Snow Melt Chemistry: Major and Trace Cation Contributions to Downstream Systems from the Llewellyn and Matthes Glaciers, Juneau Icefield

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I. INTRODUCTION

- This study characterizes the spatial variation of trace and major elements on a transect across the Juneau Icefield from the Alaskan side into British Columbia.
- Glaciers in the Pacific Coastal Temperate Rainforest (PCTR) are losing mass at among the highest rates in the world (O'Neel et al., 2015).
- Runoff from these glaciers carries nutrients and elements to downstream ecosystems (O'Neel et al., 2015). Trace elements are understudied.
- The connection of glaciers to downstream ecosystems can help give us a broader, more comprehensive understanding of nutrient cycling in this and similar regions.
- We characterized the variability of chemistry across a transect to understand inputs, outputs, and effects of melt on biogeochemical cycling.

II. SITE DESCRIPTION

Copernicus Sentinel-2 data 2017. Downloaded via USGS Earth Explorer

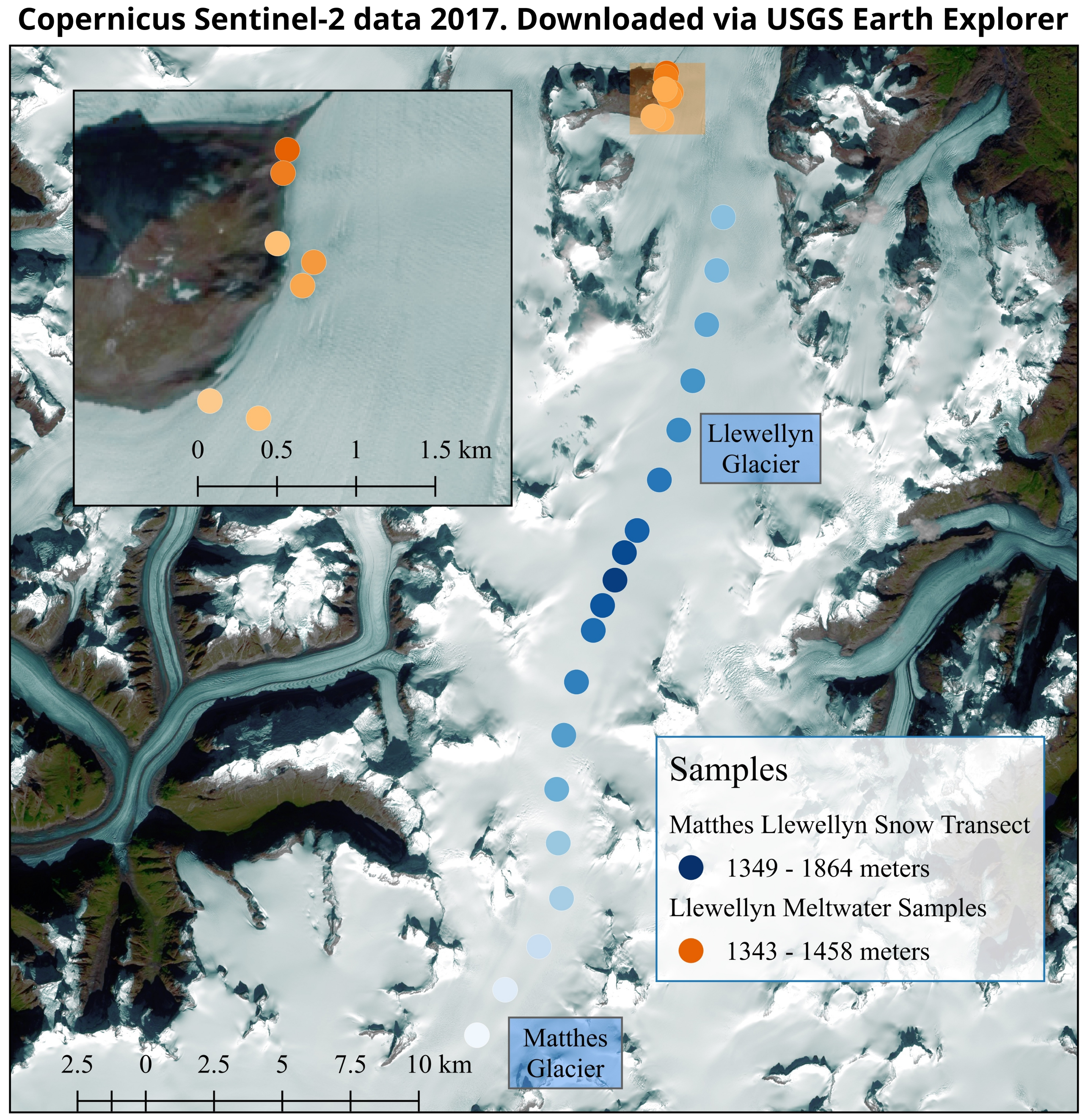
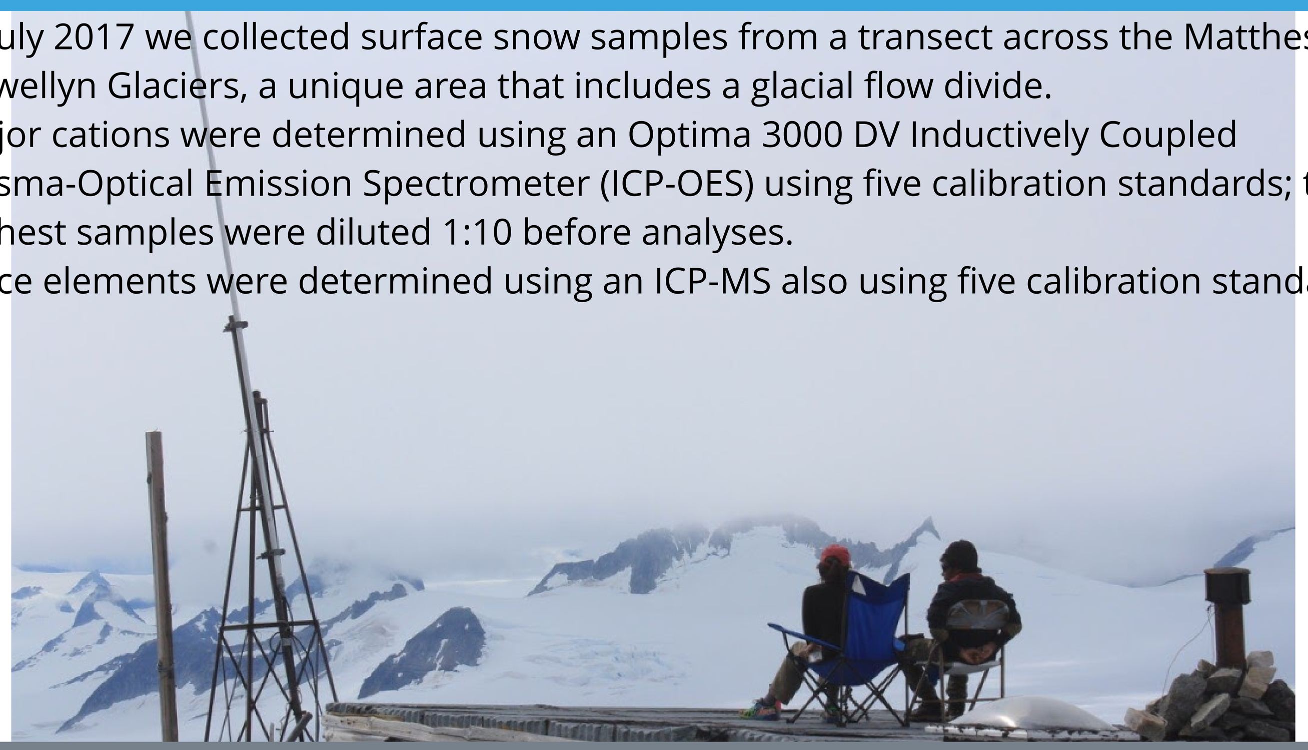


Figure 1. Map of snow sample transect across Matthes and Llewellyn Glaciers on the Juneau Icefield including elevation scale. Highest elevation is the flow divide where the two glaciers meet.

Figure 2 . Zach Gionatti sampling on the Matthes Glacier (left). Kelcy Huston, Chelly John, Zach Gionatti, and Sarah Fortner exploring supraglacial streams on the Llewellyn Glacier (right).

III. METHODS

- In July 2017 we collected surface snow samples from a transect across the Matthes and Llewellyn Glaciers, a unique area that includes a glacial flow divide.
- Major cations were determined using an Optima 3000 DV Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) using five calibration standards; the three highest samples were diluted 1:10 before analyses.
- Trace elements were determined using an ICP-MS also using five calibration standards.



IV. RESULTS

Table 1. Comparison of trace elements in glaciers (ppt). Samples are snow unless indicated.

Element	Llewellyn Supraglacial Stream (Canada) (n=4)	Llewellyn Proglacial Stream (Canada) (n=1)	Matthes/ Llewellyn Transect (Canada) (n=19)	Common-wealth Glacier (Antarctica)	Canada Glacier (Antarctica)	Howard Glacier (Antarctica)
As	0.1-0.4	53	0.5-4.7	<35-150	<35-187	<34-442
Mo	BDL	35	BDL	<8-221	<8-134	<8-441
Cd	BDL	3	0.1-0.6	<6-25	<6-38	<6-59
Sn	BDL	1	BDL-0.5	<5-115	<5-64.	<5-249
Sb	BDL	2	BDL-0.5	<2-38	<2-8	<2-20
Pb	5-24	340	6-51	9-705	6-2280	33-2690
V	2-10	134	5-42	-	-	-
Co	BDL	40	0.1-5	-	-	-
Cu	0.8-5	100	4-36	<35.6-3113.8	<35.6-6354.6	76.3-12073.7

Table 2. Comparison of major ion concentrations in glaciers (ppb). Samples are snow unless indicated.

Ion	Llewellyn Supra-glacial Stream (Canada) (n=4)	Llewellyn Pro-glacial Stream (Canada) (n=1)	Matthes/ Llewellyn Transect (Canada) n=19)	Common-wealth Glacier (Antarctica)	Canada Glacier (Antarctica)	Howard Glacier (Antarctica)	Haxilegen Glacier (China)	Mt. Yulong (Tibet)
Ca^{2+}	BDL	6620	52-75	16.1-759	16-4368	81-5890	69-220	1990-3130
Mg^{2+}	7-17	1040	19-85	-	-	-	17-22	199-1800
Na^{+}	BDL	470	9-41	80-1082	40-561	40-3807	17-27	2-101
K^{+}	7-18	460	16-68	-	-	-	15.8-22.4	24-168

V. DISCUSSION

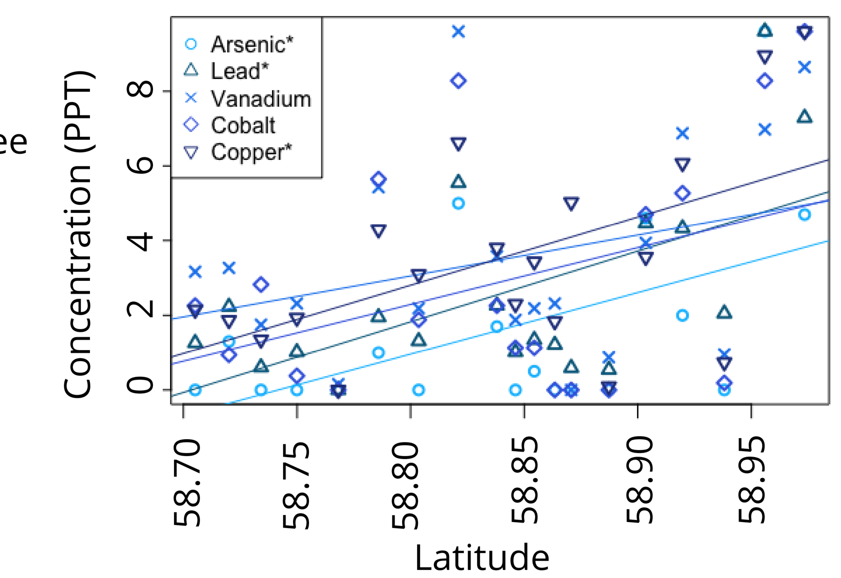


Figure 3. Trace element concentrations increased to from south to north. As, Cu, & Pb had p-values of <0.05.

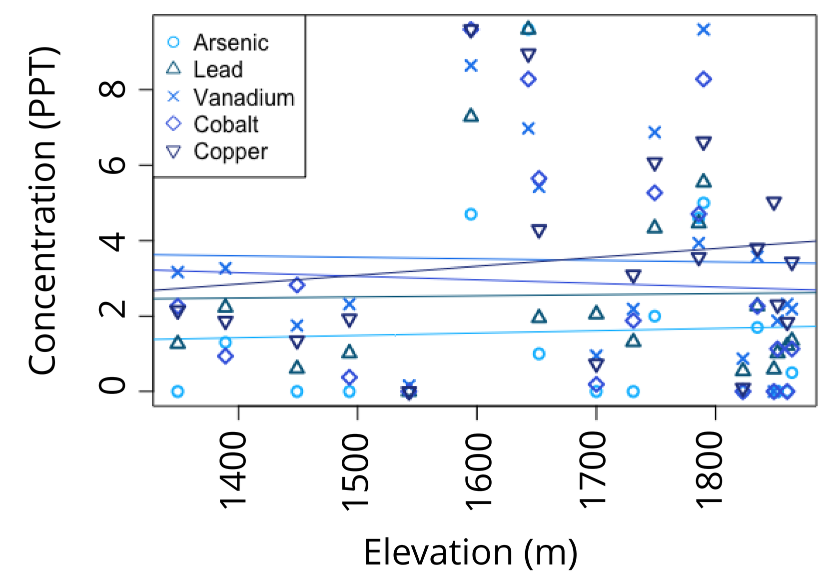
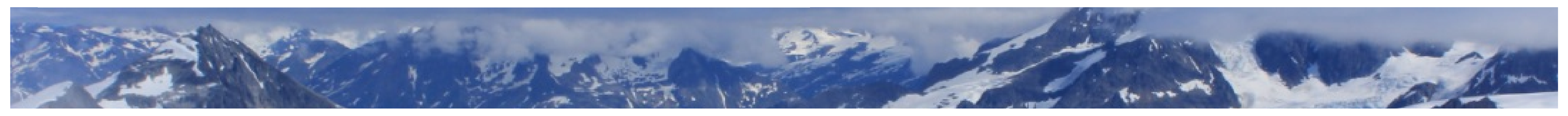


Figure 4. No trends were seen for trace elements vs. elevation.



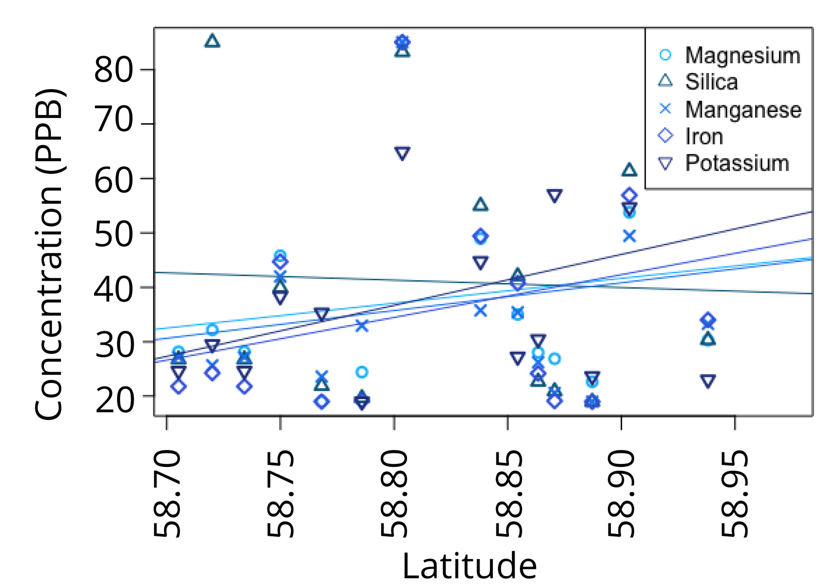


Figure 5. There was a slight increase in concentrations from south to north of minor ions, but this trend was less defined.

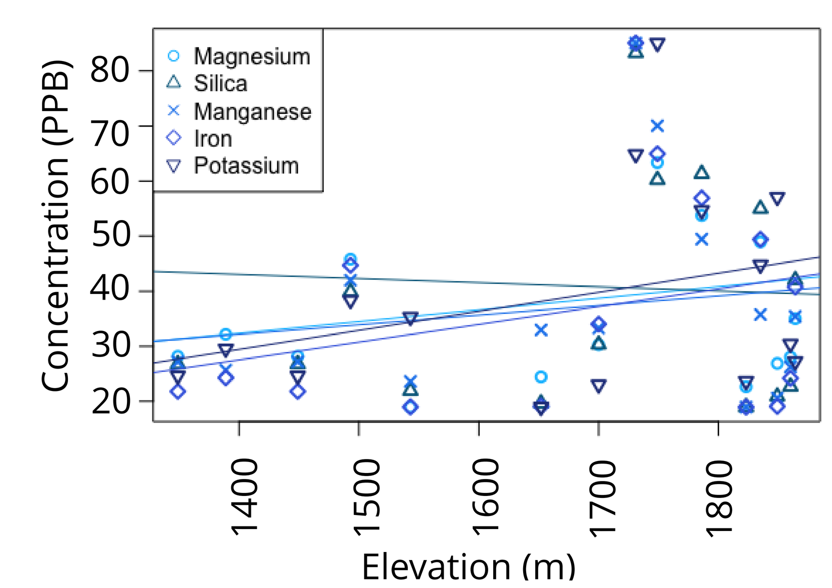


Figure 6. Element distribution shows stronger spatial distribution trends than ion distribution.

- Elements appeared to increase with increasing latitude, suggesting that the primary chemical source was from the north. There was no trend with elevation.
- As, Pb, and Cu were the only elements to show a significant trend, reflecting possible anthropogenic sources.
- Proglacial samples had concentrations that were an order of magnitude higher than supraglacial and snow samples.
- Snow and proglacial samples had higher relative concentrations of carbonate-associated ions (calcium and magnesium) than potassium and sodium.
- Supraglacial streams were depleted in carbonate-associated ions, perhaps reflecting longer times to solubilize.

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