THE UNIVERSITY OF ALABAMA | Alabama Water Institute

OWP | OFFICE OF WATER PREDICTION

NEXTGEN IN A BOX (NGIAB)

CIROH

Unlock the potential for collaborative research

Presenters:

Arpita Patel – The University of Alabama

Zach Wills – Lynker

Giovanni Romero - Aquaveo

Developers CONFERENCE

May 29 - June 1, 2024 | Salt Lake City, Utah

Lynker

AQUAVEO™

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

CIROH

AGENDA

- Introduction
- NextGen Basics
- NGIAB Applications
- NextGen In A Box
- Hands-on demo of NextGen In A Box (NGIAB) on local machine
- NextGen In A Box (NGIAB) Visualizer
- Future Work
- Q&A

NextGen Track Workshops at DevCon24

Day 1 - The NextGen **Hydrofabric**: What is it, how to get it, and how to make your own?

Day 1 - Get your model ready for NextGen with **BMI**

Day 2 - NextGen In A Box (**NGIAB**)

Day 2 - NextGen Simulation Development **Tools**

Day 3 - Building and Executing **Cloud Workflows** to Support NGEN Modeling Applications

Day 3 - Using **TEEHR** to explore, compare and evaluate streamflow simulations from different model formulations.

Day 4 - Using **Actors** for Parallelization in Hydrology

CIROH-UA Team

Steve Burian

Purushotham Bangalore

Jeffrey Carver

James Halgren

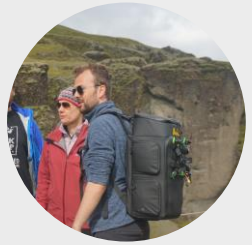
Arpita Patel

Benjamin Lee

Sepehr Karimi

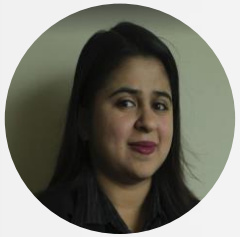
Shahab Alam

Hari Teja Jajula

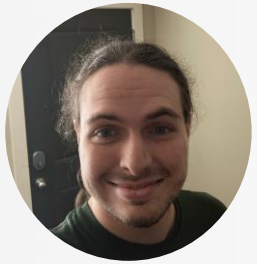


Josh Cunningham

Trupesh Patel



Manjiri Gunaji



Chad Perry

Karnesh Jain

Manjila Singh

Lynker, BYU and Aquaveo Team

Nels Frazier

Zach Wills

Jordan Laser

Mike Johnson

Josh Sturtevant

Keith Jennings

Gio

Dan Ames

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
- NextGen Wiki: GitHub: NOAA-OWP/ngen/wiki

NEXTGEN IN A BOX

- USE CASE
- OVERVIEW OF NEXTGEN
- OBJECTIVES AND BENEFITS OF NEXTGEN
- KEY FEATURES

Community NextGen Development

Goal:

Advance research related to NextGen and accelerate R2O transition

Mission:

Community accessible Nextgen

Reproducible research

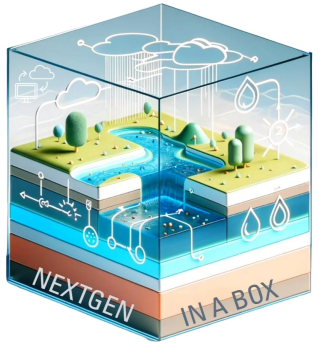
Vision:

Shared NextGen advancements using shared computing

NextGen In A Box (NGIAB) Overview

Containerized Solution

- Run anywhere
- **Pre-compiled images** available in Docker Hub and Singularity Hub



Cloud Friendly Nature

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

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.

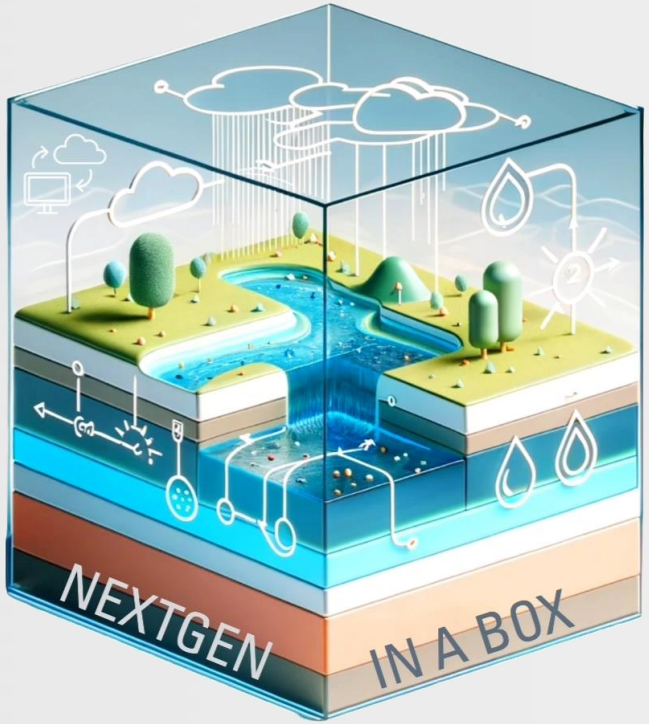
Simplifies NextGen Access

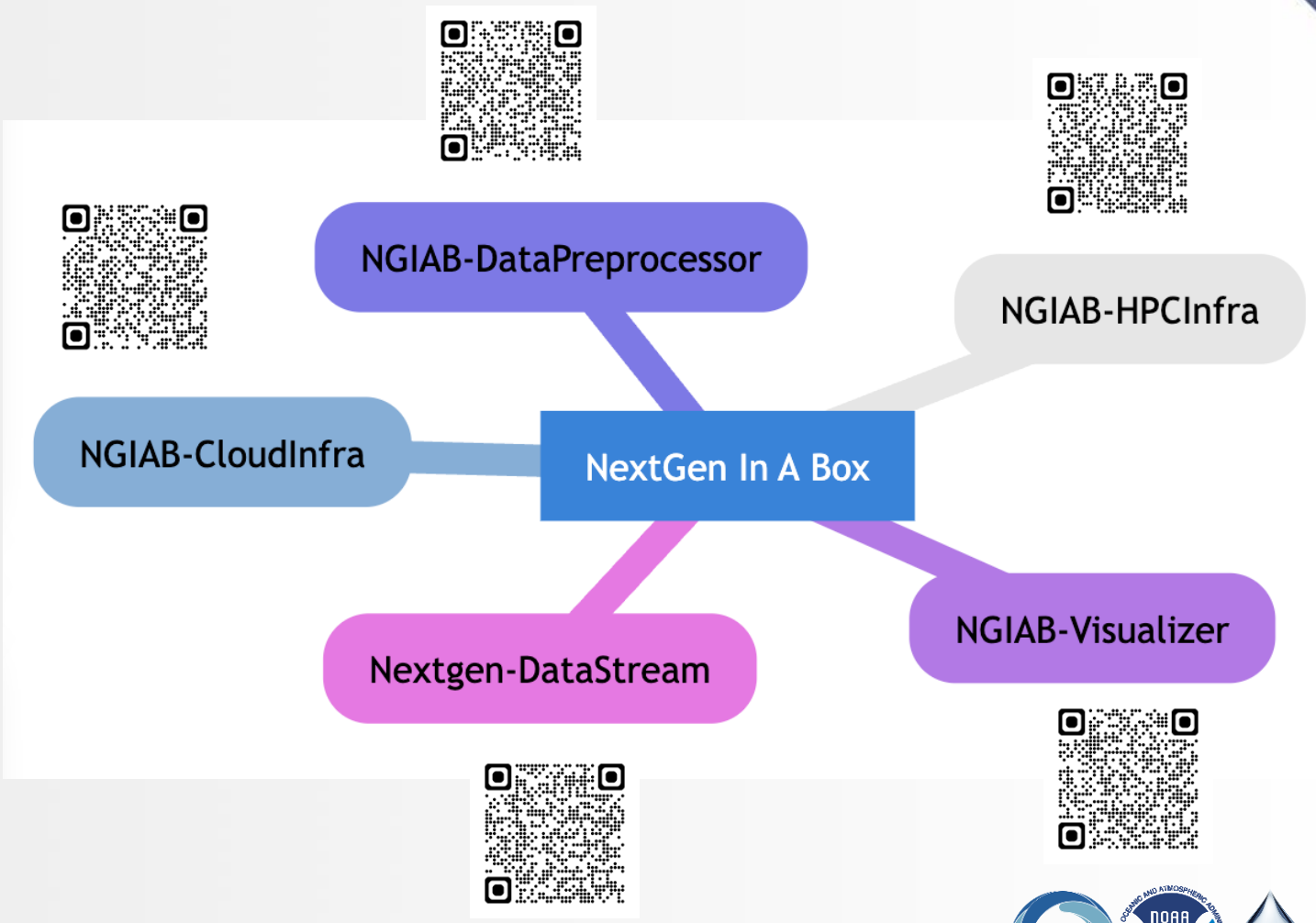
- Reduce **learning curve** for NextGen framework
- Compare **model performance**
- Facilitates accessibility and **accelerates modeling**

Collaborative Modeling Tool

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

NextGen In A Box Tools

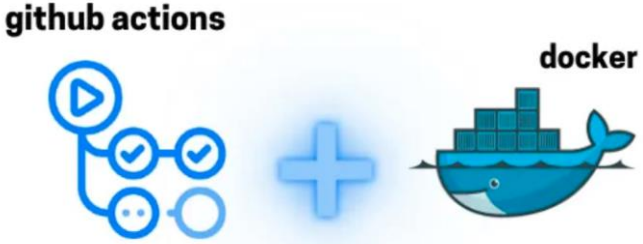




Open-Source Research Practices

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

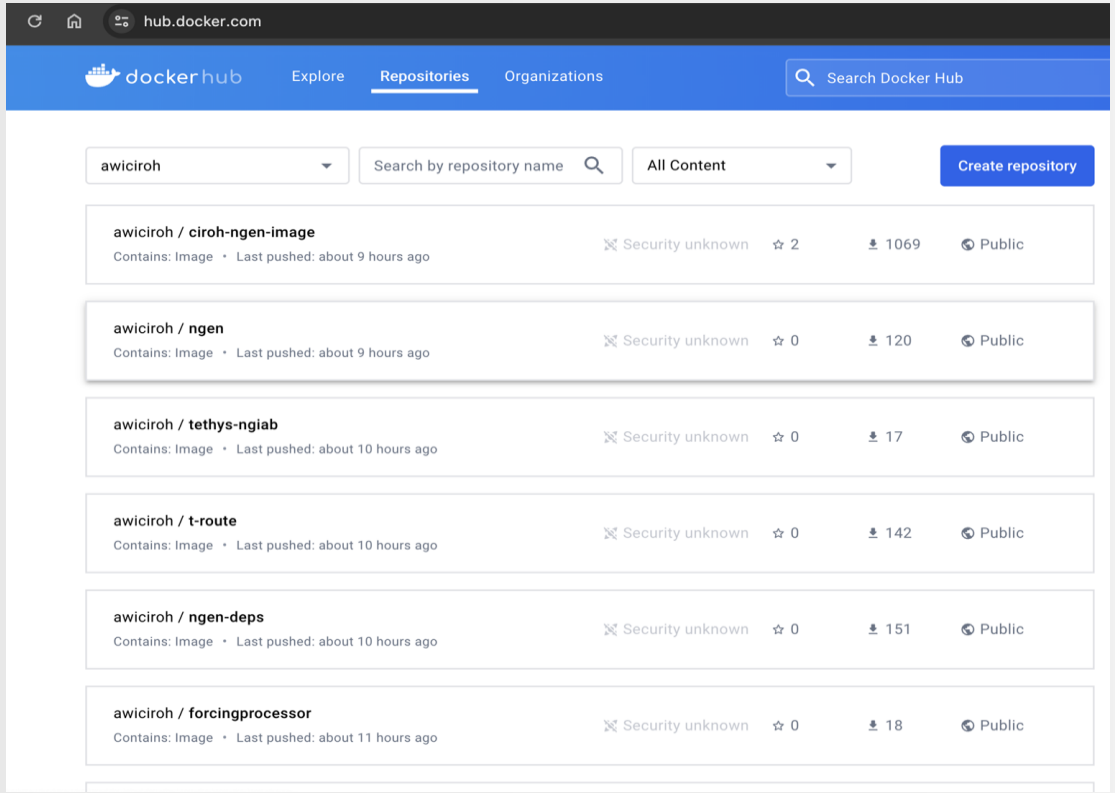
- Leveraging Open-Source Technologies
  - Git version control
  - **GitHub**
  - Continuous Integration & Continuous Deployment (CI/CD)
  - **GitHub Actions**
  - **Docker**
  - Singularity



- Fostering Transparency and Reproducibility in Research

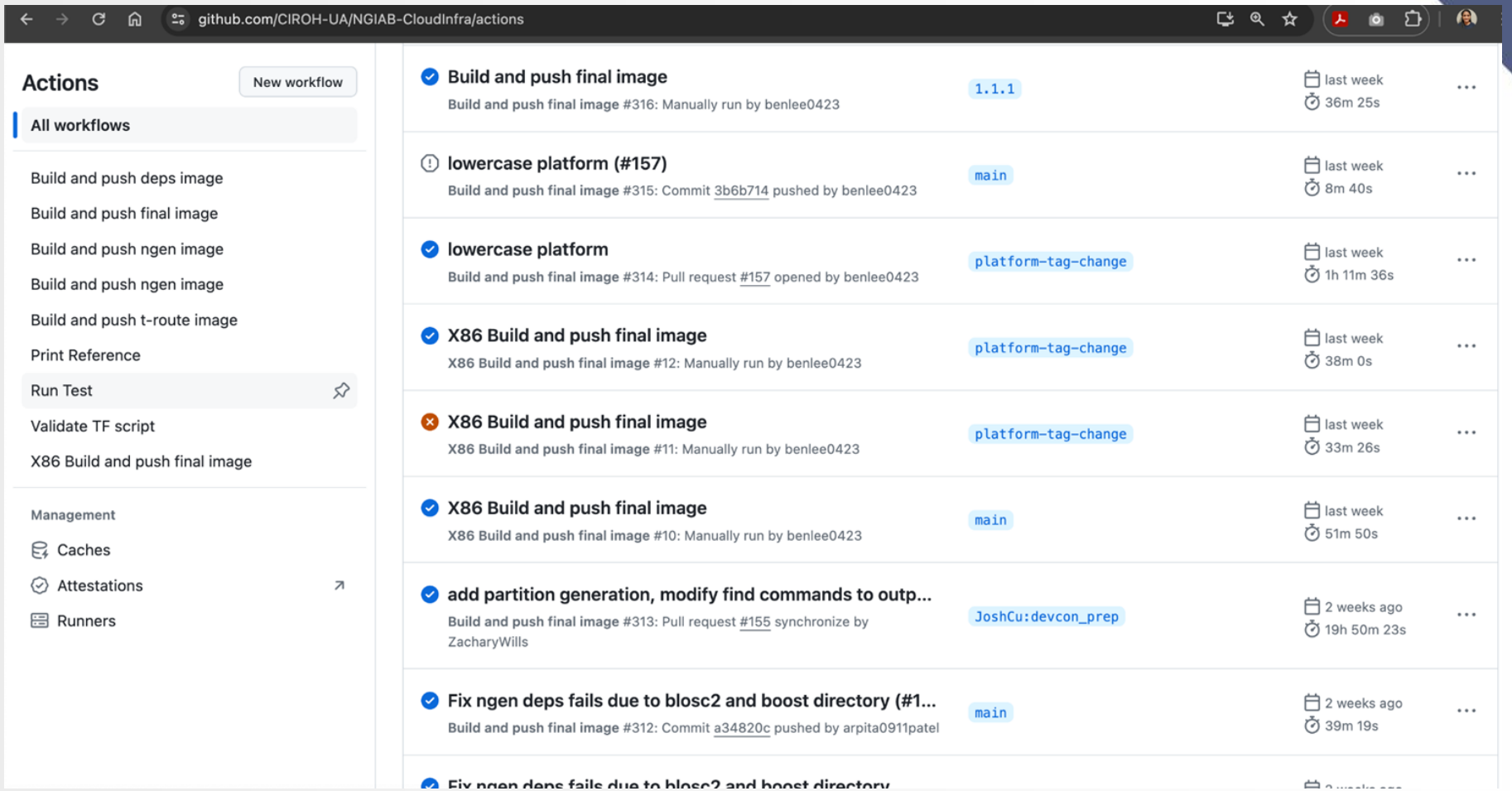
NGIAB Images

- **Docker Image :** awiciroh/ciroh-ngen-image
- **Image tags:** latest_x86, latest
- **Singularity Image:** ciroh-it-support/ngiab/ciroh-ngen-singularity: latest_x86



NEXTGEN IN A BOX : CI WORKFLOW

- Using **Github Actions** to run workflows.
- Automated flow to builds and push the docker image to Dockerhub once Pull Request is merged.
  - On Pull Request, triggers action workflow and validates changes.
  - On merge to main branch, triggers action, builds docker image and pushes to DockerHub.

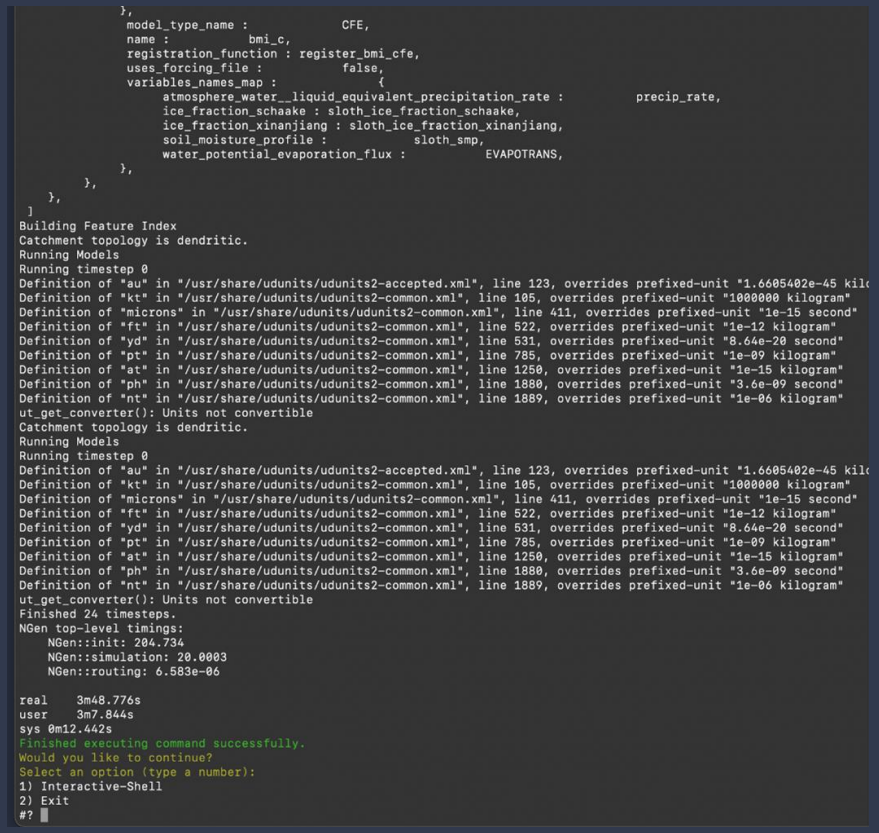


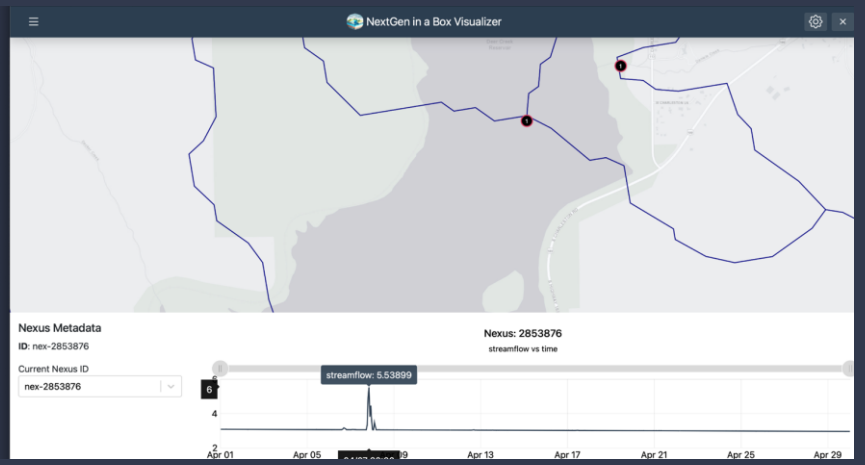
NEXTGEN IN A BOX

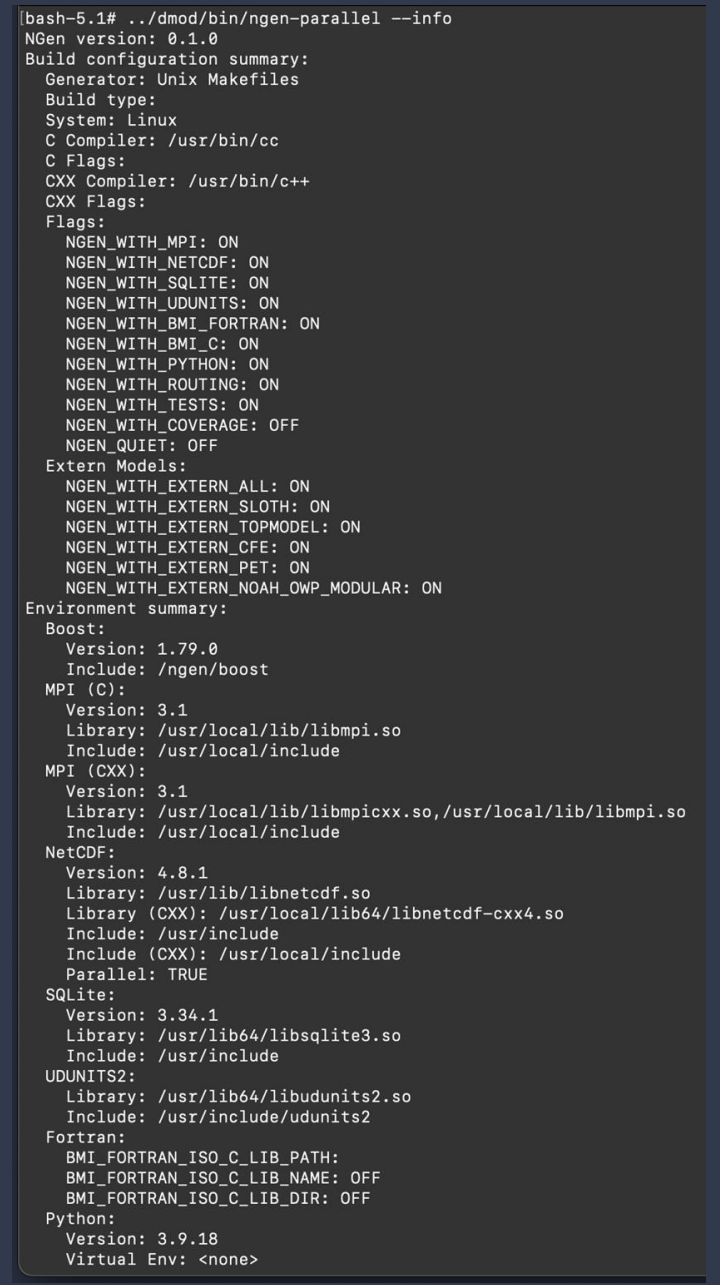
NextGen Model Framework Tutorial

AutoMode

NGEN Ecosystem







NEXTGEN IN A BOX

Conceptual Relationships:

Standard Data Structure

#	name	type	size
0	config	dir	288 B
1	forcings	dir	343.8 KiB
2	lakeout	dir	64 B
3	outputs	dir	592.3 KiB
4	restart	dir	64 B

Mount

Pre-compiled Models,
Tutorial, Runtime

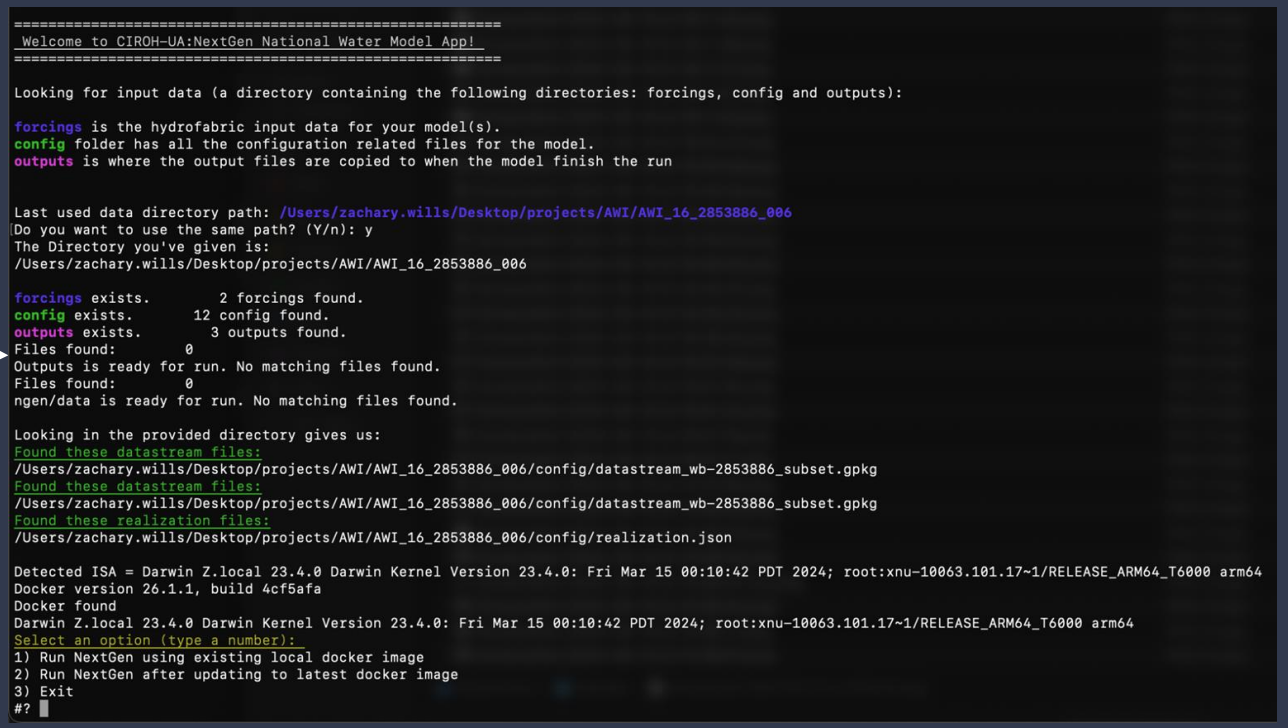
0	ngen-serial
1	ngen-parallel
2	partitionGenerator
3	HelloNGEN.sh

NEXTGEN IN A BOX

AWI Data Package

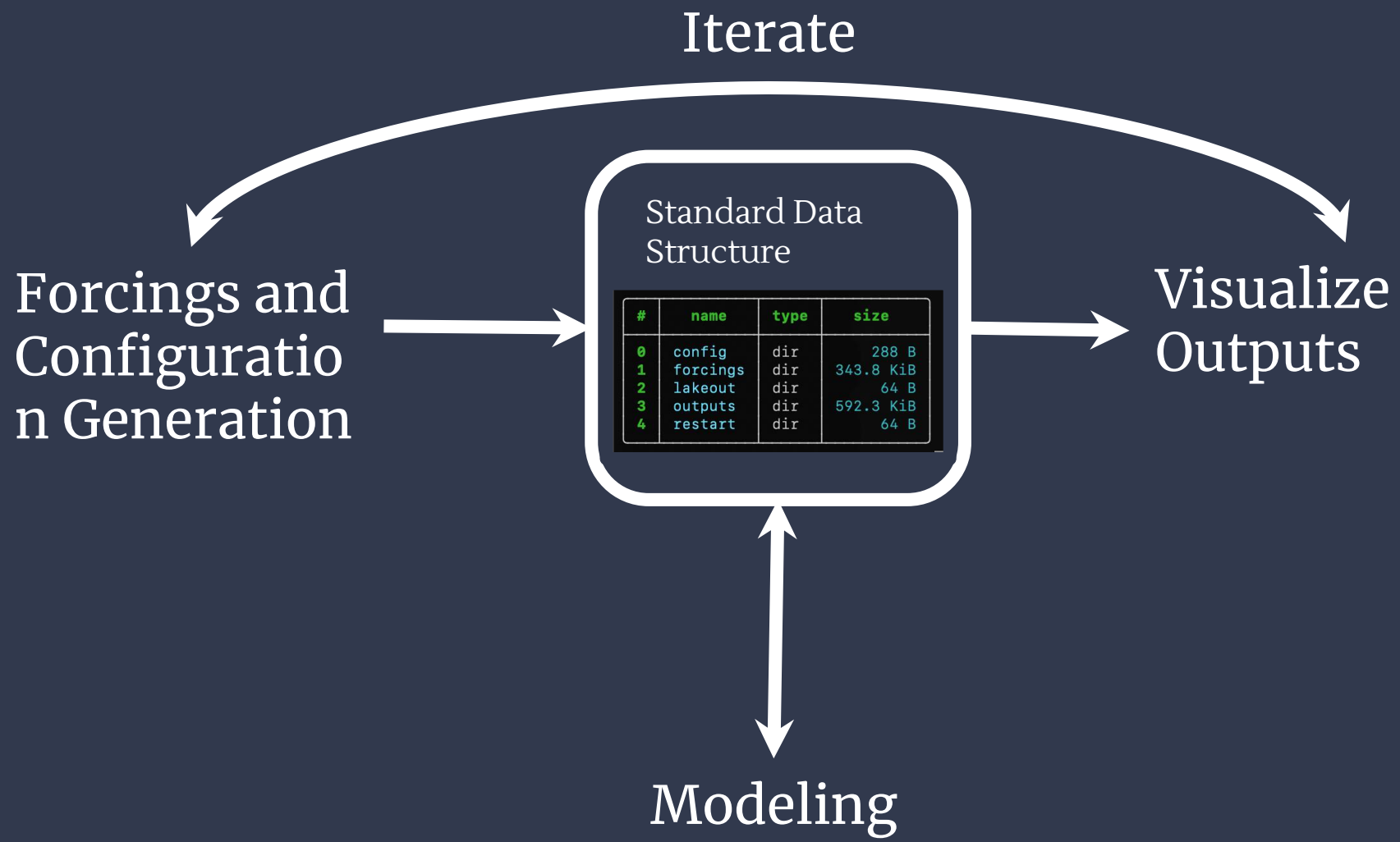
Standard Data Structure

#	name	type	size
0	config	dir	288 B
1	forcings	dir	343.8 KiB
2	lakeout	dir	64 B
3	outputs	dir	592.3 KiB
4	restart	dir	64 B



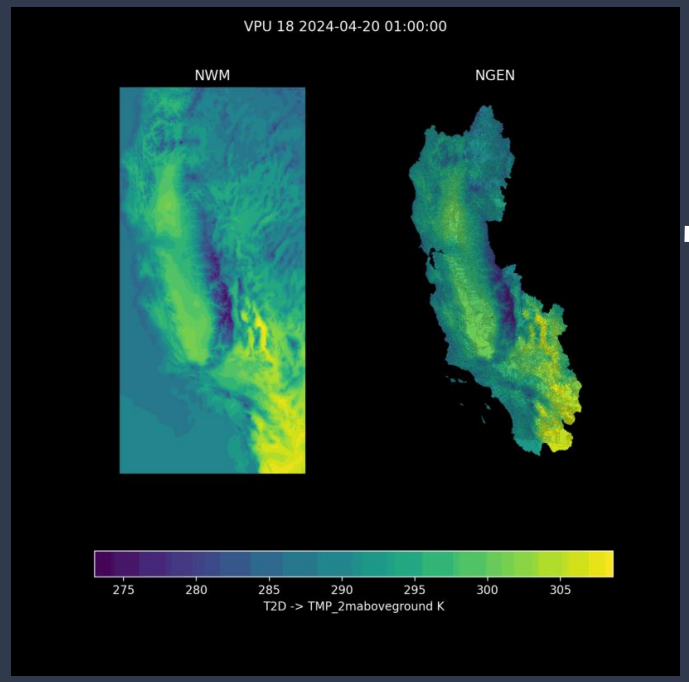
NEXTGEN IN A BOX

Workflow



NEXTGEN IN A BOX

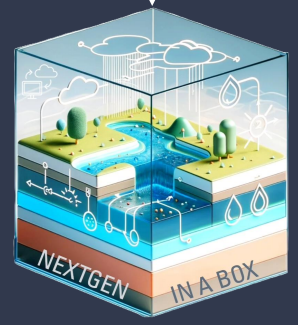
EcoSystem



Forcings and Configuration Generation

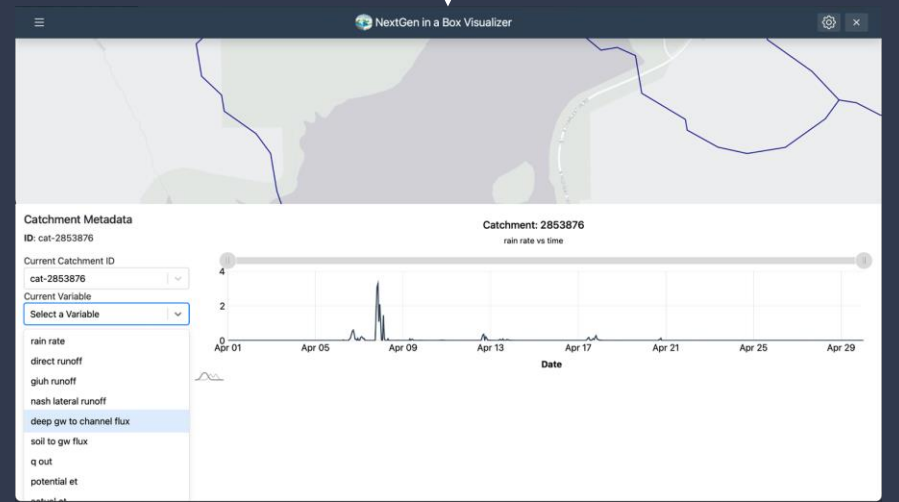
Standard Data Structure

#	name	type	size
0	config	dir	288 B
1	forcings	dir	343.8 KiB
2	lakeout	dir	64 B
3	outputs	dir	592.3 KiB
4	restart	dir	64 B



NextGen Model Run

Visualize in Tethys



NEXTGEN IN A BOX

EcoSystem

All on your
laptop.

NEXTGEN IN A BOX

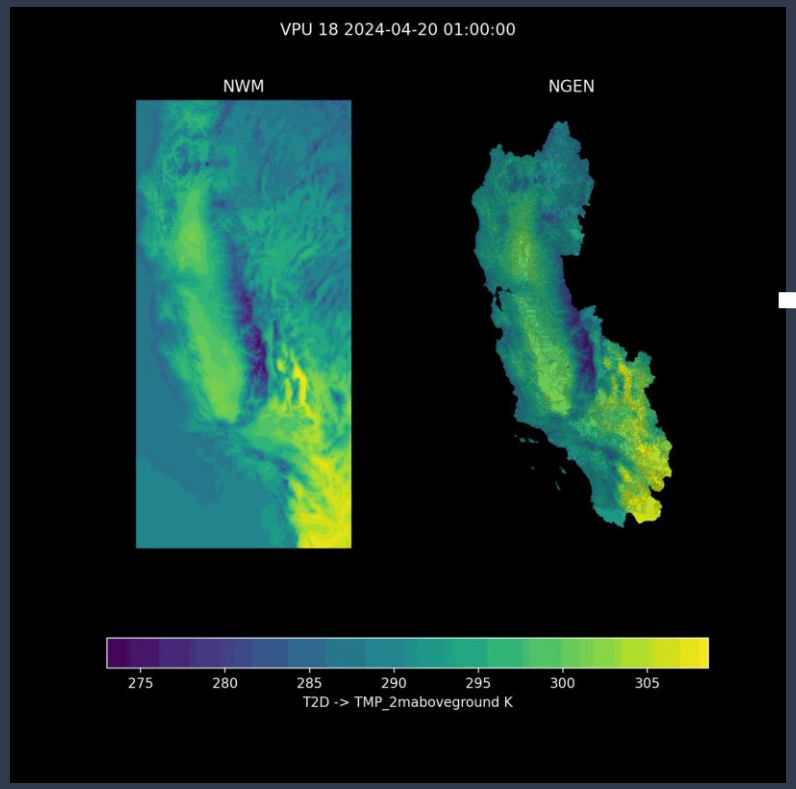
EcoSystem

All on your
laptop.

Then your HPC.

NEXTGEN IN A BOX

EcoSystem



Forcings and Configuration Generation

Standard Data Structure

#	name	type	size
0	config	dir	288 B
1	forcings	dir	343.8 KiB
2	lakeout	dir	64 B
3	outputs	dir	592.3 KiB
4	restart	dir	64 B

Singularity NextGen Model Run

The common data structure means that NGEN Framework Inputs and Outputs are portable and reproducible based on the Standard Data structure.

HANDS-ON DEMO

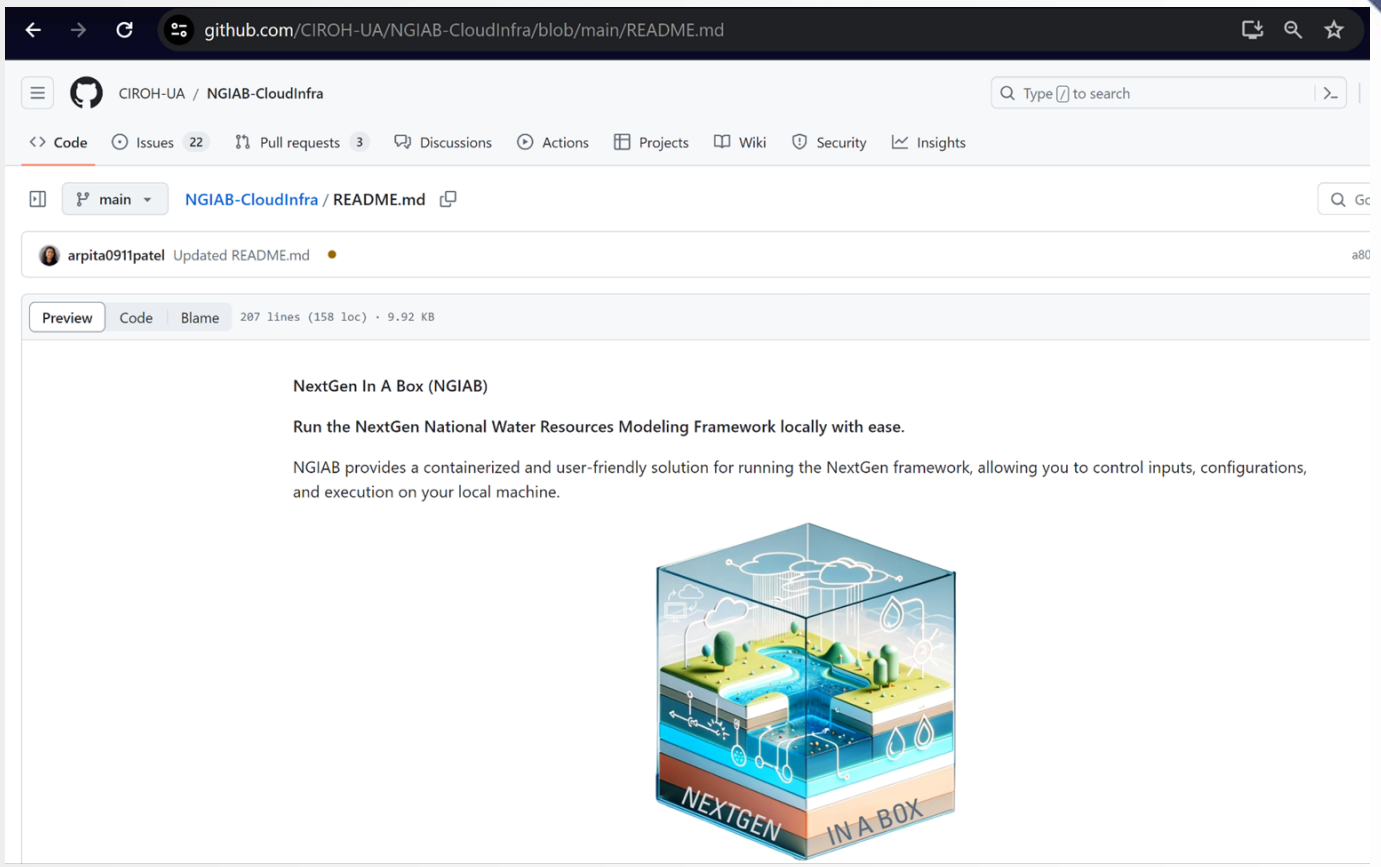
README.md

Open README file:

https://tinyurl.com/ngiab-cloudinfra

3 Steps:

1. Install docker
2. Download sample data
3. Run NextGen In A Box – guide.sh



STEP 0 : ONLY FOR VIRTUAL INSTANCES

If you are working from a virtual instance: you might need to do the following:

Steps :

1. Download the key from:
    1. https://alabama.app.box.com/s/fig2o4uko0j29bigholkolgsze96qtvh
2. Connect to the instace:
    1. $ ssh -i <your_key_pem_file> <user>@<remote IP host>

You do not need to install docker in this instance. It came with docker pre-install.

STEP 1 : INSTALL DOCKER

On Windows:
Install Docker Desktop on Windows : https://docs.docker.com/desktop/install/windows-install/#install-docker-desktop-on-windows

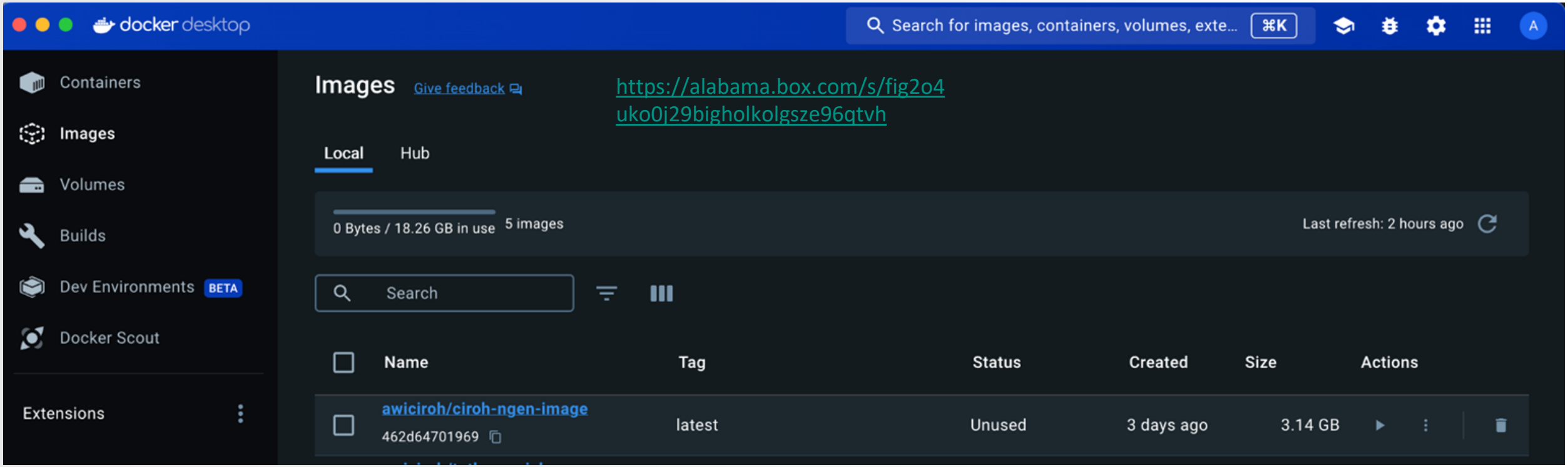
Install WSL: https://learn.microsoft.com/en-us/windows/wsl/install

On Mac:
Install docker on Mac : https://docs.docker.com/desktop/install/mac-install

- Once docker is installed, start **Docker Desktop**.
- Open **terminal** app
- Type 'docker ps –a' to make sure docker is working.

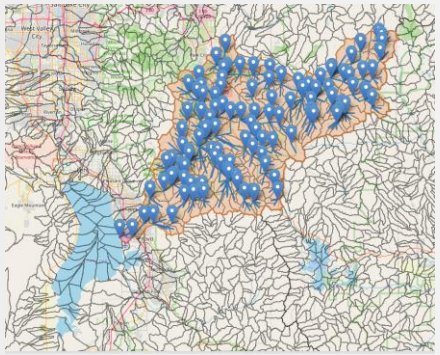
On Linux:
Install docker on Linux : https://docs.docker.com/desktop/install/linux-install

- Follow similar steps as Mac for starting Docker and verifying the installation



STEP 2 : DOWNLOAD SAMPLE DATA

Use Case: AWI_006 - Provo River Basin, UT - **16 VPU**



Steps :

$ mkdir -p NextGen/ngen-data
$ cd NextGen/ngen-data

$ wget --no-parent https://ciroh-ua-ngen-data.s3.us-east-2.amazonaws.com/AWI-006/AWI_16_2853886_006.tar.gz

```
apatel54@UA-W2RP43G:~/NextGen/ngen-data|⇒  wget --no-parent https://ciroh-ua-ngen
-data.s3.us-east-2.amazonaws.com/AWI-006/AWI_16_2853886_006.tar.gz
--2024-05-13 21:54:25--  https://ciroh-ua-ngen-data.s3.us-east-2.amazonaws.com/AW
I-006/AWI_16_2853886_006.tar.gz
Resolving ciroh-ua-ngen-data.s3.us-east-2.amazonaws.com (ciroh-ua-ngen-data.s3.us
-east-2.amazonaws.com)... 52.219.108.186, 3.5.132.135, 52.219.177.90, ...
Connecting to ciroh-ua-ngen-data.s3.us-east-2.amazonaws.com (ciroh-ua-ngen-data.s
3.us-east-2.amazonaws.com)|52.219.108.186|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 40323415 (38M) [application/x-tar]
Saving to: 'AWI_16_2853886_006.tar.gz'

AWI_16_2853886_006.t 100%[===================>]  38.46M  36.9MB/s    in 1.0s

2024-05-13 21:54:27 (36.9 MB/s) - 'AWI_16_2853886_006.tar.gz' saved [40323415/403
23415]
```

$ tar -xf AWI_16_2853886_006.tar.gz

$ mv AWI_16_2853886_006 my_data

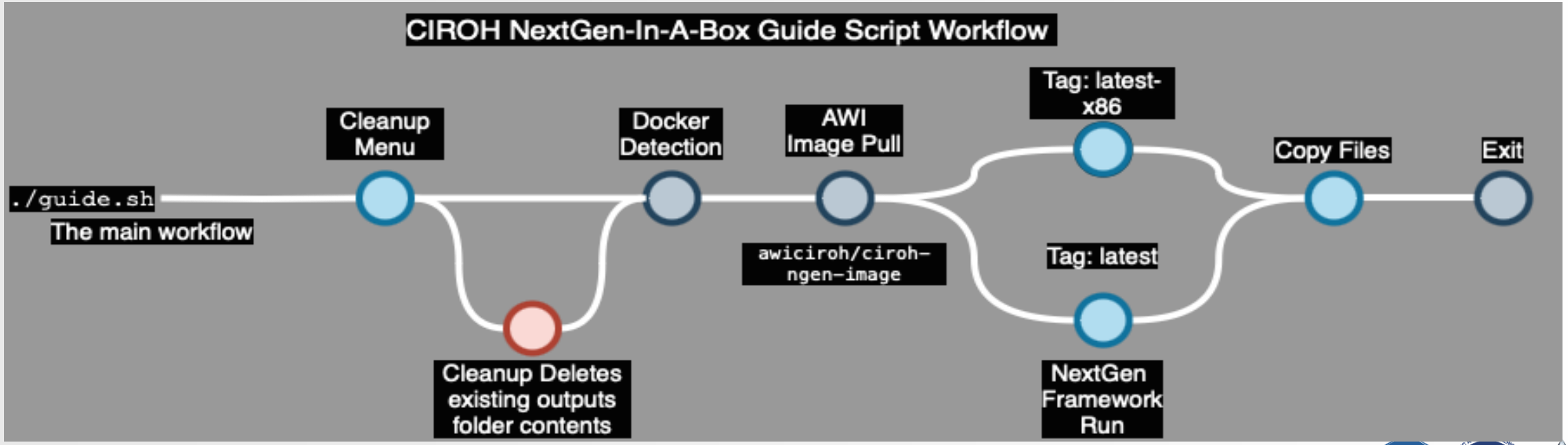
$ pwd

Please attend following workshop for more info on how to prepare the dataset:
NextGen Simulations Development Tools (Day 1 afternoon)

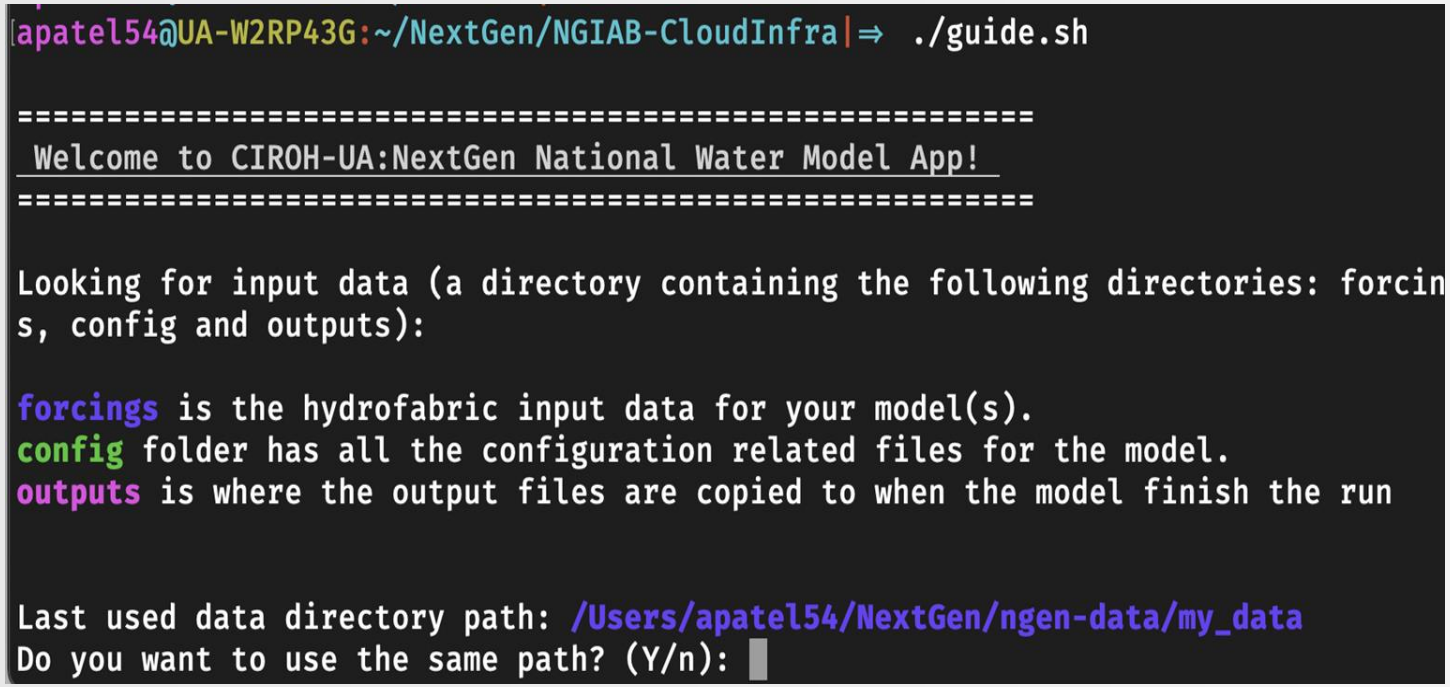
STEP 3: NEXTGEN IN A BOX: GUIDE.SH WORKFLOW

Clone repo:
$ cd NextGen
$ git clone https://github.com/CIROH-UA/NGIAB-CloudInfra.git
$ cd NGIAB-CloudInfra

Latest guide.sh location: https://github.com/CIROH-UA/NGIAB-CloudInfra/blob/main/guide.sh



STEP 3: RUN GUIDE.SH



~/NextGen/NGIAB-CloudInfra => ./guide.sh

....

....

....

Script will execute and prompt the user for entering the absolute path of input data.

Enter absolute input data path.

e.g: /Users/apatel54/DevCon24/NextGen/ngen-data/my_data/

NOTE: If you are rerunning the script, it will reuse the path from previous run.

```
Looking for input data (a directory containing the following directories: forcing
s, config and outputs):

forcings is the hydrofabric input data for your model(s).
config folder has all the configuration related files for the model.
outputs is where the output files are copied to when the model finish the run


Last used data directory path: /Users/apatel54/NextGen/ngen-data/my_data
Do you want to use the same path? (Y/n): Y
The Directory you've given is:
/Users/apatel54/NextGen/ngen-data/my_data

forcings exists.      230 forcings found.
config exists.      471 config found.
outputs exists.     1043 outputs found.
Files found:     1043
Cleanup Process: matching files (-name '*' ) in Outputs: /Users/apatel54/NextGen/
ngen-data/my_data/outputs/
Select an option (type a number):
1) Delete files and run fresh  3) Exit
2) Continue without cleaning
#?
```

~/NextGen/CloudInfra => ./guide.sh

....

....

Script will prompt user if the cleanup steps are needed.

Enter “1” if output files needs to be deleted before running the model.

```
1) Delete files and run fresh  3) Exit
2) Continue without cleaning
#? 1
Cleaning folder for fresh run
Files found:        0
Restarts is ready for run. No matching files found.

Looking in the provided directory gives us:
Found these hydrofabric files:
/Users/apatel54/NextGen/ngen-data/my_data/config/wb-2853886_subset.gpkg
Found these realization files:
/Users/apatel54/NextGen/ngen-data/my_data/config/realization.json

Detected ISA = Darwin UA-W2RP43G 23.2.0 Darwin Kernel Version 23.2.0: Wed Nov 15
21:53:18 PST 2023; root:xnu-10002.61.3~2/RELEASE_ARM64_T6000 arm64
Docker version 26.0.0, build 2ae903e
Docker found
Darwin UA-W2RP43G 23.2.0 Darwin Kernel Version 23.2.0: Wed Nov 15 21:53:18 PST 20
23; root:xnu-10002.61.3~2/RELEASE_ARM64_T6000 arm64
Select an option (type a number):
1) Run NextGen using existing local docker image
2) Run NextGen after updating to latest docker image
3) Exit
#?
```

~/NextGen/CloudInfra =>
./guide.sh

....

- Script will display hydrofabric and realization files under input data.
- Script will detect the OS architecture (arm vs x86) and make sure Docker is running.
- Script will prompt user to enter "1" if ready to run the Model using local docker images.
- enter “2” to pull latest docker image.

```
ngen/data within the container.
Working directory is:
/ngen/ngen/data


Found these Catchment files:
./config/wb-2853886_subset.gpkg


Found these Nexus files:
./config/wb-2853886_subset.gpkg


Found these Realization files:
./config/realization.json


Entering Interactive Mode
Select an option (type a number):
1) Run NextGen model framework in serial mode
2) Run NextGen model framework in parallel mode
3) Run Bash shell
4) Exit
#?
```

~/NextGen/CloudInfra =>
./guide.sh

....

- Script will display catchment, nexus and realization files.

- The user is then prompted to select whether they want to run the model in serial mode (1), parallel mode (2) or Run bash shell (3).

```
Found these Realization files:
./config/realization.json


Entering Interactive Mode
Select an option (type a number):
1) Run NextGen model framework in serial mode
2) Run NextGen model framework in parallel mode
3) Run Bash shell
4) Exit
#? 1


Selected files:
Catchment: ./config/wb-2853886_subset.gpkg
Nexus: ./config/wb-2853886_subset.gpkg
Realization: ./config/realization.json

Your NGEN run command is /dmod/bin/ngen-serial ./config/wb-2853886_subset.gpkg al
l ./config/wb-2853886_subset.gpkg all ./config/realization.json
If your model didn't run, or encountered an error, try checking the Forcings path
s in the Realizations file you selected.
Do you want to redirect command output to /dev/null? (y/N, default: n):
```

~/NextGen/CloudInfra => ./guide.sh

....

....

- Enter "1" for serial mode run.
- Model will run in serial mode using /dmod/bin/ngen-serial command.
- Enter “n” if you want to check the console output.

```
Config Value - Param: 'soil_params.expon' | Value: '1' | Units: ''
Config Value - Param: 'soil_params.expon_secondary' | Value: '0.005' | Units: ''
Config Value - Param: 'max_gw_storage' | Value: '249.814804077' | Units: 'm'
Config Value - Param: 'Cgw' | Value: '0.0018' | Units: 'm h-1'
Config Value - Param: 'expon' | Value: '6.0' | Units: ''
Config Value - Param: 'gw_storage' | Value: '0.05' | Units: 'm/m'
Config Value - Param: 'alpha_fc' | Value: '0.33' | Units: '(null)'
Config Value - Param: 'soil_storage' | Value: '0.05' | Units: 'm/m'
Config Value - Param: 'K_nash' | Value: '0.03' | Units: ''
Config Value - Param: 'K_lf' | Value: '0.01' | Units: ''
Config Value - Param: 'nash_storage' | Value: '0.0,0.0' | Units: '(null)'
Config Value - Param: 'giuh_ordinates' | Value: '1.00,0.00' | Units: '(null)'
Found configured GIUH ordinate values ('1.00,0.00')
Config Value - Param: 'num_timesteps' | Value: '1' | Units: '(null)'
Config Value - Param: 'verbosity' | Value: '1' | Units: '(null)'
Config Value - Param: 'DEBUG' | Value: '0' | Units: '(null)'
Config Value - Param: 'refkdt' | Value: '3.878265282527349' | Units: '(null)'
Schaake Magic Constant calculated
All CFE config params present
GIUH ordinates string value found in config ('1.00,0.00')
Counted number of GIUH ordinates (2)
Finished function parsing CFE config
At declaration of smc_profile size, soil_reservoir.n_soil_layers = 0
```

~/NextGen/CloudInfra =>
./guide.sh

....

....

- This output on console indicates script is running.
- This step will take few mins depending on machine/specs.

```
Definition of "pt" in "/usr/share/udunits/udunits2-common.xml", line 785, overrid
es prefixed-unit "1e-09 kilogram"
Definition of "at" in "/usr/share/udunits/udunits2-common.xml", line 1250, overri
des prefixed-unit "1e-15 kilogram"
Definition of "ph" in "/usr/share/udunits/udunits2-common.xml", line 1880, overri
des prefixed-unit "3.6e-09 second"
Definition of "nt" in "/usr/share/udunits/udunits2-common.xml", line 1889, overri
des prefixed-unit "1e-06 kilogram"
Running timestep 100
Running timestep 200
Running timestep 300
Running timestep 400
Running timestep 500
Running timestep 600
Finished 697 timesteps.
creating supernetwork connections set
supernetwork connections set complete
... in 0.12949371337890625 seconds.
2024-05-14 01:47:51,505    INFO [AbstractNetwork.py:494 - create_independent_netw
orks()]: organizing connections into reaches ...
2024-05-14 01:47:51,506    INFO [AbstractNetwork.py:651 - initial_warmstate_prepr
ocess()]: setting channel initial states ...
Reformating qlat nexus files as hourly binary files...
```

~/NextGen/CloudInfra =>
./guide.sh

....

....

....

....

....

....

- This output on console indicates script is still running.

```
2024-05-20 15:26:14,392    INFO [AbstractNetwork.py:125 -    assemble_forcings()]: Creating a DataFrame of lateral inflow forcings ...
2024-05-20 15:26:17,362    INFO [__main__.py:1074 -           nwm_route()]: executing routing computation ...
2024-05-20 15:26:17,363    INFO [compute.py:418 - compute_nhd_routing_v02()]: JIT Preprocessing time 0.0009942054748535156 seconds.
2024-05-20 15:26:17,363    INFO [compute.py:419 - compute_nhd_routing_v02()]: starting Parallel JIT calculation
2024-05-20 15:26:18,144    INFO [compute.py:648 - compute_nhd_routing_v02()]: PARALLEL TIME 0.7807533740997314 seconds.
2024-05-20 15:26:18,149    INFO [output.py:109 - nwm_output_generator()]: Handling output ...
/usr/local/lib64/python3.9/site-packages/troute/nhd_io.py:2162: FutureWarning: Downcasting object dtype arrays on .fillna, .ffill, .bfi
ll is deprecated and will change in a future version. Call result.infer_objects(copy=False) instead. To opt-in to the future behavior,
set `pd.set_option('future.no_silent_downcasting', True)`
  empty_df = pd.DataFrame(index=empty_ids, columns=nudge_df.columns).fillna(-9999.0)
/usr/local/lib64/python3.9/site-packages/troute/nhd_io.py:2163: FutureWarning: The behavior of array concatenation with empty entries i
s deprecated. In a future version, this will no longer exclude empty items when determining the result dtype. To retain the old behavio
r, exclude the empty entries before the concat operation.
  nudge_df = pd.concat([nudge_df, empty_df]).loc[flowveldepth.index]
************ TIMING SUMMARY ************
----------------------------------------
Network graph construction: 0.32 secs, 0.41 %
Forcing array construction: 77.06 secs, 97.31 %
Routing computations: 0.78 secs, 0.99 %
Output writing: 1.02 secs, 1.29 %
----------------------------------------
Total execution time: 79.17999999999999 secs
Finished routing
NGen top-level timings:
       NGen::init: 13.0649
       NGen::simulation: 34.9045
       NGen::routing: 79.2219

real    2m7.786s
user    0m36.592s
sys     0m8.822s
Finished executing command successfully.
Would you like to continue?
Select an option (type a number):
1) Interactive-Shell
2) Exit
#?
```

~/NextGen/CloudInfra =>
./guide.sh

....

....

- Timing summary is displayed.
- User is prompted if they want to select Interactive-Shell(1) or exit (2)
- Select "2" to Exit and copy the output files.

```
/usr/local/lib64/python3.9/site-packages/troute/nhd_io.py:2162: FutureWarning: Downcasting object dtype arrays on .fillna, .ffill, .bfi
ll is deprecated and will change in a future version. Call result.infer_objects(copy=False) instead. To opt-in to the future behavior,
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/usr/local/lib64/python3.9/site-packages/troute/nhd_io.py:2163: FutureWarning: The behavior of array concatenation with empty entries i
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        NGen::routing: 79.2219

real    2m7.786s
user    0m36.592s
sys     0m8.822s
Finished executing command successfully.
Would you like to continue?
Select an option (type a number):
1) Interactive-Shell
2) Exit
#? 2
Have a nice day.
    1043 new outputs created.
Any copied files can be found here: /Users/apatel54/NextGen/ngen-data/my_data/outputs
Darwin UA-W2RP43G 23.2.0 Darwin Kernel Version 23.2.0: Wed Nov 15 21:53:18 PST 2023; root:xnu-10002.61.3~2/RELEASE_ARM64_T6000 arm64
\e[33mVisualize outputs using the Tethys Platform (https://www.tethysplatform.org/)? (y/N, default: y):\e[0m
```

~/NextGen/CloudInfra => ./guide.sh

....

- Output files are copied to path displayed.
- If no errors, new output folders and files are created.
  - Once the guide.sh has finished running the script, the user can be prompted to use NGIAB-Visualizer app for visualization (Tethys Platform)
  - For demo say “Y”, if you also want you can run the visualization separately (./viewOnTethys.sh)

NGIAB-Visualizer

```
Would you like to continue?
Select an option (type a number):
1) Interactive-Shell
2) Exit
#? 2
Have a nice day.
1043 new outputs created.
Any copied files can be found here: /home/gio/tethysdev/docker/NextGen/ngen
-data/AWI_16_2853886_006/outputs
Visualize outputs using the Tethys Platform (https://www.tethysplatform.org
/)? (y/N, default: y):
y
Setup Tethys Portal image...
Select an option (type a number):
1) Run Tethys using existing local docker image
2) Run Tethys after updating to latest docker image
3) Exit
#? 2
Pulling container...
dev-r1: Pulling from awiciroh/tethys-ngiab
Digest: sha256:498e5c819e72c50e1db28ee6565479d612435d8a5da34f356840ce3a87a9
822b
```

- ~/NextGen/CloudInfra => ./guide.sh
    - Enter ”2” to pull the NGIAB-Visualizer app image.

NGIAB-Visualizer

```
\e[33mVisualize outputs using the Tethys Platform (https://www.tethysplatform.org/)? (y/N, default: y):\e[0m
y
\e[32mSetup Tethys Portal image...\e[0m
Select an option (type a number):
1) Run Tethys using existing local docker image
2) Run Tethys after updating to latest docker image
3) Exit
#? 2
Pulling container...
main: Pulling from awiciroh/tethys-ngiab
Digest: sha256:124b13df3d9437ce8e20d115d648229ce8e806f77ef2a8350b740837a828a99c
Status: Image is up to date for awiciroh/tethys-ngiab:main
docker.io/awiciroh/tethys-ngiab:main

What's Next?
  View a summary of image vulnerabilities and recommendations → docker scout quickview awiciroh/tethys-ngiab:main
7341de5c3ad42be2da85e44abf336764fb53fda24811a6e1cd97d36a233fc166
\e[32mSetup GeoServer image...\e[0m
Select an option (type a number):
1) Run GeoServer using existing local docker image
2) Run GeoServer after updating to latest docker image
3) Exit
#?
```

~/NextGen/CloudInfra =>
./guide.sh

- Enter ”2” to pull the GeoServer image.

NGIAB-Visualizer

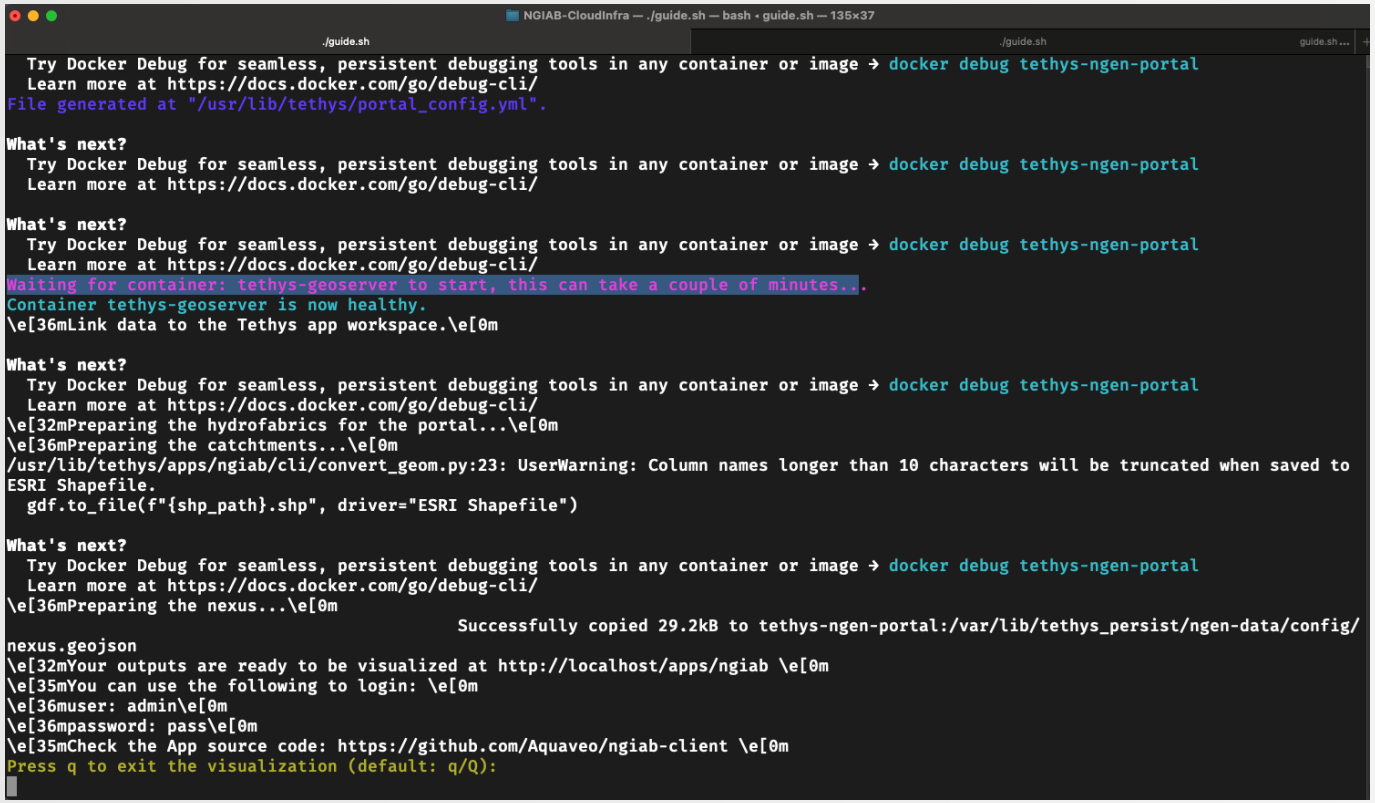
~/NextGen/CloudInfra => ./guide.sh

```
What's Next?
  View a summary of image vulnerabilities and recommendations → docker scout quickview awiciroh/tethys-ngiab:main
7341de5c3ad42be2da85e44abf336764fb53fda24811a6e1cd97d36a233fc166
\e[32mSetup GeoServer image...\e[0m
Select an option (type a number):
1) Run GeoServer using existing local docker image
2) Run GeoServer after updating to latest docker image
3) Exit
#? 2
Pulling container...
2.25.x: Pulling from geoserver
Digest: sha256:a21b6a4c7255bc3f0fcc295ebc9e5a6d0ef8e1cf5462378ed54c6ea07213b678
Status: Image is up to date for docker.osgeo.org/geoserver:2.25.x
docker.osgeo.org/geoserver:2.25.x

What's Next?
  View a summary of image vulnerabilities and recommendations → docker scout quickview docker.osgeo.org/geoserver:2.25.x
Successfully updated GeoServer image.
WARNING: The requested image's platform (linux/amd64) does not match the detected host platform (linux/arm64/v8) and no specific platfo
rm was requested
e10ede5ee810fb683186acc6148dba684afc89e5bfc3dbf71805a6eafa6fa743
Waiting for container: tethys-ngen-portal to start, this can take a couple of minutes...
```

- If the images are pulled successfully then please wait for containers to start. This might take couple of mins.
- Open a tab with the NGIAB-Visualizer app in your current browser.

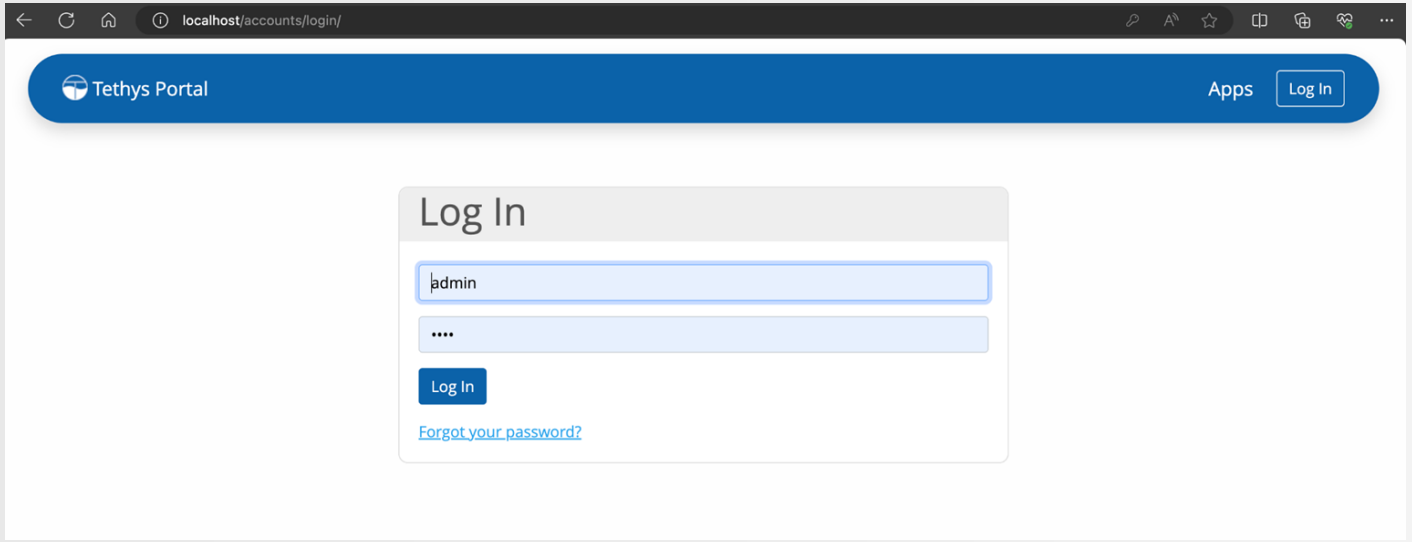
NGIAB-Visualizer



~/NextGen/CloudInfra =>
./guide.sh

- Your outputs are ready to be visualized at http://localhost/apps/ngiab
- This might take few mins depending on your hardware.

NGIAB-Visualizer

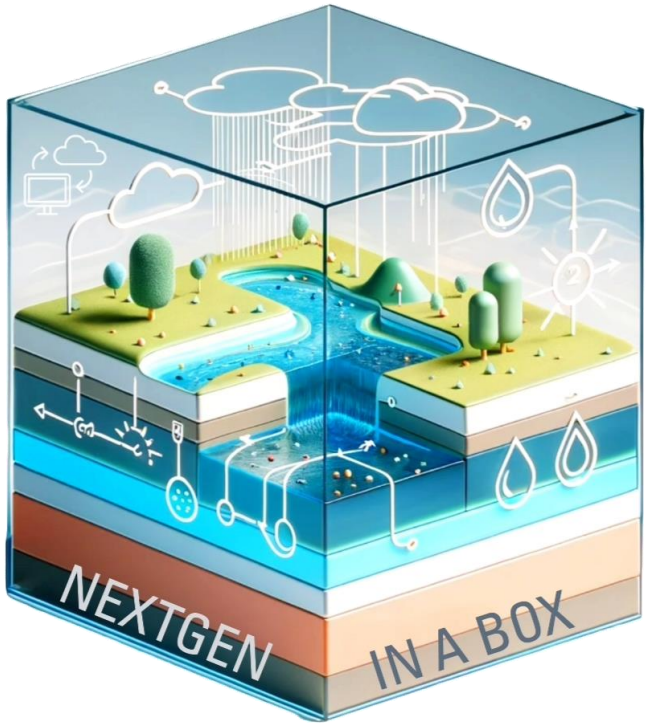


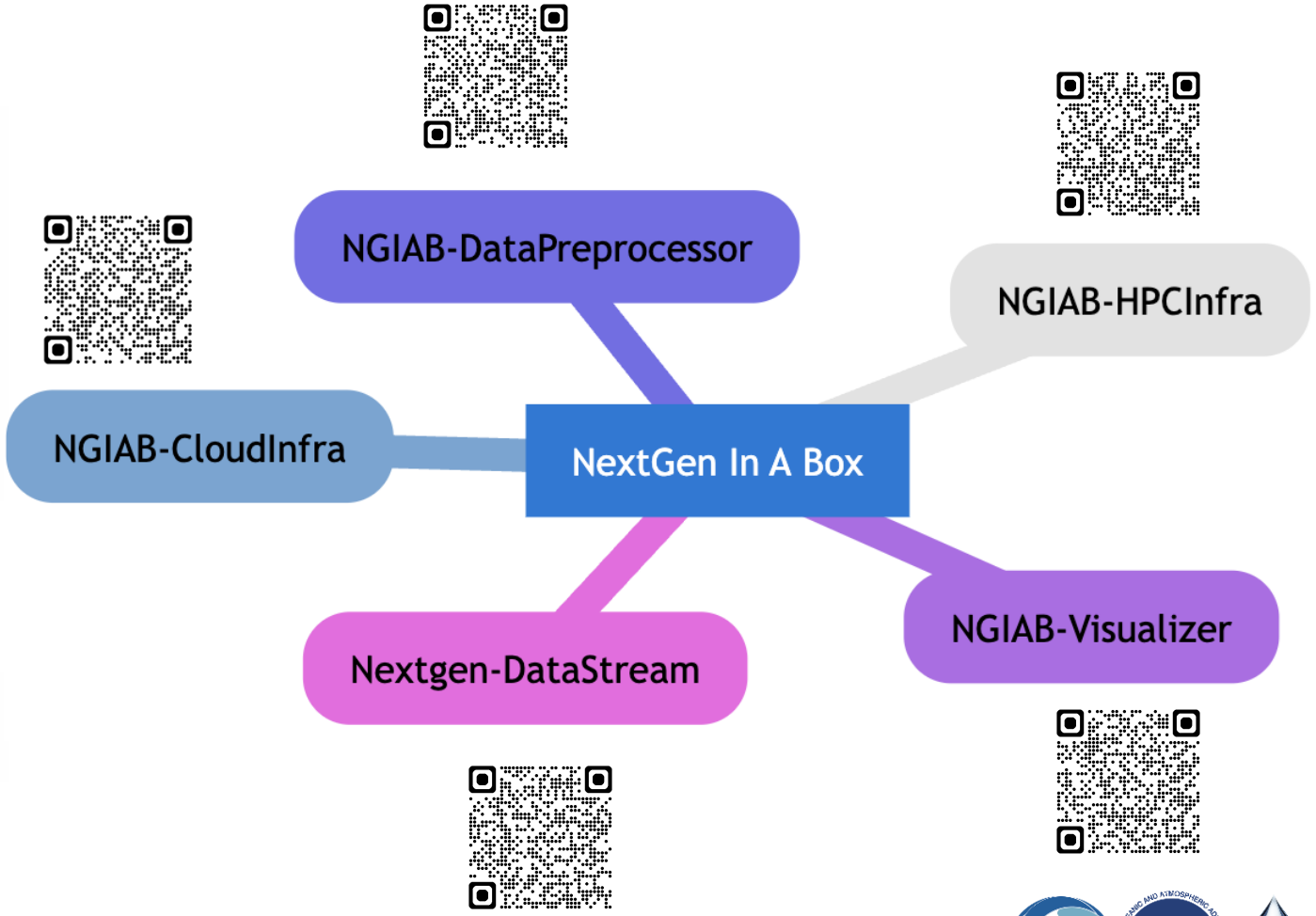
The browser will open automatically for you at: http://localhost/apps/ngiab or

- **If you are in a cloud instance run the following command:**
  - sudo ssh -i <your_key_pem> -N -L 80:localhost:80 -L 8181:localhost:8181 <user>@<host>
- If the browser does not launch, just open the browser.
- Use the following credentials to access the portal:
  - user: **admin**
  - password : **pass**

NGIAB – Applications

NGIAB Products

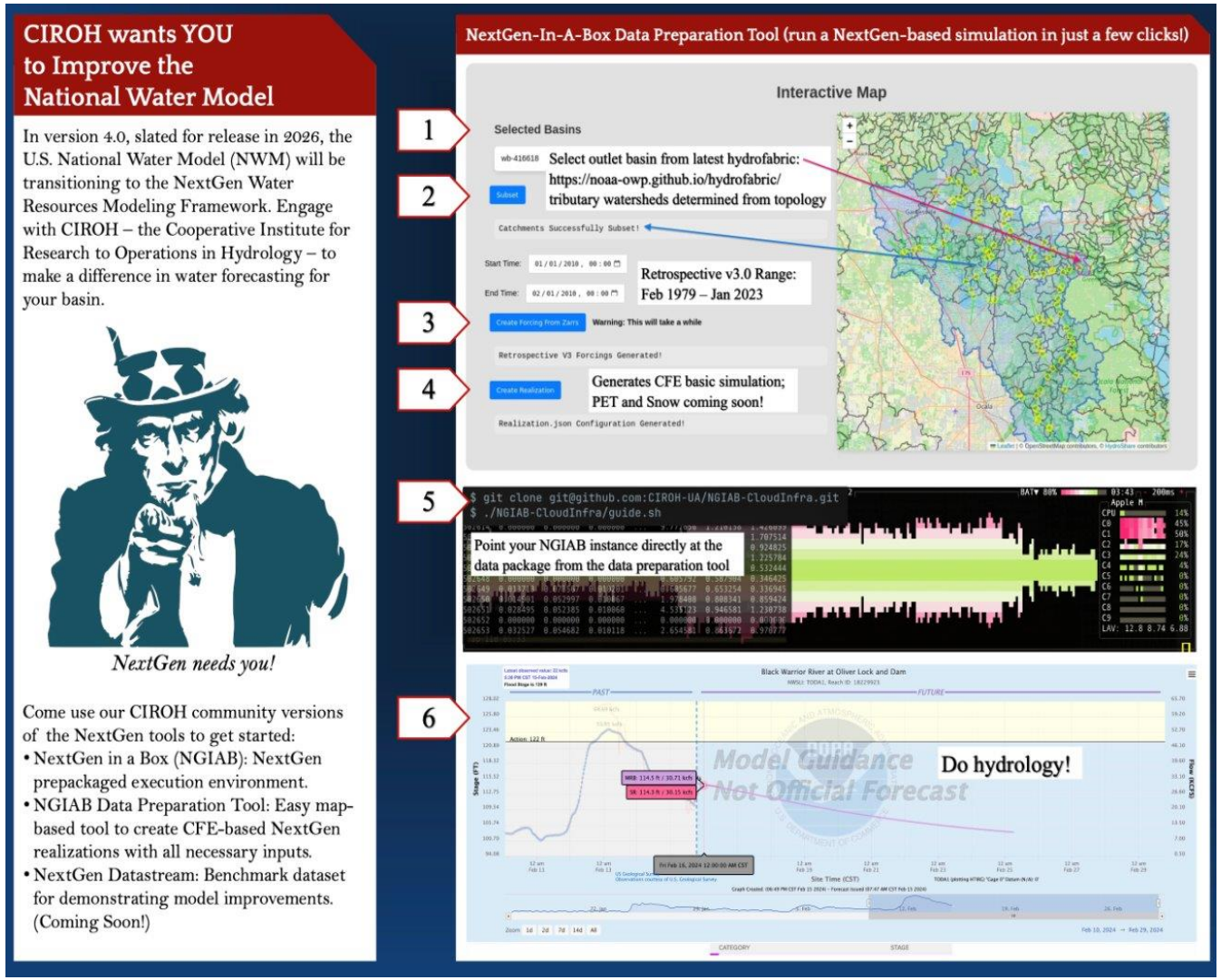




NGIAB-HPCInfra

- Repo : https://github.com/CIROH-UA/NGIAB-HPCInfra
- Provides Singularity Image for running NextGen In A Box
- Run NGIAB on any HPC using Singularity

NGIAB-Data PreProcessor



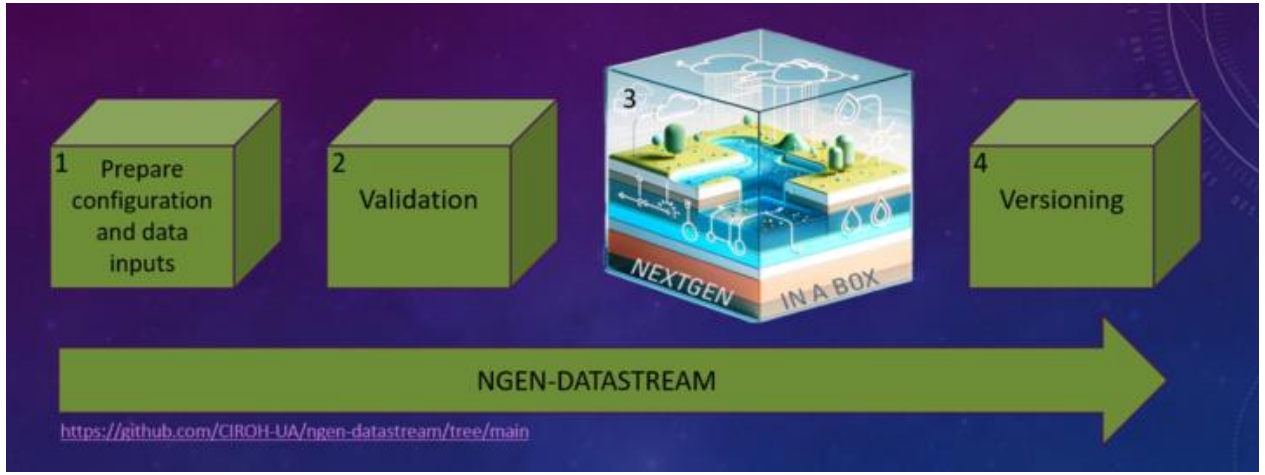
- Repo : https://github.com/AlabamaWaterInstitute/NGIAB_data_preprocess
- Provides one way to create input data for NGIAB
- Check it out later this afternoon in the NextGen Simulation Development Tools Workshop!

Ngen-DataStream

- Repo : https://github.com/CIROH-UA/ngen-datastream

- Provides continuous datastream that creates input data and runs NGIAB in one flow.

- Check it out later this afternoon in the NextGen Simulation Development Tools Workshop!

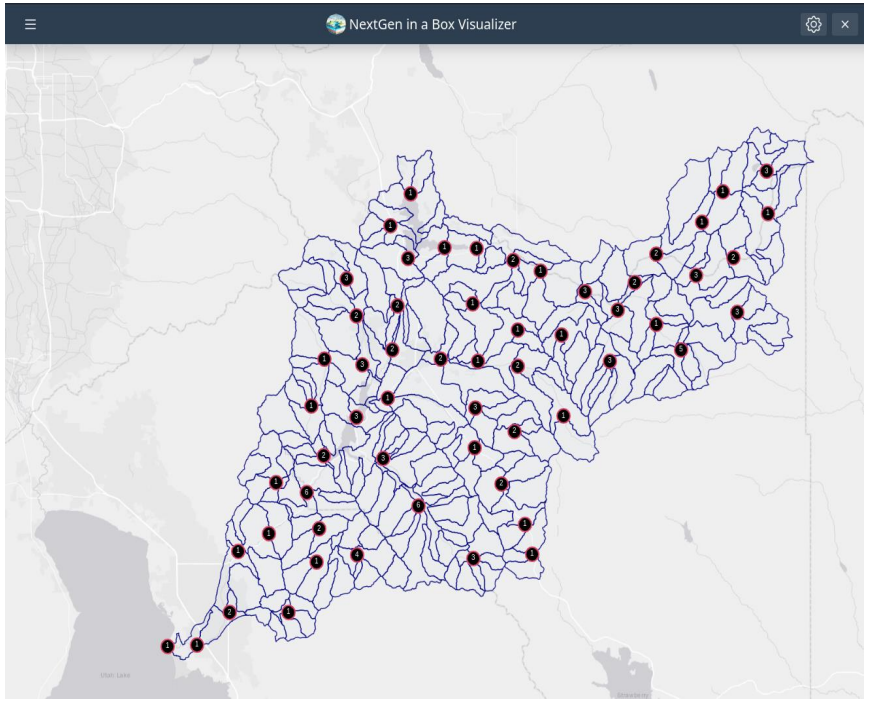


NGIAB-Visualizer

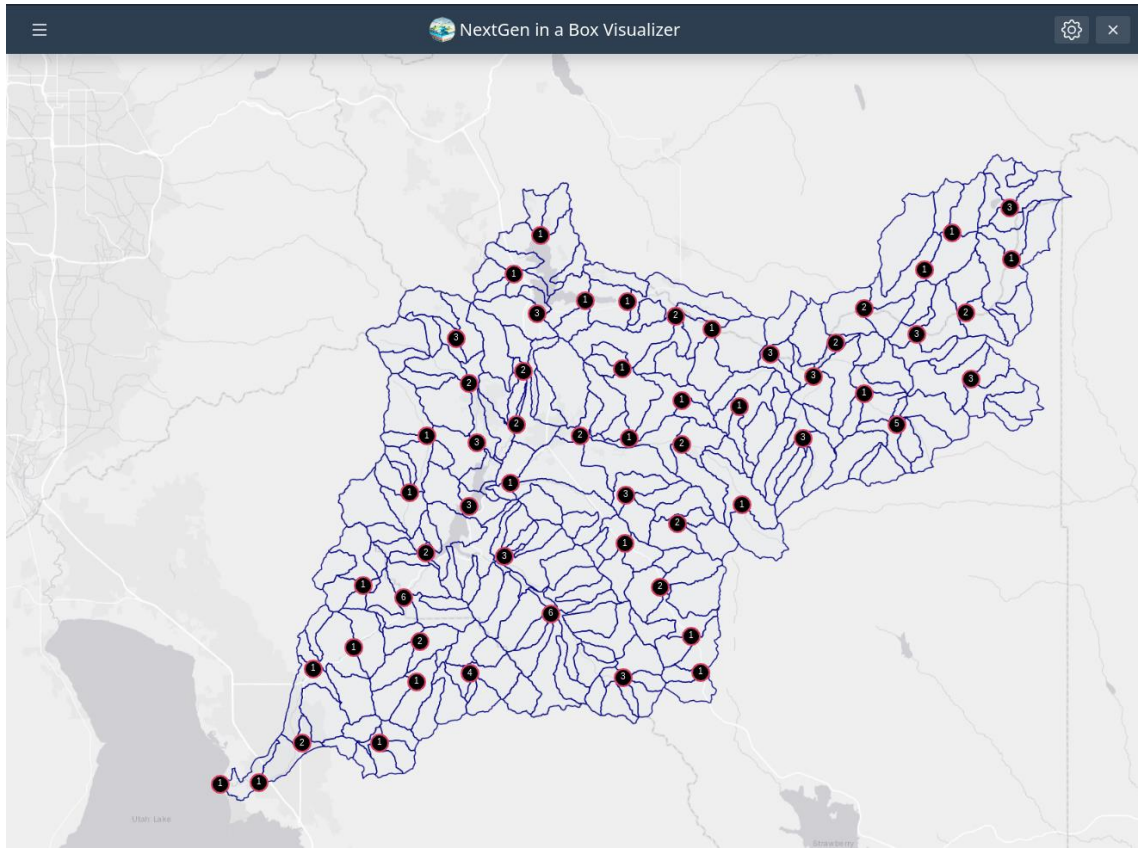
- Repo :

  https://github.com/CIROH-UA/ngiab-client

- Provides visualization capability for NGIAB output data.

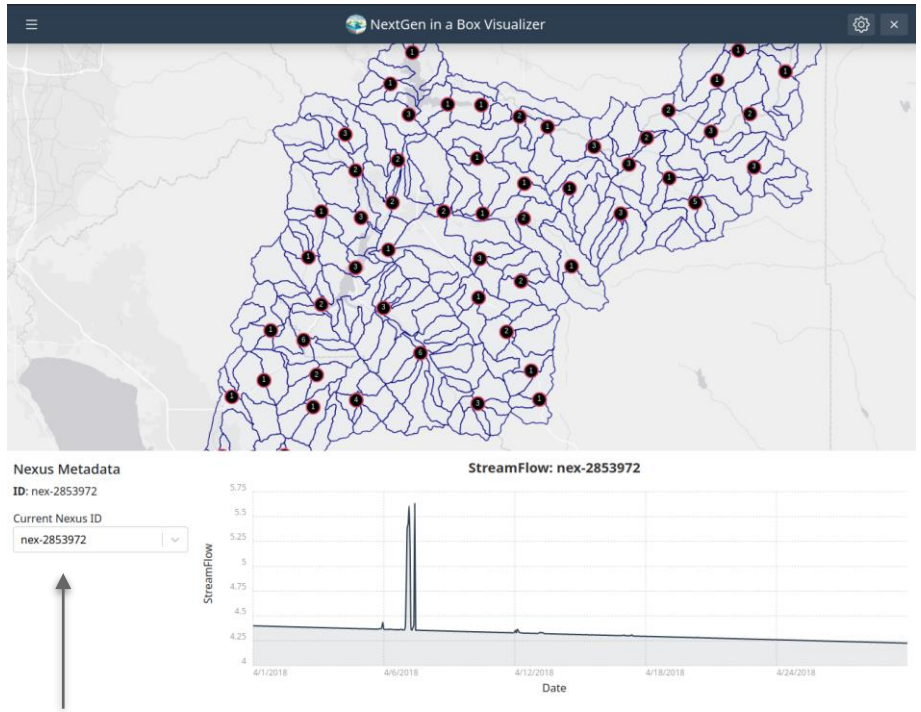


NGIAB-Visualizer



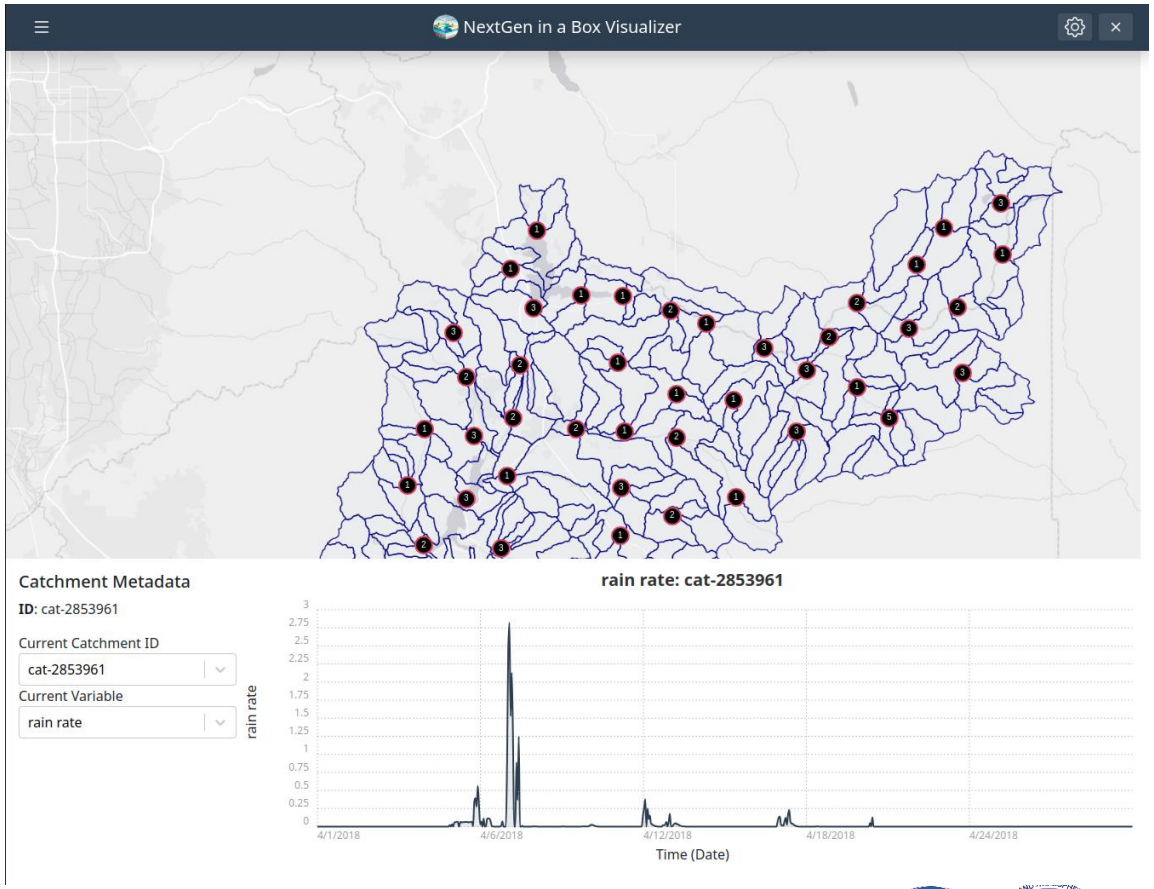
- Build using the Tethys Platform.
- Geospatial and time series visualization of the Catchments and Nexus Point.
- Outputs of different model runs can be visualized by the user mounting the outputs of the NGIAB
- It can be used with the **guide.sh**
- it can be used standalone using **viewOnTethys.sh**

NGIAB-Visualizer

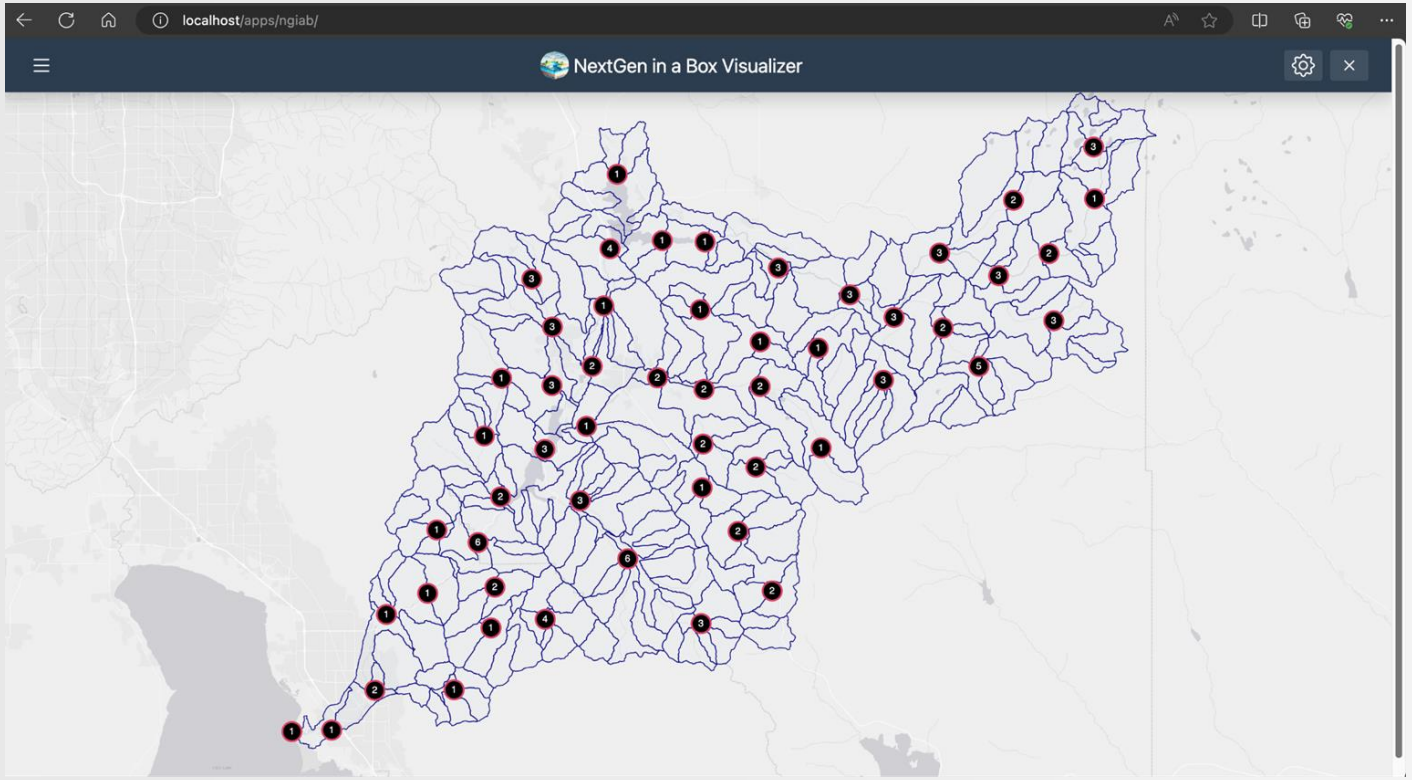


Search and lookup the Nexus/Catchment ID using a custom dropdown.

Nexus/Catchment time series visualization.

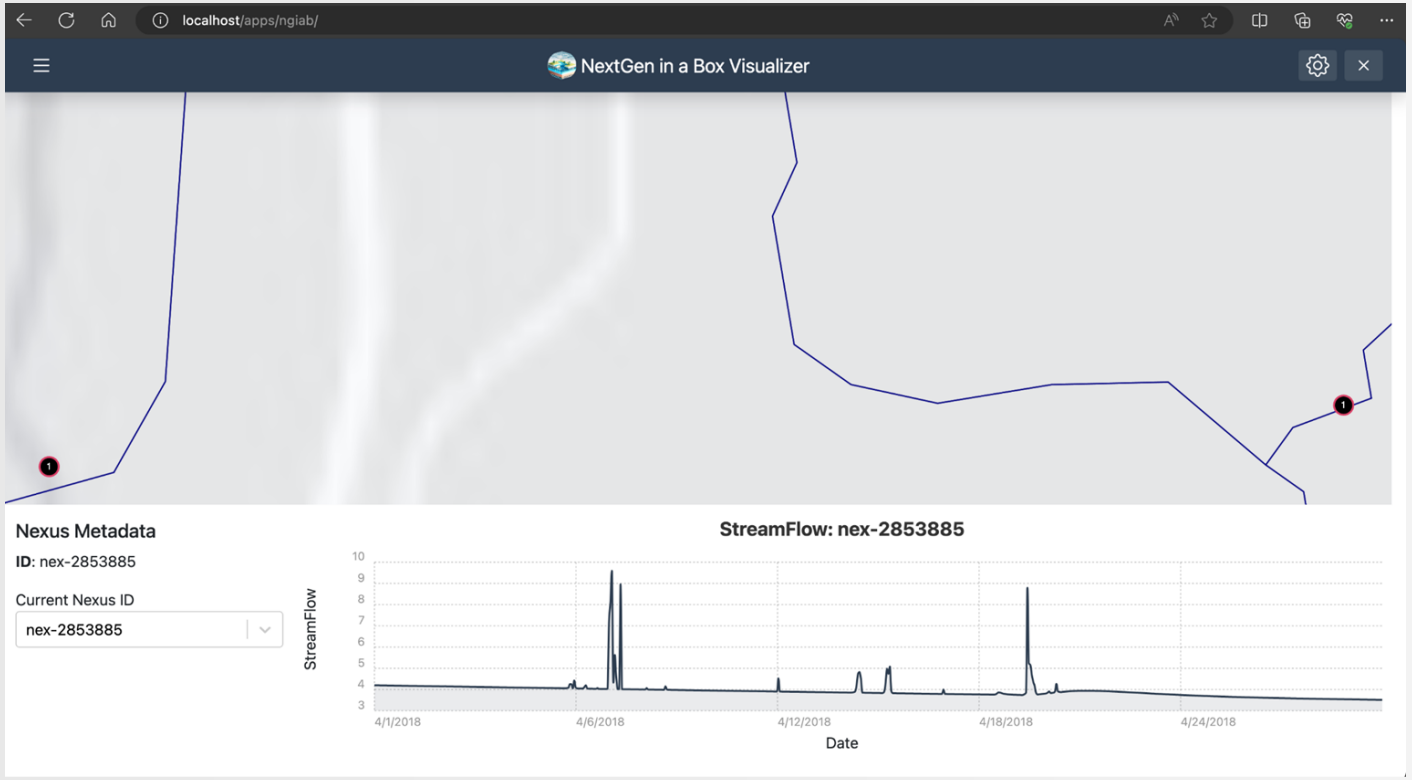


NGIAB-Visualizer



- If you do not see the layers, please refresh the page.
- Feel free to click on the nexus points and catchments.

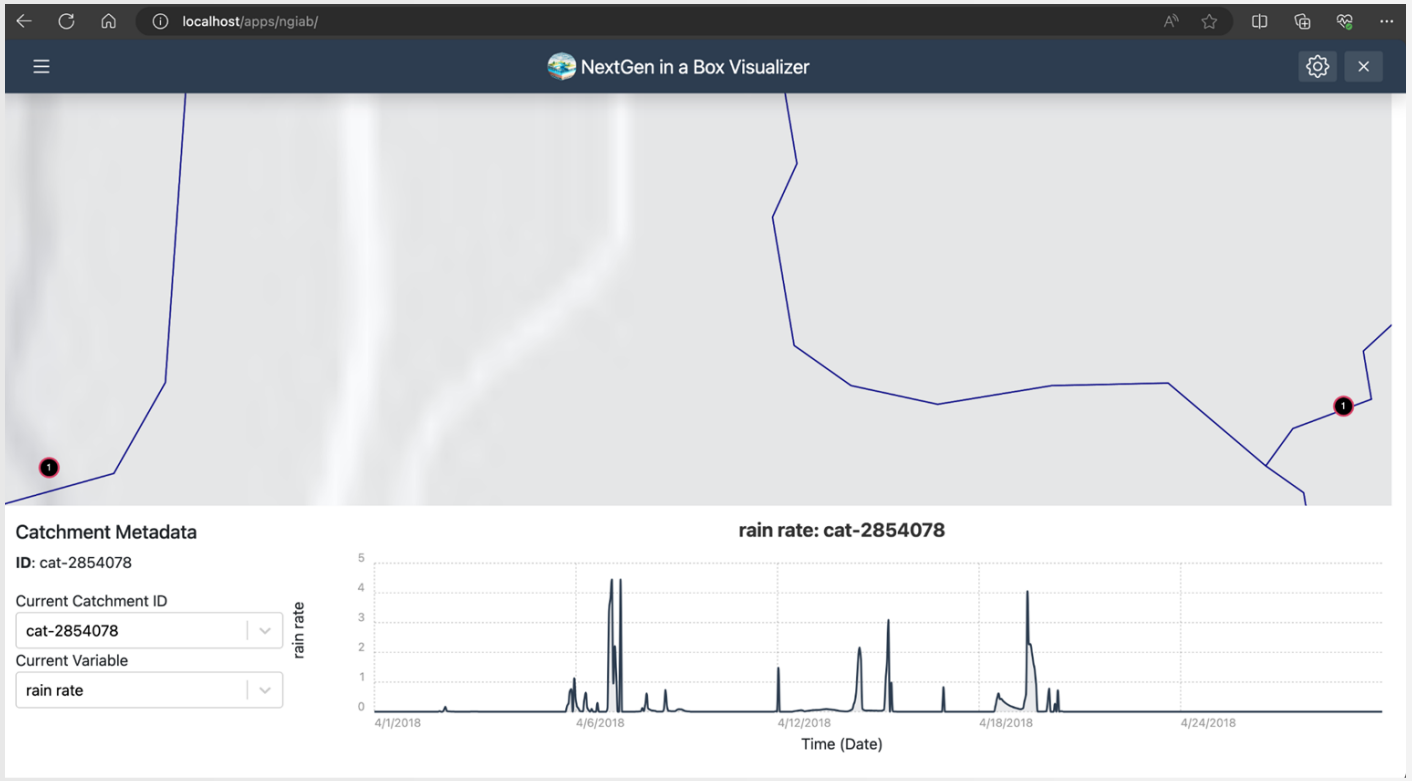
NGIAB-Visualizer



Once you click on a nexus cluster

- The cluster will zoom in revealing more nexus points
- Select a single nexus point, if this one has the “1” text.
- After clicking time series should appear in the lower portion of the application
- You can change the nexus point with the nexus ID using the custom search dropdown

NGIAB-Visualizer



Once you click on a catchment polygon

- After clicking timeseries should appear in the lower portion of the application
- You can change the catchment polygon with the catchment ID using the custom search dropdown.
- Similarly, you can change the time series variable for the catchment using the custom search dropdown for the catchment variable.

NGIAB-Visualizer

Future Work

1. More visualization

- Outputs
  - Parquet files
  - Troutes
- Forcings
- Config files:
  - Flowpaths.geojson
- Realizations

2. Hydrofabrics input creation

3. Allow the user to run NGIAB through the application

- **Local** environment, using the web interface (similar to the guide.sh).
- **Production** environment, where ngiab can be run on demand creating the necessary infrastructure using terraform through the web application

RUN PARALLEL MODE

```
Entering Interactive Mode
Select an option (type a number):
1) Run NextGen model framework in serial mode    3) Run Bash shell
2) Run NextGen model framework in parallel mode  4) Exit
#? 2


Selected files:
Catchment: ./config/wb-2853886_subset.gpkg
Nexus: ./config/wb-2853886_subset.gpkg
Realization: ./config/realization.json

Reading 230 features from layer divides using ID column `divide_id`
Partitioning 230 catchments into 10 partitions.
Reading 115 features from layer nexus using ID column `id`
Validating catchments...

Number of catchments is: 230
Catchment validation completed
Found 4 remotes in partition 0
Found 9 remotes in partition 1
Found 2 remotes in partition 2
Found 10 remotes in partition 3
Found 10 remotes in partition 4
Found 15 remotes in partition 5
Found 5 remotes in partition 6
Found 4 remotes in partition 7
Found 5 remotes in partition 8
Found 1 remotes in partition 9
Found 65 total remotes (average of approximately 6 remotes per partition)
Your NGEN run command is mpirun -n 10 /dmod/bin/ngen-parallel ./config/wb-2853886_subset.gpkg all ./config/wb-2853886_subset.gpkg all ./
config/realization.json /ngen/ngen/data/partitions_10.json
If your model didn't run, or encountered an error, try checking the Forcings paths in the Realizations file you selected.
Do you want to redirect command output to /dev/null? (y/N, default: n):
```

- There is an option to run NGIAB in parallel mode. (not part of demo)

- Repeat same steps as serial mode and enter “2” to run in parallel mode.

NEXTGEN IN A BOX – OUTPUT FILES

```
apatel54@UA-W2RP43G:~/NextGen/ngen-data/my_data/outputs|⇒ ls
ngen    parquet troute
apatel54@UA-W2RP43G:~/NextGen/ngen-data/my_data/outputs|⇒
```

```
apatel54@UA-W2RP43G:~/NextGen/ngen-data/my_data/outputs/ngen|⇒ ls
cat-2853852.csv         cat-2853968.csv         nex-2853852_output.csv
cat-2853853.csv         cat-2853969.csv         nex-2853853_output.csv
cat-2853854.csv         cat-2853970.csv         nex-2853854_output.csv
cat-2853855.csv         cat-2853971.csv         nex-2853855_output.csv
```

```
apatel54@UA-W2RP43G:~/NextGen/ngen-data/my_data/outputs/parquet|⇒ ls
201804010000NEXOUT.parquet 201804101700NEXOUT.parquet 201804201000NEXOUT.parquet
201804010100NEXOUT.parquet 201804101800NEXOUT.parquet 201804201100NEXOUT.parquet
201804010200NEXOUT.parquet 201804101900NEXOUT.parquet 201804201200NEXOUT.parquet
201804010300NEXOUT.parquet 201804102000NEXOUT.parquet 201804201300NEXOUT.parquet
```

```
apatel54@UA-W2RP43G:~/NextGen/ngen-data/my_data/outputs/troute|⇒ ls
troute_output_201804010000.csv
apatel54@UA-W2RP43G:~/NextGen/ngen-data/my_data/outputs/troute|⇒
```

- **Nexus output file** - volumetric flow (m^3/s) from the catchment to the nexus
- e.g: nex-2854051_output.csv

  0, 2018-04-01 00:00:00, 3.33025

  1, 2018-04-01 01:00:00, 3.32986

  2, 2018-04-01 02:00:00, 3.32946

  3, 2018-04-01 03:00:00, 3.32907

- **Catchment output file:**
- **e.g** : cat-2853961.csv

  Time Step,Time,RAIN_RATE,DIRECT_RUNOFF,GIUH_RUNOFF,NASH_LATERAL_RUNOFF,DEEP_GW_TO_CHANNEL_FLUX,SOIL_TO_GW_FLUX,Q_OUT,POTENTIAL_ET,ACTUAL_ET,GW_STORAGE,SOIL_STORAGE,SOIL_STORAGE_CHANGE,SURF_RUNOFF_SCHEME

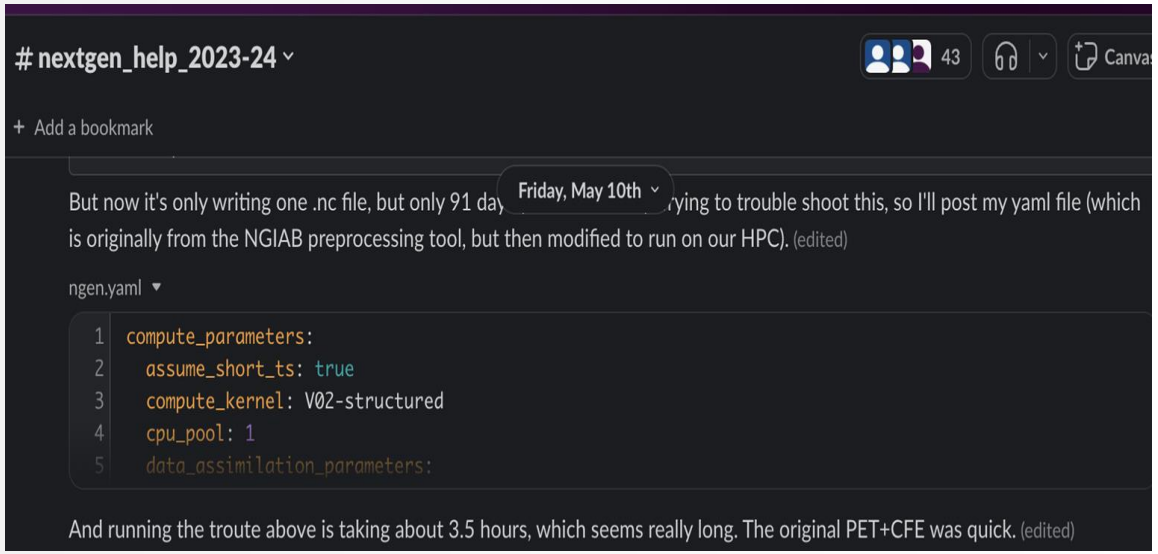
  0,2018-04-01 00:00:00,0.000000000,0.000000000,0.000000000,0.000000000,0.000629746,0.000000000,0.000629746,0.000613381,0.000000000,12.496590866,0.047898793,0.000000000,1.000000001,2018-04-01 01:00:00,0.000000000,0.000000000,0.000000000,0.000000000,0.000629709,0.000000000,0.000629709,0.000053649,0.000000000,12.495961157,0.047898793,0.000000000,1.000000000

SUPPORT

- For any questions, comments or issues:

Email us at : ciroh-it-support@ua.edu

Contact us on CIROH
Slack: **#nextgen_help_2023-24**



Q&A?

Thank you for your time and attention