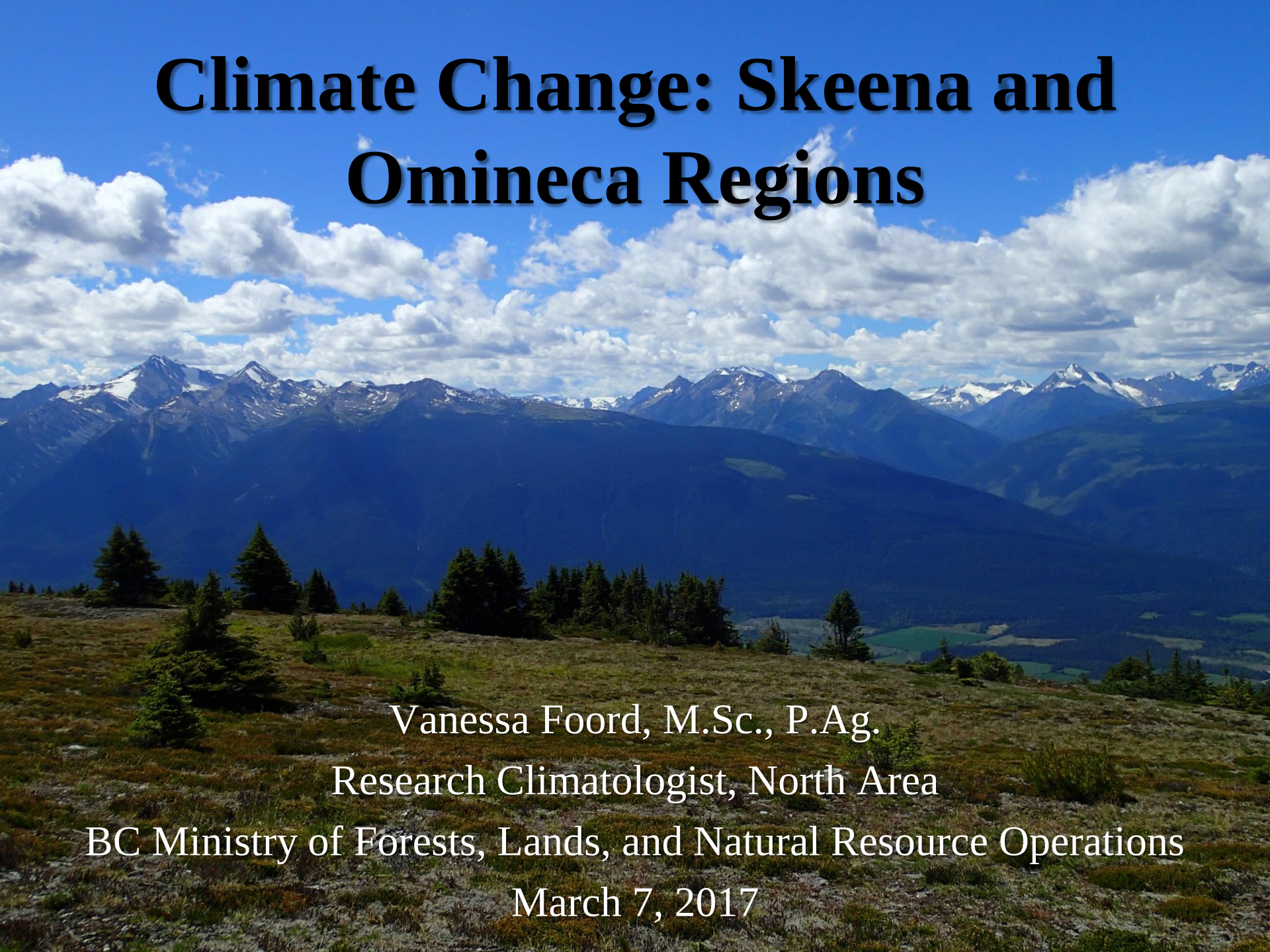
Climate Change: Skeena and Omineca Regions



Vanessa Foord, M.Sc., P.Ag.
Research Climatologist, North Area
BC Ministry of Forests, Lands, and Natural Resource Operations
March 7, 2017

Outline

1. Climate Change Basics
2. Skeena Current Trends
3. Omineca Current Trends
4. Climate Change Projections
5. Ministry's climate change response
6. Omineca Climate Action Plan
7. Discussion?

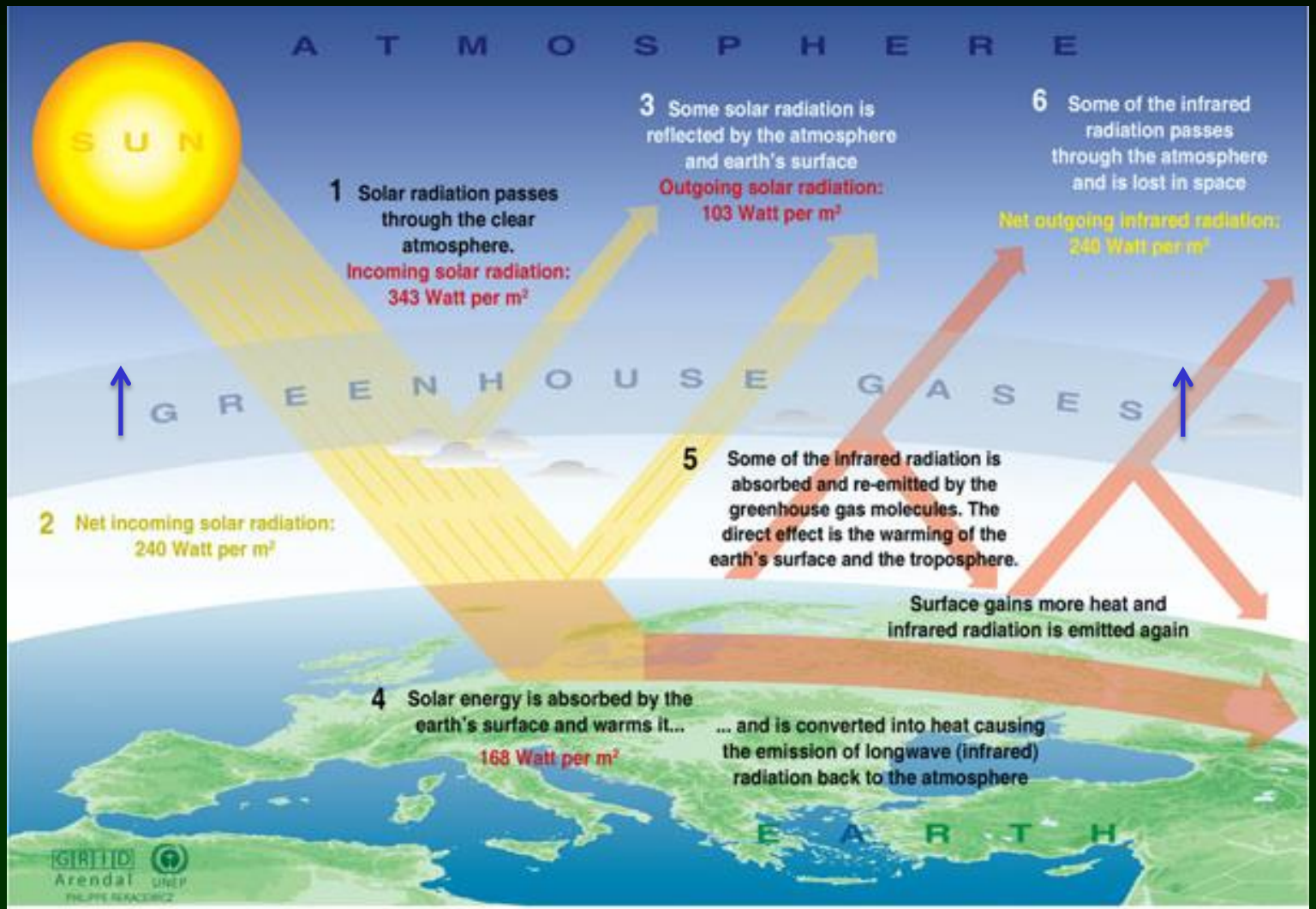
Climate Basics

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

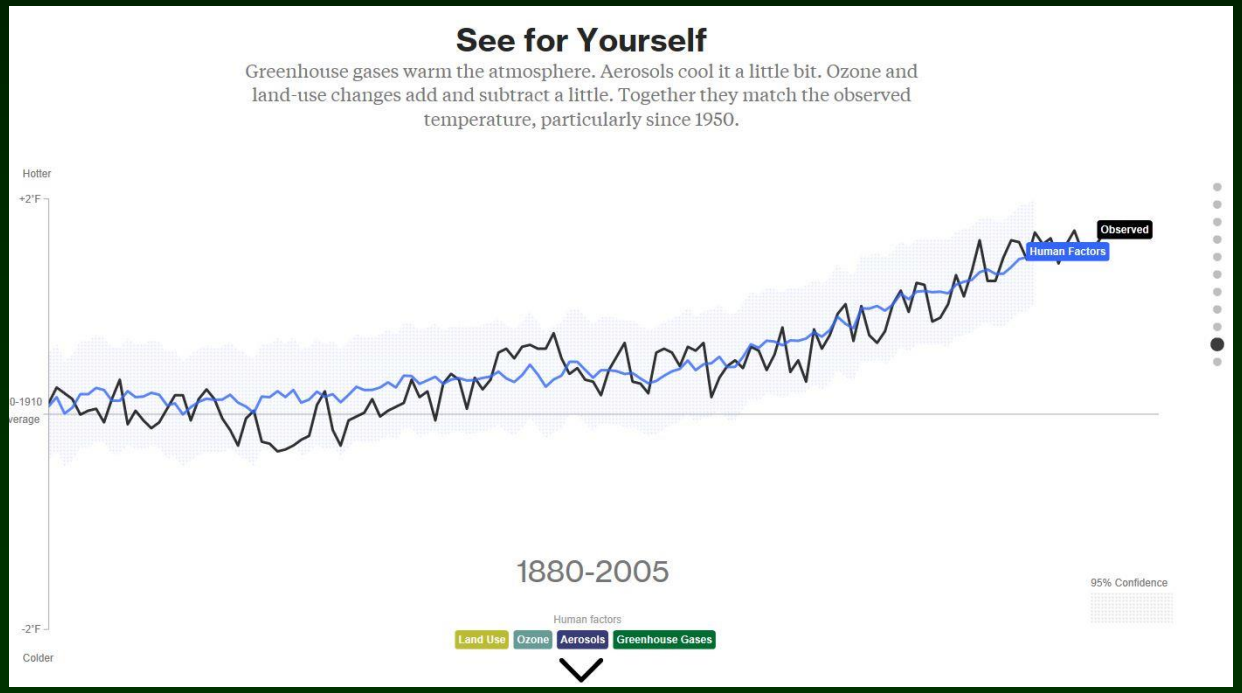
Temp ↑

Feedbacks

- Self-perpetuating mechanism of change, and the response to that change
  - Negative and Positive feedback loops
- Snow/Ice melt:
  - Positive: Exposes darker surfaces, ↑energy absorption and releases more heat, causing more melt
- Land use changes:
  - Positive (Negative): exposes surfaces with lower (higher) albedo and increases (decreases) heat absorption and radiation
- Increased CO_2:
  - Negative: ↑Temperature ~ ↑Photosynthesis ~ ↓CO_2
  - Positive: ↑Temperature ~ ↑CO_2 release from oceans, rocks, soil

Relative Contributions to Climate Change

- http://www.bloomberg.com/graphics/2015-whats-warming-the-world/

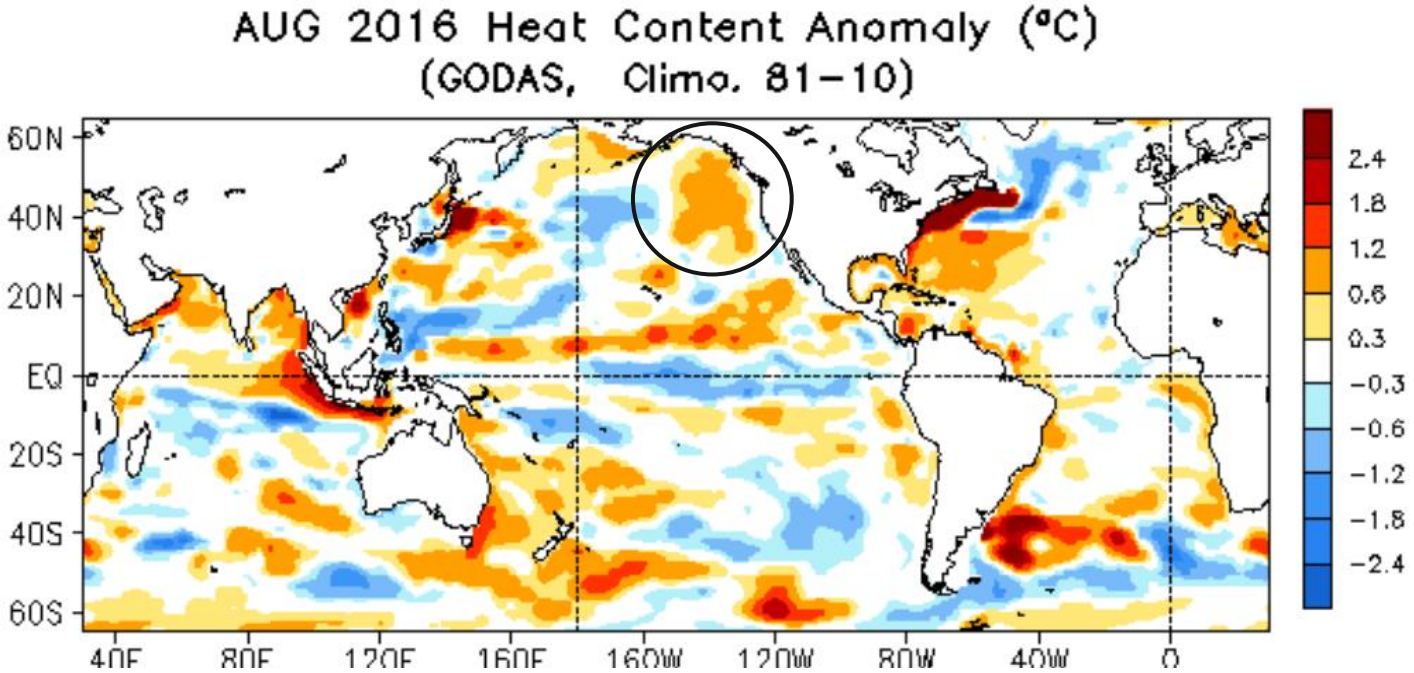


Ocean-Atmosphere Oscillations

- El Niño Southern Oscillation:
  - 3-7 year cycle
  - Northern BC impact only when moderate to strong: El Niño = warm/dry; La Niña = cool/wet
  - Strong El Niño 2015/2016 = warm/dry
- Pacific Decadal Oscillation (PDO):
  - Dominate mode of climate variability in northern BC
    - Cool: 1890-1924, 1947-1976, 1998-2015? (NW = dry, interior = wet)
    - Warm: 1925-1946, 1977-1998? (NW = wet, interior = dry)
    - 2015 shift to warm? Too soon to tell.

The Blob: 2013-2016

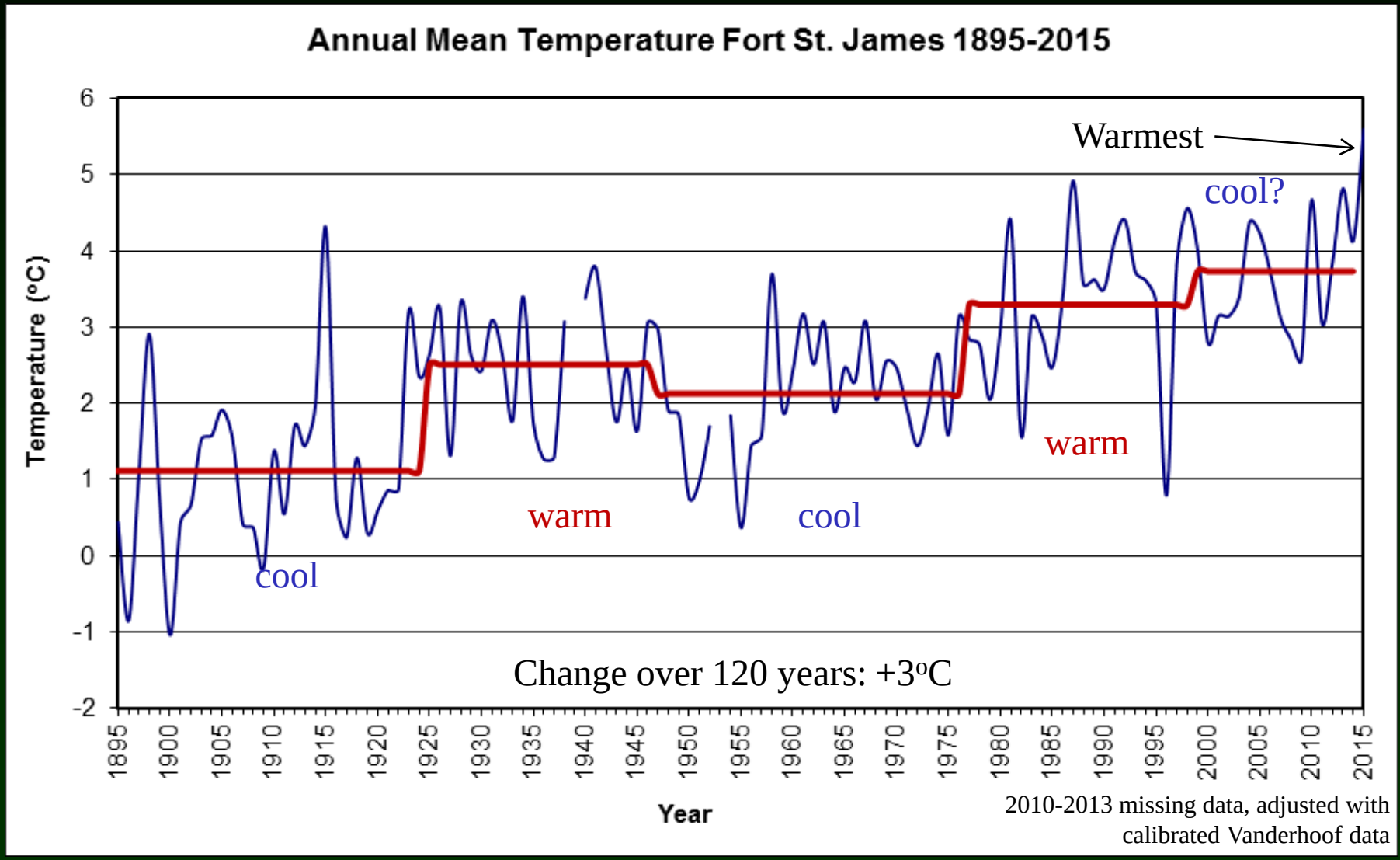
Upper Ocean Heat Content Anomaly



- SST anomalies have been as large as 3oC = translated to land
- Resulted in semi permanent high pressure ridge over Pacific NW
  - Warm winters 2014 and 2015 and record low snowpacks, PNW
  - Long fire seasons and extreme fire behaviour 2014 and 2015
  - Early, dry springs 2014-2016, Southern BC drought 2015

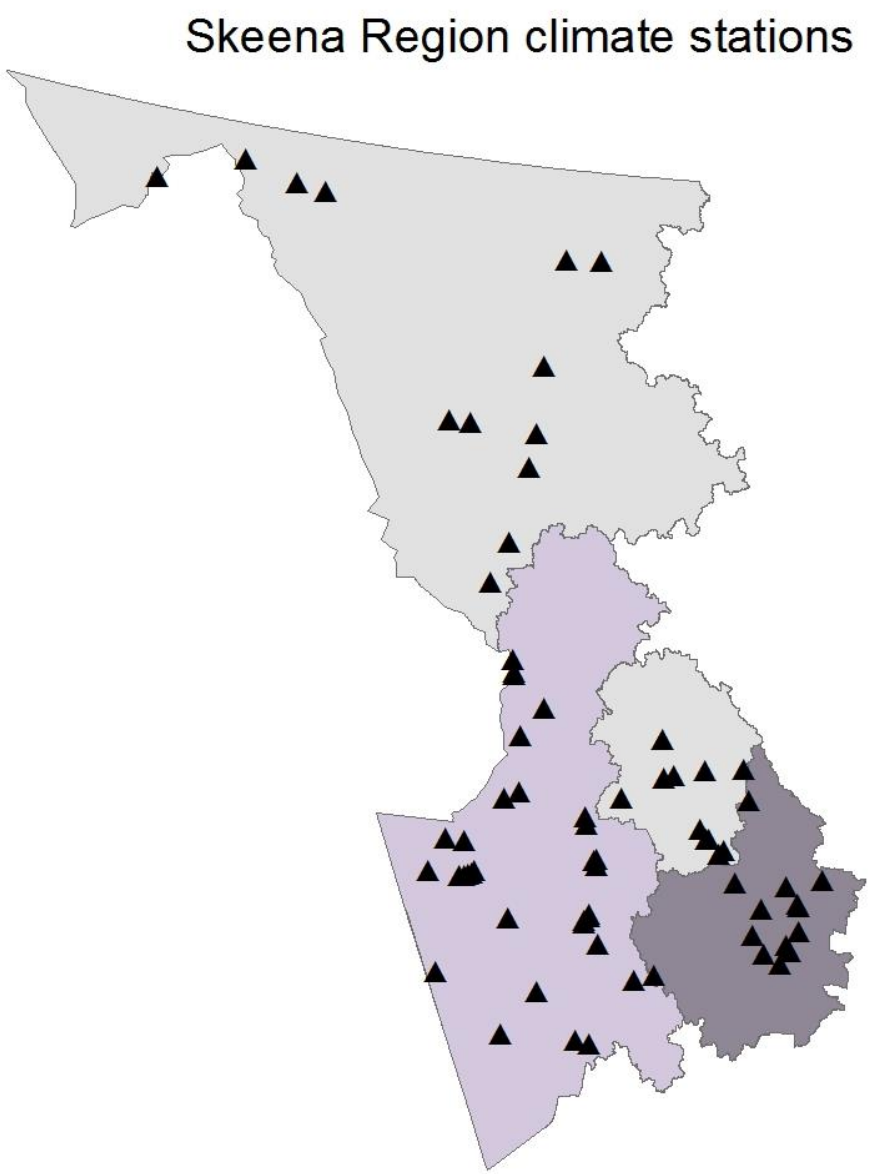
Presented by Rick Thoman, Alaska NWS, Sep 23, 2016

Climate Variability vs Climate Change



PDO next warm phase will likely be much warmer than previous warm phases.

Skeena Current Climate Trends



Environment Canada daily data: 1886-2008

Skeena Trends

Mean annual precip:+5.2%

- Spring and Summer ↑

Mean annual temp:+0.8 °C

- Winter ⟶ Fall

Extreme max temp:+0.7°C

- Summer, winter, spring,↑, fall↓

Extreme min temp:+1.7 °C

- Winter ⟶ Fall

Nadina District Trends

Nadina - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	-0.7	**-19.5**	-3.8	**10.0**	6.3
Mean Temperature (^{o}C)	**0.8**	**2.1**	0.5	0.4	0.1
Max Temperature (^{o}C)	0.0	-0.3	-0.7	-0.2	**-1.6**
Min Temperature (^{o}C)	**2.9**	**3.0**	**2.8**	**1.2**	**1.5**
	1926-2008				
	Bold statistically significant $p<0.05$				

- Significant decrease in Winter precipitation
- Significant increase in Summer precipitation
- Warm minimum temperatures
- Fall conflicts, increasing cloud?

Skeena District Trends

Skeena - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	**12.4**	**16.3**	**18.6**	**17.4**	**19.6**
Mean Temperature (°C)	0.2	**0.7**	0.3	**0.5**	-0.2
Max Temperature (°C)	0.5	0.5	0.2	**0.7**	-1.0
Min Temperature (°C)	-0.1	0.8	0.8	0.6	0.4
	1912 -2008				
	Bold statistically significant p<0.05				

- Skeena-Stikine district without Stikine

- Significant increases in precipitation – all seasons
- Few significant temperature trends in comparison to other districts

Kalum District Trends

Kalum - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	2.3	2.0	**9.3**	6.0	-1.0
Mean Temperature (^{o}C)	**0.9**	**1.9**	**1.0**	**0.7**	**0.3**
Max Temperature (^{o}C)	**1.0**	**0.9**	**0.8**	**1.0**	-0.1
Min Temperature (^{o}C)	**2.1**	**2.9**	**1.5**	**0.9**	-0.4
	1886-2008				
	Bold statistically significant $p<0.05$				

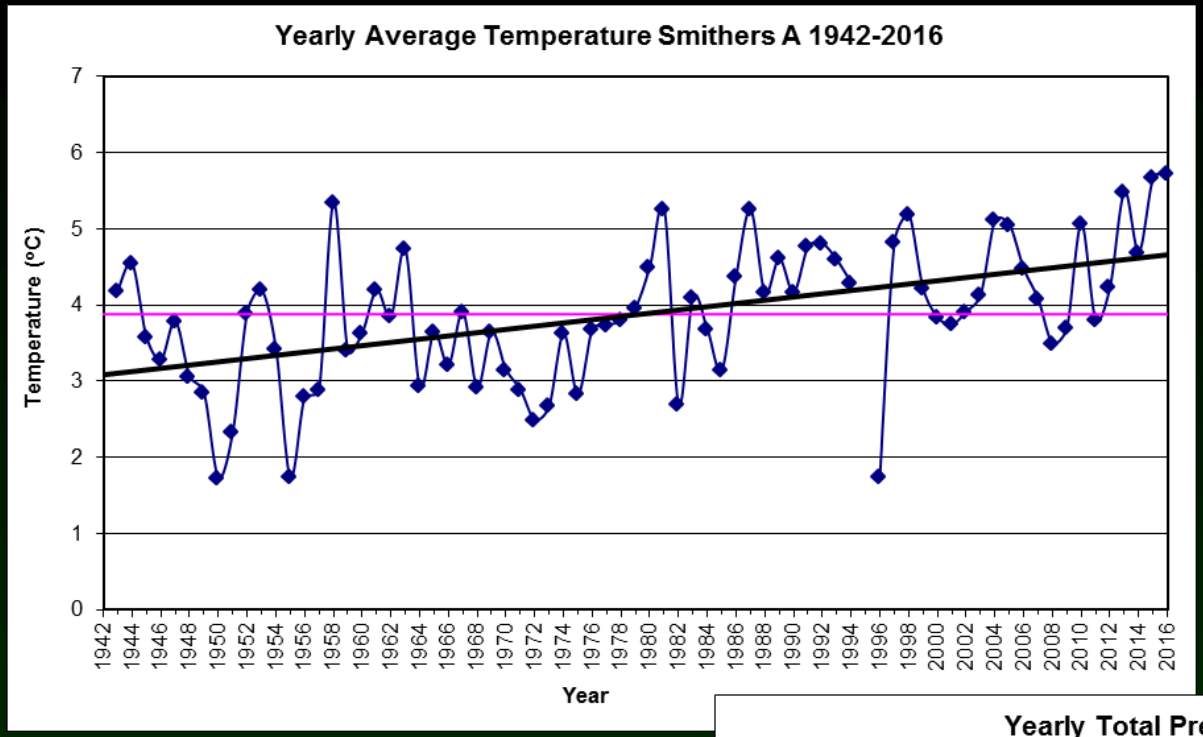
- Significant increase in Spring precipitation
- Greatest warming in Winter, then Spring

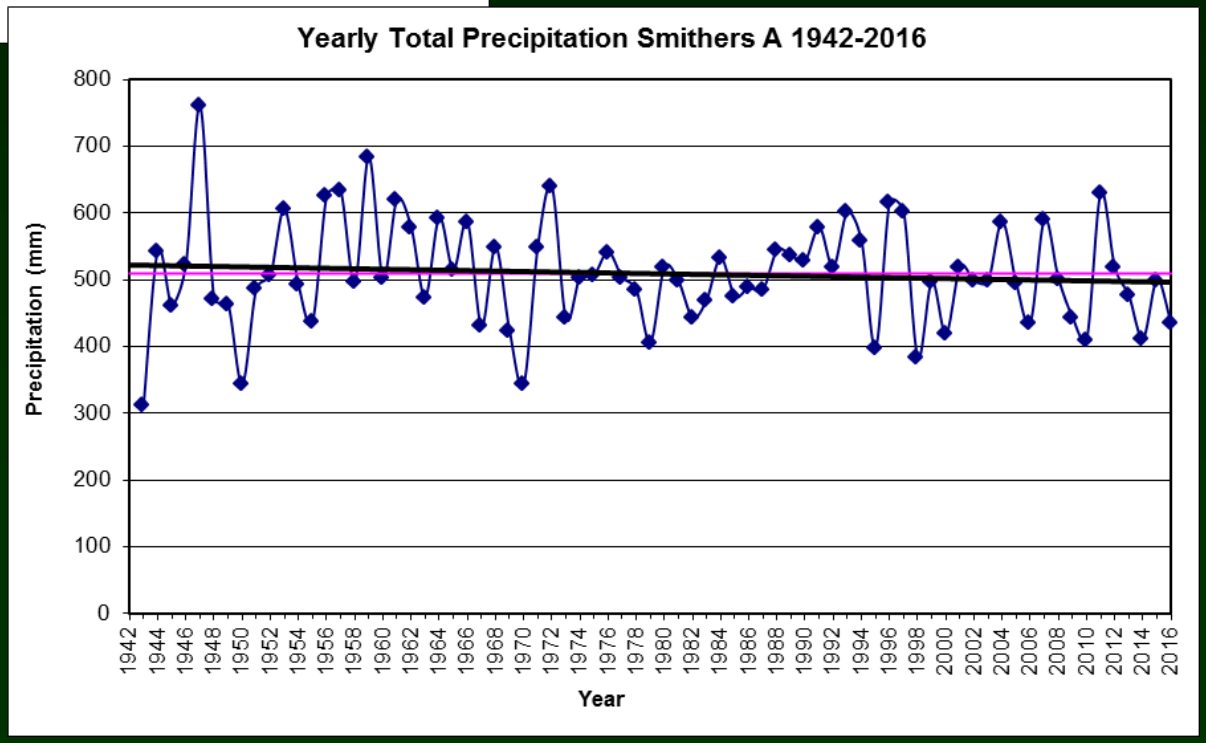
Stikine District Trends

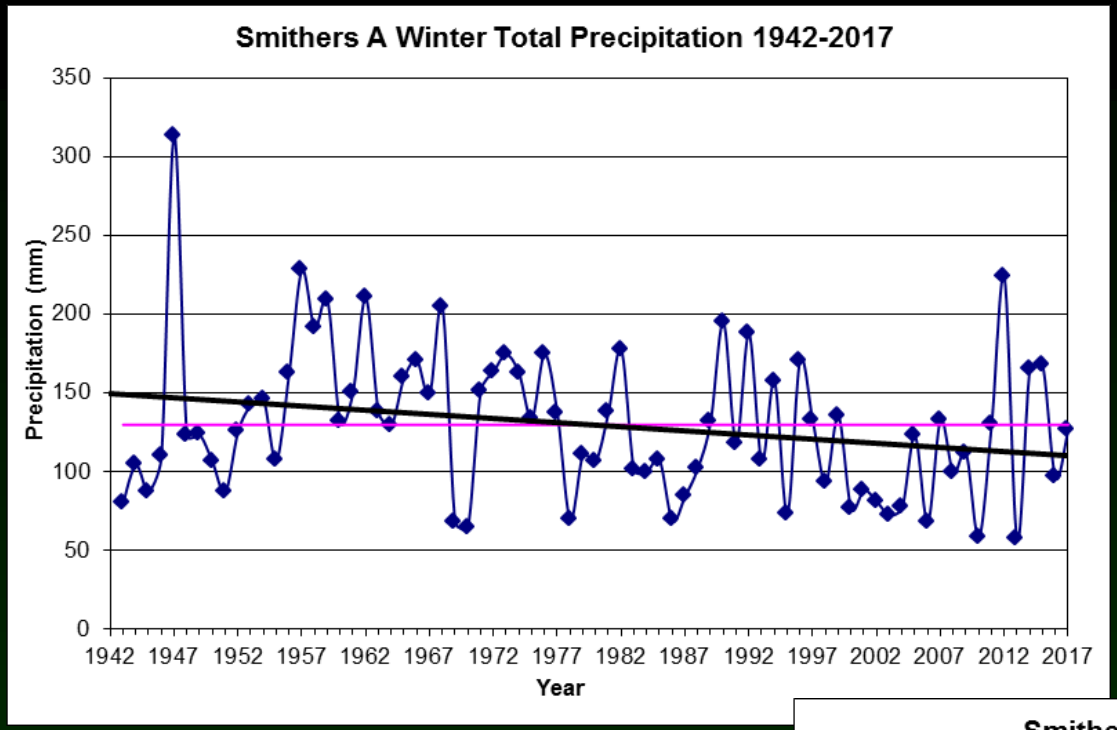
Stikine - change in:	Annual	Winter	Spring	Summer	Fall
Precipitation (%)	14.0	18.2	14.5	**19.8**	6.5
Mean Temperature (°C)	**0.9**	**2.3**	**1.1**	**0.8**	-0.1
Max Temperature (°C)	0.7	**0.9**	0.1	**0.9**	**-0.9**
Min Temperature (°C)	**1.4**	**2.2**	1.4	**0.9**	-0.3
	1905 -2008				
	Bold statistically significant p<0.05				

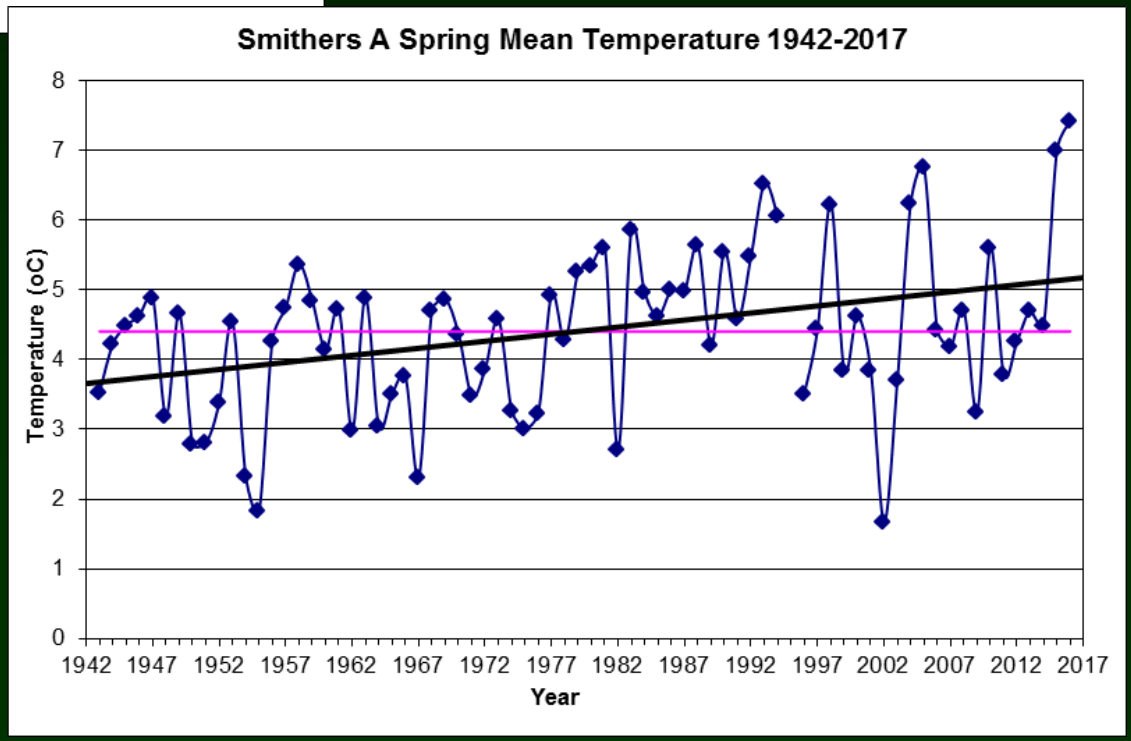
- Skeena-Stikine district without Skeena

- Large increases in Summer precipitation and temperature trends
- Increasing winter temperatures
- Significant negative fall maximum temperature trend

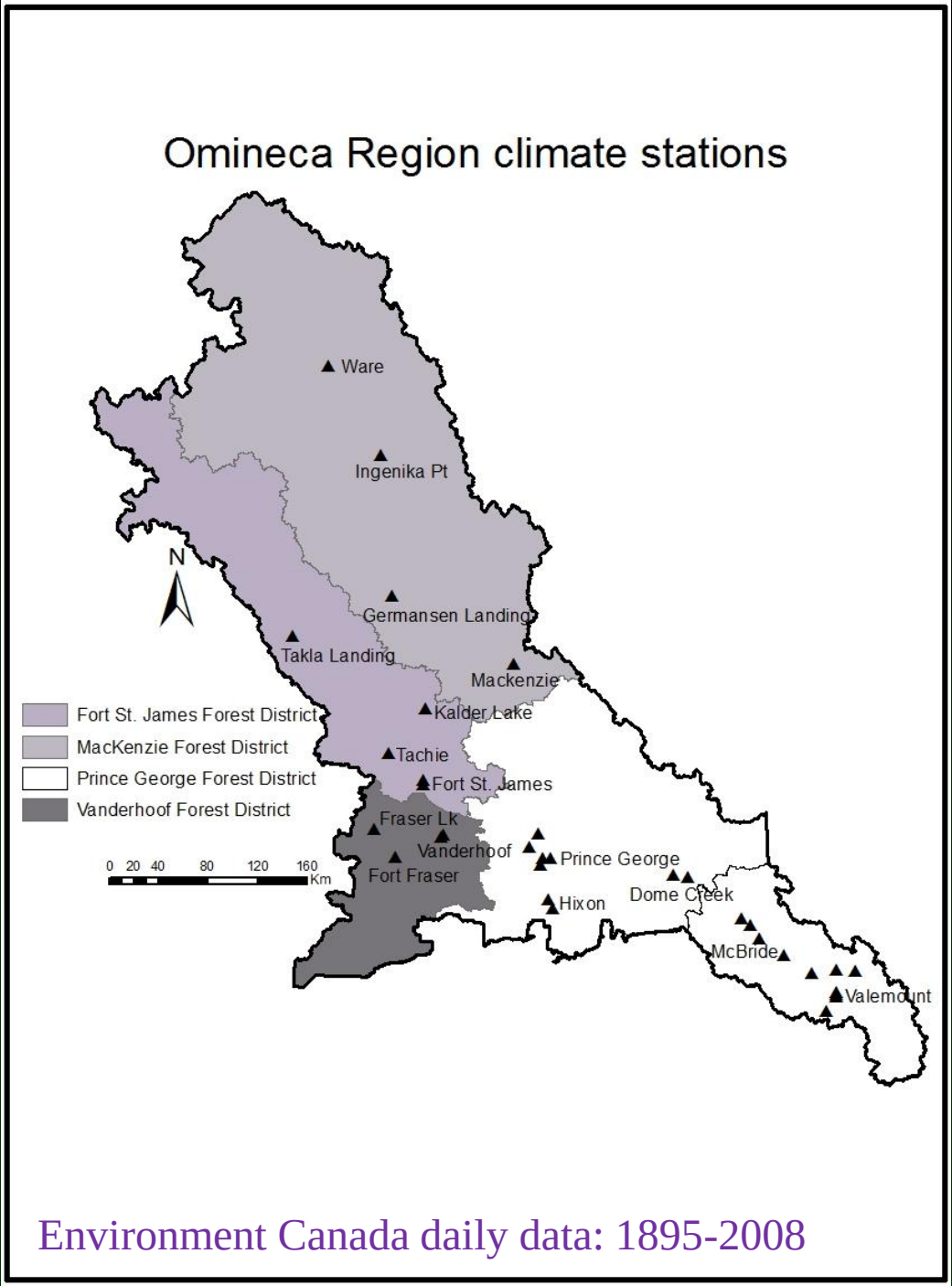

Yearly Average Temperature Smithers A 1942-2016
Temperature (°C)
Year


Yearly Total Precipitation Smithers A 1942-2016
Precipitation (mm)
Year


Smithers A Winter Total Precipitation 1942-2017
Precipitation (mm)
350
300
250
200
150
100
50
0
1942 1947 1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007 2012 2017
Year


Smithers A Spring Mean Temperature 1942-2017
Temperature (oC)
8
7
6
5
4
3
2
1
0
1942 1947 1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007 2012 2017
Year

Omineca Current Climate Trends



Environment Canada daily data: 1895-2008

Omineca Trends

Mean annual precip:+13.3%

- Spring, Summer, Fall ~20% ↑
- Winter ↓

Mean annual temp:+1.3 °C

- Largest: winter ⟶ fall

Extreme max temp:+0.8 °C

- Mostly significantly in summer

Extreme min temp:+4.5 °C

- Largest: Spring, Winter, Fall, Summer

Winter Trends

Change in:	Fort St. James	Mackenzie	Vanderhoof	Prince George	Robson Valley	Omineca
Precipitation (%)	13.9	-14.8	**-9.5**	-17.0	13.3	-1.5
Mean Temperature	**2.6**	**3.8**	**3.2**	**2.1**	0.8	**2.2**
Max Temperature	**2.0**	**0.3**	1.2	0.1	-0.9	0.3
Min Temperature	**4.9**	**3.8**	**2.3**	5.1	1.3	**3.5**

Large trends in winter mean and minimum temperatures

Lots of variability in winter precipitation trends

Spring Trends

Change in:	Fort St. James	Mackenzie	Vanderhoof	Prince George	Robson Valley	Omineca
Precipitation (%)	17.8	10.6	**31.2**	**17.9**	**22.1**	**20.0**
Mean Temperature	**2.4**	**1.5**	**1.5**	**1.1**	0.5	**1.2**
Max Temperature	1.2	-0.3	0.1	0.7	**1.9**	0.6
Min Temperature	**9.3**	**4.2**	**3.6**	**2.7**	**2.2**	**3.9**

Increasing spring precipitation

Large minimum temperatures, west to east trend

Significant increases in mean spring temperatures

Summer Trends

Change in:	Fort St. James	Mackenzie	Vanderhoof	Prince George	Robson Valley	Omineca
Precipitation (%)	**29.4**	9.2	**39.7**	13.9	21.9	**21.5**
Mean Temperature	**2.1**	**1.2**	1.1	**0.9**	**0.6**	**1.1**
Max Temperature	-0.2	**0.7**	1.1	**1.7**	0.0	**0.7**
Min Temperature	4.3	**1.1**	**1.1**	**1.0**	**1.5**	**1.7**

Large increases in summer precipitation, Fort St. James and Vanderhoof district

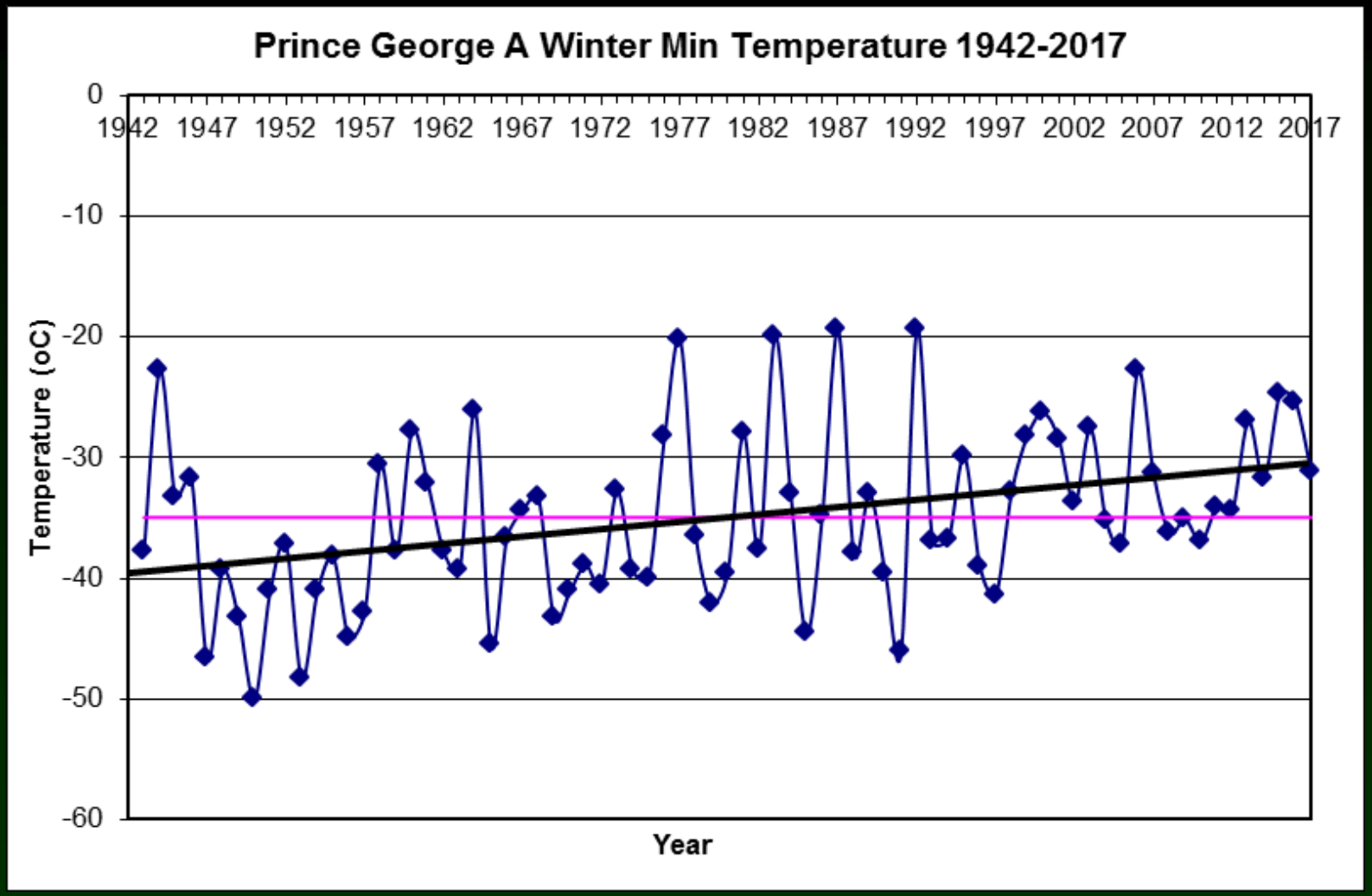
Less change in minimum temperature than spring and winter

Fall Trends

Change in:	Fort St. James	Mackenzie	Vanderhoof	Prince George	Robson Valley	Omineca
Precipitation (%)	**23.6**	9.2	**23.9**	**19.4**	**19.1**	**19.4**
Mean Temperature	**1.6**	0.7	0.8	**0.8**	-0.1	**0.7**
Max Temperature	0.1	0.0	0.8	1.5	-0.2	0.5
Min Temperature	**4.6**	**3.3**	2.4	2.3	0.3	**2.2**

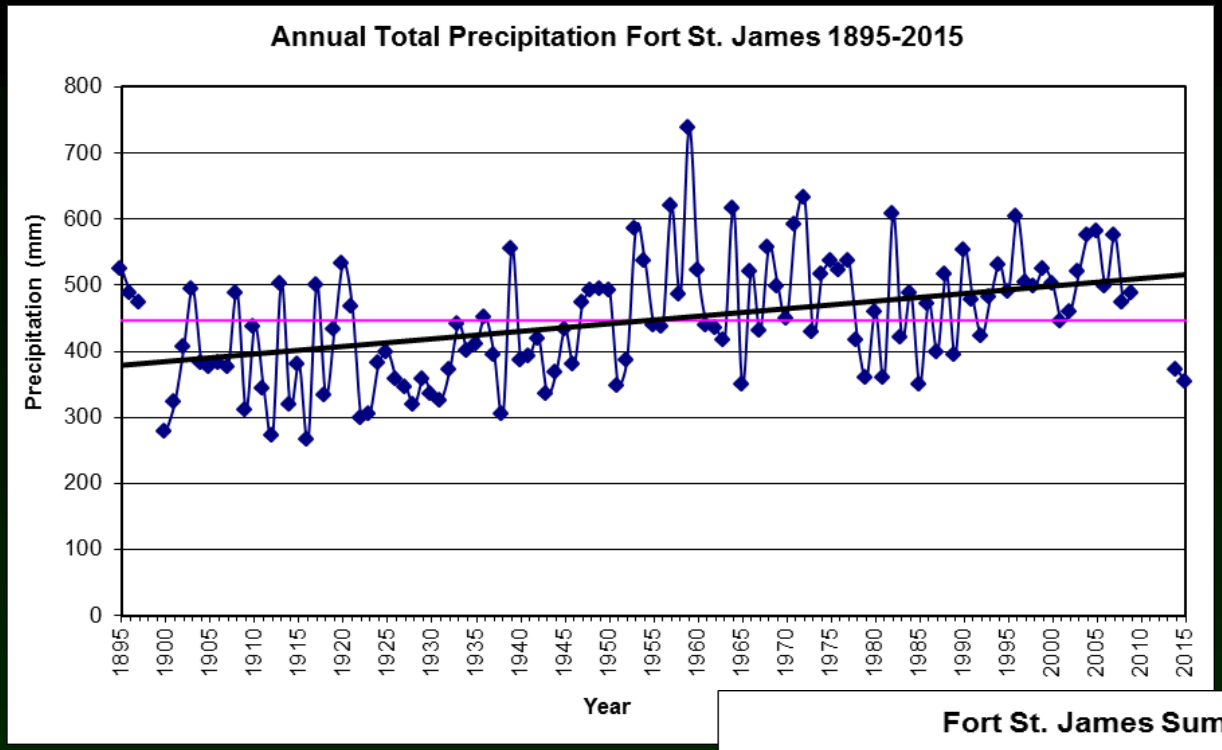
Large increases in fall precipitation

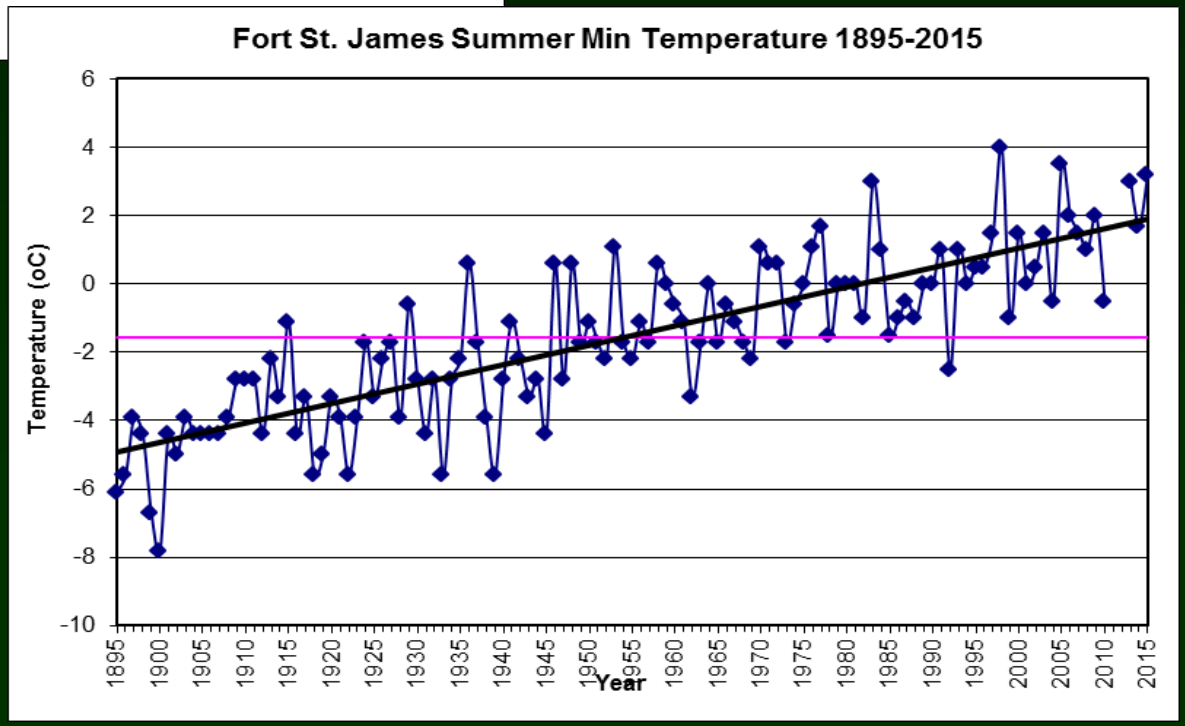
Again, large changes in minimum temperatures



Prince George winter minimum temperatures have increased by almost 10^{o}C.

Creates more favourable conditions for forests pest and diseases, and invasive species.


Annual Total Precipitation Fort St. James 1895-2015
Precipitation (mm)
800
700
600
500
400
300
200
100
0
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year


Fort St. James Summer Min Temperature 1895-2015
Temperature (oC)
6
4
2
0
-2
-4
-6
-8
-10
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Climate/Hydrology:

↓ Snowpack	↑ Minimum temperature	Overall warming	Seasonal shifts
Watershed instability	↑ Fire season length	↑ Fire severity/intensity	Extreme temperatures
Precipitation intensities	↑ Rain	↑ Freeze/thaw switches	Saturated soils
↓ Cold arctic air	↑ Evaporation	Faster snowmelt	↑ Lake temperatures
Summer drought	Isolated rainstorms	↑ Flooding	↑ High-elevation snow
Changing precipitation levels, seasonal difference	Earlier groundwater peak from early snowmelt	↑ River erosion and sediment, channel change	↑Mid-winter ice jam breakups
↑ Log jams	More “no flows”	Extreme low lake levels	↓ Frost
↑ Rain on snow events	↑ Lake algae blooms	↑ Mild, wet springs	↑ Cloud cover
↑ Extreme weather	↑ Evapotranspiration	Dry soils	↑ Stream temperatures
↑ Return intervals of precipitation events	Changes to watershed storage	Mountain permafrost changes and landslides	Early melt of low elevation snow
↑ Groundwater demands from decreased surface water supply	Groundwater tables dropping quickly and early flow into streams	Receding glaciers affecting water supply and power generation	↑ Conditions favourable for avalanches
Abrupt weather changes	Snow wetter and heavier		

Ecosystems:

Shifting ecosystems	↓ Survival of edge range plants	Natural systems out of sync	↑ Invasive species
Whitebark pine threatened: phenology, MPB, blister rust	Alder out-competing traditional riparian vegetation	Species shifting up in elevation and north in latitude	Change dynamics for species planting and suitability
Loss of biodiversity with few large leave areas	Overabundance of young seral habitat	Landscape level biodiversity impacts	↑ Grasses
↓Snow and water availability for ICH	Changes to soil moisture regimes		

Wildlife/Fish:

Changing dynamics: too warm in traditional areas for ungulates	Changes to snow depths affecting ungulate migration	Changes to fish habitat: stream temperatures too warm	↑ Frequency of disturbance: loss of habitat
↑ Elk population	↑ Moose ticks	↓ Bird nesting success	↓ Amphibians
↓ Populations (e.g moose, deer, bear)	Bulltrout threatened, habitats too warm	↑ Total dissolved solids in lakes	↑ Stream temps during spawning seasons
↑ Sediments in streams	Wildlife breaking winter dormancy (e.g. bears)	Changing bird migration patterns and timing	↑ Risks to temperature sensitive streams
↓ Old growth habitat	↓ Specialist species	Phenology changes	↓ Salmon habitat

Pest/Diseases:

MPB epidemic	↑ Rusts	↑ Dothistroma	↑ Spruce Beetle
↑ Invasive species	↑ Blowdown	↑ Moose ticks	Willow poplar weevil
↑ Foliar diseases in young pine plantations	Parasites on white-tail deer	↑ Winter survival of several pests	↑Defoliators
↑ Douglas fir beetle			

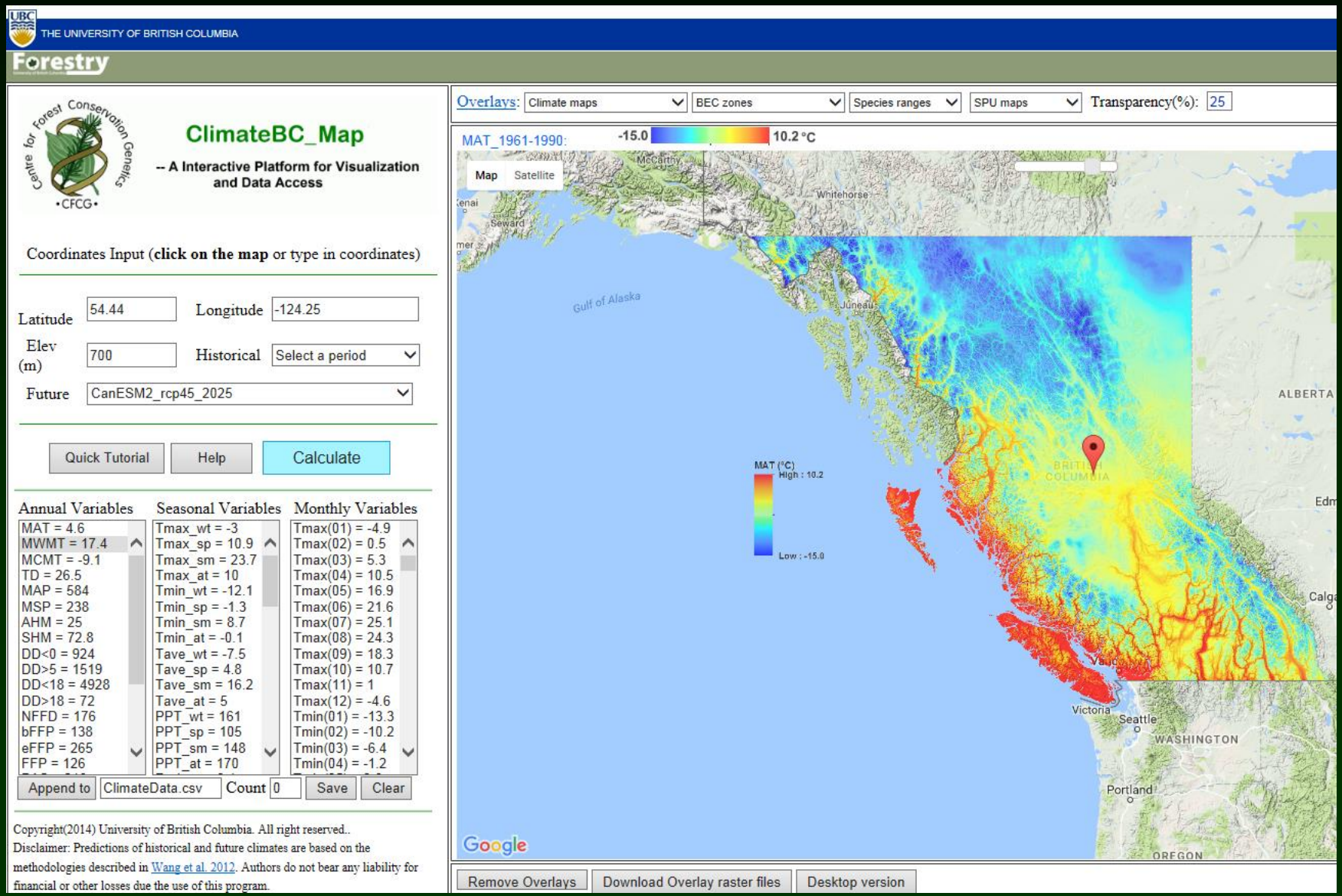
Operations/Landuse:

Longer planting season	↑ Growing season	↑ Harvest season	↓ Winter logger season
Earlier breakup	Planting different species	↓ Mid-term timber supply	↑ Cut size
↑ Harvest from MPB further aggravating climate change impacts	Changes to land absorption and buffering capacity from MPB	Changes to timing and amount of spring freshet from dead pine/harvest	Changes to water availability for power generation
↑ Salvage: ↓ stumpage and revenue	Changes to patch size/matrix composition	Wet soils in summer, loss of operability	↑ Road access and wildlife access
↓ Freezing of soils in winter season	Wildfire management: ↑ demand and costs	↓ Snowmobile season/winter tourism	↓ Well water levels in summer
Seed transfer limits moving north	Planting Douglas Fir and Western Larch	Changing dynamics of species plantings	Changes to stocking standards
↓ Carbon storage	↑ Soil disturbance		

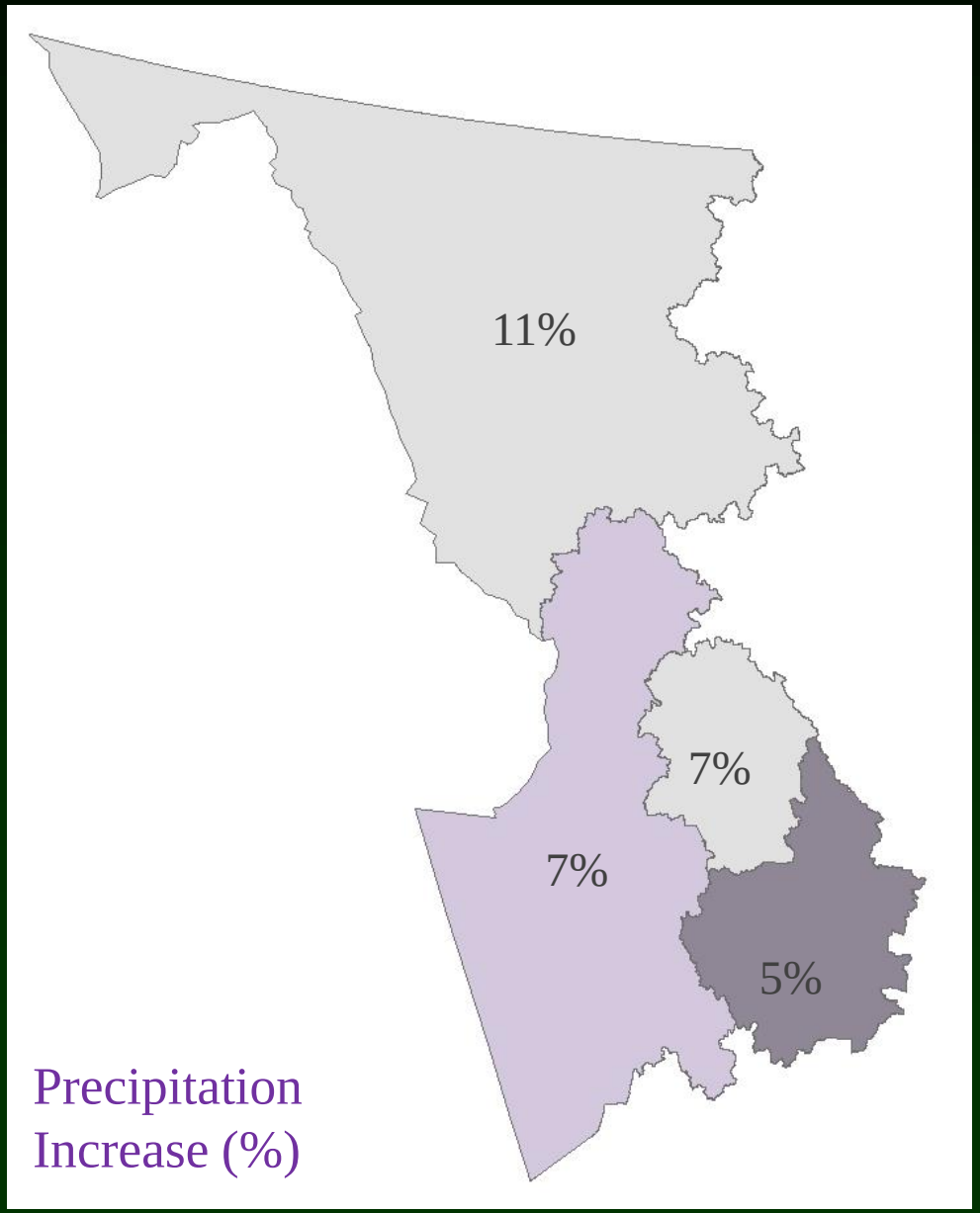
Climate Change Projections: 2040-2069

ClimateBC

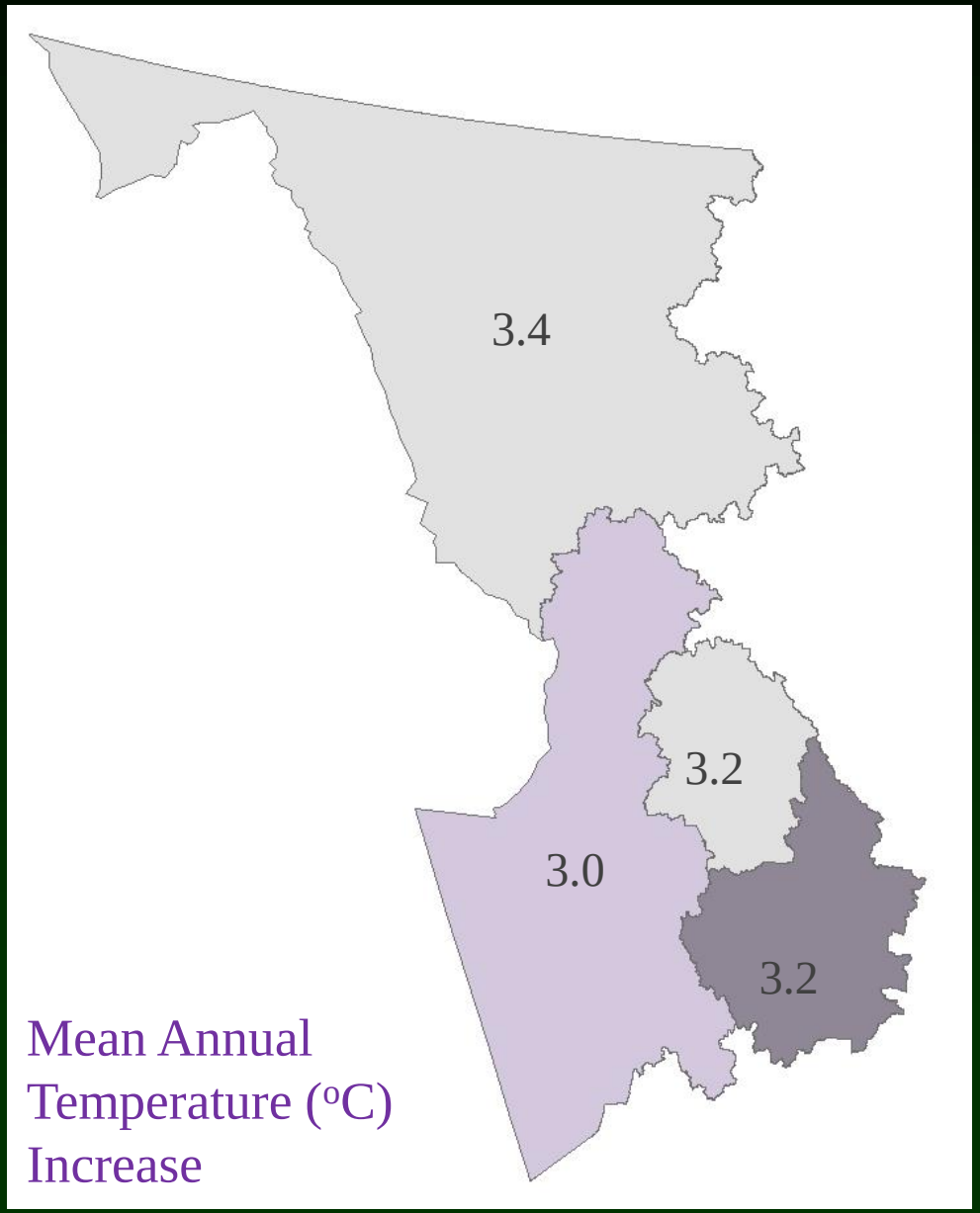
http://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/



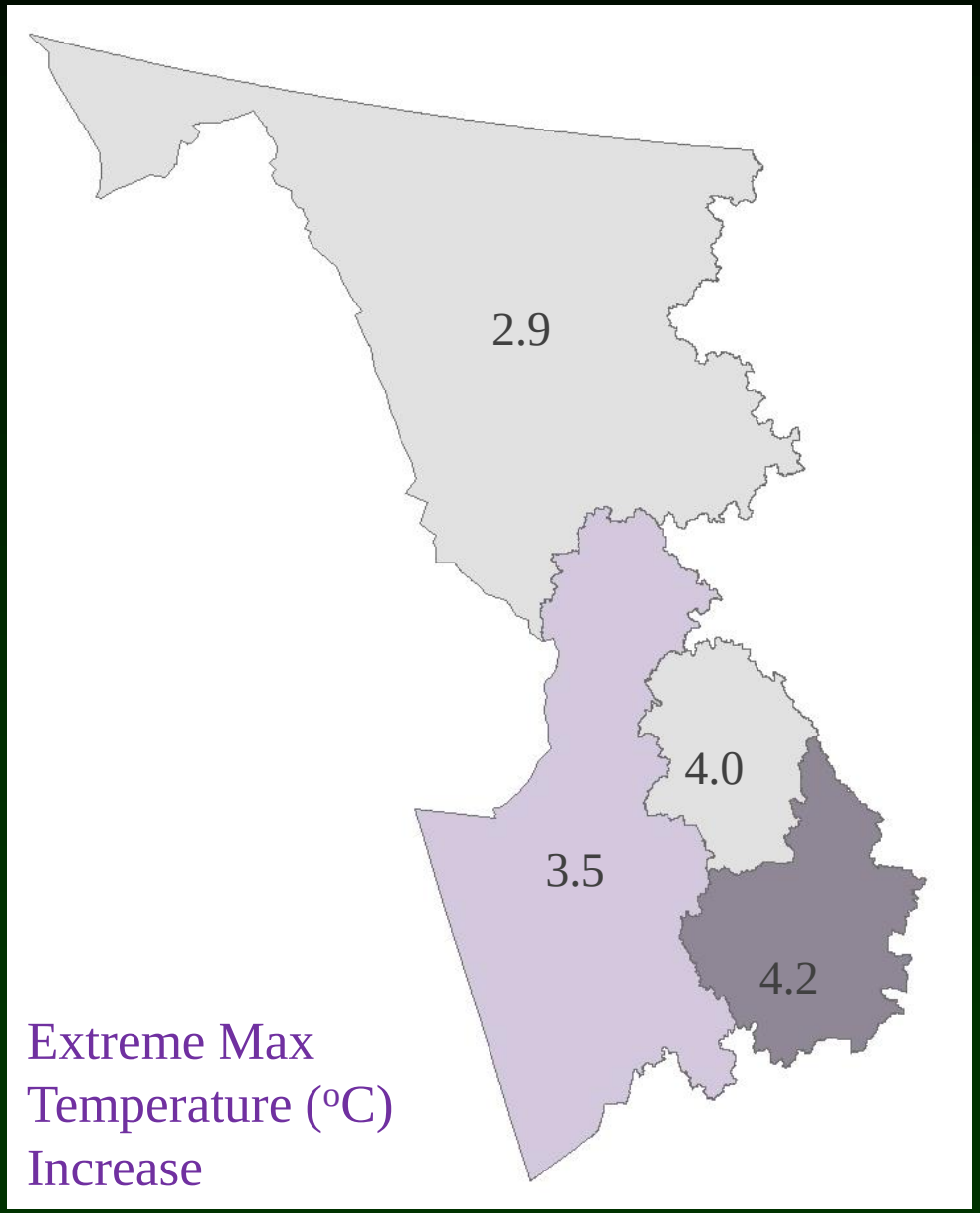
Future change: 2055



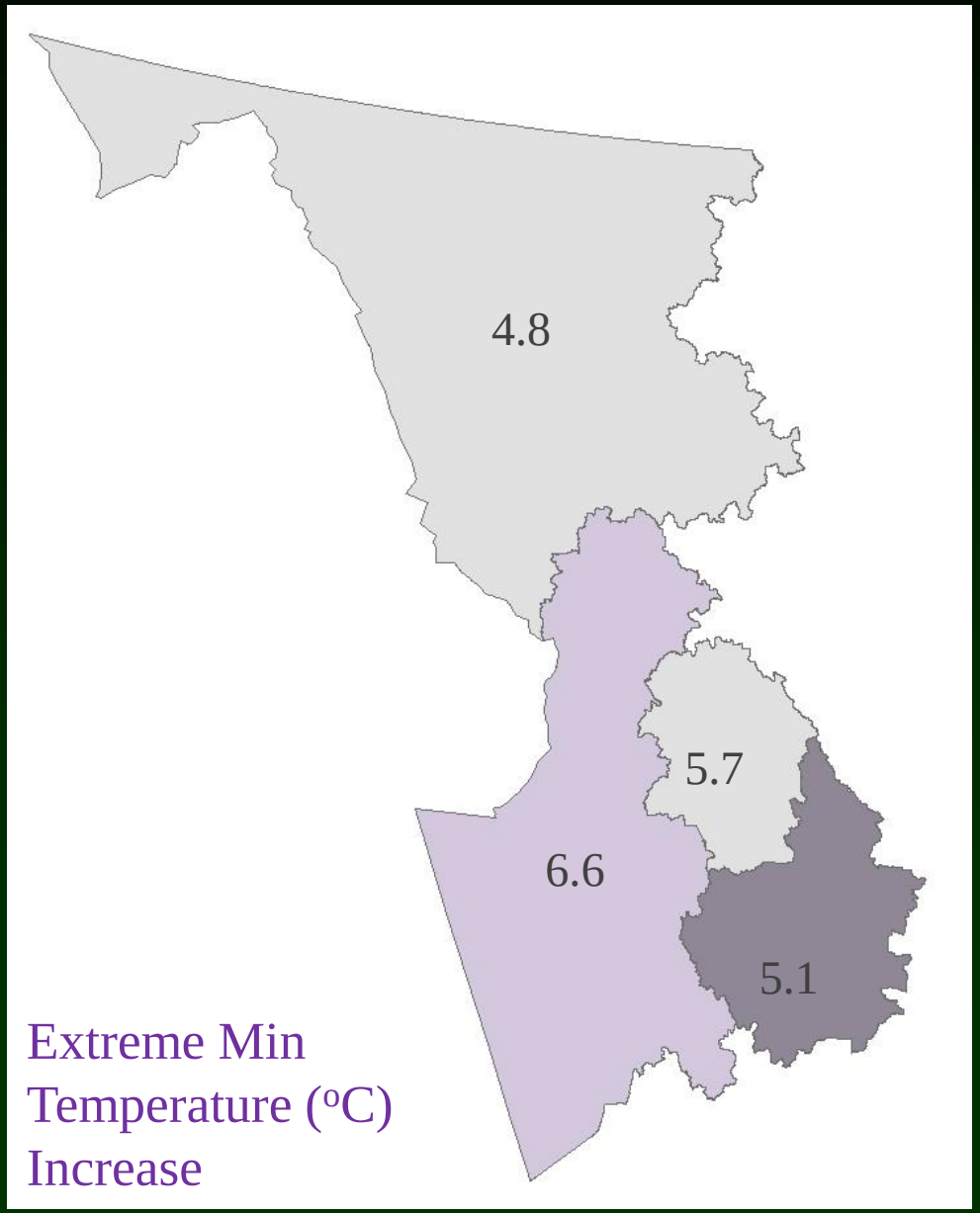
Future change: 2055



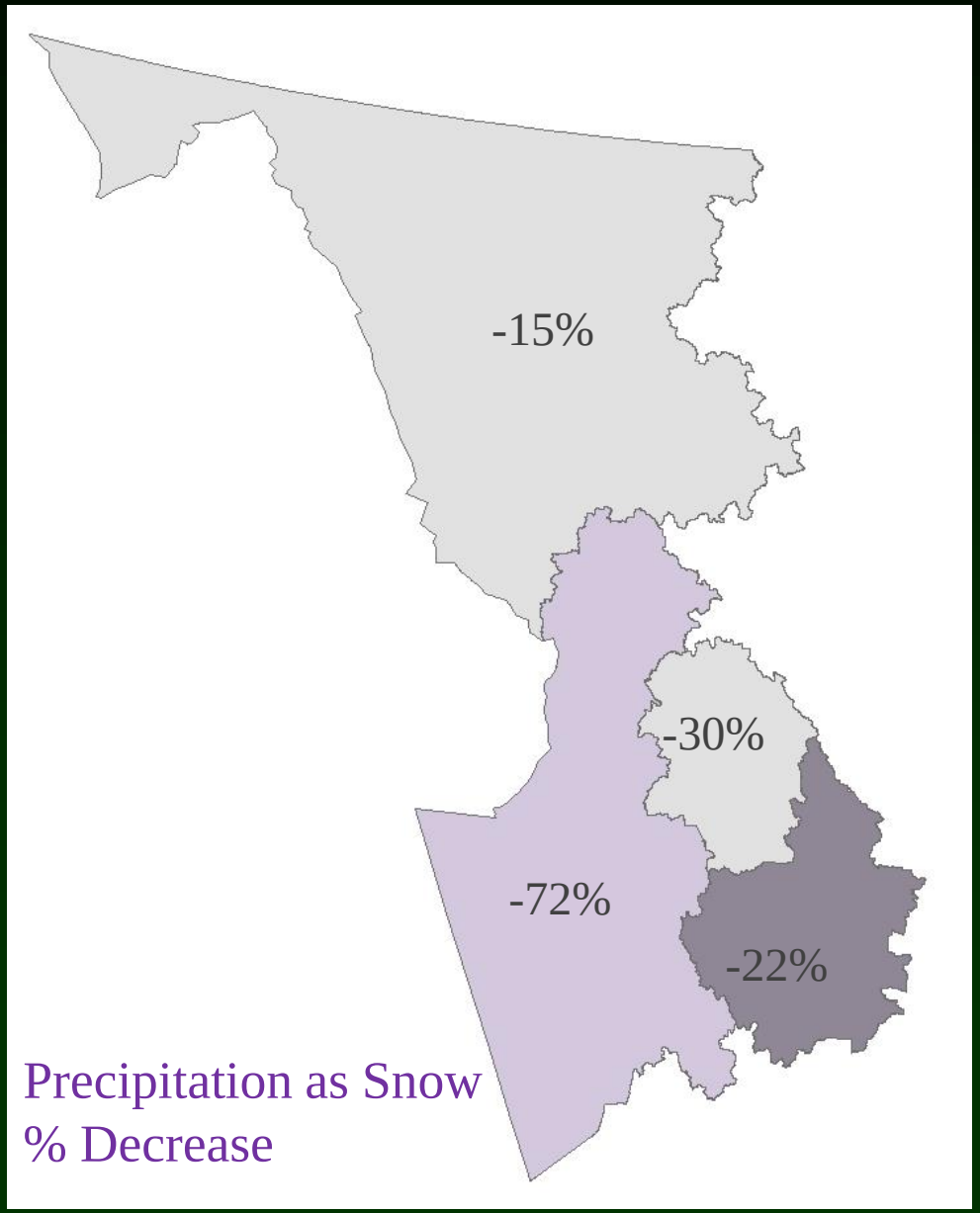
Future change: 2055



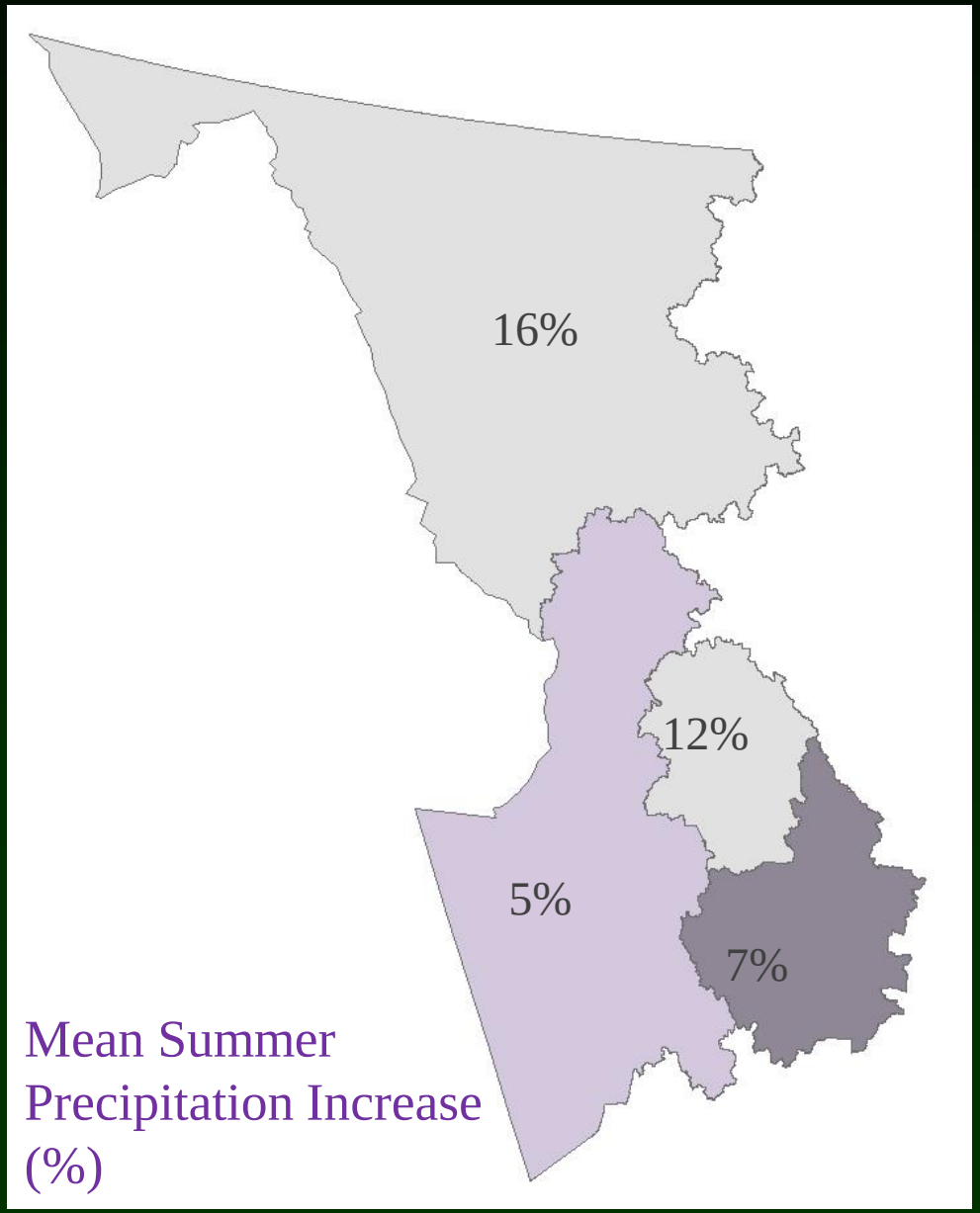
Future change: 2055



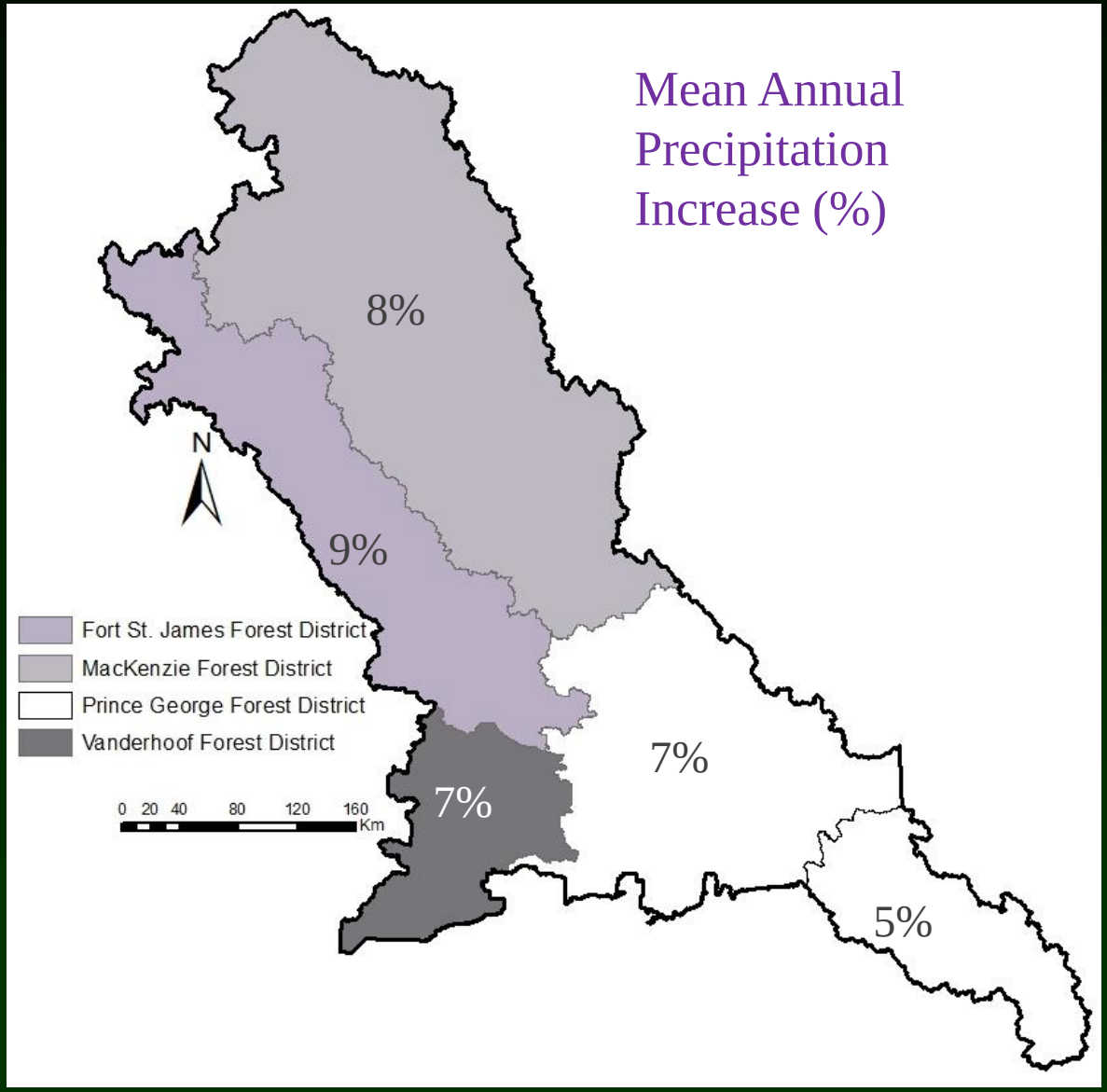
Future change: 2055



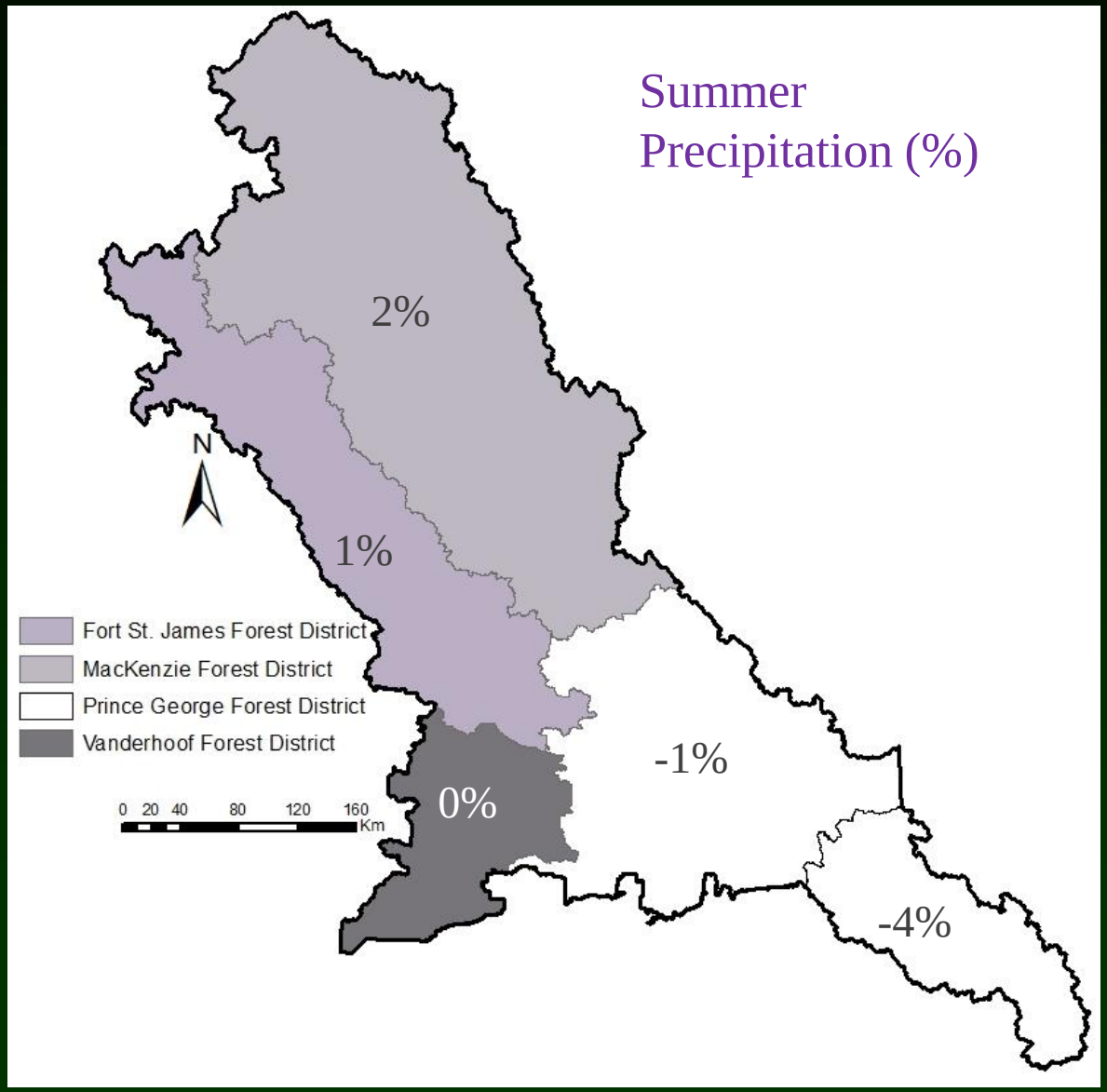
Future change: 2055



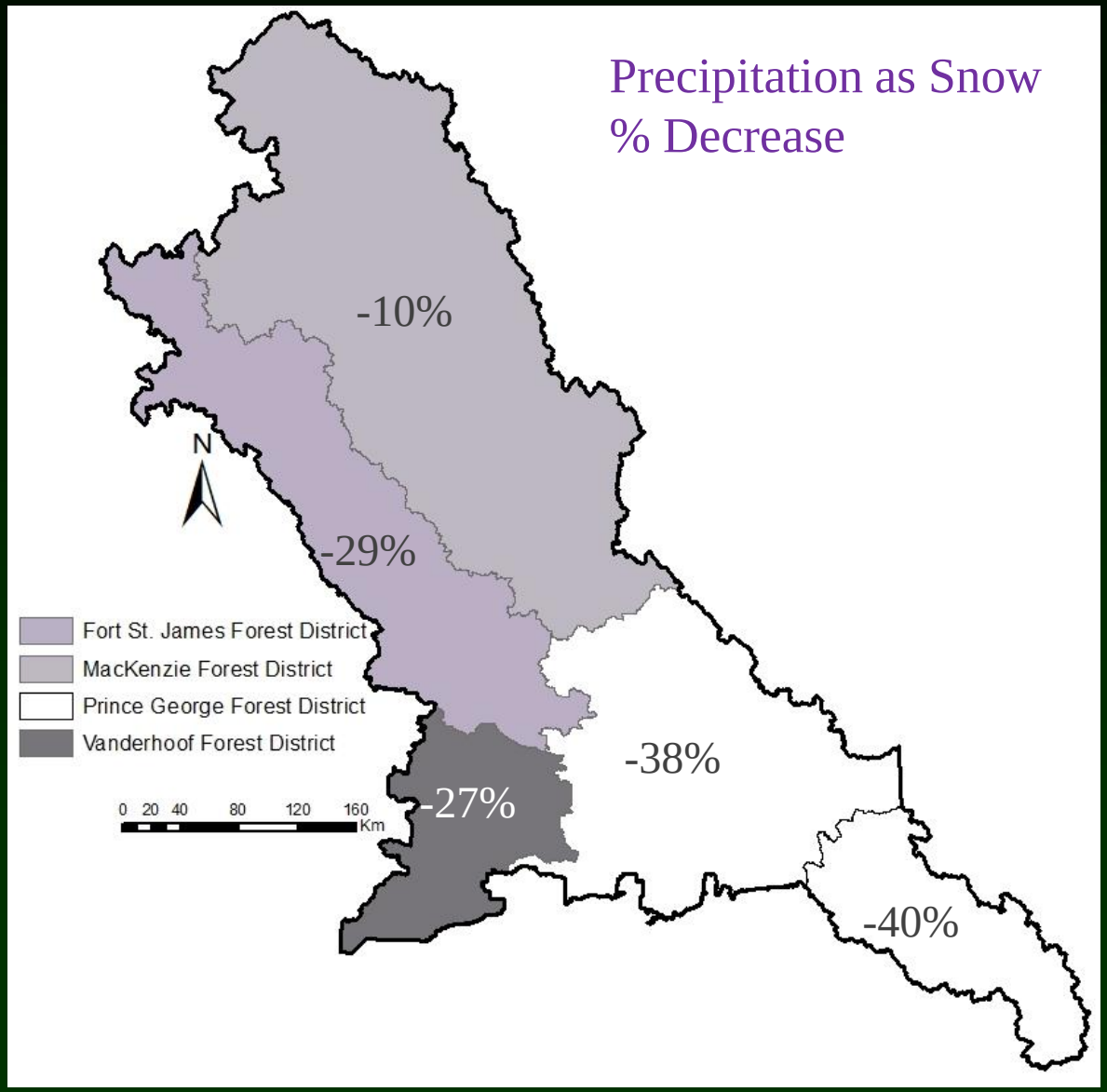
Future change: 2055



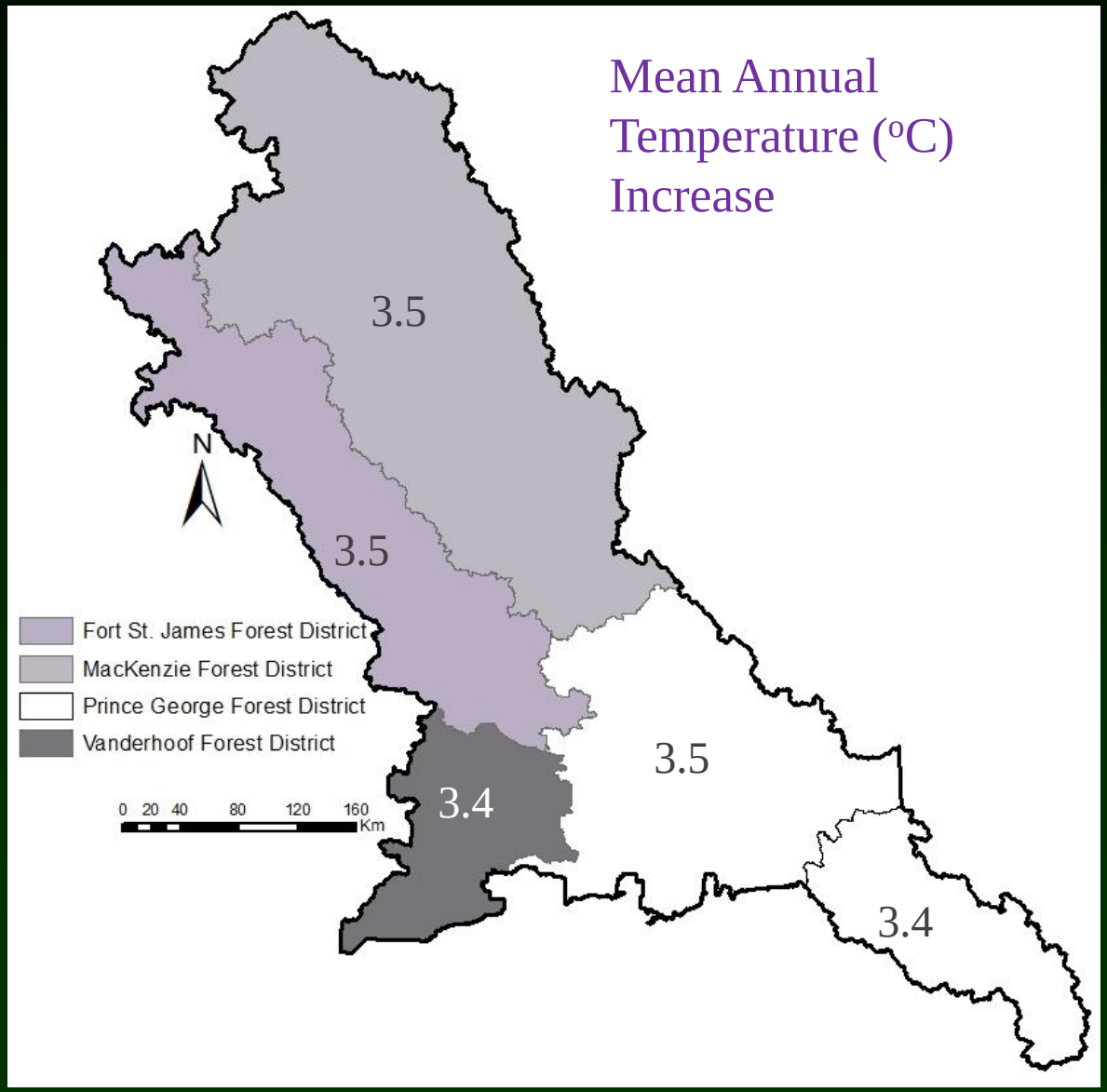
Future change: 2055



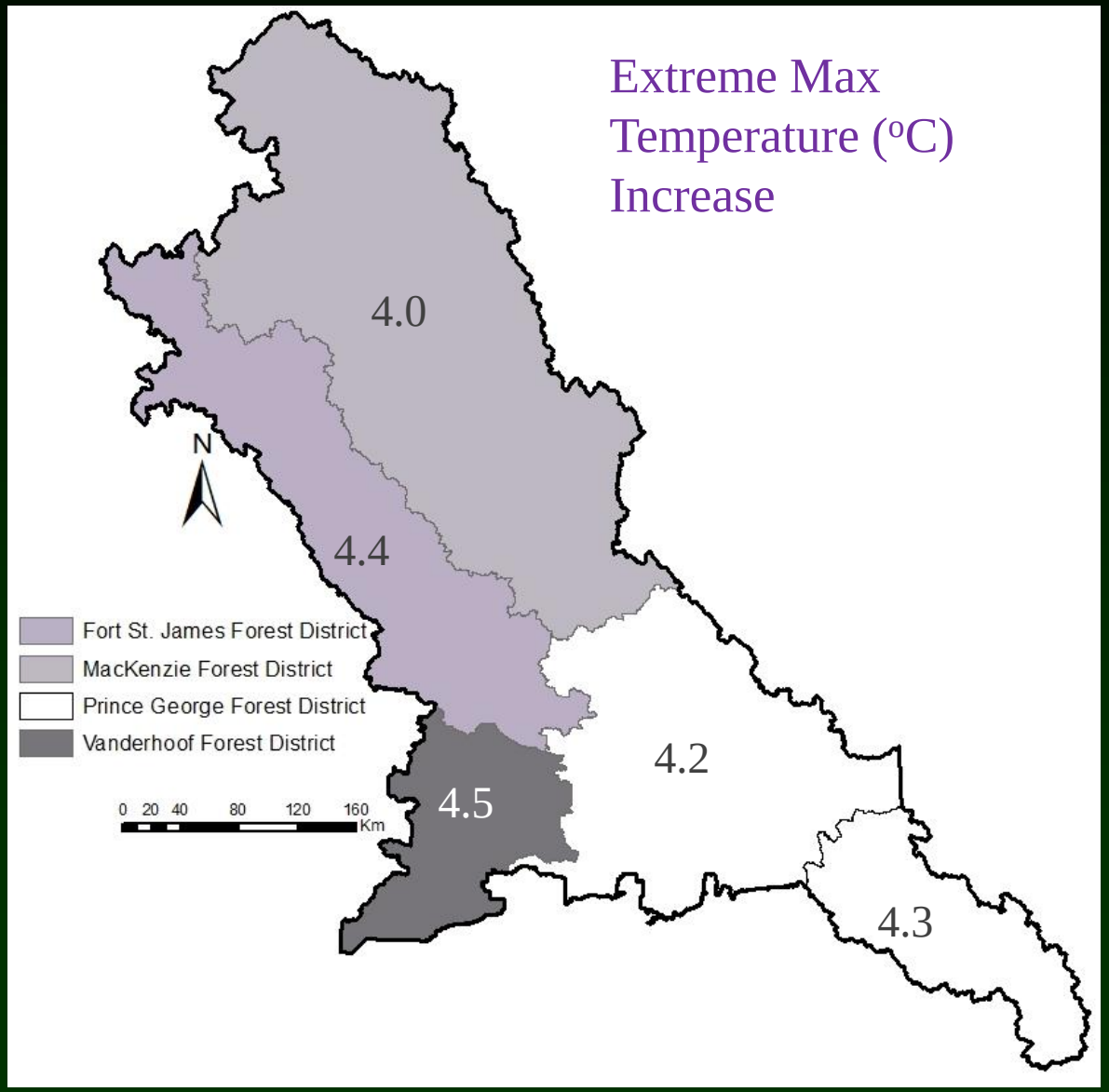
Future change: 2055



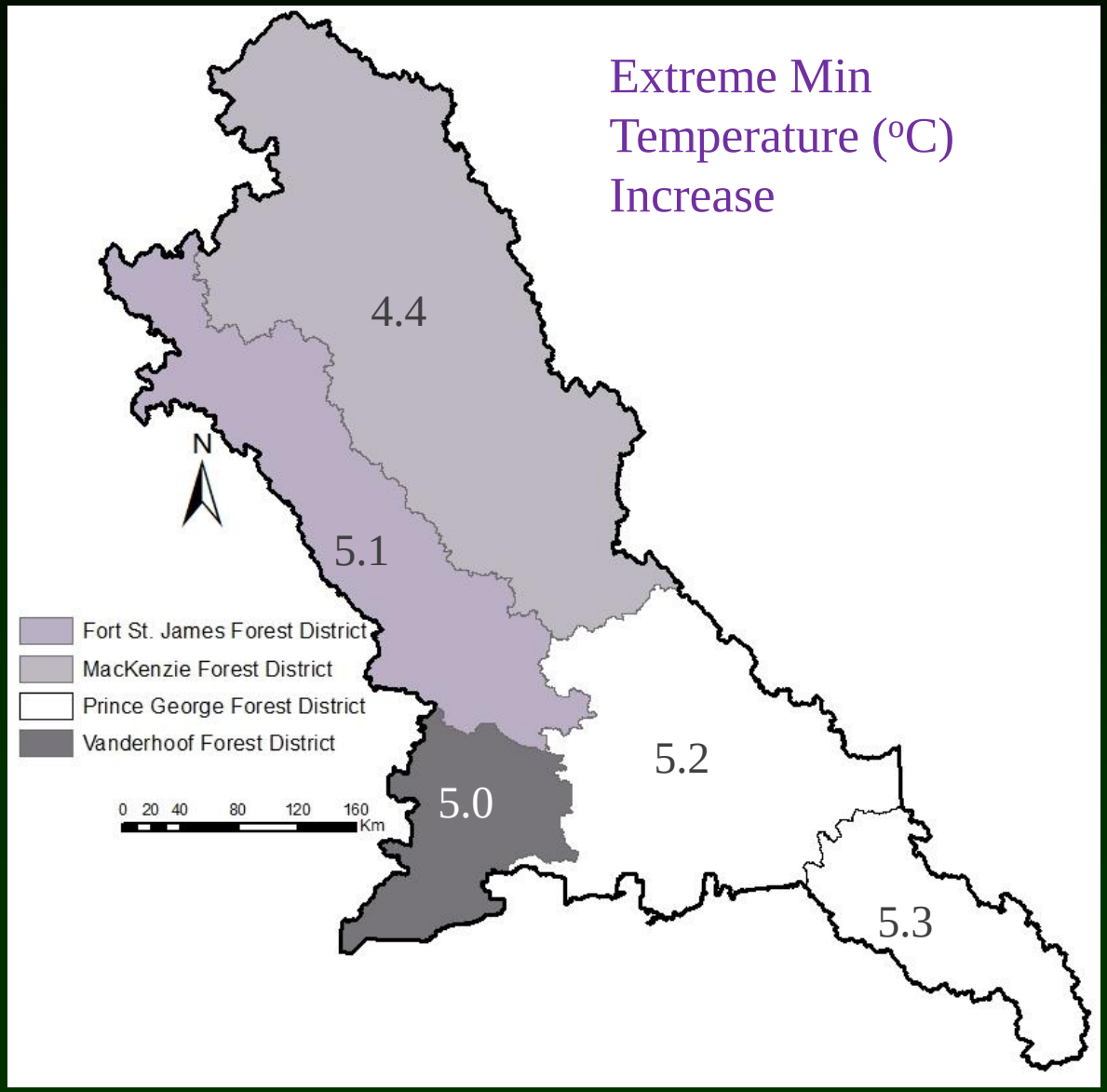
Future change: 2055



Future change: 2055



Future change: 2055



BC Government Response to Climate Change

FLNRO 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

Objectives

1. Public Safety and Natural Disaster Management
2. Climate Science
3. Climate Knowledge
4. Collaboration
5. Legislation, Policy, and Procedures
6. Management
7. Decision Making
8. Business Opportunities
9. Monitoring Performance

Actions

- All Ministry regions and branches developed Climate Action Plans
- Climate Action Plans will be implemented by September 1, 2016
- The delivery of climate action will be integrated into daily activities of staff across the ministry by March 31, 2018.
- An economic analysis on the cost of prevention versus reaction to climate impacts, to be used to help inform Ministry decision making will be completed by March 31, 2017
- Climate change risks and opportunities with regards to First Nations will be assessed by September 30, 2017
- Mechanisms to quantify climate change risk, identify thresholds for action and share cost and risk appropriately will be developed by March 31, 2018
- BC Climate Change Scorecard: Required reporting on progress by region and branch, twice annually

Current Programs – e.g's

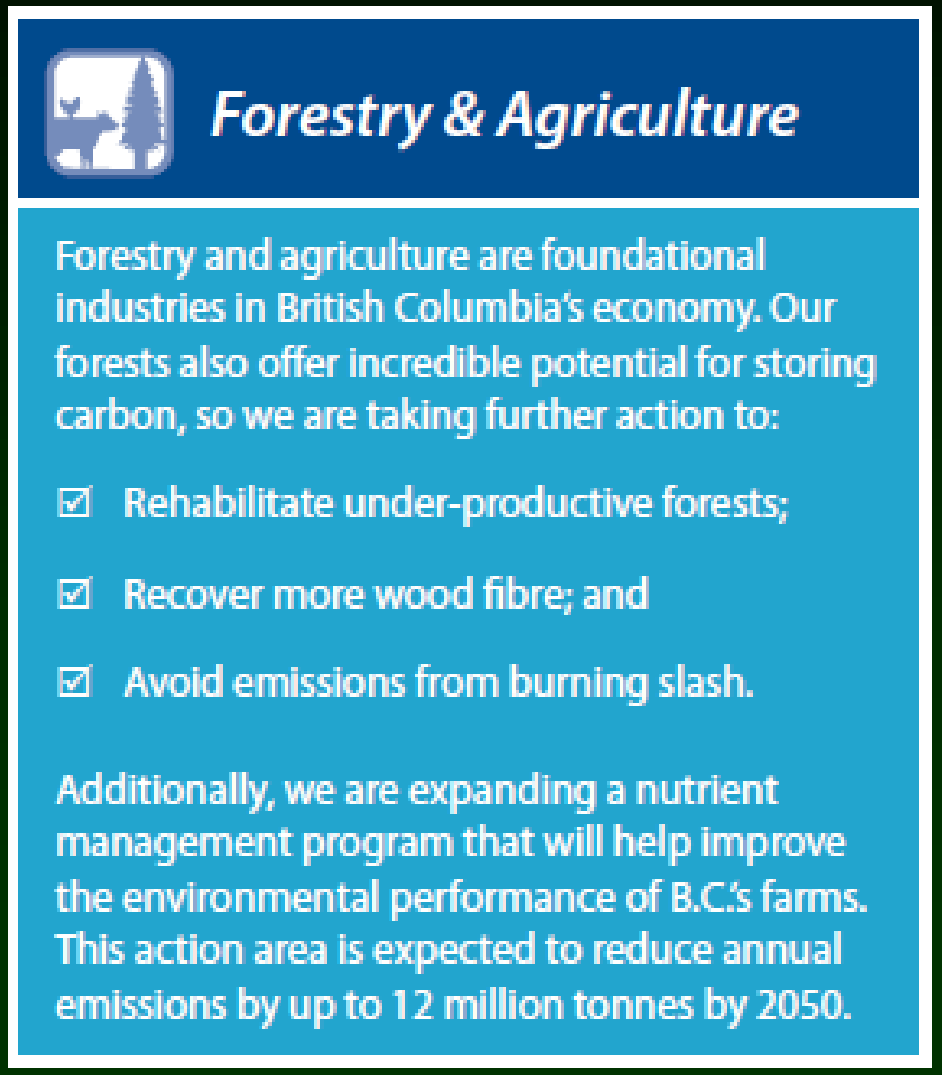
- Assisted Migration - Climate Based Seed Transfer
- Changes to Stocking Standards
- Mixed species options for Forests for Tomorrow
  - Western Larch and Douglas Fir range expansion
- Tree Species Selection Tool
- Wildfire fuel management
- Forest Carbon Offsets
- Climate Models: ClimateBC, WNA, NA
- Future Ecological Classification modelling
  - Promotion and demotion of species
- BC Forests Carbon Strategy 2016-2020

GHG Emission Mitigation Commitments

- 2008: BC legislated the reduction of greenhouse gas emissions by 80% in 2050 (from 2007 levels, 67.3 $MtCO_2e$, = 53.8)
  - 6% reduction by 2012, met, but rose back up
  - 33% of 2007 levels (~21 Mt CO2e) by 2020 ?
  - NEW: Climate Leadership Plan lists actions for reducing 25 $MtCO_2e$ by 2050
- Canada committed to reduce 30% of 2005 emissions by 2030 (~225 $MtCO_2e$): new targets in review/negotiation
- Paris agreement: keep global temperature increase below 2°C (global emissions = zero by 2100)
  - Not legally bound to reduce emissions, legally required to report
  - Fund $100B/yr (2020-25) for developing countries impacts
  - Save remaining intact forests and leave fossil fuels in the ground

Climate Leadership Plan 2016

- Forest Carbon Initiative will rehabilitate 300,000 ha of MPB and wildfire impacted sites over first 5 years
- Fibre Action Plan: fibre utilization and reduced slash pile burning
- By 2050: Annual reduction of GHG emissions up to 12 Mt CO_2e, creation of 19,000+ jobs and $681M in economic activity



BC Forest Carbon Strategy 2016-2020

- Goal 1: Enhance the capacity of BC's public forests as a net carbon sink.
- Goal 2: Increase the contribution of forest products to mitigating climate change
- Goal 3: Increase collaboration with First Nations, communities and stakeholders
- Goal 4: Research to inform policy development

Example Actions:

- Reduce fire risk through Forest Enhancement Society
- Guide forest carbon offset investment in FCOProtocol
- Respond to disturbances through Forests For Tomorrow
- Develop carbon friendly products with FPInnovations
- Improve fibre utilization
- Encourage increased use of wood
- Promote use of value-added products
- Work directly with First Nations
- Collaborate with CFS, PICS, PCIC
- Climate change and forest carbon modelling
- Improve extension and communication

Omineca Climate Action Plan

Background

- Omineca Climate Action Plan developed 2014
  - Goals, Objectives, Actions for each theme
  - Water; Terrestrial Habitat and Wildlife; Aquatic Habitat and Fish; Forests, Range, Ecosystems; Geohazards, Landscape-Level Impacts and Cumulative Effects
- Workshop December 2015:
  - Refine actions identified during 2014 workshop
  - Action status, context, responsibility, prioritize
  - Identify top three for each theme
  - Integrate actions into workplan process, engagement
  - Implementation Plan

Results: Water

1. Research/activities to link groundwater and surface water
   - Driven by the Water Sustainability Act changes and capacity of new staff.
2. Development and improvement of assessment tools
   - i.e. Omineca Watershed Health assessment completed
3. Improved baseline monitoring
   - Installation of wells and hydrometric stations
   - Increasing frequency of sampling

Results: Terrestrial Habitat & Wildlife

1. Research & monitoring on how climate change affects ecosystem habitat
2. Focus on high priority research:
   - Moose populations – (i.e. habitat, population modelling, mortality surveys, ticks)
   - Caribou - recovery planning
   - Whitebark pine
3. Establish interdisciplinary climate change working group to increase awareness, collaboration
   - Include: FLNRO staff, First Nations, academics

Results: Aquatic Habitat & Fish

1. Sub-committee to build climate issues as value-added components of existing projects:
   - Apply for climate related funding
   - Explore partnerships to generate funds, resources
   - Integrate into regional resource discussions, raise profile of fisheries values in planning, climate change initiatives
2. Strategic plan for river/stream-temperature monitoring across the Omineca Region
3. Habitat vs. indicator species
   - Predictive tools for habitat coupled with monitoring Species at Risk

Results: Forestry, Range & Ecosystems

1. Validate the Drought Risk Assessment Tool and continue to support drought risk modelling
2. Adapt Long-Term Research Installations for assessing climate change trends
3. Use latest version of ClimateBC and Biogeoclimatic Ecosystem Classification (BEC) modelling at all ecosystem units to create Omineca BEC projections
4. Validate models by increasing climate monitoring on areas with no historical information
5. Implement stocking standards adapted to climate change
   - Increase target and minimum densities, especially for pine
6. Map and maintain natural grasslands

Results: Geohazards

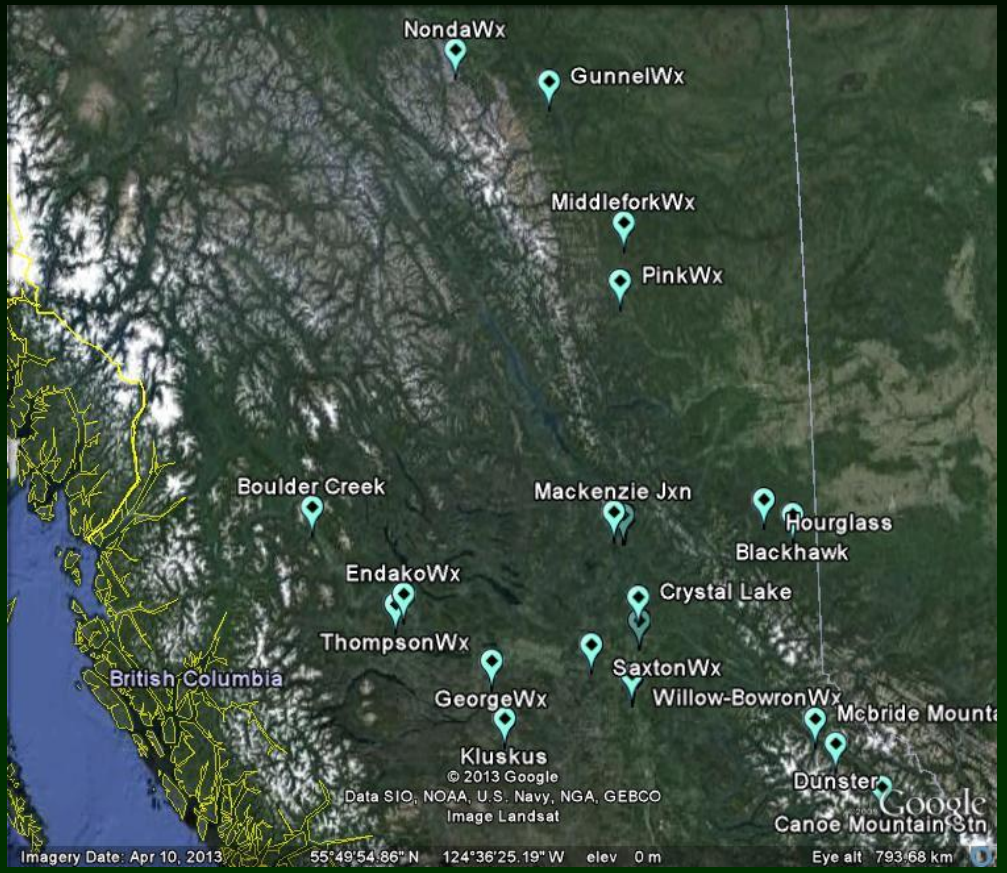
1. Increase monitoring efforts on climate and geohazards
   - Initiate landslide and geohazard database (running in parallel with provincial initiative).
   - Enhance spatial analysis
2. Proactive natural hazard management through development of automatic and integrated landslide detection tools and consider ability to do geohazard assessments for vulnerable communities
3. Increase soil moisture monitoring, use of remote sensing tools and appropriate field validation

Results: Landscape Level Impacts & Cumulative Effects

1. Continue with North Area Cumulative Effects project
2. Implement phase 2 of the Prince George Timber Supply Area Landscape Objectives Working Group pilot
   - Identify landscape biodiversity areas, 6 merged BEC units (from natural disturbance units)
3. Implement North Area Climate and Natural Disturbance Database into consideration for decision-making and expand climate monitoring in a variety of landscapes to quantify changes, watch for emerging issues, and incorporate into operational activities or management plans where appropriate

Forest Ecosystem Research Network

- 25 weather stations, 28 research locations
- temperature, relative humidity, pressure, rainfall, solar radiation, wind speed/direction, snow depth, soil moisture
- temperatures at various heights: air, snow, soil, and rock (~350)
- leaf wetness, understory light/radiation
- snow cores: depth, density, snow water equivalent



- Weather stations filling gaps in our provincial monitoring networks: north, mid to high elevations, additional measurements
- Data is online via PCIC BC Station Data Portal
- Real-time data starting to become available

Current Research Projects

1. Disease severity of young pine stands related to microclimate and climate change
2. Impacts of mountain pine beetle to carbon flux, ecosystem productivity, hydrology, and understory light of non-harvested stands
3. Climate of permafrost regions (mountains and isolated patches), impacts of climate change and potential stability risks
4. Kiskatinaw River peak flow modeling, climate/snow monitoring
5. Assessing drought risk, validation of Drought Risk Analysis Tool
6. Indicators of climate change to aid adaptation in resource management: tools and model validation





Citation

Foord, V. 2016. Climate patterns, trends, and projections for the Omineca, Skeena, and Northeast Natural Resource Regions, British Columbia. Prov. B.C., Victoria, B.C. Tech. Rep. 097. www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr097.htm

https://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/TR097.htm

Data source for slides: 16, 17, 24, 25: based on Environment Canada weather stations.

Questions?

Vanessa.Foord@gov.bc.ca

250-561-3459