

Author's response to Anonymous Referee #2

This paper presents a long-term study on detecting and quantifying methane emissions from a landfill. The authors conducted 21 measurement campaigns over a period of 3 years, using a combination of ground-based and airborne measurements to estimate methane emissions. They found that the landfill was a significant source of methane emissions, with emissions varying depending on factors such as temperature and precipitation. The study provides valuable insights into reducing greenhouse gas emissions and highlights the importance of long-term monitoring to accurately estimate emissions. This study has more strengths as compared to weaknesses.

We thank the reviewer for this general assessment of our manuscript and for the comments, which helped complement our manuscript with some additions in the introduction and discussion of results.

Strengths

- The study provides a comprehensive analysis of methane emissions from a landfill over a long period of time, which is valuable for understanding the factors that contribute to emissions.
- The authors used a combination of ground-based and airborne measurements, which provides a more complete picture of emissions than using only one type of measurement.
- The study highlights the importance of long-term monitoring to accurately estimate emissions and provides insights into how to improve monitoring methods.

We thank the reviewer for listing the strengths of the study. We would just like to indicate that the measurements conducted within the landfill are on foot measurements while "airborne measurements" is rather used for measurements from drones or aircrafts which is why we do not use such a term in the manuscript.

Weakness

- The study only focuses on one landfill, so the findings may not be generalizable to other landfills.

The landfills differ in terms of topographical features, types of wastes, management practices by the site operators, etc. Therefore, we will need other studies such as this one to support the establishment of standard atmospheric monitoring techniques that are robust for any landfills, and even more studies to improve the definition of emission factors associated to the landfill methane emissions in general.

We needed much resources and efforts for a long-term monitoring of the emission from the landfill we study here. Some studies cover several landfills (e.g., Mønster et al., 2015) but with two drawbacks:

- by providing single or few instant emissions estimates
- by using a monitoring approach for a given landfill which is often limited by the lack of specific measurements or of analysis due to the need for a relatively fast approach when covering many sites

Both types of studies are complementary, and the build-up and progress of the two types of studies should support the development and improvement of the atmospheric monitoring techniques and the derivation of more accurate emission factors and understanding of the process governing the landfill emissions. Our study participates to the corresponding long-term effort, but it could not have the too ambitious objective of providing a general conclusion on the landfill emissions in general. However, our atmospheric measurement strategy and the inversion approach to estimate the methane emission is general enough to be followed to monitor the emissions from other landfills. Our methodological conclusions can be used as a basis for future applications and developments.

We now better clarify this point in the introduction and discussion of the manuscript.

- The paper could benefit from more discussion on the implications of the findings for reducing greenhouse gas emissions.

This connects to the previous comment: as indicated above, we now clarify in the introduction and discussion the scope of our conclusions. We also remind the need for better methane emission factors to support the reduction of greenhouse gas emissions.

Overall, this paper provides valuable insights into detecting and quantifying methane emissions from landfills and highlights the importance of long-term monitoring for accurately estimating emissions. The study could be improved by providing more discussion on the implications of the findings for reducing greenhouse gas emissions.

We thank the reviewer for these final remarks and as detailed above, we have included some additional discussions in the revised manuscript following these recommendations.

References

Mønster, Jacob, et al. "Quantification of methane emissions from 15 Danish landfills using the mobile tracer dispersion method." *Waste Management* 35 (2015): 177-186.