S1: Atmospheric Conditions during the Test Period

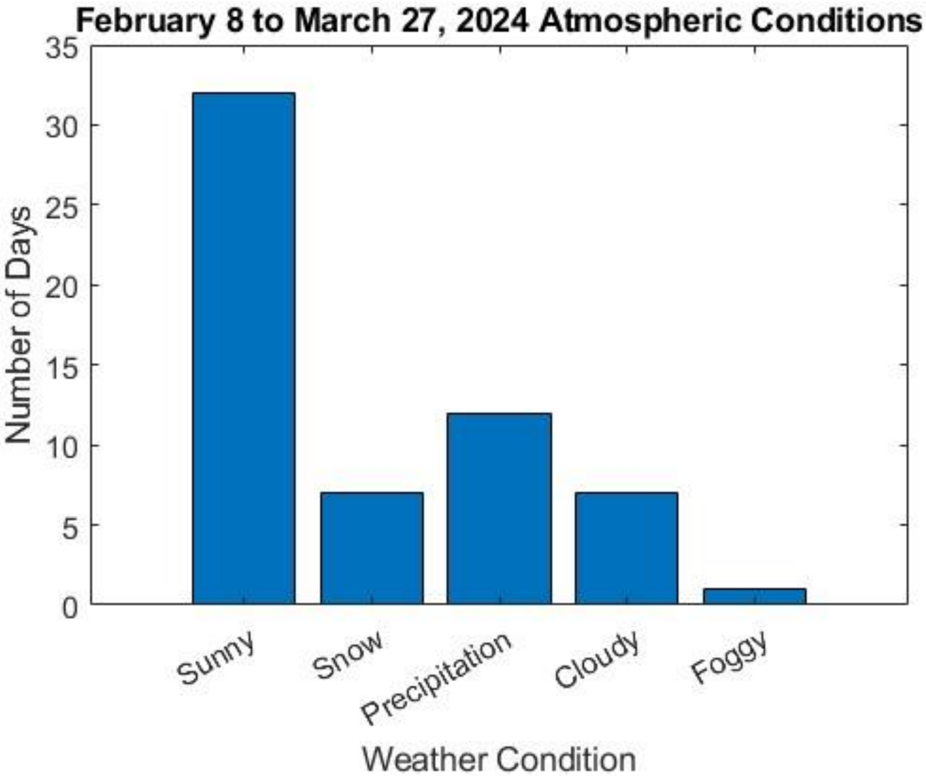

Figure S1. A bar plot of weather conditions during the test period

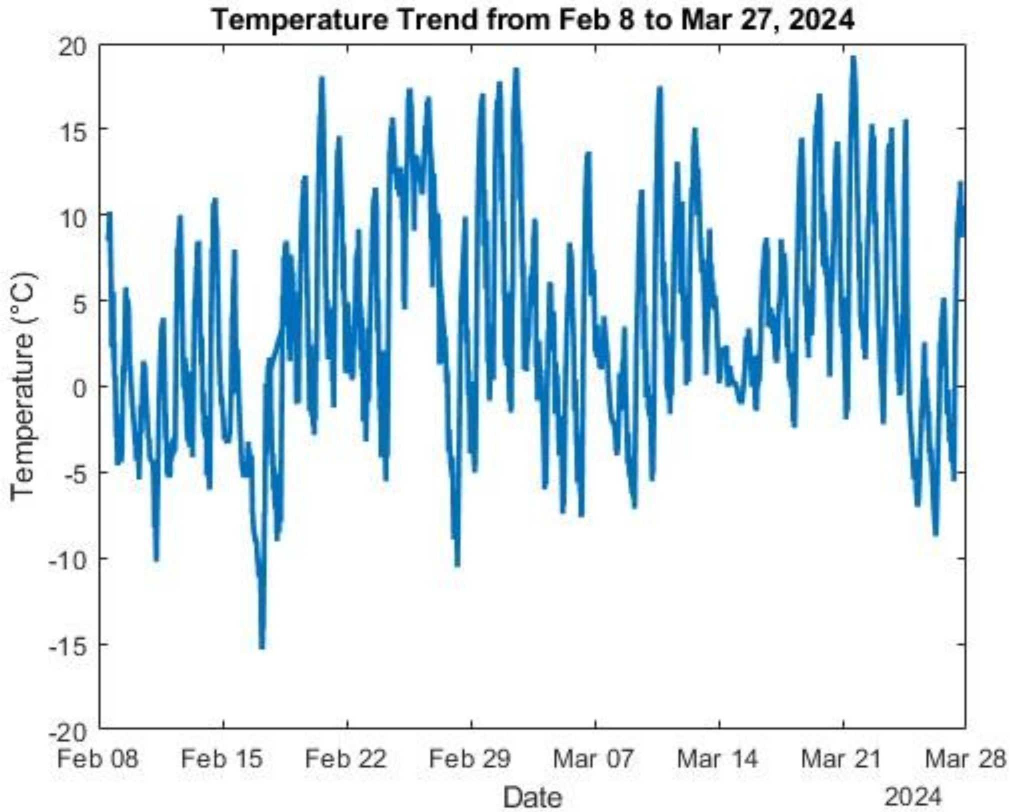

Figure S2. A plot of temperature during the test period

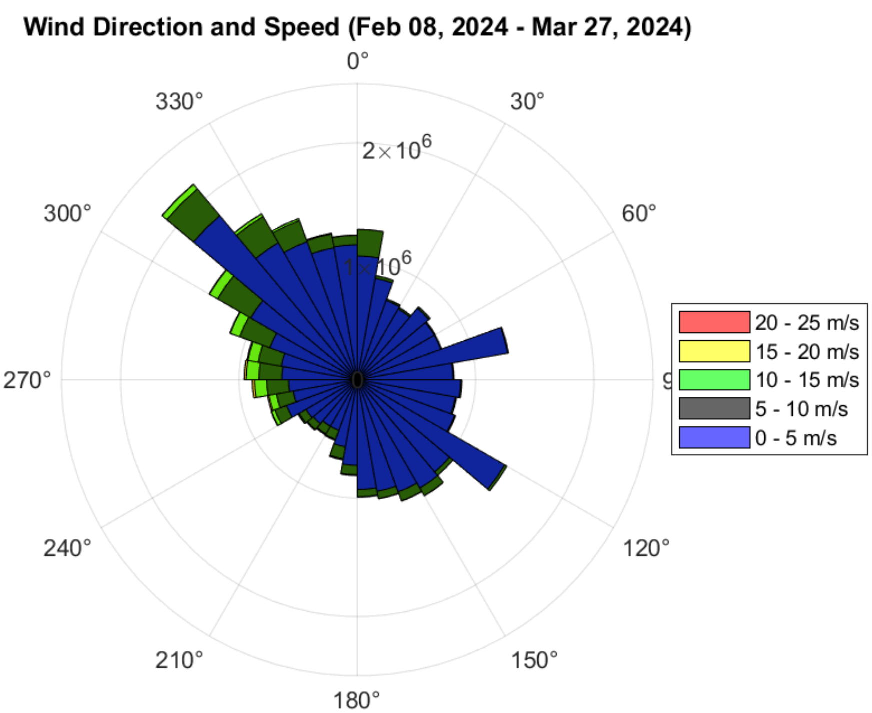

Figure S3. A wind rose plot of wind direction and wind speed during the test period

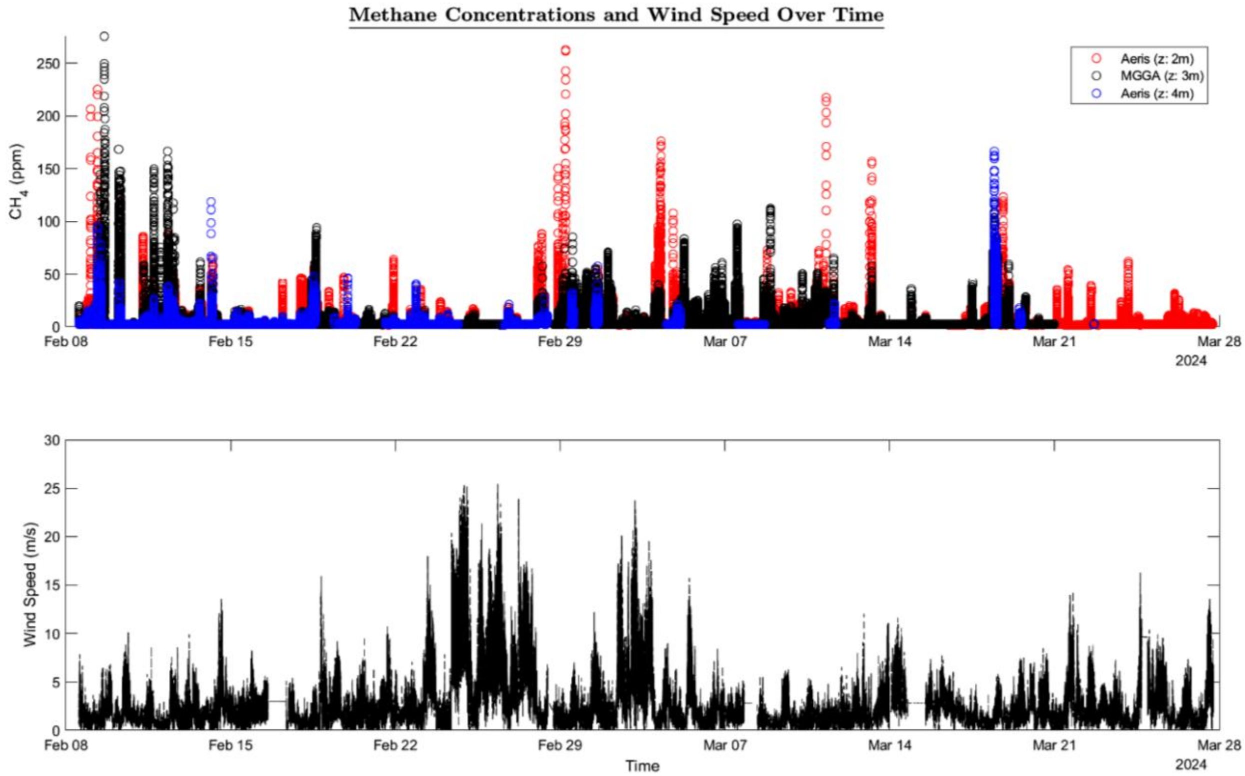

Figure S4. Top plot: A time series plot of CH_4 concentrations during the test period. Bottom plot: A time series of wind speed during the test period

S2.1: Equations

$$z0 = z * \exp\left(-\frac{0.4U}{u_*}\right) \tag{S1}$$

$$u_* = \left[\left(\overline{u'w'}\right)^2 + \left(\overline{v'w'}\right)^2\right]^{1/4} \tag{S2}$$

Where z0 = roughness length (m)

z = measurement height (m)

U = mean wind speed (m/s)

u_* = surface friction velocity (m/s)

u and v = horizontal wind speeds (m/s)

w = vertical wind speed (m/s)

L was calculated from the surface friction velocity (u_*, m s^{-1}), mean potential temperature (Θ, K), von Kármán's constant (*k*, 0.41), gravitational acceleration (*g*, 9.8 m s^{-1}) and the surface (kinematic) turbulent flux of sensible heat w'Θ' (Equation 3) (Kljun et al., 2015; Stull, 1988).

$$L = -\frac{u_*^3 \Theta}{k_v g \overline{w'\Theta'}} \tag{S3}$$

The wind direction (*WD*) and speed (*WS*) were calculated from the wind vectors u and v, based on the manufacturer's configuration: +*u* values = wind from the east, +*v* values = wind from the north, and +*w* = updraft (Equations 4 and 5).

$$WD = \mathrm{mod}(90 - \mathrm{atan2d}(v, u), 360) \tag{S4}$$

$$\mathrm{WS} = \sqrt{\mathrm{u}^2 + \mathrm{v}^2} \tag{S5}$$

$$\mathrm{F} = \frac{\mathrm{u}_* \mathrm{k}_\mathrm{v} (\mathrm{c}_2 - \mathrm{c}_1)}{\mathrm{In}\left(\frac{\mathrm{z}_2}{\mathrm{z}_1}\right) - \Psi_{\mathrm{c},2} + \Psi_{\mathrm{c},1}} \tag{S6}$$

$$\mathrm{Q} = \frac{\mathrm{mean_{Enh}}(\mathrm{x}, \mathrm{y}, \mathrm{x}) * 2\pi\sigma_\mathrm{y}\sigma_\mathrm{z}\mathrm{U}}{\exp\left(-\frac{\mathrm{y}^2}{2{\sigma_\mathrm{y}}^2}\right) * \left(\exp\left(-\frac{(\mathrm{z}-\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right) + \exp\left(-\frac{(\mathrm{z}+\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right)\right)} \tag{S7}$$

$$\mathrm{Q} = \frac{\mathrm{mean_{Enh}}(\mathrm{x}, \mathrm{y}, \mathrm{x}) * 2\pi\sigma_\mathrm{y}\sigma_\mathrm{z}\mathrm{U}}{\exp\left(-\frac{\mathrm{y}^2}{2{\sigma_\mathrm{y}}^2}\right) * \left(\exp\left(-\frac{(\mathrm{z}-\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right) + \exp\left(-\frac{(\mathrm{z}+\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right) + \exp\left(-\frac{(\mathrm{z}-2\mathrm{h}+\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right) + \exp\left(-\frac{(\mathrm{z}+2\mathrm{h}-\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right) + \exp\left(-\frac{(\mathrm{z}-2\mathrm{h}-\mathrm{H})^2}{2{\sigma_\mathrm{z}}^2}\right)\right)} \tag{S8}$$

Where

Q = point source emission rate (kg h^{-1})

$mean_{Enh}$ (x,y,z) = mean CH_4 enhancement at the measurement point (ppm)

σ_y (m) = horizontal dispersion coefficient calculated as $\sigma_v(x/U)$: σ_v is the standard deviation of v wind speed from the sonic anemometer, x is the downwind distance from the point source and U is the mean wind speed

σ_z (m) = vertical dispersion coefficient calculated as $\sigma_w(x/U)$: σ_w is the standard deviation of w wind speed from the sonic anemometer, x is the downwind distance from the point source and U is the mean wind speed

y (m) = mean cross wind distance in the averaged period

z (m) = measurement height

h (m) = height of boundary layer: estimated based on Kljun et al. (2015)

H (m) = point source height

S2.2: Instrument Sampling Frequency

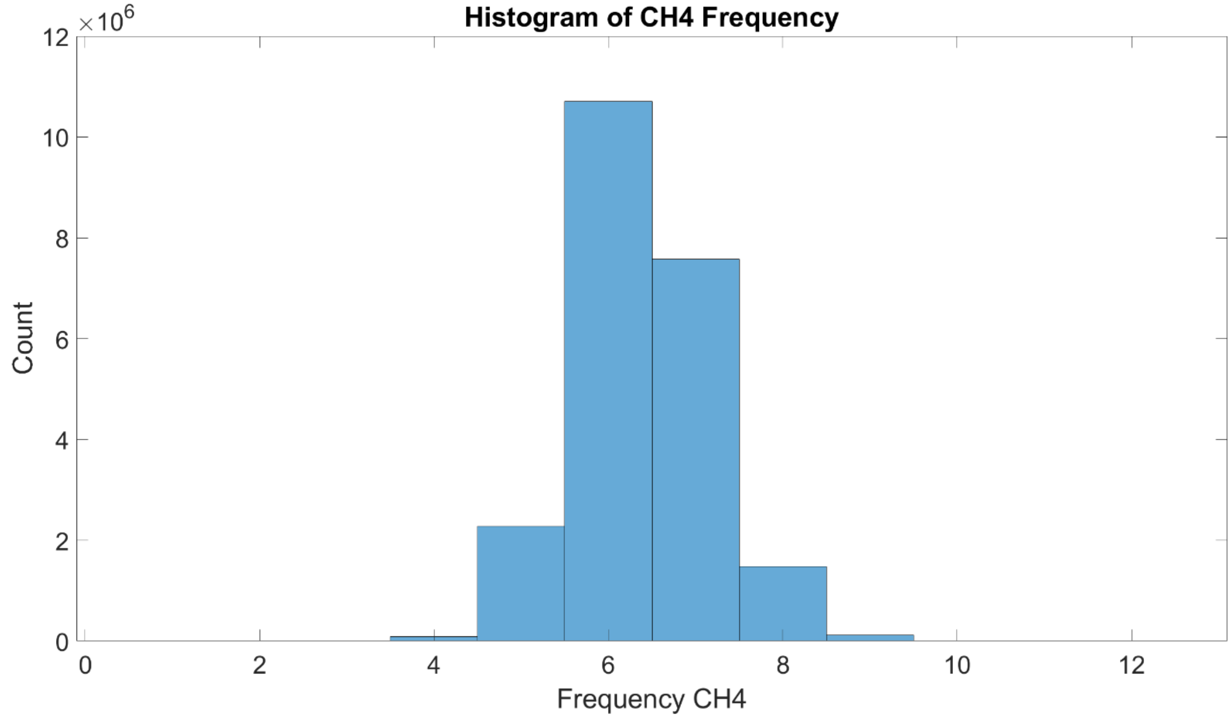

Figure S5. A histogram of CH_4 sampling frequency by the MGGA

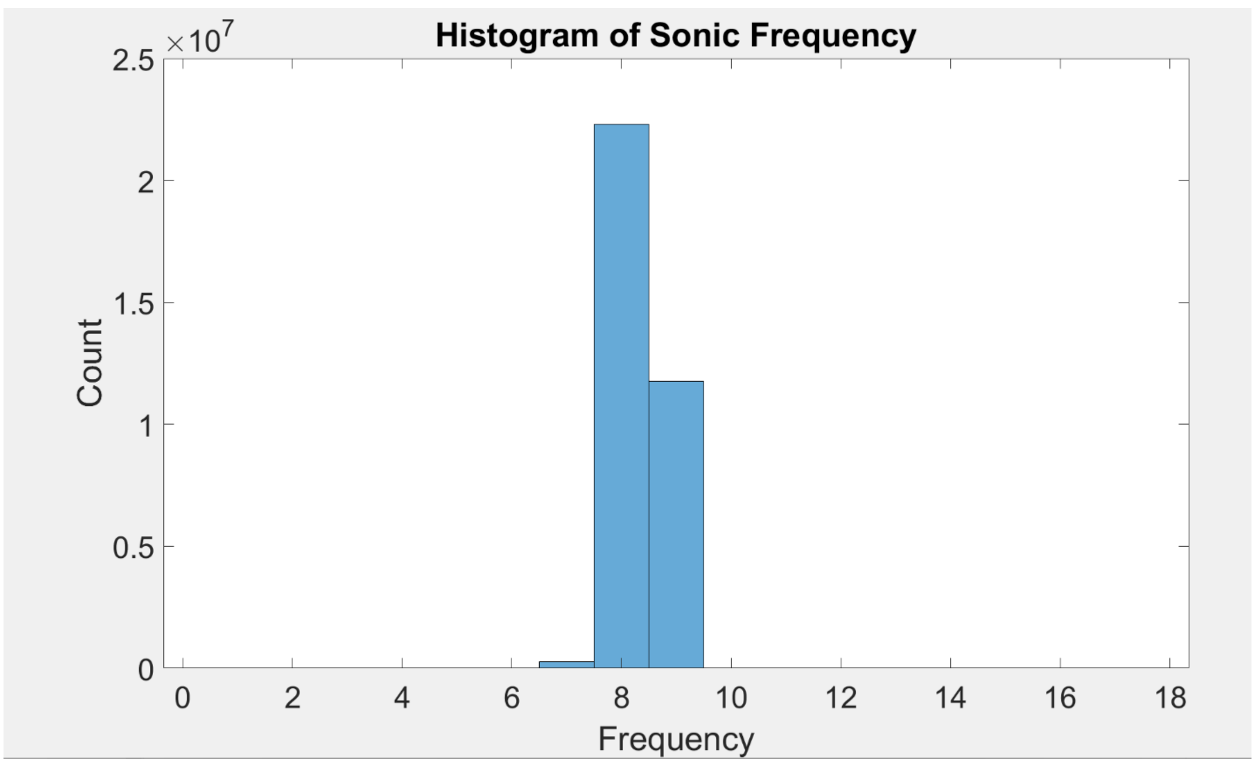

Figure S6. A histogram of sonic anemometer sampling frequency

S2.3 Cospectra/ogive/u*/stationarity

S2.3.1 Cospectra analysis

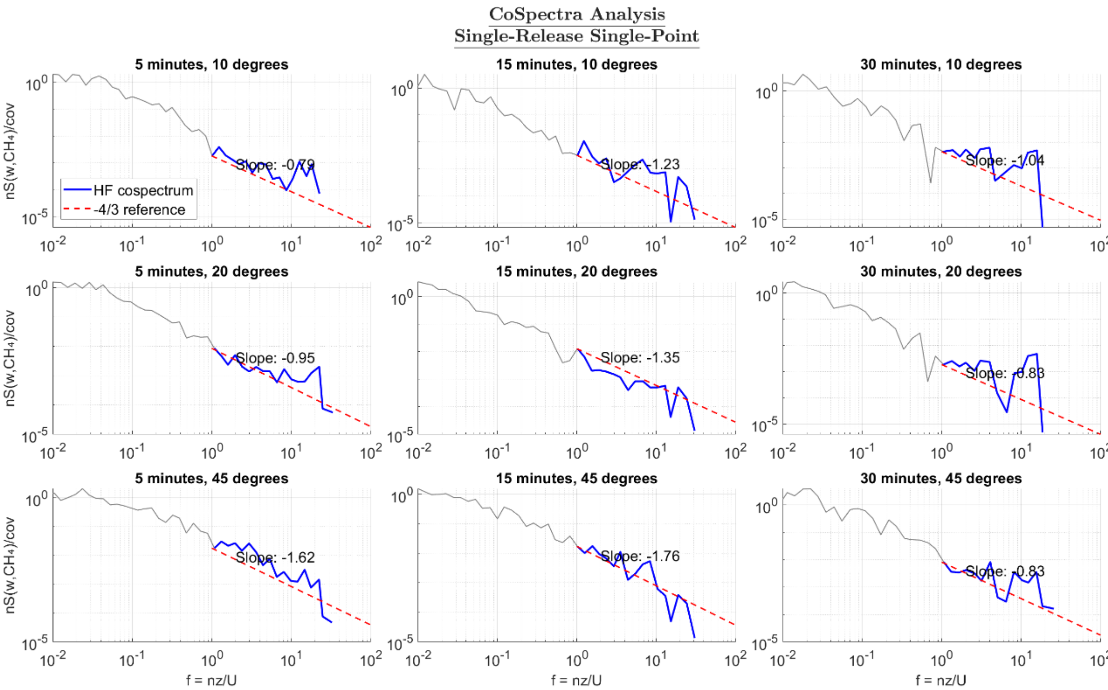

Figure S7. CoSpectra analysis for the eddy covariance fluxes for single release single point emissions

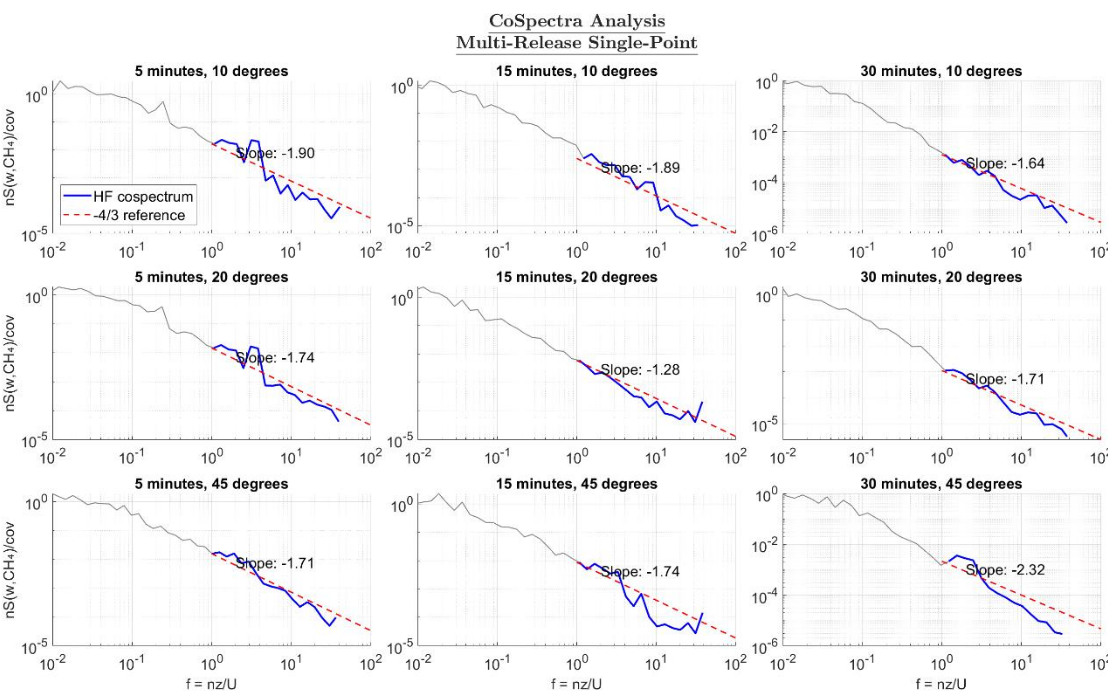

Figure S8. CoSpectra analysis for the eddy covariance fluxes for multi release single point emissions

S2.3.2 CH_4 Flux vs u*

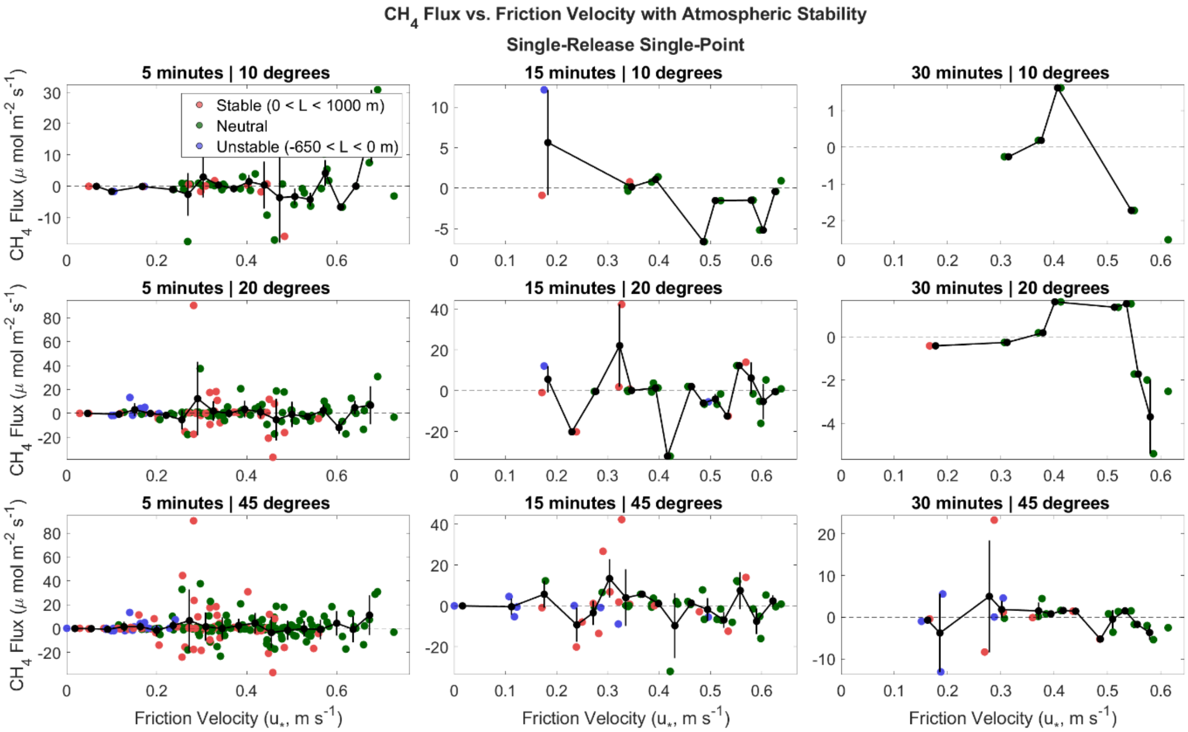

Figure S9. A plot of CH_4 flux vs friction velocity for the eddy covariance fluxes for single release single point emissions

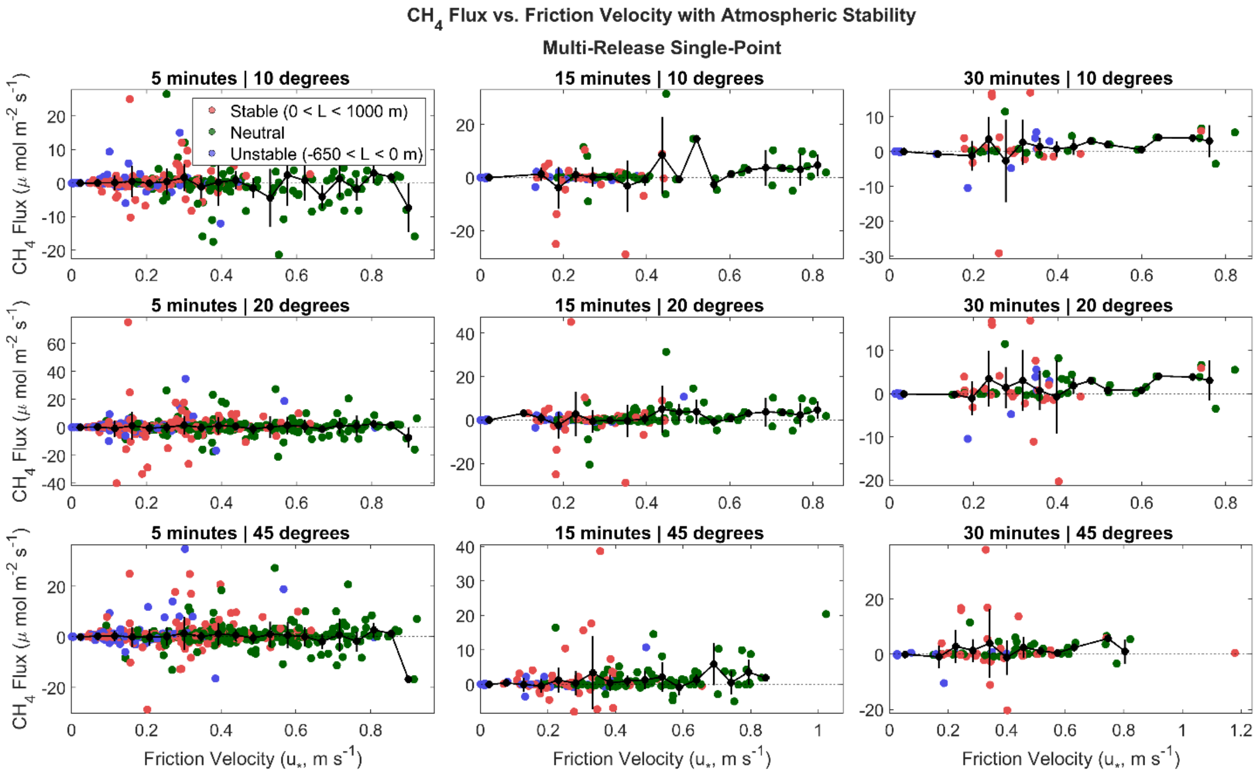

Figure S10. A plot of CH_4 flux vs friction velocity for the eddy covariance fluxes for multi release single point emissions

S2.3.3 Ogive Analysis

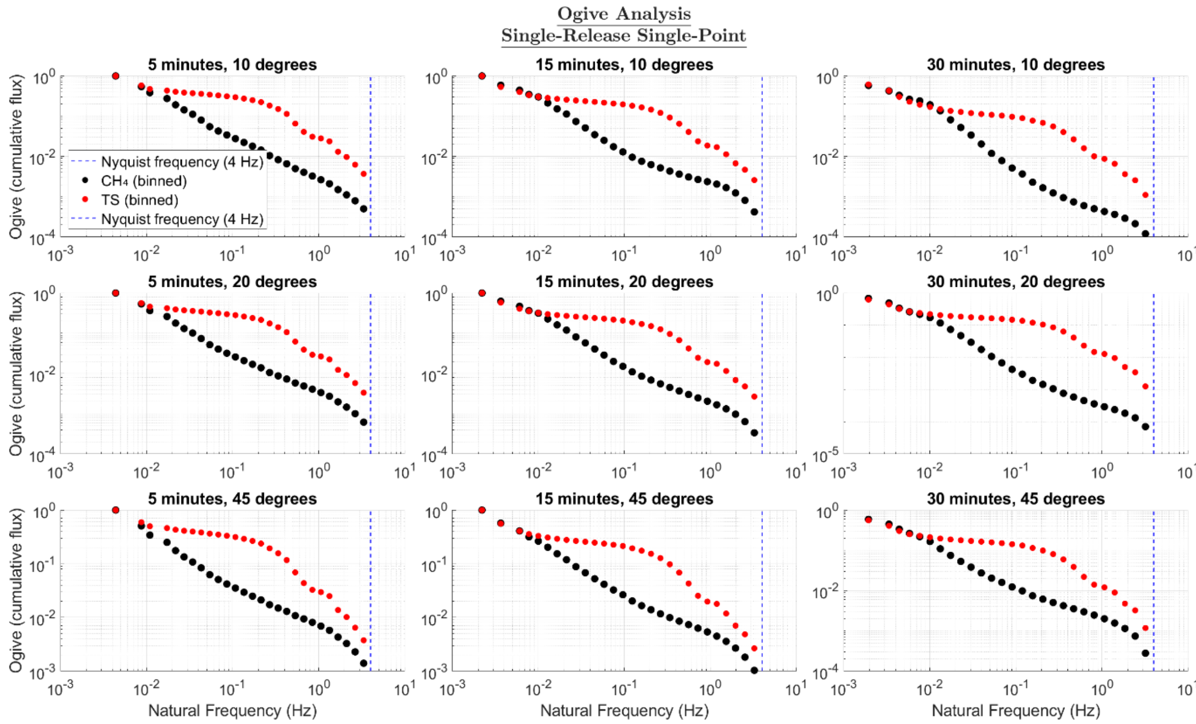

Figure S11. Ogive analysis for the eddy covariance fluxes for single release single point emissions

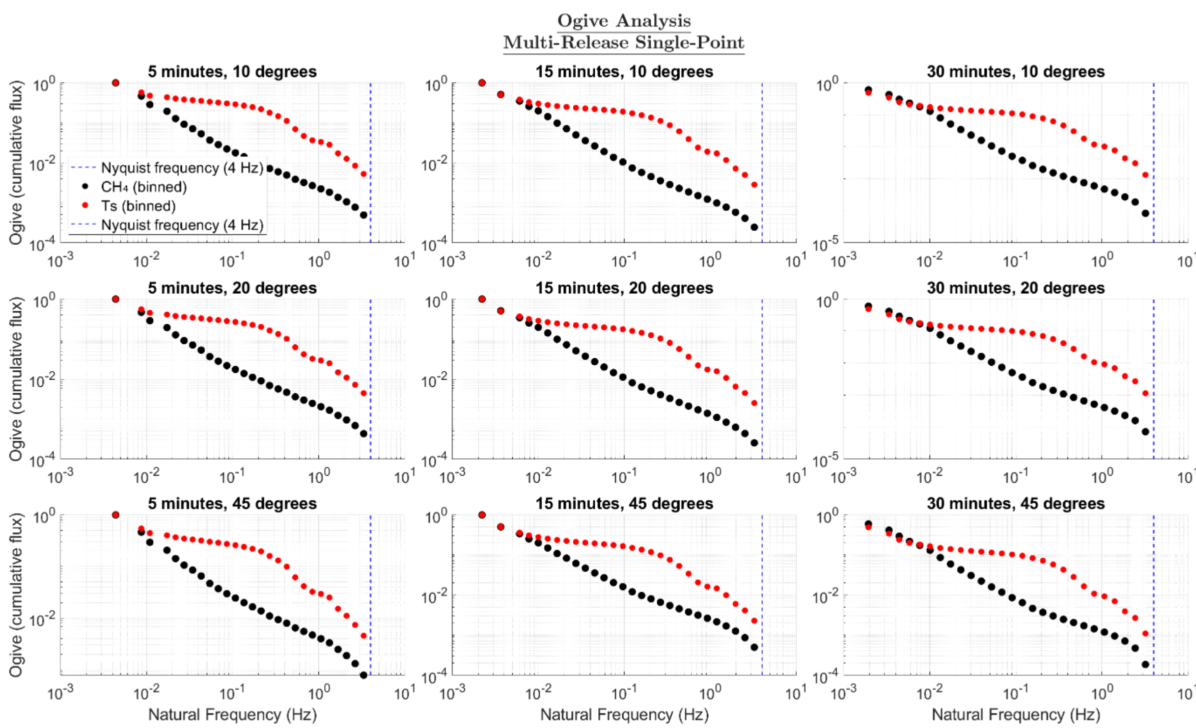

Figure S12. Ogive analysis for the eddy covariance fluxes for Multi release single point emissions

S2.3.4 Stationarity Plot

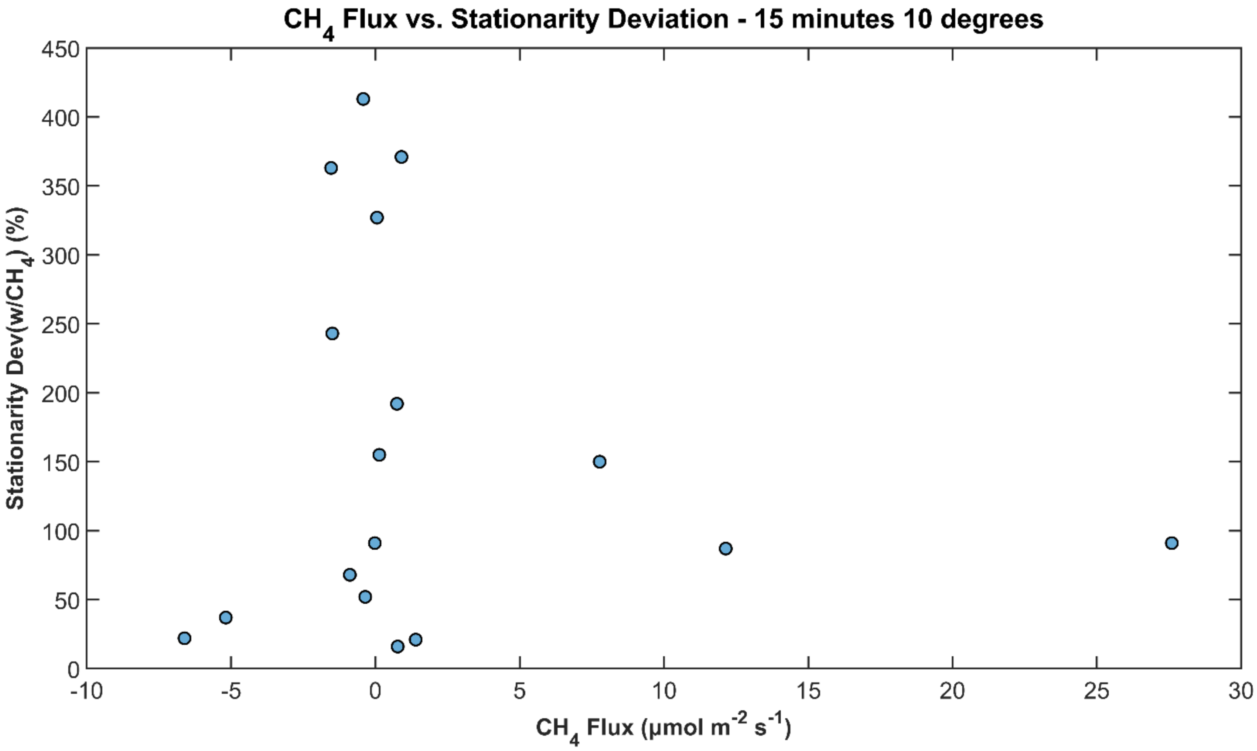

Figure S13. A sample plot of CH_4 flux vs stationarity deviation for the eddy covariance fluxes-15 minutes 10 degrees wind sector

S3: Results

S3.1 Eddy Covariance

S3.1.1 Single Release Single Point

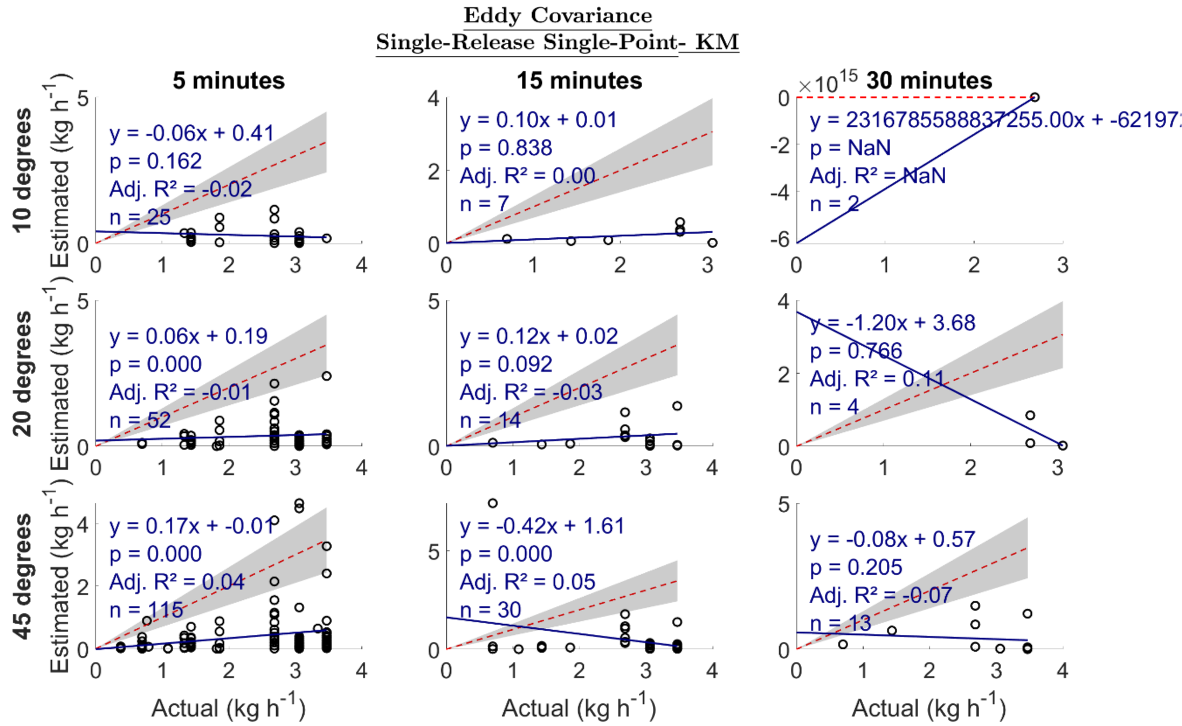

Figure S14. Estimated emission vs actual emission (kg h^{-1}) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.1.2 Multi-Release Single-Point

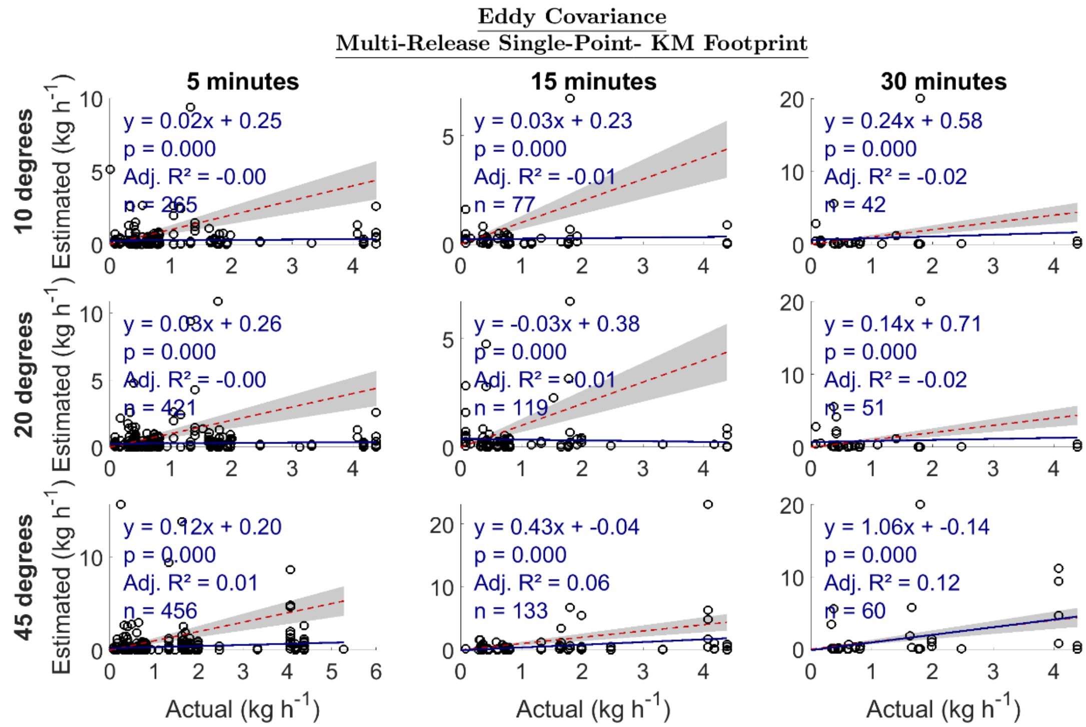

Figure S15. Estimated emission vs actual emission (kg h^{-1}) for multi-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.2 Gaussian Plume Inverse Method: Single-Release Single-Point

S3.2.1 Scenario 1: Equation S7 & ~10 Hz sonic anemometer dispersion coefficients

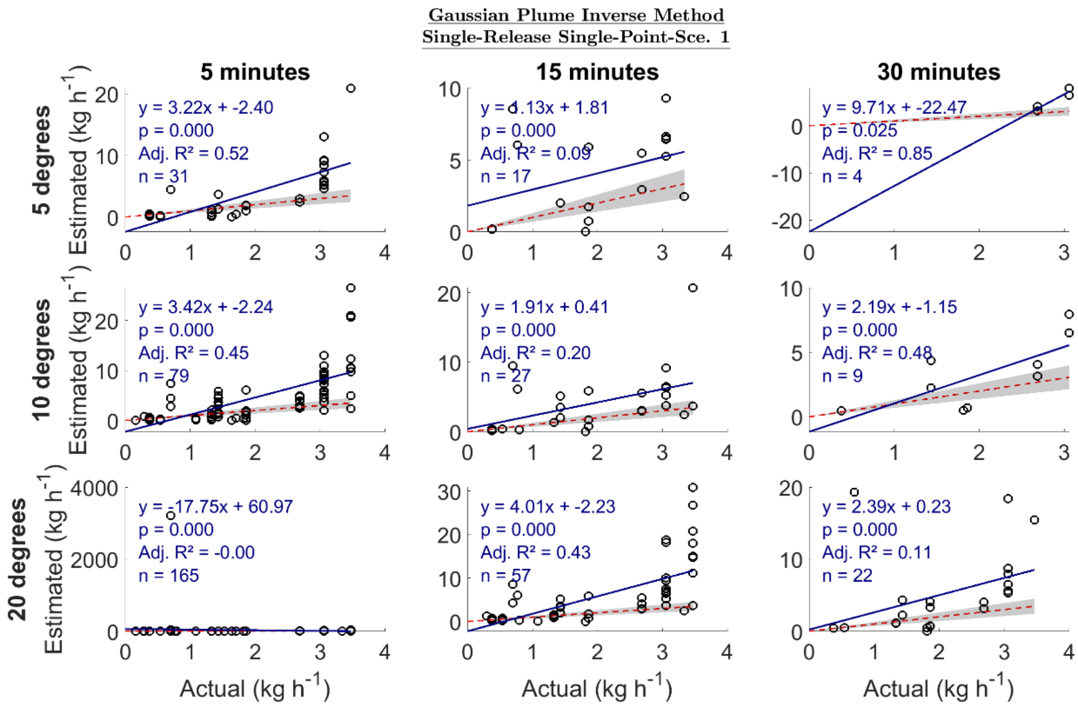

Figure S16. Estimated emission vs actual emission (kg h^{-1}) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.2.2 Scenario 2: Equation S8 & ~10 Hz sonic anemometer dispersion coefficients

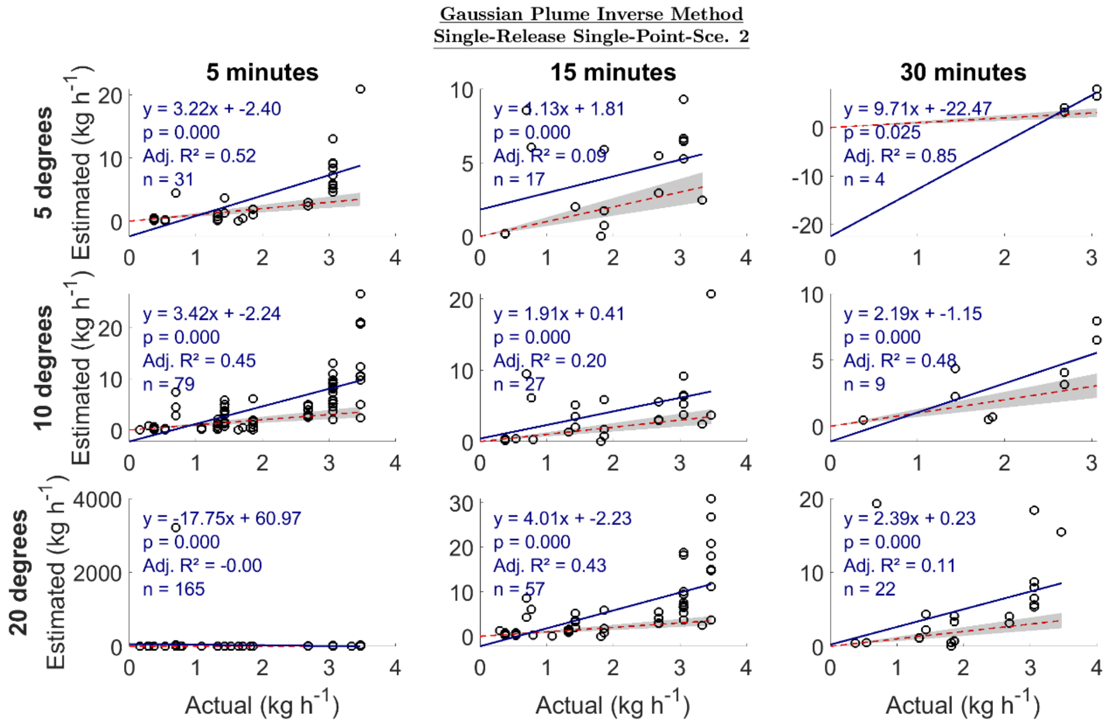

Figure S17. Estimated emission vs actual emission (kg h-1) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.2.3 Scenario 3: Equation S7 & EPA 2013 dispersion coefficients

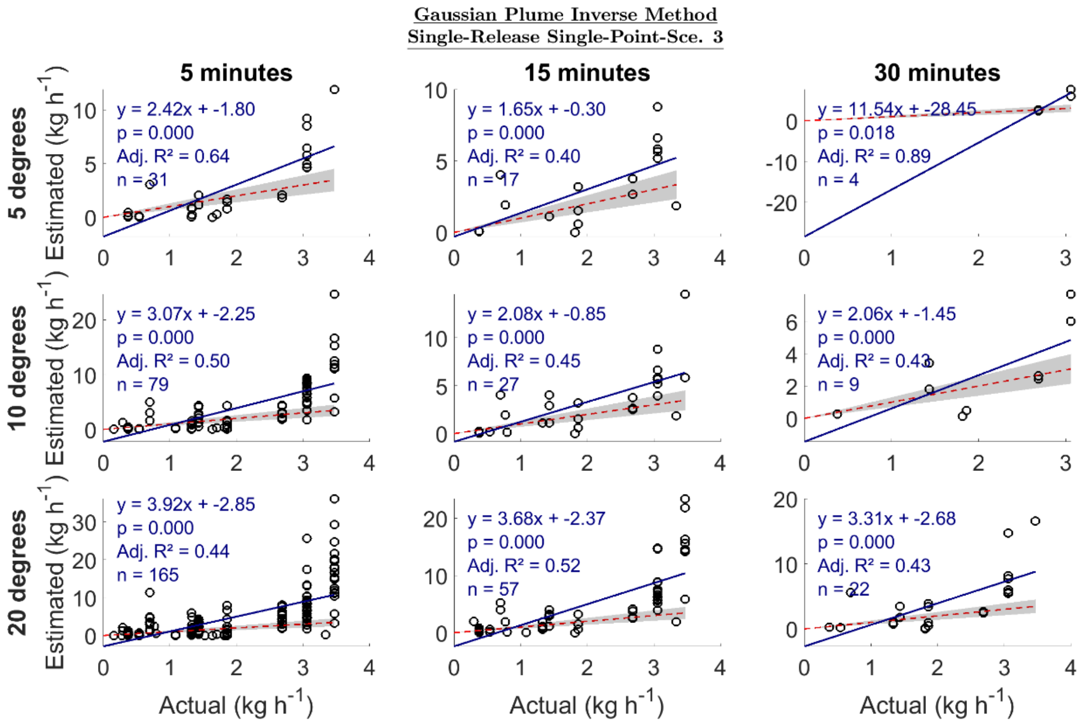

Figure S18. Estimated emission vs actual emission (kg h^{-1}) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.2.4 Scenario 4: Equation S8 & EPA 2013 dispersion coefficients

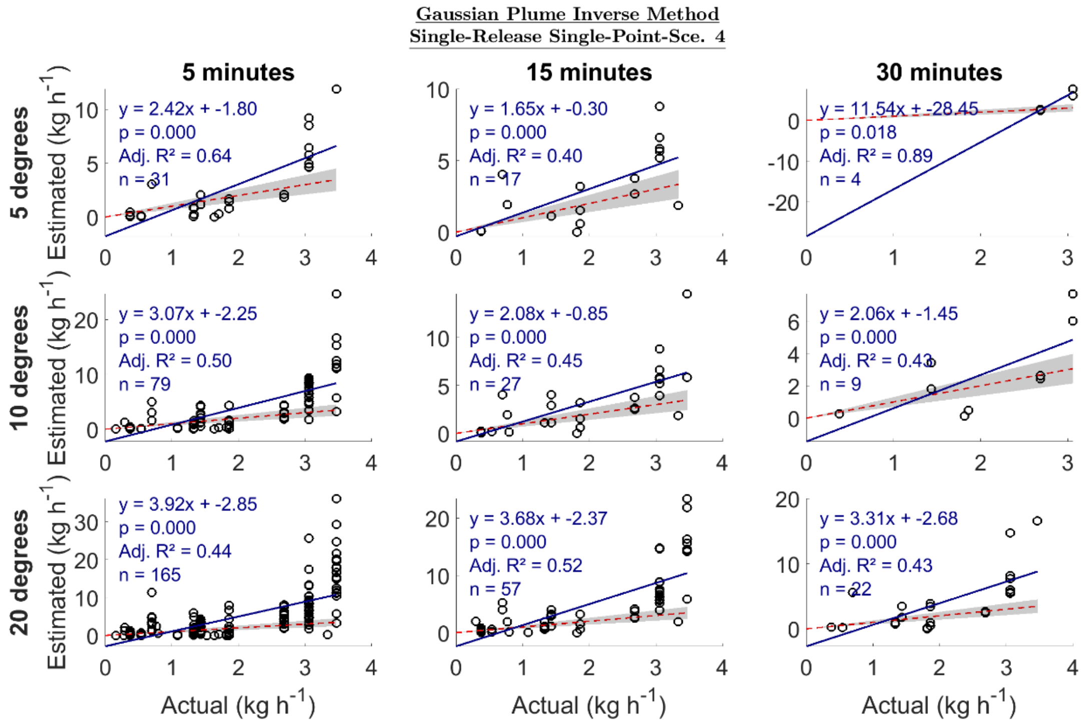

Figure S19. Estimated emission vs actual emission (kg h^{-1}) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.2.5 Scenario 5: Equation S7 & 1 Hz sonic anemometer dispersion coefficients

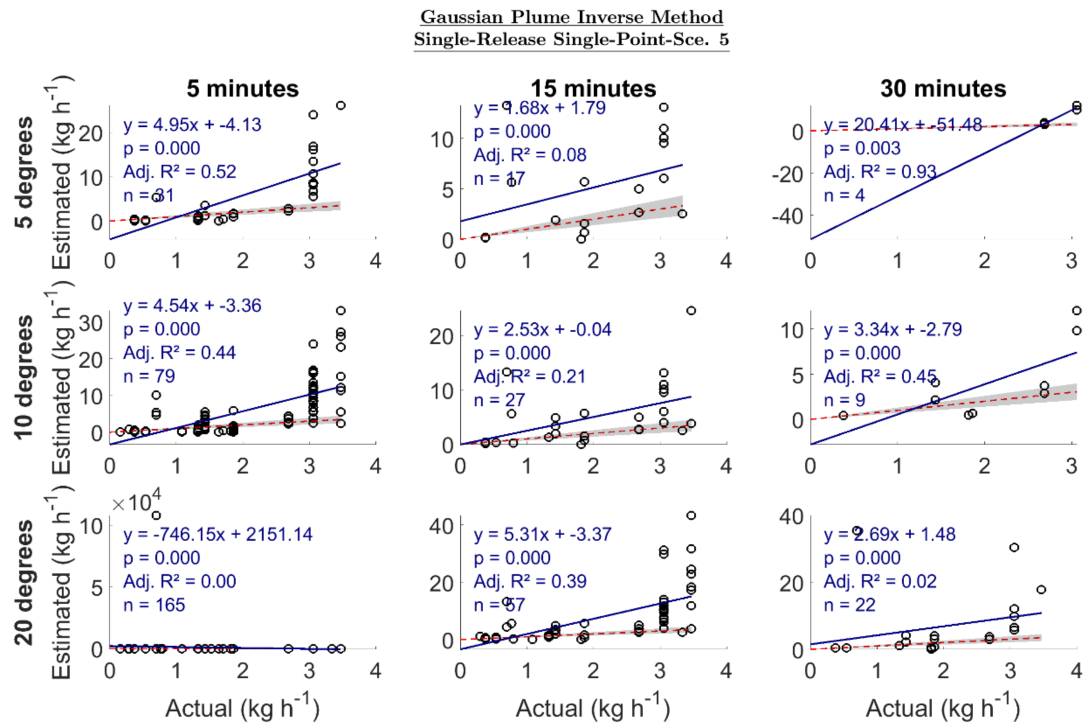

Figure S20. Estimated emission vs actual emission (kg h^{-1}) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.

S3.2.6 Scenario 6: Equation S8 & 1 Hz sonic anemometer dispersion coefficients

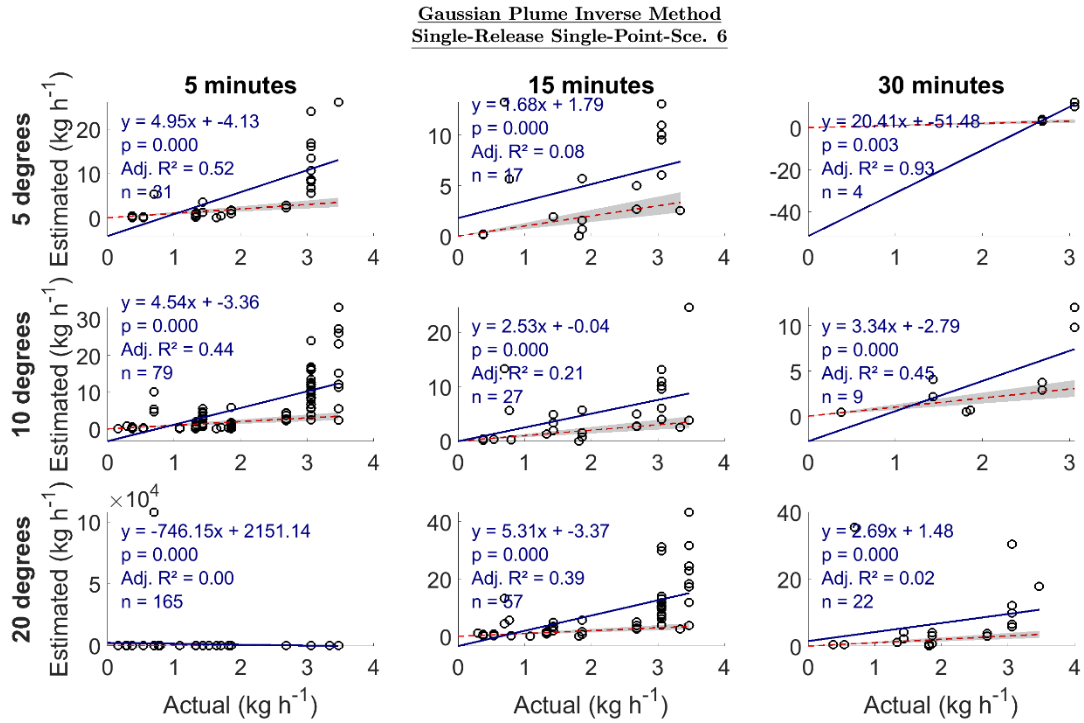

Figure S21. Estimated emission vs actual emission (kg h^{-1}) for single-release single-point emissions. The red dotted line is a 1:1 line based on actual emissions i.e. points below the line are underestimated and above are overestimated emissions. The gray region represents ±30% of the actual emission. Adj. R^2 is the adjusted R^2. The sample size is n.