Community Training, Resources, & Support

for the **WRF-Hydro®** Modeling System and
its Configuration as the **National Water Model**

Webinar: 12 November 2019 10:00am MT

Presented by:
NCAR & CUAHSI

NCAR
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CUAHSI
UNIVERSITIES ALLIED FOR WATER RESEARCH

Outline

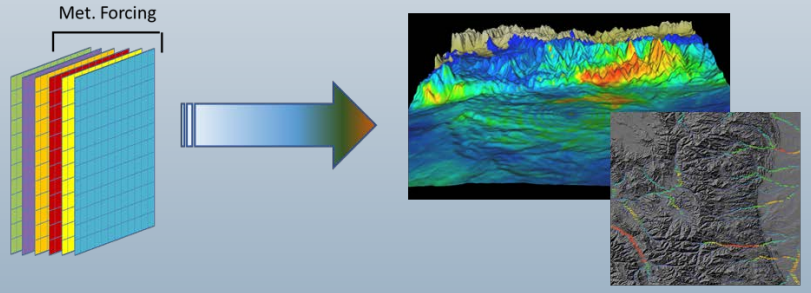
- Provide an listing of community user resources for WRF-Hydro and its configuration as the NWM
- Singular reference for code, data processing tools, training materials, user support mechanisms
- Highlight different development and use applications by user community around the world

WRF-Hydro Model Overview

- WRF-Hydro began in 2003 (as 'Noah-distributed')
  - Originally: Hydrologically-enhanced land surface model used for land surface initialization of weather and climate prediction models
  - Evolved: Multi-scale representation of terrain and channel routing physics and multi-physics land surface thermodynamics
- Able to run with prescribed meteorological data ('one-way) or in a 'two-way' coupled mode with an atmospheric model

One-way ("uncoupled") →

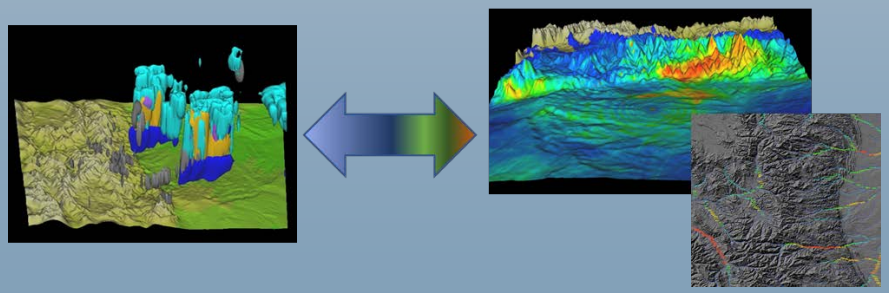
Gridded atmospheric data



Land surface hydrologic states & fluxes

Two-way ("coupled") ↔

Fully dynamic atmospheric model



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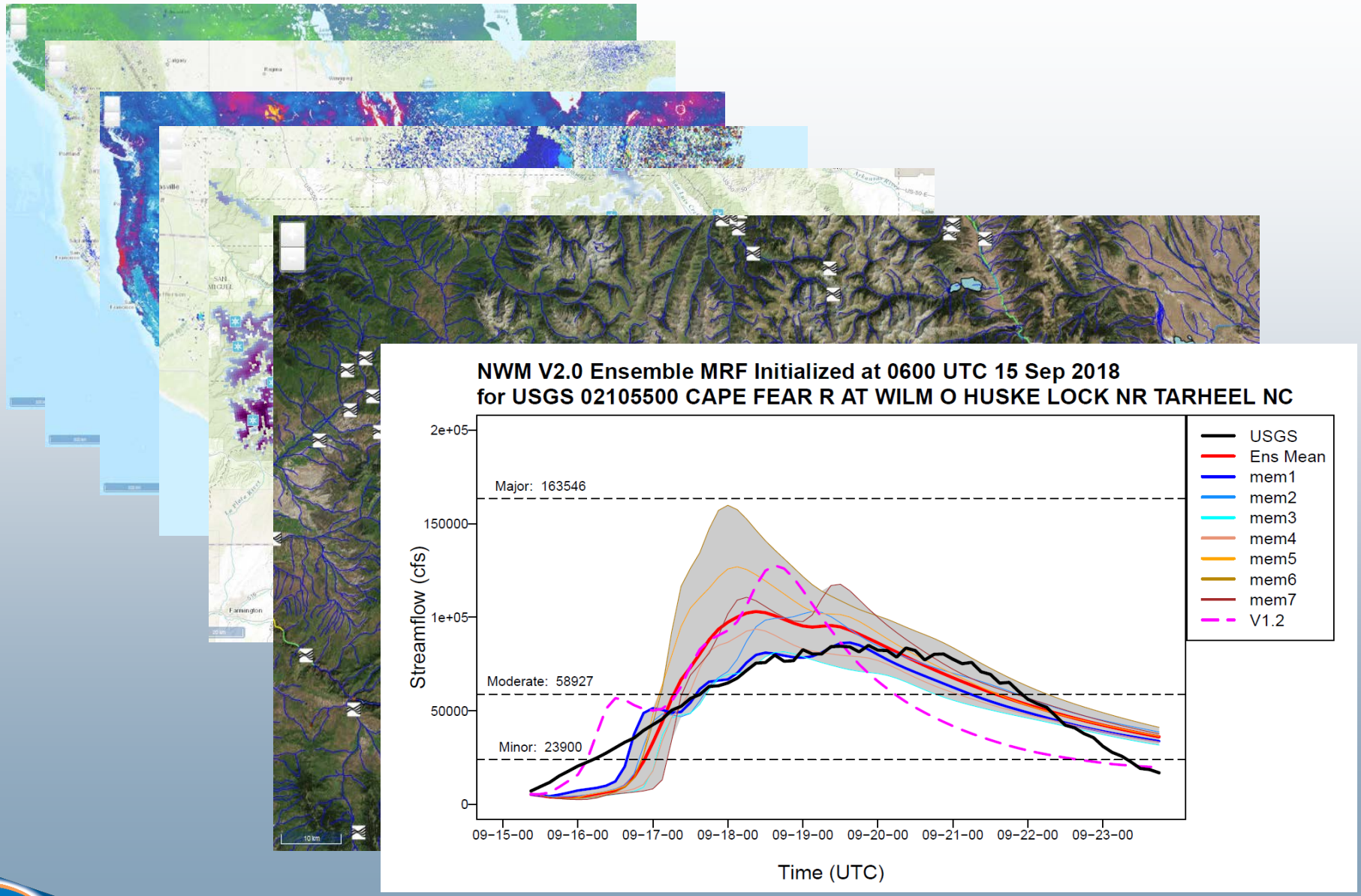
Model Outputs: Examples from the NWM

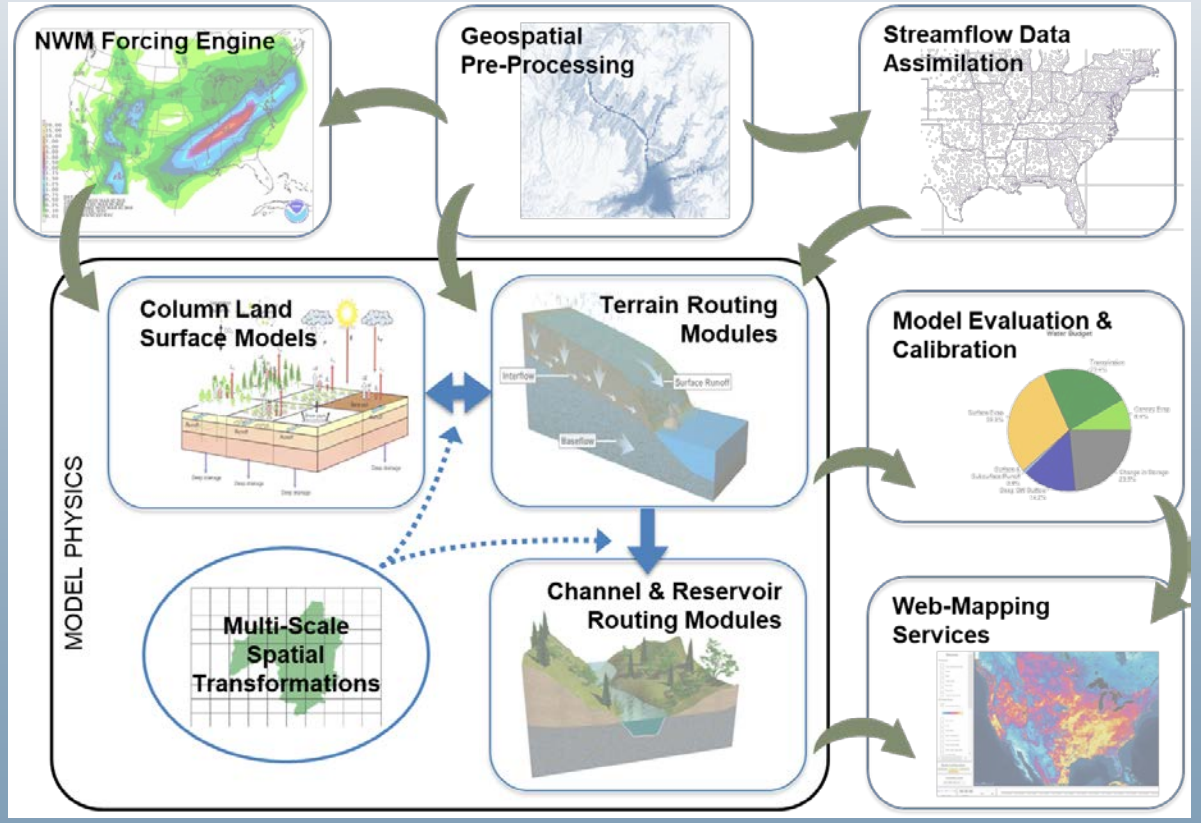


Ensemble streamflow predictions

WRF-Hydro Model Overview

- The National Water Model configuration of WRF-Hydro began operations in Aug. 2016 by NOAA NWS/OWP
- NWM configuration contains a set of physics options, model element/resolution selections and data processing algorithms *tailored for operational hydrologic prediction for the CONUS*

WRF-Hydro Model 'Ecosystem'



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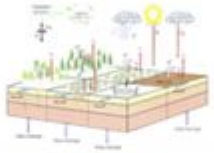
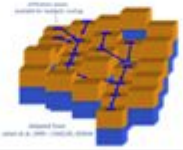
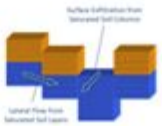
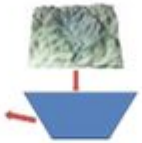
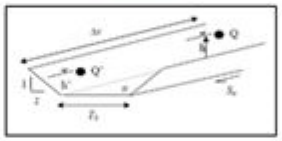
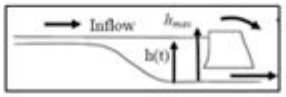
Model Overview

WRF-Hydro Physics Permutations

		WRF-Hydro Options	Current NWM Configuration
Column Land Surface Model		**3 Up-to-date Column Land Models**: Noah, NoahMP (w/ built-in multi-physics options) Sac-HTET	NoahMP
Overland Flow Module		**3 Surface routing schemes**: Diffusive wave Kinematic wave Direct basin aggregation	Diffusive wave
Shallow Lateral Subsurface Flow Module		**1 Subsurface routing scheme**: Boussinesq shallow saturated flow	Boussinesq shallow saturated flow
Deeper Groundwater Flow		**3 Groundwater schemes**: 2d aquifer model Direct aggregation storage-release: pass-through or exponential model	Exponential model
Channel Routing/ Hydraulics		**5 Channel flow schemes**: Diffusive wave, Kinematic wave, RAPID, Custom-network Muskingum Muskingum-Cunge	Custom-network (NHDPlus) Muskingum-Cunge model
Lake/Reservoir Management		**1 Lake routing scheme**: Level-pool management	Level-pool management

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Model Resources

https://ral.ucar.edu/projects/wrf_hydro

Resources: Website

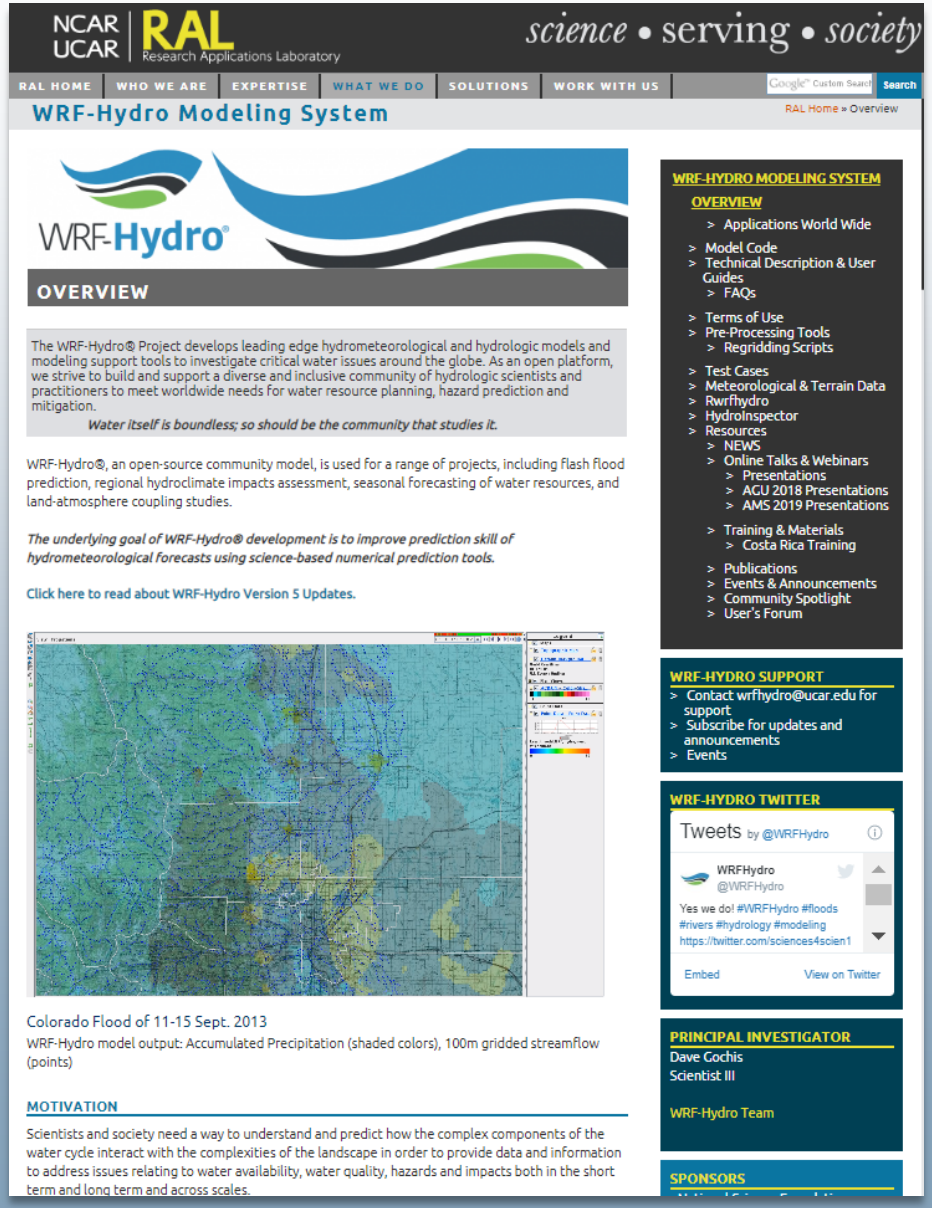
https://ral.ucar.edu/projects/wrf_hydro

One point of information for all things WRF-Hydro®

179,843 page views by
52 countries

Provides Access to:

- Model code (via GitHub, packaged releases & Docker containers)
- Processing Tools
- Support & Training Materials
- Presentations
- Publications
- Events
- Community Profiles



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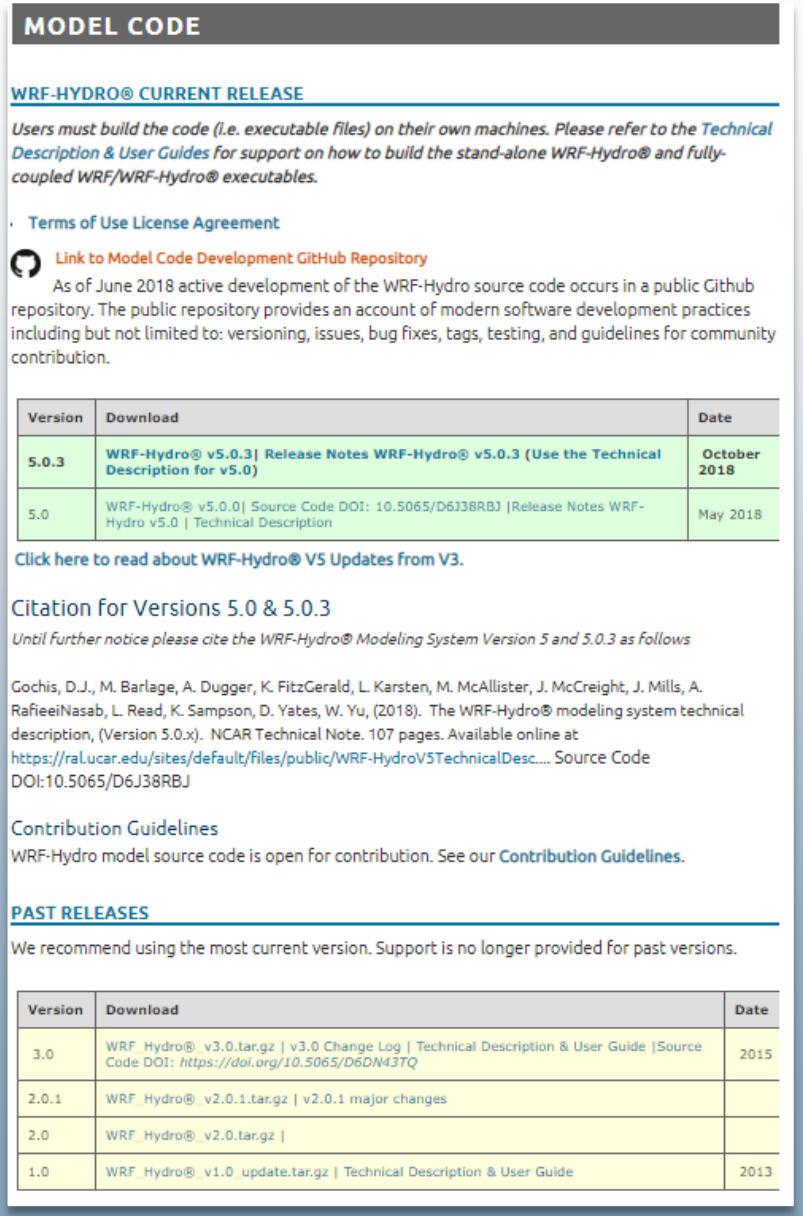
Resources: Model Code

https://ral.ucar.edu/projects/wrf_hydro/model-code



MODEL CODE

WRF-HYDRO® CURRENT RELEASE

Users must build the code (i.e. executable files) on their own machines. Please refer to the Technical Description & User Guides for support on how to build the stand-alone WRF-Hydro® and fully-coupled WRF/WRF-Hydro® executables.

- Terms of Use License Agreement

Link to Model Code Development GitHub Repository

As of June 2018 active development of the WRF-Hydro source code occurs in a public Github repository. The public repository provides an account of modern software development practices including but not limited to: versioning, issues, bug fixes, tags, testing, and guidelines for community contribution.

Version	Download	Date
5.0.3	WRF-Hydro® v5.0.3| Release Notes WRF-Hydro® v5.0.3 (Use the Technical Description for v5.0)	October 2018
5.0	WRF-Hydro® v5.0.0| Source Code DOI: 10.5065/D6J38RBJ |Release Notes WRF-Hydro v5.0 | Technical Description	May 2018

Click here to read about WRF-Hydro® V5 Updates from V3.

Citation for Versions 5.0 & 5.0.3

Until further notice please cite the WRF-Hydro® Modeling System Version 5 and 5.0.3 as follows

Gochis, D.J., M. Barlage, A. Dugger, K. FitzGerald, L. Karsten, M. McAllister, J. McCreight, J. Mills, A. RafieeiNasab, L. Read, K. Sampson, D. Yates, W. Yu, (2018). The WRF-Hydro® modeling system technical description, (Version 5.0.x). NCAR Technical Note. 107 pages. Available online at https://ral.ucar.edu/sites/default/files/public/WRF-HydroV5TechnicalDesc.... Source Code DOI:10.5065/D6J38RBJ

Contribution Guidelines

WRF-Hydro model source code is open for contribution. See our Contribution Guidelines.

PAST RELEASES

We recommend using the most current version. Support is no longer provided for past versions.

Version	Download	Date
3.0	WRF_Hydro®_v3.0.tar.gz | v3.0 Change Log | Technical Description & User Guide |Source Code DOI: *https://doi.org/10.5065/D6DN43TQ*	2015
2.0.1	WRF_Hydro®_v2.0.1.tar.gz | v2.0.1 major changes	
2.0	WRF_Hydro®_v2.0.tar.gz |	
1.0	WRF_Hydro®_v1.0_update.tar.gz | Technical Description & User Guide	2013

Publicly available since 2009

~2,000+ Downloads/Clones per Release (annually)

Public GitHub Repository:

https://github.com/NCAR/wrf_hydro_nwm_public/releases

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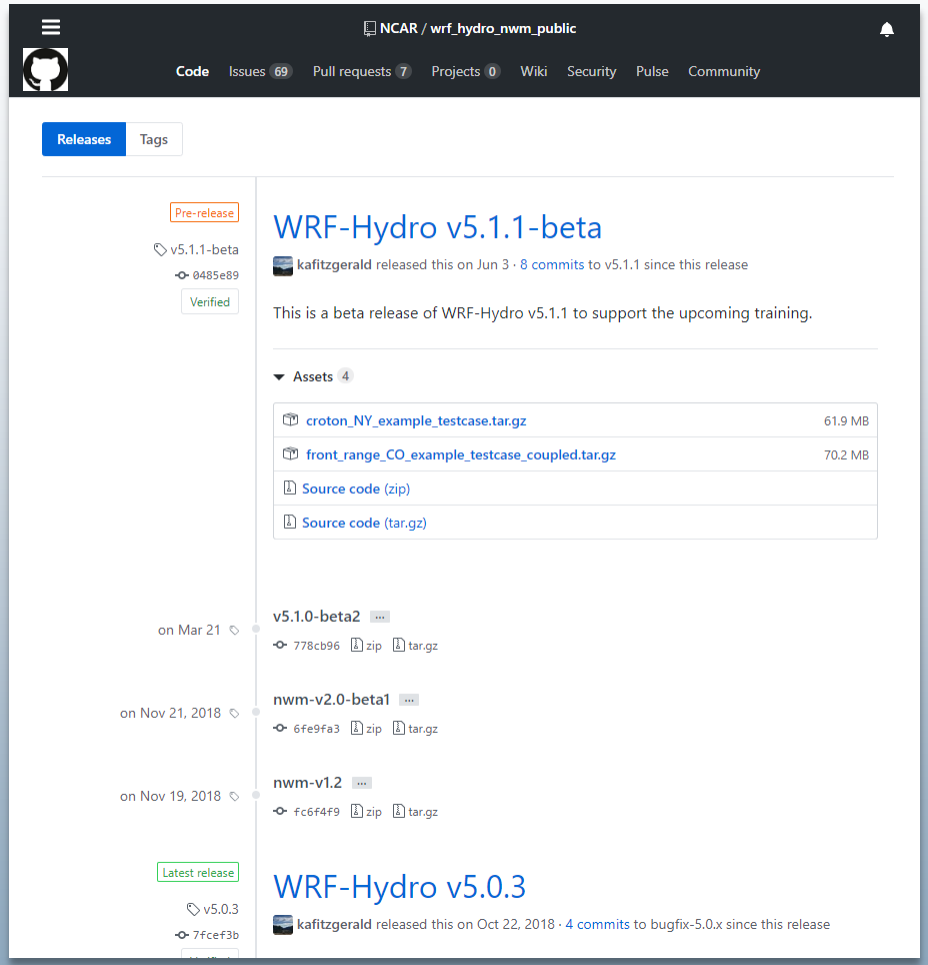
Resources: Model Code Development

https://github.com/NCAR/wrf_hydro_nwm_public/



- Public Github repository since June 2018 (migrated from internal svn repo)
- Complete & open view of active development
- Contribution guidelines mark-down document
- Code of conduct

Resources: Documentation

https://ral.ucar.edu/projects/wrf_hydro/technical-description-user-guide

TECHNICAL DESCRIPTION & USER GUIDES

TheWRF-Hydro V5 Technical Description describes the WRF-Hydro model architecture and physics options, released in May 2018. Please send feedback to wrfhydro@ucar.edu

Citation: Until further notice please cite the WRF-Hydro Modeling System V5 as follows

Gochis, D.J., M. Barlage, A. Dugger, K. FitzGerald, L. Karsten, M. McAllister, J. McCreight, J. Mills, A. RafieeiNasab, L. Read, K. Sampson, D. Yates, W. Yu, (2018). The WRF-Hydro modeling system technical description, (Version 5.0). NCAR Technical Note. 107 pages. Available online at https://ral.ucar.edu/sites/default/files/public/WRF-HydroV5TechnicalDesc.... Source Code DOI:10.5065/D6J38RBJ

Most documents listed in the table below can be viewed in a web browser or a PDF reader and have interactive tables of contents and bookmark navigation.

WRF-Hydro V5.0.x Documentation
WRF-Hydro V5 Technical Description
How To Build & Run WRF-Hydro in Standalone Mode
How To Build & Run WRF-Hydro V5 Coupled to WRF
Noah namelist.hrldas file with description of options for use with V5
Noah-MP namelist.hrldas file with description of options for use with V5
Noah-MP namelist Options Indicators of usage with WRFHydro v5/NWM
WRF-Hydro V5.0 hydro.namelist file with description of options
WRF-Hydro V5.0 Output Variable Matrix
WRF-Hydro V5 Standalone Test Case User Guide
Coupled WRF|WRF-Hydro V5 Test Case User Guide
Using Restart Files in WRF-Hydro Simulations
Documentacion WRF-Hydro V5.0 en Espanol
Descripción técnica del Sistema de modelado WRF-Hydro de NCAR
Cómo compilar y ejecutar WRF-Hydro V5 en modo autónomo
Guía del usuario de casos de prueba de WRF-Hydro V5
Matriz de variables de salida de WRF-Hydro V5
WRF-Hydro V3.0 Documentation
WRF-Hydro V3 Technical Description & User Guide
NoahMP namelist.hrldas with a Description of OptionsFor use with V3
V3 Input Variables
V3 Output Variables

Spanish Docs Released in 2018

FAQ Page viewed 2,515 times in 2 years

FAQS

FREQUENTLY ASKED QUESTIONS

- What is new in Version 5? +
- How should I cite versions of WRF-Hydro? +
- What are the software installation requirements? +
- Do you have an example installation set up? +
- Where should I start? & Best Practices –
  1. We suggest you begin by downloading the model code and follow the Techincal Description and User Guides.
  2. Build the model and run a provided Test Case with 'idealized' forcing to assure that your set up is correct. The test case packages provide all the needed input data required for running the model over a small to moderate domain.
  3. Then run the test case with one of the configurations available and compare your model output with the output files provided.
  4. Next create customized geographical inputs and forcing data
  5. Run the model with your customized geographical inputs, the land surface model only, and idealized forcing
  6. Run the model with your customized geographical inputs, the land surface model only, and your forcing data
  7. Run the model with your customized geographical inputs, your forcing data, and minimal routing physics. Turn physics options on one at a time starting with 1. SFc/subsfc 2. GW/baseflow 3. Channel flow 4. Reservoirs
  8. Once you finalize your configuration you can then move on to a full model simulation.
- What is the workflow for creating inputs to work with WRF-Hydro in standalone mode? +
- Can I use my Version 3 inputs with Version 5 code? +
- Why NoahMP vs. Noah? +
- How can I report a bug or contribute to the model code? +
- What is the configuration of the National Water Model? +
- Where can I find NWM v1.2 Retrospective Data? +
- Which NWM Data are available through Amazon Web Services? +
- Why am I getting a "NETCDF path is not defined" error message upon set up? +

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Resources: Tools & Test Cases

https://ral.ucar.edu/projects/wrf_hydro/pre-processing-tools

PRE-PROCESSING TOOLS

PRE-PROCESSING UTILITY SCRIPTS

Below are utility scripts that are useful in pre-processing data for input into WRF-Hydro.

- create_wrfinput.R: An R script to create a very basic WRF-Hydro initialization file (wrfinput) from a WRF geogrid file and a set of user-specified conditions. The script produces fields of spatially uniform initial model states of soil moisture, soil temperature, soil liquid water content and skin temperature among a few other variables necessary for model cold-start initialization. The script uses NCO commands to create this file. **This file can be used as a 'cold start' for long-term model spin-up or users can overwrite the fields in the file created.** Please refer to the script header for specific use information. Sophisticated and WRF-savvy users can bypass this script and use the WRF utility REAL.EXE to create a wrfinput file from model or reanalysis products. **Note:** This script does not currently work with the Noah LSM. This script works with both WRF-Hydro V3 and V5.0.x.
- create_soilproperties.r (for use with v5.0.x model code): An R script developed for the purpose of creating **OPTIONAL** spatially distributed soil and vegetation parameter files for Noah-MP and WRF-Hydro Version 5.0. These are read from the provided parameter tables (e.g., MPTABLE.TBL, HYDRO.TBL, etc.) and mapped to the appropriate soil or vegetation class map to create the 2D and 3D fields. These default parameter values can now be manipulated in 2 and 3 dimensions (e.g., via model calibration). After creating this file, use the compile option "SPATIAL_SOIL =1" to activate it, and specify the file in the namelist.hrldas. If the spatial soil option is turned off, the code will default to using the traditional TBL files and this file is not required. Please refer to the script header for specific use information.
- create_SoilProperties.R (for use with upcoming v5.1 model code): An R script developed for the purpose of creating **OPTIONAL** spatially distributed soil and vegetation parameter files for Noah-MP and WRF-Hydro Version 5.0. These are read from the provided parameter tables (e.g., MPTABLE.TBL, HYDRO.TBL, etc.) and mapped to the appropriate soil or vegetation class map to create the 2D and 3D fields. These default parameter values can now be manipulated in 2 and 3 dimensions (e.g., via model calibration). After creating this file, use the compile option "SPATIAL_SOIL =1" to activate it, and specify the file in the namelist.hrldas. If the spatial soil option is turned off, the code will default to using the traditional TBL files and this file is not required. Please refer to the script header for specific use information. **Note:** MPTABLE.TBL files from versions of WRF-Hydro 5.0.x and earlier will likely break the script. Get an updated MPTABLE.TBL file here. However, the new output files should work with both versions of the model code.
- convert_LAKEPARM_to_V5.sh: The v5.0 release version of the WRF-Hydro model code has modifications to several variable names in the LAKEPARM.nc file. This shell script will update these variables from an older (pre v5.0) version of the LAKEPARM.nc file.

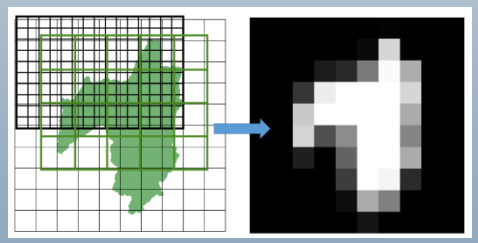
ARC-GIS TOOLS FOR PREPARING WRF-HYDRO ROUTING GRIDS

To help WRF-Hydro users create surface input data for WRF-Hydro we have created a set of tools. Presently these tools consist of scripts for use with the ArcGIS Geographical Information System. This is a stand-alone set of scripts which ArcGIS users can install and run locally on their own systems. ArcGIS is a commercial software product available from ESRI.

The purpose of the WRF Hydro GIS Pre-Processing Toolkit is to create the data layers for terrestrial overland flow, subsurface flow and channel routing processes required by WRF Hydro. The outputs from these tools are geospatial and tabular data layers for use with WRF-Hydro model code V5.1.x. This processing workflow for creating WRF-Hydro routing grids is available to users as an ArcGIS Python Toolbox.

- WRF-Hydro GIS Pre-processing Toolkit v5.1 (1.79MB) for use with ArcGIS v10.3.1-10.7 and ArcGIS Pro 2.3.
  Updates in this version include the ability to put forecast points on a vector nextwork. The output from this version are backwards compatible with WRF-Hydro model code back to v5.0.
- WRF-Hydro_GIS_Pre-processing Toolkit_v5.1.pdf Documentation
- WRF-Hydro GIS Pre-processing Toolkit Github Repository

The input files created by this toolkit should not be deemed as definitive and accurate for every application. Preparation of hydrologic network data (such as channel networks and station data) is inherently an iterative process fraught with geospatial data uncertainties. Therefore we encourage users to closely examine the outputs from the tools provided here and make their own necessary adjustments.



https://ral.ucar.edu/projects/wrf_hydro/testcases

TEST CASES

Example Test Cases include prepared geospatial data, input files, configured namelists **, and forcing data for sample regions (domains). They can be used to test your model build as well as to explore model configurations.**

Version 5.0.3 Test Cases

WRF-Hydro V5 Test Case User Guide

Croton New York Test Case (for use with v 5.0.3): This example test case includes a small region (15km by 16km) encompassing the West Branch of the Croton River, NY, USA (USGS stream gage 0137462010) during hurricane Irene, 2011-08-26 to 2011-09-02. The simulation begins with a restart from a spinup period from 2010-10-01 to 2011-08-26. There are 3 basic routing configurations included in the test case, National Water Model (NWM), Gridded, and NCAR Reach.

Coupled WRF|WRF-Hydro V5 Test Case User Guide

Colorado Front Range Coupled Test Case (for use with v5.0.3): This is a test case for the coupled WRF | WRF-Hydro modeling system. It includes prepared namelists for all model components, domain and parameter files generated from the WRF-Hydro GIS preprocessing tools, and data to be used as initial and boundary conditions for the simulations period. This test case was developed with the intent for it to be able to be run on relatively small (e.g. desktop) systems for instructional purposes and used as a tool to ensure that the coupled modeling system is functioning properly. In this test case, two nested model domains (with hydro components operating on the inner domain) extend over a portion of the Colorado Front Range influenced by a large flood event in 2013. Initial and boundary conditions for the simulation are prescribed from the NAM forecast. Users should be aware that modifications have been made to the model configuration and initial conditions in order to produce a hydrologic response over a relatively small geographic domain and period of interest. Therefore namelists should not be referenced as an example of best practices for domain configuration and model physics selection. Likewise, the simulation results should not be evaluated as a real simulation.

Version 3.0 Test Cases

Support is limited for version 3 example test cases.

Boulder Creek Test Case: Example test case for a single small watershed (Boulder Creek, Colorado) using idealized forcing in standalone mode. This test case shows examples of the Noah and NoahMP LSMs driven by idealized forcing (FORC_TYP = 4). No external forcing datasets are provided or required for this test case.

Front Range Test Case: Example test case for stand-alone/uncoupled WRF-Hydro run with either the Noah or NoahMP land surface models. This test case covers the Colorado Front Range region. The Noah and NoahMP LSMs are configured on a dx=1km grid and the routing grid is configured with dx=100m. Input forcing data for this WRF-Hydro run is provided in both standard, preprocessed input format (i.e. 'LDASIN' files - FORC_TYP = 1) or in native (unmanipulated) wrf model output (i.e. 'wrfout' files - FORC_TYP = 3) in netcdf format. [Note that the time window of the different forcing data is different so users need to edit the namelists to reflect those different run times.] Users should consult the Version 3 Technical Description and User Gudie for more specific descriptions of

Standalone Testcase – Gridded, NWM

Coupled Testcase - Gridded

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Resources: Online Training Materials

https://ral.ucar.edu/projects/wrf_hydro/training-materials

TRAINING & MATERIALS

HANDS-ON TRAINING MATERIALS:

The Community WRF-Hydro Modeling System
October 2019 Training Workshop Materials

Presentations:

WRF-Hydro System Overview
WRF-Hydro System Conceptualization
WRF-Hydro Physics Components Overview
Noah-MP Column Land Surface Model Overview
Channel Routing and Lakes/Reservoirs in WRF-Hydro
Defining the Model Domain & Initial Conditions
WRF-Hydro GIS Pre-processing Tool Overview
WRF-Hydro Forcing Engine Overview
Overview of WRF-Hydro/NWM Calibration
WRF-Hydro Coupling with the Weather Research and Forecasting model (WRF)
WRF-Hydro Implementation & Best Practices

Click here to Access the WRF-Hydro GIS Pre-processing Tool version 5 Tutorial Demo.

This demo walks through the process of creating WRF-Hydro hydrologic routing input for the Croton New York example test case.

Requirements for Online Utilities and Lessons:

Docker (Community) = > v.17.12 (currently we use 2.1.0.3)
Web browser (Google Chrome recommended) for accessing the Jupyter notebooks/Jupyter Lab.
Note: Each machine is different. You will need to alternate your Docker settings such as CPUs, Memory, and Disk Space allocations according to your machine to optimize runtime. If you find a bug or other technical issue please log it on the github issues site

- **Click Here to Access WRF-Hydro Standalone Test Case Online Lessons**

  Lessons walk you through model compiliation and various model simulations with different configurations.
  Click Here to download a .zip file of the completed lessons for reference

- **Click Here to Access the WPS Geogrid and WRFinput Preprocessing Training Utility for CONUS**

  Click Here for the completed WPS lesson html file for reference

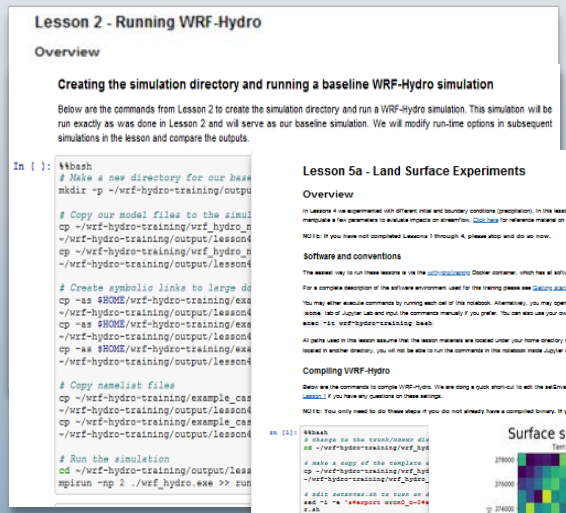
- **Freetime Standalone Exercise Resources:**
  Click Here to Access Freetime Exercises Reference Sheet
  Solutions to the Freetime Standalone Exercises:
  Post Fire Simulation Exercise Solutions
  Precipitation Uncertainty Exercise Solutions
  Initial Soil Moisture State Sensitivity Exercise Solutions

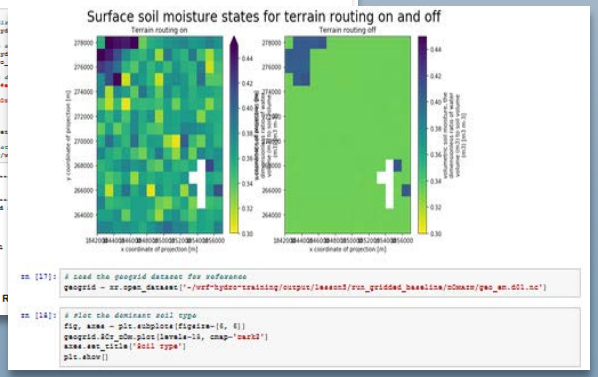
- **Click Here to Access the WRF|WRF-Hydro Coupled Test Case Online Lesson**

  Click Here for the HTML file of the completed WRF|WRF-Hydro Coupled Test Case Online Lesson

YouTube Video Viewed
1,600 times in 1 year

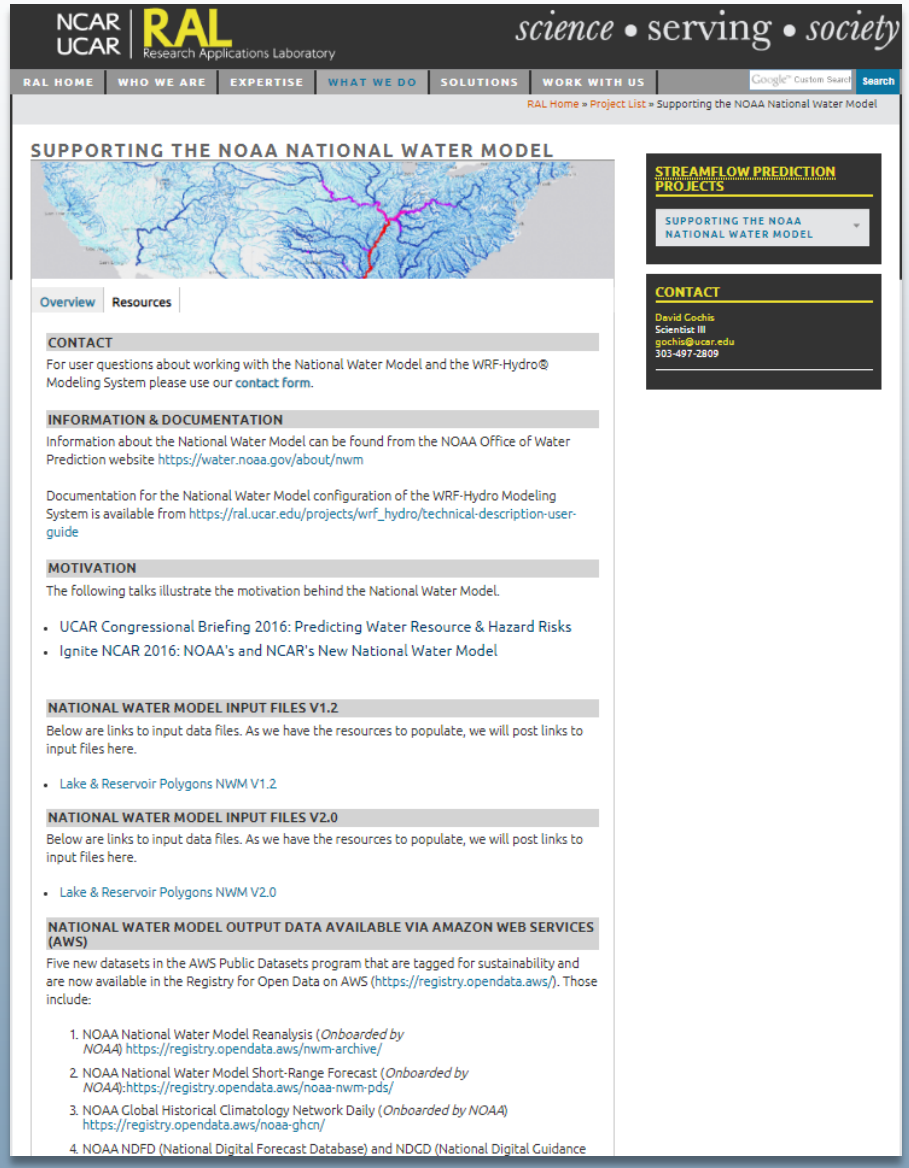
Training Containers Downloaded
1,800 times in 1 year





Resources: NWM Configuration

https://ral.ucar.edu/projects/supporting-the-noaa-national-water-model



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SUPPORTING THE NOAA NATIONAL WATER MODEL

Overview | Resources

CONTACT

For user questions about working with the National Water Model and the WRF-Hydro® Modeling System please use our contact form.

INFORMATION & DOCUMENTATION

Information about the National Water Model can be found from the NOAA Office of Water Prediction website https://water.noaa.gov/about/nwm

Documentation for the National Water Model configuration of the WRF-Hydro Modeling System is available from https://ral.ucar.edu/projects/wrf_hydro/technical-description-user-guide

MOTIVATION

The following talks illustrate the motivation behind the National Water Model.

- UCAR Congressional Briefing 2016: Predicting Water Resource & Hazard Risks
- Ignite NCAR 2016: NOAA's and NCAR's New National Water Model

NATIONAL WATER MODEL INPUT FILES V1.2

Below are links to input data files. As we have the resources to populate, we will post links to input files here.

- Lake & Reservoir Polygons NWM V1.2

NATIONAL WATER MODEL INPUT FILES V2.0

Below are links to input data files. As we have the resources to populate, we will post links to input files here.

- Lake & Reservoir Polygons NWM V2.0

NATIONAL WATER MODEL OUTPUT DATA AVAILABLE VIA AMAZON WEB SERVICES (AWS)

Five new datasets in the AWS Public Datasets program that are tagged for sustainability and are now available in the Registry for Open Data on AWS (https://registry.opendata.aws/). Those include:

1. NOAA National Water Model Reanalysis (*Onboarded by NOAA*) https://registry.opendata.aws/nwm-archive/
2. NOAA National Water Model Short-Range Forecast (*Onboarded by NOAA*):https://registry.opendata.aws/noaa-nwm-pds/
3. NOAA Global Historical Climatology Network Daily (*Onboarded by NOAA*) https://registry.opendata.aws/noaa-ghcn/
4. NOAA NDFD (National Digital Forecast Database) and NDGD (National Digital Guidance

STREAMFLOW PREDICTION PROJECTS

SUPPORTING THE NOAA NATIONAL WATER MODEL

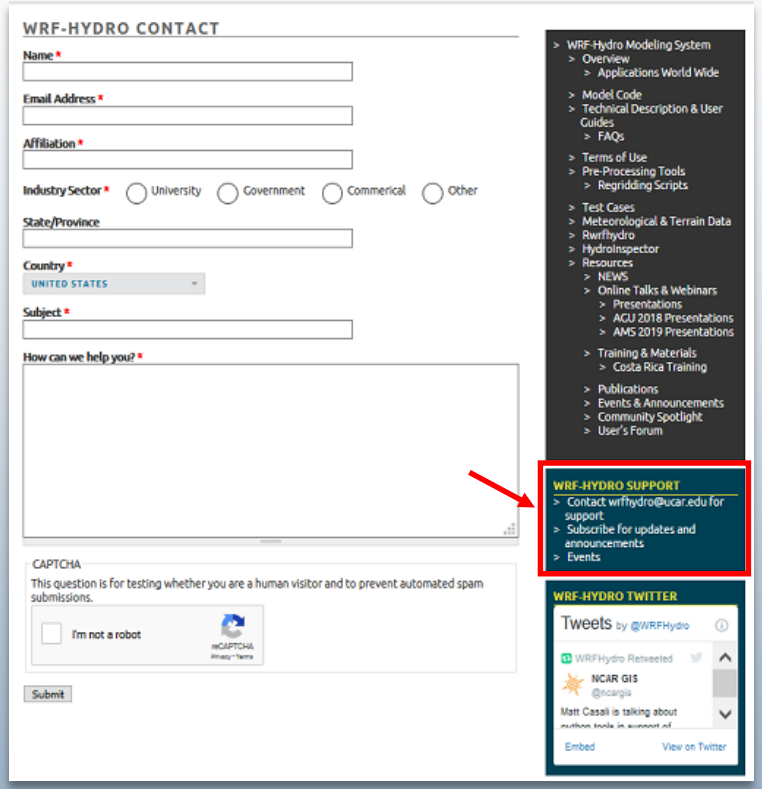
CONTACT

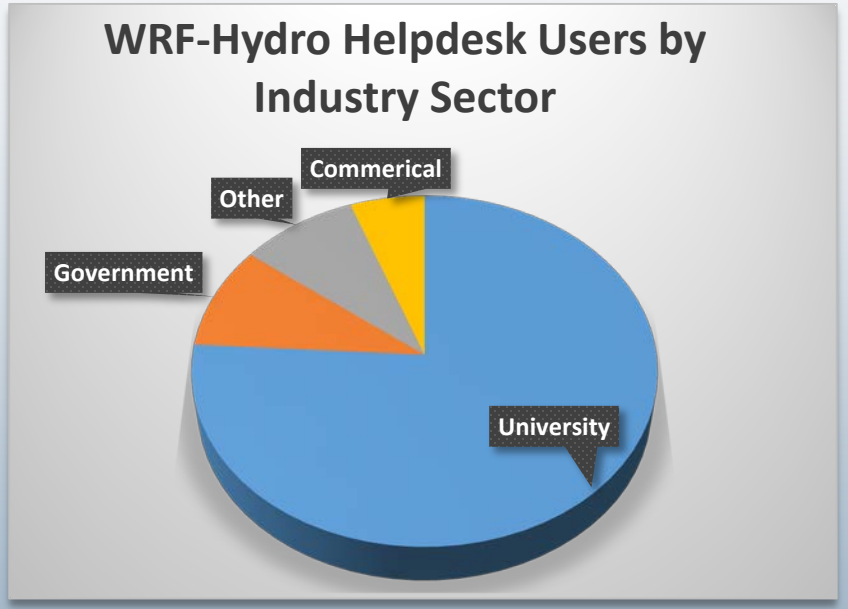
David Gochis
Scientist III
gochis@ucar.edu
303-497-2809

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Support: Helpdesk & Forum

https://ral.ucar.edu/projects/wrf_hydro/contact





Support: User's Forum

http://bit.ly/wrfhydrousersforum

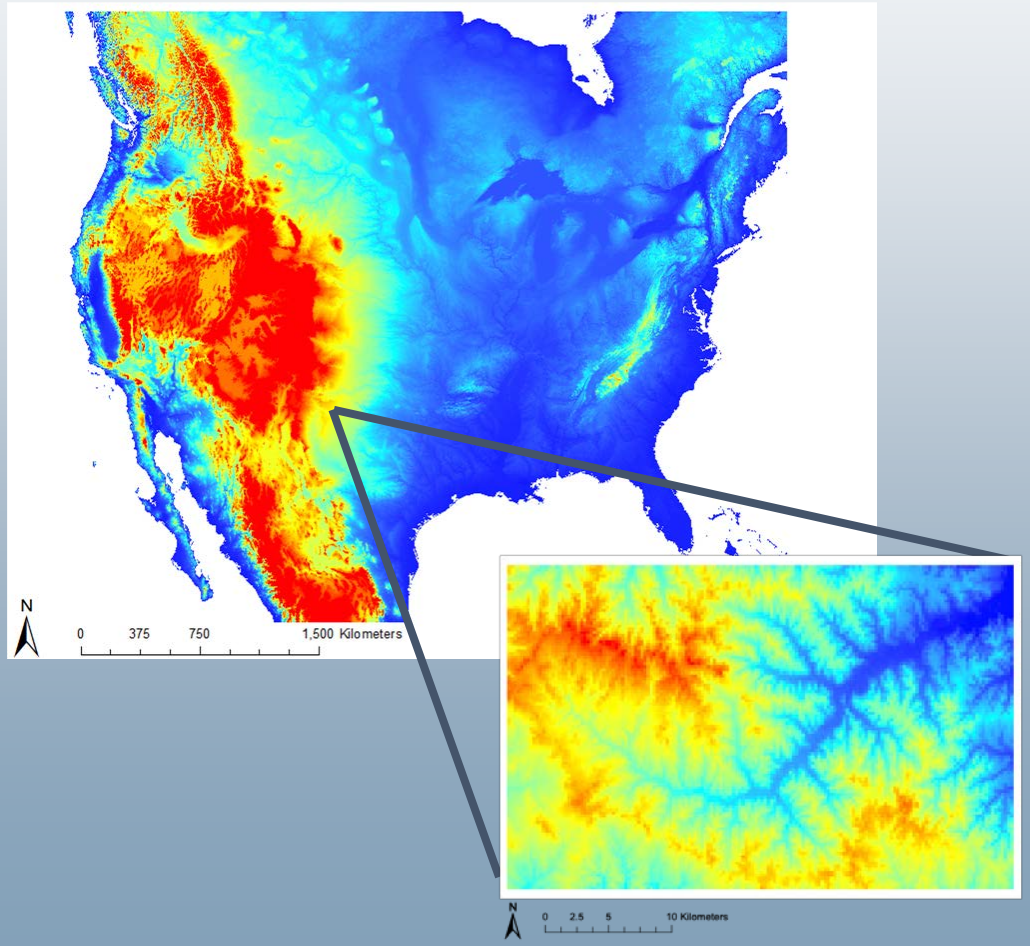
Users Helping Users

NCAR

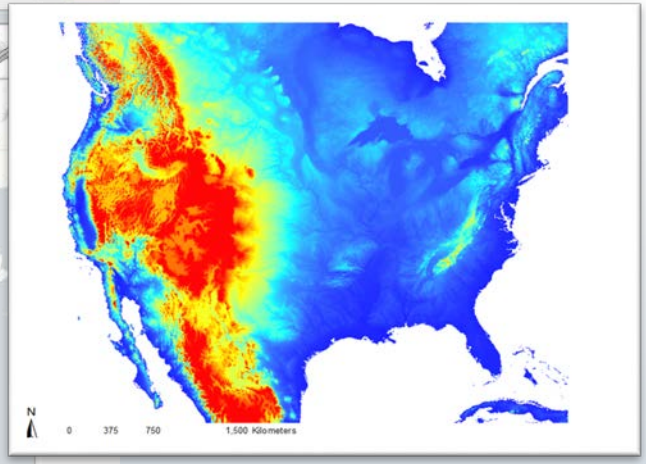
CUAHSI Subsetter

Improve community access to CONUS-scale model domains

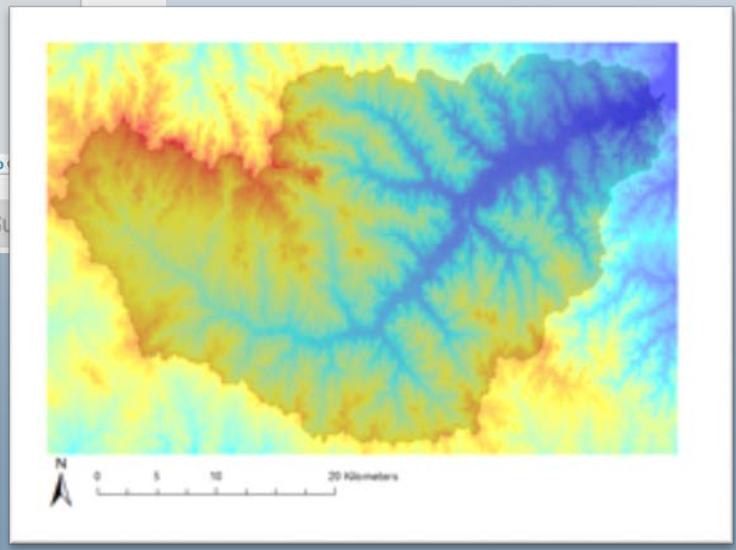
- Watershed scale data access
- Research and education
- Support multiple models



Subsetter: Web Application



(4608 km, 3840 km)
~ 30 Gb



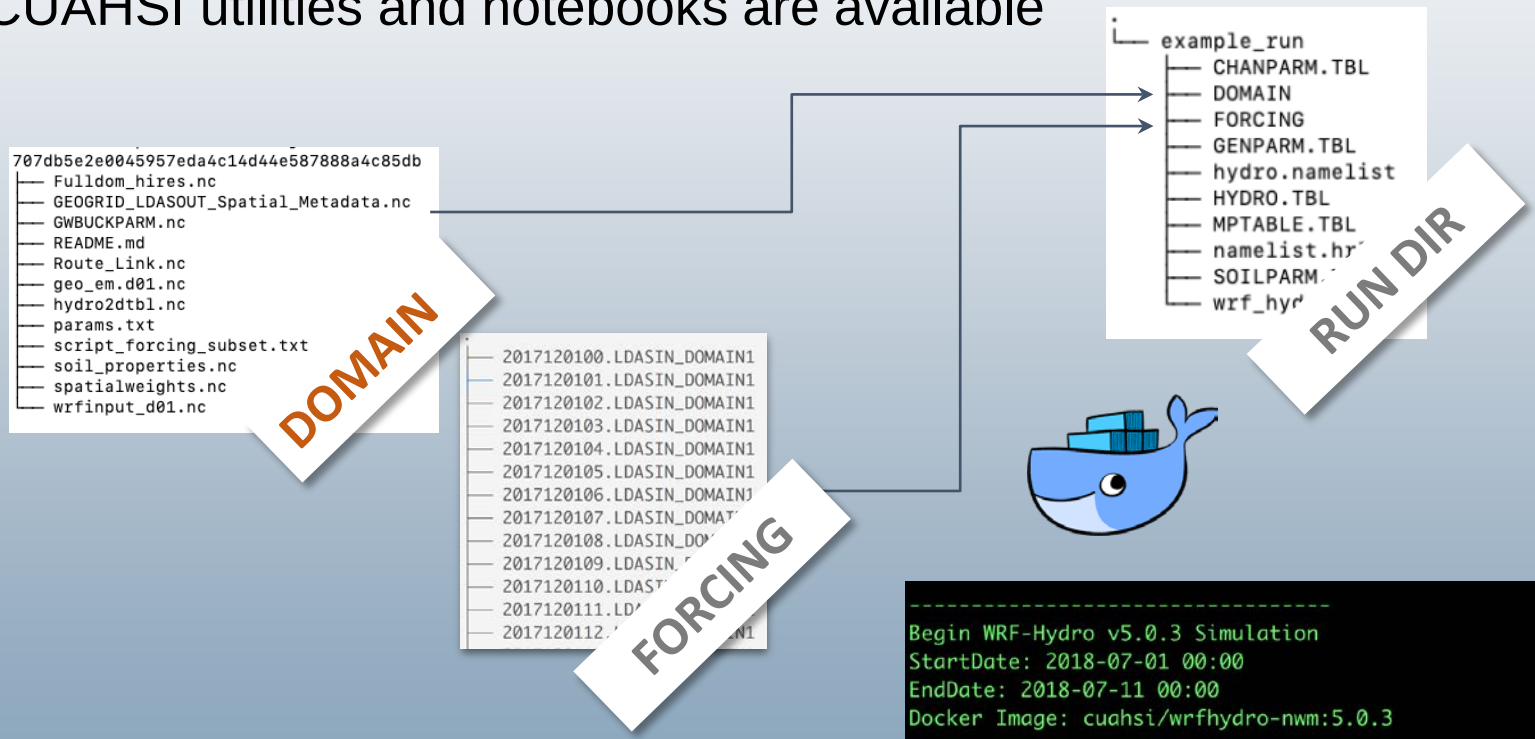
(160 km, 104 km)
~ 70 Mb

```
/07db5e2e0045957eda4c14d44e587888a4c85db
├── Fulldom_hires.nc
├── GEOGRID_LDASOUT_Spatial_Metadata.nc
├── GWBUCKPARM.nc
├── README.md
├── Route_Link.nc
├── geo_em.d01.nc
├── hydro2dtbl.nc
├── params.txt
├── script_forcing_subset.txt
├── soil_properties.nc
├── spatialweights.nc
└── wrfinput_d01.nc
```

http://subset.cuahsi.org

NWM Subsetter: Running a Simulation

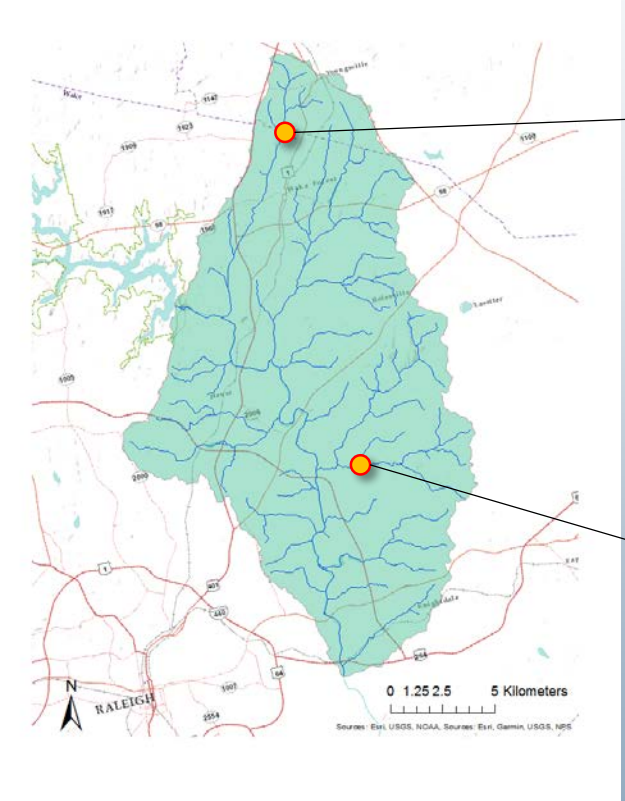
- Provides static domain data
- Requires gridded FORCING data, e.g. NLDAS
- Executed using https://github.com/NCAR/wrf_hydro_nwm_public
- CUAHSI utilities and notebooks are available

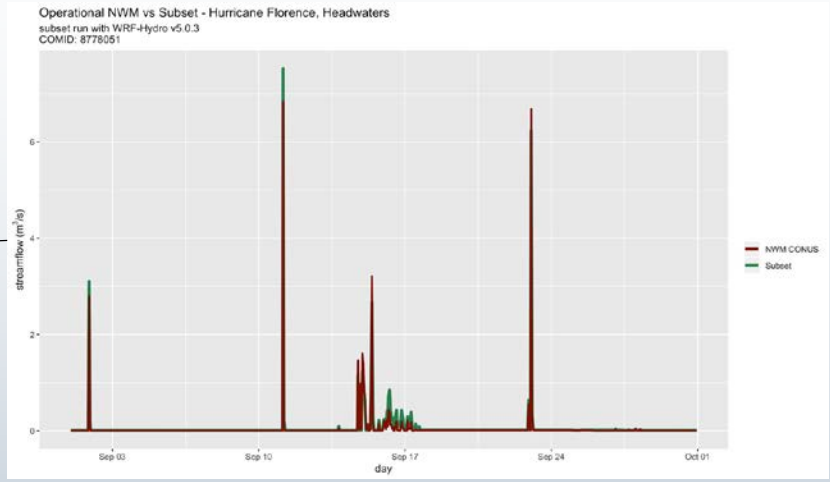


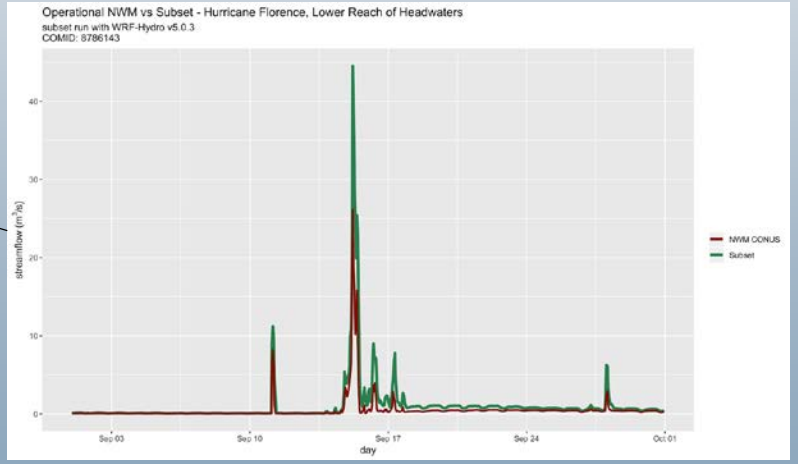

```
---------------------------------
Begin WRF-Hydro v5.0.3 Simulation
StartDate: 2018-07-01 00:00
EndDate: 2018-07-11 00:00
Docker Image: cuahsi/wrfhydro-nwm:5.0.3
---------------------------------

Running Simulation
[#------------------] 7.00% - Simulation Time: 2018-07-01 17:00
```

NWM Subsetter: Caveats

Headwater Reaches





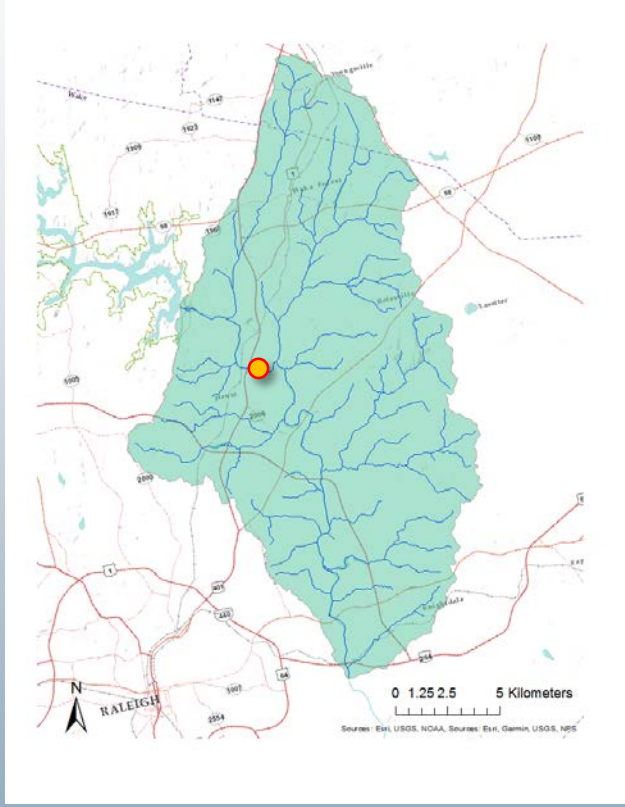


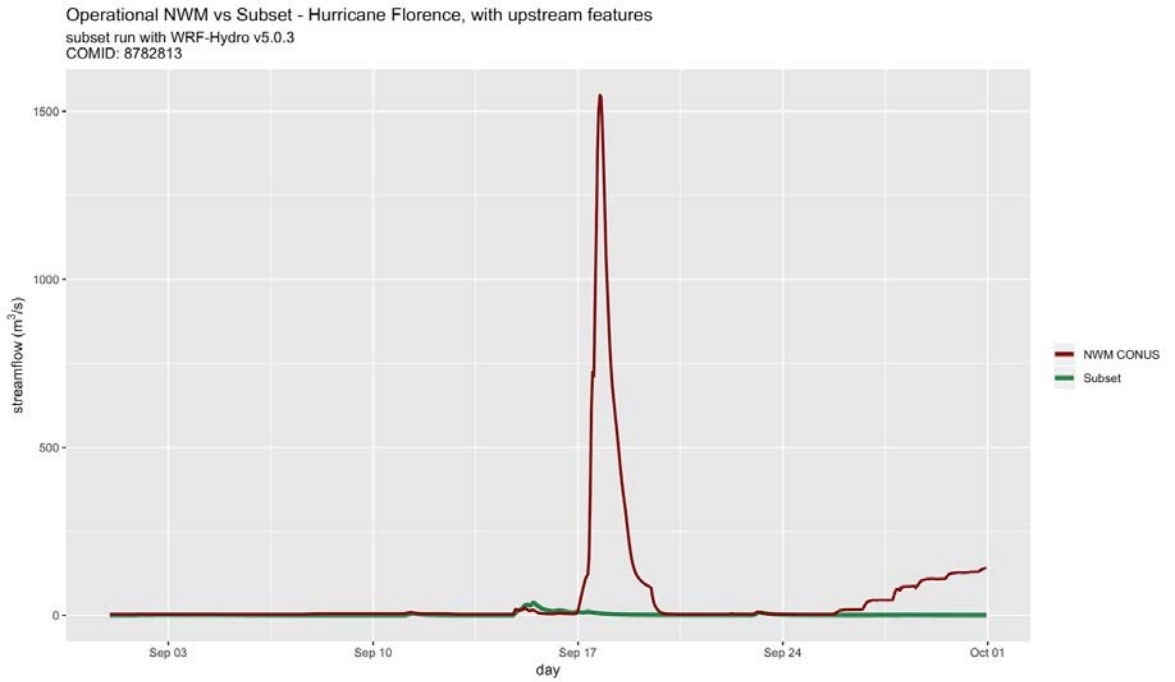
Expect differences in operational results and subset results caused by: No lakes and reservoirs*, nudging, or, restarts.

*a decision made by the NWS Office of Water Prediction

NWM Subsetter: Caveats

Partial Mainstem





USER BEWARE: There are NO checks to ensure that the entire upstream watershed has been subset!

NWM Subsetter: Notebook Resources

CUAHSI Domain Subsetter Workflow - NWM

Open with...

Authors: Danielle Tijerina | Anthony Michael Castronova
Sharing Status: Private
Owners: Anthony Michael Castronova | Danielle Tijerina
Views: 30
Resource type: Composite Re
Storage: The size of thi
Created: Jun 18, 2019
Last updated: Jun 20, 2019
Castronova
Citation: See how to cit

Abstract

The purpose of this resource is
(subset.cuahsi.org) introduces
watershed scales. Our hope is t
scientists from a diverse spectr
tools, researchers will have acc
resources. This work provides t

Subsetting the National Water Model Domain

Authors: Tony Castronova acastronova@cuahsi.org
Danielle Tijerina dtijerina@cuahsi.org
Date Modified: 06/20/2019
Affiliation: CUAHSI

1. Objective

This notebook will walk you through the pr
Model Hydro-Fabric for an area of interest
This will include:

1. going to subset.cuahsi.org
2. selecting location of interest and reque
3. downloading data via wget
4. inspecting the content

2. Background

The purpose of this application is to introdu
sharing subsets of the National Water Mod
hope is that these efforts will lower the bar
engage a wide variety scientists from a div
modern cyberinfrastructure techniques and
have access to subsets of National Water
computational resources. This work provid
applied to other large-scale model simulati

3. Subsetting Exercise

In [ ]:
```
# import Python libraries

import os
import wget
import glob
import shutil
import tarfile
```

Collect NLDAS Forcing Data

This notebook demonstrates the process of collecting NLDAS forcing data, regri
onto an existing WRF-Hydro (domain collected in the previous notebook).

1. Objective

This notebook illustrates the process of collecting and regridding NLDAS data fo
domain. This include:

1. Subsetting NLDAS data from Earthdata.nasa.gov
2. Downloading NLDAS data
3. Regridding NLDAS using the ESMF regridding scripts

In [ ]:
```
import os
import sys
import wget
import time
import glob
import shutil
import tarfile
import getpass
import urllib.parse as p
import multiprocessing as mp
from urllib.request import urlopen
from subprocess import Popen, PIPE, STDOUT, check_output, Ca
```

Make sure that the NCAR Command Language is installed. Detailed instructions
This following cell will install `ncl` into your conda environment if it doesn't alrea

In [ ]:
```
# make sure we invoke the NCL that is installed in our conda
ncl_exec = os.path.join(os.path.dirname(sys.executable), 'nc
try:
    output = check_output([ncl_exec, '-V'])
    print('NCL is already installed :)')
except Exception as e:
    !conda install -y ncl
```

Running a WRF-Hydro Simulation

This notebook demonstrates how to executed the WRF-Hydro model using the `DOMAIN` and `FORCING` data collected in the two previous notebooks. We'll be using a containerization technology called Docker to simplify this process and eliminate the need for compiling any source code.

> Docker is a tool designed to make it easier to create, deploy, and run applications by using containers. Containers allow a developer to package up an application with all of the parts it needs, such as libraries and other dependencies, and ship it all out as one package. By doing so, thanks to the container, the developer can rest assured that the application will run on any other Linux machine regardless of any customized settings that machine might have that could differ from the machine used for writing and testing the code.

Please see the following link for further description of Docker:
https://opensource.com/resources/what-docker

Before we begin, we need to make sure that Docker is installed on your computer. If you're unsure if Docker is already installed on your computer, open a terminal and type `docker -v`. If it's installed, you should see output similar to: `Docker version 18.09.2, build 6247962`.

Install Docker by following the instructions at this link.

In [ ]:
```
# verify the docker is installed and running
!docker -v
```

Next, let pull a precompiled version of WRF-Hydro onto our computer. This image is a slight variation from the standard NCAR WRF-Hydro image specifically designed to work with the `DOMAIN` data you prepared in the first notebook.

In [ ]:
```
!docker pull cuahsi/wrfhydro-nwm:5.0.3
```

Make a directory for our simulation output.

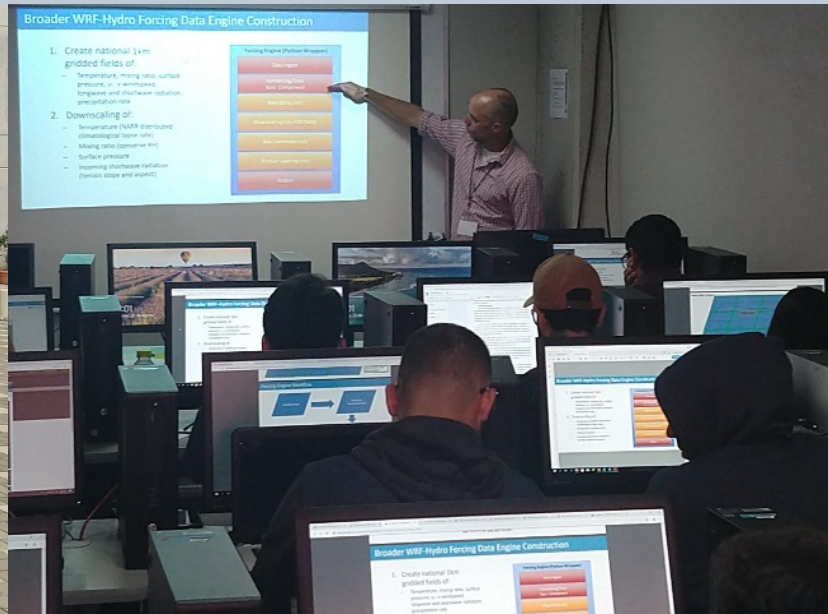
In [ ]:
```
!mkdir ./OUTPUT
```

Hands-On Training: Workshops

- Taught by subject matter experts
- Provide in depth & individual support
- Face to face networking

- 2 International since 2014
- 3 NWM Federal Agency since 2017

https://ral.ucar.edu/projects/wrf_hydro/events



Hands-On Training: Workshops

- 7 Co-Sponsored with CUAHSI since 2015 (2 x Year)
- Application process began in 2018
- Out of 548 applicants – have served 302

Hands-On Training: Workshops

Next NCAR-CUAHSI Workshop:

- June 1-5, 2020
- Applications open in January
- Travel support available for graduate students

More information: cuahsi.org/education/training

Hands-on Training:
Summer Institute at the National Water Center

- Partnership between CUAHSI and the National Weather Service
- Seven-week residential program at the National Water Center in Tuscaloosa, Alabama
- Eligibility: MS and PhD students enrolled in US universities
- 147 students from 77 universities have been trained on the National Water Model since 2015
- National Water Model developed from WRF-Hydro®
- Described as a “transformational educational experience”
- **Students: Apply by January 13, 2020**

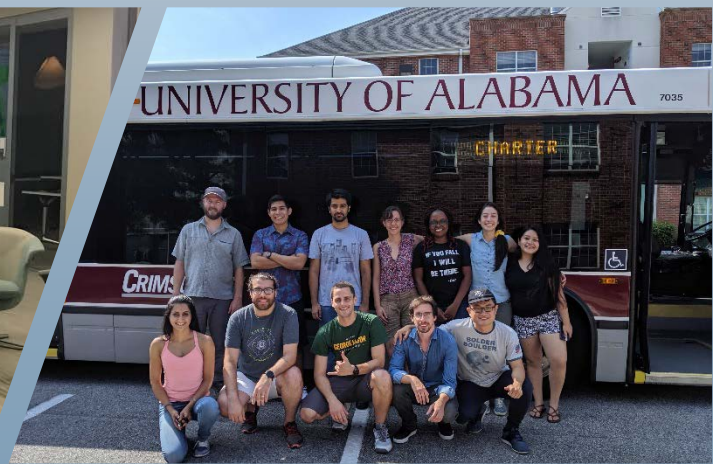
cuahsi.org/education/summerinstitute

Upcoming Summer Institute Overview Webinar

Wednesday November 20th 2:00 pm EST

Fred Ogden, Visiting Senior Scientist, National Water Center, NOAA/NWS/Office of Water Prediction

Connection information: cuahsi.org/education/summerinstitute

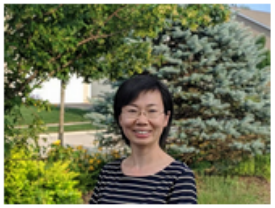


Community: Spotlight

Highlighting Users, their research, and their contribution to the WRF-Hydro Community.

WRF-Hydro®

COMMUNITY SPOTLIGHT



This Community Spotlight focuses on Dr. Jiali Wang and her work on the AT&T climate resiliency study for which she was the primary modeler using WRF-Hydro® and WRF.
>Read the White Paper here<

See our **>NEWS page<** for links to the NPR Science Friday podcast.

Dr. Jiali Wang is currently an Assistant Atmospheric Scientist in the Environmental Science Division at Argonne National Laboratory. Below is a Q&A with Dr. Wang about her background, experience on the project, and experience with using WRF-Hydro®.

What I have learned from this project is how to effectively transfer the massive dataset to much less amount yet the most important and useful information for the industry partners.

Q: What initially excited you about modeling as your chosen area of study?

A: Numerical modeling is very powerful, although it is not perfect. Using modeling can explore questions that observation data can not do. During my Phd, I investigated urbanization impact on climate (temp; precip) over mega-cities like Beijing. During my postdoc, I investigated global climate warming impact on local weather and climate extremes. For the AT&T project, we look at the global climate change impact on water cycles and wind gust and coastal flooding. Moreover, with the increased size of datasets generated by modeling, there are great opportunities to explore potentials of AI (artificial intelligence). These topics are all exciting to me.

NCAR

https://ral.ucar.edu/projects/wrf_hydro/communityspotlight

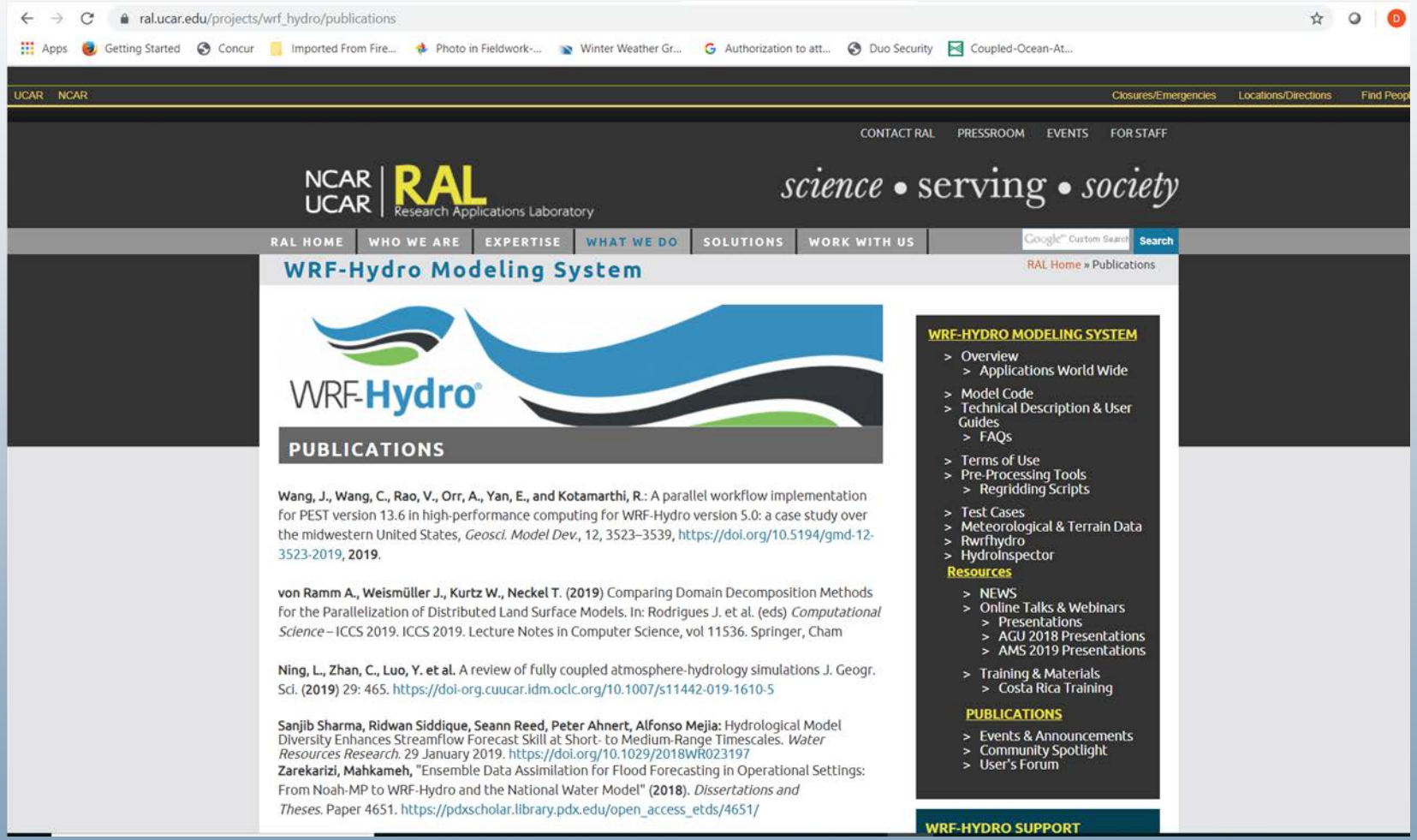
Community: Connection

- **Social Medial Outlets:**
  - @WRFHydro https://twitter.com/WRFHydro
    - #WRFHydro
  - @CUAHSI https://twitter.com/CUAHSI
- **User's Forum:** http://bit.ly/wrfhydrousersforum
- **Email List serv:** https://ral.ucar.edu/projects/wrf_hydro/subscribe
- **News:** https://ral.ucar.edu/projects/wrf_hydro/news
- **Community Spotlight:** https://ral.ucar.edu/projects/wrf_hydro/communityspotlight
- **Contact Us:** https://ral.ucar.edu/projects/wrf_hydro/contact
- **Events:** https://ral.ucar.edu/projects/wrf_hydro/event
- **CUAHSI:**
  - Email: commgr@cuahsi.org
  - Website: https://www.cuahsi.org

NCAR

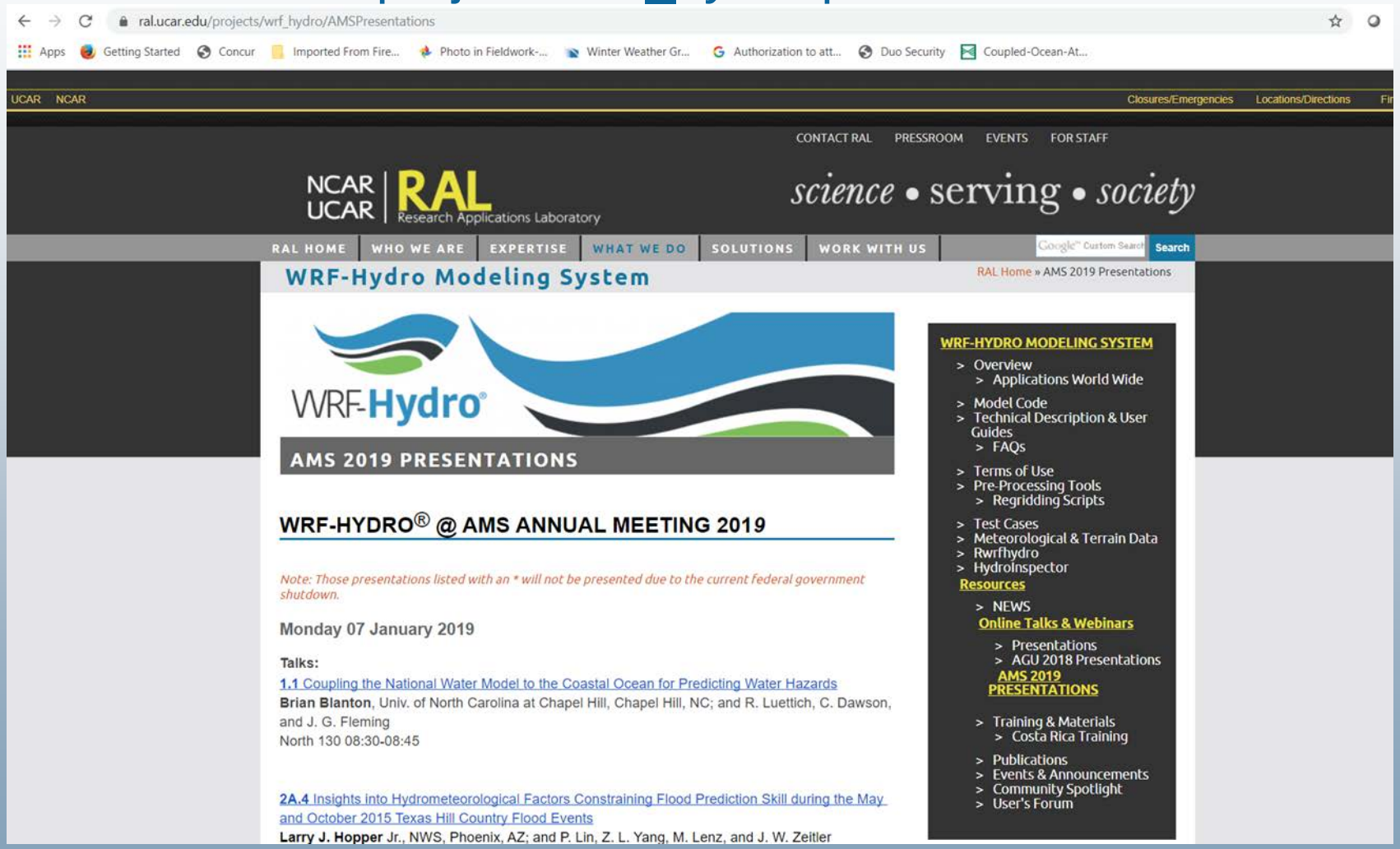
Publications

https://ral.ucar.edu/projects/wrf_hydro/publications



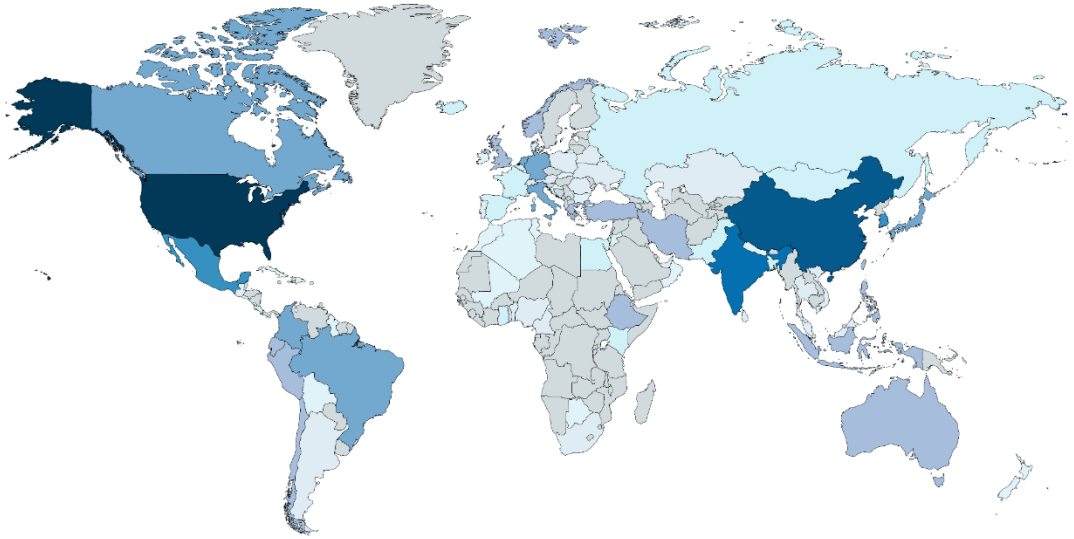
Presentations

https://ral.ucar.edu/projects/wrf_hydro/presentations

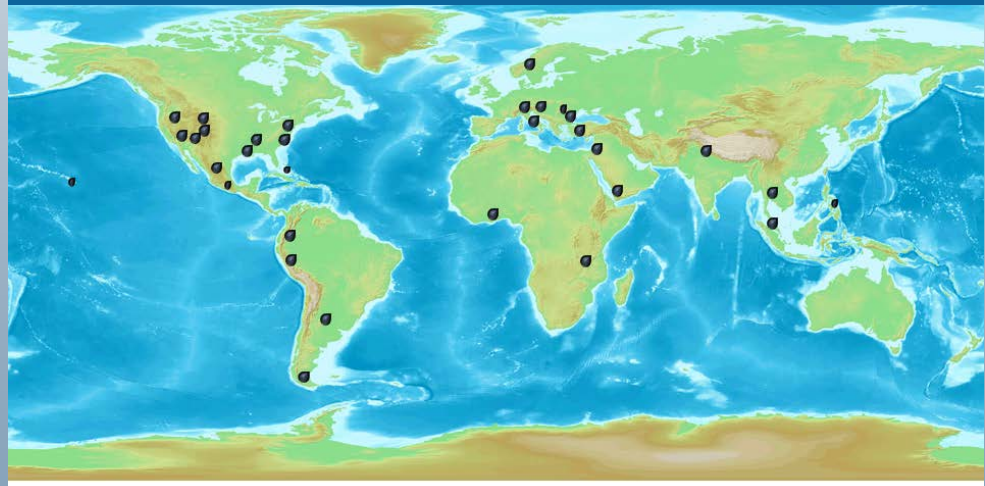


Community: Users World Wide

Usage by Country of WRF-Hydro® Online Resources



Ongoing Collaborations & Applications



- Operational Streamflow Forecasting
- Streamflow Prediction Research
- Diagnosing Climate Change Impacts on Water Resources
- Diagnosing Land-Atmosphere Coupling Behavior in Mountain Front Regions
- Diagnosing Impacts of Disturbed Landscapes on Coupled Hydrometeorological Predictions
- Coupling WRF-Hydro with Coastal Process Models

NCAR

Summary

Online Resources:

- https://ral.ucar.edu/projects/wrf_hydro
  - Contact: wrfhydro@ucar.edu
- https://www.cuahsi.org
  - Contact: commgr@cuahsi.org

Presenters:

- David Gochis – gochis@ucar.edu
- Anthony Castronova - acastronova@cuahsi.org
- Julia Masterman - jmasterman@cuahsi.org

Organizers:

- Molly McAllister – mollymca@ucar.edu
- David Gochis – gochis@ucar.edu
- Julia Masterman - jmasterman@cuahsi.org
- Anthony Castronova - acastronova@cuahsi.org
- Emily Clark - eclark@cuahsi.org