EF5: A hydrologic model for prediction, reanalysis and capacity building

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Ensemble Framework for Flash Flood Forecasting

Inputs
Model
Outputs

Flamig, Z. L., H. Vergara, R. Clark III, Y. Hong, and J. J. Gourley, 2016: EF5: Version 1.0. doi: 10.5281/zenodo.59123

Precipitation
Native data options:
1. MRMS
2. GPM/TMPA RT
3. Any GeoTIFF
   - ✓ QPE
   - ✓ QPF

Evapotranspiration
Native data options:
1. GeoTIFF PET
2. GeoTIFF temperatures

Snowmelt
Simulation options:
1. SNOW-17

Surface Runoff
Simulation options:
1. CREST
2. SAC-SMA
3. Hydrophobic

Routing
Simulation options:
1. Linear reservoir
2. Kinematic wave

Inundation
Simulation options:
1. Mass conservation

Outputs
Type options:
1. Streamflow
2. Recurrence interval
3. Water depth
4. Soil moisture

Parameter Optimization
Type options:
1. DREAM

23 May 2017

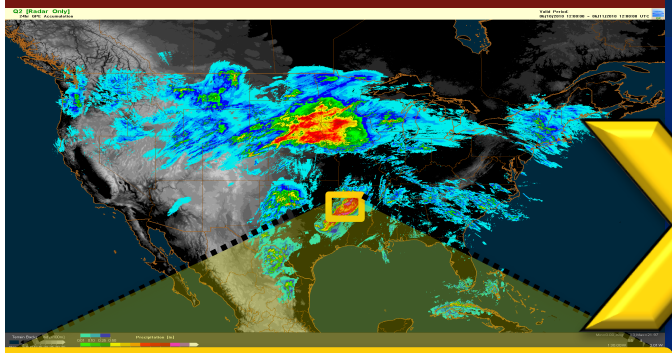
Ensemble Framework for Flash Flood Forecasting

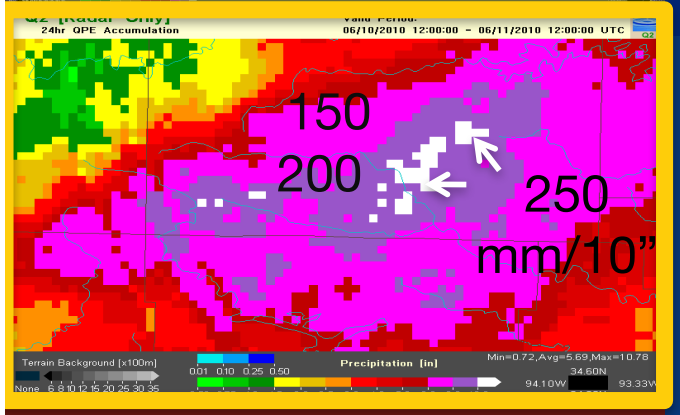
- C++
- 19,815 Lines of code
- 1,189 Total water balance (6%)
- 919 Total routing (5%)
- 89% “Glue” code!
  - Configuration
  - I/O

Multi-Radar Multi-Sensor QPE (MRMS) Flooded Locations And Simulated Hydrographs (FLASH)

FLASH
Flooded Locations and Simulated Hydrographs Project

MRMS/Q3 Rainfall Observations
-1km²/2 min



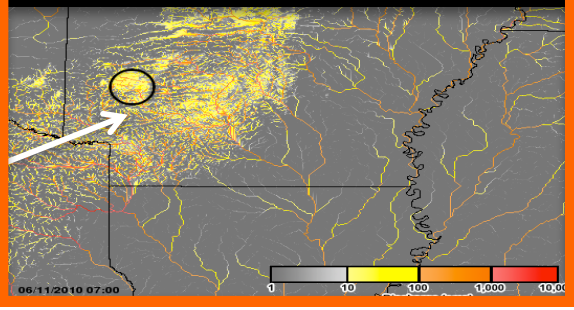


10-11 June 2010, Albert Pike Rec Area, Arkansas

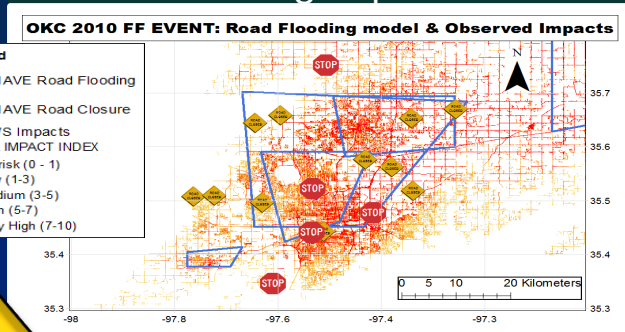
Stormscale Distributed Hydrologic Model Framework
-1km²/10 min

20 fatalities

Simulated surface water flows and return period



Flooding Impacts



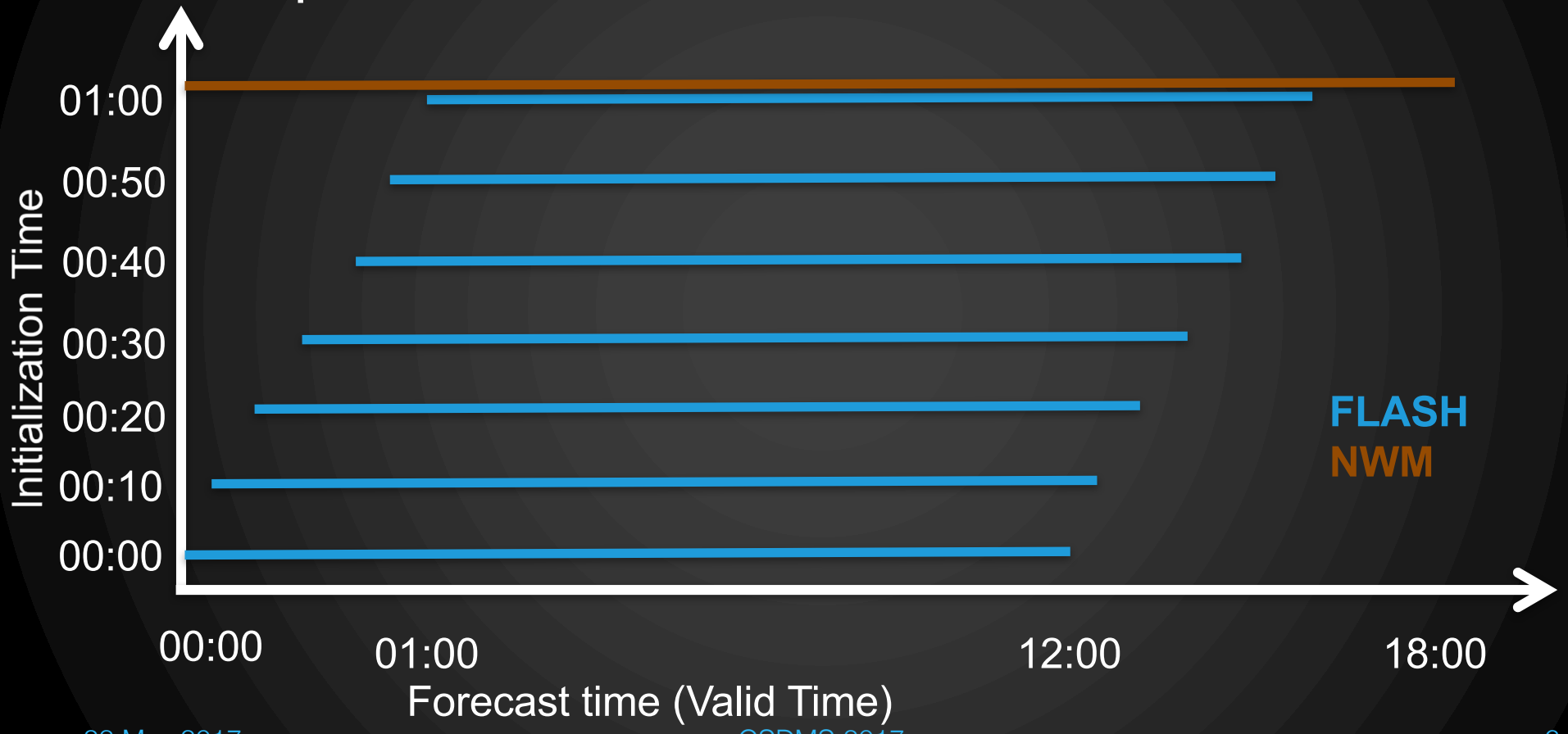
Probabilistic Forecast Products on the Flash Flood Impacts and Magnitudes (70% chance of hazardous road flooding)

First distributed hydrologic modeling framework to operate at the flash flood scale in real-time across the conterminous USA

Comparison with National Water Model

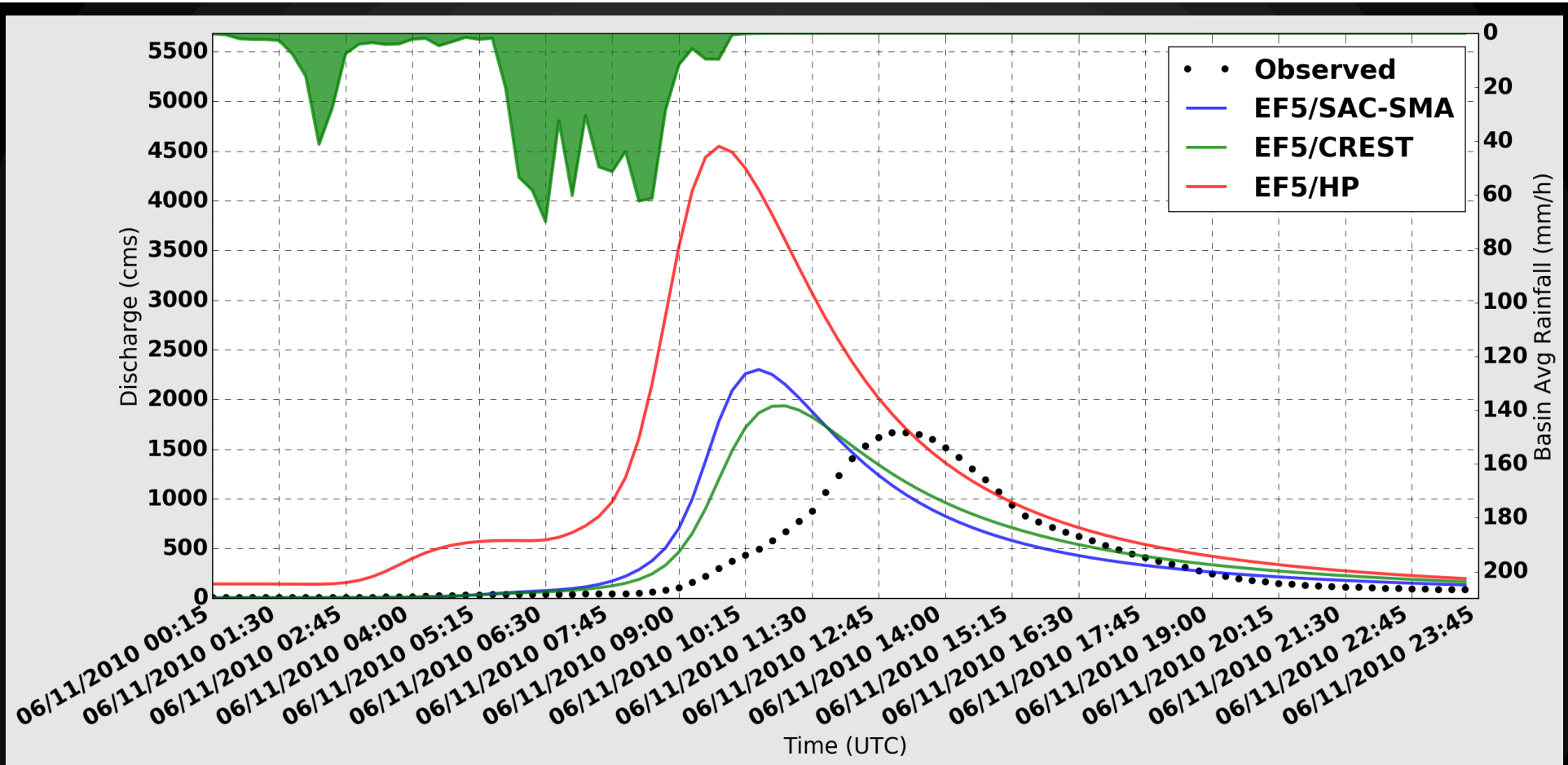
- NWM
  - 2.6 million forecast points
  - Single physics solution
  - Calibrated
- FLASH
  - 10.2 million forecast points
  - Multiple water balance physics
  - A priori parameters

Comparison with National Water Model

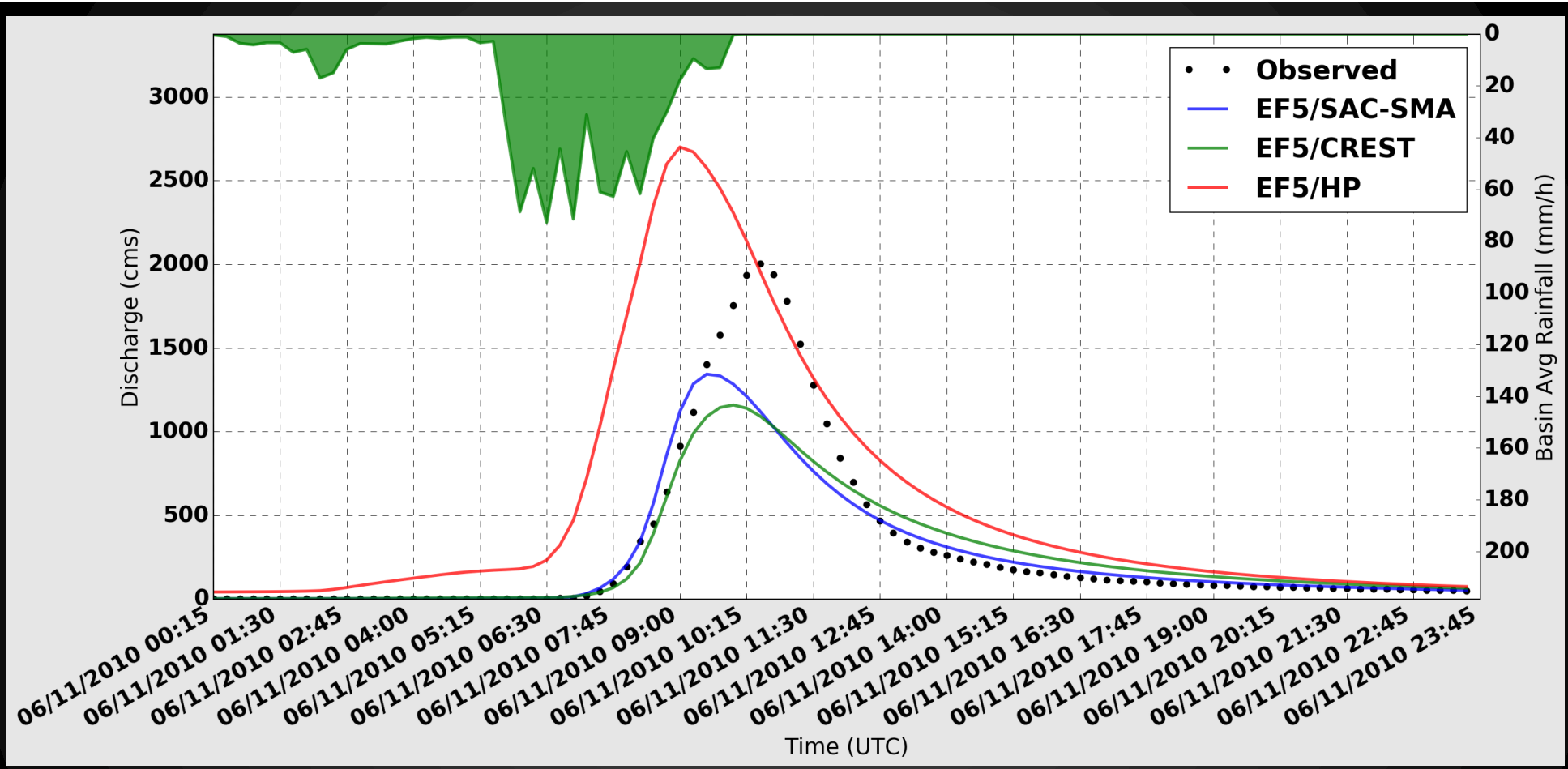


Hydrologic Reanalysis

- EF5 with CREST/SAC-SMA/HP & Kinematic Wave Routing
  - Apriori parameters
  - 0.01x0.01˚ spatial resolution over CONUS
  - 5-minute time steps
  - MRMS precipitation rate as forcing
- Kept daily values
  - Maximum Q
  - Time of maximum Q
  - Maximum unit Q
  - Minimum soil moisture
- Kept complete basin outlet time series for gauged basins <1000 km^2
- 2002-2011 period of record for MRMS forcing
  - 2001 used as warmup period

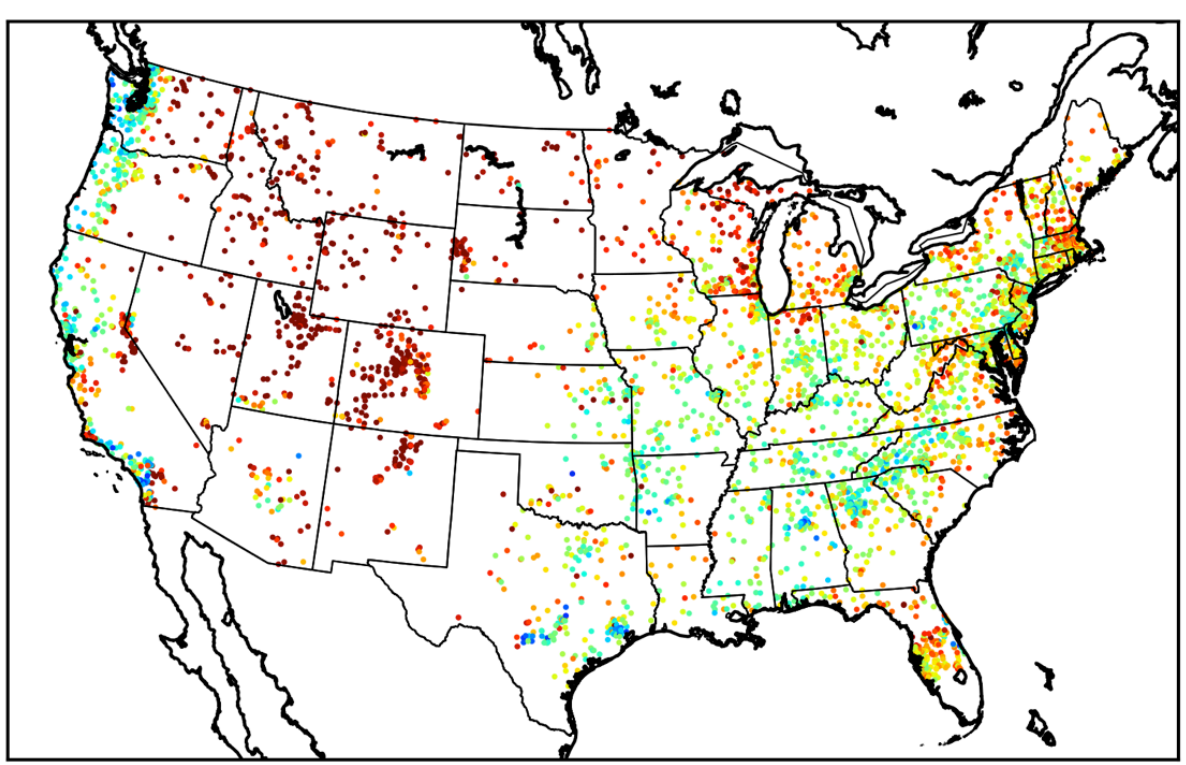


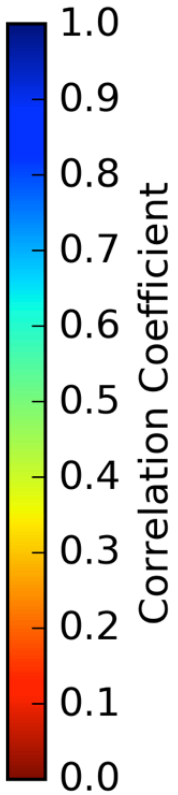
Observed and simulated hydrographs from Caddo River near Caddo Gap, AR. The contributing basin area at this point is 352 km^2.



Observed and simulated hydrographs from Little Missouri River near Langley, AR. The contributing basin area at this point is 177 km^2.

Simulation Validation

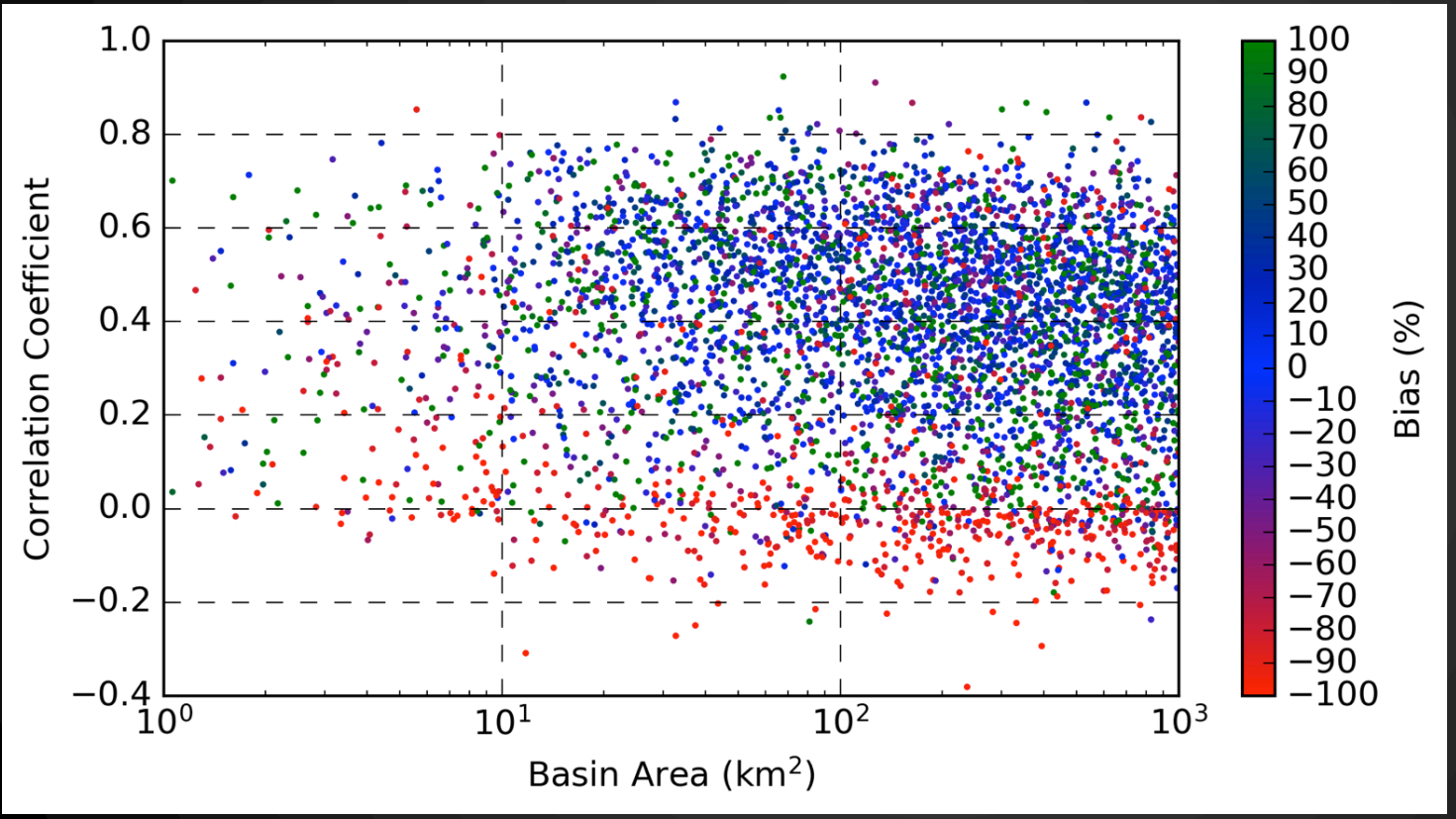




CREST water balance

4,366 USGS gauges

Simulation Validation



CREST water balance

4,366 USGS gauges

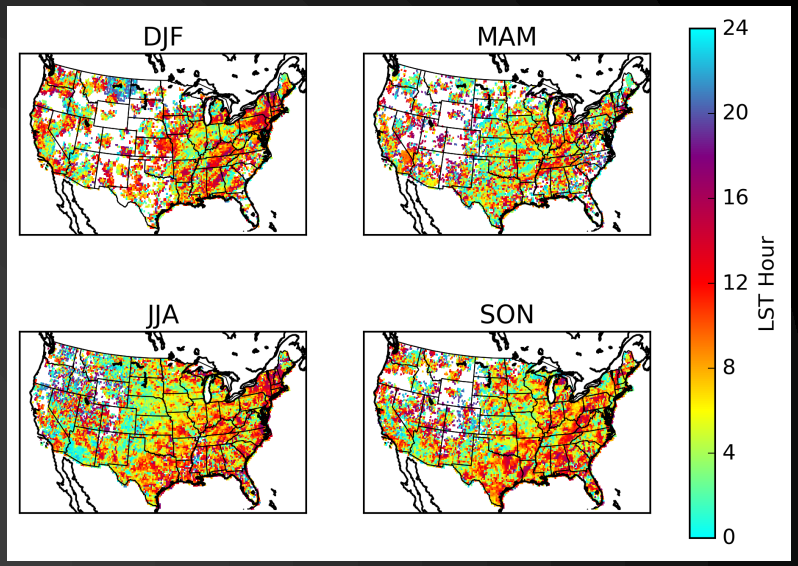
FLASH Reanalysis

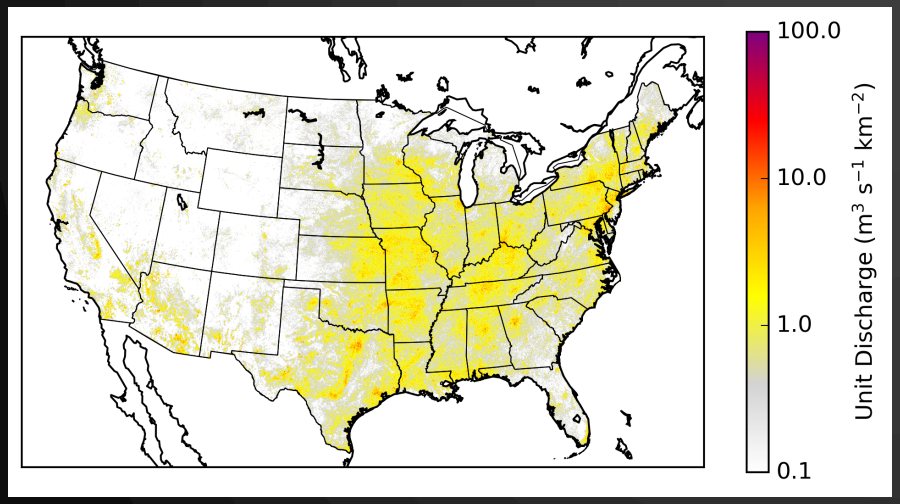
Flooded Locations and Simulated Hydrographs Project

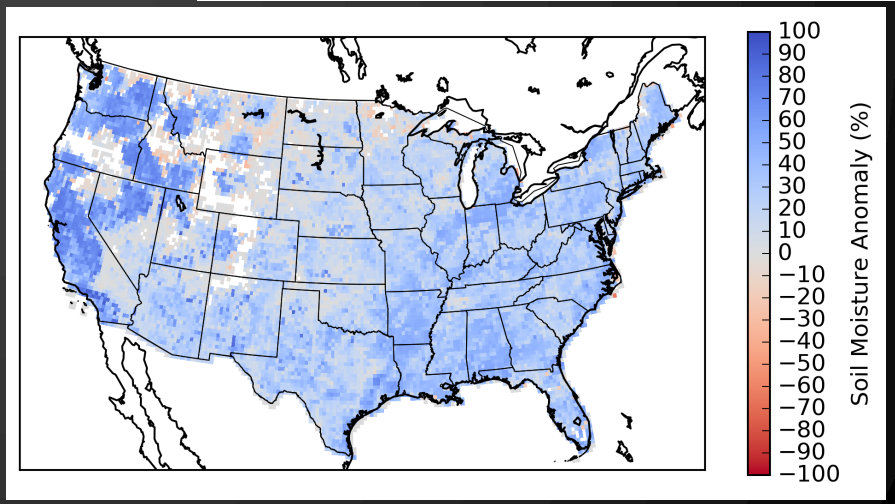
http://flash.ou.edu/reanalysis

Produced daily from 2002-2011:

- Maximum Streamflow
- Maximum Unit Streamflow
- Time of day of Maximum Streamflow
- Minimum Soil Moisture







EF5 Capacity Building

Windhoek, Namibia 2015

Puebla, Mexico 2015

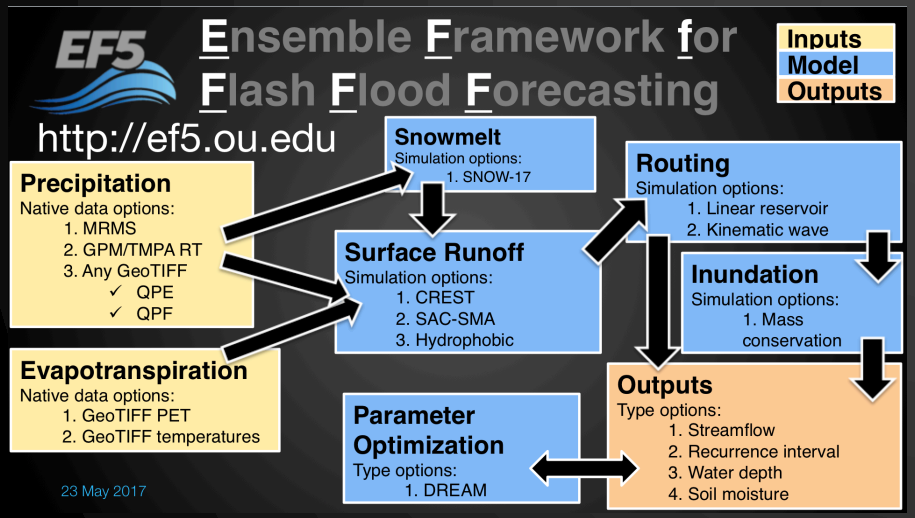
Nairobi, Kenya 2017

Villahermosa, Mexico 2015

Windhoek, Namibia 2016

EF5

http://ef5.ou.edu



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Produced daily from 2002-2011:

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http://ef5.ou.edu/videos