Author comments and responses to J. Rudolph (Referee)

First of all, the authors would like to thank J. Rudolph for his insightful comments on this draft, which definitely improve the quality of this paper. Based on the interactive comments by J. Rudolph, the authors have carefully revised the paper. Below are the authors' responses to the specific question or comment.

i) The paper presents results of a variety of blank tests, however it is not always clear which process contributes to the blank and to which extent the blanks indeed can be ascribed to specific parts of the procedure. The results in Table 3 strongly suggest linear dependence between the magnitude of the blank and sample volume and/or sample collection time. Is there any information which would allow separating the two possible influences?

Answer: There are two different blanks addressed in the paper: Schütze blank and ice blank. The Schütze blank arises from the cryogenic vacuum extraction system itself. While the origin of the Schütze blank is not clear, it is likely impurities from the ingredients used to make the reagent are responsible for the majority. Another possibility is outgassing from the viton o-rings, however after three years' use the blank has not changed appreciably. All viton o-rings were originally baked out at 130ºC for 24 hrs after which the blank was unchanged. The ice blank arises from the cleaning process of ice and wet extraction process. To derive the final CO concentration or isotopic ratios for ice core samples, the signal from these two blanks is subtracted from the sample signal with a mass balance calculation. Therefore, characterization for blanks is very crucial for our results. The Schütze blank signal (table 3) is believed to be proportional to the collection time rather than the sample amount. First, the CO concentration of the zero air used to determine Schütze blank is estimated to be less than 1 ppbv based on the conventional extraction method by processing hundreds of liters of sample. Second, with the same collection time, doubling the flow rate from 50 mL/min to 100 mL/min only increases the Schütze blank by 10%, indicating the Schütze blank is not sensitive to sample volume at all.

ii) The impact of blank size on the results depends on sample volume, difference in isotope ratios between blank and sample and potentially a range of other factors. I could not find a clear explanation of how the measurements were corrected for blank values (if they were) or how the results may be biased by the blank values and how the blanks will impact the reproducibility of the results. It is also somewhat confusing that the blank values for tests are typically given as pmol CO, whereas the results of sample analysis are given as ppb. This makes it very difficult for the reader to form an own opinion about the possible bias and uncertainty resulting from blanks.

Answer: As mentioned above, a mass balance calculation based on the peak area and isotopic ratios of both the Schütze blank peak and sample peak is applied to subtract the blank signal from the sample signal. The system blank is crucial for the ice core data since it accounts for ~30% of the total signal. We have carefully characterized the blanks for each sample, including the CO concentration and isotopic ratios of blanks. Finally, we get the precisions listed in table 4. The blanks are given as pmol because we test different

volume sizes and this CO blank signal will be normalized to ~100 mL of air released from each ice core sample. Generally speaking, the number of pmol multiples 0.2 and roughly gives the number of ppbv. The final blank signals have been added in table for the ice core data.

iii) The light dependence of blank values was determined using artificial ice samples. This may not be truly representative since light induced formation of CO will depend on the composition of the ice. This needs to be discussed briefly.

Answer: The test of light dependence of blank gives the information that the CO contamination during the ice preparation process arises from the CO residual on any surface or the in situ oxidation of any organic compounds on the ice surface. We do not discuss the details for the mechanisms of in situ production of CO in the ice in this paper since we believe Antarctic ice cores are free of in situ production of CO. Details on in-situ production of CO in ice have been discussed in Z Wang, PhD thesis, Stony Brook University, 2009.

iv) There are some statements in the text and discussion which may be better suited for the conclusions, need to be supported by evidence, or simply may be deleted: - Line 19-23, page 2693: “Use of a Teflon beaker was also investigated: : :.However permeability limits: : :” It is not clear what the consequences of the permeability were and what was tested. - Bottom of page 2693:

Answer: This part has been revised. The permeability of major components of air across a Teflon film limits the use of this material (MSDS from Dupont) because it is impossible to evacuate the Teflon container with ice sample inside. Tedlar was investigated as a low permeable substitute (MSDS from Dupont) for Teflon. However, the rigidity of Tedlar film makes it quite difficult to engineer a Tedlar liner and gives no advantage.

“Clearly an old fashioned Toepler pump: : :..” This is a somewhat farfetched conclusion since no tests using a Toepler pump are presented or cited which would support this statement.

Answer: Brenninkmeijer 1983 and Brenninkmeijer, p. comm. have been cited.

Chapter 2.2 starts with a statement that sounds more a like a conclusion than an explanation of what was done.

Answer: it has been changed.

v) The paper contains many grammatical errors and poorly phrased sentences. They are too many to list here. I strongly suggest that the language and grammar is checked thoroughly be a native English speaker.

Answer: the paper has been checked thoroughly by a native English speaker.