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Interactive comment on “A new Himalayan ice core CH₄ record: possible hints on the preindustrial latitudinal gradient” by S. Hou et al.

Anonymous Referee #1

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The manuscript by Hou et al. presents and discusses results of atmospheric CH₄ mixing ratios, analyzed in two ice cores recovered from the Himalayan East Rongbuk Glacier on Mt. Qomolangma (Everest). The derived CH₄ record is spanning the last 1200 years, but the major part of the record is affected by artifacts which are assumed to originate from in-situ production. The authors thus applied different criteria to filter the record in order to remove biased samples. The filtered record, which may represent the true atmospheric mixing ratio is discussed and compared with model simulations of the CH₄ latitudinal gradient. The paper concludes that either the models might not get a correct balance between high and low latitude CH₄ or that also the filtered CH₄ profile may still contain some bias due to artifacts. The authors point to the fact that additional CH₄ records from high mountain ice cores are necessary in order to obtain more robust data. Due to disturbances related with melting and the warming of such

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glaciers, retrieval of such records becomes urgent.

This study makes a further effort to use glaciers from low latitudes to access CH₄ records from those regions. Such records have the potential to provide observational constraint for a better understanding of the relative weight of different CH₄ sources with time. This is an important addition to the existing and future records of CH₄ mixing ratios and stable isotope ratios obtained from the polar regions. The paper is clearly written and well structured. It openly and honestly discusses the remaining uncertainties in the conclusion of this study. This manuscript is an important contribution to the field as it may initiate further efforts, potentially with improved analytical techniques (laser based online measurements) in this direction of investigations. For the above reasons I can recommend the manuscript by Hou et al. for publication after minor revisions.

Specific comments:

Page 2474

Line 8-11: In total it seems that 3 cores have been retrieved. One from 2001 and two from 2002. However, the three cores are referred to only 2 acronyms: Core2001 and Core2002. This is a bit confusing. Are the two cores from 2002 combined into one record? How do they compare (profiles of proxies used for dating etc), how is their dating matched, why are they of different length etc? Please clarify.

Line 14: The borehole temperatures (around -10°C) are relatively warm compared to polar sites. An increase of the ice temperature to -5°C does not seem to really accommodate for gas analysis since it is known that storage temperature has a significant effect and should be as low as possible (e.g. Bereiter et al., GRL, 2009). I would therefore assume that in an optimal scenario, the core should at least have been kept at temperatures lower than measured in the borehole in order to accommodate for gas analysis. I am of course aware that this may not have been possible under the given circumstances of extreme environment (e.g. altitude) and logistic challenges. Nevertheless, the text implies such an optimal scenario. I suggest to change along the lines:

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“...due to circumstances of extreme environment and the apparent logistic challenges, the core temperature was tried to be kept as low as possible in order to accommodate for gas analysis but slight warming of the ice compared to the natural existing temperatures in the glacier (as determined by borehole measurements) could not be prevented.” A resulting potential (presumably small) increase in the in-situ production should also be shortly discussed.

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Line 15..: Is the bubble-free ice melted when adding and measuring the standard gas over it? If yes, might the blank correction not be too high since bubble-free is not necessarily equal to gas-free ice. Please comment and add to the text in order to clarify.

Chapter 3: What was the achieved measurement precision for those samples? This seems important due to the applied criteria to remove biased data points (see comment further down).

Page 2477

Dating: As mentioned before, Core2002 is in fact two cores, correct? How do those cores compare, are they independently dated? Is the presented CH4 data a combination of measurements done on both cores? Please clarify in the text.

Page 2477 and 2478 - Discussion to line 27:

1) The criterion does not seem to consider any measurement uncertainty. I would assume that this uncertainty is bigger than the used per-industrial growth rate criterion of max ± 1 ppmv applied to adjacent samples? If considering the uncertainty the resulting record might look different. Please comment.

2) Page 2478 line 19-20: “We then reject the high CH4 values when the growth rate calculated before or after them overruns this criterion.” I do not understand this sentence. Why after them? Would you in this case not remove the following point instead?



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I might have a general problem in understanding how this was done. Do you not need to assign one point (for which its value has to be assumed to reflect the true atmospheric signal) as the starting point and then successively apply the criterion to the points around it? Once you removed one point, is the criterion further applied to samples which are not next to each other (i.e. are not adjacent samples)? Dependent on how these criterion are applied and which point is used as the starting point a quite different “final” record may result. Please clarify and discuss in the text.

Figure 4:

For better understanding of the text on page 2479 and the understanding of Figure 4 it would be helpful if the values derived in this study (ER) and the measured values in the GRIP ice core would be included as data points (with error bars). This allows direct, optical comparison between the shown model output and the proxy data.

Page 2480

Line 14: change “...are also affected by less pronounced artifacts” to “...are still affected by artifacts which could not be removed with the applied criteria”.

Technical corrections:

Page 2472

Line 8-9: In order to be consistent with the notation in the main text (e.g. line 19-20), change “...which is $\sim 36 \pm 17$ ($\sim 73 \pm 18$) ppbv higher than the atmospheric levels recorded respectively in Greenland and Antarctic ice cores.” to “...which is $\sim 36 \pm 17$ ($\sim 73 \pm 18$) ppbv higher than the atmospheric levels recorded in Greenland (Antarctic) ice cores.”

Line 12: replace “infected” by “biased”

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