

Reviewer 1:

The paper presents an interesting attempt to estimate CCN concentrations from lidar observations with the support of ground-based in situ CCN observations. I have only a few point. Minor revisions are needed.

We thank the reviewer for the positive feedback.

Detailed comments:

P7, l218: kNN is not explained in the main text body, only in the abstract. Thus, please explain the abbreviation here, i.e., mention: k-Nearest Neighbors classifier

The full term has been added at its first occurrence: “k-Nearest Neighbors (kNN) classifier”.

P5, Data section

In this section, one should present a simple sketch that provide an overview of the entire data analysis concept. This sketch should include the near-surface in-situ CCN observation (station), a lidar backscatter profile (from the ground up to a cloud base...), a horizontal line indicating the top of the aerosol layer (boundary layer) and a tiny cumulus cloud with cloud base height close to or at the boundary layer top (and the lidar profile ends at cloud base), and maybe even another (varying) vertical line indicating homogeneous aerosol type conditions or slightly varying aerosol-type conditions with height In this way the reader would be able to easily understand the entire retrieval concept.

Thank you for this helpful suggestion! We have added a new conceptual schematic figure to provide an overview of our framework. In addition to illustrating the main observational components (e.g., lidar profile, boundary-layer/aerosol-layer top, and cloud), the figure also summarizes the analysis concept and the main conclusions of this study.

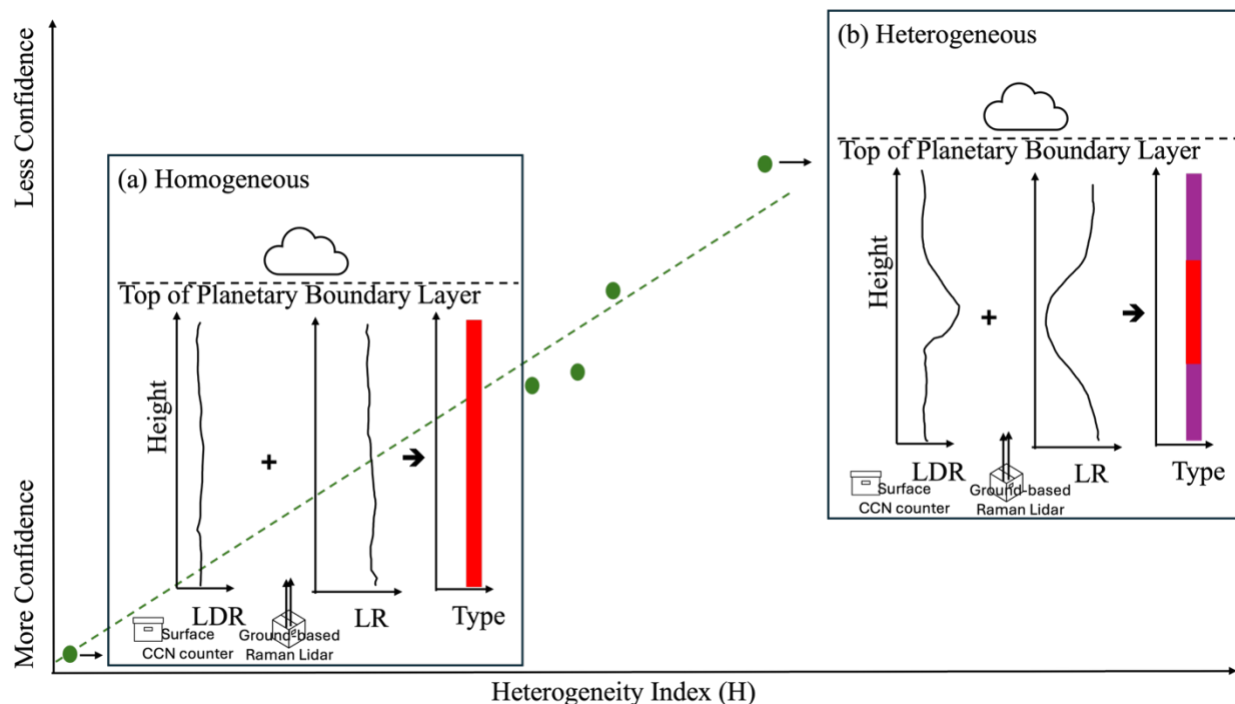


Figure 7. Conceptual overview of the analysis framework. The two panels contrast vertically homogeneous and heterogeneous aerosol conditions, and their influence on RNCCN retrieval performance. Green dots represent conceptual case-level relationships between aerosol vertical

heterogeneity and the RNCCN–aircraft difference, while the dashed green line illustrates the overall trend of increasing RNCCN–aircraft difference (i.e., decreasing retrieval confidence) with increasing aerosol vertical heterogeneity.

P18, 1491: The method is exclusively applicable to PBL clouds? What about CCN estimates in the free troposphere. Should be discussed.

Our analysis in this study is limited to the PBL, and we have added discussions in the manuscript: *“The surface-anchored RNCCN method is best suited to the boundary layer: scaling a surface CCN measurement by the surface-normalized extinction ratio (Eq. 1) assumes surface aerosol is representative of aerosol aloft, more valid in PBL but generally not in the free troposphere, where decoupled or transported layers can differ substantially from the surface. This restricts the analysis to PBL.”*

“However, the diagnostic tools developed here (kNN typing and the heterogeneity index H) are not subject to this limitation, as they rely only on lidar LR and LDR and can be applied throughout the column to flag elevated, decoupled layers.”