

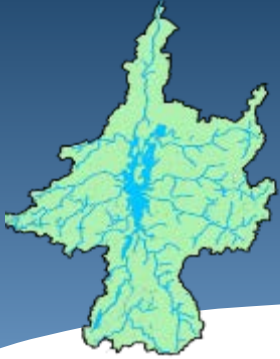
Technical webinar

Improvements in flood forecasting

Dominic Roussel (MELCC) and William Saunders (NOAA)

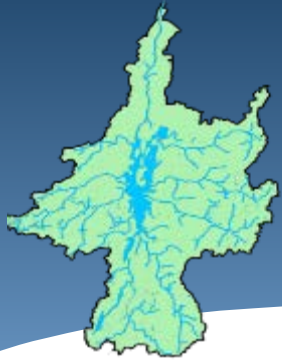


Webinar content



- Current flood forecasting services
- How a flood forecast is produced
- Technological improvements driven by the LCRR study
- Integration of multiple forecasts
- Towards flood mapping services





Flood forecasting services in the US

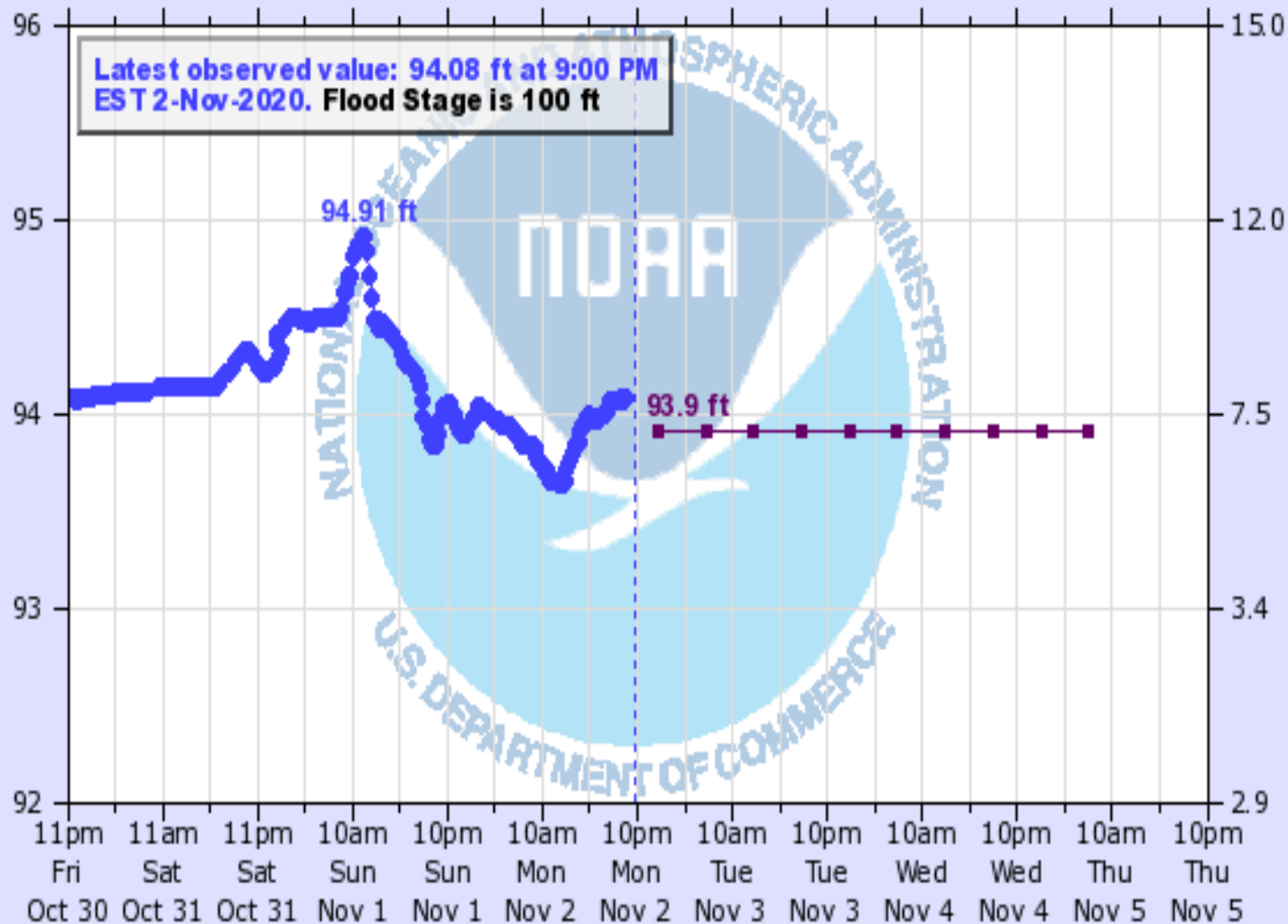
- River and Flood Forecasts (**Flow/Stage**) are Provided by the **NOAA National Weather Service**
- Regional **River Forecast Centers** Produce the Forecasts
- Local **Weather Forecast Offices** Issue Flood Watches & Warnings
- Products Include:
 - Deterministic Forecasts for over 4000 locations (21 in Champlain basin)
 - Text and Graphical
 - Graphical Outlook Products (5-day, Seasonal)
 - Flash Flood Guidance
 - Ensemble Forecasts



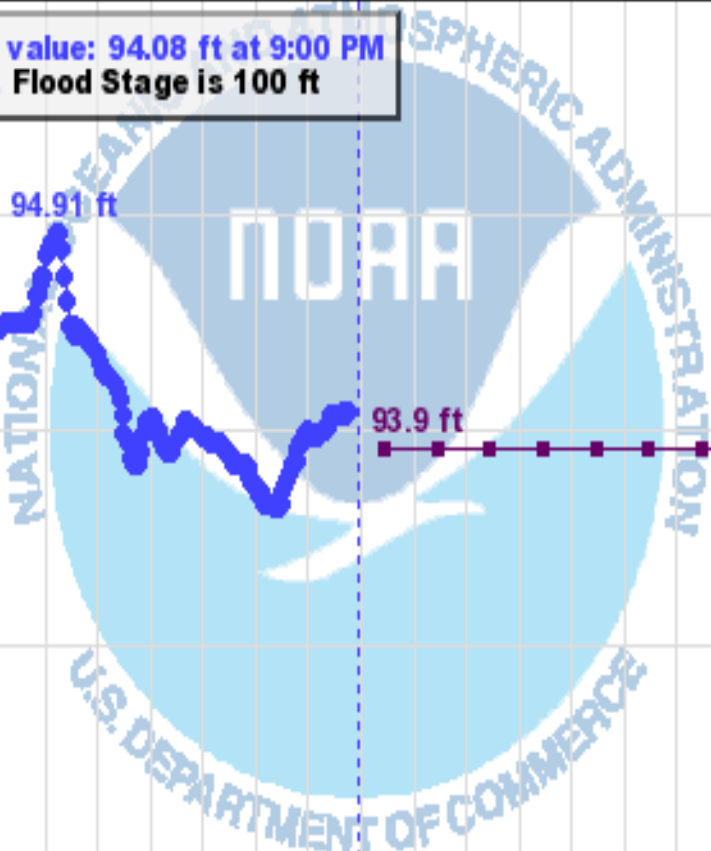
LAKE CHAMPLAIN AT ROUSES POINT

Universal Time (UTC)

3Z 15Z 3Z 15Z 3Z 15Z 3Z 15Z 3Z 15Z 3Z 15Z 3Z
 Oct 31 Oct 31 Nov 1 Nov 1 Nov 2 Nov 2 Nov 3 Nov 3 Nov 4 Nov 4 Nov 5 Nov 5 Nov 6



Latest observed value: 94.08 ft at 9:00 PM EST 2-Nov-2020. Flood Stage is 100 ft



Site Time (EST)

--- Graph Created (10:00PM Nov 2, 2020) ● Observed ■ Forecast (issued 10:54AM Nov 2)

000

FGUS51 KTAR 021600

RVFBTV

RIVER STAGE FORECAST

NATIONAL WEATHER SERVICE

NORTHEAST RIVER FORECAST CENTER...NORTON, MA

1055 AM EST Mon Nov 02 2020

:

:THIS IS A NWS GUIDANCE PRODUCT FROM THE NORTHEAST RIVER FORECAST CENTER.

:OFFICIAL FORECASTS/WARNINGS ARE ONLY ISSUED BY LOCAL NWS OFFICES.

:|

:*****

:Richelieu River - Rouses Point, NY

:Flood Stage 100.0 ft

:Latest Observed Value: 93.75 ft at Nov-02 10:00 am

:

.ER ROUN6 20201102 E DC202011021054/DH13/HGIFF/DIH6

:STAGE FCST 1AM 7AM 1PM 7PM

.E1 :1102: : :/ 93.9/ 93.9

.E2 :1103:/ 93.9/ 93.9/ 93.9/ 93.9

.E3 :1104:/ 93.9/ 93.9/ 93.9/ 93.9

.E4 :1105:/ 93.9/ 93.9

: Local QPF - 6 hr timestep

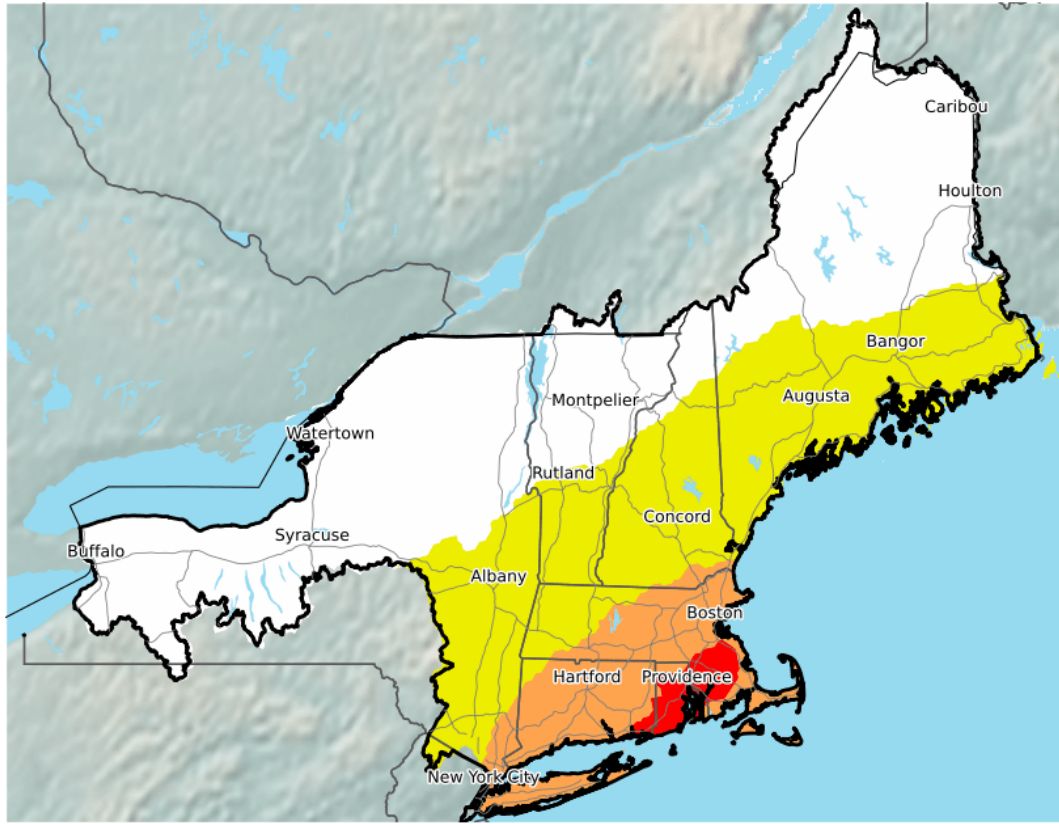
: 0.02/ 0.00/ 0.14/ 0.06/ 0.01/ 0.00/ 0.00/ 0.00/ 0.00/ 0.00/ 0.00/ 0.00/

: FORECAST DOES NOT INCLUDE WIND EFFECTS

:*****

Flow (k cfs)

5-Day Significant River Flood Outlook
 Valid: 10/22/2019 08:00 AM - 10/27/2019 08:00 AM EDT



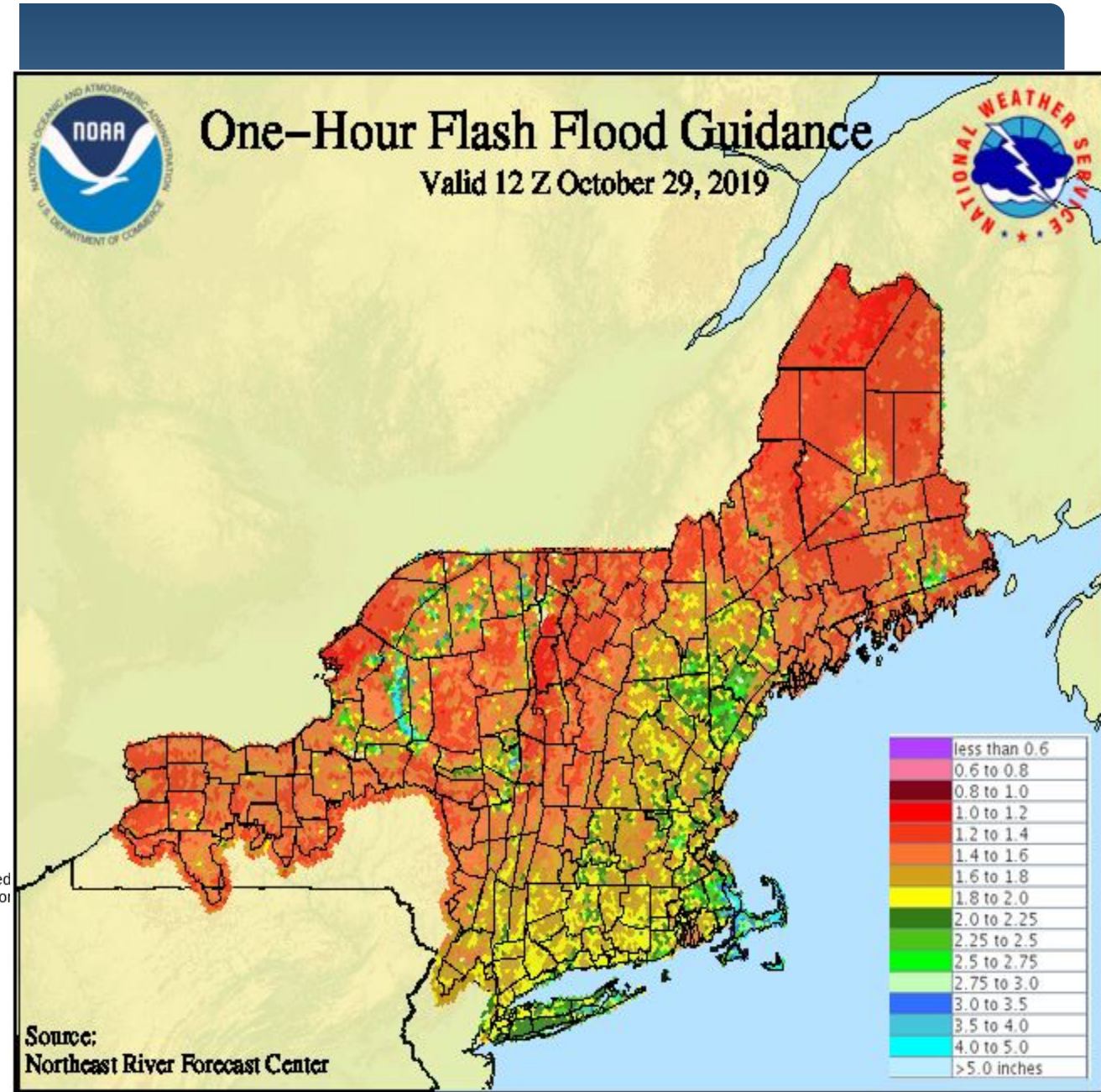
National Weather Service
Northeast RFC
 10/22/2019 03:14 PM EDT

Follow Us:   
weather.gov/nerfc

Significant River Flooding impacts include road hazards and damage to residential, commercial, and/or agricultural areas. Evacuation may be required. Flash flooding or Minor river flooding are NOT included in this outlook. Check your local weather forecast frequently for the most up-to-date information for your area.

Shaded areas are the forecast region of the Northeast River Forecast Center

-  **Significant River Flooding Not Expected**
-  **Significant River Flooding Possible**
Weather conditions indicate, without certainty that significant river flooding could occur
-  **Significant River Flooding Likely**
Weather conditions indicate that significant river flood conditions can be expected
-  **Significant River Flooding Occurring**
Significant river flooding is occurring at this time



Source:
 Northeast River Forecast Center



Flood forecasting services in the US

Experimental Short Range Forecast Uncertainty (AHPS) - External Links: [Product Description Document](#) | [Custom](#)

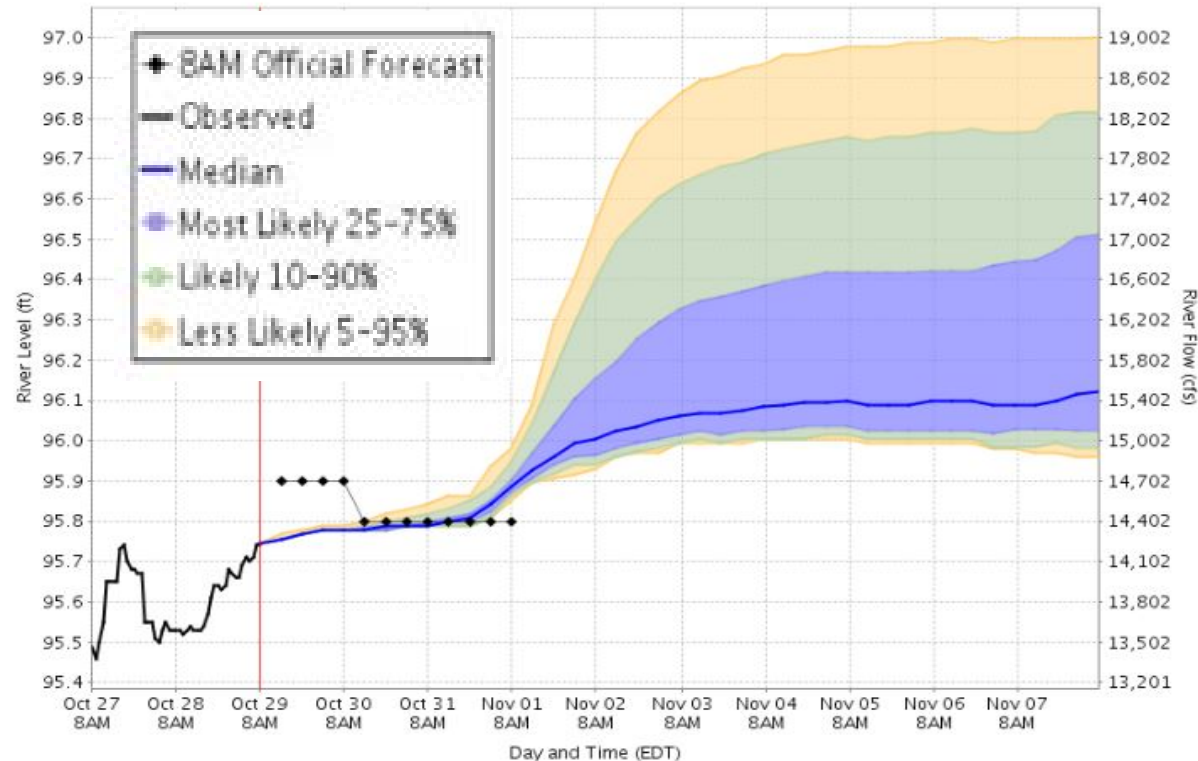


10 Day River Level Probabilities

Used to Estimate the Range of Possible River Levels
[without ENSPOST (Experimental)]

Caution: Official forecast may be updated after this graph is generated.
For the latest official forecast, go to <http://water.weather.gov/ahps>

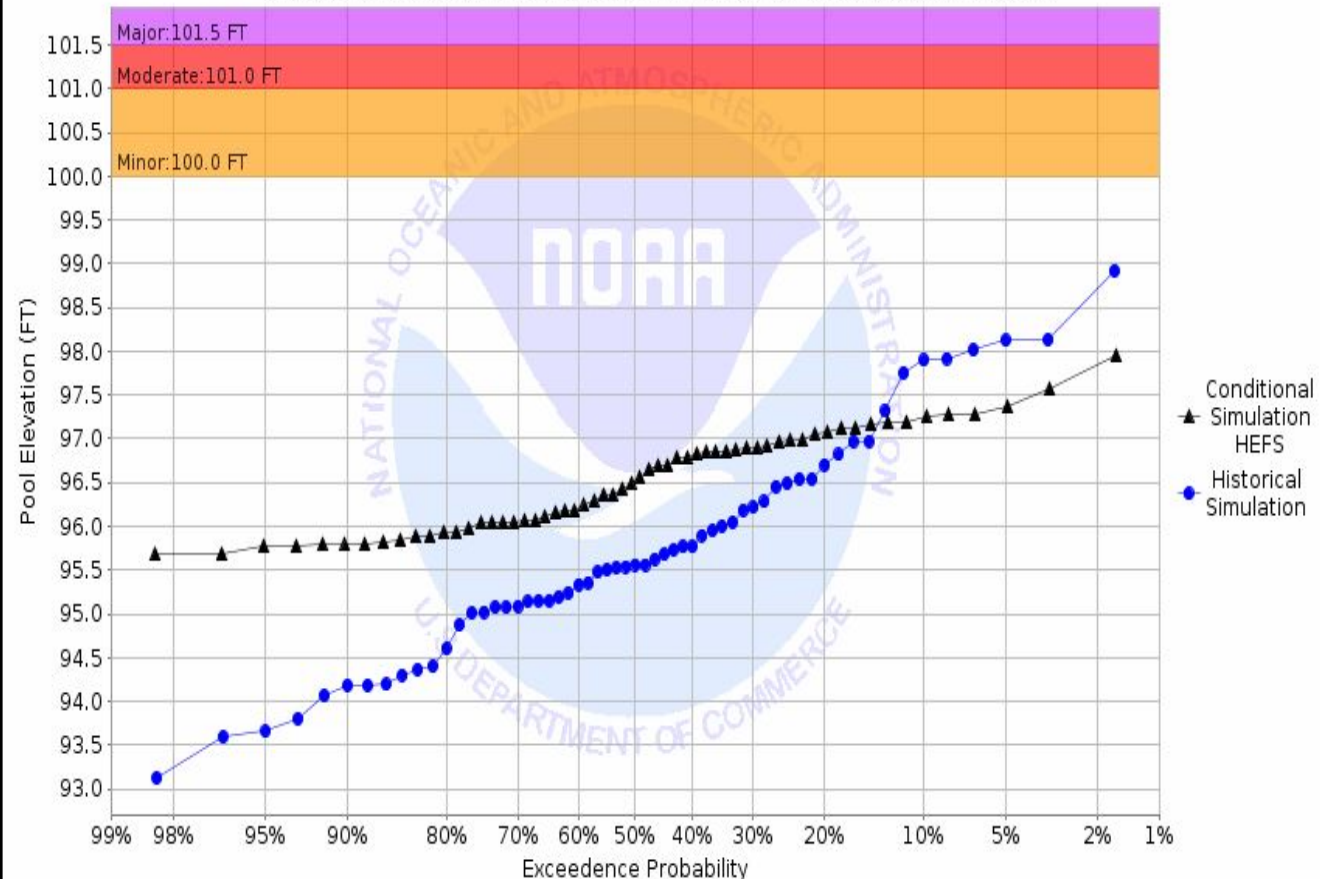
Richelieu River at Rouses Point, NY (ROUN6)

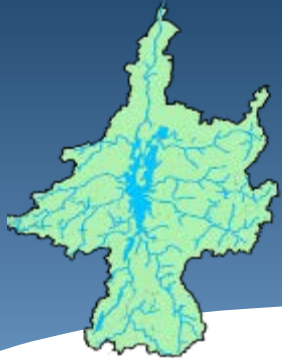


▲_{CS} = Conditional Simulation

●_{HS} = Historical Simulation

Chance of Exceeding Pool Elevation at Richelieu River at Rouses Point, NY (ROUN6)
Forecast for the period 10/28/2019 - 01/26/2020
This is a conditional simulation based on the current conditions as of 10/28/2019





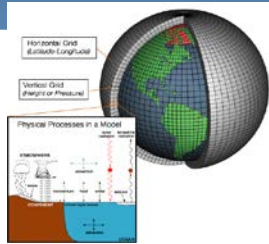
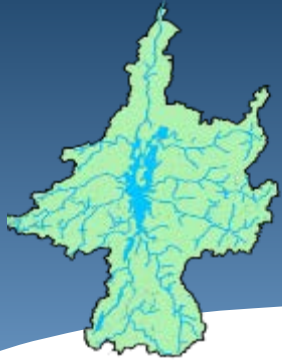
How a flood forecast is produced

- Simply a flood forecast is produced by converting a **weather forecast (precipitation, temperature)** and **current watershed conditions** (soil moisture, snow) into a **flow and/or stage** forecast (i.e. for rivers OR lakes)

The flow and/or stage is then compared to various **flood thresholds (Minor, Moderate, Major)** that have been pre-determined for each forecast location.



How a flood forecast is produced



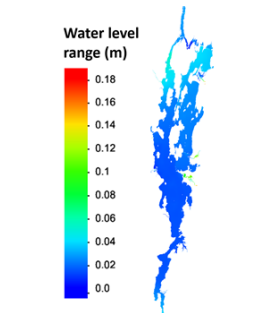
Numerical weather models & Assimilated Observations
Simulate atmospheric variables and produced weather forecasts

Forecasted P, T and wind speed



Hydrological models
Simulate water cycle inside a watershed (or catchment)

Forecasted Flow



Hydraulic/Hydrodynamic models
Simulate water level and velocity inside a water body (river or lake)

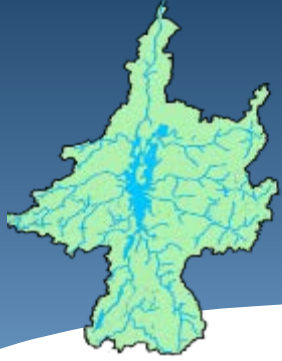
Forecasted level (Stage)



Thresholds
Flow or level at which flooding occurs

FLOOD FORECAST

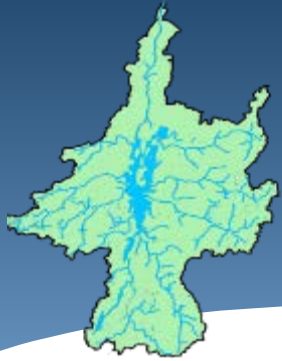




Technological improvements

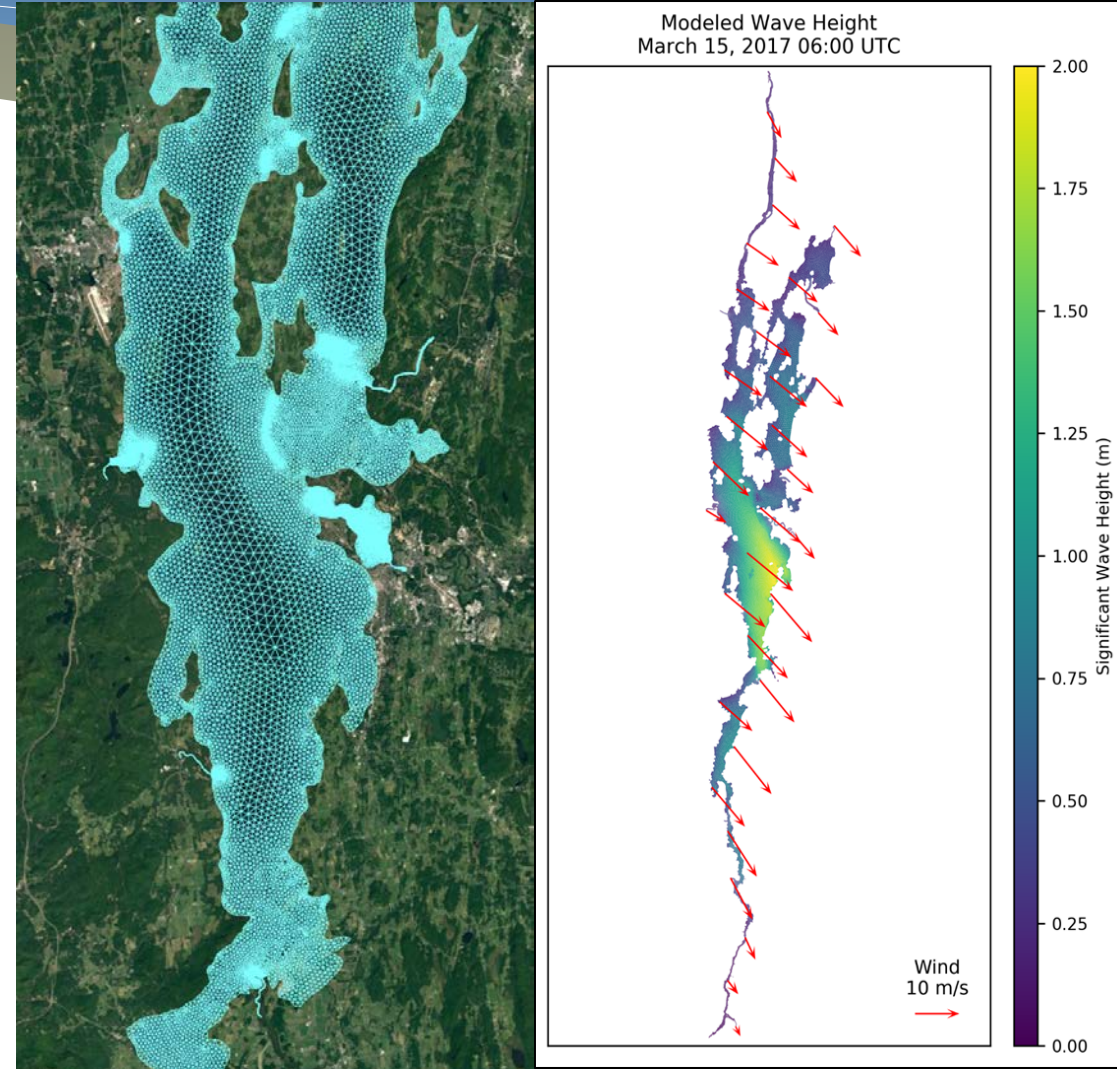
- GEM-Hydro (hydrological model) (CAN)
- H2D2 model (hydrodynamic model) (CAN)
- ETS model (Wind effect model) (CAN)
- WRF-Hydro (hydrological model) (US)
- FVCOM (hydrodynamic model) (US)
- WaveWatch III (Wind Wave Model) (US)



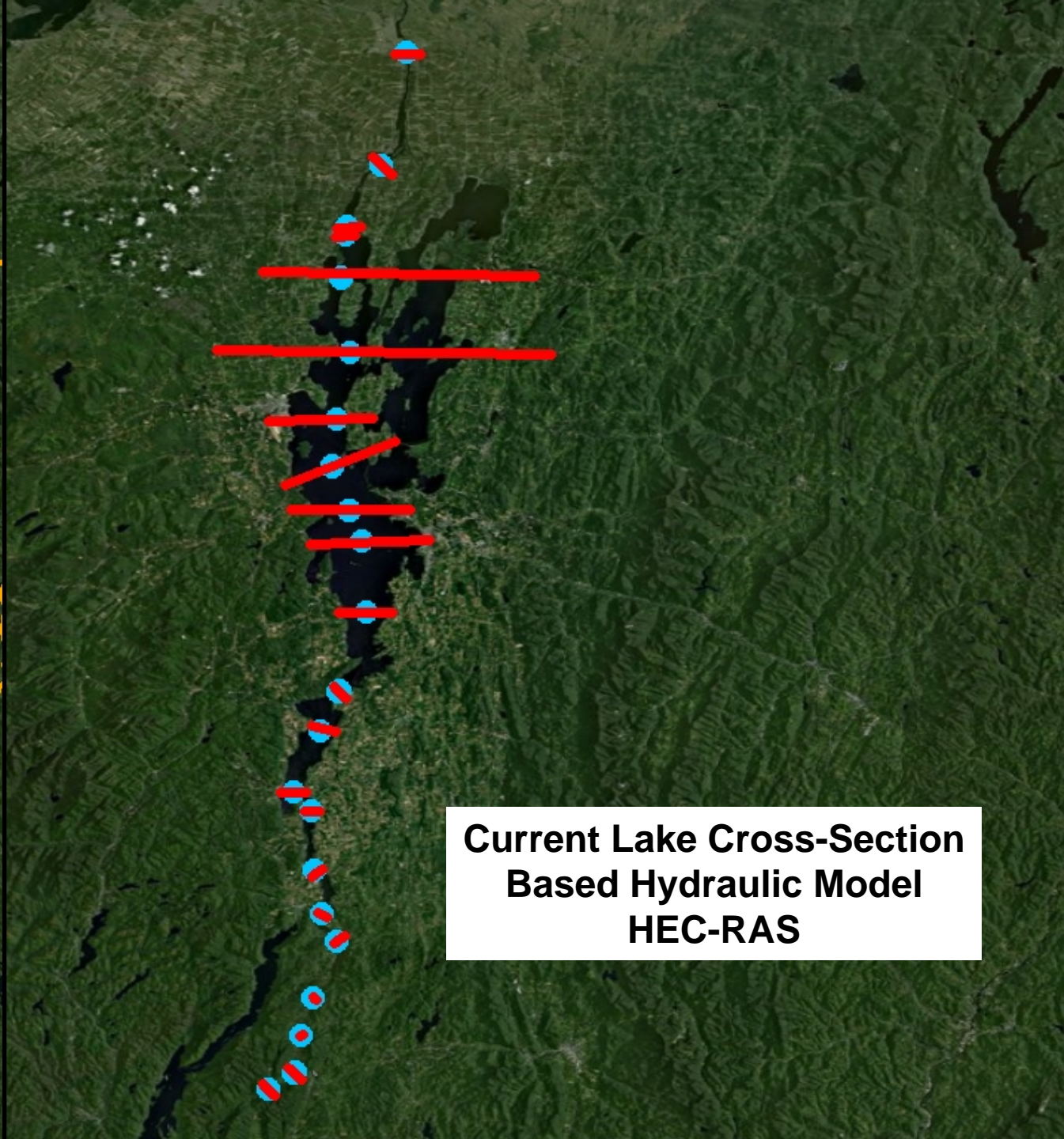
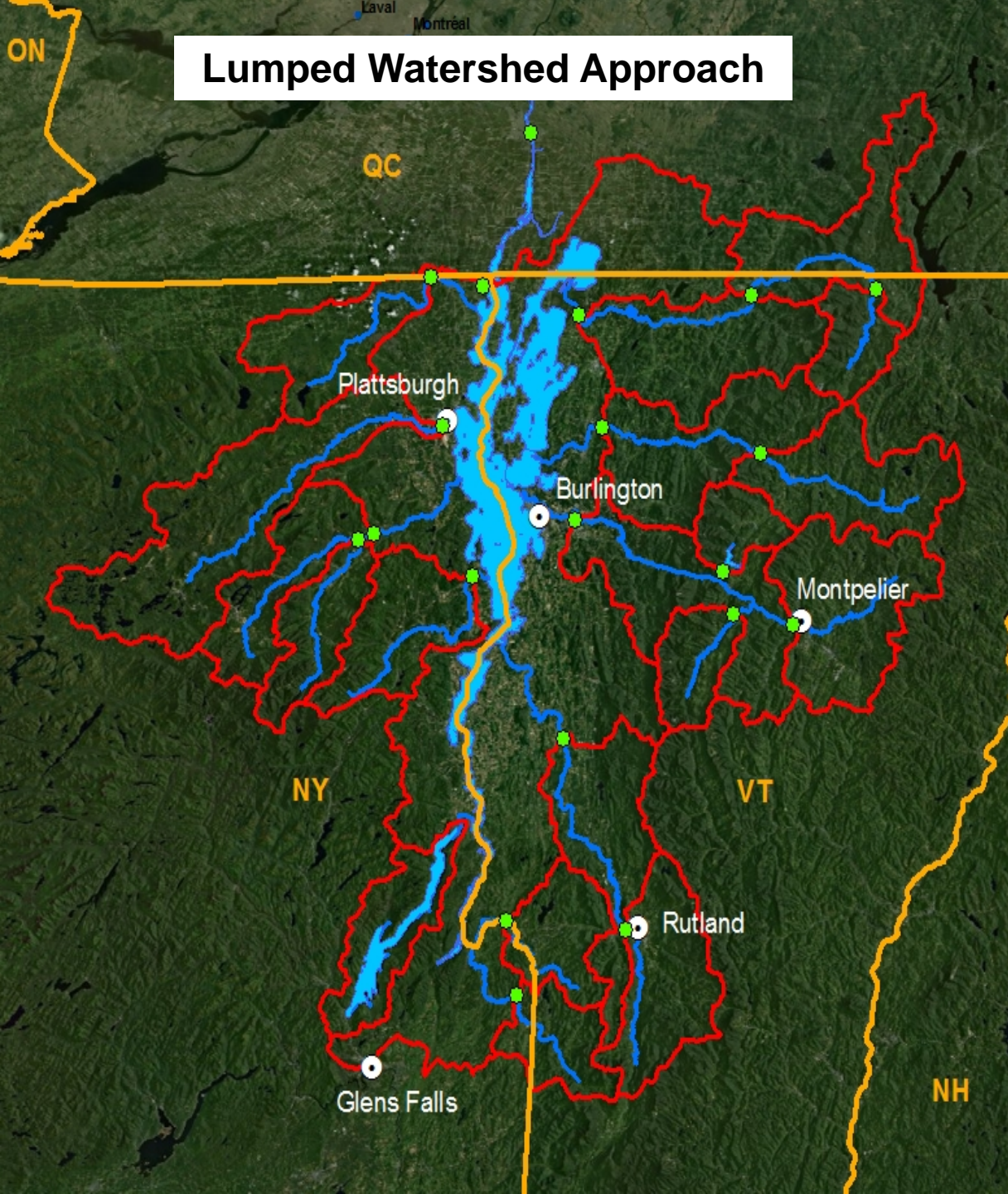


U.S. Technological Improvements

- New Flood Forecast System with 3 New Models Generated:
 - WRF-Hydro (National Water Model) – Basin Hydrology
 - FVCOM – Lake Champlain Hydrodynamic Model
 - WaveWatch III – Lake Champlain Wind Wave Model

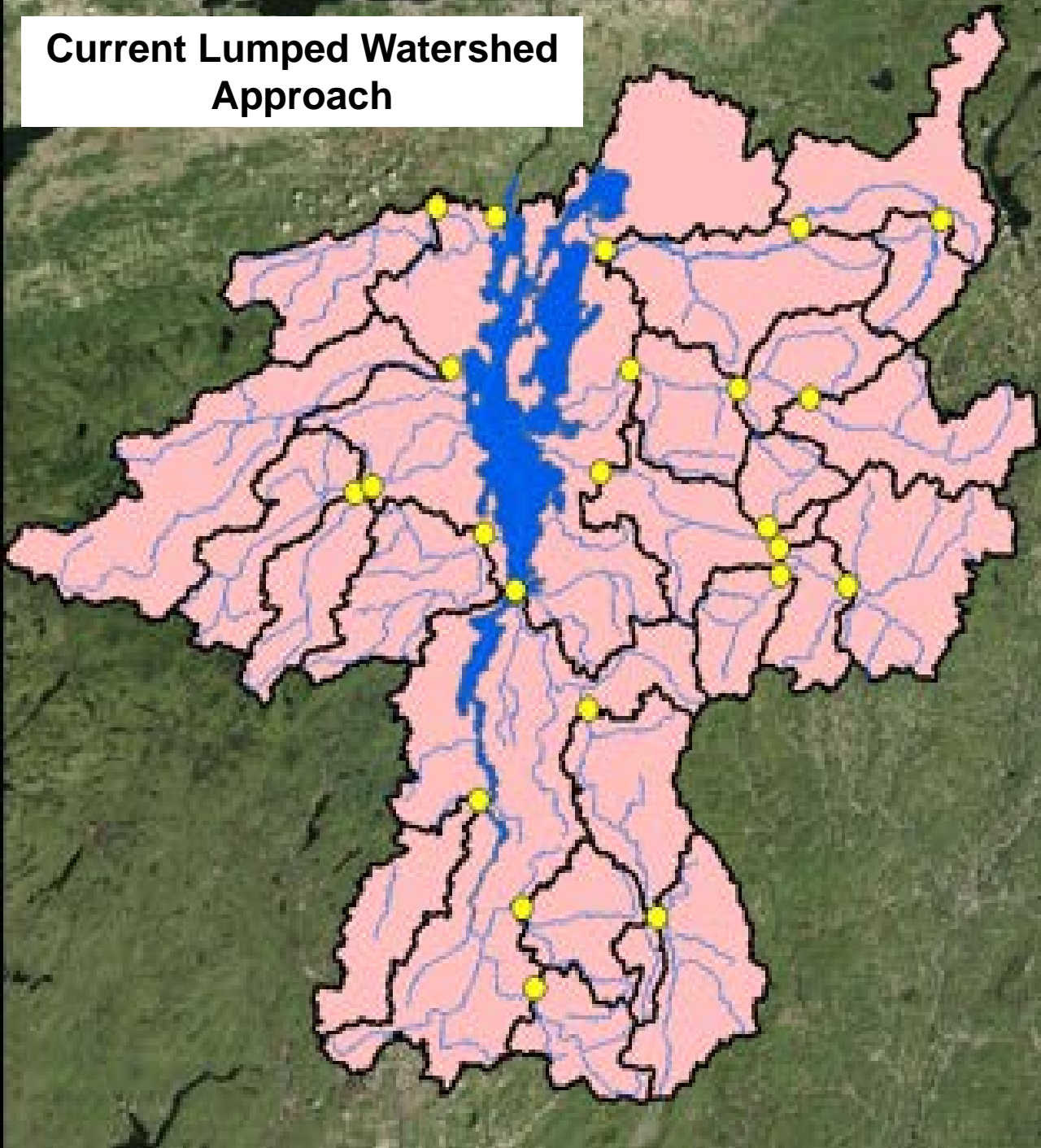


Lumped Watershed Approach

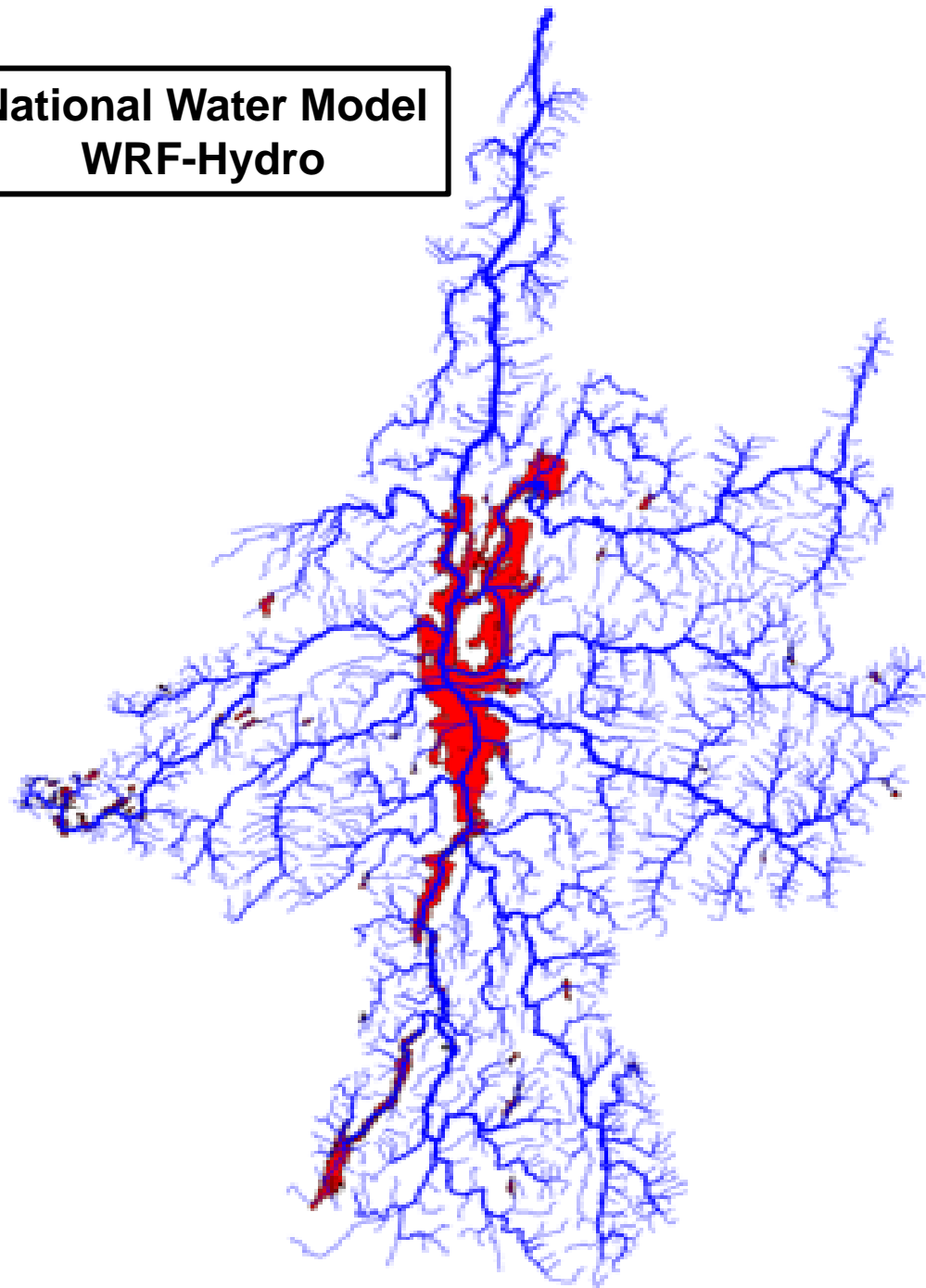


**Current Lake Cross-Section
Based Hydraulic Model
HEC-RAS**

Current Lumped Watershed Approach



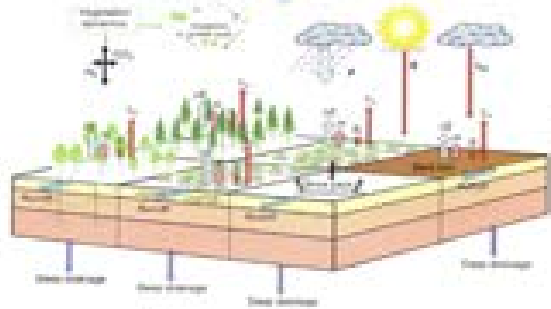
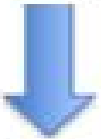
**National Water Model
WRF-Hydro**



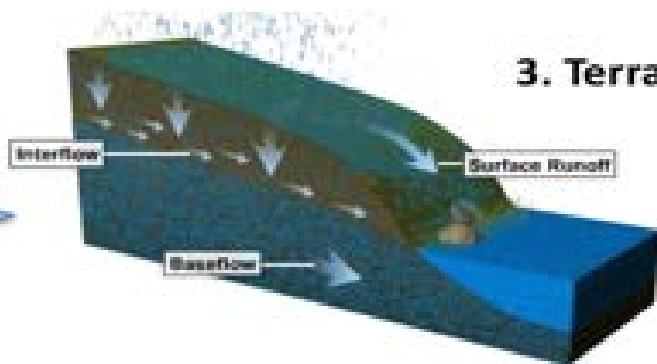


WRF-Hydro (NWM)

1. NWM Forcings Engine (NWS numerical weather models and observations)



2. NoahMP LSM
(1 km grid)

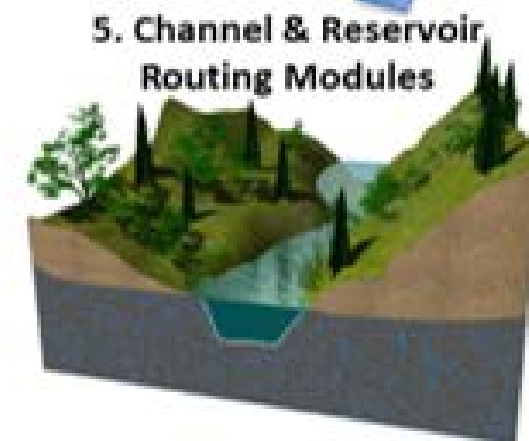


3. Terrain Routing Module
(250 m grid)

4. NHDPlus Catchment Aggregation



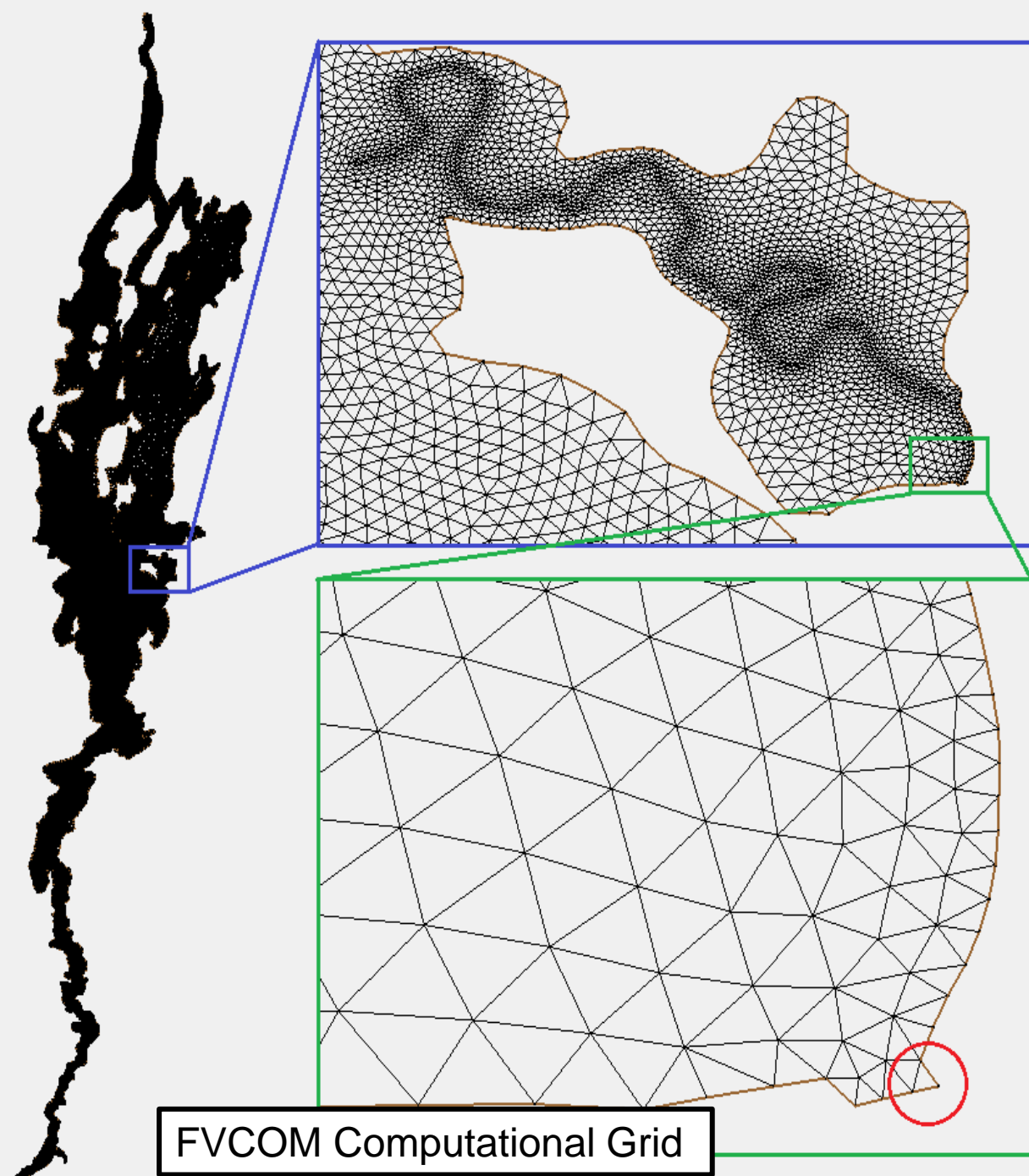
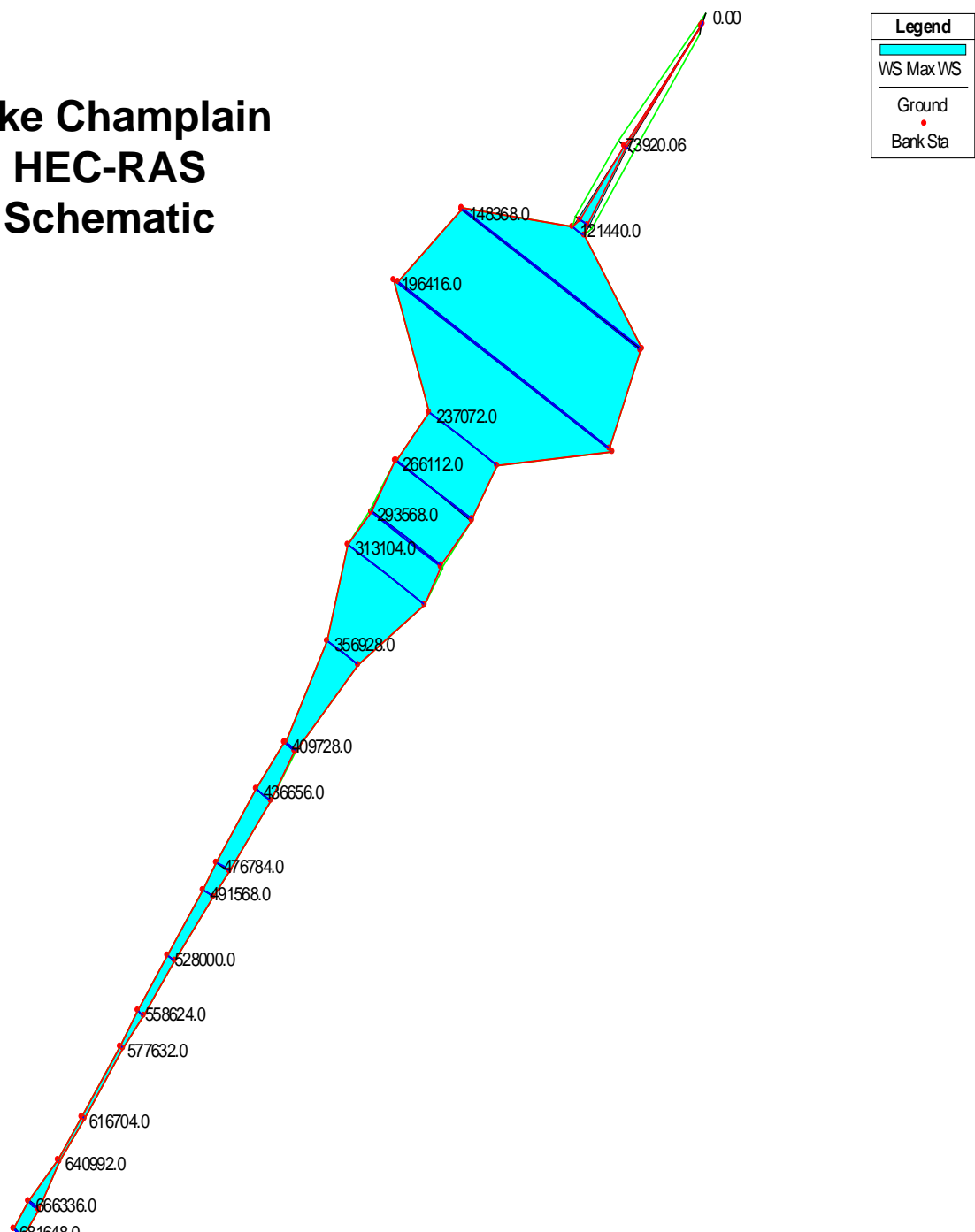
(avg. size ~1mi²)

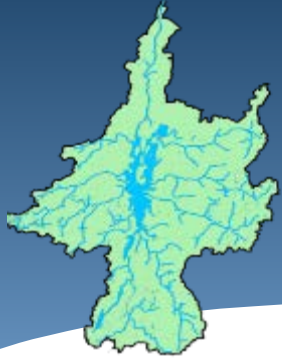


5. Channel & Reservoir
Routing Modules

Forecasts

Lake Champlain HEC-RAS Schematic



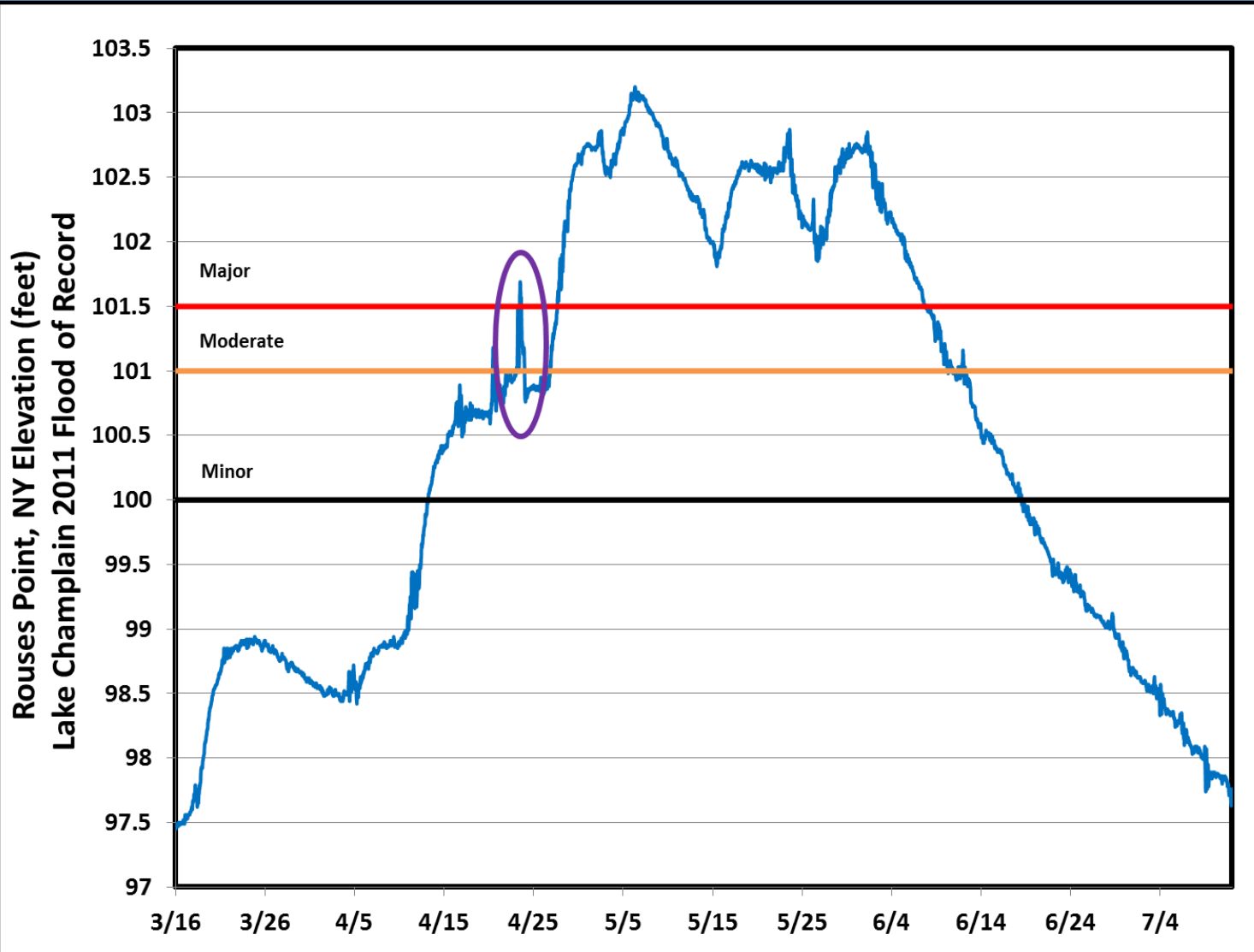
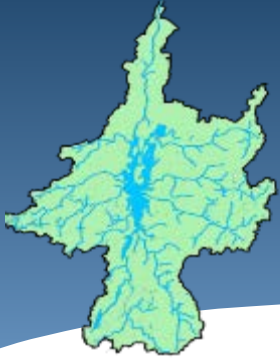


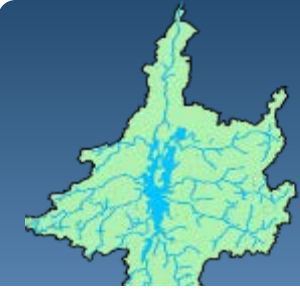
FVCOM Hydrodynamic Model

- Improves Lake Forecast by Adding Wind Effects
- Consistent Approach as for Great Lakes
- Allows for Simulation & Prediction of Wind Setup and Seiche



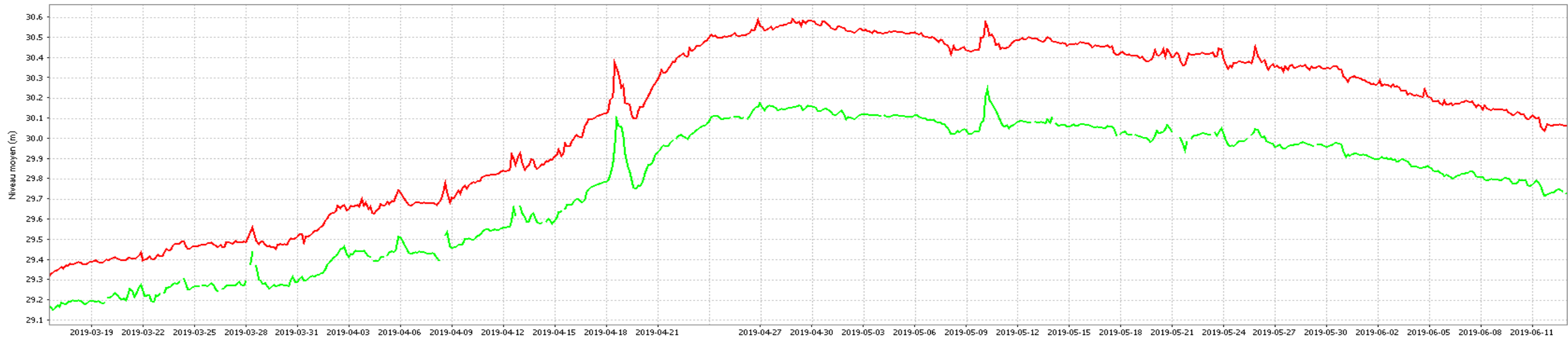
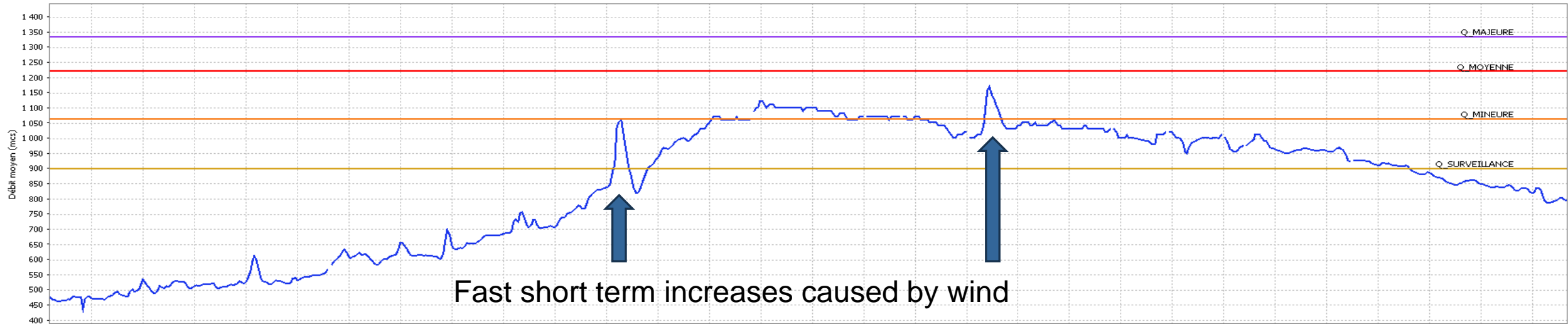
Need For Wind Effects

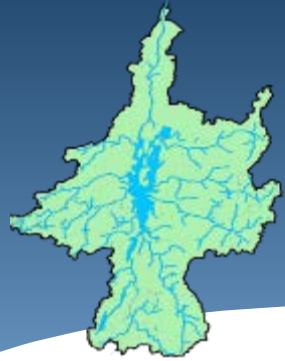




Need For Wind Effects

Prévision SRPD-SGPD



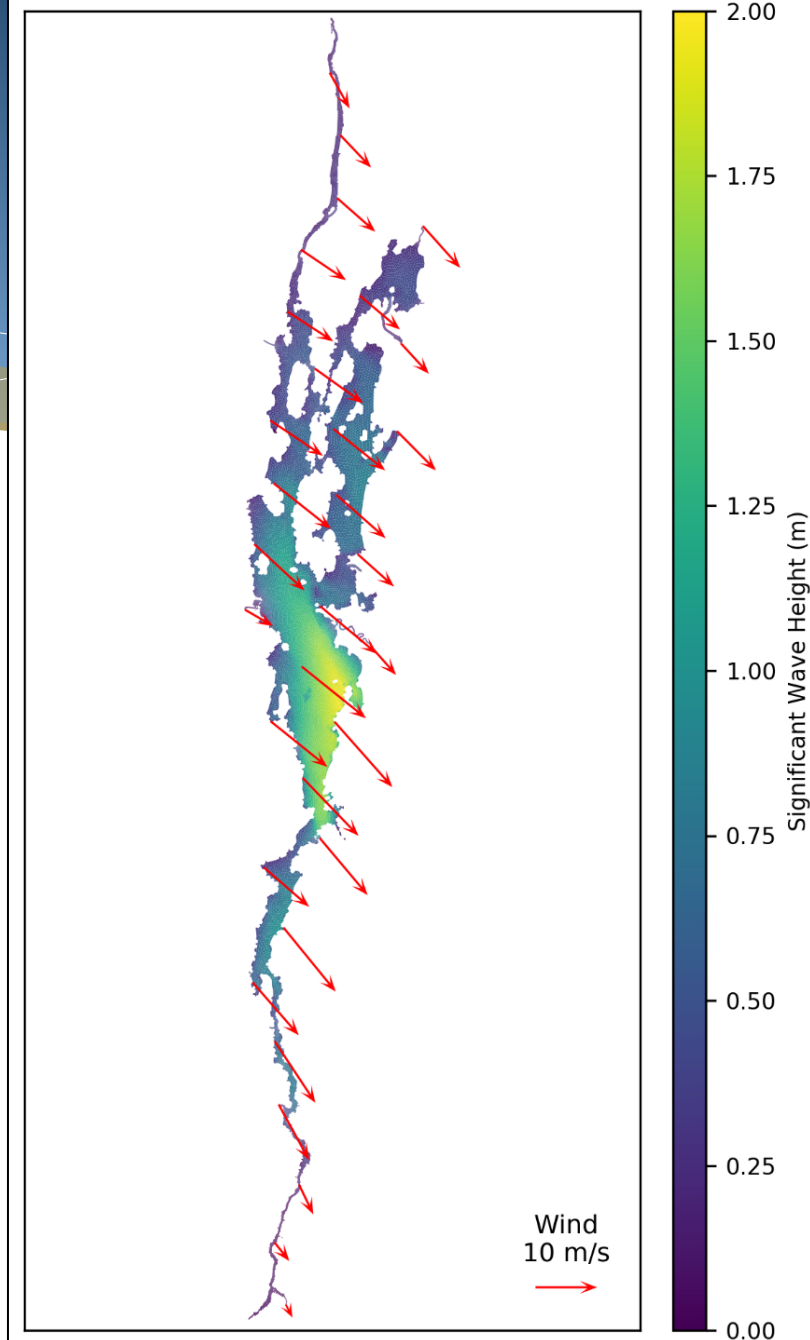


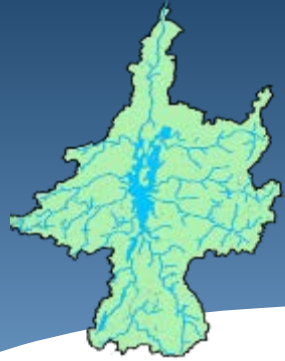
WaveWatch III – Wind Wave Model

- Wave Heights on Champlain – In-Demand Product
- Simulating lake and on-shore effects of wind-driven waves on top of lake levels (i.e. from FVCOM)
- Same unstructured grid as FVCOM
- Champlain domain to be integrated into Great Lakes Wave Model – NOT standalone
- GLWM is executed hourly



Modeled Wave Height
March 15, 2017 06:00 UTC





FVCOM and Wave Watch III

- Both Models Presently Running Stably in Experimental Mode on GLERL HPC
- Providing Hourly Output
- Running with winds from HRRRx (v4)
- Real-Time Results Online for Evaluation by Forecasters
- www.glerl.noaa.gov/res/champlain



NOAA/CIGLR is not an operational center. We make every effort to ensure accuracy and maximize uptime, however, we cannot guarantee that data and products will always be available and/or accurate. Our forecasts and products should be considered experimental. Please review our [disclaimer](#).

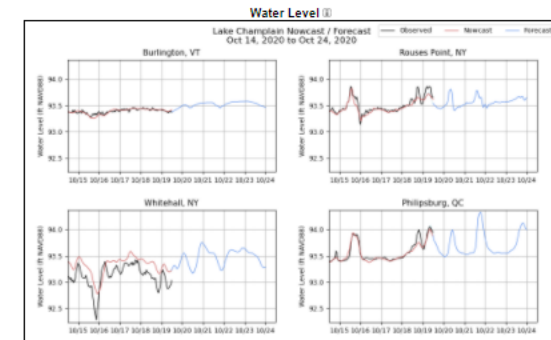


Lake Champlain Nowcast / Forecast System
Demo Version

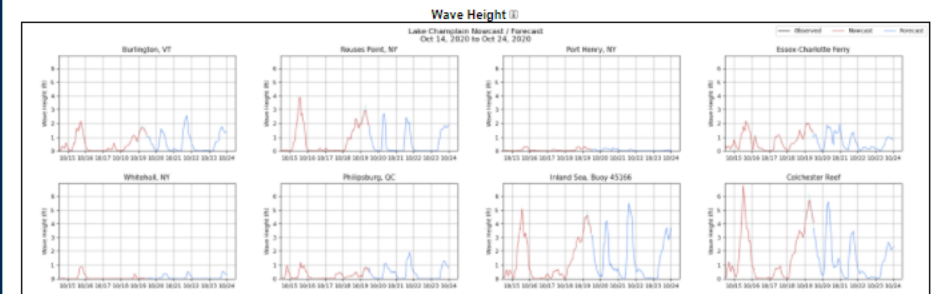


This project is funded by the International Joint Commission's Lake Champlain-Richelieu River Study.

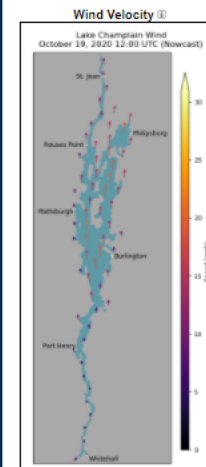
The nowcast is updated four times per day, running at 00:00, 06:00, 12:00, and 18:00 UTC. A 5-day forecast is produced once per day from 00:00 UTC. The Lake Champlain Nowcast / Forecast system is currently in a research and testing phase. Results presented should be considered experimental.



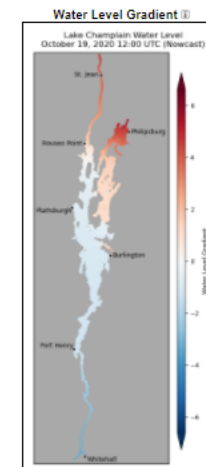
Interactive



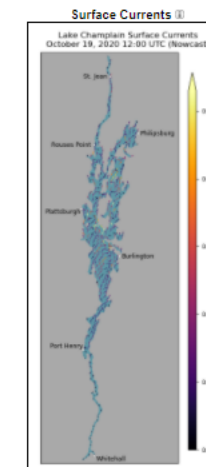
Interactive



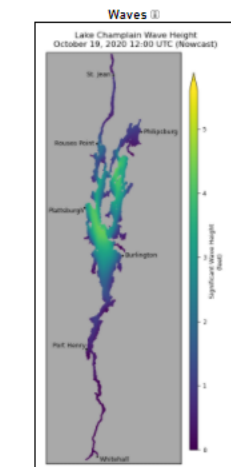
Interactive Current Conditions



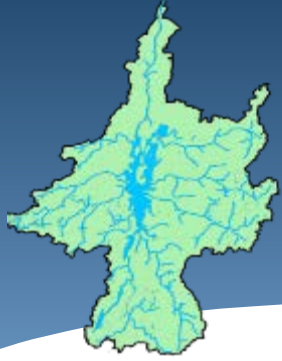
Interactive Current Conditions



Interactive Current Conditions



Interactive Current Conditions



Integration of multiple forecasts

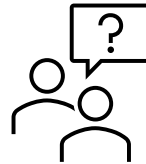
What we don't want

"Short term forecast indicate minor flooding risk."

"Based on this guidance, could be lower than what they are predicting"

"Large snowpack increase long term risk"

"Current SWE values decrease long term risk"



"Will not reach 2011 values"

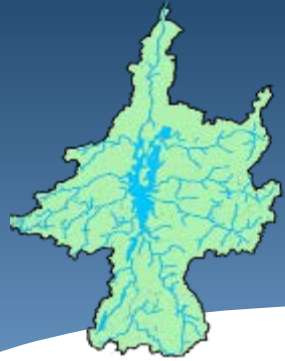
"Lots of uncertainty..."

"Could reach 1435 cms next week"

"Could reach 2011 values"

"Wind effect will not cause issues"





Integration of multiple forecasts

What we want

"Multiple weather forecast guidances"

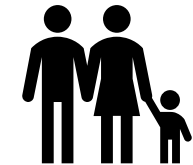
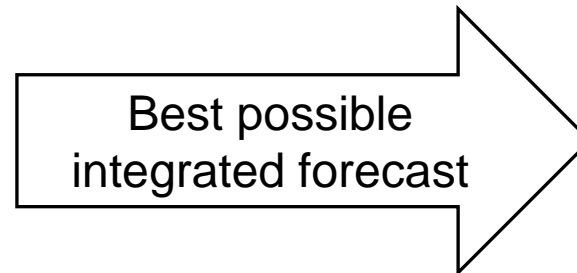
"Multiple hydrological modelling assessment"

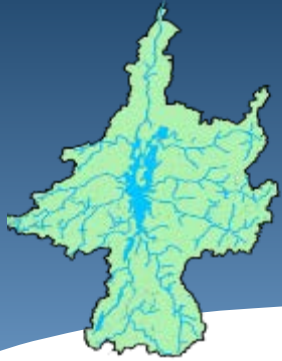
"Assimilation of latest available data"

"Hydrodynamic modelling"

"Correction of wind effect"

"Uncertainty assessment"



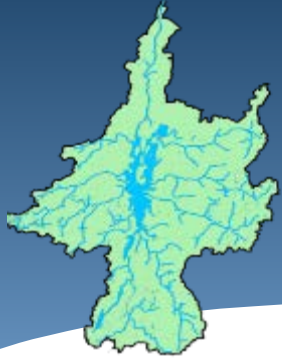


Integration of multiple forecasts

How it can be done

- If flood mitigation measures do not include an actively managed structure:
 - Integration of multiple forecasts should be done by **currently responsible agencies**, namely NWS in the US and MELCC-MSP in Canada.
- If flood mitigation measures include an actively managed structure:
 - Integration of multiple forecasts should be done by a **single structure managing entity** for the US and Canada.





Integration of multiple forecasts

No managed structure

"Multiple weather forecast guidances"

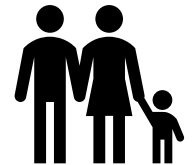
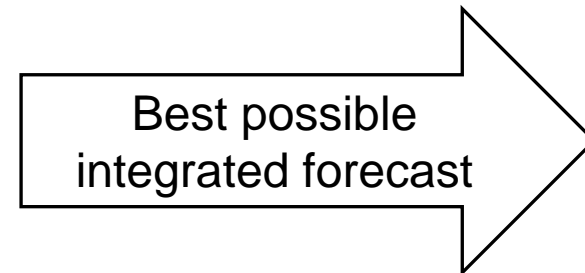
"Multiple hydrological modelling assessment"

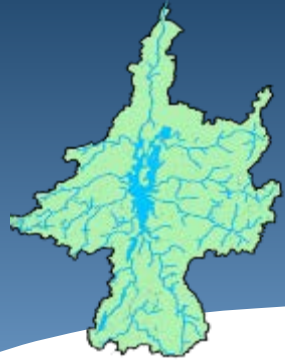
"Assimilation of latest available data"

"Hydrodynamic modelling"

"Correction of wind effect"

"Uncertainty assessment"





Integration of multiple forecasts

Managed structure

"Multiple weather forecast guidances"

"Multiple hydrological modelling assessment"

"Assimilation of latest available data"

"Hydrodynamic modelling"

"Correction of wind effect"

"Uncertainty assessment"



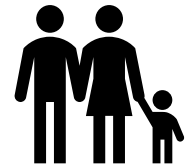
Bi-national
managing
entity

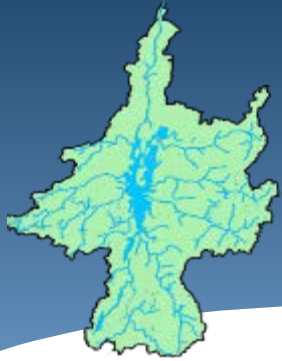
Environnement
et Lutte contre
les changements
climatiques

Québec

Sécurité publique
Québec

Best possible
integrated forecast

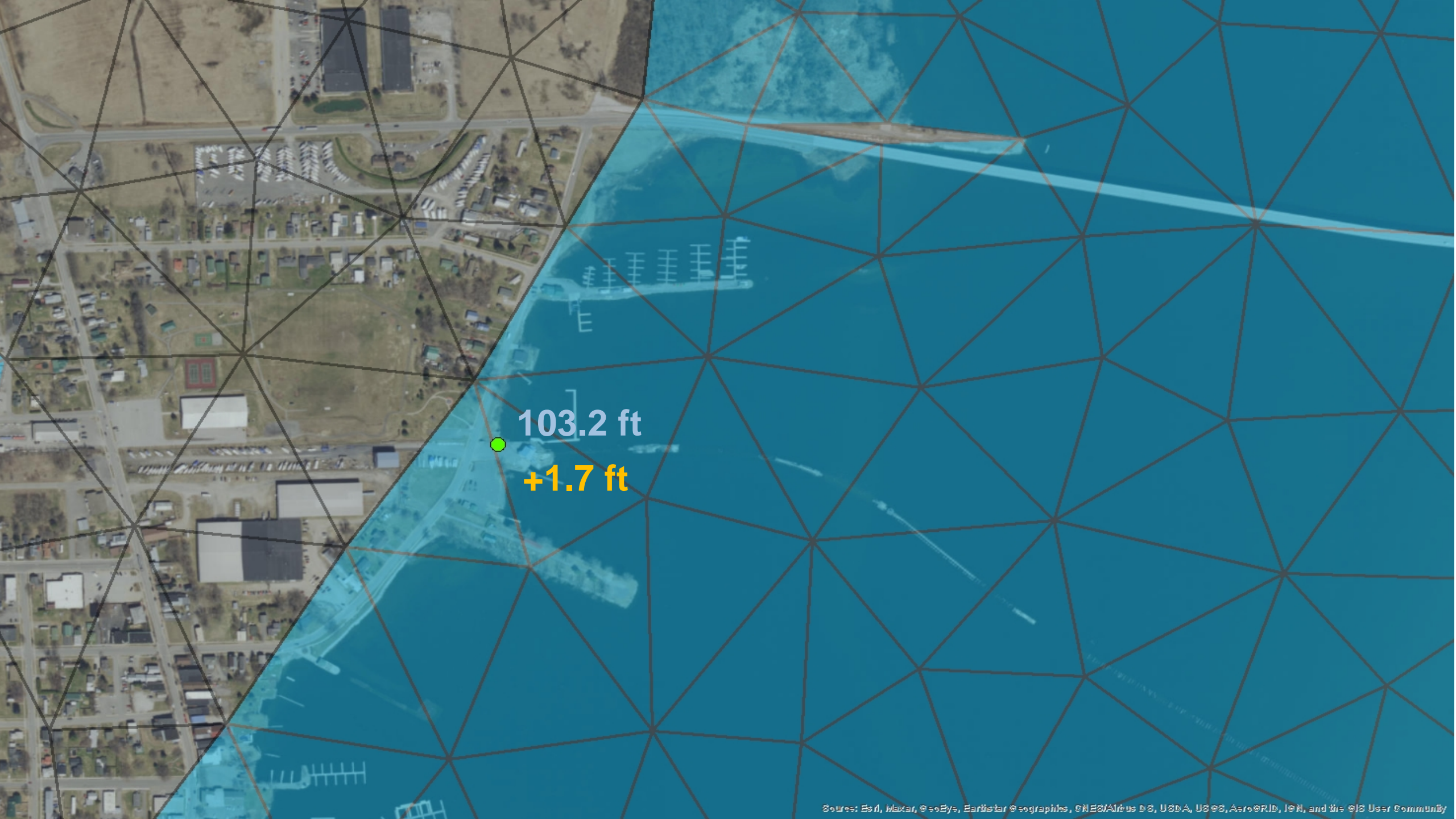




Towards flood mapping services in the US

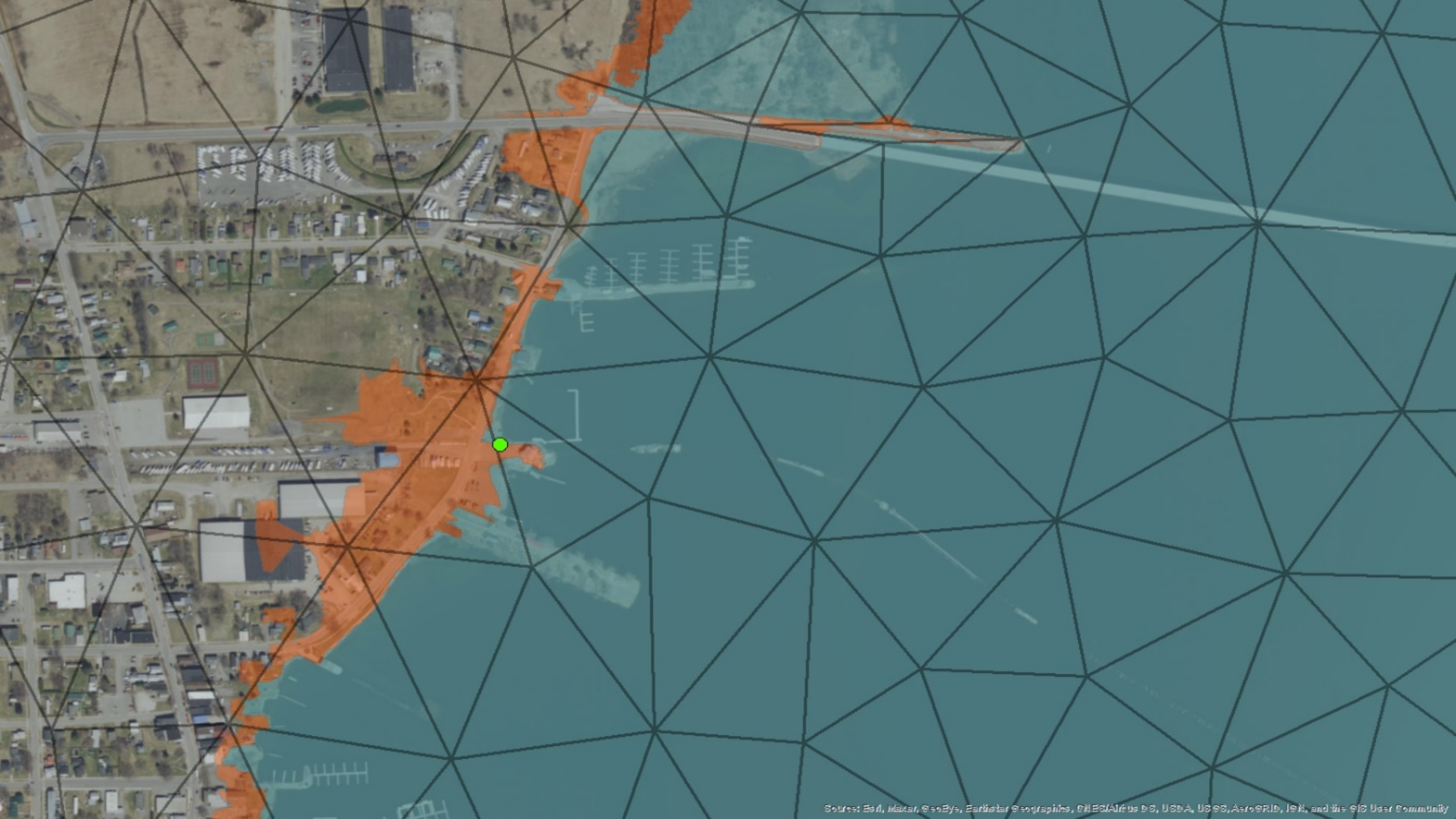
- The “Service” Aspect (i.e. what Agency will be responsible for generating inundation maps) Still Needs to be Determined
- NWS presently provides Inundation Maps for Ranges of Discrete Elevations (via AHPS pages)
- Technical approaches for real-time inundation on the lake based on:
 - FVCOM predicted Shoreline Stages (for most Probable conditions)
 - WaveWatch III predicted Shoreline Stages (for Worst Case scenario)
 - Static Inundation Extents from Maps Developed in 2015 IJC Project

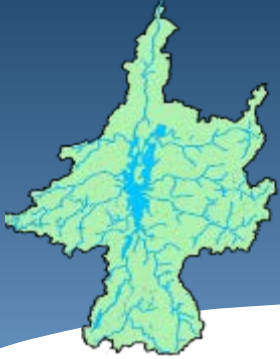




103.2 ft

+1.7 ft



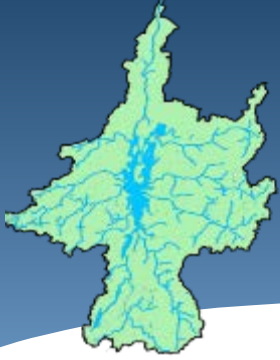


Key Messages

- Existing Flood Forecast Coordination between NWS and MELCC will continue
- New Modeling Software for both Lake Champlain and Richelieu River
- Recommendation for Single Bi-National Forecast on Lake/River IF Mitigation Measures will Include an Actively Managed Structure
- Inundation Flood Mapping can Leverage new technological improvements AND existing products.



Questions?



- Thank you for your time
- Feel free to contact me anytime regarding these topics:
 - william.saunders@noaa.gov

