

Review of “Quantification of carbon monoxide emissions from African cities using TROPOMI” by G. Leguijt et al. submitted to ACP, 2023

General Description and Recommendation:

The authors quantify urban CO emissions in large cities in Africa by applying the cross-sectional flux (CSF) method to satellite observations of CO from TROPOMI following theoretical assessment of the approach using synthetic columns from the WRF-Chem model. This is a potentially interesting application of this technique, but the paper in its current form is problematic, as there is limited reference to past studies focusing on Africa in the introduction, the methods are difficult to follow making it challenging to review the results, and absent is an assessment of contamination of urban CO from widespread and intense open burning of biomass. My recommendation is to resubmit the manuscript following major revision.

The introduction only really includes information about dominant emission sources from a global study, rather than using information that has been gained from regional emission inventories (DACCIWA, DICE-Africa) and local field campaign measurements of emissions or concentration measurements that provide constraints on emissions.

The methods provide insufficient or unclear information to follow what was done. My concerns are given below by subsections:

Section 2.3: It's not clear how the model is sampled (during the satellite overpass time?) to obtain synthetic columns.

Section 2.4: What is the quantification point that is referred to a few times in this section? A width and length are given, but why not longitude and latitude (L128)? Why use DACCIWA to identify the city centre, when Google Maps could be used? From “-90 to 90 deg” (L129) suggests the box ends up back where it started. Why is the transect (L143) 0.1 degree longer than the initial box width given in line 141? What is “the plume mask” (L144), as it's not defined earlier? Is the “3 pixels” (L145) for each transect? Is the mean of overlapping pixels assessed for the “two consecutive lines” (L147)? Given that the CO pixels in Figure 2(c) are not a plume, should scenes such as this one really be processed and used to estimate urban CO emissions? Where is the city centre located in Figure 2? What purpose does the wind speed colorbar serve in Figure 2? Is “wind speed at each transect” (L152) from GEOS-FP and, if so, what is the spatial resolution? What's the effect of removing (L156) the “first two lines” on the emissions estimates?

Section 2.6: It would be helpful in the first sentence to state the purpose of this Calibration to make clearer why this is done. What “TROPOMI filtering” (L170, L186) is this referring to? It would be helpful to give some context to “injection heights” in L177 by indicating what range is expected for a city plume. What's the relevance of being able to scale modelled emissions up or down (L188-L190)? Where does the “emission sector” information come from (L190)? Why use GEOS-FP instead of WRF winds (L194-L195)?

Missing from the paper is an assessment of contamination of urban CO due to CO (primary and secondary) from open burning of biomass. This is a very large source of air pollution during the dry burning season in large portions of northern and southern Africa. Given this, it would improve confidence in application of the CSF approach for deriving urban CO emissions and evaluating emission inventories if it can be demonstrated that there is limited or no contamination from open burning of biomass.