Environnement et Changement climatique Canada

Environment and Climate Change Canada

Canada

The MESH Model: Past, Present and Future

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Global Water Futures AGM
Hamilton, ON
June 6, 2018

Past – How was MESH created?

An idea… a conversation

↓

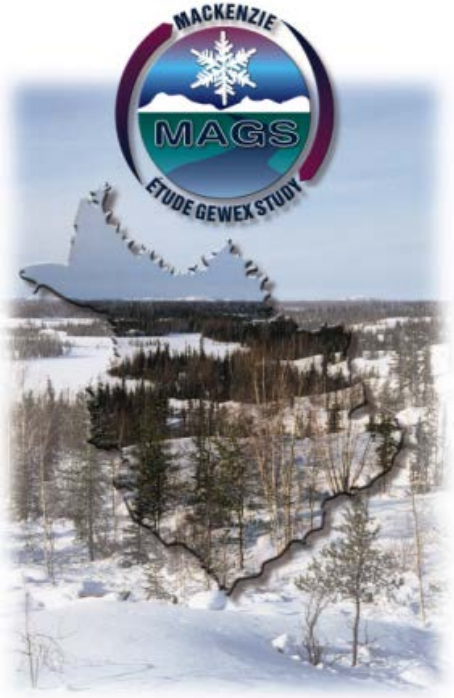
WATCLASS

↓

MESH

Modélisation Environnementale Communautaire - Surface Hydrology

Past – How did MESH develop?



DRI
DROUGHT RESEARCH INITIATIVE
RÉSEAU DE RECHERCHE SUR LA SÉCHERESSE

BOREAL ECOSYSTEM–ATMOSPHERE STUDY
BOREAS

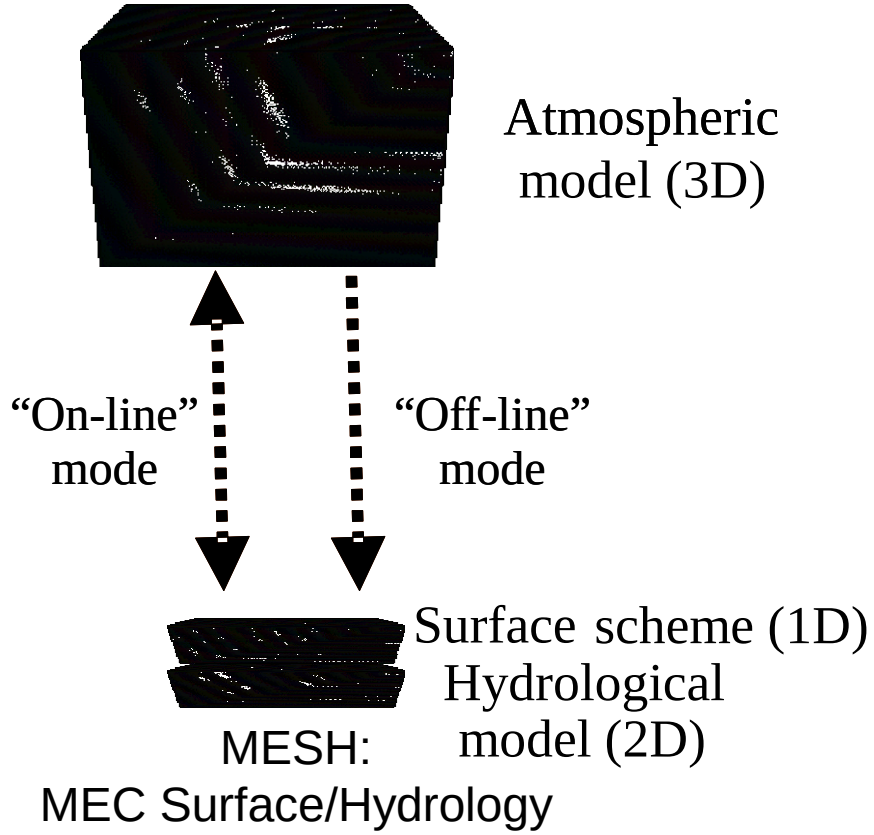
The BOREAS Information System
Boreal Ecosystem-Atmosphere Study
NASA, NOAA, NSF, EPA
NSERC, CCRS, NRC, CFS
Environment Canada,
Agriculture Canada
Goddard Space Flight Center
Greenbelt, Maryland, USA

IP3
Improving Processes & Parameterization for Prediction in Cold Regions Hydrology
Centre for Hydrology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
A CFCAS-Funded Research Network

INTERNATIONAL POLAR YEAR
2007-2008

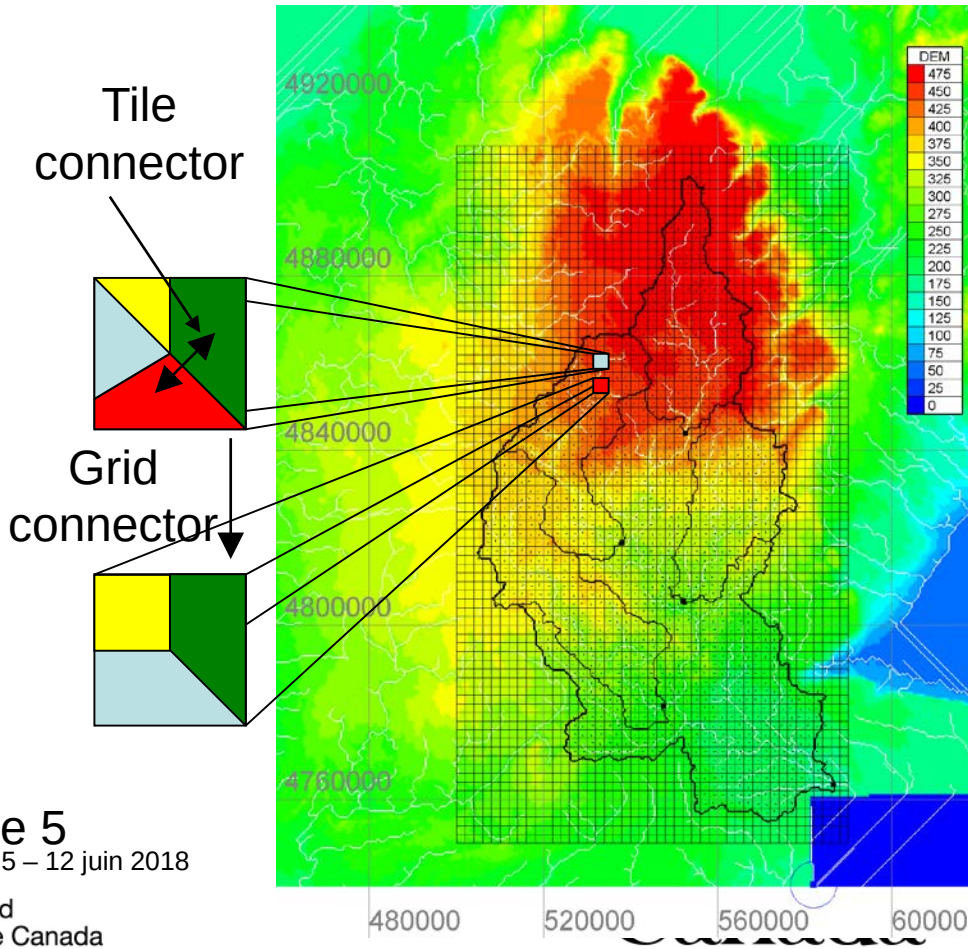
MESH – What is it?

- The surface model is less costly to run than the atmospheric model, and can benefit from a higher resolution
  - It can be run at the resolution of the hydrologic model
  - The LSS and the hydrologic model can then be closely linked to better parameterize subgrid-scale processes
  - The atmospheric and hydrological models still share the LSS

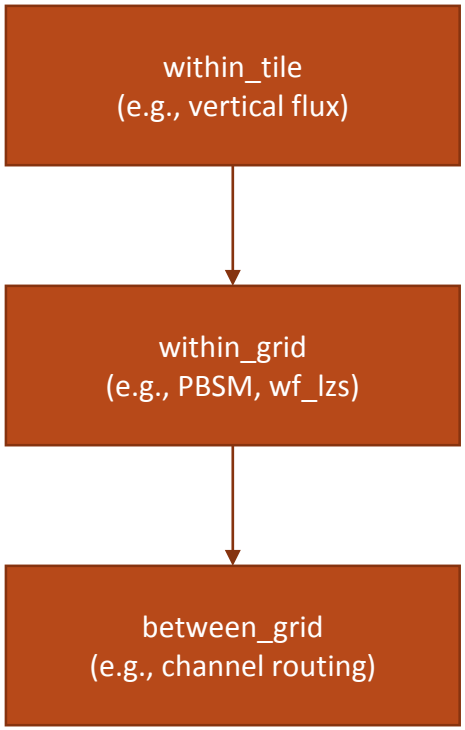


MESH: A MEC surface/hydrology configuration designed for regional hydrological modeling

- The tile connector (1D, scalable) redistributes mass and energy between tiles in a grid cell
  - e.g. snow drift
- The grid connector (2D) is responsible for routing runoff
  - can still be parallelized by grouping grid cells by subwatershed



Process organization



INTRA-tile and **INTRA**-grid

- CLASS 3.6, SVS, BASEFLOWFLAG luo_2012, CLASS output files

INTER-tile and **INTRA**-grid

- PBSM, BASEFLOWFLAG wf_lzs

INTER-grid

- WF_ROUTE, RTE, basin outputs, AUTOCALIBRATIONFLAG (SIMSTATS)

MESH development strategy set at CCRN meeting 2014

- Speed-up/parallelize standalone MESH
- Being able to choose which grid squares use PDMROF and which use WATROF
- Merging standalone MESH and SPS
- Incorporating Murray's 1-D lake model in MESH
- Incorporating wetland module in MESH
- Implementing human influences into MESH (reservoirs, irrigation, inter-basin transfers)
- Implement standalone MESH testing platform
- MESH with Ostrich (for calibration, Monte-Carlo simulations) on clusters (compare UofS cluster and EC's Pegasus cluster)
- Update user/developer documentation and wiki pages
- Managing code reviews and testing
- Assimilating satellite data in MESH (e.g. GRACE, SMOS)

MESH development strategy set at CCRN meeting 2014

- ~~Speed-up/parallelize standalone MESH~~
- ~~Being able to choose which grid squares use PDMROF and which use WATROF~~
- ~~Merging standalone MESH and SPS –~~ different container, common processes = same code
- ~~Incorporating Murray's 1-D lake model in MESH –~~ needs improvement
- Incorporating wetland module in MESH
- ~~Implementing human influences into MESH (reservoirs, irrigation, inter-basin transfers)~~
- Implement standalone MESH testing platform
- ~~MESH with Ostrich (for calibration, Monte-Carlo simulations) on clusters (compare UofS cluster and EC's Pegasus cluster) –~~ both MESH and Ostrich can be scaled to clusters
- Update user/developer documentation and wiki pages
- Managing code reviews and testing – regular meetings, seasonal code reviews; informal
- Assimilating satellite data in MESH (e.g. GRACE, SMOS)

Present – Who's working with MESH?

CCRN
Changing Cold Regions Network

McMaster University

UNIVERSITY OF WATERLOO

UNIVERSITY OF SASKATCHEWAN
Global Institute for Water Security
USASK.CA/WATER

Environment and Climate Change Canada
Environnement et Changement climatique Canada

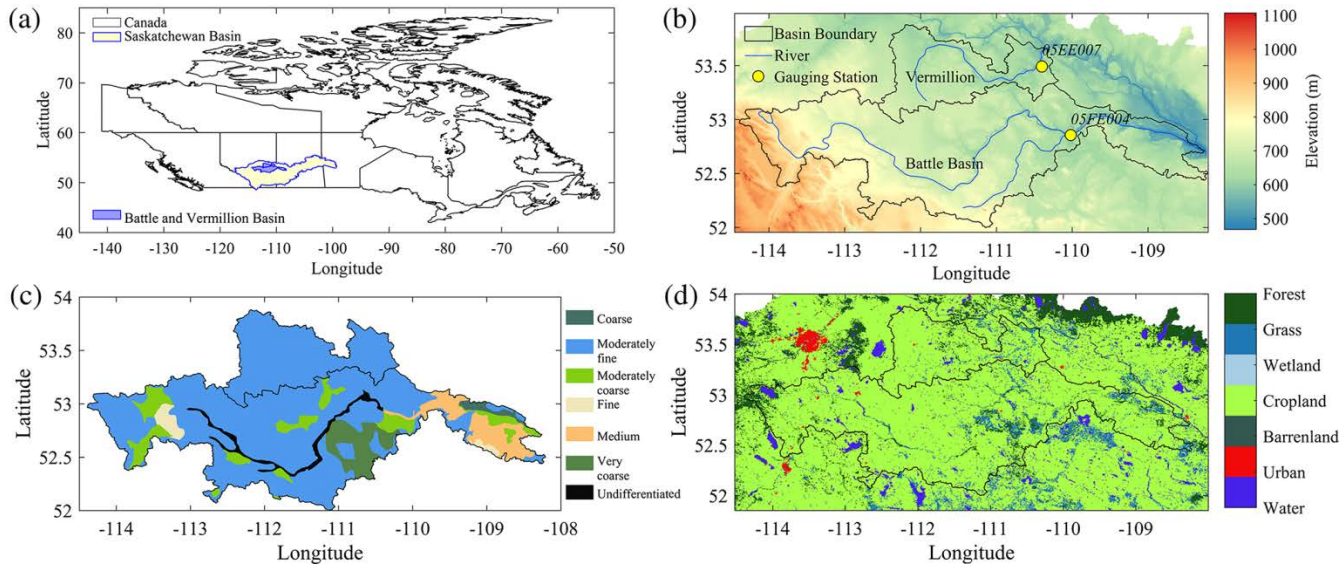
UNIVERSIDAD NACIONAL DE COLOMBIA

UNIVERSITY OF SASKATCHEWAN

Present – Who's working with MESH?

Canada

Saskatchewan River Basin (405,000 km^2)



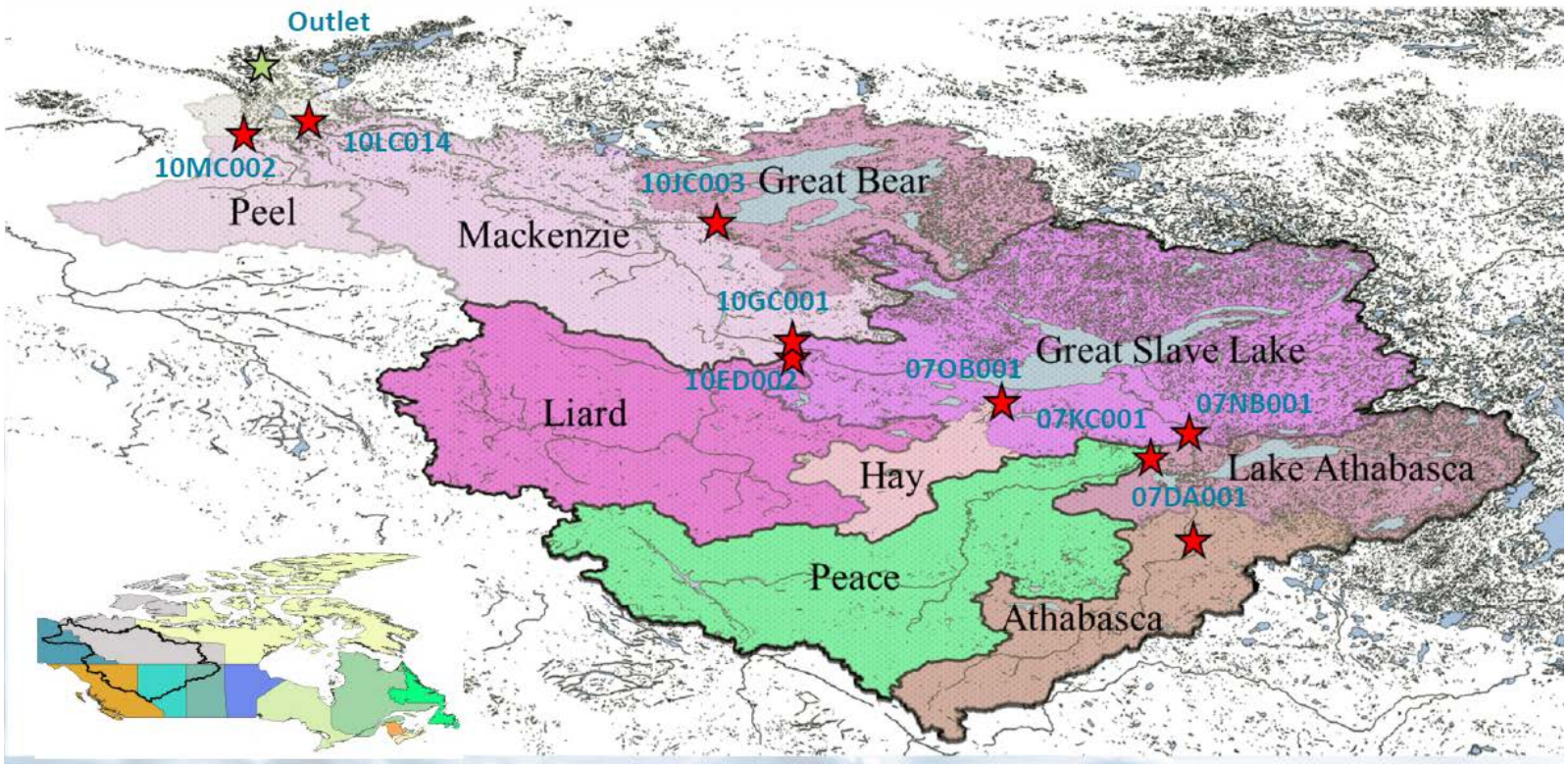
(a) The location map of Saskatchewan River Basin (SaskRB) and its Battle and Vermilion subbasins used in this study. (b) Battle and Vermilion subbasins DEM, boundary, and gauging stations. (c) The map of soil parent material texture groups. (d) The map of landcover

Enhanced identification of a hydrologic model using streamflow and satellite water storage data: A multicriteria sensitivity analysis and optimization approach, Volume: 31, Issue: 19, Pages: 3320-3333, First published: 01 July 2017, DOI: (10.1002/hyp.11267)

Present – Who's working with MESH?

Canada

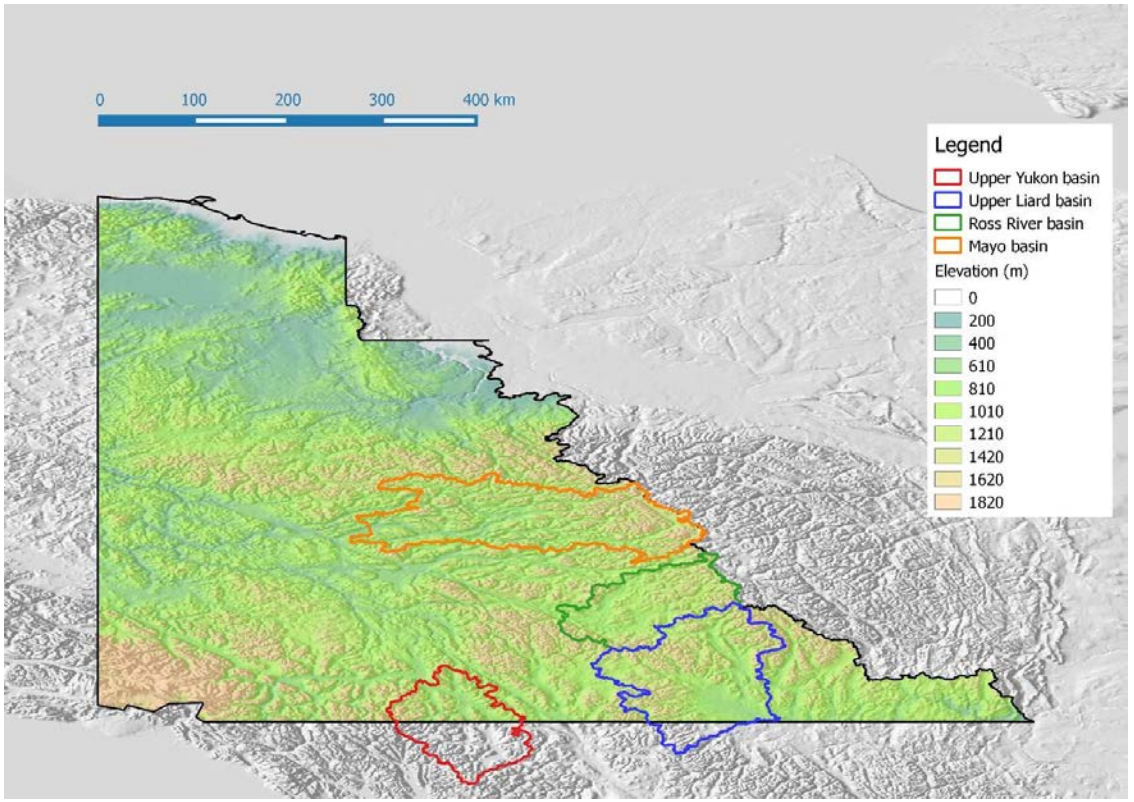
Mackenzie River Basin (1,800,000 km^2)



Present – Who's working with MESH?

Canada

Yukon River Basin (850,000 km^2)

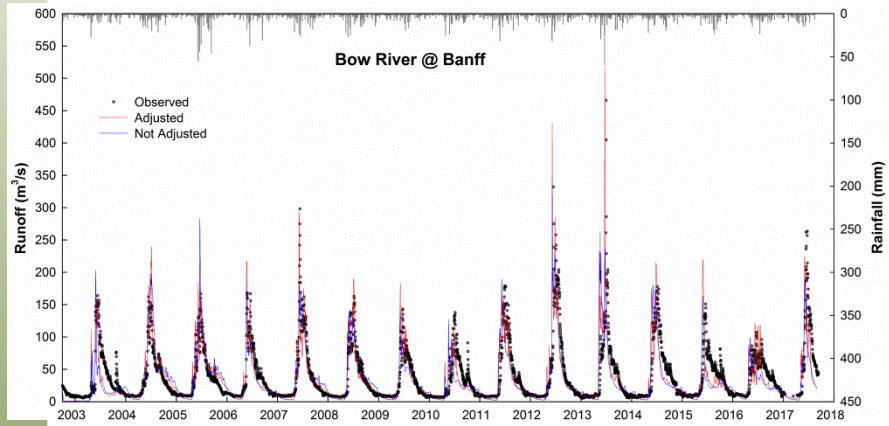


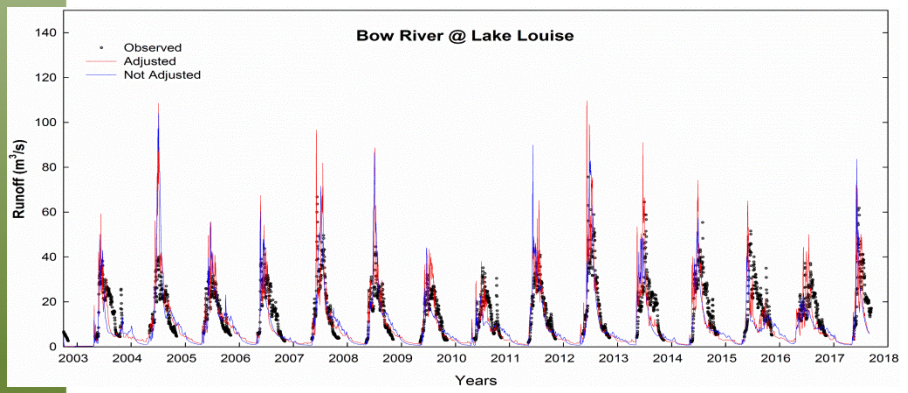
Present – Who's working with MESH?

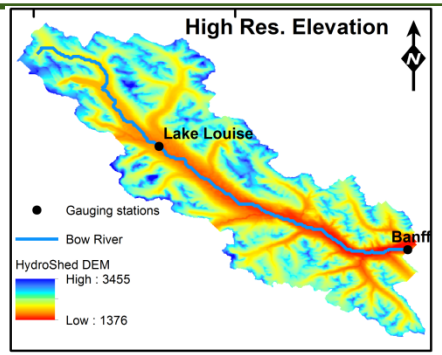
Present – Who's working with MESH?

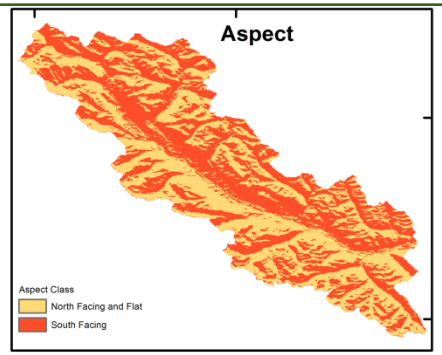
Canada

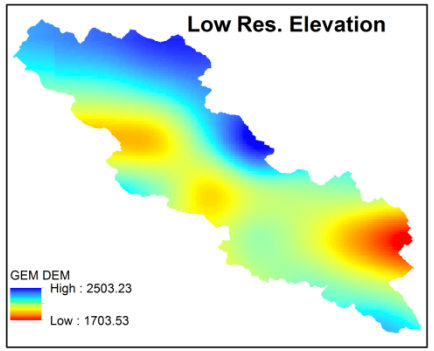
Bow River at Banff (2,207 km^2)

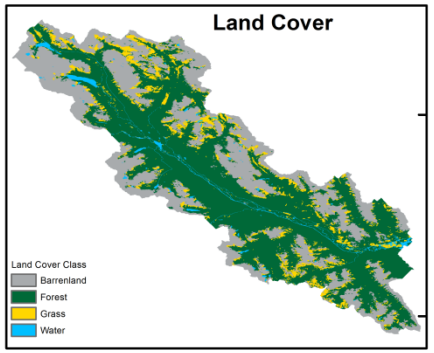


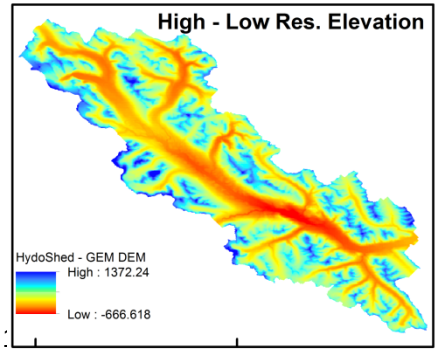


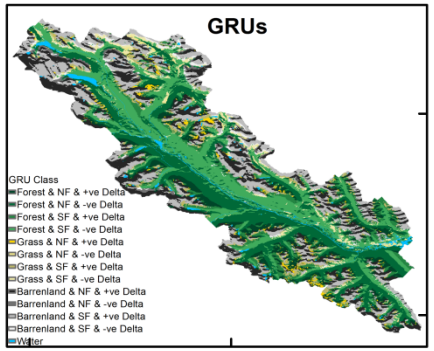












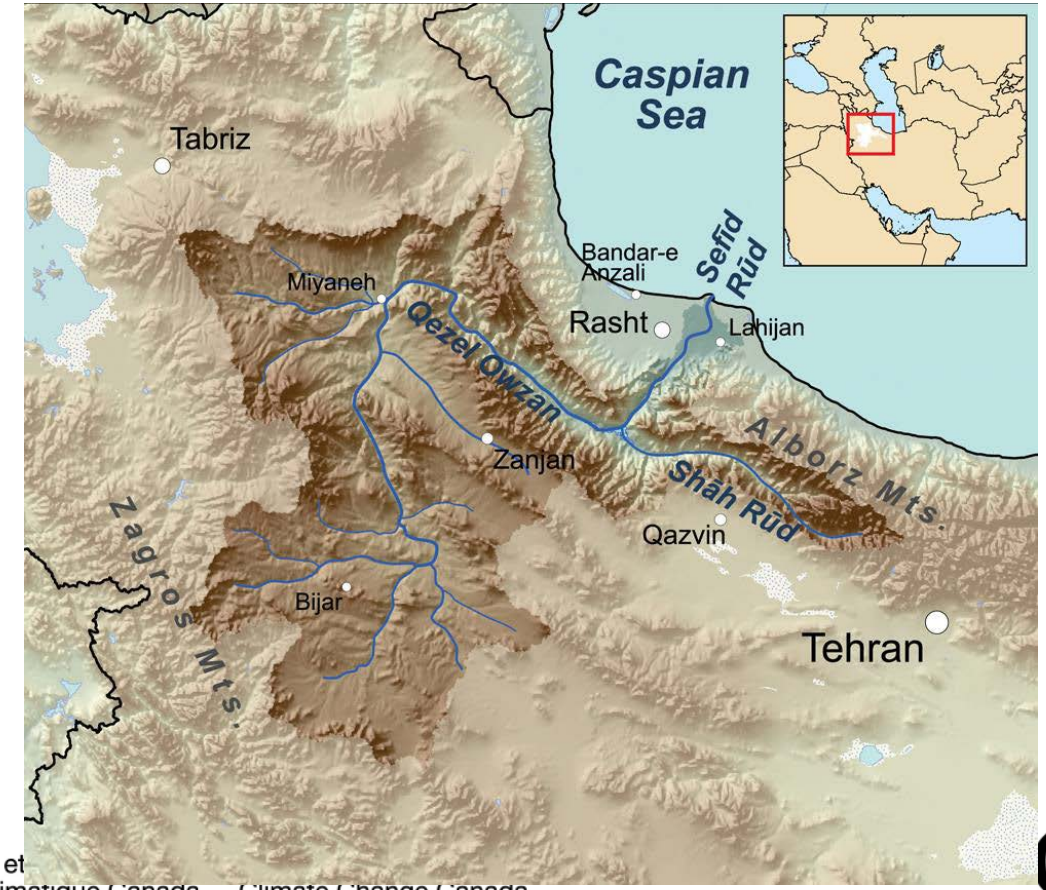
Present – Who's working with MESH?

Columbia

Coello River Basin (1,800 km^2) within the Magdalena Cauaca Basin (273,000 km^2)

Present – Who's working with MESH?

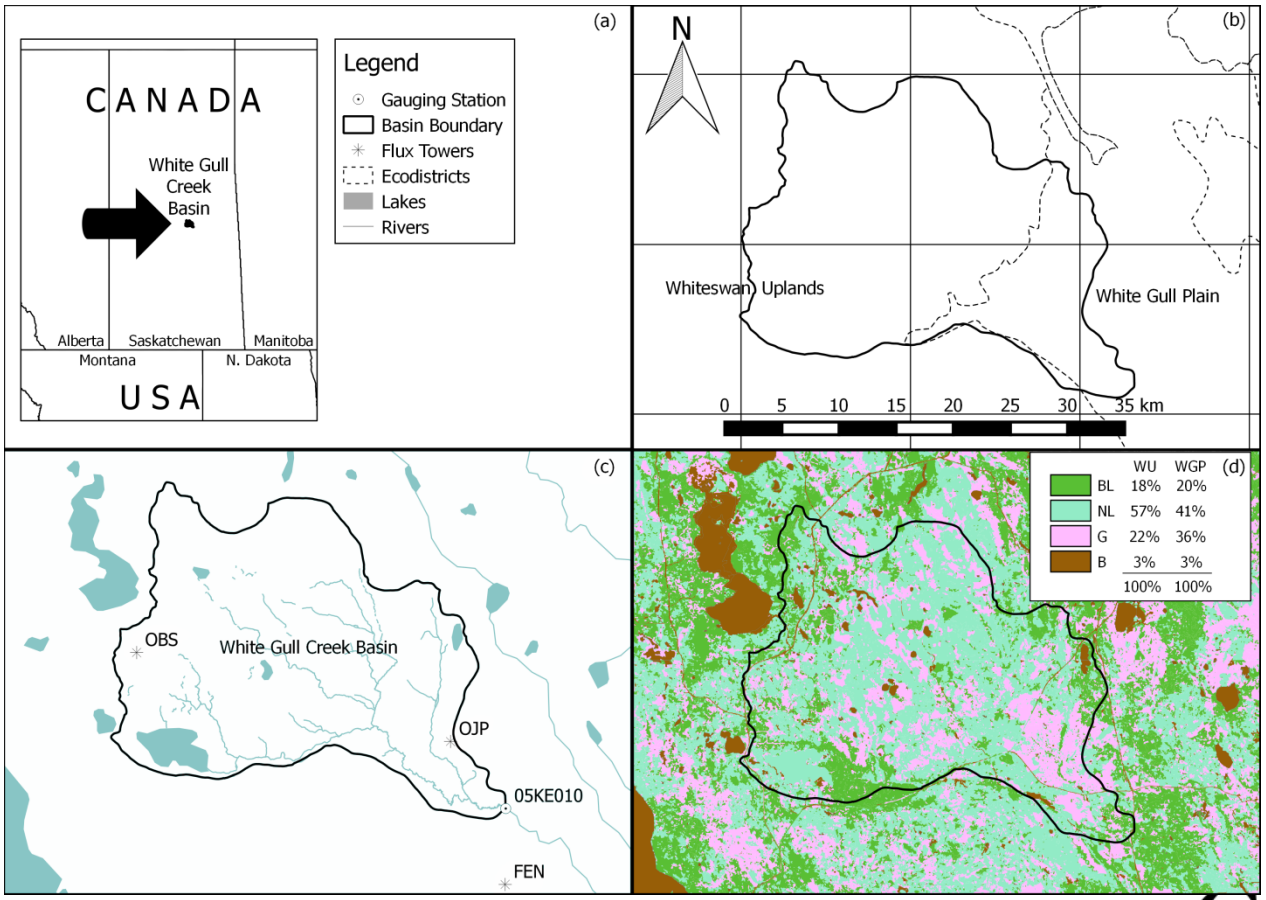
Iran
Sefidrud River Basin (65,000 km^2)



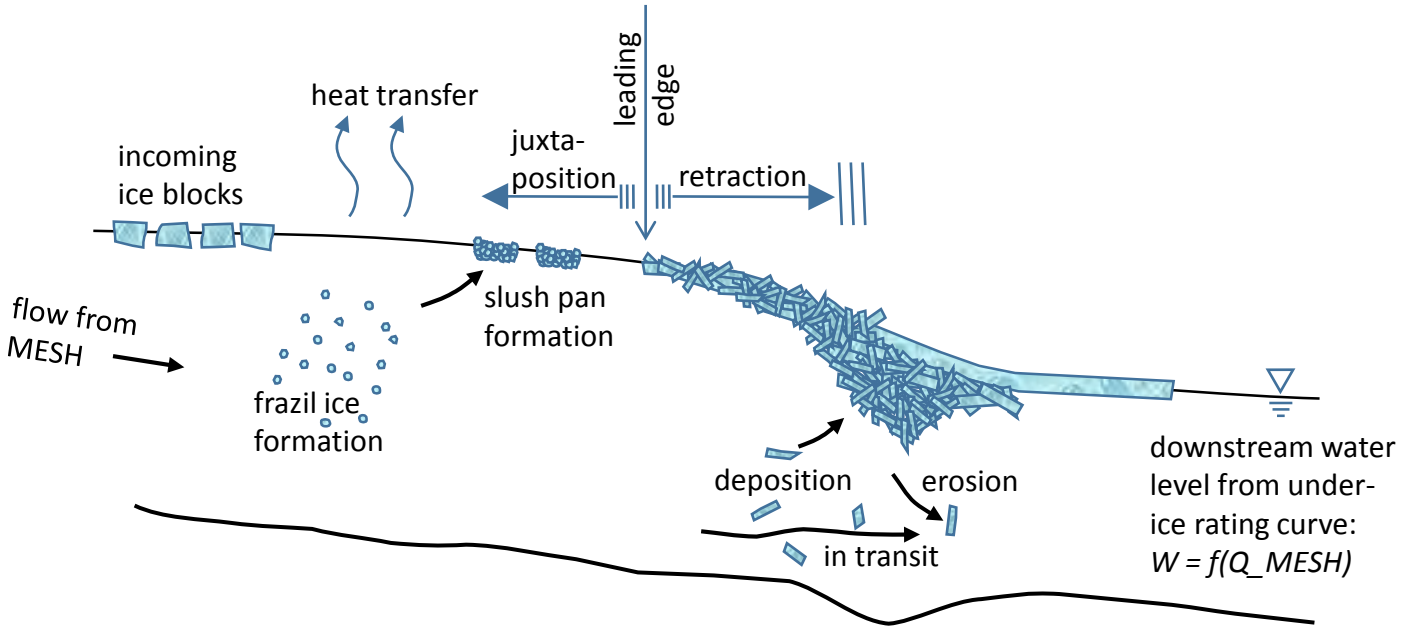
Present – Who's working with MESH?

Canada

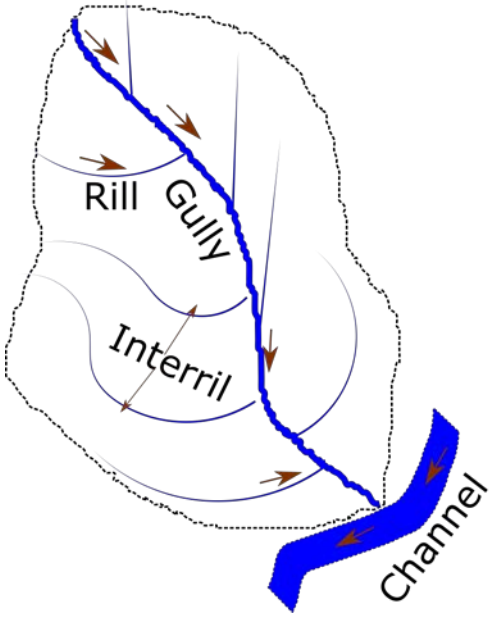
Whitegull Creek (603 km^2)

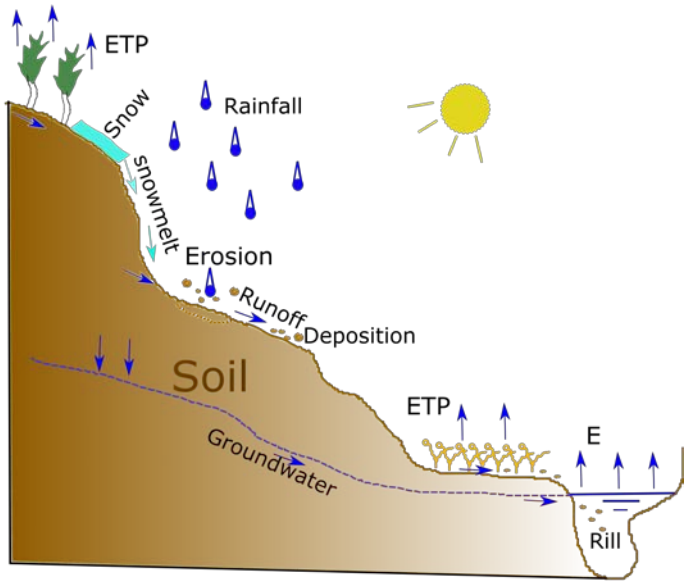


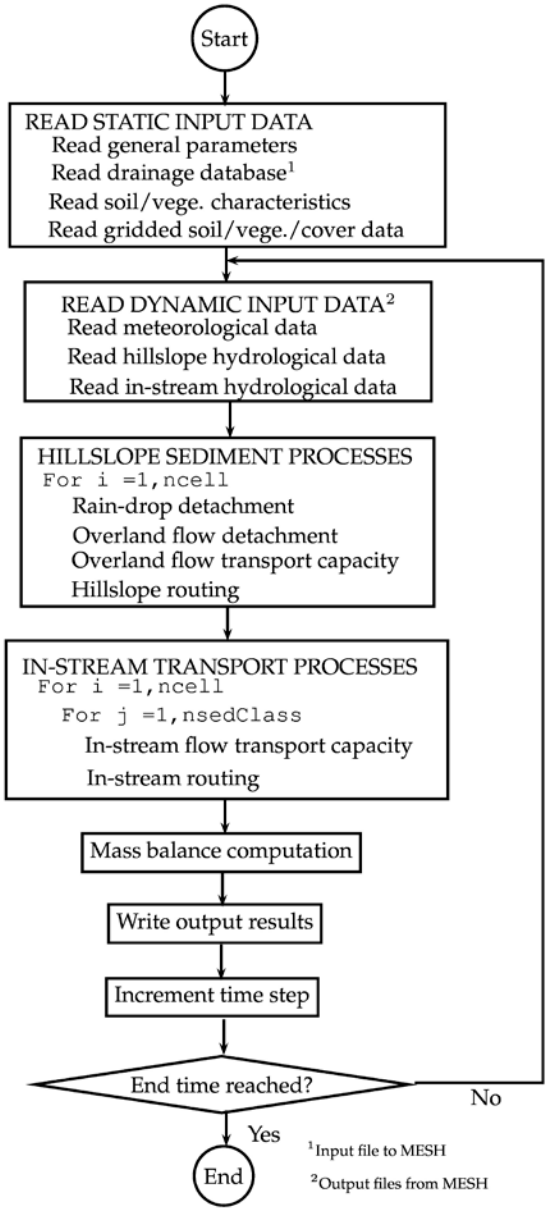
Successful MESH-RIVICE coupling – Ice Jam flood modelling for the lower Athabasca



MESH-SED conceptualization and software flow diagram - Sediment & nutrient transport modelling for the Athabasca River basin







Future

CentrEau
Centre québécois de recherche sur l'eau
Quebec Water Research Centre

GWF

McMaster University

UNIVERSITY OF WATERLOO

UNIVERSITY OF SASKATCHEWAN
Global Institute for Water Security
USASK.CA/WATER

Environment and Climate Change Canada
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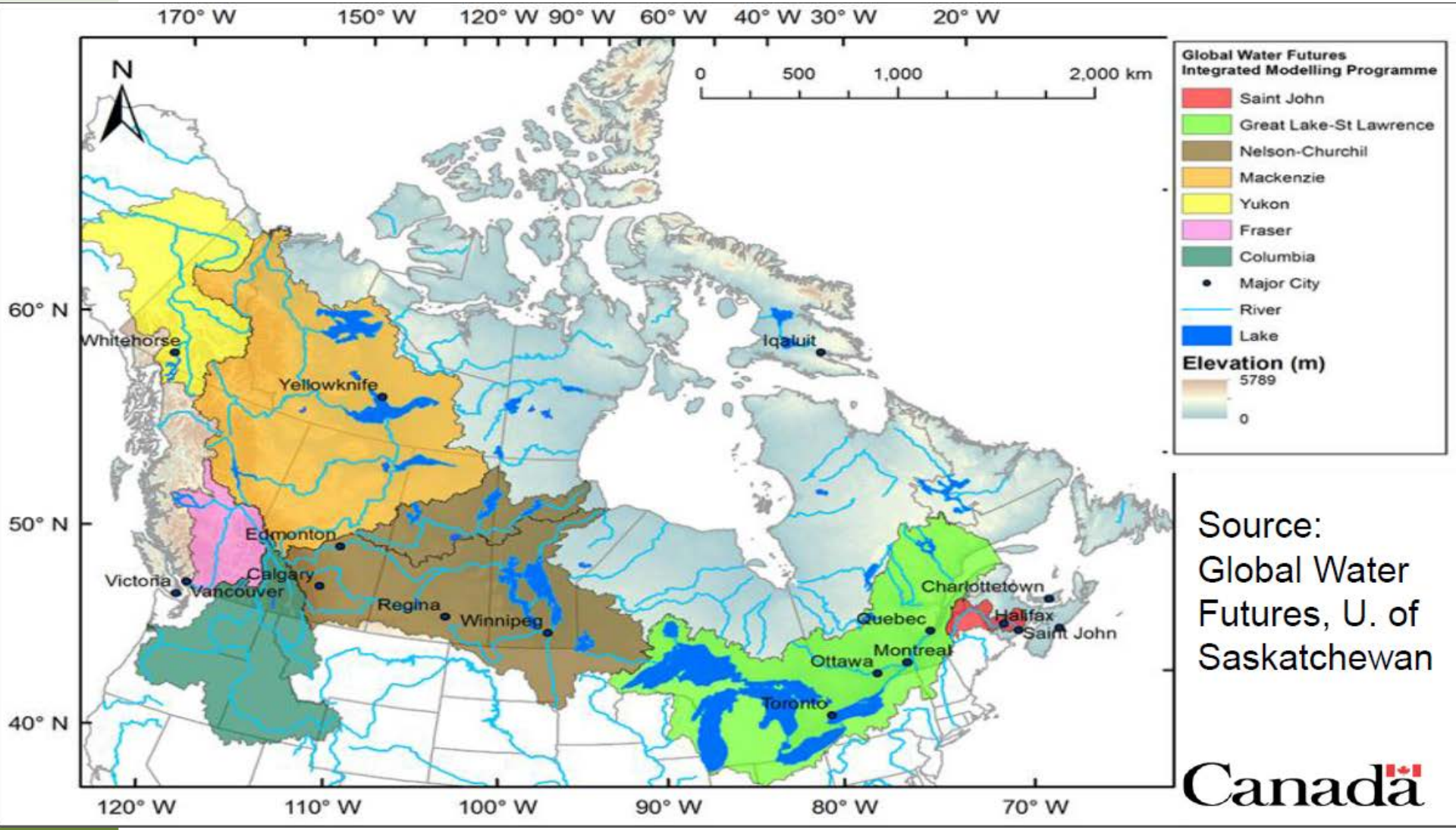
UNIVERSITY OF SASKATCHEWAN

Future



Source: Global Water Futures, U. of Saskatchewan

Canada