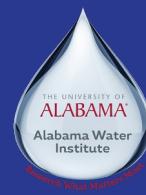


NextGen In A Box (NGIAB): Advancing Collaborative Modeling for Enhanced Water Resource Management

CIROH@UA : Arpita Patel, James Halgren, Benjamin Lee, Sepehr Karimi, Trupesh Patel, Josh Cunningham, Shahab Alam, Steve Burian, Purushotham Bangalore, Jeff Carver

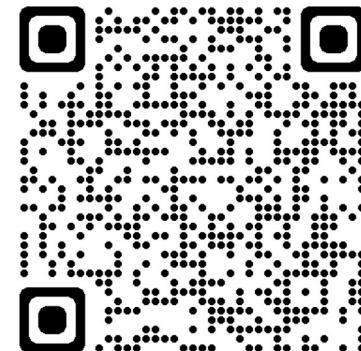
Lynker: Nels Frazier, Zach Wills, Jordan Laser, Mike Johnson, Josh Sturtevant

Date: 13th Dec, 2023



NextGen Framework

- The NextGen Water Resources Modeling Framework (NextGen) is developed by **NOAA OWP** at **the National Water Center**
 - Enhance the forecasting of **flooding and drought**
 - Improve water resource management
 - Protect lives, property, and the environment
 - Multimodel computational framework for **NWM (National Water Model)**
- NextGen GitHub Repository: [GitHub: NOAA-OWP/ngen](https://github.com/NOAA-OWP/ngen)
- NextGen Wiki: [GitHub: NOAA-OWP/ngen/wiki](https://github.com/NOAA-OWP/ngen/wiki)



NextGen In A Box (NGIAB)

NextGen In A Box Ready-to-run, containerized and cloud-friendly version of **NextGen framework**, packaged with scripts to help prepare data and get you modeling more quickly.

Containerized Solution

Cloud Friendly Nature

Simplifies NextGen Access

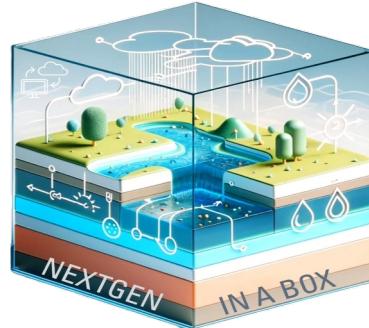
Collaborative Modeling Tool

- Run anywhere
- Pre-compiled images available in Docker Hub

- Reduce the **research time**
- Easily configure **multiple models**
- **Multi-cloud** compatible

- Reduce **learning curve** for NextGen framework
- Compare **model performance**
- Facilitates accessibility and **accelerates modeling**

- **Easy to use**
- **Reproducible** research outcomes
- Increase **collaboration** among researchers

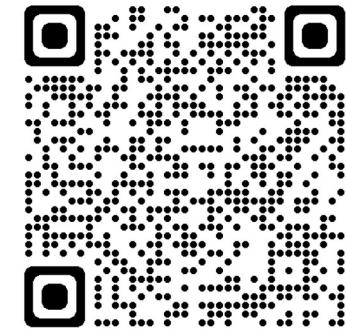


Open-Source Research Practices

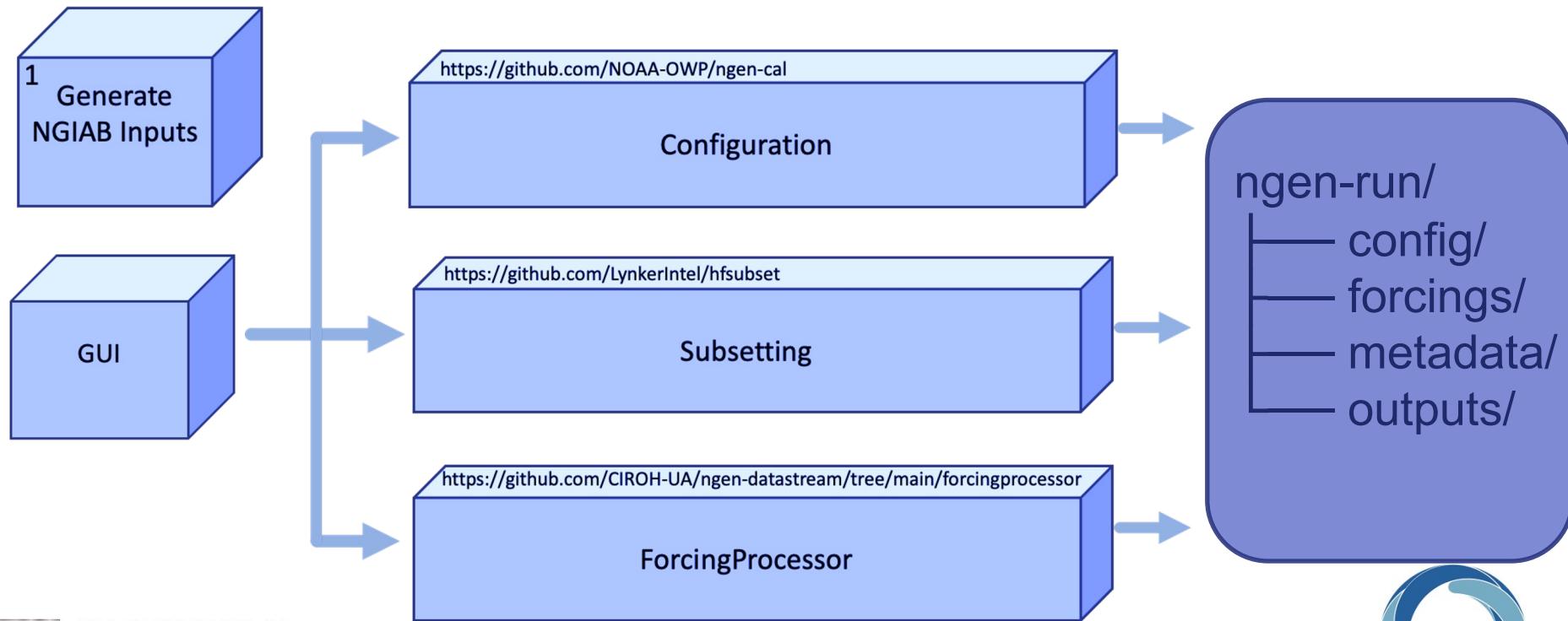
NGIAB GitHub Repository: <https://github.com/CIROH-UA/NGIAB-CloudInfra>

Leveraging Open-Source Technologies

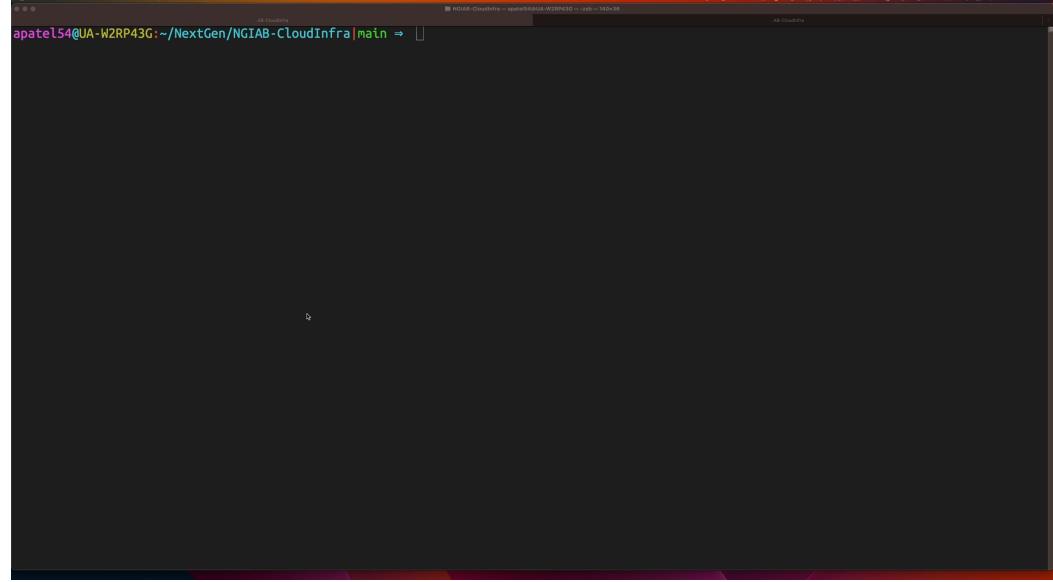
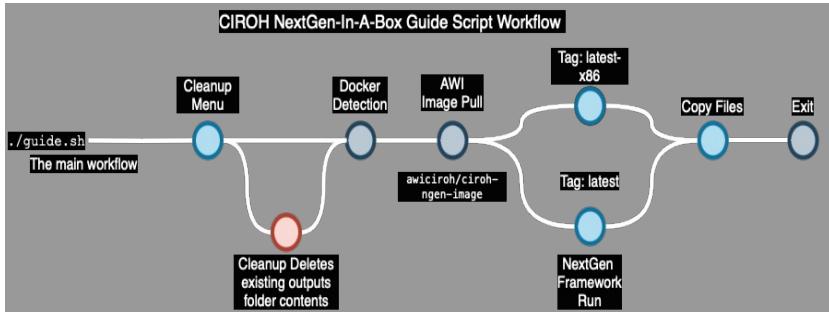
- Git version control
 - **GitHub**
 - Continuous Integration & Continuous Deployment (**CI/CD**)
 - **GitHub Actions**
 - **Docker**
 - Singularity
-
- Fostering **Transparency** and **Reproducibility** in Research



How to Generate NGIAB Inputs?



How to Run NGIAB?



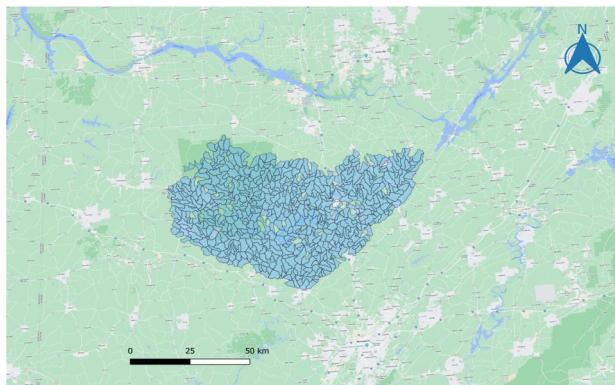
```
113038 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ... 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ...  
113039 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ... 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ...  
125120 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ... 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ...  
125121 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ... 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ...  
125122 0.087620 0.091268 0.018146 0.022387 0.216907 0.076134 ... 0.000178 0.024665 0.001349 0.000174 0.024257 0.001323  
125123 0.099853 0.086726 0.010178 0.026739 0.159386 0.023536 ... 0.000198 0.028493 0.001901 0.000193 0.028134 0.001865  
125124 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ... 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 ...  
[539 rows x 8640 columns]  
2023-12-08 20:44:05,250 DEBUG [output.py:394 - nwm_output_generator()]: output complete in 2.086799383163452 seconds.  
2023-12-08 20:44:05,250 DEBUG [main.py:277 - main_v04()]: process complete in 285.1977895603943 seconds.  
***** TIMING SUMMARY *****  
Network graph construction: 0.52 secs, 0.18 %  
Forcing array construction: 281.59 secs, 98.74 %  
Routing computations: 0.99 secs, 0.35 %  
Output writing: 2.09 secs, 0.73 %  
-----  
Total execution time: 285.18999999999994 secs  
Finished routing  
  
real 6m0.672s  
user 1m50.861s  
sys 0m32.431s  
Finished executing command successfully.  
Would you like to continue?  
Select an option (type a number):  
1) Interactive-Shell  
2) Exit
```



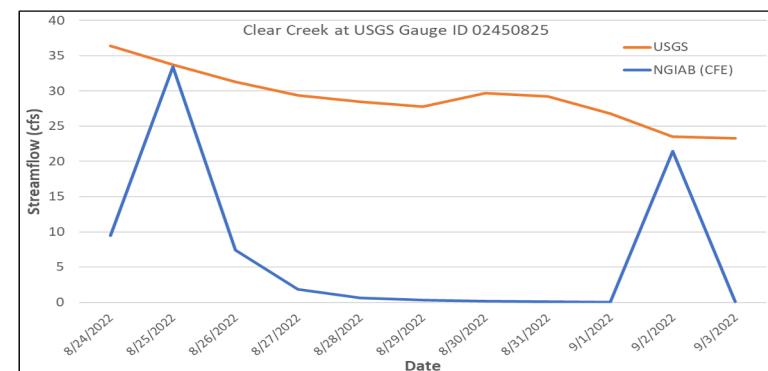
Example Case 1

Sloth + CFE + Trout using NextGen for streamflow modeling for **Sipsey Fork, Black Warrior River near Clear Creek, AL (03W VPU)**

- 10 days of simulation for 500+ catchments.
- Results can be replicated by anyone.
- **Data package** : https://ciroh-ua-ngen-data.s3.us-east-2.amazonaws.com/AWI-002/AWI_03W_113060_002.tar.gz



Input Map for Sipsey Fork, Black Warrior River, AL

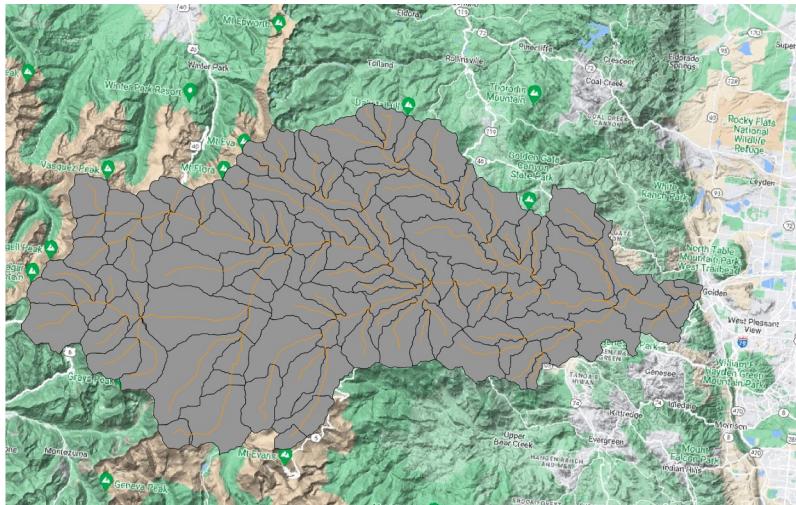


Output plot showing Streamflow for Clear Creek at USGS Gauge ID

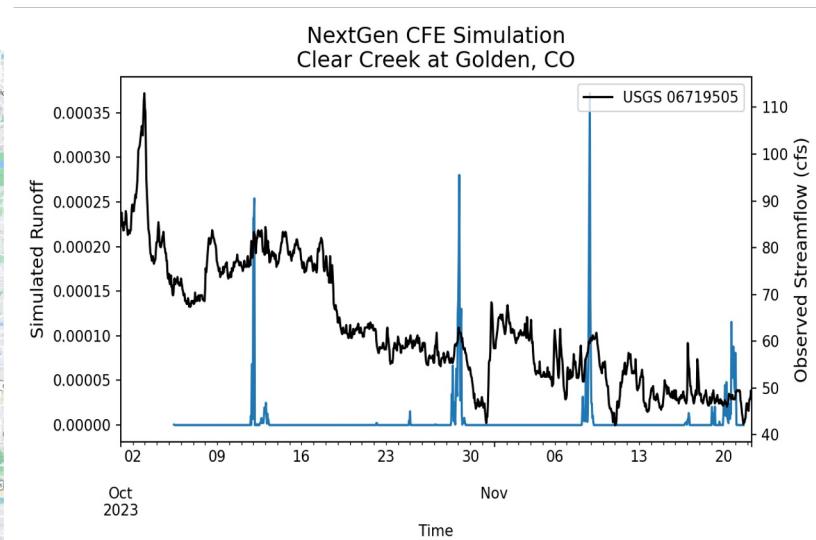
Example Case 2

Simulation using **CFE** within NextGen for streamflow modeling for **Clear Creek at Golden, CO**

Data package : coming soon



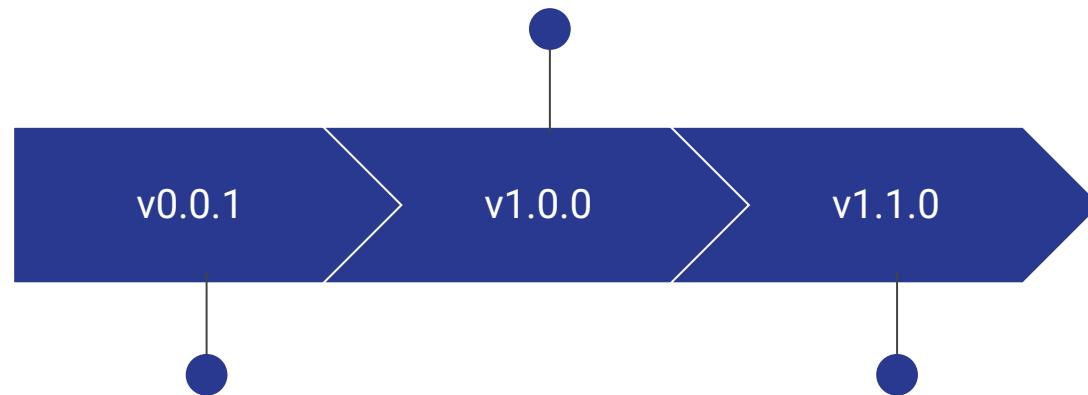
Input Map for Golden, CO



Output plot showing Simulated Runoff for Clear Creek at Golden, CO

NGIAB Releases

Release : 16th May 2023
CFE, NOAA-MP, Python support



NGIAB - Feb 3, 2023
Initial Version

Release : 28th Nov 2023
CFE + SLOTH + t-route Models supported - for serial
and parallel mode.

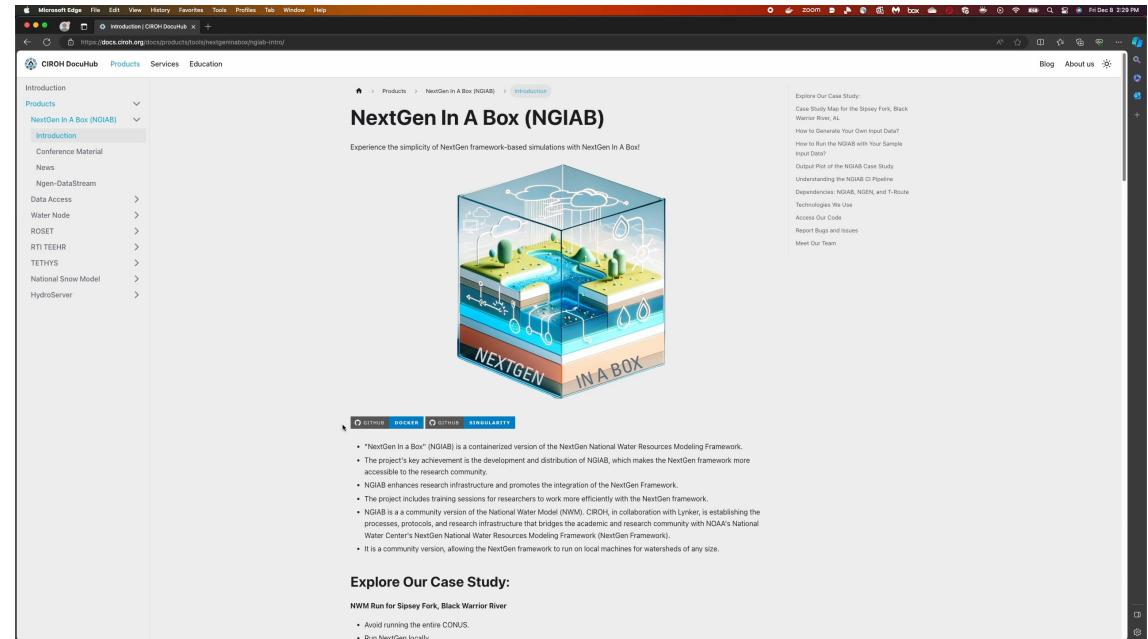
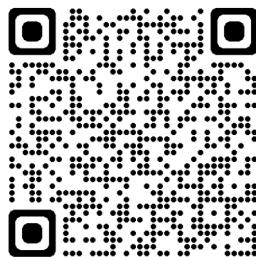


CIROH DocuHub

DocuHub: docs.ciroh.org

Community editable
technical documentation
hub!

Documentation, Services,
and news at CIROH
DocuHub!



The screenshot shows the CIROH DocuHub website with a navigation bar for Microsoft Edge. The main content area is titled "NextGen In A Box (NGIAB)" and features a large image of a 3D cube labeled "NEXTGEN IN A BOX" containing a landscape with water bodies and greenery. Below the image is a list of bullet points about the project. To the right, there's a sidebar with links like "Explore Our Case Study", "Case Study Map for the Sipsey Fork, Black Warrior River, AL", and "How to Generate Your Own Input Data".

NextGen In A Box (NGIAB)

Experience the simplicity of NextGen framework-based simulations with NextGen In A Box!

- *NextGen In A Box* (NGIAB) is a containerized version of the NextGen National Water Resources Modeling Framework.
- The project's key achievement is the development and distribution of NGIAB, which makes the NextGen framework more accessible to the research community.
- NGIAB provides a common infrastructure and promotes the integration of the NextGen Framework.
- The project includes training sessions for researchers to work more efficiently with the NextGen framework.
- NGIAB is a community version of the National Water Model (NWM). CIROH, in collaboration with Lyneke, is establishing the processes, protocols, and research infrastructure that bridges the academic and research community with NOAA's National Water Center's NextGen National Water Resources Modeling Framework (NextGen Framework).
- It is a community version, allowing the NextGen framework to run on local machines for watersheds of any size.

Explore Our Case Study:

NWM Run for Sipsey Fork, Black Warrior River

- Avoid running the entire CONUS.
- Run NextGen locally.

Find information about NGIAB and data stream here:
<https://docs.ciroh.org/docs/products/tools/nextgeninabox>



Insights

NGIAB GitHub Repository

- # of views
- Unique clones
- Forks
- Popular content



Popular content

Content	Views	Unique visitors
GitHub - CIROH-UA/NGIAB-Clo...	206	29
NGIAB-CloudInfra/terraform at ...	145	4
Issues	115	10

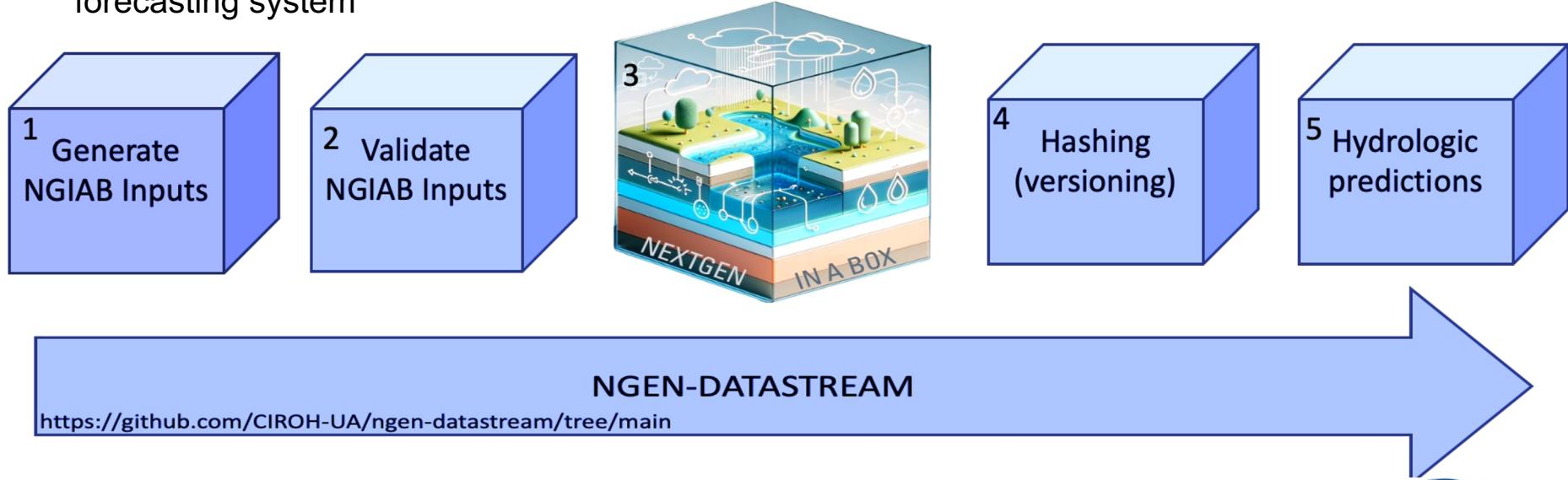
Referring sites

Site	Views	Unique visitors
github.com	203	10
ciroh.ua.edu	28	3
Google	8	5

Future Development

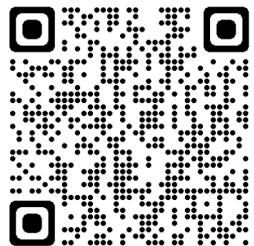
NextGen Data Stream Conceptual Model

We are working on to build out an "over-the-loop" (i.e. automated) real-time streamflow forecasting system



Community Impact

- **Community** plays big role in contributing to the **enhancement** of NGIAB.
- Community Development Version
- Facilitates **easy adoption** for researchers of all technical background.
- Supports diverse **research** and **development projects**.
- **Driven by active collaboration and contribution** from the community.



Call for Community Engagement!



CIROH DevCon1 - May 2023 (Salt Lake, UT)

Contribute:
<https://github.com/CIROH-UA/NGIAB-CloudInfra/issues>

Useful links and ongoing development

- NGIAB (using docker) - <https://github.com/CIROH-UA/NGIAB-CloudInfra>
- NGIAB (using singularity) - <https://github.com/CIROH-UA/Ngen-Singularity>
- CIROH DocuHub - <docs.ciroh.org> , https://github.com/CIROH-UA/ciroh-ua_website
- NGIAB Docs - <https://docs.ciroh.org/docs/category/nextgen-in-a-box-ngiab>
- DataStream - <https://github.com/CIROH-UA/ngen-datastream>
- ForcingProcessor - <https://github.com/CIROH-UA/ngen-datastream/tree/main/forcingprocessor>
- Realization generation and ngen run folder validation - <https://github.com/NOAA-OWP/ngen-cal>
- Hydrofabric subsetting - <https://github.com/LynkerIntel/hfsubset>
- Hashing/Versioning - <https://github.com/aaraney/ht>
- Ngen Wiki - <https://github.com/NOAA-OWP/ngen/wiki>
- HyAggregate - <https://mikejohnson51.github.io/hyAggregate/>
- CIROH - ciroh.ua.edu

Key Terminology

- **NGIAB** - NextGen In A Box (Next Generation National Water Model)
- **NGEN** - Next Generation National Water Model
- **Catchment** - geographic area characterized by a single location, a nexus, where all precipitation in the area runs off through. A drainage basin.
- **Nexus** - the singular point where water flows into or out of a catchment. Often a point along a river.
- **Subsetting** - to reduce a large geopackage (many catchments) down to a smaller geopackage (fewer catchments) . In effect, this is choosing the domain over which ngen will run.
- **Hashing** - SHA256 algorithm applied to files to generate a unique id for a file. Useful for preserving and distinguishing unique inputs.
- **Validation** - Ensuring the ngen input directory data_dir has been constructed properly. Properly meaning that NextGen will not crash and will generate output data.

Q&A

- **NGIAB Support Team**
 - Join us on [CIROH Slack](#)
 - Channel [CIROH Slack: #nextgen_help_2023](#)
 - Email : ciroh-it-admin@ua.edu



Arpita Patel
apatel54@ua.edu

Thank You!

