

1 Responses to Editor and Reviewer Comments for “**What caused record-breaking aerosol**
2 **loading over the South China Sea in April 2023**” by Saginela Ravindra Babu and Neng-Huei
3 Lin.

4 Dear Editor,
5 Jason Cohen,

6 We are submitting the revised version of our manuscript entitled “**What caused record-breaking**
7 **aerosol loading over the South China Sea in April 2023**”. We sincerely thank the Editor for the
8 careful handling of our manuscript and for providing constructive suggestions that helped improve
9 the quality and clarity of the study. We also thank Reviewers 2 and 3 for their positive evaluation
10 and acceptance of the manuscript. In addition, we are grateful to Reviewer 1 for the additional
11 comments and suggestions, which significantly helped us improve the manuscript. We have
12 carefully considered all comments and suggestions provided by the Editor and Reviewer 1, and
13 the manuscript has been revised accordingly. The major revisions include the following:

- 14 ● As suggested by the Editor and Reviewer 1, we revised the language throughout the
15 manuscript to avoid over-claiming uniqueness or causality.
- 16 ● The Abstract, Summary, and Conclusions sections were substantially rewritten to ensure a
17 more balanced and cautious scientific interpretation, following the recommendations of the
18 Editor and Reviewer 1.
- 19 ● Most figures were redrawn using updated world map backgrounds to improve clarity and
20 presentation quality in the revised manuscript.

21 With these revisions, we believe that the manuscript has been substantially improved and is well
22 suited for publication in **Atmospheric Chemistry and Physics**. We have provided detailed, point-
23 by-point responses to all comments and suggestions from the Editor and Reviewer 1. Reviewer
24 and Editor comments are shown in black font, followed by our responses in blue font.

25 Kind regards,

26 **Saginela Ravindra Babu** (on behalf of the co-authors)

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Response to Editor

The revised manuscript has been evaluated by three reviewers. Two reviewers recommend publication, while the third continues to raise some concerns. After careful consideration, I have concluded that the manuscript is scientifically sound, and makes a sufficient contribution for publication in ACP. However, this is subject to the following mandatory revisions:

1. Scientific framing and Tone

Please revise the language throughout to avoid over-claiming uniqueness or causality. Specifically:

- Replace "confirming" with "strongly suggesting" or "consistent with" in the transport attribution section.
- Replace "primary mechanism" with "important mechanism" (or similar).
- Add a sentence acknowledging that southward transport of PSEA smoke has been documented in other high-biomass-burning years (e.g., 2016), and that 2023's distinctiveness lies in the magnitude of the anomalies and the specific circulation pattern, not solely in the southward transport.

Reply: We thank the Editor for the thorough review of our revised manuscript and for providing valuable guidance. We have made adjustments to soften the scientific framing and prevent overstatement. In the transport attribution discussion, we replaced words like “confirming” with more cautious phrases such as “strongly suggesting” or “consistent with.” We've also changed “primary mechanism” to “important mechanism” (or similar wording) throughout the manuscript where appropriate. Additionally, we added a statement recognizing that southward transport of PSEA smoke has been observed during other severe biomass-burning years, such as 2016. We clarified that the uniqueness of the 2023 event mainly lies in the extraordinary magnitude of the anomalies and the circulation pattern, not in southward transport alone. These revisions enhance the balance and accuracy of the overall presentation.

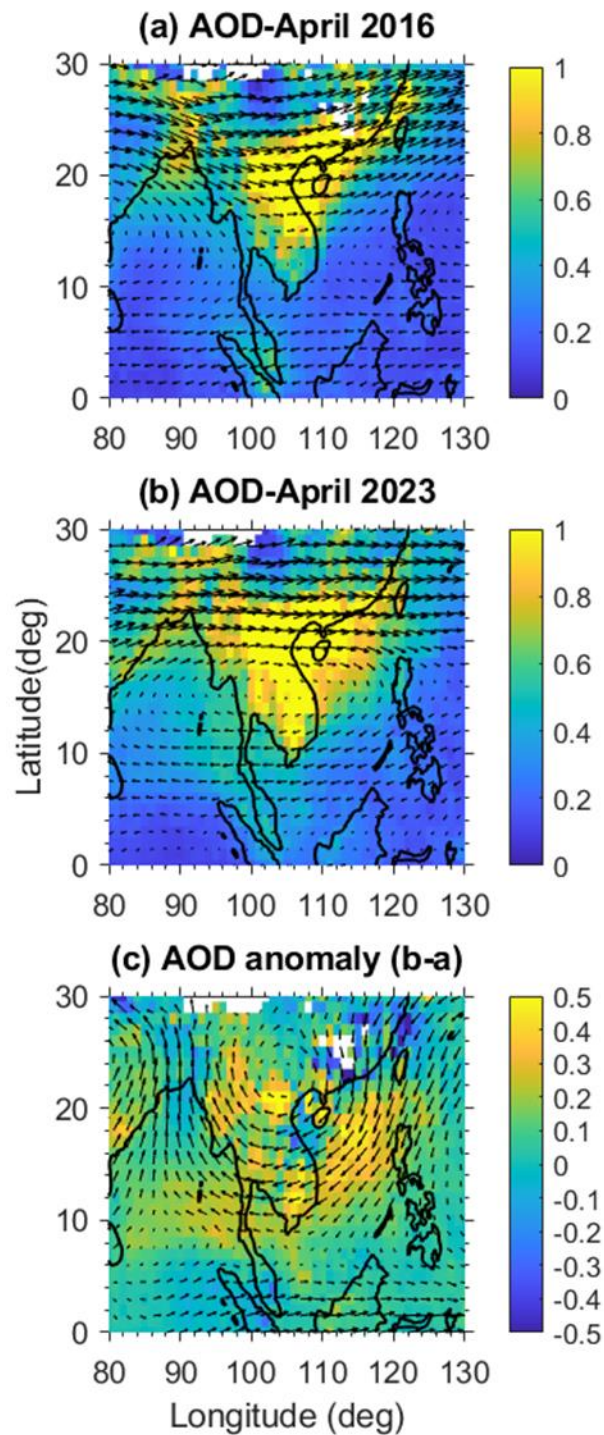
We have modified the text as follows in the revised manuscript. Please refer to Lines 339-341:

“When overlaid on the monthly mean MODIS AOD (Fig. 8b), these trajectories reveal transport pathways that coincide with regions of high aerosol loading, strongly suggesting that long-range transport of PSEA BB smoke likely transported to the SCS”.

Regarding 2016, please refer to Lines 492-497:

“An additional comparison between April 2016 and April 2023 (Fig. S15 in the supplement) showed similar spatial patterns, including enhanced AOD over southern PSEA. However, the magnitude and spatial extent of the AOD enhancement were greater in 2023. The AOD anomaly between 2023 and 2016 further revealed pronounced increases over the SCS and southern BoB, coinciding with enhanced northerly anomalies.”

We have also included the following figure in the supplement.



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70 **Figure S15.** Spatial distribution of MODIS aerosol optical depth (AOD), MERRA-2 500-hPa wind
 71 vectors in (a) April 2016, (b) April 2023, and (c) AOD anomalies between April 2023 and April
 72 2016.

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74 2. Map boundary correction

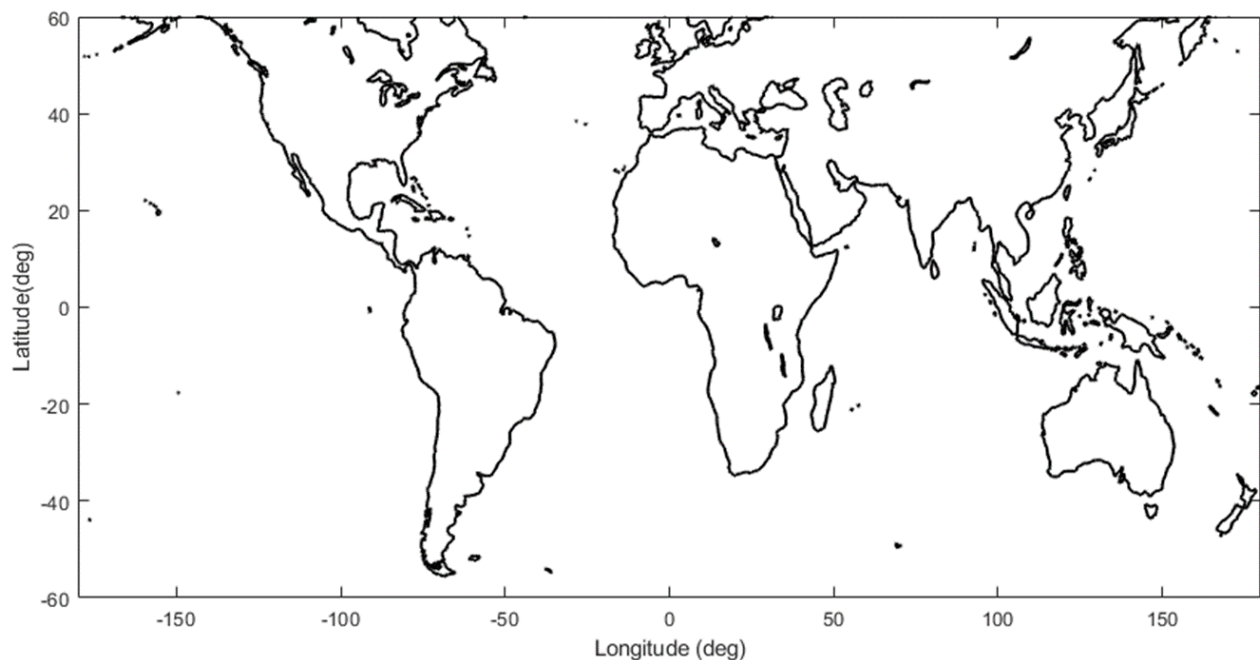
75 All figures showing political boundaries must be revised to comply with international cartographic
76 neutrality. Please choose one of the following options:

77 (a) Crop all maps to the domain 80oE-140oE, 0oN-40oN, which removes the disputed India-
78 Pakistan-Nepal-China border region from prominent display; or

79 (b) Replace solid boundaries in disputed areas with dashed lines and include a standard disclaimer
80 in the caption; or

81 (c) Use a UN Map.

82 **Reply:** We appreciate the Editor's valuable suggestion on cartographic neutrality. In the revised
83 manuscript, we replaced the original world map with an updated version based on a neutral
84 cartographic base map, following standard international mapping conventions. This revision
85 ensures a consistent, non-interpretive representation of administrative boundaries (see the
86 following Figure). All figures have been updated accordingly.



87
88 Please submit the revised figures (containing the maps), and the modified manuscript (with and
89 without tracked changes) when you are ready.

90 **We once again thank the Editor for going through the manuscript carefully and providing**
91 **constructive comments/suggestions which made us improve the manuscript content**
92 **significantly.**

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Response to Reviewer 1

98 The revised manuscript has improved compared with the original submission. The authors have
99 made visible efforts to reorganize the paper, separate data categories more clearly, and add several
100 new analyses, including HYSPLIT back trajectories, CALIPSO aerosol subtype images, MERRA-
101 2 vertical BC/OC profiles, and comparisons with high biomass-burning years. These additions
102 make the revised version more complete and better structured than before.

103 However, in my opinion, the major concerns raised in the first round are still only partially
104 addressed. The manuscript is now stronger as an observational event study, but it remains largely
105 descriptive, and the mechanistic attribution is still not fully rigorous enough for the strength of the
106 current conclusions. In particular, although the revised version better highlights the unusually
107 southward transport in April 2023, it still does not sufficiently demonstrate why 2023 was
108 fundamentally different from other high biomass-burning years. Further substantial revision is
109 therefore still needed.

110 Major Comments

111 1) The novelty is improved, but the event significance should be framed more cautiously.

112 The revised manuscript now better highlights the unusually southward transport in April 2023,
113 which is a meaningful improvement over the original version. However, I suggest that the authors
114 avoid overemphasizing the uniqueness of this event unless stronger comparative evidence is
115 provided. For this type of event study, it would be sufficient to clarify why this case is noteworthy
116 compared with previously documented PSEA-to-SCS transport events, rather than trying to
117 establish a fully exceptional status in all respects.

118 *Reply: We appreciate the reviewer's constructive feedback and acknowledgment of the improved*
119 *presentation of the event's significance. We concur that the importance should be communicated*
120 *carefully. Our goal is not to claim that the April 2023 event is entirely unique, but to highlight that*
121 *it is a rare and significant example among documented PSEA-to-SCS transport events.*
122 *Specifically, long-term MODIS AOD data (2003–2023) indicate that April 2023 had the highest*
123 *aerosol loading over the South China Sea (SCS), with anomalies roughly four times the average.*
124 *Additionally, this event involves unusually strong southward transport extending into the southern*
125 *SCS and toward the southern Bay of Bengal, unlike typical transport which is usually confined*
126 *north of about 17.5°N. While biomass-burning outflows are common, the combination of high*
127 *intensity and unusual spatial extent makes this case distinct from previous research. We have*
128 *revised the manuscript to avoid overstating and to accurately present this event as a rare*
129 *combination of magnitude and transport pattern, validated by long-term data. We hope this*
130 *revision addresses the reviewer's concerns and provides a balanced perspective on the event's*
131 *significance.*

132 2) The source attribution is better supported than before, but the conclusions are still somewhat
133 stronger than the evidence.

134 The newly added CALIPSO, MERRA-2, and HYSPLIT analyses do improve the plausibility of
135 the proposed source–transport link, especially for the elevated smoke layer in the mid-troposphere
136 and the likely contribution from northern PSEA. These analyses still provide supporting evidence
137 rather than definitive attribution. Therefore, some statements in the manuscript should be
138 moderated. For example, expressions such as “confirming” the transport pathway or identifying a
139 “primary mechanism” or “primary source” may be too strong given the current level of analysis. I
140 suggest replacing such wording with more cautious expressions such as “strongly suggests,” “is
141 consistent with,” or “provides supporting evidence for.”

142 Reply: We thank the reviewer for this constructive comment and for acknowledging the added
143 value of the CALIPSO, MERRA-2, and HYSPLIT analyses in supporting the source–transport
144 interpretation. We agree that, although these multiple lines of evidence are mutually consistent and
145 provide strong support for the proposed transport pathway and source region, they do not constitute
146 definitive attribution. We therefore acknowledge that some wording in the original manuscript was
147 stronger than warranted by the level of evidence. In the revised manuscript, we have systematically
148 moderated such statements. Specifically, terms implying certainty or exclusivity (e.g.,
149 “confirming,” “primary mechanism,” and “primary source”) have been replaced with more
150 appropriate and cautious formulations such as “is consistent with,” “strongly suggests,” and
151 “provides supporting evidence for.” This revision applies throughout the relevant sections to
152 ensure consistency.

153 3) The manuscript structure is clearer, but the paper still relies too heavily on descriptive diagnosis.

154 The revised structure is much improved, and the Results section now follows a clearer sequence
155 from event confirmation to source attribution and then to circulation anomalies. This addresses
156 one of the major structural concerns from the first round. Still, the overall framework remains
157 based mainly on climatological anomalies, sigma-threshold exceedances, correlations, trajectories,
158 and reanalysis diagnostics. These approaches are acceptable for an event-oriented study, but they
159 support a descriptive/diagnostic interpretation more than a fully mechanistic one. If the authors
160 wish to retain the current strength of their conclusions, they should further strengthen the evidence;
161 otherwise, the conclusions should be toned down accordingly.

162 Reply: We appreciate the reviewer’s constructive comment and their recognition of the
163 manuscript’s improved organization. In response to their suggestion, we have softened the
164 conclusions to better align with the diagnostic nature of the analysis and to prevent overstating
165 mechanistic interpretations. The updated conclusions now highlight observationally supported
166 event features and the consistent source transport, while steering clear of overly definitive causal
167 or mechanistic statements. We believe this revision enhances the balance between the evidence
168 provided and the conclusions drawn.

169 4) the main text should better carry the key argument.

170 Some important supporting evidence still remains in the Supplement, such as the AOD–CO
171 relationship, BC/OC vertical changes, and high-BB-year comparisons. I suggest that the authors
172 move at least one of the most important supporting figures into the main text, or discuss these
173 supplementary results more explicitly in the main narrative. Otherwise, some central claims still
174 depend too heavily on the Supplement.

175 Reply: We thank the reviewer for this helpful suggestion. We agree that several key supporting
176 analyses are important to strengthening the study's main arguments. In response, we have revised
177 the manuscript to better integrate the supplementary results into the main text. In particular, we
178 have moved the most relevant supporting evidence (AOD–CO relationship and the high-BB-year
179 comparison) into the main manuscript, and/or explicitly discussed them in the results section where
180 appropriate.

181 5) The discussion of broader significance is still weak.

182 The manuscript states that the event has implications for regional air quality and climate, but this
183 point is not really developed. A full impact assessment is not necessary, but the Discussion should
184 include a more concrete explanation of why this unusually southward transport matters
185 scientifically or regionally, especially compared with the more typical springtime transport
186 pathway.

187 Reply: We appreciate the reviewer's valuable suggestion. In response, we've expanded the
188 discussion to better explain the regional importance of the unusually southward transport
189 compared to the typical springtime PSEA pathway. Specifically, this event increases aerosol
190 loading over the southern South China Sea and parts of the Bay of Bengal, areas usually less
191 affected by intense biomass-burning outflows in April. This atypical aerosol transport could impact
192 regional radiative effects, cloud–aerosol interactions, and atmospheric composition. While a
193 comprehensive quantitative assessment of downstream effects is beyond this study's scope, we've
194 revised the manuscript to highlight these qualitative implications and underline the novelty of this
195 transport pathway.

196 6) The manuscript still needs careful polishing.

197 Although the clean version is much better than the preview version, there are still obvious language
198 and formatting issues, such as “2..1.2,” and “long-term mea.”

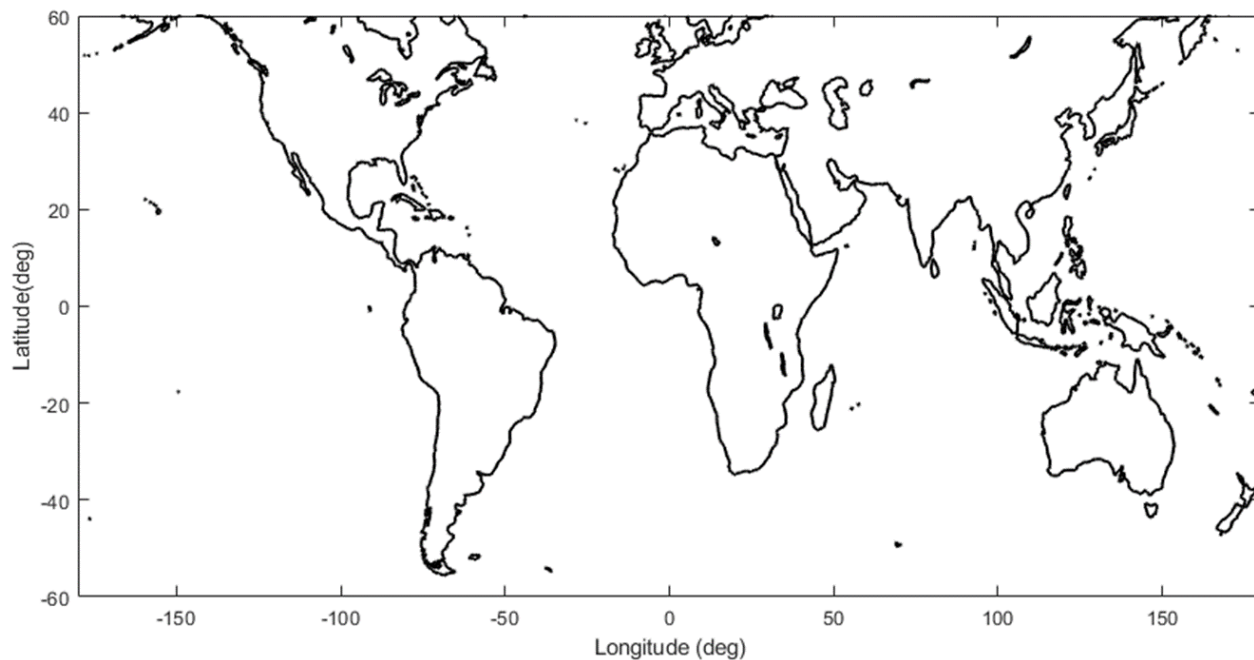
199 Also, the response states that the ozone analysis was removed, but the manuscript still mentions
200 ozone was utilized. This should be cleaned up for consistency.

201 Reply: Corrected in the revised manuscript.

202 7) Map presentation should still be checked carefully.

203 The treatment of boundaries in the current figures does not appear to have been substantially
204 revised. All maps should be checked carefully to ensure appropriate cartographic neutrality for an
205 international journal.

206 Reply: We thank the reviewer for this careful observation and suggestion. In the revised
207 manuscript, we replaced the original world map with an updated version based on a neutral
208 cartographic base map, following standard international mapping conventions. This revision
209 ensures a consistent, non-interpretive representation of administrative boundaries (see the
210 following Figure). All figures have been updated accordingly.



211
212 **We once again thank the Reviewer 1 for going through the manuscript carefully and**
213 **providing constructive comments/suggestions which made us improve the manuscript**
214 **content significantly.**

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