

Comments on “Sensitivity of Marine Cloud Brightening over the Great Barrier Reef to Spatial Variability in Aerosol Forcing: A Case Study using convection-permitting model” by Wenhui Zhao, et al.

General comments:

This study examines the potential impacts of MCB in the Great Barrier Reef region by employing a convection-permitting WRF model to systematically investigate the effects of aerosol emission spatial configurations on cloud microphysical properties and radiative responses. The topic is of considerable scientific significance and practical relevance, with a clearly defined research question and a generally well-designed set of numerical experiments. The simulation results provide strong support for the authors' primary conclusion that the Twomey effect is dominant, while also demonstrating the modulating influence of meteorological conditions on cloud water path responses. Overall, the manuscript contains no major conceptual or theoretical flaws. The understanding of the underlying physical mechanisms, the numerical experiment design, and the interpretation of results are sound, and the main conclusions are valid and internally consistent within the current theoretical framework of cloud-aerosol interactions (including the Twomey effect, Albrecht effect, and related processes). However, the manuscript contains several technical, editorial, and consistency issues, which are listed in detail below. I therefore recommend Major Revision.

Specific comments:

- Line 185

Regarding the mention of “(not shown)”, I suggest that if the data is crucial for demonstrating the model's skill, it should at least be included in the Supplementary Materials rather than being omitted entirely.

-Lines 239-244

The manuscript explicitly states that the nonlinear dependence of precipitation scavenging efficiency on aerosol number concentration in the WRF-Thompson aerosol-aware scheme causes more effective local self-scavenging in EXP100, resulting in a smaller domain-mean aerosol enhancement than in EXP20. However, the simulated regime is non- to weakly precipitating, with surface rain rates remaining extremely low (mostly $< 0.01 \text{ mm h}^{-1}$; see Figure S3). Additional quantification of the dominant removal mechanism (precipitation scavenging by cloud/rain droplets versus dry deposition or coagulation) and supporting evidence for the enhanced scavenging efficiency under EXP100 would strengthen this explanation.

-Line 105

“All simulations are initialized at 00:00 UTC on 6 Feb 2024 and running for 3 days.” However, all the observational data, satellite images, sounding charts, supplementary materials in the entire text are from 2022. Please confirm whether the actual year of

this case study is 2022 or 2024?

-Line 162:

“Himwari-8” change to “Himawari-8”.

-Line 167:

“As result” change to “As a result”.

-Line 266:

“aera-averaged” change to “area-averaged”.

-Lines 311:

“bule numbers” change to “blue numbers”.

-Figure 7(d):

“OPTical Depth” change to “Optical Depth”.

-Figure 8(a):

“Aeorosl N.” change to “Aerosol N.”.

-The spelling of “Cairns region” is consistent, but “Cairns” has multiple spelling errors.

-CWP: Change “g/m²” to “g m⁻²” in Figure 7(c), Figure 8(c), and Figure 10(a, b, c).

-rain rate: Change “mm/h” to “mm h⁻¹” in Figure S3.

-In Section 2.1 (Line 96), the text explicitly mentions “two nested domains (denoted d01 and d02)”. However, the header for Table 1 (Line 104) lists “(d01, d02, d03)”. How many nested domains were actually utilized? If there are only two, please correct the Table 1 header. If a third domain (d03) exists, please provide its configuration details (e.g., resolution, location) in the text.

-The box in Figure 1 d02 is not clearly visible. It is recommended to change the color.

-Lines 37-38:

The text cites “AIMS, 2024” and “AIMS, 2026”. However, the reference list only contains an entry for “AIMS, 2026”.

-Line 286-287:

The text refers to “Figure 5c” regarding CWP. However, Figure 5 depicts CDNC. This should be changed to Figure 7c or Figure 8c

Line 306:

The text lists “and (4) synthetic cloud albedo”. This is a typographical error and should be changed to (e) to match the figure panels.

-Supplementary material: The time label “02-07 09” in Figure S3 does not match the time format of the main paper. It is recommended to standardize the format.

- The header colors/styles for Table 1 and Table 2 should be unified (one in blue, the other without any color).