Reviewer 1

1. The paper "Application of the Multi-Scale Infrastructure for Chemistry and aerosol version 0 (MUSICAv0) for air quality in Africa by Tang et.al. Suggest change in the title to show with the application is research or forecasting of air quality?
Response: We changed the title to "Application of the Multi-Scale Infrastructure for Chemistry and Aerosols version 0 (MUSICAv0) for air quality research in Africa".

2. The paper describes the new model and compares it with currently existing models in use by the community and satellite measurements and makes a recommendation as the most appropriate tool for use in East Africa. The development of this model and the intended application is very timely as Africa is experiencing an unprecedented economic and population growth.
Response: Thank you!

3. Of all of the developing world, Africa has experienced the highest urban growth rate during the last two decades at 3.5% per year, and this rate is expected to hold into 2050. With increased urbanization rates, Africa is facing increasingly serious urban air quality problems. Despite the seriousness of the impact of air pollution in the continent studies addressing this problem are very few. While the paper indicates the scarcity of ground-based observations, the many environmental challenges, the core reason for these is not addressed. The colonial legacy and the continued neo colonialism will continue to hinder the efforts of environmental challenges. While the scientific research helps show the problems, will not contribute to the deeper crisi and problems the continent faces as it turns out to be the ground for scramble for economic power houses in North America, China, and Europe. While this is a purely scientific paper, the introduction that addresses the environmental challenges, poverty (A continent with vast natural resources suffering of poverty), and deficit of knowledge needs to at least mention the political forces that caused the current situation in Africa.
Response: We added the following statement to Introduction:
"Intergovernmental Panel on Climate Change (IPCC) computes a human vulnerability metric from existing challenges such as poverty, access to health care plus expected mortality for climate hazards such as heat, drought, flood, fires and constraints to adaptation like funding, and government infrastructure (Moss et al., 2001). Many regions in Africa exhibit the most extreme values for this metric."
This statement hints at political instability. Further discussion on political forces beyond this is beyond the scope of this paper.

4. Line 73-74 "Atmospheric chemistry modeling is a useful tool to perform research on air quality conditions and evolution".. doesn't make sense. The model can be used to provide air quality forecasts or perhaps understand the chemical processes.
Response: We revised the sentence to "Atmospheric chemistry modeling is a useful tool to provide air quality forecasts and to understand chemical processes."

5. Line 100-103; "MUSICAv0 reproduces the results of WRF-Chem" is not enough justification to introduce a new model. The unique and added values of MUSICAv0 should be clearly stated. Reproducing what other models can do is not enough justification.

Response: Lines 100-103 only explains the reason for including WRF-Chem in this study. We compared MUSICAv0 with WRF-Chem because MUSICAv0 with Africa refinement is newly developed while WRF-Chem has been previously used for African air quality. Reproducing the results of WRF-Chem is only one of the conclusions of this paper. We evaluated MUSICAv0 against in situ observations and compared MUSICAv0 results with satellite retrievals to justify the usage of this new model. The uniqueness and added values of MUSICAv0 is stated in the Introduction and Section 2.1.

6. Line 264: MODIS AOD. Satellite-based aerosol retrievals of aerosol optical depth (AOD) provide exceptional spatial coverage but suffer over bright surfaces and regions with complicated surface terrain. East Africa has a complicated terrain due to mountains and the rift valley. This issue should be addressed when comparing MODIS AOD products and compare with MUSICAv0 model performance.

Response: We used Deep Blue Aerosol retrievals in this study to address the issues with bright surfaces. Deep blue uses maps and libraries of surface reflectance in the blue channels to account for the surface signal as well as spectral reflectance ratios. This method works best over bright land surfaces but can also retrieve aerosols over most vegetated targets. We thank the reviewer for pointing out the issue of complex terrain due to mountains and the rift valley. We have added the following statement in Section 2.11:

"East and Southern Africa have complex terrain due to mountains and rift valleys. This may lead to some uncertainties in MODIS AOD retrievals."

7. Line 274-275:" CO is a good tracer of anthropogenic and biomass burning emissions and modeled CO tracers are used." The tracer method has been widely used to identify certain emission sources. For biomass burning, acetonitrile (de Gouw et al.,2003, G. Wang, et al.,2016 hydrogen cyanide Hornbrook et al.2011), methyl chloride (de Gouw et al., 2004 furans (Coggon et al., 1016), levoglucosan (Bhattarai et al., 2019), The authors should provide justification for using just CO.

Response: CO and the tracers mentioned by the reviewer are all valid tracers. However, CO is a commonly used tracer in models. Acetonitrile, methyl chloride, and levoglucosan are used as tracers in observation-based studies. We added the following statement to Section 3 for explanation.

"CO is a commonly used tracer in models with only one photochemical sink and an intermediate lifetime (e.g., Tang et al., 2019). CO tracers also allow clear identification of simulated anthropogenic and biomass burning contributions. Therefore, tagging CO is computationally efficient and tagged CO is relatively reliable as a tracer in models."

8. Considering the flow of pollutants across the different regions in Africa, across all regions, local emissions from biomass burring and anthropogenic sources impact ambient PM2.5 the most within the source region itself. The impacts of emissions from one region on the annual-average ambient PM2.5 in another region depends strongly on meteorology. For example, the combustion sources in East Africa contribute 20% of the annual-average ambient PM2.5 over Central Africa. (see https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022GH000673

The authors should address the impact of meteorology in distributions of pollutants across the regions.

Response: We agree with the reviewer that meteorology has a significant impact on the distributions of pollutants across the regions. The modeled CO tracers used in this study are subject

to model meteorology and the results have taken into consideration of meteorology and transport. In Figure 4, for a specific region, the contribution of CO tracers from different regions is a result of both emissions and meteorology (transport). We added the following statement to Section 3 to explain that we accounted meteorology:
"Meteorology has a significant impact on the distributions of pollutants across the regions (e.g., Gordon et al., 2023). The CO tracers in the model go through the same model processes (e.g., transport) as CO. Therefore, the source contribution shown by the CO tracers is a result of both emissions and transport."

9. Line 372 "Column peak in September likely driven by fire emissions" – This is incorrect. In the southern, western, and eastern regions of Africa, the trees and grass of the savannah biome become extremely flammable during the dry season, which lasts from May to October in southern Africa and January to April in west and east Africa. September is just the end of the rainy season in East Africa.

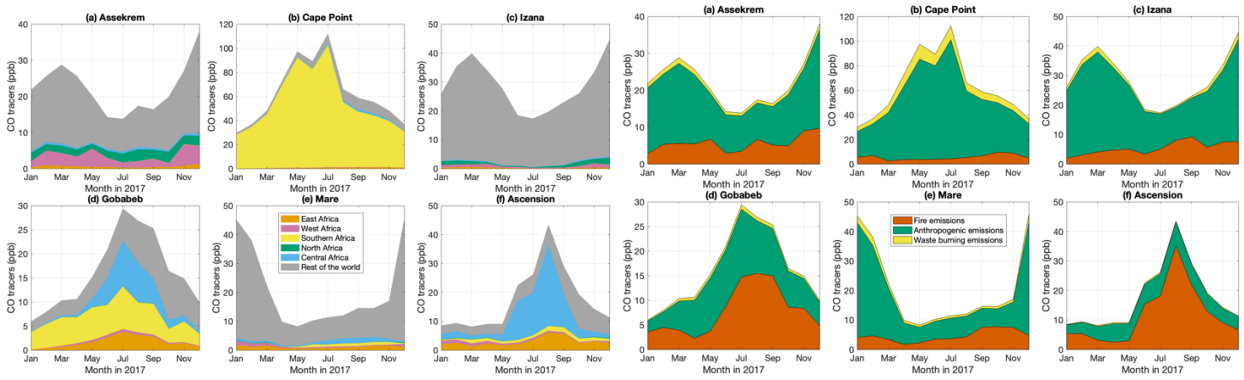
Response: Fire emissions from central Africa peaks in September and can be transported to East Africa. In addition, the definition of East Africa encompasses a large area of the southern hemisphere, which is subject to fires at this time. Figure 2 shows this for CO. To address the reviewer's comment, we modified the statement. See below for the updated statement.
"The biases in CO column and tropospheric NO_2 column peak in September. One possible driver could be fire emissions from other regions (Figure 4), however, further studies will be needed to address this."

10. Line 389: "There are two surface PM2.5 sites in East Africa" In addition to the Embassy Sites, MAIA project has several instruments in Addis Ababa. The authors need to mention the type of the instruments at the sites etc.

Response: The instrument types and other relevant information are described in Section 2.7.
"At the U.S. embassies, regulatory-grade monitoring data are collected with Beta Attenuation Monitors (BAMs), using a federal equivalent monitoring method, with an accuracy within 10% of federal reference methods (Watson et al., 1998; U.S. EPA, 2016). These instruments are operated by the U.S. State Department and the U.S. EPA, and data are available through AirNow (https://www.airnow.gov/international/us-embassies-and-consulates/)."
We only used publicly available measurements for the year 2017. We were not able to find measurements from MAIA project for 2017 while conducting this study. Nevertheless, we changed the statement "There are two surface PM2.5 sites in East Africa" to "We compare the model results with PM2.5 measurements from two surface sites in East Africa" to avoid any confusion.

11. Line 415-416: "Overestimation of CO by MUSICAv0 should be due to overestimation of anthropogenic emissions from Southern Africa" This depends on the period. Southern Africa Fire season goes from April to August.

Response: The conclusion "Overestimation of CO by MUSICAv0 should be due to overestimation of anthropogenic emissions from Southern Africa" is based on source contribution by model CO tracers for Cape Point in Figures S4 and S5 (also shown below). As shown by the CO tracers, the CO concentration at Cape Point is dominant by anthropogenic emissions from Southern Africa. Fire emissions only contribute to less than 10 ppb (Figure S5b) and cannot be the reason for the overestimation of 40 ppb.



12. Line 493-494- "And then three…." Starting a sentience with And is odd

Response: Thank you. We deleted "And".

13. Please consider revising paragraph starting line 508-520

For example, Line 514-515, "Anthropogenic emissions play a more important role in the region compared to East Africa "The paragraph starts addressing East Africa, what is the region mentioned in the sentence above that is being compared with east Africa?

Response: This paragraph focus on the 30°E – 45°E, 5°S – 5°N region, which is a sub-region in East Africa rather than the whole East Africa. This paragraph compares this sub-region with East Africa in general. To avoid any confusion, we changed the first sentence of the paragraph to:

"The 30°E – 45°E, 5°S – 5°N region (a sub-region in East Africa) is potentially a favorable location for future field campaign(s)". We also changed "Anthropogenic emissions play a more important role in the region compared to East Africa in general" to "Anthropogenic emissions play a more important role in the 30°E – 45°E, 5°S – 5°N region compared to East Africa in general".

14. Line 517-518 "Note that the source analysis using model tracers may be subject to uncertainties in the emission inventories". Needs to be clarified which inventories are considered? It should also be pointed out that Most modeling studies have relied on emission factors measured outside the continent of Africa (Lamarque et al. 2010; Klimont, Smith, and Cofala 2013; Pokhrel et al. 2021).

Response: Thank you for pointing this out. We listed the inventories and added discussion on emission factors:

"Note that the source analyses using model tracers may be subject to uncertainties in the emission inventories, in this case CAMSv5.1, QFED, and the waste burning inventory used here. As discussed above (e.g., Section 3.4), there might be missing sources in the region. In addition, emission factors used in many emission inventories are based on measurements outside the continent of Africa (e.g., Lamarque et al. 2010; Klimont et al., 2013; Pokhrel et al. 2021). It is not clear so far if these emission factors are applicable to emissions in Africa (e.g., Keita et al., 2018). Therefore, a field campaign in the region can help address these issues."