

Workshop Summary

Collaborating on Subseasonal to Annual Water Level Forecasting in the Great Lakes

Hosted by GLERL & CIGLR

May 18, 2023



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Acknowledgements

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Acronym List

ASFPM - Association of State Floodplain Managers
ASTD - Atmospheric Science and Technology Directorate (ECCC)
BIL - Bipartisan Infrastructure Law
CaPA - Canadian Precipitation Analysis
CaSPAr - Canadian Surface Prediction Archive
CCGLBHHD - Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data
CCMEP - Canadian Centre for Meteorological and Environmental Protection
CFE - Conceptual Functional Equivalent model
CHPS - Community Hydrologic Prediction System
CIGLR - Cooperative Institute for Great Lakes Research
CIROH - Cooperative Institute for Research to Operations in Hydrology
CIS - Canadian Ice Service
CMC - Canadian Meteorological Centre (ECCC)
CO-OPS - Center for Operational Oceanographic Products and Services (NOAA)
CONUS - Continental United States
CRD - Climate Research Division (ECCC)
CWMS - Corps Water Management System (USACE)
DFO - Fisheries and Oceans Canada
DMP - Data Management Plan
DNR - Department of Natural Resources
DST - decision support tool
ECCC - Environment and Climate Change Canada
ECMWF - European Centre for Medium-Range Weather Forecasts
EER - Environmental Emergency Response Division (ECCC)
EPA - US Environmental Protection Agency
FEMA - Federal Emergency Management Agency
FIM - Flood Inundation Mapping
GLAM Committee - Great Lakes-St. Lawrence River Adaptive Management Committee
GLERL - Great Lakes Environmental Research Laboratory
GLIFWC - Great Lakes Indian Fish and Wildlife Commission
GLISA - Great Lakes Integrated Sciences and Assessments
GLOS - Great Lakes Observing System
GLRI - Great Lakes Restoration Initiative
GLSLRO - Great Lakes - St. Lawrence Regulation Office (ECCC)
HAB - Harmful Algal Bloom
HEFS - Hydrologic Ensemble Forecasting Service
HSDC - Hydrometeorological Design Studies Center (NOAA NWS/OWP)
IGLD - International Great Lakes Datum
IJC - International Joint Commission
ILOSLRB - International Lake Ontario - St. Lawrence River Board
IOOS - Integrated Ocean Observing System (NOAA)
ISEE - Integrated Social, Economic, and Environmental System
L2SWBM - Large Lake Statistical Water Balance Model
LSTM - Long Short-Term Memory network
MARFC - Middle Atlantic River Forecast Center (NOAA NWS)
MPE - Multi-Sensor Precipitation Estimates
MRD - Meteorological Research Division (ECCC)

MRMS - Multi-Radar/Multi-Sensor System
MSC - Meteorological Service of Canada
NCCOS - National Centers for Coastal Ocean Science (NOAA)
NCRFC - North Central River Forecast Center (NOAA NWS)
NEMO - Nucleus for European Modelling of the Ocean
NERFC - Northeast River Forecast Center (NOAA NWS)
NextGen - Next Generation Water Resources Framework (National Water Model)
NGS - National Geodetic Survey (NOAA)
NHS - National Hydrological Services
NOAA - National Oceanic and Atmospheric Administration
NOS - National Ocean Service (NOAA)
NSRPS - National Surface and River Prediction System (ECCC)
NWC - National Water Center
NWIS - National Water Information System (USGS)
NWLON - National Water Level Observation Network (NOAA CO-OPS)
NWM - National Water Model
NWS - National Weather Service (NOAA)
O2R - Operations to Research
OAR - Oceanic and Atmospheric Research (NOAA)
OCM - Office for Coastal Management (NOAA)
OCS - Office of Coast Survey (NOAA)
OHRFC - Ohio River Forecast Center (NOAA NWS)
ORTA - Office of Research, Transition, and Application
OWP - Office of Water Prediction (NOAA NWS)
PI - Principal Investigator
PSL - Physical Sciences Laboratory (PSL)
RandD - research and development
R2O - Research to Operations
RDRS - Regional Deterministic Reforecast/Reanalysis System (ECCC)
RES - Research Engagement Specialist (CIGLR/GLERL)
RFCs - River Forecast Centers (NOAA NWS)
RL - Readiness Level
SA - Subseasonal to Annual
SBIR - Small Business Innovation Research
STC - Science Technology Corporation
SWE - snow water equivalent
SWOT - Surface Water and Ocean Topography
TP - Transition Plan
TPO - Technology Partnerships Office
UM - University of Michigan
USACE - United States Army Corps of Engineers
USCG - US Coast Guard
USGS - United States Geological Survey
UxSRTO - Uncrewed Systems Research Transition Office
WCOSS - Weather and Climate Operational Supercomputing System
WCPS - Water Cycle Prediction System
WFOs - Weather Forecast Offices (NOAA NWS)

Executive Summary

On May 18th, 2023 the Great Lakes Environmental Research Lab (GLERL) and the Cooperative Institute for Great Lakes Research (CIGLR) hosted a four hour virtual workshop to increase collaboration in subseasonal to annual (SA) water level forecasting in the Great Lakes. This event brought together ~80 water level prediction operators, users, and stakeholders to share information on agency/organization missions, project scopes, and existing/in development products relevant to Great Lakes SA water level forecasting and decision support. A large goal of the workshop was also to identify a research to operations pathway for the next-generation forecast in development at GLERL/CIGLR (see [Appendix D](#) for more information on this project) and discuss ways stakeholders can engage in the co-development of this product.

The workshop included three information sharing sessions where presenters were invited to discuss the following topics on behalf of their organization:

1. Agency Overviews: Understanding roles, missions, and products
2. Organizational Capacities: Connecting mission to operations
3. Stakeholder Engagement: Who do you serve and how do you involve them?

Each session was followed by a brief discussion/Q&A period.

In addition to these sessions, NOAA's Office of Research Transition and Application (ORTA) presented about the research to operations process at NOAA (see [Appendix B](#) for presentation slides). The workshop concluded with a discussion on opportunities for collaboration and involvement with the next-generation forecast at GLERL/CIGLR. Outcomes from the workshop [can be reviewed here](#).

Introduction

Project Background: GLERL/CIGLR next generation forecast

Last year, NOAA received \$492M to advance flood and inundation mapping and forecasting through the 3rd provision of the Bipartisan Infrastructure Law. This funding includes a component to build out subseasonal to annual integrated water capabilities (referred to SA across NOAA). NOAA's plans for provision 3 include an agency-wide effort to build out subseasonal to annual integrated water capabilities, with the second component specifically targeting the development of a next generation prediction system for determining mean and extreme water levels across subseasonal to annual time scales for the open coasts and Great Lakes. The GLERL/CIGLR BIL SA project contributes to this SA component.

The intended outcomes of the GLERL/CIGLR BIL SA project are to:

- Advance the modeling behind seasonal water level forecasts by extending outlooks beyond 6 months and incorporating state-of-the-art operational products and data science
- Design a decision support tool(s), informed by the next generation forecast framework, to guide management decisions and coastal resilience planning in the Great Lakes

A project fact sheet is available in [Appendix D](#), which provides more details about the scope of this work.

Workshop Background

To ensure the success of the GLERL/CIGLR BIL SA project, it was important to leverage and build on existing partnerships, operational frameworks and expertise, as well as identify an operational partner to ensure the transition from research to sustained operations.

More broadly, the project team saw the workshop as an opportunity for information sharing and developing a shared understanding of mission and roles in subseasonal to annual water level forecasting across organizations in the Great Lakes region. No single agency or organization can do this work alone—it is important to forefront collaborative efforts to ensure projects are designed effectively. This project presents an opportunity to build on the history of binational cooperation and further engage with stakeholders in the region.

A detailed agenda and other information about the workshop can be found in the participant [Google Drive](#) (or via email per request).

Formation of Workshop Steering Committee and Selection of Presenters

In an effort to guarantee this workshop would be designed in a collaborative manner, the GLERL/CIGLR project team engaged the support of a workshop steering committee. Steering committee members supported GLERL and CIGLR organizers by providing feedback on the workshop agenda, helping articulate the goals and objectives of the workshop, informing facilitation planning, and guiding the selection of workshop presenters and observers.

Participation in the workshop committee was voluntary and greatly contributed to the successful development and implementation of the workshop.

Steering committee members included:

- Andrew Peck (NOAA / OAR / ORTA)
- Casey Brown (UMass Amherst)
- Deanna Fielder (USACE Detroit District)
- John Allis (IJC)
- John Callahan (NOAA / NOS / CO-OPS)
- Mimi Hughes (NOAA / OAR / PSL)

Presenters for the workshop were selected with the input of the steering committee, with particular attention to the federal/binational agencies involved in Great Lakes outflow management and forecasting in the Great Lakes region. Workshop participants (or “observers”) were similarly selected by the steering committee and GLERL/CIGLR project teams. Our goal was to involve organizations and agencies with a stake in SA forecasting in the Great Lakes region.

The project team recognizes that due to the scope of the workshop (particularly its role as a forum for discussion regarding the GLERL/CIGLR BIL SA project transition pathway), some voices may have been left out of the conversation. The project team has continued engagements planned throughout the duration of the project (see [Next Steps for Engagement](#) section below) and encourages all interested stakeholders/rights holders to participate if they would like to contribute to the co-design and/or dissemination of the forecast and/or decision support tool for this project. Interested parties may also contact the CIGLR Lead Research Engagement Specialist (Dr. Riley Ravary, ravary@umich.edu) for further information.

Summaries of Workshop Sessions

Agency Overviews: Understanding roles, missions, and products

The objective of this session was to share information about the missions, project scopes, and products related to Great Lakes water level forecasting / forecast use at each agency or organization invited to present. This session consisted of ten presentations 3-5 minutes in length each, followed by ten minutes of discussion time.

Presenters

- [GLERL / CIGLR](#) - Dr. [Lauren Fry](#)
- [NOAA National Ocean Service \(NOS\)](#) - [Audra Luscher](#)
- [NOAA National Weather Service \(NWS\) River Forecast Centers](#) - [Jim Noel](#)
- [National Water Center \(NWC\) / Office of Water Prediction \(OWP\)](#) - Dr. Trey Flowers*
- [International Joint Commission \(IJC\)](#) - John Allis
- [Great Lakes - St. Lawrence River Adaptive Management Committee \(GLAM\)](#) - Chris Warren
- [U.S. Army Corps of Engineers \(USACE\) Detroit District](#) - Keith Kompoltowicz
- [U.S. Army Corps of Engineers \(USACE\) Buffalo District](#) - Keith Koralewski
- [Environment and Climate Change Canada \(ECCC\) Canadian Meteorological Centre \(CMC\)](#) - Dr. Vincent Fortin
- [Environment and Climate Change Canada \(ECCC\) Great Lakes and St. Lawrence Regulation Office \(GLSLRO\)](#) - Jacob Bruxer

*unable to attend, but slides still shown briefly at workshop and included in distributed slide deck

Discussion Summary

Discussion following the presentations centered around coordination of resources and information. Specifically, there was recognition that the Coordinating Committee plays an important role in coordinating specific basic data and operational 6-month forecasts used for water management, but there is a desire to more broadly improve coordination by building awareness of how products, models, and data are interconnected.

- The Coordinating Committee for Great Lakes Basic Hydraulic and Hydrologic Data ([Coordinating Committee](#)) is an ad hoc binational committee that has met continuously for 60 years, and includes colleagues from federal agencies that support Great Lakes water management in both Canada and the U.S. The Coordinating Committee's role is to coordinate basic hydraulic and hydrologic data and provide basic data to support the water management missions of many agencies (such as the IJC). This includes subcommittees for vertical control/water levels, hydraulics, and hydrology.
- In addition to coordination of basic data, the Coordinating Committee produces a [6-month water level forecast](#), which is informed by outputs of operational forecasts from USACE-Detroit and ECCC GLSLRO. The resulting [6-month water level forecast](#) is made available through monthly publications by USACE-Detroit and ECCC GLSLRO.

- There is a desire for, but no current known resource that identifies all Great Lakes water level models and data inputs and how they interact at a interagency/binational scale
 - The Hydrology Subcommittee of the Coordinating Committee does have a regular effort to inventory applicable and available data sources.
 - The Coordinating Committee produces input datasets and routing models, including datasets required for regulation of the St. Lawrence-Lake Ontario river basin as it relates to Plan 2014.
- As part of the [GLAM Expedited Review](#) of Plan 2014, GLAM is working to develop different input datasets for long-term planning, which could also be used for subseasonal to annual forecasting.

Research to Operations: What does R2O mean to NOAA?

This session consisted of a 15 minutes presentation from NOAA's Office of Research Transition and Application (ORTA), then 15 minutes of Q & A. ORTA presenters discussed the NOAA process of transitioning a product (e.g. the next-gen forecast in development) from experimental to operational. ORTA reviewed what a transition plan is, why it is important to plan for transitions, and how policies and processes of transition have evolved. See [Appendix B](#) for the full presentation slide deck.

Key Takeaways

- The ORTA mission is to advance innovative research and development to support NOAA's mission and the U.S. economy.
- A transition plan is a document that lays out a roadmap to move R&D into use based on Readiness Levels (RL).
- Transition Plans are living documents to be amended with increasing detail as the innovative technology matures.
- Both/all parties involved in a transition sign the transition plan, which provides situational awareness of the work and review / approval to move forward. It does not represent a binding agreement and/or funding availability.
- Transition plans facilitate end user engagement and transfer of technology
- ORTA has the knowledgeable staff and tools to provide assistance and leverage collaborations when opportunities exist.
- ORTA websites: orta.research.noaa.gov | oar.orta@noaa.gov

ORTA is willing and able to assist with transition planning for the next-gen forecast moving forward. GLERL/CIGLR will be utilizing their expertise and involving them in the process of transitioning the next-gen forecast to its operational home. This will facilitate a smooth transition and maximize the forecast's effective use.

Discussion Summary

Discussion following the presentation provided clarification of transition planning purpose and procedure, specifically how to include organizations external to NOAA in the transition planning process.

- A transition plan is a vision or a roadmap. It is not a binding document, and it does not guarantee funding. Transition plans get signatures of acknowledgement, not signatures of approval.
- The transition process is typically internal to NOAA, but leveraging connections and collaborating with outside organizations (e.g. USACE) is very useful. NOAA PIs should collaboratively engage stakeholders and end-users.
- External organizations don't sign the transition plan; instead, ORTA asks that they sign letters of support. ORTA helps NOAA PIs engage outside organizations in this process.
- An example of NOAA working with an outside organization: GLERL's HABs plan considered Toledo water managers to be secondary end-users.

- Transition plans provide visibility to NOAA leadership for projects that have received funding and meet advanced Readiness Levels.
- Potential operational homes or end-users see the value of a transition plan that can be adjusted throughout the process
- It is very helpful to think about transition planning early in project development, especially when multiple agencies are involved, in order to consider other agencies' expertise and technical capabilities.

Organizational Capacities: Connecting mission to operations

The objective of this session was to understand the organizational capacity of each agency to contribute to the co-development, technical review, or operational hosting of the next-generation Great Lakes water level forecast in development at GLERL/CIGLR. This session consisted of 6 presentations 3-5 minutes in length each, followed by ten minutes of discussion time.

Presenters

- NOAA [GLERL / CIGLR](#) - Dr. [Lauren Fry](#) / Dr. [Yi Hong](#)
- NOAA [National Ocean Service \(NOS\)](#) - [Brandon Krumwiede](#)
- [National Weather Service \(NWS\) River Forecast Centers](#) - [Jim Noel](#)
- [National Water Center \(NWC\) / Office of Water Prediction \(OWP\)](#) - Dr. Trey Flowers*
- [U.S. Army Corps of Engineers \(USACE\) / Environment and Climate Change Canada \(ECCC\)](#) Regulation Offices - Jacob Bruxer and Deanna Fielder
- [U.S. Army Corps of Engineers \(USACE\) Detroit District](#) - Deanna Fielder

*unable to attend, but slides still shown briefly at workshop and included in distributed slide deck

Discussion Summary

In the discussion that followed presentations, key themes that emerged were (1) challenges and constraints that may be encountered during a cross-agency co-design and transition process, (2) importance of considering translation of project outcomes, (3) a need to expand on existing collaborative efforts, and (4) interest by participants to participate in the co-development and R2O process.

- When discussing technical capacity and capacity to collaborate on the GLERL/CIGLR next-gen forecast development (such as time to work with GLERL or to participate in a working group) it was noted that many organizations are stretched thin in terms of time and capacity.
- A potential challenge that was noted is the technology constraints to working across agencies and internationally (e.g. NOAA has limited access to Zoom; USACE has limited access to Google Suite).
 - This is a discussion that will be continued during transition planning discussions.
- There have been collaborative efforts internally at NOAA regarding Great Lakes data, and there is a need to expand upon that and ensure others are involved, especially with a project at the scale of the next-gen forecast.
- NOAA and ECCC, through the Coordinating Committee, work to understand what evaporation products are available. For example, the [Great Lakes Evaporation Network](#) provides monitoring.
- The Army Corps in Detroit expressed desire to be involved in the co-development and transition process as an operational home for the forecast.
- ECCC GLSLRO also expressed interest collaborating in co-development, and perhaps transition process.
- ECCC/ASTD is interested in collaborating with NOAA to assess and improve evaporation and precipitation predictions over the Great Lakes.

Stakeholder Engagement: Who do you serve and how do you involve them?

The objective of this session was to share past, current, and planned stakeholder engagement efforts. Note overlaps and areas for collaborative engagement efforts, as well as gaps in engagement about subseasonal to annual water level forecasting and decision support. This session consisted of 6 presentations 3-5 minutes in length each, followed by fifteen minutes of discussion time.

Presenters

- NOAA [GLERL](#) / [CIGLR](#) - [Dr. Riley Ravary](#)
- [National Weather Service \(NWS\) River Forecast Centers](#) - Jim Noel
- [International Joint Commission \(IJC\)](#) - John Allis
- [Great Lakes - St. Lawrence River Adaptive Management Committee \(GLAM\)](#) - Chris Warren
- [U.S. Army Corps of Engineers \(USACE\) Detroit District](#) - Deanna Fielder
- NOAA [National Ocean Service \(NOS\)](#) - Laura Rear McLaughlin

Discussion Summary

The primary theme that emerged out of this discussion was consideration of challenges related to the "crowded space" of coastal resiliency and the resulting large number of tools/products, and stakeholder fatigue.

- It was noted that there are many tools in this arena, and users struggle to know which is best to use for their specific needs and goals (e.g. municipal planners). Solutions to this include increased product transparency and the enhancement of end-user engagement and translation.
 - Additionally, partnerships with organizations such as the [Learning Services Division](#) at OCM can help educate communities about data tools and services.
 - The GLERL/CIGLR project team will communicate with such partners as the next-gen forecast develops.
 - NOAA Digital Coast noted they have had challenges in highlighting the best tools and resources due to the wide scale ability for people to create web maps and tools now.
- There was discussion on stakeholder engagement fatigue and opportunities to collaborate on overlapping engagement efforts.
 - There will be public meetings on GLRI
 - IJC will be holding public forums
 - The NOAA SA3 team is planning similar engagement
 - NOS has staff specific to stakeholder engagement too, and they are conducting outreach for the monthly outlook. They may have overlapping engagement work related to the ocean side of things as well.
 - NOS is also working to develop a list of conferences and users, including who might want forecasts for that time period; after that is established, they would like to share with Great Lakes colleagues.

- The [Coastal Issues Committee](#) is always looking for webinars and other engagement opportunities throughout the year.
- CIGLR is forming working groups related to the next-gen forecast where partners can provide input on stakeholder engagement efforts.
 - There will also be a DST working group where people who distribute that information are involved in the co-design of the product and the DST.
- CIGLR will be conducting user needs assessments and working with the social science team (led by Sara Hughes) to engage with people at the municipal level. The GLERL/CIGLR project team is aware of stakeholder fatigue issues and have discussed this with people who are familiar with them. The team is open to advice/collaboration on the transition plan and engagement activities.
- Noted that multiple private sectors may be interested in the next-gen forecast and DST as they are interested in water level prediction:
 - Realtors and platforms such as Zillow
 - Engineering and design firms
 - Insurance (home, flood, etc.)
 - [ASFPM](#) - a national organization and part of the [OCM Digital Coast](#) partnership
- This workshop aims to be a spark for the situational awareness discussed in terms of who everyone collaborates with and how GLERL/CIGLR can facilitate connection among stakeholders engagement activities for the next-gen forecast.

Discussion: Opportunities for collaboration

During this session, the group heard a brief presentation from the Lead Research Engagement Specialist at CIGLR regarding the plans for stakeholder engagement for the next-gen forecast. The group then discussed collaboration opportunities and engagement next steps specific to the co-design of the next generation forecast. Participants were also encouraged to consider and discuss opportunities for broader collaboration in subseasonal to annual water level forecast development and decision support.

Discussion Summary

A core takeaway from this discussion was the need for collaborative design and engagement in the development of the GLERL/CIGLR forecast and DST. A few participating organizations noted that they would like to be involved in the co-design process.

- Multiple entities noted interest in participating in the co-development of the next-gen forecast and DST with GLERL/CIGLR:
 - It was noted that ECCC-GLSLRO is a potential end-user and would be interested in contributing to the next-gen forecast from that perspective. This involvement would be through existing ties to the Coordinating Committee and GLAM initiatives.
 - OCM looks forward to the next-gen forecast and DST, because it would probably be link to Digital Coast. Stakeholders have asked which Great Lakes tools are available through Digital Coast, so they would love to highlight these when they're available and drive traffic to these tools
 - USACE Detroit District hopes to be an operational home and use the next-gen forecast. As far as the DST, it is not clear at this point whether the Corps would be the best place for this, but they are open to discussions on this.
- Plans were made for CIGLR's Research Engagement team to attend the [Great Lakes Sea Grant Network Regional Meeting](#), where colleagues from NOAA will be discussing projects relevant to Sea Grant and coastal resilience.
- There was discussion about Digital Coast:
 - As part of the Digital Coast 3.0 revamp, there will be an option to sort for Great Lakes-specific tools.
 - Digital Coast is a partnership, so it does not host tools, it just points to where tools live (e.g. from The Nature Conservancy, EPA, USACE, etc.). There are ongoing efforts to distill these tools down to what exactly partners need for coastal resiliency.
- There were questions about what the GLERL/CIGLR DST may look like:
 - **Q:** What is the intent and scope of the DST? Is it mainly to support GLAM and other agencies, or is the aim more broad (e.g., to assist planners and municipal leaders)?
 - **A:** There's a lack of definition because the answer will depend on the co-development process. GLERL/CIGLR does not want to produce something if it's not wanted or won't be of value, so decision support is something that will

depend on the results of engagement activities. The scope of the DST will also depend on where it's transitioning, and who will operate it.

- It was noted that the fundamental purpose of this project at GLERL/CIGLR is to improve the skill of the forecast; and secondarily, to develop decision support tools based on that. However, if the DST isn't functional, the forecast won't be as valuable. It's going to take a lot of engagement, and we won't know the answer to this question until the team gets farther along in this engagement process.
- There were questions regarding forecast skill: is there an established goal or metric to define success? GLERL/CIGLR will discuss this and follow-up with the conversations about forecast skill in future workshops and meetings.
- Next steps:
 - GLERL/CIGLR will be looking toward initiating the transition planning process during a workshop late summer; they're also looking to form working groups to work on co-design for the forecast and the DST
 - Keep an eye out for more information on the GLERL/CIGLR user needs assessment soon

Workshop Outcomes

Gaps and Collaboration Opportunities in SA Forecasting

Interagency Coordination and Regional Collaboration

- There are opportunities to further expand collaboration and involvement in the GLERL/CIGLR project, and leverage existing work in the region. For example, the project team should reach out to boundary organizations involved in Great Lakes decision-support, contact relevant federal agencies such as FEMA for input, and identify ways to enhance ongoing SA efforts in NOAA NOS. The GLERL/CIGLR project team is interested in engaging interested stakeholders in the co-design of the next-generation forecast and decision support tool.
- NOAA staff in the Great Lakes have had recent discussions about the speed of technology changes and how that impacts collaboration. Interagency discussions are needed to ensure technology developments do not impact data sharing in the region.
- USACE - Detroit District and ECCC are interested in being involved in co-design of the GLERL/CIGLR next-generation forecast.
- IJC and GLAM are interested in linking forecasts to both short-term and long-term management decisions (e.g., regulation and technical guidance), if the quality/skill of forecasts are improved.
- Multiple Great Lakes agencies/organizations identified the need to develop meaningful relationships with Indigenous Nations (e.g., governing agencies, communities, organizations).
- Agencies and organizations working on SA forecasting in the Great Lakes have a lot of overlap in stakeholders, as well as institutional structures.

Resources and Decision Support Tools

- Currently, there is no resource that identifies water level models, their requirements, inputs and outputs, and how they are applicable to SA forecasting in the Great Lakes. The Coordinating Committee Hydrology Sub-Committee encounters and discusses this information regularly at their meetings, but there is not an interagency, binational scale model of these data sources. Improving knowledge on how products relate to one another could enhance collaborative efforts in forecasting, for example by identifying efficiencies that could be gained by making use of ongoing advancements of existing products. The presentations that are compiled in [Appendix A](#) offer a starting point for generating such a “model-of-models,” which could be used to inform the conceptual co-design of the next-generation Great Lakes water level forecast.
- There are many boundary organizations in the Great Lakes region that have established connections with communities, knowledge of ongoing climate adaptation planning, and critical expertise in decision-support. It is important to involve these organizations early in the GLERL/CIGLR project timeline (and be attentive to their capacity to be involved) to ensure engagement in product co-design, translation, and dissemination is successful.

- There is a surplus of decision support tools (a “tool-a-palooza”) and sources of information relating to coastal resiliency in the Great Lakes region currently. Decision makers are overwhelmed by the quantity of information, are struggling to identify and/or utilize tools available/relevant to their work, and experiencing burn out from being involved in so many projects. It is critical to collaborate with other agencies/organizations to reduce redundancies in decision support, make information more accessible as a collective unit (when appropriate), and be attentive to the available time and resources of collaborators.
- NOAA Digital Coast is improving search functionality to allow users to search products by region (meaning users can now search specifically for Great Lakes products). Staff are interested in collaborating with others to drive traffic to the site and highlight new products available in the region. Digital Coast is a partnership and also lists non-NOAA products that have been vetted—they are invested in distilling the data and resources available in the region to make content more accessible and usable for partners working in coastal resiliency.

Next Steps for Involvement

The GLERL/CIGLR project team is looking to form technical working groups to provide input and review of the next-gen forecast throughout the design and development process. They are also planning a user needs assessment for both the forecast itself and a potential resulting decision support tool. The planned timeline (subject to change) for these activities is below.

Opportunities to Engage with the GLERL/CIGLR Next-Gen Forecast

To stay up-to-date on project activities, including co-design opportunities, please contact CIGLR Lead Research Engagement Specialist (Dr. Riley Ravary, ravary@umich.edu) and/or subscribe to our newsletter.

Key Stakeholder Interviews

- What: Virtual interviews
- Timeframe: Ongoing throughout project
- Commitment: ~1 hour or less
- Objective: Discuss GL water level management, SA forecasting, user needs, decision support, etc.

User Needs Assessment

- What: Online survey
- Timeframe: Mid-summer 2023
- Commitment: Approx. 30 min to 1 hr
- Objective: Assess user needs for forecast and decision support tool

Forecast Co-Design Focus Group

- What: In-person focus group
- Timeframe: Late summer 2023
- Commitment: ~ ½ day
- Objective: Inform transition plan and forecast co-design; Connect users and modeling team

Transition Workshop

- What: Workshop to plan transition with operational host
- Timeframe: Late summer 2023-2026
- Commitment: Hybrid or in-person meetings, 2x/year
- Objective: Collaboratively determine transition plan from research to operations

Technical Working Groups

- What: Working groups for forecast co-design and decision support tool co-design
- Timeframe: Fall 2023-Fall 2027
- Commitment: Hybrid meetings, quarterly
- Objective: Co-design engagements, provide project updates and opportunities for input

Usability Testing

- What: Hybrid focus groups and 1-on-1s

- Timeframe: Fall 2024
- Commitment: One to two 2-hour sessions
- Objective: Assess usability of forecast and decision support tool

Outreach and Decision Support Training

- What: Hybrid outreach and training for decision support tool
- Timeframe: Summer to Fall 2025
- Commitment: ~1 hr session
- Objective: Engage with and train stakeholders about forecast and decision support tool products

Appendices

Appendix A: Workshop slide deck

Workshop slide deck 5/18/2023

Collaborating on Subseasonal to Annual Water Level Forecasting in the Great Lakes

Thursday, May 18th 1 - 5 pm EDT

GoTo Meeting: <https://meet.goto.com/213589349>

For help with technological or logistical concerns throughout the workshop, please contact: mdicocco@umich.edu; ravary@umich.edu; mseibold@umich.edu



Opening Remarks - *Ms. Deborah Lee, NOAA GLERL Director*

Thank you to the Workshop Steering Committee:

- Andrew Peck, ORTA
- Casey Brown, UMass Amherst
- Dee Fielder, USACE Detroit District
- John Allis, IJC
- John Callahan, NOS / CO-OPS
- Mimi Hughes, PSL

And CIGLR facilitation assistance:

- Meredith Seibold
- Mary Ogdahl
- Margaret Throckmorton



Workshop Background & Introduction – Dr. Lauren Fry, NOAA GLERL



Workshop Background & Introduction

The screenshot shows a web browser displaying the NOAA website. The address bar shows the URL: <https://www.noaa.gov/infrastructure-law/infrastructure-law-climate-data-and-services/flood-and-inundation-mapping-and-forecasting>. The page header includes the NOAA logo and the text "National Oceanic and Atmospheric Administration, U.S. Department of Commerce". A search bar is present with the text "Search NOAA sites". Below the header, there is a navigation menu with the following items: "Infrastructure Law home", "NOAA provisions", "Climate data and services", "Climate ready coasts", and "Fisheries & protected resources". The main heading of the page is "Flood and inundation mapping and forecasting". Below the heading, there is a "Share:" section with icons for Twitter, Facebook, and Email. A summary of the Bipartisan Infrastructure Law is provided: "Bipartisan Infrastructure Law summary: 'Shall be for coastal and inland flood and inundation mapping and forecasting, and next-generation water modeling activities, including modernized precipitation frequency and probable maximum studies.'" A small satellite-style image of a coastal area is visible in the bottom right corner of the page content.

Build out subseasonal to annual integrated water capabilities (SA)

SA1 Improve the understanding and modeling of coupled—ocean, climate, land, hydrologic, hydrodynamic, wave—drivers/contributions to mean and extreme total water levels at the coast

SA2 Develop the next generation prediction system for determining the mean and extreme water levels to provide the foundation for defining risk of coastal inundation impacts across subseasonal to annual time scales for the open coast and Great Lakes

SA3 Transition gridded model output (from SA - 2) to develop coastal inundation outlook products supporting monthly-to-annual management and resource planning. Develop exposure data and mapping based on user defined thresholds. Integrate data and map visualizations into NOAA decision support tools and integrate it into a centralized framework. Perform community-based adaptation research and social science methodologies for working with underserved, unserved, and vulnerable populations in coastal locations.

Service Delivery* Establish NOAA Social and Behavior Observation Database -Advance Equitable Service Delivery through operational application/exploration of Agent-based modeling capacity -Transformative Foundational Social Science Research (Internal and External)

GLERL BIL SA Project Outcomes

- Advance the modeling behind seasonal water level forecasts by extending outlooks beyond 6 months and incorporating state-of-the-art operational products and data science
- Next generation forecast framework will inform a decision support tool(s) (DST) designed to guide management decisions and coastal resilience planning in the Great Lakes

Why have a workshop?

Project success requires

- Leveraging and building on existing partnerships, operational frameworks, and expertise, and
- Identifying an operational partner (or partners) to ensure transition to sustained operations

Also, more broadly, we see an opportunity for **information sharing** and developing a **shared understanding** of mission and roles in subseasonal to annual water level forecasting across organizations.

Participating Agencies, Offices, and Organizations

- Cooperative Institute for Great Lakes Research (CIGLR)
- Cornell University
- Environment and Climate Change Canada (ECCC)
- Great Lakes-St. Lawrence River Adaptive Management Committee (GLAM)
- Great Lakes Indian Fish & Wildlife Commission (GLIFWC)
- Great Lakes Integrated Sciences and Assessments (GLISA)
- International Joint Commission (IJC)
- Michigan Technological University
- NOAA
- Sea Grant
- University of Michigan
- University of Massachusetts Amherst
- US Army Corps of Engineers (USACE)
- US Geological Survey (USGS)

Workshop Overview & Logistics –

Megan DiCocco, CIGLR RES



Workshop Overview: agenda for the day

Time	Topic / Activity
1:15-2:15	Agency Overviews: Understanding roles, missions, & products <ul style="list-style-type: none"> Presenters: NOAA GLERL/CIGLR, NOS, NWS RFCs, NWC/OWP, IJC, GLAM, USACE Detroit District, USACE Buffalo District, ECCC CMC, ECCC GLSLRO Discussion and questions
2:15-2:45	Research to Operations: What does R2O mean to NOAA? <ul style="list-style-type: none"> Presenter: NOAA Office of Research Transition and Application (ORTA) Open Q & A
	5-Minute Break
2:50-3:40	Organizational Capacities: Connecting mission to operations <ul style="list-style-type: none"> Presenters: NWC/OWP, GLERL/CIGLR, NOS, NWS RFCs, USACE & ECCC Regulation Offices, USACE Detroit District Discussion and questions
3:40-4:30	Stakeholder Engagement: Who do you serve and how do you involve them? <ul style="list-style-type: none"> Presenters: NOAA GLERL/CIGLR, NWS RFCs, IJC, GLAM, USACE Detroit District, NOS Discussion and questions
	10-Minute Break
4:40-5:00	Discussion: Opportunities for Collaboration <ul style="list-style-type: none"> Presenter: CIGLR Research Engagement Team Open discussion and wrap-up

Ground Rules

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- Mute your microphone when not speaking
- Keep your camera on for discussions, if possible
- Share air time: support each participant's right to be heard
- Keep the discussion focused on the topic at hand
- Limit distractions & engage in discussion
- Please add notes or questions to the meeting chat, but we will take questions during specified discussion times

Other Notes:

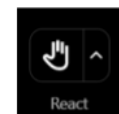
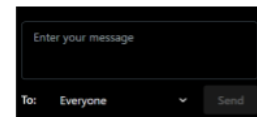
- If presentations or discussions run short, we will continue through the agenda rather than taking additional breaks.
- Notes and summary documents for this workshop will *not* include specific names.
- **Presenters:** Please watch your chat while you present, we will send you a warning when your time is almost up

GoTo Meeting Tips



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- **Mute & unmute:** use the **Audio icon** in your Control Panel
- **Chat:** Open in the top right hand corner of your screen
 - Use the **Send To** drop-down menu to select your recipients:
 - Everyone
 - Organizers only
 - Specific attendee
- **Raise hand function:** Hover over **React** and select **Raise your hand**. The hand icon will glow while it is raised and return to white/gray once it is lowered by you or the organizer.
- **Zoom in/out:** when someone shares their screen, you can personally zoom in or out



Agency Overviews: Understanding roles, missions, & products

Objective: To share information about the missions, project scopes, and products related to Great Lakes water level forecasting / forecast use at each agency or office.

1. 10 brief presentations
2. Discussion & questions



Agency Overviews: understanding roles, missions, & products

GLERL / CIGLR
Lauren Fry, GLERL PI



Agency Mission (with respect to Great Lakes water level forecasting):

Improve accuracy, precision, and efficiency of forecasts and predictions to save lives and property and support a vibrant economy. (OAR & GLERL Strategic Plans)

Organizational Structure: Cooperative Agreement between NOAA Office of Oceanic Atmospheric Research and the University of Michigan (including a regional consortium of ten universities and five private sector organizations). CIGLR Staff are embedded within the GLERL Laboratory in Ann Arbor.

Funding source(s): annual budget appropriations, Great Lakes Restoration Initiative (GLRI), interagency agreements, competitive grants, *Bipartisan Infrastructure Law*, etc.

Primary stakeholders: States and tribal governments, NOAA operational offices, federal Great Lakes water management agencies, public users

Primary collaborators: U.S. Federal water management agencies, NOAA operational offices, Canadian federal water management agencies, academic institutions

GLERL / CIGLR
Lauren Fry, GLERL PI



Products and/or projects related to water level forecasting & decision support:

- Identification of indicators of hydroclimatic changes - **USACE** (with UM, Cornell)
- Framework for Resilient GLRI Investments - **GLRI** (with USACE, USGS, Cornell)
- Great Lakes Evaporation Network - **Base** (with ECCC, UC Boulder, UM)
- Next Generation Subseasonal to Annual Forecast of Great Lakes Water Levels - **BIL**
- Existing products: Great Lakes Seasonal Hydrological Forecasting System, Large Lake Statistical Water Balance Model - **Transitioned to USACE, Coordinating Committee**

Future goals or outlook on future work:

- Link forecast developments with water management decision support (with GLAM, regulation offices)
- Advance the use of regional climate information in water level forecasts (with federal and academic partners)
- Transition research to advance Great Lakes hydrological prediction to application/operation

National Ocean Service
Audra Luscher
Coastal Hazards Branch Chief, CO-OPS



National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Agency Mission (with respect to Great Lakes water level forecasting): Our mission is to focus on **SERVICE DELIVERY** to provide **science-based** solutions through collaborative partnerships to address evolving economic, environmental, and social pressures on our ocean and coasts.

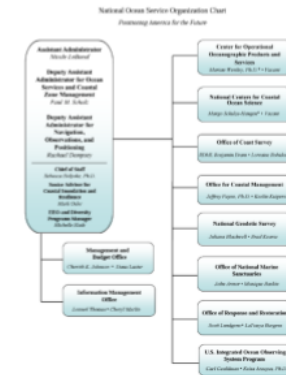
Organizational Structure & funding source(s): With 8 Program Offices, NOS has a diversity of Mission Areas. Recently established two Deputy Assistant Administrators (DAA) Rachael A. Dempsey, our first-ever deputy assistant administrator for navigation, observations, and positioning. Paul M. Scholz is the Ocean Services and Coastal Zone Management.

NOS is also establishing SES level positions beyond Program Office Directors. The ST/SL position will focus cross-Office/Agency initiatives and leadership. Examples are: Mark Osler, Senior Advisor for Coastal Inundation and Resilience, Mark Monaco, Senior Advisor for Coastal Ocean Science, and Dan Roman, Senior Advisor Geodetic Science.

Primary stakeholders: Due to the number of Program Offices and Mission Areas, NOS has likely the broadest stakeholder array of any NOAA Line Office.

Primary collaborators: (with respect to GL water level forecasting)

Bi-national, USACE, USGS, GLERL/CIGLR, GLOS, GLRI, GLCommission, NWS Central Region/WFOs



National Ocean Service

Audra Luscher

Coastal Hazards Branch Chief, CO-OPS



National Ocean Service

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Products and/or projects related to water level forecasting & decision support:

- Water Levels (CO-OPS)
- Operational Forecast Systems (CO-OPS/OCS/GLERL)
- Coastal Inundation Dashboard (CO-OPS)
- International Great Lakes Datum (binational)
- Coastal Flood Exposure Mapper (OCM)
- Lake Level Viewer (OCM)
- Seagull (IOOS/GLOS)
- Shoreline Data Explorer (NGS)

Future goals or outlook on future work:

- Updated Lake Level Viewer is in progress
- Additional water level instrumentation through GLOS
- Updating IGLD and Low Water Datum
- Low water alerts at each Water level gauge
- Gridded 40 year water level/wave reanalysis to support generation of inundation outlooks beyond NWLON.

NOAA/NWS/OHRFC

Jim Noel - Service Coordination Hydrologist



Agency Mission: *The National Weather Service (NWS) provides weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy*

Organizational Structure & funding source(s): *The 13 NWS River Forecast Center's (RFCs) are a part of the NWS. The Great Lakes are served by NCRFC (Superior, Michigan, Huron), OHRFC (Erie) and NERFC/MARFC (Ontario). NWS RFC funding is centrally funded (no private/outside). Work is completed in kind out of budget.*

Primary stakeholders: *Core partners include USACE, USGS, FEMA, USCG, navigation, sanitary/sewer districts, drinking facilities and river basin commissions etc. Additional partners include energy companies impacting river forecasts such as AEP or Eagle Creek Re.*

Primary collaborators: *USACE, USGS, NWC, universities*

NOAA/NWS/OHRC

Jim Noel – Service Coordination Hydrologist



Products and/or projects related to water level forecasting & decision support:

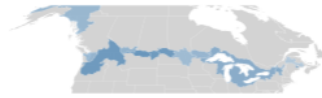
- Blended MPE/CaPA Product for CCGLBHH/USACE/ECCC
<https://mrcc.purdue.edu/qismaps/naprecip.htm>
- Great Lakes Seasonal Coordinated Messaging
- Hydrologic Ensemble Forecasting Service (HEFS) to 90 days
- Harmful Algal Bloom (HABs) Inflow Forecasts from Maumee River to Lake Erie to support NOAA/NOS forecasts

Future goals or outlook on future work:

- Development of the operational MRMS/CaPA bi-national product for both NOAA and ECCC
- Expansion of the HEFS probabilistic outlooks up to 365 days on U.S. side only
- Flood inundation mapping (Categorical FIM) could be used for long range Great Lakes tributary outlook planning
- Expansion of Runoff Risk Tool and NWM

International Joint Commission

John Allis, Senior Engineering Advisor



Pierre Bilodeau
Canadian Commissioner/Chair



Henry Lukersmith
Canadian Commissioner



Marcel Ann Shantz
Canadian Commissioner



Robert Simon
US Commissioner/Marketing Chair



Leslie Yule
US Commissioner



Agency Mission:

- Boundary Waters Treaty 1909
- Preventing and resolving disputes in shared boundary waters

Organizational Structure & funding source(s):

- 3 US Commissioners, 3 CA Commissioners
- Section Offices: Washington DC, Ottawa
- Great Lakes Regional Office: Windsor, ON
- 3 Great Lakes Boards of Control

Primary stakeholders:

- Indigenous, Hydropower, Municipal/Industrial, Navigation, Riparian, Environment, Recreation, all users of Great Lakes!

Primary collaborators:

- Great Lakes Boards: USACE, ECCC
- Department of State, Global Affairs Canada

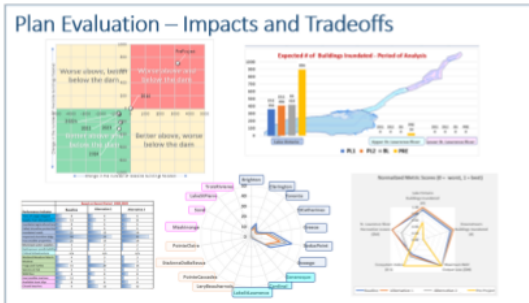


International Joint Commission John Allis, Senior Engineering Advisor



Products and/or projects related to water level forecasting & decision support:

- Board forecasts
- Regulation Plan Performance



Future goals or outlook on future work:

- Continued Evaluation of Regulation Plans
- Incorporating Forecasts into Regulation (if skill improves)

Great Lakes – St. Lawrence River Adaptive Management Committee Chris Warren, U.S. Chair



Agency Mission (with respect to Great Lakes water level forecasting)

Use forecasts and predictions to develop tools in support of the International Joint Commission's (IJC) water control Boards' assessment and evaluation of regulation strategies.

Organizational Structure & funding source(s): GLAM is a committee of the IJC that reports to the three water control boards on the Great Lakes. GLAM receives funding through U.S. Department of State as part of annual appropriations and through the International Watershed Initiative.

Primary stakeholders: Great Lakes Boards

- International Lake Superior Board of Control
- International Niagara Board of Control
- International Lake Ontario – St. Lawrence River Board

Primary collaborators: USACE, Environment and Climate Change Canada, GLERL, CIGLR, academic institutions

Great Lakes – St. Lawrence River Adaptive Management Committee

Chris Warren, U.S. Chair



Products and/or projects related to water level forecasting & decision support:

- Evaluation of regulation plans for the Great Lakes (long term)
- Expedited Review of Lake Ontario – Decision Support Tool

Future goals or outlook on future work:

- Linking forecasts to both short-term and long-term water management decisions.
- Monitoring for changes and drivers of future water supplies.

U.S. Army Corps of Engineers, Detroit District

Keith Kompoltowicz, Chief of Hydraulics & Hydrology Branch



Agency Mission (with respect to Great Lakes water level forecasting):

- Provide support to IJC Boards and GLAM to aid in water management decisions in the Great Lakes
- Create water level forecasting products that help stakeholders and the general public prepare for potential water level conditions.
- Monitor basin conditions regularly to understand water supply to the lakes.

Organizational Structure & funding source(s):

- Hydraulics and Hydrology Branch -> Watershed Hydrology Section -> Forecast Team (~5 members)
- Annual budget from Surveillance of Boundary Waters

Primary stakeholders: Boating Groups/Associations, State agencies (Sea Grants, DNR), shoreline communities

Primary collaborators: Environment and Climate Change Canada, NOAA GLERL/CIGLR, USACE Buffalo, GLAM committee, IJC Boards

U.S. Army Corps of Engineers, Detroit District

Keith Kompoltowicz, Chief of Hydraulics & Hydrology Branch



Products and/or projects related to water level forecasting & decision support:

- 6-Month Water Level Forecast – Coordinated with ECCC
- Weekly and Channel Depth Forecast – updated weekly (outlook 1-month)
- Water Level Future Scenarios Product (updated monthly – outlook 1 year)
- 5-Year Forecast – Provided **only** to Ontario Power Generation and New York Power Authority
- Large Lake Statistical Water Balance Model (L2SWBM)

Link to forecast products:

<https://www.lre.usace.army.mil/Missions/Great-Lakes-Information/Great-Lakes-Water-Levels/Water-Level-Forecast/>

Future goals or outlook on future work:

- Improvements to be made to current forecast products.
 - Incorporate machine learning techniques into statistical forecast models being used.
 - New appearance of graphics to show/emphasize full range of potential outcomes
 - Enhance ways to incorporate climate information
 - Development of new scenarios for Water Level Future Scenarios – go beyond historical Water supply data

USACE/Buffalo District

Keith Koralewski, Chief, H&H Engineering and Water Management Section



Agency Mission (with respect to the Niagara and Ontario Boards):

International Niagara Board of Control

- Monitor ice conditions on Lake Erie and in the Niagara River
- Monitor the power entities' installation, operation, and removal of ice boom
- Monitor flows and verify gauge ratings
- Investigate man-made obstructions in the Niagara River which could impact the Niagara River and Lake Erie water level

International Niagara Committee

- Monitor the Lake Erie Outflows and Diversions
- Monitor the flow over Niagara Falls

International Lake Ontario – St. Lawrence River Board

- Monitor operation of Control Structures
- Regulate Lake Ontario outflow weekly, including authorized deviations
- Monitor flow reporting, operation of gauges
- Provide technical assistance to IJC

Organizational Structure & funding source(s):

- Water Management Team consisting of four engineers and one civil technician
- Funding is provided through our Survey of Northern Boundary Waters program

Agency Overviews: understanding roles, missions, & products

USACE/Buffalo District

Keith Koralewski, Chief, H&H Engineering and Water Management Section



US Army Corps of Engineers®

Primary stakeholders:

International Niagara Board of Control

- Federal Energy Regulatory Commission
- Power Entities (Ontario Power Generation & New York Power Authority)
- Recreation (recreational boating, Maid of the Mist Boat Tour, Whirlpool Jet Boat Tour, etc.)

International Niagara Committee

- Reports directly to the US State Department
- Power Entities (Ontario Power Generation & New York Power Authority)
- Recreation (recreational boating, Maid of the Mist Boat Tour, Whirlpool Jet Boat Tour, etc.)

International Lake Ontario – St. Lawrence River Board

- Riparians – along the coast of Lake Ontario and the St. Lawrence River system
- Navigation and recreational boating
- Power Entities (Ontario Power Generation & New York Power Authority)
- Municipal Water

Primary collaborators:

- Corps of Engineers – Detroit District
- Environment and Climate Change Canada

Agency Overviews: understanding roles, missions, & products

ECCC ASTD+CCMEP

Vincent Fortin

Research scientist, ASTD



Environment and Climate Change Canada

Environnement et Changement climatique Canada

Atmospheric Science and Technology Directorate (ASTD) + Canadian Centre for Meteorological and Environmental Prediction (CCMEP)

Agency Mission: CCMEP provides operational analysis and forecast products informing on various aspects of the water cycle for the recent past, the present and the near future. Products made available through web services. Focus is on products that require HPC and 24/7 support.

Organizational Structure & funding source(s): CCMEP is supported by ASTD to ensure that the products are based on the best available science, more precisely by Meteorological Research Division (MRD) and Climate Research Division (CRD) of ASTD. MRD focusses on lead times of up to one month. Research on seasonal forecasting is a shared responsibility between CRD and MRD. All are part of ECCC, and most funds are provided by Treasury Board of Canada.

Primary stakeholders: Internal to ECCC: National Hydrological Services (NHS), Canadian Ice Service (CIS), Environmental Emergency Response Division (EER). Other federal dept.: Public Safety, Coast Guard. Some products used by Great Lakes Coordinating Committee's L2 model.

Primary collaborators: NHS, Multiple Canadian universities, NOAA/GLERL, NWS/OHRFC (binational precipitation analysis), Mercator-Ocean (NEMO lake model), Meteo-France, ECMWF

Agency Overviews: understanding roles, missions, & products

ECCC ASTD+CCMEP
Vincent Fortin
 Research scientist, ASTD



Environment and Climate Change Canada **Environnement et Changement climatique Canada**
 Atmospheric Science and Technology Directorate (ASTD) +
 Canadian Centre for Meteorological and Environmental Prediction (CCMEP)

Products and/or projects related to water level forecasting & decision support:

- Operational products (with 24/7 support)
 - Weather forecasts (1 day to 1 year)
 - Canadian Precipitation Analysis (CaPA)
 - Water Cycle Prediction System (WCPS)
 - Net Basin Supply analyses and forecasts
- Experimental products (running in operations):
 - National Surface and River Prediction System (NSRPS)
 - SHOP hydrodynamic prediction system for the St. Lawrence downstream of Montreal
- Research products (best effort basis):
 - Regional Deterministic Reforecast/Reanalysis System (RDRS, 1980-present)
 - Data prepared for Canadian Surface Prediction Archive (CaSPAR)

Future goals or outlook on future work:

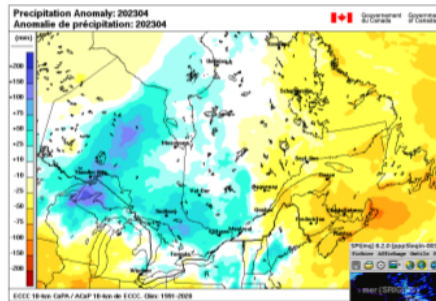
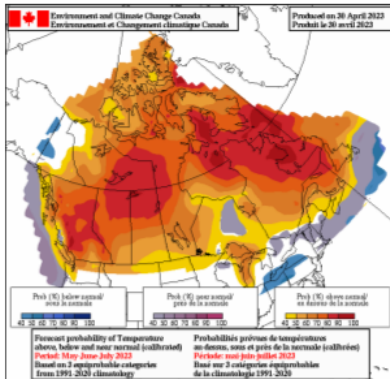
- Operational status for experimental systems
 - SHOP, NSRPS and RDRS
- R&D activities:
 - Improving snow modelling and data assimilation
 - Statistical post-processing of streamflow and water level forecasts
 - SHOP upstream of Montreal
 - Assessing and taking advantage of SWOT satellite altimetry data
 - Extending reanalysis to 1950-present
- Sustainable solution for disseminating archive of past forecasts and reanalysis

Agency Overviews: understanding roles, missions, & products

ECCC ASTD+CCMEP
Vincent Fortin
 Research scientist, ASTD

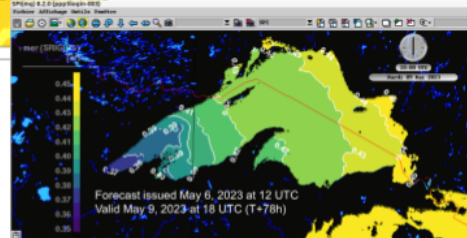


Environment and Climate Change Canada **Environnement et Changement climatique Canada**
 Atmospheric Science and Technology Directorate (ASTD) +
 Canadian Centre for Meteorological and Environmental Prediction (CCMEP)



Available data - MSC Open Data

- Documentation
- Links to access data
- [MSC AniMet](#)
- Basic web viewer
- [CaSPAR \(caspar-data.ca\)](#)
- Archive of (re)analyses and forecasts



Agency Overviews: understanding roles, missions, & products

National Hydrological Services, Great Lakes – St. Lawrence Regulation Office

Jacob Bruxer, Section Head, NHS-GLSLRO



Environnement et
Changement climatique Canada

Environment and
Climate Change Canada

Agency Mission (with respect to Great Lakes water level forecasting):

Provide the necessary applied science, engineering and technical expertise to fulfill ECCC's transboundary water management obligations outlined under the Department of Environment Act □ support "the enforcement of any rules or regulations made by the International Joint Commission... relating to boundary waters and questions arising between the United States and Canada"

- Operational support to the IJC Great Lakes Boards, binational regulation of Lake Superior and Lake Ontario outflows, Great Lakes – St. Lawrence River water level forecasting and adaptive management measures, national archive for basic hydraulic and hydrologic datasets for the GL-SLR basin

Organizational Structure & funding source(s):

NHS is part of the Meteorological Service of Canada, primary responsibilities are transboundary water management and the national hydrometric program;

GLSLRO funding is primarily ongoing (A-base) departmental funding, some additional transient external support, mainly through IJC

Primary stakeholders:

IJC, provinces of Ontario / Quebec, operational interests (hydropower, navigation), public users (e.g. shoreline properties, recreation)

Primary collaborators:

IJC // USACE, NOAA, USGS // DFO, NRCan (including through Coordinating Committee)

Agency Overviews: understanding roles, missions, & products

National Hydrological Services, Great Lakes – St. Lawrence Regulation Office

Jacob Bruxer, Section Head, NHS-GLSLRO



Environnement et
Changement climatique Canada

Environment and
Climate Change Canada

Products and/or projects related to water level forecasting & decision support:

- Monthly, 6-month Great Lakes forecast (with USACE-Detroit)
 - <https://www.tides.gc.ca/en/monthly-water-level-bulletin-great-lakes-and-mont-real-harbour>
- Weekly, 6-month Lake Ontario – St. Lawrence River (ILOSRL Board) forecast
 - <https://ijc.org/en/losrlb/watershed/forecasts>
- Great Lakes Regulation & Routing Model (GLRRM) update
 - Private github repo, access available upon request
- Great Lakes – St. Lawrence River Adaptive Management (GLAM) Committee
 - Decision Support Tool, Integrated Social, Economic and Environmental System (ISEE)
- Integration of 1-4 week water supply forecasts from ECCC numerical weather prediction systems

Future goals or outlook on future work:

- Integration of additional inputs from ECCC, US, provincial partners, other providers
- Sensitivity analysis and robust evaluation
- Consideration for use in alternative regulation plan formulations
- Coordination with additional federal/provincial partners and initiatives
- Improved communications (more accessible products, better stakeholder engagement, adjustments based on user feedback)

Office of Water Prediction / National Water Center

Dr. Trey Flowers, *Director of the OWP Analysis and Prediction Division*



Agency Mission: (with respect to Great Lakes water level forecasting):

The NWC's mission is collaboratively research, develop and deliver timely and consistent, state-of-the-science national hydrologic analyses, forecast information, data, guidance, and decision-support services to inform essential emergency management and water resources decisions across all time scales.

Organizational Structure:

The OWP is a geographically distributed organization which includes elements in Maryland, Minnesota and Alabama and is structured into 6 main divisions lead by the OWP front office. (1) Analysis and Prediction, (2) Geo-Intelligence, (3) Integrated Science & Engineering, (4) Project Management (5) Service Innovation & Partnership, (6) Water Prediction Operations.

Funding source(s):

Annual budget appropriations, including Cooperative Institute for Research to Operations in Hydrology; Bipartisan Infrastructure Law (Provision 3), reimbursable (HSDC)

Primary stakeholders:

Decision makers (emergency management), transportation, agriculture, power generation, recreation, flood control, ecosystem managements, river commerce, and water supply communities.

Primary collaborators:

NWS Field Offices (River Forecast Centers, Weather Forecast Offices, Regional Operations Centers, Analyze, Forecast, & Support Office's Water Resources Service Branch) NOAA line offices (NOS), Federal water agencies (FEMA, USGS, USACE), academia (through Cooperative Institute for Research to Operations in Hydrology)

Office of Water Prediction / National Water Center

Dr. Trey Flowers, *Director of the OWP Analysis and Prediction Division*



Products and/or projects related to water level forecasting & decision support:

- National Water Model Next Generation Water Resources Framework (NextGen)
- Community Hydrologic Prediction System (CHPS)
- Flood Inundation Mapping (FIM)
- Hydrologic Ensemble Forecast Service (HEFS)
- National Water Model (NWM) v3.0 – total water forecasting capability

Future goals or outlook on future work:

- Implement NWM v4.0 based on the NexGen Framework
- Implement FIM operationally in phases to U.S population by the end of FY26.
 - 10% → 30% → 60% → 100%
- Complete implementation of HEFS v1.0
- Atlas: by 2026 deliver estimates, documentation and supplementary products to stakeholders in CONUS



Agency Overview Questions & Discussion



Research to Operations: What does R2O mean to NOAA?

Objective: NOAA's Office of Research Transition and Application will discuss the NOAA process of transitioning a product from experimental to operational.

1. Presentation from NOAA's Office of Research Transition and Application (ORTA)
2. Open Q&A



Organizational Capacities: Connecting mission to operations

To understand the organizational capacity of each agency to contribute to the co-development, technical review, or operational hosting of a next-gen forecast.

1. 6 brief presentations
2. Discussion & questions



Organizational Capacities: connecting mission to operations

GLERL / CIGLR
Yi Hong, CIGLR PI



Staff profile (Relevant to Subseasonal to annual Great Lakes water level forecasting):

- Hydrological, atmospheric, and hydrodynamic modelers, a data scientist (TBD) and research engagement specialists at staff, postdoc, principal investigator, and director levels.

Technical capacities:

- Work stations (Windows, Linux, Mac)
- Local HPC resources (at GLERL and UMich)
- Coding in Python, R, Matlab, NCL, Fortran, ...
- Large data and geospatial data analysis
- A variety of hydro-climate modeling programs and software

Transition plans are a requirement for R2X projects

Organizational Capacities: connecting mission to operations

GLERL / CIGLR
Lauren Fry, GLERL PI



Organizational growth:

- Large and growing team focused on BIL SA and related projects



Capacity to contribute to development of GLERL's next-gen forecast:

- Committed to do research and transition to operational home under the NOAA spend plan for BIL Provision 3 (~\$3.6M over 6 years)
- Development, application, and evaluation of the next-gen experimental forecasting system
- Stakeholder engagement and analysis to meet stakeholder needs and complement existing efforts
- Prototyping, demonstrating and transitioning the experimental system for the co-development of decision support tools

Organizational Capacities: connecting mission to operations

National Ocean Service
Brandon Krumwiede
Physical Scientist, OCM



National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Office profiles: (Relevant to Subseasonal to annual Great Lakes water level forecasting)

- Center for Operational Oceanographic Products and Services (CO-OPS)
- National Centers for Coastal Ocean Science (NCCOS)
- National Geodetic Survey (NGS)
- Office for Coastal Management (OCM)
- Office of Coast Survey (OCS)
- U.S. Integrated Ocean Observing System (IOOS) → GLOS

Technical capacities:

- CO-OPS operates 53 real-time water level stations in the Great Lakes
- CO-OPS operates 5 OFS in the Great Lakes
- Shoreline mapping efforts (NGS)
- Bathymetric surveys (OCS)
- Visualization tools (OCM)

Organizational Capacities: connecting mission to operations

National Ocean Service

Brandon Krumwiede
Physical Scientist, OCM



National Ocean Service

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Organizational growth:

- Leadership: Rachael A. Dempsey, our first-ever deputy assistant administrator for navigation, observations, and positioning.
- Funding: Through BIL additional work has started to address coastal inundation science and improve coordination and collaboration activities among the offices and external partners.

Capacity to contribute to development of GLERL's next-gen forecast:

- High resolution nearshore digital elevation models
- High resolution nearshore water level modeling
- New visualization tools and dashboards
- Community engagement, outreach and education

Organizational Capacities: connecting mission to operations

NOAA/NWS/OHRFC

Jim Noel - Service Coordination Hydrologist



Staff profile (Relevant to Subseasonal to annual Great Lakes water level forecasting):

- RFCs are small staff under 20
- Individual or small climate teams at each RFC

Technical capacities:

- Papers
- Technical Review mainly hydrology/hydraulics for U.S. tributaries
- Review NWM for tributaries
- Feedback

Organizational Capacities: connecting mission to operations

NOAA/NWS/OHRC

Jim Noel – Service Coordination Hydrologist



Organizational growth:

- N/A

Capacity to contribute to development of GLERL's next-gen forecast:

- Work with CCGLBHHD
- Observational datasets included MPE, MRMS, CaPA, SWE (input forcings are fundamental to climate forecasting)
- Probabilistic forecasting into climate time-scale via HEFS
- FIM Reviews of tributaries (not currently total water levels wind driven)

Organizational Capacities: connecting mission to operations

USACE and ECCC

Jacob Bruixer, ECCC



Environment and Climate Change Canada

Environnement et Changement climatique Canada



US Army Corps of Engineers® Detroit District



US Army Corps of Engineers® Buffalo District

Staff profile (Relevant to Subseasonal to annual Great Lakes water level forecasting):

- Members from US and Canada sit on IJC Boards (Superior, Niagara and Lake Ontario-St. Lawrence) and employees in USACE District Offices and ECCC's National Hydrological Services support the boards to help make water management decisions.
- Support positions are hydraulic, civil, environmental engineers, physical scientists with expertise in meteorology, climate science and Great Lakes hydrology.

Technical capacities:

- Expertise on IJC Board operations, regulation plans (Lake Superior Plan 2012 + Lake Ontario Plan 2014), how they work + influence on water levels and flows throughout Great Lakes - St. Lawrence River
- Great Lakes Adaptive Management – regulation plan reviews
- Developing and evaluating Great Lakes regulation and routing models
- Coordination and end-users of hydrologic and hydraulic data (obs + forecast)
- Production and coordination of lake-wide average water level forecast
 - 6-month forecast monthly for all Great Lakes
 - weekly board forecast for Lake Ontario
- Communications and outreach



Organizational Capacities: connecting mission to operations

USACE and ECCC
Dee Fielder, USACE



Environment and
Climate Change Canada

Environnement et
Changement climatique Canada



**US Army Corps
of Engineers ®**
Detroit District



**US Army Corps
of Engineers®**
Buffalo District

Organizational growth:

- Each board has representatives from U.S. and Canadian agencies
- Small core team in Canada, rely heavily on support from others within ECCC and in U.S.

Capacity to contribute to development of GLERL's next-gen forecast:

- Provide input on user-needs, evaluate and provide feedback on use in practical applications related to Board operations
- Provide input on regulation procedures to include/account for in the development of the next gen-forecast.
- Operational use of the next-gen forecast to guide and inform water management decisions.

Organizational Capacities: connecting mission to operations

U.S. Army Corps of Engineers, Detroit District
Dee Fielder, Lead Forecaster/Meteorologist



**US Army Corps
of Engineers ®**
Detroit District

Staff profile (Relevant to Subseasonal to annual Great Lakes water level forecasting):

- Watershed hydrology section is made up of meteorologists, environmental, civil, and hydraulic engineers.

Technical capacities:

- Workstations are Windows
- Data reports stored in Corps Water Management System (CWMS)
- Coding capabilities in R, Python, some Visual Basic (in excel sheets)

U.S. Army Corps of Engineers, Detroit District
Dee Fielder, Lead Forecaster/Meteorologist



Organizational growth:

- Current forecast team about 5 members, hiring of an addition employee likely coming soon.

Capacity to contribute to development of GLERL's next-gen forecast:

- Provide input and assistance to project team in development and testing of the next-gen forecast.
- Plan to be an operational home for the next-gen forecast.

Office of Water Prediction / National Water Center
Dr. Trey Flowers, *Director of the OWP Analysis and Prediction Division*



Staff profile (Relevant to Subseasonal to annual Great Lakes water level forecasting):

- Hydrologists, Physical Scientists, Computational Scientists, Social Scientists, Geographers, Geospatial Scientists

Technical capacities:

- Work stations (Windows, Linux, Mac)
- NextGen – Model agnostic, leverages multi-lingual, open source, modular approach
- Python, C, C++, LSTM, CFE, Fortran, NoahOWP+CFE
- Weather and Climate Operational Supercomputing System (WCOS)
- Geographic Information System (GIS)

Office of Water Prediction / National Water Center
Dr. Trey Flowers, *Director of the OWP Analysis and Prediction Division*



Organizational growth:

- Reach Full Operational Capability
- BIL investments to advance NextGen, FIM and Atlas
- CIROH to accelerate R2O for hydrology/water prediction

Capacity to contribute to development of GLERL's next-gen forecast:

- BIL, CIROH
- NWM & NexGen Framework



Organizational Capacities Questions & Discussion

We are taking a short break

The workshop will resume at
3:40pm EDT

The next session will be *Stakeholder Engagement:
Who do you serve and how do you involve them?*

Stakeholder Engagement: Who do you serve and how do you involve them?

Share past, current, and planned stakeholder engagement efforts. Note overlaps and areas for collaborative engagement efforts, as well as gaps in engagement about subseasonal to annual water level forecasting and decision support.

1. 6 brief presentations
2. Discussion & questions



Stakeholder Engagement: Who do you serve and how do you involve them?

GLERL/CIGLR

Dr. Riley Ravary, CIGLR Lead Research Engagement Specialist



Key stakeholders & rights holders (specific to GL SA water level forecasting):

- Great Lakes water managers, governing bodies & residents
- Decision makers (e.g., adaptation professionals, emergency managers, public health & human service professionals, developers, land use & municipal planners, engineers, water & natural resource managers, realtors & insurers, coastal & floodplain managers, policy makers & transportation/navigation)
- Economic sectors (e.g., agriculture, fisheries, energy, navigation, manufacturing, shipping & transport, and real estate & property, tourism, & recreation)

Primary engagement strategies:

- Co-design
- User needs assessment & usability evaluation
- Research translation
 - Ensuring knowledge & outcomes translate into decision support & operations

Current engagement efforts:

- This workshop!
- Interviews & Qualitative Analysis
- User Needs Assessment (being drafted)
- Technical Working Groups - Forecast & Decision Support Tool Co-Design



Stakeholder Engagement: Who do you serve and how do you involve them?

GLERL/CIGLR

Dr. Riley Ravary, CIGLR Lead
Research Engagement Specialist



Engagement advancement goals:

- Follow NOAA Water Initiative Service Delivery Framework & CIGLR Research Engagement Strategy
- Engage key stakeholders to help establish a basis for developing a forecast system that both addresses requirements for water management decisions & complements existing tools & developments underway
- Identify an appropriate transition pathway & associated requirements for transition

Engagement gaps & collaboration opportunities:

- Gaps
 - Residents / frontline communities
 - Tribal governments
- Collaboration Opportunities
 - Technical working groups
 - Interviews on forecast needs & decision support needs
 - Usability testing
 - Information sharing & reducing redundancies in SA engagements

Stakeholder Engagement: Who do you serve and how do you involve them?

NOAA/NWS/OHRFC

Jim Noel – Service Coordination Hydrologist



Key stakeholders & rights holders (specific to GL SA water level forecasting)

- Key partners at RFCs include USACE, USGS, FEMA, USCG, navigation etc.

Primary engagement strategies:

- Work directly with partners to meet operational needs and on development projects related to climate and hydrology

Current engagement efforts:

- Climate Change - NCA5, NOS for Harmful Algal Blooms, Blended precipitation products to improvement input forcings to short and long term hydro modeling

Stakeholder Engagement: Who do you serve and how do you involve them?

NOAA/NWS/OHRFC

Jim Noel – Service Coordination Hydrologist



Engagement advancement goals:

Implement short and long range HEFS across the U.S. including the Great Lakes. NCRFC out to 14 days now, NERFC 90 days (using climatology), OHRFC 90 days (using CFS model - but does run out 270 days). Using links below to collaborate on future looks of HEFS nationally. It will fall under NWPS at some point for both short and long range.

<https://www.cbrfc.noaa.gov/dbdata/station/ensgraph/map/ensmap.html>

https://water.weather.gov/ahps/long_range.php

Engagement gaps & collaboration opportunities:

- HEFS only covers U.S. side of Great Lakes.
- Input forcings (including precipitation) for climate and hydro modeling are still scattered and funded across multiple agencies and branches on U.S. side where ECCC structures things under one umbrella.
- Operational Blended MRMS/CaPA is an ongoing gap. (Possible Pass 4 through MRMS/ECCC).

Stakeholder Engagement: Who do you serve and how do you involve them?

International Joint Commission

John Allis, Senior Engineering Advisor



Key stakeholders & rights holders (specific to GL SA water level forecasting)

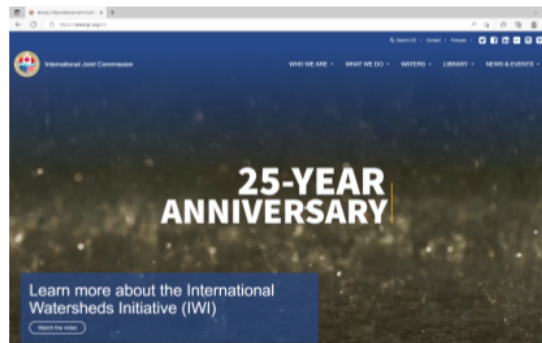
- Indigenous, Hydropower, Navigation, Municipal/Industrial, Riparian, Environment, Recreation, Agriculture
- State, Provincial, Municipal Governments and Local Organizations

Primary engagement strategies:

- Direct IJC Communication
- Board Communication
- Agency Communication

Current engagement efforts:

- IJC Webinars, Website, Newsletters
- Board Forecasts and Products
- Public Advisory Groups
- Indigenous Engagements
- Facebook



Stakeholder Engagement: Who do you serve and how do you involve them?

International Joint Commission
John Allis, Senior Engineering Advisor



Engagement advancement goals:

- Increased Indigenous engagement
- Direct communication with stakeholder groups and leaders
- More transparent tools and information

Engagement gaps & collaboration opportunities:

- Normalizing Indigenous participation.
- Easily understandable, targeted products.
- Addressing common regulation misconceptions.

Stakeholder Engagement: Who do you serve and how do you involve them?

Great Lakes – St. Lawrence River Adaptive Management Committee
Chris Warren, U.S. Chair



Key stakeholders & rights holders (specific to GL SA water level forecasting)

- Municipal and Industrial water usage
- Commercial Navigation
- Hydropower
- Coastal Development
- Ecosystems
- Recreational Boating

Primary engagement strategies:

- Formation of a Public Advisory Group (PAG), Partnership with existing Board and IJC communication teams

Current engagement efforts:

- PAG meetings, indigenous outreach, support of Board communications during high water

Stakeholder Engagement: Who do you serve and how do you involve them?

Great Lakes – St. Lawrence River
Adaptive Management Committee
Chris Warren, U.S. Chair



Engagement advancement goals:

1. Education of the possibilities in forecasting and water management - lead times and uncertainty.
2. Forecast uncertainty and risk

Engagement gaps & collaboration opportunities:

1. Can we use forecasting as *part* of a regulation plan?
2. Integration of forecast improvements into water management decisions

Stakeholder Engagement: Who do you serve and how do you involve them?

U.S. Army Corps of Engineers, Detroit District
Dee Fielder, Lead Forecaster/Meteorologist



Key stakeholders & rights holders (specific to GL SA water level forecasting:)

- Public groups – Boating (power squadrons, yacht/sail clubs), State agencies (Sea Grants, Waterways Commission), property owners, media

Primary engagement strategies/ Current engagement efforts:

- Beach Walks done each summer (Coastal and Water levels focus)
- On the Level Videos
- Provide presentations upon request to various groups.
- Respond to media requests
- Conduct outreach with other Corps offices (Regulatory, Emergency Management, Operations)

Stakeholder Engagement: Who do you serve and how do you involve them?

U.S. Army Corps of Engineers, Detroit District
Dee Fielder, Lead Forecaster/Meteorologist



Engagement advancement goals:

- Respond to requests for presentation and partnerships to enhance communication of water levels to public.
- Work with partners (NOAA, ECCC) to continue to develop forecasts of water levels.

Engagement gaps & collaboration opportunities:

- Gaps/Collaborations
 - Providing full story including shoreline impacts. During high water, did many combined presentations with Sea Grants (WI & MI), DNR, Emergency Management, and EPA.
 - Hope that this project will help to answer a very common question of future water levels in a changing climate? Research has been done in this area, but how can we implement this into operations?

Stakeholder Engagement: Who do you serve and how do you involve them?

National Ocean Service
Laura Rear McLaughlin
Stakeholder Services Branch Chief, CO-OPS



Key stakeholders & rights holders: (specific to GL SA water level forecasting)

- National Weather Service
- GLERL
- US Army Corps of Engineers
- IJC and Boards of Control
- Canadian Hydrographic Service
- US Geological Survey
- Canadian Coast Guard
- Canadian Geodetic Survey
- Mariners and vessel pilots
- Coastal planners
- NY Power Authority
- Ontario Power Generation
- Environment and Climate Change Canada
- NERRS
- First Nations and Tribal Partners
- Great Lakes Commission

Primary engagement strategies:

- Incorporating NOAA's Service Delivery Framework - continuous user engagement throughout product lifecycle
- User meetings and workshops
- 1-on-1 interviews
- Emails, Newsletters, trainings
- Through partners

Current engagement efforts:

- NGS Regional Advisors
- OCS Navigation Manager
- OCM Geospatial Advisor
- Great Lakes Regional Collaboration Team Communications and Outreach Working Group
- ORR Scientific Support Specialist
- NERRS
- Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data
- Coastal Coupling Community of Practice

National Ocean Service

Laura Rear McLaughlin
Stakeholder Services Branch Chief, CO-OPS



National Ocean Service

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Engagement advancement goals:

- Ensure what we build is what customers want
- Ensure that what is built has an operational home and operational users
- Avoiding overlap with existing binational products and decision support tools

Engagement gaps & collaboration opportunities:

- No central effort
- Binational Opportunities
- IJC
- Tribal Consultations
- Opportunities to engage together to ensure we meet stakeholders needs (need to also follow PRA rules)

A light gray silhouette map of the United States, including Alaska and Hawaii, serving as a background for the title.

Stakeholder Engagement Questions and Discussion



We are taking a 5 minute break

The workshop will resume soon at 4:37



Discussion: Opportunities for Collaboration

Consider interagency opportunities for collaboration in subseasonal to annual water level forecast development and decision support. Discuss collaboration and next steps specific to the co-design of the next generation forecast in development at GLERL/CIGLR.

1. Brief presentation from CIGLR RES
2. Discussion about next-gen forecast
3. Open discussion time



Opportunities for Collaboration

GLERL/CIGLR

Dr. Riley Ravary, CIGLR Lead Research
Engagement Specialist



Co-development Plan for the Next-Generation Forecast

Summary of Research Engagement Objectives:

- Identify stakeholders & rights/title holders in BIL SA project, & appropriate methods for engagement
- Recommend transition pathway from research to operational use of products, & support process of transition
- Engage stakeholders, rights/title holders, & operational host in co-design of forecast framework & decision support tool(s) to ensure products meet user needs & technical requirements
- Disseminate results & evaluate engagement

October 2023-September 2024 (Year 1) Objectives:

- Inventory & concept map
- Identify stakeholders & rights holders
- Identify possible operations hosts & end users
- Develop & implement user needs assessment
- Report findings & identify R2O pathway
- Draft plans for transition & co-design with operational host



Co-produced knowledge joins scientific & technical knowledge with practical, traditional, local, experiential, & other ways of knowing. **Co-design is creating something (e.g., research projects or products) with users, not for users.** These processes are collaborative & involve stakeholder/rights holder input from the beginning to the end of a project.

Opportunities for Collaboration

GLERL/CIGLR

Dr. Riley Ravary, CIGLR Lead Research
Engagement Specialist



Opportunities to Collaborate & Engage

- Key Stakeholder Interviews
 - What: Virtual interviews
 - Timeframe: Ongoing throughout project
 - Commitment: ~1 hour or less
 - Objective: Discuss GL water level management, SA forecasting, user needs, decision support, etc
- User Needs Assessment
 - What: Online survey
 - Timeframe: Mid-summer 2023
 - Commitment: Approx. 30 min to 1 hr
 - Objective: Assess user needs for forecast & DST
- Forecast Co-Design Focus Group
 - What: In-person focus group
 - Timeframe: Late summer 2023
 - Commitment: ~ ½ day
 - Objective: Inform transition plan & forecast co-design; Connect users & modeling team
- Transition Workshop
 - What: Workshop to plan transition with operational host
 - Timeframe: Late summer 2023-2026
 - Commitment: Hybrid or in-person meetings, 2x/year
 - Objective: Collaboratively determine transition plan from research to operations
- Technical Working Groups
 - What: Working groups for forecast co-design & DST co-design
 - Timeframe: Fall 2023-Fall 2027
 - Commitment: Hybrid meetings, quarterly
 - Objective: Co-design engagements, provide project updates & opportunities for input
- Usability Testing
 - What: Hybrid focus groups & 1-on-1s
 - Timeframe: Fall 2024
 - Commitment: One to two 2-hour sessions
 - Objective: Assess usability of forecast & DST
- Outreach & Decision Support Training
 - What: Hybrid outreach & training for DST
 - Timeframe: Summer to Fall 2025
 - Commitment: ~1 hr session
 - Objective: Engage with & train stakeholders about forecast & DST products

Discussion Prompts

- What is a logical transition pathway for the GLERL/CIGLR next-gen forecast system?
- What is a logical transition pathway for the GLERL/CIGLR decision support tool(s)?
- What kinds of data, products, or services does your organization have that are accessible to other organizations for collaborative efforts?
- Are there any products or services that you wish others knew about and/or utilized?
- How can we avoid overlap or redundancies in SA forecasting and decision support in the Great Lakes?
- Does your organization collaborate with other organizations on SA forecasting and decision support? If so, who?



Workshop Wrap Up – Dr. Lauren Fry

- Lessons learned today
- Next steps for collaboration
- Outputs from today's event
- Feedback survey

Thank you for your participation

<https://www.glerl.noaa.gov/>
<https://cigl.seas.umich.edu/>



Transition Planning and Process

How Policies and Processes of Transitions have Evolved

May 18, 2023

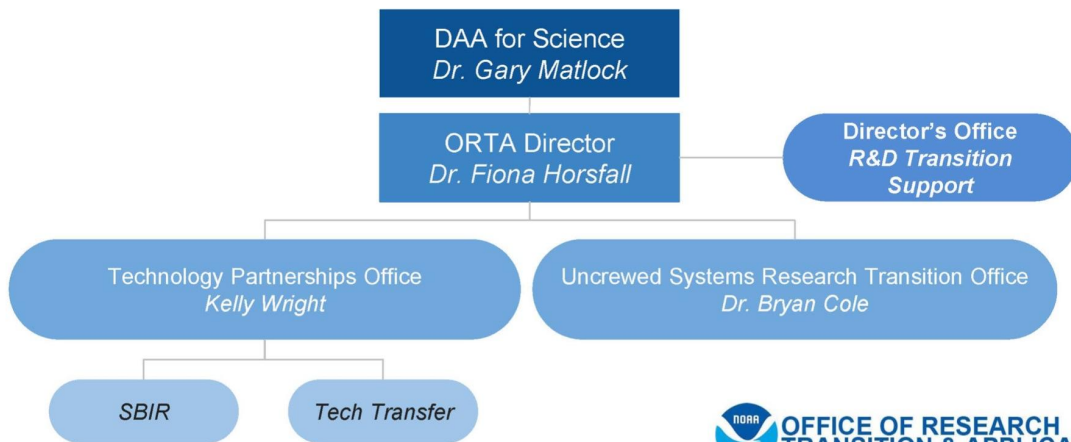
Kenneth Vierra (ORTA/UxSRTO/STC)

Andrew Peck (ORTA)

**NOAA Office of Oceanic and Atmospheric Research (OAR)
Office of Research, Transition, and Application (ORTA)
Uncrewed Systems Research Transition Office (UxSRTO)
Science Technology Corporation (STC)**



NOAA OAR Office of Research, Transition, and Application (ORTA)




 **OFFICE OF RESEARCH
TRANSITION & APPLICATION**
orta.research.noaa.gov | oar.orta@noaa.gov



ORTA Offices

Uncrewed Systems Research Transition Office (UxSRTO)
Focus: support innovative R&D and transition of uncrewed systems into NOAA and U.S. industry



Technology Partnerships Office (TPO)
Focus: TPO drives innovation and catalyzes economic development across NOAA's mission areas. TPO's two programs are central to NOAA's innovation ecosystem.

SBIR - SMALL BUSINESS INNOVATION RESEARCH

- **NOAA SBIR Program Mission:**
- To stimulate U.S. economic and business growth through the commercialization of innovative mission-relevant technologies by
 - Investing NOAA research funds in small businesses
 - Providing education and support to entrepreneurs throughout the process of researching, developing, and commercializing products or services.

TECH TRANSFER/ COMMERCIALIZATION

- **NOAA Technology Transfer Program Mission:**
- To promote increased use and commercialization of NOAA's innovative technologies and knowledge by
 - Ensuring the rapid and cost-effective transfer of intellectual property from NOAA labs and programs to other federal agencies, academia, and the U.S. private sector
 - Facilitating strategic partnerships



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ORTA Mission

Advance innovative research and development to support NOAA's mission and the US economy



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Why Make A Transition Plan

“It is a way to make people fully aware of what our portfolio looks like, what your research is, and how it fits into the NOAA mission.”

“The bottom line, as I see it, is transition plans will play a more prominent role in what we do...if we establish our transition portfolio much more aggressively, as stipulated in the administrative order, we ensure early engagement by the user side, they are aware of what the research passes from the concept all the way to their need. It reduces the chances of stalled transitions. Everyone knows what the steps are and understand where the risks are and it is an extraordinarily valuable tool for the budget process”

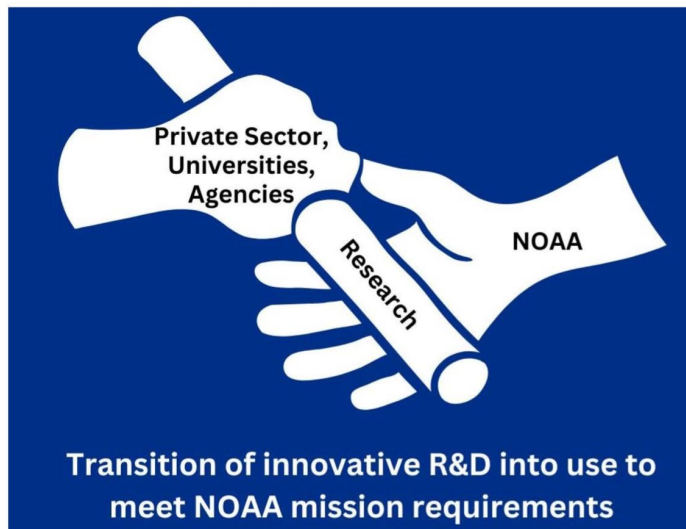
DR. RICHARD W. SPINRAD, NOAA
ADMINISTRATOR

JANUARY 18, 2022 | NOAA CENTRAL LIBRARY SEMINAR - DEVELOPING A TRANSITION PLAN: A FIRESIDE CHAT

OFFICE OF RESEARCH, TRANSITION, AND APPLICATION
National Oceanic and Atmospheric Administration

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Transition Plans Facilitate End User Engagement and Transfer of Technology

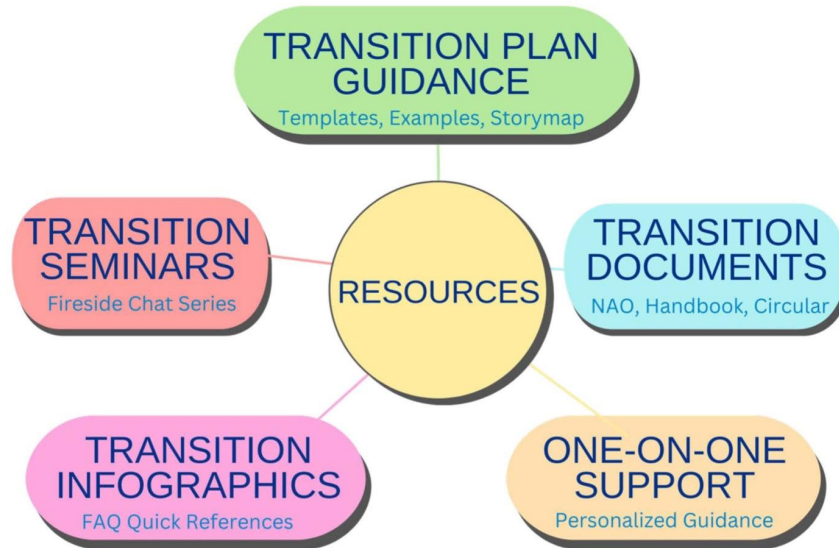


- Transition Plans are **living documents** to be amended with increasing detail as the innovative technology matures and will remain valid as long as the corresponding development project is completed successfully.
- The Signing of a transition plan provides situational awareness of the work and review / approval to move forward and **does not represent a binding agreement** and/or funding availability.



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ORTA R&D Transition Support



Key Component of Transition Support - Transition Plan

FOR THE PIS AND THEIR TEAM

- Project exposure to NOAA leadership
- A path for the R&D to be applicable

FOR THE OFFICE AND LAB

- Project becomes more competitive when seeking further funding to cross over the R&D valley of death
- Project exposure to NOAA leadership

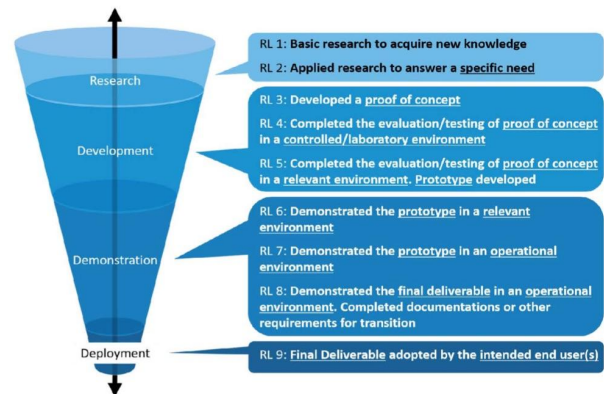
FOR ADOPTERS

- A transition plan can provide resource expectation when R&D is being put into use
- Allow adopters to contribute to the R&D process from the perspective of how the R&D would be used after development

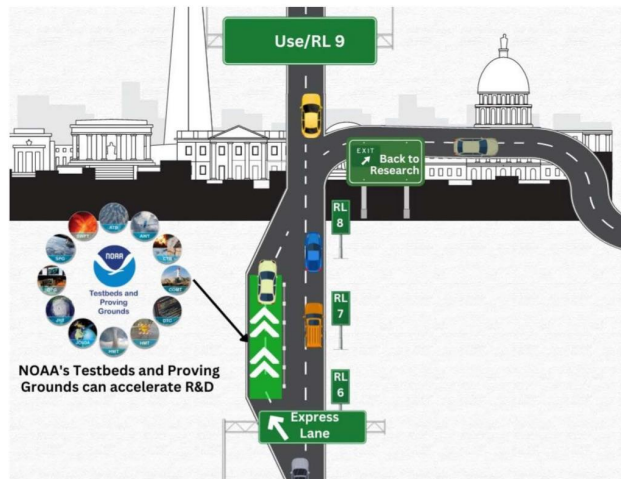
FOR LEADERSHIP

- More information on NOAA's R&D enterprise
- Better enable identification of resources or aid in order to help R&D transition to use

A transition plan is a document that lays out a roadmap to move R&D into use based on Readiness Levels (RL)



NOAA Testbeds & Proving Grounds



A major facilitator of R2O, accelerating innovative technologies through “funnel” – and of O2R



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ORTA R&D Transition Support

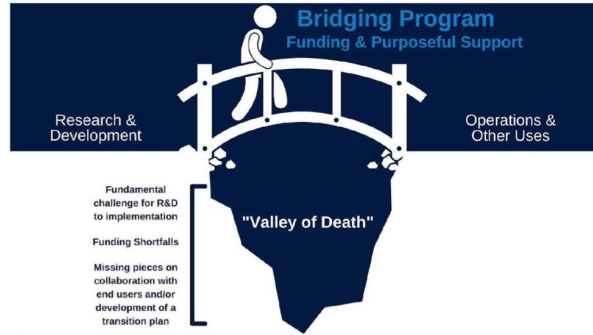
- ORTA has the knowledgeable staff and tools to provide assistance and leverage collaborations when opportunities exist
- Liaison to entities looking to transition R&D into NOAA
 - Serve as a point of contact within NOAA to help identify technologies of mutual interest and end users when needed



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ORTA Bridging Program

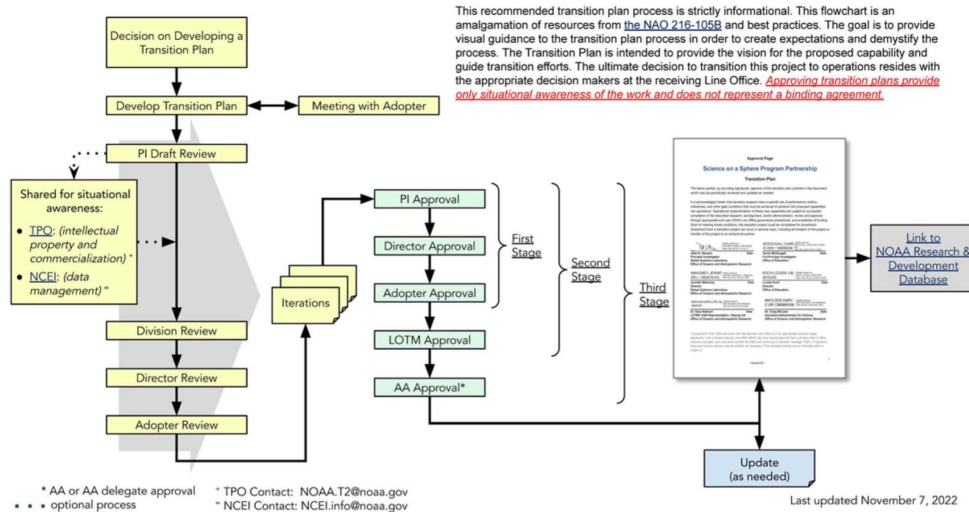
- Many research and development (R&D) projects are unable to cross the “valley of death,” the term that describes the gap that exists between R&D and operations, mission needs, application, and other uses.
- Examples of possible reasons for the “stall”
 - Funding shortfalls
 - Missing pieces on collaboration with end users
 - Development of a transition plan
 - Hardware issues
- ORTA has a pilot Research to Operations (R2X) Bridging Program to help address projects that fall short of implementation



Note: “Crossing the Valley of Death” was outlined in a National Academy of Sciences publication in 2000 as a “fundamental challenge for research and development to implementation.” National Research Council 2000. From Research to Operations in Weather Satellites and Numerical Weather Prediction: Crossing the Valley of Death. Washington, DC: The National Academies Press. <https://doi.org/10.17226/9948>

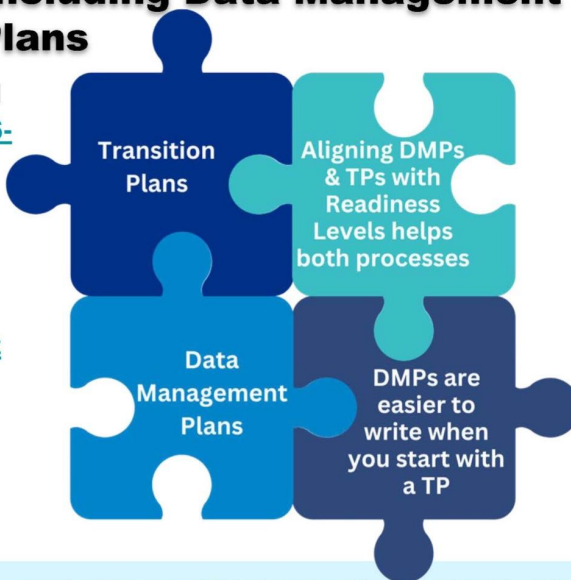


ORTA Recommended Transition Plan Process



Processes and Tools Make it Easy to Complete Policy Requirements, Including Data Management Plans

- Transition plans (TPs) are recommended in [NOAA Administrative Order \(NAO\) 216-105B](#) for projects at RL4 and above
- OAR is issuing a new circular requiring transition plans for projects at RL4 and above
- Data management plans (DMs) are prescribed by [NAO 212-15 “Management of Environmental Data and Information”](#)
- TPs and DMs can be developed in parallel, which reduces the work
- ORTA and NCEI have tools to help with development of both



Ways ORTA Engages on Transition Planning and Process



Each phase contributes to facilitating a successful transition plan development



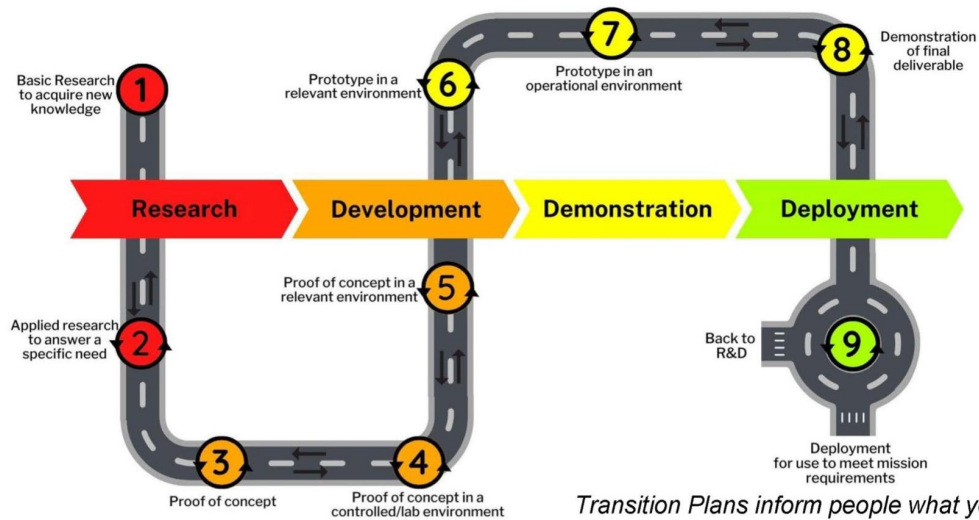
Transition and Data Management Plan Relationship

Transition Plans	Data Management Plans
<ul style="list-style-type: none"> provide a vision for how a developing technology will be used to meet mission requirements living document amended with increasing detail as the project matures remain valid until development completed enable planning and milestone reviews satisfy end user-defined Line Office metrics for success w/ potential constraints 	<ul style="list-style-type: none"> enable sharing data that advances science and maximizes research investment, allowing others to build on your work. living document that provides evidence for your research, tied to published results increases impact and visibility of your research with data citations comply with funding /copyright mandates preserves data for the long term, minimizing loss

When data are shared through an archive, research productivity increases and we can demonstrate NOAA's research investment.



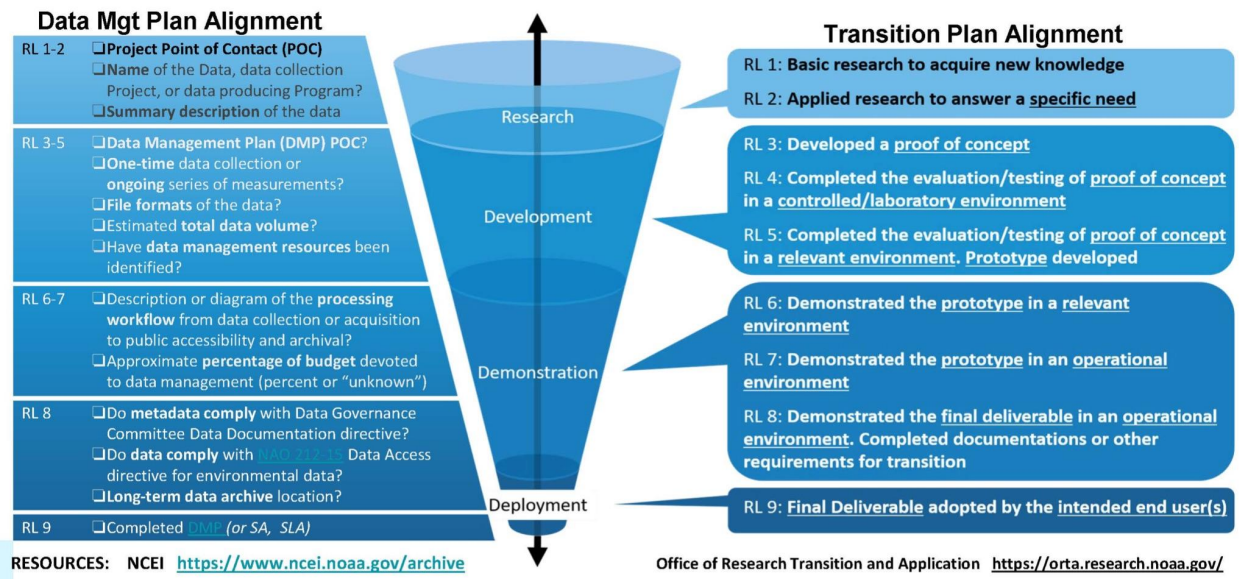
Pathway of R&D to Deployment or Use



Transition Plans inform people what you have in mind if you are successful with your R&D



ORTA and NCEI Aligning R&D Transition and Data Management Planning



ORTA Transition Support is here to help!

We are resource to assist with the development of Transition Plans and streamline transition processes across all of NOAA

[ORTA Feedback Form](#)

SUBMIT FEEDBACK

Future ORTA Plans:

- Create tools to streamline the transition process
- Increase engagement with users
- Expand our role in the

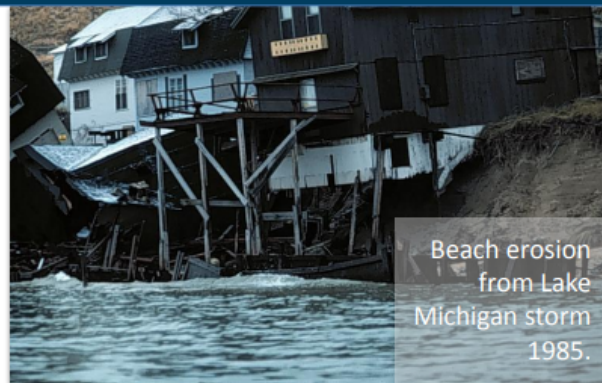
orta.research.noaa.gov | oar.orta@noaa.gov

Appendix C: Workshop attendee list

List of attendees logged into the virtual meeting as recorded by the hosting platform. Others may have been present and not recorded. Please see [Workshop Directory](#) for additional information about participants, including titles, affiliations, research interests, and web links.

Aaron Pratt	Jim Noel - NOAA/NWS/OHRFC	Robert (Robin) Webb
Abby Arnold	John Allis - IJC	Satbyeol "Joy" Shin
Adam Bechle	John Callahan	Scott Steinschneider
Adam Greeley - IJC	John Scinocca	Sophie Orendorf
Analise Keeney	Judy Levan - NWS Buffalo	Taylor Asher
Andrea Holz - IJC	Keith Kompoltowicz - USACE Detroit	Trent Frey - NWS Detroit
Andrew Peck	Keith Koralewski - USACE Buffalo	Vincent Fortin
Anna Gossard - University of Michigan	Kenneth Vierra	Yi Hong
Audra Luscher	Kim [No Surname Listed]	Zoe Miller
Ayumi Fujisaki-Manome - CIGLR	Lacey Mason	Matt [No Surname Listed]
Bill Saunders	Laura Rear McLaughlin	Rob Cifelli
Billy Brooks	Lauren Fry	
Brandon Krumwiede	Lindsay Fitzpatrick	
Bryan Mroczka - NOAA GLERL	Lynn Greer	
Bryce Carmichael - USACE	Madison Rodman - MN Sea Grant	
Chanse Ford - USGS	Manish Venumuddula	
Charles Sidick	Margaret Throckmorton - CIGLR	
Chiara Zuccarino-Crowe - GL Sea Grant Network	Mary Ogdahl - CIGLR	
Chris Hoard	Megan DiCocco	
Chris Warren - GLAM	Meredith Seibold	
David Fay - IJC	Mike W.	
David Wright - NOAA/GLERL	Mimi Hughes	
Deanna Fielder - USACE Detroit	Missy Kropfreiter - GLAM and USACE	
Deborah Lee - NOAA GLERL	Narayan Shrestha - ECCC	
Doug Marcy - NOS\OCM	Natalie Gervasi	
Drew Gronewold - UM	Nhan-NWS-NCRFC	
Erika Klyszejko	Nicole O'Brien	
Jennifer Jury - USACE-Detroit	Pengfei Xue	
Jeremy Bricker	Rich Pollman-NWS	
Jesse Feyen	Riley Ravary - CIGLR	

Appendix D: GLERL project factsheet



The Future of Great Lakes Water Level Forecasting

Developing a Next Generation Prediction System for Great Lakes Water Levels to Inform Lake Management Decisions

The Bipartisan Infrastructure Law (BIL) is a transformational opportunity to make an impact against the climate crisis across the country, improve resilience, strengthen aging infrastructure, and invest in communities. A \$904 million investment in NOAA's climate data and services will result in critical climate information in the hands of decision-makers. With BIL funding, researchers at the NOAA Great Lakes Environmental Research Laboratory (GLERL) and the University of Michigan Cooperative Institute for Great Lakes Research (CIGLR) are developing a next generation prediction system for determining baseline and extreme water levels in the Great Lakes. The forecast will be developed collaboratively with Great Lakes water managers, and will transition from research at GLERL to sustained operations at a federal partner agency.

Quick facts:

- The Great Lakes is a shared resource between the US and Canada. Successful forecast development and its transition from research to operations will be ensured by leveraging existing federal and binational partnerships that have evolved over more than 100 years of shared water management.
- This project aims to advance the modeling behind current seasonal water level forecasts by extending outlooks beyond 6 months and incorporating state-of-the-art operational products and data science.
- The next generation forecast framework will inform a decision support tool(s) (DST) designed to guide management decisions and coastal resilience planning in the Great Lakes.
- The improved water level forecast will have the potential to inform adaptive management of Great Lakes outflows and prepare commercial shipping, coastal residents, recreational users, and other stakeholders for potential hazards due to fluctuating lake levels.
- This 5-year project began in October 2022 and will be completed in September 2027.



Technological advancements pave the way for advanced prediction

Great Lakes water resource managers have a critical need for flood risk predictions on a subseasonal to annual time scale (1-12 months). This requires accurate predictions of how environmental factors will influence water supply and water level changes. Existing 6-month forecasts of water levels are valuable communication tools that reach stakeholders on both sides of the U.S.-Canada border via mailing lists, web content, binational technical committees, and interagency coordination. The use of these forecasts for decision making has been limited, however, due to historically large uncertainties. Recent advancements in atmospheric modeling, application of machine learning, and continental scale hydrological modeling have paved the way for improvements to forecasts. Ultimately, these developments increase confidence in water level forecasts, provide critical information to decision makers, and support efforts to strengthen coastal resiliency.

NOAA's development of a next generation prediction system for Great Lakes water levels

- **Hydrological, Statistical, and Climate Modeling:** Researchers are advancing Great Lakes water cycle prediction by incorporating output from state-of-the-art hydrological and atmospheric models with artificial intelligence and machine learning techniques. These efforts will advance forecast technologies and produce optimized forecasts for target users and locations.
- **Stakeholder Engagement:** CIGLR and GLERL researchers are co-developing the forecast framework and decision support tool(s) with stakeholders, including federal partners who produce and communicate forecasts, to ensure that the resulting products both (1) augment or advance existing forecast operations and decision support products, and (2) address requirements for water management decisions and coastal resilience planning.
- **Social Science:** This project will survey decision-makers in the Great Lakes region (from the local to national level) about barriers and drivers of coastal risk management decision-making.

Who will benefit:

- *Great Lakes water managers* including the International Joint Commission, U.S. Army Corps of Engineers, and Environment and Climate Change Canada.
- *Great Lakes governing bodies* including Indigenous Nations, binational governing organizations, U.S. federal agencies, U.S. state, county and municipal governments, and Canadian government agencies.
- *Decision makers* such as adaptation professionals, emergency managers, public health and human service professionals, developers, land use and municipal planners, engineers, water and natural resource managers, realtors and insurers, coastal and floodplain managers, policy makers, and transportation and navigation professionals.
- *Economic sectors* including agriculture, fisheries, energy, navigation, manufacturing, shipping and transport, real estate and property, tourism, and recreation.
- *Great Lakes residents* such as coastal communities, property owners, and recreators.



For additional information, please contact:
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