

# ***Interactive comment on “Understanding the development of systematic errors in the Asian Summer Monsoon” by Gill M. Martin et al.***

## **Anonymous Referee #2**

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This article develops a systematic method to detect biases in model simulations to improve the representation of various features of the Asian summer monsoon system in climate models. The study used multiple configurations of the Met Office Unified Model which encompass global climate simulations (fully coupled and atmosphere only), regional climate simulations, and regional nudging simulations. The authors focused on ocean-centric regions such as the Indian Ocean, Maritime Continent, and the Philippines to demonstrate the growth of regional erroneous atmospheric-ocean circulation over time that can impact the Asian summer monsoon system.

## General Comments

By providing a multilayered framework when simulating the Asian monsoon system the authors identified key ocean regions that produce systematic errors and that if cor-

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rected will improve how climate and weather models simulate the system. That alone is crucial for the field and although this framework is overall beneficial, the presentation of the text and results could be further improved.

### Specific Comments

The title and abstract could use some refocusing no need to mention Asian monsoon if your main goal is only the EASM. Otherwise, the authors should add some minor additional work to fully represent the title.

The authors should restructure the manuscript into EASM, SASM, and Southeast Asia analyses.

The RCM simulations only focused on the EASM. If this is not the case then further expand on the Indian monsoon. The regions selected for the RCM simulations have domain cut-offs near high topography regions most likely resulting in erroneous values. Also, it seems like adding china west to China1SE (Figure 4 analysis) would improve the RCM representation of the Indian Monsoon. The same problem occurs in section 3.4 the authors switch focus on the Indian monsoon but don't provide any nudged simulations of the EASM.

The authors used multiple model configurations with varying model resolutions and configurations. It seems important for the authors to note that increasing model resolutions can impact the regional circulation. This is particularly important when looking at a region that is strongly influenced by the regional topography. Add a section talking about the improvements and errors when increasing model resolution.

Lastly, the results incorporate many discussion points. For clarification, either add a separate discussion section or change the section to Results and Discussion as the title for section 3.

### Technical corrections

Line 12 seamless modeling approach is vague. Perhaps adding a table of all the mod-

els, reanalysis, and observation used could help the readers.

Please be clear when using an abbreviation in the text. NWP or CPLDNWP should be stated in the text as coupled (CPLD) or uncoupled (UNCPLD) Northwest Pacific (NWP).

Consider adding a regular climatology figure for either GC2 or obs with some added labels/information of what the readers should focus on e.g. Indian and East Asian monsoon regions.

It seems like errors in GC2 are remedied in GloSea5. Perhaps the color bar needs to be adjusted since it would suggest that there are biases everywhere. The authors can also add a pattern correlation to clarify.

Paragraph 166 Is red warm SST bias and blue is cold bias? The text says Cold errors in the Arabian sea when I see red across the Somalia Jet region. Again a climatological figure or a description would help the readers. The same notation is used in the following paragraph.

Line 201 winter errors need a citation?

Line 215 consider the impact of changing model resolution over mountainous regions citations such as Curio et al., 2015, Acosta and Huber 2017, Anand et al., 2018

Figure 4 top panels are units the same as figure 1?

Figures 6 and 8 expand the region westward similarly to figure 7. Enhancement of warm SST anomalies over Somalia is cooccurring with the westward expansion of the EEIO cold anomalies should be noted.

Figure 9 add a caption for the red dashed box. Line 348 is the red dashed box in figure 9 northern EEIO?

Figure 13 and Line 350, should the readers focus on FOAM or OISSTV2 as the better model? Please state in the text why one would use FOAM. Why not show HadISST

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like the rest of the analysis.

The comparison between CPLD and UNCPLD is interesting, the disparity in radiative fluxes during pre-monsoon should be further teased out.

Line 385 add a small explanation to identify the purpose of the selected regions.

Line 448 is vague and fully lets the ocean model off the hook. It should be further elaborated on and point out that an imbalance in net radiation fluxes leads to weak surface wind errors and is exacerbated by the inaccurate representation of the ocean mixed layer. Several studies have extensively studied the role of ocean heat transport and the authors should also note the role of land-ocean interaction which is not touched upon by the current study. See Chen and Bordoni 2014, and Park et al 2015 for EASM, and Lutsko et al 2019 for the Indian monsoon.

Line 452 again oceanic regions will not benefit from increased horizontal resolution however, many sections of the ASM region are over topography which will improve as you change model resolution.

Line 464 it should be noted that several similar works on the CMIP models have been done. See Sabeerali et al 2014, Anand et al 2018, Prasanna et al 2020, and Pathak et al 2019.

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