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Supplement of

Variability of sea salts in ice and firn cores from Fimbul Ice Shelf, Dronning Maud Land, Antarctica

Carmen Paulina Vega et al.

Correspondence to: Carmen Paulina Vega (carmen.vegariquelme@ucr.ac.cr)

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Supplementary material

Table S1. k_{seawater} calculated from standard seawater composition (Summerhayes and Thorpe, 1996) and used in the ss- and nss-fraction calculations, where $k_{\text{seawater}} = \frac{[\text{X}]_{\text{seawater}}}{[\text{Na}^+]_{\text{seawater}}}$. Concentrations used to calculate k_{seawater} were in $\mu\text{mol L}^{-1}$.

Ratio in seawater	k_{seawater}
Cl^-/Na^+	1.16
$\text{SO}_4^{2-}/\text{Na}^+$	0.065
K^+/Na^+	0.02
$\text{Mg}^{2+}/\text{Na}^+$	0.11
$\text{Ca}^{2+}/\text{Na}^+$	0.02

Table S2. Complement to Table 2. Mean, maximum, minimum, and standard deviation (σ) of ion concentrations (in $\mu\text{mol L}^{-1}$) in the KC, KM, BI, and S100 firn/ice cores.

Site	Period (years)	MSA	Cl ⁻	NO ₃ ⁻	SO ₄ ²⁻	Mean	Maximum	Minimum	σ	Ca ²⁺
						Na ⁺	K ⁺	Mg ²⁺		
($\mu\text{mol L}^{-1}$)										
KC	1958–2007	0.2	11.3	0.7	2.1	12.1	0.2	1.0	1.8	
		0.9	59.3	1.8	10.3	162.6	1.5	4.2	62.7	
		0.0	1.7	0.2	0.1	1.1	0.0	0.2	0.2	
		0.2	7.0	0.4	1.5	12.2	0.2	0.6	6.5	
KM	1995–2012	0.5	119.7	0.5	6.2	88.6	2.0	8.8	2.2	
		9.4	571.6	5.4	84.5	654.8	16.1	45.5	10.6	
		0.0	6.9	0.1	0.5	2.9	0.1	1.0	0.4	
		0.6	104.4	0.4	7.5	92.6	1.8	7.4	1.8	
BI	1996–2012	0.5	27.0	0.5	2.5	22.5	0.6	2.4	0.7	
		2.0	185.8	2.3	11.2	161.8	5.0	15.9	3.5	
		0.0	1.8	0.1	0.3	1.7	0.0	0.3	0.3	
		0.4	20.3	0.4	1.9	17.3	0.5	1.7	0.4	
S100	1737–2000	0.2	78.2	0.6	2.6	75.5	1.6	4.4	1.8	
		5.6	2174.1	1.8	56.0	1315.5	39.6	35.9	40.0	
		0.0	3.7	0.1	0.2	3.7	0.1	0.0	0.1	
		0.3	187.7	0.3	5.2	149.8	3.4	5.4	3.6	
S100	1995–2000	0.2	220.8	0.6	6.0	209.0	4.4	10.8	4.2	
		1.0	2174.1	1.4	35.8	1315.5	39.6	35.9	40.0	
		0.0	11.3	0.1	0.8	11.0	0.3	1.5	0.5	
		0.2	332.1	0.3	7.4	232.0	5.9	6.2	6.0	
S100	1737–1949	0.1	18.8	0.6	1.1	18.4	0.4	1.6	0.6	
		0.8	120.9	1.8	4.8	138.8	2.1	6.3	5.7	
		0.0	3.7	0.1	0.2	3.7	0.1	0.3	0.1	
		0.1	12.9	0.3	0.5	14.2	0.2	0.9	0.2	
S100	1950–2000	0.2	179.2	0.6	5.2	172.6	3.6	9.1	3.7	
		5.6	2174.1	1.5	56.0	1315.5	39.6	35.9	40.0	
		0.0	9.1	0.1	0.4	8.6	0.2	0.0	0.3	
		0.5	280.9	0.3	7.9	213.2	5.0	6.4	5.4	

Table S3. Slope and standard error (σ) of the linear regression for annual ion concentrations ($\mu\text{mol L}^{-1}$) with time (years) at different time periods in the S100 and KC cores. Significant values at the 95 % confidence level are shown in bold numbers. (SMB: Surface mass balance).

Ion	S100 (1737–1949)		S100 (1950–2000)		KC (1958–2012)	
	Slope ($\mu\text{mol L}^{-1} \text{y}^{-1}$)	σ	Slope ($\mu\text{mol L}^{-1} \text{y}^{-1}$)	σ	Slope ($\mu\text{mol L}^{-1} \text{y}^{-1}$)	σ
MSA	2×10^{-4}	$\pm 1 \times 10^{-4}$	-0.010	± 0.01	8×10^{-4}	$\pm 1 \times 10^{-3}$
Cl ⁻	0.06	\pm 0.01	4.05	\pm 0.86	0.02	± 0.04
NO ₃ ⁻	-1×10^{-3}	\pm 2×10^{-4}	4×10^{-3}	\pm 2×10^{-3}	-1×10^{-3}	$\pm 2 \times 10^{-3}$
SO ₄ ²⁻	1×10^{-3}	\pm 5×10^{-4}	0.11	\pm 0.03	-5×10^{-3}	$\pm 9 \times 10^{-3}$
Na ⁺	0.05	\pm 0.01	2.9	\pm 0.60	-0.10	± 0.05
K ⁺	1×10^{-3}	\pm 2×10^{-4}	0.07	\pm 0.02	-5×10^{-5}	$\pm 8 \times 10^{-4}$
Mg ²⁺	6×10^{-3}	\pm 8×10^{-4}	0.15	\pm 0.03	3×10^{-3}	$\pm 4 \times 10^{-3}$
Ca ²⁺	3×10^{-3}	\pm 4×10^{-4}	0.08	\pm 0.02	-0.02	± 0.05
SMB	2×10^{-4}	$\pm 1.1 \times 10^{-4}$	-2×10^{-3}	\pm 8×10^{-4}	-2×10^{-3}	$\pm 1 \times 10^{-3}$

Table S4. Complement to Table 4. Mean, maximum, minimum, and standard deviation (σ) of the Cl^-/Na^+ ratio (using concentrations in $\mu\text{mol L}^{-1}$), ssNa^+ , and nssNa^+ concentrations.

Site	Period (years)	Cl^-/Na^+	Mean Maximum Minimum σ		
			ssNa^+ ($\mu\text{mol L}^{-1}$)	$\text{nssNa}^+(\text{crustal})$ ($\mu\text{mol L}^{-1}$)	
		All values	Only positive values		
KC	1958–2007	1.1	9.9	11.5	2.3
		1.9	163.7	163.7	89.7
		0.1	–69.3	0.4	–1.0
		0.3	14.9	12.5	9.2
KM	1995–2012	1.3	88.1	88.1	0.5
		3.8	662.9	662.9	9.2
		0.8	2.5	2.5	–8.1
		0.2	92.8	92.8	0.9
BI	1996–2012	1.2	22.1	22.1	0.3
		1.5	161.4	161.4	0.8
		0.9	1.4	1.4	0.0
		0.1	17.3	17.3	0.1
S100	1737–2000	1.0	75.1	75.1	0.4
		2.1	1295.7	1295.7	34.3
		0.1	3.6	3.6	–4.8
		0.2	149.3	149.3	2.1
S100	1995–2000	1.0	208.9	208.9	0.0
		2.1	1295.7	1295.7	19.7
		0.1	10.1	10.1	–3.3
		0.2	230.5	230.5	2.9
S100	1737–1949	1.1	18.1	18.1	0.4
		1.8	141.4	141.4	7.8
		0.6	3.6	3.6	–2.6
		0.2	14.3	14.3	0.6
S100	1950–2000	1.0	172.2	172.2	0.3
		2.1	1295.7	1295.7	34.3
		0.1	8.0	8.0	–4.8
		0.2	212.2	212.2	3.4

Table S5. Complement to Table 5. Mean, maximum, minimum, and standard deviation (σ) of ss- and nss-fractions in the KC, KM, BI, and S100 cores.

Core	Period (years)	Mean Maximum Minimum σ									
		Cl ⁻		SO ₄ ²⁻		K ⁺		Mg ²⁺		Ca ²⁺	
		ss	nss	ss	nss	ss	nss	ss	nss	ss	nss
KC	1958–2007	11.4	-0.1	0.6	1.5	0.2	0.0	1.1	0.0	0.2	1.6
		189.9	98.9	9.8	8.2	3.3	1.8	18.0	9.7	3.3	64.0
		-80.3	-170.9	-4.2	-0.6	-1.4	-2.0	-7.6	-17.3	-1.4	-0.7
		17.3	15.8	0.9	1.4	0.3	0.3	1.6	1.7	0.3	6.6
KM	1995–2012	102.2	7.5	5.3	0.9	1.8	0.2	9.7	-0.9	1.8	0.4
		769.0	70.5	39.8	44.8	13.3	13.7	72.9	23.6	13.3	6.5
		2.7	-221.8	0.1	-15.7	0.0	-8.8	0.3	-56.2	0.0	-5.8
		107.7	19.9	5.6	4.4	1.9	1.3	10.2	6.9	1.9	0.7
BI	1996–2012	25.7	1.3	1.3	1.2	0.4	0.1	2.4	-0.1	0.4	0.2
		187.2	12.9	9.7	7.4	3.2	4.5	17.7	2.0	3.2	0.6
		1.6	-4.0	0.1	-1.5	0.0	0.0	0.2	-3.5	0.0	0.0
		20.0	1.6	1.0	1.7	0.3	0.3	1.9	0.5	0.3	0.1
S100	1737–2000	87.2	-9.0	4.5	-1.9	1.5	0.1	8.3	-3.9	1.5	0.3
		1503.0	671.1	77.7	4.6	25.9	13.7	142.5	3.6	25.9	24.5
		4.1	-601.0	0.2	-46.2	0.1	-2.9	0.4	-106.7	0.1	-3.5
		173.2	53.4	9.0	5.2	3.0	0.8	16.4	11.7	3.0	1.5
S100	1995–2000	242.4	-21.5	12.5	-6.6	4.2	0.2	23.0	-12.2	4.2	0.0
		1503.0	671.1	77.7	3.1	25.9	13.7	142.5	3.3	25.9	14.1
		11.7	-601.0	0.6	-42.0	0.2	-1.4	1.1	-106.7	0.2	-2.4
		267.4	132.2	13.8	8.5	4.6	2.0	25.4	19.6	4.6	2.1
S100	1737–1949	20.9	-2.2	1.1	0.1	0.4	0.0	2.0	-0.4	0.4	0.3
		164.0	9.7	8.5	4.1	2.8	0.6	15.6	3.6	2.8	5.6
		4.1	-49.1	0.2	-7.4	0.1	-0.7	0.4	-14.5	0.1	-1.8
		16.6	4.8	0.9	0.8	0.3	0.1	1.6	1.2	0.3	0.5
S100	1950–2000	199.8	-20.6	10.3	-5.1	3.4	0.1	18.9	-9.9	3.4	0.2
		1503.0	671.1	77.7	4.6	25.9	13.7	142.5	3.3	25.9	24.5
		9.3	-601.0	0.5	-46.2	0.2	-2.9	0.9	-106.7	0.2	-3.5
		246.2	86.5	12.7	7.4	4.2	1.4	23.4	17.7	4.2	2.4

Table S6. Complement to Table 6. Mean, minimum, maximum, and standard deviation (σ) of MSA/nssSO₄²⁻ ratios, and bio-nssSO₄²⁻ in the KC, KM, BI, and S100 cores.

Site	Period (years)	Mean Maximum Minimum σ		
		MSA/nssSO ₄ ²⁻		bio-nssSO ₄ ²⁻
		All values	Only positive values	
KC	1958–2007	0.7	1.0	1.2
		208.3	208.3	0.0
		-56.9	0.0	5.2
		11.8	11.6	1.0
KM	1995–2012	0.1	0.6	2.9
		26.2	26.16	0.1
		-25.1	0.0	52.3
		2.2	2.0	3.5
BI	1996–2012	-1.6	0.8	2.7
		16.2	16.2	0.1
		-687.2	0.0	11.3
		36.1	1.6	2.4
S100	1737–2000	0.0	1.4	1.0
		59.9	59.9	0.0
		-59.1	0.0	31.4
		5.6	4.9	1.6
S100	1995–2000	0.0	0.7	1.0
		5.1	5.1	0.1
		-2.1	0.1	5.4
		0.8	1.5	1.2
S100	1737–1949	0.2	1.5	0.8
		59.9	59.9	0.0
		-59.1	0.0	4.4
		6.5	5.2	0.5
S100	1950–2000	-0.3	0.8	1.2
		9.2	9.2	0.1
		-37.2	0.0	31.4
		3.2	1.9	2.6

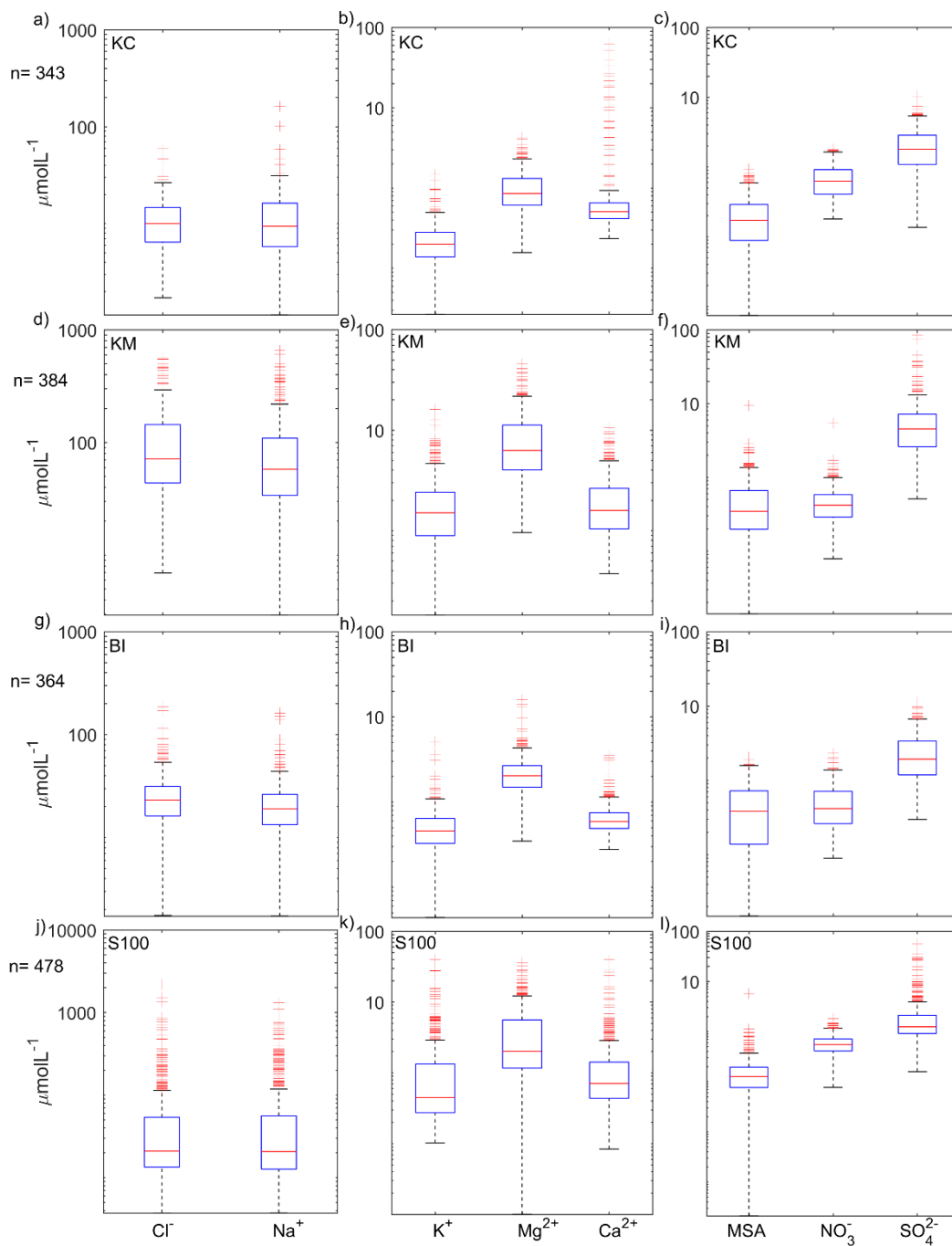


Figure S1. Box-plot of raw ion concentrations in the different cores: a-c) KC, d-f) KM, g-i) BI, and j-l) S100. Y-axis is in logarithmic scale, n represents the sample size, and whiskers are Tukey style.

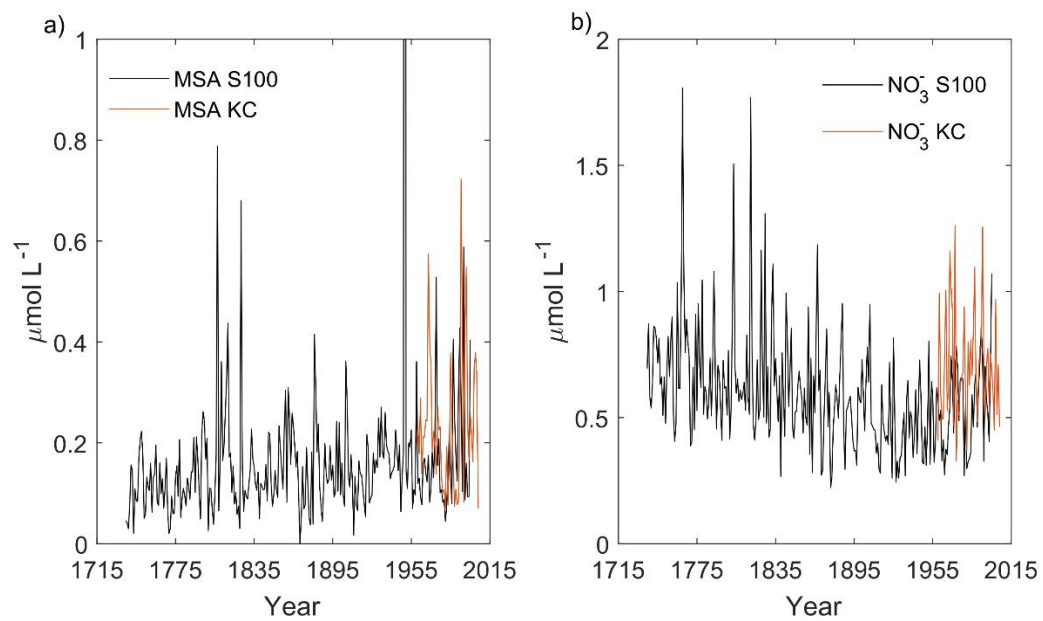


Figure S2. a) MSA and b) NO_3^- annual concentrations in the S100 and KC cores.

References

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