The National Water Center Summer Institute

Sagy Cohen, University of Alabama
Jim Nelson, Brigham Young University
Sarah Praskievicz, University of Alabama
Dinuke Munasinghe, University of Alabama

David Maidment, University of Texas Austin
Fred Ogden, University of Wyoming
Mike Johnson, University of California
Jim Coll, University of Kansas

NWC | NATIONAL WATER CENTER

OWP | OFFICE OF WATER PREDICTION

NWC Summer Institute Program

The NWC Summer Institute (SI) is an annual program under the auspices of the NWC's Innovators Program.

Administered by the The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)

Seven-week event at the NWC and UA in which graduate student collaborated intensively to work on projects designed to contribute to the NWC goals.

Project themes are defined in advance to reflect the NWC goals.

The SI is led by faculty theme leads with daily oversight provided by post-doctoral or PhD course coordinators (selected by a committee; open application).

CUAHSI
Universities Allied for Water Research

Summer Institute Process

2015 SI

6 June to 20 July 2016

Plan and Prototype — 2016 SI — Publication

10 months — 7 weeks — 1 year

2017 SI

Goals: 2015 – a prototype national flood forecasting system
2016 – flood inundation mapping for continental US
2017 – hyper-resolution simulation in cities (streets, pipes, streams)

2016 Summer Institute: 34 Graduate Students from 21 Universities

Oregon State University

PennState

Purdue University

Texas — The University of Texas at Austin

UC Santa Barbara

Brigham Young University — Founded 1875 — BYU — Provo, Utah

Auburn University

UTSA

KU

State

The University of Alabama

NC State University

UT Dallas

UTRGV

CUNY — The City University of New York

University of Hawai'i Mānoa

Jacksonville State University

Northeastern University

Villanova University

UMass Amherst

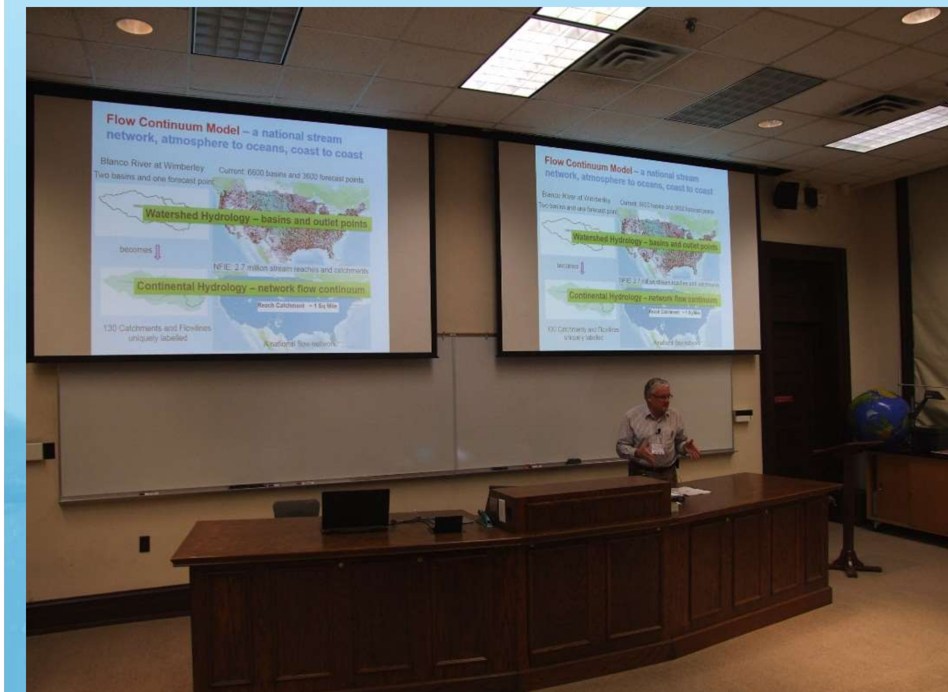
The University of Iowa

University of Texas Arlington

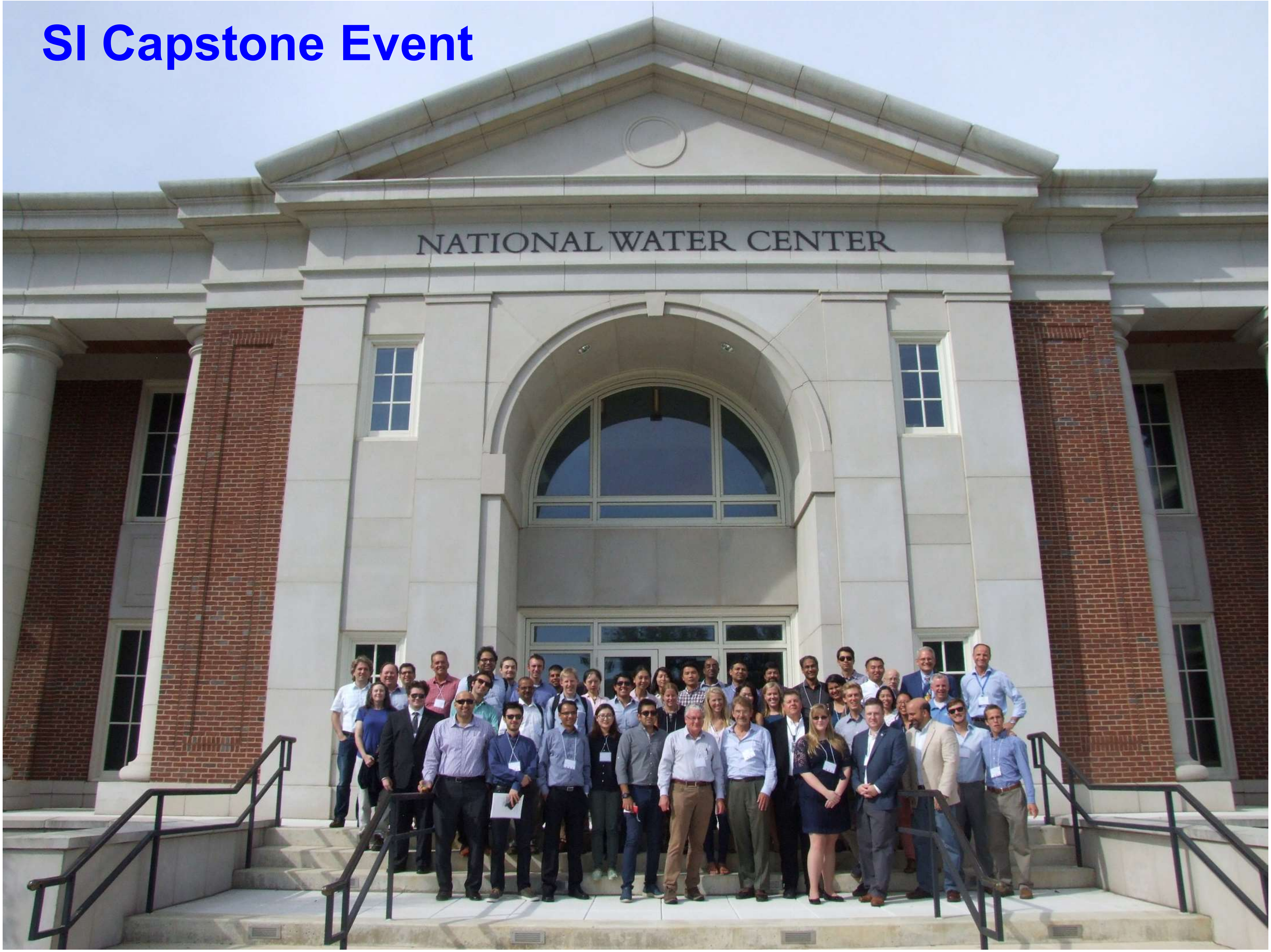
2016 Summer Institute Projects

Theme	*Project*	*Topic*	*Students*
Flood Modeling	1	Radar measurement and flow modeling	James Coll, Mike Johnson, Paul Ruess
	2	Hydrologic mapping of the Lower Rio Grande Valley	Brenda Eliza Bazan, Mark Hagemann, Kyungmin Kim
	3	Flood Inundation by Physical and Non-physical models	Shahab Ansari, Ehsan Omranian, Dongmei Feng
Inundation Mapping	4	The Modified HAND Method	Ryan McGehee, Lingcheng Li, Emily Posten,
	5	Object-based Flood Inundation Mapping	Yan-Ting Liau, Krishna Gadiraju
	6	Comparison of Flood Inundation Mapping Techniques	Jiaqi Zhang, Dinuke Munasinghe, Yu-Fen Huang
Forecast Uncertainty	7	Real-Time Postprocessor for Flood Inundation Mapping	Sanjib Sharma, Binqing Lu
	8	Uncertainty in Flood Inundation Mapping	Ridwan Siddique, Christopher Zarzar, Hossein Hosseiny, Michael Gomez
	9	Assimilation of Water Level Observations	Amir Javaheri, Mohammad Nabatian
Emergency Response	10	HAND Flood Mapping through the Tethys Platform	Savannah Keane, Christian Kesler, Xing Zheng
	11	Reimagining Disaster Warning Systems	Mike Johnson, Paul Ruess, James Coll
	12	Translater TTX and Citizen Awareness of Floods	Whitney Henson, Richard Garth, Chris Franklin, Dawne Butler

SI Capstone Event



SI Capstone Event



Post-SI

Consortium of Universities for the Advancement of Hydrologic Science, Inc.

TECHNICAL REPORT 13
JULY 20, 2016

NWC | NATIONAL WATER CENTER

CUAHSI
universities allied for water research
www.cuahsi.org

NATIONAL WATER CENTER
INNOVATORS PROGRAM
SUMMER INSTITUTE REPORT 2016

Journal of the American Water Resources Association
Special Issue

JAWRA
JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION

MOVING TO ONLINE-ONLY IN 2016

APRIL 2016

AWRA
Community, Conversation, Connections
AMERICAN WATER RESOURCES ASSOCIATION

Wiley Online Library

2017 Summer Institute: 32 Graduate Students from 24 Universities

University of Colorado Boulder

UCSB geography

San Francisco State University

The University of Texas at El Paso

Brigham Young University · BYU · Provo, Utah

Purdue University

Utah State University 1888

Colorado School of Mines 1874

University of Wyoming

Carnegie Mellon University · Pittsburgh Pennsylvania 1900

LSU · Louisiana State University

KU · The University of Kansas

PennState 1855

Iowa State University

Alabama Crimson Tide

The University of Iowa

UAB

The University of Texas at Austin

Syracuse University · Founded 1870

Ohio State

The University of Utah

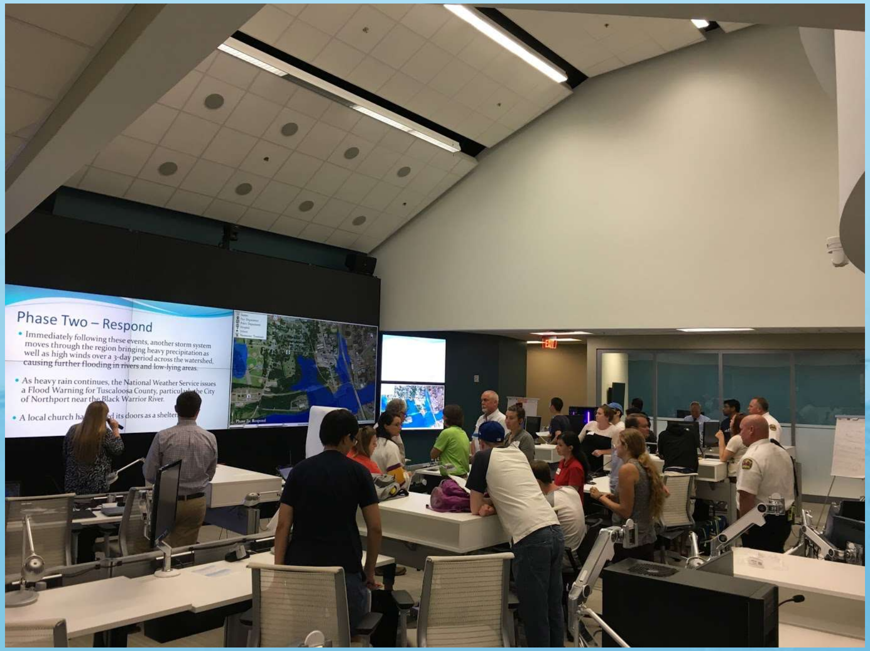
UT Dallas

UF · University of Florida

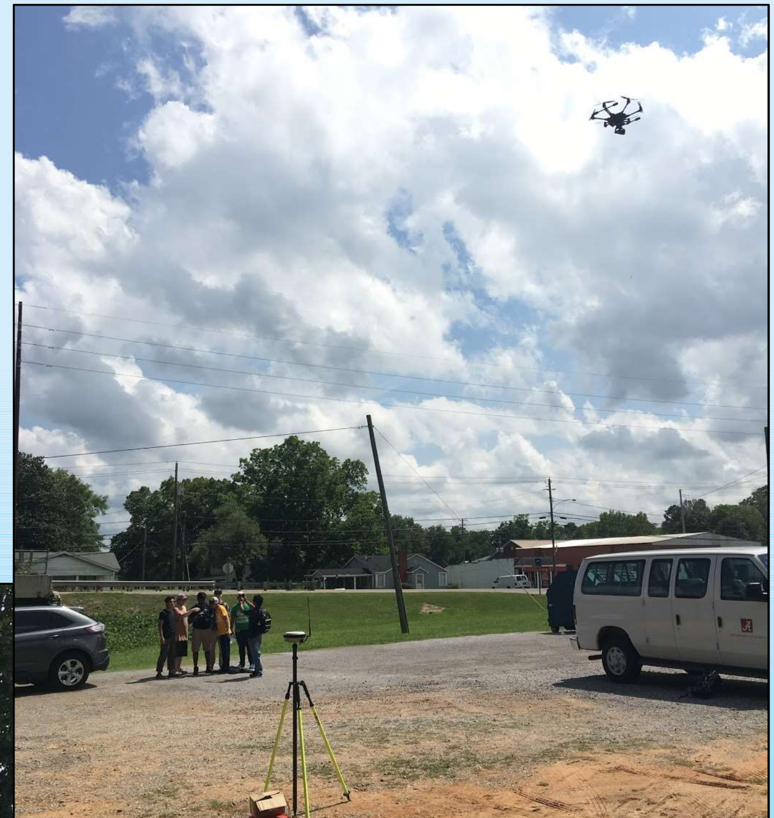
UND · University of North Dakota

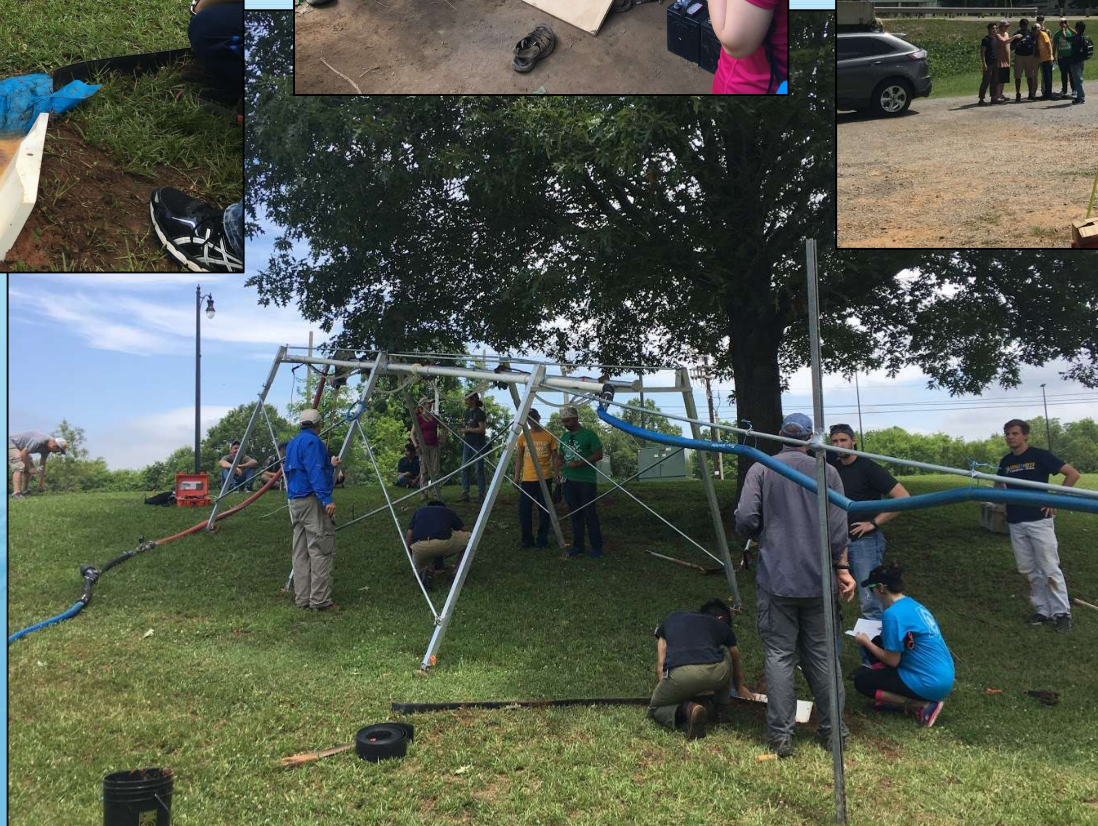
Slide: Jim Coll and Mike Johnson

First Responders Day

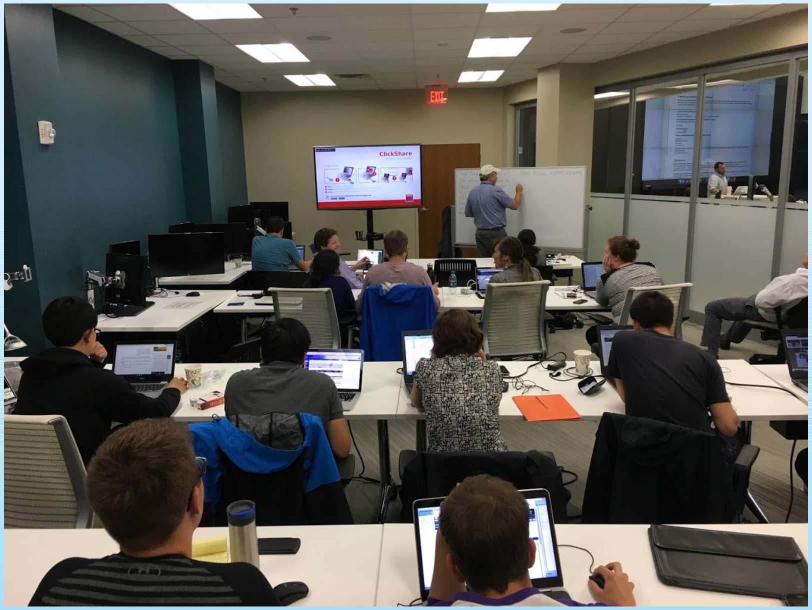


Field Day





Modeling/Data/Development Training



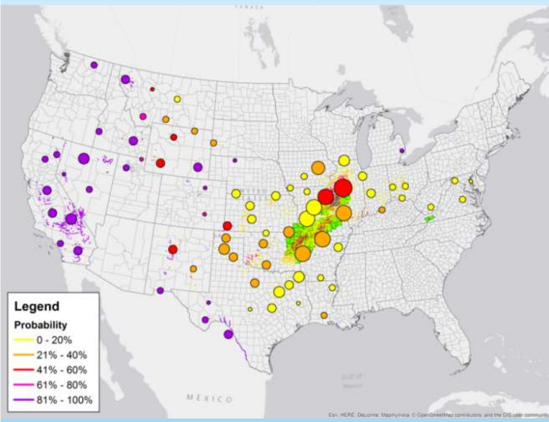
2017 Summer Institute Research Themes:

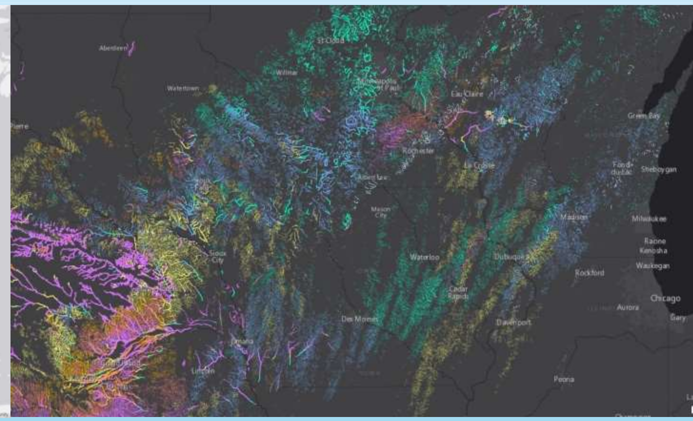
Theme 1: Hyper-Resolution Simulation

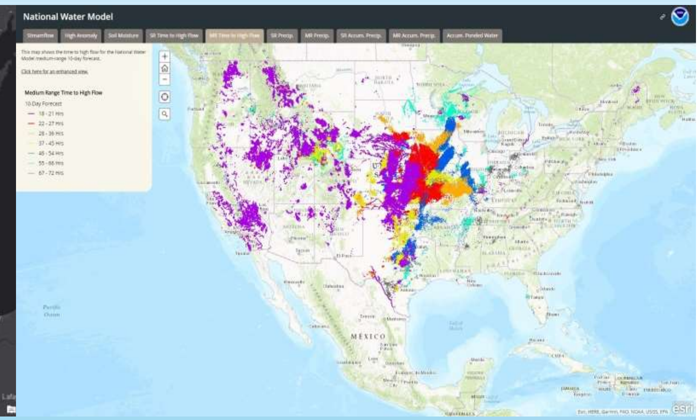
Theme 2: Flood Inundation Mapping

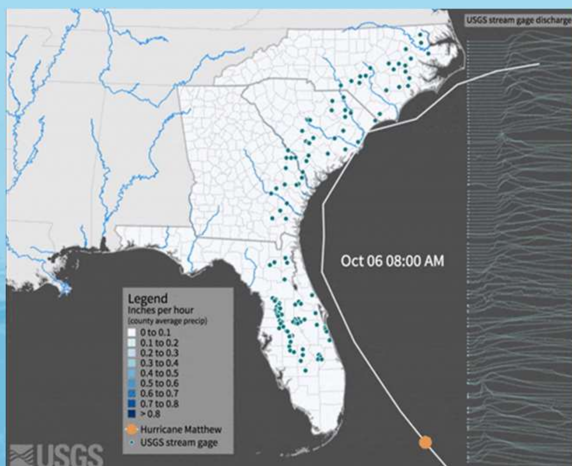
Theme 3: Communicating National Water Model Results

Communicating NWM Results – Extracting Geospatial Intelligence from National Water Model Data

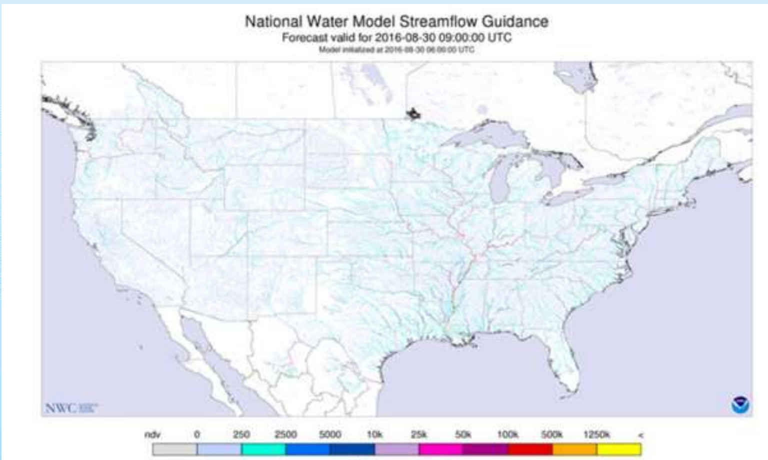


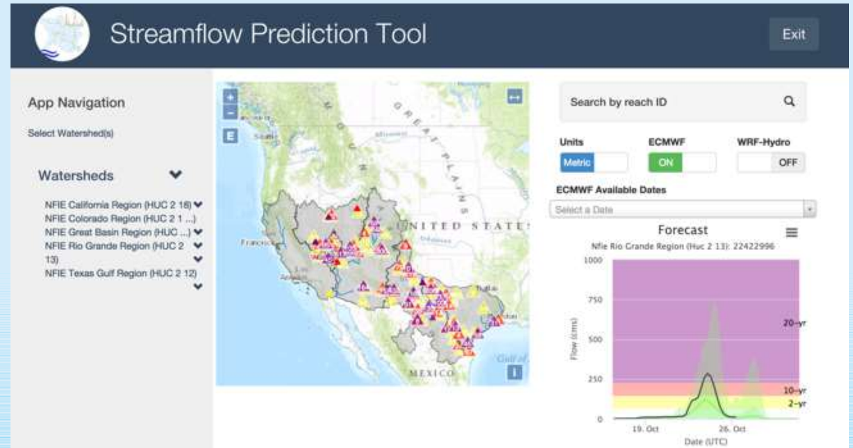


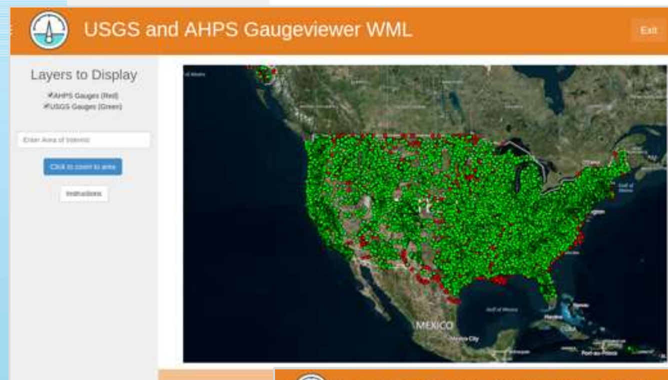


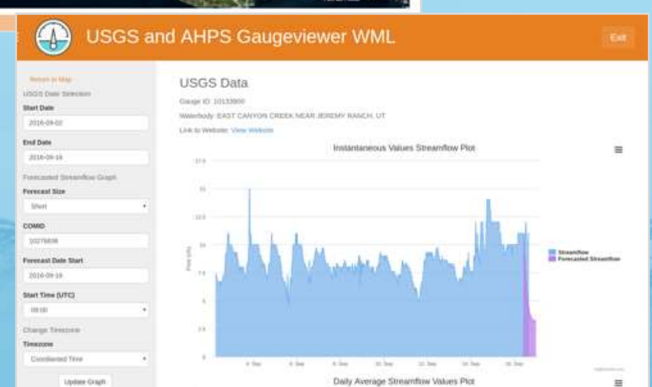


Previous Work

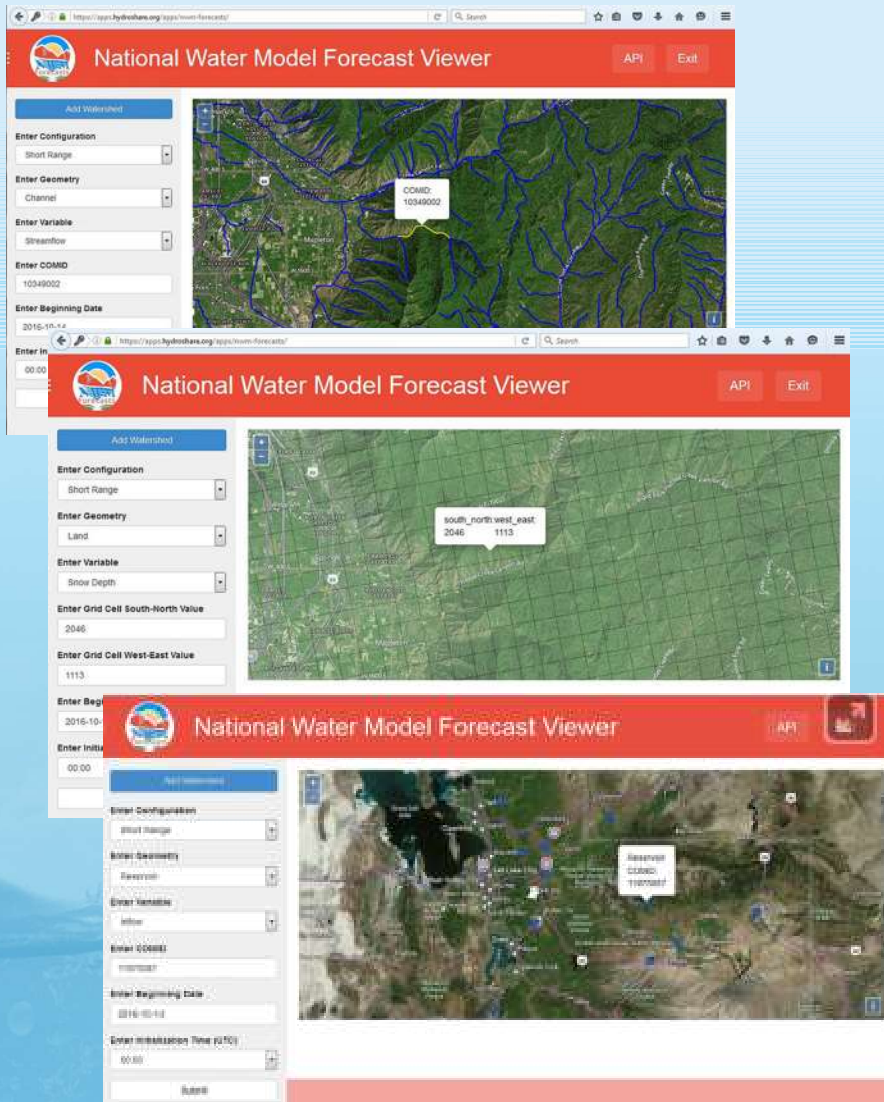


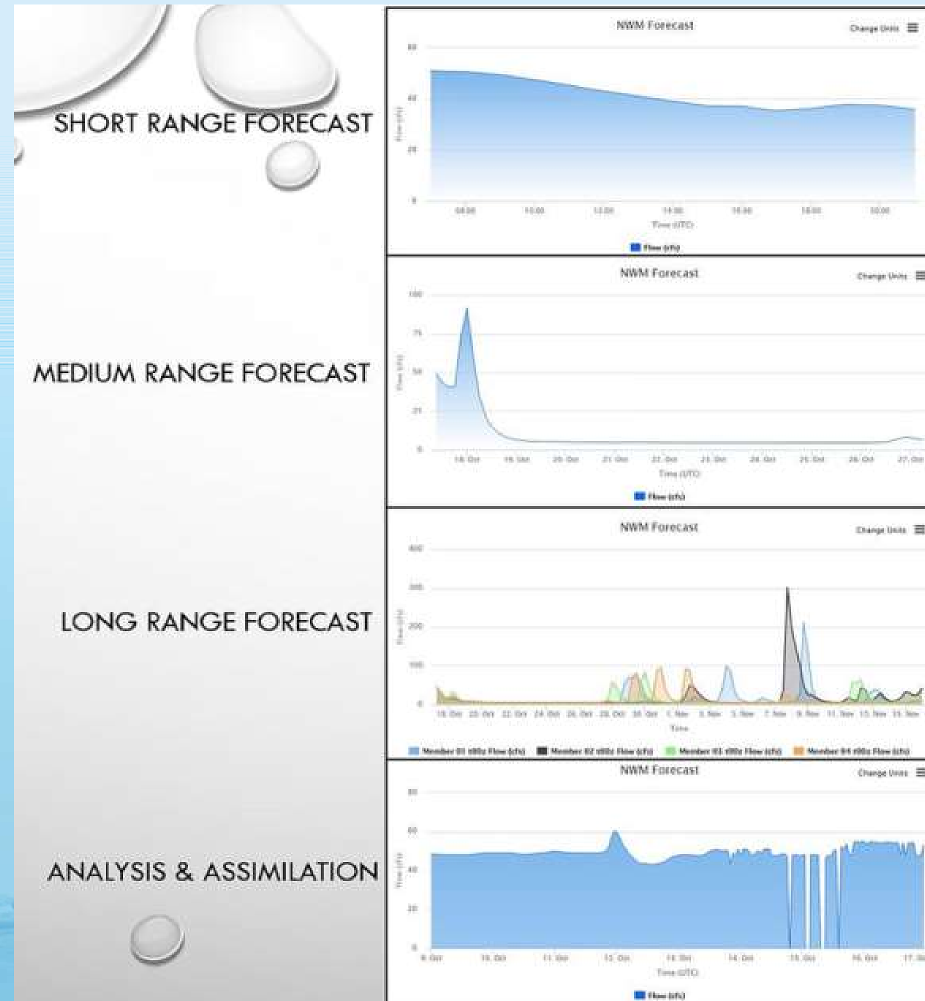






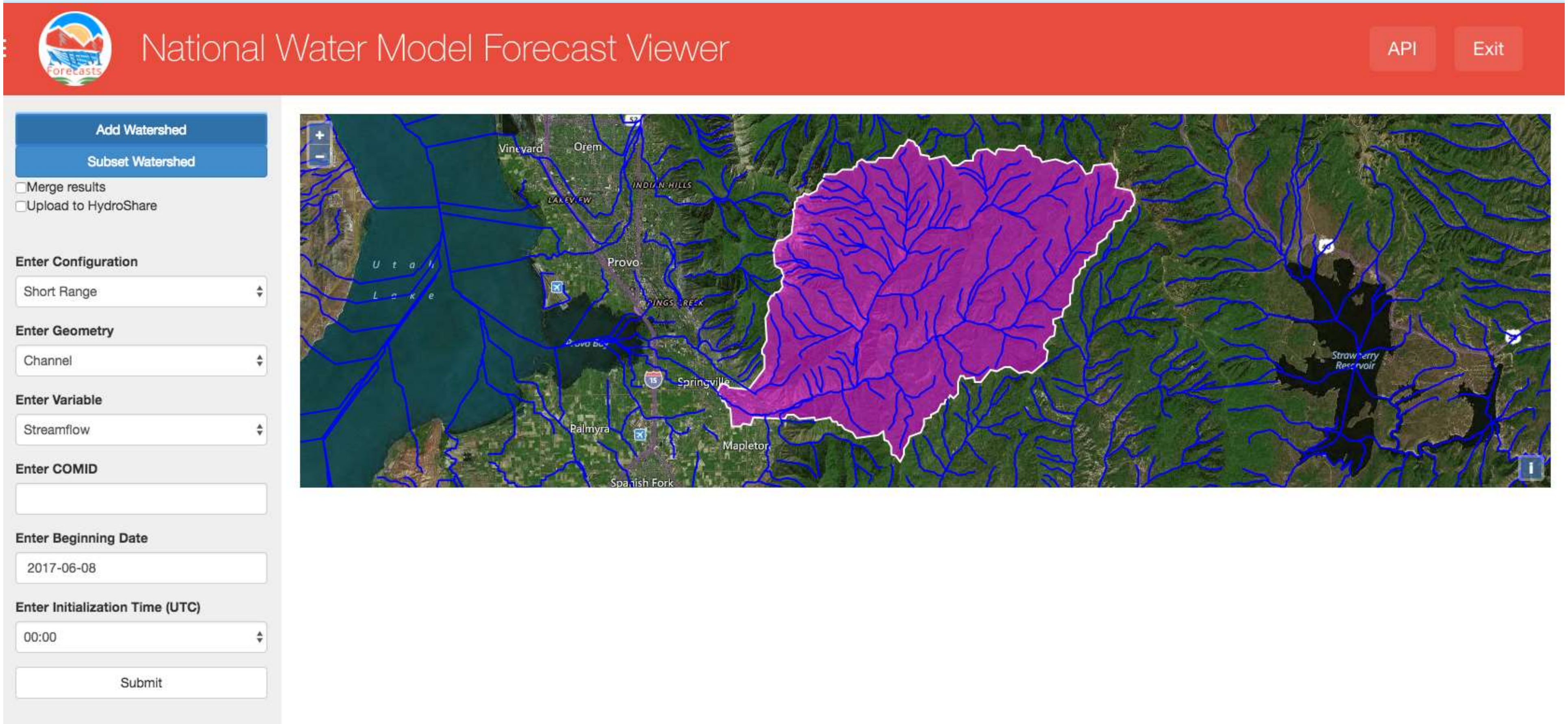
NWM Viewer


National Water Model Forecast Viewer
API
Exit
Add Watershed
Enter Configuration
Short Range
Enter Geometry
Channel
Enter Variable
Streamflow
Enter COMID
10349002
Enter Beginning Date
COMID:
10349002
National Water Model Forecast Viewer
API
Exit
Add Watershed
Enter Configuration
Short Range
Enter Geometry
Land
Enter Variable
Snow Depth
Enter Grid Cell South-North Value
2046
Enter Grid Cell West-East Value
1113
south_north west_east
2046 1113
National Water Model Forecast Viewer
API


SHORT RANGE FORECAST
MEDIUM RANGE FORECAST
LONG RANGE FORECAST
ANALYSIS & ASSIMILATION
NWM Forecast
NWM Forecast
NWM Forecast
NWM Forecast

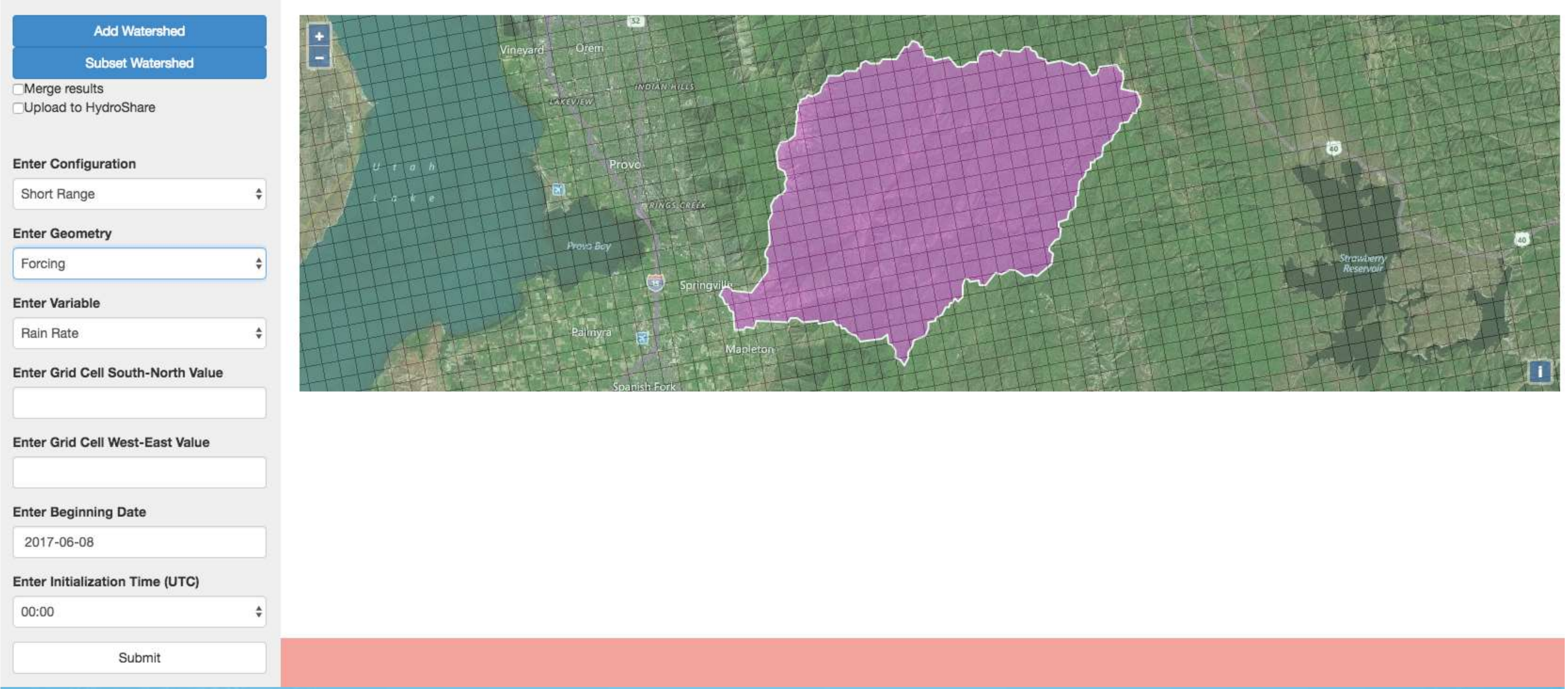
Additions for SI 2017 Support

- Add your Watershed and subset results



Additions for SI 2017 Support

- Forcings as well (can be used in other models)



API Access to retrieve NWM Data

National Water Model Data Explorer

Exit

GetWaterML

Parent App	nwm-forecasts
Supported Methods	GET
Returns	A WaterML file of the specified forecast.

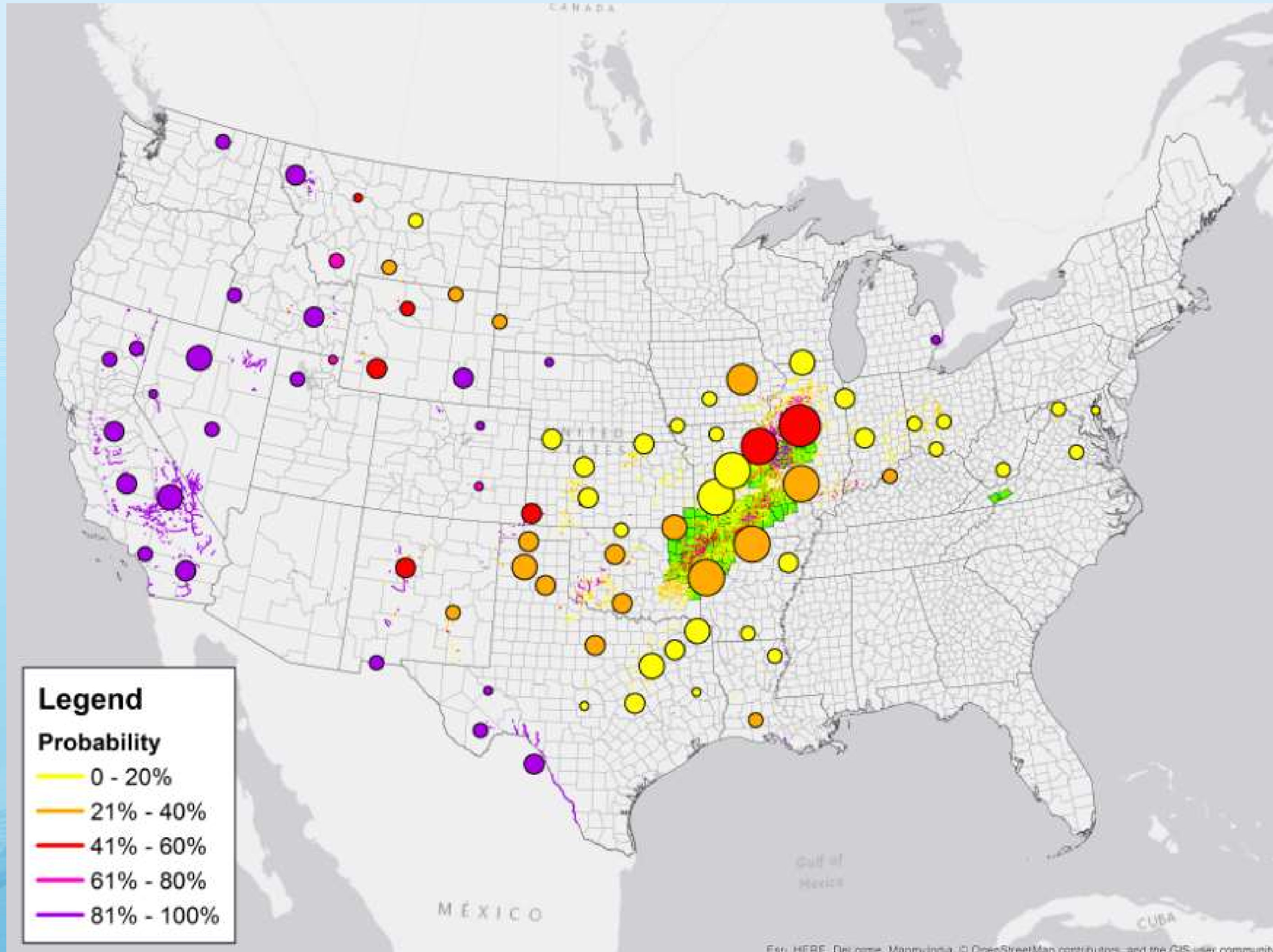
Name	Description	Valid Values	Required	Default if omitted
config	The configuration of the forecast.	One and only one of the following strings: "short_range", "long_range", "medium_range", "analysis_assim", "fe_short_range", "fe_medium_range", or "fe_analysis_assim".	Yes	Cannot be ommitted.
geom	The geometry of the forecast.	One and only one of the following strings: "channel_rt", "land", or "reservoir".	Yes.	Cannot be ommitted.
variable	The variable of the forecast.	One and only one of the following strings, depending on the specified configuration and geometry. For config=analysis_assim and geom=channel_rt: "streamflow", or "velocity". For config=analysis_assim and geom=reservoir: "inflow", or "outflow". For config=analysis_assim and geom=land: "SNOWH", "SNEQV", "FSNO", "ACCET", "SOILSAT_TOP", or "SNOWT_AVG". For config=short_range and geom=channel_rt: "streamflow", or "velocity". For config=short_range and geom=reservoir: "inflow", or "outflow". For config=short_range and geom=land: "SNOWH", "SNEQV", "FSNO", "ACCET", "SOILSAT_TOP", or "SNOWT_AVG". For config=medium_range and geom=channel_rt: "streamflow", or "velocity". For config=medium_range and geom=reservoir: "inflow", or "outflow". For config=medium_range and geom=land: "SNOWH", "SNEQV", "FSNO", "ACCET", "SOILSAT_TOP", "SNOWT_AVG", "UGDRNOFF", "ACCECAN", "SOIL_T", "SOIL_M", or "CANWAT". For config=long_range and geom=channel_rt: "streamflow". For config=long_range and geom=reservoir: "inflow", or "outflow". For config=long_range and geom=land: "SNEQV", "ACCET", "SOILSAT", "UGDRNOFF", "SFCRNOFF", "CANWAT". Where "SNOWH" is Snow Depth, SNEQV is Snow Water Equivalent, "FSNO" is Snow Cover, "ACCET" is Accumulated Total Evapotranspiration, "SOILSAT_TOP" is Near-surface Soil Saturation, "SNOWT_AVG" is Average Snow Temperature, "UGDRNOFF" is Accumulated Groundwater Runoff, "ACCECAN" is Accumulated Canopy Evaporation, "SOIL_T" is Soil Temperature, "SOIL_M" is Volumetric Soil Moisture, "CANWAT" is Total Canopy Water, "SOILSAT" is Soil Saturation (Column Integrated), and "SFCRNOFF" is Accumulated Surface Runoff,	Yes.	Cannot be ommitted.
COMID	The identifier of the stream reach, reservoir, or grid cell	A numeric string. e.g. "12345678". If geometry=land, enter the grid south_north index followed by a comma and then the grid west_east index. e.g. "1357,2468"	Yes.	Cannot be ommitted.

https://appsdev.hydroshare.org/apps/nwm-forecasts/api/GetWaterML/?config=short_range&geom=channel_rt&variable=streamflow&COMID=10376606&startDate=2017-06-06&time=00

Streamflow Anomaly

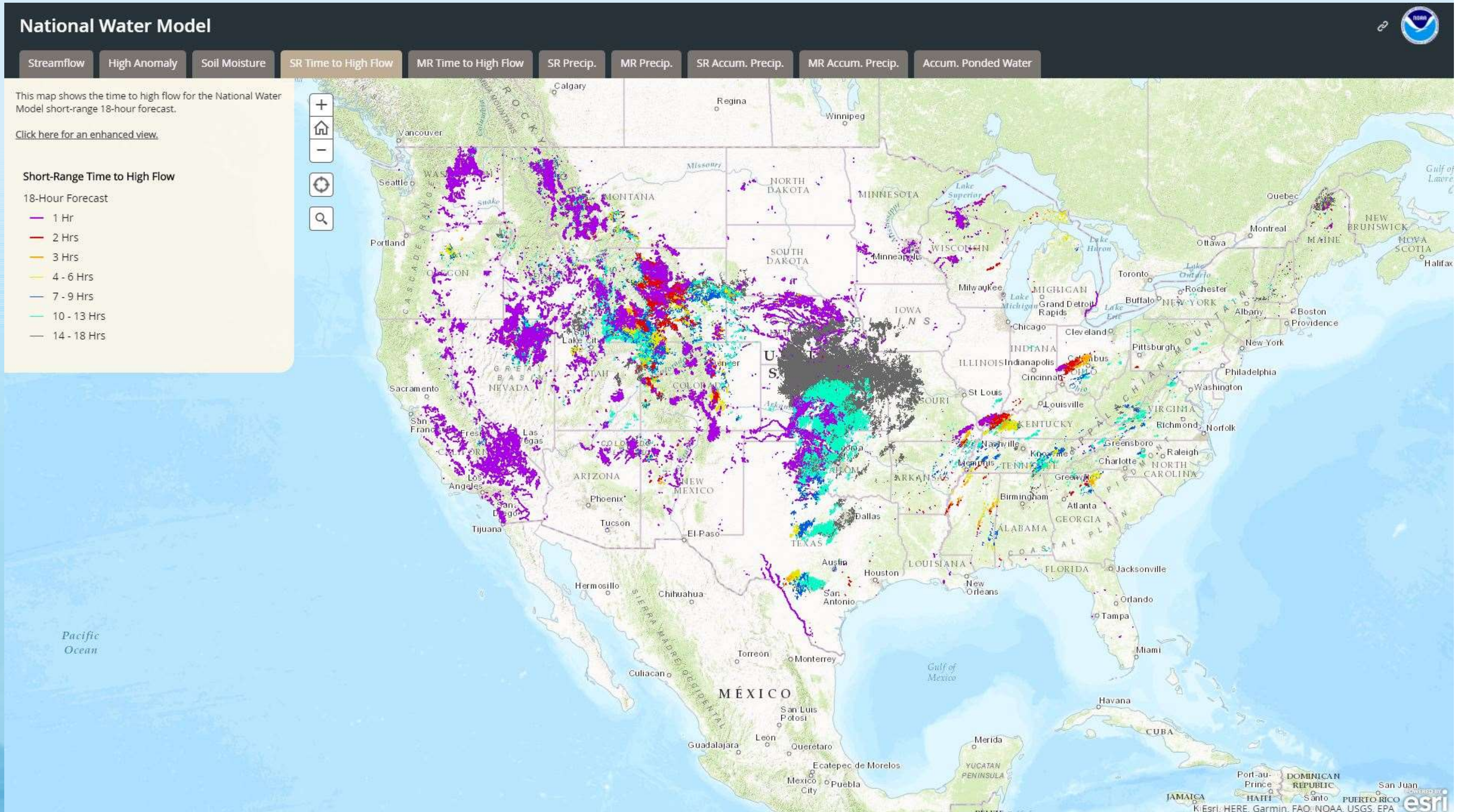
OFFICE OF WATER PREDICTION

Probabilistic High Flow



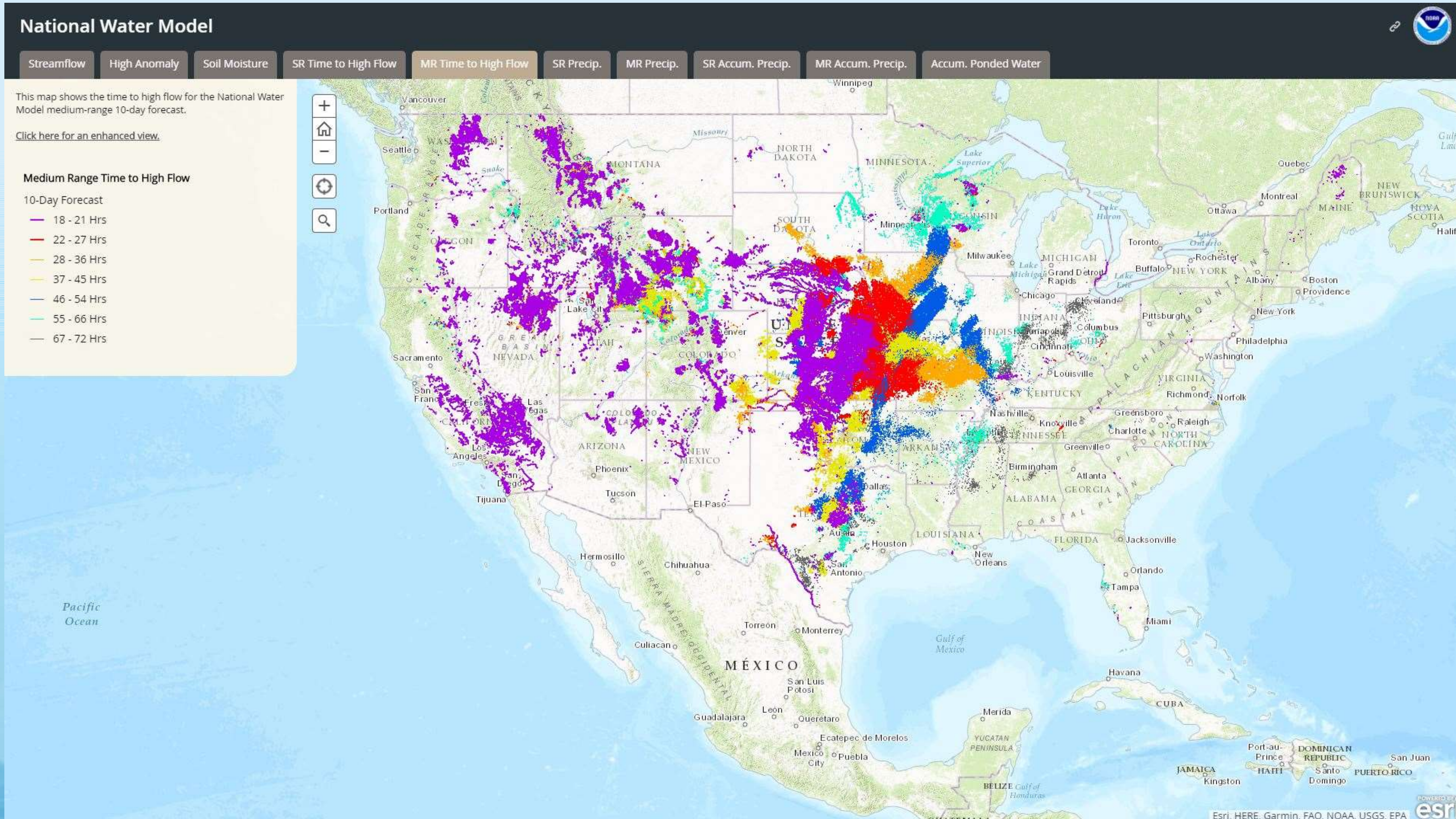
OWP | OFFICE OF WATER PREDICTION

Time to Exceed High Flow Short Range



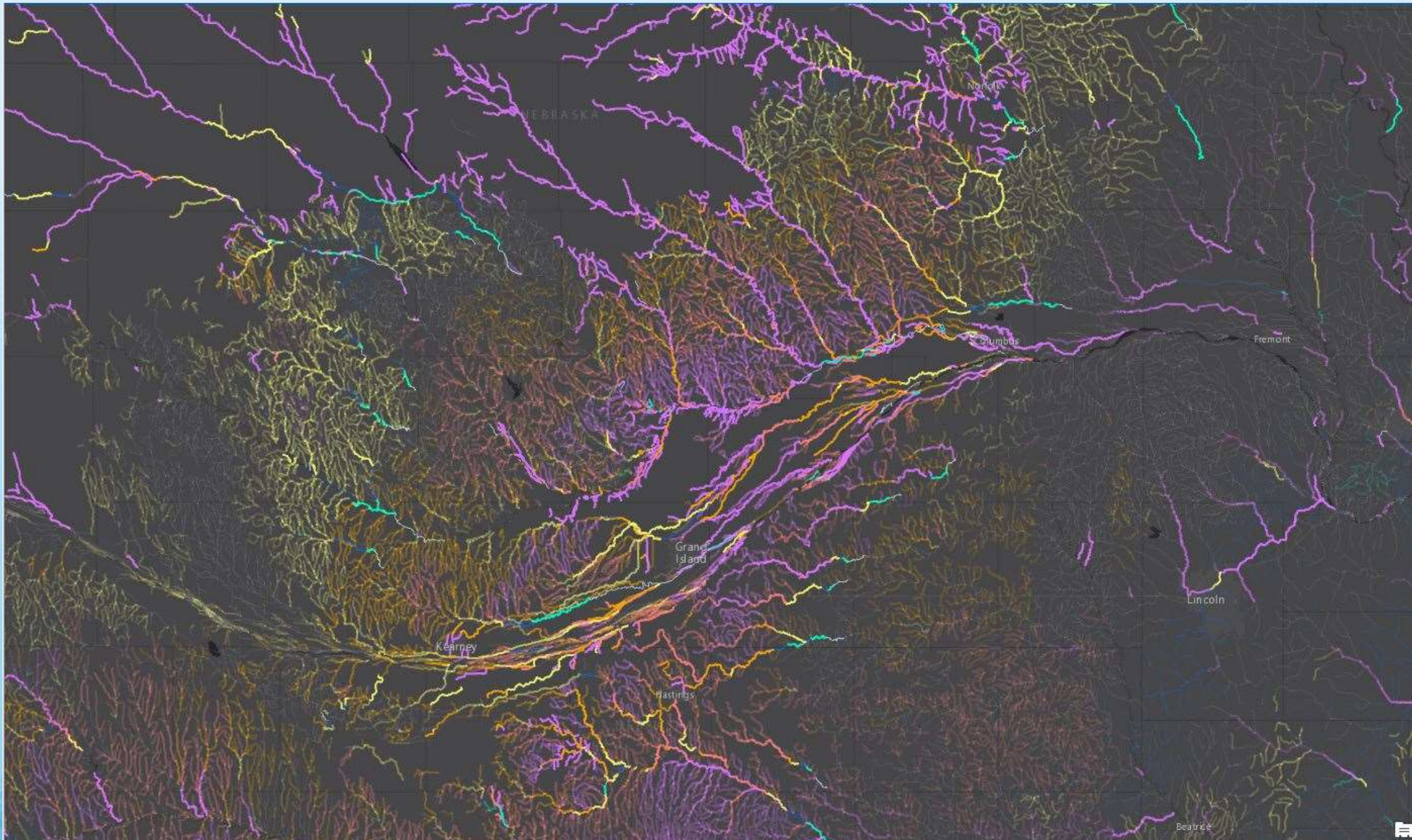
OWP | OFFICE OF WATER PREDICTION

Time to Exceed High Flow Medium Range



OWP | OFFICE OF WATER PREDICTION

Time to Exceed High Flow and High Flow Duration



OWP OFFICE OF WATER PREDICTION

*Stream transparency indicates the forecasted duration of high flow, i.e. fainter-colored lines indicate shorter forecasted durations than bolder-colored lines.

Hyper-Resolution Simulation Theme (led by Fred Ogden)

- Need actionable hydrological information at points that are not on the NHD+ network where HAND is not useable
- Particularly true in urban areas where channel networks have been heavily modified or buried
- Needed at locations on NHD+ network where small scale features such as levees/embankments/backwater control flooding
- Creates need for a hyper-resolution modeling capability in addition to NWM

Slide by Fred Ogden

What is a hyper-resolution model?

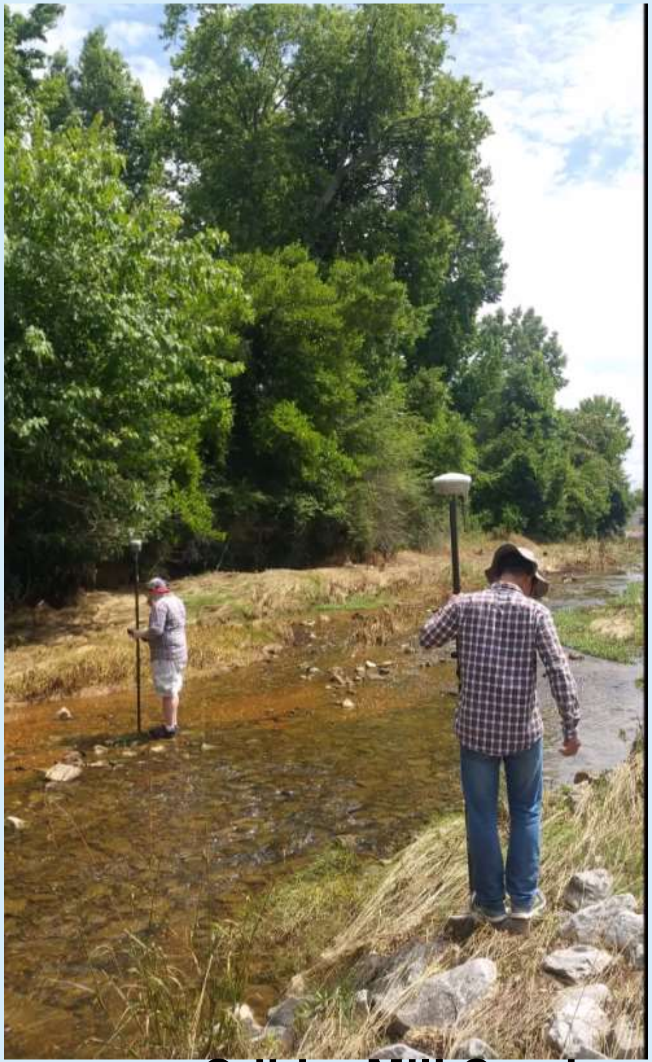
- Resolves features less than 100m in size
- Can dynamically describe hydrologically important man-made features such as:
  - Roadway embankments
  - Ditches/drains
  - Levees and flood walls
  - Stormwater detention structures
  - Perennial lakes with passive or managed outlets
  - Dynamic land-use effects

Slide by Fred Ogden

Summer Institute Field Activities

Radar Measurement Demonstration Sites

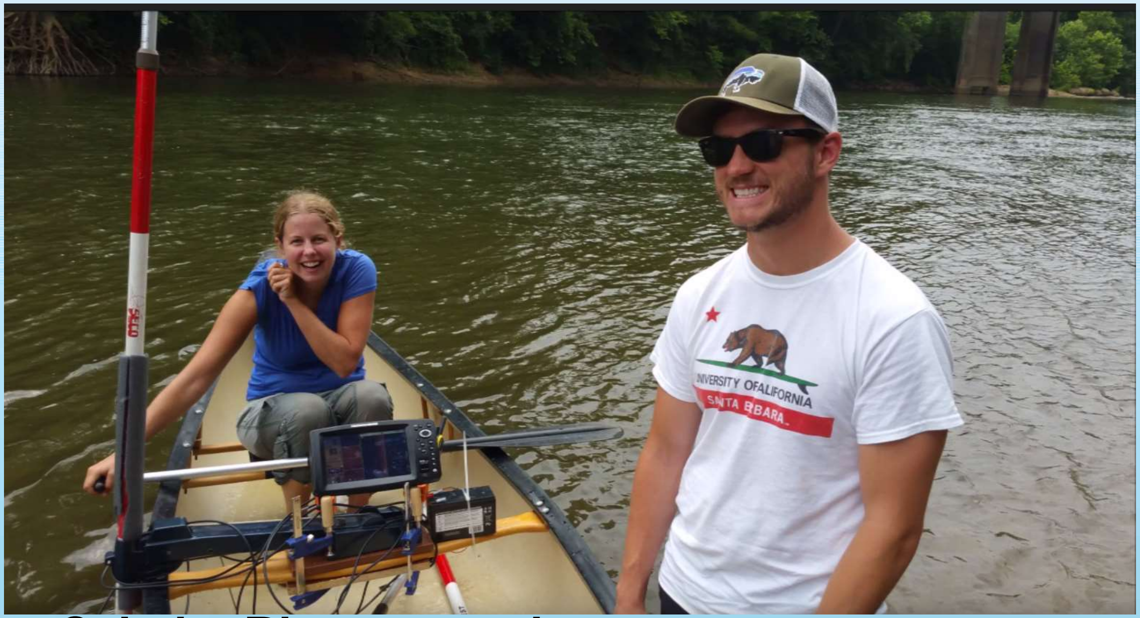
Cahaba River



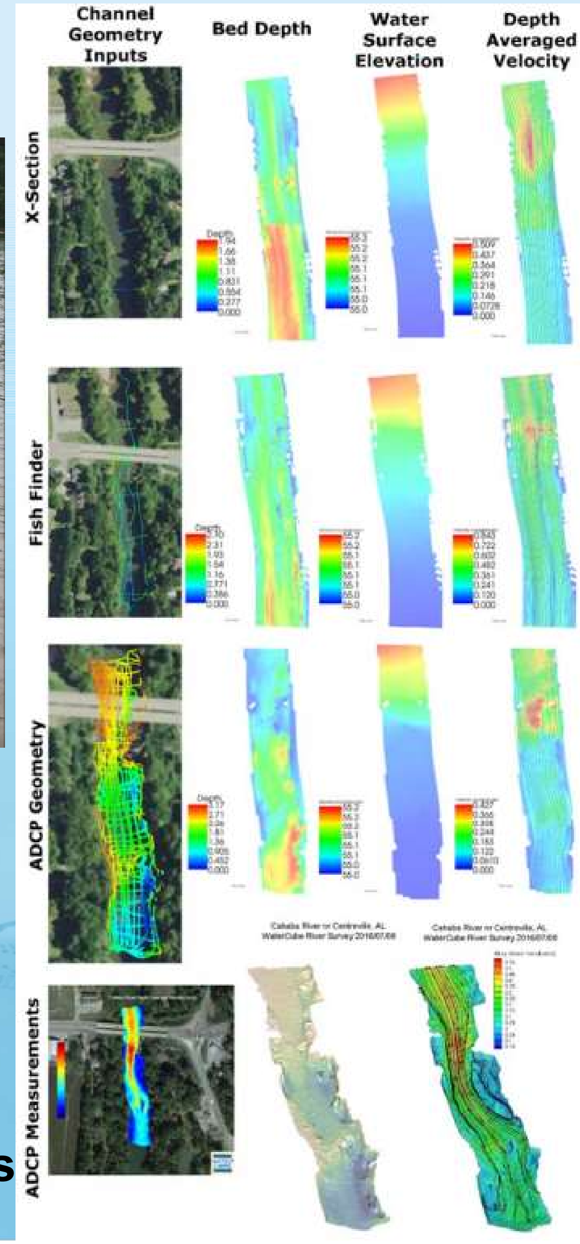
Cribbs Mill Creek

2016: Radar Measurement and Flow Modeling

Jim Coll, Mike Johnson, and Paul Ruess



Cahaba River surveying



FaSTMECH model outputs

2017: River Surveying

ADCP surveying

Looking at
ADCP output

Flying UAV

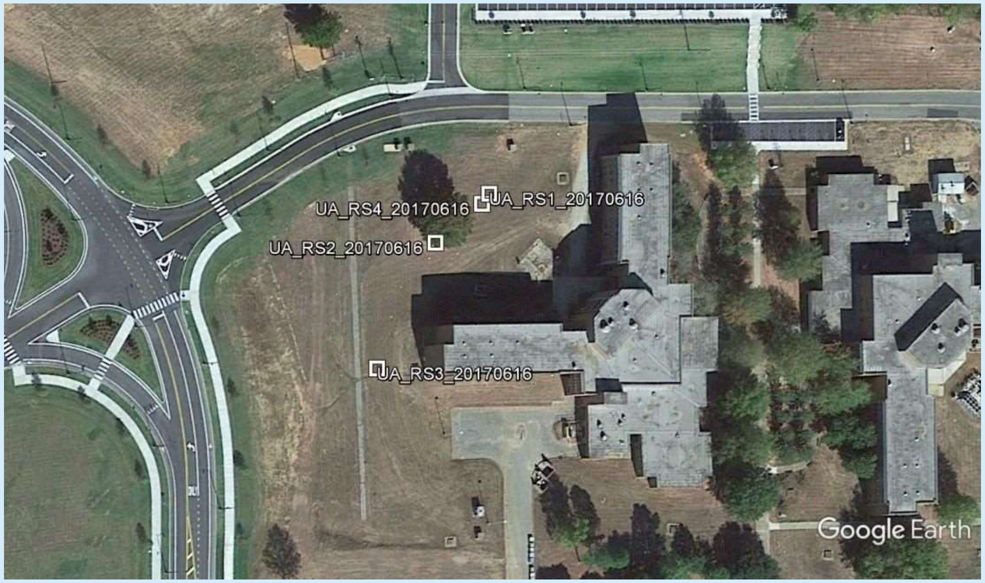
2017: Rainfall Simulator

Setting up experiment

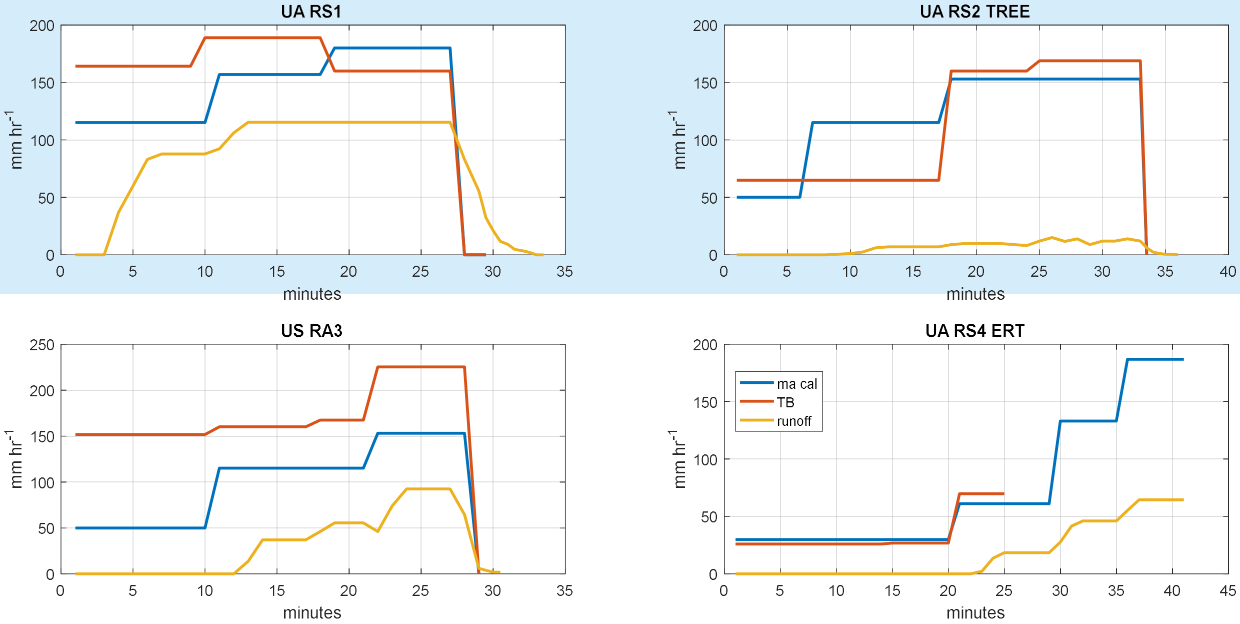
Setting up ERT cables

Measuring runoff

2017: Rainfall Simulator Results

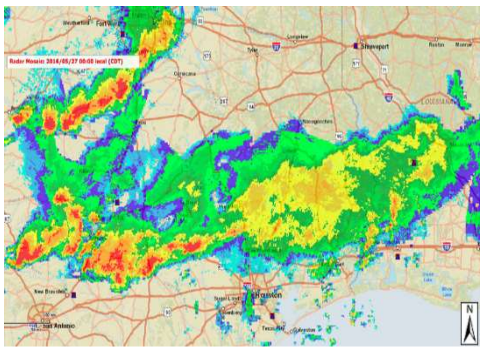


Site locations



Results

Comparison of Flood Inundation Mapping Techniques between Different Modeling Approaches and Satellite Imagery



Jiaqi Zhang, University of Texas at Arlington

Yu-Fen Huang, University of Hawaii at Manoa

Dinuke Munasinghe, University of Alabama

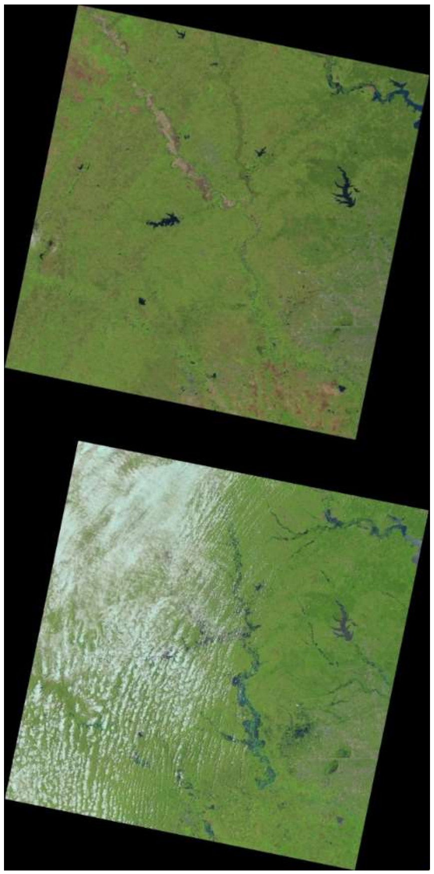
Objectives

- To simulate flood inundation maps
  - ➢ *Height Above the Nearest Drainage* (HAND)
  - ➢ *International River Interface Cooperative* (iRIC)
- To generate observed flood inundation maps from Landsat 8
- To compare the modeled inundation maps with observation
- To gain perspective on the pros and cons of individual mapping tool



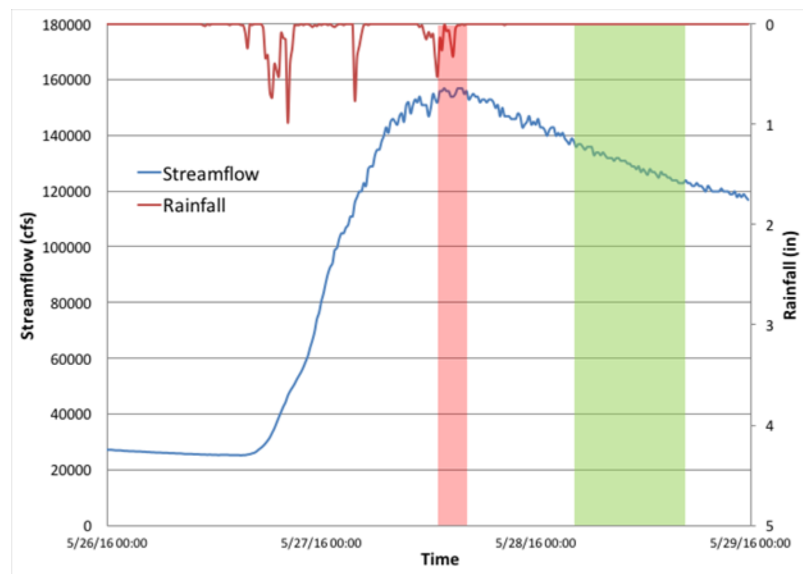

Study area

May 26 to 27th Flood in Brazos River, TX



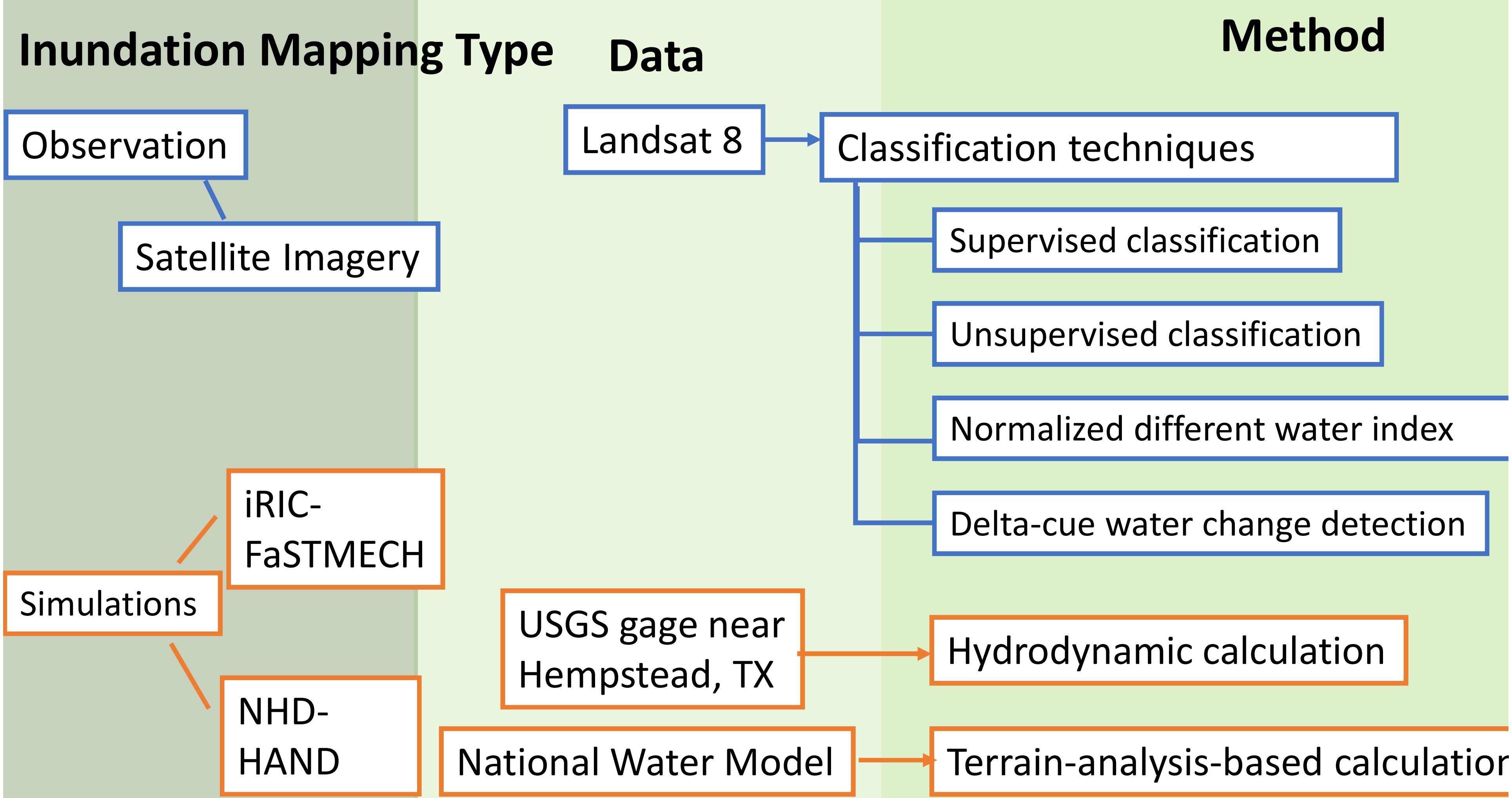
Research area

USGS gage ID: 08111500



Total rainfall: 10.07 inch in 30 hrs
Peak discharge: 157000 cfs
Peak timing: 2 pm, May 27th ,2016
Satellite image taken: May 28th,2016

Methodology



Advanced Fitness Index

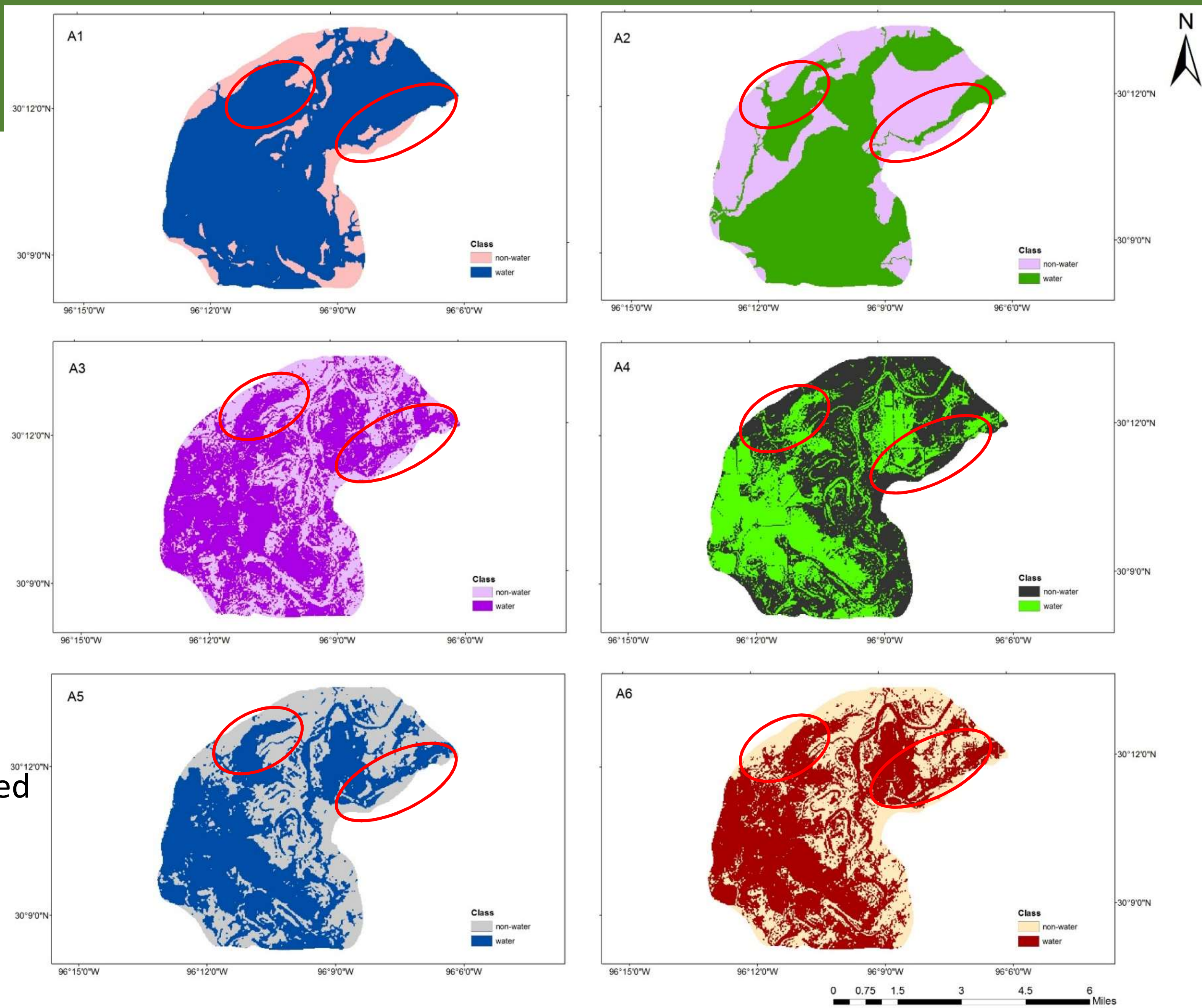
$$\text{Advanced Fitness (\%)} = \frac{IA_{obs} \cap IA_{model} + NIA_{obs} \cap NIA_{model}}{A_{obs} \cup A_{model}} \times 100$$

where IA_{obs} /NIA_{obs} is inundated/non-inundated area from the satellite imagery;

IA_{model}/NIA_{model} is inundated/non-inundated area from the model;

A_{obs}/A_{model} is the entire calculated area from the satellite imagery/model.

Results



(A1) iRIC

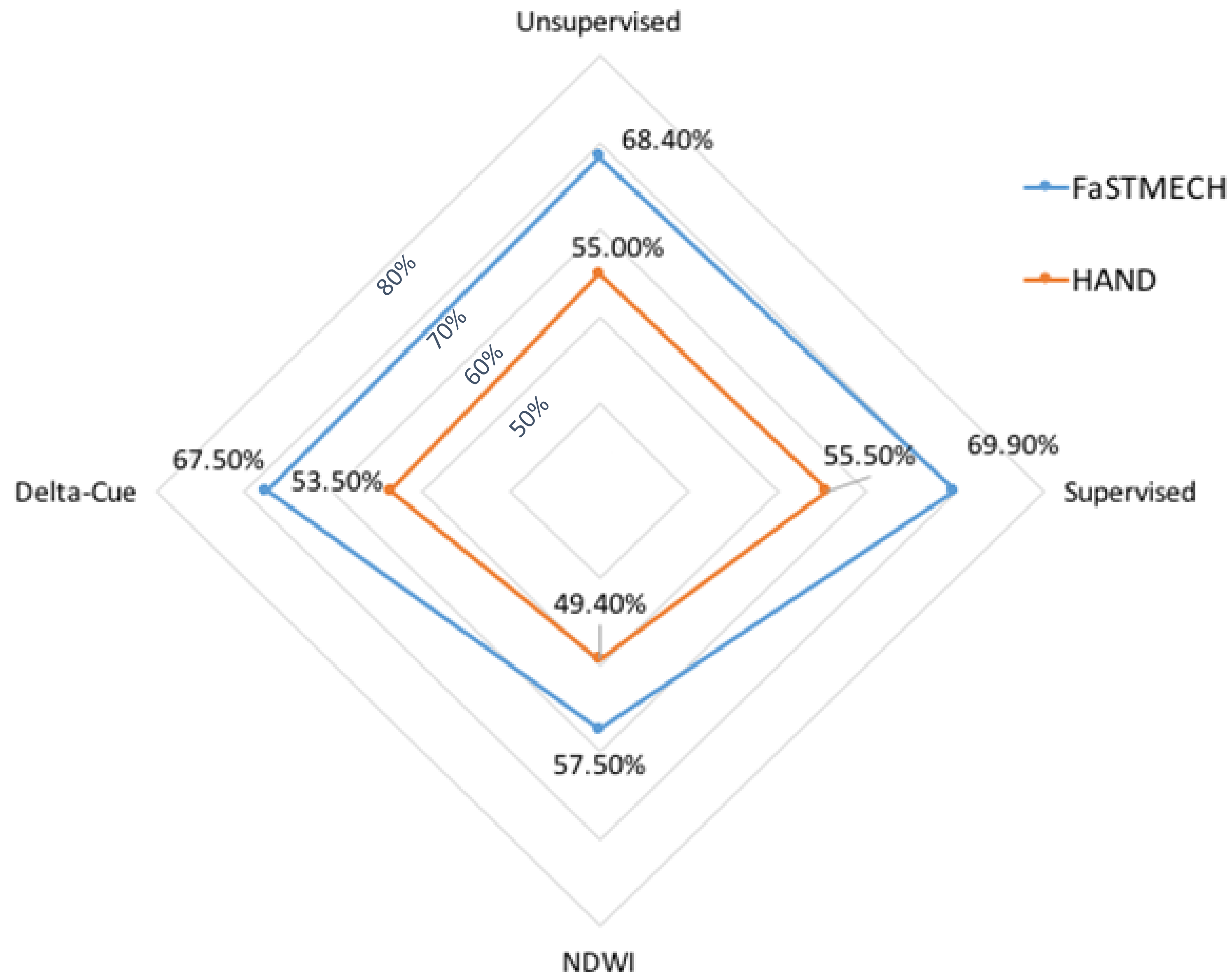
(A2)HAND

(A3) Delta-Cue

(A4)NDWI

(A5) Unsupervised

(A6) Supervised



Unsupervised
Supervised
NDWI
Delta-Cue
80%
70%
60%
50%
68.40%
55.00%
69.90%
55.50%
57.50%
49.40%
67.50%
53.50%
FaSTMECH
HAND

Conclusion

- Both HAND and iRIC generated fair (> 50%) fit with the satellite imagery.
- iRIC performed better (~ 70%) in this case.
- HAND better captured details than iRIC in some inundated areas.
- Modified HAND is needed when subcatchments are behaving interactively
- Solely based on the studied flood event, one cannot simply conclude iRIC is a superior approach than HAND considering the uncertainties in remote sensing observations and iRIC parameters.

Thank you!