Manuscript submission : egusphere-2025-4962

Response to Reviewers

Reviewer 2

We wish to thank Reviewer 2 for much appreciated comments and suggestions to our manuscript. We have revised the manuscript according to the Reviewer's suggest, considering the main comment on EF>1.

Minor manuscript edits:

Line 63 of the revised manuscript : « quantity » was changed to « quantities »

Figure 2 caption (line 230 of the revised manuscript) : « d » was replaced by « e »

Line 300 onward in the revised manuscript: Reviewer suggests significant inputs from anthropogenic emission for elements which EF are exceeding 5. While we agree that the influence of anthropogenic emission in these samples cannot be ruled out, the significance of such inputs remain to be proven. However, we reject the idea of a substantial anthropogenic influence due to the following facts : 1) there is an extremely high variability in TM composition across the world's upper crust materials ; 2) we do not have sufficient knowledge on source's chemical fingerprint to disentangle fractionation due to soil erosion, entrainment and transport that can be attributed to mining activity rather than natural dust emission and ; 3) anthropogenic inputs are usually associated with a noticeable/clear increase in human activity-associated elements (e.g., V, Pb) that usually result in **significant** increase in EF (>10 or more). In the absence of further proof of significant anthropogenic enrichment in our samples (carbon or ion analysis or conclusive air-mass analysis), we prefer to remain cautious with our interpretation of source apportionment while still mentioning the possibility for insignificant anthropogenic inputs in our samples. It should be mentioned that, regardless of the EF threshold applied, the conclusions of this manuscript will remain unchanged. For these reasons, we modified the manuscript accordingly:

l. 184-189 "A threshold value of 10 was chosen, above which metal content in aerosols is deemed "enriched" by anthropogenic inputs (Shelley et al., 2015). Such threshold must be sufficiently high to account for natural variability across dust sources worldwide and natural fractionation processes occurring during the production, emission and transport of aerosols (Hird et al., 2024; Reimann and de Caritat, 2005). A minor and insignificant contribution of anthropogenic emissions can never be completely ruled out as it can be one of many factors resulting in the increase in one element's EF over the expected crustal value of 1."

and

l. 300-316 “Contrasting enrichment was obtained for Cr (median: 138), with EF values lower than 10 calculated for high total trace element mass loading samples (A1, A6, A8, and A9) and severe enrichment ranging 138 - 672 found in low trace element total mass loading samples (A4, A5, and A10) as well as in A3 (Figure 4). This indicates that, while natural sources dominate the Cr content in high total trace element loading samples, with no or small anthropogenic inputs suggested, human-derived Cr emissions are likely to predominate the Cr content in low total trace element loading samples.

Amongst minor elements, V, Ni and Pb showed EFs lower than 10, with median values of 0.4, 5.2 and 7.2, respectively (Figure 4). This indicated a prevailing crustal origin for the three metals in most aerosol samples (Reimann and de Caritat, 2005). While minor contribution from anthropogenic sources cannot be completely ruled out in the case of Ni and Pb, we consider this input insignificant with respect to the crustal contribution. Sample A4 represents one exception for which Ni enrichment exceed the threshold of 10 (EF_{Ni}=14), highlighting non-negligible inputs from anthropogenic sources in this sample. »

Line 487 of the revised manuscript : the word « first » was removed from the sentence

Reviewer 3

We are very grateful to Reviewer 3 for insightful and extensive comments and suggestions on our manuscript. We have addressed most Reviewer’s comments in the reviewed manuscript. Our response to Reviewer 2 comment on lines 297 – 299 applies to Reviewer’s 3 comment on the same point. We tried our best to modify the manuscript according to both Reviewer’s suggestions while refraining from suggesting a **significant** anthropogenic input. Indeed, we believe that further evidence would be necessary to prevent any source mis-ascription (see our responses above to Reviewer 2).

Minor manuscript edits:

Title : the spelling of « southern Mozambique Channel » was made uniform throughout the text.

Line 50 of the revised manuscript : The role of ephemeral rivers was acknowledged as a dust source from Namibia and Botswana (l 47):

“Earth system models and satellite observations consistently identify the Namib Desert, the Etosha basin in Namibia, the Kalahari Desert in Botswana as well as local ephemeral rivers (Bhattachan et al., 2015) as major dust sources in Southern Africa. »

Line 57 of the revised manuscript : The Belelie et al. (2025) publication refers to dust inputs from southern Africa into the Benguela Upwelling System. The addition of dust (and presumably iron) to a macronutrient-rich upwelling system is likely to elicit responses that differ significantly from those observed in an oligotrophic region, such as the Mozambique Channel. For this reason, the study was not cited.

Lines 333-341 of the revised manuscript : Few sentences on the differences between models were added to the revised manuscript while kept limited due to limited data available in some of the cited literature (and references therein). We have also added a sentence on the use of modern satellite observations in order to refine dust source identification as small scale dust sources (which may seasonally prevail in our study region) are poorly capture (if at all) by large scale models and satellites (l.319):

“While we observe a large variability in our F_{Dust} estimates, the consistency between our values and the mean annual dust deposition fluxes reported by ESM in the 20° S-30° S region of the southern Mozambique Channel could imply either 1) a limited year-to-year variability in dust deposition over the southern Mozambique Channel or 2) a poor constraint on F_{Dust} estimates by ESM due to a paucity of data. These global models vary in spatial and temporal resolution and use different satellite and ground-based observations to validate their outputs which result in a large range of dust deposition fluxes reported by different modelling studies (references in Table 2). For example, Wagener *et al.* (2008) used a global model output forced to fit the data obtained from two oceanographic campaigns, including around the Kerguelen Island plateau. Using limited observational data to constrain the models appears to result in an underestimation of atmospheric dust deposition near terrestrial emission sources. Additional field observations such those provided in our study and the use of new high-resolution satellite observation would help refining model outputs in this drastically under sampled study region where small-scale emission sources may prevail. “

Lines 352-356 of the revised manuscript : units were made consistent with journal requirements, thank you for pointing out this typo.

Lines 368 and 384 onwards in the revised manuscript: The suggested reference was added to the revised manuscript, reinforcing that observations we made were consistent with published literature:

l. 368-370 “Our results corroborate findings by Freiman and Piketh (2002) that 27% of the southern Africa atmospheric circulation reaches the Indian Ocean during the austral autumn, yet this air-mass is transported to the south of our study region (Freiman and Piketh, 2003).”

and

l. 384-386 “This finding reinforced our AMBT analysis showing a predominant influence from long-range atmospheric transport of westerly winds from across the Southern Ocean (Figure 2). However, sporadic inputs of lithogenic Al, Fe, Ni, Pb, Ti and V (EF<10, Figure 4) and anthropogenic Cu ($\mathrm{EF}_{\mathrm{Cu}}$=72, Figure 4) emissions from Madagascar and southern Africa cannot be ruled out given the proximity of both landmasses and the extensive and increasing anthropogenic activity they hold (including copper mining and smelting activity in South Africa and Zambia, Makgetla et al., 2019; Nex and Kinnaird, 2019; Sikamo, 2016). Indeed, the more detailed analysis of air-mass back trajectory transport shows, for all 3 sample groups, instances (at least one air-mass) of air-mass crossing the southern African continent then travelling over the ocean before reaching our sampling position. Such a diluted atmospheric signal observed in our study is consistent with the southern Africa atmospheric recirculation pathway previously highlighted by Freiman and Piketh (2002). »