Response to the Reviewer #1

We really appreciate your time and effort taken to review our manuscript submitted to Atmospheric Chemistry and Physics. Thank you very much for your constructive comments and suggestions that are very useful to greatly improve our manuscript. We have revised our manuscript according to your comments as explained below. Please see the following for our point-by-point responses shown in red just below the corresponding comments shown in black.

General note on the revision:

Before addressing the individual comments, we summarize several major revisions that affect multiple points raised by Reviewer #1. In response to the reviewers' comments, we have substantially revised the Doppler-velocity processing and the presentation of the results. We now explicitly distinguish between non-folded convective columns, for which MaxVd can be quantified, and Doppler-velocity folded columns, for which quantitative MaxVd is unavailable and which are treated as extreme-updraft (EU) candidate columns. The 3 km averaging is now applied in pulse-pair covariance space rather than by directly averaging velocity values. We also revised the folding flag, reconstructed the relevant figures and tables, and clarified that the MaxVd-based SU and folding-based EU occurrence ratios use the same denominator, namely the total number of selected convective columns. Because MaxVd is quantified only for non-folded columns, we avoid interpreting MaxVd-based SU columns as the absolute strongest convective cores observed by EarthCARE/CPR throughout the revised manuscript.

Unless otherwise noted, figure and table numbers in this response refer to the revised manuscript. The revised Table 1 now reports both MaxVd-based SU and Doppler-velocity folded-column (EU) counts and ratios using the same denominator, i.e. the total number of selected convective columns. The former Table 3 has been integrated into the revised Table 1.

The paper investigates the characteristics of tropical convective clouds in light of the novel Doppler velocity measurements from EarthCARE/CPR. The topic is of great interest for the cloud dynamics community. Results are well presented and introduce the first global climatology of convective motions (of course with the limitations of the CPR measurements). I would suggest a clear statement in the abstract that the SU (strong convection) cases actually are not surely representing the strongest updrafts measured by EC (which vice versa will correspond to the folded cases). This has to come clear even to readers who are not EC-CPR experts. I have then some specific comments.

We agree that the original manuscript was not clear enough to state that the MaxVd-based SU category is restricted to non-folded convective columns and therefore does not necessarily contain the strongest convective cores observed by EarthCARE/CPR. In the revised abstract, we now state explicitly that the most intense convective cores are susceptible to velocity folding, and that MaxVd and SU are defined only for non-folded columns. We also revised the manuscript throughout to emphasize that folded columns are treated separately from non-folded columns as candidates for the most extreme-updraft (EU) regimes.

1) "We exploit EarthCARE's Doppler capability to analyze vertical velocity w even in clouds with weak radar echoes". Not sure what the authors mean. What Reflectivities are we talking about? I would avoid vague statements.

We agree that the phrase "weak radar echoes" was vague. We have removed this wording and now specify the reflectivity threshold of −19 dBZ used for Doppler-velocity quality control.

2) Line154-155: "To correct for ε_pointing, we apply a bias correction based on the assumption that the Doppler velocity averaged horizontally over 100 km at the surface is zero ". I am not so sure about this. Ocean surface is fine for Doppler calibration but not the same can be said for the land (see Bernat et al., 2025 paper on mispointing).

We thank the reviewer for pointing this out. We agree that the assumption of zero mean surface Doppler velocity is much more robust over homogeneous ocean surfaces than over heterogeneous land surfaces. In the revised manuscript, we have clarified that the surface-based bias correction may not fully remove the bias over land because of contamination by surface-property-dependent signals. We now cite Puigdomènech Treserras et al. (2025), who showed that accurate CPR antenna pointing is essential for high-quality Doppler velocities. We also added the reference to JAXA (2026) (https://www.eorc.jaxa.jp/EARTHCARE/document/JAXAL2ProductList/ATBD/EarthCARE_JAXA_L2_ATBD_verP_Apr2026.pdf) for the product-level bias-correction procedure.

3) Folding and averaging of Vd: it is not clear to me what has been done. The authors mention "first-pass dealiasing applied following Hagihara et al. ", maybe it would be good to include details here. Afterwards, how is the averaging of Vd over 3 km windows performed? (Are these simple Vd averages? Are you averaging in the lag-1 correlation space)? What happens if there are multiple scattering contaminated pixels in the averaging region?

We thank the reviewer for noting that the original description of the Doppler-velocity processing was not clear enough. We revised the processing description and reconstructed all the figures and tables affected by this procedure.

First, the reference to “first-pass dealiasing following Hagihara et al.” has been removed because it was misleading in the context of this study. That procedure is designed to treat upward-folded rainfall velocities in regions warmer than 273.15 K. Because our MaxVd analysis is restricted to the subfreezing portion of the column, this first-pass dealiasing does not affect the analysis presented here. We therefore removed the statement to avoid confusion.

Second, we now explain that the 3 km horizontal averaging of Doppler velocity is performed in pulse-pair covariance space, not by directly averaging Doppler-velocity values. For each valid gate, Vd is converted to the real and imaginary components of the lag-1 covariance using the local Nyquist velocity. These components are then summed over the averaging window with reflectivity weighting, and the resulting phase is converted back to Vd. This procedure avoids artificial cancellation and wrap-around artifacts that can occur when velocities close to the Nyquist limit are averaged directly in velocity space.

Third, we clarified how invalid and multiple-scattering-contaminated pixels are treated. Only gates passing the validity filters, including the cloud-mask and reflectivity thresholds, are used. Pixels likely affected by multiple scattering are excluded. If the averaging window contains invalid or multiple-scattering-contaminated gates, the corresponding averaged value is not used for the statistics.

Finally, we revised the folding flag. In the original manuscript, a column was flagged when a vertical jump in the 3 km-averaged Vd exceeded the local Nyquist velocity. In the revised analysis, a jump is counted as a folding signature only when it satisfies three conditions: (i) the jump exceeds 1.5 times the local Nyquist velocity, (ii) the adjacent gates have opposite signs, and (iii) at least one of the two gates is close to the local Nyquist limit. This definition is more directly tied to the expected signature of Nyquist folding than a simple large-gradient threshold.

4) Definition of MaxVd: "We then define MaxVd, the column-maximum Doppler velocity, as the largest Vd within the portion of the 3-km– and 200-m–averaged profile that is colder than 273.15 K for columns that are not flagged as folded." Not sure this is the right definition. I suppose you are searching for a maximum in the entire column among the the 3-km– and 200-m–averaged Vd values?

Thank you for pointing out the ambiguity. MaxVd is defined as the maximum value of the quality-controlled, pulse-pair-averaged Vd over all valid subfreezing gates in an unfolded column. Thus, the maximum is searched over the full valid subfreezing portion of the unfolded column after the 3 km horizontal and two-gate vertical averaging. Columns flagged as folded are excluded from this quantitative MaxVd analysis and are analyzed separately as folded columns.

5) "The main results are insensitive to reasonable variations in these parameters". A little bit too vague. Can we be more specific? I suppose that if we start averaging too much we may end up with serious issues. Also if the averaging has been done in the velocity space, aliasing issues can come into play (and tend to bias averaged velocities towards zero values)

We agree that the original statement was too vague. We replaced it with a quantitative sensitivity analysis and now explain why the 3 km × 200 m setting was chosen.

For the folding flag, we tested horizontal averaging windows of 1, 3, 5, and 10 km using the 100 m vertical sampling. For the MaxVd-based SU classification, we tested all combinations of horizontal averaging windows of 1, 3, 5, and 10 km and vertical averaging windows of 100, 200, 300, and 500 m. These sensitivity analyses have been added to the Supplement as Figs. S1 and S2, respectively.

The folded-column fraction probability decreases as horizontal averaging becomes coarser, from 16.5% at 1 km to 7.2% at 3 km, 4.8% at 5 km, and 2.5% at 10 km. The distribution of MaxVd is shown in Fig. S1. The 1 km case retains an unusually long tail of MaxVd values toward the Nyquist limit, suggesting that random Doppler errors are not sufficiently suppressed. In contrast, the 10 km case concentrates MaxVd close to 0 m/s, indicating that local convective-core signals are overly smoothed. The SU fraction also decreases with coarser horizontal and vertical averaging as shown in Fig. R1-2. This behavior is expected: stronger smoothing reduces noise-induced false detections, but it also suppresses narrow convective-core signals.

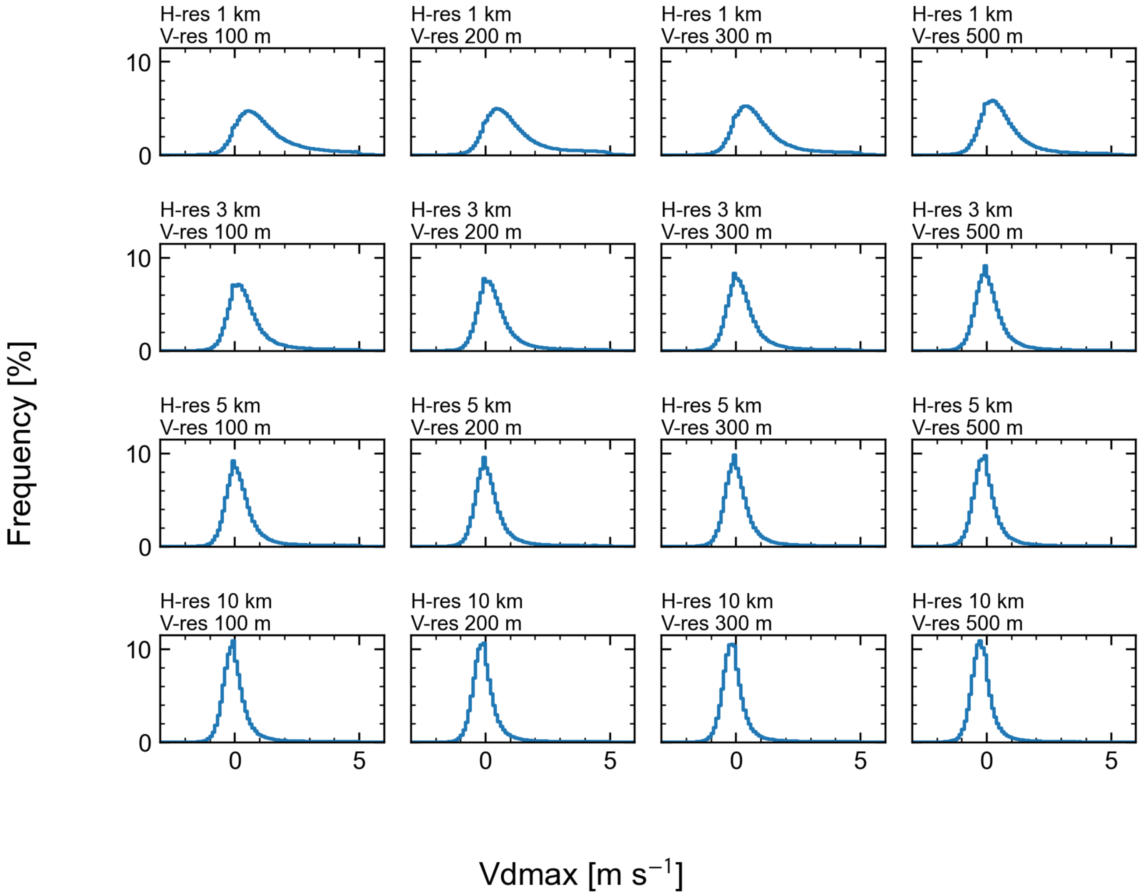

Figure S1. Sensitivity of the MaxVd distribution to the horizontal and vertical averaging scales. Each panel shows the normalized frequency distribution of MaxVd for selected convective columns after Doppler-velocity quality control and exclusion of folded columns. Rows correspond to horizontal averaging windows of 1, 3, 5, and 10 km, and columns correspond to vertical averaging windows of 100, 200, 300, and 500 m.

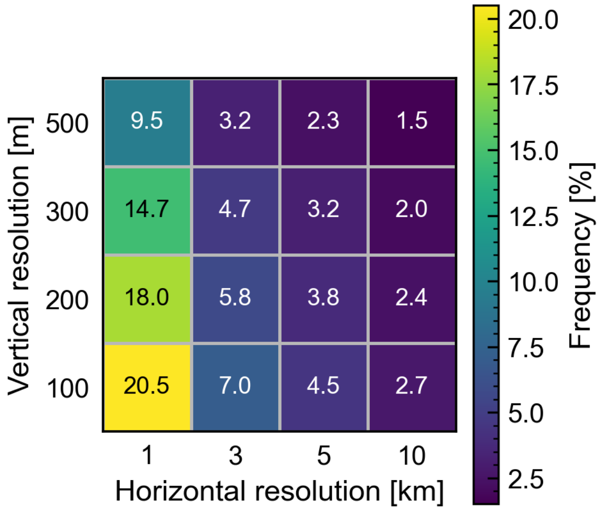

Figure S2. Sensitivity of MaxVd-based SU occurrence to the horizontal and vertical averaging scales. Colors and numbers show the percentage of selected convective columns classified as MaxVd-based SU, defined as non-folded columns with MaxVd > 2.0 m s⁻¹, for each combination of horizontal and vertical averaging windows. The denominator is the number of all selected convective columns for each sensitivity test. Coarser averaging suppresses the MaxVd tail and reduces the occurrence of MaxVd-based SU columns.

Based on these assessments, we chose 3 km x 200 m as a compromise between reducing EarthCARE/CPR Doppler-velocity noise and retaining convective structures on physically relevant scales. This choice is also consistent with previous discussions of spaceborne Doppler-radar design, which indicate that many deep-convective updraft cores are narrower than 5 km and that the core-width distribution peaks around 2-3 km (Kollias et al., 2023 (https://doi.org/10.3389/frsen.2022.860284)).

6) "the native 1 km × 200 m Doppler-velocity field": I thought the native was 500m x 100m

We thank the reviewer for catching this. The original wording was confusing. The EarthCARE/CPR sampling is approximately 500 m along track and 100 m vertically, whereas the field shown in Fig. 1b corresponds to the CPR_CLP product grid before the additional averaging used in this study. We have removed the word “native” where it could be interpreted as the instrument sampling and now refer to the “input”. To make the effect of spatial averaging clearer, Fig. 1b now shows the input CPR_CLP Doppler-velocity field at 1 km x 100 m resolution with only the cloud-mask threshold applied.

7) Fig1:

a) Fig1c: I do not see any flagging to multiple scattering. I would expect there is something around pixel 500.

We agree that the multiple-scattering mask was not clearly visible in the original Fig. 1c. In the revised figure, we explicitly show the multiple-scattering mask using grey shading. The region near column index approximately 500 is now marked as affected by multiple scattering and is excluded from the MaxVd calculation. We also revised the caption to state this explicitly.

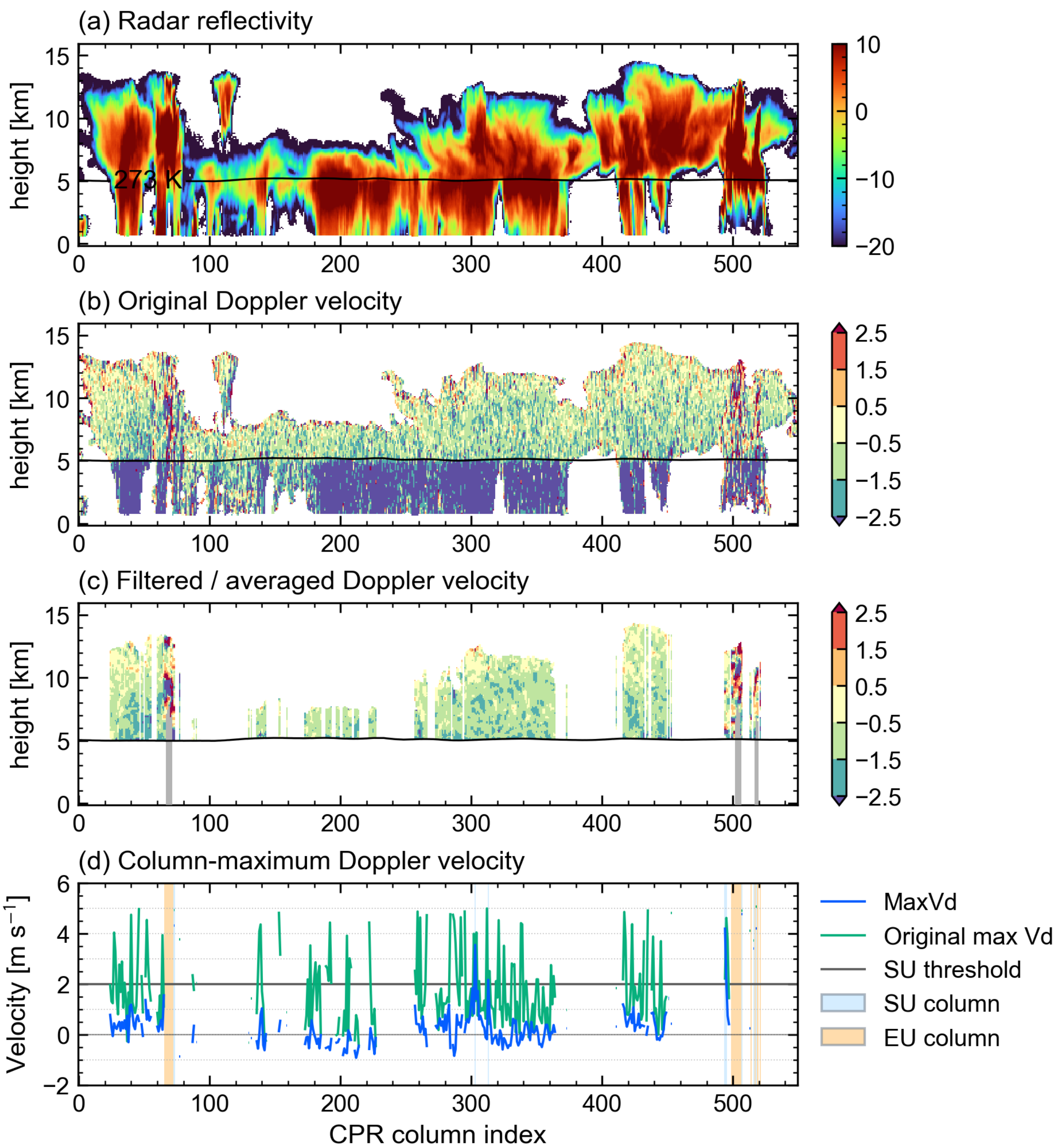

Figure 1: Example illustrating Doppler-velocity quality control, folding detection, and the definition of the updraft metric MaxVd for an EarthCARE/CPR scene. (a) Radar reflectivity factor (Ref; dBZ). (b) Input CPR_CLP Doppler velocity (Vd; m s^{-1}) after applying only the cloud-mask threshold (cloud mask ≥ 20); positive values indicate upward motion. The black line marks the 273.15 K isotherm. (c) Doppler velocity after applying the column-selection criteria and quality control. Gaps indicate columns or gates for which no valid Doppler velocity remains after column selection and quality control. Grey shading near column indices approximately 70, 500, and 510 denotes gates flagged as being affected by multiple scattering. (d) Column-maximum Doppler velocity as a function of column index, computed from the input field in (b) for visual comparison ("Original"; green) and from the filtered and averaged field in (c) for the quantitative metric ("MaxVd"; blue). Light-orange shading denotes columns flagged as folded and classified as extreme-updraft (EU) candidate columns. Light-blue shading denotes columns with MaxVd > 2.0 m s^{-1}, classified as strong-updraft (SU) columns.

b) Panel d: difference between orange and blue line. Of course going to 3 km scale significantly reduce the Vd intensity (convective cores are typically much smaller than 3 km). Again if averaging is done in the Vd space this may be an "artificial" effect due to folding. Indeed I strongly disagree with the statement at line 218-219 "while preserving the location and relative magnitude of embedded updraft cores" (in fact the difference between the blue and orange line shows exactly that!). All the discussion at line 235-238 in fact mention that. Airborne measurements are typically representative of averages at much shorter scales!

We agree with the reviewer. The original statement overstated the extent to which the averaging preserves the magnitude of embedded updraft cores. We have revised the text to state that the quality-control and averaging procedure suppresses noisy and cloud-edge fluctuations and yields a coherent 3 km-scale Doppler metric, but that it also reduces the peak amplitude of Doppler velocity in narrow convective cores.

c)"Grey shading denotes columns flagged as being affected by residual velocity folding": I am surprised not to see any at around index 75.

Thank you for pointing this out. With the revised residual-folding criterion, these columns are now flagged as folded and shaded in light-orange. Fig. 1 and the caption have been updated accordingly.

8) Sect 3.2 and after. All Tables and percentages are defined with respect to the number of QC 3-km columns, correct?

This could be improved. In fact in some cases you get percentages up to 9% which is definitely too high!! We would like to know how frequent these convective clouds are (thus with respect to all 3-km columns). Also it is probably better to put together in the same Table results for SU and EU (extreme updraft corresponding to velocity folding, I would introduce some terminology there). I would actually term SU ==> MU (moderate updrafts) and Doppler foldings ==> SU (strong updrafts).

We agree that the denominator of the reported percentages needed to be stated more clearly and that the MaxVd-based SU statistics and folded-column statistics should be presented on a common basis. In the revised manuscript, we now use all the selected convective columns as the common denominator for Fig. 6, Fig. 7, Fig. 9, and Table 1. Here, “all the selected convective columns” includes both non-folded convective columns and columns flagged as Doppler-velocity folded.

Accordingly, the MaxVd-based SU occurrence is defined as the number of non-folded convective columns with MaxVd > 2.0 m s^{-1} divided by the number of all the selected convective columns. The EU occurrence is defined as the number of folded convective columns divided by the same denominator. This common denominator allows measurable MaxVd-based SU columns and folded, potentially more extreme, columns to be compared directly.

We also revised the SU definition from the original threshold of MaxVd > 2.5 m s^{-1} to MaxVd > 2.0 m s^{-1} and reconstructed all the figures, tables, and text. Table 1 now reports, for each region and local overpass time, the total number of selected convective columns, the number and occurrence of MaxVd-based SU columns, and the number and occurrence of folded columns.

We considered the reviewer’s suggestion to rename the non-folded MaxVd category as “moderate updrafts” and the folded category as “strong updrafts.” However, because the Doppler velocities in folded columns are aliased, we cannot assign a quantitative updraft speed or a quantitative updraft class to these columns. We therefore retain the operational term “MaxVd-based SU” for non-folded columns with MaxVd > 2.0 m s^{-1}, while consistently describing folded columns as extreme-updraft (EU) candidate regime that likely samples more extreme convection. We revised the manuscript throughout to avoid implying that MaxVd-based SU columns contain the absolute strongest convective cores observed by CPR.

9) Line 601-602: "As a result, we cannot yet directly evaluate echo-top height climatologies at 20–40 dBZ derived from the TRMM and GPM precipitation radars". Well the Ku-band 20-40 dBZ levels are certainly detected by EC but non-Rayleigh effects are substantially reducing

those levels (in addition to attenuation). The recent paper by Chase et al., A Multifrequency Spaceborne Radar Perspective of Deep Convection should be mentioned here.

Thank you for pointing this out and for information of the paper by Chase et al. We agree that the original wording was inaccurate. EarthCARE's W-band CPR can observe high reflectivities, but direct comparison with Ku-band 20–40 dBZ echo-top climatologies is complicated by non-Rayleigh scattering, attenuation, and multiple scattering in deep convection. We have revised the discussion accordingly with reference to Chase et al. (2025), as the reviewer suggested.

Response to the Reviewer #2

We really appreciate your time and effort taken to review our manuscript submitted to Atmospheric Chemistry and Physics. Thank you very much for your positive evaluation and helpful suggestions that are very useful to greatly improve our manuscript. We have revised our manuscript according to your comments as explained below. Please see the following for our point-by-point responses shown in red just below the corresponding comments shown in black. In response to the reviewers' comments, we have revised the abstract to avoid overinterpreting CPR Doppler velocity as a direct measure of air updraft velocity and to state explicitly that the most intense convective cores may be affected by Doppler-velocity folding. We also have revised Fig. 1 to make the folded-column shading and quality-control gaps clearer.

This paper analyzes strong updrafts identified in nine months of cloud-profiling radar measurements taken the EarthCARE retrievals. The paper is well written and satisfies with the journal's goal to publish work that provides new insights into atmospheric physics. One significant outcome of this paper is the ability to extend the conclusions here to data from other satellite missions, like CloudSat.

I recommend this for publication, and have minor suggestions to improve the clarity of the paper:

- L9: Stating that this data "[enables] direct constraints on convective updraft intensity" is too strong of a statement when there are several limitations to consider when we use this data. The velocity of very strong updrafts cannot be measured, for example. I suggest replacing this with something like "enabling spaceborne measurements" to emphasize the novelty of the data. Broadly, I suggest softening this statement.

We agree that the original wording was too strong because CPR Doppler velocity is a reflectivity-weighted hydrometeor Doppler velocity and because the most intense convective cores can be affected by velocity folding. We have softened the abstract to emphasize the novelty of spaceborne Doppler measurements while making the limitation explicit.

- L211-222: "Columns whose 3 km–averaged Vd profiles exhibit discrete vertical jumps with magnitudes exceeding the Nyquist velocity are flagged as folded (as described in Sect. 2.3) and are shaded in grey in Fig. 1d." Is the shading you refer to shown at CPR column index ~300 and ~500. If so, this is very hard to see, so I suggest revising this figure for clarity. The shading is also mentioned in the caption (L193).

We agree that the folded-column shading in Fig. 1d was difficult to see. We revised the figure and the caption now explicitly identifies the relevant column-index ranges.

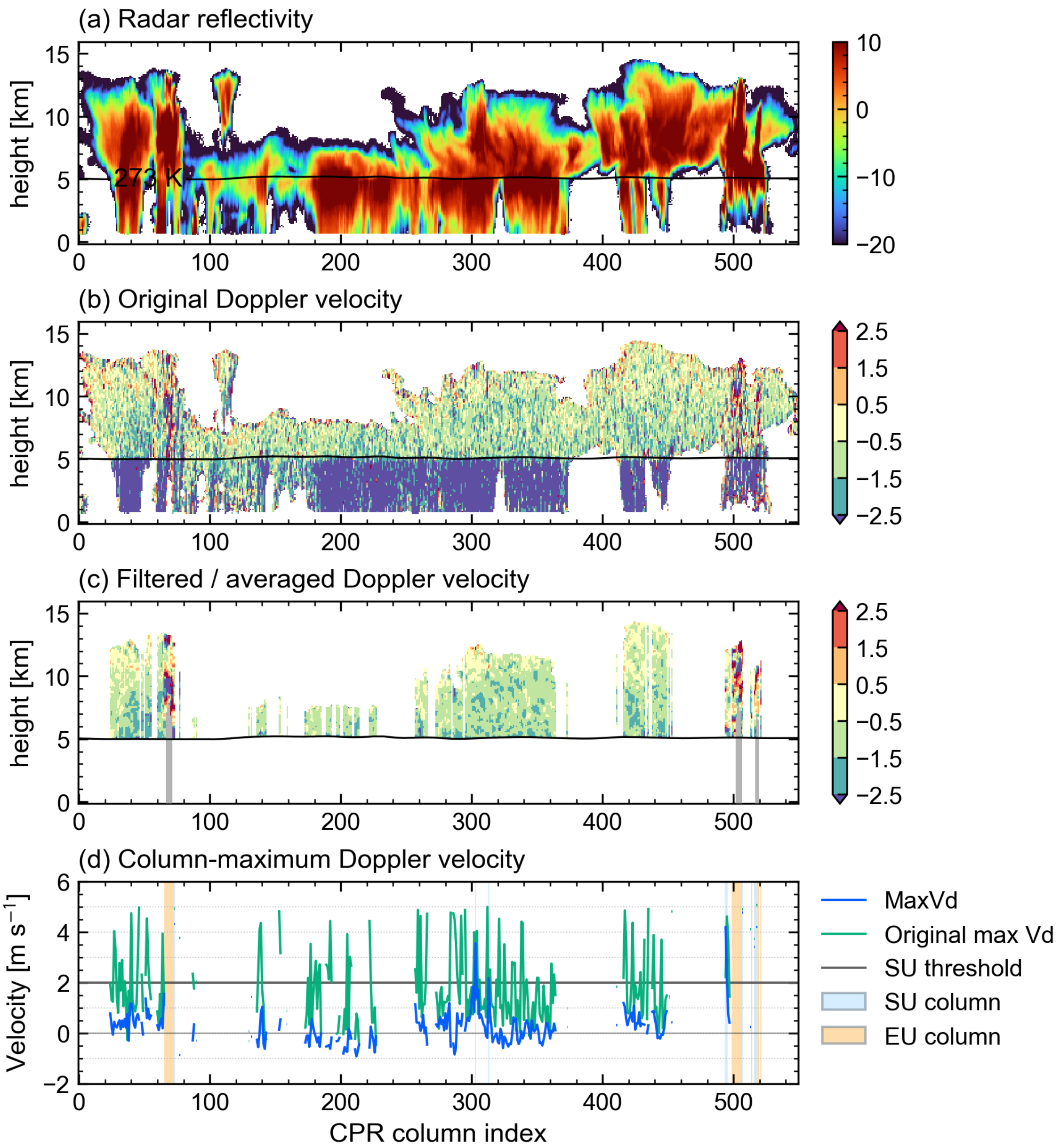

Figure 1: Example illustrating Doppler-velocity quality control, folding detection, and the definition of the updraft metric MaxVd for an EarthCARE/CPR scene. (a) Radar reflectivity factor (Ref; dBZ). (b) Input CPR_CLP Doppler velocity (Vd; m s^{-1}) after applying only the cloud-mask threshold (cloud mask ≥ 20); positive values indicate upward motion. The black line marks the 273.15 K isotherm. (c) Doppler velocity after applying the column-selection criteria and quality control. Gaps indicate columns or gates for which no valid Doppler velocity remains after column selection and quality control. Grey shading near column indices approximately 70, 500, and 510 denotes gates flagged as being affected by multiple scattering. (d) Column-maximum Doppler velocity as a function of column index, computed from the input field in (b) for visual

comparison ("Original"; green) and from the filtered and averaged field in (c) for the quantitative metric ("MaxVd"; blue). Light-orange shading denotes columns flagged as folded and classified as extreme-updraft (EU) candidate columns. Light-blue shading denotes columns with MaxVd > 2.0 m s^{-1}, classified as strong-updraft (SU) columns.

- Why does the orange quality-controlled line in Fig. 1 have points missing? Are those points flagged as Nyquist folded?

We have clarified this in the revised caption. The orange line shows the MaxVd values used for the quantitative non-folded statistics. Gaps indicate columns for which no valid Doppler velocity remains after the combined quality-control procedure, including low-confidence Doppler estimates, multiple scattering, and velocity folding. To make the figure clearer, we also restrict the "Original max Vd" line to columns with valid Doppler-velocity data, so that the difference between the two lines more directly illustrates the effects of quality control, spatial averaging, and folding detection rather than differences in column selection.

- Section 2.4 (and elsewhere). Does "non-folded" refer to samples for which convection was identified and its velocity profile passes your folding test? When there is no updraft/downdraft, is the column still non-folded? Maybe this is implied for people who work with doppler radar. Should we interpret the top panel in Fig. 2 as the distribution of MaxVd conditioned on the convection being detected and the column being non-folded?

Thank you for pointing this out. We agree that this terminology needs clarification. In the revised manuscript, "non-folded" refers to selected convective cloud columns that pass the folding test described in Sect. 2.3. It does not imply that a column necessarily contains a strong updraft; rather, it means that the column is suitable for quantitative MaxVd analysis because no fold-like discontinuity is detected in the subfreezing Doppler-velocity profile.

Accordingly, Fig. 2a should be interpreted as the distribution of MaxVd conditioned on the column being selected as a convective cloud column and not being flagged as folded. We have revised the text and caption to make this conditioning explicit.

- Fig 7a The title has a typo: Numer -> Number

Corrected. "Numer" has been changed to "Number."

Response to the Reviewer #3

We really appreciate your time and effort taken to review our manuscript submitted to Atmospheric Chemistry and Physics. We have revised our manuscript according to your comments as explained below. Please see the following for our point-by-point responses shown in red just below the corresponding comments shown in black.

This study analyses EarthCARE CPR observations to investigate the statistical relation between Doppler velocity and existing indices of convective intensity such as cloud-top height and echo-top height (0 dBZ or 10 dBZ). It is concluded that delta H = cloud-top height minus 0-dBZ height is a robust proxy of updraft strength. Region-to-region comparison consistently supports this conclusion. The findings appear to be focused on a confirmation of the widely-known climatology of convective systems (ocean-land contrast in convective intensity etc.) rather than an exploration of previously unknown aspects. This paper nonetheless convincingly underscores the utility of EarthCARE for better understanding the convective dynamics and microphysics. I have several suggestions that would hopefully help the authors improve the paper, but otherwise the paper is well worth publishing in ACP.

Thank you very much for the thoughtful assessment and constructive suggestions that are very useful to greatly improve our manuscript. Before addressing the specific comments, we note that the folding-related results have been reorganized in the revised manuscript. Doppler-velocity folded columns are now treated as candidate extreme-updraft (EU) columns throughout the manuscript. The former standalone folding-ratio figure, originally Fig. 10, has been incorporated into revised Fig. 6, where the MaxVd-based SU ratio and the Doppler-velocity folded-column (EU) ratio are shown side by side as functions of CTH and ETH(0 dBZ). The folded-column CFAD requested by the reviewer has been added as panel (c) of revised Fig. 3 and is now described as the EU-column CFAD.

Major comment ---

As the authors are aware, a major technical limitation of EarthCARE CPR is the velocity folding, hindering measuring very intense convection with a Vd exceeding the Nyquist velocity (~5 m/s). I think that Section 3.3 would benefit from an additional plot or two demonstrating the extent to which vigorous convection is made inaccessible by the Vd folding.

1) In Figure 10, color scale is saturated in reddish pixels especially near the top-right corner: the values can be 0.2 or possibly as high as, say, 0.5 but I can't tell. If the number is close to 0.5, that would mean that aliasing occurs almost as often as it doesn't. The color scale can be adjusted to avoid saturation, or

alternatively a similar PDF plot could be added with the folding occurrence normalized by the unfolding occurrence (instead of the total) to better emphasize the domains with a high occurrence of folding.

We agree that the original Fig. 10 color scale did not adequately show the high-folding-frequency regime. In the revised manuscript, the former Fig. 10 has been incorporated into revised Fig. 6. Revised Fig. 6 now shows both the MaxVd-based SU ratio and the Doppler-velocity folded-column ratio, with an expanded color scale for the folded-column ratio to avoid saturation.

After revising the folding criterion, the overall folding fraction increased, and the high-frequency regions became clearer. We have revised the color scale in revised Fig. 6 to avoid saturation and added quantitative statements in the text. Specifically, in the extreme cases with CTH >= 11 km and CTH - ETH(0 dBZ) <= 0.5 km, more than half of the selected convective columns are now flagged as folded. This emphasizes that velocity folding marks a regime in which quantitative MaxVd is unavailable and the folded columns must be interpreted separately.

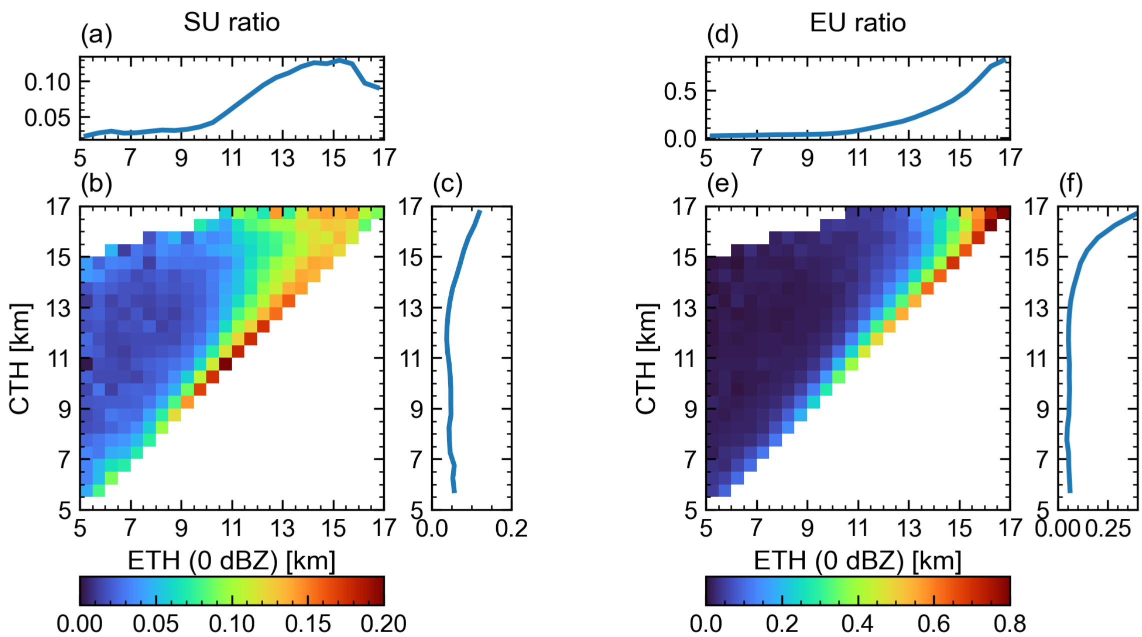

Figure 6 in the revised manuscript. Occurrence ratios of SU columns and EU columns as functions of ETH(0) and CTH. (a–c) SU ratio and (d–f) EU ratio. The SU ratio is defined as the number of non-folded columns with MaxVd > 2.0 m s^{-1} divided by the total number of selected convective columns in each bin. The EU ratio is defined as the number of folded columns divided by the same denominator. Note that the SU and EU panels use different color scales. Panels (b) and (e) show two-dimensional ratios in the CTH–ETH(0) phase space; marginal ratios are shown as functions of ETH(0) and CTH.

2) I would like to see a CFAD for Vd-folded columns only. How would it compare with Figure 3, in particular the SU CFAD?

Thank you very much for such a nice suggestion. We now have added the requested folded-column CFAD as a new figure. Because the measured Vd values in folded columns are aliased, the CFAD focuses on reflectivity rather than the aliased Doppler velocity. The folding-based EU CFAD shows that folded columns occupy an extreme structural regime relative to the MaxVd-based SU population, with high reflectivities extending to high altitudes. We now added some discussion referring to this result in the revised manuscript.

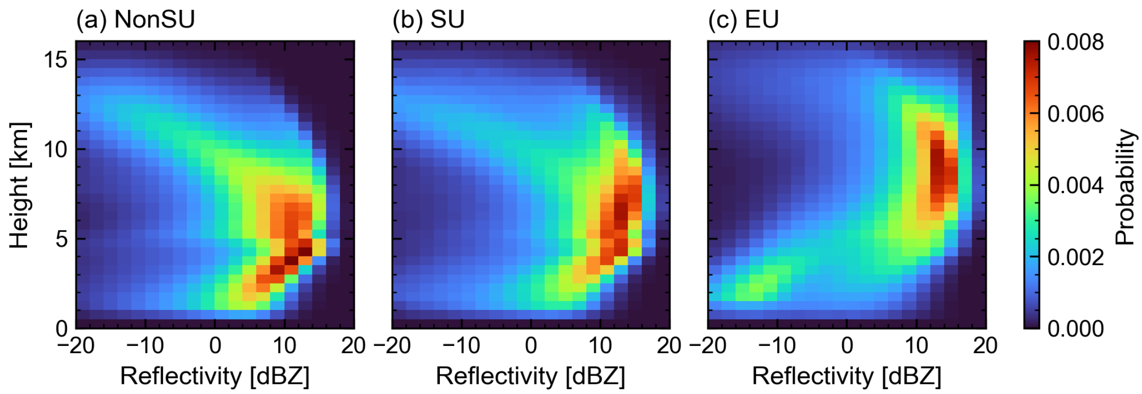

Figure 3 in revised manuscript. Normalized contoured frequency-by-altitude diagrams (CFADs) of EarthCARE/CPR radar reflectivity (Ref; dBZ) for (a) non–strong-updraft (NonSU) columns, (b) strong-updraft (SU) columns, and (c) extreme-updraft (EU) candidate columns. Reflectivity is binned in 2 dBZ intervals, and the vertical coordinate is binned in 500 m intervals. Each panel is normalized by its total number of height–reflectivity samples such that the color indicates probability (i.e., the sum over all bins in each panel equals 1).

Specific points ---

l.25: "determines" might be a little too strong a word here. Something like "accounts partly for" may sound better. The maximum height of convection depends on many factors including environmental stability (LNB) and entrainment rate. Updraft certainly correlates with the maximum height but is not the sole reason for it.

We agree and have softened the wording as follows.

“The strength of these updrafts also contributes to the maximum height reached by convective clouds and the horizontal extent of their anvils.”

l.30: For the same reason as above, "...are controlled by" could be toned down to "...related to the strength of" or something like that.

We agree. We replaced “are controlled by” with softer wording as follows.

In addition, the heights and lifetimes of deep clouds, which are affected by updrafts, exert a strong influence on the planetary energy budget by reflecting incoming shortwave radiation and trapping outgoing longwave radiation (Ramanathan et al., 1989; Hartmann et al., 2001).

l.156: Where does the threshold of -19 dBZ come from? Would you be able to add a reference?

Thank you for noting this omission. We have added a reference to Hagihara et al. (2023), who evaluated Doppler-velocity uncertainty as a function of radar reflectivity and showed that random errors increase at low SNR. We also clarified that -19 dBZ is used as a quality-control threshold to remove unreliable Doppler estimates, not as a physical threshold separating cloud regimes.

l.204: Multi-layered clouds in Figure 1 look confined to x=100-120 rather than "column indices 80-180" as indicated. I am wondering why a large portion of the cloud layer between x=80 and 260, which seems to clear all the filtering criteria, is missing in Figure 1c except for sparsely survived columns.

We are sorry that the original description of the multilayer cloud region was inaccurate. We corrected the column-index range from “80-180” to approximately “100-120.” We also clarified why many radar-echo columns between approximately x = 80 and 260 do not appear in Fig. 1c. Panel 1c shows only columns that pass both the convective-selection criteria and the Doppler-quality filters, not all radar echoes. Columns are removed, for example, when cloud layers are vertically separated, when the cloud-top temperature is warmer than 258.15 K, when the cloud-base temperature is colder than 273.15 K, or when insufficient valid Doppler pixels remain after quality control. We revised the manuscript to make this point explicit.

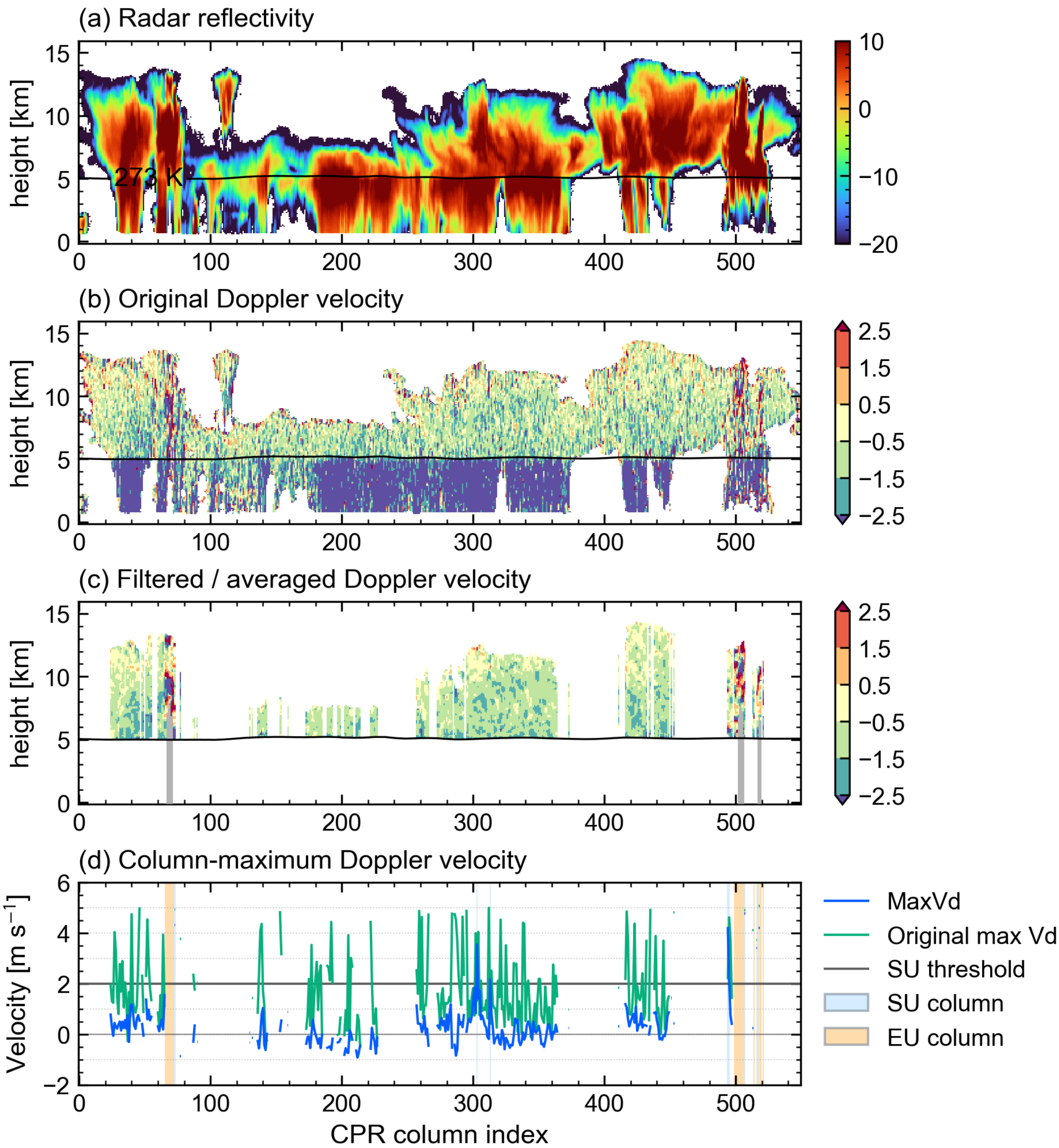

Figure 1 in the revised manuscript. Example illustrating Doppler-velocity quality control, folding detection, and the definition of the updraft metric MaxVd for an EarthCARE/CPR scene. (a) Radar reflectivity factor (Ref; dBZ). (b) Input CPR_CLP Doppler velocity (Vd; m s^{-1}) after applying only the cloud-mask threshold (cloud mask ≥ 20); positive values indicate upward motion. The black line marks the 273.15 K isotherm. (c) Doppler velocity after applying the column-selection criteria and quality control. Gaps indicate columns or gates for which no valid Doppler velocity remains after column selection and quality control. Grey shading near column indices approximately 70, 500, and 510 denotes gates flagged as being affected by multiple scattering. (d) Column-maximum Doppler velocity as a function of column index, computed from the input field in (b) for visual comparison ("Original"; green) and from the filtered and averaged field in (c) for the quantitative metric ("MaxVd"; blue). Light-orange shading denotes columns flagged as folded and classified

as extreme-updraft (EU) candidate columns. Light-blue shading denotes columns with MaxVd > 2.0 m s^{-1}, classified as strong-updraft (SU) columns.

l.212: To my eyes, a convective tower around x=60-80 is obviously affected by velocity folding but is not marked as grey. The filtered MaxVd there exhibits a sudden jump, which I am afraid might be an aliased artifact that failed to be filtered out for some reason. Do you have any comment on this?

We thank the reviewer for identifying this case. We re-examined the tower near column indices 60-80 and found that the original folding detection missed this example. In the revised analysis, we apply the updated folding criterion, and this region is now flagged as folded. We therefore updated Fig. 1 and repeated the statistical analysis throughout the manuscript using the revised folding flag.

l.235-239: I agree that the targeted life stages and de-aliasing/averaging operations are among the reasons why Vd is much smaller than the typical updraft velocities as known in the literature. That said, it seems to me that a more essential reason may be that Vd is not updraft velocity itself. Vd can be far lower in magnitude than updraft, or even negative (falling) within an ascending cloud air, in the presence of large precipitating ice. The Z-weighted terminal velocity depends heavily on large particles and even a limited amount of large particles could have an overwhelming effect. You can see how Vd differs from updraft velocity even above the freezing level in Figures 2-4 of Heymsfield et al. (2010).

We fully agree. This is an important clarification. We added text explaining that CPR Doppler velocity is a reflectivity-weighted hydrometeor Doppler velocity, not the air vertical velocity itself. In the presence of large precipitating ice particles, the reflectivity-weighted terminal fall velocity can substantially offset upward air motion, as the reviewer pointed out. As a result, Vd can be much smaller than the true air updraft velocity, or even downward, within ascending cloudy air. We also have added Heymsfield et al. (2010) as a reference to this additional argument, as the reviewer suggested.

l.270: "strong updraft loft large hydrometeors" may be only a part of the story. A strong updraft may also promote the production (deposition) of ice particles and a subsequent growth by aggregation or riming at a higher altitude than a weaker updraft.

We agree that dynamical lofting is only a part of the interpretation. We revised the sentence to include both lofting and microphysical growth processes, including ice production and growth by deposition, aggregation, and riming at higher altitudes.

l.296: "Relation" may be a better word for "interplay" in this context?

Corrected. We replaced “interplay” with “relation” in this context.

l.370-373: I would suggest that you consider to mention Jeyaratnam et al. (2021, https://doi.org/10.1029/2020GL090675) as well. Their Figure 4 looks consistent with the present result.

We thank the reviewer for this useful suggestion. We added Jeyaratnam et al. (2021) to the discussion and now mention that their satellite-based vertical-velocity estimates show behavior consistent with our regional contrast. This connection helps place the EarthCARE Doppler-based results in the context of earlier satellite-based estimates of convective vertical velocity.

Reference: The reference list can be improved for readability by applying a hanging indent. The publisher will take care of it anyway but it will be easy for authors to do that.

Thank you for this suggestion. We checked the current Copernicus Word template and retained the template formatting for the reference list. The template examples do not appear to use an explicit hanging indent. We therefore did not manually apply additional indentation. The final layout will be handled during production if further formatting is required.