Appendix 1

Data processing

Plume structure

In our first attempt at the analysis we assumed that the recording of concentration at each sensor, when plotted, would show a smooth increase from some background level to either a peak, or asymptote. We then intended to specify an arbitrary threshold concentration value and then determine the first time point in our recording when this threshold value was detected at each sensor. This method was not successful because the sensor readings for each location were not smooth accumulation curves as expected, but instead random and highly variable (Supplemental Figs S2-S6).

To determine the appropriate variance functions, we tried different combinations of models with different variance functions and selected the 'best' model by inspecting AIC values. In all analyses the 'best' model was the one that contained variance functions for trap type, sensor height and distance (see Bouwer et al., 2019). These models were an improvement on the initial models, but still exhibited some issues with normality of the residuals. We deemed these to be acceptable as we were only interested in the differences among the levels of the factors and not in developing predictions from the models.

Plume structure

Plume visualization

Three sets of contour plots were constructed to visualize the plume shape. These sets were based on the ln(stdev[CO2ppm]), ln(mean amplitude[ppm] above noise+1) and a counting variable defined as the number of concentration [ppm] recordings occurring above noise threshold (3σ). These contour plots were made for chosen planes within the measurement cuboid. Chosen planes were all horizontal planes and vertical planes parallel and perpendicular to the trap location. The recording done at the (X = -1.0; Y = 0; Z = -0.5) position for each experiment was used to estimate the standard deviation of background CO2 levels. This location was chosen because it was observed to resemble background CO2 levels when compared to other measured locations in the cuboid. An amplitude noise threshold of three times σ at this location was used to filter out false positive amplitude values for all measured positions. Plots were made in R statistical computing environment version 3.4.3 (R Development Core Team 2017).

Results

Plume structure

Plume visualization

Topic: Visual comparison between plume contour plots

Differences between plume shapes of the different treatments were not visually apparent when comparing most of the contour plots (Supplemental Figures S8-S16). In general, the contour plots show plumes shapes that appeared to have a funnel like structure leading up to the CO2 release point in two-dimensional space. Plumes depicted in the contour plots tend to rise rather than fall from the CO2 release point. Some obvious differences were noted when comparing the SLAM trap plume shape to the other treatments. For example, we noted that the SLAM trap plume shape was the widest of all the treatments, especially near the CO_2 source. The SLAM trap plume shape also appeared shorter in terms of the down wind dimension. These differences were also apparent in the sparkline plots where highly variable signals were observed closer to the CO_2 source of the SLAM trap compared to the other traps (Figure 2 and Supplemental Figures S2-S6).

Supplemental Figure captions

Figure S1: A schematic diagram of the greenhouse and where the trap was placed relative to the recording cuboid grid. B-F: Treatments during plume structure measurements and how they were setup in the greenhouse. B: the blank treatment, C: the modified multifunnel trap, D: the multifunnel trap, E: the panel trap and F: the SLAM trap. Treatments are arranged from the smallest to the largest trap and the CO_2 release point is indicated with a red square. G: The sampling grid in three dimensions with the height width and length indicated in meters. Measurements were taken where lines cross in the cuboid. H: A picture to show an example setup for a single measurement.

Figure S2: CO_2 concentrations recorded by a sensor over a 53-second recording period located downwind (rows) and crosswind (columns) of a CO_2 emitter. Note that the scale of the y-axis changes over the rows of the plot, in each row the vertical distance between 2 axis tick marks corresponds to 50 units (ppm CO_2). Colours indicate the height above ground of the sensor when the CO_2 readings were taken. The missing trace in the 15th row is for the sensor immediately down-wind of the emitter. Recordings from this sensor were not included in our analyses because they were often an order of magnitude greater than all other recordings owing to their proximity of the sensor to the emitter (see text for further discussion).

Figure S3: CO_2 concentrations recorded by a sensor over a 53-second recording period located downwind (rows) and crosswind (columns) of a CO_2 emitter placed inside a modified multifunnel trap. See caption for Figure S2 for an explanation of the plot.

Figure S4: CO_2 concentrations recorded by a sensor over a 53-second recording period located downwind (rows) and crosswind (columns) of a CO_2 emitter placed inside a multifunnel trap. See caption for Figure S2 for an explanation of the plot.

Figure S5: CO_2 concentrations recorded by a sensor over a 53-second recording period located downwind (rows) and crosswind (columns) of a CO_2 emitter placed inside a panel trap. See caption for Figure S2 for an explanation of the plot.

Figure S6: CO_2 concentrations recorded by a sensor over a 53-second recording period located downwind (rows) and crosswind (columns) of a CO_2 emitter placed inside a SLAM trap. See caption for Figure S2 for an explanation of the plot.

Figures S7-S15: Plume shape contour plots of chosen planes within the measurement cuboid for the treatments. Chosen planes are horizontal to the ground at different heights (Fig.S8, S11 and S14), vertical planes are parallel (Fig. S9, S12 and S15) and perpendicular (Fig. S10, S13 and S16) to the trap location. The axes denote distance in meter and the Z axis was colour coded for either ln(stdev[CO2ppm]) in Figures S8-10, ln(mean amplitude[ppm] above noise+1) in Fig. S11-13 or number of observations above 3 σ in Fig. S14-16. On these contour plots the CO2 release point was set at 1.6 meter column with the (x;y) = (0;1) for Fig.S8, S11 and S14, 0 meter column (x;y) = (1;1.6) for Fig. S9, S12 and S15 and 1 meter column (x;y) = (0;1.6).

Figures S16: Changes in bout frequency (Hz) and maximum amplitude intensity (ppm) of CO2 bouts that occurred in the central horizontal plane of the measurement cuboid. Note that bout frequency remains relatively constant as distance increases from the CO2 release point. In contrast bout amplitude declines exponentially with increased distance from the CO2 source. Black lines represent the central trajectory along this central horizontal plane and the orange and blue lines represent the trajectories 0.5 and 1 meter away from the central trajectory.