Climate Change Overview: NE Region

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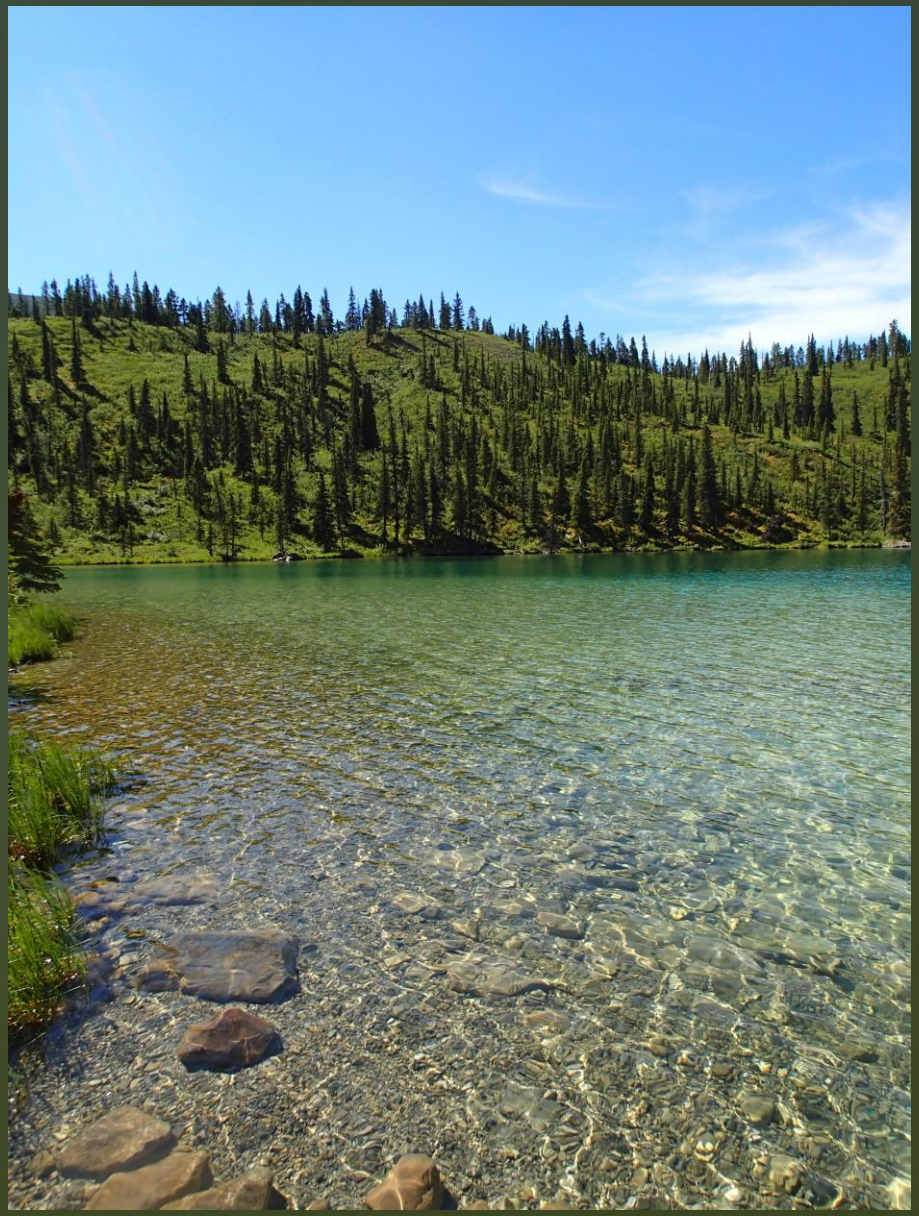
2013/09/11

Outline

- Climate Change Overview
- Northeast BC Trends
- Current Impacts
- Projections
- BC Climate Change Initiatives



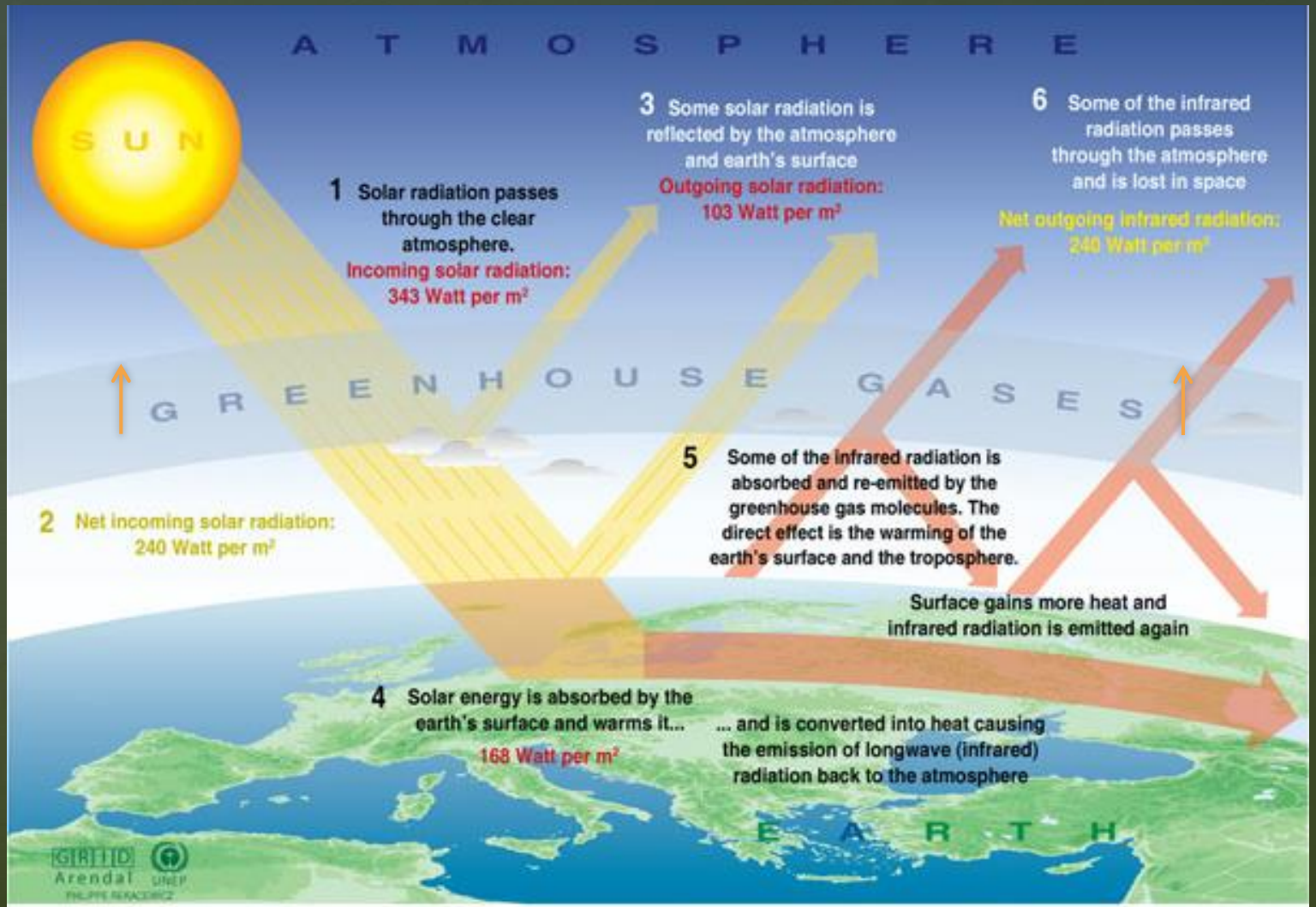
Climate Change Overview

Climate Change and the Greenhouse Effect

Temp↓

Temp↑

Temp↑



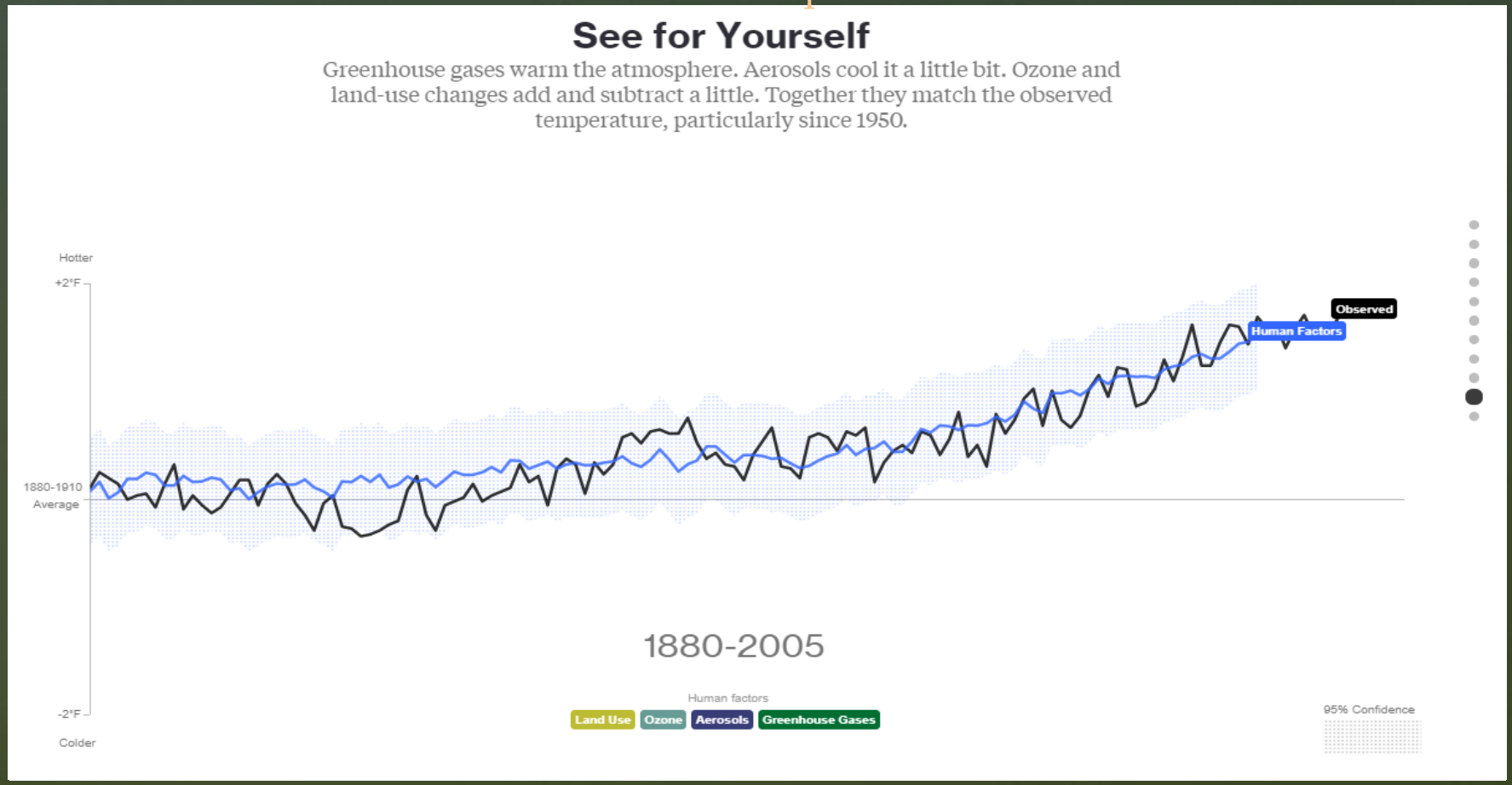
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

2016 = 400 ppm CO_2e

Temp↑

What is natural and what isn't?

Data from: NASA's Goddard Institute for Space Studies



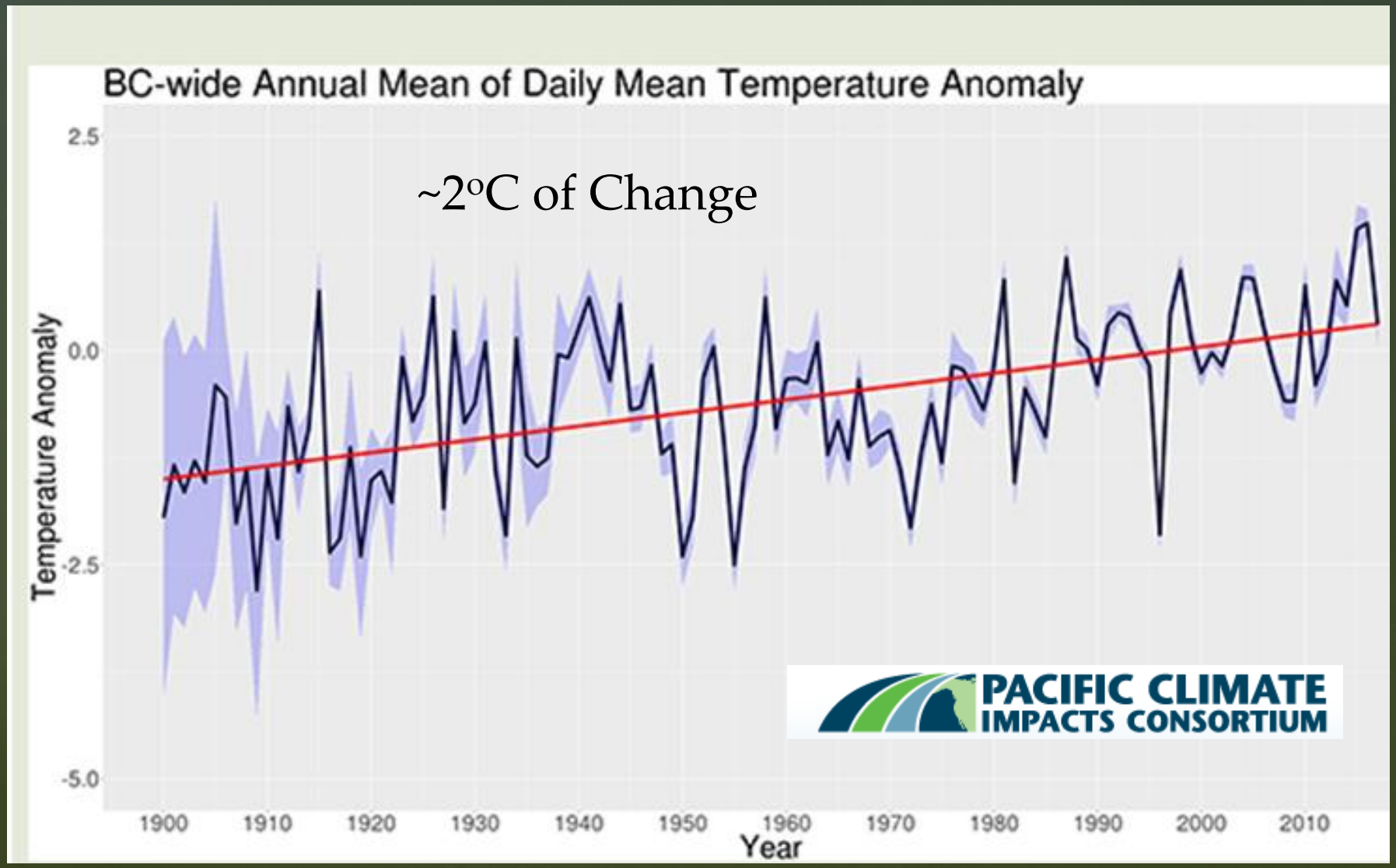
- In BC, only ~13% of warming in mean annual temperature (1948-2012) is explained by natural factors (Wan et al. 2018)

Top Ten Hottest Years (1880-2019)

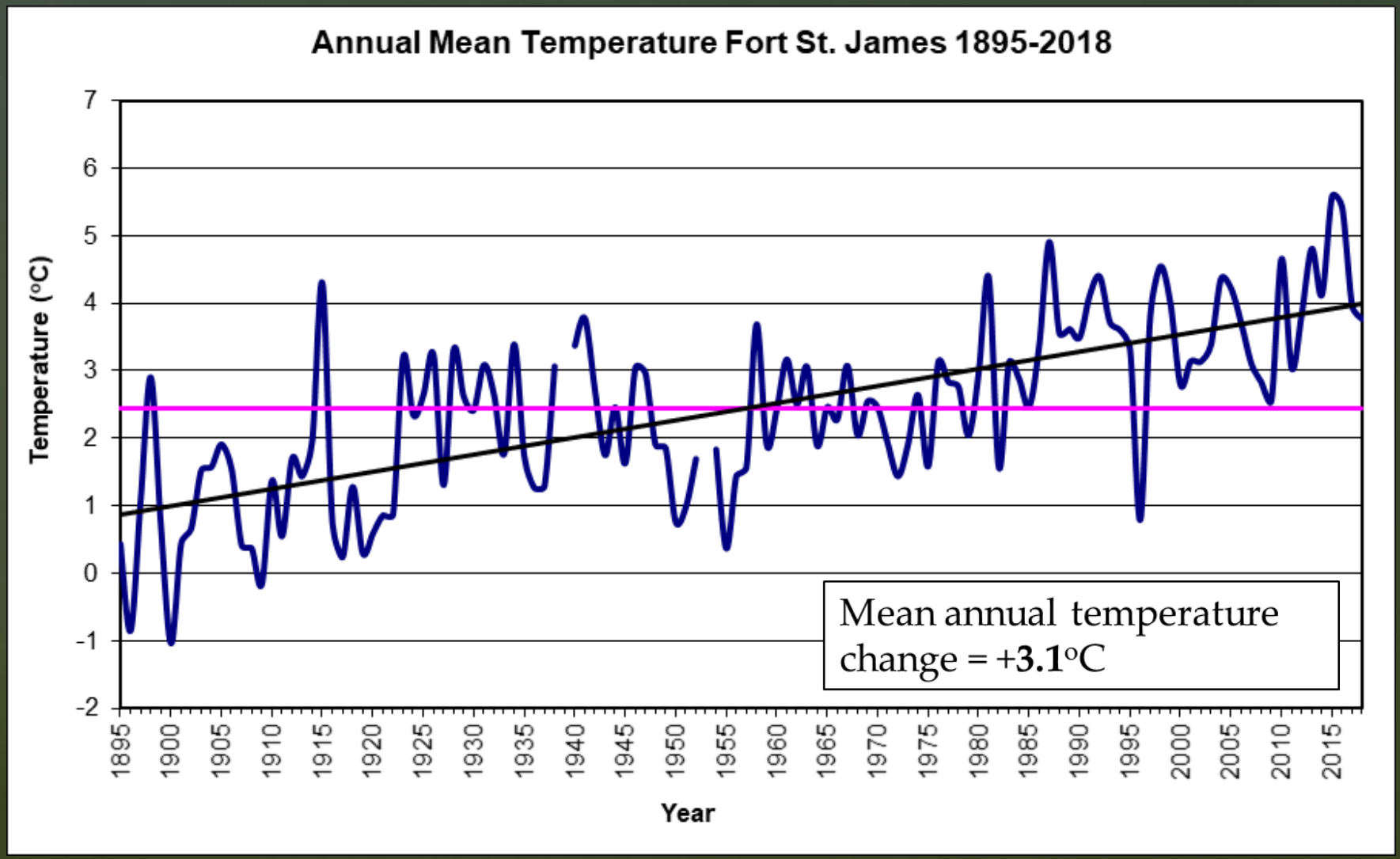
1. 2016
2. 2019
3. 2015
4. 2017
5. 2018
6. 2014
7. 2010
8. 2013
9. 2005
10. 2009

- 5 hottest years on record all occurred in last 5 years
- 10 hottest years have all occurred in the last 15
- Dec 2019 = 420 month in a row with above average global temperature
- Current global warming ~1^{o}C

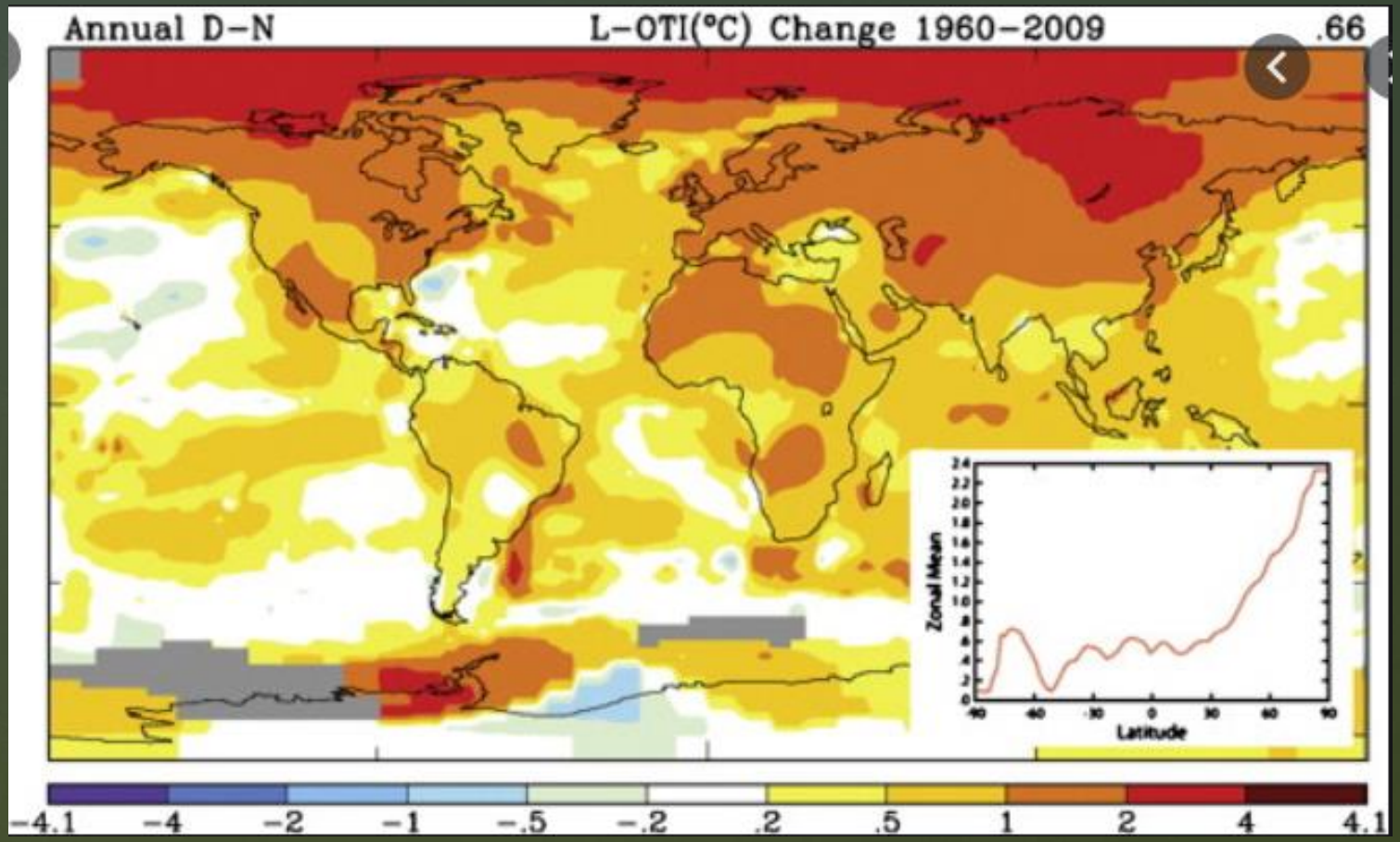
BC Climate Change



Northern BC Climate Change



The Poles warm faster than Equator

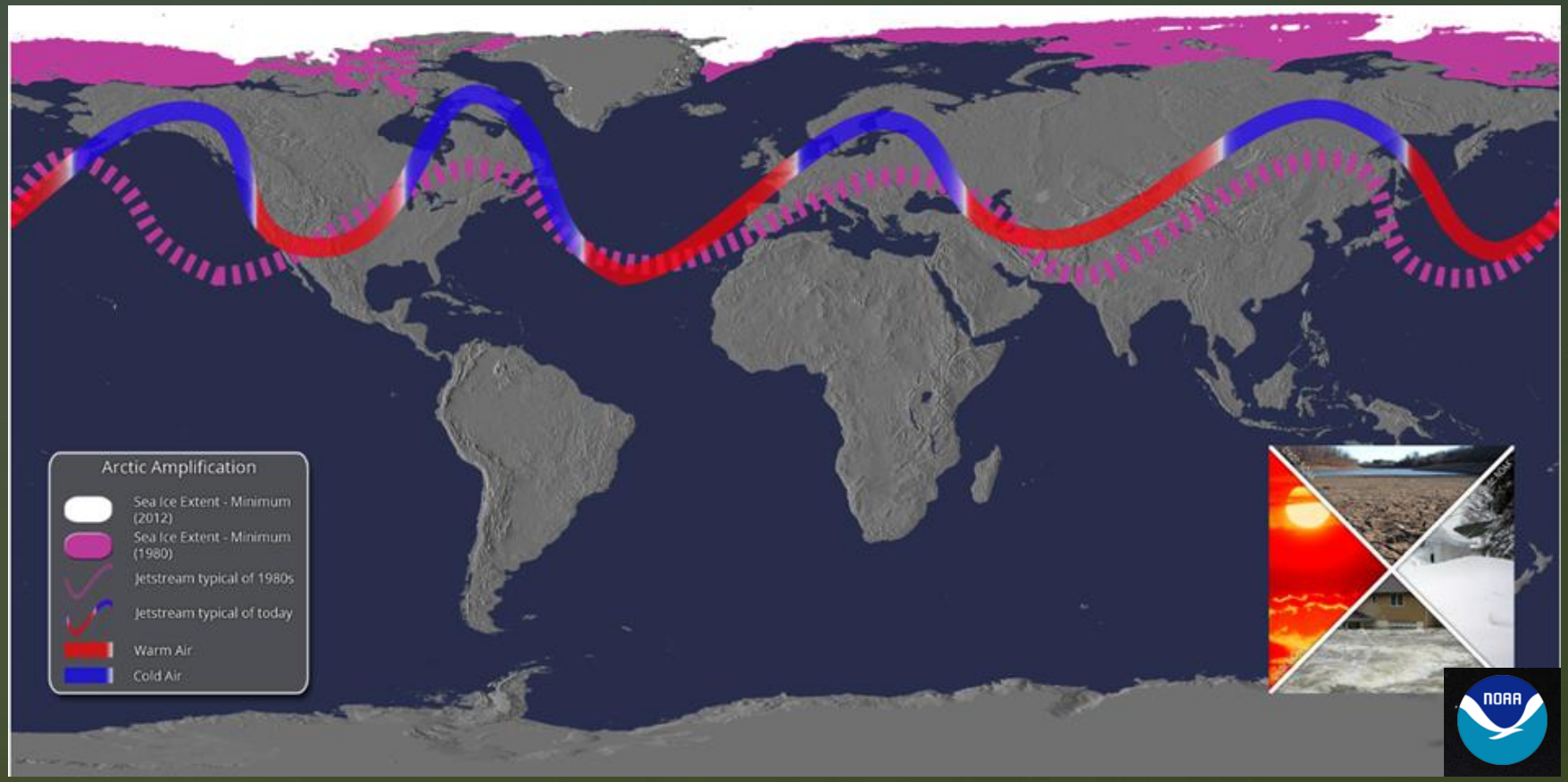


Serreze and Barry, 2011. Global and Planetary Change

Arctic Amplification: loss of sea ice and snow cover enhance temperature increases (lowering albedo, surface and ocean's are darker and absorb more heat – positive feedback loops)

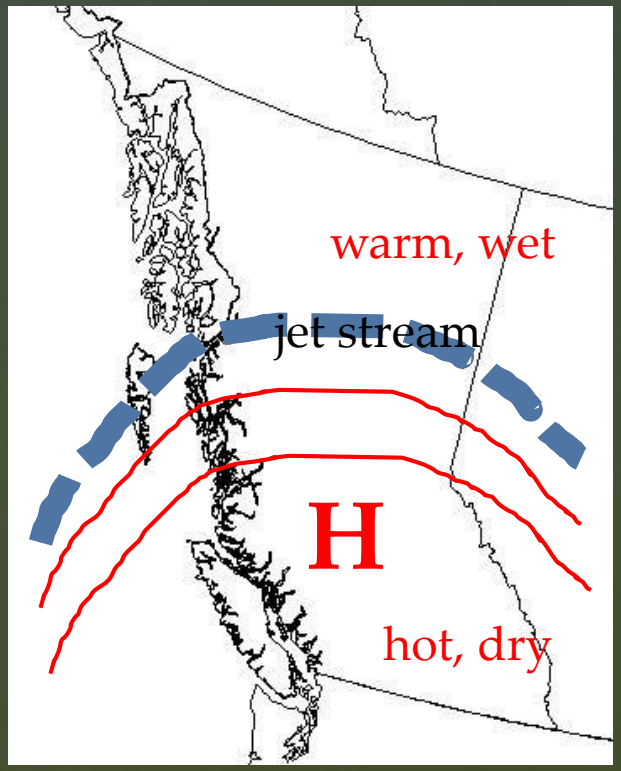
- Darker surfaces absorb heat from solar radiation and cause warming
- Snow and ice reflect solar radiation and cause cooling

Impact to mid-latitude jet stream

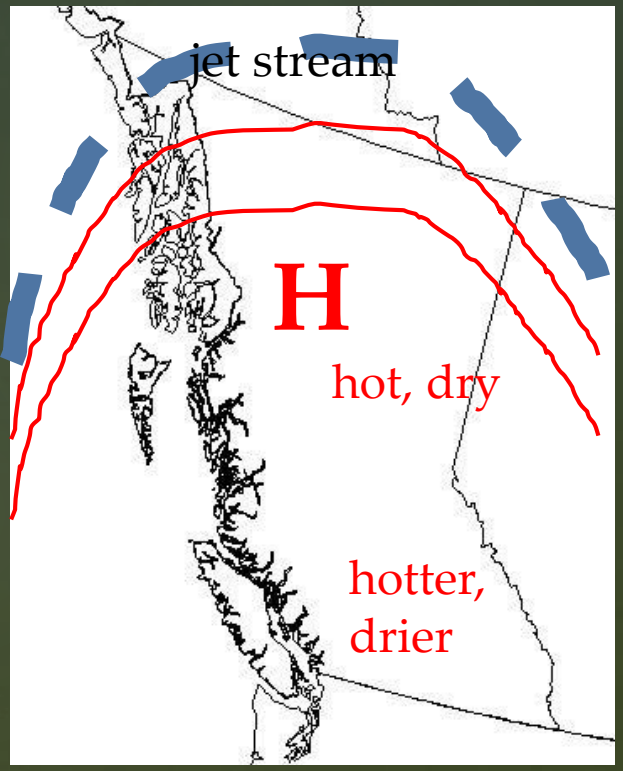


- dissipates heat from the equator to the poles (hot to cold)
- as the temperature difference between the poles and the equator lessens (due to arctic amplification) the mid-latitude jet streams slow down and becomes wavier

Effect on BC weather/extreme events



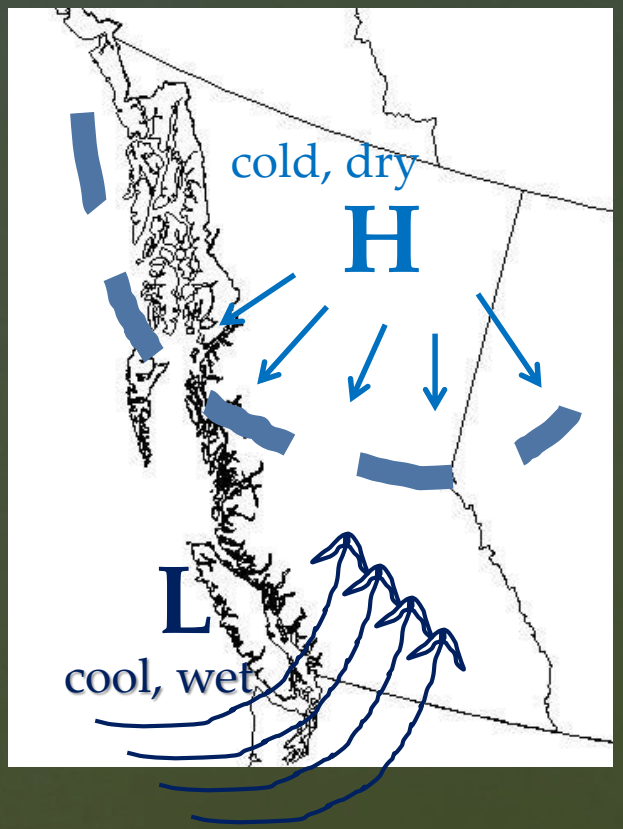
"Typical" summer weather

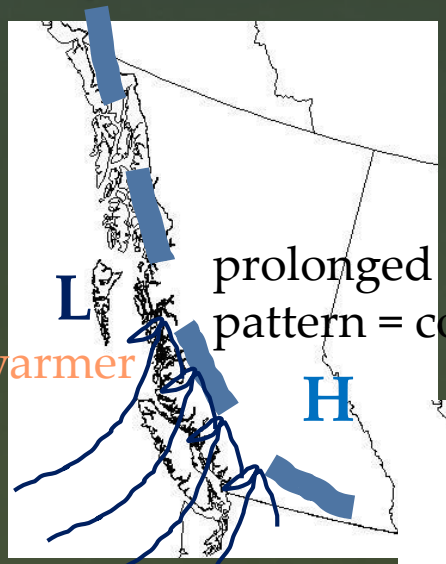


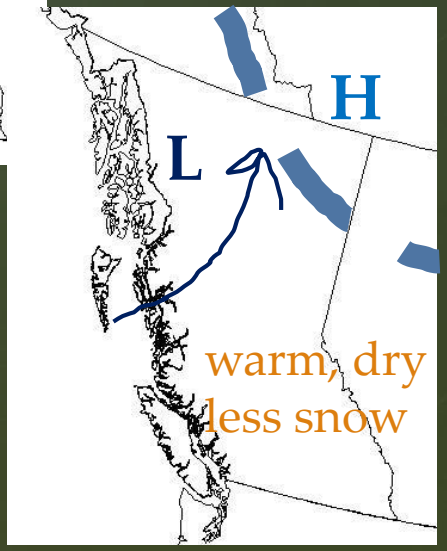
"Future" summer weather
- hotter, larger, longer

Amplification of summer "Pacific Highs" leads to more extreme fire conditions and drought

Effect on BC weather/extreme events



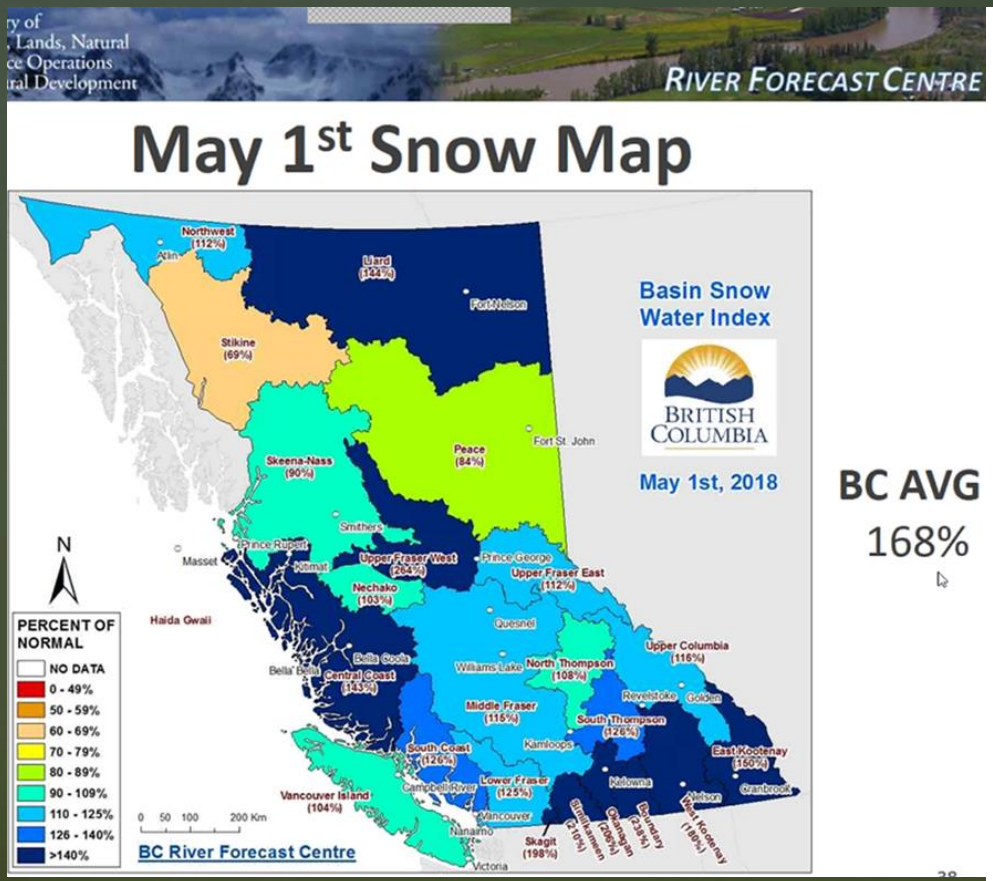




"Typical" winter weather
- jet stream defines boundary between Arctic High (north) and Pacific Low (south)

"Future" winter weather
- depending on location of jet stream, could lead to prolonged cold and extreme coastal precip (spring flooding), or "warm" and dry for most of the province (spring drought, early fire, water shortages)

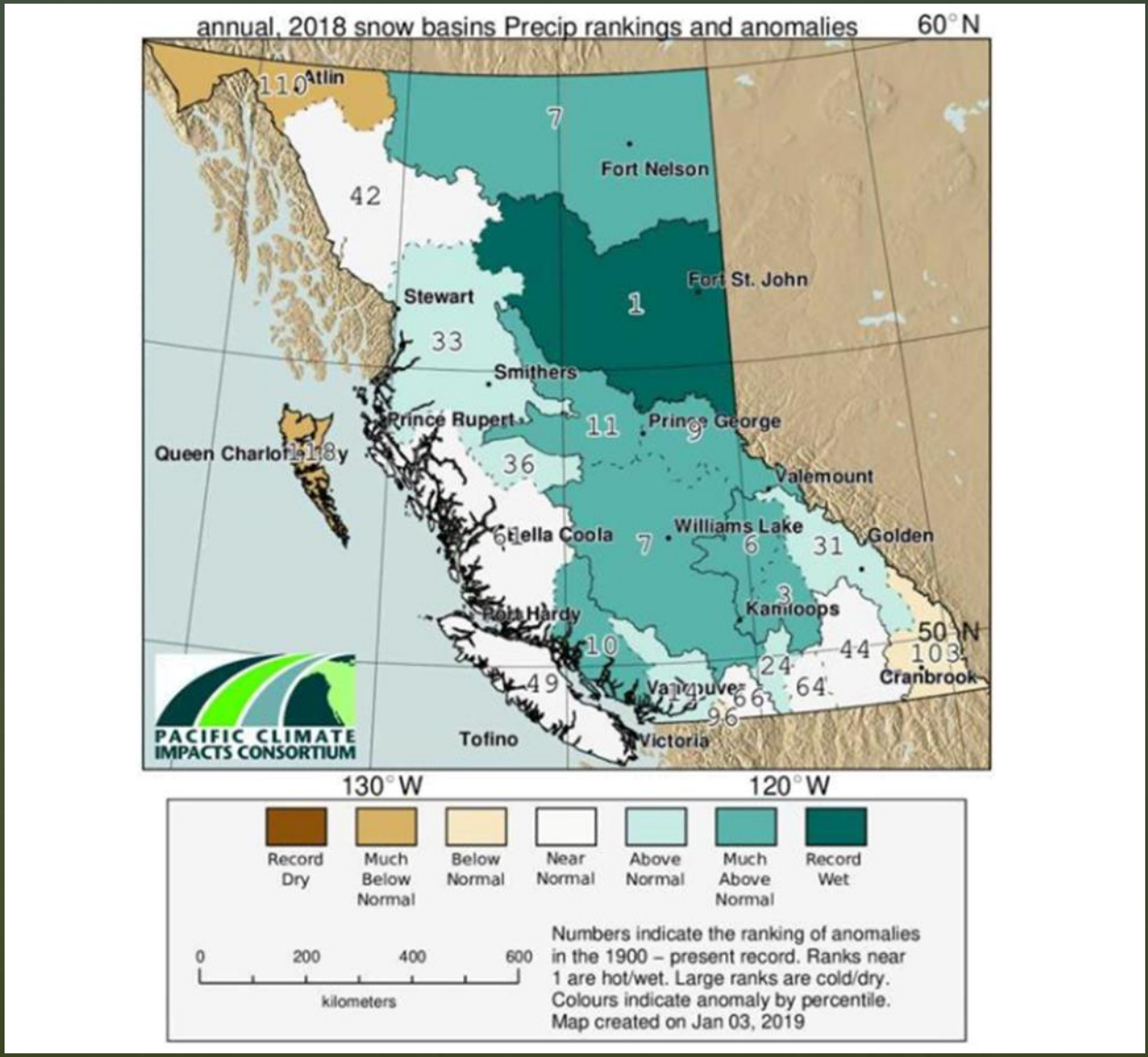
Extreme Events: Too Close Together



- Spring flooding
- Record fire season

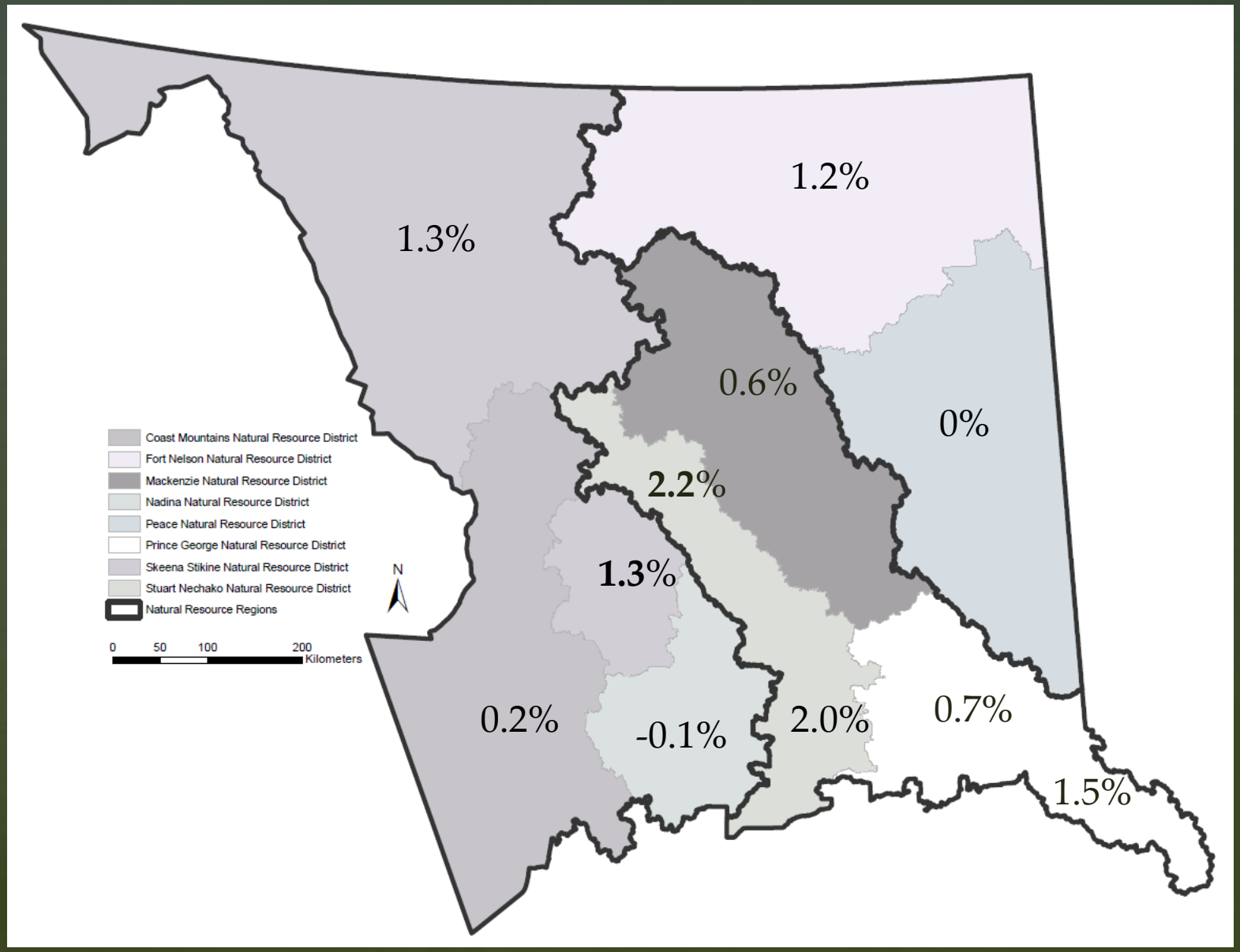
Exact same opposing extreme events within short period of time occurred last year, different areas

Extreme Conditions: Too Close Together

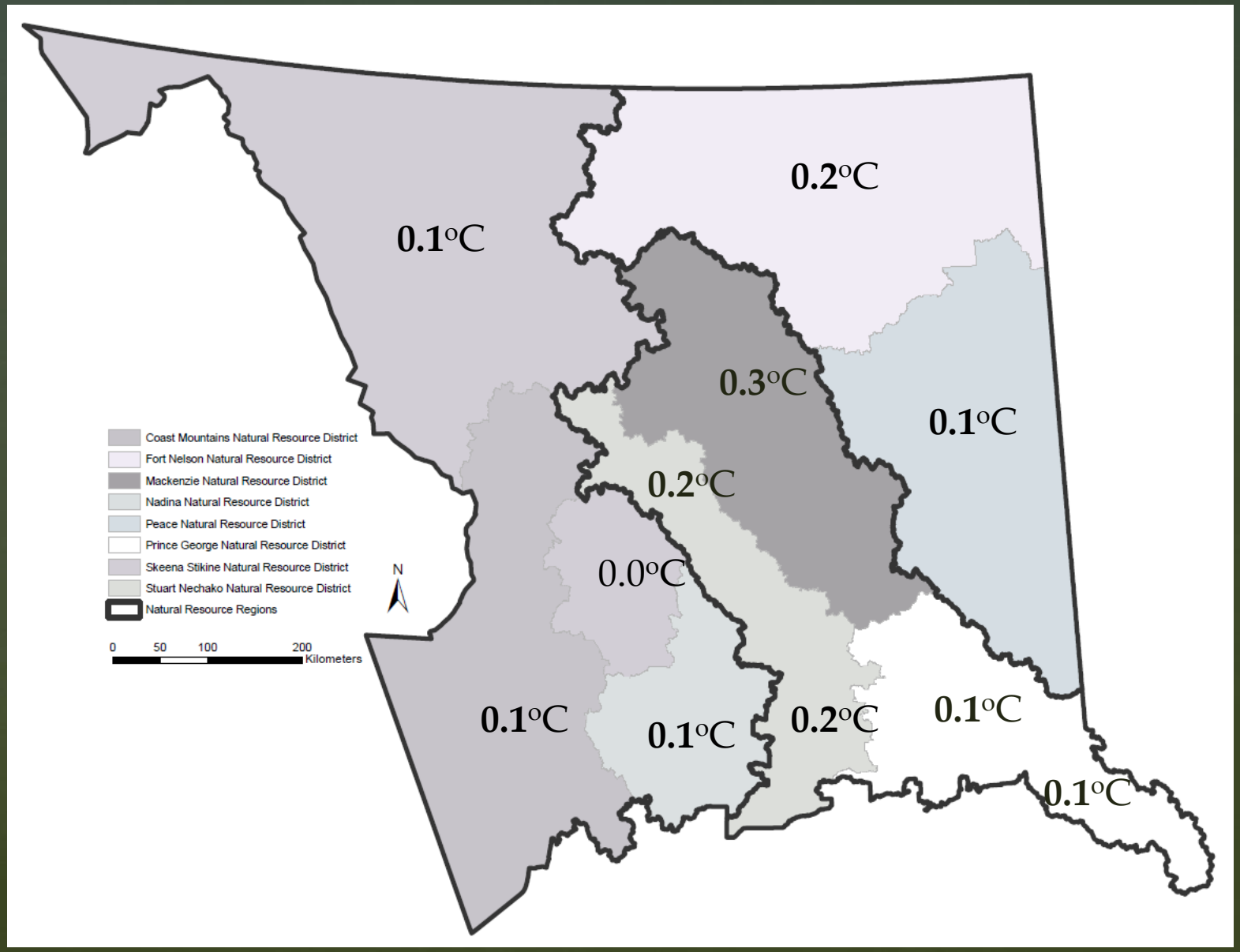


Northeastern BC Climate Trends and Impacts

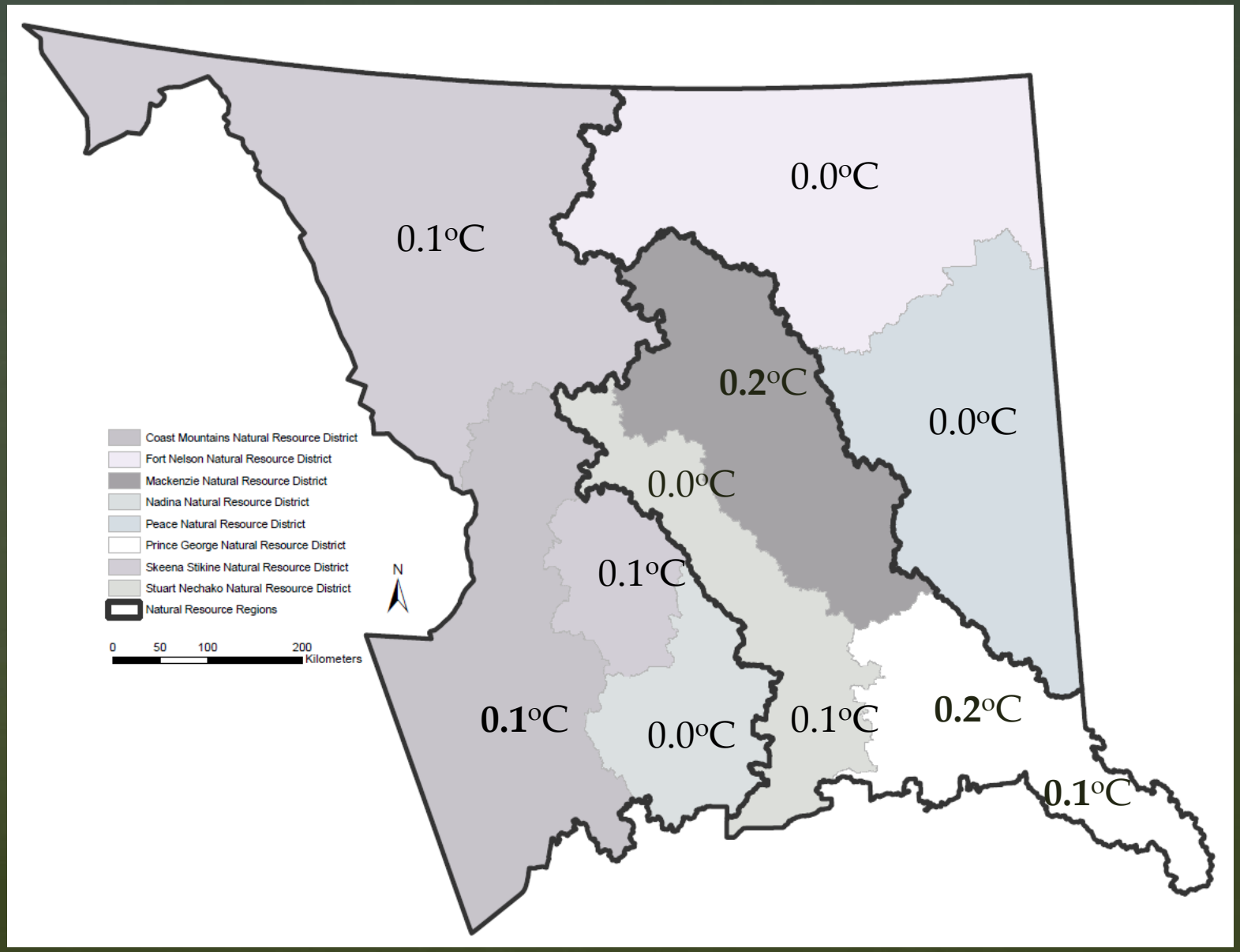
Mean Annual Precipitation Change/Decade



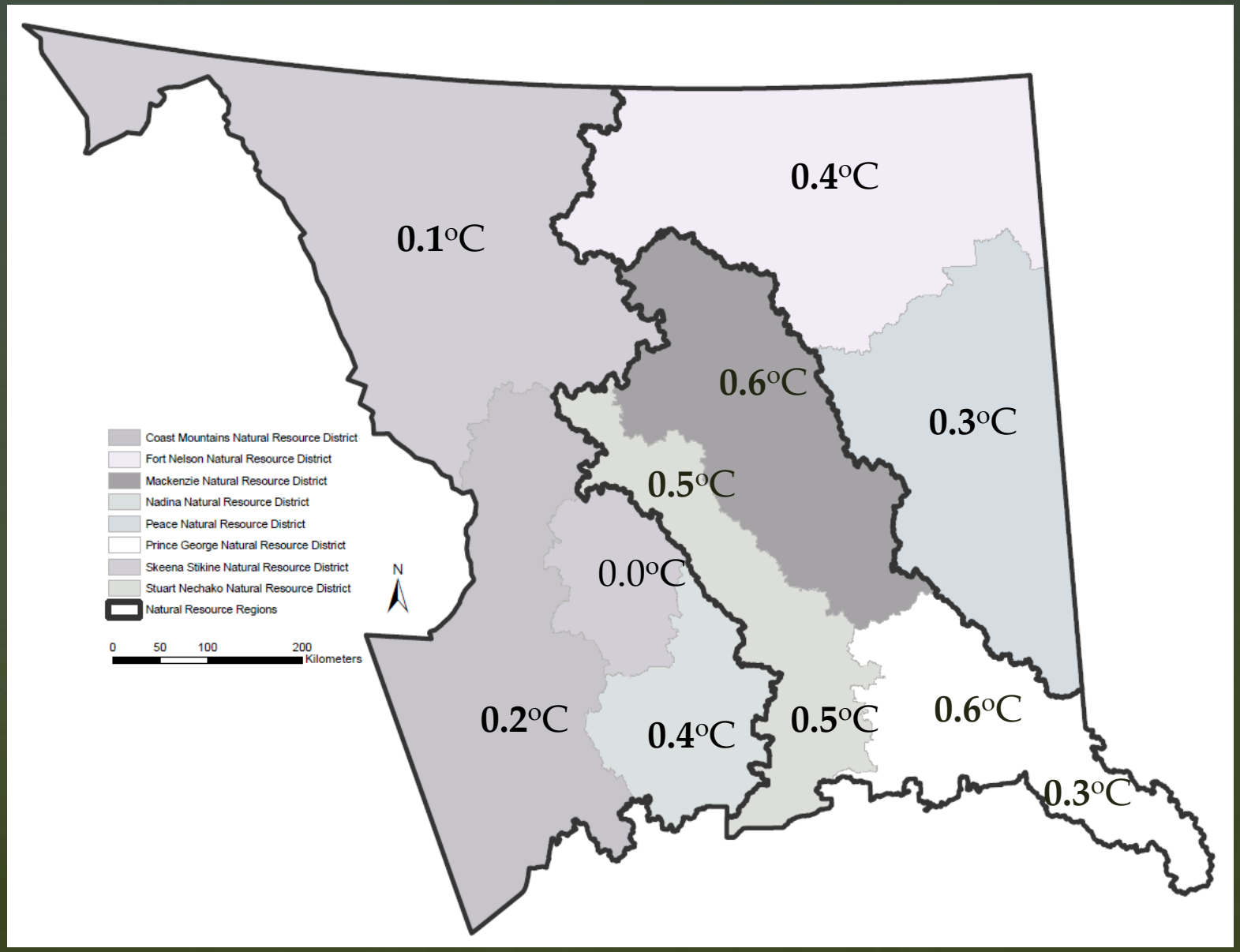
Mean Annual Temperature Change/Decade



Extreme Max Temperature Change/Decade



Extreme Min Temperature Change/Decade



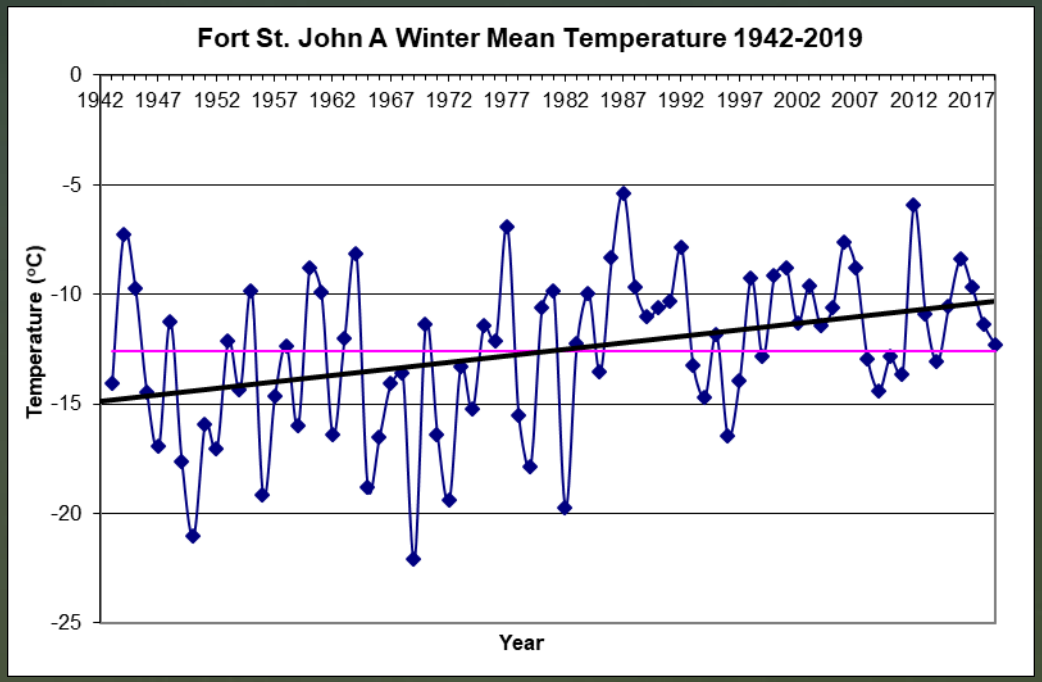
Fort St John Trends

1942-2019

Fort St John A - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	10.7	-18.7	20.6	4.4	**42.2**
Mean Temperature (°C)	**1.6**	**4.6**	1.1	**0.8**	-0.2
Max Temperature (°C)	0.1	**1.7**	0.3	-0.4	-0.6
Min Temperature (°C)	**5.2**	**5.3**	**4.0**	0.8	2.0

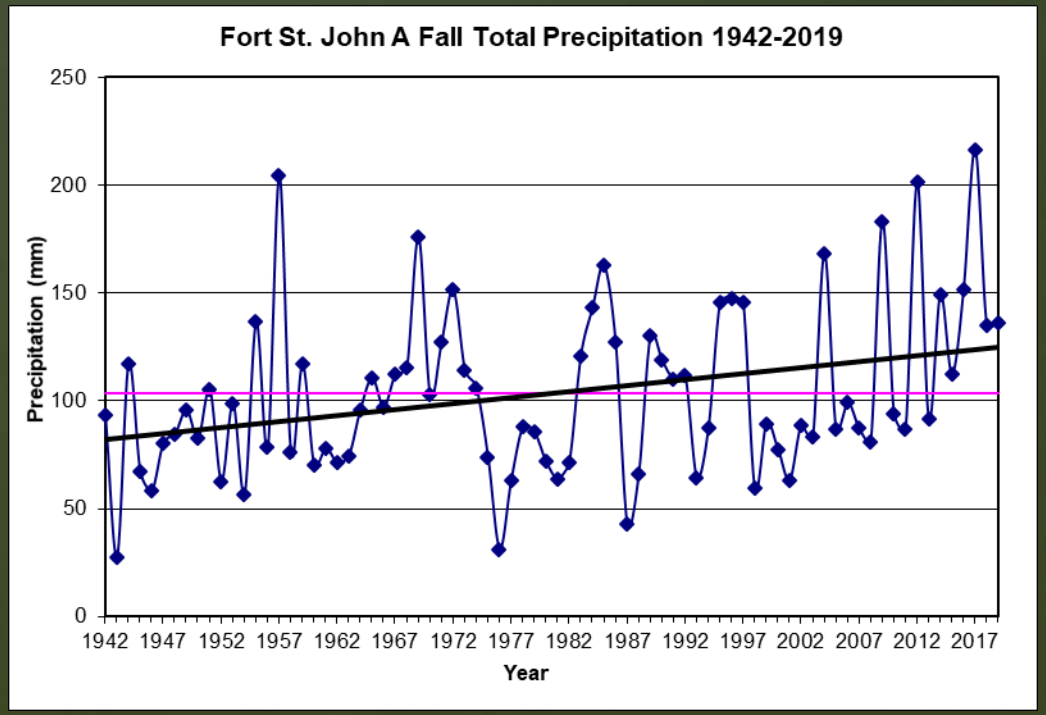
1942-2019

Bold statistically significant $p<0.05$



Fort St John winter mean temperature has increased 4.6°C

Fall total precipitation has increased 42%



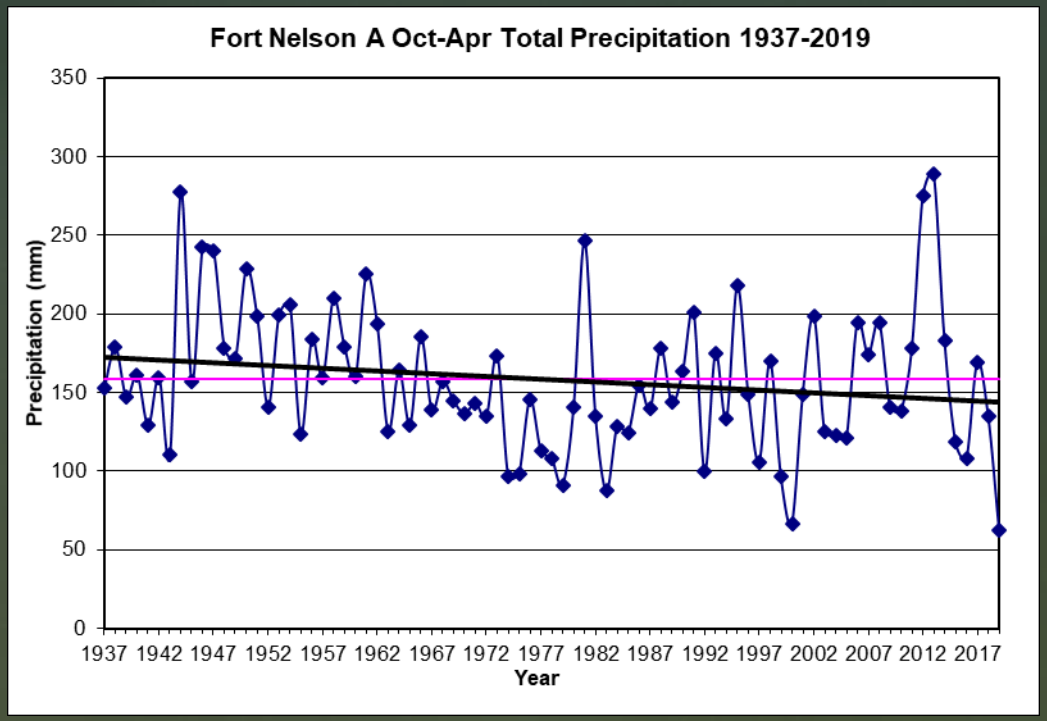
Fort Nelson Trends

1942-2019

Fort Nelson A - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	7.8	**-31.1**	2.6	**28.1**	5.9
Mean Temperature (°C)	**2.0**	**4.9**	**1.6**	**1.1**	0.5
Max Temperature (°C)	-0.2	**3.1**	0.6	-0.3	-1.2
Min Temperature (°C)	**6.4**	**6.7**	**4.7**	0.7	**3.8**

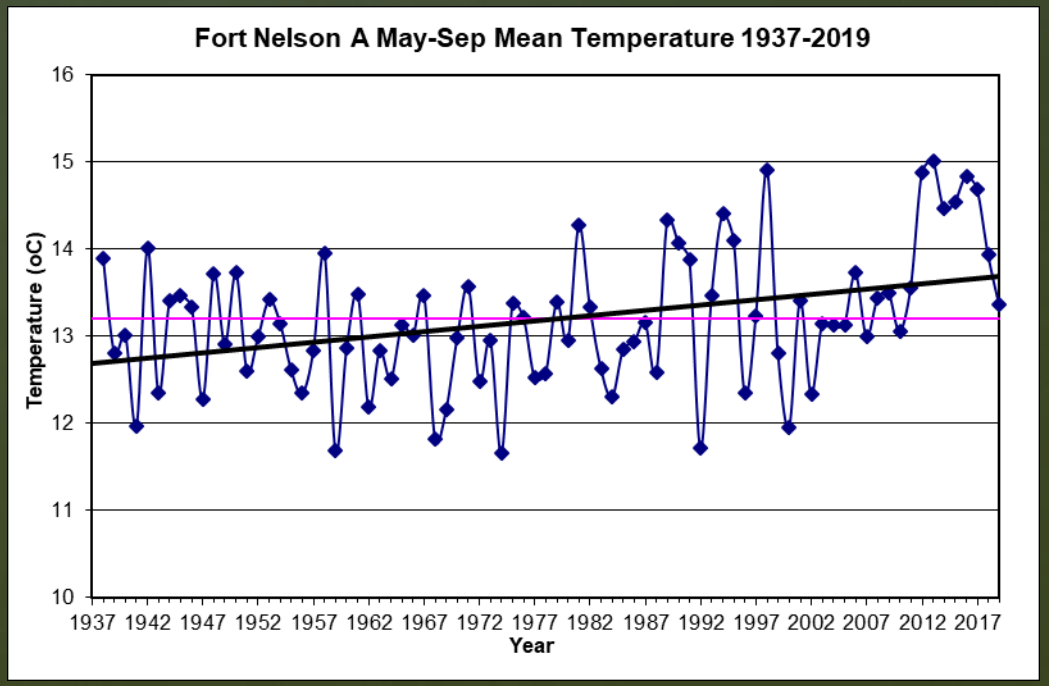
1942-2019

Bold statistically significant $p<0.05$



- Fort Nelson Oct-Apr precipitation decline of 14%
- 2018/19 driest Oct-Apr on record

- Recent warm growing seasons
- Increase of 1.0°C overall



Mackenzie Trends

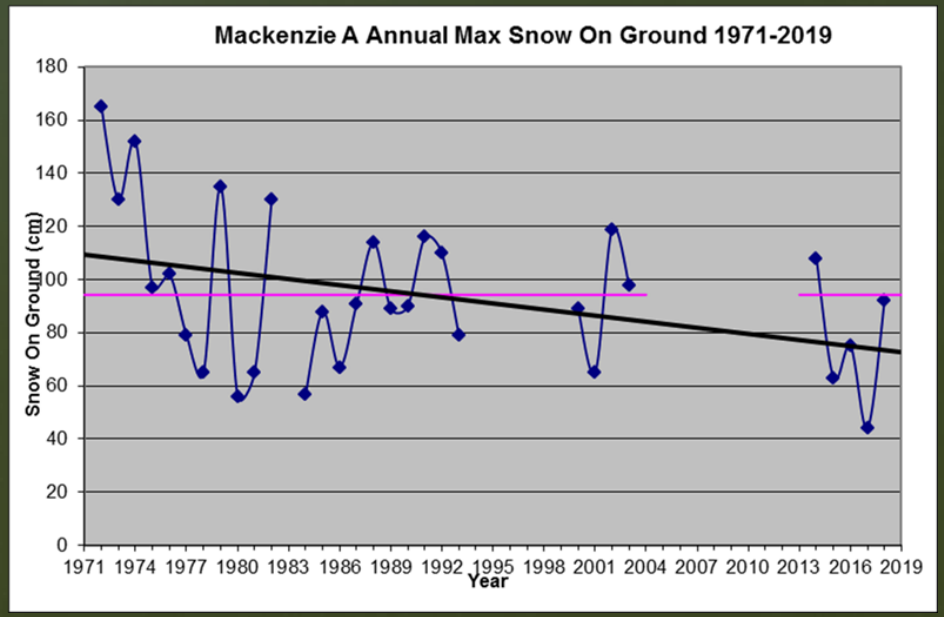
Mackenzie A - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	**-24.8**	**-50.1**	-15.3	**-30.1**	-7.1
Mean Temperature (°C)	**1.9**	**3.5**	**1.5**	**1.9**	**1.1**
Max Temperature (°C)	0.4	-0.1	-0.1	0.7	**2.8**
Min Temperature (°C)	**9.9**	**6.7**	3.2	**2.4**	4.3

1971-2019

Bold statistically significant $p<0.05$

1971-2019

24% decline in maximum snow on the ground



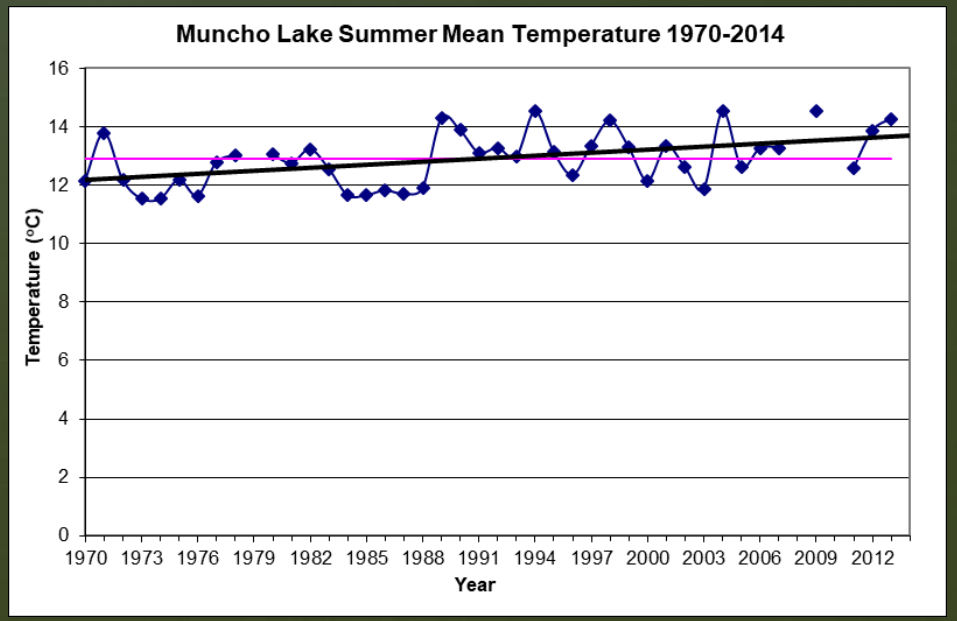
Muncho Lake

Muncho Lake - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	**15.2**	25.7	16.9	12.5	15.2
Mean Temperature (°C)	**1.4**	**4.9**	0.2	**1.4**	0.6
Max Temperature (°C)	0.6	1.1	-1.0	1.1	1.8
Min Temperature (°C)	1.6	2.1	0.5	0.6	-3.1

1970-2013

Bold statistically significant $p<0.05$

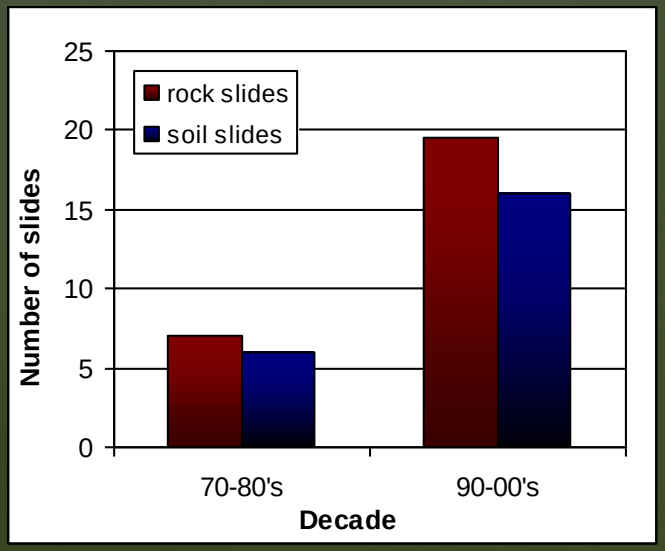
1970-2013



NEBC Current Impacts

Large Landslides

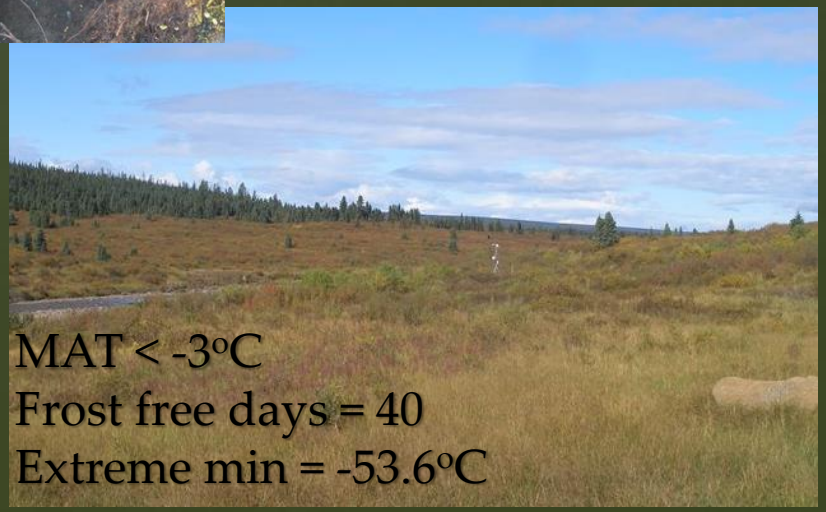
- Long-term increases in precipitation and temperature precondition slopes for failure
- Large cyclonic storms or isolated convective thunderstorms are the triggers



(Geertsema et al. 2007)

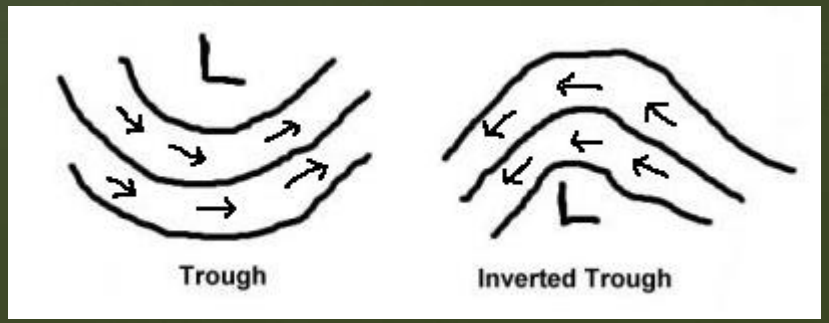
Permafrost: Isolated Patches

- Occurs in black spruce, thick moss, hummocks, north slopes.
- Melts: drunken trees, landslides, road issues
- Warm: just below zero, ice fragments/crystals in soil
  - 0.5 to 1.2 m depth and dropping (20-40cm thaw)
- Cold air drainage extremes
  - Upslope 36 m and 1 km west, 5.3°C warmer
  - Upslope 72 m and 0.7 km east, 14.5°C warmer

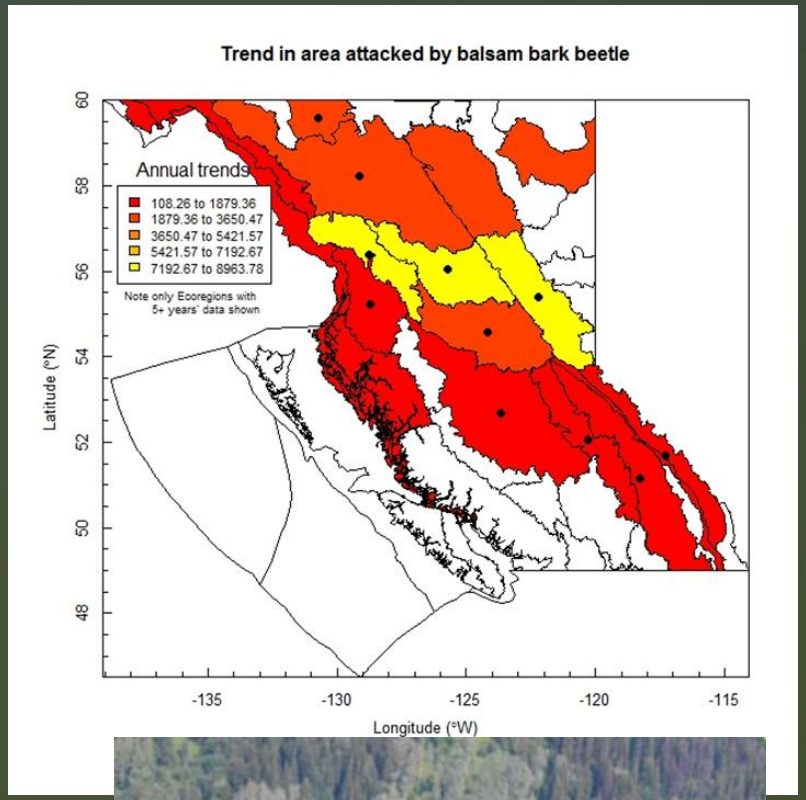


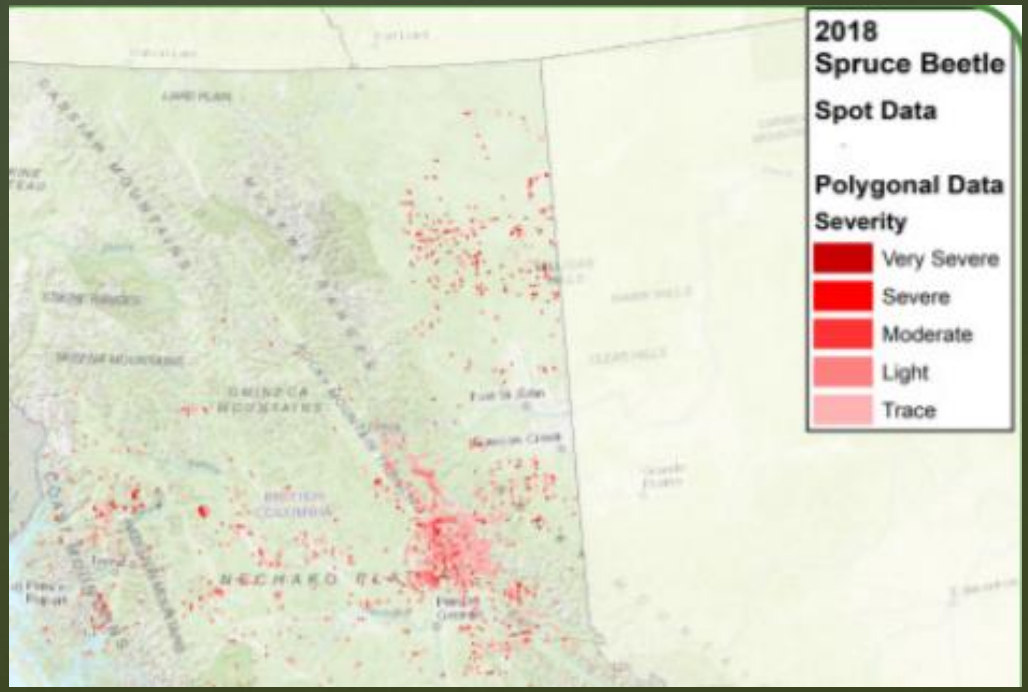
Flooding

- Late spring/early summer inverted troughs (cold lows), easterly flow onto Rockies with rain on snow
- Convective summer storms



Forest Pests – e.g.'s





Evaporation/Soil Moisture

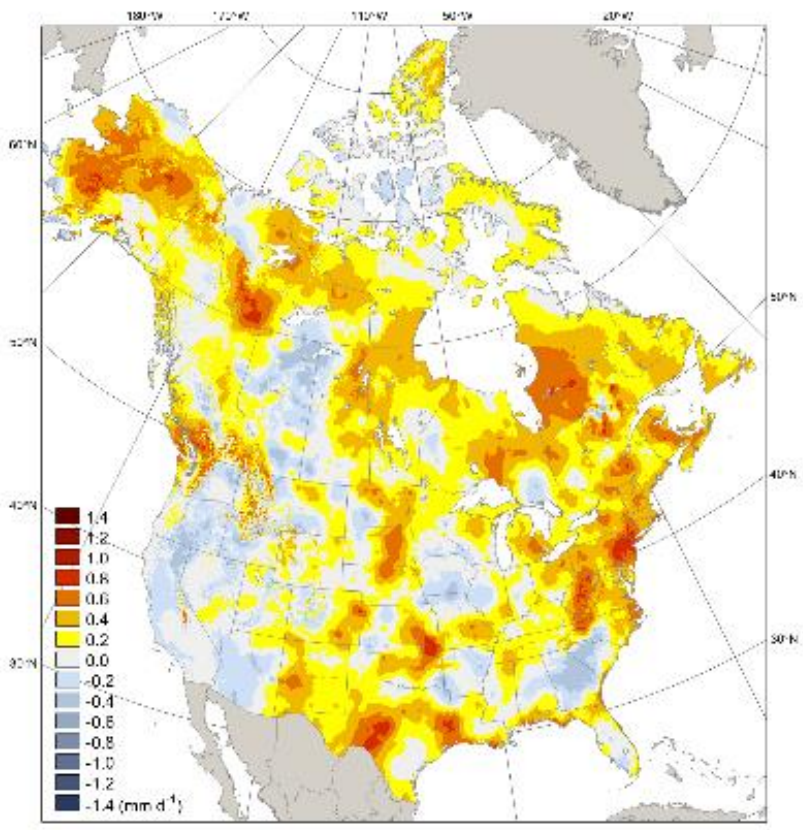


Figure 6.8. *Trend in warm-season (May-Sept.) mean actual evapotranspiration over 1951-2016 (mm/d).*

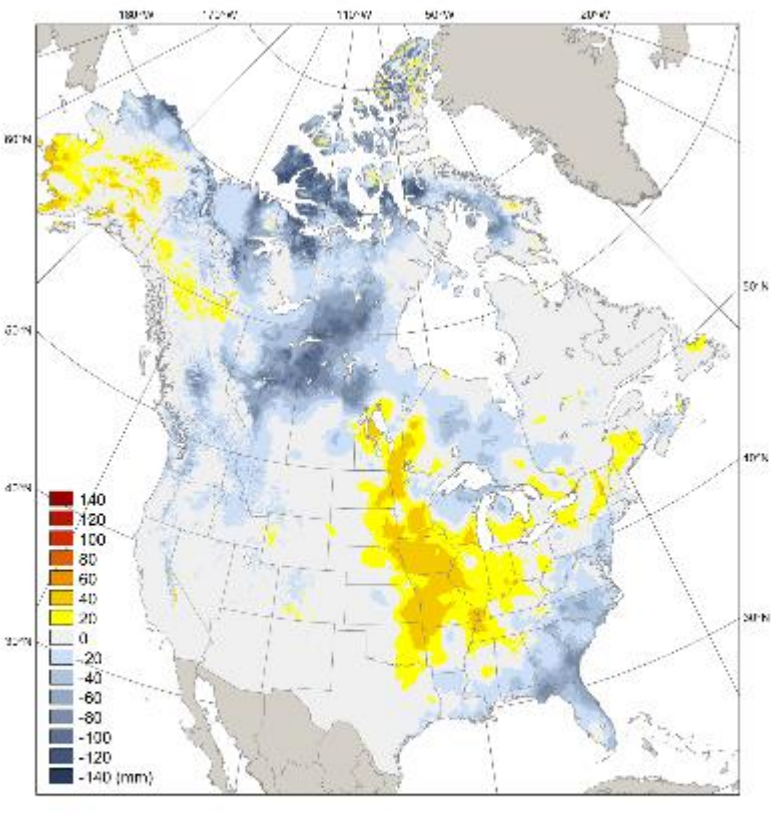
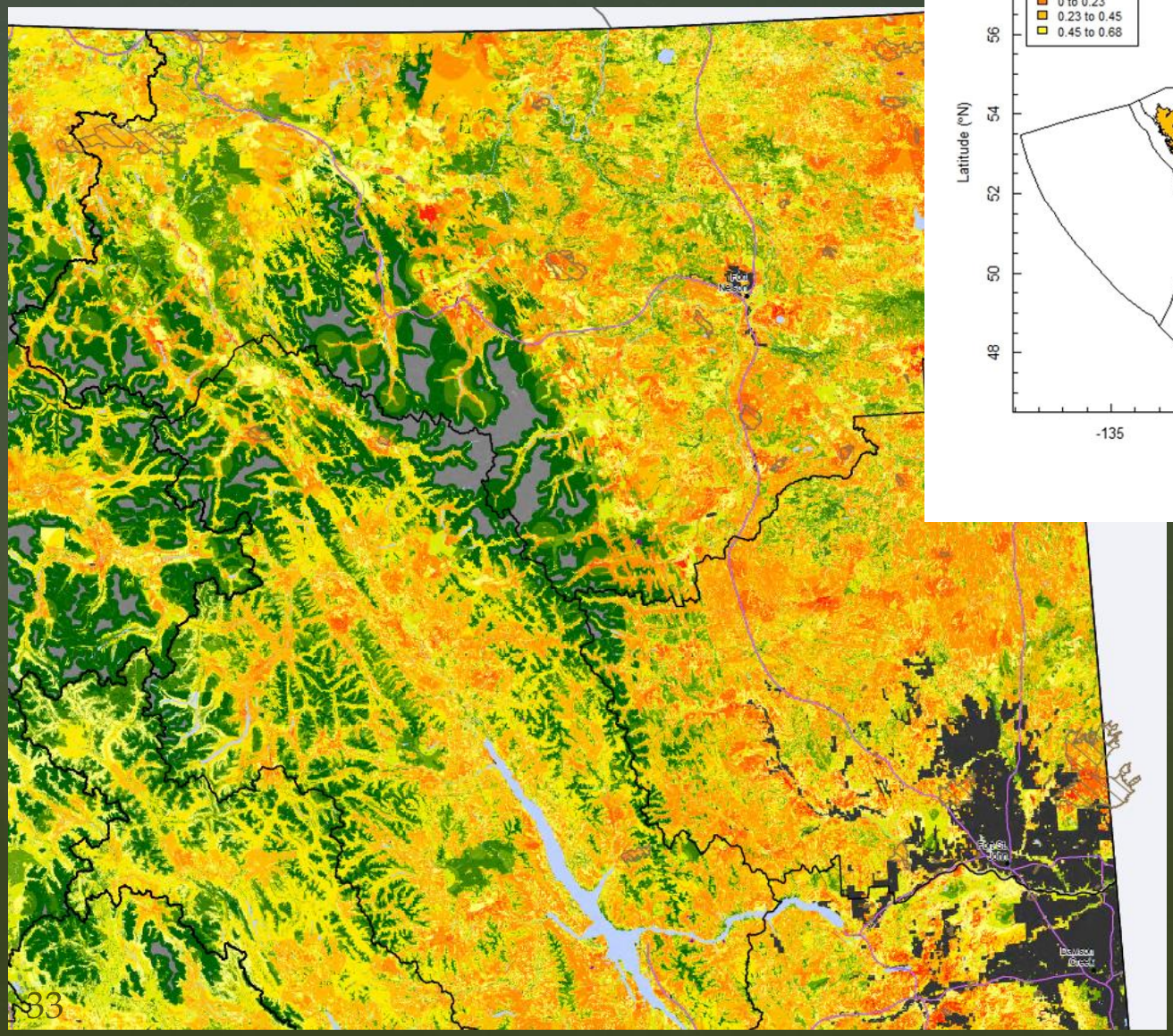
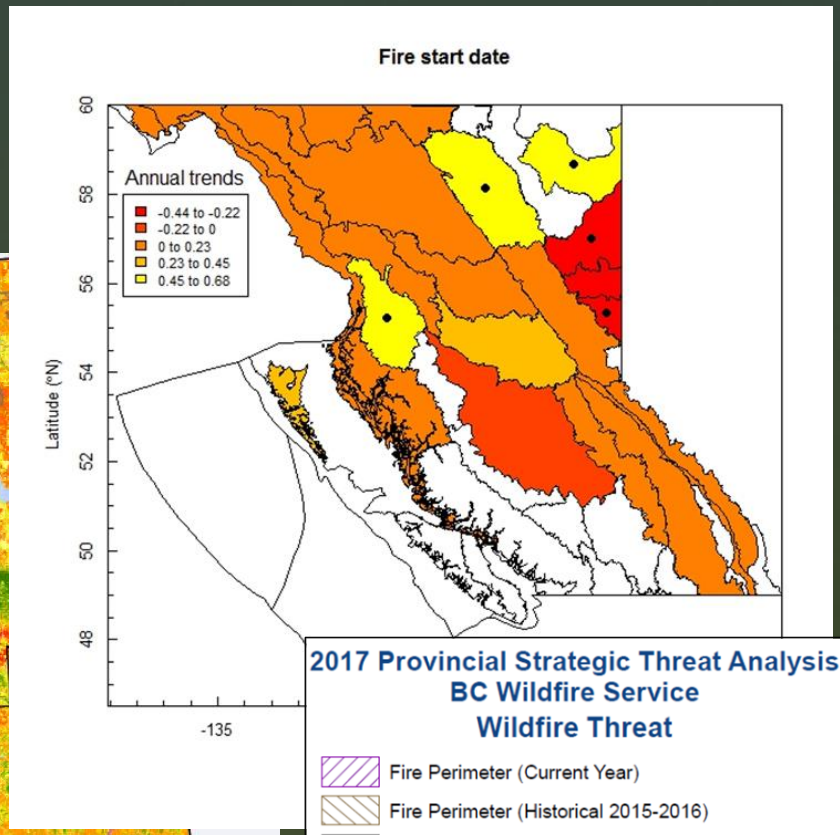


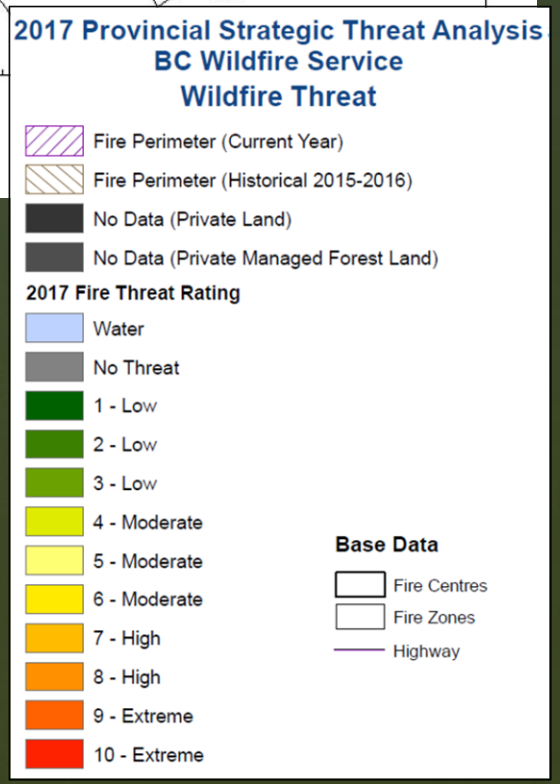
Figure 6.10. *Trend in warm-season (May-Sept.) mean soil water content integrated over 1951-2014. Units are mm water depth.*

Source: https://www.sites.google.com/a/bioclimate-research.org/nacid/surface-water-balance

Wildfire Risk





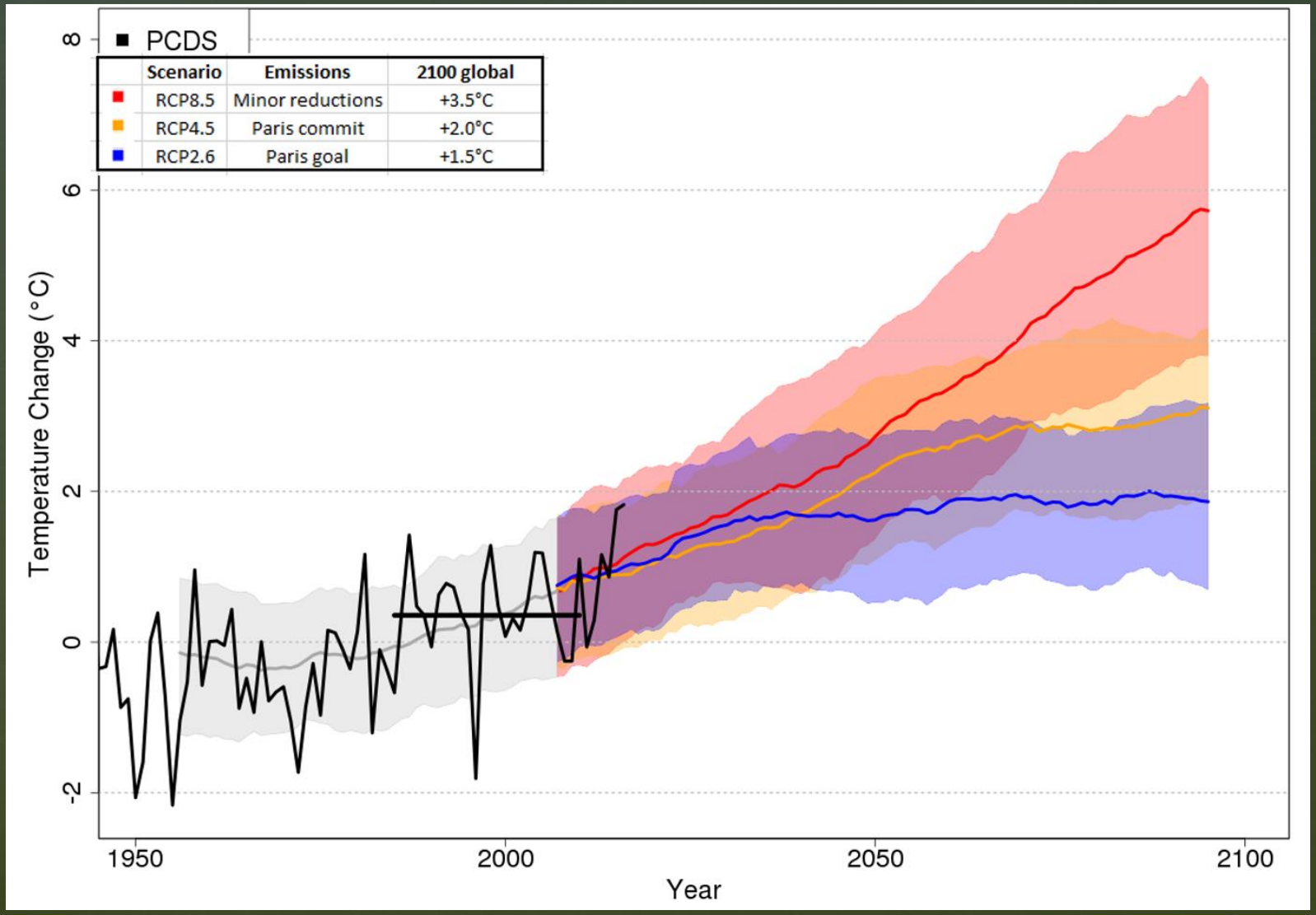


Climate related Disturbances

Climate Trend	Disturbance (s)	Impact (s)
↑MAT	↑ Large Rockslides ↑ Large Debris slides, Permafrost melt	Loss of harvestable land, Loss of infrastructure (roads, pipelines), Safety concerns
↓Winter Precipitation	↓ Snow storage	Summer water availability
↑MAT and Warmer summers	↑Stream Temperatures	Suitable fish habitat Low flows
↑ Winter Min Temps	↑ Pest survival (e.g. MPB, Spruce Beetle, Balsam Bark Beetle)	Loss of harvestable land
↑Spring/Fall Min Temps	↑ Pest survival and shorten life cycles	Loss of harvestable land
↑Summer Precipitation	↑ Extreme Storms ↑ Landslides	E.g. Floods (Dawson Creek, Pine Pass), rail and highway washouts, slope failures
↑Summer Mean and Min Temp, ↓ Frost	↑ Forest Pest and Diseases	Loss of harvestable land
↑ Dec diurnal temp range (i.e. temp swings)	↑ Forest Pest and Diseases breaking winter dormancy	Loss of harvestable land

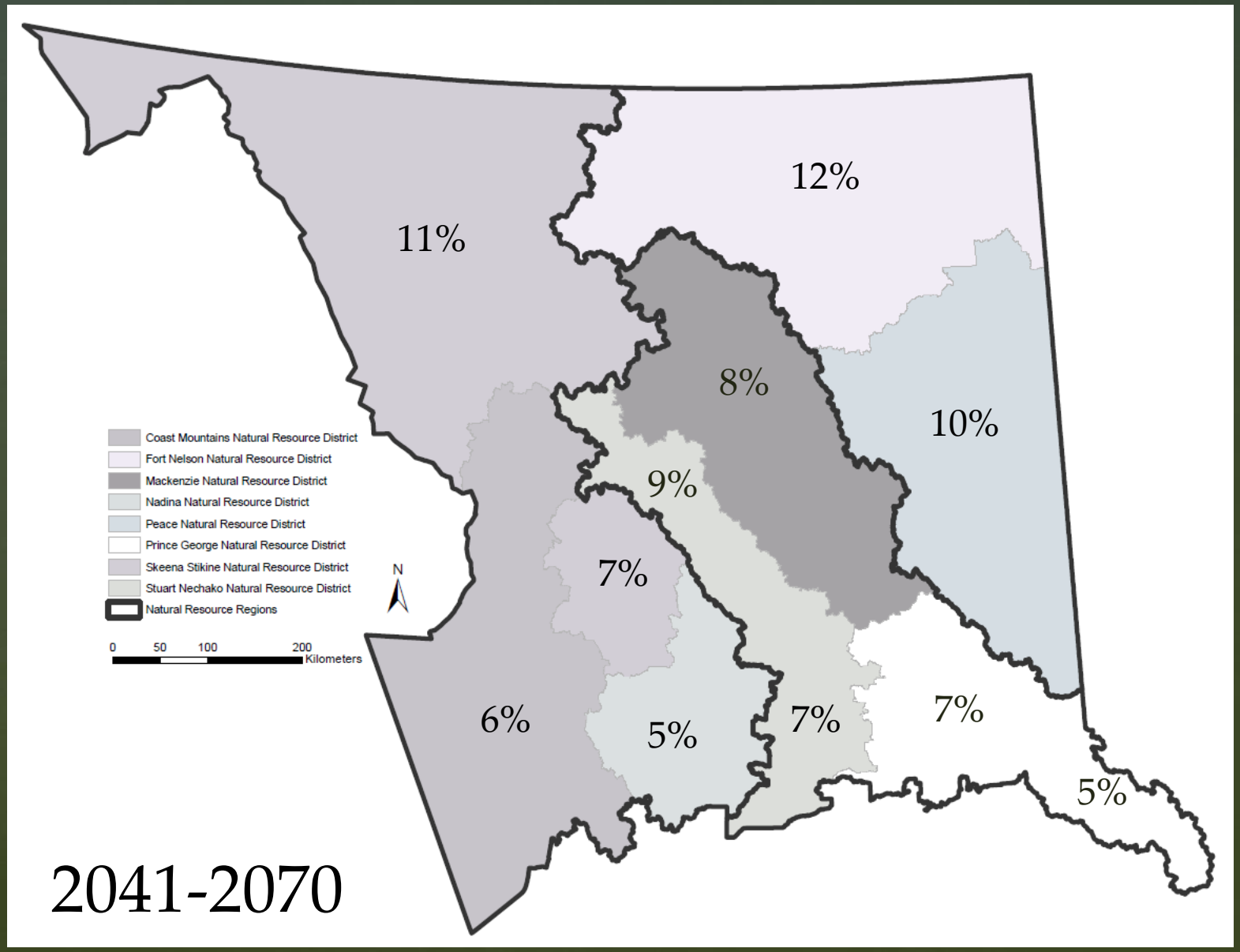
Future Projections (2041-2070)

Future BC Temperatures

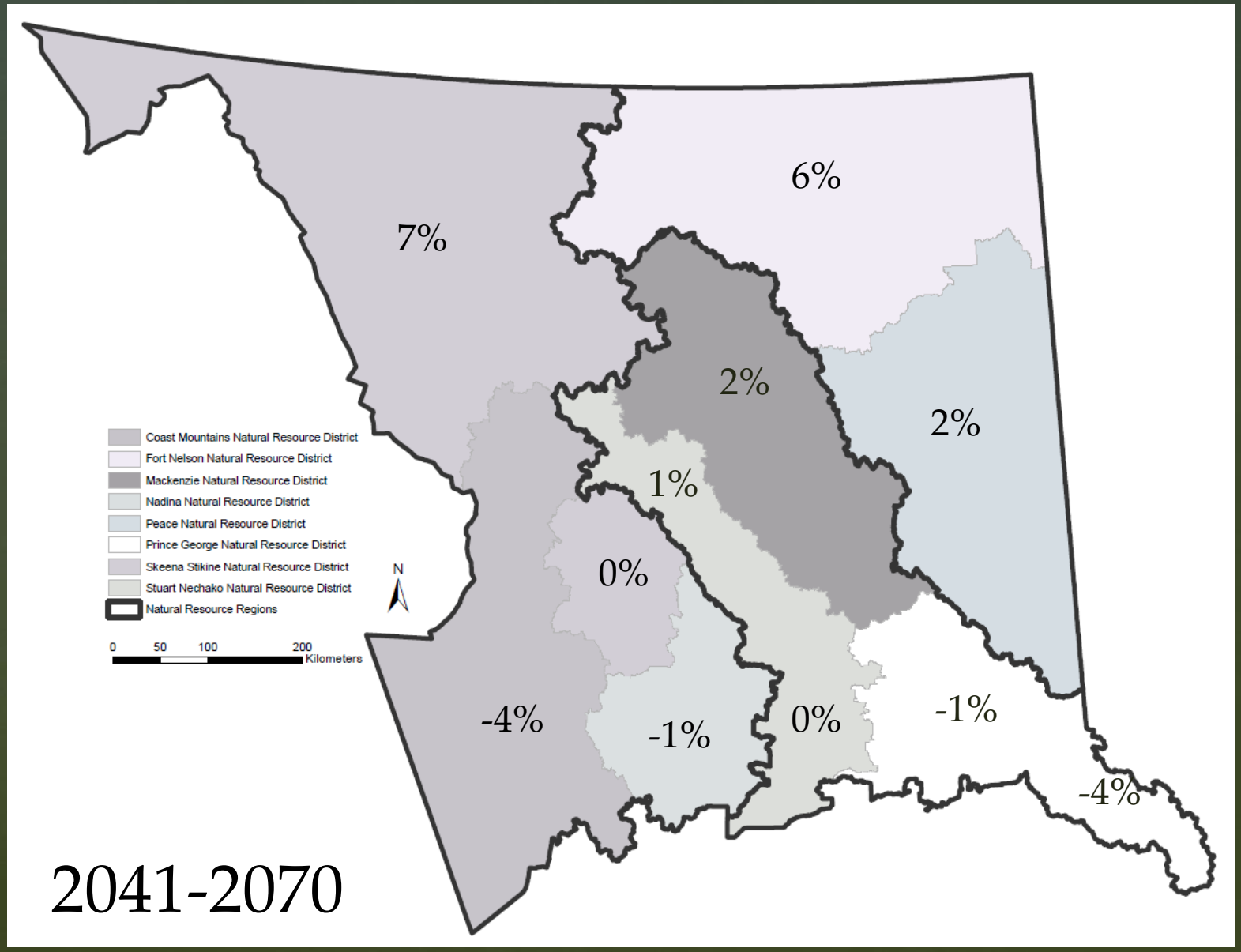


Trevor Murdock, Pacific Climate Impacts Consortium: Presentation Jun 2019

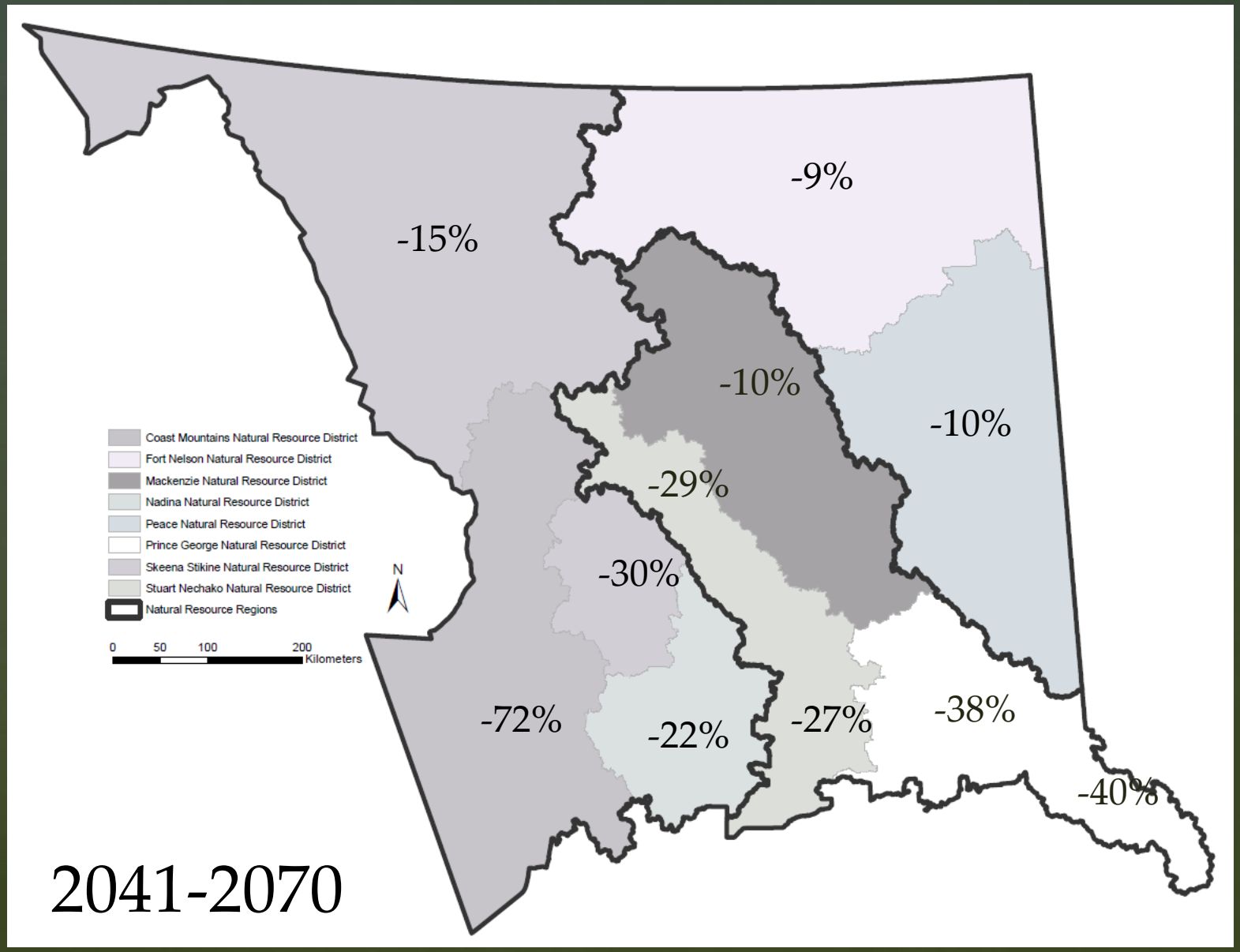
Change in Mean Annual Precipitation



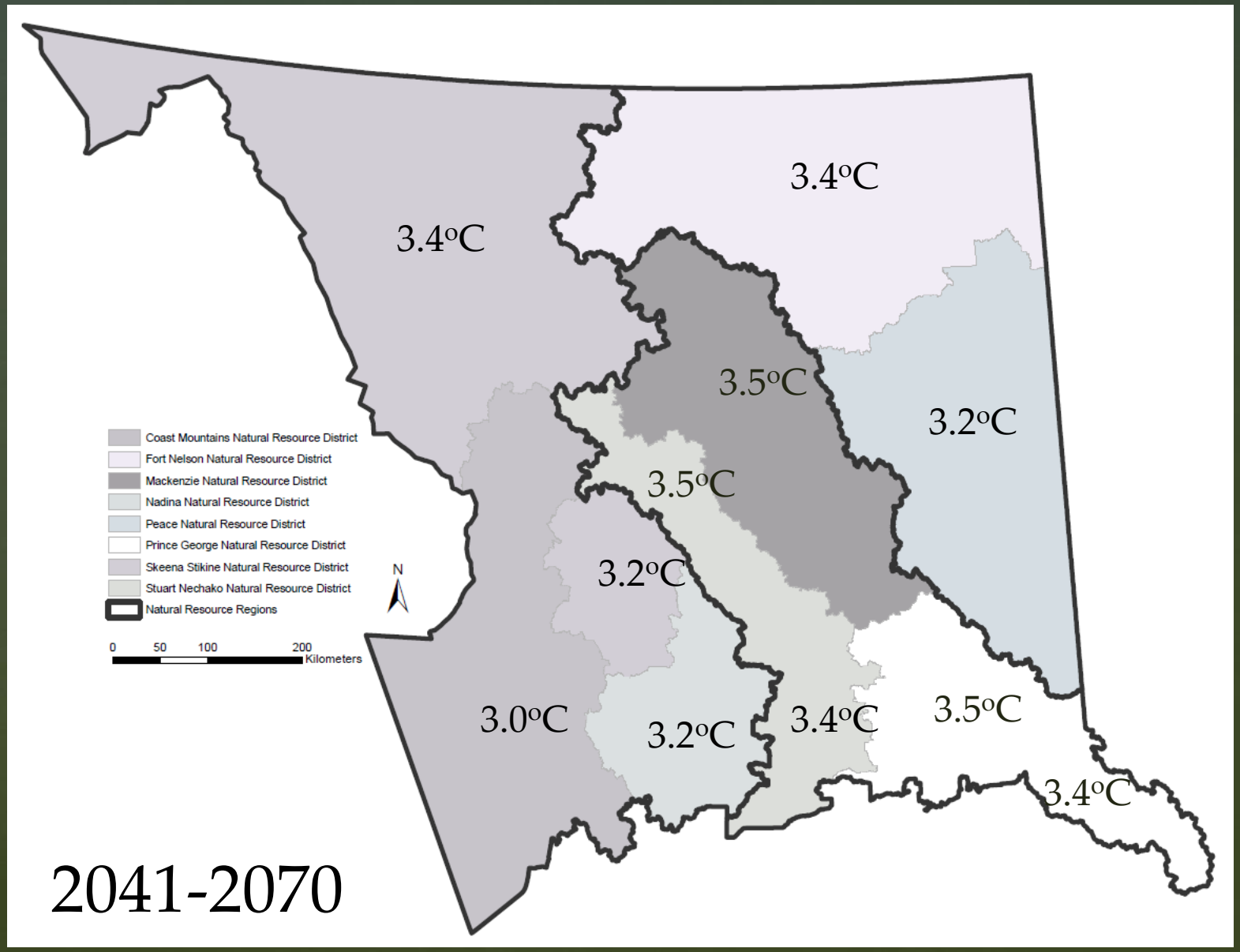
Change in Summer Precipitation



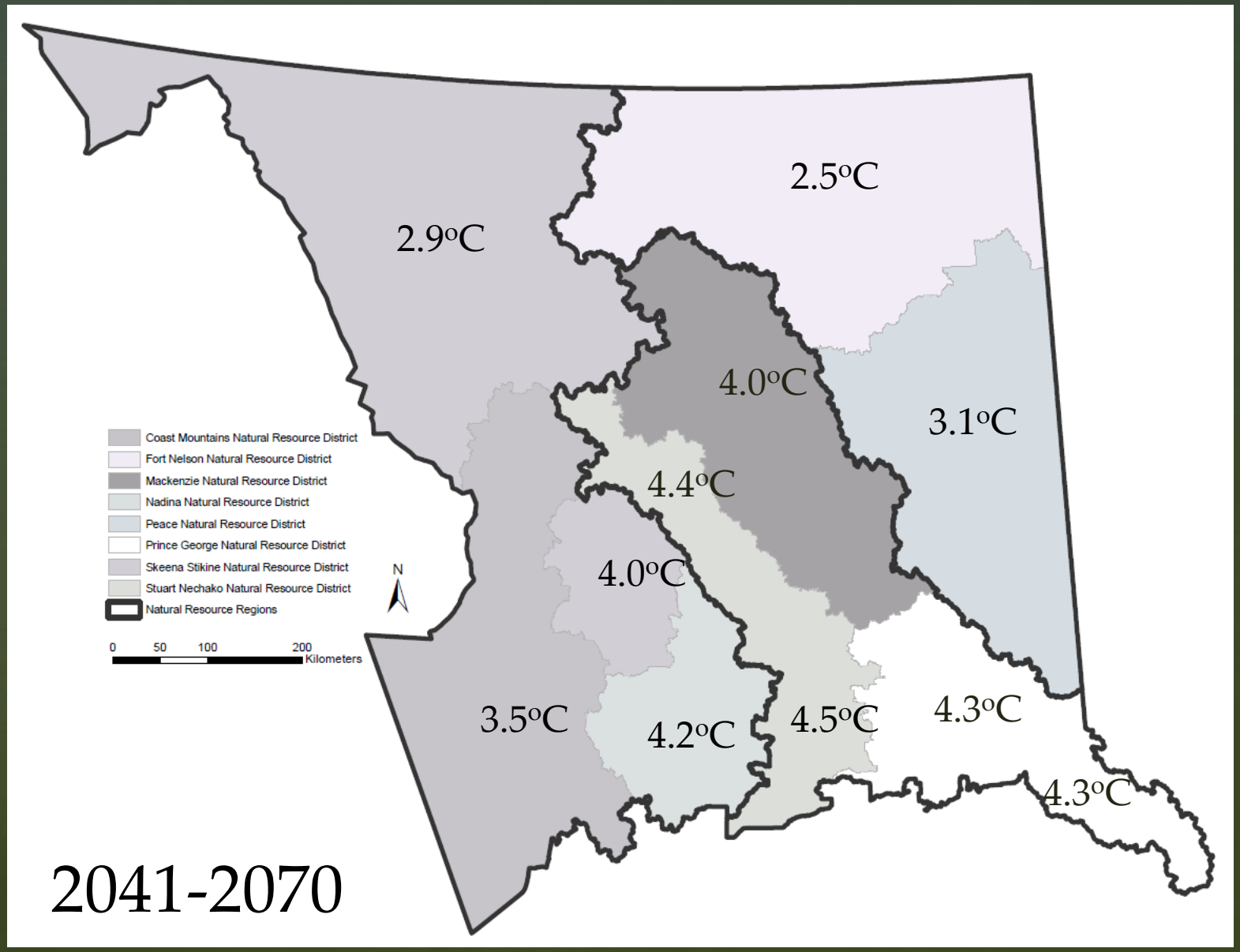
Change in Precipitation as Snow



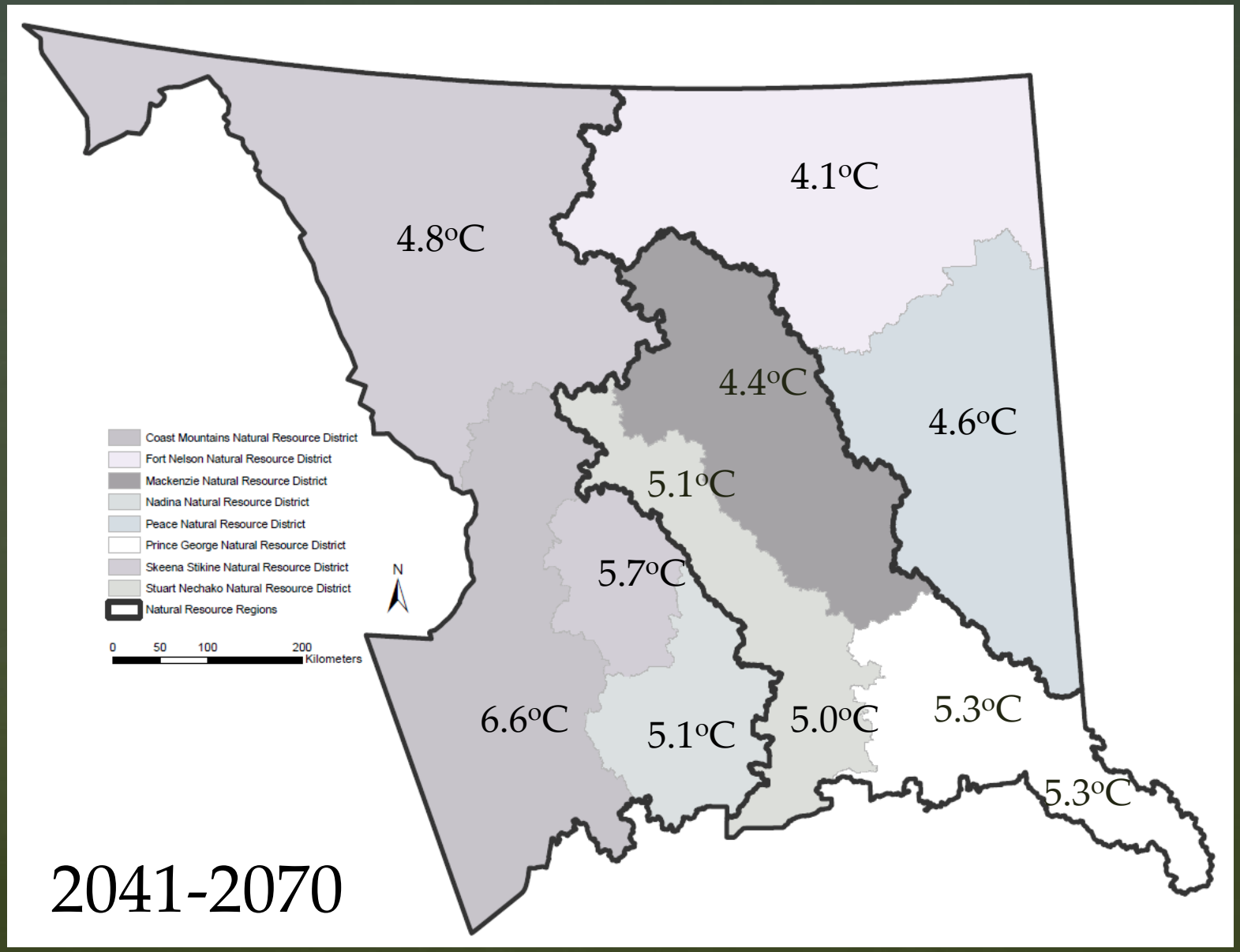
Change in Mean Annual Temperature



Change in Extreme Max Temperature



Change in Extreme Min Temperature



For more projections:

https://www.fraserbasin.bc.ca/_Library/CCAQ/fbc_ne_climatereport_web.pdf

BC Climate Change Initiatives

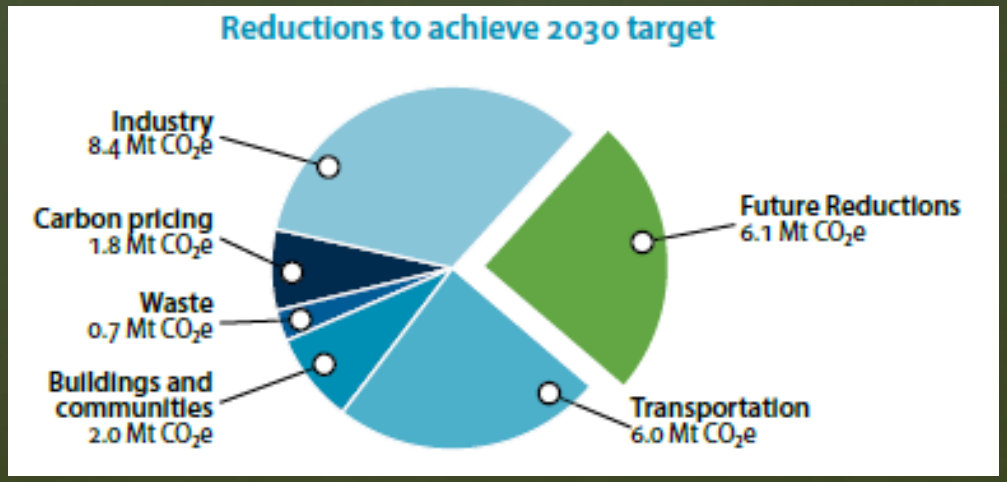
BC Government Direction

GHG Emission Legislated Targets:

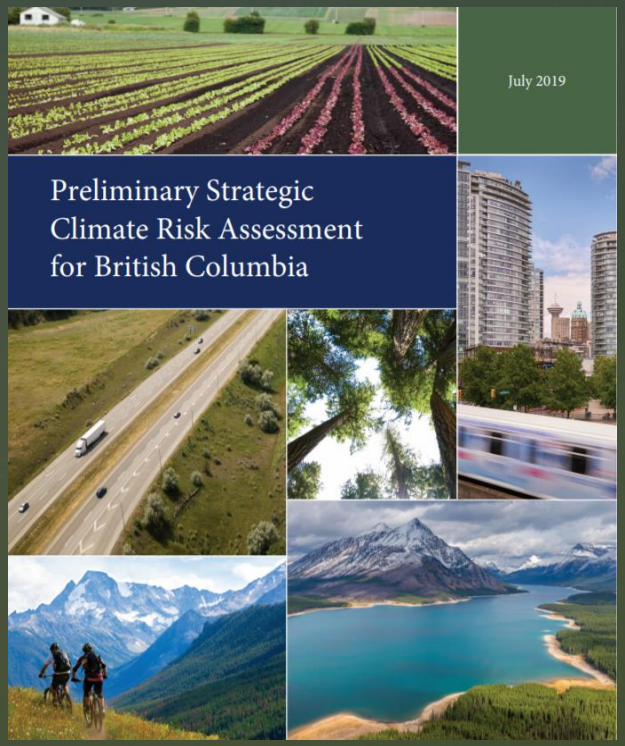
- 40% reduction by 2030
- 60% reduction by 2040
- 80% reduction by 2050

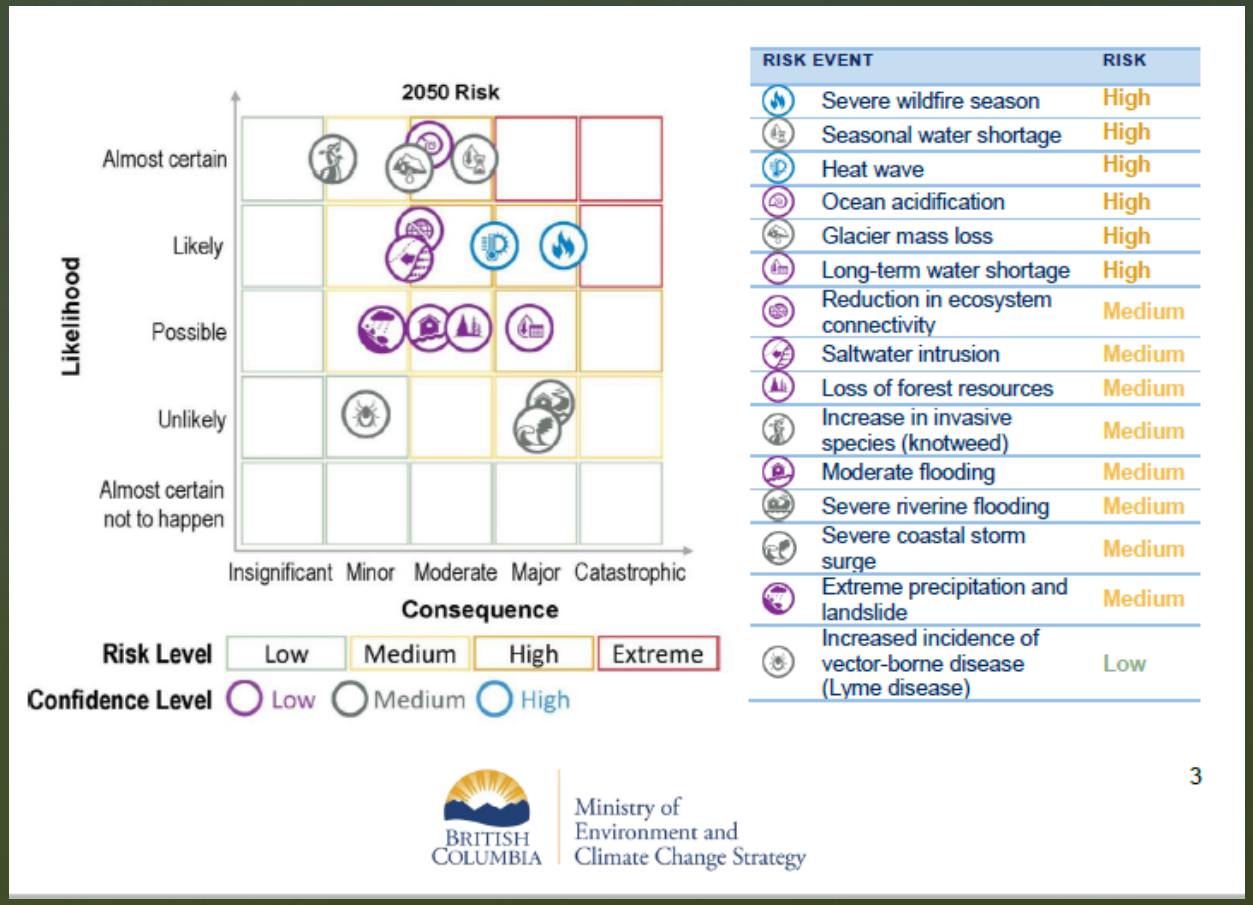
CleanBC:

- Plan to reduce 30% of GHG emissions by 2030



Preliminary Strategic Climate Risk Assessment





https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/climate-risk-summary.pdf

BC Climate Change Adaptation Plan to come 2020

FLNRORD Climate Change Strategy 2015-20 (updated from 2013)

- *"FLNR is a leader in adaptation and mitigation actions aimed at improving the resilience of B.C.'s natural, cultural and heritage resources and values in response to climate change."*
- Goal 1: Manage climate change as a core part of FLNR business
- Goal 2: FLNR will increase the use of climate relevant science, data, and knowledge to better understand the environmental, social, and economic implications of climate change on core business
- Goal 3: Climate change adaptation and mitigation is integrated into program areas, operations, resource management decisions, and actions

Adaptation – e.g's

- Climate Based Seed Transfer
- Forest Stewardship Action Plan
- Region and Branch Climate Action Plans
- Forests for Tomorrow
  - Mixed species options
  - Western Larch and Douglas Fir range expansion
- Climate-change related silviculture stocking standards
- Silvicultural Regimes for Fuel Management
- Assisted Migration Adaptation Trials
- Climate Models: ClimateBC, WNA, NA
- Climate Changed Informed Species Selection Tool
- Future Ecological Classification modelling
  - Promotion and demotion of species
- Regional adaptation and climate trend extension notes

BC Forest Carbon Strategy 2016-2020

- Goal 1: Increase or maintain forest area
- Goal 2: Increase stand-level carbon density
- Goal 3: Reduce emissions associated with forestry operations
- Goal 4: Increase landscape-level carbon density
- Goal 5: Increase the proportion of harvested wood that is used for long-lived wood products
- Goal 6: Create forests that are more resilient to changes in climate suitability, pathogens, invasive species, drought and wildfire

Forest Carbon Initiative Research and Science Agenda

1. Tools/Extension
2. Growth and mortality
3. Decrease slash pile burning
4. Rehabilitation
5. Fertilization
6. Pests, disease, and drought
7. Wildfire
8. Thinning
9. Tree Improvement
10. Old growth management
11. Soil carbon

Incorporating climate change in to decision making – e.g's

- Climate research considered in recent decisions - North
  - AAC determinations (Lakes, PG, Fort St John, Fort Nelson)
  - Fisheries Sensitive Watersheds designations, Grizzly Bear Management guidance, Water allocations, Prescribed fire guidance
- Vulnerability Assessments
  - PIEVC on forest service roads (e.g. Willow FSR)
- Research designed to inform forest management
  - BEC/climate model validation
  - Climate shield/bull trout project
  - Stand-level drought risk assessment tool
    - Integrate with Omineca watershed health tool, BEC climate projections and tree species selection
  - Climate and disease severity of young pine plantations
- Support for First Nations: e.g. Lake Babine salmon habitat


Questions?
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