We would like to thank the referee 1, Hugh Pumphrey, for the helpful comments. We agree with everything said in the general remarks and will reply to the specific comments and technical corrections below.

1 Answers to specific comments

- Page 4217, line 15 (Long-term perspective of using SABER temperatures): This is indeed a good point, since one of the major future goals is to obtain a long-term time series of CO using KIMRA. However, as you mention, performing a reliable and consistent microwave measurement is still a challenging task and we want to exclude as many potential error sources as possible in this first stable retrieval version. So we decided to use the SABER measurements for two reasons. First, they are probably the best temperature data for the relevant region at the moment, as you mention. And second, for the planned near future application of the retrieved KIMRA CO data, the presented period is sufficient. However, the retrieval could easily be performed with alternative temperature datasets once the long-term feature comes more into the focus and SABER temperatures are not available anymore. Then the complete dataset should be retrieved again and the influence of the alternative temperature dataset could be established by comparing the new retrieved dataset to the presented, reliable version. In all cases, we have to use external temperature data, since the temperature cannot be retrieved from the KIMRA microwave spectra. We will add a comment on this in the revised paper.

- Page 4218, line 14 (Standing waves): We agree, that this is one of the main technical problems in microwave radiometry and we also agree that this discussion is too short in the manuscript. This is due to the fact, that for our particular case, the standing waves turned out not to be a major problem for the retrieval, since they have rather large wavelengths and can therefore easily be distinguished from the relatively narrow CO line. We fit three different wavelengths (55 MHz, 36.6 MHz and 27.5 MHz) with amplitudes of approximately 0.1 K. We will include this information in the revised paper. The measured spectrum in Fig. 2 was actually a corrected one, however a difference to the original measurement is small. We will additionally include the original spectrum in the revised version.

- Page 4219 and Figure 2 (Show spectrum of a priori $F(x_a)$ in Fig. 2): We think that adding $F(x_a)$ to Fig. 2 could lead to confusions. The reader might think that the change of the spectrum from $F(x_a)$ to $F(\hat{x})$ directly corresponds to the change from the CO a priori to the CO retrieved profile shown in Fig. 3. However, the state vector contains at this point more than CO and particularly the continuum absorption contributes significantly to the change from $F(x_a)$ to $F(\hat{x})$. Therefore, we prefer not to include $F(x_a)$ in Fig. 2.

- Page 4228 and Figure 7 (Show vmr profile together with error contributions in Fig.

7): will be done.

- Page 4230 and Figure 9 (Include MLS CO time series for a visual comparison to shown KIMRA time series): We also think that this is a good first consistency check and did perform it in advance. This was simply not shown in the manuscript, to reduce the number of figures, and to focus on the KIMRA data as much as possible. But following this comment, we will include the MLS time series in the revised manuscript. You included a first cut of the MLS time series in the comment, so we in turn include both time series in this document (Fig. 1 and Fig. 2), showing similarity in all major features. Furthermore, more short-term structure is identified in the KIMRA measurements due to the averaging of the MLS profiles (collocation in circle with 500 km radius around Kiruna, collocated profiles averaged daily; MLS profiles convolved with KIMRA AVK). For a discussion of an appropriate color scale (log or 'squeezed' linear) see below.
- Page 4233, lines 23ff: will be done.
- Page 4239, lines 10-12: will be done.

2 Answers to technical corrections

- Page 4210, line 8: will be changed everywhere in the revised manuscript.
- Page 4211 line 10: will be changed in the revised manuscript.
- Page 4211 line 20: will be changed in the revised manuscript.
- Page 4212 line 25: will be changed in the revised manuscript.
- Page 4214 line 13: will be changed in the revised manuscript.
- Page 4215 line 11: will be changed everywhere in the revised manuscript.
- Page 4215 line 22: will be changed in the revised manuscript.
- Page 4216 equation 2: will be changed in the revised manuscript.
- Page 4216 line 6: will be changed in the revised manuscript.
- Page 4216 line 17: will be changed in the revised manuscript.
- Page 4217 line 9: will be changed in the revised manuscript.
- Page 4219/4254, Figure 2: The font size of the text 'sensitive range' is exceptional small, we will change this in the revised document. We have also checked that the other figures are not affected by exceptional small text and think that the standard font size chosen for the figures is appropriate.

- Page 4223 line 20: will be changed in the revised manuscript.
- Page 4228 lines 23-24: We will rewrite this point to clarify it in the revised manuscript.
- Page 4229 and Figure 8: We will omit all curves of the factor 1.5 case in the top panel and mention in the caption that data of the 0.5 and the 1.5 case behave similarly. This makes the top panel more clear, whereas the bottom panel still contains the most important information on both cases, namely the deviation from the standard case.
- Page 4229 and Figure 9: We generally agree, that using a log scale is appropriate for contour plots of the CO time series. However, this assumes that the CO vmr is never negative, which is of course valid in the real world. But as mentioned in the manuscript, the KIMRA measurements contain negative vmr overshoots, although KIMRA observes the real atmosphere. Therefore negative values are not unphysical from the KIMRA perspective (and the KIMRA AVK applied on the real world will also lead to negative vmr). Thus, negative values belong to the KIMRA dataset, which makes the log scale inappropriate for this particular case and led us to use the linear scale with a squeezed colorbar. One might think about excluding negative values from the plot (as done in Fig. 3 and Fig. 4, which contain again the KIMRA and MLS dataset respectively but use a log scale), but we think that this is not a complete representation of the obtained dataset. Therefore we prefer to use further on the linear scale. However we have modified the colorbar slightly, so that there is more contrast in the former orange region.
- Page 4231 line 8: will be changed in the revised manuscript.
- Page 4231 line 21: will be changed in the revised manuscript.
- Figures 10 and 12: We agree, that these figures contain a lot of lines. The only good way of simplifying the figures without adding additional figures to the paper, appears to be a reduction of the shown data to selected cases. We will do this for figure 12 in the revised paper. For figure 10, however, we did not find a self-contained subset of the curves. Furthermore we think that this figure is already clearer than figure 12 might be acceptable, so that we prefer to leave this figure as it is.

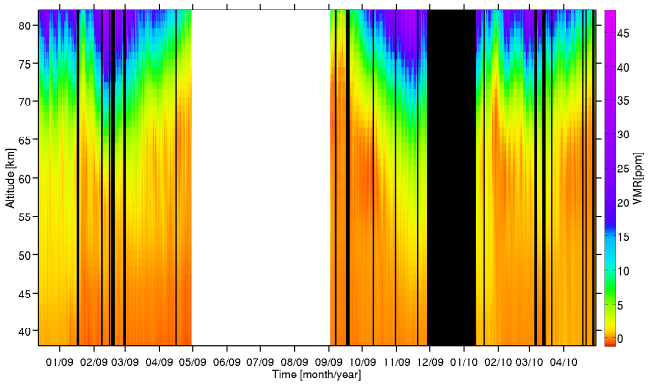

Figure 1: KIMRA time series with linear contours, which have been slightly modified to show more feature in the lower region.

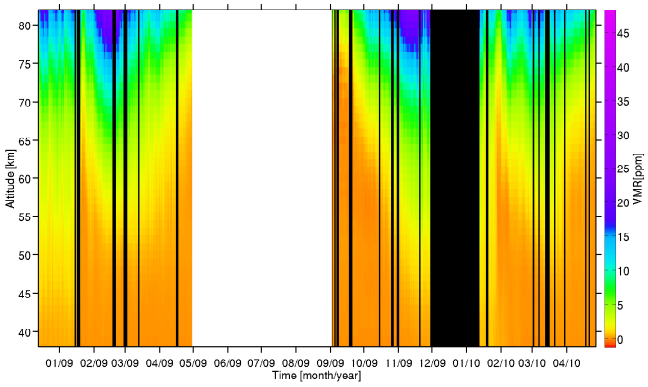

Figure 2: MLS time series corresponding to Fig. 1. Profiles within a circle around Kiruna with 500 km were considered. They were convolved with KIMRA AVK and averaged daily

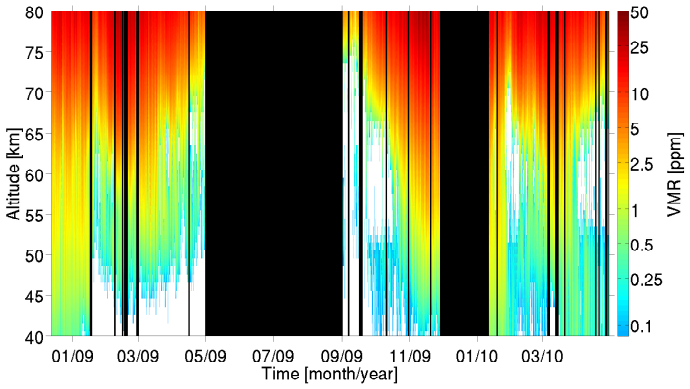

Figure 3: Same as Fig. 1 but in logarithmic color scale. Negative retrieval results have been removed.

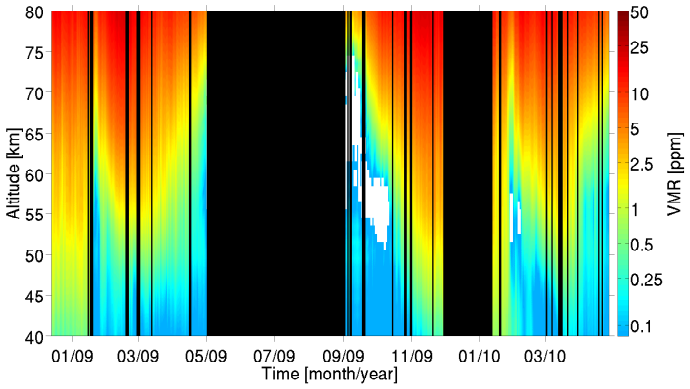

Figure 4: Same as Fig. 2 but in logarithmic color scale. Negative retrieval results have been removed.