**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.

**P. Köhler et al.**

peter.koehler@awi.de

We repeated the key test of the filter function. Again, we took $CH_4$ from high accumulation sites as a surrogate of the atmospheric signal, and smoothed it with the filter functions used for $CO_2$ in EPICA Dome C (EDC).

This time we also included the rapid rise in $CH_4$ at the end of the Younger Dryas (YD) around 11.5 kyr BP. However, the situation is different here, because (as shown in our paper, Fig. 3), another width of the age distribution PDF is necessary. Therefore, the filtering was split in two parts, first containing the rapid rise in $CH_4$ at the onset of the B/A warming (14.6 kyr BP) with $E = 400$ yr, second the rapid rise in $CH_4$ at the end of

the Younger Dryas around 11.5 kyr BP with $E = 300$ yr.

In our first attempt we indeed did not interpolate prior to filtering, but used only the data points available from the ice core to support our approach. We think this is more appropriate, because with interpolation single in situ measured data points in under-sampled records are more important (thus single errors have a larger potential to bias the overall record). However, the calculated slopes of the filtered time series with and without interpolation do not differ a lot (see below).

We calculated the slope from two points in each time series which characterize the rapid rise in $CH_4$. All chosen points are plotted in Fig. 1. The slopes of rapid rise in $CH_4$ measured in situ in the ice cores and after filtering with the log-normal function are as follows (Fig. 1):

Slope of $CH_4$ rise at BA and YD in ppbv per century (interp.: interpolation to $dt = 1$yr).

| ice core | onset B/A, $E = 400$yr | | | end of Y/D, $E = 300$yr | |
|---|---|---|---|---|---|
| | original | filtered | | original | filtered |
| | | no interp. | with interp. | | with interp. |
| Greenland | 171 | 27 | 23 | 355 | 49 |
| Byrd | 53 | 21 | 21 | 45 | 28 |
| EDML | 48 | 22 | 21 | 160 | 33 |
| | | | | | |
| EDC target | | **39** | | | **91** |

We can only repeat our results given in the first response to the review, that this follows very closely our expectations:

1. $CH_4$ measured in situ in ice cores changes more rapidly in high accumulation sites (Greenland > EDML > EDC). The Byrd ice core should be placed between Greenland and EDML. This is the case for the B/A, but not for the YD, because

the temporal resolution of data points is so low (only 6 data points between 12 and 11 kyr BP, while all other ice cores had 15 to 22 data points and thus a three times higher temporal resolution here).

2. After the filtering those records with highest accumulation rates (with presumably a record of $CH_4$ most closely to the atmospheric $CH_4$) are closest to the target slope of EDC. The slope in filtered data in Byrd and EDML are very similar. Again, we have to acknowledge that result from Byrd heavily depend on the sampling.

3. Because of the mentioned limitation in our first response letter (no ice core $CH_4$ in high accumulation sites is identical to the atmospheric record) we can not expect, that the slope of the filtered time series is identical to the slope in EDC. We expected what we found. Slopes in the ice core records are already smoothed in comparison to atmospheric $CH_4$ and therefore the slopes in the filtered time series (based on these ice core $CH_4$ data) should be smaller than the slope in the original $CH_4$ data in EDC: the smaller the accumulation rates the larger the offset of the filtered $CH_4$ records from $CH_4$ measured in situ in EDC.

Again we like to caution the reader that this exercise heavily depends on the temporal resolution of the ice core data and the correctness of the gas age models. The comparison should only be applied for the slope of rapid changes in $CH_4$, not for the exact timing of events, because rapid changes in $CH_4$ measured in situ in ice cores are wiggle-matched onto each other in synchronization efforts, which were used in the development of gas age chronologies.

Given these analyses we still think our approach is relatively robust. It passed the test suggested by the reviewer and a substantial revision of the PDF is not necessary.

Interactive comment on Clim. Past Discuss., 6, 1473, 2010.
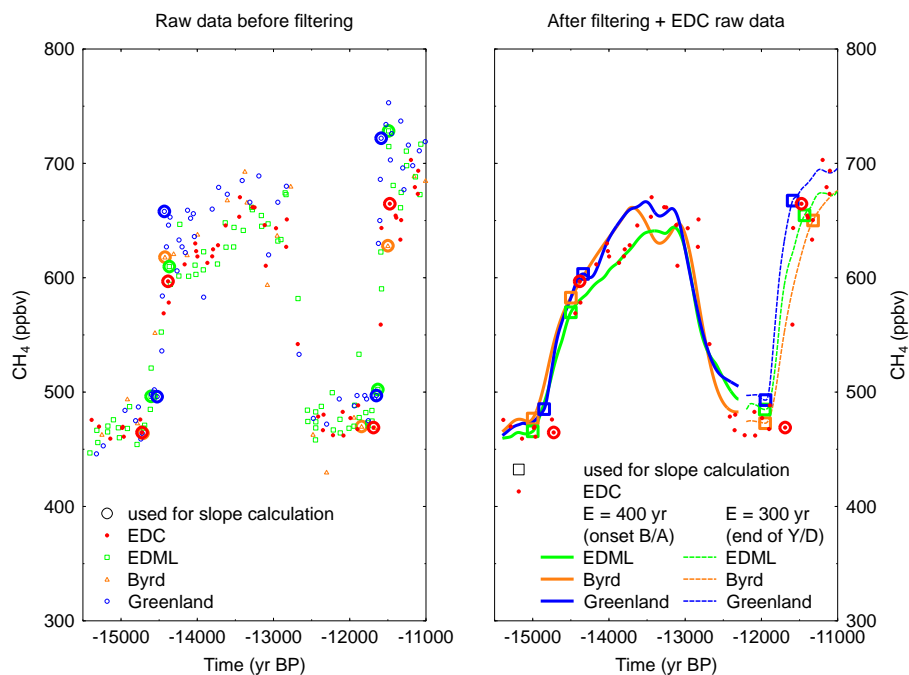
**Fig. 1.** Left: Methane data. Right: Testing our filter with methane from various ice cores. Methane time series were interpolated to dt=1yr before filtering.