

review of Liu et al., 2026 ACPD

General Comments:

This study investigates the aerosol-cloud interaction (ACI) susceptibility over the South China Sea across three distinct monsoon periods. While the dataset and the regional focus are valuable, the current methodology and physical interpretations raise several significant concerns. The classification of monsoon periods appears to conflate meteorological effects with aerosol characteristics, and several "findings" seem to align with established knowledge without providing substantial new insights. Furthermore, the physical explanation for ACI sensitivity under high LWP conditions requires more rigorous validation.

Major Comments:

1. The authors categorize the study periods into SWMW, NEMW, and NEMD based on meteorological parameters (humidity and wind at 850 hPa). However, this classification essentially serves as a proxy for cloud types and meteorological regimes. This method inherently conflates meteorological forcing (stability, moisture) with aerosol loading/type (terrestrial pollution vs. maritime air). It is unclear whether the observed differences in ACI are driven by the monsoon regime itself or simply reflect the underlying aerosol chemical composition and size distribution changes. The authors should perform a sensitivity analysis or a controlled binning (e.g., controlling for LTS and moisture regardless of the monsoon label) to demonstrate if the "monsoon"

categorization provides any statistical power beyond standard meteorological grouping.

2. Figure 7 shows that for a given LWP, higher AI leads to smaller CER, and this behavior is consistent across all three monsoon periods. This is a well-established microphysical reality. The authors should clarify what unique insight the monsoon-specific curves provide if the fundamental response is nearly identical. Aerosol Index (AI) is heavily weighted toward fine-mode particles and often fails to represent coarse-mode sea salt aerosols. In a marine environment like the South China Sea, giant CCN (sea salt) can significantly offset the Twomey effect. The authors must discuss the potential bias introduced by ignoring the contribution of sea salt and coarse particles in their ACI calculations.

3. The authors define "non-precipitating" clouds using an IMERG threshold of < 0.2 mm/h. However, warm clouds with LWP > 200 g/m² (as seen in Fig 8) are almost certainly undergoing collision-coalescence and likely producing light rain that IMERG may fail to detect. This "hidden" precipitation could lead to a scavenging of aerosols, creating a spurious correlation. The finding that re and Nd sensitivity to AI increases with LWP is counter-intuitive, as one would expect saturation effects or the dominance of collision-coalescence to reduce sensitivity at high LWP. The authors invoke "anti-Twomey" effects, but the physical evidence provided is insufficient. This trend might be a statistical artifact of the LWP-AI co-linearity or the lack of adiabaticity in thick clouds.

4. Figure 9 essentially proves that different meteorological conditions (LTS, moisture) dictate ACI. This conclusion can be reached without the monsoon labels. By "packaging" existing knowledge into monsoon categories, the authors may be obscuring the primary physical drivers rather than revealing new ones. What specific new insight is gained by using the monsoon framework that a simple multi-variate regression with LTS and q would not provide?

5. Other issues:

1) Adiabatic Assumption: The use of a constant adiabatic fraction $f_{ad} = 0.7$ to calculate N_d is problematic. Entrainment-mixing processes vary significantly between the moist SWMW and the drier NEMD. A fixed f_{ad} may introduce systematic biases in N_{nd} across seasons, artificially inflating or deflating the ACI indices.

2) MERRA-2 aerosol products in the SCS region have known discrepancies, particularly regarding biomass burning plumes and sea salt concentrations. The authors should validate these aerosol fields against AERONET or other independent observations if available.

3) The manuscript is excessively long and contains redundant descriptions of standard ACI formulas. I suggest streamlining the text to focus on the unique physical mechanisms (if any) that differentiate the monsoon regimes.

Summary:

In its current form, the manuscript lacks sufficient original scientific contribution and suffers from methodological ambiguities. A major revision is

required to disentangle meteorological drivers from aerosol effects and to validate the physical consistency of the ACI sensitivity trends.