ADVANCES ON WATER QUALITY AND RIVER ICE MODELLING IN LARGE-SCALE CATCHMENTS

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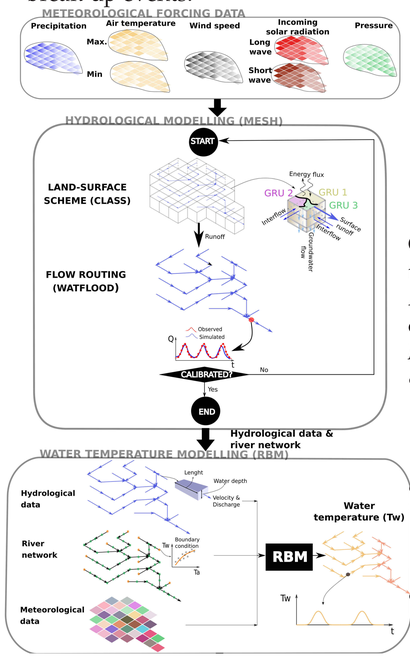
MESH-RBM

Integration of the grid-based semi-Lagrangian model (RBM) into the semi-distributed physically-based hydrological model, MESH, to simulate stream water temperatures.

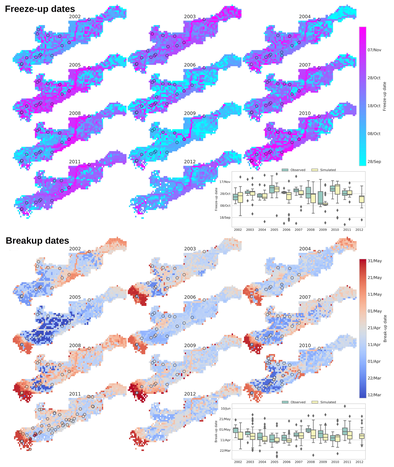
Rationality

- Water temperature (T) controls river ecosystem functioning (e.g. increases in T threat biodiversity and aquatic ecosystem integrity)
- Water temperature modelling in cold region river catchment aids to improve the predictability of ice freeze-up and break-up events.



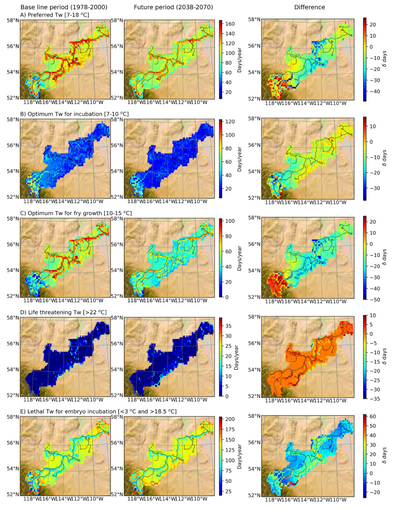
A hydrological and water temperature modelling framework to simulate the timing of river freeze-up and ice-cover breakup in large-scale catchments (2019). *Environmental Modelling & Software*, 114, pp.49-63.

- A new modelling framework is introduced here to analyse the spatio-temporal variability of freeze-up and breakup events.
- This novel modelling system could provide useful information to establish ice-jam flood mitigation plans.
- In the main tributaries of the ARB, freeze-up timing spans from the last week of September to the second week of November.
- The breakup timing spans from the second week of March to the last week of May and occurs first at headwater reaches.



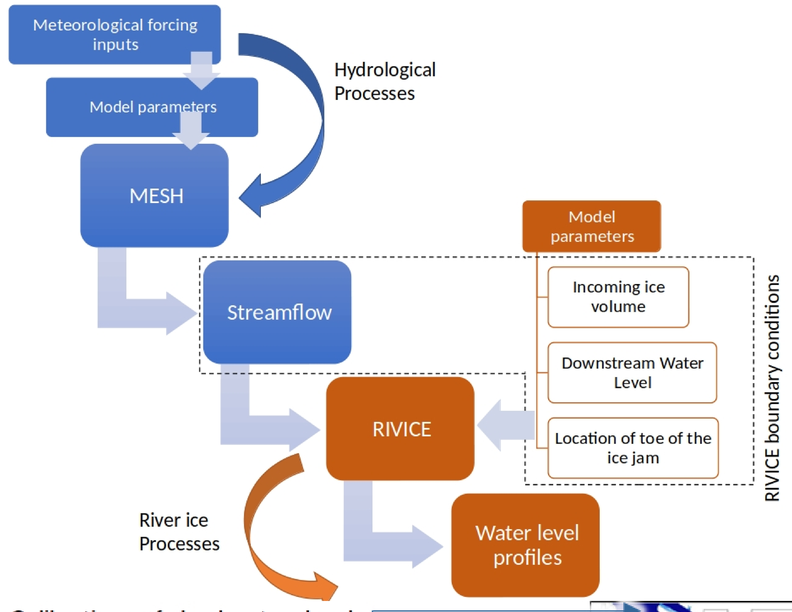
Changes in streamflow and water temperature affect fish habitat in the Athabasca River basin in the context of climate change (In revision) *Ecological Modelling*.

- Predicted increases in water temperature will result in habitat contraction concentrating ART in the upper headwater of the ARB.
- Contraction of ART habitat may open niches for non-native trout species and limit the ability of ART to utilize that habitat when conditions are favorable.
- ART habitat can potentially be reduced as the frequency of occurrence of life threatening and lethal water temperatures tend to increase.

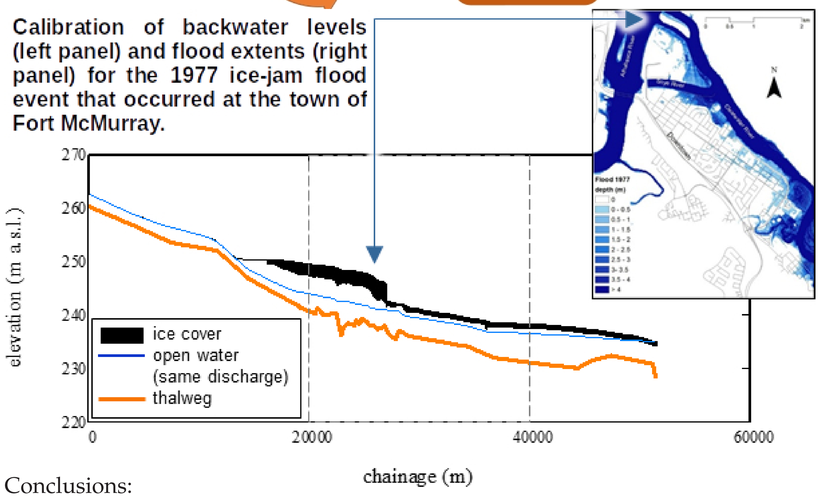


MESH-RIVICE

A novel forecasting methodology, in which an ice hydraulic model (RIVICE) is coupled to MESH, is placed within a stochastic framework in which an ensemble of backwater staging profiles are simulated to provide a probability of flood extents and depths in a flood hazardous region.



Calibration of backwater levels (left panel) and flood extents (right panel) for the 1977 ice-jam flood event that occurred at the town of Fort McMurray.

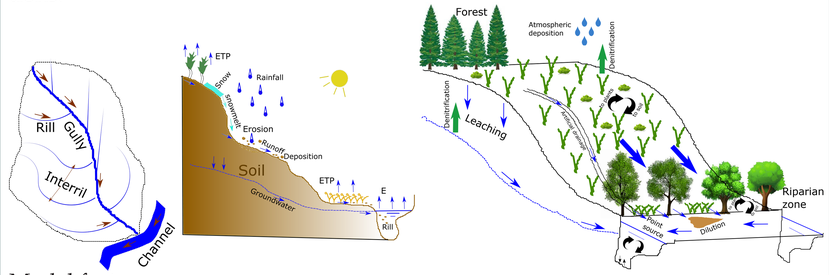


Conclusions:

- The ice-jam flood forecasting and hazard mapping of the downtown area of Fort McMurray was successfully carried out for the ice-cover breakup event of spring 2018. It is hoped that
- These research findings will advance the operational forecasting of ice-related flooding, which will aid preparedness and mitigation of ice-jam flooding, reduce flood damages and protect human life along rivers prone to major ice jam events.
- Forecasting such events ice-jam flood events is also needed to reduce economic damage and reduce negative impacts to society.
- The volume of ice still remains the most uncertain variable in the forecasting framework due to the continually changing conditions of the ice cover during breakup.

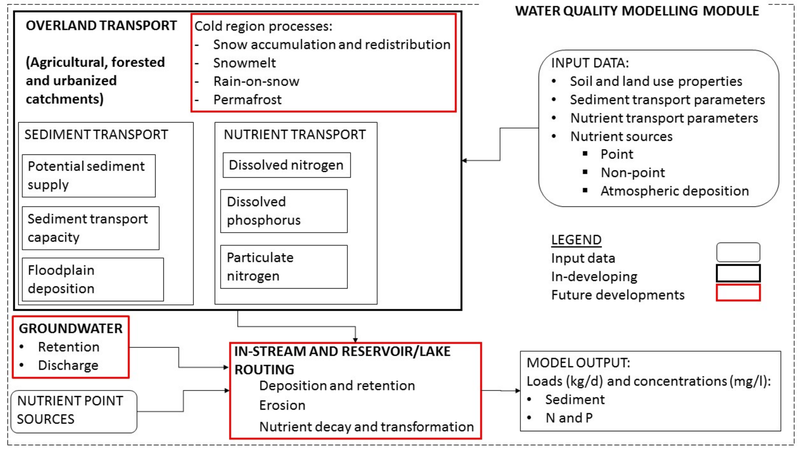
MESH-SOL

A modelling framework of solute transport in large-scale cold region catchment is presented. The new solute transport model (MESH-SOL) is couple to the semi-distributed hydrological land surface scheme model MESH. The model is implemented at the catchment scale for long-term continuos and storm-event simulations.



Model features:

- loosely coupled with MESH.
- physically-based watershed sediment transport model.
- developed based on SHETRAN and SHESED.
- semi-distributed model that work on a orthogonal grid (MESH grid).
- suitable for large-scale catchment to run on a continuous basis.
- include different sediment classes.
- future work: sedimentation in reservoirs, code parallelization.



Observed vs simulated sediment loads at AB07CC0030