Quantitative Precipitation Forecast Challenges and Opportunities

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HPC Operations

Hydrometeorological guidance for:

- NWS field offices
- Other NCEP centers
- Federal/state agencies
- Aviation
- Media
- Private sector
- International partners
- Academic community
- General public

QPF

Winter Weather

Medium Range

Surface Analysis

Model Diagnostics

Short Term Weather

Alaska Med. Range

Daily Weather Map

Tropical

Motivation

Flooding is a leading cause of weather-related deaths

Nashville: May 1, 2010

Seattle: Jan 7, 2009
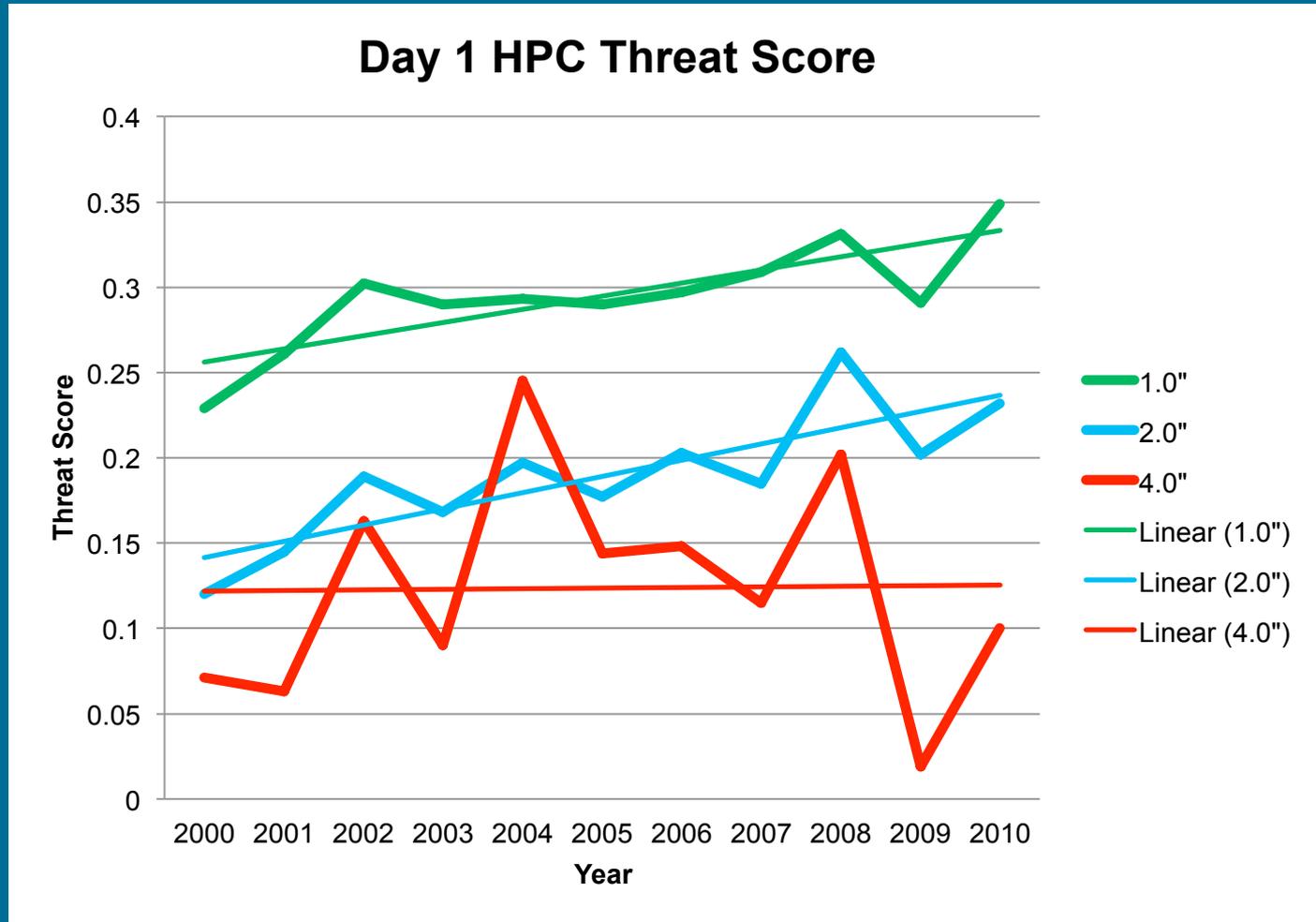

Atlanta: Sept. 21, 2009

"Improvements in QPF and mesoscale rainfall prediction need to be a top NWS research and training priority."
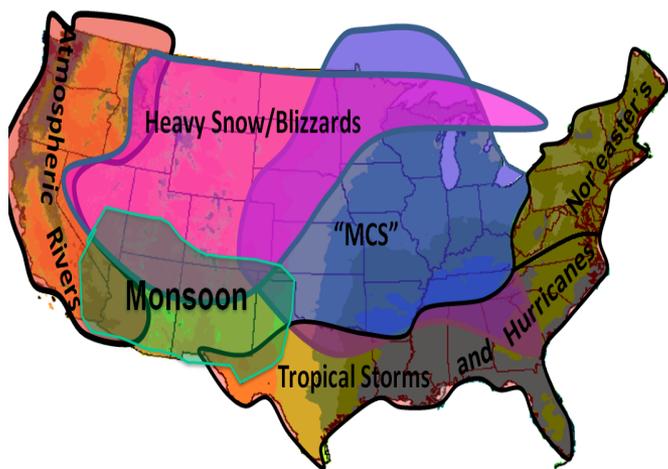
2009 SE US Flood Service Assessment

Extreme Events are Challenging

Forecast improvement of extreme events (4") lags improvement of more common events (1")

Day 1 HPC Threat Score
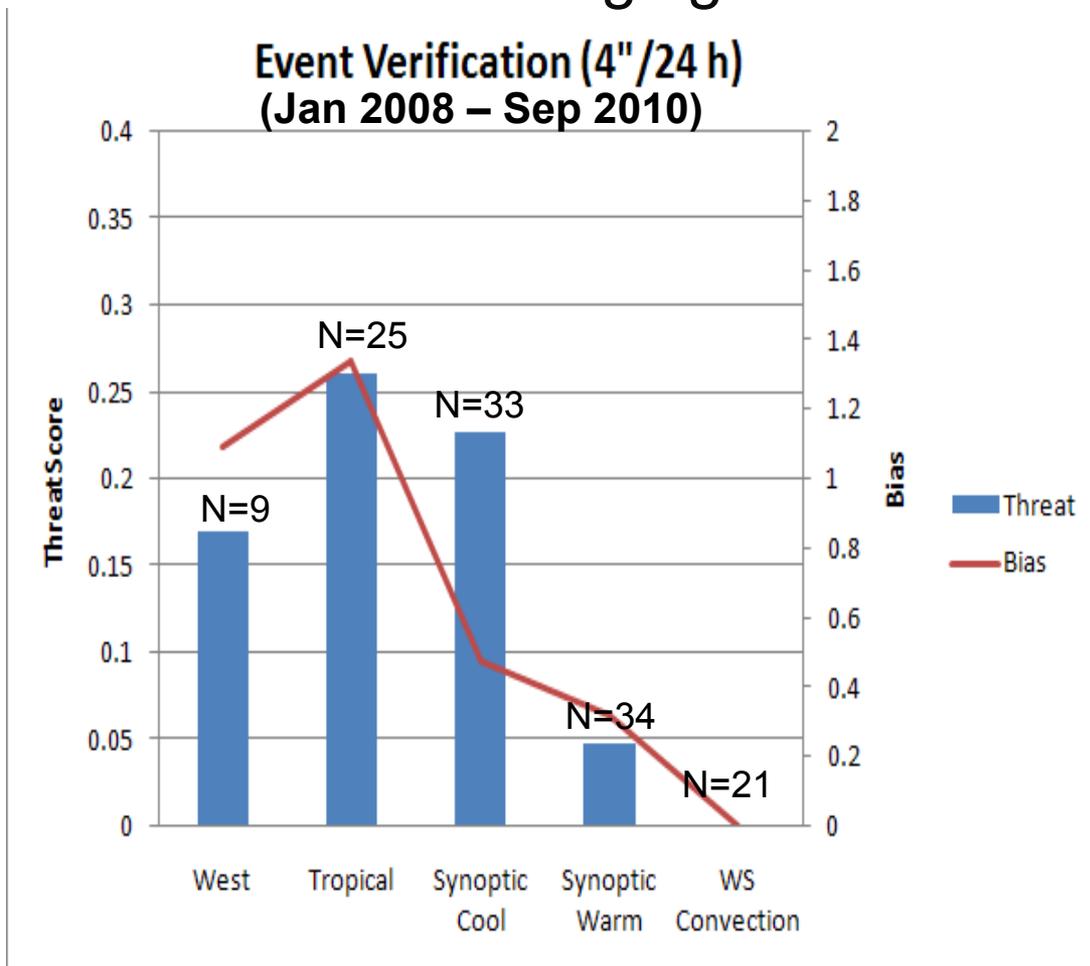
Predictability Varies by Event Type

Variety of extreme precipitation hazards

Best: Tropical

Worst: Warm Season Convection

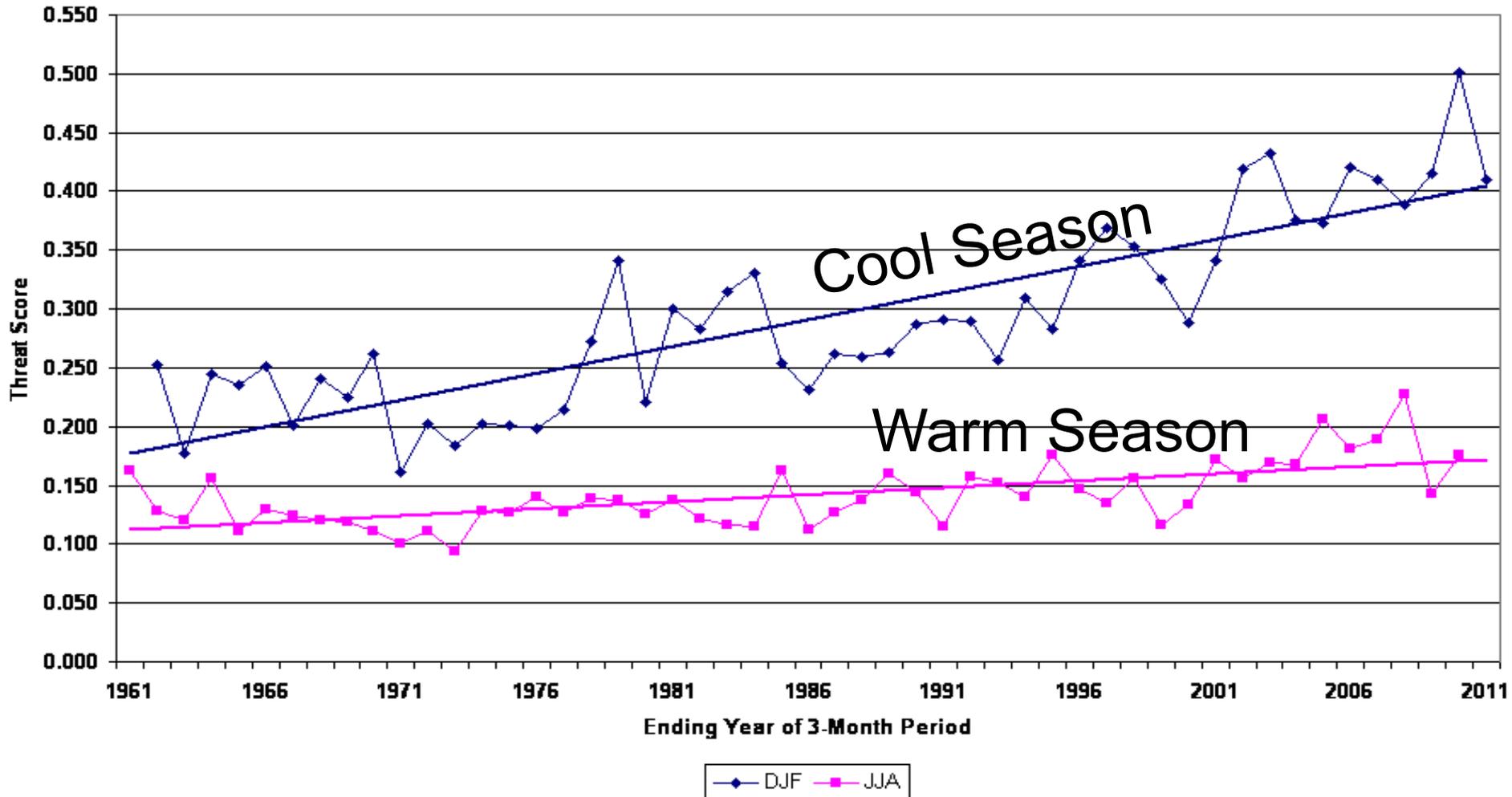**-All poorly forecast**
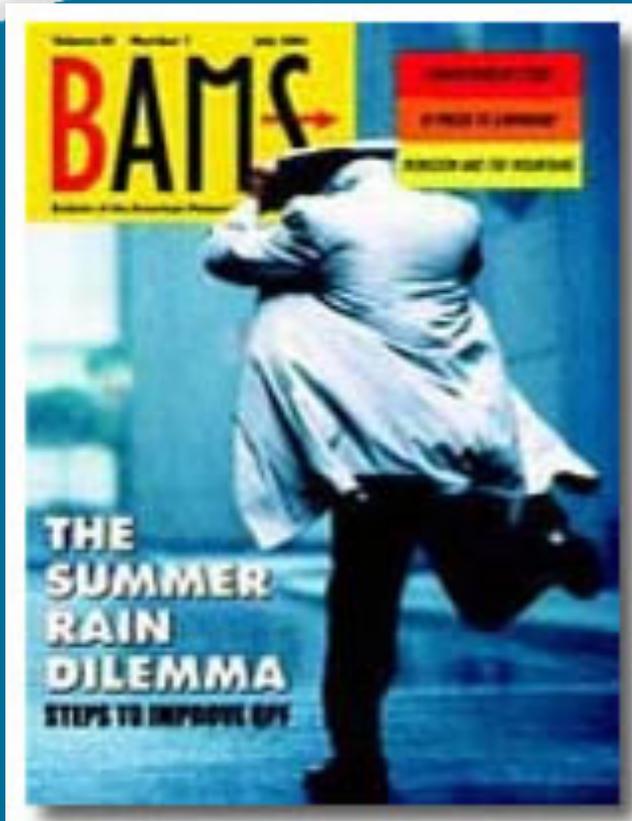-Some more challenging than others

Event Verification (4"/24 h)
(Jan 2008 – Sep 2010)

N=9
N=25
N=33
N=34
N=21

Threat
Bias

West Tropical Synoptic Cool Synoptic Warm WS Convection

QPF Improvement Gap

Threat Scores: 1-Inch QPF Day 1
Dec-Jan-Feb and Jun-Jul-Aug

Cool Season

Warm Season

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Improving Warm Season QPF
A multi-faceted problem

Fritsch and Carbone (2004)

Observations (Dual-Pol, Satellites, UAV)

Data Assimilation (EnKF)

Model & Ensemble System
- Resolution
- Physics
- Ensemble configurations

Post Processing (Bias-correction, etc)

Communicating Uncertainty

Critical Needs
- High Performance Computing
- Testbeds

Testbeds – A Continuing Success Story
Spring Experiment

HMT-HPC Leading QPF Component of Hazardous Weather Testbed Spring Experiment since 2010
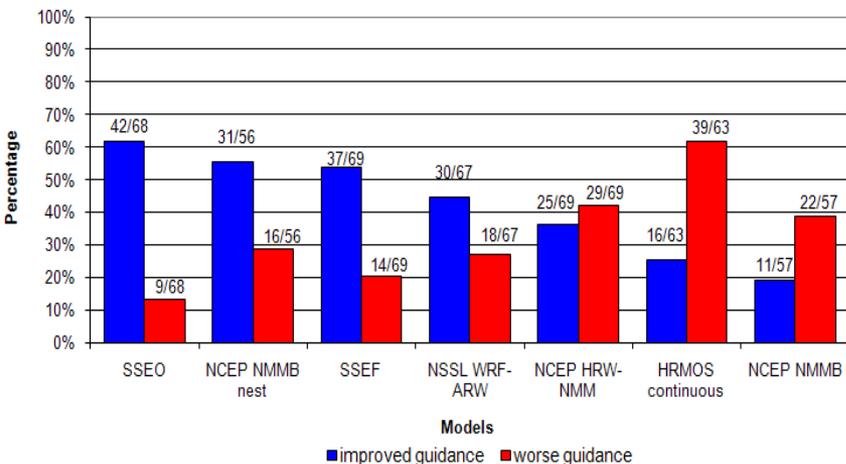
Partners: ESRL, SPC, OU, NSSL, DTC, GOES-R

QPF Goal: Do convection-allowing models improve warm season QPF?

- 3 components (Severe, Initiation, QPF)

- 5 week program (May 9 - June 10)

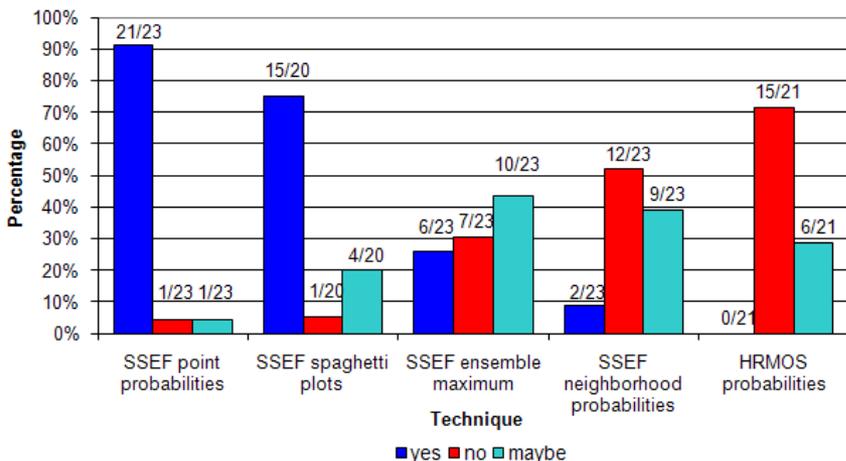- ~80 participants from research, academia, and operations
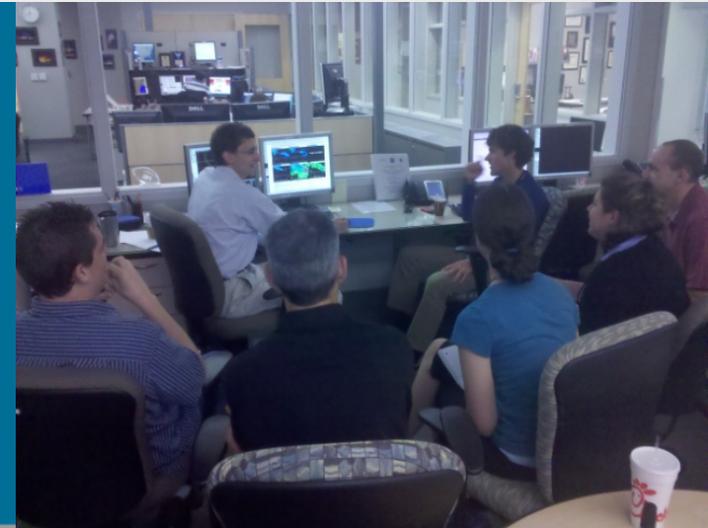
Preliminary 2011 Results

2011 HWT Spring Experiment
High Resolution Model Performance Compared to the NAM/SREF

2011 HWT Spring Experiment
Are Post-Processing Techniques Ready for Operational Implementation?

Skill varies widely among convection allowing-guidance

Best performing
-Parallel NAM nest (NMMBnest)
-"Poor man's" ensemble (SSEO)
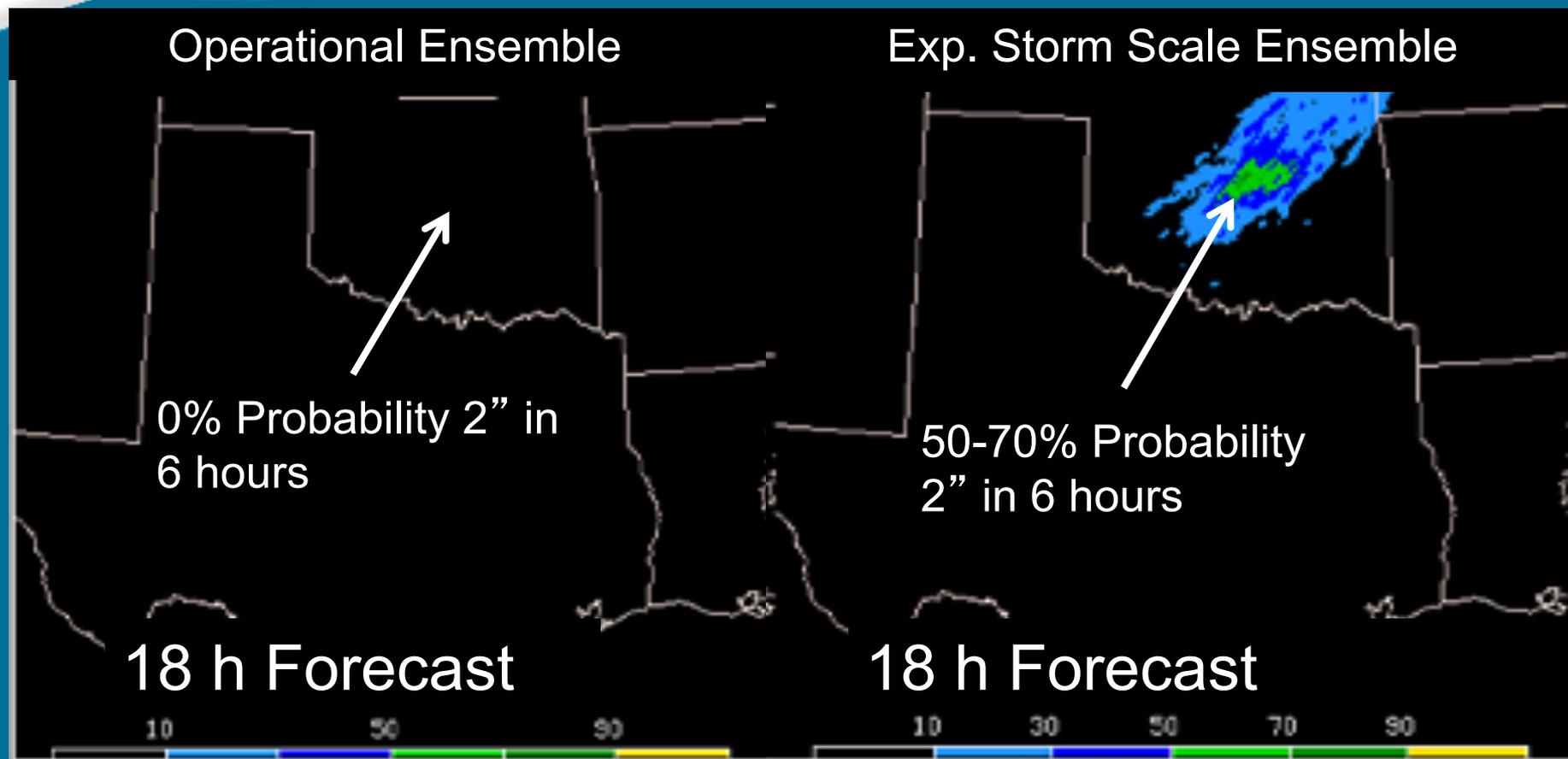-Storm Scale Ensemble (SSEF)

Visualizations tested
-Spaghetti plots to be adopted

Full Report: http://www.hpc.ncep.noaa.gov/hmt/ongoing_research.shtml

Warn-on-Forecast for Flash Floods
Oklahoma City, June 14, 2010

Operational Ensemble

Exp. Storm Scale Ensemble

0% Probability 2" in 6 hours

50-70% Probability 2" in 6 hours

18 h Forecast

18 h Forecast

Spring Experiment has demonstrated concept

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O2R-R2O

Convection-allowing runs being integrated into HPC operations via Hydrometeorological Testbed

547 AM EDT TUE JUL 20 2010
VERY FRUSTRATING QPF PATTERN…PIECES OF SHRTWV ENERGY FIRING CNVCTN WHICH THEN…BEGINS TO TAKE ON A LIFE OF ITS OWN…THE BULK OF MODEL GUIDANCE HAS WOUND UP BEING <u>TOO FAR NORTH</u> WITH THE AXIS OF HEAVIEST PCPN. **THE HI RES ARW HAS DONE A MUCH BETTER JOB THAN NCEP AND NON-NCEP MODEL SUITES IN SHOWING THIS SRN DISPLACEMENT**…

A Proposal

An Extreme Rainfall Improvement Analogy

- Extreme rainfall analogous to hurricane intensity problem
  - Deadly
  - Little progress made
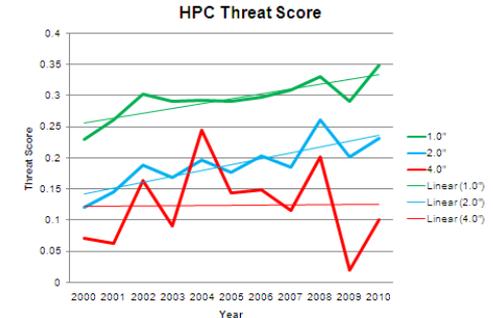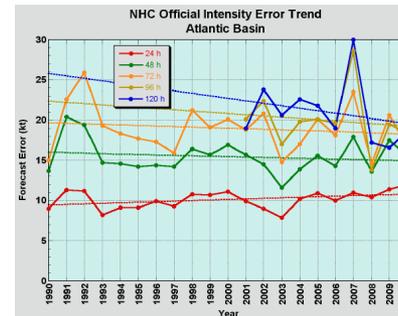
- NOAA Hurricane Forecast Improvement Project (HFIP)
  - Reduce track & intensity error 20% within 5 years
  - Catalyst & focusing mechanism for community
  - Uses testbeds embedded within operational center
  - Resourced
    - Solicit proposals on direct operational forecast challenges
    - Staffed to do testing and evaluation

Imagine the HFIP of Extreme Rainfall
Main Themes

- Focus community around ambitious operational goals
  - e.g., Double Extreme Rainfall Threat Score
  - e.g., Establish probabilistic QPF and services

- Focus relevant NOAA testbeds to support effort
  - Collaborative regional/ phenomenon-based experiments and demonstrations
  - Solicit proposals from research community
  - Embed within operational centers

- Build relevant IRWSS partnerships

- Resource the effort
  - High performance computing
  - Test and evaluation staff

Imagine the HFIP of Extreme Rainfall
Benefits

- Reduce deaths and damage associated with floods

- Advance the end-to-end prediction system
  observations → models → hydro forecasts → communication

- Build Warn-on-Forecast for Floods

- Improvements benefit other disciplines
  - If you improve extreme rainfall predictions, you likely improve aviation, severe, winter, and tropical weather predictions