

This study aims at delineating areas that can generate detectable atmospheric satellite CO₂ plumes. A large fraction of fossil fuel CO₂ emissions is coming from a very small fraction of the land surface, namely the emission clumps. Identifying these clumps is important for comparing fossil fuel CO₂ emissions across different emission inventories and useful for observations of CO₂ plumes from the space. To identify the clumps, the authors developed a random walker algorithm to consider the area in the vicinity of the cores and split the area between different clumps based on the spatial gradients in the emission field. In addition, a state-of-the-art CO₂ emission inventory (ODIAC 2017) at a 30 x 30 arc-seconds is employed to perform this study.

This question is interesting. However, there is a question which is not answered by the authors. As pointed out by the authors, the emission clumps could be a useful tool to “provide a global dataset of fossil fuel CO₂ emission clumps for high-resolution atmospheric inversions that will use XCO₂ imager data”. However, these emission clumps are not fixed over time. The authors should explain how their emission clumps can be used in identifying hotspots in the future global satellite imagery of XCO₂, when the emission clumps are evolving themselves from month to month and from year to year.

In addition, there are some necessary information that are missed in the paper. Please see some comments below. The paper can be accepted for publication after addressing all these comments.

Specific comments:

Line 21: For “cities and power plants”, the relationship between the two concepts is ambiguous.

Line 23: Delete “very”. I do not understand “closely”. Rephrase “there is no detailed emission inventory for most of them”. The English is not clear at some places, may be polished by a native speaker.

Line 27: Define “XCO₂” before it is formally used.

Line 30: This sentence is too long, and should shorten for clarity.

Line 49: For “cities and power plants”, the relationship between the two concepts is ambiguous. They may overlap.

Line 51: This sentence is too long, and should shorten for clarity.

Line 82: “a high resolution global map of fossil fuel CO₂”, it seems that the authors realized the importance of a high spatial resolution. However, what about the high temporal resolution? Does this affect the identification of emission clumps.

Line 131: Provide evidence that the emission spatial distributions do not change significantly from year to year.

Line 139-163: These two paragraphs are given under a section namely “ODIAC fossil fuel CO₂ emission map”. However, the authors are not introducing the ODIAC product here, and it confuses me a lot when I was reading these paragraphs. I cannot understand the relationship between the ODIAC product and LEO, OCO-2, GOSAT and GeoCARB imagers.

Figure 1: I do not quite understand this graph. How do the authors divide the total cumulative share of global annual emissions into power plants and area sources?

Line 176-216: The presentation of the method used to identify the emission clumps is not clear. I tried to follow the steps in these paragraphs, but I was stopped by “Firstly” (line 177), “Secondly” (line 184), “1)” (line 191), “2)” (line 196), “3)” (line 204), “4)” (line 211). The structure is unclear. Since the core of this paper is to present a new method, the authors need to convince us that this method could be easily performed and possibly repeated by other researchers.

Line 176-216: Meanwhile, the authors should publish the original code that is used to produce the emission clumps.

Line 196: What is the relationship between the emission clumps identified by step “1)”, “2)” and “3)”? Saying that they are independent, I would re-name them as Category A, B, C, ... or those names used in Figure 6.

Line 204: What is the difference between “cities” and “towns”?

Line 266: “The clump with largest emission is Shanghai” Is it total emission or emission density?

Line 272-274: I cannot understand these sentences. Shorten for clarity.

Line 280: There are other data sets for power plants in China better than the CARMA data set, e.g. the MEIC inventory, which has been noticed by the authors.

Figure 5: I do not understand why most emission clumps look like circles or dots in the four zoomed region. Is it a visual illusion?

Section 4: there are too many materials dropped in this part, among which the relationship is not very clear. If these discussions are independent, they can be organized in different parts under different headlines.

Line 466: “a set of large emission clumps” for a large area or a large emission?

Line 467: “This identification method identify” -> “This method identifies”.

Line 476: “Given actual atmospheric transport,” -> “Given actual atmospheric transport condition,”.