

## REPLY TO THE ANONYMOUS REFEREE #1

We thank Referee #1 for the valuable comments in the interactive discussion of our ESSD preprint review article and for acknowledging the “crucial” interest of this study.

“The paper provides an analysis of greenhouse gas (GHG) emissions and trends in Africa over the past three decades, focusing on evaluating different datasets and their potential for verifying official country-reported data. The study examines emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) using both bottom-up approaches (such as national inventories and ecosystem models) and top-down methods (including atmospheric inversions).

The findings contribute to understanding emission trends and uncertainties in Africa, which is crucial for climate policy and the goals of the Paris Agreement. Overall, the topic is interesting.

However, I have some concerns as follows:

1. In addition to providing the datasets (<https://doi.org/10.5281/zenodo.7347077>), this paper needs to include datasets usage (quality control method, datasets limitation, etc.)”

We agree and will add a detailed section named datasets usage including quality control method, datasets limitation in the Zenodo repository.

2. “The method for calculating trends needs to be described and the impact of different trend calculation methods on trend results needs to be discussed.”

Thanks, the revised paper will contain the description of the different computation methods on trends with further details. (For estimating linear trends and their significance, we used the R Python function to compute the correlation coefficient for medians values over overlapping time periods, that we will describe more in detail. We also computed GINI for emissions per GDP that we will further detail).

3. “As statistics play a crucial role in this study, it is important to provide further details, such as confidence intervals, to ensure its robustness.”

Thanks for your comment, we agree with Referee#1 that confidence intervals are critical. Given that some of our estimates are based on a small number of models / estimates, we cannot calculate the full distribution and a 95% CI but we rather reported ranges with min / max. Assuming that the unknown distributions would be Gaussian, like in Schultze et al. (2011) we could infer a 2-sigma ( $\approx 95\%$ ) CI if we assumed that min-max are equivalent to 3-sigma, but in view of the small numbers of estimates e.g. for N<sub>2</sub>O with only 3 inversions, we prefer to just give the min-max range. Moreover, for NGHGI, this is more tricky and as

all African countries are non-Annex I, they unfortunately do not deliver confidence intervals but Grassi et al. (2022) estimated for CO<sub>2</sub> LULUCF fluxes uncertainties of 50 % for the average of non-Annex-1 countries, which we mentioned in the text and used by default in the revised manuscript.

We extended the discussion on uncertainties in section 1 (methods and datasets), we added the following paragraph about the underlying data uncertainty description in the method section (page 6, lines 173-180):

*“No specific standard guidelines currently exist for defining uncertainties for datasets from BU and TD data products. In general, uncertainty estimates are understood as the spread among minimum and maximum values from one methodology. A main source of uncertainty in the comparison of country-reported data with other data products is the inclusion or not of natural fluxes additionally to anthropogenic emissions sectors. For inversions, the prior geospatial distribution of emissions is a critical source of uncertainty. For the comparability of the different data products presented in this study, we discuss only the mean value over the period of overlapping data availability. Referenced datasets are available at <https://doi.org/10.5281/zenodo.7347077>(Mostefaoui et al., 2022).”*

In the discussion paragraph 3.5 about uncertainties for DGVM and inversions for LULUCF CO<sub>2</sub> (pages 41-42, lines 751-773) we also reminded how uncertainties were defined for each method while discussing “unknown-unknown” types of uncertainties.

4. “When employing in situ surface networks for dataset validation, are there specific factors, such as latitude, longitude, climate zones, etc., that exhibit correlations with the product's quality?”

Thanks for the question. May we please ask to what line of the paper exactly does the anonymous referee #1 refer to? We have not used in situ for dataset validation per se, only the GOSAT data were evaluated against TCCON independent ground based total column XCH<sub>4</sub>.

The African ground-based network is very sparse. There are only three currently active surface flasks over this whole continent, located in Namibia (Gobabeb), in the Seychelles (Mahe Island), and in South Africa (Cape Point). The one in Algeria (Assekrem) was terminated on 26/08/2020, and the one in Kenya has been inactive since 21/06/2011. We summarize the characteristics of the surface flasks in Africa, available on the NOAA website in the table below:

Station name, Country	Parameter	First sample date	Status for the three GHG	Frequency	Elevation (in meters above mean sea level)	Cooperating Agencies
Assekrem, Algeria	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	12/09/1995 12/09/1995 12/09/1995	Terminated since 26/08/2020	Discrete Monthly	2710	Algerian National Office of Meteorology
Gobabeb, Namibia	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	13/01/1997 13/01/1997 13/01/1997	Ongoing	Discrete Monthly	456	Gobabeb Training and Research Center
Mahe Island, Seychelles	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	15/01/1980 12/05/1983 13/06/1997	Ongoing	Discrete Monthly	2	Seychelles Bureau of Standards
Cape Point, South Africa	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	5/01/1980 12/05/1983 13/06/1997	Ongoing	Discrete Monthly	230	South African Weather Service
Mt. Kenya, Kenya	CO <sub>2</sub> CH <sub>4</sub> N <sub>2</sub> O	11/02/2010 11/02/2010 11/02/2010	Inactive since 21/06/2011	Discrete Monthly	3644	Kenya Meteorological Department

**Table with Surface flask characteristics over the African continent. Data synthesized from NOAA website.**

5. “Lines 89-90. BU methods and TD methods need to be further explained.”

Thank you, we will add more detailed explanations in the revised manuscript.

6. “Line 124 and Line 162. Redefinition for the abbreviation "bottom-up (BU)". You have already defined it in line 89. Please recheck the manuscript to ensure that the same error does not occur.”

Thanks, we will make sure that acronyms / abbreviations are only defined once.