

Cover letter to the editor of EGUSPHERE-2024-2559

Dear Sergio Rodríguez,

We thank you and the reviewers for reviewing our paper and providing invaluable feedback, which improved our manuscript.

The reviewers comments and a reassessment of the clustering code led to three major changes in the manuscript:

1. **Trajectory Length Adjustment:** The cirrus cloud trajectory length was reduced from 24 hours to 12 hours to better reflect typical cirrus cloud lifetimes. Since some clouds persist beyond 12 hours, an analysis using 24-hour trajectories is included in the appendix. The results of the 12-hour trajectory clustering differ slightly from the original submission, as discussed in point 3.
2. **Removal of Vertical Velocity Clustering:** The nested clustering based on vertical velocity clusters (formerly Section 3.2) was removed to enhance the focus on the two main contributions of the paper: (i) the data-driven identification of cirrus cloud formation regimes based on temperature trajectories and (ii) the sensitivity of different clusters to dust aerosol exposure.
3. **Correction in Clustering Approach:** While rerunning the clustering for 12-hour trajectories, a bug in the data preprocessing was identified—only midlatitude cirrus clouds were used for clustering in the initial submission, and the resulting model was applied to both midlatitude and tropical cirrus. Initially, we described fitting separate clustering models for cirrus clouds in the tropics and midlatitudes (l. 170). However, after reconsidering this approach, we opted for a single clustering model trained on all cirrus cloud trajectories to improve comparability between the two regions. To still account for regional differences, the analysis of cloud properties and dust sensitivities is conducted separately for the tropics and midlatitudes.

Although these changes do not alter the core findings and conclusions, some minor adjustments in the results include:

- Instead of two liquid-origin clusters, the revised clustering identifies two temperature-separated in situ clusters.
- The sign of cloud-type sensitivity to dust aerosol exposure remains largely unchanged, though the magnitude of sensitivities has been slightly adjusted.

The described changes are also reflected in the accompanying code and data repositories.

Following the recommendation of the editorial support, we updated the color scheme of Figures 4, 5, 7, and 8 to allow readers with colour vision deficiencies to correctly interpret our findings.

Sincerely,

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