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Advancing Development of Emission Detection

Advanced Development of Emissions Detection (ADED)

Objectives:

1) Continue use of developed protocols for controlled release testing that reliably assess leak detection and quantification (LDAQ) solutions under a range of representative field conditions at a controlled test facility;

2) Develop protocols for field trials while continuing comprehensive, multi-solution, field trials including a range of facility types;

3) Advance the state of solution testing to be scientifically rigorous, affordable, repeatable, and adaptable to field conditions, and make this knowledge generally available to all stakeholders;

4) Propose test standards from the results of Objectives 1-3 that can be adopted and adapted by (a) state and federal regulatory agencies for regulatory approval of LDAQ solutions, and by (b) operators for internal emissions-mitigation efforts.

Figure 1 shows testing conducted at CSU's Methane Emissions Technology Evaluation Center (METEC)

Figure 2 shows field trial testing at a production site during the 2022-23 oil and gas site deployment

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Field Trial Site Rate Estimate Results
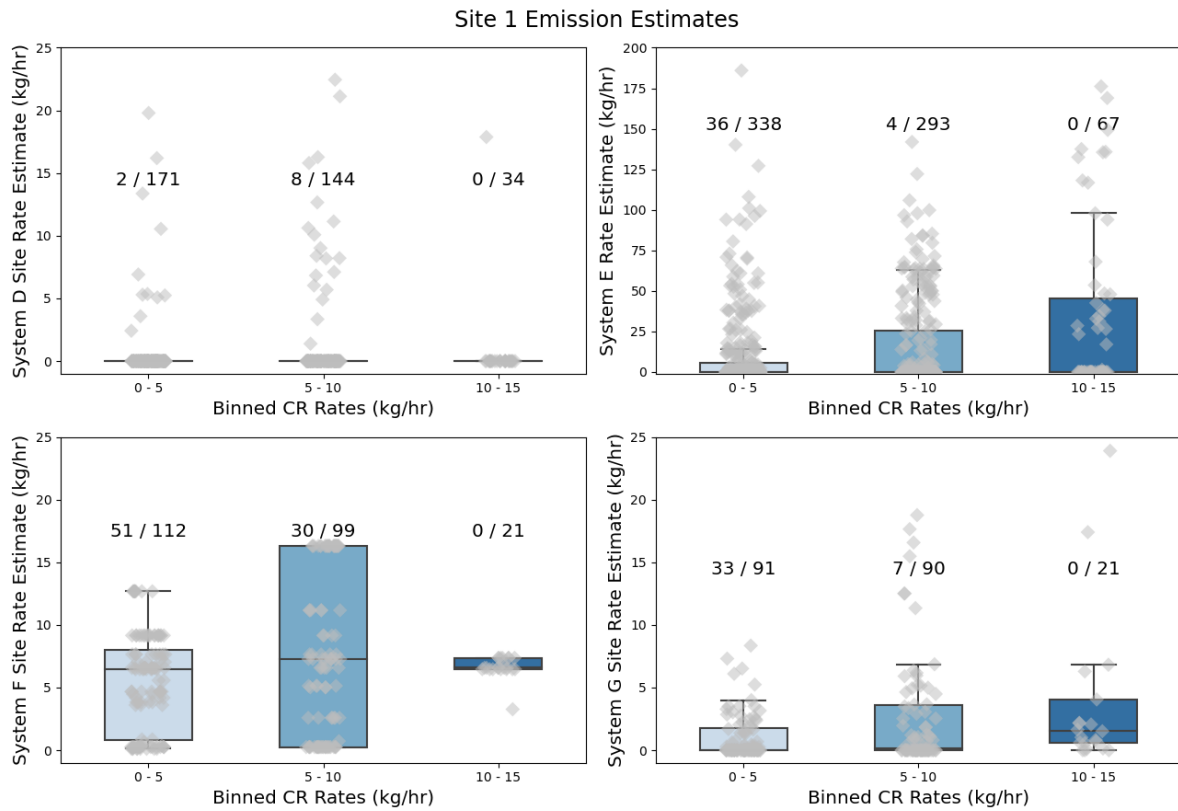

Site 1 Emission Estimates

Figure 3 shows solution company's estimates for all the coinciding controlled release (CR) rates at one of the production sites during ADED's field trial. The ratios show how many non-zero estimates (NZE) were within the binned CR rates over the number of possible estimates that could have been made within the binned CR rates. This number of possible estimates is slightly different for each *solution* at each site, as they provide estimates in different time intervals. Note that estimates of 0 kg/hr are shown in the box and scatter plots, but not counted in the ratios.
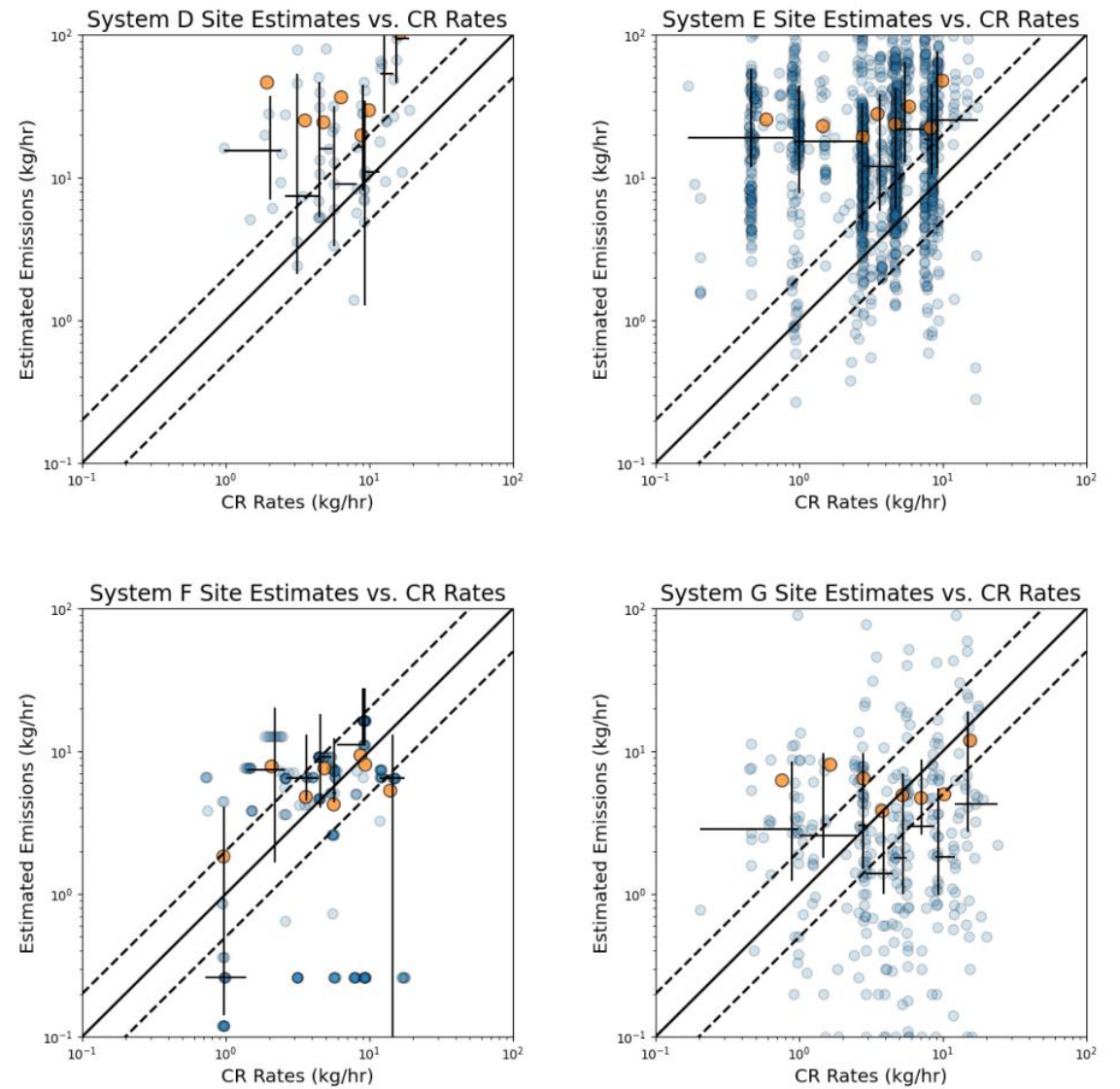
Figure 4 shows a log scale plot of all NZE with the CR rates. Orange markers show the mean of the NZE for each binned CR rate with whiskers showing the 25th and 75th percentiles, crossing at the median of binned NZEs.

Field Trial Statistical Significance Results

Detection Confusion Matrix

	Not Releasing	Releasing
Not Detect	$E_{NR} < \mu_{NR} + \sigma_{NR}$	$E_{CR} < \mu_{NR} + \sigma_{NR}$
Detect	$E_{NR} \geq \mu_{NR} + \sigma_{NR}$	$E_{CR} \geq \mu_{NR} + \sigma_{NR}$

Table 1 shows the matrix used to statistically compare estimates made when CRs were not occurring (E_{NR}) with estimates that were made while CRs were occurring (E_{CR})

Quantification Confusion Matrix

	Not Releasing	Hard to See Release	Visible Release
Estimate = 0 kg/hr	$E_{NR} = 0$	$CR \leq SR,$ $E_{CR} = 0$	$CR > SR,$ $E_{CR} = 0$
Outside Limits	$E_{NR} > SR * 3$ or $E_{NR} < \dfrac{SR}{3}$	$CR \leq SR,$ $E_{CR} > (SR + CR) * 3$ or $E_{CR} < \dfrac{(SR + CR)}{3}$	$CR > SR,$ $E_{CR} > (SR + CR) * 3$ or $E_{CR} < \dfrac{(SR + CR)}{3}$
Within Limits	$E_{NR} \leq SR * 3$ or $E_{NR} < \dfrac{SR}{3}$	$CR \leq SR,$ $E_{CR} \leq (SR + CR) * 3$ & $E_{CR} \geq \dfrac{(SR + CR)}{3}$	$CR > SR,$ $E_{CR} \leq (SR + CR) * 3$ & $E_{CR} \geq \dfrac{(SR + CR)}{3}$

Table 3 shows the matrix used to statistically compare estimates made when CRs were not occurring (E_{NR}) with estimates that were made while CRs were occurring (E_{CR})

Detection Matrix

	Not Releasing (%)	Releasing (%)
Estimate below NR mean + StDev	98	93
Estimate above NR mean + StDev	2	7

Table 2 shows the average of results from Table 1 for all the companies at all the sites. 7% of the E_{CR} are within the definition of detection.

Quantification Matrix

|	Not Releasing (%)	Hard to See (%)	Visible Release (%)
Estimate 0 kg/hr	72	63	54
Estimate outside limits	16	21	33
Estimate within limits	12	16	13

Table 4 shows the average of results from Table 3 for all the companies at all the sites. 13% of the E_{CR} are visible, or within the definition of quantification of CR rates that are above the SR. 16% of the E_{CR} are within the definition of quantification of CR rates that are below the SR.

Chi-squared Results

	Accept	Reject
Detection	12	7
Quantification	3	17

Table 5 shows chi-squared results with a null hypothesis of there being no statistical significance between the CR and NR data. 12/17 of the detections show no statistical significance while 14/17 of the quantifications show statistical significance

Field Trial and METEC Probability of Detection Results
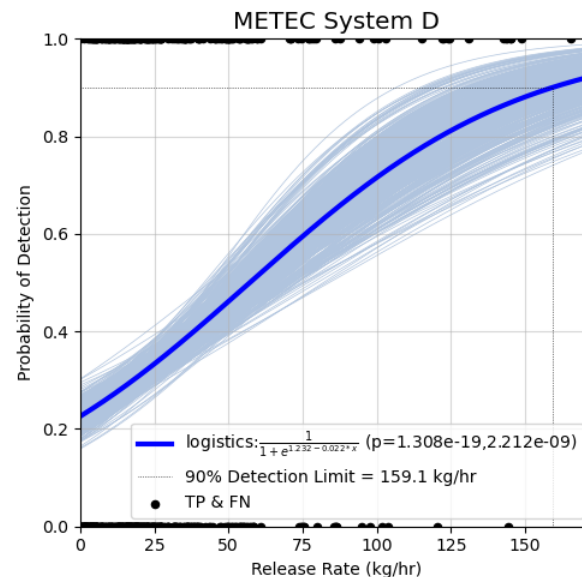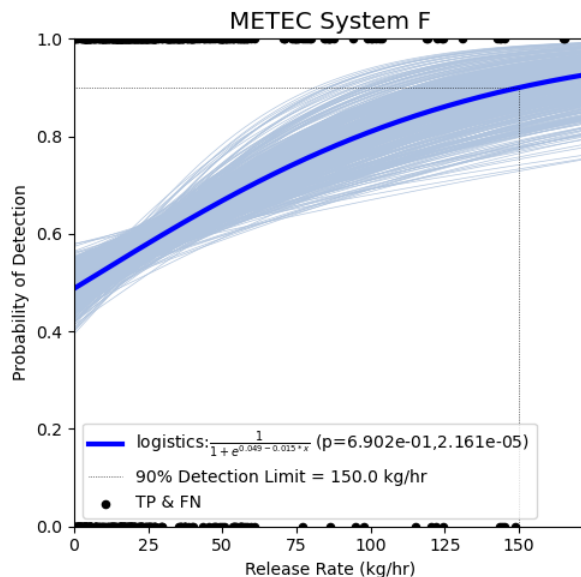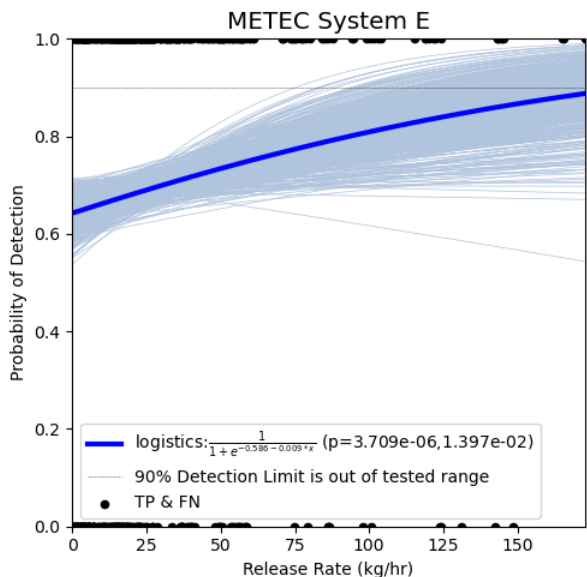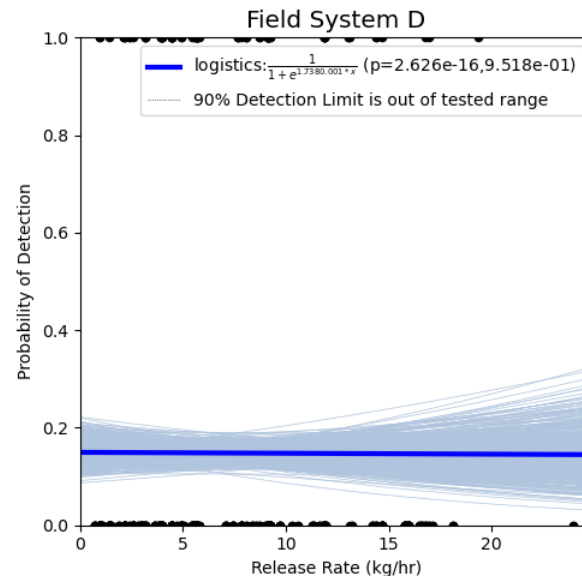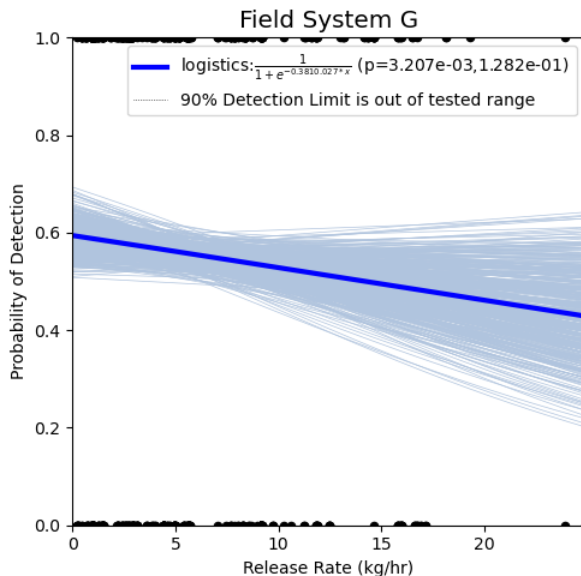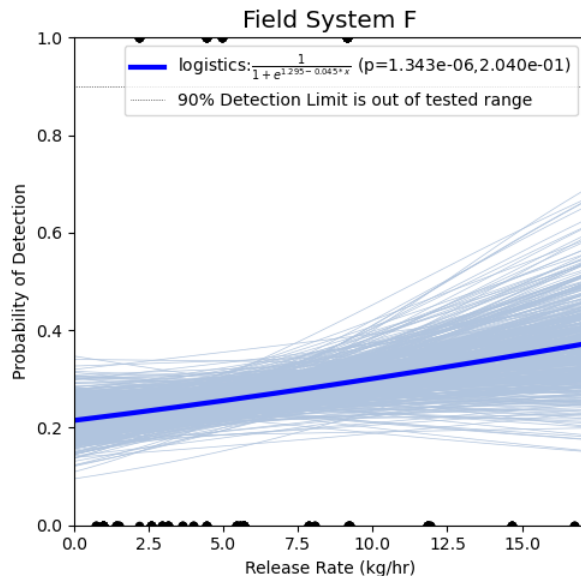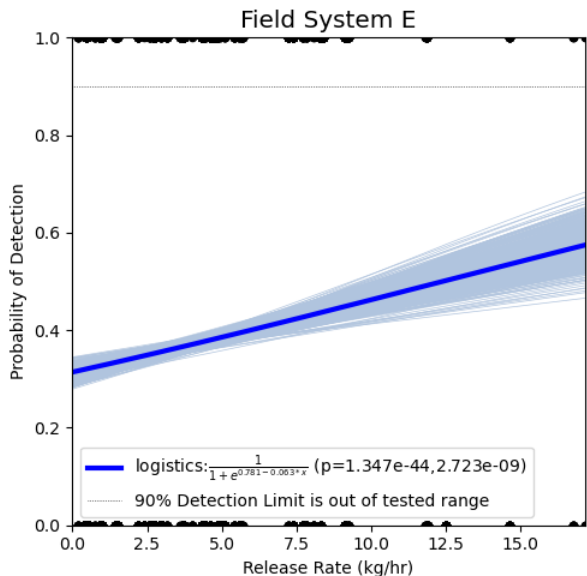
Thank You

Contact

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