Gap Analysis and Overview of Weather Station Data in British Columbia Agricultural Regions

Gap Analysis and Overview of Weather Station Data in British Columbia Agricultural Regions

September 2018

AUTHORS:

Stephanie Tam, P.Eng.
Water Management Engineer
B.C. Ministry of Agriculture
Innovation and Adaptation Services Branch
Abbotsford, B.C.
(Responsible for Overall Report Write-up)

Faron Anslow, Ph.D.
Lead
Climate Analysis and Monitoring
Pacific Climate Impacts Consortium
Victoria, B.C.
(Responsible for Section 4 and Appendix)

Funding for the weather data gap analysis portion (Section 4 and Appendix) of this project has been provided by *Growing Forward 2*, a federal-provincial-territorial initiative.

DISCLAIMER

The data that is presented in this report provides the best estimates. While every effort has been made to ensure the accuracy and completeness of the information, the information should not be considered as final. The Governments of Canada and British Columbia are committed to working with industry partners. Opinions expressed in this document are those of the authors and not necessarily those of the Governments of Canada and British Columbia.

Acknowledgement

This project was initiated and coordinated by the British Columbia Agricultural Climate Adaptation Research Network (ACARN). The network is a collaboration between academic, government and industry groups, and works closely with the B.C. Agriculture and Food Climate Action Initiative to enhance climate change adaptation research and extension strategies for the agricultural sector in the Province of British Columbia.

BC Agricultural Climate Adaptation Research Network

The authors would like to acknowledge the collaborative work of the project steering committee which comprised of the following individuals:

Project Coordinator:

Jason Lussier	B.C. Agricultural Climate Adaptation Research Network	Network Coordinator

Project Steering Committee:

Andy Black	University of British Columbia	Professor, Biometeorology and Soil Physics
Serena Black	University of Northern British Columbia	Researcher
Nathaniel K. Newlands	Agriculture and Agri-Food Canada	Research Scientist, Summerland
Rishi Burlakoti	Agriculture and Agri-Food Canada	Research Scientist, Agassiz
Shabtai Bittman	Agriculture and Agri-Food Canada	Research Scientist, Agassiz
Emily MacNair	B.C. Agriculture and Food Climate Action Initiative	Manager

The authors also would like to thank the following individuals for their time to review (full or parts of) the report, and/or for their valuable comments:

Michelle Cook	Okanagan-Kootenay Sterile Insect Release Program	Project Manager
Joshua Espiritu	B.C. Ministry of Agriculture	Co-op Student
Andrew Petersen	B.C. Ministry of Agriculture	Water Management Specialist
Mark Raymond	B.C. Ministry of Agriculture	Manager
Ted van der Gulik	Partnership for Water Sustainability in British Columbia	President

Executive Summary

The British Columbia Ministry of Agriculture (AGRI) collaborated with Agriculture and Agri-Food Canada (AAFC) and Pacific Field Corn Association (PFCA) to launch a website called Farmwest.com in 2001 to provide real-time weather information for free to farmers, irrigators and researchers in British Columbia. To date, Farmwest is linked to the federal, provincial and private weather networks with over 300 stations across Canada, of which over 150 stations are within B.C. including 18 agricultural stations. A number of decision tools have been developed on Farmwest utilizing the weather data collected, e.g., evapotranspiration, corn heat units, growing degree days, and pest degree days, all publicly available to help farmers to make informed decision in managing our natural resources.

AGRI and Farmwest are part of the Climate Related Monitoring Program (CRMP) which is an initiative led by BC Ministry of Environment in 2010, in collaboration with the federal government (Environment and Climate Change Canada), provincial agencies (Ministries of Agriculture, Forests, Lands, Natural Resource Operations and Rural Development, and Transportation), private organizations (BC Hydro, and Rio Tinto Alcan), and a non-profit organization specializing in climate data (Pacific Climate Impacts Consortium). The objective of the CRMP is to integrate all federal, provincial, municipal and private weather station networks into a single network for BC, including a standardized data quality control protocol, a centralized data processing system, and a data-sharing web portal publicly available. The CRMP group shares a common interest in meteorological monitoring and environmental quality management, dissemination of environmental information, and promoting science-based decisions, and creating a climate data set with transparent data sharing to enhance understanding of the scope of climate change and climate variability within B.C.; thereby, providing long-term public benefits for British Columbians.

There are a number of non-profit agricultural organizations that strive to collaborate within the industry to advance climate change prediction and develop resilience strategies using weather station networks. These organizations include the British Columbia Agricultural Climate Adaptation Research Network (ACARN), Okanagan-Kootenay Sterile Insect Release (SIR) program, Pacific Field Corn Association (PFCA), Irrigation Industry Association of British Columbia (IIABC), and Partnership for Water Sustainability in British Columbia (PWSBC).

Real-time weather information and forecast help farmers manage their irrigation water use and predict what the supply will be, pest disease in orchards and berries, manure and pesticide application, animal production and welfare. Weather information also helps to prepare and response to air-borne disease outbreak, drought, flooding, and wildfire management. Climate change adaptation is a long-term commitment where weather stations provide the data necessary to assess climate change impacts and develop climate change adaptation strategies for agriculture.

B.C. is only 50% food self-reliant. With increased population growth and climate change, B.C. needs to become more self-reliant. The Province of B.C. requires improved monitoring of weather stations to support crop and livestock growth, improve food security for British Columbians, and strengthen the capacity of B.C. agricultural sector for local and international markets.

Acronyms

AAFC	Agriculture and Agri-Food Canada
ACARN	British Columbia Agricultural Climate Adaptation Research Network
AEPI	Agriculture Environment Partnership Initiative
AGRI	British Columbia Ministry of Agriculture
ALR	Agricultural Land Reserve
ALUI	Agricultural Land Use Inventory
ARDCorp	British Columbia Agricultural Research and Development Corporation
AWDM	Agriculture Water Demand Model
B.C.	British Columbia
BCAC	British Columbia Agriculture Council
BCFC	British Columbia Forage Council
BCTF	British Columbia Tree Fruits Corporation
BMP	Beneficial Management Practices
BRMB	Business Risk Management Branch
CAP	Canadian Agricultural Partnership
CBCWSEP	Canada British Columbia Water Supply Expansion Program
CRD	Capital Regional District
CRMP	Climate Related Monitoring Program
ECCC	Environment and Climate Change Canada
EFN	Environmental Flow Needs
EFP	Environmental Farm Plan Program
EMBC	Emergency Management of British Columbia
ENV	British Columbia Ministry of Environment and Climate Change Strategy
ET	Evapotranspiration
DAS	Decision-Aid System
FLNR	British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FVRD	Fraser Valley Regional District
GF	Growing Forward
GF2	Growing Forward 2
GS	Grower's Supply Co.
IAF	Investment Agriculture Foundation
IIABC	Irrigation Industry Association of British Columbia
MSC	Meteorological Service of Canada
MV	Metro Vancouver
NA	Not Applicable
NoN	Network of Networks
OBWB	Okanagan Basin Water Board
PCDS	Provincial Climate Data Set
PCIC	Pacific Climate Impacts Consortium
PFCA	Pacific Field Corn Association
PRFSA	Peace Region Forage Seed Association
PWSBC	Partnership for Water Sustainability in British Columbia
SCC	Standards Council of Canada
SIR	Sterile Insect Release
TRAN	British Columbia Ministry of Transportation
WSA	Water Sustainability Act
WSU	Washington State University

Table of Contents

List of Figures

List of Tables

1. Introduction

Enhancing weather data accuracy in agricultural regions of British Columbia (BC) is critical for supporting crop production and mitigating risk due to climate change. These data are determined by weather stations which have sensors capable of detecting precipitation, temperature, wind speed and direction, humidity, leaf wetness, and solar radiation. In addition to providing a baseline for climate projection models, accurate weather data is useful for developing decision-support tools which assist farm management practices such as irrigation, pest, manure/nutrient application, crop harvest and variety selection. Historical climate data can be compiled to provide important information on crop phenology, pest biology and water management in agricultural systems.

There are at least a dozen of weather station networks in the Province that are currently operated individually by various municipal, provincial and federal agencies, producer groups, private companies and individuals. The B.C. Ministry of Agriculture (AGRI) is currently utilizing weather data from 132 stations in these networks to supplement the existing 18 stations AGRI owns. The data is provided to the sector on Farmwest.com website.

Many of the weather stations from the partnering networks to Farmwest are located in non-agricultural areas. They are located where the organization specializes their work activities, and therefore not useful for agricultural purposes due to extremely high elevation or outside the agricultural areas.

Farmers require weather stations to be located on or close to agricultural lands. The weather information collected from the stations will be representative of the climate where agricultural activities occur; and therefore suitable for producers to make informed decisions.

1.1 Objective

The objective of this project is to provide a province-wide analysis of weather station data usage and spatial distribution of existing weather stations in agricultural regions, and to recommend steps to enhance weather station networks for supporting climate change adaptation and mitigation for the agricultural sector.

1.2 Deliverables

The project is intended to:

1. Identify current and future usage of weather station data, challenges and barriers for using the data in the B.C. agricultural industry
2. Assess the distribution and types of weather data monitored in major agricultural regions in B.C.

3. Evaluate the collection, robustness and security of data, and explore methods for enhancing the quality control of weather data
4. Identify strategies to improve the accuracy, accessibility and application of weather data at the regional and provincial level to enhance climate change adaptation.

1.3 B.C. Ministry of Agriculture's Initiative

This project aligns with the *Ministry's Service Plan 2018/19 to 2020/21*,

> ***Ministry's Service Plan***
>
> *Objective 1.5: Support Climate Adaptation and Mitigation*
>
> *"To increase agriculture sector capacity to maintain competitiveness, manage risks, enhance productivity and contribute to economic growth through action on climate change and increasing environmental sustainability."*

The key strategies that align to this project are to work with industry, local governments, research organizations, and other government agencies, and support the development and adaptation of environmental and climate change adaptation and mitigation practices, processes, technologies and infrastructure.

1.4 Pacific Climate Impacts Consortium (PCIC)

Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that conducts studies on the impacts of climate change and climate variability in the Pacific and Yukon region. Results from this work provide regional climate stakeholders with the information needed to develop plans for reducing the risks associated with climate variability and change. PCIC plays an important bridging function between climate research and the practical application of that knowledge by decision makers. PCIC's applied research program is focused on hydrologic impacts, regional climate impacts, and climate analysis and monitoring.

1.5 B.C. Agricultural Climate Adaptation Research Network (ACARN)

The B.C. Agricultural Climate Adaptation Research Network (ACARN) was formed in May 2017 to improve linkages among agricultural researchers, industry specialists, policy-makers, and producers from across the Province. The aim of the network is to be a provincial hub that fosters a collaborative approach for agricultural climate change adaptation research and extension strategies in British Columbia.

2. Weather and Climate Initiatives

There have been a number of initiatives concerning weather and climate data at all levels of government.

2.1 Farmwest

Farmwest.com is a website launched in 2001 to provide weather and climate information as well as a number of decision-support tools to the agricultural sector for free. The website is made possible and continues to grow with the partnership of Pacific Field Corn Association (PFCA), Agriculture and Agri-Food Canada (AAFC), and AGRI.

Farmwest is linked to 397 weather stations across Canada from federal, provincial, municipal and private weather station networks, among which 179 weather stations are in B.C. including 46 stations set up specifically on agricultural lands (*Figure 1*).

1. **Federal Government**
   - 49 Environment and Climate Change Canada (ECCC)
2. **Provincial Government**
   - 46 B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNR)
   - 24 B.C. Ministry of Transportation (TRAN)
   - 26 B.C. Ministry of Agriculture (AGRI)
3. **Municipal Government**
   - 11 Metro Vancouver (MV)
4. **Non-Profit Organization**
   - 3 Okanagan Basin Water Board (OBWB)
5. **Private Networks (Agricultural Stations)**
   - 20 Grower's Supply Co. (GS)

Since the inception of Farmwest, a number of decision-support tools have been developed on Farmwest that integrate weather data for:

1. Temperature monitoring of extreme high and low temperatures to advocate for animal welfare and production quality (e.g., milk production)
2. Pest degree days for pest disease management in orchards and berries
3. Wind condition for pollination, manure spreading, pesticide spraying, emergency response of air-borne disease outbreak, e.g., avian influenza
4. Growing degree day and corn heat unit to predict the number of days that corn and other crops will reach maturity and ready for harvest
5. Evapotranspiration calculator for scheduling irrigation

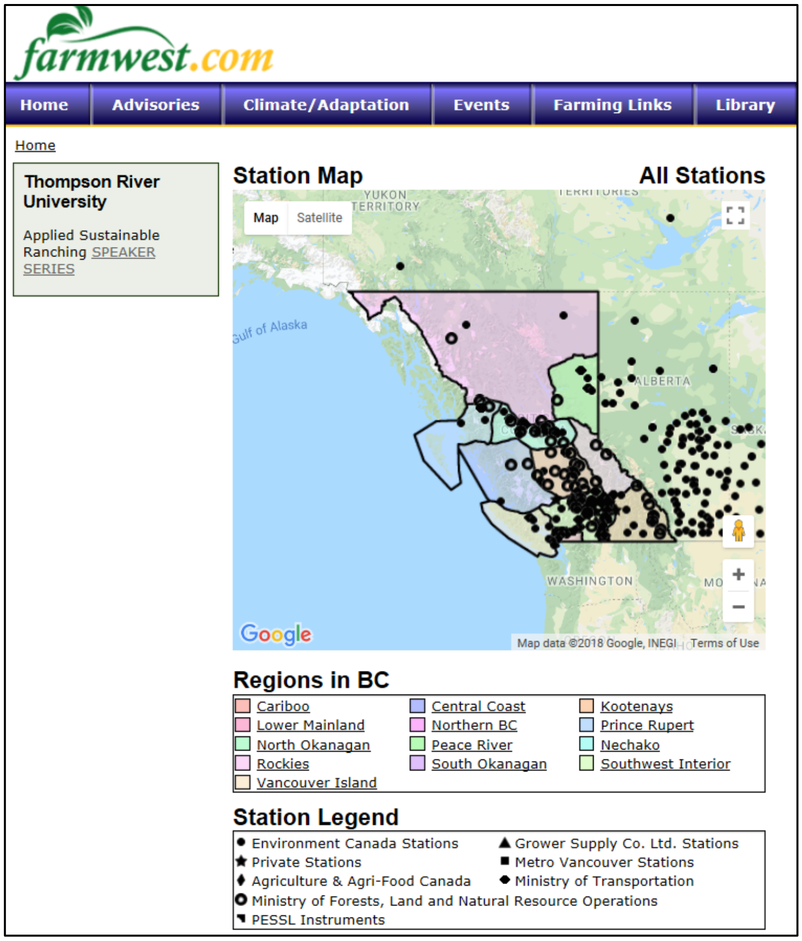

Figure 1. Farmwest Weather Station Map

Farmwest has historically been receiving sponsorship from a number of provincial government agencies and industry associations. Currently, only the Irrigation Industry Association of British Columbia (IIABC) provides $1,000 per year to support the operation, administration and maintenance of the website.

Over the years, Farmwest has gone through a complete redesign of the website, integration of additional provincial networks into Farmwest database, upgrades of the website functionality, as well as the addition of a mobile capable version of the entire website. The majority of the funding came from AGRI base budget to start up the website, and later from a number of provincial-federal-territorial funding programs, i.e., Canada-British Columbia Water Supply Expansion Program (CBCWSEP), Growing Forward (GF), and most recently Growing Forward 2 (GF2).

AGRI is the only provincial government agency which has a weather station network to serve farmers but has not established an annual operational budget contributing to the network. Weather data is used for many of the long-term agricultural and climate related initiatives that AGRI commits to in the Ministry's Service Plan and other strategic plans.

2.2 Climate Related Monitoring Program (CRMP)

There are many weather station networks like Farmwest in the Province, each operating on their own. Each network has their own data processing protocol, and stations within close proximity to stations in another network. To streamline all the networks in the Province, ENV initiated the Climate Related Monitoring Program (CRMP) in 2010, in collaboration with all levels of government and organizations. An MOU with no financial commitment has been signed by the following partners:

1. **Federal Government**
   - Environment and Climate Change Canada (ECCC)
2. **Provincial Government**
   - Ministry of Agriculture (AGRI)
   - Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (FLNR)
   - Ministry of Transportation (TRAN)
3. **Municipal Government**
   - Capital Regional District (CRD)
   - Metro Vancouver (MV)
4. **Crown Corporation**
   - BC Hydro
5. **Private Company**
   - Rio Tinto Alcan
6. **Non-Profit Organization**
   - Pacific Climate Impacts Consortium (PCIC)

The objectives of the CRMP are to:

- Integrate all federal, provincial and private weather station networks within B.C. into a single network for the Province of British Columbia, including a standardized data quality control protocol, a centralized data processing system, and a data-sharing web portal that is publicly available. Stations from existing CRMP partners are listed in *Table 1*.
- Harmonize operational standards, plans and technologies across the meteorological networks operated by the participating networks while maintaining their operational mandates
- Maintain a unified Provincial Climate Data Set (PCDS) (*Figure 2)* at PCIC that supplements the national climate data set maintained by ECCC.

The intent of the CRMP is **not** to change the existing operations of any individual CRMP partners, but to maximize data-sharing power that benefits all data users in the Province.

AGRI is part of the CRMP team, and has been providing in-kind support to operate weather stations in agricultural zones, and supplying weather data to farmers free of charge through Farmwest.com.

Table 1. Number of Weather Stations from the CRMP Partners

CRMP Partners	Number of Weather Stations
Federal Government	
Environment and Climate Change Canada (ECCC)	306
Provincial Government	
Ministry of Agriculture (AGRI) Farmwest.com	26
Ministry of Environment and Climate Change Strategy (ENV)	
Air Quality Program	50
Snow Program	48
Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNR)	
Wildfire Service	221
Forest Ecosystems Research Network	53
Ministry of Transportation (TRAN) Avalanche and Weather Program	172
Municipal Government	
Capital Regional District (CRD) Water Services	10
Metro Vancouver (MV)	
Planning and Parks	30
Water Services	15
Crown Corporation	
BC Hydro	
Generation and Hydro-Meteorological Information	61
Site C	8
Private Company	
Rio Tinto Alcan	6

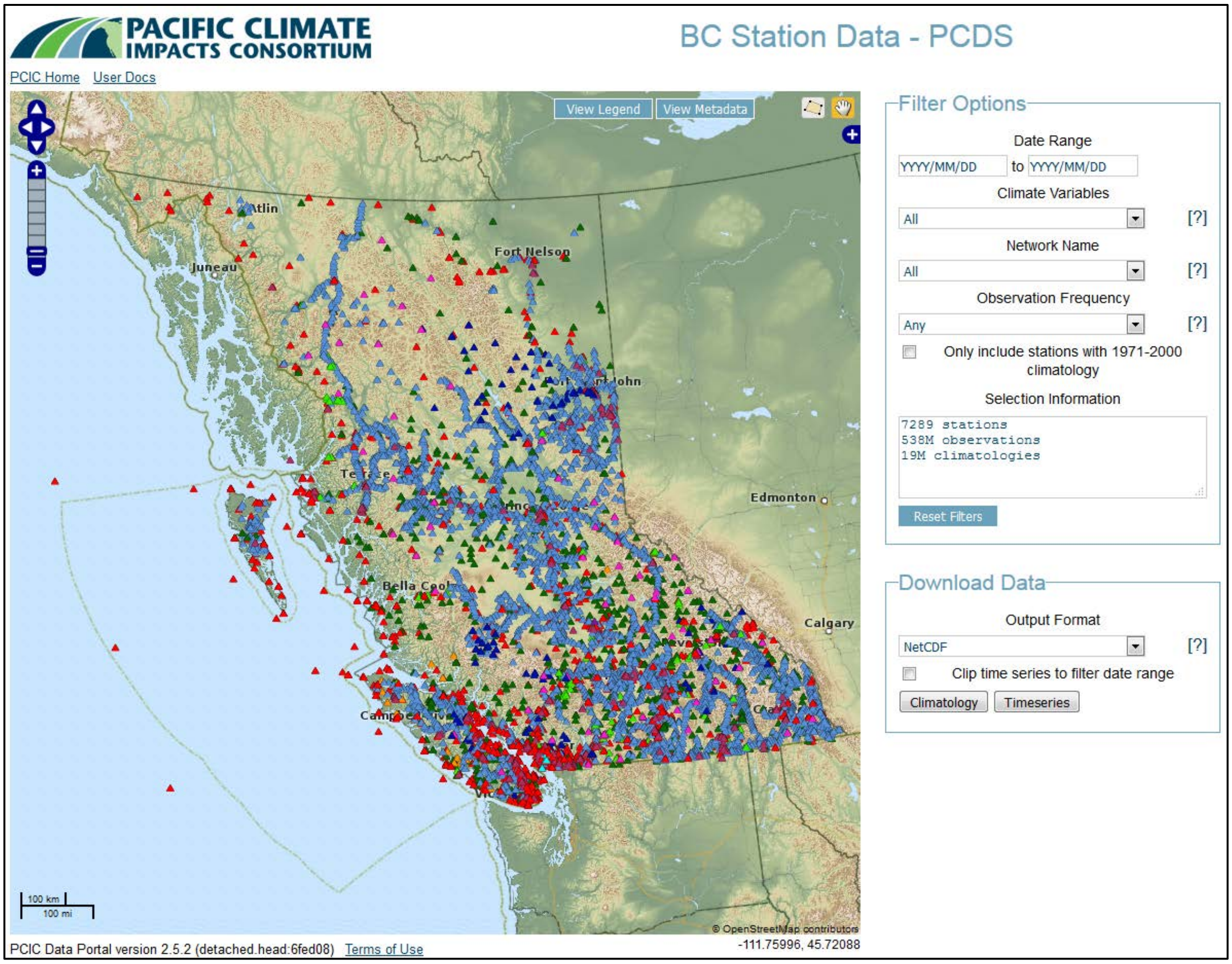

Figure 2. Provincial Climate Data Set (PCDS) from Pacific Climate Impacts Consortium (PCIC)

The key successes of the CRMP since its inception include:

- ✓ A public data portal, i.e., Provincial Climate Data Set (PCDS), hosted by PCIC. This is the first comprehensive data portal in Canada to make current and historical meteorological data from weather stations operated by participating networks publicly available, and allows for the development of climate analysis tools at PCIC.
- ✓ A centralized data processing system established under ECCC's Network of Networks initiative to enhance and exchange quality weather data for all Canadians.
- ✓ Efficiency in data management/exchange across all parties
- ✓ Improved coverage to define and monitor climate change in B.C.
- ✓ Improved observational reliability archived by sharing maintenance practices
- ✓ Technological improvements to winter precipitation monitoring at a number of sites.
- ✓ Improved network documentation, i.e., meta-data, for many meteorological sites operated by participating networks for evaluating the station configuration standards, and financial resources required for maintenance and improvement.

2.3 Network of Networks (NoN)

The CRMP is part of the Network of Networks (NoN) initiative led by ECCC to respond to the government priority of strengthening our national capacity to monitor severe weather and climate change through collaboration with Provinces/Territories and other data owners. The initiative is supported by $4.6 million federal funding over 10 years (since August 2014). The objective of the NoN is to enhance the access, exchange and quality of hydro-meteorological data in Canada for the benefits of all Canadians. Participation is voluntary to exchange free, open and quality data among networks operated by public sector data providers under formal data-sharing Memorandums of Understanding (MOUs). In the NoN pilot phase, task teams have been established with representatives from agencies for British Columbia and Ontario to develop best practices, standards and policies.

In B.C., the NoN pilot project consists of three phases:

1. Phase 1 includes the first group of CRMP partners, i.e., ENV, FLNR, and TRAN, and work is currently in progress:
2. Phase 2 will include the second group of CRMP partners, i.e., AGRI, BC Hydro, and Rio Tinto Alcan, with a target date of 2019 to commence work:
3. Phase 3 will include the third group of CRMP partners, i.e., CRD, MV and other future partners.

ECCC will also work on optimizing joint monitoring investments to address redundancies, improve coverage, and target stations of interests, as well as potential collaboration on network operations regarding infrastructure, instrumentation, maintenance, and data management. The benefits of joint network operations will provide opportunities to leverage advancements in innovation and technology, and improve network operation efficiencies and data quality/accuracy of public weather information, forecasts and warnings.

ECCC also runs the Meteorological Service of Canada (MSC) which is a service delivery portal to provide free weather data online for the general public. ECCC has committed $107 million over 11 years to improve the MSC online portal, provide user support desk for guidance of data use, train staff and allocate a coordinator to communicate with existing provincial partners. This funding is in addition to the financial commitment to support the NoN initiative.

2.4 Standards Council of Canada (SCC)

The Standards Council of Canada (SCC) is a federal Crown corporation with a mandate to promote efficient and effective standardization in Canada. SCC hosted a nation-wide meeting in mid-February 2018 as part of its *Standards to Support Resilience in Infrastructure Program*, in support of the Government of Canada's objective to adapt infrastructure to climate change impacts. Key stakeholders from existing meteorological and hydro-climate data networks from all provinces and territories across Canada were invited to this meeting, with AGRI representing the Province of British Columbia.

This standardization of weather and climate data is part of SCC's Infrastructure Program which is supported by a federal commitment of $11.7 million over five years (2016 – 2021), and includes:

- $4.9 million – standardization guidance for weather data, climate information and projections
- $4.9 million – updating existing infrastructure standards
- $1.9 million – Phase 2 of the Northern Infrastructure Standardization Initiative

The goal of standardization is to develop climate information standards for the collection and acquisition of weather data and climate information, to support infrastructure design. The objective is to provide the best advice to proceed to design voluntary standards and allow data to be shared among intended users across the country, as well as get a better understanding of how to use the data and the risk of using the data. The standardization is not intended to change the current operations of individual organizations.

SCC is also working with ECCC to identify common interests and potential collaboration opportunities on this topic through ECCC's NoN initiative. SCC's intent is to build on ECCC's work and to leverage the expertise from ECCC and provincial/territorial partners.

By 2020, a series of standards for weather and climate data will be completed, ready for testing. The standards will be evaluated using ECCC's NoN data. It is anticipated that AGRI's weather network data will be part of this pilot project by then. After the standards are finalized, SCC will review and revise the standards every five years to keep them current.

3. Regional Agricultural Network

A number of local and regional agricultural networks have joined or are interested in joining Farmwest.

3.1 Okanagan

In 2002-2004, Grower's Supply Co. (GS) received $150,000 from the Agriculture Environment Partnership Initiative (AEPI) of the British Columbia Agriculture Council (BCAC) to purchase and install 20 weather stations in the Okanagan Valley to help with the tree fruit industry, primarily on pest management. A data sharing agreement was executed in 2003 to allow Farmwest free access to the 15-minute weather data from GS's 20 weather stations for 10 years.

3.1.1 Business Risk Management Branch (BRMB)

The Business Risk Management Branch (BRMB) within AGRI uses weather data to assess claims and conduct analysis under their Production Insurance program. In mid-2000, BRMB approached Farmwest for weather data, and found Farmwest offers a very easy way to download weather data from any stations in B.C. (including GS stations) in Microsoft Excel format. The BRMB staff in the Production Insurance program are able to utilize the data conveniently for analysis and claim processing.

When the 10-year data sharing agreement between GS and Farmwest ended, BRMB wished to have GS weather data continue to be shared with Farmwest, and therefore executed a contract to purchase data from GS under the *Growing Forward 2* (GF2) funding program. When GF2 ended in March 2018, BRMB remains a strong partner with Farmwest, and established a second contract with GS to purchase their data under the five-year Canadian Agricultural Partnership (CAP) funding program to support their Production Insurance program.

3.1.2 Sterile Insect Release (SIR) Program

The Okanagan-Kootenay Sterile Insect Release (SIR) program is an environmentally responsible, area-wide approach to control codling moth pest populations, one of the B.C. tree fruit industry's most damaging and costly pests. The SIR serves the following four regional districts where the tree fruit industry plays an important role in the region:

1. Regional District of Okanagan Similkameen
2. Regional District of Central Okanagan
3. Regional District of North Okanagan
4. Columbia Shuswap Regional District

Sterile codling moths are bred and released at regular intervals in orchards all over the Okanagan, Similkameen, and Shuswap Valleys. Since the beginning of the SIR Program, wild codling moth populations have been reduced by 94%, thereby cutting the amount of pesticide used against the moth by 96%.

For the ongoing successful operation of the SIR program, it is very important to have good working weather stations in the Program's region. Accurate and up-to-date weather data helps the SIR Program track codling moth pest degree days so they can successfully monitor the life cycle of the codling moth throughout the different microclimates in the valleys. SIR has collaborated with the B.C. Tree Fruits Cooperative (BCTF), AAFC Summerland Research Station and the BC Fruit Growers Association over the last 20 years on a number of climate and pest related projects.

Most recently SIR has collaborated with the Tree Fruit Research and Development Center at the Washington State University (WSU) to adopt their successful Decision-Aid System (DAS) to the SIR Program area. Initial project funding to support the development, testing and launch of BC DAS has been provided in part by the SIR and in part by the Governments of Canada and British Columbia through the Investment Agriculture Foundation (IAF) of BC under Growing Forward 2, a federal-provincial-territorial initiative.

Around-the-clock and accurate weather data are at the core of BC DAS. BC DAS collects real-time weather data from local stations (ECCC's weather stations and BCTF Grower's Supply weather stations) to calculate current model conditions. BC DAS uses daily forecast temperature data to make predictions about pest, disorder, or plant development for up to 16 days into the future and the local 10-year average temperature values are used to make predictions up to 42 days ahead. Model outputs are only as good as the model inputs. Keeping the local weather network running successfully is important to the SIR Program and the success of the BC DAS project.

In addition to the Grower's Supply network, the SIR program would like to receive data from AGRI's network for their DAS project. However, the DAS tool requires hourly data to be sent to their database on an hourly basis (or more frequently) for generating real-time pest disease modelling results. AGRI's weather stations collect hourly data and sent to Farmwest database on a daily basis. Increasing data transmission frequency from daily to hourly would at least double Farmwest's operating costs. Farmwest cannot afford the additional costs.

3.2 Creston

The tree fruit producers in the Creston Valley are also interested in collaborating with WSU to customize DAS in the Valley; however, the Valley is outside of the SIR service area. The Creston Valley has only one ECCC's weather station, and is exploring funding opportunities to establish a weather station network in the Valley that can be connected to Farmwest, and to customize DAS for the tree fruit producers there.

3.3 North Okanagan

The B.C. Agricultural Research and Development Corporation (ARDCorp) is the wholly owned subsidiary of the British Columbia Agriculture Council (BCAC). Working with BCAC and provincial government, ARDCorp delivers effective, affordable programs and services that advance both the individual producer and entire agricultural sector while benefiting local communities. ARDCORP is the delivery agent of the British Columbia Environmental Farm Plan (EFP) program.

The EFP program provides Beneficial Management Practices (BMP) cost-share funding to producers to establish weather stations on their farm properties for improved management of our natural resources. To qualify for the BMP funding program, weather stations are required to be connected to Farmwest.com to share data openly with the agricultural sector. Under this program, Emerald Bay Agricultural Services Ltd. has installed six weather stations in the North Okanagan region using equipment from Pessl Instruments.

Two additional weather stations in the North Okanagan region have been operational and connected to Farmwest.com since May 2018 to help with monitoring and assessment of the water quality within the Hullcar aquifer #103. This is an emerging environmental issue that ENV is working on collaboratively with AGRI, Interior Health Authority, and FLNR. This cross-government team is focused on identifying significant sources of pollutants, assessing a variety of approaches to resolve the water quality issue, as well as conducting monitoring of the activities above the aquifer.

The EFP BMP program was/is funded by Growing Forward (GF), Growing Forward 2 (GF2), and Canadian Agricultural Partnership (CAP), all of which are a federal-provincial-territorial initiative.

3.4 Peace

The Peace Region Forage Seed Association (PRFSA) is currently working with AGRI to convert the host of their network of 23 weather stations from Weather Innovations (a company based in Ontario) to Farmwest. The Association wishes to develop mobile capability for their decision support tools to allow their members access weather data and decision tools on their mobile devices. Farmwest has a mobile capability built for the entire website since 2017 with GF2 funding. The PRFSA therefore would like to explore collaboration opportunities with Farmwest.

3.5 Vanderhoof

In 2015, the British Columbia Forage Council (BCFC) received funding from Climate Action Initiative (CAI) to develop an on-farm research demonstration project that included the establishment of four new stations in the Vanderhoof area. These stations have been connected to Farmwest since then. The Council continues to support the network as of today, providing useful weather information to producers in the region.

3.6 B.C. Agricultural Climate Adaptation Research Network

While the newly developed B.C. Agricultural Climate Adaptation Research Network (ACARN) does not currently oversee weather stations in the Province, the group is interested in developing strategies to improve weather station data to enhance climate change research and tools. Members of the network are located across British Columbia and are involved in various agricultural climate change disciplines. There is strong potential to leverage this interdisciplinary network by collaborating with regional and provincial groups to develop weather station networks and weather-based decision aid tools that support producer adaptation to climate change.

3.7 Other Networks

A number of organizations and agencies have expressed interests to connect their weather stations to Farmwest and join the CRMP, e.g., Fraser Valley Regional District (FVRD), City of Surrey, and FLNR Aquarius program.

4. Weather Data Gap Analysis

This section discusses the gap analysis conducted by PCIC of weather data from stations across the Province. The analysis used a total of 1,092 active stations listed in Table 4-1. More stations have been added to some of the networks since the analysis was completed, and only the active stations are part of the analysis; therefore, the numbers in this table may be different from the list in Section 2.

Table 2. Number of Weather Stations by Agencies/Organizations for the Gap Analysis

Agencies/Organizations	Number of Weather Stations
Federal Government	
Environment and Climate Change Canada (ECCC)	306
Provincial Government	
Ministry of Agriculture (AGRI) Farmwest.com	18
Ministry of Environment and Climate Change Strategy (ENV)	90
Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNR)	354
Ministry of Transportation (TRAN)	145
Municipal Government	
Capital Regional District (CRD)	10
Metro Vancouver	45
Crown Corporation	
BC Hydro	80
Non-Profit Organization	
BC Forage Council (BCFC)	4
Peace Region Forage Seed Association (PRFSA)	23
University	
University of Northern BC	11
Private Company	
Rio Tinto Alcan	6
Total =	**1,092**

The observation of meteorological variables is a crucial aspect of agricultural work for farmers, researchers and others with interest in crop production. Understanding weather conditions on short time scales helps with planning while an understanding at longer scales informs about drought and other seasonal climate effects. At the scale of several decades, the averages of weather variables and their variability are indicative of growing potential of a given region as well as potential risks involved with utilizing a given piece of land for crop production. Even those who grow crops in enclosed or semi-enclosed structures such as greenhouses are subject to weather and climate as heating, cooling or lighting demands may change under different external conditions. For farmers producing livestock, temperature and water availability are key factors in the health of the herd with extremes playing a particularly important role in terms of heat stress, water availability or dangers from extreme cold.

The needs for weather observation are compounded by climate change. As a first measure, understanding the present-day weather variability and climate at the finest possible spatial scales aids in projecting the impacts of climate change. This understanding is based on knowledge of long term averages and their variations as well as frequency and magnitude of extreme events. Such extremes, although rare, are capable of generating rapid and devastating losses to crops and livestock resulting in impacts on food availability locally and internationally.

4.1 Data Source

This gap analysis comprises weather observational data, metadata on the operational observational networks and geographical data that describes spatial coverage within a geographical information systems context. At present there are more than half a billion observations of numerous variables in the CRMP database from more than 7,000 observing locations in B.C. This work is concerned with analyzing the temperature and precipitation data and summarizing the availability of other variables in the agricultural regions of B.C.

Crop data from the National Annual Crop Inventory as well as AGRI's Agricultural Land Use Inventory (ALUI) were used in this analysis. However, the data from the National inventory was very coarse compared to the parcel based ground-truth ALUI dataset. The ALUI is expected to be completed for the whole Province of B.C. by Year 2021, by which a revision of the gap analysis can be conducted.

4.2 Methodology

To approach the objective of investigating the sufficiency of the observational network for agricultural regions, two approaches were used. First, a quantitative analysis of the meteorological observation locations and their recorded variables within agricultural regions of the province was conducted. Secondly, the observational network's sufficiency in terms of precipitation and temperature measurements was assessed through objective network analysis. This research technique investigates the relationships among all observational locations and all observations throughout the historical observational period.

4.3 General Geographical and Objective Analysis Results

The most general part of the geographical analysis was the determination of distance statistics between stations as it varies by region. These results along with the average area results are presented in Table 4-2 and give an indication of the sparseness of observational stations in each region. These results are based on the complete active network of stations so distances will be larger for the subnetworks of individual variables.

- The **North region** has the largest maximal distance between stations which is not surprising given the size of the region and its relatively small number of stations. This maximal distance is almost double that for the next sparsest region.
- The median distances to stations indicate that the **Central Coast** region might have the most consistently isolated stations with median separation distances to the first station of 21 km and 34 km to the next closest.
- The **Cariboo** and **North** regions are the next sparsest and show similarly large median inter-station distances.
- The **Lower Mainland**, the **North Okanagan** and **South Okanagan** have the closest station spacing with a maximal spacing between stations just over 20 km for the three regions.
- Median distances to the nearest station are less than 10 km for all but four of the regions which are probably indicative of station clustering near population centres.

In all cases, the median statistics are skewed toward low median distance by clustering of stations near population centres. These station separation statistics should not be directly compared with the objective analysis results' representativeness distances which are typically of the same magnitude but larger. Doing so would lead to a false inference that no gaps exist in these regions which is not the case because stations are not homogeneously distributed across space in British Columbia.

Table 3. Statistics describing distances to nearest and second nearest stations in agricultural regions in British Columbia within the active observational network. 1st indicates distance to the nearest stations while 2nd indicates distance statistics to the second nearest station.

Region	Med. to 1st (km)	Med. to 2nd (km)	Max. to 1st (km)	Max. to 2nd (km)
North	18	34	152	153
Peace	8	17	68	71
North Coast	7	20	44	99
Prince George	7	14	45	49
Rockies	13	20	46	52
Central Coast	21	34	76	90
Cariboo	18	23	53	60
Kootenay	7	14	49	50
Vancouver Island	7	10	41	78
South Okanagan	8	12	21	21
Lower Mainland	2	5	12	21
Southwest Interior	7	12	47	54
North Okanagan	5	11	17	24

Part of the objective network analysis is quantifying the functional relationship between correlation and distance between stations for the available data. The decrease in correlation with distance is not fully diagnostic of representativeness distance scales, but does give an indicator of how relationships between stations change with distance and how that varies with the month or season analyzed.

4.4 BC-Wide Overview of Network Sufficiency

An initial assessment of the observational network coverage for the entirety of British Columbia can be made by looking at the radius of representativeness for precipitation applied to the active network of observational stations in the Province.

The following maps indicate seasonal averages of representativeness for monthly precipitation within 30% of the nearby station's value. These maps have been created with a translucent indicator of the radius such that areas with many overlapping radii have darker shading than those with fewer overlaps.

Overall, the radii are smallest for winter (December, January and February) and largest for spring (March, April and May) while summer (June, July and August) and fall (September, October and November) are intermediate in radius and thus coverage. The map for winter is given in *Figure 3* and shows that the radii are the smallest in northern BC and larger through the central and coastal parts of B.C. Numerous gaps are present in the north, but there is very little agricultural activity there based on the limited extent of the Agricultural Land Reserve (ALR) and the lack of agricultural activities in the 2016 inventory. The exception is Fort Nelson where few observational stations exist and substantial ALR lands are present. The Lower Mainland and Vancouver Island are very densely observed and very few gaps in observations exist from this monthly observational frequency standpoint. Intermediately, gaps can be seen in the Peace region of northeast B.C. where ALR and the agricultural inventory regions have no or minimal coverage in some cases. Southwest B.C. and central B.C. show similar gaps where ALR, agricultural use lands, and agricultural inventoried lands show gaps in coverage or areas with only a single station providing coverage.

Results for spring (*Figure 4*) are similar despite the larger radius or representativeness present in all areas for that season. Large gaps remain in areas with no agricultural activity in northern B.C. and along the coast while the most densely observed regions are even more so for this season. Some gaps are smaller or non-existent in southwest B.C. for spring than for winter while gaps in coverage remain in NE B.C. in the Peace and central B.C. For summer (*Figure 5*) and fall (*Figure 6*) the results are intermediate owing to the intermediate size of the representative areas for each station. However, the summer results deserve greater attention due to the importance of weather and climate monitoring for the growing season. The radius of representativeness for stations in summer is more consistent between the regions of the province. Thus, the coverage in northern B.C. is better during this season. Despite this, gaps remain near Fort Nelson and in the northern parts of the Peace region.

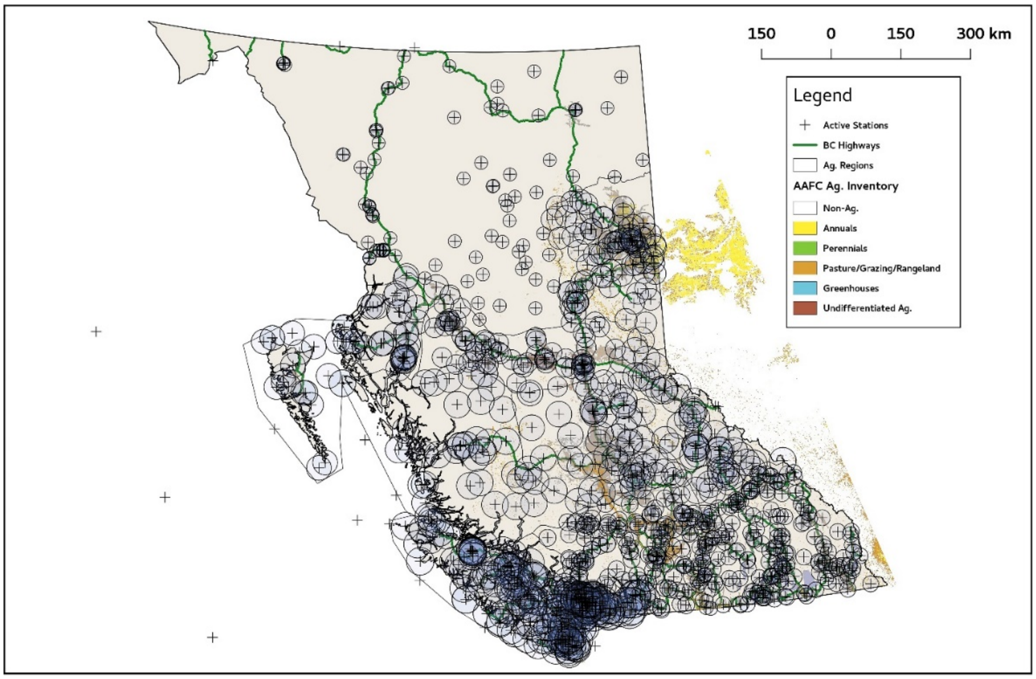

Figure 3. Map depicting the radius of representativeness about stations in the active observational network in British Columbia. The radius of influence is for winter (December, January and February) precipitation and shows the distance at which monthly precipitation total will be within 30% of a station's value. This distance is a good indicator of station representativeness for initially identifying gaps in observational networks for variables with large spatial and temporal variability.

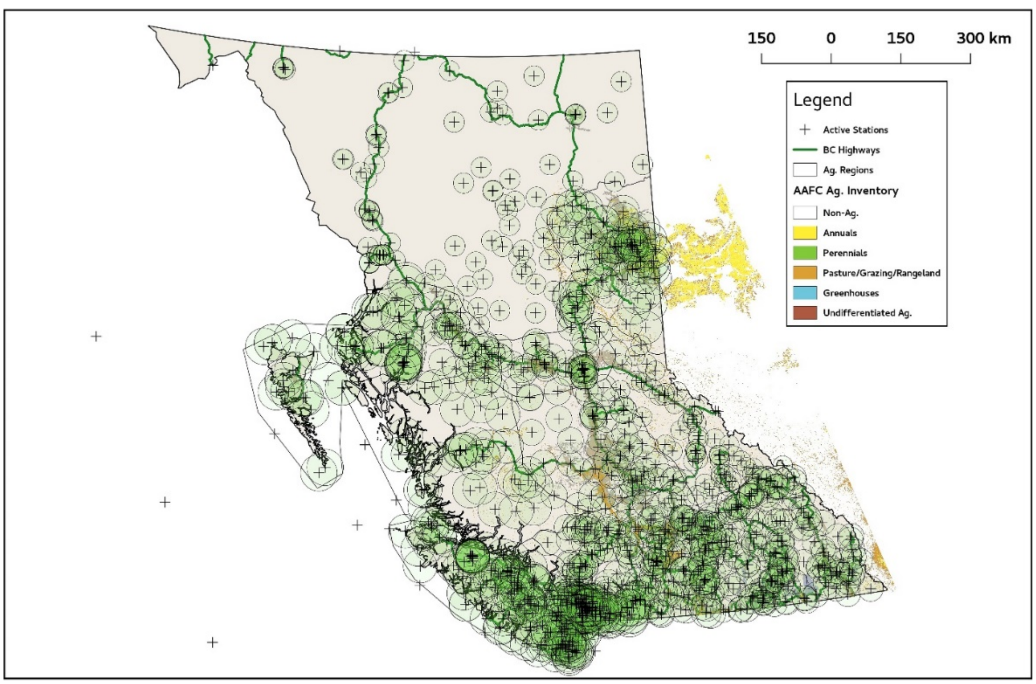

Figure 4. As in Figure 3 but for spring (March, April and May).

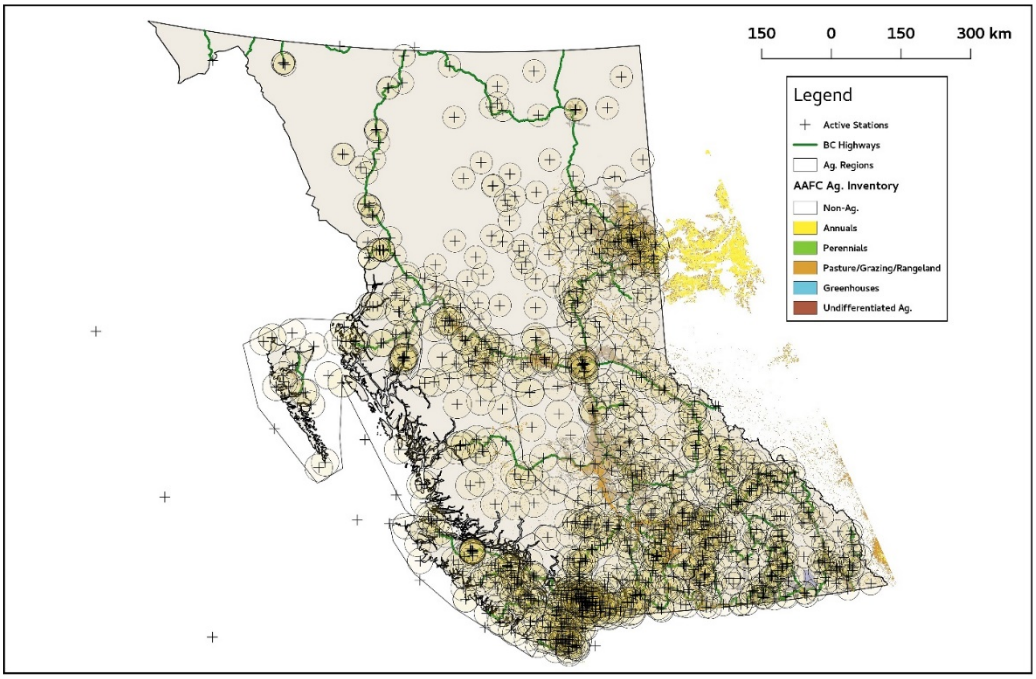

Figure 5. As in Figure 3 but for summer (June, July and August).

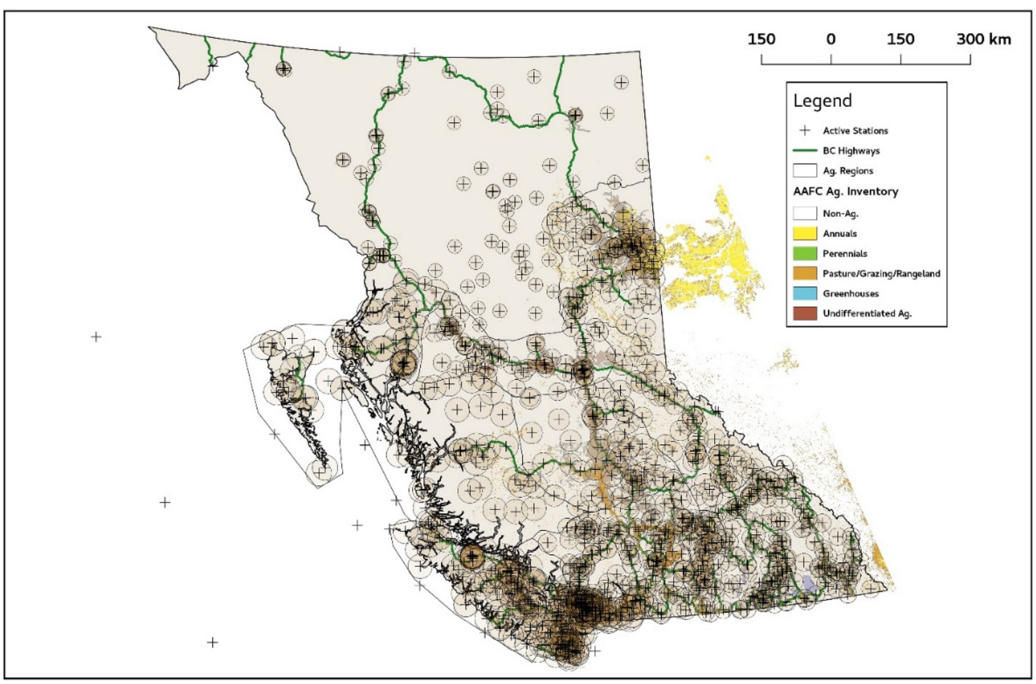

Figure 6. As in Figure 3 but for fall (September, October and November).

An analysis of the observational network sufficiency for all agricultural regions of BC has been conducted using a geographical approach and an objective analysis approach. Results show, that for monthly variables, temperature and precipitation observational coverage is sufficient in agricultural regions. For shorter observational time scales such as daily or subdaily, there are likely major gaps in the network and filling those gaps will require conducting triage on available resources, values of crops grown in various regions and other factors that this report cannot address. The network is likely insufficient at all timescales in some regions for variables such as solar and longwave radiation, all-season precipitation, and snow. This needs to be carefully assessed on a region by region and variable by variable basis using the results of this report and the maps in the report and the appendix as a guideline.

On a regional basis, the North, North Coast and Central Coast regions are overall sparsely observed, but they also contain minimal agricultural areas based on the location of the ALR and agricultural inventories. Other regions such as Vancouver Island and the Lower Mainland have dense observational networks which may even be sufficient for some areas for short timescale observations. Other regions have intermediate coverage which is likely sufficient for longer timescale monitoring needs and for variables with large spatial scales of relationship but are likely insufficient for shorter timescales and for variables with very large spatial variability and minimal spatial coherence such as wind or solar radiation.

5. Applications of Weather and Climate Data

In addition to the decision-support tools hosted on Farmwest, and other projects described in previous sections, weather and/or climate data has been used in a number of applications. Some examples are listed below.

5.1 Agriculture Water Demand Model (AWDM)

AGRI and AAFC have developed the Agriculture Water Demand Model (AWDM) to estimate current water demand for agriculture using crop, irrigation system, soil, and historical climate data, and future water demand for additional irrigated farmland using climate change scenarios. The AWDM uses 500-metre gridded climate data developed for the entire Province of B.C. Each gridded cell is populated with daily weather data from 1961 to 2010 that includes maximum temperature, minimum temperature and precipitation. The data allows the AWDM to calculate a daily reference evapotranspiration (ET_o) rate which is used in a series of algorithms to calculate the water demand.

In 2006, the AWDM was first developed in the Okanagan, one of the driest and most productive agricultural regions in B.C., and has been expanded to over half of the Province since then. It is anticipated that the AWDM will be completed for the entire Province by the Year 2021.

The water demand results set the baseline of how much water agriculture needs in each of the modelling regions. Municipalities can use the results to establish “Dedicated Agriculture Water” when developing their Water Sustainability Plans (WSPs) that the *Water Sustainability Act (WSA)* supports.

5.2 Agricultural Irrigation Scheduling Calculator

AGRI worked with the Irrigation Industry Association of British Columbia (IIABC) to develop the Agricultural Irrigation Scheduling Calculator that ingests the evapotranspiration (ET) data from Farmwest to advise producers on irrigation scheduling. The Quebec office of AAFC was very interested in the Calculator and therefore partnered with AGRI and IIABC to develop a French version of the Calculator with ET data feed coming directly from the Quebec provincial weather station network.

The scheduling calculator helps farmers conserve water in the early part of the season (April to June) when the weather is cooler, so the water will last longer in the growing season. It is important to understand that this Calculator serves as a water management tool for Drought Preparedness at the start of the season, but not for Drought Response in the hottest months (July and August).

5.3 B.C. Agriculture Water Calculator

AGRI worked with ENV, OBWB, and Partnership for Water Sustainability in British Columbia (PWSBC) to develop the B.C. Agriculture Water Calculator using 10 years of historical climate data from 2001 to 2010. It calculates how much water farmers should need for their farm in the "new climate normal", which farmers can reference in their water license applications. FLNR water authorization staff also use this Calculator when reviewing applications.

BC Agriculture
Water Calculator

5.4 Emergency Management

Many provincial agencies utilize weather data in their emergency planning, preparedness, and response, e.g.,

- Emergency BC (EMBC) hired a newly established private company called "Lightship Works" to develop emergency response (freshet and wildfire) web applications using weather data from CRMP networks
- River Forecast Centre for the Provincial Drought Response and regional flood response
- FLNR Wildfire Management Branch during wildfire season
- TRAN Avalanche Safety Program during winter season

5.5 Other Projects

There are a number of projects conducted by provincial/municipal governments and non-profit organizations surrounding Environmental Flow Needs (EFNs), aquifer mapping, water budget analyses, and streamflow studies that incorporate weather data in their analyses to ensure water users from every sector (including agriculture) has a fair and equitable share of our water resources.

A recent project completed by Urban Systems involved the development of an online tool prototype to forecast the risk of water loss for individual ponds in the rangelands in B.C.'s southern interior. The intent of the pond risk assessment tool is to provide the ranching industry and resource managers with information on ponds, so they can target thigh risk areas for proactive water development. The tool can be used in the development of water source planning strategies in response to projected future trends in pond water supply.

Overall, there has been a growing interest to develop weather and climate based tools that can better improve the capacity of the B.C. agricultural sector to adapt to climate change. Many specialists, experts and researchers have identified the need for improved climate data to develop accurate models that can support the identification and prioritization of future climate change risks and opportunities for the agricultural sector. Improved weather and climate data will help to steer future initiatives.

6. Recommendations

The Province of British Columbia is expected to continue to be part of the initiatives of the Climate Related Monitoring Program (CRMP), Network of Networks (NoN), and Standards Council of Canada (SCC) to develop and pilot the standards for weather and climate data, and to maximize data sharing capability to benefit all data users in the country. Weather and climate data is critical for the agricultural industry, and AGRI is expected to be part of the process to ensure there is proper representation of agricultural needs during the development.

This project aligns with the *Ministry's Service Plan* *2018/19 to 2020/21*,

Objective 1.5: Support Climate Adaptation and Mitigation

"To increase agriculture sector capacity to maintain competitiveness, manage risks, enhance productivity and contribute to economic growth through action on climate change and increasing environmental sustainability."

In the Service Plan, AGRI is committed to work with industry, local governments, research organizations, and other government agencies, and support the development and adaptation of environmental and climate change adaptation and mitigation practices, processes, technologies and infrastructure.

6.1 Farmwest.com

Farmwest.com has been receiving in-kind support and financial assistance from the B.C. Ministry of Agriculture (AGRI) through various federal/provincial/territorial funding programs to operate weather stations in agricultural zones, and supplying weather data to farmers for free. The agricultural weather station network is the only sector-based network that operates with no annual funding established (*Table 4*). Please note the budgets from other provincial networks are only estimates.

Table 4. Annual Operational Budget of Provincial CRMP Partners

CRMP Provincial Partners	Number of Weather Stations	Annual Operational Budget
AGRI Farmwest.com	26	$0 (none)
ENV Air Quality Program	50	$40,000
ENV Snow Program	48	$180,000
FLNR Wildfire Service	221	$500,000
FLNR Forest Ecosystems Research Network	53	$120,000
TRAN Avalanche and Weather Program	172	$800,000

Many stations from other CRMP networks are not located near agricultural lands and are not good representation of the weather conditions for agricultural use. Therefore, new stations will be required to be added to AGRI's network for the agricultural sector as per the gap analysis explained in the previous section.

It is estimated that an annual budget of $50,000 is required to operate the agricultural weather station network with the current 26 private stations and to support incremental improvements to the network (*Table 5*).

Table 5. Estimated Annual Operating Cost for AGRI's Weather Station Network

Deliverables	Estimate Cost
1. Data transmission cost ($30 per cellular station, $50 per satellite station)	$10,000
2. Existing station repair and maintenance, and installation of 2 new stations per year	$20,000
3. Farmwest.com web operational and maintenance	$5,000
4. Weather data research and analysis	$15,000
Annual Total Cost for the Agricultural Sector	**$50,000**

RECOMMENDATION #1

Farmwest.com continues to seek funds and grants from funding programs/organizations, e.g, Canadian Agricultural Partnership (CAP) to support the ongoing operation of Farmwest in the long run.

6.2 Provincial Weather Station Network

Over 10 years ago, the Province of Quebec spent approximately $2 million provincial dollars to establish a unified weather station network for Quebec, with a provincial contribution of approximately $1 million per year for on-going operational and maintenance support.

The MOU that the Province of British Columbia has signed and committed to the CRMP initiative does not include any financial commitment. It is a long process trying to collaborate with so many agencies especially without financial support. AGRI has been and will continue to be part of the process to achieve the goal, and B.C. may be the second province to have a provincial weather station network. However, some degree of financial commitment will be required to advance the process much quicker, and help fill in the data gaps for improved collaboration on any climate-related work for agriculture.

RECOMMENDATION #2

The agricultural sector seeks funds to support the CRMP initiative to develop a provincial weather station network. This funding would complement the existing funding provided to various agencies to operate and maintain their networks.

6.3 Collaboration with Other Agricultural Groups

There are many other non-profit agricultural groups interested in enhancing weather and climate data in agricultural regions of the Province. A collaborative effort is critical for ensuring that future regional initiatives can contribute to the work that AGRI is conducting on a provincial scale. This may include future consultation with specialists, researchers, producers and policy makers to determine the need for weather and climate data in the agricultural sector.

RECOMMENDATION #3

The agricultural sector continues to support the collaboration among non-profit agricultural groups who are interested in weather and climate data to enhance regional and provincial weather station networks and the applications of weather and climate data.

6.4 Future Research Opportunities

Some future research opportunities may include but not limited to the following:

1. Conduct detailed gap analyses by region where extreme micro-climate exists.
2. Assess observational network sufficiency for shorter time scales of observation;
3. Explore other approaches that better elucidate microclimatological effects on observational needs such as PRISM uncertainty or local variability;
4. Explore a more dynamic mapping approach utilizing web tools that enable interested users to explore the results without being hindered by static map images that may not reflect their needs.
5. Implement a more recent and high resolution crop inventory such as the Agricultural Land Use Inventory (ALUI) created by AGRI to help reveal the intersection between station gaps and crop values and enable a most accurate possible assessment of need for new observational locations. A more complete analysis can be done by crop type to address commodity-based concerns when AGRI completes the ALUI for the Province of B.C. by Year 2021.
6. Identify future weather station data needs for researchers, producers and policy-makers associated with the B.C. agricultural industry.
7. Enhance existing and develop new weather and climate based decision aid tools that support.

RECOMMENDATION #4

Farmwest and interested agricultural organizations seek funding and develop a workplan to implement future research opportunities described in Section 6.4.

7. Conclusion

The multi-stakeholder and multi-disciplinary initiatives over the past decades have created positive synergy and enthusiasm among many technical experts supporting weather and climate data across the country. B.C.'s hydro-meteorological observation needs can be best addressed by working in cooperation or partnership. Standardization of weather and climate data will help to improve the coverage, accessibility and quality of data.

Many past and current projects that utilized weather/climate data experienced some or huge data gaps; therefore, some degree of substitution is required to make the best estimation. Data is knowledge. Knowledge is power. When we have weather/climate data, we will have the knowledge and the power (the ability) to provide recommendations or directions on how to move forward. Whether it is about day-to-day farm operations, climate change adaptation, long-term water use planning, reserving water for agriculture, emergency preparedness/response, with the availability of quality climate data, more reliable and robust scientific information will become available to support provincial initiatives and policy directions.

B.C. is only 50% self-reliant on food. Our food security needs to be improved to match with the growing population within B.C. and Canada, and globally. The Agricultural Land Reserve (ALR) must be protected to allow for food production. Quality and reliable weather data must be readily available across the Province including microclimate regions. These will provide the knowledge and tools that producers need to:

1. Make informed decisions in managing our natural resources;
2. Prepare and respond to extreme weather events, e.g., wildfire, drought, flooding;
3. Increase the productivity of the ALR and non-ALR lands;
4. Adapt and mitigate climate change impacts;
5. Strengthen the growth and viability of the agricultural sector; and
6. Help shape the future of food security in B.C.

Climate change adaptation is a long-term commitment. Collecting, storing, and sharing weather and climate data must continue indefinitely to achieve the goals. Weather stations are critical to provide the data necessary to evaluate climate change impacts and develop climate change adaptation strategies for agriculture (and for all other sectors) in B.C.

Farmers grow food.

APPENDIX

Appendix

This appendix presents results useful for interpreting the network sufficiency for each region in B.C. There are two maps for each region.

1. The first map presents the active observational network for the region regardless of observed variable.
2. The second map shows the radius of representativeness around the subnetwork for a moderately well observed variable, atmospheric pressure. The radius chosen for these maps is that for summer precipitation in the region. Although air pressure typically has large spatial scales of relationship, the moderate availability of stations with this variable helps indicate some of the gaps in the observational network for the individual regions.

Following the maps, two tables are presented that give results from the geographic and then the objective analysis.

1. The first table presents the statistics on areal distribution of the stations within individual subnetworks differentiated by observed variable. Area statistics are based on direct division of the region's area by the number of stations with a given variable as well as a Voronoi polygon analysis. The Voronoi analysis helps to present the extremes of station isolation and clustering present in a given region. A limitation of this work is that the area statistics were not calculated within a given distance of areas with agricultural activity. That approach would have helped focus the analysis on the needs of the agricultural community and will be considered for an update to this work in the future.
2. The second table presents the results of the objective analysis in terms of the radius of representativeness for each variable and month. Results are presented for temperature accuracy thresholds of 0.5 °C and 1.0 °C and a precipitation accuracy threshold of 30%. The table also gives the spatiotemporal variance, σ_T, in the data for each variable and month.

Appendix Table of Contents

1. North

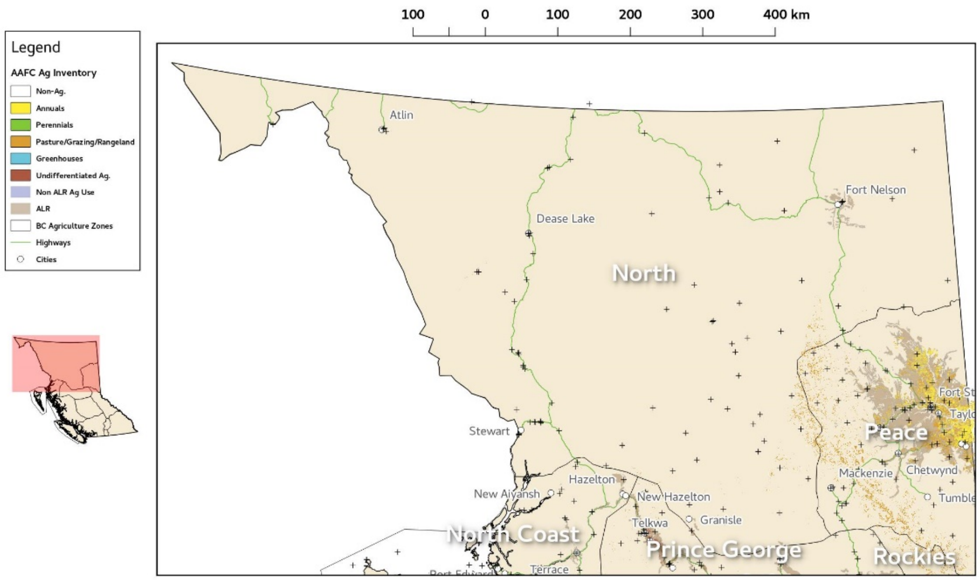

Figure 1.** **Map depicting the Northern agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Finally, data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the North region, the inventory is limited to Annuals and Pasture/Grazing/Rangeland types. Overall, the land under agricultural use is limited in this region.

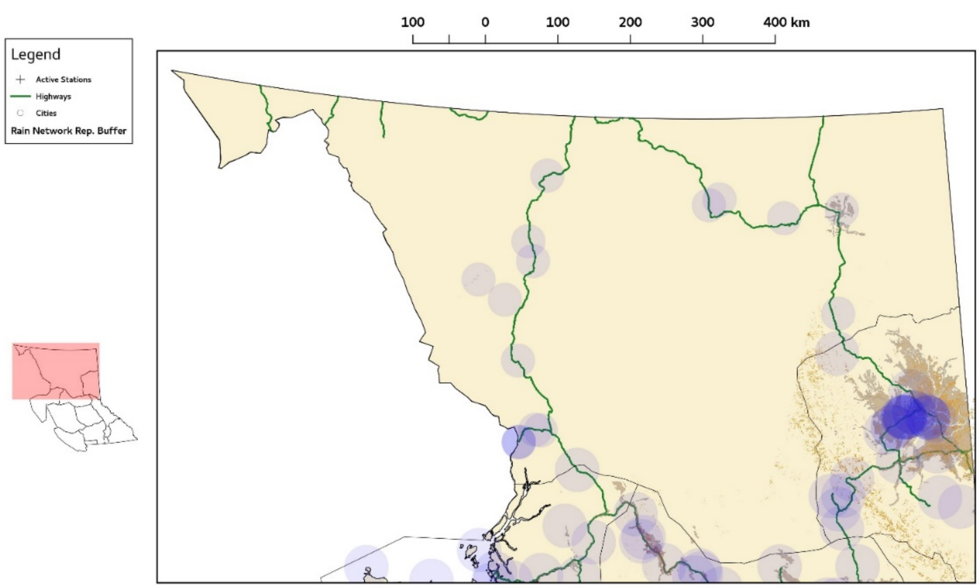

Figure 2.** **Map depicting the Northern agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

Table 1. Statistics describing the area coverage of stations by variable within the Northern agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on A_{vor} in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	84	4363	2869	31	26431
Humidity	58	6320	4963	74	26737
Precipitation	73	5021	3194	43	26431
Rainfall	67	5471	4019	271	26431
AS Precipitation	37	9906	5107	440	37157
Snow	36	10181	6032	440	26284
Wind	54	6788	5601	74	26737
Any Radiation	1	366533	30048	30048	30048
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	1	366533	30048	30048	30048
Long Wave	0	NA	NA	NA	NA
Air Pressure	16	22908	9618	1181	34517
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	8	45817	8818	1836	22815

Table 2. Local field variance (σ_T) and distance of representativeness scales for the "North" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	3.2	0	20	4.2	0	30	48	30
Feb.	2.5	0	100	3.7	0	110	53	40
Mar.	2.0	0	430	2.5	0	300	58	40
Apr.	1.6	10	640	1.4	10	2360	53	40
May	2.3	20	1300	1.3	180	3360	50	90
Jun.	2.0	30	1340	1.2	150	1210	47	100
Jul.	1.9	20	1180	1.0	40	1450	46	50
Aug.	1.8	10	1050	1.1	20	1510	53	20
Sep.	1.9	50	980	1.2	60	2940	55	30
Oct.	1.6	20	2190	1.4	30	2430	52	40
Nov.	2.6	0	260	3.2	0	330	40	10
Dec.	2.8	0	30	3.9	0	50	48	10

2. Peace

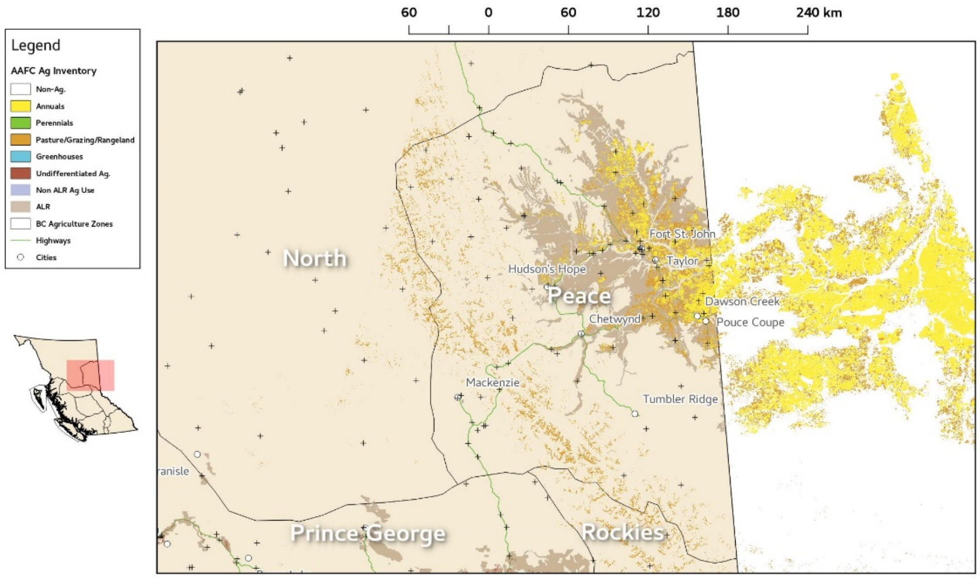

Figure 3. ***Map depicting the Peace agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Peace region, the inventory is limited to Annuals and Pasture/Grazing/Rangeland types.***

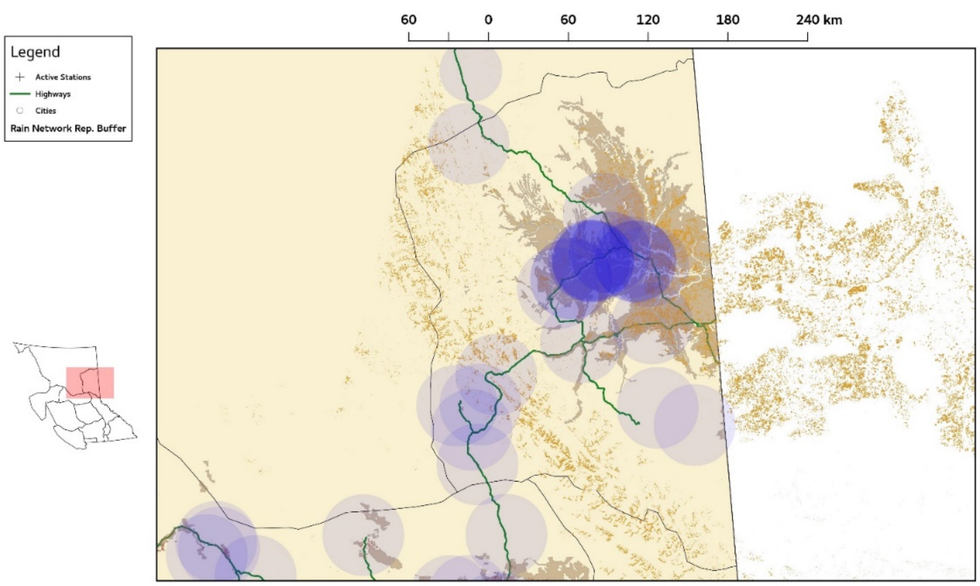

Figure 4. ***Map depicting the Peace agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.***

Table 3. Statistics describing the area coverage of stations by variable within the Peace agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	91	736	614	2	2991
Humidity	67	1000	579	2	8771
Precipitation	78	859	693	2	3142
Rainfall	77	870	686	2	3997
AS Precipitation	23	2913	3199	152	12288
Snow	20	3349	3189	152	16991
Wind	69	971	547	2	8771
Any Radiation	17	3941	1129	2	44654
Net Radiation	7	9570	1235	48	91177
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	13	5153	1429	99	50995
Long Wave	4	16747	40	0	84
Air Pressure	27	2481	841	2	19213
Ground Flux	11	6090	48	2	259
Hydrol. Vars.	9	7443	10236	3914	32027

Table 4. Local field variance (σ_T) and distance of representativeness scales for the "Peace" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	4.5	0	50	5.0	0	50	57	50
Feb.	3.8	0	180	4.5	0	140	68	50
Mar.	3.2	20	750	3.7	0	330	57	50
Apr.	2.1	40	790	1.7	20	2360	63	70
May	2.2	20	1330	1.4	170	3360	60	100
Jun.	1.6	30	1350	1.0	90	1210	55	120
Jul.	1.7	20	1180	1.1	20	1450	57	60
Aug.	1.9	10	1100	1.2	10	1510	62	30
Sep.	2.3	80	1030	1.4	70	2940	62	40
Oct.	2.1	30	2300	1.6	40	2430	54	50
Nov.	3.9	0	340	4.1	0	390	57	30
Dec.	4.3	0	90	4.9	0	70	64	10

3. North Coast

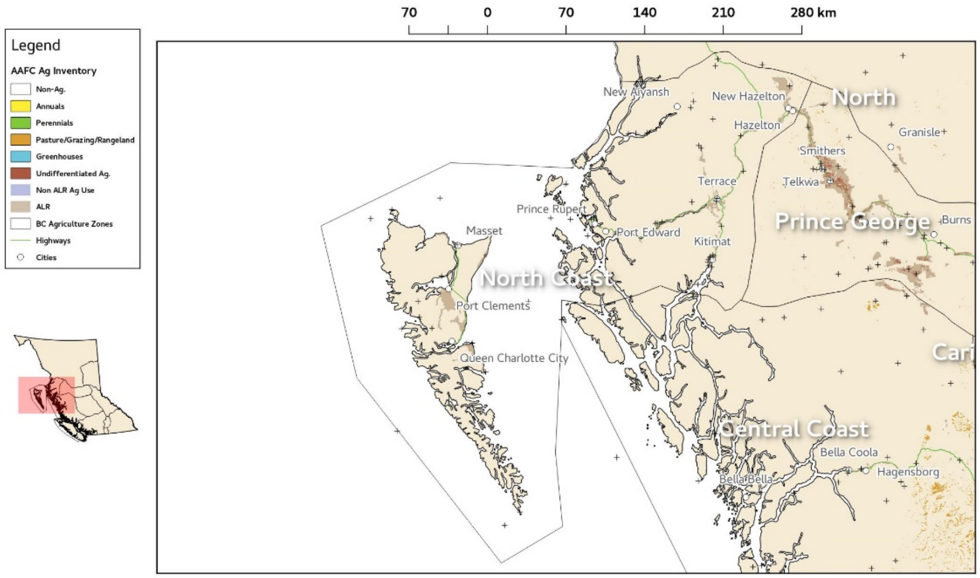

Figure 5. Map depicting the North Coast agricultural region. The network of all active stations is shown shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the North Coast region, the inventory shows very limited active crop land.

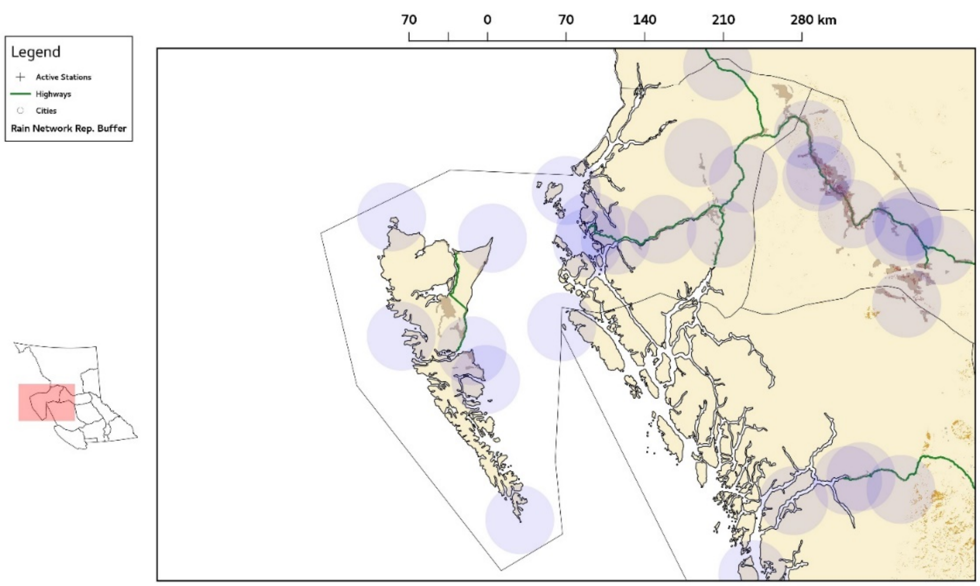

Figure 6. Map depicting the North Coast agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

Table 5. Statistics describing the area coverage of stations by variable within the North Coast agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	50	1751	1087	11	3923
Humidity	33	2653	2067	557	7473
Precipitation	40	2189	1431	228	4335
Rainfall	37	2366	1402	228	4383
AS Precipitation	29	3019	1725	228	6987
Snow	29	3019	1725	228	6987
Wind	35	2501	2067	128	7255
Any Radiation	0	NA	NA	NA	NA
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	0	NA	NA	NA	NA
Long Wave	0	NA	NA	NA	NA
Air Pressure	15	5836	3730	1850	17975
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	0	NA	NA	NA	NA

Table 6. Local field variance (σ_T) and distance of representativeness scales for the "North Coast" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.2	0	40	2.5	0	40	39	50
Feb.	1.8	0	130	2.2	0	110	49	50
Mar.	1.6	0	580	1.5	0	260	40	70
Apr.	1.5	30	780	1.1	20	2360	47	80
May	1.9	30	1330	1.2	200	3360	49	100
Jun.	2.1	60	1350	1.1	190	1210	45	120
Jul.	1.8	40	1260	0.9	60	1450	57	60
Aug.	1.7	20	1110	0.9	20	1510	51	40
Sep.	1.5	0	850	1.0	50	2940	45	60
Oct.	1.1	10	2080	1.1	20	2430	33	60
Nov.	1.7	0	350	1.9	0	320	36	50
Dec.	2.1	0	60	2.5	0	50	44	20

4. Prince George

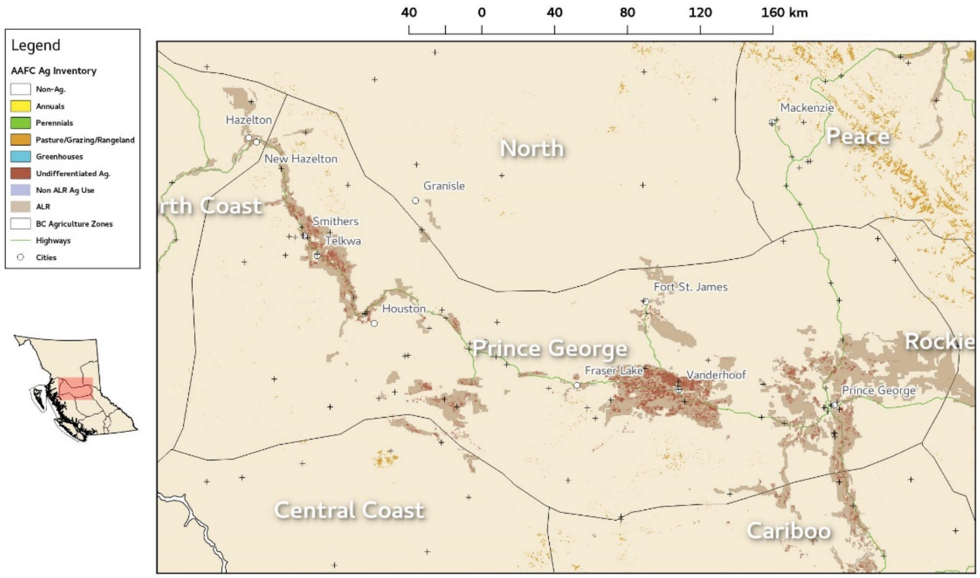

Figure 7. Map depicting the Prince George agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Prince George region, the inventory shows mostly undifferentiated agricultural land with some Pasture/Grazing/Rangeland. A substantial amount of the land area is designated ALR.

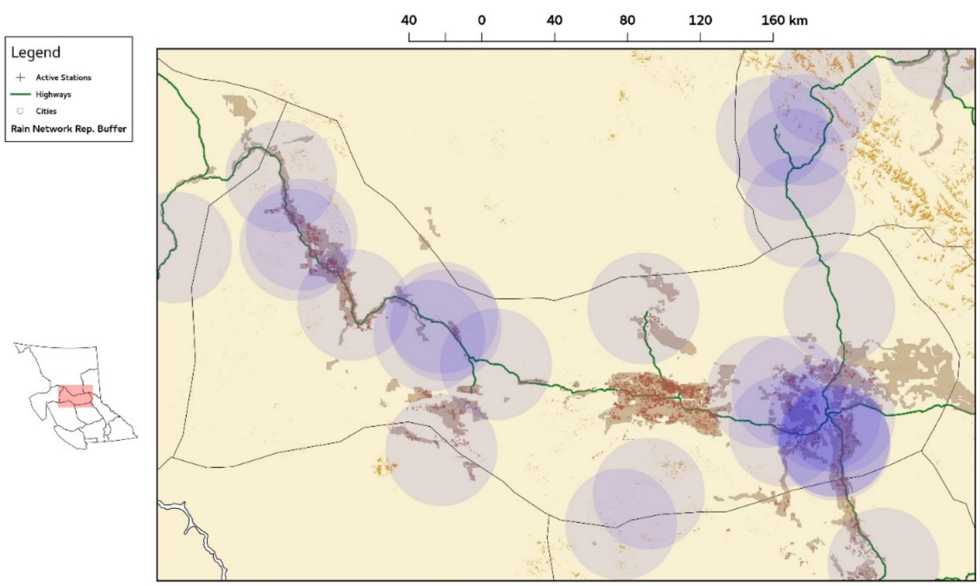

Figure 8. Map depicting the Prince George agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

Table 7. Statistics describing the area coverage of stations by variable within the Prince George agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	68	789	661	0	2549
Humidity	56	958	919	0	7060
Precipitation	49	1095	1011	76	2637
Rainfall	47	1141	1018	219	2713
AS Precipitation	27	1987	1837	76	4958
Snow	22	2438	2259	76	6918
Wind	58	925	880	0	6776
Any Radiation	5	10728	26444	7665	145541
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	5	10728	26444	7665	145541
Long Wave	0	NA	NA	NA	NA
Air Pressure	20	2682	3596	42	22044
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	0	NA	NA	NA	NA

Table 8. Local field variance (σ_T) and distance of representativeness scales for the "Prince George" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	3.5	0	50	4.4	0	60	59	60
Feb.	3.0	0	190	3.9	0	140	56	40
Mar.	2.1	20	750	2.5	0	350	55	50
Apr.	1.7	60	850	1.2	30	2360	57	60
May	2.1	40	1330	1.4	240	3360	50	80
Jun.	1.9	70	1350	1.2	190	1210	50	120
Jul.	1.8	50	1280	1.0	70	1450	54	60
Aug.	1.8	30	1180	1.1	30	1510	59	30
Sep.	2.0	130	1100	1.1	80	2940	51	40
Oct.	1.5	30	2300	1.2	40	2430	43	60
Nov.	2.5	0	400	2.9	0	370	40	20
Dec.	3.3	0	110	4.0	0	80	53	10

5. Rockies

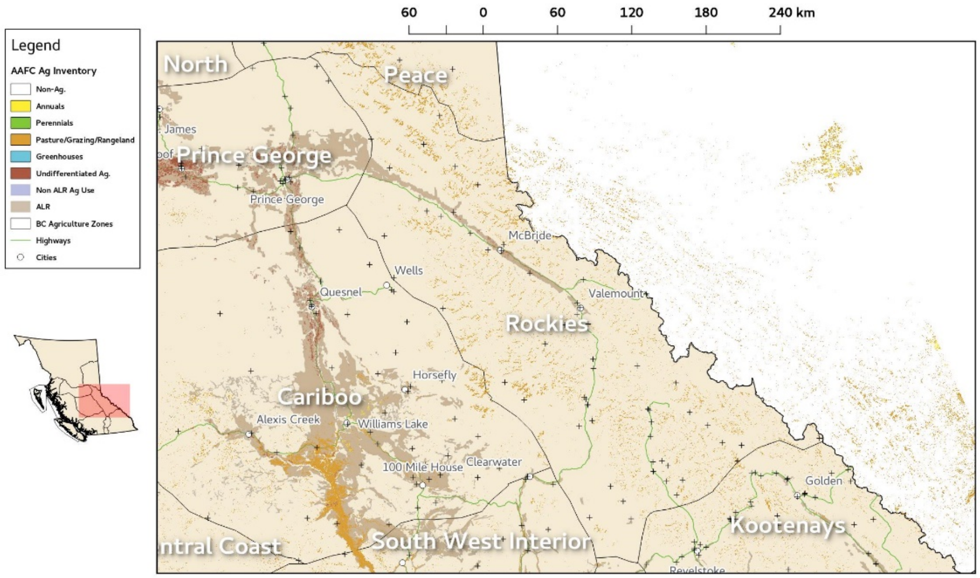

Figure 9. Map depicting the Rockies agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Rockies region, the inventory shows limited agricultural land use primarily as Pasture/Grazing/Rangeland with limited undifferentiated agricultural.

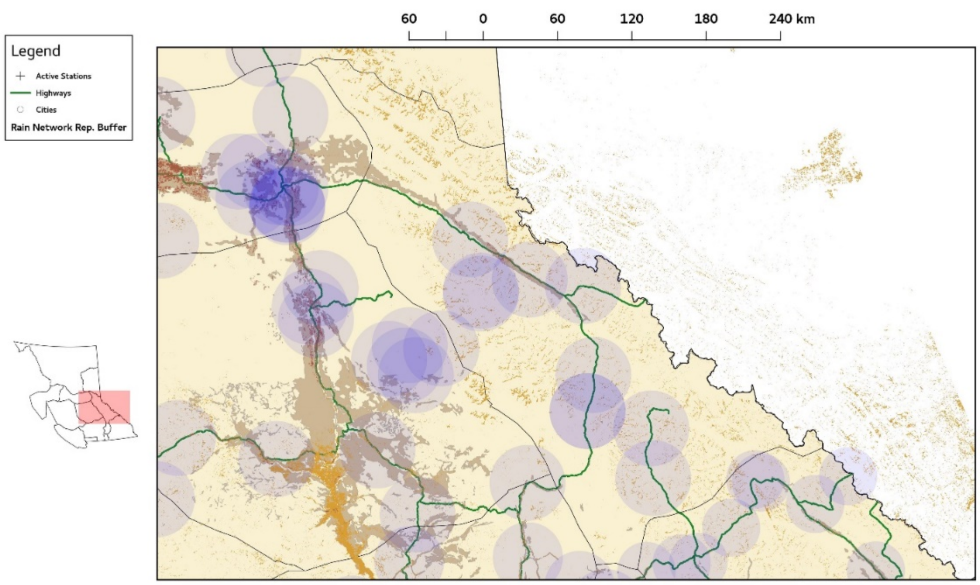

Figure 10. Map depicting the Rockies agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

*Table 9. **Statistics describing the area coverage of stations by variable within the Rockies agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.***

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	60	918	810	85	2887
Humidity	40	1377	1259	265	3853
Precipitation	58	949	832	76	2887
Rainfall	56	983	832	85	2888
AS Precipitation	33	1669	1566	85	3937
Snow	30	1836	1751	85	4388
Wind	38	1449	1409	265	3853
Any Radiation	0	NA	NA	NA	NA
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	0	NA	NA	NA	NA
Long Wave	0	NA	NA	NA	NA
Air Pressure	10	5507	4447	972	10662
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	2	27533	29767	7541	51993

Table 10. Local field variance (σ_T) and distance of representativeness scales for the "Rockies" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.5	0	20	3.3	0	20	62	60
Feb.	2.4	0	130	3.4	0	90	68	60
Mar.	2.1	10	670	2.2	0	290	48	40
Apr.	1.9	30	760	1.4	20	2360	37	40
May	2.2	10	1290	1.2	160	3360	43	60
Jun.	1.9	30	1350	1.0	90	1210	40	100
Jul.	2.2	40	1270	1.0	30	1450	55	60
Aug.	1.9	20	1120	1.2	10	1510	43	20
Sep.	2.3	110	1080	1.2	60	2940	53	50
Oct.	1.5	10	2120	1.4	30	2430	45	70
Nov.	2.1	0	320	2.5	0	330	40	40
Dec.	2.5	0	40	3.1	0	50	38	10

6. Central Coast

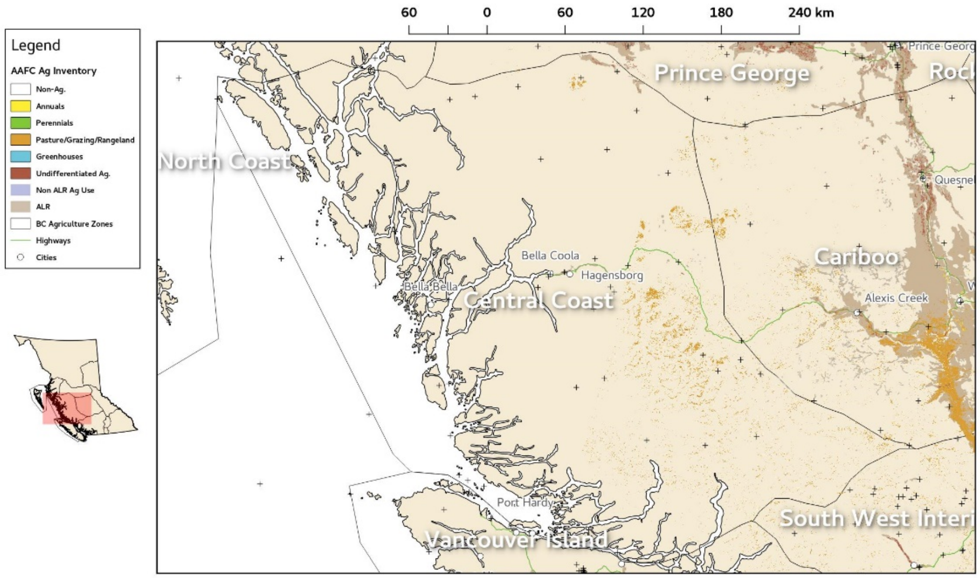

Figure 11. Map depicting the Central Coast agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Rockies region, the inventory shows limited agricultural land use primarily as Pasture/Grazing/Rangeland with limited undifferentiated agricultural.

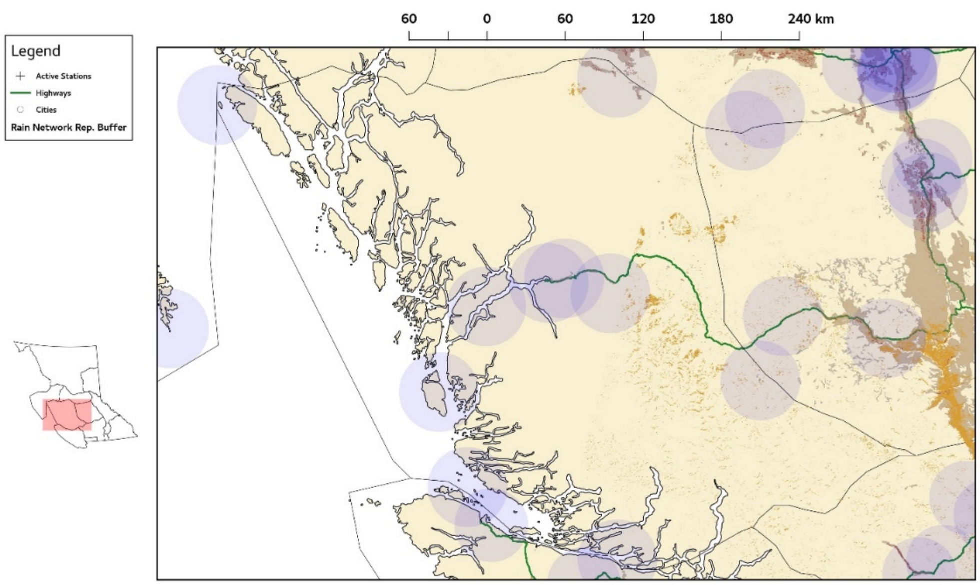

Figure 12. Map depicting the Central Coast agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

***Table 11.** Statistics describing the area coverage of stations by variable within the Central Coast agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.*

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	44	2667	1974	271	7036
Humidity	25	4695	3130	387	11180
Precipitation	44	2667	1988	271	7117
Rainfall	39	3009	2179	271	7121
AS Precipitation	30	3912	2675	389	9241
Snow	28	4192	2957	734	9241
Wind	21	5589	4131	1366	10604
Any Radiation	2	58683	37807	34243	41372
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	2	58683	42145	34243	50046
Long Wave	0	NA	NA	NA	NA
Air Pressure	10	11737	8820	4281	15289
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	0	NA	NA	NA	NA

***Table 12.** Local field variance (σ_T) and distance of representativeness scales for the "Central Coast" agricultural region.*

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.3	0	20	2.8	0	20	46	60
Feb.	2.5	0	110	2.6	0	70	51	60
Mar.	2.0	10	690	2.1	0	230	50	80
Apr.	1.7	50	820	1.2	30	2360	52	60
May	1.9	30	1330	1.2	190	3360	49	90
Jun.	2.0	50	1350	1.1	140	1210	50	100
Jul.	1.9	50	1280	1.0	60	1450	65	60
Aug.	1.5	10	1080	1.0	30	1510	63	30
Sep.	2.0	90	1040	1.0	40	2940	70	50
Oct.	1.6	10	2120	1.2	20	2430	38	50
Nov.	2.0	0	300	2.2	0	230	37	30
Dec.	2.4	0	50	3.1	0	40	45	10

7. Cariboo

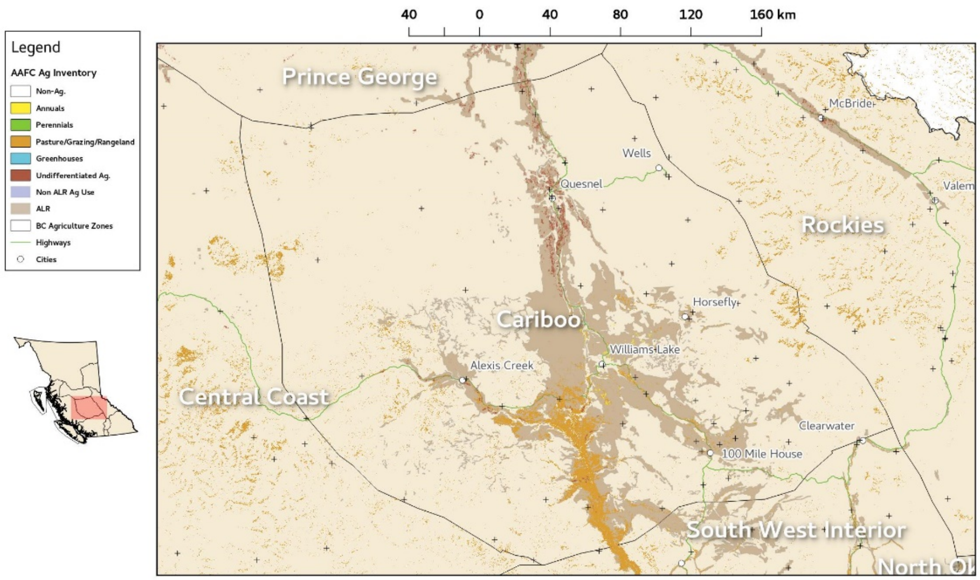

***Figure 13.** Map depicting the Cariboo agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Cariboo region, the inventory shows primarily Pasture/Grazing/Rangeland with undifferentiated agricultural and annuals also present.*

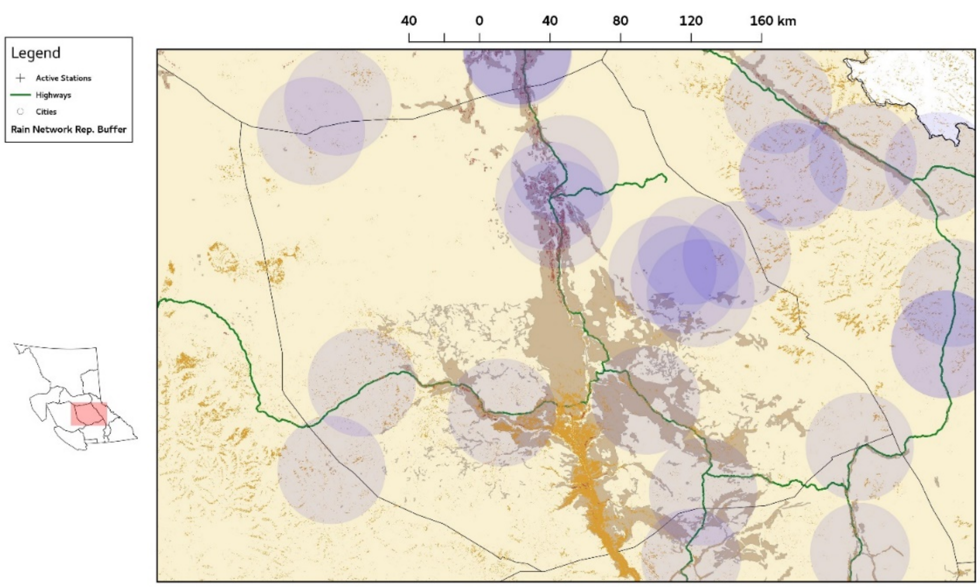

***Figure 14.** Map depicting the Cariboo agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.*

Table 13. Statistics describing the area coverage of stations by variable within the Cariboo agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	58	1159	978	41	4316
Humidity	43	1563	1234	41	4921
Precipitation	54	1245	1001	165	4316
Rainfall	53	1268	1009	165	4316
AS Precipitation	32	2100	1433	168	6514
Snow	31	2168	1396	168	6700
Wind	42	1600	1250	41	4926
Any Radiation	1	67213	22276	22276	22276
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	1	67213	22629	22629	22629
Long Wave	0	NA	NA	NA	NA
Air Pressure	13	5170	4090	452	12269
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	0	NA	NA	NA	NA

Table 14. Local field variance (σ_T) and distance of representativeness scales for the "Cariboo" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	3.4	0	40	4.4	0	40	57	60
Feb.	3.0	0	170	4.0	0	140	66	60
Mar.	2.3	20	740	2.5	0	320	55	50
Apr.	1.8	60	840	1.3	30	2360	56	60
May	2.0	40	1330	1.1	200	3360	52	90
Jun.	2.0	80	1350	1.0	150	1210	50	120
Jul.	1.9	60	1280	1.0	60	1450	56	60
Aug.	1.7	30	1190	1.1	30	1510	61	30
Sep.	2.4	130	1110	1.2	70	2940	55	40
Oct.	1.7	30	2270	1.3	40	2430	46	60
Nov.	2.2	0	350	2.8	0	360	48	50
Dec.	3.1	0	90	3.8	0	70	53	20

8. Kootenay

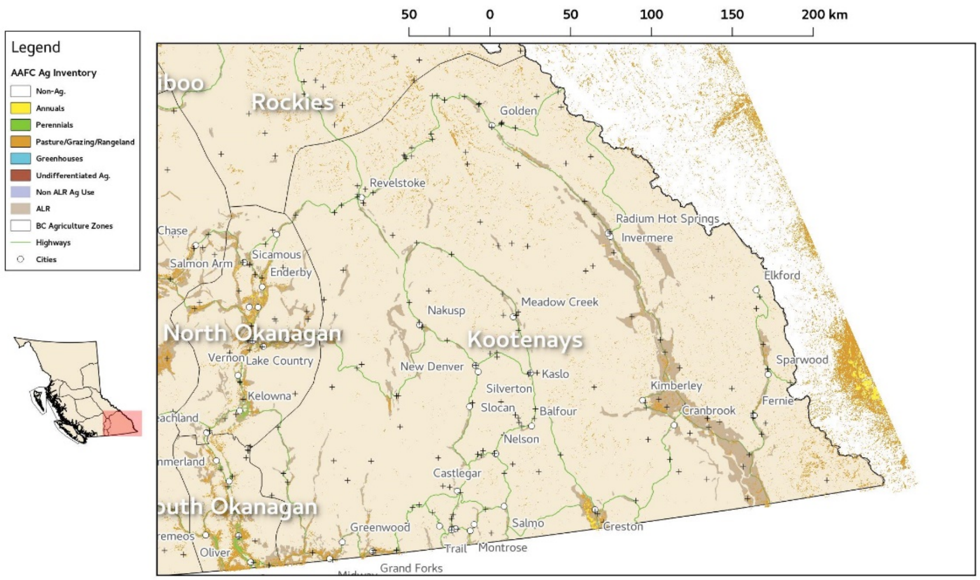

Figure 15. Map depicting the Kootenay agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Kootenay region, the inventory shows primarily Pasture/Grazing/Rangeland with annuals also present.

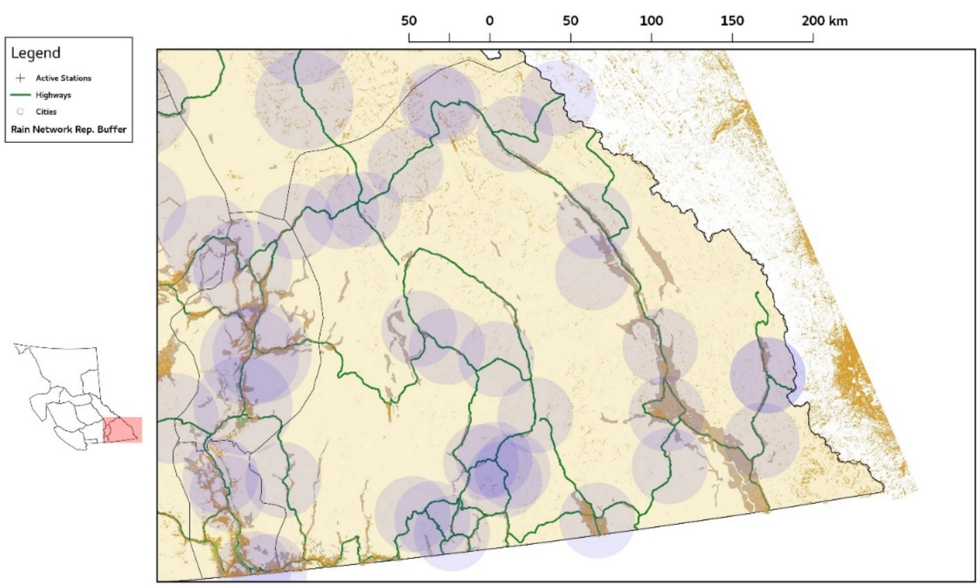

Figure 16. Map depicting the Kootenay agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

Table 15. Statistics describing the area coverage of stations by variable within the Kootenays agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	162	476	410	7	2738
Humidity	106	728	756	7	2985
Precipitation	143	539	457	26	2738
Rainfall	138	559	477	26	2738
AS Precipitation	78	989	853	64	2825
Snow	74	1042	902	64	2825
Wind	102	756	767	20	2985
Any Radiation	1	77126	6420	6420	6420
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	1	77126	61867	61867	61867
Long Wave	0	NA	NA	NA	NA
Air Pressure	29	2660	3274	166	5284
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	12	6427	7001	2285	20753

Table 16. Local field variance (σ_T) and distance of representativeness scales for the "Kootenay" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.1	0	20	2.9	0	20	44	40
Feb.	2.1	0	110	2.7	0	90	57	40
Mar.	2.0	10	630	1.8	0	190	49	60
Apr.	1.9	30	780	1.3	20	2360	41	60
May	1.9	20	1310	1.1	160	3360	44	70
Jun.	1.9	50	1350	1.1	130	1210	45	110
Jul.	2.3	50	1280	1.2	50	1450	54	50
Aug.	2.0	20	1140	1.2	10	1510	66	30
Sep.	2.5	100	1060	1.3	50	2940	62	40
Oct.	1.7	20	2160	1.4	20	2430	56	60
Nov.	1.8	0	230	2.2	0	260	45	30
Dec.	1.9	0	30	2.5	0	30	43	0

9. Vancouver Island

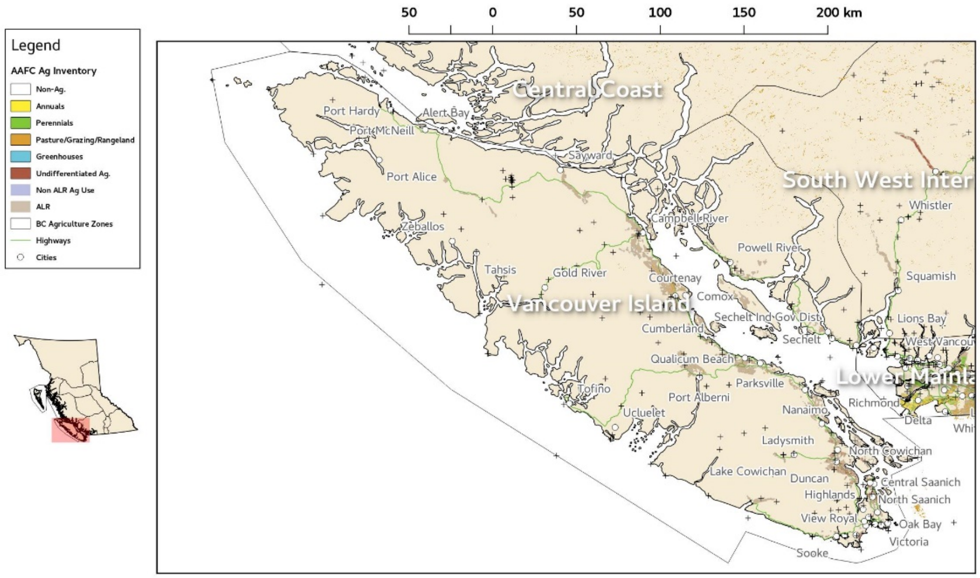

***Figure 17.** Map depicting the Vancouver Island agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Vancouver Island region, the inventory shows primarily undifferentiated agricultural land with annuals also present.*

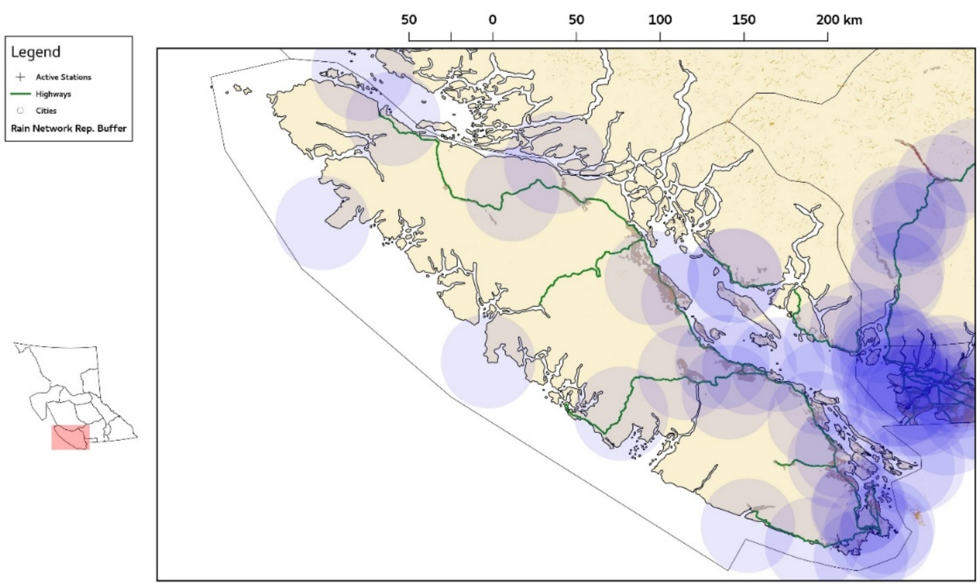

***Figure 18.** Map depicting the Vancouver Island agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.*

Table 17. Statistics describing the area coverage of stations by variable within the Vancouver Island agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	156	446	236	1	2906
Humidity	72	966	438	0	3546
Precipitation	145	480	261	2	2906
Rainfall	139	500	285	2	2906
AS Precipitation	96	725	386	7	6100
Snow	92	756	435	7	6100
Wind	74	940	390	1	4320
Any Radiation	8	8695	2856	95	23677
Net Radiation	1	69557	334	334	334
Photosynthetically Active Radiation	1	69557	334	334	334
Short Wave	6	11593	2684	95	37030
Long Wave	0	NA	NA	NA	NA
Air Pressure	30	2319	1274	71	7079
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	10	6956	3823	51	22288

Table 18. Local field variance (σ_T) and distance of representativeness scales for the "Vancouver Island" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	1.6	0	30	1.7	0	20	41	60
Feb.	1.5	0	110	1.6	0	80	52	60
Mar.	1.4	10	630	1.2	0	180	43	70
Apr.	1.3	30	770	1.1	20	2360	45	70
May	1.5	10	1280	1.1	190	3360	48	90
Jun.	1.7	40	1350	0.9	140	1210	52	120
Jul.	1.6	20	1190	0.9	30	1450	71	60
Aug.	1.4	10	1040	0.9	10	1510	92	40
Sep.	1.4	20	910	1.0	50	2940	77	50
Oct.	1.0	0	1960	1.1	20	2430	56	80
Nov.	1.3	0	260	1.5	0	250	40	50
Dec.	1.4	0	30	1.5	0	30	36	10

10. South Okanagan

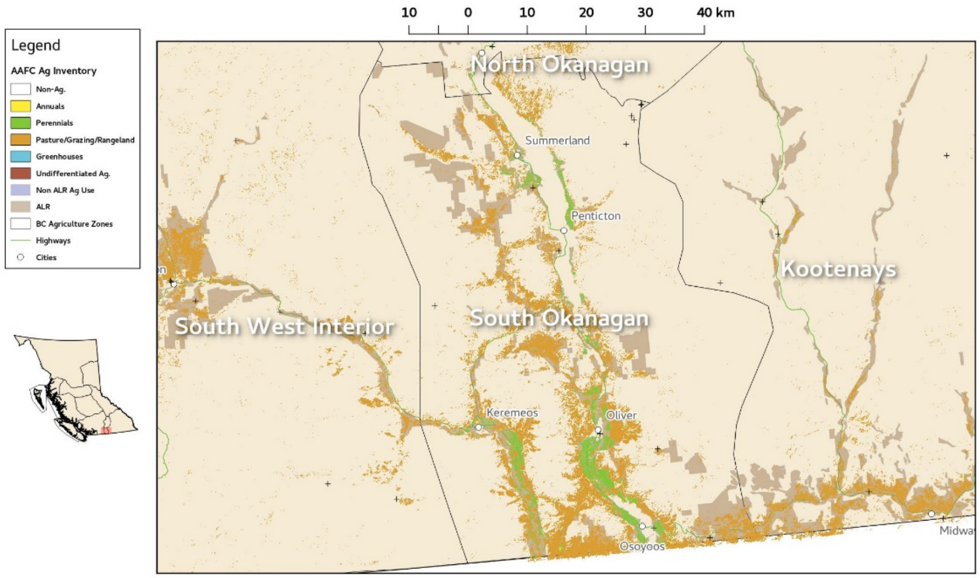

***Figure 19.** Map depicting the South Okanagan agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the South Okanagan region, the inventory shows the abundance of annuals in the form of fruit crops as well as Pasture/Grazing/Rangeland and some Annuals.*

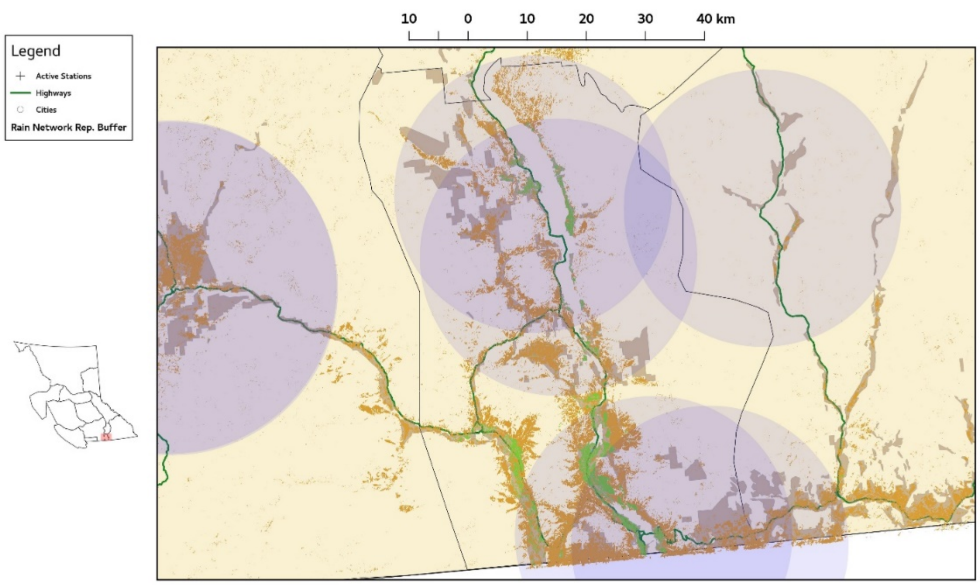

***Figure 20.** Map depicting the South Okanagan agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.*

Table 19. ***Statistics describing the area coverage of stations by variable within the South Okanagan agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.***

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	13	319	342	19	742
Humidity	11	377	473	19	1254
Precipitation	13	319	342	24	742
Rainfall	9	461	384	213	742
AS Precipitation	10	415	388	24	1104
Snow	11	377	392	24	855
Wind	11	377	473	19	1257
Any Radiation	0	NA	NA	NA	NA
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	0	NA	NA	NA	NA
Long Wave	0	NA	NA	NA	NA
Air Pressure	4	1036	1535	1383	1681
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	0	NA	NA	NA	NA

Table 20. ***Local field variance (σ_T) and distance of representativeness scales for the "South Okanagan" agricultural region.***

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.6	0	50	3.0	0	40	53	30
Feb.	2.2	0	160	2.5	0	110	59	30
Mar.	1.9	10	690	1.4	0	200	50	50
Apr.	1.7	60	840	1.3	30	2360	56	70
May	1.8	30	1330	1.2	190	3360	54	90
Jun.	2.0	70	1350	1.3	190	1210	45	100
Jul.	2.0	40	1280	1.3	70	1450	66	50
Aug.	1.8	20	1150	1.3	20	1510	77	20
Sep.	2.1	90	1060	1.3	60	2940	80	40
Oct.	1.4	10	2130	1.3	20	2430	62	60
Nov.	2.0	0	360	2.1	0	310	55	40
Dec.	2.2	0	80	2.5	0	50	59	10

11. Lower Mainland

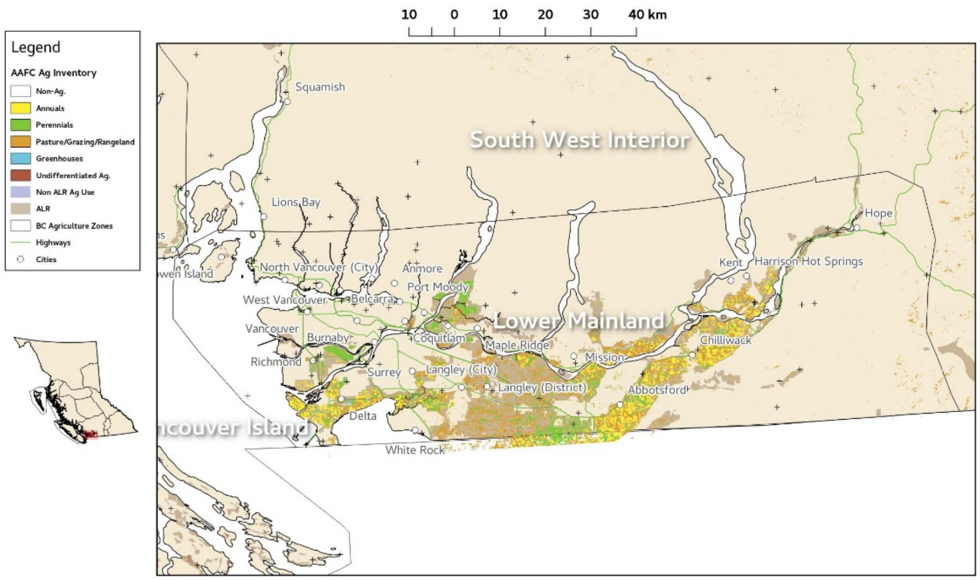

Figure 21. Map depicting the Lower Mainland agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Lower Mainland region, the inventory shows a great diversity of crops including perennials, annuals, and greenhouse crop types.

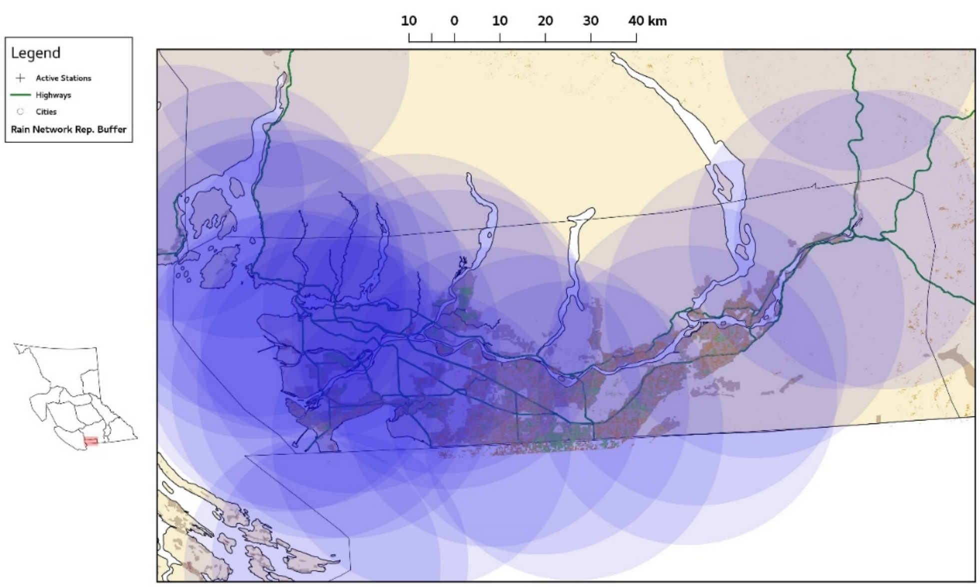

Figure 22. Map depicting the Lower Mainland agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

***Table 21.** Statistics describing the area coverage of stations by variable within the Lower Mainland agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.*

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	82	96	57	9	617
Humidity	47	168	112	14	1006
Precipitation	75	105	65	10	618
Rainfall	73	108	68	10	629
AS Precipitation	42	188	202	16	833
Snow	40	197	237	16	833
Wind	55	143	84	7	1006
Any Radiation	0	NA	NA	NA	NA
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	0	NA	NA	NA	NA
Long Wave	0	NA	NA	NA	NA
Air Pressure	21	375	426	83	1804
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	3	2628	2637	2291	29315

***Table 22.** Local field variance (σ_T) and distance of representativeness scales for the "Lower Mainland" agricultural region.*

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	1.9	0	30	2.1	0	30	39	70
Feb.	1.8	0	140	1.6	0	70	52	70
Mar.	1.7	10	690	1.3	0	210	39	80
Apr.	1.5	50	810	1.1	20	2360	38	80
May	1.7	20	1330	1.1	190	3360	42	100
Jun.	1.8	60	1350	1.0	180	1210	50	130
Jul.	1.7	40	1260	0.9	50	1450	69	70
Aug.	1.6	20	1140	1.0	20	1510	88	50
Sep.	1.7	80	1040	1.1	70	2940	68	60
Oct.	1.2	10	2110	1.1	20	2430	53	90
Nov.	1.5	0	290	1.6	0	280	34	60
Dec.	1.7	0	40	1.8	0	30	37	20

12. Southwest Interior

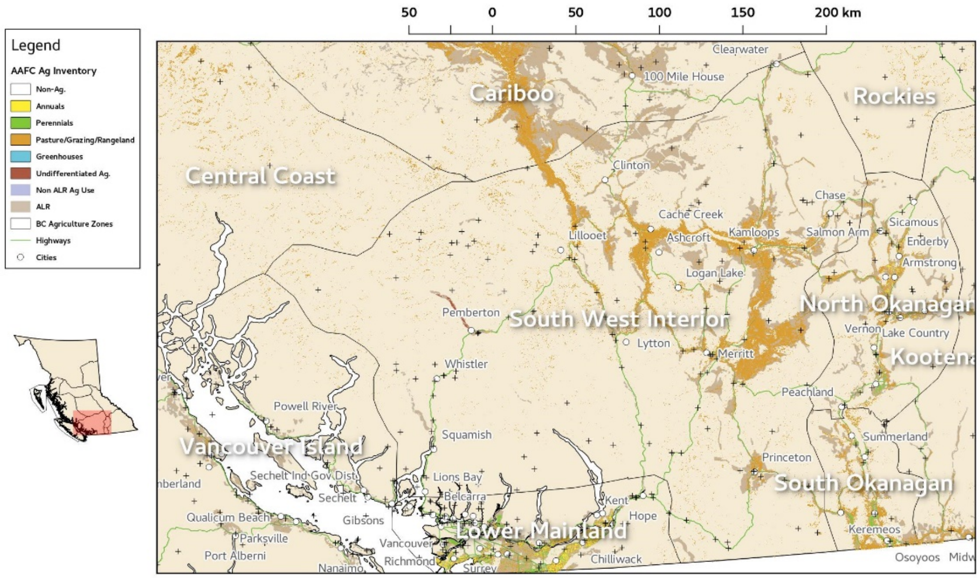

Figure 23. Map depicting the Southwest Interior agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the Southwest Interior region, the inventory shows primarily Pasture/Grazing/Rangeland crop types.

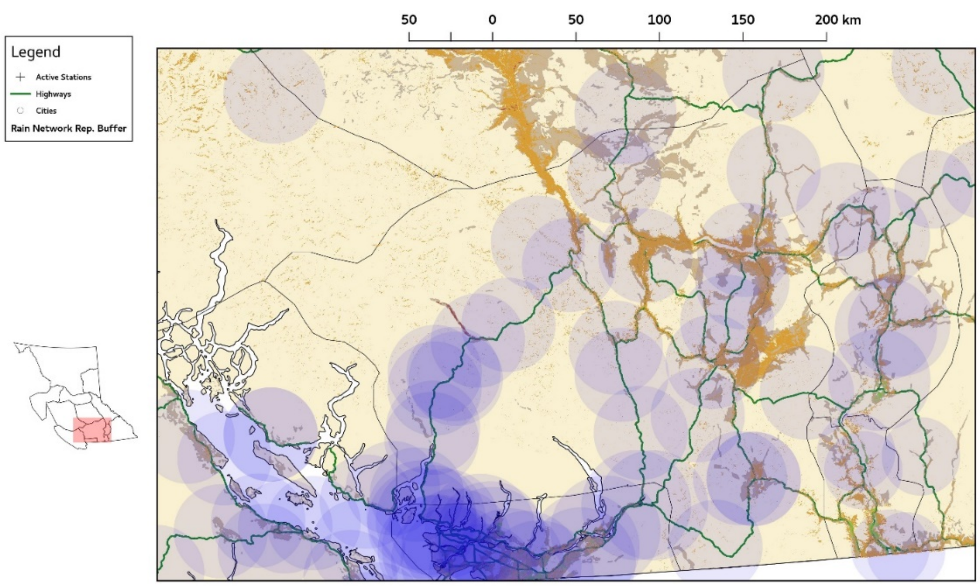

Figure 24. Map depicting the Southwest Interior agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

Table 23. Statistics describing the area coverage of stations by variable within the Southwest Interior agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	137	469	453	17	4205
Humidity	96	669	609	63	5421
Precipitation	128	502	511	23	4205
Rainfall	123	522	518	23	4205
AS Precipitation	75	856	654	110	4716
Snow	71	905	825	110	4716
Wind	86	747	658	71	5421
Any Radiation	10	6424	11967	1577	28094
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	1	64237	55673	55673	55673
Long Wave	0	NA	NA	NA	NA
Air Pressure	28	2294	1993	283	5549
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	7	9177	8381	1804	37830

Table 24. Local field variance (σ_T) and distance of representativeness scales for the "Southwest Interior" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.3	0	20	2.8	0	20	47	40
Feb.	2.2	0	110	2.6	0	90	60	40
Mar.	2.0	10	650	1.8	0	230	48	50
Apr.	1.8	50	810	1.2	20	2360	48	60
May	2.0	20	1330	1.2	200	3360	52	90
Jun.	2.2	60	1350	1.1	150	1210	49	110
Jul.	2.2	50	1280	1.1	50	1450	64	60
Aug.	1.8	20	1150	1.1	20	1510	78	30
Sep.	2.4	100	1060	1.2	60	2940	67	40
Oct.	1.6	10	2140	1.3	20	2430	53	60
Nov.	2.0	0	280	2.2	0	280	49	40
Dec.	2.3	0	30	2.8	0	40	45	10

13. North Okanagan

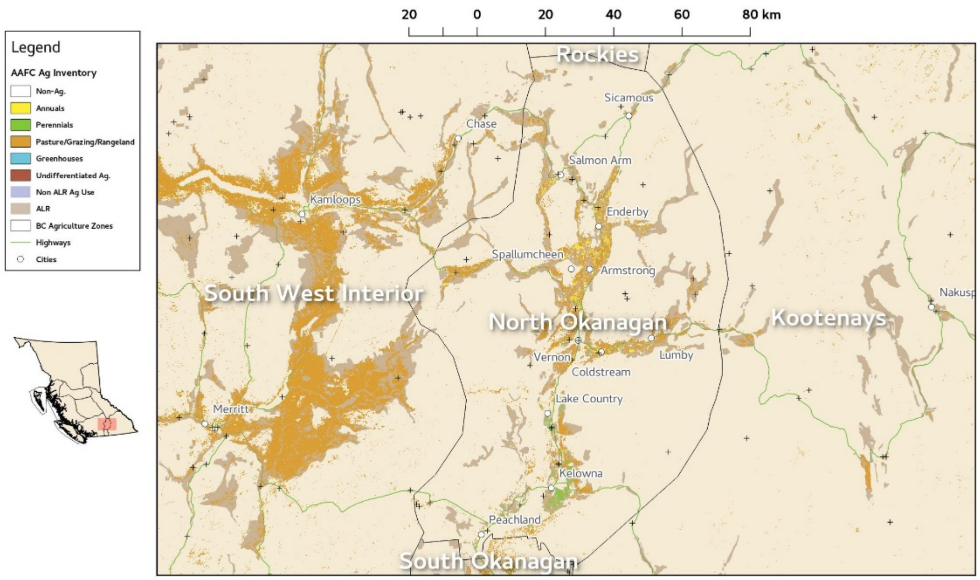

Figure 25. Map depicting the North Okanagan agricultural region. The network of all active stations is shown with crosses. Highways are shown in green, the ALR and non ALR agricultural use regions are indicated. Data from AGRI's Agricultural Land Use Inventory (ALUI) simplified into six categories are depicted. For the North Okanagan region, the inventory shows perennial crops in the southern part of the region and annual crop types elsewhere with abundant area devoted to Pasture/Grazing/Rangeland crop types.

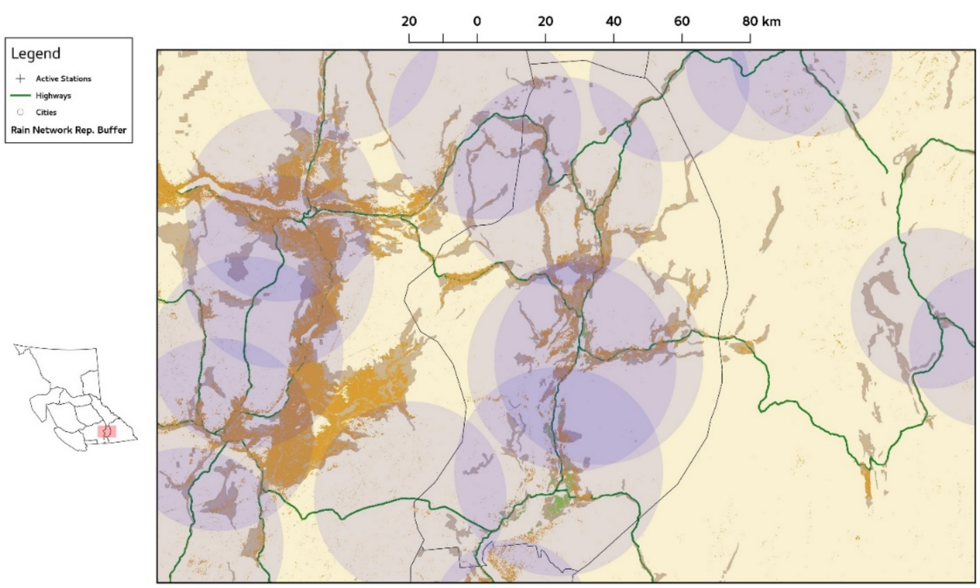

Figure 26. Map depicting the North Okanagan agricultural region with the radius of representativeness for monthly precipitation within 30% accuracy during the summer months June, July and August. The station coverage for this variable and season is a good indicator of gaps that may be present in the network for variables with large temporal and spatial variability such as precipitation.

Table 25. Statistics describing the area coverage of stations by variable within the North Okanagan agricultural region. Area in column 3 was computed by dividing the area of the agricultural region by the number of stations recording a particular variable. Statistics on Avor in the 4th, 5th and 6th columns are based on station area as ascribed by the Voronoi polygon set for the given network for a particular variable.

Variable	N	A (km^2)	Median A_{vor} (km^2)	Min. A_{vor} (km^2)	Max. A_{vor} (km^2)
Temperature	32	302	253	28	894
Humidity	17	568	591	107	935
Precipitation	28	345	291	28	894
Rainfall	28	345	293	28	894
AS Precipitation	22	439	366	85	1384
Snow	22	439	366	85	1384
Wind	15	644	629	107	949
Any Radiation	3	3220	320	1	1730
Net Radiation	0	NA	NA	NA	NA
Photosynthetically Active Radiation	0	NA	NA	NA	NA
Short Wave	0	NA	NA	NA	NA
Long Wave	0	NA	NA	NA	NA
Air Pressure	4	2415	1840	1323	3150
Ground Heat Flux	0	NA	NA	NA	NA
Hydrol. Vars.	0	NA	NA	NA	NA

Table 26. Local field variance (σ_T) and distance of representativeness scales for the "North Okanagan" agricultural region.

	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T °C	0.5 °C (km)	1.0 °C (km)	σ_T %	30 % (km)
	Daily Maximum Temperature			**Daily Minimum Temperature**			**Precipitation**	
Jan.	2.6	0	50	3.4	0	50	46	30
Feb.	2.1	0	170	2.7	0	130	57	40
Mar.	1.9	10	690	1.6	0	240	44	40
Apr.	1.6	60	840	1.1	20	2360	45	60
May	1.9	40	1330	1.2	180	3360	43	90
Jun.	2.0	70	1350	1.2	180	1210	43	110
Jul.	2.1	60	1280	1.2	60	1450	64	60
Aug.	2.0	30	1180	1.2	20	1510	65	30
Sep.	2.3	120	1090	1.3	60	2940	66	50
Oct.	1.3	20	2170	1.2	20	2430	49	60
Nov.	2.2	0	400	2.4	0	360	47	30
Dec.	2.4	0	90	2.8	0	60	46	10