Flash Flood Warning Performance Improvement

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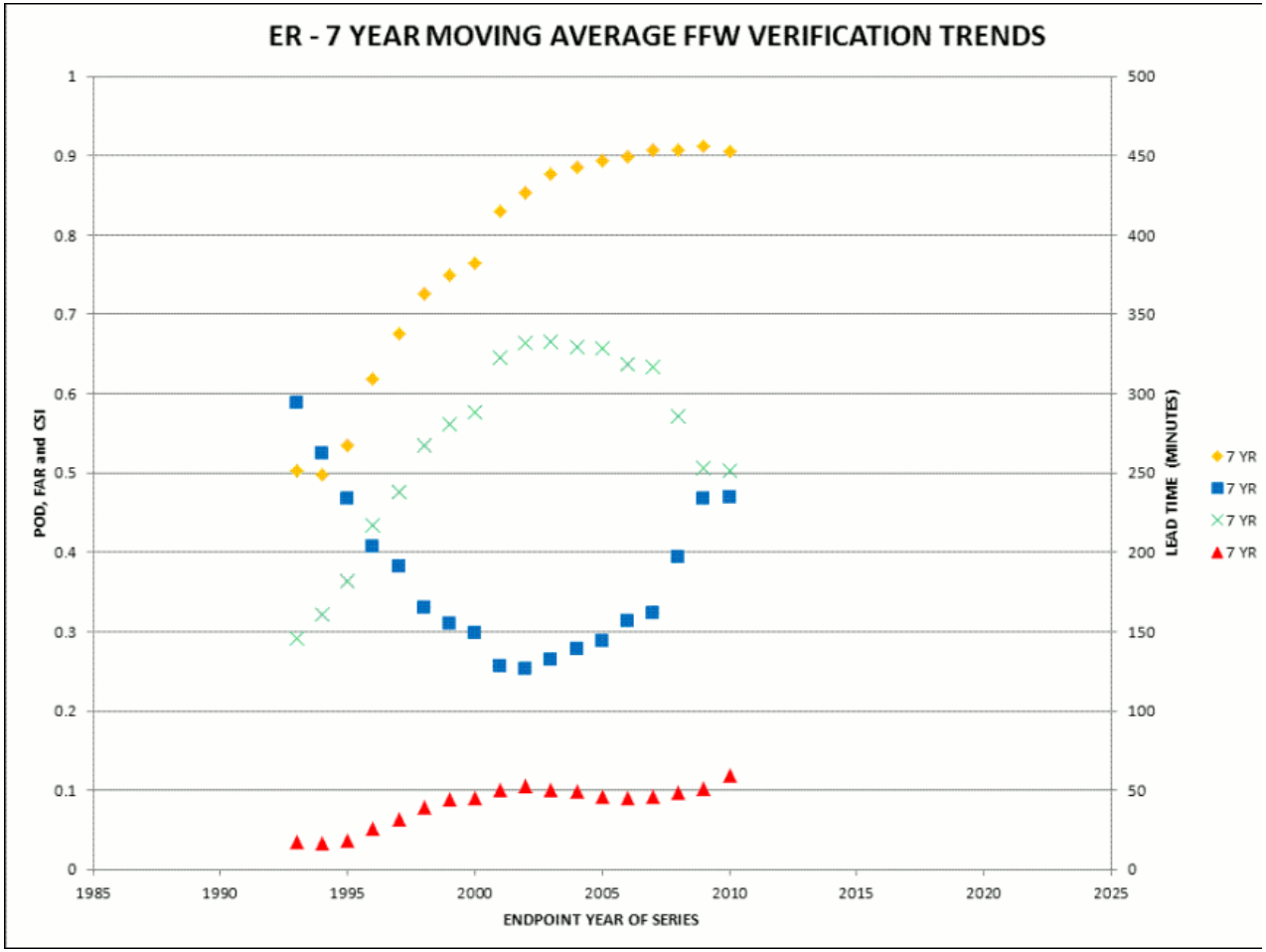
Outline

- Motivation / Statistics
- Specific Topics
  - A Sampling of Past and Present WFO BGM Research on Flooding
    - “Three Strikes and You’re Out”
    - Flash Flood Potential Index (FFPI)
    - Maximum Potential PWAT

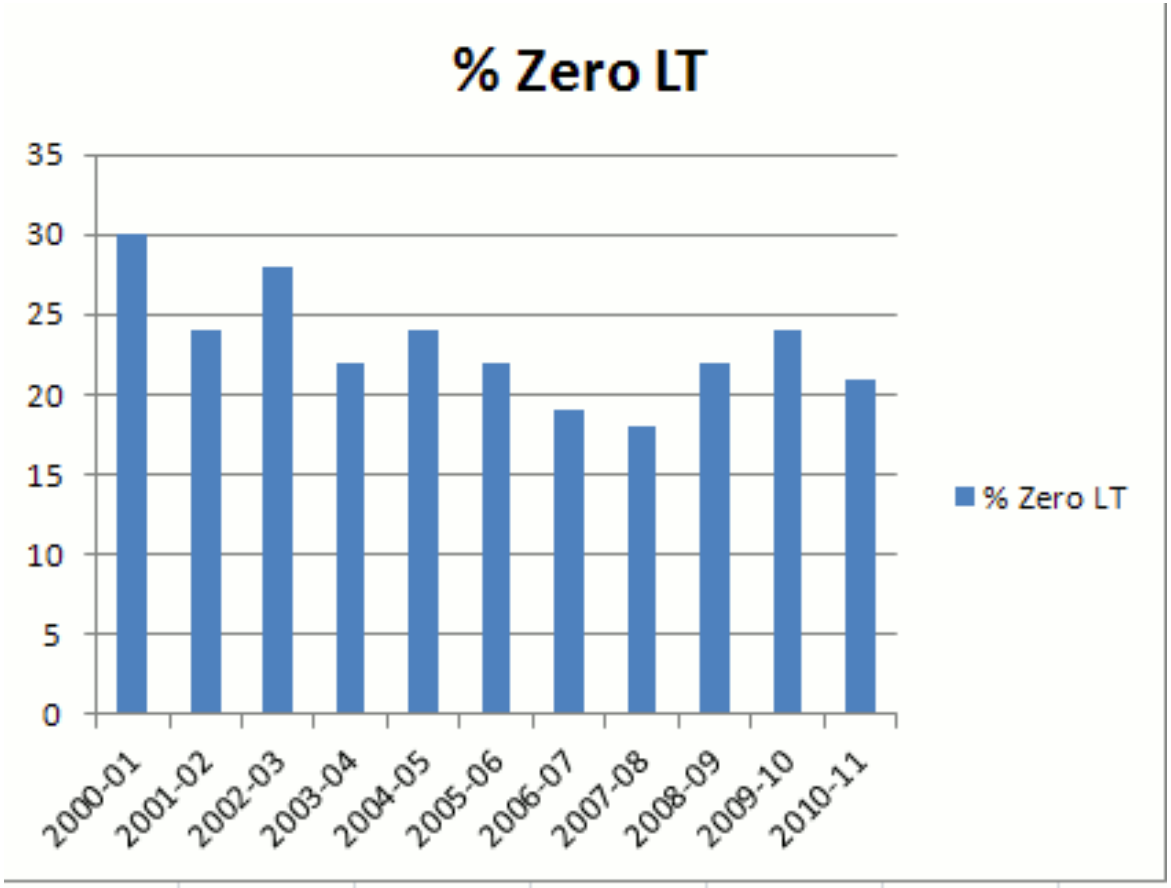
Flash Flood Warning Performance Improvement

- *Motivation*

ER FFW Statistics



ER FFW Lead Time Issues



Things to Consider

- Although overall trends in LT have been good through the last 10 years:
  - Zero LT Warnings are still running 15-25%
    - About 1 out of every 5 FFW's
    - Simply in "reactive mode"
- POD has remained about steady, however:
  - FAR's have steadily increased
    - As a result, CSI's have lowered over time
- What to do ?

Flash Flood Warning Performance Improvement

- *WFO BGM "Three Burst" Study (a.k.a "Three Strikes and You're Out")*

Significant FF vs. Nuisance Runoff

- An established “tool of the trade” for warning operations is comparing Gridded FFG to accumulated / radar estimated rainfall
  - Other tools / strategies to help us better differentiate?

Looking Back to Go Forward

- Previous research by Davis (2000) and Kelsch (2001)
  - Frequency of short-duration bursts vs. FFG / cumulative rainfall ratios
    - Main suggestion: Monitoring instantaneous rate trends may be at least as important as using FFG (especially in fast responding watersheds)

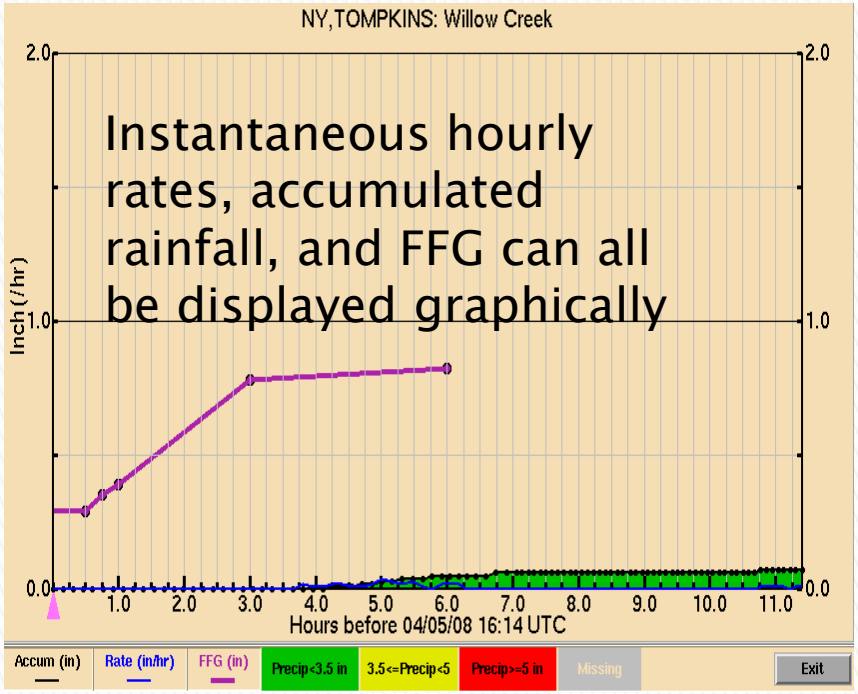
Database

- Selected 10 major flash flood events from NY / PA since 2002
  - Combined costs:
    - 11 fatalities
    - At least hundreds of millions of dollars in damages
  - Other numbers:
    - Warm season cases (8):
      - Averaged 6-7" rainfall / 3 hours
      - Maximum: 10+" on 6/19/07 (Colchester, NY)
    - Cool season cases (2):
      - Averaged 2-3" rainfall / 2 hours

Testing the Hypothesis / Methodology

- For our selected list of events, we evaluated the following data:
  - KBGM WSR 88-D
    - 0.5 Degree Base / Composite reflectivity
    - 1-hour, 3-hour, and storm total rainfall
    - Calculated 1-hour instantaneous rates
  - 1-hour and 3-hour FFG (MARFC)
    - Unavailable for one of the cases
- Graphically compared the following
  - Instantaneous rates over time
  - Ratios of accumulated rainfall to FFG

Rainfall Rates and FFMP



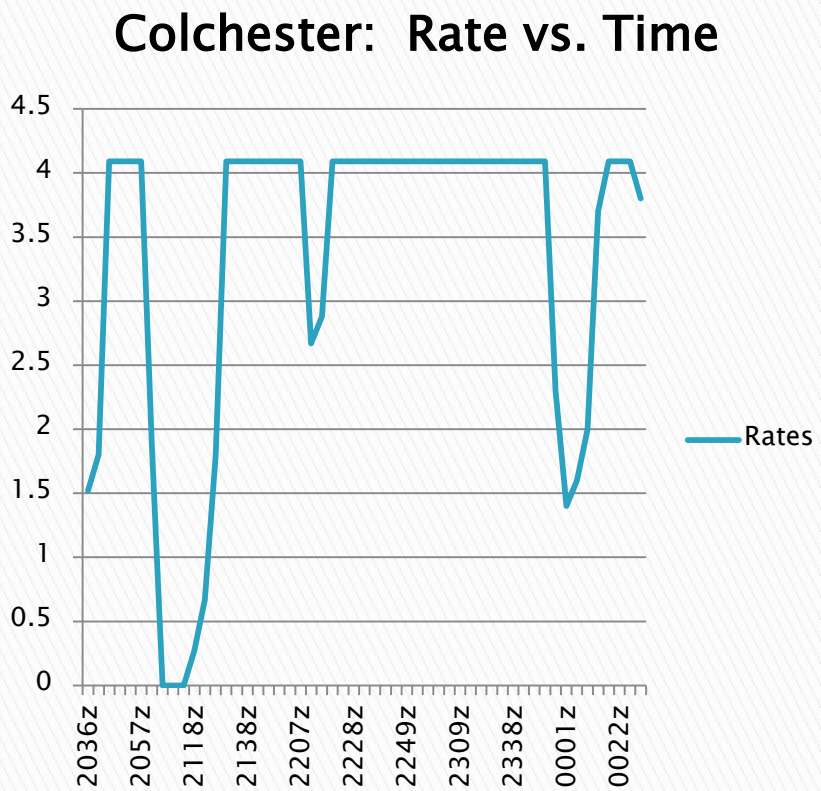
Threat Basin Table

Basin Trend Graphs

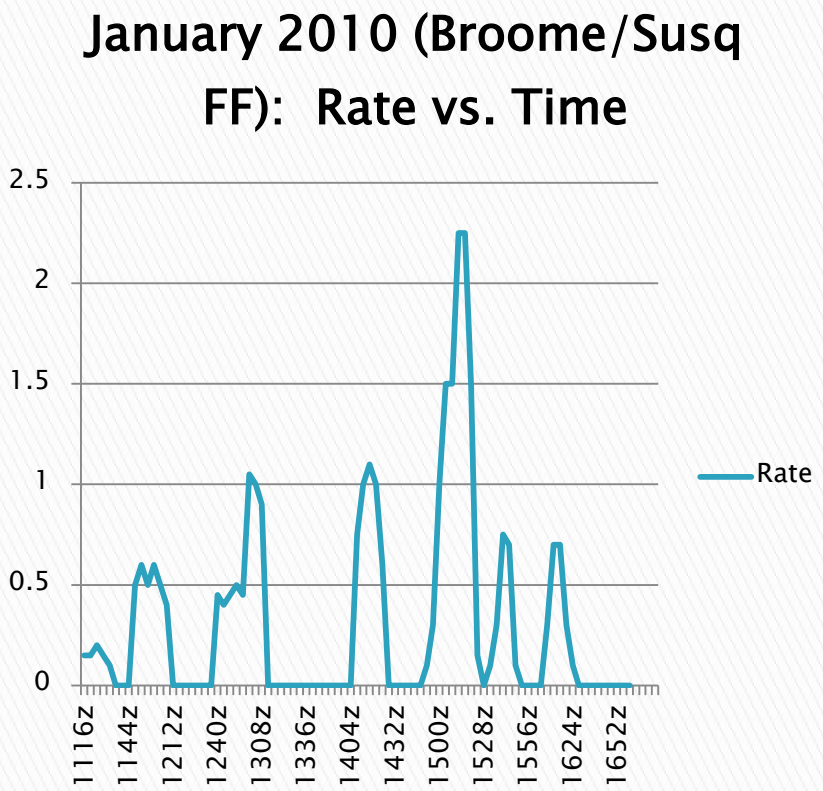
Heavy Rain Bursts

- In the majority of cases (8 / 10), initial reports of major flooding coincided with the *third burst* of high intensity rainfall
  - Specific rainfall rates were relative (air mass / season dependent)

Rates vs. Times Examples



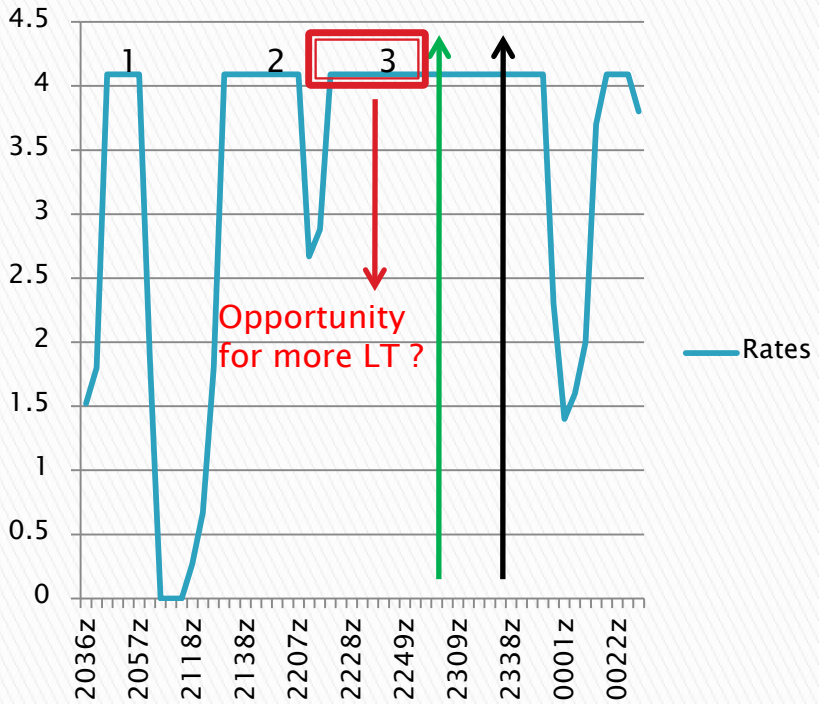
June 19, 2007



January 25, 2010

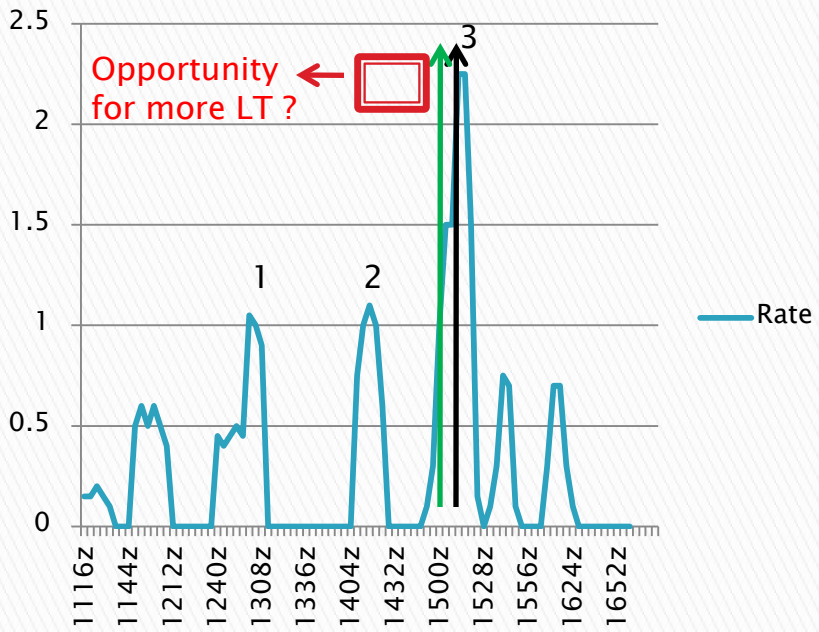
FFW vs. Actual Flooding (LT Issues)

Colchester: Rate vs. Time



June 19, 2007

January 2010 (Broome/Susq FF): Rate vs. Time

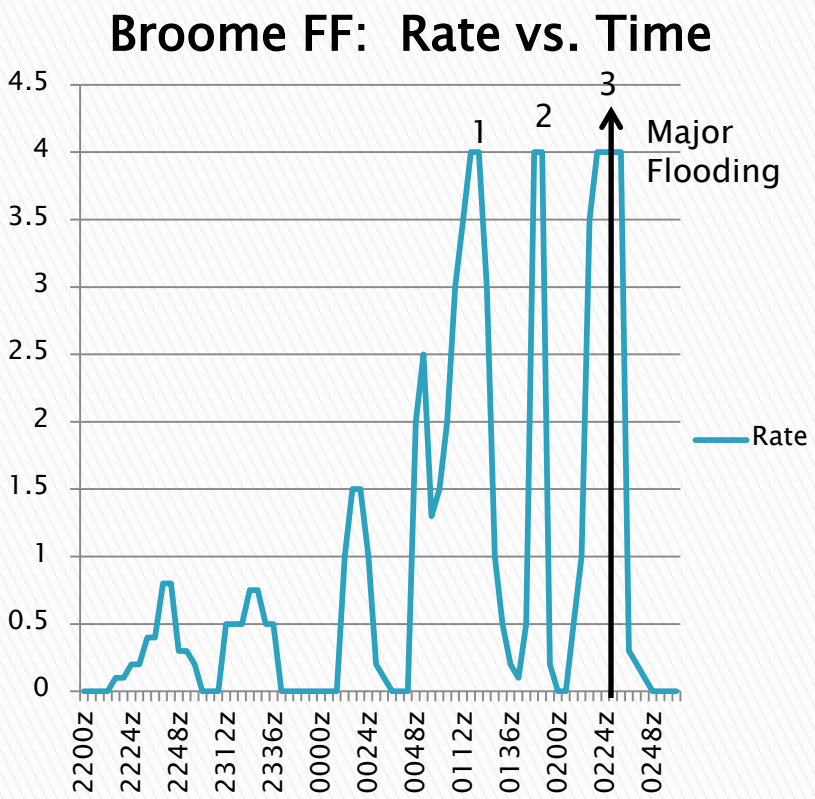


January 25, 2010

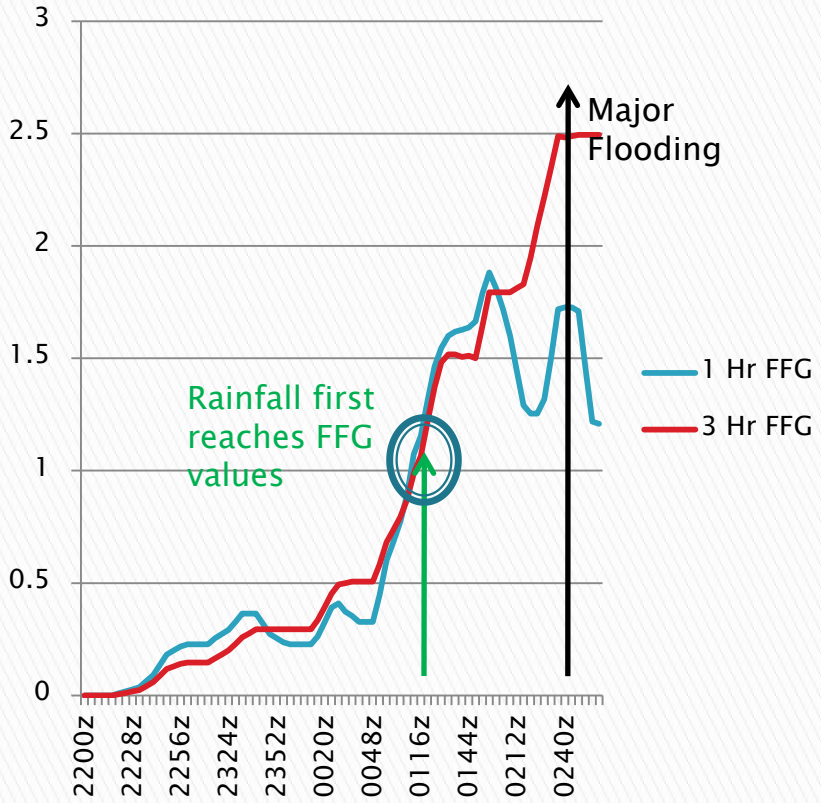
Rainfall to FFG Ratios

- At times when major flooding was reported / observed, mean accumulated rainfall to FFG ratios were:
  - Warm season
    - 1-hour: 1.45; 3-hour: 1.95
    - Significant flooding normally occurred *well after FFG values were exceeded*
  - Cool season
    - 1-hour: 0.75; 3-hour: 0.9
    - Significant flooding occurred *prior to FFG values being reached*
      - Impervious / frozen surface ?

Warm Season Case

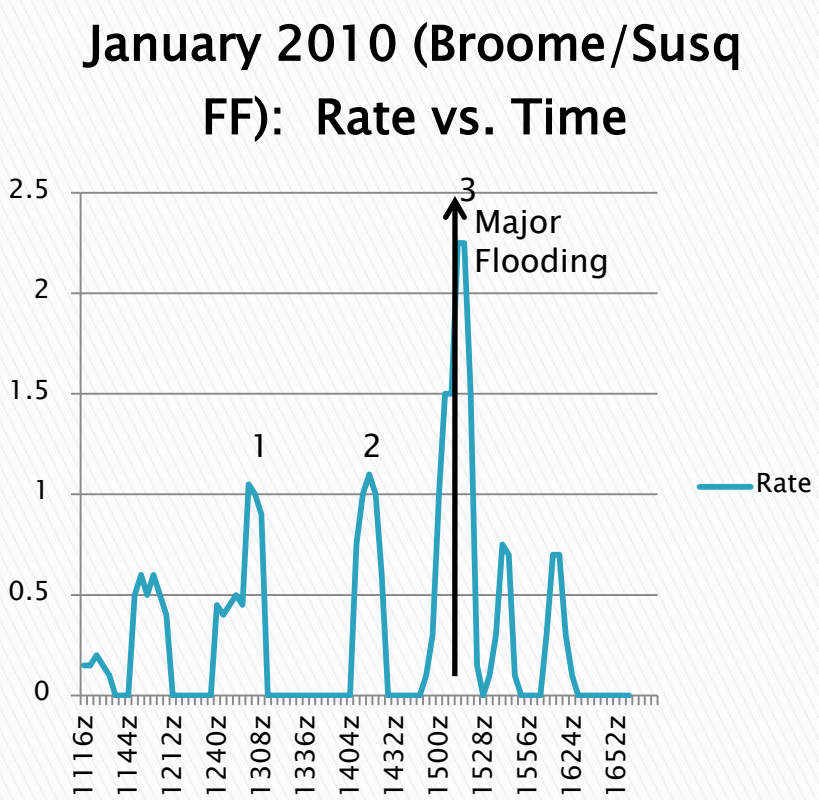


22z, 13 June – 03z, 14 June 2003 (Rate vs. Time)

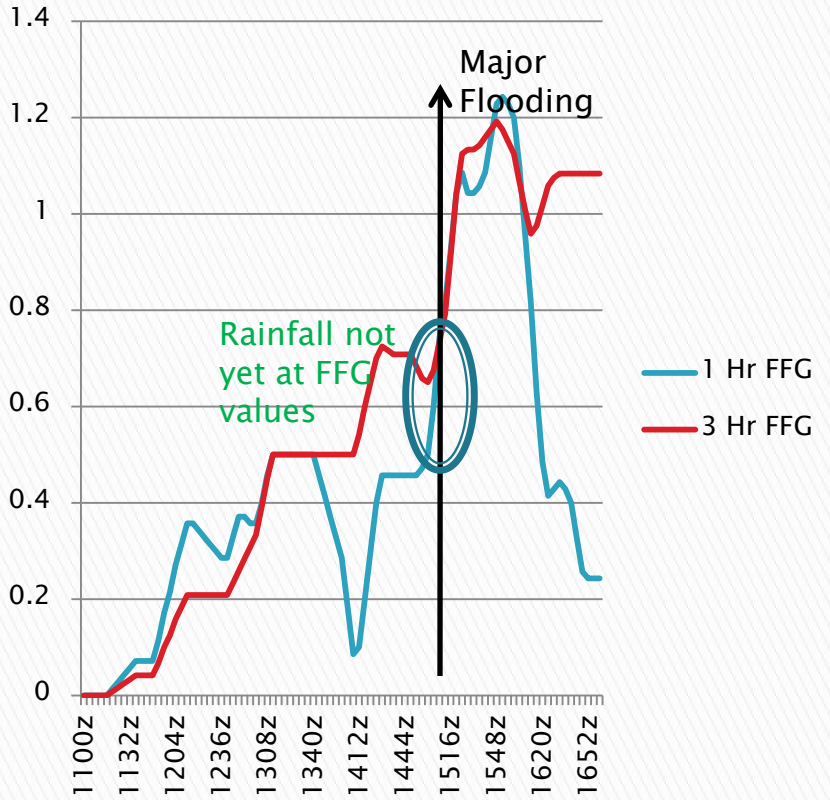


22z, 13 June – 03z, 14 June 2003 (Rainfall / FFG Ratio vs. Time)

Cool Season Case



11z – 17z, 25 January 2010 (Rate vs. Time)



11z – 17z, 25 January 2010 (Rainfall / FFG Ratio vs. Time)

Potential Uses / Caveats

- Timing bursts of high intensity rainfall show promise as a flash flood predictor
  - At least for higher-end events
    - Opportunities to combine this kind of diagnosis with analyses of FFG
    - Sooner recognition of major flooding / better LT ?
- Rainfall amounts tend to "rocket" past FFG values for significant warm season flash floods
  - Possible assistance in warning decision making
  - Lower FAR's / better CSI's ?
- However, the BGM CWA features fairly homogenous soil types / similar land uses most areas
- No accounting was made for antecedent conditions

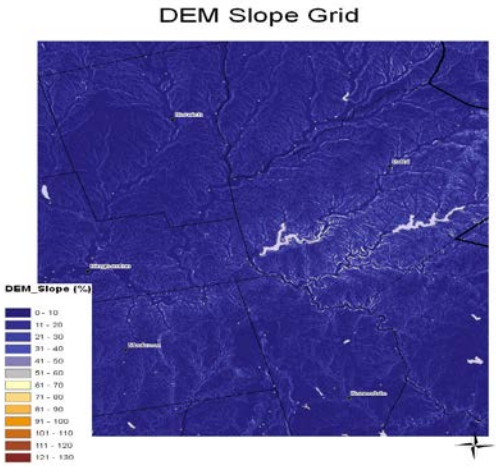
Flash Flood Warning Performance Improvement

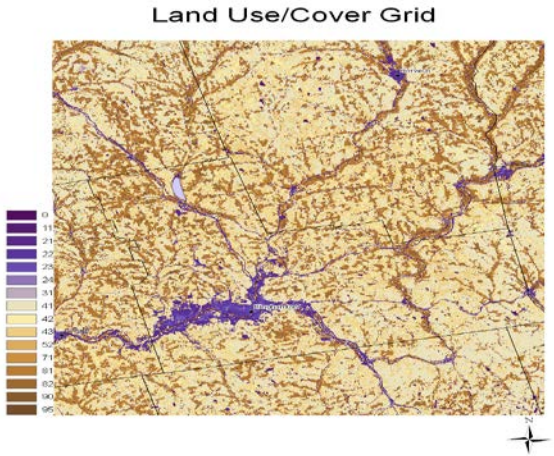
- *FFPI*

FFPI Refresher

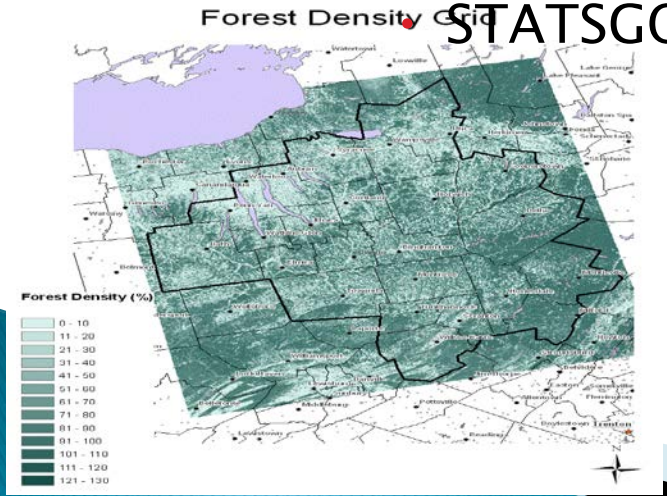
- Index is a mathematical average of geophysical characteristics of a basin
  - Slope
  - Land Use/Land Cover
  - Soil Type
  - Forest Density
- Index gradient is from 1 (Low) to 10 (High)
  - Basin's potential to respond to heavy rain events leading to flash flooding.
- Antecedent conditions not accounted for

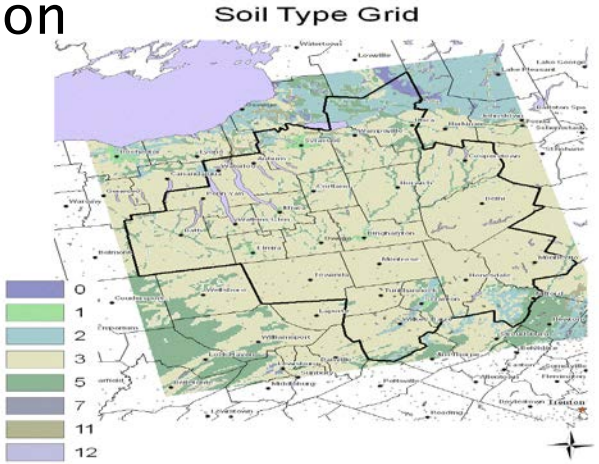
The Data





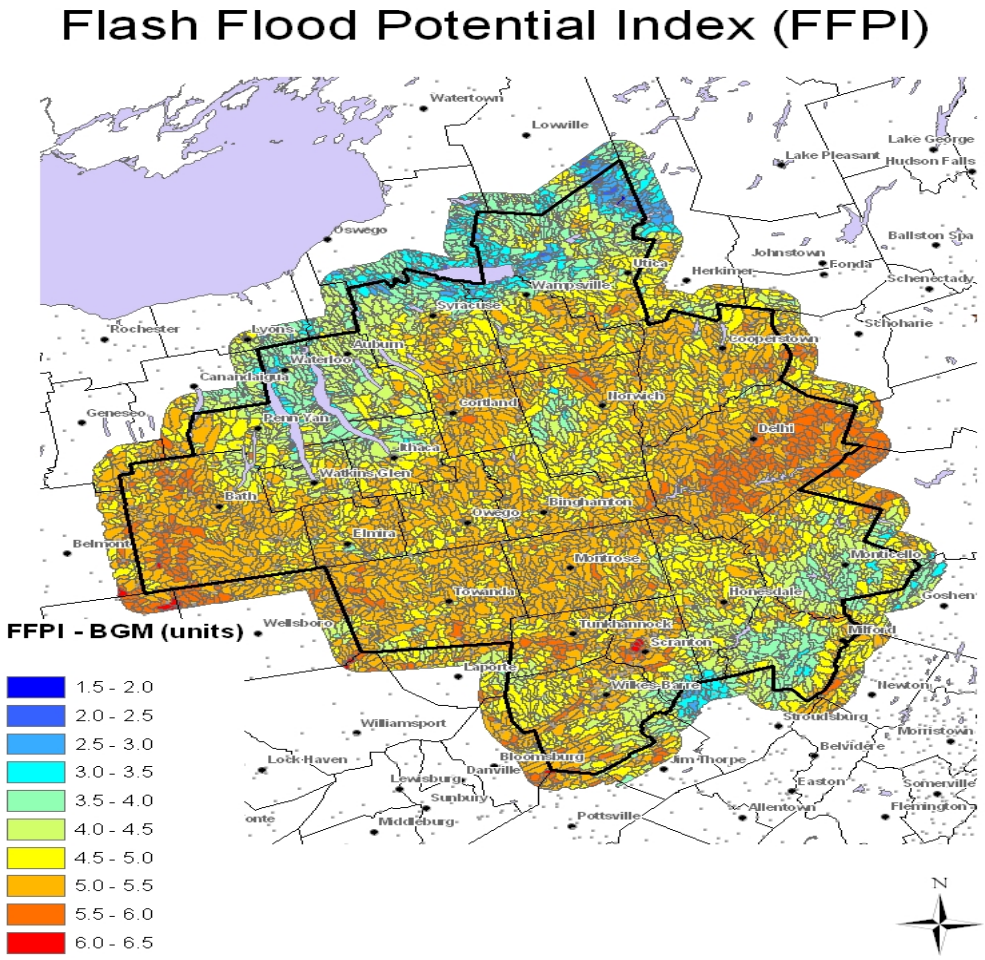
- Four geographic data sets were utilized.
  - Slope derived from the USGS DEM
  - MLRC Land Use/Land Cover Grid
  - AVHRR Forest Density Grid
  - STATSGO Soil Type Classification





FFPI mapped to FFMP Basins

- Note the good fit to empirical understanding developed over the years
- Also some new realizations, especially the low potential areas
- Differentiates the “best of the worst” basins in an area generally known for high flash flood potential



Current/Future Enhancements

- Resolution increased from 90 m to 30 m
- Readily displayable in AWIPS
- Further tweaks / mathematical re-indexing is ongoing
  - Based on FF reports / case studies
- For further information: James.Brewster@noaa.gov (WFO BGM SSH)

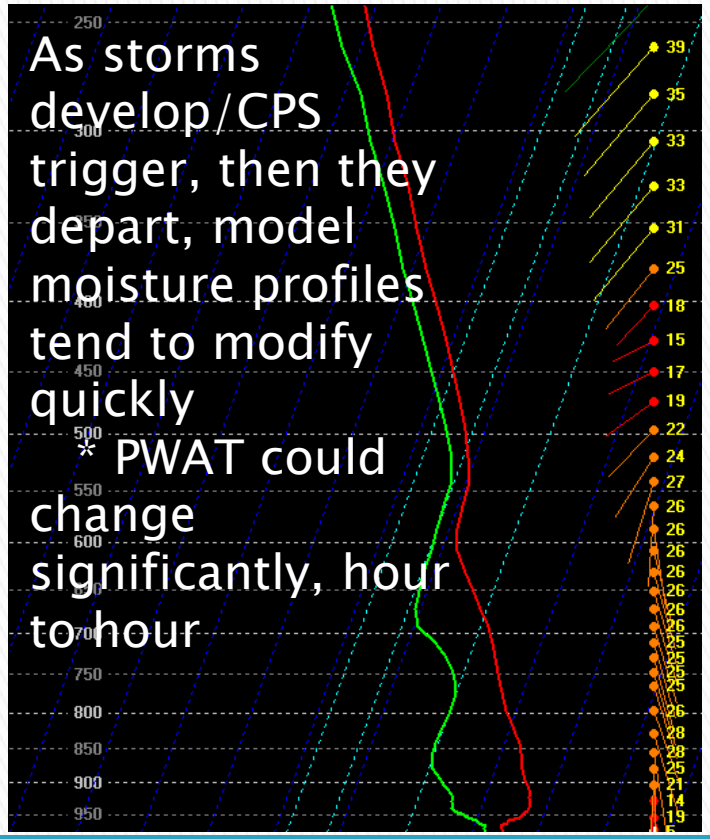
Flash Flood Warning Performance Improvement

- *Maximum Potential PWAT*

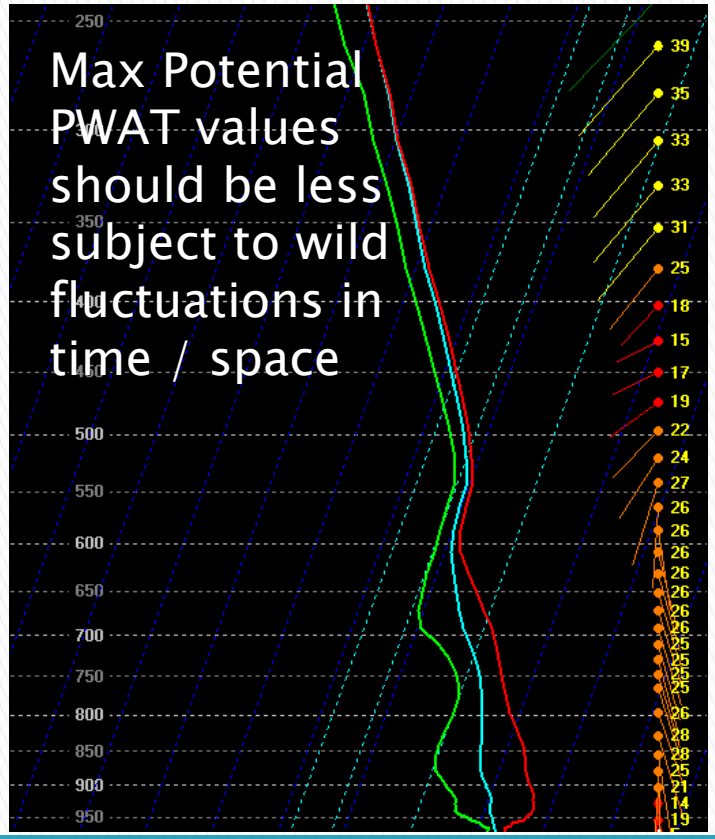
Maximum Potential PWAT (Rationale)

- Assessing flash flood potential can be especially difficult in rapidly changing situations
  - Severe threat evolving to a flash flood threat
- Precipitable water (PWAT) can be a fickle parameter
  - Values can change substantially / quickly as NWP convective schemes trigger
    - Another way to view this field ?

BUFKIT Comparisons



Standard Profile



Max Potential PWAT (saturated along WB temp (light blue trace))

Potential Uses / Future Work

- Maximum potential PWAT (Arnott, 2008, *http://www.erh.noaa.gov/bgm/research/2008/MaxPwat_Abstract.pdf*) may provide a useful way to assess flash flood potential ahead of time, especially given the expectation of training / repeat cells
  - May have the advantage of being a more stable value
- Needs an automated application to run (not yet developed)
- Local testing planned at WFO BGM

References

Arnott, J., 2008: Maximum Potential Precipitable Water – A More Robust Moisture Variable? <http://www.erh.noaa.gov/bgm/research/2008/MaxPwat_Abstract.pdf>.

Davis, R. S., 2000: Detecting flash flood on small urban watersheds. Preprints, 15th Conference on Hydrology, Amer. Meteor. Soc., 233-236.

Kelsch, M., 2001: The relationship between intense, short-duration precipitation and flash floods. Preprints, Symposium on Precipitation Extremes: Prediction, Impacts, and Responses, Amer. Meteor. Soc., 124-128.

The End !!

Questions ??