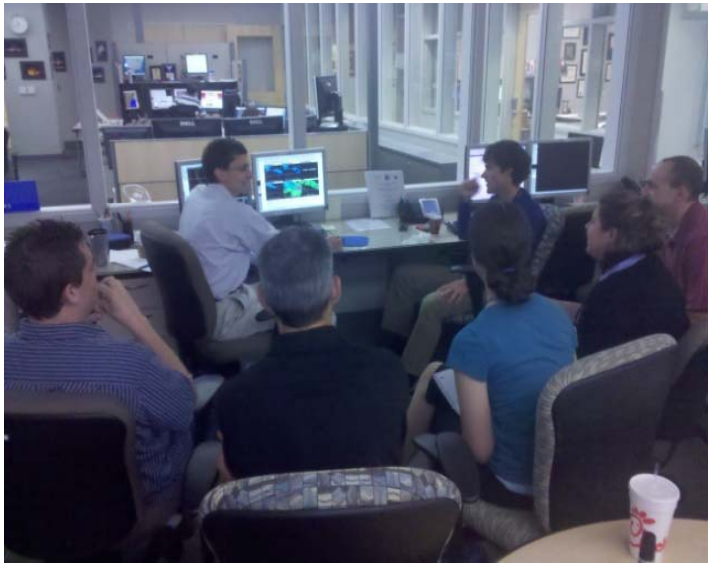
Where the Rubber Meets the Road:

The Hydrometeorological Testbed – HPC

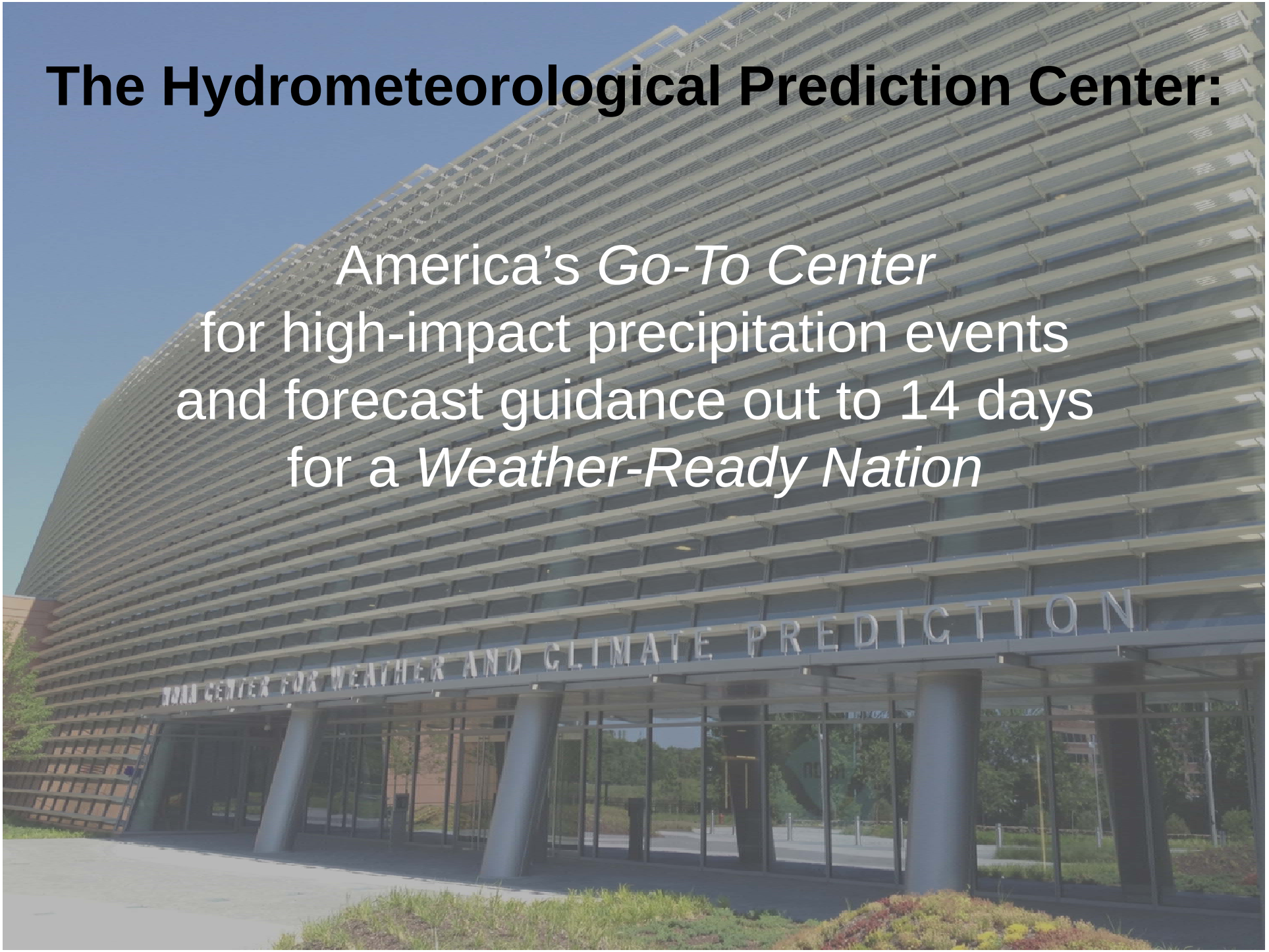


David Novak[1], Faye Barthold[2], Tom Workoff[3], Mike Bodner[1], and Wallace Hogsett[1]

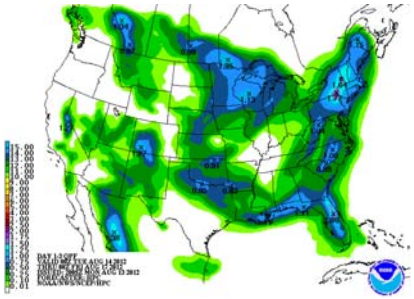
[1]NOAA/NWS/HPC
[2]I.M. Systems Group
[3]SRG

The Hydrometeorological Prediction Center:

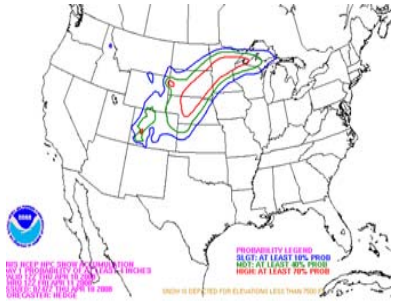
America's *Go-To Center*
for high-impact precipitation events
and forecast guidance out to 14 days
for a *Weather-Ready Nation*



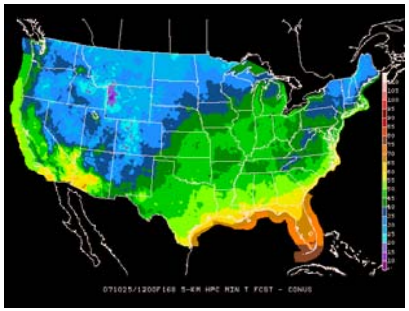
HPC Operations



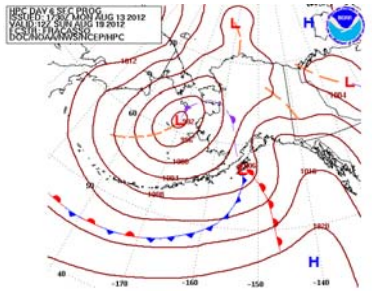
QPF



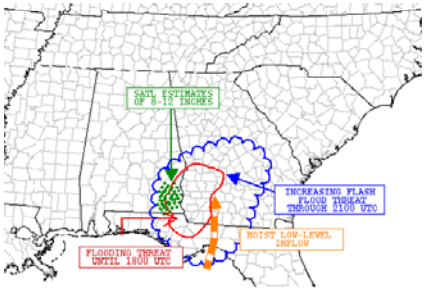
Winter Weather



Medium Range

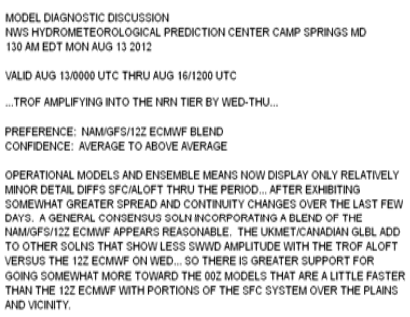


Alaska Med. Range



HPC MPD #0072

Met Watch



MODEL DIAGNOSTIC DISCUSSION
NWS HYDROMETEOROLOGICAL PREDICTION CENTER CAMP SPRINGS MD
130 AM EDT MON AUG 13 2012

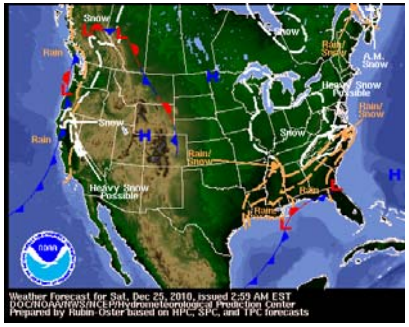
VALID AUG 13/0000 UTC THRU AUG 16/1200 UTC

...TROF AMPLIFYING INTO THE NRN TIER BY WED-THU...

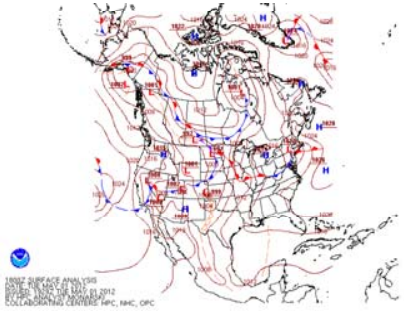
PREFERENCE: NAM/GFS/12Z ECMWF BLEND
CONFIDENCE: AVERAGE TO ABOVE AVERAGE

OPERATIONAL MODELS AND ENSEMBLE MEANS NOW DISPLAY ONLY RELATIVELY MINOR DETAIL DIFFS SFC/ALOFT THRU THE PERIOD... AFTER EXHIBITING SOMEWHAT GREATER SPREAD AND CONTINUITY CHANGES OVER THE LAST FEW DAYS. A GENERAL CONSENSUS SOLN INCORPORATING A BLEND OF THE NAM/GFS/12Z ECMWF APPEARS REASONABLE. THE UKMET/CANADIAN GLBL ADD TO OTHER SOLNS THAT SHOW LESS SWWD AMPLITUDE WITH THE TROF ALOFT VERSUS THE 12Z ECMWF ON WED... SO THERE IS GREATER SUPPORT FOR GOING SOMEWHAT MORE TOWARD THE 00Z MODELS THAT ARE A LITTLE FASTER THAN THE 12Z ECMWF WITH PORTIONS OF THE SFC SYSTEM OVER THE PLAINS AND VICINITY.

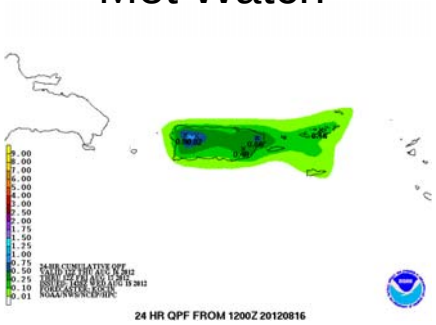
Model Diagnostics



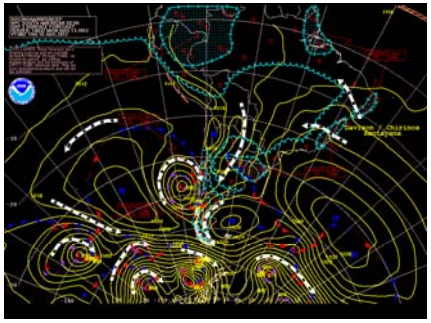
Short Range



Surface Analysis



Puerto Rico QPF



International

Tropical

NAM AIR QUALITY DIAGNOSTIC DISCUSSION
NWS HYDROMETEOROLOGICAL PREDICTION CENTER CAMP SPRINGS MD
1024 AM EDT FRI AUG 03 2012

...INTERIOR VALLEYS OF CALIFORNIA...

THE NAM INITIALIZED TEMPERATURES ON THE ORDER OF 10 TO 15 DEGREES TOO LOW IN THE SOUTHERN VALLEYS...ESPECIALLY NEAR MOJAVE AND PALM SPRINGS.

...NORTHERN TENNESSEE VALLEY...

THE RAINFALL ASSOCIATED WITH THE DECAYING MCS WAS NOT INITIALIZED WELL BY THE NAM ACROSS CENTRAL AND EASTERN TENNESSEE...AS THE MODEL WAS TOO LIGHT WITH THE RAINFALL COMPARED TO THE OBSERVED RADAR IMAGERY AND PRECIPITATION ESTIMATES.

Air Quality

HMT – HPC

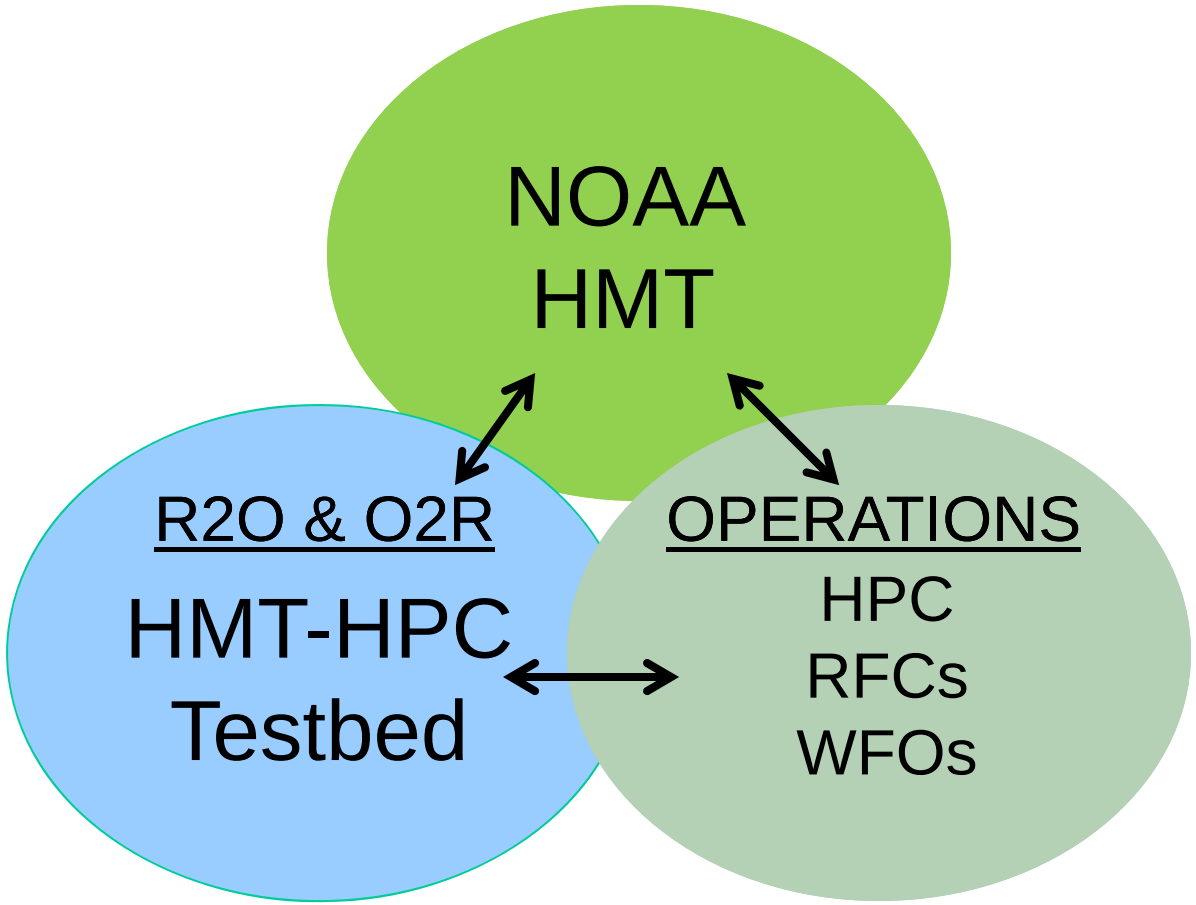
Description

A component of the NOAA HMT

Goal: Transfer science and technology innovations into operations to improve prediction of heavy precipitation

Roles:

- Identify and test new datasets to improve HPC forecasts
- Develop forecaster-relevant tools/techniques
- Provide training in new techniques to forecasters & researchers



Focus and Methods

Focus: Improve and extend prediction of heavy precipitation

Approach:

- Improve understanding of heavy precipitation phenomena
- Improve application of high-resolution and ensemble guidance

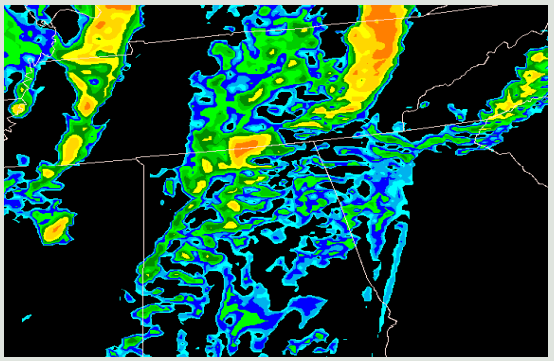
Real-Time Collaborative Experiments

Test New Datasets

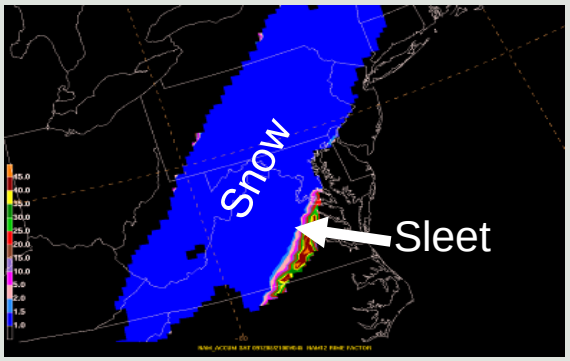
Develop New Tools/Techniques

Train Forecasters & Researchers

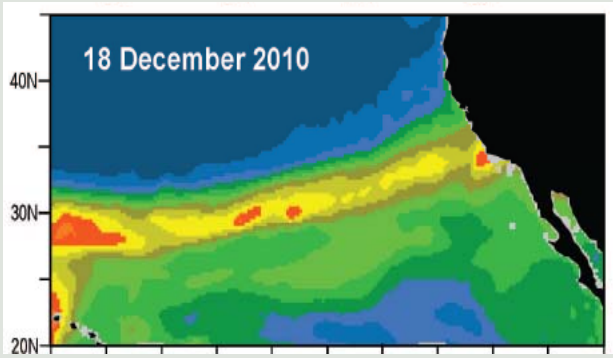
Warm-Season



Winter Weather



Atmospheric River



Warm Season Rainfall

MetWatch Desk Prototype

Many field office requests for enhanced guidance and situational awareness in developing flash flood situations

MetWatch Desk Prototype

In response, HPC prototyped a "Meteorological Watch" Desk from May 16–September 14, 2012

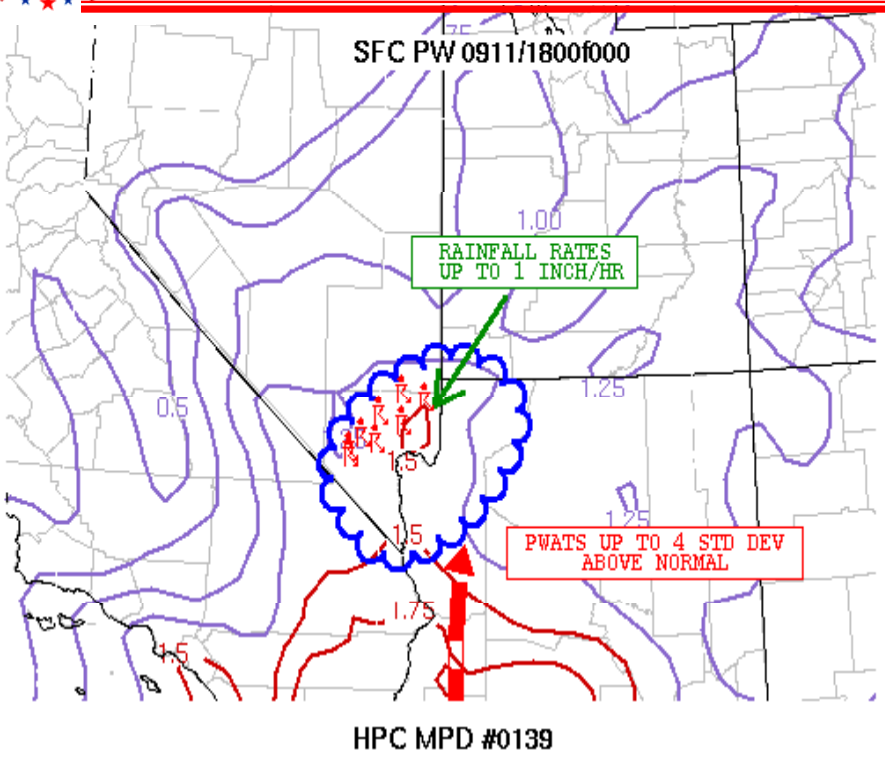
GOAL: Enhance NWS warning services by providing enhanced situational awareness of potential flash flood events.

HMT supported the science, datasets, staff training, and methodology of the prototype

"Would not have been possible without HMT effort"

(Ed Danaher – HPC Forecast Operations Chief)

MetWatch Desk Prototype



HPC MPD #0139

MESOSCALE PRECIPITATION DISCUSSION 0139
NWS HYDROMETEOROLOGICAL PREDICTION CENTER COLLEGE PARK MD
332 PM EDT TUE SEP 11 2012

AREAS AFFECTED...SERN NV...NWRN AZ

CONCERNING...HEAVY RAINFALL...FLASH FLOODING POSSIBLE

VALID 111930Z - 120130Z

PROTOTYPE FORECAST ONLY - THIS IS ONLY A TEST

...SLOW-MOVING CONVECTION WITH VERY HEAVY RAINFALL NEARING LAS VEGAS...

LATEST VIS SATELLITE IMAGERY SUGGESTS ROBUST SURFACE HEATING OVER FAR SERN NV...WITH AN INCREASINGLY AGITATED CU/TCU NOTED OVER THE LAST COUPLE OF HRS. STG DIURNAL HEATING SHOULD CONTINUE AND THIS COUPLED WITH AN ANOMALOUSLY MOIST BNDRY LAYER SHOULD WILL FOSTER ADDITIONAL CONVECTIVE DEVELOPMENT OVER THE NEXT SEVERAL HRS. THE CONVECTION WILL BE FURTHER AIDED BY STG MID/UPR LVL SHRTWV DYNAMICS ASSOC WITH THE ENERGY DIGGING SEWD OUT OF CNTRL CA. CONVECTIVE CELLS ARE EXPECTED TO BE SLOW-MOVING AND THERE WILL BE A THREAT OF CELL MERGERS WITH THE ACTIVITY LIKELY TO GRADUALLY ENVELOPE MUCH OF FAR SERN NV AND ALSO REDEVELOPING OVER PORTIONS OF NWRN AZ OVER THE NEXT COUPLE OF HRS. CONSEQUENTLY...EXPECT A THREAT FOR LOCALLY VERY HVY RAINFALL WHICH COULD RESULT IN AN ELEVATED FLASH FLOOD THREAT. PWATS BASED ON GOES-SOUNDER AND GPS DATA SOURCES ARE RUNNING CLOSE TO 4 STD DEV ABOVE NORMAL...AND THIS WILL CONTRIBUTE TO INTENSE AND LOCALLY EXCESSIVE RAINFALL RATES...UP TO 1 IN/HR.

ORRISON

Mesoscale discussions will:

- Cover events in the 1-6 hour period
- Be issued at the forecaster's discretion
- Focus on an evolving *flash flood threat*
- Be coordinated with WFOs, RFCs and NESDIS

FY13 MetWatch Desk Activites

Feedback was very positive

Begin experimental status in early Spring 2013

In the mean time…implement new tools and datasets to support effort

- -High Resolution Rapid Refresh
- -NSSL Q2 products
- -Flash Flood Verification

FY13 Heavy Rainfall and Flash Flood Experiment

July 2013

Goal:

Improve flash flood forecasts and decision support services through integration of meteorology and hydrology

Motivation:

Meteorology and Hydrology can work together to improve flash flood services

HPC responsible for:

- **National QPF and excessive rainfall forecasts**
- **Mesoscale Precipitation Discussions (MPDs)**

Partners:

NSSL

ESRL-PSD

NWS Regions

FY13 Heavy Rainfall and Flash Flood Experiment

GOALS

- **Explore the relationship between QPFs and hydrologic impacts to improve flash flood services.**
- **Assess the added value of experimental numerical guidance compared to operational guidance.**
  - Convection-allowing models
  - Radar assimilation
  - Statistical/dynamical approaches
- **Evaluate the use of FLASH and NSSL Q2 datasets**
- **Facilitate interactions among research scientists, model developers, and forecasters**
  - BOTH meteorology and hydrology

FY13 Heavy Rainfall and Flash Flood Experiment

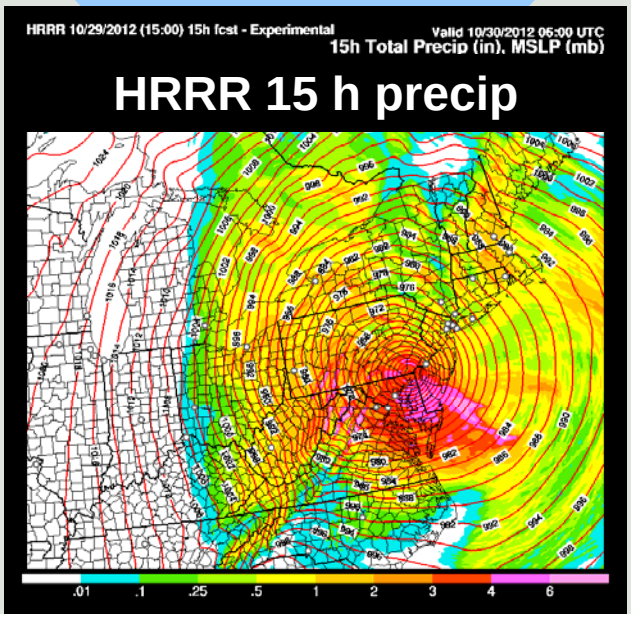
Meteorology

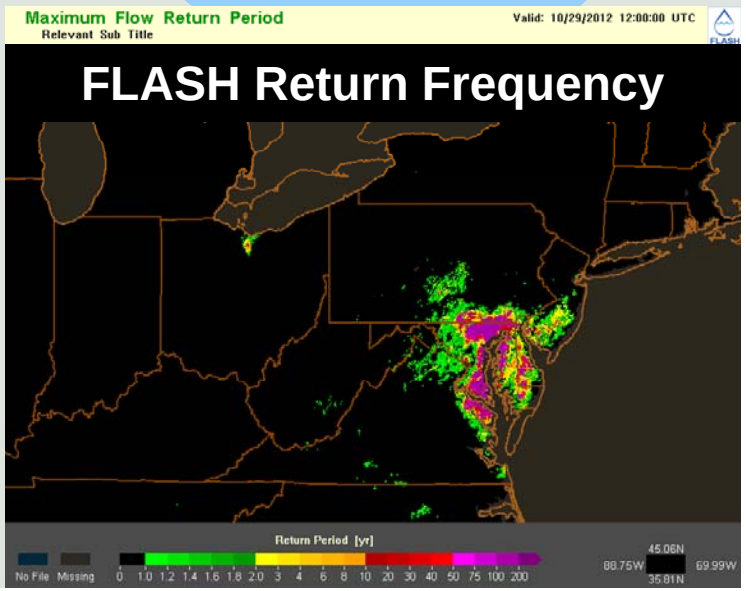
- Zero to 12 h probabilistic rainfall forecasts
- Satellite Nowcast
- MDL Nowcast
- HRRR

Probabilistic Flash Flood threat product

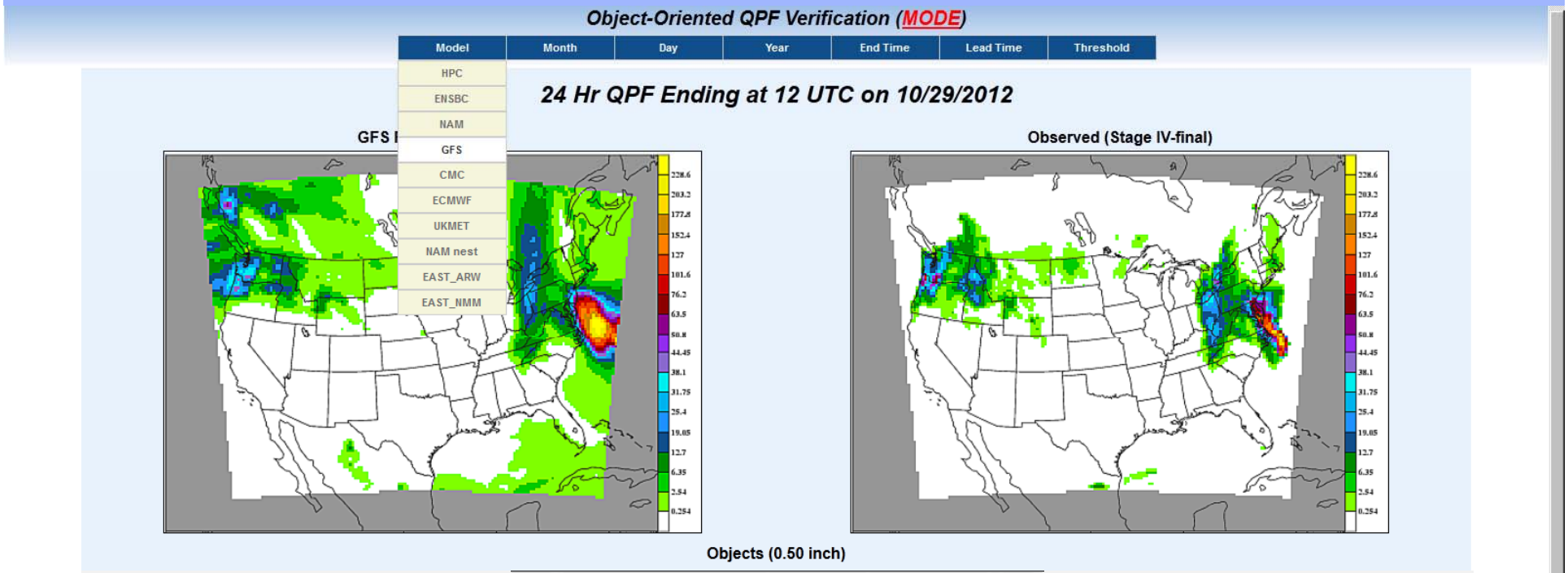
Hydrology

- QPE
- River Stages
- Flash Flood Guidance
- FLASH hydrologic model





Object-Oriented Verification



FY12 Activities

- Added 5 models
- Extended Verification to Day 3

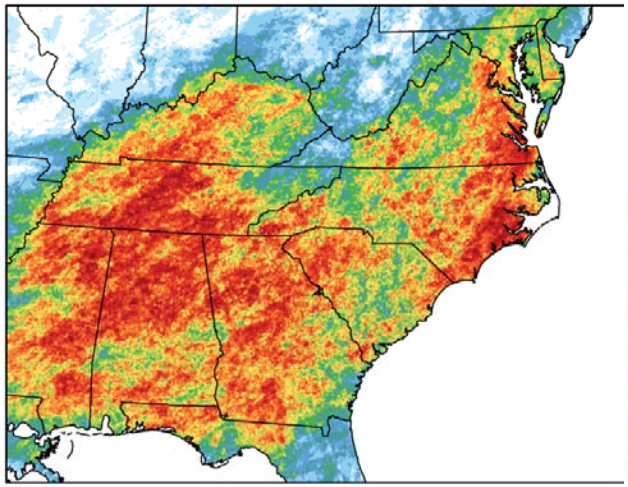
FY13 plans

- Add statistical information to website
- Continue to refine configuration
- Share configuration work with ESRL-PSD

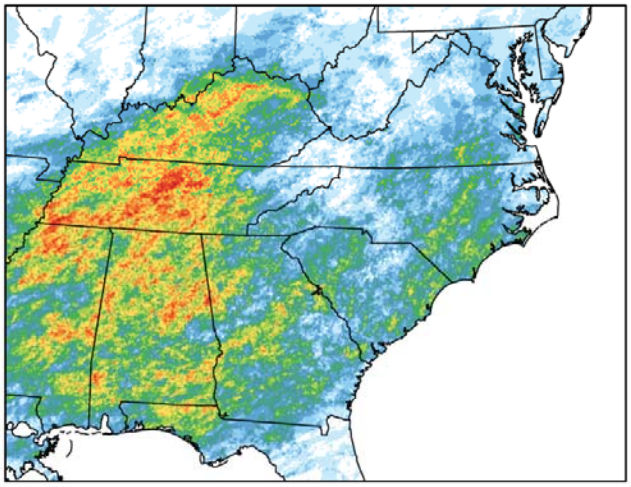
HMT-Southeast Collaboration

- Train forecasters on latest ESRL results
- Gather data and conduct analysis to support HMT effort
- Stay engaged with latest ESRL/NASA results (meetings, calls)

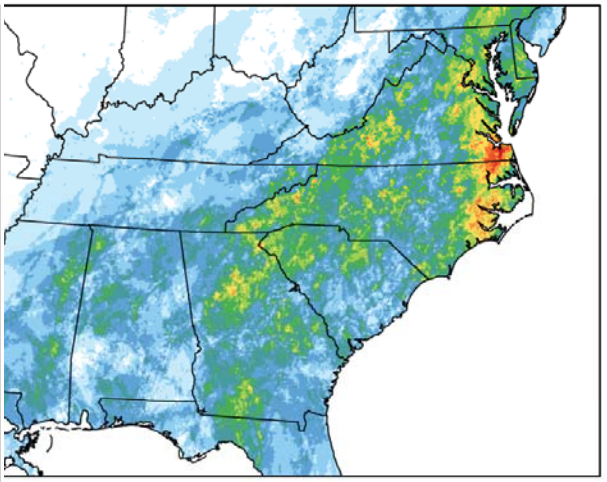
All events (N=182)

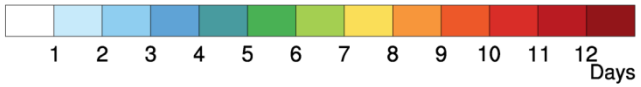


Nontropical events (N=131)



Tropical events (N=51)





Winter Weather

2012 Winter Weather Experiment

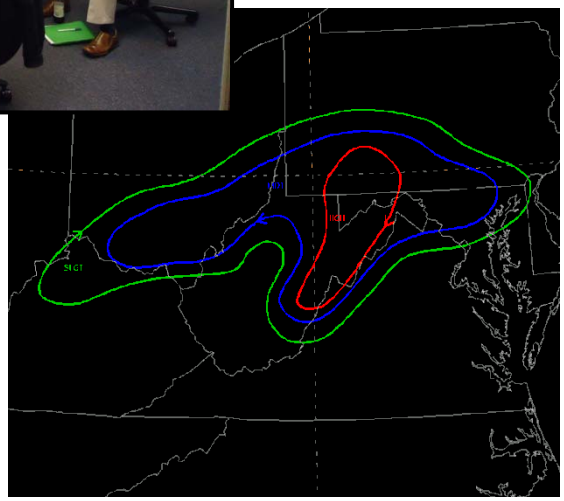
January 9 – February 10, 2012

Goal:

Explore the use of ensemble systems to better quantify and communicate uncertainty in winter weather forecasts

21 participants

- **Operations**
- **NOAA Research**
- **Academia**
- **Private Sector**

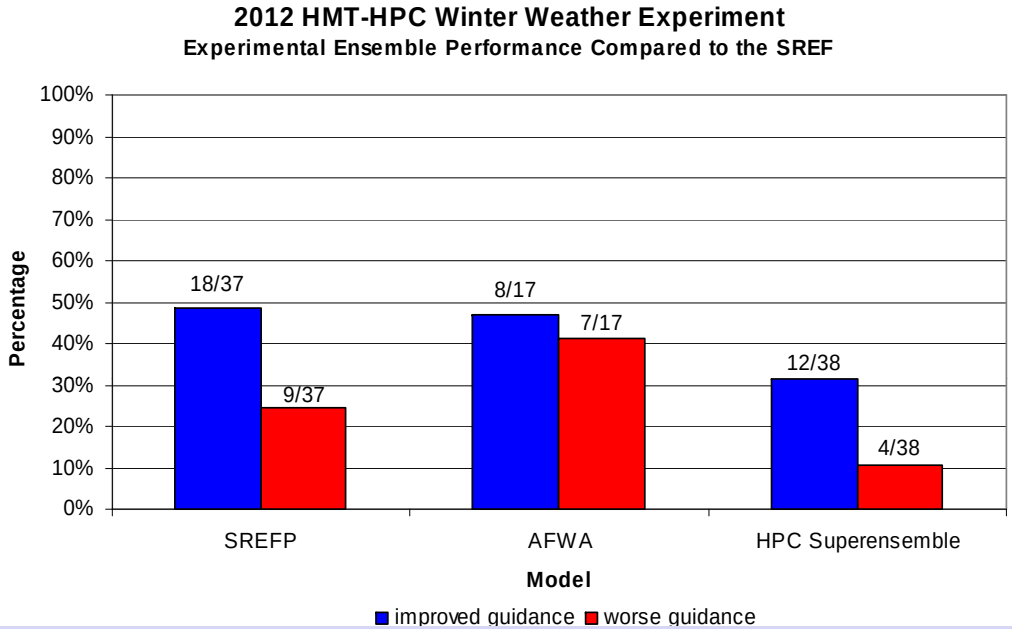


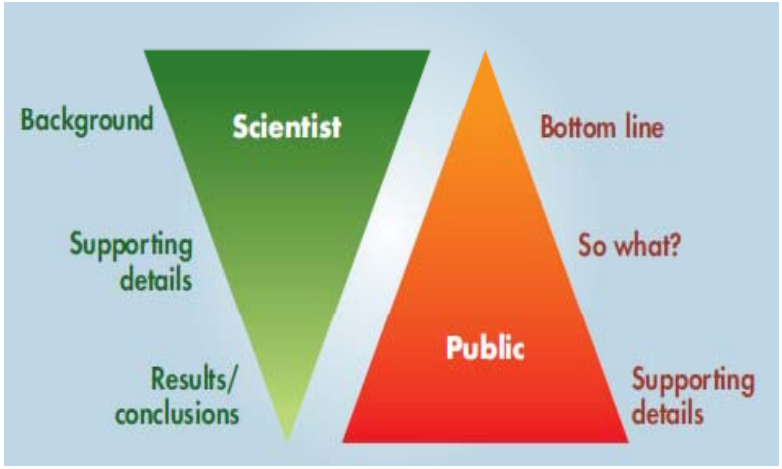
Activities:

- **Test NCEP parallel SREF ensemble**
- **Test AFWA storm scale ensemble**
- **Initiate collaboration with social scientists to improve communication**

2012 Winter Weather Experiment

January 9 – February 10, 2012





Operational Impacts

- NCEP Parallel SREF and AFWA storm scale ensemble provided useful and realistic forecast details, but tended to have a high bias

- Forecasters gained experience communicating uncertainty

- Participants struggled to differentiate between projecting authority in the delivery of their briefing, and conveying their level of forecast confidence.

2013 Experiment Plans

January 15 – February 15, 2013

Assess and quantify forecast uncertainty

- Evaluate experimental ensembles from AFWA
- Evaluate ensemble data-mining and post-processing techniques
  - Ensemble sensitivity (CSTAR – Stony Brook University)
  - European Extreme Forecast Index
  - SREF weighted mean

Begin exploration of extended winter weather forecasts (Day 4-5)

Evaluate explicit model snowfall accumulation techniques

- Use NAM microphysics to modify SLR

Improve decision support services

- Mock decision support briefings
  - WxEM social science research team

Participation – 5 weeks, new group each week

- WFO, NCEP, ESRL, academia

2013 Experiment Plans

Featured Datasets

	Provider	Model	Resolution	Forecast Hours	Notes
Operational	EMC	SREF (21 members)	16 km	87	Operational SREF
Operational	EMC	NAM	12 km (parent) 4 km (nest)	84 60	Operational NAM; includes 12 km parent model and 4 km nest
Operational	HPC	Autoensemble (28 members)	32 km	72	Composed of 21 SREF members, GEFS mean (2), ECMWF mean, and deterministic NAM, GFS, CMC, and ECMWF
Experimental	AFWA	WRF (10 members)	20 km	144	UKMET boundary and initial conditions
Experimental	AFWA	WRF (10 members)	4 km	72	Multi-physics, multi-initial condition convection-allowing ensemble
Experimental	EMC	NAMP	12 km (parent) 4 km (nest)	84 60	Pre-implementation version of the new NAM; includes 12 km parent model and 4 km nest

* all other operational guidance will also be available to the participants

Atmospheric Rivers

Atmospheric Rivers Retrospective Experiment

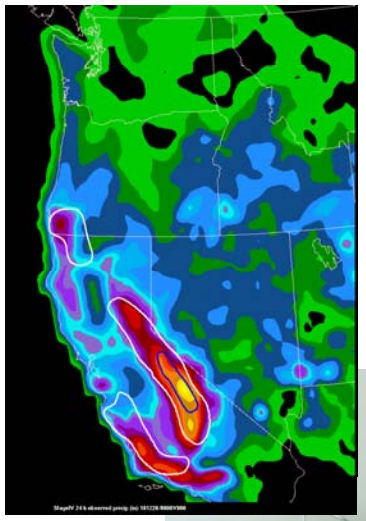
- Hosted 17 forecasters, researchers, and model developers at HPC
- Used 8 past cases over the 2008-2011 time period
- Verified using RFC precip analysis and HMT AR Observatories

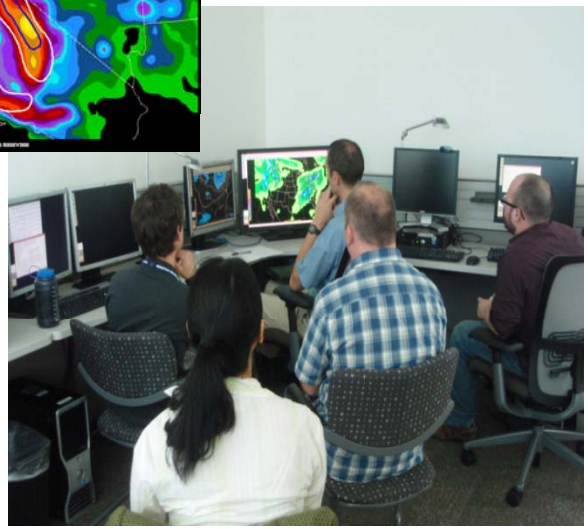
GOALS

Does the HMT-ensemble, multi-model ensemble, and reforecasting dataset improve extreme precipitation forecasts?

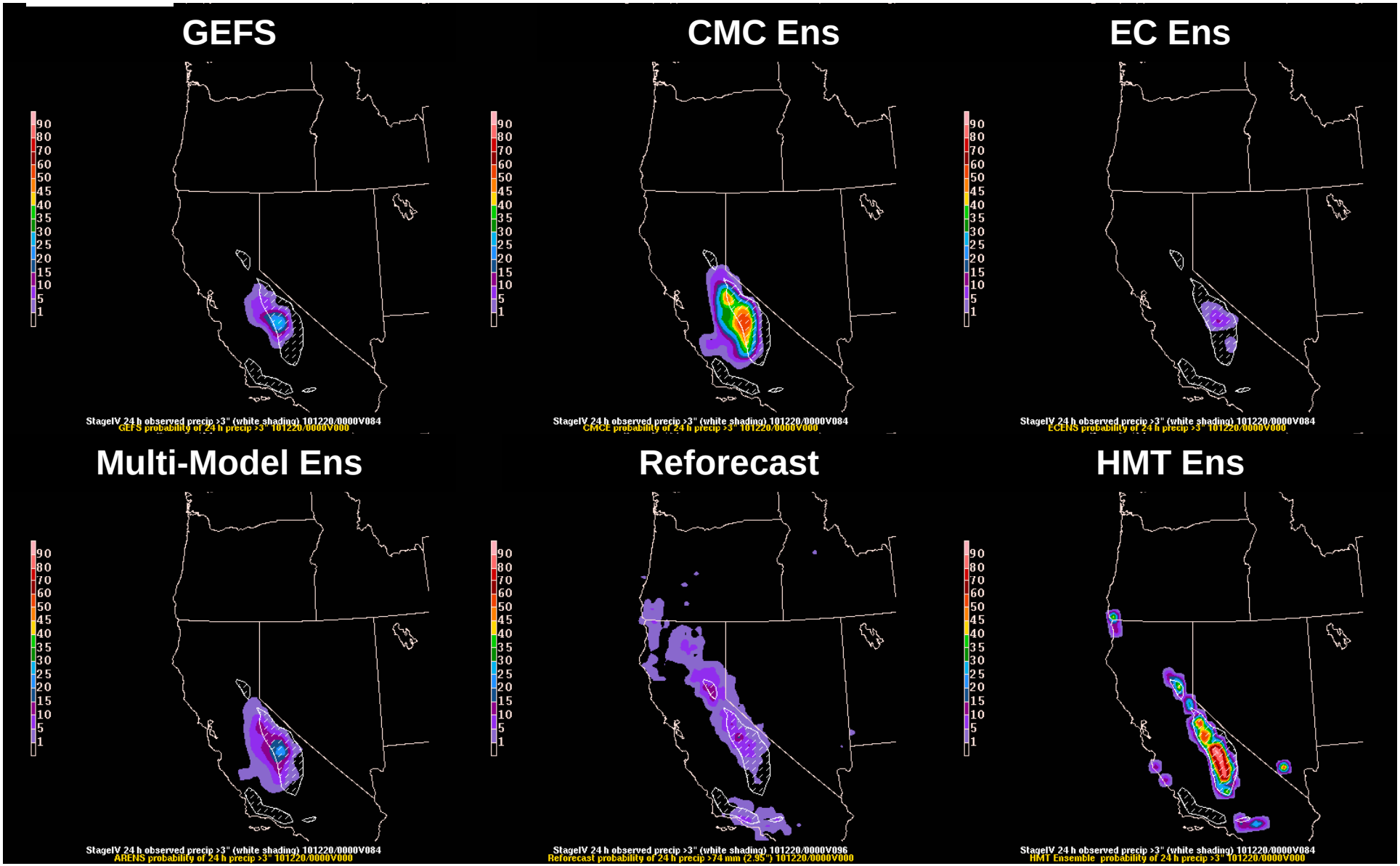
What are the strengths & weaknesses of current model guidance?

How can forecasters add value to extreme precipitation forecasts?

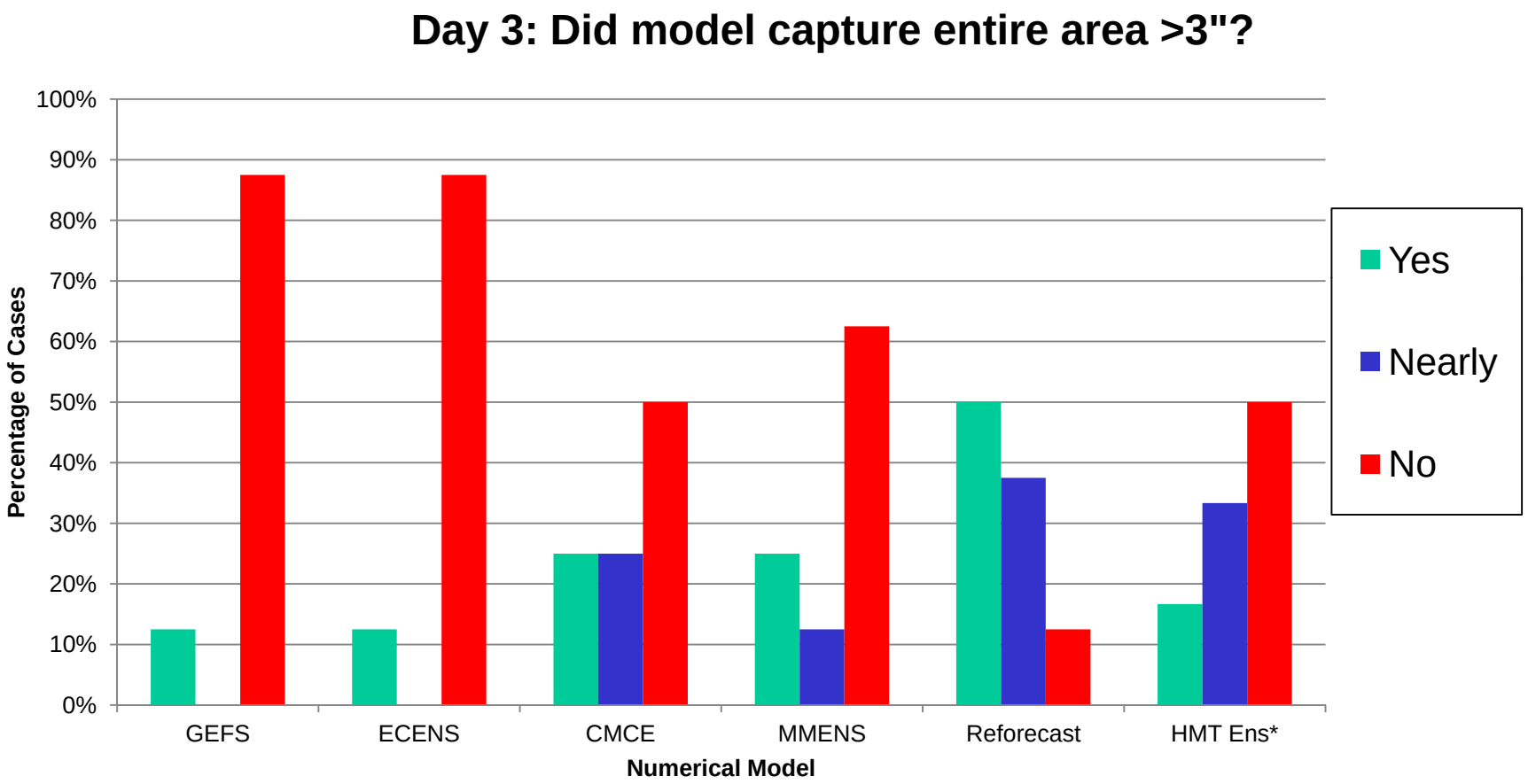




Atmospheric Rivers Retrospective Experiment



Atmospheric Rivers Retrospective Experiment



→ Reforecast deemed 'most helpful' in 6 cases

→ Reforecast and HMT-Ens consistently better than ECENS

Atmospheric Rivers Retrospective Experiment

- **Reforecast (PQPF) and HMT-ensemble data largely considered the best guidance**
  - HMT could be *too* wet (?)
- **Higher-resolution data is very beneficial in the West**
  - Resolution of global ensembles a detriment
  - Surprised by HMT & NAM performance
- **PQPF seems to be a worthwhile way to explore extreme QPF at mid-range lead times**
- **Several participants noted that their time in the experiment was beneficial: *interaction, discussion, training, additional insight, product development, etc….***

FY13 Plans

2012 Atmospheric River Experiment Follow-up

- **Need to get OAR Reforecast Dataset into Operations!**
- Analyze ARRFEX participant survey results (Lead: Tom Workoff)
- Conduct objective and spatial verification of the ARRFEX data (Lead: Ellen Sukovich)
- Continue to investigate the reforecast dataset for AR events and precipitation (Lead: Ben Moore)
- Investigate correlation between various model parameters and QPF duration, location, and intensity (Lead: Tom Workoff)
- Study MJO and AR relationships (Lead: Tom Workoff & Mike Bodner)

Operational Impacts

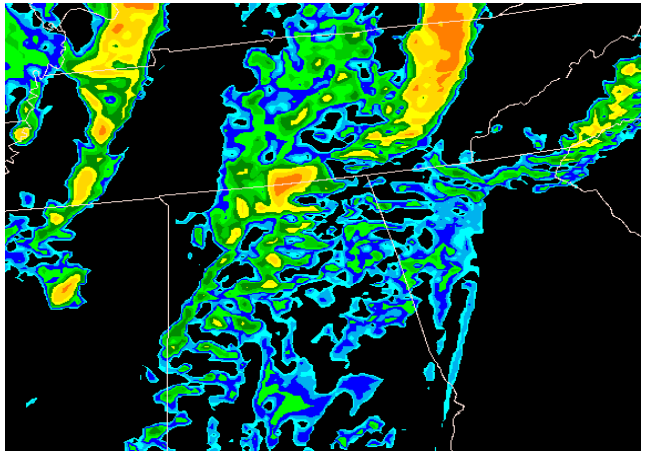
Operational Impacts

- Evaluated 11experimental modeling systems over last 3 years; 6 now used in operations

- Built forecaster “buy-in” for using high-res and ensemble data

- Create excitement by exposing forecasters & researchers to cutting-edge data
  - Staff view experiment participation as a reward (UCAR Review)

- Builds trust between researchers, developers, and forecasters
  - Catalyst for collaborative relationships



Challenges and Opportunities

Challenges and Opportunities

BUDGET

NWS travel restrictions and budget threaten WFO/RFC participation in testbed

- Winter Weather Experiment
- Flash Flood Experiment

Even 5-10K can promote an optimal mix of forecasters, researchers, and developers

Leveraging with other funded sources

- WxEM social science research team
- GOES-R
- NSSL

Challenges and Opportunities

Supporting the R2O Process

Operations sets a high bar. Candidate data or technique must be:

- Beneficial
- Efficient
- IT compatible
- Sustainable

Creating a dataset isn't enough – needs to be supported and follow through to implementation.

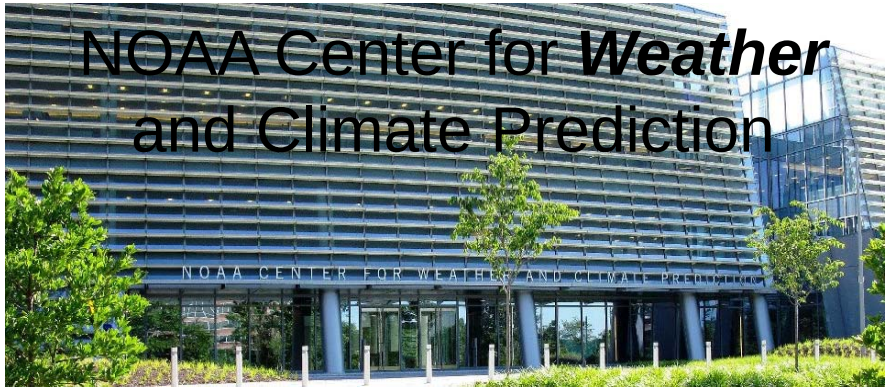
e.g. Reforecast dataset

Requires close NWS-OAR connection

Challenges and Opportunities

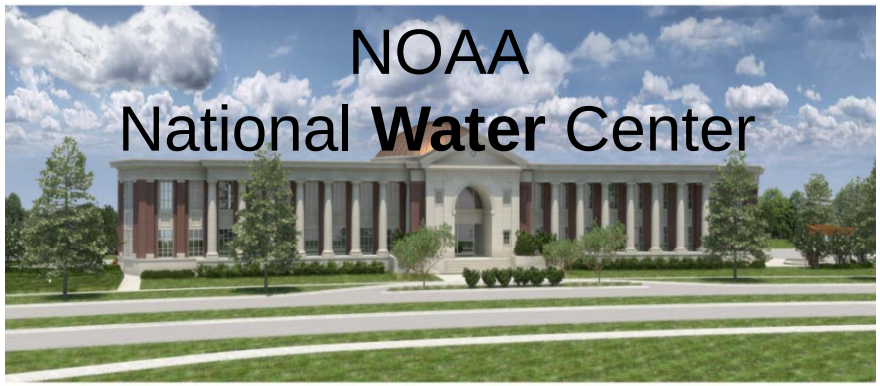
Weather – Water Connection

Weather



- Water in the air
- Meteorologists
- Forecasts to 8 days

Water



- Water in & on the ground
- Hydrologists
- Forecasts to months

Summary

HMT-HPC Testbed established to improve and extend prediction of heavy precipitation. Embedded with HPC operations.

Operations sets a high bar. Candidate data or technique must meet operational time constraints and IT requirements and improve forecast accuracy.

Warm-season, Winter, and Atmospheric River Experiments benefiting operations.

-Evaluated 11experimental modeling systems over last 3 years; 6 now used in operations

http://www.hpc.ncep.noaa.gov/hmt/

Backup

Success Criteria

"Is data/technique feasible for operations?"

- **Benefit:** expected improvement in operational forecast and/or analysis accuracy
- **Efficiency:** adherence to forecaster time constraints and ease of use needs
- **Compatibility:** IT compatibility with operational hardware, software, data, communications, etc.
- **Sustainability:** availability of resources to operate, upgrade, and/or provide support

2013 Winter Weather Experiment

Daily Activities

- Experimental forecasts
  - Probability of exceeding 2”, 4”, 8” of snow
    - Include freezing rain or higher snowfall thresholds as the situation warrants
  - Forecast confidence discussion
- Decision support
  - Public forecast graphic highlighting timing and location of winter weather hazards
  - Mock decision support briefing for emergency managers
- Day 4-5 winter weather outlook forecast
- Subjective model evaluation