Different types of flash flood observations for model development and diagnosis

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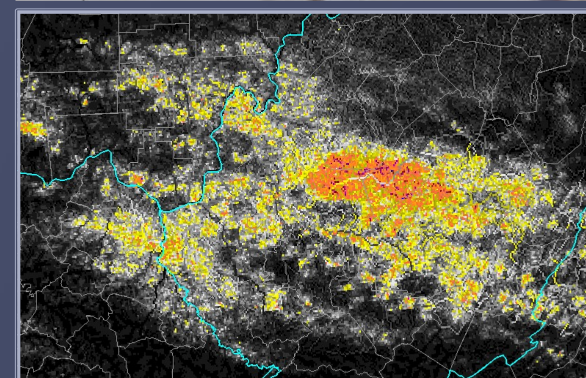


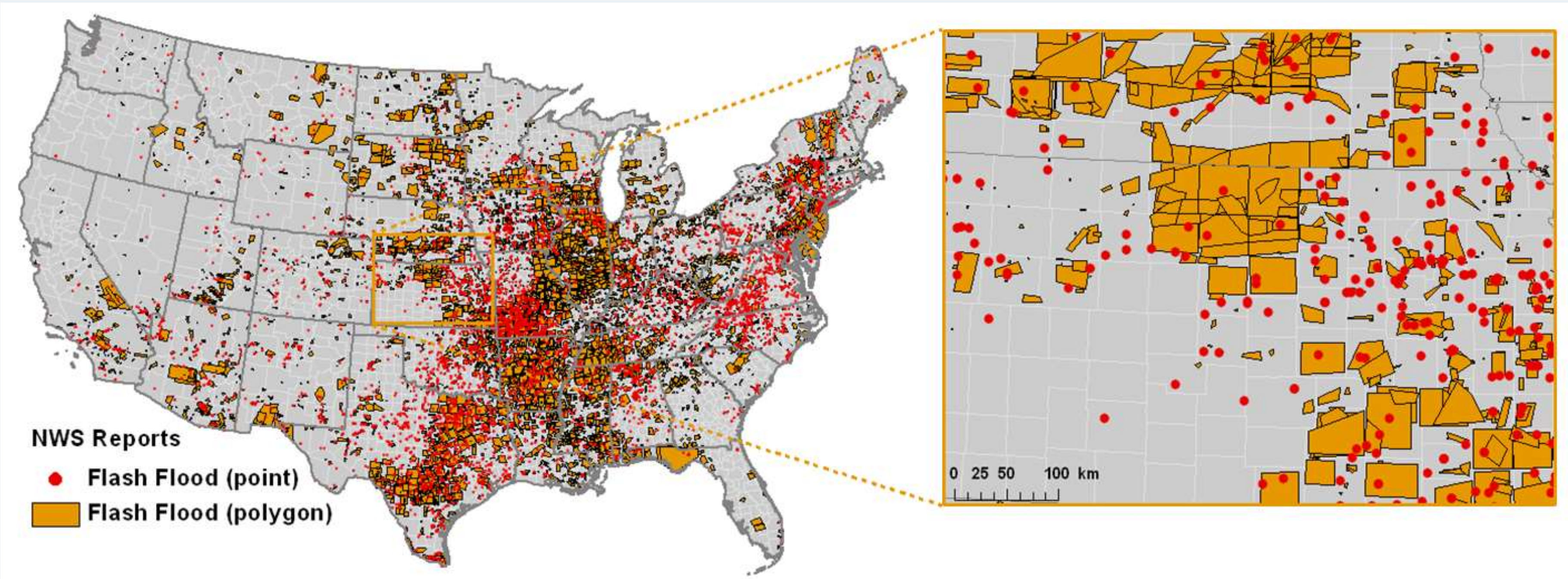
Global Flood Partnership 2017 Conference *Tuscaloosa, Alabama* *27-29 June 2017*

Flash flood observations

1. **Storm reports from government met agencies (e.g., NWS)**
   - Include major events
   - Can be binary, often no magnitude assessments or impact type
   - Specificity of time and location varies (bounding polygons, points)
2. **Streamflow measurements (e.g., USGS)**
   - Automated, objective information
   - Don't always know threshold (e.g., bankfull) when impacts occur
   - Often have long period of record
   - Not spatially ubiquitous; costly to maintain (USD 15k/yr)
   - Options for remote sensing technologies?
3. **Impact databases from private industry, citizen scientists, other government agencies (e.g., transportation)**

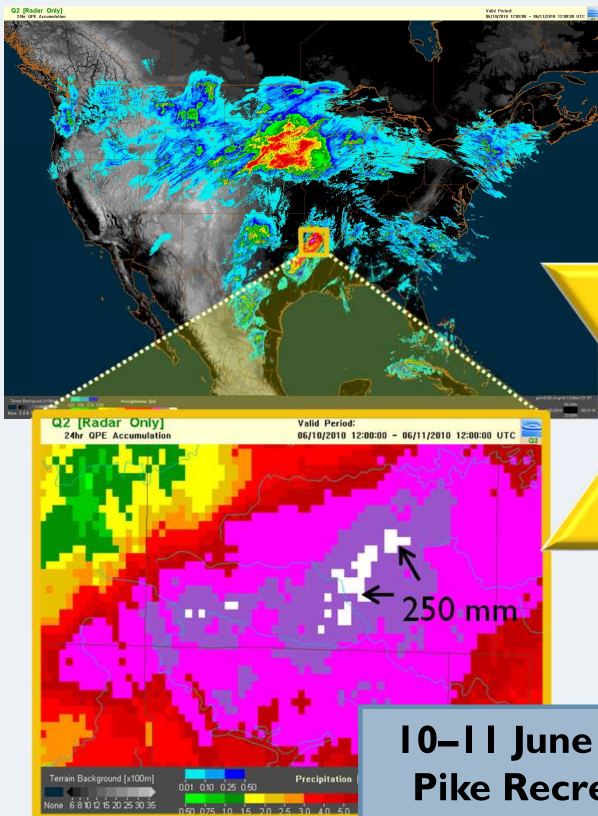
1. Local storms reports collected by met agencies

- Report represents a threat to life or property with depth of 0.15m of moving water or 0.91m of standing water
- Often associated with a NWS-issued flash flood warning

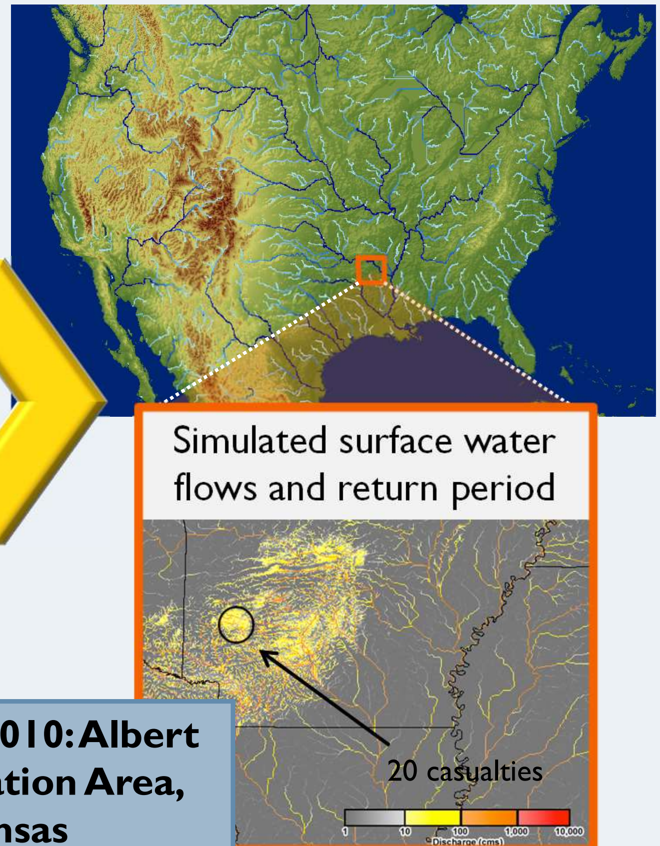


High Spatiotemporal Resolution Output Using MRMS and FLASH

MRMS Radar-Only QPE (1 km^2, 2 min)



10–11 June 2010: Albert Pike Recreation Area, Arkansas



FLASH Stormscale Distributed Hydrologic Model Framework (1km^2, 10 min)

Forecast lead time = 12 hr

Spatial Resolution = 0.01 deg

Frequency = 2-10 min

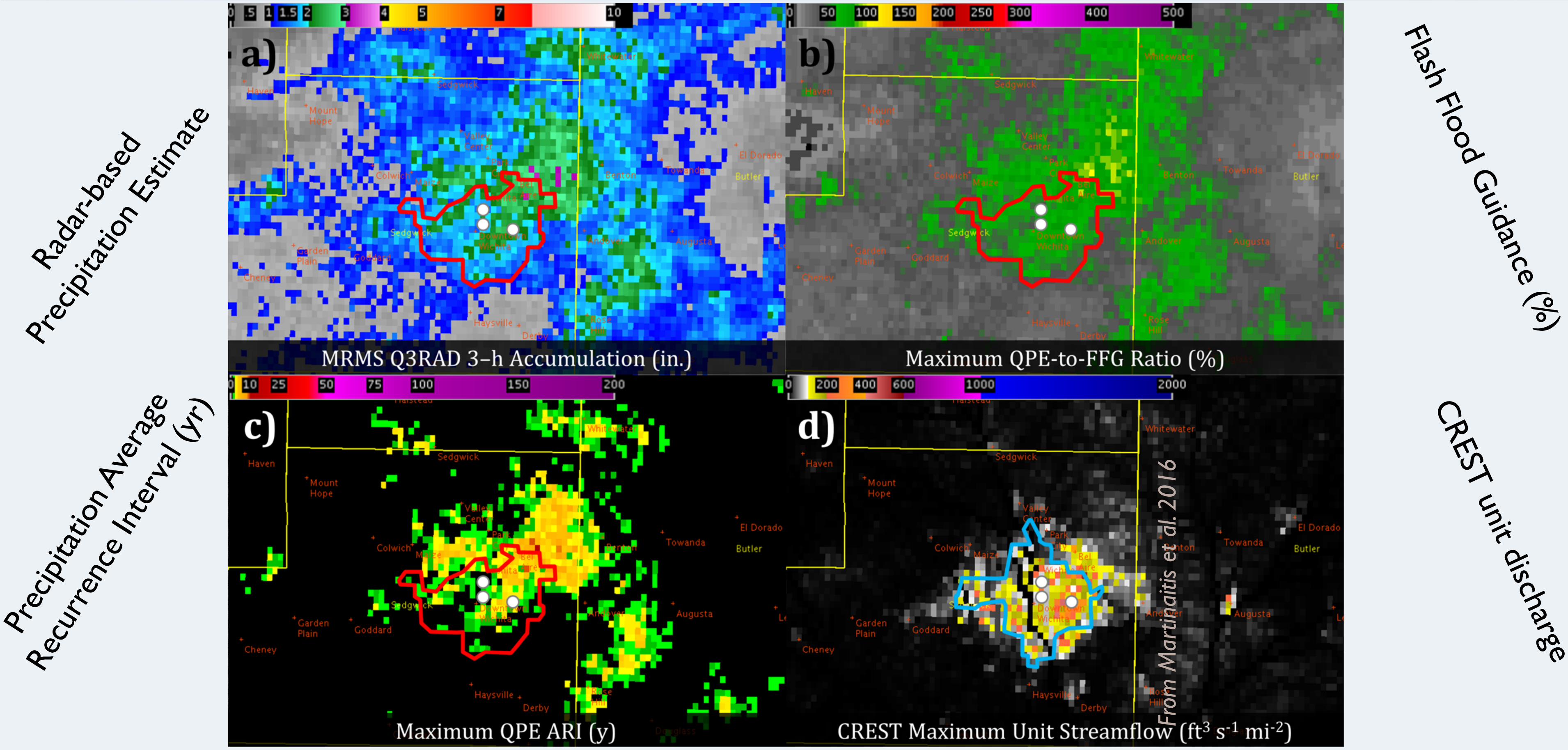
Latency = 6-8 min

Variable = Q, unit Q

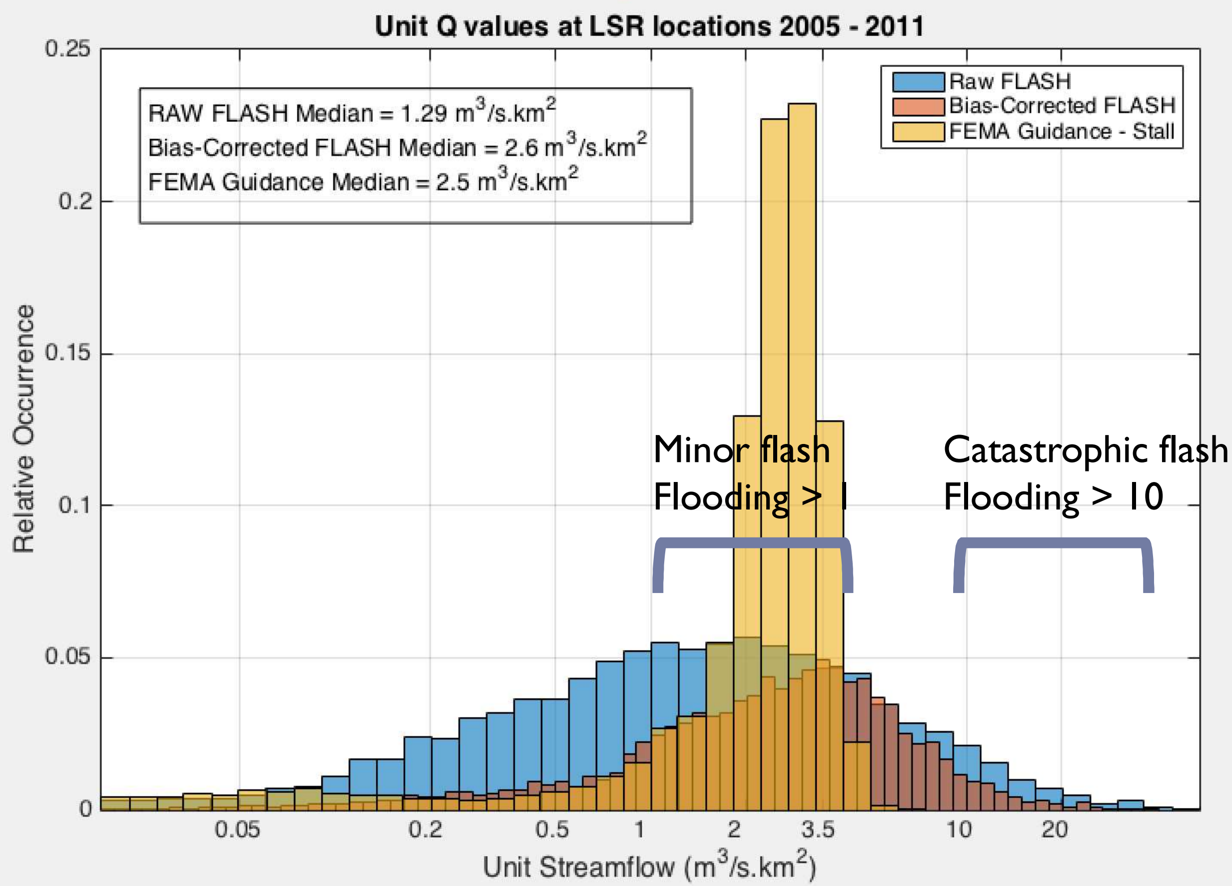
Type = probability of impact

Coverage = U.S.

Marginal event in an urban setting

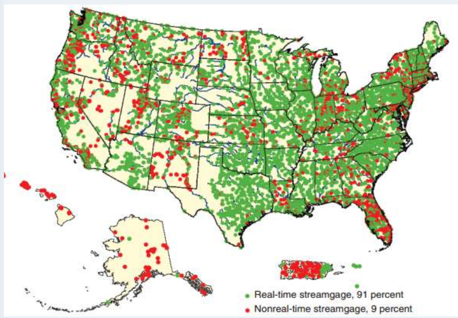


Model tuning using local storm reports

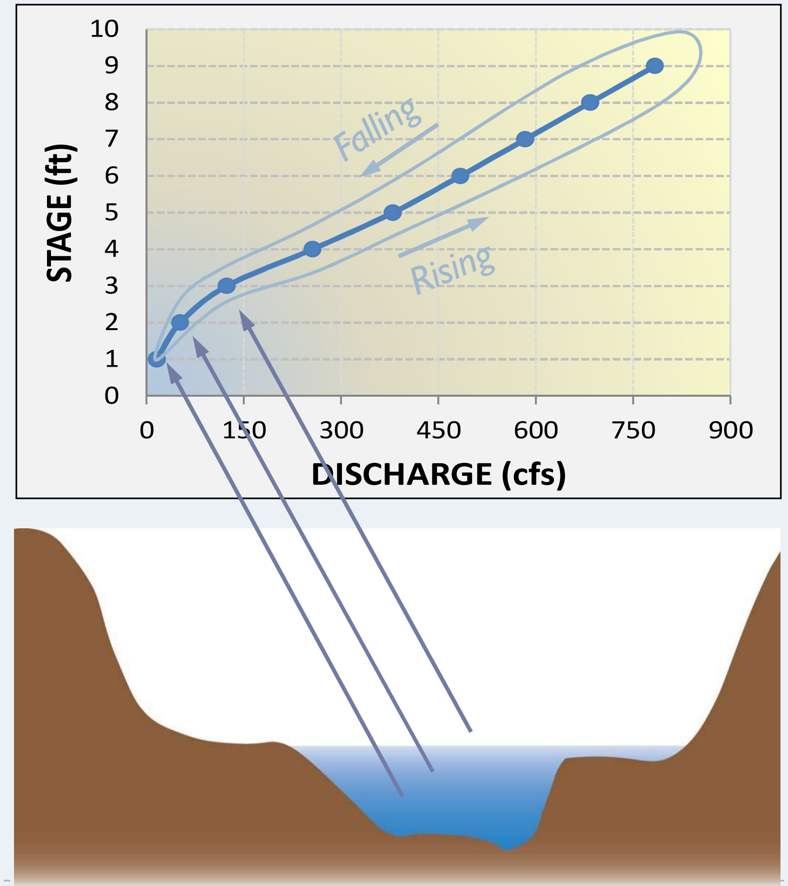


- Histogram of reforecast unit discharge values for reported flash flood events
- Threshold ~1-2 cms/km^2 identified as lower bound
- Values > 10 cms/km^2 associated to catastrophic flash floods

2. Conventional Discharge Estimation



- 7400 gaged locations; 9800 ungaged watersheds
- $15k hardware; $15k/yr O&M
- Most gages measure stage; want discharge



Conventional method:

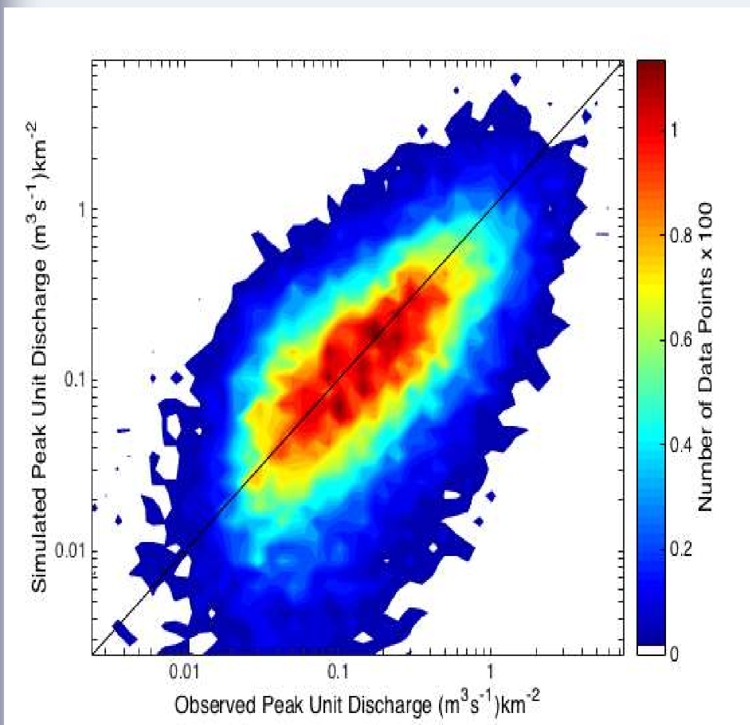
1. Read stage reported by gage
2. Manually measure discharge
3. Repeat for various stages to develop rating curve

Problems:

- Labor-intensive
- Can only interpolate within measured range
- Rating may be hysteretic
- Streambed changes alter rating

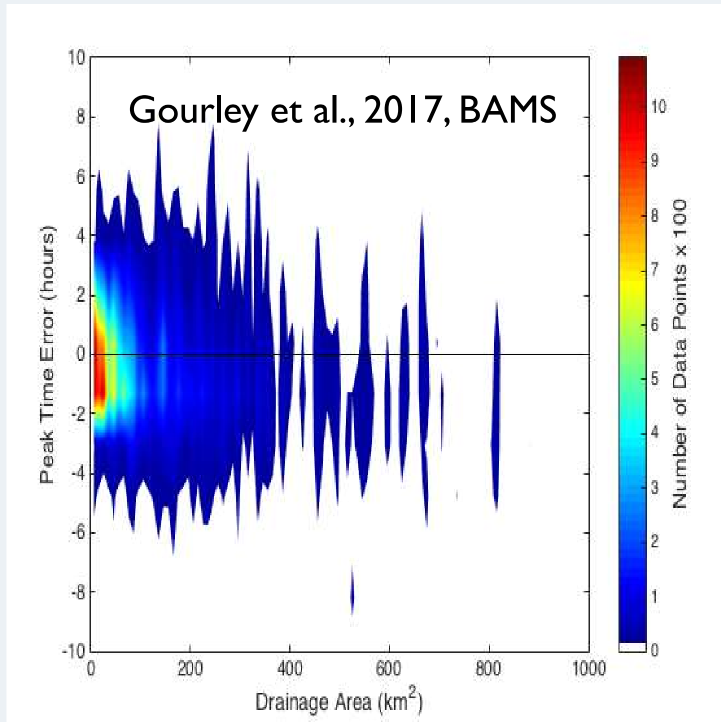
Model validation of peak flow and peak timing using conventional streamgauge data

Unit Peak Discharge



Linear correlation = 0.64
Rank correlation = 0.79

Timing of Peak Discharge



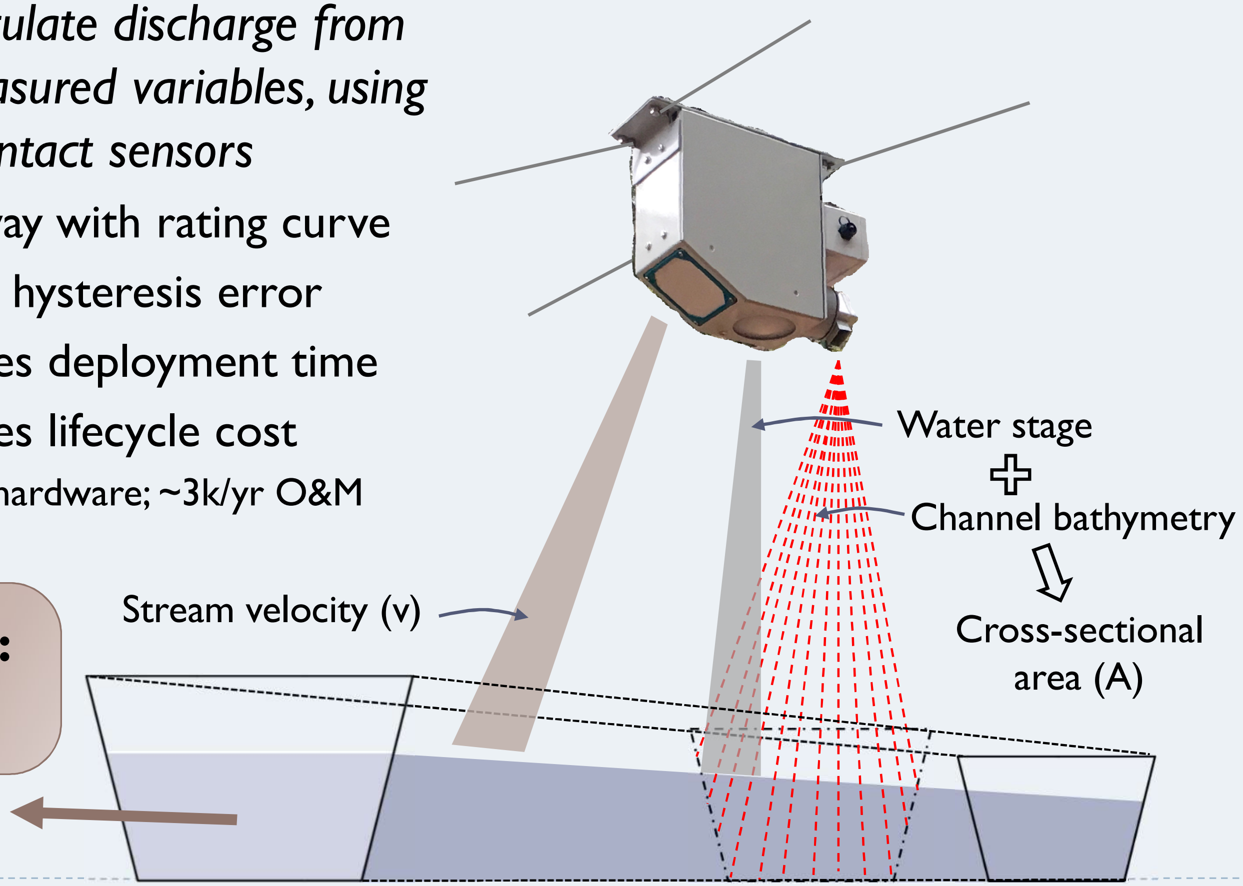
- 1837 unregulated basins
- Drainage < 1000 km^2
- Oct **2002** to Sep. **2011**
- 5 min/1 km hindcast with MRMS radar-based forcing
- > 80% of basin area with 1km radar coverage
- Snow contribution < 30% of annual precip
- **88,241** significant flow events

Direct Discharge Calculation

Goal: *Calculate discharge from directly-measured variables, using only non-contact sensors*

- Does away with rating curve
- Prevents hysteresis error
- Decreases deployment time
- Decreases lifecycle cost
  - $18k hardware; ~3k/yr O&M

Discharge: Q=vA

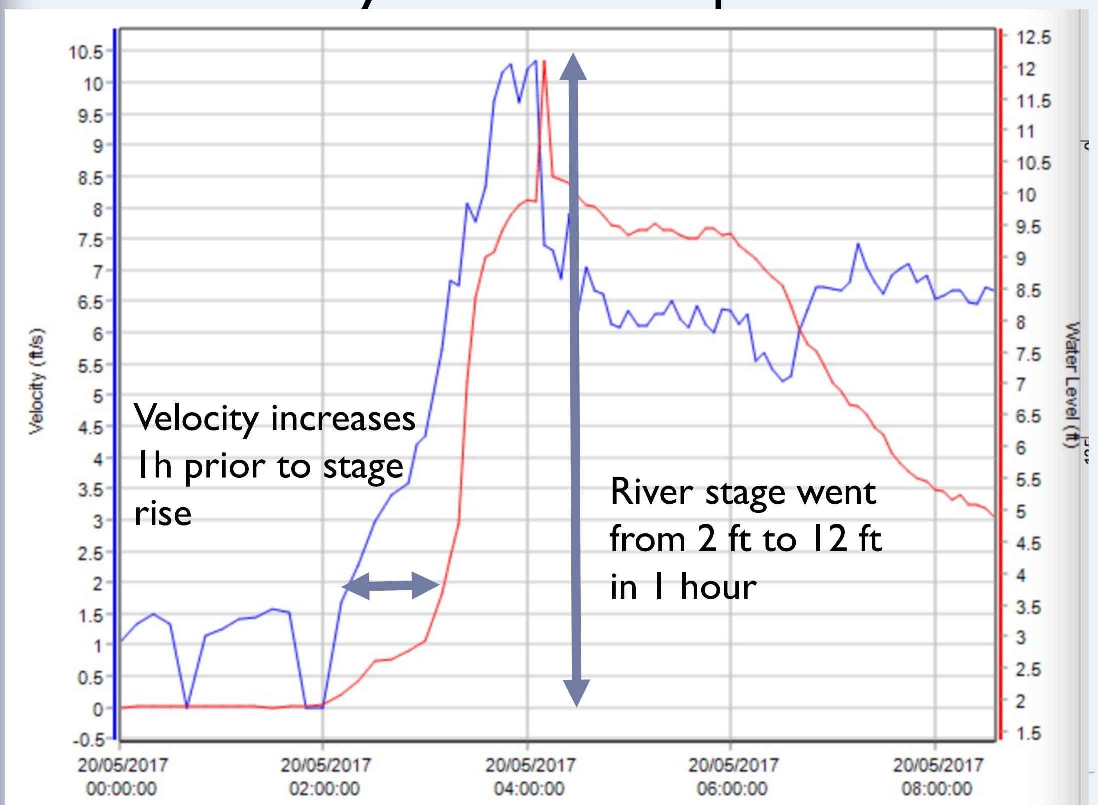


Gaging With Stage/Velocity Radars

- Simplified infrastructure
  - No gage house, stilling well, or underwater plumbing
  - Carry on foot and deploy in one day
- Adaptive data logging
  - Increase logging/transmitting frequency as stage/velocity increase
  - Emergency SMS notifications for flood events

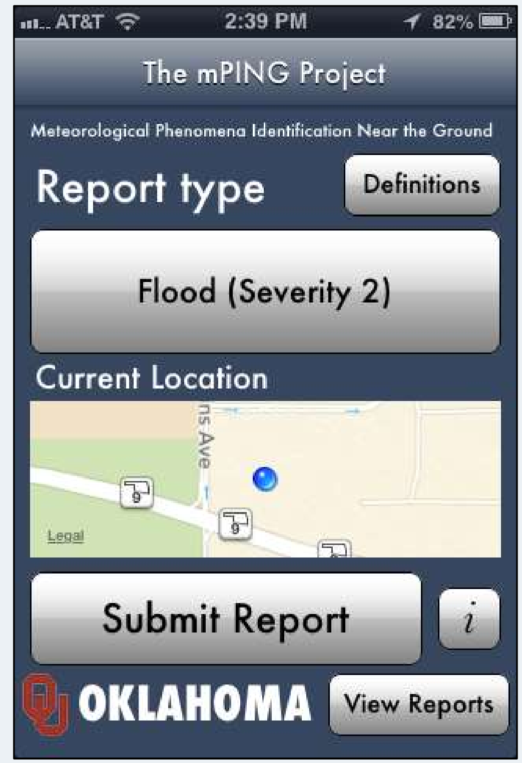
Fall's Creek Summer Camp

- 65,000 visitors over a 10-week period in summer
- As many as 7500 campers on site at a given time



3. Impact databases from nonconventional sources

- **mPING** – meteorological Phenomena Identification Near the Ground
- A free citizen science app for reporting weather impacts at user's location
- **Flood severity levels**
  - Basic 4 tiered scale
    - Minor, Moderate, Serious, Severe
- **Crowdsourced FF reports**
  - High-resolution spatial representation

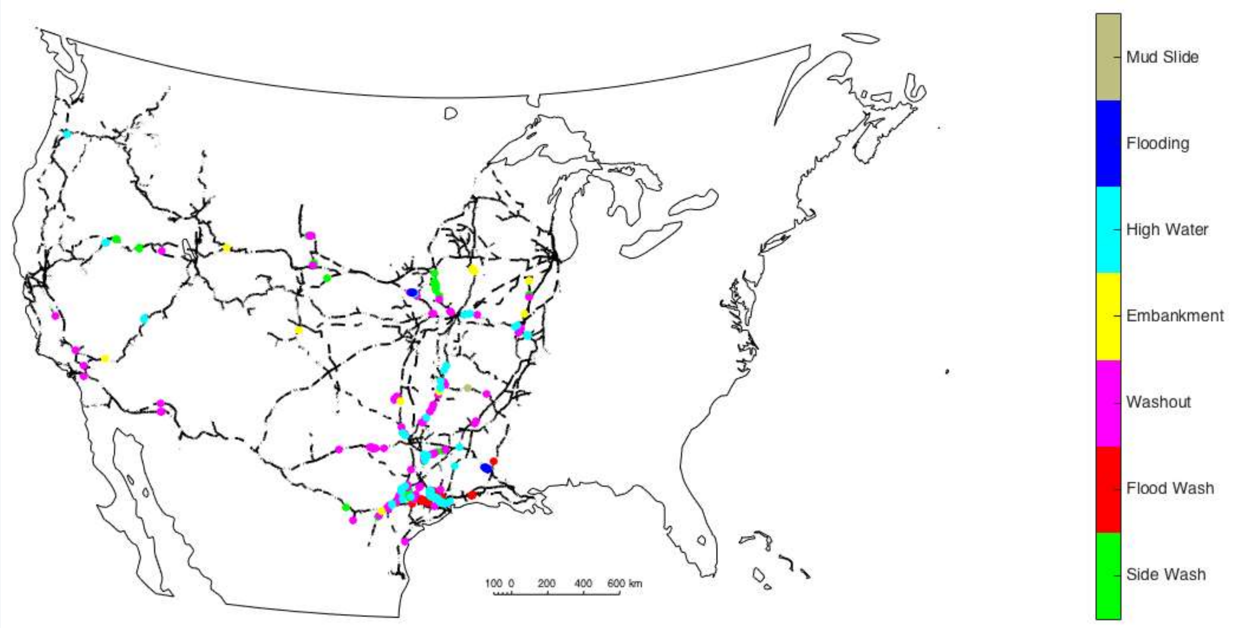


Customizing EF5 for Railroad Track Impacts

- A total of 461 Reports between 05/15 and 01/17
  - 998 FLASH pixels (i.e. unit q values)

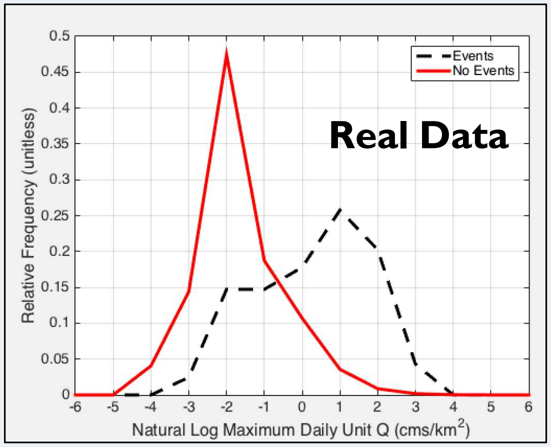
There are 7 broad categories:

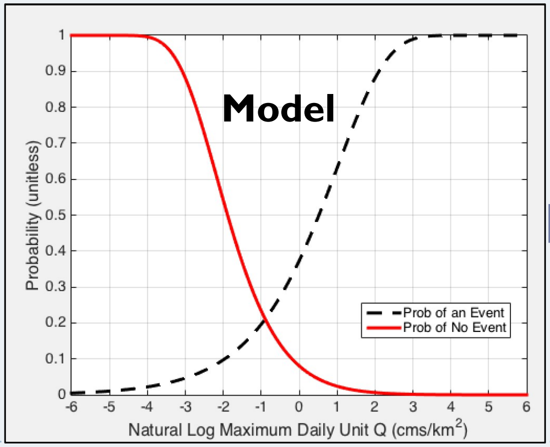
Washout – 288 instances (28.86%)
Side Wash – 279 instances (27.96%)
High Water – 216 instances (21.64%)
Flood Wash – 155 instances (15.53%)
Embankment – 21 instances (2.10%)
Flooding – 39 instances (3.91%)
Mudslide – 1 instance (0.10%)



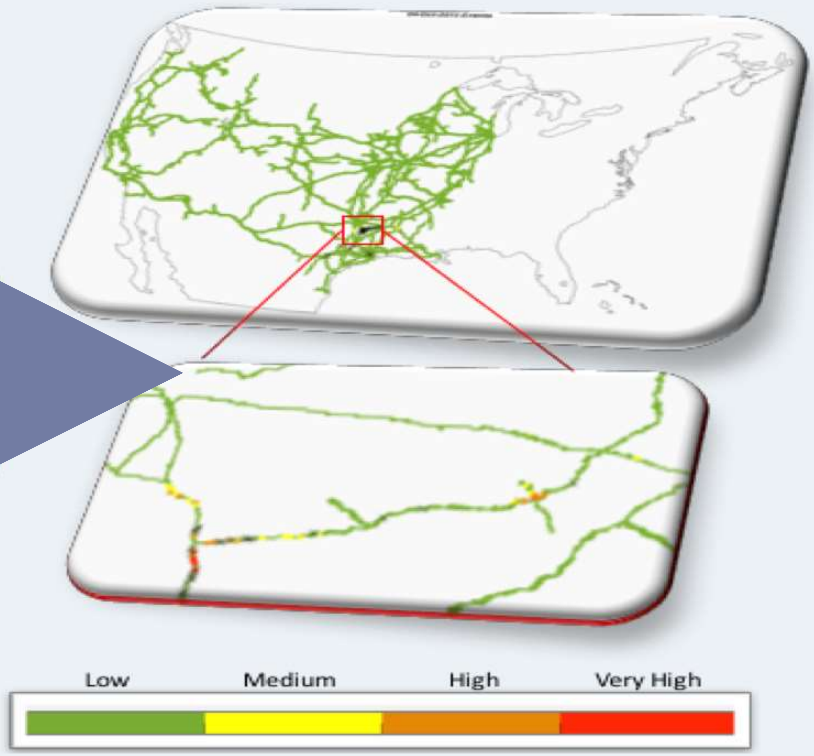
Examples of track impacts

Development of products to forecast track impacts



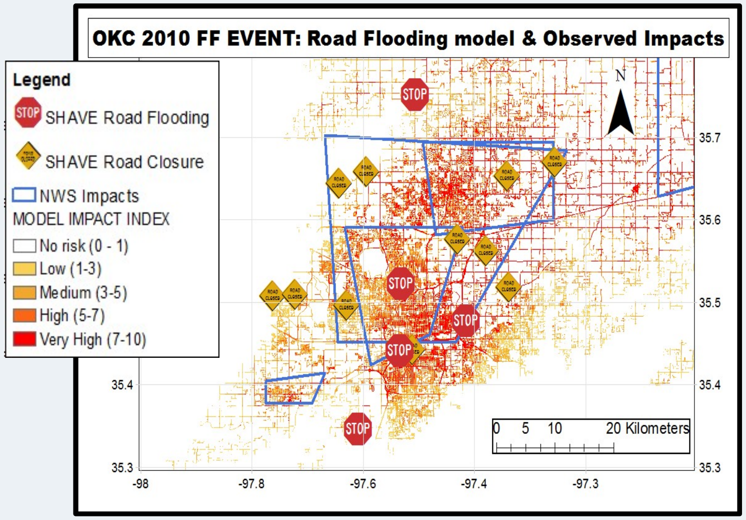


Probability of track impact



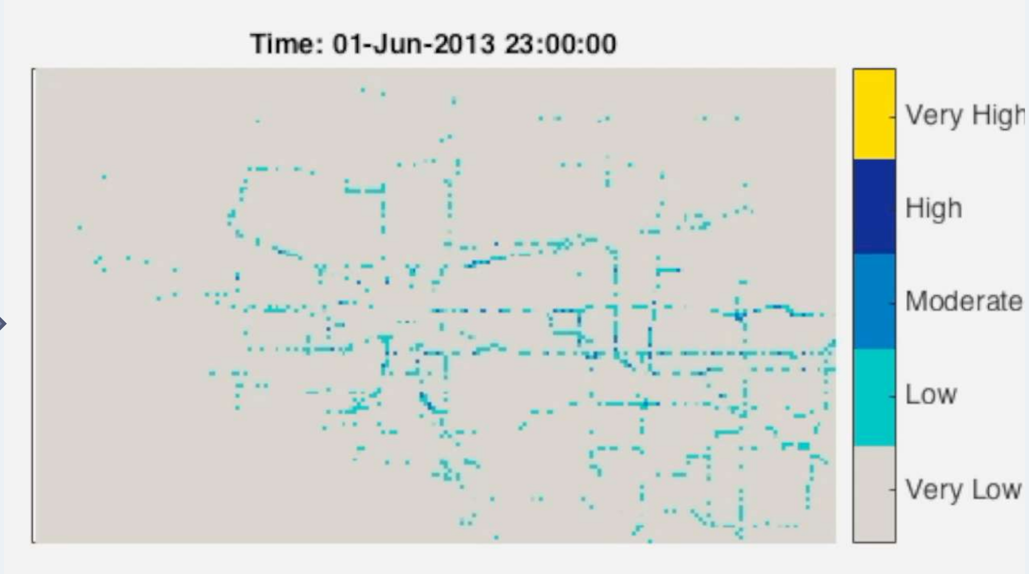
Machine learning algorithm for forecasting road flooding hazards

Database of road flooding
(Gourley et al., BAMS, 2013)



http://blog.nssl.noaa.gov/flash/database/

Probability of impacts from road flooding



Discussion Points/Questions for flash flood observations

1. What kinds of impact databases are available?
2. What is their period of record and areal coverage?
3. Are they publicly available or is there a fee?
4. What is the role of emerging remote-sensing datasets?
   - Space-based: Optical channels, passive microwave, active microwave
   - Drones