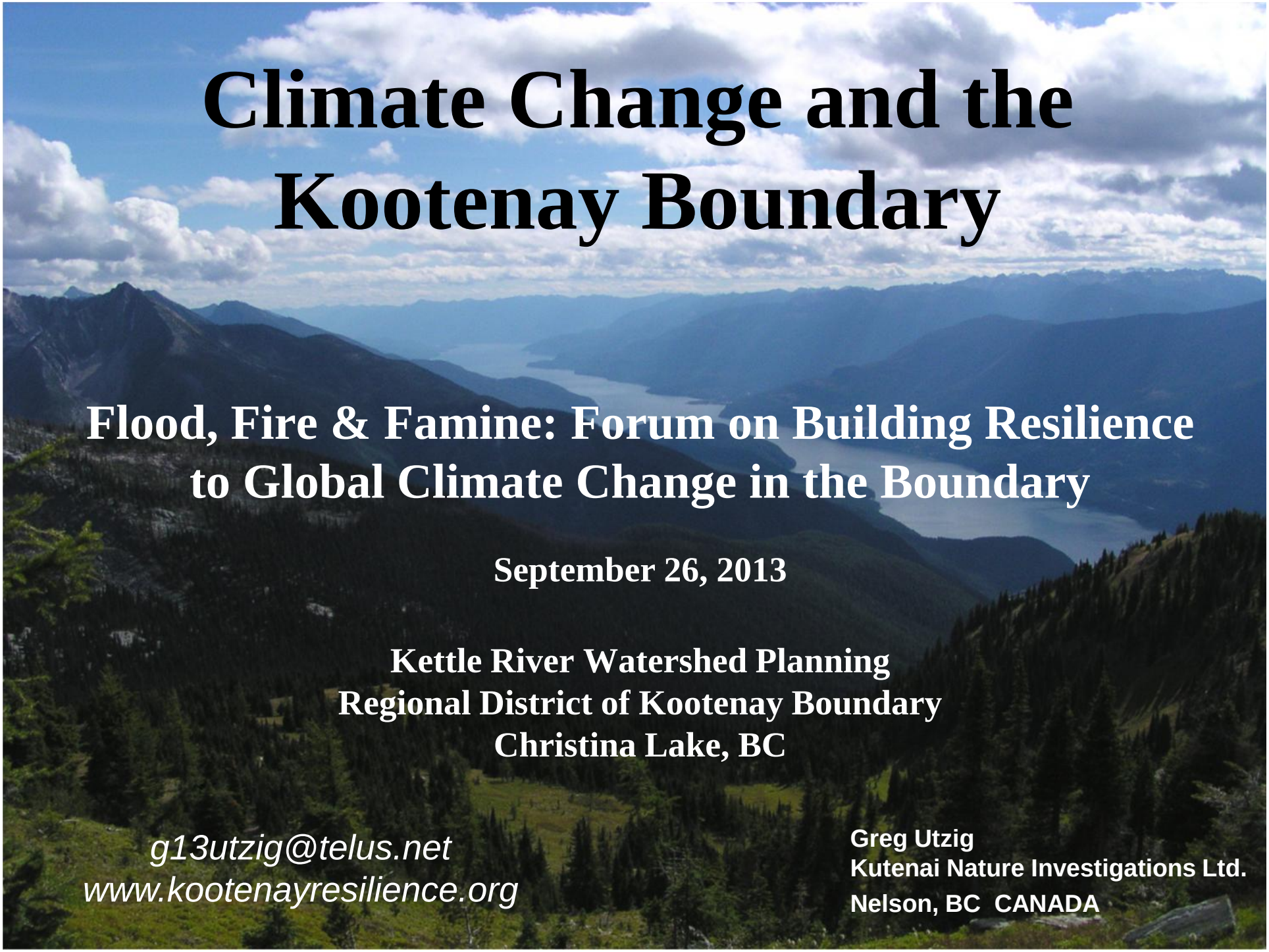


Climate Change and the Kootenay Boundary

Flood, Fire & Famine: Forum on Building Resilience to Global Climate Change in the Boundary

September 26, 2013

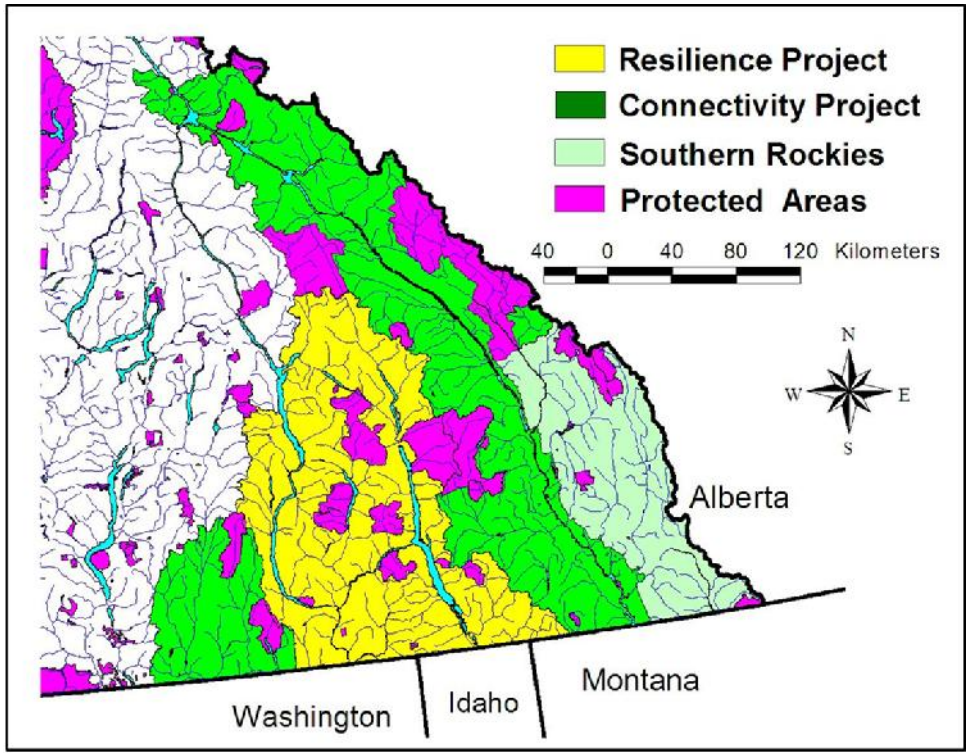
Kettle River Watershed Planning
Regional District of Kootenay Boundary
Christina Lake, BC

g13utzig@telus.net
www.kootenayresilience.org

Greg Utzig
Kutenai Nature Investigations Ltd.
Nelson, BC CANADA

Climate Change Projects

- Vulnerability/ Resilience Assessment of West Kootenay Forest Ecosystems
  - Funded by BC Government – MoFLNRO - Future Forest Ecosystem Scientific Council
- Climate Change Conservation Planning
  - Funded by ENGOs – Wildsight and Conservation Northwest

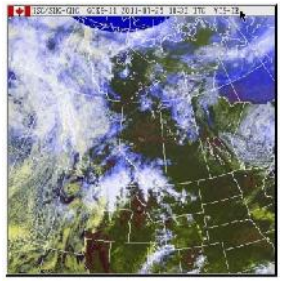


Climate Information

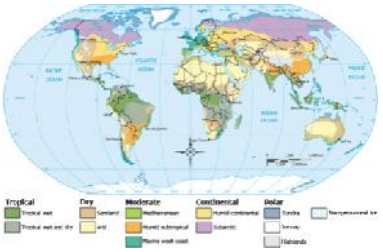
- Pacific Climate Impacts Consortium (PCIC) – U of Victoria
- Climate Western North America (ClimateWNA) – BC MoFLNRO, UBC, U of A – Edmonton
- Climate Impacts Group (CIG) – U of WA
- International Panel on Climate Change (IPCC)

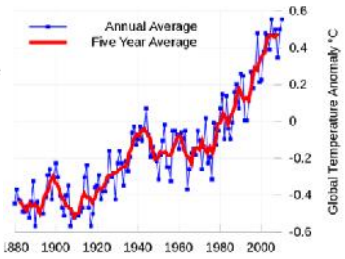
Weather and Climate

- Weather
  - Day-to-day variation in temperature, precipitation, humidity, wind and atmospheric pressure – the state of the atmosphere at a particular time

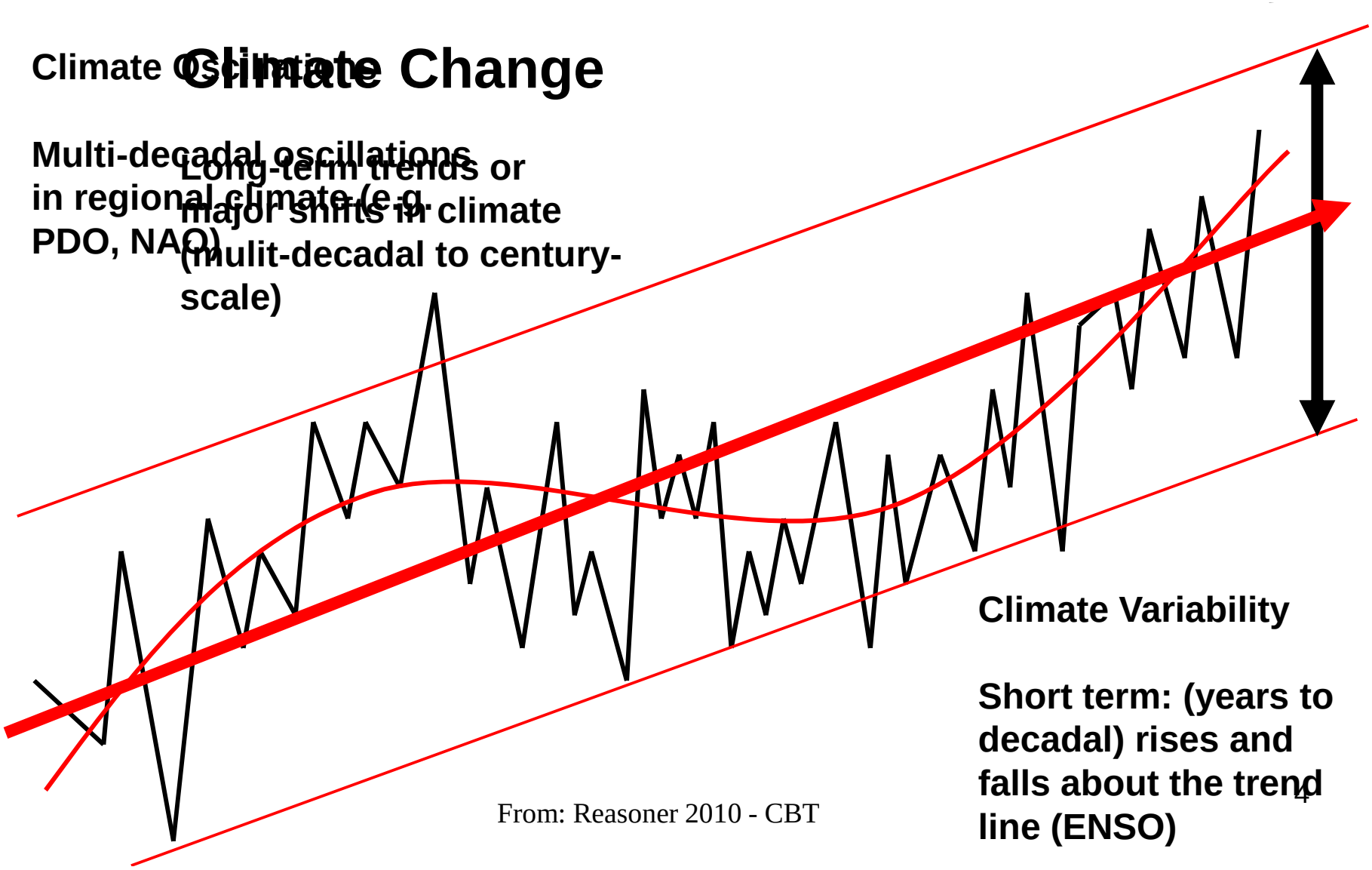


- Climate
  - Averages or extremes of temperature, precipitation and other atmospheric variables over longer periods of time (months, years, decades, centuries)



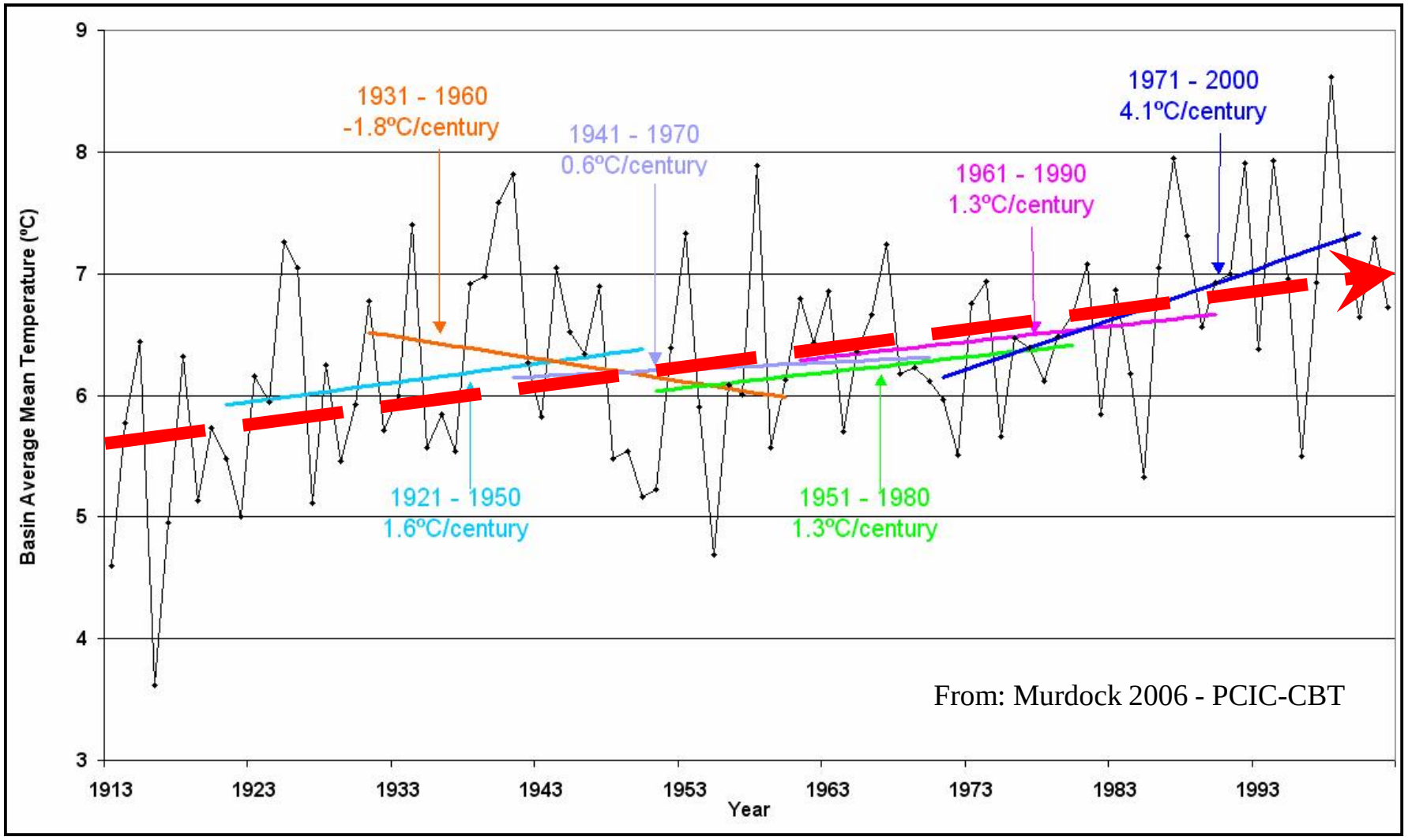


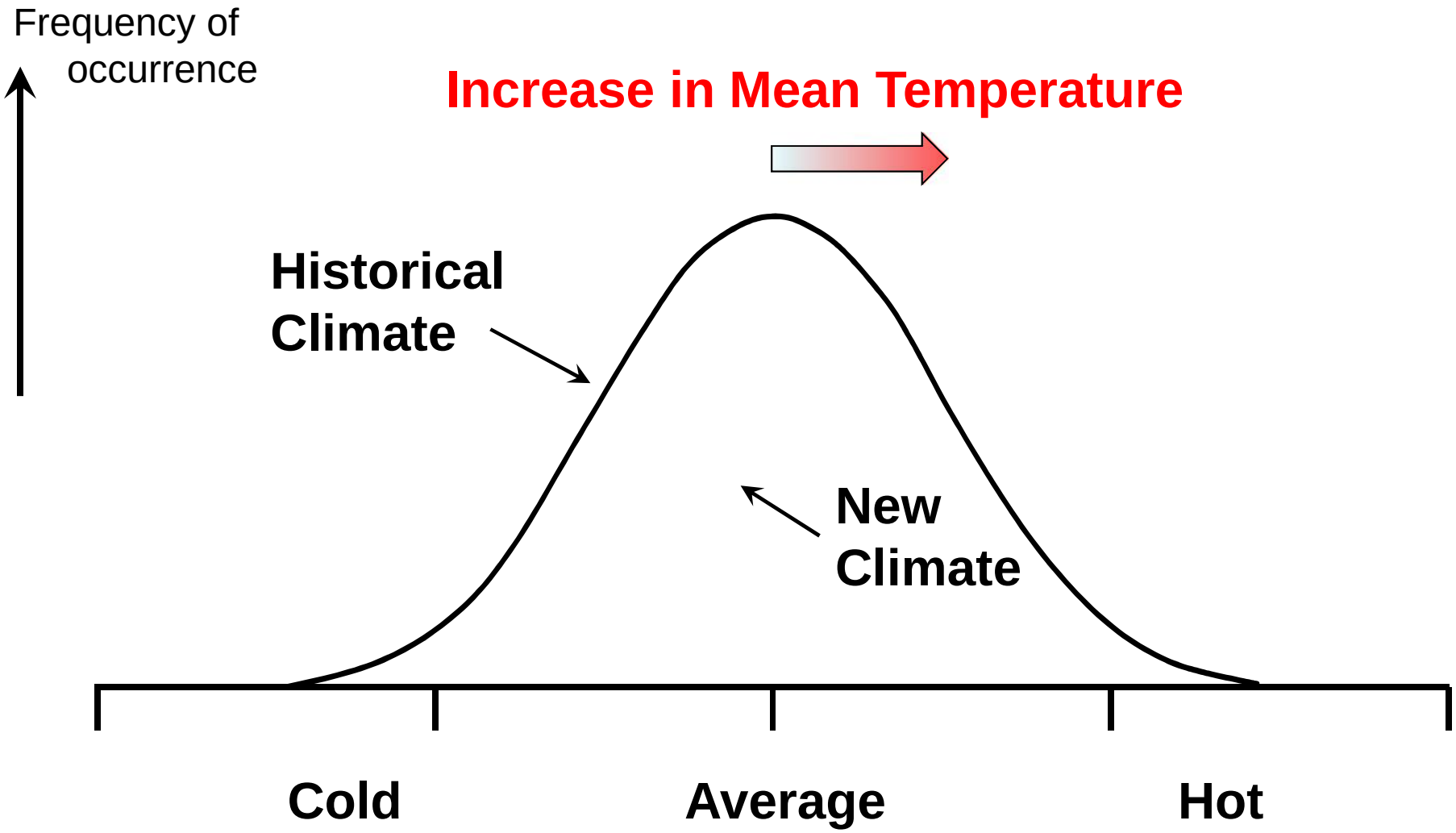
Weather and Climate Variability



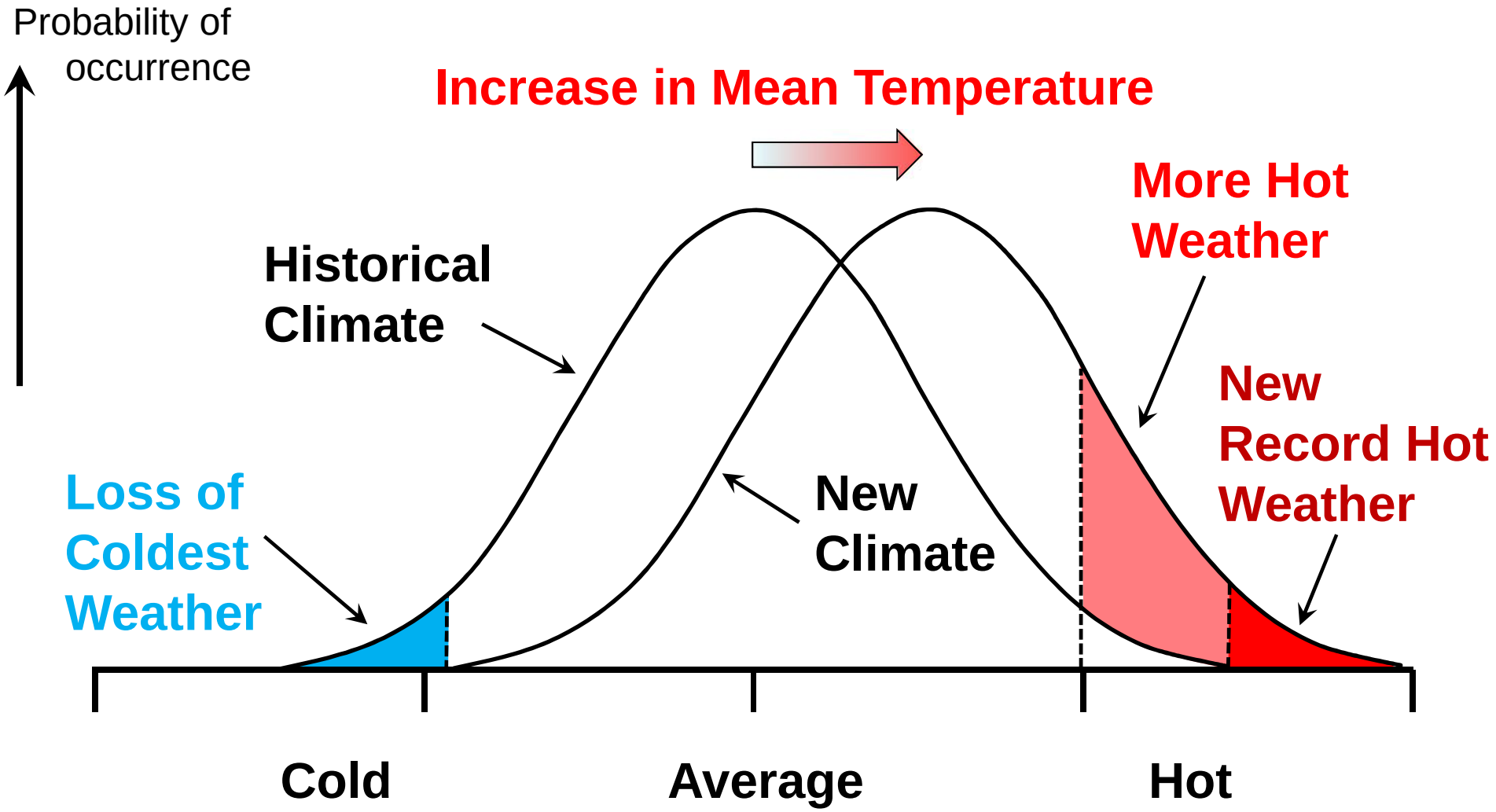
From: Reasoner 2010 - CBT

Trend of Mean Annual Temperature Columbia Basin (30 year “normals”)



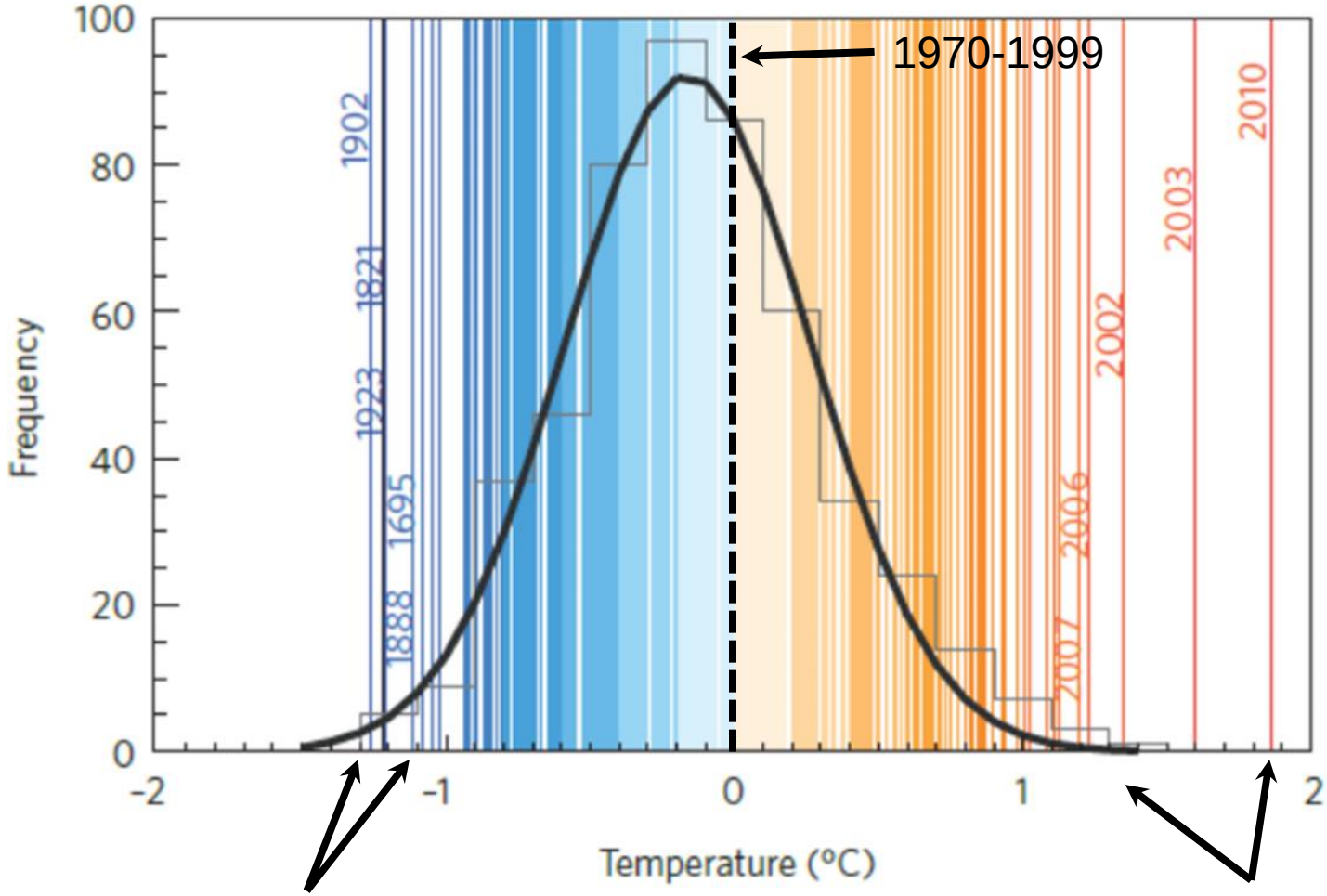


Adapted from: Reasoner 2012



Adapted from: Reasoner 2012

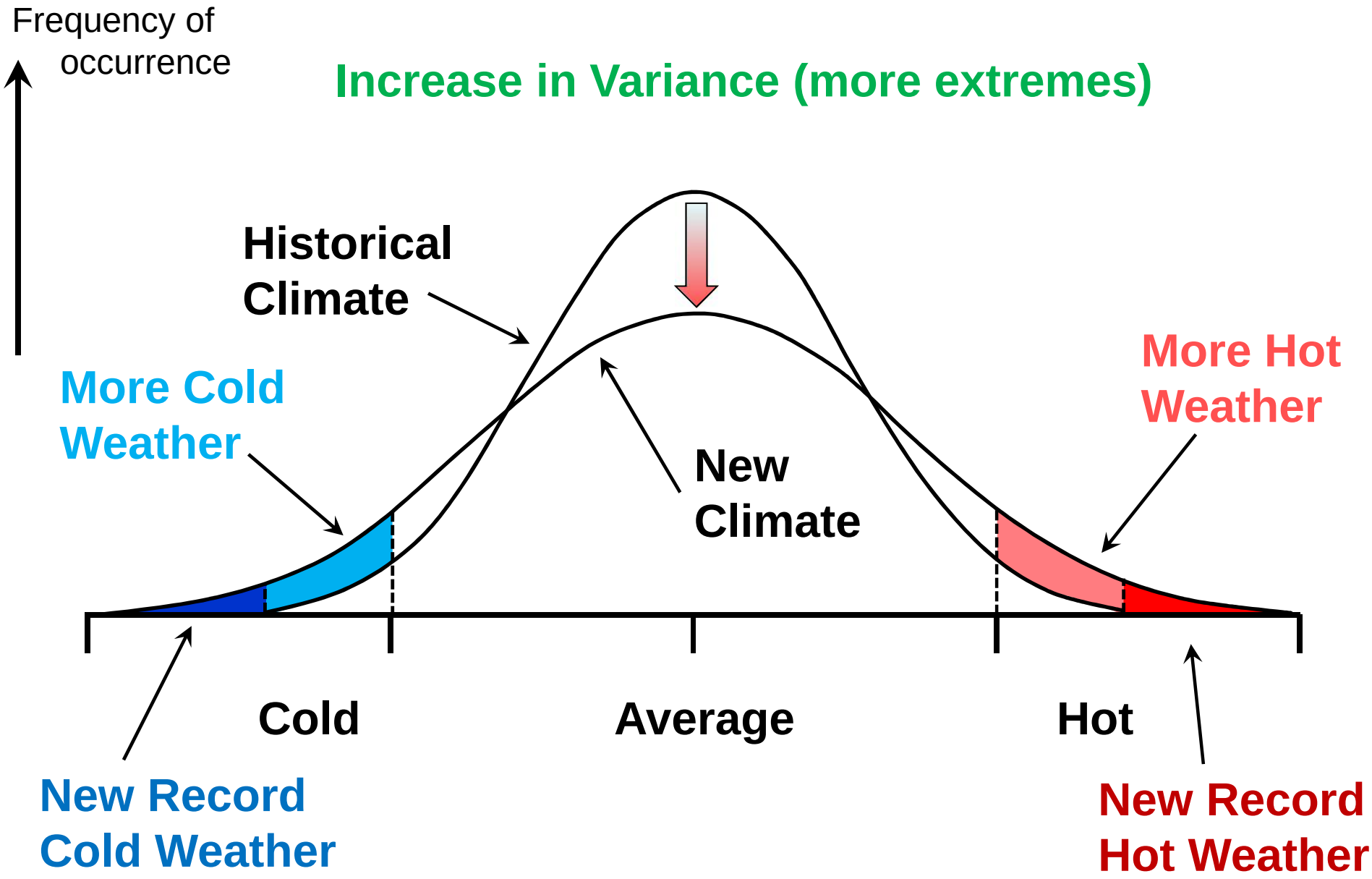
European Summer Temperatures
(1500-2010 anomalies relative to 1970-1999 mean)



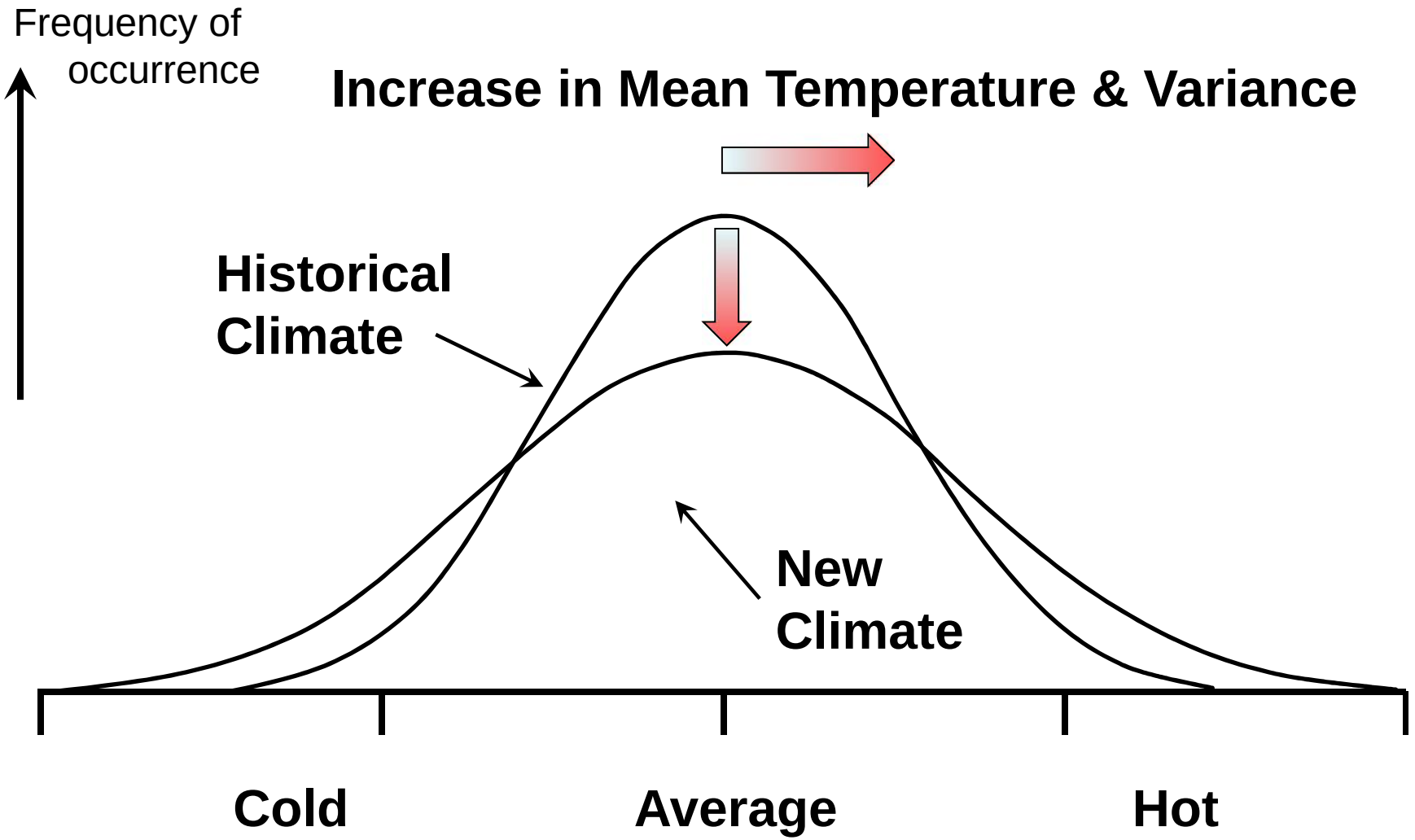
5 coldest years

5 warmest years

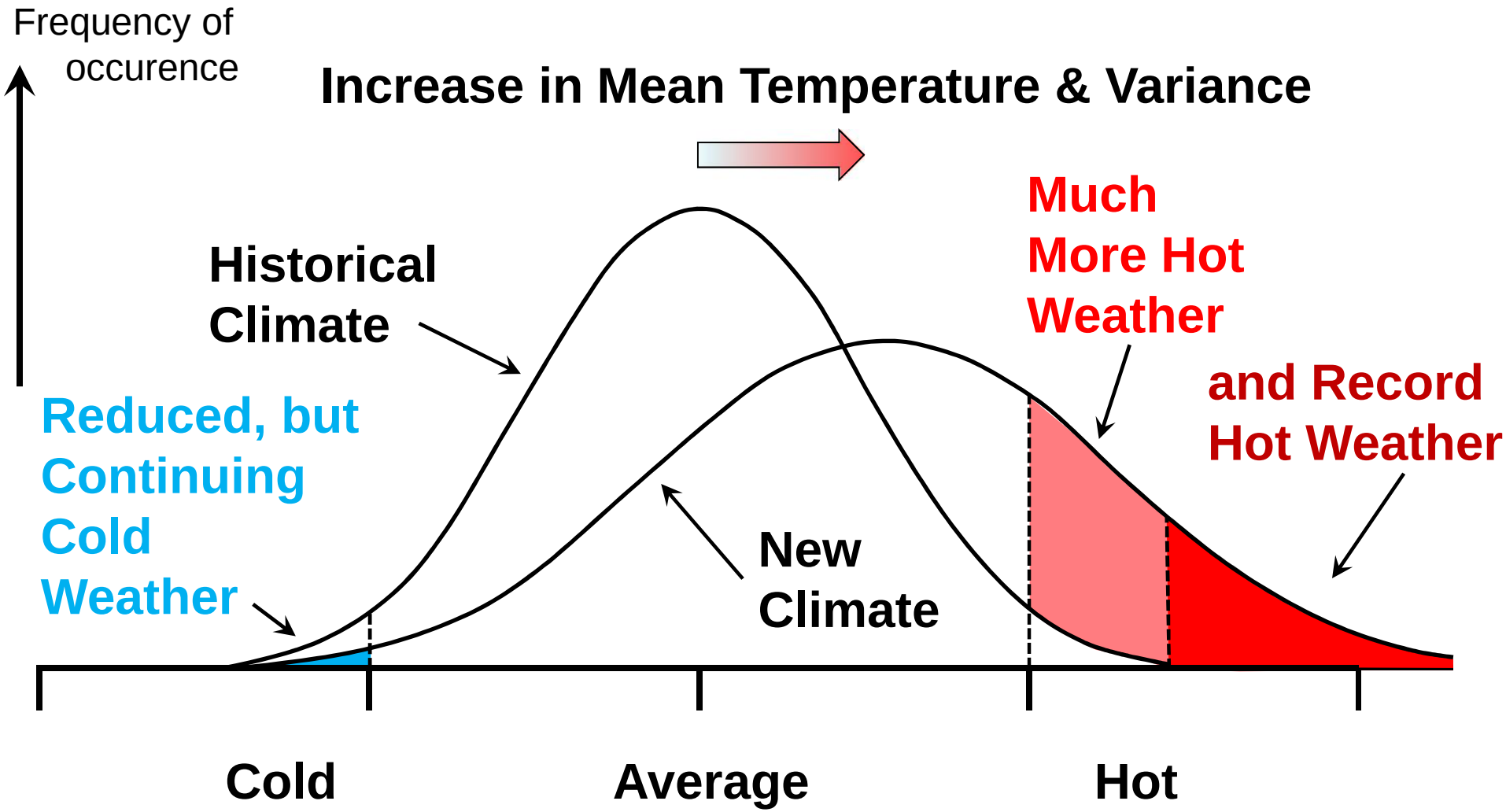
From: Coumou and Ramstorf 2012



Adapted from: Reasoner 2012



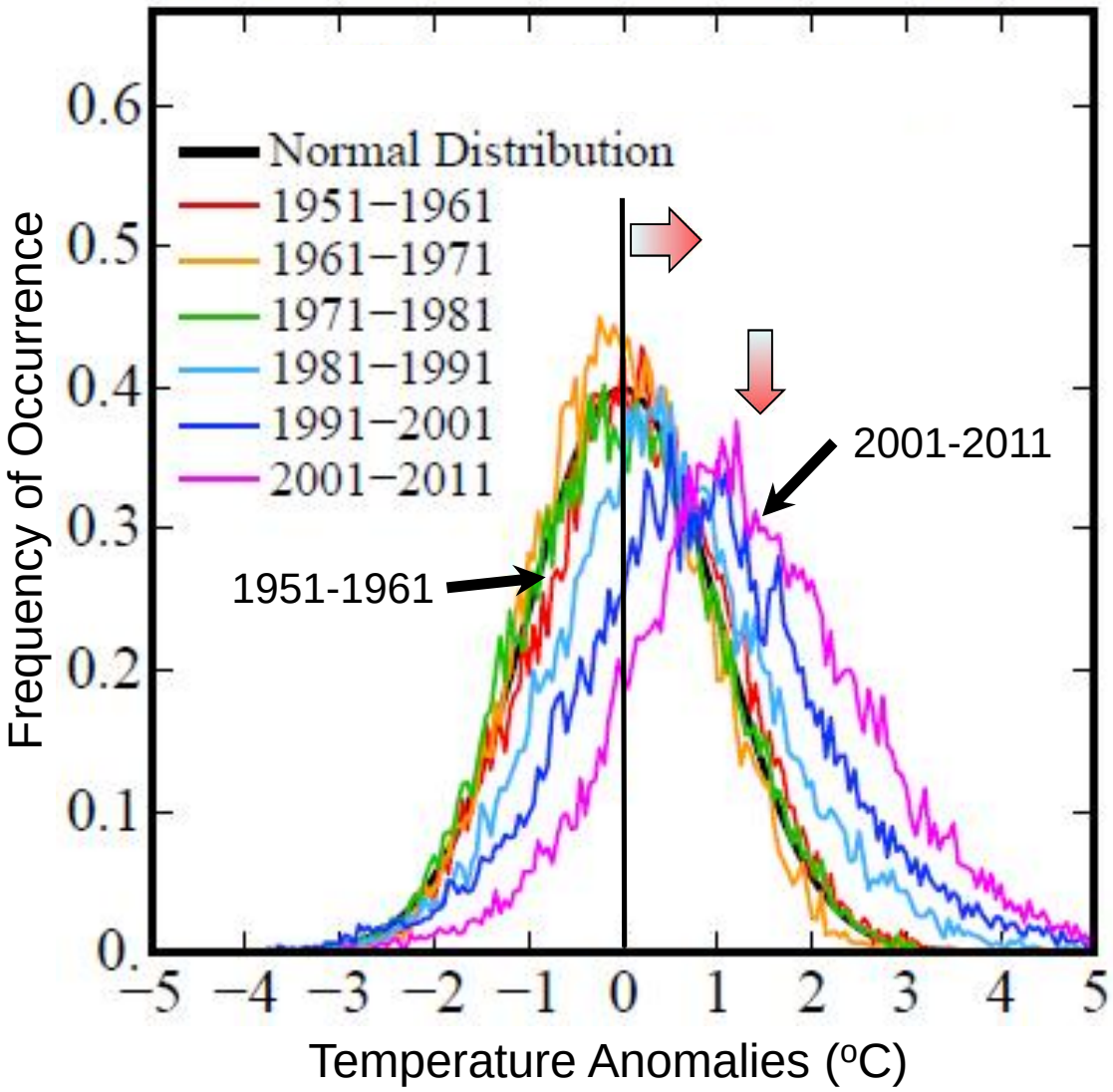
Adapted from: Reasoner 2012



Adapted from: Reasoner 2012

Decadal Summer Temperature Anomalies

Northern Hemisphere Land (1951- 61 reference period)



Adapted from:
Hansen et al. 2012

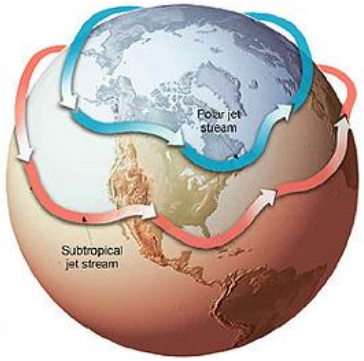
Climatic Extremes

- Heat waves
- Drought
- High intensity rainstorms/ flooding
- Windstorms/ tonadoes
- Lightening storms
- Hail storms
- Ice storms
- Early spring heat/ late frost combinations

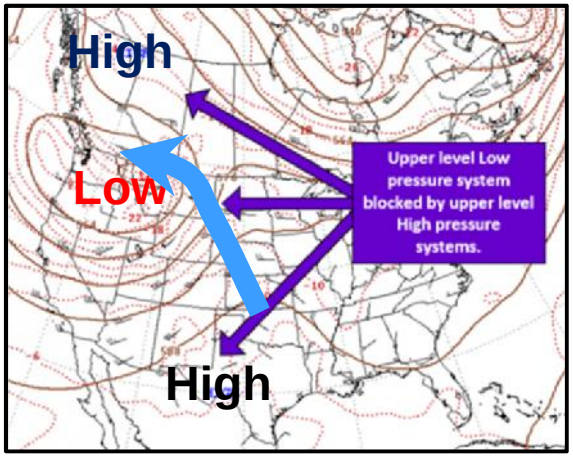
Mechanisms?

Jet Stream Modifications

- Increased amplitude
- Reduced rate of movement
- Weather systems stall



Calgary & SE BC - June, 2013



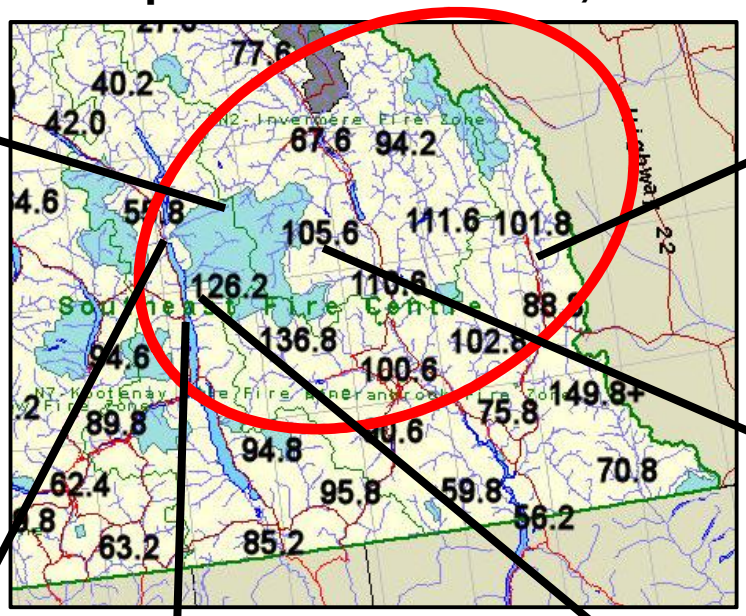
Grand Forks, BC - July, 2012

Crossfields, AB - July, 2012

Climatic Extremes – 2013 Example

High Precipitation Event

Precipitation June 18-21, 2013



Upper Hamill Creek

Lower Hamill Creek

Schroeder Creek

Upper Elk River

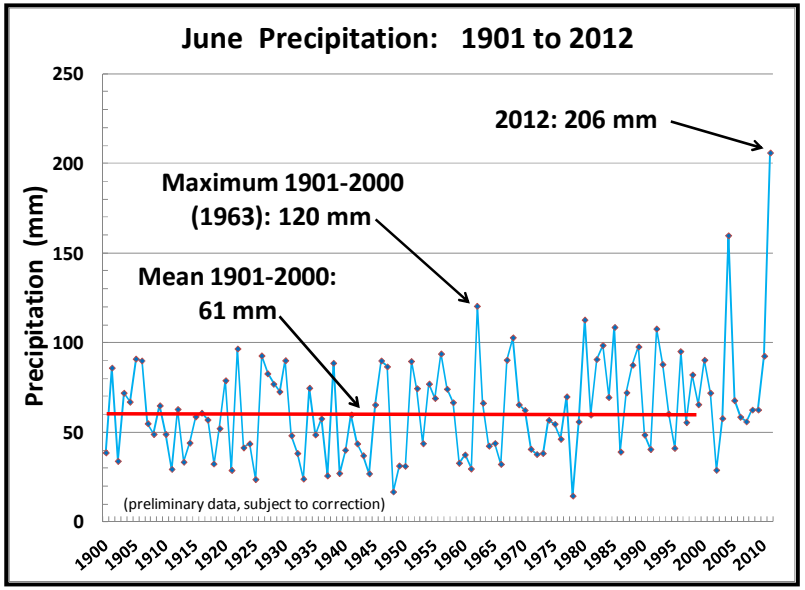
Buhl Creek

Fry Creek

Photos: Peter Jordan, Peter Holmes, Tina Zimmermann, Bob Yetter

Climatic Extremes – 2012 Example

Monthly Precipitation/ Rapid Snowmelt - Johnson's Landing



Increased Soil Moisture

Decreased Soil Strength

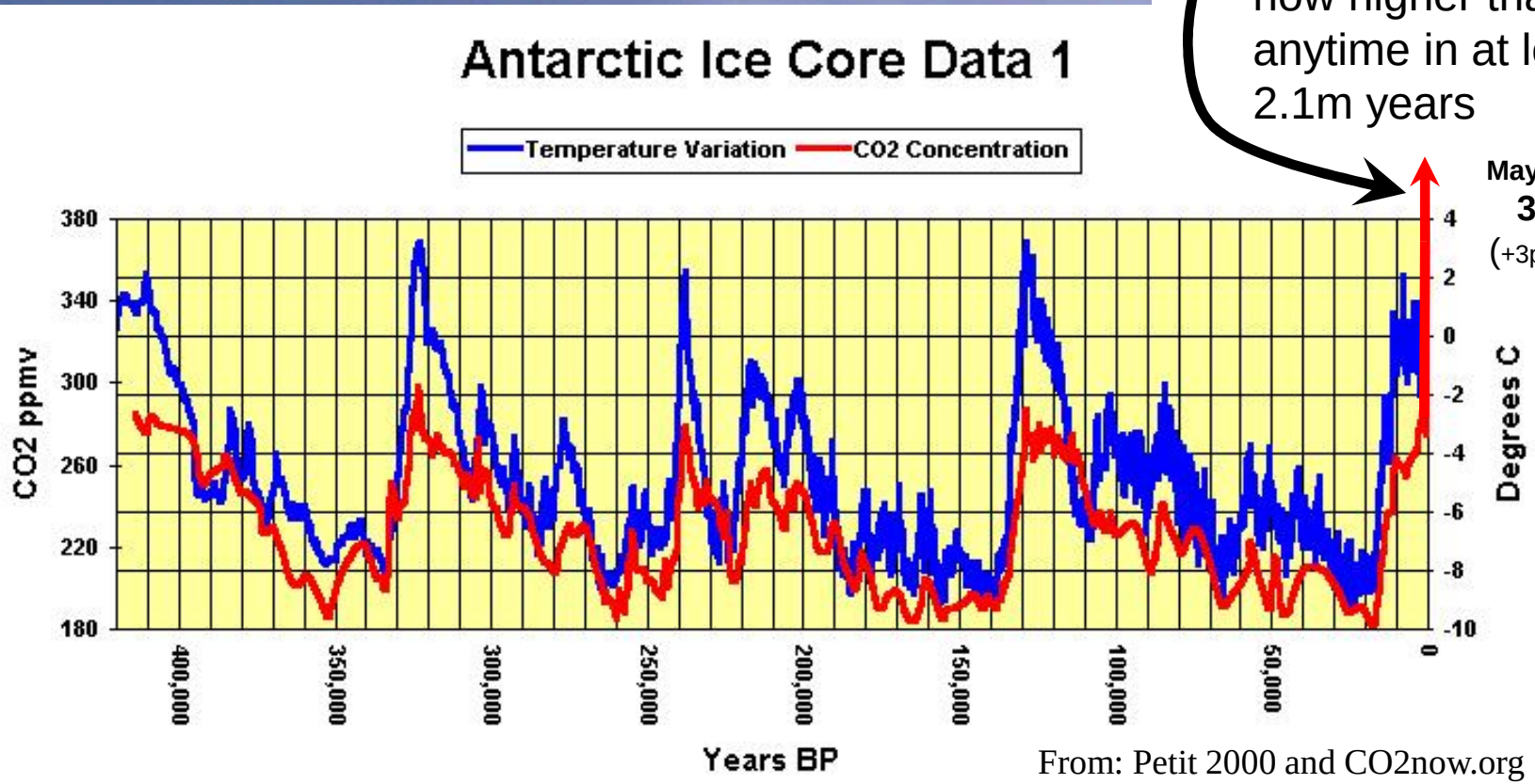
Landslide (July 12, 2012)

Impacts

- 4 people killed
- 4 houses destroyed
- 6 properties damaged/ loss of access
- Community water system destroyed
- Main road destroyed
- Damage to utilities
- Ongoing future risks

We Are the Cause

CO2 levels are now higher than anytime in at least 2.1m years

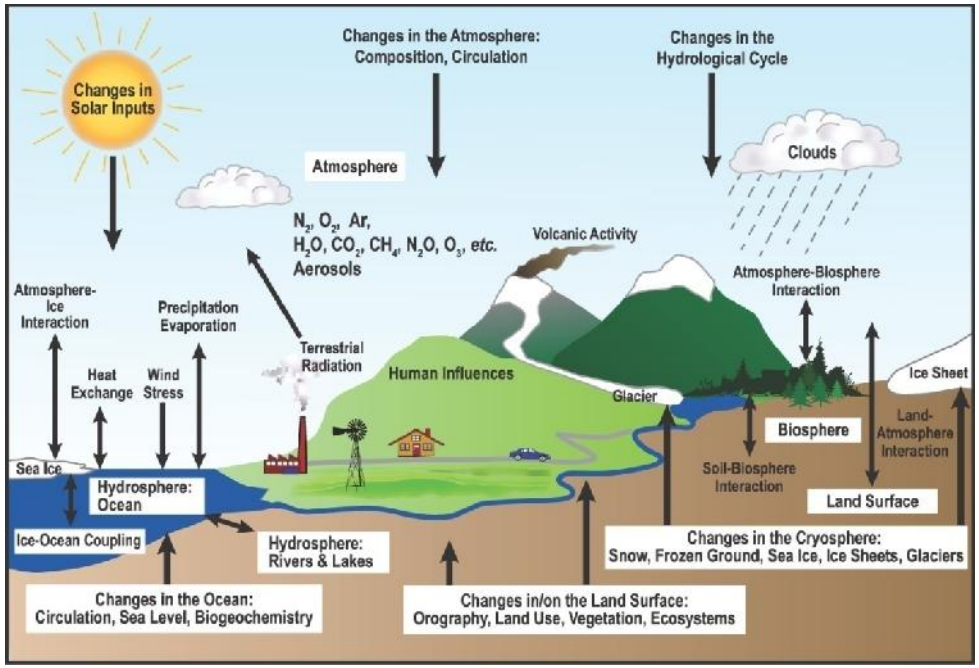


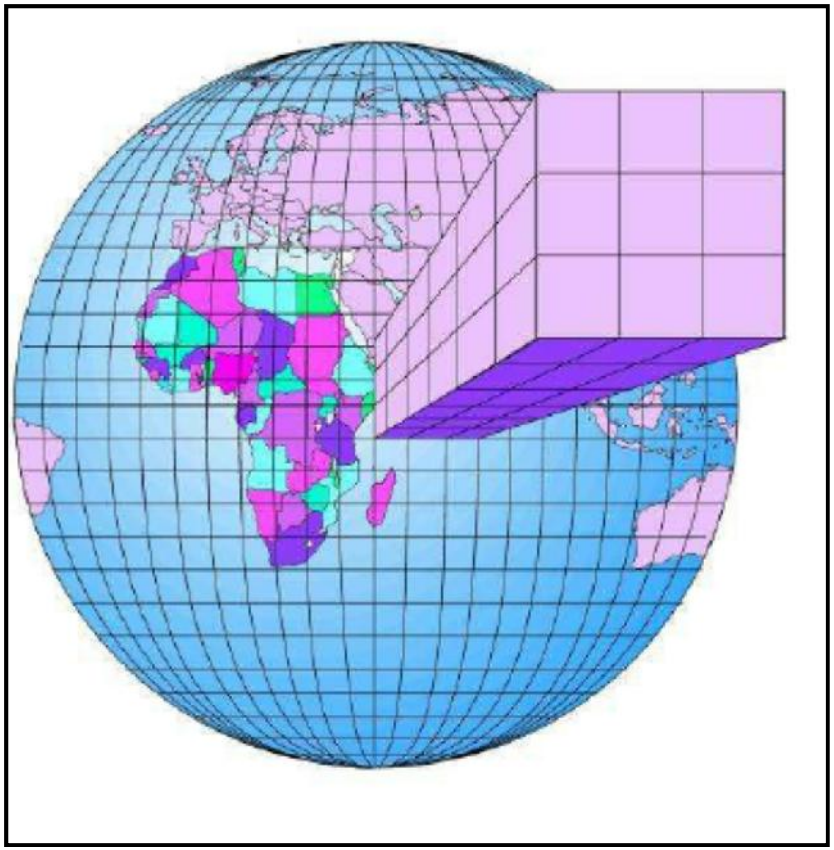
From: Petit 2000 and CO2now.org

General Circulation Models (GCMs)

"Global Climate Models"

- Mathematical representations of the global climate system



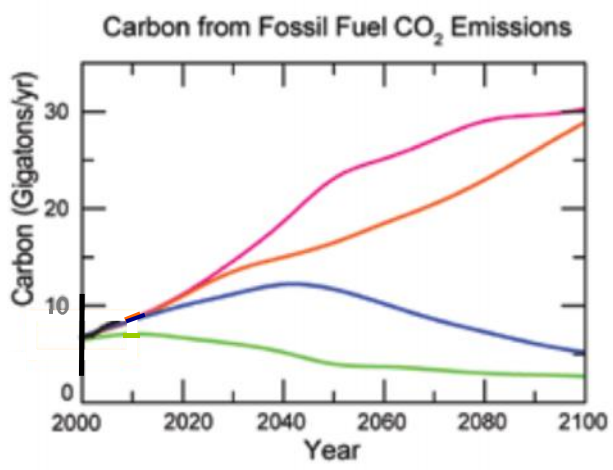


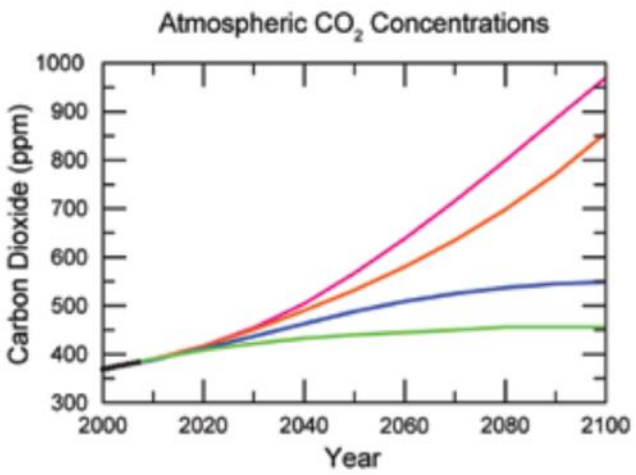
"3D pixels" representing atmospheric conditions at various elevations around the earth through time

From: IPCC 2007 - AR4 WG1

Modeling - Future Projections

Greenhouse Gas Emissions – various potential scenarios





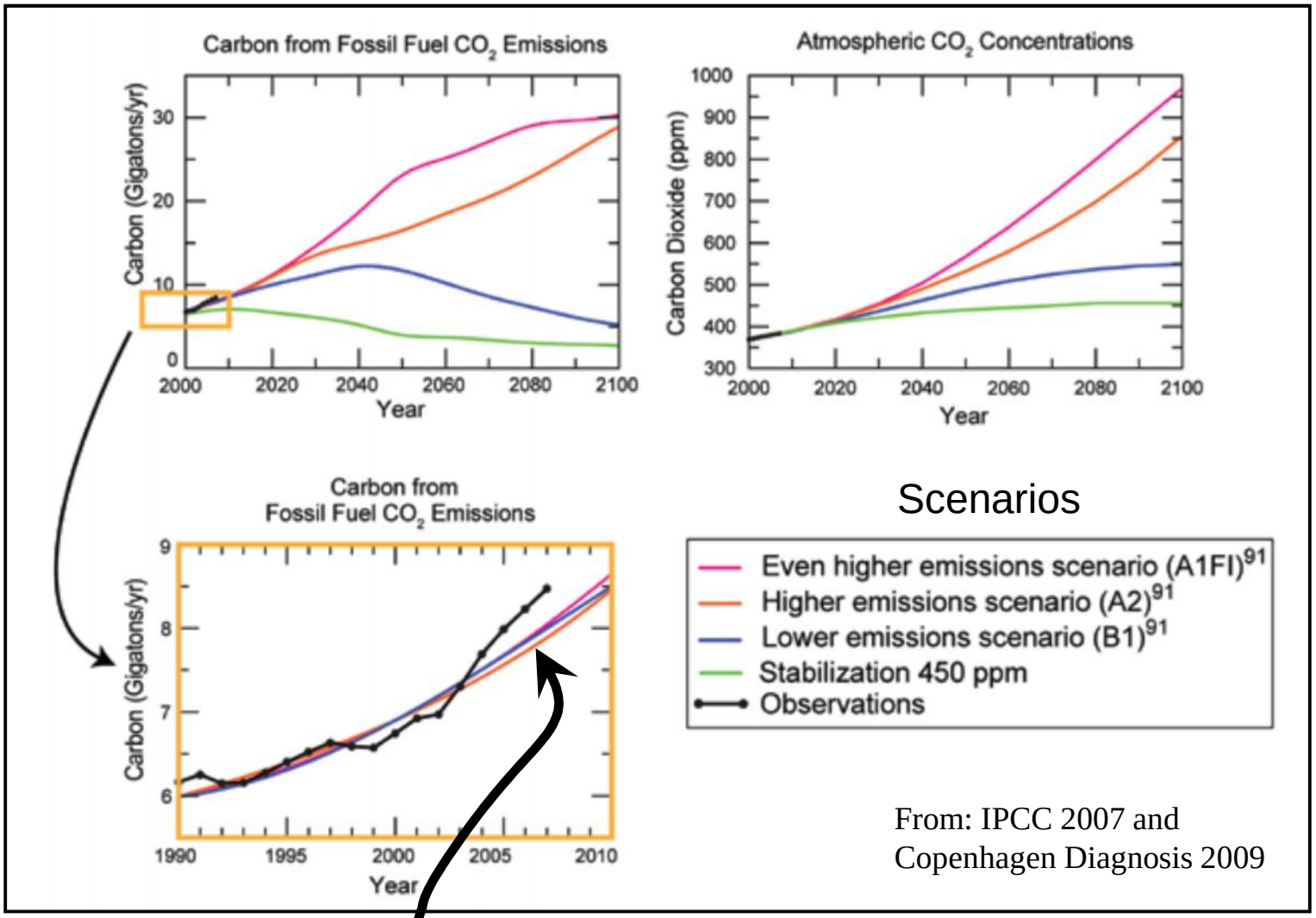
Scenarios

- Even higher emissions scenario (A1FI)[91]
- Higher emissions scenario (A2)[91]
- Lower emissions scenario (B1)[91]
- Stabilization 450 ppm
- Observations

From: IPCC 2007 and
Copenhagen Diagnosis 2009

Modeling - Future Projections

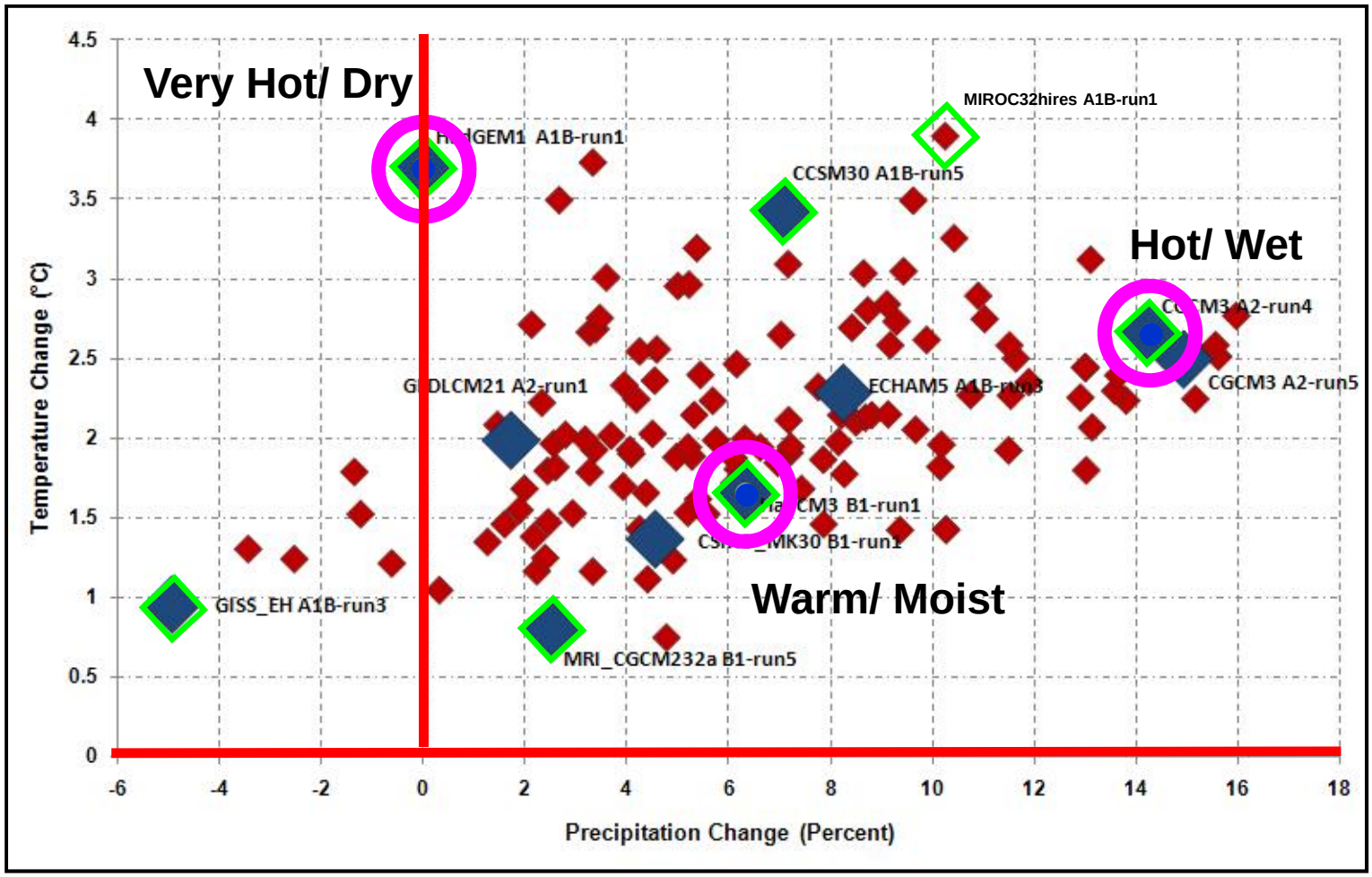
Greenhouse Gas Emissions – various potential scenarios



Current emissions exceed all projections

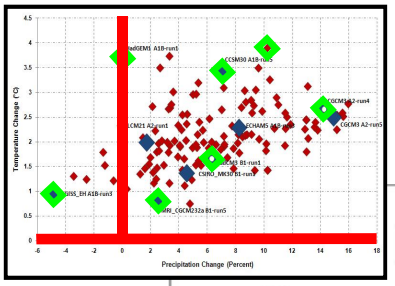
GCM / Scenario Combinations

2050s Mean Projections for British Columbia
Annual Temperature and Precipitation

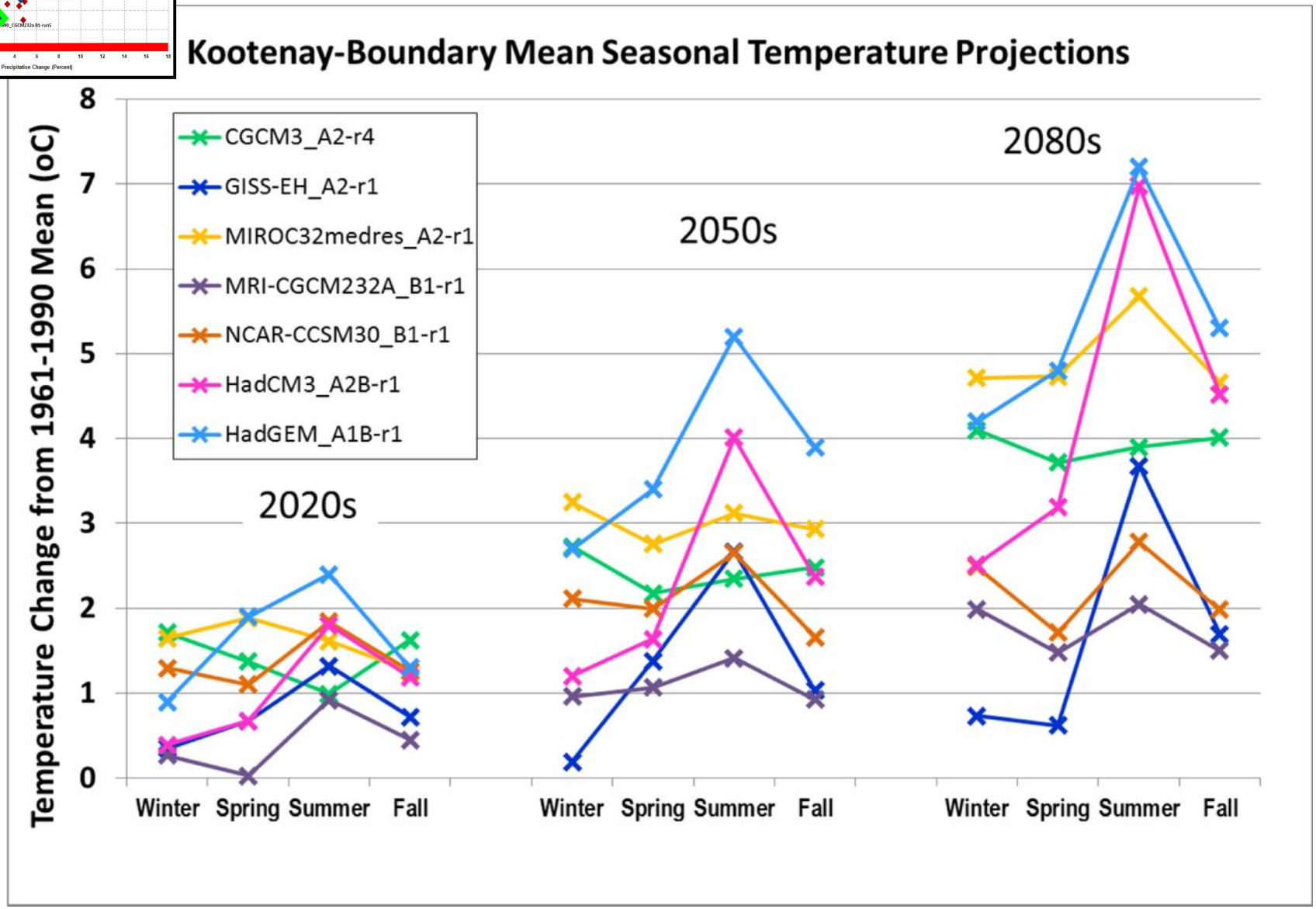


Blue diamonds recommended scenarios
Green/ Purple - scenarios investigated for the Kootenays

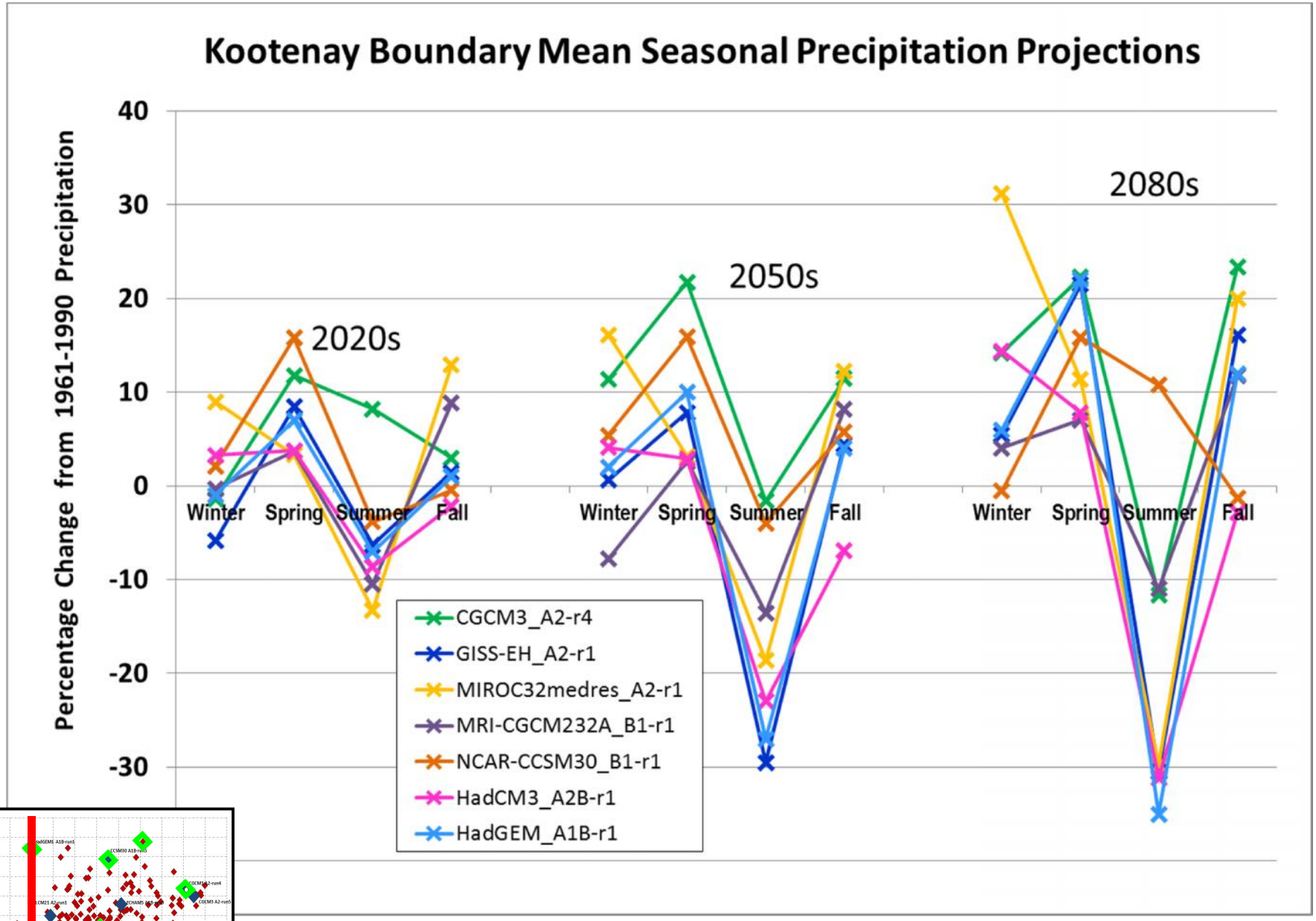
Adapted from:
Murdock and Spittlehouse 2010

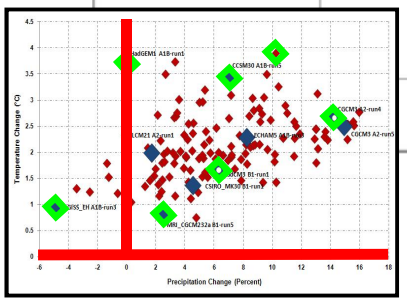


Kootenay-Boundary Mean Seasonal Temperature Projections



Data from: PCIC Regional Analysis Tool and Plan2Adapt



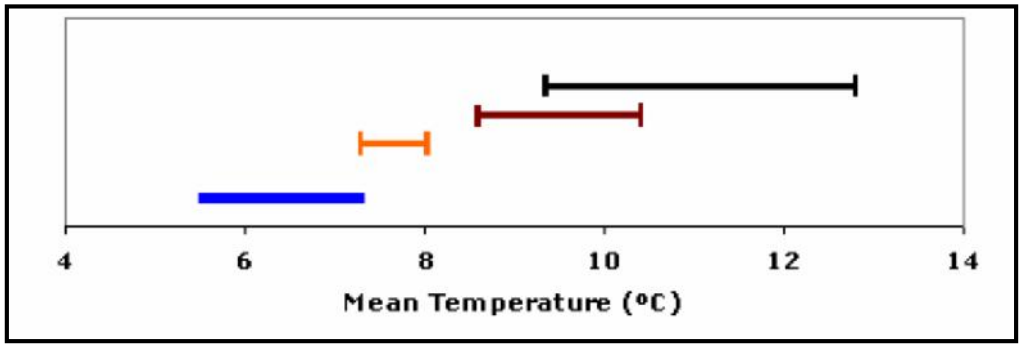


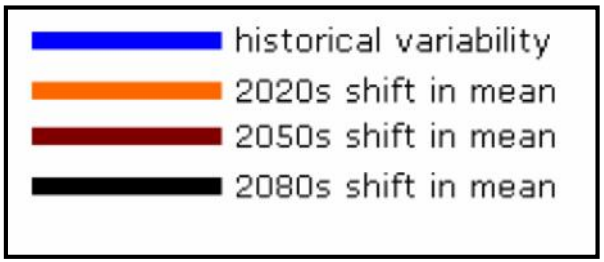
Data from: PCIC Regional Analysis Tool and Plan2Adapt

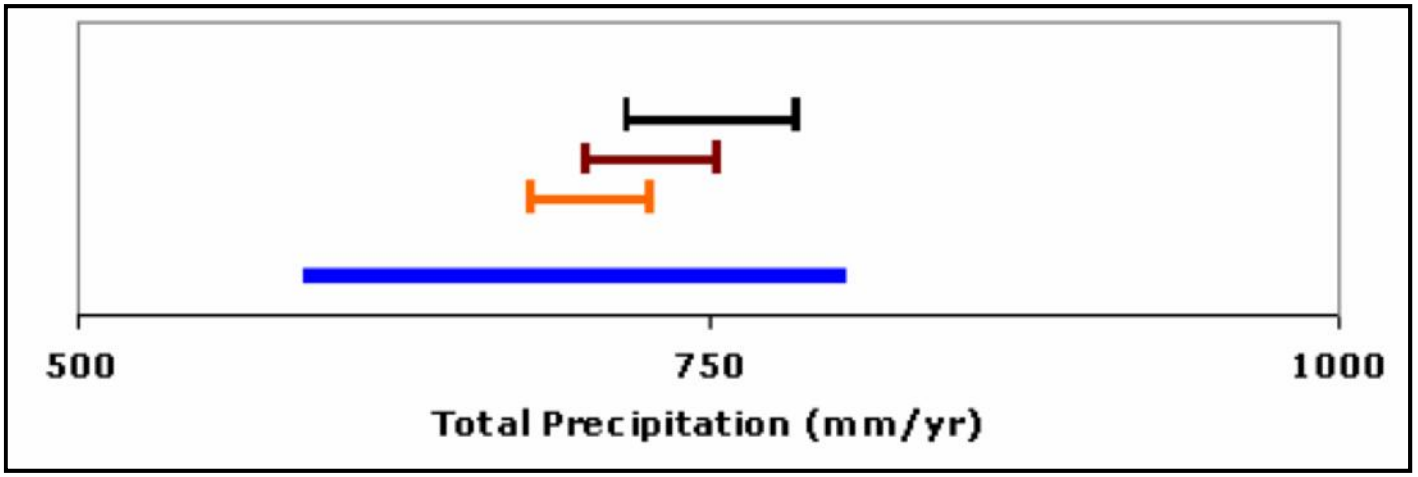
Variability: Past vs. Potential Future

for the Columbia Basin

Note that the projected annual temperature shifts far exceed historical variability (20th century), while the projected precipitation shifts do not.



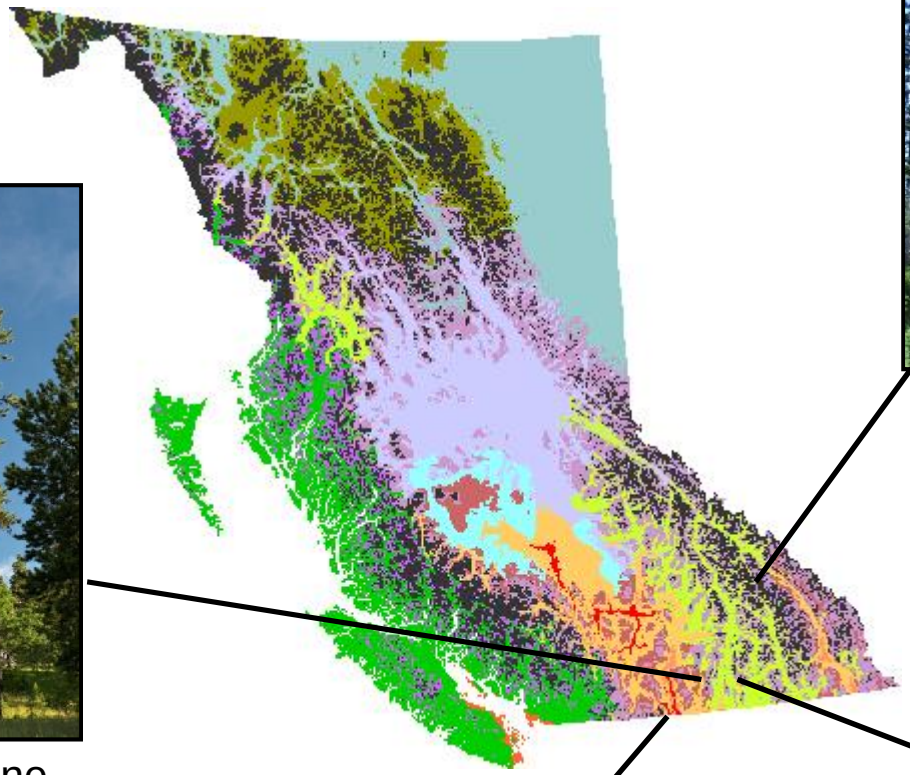




From: Murdock 2006 - PCIC-CBT

Biogeoclimatic (BEC) Zones

Ponderosa Pine

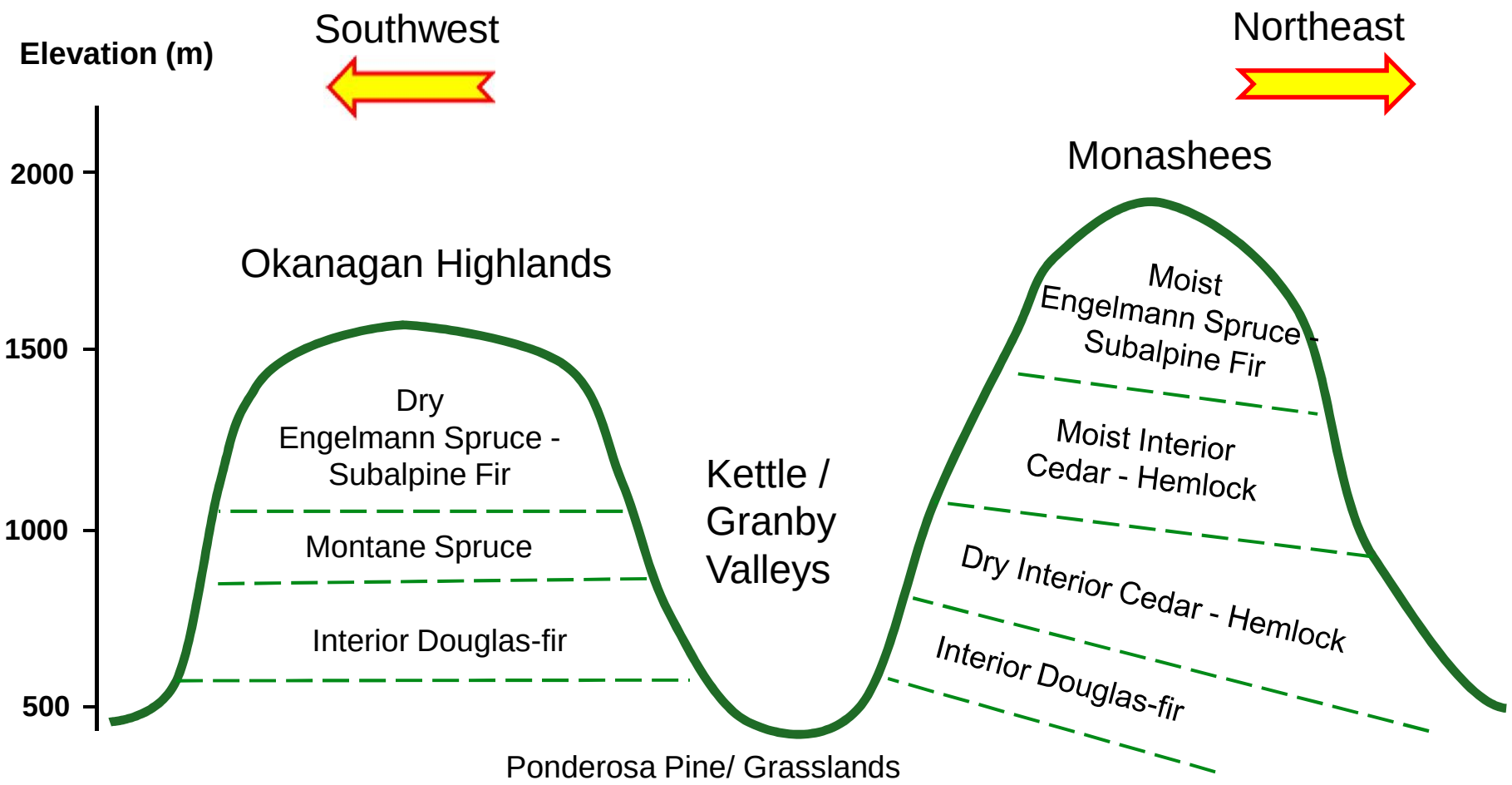


Engelmann Spruce –
Subalpine Fir

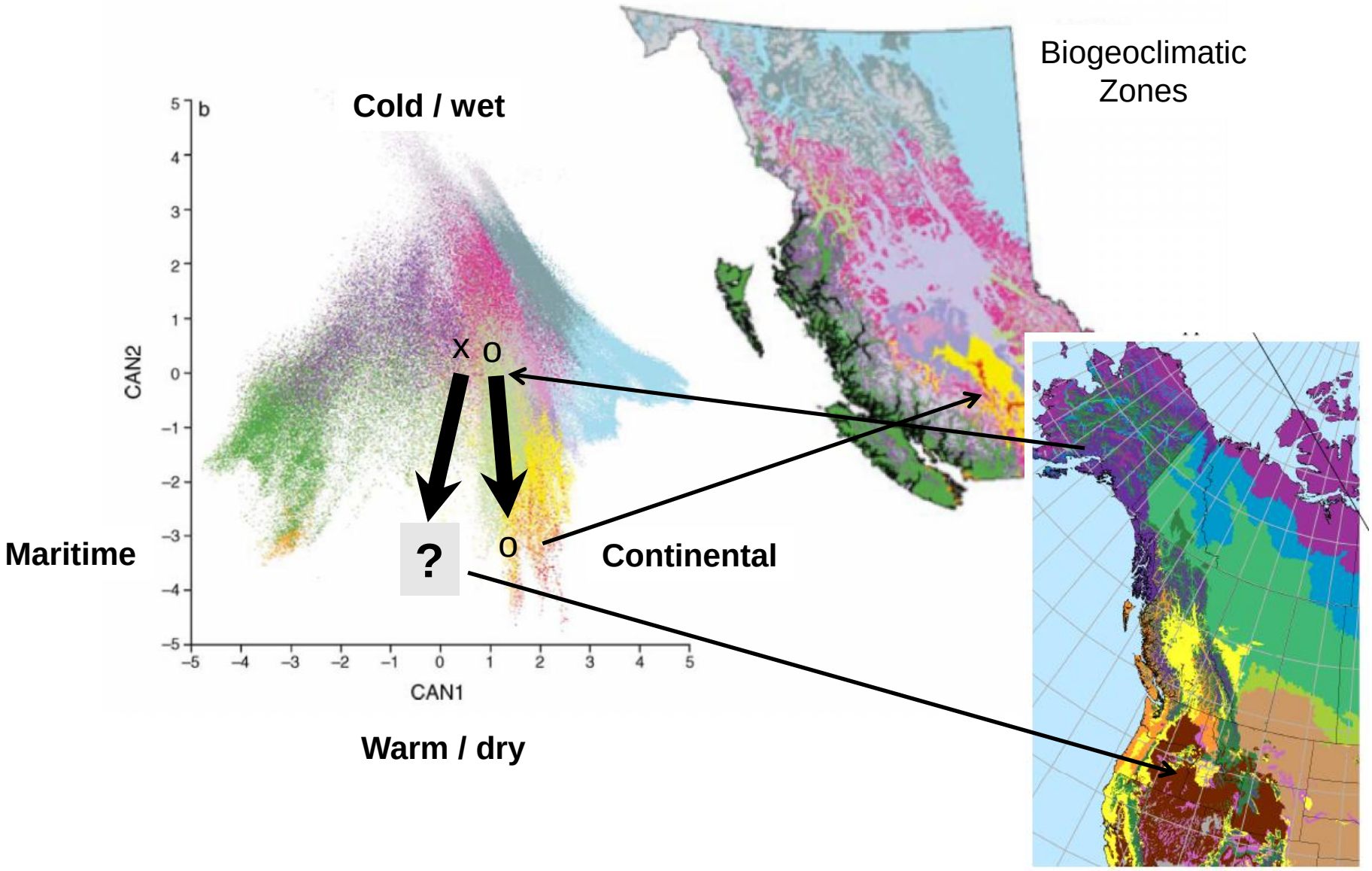
Interior Cedar –
Hemlock

Grasslands/
Sage Brush

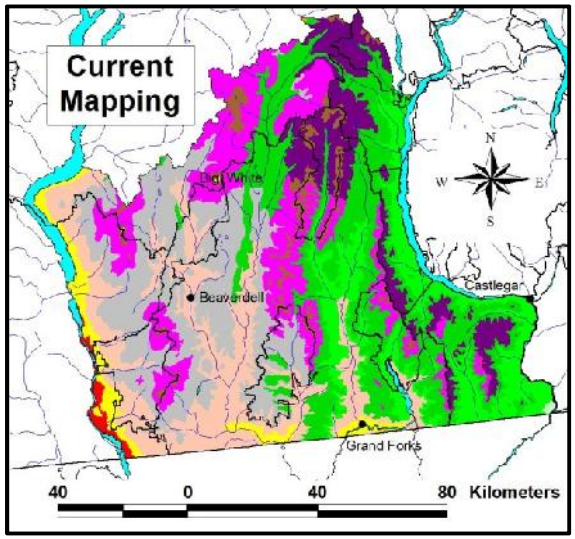
Biogeoclimatic Zones



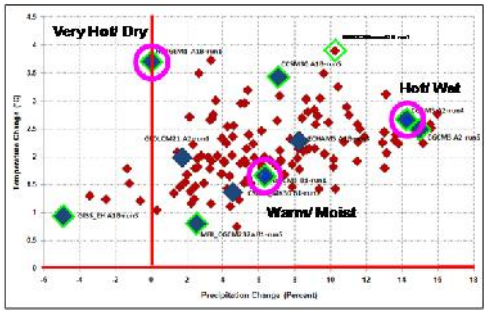
Ecosystem Units as “Bioclimate Envelopes”



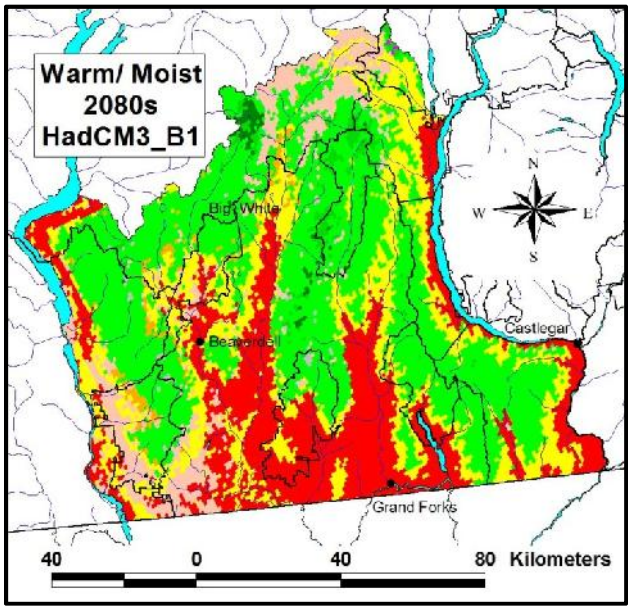
Adapted from: Hamann and Wang 2006 & Roberts and Hamann 2011

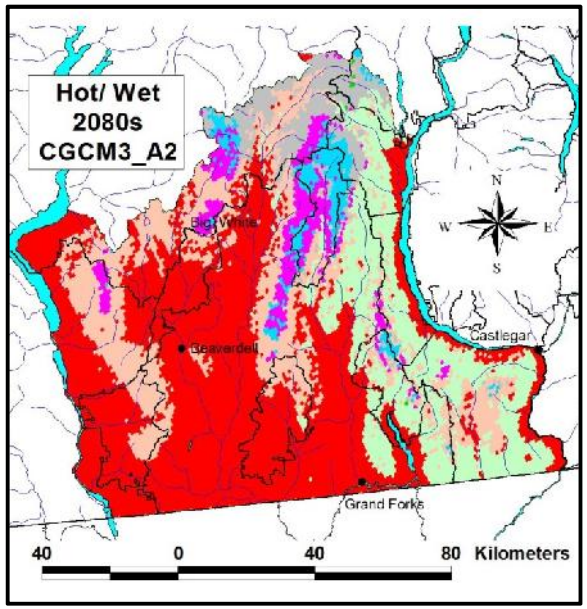


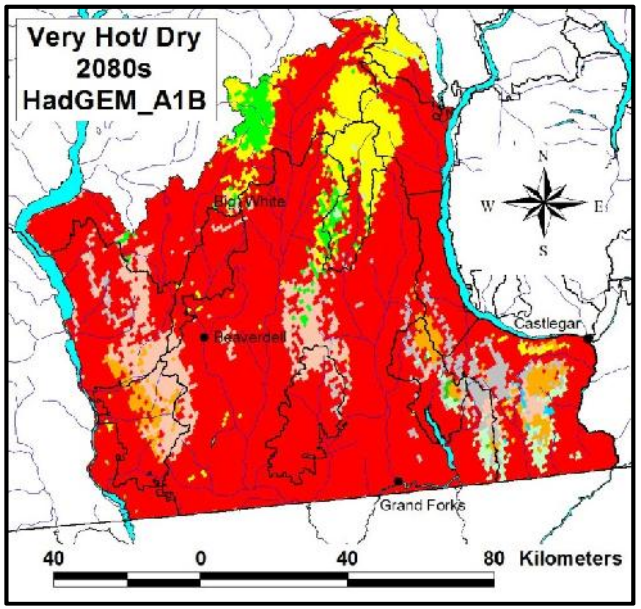
- Alpine
- Alpine parkland
- Wet subalpine forest
- Dry subalpine forest
- Coastal hemlock
- Transitional coast/ interior hemlock
- Montane/sub-boreal spruce forest
- Wet interior cedar/ hemlock
- Moist interior cedar/ hemlock
- Dry interior cedar hemlock
- Grand fir/ Douglas-fir
- Wet Douglas-fir
- Dry Douglas-fir
- Ponderosa pine savanah
- Grassland/ steppe



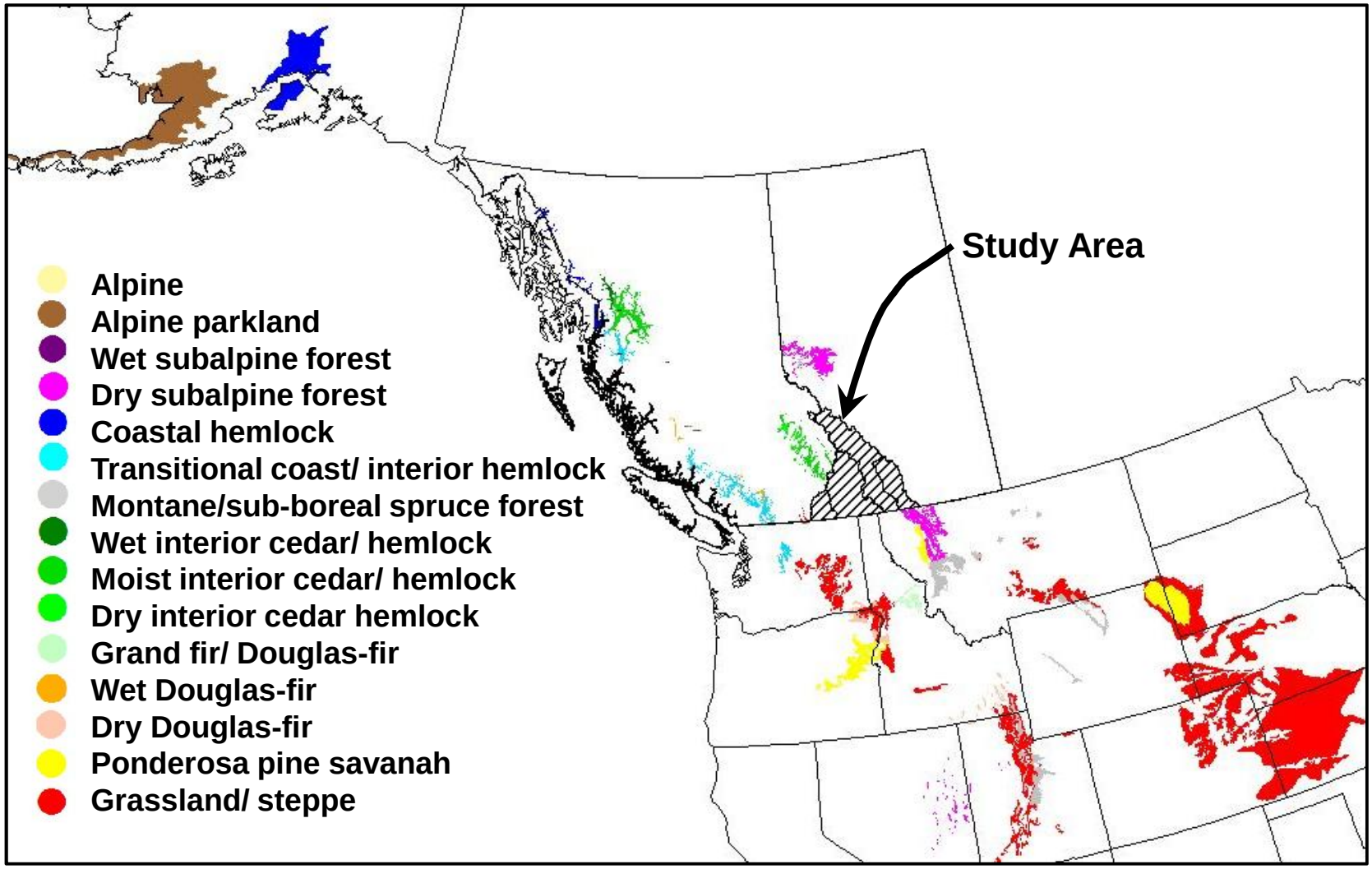
A Range of Projected Bioclimate Envelopes







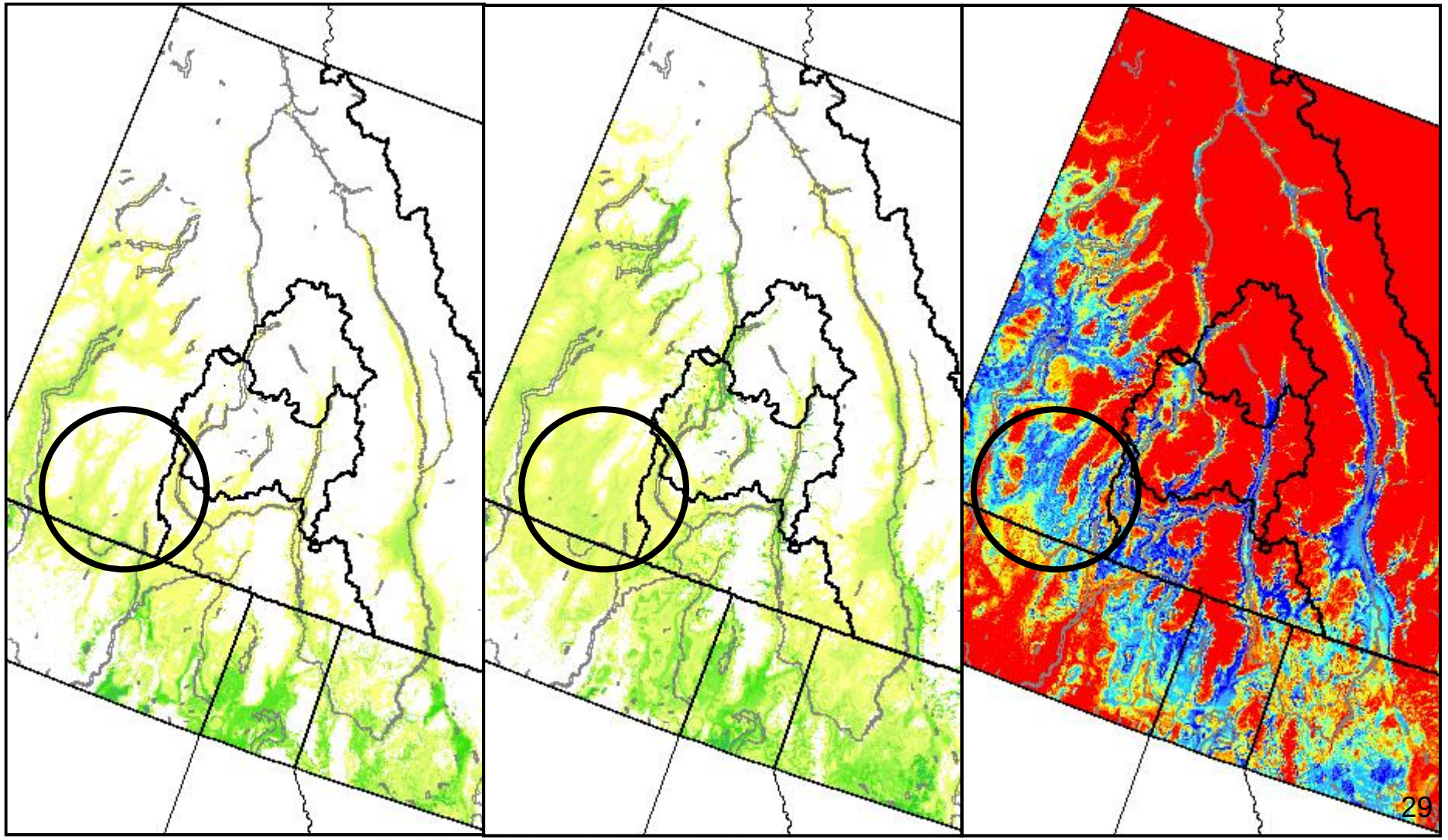
Bioclimate Envelopes and Ecosystems



Original data from: Roberts and Hamann, U of A

Habitat projections for Ponderosa Pine

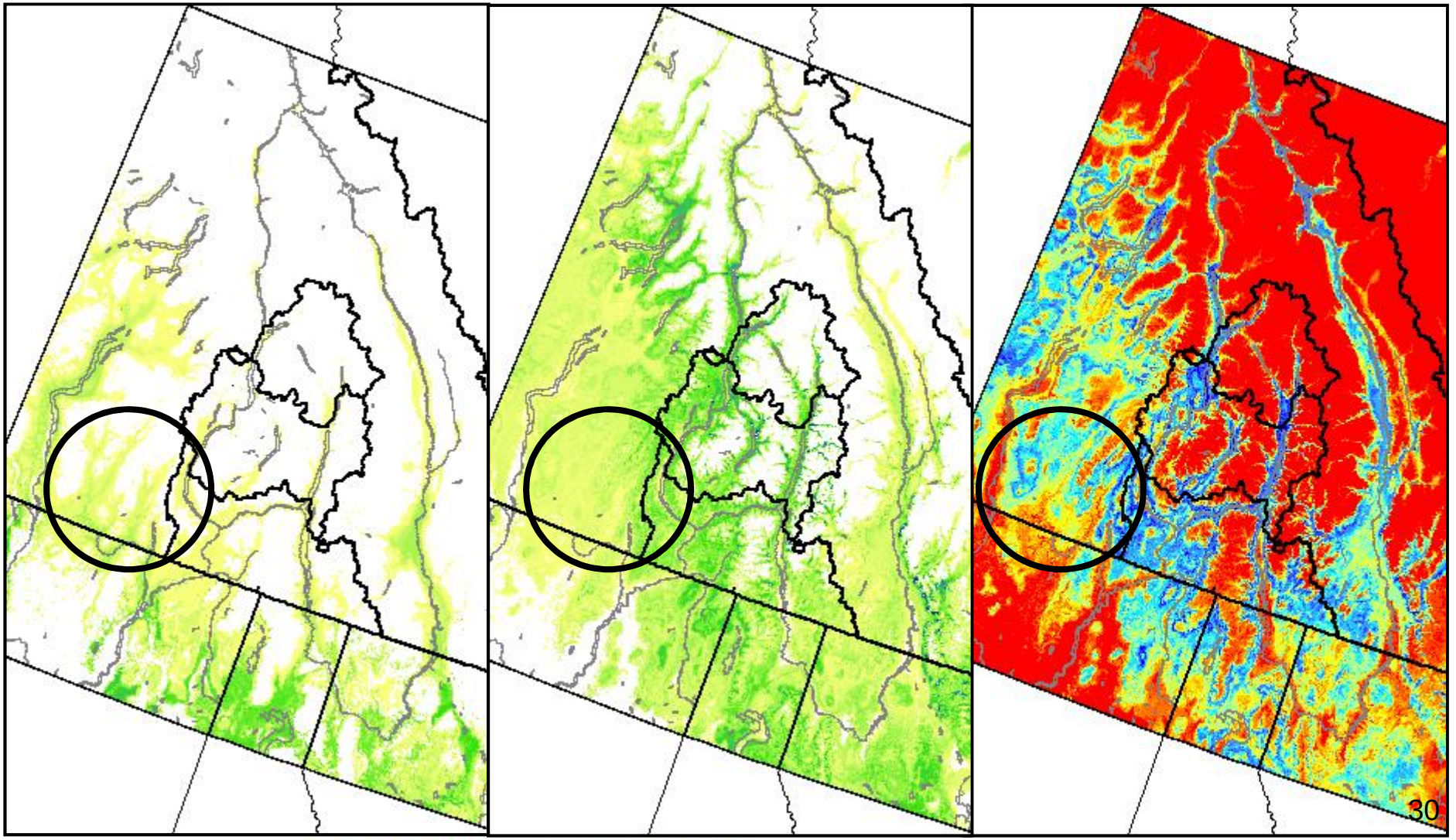
Current **2020s**



From:
Laura Gray 2010

Habitat projections for Ponderosa Pine

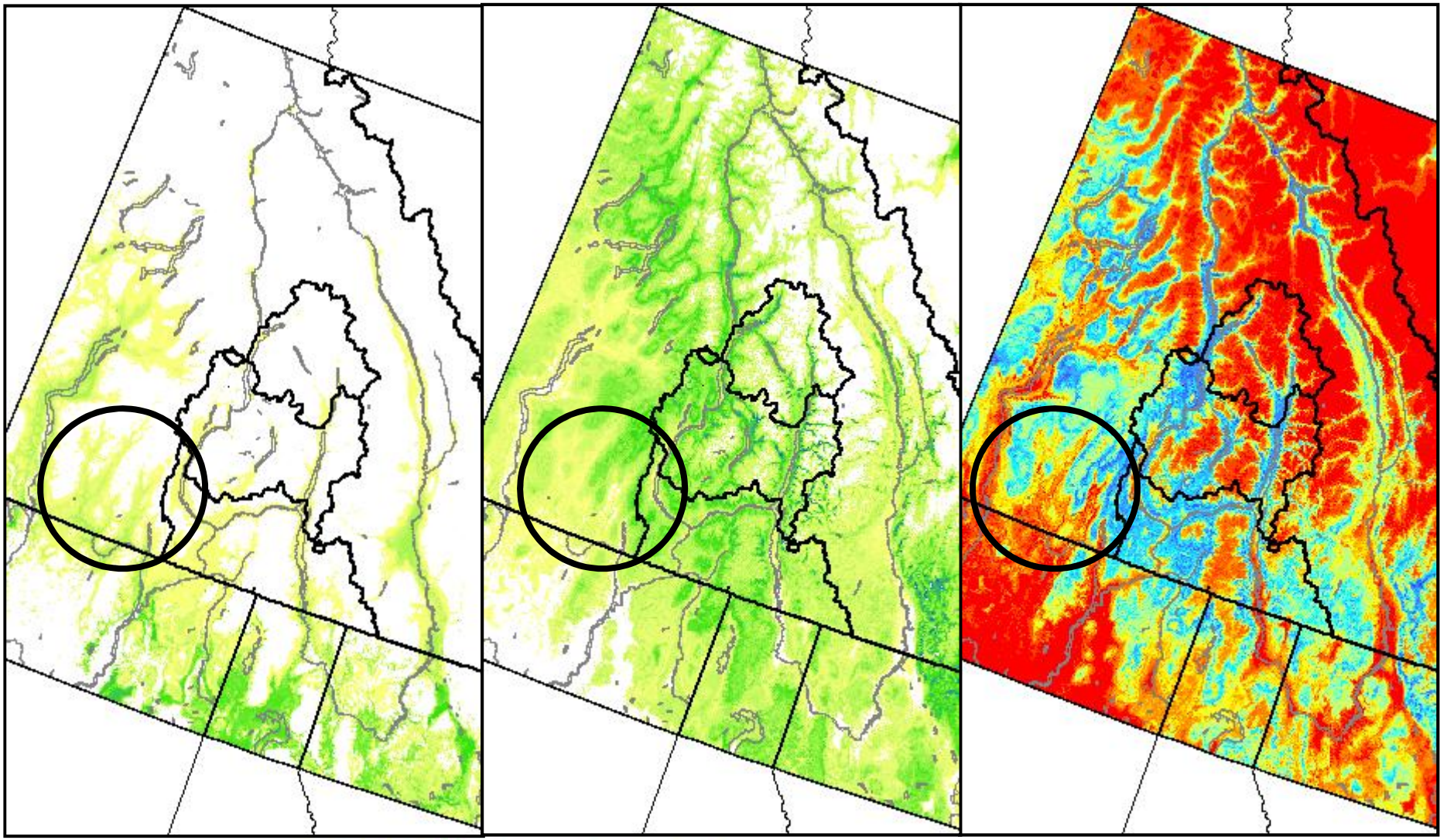
Current **2050s**



From:
Laura Gray 2010

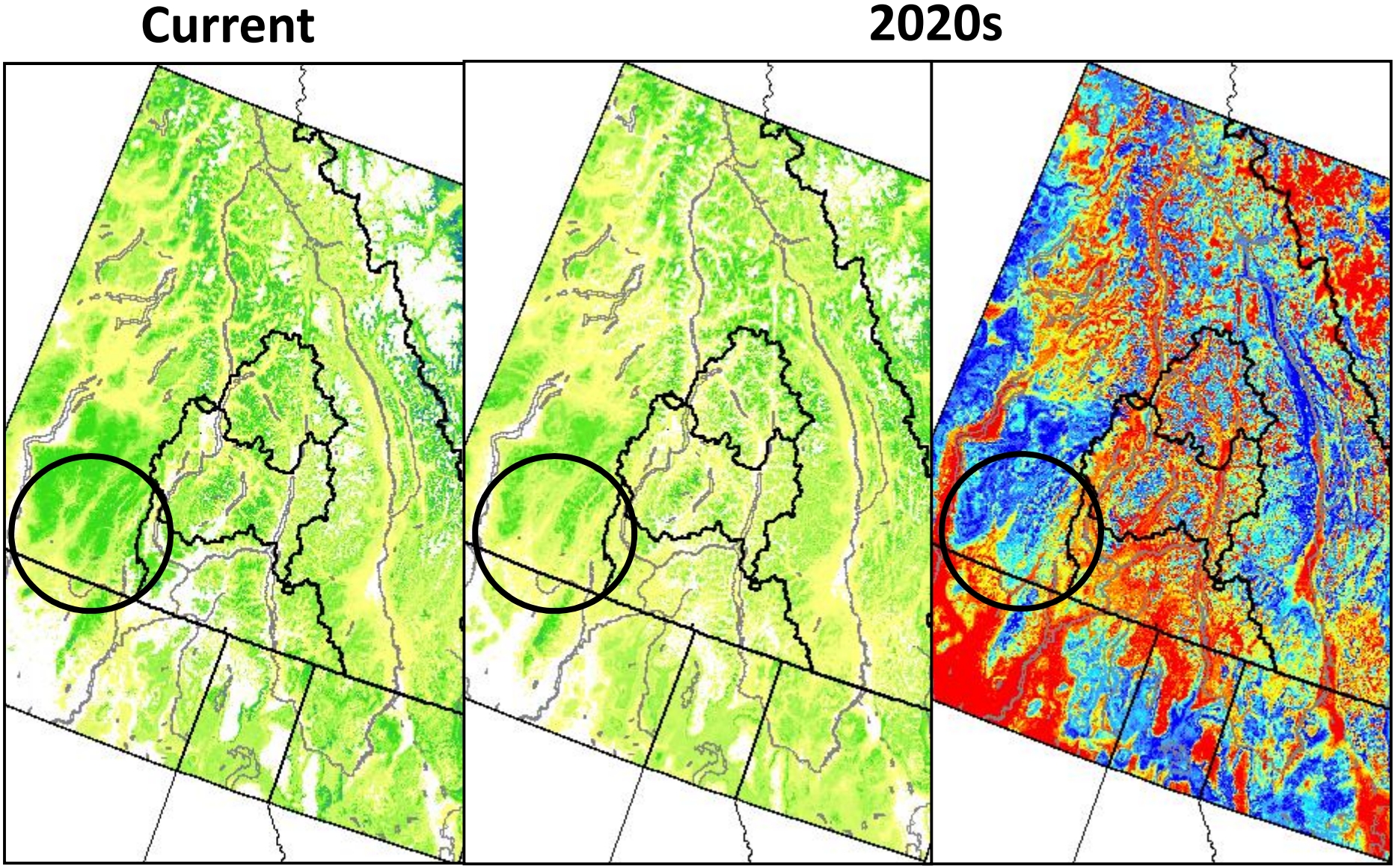
Habitat projections for Ponderosa Pine

Current **2080s**



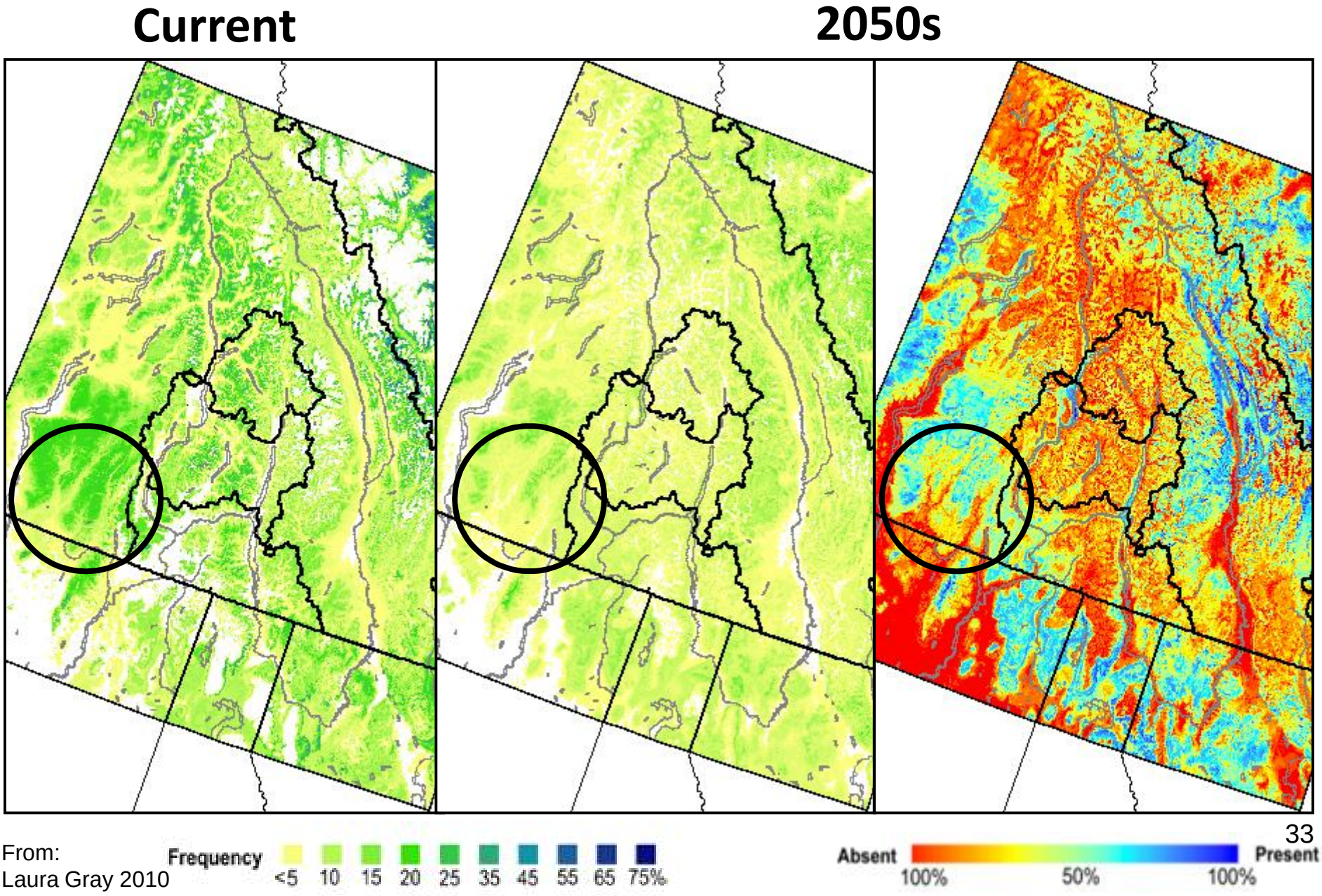
From:
Laura Gray 2010

Habitat projections for Engelmann Spruce



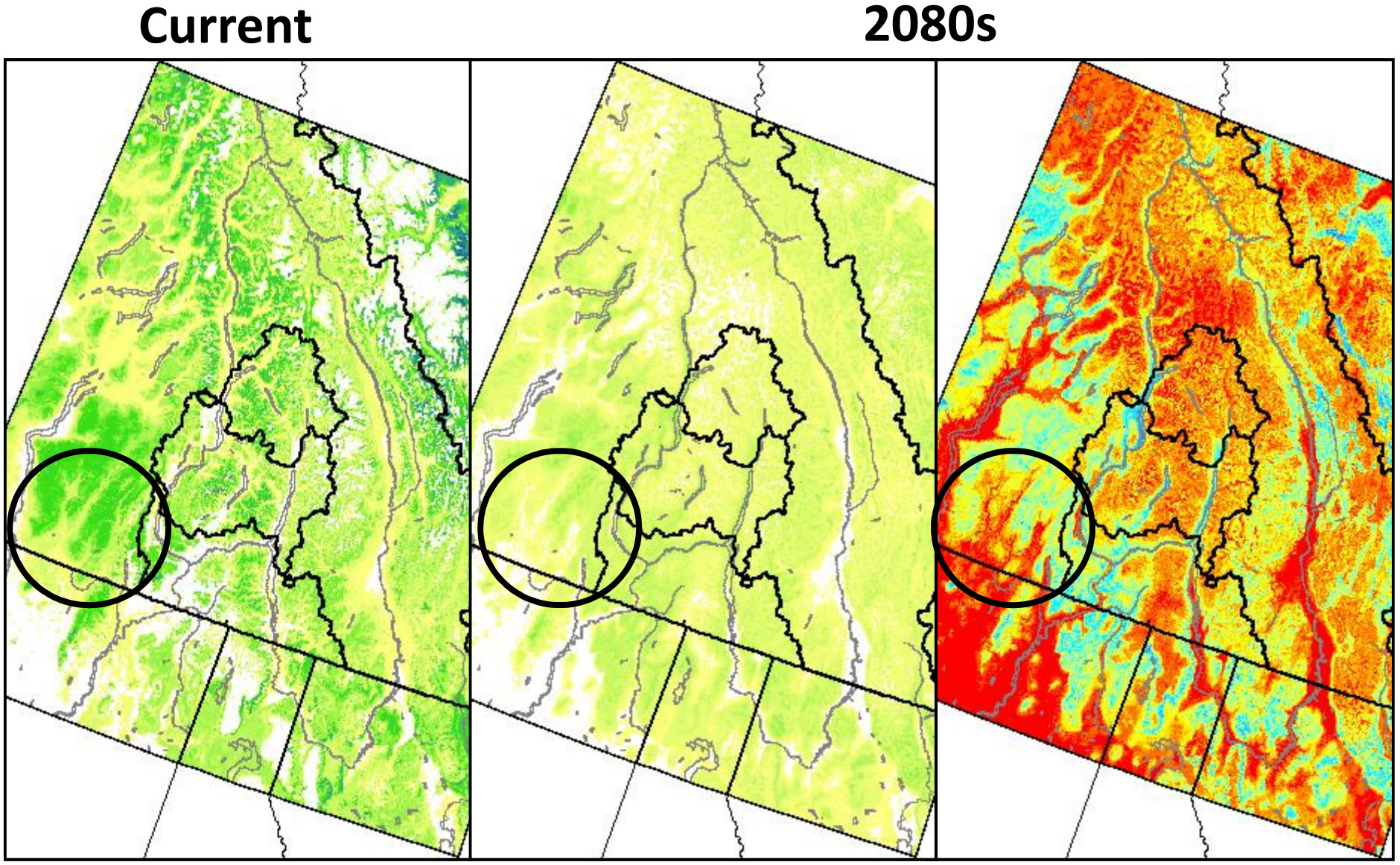
From:
Laura Gray 2010

Habitat projections for Engelmann Spruce



From:
Laura Gray 2010

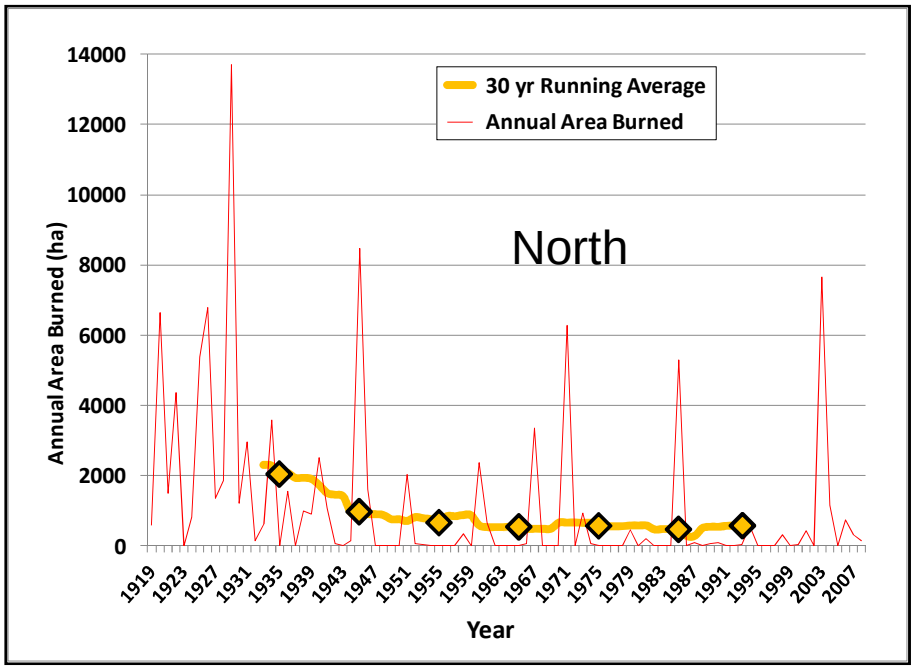
Habitat projections for Engelmann Spruce



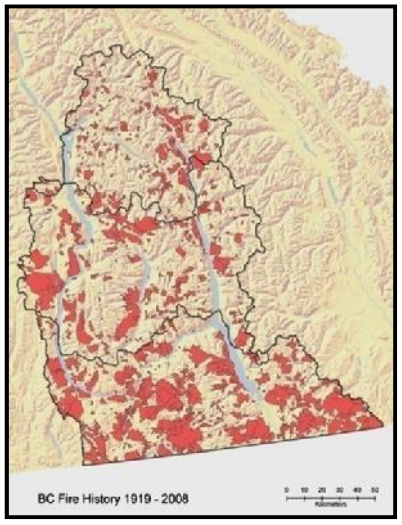
From:
Laura Gray 2010

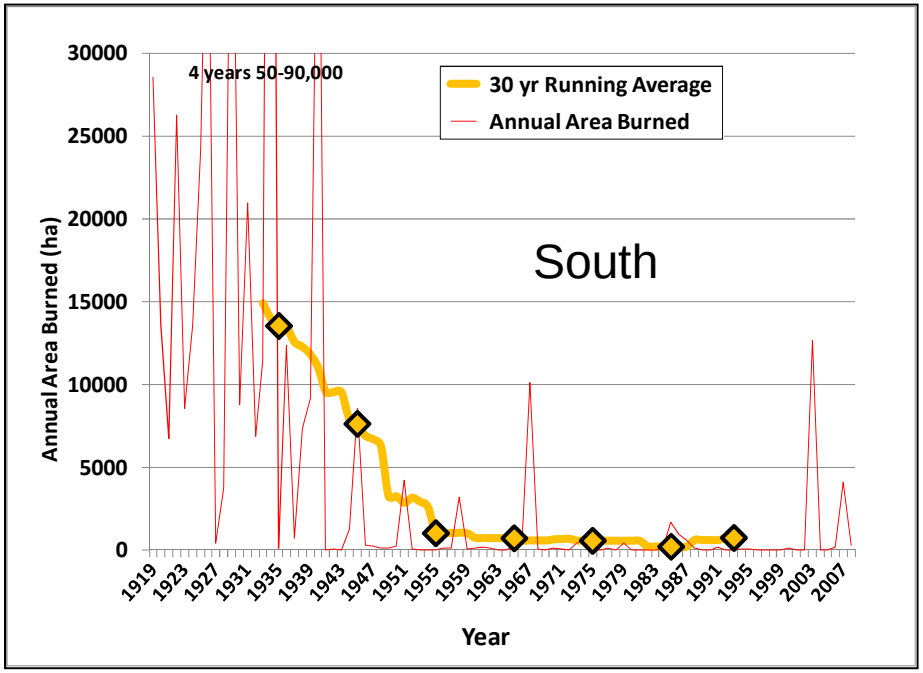
West Kootenay Fire History

Area Burned



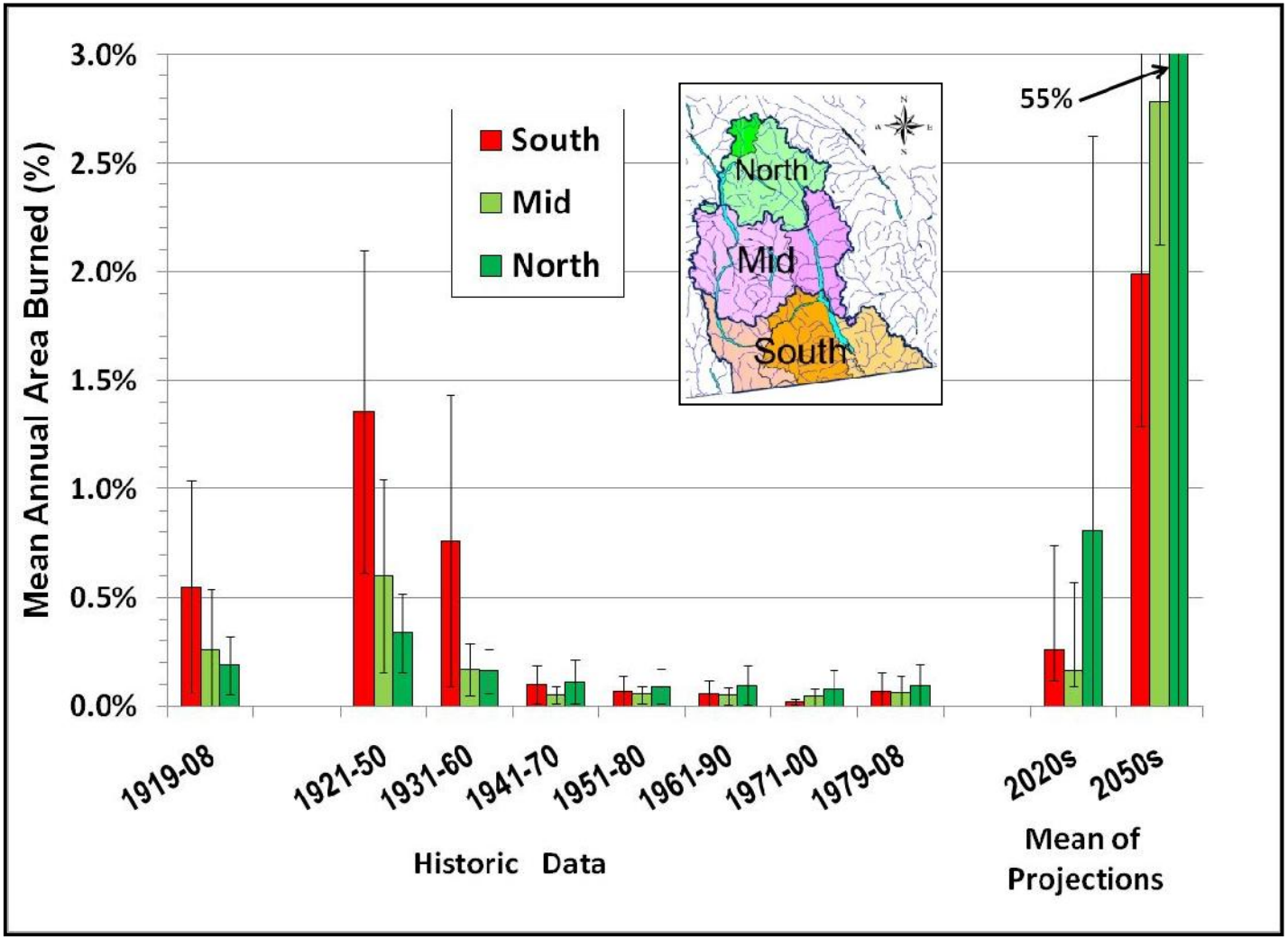
Touchstones Archives, Nelson





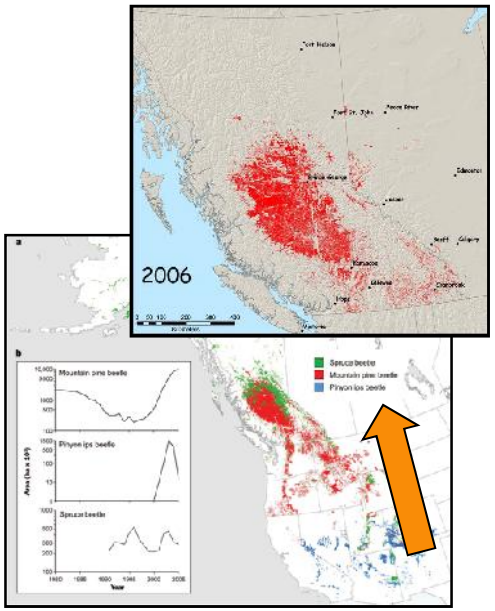
Changes in Area Burned

Jordan 2007

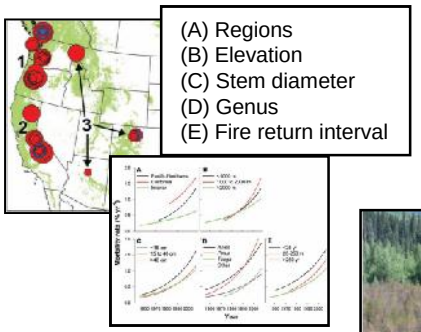


Insects/ Pathogens /Decline Syndromes

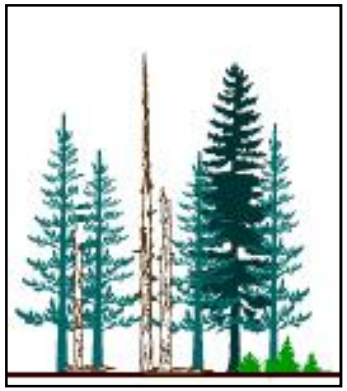
- Tree decline – drought/ resistance
- Bark Beetles
  - Mountain pine beetle, spruce bark beetle, Ips beetles, Douglas-fir beetle …..
- Defoliators, blights, pathogens
  - Spruce budworm, dothistroma, larch needle cast, root disease
- Complex Interactions
  - Birch die-back, yellow cedar, 5-needle pines



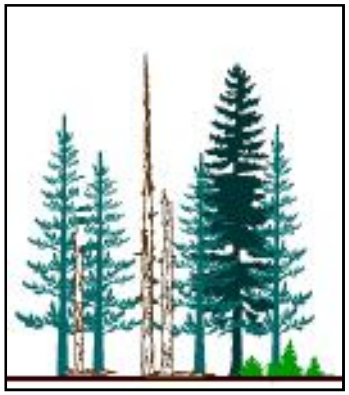
From: Raffa et al. 2008



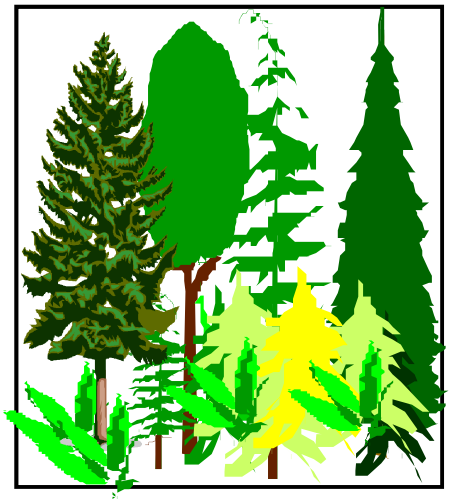
Ecosystem Response

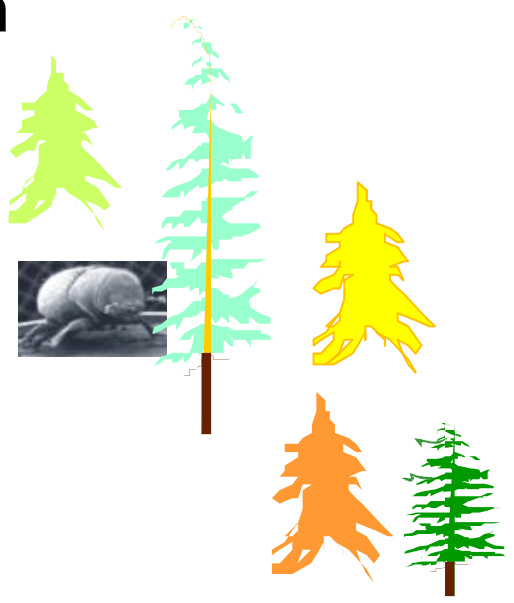


Ecosystem Range Shifts



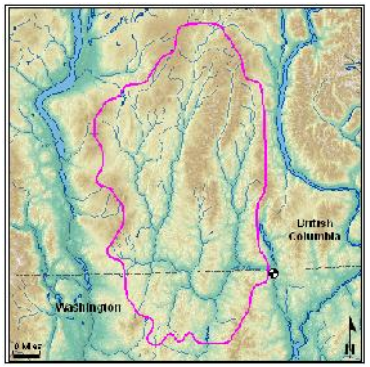
Ecosystem Re-organization



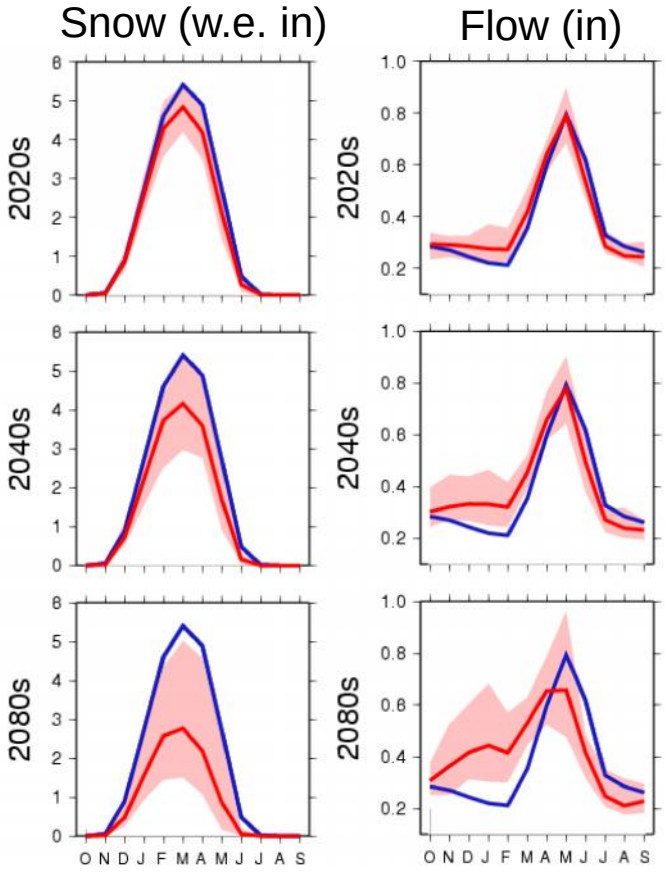


Hydrologic Changes

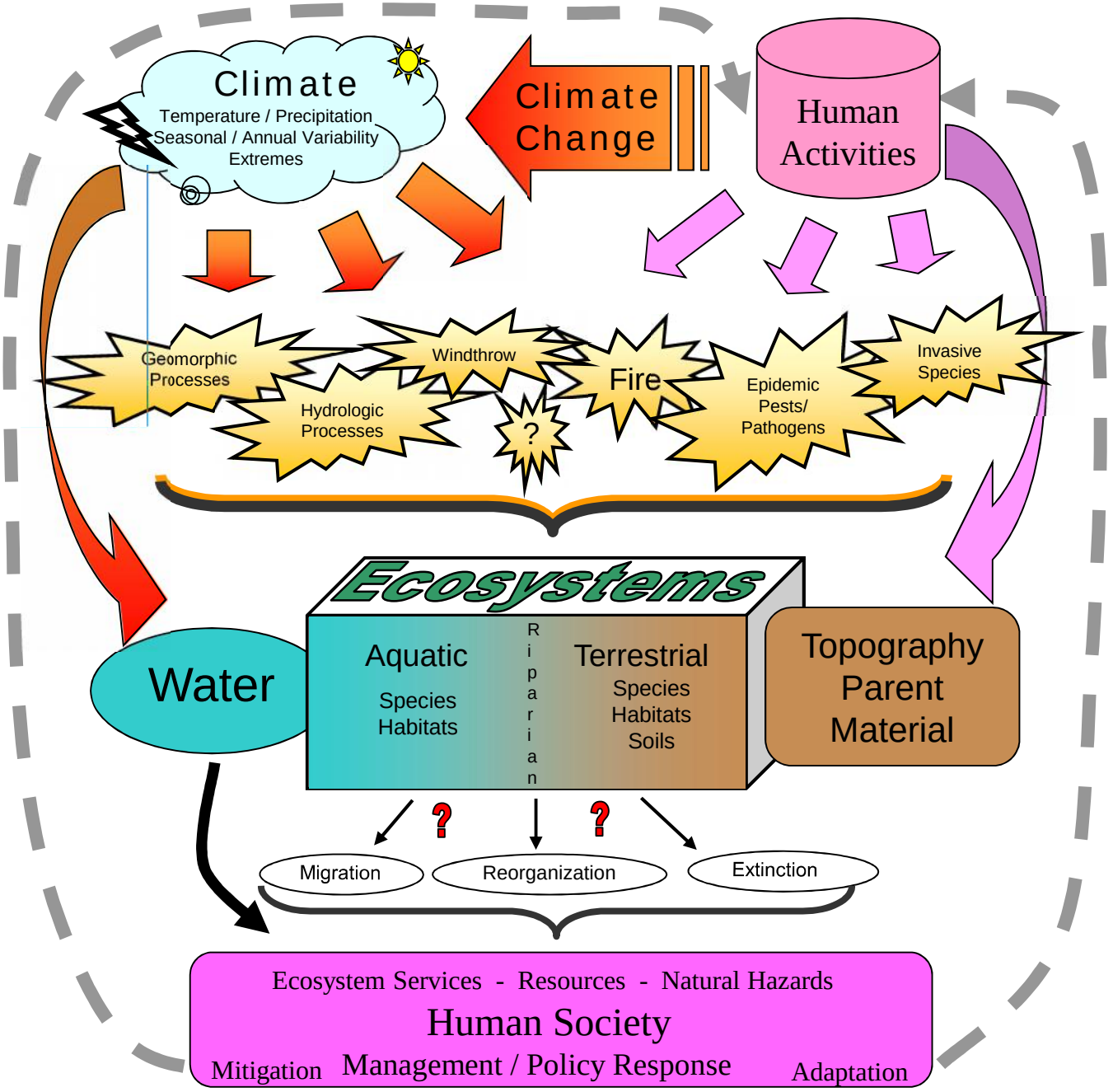
- Direct Effects
  - Reduced snow storage
  - Increased winter flows
  - Reduced spring peak flows
  - Reduced summer/fall low flows
- Indirect Effects
  - Loss of forest cover – increased erosion and snowmelt rates
  - Increased irrigation demands, decreased water availability



10 GCMs
A1B scenario
VIC hydrology model



From: CIG Univ. WA


Climate
Temperature / Precipitation
Seasonal / Annual Variability
Extremes
Climate Change
Human Activities
Geomorphic Processes
Windthrow
Fire
Invasive Species
Hydrologic Processes
?
Epidemic Pests/ Pathogens
Ecosystems
Water
Aquatic
Species
Habitats
Riparian
Terrestrial
Species
Habitats
Soils
Topography
Parent
Material
?
?
Migration
Reorganization
Extinction
Ecosystem Services - Resources - Natural Hazards
Human Society
Mitigation
Management / Policy Response
Adaptation

What to do?

- **Adaptation**
  - Increase research and modeling to anticipate changes
  - Increase monitoring to provide early warning of surprises
  - Increase conservation to aid natural adaptation
  - Plan for change – rethink everything we are doing now
- **Mitigation**
  - **STOP burning fossil fuels (coal, oil, natural gas)**
  - Eliminate other GHG emissions (cement, landfills)
  - Conserve energy
- **Look for adaptation-mitigation combinations**
  - Use wood from interface fire treatments to displace fossil fuels for heat
  - Protect forests to sequester carbon and assist ecosystem adaptation
  - Increase building insulation to reduce fuel use and adapt to summer heat waves

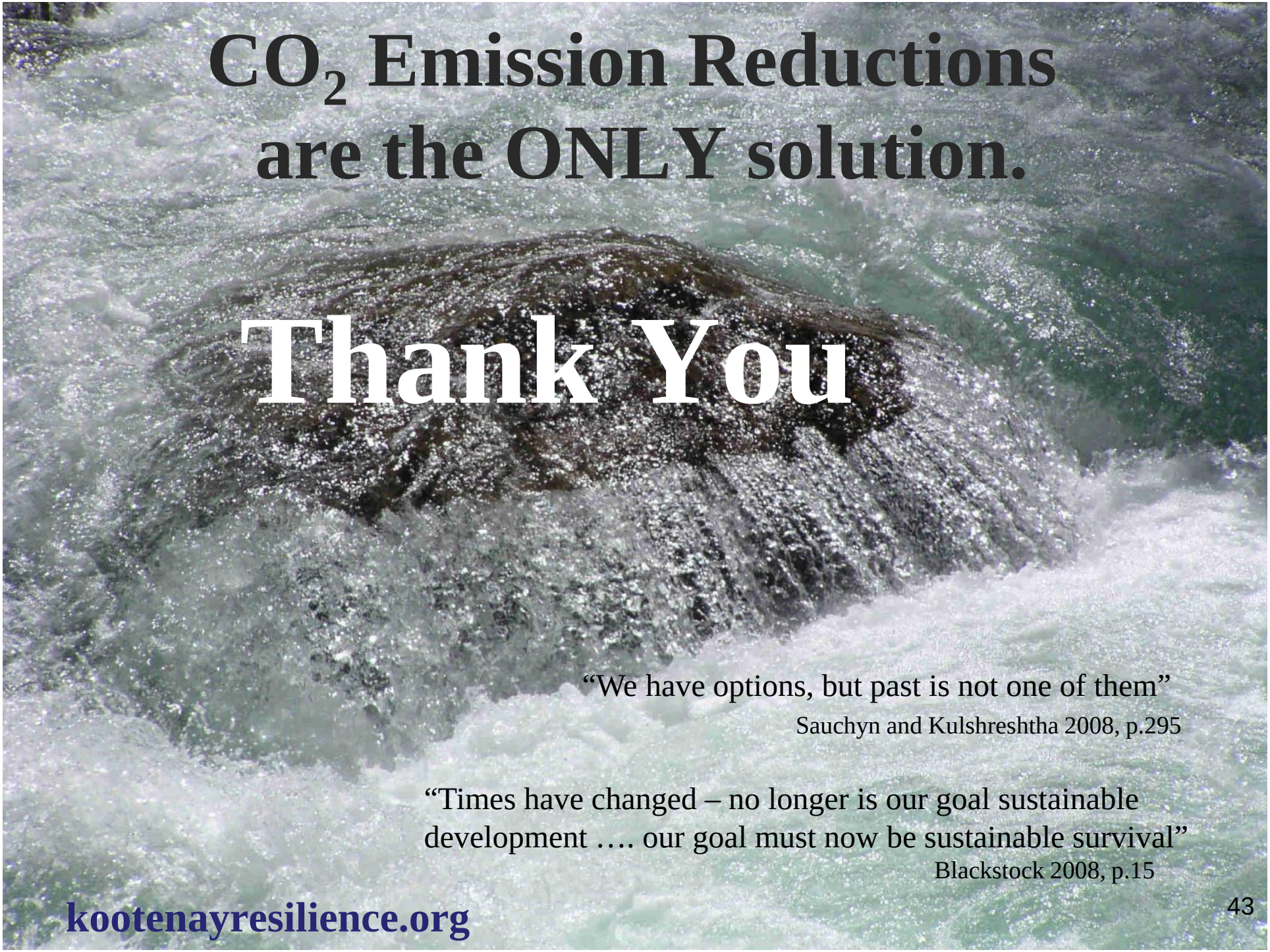
Challenges – Opportunities Forestry/ Ecosystems

- **Challenges**
  - Increasing fire frequency and intensity
  - Changing habitats and consequent species loss
  - Reforestation/ restoration – species suitability
- **Opportunities**
  - Harvesting/ silviculture treatments to increase resilience and decrease interface fire risk
  - Using wood waste to replace fossil fuels
  - Increased grassland habitats and rangelands
- **Example**
  - “Fuels for Schools” program

Chipping Slash

Hazard Reduction

School Boiler



CO_2 Emission Reductions are the ONLY solution.

Thank You

"We have options, but past is not one of them"

Sauchyn and Kulshreshtha 2008, p.295

"Times have changed – no longer is our goal sustainable development …. our goal must now be sustainable survival"

Blackstock 2008, p.15