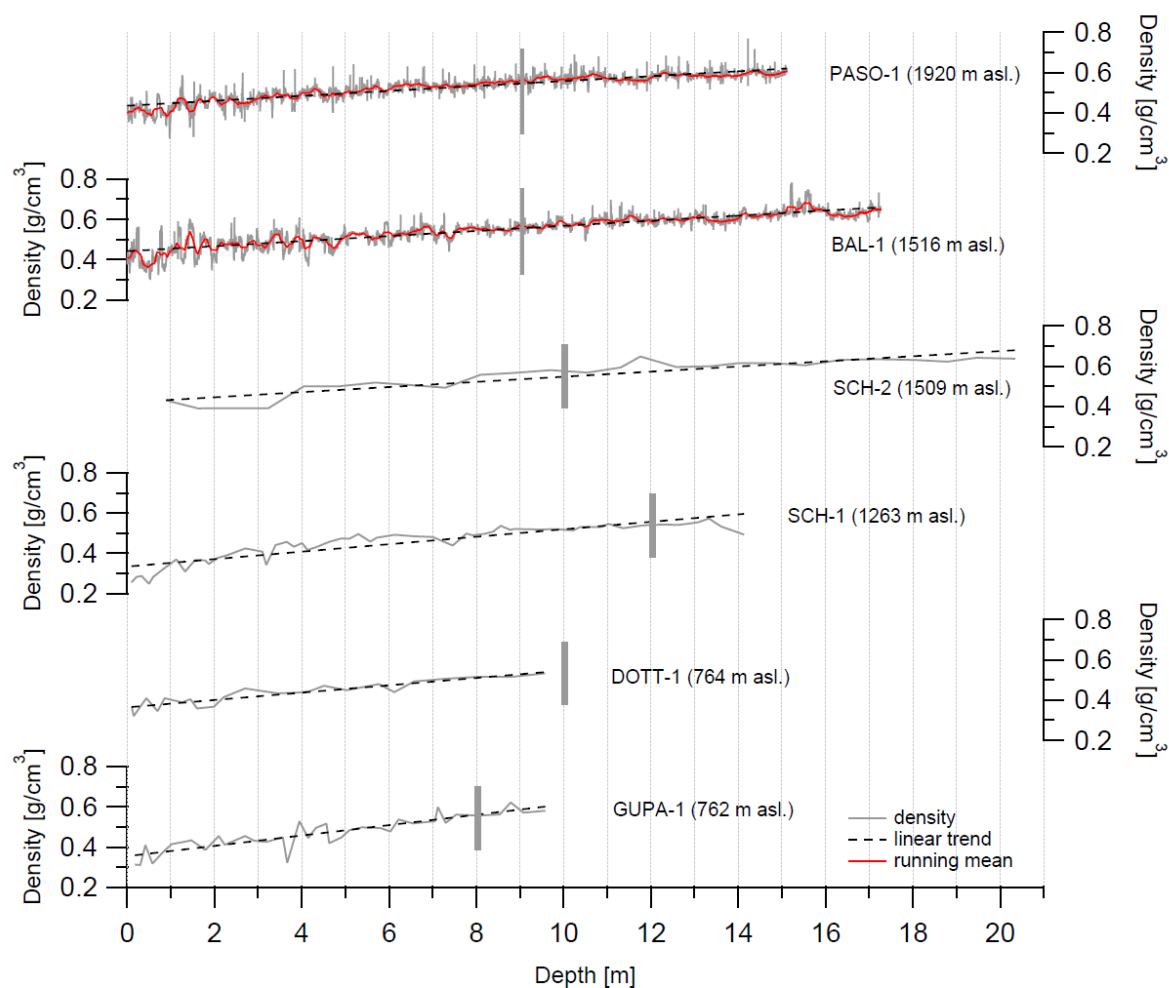
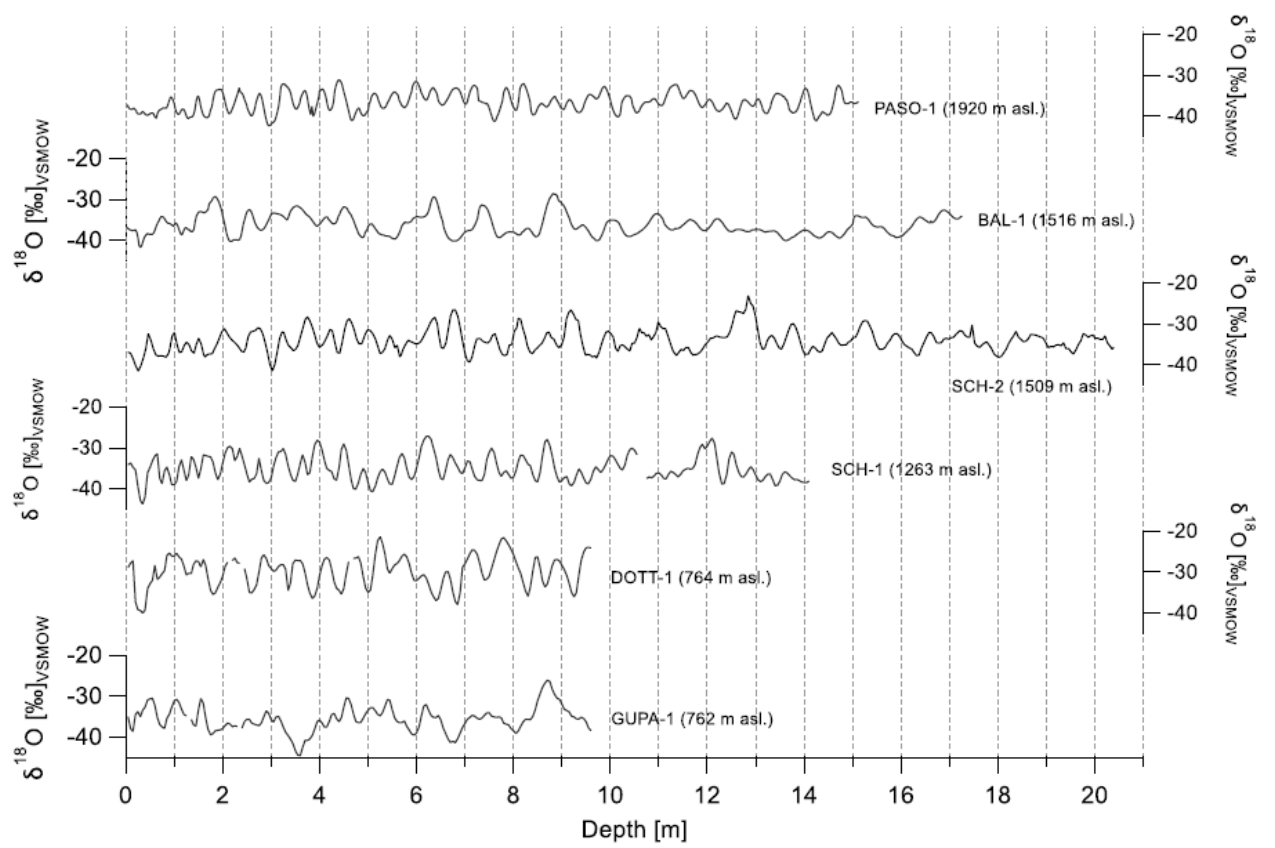
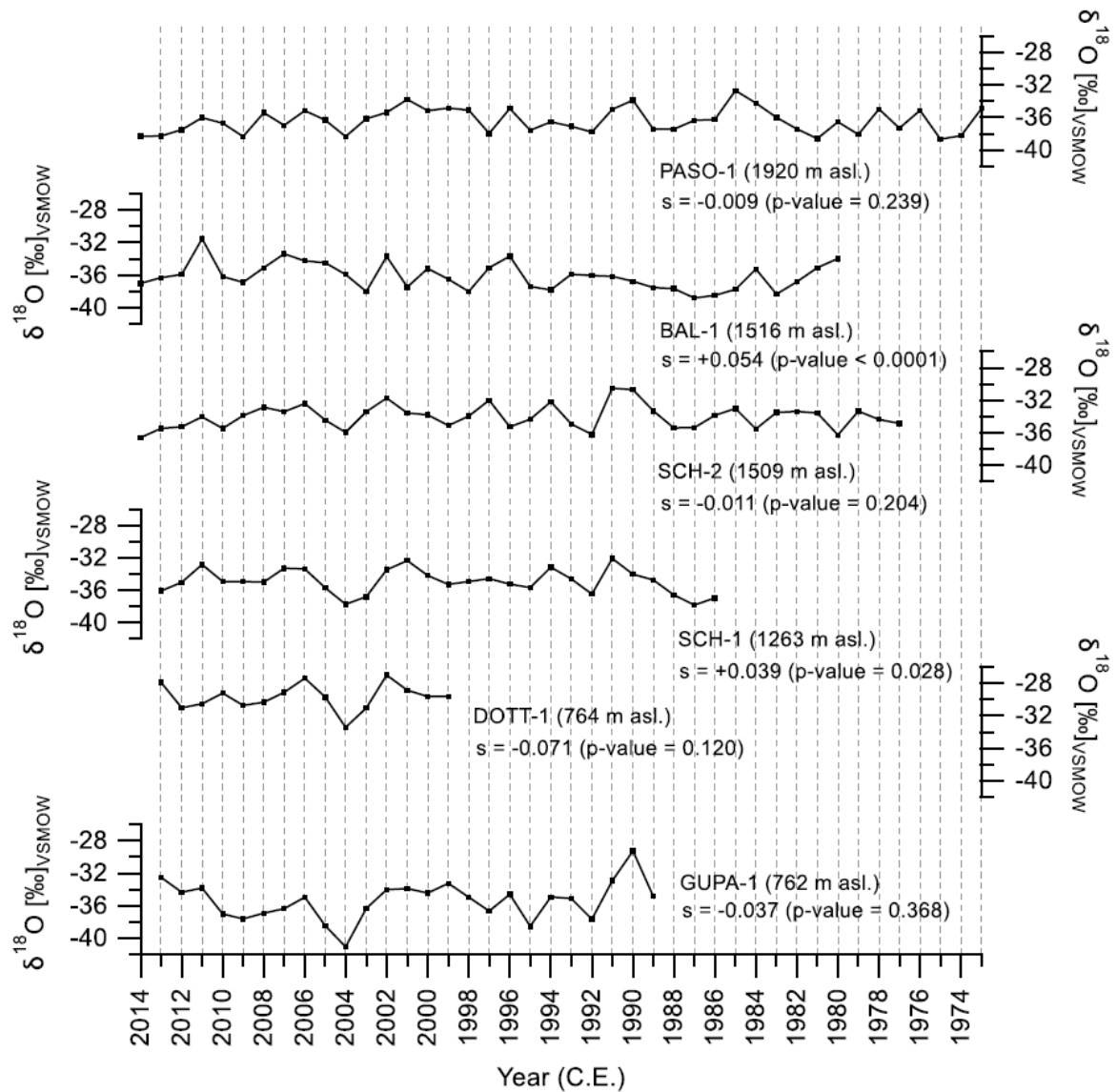
Supplementary information

S1: Density profiles of the six firn cores from Union Glacier (UG). Density profiles of cores BAL–1 and PASO–1 were obtained by X–ray microfocus tomography and are at < 1mm resolution. The running mean is shown in red. The window size for calculating the running mean was chosen to be 1700 points for BAL–1 and 1250 points for PASO–1 as these values correspond to a period of approximately half a year within the respective core record. For each core the linear trend of increasing density with depth due to firn compaction and the approximate depth of the snow-firn-density boundary (0.55 g/cm^3; grey bar) are indicated. Note that for core DOTT–1 the snow–firn–density boundary is not reached within the drill depth and therefore its location was determined by linear extrapolation at the lower end of the core.

S2: Profiles of the stable water isotope composition ($\delta^{18}O$) of the six firn cores from UG with respect to depth.

S3: Non-standardized annual mean stable oxygen isotope composition of the six firn cores from UG for the period covered by the respective core. Sen slopes (s) and p-values are given for each core.

S4: Results of cross-correlation analysis for accumulation rates and mean annual stable water isotope composition of the six firn cores from UG. Prominent correlations are marked bold and if statistically significant (p–value < 0.01, α = 0.05) in red and bold.

Accumulation	GUPA-1	DOTT-1	SCH-1	SCH-2	BAL-1	PASO-1
GUPA-1	1	-0.076	**0.422**	**0.449**	0.250	**-0.428**
p-value	0	0.787	0.036	0.024	0.229	0.033
DOTT-1		1	0.399	0.314	**0.444**	0.262
p-value		0	0.140	0.255	0.098	0.346
SCH-1			1	**0.626**	**0.335**	-0.053
p-value			0	0.000	0.081	0.789
SCH-2				1	**0.365**	**-0.303**
p-value				0	0.031	0.065
BAL-1					1	-0.157
p-value					0	0.368
PASO-1						1
p-value						0

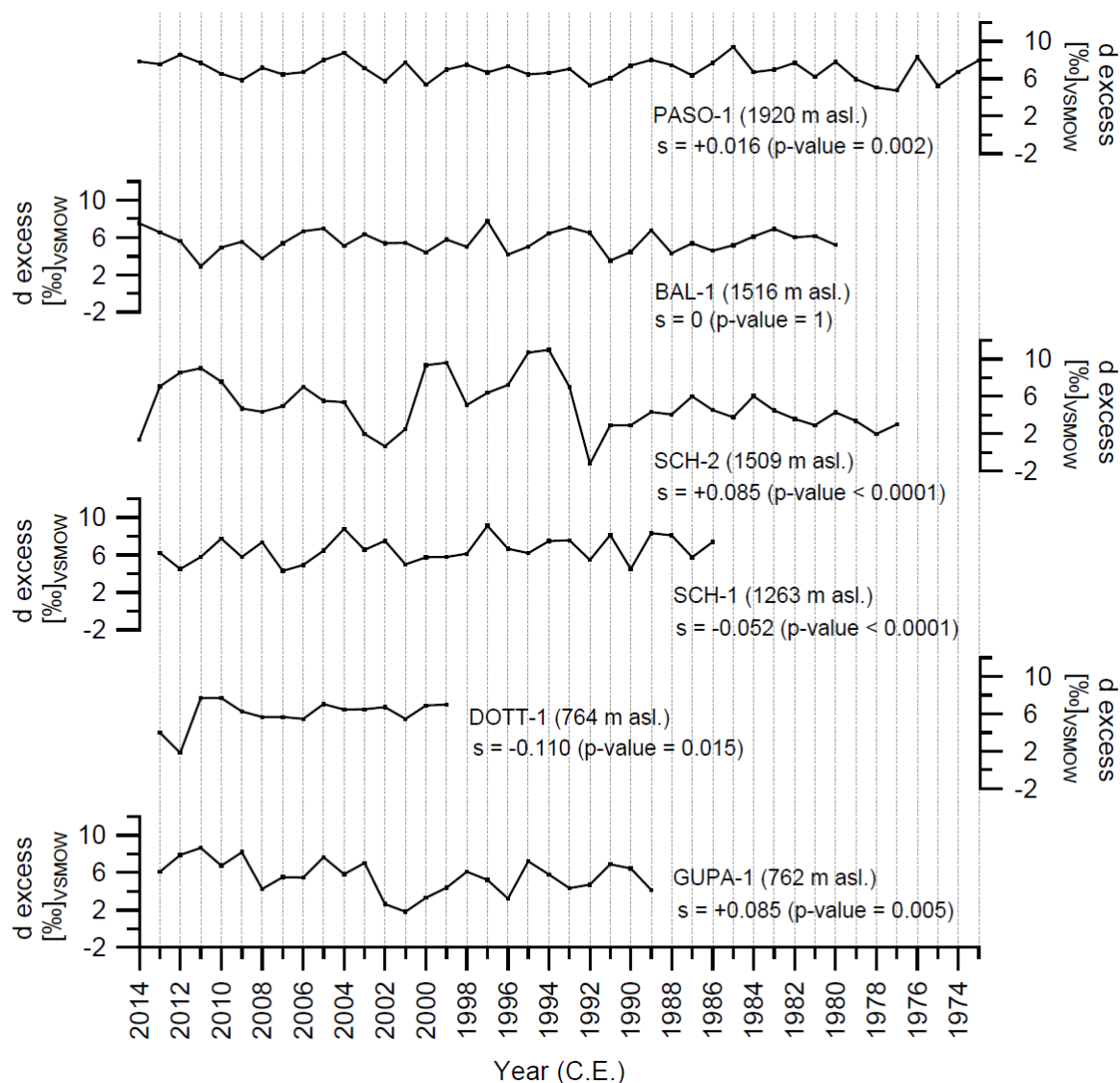
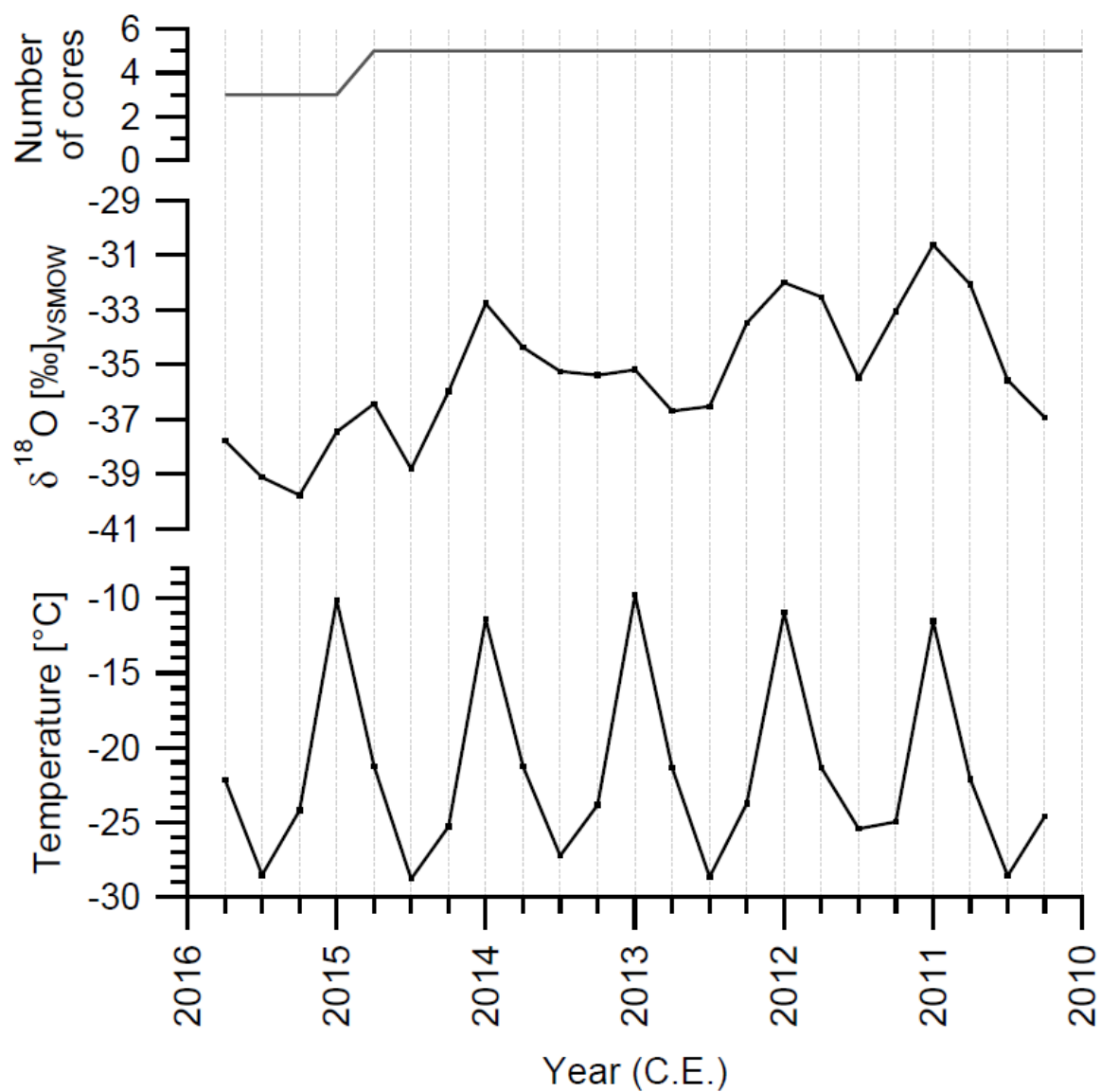
δ¹⁸O

δ¹⁸O	GUPA-1	DOTT-1	SCH-1	SCH-2	BAL-1	PASO-1
GUPA-1	1	**0.634**	**0.548**	**0.454**	0.005	**0.595**
p-value	0	0.011	0.005	0.023	0.982	0.002
DOTT-1		1	**0.585**	**0.521**	0.228	0.433
p-value		0	0.022	0.046	0.414	0.107
SCH-1			1	**0.658**	**0.441**	**0.480**
p-value			0	0.000	0.019	0.010
SCH-2				1	0.022	**0.359**
p-value				0	0.900	0.027
BAL-1					1	0.006
p-value					0	0.973
PASO-1						1
p-value						0

δD

δD	GUPA-1	DOTT-1	SCH-1	SCH-2	BAL-1	PASO-1
GUPA-1	1	**0.567**	**0.501**	**0.471**	-0.018	**0.565**
p-value	0	0.028	0.011	0.018	0.932	0.003
DOTT-1		1	**0.597**	0.569	0.285	0.424
p-value		0	0.019	0.027	0.304	0.115
SCH-1			1	**0.707**	**0.426**	**0.435**
p-value			0	0.000	0.024	0.021
SCH-2				1	0.028	**0.341**
p-value				0	0.873	0.036
BAL-1					1	-0.037
p-value					0	0.831
PASO-1						1
p-value						0

d excess

GUPA-1	1	-0.059	-0.119	0.244	-0.100	0.188
p-value	0	0.836	0.572	0.240	0.635	0.368
DOTT-1		1	**0.455**	-0.053	-0.296	-0.391
p-value		0	0.088	0.852	0.284	0.150
SCH-1			1	-0.043	0.081	0.095
p-value			0	0.829	0.683	0.632
SCH-2				1	-0.112	0.149
p-value				0	0.515	0.371
BAL-1					1	-0.006
p-value					0	0.974
PASO-1						1
p-value						0

S5: Non-standardized annual mean d excess of the six firn cores from UG for the period covered by the respective core. Sen slopes (s) and p-values are given for each core.

S6: Non–standardized seasonal means of near–surface air temperature (derived from the AWS composite record) and firn core $\delta^{18}O$ in the UG region for the period 2010–2015.