Reviewer comments on *Why Is Height-Dependent Mixing Observed in Stratocumulus?*

This manuscript examines how to interpret homogeneous versus inhomogeneous mixing (HM/IM) signatures in stratocumulus, integrating insights from in-situ observations and modeling with a framework that explicitly resolves inhomogeneous mixing. This manuscript provides a clear demonstration that the frequently reported IM near cloud top and HM deeper in cloud can arise as a collective signal from parcels with distinct entrainment–evaporation histories, rather than a true local mixing mode. It offers a compelling reframing of bulk versus local perspectives. The goals and message are clear, and the results have practical value for the community by informing the design and interpretation of in-situ aircraft measurements as well as LES/Lagrangian modeling strategies to diagnose entrainment and mixing in stratocumulus clouds.

I find this a valuable contribution and suitable for prompt publication after revision. I recommend addressing several points of clarification in the discussion and adding a small set of targeted sensitivity tests.

Comment 1:

The time evolution of the standard deviation of δq_v in Fig. 8 is highly informative. However, as the authors note, post-entrainment descent is the more realistic pathway in marine stratocumulus. I therefore suggest presenting the same diagnostics for a descending (non-isobaric) configuration (e.g., the Control experiment) to assess how adiabatic warming during descent modifies both the characteristic reaction time and the HM IM transition. This would further help LES and Lagrangian trajectory studies that have adopted fixed-lag windows for mixing diagnostics (e.g., Lim & Hoffmann, 2023, 2024), in non-isobaric conditions.

Comment 2:

The authors use a monodisperse NaCl aerosol initially and CCN-free entrained air. While this isolates sampling effects, many studies show that entrained aerosols and the pre-mixing droplet size distribution (DSD) shape strongly govern the relative changes in N and r, and thus the HM/IM diagnostics (Krueger et al., 2008; Luo et al., 2022; Lim & Hoffmann, 2023). In particular, broader spectra with many small droplets can favor N reductions via complete evaporation, altering the n–r^3 change. Please either add sensitivity results or, if out of scope, expand the discussion to explain the expected impacts and identify this as a priority for follow-up.

Comment 3:

Parcels in real clouds often dwell near the cloud top for a short time after entrainment before descending. Please add a dwell-then-descent variant in which the post-entrainment velocity is held at $w = 0$ for a prescribed τ_{dwell} (tens of seconds) and then switched to the descending value used in Control. It would be useful to clarify whether this pathway yields a stronger HM or IM signal in both the local and bulk perspectives. Moreover, the local HM to IM interpretation may partly reflect insufficient time for droplets to respond, where mixing diagnostics require adequate time for both scalar mixing and microphysical adjustment. The current mixing-diagram framework should explicitly acknowledge this timescale dependence. I therefore recommend adding a short discussion on how analysis-window length and parcel dwell affect the local perspective of the mixing process.

Grammar and Typo

- It seems like the unit of entrained air water vapor is wrong. $8.6*10^{-3}$ g / kg seems to be too small.
- In Line 17, the IH characteristic should be the IM characteristic.
- Sometimes, ψ and φ are mixed when referring to the homogeneous mixing degree (e.g., Fig. 5). Please fix this for consistency.

References

Krueger, S. K., Schlueter, H., & Lehr, P. (2008). Fine-scale modeling of entrainment and mixing of cloudy and clear air. In *15th international conference on clouds and precipitation, cancun, mexico.*

Lim, J.-S., & Hoffmann, F. (2023). Between broadening and narrowing: How mixing affects the width of the droplet size distribution. *Journal of Geophysical Research: Atmospheres*, *128*(8), e2022JD037900.

Lim, J.-S., & Hoffmann, F. (2024). Life cycle evolution of mixing in shallow cumulus clouds. *Journal of Geophysical Research: Atmospheres*, *129*(10), e2023JD040393.

Luo, S., Lu, C., Liu, Y., Li, Y., Gao, W., Qiu, Y., … others (2022). Relationships between cloud droplet spectral relative dispersion and entrainment rate and their impacting factors. *Advances in Atmospheric Sciences*, 1–20. doi: 10.1007/s00376-022-1419-5