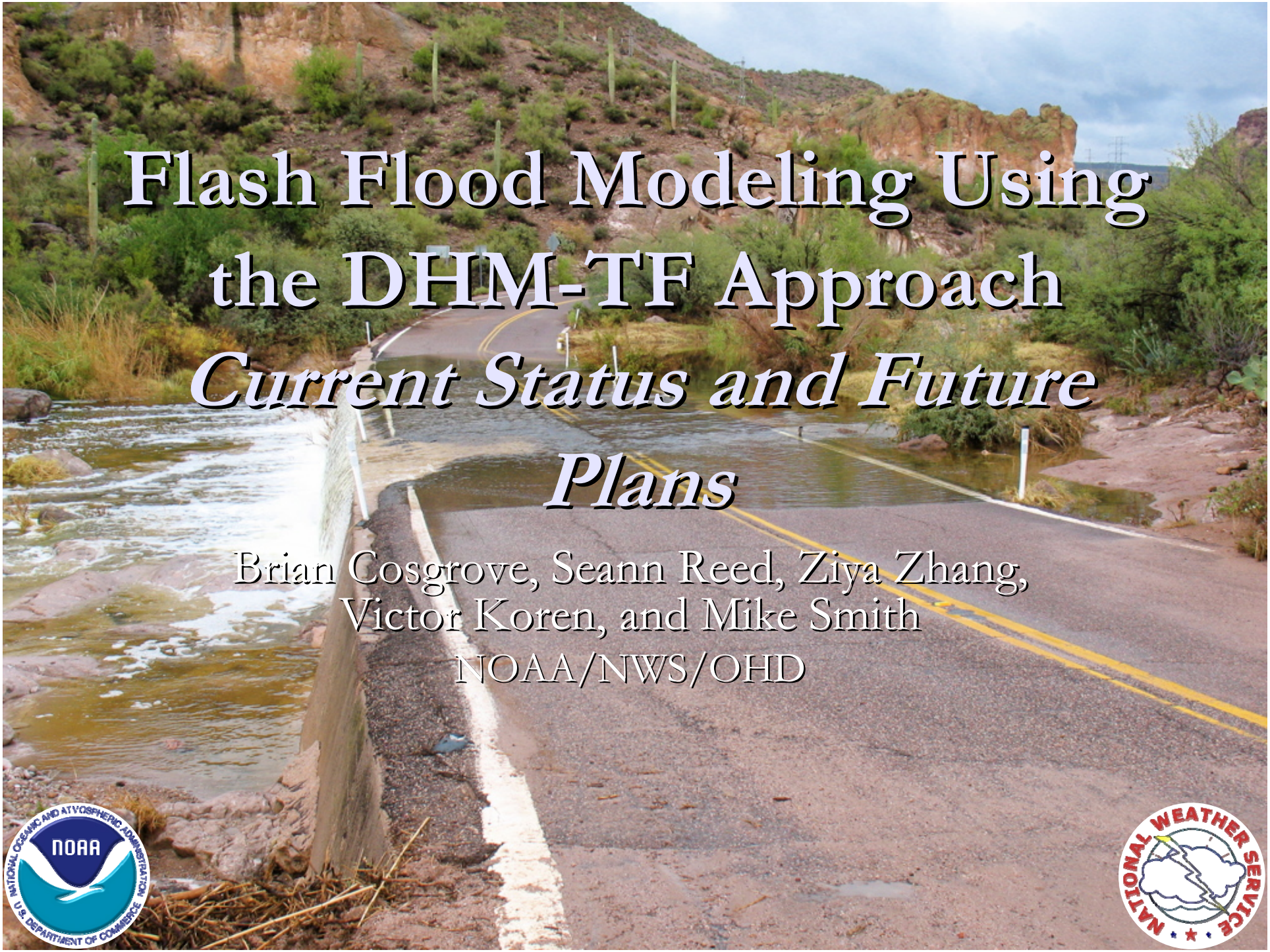


Flash Flood Modeling Using the DHM-TF Approach

Current Status and Future Plans

Brian Cosgrove, Seann Reed, Ziya Zhang,
Victor Koren, and Mike Smith
NOAA/NWS/OHD

Distributed Hydrologic Model-Threshold Frequency (DHM-TF) Approach

- DHM-TF system: Combine a distributed hydrologic model with a threshold frequency post-processor to improve flash flood forecasts at ungauged locations
- DHM produces gridded flow forecasts, from which gridded frequency forecasts are derived using historical simulations
- Historical simulations are conducted using DHM and same type of forcing data used in forecast simulations to maintain consistency
- Threshold frequency grids are derived from local information and compared with frequency forecasts for flash flood determination
- Sacramento with kinematic routing used in OHD's implementation, but any hydrologic model can be used

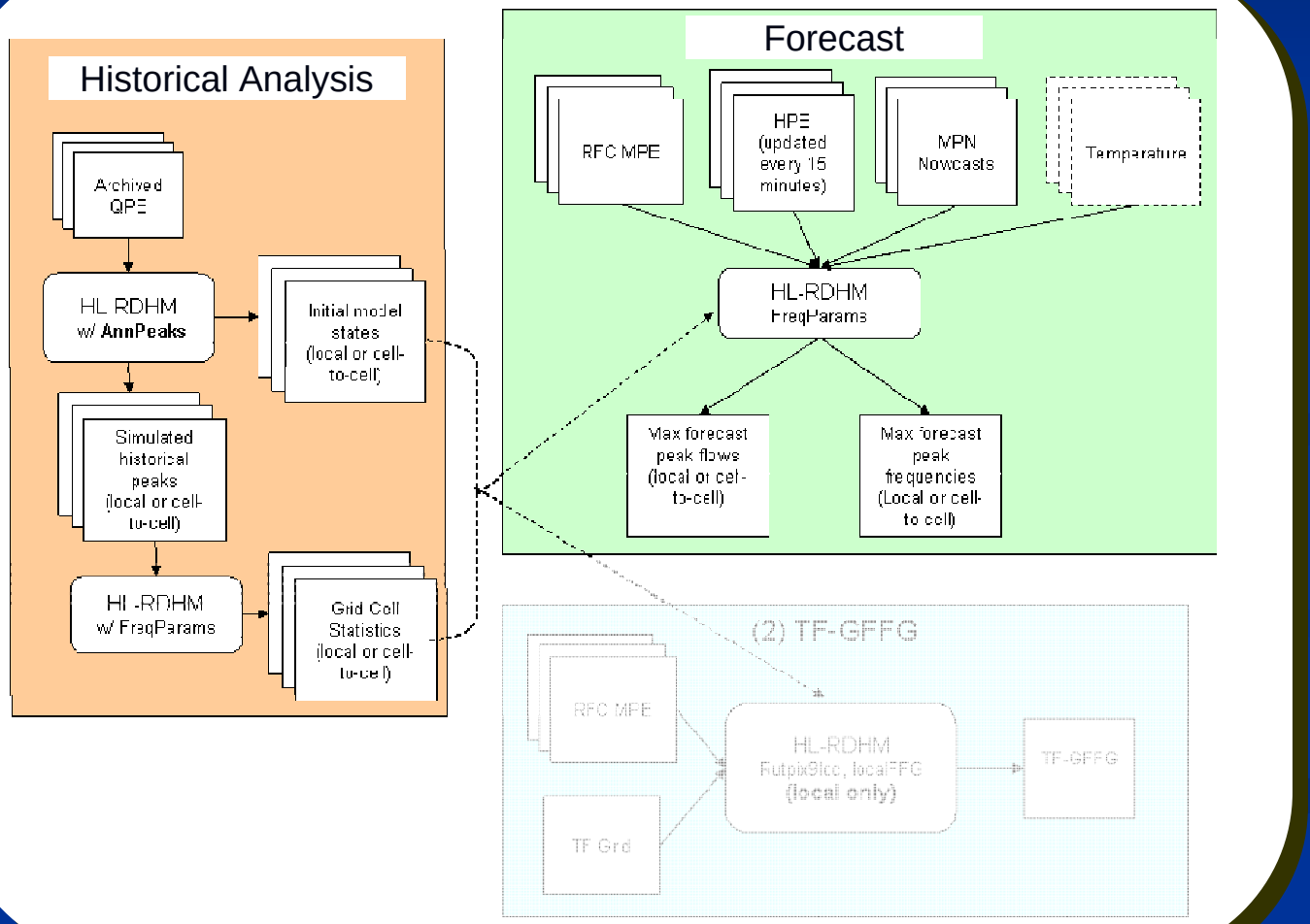
DHM-TF Motivation

- DHM-TF is able to predict flash flooding at ungauged locations
- System provides inherent bias correction to model flow predictions (concept that the relative rank of events—and therefore frequency—can be well-simulated even if the flow is biased)
- Superior to standard flash flood guidance
  - Computed at 2km to 4km resolution versus > 260km^2 basin scale
  - Can be updated every 15 minutes versus 1 to 6 hours
  - Produces verifiable small basin flow estimates

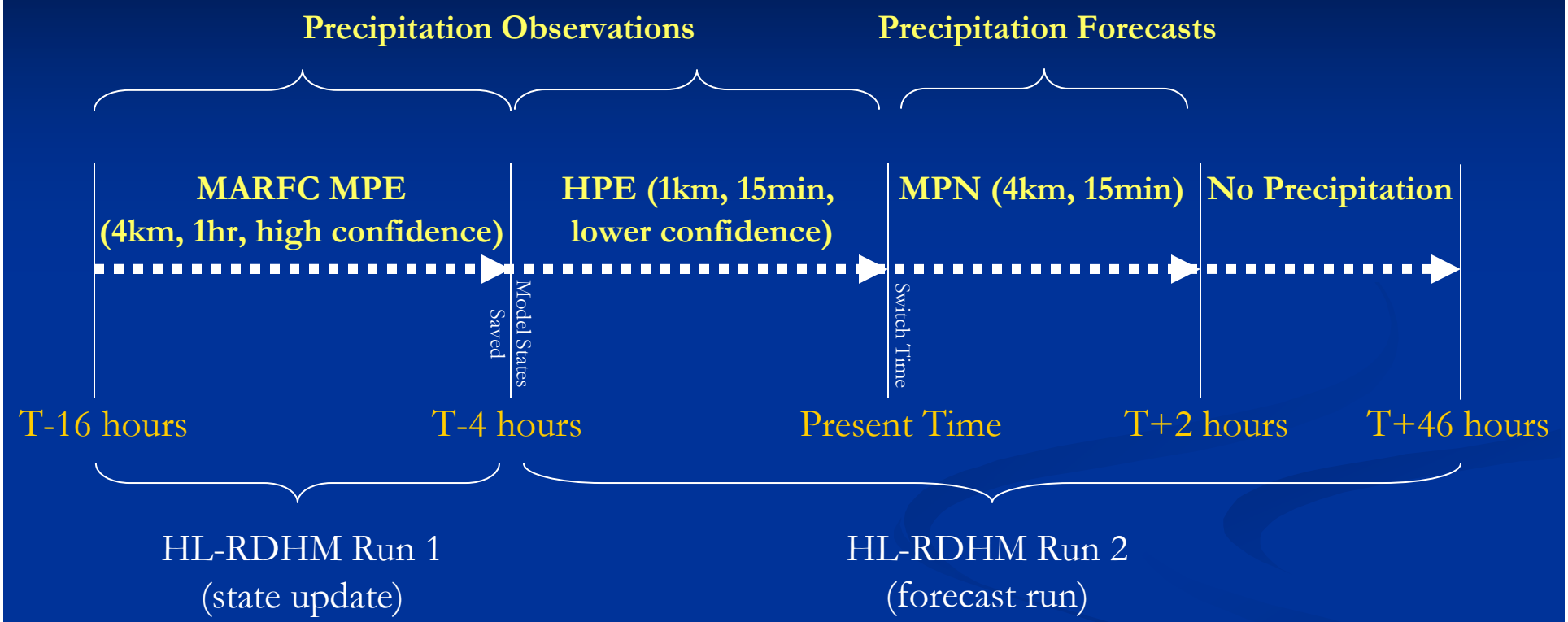
DHM-TF History

- 2003: Threshold frequency concept advocated at DOH workshop
- 2003: Concept expanded and initial development of software
- 2004: Statistical flash flood modeling paper presented at AMS
- 2006: DHM/QPF flash flood prediction paper presented at AMS
- 2006-2007: DHM-TF simulations conducted over Oklahoma-domain, work is published in Journal of Hydrology
- 2007: Discussions with Sterling WFO concerning use of DHM-TF
- 2007: Maryland case developed to support Sterling WFO transfer
- Now: Brian Cosgrove takes over DHM-TF work

DHM-TF Overview



Real-time DHM-TF Prototype



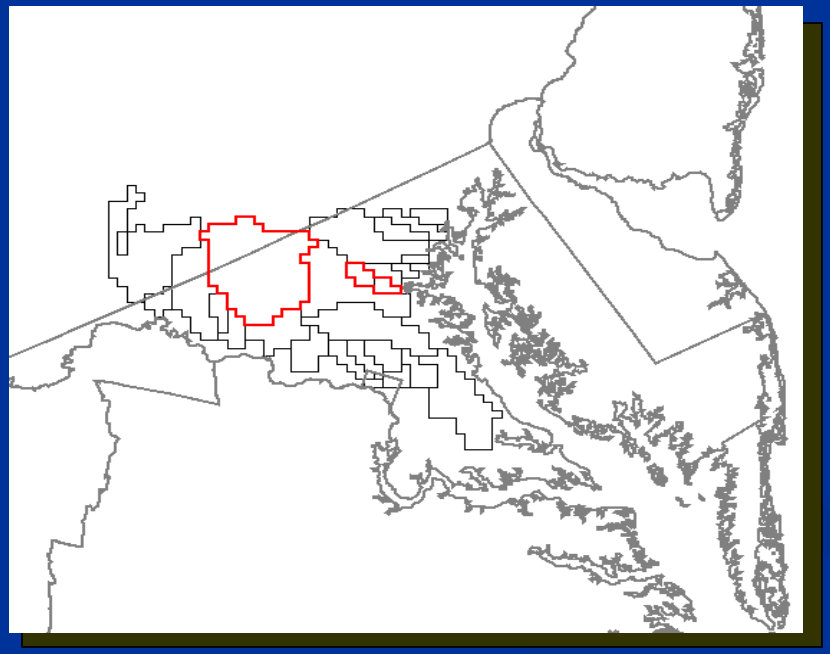
***Cycle automatically repeated every hour in current setup**

***Can be set to update forecast run every 15 minutes, using more HPE and less MPN data**

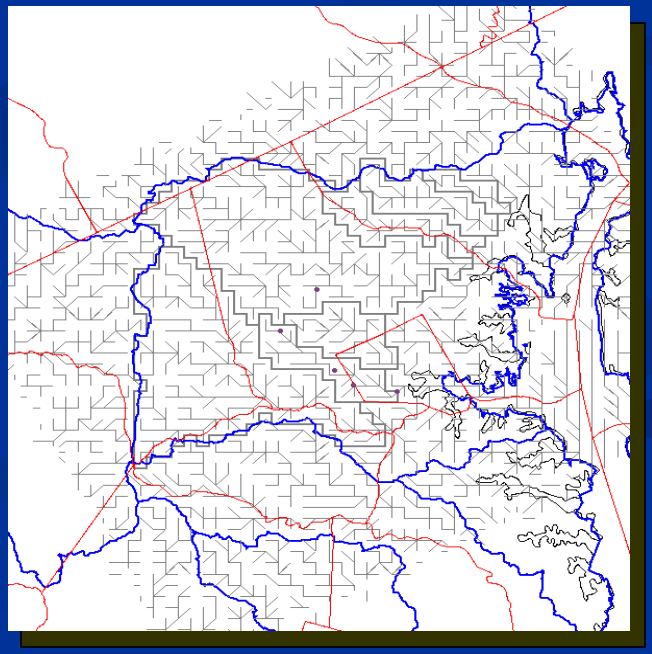
DHM-TF Maryland Pilot Project

- Maryland area well-suited for implementation of prototype DHM-TF
  - HPE/MPN prototype currently running over this region
  - Includes Baltimore, a well-studied, high profile, flash flood prone area
  - Local basins, MARFC, and Sterling WFO are accessible for site visits
  - Large number of stream gauges are available in Baltimore County for validation
  - Mix of urban and suburban areas
- Using MARFC MPE precipitation data for historical simulations

Current: 4 km model with 28 outlets defined

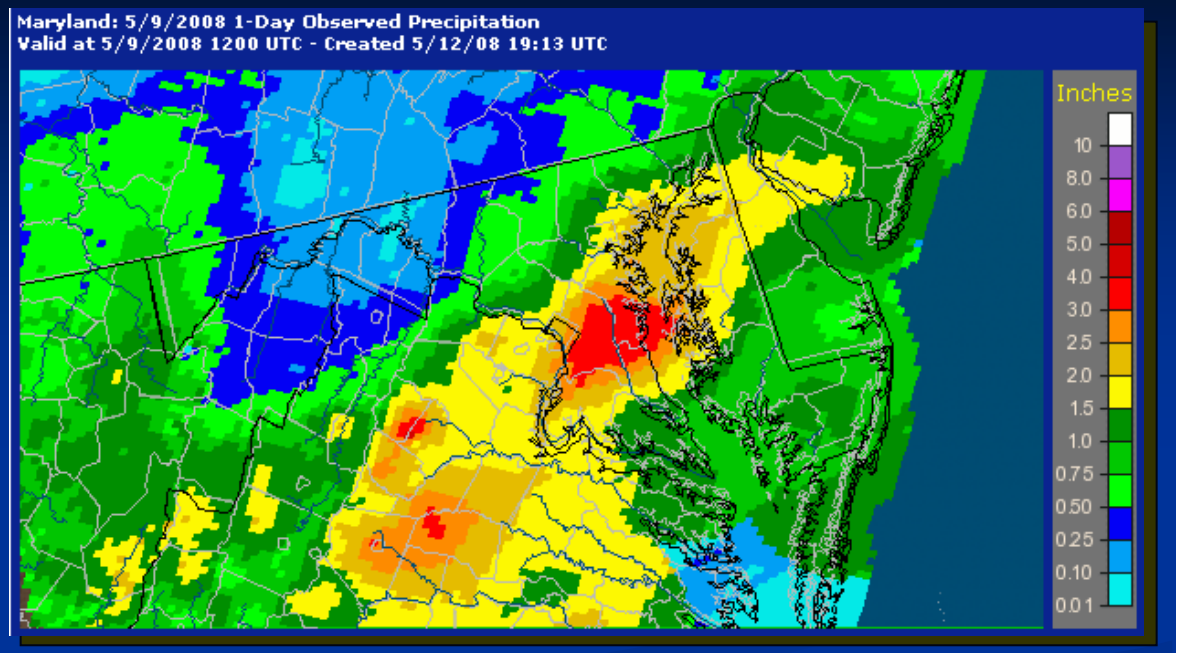


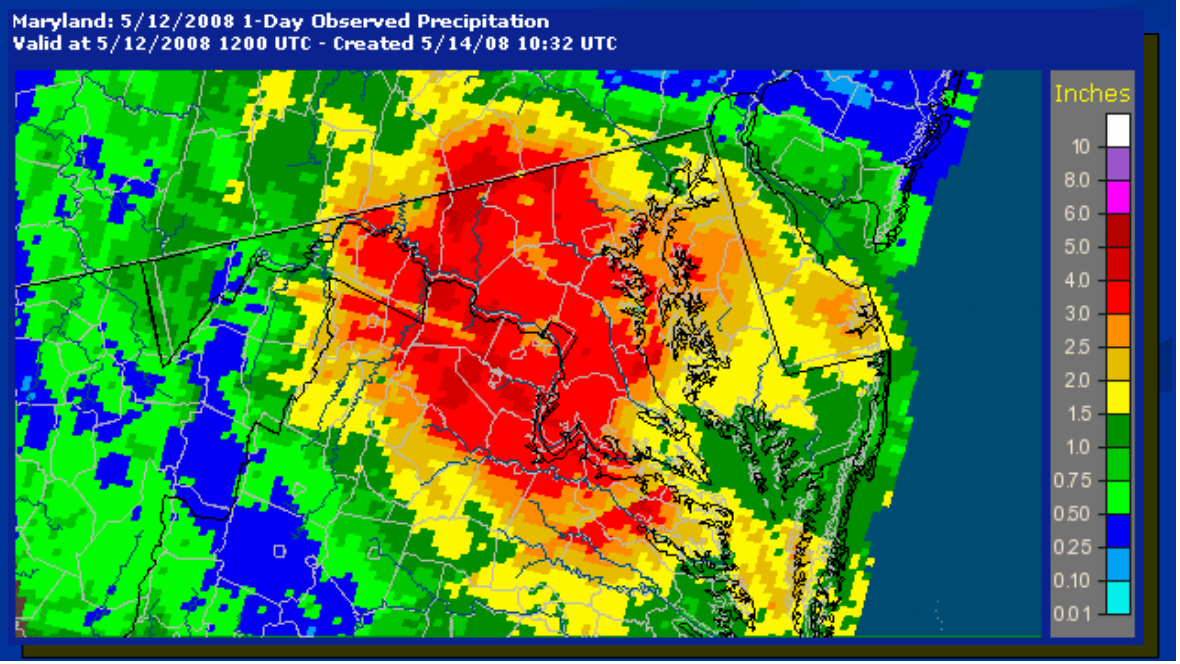
Planned: 2 km model with 12 outlets defined



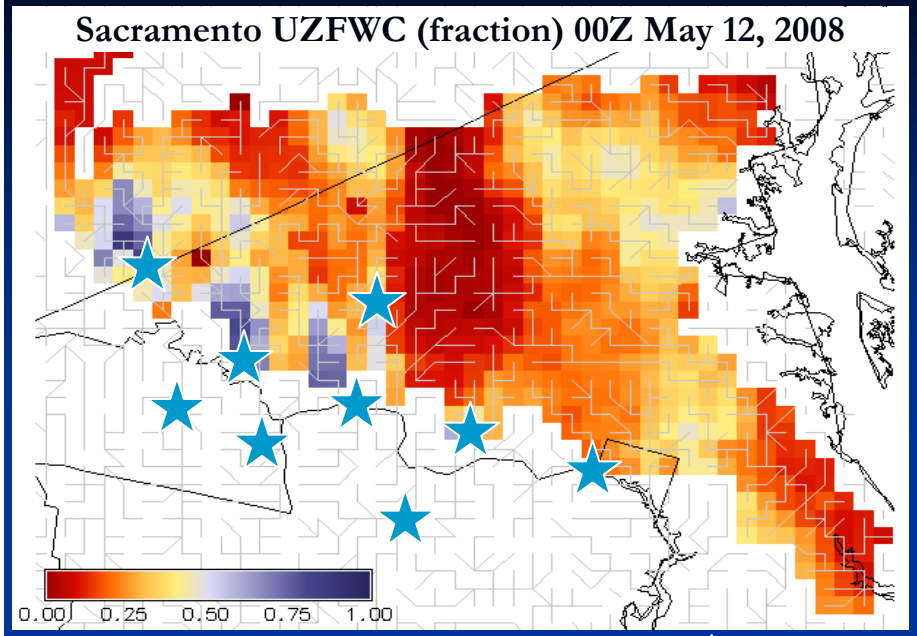
Maryland DHM-TF Case Study

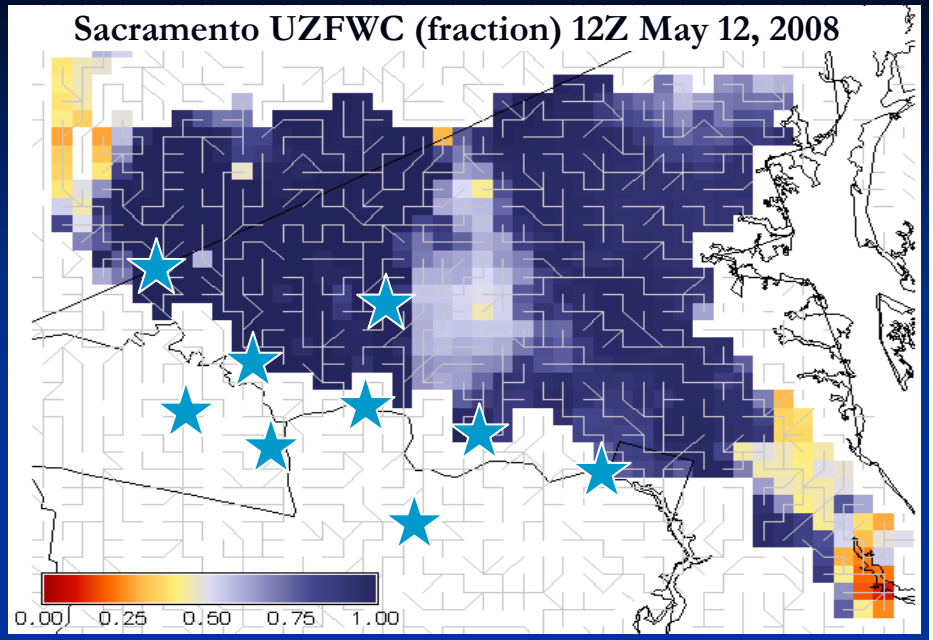
- Multiple rain events, May 9th-12th, 2008
- Several flash flood warnings issued by Sterling WFO for Washington DC and surrounding counties on May 9th
- Tornado warnings for Prince Georges and Charles Counties in Maryland



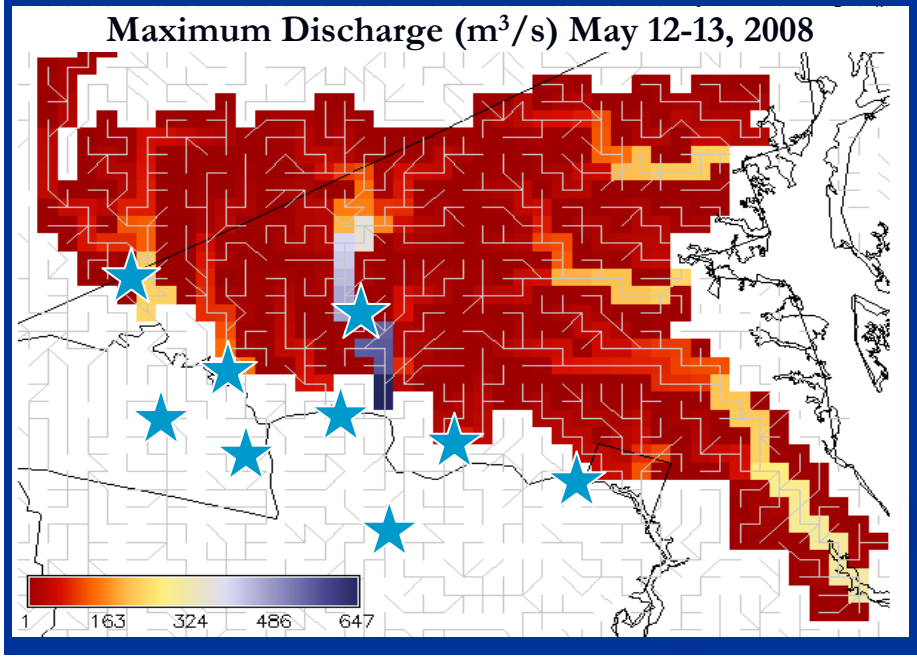


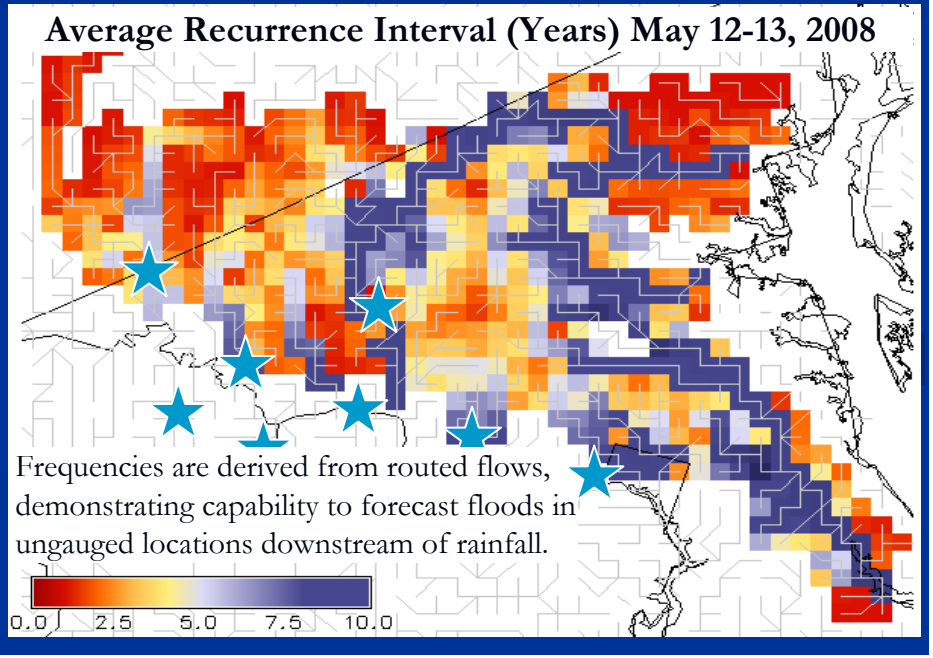
Maryland Case Study: May 12-13 2008





★ = Forecast Gauge Locations

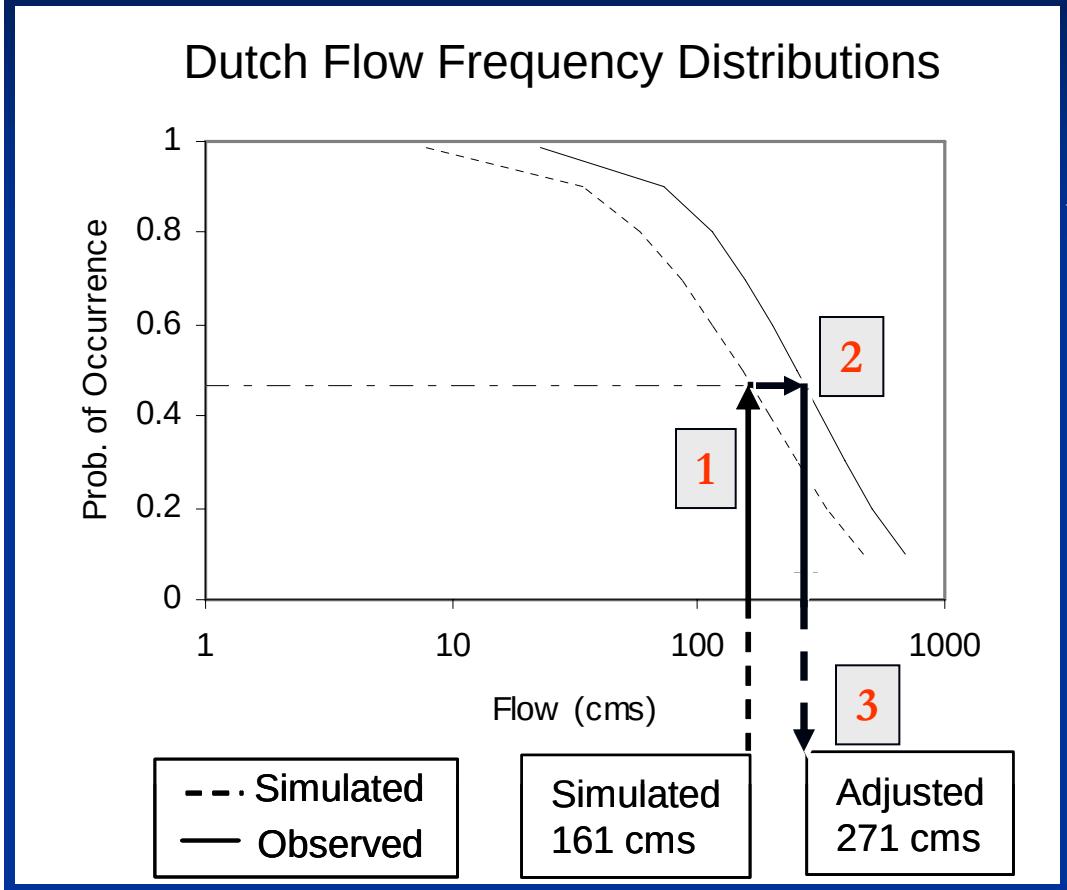




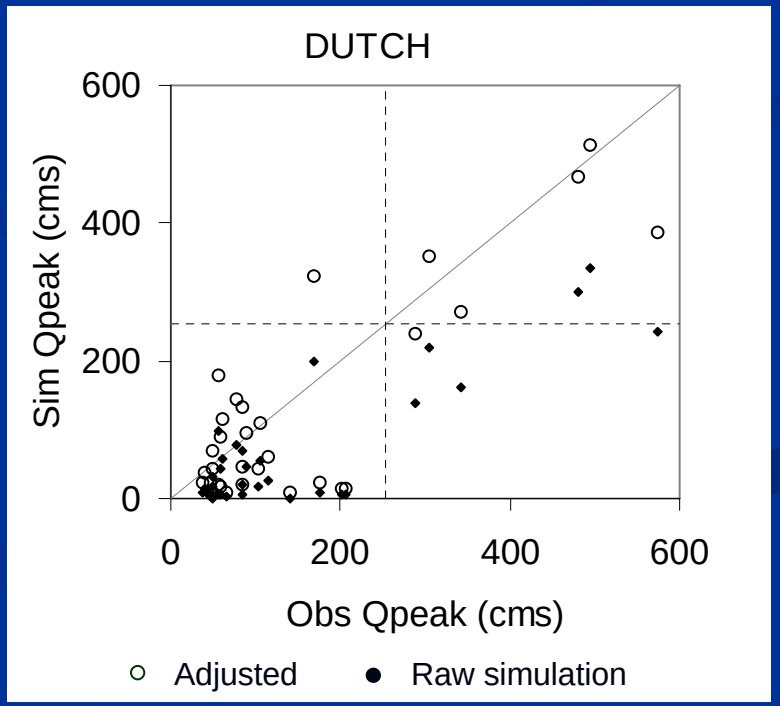
Frequencies are derived from routed flows, demonstrating capability to forecast floods in ungauged locations downstream of rainfall.

Assessing the Inherent DHM-TF Bias Correction

(Are flow ranks and frequencies correct even if flow magnitudes are biased?)



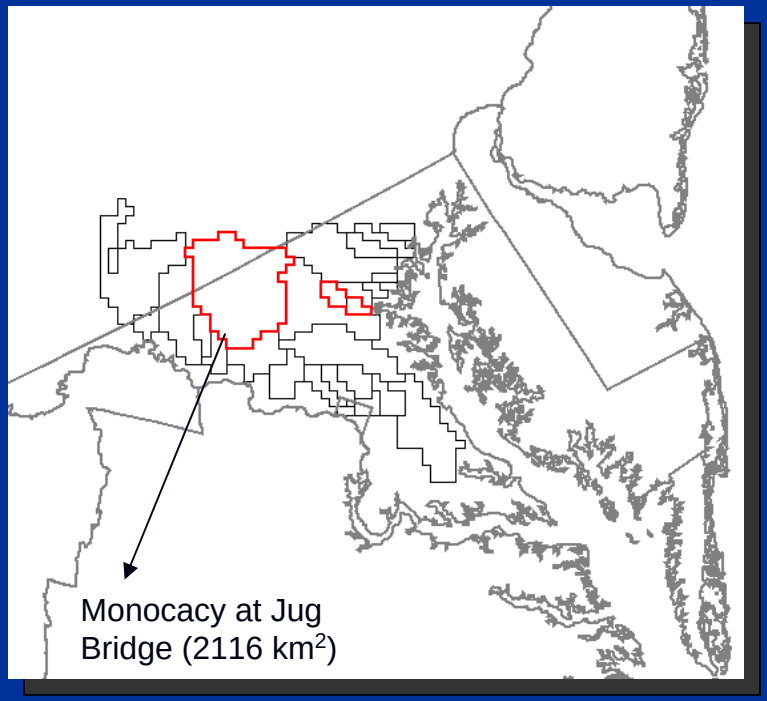
Compute peak flow adjustments at gauged validation points using observed and modeled flow frequency distributions

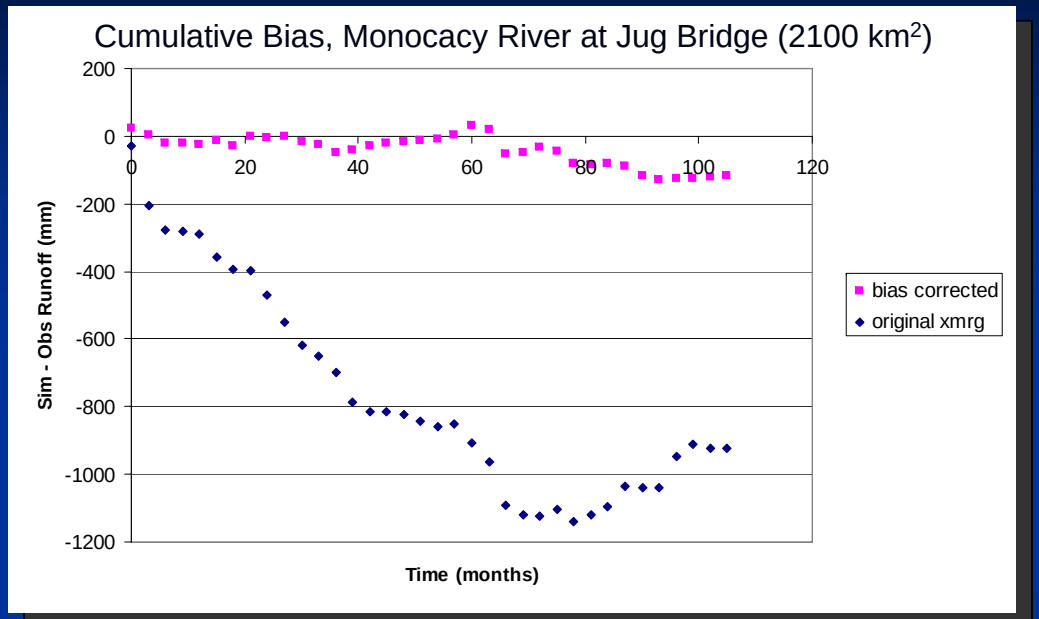


- Supports concept that frequency is well-simulated even if flows are biased
- Potential exists for implementing DHM-TF approach even if model is not well calibrated

Bias Correction of Precipitation

- Bias detected in MARFC MPE archives prior to 2004
- Bias corrected precipitation needed to support unbiased simulation statistics for a reasonable historical period (~9 years)

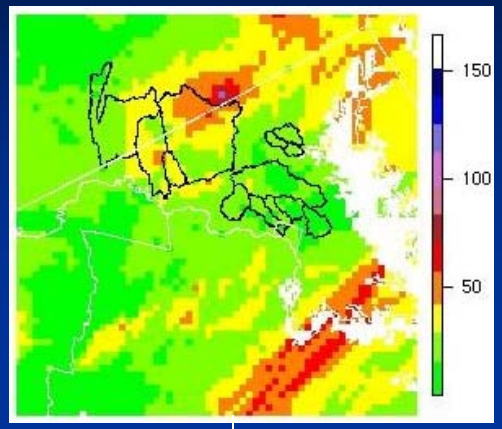




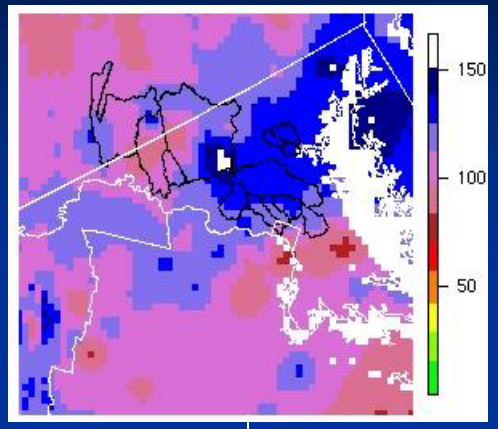
- Analysis of Monocacy River flow shows reduction in cumulative bias and improved consistency when bias corrected precipitation is used
- Consistent bias can be removed through calibration or through DHM-TF approach

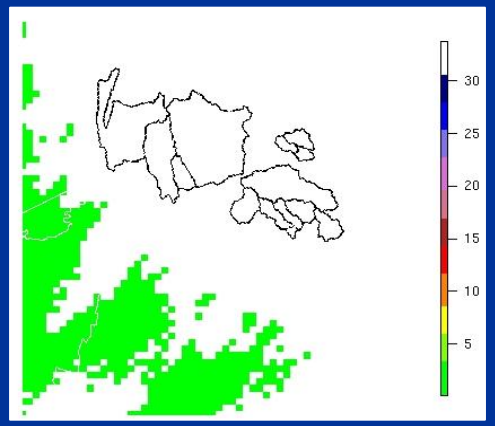
Bias Correction of Precipitation

Monthly RFC MPE Precipitation 03/97 (mm)

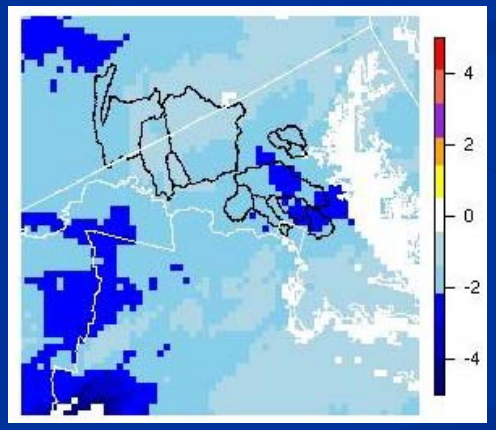


Monthly PRISM Precipitation 3/97 (mm)

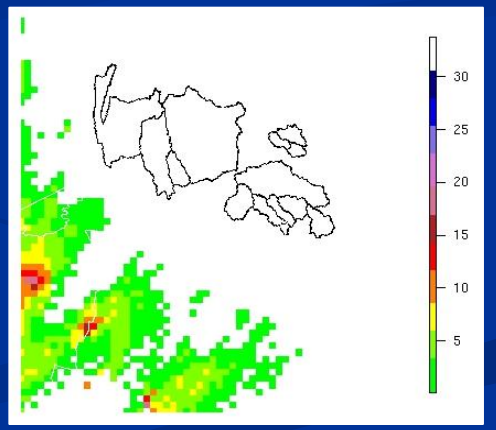




RFC Hourly MPE Precipitation 03/01/97 12z (mm)



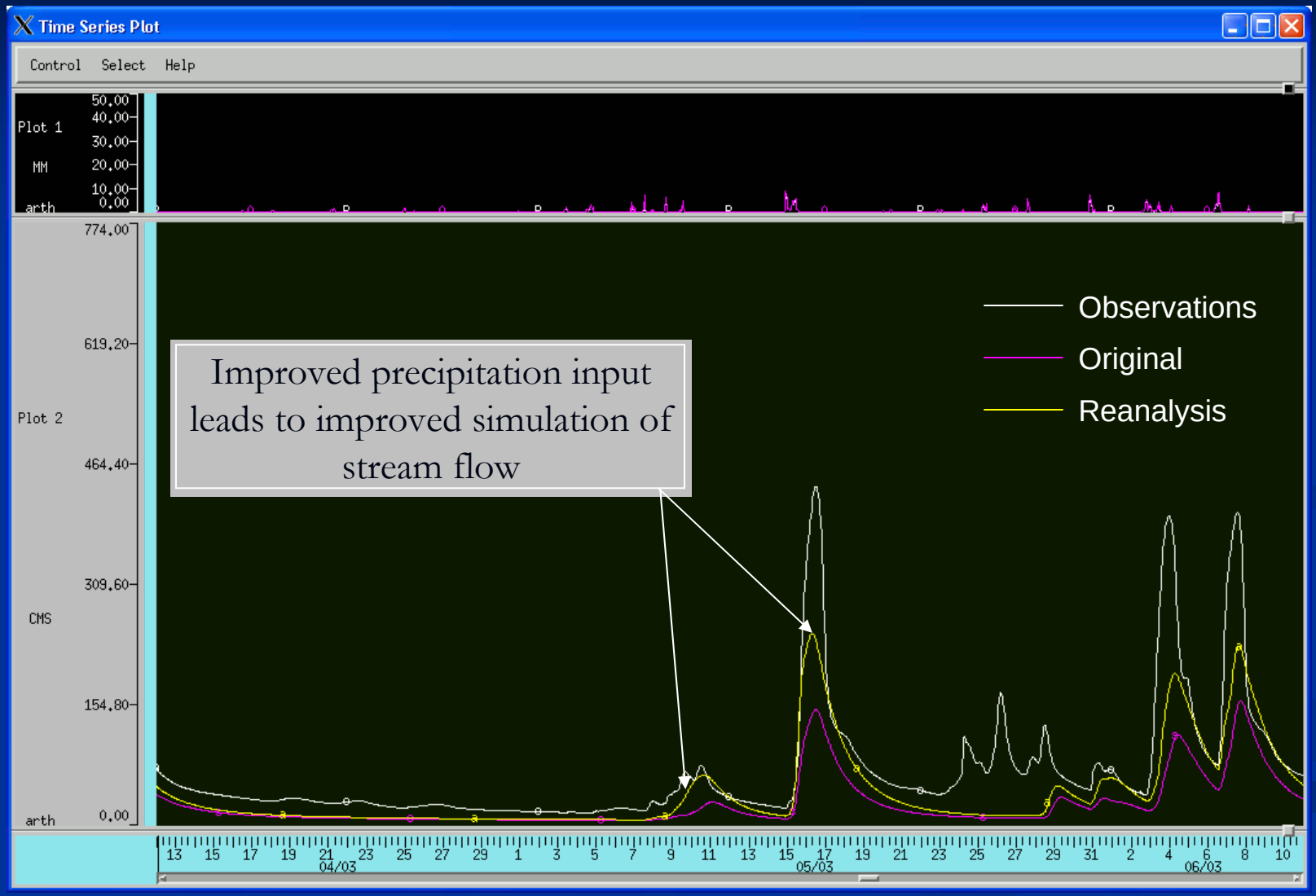
Monthly Bias (ratio)



Adjusted RFC Hourly MPE Precipitation 03/01/97 12z (mm)

Yu Zhang

Impact of Precipitation Bias Correction



Monocacy River Flow: April 12 through June 11, 2003

Prototype Tools Available from the DHM-TF Project

- New HL-RDHM routines needed for DHM-TF approach
  - monthlySum: generates gridded monthly total precipitation
  - xmrgAdjust: bias corrects hourly precipitation data with PRISM
  - AnnPeaks: produces annual grids of maximum peak discharges
  - FreqParams: reads annual peak files, computes frequency distribution at each grid cell and outputs distribution parameters
  - getMaxRet: computes maximum discharge and return period during forecast period
- GRASS and GrADS scripts for visualizing input and output
- Cron scripts for real-time prototype
- Full set of DHM-TF components available through the LAD by mid-August

Future Work

- Reestablish real-time experimental DHM-TF runs at OHD
- Increase run resolution to 2km (1/2 HRAP)
- Add Snow-17 into prototype DHM-TF system
- Finish creating graphical tools and scripts needed for output visualization at RFCs and WFOs
- Finish comprehensive documentation of DHM-TF
- Define requirements for operational development
- Coordinate with Sterling WFO on implementation of experimental DHM-TF system
- Continue to bias correct MPE precipitation with PRISM data (Hydromet Group)