A5: Hydrologic model inter-comparison and multi-model analysis for improved prediction

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Project A5 Description in IWPC Proposal

- **Context**: Advancing and improving land-surface hydrologic modelling requires detailed model intercomparison studies to learn about shortcomings in specific models and ultimately perform multi-model analysis to describe model prediction uncertainties.

- **Objectives and Method**: This WP will carefully benchmark the GWF land surface hydrologic models (MESH, VIC, HYPE, etc.) against each other on multiple distinct modelling case studies. Research questions include: what amount of monitoring data is needed to distinguish model performance levels? What kind of calibration effort is required to fit the models to the available data? These efforts will be linked to the Great Lakes Inter-comparison Project (GRIP).

- **Deliverables**: Hindcasting prediction quality of the different models assessed and compared in the first three years. In subsequent years the assessment will be from a forecasting perspective. Study Areas: Nelson-Churchill, Mackenzie and Great Lakes.

Researcher/HQP and Basins and Models

- Tolson
  - 0.8 PhD (Shen)
  - 0.5 PDF Core (TBD)
- Stadnyk
- Razavi
- Pietroniro
- Pomeroy
- Wheater
- *Fortin*
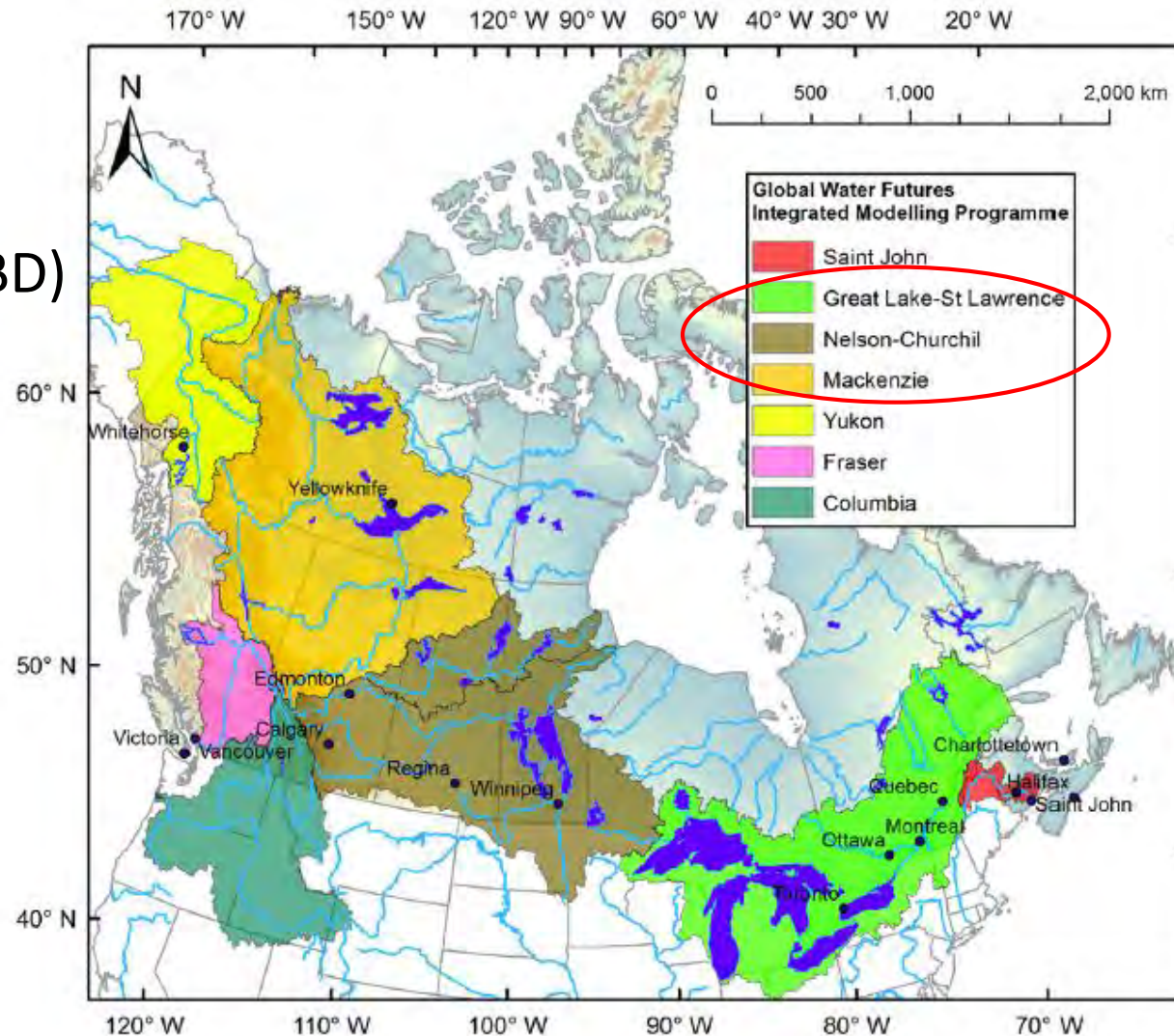
- VIC
- HYPE
- MESH

- GEM-HYDRO
- WRF-HYDRO
- CHRM
- LBRM

Modelling Scale Question

- Think of this in terms of what will be in a published comparison paper
- MESH vs HYPE vs VIC compared:
    a. in multiple major Canadian River basins (~across Canada)
    b. in one of the three major Canadian River basins (e.g., Great Lakes St. Lawrence)
    c. <u>In one large subbasin of a major Canadian River Basin</u> (e.g., Lake Erie subbasin)
    d. In smaller well-instrumented research watersheds
- My suggestion is: starting with c), then possibly moving to b), <u>and later</u> d) could be real interesting but option d) not explicitly listed in proposal …
- Research question regarding amount of data needed to distinguish model performance is best suited for d) in my opinion
- *What scale are model users interested in? And which users are linked with project A5?*

Surveying Collaborators

- Survey of modelling by collaborators across Great Lakes St. Lawrence, Nelson-Churchill, Mackenzie River Basins

- Note scale/location modelled, if work is completed or ongoing or part of IMPC, model simulation period, citation, *anything else?*

Researcher	MESH	VIC	HYPE	Other models
Tolson & Hagnegahdar	- Great-Lakes St Lawrence (most of basin) - Completed - Simulation period* - citation			
Razavi				
Stadnyk				
Pomeroy				
Wheater				
Fortin				

Making this work …

- Challenge here is collaborators not explicitly funded in A5 …
- Plan for my team: 0.5 Core modeller (& 0.8 of PhD Shen)
  - Somehow organize and make available a consistent set of climate forcing data and system response data for each study area considered
  - Consistent format for easy sharing
  - Responsible for modelling with VIC and at least one of MESH and HYPE depending on other researchers participating in comparison
  - Making baseline model discretization decisions
  - Responsible for performing consistent calibration experiments (algorithm, supercomputer support)
  - Address multi-model research questions
- Plan for the rest of the collaborators:
  - …

Making this work …

- Plan for the rest of the collaborators:
  - Host core modeler for data mining of your past modelling studies in select basin?
  - Invite all of you to participate in the *IMPC Model Intercomparison Challenge for Basin X*
  - Tolson research team will make this as easy as possible for you and the expectation is co-authorship of corresponding journal paper
- Making this a 'challenge' functions to:
  - Keep participation optional for all of you
  - Leaves it open for any of you to add whatever model you wish to the comparison
  - Create the potential to open this up to researchers around the world to participate

After the Challenge is completed

- My team will archive results
- Archived results form a baseline for assessing quality/success of any future enhancements to MESH/HYPE/VIC etc.

How my team is getting started

- PhD Shen will review Grip-O (Lake Ontario local subbasin) publication work that was led by Fortin's ECCC team (collaborating with US counterparts and my team)

- PhD Shen will use Grip-O results/inputs to quickly apply VIC to various subbasins from Grip-O [target completion is December]

- We continue to look for an ideal core modeler (PDF) but hiring is unlikely until Jan or May, 2018

Work Progression – by basin/subbasin

- Lake Ontario:
  - Perhaps we should consider augmenting Grip-O study with HYPE and other models … essentially repeat?
- In my discussions with some partners, the interest was in:
  - Lake Erie subbasin (ties nicely into other GWF projects at Waterloo)
  - Lake Champlain subbasin
  - Interest in Grand River watershed scale models (subbasin of Lake Erie)
  - All of which are in Great Lakes St Lawrence region
- My team is keen to move forward first on one or more of these subregions and I envision doing this in close collaboration with Fortin's team and US collaborators/partners
- Next basin depends on survey results and interest level of collaborator(s)

Other Discussion Points

- My related work in FloodNet
  - CASPAR
  - Robust modelling with single model (versus multi-model)
- Model comparison design needs to consider:
  - All measured response data
  - Uncertainty
- Despite their simplicity, we have seen in Grip-O some value in using lumped models like GR4J, LBRM to benchmark more complex model performance