Reply to editor comments on egusphere-2024-3981

Evidence of Tropospheric Uplift into the Stratosphere via the Tropical Western Pacific Cold Trap by Sun et al.

P2, L33: add “by” so that it reads “These cold temperatures significantly modify the pathways of air masses by dehydrating air and by the release of latent heat.” Or change the latter part to “……..and releasing latent heat.”

Added.

P2, L42: troposphere -> tropospheric

Corrected.

P3, L74-75: Add “used” so that it reads “Further details about the lidar measurements used in this study will be given in Sect. 2.” However, I think this sentence is obsolete and should be deleted since almost the same is stated in the next paragraph.

Thanks, we’ve deleted this sentence.

P3, L76: Instead writing “In the following” I would suggest to write “In Sect. 2….”.

Corrected.

P3, L78: delete “in Sect. 2”.

Deleted.

P3, L81: “For an improved representation” not clear. Do you mean an improved representation of the results in this paper?

Deleted.

P3, L80-83: The text would be better readable if you would just write what is found in Section 3 without referring to every single subsection.

Corrected.

P3, L82-83: Rather write “In the discussion (Sect. 4) we provide …….and use this to discuss…….”.

Corrected.

P3, L84-85: Either rephrase the sentence to be more clear or just write “In Sect. 5 conclusions are drawn.”

Corrected.

P3, L90: add “measurements” or “observations” after “lidar” and replace “is” by “are”.

Corrected.

P4, L93 and 97: Make one paragraph from these three paragraphs.

Corrected.

P4, L94: operating -> operations

Corrected.

P5, L132: Here and later ERA5 has been used, but ERA5 or any other reanalysis data has been described in the method section. Thus, at least one or two sentences plus references as for NCEP should be added here.

Thanks, we've added the references here.

P5, L133: Remove "the" before "Appendix".

Removed.

P5, L136: This is not clear. How can you derive information about condensation and dehydration from the cloud measurements? The presence of the clouds may be related to condensation, but not dehydration. Please rephrase the sentence.
Reply:

Thank you for pointing out this confusion. Indeed, the lidar cloud measurements alone only directly indicate the presence of condensation processes, as clouds form by condensation. Dehydration, however, is inferred indirectly because cloud formation implies that water vapor has condensed into ice particles, thus potentially removing moisture from the air parcel. We acknowledge that lidar data alone do not directly measure dehydration. We will rephrase this sentence clearly to specify that dehydration is an inferred rather than directly measured process.

We rephrased this sentence in L136:

"When these clouds are detected, it suggests that condensation processes have occurred, potentially leading to associated dehydration of air masses through the removal of water vapor by ice particle formation."

P5, L138: Also here the sentence need to be revised. How can you just from the location of the trajectory in relation to the cloud top/bottom make statements on condensation or dehydration. I do not understand what physical mechanism should be behind this. Further, as your trajectory comparison shows differ the results between the trajectories significantly, thus, the location of the trajectory above or below the measured cloud could also be just related to model uncertainty.

Reply:

We agree with your comment that the vertical displacement of trajectory points relative to the cloud layers does not directly provide evidence of dehydration processes. Our intended meaning was to use the vertical displacement observed from the trajectory model as an indicator of general vertical motion (uplift or descent) of air masses after clouds are detected.

We will clarify in the manuscript that vertical displacement inferred from trajectories serves only as an indicator of possible vertical transport pathways, and explicitly acknowledge model uncertainties. For the uncertainties, we compare two trajectory models with different reanalysis data and vertical cordite approaches, as shown in the appendix. We also have rephrased these sentences to illustrate our concern about uncertainty by two trajectory comparisons:

"…When considering potential uncertainties arising from trajectory models, we compared calculations using these two models. Although the comparisons revealed differences and inherent uncertainties (See Appendix A), they show a consistent circulation pattern: air masses move upward/downward toward the cloud layer from lower altitudes in backward trajectories, and subsequently move upward/downward away from the cloud layer toward higher altitudes in forward trajectories. This pattern supports the inference of an ascending/descending transport process."

P7, Figure 1: Space between panel c and d is missing.

Corrected and space between panels was added.

P7, Figure 1 caption: remove space between “30” and degree sign.

Corrected.

P8, L178: Put “Fig. 2c” in parentheses.

Corrected.

P9, Figure 2: Remove “the” before “upper cloud” and “lower cloud” in the figure panels of Fig 2 a and b.

Removed.

P9, Figure 2 caption: “as a function of time corresponds to Fig. 3a.” not clear. Remove this text part.

Also remove “The backscatter ratio (BSR) at 532 nm as a function of time and altitude” since this sentence appears twice. The reference to Section 2 is not necessary here, I would suggest to omit this here.

Corrected.

P10, Figure 3 caption: put “Fig. 2” in parentheses and replace “in” by “for” and change “see supplement Fig. S1 and S2” to “see Fig S1 and Fig. S2”. Further, I would suggest to write “for the winter case (Case 1)” (thus omitting “corresponding to”).

Corrected.

P11, L229: remove space between opening parenthesis and “Fig.”

Corrected.

P11, L239: will be -> can be found (?)

Corrected.

P11, L243: which case? Case 1 or Case 2. Generally, you could make more usage of the already introduced naming of cases to make it easier for the reader to follow.

Corrected.

The same phrases for the “case” were corrected in the following draft.

P11, L247: Lidar -> lidar and replace “case” by “study” and change “previous studies in other regions” to “in previous studies over other regions”.

Corrected.

P12, L252: you mean in an extremely cold “cold trap”?

Yes, we mean an extremely cold "cold trap." Specifically, we refer to conditions characterized by extremely low tropopause temperatures, which enhance dehydration processes and thus strengthen upward transport over the TWP during NH winter. We will clarify this in the revised text.
We rephrased it as:

"This contrast aligns with … supporting enhanced upwelling over the TWP under conditions of an extremely cold 'cold trap' …"

P12, L253: add “is found” after analysis.
Added.

P12, Figure 4 caption: Add “Case 2” after “1 August 2022” and replace “in” by “for”.

Added.

P13, Figure 5: Remove “the” before “upper cloud” and “lower cloud”.

Removed.

P13, Figure 5 caption: Replace “in” by “for” and add after case “Case 2” and delete “corresponding to Fig. 4”.

Corrected.

P13, 261: Replace “Same to the” with “As for the”

Corrected.

P13, L261: This is not clear. Are you calculating here different trajectories or do you just consider another parameter along the trajectories?

Reply:

We did not perform separate trajectory calculations for potential temperature. Instead, we computed potential temperature as an additional meteorological parameter along the previously calculated trajectories. Thus, the trajectories themselves remain the same; potential temperature is presented to illustrate the quasi-horizontal nature of transport over the TWP.

Rephrased as:

“Additionally, we present potential temperature as an additional meteorological parameter along the previously calculated trajectories to illustrate the quasi-horizontal transport over the TWP."

P13, 263: Remove sentence “The trajectory setup details are described in Sect. 2.3 and Appendix A.” Just add in parenthesis “see Sect. 2.3 and Appendix A”.

Corrected.

P14, Figure 6 caption: “For the clarity of display, the trajectory points in the figure are sparsified at intervals of 24 points (24 h).” not clear. Does this mean you have an hourly output and only one point per day is plotted?

Yes, for the clarity and not overwhelming the plot with 1-h interval output. We cut this sentence in the caption. And added the sentence in L264:

“Although trajectories were calculated hourly, points are plotted here at daily intervals (every 24 hours) to enhance visual clarity. All trajectories were originally calculated over 20 days, but only the first 10 days are presented here to avoid overwhelming the figure; full 20-day trajectories are shown in Fig. S3 in the supplement.”

P14, Figure 6 caption: “For 20-d trajectories with similar results, please see the supplement Fig. S3.” This sentence is also not clear and such a remark should rather appear in the main text than in the figure caption. Please rephrase or omit this sentence. I also do not really understand why you have two sets of trajectories, one 20d and one 10d?

Reply:

Here we want to present 10-day backward and forward trajectory results of air masses corresponding to Fig. S3 in the supplement. While all trajectory calculations in this study were performed over 20 days, only 10-day trajectories are shown in Fig. 6 to maintain visual clarity. Here, the complete 20-day trajectories are presented to provide comprehensive information without overwhelming the main manuscript.

P14, L280: Fig. 8 -> Fig. 7

Corrected.

P15, 283: ranges corresponding to -> ranges correspond to (?)

Corrected.

P15, L288: Remove parentheses around the references and add “are” after “but”.

Corrected.

P15, L308-309: Delete sentence “The inter-hemispheric mixing controls the origins of air masses from the northern or southern hemisphere in the tropics.” since it appears here for the second time.

Corrected.

P16, L316: compare Fig. 1 -> see Fig. 1

Corrected.

P16, L319: delete “in Fig. 9c” since Fig. 9c has just been referred to.

Corrected.

P16, L324: Tab. 1 -> Table 1

Corrected.

P17, L339: sinking -> descending

Corrected.

P18, L344-345: Delete “in a white dashed line”. This should rather appear in the figure caption. However, in the figure I cannot see any dashed white line.

Deleted.

P18, L351: ……leading to dehydration of air parcels and cloud formation…. How do you achieve this? Cloud formation and dehydration are not measured. Please rephrase the text.

Rephrased:

“… cloud formation …, as inferred from our lidar observations of cirrus clouds and relative humidity profiles in December.”

P18, L352: we -> was

Corrected.

P18, L368: What is a/the “triple La Nina”?

Cut triple.

P18, L373: Sec. 3.4 -> Sect. 3.4

Corrected.

P18, L373: add references for the QBO phases.

Added.

P18, L378: Remove "(marked as a grey shaded area and dashed curves on the bottoms of Fig. 9a and b)"

Corrected.

P19, L399-400: Rephrase/Correct sentence "In consistency with other studies Randel and Park (2019); Pan et al. (2016), their work shows the possible pathway of air masses toward the TWP on the one hand."

Reply:

Corrected as:

Honomichl and Pan (2020), using ERA-Interim data from 1979–2017, analyzed transport pathways from the ASM via the western Pacific anticyclone to the western Pacific, consistent with other studies (Randel et al., 2019; Pan et al., 2016), highlighting potential air mass transport routes toward the TWP.

P19, L405: Lidar -> lidar

Corrected.

P19, 407: What about the uncertainty of the trajectories? Couldn't it be that just the trajectories are not accurate enough?

Reply:

Thank you very much for your questions. Indeed, trajectory calculations inherently contain uncertainties and may not always be fully accurate. To evaluate and address this uncertainty, we performed trajectory analyses using both the ATLAS and HYSPLIT models and compared their outputs. As discussed in detail in the Appendix, we quantified differences between these two trajectory models and examined the sources of discrepancies. Our analysis indicates that the primary cause of uncertainty between ATLAS and HYSPLIT trajectories arises from differences in their representation of the vertical coordinate. Importantly, artificial effects related to the kinematic vertical velocity calculations primarily occur only towards the very end of the 20-day trajectories. Apart from this, both models consistently show the same seasonal transport pattern: ascending air masses in winter and descending in summer, providing confidence in our conclusions despite these acknowledged uncertainties.

We added the following sentence in L431 for the uncertainty of the trajectories:

"To account for the uncertainty inherent in trajectory calculations, we compared trajectory results from two Lagrangian transport models, ATLAS and HYSPLIT, confirming that both models consistently show the same seasonal transport patterns, with discrepancies primarily arising from differences in vertical coordinate."

Section 4: The discussions is extremely long, thus consider shortening.

We split the discussion section into two sections, one is a subsection in the result section for the different transport pathways (With Fig. 9) and another is the discussion section.

P22, L477: Add references for the trajectory studies.

Corrected.

P23, Figure A1: Add altitudes for the upper and lower cloud.

Corrected.

P23, L481: Write “Case 2 (December)”

Corrected.

Put Fig. A1 and A2 on one page and Fig. A3 and A4 so that these can more easily be compared.

Corrected.

Appendix Figures: Remove “the” before upper cloud and lower cloud and add altitudes.

Corrected.

Figure A5: Also add here the altitude for the upper and lower cloud.

Added.

P26, L491: has been partly available -> has been partly made available (?)

Corrected.

P26, L496: Remove comma before Hersbach et al.

Corrected.

Supplement:

• Supplementary figures should be labelled as Fig. S1, Fig. S2 and so on.

Corrected.

• Remove in all figures “the” before upper cloud and lower cloud.

Corrected.

• Add the altitude for the upper and lower clouds.

Added.

• Replace “in” by “for” so that it reads “for the winter” add which Case you are referring to (Case 1 or Case 2).

Corrected.

• Don’t repeat the entire caption text. Write “As Fig. xx, but……” and point out the differences to the other figure.

Corrected.

• Fig. S3 caption: What is meant with simulation results? Once you calculate 10d trajectories and once 20d trajectories. Why you do this did not become clear while reading your manuscript.

Reply:

Here we want to present 20-day backward and forward trajectory results of air masses corresponding to Fig. 6 in the main manuscript. While all trajectory calculations in this study were performed over 20 days, only 10-day trajectories are shown in Fig. 6 to maintain visual clarity. Here, the complete 20-day trajectories are presented to provide comprehensive information without overwhelming the main manuscript.

Best regards,

Co-authors