Please view the accompanying poster for manual flood forecasting with WATFLOOD and GreenKenue

Operational Flow Forecasting in the Mattagami River Basin with HydrologiX II

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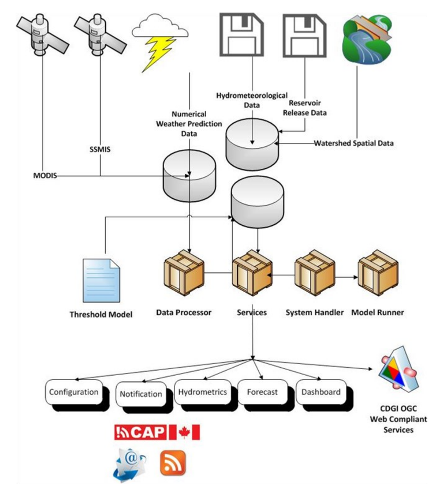
System

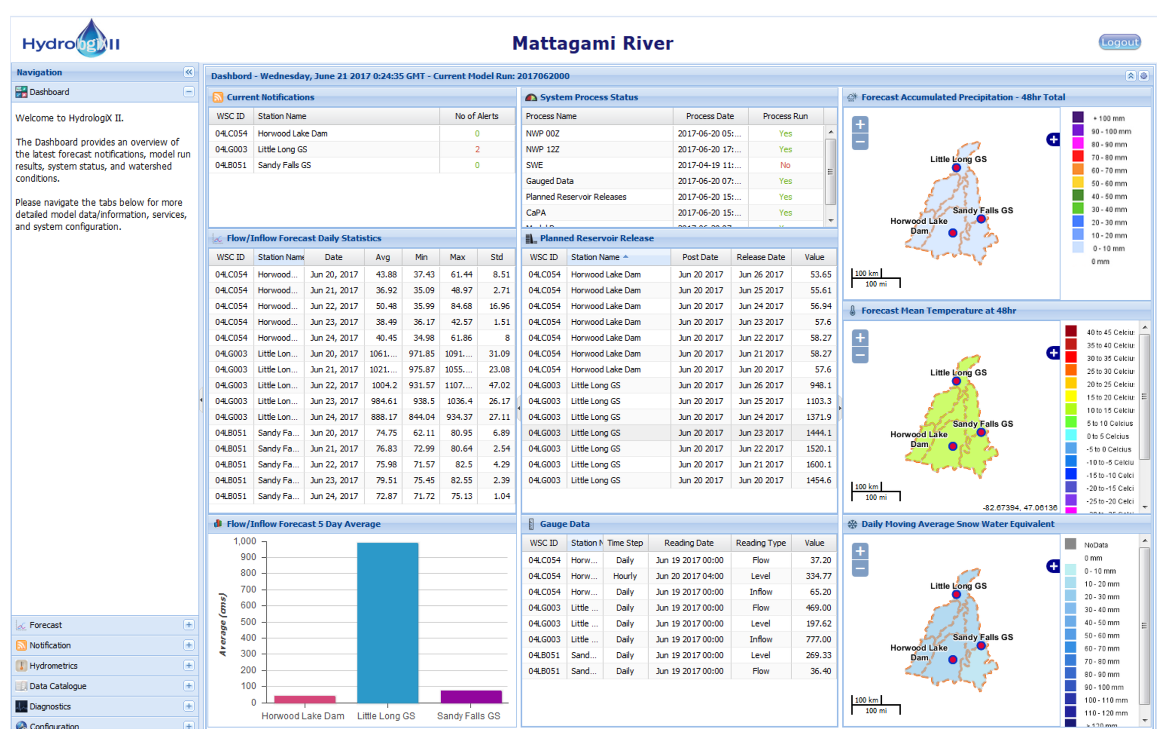
HydrologiX II is a fully automated operational flow forecasting system based on integrating hydrological process modelling with numerical weather prediction data. Key features of the HydrologiX II system:

- Data feeds for acquisition of meteorological, hydrometric and earth observation data from various sources
- Pre-processors for generating inputs to hydrological model (currently WATFLOOD/CHARM) and model runner for generating daily 10-day forecast
- Model neutral architecture open to using other models
- Feature-rich web interface for presenting forecast results, basin conditions (recent and forecasted temperature and precipitation, snowpack), system state
- Email and RSS notification system using flows and levels threshold model
- Data dissemination via OGC Compliant Web Services (WMS/WFS/SOS/WCS/CWS)

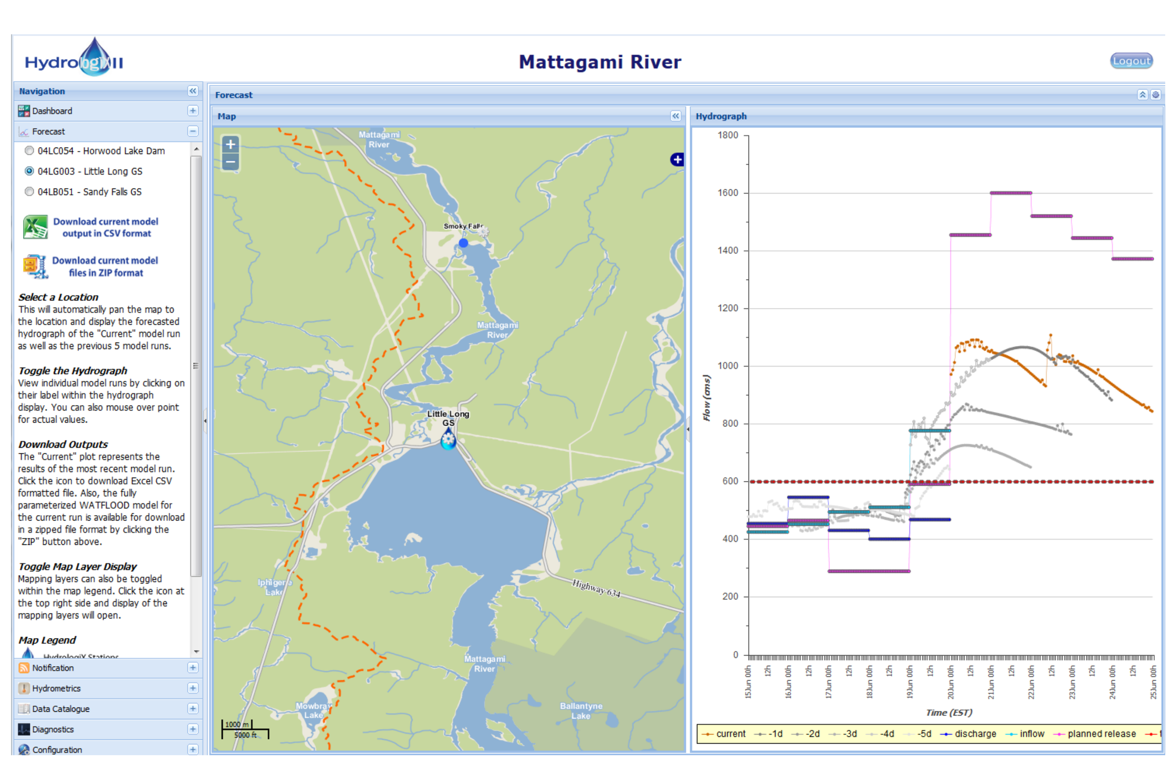


Other capabilities:

- Downloading model results of complete set of model files
- Diagnostics: model diagnostics plots
- Data catalogue
- System configuration



HydrologiX II dashboard provides situational awareness of the system and basin conditions



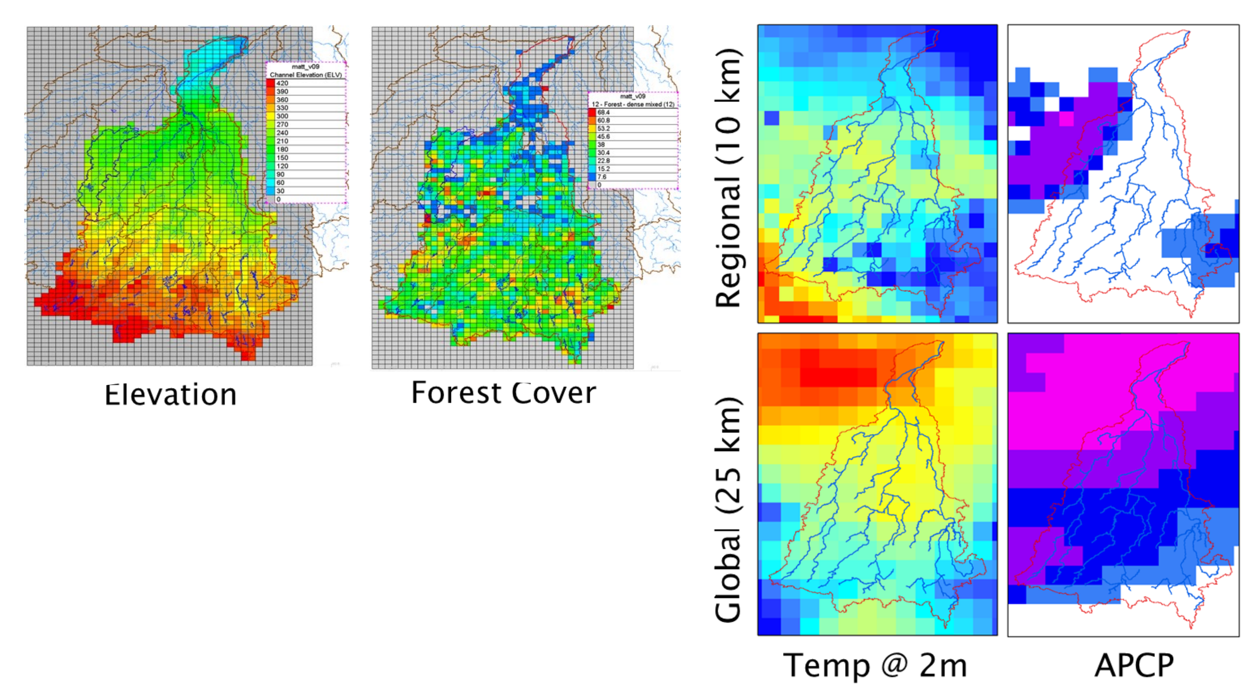
Forecast panel presents hydrographs at key locations of interest

Data

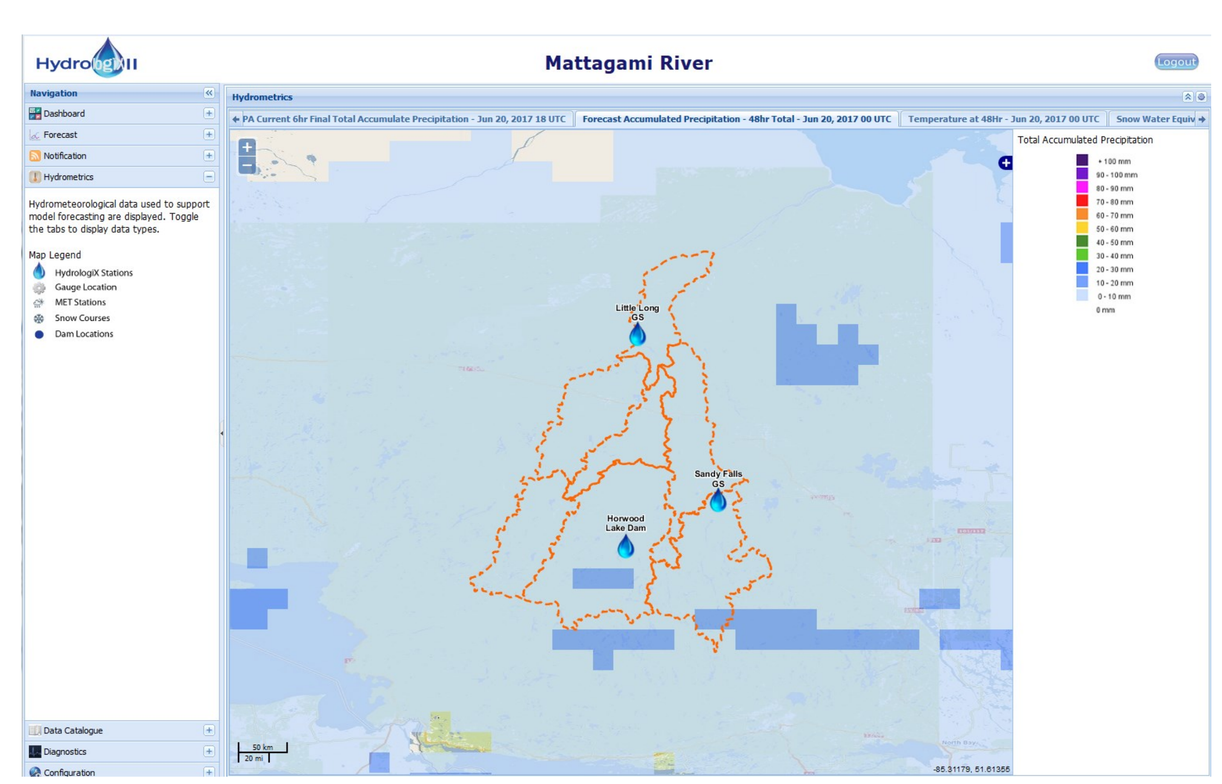
Data used:

- North American Regional Reanalysis (NARR)
- Canadian Precipitation Analysis (CaPA)
- Numerical weather prediction (NWP) data — Environment Canada GEM:
  - Regional Deterministic Prediction System (RDPS)
  - Global Deterministic Prediction System (GDPS)
- Water Survey of Canada hydrometric data

		Precipitation	Temperature
Long-term	Model calibration and validation (2002 - July 2014)	CaPA	NARR
Operational	Hindcast	CaPA	NWP RDPS
	Forecast (10-day)	Days 0-1: NWP RDPS Days 2-9: NWP GDPS	



Elevation and forest cover (left), example of numerical weather prediction data: air temperature and 6-hourly accumulated precipitation



48-hour forecasted total precipitation

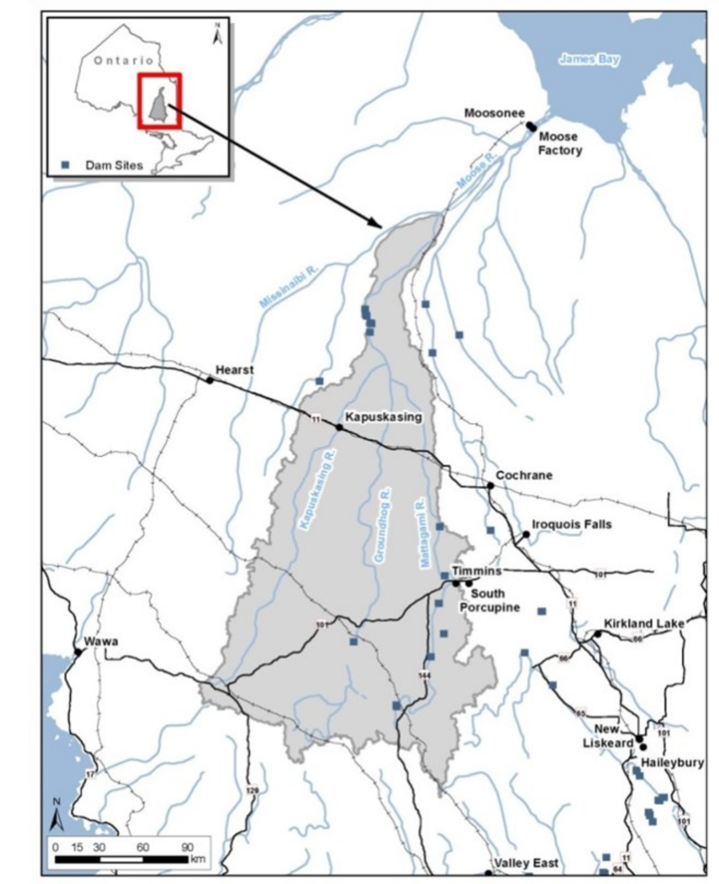
Model Development

HydrologiX II is currently using the WATFLOOD/CHARM distributed hydrological model (Dr. Nicholas Kouwen, University of Waterloo)

Model Setup

Mattagami River basin:

- 36,000 km^2, ~4.5 km model cell size
- 12 land cover classes
- Multiple lakes and reservoirs
- Hydropower water diversion



Model Calibration

- Manual calibration via trial-and-error: flow volume (emphasis on high flows), seasonal flow pattern, soil storage and runoff generation, snowpack and snowmelt, flow recession and baseflow, reservoir storage
- Automated: using Dynamically Dimensioned Search (DDS) algorithm in the OSTRICH optimization software package

Objective functions: model bias (volume error), root mean square error (RMSE), Nash-Sutcliffe efficiency (NS)

Key Results

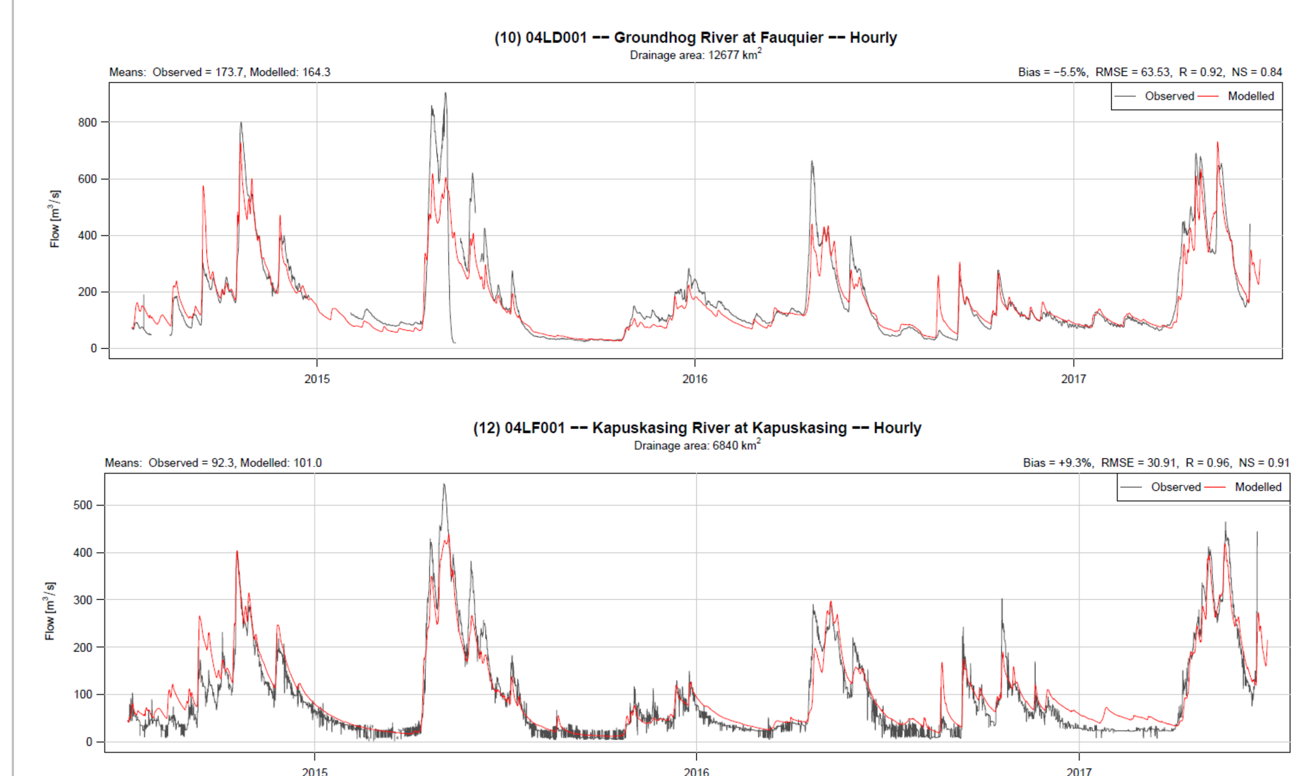
- Model bias within 1% overall, within 10% for 9 stations out of 11
- NS above 0.75 for 8 stations out of 11
- Performance is best for high flow periods (> Q3, i.e. above 75th percentile), lower for low (below 25th percentile) and intermediate (25th to 75th percentile) flows

Key model performance metrics. The metrics were calculated as the weighted means of corresponding objective functions across all 11 hydrometric gauges, where weights are long-term mean flows at the gauges.

Calibration Approach	Global Performance			Nash-Sutcliffe (NS) by		
	Bias [%]	RMSE	Nash-Sutcliffe (NS)	Low (< Q1)	Intermediate (Q1-Q3)	High (> Q3)
Manual	-1.61	42.02	0.82	-1.51	-1.79	0.73
Automated	1.11	29.99	0.87	-1.39	-1.05	0.80

Flow Forecasting

Hindcast Performance

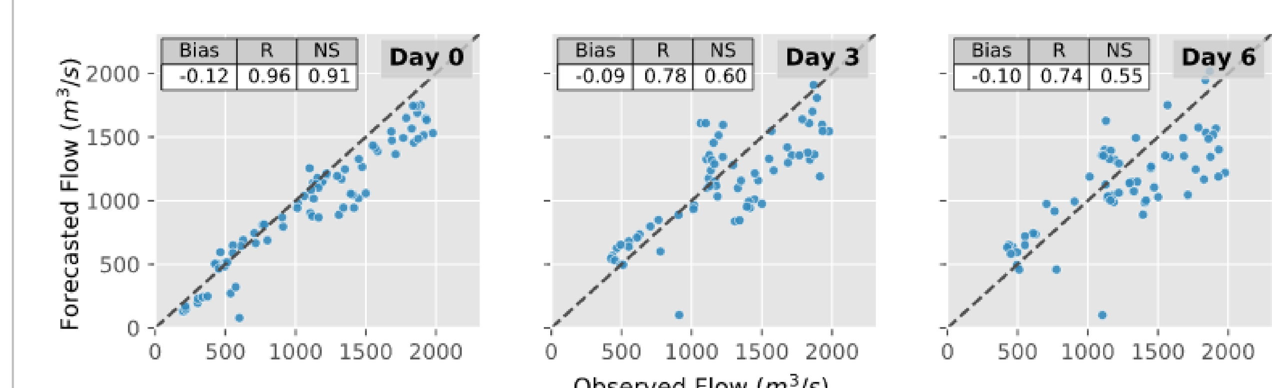


Model hindcast performance (July 2014–June 2017).

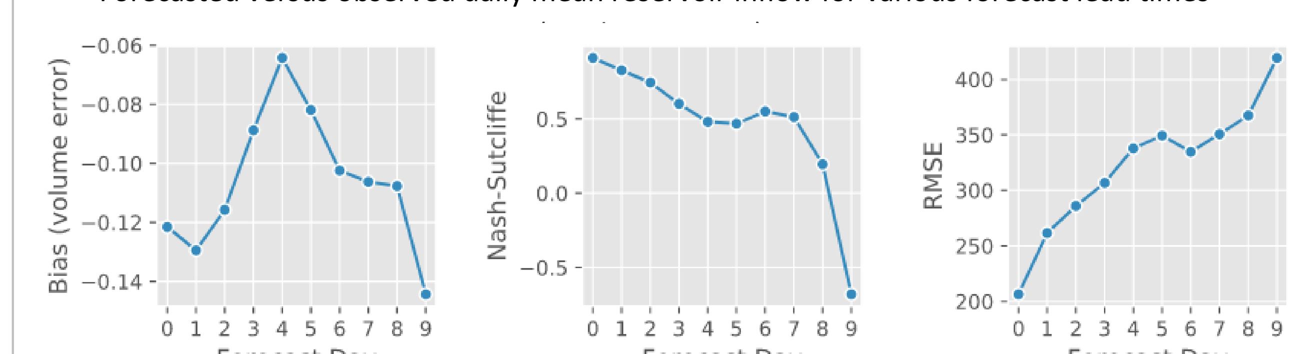
Forecast Performance

Example of reservoir inflow forecast:

- Reasonable fit for the first few days, deteriorates with forecast lead time (especially after day 6-7)



Forecasted versus observed daily mean reservoir inflow for various forecast lead times



Performance of reservoir inflow forecast as a function of forecast lead time (April–June 2017).

Acknowledgements