Contribution of atmospheric rivers to extreme snowfall across British Columbia, Canada

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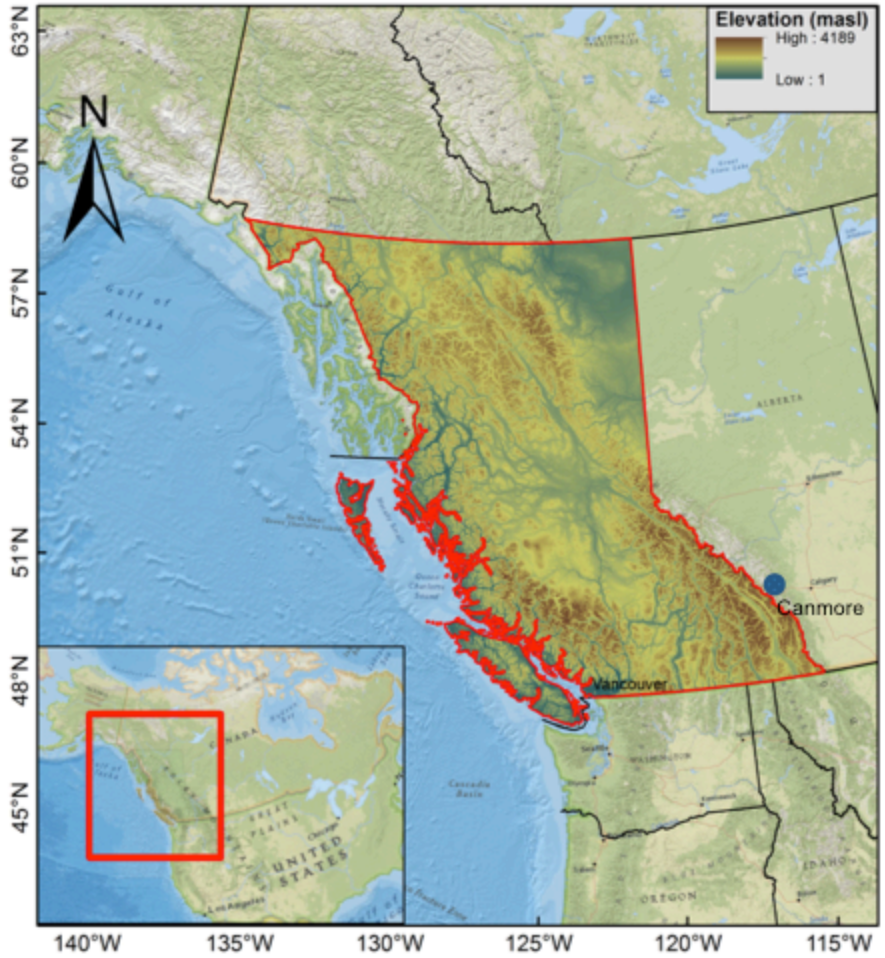
Background

- British Columbia (BC) generally receives copious amount of snowfall during winter months from atmospheric rivers (ARs), especially in mountainous regions.

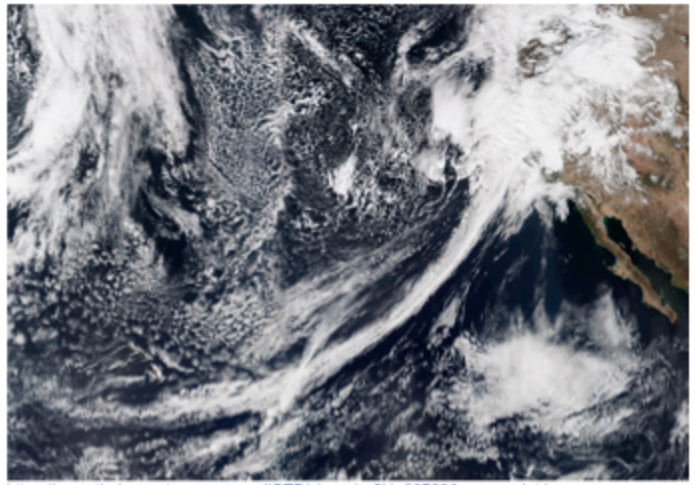
- Snow forms a significant component of the high altitude/latitude terrestrial climate system and water resources of this region. (Vavrus, 2007; O'Gorman, 2014)

- Climate modeling studies suggest that we are likely to experience changes in the future extremes. (Easterling et al., 2000)



Research Questions

- What are the changes in variability and trends of extreme snowfall events?
- What is the elevational dependence of extreme snowfall events?
- What fraction of extreme snowfall events are caused by ARs?
- How are extreme snowfall events changing across BC ?



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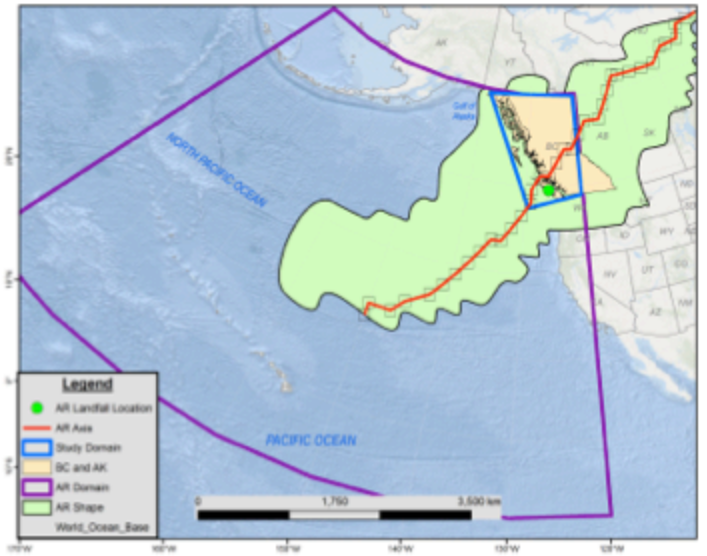


An AR on 25 Sep 2010

Data & Methods

Data

- Daily precipitation (ECCC and BCRFC)
- ANUSPLIN observation- based gridded (McKenney et al. 2011)
- Atmospheric Rivers Catalog from Scripps Institution of Oceanography (SIO-R1 catalog) (Gershunov et al. 2017)

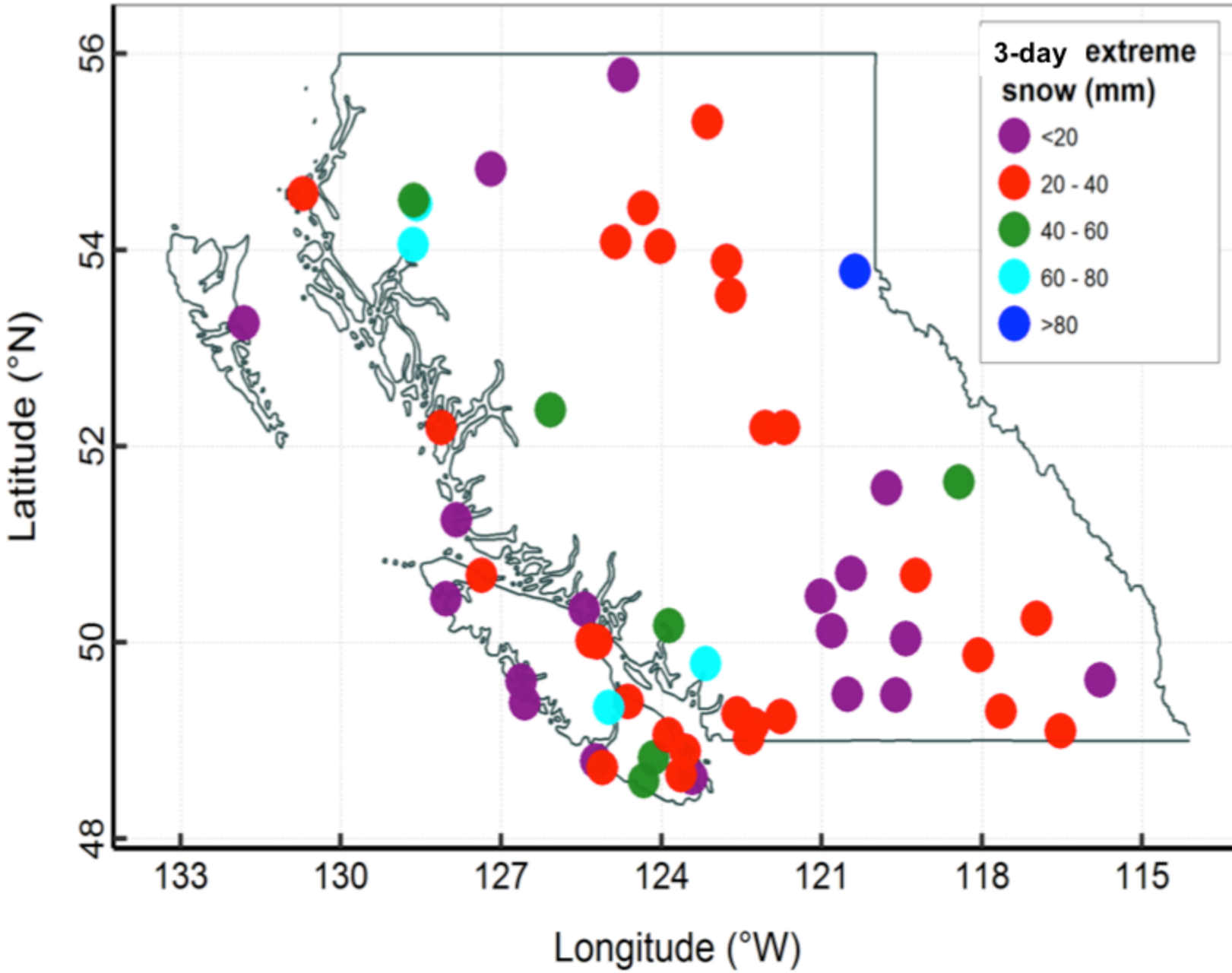
Methods

- Snowfall obtained from daily precipitation
- POT (Station data, >95th percentile) and block-maxima (gridded data)
- Mann-Kendall Trend test, significant when *p-value* <0.05
- Calculated the fraction of extreme snowfall days when there is presence of AR

Snowfall distribution

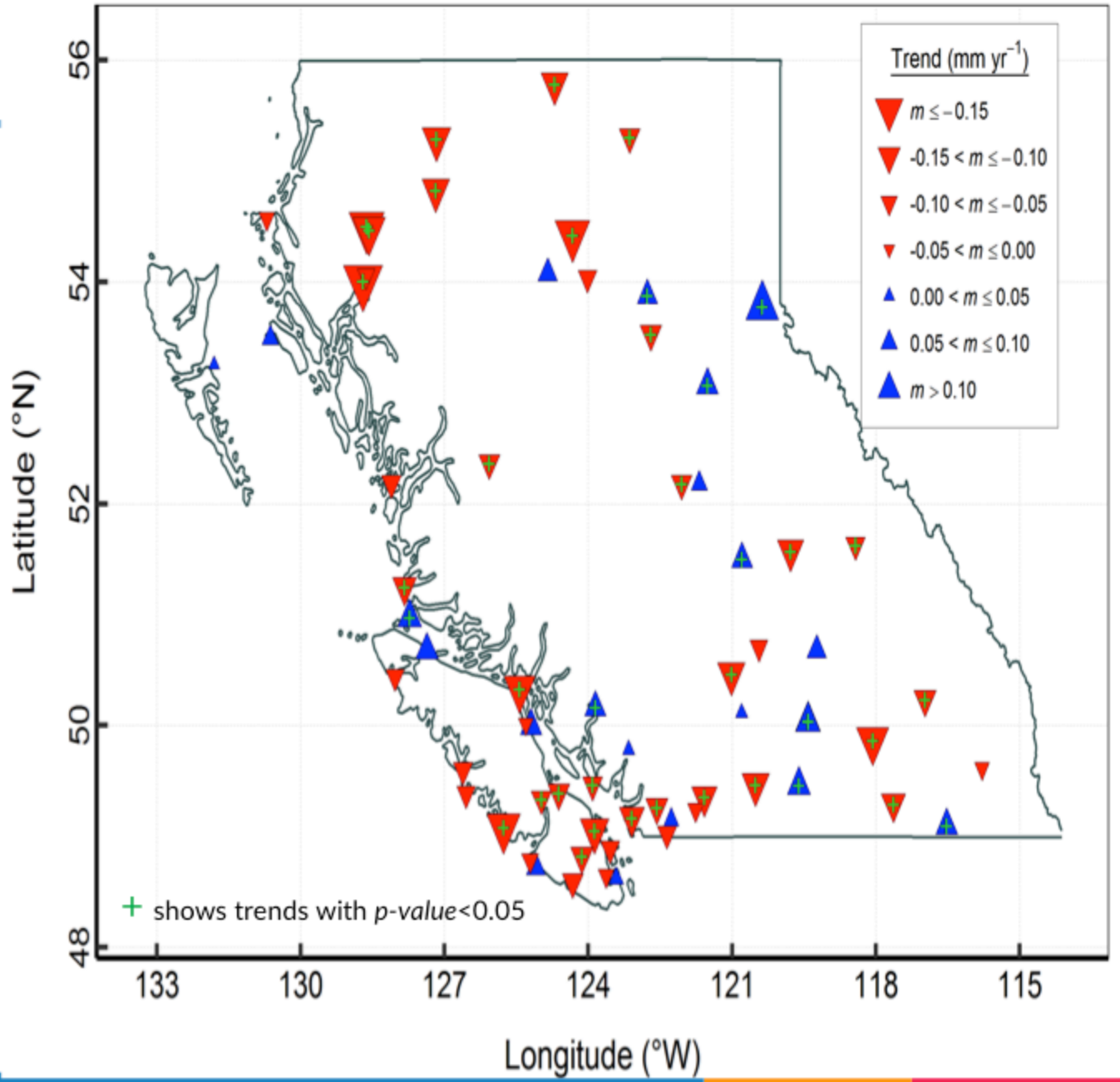
Study area and spatial distribution of stations (1985-2015)

Average 3-day extreme snowfall (1985-2015)

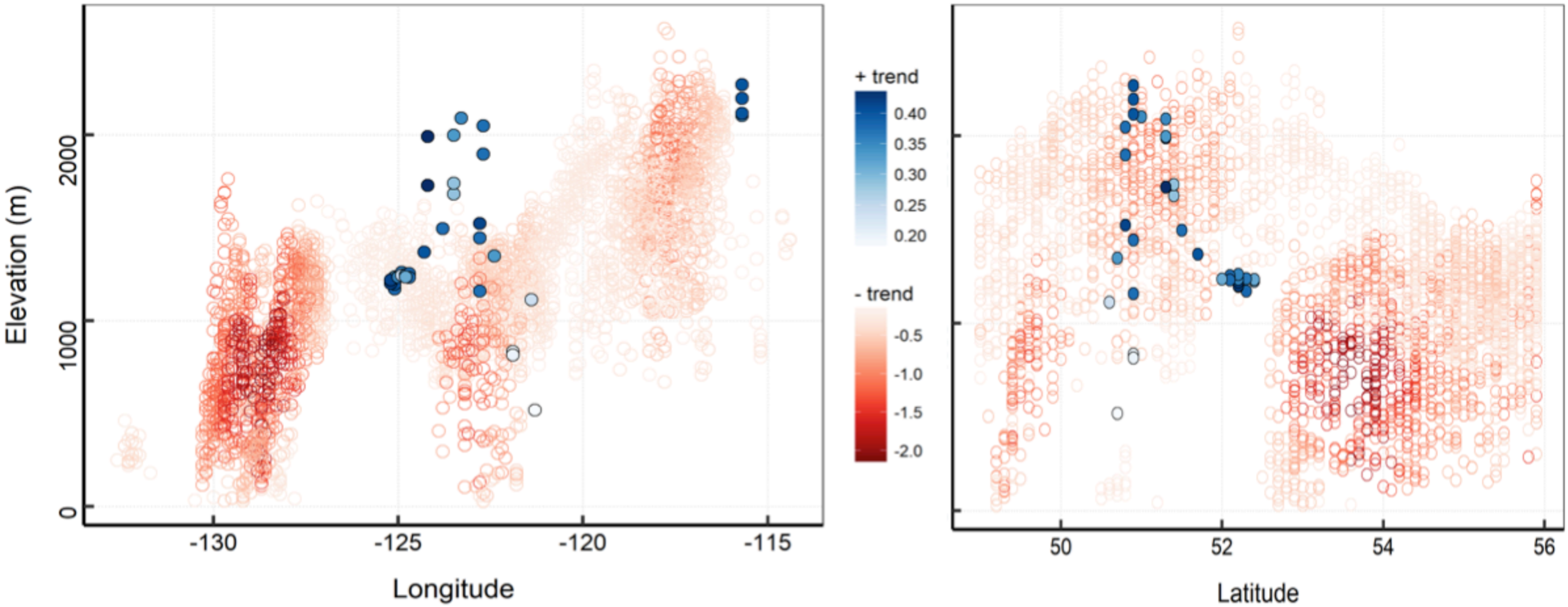


Extreme snowfall trend

- Station-based normalized 3-day extreme snowfall shows significantly increasing trend at higher elevations, no trend at mid-elevations, and declining trend at lower elevations
- Decreasing extreme snowfall trend in majority of the stations; however, increasing in higher elevation stations



Extreme snowfall trend

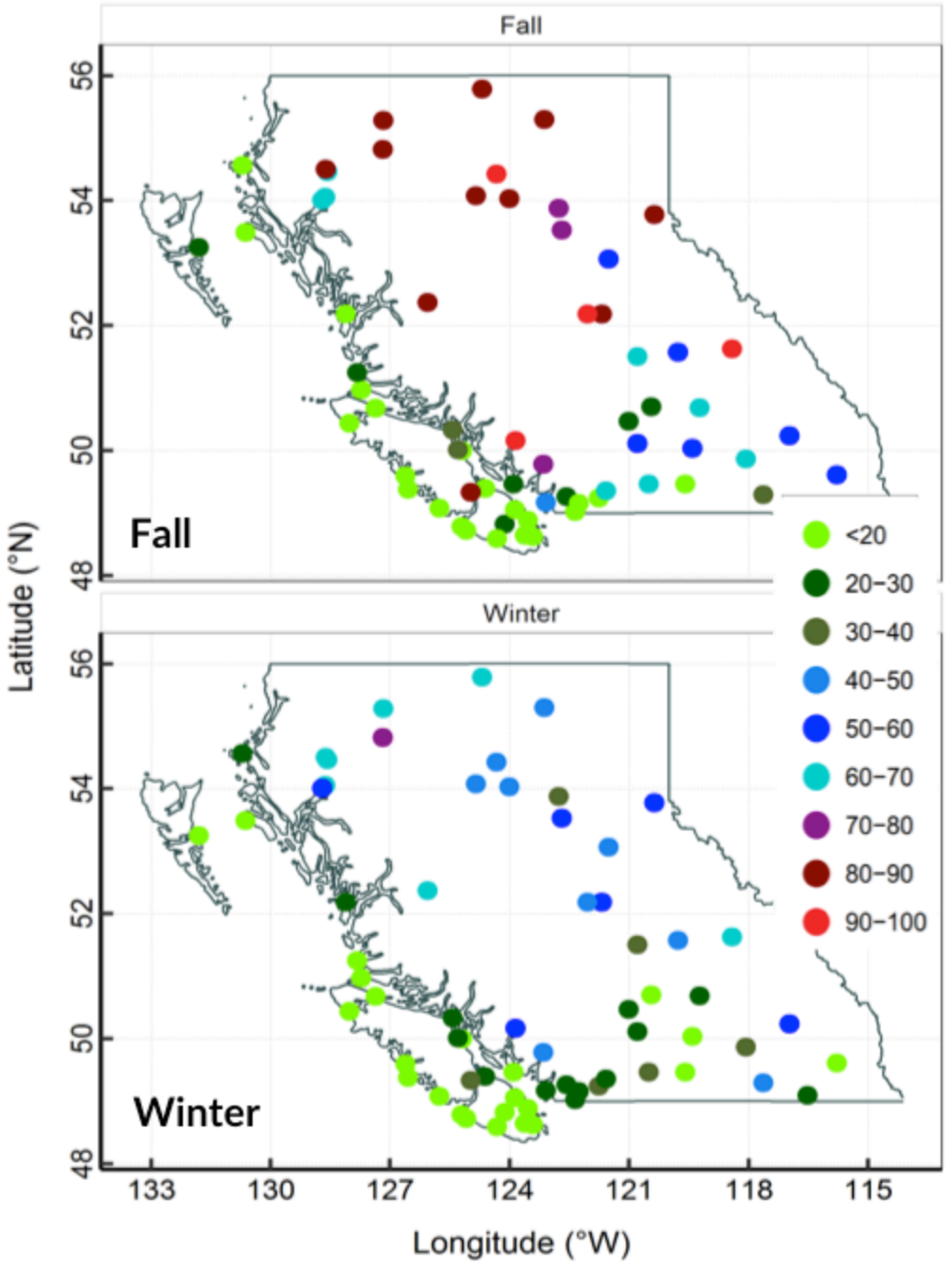


Although extreme snowfall are significantly decreasing, few of the higher elevation areas show significantly increasing trend.

AR & extreme snowfall

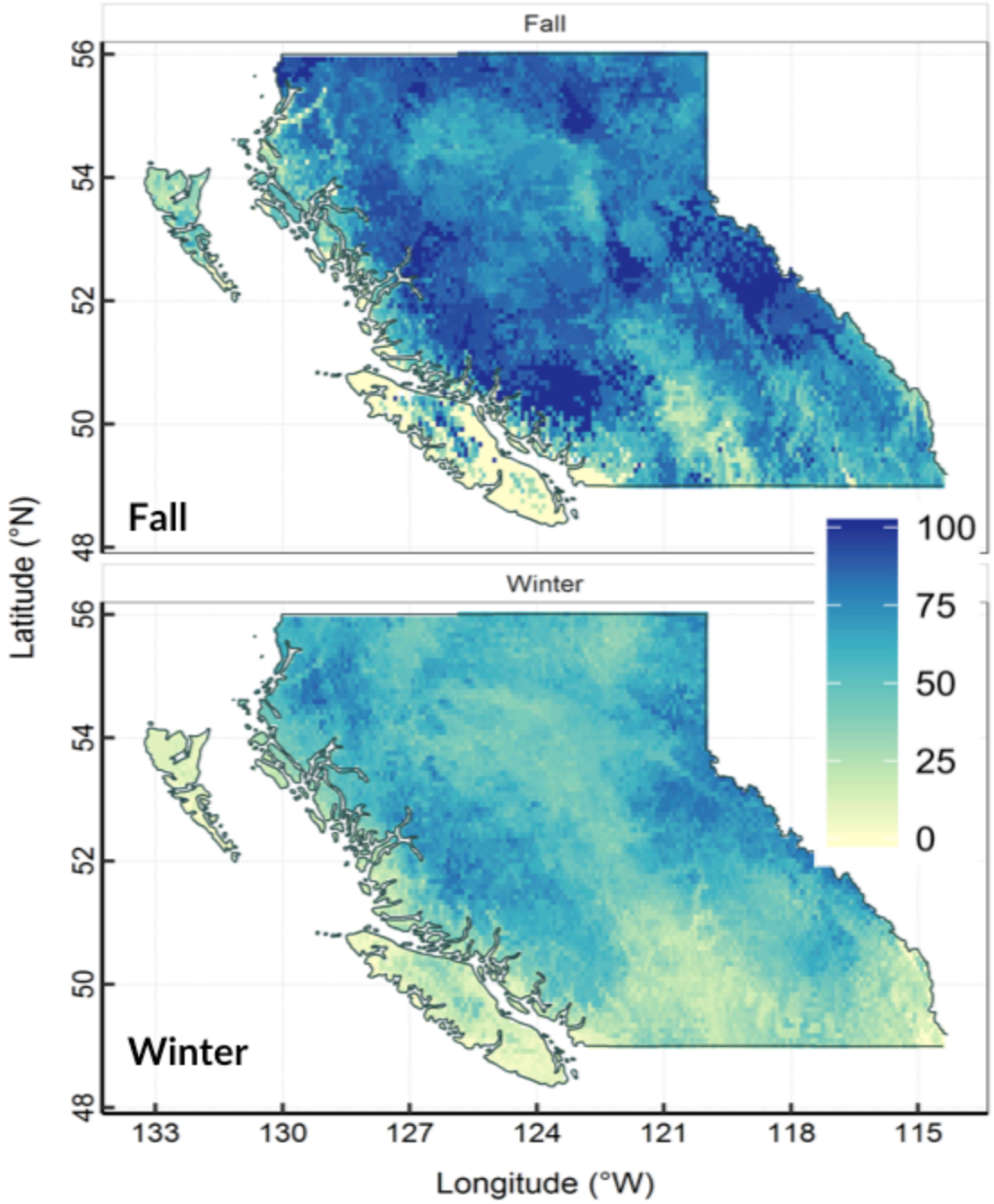
- ARs contribute on average 34% of 3-day extreme snowfall accumulations each year

- ARs contribute 42% and 33% of 3-day extreme snowfall during fall and winter seasons respectively

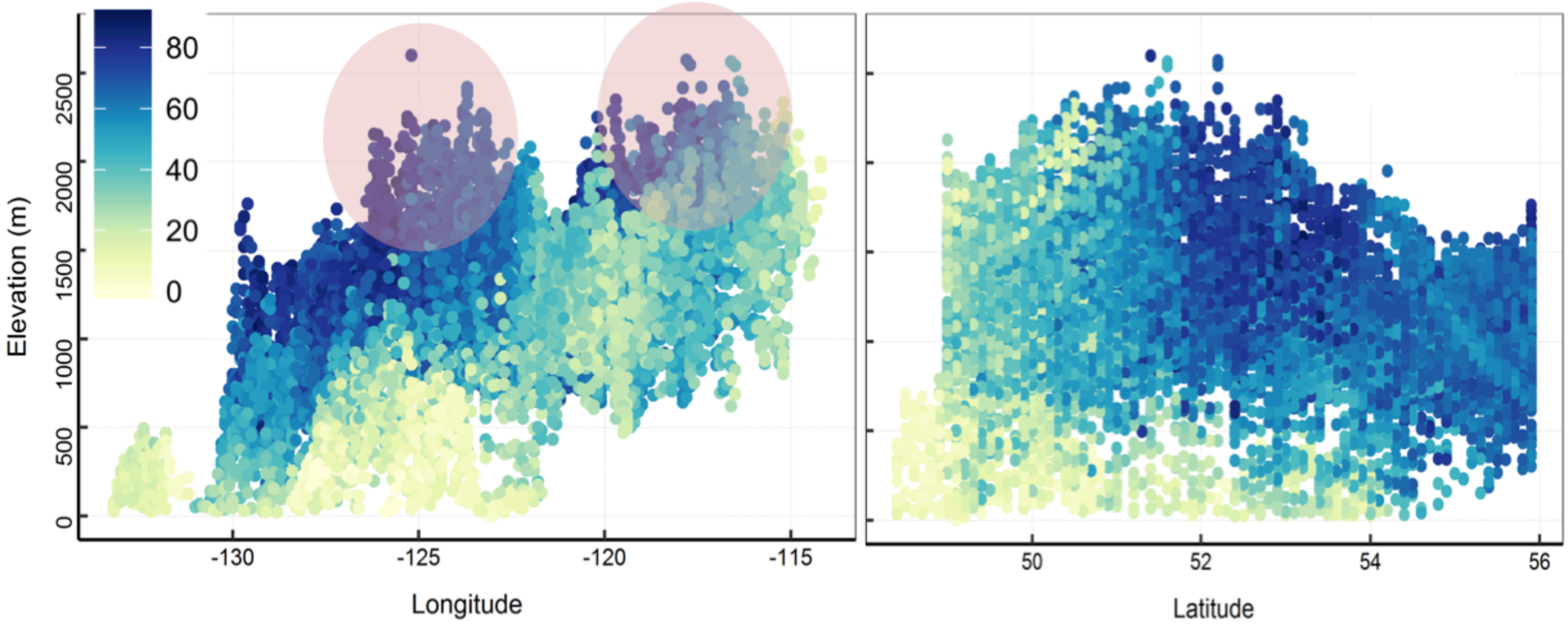


AR & extreme snowfall

- ARs contribute on average 53% of extreme snowfall
- The contribution is higher in fall (68%) followed by winter (47%)
- Higher contributions are in the higher elevation areas of the Coast and Rocky Mountains



AR & extreme snowfall



Contribution of ARs decreases moving inland with clear variation in the Coast and Rocky Mountains.

Summary

- On average, 3-day extreme snowfall is decreasing at lower elevations [<500 m], remains stable at mid-elevations [500 m -1500 m], and is increasing at higher elevations [>1500 m] during the period of 1985-2015.

- The significant decrease rate of extreme snowfall is higher (up to 2.1 mm yr^{-1}) compared to increase rate (0.5 mm yr^{-1}).

- Extreme snowfall trends show strong dependence with elevation and continentality.

Summary

- ARs contribute about 50% of 3-day extreme snowfall in BC; highest contributions are during Fall when there are highest number of landfalling ARs.
- AR contribution on extreme snowfall events are greater at the higher elevation areas specially in the Coast and Rocky Mountains.
- AR contribution on 3-day extreme snowfall decreases with longitude (west to east).
- Future research will focus on how ARs contribute on extreme streamflow events across BC and their changes over time.

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Thank You !

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