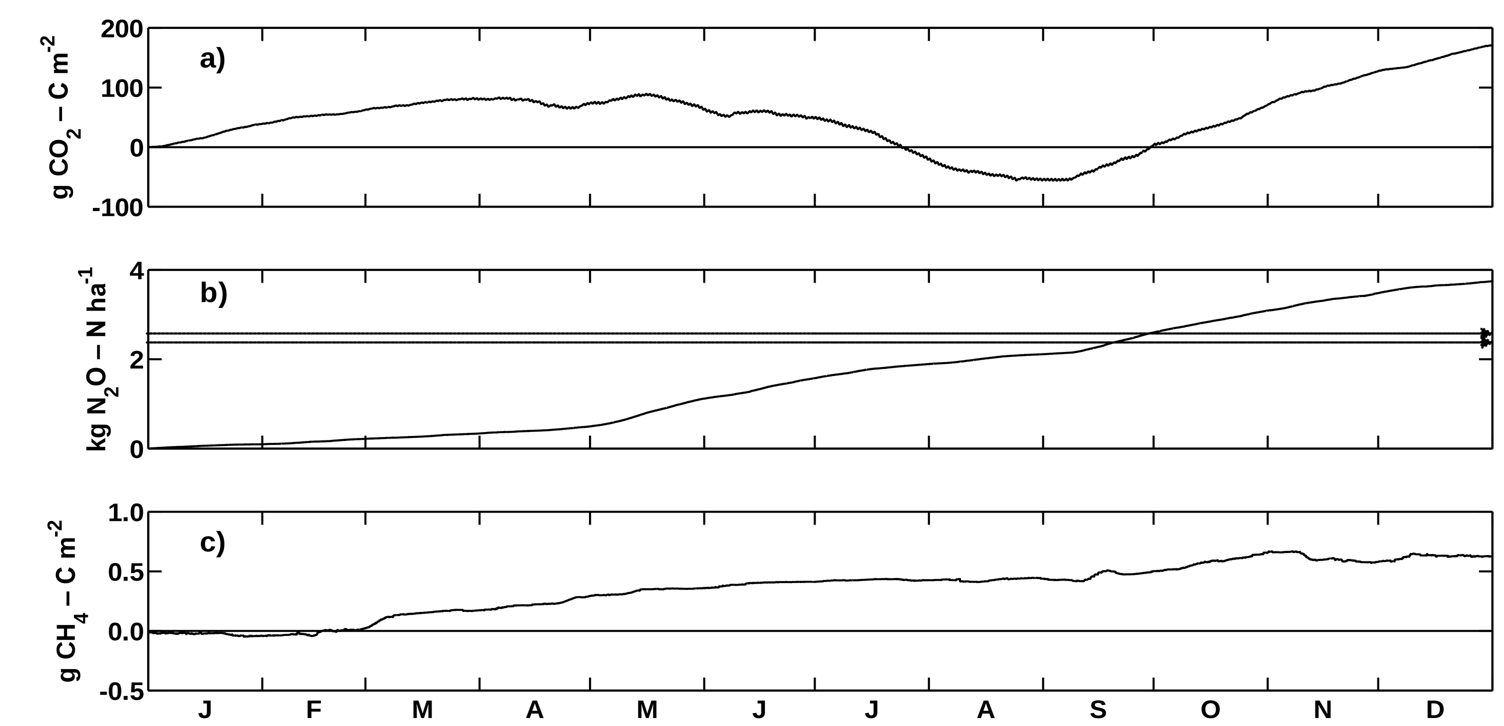

Fig 5. Cumulative GHG net ecosystem exchange of a) carbon dioxide (CO_2 – C), b) nitrous oxide (N_2O – N) and c) methane (CH_4 – C) during the study year. In panel b), the dashed line indicates the IPCC Tier 1 default emission factor of 2.4 kg N_2O – N ha^{-1} y^{-1}. The dotted line indicates the Canada-specific estimate of annual N_2O emissions proposed by Rochette et al. (2018)[5] of 2.6 kg N_2O – N ha^{-1} y^{-1}.

CONCLUSIONS

- Annually, the field was a net source of GHGs and emitted 830 g CO_2eq m^{-2} year^{-1}, with CO_2, N_2O and CH_4 contributing 76%, 21% and 3%, respectively.
- Mowing the grass-interrows decreased the C-sink strength of the field, and N-fertilization led to episodes of increased N_2O emission but with varied magnitude.
- Higher N_2O emissions were associated with the sudden onset of precipitation following prolonged drying during the growing season.
- CH_4 fluxes were small with no indication of diurnal or seasonal trends.

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