



CIROH 1st Annual Training and Developers Conference 2023  
Hands-On Demo of the CIROH Integrated Evaluation System Prototype Workshop  
Wednesday, May 17th at 1:30 PM

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**TEEHR**

Tools for Exploratory Evaluation in Hydrologic Research

# Background and Motivation

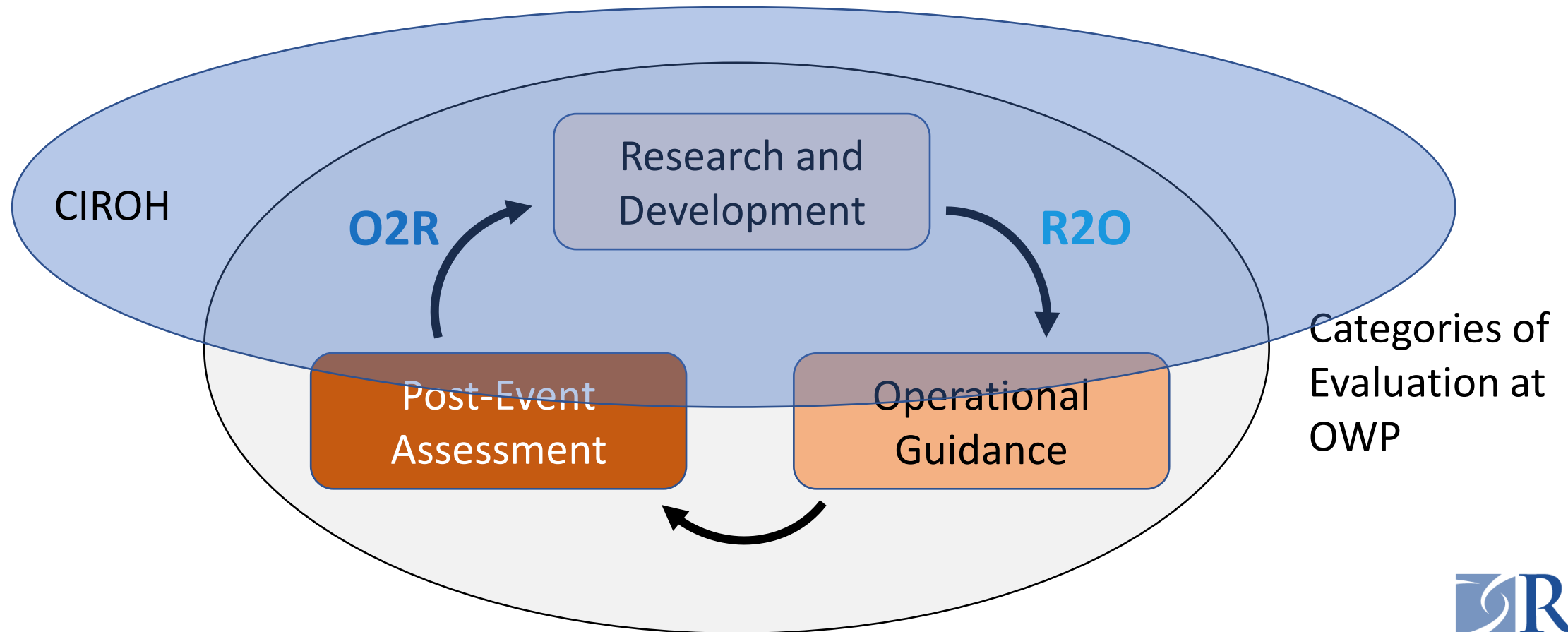


What is  
Evaluation?



# What types of evaluation are we talking about?

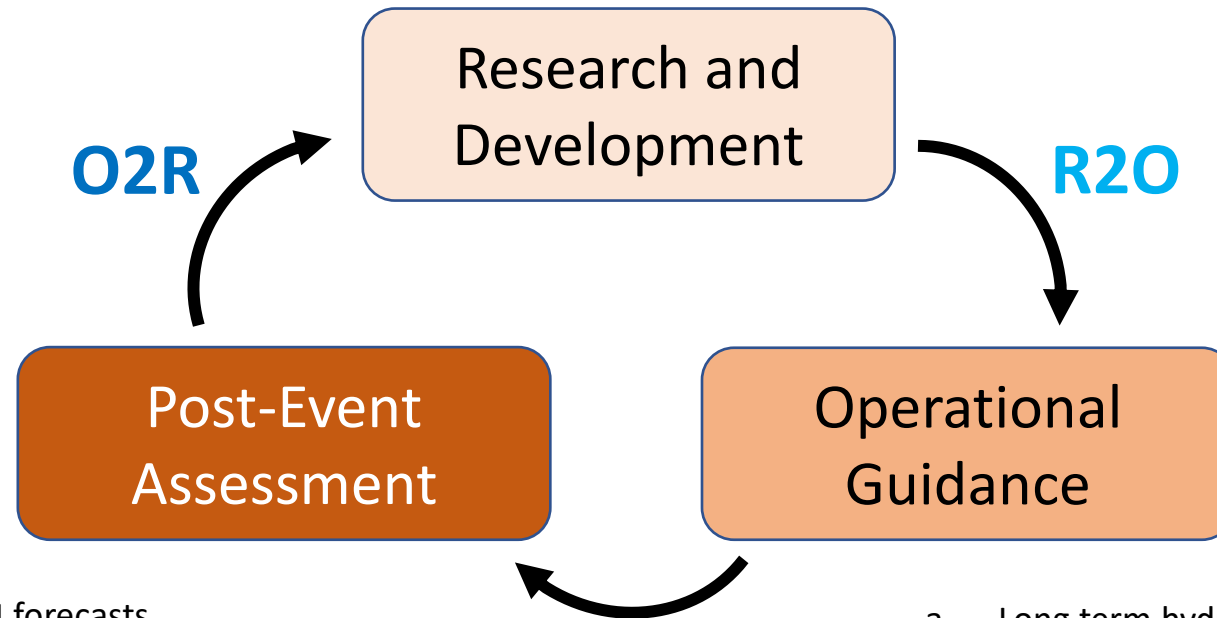
An assessment of the quality of hydrologic forecasts, or *component* of the forecast process, with respect to some baseline





# A few specific examples

- a. Hydrologic model component development (snow, land surface, subsurface, reservoir, channel...)
- b. Flood inundation model/methods
- c. Operational forecasting methods/approaches (DA method, forecast forcing, ensemble methods...)

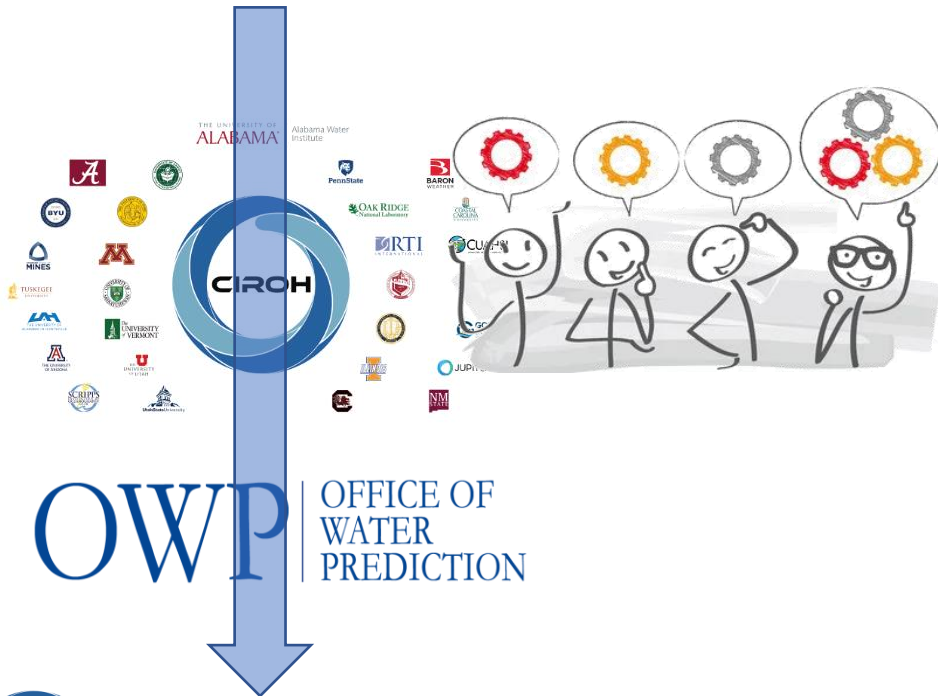


- a. Qualitative reviews of NWM forecasts
- b. Precip forecast performance assessment
- c. Hydro forecast performance assessment
- d. Hydro model performance assessment
- e. FIM performance assessment

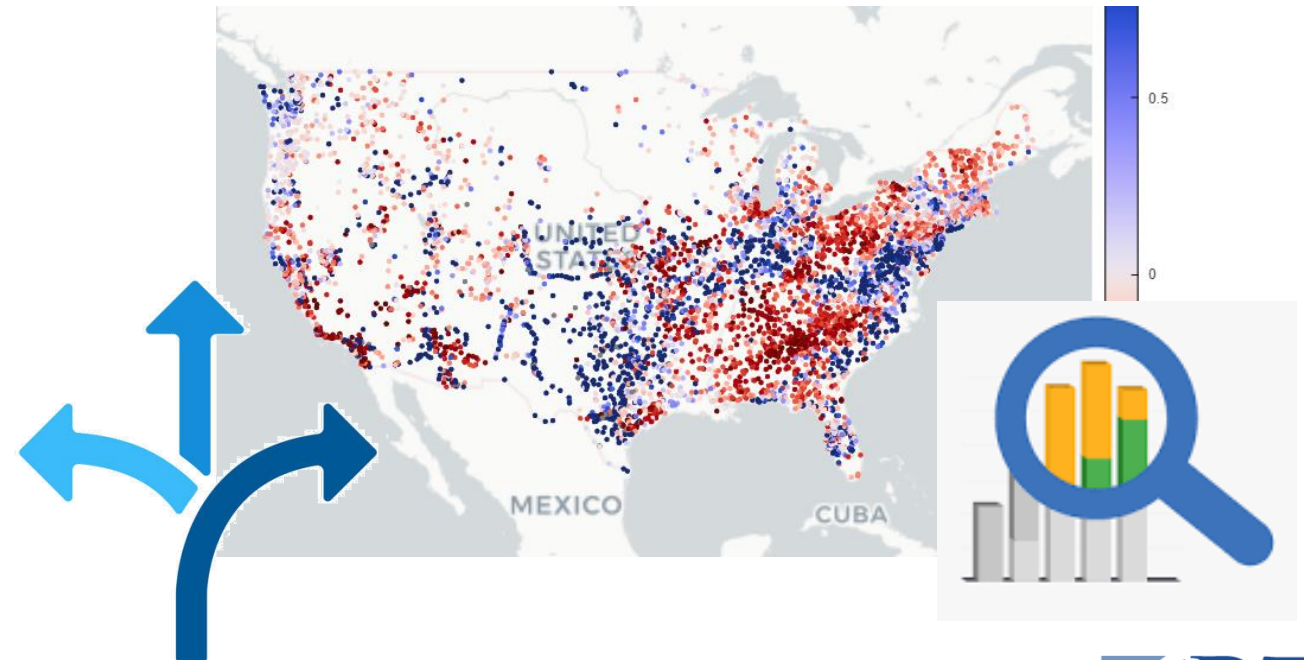
- a. Long term hydrologic model error trends
- b. Forecast forcing (QPF) trends
- c. Hydrologic reforecast/hindcast trends
- d. Current model condition assessment

# Why a CIROH Evaluation System?

Foster Consistency and  
Community Development

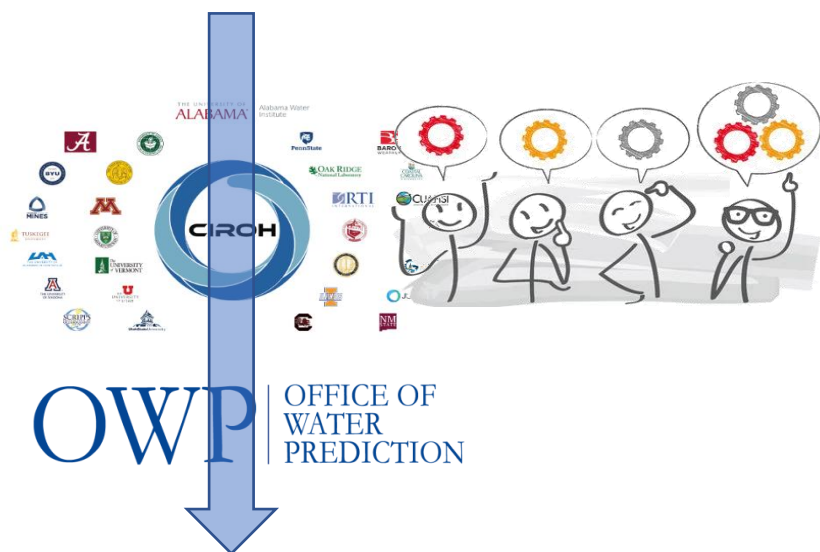


Need for Flexible, Scalable,  
Exploratory Evaluation Tools



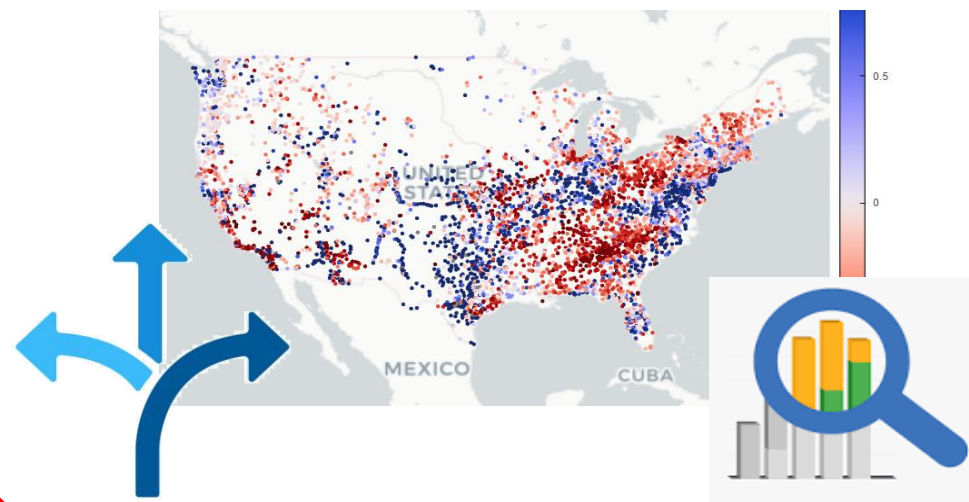
# Two Parallel Goals

1) Establish **evaluation standards** in collaboration with OWP, CIROH and broader hydrologic forecasting community → How will we judge 'improvements'



## Workshop Focus

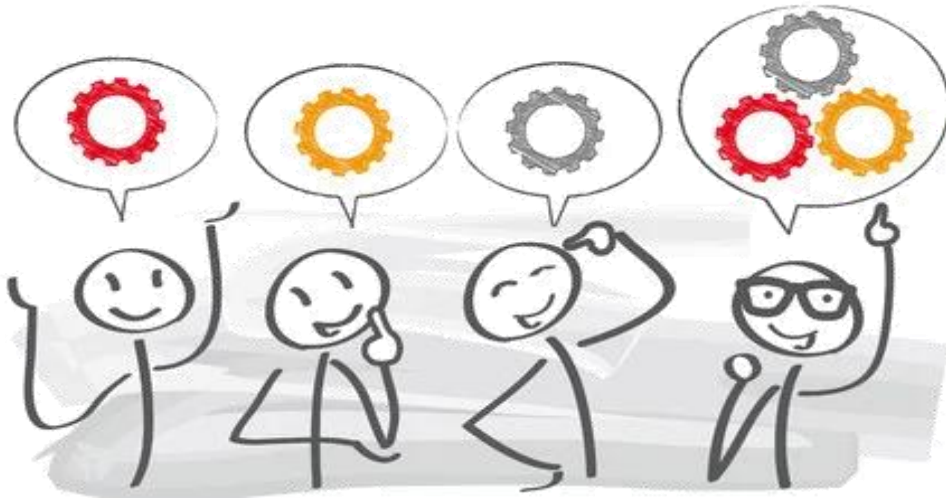
2) Create a **set of tools** for hydrologic model and forecast evaluation that are scalable and flexible for the wide range of use cases and users, that enable **highly exploratory evaluation**, and that foster open community development



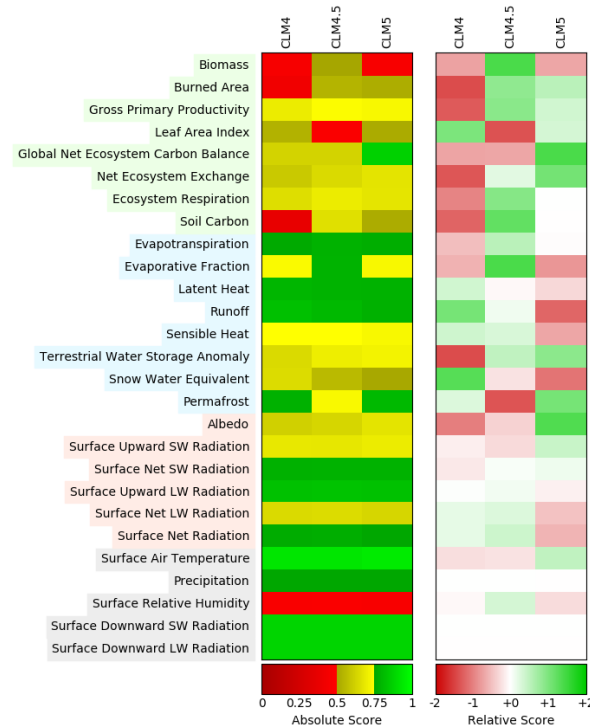
# Envisioned Strategy for Goal #1

Collaboration across  
CIROH and OWP

Converge on some standards for  
performance assessment and  
comparisons across research



e.g., CIROH Evaluation Working Group



ILAMB Example  
<https://www.ilamb.org/>



# Strategy for Goal #2



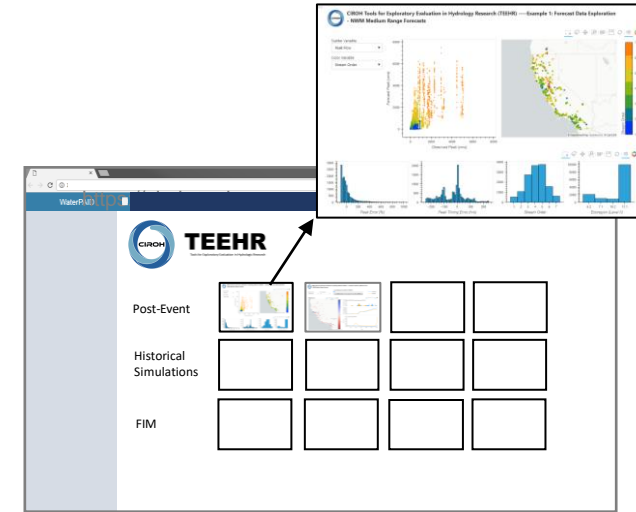
Tools for Exploratory Evaluation  
in Hydrologic Research

- Still in early stages of development
- **Tiered** (see what we did there) levels of use, interaction and contribution
- Seeking feedback on needs for different CIROH projects and use cases (today and afterwards)

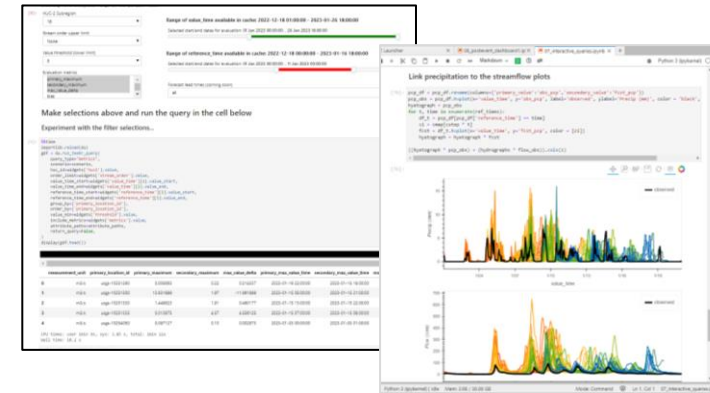
# Tiered Levels of Use



Servable Dashboards



Notebook Templates

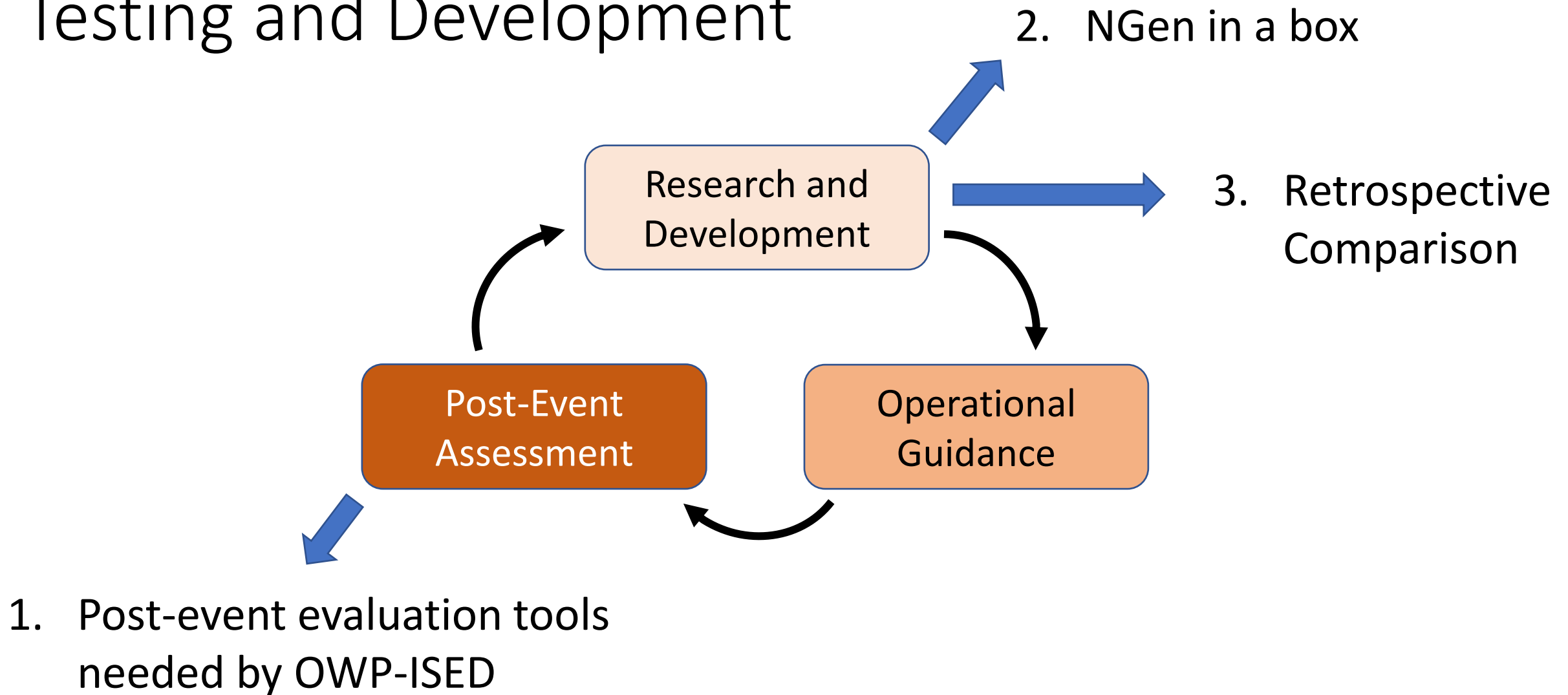


Python Package

```
qry = tod.get_metrics(  
    primary_filepath=USGS,  
    secondary_filepath=SHORT_RANGE,  
    crosswalk_filepath=CROSSWALK,  
    group_by=[primary_location_id, "reference_time"],  
    order_by=[primary_location_id],  
    include_metrics="all",  
    filters=[  
        {  
            "column": "primary_location_id",  
            "operator": "=",  
            "value": "usgs-10336676"  
        },  
        {  
            "column": "reference_time",  
            "operator": ">=",  
            "value": "2023-01-02 16:00:00"  
        }  
    ],  
    return_query=True  
)  
print(qry)
```

workshop

# Initial Use Cases for Testing and Development

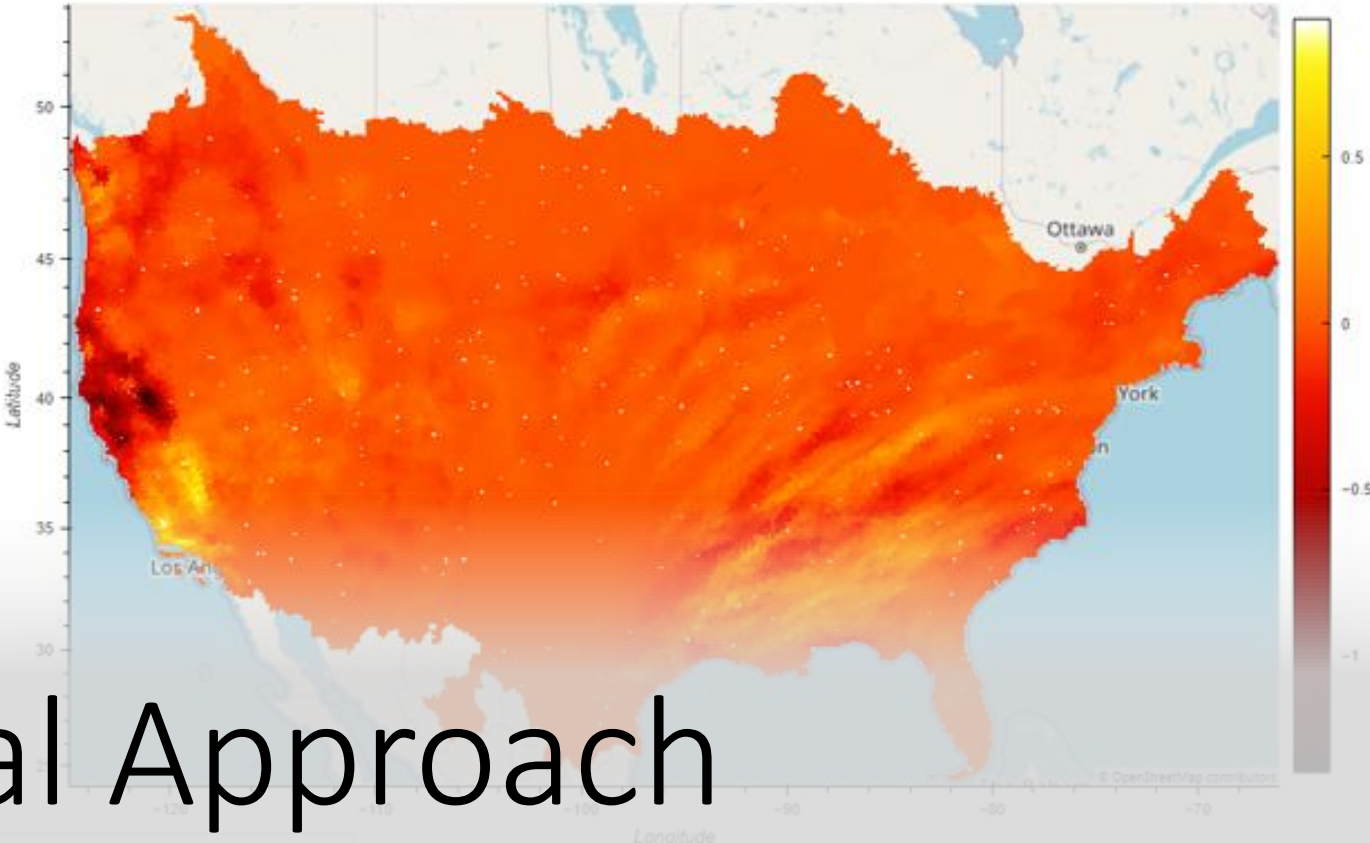


timeseries	
reference_time	[datetime]
value_time	[datetime]
value	[float]
measurement_unit	[string]
configuration	[string]
location_id	[string]

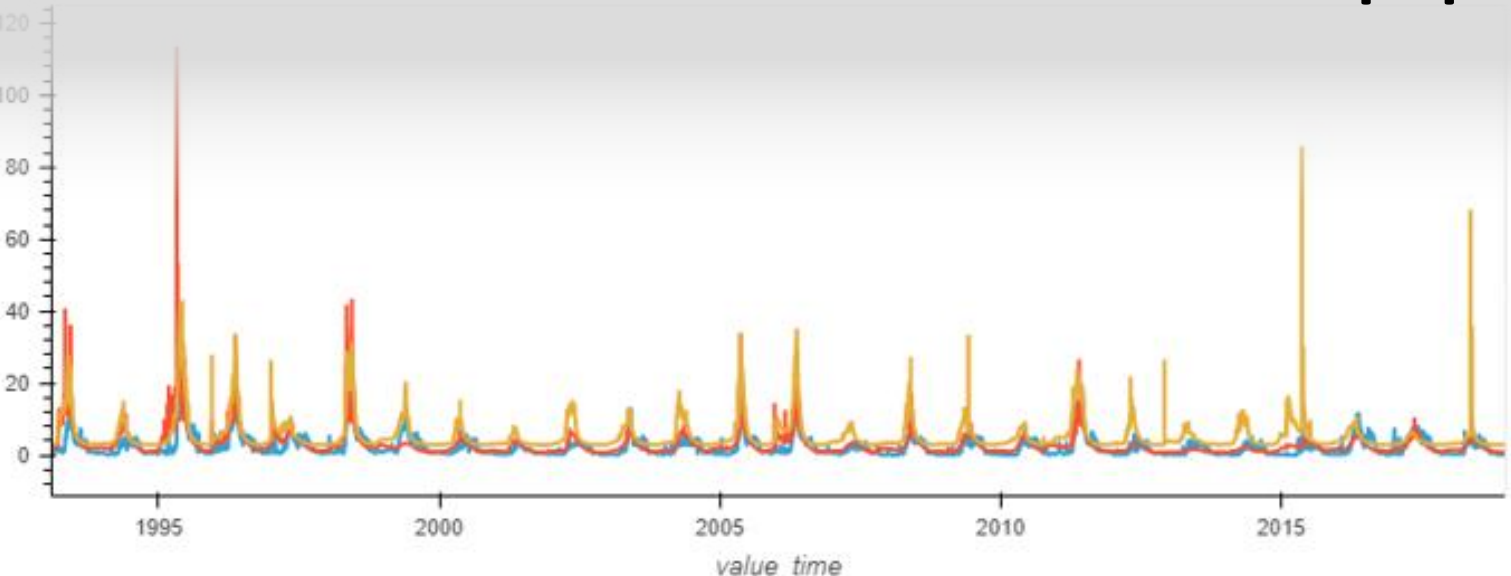
geometry	
id	[string]
name	[string]
geometry	[wkt or wkb]

attribute	
location_id	[string]
attribute_name	[string]
attribute_value	[string]
attribute_unit	[string]

crosswalk	
primary_location_id	[string]
secondary_location_id	[string]



# Technical Approach



```

qry = tqd.get_metrics(
    primary_filepath=USGS,
    secondary_filepath=SHORT_RANGE,
    crosswalk_filepath=CROSSWALK,
    group_by=["primary_location_id", "reference_time"],
    order_by=["primary_location_id"],
    include_metrics="all",
    filters=[
        {
            "column": "primary_location_id",
            "operator": "=",
            "value": "usgs-10336676"
        },
        {
            "column": "reference_time",
            "operator": "=",
            "value": "2023-01-02 16:00:00"
        }
    ]
),
return query=True

```



# Goals

Goal again: Create a **set of tools** for hydrologic model/forecast evaluation that are scalable and flexible for the wide range of use cases and users, that enable **highly exploratory evaluation**, and that foster open community development

Status: This is a CIROH funded research project. We are 9 months (~6 months of working time) into the project. We have a **prototype level** set of tools built and are figuring out what works and what doesn't. There is lots of work to do; we are open to feedback.

# Objectives

- **Easy to use** tools that will form the backbone of exploratory forecast and simulation evaluation and visualization.
- Target audience is **data scientists, hydrologists, researchers**, maybe building a dashboard for a less technical audience.
- Use **familiar tooling** (Python, Pandas, Xarray, etc. -> Pangeo)
- Engage with the **community**; clean code, good documentation and well documented examples.
- Make the library **fast, efficient, scalable** to meet needs of different users and use cases.
- Not directly tied to any specific data source (NWM, USGS, etc.)
- There is so much great work by others; don't reinvent the wheel, keep a narrow focus and scope of our work

# Technical Agenda Items

- Data Models
- Study Cache Structure
- Fetching and Loading Data
- Querying
- Visualization

*Work in progress!*

Loading

Too many to list...



netCDF



Zarr



dask



pandas

Cache/DB



Parquet

Query



DuckDB



pandas

Visualize



Panel



hvPlot



HoloViews



GeoViews



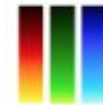
Datashader



Lumen



Param



Colorcet





**Apache Parquet** is an open source, column-oriented data **file format** designed for efficient data storage and retrieval. It provides efficient data compression and encoding schemes with enhanced performance to handle complex data in bulk.



**DuckDB** is an in-process SQL OLAP **database** management system.

With respect to TEEHR objectives, Parquet files and DuckDB provide a powerful way to store large amounts of timeseries data with a small storage footprint while still allowing relatively fast access via SQL queries. DuckDB can query Parquet files directly, including files stored in a cloud bucket.

# Login to AWI CIROH JupyterLab



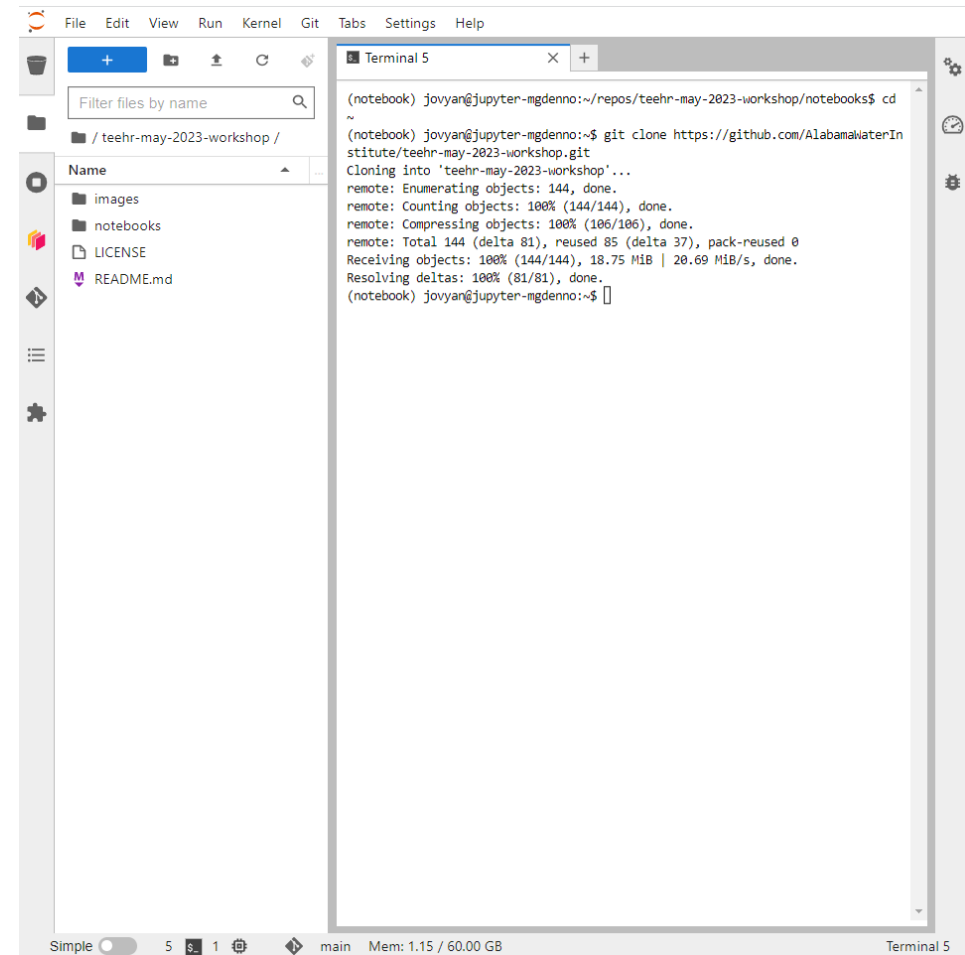
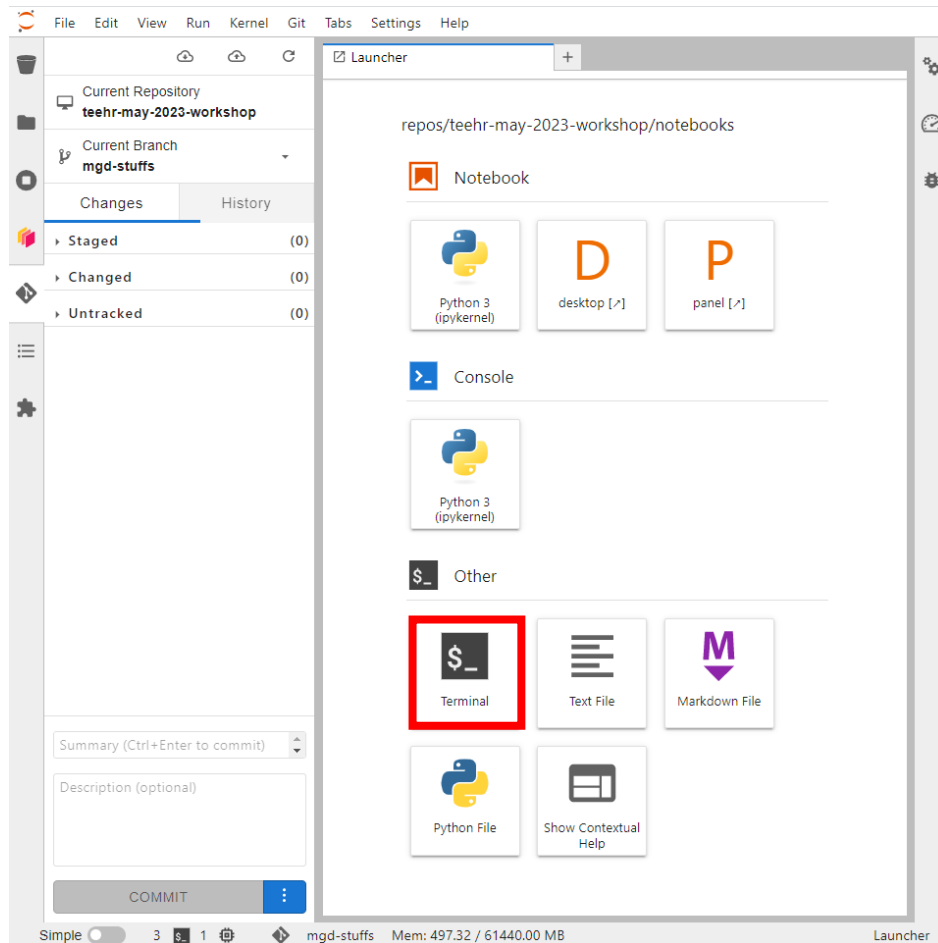
1. Login to your GitHub account
2. Accept invitation to join the **AlabamaWaterInstitute** GitHub organization (in GitHub)
3. Go to:  
<https://ciroh.awi.2i2c.cloud/hub/login>
4. Authorize 2i2c-org to access your GitHub account.

1. Open “Launcher” if not already open:

i. File > New Launcher

2. Open “Terminal” and run:

```
$ git clone https://github.com/AlabamaWaterInstitute/teehr-may-2023-workshop.git
```



# Future Work...too much to list

- Work with the community to identify standards, etc...
- Enhance the tools to work with cloud storage
- Add additional queries and metrics
- Access data remotely instead of downloading, query direct from bucket, etc.
- Research how to better utilize Parquet file strengths (i.e. wider tables)
- Tightly integrated visualization components
- Possibly prepare and stage commonly needed datasets, for example this could include, USGS gages and associated hydrologic attributes, HUC2-HUC12 polygons and weights files, etc.
- Tighter integration with NextGen
- Speed, speed, speed
- Data validation for the cache
- <https://github.com/RTIInternational/teehr/discussions/32>