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Interpreting emissions measurements via models (and vise versa)

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Clay Bell, Ph.D.

Methane Emission Technology Evaluation Center,

Colorado State University

A variety of emission modeling tools:

Model	Use	Examples
Inventory	Estimate average emissions from a set of assets	GHGI, GHGRP
Mechanistic	Estimate temporally and spatially resolved emissions resulting from process	MEET
Mitigation	Estimate emission mitigation or reduction potential	FEAST, LDAR-Sim
Dispersion	Estimate downwind mixing ratio from known emission source(s)	Gaussian
Inverse	Estimate emission source(s) from observed downwind mixing ratio	Bayesian

Reconciliation

- Reconciliation is often performed between two models, both of which have assumptions and uncertainties.
- E.g. a “top-down/bottom-up” reconciliation may compare:

1. The “top-down” basin total emissions ***estimated by an inverse model*** which is informed by the mixing ratio observed by an aircraft (or satellite) and meteorological data

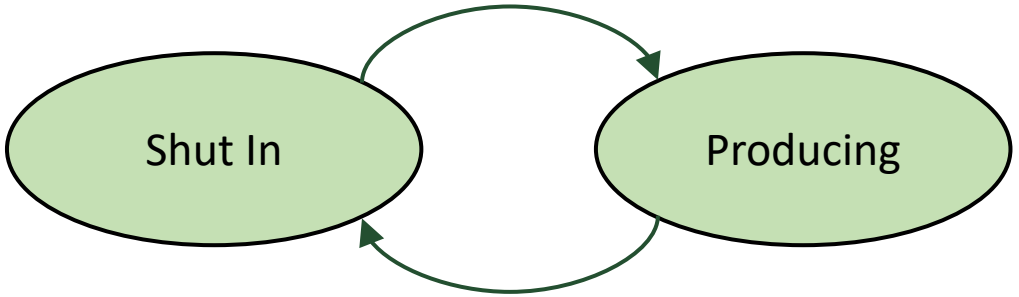
2. The “bottom-up” basin total emissions ***estimated by a mechanistic model*** which is informed by dynamic activity data and direct measurements

What is a mechanistic model?

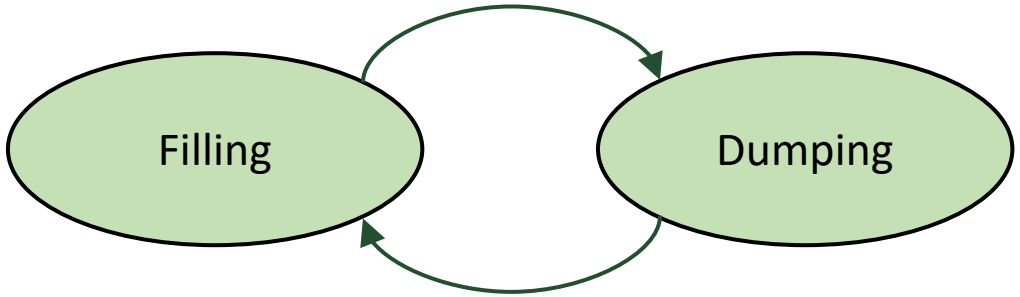
Example: ~~Methane~~ Mechanistic Emissions Estimation Tool

- Developed by University of Texas and Colorado State University
- Combines aspect of an inventory with state based process models and dynamic activity data to produce temporally and spatially resolved emission estimates.

A simple state machine for a well:



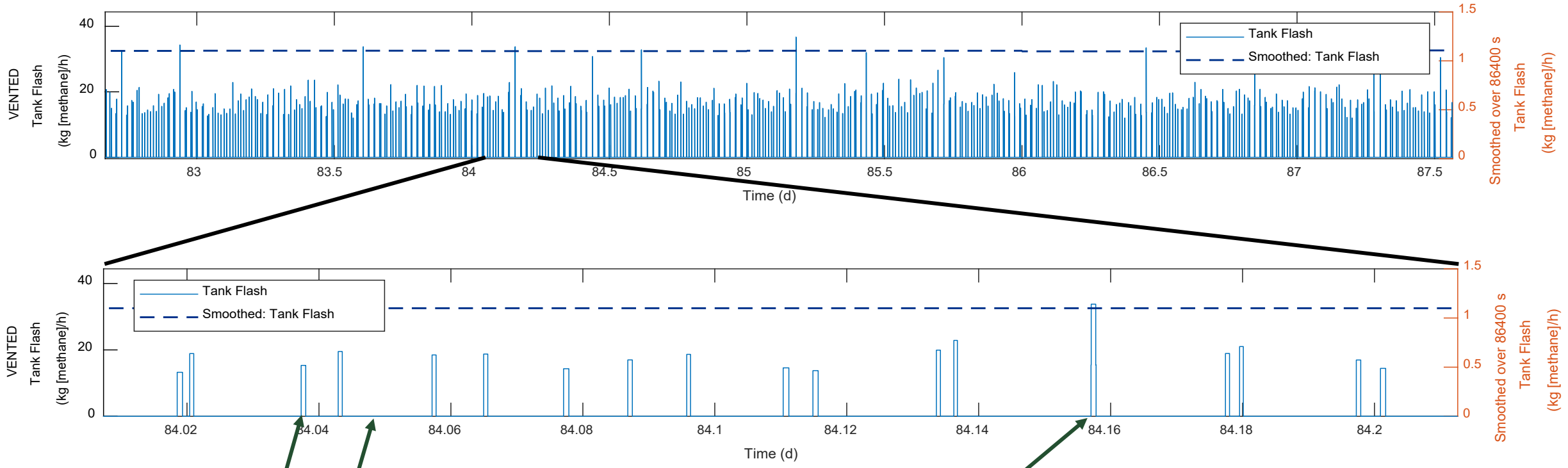
A simple state machine for a separator:



Uncontrolled Tank Flash

Tank flash emission rate is proportional to tank fill rate. Timing corresponds to separator dumps.

Instantaneous emissions (left axis)
~10 - 30X larger than
time averaged emissions (right axis)



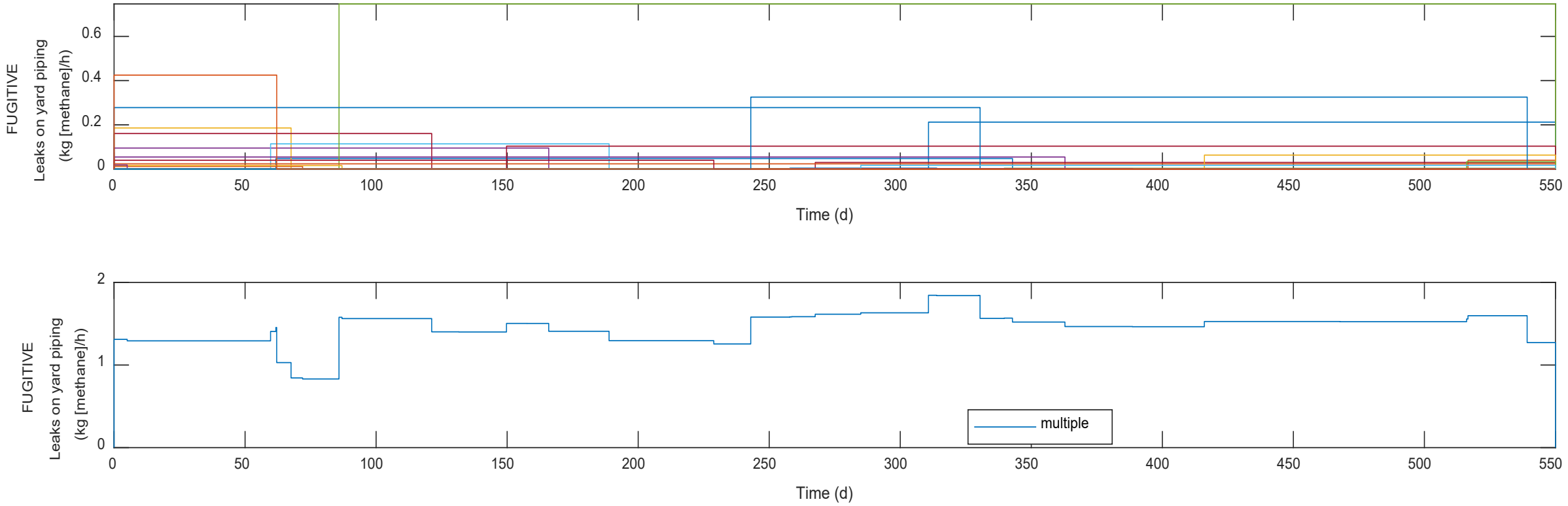
Flash during dumps;
Zero between dumps

Overlapping dump events lead to higher instantaneous emission rates

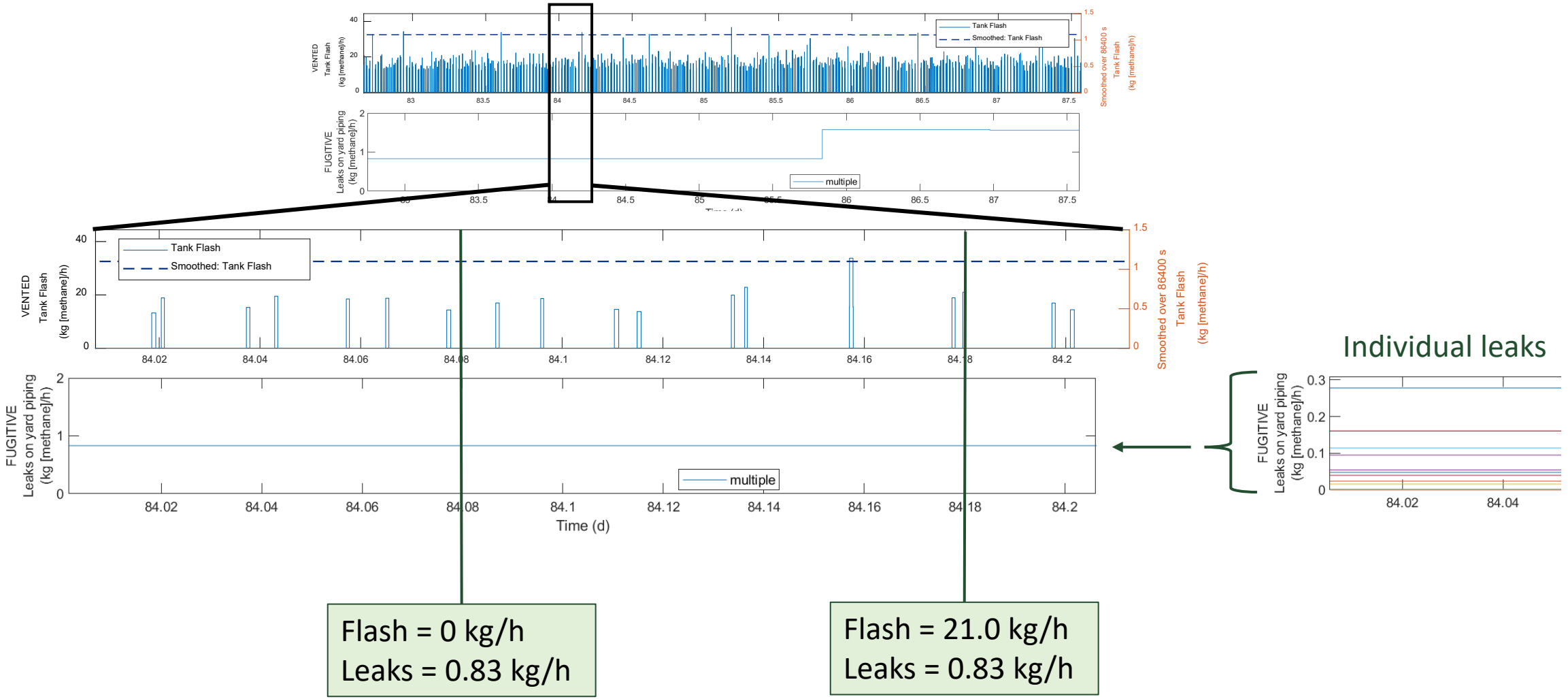
**Most leak detection methods will see instantaneous emissions

Component Leaks

- Input: 800 potential leaks sources, nominally 15 leaks at any given time, nominally 15 new leaks per year.

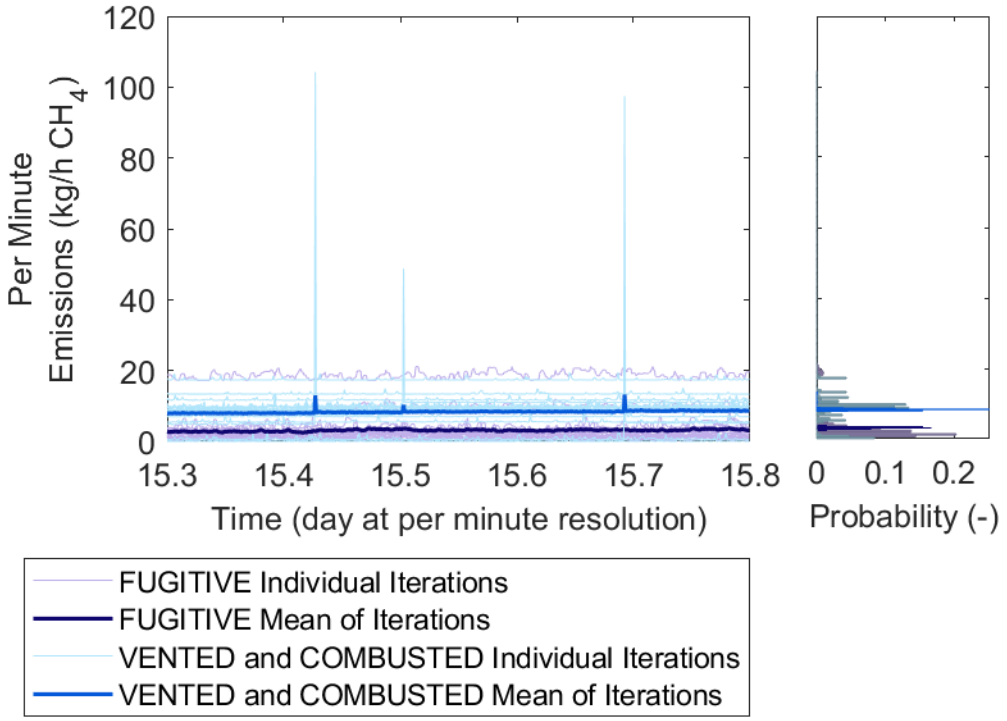


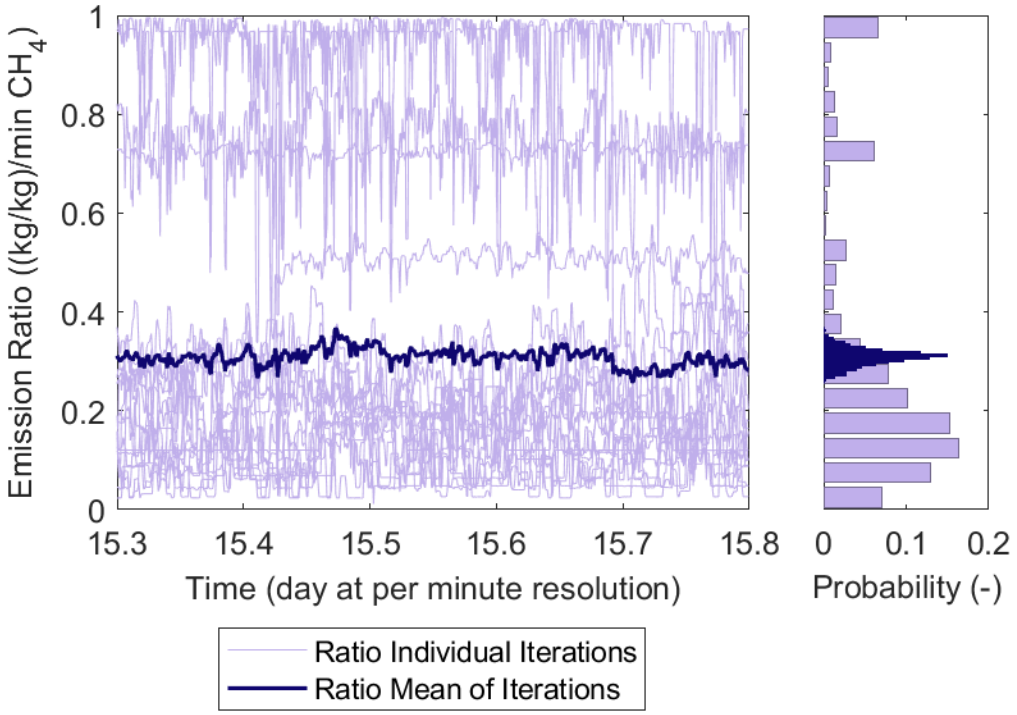
Site Survey Methods – Timing is Everything



Continuous Monitors - A Needle in a Haystack

- Picking out the fugitive emissions from a background is a challenging problem.
- Both fugitive and vented emission sources have temporal variability.





Take aways

- There are a wide variety of models and applications within the emissions field.
- Reconciliations are typically model-to-model, not model-to-measurement.
- Mechanistic models offer some understanding of temporal variability.
  - They provide opportunity to explain some differences observed by multiple measurement techniques.
  - They provide opportunity to assess sensitivity requirements for continuous monitors.
- All models have assumptions and uncertainties. Take care interpreting results!

Thank You

Contact

Clay Bell, Research Scientist I, Energy Institute
Clay.bell@colostate.edu | 304-216-4725

@CSUenergy

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