Comparison of the isotopic and conductivity variations between a glacial and a non-glacial watershed, Kluane region, Yukon

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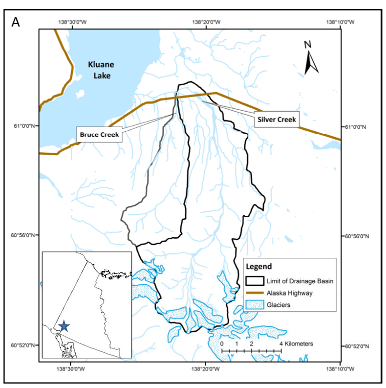
WHAT?

The present study focuses on hydrograph separation, using oxygen and hydrogen stable isotopes, and conductivity, to distinguish, on a diurnal scale, the signature of meltwater in Silver Creek, a glacial regime watershed, situated in the Kluane region, Yukon. The results are put in comparison with a nearby watershed of mixed, but non-glacial regime, Bruce Creek, used as a baseline. Isotopic composition of oxygen and hydrogen in the water, along with electrical conductivity, are put in relation with water level changes of both creeks to determine the origin of their variability and to distinguish the properties of their respective regimes.

WHERE?



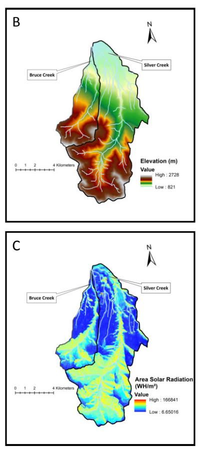


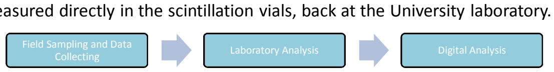
Figure 1: (A) Location of the Silver Creek and Bruce Creek watersheds in the Kluane region, Yukon (B) Elevation map of the studied area (C) Solar analysis of the studied period

WHY?

Understanding river regimes, more specifically discharge variability and its implications, plays a pivotal role in water resource development. In Canada, many rivers are issued from the meltwater of glaciers. These rivers of glacial regime are strongly influenced by climate parameters, which affect glacier dynamics, at different time scales. Yearly, seasonal and even monthly changes in river hydrographs in relation to the isotopic composition and conductivity of the water have been largely documented in different parts of the world (Theakstone & Knudsen, 1996; Zhang & al., 2009, Bhatia & al., 2011; Cable & al., 2011). However, few studies have been conducted on the daily isotopic and conductivity variability of glacial watersheds. Therefore, the main purpose of this study is to determine if a glacial regime watershed experiences diurnal variations that can be related to meltwater input and the implications of such changes at a local scale.

HOW?

Fieldwork was conducted from July 6th to July 17th. Work on the field consisted of discrete data collection (water chemistry and discharge measurements) and water sampling (Silver Creek, Bruce Creek and rain) which were done at different times of the day for the study period, with a 5 days hiatus from July 9th to July 14th. Water level loggers were also placed on each creek along with a weather station which was installed near Silver Creek to monitor the local climatic parameters (temperature, insolation, atmospheric pressure, etc.). Both recorded data automatically for the whole study period. Laboratory work consisted of sample preparation and conductivity measurements. 68 samples, 34 from Silver Creek, 32 from Bruce Creek and 2 samples from the July 9th rain event were filtered and then sent to the G.G. Hatch Laboratory for isotopic analysis. Electrical conductivity was measured directly in the scintillation vials, back at the University laboratory.



DATA

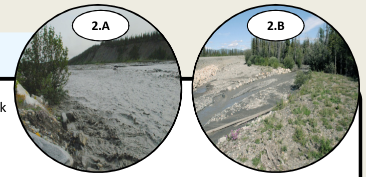


Figure 2: Overview of (A) Silver Creek and (B) Bruce Creek study sites

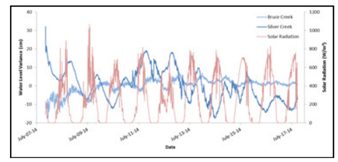


Figure 3: Relation between water level variance of Silver Creek and Bruce Creek and insolation

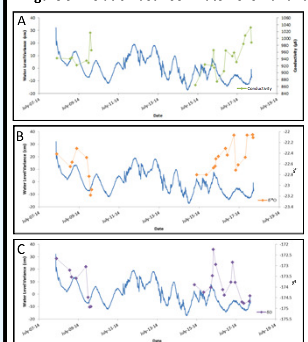


Figure 4: Silver Creek water level departure from the mean and (A) conductivity, (B) $\delta^{18}O$ and (C) $\delta^{2}H$

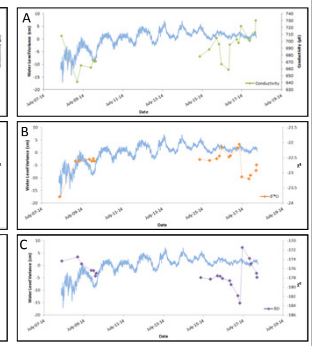


Figure 5: Bruce Creek water level departure from the mean and (A) conductivity, (B) $\delta^{18}O$ and (C) $\delta^{2}H$

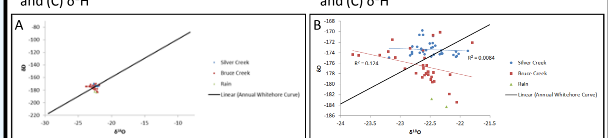


Figure 6: Relation between oxygen-18 and deuterium in Silver Creek, Bruce Creek and meteoric water compared to the annual curve for Whitehorse: (B) is an enlarged view of (A) (Lacelle,2011)

DISCUSSION

Silver Creek's glacial regime was supported by its daily tendency to closely follow the insolation curve. Its lag time can be explained by the time it takes for the meltwater to travel down the drainage basin and reach the study site (figure 3). A correlation between conductivity, water isotopes and water level variations was also observed in Silver Creek and not in Bruce Creek (figures 4 and 5). Conductivity has an inverse relation with water level variance, because meltwater tends to have less contact with the bedrock than the base flow. Both heavy isotopes have a direct relation with water level which confirms that $\delta^{18}O$ and $\delta^{2}H$ proportions should be higher in meltwater than in the baseflow of a glacial catchment. However, the direct correlation between water levels and isotopic composition is very poor in both creeks, computed correlation coefficients being less than 0. Also, the isotopic values are still representative of the normals of the geographic area; even if the general trend of these scatter plots is slightly negative (figure 6).

NOW WHAT?

The main objective of this study was to determine if changes in the glacial watershed could be distinguished on a diurnal scale. However, the methods used were not precise enough to capture the resolution of the daily isotopic and conductivity variations. T-tests conducted for $\delta^{18}O$ and $\delta^{2}H$ between both Silver Creek and Bruce Creek sample groups resulted in very poor values for both data sets, making the results can not significantly different from each other. More water sampling at move even intervals and different periods of the year could lead to more conclusive results. However, the general tendencies discussed previously can still be ensued from this project.

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FOR FULL REFERENCES: