Reviewer Response:

We thank the reviewer and editor for the comments and insightful critique of the manuscript. We have addressed the detailed comments below.

Campbell et al. made changes based on most of my comments, most importantly nuancing the significance of the emission results. I am still not sure I understand the method for their upscaling (Original Comment P5L129; P8L184). I understand that counting infrastructure in visual imagery for the entire region is impossible but now the upscaling seems inconsistent with the established emission factor, as that did rely on facility counts (and not on flare counts like the extrapolation). I would also argue that evaluating the albedo correlation of the results would be worthwhile (P12L260) but that is less urgent considering the significance of the results has been downplayed. I think ideally more data (masked plumes) would be available on the GHGSat aspect of the study, but I understand there may be limitations there (P15L331).

We agree with the reviewer and have sought to clarify the upscaling methodology in the revised manuscript. Our approach uses facility counts only to estimate the likelihood *of* plume occurrence at GHGSat observed sites. This likelihood is then applied to all flaring locations, which we treat as proxies for oil and gas infrastructure complexes, i.e. what is represented by the GHGSat ground swath. We rely on flaring locations because they are the only spatially complete, domain-wide dataset of oil and gas activity available for the WSL; infrastructure datasets and field boundaries are incomplete and would misallocate emissions to inactive areas. We now explicitly explain this distinction in the manuscript.

New and revised sentences include L131 “Flaring locations were utilized as a proxy for oil and gas infrastructure due in part to their previous utilization to develop geospatial information on oil and gas field locations (Zhang et al. 2019). We did not utilize infrastructure as it is incomplete for the region or oil and gas fields as that would have distributed emissions to areas not in active production.”

Additionally, line 151. “We treated each flaring location as a proxy for a complex of oil and gas infrastructure, consistent with the GHGSat observation sites. Consequently, the calculated occurrence rate was applied uniformly across all flaring locations.”

These revisions clarify that the facility counts are used to derive the occurrence probability, while the spatial extrapolation is based on flaring locations as the best available representation of infrastructure distribution.

Regarding the reviewer's suggestion on albedo, we now explicitly note this as an important next step:

New sentence**:** *"Additionally, the WSL would be an ideal location to analyse the relationship between surface albedo and model performance to better understand its impact on the IMI."*

Finally, we agree that additional GHGSat observations would strengthen the analysis, but these data are not currently available.

I think it would be worthwhile to check the edits for small mistakes and typos. I noticed several minor issues, for example (using references to my original comments):

We have read through the manuscript in depth and made several additional minor revisions highlighted in the revised text.

• P1L26-L27 The edit suggested in the response does not match the edit in the manuscript.

Updated to accurately incorporate the edit. "While aquatic and wetland sources remain significant recent budgets allocate more of these emissions to anthropogenic sources through eutrophication, reservoir emissions, and warming (Jackson et al. 2024). Despite reduction in methane attributed to aquatic and wetland ecosystem they remain the greatest uncertainty in global budgets (Saunois et al. 2025)."

• P2L42 The caption is not that clear to me on where/why there may be gaps.

Updated the caption to clarify

• P2L57 I do not think the emissions from EDGAR are country-reported? The sentence is now a bit confusing "In databases such as Climate TRACE."

Removed country-reported from the sentence for clarity. And revised the sentence. Though EDGAR does report at the national level "Bottom-up global inventories (such as EDGAR) compute emissions for each sector, pollutant, and year at the national level, making use of international statistics and official guidelines for emission computation " (Crippa et al. 2024).

We have revised the second sentence for clarity. "Bottom-up inventories such as Climate TRACE. GFEI and EDGAR use the best available geospatial data to estimate the spatial distribution of emissions from various sectors, for example, oil refineries."

• Typo on the initial date of the spinup period "1/05/201".

Corrected to 01/05/2021.

- “falling a similar approach to Naus et al. (2023).”

Changed to following.

Crippa, M., Guizzardi, D., Pagani, F., Schiavina, M., Melchiorri, M., Pisoni, E., Graziosi, F., Muntean, M., Maes, J., Dijkstra, L. and Van Damme, M., 2024. Insights into the spatial distribution of global, national, and subnational greenhouse gas emissions in the Emissions Database for Global Atmospheric Research (EDGAR v8. 0). *Earth System Science Data*, *16*(6), pp.2811-2830.