Review of: "*Launch Emission Assessment Tool (LEAT v1.0): Part I Development of a tool to calculate altitude-dependent rocket launch emissions for use in chemistry-climate models"* by Fischer et al.

This manuscript presents a tool for quantifying emissions from rocket launches and translating these emissions into atmospheric inventories suitable for atmospheric chemistry and climate applications. The topic is timely given the rapid growth of the commercial space sector and the increasing recognition that rocket emissions may have non-negligible impacts on atmospheric composition, ozone chemistry, and radiative forcing.

The manuscript is generally well written, technically sound, and addresses an important gap between propulsion engineering and atmospheric modelling. The tool appears sufficiently flexible to incorporate diverse propulsion technologies and launch configurations, while extending beyond many previous approaches through the inclusion of afterburning, altitude-dependent processing, and atmospheric interactions.

The paper makes a valuable methodological contribution and should be of interest to both the atmospheric-science and aerospace communities. **I recommend publication after minor revision.**

Major comment: While the introduction and model description describes and highlights advantages of LEAT in detail compared to other emission inventories, there is no comparison with these emission inventories in the results or discussion section. The discussion section only compares the emission profiles to Ross and Schäfer 2014 in detail. But how does your overall emission inventory compare to the inventories listed in Table 4? This would be important to demonstrate that the detailed calculations performed here result in improved outcomes.

General comment: "Launch Emission Assessment Tool" could also make people expect that you assess the impacts of launch emissions. But the tool only quantifies the emission trajectory and mass based on different parameters. Thus, it can be used to generate detailed emission inventories. This clarification should be made clear early in the text to avoid wrong expectations.

General comment: With 35 pages (excluding the reference list), the manuscript is rather long and at some places repetitive. The paper could easily be cut by 30% without losing information by being more concise. This is not a critical request but rather a suggestion to increase reader friendliness.
I also don't think it is useful to mention code/python specific variables or input files in the main text. This is not useful for the general reader. These explanations could still be put into the supplement for those people who are interested. I think the paper should focus on description and validation.

Line 30-32: Maloney et al., 2025 looked at re-entry emissions, which is not context here. A better citation might be Revell et al., 2025.

Line 50-52: On point iii) Why altitude and density? I understand that air density has an impact and it decreases as a function of altitude. But why altitude as a standalone? I would expect iii) to be also strongly dependent on mixing rates with ambient air (i.e., the dilution rate), which are very different for the troposphere (turbulent, easier vertical missing) vs. stratosphere (well stratified, fast horizontal mixing). Maybe this is something to add. Also, what about microphysical processes in the plume such as agglomeration, condensation ect.? And what about atmospheric composition?

Line 63: "CEA" (abbreviation not defined) and "Cantera" comes a little out of the blue. These "approaches" require some more detailed explanation. Are these two different methods? Maybe slightly reformulate the introduction of CEA and Cantera here.

Line 128-131: "Potentially, also effects on cloud formation (see e.g. Stevens et al., 2003, 2005; Voigt et al., 2016) and their impact on on the radiation budget as well as the effects from Al2O3 (see e.g. Maloney et al., 2025; Ross and Sheaffer, 2014; Jain et al., 2023; Weisenstein et al., 2015) are discussed."
This sentence needs to be reformulated. An effect is either discussed or not. It cannot be potentially discussed. You already mention the radiative balance in the sentence before. Which effects of alumina are you referring to? For effects of alumina on stratospheric ozone, I also suggest having a read of Vattioni et al., 2023 and maybe add it to the reference list here.

Line 131/132: What about ozone effects of alumina? See Vattioni et al., 2023

Figure 2: Increase consistency between what is listed in Figure 2 and what is discussed in the text.

Line 183: How can exhaust be compressed upon exit when it is designed to generate thrust and assuming it leaves the nozzle with several hundred °C at any atmospheric background condition?

Line 195-196: What about dilution rates? See comments above.

Line 737: Your results show similar results?

Figure 9: What does grey area indicate? Make like colours more distinguishable. Hard to distinguish different lines.

Figure 10: Use different colour codes for frozen and Equilibrium. Impossible to distinguish. Also, the caption mentions centra in red, but there is no red.

Typos:

Line 29: "which affect ~~on~~ Earth's radiative budget"

Line 126-128: Check subscripts!

Line 129: "impact on ~~on~~ the radiation budget"

Line 131: “Furthermore, …”

Line 153: "Engines ~~are~~ typically have a fuel-rich mixing ratio"

Line 264: "Ground-based measurements"

Line 263-264: Check grammar.

Line 273: "loaded and ~~and~~ stored in data frames"

Line 320/328: "fixed or altitude-dependent"

Line 349: “post-combustion”

Line 547: Subscript in H2O.

Figure 2: “emmissions to air”, “occuring chemical reactions”

Table 1: Make all “N2” subscript “N_2”.

Some references to Figures and Tables do not have a space between Fig. and number.

References:

Maloney, C. M., Portmann, R. W., Ross, M. N., and Rosenlof, K. H. (2025) Investigating the Potential Atmospheric Accumulation and Radiative Impact of the Coming Increase in Satellite Reentry Frequency, Journal of Geophysical Research: Atmospheres, 130, e2024JD042442, https://doi.org/https://doi.org/10.1029/2024JD042442

Revell, L.E., Bannister, M.T., Brown, T.F.M. *et al.* Near-future rocket launches could slow ozone recovery. *npj Clim Atmos Sci* **8**, 212 (2025). https://doi.org/10.1038/s41612-025-01098-6

Vattioni, S., Luo, B., Feinberg, A., Stenke, A., Vockenhuber, C., Weber, R., et al. (2023). Chemical impact of stratospheric alumina particle injection for solar radiation modification and related uncertainties. *Geophysical Research Letters*, 50, e2023GL105889. https://doi.org/10.1029/2023GL105889