Understanding streamflow predictability on seasonal timescales across North America

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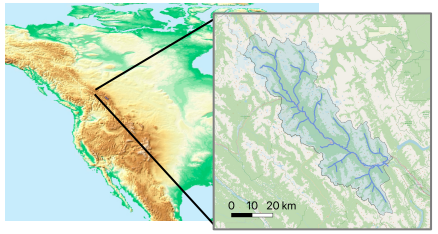
Motivation & aims

Sub-seasonal to seasonal (S2S) streamflow forecasts are critical operational inputs for water sectors & society. But S2S hydrological forecast skill is still limited despite advances in relevant capabilities. To build a continental-domain forecasting system that has value locally, streamflow predictability should be quantified & communicated. The aims of this work are to:

1) **Produce N. America-wide S2S hydrological hindcasts**
2) **Quantify S2S streamflow predictability**

Here, we present preliminary results for a testbed: the Bow River at Banff, a snow-fed river basin in the Canadian Rockies. Future work will focus on upscaling these workflows to N. America.

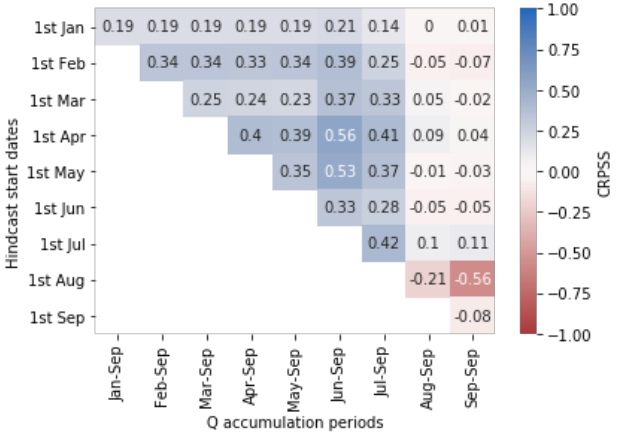


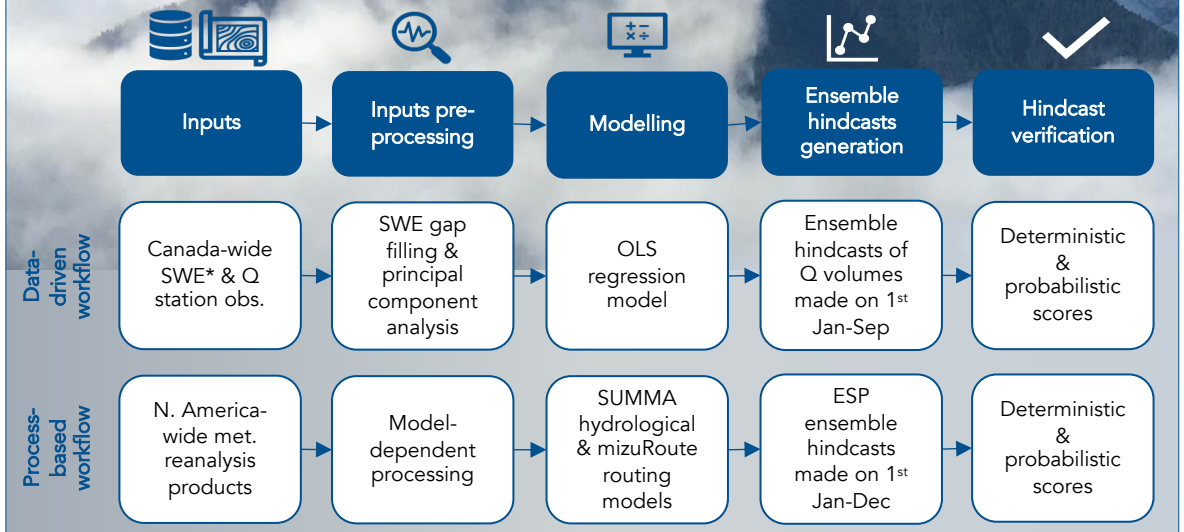
1) Towards N. America-wide S2S hydrological hindcasts

We are developing 2 S2S streamflow forecast workflows: data-driven & process-based (see flowcharts).

Preliminary results: Quality of data-driven hindcasts for the Bow at Banff. The CRPSS (Continuous Ranked Probability Skill Score; baseline: obs. climatology) is shown for various hindcasts starting dates (rows) & streamflow accumulation periods (rows):

- CRPSS > 0: hindcasts better than baseline
- CRPSS = 0: hindcasts as good as baseline
- CRPSS < 0: hindcasts less good than baseline



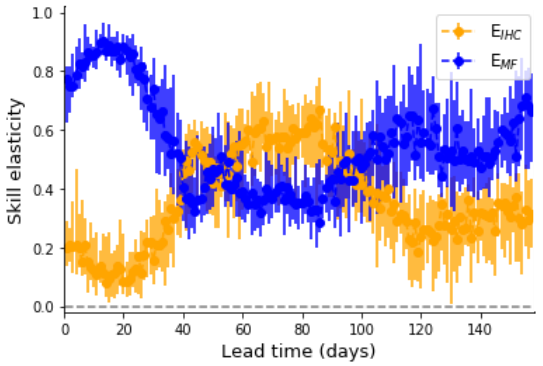


2) Quantifying streamflow predictability

From process-based hindcasts, we use the EPB method** to explore the elasticity (E) of streamflow skill – i.e., the increase in Q forecast skill achievable by improving the system's initial hydrological conditions (IHC) or met. forcings (MF). These results can help guide resources for tangible forecast improvements.

Preliminary results: Skill elasticities (with confidence intervals) for the Bow at Banff, for 12 years of hindcasts made on 1st May with up to 187 days lead time.

- E > 0: expect positive impacts from IHC / MF improvements on Q forecast skill
- E = 0: expect no impacts on Q forecast skill
- E < 0: expect negative impacts on Q forecast skill



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*Vionnet, V., Mortimer, C., Brady, M., Arnal, L. & Brown, R. Canadian historical Snow Water Equivalent dataset (CanSWE, 1928-2020). Earth System Science Data Discussions 1–22 (2021) doi:10.5194/essd-2021-160.

**Arnal, L., Wood, A. W., Stephens, E., Cloke, H. L. & Pappenberger, F. An Efficient Approach for Estimating Streamflow Forecast Skill Elasticity. J. Hydrometeor. 18, 1715–1729 (2017), doi:10.1175/JHM-D-16-0259.1.