UNIVERSITY OF NORTHERN BRITISH COLUMBIA

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NHG

The Nechako IRC Newsletter

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An update from Dr. Stephen Déry, Project Leader

Autumn is already coming to an end after an unprecedented stormy season! Recent weather reports had ominous terms like 'bomb cyclones', 'atmospheric rivers', and even a waterspout/tornado in Vancouver! The mid-November atmospheric river was particularly destructive, washing out major highways and rail lines. This caused havoc on transportation across the southern half of the province further disrupting the supply chain in northern BC and the remainder of Canada. Major flooding and washouts associated with the mid-November storm caused five fatalities and the loss of countless farm animals. Quite unfortunately, this may well end up being the costliest natural disaster in Canadian history as flood waters recede and the cleanup and repairs begin. While the upper Nechako did not experience such extreme conditions, several major storms dumped copious amounts of precipitation leading to localized flooding, particularly along the Pacific Coast this autumn. The IRC team at UNBC was, however, well prepared for the inclement weather and poised to collect detailed storm measurements during the Tahtsa Ranges Atmospheric River Experiment (TRARE) held in September and October.

Indeed, we had a full crew of researchers and graduate students based at Huckleberry Mine and at Nadina Lake Lodge over two months to collect meteorological and hydrological data during atmospheric rivers, perhaps better known as Pineapple Express storms. In this newsletter, you will therefore find Kelly Hurley's summary of the TRARE field campaign, information on the data collected and some of the storms that impacted the upper Nechako Watershed. In particular, Anna Kaveney and Derek Gilbert report on the terrestrial hydrological response to the 21 September atmospheric river that impacted the TRARE study area, while Bruno Sobral describes the 24 October bomb cyclone that affected a vast stretch of North America's western coast. The newsletter also includes a brief overview of climate change projections for the Nechako Watershed by Jingwen Wu and Rajtantra Lilhare. Finally, Jeremy Morris summarizes recent activities within the group in his role as research manager.

Undertaking such an intensive field campaign required much planning and preparation, plus hard work by a dedicated team of personnel. First and foremost, sincere thanks to Kelly Hurley who, as TRARE project manager, oversaw the entire field campaign from the early planning stages in October 2020 to the successful completion of our massive data collection efforts. Kudos as well to the entire team of researchers and graduate students who took storm measurements, often during nightshifts, and assisted with field work across the upper Nechako Watershed. We express our deep gratitude to our colleagues from the Université du Québec à Montréal (UQAM) who loaned meteorological equipment and provided staff support for TRARE, while McGill University provided additional instrumentation. We are most grateful to our industry partner, Rio Tinto, for logistical support allowing us to add study sites both at Kemano and Skins Lake Spillway. The staff at both Huckleberry Mine and at Nadina Lake Lodge also greatly facilitated our extended stays in the remote reaches of the upper Nechako Watershed, while the Fisheries and Oceans Canada staff at the Nadina River Spawning Channel provided an ideal site for deployment of a meteorological station. We are also much indebted to the Cheslatta Carrier Nation for collecting additional precipitation data over the course of the field campaign.

We now begin our data analysis efforts and will continue to report on our findings from TRARE in future issues of the Nechako IRC Newsletter. In the meantime, we look forward to the winter season and the arrival of snow for outdoor recreation. The IRC team at UNBC wishes one and all very Happy (and safe!) Holidays! We hope 2022 will bring everyone good health and prosperity, and we look forward to more interactions in person as we pursue our study on the changing Nechako Watershed.
Season's Greetings and Happy Holidays!

Stephen Déry

Inside this issue

Special points of interest

- TRARE debrief
- Climate change in the Nechako
- Stellako River Historical Discharge
- Farwell to RM

NHG Snowman, AKA Ancient Forest weather station on 18 Nov 2021.

Research Manager Update

Jeremy Morris

With the TRARE Project finished I am grateful to be back in Prince George to catch up on NHG tasks outside of the Upper Nechako. We have been catching up with site visits in the immediate area to reestablish cell modem communications with several climate stations and prepare them for winter. We are very grateful to our part-time research skills trainee, Spencer Woyke, for conducting a visit to four stations in the Quesnel Lake area. Spencer successfully collected at three stations on the Lake, connected remotely to our mountaintop station, and prepared our Geonor all weather precipitation gauge at Quesnel River Research Centre for snowfall.

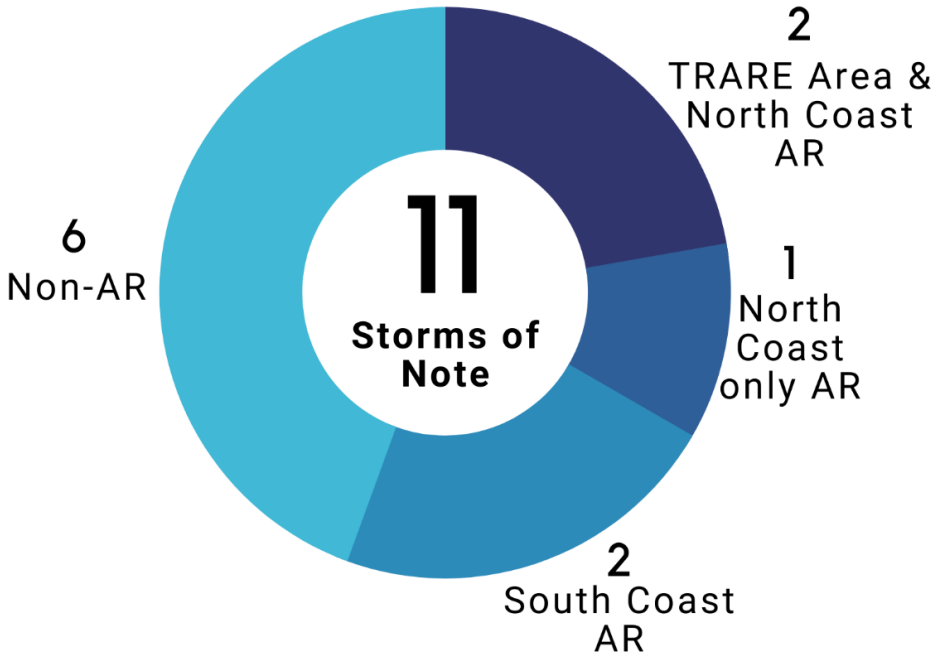
Going into winter time, field work is winding down in the research group and a number of members are working on the data amassed during TRARE in preparation for publication. While that goes on I will be working to transition my role to the next Research Member, who will be introduced in the next newsletter. In addition to handing over this role we will be working to transition NHG station data to UNBC's Nechako Portal, a database system that will allow for development of a website through which data can be viewed by the public. In addition we are working to publish climate data amassed over the last three years through NHG's network of climate stations.

This will potentially be my last major entry as RM for the IRC, I am so grateful for the opportunity to have worked in the Nechako Watershed so much. I hope to remain engaged in the watershed through my connections with UNBC going into the future. Many thanks to all of those who have put up with my many requests throughout the region, this project would not be possible if not for the local support.

TRARE Wrap Up

Kelly Hurley

After a safe and successful field campaign for the Tahtsa Ranges Atmospheric River Experiment (TRARE), many of us are tired, but proud of our work. Although the data analysis is yet to begin, here are some metrics to sum up the TRARE field campaign. Thank you to every volunteer and collaborator who helped make this project a tremendous success!



15

Field Sites

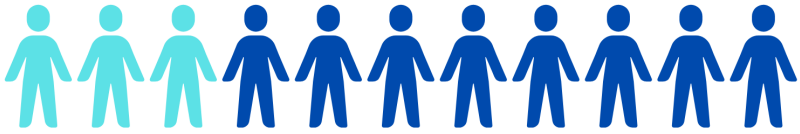
Total Precipitation at Huckleberry Mine during TRARE

250

mm

11

Participants



Women

Men

59

Field Days

Animal Sightings

75

Gigabytes of Data Collected

Atmospheric Rivers during the TRARE Campaign

Anna Kaveney & Derek Gilbert

Throughout the Tahtsa Ranges Atmospheric River Experiment (TRARE) field campaign, we had the opportunity to take stream discharge measurements using a FlowTracker (kindly lent to us by Kirsti Fairweather and the Water Survey of Canada). We collected data on streamflow, water temperature and water level at two locations in the Nechako Watershed, Rhine and Whiting Creeks. The FlowTracker measures streamflow by tracking the area of the river, depth of water and velocity of water. The FlowTracker utilizes these parameters to calculate the rate at which water passes through a stream channel, measured in cubic meters per second (m^3s^{-1}). The actual collection of these measurements involved wading in a stream for about an hour in a variety of weather conditions, including one particularly chilly snowstorm.

On 20-21 September 2021, the TRARE area was hit by the first atmospheric river (AR) of our field campaign. This AR event brought in over 60 mm of precipitation (Figure 1), which led to a significant rise in water levels (Figure 2) and discharge in our study creeks. The water levels depicted in Figure 2 belong to Whiting Creek and Rhine Creek which deliver water to the Tahtsa Reach in the Nechako Reservoir. Water level measurements were obtained from Odyssey water level loggers that recorded the water level at 5 minute intervals throughout the TRARE campaign.

Our experience during the TRARE campaign was one for the books, filled with lots of hands on fieldwork, data analysis, gorgeous views, and lots of interaction and collaboration with the surrounding communities. We learned so much about these impressive weather events and are looking forward to working with all the data collected over the course of the TRARE campaign.

Photo: Climate equipment at Huckleberry Mine after a dusting of snow.

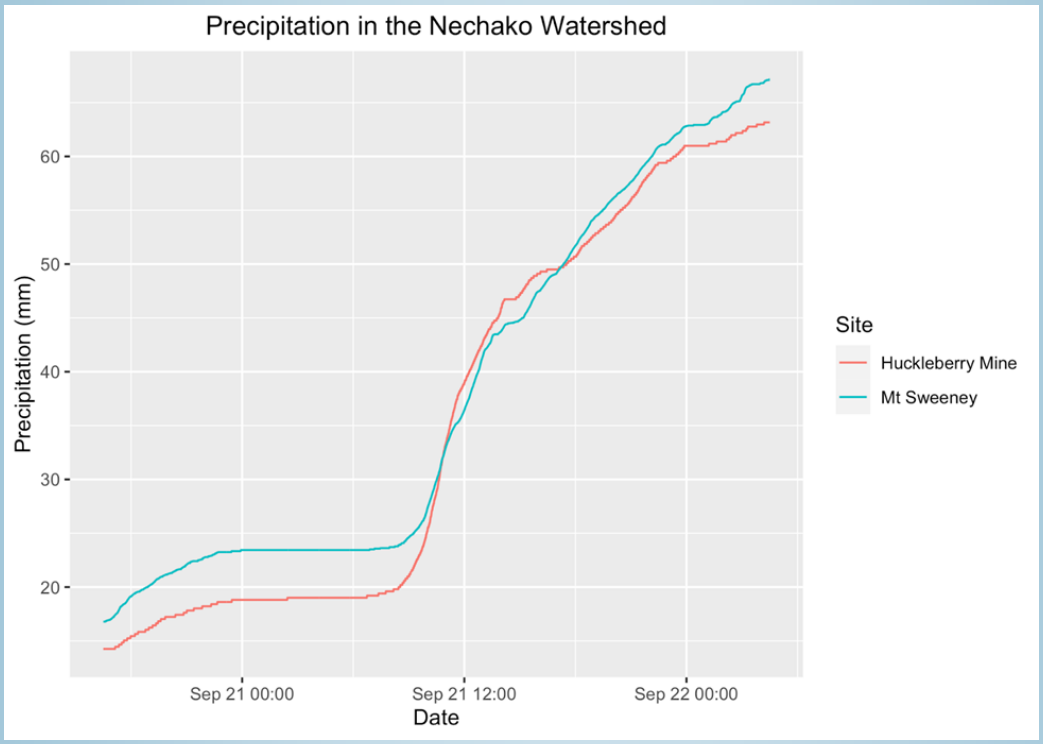


Figure 1: Sample of atmospheric conditions during the first atmospheric river to make landfall in the TRARE study area.

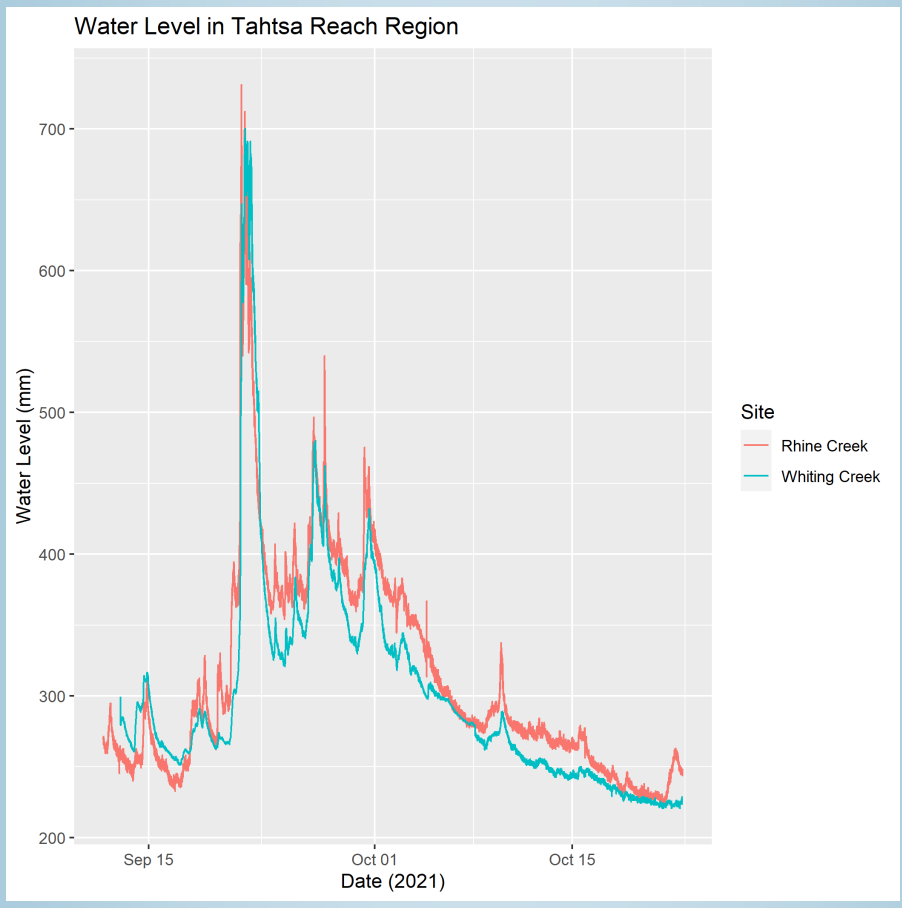


Figure 2: Water levels of Whiting Creek (01MS001) and Rhine Creek (01MS002) for the entirety of the TRARE field campaign. The first large pulse (400-700 mm) indicates the conditions of the creeks during the first AR event

Bomb Cyclone

Bruno Sobral, PhD Candidate

In the final days of the TRARE field campaign, more precisely on the 24th of October, the Pacific Northeast region experienced an exceptional storm categorized as a “bomb cyclone”. This mid-latitude bomb cyclone rapidly intensified through a persistent stream of atmospheric rivers that hit the coast of western North America. This rare type of cyclone is named after a process known as “bombogenesis” or “explosive cyclogenesis”, in which the low-pressure area of a mid-latitude cyclone deepens rapidly. To be classified as a bomb cyclone, a storm requires its central pressure to drop by at least 24 hectoPascals (hPa) in 24 hours or less, while this event dropped an astonishing 45.5 hPa in one day! At its peak, this was the deepest low-pressure system (central sea-level pressure of 942.5 hPa) ever recorded for the region and followed the third-deepest low-pressure (central sea-level pressure of 951 hPa) storm registered just three days before, on October 21st.

These meteorological conditions caused very intense precipitation in a short period, causing floods, mudslides and power outages in many regions of western North America. It was one of the largest cyclones ever seen in the region and the footprint left by strong precipitation and winds was felt from British Columbia to California. In British Columbia, adverse impacts were felt mainly in the Lower Mainland and Sunshine Coast regions as rain, and with less intensity as snow, in the interior central region of the province. This record-breaking event is an example of how atmospheric rivers can enhance meteorological phenomena and the resulting impacts, aside from causing copious orographic precipitation amounts in mountainous areas.

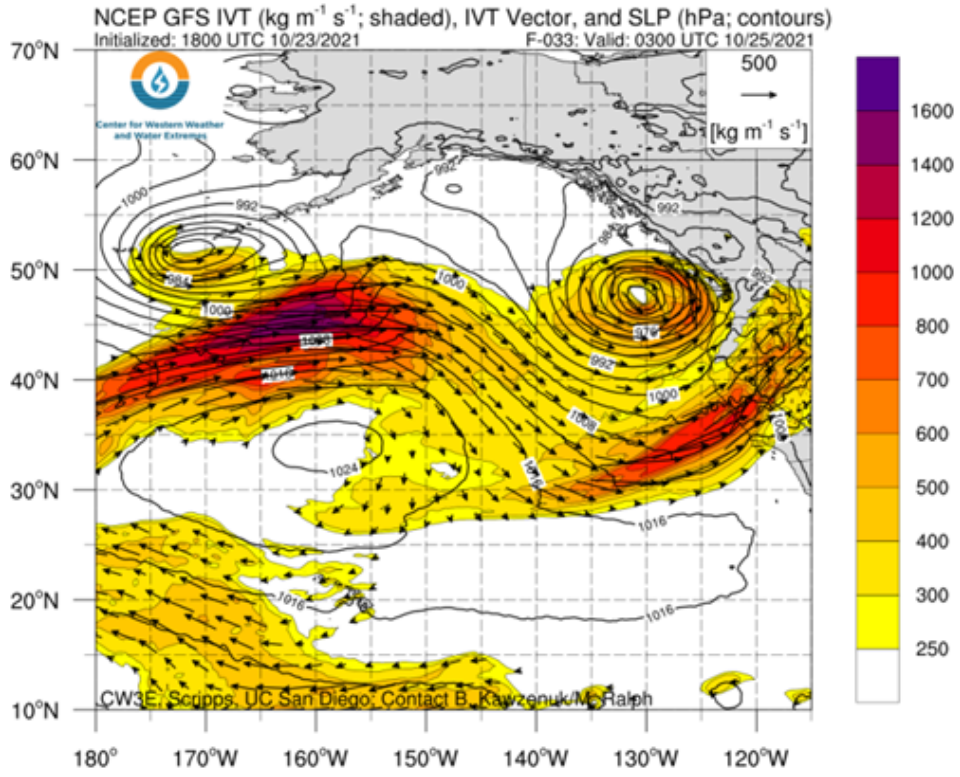


Figure 3: Model for integrated water vapour (IVT) conditions over the North Pacific Ocean for the bomb cyclone on 25 October 2021. Black continuous lines represent lines of equal sea-level pressure. Arrows represent wind direction and intensities while the colors represent the thresholds of IVT estimated by the model. Southwest of BC, near coordinates (50N, 130W), is the formation of the record-breaking bomb cyclone.

Future changes in precipitation and air temperature across the Nechako Watershed

Rajtantra Lilhare & Jingwen Wu

In this section, we investigate the projected changes in total annual precipitation and mean air temperature for the near future (2030s: 2021–2050) across the Nechako Watershed. For this analysis, we collected projected climate data from several climate models and calculated average changes in precipitation and air temperature for the next 30 years (2021–2050) with respect to the historic climate (1990s: 1981-2010). Previous studies have shown that the mean air temperature has increased over the Nechako Watershed by more than 1°C during the last several decades, and subsequently, water temperatures have warmed across the Nechako. Our analyses indicate that the Nechako Watershed may face warming of ~1.2°C whereas the upper and lower Nechako may experience drier and wetter climatic conditions in the 2030s, respectively (Figures 1a and 1b). Despite the warming future conditions, the lower Nechako Watershed will experience a wetter climate with a 5-10% increase in projected annual precipitation during the 2030s. It is projected that under a robust greenhouse gas emission scenario, the Nechako Watershed may experience 2% and 39% increase in total precipitation and rainfall, respectively; conversely, snowfall may decline by 37% during the 2030s. These changing conditions in precipitation and air temperature influence the water cycle and play a crucial role in the hydrology of the watershed. Therefore, we were interested in investigating precipitation and air temperature changes over the watershed as many previous research suggests that they are primarily responsible for affecting seasonal flows, river water temperature, early snowmelt, and spring freshets.

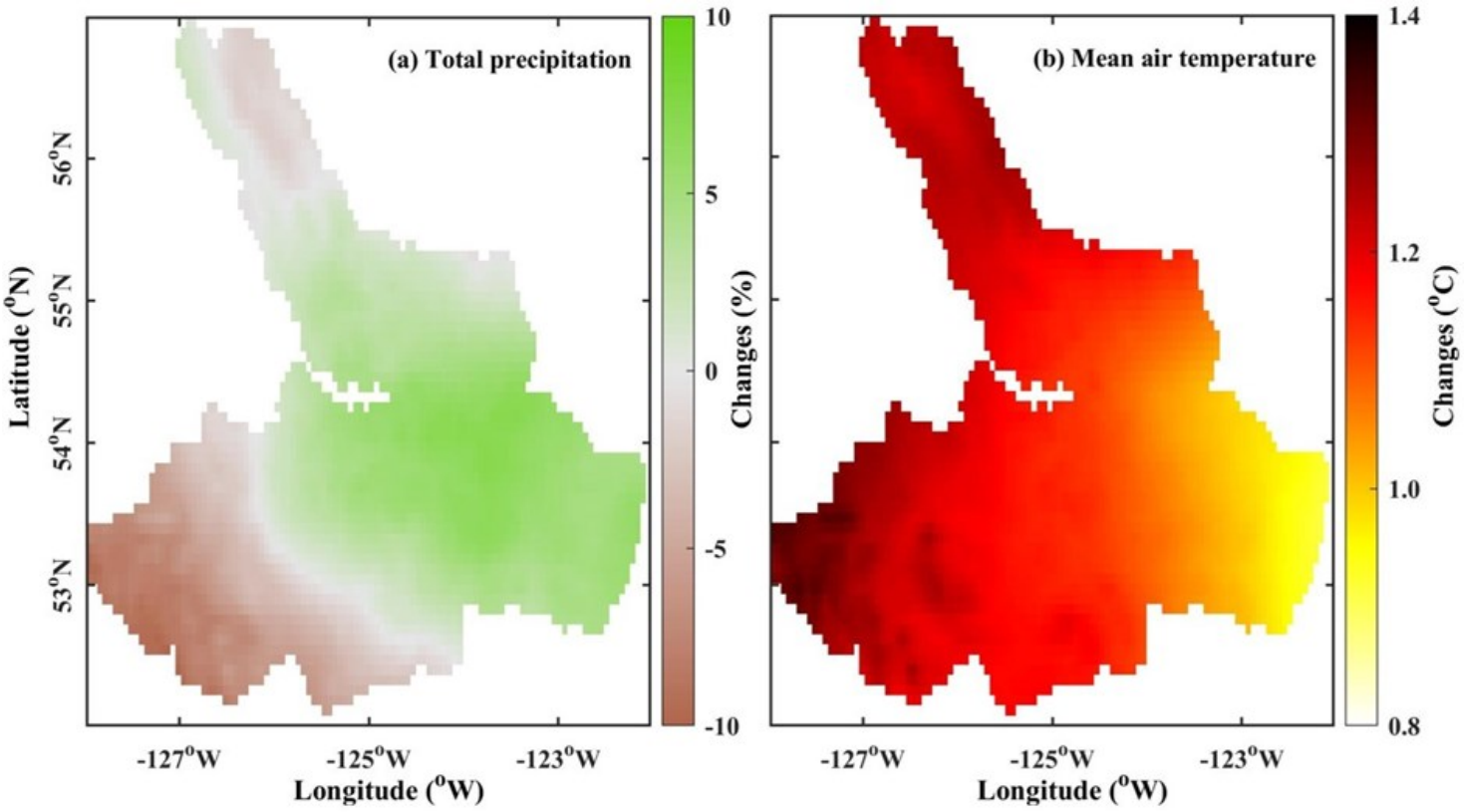


Figure 3: Future changes (2050s-1990s) in the spatial distribution of mean annual (a) total precipitation (%) and (b) air temperature (°C) across the Nechako Watershed for a robust greenhouse gas emission scenario.

Farewell to Research Manager Jeremy Morris

The Northern Hydrometeorology Group (NHG) is saddened to announce the imminent departure of Jeremy Morris who has fulfilled the role of our team's Research Manager (and recently Outreach Coordinator as well) for the past couple of years. Jeremy joined the NHG as a field assistant in May 2018 and rapidly learned how to operate the meteorological equipment we maintain across northern BC. Subsequent to this position, he undertook a Master's degree starting in January 2019, which he successfully completed in summer of 2021. Since then, Jeremy has worked as full-time Research Manager and spent considerable time in the upper Nechako Watershed for the TRARE field campaign.

Jeremy's dedication to his work, strong leadership skills and gregarious personality will leave a big hole in the team when his position comes to an end in late February 2022. We are, however, incredibly grateful for everything he's achieved since joining the NHG and we wish him all the best in his future endeavours. Jeremy will transition from part-time to full-time employment at Environmental Dynamics in Prince George, so we expect to still encounter him on a regular basis. All the best Jeremy!

Climate Station at Nadina Spawning Channel before its removal at the end of TRARE.

Aleza Lake Research Forest climate station on 18 November 2021 during a field visit.

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Outreach Coordinator Update

Jeremy Morris, Outreach Coordinator

Presentations

- 2021/11/17—Jeremy delivered a "Lunch and Learn" presentation to EDI in Prince George outlining IRC research and an overview of Atmospheric Rivers

Extension and Outreach

- 2021/11/08 – Stephen delivered a guest lecture in Geography 416 ("Mountains") at UNBC during which he reported on the TRARE field campaign and other IRC-related research
- 2021/11/19 – Stephen gave another guest lecture, this one in ENSC 111 ("Introduction to Environmental Science") at UNBC that provided an overview of IRC-related research including the TRARE field campaign

Participation in Stakeholder Groups

- 2021/11/17 – Stephen and Jeremy participated in the Nechako Watershed Roundtable's annual meeting.
- 2021/11/24 – Stephen gave a presentation on TRARE to the Water Engagement Initiative's main table.

Annual IRC Report

- The final draft of the 2020/2021 Annual Report for the IRC is now available on the IRC website. Click here to view

Interactions with Media

- 2021/09/28 - The Tahtsa Ranges Atmospheric River Experiment (TRARE), Daybreak North, CBC Radio. Click here to listen
- 2021/11/16 – Stephen gave an interview to a Postmedia reporter on climate change impacts in northern BC. Click here to view
- 2021/11/19 – Stephen gave an interview to the Radio-Canada program "Les Années Lumières" on the recent atmospheric river event in southern BC. Click here to view
- 2021/11/22 – Stephen gave an interview to Radio-Canada (in French) to explain the atmospheric river phenomenon
- 2021/11/23 – Stephen participated in an interview on Daybreak North, CBC Radio to explain atmospheric rivers and their recent impacts in BC

UNBC Media Videos on Social Media

- Youtube—What are Atmospheric Rivers?
- Facebook —Nechako Watershed temperature monitoring