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The sensitivity of estuarine aragonite saturation state and pH to the carbonate chemistry of a freshet-dominated river

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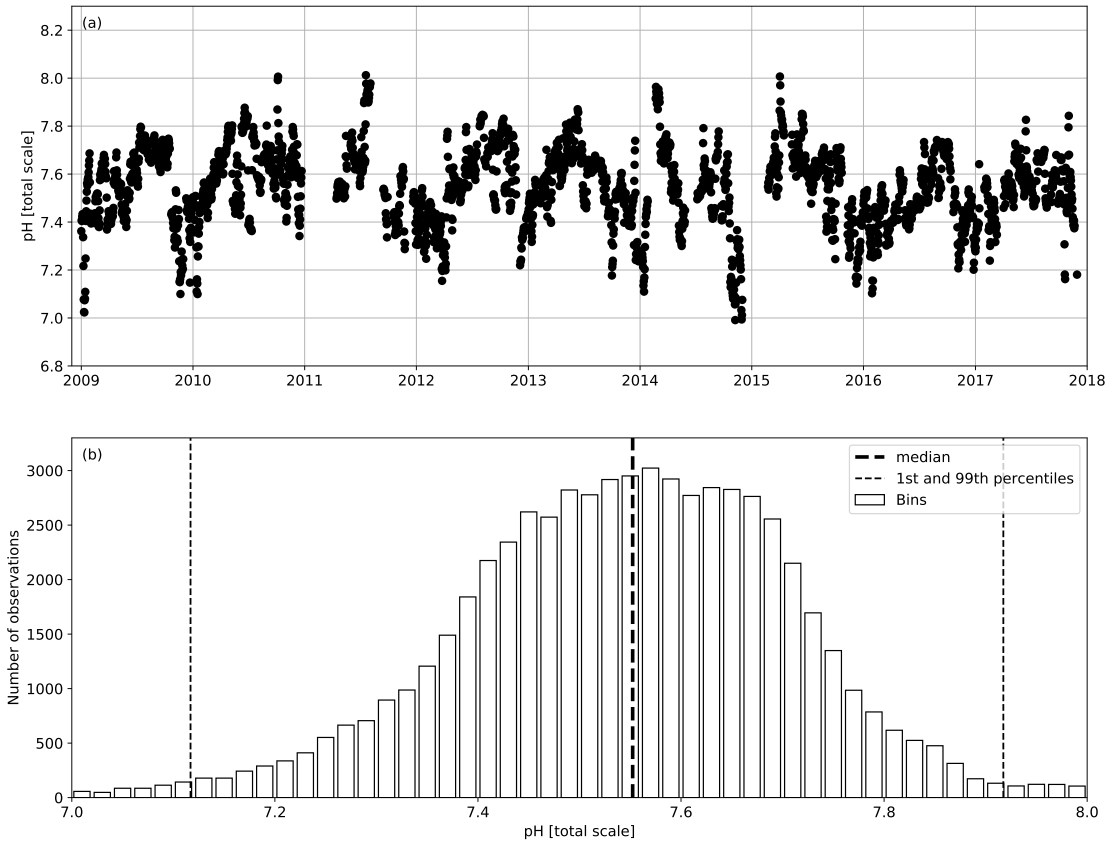

Figure S1. Observations from the Environment and Climate Change Canada (ECCC) Fraser River Water Quality Buoy located near the mouth of the Fraser River (Fig. 1b). Buoy pH is measured potentiometrically using a YSI ADV6600 multisensor and recorded hourly (see Sect. 2.3). The pH timeseries follows a seasonal cycle but a weak correlation to discharge (not shown) suggests the cycle is mainly governed by estuarine biology. The approximate first, 50th (median), and 99th percentiles are used as the basis for the respective High, Med, and Low Carbon freshwater DIC:TA scenarios employed in the sensitivity analysis (Table 2).

Table S1. List of sampling dates for data used to constrain the freshwater TA endmember. All vertical profiles were sampled near the Fraser River plume region (Fig. 1b). Data first appearing in the present study (2014.50 and 2016.05) were collected as part of a continuing sampling campaign described by Ianson et al. (2016) and were sampled and measured according to Dickson et al. (2007). Salinity samples were collected from the same Niskin bottle as TA and measured using a laboratory salinometer.

Cruise ID	Sampling date	Source
2010.73	2010 Oct 31	Ianson et al. (2016)
2011.09	2011 Jun 24	Ianson et al. (2016)
2011.60	2011 Aug 7	Ianson et al. (2016)
2012.05	2012 Jun 16	Ianson et al. (2016)
2012.57	2012 Jul 16	Ianson et al. (2016)
2014.50	2014 Oct 28	present study
2016.05	2016 Apr 23	present study

Table S2. Ranges (high to low) of TA, and corresponding ranges of DIC, pH, pCO_2, and T in several world rivers, in order of increasing latitude.

River	TA (μeq kg^{-1})	DIC (μmol kg^{-1})	pH (NBS)	pCO_2 (μatm)	T (°C)	Location (km upstream)	Frequency	Time range	Source
Amazon	549-246[a]	–	–	–	–	delta	monthly	1963–1964	Gibbs (1972)
	–	500–600[b]	6.5–7.2	–	–	400	8 cruises	1982–1984	Richey et al. (1990)
Congo	235–85	258	6.7–5.7	2018–6853	28	350	monthly	2011	Wang et al. (2013)
Changjiang	1970–1575	1995–1575	8.0–7.8	607–1395	7–29	60	4 cruises	2003–2006	Zhai et al. (2007)
Maipo	–	4100–2400	7.4–7.5	6700–3500	23–12	–	–	–	–
Mississippi	2870–2115	2920–2155	–	–	–	delta	2 cruises	Aug–Sep 1998	Cai (2003)
	–	–	–	–	8–30	100	daily	1983–2012	White and Visser (2016)
Biobio	–	1000–850	8.1–7.7	550–700	29–9	–	–	–	–
Columbia	1300–600	–	–	–	3–24	100	monthly	1995–2012	Evans et al. (2013)[c]
	–	–	–	735–176	–	estuary	8 cruises	2007–2008	Evans et al. (2013)
Kennebec	510–87	557–110	4.9–7.0	1771–203	27–0	0–50	monthly	2004–2008	(Hunt et al., 2014)
Scheldt	4600–6500[b]	5000–7000[b]	7.9–7.5	4000–14000	25–3	81–96	monthly	1996–1999	(Hellings et al., 2001)
Rainfall[d]	420–178	420–206	–	–	–	delta	sporadic	2015–2016	See acknowledgements
Ob	1218–744[a]	–	8.0–7.2	–	−2–17	–	regularly[f]	2009–2011	Arctic-GRO I[e]
Yenisey	1128–593[a]	–	8.3–7.7	–	1–13	–	regularly[f]	2009–2011	Arctic-GRO I[e]
Mackenzie	1747–1350[a]	–	8.2–7.8	–	0–15	–	regularly[f]	2009–2011	Arctic-GRO I[e]
Lena	860–651[a]	–	8.0–7.4	–	0–11	–	regularly[f]	2009–2011	Arctic-GRO I[e]
Yukon	2276–1137[a]	–	8.1–7.2	–	0–15	–	regularly[f]	2009–2011	Arctic-GRO I[e]
Kolyma	536–369[a]	–	8.2–7.1	–	0–10	–	regularly[f]	2009–2011	Arctic-GRO I[e]
Glacial	50	80	–	380	0	iceberg	once	2013	(Meire et al., 2015)

[a]Reported as HCO_3^- in mg L^{-1}. Converted using 60.0168 g HCO_3^- mol^{-1} molecular weight and approximating density as 10^3 kg m^{-3}.

[b]Reported as μmol L^{-1} or μeq L^{-1}. Converted by approximating density as 10^3 kg m^{-3}.

[c]United States Geological Survey (USGS) National Stream Quality Accounting Network (http://water.usgs.gov/nasqan/).

[c]Summarized from data collected in several small rivers in the Strait of Georgia.

[e]Arctic Great Rivers Observatory I constituent data (NSF-1107774, http://www.arcticgreatrivers.org/data.html).

[f]15 comprehensive campaigns with a focus on freshet, late summer, and under-ice periods; daily samples over the freshet.

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