

## Theory of inorganic mineral flocculation within mid to high latitude deep coastal basins

Jaia Syvitski<sup>a</sup>, Ross Powell<sup>b</sup>, Kumiko Azetsu-Scott<sup>c</sup>, Ken Asprey<sup>d</sup>, Eric Hutton<sup>a</sup>, Gwyn Lintern<sup>e</sup>

<sup>a</sup> CSDMS, Institute of Arctic and Alpine Research, U. of Colorado, Boulder, 80305, USA

<sup>b</sup> Department of Geology, Northern Illinois University, DeKalb, IL 60115, USA

<sup>c</sup> Bedford Inst. of Oceanography, Dept. Fisheries and Oceans, Dartmouth, NS, Canada, B2Y4A2

<sup>d</sup> Geol. Survey of Canada— Atlantic, Bedford Inst. Oceanography, Dartmouth, NS, B2Y4A2, Canada

<sup>e</sup> Geological Survey of Canada— Pacific, Inst. Ocean Sciences, Sidney, BC, V8L4B2

### Definitions (unit example)

bsl: below sea level (m)

BBL: bottom boundary layer (m)

Ca: SPM concentration measured in air ( $\text{g}/\text{m}^3$ )

Cf: in situ floc mass concentration ( $\text{g}/\text{m}^3$ )

Cw: SPM concentration in seawater ( $\text{g}/\text{m}^3$ )

CGR: constituent grain and unit floc reservoir ( $D < 50 \mu\text{m}$ )

DBW: deep basin water

FCA: floc camera assembly

FF: flocculation front (m)

LFR: large floc reservoir ( $D = 650$  to  $5000 \mu\text{m}$ )

MFR: medium floc reservoir ( $D = 50$  to  $650 \mu\text{m}$ )

SNL: shelf nepheloid layer (m)

SPM: suspended particulate matter ( $\text{g}/\text{m}^3$ )

SR: stringer reservoir ( $L = 5$  to  $100 \text{ mm}$ )

wd: water depth (m)

All other symbol definitions with units are in Table S1 below.

Table S1: Hydrodynamic properties of floccules for Lake Melville (LM), Bedford Basin (BB), and all data shown in red. Primary properties are based on in situ settling tank observations and are highlighted in yellow boxes. Green boxes show derived floc properties. NA=not applicable or none.

Symbol	Property	Observations or Theory	Observation mean $\pm$ std	Observation range	Best Fit	R <sup>2</sup>	Comments
<b>D</b>	floc nominal diameter	LM observations BB observations	1610 $\pm$ 730 940 $\pm$ 630 $\mu\text{m}$	72 – 4500 71 – 4650 $\mu\text{m}$	NA	NA	D = diameter of circle equal to particle area
<b>Np<sub>i</sub></b>	floc numbers per i <sup>th</sup> size interval per liter	LM observations BB observations	833 $\pm$ 850 939 $\pm$ 627 no./l	12 – 11,000 24 – 7350 no./l	NA	NA	flocs are > 50 $\mu\text{m}$ in diameter
<b>D<sub>n</sub></b>	mean diameter from volume-size frequency	$D_n = \Sigma(Np_i D_i) / \Sigma Np_i$	556 $\pm$ 221 537 $\pm$ 89 $\mu\text{m}$	200 – 990 374 – 780 $\mu\text{m}$	NA	NA	Np <sub>i</sub> = count per i <sup>th</sup> size interval
<b>D<sub>min</sub>/D<sub>max</sub></b>	shape factor	LM observations BB observations	0.76 $\pm$ 0.14 0.67 $\pm$ 0.08	0.4 – 1.0 0.05 – 0.98	NA	NA	NA
<b>w</b>	floc settling velocity	LM observations, n=125 BB observations, n=644 All observations, n=769	166 $\pm$ 107 43 $\pm$ 46 m/day	8– 433 1.3 – 359 m/day	$w = 0.42 D^{0.79}$ $w = 0.47 D^{0.63}$ $w = 0.16 D^{0.82}$	0.36 0.40 0.45	w in m/day D in $\mu\text{m}$
<b>Re</b>	particle Reynolds number	$Re = w D \rho_f / \eta$ $\eta = 0.00172 \text{ kg/m/s}$ $\rho_f = 1007 – 1030 \text{ kg/m}^3$	2.1 $\pm$ 1.8 0.41 $\pm$ 7.3	0.02– 12 0.001 – 6	$Re = 2.9 \cdot 10^{-6} D^{1.79}$ $Re = 3.2 \cdot 10^{-6} D^{1.63}$ $Re = 1.1 \cdot 10^{-6} D^{1.82}$	0.74 0.79 0.80	$\eta$ = dyn. viscosity 70% Re >1 82% Re <1
<b>Cd</b>	particle drag coefficient	$Cd = 26.8/Re$ ; Re $\leq$ 1; $Cd = ((26.8/Re)^{0.84} + 0.735)^{1.19}$ ; Re>1	95 $\pm$ 250 670 $\pm$ 1500	3.3 – 1700 5.6 – 20,460	NA	NA	Camenen (2007)
<b><math>\rho_e</math></b>	excess floc density	$\rho_e = \rho_{floc} - \rho_f$ $\rho_e = (Cd \rho_f w^2) / (4/3 g D)$	5.6 $\pm$ 9.0 6 $\pm$ 14	0.3 – 66 0.1 – 200	$\rho_e = 8935 D^{-1.11}$ $\rho_e = 9000 D^{-1.35}$ $\rho_e = 5660 D^{-1.16}$	0.50 0.72 0.61	$\rho_{floc}$ = floc density in kg/m <sup>3</sup> , D in $\mu\text{m}$
<b>M</b>	floc mass	$M = 4/3 \pi (D/2)^3 \rho_e$	0.0076 $\pm$ 0.0073 mg 0.0014 $\pm$ 0.0026 mg	4x10 <sup>-6</sup> – 0.024 5x10 <sup>-5</sup> to 0.054 mg	$M = 5 \cdot 10^{-9} D^{1.89}$ $M = 4 \cdot 10^{-9} D^{1.65}$ $M = 3 \cdot 10^{-9} D^{1.84}$	0.74 0.81 0.80	LM's average floc weighs 0.0057 mg equal to a 160 $\mu\text{m}$ quartz grain
<b><math>\xi</math></b>	floc porosity	$\xi = 1 - (\rho_e / (\rho_s - \rho_f))$	0.997 $\pm$ 0.006 0.996 $\pm$ 0.008	0.96– 0.9998 0.88– 0.9999	$\xi = 0.96 D^{0.0057}$ $\xi = 0.96 D^{0.0064}$ $\xi = 0.96 D^{0.0052}$	0.49 0.40 0.30	NA
<b>Ds</b>	equiv. spherical sedimentation diameter	$Ds = Cd \rho_f w^2 / [4/3 g (\rho_s - \rho_f)]$	3.1 $\pm$ 2.0 $\mu\text{m}$ 1.4 $\pm$ 1.4 $\mu\text{m}$ 1.6 $\pm$ 1.7 $\mu\text{m}$	0.3 – 9.4 $\mu\text{m}$ 0.1 – 22 $\mu\text{m}$	NA	NA	$\rho_s$ = grain density 2650 kg/m <sup>3</sup>
<b>D<sub>cp</sub></b>	constituent particle size	$D_{cp} = [(\rho_s - \rho_f) / \alpha]^{-1/(Kp)}$ $\alpha = \rho_e$ of a 1 cm floc	4.7 $\mu\text{m}$ 6.5 $\mu\text{m}$	NA	Mean size from Coulter Counter 5.6 $\mu\text{m}$	NA	Kp: 1.11, 1.35, 1.16 $\alpha = 0.324, 0.080, 0.130 \text{ kg/m}^3$
<b>N<sub>cp</sub></b>	number of constituent grains	equal to a floc mass of size D <sub>i</sub>	NA	NA	for Lake Melville $N_{cp} = 0.0314 D^{1.99}$	NA	Based on D <sub>cp</sub> in $\mu\text{m}$
<b>Cf</b>	Floc (D >50 $\mu\text{m}$ ) concentration mg/l or g/m <sup>3</sup>	$Cf = \Sigma Np_i M_i$	0.22 $\pm$ 0.11 0.52 $\pm$ 0.28 mg/l or g/m <sup>3</sup>	0.04 – 0.81 0.01 – 2.98 mg/l or g/m <sup>3</sup>	NA	NA	M <sub>i</sub> = floc mass per i <sup>th</sup> size interval
<b>D<sub>m</sub></b>	Mean diameter from mass-size frequency	$D_m = \Sigma(Cf_i D_i) / \Sigma Cf_i$	1147 $\pm$ 3330 793 – 2010 $\mu\text{m}$	277 – 1879 421 – 1280 $\mu\text{m}$	NA	NA	Cf <sub>i</sub> = particle concentration per i <sup>th</sup> size interval
<b>Z</b>	sedimentation rate	$Z = \Sigma M_i Np_i w_i$	17 $\pm$ 8 10 $\pm$ 9	0.1 – 49 1.0 – 50	NA	NA	Values in g/m <sup>2</sup> /day

Table S2. Cruises that collected FCA profiles and floc settling data.

Cruise No.	Location	Stations	Lat°	Long°	Reference
HU83028; PA85062	Baffin Island fjords	5	66° - 72° N	62° - 74° W	Syvitski & Heffler 1983; Winters & Syvitski, 1992
DA87023; DA88008	St. Lawrence Estuary, Gulf; Chaleur Bay	13	48° - 50° N	63° - 70° W	Praeg et al. 1987; Syvitski 1988; Syvitski et al. 1991
R/V SigmaT	Halifax Inlet, Nova Scotia	3	44.3° - 44.4° N	63.3° - 63.4° W	Syvitski et al., 1995
BA89014; HU91033	Lake Melville, Labrador	27	53.2° - 54° N	58.5° - 60.2° W	Long et al., 1989; Johnston et al., 1991
R/V Polar Duke	Brialmont Cove Antarctica	1	64.2° - 64.15° S	61° - 61.2° W	Domack et al., 1994
HU93030	Kangerlussuaq Fjord to slope, East Greenland	7	65.5° - 68.4° N	29.1° - 32.5° W	Syvitski et al., 1996; Azetsu-Scott & Syvitski, 1999
R/V Alpha Helix	Alaskan fjords	15	58.3° - 61.2° N	135.4° - 148° W	Hill et al., 1998; Curran et al., 2004

Table S3: Fjord basins listed in order of average floc size (Dm,  $\mu\text{m}$ ), with floc numbers (Np/l), floc concentration (Cf,  $\text{g}/\text{m}^3$ ), floc sedimentation rate (Z,  $\text{g}/\text{m}^2/\text{day}$ ), % of SPM as flocs, mean settling velocity w (m/day: 50 m/day = 0.6 mm/s), days to reach the seafloor, maximum basin depth, number of FCA casts, and number of water column samples (N). ND= no data. CoV is the station coefficient of variation.

Fjord	Dm $\mu\text{m}$	CoV Dm	Mean Np/l	CoV Np	Cf $\text{g}/\text{m}^3$	CoV Cf	Sed Rate Z $\text{g}/\text{m}^2/\text{d}$	CoV Z	% SPM as Floc	Mean w m/day	Transit time days	Max depth m	FCA casts	Data N=
College Fjord, Alaska, Harvard Glacier	1493	0.34	2640	0.67	3.9	0.8	260	0.9	ND	64	1.9	120	1	23
Muir Inlet, Glacier Bay, Alaska	1258	0.30	1820	0.62	1.6	0.5	100	0.7	ND	56	3.3	182	4	139
Kangerlussuaq Fjord, East Greenland	1151	0.22	120	1.61	0.1	0.8	5.4	0.8	15%	48	18	873	7	172
Yakutat Bay, Alaska, Hubbard Gl.	1075	0.20	2090	0.37	2.4	0.4	120	0.5	39%	49	3.3	164	4	54
Brialmont Cove, Antarctica	1050	0.12	2025	0.45	2.1	0.4	100	0.4	60%	48	8.8	425	1	32
Lake Melville, Labrador	990	0.19	760	0.61	0.4	0.6	15	0.7	44%	46	2.2	161	32	212
Tarr Inlet, Alaska, Grand Pacific Glacier	829	0.16	1010	0.67	0.9	0.6	38	0.7	ND	40	5.7	223	6	367
Gulf of St. Lawrence, Quebec	745	0.22	1600	0.58	0.6	0.6	19	0.6	ND	36	4.3	182	3	35
Halifax Inlet, Nova Scotia	727	0.21	1550	0.65	0.7	0.6	23	0.6	81%	36	1.2	77	18	225
Lower St. Lawrence Estuary, Quebec	680	0.12	2530	0.35	0.9	0.4	31	0.4	ND	34	7.8	263	4	74
<b>average total</b>	<b>1000</b>	<b>0.2</b>	<b>1615</b>	<b>0.7</b>	<b>1.4</b>	<b>0.6</b>	<b>71</b>	<b>0.6</b>	<b>48%</b>	<b>46</b>	<b>5.6</b>	<b>267</b>	<b>80</b>	<b>1333</b>

Table S4: Floc property averages from 42 stations along environmental transects or station repeats. The average percentage of SPM only includes within basin values (excluding shelf and slope values). CoV = coefficient of variation (standard deviation/mean)

Transect or Station	Station ID	distance km or time hr	max depth m	mean Np/l	CoV Np/l (-)	Dm $\mu$ m	transit time days	avg Cf g/m <sup>3</sup>	CoV Cf (-)	* Sed rate Z g/m <sup>2</sup> /d	CoV Z (-)	% floc	avg w m/d	N=
Lower St. Lawrence Estuary & Sept Isle, Quebec (summer)	1	1	263	3660	0.35	590	8.8	1.0	0.40	30	0.43	ND	30	20
	2	2	255	2800	0.25	700	7.4	1.0	0.20	34	0.26	ND	35	17
	3	100	263	2120	0.44	740	7.3	0.6	0.50	23	0.48	ND	36	19
	4	250	259	1540	0.33	690	7.6	1.0	0.40	35	0.37	ND	34	18
Gulf of St. Lawrence, Quebec (summer)	6	3	136	2720	0.64	740	3.8	1.1	0.73	31	0.58	ND	36	9
	7	5	156	1440	0.69	760	4.2	0.5	0.60	16	0.59	ND	37	12
	5	180	175	630	0.41	850	4.3	0.2	0.50	10	0.68	ND	36	14
Halifax Inlet, Nova Scotia (seasonal)	3	4	66	940	0.43	780	1.8	0.5	0.60	19	0.53	82%	38	26
	2	8	29	1120	0.84	700	0.8	0.6	0.67	19	0.63	62%	34	24
	1	26	32	2580	0.70	690	0.9	0.9	0.67	31	0.58	99%	40	55
Lake Melville, Labrador (summer, fall)	0	9	57	660	0.65	940	1.3	0.3	0.67	11	0.91	10%	44	7
	3	22	42	1070	0.76	750	1.2	0.4	0.75	14	0.71	16%	36	7
	7	27	94	870	0.59	1120	1.9	0.6	0.50	27	0.52	56%	51	21
	8	33	113	530	0.60	1160	2.2	0.3	0.67	12	0.72	55%	52	26
	9	38	154	870	0.52	880	3.7	0.4	0.50	11	0.58	58%	42	25
	10	43	161	550	0.53	1100	3.2	0.3	0.33	16	0.45	70%	50	30
Kangerlussuaq Fjord to continental slope, East Greenland (freeze-up)	KF4	1	453	360	0.81	920	10	0.25	0.76	11	0.74	29%	43	27
	KF2	10	666	72	0.53	960	15	0.06	0.50	2.7	0.56	7%	45	29
	KF1	60	873	120	3.25	1730	12	0.11	0.55	7.0	0.40	50%	72	35
	KFM	70	597	21	1.00	970	13	0.017	1.12	0.90	1.22	8%	45	26
	KT3	190	713	5.1	2.49	900	17	0.003	1.00	0.12	1.08	ND	42	25
	DS2	340	541	3.1	1.10	950	12	0.002	1.00	0.10	1.00	ND	44	25
	DS1	360	1821	1.3	0.67	830	46	0.001	1.00	0.05	2.20	ND	40	32
Tarr Inlet, Alaska Grand Pacific Glacier (spring)	C1	0hr	223	1390	0.64	850	5.5	1.3	0.65	55	0.65	ND	40	65
	C2	2hr	223	900	0.59	970	5.0	1.0	0.53	44	0.55	ND	45	58
	C3	4hr	223	1580	0.56	800	5.8	1.4	0.56	54	0.59	ND	38	57
	C4	6hr	223	600	0.67	700	6.5	0.4	0.58	13	0.64	ND	34	62
	C5	8hr	223	870	0.71	890	5.3	0.86	0.67	37	0.68	ND	42	62
	C6	10hr	223	790	0.85	750	6.1	0.68	0.87	27	0.89	ND	36	63
Yakutat Bay, Alaska Hubbard Glacier (spring)	C1	1	164	1530	0.31	1140	3.2	2.0	0.65	110*	0.91	30%	51	7
	C2	2	164	2160	0.37	1070	3.4	2.7	0.37	130	0.46	35%	49	14
	C3	4	163	1940	0.39	1040	3.4	2.2	0.41	110	0.40	41%	48	16
	C4	7	162	2740	0.43	1050	3.4	2.8	0.32	130	0.34	51%	48	17
College Fjord, Alaska Harvard Glacier (spring)	C1	1	120	2640	0.67	1490	1.9	0.79	3.1	260	0.88	ND	64	23
Muir Inlet, Alaska Muir Glacier, (spring)	C1	0hr	177	1340	0.42	900	4.2	1.1	0.36	45	0.56	ND	42	36
	C2	2hr	174	1780	0.56	1620	2.5	2.1	0.57	160	0.75	ND	68	34
	C3	4hr	182	2050	0.98	1070	2.3	1.4	0.50	70	0.57	ND	80	36
	C4	6hr	181	2100	0.52	1400	3.0	2.0	0.50	140	0.79	ND	61	36
Brialmont Cove Antarctica (summer)	NA	1	425	2025	0.45	1050	8.8	2.1	0.38	102	0.74	60%	48	32

\* a 100 g/m<sup>2</sup>/day sedimentation rate equals 2.4 cm/year accumulation rate if the rate could be maintained across a year, and seafloor bulk density was 1500 kg/m<sup>3</sup>.



Table S5. Modelled floc attributes from Table S1 regressions of observational floc data. See Table S1 and text for definition of parameters.

D $\mu\text{m}$	$\rho_e$ $\text{kg/m}^3$	w (m/day)	M (g)	Ncp	Particle Reservoir
10	392	1.1	$2.1 \cdot 10^{-07}$	$3.1 \cdot 10^0$	CGR
50	61	4	$4.0 \cdot 10^{-06}$	$7.5 \cdot 10^1$	CGR
100	27	7	$1.4 \cdot 10^{-05}$	$3.0 \cdot 10^2$	MFR
500	4.2	26	$2.8 \cdot 10^{-04}$	$7.4 \cdot 10^3$	MFR
1000	1.9	46	$1.0 \cdot 10^{-03}$	$2.9 \cdot 10^4$	LFR
5000	0.3	173	$1.9 \cdot 10^{-02}$	$7.2 \cdot 10^5$	LFR

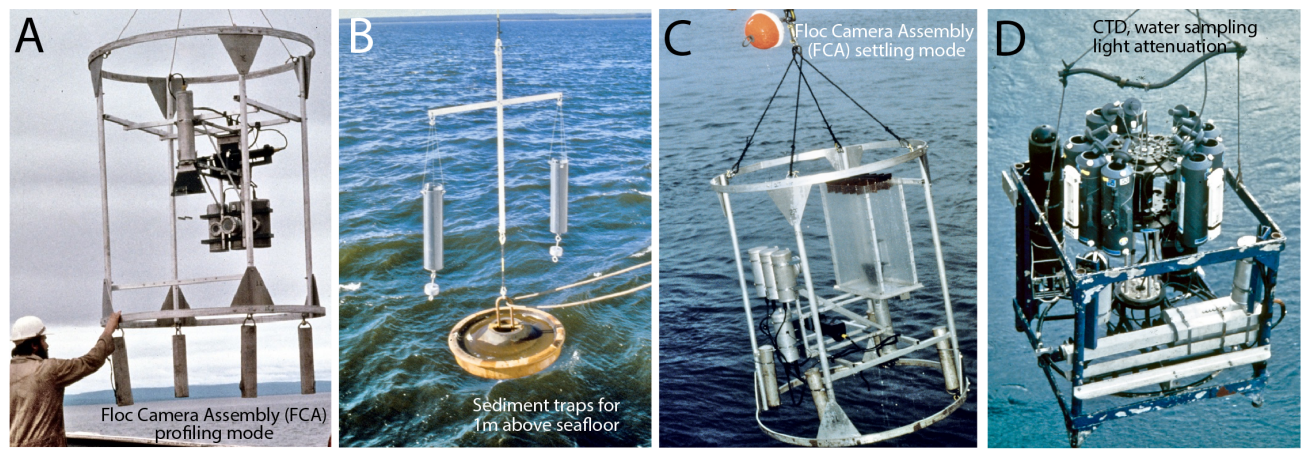
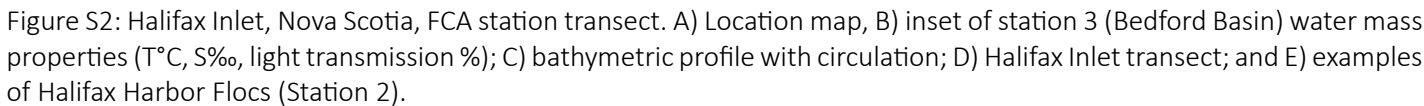


Figure S1: Key equipment used in study. A) Geological Survey of Canada, Floc Camera Assembly (FCA) in profiling configuration, eliminates 'bow- wave' effects that can interfere with the photography of fragile in situ suspended particles. Descent speed is  $< 0.25$  m/s. A Seatech® transmissometer (660 nm wavelength, 25 cm path length) offers important data on unflocculated particles. B) Paired sediment traps remain vertical in relatively strong currents. C) FCA in bottom-moored sedimentation configuration showing stilling tank and baffles. D) CTD package with Niskin bottle rosette water sampler and transmissometer.



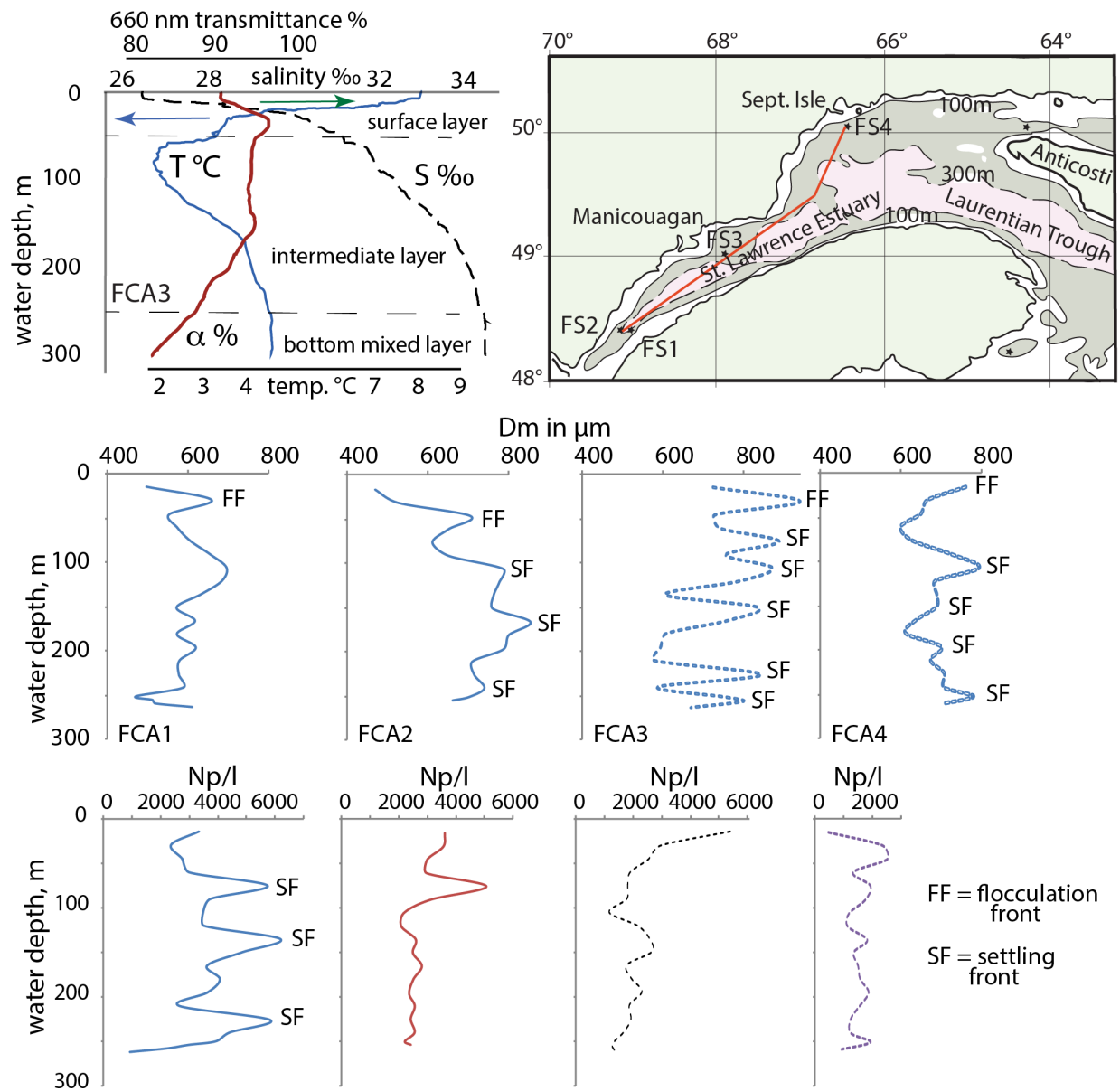


Figure S3: St. Lawrence Estuary transect of DA88008 FCA stations. Floccs are small and numerous.

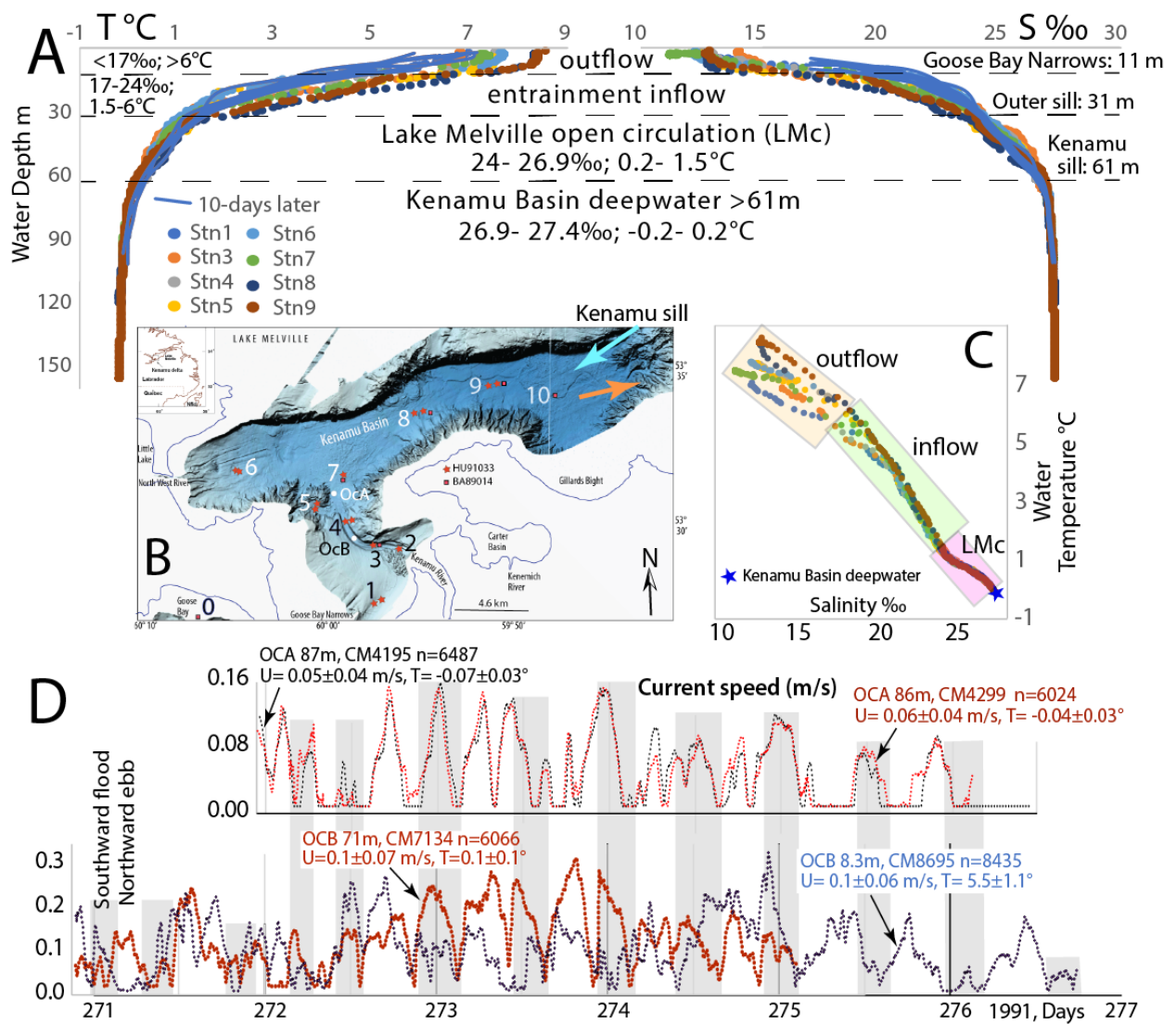


Figure S4: A) CTD profiles (d268-d271 1991) from Kenamu Basin, Lake Melville, with repeat ~10 days later (HU91033). Three sills control the characteristics of water masses: 1) ~31 m-deep outer sill; 2) 11 m-deep Goose Bay Narrows; and 3) the 61 m-deep Kenamu sill that isolates Kenamu Basin deepwater from Grand Trough deepwater. B) Stations located on multibeam bathymetry (graded 50 to 250 m). C) TS diagram shows 4 main water masses in Kenamu Basin. D) Station OCA current meters CM4195 and CM4299 were placed 1 and 2 m above the seafloor and recorded flood-dominated tidal currents (wd= 88 m). Station OCB current meter CM7134 was placed 1 m above the seafloor between 40 m high channel walls, and CM8695 was placed 8.3 m below the sea surface.

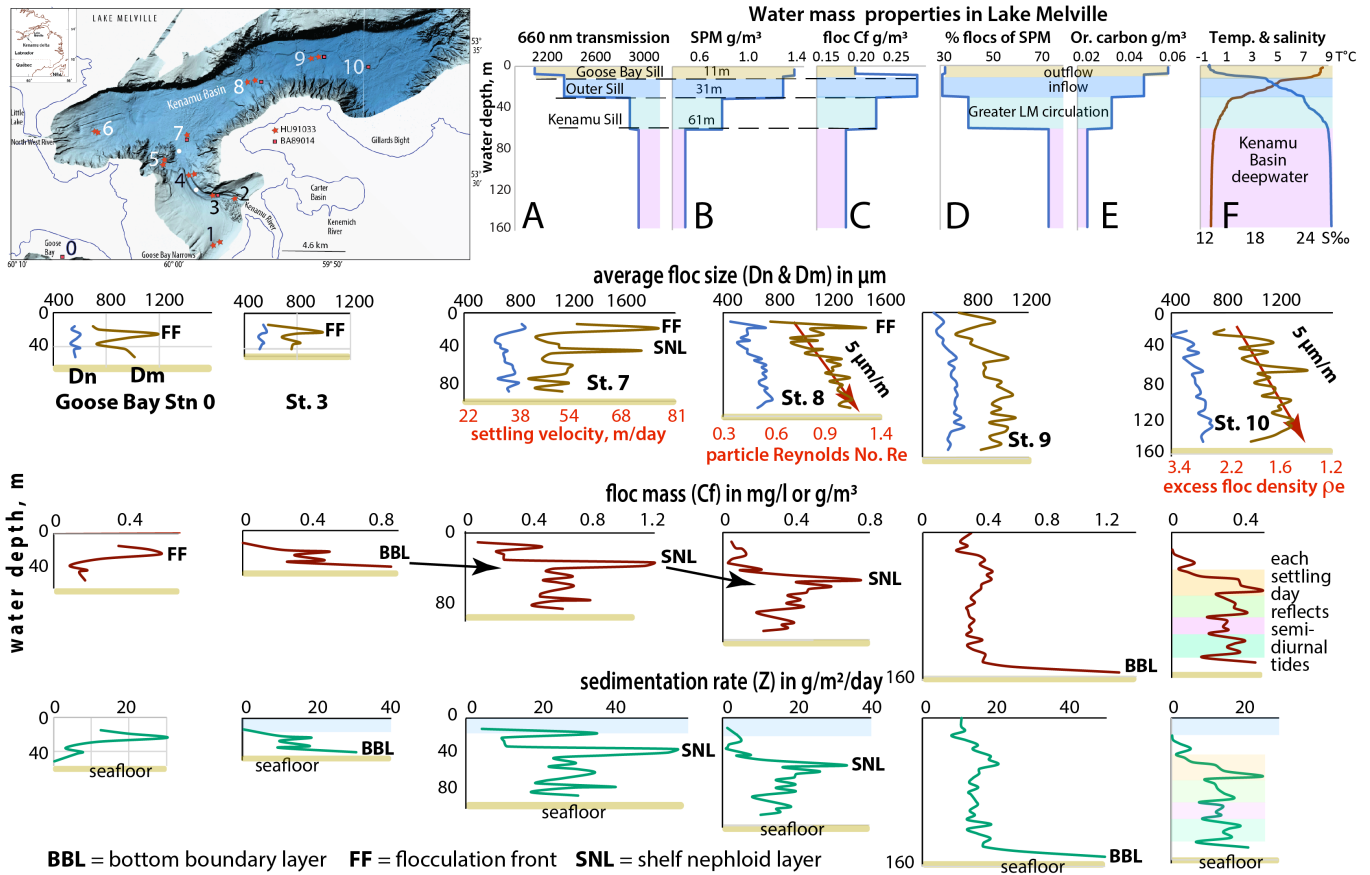


Figure S5: Goose Bay – Kenamu Basin FCA transect acquired July (BA89014). Upper panel shows station locations on multibeam bathymetry (graded 50 to 250 m), and water mass averages: A) light transmission, B) suspended particulate matter (SPM), C) floc concentration, D) floc mass as a percentage of SPM mass, E) SPM organic carbon, and F) salinity and water temperature. Remaining panels show FCA station profiles of mean floc size ( $D_m$ ), floc mass ( $C_f$ ) ( $\text{g/m}^3$ ), and sedimentation rate ( $Z$ ) ( $\text{g/m}^2/\text{day}$ ). Highlights include 1) shelf bottom boundary layer transitioning to basin nepheloid layer, 2) growth of floc diameter with settling depth (Stn. 8 and 10), 3) settling fronts shaped by semidiurnal tidal currents (St. 10), and 4) flocculation front (FF) developed just below the surface layer. Settling velocity ( $w$ ) scaling is shown with station 7- $D_m$ ; particle Reynold's number ( $Re$ ) with station 8- $D_m$ , and excess floc density ( $\rho_e$ ) with station 10- $D_m$ .



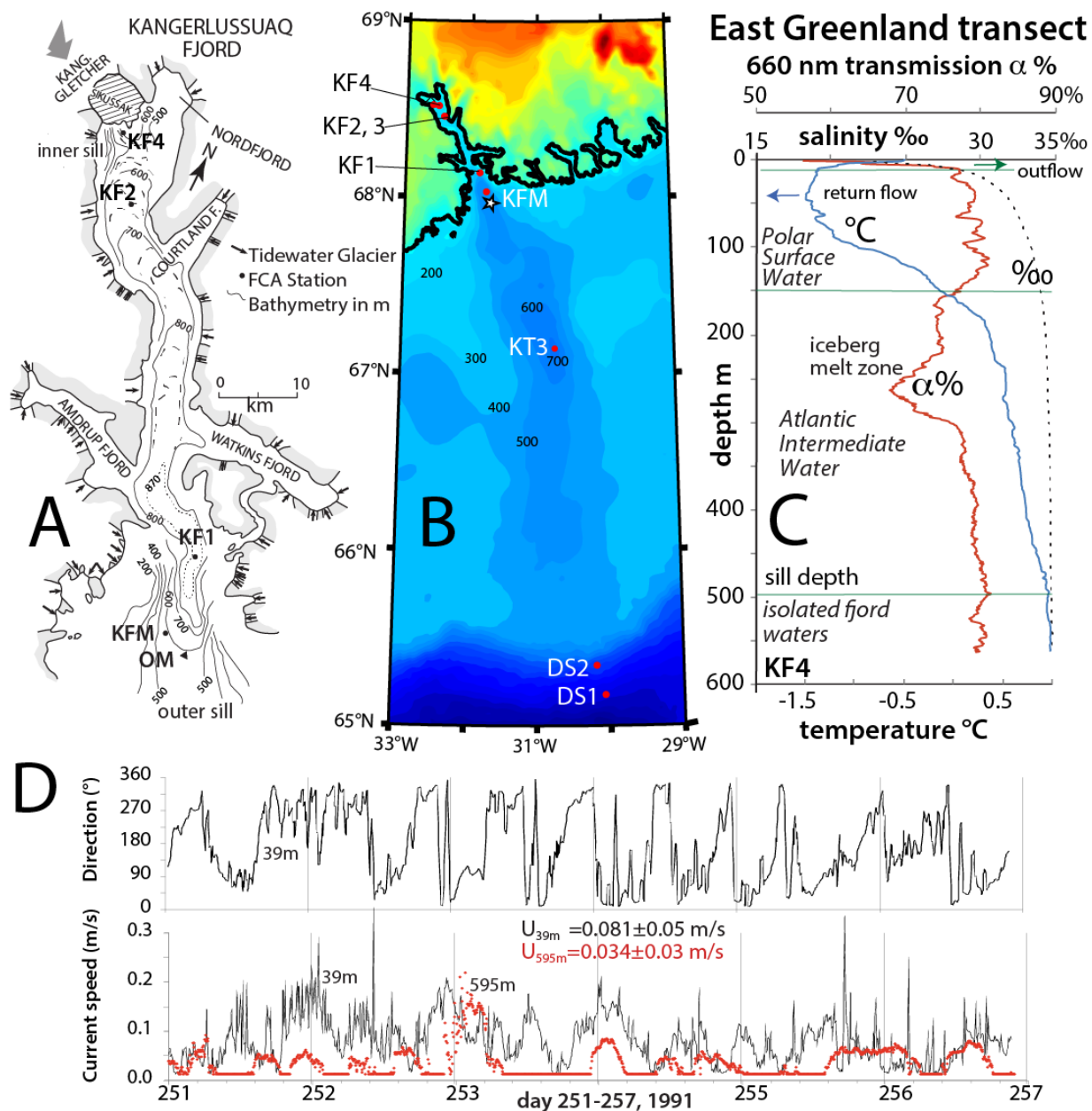


Figure S6 A) Kangerlussuaq Fjord bathymetry and lateral glaciers, showing FCA stations (HU93033). B) East Greenland bathymetry and FCA stations. C) CTD station KF4 showing the main water masses in Kangerlussuaq Fjord. D) KF0 mooring observations of current speed (m/s) and direction (°).

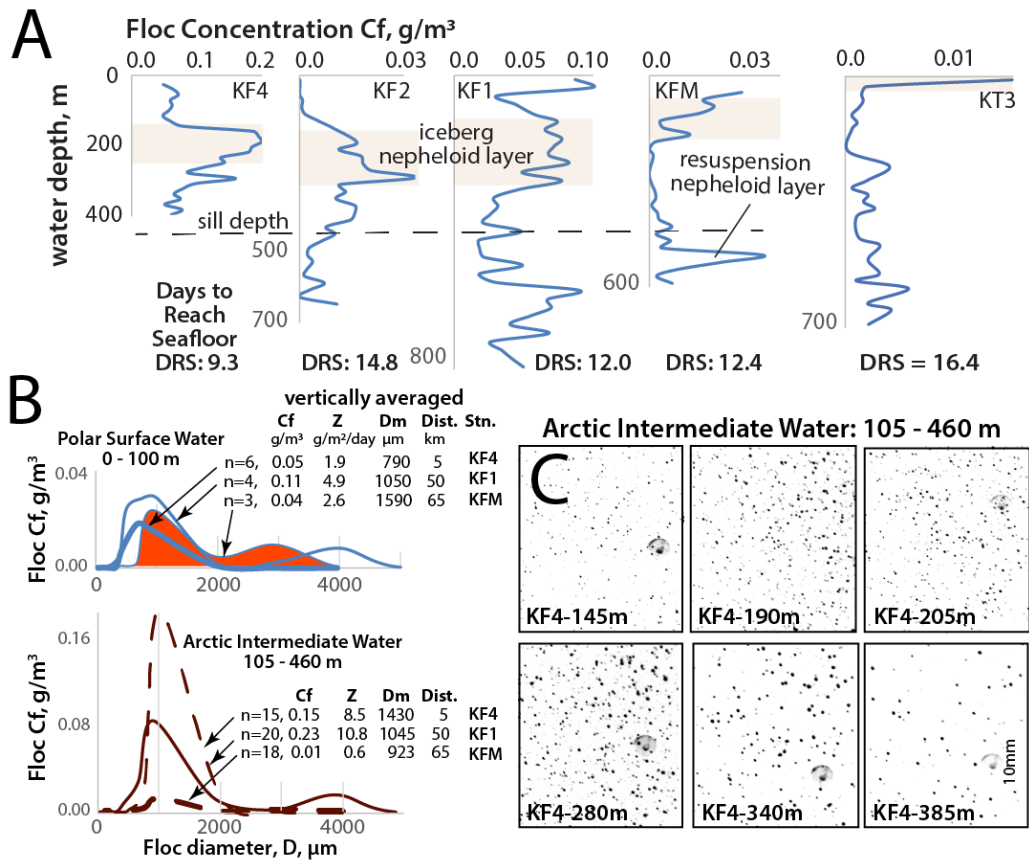


Figure S7: A) Vertical profiles of floc concentration from Kangerlussuaq Fjord, highlighting the iceberg-generated nepheloid layer within the Arctic Intermediate Water layer, and the resuspension nepheloid layer (station KFM). B) Size frequency distributions of flocs as averaged across stations and water masses. The Polar Surface Water (PSW) contains fewer flocs; the Arctic Intermediate Water (AIW) highlights sediment introduced at depth from melting icebergs. C) FCA images through the iceberg-melt nepheloid layer. At station KF4 sand grains were recovered at depth from waters surrounding drifting icebergs.

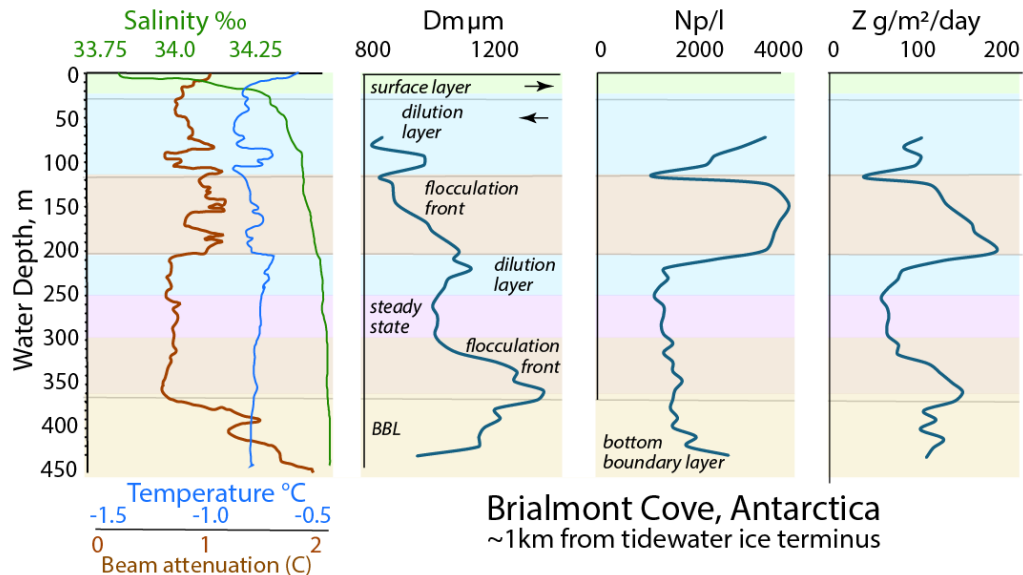


Figure S8: CTD and FCA profiles taken ~1 km from the ice margin entering Brialmont Cove, Antarctic Peninsula (see Domack et al., 1996)

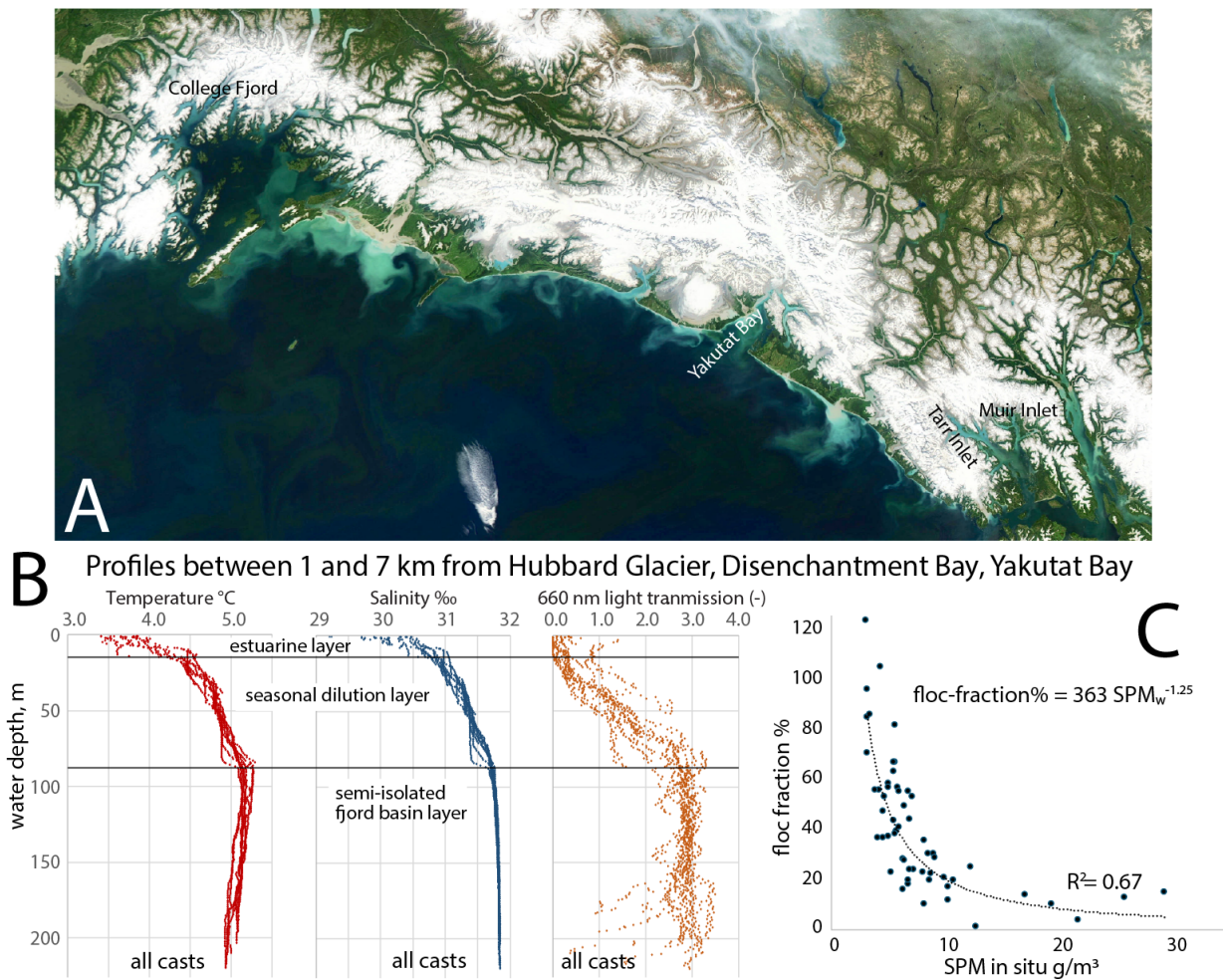


Figure S9: A) Landsat image of the northern Gulf of Alaska showing FCA investigated inlets: Muir Inlet, Tarr Inlet, Yakutat Bay, and College Fjord. B) 7 km-long transect of water column properties out from Hubbard Glacier, Disenchantment Bay, Yakutat Bay Alaska: temperature (°C), salinity (‰), 660 nm light transmission (-), and C) the flocculation fraction as percentage of SPM in water ( $\text{g/m}^3$ ). Low flocculation fractions occur when SPM values are high.



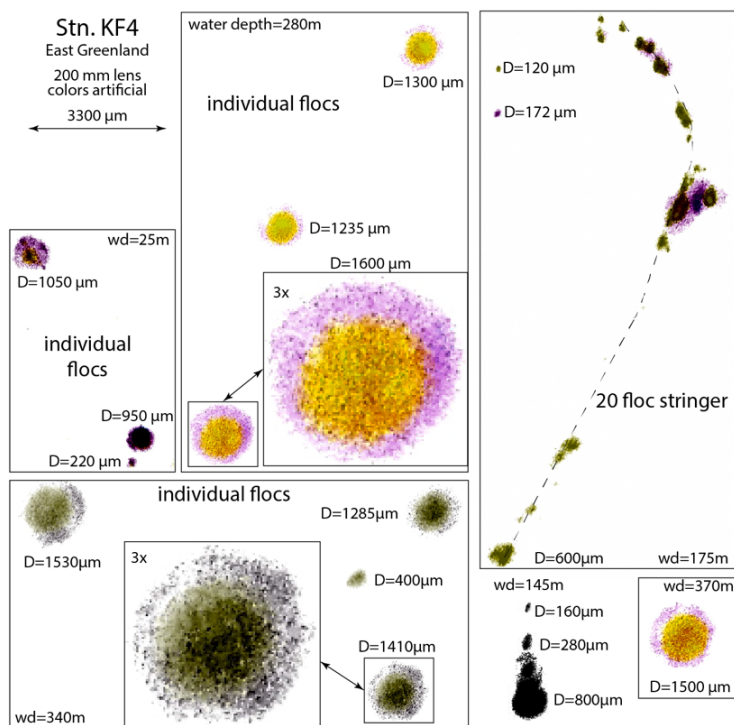


Figure S10: The FCA 200 mm-lens camera records details of smaller individual floccules, here from East Greenland's Kangerlussuaq Fjord, station KF4, 1 km from the head of the fjord (see Fig. S5 for location). Floccs develop from sediment grains primarily released from iceberg melting. A single floccule comprises many (e.g.  $>10^4$ ) individual component grains or unit floccs. Depth below sea level (wd = water depth) of FCA images is shown.

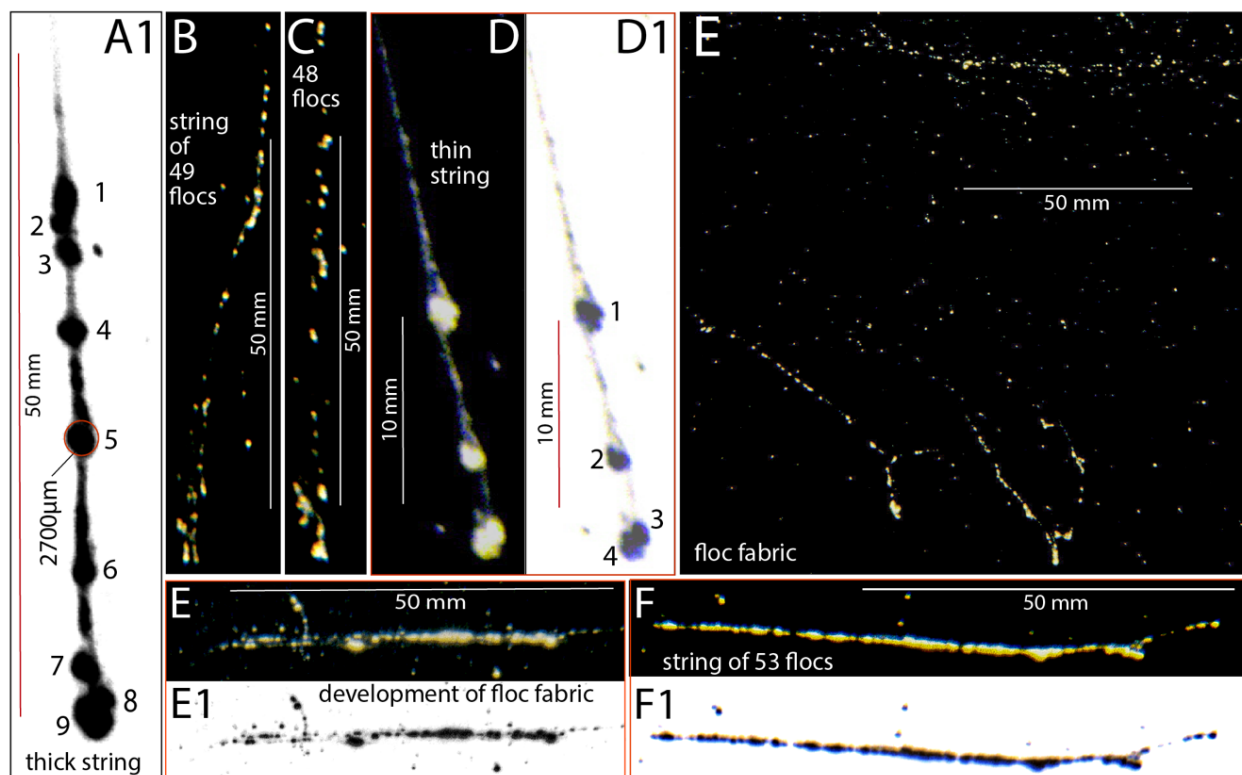


Figure S11: Examples of stringers from Lake Melville (BA89014) with both vertical and horizontal orientations. Stringers are comprised of a connected sequence of floccs. Stringers can form a connected water column "floc fabric". Number of floccs on strings indicated. A1, D1, E1, F1 are images in B&W.

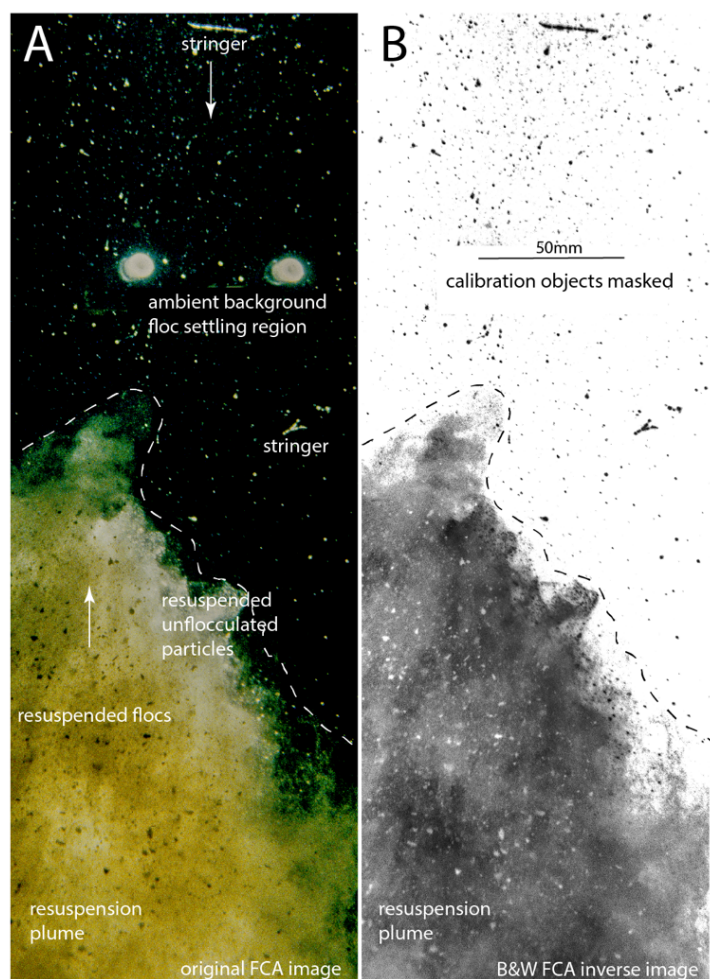


Figure S12. A FCA image (station 10; Figure S4 for location) of “impact-resuspension” showing sediment rising from a 160 m-deep seafloor Kenamu Basin, in the form of flocs and constituent grains. The images are identical with A) in original color, the B) in black and white. Impact resuspension shows there is little size sorting of resuspended material with both coarse and fine grains carried in the expanding impact plume. The ambient background water column (top portion) carries typical flocs on their descent to the seafloor.

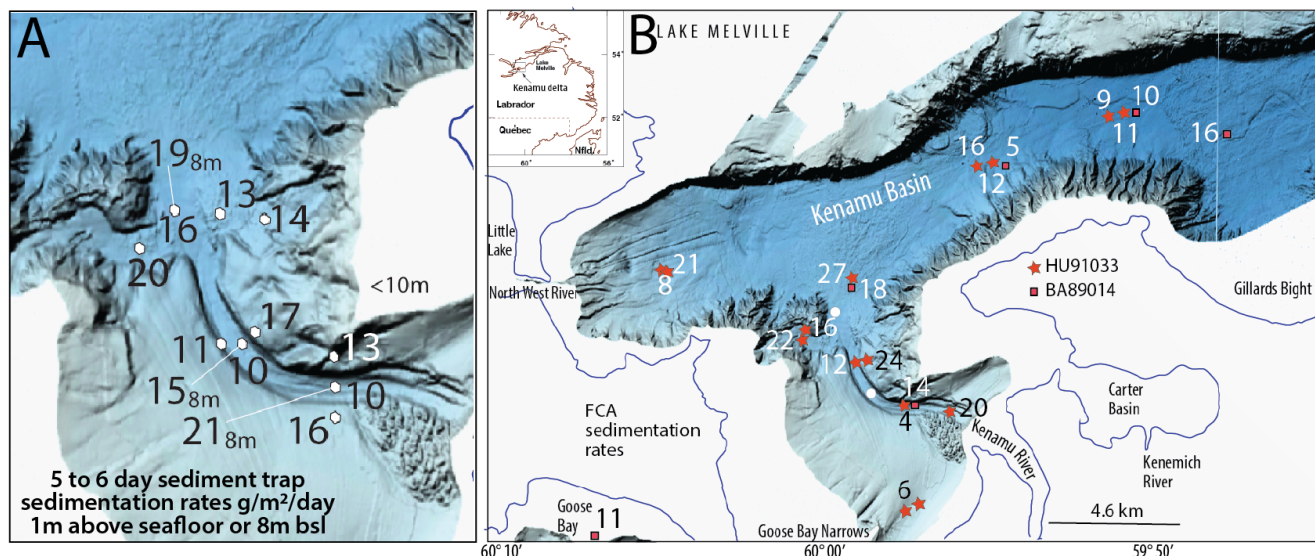


Figure S13: A) Trap-determined accumulation rates ( $\text{g/m}^2/\text{day}$ ), 1 m above the seafloor for 10 Kenamu River prodelta locations, and three near-surface (8.3 m bsl) traps, averaged over 4.5 to 6.3-days in early fall (HU91033). Also shown are BA89014 FCA rates. B) The FCA-determined instantaneous rates for the same interval are water column averages.

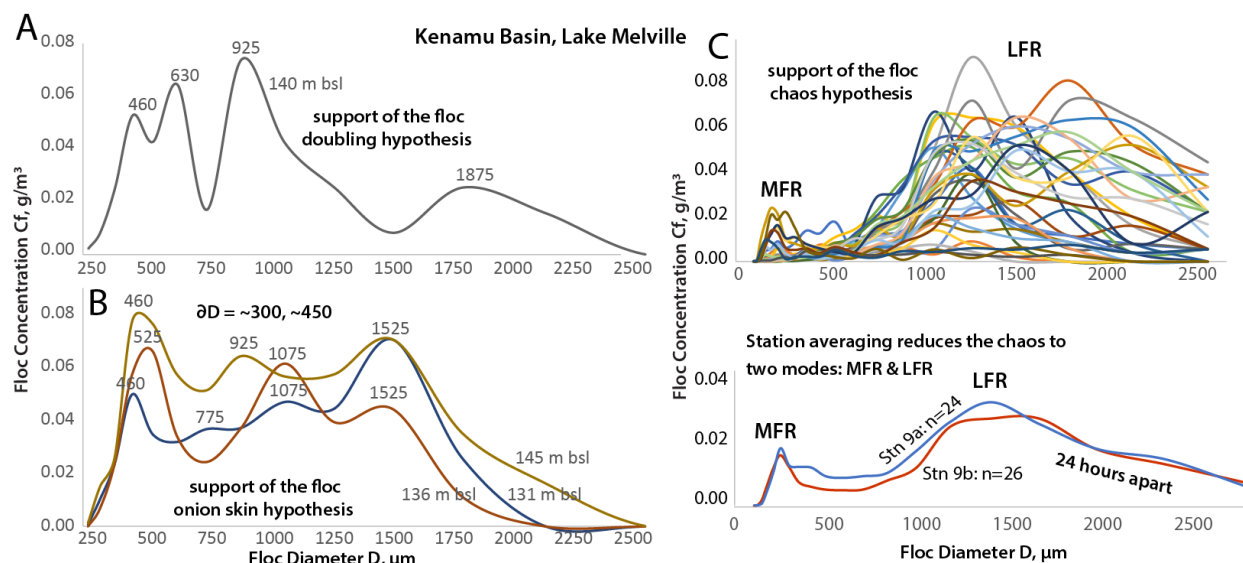


Figure S14 Examples of floc SFDs from station 9 Lake Melville (see Figs. S4, S5 for station location). Station 9a and 9b are separated by 24 hours and their water column Cf averages are nearly identical showing only two permanent modes: a 300  $\mu\text{m}$  MFR mode and a 1400  $\mu\text{m}$  LFR mode.

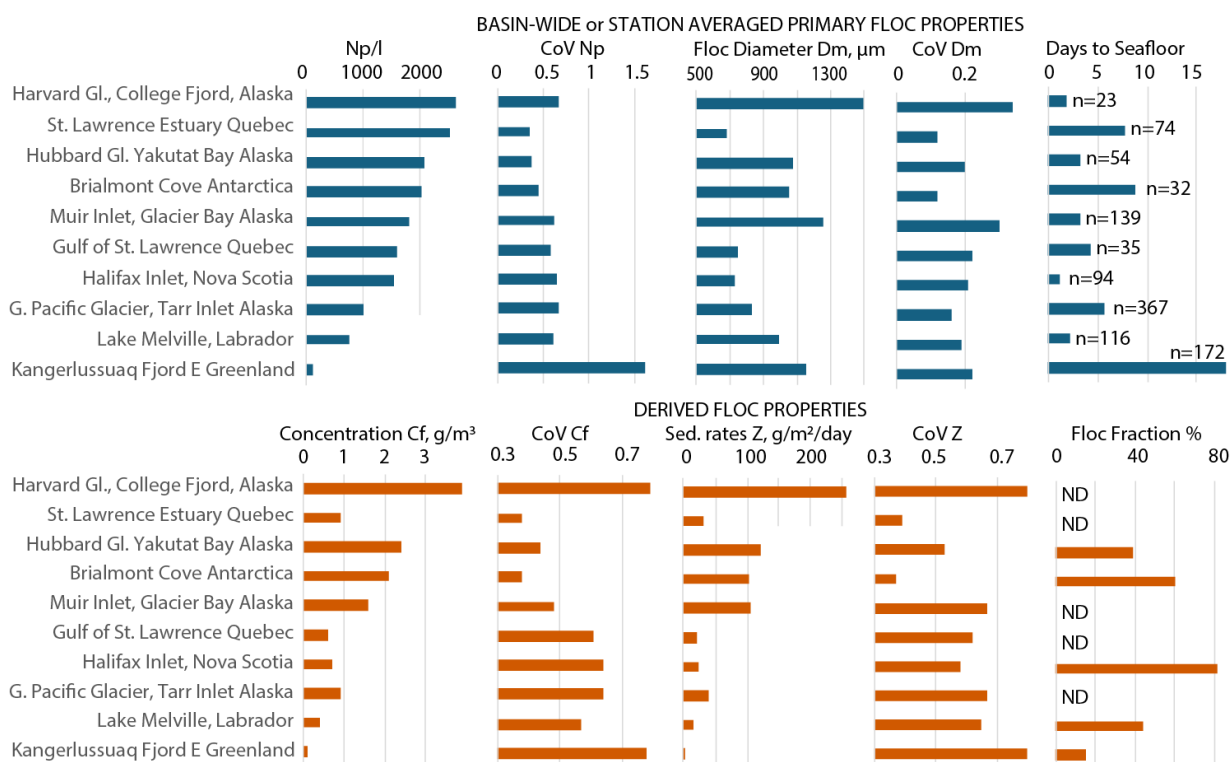


Figure S15. Comparing fjords as ordered by number of flocs ( $D \geq 50 \mu\text{m}$ ). Primary and derived floc properties are from basin averages (all stations, depths and times per fjord). Note:  $Z = 100 \text{ g/m}^2/\text{day}$  equals  $2.4 \text{ cm/year}$ , if the rate could be maintained across a year, and using a bulk density of  $1500 \text{ kg/m}^3$ . Derived properties are based on the set of relationships based on all observations (Table S1). ND = no data; n = number of samples supporting these environmental averages. CoV = coefficient of variation (= standard deviation/mean) define water column variations.

## Supplemental References

- Azetsu-Scott, K., Syvitski, J.P.M., 1999. How melting icebergs influence particle distribution in the water column. *Journal of Geophysical Research*, 104: 5321-5328.
- Camenen, B. 2007. Simple and general formula for the settling velocity of particles. *Journal of Hydraulic Engineering*, 133 (2), 229–233.
- Curran, K.J., Hill, P.S., Milligan, T.G., Cowan, E.A., Syvitski, J.P.M., Konings, S.M., 2004. Fine-grained sediment packaging below the Hubbard Glacier meltwater plume, Disenchantment Bay, Alaska. *Marine Geology* 203, 83-94.
- Domack, E.W., Foss, D.J.P., Syvitski, J.P.M., McClennen, C.E., 1994. Transport of suspended particulate matter in an Antarctic fjord. *Marine Geology* 121: 161-170.
- Hill, P., Syvitski, J.P., Powell, R.D., Cowan, E.A., 1998. In situ observations of floc settling velocities in Glacier Bay, Alaska. *Marine Geology* 145(1-2), 85-94.
- Johnston, B.L., Asprey, K.W., Syvitski, J.P.M., Schafer, C.T., Uyesugi, M., Chapman, C.B., Merchant, S., Boyce, W.A., Murphy, R.J., LeBlanc, K.W., Hinds, S., Hamblin, P., Locat, J., 1991. Hudson 91-033 cruise report. Geological Survey of Canada Open File Report 2468, 100 p.
- Praeg, D.B., Syvitski, J.P.M., Asprey, K., Currie, R., Hein, F.J., Miller, A., Sherin, A., Standen, G., 1987. Report of C.S.S. Dawson Cruise 87-023 in the Gulf of St. Lawrence. Geological Survey of Canada Open File Report 1678, 86 pp.
- Syvitski, J.P.M. 1988. DAWSON 88-008 Technical Cruise Summary. Geological Survey of Canada Open File Report 1920, 60 pp.
- Syvitski, J.P.M. and Heffler, D.E., 1983. The floc camera. *Bedford Institute of Oceanography Review* p. 50-51.
- Syvitski JPM, Hutton EWH, 1996, *In situ* characteristics of suspended particles as determined by the Floc Camera Assembly FCA. *Journal of Sea Research* 36: 1-12.
- Syvitski JPM, Hutton EWH, 1997, FLOC: Image analysis of marine suspended particles. *Computers and Geosciences* 23(9): 967-974.
- Syvitski, J.P.M., Andrews, J.T., Dowdeswell, J.A. 1996. Sediment deposition in an iceberg-dominated glacialmarine environment, East Greenland: basin fill implications. *Global and Planetary Change* 12, 251-270.
- Syvitski, J.P.M., Asprey, K.W., Heffler, D.E., 1991. The floc camera: A 3-D imaging system for suspended particulate matter. In: R.H. Bennett, W.R. Bryant and M.H. Hulbert (Eds.) *The Microstructure of Fine-grained Sediment- from Muds to Shale*. *Frontiers in Sedimentary Geology*, Springer-Verlag, N.Y., p. 281-289.
- Syvitski, J.P.M., Asprey, K.W., LeBlanc, K.W.G., 1995. In-situ characteristics of particles settling within a deep-water estuary. *Deep-Sea Research II* 42(1), 223-256.
- Winters, G.V., Syvitski, J.P.M., 1992. Suspended sediment character and distribution in McBeth Fiord, Baffin Island. *Arctic* 45, 25-35.