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HELMHOLTZ GEMEINSCHAFT

Spatial variability in isotope signatures of precipitation around Neumayer station, East Antarctica

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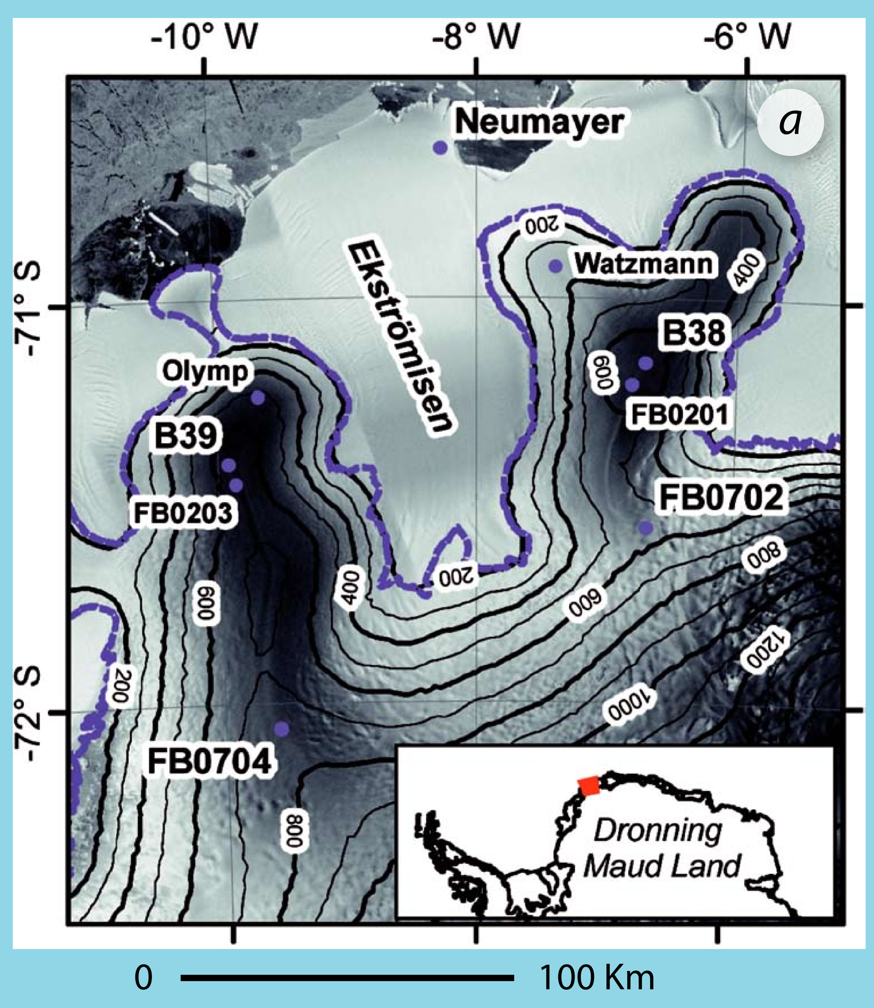
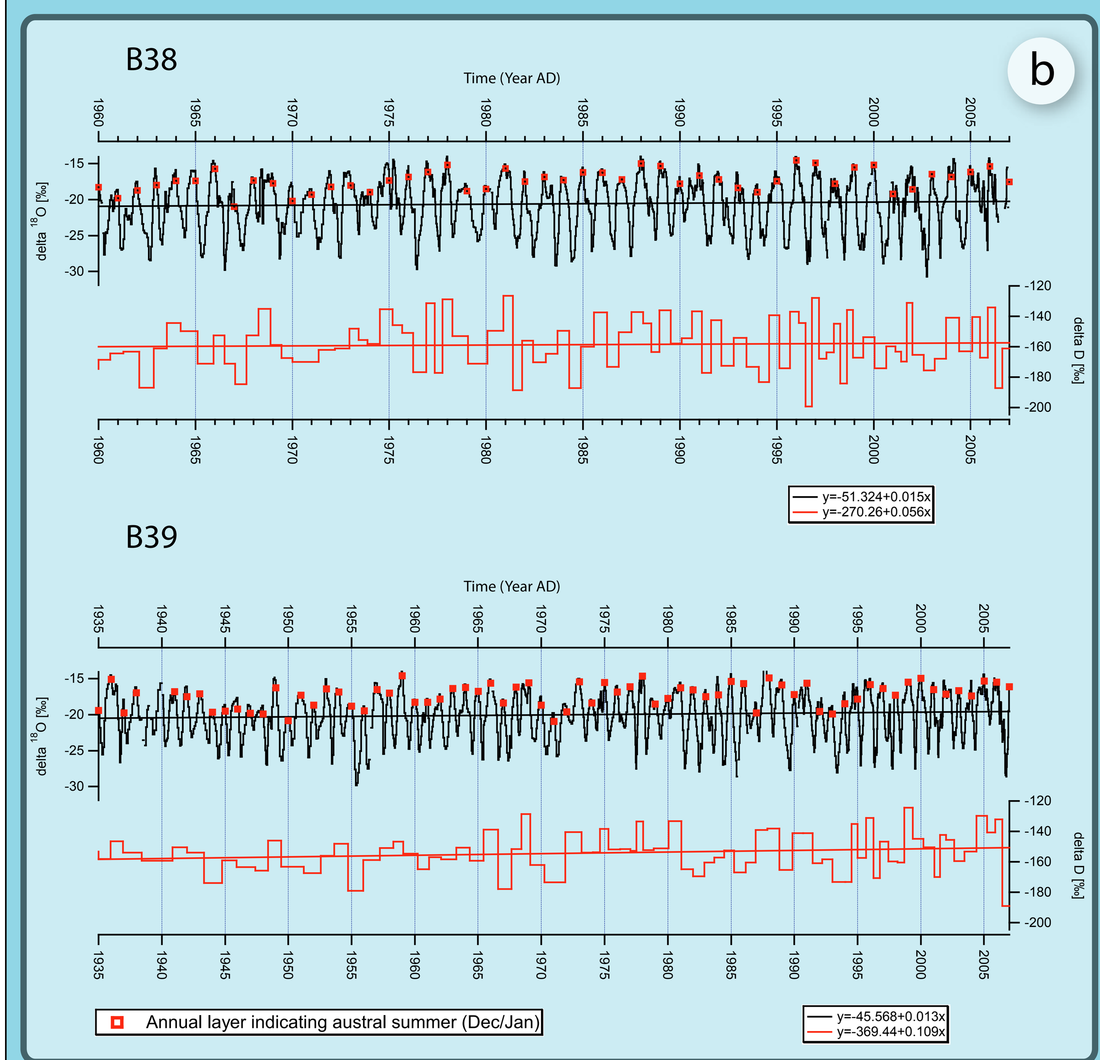
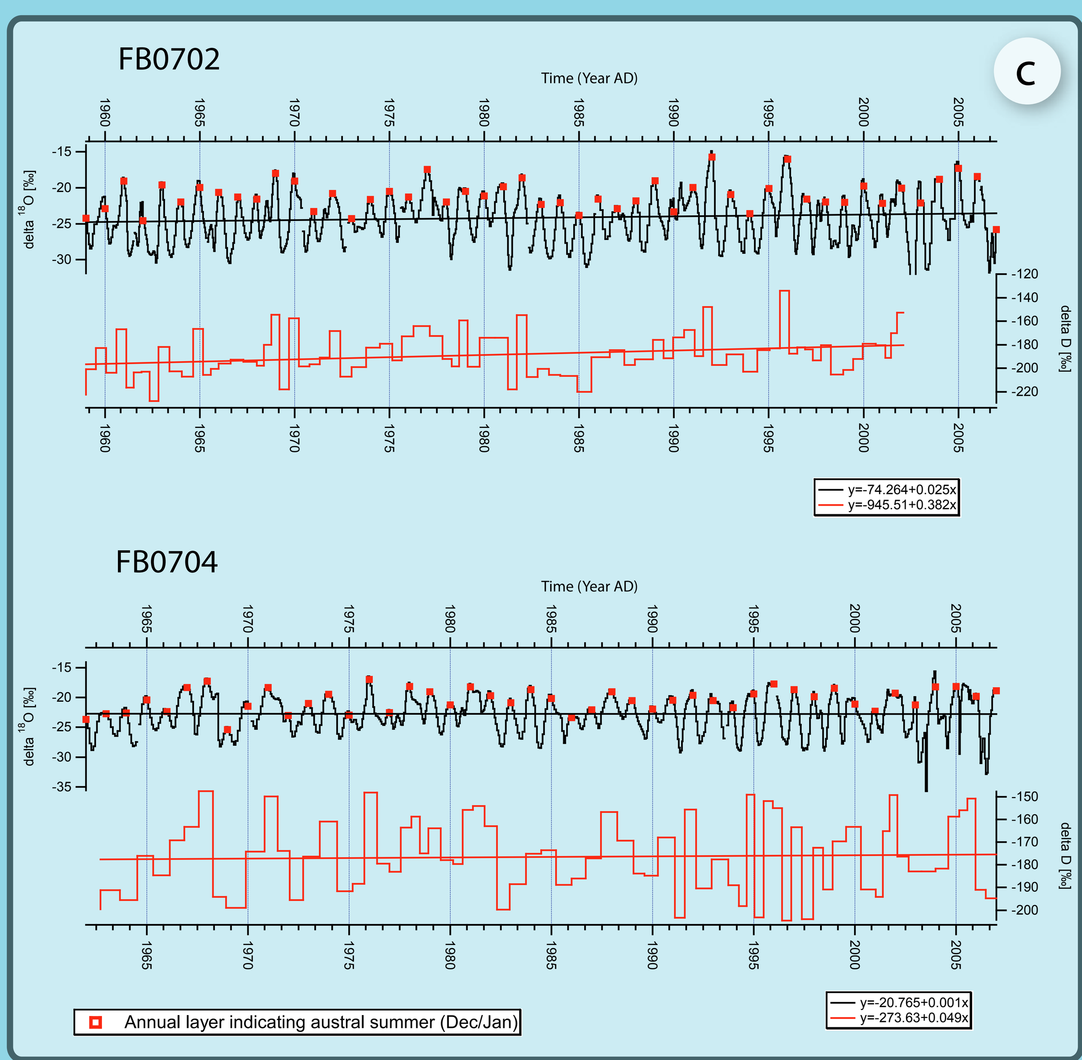


Within the framework of the International Partnership in Ice Core Sciences (IPICS), a campaign was carried out in the surroundings of Ekströmisen in 2006-2007. One aim of the IPICS is to drill ice cores in coastal areas, covering the time span of the past 2000 years. Four ice-cores were retrieved on Halfva (B38 - FB0702) and Søråsen (B39 - FB0704) ridges (figure a). At the German Antarctic Neumayer Station located on Ekströmisen (70°39´S, 8°15´W and 40 m a.s.l.), fresh snow was sampled during the past 26 years. The stable-isotope composition ($\delta^{18}O$ and δD) of snow samples and ice-cores have been analysed to reconstruct its temporal and spatial variability. The climatic implication was studied over the past 50 and more years. $\delta^{18}O$ analysis was done for all cores with high deep resolution (7-5 cm). δD measurements were carried out only on 0.5 m or 1 m samples. Dating of the ice cores was done by layer counting ($\delta^{18}O$) assisted by tritium data (only B38 and B39) - (See Poster by Oerter *et al.*, this session).

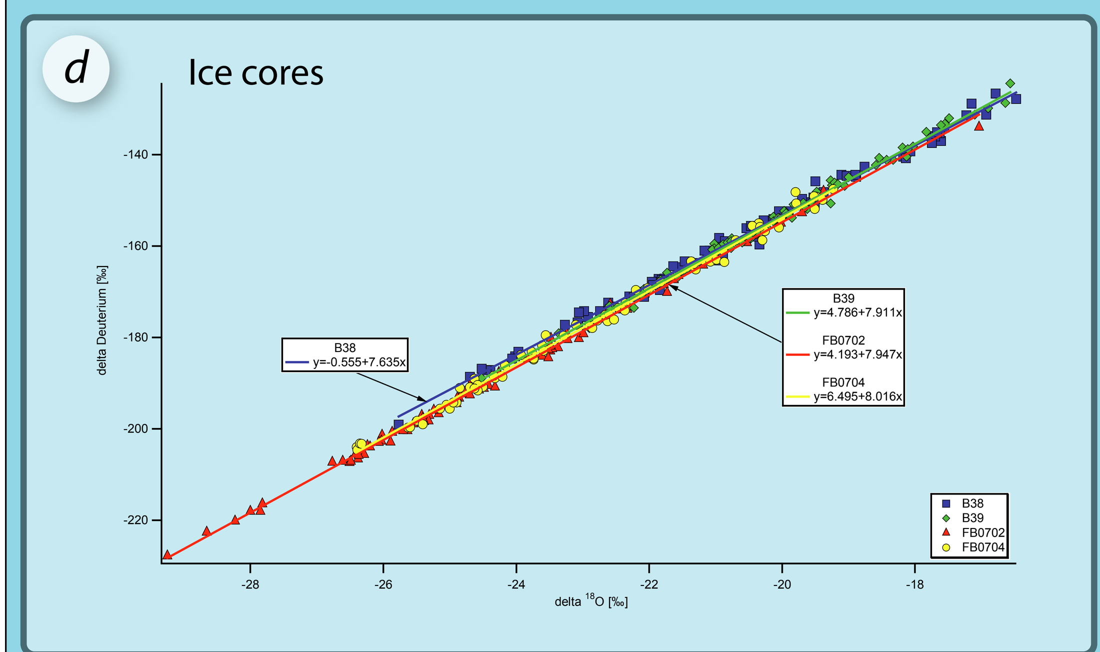


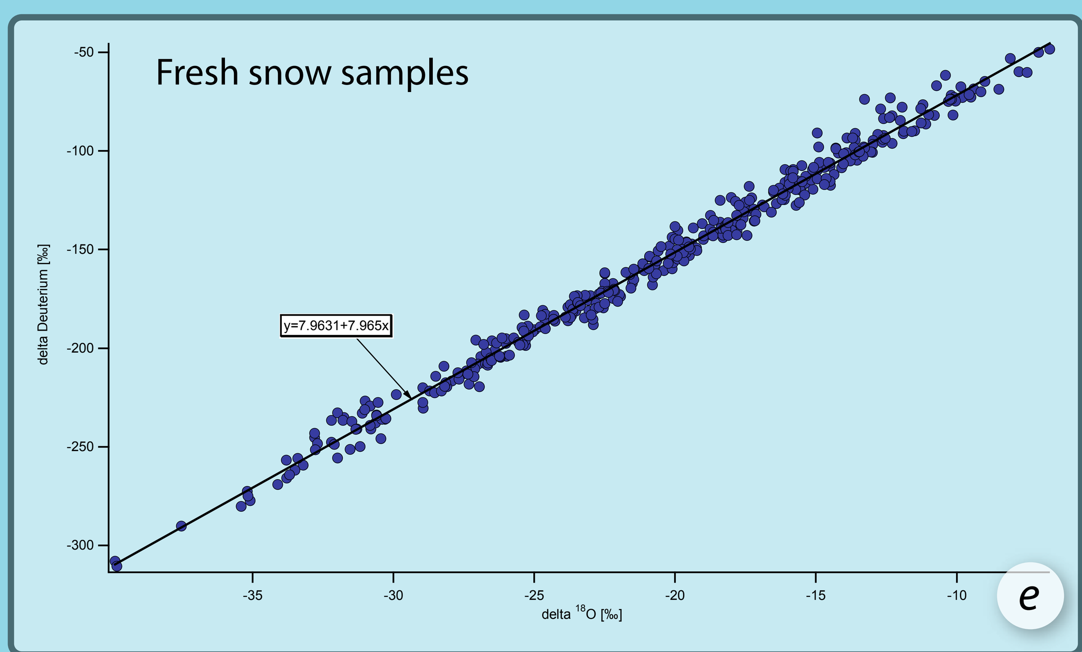


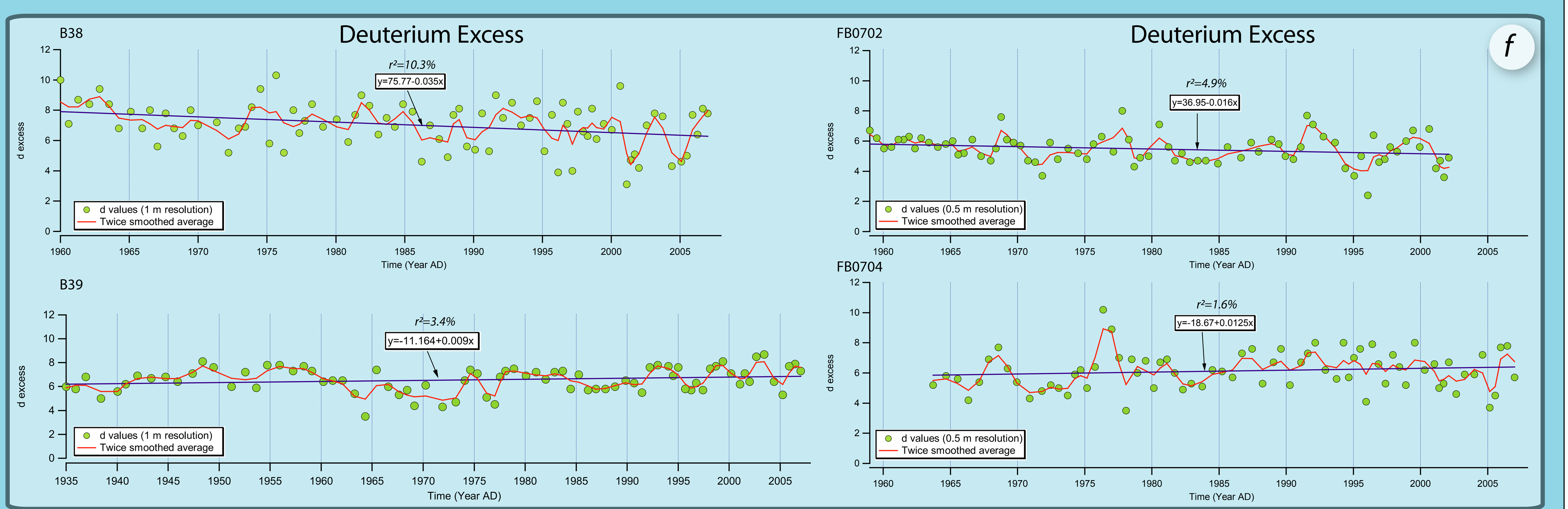
In order to figure out temporal trends of isotopic values, linear regressions were calculated for both δD and $\delta^{18}O$ of all firn-cores (figure *b* and *c*). The linear regression shows no significant tendency for those parameters at least since 1935. Due to the well know relation between isotope composition and air temperature, no warming trend at this location is inferred. This conclusion agrees with mean annual air temperature (MAAT) registry in the Neumayer Station: -16°C at 2 m level between 1982 and 2006. A mean annual temperature of -18°C to -20°C is estimated as the 10-meter borehole temperature at the core drilling locations.

Firn-cores B-38 and B-39 are located at 690 and 655 meters of elevation and 81 km to the south-east and 110 km to the south-west of the German Station Neumayer, respectively. The mean annual $\delta^{18}O$ values -accumulation weighted-, of -20.58 ‰ for B-38 and -19.96‰ for B39, are close to the annual average value for fresh snow precipitation at the Neumayer Station (-20.49‰). Despite of the elevation difference of approximately 600 m between Neumayer station and the drill sites, no significant altitude effect is observed. The other two cores, located more towards the interior of the continent, have more negative $\delta^{18}O$ values: -24.23‰ for FB0702 (539 m a.s.l.) and -22.74‰ for FB0704 (760 m a.s.l.). Based on these observations, it is likely that the altitude effects in this region start taking place at heights above 690 m a.s.l. The core FB0702 shows a difference of -1.49 ‰ $\delta^{18}O$ in mean value with respect to FB0704, but having lower elevation. This discrepancy can not be explained neither by altitude nor by continentally effects. A strong topographic influence at this point, with an important input of precipitation of higher elevations coming from the south of Halvfarryggen is most like. This point will be later revisited.

Deuterium analyses were carried out, as a first step, with a resolution of 0.5 and 1.0 m. In general, the obtained values are in good agreement with the oxygen high resolution values, except for the core FB0702. But for this core the first 4 meters were not yet measured and could cause this bias, due to the great variability at this coarse resolution.







The co-isotope $\delta^{18}O$ *v/s* δD plot (figure *d* and *e*), shows a good correspondence for most of the slopes of the ice cores and fresh snow. All slopes, apart from the core B38, are close to 8, like the slope of the Global meteoric water line (GMWL), meaning that no secondary re-evaporation is occurring at this area. The deuterium excess ($d = \delta D - 8\delta^{18}O$) is directly linked to the origin of the moisture that produces precipitation, and can be used as geochemical tool to distinguish between the different source regions. Figure *f* shows for the Halvfa ridge a negative trend, in contrast Søråsen ridge evidence a positive trend. The change in time of the excess d reveals a variation in the source of the moisture during the last decades.

The lowest mean *d* is found at the core FB0702 (data table 1), and this core has the lowest standard deviation. That reveals a more evolved (continental) precipitation contribution for this region. In contrast high standard deviation values reflect oceanic precipitation, as it can perfectly seen at the Fresh Snow samples in the Neumayer station (d excess with s.dev = 6.4, table 1). This idea supports the conclusion about the low mean $\delta^{18}O$ value at FB0702, previously mentioned.

At figure *g*, D excess is seasonally classified according to its $\delta^{18}O$ average into autumn-winter and spring-summer events. Seasonal differentiated linear regression shows no statistically significant correlation with the data for autumn-winter. Improved correlation, but still low significant, is found for spring-summer (especially at B38). The trend of those linear regressions shows a change of the moisture source of the different year's seasons on the time gap covered by the cores. Such observation should be revised through high-resolution δD measurement, in order to increase the amount of the data and the statistical significance.

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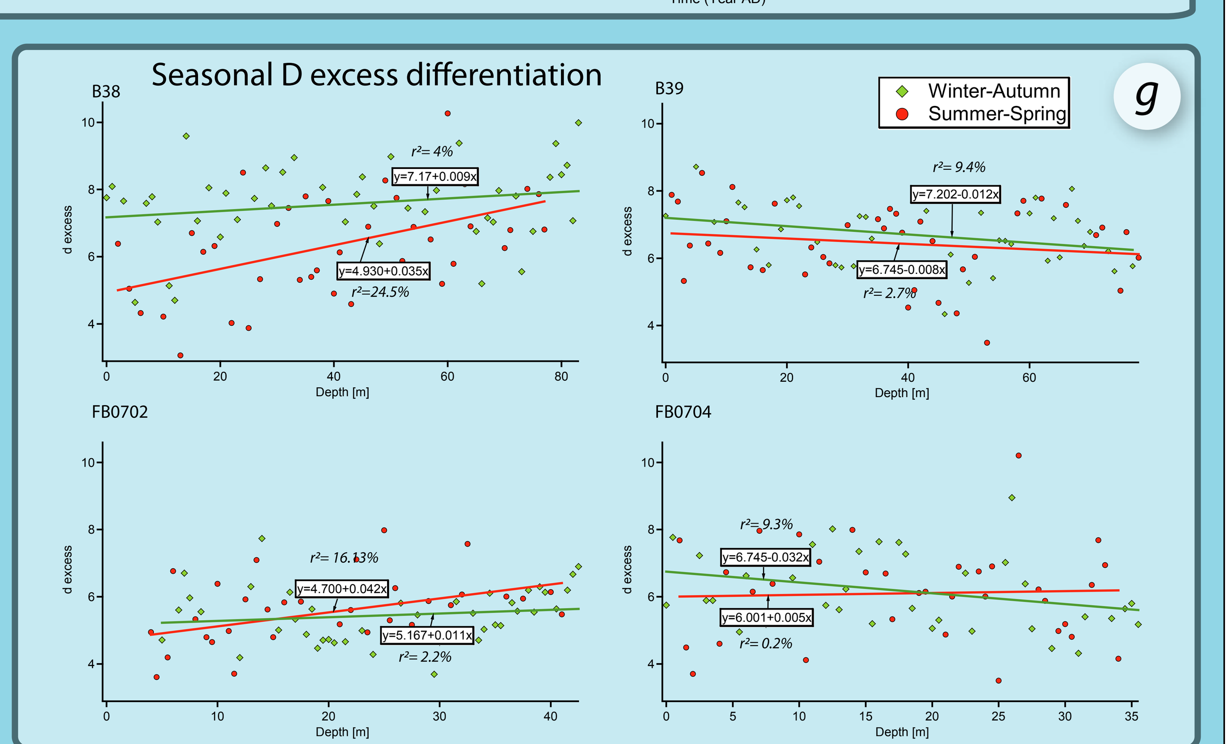
Averages

	Accum. ($kg\ m^2\ a^{-1}$)	$\delta^{18}O$ High resolution	$\delta^{18}O$ Low resolution	δD	d excess			
B38		(7 cm resolution)	(1 m resolution)			δD v/s $\delta^{18}O$ Slope	Coord.	71.16°S/6.70°W
Mean	1252	-20.58	-20.69	-158.51	7.01		Altitude	690 m a.s.l.
sdev	341	3.57	2.17	16.64	1.49	7.64	Depth	84 m
Min	501	-30.74	-25.77	-199.07	3.06	δD v/s $\delta^{18}O$ Intercept	Age	1960-2007
Max	2003	-13.80	-16.48	-126.57	10.27			
n	47	1238	84	84	84	-0.56		
FB0702		(5 cm resolution)	(0.5 m resolution)			δD v/s $\delta^{18}O$ Slope	Coord.	71.57°S/6.67°W
Mean	558	-24.23	-24.29	-188.81	5.49		Altitude	539 m a.s.l.
sdev	174	3.40	2.31	18.39	0.96	7.95	Depth	43 m
Min	257	-33.00	-29.25	-227.83	2.36	δD v/s $\delta^{18}O$ Intercept	Age	1959-2007
Max	979	-14.90	-17.04	-133.96	7.98			
n	41	845	78	78	78	4.19		
B39		(7 cm resolution)	(1 m resolution)			δD v/s $\delta^{18}O$ Slope	Coord.	71.41°S/9.9°W
Mean	772	-19.96	-20.07	-154.01	6.57		Altitude	655 m a.s.l.
sdev	225	3.18	1.62	12.82	1.03	7.91	Depth	78.5 m
Min	405	-29.84	-24.52	-188.87	3.49	δD v/s $\delta^{18}O$ Intercept	Age	1935-2007
Max	1467	-13.17	-16.57	-124.41	8.72			
n	72	1167	79	79	79	4.79		
FB0704		(5 cm resolution)	(0.5 resolution)			δD v/s $\delta^{18}O$ Slope	Coord.	72.06°S/9.56°W
Mean	489	-22.74	-22.82	-176.40	6.14		Altitude	760 m a.s.l.
sdev	128	3.10	2.04	16.39	1.26	8.02	Depth	36 m
Min	326	-35.72	-19.23	-204.58	3.50	δD v/s $\delta^{18}O$ Intercept	Age	1962-2007
Max	835	-15.62	-19.23	-147.49	10.21			
n	45	716	72	72	72	6.50		
Fresh Snow						δD v/s $\delta^{18}O$ Slope	Coord.	70.65°S/8.25°W
Mean	287	-20.54		-156.33	8.60		Altitude	40
sdev	(1981-1996)	6.69		53.31	4.40	7.96	Age	1981-2006
Min	-	-39.88		-310.60	-4.80	δD v/s $\delta^{18}O$ Intercept		
Max	-	-6.70		-48.30	28.80			
n	-	396		383	383	7.96		



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