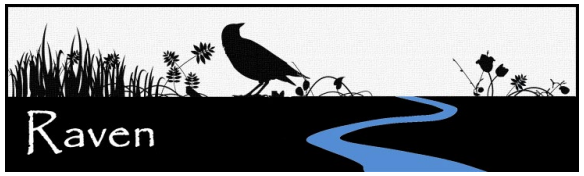

CALIBRATION, TEMPLATES, HYDROFABRICS, AND OTHER RAVEN MISCELLANY

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Raven Workshop. May 29, 2025. Penticton, B.C.

UNIVERSITY OF WATERLOO

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heron hydrologic

Goals

- Knowledge sharing
  - … after teaching 62 UWaterloo undergrads hydrologic modelling with Raven
- Convince you all to use RavenView **from this day forth**
- Convince you all to use the Canadian Lake & River Hydrofabric (or OLRRPv2 in Ontario) to build your next Raven model
- Learn about your modelling needs and suggestions

Surveys

- RavenView
  - How many Raven modellers have NOT used RavenView in practice?
- Uwaterloo hydrofabrics (CLRH or OLRRP)
  - How many Raven modellers have NOT used CLRH/OLRRP to date?

RavenView Demo 1: no geojson files

- Open RavenView: https://raven.uwaterloo.ca/RavenView/RavenView.html
- Import any Raven time series file with this button:

  - Forcing file .rvt
  - Observed streamflow .rvt
  - **any** Raven output file
- Begin your diagnosis and inspection!!!

Canadian Lake & River Hydrofabric

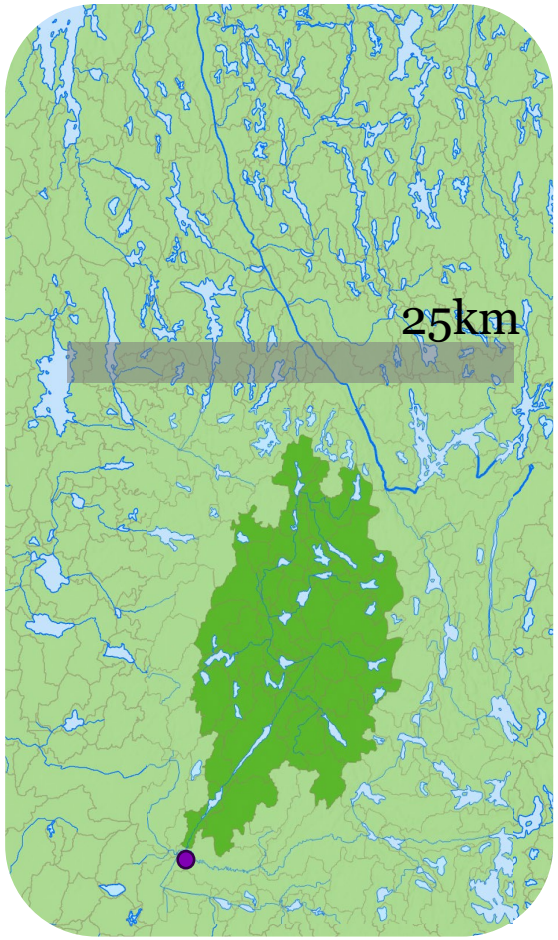
- Go here: hydrology.uwaterloo.ca/CLRH/

- Check out **08JB006**

The Canadian Lake-River Hydrofabric (CLRH)

CLRH:

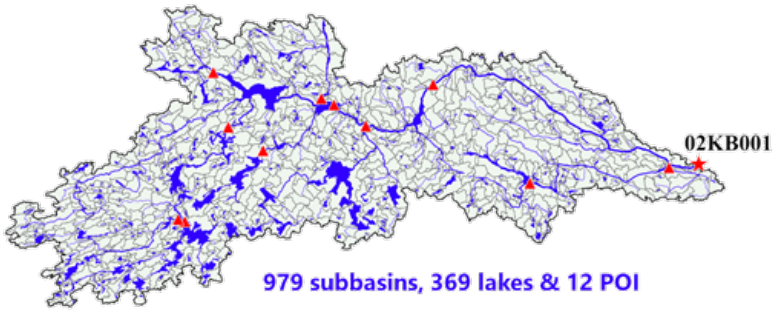
- Is as consistent as possible with NHS National Hydrometric Network Basin Polygons prerelease (2024/08/29) - uses ECCC flow direction raster developed with NHN (J. Weibe's group)
  - Blue line network respected!
- Resolves subbasins at a scale of ~5km², lakes >0.1km²
- Includes subbasin outlets at key points of interest (POIs)
  - HYDAT gauges,
  - Available provincial flow and level monitoring gauges
  - River crossings along U.S. border
- Subjected to rigorous quality control

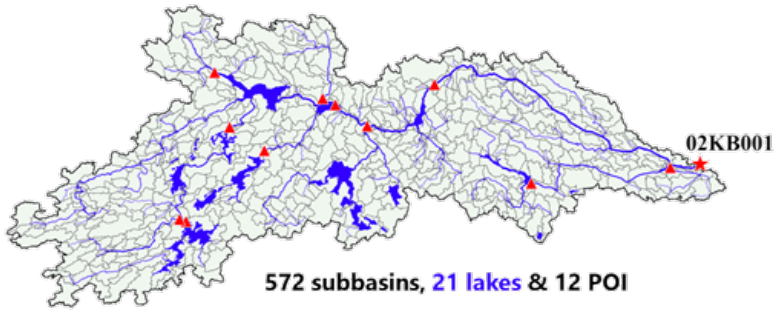


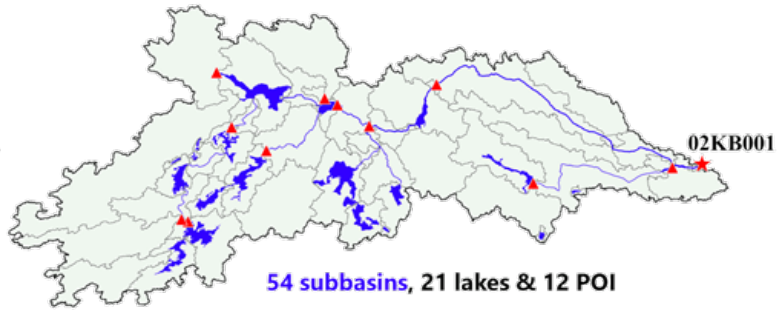
CLRH & BasinMaker 3.1

https://hydrology.uwaterloo.ca/basinmaker/

- Open source software tool developed at uWaterloo
- Can delineate site-specific routing network from any DEM/FDR/Lake polygon dataset
  - Key strength – proper delineation of Lakes!
- Can be used to customize base CLRH data for user purposes
  - Add/remove POIs
  - Decrease spatial resolution
  - Decrease number of lakes based on threshold
- Can directly generate Raven hydrological model input files







Canadian Lake & River Hydrofabric DEMO

- Looking for a volunteer:
  - Do you have one of your Raven models you can run on your laptop here?
  - Is it a lumped model? [or did you build your .rvh without using CLRH?]
  - Is your watershed < 5000 km2?
  - Will you provide the group a WSC gauge ID or watershed outlet location?

Canadian Lake & River Hydrofabric

- Go here: hydrology.uwaterloo.ca/CLRH/
- Follow along and we can all delineate our new favourite watershed

Canadian Lake & River Hydrofabric DEMO

Updating your model to use the new CLRH files from BasinMaker Colab:

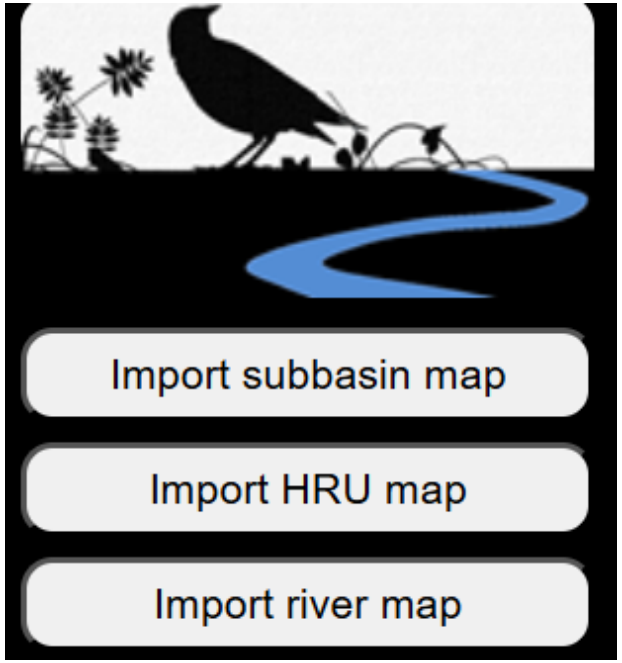
1. Replace your .rvh and channel_properties.rvp files with ones from CLRH
2. Edit .rvp as follows:
   a. Insert a redirect to channel_properties.rvp at the end of the file
   b. Change your dominant LAND_USE_CLASS VEG_CLASS SOIL_PROFILE names to (respectively):

      Landuse_Land_HRU Veg_Land_HRU Soil_Land_HRU

3. In .rvi, use :Interpolation INTERP_NEAREST_NEIGHBOR
4. Change the SubID in your observed flow .rvt to the CLRH subbasin ID containing your WSC gauge
5. Try and run it!

RavenView Demo 2: geojson files from CLRH

- Open RavenView: https://raven.uwaterloo.ca/RavenView/RavenView.html
- Import any CLRH generated geojsons with these buttons:



← finalcat_info_v1-0.geojson (the one you just downloaded)

← routing_product_lake_river.geojson (the one you just downloaded)

- Begin your diagnosis and inspection!!!

RavenView Demo 3: geojsons & Raven output files

- You can do this one yourself
- Click the Help button
  - Watch the 5 minute Youtube video starring James Craig
  - https://www.youtube.com/watch?v=-znMUKHjee0&feature=youtu.be

- Combination gives you your **map-based Raven output viewer**

- **If you think you might like to create a permanent RavenView webpage hosting your model and results … email the Heron Hydrologic team (Rob, Bryan, James, Hannah)**

Semi-distributed model templates: Coming Soon

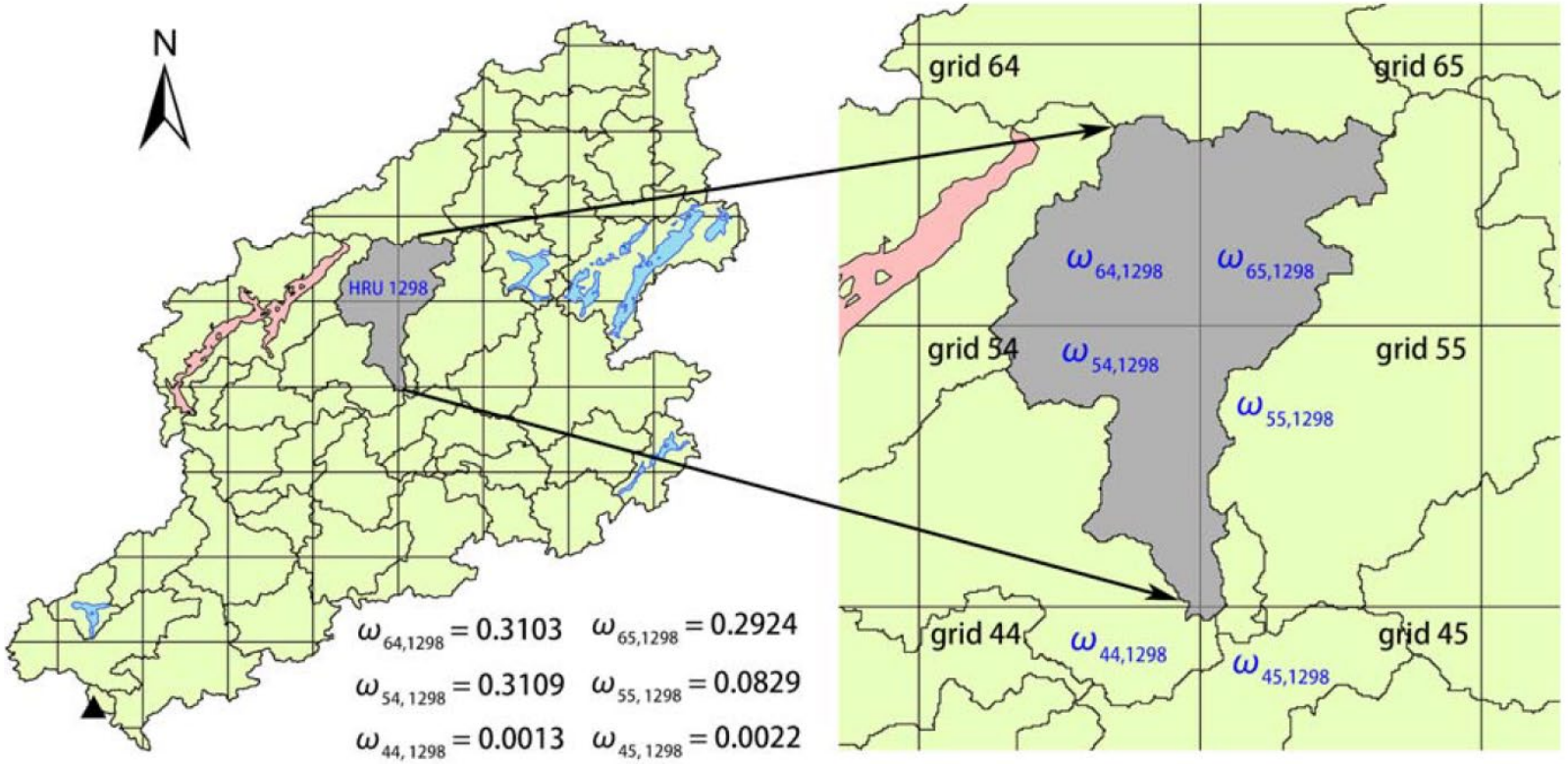
- Current Raven model template files apply directly to lumped model configurations
- **Next Raven release**, each template will be constructed with a semi-distributed (land & lake HRU) configuration as the assumed default user case:
  - .rvi will be paired with an .rvp file:
  - Provides reasonable parameter default values
  - Will identify inactive/artificial parameters with 'Not_used' label (and Raven will warn you if it wants to use that value)
    - Saves unnecessary sensitivity analysis & helps keep your model truly the 'HBV-EC' model
- **To get a model simulating:**
  1. **Generate CLRH routing network/delineation files (.rvh from Colab) +**
  2. **The new template files (.rvp & .rvi) +**
  3. **Your climate forcing inputs (.rvt)**

Canadian Surface Reanalysis (CaSR) version 3.1

- A few weeks ago ECCC released version 3.1 of their Canadian Surface Reanalysis forcing product (Khedhaouiria et al., 2025)
  - https://hpfx.collab.science.gc.ca/~scar700/rcas-casr/index.html
- 43 yrs of 10x10 km gridded model forcings from CaSR v3.1 subdaily timestep data:
  - Derived analysis rainfall (1-hour timestep)
  - Derived analysis snowfall (1-hour timestep)
  - Analysis air temperature (3-hour timestep)
- **Analysis** here means forcing variable is the ECCC numerical weather forecast model predictions with assimilated daily observations
- **If you are building a Raven model for forecasting, THIS is the forcing data you really should use to calibrate**

Khedhaouiria, D., Gasset, N., Fortin, V., Dimitrijevic, M., Lauer, A.. et Bulat, M. (2025): Canadian Surface Reanalysis [CaSR] v3: ECCC hourly 0.1° surface reanalysis across North America [IN PREPARATION]

Remapping gridded forcings to HRUs/subbasins: Grid Weights



- UWaterloo team has 2-3 open source toolkits for generating the grid weights file

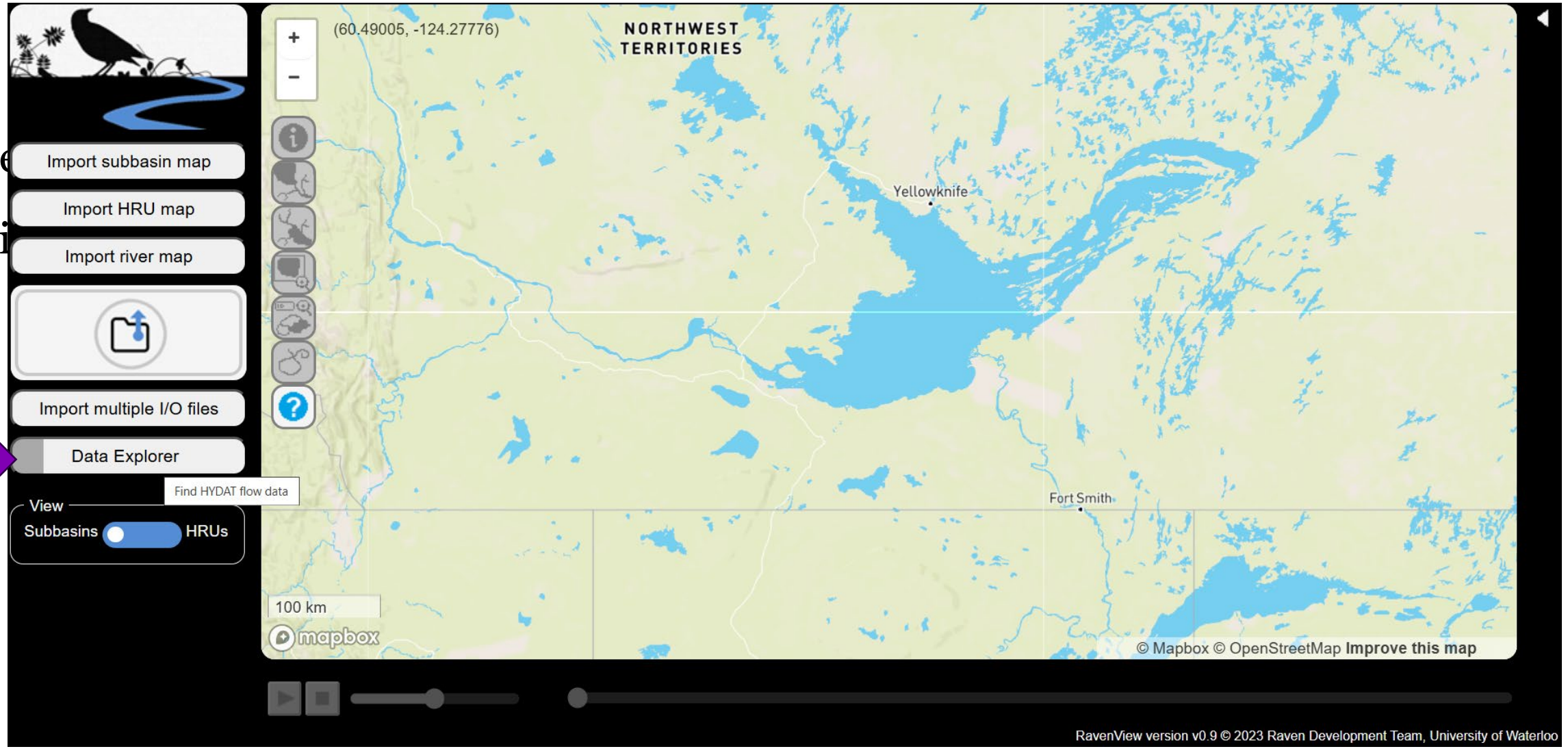
Canadian Surface Reanalysis (CaSR) version 3.1

- Comes in NetCDF format
- https://hpfx.collab.science.gc.ca/~scar700/rcas-casr/download_CaSRv3.1_regions_var_period.html
- Team Raven is very good at using this NetCDF format data
- But is this useable for you and your team (NetCDF)?
- Heron/UWaterloo team wants to help make this more accessible to you all. Ideas?

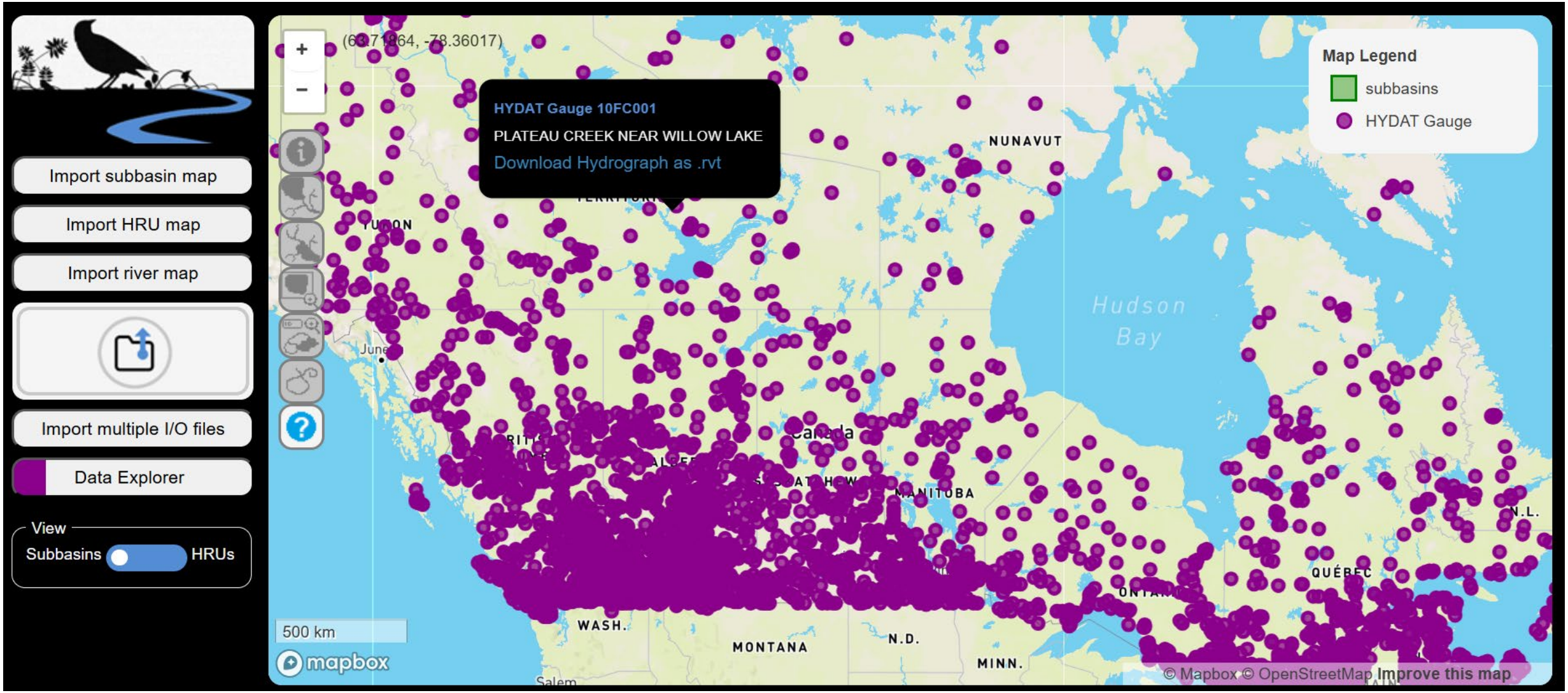
RavenView Next Generation: ECCC Data Explorer Mode

Some

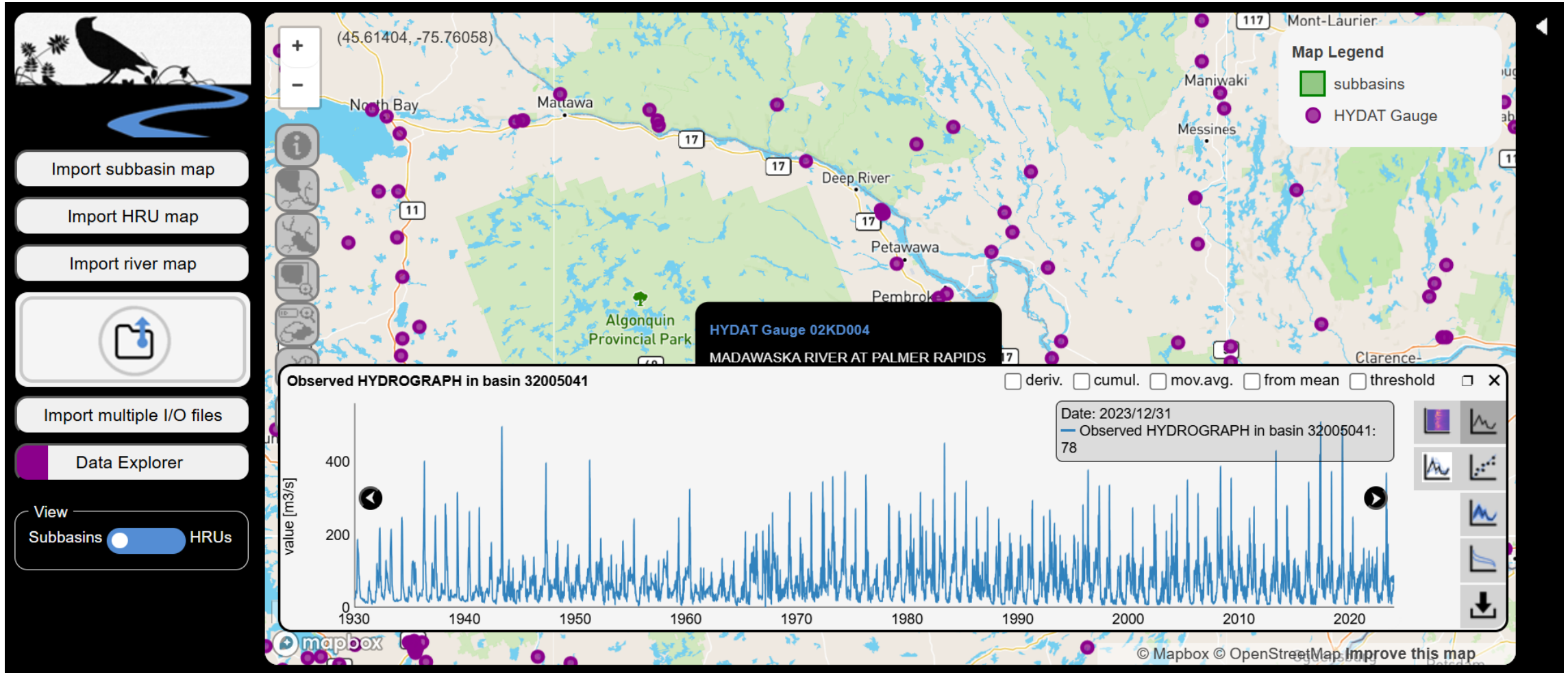
- Pri



RavenView Next Generation: ECCC Data Explorer Mode



RavenView Next Generation: ECCC Data Explorer Mode



RavenView Next Generation: ECCC Data Explorer Mode

- Official release date is Ju** this year ☺
- Serves up daily time step .rvt formatted files for all WSC streamflow gauges (plug into your model)
  - Referenced to CLRH subbasin ID's
- Gives you all RavenView functionality to inspect and analyze observed flow data
- Drag and drop hydrographs onto one another …

Raven framework functions you should know about

- **:AggregateDiagnostic**
  - e.g. median KGE of multiple gauges

```
:AggregateDiagnostic [agg_stat] [datatype]
e.g.,
:AggregateDiagnostic AVERAGE HYDROGRAPH
```

- **:EvaluationPeriod** *cond* options
  - Diagnostics for flows beyond specified percentile

The optional arguments `cond` and `thresh` can be used to exclude observation data based upon a threshold percentile. `cond` can be one of `IS_GREATER_THAN` or `IS_LESS_THAN` and `thresh` is a number between 0 and 1. This conditional clause determines the frequency of observed flows in the evaluation period then retains data above or below the specified threshold percentile (expressed from 0 to 1). For instance,

```
:EvaluationPeriod CALIB_HI 2002-10-01 2008-09-30 IS_GREATER_THAN 0.2
```

Evaluates the diagnostics for the 80% highest magnitude observations during the simulation duration, and disregards the 20% smallest observations. For observed hydrographs, this may be considered retaining all flows larger than the Q20 flow.

- **:LateralEquilibrate**
  - Creates one groundwater store per subbasin (or watershed) instead of one per HRU

The Lateral Equilibrate process

Lateral equilibration is used to represent the basin-wide equilibration of storage over time. It would typically be used to represent groundwater exchange between deep groundwater storage or wetlands. The `:LateralEquilibrate` process uses the following syntax:

```
:LateralEquilibrate RAVEN_DEFAULT [HRUGroup] [SV] [mix_rate] {INTERBASIN}
```

Where `HRUGroup` denotes which HRU group this applies to in a given basin (often all HRUs), the `SV` refers to a source variable from table D.1). `mix_rate` is the percentage of water equilibrated per day (for a time step of 1.0 and mixing rate >1/d, the storage will be instantaneously equilibrated every day).

Calibrating to Water Levels

- You can do this easily … talk to myself or James if questions

Raven Input file in Routing Only Mode is Very Simple

SE.rvi

```
# ------------------------------------------
# Raven Input file
# GEM-Hydro SE region
# ------------------------------------------
:StartDate              2010-01-01 00:00:00          # Model run start time, f
:EndDate                2015-12-31 00:00:00          # Model run end time, for
:Method                 ORDERED_SERIES               # Numerical method used f
:TimeStep               24:00:00                     # Expressed in days as a
:RunName                SE                           # The name of model run.

:CatchmentRoute         ROUTE_DUMP                   # Catchment routing metho
:Routing                ROUTE_DIFFUSIVE_WAVE         # Channel routing method
:PrecipIceptFract       PRECIP_ICEPT_NONE            # Estimation of the preci
:PotentialMeltMethod    POTMELT_NONE                 # Estimation of the poten
:SWRadiationMethod      SW_RAD_NONE                  # Estimation of shortwave
:SoilModel              SOIL_ONE_LAYER               # In this routing model,
:OW_Evaporation         PET_NONE                     # Over water evporation,

:HydrologicProcesses
  :Precipitation     PRECIP_RAVEN          ATMOS_PRECIP     PONDED_WATER
  :Flush             RAVEN_DEFAULT         PONDED_WATER     SURFACE_WATER
  :Recharge          RAVEN_DEFAULT         ATMOS_PRECIP     SOIL[0]
  :Baseflow          BASE_THRESH_POWER     SOIL[0]          SURFACE_WATER
:EndHydrologicProcesses
```

Concluding Pledges for all of us ☺

1. From this day forth, I shall utilize RavenView to help me build my Raven models

2. Next time I build a Raven model, I shall attempt to use CLRH* for subbasin and lake delineation

*OLLRPv2 if I am building models in Ontario.

QUESTIONS ??