Integrated Modelling Program for Canada
Global Water Futures

Multi-model Intercomparison Project on the Saskatchewan-Nelson-Churchill River Basin (Nelson-MiP project)

Monthly meeting - May 13th, 2020

Environment and Climate Change Canada
Environnement et Changement climatique Canada

STRATEGIC COMMUNITY CONSULTING

Western University · Canada

University of Saskatchewan

Manitoba
Manitoba Infrastructure

Water Security Agency

UNBC University of Northern British Columbia

University of Waterloo

Manitoba Hydro

University of Alberta

University of Manitoba

University of Calgary

Agenda

1. Presentation of results from a MiP project led by AEP (Khaled - AEP)
2. Presentation of VIC configuration and input (Raj - UNBC)
3. Presentation of SUMMA configuration and input (Wouter - USask)
4. OneDrive repository for data storage & retrieval
5. Deliverables for next meeting & follow-up

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AEP-led MiP project

By:

Khaled Akhtar

(Alberta Environment & Parks)

The Variable Infiltration Capacity (VIC) Model

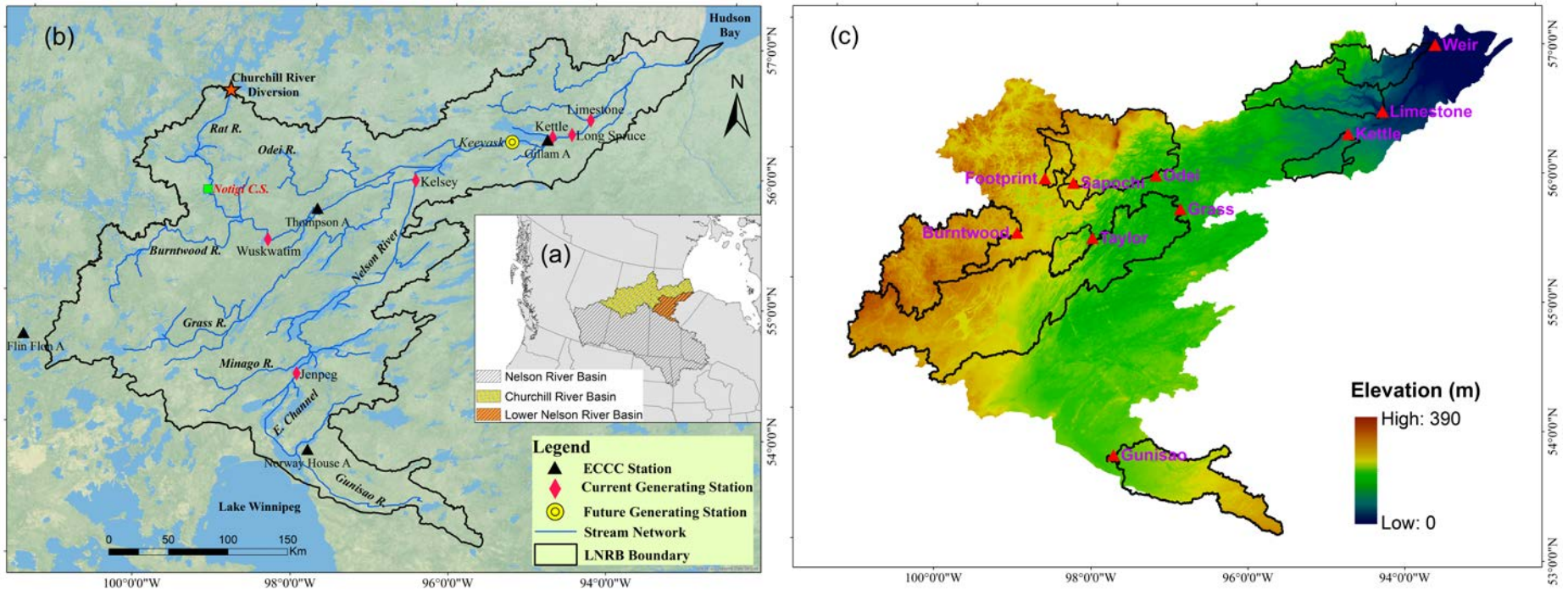
By:

Rajtantra Lilhare

(University of Northern British Columbia)

1. Study Area

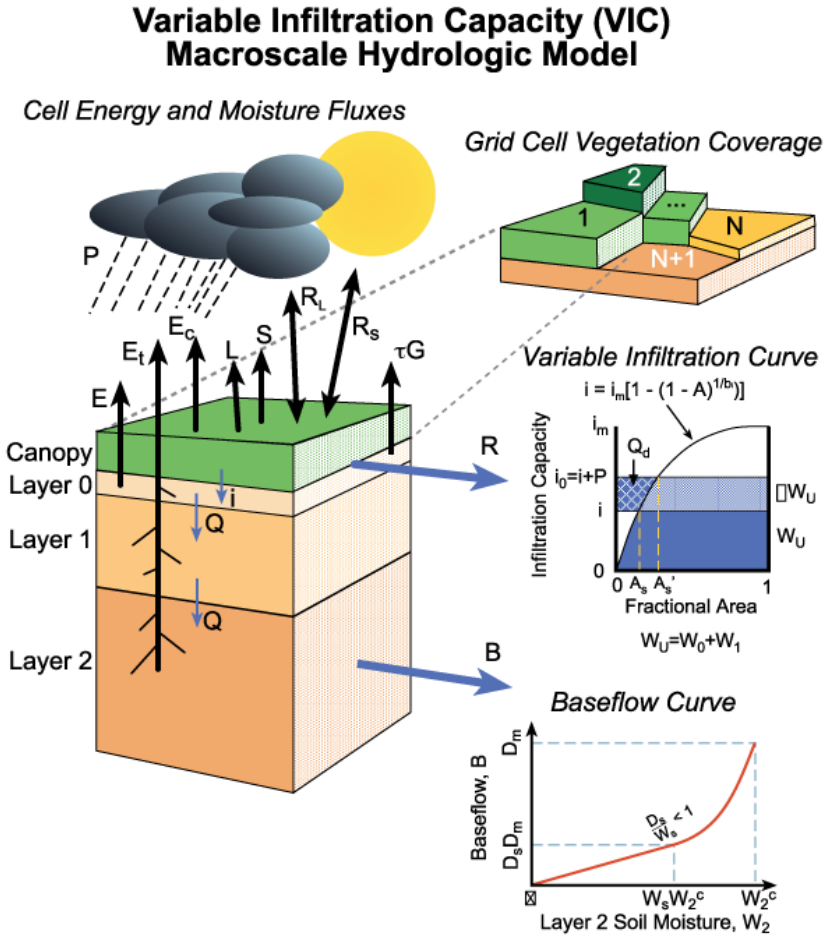
The Lower Nelson River Basin (LNRB)

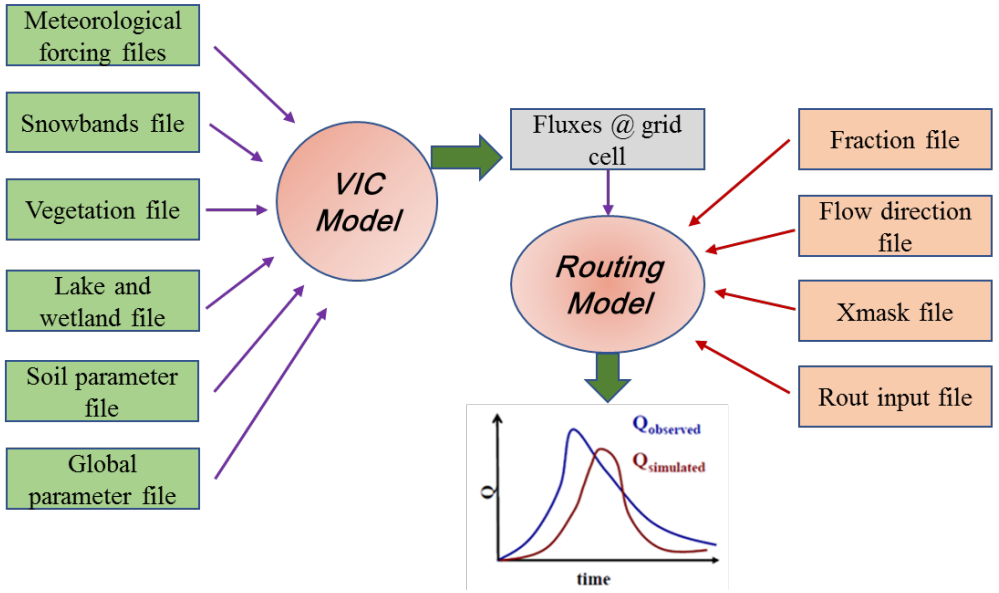


- Receiving major outflow from the Nelson River Basin (~970,000 km^2)
- The LNRB area: ~90,580 km^2
- Churchill River Diversion started in 1977, operated by Manitoba Hydro
- Managed at Notigi Control Structure on the Rat River

2. Model Description

The Variable Infiltration Capacity Model





Source: http://vic.readthedocs.io/en/master/Overview/ModelOverview/

3. Input Data Used

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Table 1 Description of the input data used for the VIC model setup and their sources

Characteristic/Data type	Information/Product	Source
Topography	90 m Shuttle Radar Topography Mission (SRTM) digital elevation model	United States Geological Survey (2013)
Soil characteristics	The multi-institution North American Land Data Assimilation System (NLDAS) project at 0.50° resolution	Cosby, Hornberger, Clapp, & Ginn (1984)
Land use	GeoGratis - Land Cover, circa 2000-Vector (LCC2000-V) product	Natural Resource Canada (2000)
Lake and wetland	Global Lake and Wetland Database (GLWD)	Lehner and Doll (2004)
Discharge	1. HYDAT, 2. Manitoba Hydro	1. Water Survey of Canada
Meteorological forcings	Hydrological Global Forcing Data (Hydro-GFD)	Berg et al. (2017)

3. VIC Calibration

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1. VIC Calibration and Validation:

Parameter [units]	Definition	Range
b_{inf} [fraction]	Parameter used to describe the variable infiltration curve	> 0 to 0.40
Ds [fraction]	Fraction of the Ds_{max} parameter at which nonlinear base flow occurs	> 0 to 1
Ws [fraction]	Fraction of maximum soil moisture where nonlinear base flow occurs	> 0 to 1
D2 [m]	Depth of second soil layer	0.3 to 1.5
D3 [m]	Depth of third soil layer	0.3 to 1.5
Ds_{max} [mm day^{-1}]	Maximum velocity of base flow for each grid cell	> 0 to 30

- ✓ Daily and monthly calibration using the University of Arizona multiobjective complex evolution (MOCOM-UA) optimizer.
- ✓ Years 1981–1985 (dry/cool) and 1995–1999 (wet/warm) are used for calibration, and 1986–1994 (average) forms the validation period.

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THANK YOU!

Questions?

Structure for Unifying Multiple Modeling Alternatives (SUMMA)

By:

Wouter Knoben

(University of Saskatchewan)

1. Study Area

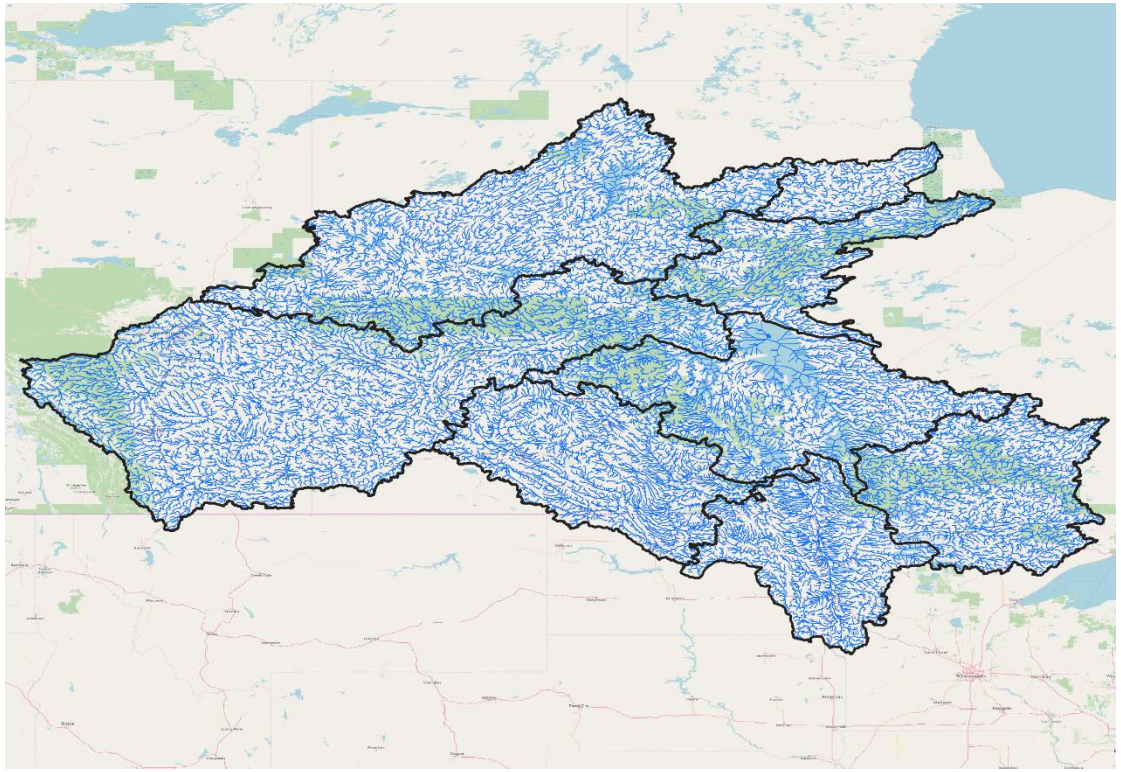

Figure 1 Main Nelson sub-basins with MERIT stream network

Nelson Churchill River Basin

Gross Area

1.4 million square kilometers

Elevation Range

Sea level to 3548 M.S.L.

Exact configuration to be decided, but Pfaffstetter coding of river network allows flexible aggregating of catchments without need to reconfigure routing

1. Study Area

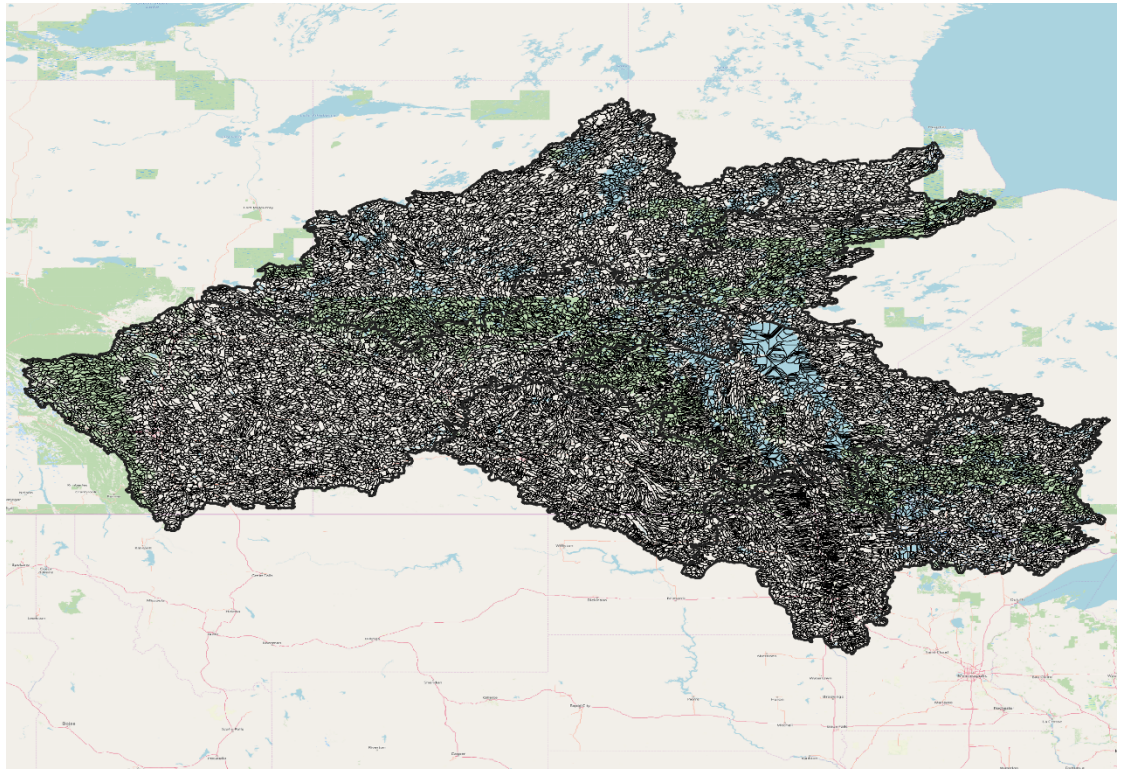

Figure 1 Main Nelson sub-basins with MERIT Hydro catchment delineation

Nelson Churchill River Basin

Gross Area

1.4 million square kilometers

Elevation Range

Sea level to 3548 M.S.L.

Exact configuration to be decided, but Pfaffstetter coding of river network allows flexible aggregating of catchments without need to reconfigure routing

1. Study Area

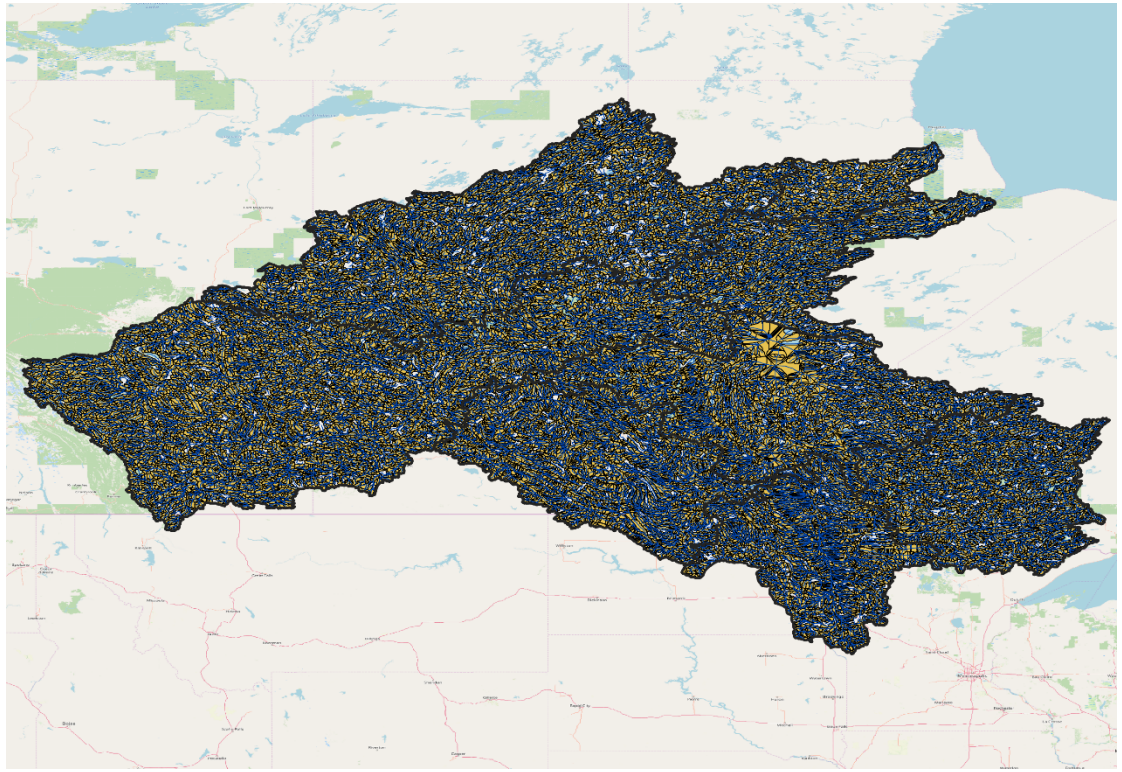

Figure 1 Main Nelson sub-basins with MERIT Hydro catchment delineation and stream network

Nelson Churchill River Basin

Gross Area

1.4 million square kilometers

Elevation Range

Sea level to 3548 M.S.L.

Exact configuration to be decided, but Pfaffstetter coding of river network allows flexible aggregating of catchments without need to reconfigure routing

2. Model Description

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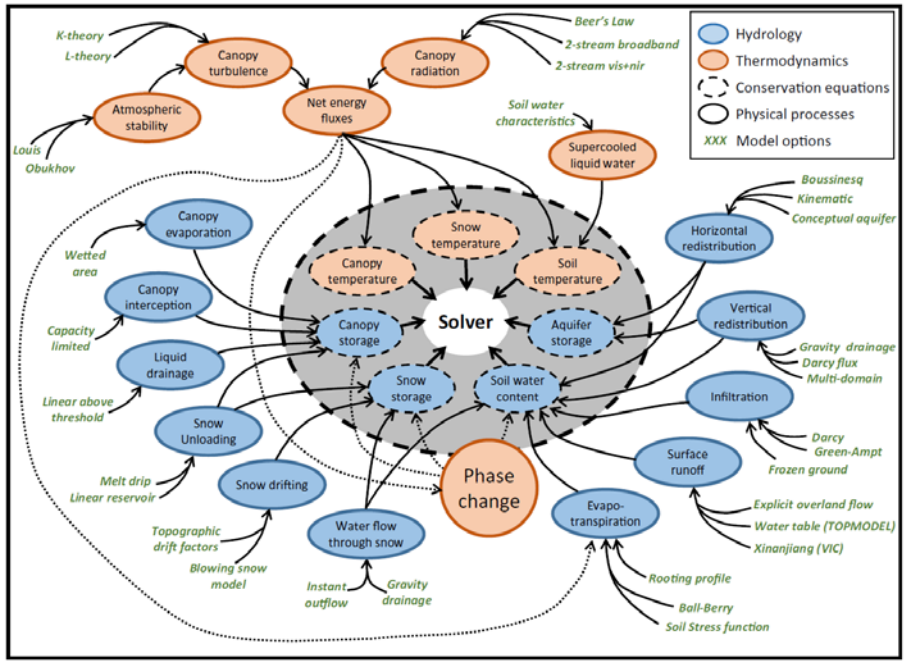

Figure 2 SUMMA setup: multiple modeling options are part of a common numerical solver

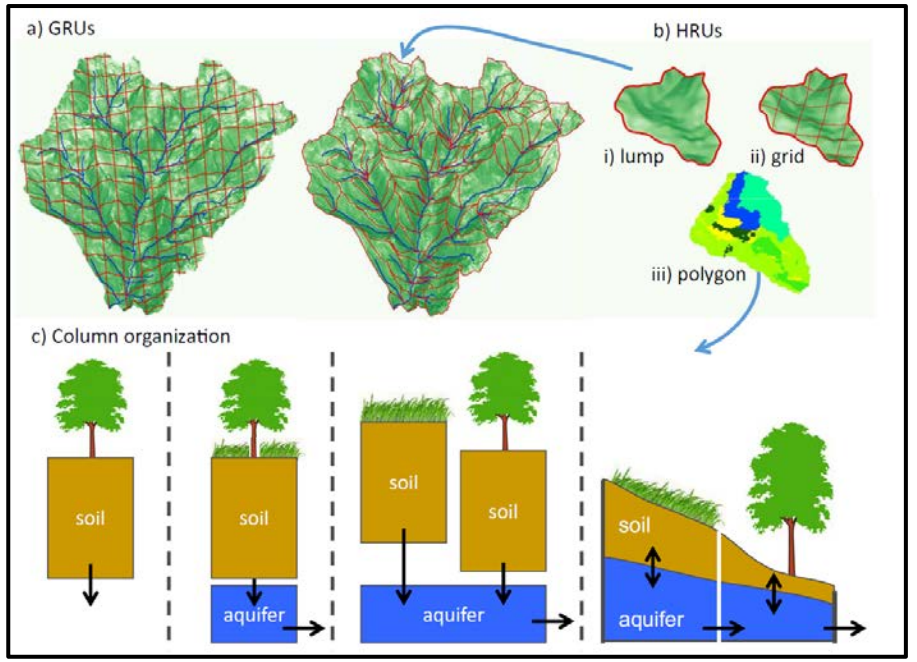

Figure 3 Spatial organization is flexible

Figures from Clark et al. (WRR, 2015)

3. Input Data Used

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Table 1 Description of the input data used for the model setup and their sources

Characteristic/ Data type	Information/Product	Source
Topography	MERIT Hydro	Yamazaki et al. (2019)
Soil characteristics	SOILGRIDS	Hengl et al. (2017)
Land use	MODIS Vegetation	Didan et al. (2010)
Lake and wetland	MERIT Hydro (lakes)	Yamazaki et al. (2019)
Reservoirs	n/a	Planned as future development
Discharge	tbd	
Meteorological	ERA5	Copernicus Climate Change Service (2017)
Snow	n/a	Calculated internally
Glacier fluctuations	n/a	Planned as future development
Evapotranspiration	n/a	Calculated internally

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Data exchange for Nelson-MiP

- UC-HAL is providing a private OneDrive repository named **Nelson MIP** for data storage and retrieval for this project.

- All project participants will have a **read-only access** to the repository and thus can access/download inputs and other modelers' outputs.

- For data upload (e.g. model outputs) you will have to send me or Trish and email with a link to the data to be uploaded.

If you are NOT willing to share your model outputs and model configuration open source with others? Please let us know before submitting any data. Accommodations can be made, but the preference is that all models and data are shared.

- When **using data from other modellers, we require you to get their written consent** and inform the project coordination prior to any form of publication.

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Data exchange for Nelson-MiP

- 3 folders in Nelson MIP: Model_results

  Input_data_NCRB
  Reports_monthly_meetings

- In the sub-folder Input_data_NCRB we have folders for:

  - GSDE soil data for NCRB

  - NALCMS land use data for NCRB

  - natural gauge stations for calibration (i.e. list of stations in excel file and streamflow data in native formats)

  - shapefiles of modelling domain and mask

  - WFDEI data for NCRB

In each data folder a **README_ME_FIRST**.txt file explains the contain of the folder.

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Deliverables & Follow-up

- Model presentations on SWAT-GWF (Ualberta) and HEC-HMS (Strategic Consulting) are confirmed for next meeting.
- Presentation of a new hydrologic routing during next meeting by Bryan Tolson (UWaterloo)
- Comparison of ERA5 and WFDEI-GEM-CaPA by Scott Pokorny (Strategic Consulting) during next meeting
- For **MESH** (USask), **HBV-EC** & **WATFLOOD-MI** (Manitoba Infrastructure), send your slides by June 3 if you are interested in presenting your model.
- UC-HAL have granted read-only access to OneDrive project repository (Nelson-MIP) to all project participants. Reach out to Trish if you don't have access yet and to me for data issue.
- **Start of model setup before next meeting**, once access to data is granted. Discuss/report challenges using the SLACK channel
- A **SLACK channel** is available to facilitate informal communication for Nelson-MiP

  Channel link: https://uc-hal.slack.com/archives/C011BTG7GL8

  Channel name: #ncrb_mip
- Next meeting scheduled for **Wednesday June 10 @ 10:00AM MDT**