Collection of Witness Reports and Evaluation of Prediction Tools for Flash Flood Events

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W1.6 – Heavy Precipitation, Flash Floods,and Floods

Motivation

- Level of detail in FF observational datasets insufficient to depict their frequency, magnitude and spatial patterns*
  - Automated stage height/discharge measurements often restricted to main river branches
  - *Ex post facto* field investigations of major impact events[#]
  - Databases from operational agencies for warning verification
- Operational tools used to monitor and predict flash floods often simple and largely untested
  - Rainfall thresholds (flash flood guidance) established from simulated streamflow responses to theoretical rainfall rates
  - Hydrologic models often calibrated for large, "non-flashy" basins

Flash flooding is the #1 weather-related killer !!!

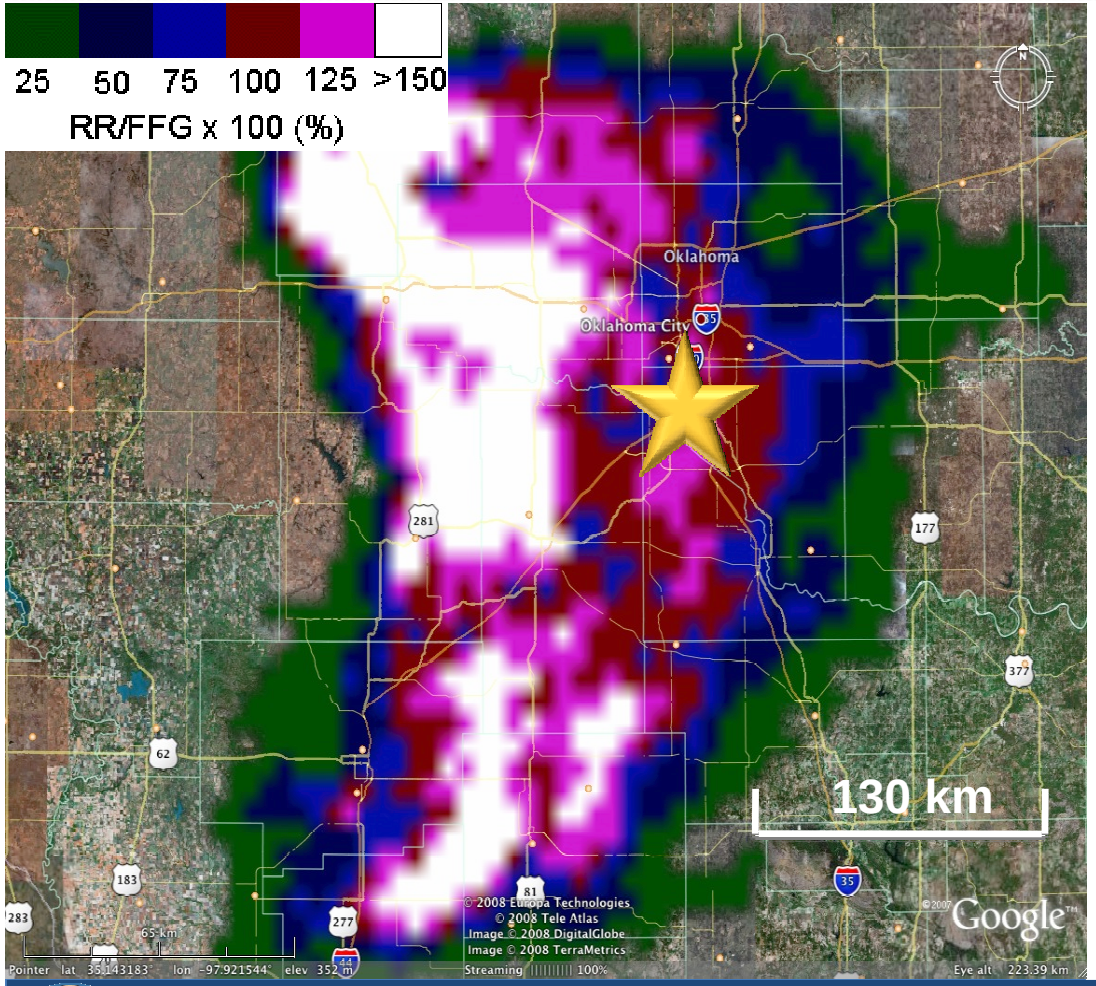
*Gruntfest, E., 2009. Editorial. *J. Flood Risk Manag.*, **2,** 83-84.
[#]Gaume, E., and M. Borga, 2008. Post-flood field investigations in upland catchments after major flash floods: proposal of a methodology and illustration. *J. Flood Risk Manag,* **1**, 175-189.

Severe Hazards Analysis and Verification Experiment (SHAVE)*

- Developed capability in GoogleEarth™ to display radar-based warning products along with georeferenced phone numbers (Delorme™) of US residents
- Hire 5-6 undergraduate meteorology students for summer
- Target storms occurring in populated areas in the US, call, call, call !!!

*Ortega, K.E., T.M. Smith, K.L. Manross, A.G. Kolodziej, K.A. Scharfenberg, A. Witt, and J.J. Gourley, 2009: The severe hazards and verification experiment, *Bull. Amer. Meteor. Soc.,* **90,** 1519-1530.

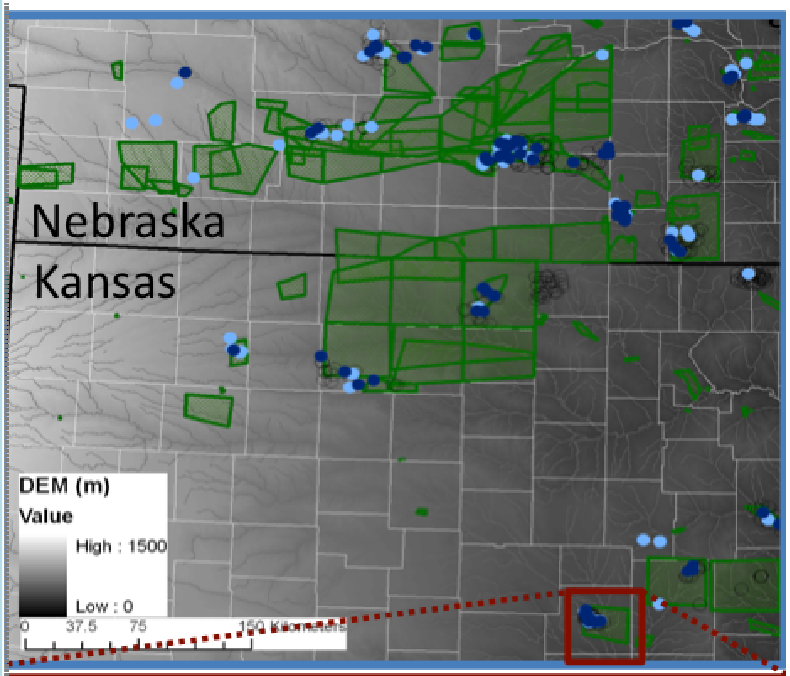
Criteria for Initiating Questionnaire

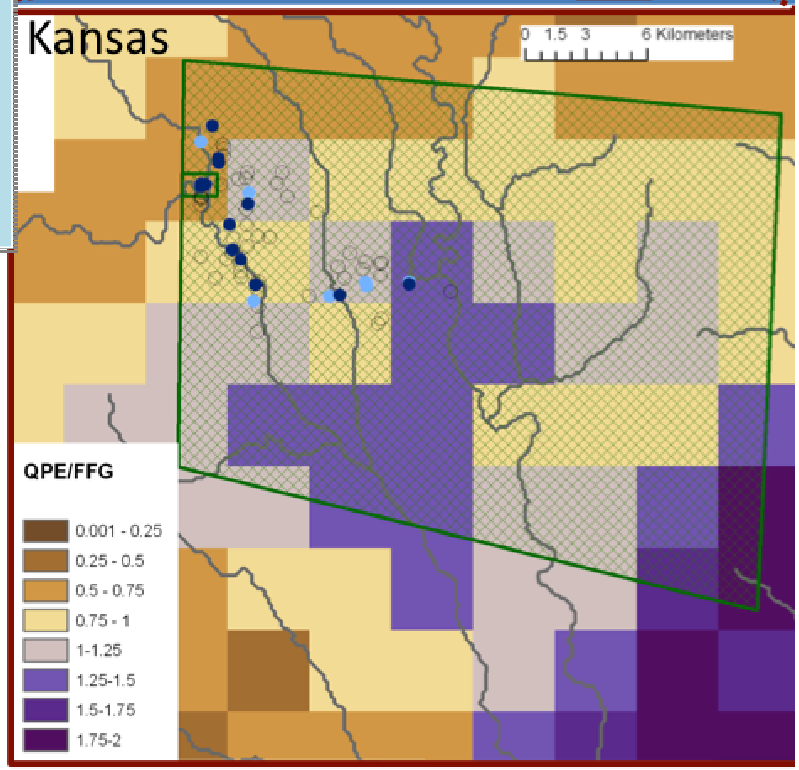


- The NWS had issued a flash flood warning or urban/small stream advisory
- Q2 Rainfall > Flash Flood Guidance, or
- A call for another targeted hazard (e.g., hail) suggested flooding was a problem

Questionnaire for Flash Flooding

- 68.1% of SHAVE reports fell outside an NWS observation polygon
- SHAVE reports are more dense than NWS reports (e.g., 50:1)
- Unique data collected in SHAVE
  - Reports of no flooding
  - Specific impact
  - Lateral extent/depth/motion of water
  - Respondent-estimated frequency





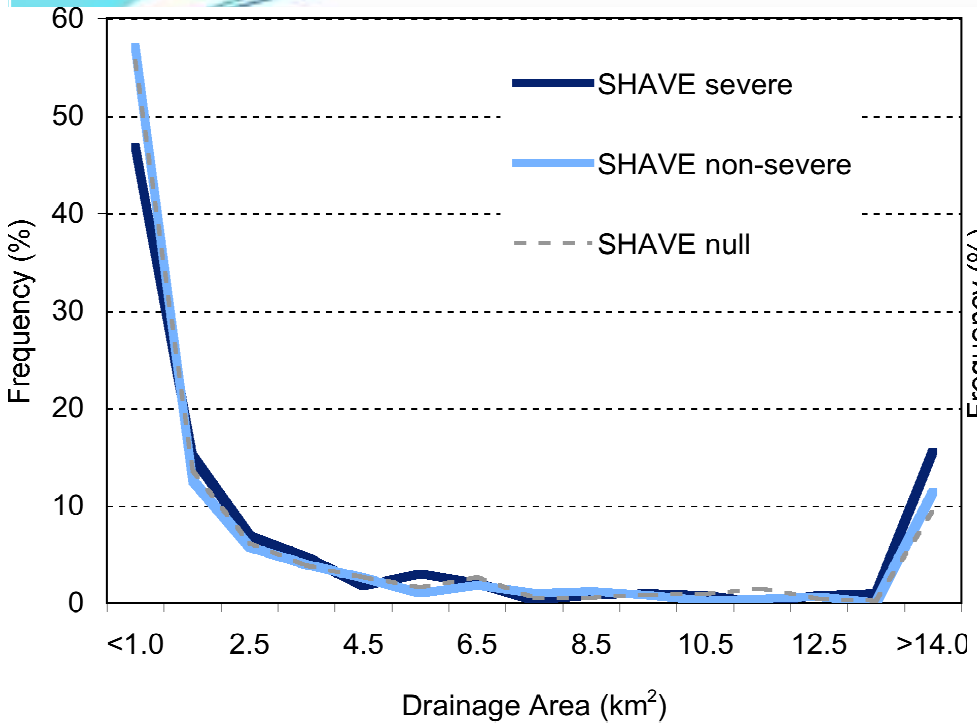
N=406 SHAVE Severe Flooding

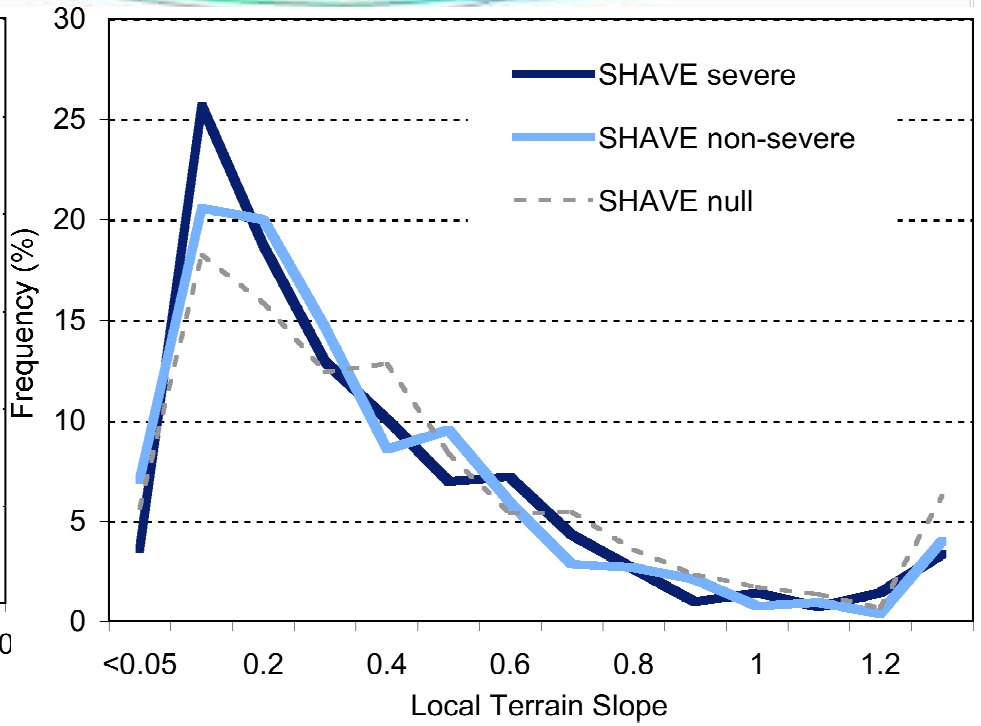
N=510 SHAVE Non-Severe Flooding

N=1848 SHAVE No Flooding

NWS Flash Flood

GIS Analysis of SHAVE Reports*





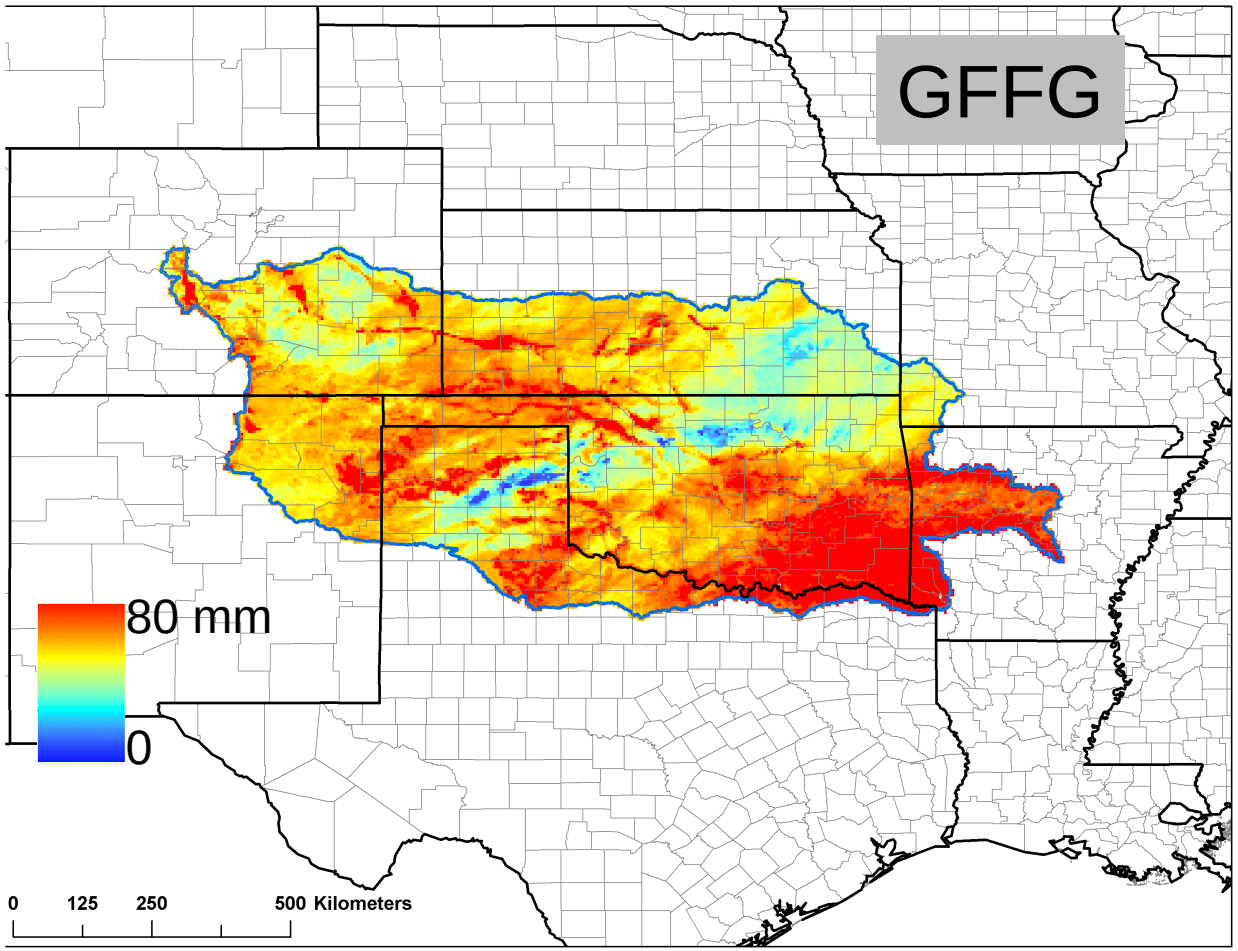
Proximity to Stream ➔

- Severe flash flooding impacts occur more frequently at residences situated: 1) Close to streams and 2) In flat terrain

*Gourley, J. J., J. M. Erlingis, T. M. Smith, K. L. Ortega, and Y. Hong, 2010: Remote collection and analysis of witness reports on flash floods. *J. Hydrol.*, doi: 10.1016/j.jhydrol.2010.05.042.

Operational Flash Flood Prediction

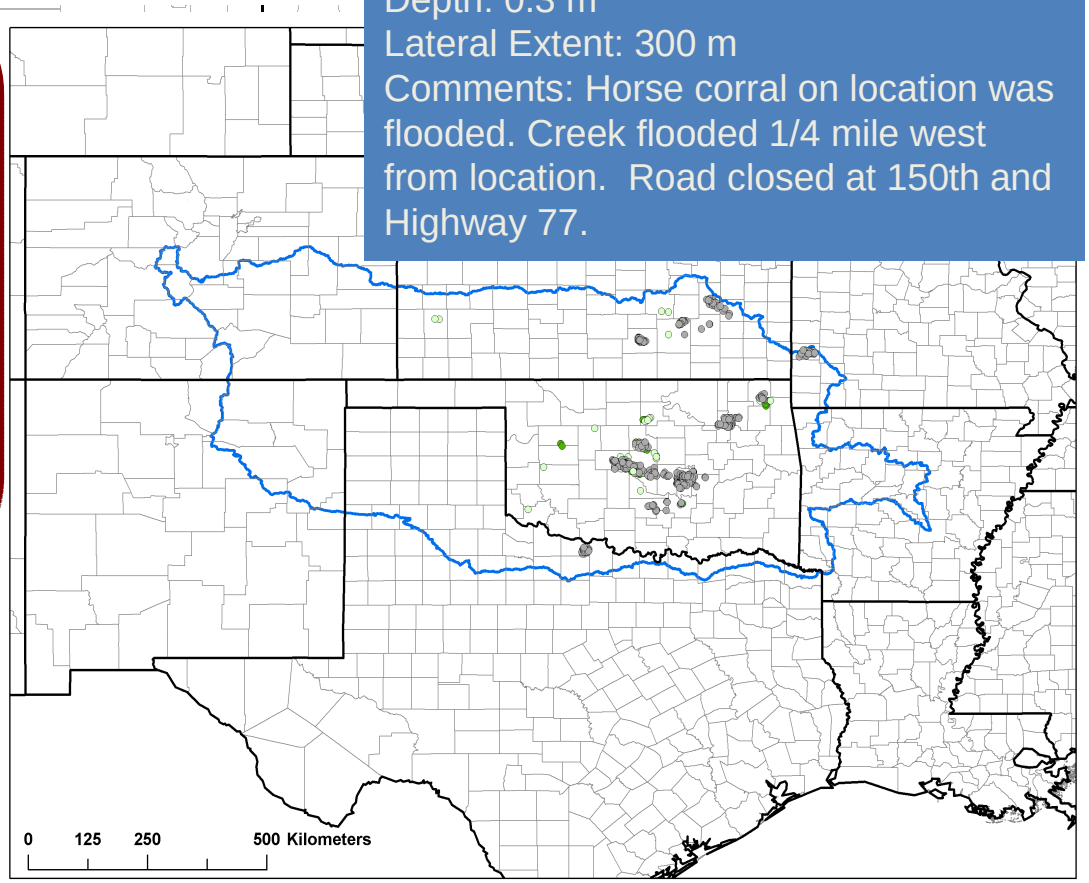
- 1-, 3-, 6-h gauge-adjusted radar rainfall
- Legacy, basin-wide flash flood guidance (FFG)
- New, gridded flash flood guidance (GFFG)



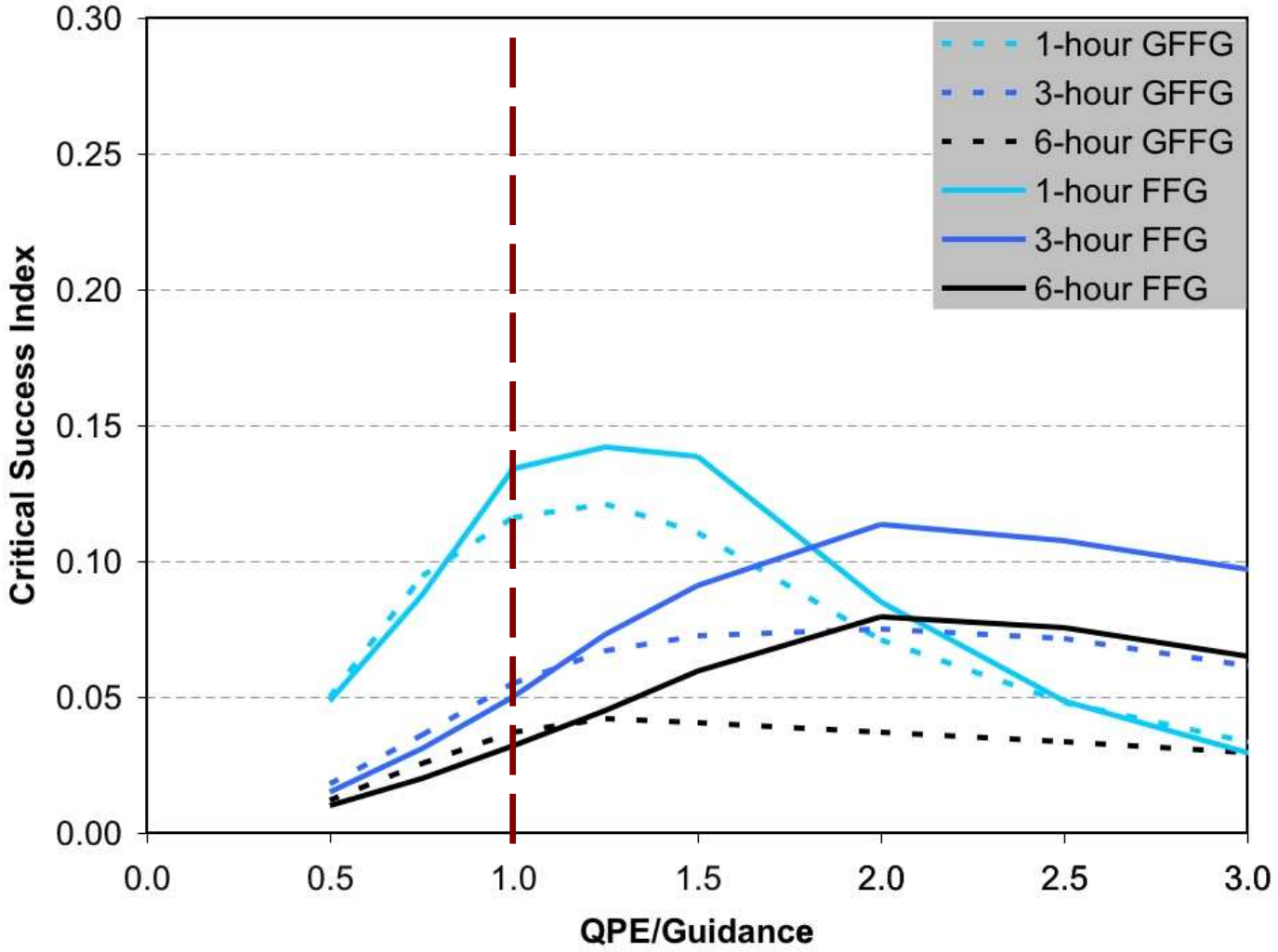
Candidate Verification Sources

1. NWS flash flood reports from Sept 2006 - Aug 2008
   - \+ Designed to encompass all events in forecaster's area of responsibility
   - \- Dependent upon NWS warning process, population density
2. 15-minute streamflow data from USGS
   - \+ Objective measurement of discharge
   - \- Only 19 gauges with basin area < 260 km^2 (flash flood scale)
   - \- Flash flood defined as 2-year return period
3. 2008 SHAVE flash flood reports
   - \+ High spatial and temporal resolution
   - \+ Flood characteristics
   - \- Database is storm-targeted; does not encompass all flash flood events
   - \- Dependent on population density
   - \- 158 "No Flood" Reports, 92 "Flood" reports

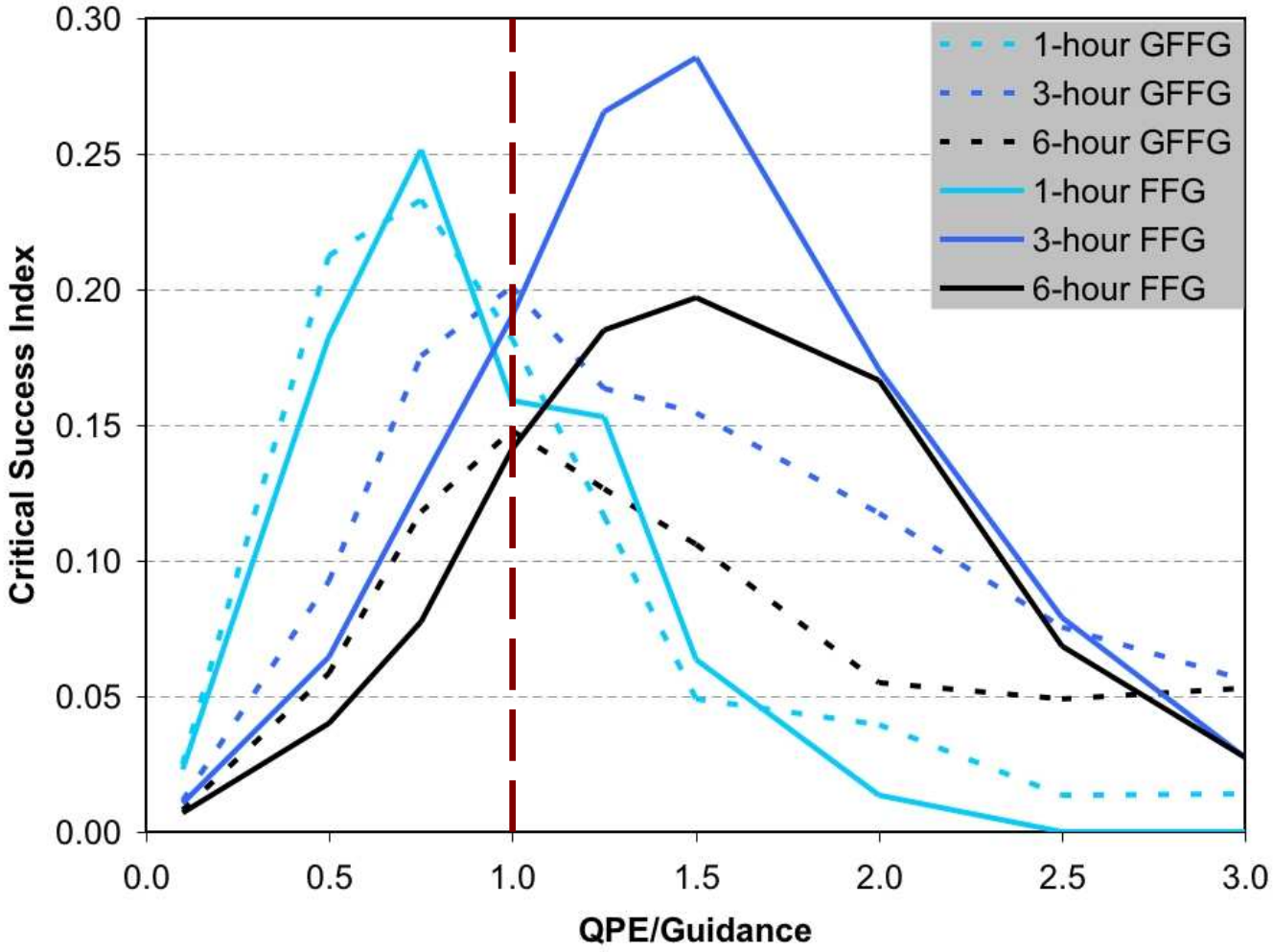
Event Type: Flood
Start Time: 6/27/2008 11:30 A.M.
Latitude: 38.013824
Longitude: -96.715266
County: Butler
State: Kansas
Flood Nature: Overflow road other
Depth: 0.3 m
Lateral Extent: 300 m
Comments: Horse corral on location was flooded. Creek flooded 1/4 mile west from location. Road closed at 150th and Highway 77.



1) Results: NWS Flash Flood Reports



2) Results: Streamflow



Summary

- Analysis of SHAVE reports collected during 2008 indicated severe flash flooding impacts occurred more often
  - In flat terrain
  - In close proximity to streams
- Operational tools to monitor and predict flash flooding are only marginally skillful
  - FFG better than GFFG according to *independent* NWS spotter reports and 2-yr return flows from basin-integrated streamflow measurements; i.e., larger scales
  - GFFG and FFG are more skillful at longer accumulation periods (3 and 6 hr) if exceedances of 150-200% are considered (not just QPE>FFG)
  - The spatial precision, density, and unique details of targeted SHAVE observations will be used on a case study basis for assessment at small scales

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Possible Role of SHAVE in HYMEX? "euroSHAVE"

- SHAVE is an inexpensive, student-run experiment that provides for a rich learning experience and yields research-quality datasets for depicting spatial patterns of flash floods
- Social science questions could be integrated in questionnaire and thus better tie WG3 to WG5
- There are some "eurochallenges" though…
  - Digital database of telephone numbers for Europe?
  - Consistent flash flood forecast products for identifying potentially impacted regions?
  - Language barriers/need for multilingual students?


Questions ???
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PROBE 2

Distributed Model Simulations

HL-RDHM Model

- 19 parameters
- 6 state variables
- 4.7 km resolution
- Kinematic wave routing

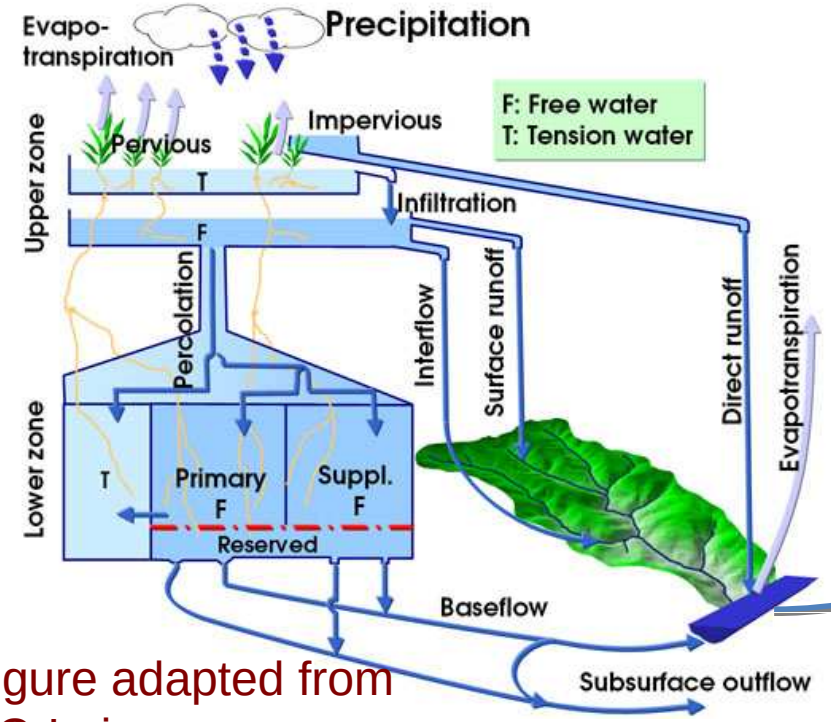
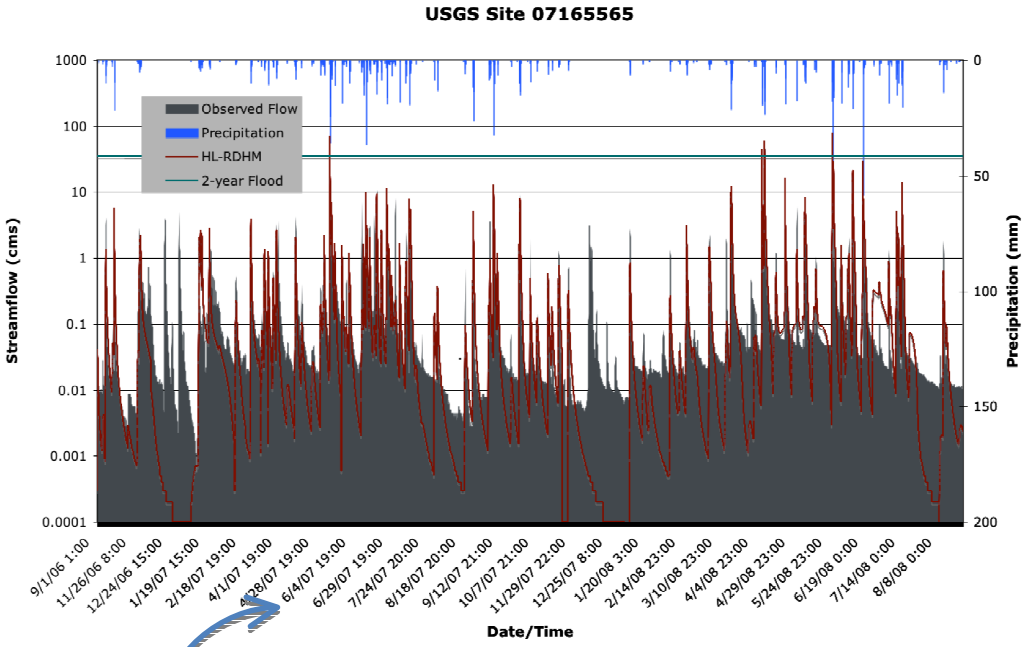
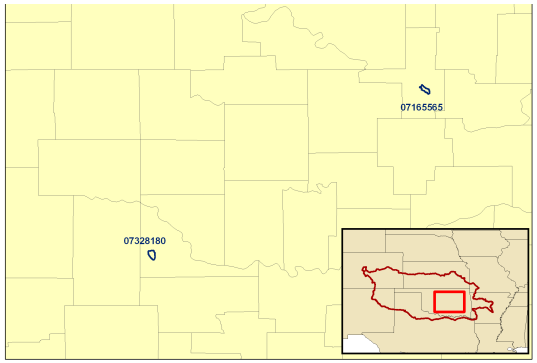


Figure adapted from UC-Irvine



NSCE = 0.68
BIAS = -6.2%



Comparison to Operational, "Calibrated" Prediction Tools

Basin 1

Forecast \ Observation	Yes	No
Yes	8	3
No	4	N/A

FFG

Forecast \ Observation	Yes	No
Yes	8	3
No	4	N/A

GFFG

Forecast \ Observation	Yes	No
Yes	12	7
No	0	N/A

Model

Basin 2

Forecast \ Observation	Yes	No
Yes	3	2
No	2	N/A

FFG

Forecast \ Observation	Yes	No
Yes	2	0
No	3	N/A

GFFG

Forecast \ Observation	Yes	No
Yes	4	0
No	1	N/A

Model