River water control of stratification in Arctic marginal seas

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Table S1: Seasonal contribution of salinity gradient ($\Delta S/\Delta z$; S m^{-1}) and temperature gradient ($\Delta\theta/\Delta z$; °C m^{-1}) to potential density gradient ($\Delta\rho_\theta/\Delta z$; kg m^{-3} m^{-1}) across water columns of Hudson and James Bays (HJB), evaluated using multiple linear regression analysis.

Season	Stations	Samples	α^a	β^b	γ^c	R^2 (model)	R^2 ($\Delta S/\Delta z$)	R^2 ($\Delta\theta/\Delta z$)	*p-value*	*p-value* ($\Delta S/\Delta z$)	*p-value* ($\Delta\theta/\Delta z$)
Early Summer	58	301	−0.07	0.78	0.00	0.99	0.99	0.90	< 0.001	< 0.001	< 0.001
Late Summer	12	16	−0.11	0.77	0.00	0.99	0.99	0.97	< 0.001	< 0.001	< 0.001
Fall	2	19	−0.09	0.78	0.00	0.99	0.98	0.92	< 0.001	< 0.001	< 0.001
All	72	336	−0.08	0.78	0.00	0.99	0.99	0.91	< 0.001	< 0.001	< 0.001

[a]Thermal expansion coefficient (kg m^{-3} °C^{-1})

[b]Haline contraction coefficient (kg m^{-3} S^{-1})

[c]y-intercept (kg m^{-3} m^{-1})

Table S2. Seasonal contribution of river water ($|\Delta RW/\Delta z|$; fraction m^{-1}) and sea-ice melt ($|\Delta SIM/\Delta z|$; fraction m^{-1}) gradients to salinity gradients ($\Delta S/\Delta z$; S m^{-1}) at the depth of maximum salinity gradient (z_{SGM}; m), across the Hudson and James Bay (HJB) evaluated using multiple linear regression analyses.

Season	Stations	β_{RW}[a]	β_{SIM}[b]	λ[c]	R^2 (model)	R^2 ($\|\Delta RW/\Delta z\|$)	R^2 ($\|\Delta SIM/\Delta z\|$)	*p-value* (model)	*p-value* ($\|\Delta RW/\Delta z\|$)	*p-value* ($\|\Delta SIM/\Delta z\|$)
Early Summer	69	26.0	30.5	−0.01	0.94	0.89	0.53	< 0.001	< 0.001	< 0.001
Late Summer	54	25.9	27.3	−0.01	0.94	0.84	0.29	< 0.001	< 0.001	< 0.001
Fall	48	30.4	30.1	−0.02	0.95	0.88	0.92	< 0.001	< 0.001	< 0.001
All	171	26.1	29.9	−0.01	0.94	0.89	0.74	< 0.001	< 0.001	< 0.001

[a] Haline contraction coefficient: river water component (S fraction^{-1})

[b] Haline contraction coefficient: sea-ice melt component (S fraction^{-1})

[c] y-intercept (S m^{-1})

Table S3: Seasonal characteristics of the halocline in James Bay and south of 60° N in Hudson Bay.

Halocline Characteristics	Season	JB[a]		SEHB[b]		WT[c]		SHB[d]		SWHB[e]		CHB[f]	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
z_{SGM}[g] (m)	Early Summer	15.4	9.8	18.3	6.1	16.0	5.5	15.8	6.6	14.5	5.7	17.0	6.1
	Late Summer	19.7	13.6	35.0	23.5	–	–	48.0	11.3	33.3	15.3	–	–
	Fall	34.9	15.8	36.2	14.6	35.0	15.9	–	–	27.8	15.7	35.0	–
	All	24.9	15.9	28.2	16.8	28.2	15.9	23.9	16.5	23.5	14.3	21.5	10.3
S_{SGM}[h] (psu)	Early Summer	25.3	3.8	28.3	1.6	30.0	1.0	30.7	0.3	30.5	1.6	32.0	0.1
	Late Summer	23.0	3.8	29.6	1.1	–	–	31.4	0.5	30.4	1.1	–	–
	Fall	29.3	1.5	29.2	1.8	30.5	2.4	–	–	29.6	3.2	32.2	–
	All	25.9	4.2	28.9	1.6	30.3	2.0	30.9	0.4	30.0	2.6	32.0	0.2
ΔS[i] (psu)	Early Summer	2.8	–	3.4	–	2.9	–	1.7	–	1.2	–	0.6	–
	Late Summer	2.1	–	3.2	–	–	–	1.6	–	0.6	–	–	–
	Fall	4.6	–	3.0	–	3.4	–	–	–	2.7	–	2.8	–
	All	3.2	–	3.2	–	3.2	–	1.7	–	1.9	–	1.2	–
RW_{SGM}[j] (fraction)	Early Summer	0.221	0.123	0.139	0.052	0.096	0.010	0.091	0.037	0.085	0.035	0.058	0.015
	Late Summer	0.279	0.106	0.070	0.026	–	–	0.031	0.017	0.005	0.034	–	–
	Fall	0.119	0.041	0.121	0.040	0.095	0.057	–	–	0.102	0.118	0.007	–
	All	0.206	0.114	0.114	0.050	0.096	0.045	0.076	0.042	0.086	0.093	0.045	0.028
SIM_{SGM}[k] (fraction)	Early Summer	−0.001	0.012	−0.011	0.012	−0.018	0.032	−0.038	0.031	−0.024	0.032	−0.043	0.017
	Late Summer	0.013	0.037	0.021	0.012	–	–	0.004	0.002	0.064	0.005	–	–
	Fall	−0.021	0.018	−0.021	0.025	−0.034	0.020	–	–	−0.013	0.047	0.001	–
	All	−0.003	0.031	−0.005	0.023	−0.028	0.025	−0.027	0.033	−0.009	0.046	−0.032	0.026
$\lvert\Delta RW\rvert/(\lvert\Delta RW\rvert + \lvert\Delta SIM\rvert)_{SGM}$[l]	Early Summer	0.96	–	0.91	–	0.76	–	0.71	–	0.74	–	0.57	–
	Late Summer	0.92	–	0.77	–	–	–	0.88	–	0.30	–	–	–
	Fall	0.83	–	0.83	–	0.74	–	–	–	0.79	–	0.85	–
	All	0.90	–	0.86	–	0.75	–	0.72	–	0.73	–	0.58	–
$(\Delta S/\Delta z)_{SGM}$[m] (psu m^{-1})	Early Summer	0.64	0.63	0.17	0.09	0.33	0.17	0.24	0.13	0.40	0.47	0.06	0.05
	Late Summer	0.65	0.88	0.07	0.01	–	–	0.06	0.00	0.04	0.04	–	–
	Fall	0.15	0.08	0.20	0.17	0.13	0.04	–	–	0.40	0.73	0.12	–
	All	0.45	0.66	0.15	0.11	0.20	0.14	0.20	0.14	0.36	0.60	0.08	0.05
$(\Delta RW/\Delta z)_{SGM}$[n] (fraction m^{-1})	Early Summer	−0.0206	0.0242	−0.0032	0.0009	−0.0019	0.0011	−0.0031	0.0017	−0.0102	0.0127	−0.0004	0.0007
	Late Summer	−0.0215	0.0318	−0.0023	0.0013	–	–	−0.0007	0.0000	−0.0020	0.0017	–	–
	Fall	−0.0043	0.0027	−0.0062	0.0073	−0.0018	0.0011	–	–	−0.0062	0.0137	0.0012	–
	All	−0.0146	0.0239	−0.0038	0.0041	−0.0018	0.0011	−0.0025	0.0018	−0.0072	0.0126	−0.0000	0.0010
$(\Delta SIM/\Delta z)_{SGM}$[o] (fraction m^{-1})	Early Summer	0.0011	0.0066	−0.0019	0.0025	−0.0085	0.0045	−0.0046	0.0026	−0.0023	0.0027	−0.0016	0.0010
	Late Summer	0.0017	0.0072	−0.0001	0.0013	–	–	−0.0012	0.0000	0.0007	0.0014	–	–
	Fall	−0.0003	0.0010	0.0001	0.0023	−0.0022	0.0012	–	–	−0.0063	0.0183	−0.0052	–
	All	0.0008	0.0054	−0.0008	0.0023	−0.0045	0.0041	−0.0038	0.0027	−0.0042	0.0135	−0.0025	0.0020

[a] James Bay

[b] Southeastern Hudson Bay

[c] Winisk Trough

[d] Southern Hudson Bay

[e] Southwestern Hudson Bay

[f] Central Hudson Bay

[g] depth at salinity gradient maximum

[h] salinity at z_{SGM}

[i] salinity difference between top and bottom boundaries of the halocline

[j] river water fraction at z_{SGM}

[k] sea ice melt fraction at z_{SGM}

[l] apparent river water influence

[m] vertical salinity gradient at z_{SGM}

[n] vertical river water gradient at z_{SGM}

[o] vertical sea ice melt gradient at z_{SGM}

Table S4: Seasonal characteristics of the halocline north of 60° N in Hudson Bay and for Hudson Bay combined north and south.

Halocline Characteristics	Season	NHB[a]		NEHB[b]		NWHB[c]		NAR[d]		HB[e]	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
z_{SGM}[f] (m)	Early Summer	40.0	26.5	43.3	28.9	33.8	20.3	67.5	25.0	27.3	20.6
	Late Summer	–	–	24.2	9.7	14.4	11.0	35.2	17.2	31.6	17.5
	Fall	30.0	0.0	50.0	–	–	–	25.0	21.2	31.7	15.0
	All	36.0	19.5	32.5	18.9	29.9	20.2	39.4	21.8	29.7	18.4
S_{SGM}[g] (psu)	Early Summer	31.2	1.8	30.8	2.0	32.4	0.6	32.4	0.3	31.0	1.8
	Late Summer	–	–	29.9	0.7	31.3	0.8	31.9	0.7	31.1	1.2
	Fall	32.0	0.2	31.6	–	–	–	31.5	0.9	30.1	2.6
	All	31.5	1.4	30.3	1.2	32.2	0.8	31.9	0.7	30.8	1.9
ΔS[h] (psu)	Early Summer	2.4	–	2.0	–	0.6	–	1.1	–	1.6	–
	Late Summer	–	–	3.6	–	0.4	–	1.5	–	1.8	–
	Fall	3.4	–	1.4	–	–	–	1.3	–	2.8	–
	All	2.8	–	2.9	–	0.5	–	1.4	–	2.0	–
RW_{SGM}[i] (fraction)	Early Summer	0.044	0.055	0.029	0.096	0.026	0.020	0.004	0.038	0.065	0.055
	Late Summer	–	–	0.058	0.011	0.017	0.016	−0.005	0.025	0.020	0.037
	Fall	0.007	0.018	0.002	–	–	–	0.012	0.055	0.088	0.091
	All	0.029	0.045	0.044	0.050	0.024	0.020	−0.003	0.029	0.058	0.067
SIM_{SGM}[j] (fraction)	Early Summer	−0.004	0.008	0.025	0.036	−0.025	0.026	−0.002	0.032	−0.019	0.029
	Late Summer	–	–	0.022	0.023	0.020	0.010	0.026	0.013	0.026	0.018
	Fall	0.009	0.024	0.028	–	–	–	0.019	0.027	−0.015	0.037
	All	0.001	0.015	0.024	0.024	−0.016	0.030	0.021	0.020	−0.005	0.035
$\lvert\Delta RW\rvert/(\lvert\Delta RW\rvert + \lvert\Delta SIM\rvert)_{SGM}$[k]	Early Summer	0.90	–	0.65	–	0.49	–	0.55	–	0.71	–
	Late Summer	–	–	0.70	–	0.47	–	0.44	–	0.56	–
	Fall	0.43	–	0.06	–	–	–	0.67	–	0.77	–
	All	0.77	–	0.66	–	0.48	–	0.48	–	0.70	–
$(\Delta S/\Delta z)_{SGM}$[l] (psu m^{-1})	Early Summer	0.09	0.05	0.16	0.22	0.05	0.05	0.02	0.01	0.17	0.25
	Late Summer	–	–	0.13	0.06	0.55	1.14	0.11	0.28	0.15	0.43
	Fall	0.09	0.01	0.06	–	–	–	0.10	0.08	0.25	0.50
	All	0.09	0.04	0.13	0.12	0.15	0.51	0.09	0.24	0.19	0.38
$(\Delta RW/\Delta z)_{SGM}$[m] (fraction m^{-1})	Early Summer	−0.0039	0.0043	−0.0061	0.0090	−0.0016	0.0023	−0.0012	0.0008	−0.0037	0.0064
	Late Summer	–	–	−0.0015	0.0019	−0.0114	0.0237	−0.0028	0.0061	−0.0034	0.0091
	Fall	−0.0010	0.0011	−0.0030	–	–	–	−0.0046	0.0024	−0.0045	0.0095
	All	−0.0028	0.0035	−0.0030	0.0050	−0.0036	0.0107	−0.0027	0.0054	−0.0038	0.0081
$(\Delta SIM/\Delta z)_{SGM}$[n] (fraction m^{-1})	Early Summer	0.0014	0.0044	0.0011	0.0022	0.0002	0.0014	0.0006	0.0006	−0.0016	0.0035
	Late Summer	–	–	−0.0027	0.0039	−0.0056	0.0120	−0.0007	0.0027	−0.0014	0.0048
	Fall	−0.0019	0.0007	0.0011	–	–	–	0.0015	0.0001	−0.0034	0.0122
	All	0.0001	0.0036	−0.0012	0.0037	−0.0009	0.0056	−0.0003	0.0025	−0.0020	0.0071

[a]Northern Hudson Bay

[b]Northeastern Hudson Bay

[c]Northwestern Hudson Bay

[d]Narrows

[e]Hudson Bay

[f]depth at salinity gradient maximum

[g] salinity at z_{SGM}

[h] salinity difference between top and bottom boundaries of the halocline

[i] river water fraction at z_{SGM}

[j] sea ice melt fraction at z_{SGM}

[k] apparent river water influence

[l] vertical salinity gradient at z_{SGM}

[m] vertical river water gradient at z_{SGM}

[n] vertical sea ice melt gradient at z_{SGM}

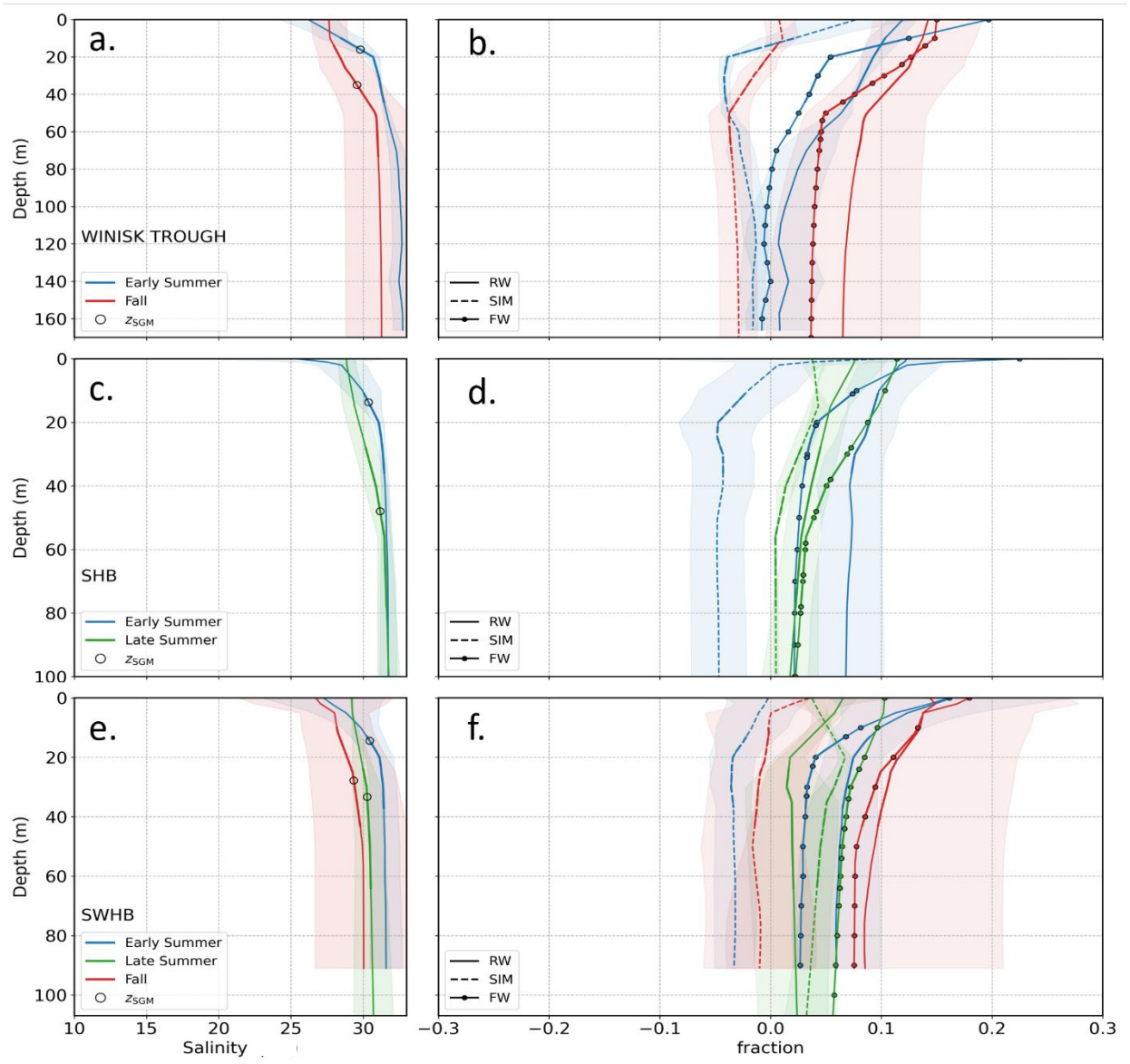

Figure S1: Vertical profiles of salinity, river water (RW), sea ice melt (SIM), and freshwater (FW = RW + SIM) during early summer, late summer, and fall in (a–b) Winisk Trough, **(c–d)** southern Hudson Bay (SHB), and **(e–f)** southwestern Hudson Bay (SWHB). Shaded envelopes show ±1 standard deviations for each variable. Thick segments within vertical profiles denote the halocline layer. Black circles in panels **(a)**, **(c)**, and **(e)** mark the depth of the salinity gradient maximum (z_{SGM}; m).

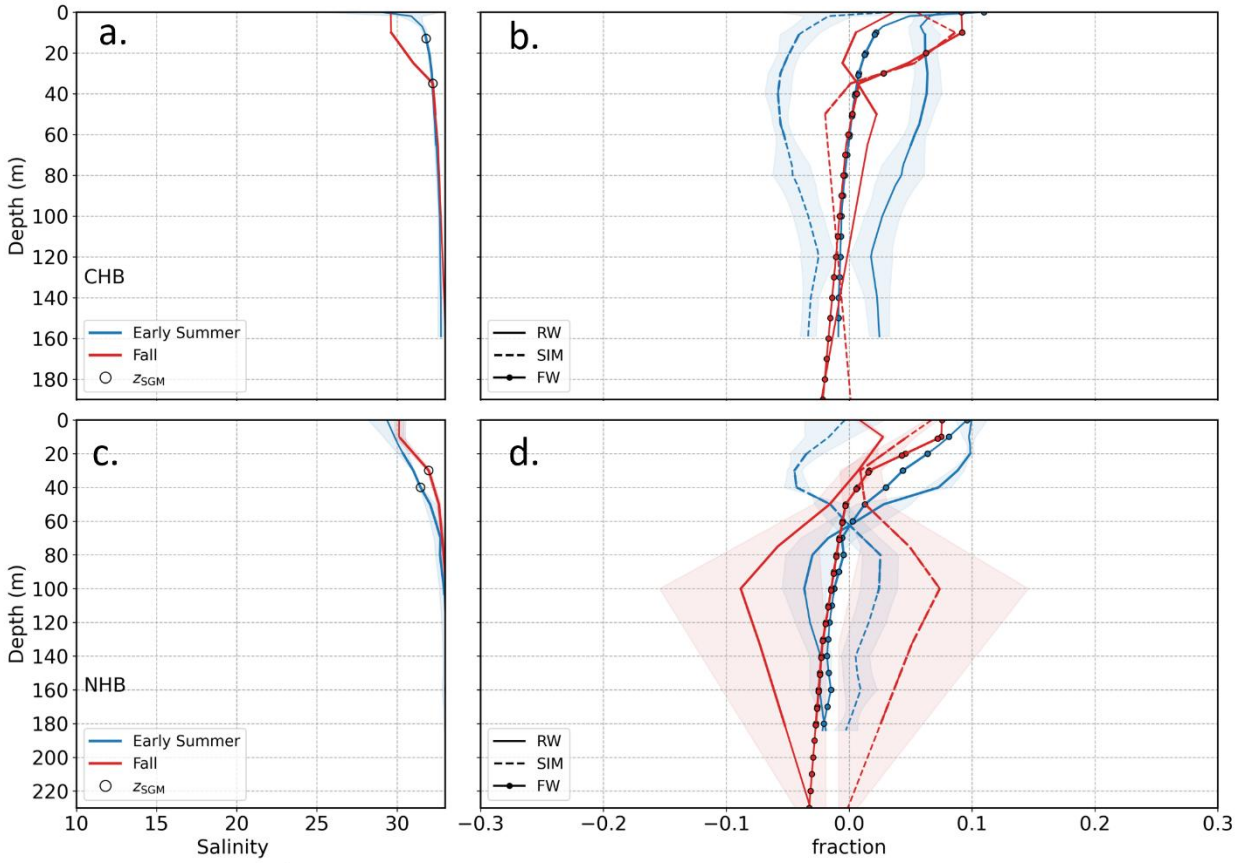

Figure S2: Vertical profiles of salinity, river water (RW), sea ice melt (SIM), and freshwater (FW = RW + SIM) during early summer, late summer, and fall in (a–b) central Hudson Bay (CHB), and **(c–d)** northern Hudson Bay (NHB). Shaded envelopes show ±1 standard deviations for each variable. Thick segments within vertical profiles denote the halocline layer. Black circles in panels **(a)**, and **(c)** mark the depth of the salinity gradient maximum (z_{SGM}; m).

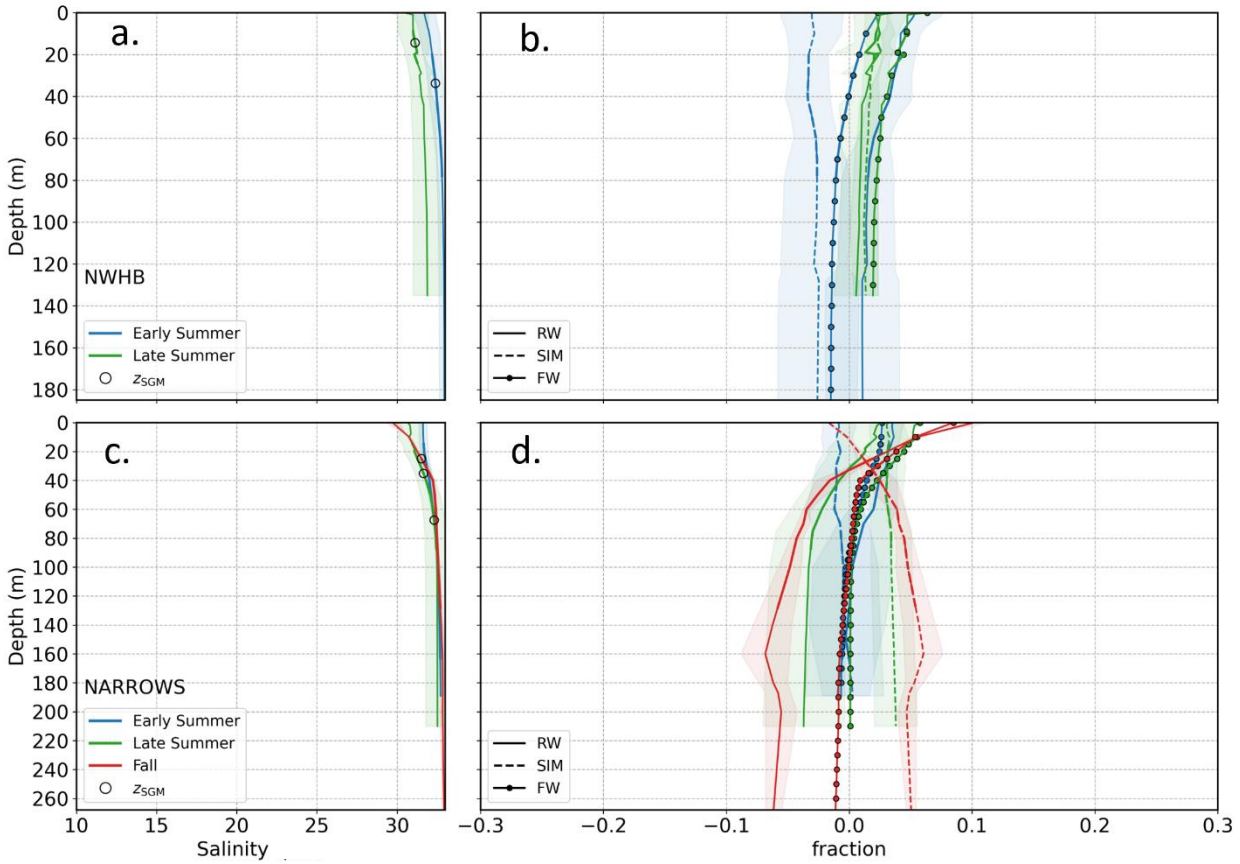

Figure S3: Vertical profiles of salinity, river water (RW), sea ice melt (SIM), and freshwater (FW = RW + SIM) during early summer, late summer, and fall in (a–b) northwestern Hudson Bay (NWHB), and **(c–d)** Narrows. Shaded envelopes show ±1 standard deviations for each variable. Thick segments within vertical profiles denote the halocline layer. Black circles in panels **(a)**, and **(c)** mark the depth of the salinity gradient maximum (z_{SGM}; m).