

INTEGRATION OF RCM AND DEEP LEARNING FRAMEWORK FOR SNOW DYNAMICS AND SNOW DEPTH ESTIMATION

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Introduction:

- Seasonal snow and river ice processes control runoff, flooding and water availability in Cold regions.
- Optical sensors suffer from cloud and darkness.
- RCM C-band SAR offer all weather, high frequency imaging.
- Obtain both spatial and temporal information, combining EM classification and attention-based LSTM.

Objectives:

- Mapping snow melt dynamics using dual polarized RCM data (HH-HV).
- Predict daily snow depth from meteorological and SAR derived variables using Attention LSTM.
- Integrate both approaches for improved spatio-temporal monitoring.
- Assess model accuracy and applicability to cold region hydrology.

Study Area:

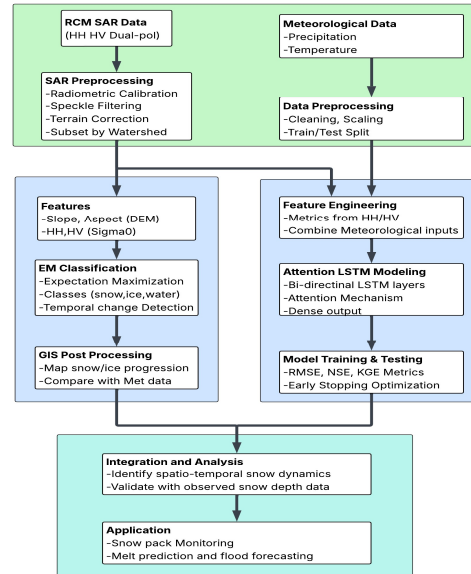
- Credit River Watershed, Monitored Feb - March 2025 for melt progression and snow depth.
- Trent River Watershed, examined Jan 2025 for ice jam formations.

Data:

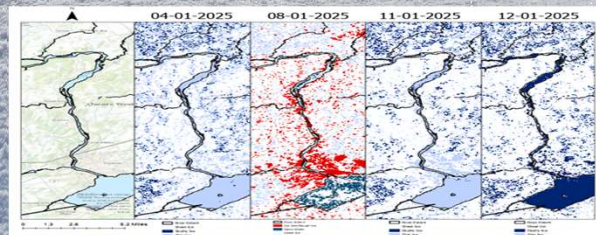
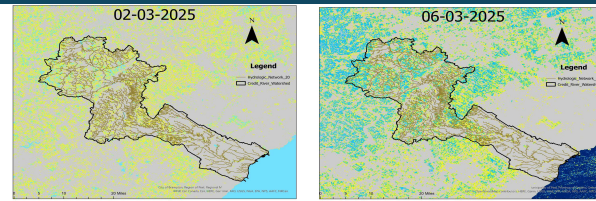
Dataset	Source	Key Details
RCM SAR	EODMS	HH HV GRD
DEM	SRTM 1 sec HGT	Slope & Aspect
Meteorology	ECCC & CVC	Temp, Precip
Snow Depth	CVC	Ground Truth

- EODMS- Earth Observation Data Management System
- ECCC- Environment and Climate Change Canada
- CVC- Credit Valley Conservation Authority

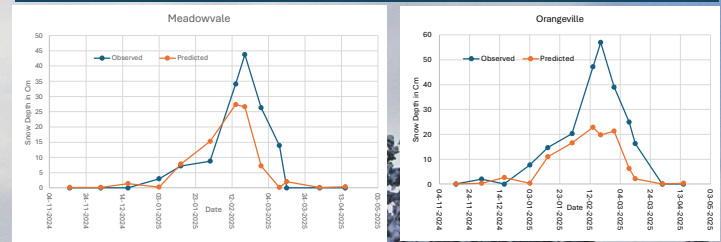
Methodology:



Result:



Result:



Snow/Ice Mapping:

- RCM EM classified daily changes (Feb 27 - Mar 7, 2025); peak melt Mar 5 aligned with 13.8 mm rain and 4.7 °C temperature.
- Trent River series identified ice jam zones during Jan

Snow-Depth Prediction:

- Attention-LSTM captured accumulation-melt cycles with $R^2 \approx 0.54$ and $RMSE < 10$ cm.

Discussions:

- The EM-classified RCM imagery provides fine spatial mapping of snow and ice states, while the LSTM adds temporal continuity for depth evolution.
- RCM's dual-pol signal proved sensitive to melt phases, and the attention mechanism improved feature interpretability.

Future Work:

- Combining both delivers a spatio-temporal view of snowpack dynamics, supporting hydrological modelling and flood forecasting.
- Extend to multi-year trend analysis and higher-resolution RCM scenes.

References:

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