NSERC/Rio Tinto Industrial Research Chair

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The Nechako IRC Newsletter

Season's Greetings!

The end of the fall 2022 semester is fast approaching, meaning that the winter Holiday Season is just around the corner!

"We wish everyone very Happy Holidays - may 2023 bring you joy, peace, and prosperity "

This past fall season can readily be divided into two periods. From early September until the third week of October, conditions were relatively warm and dry, almost summer-like. Then in late October stormy weather hit the Nechako Watershed with an atmospheric river making landfall bringing copious amounts of precipitation and high winds. Soon thereafter, a frigid Arctic air mass infiltrated into northern BC, preserving the early snowpack and freezing many lakes and streams.

Despite the occasional warm-up, conditions have been winter-like since early November, making "autumn" conditions rather brief this year! With the onset of the wintry weather, outdoor recreation such as ice skating, skiing and snowshoeing will certainly be popular through the Holiday Season.

The NSERC/Rio Tinto IRC team thanks members of the many communities across the Nechako Watershed and beyond that fully supported our research and field activities in 2022. We wish everyone very Happy Holidays – may 2023 bring you joy, peace, prosperity and good health!

Sincerely,
The NHG team

Figure 2. Winter scene from Ness Lake.

Figure 1. Mt. Sweeney Weather

Inside this issue

Special points of interest

- New members of the IRC team.
- Snow depth decreasing in the Nechako River Basin.
- Atmospheric Rivers are a major contributor to the Nechako River Basin's water budget during the fall season.
- New floodplain mapping project.

Figure 3. Angel the dog enjoying a cozy afternoon during the cold winter spell.

Summary of Research

In this month's issue of the Nechako IRC Newsletter, post-doctoral fellow Jingwen Wu explores how snow depth has evolved in response to climate change across the Nechako Watershed between 1950 and 2021. As well, PhD candidate Bruno Sobral discusses the important role atmospheric rivers play in replenishing water resources across the Nechako Watershed.

Undergraduate student assistants/field technicians Jade Reynolds and Spencer Woyke provide an update on fall season field activities including the retrieval of water temperature and meteorological data at our many field sites.

Justin Kokoszka also reports on the managerial and data management aspects of all IRC-related activities plus ongoing outreach and communication activities.

Project Leader Update
Stephen Déry

As highlighted in the last newsletter, the IRC team has seen a transition of personnel in late summer. We have been most fortunate to quickly fill the position vacated by the recent departure of former research manager Kelly Hurley. Indeed, Justin Kokoszka has graciously stepped into this role on a part-time basis. His involvement in the IRC program of research over the past two years including his leadership with the data management efforts have provided him vital experience to tackle the role of research manager.

In mid-November we recruited a full-time hydrometeorological technician, Kirsten Calder-Sutt, to tackle the development of the MECHE meteorological observatory and preparing for another busy field season in 2023. We are delighted to welcome Tamar Richards-Thomas to the IRC team as she transitions from another project to tackle data analysis from the Tahtsa Ranges Atmospheric River Experiment (TRARE). You will find short biographies for both Kirsten and Tamar later in this issue of the Nechako IRC Newsletter.

Undergraduate research assistant Jade Reynolds' term with the IRC team has now ended as she focuses on completing her coursework and graduating from UNBC in 2023. Meanwhile, Spencer Woyke continues being part of the IRC team as he works on an undergraduate thesis as part of his environmental science program at UNBC.

In addition to the research updates and introductions to new team members, you will find in this newsletter information on a new project being initiated to map flood plains along the Nechako River from Vanderhoof to Prince George. This effort is being led by Associated Engineering with support from the University of Saskatchewan, UNBC and Rio Tinto.

As well, another funding application is in development with partners at INRS, ETS, UBC and UNBC to explore thermal refugia used by Chinook salmon and white sturgeon in the Nechako River. Details on this project will be shared in an upcoming issue of the Nechako IRC Newsletter if funding is indeed approved.

"The Natural Sciences and Engineering Research Council of Canada (NSERC) that funds the IRC position in partnership with Rio Tinto may allow a one-year extension to this program of research."

Finally, the Natural Sciences and Engineering Research Council of Canada (NSERC) that funds the IRC position in partnership with Rio Tinto may allow a one-year extension to this program of research. If approved by NSERC, this would extend the IRC position by one year, meaning it would end on 30 June 2025.

The IRC team continues its outreach and communication efforts through various platforms and forums. I participated in Rio Tinto's Water Engagement Initiative during the summer and early fall but had to curtail my involvement thereafter due to heavy teaching duties at UNBC. I anticipate reconnecting with this community engagement effort in December as my teaching responsibilities ease. On October 27th, Justin and I participated in the fall meeting of the Nechako Watershed Roundtable during which I presented an update on our research along with colleagues from UNBC's Integrated Watershed Research Group.

Furthermore, I continue interacting with regional media on recent weather conditions and climate change in the Nechako Watershed. Finally, we remind our readers that we have an up-to-date website where you can obtain current information on our group's research, field activities, and outreach efforts along with access to data and publications: https://web.unbc.ca/~sdery/irc/.

Farewell to Jade Reynolds

Jade began her work with the IRC back in May of 2022 as a Field Technician Research Skills Trainee. During her time with IRC, Jade conducted several field visits to deploy and maintain our monitoring network. This work included visits to stream temperature monitoring sites, tipping bucket rain gauge sites, as well as several weather stations. Jade also applied her exceptional organizational skills to organize our lab and contributed many hours dedicated to data entry to get our NHG database up to date.

Jade will spend the next few months focusing on her undergraduate degree at the University of Northern British Columbia. We wish Jade all the best with her future goals and endeavors.

Figure 6. Jade Reynolds conducting inventory and organizing our research lab.

New IRC Team Members

Kirsten Calder-Sutt
Hydrometeorological Technician

Kirsten Calder-Sutt began a one-year contract as Hydrometeorological Technician (HT)/Research Associate with the NHG on November 14, 2022. They convocated from Simon Fraser University in 2019 with a B.Sc. in Environmental Science.

Since then, Kirsten has worked with municipal and provincial government, including on Ministry of Forests Research and Water Stewardship teams within the Omineca region. Their work experience includes 6 seasons of diverse field work in environmental science and conservation, as well as several years of office-based GIS and water authorizations work.

Major responsibilities of the HT will include leading the deployment of equipment related to the MECHE observatory as well as the maintenance of CAMnet. Over the course of the following months, Kirsten will conduct comprehensive field planning for the 2023 field campaign, test all new and existing hydrometeorological equipment prior to deployment, assist with recruitment of new Highly Qualified Professionals for the field season, and perform weekly checks of meteorological stations with remote connectivity. Other tasks will include various outreach and communication activities, field vehicle inspections and maintenance, and identification of future stream temperature logger and, potentially, meteorological station deployment sites as well as maintaining data within the NHG's database.

Figure 4. Hydrometeorological Technician—Kirsten Calder-Sutt

Tamar Richards-Thomas
Research Skills Development Trainee

Tamar Richards-Thomas recently joined the IRC program as a part-time Research Skills Development Trainee in NHG.

Prior to starting this position with the IRC program, Tamar also worked on a couple of projects funded by Mountain Water Futures in NHG. The research projects explored objectives aimed i) to understand the climatology of the mid-November 2021 flood in British Columbia (BC) and ii) to understand how flood events in BC are exacerbated by land cover disturbances.

Tamar earned a Bachelor of Science in Physics (honors) from the University of the West Indies, a Master of Science in Earth & Atmospheric Science from the University of Alberta, and a Doctor of Philosophy in Environmental & Life Sciences at Trent University. Her doctoral thesis offered valuable insights into the entrainment, emission, transport, and deposition of Icelandic Dust completed in 2019. Her research interests include studying hydrology, hydrometeorology, climatology, air quality and pollution, as well as fluid dynamics.

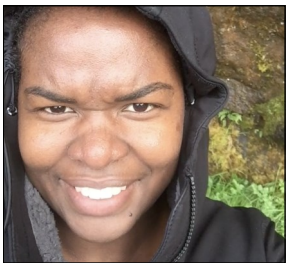

Figure 5. Research Skills Development Trainee—Tamar Richards-Thomas

Figure 6. A) Nechako River at our Miworth site, B) Research Manager Justin Kokoszka in the field this past summer, C) sensor housing at our Chilako site, D) Jade and Spencer deploying a new stream temperature logger at Miworth, and E) stream temperature logger at Chilako.

Research Manager Update

Justin Kokoszka

I have accepted the roles of Research Manager and Outreach Coordinator (RM/OC) with the NHG on a part-time basis. Since May of 2020 I have been with the NHG as a graduate student as well as the part-time Data Manager and will continue to fulfill these roles moving forward. I plan to utilize my skills and experiences with the RM/OC roles at the NHG, while continuing to learn and develop my professional skills. I look forward to continuing my roles with the NHG and involvement with the IRC.

Fall 2022 has certainly been a chilly one as our field season winds down. I am very grateful for our two summer field technicians, Jade and Spencer who have taken the initiative to conduct our fall fieldwork as I transition into the role of Research Manager. Jade and Spencer's newsletter entry provides an overview of their fall fieldwork with respect to the IRC, but I would also like to highlight the status of our research network within the Nechako River Basin.

Our Nechako Basin Monitoring Network consists of 6 tipping bucket rain gauges, 4 weather stations, and 29 stream temperature sites. Together these monitoring sites provide essential data regarding the state of stream temperature and weather conditions within the Nechako River Basin. Of the 39 monitoring sites, 38 are operational with only one tipping bucket rain gauge in need of replacement.

Looking forward, our team will be preparing for the spring/summer 2023 field season which will include field trip planning, equipment testing, and preparing our database for future projects/deployments. These include the deployment of two weather stations in collaboration with the Cheslatta Carrier Nation as well as deployment of various equipment for use during the MECHE initiative for which we have already received and inventoried several pieces of equipment.

This winter is sure to involve much planning and organization in preparation for a busy spring/summer field season in the new year!

Field Work Overview

Jade Reynolds and Spencer Woyke

From September to November 2022, research technicians Jade Reynolds and Spencer Woyke orchestrated several site visits around Prince George. The purpose of these trips was to fill in gaps in data collection as well as to conduct site maintenance at stream temperature (ST) sites from the most recent summer season. In total, three ST site visits were conducted: Chilako at Upper Mud River Road (Chilako), Nechako at Dellwood (Dellwood), and Nechako at Miworth (Miworth).

Two site visits to Miworth were required because the tether had snapped when pulling up the sensor assembly during the first visit. To get around this issue, a second ST sensor assembly was deployed during the same visit; then, data were successfully collected from this sensor during the second visit.

During the Dellwood visit, one sensor assembly (that had been deployed in the summer of 2022 due to high water levels) had to be removed because it was no longer submerged in the Nechako. The other sensor assembly (that had existed prior to the summer of 2022) was accessible but had a dead battery, so data were only collected from it up until October 2021. Fortunately, no issues were present during the data download at Chilako.

We look forward to the summer 2023 field season!

Climate Change Decreases Snow Depth Across the Nechako River Basin

Jingwen Wu

Snow forms an important reservoir for freshwater while also acting as a climate change variable in the Earth's climate system. Snow affects climate by cooling the Earth's surface, supplying water for a variety of human uses, and sustaining healthy ecosystems, including fish and wildlife populations. It is also sensitive to even modest changes in climate. This is a concern as according to a recent federal government report, Canada's average (mean) annual temperature increased by 1.7 °C from 1948 to 2016, about double the global rate. Therefore, it is important to explore how snow changes in this warming situation, especially in the snowy Nechako River Basin.

"...with ongoing global warming as projected by the Intergovernmental Panel on Climate Change (IPCC), snow depth are likely to continue decreasing."

In this section, we investigated historical (1950–2021) changes in snow depth across the Nechako River Basin. We collected historical snow depth from one climate reanalysis dataset. We observe that the annual snow depth shows a significant downward trend over the Nechako River Basin during 1950 to 2021 (Figure 7), with a decreasing value of 0.15 cm per year.

We also analyzed the seasonal changes in snow depth over the Nechako River Basin between 1950 and 2021. It clearly shows decreasing trends in all seasons (Figure 8), moreover the spring snow depth declines most with a decreasing value of 0.21 cm per year. It is mainly due to a warmer climate which not only causes a shift in precipitation from snowfall to rainfall-dominated events, but also by accelerating snowmelt.

Our analyses show that the changes in climate plays a vital role in changing snow conditions and evolution; with ongoing global warming as projected by the Intergovernmental Panel on Climate Change (IPCC), snow depth are likely to continue decreasing.

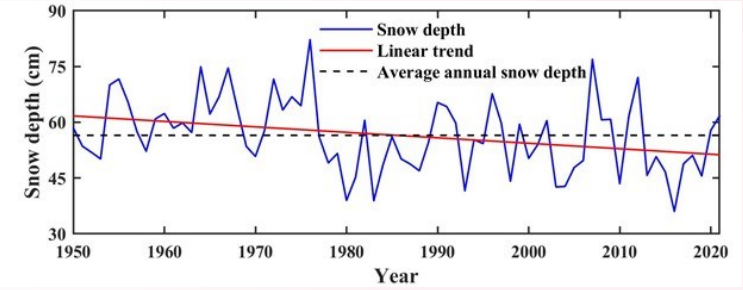

Figure 7: Annual snow depth in Nechako River Basin during 1950-2021.

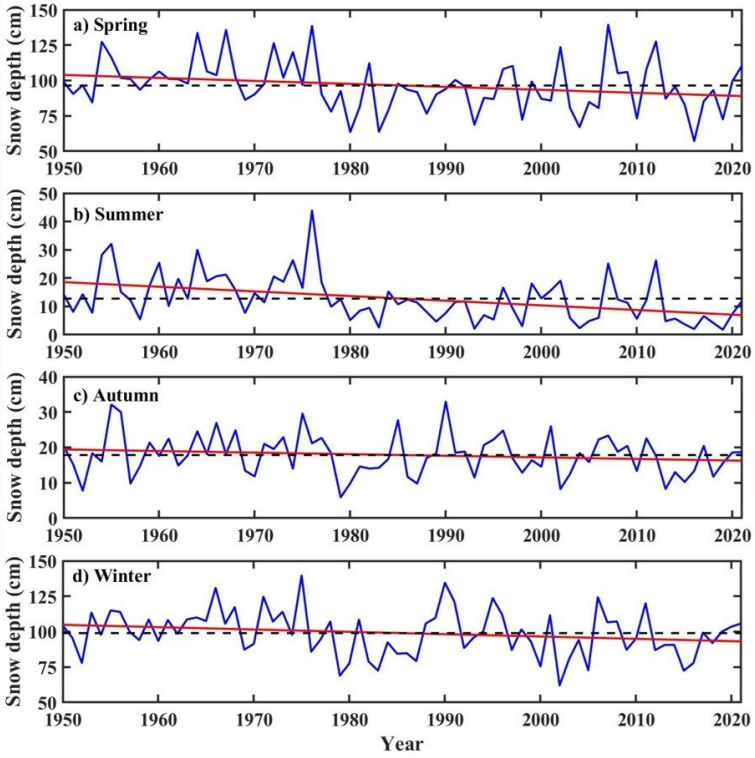

Figure 8: Seasonal mean snow depth in Nechako River Basin during 1950-–2021. Spring denotes March, April and May; Summer denotes June, July and August; Autumn denotes September, October and November; Winter denotes December, January and February. Blue lines denote mean seasonal snow depths; Red lines denote linear trends of seasonal snow depths; Black dotted lines denote overall mean of seasonal snow depths for 1950-2021.

Atmospheric Rivers in the Nechako River Basin

Bruno Sobral

With the deepening of my PhD studies on the influence of atmospheric rivers (ARs) in the Nechako River Basin (NRB), preliminary results illustrate the regional distribution of AR-related water resources. Using a simplified model, where the difference between total precipitation and evaporation values estimates the water budget (WB), seasonal maps were created to reveal the spatial distribution of the regional WB linked to ARs. This part of the work aims to estimate the contribution of ARs to the hydrological cycle of the NRB during the different seasons and using ERA5-Land data.

The fall stands out as the season with the most contribution of ARs to the WB. From September to November, the NRB presents ~40% of its WB linked to ARs. In the winter (>20%) and spring (>13%), ARs are more representative in the WB of the Upper Nechako, Stellako and Upper Stuart sub-basins, which share mountainous terrain and form the western and northern portion of the NRB. The Chilako and Lower Nechako, which make up the central and southeastern parts, are less influenced by ARs during all seasons except summer.

"The fall stands out as the season with the most contribution of atmospheric rivers to the water budget."

During the summer, the Lower Nechako and Lower Stuart show a slightly higher contribution of ARs to their WB than the Upper Nechako and Upper Stuart. This may be linked to the northwest-southeast direction of ARs that hit the NRB, particularly in the late summer, when AR activity is higher in the coastal northwest BC. The WB of the Stellako (26%) shows greater dependence on ARs throughout the year compared to an average AR contribution of 23% to the WB of the entire NRB. In sum, the WB of the NRB seems considerably affected by AR-related precipitation, with ~1 in every 4 drops of water linked to AR activity.

These results confirm the significance of ARs to the regional WB and the importance of better understanding regional AR events.

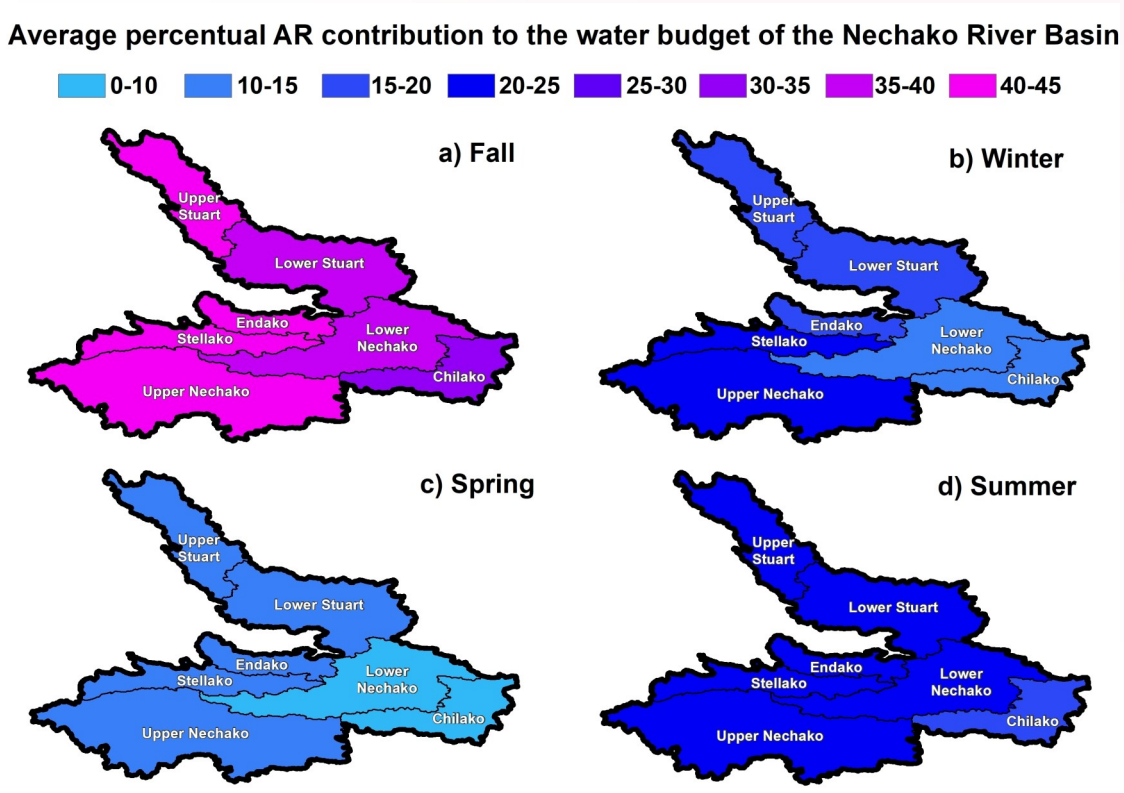

Figure 9. Average seasonal atmospheric river contribution to the water budget of the Nechako River Basin.

Data Management Update
Justin Kokoszka

Our data NHG database has been operational since July of 2022! The database allows our field crew to keep detailed records for each site visit including information associated with data downloads, equipment records, and site maintenance. This allows our team to preserve the legacy of data collected during the IRC and ensure accessibility of data for those who are interested.

Since the release of the database our crew has managed to inventory 226 pieces of equipment and record 52 separate field sites across Northern British Columbia including active and historical sites.

Our data management team continues to improve and develop the database including the compilation of historical data, data collected during the TRARE campaign, and preparation for data collected during the MECHE program.

New Project Announcement
Floodplain Mapping

UNBC's Northern Hydrometeorology Group (NHG) is pleased to announce its involvement in a new project to develop floodplain mapping along the lower Nechako River and the upper Fraser rivers. The project is led by Associated Engineering with collaborators from both the University of Saskatchewan and UNBC.

Fraser Basin Council is administering the project on behalf of the Province of British Columbia (BC) with funding support from BC and the Government of Canada. Through a series of projects, the Province aims to identify flood hazards throughout BC including the lower Nechako and upper Fraser rivers with a particular focus on cities, towns and First Nations communities with higher flood risks.

A key aspect of this effort is to project potential peak flows and critical flood conditions under the influence of climate change and the watershed's complex hydrology. Past flood events along both river reaches have occurred during open water and ice-covered conditions. Potentially critical conditions include current and future peak flows that could occur under naturalized flow conditions.
The system is also affected by Rio Tinto's water management operations through water retention in the Nechako Reservoir and water releases at the Skins Lake Spillway and through to the Kemano Powerhouse. The project will make use of hydrological simulations conducted with the Variable Infiltration Capacity (VIC) model spanning 1950-2100 from UNBC along with regulation scenarios from Rio Tinto. Furthermore, ice influences and other natural and anthropogenic impacts such as forest fires, pest infestations, and land use activities will also be considered.

"A key aspect of this effort is to project potential peak flows and critical flood conditions under the influence of climate change and the watershed's complex hydrology."

The ultimate deliverable will be high-quality, detailed flood maps, for a variety of return periods and flow conditions for vulnerable communities along the upper Fraser and lower Nechako rivers. A community engagement plan will also be initiated in December 2022 to learn from community partners about their interests in the project and to keep interested parties informed of project progress and findings.

Associated Engineering · University of Saskatchewan · UNBC · Rio Tinto

Outreach Update
Justin Kokoszka

Although the fall season has been chilly, our team continues to advance our outreach goals!

Stephen continues to participate in the bi-weekly meetings of the Technical Working Group of the Water Engagement Initiative. Both Stephen and Justin attended the Nechako Watershed Roundtable Fall Meeting, which provided a great opportunity for networking! We have also been busy collaborating with the Cheslatta Carrier Nation and Huckle Berry Mine regarding future deployments of monitoring equipment.

Both Stephen and Bruno delivered four guest lectures in Geography and Environmental Science courses at UNBC in which IRC research was heavily profiled. Furthermore, Stephen provided two media interviews including: 'How the Kenney Dam broke the Nechako River' (The Tyee) as well as 'Current warm, dry spell in northern BC' (CKPG News).

Last but not least, our team published a video in collaboration with the UNBC media team. The video 'Tahtsa Ranges Atmospheric River Experiment - Preliminary Modeling' describes our preliminary modeling efforts associated with last year's TRARE campaign.

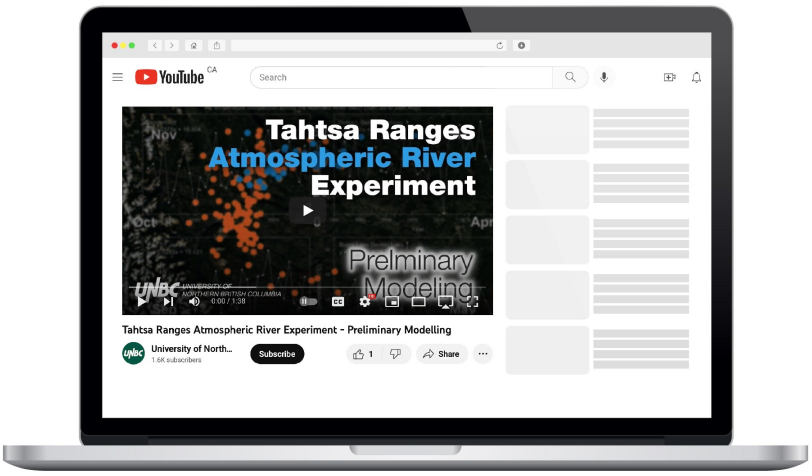

Figure 10. Tahtsa Ranges Atmospheric River Experiment - Preliminary Modeling 13, Oct 2022

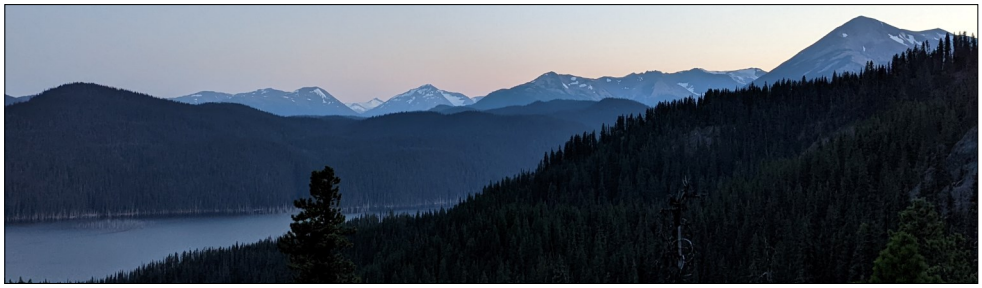

Figure 10. View of the Tahtsa Ranges.

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