In blue: Reviewer's comments. [ ] = Numbering

In black: Answers to referees.
P=Page; L=Line; Track change version
In black and italic: Modification added to text.

Editor:

Dear Authors

thank you for carefully answering the comments of the two referees.

I have a few comments:

[1] Both reviewers asked to clarify the calculation of the diffusion coefficient (D) across the snow pack and you argued for a vertically constant D as the measured vertical concentration gradient was linear. On the other hand you find vertical differences in the snow density and the formation of a depth hoar layer. You explain that you have collected snow density every 5 cm to calculate snow porosity, tortuosity and the CO2 diffusion coefficient. I would like you to show the data on the vertical stratification of the snow pack physical state (at least some examples as supplementary material) and the local D values and see whether or not there is a contradiction between the conclusion from the CO2 concentration profiles (D = const.) and the D calculated for vertical strata from snow pack physical states.

The diffusion coefficient depends on temperature and only changes by a few percent across temperatures between 0°C and -20°C (Eq. 4, P6). Snow porosity and tortuosity depend on snow density, which displays vertical stratification. An average snow density, and therefore an average porosity and tortuosity, was used in CO_2 flux calculations (Eq. 1, P6) since the diffusion gradient remained linear despite vertical stratification in snow density. Figure A3 was added in Appendix A to display a few examples of typical snowpack concentration gradients at each study site along with snow density stratification.

P7, L224-225: *Examples of snow density vertical stratification along with CO_2 concentration measurements can be found in Appendix A (Fig. A2).*

P31, Figure A2: *Examples of snow density (ρsnow) vertical stratification and CO_2 concentration ($[CO_2]$) gradient measurements in function of snow height (h_{snow}) from the ground level. The coefficient of determination (R^2), $[CO_2]$ gradient (m) and y-axis intercept (b) for the linear regressions on the $[CO_2]$ gradient measurements are provided. Data from (a) Montmorency Forest balsam fir closed-crown coniferous boreal forest on 2021-02-26, (b) Cambridge Bay prostrate-shrub tundra (hydric tundra: hydric sedge fen) on 2022-04-15, (c) Trail Valley Creek erect-shrub tundra (lichen) on 2022-03-26, and (d) Havikpak Creek black spruce open-crown coniferous boreal forest on 2022-03-16.*

[2] The comment of Referee 1 on the title and especially the examined period is very relevant and I strongly recommend you do reconsider your decision.
- You do neither define the growing season nor the non-growing season
- Even if you did, the non-growing season might span wider than what you observed
- Your discontinuous measurements do not cover a whole season anyway, but are rather examples for situations with snow.
- Your work is very much on snow , isn't it? So why not using one of the following: "cold season", "winter" or even better "snow period" in the title and the abstract ?

The examined period was replaced from "non-growing season" to "winter" throughout the manuscript. This is coherent with published articles such as Natali et al. (2019), Björkman et al. (2010), Kim et al. (2019), Monson et al. (2006), Sturm et al. (2005) and Wang et al. (2011).

Title: Environmental controls of *winter* soil carbon dioxide fluxes in boreal and tundra environments

[3] Your answer on atmospheric pressure (p_a) changes raised by Referee 1 is incomplete: The pressure does not only change with wind but at synoptic time scales with high and low pressure systems passing the site, see, e.g., Kissas et al. (2022) (for illustration, no need to cite this paper if you do not deem it relevant). Please refer to meteorological data products (e.g. ERA5) to examine whether such event had resolved the observed peak emissions. in that case the mechanisms might even be comparable with Kissas' study.

A few sampling locations at two study sites (Trail Valley Creek and Cambridge Bay) were revisited daily or every few days over a few weeks. No major disparities were observed in the range of F_{CO2} measurements over time at those sampling locations despite fluctuations in wind speed and atmospheric pressure. Figure A1 was added as an example of such measurements in Appendix A. We also added text in the manuscript.

P6, L186-188: *Monitoring of F_{CO2} at a few sampling locations did not show any relationship between F_{CO2} and wind speed or atmospheric pressure (e.g., Fig. A1).*

P30, Figure A1: *CO_2 fluxes (F_{CO2}) at a sampling location in the Trail Valley Creek erect-shrub tundra (lichen) between March 19th and March 27th, 2022. Atmospheric pressure and wind speed were obtained from Environment and Climate Change Canada's Meteorological Service of Canada meteorological station at Trail Valley Creek (https://climate.weather.gc.ca/historical_data/search_historic_data_e.html).*

[4] in your revised section "P17, L493-495:" consider changing "were *not* addressed nor measured in this study" to " were *neither* addressed nor measured in this study".

Modified.

P17, L489-491: The unexplained variance (16%) suggests that non-growing season CO_2 fluxes might have been controlled by other environmental variables such as soil physicalchemical properties regulating soil biogeochemistry and soil redox csonditions, which were *neither* addressed nor measured in this study.