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Supplement of

Multiproxy analyses of multiple shallow firn cores from coastal Adélie Land

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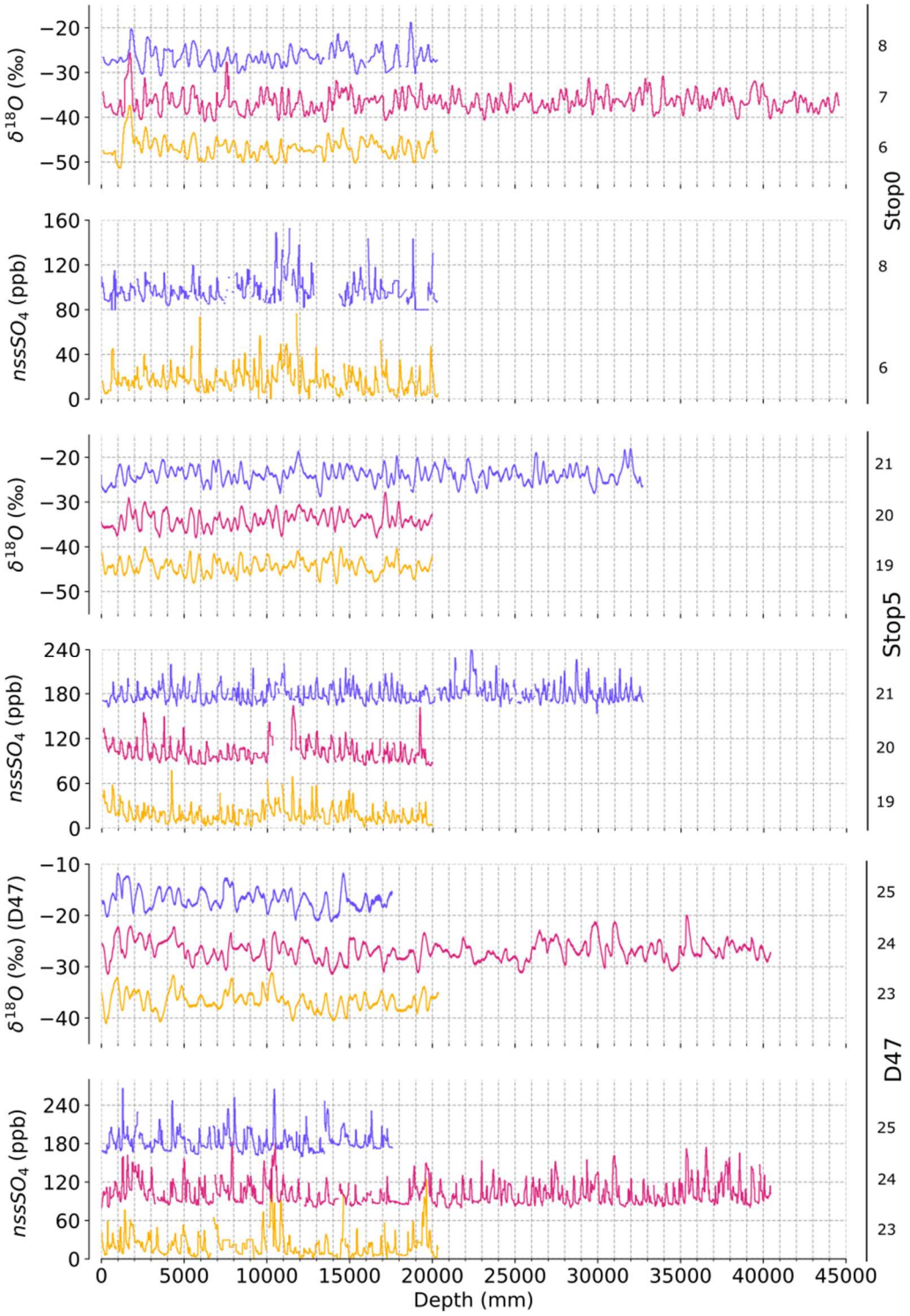

Fig. S1: $\delta^{18}O$ and $nssSO_4$ records at ASUMA sites Stop0, Stop5 and D47 over the entire depth covered. The labels on the right vertical axis correspond to the core number.

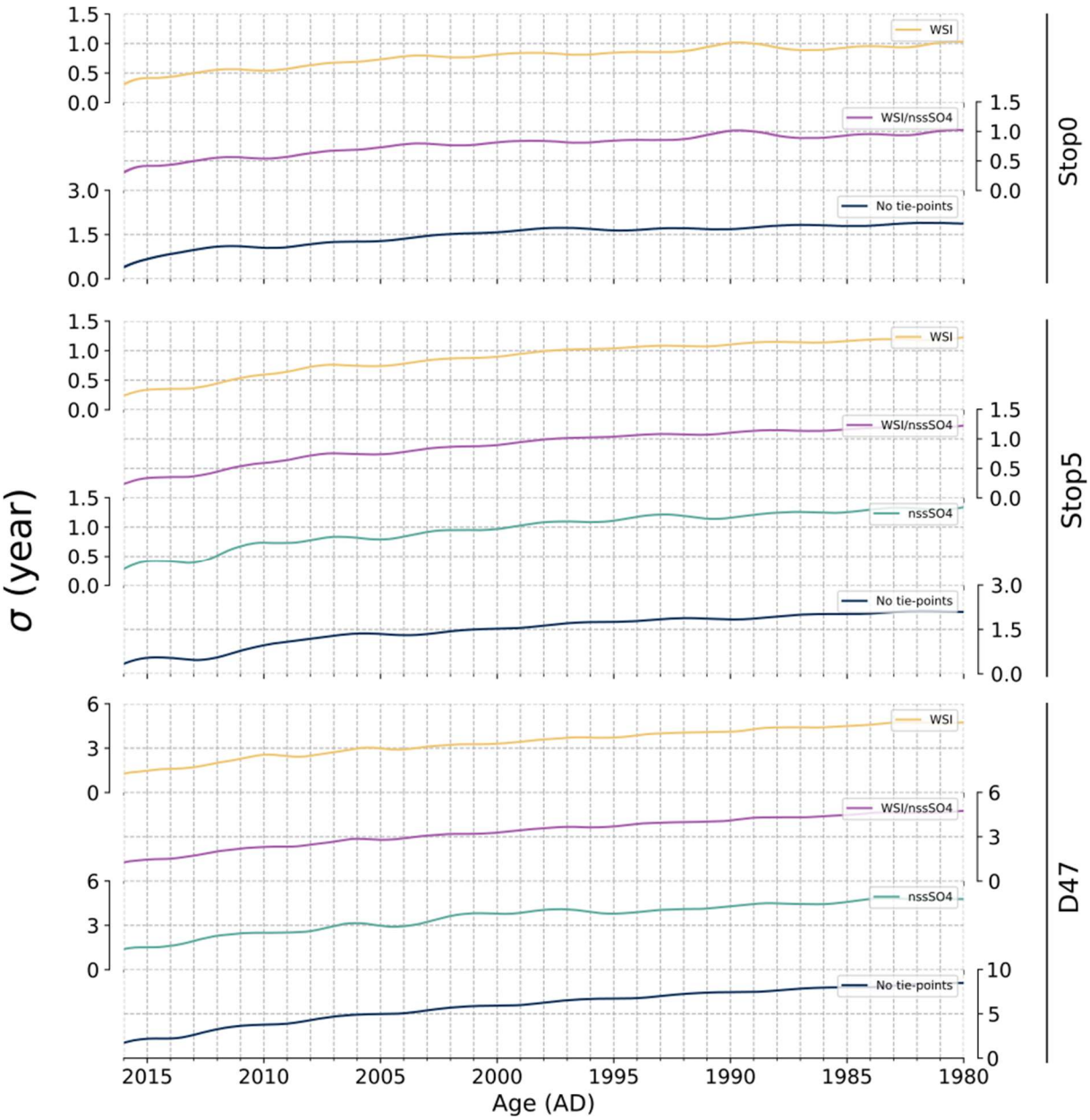

Fig. S2: Uncertainties associated with the output chronologies at all sites performed with water isotopes tie-points (yellow curve), nssSO4 tie-points (green curve), both water isotopes and nssSO4 tie-points (purple curve) and no tie-points (blue curve).

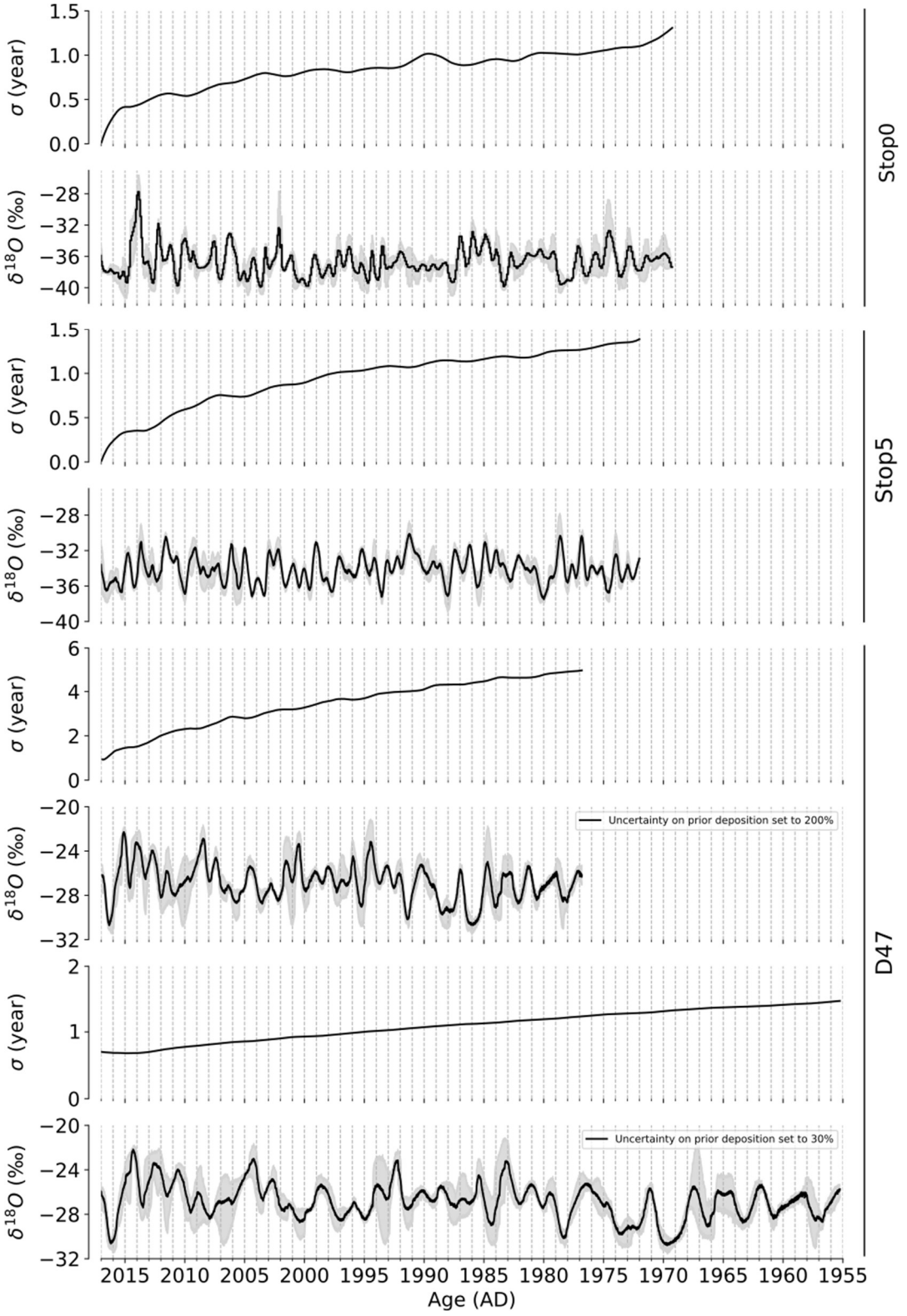

Fig. S3: For each site, the dating uncertainty computed by Paleochrono (upper panel) and the δ18O stacked record (lower panel) are plotted over the common period of the 3 individual firn cores. The shaded envelope is the maximum and minimum values of these 3 records. At D47, site the chronology is performed with an uncertainty on the prior deposition scenario equal to 30 % or 200 %. For both outputs, all other parameters inputted to the model are fixed.

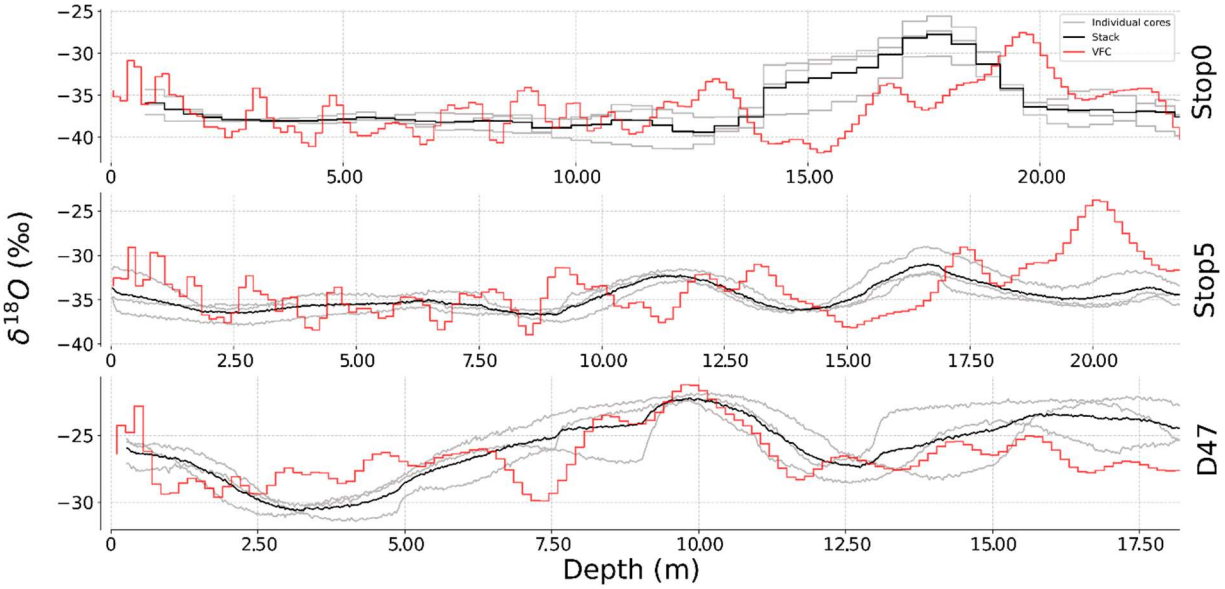

Fig. S4: Zoom on the upper part of $\delta^{18}O$ signal of the stack of each site (black curve) and the three related individual cores (grey curves), and comparison with the associated ECHAM6-wiso VFC (red curve).

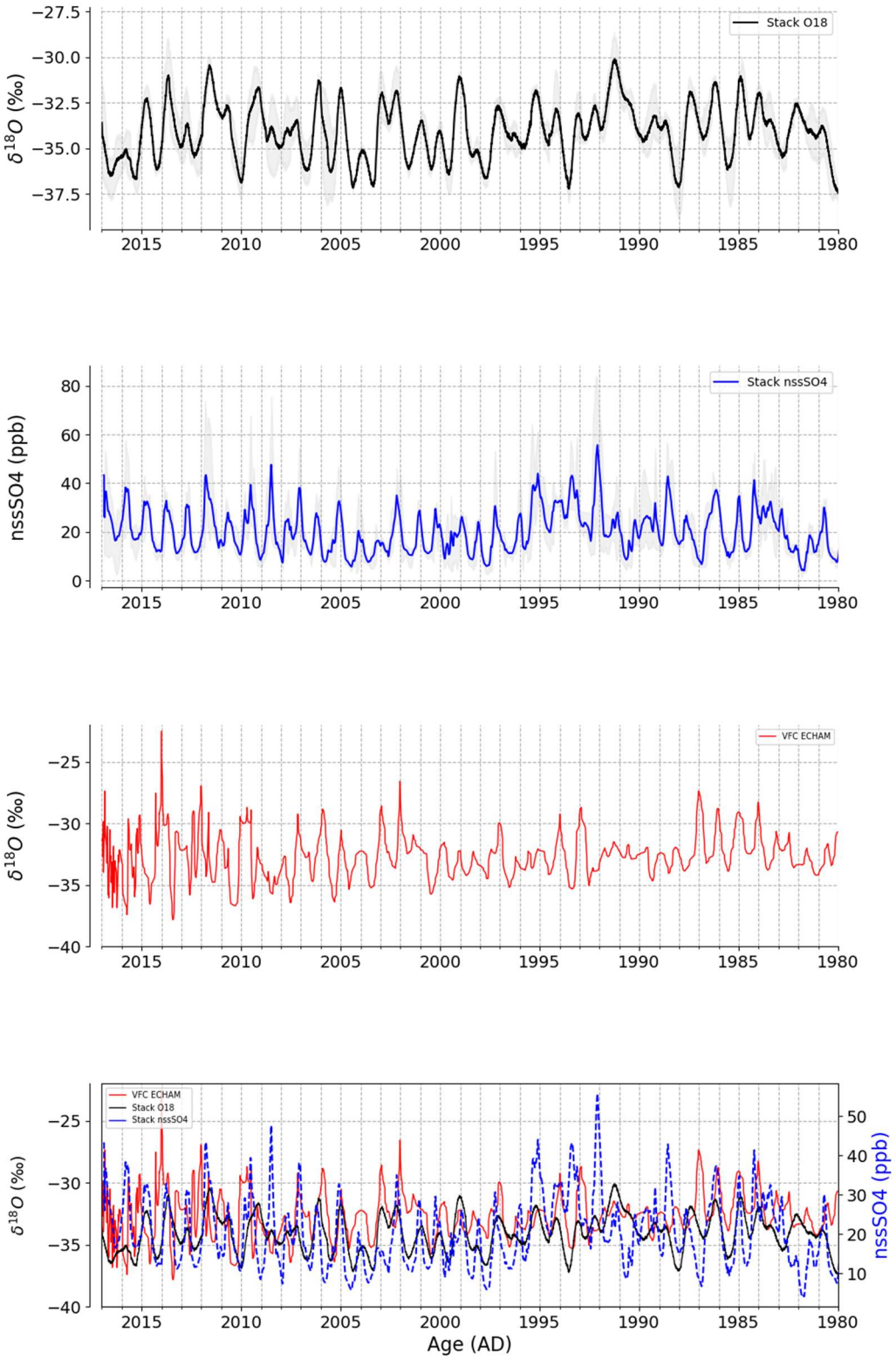

Fig. S5: Stacked $\delta^{18}O$ (black curve) and nssSO4 records (blue curve) and $\delta^{18}O$ series of the ECHAM derived VFC (red curve) at Stop5.

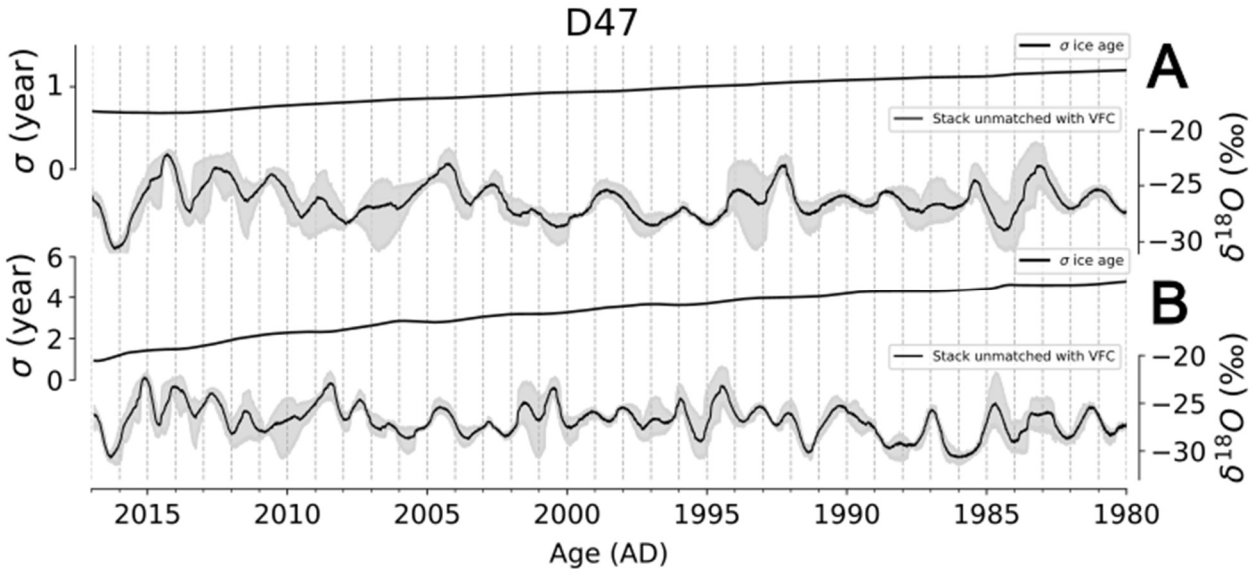

Fig. S6: Stacked $\delta^{18}O$ for D47 site when the chronology is performed with an uncertainty on the prior deposition scenario equal to 30 % (panel A) or 200 % (panel B). All other parameters inputted to the model are fixed.

Table S1: List of the dated intervals used as inputs in Paleochrono software to establish the common chronology for all the cores at all sites. They are assessed as explained in section 2.3 by counting the number of seasonal peaks in regular 2-meter intervals core sections. The uncertainty is determined by adding 0.5 yr each time a peak identification is unclear.

Dated interval											
D47											
ASUMA2016_23				ASUMA2016_24				ASUMA2016_25			
Top depth (mm)	Bottom depth (mm)	Duration (year)	Uncertainty (year)	Top depth (mm)	Bottom depth (mm)	Duration (year)	Uncertainty (year)	Top depth (mm)	Bottom depth (mm)	Duration (year)	Uncertainty (year)
0	2000	2.5	2.5	0	2000	4.5	4.5	0	2000	3.5	3.5
2000	4000	4	4	2000	4000	3	3	2000	4000	3.5	3.5
4000	6000	4	4	4000	6000	4.5	4.5	4000	6000	3	3
6000	8000	4	4	6000	8000	3.5	3.5	6000	8000	3	3
8000	10000	4	4	8000	10000	3	3	8000	10000	4.5	4.5
10000	12000	4	4	10000	12000	3.5	3.5	10000	12000	3.5	3.5
12000	14000	3.5	3.5	12000	14000	3.5	3.5	12000	14000	3.5	3.5
14000	16000	3.5	3.5	14000	16000	3.5	3.5	14000	16000	3.5	3.5
16000	18000	3.5	3.5	16000	18000	3.5	3.5	16000	17585	4	4
18000	20000	3.5	3.5	18000	20000	3.5	3.5				
				20000	22000	3	3				
				22000	24000	5	5				

				24000	26000	3.5	3.5				
				26000	28000	4.5	4.5				
				28000	30000	2.5	2.5				
				30000	32000	3	3				
				32000	34000	3.5	3.5				
				34000	36000	3	3				
				36000	38000	4.5	4.5				
				38000	40000	4.5	4.5				
Stop5											
ASUMA2016_19				**ASUMA2016_20**				**ASUMA2016_21**			
Top depth (mm)	**Bottom depth (mm)**	**Duration (year)**	**Uncertainty (year)**	**Top depth (mm)**	**Bottom depth (mm)**	**Duration (year)**	**Uncertainty (year)**	**Top depth (mm)**	**Bottom depth (mm)**	**Duration (year)**	**Uncertainty (year)**
0	2000	4.5	0.5	0	2000	4	1	0	2000	3.5	1
2000	4000	6	1.5	2000	4000	4	1	2000	4000	4	1
4000	6000	4	0.5	4000	6000	4	1.5	4000	6000	5	1
6000	8000	5	1	6000	8000	5	1	6000	8000	5	1
8000	10000	5	1	8000	10000	5	1	8000	10000	5	1
10000	12000	4.5	0.5	10000	12000	4	0.5	10000	12000	5	1.5
12000	14000	6	1	12000	14000	5.5	1	12000	14000	5	0.5
14000	16000	4.5	0.5	14000	16000	5	1	14000	16000	4.5	0.5
16000	18000	5	1	16000	18000	5	1	16000	18000	5	1
18000	19984.4	4.5	1	18000	20002.2	5	1	18000	20000	4.5	1
								20000	22000	5	1.00
								22000	24000	3	1.00
								24000	26000	4.5	0.5
								26000	28000	5.5	1.50
								28000	30000	5	0.5
								30000	32000	4	1.00
								32000	32730	1.5	0.5
Stop0											
ASUMA2016_6				**ASUMA2016_7**				**ASUMA2016_8**			
Top depth (mm)	**Bottom depth (mm)**	**Duration (year)**	**Uncertainty (year)**	**Top depth (mm)**	**Bottom depth (mm)**	**Duration (year)**	**Uncertainty (year)**	**Top depth (mm)**	**Bottom depth (mm)**	**Duration (year)**	**Uncertainty (year)**
0	2000	2.5	1.5	0	2000	3	1	0	2000	3	1
2000	4000	3.5	0.5	2000	4000	3.5	0.5	2000	4000	3.5	0.5
4000	6000	4	1	4000	6000	4	1	4000	6000	3.5	1.5
6000	8000	4	1.5	6000	8000	3.5	0.5	6000	8000	3.5	0.5
8000	10000	5	0.5	8000	10000	4.5	0.5	8000	10000	5	0.5

10000	12000	4	0.5	10000	12000	4	0.5	10000	12000	4	0.5
12000	14000	5.5	1	12000	14000	5.5	0.5	12000	14000	5	1
14000	16000	4	1	14000	16000	4.5	1	14000	16000	4	0.5
16000	18000	5	2	16000	18000	4.5	1	16000	18000	4	1.5
18000	20000	4	1.5	18000	20000	5.5	1	18000	20000	5	1.5
				20000	22000	5.5	0.5				
				22000	24000	5.5	0.5				
				24000	26000	5.5	1.5				
				26000	28000	6	1				
				28000	30000	5	0.5				
				30000	32000	6	1				
				32000	34000	5	0.5				
				34000	36000	4	0.5				
				36000	38000	5.5	0.5				
				38000	40000	3	0.5				
				40000	42000	6	1				
				42000	44000	6	0.5				

Table S2: Depth values of the water isotopes tie-points identified between the 3 cores of each site. These values were inputted into Paleochrono as matching constraints.

D47			**Stop5**			**Stop0**		
Tie-points water isotopes								
ASUMA2016_23 (mm)	ASUMA2016_24 (mm)	ASUMA2016_25 (mm)	ASUMA2016_19 (mm)	ASUMA2016_20 (mm)	ASUMA2016_21 (mm)	ASUMA2016_6 (mm)	ASUMA2016_7 (mm)	ASUMA2016_8 (mm)
952	1003	1005	1139	1184	1096	1654	1732	1787
1498	1737	1562	1679	1649	1662	2386	2314	2458
	2006	1916	2627	2608	2678	2610	2621	2750
2238	2338	2224	3064	3150	3044	3149	3239	3230
2794	2892	2912	3422	3519	3338	3500	3585	3553
4337	4405	4103	3923	3922	3676	3750	3918	
4859	4865	4644		4586	4643	4128	4251	
	5227	5261		4847	4855	4888	4898	5006
6027	6039	6008	5348	5409	5366	5529	5514	5496
6304	6378	6623	5891	5897	5852	6366	6492	6446
6773	6779	6869	6348	6383	6391	6889	7001	7006
7483	7270	7532	6793	6847	6764	7454	7563	7612

7630		7762	7144	7133	7086	7879	8111	8090
7873	7817	7895	7623	7629	7627	8366		8502
8415	8451	8473	7957	8040	8009	8764	8823	8881
8951	8882	8846	8380	8442	8440	9177	9370	9328
9729	9777	9796	8787		8765	9635	9646	
10033	10107	10035	9245	9256	9150	10012	10010	10000
10293	10464	10412	10073	10086	10028		10480	10517
10874	10969	10991	10565	10560		10814	10925	10982
11271	11458	11447	10794	10895	10786	11243	11320	11397
11588	11734	11735	11048	11154	11020	13647	13750	13863
12157	12138	12231	11422	11501	11422	14092	14190	14268
13055	13141		11868	11927	11902	14569		14775
13558	13569	13554	12901	12909	12935	15020		15163
14464	14398	14615	13205	13056	13200	15653	15600	15670
15327	15253		13425	13421	13482		16535	16592
15898	15963	15980	13861	13885	13925	17099	16975	16932
16218	16243	16202	14455	14395	14401	17575	17770	17822
16887	16752	16840	14793	14891	14855	18452	18565	18684
17560	17622		15118		15131	18822	19116	18960
18877	18801		15284	15370	15460	19103	19357	19287
19488	19477		15689	15704	15691		19825	19740
19709	19837		16314	16319	16214			
19910	20179		16530	16611	16513			
			17230	17169	17070			
			17581	17580	17520			
			17878	17949	17839			
			18313	18383	18138			
			18626	18696	18524			
			19151	19169	19082			
			19556	19531	19551			

Table S3: Depth values of the nssSO_4 tie-points identified in the 3 cores of each site. These values were inputted into Paleochrono as matching constraints.

D47			**Stop5**			**Stop0**		
Tie-points nssSO4								
ASUMA2016_23 (mm)	ASUMA2016_24 (mm)	ASUMA2016_25 (mm)	ASUMA2016_19 (mm)	ASUMA2016_20 (mm)	ASUMA2016_21 (mm)	ASUMA2016_6 (mm)	ASUMA2016_7 (mm)	ASUMA2016_8 (mm)
1143	813	1049	623	636	664	2155		2140
1398	1299	1273	1090	1133	1152	2596		2629
2968	3025		1629	1596	1557	3723		3777
4459	4307	4278	2128	2100	2126	4170		4191

5837	5893	5912	4203	4116	4168	5438		5521
6208	6235	6514		4631	4646	5934		5891
	7254	7378		4905	4945	8297		8466
	7878	8022	5385	5353	5311	11184		11363
	8834	8817	5889	5867	5816	11394		11581
	9018	9068	6372		6298	15586		15663
9782	9824		6725		6658	16538		16536
10244	10504	10434	7166		7172			
10819	10978	11066	7580	7576	7596			
11337	11484	11463	7898	7977	7928			
	11886	11781	8809	8803	8818			
	12525	12371	9594	9754	9657			
13138	13160		11940	11972	11853			
13558	13588	13657	12260	12330	12188			
15445	15335	15362	12936	12976	12987			
16146	16051		13914	13851	13951			
16347	16298	16310	14435	14364	14388			
16902		16938	14780	14715	14726			
17075	17109	17075		15103	15180			
17288		17260		15396	15414			
18520	18602		16365	16340	16279			
18819	18907		18179	18295	18308			
				18739	18630			

Table S4: Mean $\delta^{18}O$ values of stacked data and VFC records at all sites. Longitude, latitude and altitude of the grid point or the drilling point for the data are also displayed. ΔAltitude refers to the difference between the altitude of the grid cell and the drilling site, and $\Delta\delta^{18}O$ to the difference between the mean isotopic composition of VFC and the one of the stacked data from our cores. We also display mean annual temperature inferred from the drilling hole temperature measured at 20 m below the surface immediately after the extraction.

Site	Record	Mean $\delta^{18}O$ values (‰)	Longitude	Latitude	Altitude (m a.s.l)	ΔAltitude data/model (m)	$\Delta\delta^{18}O$ data/model (‰)	Mean annual temperature (°C)
Stop0	Stacked data	-36.7	135.28	-69.64	2421			-
	ECHAM6-wiso VFC	-34.2	135.00	-69.66	2425	+4	+2.5	-37.9
	LMDZ6iso VFC	-39.5	135.00	-69.72	2413	-8	-2.8	-42.8
	Drilling hole temperature							-41.2
Stop5	Stacked data	-34.1	137.44	-68.75	2317			
	ECHAM6-wiso VFC	-32.5	137.81	-68.73	2299	-18	+1.6	-35.6
	LMDZ6iso VFC	-33.7	137.50	-68.45	2287	-30	+0.4	-34.4

	Drilling hole temperature							-37.2
D47	Stacked data	-26.8	138.71	-67.40	1516			
	Automatic Weather Station							-24.6
	ECHAM6-wiso VFC	-27.2	138.75	-67.79	1790	+274	-0.4	-28.5
	LMDZ6iso VFC	-27.4	137.50	-67.18	1405	-111	-0.6	-25.8
	Drilling hole temperature							-25.9

Table S5: Dates of all the $\delta^{18}O$ tie-points used to match stacks and VFC (ECHAM6-iso and LMDZ6iso).

Tie-point year (stack|model)					
Stop5 ($\delta^{18}O$ assignation)		**Stop5 (matching summer of $nssSO_4$ peaks)**		**Stop0 ($\delta^{18}O$ assignation)**	
2017	2017	2017	2017	2017	2017
2014.76	2015.131	2015.76	2016	2013.89	2014
2013.68	2014	2014.76	2015.1	2012.21	2012
2012.71	2013	2013.7	2014	2011.22	2011
2011.6	2012.01	2012.72	2013	2010.59	2010.52
2010.71	2011.036	2011.6	2012	2009.97	2009.73
2009.56	2010.05	2010.68	2011	2009.32	2009.15
2008.09	2008.479	2009.53	2010	2007.51	2007.17
2007.2	2007.19	2008.53	2009	2006.23	2005.95
2006.71	2006.43	2007.69	2008	2005.05	2005
2006.09	2005.879	2007.09	2007	2004.23	2004.24
2005	2005	2006.24	2006	2003.27	2002.94
2003.92	2004	2005	2005	2002.16	2002.03
2002.96	2002.94	2003.95	2004	2001.13	2001
2002.21	2002.04	2003.05	2003	2000.16	1999.9
2000.48	2000.45	2002.21	2002	1999.15	1998.99
2000.04	1999.82	2001.06	2001	1997.95	1998
1999.01	1999.03	2000.26	2000	1997.18	1997
1997.12	1997.03	1998.97	1999	1996.26	1996.21
1995.2	1995	1998.07	1998	1995.27	1995.1
1994.16	1993.98	1997.14	1997	1994.36	1993.98
1993.56	1993.49	1996.03	1996	1993.54	1992.92
1993.08	1992.93	1995.08	1995	1992.12	1991.22
1991.25	1991.28	1994.16	1994	1988.26	1988.12
1989.23	1988.91	1993.14	1993	1986.96	1987.03
1988.7	1988.17	1992.1	1992	1985.95	1986.06
1987.42	1987.03	1991.05	1991	1984.91	1985.06
1986.21	1986.03	1990.25	1990	1983.97	1984.05
1985.54	1985.53	1989.25	1989	1982.72	1983.07
1984.91	1985.03	1988.55	1988		
1983.97	1984.03	1987.46	1987		
1983.42	1983.13	1986.21	1986		
1982.12	1982	1984.92	1985		
		1983.97	1984		
		1983.27	1983		

Table S6: Correlation coefficients and associated p-values between individual cores and stacked $\delta^{18}O$ data at each site and ECHAM6-wiso and LMDZ6iso derived VFC $\delta^{18}O$ series. These correlation coefficients are computed after realignement with Paleochrono and are therefore maximum values.

		r VFC ECHAM6-wiso	pval VFC ECHAM6-wiso	r VFC LMDZ6iso	pval VFC LMDZ6iso
Stop0	ASUMA2016_6	0.44	<0.005	0.41	<0.005
	ASUMA2016_7	0.54	<0.005	0.54	<0.005
	ASUMA2016_8	0.53	<0.005	0.49	<0.005
	Stack	**0.58**	**<0.005**	**0.55**	**<0.005**
Stop5	ASUMA2016_19	0.45	<0.005	0.52	<0.005
	ASUMA2016_20	0.56	<0.005	0.57	<0.005
	ASUMA2016_21	0.43	<0.005	0.54	<0.005
	Stack	**0.54**	**<0.005**	**0.60**	**<0.005**

Table S7: Correspondences between the 12 highest maximums in VFC $\delta^{18}O$ inferred from ECHAM6-wiso and stacked data at Stop0 site.

12 maximums in ECHAM VFC $\delta^{18}O$	Maximums in stack $\delta^{18}O$
2014	X
2012	X
2010	X
2007	X
2005	
2003	
2002	X
1997	
1987	X
1986	X
1985	X
1984	
Proportion	8/12

Table S8: Summers associated with the 12 highest precipitation-weighted temperatures at Stop0 from ERA5 (left part of the table), and with the 12 highest monthly mean temperatures (right part). For each of these years, we indicate a cross if this year also corresponds to one of the 12 maximums in the LMDZ6iso VFC and in stacked $\delta^{18}O$ series, and in bold underlined, the years where all the series record one of the 12 highest values.

Maximums in summer precipitation-weighted temperature	**Maximums in stack $\delta^{18}O$**	**Maximums in LMDZ6iso VFC $\delta^{18}O$ series**	**Maximums in summer temperature**	**Maximums in stack d18O**	**Maximums in LMDZiso VFC $\delta^{18}O$ series**
2013-2014	**X**	**X**	**2013-2014**	**X**	**X**
2011-2012	X	X			
2010-2011	X				
			2009-2010		
2005-2006	**X**	**X**	**2005-2006**	**X**	**X**
2004-2005		X	2002-2003		
2001-2002	**X**	**X**	**2001-2002**	**X**	**X**
1993-1994		X	2000-2001		
1991-1992			1991-1992		
1989-1990			1986-1987	X	X
1985-1986	X	X			
1984-1985	**X**	**X**	**1984-1985**	**X**	**X**
1983-1984		X	1983-1984		X
			1982-1983		
			1979-1980	X	
Proportion	7/12	9/12	**Proportion**	6/12	6/12