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Climate of the Past Discussions

Interactive comment on "Rapid changes in ice core gas records – Part 2: Understanding the rapid rise in atmospheric CO_2 at the onset of the Bølling/Allerød" *by* P. Köhler et al.

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The reviewer argues that the difference in the slopes between Greenland and EDC should be similar or larger than the difference in the slopes from the synthetic data (larger because of the existing interhemispheric gradient in methane, which is not considered in the synthetic data). It is furthermore argued, that from looking at the plot in our last response letter that the difference in the slopes in the ice core data is less than in the synthetic data. According to the reviewer "this is most clear in the decline of methane concentrations into the Younger Dryas, but it also seems to be the case for the Bølling".

We so far used in the last response letter an artificial CH_4 peak, which rose with a slope m of 2000 ppbv per century, or in detail 200 ppbv in 10 yr. However, this was chosen for the sake of argument to document how the filter works and for some estimates how the filter influences the input data. Because the original slope in the atmospheric CH_4 data during that time is not precisely known, other slopes are certainly reasonable and justifiable within our present knowledge. Simply by choosing other artificial CH_4 data with smaller slope m as input into our filter we are able to generate the behaviour which is according to the reviewer necessary (a smaller difference in the slope Δm of Greenland and EDC in the artificial data than in the ice core data, see table below). This is obtained from input data which have a slope m within a realistic range (a rise in CH_4 of 200 ppbv in 50 or 80 yr corresponding to a slope of $m = 400$ or 250 ppbv/century, respectively). An upper limit for m would be the slope in the Greenland ice core data, which rose at the steepest part by 162 ppbv in 95 years, thus $m = 171$ ppbv/century. This behaviour (if Δm is larger or smaller in the ice core or synthetic data) is not a characteristic of the filter, but of the underlying data and therefore, the conclusion of the reviewer, that the filter failed to pass the test is not valid and his/her conclusion, that this study should be rejected is not based on firm ground.

All other points of the original review were responded to in our first reply. We therefore see no reason for rejecting this paper.

A final remark on the interhemispheric gradient in CH_4 during the rapid rise at the onset of the Bølling/Allerød warm period on which this argumentation is based on: While it was shown in Dällenbach et al. (2000) that the interhemispheric gradient in CH_4 should be larger during warm periods (interstadials) than during cold periods (stadials) (which is the underlying assumption of the reviewer for this kind of test), it is not entirely sure how large the interhemispheric gradient changes over our time window of interest (which is the onset of the B/A warming). It was suggested by Brook et al. (1999) (based on GISP2 and Taylor Dome data) that there was no measurable increase of the interpolar gradient in CH_4 through the transition to the B/A. Furthermore, the gas enclosure procedure dampens a part of the CH_4 signal recorded in ice cores with lower accumulation rate (e.g. in Antarctica) making it difficult to estimate the real atmospheric signal of the southern hemisphere, and thus to precisely determine this interhemispheric gradient in CH_4.

Slope m of CH_4 rise at onset of BA warm event in ppbv per century

ice core	ice core data original	artificial peak with different m: $m = 2000$	$m = 400$	$m = 250$
Greenland	171 ± 15	234 ± 50	181 ± 24	146 ± 15
Greenland filtered to EDC	28 ± 5	32 ± 7	32 ± 6	33 ± 7
EDC target	39 ± 4	36 ± 8	36 ± 5	35 ± 7
Δm difference (Greenland – EDC)	132 ± 16	198 ± 51	145 ± 25	111 ± 17

References

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Dällenbach, A., Blunier, B., Flückiger, J., Stauffer, B., Chappellaz, J., and Raynaud, D.: Changes in the atmospheric CH_4 gradient between Greenland and Antarctica during the last glacial and the transition to the Holocene, Geophysical Research Letters, 27, 1005–1008, 2000.

Interactive comment on Clim. Past Discuss., 6, 1473, 2010.