

Supplementary Information for:

Isotopic evidence for sources of dissolved carbon and the role of organic matter respiration in the Fraser River basin, Canada

Submitted to: *Biogeochemistry*

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Table S1. Study sampling sites and corresponding Environment Canada gauging stations

List of sampling sites and, where available, corresponding Environment Canada (EC) flow gauging stations used to calculate fluxes. Discharge for both the Fraser at Fort Langley and Fraser at Vancouver sites was calculated as the sum of discharge at the Fraser at Hope and the Harrison River stations on the sampling day.

Study Site	Latitude (°N)	Longitude (°W)	EC Station Name	EC Station Code	EC Station Latitude (°N)	EC Station Longitude (°W)
Fraser at Fitzwilliam	52.8526	118.6063	Fraser River at Red Pass	08KA007	52°59'10"	119°00'24"
Fraser at McBride	53.3023	120.1411	Fraser River at McBride	08KA005	53°18'06"	120°08'27"
Fraser at Hansard	54.0817	121.8462	Fraser River at Hansard	08KA004	54°04'43"	121°51'01"
Fraser at Stoner	53.6384	122.6652	--	--	--	--
Fraser at Lillooet	50.7080	121.9132	Fraser River above Texas Creek	08MF040	50°36'49"	121°51'12"
Fraser at Lytton	50.2479	121.5910	--	--	--	--
Fraser at Hope	49.3893	121.4557	Fraser River at Hope	08MF005	49°23'09"	121°27'15"
Fraser at Fort Langley	49.1801	122.5672	--	--	--	--
Fraser at Vancouver	49.2145	122.7829	--	--	--	--
Robson River	53.0506	119.2138	--	--	--	--
Bowron River	53.8971	121.9869	Bowron River below Box Canyon	08KD007	54°01'01"	122°06'10"
McGregor River	54.2202	121.9020	McGregor River at Lower Canyon	08KB003	54°13'52"	121°40'07"
Willow River	54.0678	122.4675	Willow River above Hay Creek	08KD006	54°02'44"	122°22'23"
Nechako River	53.9265	122.7379	Nechako River at Isle Pierre	08JC002	53°57'37"	123°14'05"
Blackwater River	53.2891	123.1380	West Road River near Cinema	08KG001	53°18'23"	122°53'30"
Quesnel River	52.9725	122.4935	Quesnel River near Quesnel	08KH006	52°50'35"	122°13'31"
Chilcotin River	51.8307	122.5718	Chilcotin River below Big Creek	08MB005	51°50'52"	122°39'17"
Bridge River	50.7513	121.9339	--	--	--	--
Thompson River	50.2367	121.5315	Thompson River near Spences Bridge	08LF051	50°21'16"	121°23'37"
Harrison River	49.2361	121.9621	Harrison River at Harrison Mills	08MG014	49°14'04"	121°57'33"
Pitt River	49.3496	122.6162	--	--	--	--

Table S2. Discharge data for study sites

List of sampling sites and corresponding discharge values. IGSN codes refer to International GeoSample Numbers in the System for Earth Sample Registration (SESAR) database; sample metadata can be accessed at www.geosamples.org.

Site	Date (yyyy-mm-dd)	Parent IGSN	Discharge (m ³ s ⁻¹)
Fraser at Fitzwilliam	2010-10-14	GRO000027	35.8
Fraser at Fitzwilliam	2009-08-03	GRO000009	85.3
Fraser at Fitzwilliam	2011-06-03	GRO000073	107
Fraser at McBride	2010-10-14	GRO000030	148
Fraser at McBride	2009-08-04	GRO000011	454
Fraser at McBride	2011-06-02	GRO000070	473
Fraser at Hansard	2010-10-16	GRO000038	267
Fraser at Hansard	2009-08-04	GRO000012	696
Fraser at Hansard	2011-06-01	GRO000066	1420
Fraser at Stoner	2010-10-19	GRO000041	
Fraser at Stoner	2009-08-08	GRO000018	
Fraser at Lillooet	2010-10-21	GRO000045	913
Fraser at Lillooet	2009-08-10	GRO000022	2110
Fraser at Lillooet	2011-05-28	GRO000058	6160
Fraser at Lytton	2010-10-22	GRO000047	
Fraser at Lytton	2009-08-01	GRO000008	
Fraser at Hope	2010-10-24	GRO000048	1880
Fraser at Hope	2011-05-27	GRO000055	8790
Fraser at Fort Langley	2010-10-25	GRO000051	2189
Fraser at Fort Langley	2009-07-30	GRO000001	4694
Fraser at Fort Langley	2009-08-13	GRO000025	3416
Fraser at Fort Langley	2011-06-07	GRO000076	10120
Fraser at Vancouver shallow	2009-07-28	GRO000002	4571
Fraser at Vancouver deep	2009-07-28	GRO000002	4571
Robson River	2010-10-14	GRO000029	
Robson River	2009-08-03	GRO000010	
Robson River	2011-06-03	GRO000074	
Bowron River	2010-10-15	GRO000035	30.2
Bowron River	2009-08-05	GRO000014	24.8
Bowron River	2011-05-31	GRO000062	303
McGregor River	2010-10-16	GRO000037	122
McGregor River	2009-08-05	GRO000013	210
McGregor River	2011-06-01	GRO000065	686
Willow River	2010-10-15	GRO000036	10.8
Willow River	2009-08-06	GRO000015	7.56

Willow River	2011-05-31	GRO000063	231
Nechako River	2010-10-17	GRO000039	107
Nechako River	2009-08-06	GRO000016	566
Nechako River	2011-05-31	GRO000064	748
Stuart Lake	2009-08-07	GRO000017	243
Blackwater River	2010-10-18	GRO000040	24.3
Blackwater River	2009-08-08	GRO000019	22.3
Blackwater River	2011-05-30	GRO000061	416
Quesnel River	2010-10-19	GRO000042	126
Quesnel River	2009-08-09	GRO000020	276
Quesnel River	2011-05-30	GRO000060	828
Chilcotin River	2010-10-20	GRO000043	98
Chilcotin River	2009-08-09	GRO000021	251
Chilcotin River	2011-05-29	GRO000059	216
Bridge River	2010-10-21	GRO000044	
Bridge River	2009-08-10	GRO000023	
Bridge River	2011-05-28	GRO000057	
Thompson River	2010-10-22	GRO000046	430
Thompson River	2009-08-01	GRO000007	967
Thompson River	2011-05-27	GRO000056	2360
Harrison River	2010-10-24	GRO000049	287
Harrison River	2009-07-31	GRO000006	669
Harrison River	2011-05-26	GRO000054	570
Pitt River	2010-10-25	GRO000050	
Pitt River	2009-08-13	GRO000024	
Pitt River	2011-05-26	GRO000053	

Table S3. Non-carbonate DIC estimate inputs

These data constitute the inputs to the calculations made in Equations 1-20. Major ion concentration data (Ca, Mg, Na, SO₄, and Cl) are from Voss et al. (2014) and were obtained from samples collected concurrently with the DIC and DOC samples reported in this study. Data for pH (measured with a multi-parameter probe) are included to demonstrate that HCO₃⁻ is the dominant dissolved carbonate species in these samples. No pH value is available for the Blackwater River on this sampling date.

Site	pH	Ca ($\mu\text{mol L}^{-1}$)	Mg ($\mu\text{mol L}^{-1}$)	Na ($\mu\text{mol L}^{-1}$)	SO ₄ ($\mu\text{mol L}^{-1}$)	Cl ($\mu\text{mol L}^{-1}$)
Fraser at Fitzwilliam	7.99	229	211	22	176	3
Fraser at Stoner	8.04	410	140	79	78	14
Fraser at Vancouver shallow	7.82	420	116	95	66	15
Nechako River	7.98	287	113	84	34	6
Blackwater River		398	377	258	15	7
Quesnel River	8.19	456	93	36	73	3
Chilcotin River	7.95	218	58	67	63	5
Thompson River	7.97	287	68	70	71	15
Robson River	8.22	515	183	9	71	3*

* See main text section 4.3 for an explanation of this value.

Table S4. Non-carbonate DIC estimate end-members

The values below summarize end-member values used in the calculations made in Equations 1-20. Subscripts indicate the following: *carb* = carbonate weathering end-member; *sil* = silicate weathering end-member; *ss* = sea salt end-member. See text section 4.3 for a discussion of the choice of silicate and carbonate weathering end-members.

Parameter	Value	Source
δ_C	-8.25‰	Spence & Telmer (2005)
δ_S	0.5‰	Spence & Telmer (2005)
Δ_C	-476‰	Average of atmospheric CO ₂ and ¹⁴ C-free OC (-1000‰)
$\epsilon_{CO_2-HCO_3}$	9.6‰	Clark and Fritz (1997)
$\delta^{13}C\text{-atmCO}_2$	-7.25‰	Marwick et al. (2015)
$\Delta^{14}C\text{-atmCO}_2$	47.9‰	Estimated for July 2009; Graven et al. (2012)
$(Ca/Na)_{carb}$	75	Robson River; Voss et al. (2014)
$(Mg/Na)_{carb}$	10	Gaillardet et al. (1999)
$(HCO_3/Na)_{carb}$	120	Gaillardet et al. (1999)
$(Ca/Na)_{sil}$	0.2	Voss et al. (2014)
$(Mg/Na)_{sil}$	0.46	Voss et al. (2014)
$(HCO_3/Na)_{sil}$	2	Gaillardet et al. (1999)
$(Na/Cl)_{ss}$	0.870	Gaillardet et al. (1999)
$(Ca/Cl)_{ss}$	0.017	Gaillardet et al. (1999)
$(Mg/Cl)_{ss}$	0.0019	Gaillardet et al. (1999)
$(HCO_3/Cl)_{ss}$	0.000008	Gaillardet et al. (1999)

Table S5. Monte Carlo simulation parameters

We performed a Monte Carlo simulation of 10,000 normally distributed random values of the parameters below for the Fraser River at Stoner in 2009. Uncertainties of measured concentration and isotope composition parameters are described in the main text section 2 and Voss et al. (2014).

Parameter	Standard Deviation
DIC	5%
DOC	20%
$\delta^{13}\text{C-DIC}$	0.04‰
$\delta^{13}\text{C-DOC}$	0.04‰
$\Delta^{14}\text{C-DIC}$	4‰
$\Delta^{14}\text{C-DOC}$	54‰
Ca	5%
Mg	5%
Na	5%
Cl	5%
δ_{C}	20%
δ_{S}	20%
Δ_{C}	20%
Δ_{S}	20%
$\epsilon_{\text{CO}_2\text{-HCO}_3}$	20%
$\delta^{13}\text{C-atmCO}_2$	20%
$\Delta^{14}\text{C-atmCO}_2$	20%
f_{S}	20%
$(\text{Na/Cl})_{\text{ss}}$	20%
$(\text{Ca/Cl})_{\text{ss}}$	20%
$(\text{Mg/Cl})_{\text{ss}}$	20%
$(\text{HCO}_3/\text{Cl})_{\text{ss}}$	20%
$\text{Cl}_{\text{Robson}}$	80%
$(\text{Ca/Na})_{\text{carb}}$	20%
$(\text{Mg/Na})_{\text{carb}}$	20%
$(\text{HCO}_3/\text{Na})_{\text{carb}}$	20%
$(\text{Ca/Na})_{\text{sil}}$	20%
$(\text{Mg/Na})_{\text{sil}}$	20%
$(\text{HCO}_3/\text{Na})_{\text{sil}}$	20%