



HIGH-RESOLUTION FLASH FLOOD FORECASTING FOR THE DALLAS-FORT WORTH METROPLEX (DFW)

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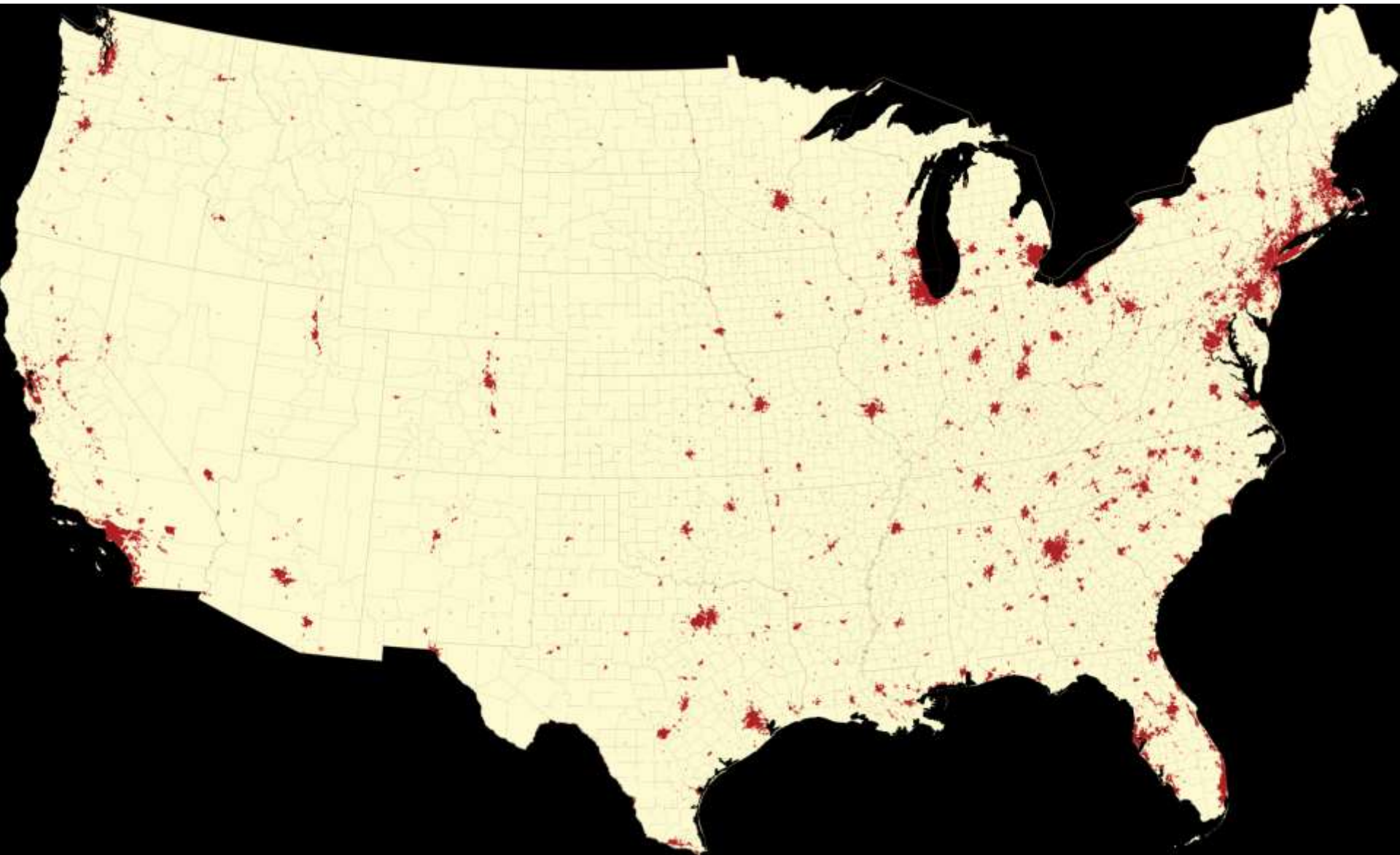
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Acknowledgements

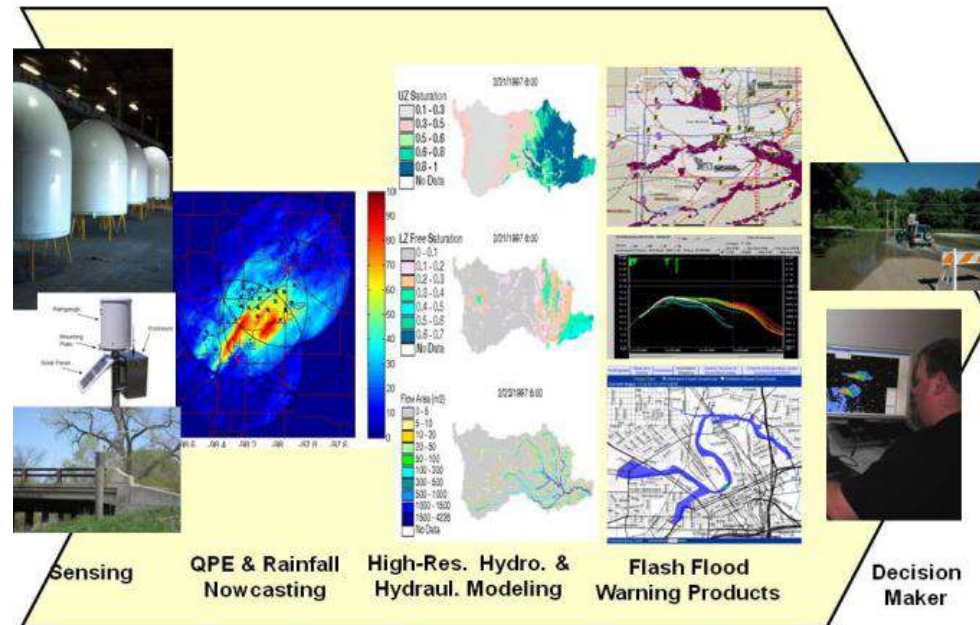
- NWS/OHD – Zhengtao Cui, Brian Cosgrove, Victor Koren, Mike Smith
- NWS/WFO Dallas-Fort Worth – Tom Bradshaw, Greg Patrick
- NWS/WGRFC – Just about everyone
- NWS/MARFC – Seann Reed
- NWS/APRFC – Dave Streubel
- University of Texas at Arlington/CE – Xinbao Yu, John McEnergy
- AECOM – Zubin Sukheswalla
- University of Louisiana at Lafayette – Emad Habib
- The City of Fort Worth – Anthony Garma, Tim Royer
- The City of Arlington - Bill Brown, Mandy Clark
- The City of Grand Prairie – Gabe Johnson, Mazan Kawasmi, David McKee
- DEC Data Systems – Donald Colton
- Freese & Nichols – Justin Naylor



Urban flash flood warning for the City of Fort Worth

- ❑ Part of NSF AIR project (2013~2015)
- ❑ Work in progress
- ❑ Develop and implement a prototype flash flood forecasting system for the City of Fort Worth
 - High-resolution quantitative precipitation estimation (QPE)
 - Precipitation nowcasting
 - Hydrologic modeling
 - City-wide
 - Hydraulic modeling
 - At selected locations
 - Decision support

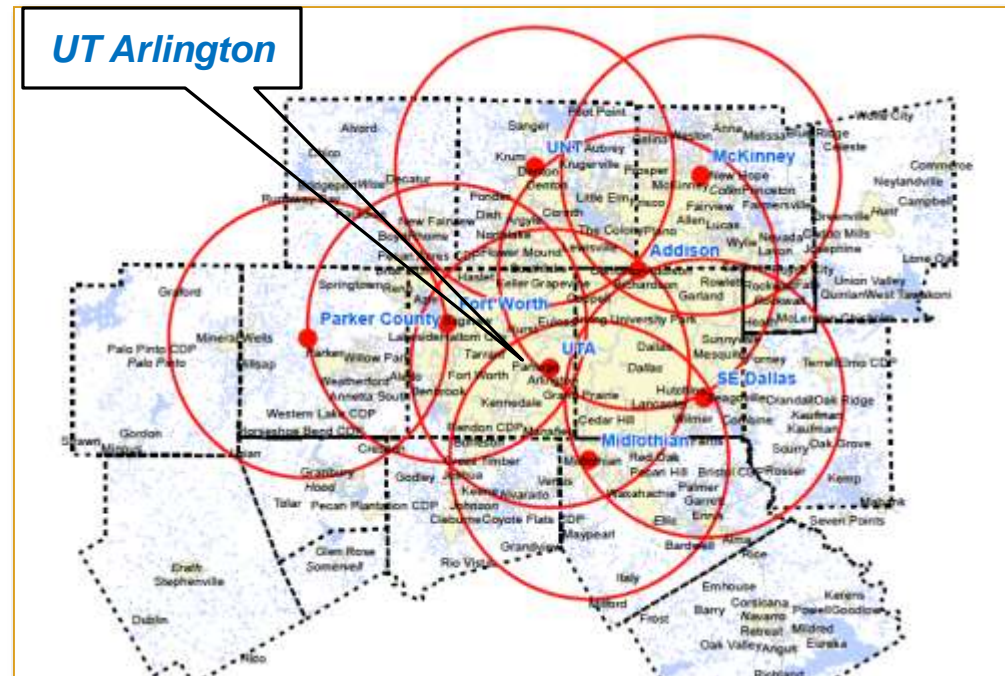
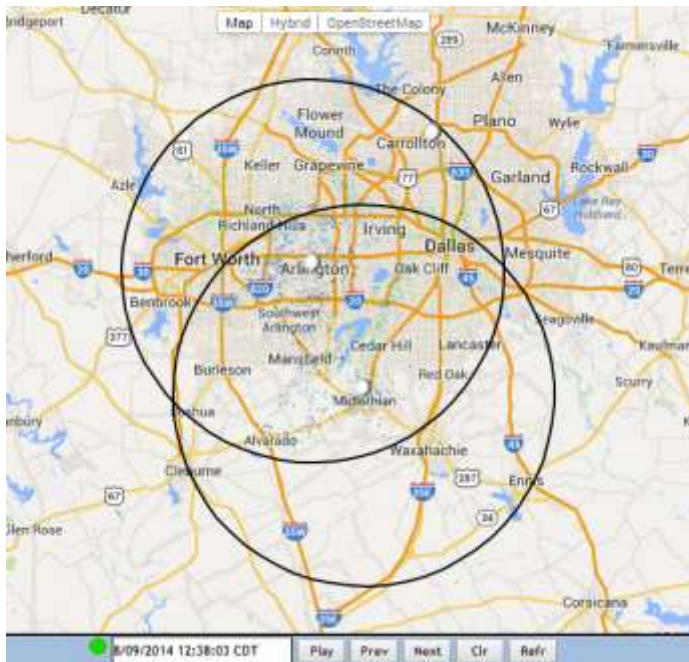
In this presentation



DFW Urban Testbed

• Goals

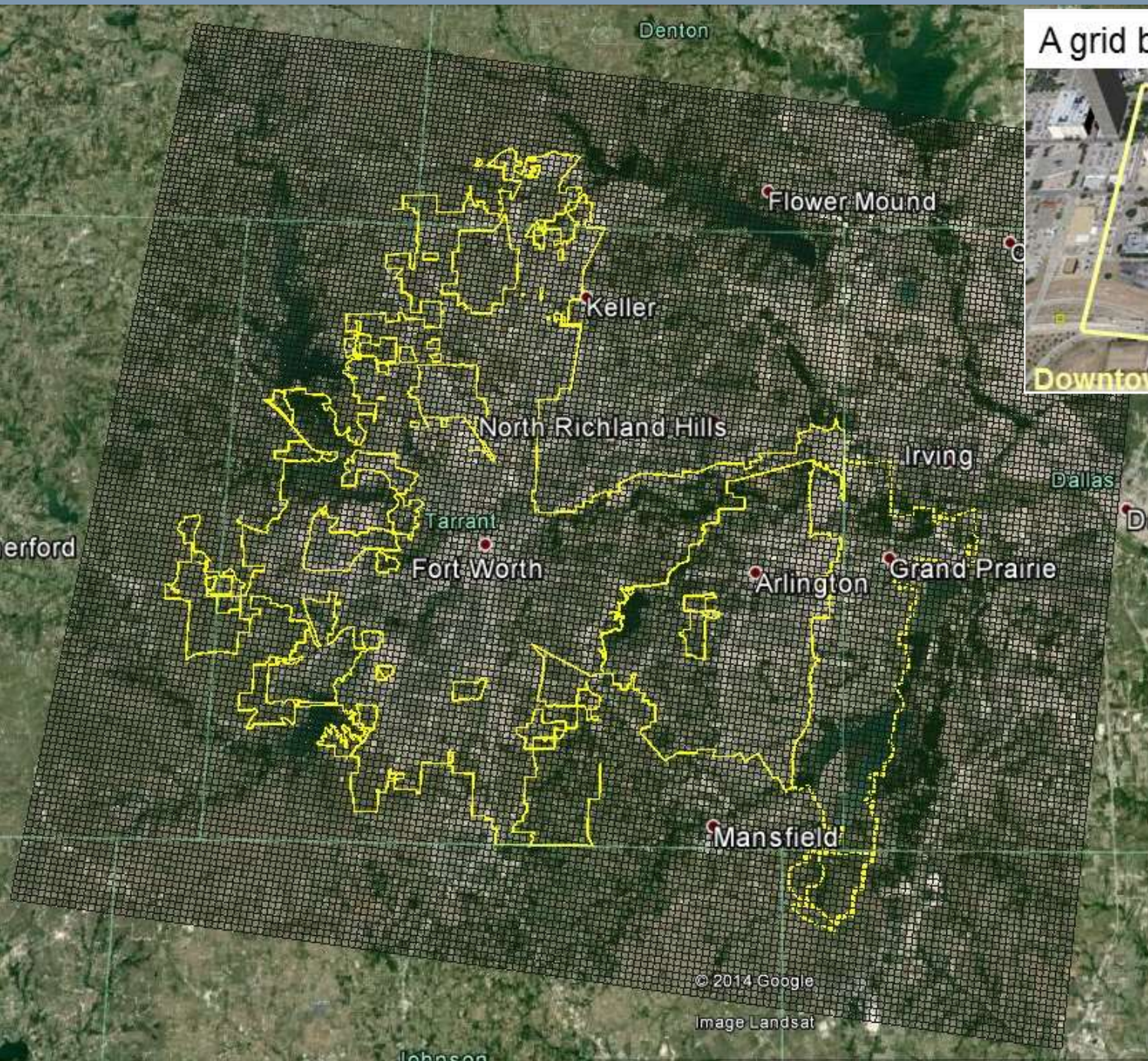
- Demonstrate the CASA radar system's public safety and economic benefits in a densely populated urban environment
- Improve the capacity of the North Central Texas emergency management, environmental, and transportation systems and other benefits
- <http://droc1.srh.noaa.gov/dfw/>



Hydrologic models

- The Hydrology Laboratory Research Distributed Hydrologic Model (HL-RDHM) developed by the NWS Hydrology Laboratory
 - Koren et al. (2004), many DMIP and other references
- Designed for flash flood forecasting, river forecasting and water resources applications
 - Used at Weather Forecast Offices (WFO), River Forecast Centers (RFC) and National Centers for Environmental Prediction (NCEP)
- Supports gridded modeling (w/ or w/o routing)
 - Flexible I/O in standard NWS formats
 - Multiple resolutions
 - **Rainfall-runoff (SAC-HT), snow, frozen ground, hillslope and channel routing (kinematic wave)**
 - Simulation and calibration modes

Models used in this work



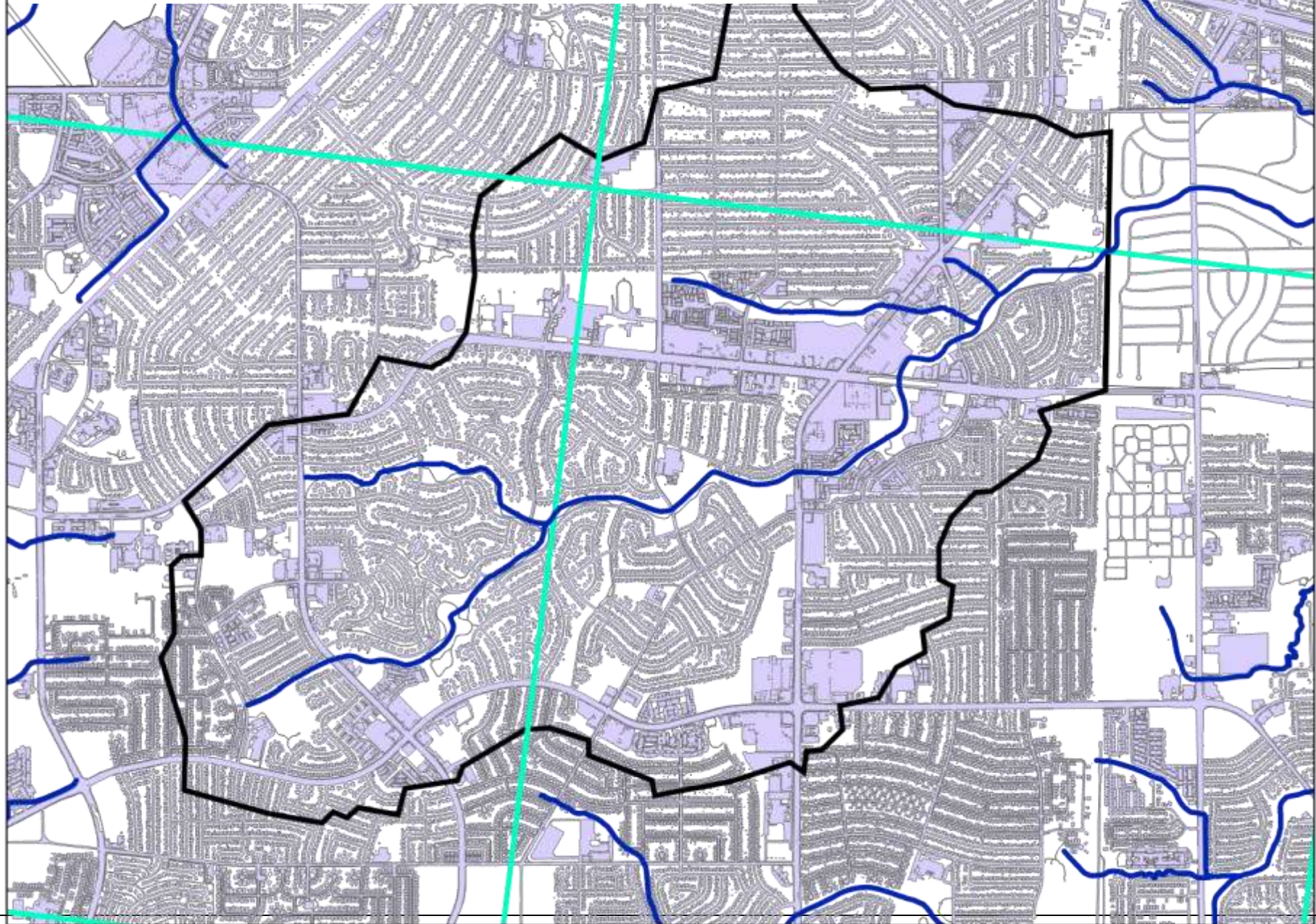
A grid box ($\sim 500 \times 500 \text{ m}^2$)



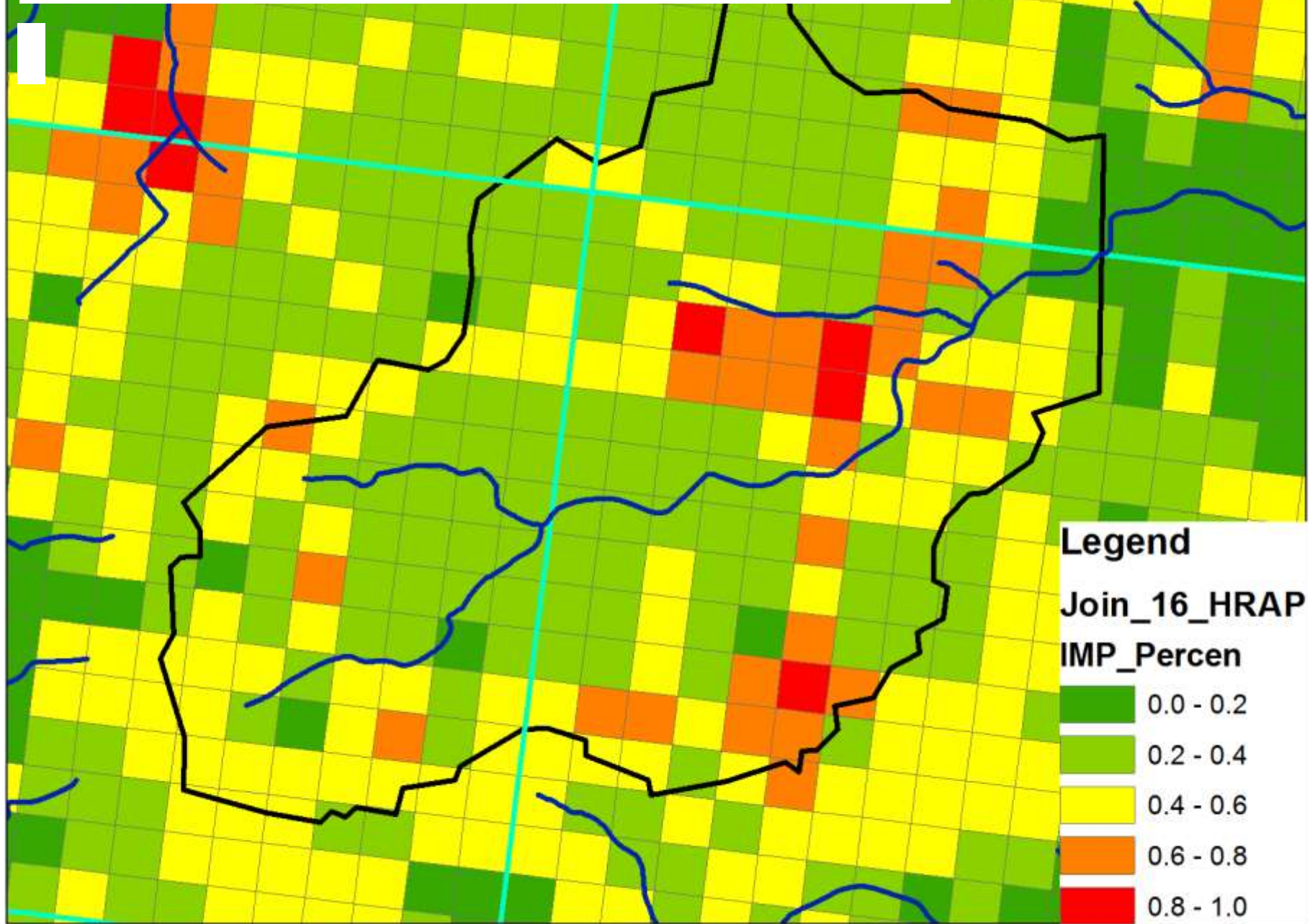
The HLRDHM domain encompassing Fort Worth, Arlington and Grand Prairie.

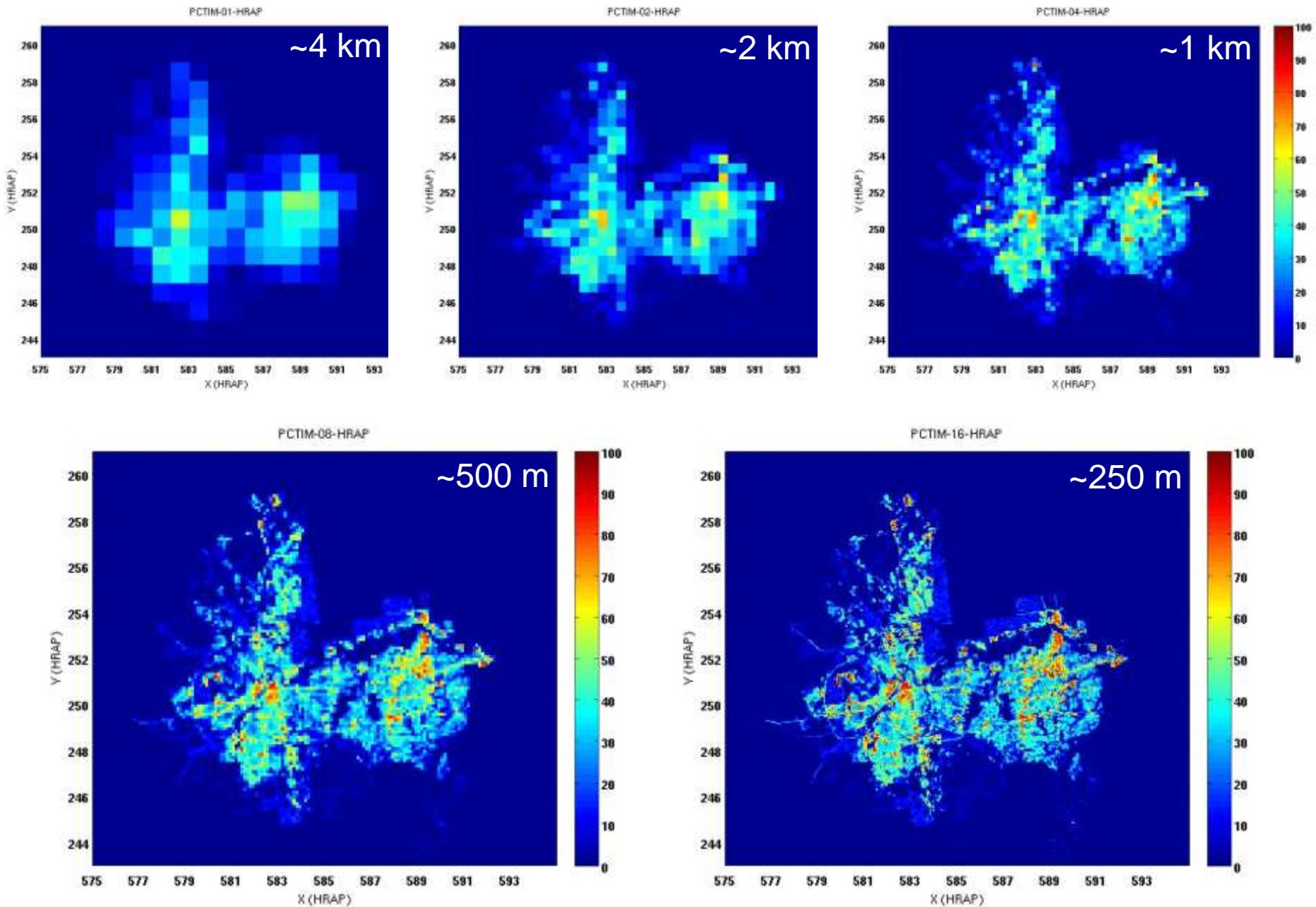
Overlaid is the $500 \times 500 \text{ m}^2$ CASA QPE grid.

Composite of all impervious layers



Imperviousness map on 1/16 HRAP (~250 m) grid



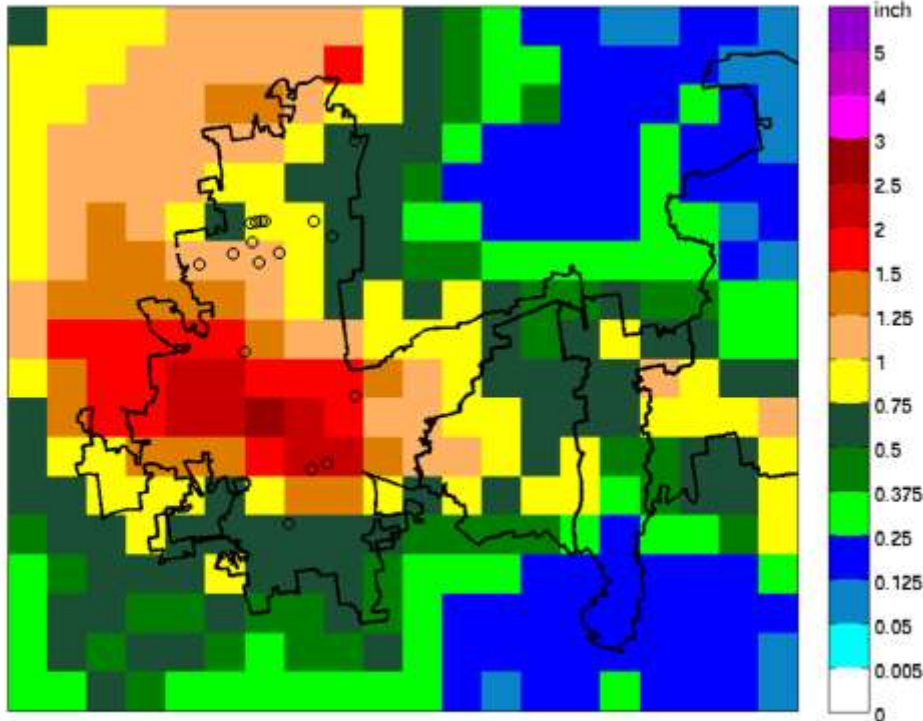


Total precipitation for June 24, 2014

<https://www.youtube.com/watch?v=7clxVjQWj1Q> (from 0:10)

MPE (1 HRAP, 1 hr)

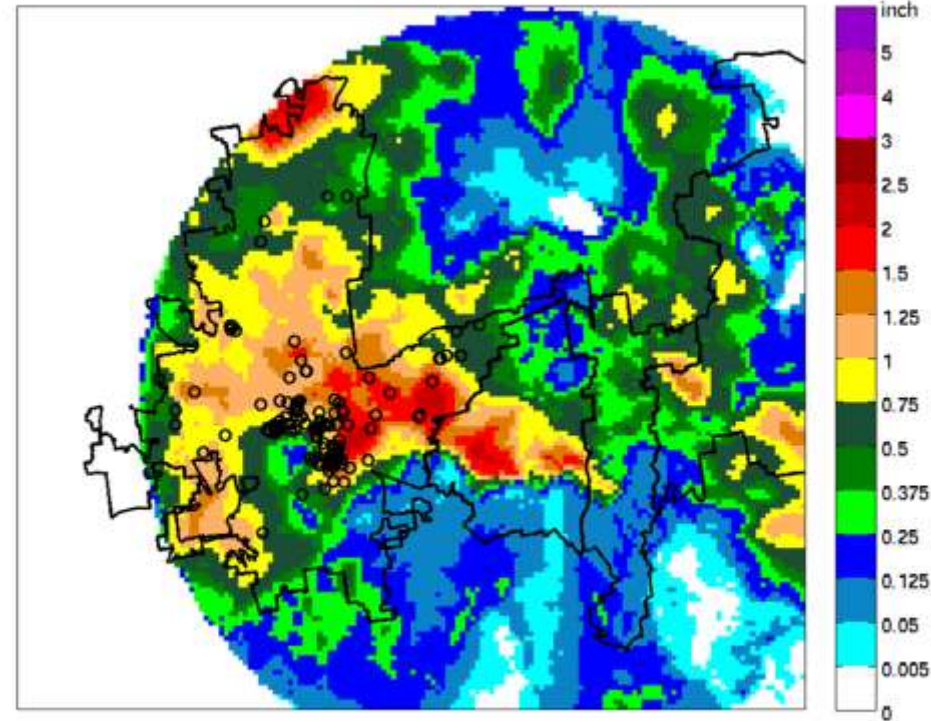
2014 06 24



1 HRAP ~ 4 km

CASA (1/8 HRAP, 1 min)

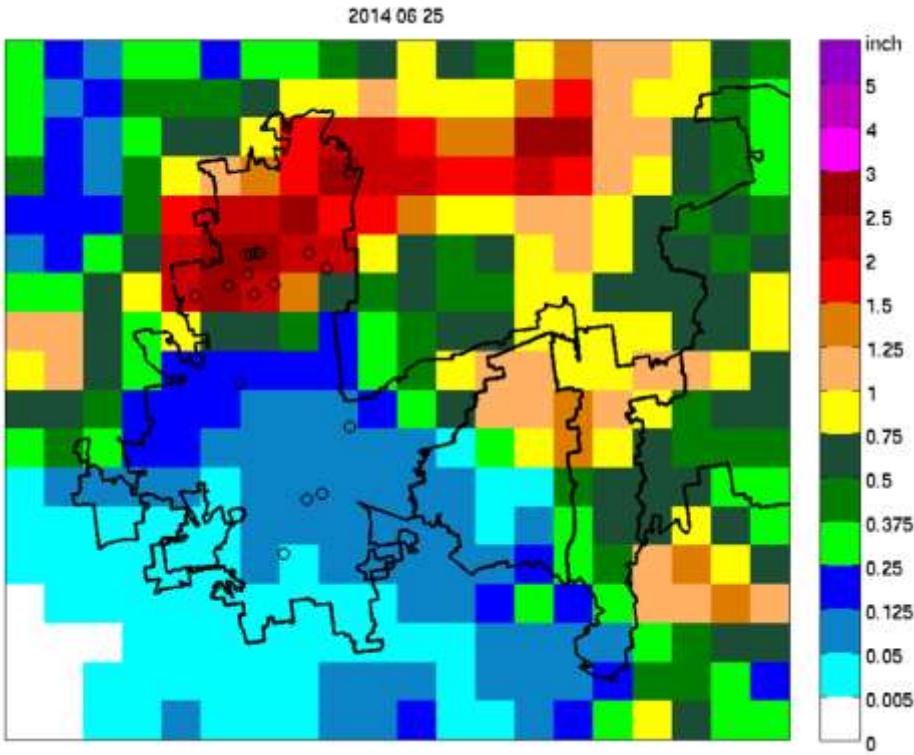
2014 06 24



1/8 HRAP ~ 500 m

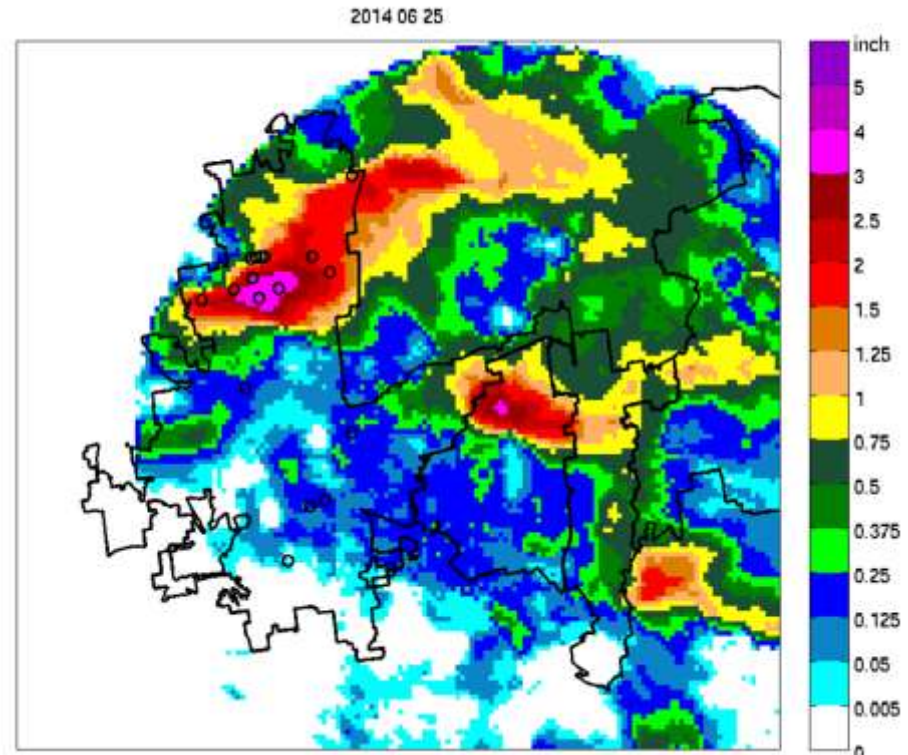
Total precipitation for June 25, 2014

MPE (1 HRAP, 1 hr)



1 HRAP ~ 4 km

CASA (1/8 HRAP, 1 min)



1/8 HRAP ~ 500 m

June 24, 2014, flash flooding in Fort Worth, TX

FLASH FLOOD WARNING

NATIONAL WEATHER SERVICE FORT WORTH TX

434 PM CDT TUE JUN 24 2014

THE NATIONAL WEATHER SERVICE IN FORT WORTH HAS ISSUED A

* FLASH FLOOD WARNING FOR...

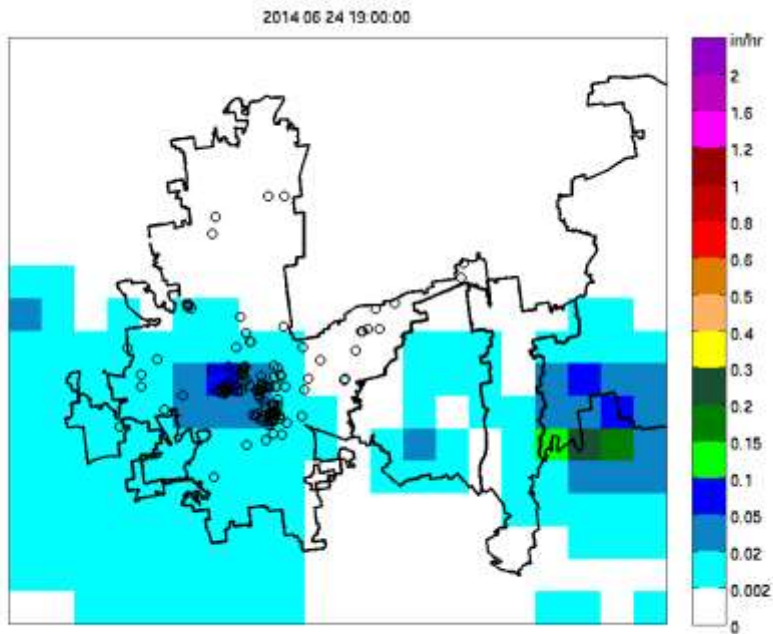
TARRANT COUNTY IN NORTH CENTRAL TEXAS

* UNTIL 630 PM CDT

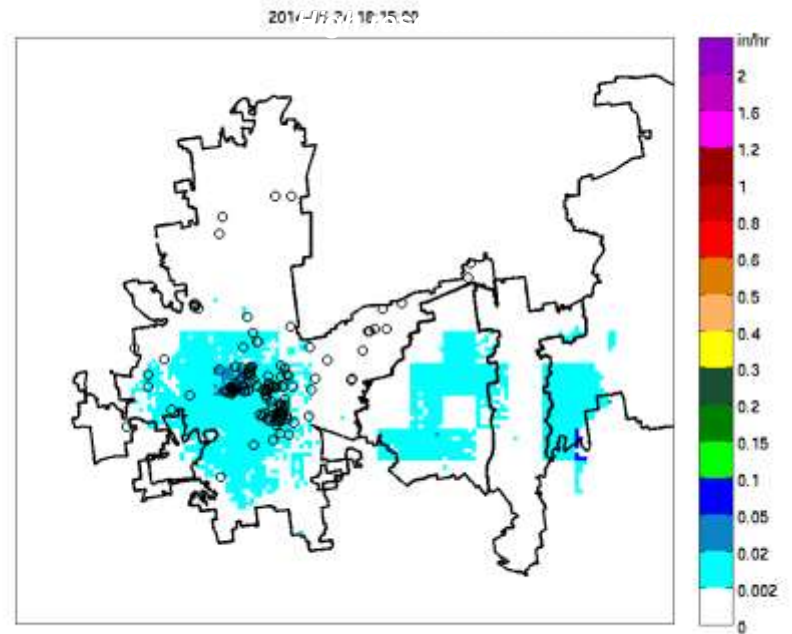
* AT 433 PM CDT...NATIONAL WEATHER SERVICE METEOROLOGISTS DETECTED THUNDERSTORMS WITH HEAVY RAINFALL ALONG A LINE EXTENDING FROM LAKESIDE TO DOWNTOWN FORT WORTH TO PANTEGO. THE STORMS PRODUCING THE HEAVY RAINFALL WERE NEARLY STATIONARY. VERY HEAVY RAINS HAVE ALREADY OCCURRED ACROSS CENTRAL TARRANT COUNTY...AND ADDITIONAL HEAVY RAINFALL WILL RESULT IN FLASH FLOODING THROUGH 630 PM CDT.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

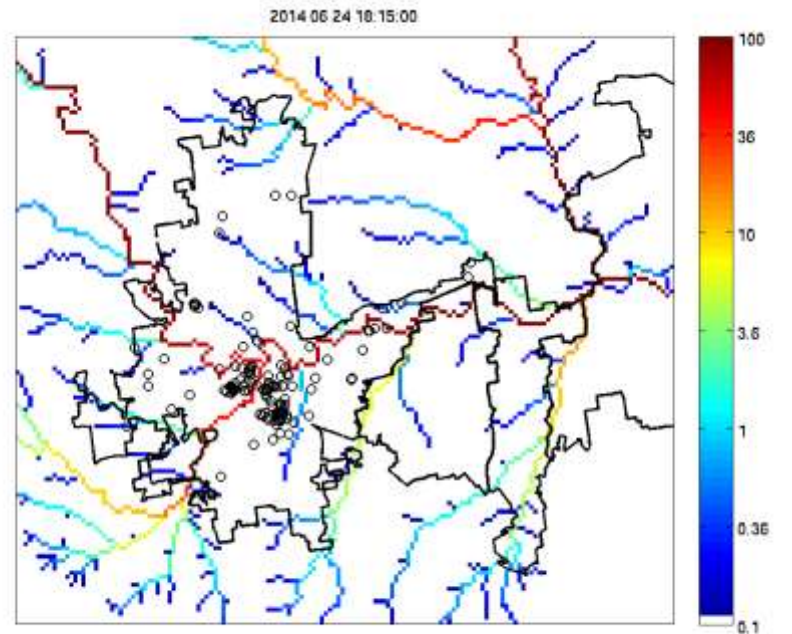
DO NOT DRIVE THROUGH WATER OF UNKNOWN DEPTH. TURN AROUND...DONT DROWN. IT ONLY TAKES TWO FEET OF MOVING WATER TO CARRY AWAY MOST VEHICLES...INCLUDING PICKUPS AND SPORT UTILITY VEHICLES. TAKE A DIFFERENT ROUTE TO REACH YOUR DESTINATION OR WAIT UNTIL WATER RECEDES. CHILDREN SHOULD NEVER PLAY AROUND HIGH WATER...DRAINAGE DITCHES...STORM DRAINS...OR FLOODED STREAMS.



MPE precipitation



MPE-forced runoff



MPE-forced streamflow

4 km, hourly precipitation uniformly disaggregated to 500 m, 15 min

The empty black circles represent the locations of flooding reports by residents during the course of each day of the 2-day period.

The circles turn red at the time when flooding was first reported.

2014-06-24 18:01:00



CASA precipitation

500 m, 1 min

The empty black circles represent the locations of flooding reports by residents during the course of each day of the 2-day period.

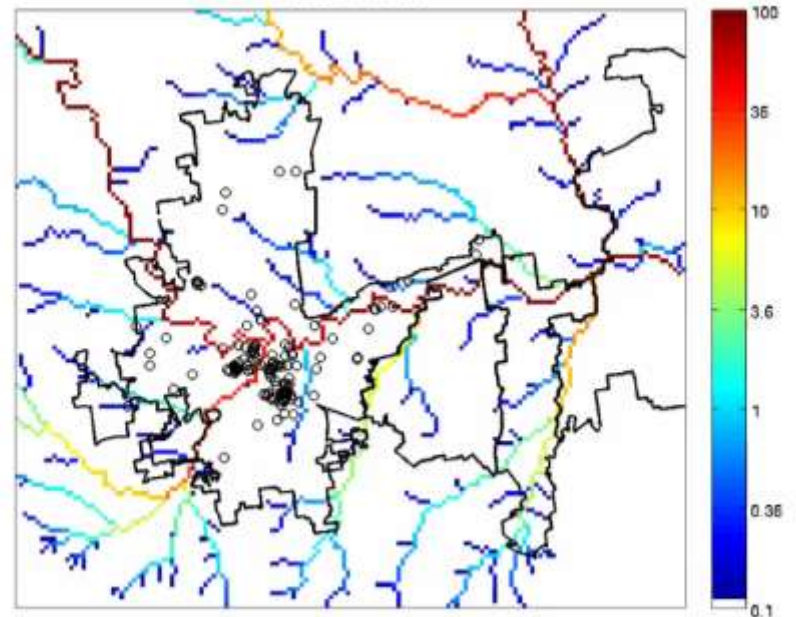
The circles turn red at the time when flooding was first reported.

2014-06-24 18:01:00



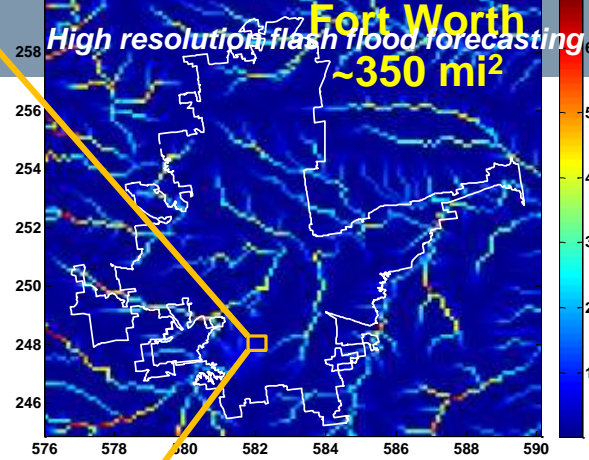
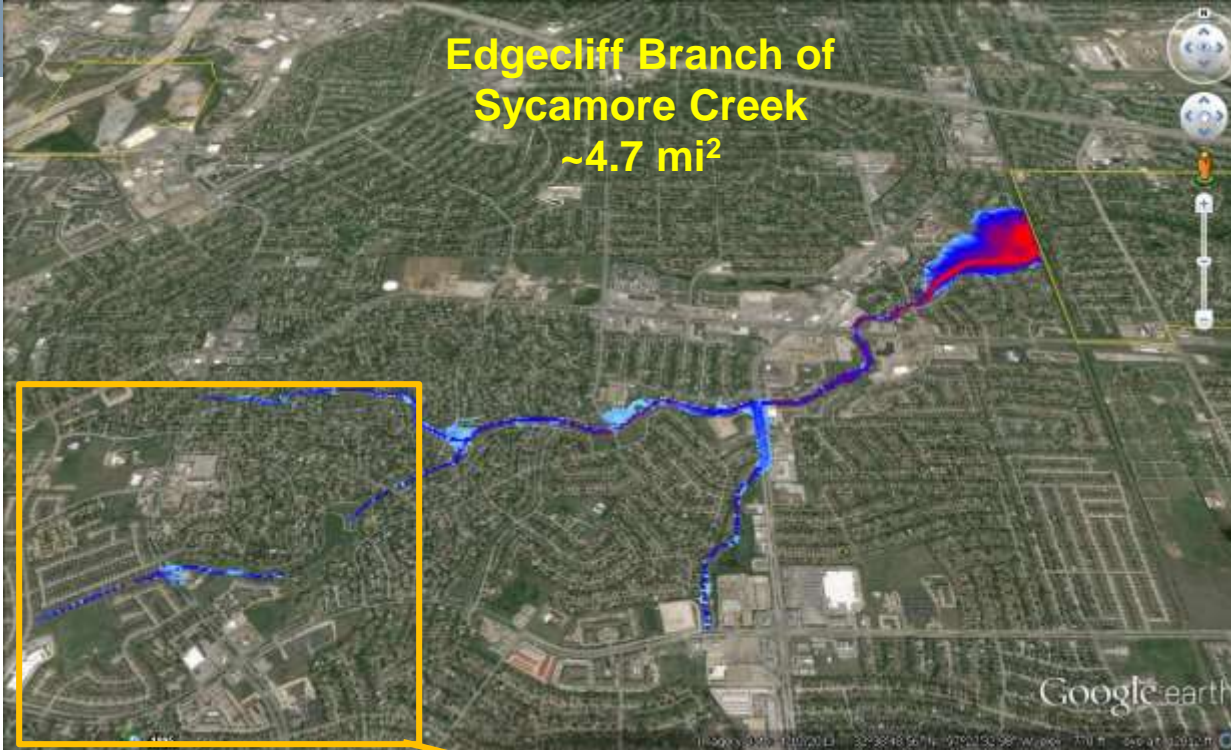
CASA-forced runoff

2014-06-24 18:01:00



CASA-forced streamflow

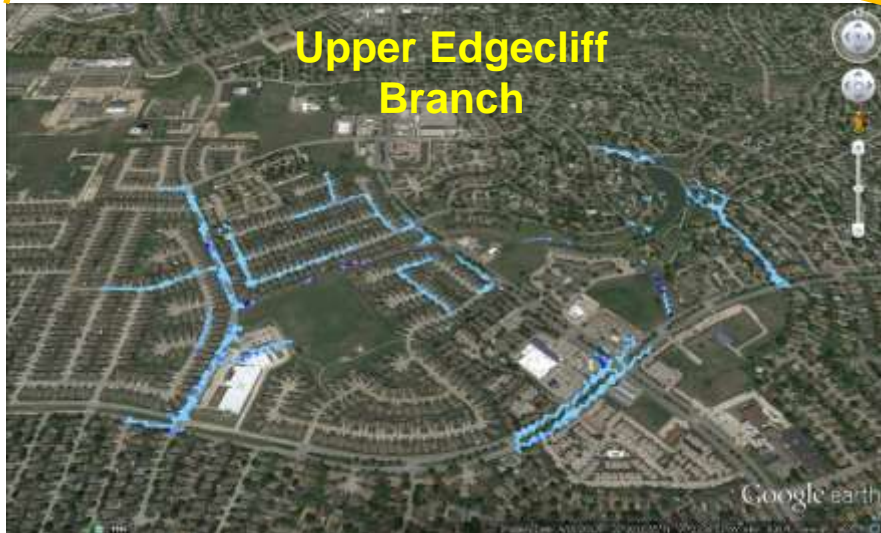
**Edgecliff Branch of
Sycamore Creek
~4.7 mi²**



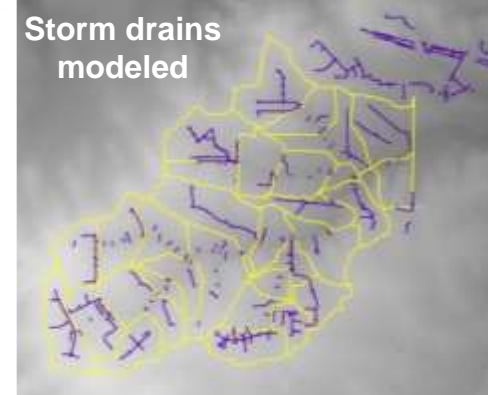
**Channel flow modeled
by HLRDHM**

**1-D channel and storm drain
flow + 2D surface water flow
modeled by SWMM for the
Edgecliff Branch of the
Sycamore Creek**

**Upper Edgecliff
Branch**

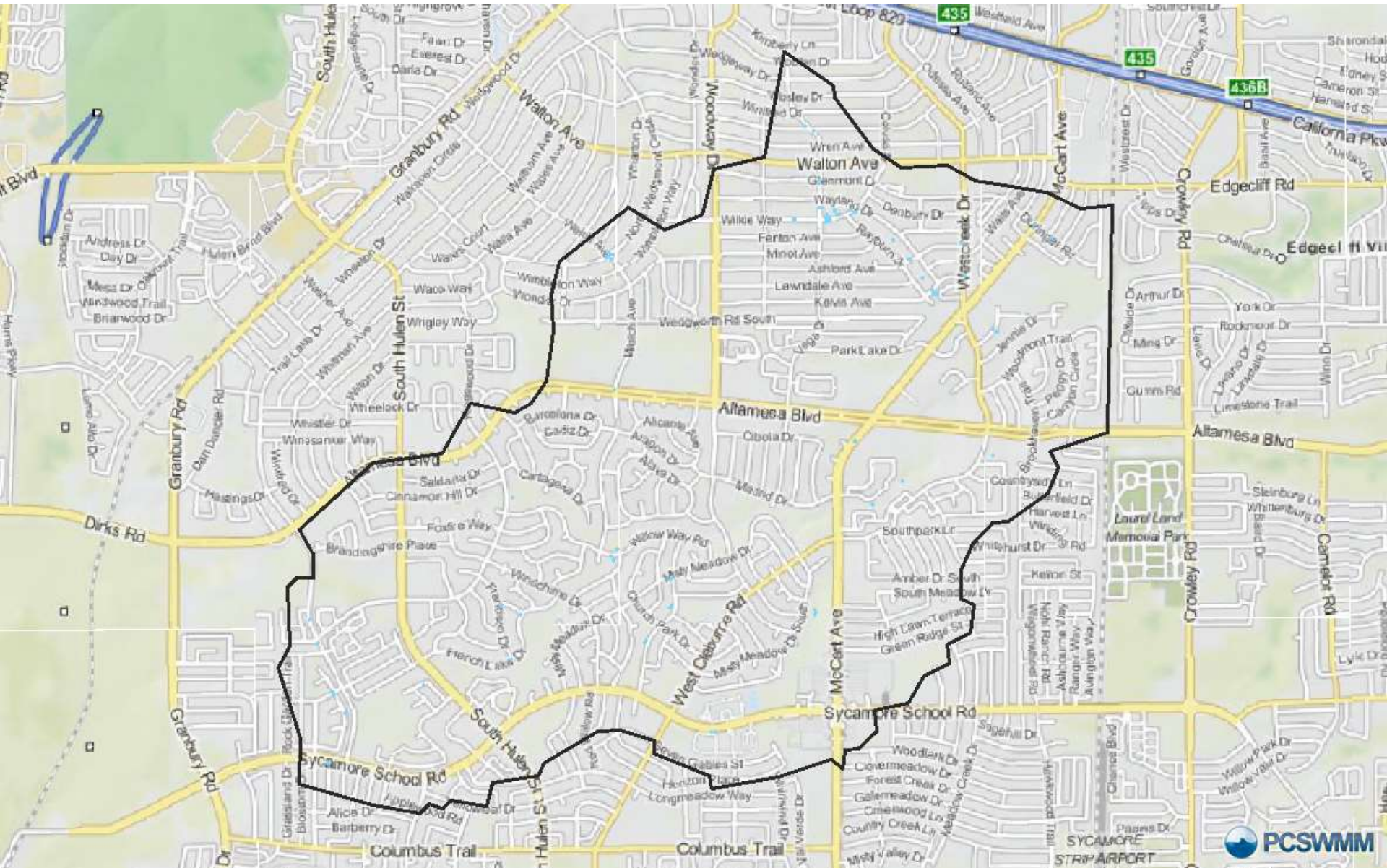


**1D-2D flow modeled
by SWMM for upper
part of the Edgecliff
Branch**



**Storm drains
modeled**

Oct 12, 2011, event - Water depth

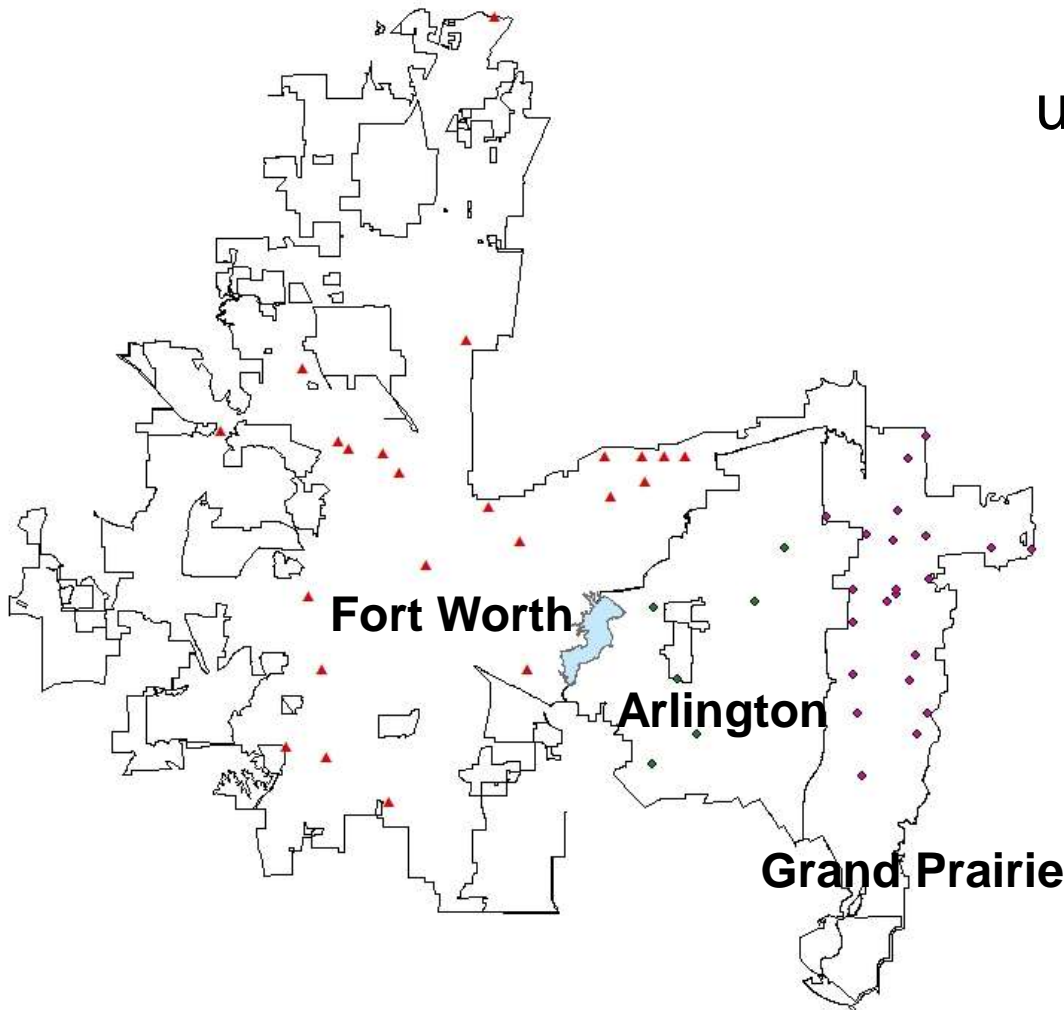


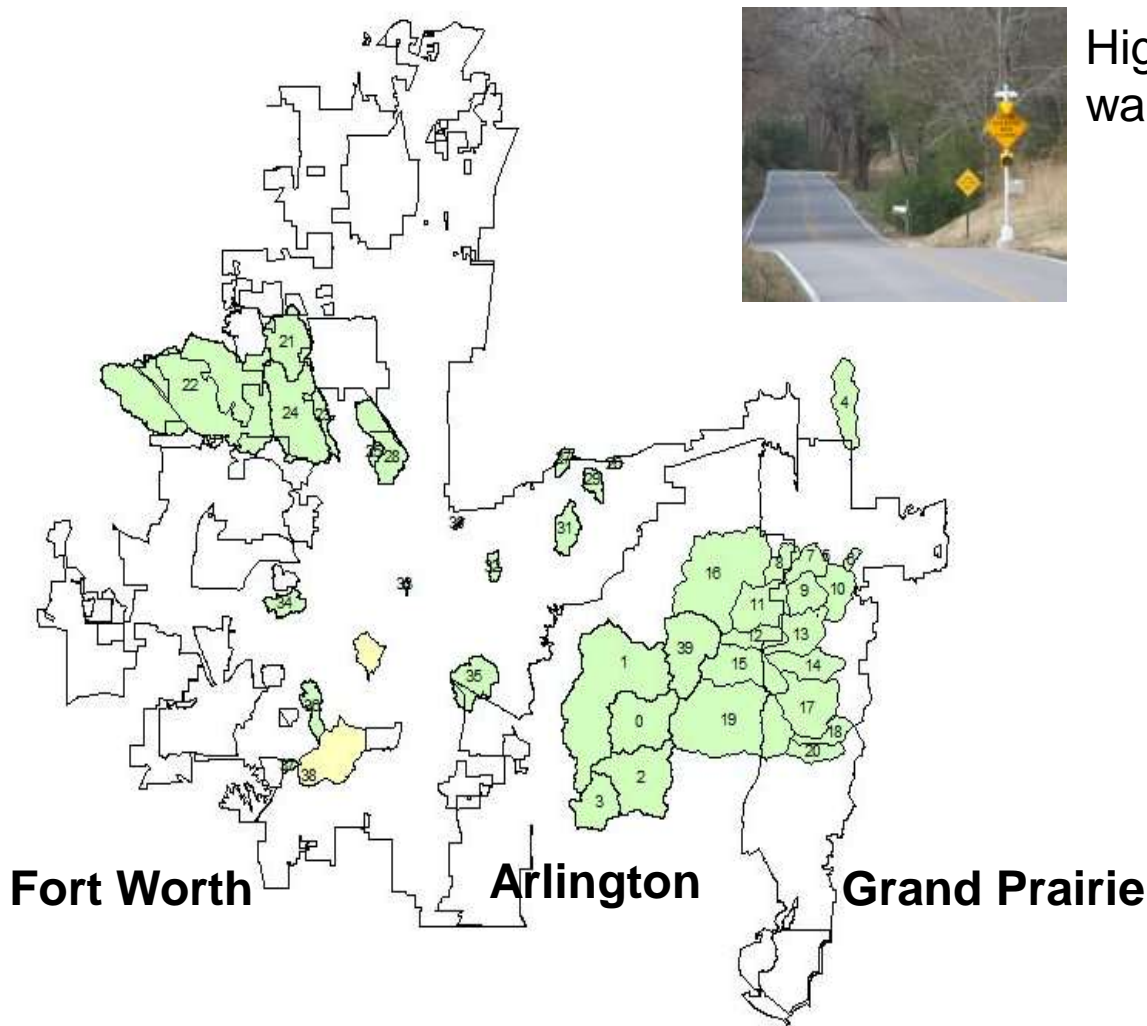
Oct 12, 2011, event – Water velocity



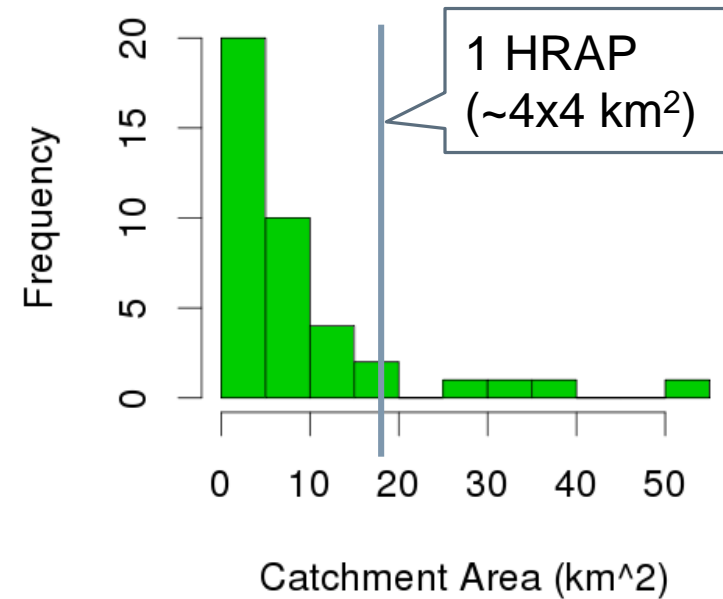
Hydrologic evaluation

Water level observations
using pressure transducers



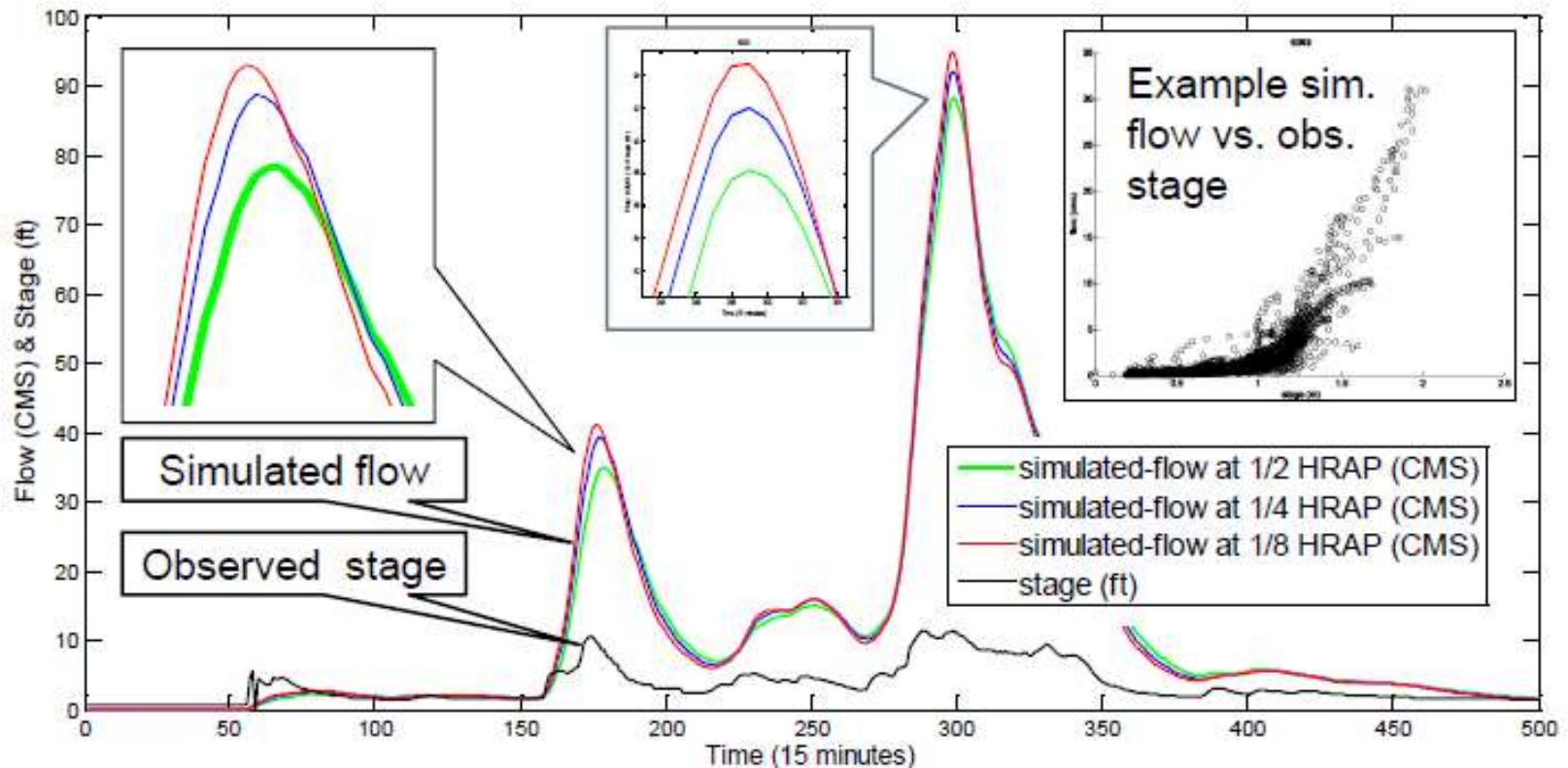


High-water
warning flasher

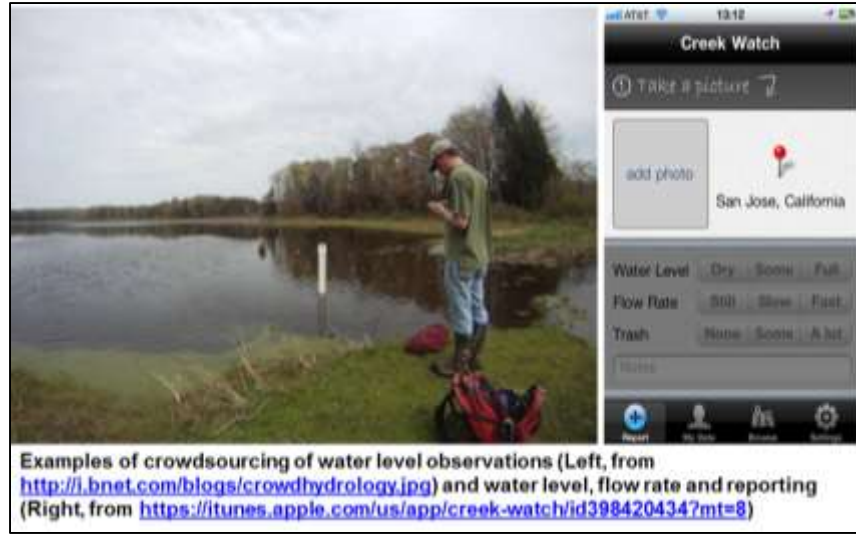
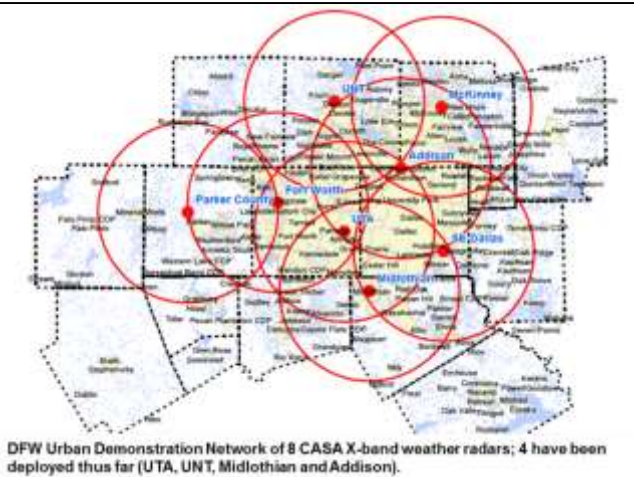


Water level sensor locations and the contributing areas in Fort Worth (left), Arlington (middle) and Grand Prairie (right). Also shown in yellow are the Edgecliff Branch of the Sycamore Creek (lower) and the Forest Park-Berry (upper) Catchments.

Streamflow simulation results (cont.)



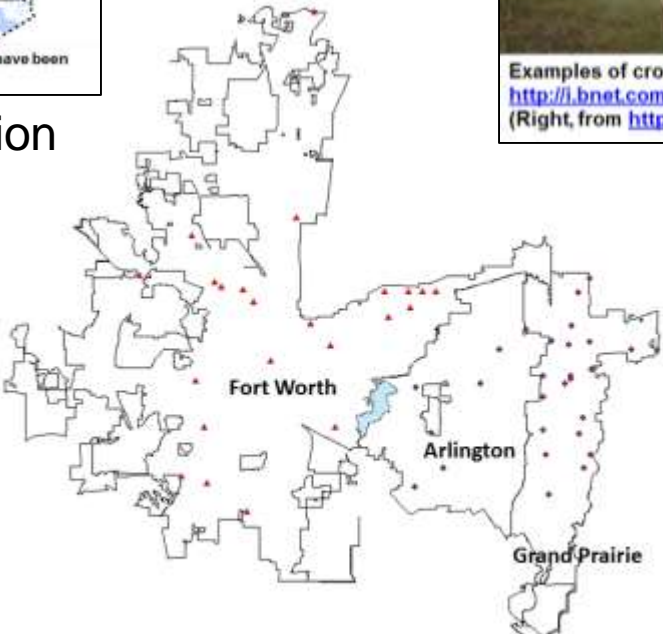
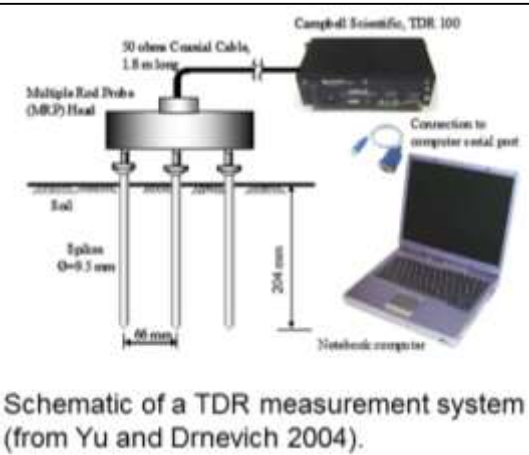
Example HLRDHM simulations of streamflow at different resolutions at Johnson Creek at Avenue J in Grand Prairie, TX, for Tropical Storm Hermine in Sep 2010.



High-resolution precipitation

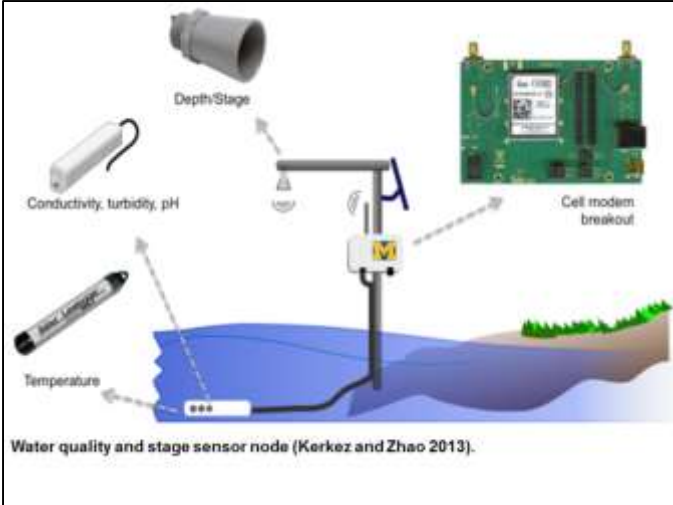
Crowd-sourced water obs

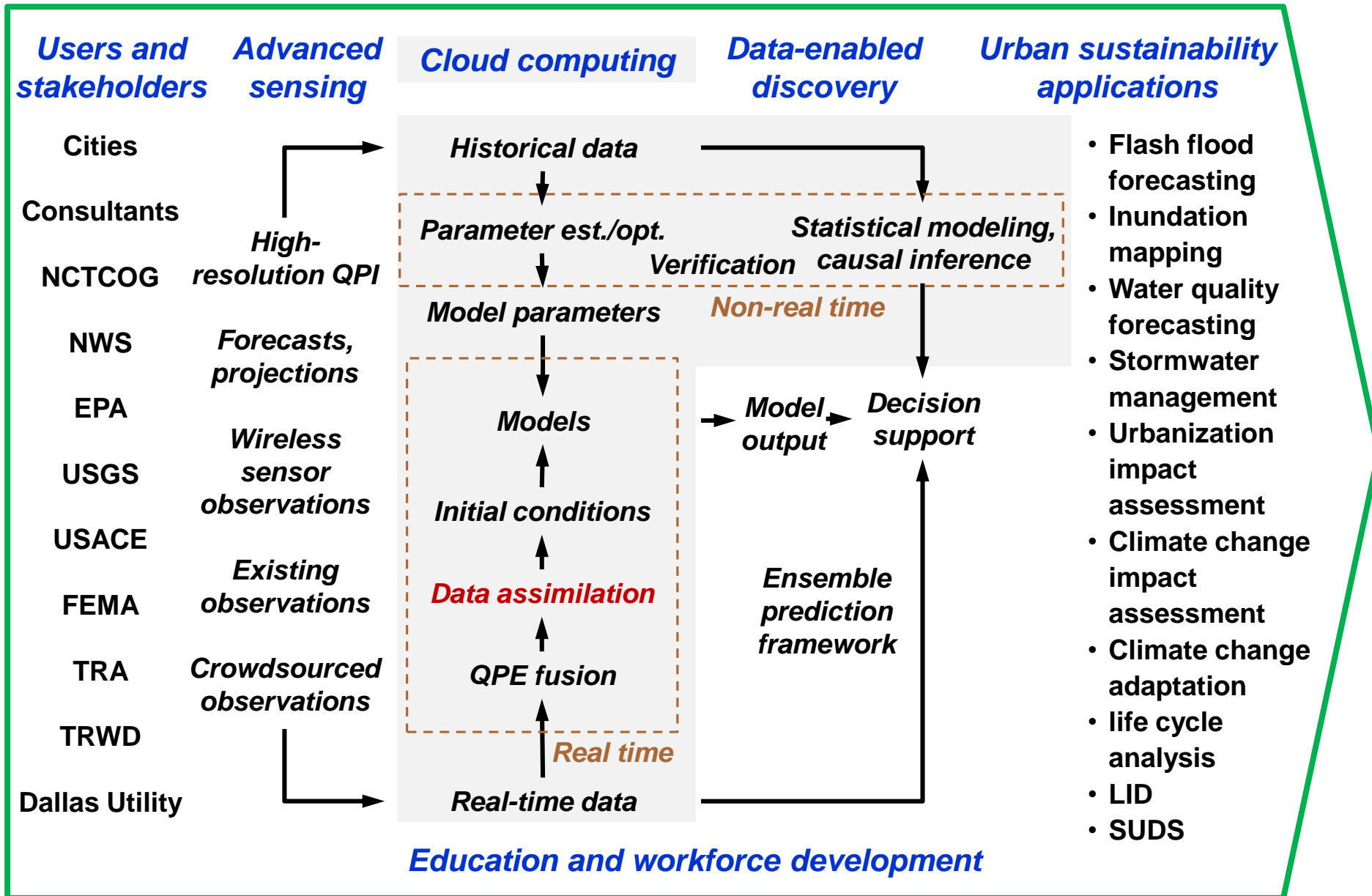
Soil moisture



Improving understanding and prediction of the urban water cycle via improved observation, modeling and model-data fusion

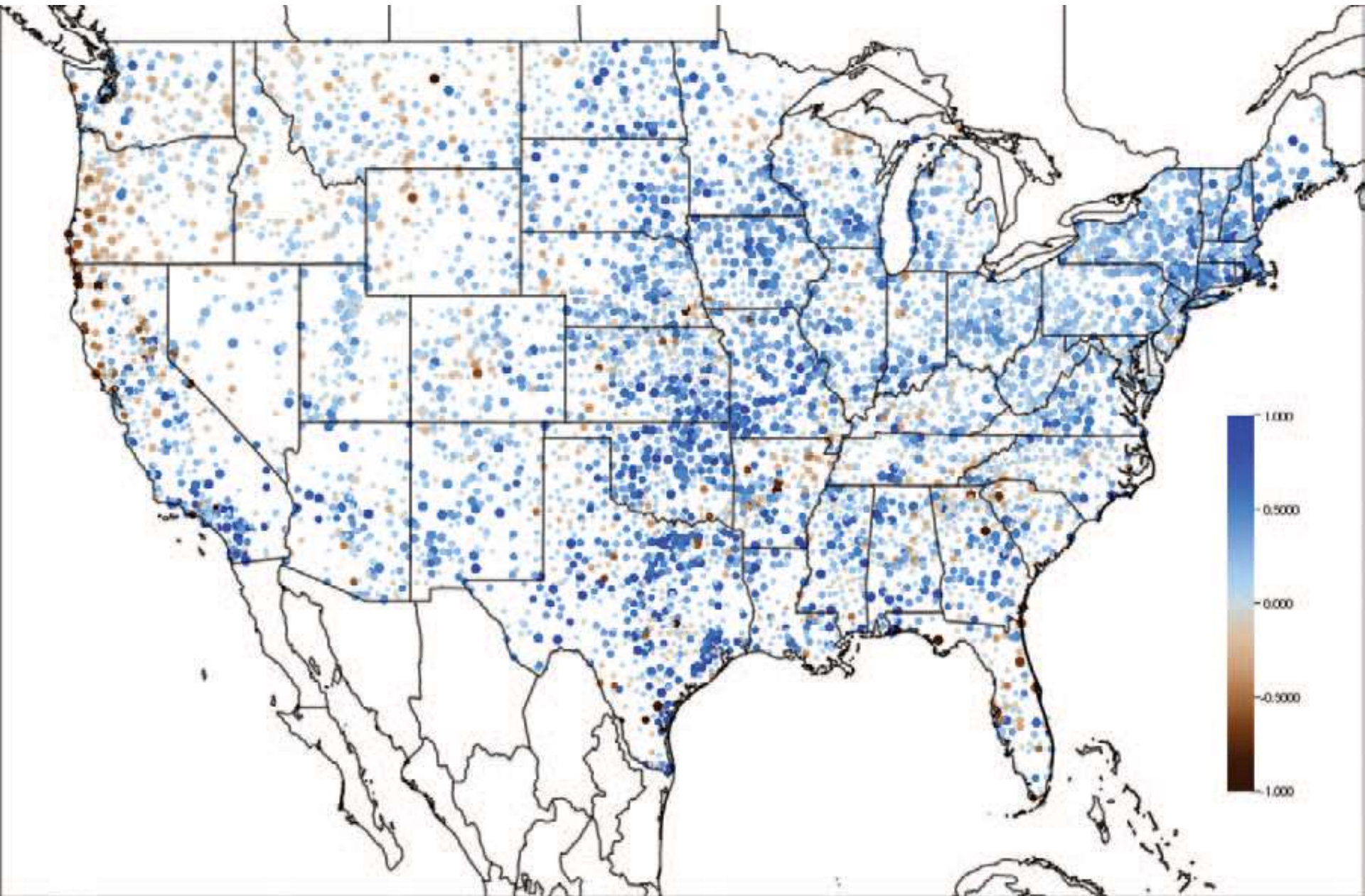
Water level, quality





Integrative sensing and prediction of urban water for sustainable cities (iSPUW)

Changes in observed 20-yr return value of the daily accumulated precipitation (in.) from 1948 to 2010 (Kunkel et al. 2013)



THANK YOU

Q/A, Discussion

For more info, contact

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To benefit from high-resolution modeling, high-resolution high-quality QPE is necessary

