

Comments on WCD-2021-12-R1

Summary

Thanks to the authors for their efforts in revising the original manuscript. The revised version has been largely improved and the authors' responses have cleared most of my concerns. Particularly, the authors provided a more thorough literature review on frontal detection methods and expanded their analysis for a more comprehensive survey of insights revealed from the frontal detection algorithm proposed in this work. My comments in this round are mainly clarifications, focusing on making sure the message is clear and direct to the readers. I recommend the paper for publication in the journal after the authors address these comments.

1. I think the authors should highlight the most novel element in the title of their manuscript. In my view, the most novel thing in this work is that they proposed a frontal detection algorithm and validated its fidelity in capturing the climatology and interannual variability of the EASM. So, I suggest changing the title to something like "Understanding the seasonal evolution and interannual variability of the East Asian summer monsoon through a novel frontal detection algorithm"
2. Line 6. Please clarify here you meant "interannual variability"
3. Line 9. I think you should highlight that Mei-Yu is the primary stage of the EASM.
4. Line 10. This sentence should be revised and clarified. What does "These forcings" mean? The authors seem to argue that the low-level southerly flow is modulated by the seasonal evolution of the South Asian Monsoon system, not in part due to WNPSH? In my view, both the South Asian origin and those along the edge of the WNPSH contribute to the southerly flow.
5. Line 13. Clarify "the midlatitude flow impacting on the northern side", in the spirit of being concise and clear, suggest changing to "extratropical northerly flow"
6. Line 17. Clarify "the regional flow"; suggest being specific and clear which regional circulation systems drive the airmasses converging at the front; also, is it true that only "the low-level airstreams" matter? The authors also showed in the paper that the northerly flow from higher levels is needed for the formation of the Mei Yu front.
7. Line 38. Provide the full name of EASMF as it is the first time it appears in the main text.
8. Line 42-44. This statement is oversimplified and might be misleading. The whole sentence is a paraphrase of the texts below Figure 4 from Wang and LinHo (2002). And if I understand correctly, Wang and LinHo (2002) is not about how the whole Asian monsoon (including the Indian Summer monsoon, East Asian summer monsoon, and the WNP summer monsoon) affects the EASM, rather, they discuss how the Asian monsoon system as a whole progress across the season. So, I don't think it is reasonable using this single

paper as a reference for arguing tropical influence on EASM. The authors mentioned other tropical influences before closing that paragraph; it is more appropriate to include those factors (ENSO, tropical convection) into the opening sentence of the paragraph. And you can elaborate how the EASM is related to other components in the Asian monsoon system after that.

9. Line 45-46. Suggest removing the redundant information and rephrase to "..., the poleward transport of moisture over the South China Sea is associated with the Western North Pacific subtropical high (WNPSH)."
10. Line 53. Provide full name of "ENSO"
11. Line 56-57. I don't disagree with the authors that diabatic heating over the orography can affect the meridional position of the STWJ, but the current description is too vague. Please provide references (if there is any) that have discussed effect of the springtime diabatic heating on the northward migration of the STWJ. Also, the seasonal cycle of insolation and the resulted changes in the meridional temperature gradient should be more instrumental in driving the northward progression of the jet from spring to summer.
12. Line 57. I think the authors meant the diabatic heating over the TP, but please be more specific and clarify what are "These processes" as the preceding sentences have covered both STWJ and the diabatic heating.
13. Line 85-86. Can the authors clarify the blocking anticyclones over which regions are of particular importance in causing the dry air intrusion that may affect EASM?
14. Line 87-89. The original papers of the Silk Road Pattern should be cited (see references in Hong et al). Suggest adding one sentence to briefly introduce what is the Silk Road Pattern, otherwise readers who are not familiar with this pattern might have a hard time appreciate the summarized studies of Hong et al.
15. Line 90-92. Did the author mention the interaction between the tropical dynamics and the TP in the introduction section?
16. Line 105-106. Suggest rephrasing to "...we focus on the role of ... masses in the EASM progression"
17. Line 106 and in other related lines. Is it possible to replace "a Parker et al. (2016)-like framework" with a more physical description? The author cited Parker et al. (2016) as one motivation for understanding the dynamics of the EASM from the perspective of the interaction of tropical and extratropical air masses. But this study used very different approach or methods throughout, so I don't suggest the authors to use "Parker et al. 2016-like framework or Parker et al. 2016-like approach" to describe this motivation.

18. Section 2.2.1. Since the main purpose of this section is to introduce the previously proposed algorithms and justify the choice of using the horizontal gradient of θ_e in the EASMF detection, I think it would make more sense to first introduce the methods based on the baroclinicity/SOM/rainband summarized in Line 160-170, then introduce the thermodynamic definitions as mentioned in Line 140-159, and then continue in Line 171-187 to justify the parameter used in this work. Other minor comments in this section include
- a. Suggest using a title such as something like “Existing front detection algorithms in the literature”
 - b. Line 135. Suggest rephrasing to “... have been proposed in the literature to identify ...”
 - c. Line 147-150. To make it more concise, suggest replacing “While this... Being dependent on moisture content,” with “As a result,” because the description of Line 152-155 have covered similar information; also suggest replacing “this front” in Line 149 with “the EASMF”
 - d. Besides providing the list of references in Line 160-165, can the author add more information for each study (or each group of studies), no need to be long, simply describing XXX used XXX methods to study fronts or airmass boundaries over which region or to study which problem (something like this) would be helpful.
 - e. Line 165-166. I did not get the point here. Can the authors reword?
 - f. Line 168. Suggest deleting “subtropical, or even” because the focus in this study is on the interaction between the tropical and extratropical airmasses.
 - g. Line 170. I think the authors also discussed higher level circulations including the STWJ and the extratropical northerly flow.
19. Line 198. Did you use a uniform 850 hPa as the threshold? Not sure whether this is a reasonable estimation because the terrain in East Asia is not that uniform, though I agree that the terrains in East China are not that high.
20. Line 203. How sensitive are the results obtained from this algorithm to the selected threshold? If this has already been discussed in previous literature, suggest the authors add that information here as well.
21. Line 214. I am curious about how these captured “other large-scale fronts” look like. I am asking because though these fronts might not look like a typical EASMF that we expect from the climatological rainband progression, but this reasoning might not be convincing enough to exclude their role in contributing to the EASM rainfall. Can the authors comment on this?
22. Another question related to the algorithm. Figure 1c shows frontal line over land along the northern front, while the southern land-based front is not considered as front though it appears to be part of the large-scale zonally coherent fronts extending from the land to the ocean. What is the reasoning for this?

23. The current shading scale in Figure 1 makes it a bit difficult to see the black contours of θ_e . I wonder whether regions where the θ_e gradient is lower than 0.03 can be blanked out.
24. Equations (3) and (4): suggest replacing “1000 hPa” with “surface”
25. Please provide references for ERA-Interim, GPCP, and APHRODITE when these datasets are mentioned.
26. For the frontal deformation analysis (Figure 6 and Lines 370-380), can the authors show the F1 and F2 separately as well, and discuss how they tell us about the front and the role of tropical and extratropical air masses?
27. Line 433. Please clarify what it means by saying these southerlies are “monsoonal”
28. Figure 10 caption, clarify it is zonal wind speed shown in the green contour

References

- Parker, D.J., Willetts, P., Birch, C., Turner, A.G., Marsham, J.H., Taylor, C.M., Kolusu, S., and Martin, G.M. (2016). The interaction of moist convection and mid-level dry air in the advance of the onset of the Indian monsoon. *Quarterly Journal of the Royal Meteorological Society* *142*, 2256–2272.
- Wang, B. and LinHo (2002). Rainy Season of the Asian–Pacific Summer Monsoon*. *J. Climate* *15*, 386–398.