

I read with great interest the manuscript entitled “Dynamic quantification of methane emissions at facility scale using laser tomography: demonstration of a farm deployment.” The study reflects the authors’ pioneering vision in addressing methane emission quantification under real-world operational conditions, a topic of considerable scientific and societal importance. The application of the method for the first time in an operational farm setting further enhances the originality and significance of the work.

This manuscript presents the first deployment of laser dispersion tomography (LDT) at an operational agricultural facility, combining multi-open-path laser dispersion spectroscopy with Bayesian state estimation (BSE) for 3D dynamic reconstruction of methane emissions. The work is methodologically ambitious and addresses a highly relevant problem in facility-scale methane emission quantification.

The paper is strong in theory and simulation but would benefit from:

- Clearer structure and tighter writing in several sections,
- More explicit discussion of model limitations and identifiability,
- Stronger validation/quantitative benchmarking in the experimental section,
- Improved explanation of uncertainty interpretation.

I provide detailed, line-by-line comments below.

L1:2- Consider focusing on Methane rather than GHGs.

L2:3- Consider explicitly stating the gap: *facility-scale dynamic quantification under complex wind conditions*.

L3:4- You might clarify that this is an integration of LDS and Bayesian inversion, currently that is implicit.

L7:11- This is a very long sentence, and requires to be shortened

- a) Consider specifying that constraints reduce state dimensionality and improve robustness.
- b) The phrase “investigate numerically whether such constraints could improve tolerance...” is long and slightly convoluted.

L11:17 - The abstract could benefit from at least one quantitative performance indicator (e.g., reduction in posterior uncertainty by X%, improvement in bias, etc.).

L28 - The claim that livestock represents “14.5% of human-induced greenhouse effect” needs careful phrasing — is this global GHG or methane only? Clarify.

L43 - The sentence: “Methods using static chambers measure emissions directly...” These measure fluxes indirectly via accumulation rate; rephrase this for precision.

L53 - The critique of open-path FTIR (“require very large retro-reflectors”) requires a citation.

L56 - The “>100 kg h⁻¹” detection threshold needs contextual comparison to expected farm emissions.

L279:285 – How similar are these sources to the actual farm field were measurements were

L452 - You exclude May 21 due to lack of metadata. But could inversion detect whether it was real emission vs transport? This requires discussion

Missing quantitative validation

Major limitation:

- No independent flux measurement (e.g., chamber, flux balance) for comparison.
- Emission magnitudes are not benchmarked against expected slurry emission rates.

You should:

- Compare estimated kg h⁻¹ to literature typical values.
- Discuss uncertainty credibility.