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A Methodological Framework to Combine Multiple Precipitation Datasets across Large River Basin

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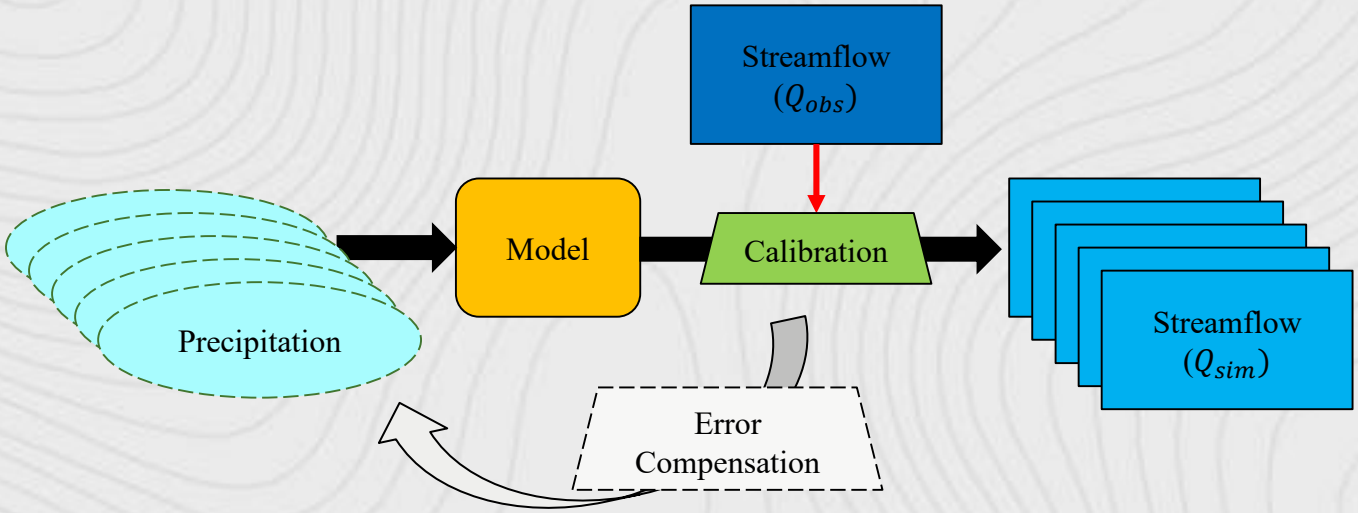
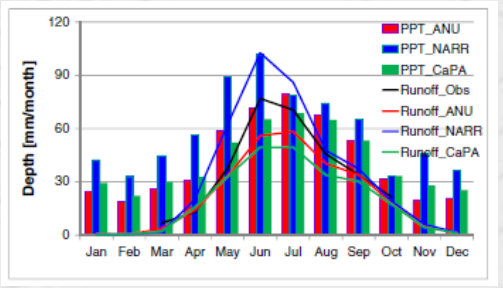
Background and Motivation

- Accuracy of precipitation dataset is essential for understanding climate system and hydrological processes
- Hydrological modelling under precipitation uncertainty
- Increasing demand for better and more reliable gridded precipitation products

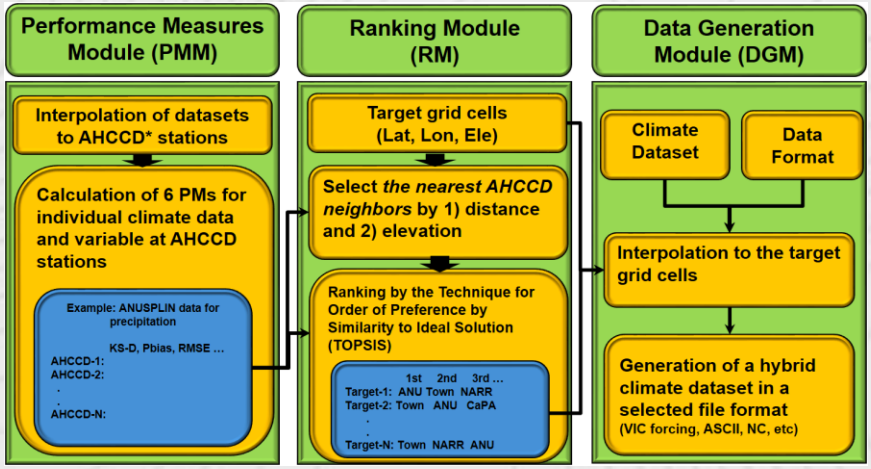




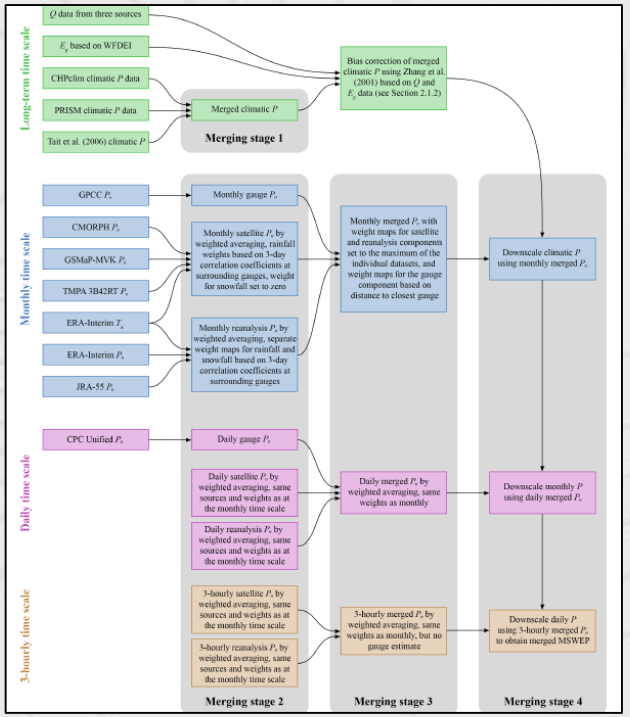
Eum et al. (2014); HP

Background and Motivation

- Generation of hybrid precipitation datasets
- Approach 1:
  - Evaluation against ground 'truth'
  - Weighting / Ranking
  - Proxy validation through a hydrological model



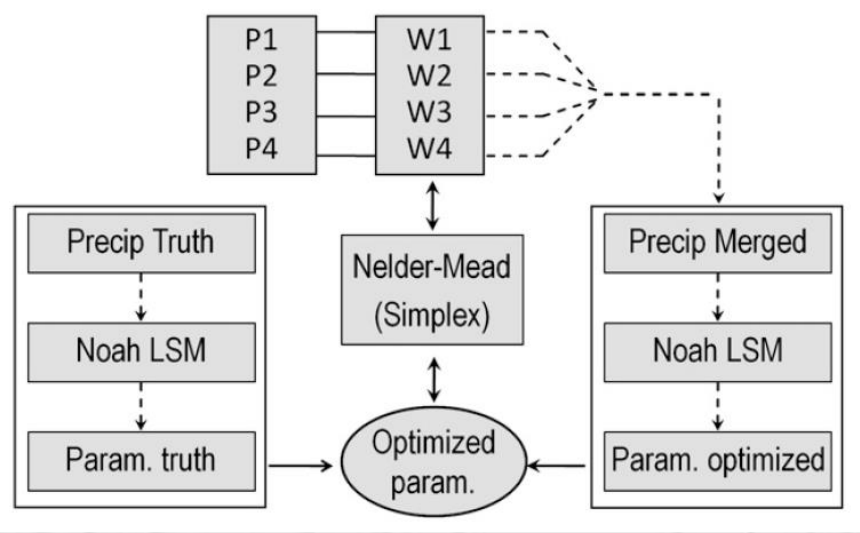
Eum & Gupta (2019); HESS



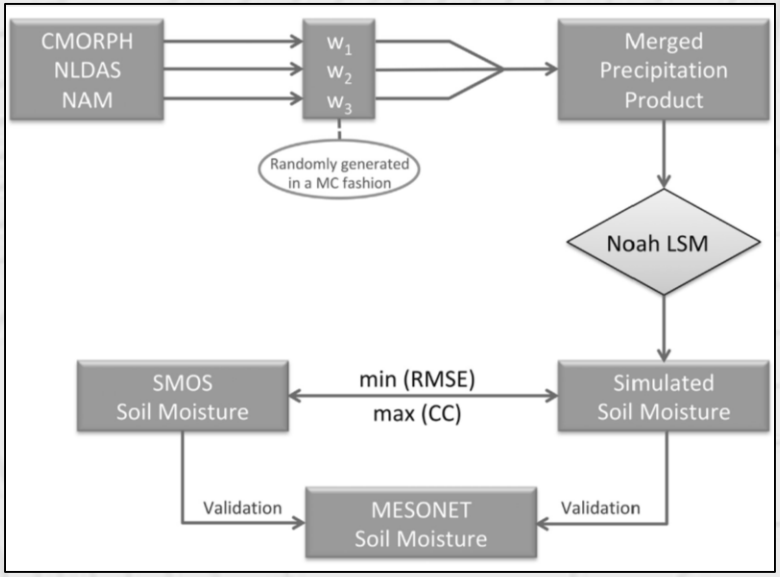
Beck et al. (2016); HESS

Background and Motivation

- Generation of hybrid precipitation datasets
- Approach 2:
  - Evaluation against hydrological outputs
  - Regression
  - Validation through independent hydrological data



Yilmaz et al. (2010); J Appl Meteorol Clim



Hazra et al. (2019); JoH

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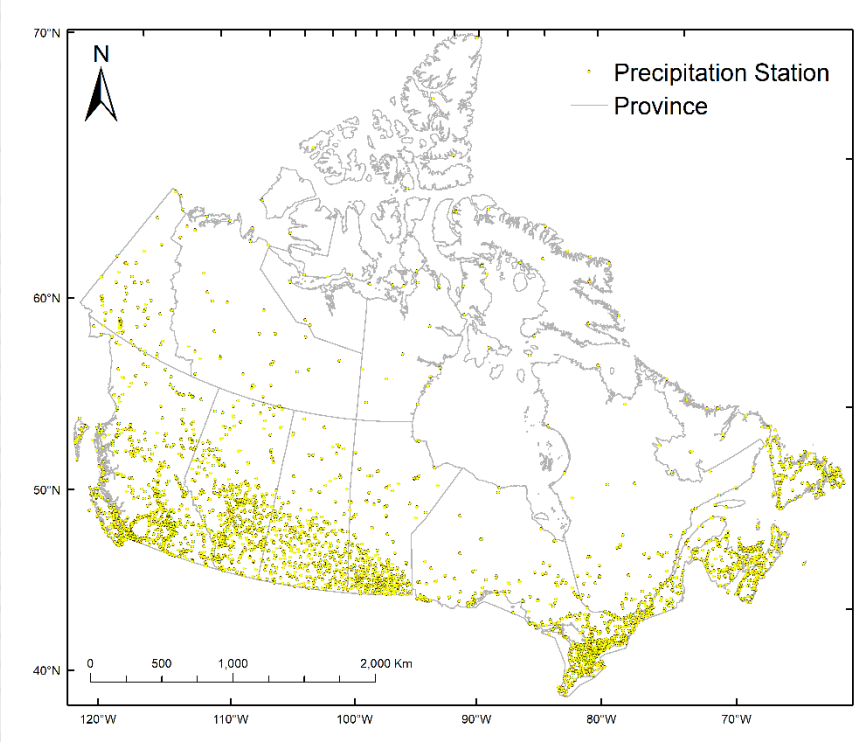
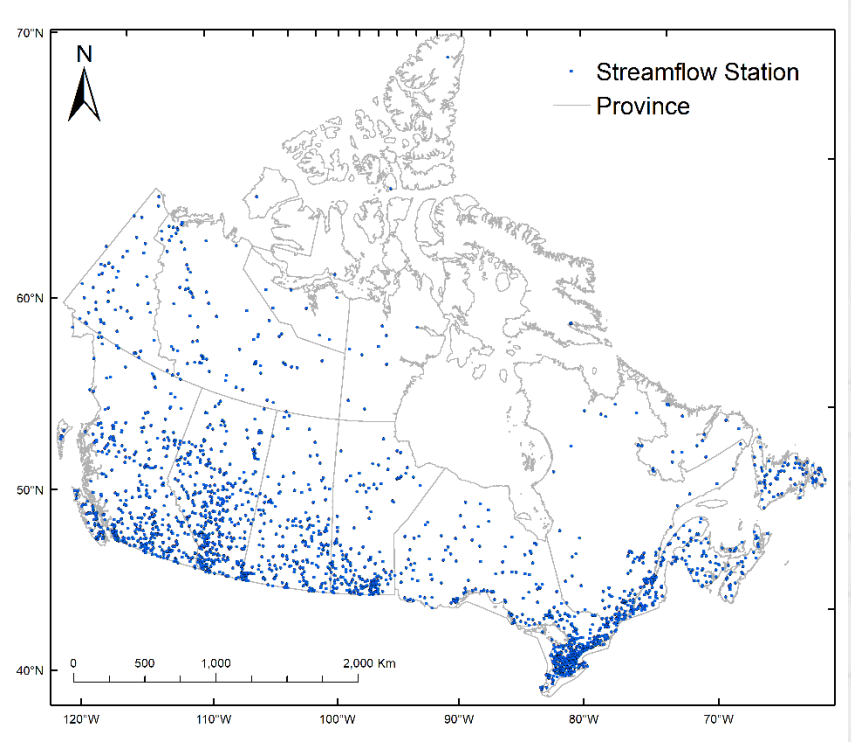
Research Objective

- To develop a methodological framework to generate a hybrid precipitation dataset based on both climate and streamflow stations that are spatially representative across large river basin





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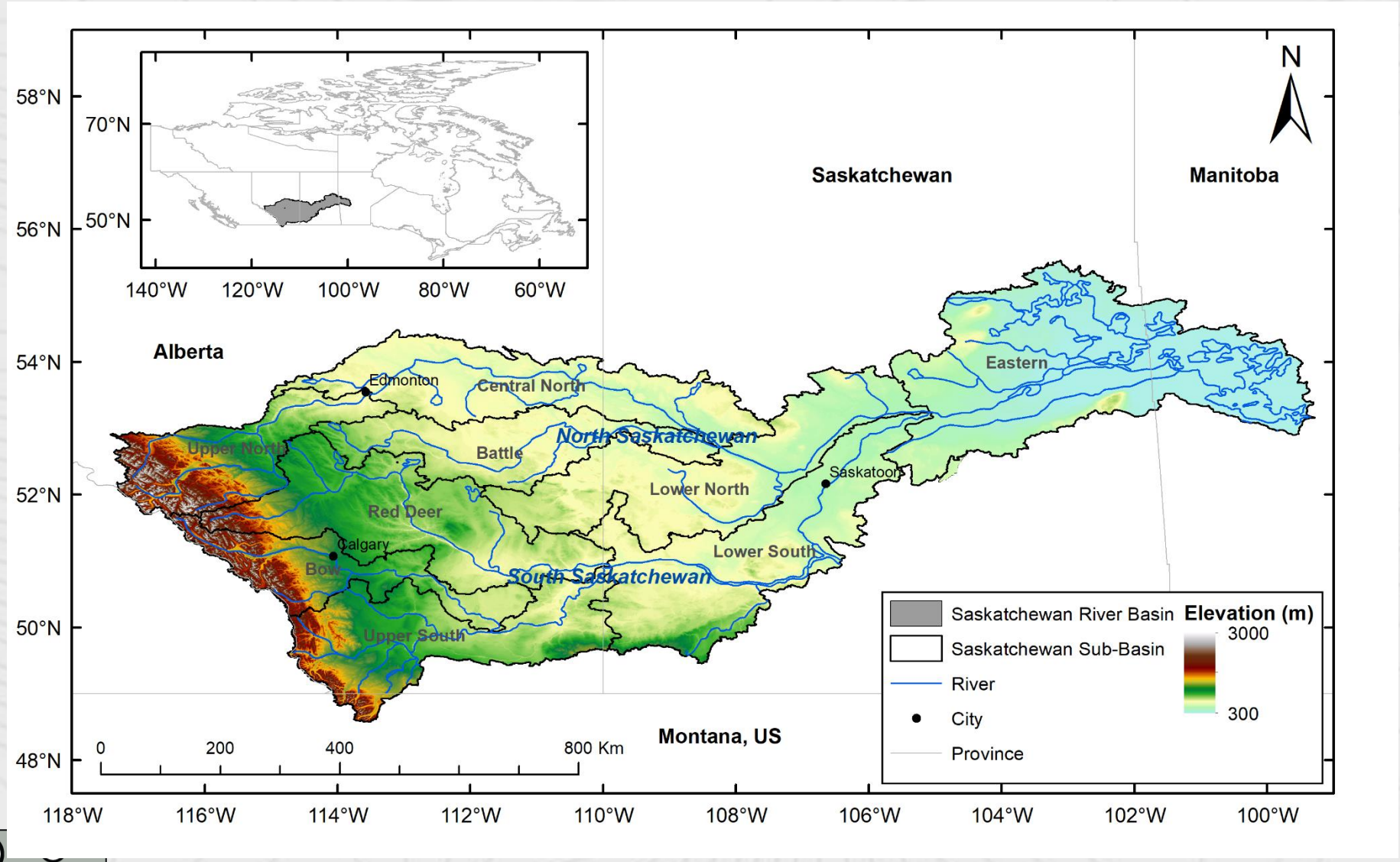
Study Area – Saskatchewan River basin (SRB)



Data

- Gridded Precipitation Datasets

Dataset	Full Name	Type	Spatial Resolution	Temporal Resolution	Duration	Coverage	Reference
Princeton	Global dataset at the Princeton University	Reanalysis-based multiple source	0.5˚ (~50 km)	3 hr	1901 – 2017	Global	Sheffield et al. (2006)
WFDEI [CRU]	Water and Global Change Forcing Data methodology applied to ERA-Interim [Climate Research Unit]	Reanalysis-based multiple source	0.5˚ (~50 km)	3 hr	1979 – 2017	Global	Weedon et al. (2014)
WFDEI [GPCC]	Water and Global Change Forcing Data methodology applied to ERA-Interim [Global Precipitation Climatology Centre]	Reanalysis-based multiple source	0.5˚ (~50 km)	3 hr	1979 – 2017	Global	Weedon et al. (2014)
NARR	North American Regional Reanalysis	Reanalysis-based multiple source	32 km (0.3˚)	3 hr	1979 – 2017	North America	Mesinger et al. (2006)
CaPA	Canadian Precipitation Analysis	Station-based Model-derived	10 km (~0.0833˚)	6 hr	2002 – 2017	North America	Mahfouf et al. (2007)

- Observed Stations
  - AHCCD Climate Data – 53 stations across the SRB
  - HYDAT Streamflow Data – 54 stations

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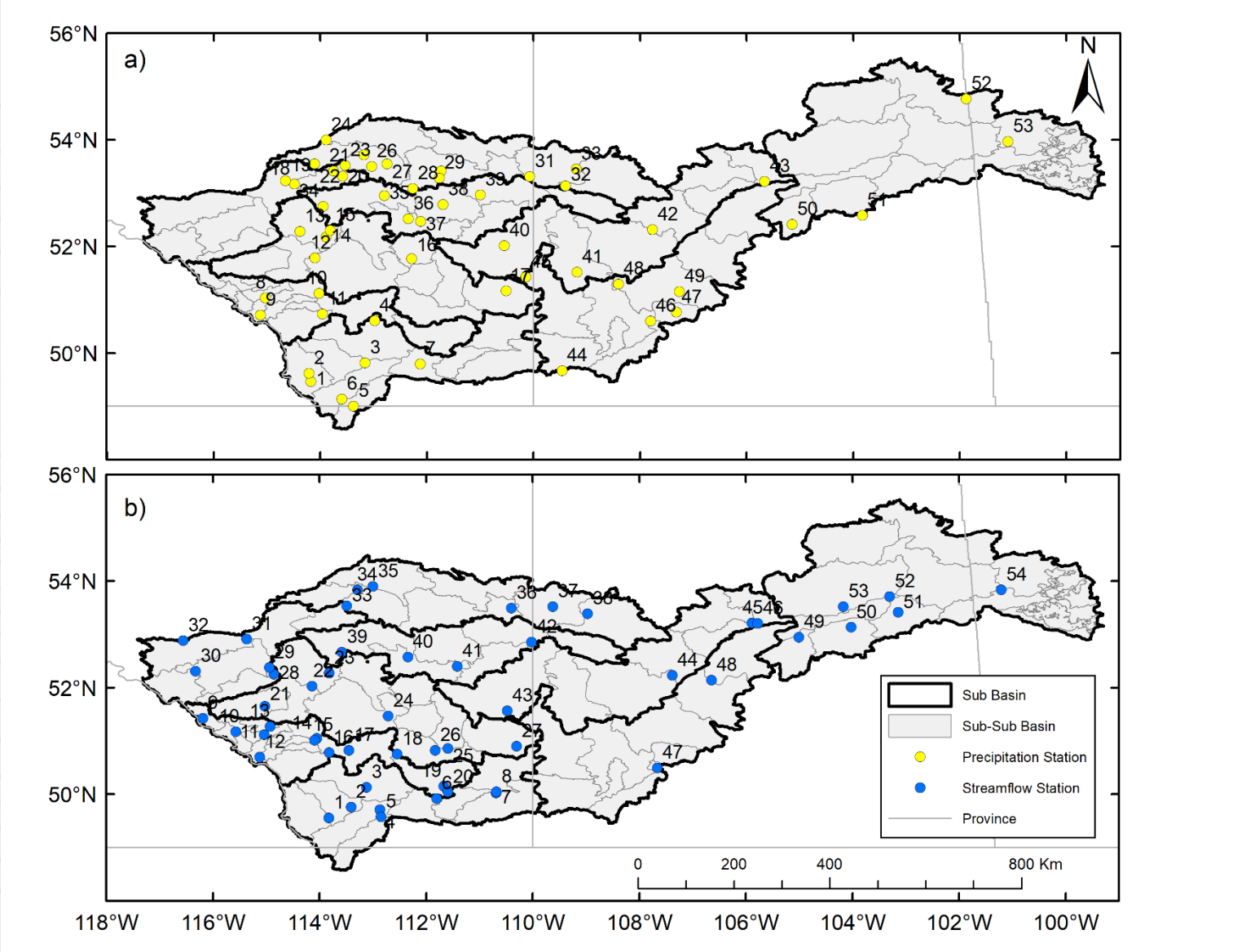
Data



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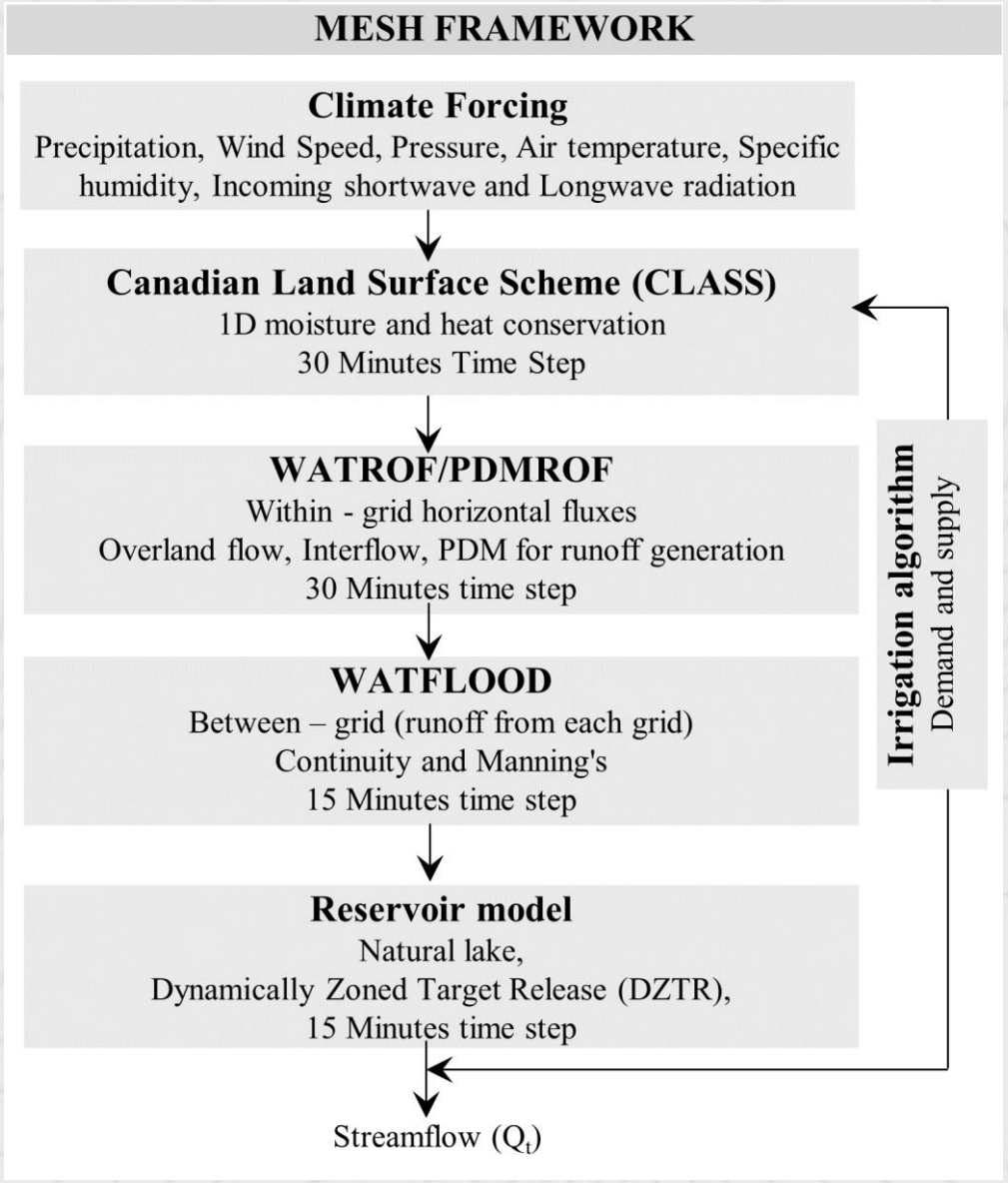
Methodology



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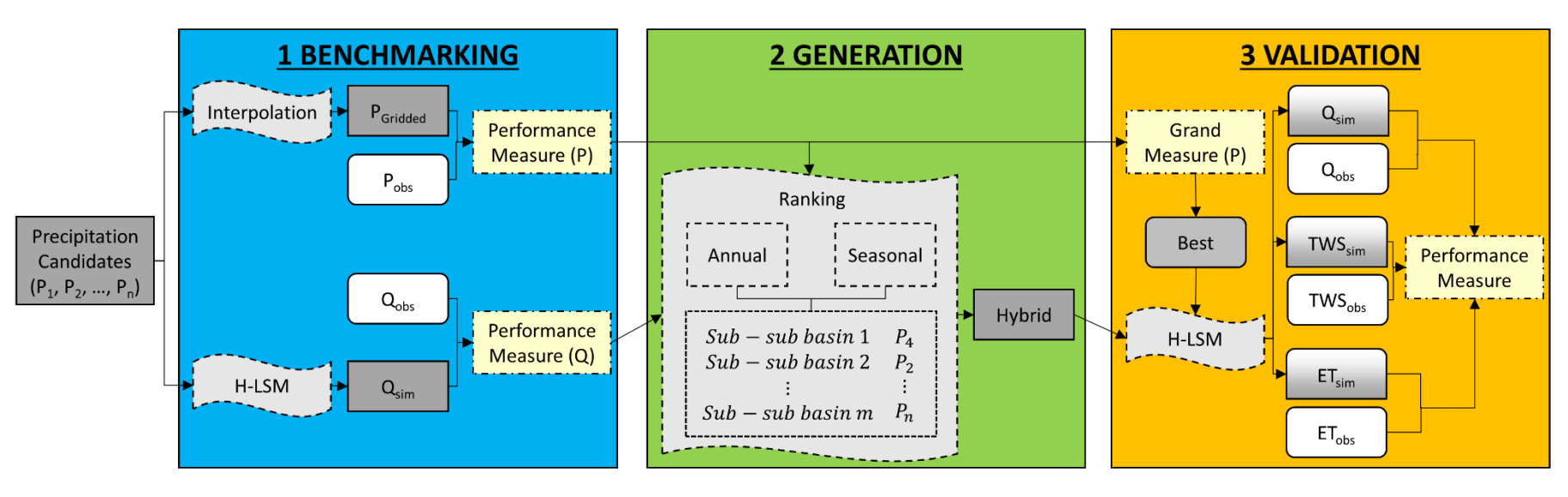
Methodology

- The framework consists of three components



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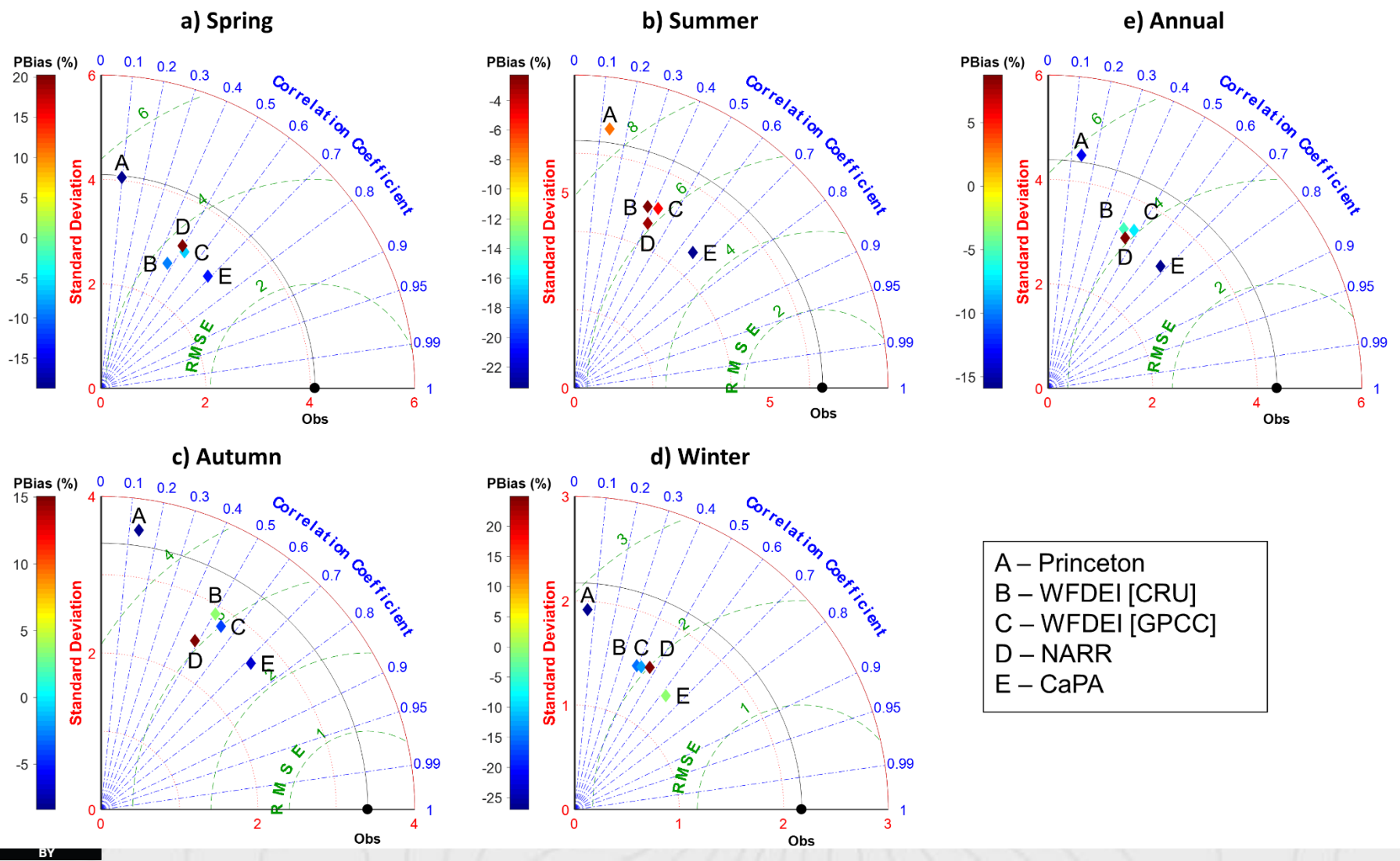
Results - Benchmarking

- Evaluation against climate stations



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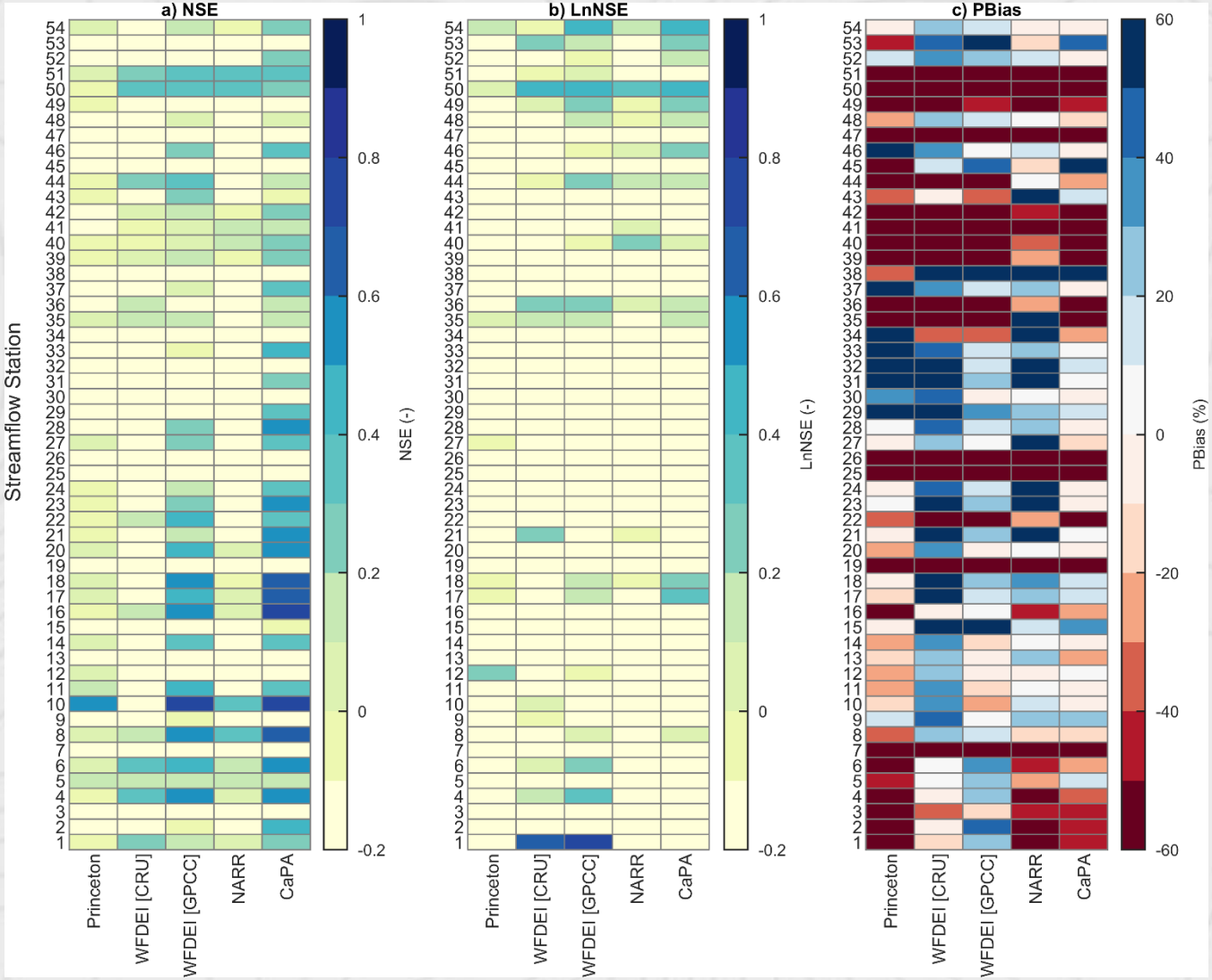
Results - Benchmarking

- Evaluation against streamflow stations



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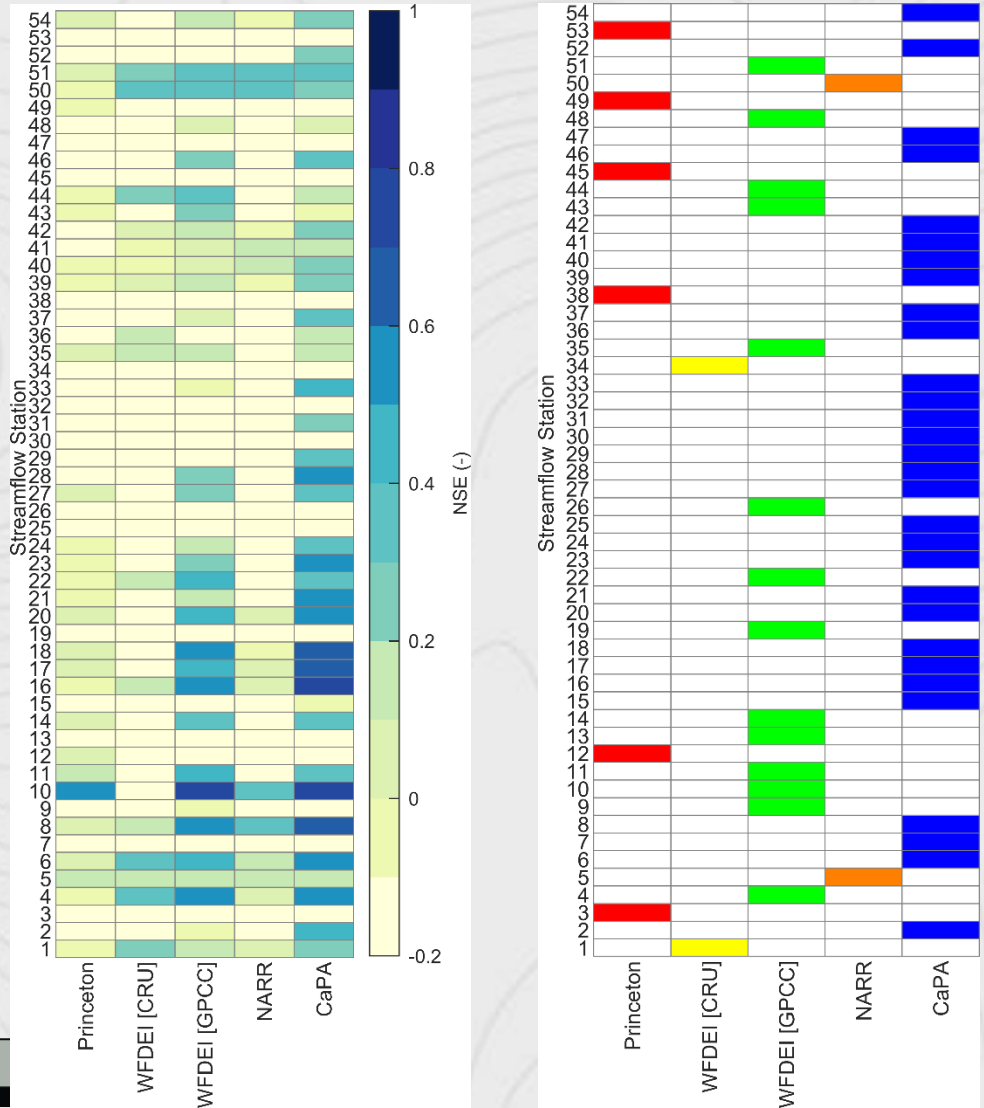
Results - Generation

- Combination



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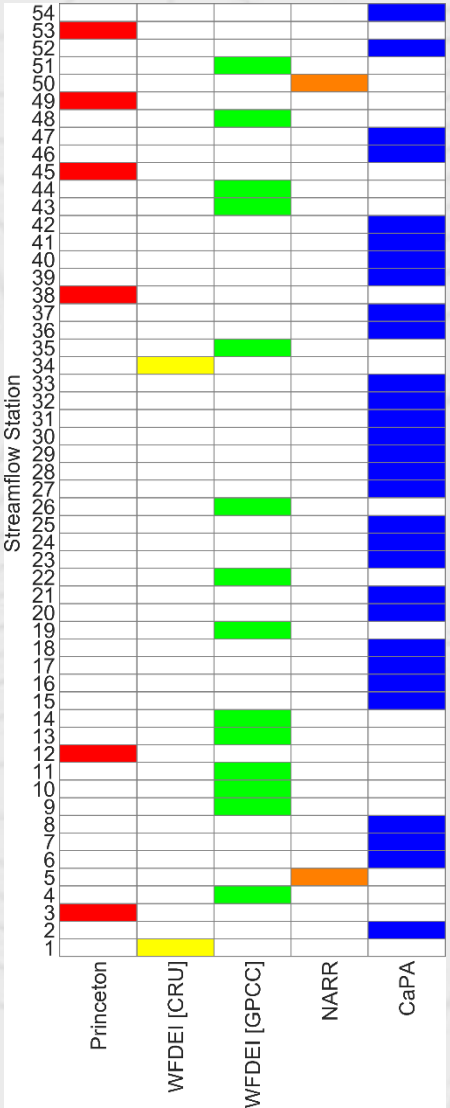

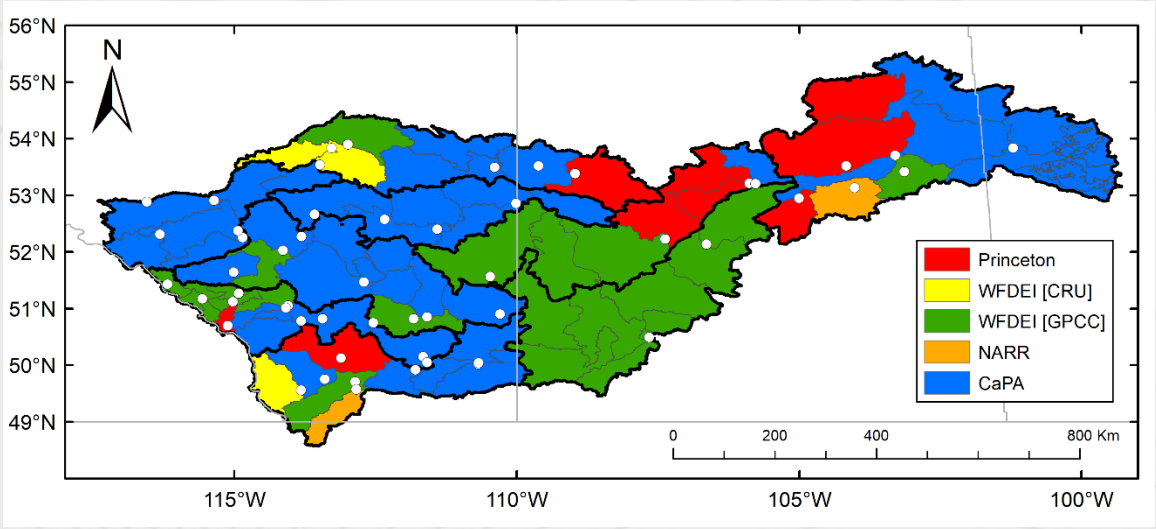

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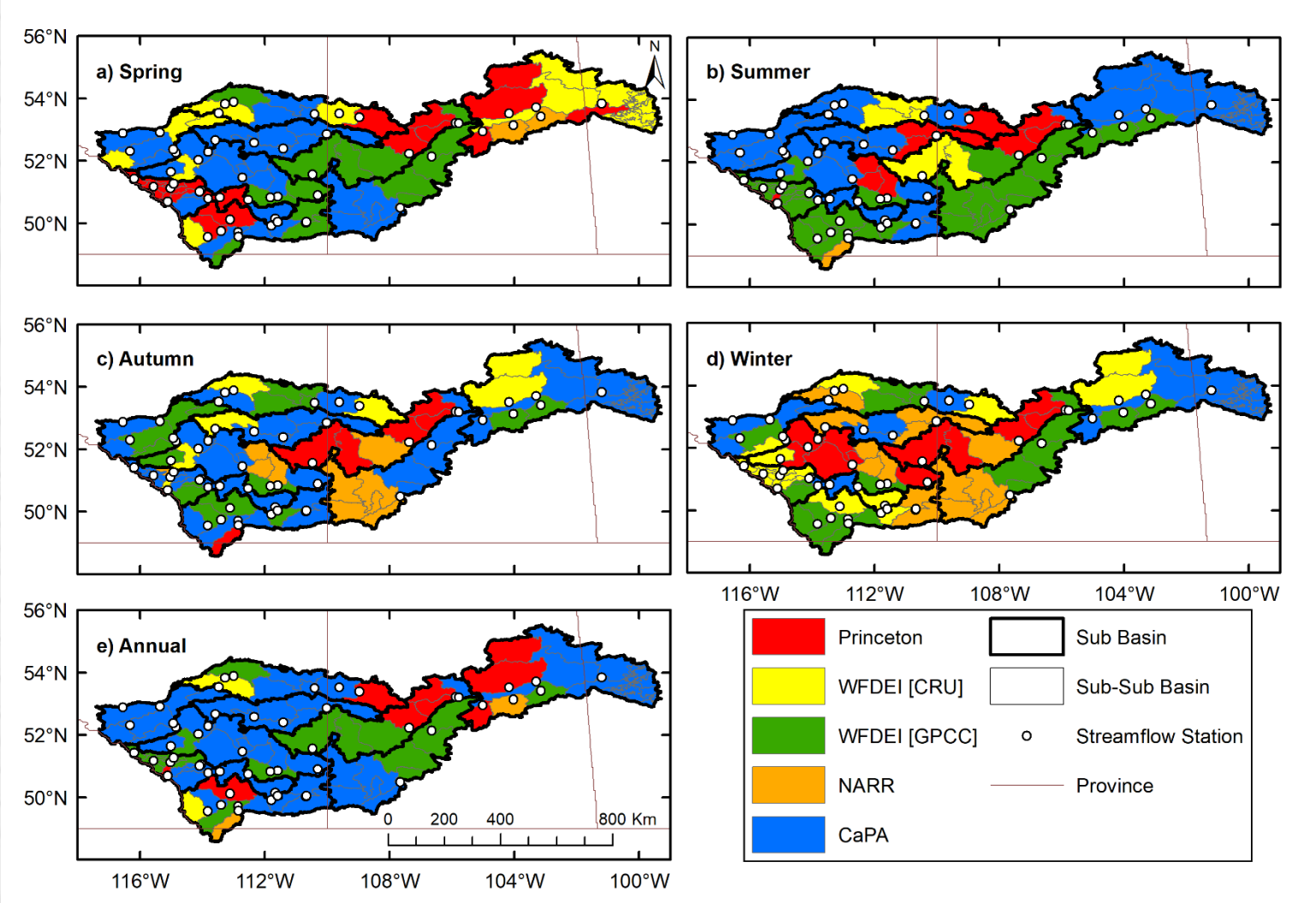

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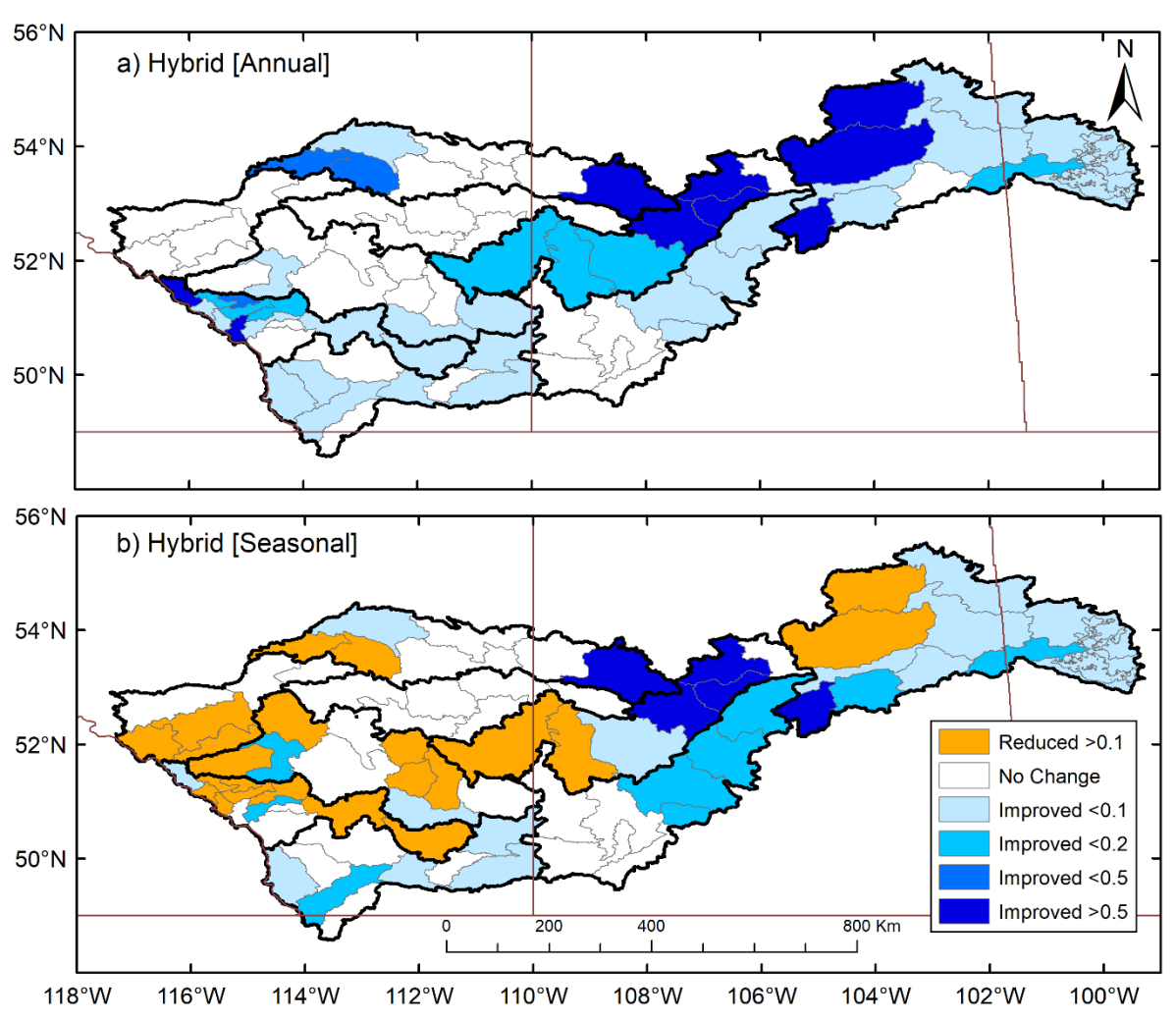
Results - Validation

- Comparison ($NSE_{Hybrid} - NSE_{CaPA}$)



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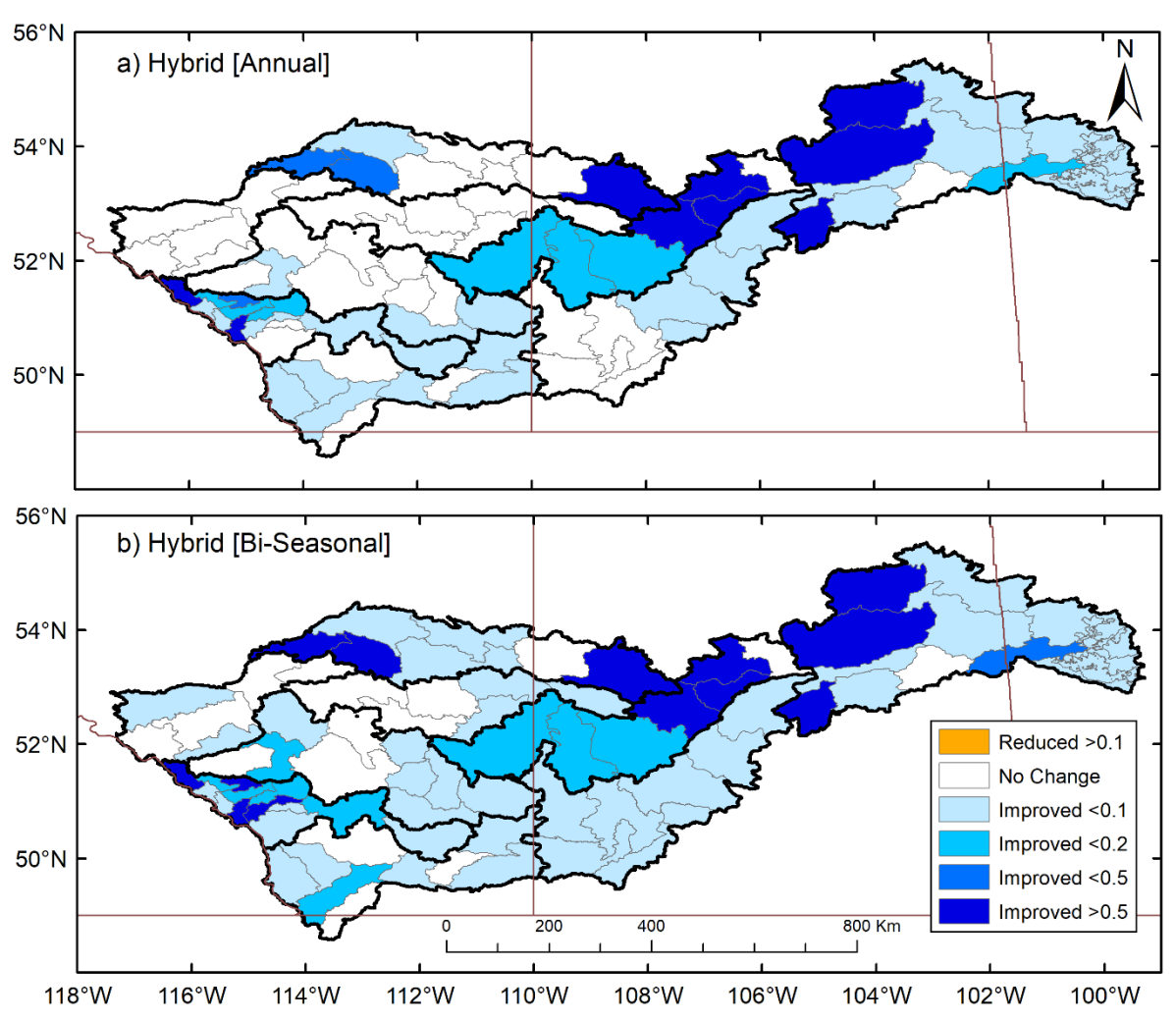

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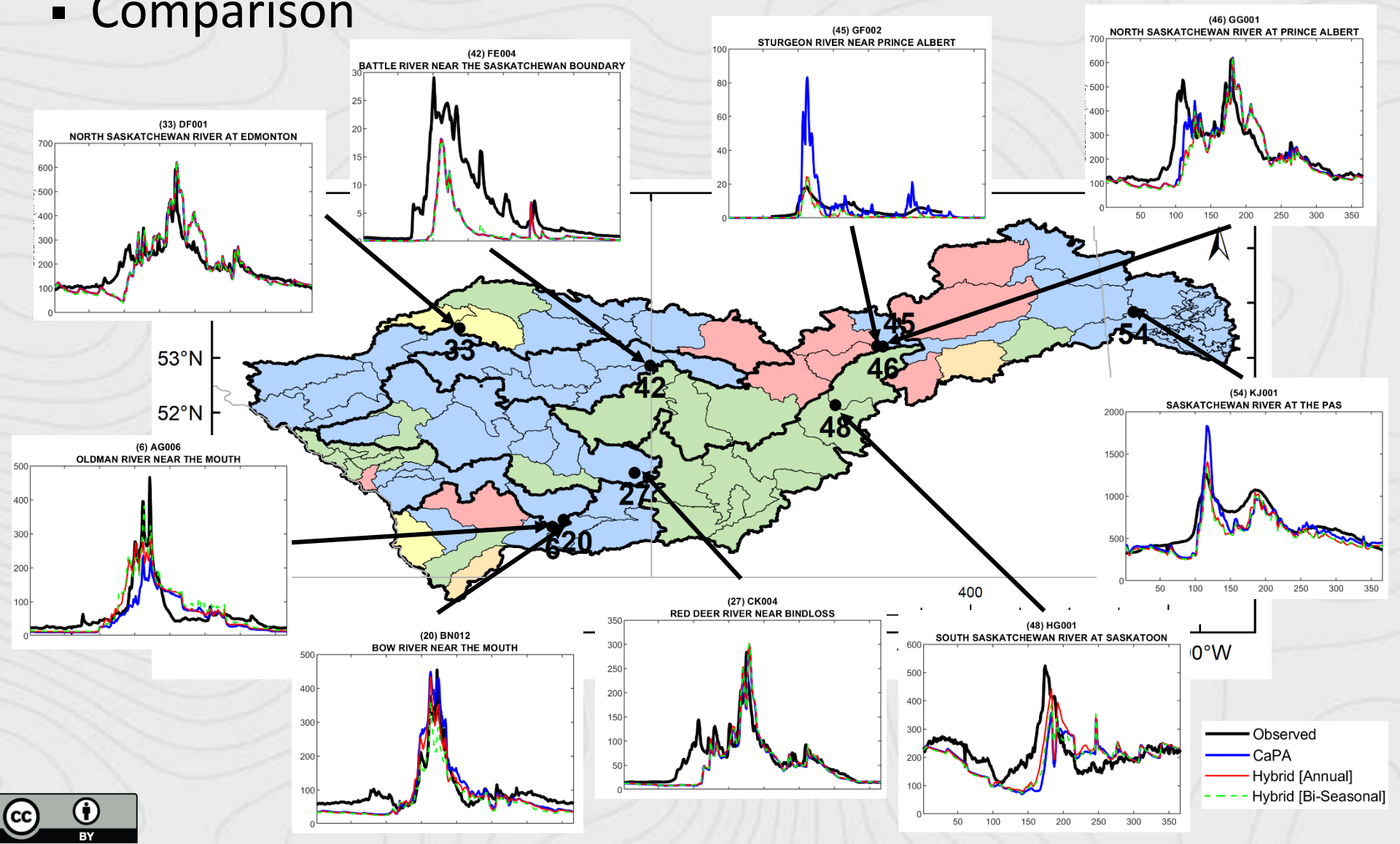
Results - Validation

- Comparison



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Conclusion

1) the best basin-wide precipitation product evaluated against the precipitation-gauge stations does not necessarily show the best hydrological performance across a large-scale river basin

2) hybrid datasets show equally good or better model performance as compared to the best basin-wide precipitation product in the headwaters and gradually perform better further downstream and at the basin outlet

3) the importance of considering seasonality with respect to the hydrological regime of the river basin when generating the hybrid dataset

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Conclusion

- Streamflow stations provide a different angle to evaluate precipitation products
  - Can be used to generate hybrid precipitation datasets for hydrological modelling
  - Can be used as a criteria of precipitation dataset selection over data-limited regions (e.g., Northern Canada)
- Flexible framework
  - shifts away from the idea of merging multiple existing products to generate one most optimal dataset that is applicable for the areas of interest to the idea of identifying existing products that are locally best performing at lower level sub-basin scale