Stable isotope studies on ice cores and snow pits in DML, Antarctica, covering the past 2000 years

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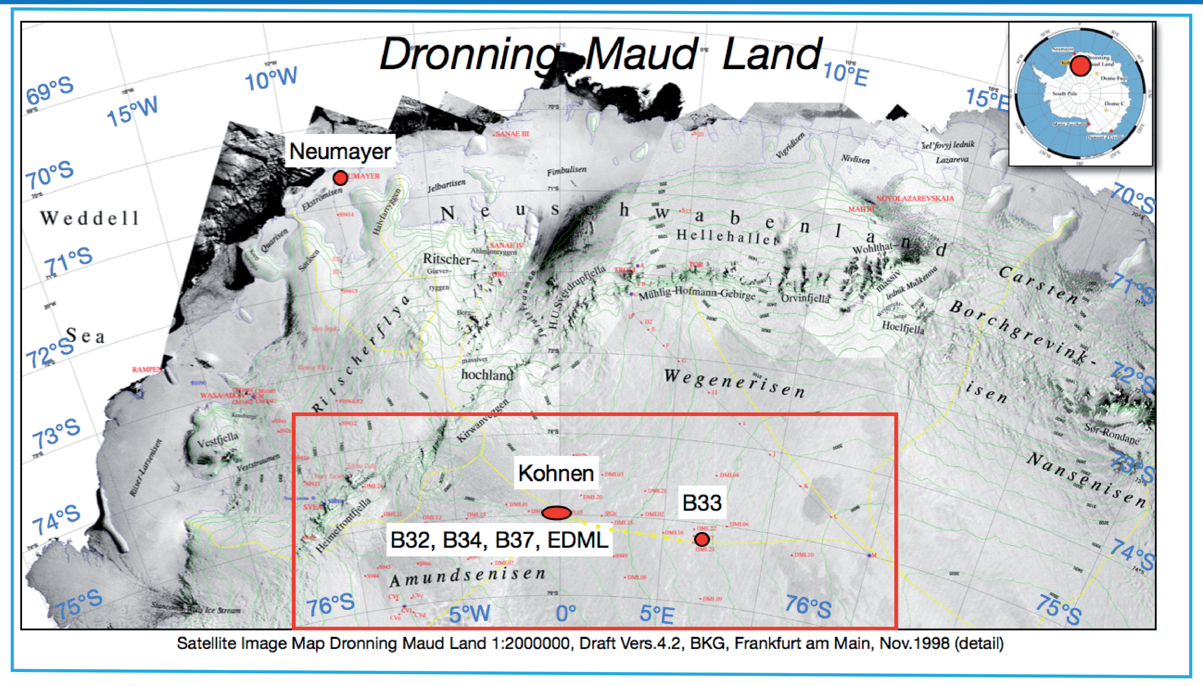

Figure 1: Ice coring on the inland-ice plateau of Dronning Maud Land, Antarctica, took place in the period 1998-2008. The central ice core is the 2774m deep EDML ice core (75.0017 S, 0.0678 E, 2882 m a.s.l.) [1] drilled adjacent to the German Kohnen station [3] in the frame of the European Project for Ice Coring in Antarctica (EPICA). In addition, the ice cores B32 (150m), B34 (200m), B37 (120m), and B33 (130m) had been used for isotope analysis. The mean accumulation rate at EDML is 64 kg/(m²a) at B33 52 kg/(m²a), the mean air temperature -44.6 °C and -46.1°C, respectively. The original depth resolution of the isotope samples was 15-10cm in the upper part and 5cm in the lower parts of the cores.

Summary

The focus of this poster is on the variation of 18-O data during the past 2 kyrs, measured on 5 ice cores (B32, B34, B37, EDML, B33) (Fig.1) and 20 snow pits. Reference horizons for synchronisation of the cores are the deposits of the Tambora eruption 1815 and of an unknown event in 1259 as indicated in the DEP profiles. The cores were used to construct a stacked isotope/temperature record for central Dronning Maud Land. The local isotope-temperature relationship to convert isotope content into temperature change is 0.77‰/°C [2]. None of the cores shows an increase of the 18-O content indicating a stable temperature regime during the past 2 kyrs. However, decadal and centennial variations are detectable with a significant increase of the 18-O content since the middle of the 19th century. This is confirmed by the snow pits covering the past 25 years, with elevated values for both the accumulation rate and 18-O content.

References:

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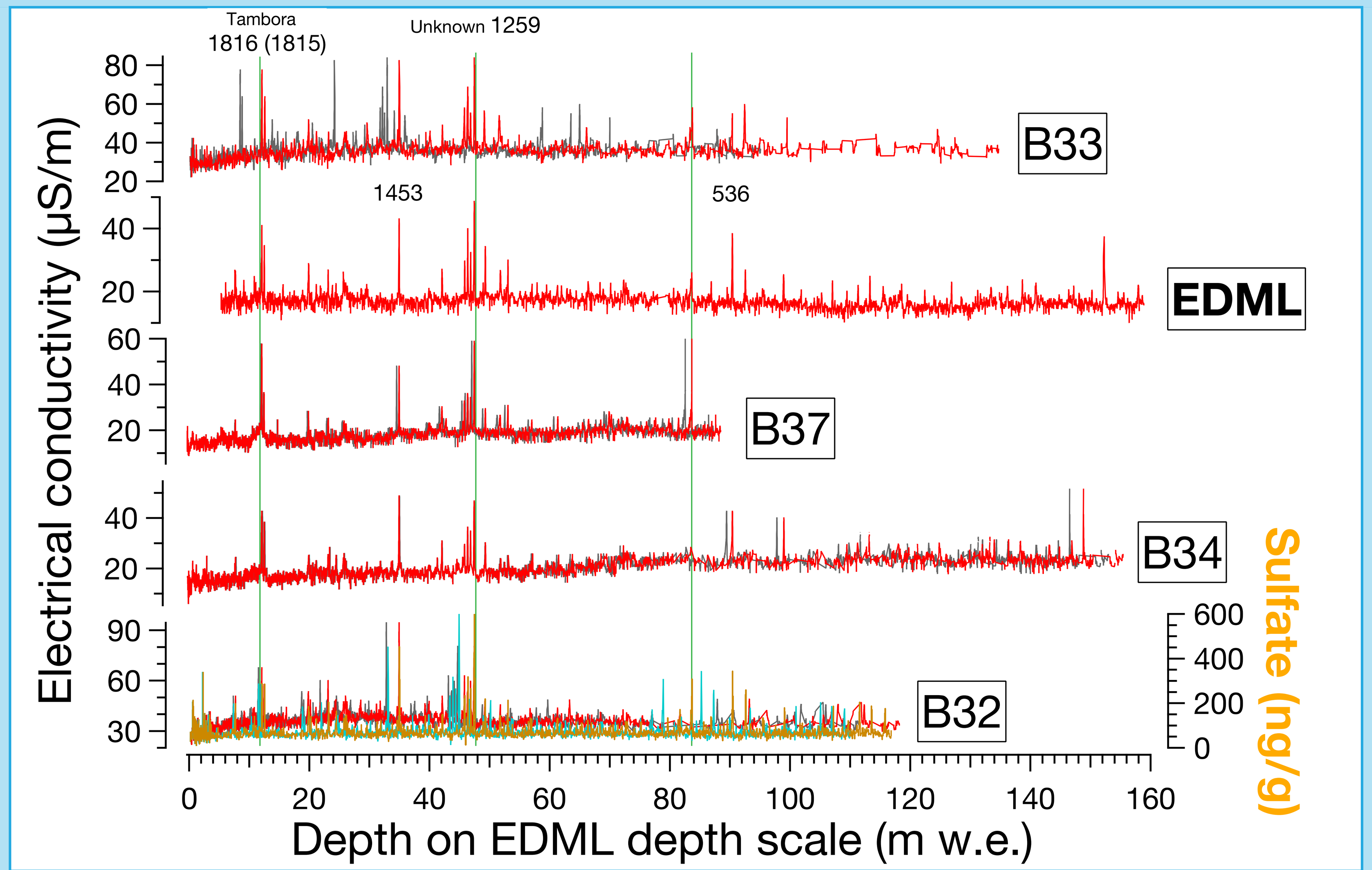

Figure 2: Electrical conductivity (measured by Di-electric profiling, DEP) of the cores B32, B34, B37, EDML, and B33 (location see Fig. 1). The grey curves show the original depth profile, the red curves were adjusted to fit in depth (given in metre water equivalent) or time, respectively, with the dated EDML record. The EDML1 age scale [5] will later be used as the reference age scae. The spikes in the DEP profiles indicate volcanic events (cf. [6]). The blue and yellow curves in the lowest panel show the original and adjusted depth profiles of nss-sulfate concentrations for core B32 [6]. Sulfate peaks on the inland-ice plateau are predominantly caused by volcanic events. The most significant and unique peaks appear in the firn layer deposited in 1816 (Tambora eruption 1815) and 1809 (unknown event) as well as a sequence of 4 peaks with the oldest and strongest deposited in the layer of 1259 (unknown events). Due to bad core quality the DEP signal of B33 is very disturbed below 100 m w.e. depth.
The same depth adjustment was later used to synchronize the 18-O profiles.
DEP data are available in PANGAEA for B32 (doi:10.1594/PANGAEA.58815), B33 (doi:10.1594/PANGAEA.58816). Data for B34, B37, and EDML are so far unpublished.

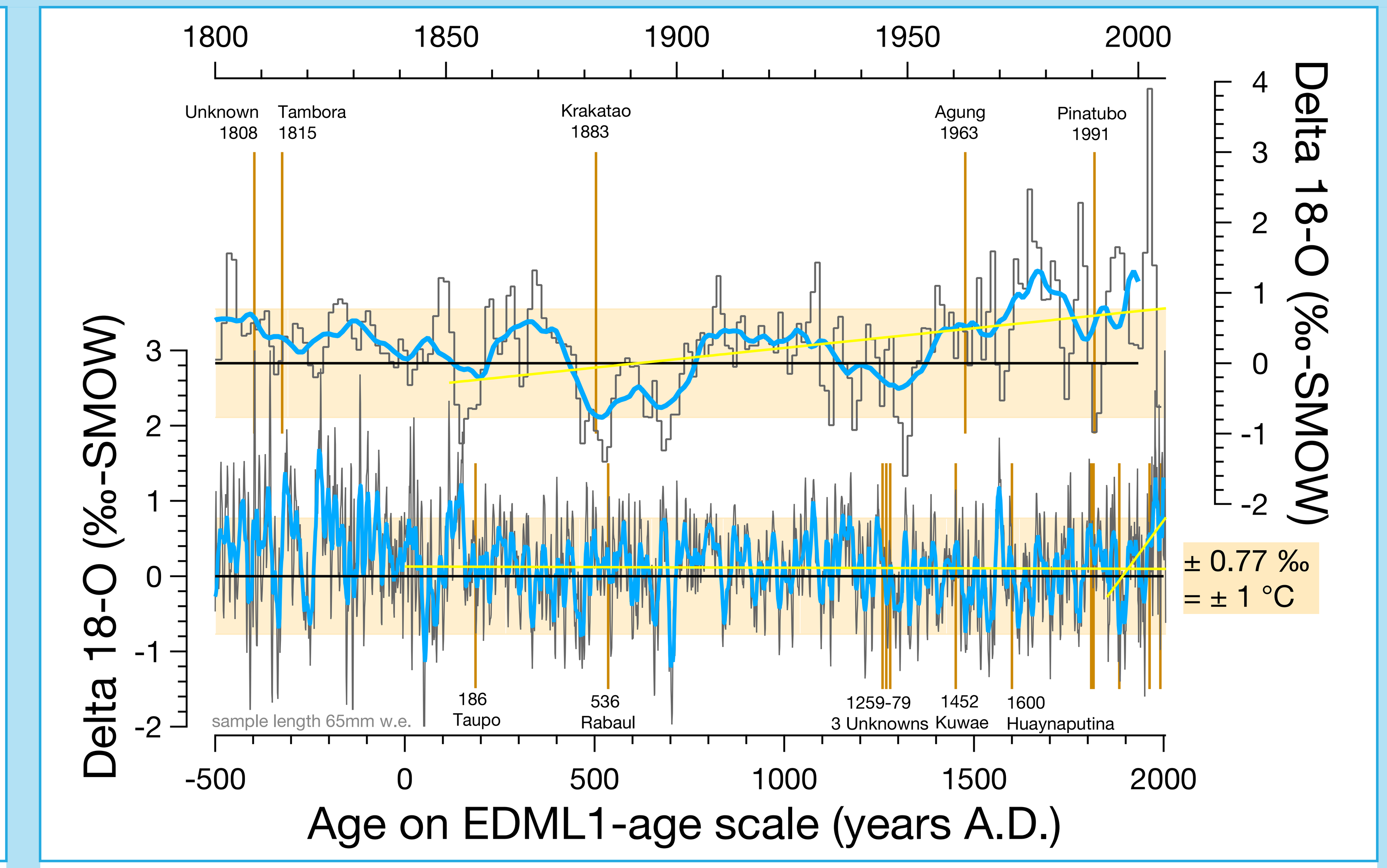

Figure 3: Stacked anomalies of δ18-O content (mean 1259-1816) for the periods 500 B.C.-2005 A.D. (lower axis) and 1800-2005 A.D. (upper axis) on the EDML1-age scale [5]. Shown are in grey colour the composite from 5 cores (B32, B34, B37, EDML, B33) and with a bold blue line the moving average over 11 samples. Selected volcanic events with eruption date are indicated by vertical bars. The ochre coloured area marks the local isotope-temperature gradient of 0.77 ‰/°C [2].
Periods with positive anomalies occured during the Roman period (before A.D.) and during the medevial times (appr. 1050-1250 A.D.).
During the 20th century an increase in isotope content/temperature can be observed, only interrupted during the 1940ies.
Most of the volcanic events in low latitudes were followed by a temperature decrease through the next 1-3 years.
The yellow lines show line fits for the periods 1-2005 A.D. and 1850-2005 A.D., respectively.

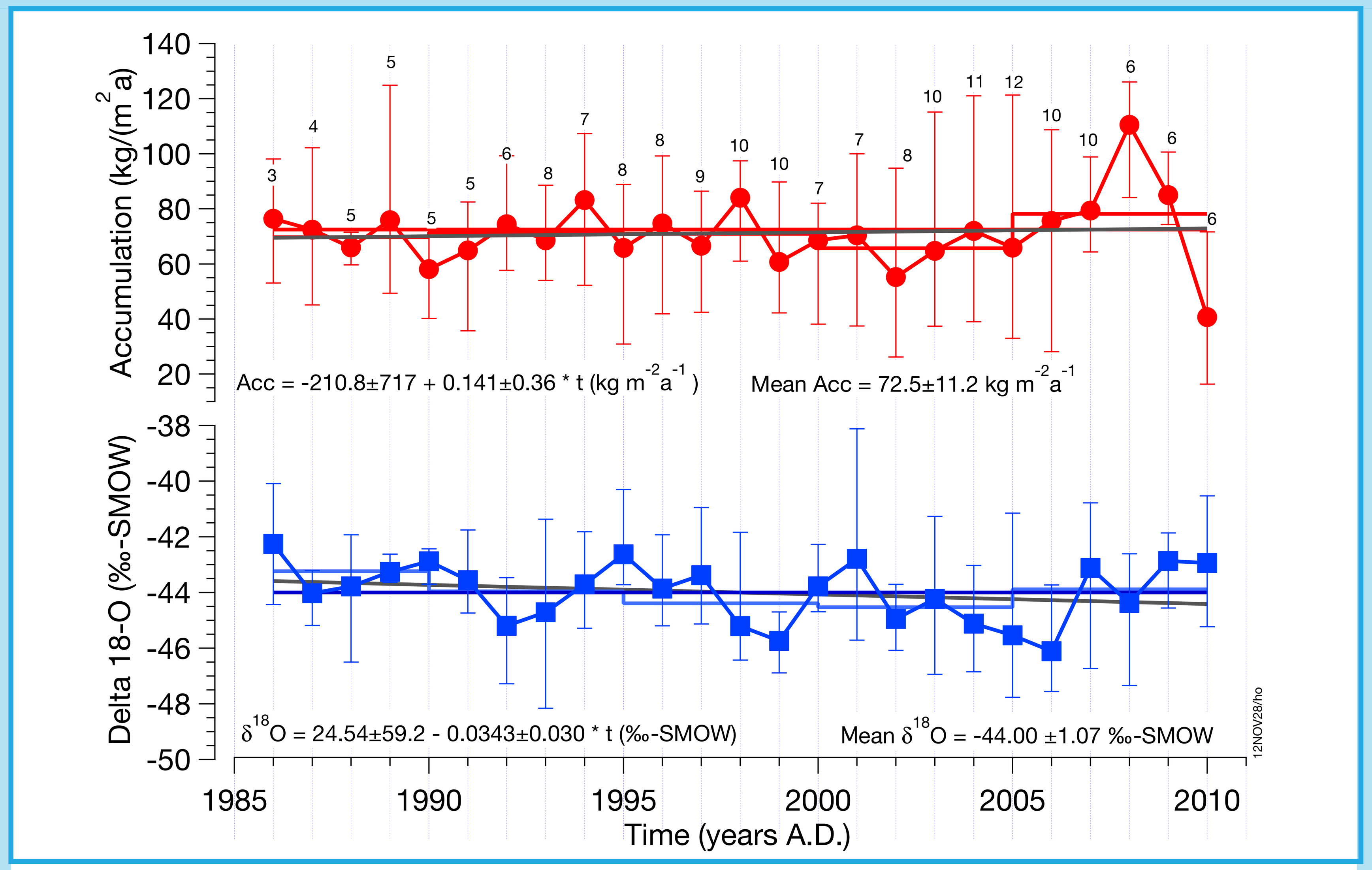

Figure 4: Mean annual accumulation (upper panel) and mean annual δ18-O content for the period 1986-2010. Between December 1997 and January 2011 20 snow pits were digged in the surroundings (radius approximately 3 km) of Kohnen station and sampled for isotope analysis with a depth resolution between1.5cm and 5cm). The numbers of overlapping yearly layers are given in the upper panel above the bars, which indicate the observed maximum and minimum values for the respective yearly layer. 5 year average are plotted for both accumulation and isotope content as well. The grey curves represent linear fits, which do not show a signifacant trend neither for accumulation nor δ18-O content. However, for the year 2008 an outstanding accumulation rate was found in all 6 snow pits digged in January 2011.
The average δ18-O content of the 4 closest cores (B32, B34, B37 and EDML) for the period 1259-1816 (cf. Fig. 3) is -45.01 ±0.16 ‰-SMOW, the mean accumlation rate is 62.3 ±1.9 kg/(m^2 a). This indicates that for the past 25 years both isotope content and accumulation rate are above the long term average for 1259-1816 (cf. Fig. 3)

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