IMPC Meeting 2019

Status report on the Great Lakes Runoff Inter-comparison Project for Lake Erie (GRIP-E)

Juliane Mai, Bryan A. Tolson, Hongren Shen, Étienne Gaborit, Nicolas Gasset, Dorothy Durnford, Young Lan Shin, Lauren M. Fry, Tim Hunter, Andrew D. Gronewold, Katelyn FitzGerald, Laura Read, Hervé Awoye, Tricia Stadnyk, Lacey Mason, Kevin Sampson, Alan F. Hamlet, Shervan Gharari, Saman Razavi, Amin Haghnegahdar, Daniel Princz, Alain Pietroniro, Frank Seglenieks Emily A. Bradley, Ming Han, Xiaojing Ni, Yuan Yongping
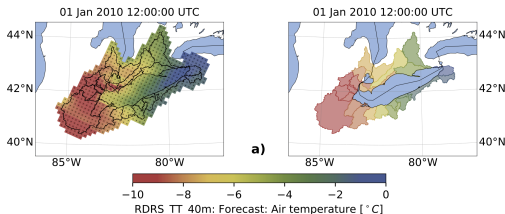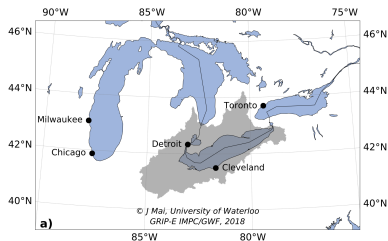
Overview

- **11 models** currently participating
- **27 collaborators** from 16 institutions (Canada and US)
- **1 domain**: Lake Erie watershed incl. Lake St. Clair
- **1 forcing dataset**: hourly RDRS dataset (2010-2014) incl. all main forcings
- **1 platform:** all data and scripts shared on GitHub
- **1 meeting** per month

RDRS_TT_40m: Forecast: Air temperature [°C]

Aim of Study

- Develop strategies to handle **cross-border issues** of available data and develop unifying approaches
- Test **relative performance** of different models
- Identify respective **strengths of models**, i.e., learning which models perform best under certain conditions

Models & Partners Currently Participating

Complexity

LBRM model (lumped)
Lauren Fry (USACE)
Emily A. Bradley (USACE)
Tim Hunter (NOAA-GLERL)

HYPE model
Hervé Awoye (U of Manitoba)
Tricia Stadnyk (U of Manitoba)

WATFLOOD model
Frank Seglenieks (ECCC)

MESH-SVS/CLASS model
Amin Haghnegahdar (U of Sask.)
Daniel Princz (ECCC)

GEM-Hydro
Étienne Gaborit (ECCC-MSC)
Dorothy Durnford (ECCC-MSC)
Young Lan Shin (ECCC-MSC)

GR4J model (lumped)
Hongren Shen (U of Waterloo)

GR4J model + Raven routing
Hongren Shen (U of Waterloo)

SWAT model
Xiaojing Ni (US EPA)
Yuan Yongping (US EPA)

VIC model + Raven routing
Hongren Shen (U of Waterloo)

VIC-GRU model + Raven routing
Shervan Gharari (U of Sask.)

WRF-Hydro
Drew Gronewold (U of Michigan)
Laura Read (NCAR)
Katelyn Fitzgerald (NCAR)
Lauren M. Fry (USACE)

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Objectives of Inter-Comparison Project

Objective 1 – Modeling Every Location of Lake Erie Watershed
(low human-impact watersheds)

- Evaluation of models based on NSE at
  28 WSC and USGS gauge stations.

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Objective 2 – Modeling only inflows to Lake Erie watershed

- Evaluation of models based on NSE at
  31 WSC and USGS gauge stations.

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31 WSC and USGS gauge stations.

Objective 3 – Modeling Inflows and Net Basin Supply
to Lake Erie and St Clair

- Monthly net basin supply and inflows provided.
Evaluation metric under discussion.

Phases of Inter-Comparison Project

Phase 0 – common climate forcings only (default model run)

     ✓ completed (WRF-Hydro pending)

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Calibration Details

- all groups performed automatic calibration
- following models use **individual** sub-basin parameterization:
    - LBRM
    - GR4J-Raven (lumped and semi-distributed)
    - SWAT
- following models used **shared** sub-basin parameterization:
    - HYPE
    - VIC
    - VIC-GRU
    - GEM-Hydro
    - MESH-SVS
    - MESH-CLASS
    - WATFLOOD
    - WRF-Hydro

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Inter-Comparison Results

– Phase 1 (Calibration) –

Model	Lead	Objective 1 Phase 1	Objective 2 Phase 1
LBRM	Fry & Bradley	0.66	0.72
GR4J-Raven-lp	Shen & Mai	0.63	0.67
GR4J-Raven-sd	Shen & Tolson	0.64	0.67
SWAT	Ni & Yuan	0.19	n/a

Values reported in table are median NSE values over
28 gauges stations (objective 1) and 31 stations (objective 2)

Inter-Comparison Results

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SWAT	Ni & Yuan	0.19	n/a
HYPE	Awoye & Stadnyk	0.52	0.48
VIC	Shen & Tolson	0.41	0.43
VIC-GRU	Gharari	0.41	0.47
GEM-Hydro	Gaborit	0.30	0.34
MESH-SVS	Princz & Gaborit	0.38	0.39
MESH-CLASS	Princz & Haghn.	🕐	🕐
WATFLOOD	Seglenieks	0.33	0.32
WRF-Hydro	Read & Gronewold	🕐	🕐

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Inter-Comparison Results
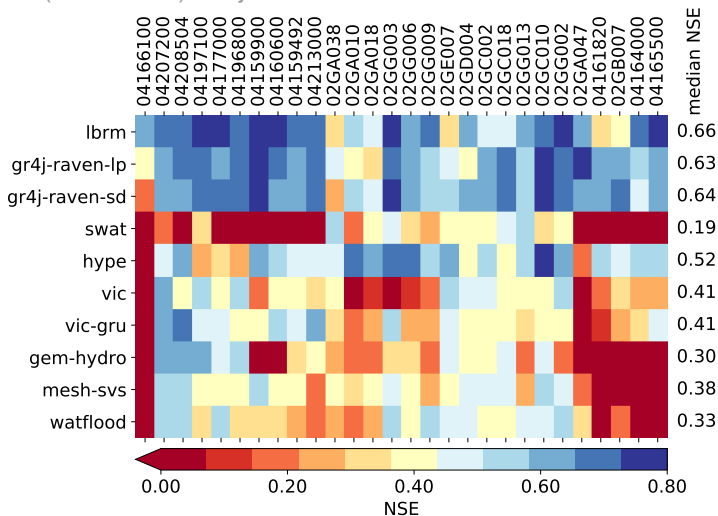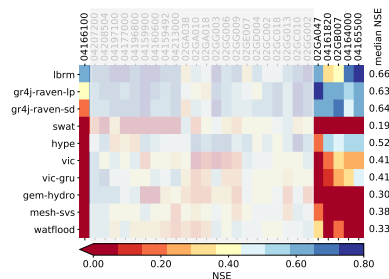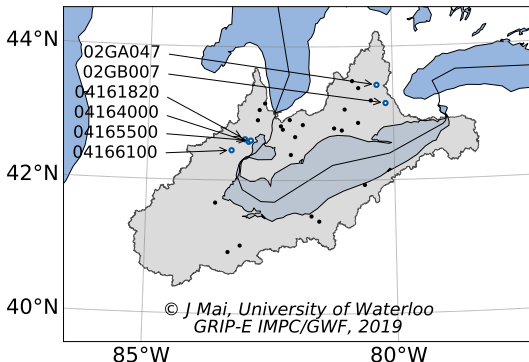
– Phase 1 (Calibration): Objective 1 –

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Inter-Comparison Results
– Phase 1 (Calibration): Objective 1 –

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GRIP-E IMPC/GWF, 2019

02GA047 ... SPEED RIVER AT CAMBRIDGE (762 km^2)
02GB007 ... FAIRCHILD CREEK NEAR BRANTFORD (389 km^2)
04161820 ... CLINTON RIVER AT STERLING HEIGHTS MI (803 km^2)
04164000 ... CLINTON RIVER NEAR FRASER MI (1143 km^2)
04165500 ... CLINTON RIVER AT MORAVIAN DRIVE AT MT. CLEMENS MI (1893 km^2)
04166100 ... RIVER ROUGE AT SOUTHFIELD MI (224 km^2)

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What's next?

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What's next?

Lake Erie but using common forcings and **common input data**?
Extend domain to **Great Lakes**?
Repeat everything for a basin in **Western Canada**?

Participation in Upcoming Phases

Phase 2: Setup and run **Lake Erie** watershed using common input and forcing dataset.
Phase 3: Setup and run **Great Lakes** watershed.

Model	Lead	Phase 2	Phase 3
LBRM	Fry & Bradley	🟩	🟩 using common dataset
GR4J-Raven-lp	Shen & Mai	🟩	🟩 using common dataset
GR4J-Raven-sd	Shen & Tolson	🟩	🟩 using common dataset
HYPE	Awoye & Stadnyk	🟩	🟩 using common dataset
VIC-GRU	Gharari	🟩	🟩 using common dataset
MESH-CLASS	Princz & Haghn.	🟩	🟩 using common dataset
WATFLOOD	Seglenieks	🟩	🟩 using common dataset
VIC	Shen & Tolson	🟧	🟧 using common dataset
GEM-Hydro	Gaborit	🟧	🟧 using common dataset
MESH-SVS	Princz & Gaborit	🟧	🟧 using common dataset
WRF-Hydro	Read & Gronewold	🟥	🟩 using individual dataset
SWAT	Ni & Yuan	🟥	🟥

🟩 . . . we are in   🟧 . . . maybe later   🟥 . . . no way

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Phases of Inter-Comparison Project

Phase 0 – common climate forcings only (default model run)

    ✓ completed (WRF-Hydro pending)

Phase 1 – common climate forcings only (calibrated model run)

    ✓ almost completed (WRF-Hydro and MESH pending)

Phase 2 – common climate and all other inputs

    ✓ completed identification of common input data
    ⊕ started: model setup
    ⊕ start Sep 1, 2019: model calibration
    ⊕ start Dec 1, 2019: model validation

Phase 3 – extend domain to Great Lakes Watershed

    ⊕ parallel to Phase 2

Common Input Dataset

Meteorological forcings (Phase 0 to 3)

Regional Deterministic Reanalysis System (RDRS)

15km, hourly, 2010-2014

Digital elevation map (Phase 2 & 3)

HydroSHEDS (3" ≈ 90m)

Land cover map (Phase 2 & 3)

NALCMS, 19 land cover classes for North America

30m, Landsat, 2010 for Mexico and Canada, 2011 for U.S.

Soil database (Phase 2 & 3)

Global Soil Dataset for Earth System Models (GSDE)

30" (≈ 1km) containing 8 layers of soil to a depth of 2.3m

Groundwater table depth (Phase 2 & 3)

Global patterns of groundwater table depth – 30" (≈ 1 km)

Fan et al. (2013) Science, 339 (6122)

Phases of Inter-Comparison Project

Phase 4:
Model-Intercomparison over Nelson-Churchill Watershed

- will run completely in parallel to Lake Erie/ Great Lakes
- will be led by Hervé Awoye and Tricia Stadnyk
- if you are interested, please contact Hervé:
  `oyemonbade.awoye@umanitoba.ca`

Integrated Modelling Program for Canada
Global Water Futures

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Thanks!