

Dear Editors and Referees:

Thank you very much for your careful review and constructive comments on our manuscript egusphere-2026-3136R. We deeply appreciate the time and effort you invested in providing such detailed feedback. In the following, we quoted each review question in the square brackets and added our comprehensive response after each paragraph, detailing the specific adjustments made and the rationale behind them.

Responses to Referee #2

[The manuscript has been improved to some extent, but there are still a few minor issues that need to be addressed. The manuscript invokes an ice-crystal "seeding" effect over horizontal distances exceeding 1000 km, but provides no quantitative demonstration that ice crystals generated over Mount Qomolangma can survive sublimation and sedimentation during transport to the claimed downstream target regions. With newly included FLEXPART trajectories, a simple scaling calculation is necessary to demonstrate that a non-negligible fraction of ice crystals can reach the downstream cloud layer intact.]

Response 1: Thank you for the reviewer's valuable suggestion. Accordingly, we have added a discussion incorporating a simple scaling calculation based on the FLEXPART trajectories in the revised manuscript (Lines 349–354), as follows:

Based on the FLEXPART simulations of ice-crystal transport, a simple scaling calculation estimates that approximately 45.68% of the ice crystals generated over MQ can survive sublimation and sedimentation during transport over horizontal distances exceeding 1000 km and reach the free troposphere over eastern China, demonstrating the existence and importance of the downstream precipitation seeding effect associated with externally introduced aerosols activated in ice clouds over MQ.

[In Sections 3.2 and 3.3, certain parts of the discussion rely primarily on qualitative visual comparisons rather than quantitative metrics. Specifically: (1) in Section 3.2, the alignment between

latent heat anomalies and cloud/precipitation anomalies is asserted based on visual inspection, without reporting the magnitude of latent heat differences or calculating a spatial pattern correlation coefficient;]

Response 2: Following the reviewer's suggestion, we calculated the spatial pattern correlation coefficient between the latent heat anomalies and ice-cloud anomalies and added the corresponding results to the revised manuscript (Lines 305–308) as follows:

In July 2018 and July 2019, the spatial correlation coefficients between latent heat anomalies at 300 hPa (Fig. 2a, 2b) and ice-phase cloud-frequency anomalies (Fig. 1f, 1g) were 0.53 ($P < 0.001$) and 0.62 ($P < 0.001$), respectively.

[(2) in Section 3.3, the invocation of the seeder-feeder mechanism is supported only by literature analogy and lacks direct quantitative constraints such as ice water content profiles or radar cross-section evidence of vertical coupling.]

Response 3: Many thanks for the reviewer's suggestions. An integrated analysis of the diurnal cycles of aerosol extinction coefficients derived from lidar observations, maximum radar reflectivity measured by X-band dual-polarization radar, and cloud-phase occurrence frequencies further reveals that aerosol concentrations exhibit statistically robust positive correlations exclusively with the occurrence of ice-phase and mixed-phase clouds, rather than with liquid- or supercooled liquid-phase clouds (Figs. 1d and 1e). Moreover, the diurnal variations in ice-phase and mixed-phase cloud occurrence show consistent peak–trough relationships with those of maximum radar reflectivity (Figs. 1d and 1e), indicating that these cloud types are the dominant manifestations of aerosol-induced activation of deep convection. Furthermore, we have added a discussion of the seeder–feeder mechanism to the revised Section 3.3 (lines 368–375) as follows:

Xu et al. (2025) showed that, clouds influenced by aerosol activation exhibited more

vigorous development. A comparison of the responses of convective-cloud development to tropospheric aerosols and water vapor indicated that convective-cloud development over the MQ region was primarily influenced by aerosol-induced ice clouds, as its response to water vapor was considerably weaker than that to AEC (Fig. 5 in Xu et al., 2025). This further confirms the seeding effects of aerosol-activated ice clouds on downstream precipitation and the ice-crystal seeder–feeder mechanism as a key process governing the evolution of convective clouds with radar cross-section evidence of vertical coupling.

References

Xu, X. D., Cai, W. Y., Zhao, T. L., Zhang, H., Guo, X. L., Liu, W. Q., Zhang, T. S., Zhao, R. Z., Wu, C., Li, Y. Q., Wang, L., Yan, P., and Yang, C. J.: Understanding clouds and precipitation over the Mount Qomolangma: how does the aerosol activation effect exist?, *Sci. Bull.*, 70, 3649–3658, <https://doi.org/10.1016/j.scib.2025.09.031>, 2025.

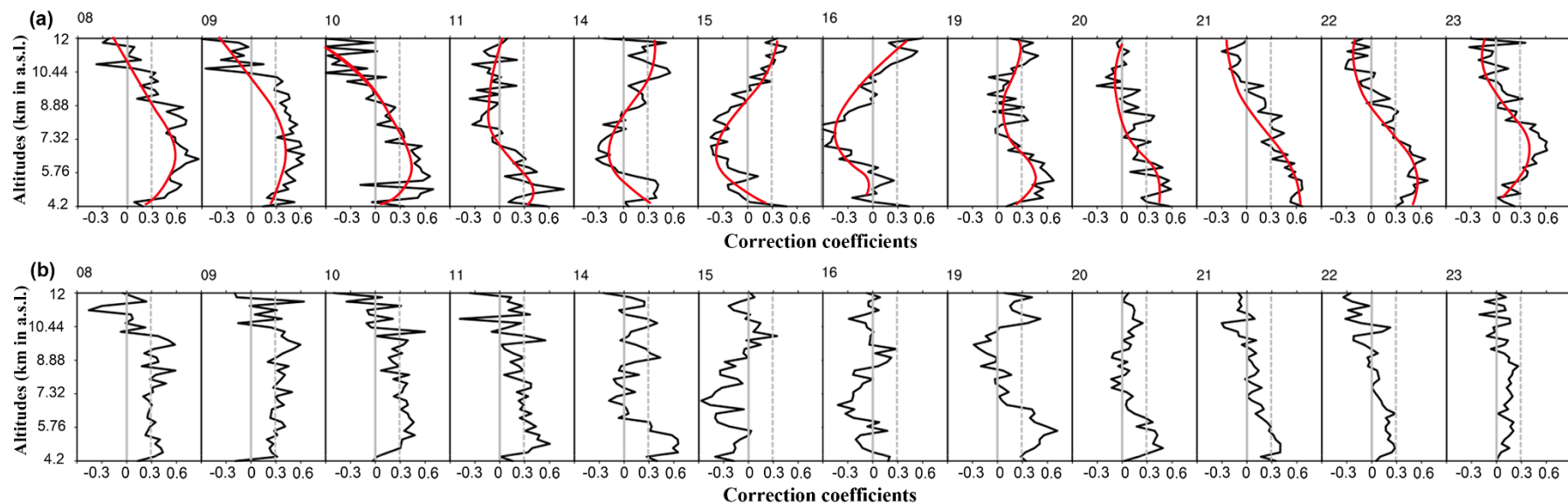


Fig. 5. Hourly changes from 08 in the responses of deep convective clouds on the MQ to (a) lower-atmospheric AEC and (b) vapor at 500 hPa (Xu et al., 2025). The x-axes present the lag correction coefficients of vertical structures of X-band dual-polarization weather radar echo reflectivity with the AEC averaged during 00:00 to 07:00 over the altitudes of 0.15-2.5 km in the upper panel and the specific humidity at 500 hPa averaged during 00 to 07 in the lower panel, and the y-axes denote the altitudes (km in a.s.l.) with zero correction (solid straight lines) and the significance level of 0.1 (dash straight lines). The solid red lines represent the change patterns of the relevant profiles. Only X-band dual-polarization weather radar and Lidar observational data from July 2019 were employed. The hourly changes in the responses of deep convective clouds on the MQ to lower-atmospheric AEC and vapor at 500 hPa are detailed in Fig. S4 (online).