

Interactive comment on “Composition of cirrus-forming aerosols at the tropical tropopause” by K. D. Froyd et al.

K. D. Froyd et al.

karl.froyd@noaa.gov

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We thank the anonymous referee for their helpful comments and particularly the suggestion to present the CVI rejection efficiency. Below are the referee's comments and author responses.

Major point: Have sufficient in-flight tests been conducted to confirm that the CVI strictly suppresses ambient and interstitial aerosol from entering the sampling line? With the much higher abundance of ambient aerosol particles (200-500 times higher abundance is stated p. 20356, l. 19) even a small fraction of $\sim 0.1\%$ of these particles entering the CVI inadvertently would influence the cirrus residue measurements significantly. Because the composition differences between the unfrozen aerosol and the ice residual particles are small, it is even more difficult to exclude this possibility. Interpretation of

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the data and the hypothesis of a "non-conventional" freezing mechanism (p. 20358, l. 5) hinges on the highly reliable performance and perfect selectivity of the CVI.

Response: We agree that demonstrating a low CVI background is important for the major points in the paper. We have determined the CVI rejection efficiency for the SVC region and further down in the TTL and compared this value to previous values. The CVI rejected ambient aerosols to better than the 1 in 11000 level. Therefore, particles detected within SVC are not simply background aerosol that penetrated the counterflow. We have added this text to the paper: "The CVI must reject ambient and interstitial aerosols with a very high efficiency in order to identify particles detected within SVC as cloud residuals. In the TTL and SVC forming regions (12-17.5 km) the PALMS acquisition rate while sampling outside cloud with the counterflow on was < 0.000074 Hz. The average aerosol rate outside cloud with no counterflow was 0.14 Hz. Adjusting for inlet aspiration efficiencies, the CVI inlet rejected TTL aerosols with an efficiency $> 99.99\%$ (1 in 11250). This is similar to previous determinations of $> 99.98\%$ in the subtropical upper troposphere (Cziczo et al., 2004b). Similarly, the data rate with the counterflow on was 800 times higher during SVC penetrations than outside cloud."

Minor points: 1) how did the authors conclude that the SVC clouds were not associated with recent convective systems and that they can be assumed to have formed in situ (e.g., p. 20353, l. 13)? Was this only based on the observed crystal sizes or has an analysis similar to Froyd et al., 2009, been performed?

Response: The text has been changed to: "Most tropopause level cirrus in this study were not directly associated with recent convective events and are presumed to have formed in situ from aerosols that slowly ascended through the tropical tropopause layer (TTL). This observation is based on 1) in situ data that did not show lower tropospheric characteristics for long-lived gas phase species (Park et al., 2007), short-lived gases (Ridley et al., 2004), or aerosol composition; 2) minimal convective influence using a trajectory based analysis (Froyd et al., 2009); and 3) flight camera and satellite imagery analysis."

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2) p. 20350, l. 13-22: how did the authors realize the switching between the measurements with and without a CVI counter flow? Was the start of the CVI counter flow triggered by other measurements (e.g. the 2-DS signal) indicating the presence of the SVC or did you just switch automatically between the two measurement modes? How frequently did you switch and how long did you wait after switching to be sure that all particles from the previous mode have been cleared from the sampling line?

Response: Inlet mode switching was built into the automated sequence for the instrument and occurred regularly throughout the flights. Additionally, when in cloudy regions the co-pilot could manually send the instrument into a mode where CVI sampling was increased. We have added the following statement to the text: "Inlet mode switching was automatic during flight, but CVI sampling time could be manually increased by the WB-57 instrument operator in cloudy regions."

3) Fig. 3: Can you give errors for the CAPS and CPI IWC measurements. Do CAPS and CPI agree with each other within the error bars?

Response: We assume that the referee is referring to Fig 2 (IWC in Fig 3 is from the 2D-S instrument, as indicated in the caption). The purpose of Fig 2 is simply to demonstrate that secondary particle generation in the CVI inlet correlates with the abundance of large cloud particles (effectively, IWC). Accurate IWC values are not an essential result for the current study, and in the text we refer readers to Lawson et al, 2008 for detailed discussion of in situ measurements of the SVC clouds encountered during this mission. Briefly, because CAPS is sensitive to smaller cloud particles, CAPS values of IWC are factors of 10-50 higher at $IWC=0.01 \text{ mg m}^{-3}$. CAPS and CPI IWC values agree to within about a factor of 2 at $IWC>1 \text{ mg m}^{-3}$, where residual particle contamination becomes problematic.

4) Figure 5 is very small.

We will request that the figure be enlarged for the final production version.

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