Recent trends and variability of river discharge in northern Canada

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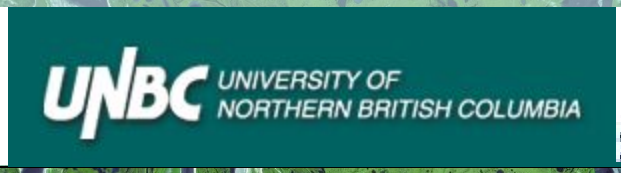
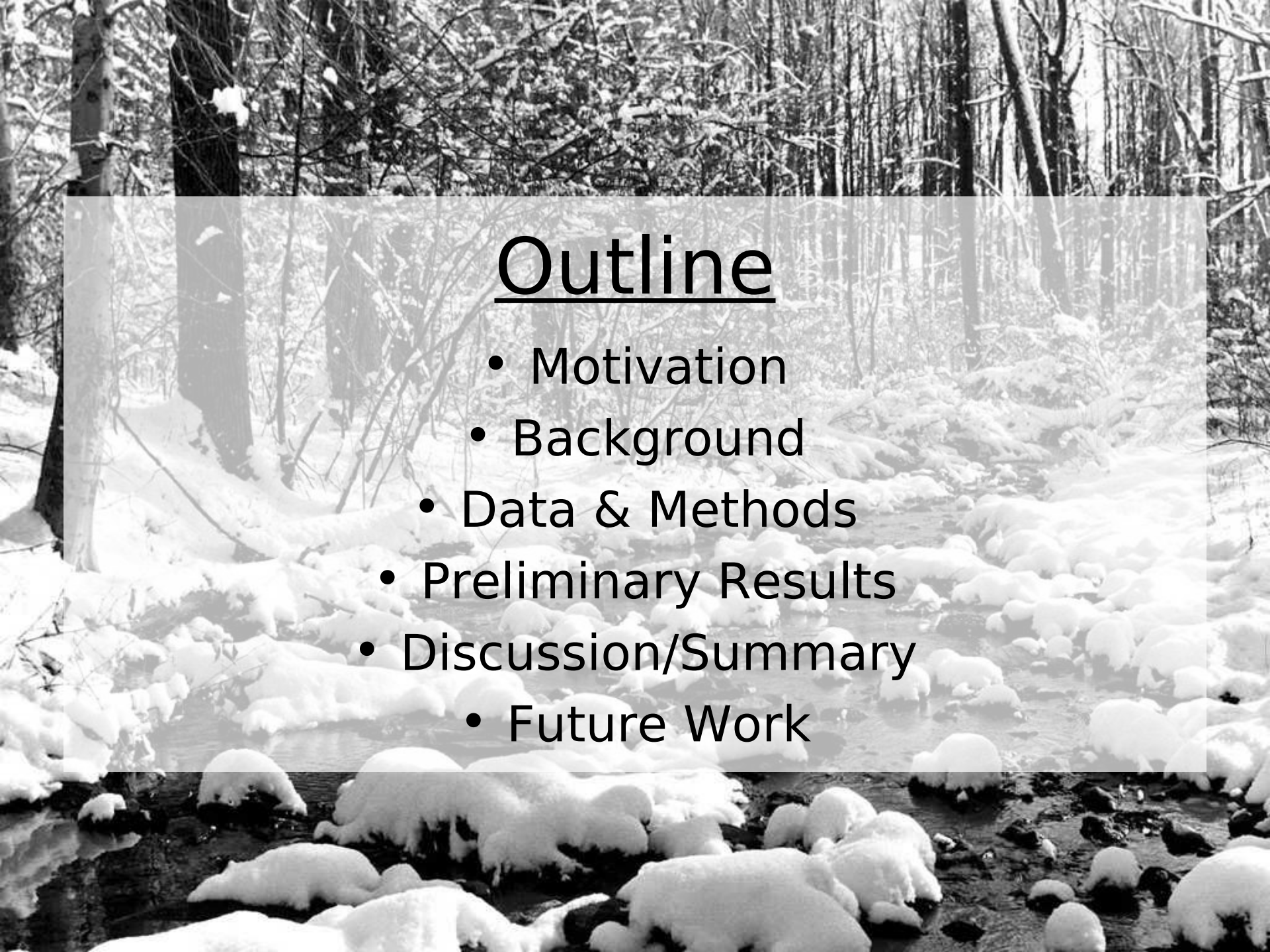




Outline

- Motivation
- Background
- Data & Methods
- Preliminary Results
- Discussion/Summary
- Future Work

Motivation

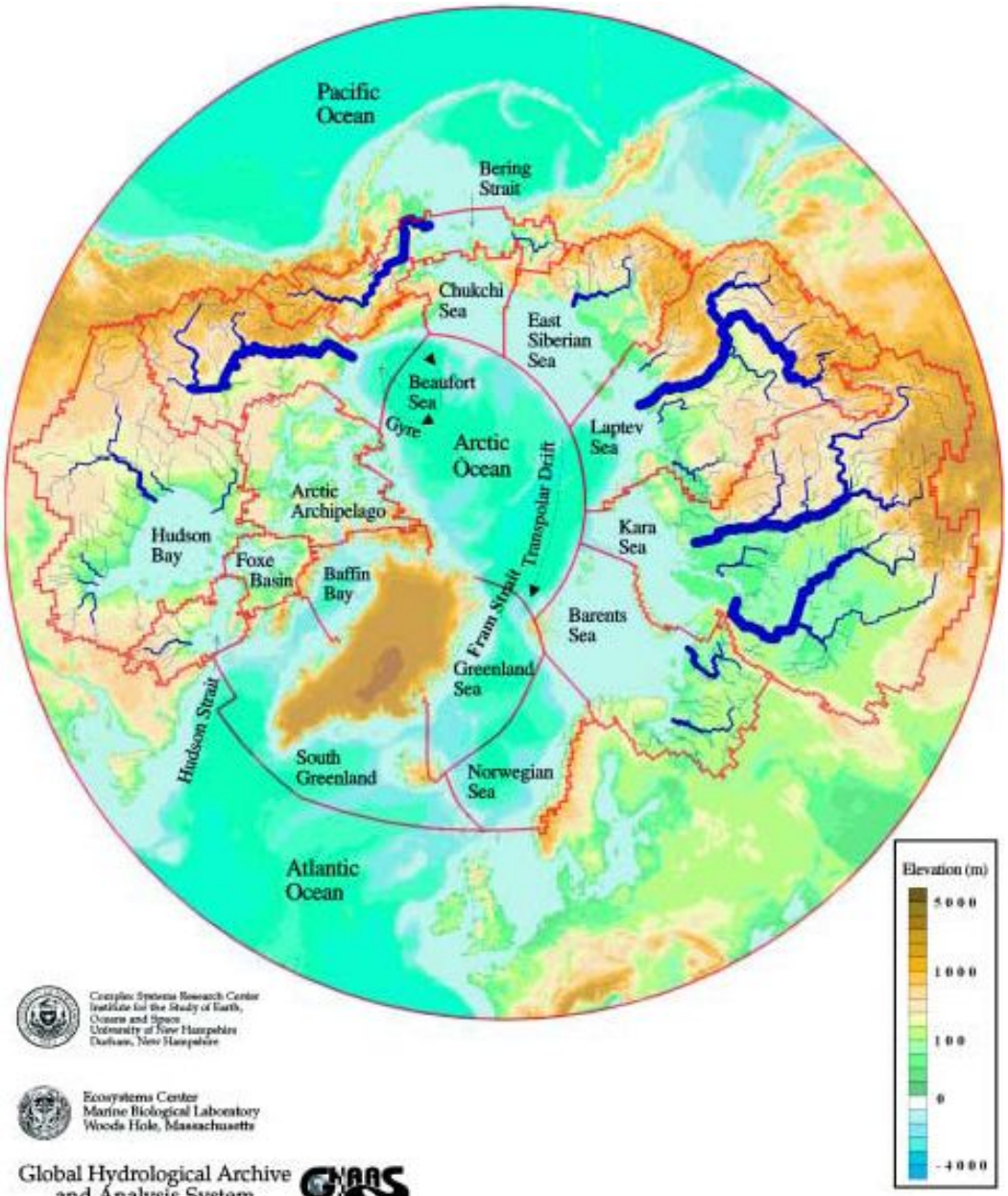
Arctic rivers form a vital link between the atmosphere, the pan-Arctic land surface, and the Arctic Ocean;

climate change may thus alter this natural pathway for freshwater, leading to significant environmental and societal change in the Arctic and beyond.

International Polar Year (IPY)

- This work is a contribution to the IPY project “Arctic Freshwater Systems”.
- Research will improve our knowledge of the ecohydrology of northern freshwater ecosystems.
- Our component seeks to better understand recent trends & variability of river discharge in northern Canada.

Pan-Arctic domain

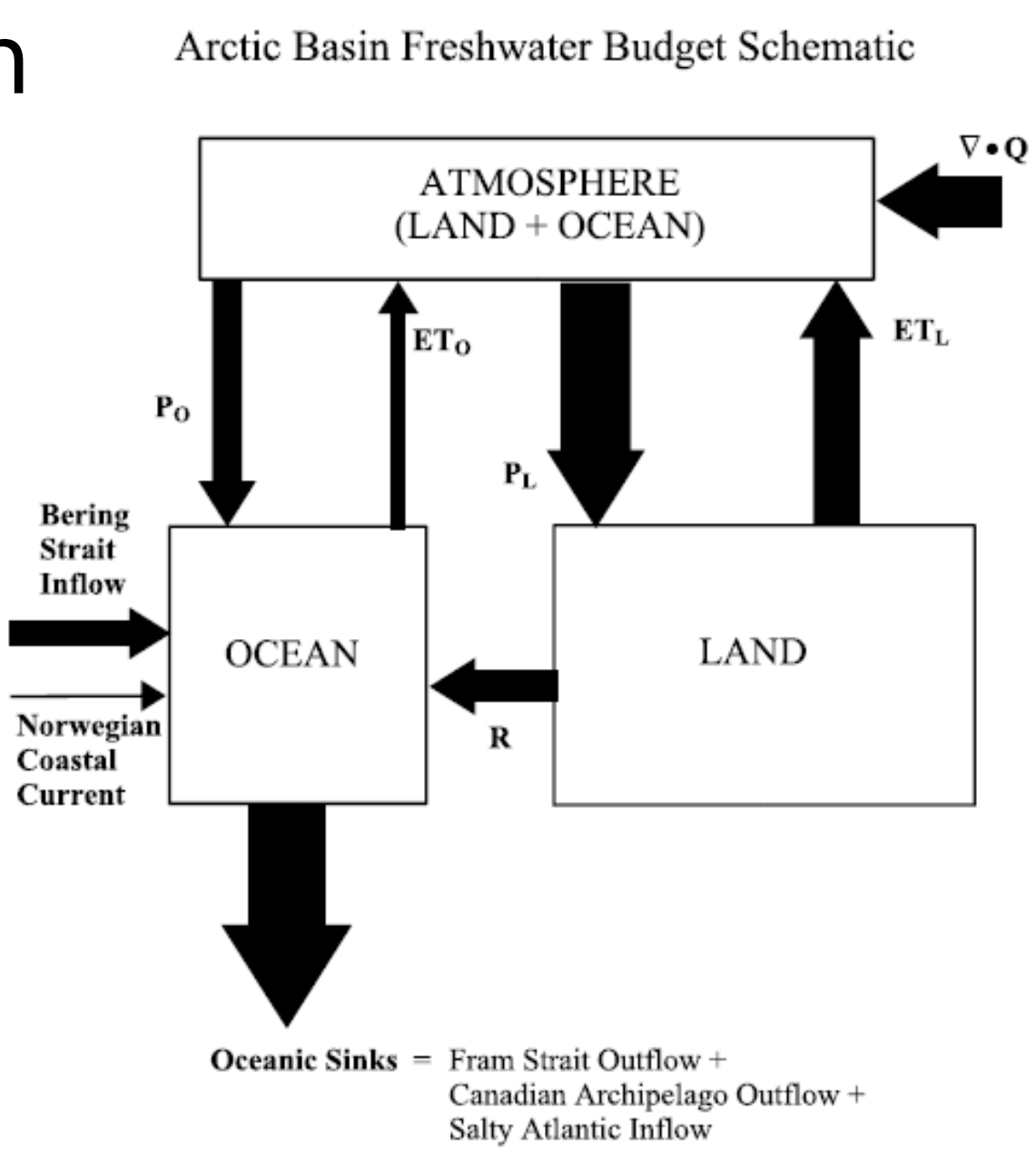


River Basin	Discharge ($km^3\ yr^{-1}$)
Lena	532
Yenisey	630
Ob	530
Yukon	205
Mackenzie	309
HJUB*	714
Pan-Arctic	~5250

*Hudson, James & Ungava Bays gauged area only

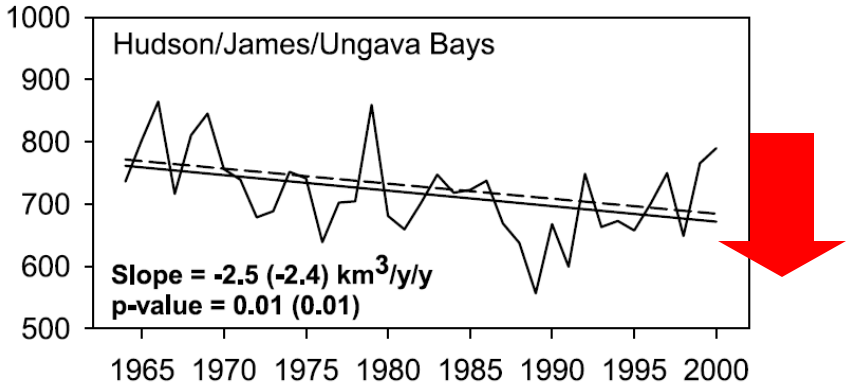
Arctic Ocean freshwater budget

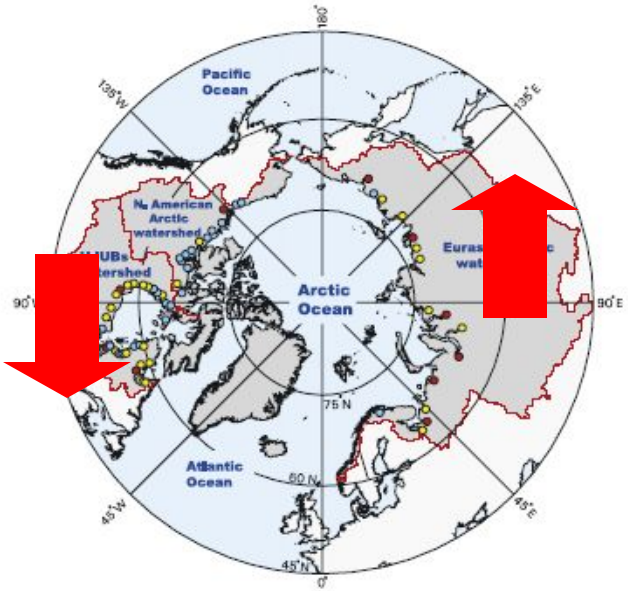
Source term	Input ($km^3\ yr^{-1}$)
Net precip.	2000 (26%)
River discharge	3200 (42%)
Bering Strait	2500 (32%)

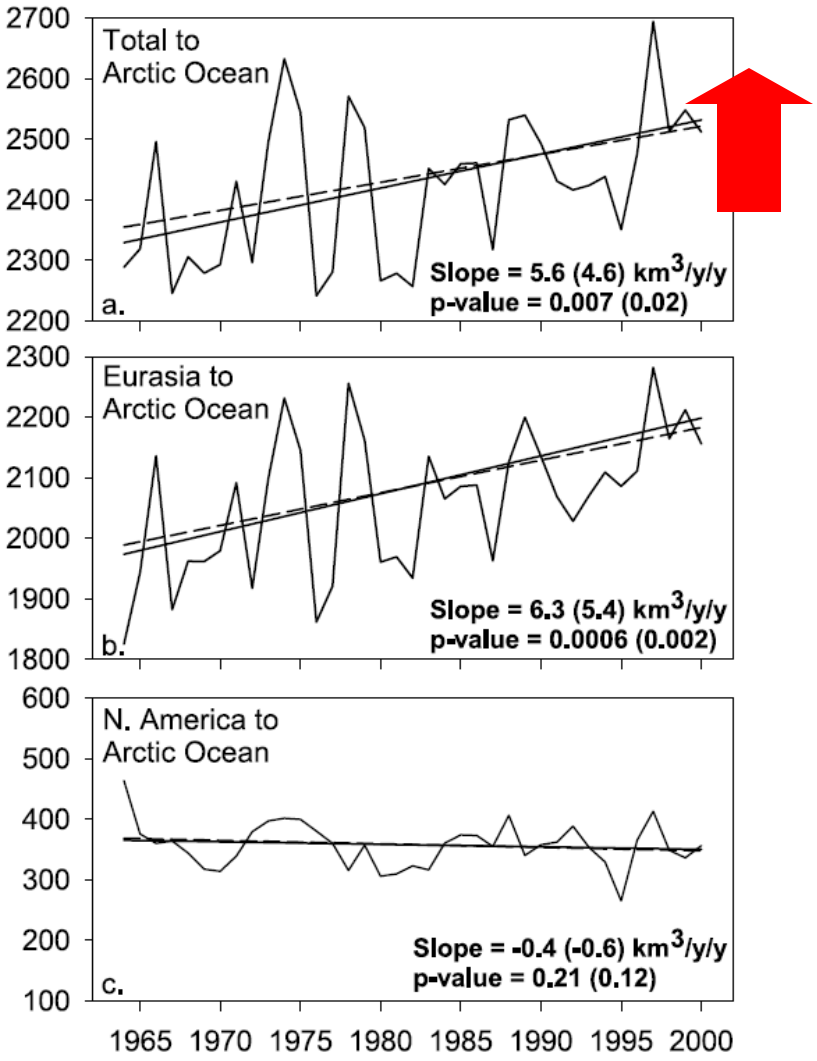


Source: Serreze et al. (2006), JGR.

Observed 20th century changes in pan-Arctic river discharge







Source: McClelland et al. (2006), GRL.

Data & Methods

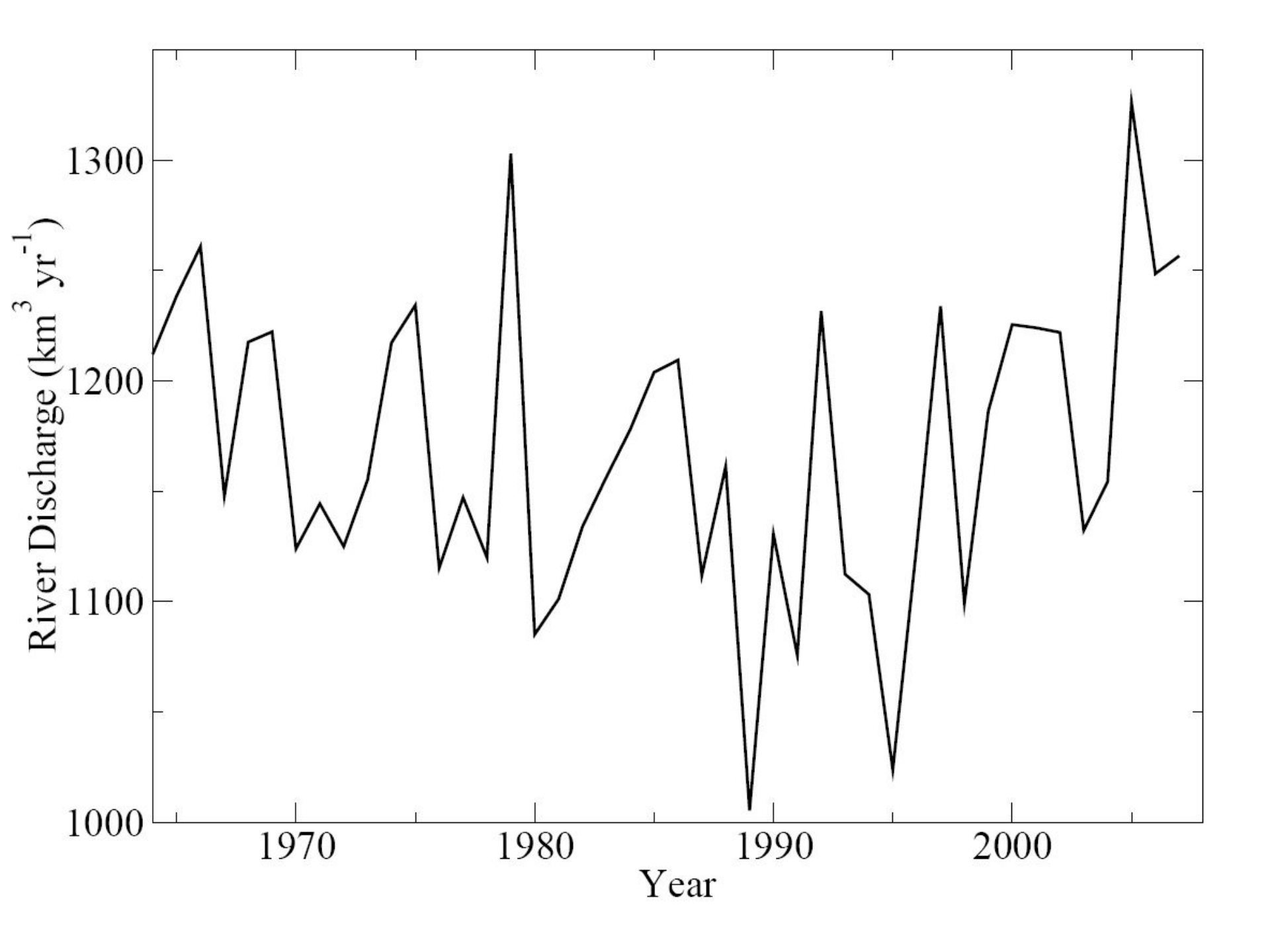
- Daily river discharge is from the online Water Survey of Canada's HYDAT.
- Recent daily data for rivers in Québec obtained from Environnement Québec & Hydro-Québec.
- A total of 45 rivers spanning > 5 million km^2 in northern Canada over 1964-2007 are used.

Detection of trends

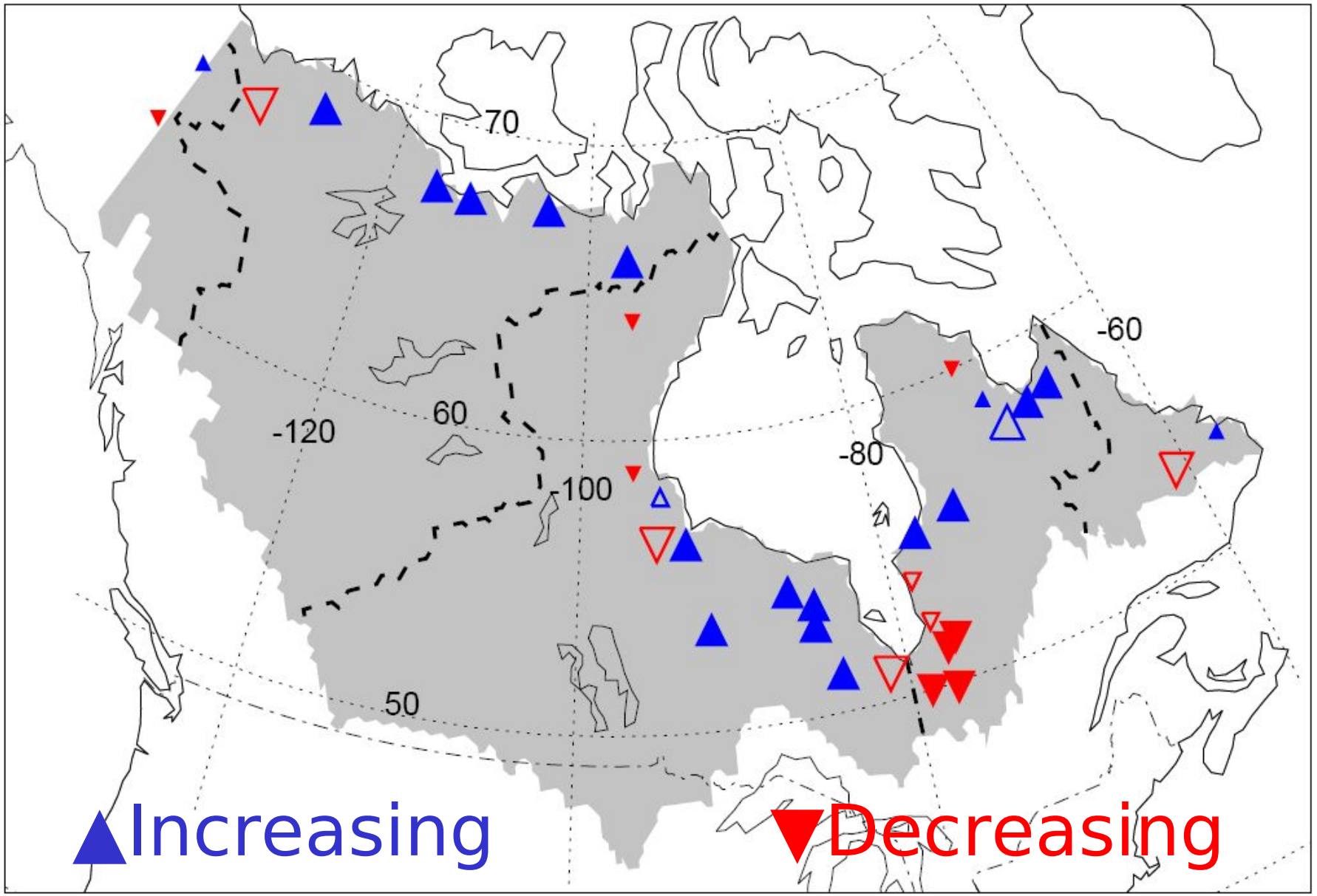
- Compute mean, standard deviation & coefficient of variation (CV) using 11-year moving windows of annual discharge.
- Linear trends of CV then determined from Mann-Kendall Test after “pre-whitening” of time series (Yue et al. 2002).
- Trends are significant when $p < 0.05$.
- Results shown when < 10% of the data are missing

Methods (cont'd)

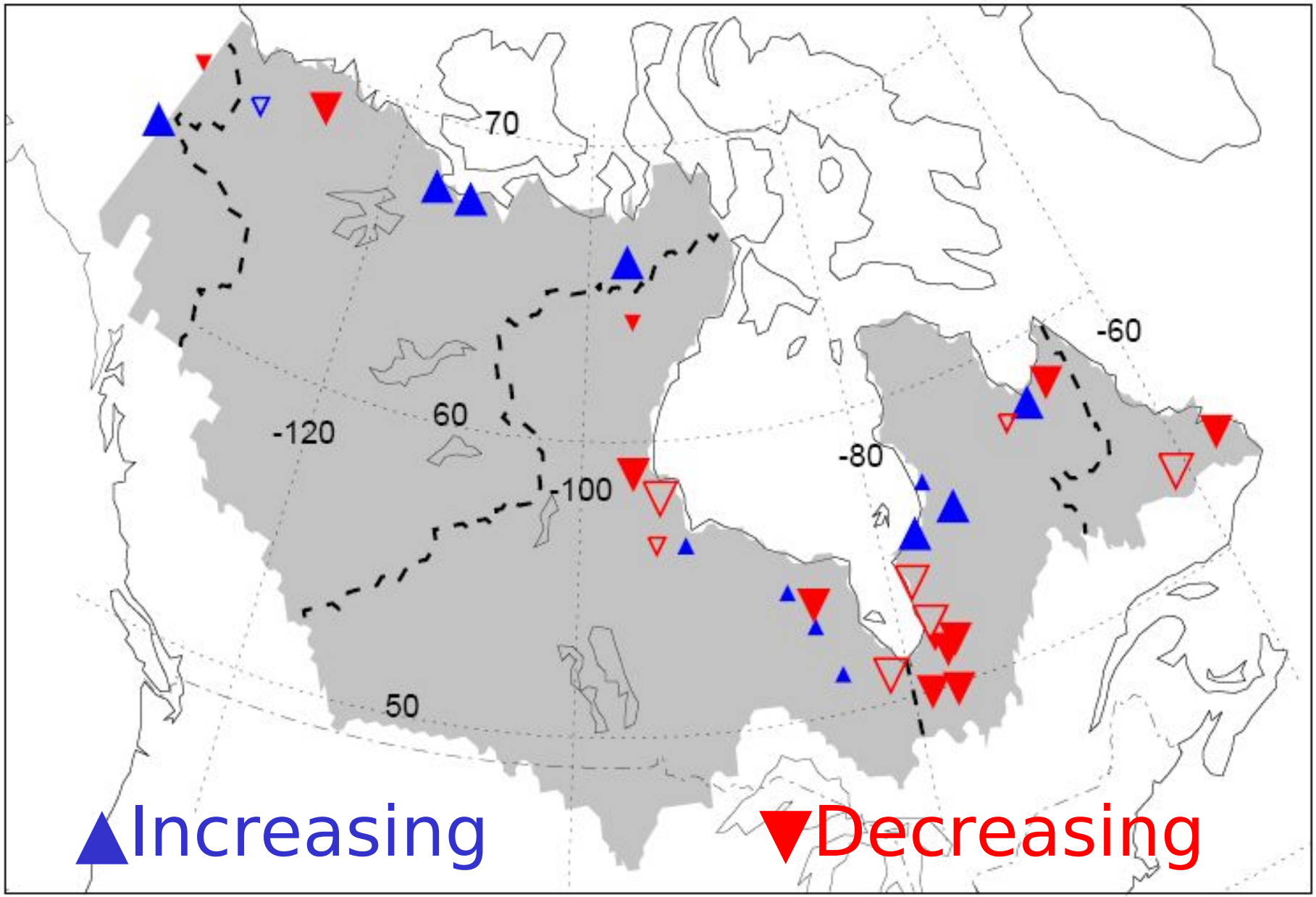
- Four trend periods: early (1970-1990), central (1976-1996), late (1982-2002), & overall (1970-2002).
- A "year" denotes the median value for the initial & final 11-year moving windows used for the analyses.


River Discharge (km^3 yr^{-1})
1300
1200
1100
1000
1970
1980
1990
2000
Year

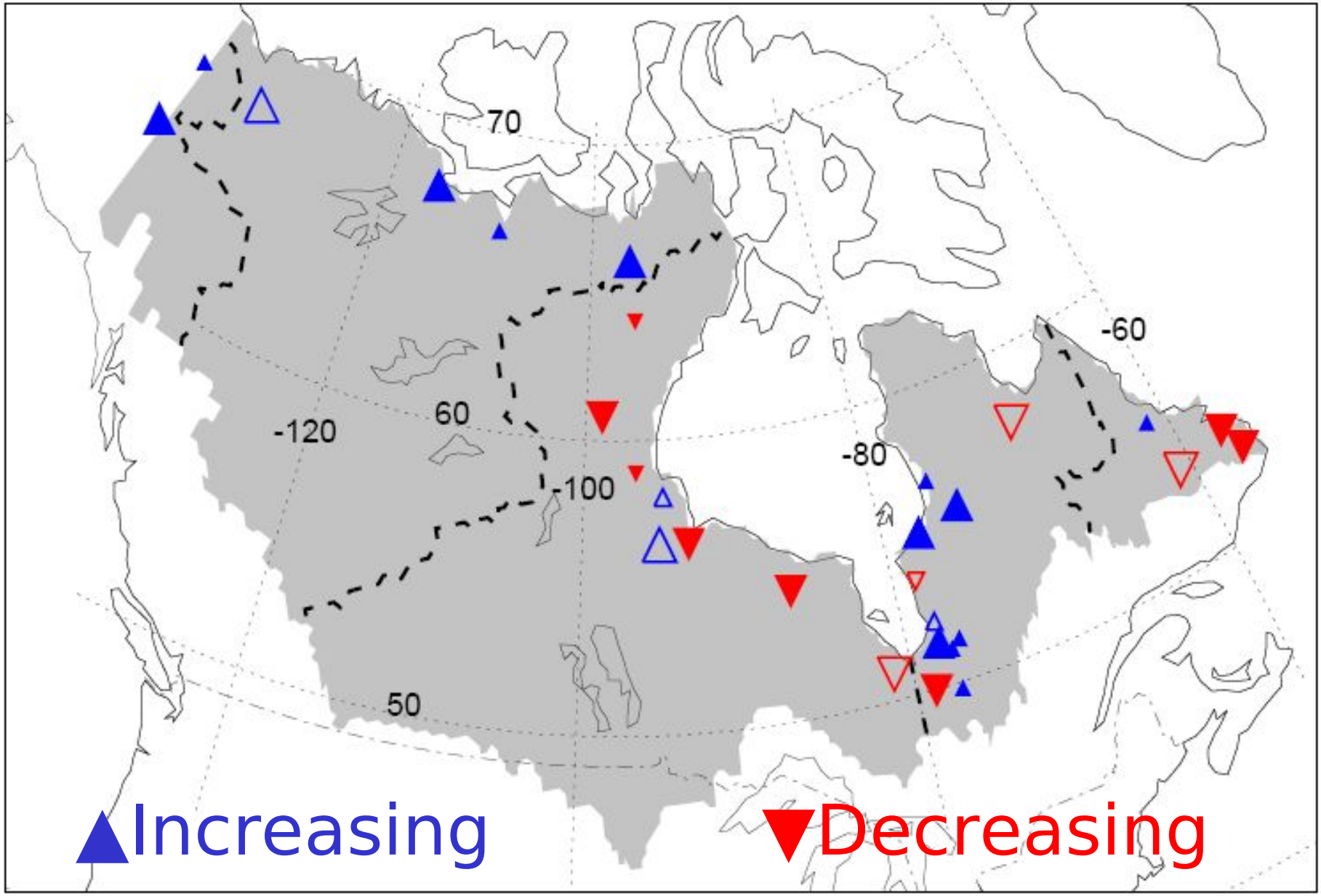
Trend in CV, 1970-90



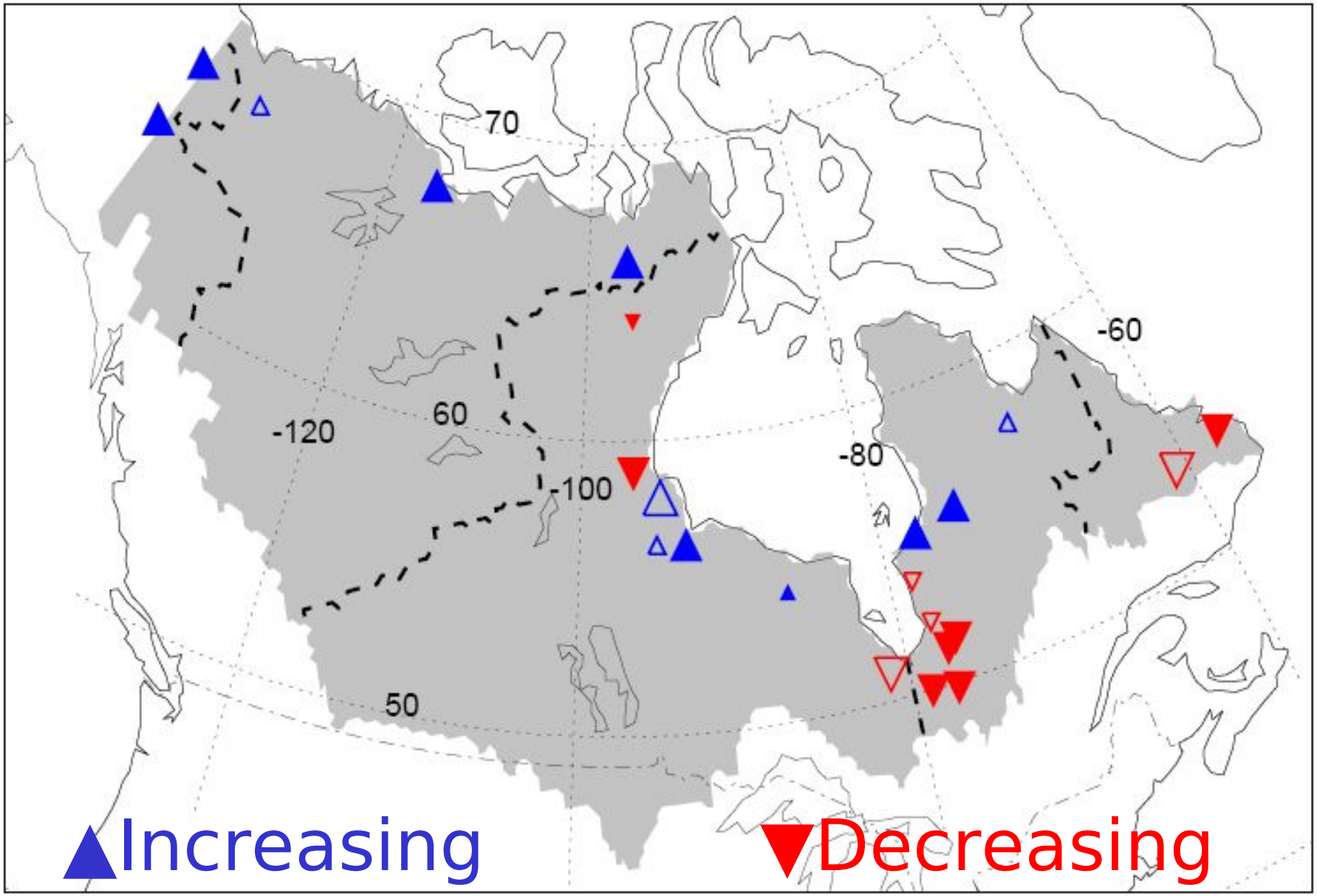
Trend in CV, 1976-1996



Trend in CV, 1982-2002



Trend in CV, 1970-2002



Discussion/Summary

- Updated data reveal a reversal to increasing river discharge in northern Canada.
- This accompanies changes in streamflow variability.
- These changes may be related to rising air temperatures that have induced changes in atmospheric & land surface processes.
- Many studies project increasing risks of hydrological extremes, as observed in parts of northern Canada.

Future Work

- Establish seasonality of river discharge changes.
- Attribute these changes including the role of large-scale teleconnections.
- Provide an updated record of river discharge time series & trends in northern Canada to the IPY community: http://nhg.unbc.ca/ipy

Acknowledgements

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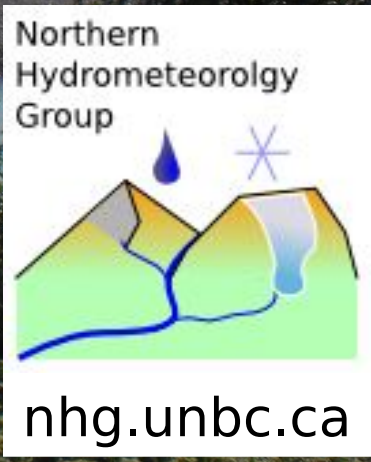
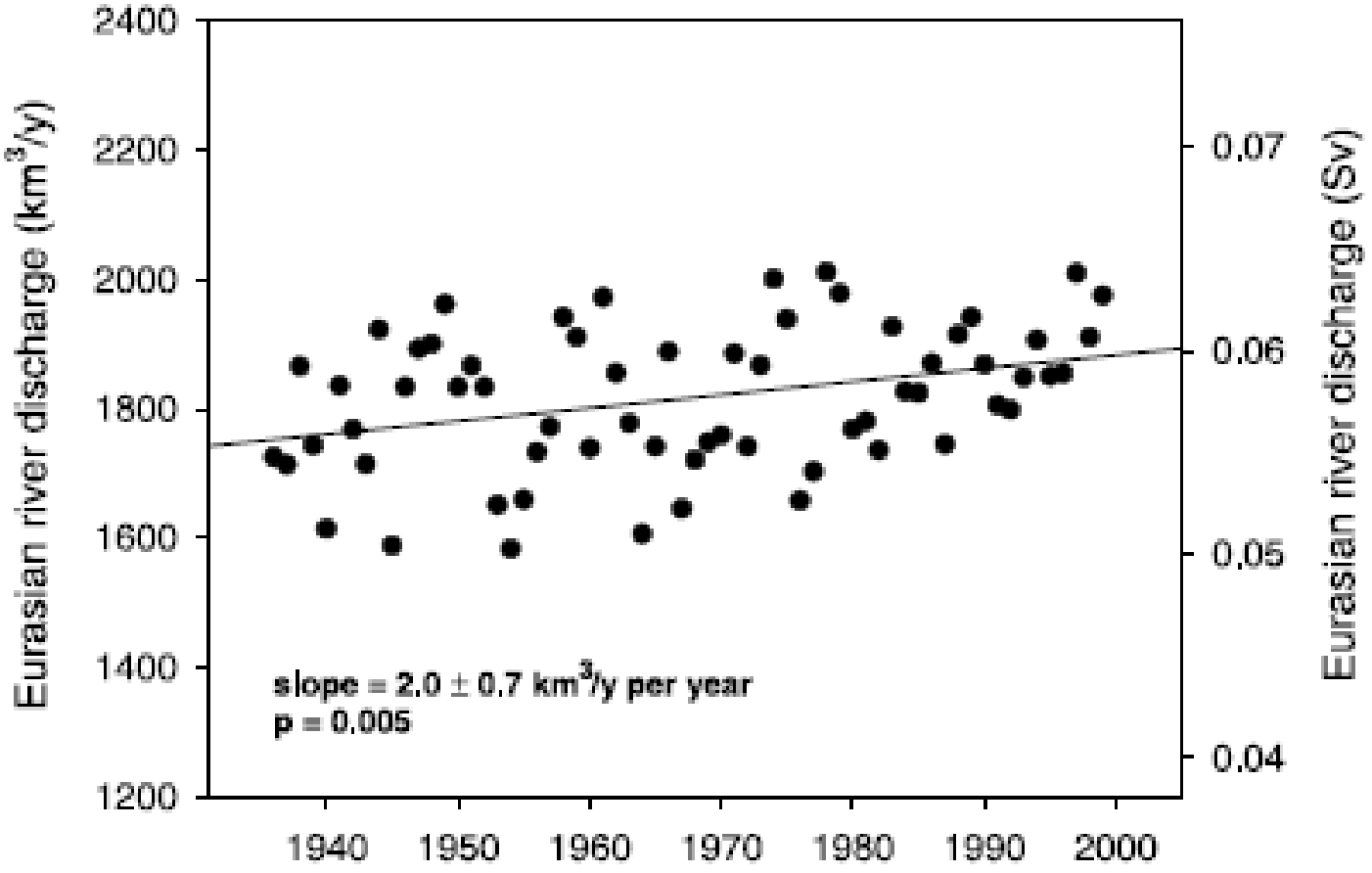
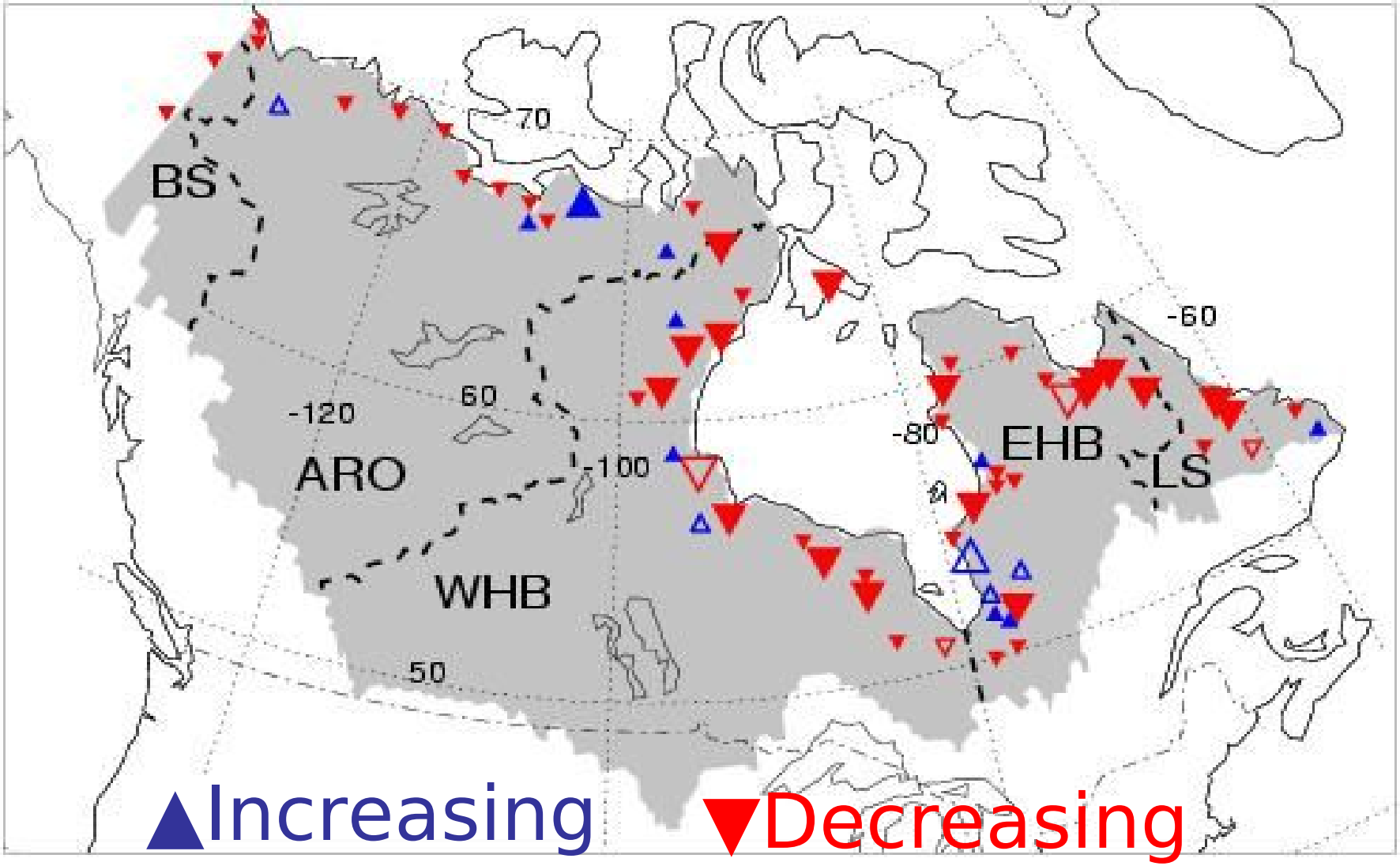


Increasing river discharge in northern Eurasia, 1936-1999



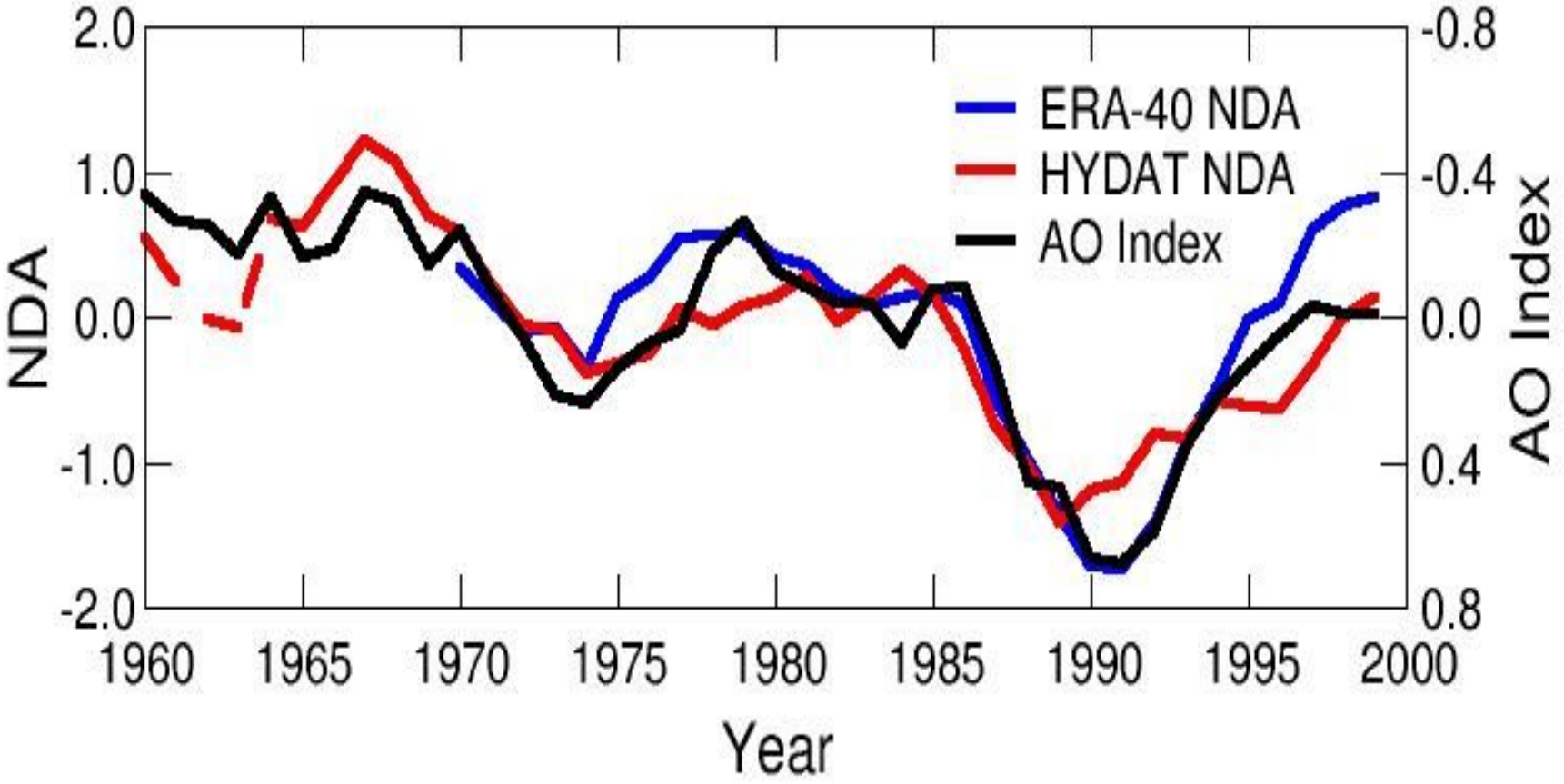
Source: Peterson et al. (2002), Science.

Decreasing river discharge in northern Canada, 1964-2003



Source: Déry and Wood (2005), GRL.

Teleconnection between the Arctic Oscillation & HJUB river discharge



Source: Déry and Wood (2004), GRL.