

# **Pointwise replies to reviewer's comments on the manuscript “Evaluating Microphysics and Boundary Layer Schemes in WRF: Assessment of 36 Scheme Combinations for 17 Major Storms in Saudi Arabia” (egusphere-2025-912)**

## **Response to the comments of Reviewer 3**

We thank Dr. Lodh for his thoughtful and constructive feedback. Below are our detailed responses to each comment:

**Comment 1:** Consider making the title slightly more concise and catchier. For example: “Evaluation of Microphysics and Boundary Layer Schemes for Simulating Extreme Rainfall events over Saudi Arabia using WRF”.

**Response:** Thank you for the title suggestion. We really like it and have used it. We also incorporated the WRF model version (WRF-ARW v4.4) as suggested by Reviewer 2.

**Comment 2:** In Abstract kindly rephrase the line: “Kling-Gupta Efficiency (KGE) incorporates correlation, variability, and overall bias.” to “The Kling-Gupta Efficiency (KGE) metric, which incorporates correlation, variability, and bias, was used for performance evaluation.” Provide necessary (original WMO) citations for the metrics used.

**Response:** Thank you for the suggestion. We have revised the sentence to read “The Kling-Gupta Efficiency (KGE), which incorporates correlation, variability, and bias, was used as performance metric.” The original citations for the KGE metric (Gupta et al., 2009; Kling et al., 2012) are already provided in the model assessment approach section (Line 7-8, 147-148, 150).

**Comment 3:** In section 1 where you structure the ten key questions, consider using letters (a, b, c...) for questions to avoid confusion with numbered sections.

**Response:** Thank you for this comment. We have replaced the numbered list of key research questions with alphabetically labeled points (a, b, c, ...). However, it is up to the typesetter whether they will adopt this in the final version of the paper.

**Comment 4:** Ensure all acronyms (e.g., MP, BL, KGE, IMERG) are defined on their first use in both the abstract and main text.

**Response:** All acronyms are now defined upon first use in both the abstract and the main text for clarity.

**Comment 5:** Add more region-specific references: While many global references are cited, consider including more recent or specific studies on EREs or WRF performance over Saudi Arabia or the Middle East (e.g., 2022–2024 publications if available).

**Response:** Thank you for the suggestion. The original manuscript already includes recent studies focusing on EREs and WRF performance over Saudi Arabia. Additionally, we will incorporate a few more relevant references covering the broader Middle East region, including publications from 2022 to present (Line 36-37).

Luong, T. M., Dasari, H. P., Attada, R., Chang, H. I., Risanto, C. B., Castro, C. L., ... & Hoteit, I. (2025). Rainfall climatology and predictability over the Kingdom of Saudi Arabia at subseasonal scale. *Quarterly Journal of the Royal Meteorological Society*, e5015.

Taraphdar, S., Gopalakrishnan, D., Liu, C., Pauluis, O. M., Xue, L., Ajayamohan, R. S., ... & Tessendorf, S. A. (2025). Subtropical jet regulates Arabian winter precipitation: A viable mechanism. *Journal of the Atmospheric Sciences*, 82(4), 713-732.

Francis, D., Fonseca, R., Nelli, N., Cherif, C., Yarragunta, Y., Zittis, G., & Jan de Vries, A. (2025). From cause to consequence: examining the historic April 2024 rainstorm in the United Arab Emirates through the lens of climate change. *npj Climate and Atmospheric Science*, 8(1), 1-14.

**Comment 6:** On page 2, after line number 25, rephrase the line “These events are often linked to the intrusion of intensified subtropical jet stream...” to: “These events are frequently associated with intrusions of an intensified subtropical jet stream...”

**Response:** Thank you for pointing this out. Done (Line 28-31).

**Comment 7:** Make the figure captions of Figure 2, 3 and 4 more self-explanatory by specifying metrics, datasets, and periods used.

**Response:** Thank you for pointing this out. Captions for Figures 2, 3, and 4 have been revised to provide more detail.

**Comment 8:** In the abstract section after line number 10, “The Thompson-YSU combination yielded the highest mean KGE...” Rephrase to “Among all 36 combinations, the Thompson-YSU pairing consistently produced the highest mean KGE across the 17 storm events.”

**Response:** Revised as suggested (Line 11-12).

**Comment 9:** Ensure consistent use of terms like “EREs,” “events,” “storms” throughout the paper. Stick with one preferred term unless differentiation is needed.

**Response:** Thank you for the suggestion. We have reviewed the manuscript and ensured consistent use of the term “EREs” throughout the text. This term is now used uniformly unless a different term is specifically required for contextual clarity.

**Comment 10:** After line number 285, “...models often struggle to replicate the spatial distribution of events precisely.” Suggestion is to rephrase: “This is expected, as localized convective systems common in the region present challenges for accurately resolving spatial rainfall patterns in mesoscale models.”

**Response:** Thank you for the suggestion. We have added a sentence conveying this message in our own words: “This is expected, as accurately simulating the location of localized convective systems remains a major challenge” (Line 293-294).

**Comment 11:** After line number 290: “...the Goddard (MP7) and Thompson (MP8) MP schemes, particularly when paired with the YSU (BL1)..... emerged as superior.” Rephrased to “...the Goddard (MP7) and Thompson (MP8) schemes, when combined with YSU (BL1), consistently ranked highest across both temporal and spatial KGE assessments.”

**Response:** Thank you for the suggestion. Done (Line 296-297).

**Comment 12:** When discussing major findings (e.g., Thompson–YSU being best), consider referencing the figure or table that supports this claim.

**Response:** Agreed, we have improved our referencing of figures and tables for clarity.

**Comment 13:** The paper can be redrafted to explain the section 4.7 in the beginning i.e. before section 4.1. This is so that readers gets a visual demonstration of the rainfall event in the domain of the study.

**Response:** Thank you for the suggestion. However, Section 4.7 presents the spatial rainfall distribution for the best-performing scheme combination (MP8\_BL1), which is identified based on analyses in Sections 4.1 and 4.2. After careful discussion with the co-authors, we believe retaining the current structure preserves the logical flow of the manuscript, and have opted to keep Section 4.7 in its original position.

**Comment 14:** In the conclusion section of the study bring out the motivation/conclusion of the study that this is a kind of a verification study for hydrometeorology.

**Response:** We appreciate the suggestion. The term "verification study for hydrometeorology" has been appropriately incorporated into the conclusion to better reflect the motivation and contribution of the work (Line 379).

**Comment 15:** The authors can also verify the 850hPa wind and near surface temperature and provide plots in supplementary section.

**Response:** As suggested, we have verified the 850 hPa wind and near-surface temperature fields and included the corresponding plots in the supplementary material (Figures S3 and S4).