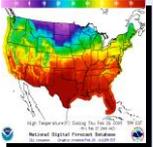


Development of the Runoff Risk Advisory Forecast (RRAF) for Wisconsin

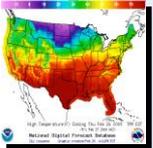
Development and Production of a Decision
Support Tool for Wisconsin Manure Producers

Dustin Goering & Brian Connelly
North Central River Forecast Center



Project Concept

- **Goal :: Provide a Decision Support Tool to help manure producers minimize the occurrence of contaminated runoff**
- **Utilize existing NWS weather and watershed models in a water quality application**
- **Highlight ability for NWS to collaborate with multiple state and federal agencies**
 - ***[Runoff Risk Advisory Forecast Working Group]***
 - Wisconsin Dept of Agriculture, Trade, and Consumer Protection (DATCP)
 - USGS WSC Middleton WI
 - University of Wisconsin Madison & Platteville
 - NRCS
 - UW Discovery Farms and Pioneer Farm



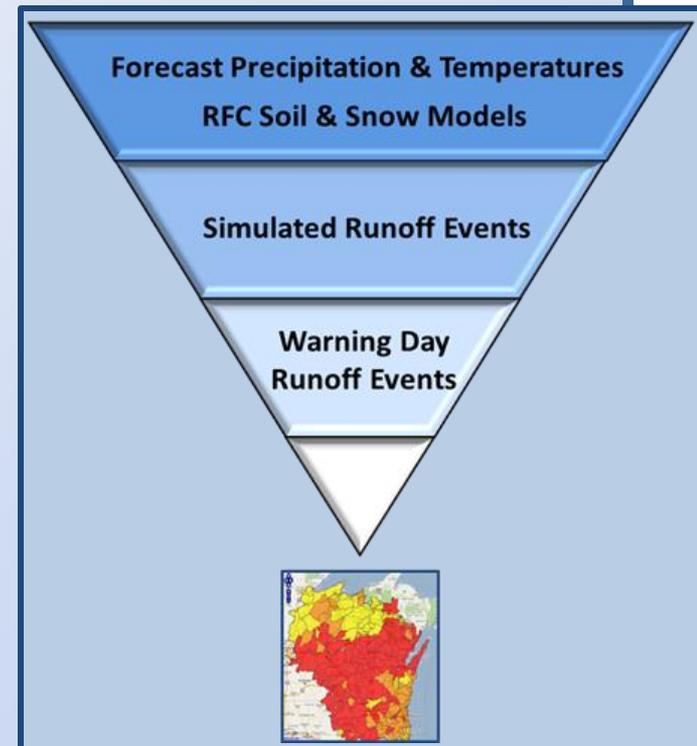
Project Development

- **DATCP has noted a high demand for this type of guidance**
 - *Dairy cows produce 150 lbs. waste / day*
 - *1.25 million dairy cows in Wisconsin*
 - *34 million tons of waste annually*
- **Currently no real-time runoff risk guidance exists**
 - *Some products rely strictly on QPF, no soil conditions or snowmelt*
 - *Other tools are very site specific and don't include forecasting ability*
- **The RRAF has been continually refined over the last few years**
 - *The RRAF Working Group held meetings and calls to discuss ideas and challenges*
 - *Many revisions to approach & webpage presentation ... expect evolution to continue*



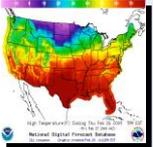
What is the RRAF?

- **End Product** :: Webpage indicating **Low - Med - High** risk for runoff
 - *List of **simulated runoff events** for 216 NWS watersheds in Wisconsin*
 - *Issued 3x daily with a forecast window out 10 days*
 - *Incorporates **5 days QPF** and **10 days forecast temperatures***
 - *Basin specific thresholds used to differentiate between med and high risk events*
- **Definition of Simulated Runoff Event:**
 - *3 model components must be present:*
 - **SAC-SMA Interflow > 0**
 - **SAC-SMA Upper Zone Tension Water Deficit = 0**
 - **Snow-17 Rain+melt > 0**
 - *Accumulation of SAC interflow runoff*
- **List of simulated events sent to DATCP**
 - *DATCP has basin thresholds, processes data*
 - *They built, maintain webpage*



Project Perspective

- **Scale is a significant issue with this approach**
 - *Fields generally 10 - 50 acres*
 - *NWS basins range from 9 – 1,800 mi² (Avg size = 301 mi²)*
- **Important assumptions must be communicated to users:**
 - *This is not meant to be the only tool for deciding when to spread*
 - *This approach will never produce perfect prediction*
 - **One farm may have runoff, the next one may not**
 - **Rainfall patterns, snowpack conditions, field aspect, etc.**
 - *Users must combine knowledge of local conditions with forecast*
- **Long term success depends on:**
 - *The model is shown to be an accurate predictor of average field scale conditions & runoff risk for a given basin*
 - *The users build trust in the product leading to decreased contaminated runoff incidents*



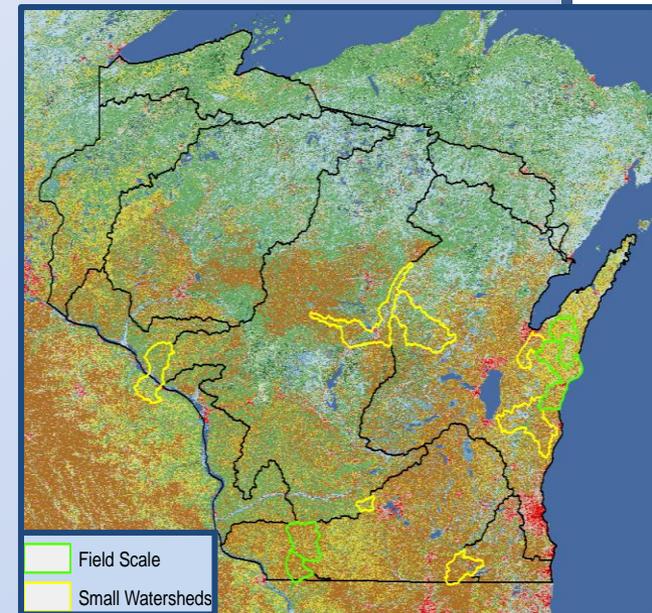
Model Validation

- Evaluate the model vs. observed runoff data
 - NCRFC model ran continuously from 1948 - 2008
 - Compared events against 4 field scale sites & 7 small USGS gauged watersheds
 - Immense difference in average watershed sizes
 - Field = 0.03 mi² NWS Basins = 229.9 mi² 0.01% NWS Basin
 - USGS = 15.9 mi² NWS Basins = 294.0 mi² 5.41% NWS Basin

➤ Field	::	Hit% = 80%	Miss% = 20%	FA% = 71%
➤ USGS	::	Hit% = 62%	Miss% = 38%	FA% = 45%
➤ Combined	::	Hit% = 71%	Miss% = 29%	FA% = 58%

- Encouraging results!
 - Stratification of observed Hit/Miss & model Hit/FA
 - Hit/Miss event magnitude Ratio = 7.7
 - Hit/FA event magnitude Ratio = 8.3
 - Capturing the larger events

- We do NOT want to promote warning fatigue
 - lose credibility with the users → product ignored
 - Can false alarms be reduced? **Key = Hit/FA ratio!**



Addressing False Alarms

➤ Goal for Reducing False Alarms ::

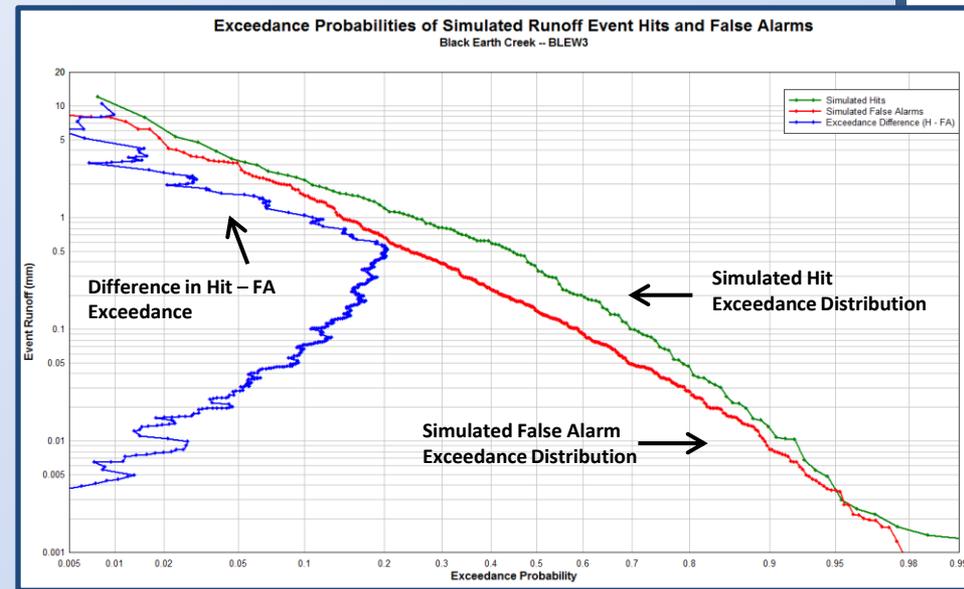
- *Extract a method from 11 observation sites that can be applied to all 216 basins*
- *Don't want strictly arbitrary approach*
- *Concern is for the larger magnitude events*

➤ For the 11 test sites ::

- *Noted max difference between simulated hit and simulated false alarm distributions*
- *Maximize the number of hits while minimizing the number of false alarms*
- **Threshold Exceedance = 0.4**
 - **Field sites = 0.39**
 - **USGS = 0.40**

➤ End Result ::

- *Smallest 60% of simulated runoff events removed*



Threshold Effects

➤ Results ::

- *Applying thresholds does lower false alarms*
- *Unfortunately, Hits decrease and Misses increase*

➤ What are we missing though?

- *Are we still hitting enough events?*
- *How significant are the events we miss?*

➤ The magnitude of **Hits** >> **Miss**

- *Obs Hit/Miss Ratio increases from 7.7 → 9.6*
- *Missed events are much smaller in magnitude*

➤ Long term how do thresholds affect model performance?

- *Review historical runs for 216 basins → Sample > 12,000 years*
- *% Time in each category*
 - **CAT 1 :: No Event simulated == 90%**
 - **CAT 2 :: Runoff Event < Threshold == 4%**
 - **CAT 3 :: Runoff Event >= Threshold == 6%**

	No Thresh	Thresh
Field		
% Hit	80%	64%
% Miss	20%	36%
% FA	71%	48%
USGS		
% Hit	62%	41%
% Miss	38%	59%
% FA	45%	19%
Combined		
% Hit	71%	53%
% Miss	29%	47%
% FA	58%	34%



RRAF in Action

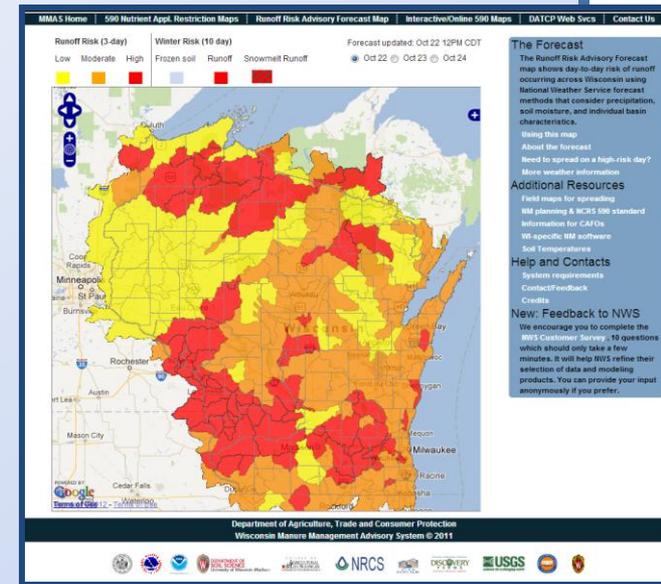
- **DATCP hosts the website**
 - Clickable basins provide precip and indicate type of runoff
 - RRAF Working Group is active in monitoring the page for problems
 - DATCP actively promotes the tool in print, web, and on radio

- **Tool highlights some RFC modeling “warts”**
 - RFC calibrated for streamflow and stage forecasting
 - Spatial or Temporal inconsistencies can lead to credibility issues

- **DATCP introduces 72-hr warning window**
 - Time allowed for manure to incorporate into soils

- **Color coding essentially == 3 day risk**
 - Only 1 event in that window needed to classify entire period
 - Worst case wins (C3 HIGH > C2 Medium) → turns it red

- **Refer to this 3 day window == Warning Day**

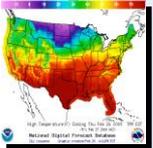


T0	1	2	3	4	5	6	7	8	9	10
WD1	Blue			Grey						
WD2	Green		Grey							
WD3	Pink	Grey								
WDX	Grey					Blue				



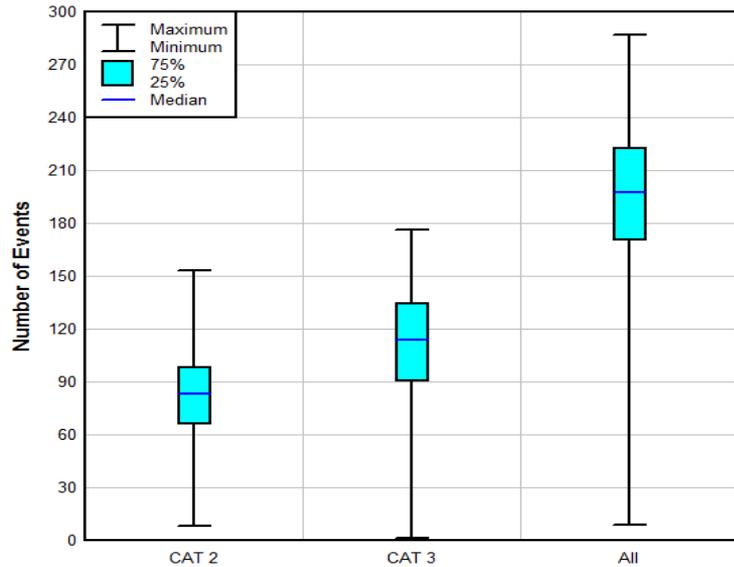
Analysis of 2011 RRAF Guidance

- **A review of RRAF products for 2011 was accomplished**
 - *365 daily runs*
 - *Using Warning Day perspective → What the user would see and “remember”*
 - *First look at forecast uncertainty included*
 - *Remember, this is not verification. This is just a sum of daily forecasts*
 - **Looking for spatial inconsistencies over the year**
 - **Large precip events or melting events can be counted several times in this approach**
- **Overall (*not Warning Day*) Metrics ::**
 - *Median # events in basin = 198 (43% C2 57% C3)*
 - *Event runoff dominated by C3 (on avg 95% is C3 → Thresholds working)*
 - *Median Percent time in category is similar to simulated historical analysis*
 - **C1 :: 92%**
 - **C2 :: 2%**
 - **C3 :: 6%**

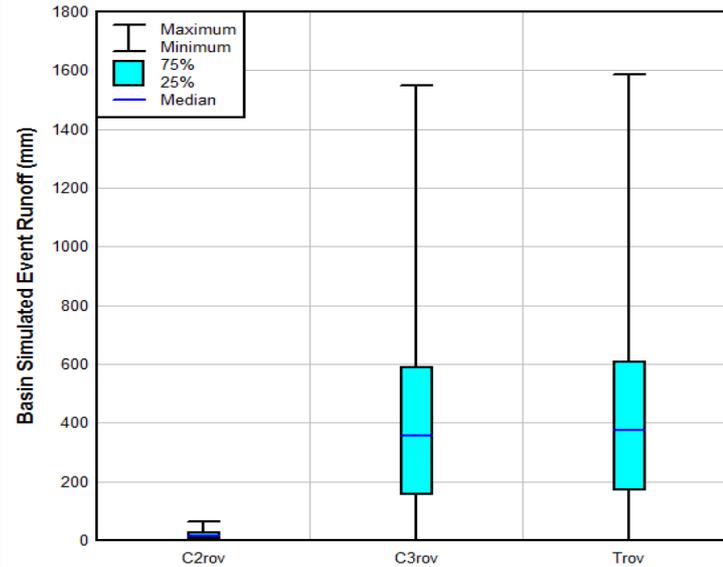


Results of 2011 Forecast Runs

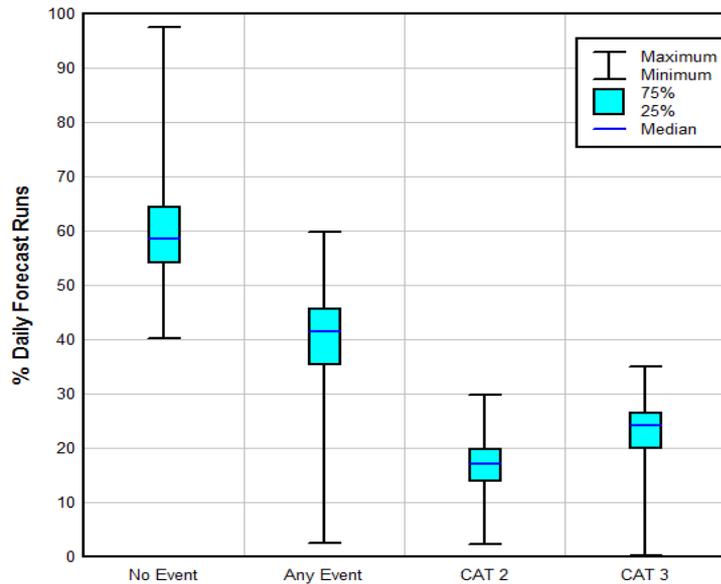
Number of Simulated Runoff Events in 2011



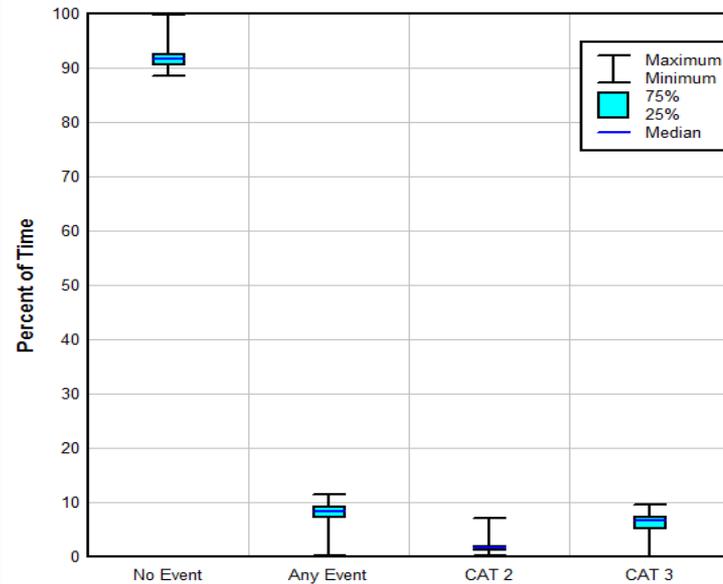
Basin Simulated Event Runoff for All Forecast Runs in 2011



Percent Daily Forecast Runs in 2011 with Condition Present



Percent of Time Basins in Each Category for 2011 Runs



Percent Daily Forecast Runs with Runoff Event by Warning Day

WD1

WD2

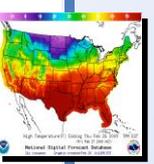
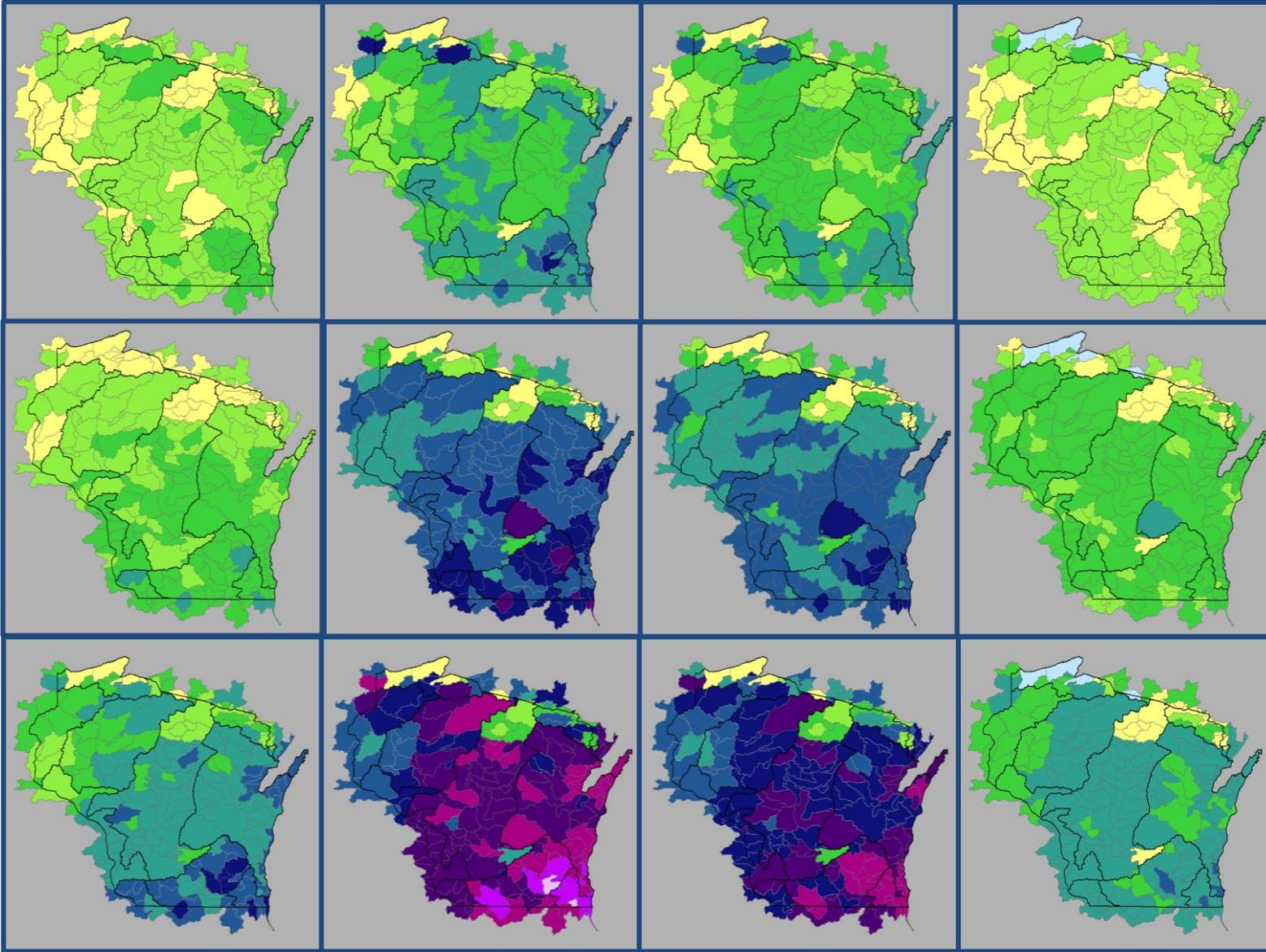
WD3

WDX

C2

C3

All



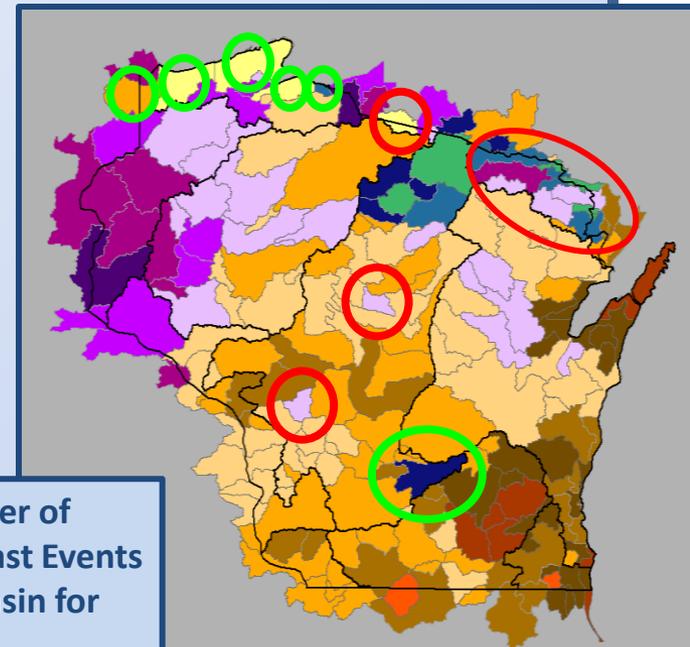
Next Steps

➤ Short Term ::

- *Finish documentation in next month*

➤ Future Steps ::

- *Conduct real verification with updated observed field data*
- *Invite further collaboration*
 - **(Universities, other Agencies)**
- *Evaluate future expansion to other states*
 - **Collaboration with other agencies, universities?**
 - **Proceed with current RRAF model?**
 - **Begin evaluating fine scale distributed model**



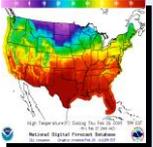
Number of
Forecast Events
per basin for
2011

Collaboration Update

- **Agencies Briefed on the RRAF:**
 - *USACE Mississippi Valley Division*
 - *EPA Region 5 (Midwest and Great Lake States)*
 - *NRCS Midwest Region*
 - *USGS Midwest Region*
 - *NOAA/National Ocean Service – Center for Sponsored Coastal Ocean Research*

 - *Illinois State Water Survey*
 - *Minnesota Department of Agriculture*
 - *University of Minnesota Morris*
 - *Red River Basin Commission*
 - *UMRBA Water Quality Program Director*
 - *Minnesota Discovery Farms*

- **Accepted to present at 2013 AWRA Spring Specialty Conference on Agricultural Hydrology and Water Quality II – St. Louis, MO**



Questions?

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<http://www.manureadvisorysystem.wi.gov/app/runoffrisk>

