

# Peer Review Report

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*Title: Can we obtain consistent estimates of the emissions in Europe from three different CH<sub>4</sub> TROPOMI products?*

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## General Assessment

This manuscript presents a comprehensive study of methane (CH<sub>4</sub>) emissions over Europe using three different satellite-based TROPOMI products. The central question—whether consistent emission estimates can be derived from these different products—is of high scientific and practical relevance. The increasing reliance on satellite-based greenhouse gas observations for policy-making and climate monitoring underscores the importance of this work.

The authors have conducted a broad and technically rich analysis, including detailed product processing, uncertainty treatment, and inverse modeling. However, the manuscript currently lacks a coherent narrative that leads the reader from the stated question to a clear, data-driven conclusion. While the technical sections are sound, the structure often obscures the main message. There is an overemphasis on methodological detail and extensive referencing at the expense of direct interpretation and hypothesis testing.

The authors need to significantly improve the clarity, structure, and focus of the manuscript to fulfill its potential. In particular, the main hypothesis must be explicitly stated, tested, and either confirmed or rejected using statistical evidence. A clearer distinction between consistency and reliability (e.g., agreement with ground truth) should also be maintained throughout.

## Major Comments

### 1. Clarity of Research Question and Structure

The central question posed in the title is not clearly answered in either the abstract or the conclusions. A well-defined hypothesis and its statistical verification should guide the structure of the manuscript. Much of the methodology section feels detached from the central question. The authors should restructure the manuscript to follow a logical flow: problem statement → methodology → analysis → results → conclusion.

### 2. Abstract and Introduction

The abstract is vague and at times contradictory. Replace vague statements with a direct summary of findings and implications. The introduction includes redundant background. Replace with targeted discussion of satellite CH<sub>4</sub> retrievals, the TROPOMI product landscape, and the importance of consistency.

### 3. Definition of Consistency and Its Measurement

Clearly define how consistency is measured (e.g., correlation, bias, RMSD). Introduce the statistical metrics and how they will be applied across spatial scales.

### 4. Overemphasis on Methodological Details

Trim excessive detail from Sections 2.1–2.4. Move technical descriptions to the Supplement unless they directly inform the consistency analysis.

### 5. Statistical Analysis and Uncertainty

Introduce proper statistical hypothesis testing and include uncertainty bounds, p-values, or confidence intervals to assess significance.

### 6. Use of Single-Year Data

Explain why 2019 is used. A single year may not capture variability. Consider a multi-year analysis or justify why this year is representative.

## Minor and Editorial Comments

### Abstract

- Improve focus and clarity. Avoid vague phrases such as 'holds promise' or 'paving the way.'
- Quantify findings where possible.
- Clarify ambiguous phrases (e.g., 'relative increase' of what? Compared to what baseline?).

### Introduction

- Avoid textbook-level background on methane (lines 17–24).
- Clarify references to BU/TD inventories—if not directly used, they may be omitted.
- Include a brief overview of available XCH<sub>4</sub> products and their known limitations.
- Define technical terms when first introduced.
- Clarify why Europe and the year 2019 were chosen.

### Methods

- Remove unnecessary numeric details unless they support later discussion.
- Equation 1: Define all variables and explain relevance.
- Explain key terms such as 'pseudo noise,' 'observational error,' 'qa\_value.'
- Provide a transparent uncertainty treatment methodology.

### Results

- Focus more on direct comparisons of the three products.
- Avoid subjective or speculative language.
- Provide uncertainty estimates for seasonal/annual budgets.

- Correct figure references (e.g., D4/D5).

### Discussion and Conclusions

- Answer the title question clearly and directly.
- Support general claims with quantitative or literature-based evidence.
- Clarify how data quality and coverage interact.
- Specify the impact of individual factors on retrieved fluxes.

### Recommendation

#### Minor Revision

This manuscript addresses an important question with strong technical depth, but the central message is lost in overly detailed methodology and a lack of structured hypothesis testing. I encourage the authors to revise the manuscript with a clearer focus on answering the title question, supported by statistical analysis, direct comparisons, and more effective framing of results and conclusions.