

Review of:

Transcontinental transport of a massive SO₂ plume from the Tehran refinery explosion in March 2026 observed from space

Liu et al., 2026

General Comments:

This paper examines the transport of a sizable SO₂ plume injected into the free troposphere following airstrikes on oil industry infrastructure in Tehran, Iran. This plume was captured by various satellite retrievals, demonstrating their value in monitoring atmospheric impacts from regional conflicts. Overall, I found the paper well-written and an interesting and timely contribution to the literature. Furthermore, it fits well within the scope of ACP. *I would recommend the paper for publication after minor revisions.* I have a few detailed comments on the paper below.

Specific Comments:

Figure 1e: I was a bit confused at first, and I think it is worth stating explicitly the geographic region that is used to compute the masses in the caption as well as in the main text. My understanding is that it is the red boxes in S1 and S2.

Line 117-118: It might be worth stating that 4 days is a reasonable lifetime for SO₂ in the free troposphere, thus helping emphasize that it is really the transport from the BL to the free troposphere that is driving the extended lifetime.

Line 122-131: What is the main takeaway from the HYSPLIT results? What is the implication of the good agreement between the satellite and the HYSPLIT simulations? Including a sentence or two on this would strengthen this part of the paper, I think.

Section 2.2: I am not familiar with CAMS, so please excuse any ignorance on my part. However, I found some of the discussion around it confusing. For instance, in Line 44 you state that CAMS relies “heavily on static emission inventories for anthropogenic sources and restrict their SO₂ data assimilation primarily to strong volcanic plumes.” What does “static” mean in this case? How is the static emission inventory able to capture one anthropogenic plume (the one occurring at the Iraq-Turkey border) but not the one originating over Tehran? I think including a

bit more context about how CAMS works and why it saw one fairly large anthropogenic plume but missed another could be helpful.

Line 172-175: This is the first time the stratosphere is mentioned in the paper, and the point you make here is certainly important. Given the importance of SO₂ in the stratosphere and the attention that it has received in recent years, for clarity I think it's worth explicitly stating that this didn't happen with the explosions in Tehran.

Section 3: To me one of the most important points of the paper is the fact that current modelling products like CAMS are not able to capture these conflict-induced plumes. I would reiterate this point in the conclusions.

Figure 2: If possible, I would use a vector graphic for figure 2 to make it easier to read (and do the same for the similar figures in the Supplement).

Figure S5, S11: Include country borders on all plots for easier side-by-side comparison of the plume location.

Technical Corrections:

Line 36: "...which is less focused in previous studies" reads awkwardly.

Line 112-113: typo in "which is equivalent to only a few one-tenth of the SO₂ released by a typical small-to-moderate volcanic eruption"

Line 116: I think "Noted" might be a typo

Line 126: "(Fig 1e)": I am not sure this is the correct figure