Elevational dependence of climate variability & trends in British Columbia's Cariboo Mountains

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5th Annual PNWCSC
09 September, 2014

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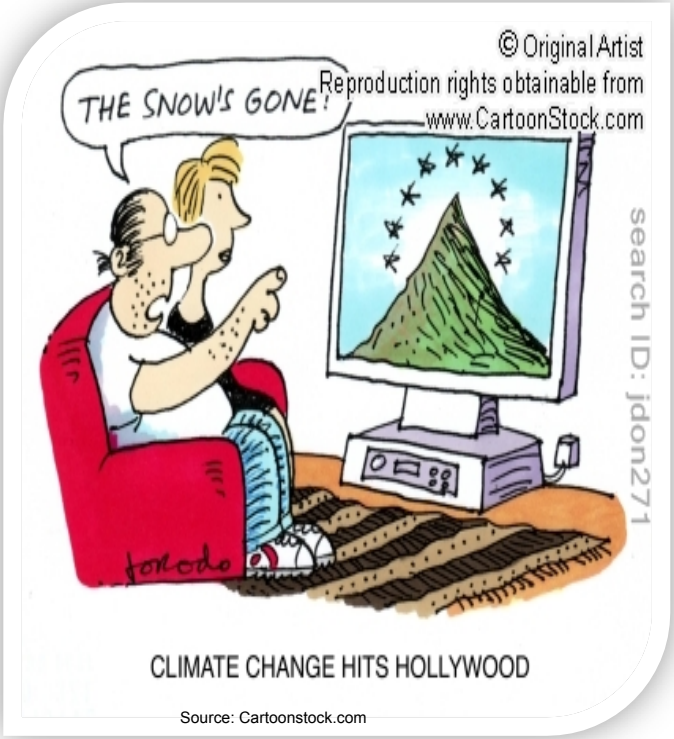
Outline

- Introduction & Motivation
- Objectives
- Study area & Methods
- Results
- Why does this matter?
- Conclusion
- Acknowledgements

Introduction & Motivation

- Mountainous regions are experiencing amplified warming
- Lack of clear understanding of what drives changes in the mountains
- Physical processes play role
  (some mountains specific)
- Relationship of climate variables to complex mountain systems is still not entirely clear



Source: Cartoonstock.com

Objectives

- What are the hydroclimatological trends in the Cariboo Mountains Region (CMR) of British Columbia (BC)?
- Do these climate trends depend upon elevation?
- Why does this matter?

Study Area

The Cariboo Mountains of east-central BC.

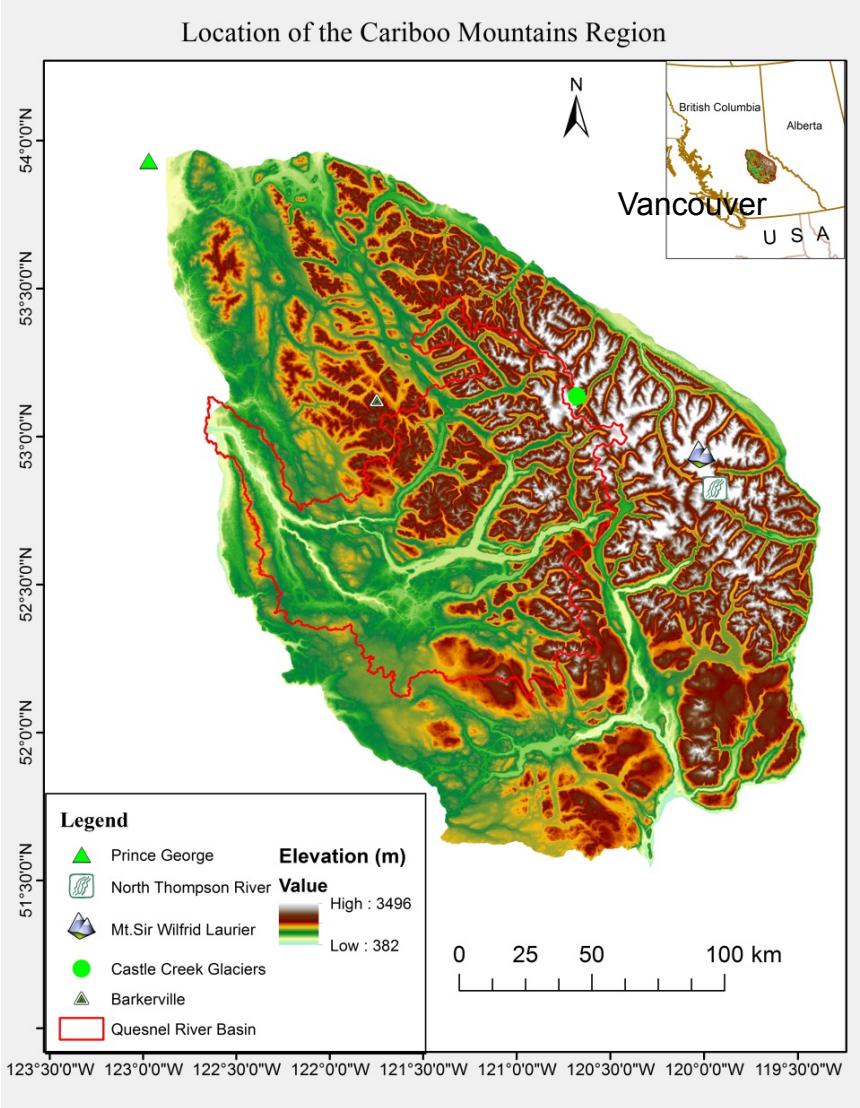
- Extents:

119°6’ -122°33’W

51°37’-53°30’ N

- Area: ~44,000 km^2
- Length: ~245 km
- Elevation:

330 m - 3520 m a.s.l



Data & Methods

Climate variables:

- Air temperature
- Precipitation

Data: NRCan ANUSPLIN interpolated

(McKenney et al. 2011)

(~10 × 10 km resolution)

- Anomaly $(z) = x - \bar{x}$

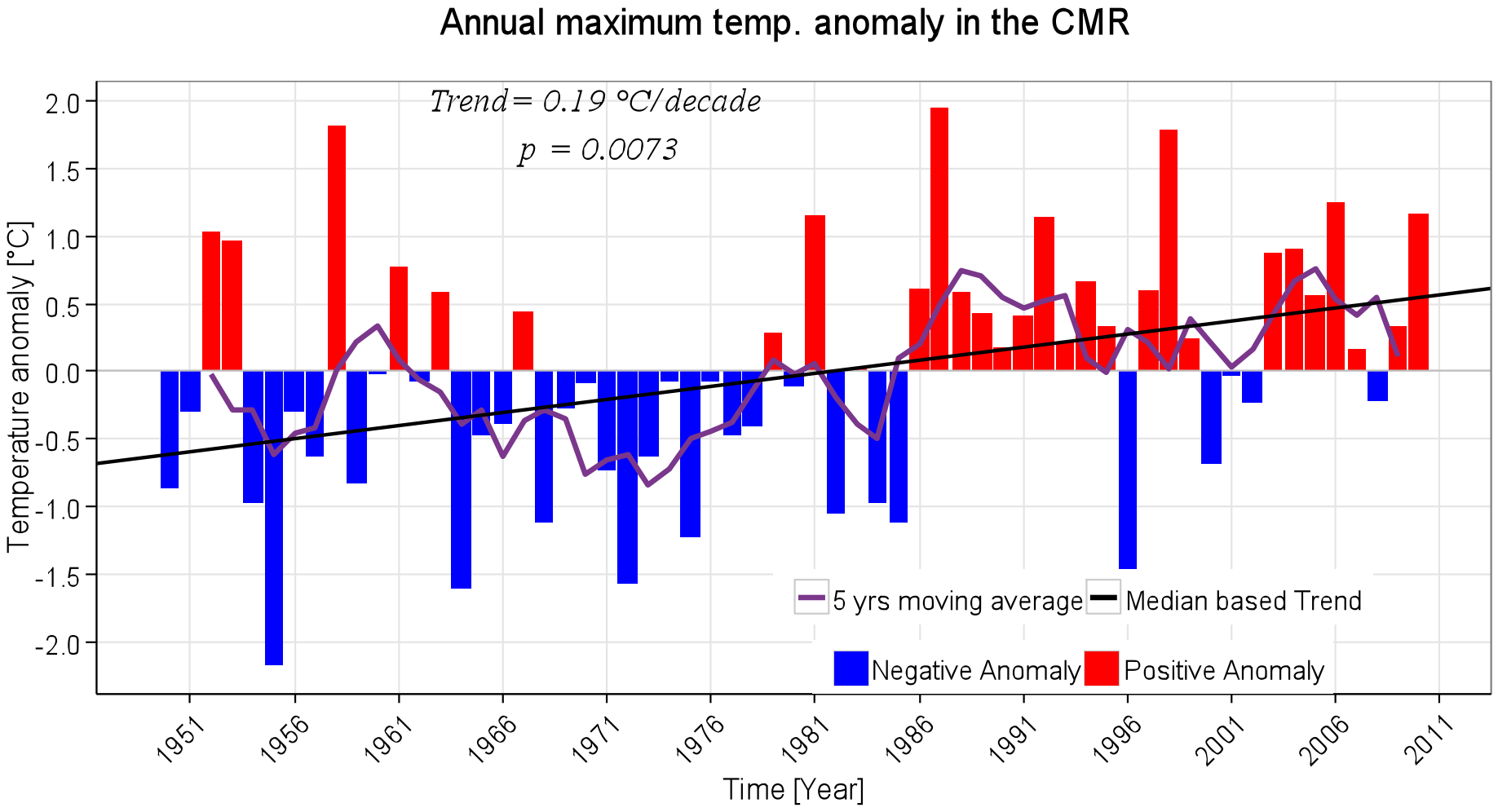
- Trend calculated performing non-parametric test: Mann-Kendall Test

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign(x_j - x_k)$$

- Trend magnitude is predicted using Sen's estimator

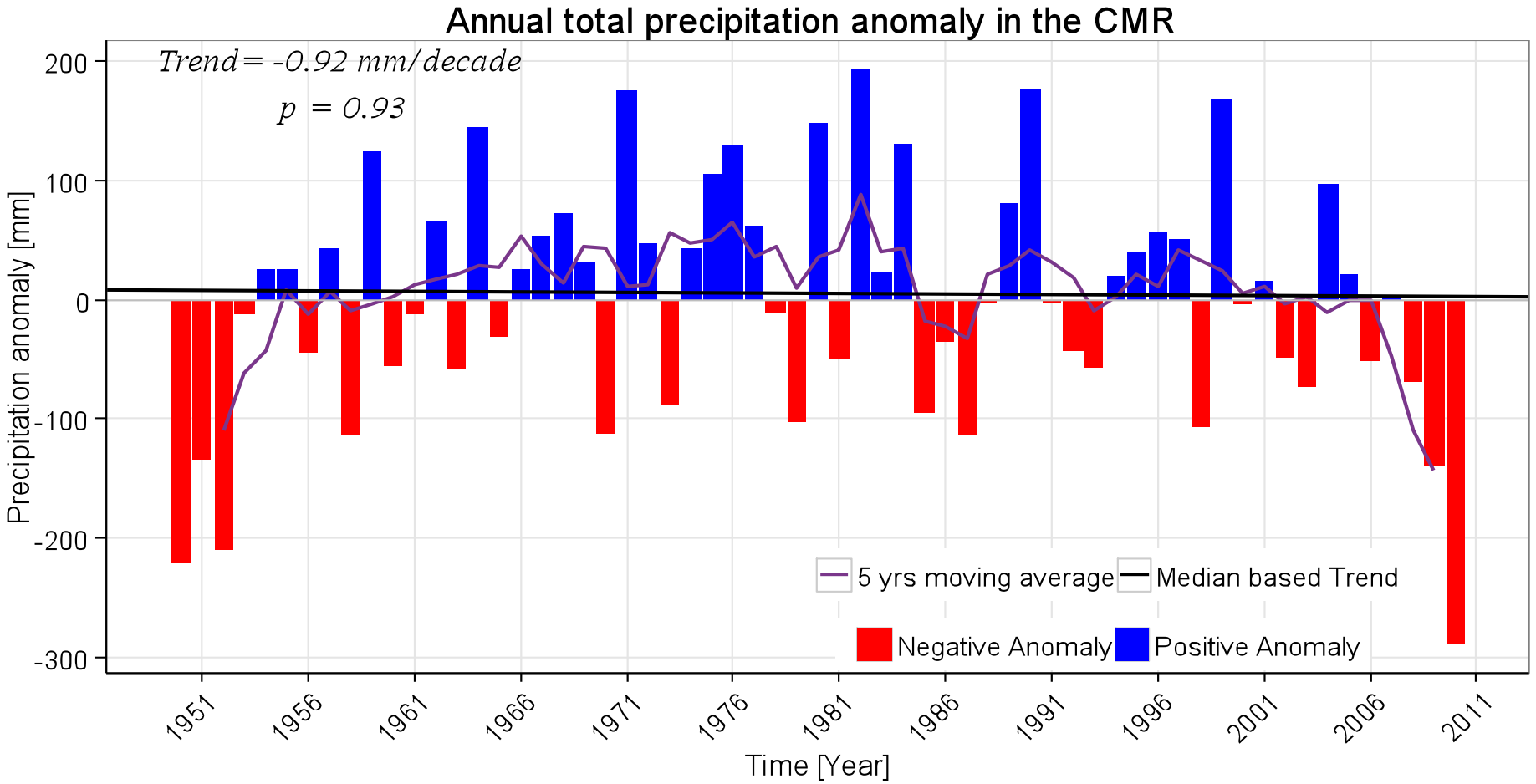
Considered significant if $p<0.05$

Results: Trends



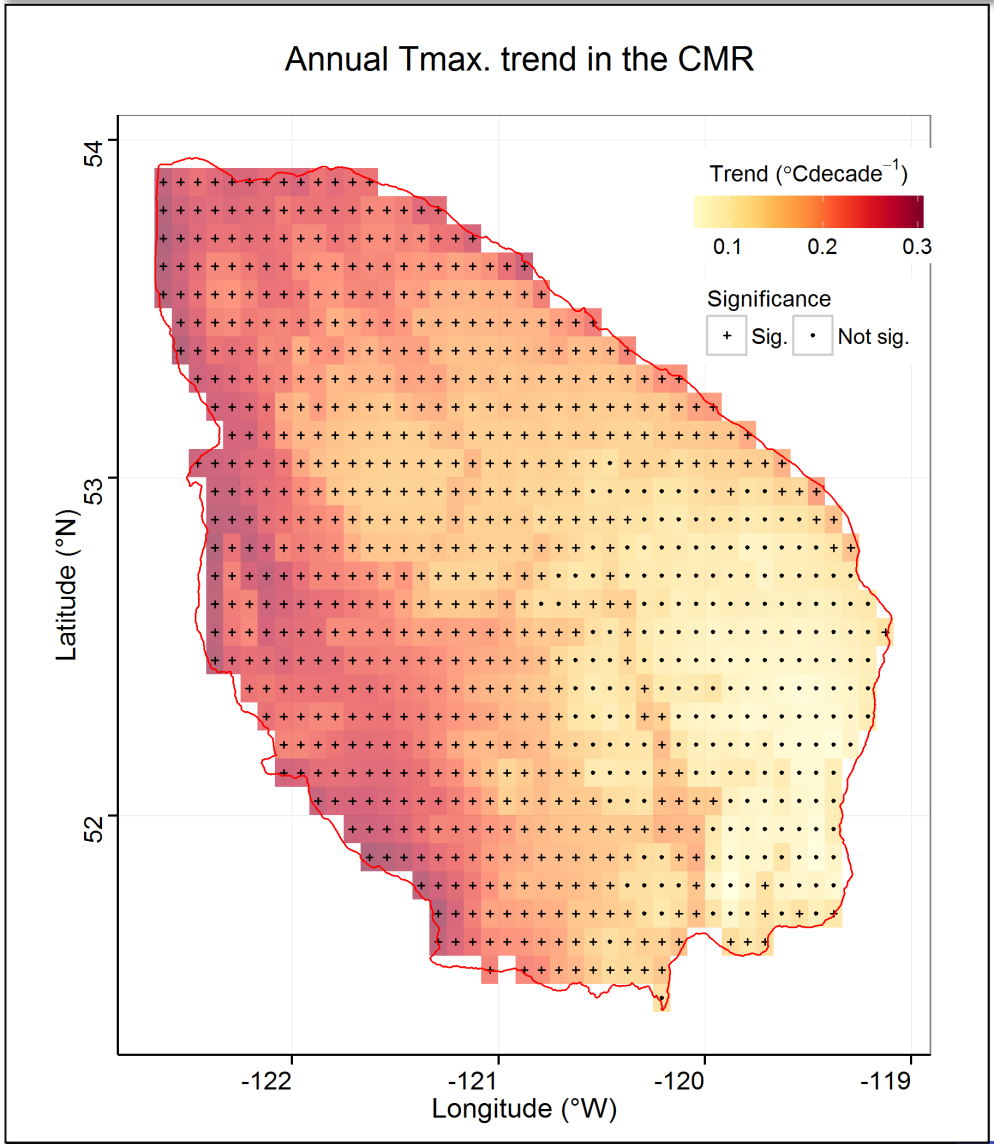
Recent years are warmer (22/30 recent years positive anomaly)

Results: Trends



No significant trend of annual precipitation

Results: Spatial Trends



- Significantly increasing annual min. daily temperature with trend upto 0.6°C decade^{-1} & value 0.3°C decade^{-1} more
- Higher the elevation, lower the trend magnitudes

Results: Elevational dependency

Physical factor	Seasonal Relevance	Temperature Response in CMR
SAF (Decreases in Snow/Ice Albedo)	Primarily spring; Important in winter (Lower elevation) and summer (Higher elevation)	Increases T_{min} Increases T_{max}
Increases in Cloud Cover (Daytime)	All seasons	Decreases T_{max}
Increases in Cloud Cover (Nighttime)	All seasons (greater effects in winter)	Increases T_{min}
Increases in Soil Moisture	Snowmelt effects are strongest in spring and winter; rainfall effects are strongest in summer	Decreases diurnal temperature range (DTR); Decrease T_{max}

Trend [°C decade⁻¹]

Trend [°C decade⁻¹]

Why does this matter?

- Seasonal shifting
  - start of melting days is decreasing (-4.1 daysdecade^{1}) in spring
  - start of freezing days is increasing (0.4 daysdecade^{-1}) in fall
- Impact on water resources
  - Hydropower generation
  - Glaciers melting, flooding, aquatic habitat

Photo: John Lehmann/The Globe & Mail

- Impacts on salmon
  - Habitat of salmon, a keystone species
  - Rising temperature in the rivers & greater fluctuation of river runoff affects on migrating and spawning salmon

Why does this matter?

- Impacts on Mountain Caribou
  - declining population of the endangered mountain caribou
  - milder winter & lower snow depth make arboreal lichen inaccessible – their main winter food
  - increase competition

- Others
  - mountain pine beetle epidemic,
  - increase forest fire events,
  - extreme weather events, etc.

Photo: Richard Wright

- The understanding of climate of the region is important to minimize the impacts associated with ecology &, hydrology of the region

Conclusion

- This study reports almost a 2°C increase of minimum air temperature in the CMR between 1950 and 2010.
- The region is warming and is likely to warm in many years to come
- Elevational dependency shows opposite pattern of minimum & maximum temperature trends
  - minimum temperature increase with increasing elevation
  - different mountain specific factors play role for this
- Such changes matter because they affect local hydrology, ecology and, therefore society and economy
- It is important to consider these changes and develop policy to minimize adverse impacts due to climate change at local to regional and provincial levels

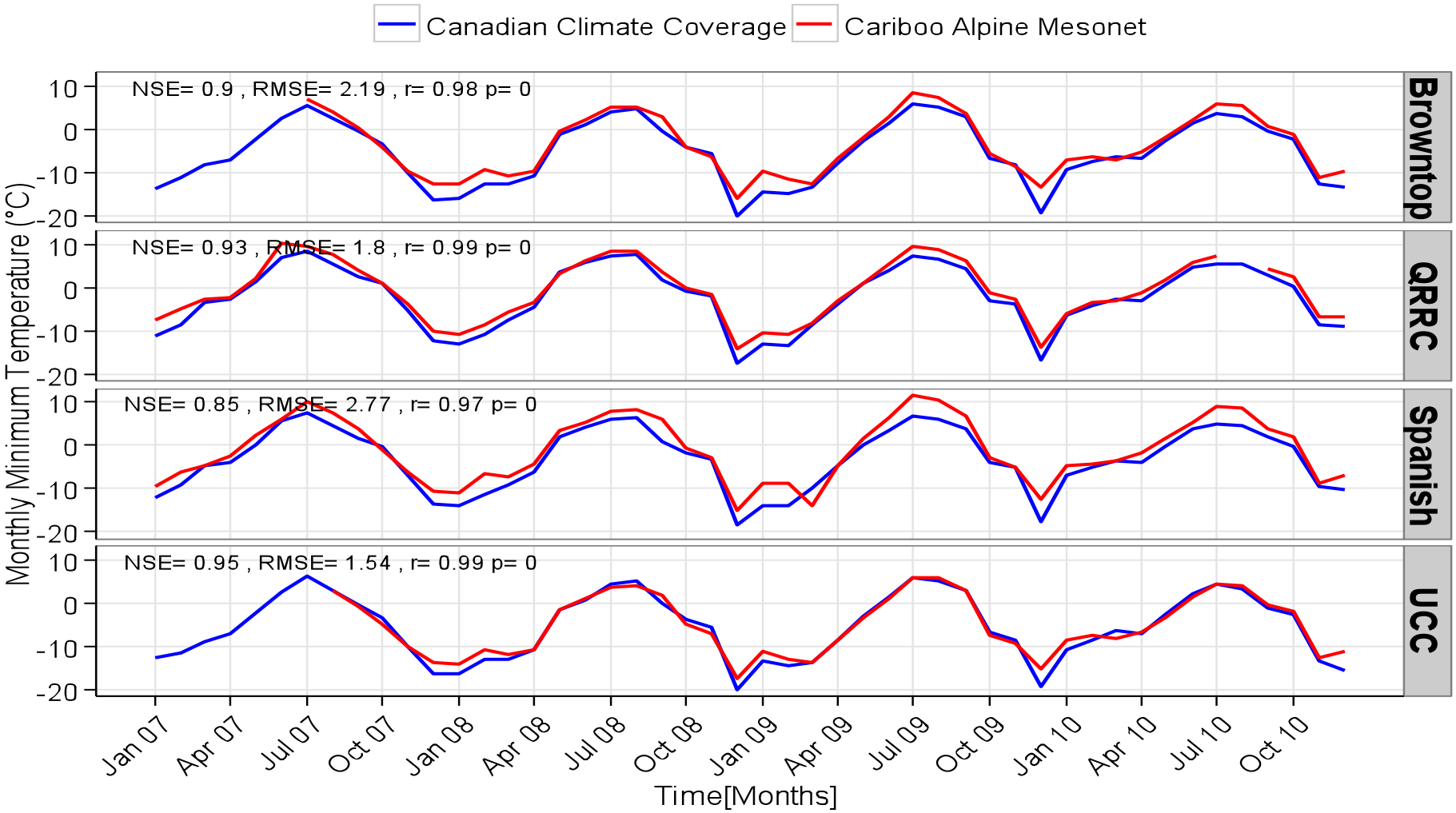
Acknowledgements

- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Natural Resources Canada (NRCan)
- Dr. Peter Jackson & Dr. Margot Parkes
- NHG Colleagues
- Bunu
- UNBC

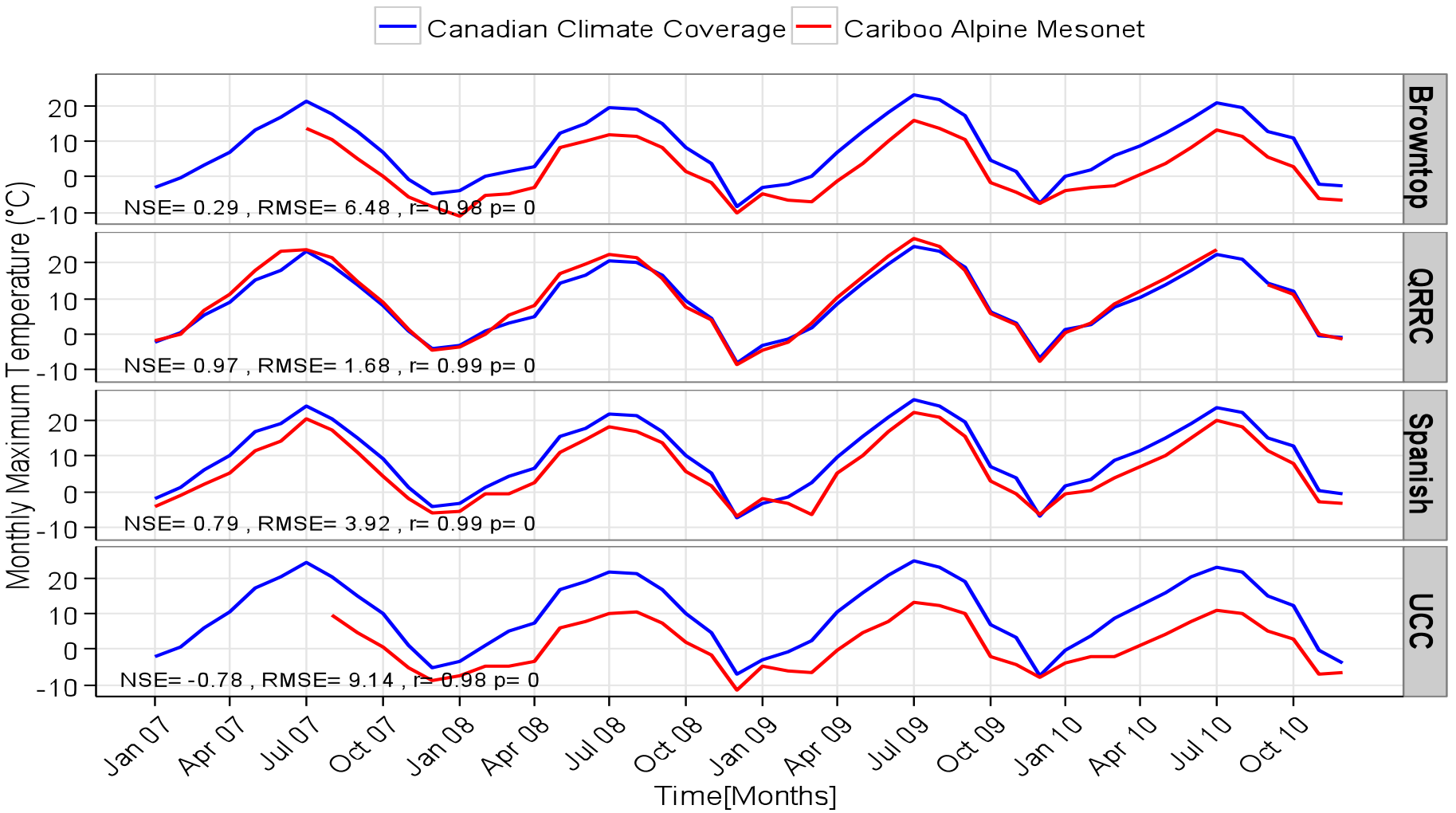
Thank y u !

Questions ?

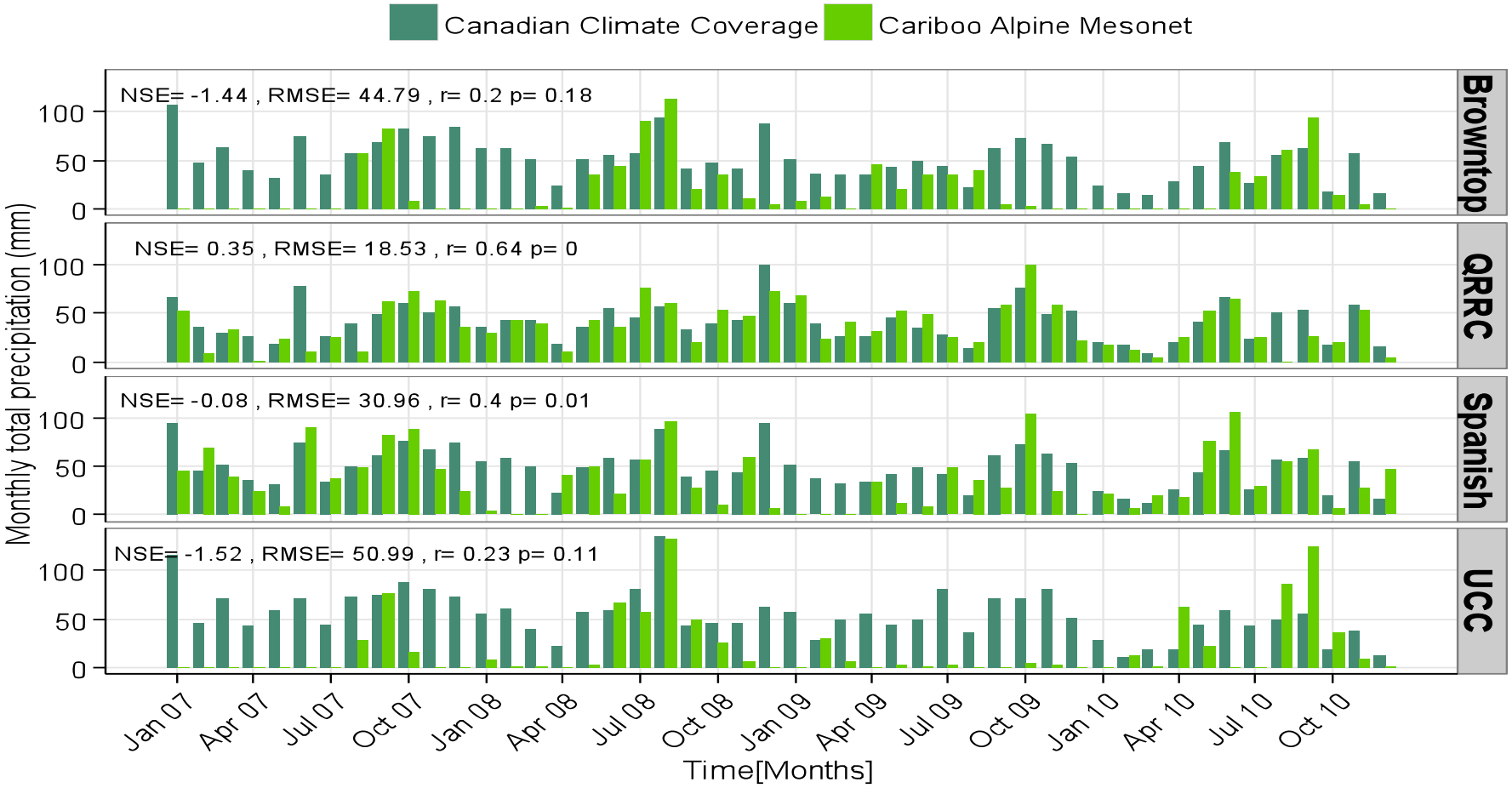
CCC & CAMnet monthly Tmin. in the Cariboo Region



CCC & CAMnet monthly Tmax. in the Cariboo Region



CCC & CAMnet monthly Prcp. in the Cariboo Region



Processes and drivers of enhanced CC

– No. of factors associated with elevational lead to different response to warming

Driver	Mechanism	Temperature response
↑ Snow-albedo	↑ surface absorption of insolation	↑ Tmax
↑ Cloud cover (Day)	↓ surface insolation	↓ Tmax
↑ Cloud cover (Night)	↑ downwelling longwave radiation	↑ Tmin
↑ Specific Humidity	↑ downwelling longwave radiation	↑ Tmin
↑ Aerosols(non-absorbing)	↓ surface insolation	↓ Tmax
↑ Aerosols(absorbing)	↓ surface insolation, ↑ mid-tropospheric heating, ↓ cloud cover	↑ Tmin Rangwala *et. al. (*2012)

Photo: https://www.flickr.com/